T2K 3.010×10^{20}-POT 3-Flavour Muon-Neutrino Disappearance Analysis

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Abstract

We report the results of the *VaLOR* (Valencia-Lancaster-Oxford-Rutherford) 3-flavour ν_μ-disappearance analysis on the combined Run 1+2+3 dataset. This analysis is an update of the work presented in Refs. [1], [2] and [3] with improved methods and an enlarged dataset. The Run 1+2+3 dataset corresponds to an integrated J-PARC neutrino beam exposure of 3.010×10^{20} POT.

This analysis predicts 204.75 $\pm$ 16.75 (syst) 1 μ-like ring events in SuperK in the absence of any oscillation, but only 58 were observed. The observed deficit has a strong energy dependence; the ratio of observed to expected, under the no-oscillation hypothesis, is $\sim$30% $<$ 0.5 GeV, $\sim$10% between 0.5 and 1 GeV and $\sim$75% $>$ 1 GeV.

A ν_μ-disappearance analysis was performed in a framework of 3-flavour oscillations including matter effects in constant-density matter. Two versions of the oscillation fit were performed: one (the '2+N' fit) allows all 48 systematics considered in this analysis to float, while the other (the '2+8' fit) allows only the 8 most dominant systematics to float (the dominant systematics are those identified as having an effect on the measured oscillation parameters that is greater than 25% of the expected statistical error, for at least one set of true oscillation parameters in the area of interest).

The '2+N' 3-flavour ν_μ-disappearance fit to the observed reconstructed energy spectrum of 1 μ-like ring events of the combined Run1+2+3 dataset, assuming the first octant ($\sin^2 2\theta_{23} \leq 0.5$), with $\sin^2 2\theta_{23}$ constrained to the physical region, yields $|\Delta m^2_{32}|$ = 2.441×10^{-3} eV^2/c^4 and $\sin^2\theta_{23}$ = 0.514 as the best-fit values (p-value = 0.80). For the '2+N' fits for $\sin^2 2\theta_{23}$, assumming both the first ($\sin^2 2\theta_{23} \leq 0.5$) and second octant ($\sin^2 2\theta_{23} \geq 0.5$), the best-fit values are almost identical. All fits used 2012 PDG values for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} [21], and assumed δ_{CP}=0 and the normal mass hierarchy.

Confidence regions obtained using both the constant-$\Delta\chi^2$ method and the method of Feldman and Cousins are shown for both the '2+N' and '2+8' fits. Using the results of the '1+N' fits, and the constant-$\Delta\chi^2$ method, the 90% CL allowed region, for the '2+N' fit for $\sin^2\theta_{23}$, can be summarized as 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| < 2.72\times10^{-3}$ eV^2/c^4 and $0.397 < \sin^2\theta_{23} < 0.630$. The corresponding limits for the '2+N' fit assuming the first octant, can be summarized as 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| <$ 2.72×10^{-3} eV^2/c^4 and $\sin^2 2\theta_{23} >$ 0.958. The corresponding limits for the '2+N' fit assuming the second octant, can be summarized as 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| < 2.72\times10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23} >$ 0.931.

Contents

1. Introduction

In this technical note, we report the results of a 3-flavour ν_μ-disappearance analysis, performed by the Valencia-Lancaster-Oxford-Rutherford (VaLOR) group, on the combined Run1+2+3 (3.010×10^{20} POT) dataset. This dataset was collected in three run periods: in January 2010 - June 2010 (Run1, 0.323×10^{20} POT), in November 2010 - March 2011 (Run2, 1.108×10^{20} POT) and, following the recovery work from the damage of the 2011 Tohoku earthquake, in March 2012 - June 2012 (Run3, 1.579×10^{20} POT).

This analysis is an update of the work presented in Refs. [1], [2] and [3] with improved methods and an enlarged dataset. It benefits from an updated flux tuning based on recent NA61 data [9][20], as well as from T2K fits of flux and cross-section parameters to ND280 measurements of muon momentum-angle distributions of ν_μ CCQE-like and CCnonQE-like events whose vertices are in the FGD [14]. Details of our updated method for predicting the reconstructed energy spectrum of single μ-like ring events in SuperK are presented in Sec. 2.

The oscillation analysis is performed using neutrino oscillation probabilities computed in a 3-flavour framework including constant-density matter effects. Details of our oscillation probability calculations, estimates of the numerical accuracy of our calculations and comparisons with calculations used by the alternative T2K oscillation analyses, are given in Appendices A and B.

We consider a total of 48 efficiency, energy scale, neutrino flux, neutrino cross-section, initial-state nuclear environment and final-state rescattering systematics. These systematic parameters and their effects on the extrapolated single μ-like ring event reconstructed energy spectrum are described in Sec. 3. Further details of them are also given in Appendices E and F.

As in our previous analyses, the oscillation fit was made using the likelihood-ratio method [24]. The oscillation fitting method is presented in detail in Sec. 4.1, while the chosen goodness-of-fit test, suitable for the Run 1+2+3 statistics, is described in Sec. 4.2. The fitter performance was tested in detail using toy MC experiments and the results of these tests are presented in Sec. 4.3 and in Appendix H. The effect of systematic parameters on the oscillation fit was studied in detail. The results of this study are summarised in Sec. 4.4 and are shown, in more detail, in Appendix G.

We considered two versions of the fit: the first version allows all 48 systematic parameters to float and is denoted the '2+N' fit, while the second version allows only the 8 most dominant systematics to float (the '2+8' fit). These 8 dominant systematic parameters are those having an effect on the oscillation parameters greater than 25% of the expected statistical error, for at least one set of true oscillation parameters in the parameter range of interest. Results are presented both for '2+N' and '2+8' fits. Further details of our fit labeling scheme are given in Sec. 4.1.6.

The confidence regions were constructed, as in our previous analyses, using the Feldman-Cousins method [26] both for '2+N' and '2+8' fits. Systematic errors were included in the oscillation contours using the Cousins-Highland method (Bayesian integration) [27]. Contours constructed with the constant-$\Delta\chi^2$ method are also shown for both fits for comparison. In Sec. 4.5 we summarise both of these methods and clearly explain the exact methodology used for incorporating systematic errors.

Sensitivity studies are shown in Appendix C, and were performed using the complete VaLOR analysis with an integrated exposure of 3.010×10^{20} POT and for a grid of oscillation points around the 2012 MINOS [31] 90% CL region.

The results of the measurement of $\sin^2 2\theta_{23}$ / $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ using the Run1+2+3 dataset are given in Sec. 5.1 of this note for both '2+N' and '2+8' fits, while the goodness-of-fit tests are presented in Sec. 5.2. The best-fit spectra for all '2+N' and '2+8' fits to the Run 1+2, Run 3 and Run 1+2+3 datasets are shown in Sec. 5.3. The Feldman-Cousins and constant-$\Delta\chi^2$ confidence regions are shown, for both fits, in Sec. 5.5. Comparisons of our results obtained with different fits and with different methods for constructing confidence regions are presented in Sec. 5.6. In that section, we also show comparisons of our T2K Run 1+2+3 results with MINOS and SuperK results, as well as with the expected T2K sensitivity for an integrated exposure of 3.010×10^{20} POT. We present the VaLOR group prespective on the choice of primary result for the Run1+2+3 disappearance analysis in Sec. 5.7. Finally, a summary is given in Sec. 6.

2. Predictions of single μ-like ring event reconstructed energy spectrum in SuperK

2.1. Methodology

In this analysis, the oscillation parameters are determined by fitting the reconstructed energy (E_r) spectrum of 1-ring μ-like events observed at SuperK with the predicted spectrum. The predicted number $N_{SK;r}$ of 1-ring μ-like events in the r^{th} reconstructed energy bin is computed as follows:

$$N_{SK;r} = \sum_m \sum_t \sum_{r\prime} P_{m;t} \cdot T_{r;r\prime;f_{\Delta E}} \cdot S_{m;t;r\prime;\vec{f}} \cdot N^{MC}_{SK;m;r\prime;t}. \quad (1)$$

In Eq. 1, $N^{MC}_{SK;m;r\prime;t}$ is the input SuperK Monte Carlo (MC) template containing the number of events in the 1-ring μ-like MC sample with true reaction mode m, and found in the true energy bin t and the reconstructed energy bin $r\prime$. The construction of the nominal MC templates is discussed in Sec. 2.2. Both flux-tuning weights based on NA61 hadro-production data (see Sec. 2.3) and flux and cross-section tuning weights based on ND280 data (see Sec. 2.4) are applied to the nominal MC templates. $S_{m;t;r\prime;\vec{f}}$ is an overall, multiplicative, systematic error factor depending on the reaction mode m, the true energy bin t, the reconstructed energy bin $r\prime$ and a vector of nuisance (systematic) parameters $\vec{f}$. A complete desciption of the nuisance parameters considered in this analysis is given in Sec. 3. $T_{r;r\prime;f_{\Delta E}}$ is a transfer function describing the migration of events between the reconstructed energy bins r and $r\prime$ due to uncertainty in the SuperK reconstructed energy scale, expressed here in terms of the nuisance parameter $f_{\Delta E}$. Finally, $P_{m;t}$ is the 3-flavour oscillation probability applied in the true energy bin t of the SuperK MC template which corresponds to mode m. Application of the term $P_{m;t}$ is discussed in Sec. 2.5.

2.2. Construction of nominal SuperK Monte Carlo templates

The nominal SuperK 1-ring μ-like MC templates $N^{MC}_{SK;m;r;t}$ are constructed by applying the 1-ring μ-like selection cuts to the official SuperK MC samples. Details of the MC samples are given in Sec. 2.2.1. The calculation of the normalization of each MC sample is described in Sec. 2.2.2. The official 1-ring μ-like selection cuts are listed in Sec. 2.2.3. The list of MC templates used in this analysis is shown in Sec. 2.2.4, while the true and reconstructed energy binning of the templates is discussed in Sec. 2.2.5.

The nominal SuperK MC templates used in this analysis are shown in Appendix I.3.

2.2.1. Input Monte Carlo samples

This analysis uses the official 2011c SuperK MC sample [17], which was generated and processed at the Kamioka cluster. The following versions of software packages were used:

- JNUBEAM flux 2011a
- NEUT v5.1.4.1
- SKDETSIM-v12p80
- ATMPD-ap11c
- SKOFL-11c

Five MC samples were generated. Four of the samples (ν_μ, $\bar{\nu_\mu}$, ν_e and $\bar{\nu_e}$) were generated using the nominal JNUBEAM flux without oscillations. A fifth sample of ν_e interactions was also generated with the ν_μ flux. This fifth sample will be denoted the 'oscillated ν_e' sample (it corresponds to the 'signal-ν_e' sample in the ν_e-appearance analysis). Samples neglected would make a negligible contribution to the single μ-like ring sample as explained in the following subsections. All samples were generated including the neutrino flux estimates up to 30 GeV. The flux histograms used for neutrino event generation had 50 MeV bins.

2.2.2. Normalization of Monte Carlo samples

The normalization (integrated exposure in terms of POT) of each event sample is calculated from the number of events with a MC truth interaction vertex within the 22.5 kt fiducial volume.

$$N = \int dSdIdE \cdot \frac{d^3\Phi_{SK}}{dSdIdE_\nu} \cdot \sigma_{H_2O} \cdot \frac{N_A}{A} \cdot \rho \cdot L \quad (2)$$

where $d^3\Phi_{SK}/dSdIdE$ is the number of flux particles, for the given neutrino species, per neutrino energy bin dE_ν, per unit area dS and per POT, σ_{H_2O} is the total interaction cross section in water for the given neutrino species, I is the beam intensity in terms of POT, N_A is Avogadro's number, A is the mass number for water, ρ is the water density and L is the neutrino path length in the water volume. The results of this calculation are shown in Tab. 1 for all 5

Sample	Number of events /22.5 kt fiducial /10^{21} POT	Number of events generated	Number of events in fiducial volume	POT normalization
ν_μ	1418.68	1000000	634998	4.4760 $\times 10^{23}$
$\bar{\nu_\mu}$	48.6039	504000	319640	6.5762 $\times 10^{24}$
ν_e	28.312	1000000	633715	2.2383 $\times 10^{25}$
$\bar{\nu_e}$	2.98885	504000	319689	1.0696 $\times 10^{26}$
Oscillated ν_e	1490.15	504000	320252	2.1491 $\times 10^{23}$

Table 1: Statistics and normalization of input SuperK MC samples.

SuperK MC samples along with the generated statistics, the numbers of events within the 22.5 kt fiducial volume and the derived POT normalization of each sample in terms of POT.

After being generated from a MC sample corresponding to a calculated integrated beam exposure I, each MC template is normalized to the integrated beam exposure of the Run1+2+3 dataset (3.010×10^{20} POT) by scaling the bin contents of the template with 3.010×10^{20}/I.

2.2.3. *Single μ-like ring event selection cuts*

The SuperK MC templates contain events from the ν_μ, $\bar{\nu_\mu}$, ν_e, $\bar{\nu_e}$ and oscillated ν_e samples passing the standard SuperK selection cuts for 1 μ-like ring events. These cuts are:

- the number of PMT hits in the highest-charge OD cluster is less than or equal to 15, and the event passes the flasher rejection cuts (`evclass == 1`),
- the reconstructed vertex is at least 2 metres away from the ID wall (`wall > 200`),
- the visible energy in the event is above 30 MeV (`evis > 30`),
- there is exactly 1 reconstructed ring in the event (`nring == 1`),
- the reconstructed ring is μ-like (`ip[0] = 3`),
- the reconstructed muon momentum is above 200 MeV (`amomm[0] > 200`), and
- there is at most 1 decay e^- in the event (`nmue <= 1`).

2.2.4. *List of Monte Carlo templates*

For each SuperK MC sample, a number of different MC templates is constructed corresponding to different true reaction modes. The template granularity depends on the type of oscillation analysis and the specific systematic parameters considered in the analysis. 12 MC templates were used for our 2010 Run1+2 2-flavour disappearance analysis [2], while 15 MC templates were used for our 2010 Run1+2 3-flavour disappearance analysis [3]. This analysis uses the following 28 MC templates:

- ν_μ CCQE
- ν_μ CC1π,
- ν_μ CC coherent,
- ν_μ CC other,
- ν_μ (and $\rightarrow \nu_e$, ν_τ) NC1$\pi^\pm$,
- ν_μ (and $\rightarrow \nu_e$, ν_τ) NC other,
- $\bar{\nu}_\mu$ CCQE,
- $\bar{\nu}_\mu$ CC1π,
- $\bar{\nu}_\mu$ CC coherent,

- $\bar{\nu}_\mu$ CC other,
- $\bar{\nu}_\mu$(and $\rightarrow \bar{\nu}_e$, $\bar{\nu}_\tau$) NC1$\pi^\pm$,
- $\bar{\nu}_\mu$(and $\rightarrow \bar{\nu}_e$, $\bar{\nu}_\tau$) NC other,
- ν_e CCQE,
- ν_e CC1π,
- ν_e CC coherent,
- ν_e CC other,
- ν_e (and $\rightarrow \nu_\mu$, ν_τ) NC1$\pi^\pm$,
- ν_e (and $\rightarrow \nu_\mu$, ν_τ) NC other,
- $\bar{\nu}_e$ CCQE,
- $\bar{\nu}_e$ CC1π,
- $\bar{\nu}_e$ CC coherent,
- $\bar{\nu}_e$ CC other,
- $\bar{\nu}_e$ (and $\rightarrow \bar{\nu}_\mu$, $\bar{\nu}_\tau$) NC1$\pi^\pm$,
- $\bar{\nu}_e$ (and $\rightarrow \bar{\nu}_\mu$, $\bar{\nu}_\tau$) NC other,
- Oscillated ν_e CCQE,
- Oscillated ν_e CC1π,
- Oscillated ν_e CC coherent and
- Oscillated ν_e CC other

In the standard 3-flavour oscillation framework, oscillations of ν_e and ν_μ can yield ν_τ, while oscillations of $\bar{\nu}_e$ and $\bar{\nu}_\mu$ can yield $\bar{\nu}_\tau$. In this analysis, we neglect contributions from ν_τ-CC and $\bar{\nu}_\tau$-CC as their energy threshold is around 3.5 GeV and their effect is negligible. Accordingly, this analysis uses no ν_τ-CC and $\bar{\nu}_\tau$-CC MC templates (and, in fact, no ν_τ and $\bar{\nu}_\tau$ SuperK MC samples are available).

It should be emphasized here that the ν_μ NC MC templates for a mode m are proxies for the NC MC templates for the mixture of ν_e+ν_μ+ν_τ resulting from 3-flavour ν_μ oscillations for that mode m. The same applies to the $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ NC MC templates. These NC MC templates are unchanged under standard 3-flavour oscillations (see also Sec. 2.5).

Also it should be noted that there are no explicit NC MC templates made from the oscillated ν_e sample. If they were used, the oscillated ν_e (i.e. ν_e coming from ν_μ oscillations) would be double counted since they are already included in the ν_μ NC MC templates.

2.2.5. Binning of Monte Carlo templates

Each of the 28 MC templates has 6132 2-dimensional bins (= 84 true energy bins $\times$ 73 reconstructed energy bins). The 84 true energy bins are arranged as follows:

- 6 50-MeV bins from 0-0.3 GeV,
- 28 25-MeV bins from 0.3-1 GeV,
- 40 50-MeV bins from 1-3 GeV,
- 5 100-MeV bin from 3-3.5 GeV,
- 1 bin from 3.5-4 GeV,

- 1 bin from 4-5 GeV,
- 1 bin from 5-7 GeV,
- 1 bin from 7-10 GeV and
- 1 bin from 10-30 GeV.

The 73 reconstructed energy bins are the following:

- 60 50-MeV bins from 0-3 GeV,
- 4 250-MeV bins from 3-4 GeV,
- 4 500-MeV bins from 4-6 GeV,
- 4 1000-MeV bins from 6-10 GeV and
- 1 bin from 10-30 GeV.

The same reconstructed neutrino energy binning is used for the fit of the 1-ring μ-like reconstructed energy spectrum.

A study was performed to decide the optimum binning scheme balancing the needs for accuracy and speed. Details are given in Appendix I.1-I.2.

2.3. Applying flux tuning based on NA61 data

In this analysis, the nominal MC templates, which were constructed using a MC event sample generated with 11a flux, are reweighted to the *2011b_v3.2_run1-3c* flux which was tuned on NA61 hadroproduction measurements [9][20]. The reweighted MC templates are denoted the *NA61-tuned* MC templates in this document. The applied weights, as a function of the true neutrino energy, were obtained from [18] and are shown in Figs. 1-4. The effect of this flux tune on the predicted reconstructed energy spectrum of single μ-like ring events is discussed in Sec. 2.6 (see Figs. 8 and 10, and Tabs. 2 and 3)

2.4. Applying flux and cross-section (BANFF) tuning based on ND280 data

This analysis uses the flux and cross-section parameter tuning performed by the beam and ND280 flux extrapolation task force (BANFF). The BANFF fit combines constraints on the beam flux from the beam monitors and NA61, constraints on interaction cross sections from external data (e.g. MiniBooNE) and ND280 measurements of ν_μ CCQE-like and CCnonQE-like events with vertices in the FGD fiducial volume. This fit provides estimates of flux and cross-section parameters and their correlations; it also reduces the uncertainties in parameters that are expected to have some cancellation between the ND280 and SuperK compared with their uncertainties from external data. Version 8 of the BANFF fit is used in this analysis [14]. A list of BANFF parameters and their best-fit values is shown in Tab. 6.

This analysis reweights the NA61-tuned MC templates to the BANFF best-fit parameters [1] [2]. The MC templates obtained are referred to, in this document, as the *BANFF-tuned* MC templates. The effect of the BANFF tune on the predicted reconstructed energy spectrum of single μ-like ring events is discussed in Sec. 2.6 (see Figs. 9 and 11, and Tabs. 2 and 3).

2.5. Applying neutrino oscillations

Oscillation probabilities are computed in a 3-flavour framework including matter effects in constant density matter (assuming an Earth crust density of 2.6 g/cm^3). Custom oscillation probability calculation code was developed within the VaLOR analysis framework. Details and estimates of the numerical accuracy of this code were first presented in [3] and, for completeness of the present VaLOR analysis paper, they are given again in Appendix A. Comparisons between the VaLOR oscillation probability calculation code and Prob3++ [44], which is typically used by the alternative T2K oscillation analyses, are shown in Appendix B.

[1] The BANFF group performed its fit using an NA61-tuned flux (*2011b_v3.2_run1-3c*), the same one used for reweighting our nominal MC templates in Sec. 2.3.

[2] Reweighting the MC templates to the BANFF best-fit parameters is, in effect, a "special" systematic variation. Therefore, more details on are presented in the section detailing the systematic parameters considered in this analysis (Sec. 3).

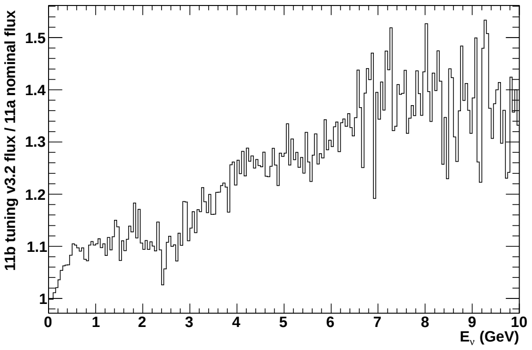

Figure 1: ν_μ 2011b_v3.2_run1-3c flux tuning weights applied to nominal ν_μ and oscillated-ν_e MC templates.

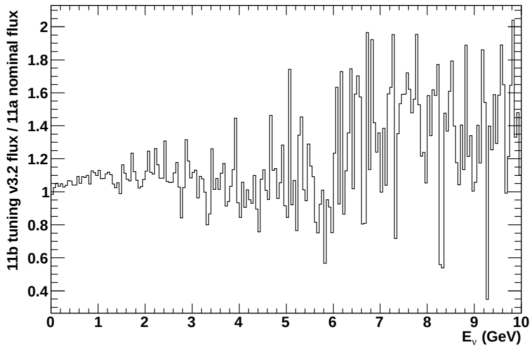

Figure 2: $\bar{\nu_\mu}$ 2011b_v3.2_run1-3c flux tuning weights applied to nominal $\bar{\nu_\mu}$ MC templates.

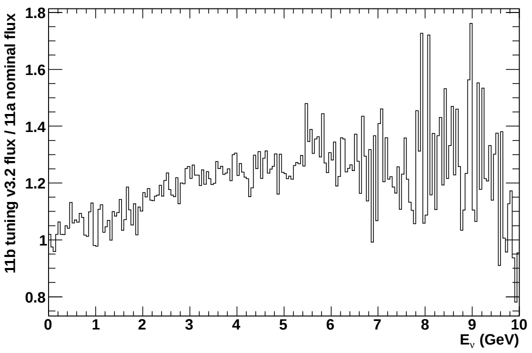

Figure 3: ν_e 2011b_v3.2_run1-3c flux tuning weights applied to nominal ν_e MC templates.

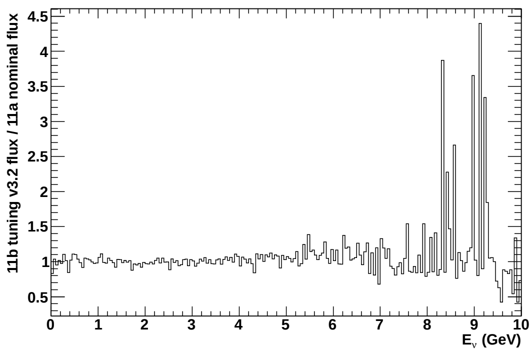

Figure 4: $\bar{\nu_e}$ 2011b_v3.2_run1-3c flux tuning weights applied to nominal $\bar{\nu_e}$ MC templates.

Oscillations are applied as a function of true energy to the ν_μ CCQE, ν_μ CC1π, ν_μ CC coherent, ν_μ CC other, $\bar{\nu}_\mu$ CCQE, $\bar{\nu}_\mu$ CC1π, $\bar{\nu}_\mu$ CC coherent, $\bar{\nu}_\mu$ CC other, ν_e CCQE, ν_e CC1π, ν_e CC coherent, ν_e CC other, $\bar{\nu}_e$ CCQE, $\bar{\nu}_e$ CC1π, $\bar{\nu}_e$ CC coherent, $\bar{\nu}_e$ CC other, oscillated ν_e CCQE, oscillated ν_e CC1π, oscillated ν_e CC coherent and oscillated ν_e CC other MC templates.

The MC templates constructed from the unoscillated MC samples are weighted with the corresponding survival probability: The ν_μ templates are weighted with P($\nu_\mu \to \nu_\mu$), the $\bar{\nu}_\mu$ templates with P($\bar{\nu}_\mu \to \bar{\nu}_\mu$), the ν_e templates with P($\nu_e \to \nu_e$) and the $\bar{\nu}_e$ templates with P($\bar{\nu}_e \to \bar{\nu}_e$). The MC templates made from the oscillated ν_e MC sample are weighted with P($\nu_\mu \to \nu_e$) (the sample was generated assuming 100% of ν_μ oscillate to ν_e).

We neglect contributions from ν_τ-CC and $\bar{\nu}_\tau$-CC as their energy threshold is around 3.5 GeV and their effect is negligible.

The same $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ parameters are used for both ν_μ and $\bar{\nu_\mu}$ oscillations.

Oscillations are not applied to the NC MC templates ν_μ NC1$\pi^\pm$, ν_μ NC other, $\bar{\nu}_\mu$ NC1$\pi^\pm$, $\bar{\nu}_\mu$ NC other, ν_e NC1$\pi^\pm$, ν_e NC other, $\bar{\nu}_e$ NC1$\pi^\pm$, $\bar{\nu}_e$ NC other since, as explained in Sec. 2.2.4, they serve as proxies for the mixtures of $\nu_e + \nu_\mu + \nu_\tau$ NC and $\bar{\nu}_e + \bar{\nu}_\mu + \bar{\nu}_\tau$ NC MC templates which are unchanged under 3-flavour oscillations.

2.6. Nominal and tuned-MC single μ-like ring spectrum predictions

In this section, we present the expected numbers of events and single μ-like ring reconstructed energy spectra in SuperK for various oscillation scenarios. We also present estimates of the effect of the NA61 and BANFF tunings and of assumptions made in the 3-flavour neutrino oscillation framework used in this analysis. Unless explicitly stated otherwise, the normal hierarchy is assumed, 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} and δ_{CP}=0. All plots were generated for an integrated exposure of 3.010×10^{20} POT.

The expected number of single μ-like ring events is shown in Fig. 5 as a function of the oscillation parameters $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$. The expected number of events ranges from $\sim$58.5 at maximal mixing and at the 2012 MINOS best-fit $|\Delta m^2_{32}|$ (2.39×10^{-3} eV^2/c^4) [31], to more than ∼76 for oscillation parameter values still within the 2012 MINOS 90% confidence region. This illustrates the great sensitivity of T2K in measuring the θ_{23} mixing angle.

Predicted single μ-like ring SuperK reconstructed energy spectra are shown in Fig. 6 for no oscillations, and in Fig. 7 for oscillations with $\sin^2 2\theta_{23}$ = 1.0 and $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4.

MC tunes derived using NA61 and ND280 data are applied to the nominal MC templates as described earlier in this section. In Fig. 8, the fractional difference is shown in the expected number of single μ-like ring events, as a function of oscillation parameters $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, obtained when this analysis switches from the nominal MC to the NA61-tuned MC templates. The fractional difference in the expected number of single μ-like ring events when switching from the NA61-tuned MC templates to the BANFF-tuned MC templates is also shown in Fig. 9. From these figures it can be seen that, for oscillation parameters in the 2012 MINOS 90% confidence region, ∼11.5-12.5% more single μ-like ring events are obtained with the NA61-tuned MC than with the nominal MC. In the same part of the parameter space, ∼1.8-2.0% fewer events are expected with the BANFF-tuned MC than with the NA61-tuned MC. The effects of the NA61 and BANFF tunes on the total expected number of single μ-like ring events and on the numbers in each of the 28 component reaction modes are shown in Tab. 2 for no oscillations, and in Tab. 3 for oscillations with $\sin^2 2\theta_{23}$ = 1.0 and $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4. Finally, the effect of the NA61 and BANFF tunes on the reconstructed energy spectrum of single μ-like ring events is shown in Figs. 10 and 11 respectively. In each case, spectra are shown for both no oscillations and for oscillations with $\sin^2 2\theta_{23}$ = 1.0 and $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4.

The effect of the choice of octant of θ_{23} [3] on the energy spectrum of single μ-like ring events is shown in Fig. 12, for oscillations with $\sin^2 2\theta_{23}$ = 0.95 (the 2012 PDG 90% lower limit) and $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4. It follows from Eq. 3 that the effect of changing from the first to second octant is to increase the depth of the oscillation dip, which is why the spectra are almost identical above the oscillation maximum. The fractional difference in the total expected number of single μ-like ring events when switching between the first and second octant is shown in Fig. 13.

When making a fit to obtain the best-fit values of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, we fix the non-23 oscillation parameters: $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ Δm^2_{21} are fixed to the 2012 PDG values and δ_{CP} is fixed to 0 (see Sec. 4.1.2). The maximum possible effect of this assumption on the expected number of single μ-like ring events is shown in Fig. 14. In each bin of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, a large number of toy MC experiments was generated with randomized values of the non-23 parameters. The random values of $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} were drawn from Gaussian distributions with means equal to the 2012 PDG values and standard deviations equal to the 1σ errors, while the values of δ_{CP} were drawn from a uniform distribution between -π and +π. These four non-23 parameters were taken to be uncorrelated. The maximum frational deviation from the default case was recorded and plotted in Fig. 14. From this figure, it can be seen that the effect of the non-23-sector oscillation parameters is small: the maximum fractional deviation from the default assumption is of the order of ∼1% in the part of the parameter space covered by the 2012 MINOS 90% confidence region.

All the results in this analysis assume the normal mass hierarchy. The effect of this assumption on the expected number of single μ-like ring events is shown in Fig. 15 as a function of the oscillation parameters $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$. The effect is large and potentially misleading, and some clarifications are in order. This analysis can assume a given hierarchy (in our case, normal) without loss of generality of its results. Fig. 15 reveals that $|\Delta m^2_{32}|$ is a poor choice as the atmospheric mass-squared difference when both mass hierarchies need to be considered, since $|\Delta m^2_{32}|$ is the largest mass-squared difference for the inverted hierarchy but the second-largest for the normal hierarchy. The large difference shown in Fig. 15 is caused by the change in value of Δm^2_{31} when switching from the normal to inverted hierarchy.

[3] It should be noted that, in the earlier versions of this note, the first octant ($\sin(\theta) \leq 0.5$) was assumed for all the PMNS oscillation angles. In this version, the first octant is assumed for all mixing angles unless explicitly stated otherwise. The octant choice does however make a difference; by making some approximations to the 3-flavour P($\nu_\mu \to \nu_\mu$) formula (neglecting $\sin^2\left(\frac{\Delta m^2_{21} L}{4E}\right)$ and $\sin^2\left(\frac{2\Delta m^2_{31} L}{4E}\right)$), we get

$$P(\nu_\mu \to \nu_\mu) \approx 1 - \left(\cos^4(\theta_{13})\sin^2(2\theta_{23}) + \sin^2(\theta_{23})\sin^2(2\theta_{13})\right)\sin^2\left(\frac{\Delta m^2_{31} L}{4E}\right). \tag{3}$$

The minimum of Eq. 3 occurs at

$$\sin^2(\theta_{23}) = \frac{1}{2(1-\sin^2(\theta_{13}))}, \tag{4}$$

and so, when $\theta_{13} \neq 0$, moves from $\sin^2(\theta_{23}) = 0.5$ to $\sin^2(\theta_{23}) > 0.5$. More discussion of this effect can be found in Appendix E of [5]. It should be noted that when $\sin^2(2\theta_{23}) = 1.000$, the oscillation probability is identical, no matter the value of θ_{13}, and no matter which octant is chosen. For both $\sin^2(\theta_{12})$ and $\sin^2(\theta_{13})$ we always assume the first octant.

Other choices exist for the atmospheric mass-squared difference, and these are explained in Sec. 4.1.1. An example of an alternative choice is shown vividly in Fig. 5 in [3]; this technical note describes a repeat, in a 3-flavour framework, of our official Run1+2 disappearance analysis [2] which was originally performed in a 2-flavour framework.

The reader may also be interested in comparisons of oscillated single μ-like ring spectra, obtained in a 3-flavour framework with spectra obtained in a 2-flavour framework. Many such comparisons were presented in [3].

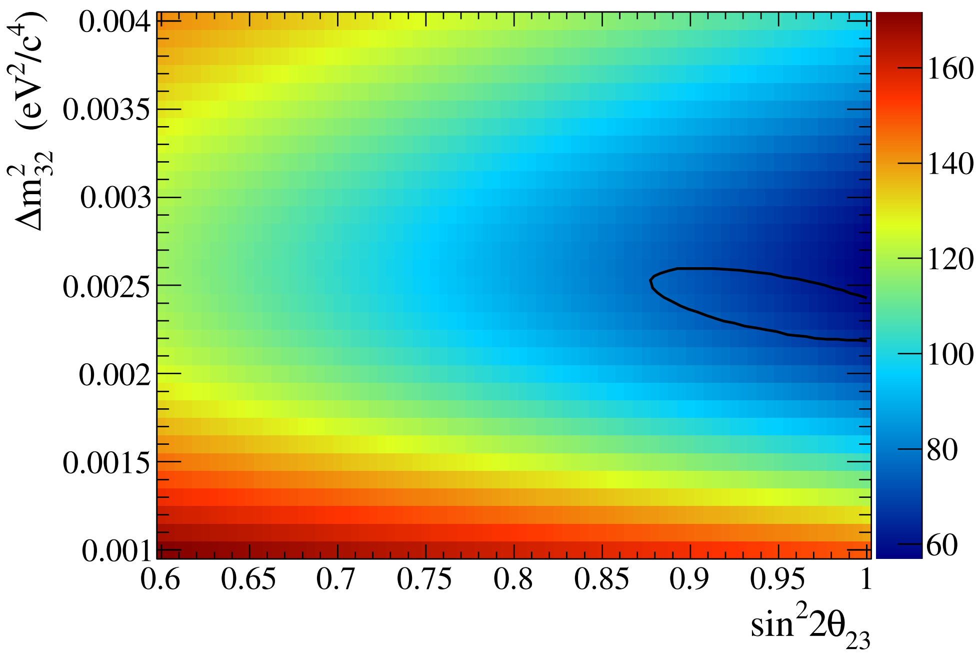

Figure 5: Predicted number of 1-ring μ-like events, as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, for an exposure of 3.010×10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates. 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} and δ_{CP}=0. The numbers shown were generated assuming the normal hierarchy. The 2012 MINOS 90% confidence region is superimposed for reference.

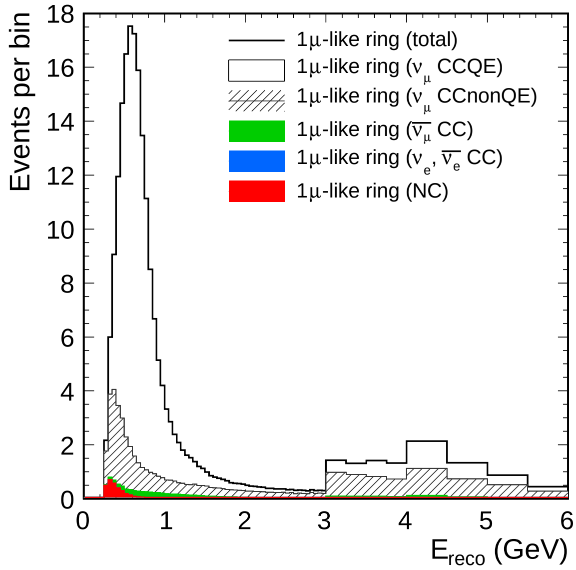

Figure 6: Predicted reconstructed-energy spectrum of 1-ring μ-like events, and contributions from various true neutrino reaction modes, for no oscillations and for an exposure of 3.010$\times 10^{20}$ POT. The 28 components of the spectrum are calculated separately in the actual analysis, but, for this plot, are grouped into just 5 categories: ν_μ CCQE, ν_μ CC-nonQE, $\bar{\nu_\mu}$ CC, $\nu_e/\bar{\nu}_e$ CC and NC. The spectrum was generated using the BANFF-tuned MC templates.

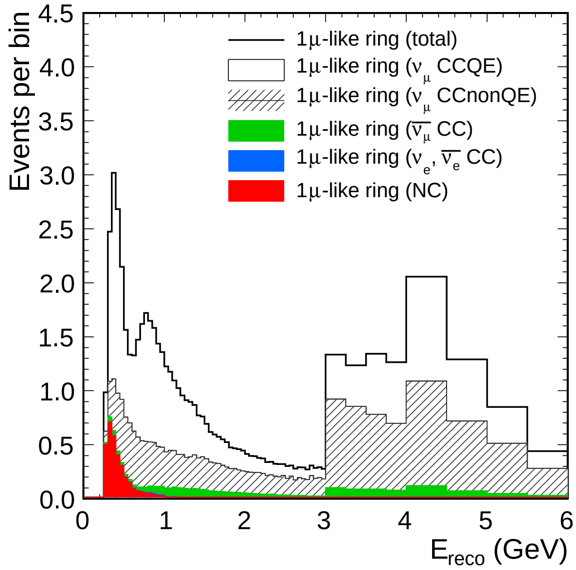

Figure 7: Predicted reconstructed-energy spectrum of 1-ring μ-like events, and contributions from various true neutrino reaction modes, for oscillations with $\sin^2 2\theta_{23}$=1.0 and $|\Delta m^2_{32}|$=2.4$\times 10^{-3}$ eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. The spectrum was generated using the BANFF-tuned MC templates. 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} and δ_{CP}=0. The spectrum shown was generated assuming the normal hierarchy. Note that the vertical axis is zoomed in by a factor of 4 compared with Fig. 6.

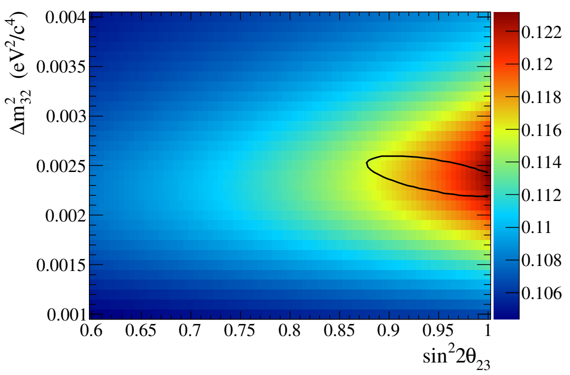

Figure 8: Fractional difference in the predicted number of 1-ring μ-like events as a result of applying the 2011b v3.2 flux tuning to the nominal MC templates. This number is shown as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for an exposure of 3.010$\times 10^{20}$ POT. The 2012 PDG parameters are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21},and δ_{CP}=0. The numbers shown were generated assuming the normal hierarchy. The MINOS 2012 90% CL region is superimposed for reference.

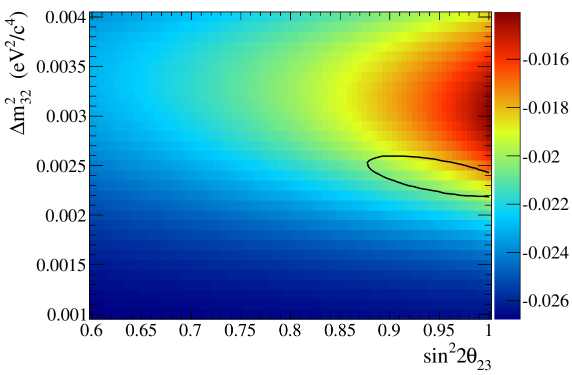

Figure 9: Fractional difference in the predicted number of 1-ring μ-like events as a result of applying the BANFF flux and cross-section tuning to the 2011b v3.2 flux tuned MC templates. This number is shown as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ and for an exposure of 3.010$\times 10^{20}$ POT. The 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. The numbers shown were generated assuming the normal hierarchy. The MINOS 2012 90% CL region is superimposed for reference.

	N_{SK} (nominal MC)	N_{SK} (NA61-tuned MC)	N_{SK} (BANFF-tuned MC)
Total	190.986142	210.464599	204.747590
ν_μ CCQE	151.820154	166.353705	155.044970
ν_μ CC 1π	25.717606	28.879686	34.945661
ν_μ CC coherent	0.898432	1.005621	0.950276
ν_μ CC other	3.584984	4.315475	4.198557
ν_μ/ν_τ NC $1\pi^{+/-}$	1.492903	1.696744	1.625483
ν_μ/ν_τ NC other	1.294522	1.521644	1.466497
$\bar{\nu}_\mu$ CCQE	4.118572	4.459811	3.981437
$\bar{\nu}_\mu$ CC 1π	1.336699	1.445418	1.762408
$\bar{\nu}_\mu$ CC coherent	0.194978	0.211123	0.202799
$\bar{\nu}_\mu$ CC other	0.236537	0.253912	0.247794
$\bar{\nu}_\mu/\bar{\nu}_\tau$ NC $1\pi^{+/-}$	0.084582	0.091984	0.090422
$\bar{\nu}_\mu/\bar{\nu}_\tau$ NC other	0.073460	0.079580	0.077614
ν_e CCQE	0.015774	0.016972	0.016260
ν_e CC 1π	0.009050	0.009932	0.013125
ν_e CC coherent	0.000403	0.000434	0.000434
ν_e CC other	0.002568	0.003048	0.003051
ν_e NC $1\pi^{+/-}$	0.042494	0.048652	0.049421
ν_e NC other	0.049084	0.057414	0.057684
$\bar{\nu}_e$ CCQE	0.000822	0.000827	0.000790
$\bar{\nu}_e$ CC 1π	0.000599	0.000601	0.000745
$\bar{\nu}_e$ CC coherent	0.000073	0.000073	0.000073
$\bar{\nu}_e$ CC other	0.000214	0.000219	0.000219
$\bar{\nu}_e$ NC $1\pi^{+/-}$	0.005755	0.005805	0.005916
$\bar{\nu}_e$ NC other	0.005876	0.005918	0.005954
Oscillated ν_e CCQE	0.000000	0.000000	0.000000
Oscillated ν_e CC 1π	0.000000	0.000000	0.000000
Oscillated ν_e CC coherent	0.000000	0.000000	0.000000
Oscillated ν_e CC other	0.000000	0.000000	0.000000

Table 2: Calculated numbers of 1-ring μ-like events without oscillations using the nominal MC templates, the NA61-tuned MC templates and the BANFF-tuned MC templates. The total numbers of events and the numbers of events from each mode considered in this analysis are shown. These numbers were calculated for an exposure of 3.010×10^{20} POT.

	N_{SK} (nominal MC)	N_{SK} (NA61-tuned MC)	N_{SK} (BANFF-tuned MC)
Total	52.890886	59.406174	58.367775
ν_μ CCQE	30.122383	33.277415	30.285520
ν_μ CC 1π	12.736216	14.628739	16.931486
ν_μ CC coherent	0.365047	0.420613	0.399710
ν_μ CC other	3.187277	3.862403	3.771051
ν_μ/ν_τ NC $1\pi^{+/-}$	1.492903	1.696744	1.625483
ν_μ/ν_τ NC other	1.294522	1.521644	1.466497
$\bar{\nu}_\mu$ CCQE	2.023300	2.190691	1.891082
$\bar{\nu}_\mu$ CC 1π	0.958303	1.032827	1.228001
$\bar{\nu}_\mu$ CC coherent	0.104487	0.112894	0.108444
$\bar{\nu}_\mu$ CC other	0.209999	0.225107	0.220043
$\bar{\nu}_\mu/\bar{\nu}_\tau$ NC $1\pi^{+/-}$	0.084582	0.091984	0.090422
$\bar{\nu}_\mu/\bar{\nu}_\tau$ NC other	0.073460	0.079580	0.077614
ν_e CCQE	0.014633	0.015752	0.015068
ν_e CC 1π	0.008572	0.009421	0.012426
ν_e CC coherent	0.000375	0.000404	0.000404
ν_e CC other	0.002530	0.003005	0.003007
ν_e NC $1\pi^{+/-}$	0.042494	0.048652	0.049421
ν_e NC other	0.049084	0.057414	0.057684
$\bar{\nu}_e$ CCQE	0.000785	0.000790	0.000755
$\bar{\nu}_e$ CC 1π	0.000583	0.000585	0.000724
$\bar{\nu}_e$ CC coherent	0.000070	0.000070	0.000070
$\bar{\nu}_e$ CC other	0.000212	0.000217	0.000217
$\bar{\nu}_e$ NC $1\pi^{+/-}$	0.005755	0.005805	0.005916
$\bar{\nu}_e$ NC other	0.005876	0.005918	0.005954
Oscillated ν_e CCQE	0.079970	0.087419	0.082883
Oscillated ν_e CC 1π	0.024965	0.027318	0.035271
Oscillated ν_e CC coherent	0.001860	0.002039	0.001949
Oscillated ν_e CC other	0.000644	0.000723	0.000672

Table 3: Calculated numbers of 1-ring μ-like events using the nominal MC templates, the NA61-tuned MC templates and the BANFF-tuned MC templates. The total numbers of events and the numbers of events from each mode considered in this analysis are shown. These numbers were calculated for an exposure of 3.010$\times 10^{20}$ POT and oscillations with $\sin^2 2\theta_{23}$=1.0 and $|\Delta m^2_{32}|$=2.4$\times 10^{-3}$ eV^2/c^4. The 2012 PDG parameters are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} and δ_{CP}=0. The normal hierarchy is assumed.

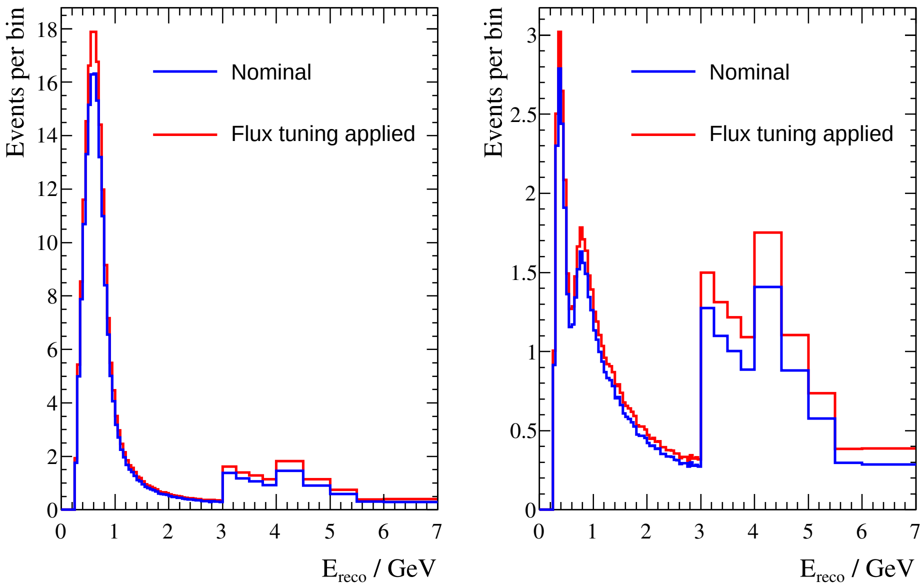

Figure 10: Reconstructed-energy spectrum of 1-ring μ-like events, for an exposure of 3.010$\times 10^{20}$ POT, both with and without the effect of the *2011b_v3.2_run1-3c* flux tuning of the nominal MC templates. The spectra are shown both for no oscillations (left) and for oscillations with $\sin^2 2\theta_{23}$=1.0, $|\Delta m^2_{32}|$=2.4$\times 10^{-3}$ eV^2/c^4, the 2012 PDG values for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0 (right). Results shown for the normal hierarchy.

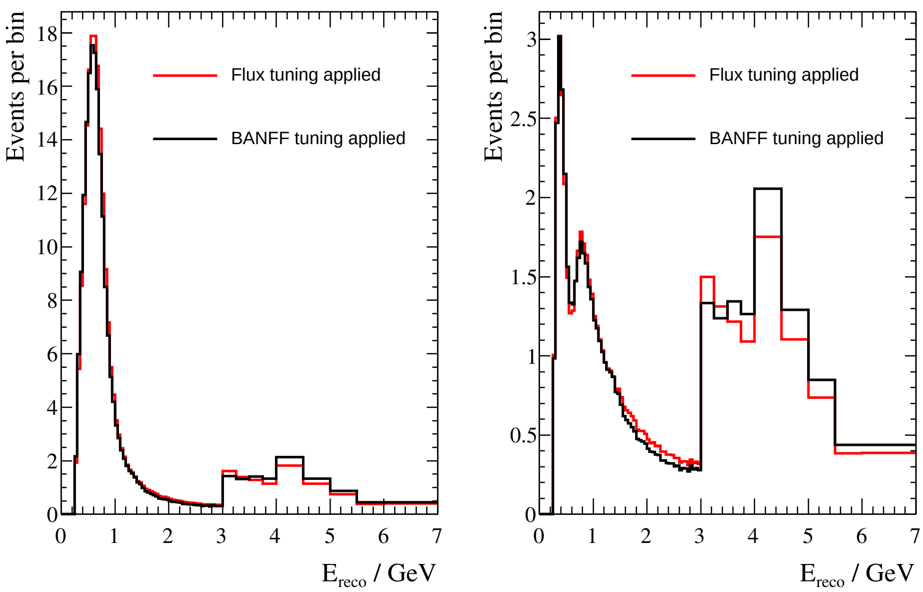

Figure 11: Reconstructed-energy spectrum of 1-ring μ-like events, for an exposure of 3.010$\times 10^{20}$ POT, both with and without the effect of BANFF flux and cross-section tuning on the NA61-tuned *2011b_v3.2_run1-3c* flux MC templates. The spectra are shown both for no 23-sector oscillations (left) and for oscillations with $\sin^2 2\theta_{23}$=1.0 and $|\Delta m^2_{32}|$=2.4$\times 10^{-3}$ eV^2/c^4 (right). In all spectra, the 2012 PDG parameters are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} and δ_{CP}=0. Results shown for the normal hierarchy.

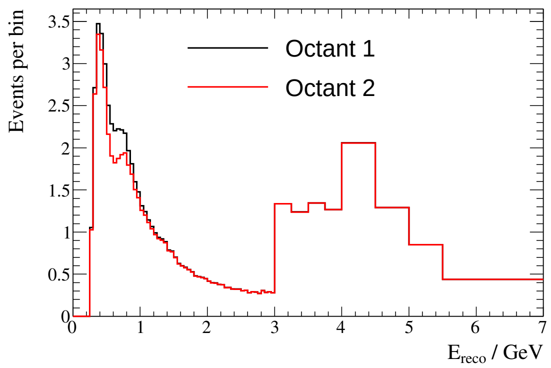

Figure 12: Predicted reconstructed-energy spectrum of 1-ring μ-like events, for an exposure of 3.010×10^{20} POT, for θ_{23} both in the first octant and second octant. The spectra are shown oscillations with $\sin^2 2\theta_{23}$=0.95, $|\Delta m^2_{32}|$=2.4×10^{-3} eV^2/c^4, the 2012 PDG values for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0 (right). Results shown for the normal hierarchy.

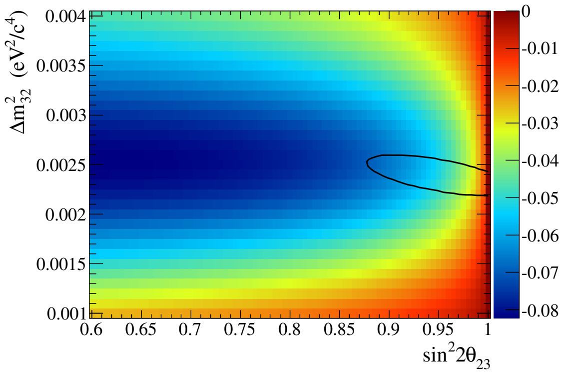

Figure 13: Fractional difference in the predicted number of 1-ring μ-like events between assuming that θ_{23} is in the first octant and assuming it is in the second octant. The fractional difference is shown as function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, for an exposure of 3.010×10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates. The 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. Results shown for the normal hierarchy. The 2012 MINOS 90% confidence region is superimposed for reference.

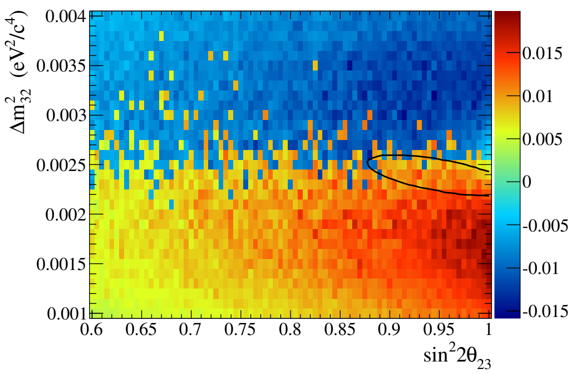

Figure 14: Maximum value of the fractional difference in the predicted number of 1-ring μ-like events between varying each of $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$, Δm^2_{21} and δ_{CP} within their allowed ranges and their nominal values (these are the 2012 PDG values for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0). The fractional difference is shown as function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, for an exposure of 3.010×10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates. The normal hierarchy was assumed. The 2012 MINOS 90% confidence region is superimposed for reference.

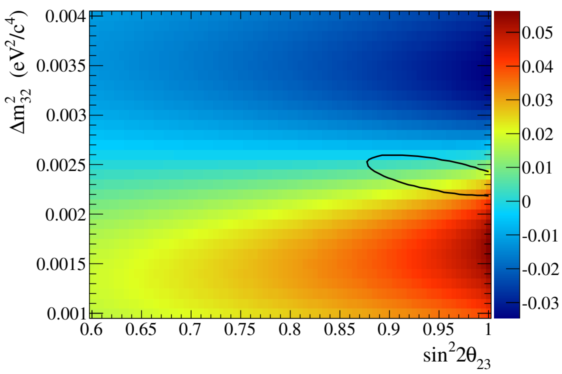

Figure 15: Fractional difference in the predicted number of 1-ring μ-like events between assuming the normal hierarchy and assuming the inverted hierarchy. The fractional difference is shown as function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, for an exposure of 3.010×10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates. The 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. The 2012 MINOS 90% confidence region is superimposed for reference.

3. Systematic effects in the prediction of the single μ-like ring event reconstructed energy spectrum

3.1. Input systematic parameters

This analysis considers 48 systematic parameters which can be grouped into 4 categories:

1. SuperK detector parameters (Sec. 3.1.1)
2. Correlated flux and cross-section parameters tuned by the BANFF group to ND280 data (Sec. 3.1.2)
3. Uncorrelated cross-section parameters (Sec. 3.1.3)
4. Intranuclear and secondary interactions (Sec. 3.1.4).

A summary of all systematic parameters considered in this analysis is given in Tab. 4. These systematic parameters are applied to the MC templates as shown in Tab. 5.

3.1.1. SuperK detector systematics

The SuperK detector systematics are unchanged from the 2010 analyses [10]. They can be broken down into two categories:

1. Reconstructed energy scale
   The effect of the uncertainty in the reconstructed energy scale is calculated by scaling the bin edges of the MC templates and, assuming uniform distribution of events within the bins, calculating the number of events gained from / lost to neighbouring bins. The systematic parameter $f^{SK}_{E;r}$ controls the energy scale and its uncertainty is estimated to be 2.3% [10]. The effect of the energy scale uncertainty is propagated to all MC templates as shown in Tab. 5.

2. Detector efficiencies
   Uncertainty in the efficiencies comes from the uncertainties in the fiducial volume and reduction chain, and the OD, ring-counting, PID, momentum and decay-electron cuts. The efficiency errors used in this analysis [10] are listed below.
   - ν_μ, $\bar{\nu}_\mu$ CCQE:
     An energy-dependent ring-counting efficiency error and an energy-independent "other" efficiency error (due to all sources of uncertainty other than ring-counting) are taken into account. For the ring-counting effciciency, we assume correlated errors in 3 E_{reco} bins: 0 - 0.4 GeV, 0.4 - 1.1 GeV and > 1.1 GeV. The following error matrix is used:
     $$\begin{pmatrix} (1.7\%)^2 & 0.59 * 1.7\% * 3.5\% & 0.33 * 1.7\% * 9.3\% \\ & (3.5\%)^2 & 0.61 * 3.5\% * 9.3\% \\ & & (9.3\%)^2 \end{pmatrix}$$
     For the "other" efficiency, we assume an energy-independent error of 1.8%.
   - ν_μ, $\bar{\nu}_\mu$ CCnonQE:
     A single 20% energy-independent error is assumed. This error was calculated by combining the quoted energy-independent ring-counting (19.9%) and other (1.7%) errors in quadrature.
   - NC:
     A single 111% energy-independent error is assumed. This error was calculated by combining the quoted energy-independent ring-counting (48.2%), PID (100%) and other (1.7%) errors in quadrature.
   - ν_e, $\bar{\nu}_e$ CC:
     A single $\sim$100% energy-independent error is assumed.

   The ν_μ and $\bar{\nu}_\mu$ CCQE ring-counting efficiency is controlled by the systematic parameters $f^{SK}_{CCQERC0;r}$ ($E_{reco} <$ 0.4 GeV), $f^{SK}_{CCQERC1;r}$ (0.4 GeV $\leq E_{reco} \leq$ 1.1 GeV) and $f^{SK}_{CCQERC2;r}$ ($E_{reco} >$ 1.1 GeV), while the "other" efficiency is controlled by parameter $f^{SK}_{CCQEoth;r}$. The ν_μ and $\bar{\nu}_\mu$ CCnonQE, the NC and the ν_e, $\bar{\nu}_e$ CC efficiencies are controlled by the systematic parameters $f^{SK}_{CCnQE;r}$, $f^{SK}_{NC;r}$ and $f^{SK}_{\nu_e;r}$ respectively. These systematic parameters are applied to the MC templates as specified in Tab. 5.

SuperK detector systematics		
$f^{SK}_{E;r}$	Reconstructed energy scale	2.3%
$f^{SK}_{CCQERCi;r}$	ν_μ, $\bar{\nu}_\mu$ CCQE ring-counting efficiency. Three correlated systematic parameters are included (i=0,1,2) corresponding to different reconstructed energy ranges. See Sec.3.1.1.	1.7% ($<$ 0.4 GeV) 3.5% (0.4-1.1 GeV) 9.3% ($>$ 1.1 GeV)
$f^{SK}_{CCQEoth;r}$	ν_μ, $\bar{\nu}_\mu$ CCQE other (all but ring-counting) efficiency. Includes fiducial volume, reduction chain, OD cut, PID cut, momentum cut and decay electron cut efficiencies.	1.8%
$f^{SK}_{CCnonQE;r}$	ν_μ, $\bar{\nu}_\mu$ CCnQE efficiency	20%
$f^{SK}_{NC;r}$	NC efficiency	111%
$f^{SK}_{\nu_e;r}$	ν_e, $\bar{\nu}_e$ efficiency	100%
Correlated flux and cross-section (BANFF) systematics		
$f^{banff}_{i;t,r}$	Flux and cross-section parameters tuned by BANFF group on ND280 data. Twenty-three correlated parameters are included (i=0,...,22). See Sec. 3.1.2.	
Uncorrelated cross-section systematics		
$f_{pF;t,r}$	Fermi momentum (CCQE only)	225±30 MeV
$f_{bindE;t,r}$	Binding energy for ^{16}O (CCQE only)	27±9 MeV
$f_{SF;t,r}$	Nuclear environment modeling; switch from Fermi Gas (RFG) to Spectral Function (SF) model (CCQE only).	0 (RFG) - 1 (SF)
$f_{\pi-less\Delta;t,r}$	Fraction of π-less Δ decays in resonance neutrino-production events	20%
$f_{CCothShape;t,r}$	Parameterizes the uncertainty in CC multipion, CC DIS and CC resonant η, K and photon production.	40%
$f_{Wshape;t,r}$	Modifies the shape of the initial pion momentum distribution (before final-state interactions) in resonance interactions.	87.8±45.3
$f_{CCcoh;t}$	CC coherent cross-section	100%
$f_{NC1\pi^{\pm};t}$	NC1$\pi^{\pm}$ cross-section	30%
$f_{NCoth;t}$	NC other (all but single $\pi^{\pm}$) cross-section	30%
$f_{CC\nu_e;t}$	ν_e / ν_μ CC cross-section ratio	3%
$f_{CC\bar{\nu};t}$	$\bar{\nu}$ / ν CC cross-section ratio	40%
FSI+SI systematics		
$f^{FSI}_{i;r}$	FSI (final state interaction / intranuclear hadron transport) and SI (secondary interaction / detector hadron transport) systematic parameters. Six correlated parameters are included (i=0,...,5) corresponding to different modes and reconstructed energy bins. See Sec. 3.1.4.	

Table 4: Summary table of systematic parameters included the VaLOR ν_μ-disappearance analysis. The nuisance parameter symbols used in this paper are shown in the first column. An index r in the nuisance parameter symbol denotes dependence on reconstructed energy while an index t denotes dependence on true energy. An index i is used where multiple systematic parameters, typically correlated between themselves, are grouped together; in these cases we refer you to the main text for the exact parameter definition and for the input covariance matrix. Wherever practical, the physics parameter affected by the systematic parameter is shown in the second column and the size of the uncertainty is shown in the third column.

	ν_μ CCQE	ν_μ CC1π	ν_μ CC coherent	ν_μ CC other	ν_μ NC1$\pi^\pm$	ν_μ NC other	$\bar{\nu}_\mu$ CCQE	$\bar{\nu}_\mu$ CC1π	$\bar{\nu}_\mu$ CC coherent	$\bar{\nu}_\mu$ CC other	$\bar{\nu}_\mu$ NC1$\pi^\pm$	$\bar{\nu}_\mu$ NC other	ν_e CCQE	ν_e CC1π	ν_e CC coherent	ν_e CC other	ν_e NC1$\pi^\pm$	ν_e NC other	$\bar{\nu}_e$ CCQE	$\bar{\nu}_e$ CC1π	$\bar{\nu}_e$ CC coherent	$\bar{\nu}_e$ CC other	$\bar{\nu}_e$ NC1$\pi^\pm$	$\bar{\nu}_e$ NC other	Osc-ν_e CCQE	Osc-ν_e CC1π	Osc-ν_e CC coherent	Osc-ν_e CC other
$f^{SK}_{E;r}$	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
$f^{SK}_{CCQERC0;r}$	✓						✓																					
$f^{SK}_{CCQERC1;r}$	✓						✓																					
$f^{SK}_{CCQERC2;r}$	✓						✓																					
$f^{SK}_{CCQEoth;r}$	✓						✓																					
$f^{SK}_{CCnQE;r}$		✓	✓	✓				✓	✓	✓																		
$f^{SK}_{NC;r}$					✓	✓					✓	✓					✓	✓					✓	✓				
$f^{SK}_{\nu_e;r}$													✓	✓	✓	✓			✓	✓	✓	✓			✓	✓	✓	✓
$f^{banff}_{0;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{1;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{2;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{3;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{5;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{6;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{7;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{8;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{9;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{10;t,r}$	✓	✓	✓	✓	✓	✓																						
$f^{banff}_{11;t,r}$							✓	✓	✓	✓	✓	✓																
$f^{banff}_{12;t,r}$							✓	✓	✓	✓	✓	✓																
$f^{banff}_{13;t,r}$							✓	✓	✓	✓	✓	✓																
$f^{banff}_{14;t,r}$							✓	✓	✓	✓	✓	✓																
$f^{banff}_{15;t,r}$							✓	✓	✓	✓	✓	✓																
$f^{banff}_{16;t,r}$	✓						✓						✓						✓						✓			
$f^{banff}_{17;t,r}$		✓		✓	✓	✓		✓		✓	✓	✓		✓		✓	✓	✓		✓		✓	✓	✓		✓		✓
$f^{banff}_{18;t,r}$	✓						✓						✓						✓						✓			
$f^{banff}_{19;t,r}$	✓						✓						✓						✓						✓			
$f^{banff}_{20;t,r}$	✓						✓						✓						✓						✓			
$f^{banff}_{21;t,r}$		✓						✓						✓						✓						✓		
$f^{banff}_{22;t,r}$		✓						✓						✓						✓						✓		
$f_{pF;t,r}$	✓						✓						✓						✓						✓			
$f_{SF;t,r}$	✓						✓						✓						✓						✓			
$f_{\pi-less\Delta;t,r}$		✓			✓	✓		✓			✓	✓		✓			✓	✓		✓			✓	✓		✓		
$f_{bindE;t,r}$	✓						✓						✓						✓						✓			
$f_{CCothShape;t,r}$				✓						✓						✓						✓						✓
$f_{Wshape;t,r}$					✓	✓					✓	✓					✓	✓					✓	✓				
$f_{CCcoh;t}$			✓						✓						✓						✓						✓	
$f_{NC1\pi^\pm;t}$					✓						✓						✓						✓					
$f_{NCoth;t}$						✓						✓						✓						✓				
$f_{CC\nu_e;t}$													✓	✓	✓	✓			✓	✓	✓	✓			✓	✓	✓	✓
$f_{CC\bar{\nu};t}$							✓	✓	✓	✓									✓	✓	✓	✓						
$f^{FSI}_{0;r}$	✓						✓																					
$f^{FSI}_{1;r}$	✓						✓																					
$f^{FSI}_{2;r}$	✓						✓																					
$f^{FSI}_{3;r}$		✓	✓	✓				✓	✓	✓																		
$f^{FSI}_{4;r}$													✓	✓	✓	✓			✓	✓	✓	✓			✓	✓	✓	✓
$f^{FSI}_{5;r}$					✓	✓					✓	✓					✓	✓					✓	✓				

Table 5: A ✓symbol denotes that the given MC template is modified when the given systematic parameter is tweaked. The table lists all 48 systematic parameters considered in this analysis (first column) and all 28 MC templates used for constructing the single μ-like ring event reconstructed energy spectrum p.d.f (first row).

Parameter	Definition	Best-fit value (tune v8)
$f^{banff}_{0;t,r}$	ν_μ flux normalisation, E = 0.0 - 0.4 GeV	0.995
$f^{banff}_{1;t,r}$	ν_μ flux normalisation, E = 0.4 - 0.5 GeV	1.007
$f^{banff}_{2;t,r}$	ν_μ flux normalisation, E = 0.5 - 0.6 GeV	1.002
$f^{banff}_{3;t,r}$	ν_μ flux normalisation, E = 0.6 - 0.7 GeV	0.963
$f^{banff}_{4;t,r}$	ν_μ flux normalisation, E = 0.7 - 1.0 GeV	0.901
$f^{banff}_{5;t,r}$	ν_μ flux normalisation, E = 1.0 - 1.5 GeV	0.910
$f^{banff}_{6;t,r}$	ν_μ flux normalisation, E = 1.5 - 2.5 GeV	0.936
$f^{banff}_{7;t,r}$	ν_μ flux normalisation, E = 2.5 - 3.5 GeV	0.967
$f^{banff}_{8;t,r}$	ν_μ flux normalisation, E = 3.5 - 5.0 GeV	0.988
$f^{banff}_{9;t,r}$	ν_μ flux normalisation, E = 5.0 - 7.0 GeV	0.997
$f^{banff}_{10;t,r}$	ν_μ flux normalisation, E = 7.0 - 30.0 GeV	1.004
$f^{banff}_{11;t,r}$	$\bar{\nu}_\mu$ flux normalisation, E = 0.0 - 0.7 GeV	0.980
$f^{banff}_{12;t,r}$	$\bar{\nu}_\mu$ flux normalisation, E = 0.7 - 1.0 GeV	0.958
$f^{banff}_{13;t,r}$	$\bar{\nu}_\mu$ flux normalisation, E = 1.0 - 1.5 GeV	0.947
$f^{banff}_{14;t,r}$	$\bar{\nu}_\mu$ flux normalisation, E = 1.5 - 2.5 GeV	0.953
$f^{banff}_{15;t,r}$	$\bar{\nu}_\mu$ flux normalisation, E = 2.5 -30.0 GeV	0.985
$f^{banff}_{16;t,r}$	CCQE axial mass normalisation, x_{MAQE}	1.049
$f^{banff}_{17;t,r}$	Resonant axial mass normation, x_{MARES}	1.011
$f^{banff}_{18;t,r}$	CCQE normalisation, E = 0.0 - 1.5 GeV	0.951
$f^{banff}_{19;t,r}$	CCQE normalisation, E = 1.5 - 3.5 GeV	0.708
$f^{banff}_{20;t,r}$	CCQE normalisation, E = 3.5 - 30.0 GeV	1.347
$f^{banff}_{21;t,r}$	CC1π normalisation, E = 0.0 - 2.5 GeV	1.370
$f^{banff}_{22;t,r}$	CC1π normalisation, E = 2.5 - 30.0 GeV	1.016

Table 6: BANFF parameters and best-fit values (v8 tune) [14].

3.1.2. Correlated flux and cross-section (BANFF) systematics

The postfit uncertainties of all BANFF flux and cross-section parameters and their correlations are taken into account. A list of the BANFF parameters is given in Tab. 6. The BANFF postfit covariance matrix is shown in Fig. 16, while both postfit and prefit 1σ fractional errors for all parameters are shown in Fig. 17. These fractional errors are computed from the square roots of the diagonal elements of the corresponding input covariance matrix.

Version 8 of the BANFF matrix is used.

Only the ν_μ and $\bar{\nu}_\mu$ flux parameters are included in the BANFF fit. The ν_e and $\bar{\nu}_e$ flux parameters have a negligible effect as shown by the results of the systematic study[4] in Tab. 7.

Only those cross-section parameters that are expected to have some cancellation between the ND280 and SuperK are included in the BANFF fit. The other cross-section parameters included in this analysis are taken to be uncorrelated with the flux parameters and to have no cancellation between the near and far detectors. These uncorrelated cross-section parameters are described in Sec. 3.1.3.

[4]The study was performed with an older version of the BANFF matrix (v5)

The BANFF parameters are applied to the MC templates as specified in Tab. 5. All but two of the BANFF cross-section parameters are simple normalization factors. The parameters $f^{banff}_{16;t,r}$ and $f^{banff}_{17;t,r}$[5] parameterize the effect of the uncertainty of the axial masses used for modeling CC quasi-elastic (M_A^{QE}) [6] and resonance neutrino-production (M_A^{RES}) events respectively; these have a more complicated, often non-linear, dependence on the true and reconstructed neutrino energy. Event reweighting methods were used to obtain the fractional changes of the number of events, in bins of true and reconstructed neutrino energy, for a range of values (-3.0σ, -2.5σ, -2.0σ, ..., +3.0σ) of the $f^{banff}_{17;t,r}$ and $f^{banff}_{18;t,r}$ parameters. In our p.d.f. calculation, cross-section splines using a polynomial of order 3 are used to interpolate between these event weights to obtain the fractional change for any value of these systematic parameters in the (-3.0σ, +3.0σ) range.

	$\sin^2(2\theta_{23})$ = 1.0)		$\sin^2(2\theta_{23})$ = 0.9	
Systematic	$\delta\ \sin^2(2\theta_{23})$	$\delta\ \lvert\Delta m^2_{32}\rvert$	$\delta\ \sin^2(2\theta_{23})$	$\delta\ \lvert\Delta m^2_{32}\rvert$
Statistical	0.17	0.00014	0.05	0.00022
$\bar{\nu}_\mu$ flux 0.0-0.4 GeV	$1 \cdot 10^{-6}$	$4 \cdot 10^{-7}$	$5 \cdot 10^{-5}$	$4 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 0.4-0.5 GeV	$1 \cdot 10^{-6}$	$3 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$4 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 0.5-0.6 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 0.6-0.7 GeV	$< 1 \cdot 10^{-6}$	$1 \cdot 10^{-7}$	$5 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 0.7-1.0 GeV	$2 \cdot 10^{-6}$	$4 \cdot 10^{-7}$	$12 \cdot 10^{-5}$	$6 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 1.0-1.5 GeV	$2 \cdot 10^{-6}$	$11 \cdot 10^{-7}$	$12 \cdot 10^{-5}$	$17 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 1.5-2.5 GeV	$1 \cdot 10^{-6}$	$9 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$15 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 2.5-3.5 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 3.5-5.0 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 5.0-7.0 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
$\bar{\nu}_\mu$ flux 7.0-30.0 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
ν_e flux 0.0-0.5 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
ν_e flux 0.5-0.7 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
ν_e flux 0.7-0.8 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
ν_e flux 0.8-1.5 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
ν_e flux 1.5-2.5 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
ν_e flux 2.5-4.0 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
ν_e flux 4.0-30.0 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
$\bar{\nu}_e$ flux 0.0-2.5 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$
$\bar{\nu}_e$ flux 2.5-30.0 GeV	$< 1 \cdot 10^{-6}$	$2 \cdot 10^{-7}$	$4 \cdot 10^{-5}$	$2 \cdot 10^{-7}$

Table 7: Maximum deviation from input values of oscillation parameters for a 2+0 fit and a single parameter ± 1 sigma deviation from nominal. This uses an old version of the BANFF matrix (v5) with a different parameter set. The ν_e and $\bar{\nu}_e$ flux parameters have negligible effect, and they were removed for BANFF v8. Similiarly, the first four and last four $\bar{\nu_\mu}$ flux parameters have negligible effect, and these were combined for BANFF v8. Made for oscillations with $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT.

3.1.3. Uncorrelated cross-section systematics

In addition to the BANFF cross-section systematics, another 11 cross-section systematics are taken into account; these additional systematics are considered to be uncorrelated between themselves and to have no cancellation between the near and far detectors [12] [13].

[5] $f^{banff}_{16;t,r}$ and $f^{banff}_{17;t,r}$ are not the *value* of M_A, but instead a multiplicative factor describing how M_A moves away from nominal; $M_A \rightarrow x_{MA} M_A$.

[6] An alternative way to treat the quasielastic axial mass was suggested [19]; use 1/(M_A^{QE})^2 instead of M_A^{QE}. This is because 1/(M_A^{QE})^2 has a more linear response than M_A^{QE}. Distributions of the predicted number of events in SuperK are shown in [23] for 20000 toy experiments with all BANFF matrix parameters randomly thrown for each of these two definitions of M_A^{QE}. Both are Gaussian, suggesting that there is no effect of the M_A^{QE} response on the far detector phase space. The shift is thought to be due to the different parameter ranges used: M_A^{QE} = 1.21$\pm$0.45 while 1/(M_A^{QE})^2 = 0.683$\pm$0.320, which translates to M_A^{QE} = $1.21^{+0.45}_{0.21}$. Therefore it was decided to use M_A^{QE}, to be consistent with the 2012 ν_e analyses.

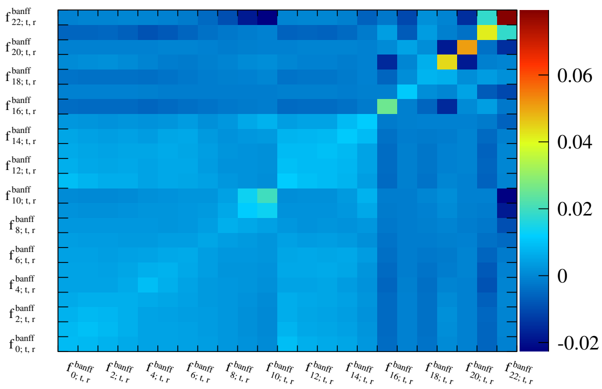

Figure 16: The input BANFF postfit covariance matrix. The meaning of each parameter is given in the text.

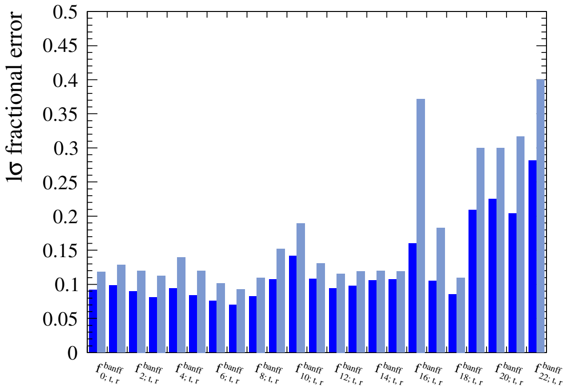

Figure 17: Postfit (dark blue) and prefit (light blue) 1σ fractional errors for BANFF parameters (computed from the square root of the diagonal elements of the corresponding input covariance matrix). The meaning of each parameter is given in the text.

Three of these additional systematics relate to the initial-state nuclear environment modeling for CCQE. Neutrino Monte Carlo generators typically use Relativistic Fermi Gas (RFG) models, with or without extensions to take nucleon-nucleon correlation into account, and with some, often simplistic, prescription for the treatment of off-shell kinematics. The RFG model implementation depends on two parameters, the Fermi momentum level (225 MeV for ^{16}O) and the nucleon binding energy (27 MeV for ^{16}O), which are extacted from quasi-elastic electron scattering data. The systematic parameter $f_{pF;t,r}$ takes into account the effect of a 30 MeV 1σ uncertainty in the Fermi momentum level for ^{16}O, while parameter $f_{bindE;t,r}$ takes into account the effect of a 9 MeV 1σ uncertainty in the nucleon binding energy for for ^{16}O. The implementation details of the nuclear model can have a significant effect and, therefore, the effect of switching between two such models was also included as a systematic uncertainty. This analysis considers the effect of switching between the RFG model and a better-motivated Spectral Function (SF) model. The latter does not assume a fixed binding energy and includes the correlations between nucleon momentum and binding energy. The systematic parameter $f_{SF;t,r}$ includes the effect of switching between the two models.

Simple, energy-independent, generator-level uncertainties are considered for the CC coherent, NC, ν_e CC and $\bar{\nu}$ CC cross sections, as the effect of these processes in the single μ-like ring sample is small. This analysis uses a 100% uncertainty for the CC coherent cross-section, a 30% uncertainty for both the NC1$\pi^{\pm}$ and NC "other" (all but single $\pi^{\pm}$) cross section, a 3% uncertainty on the ν_e / ν_μ CC cross-section ratio and a 40% uncertainty on the $\bar{\nu}$ / ν CC cross-section ratio. The effect of the variation of the above cross sections is included in the analysis through the systematic parameters $f_{CCcoh;t}$, $f_{NC1\pi^{\pm};t}$, $f_{NCoth;t}$, $f_{CC\nu_e;t}$ and $f_{CC\bar{\nu};t}$ respectvely.

The treatment of Δ resonances in the nuclear environment has been controversial in the neutrino Monte Carlo generator community. Certain models include a 20%-level of π-less Δ decays in order to include the effect of $\Delta + N \rightarrow N + N$ scattering, in which the Δ interacts before it can decay. In contrast, other models include no π-less Δ decays on the basis that this would amount to double counting since, whatever the size of the effect, it is already included in hadron-nucleus scattering data to which the intranuclear cascade Monte Carlos are tuned. This analysis uses NEUT, in which 20% of Δs have a π-less decay by default, and takes the uncertainty in this branching fraction to be 100%. The systematic parameter $f_{\pi-less\Delta;t,r}$ includes the effect of varying the fraction of π-less Δ decays to the corresponding MC templates.

The $f_{CCothShape;t,r}$ systematic parameterizes the uncertainty in CC multi-pion, CC deep inelastic scattering and CC η, K and photon production. From MINOS data, this is known to be ≈10% at 4 GeV. Using this as a reference point, the uncertainty is estimated as 0.4/E$_\nu$, where E$_\nu$ is in GeV. It might appear that this error could diverge at low energy, but this does not happen since the threshold is ≈0.6 GeV and there are very few interactions below 1 GeV.

The $f_{Wshape;t,r}$ parameter modifies the shape of the initial pion momentum distribution (before final-state interactions) by changing the distribution of the pion/nucleon invariant mass while keeping the total cross section constant. As the W shape parameter decreases, the pion momentum shifts to lower values, and this increases the probability of pion absorption in a final-state interaction. If such an absorption occurs, the event is migrated from CC1π (its true initial state) and appears to be CCQE.

The effect of the $f_{CCcoh;t}$, $f_{NC1\pi^{\pm};t}$, $f_{NCoth;t}$, $f_{CC\nu_e;t}$ and $f_{CC\bar{\nu};t}$ systematic parameters is a simple normalisation change for the corresponding MC templates and thus easily implemented. Systematic parameters $f_{pF;t,r}$, $f_{SF;t,r}$, $f_{bindE;t,r}$, $f_{\pi-less\Delta;t,r}$, $f_{CCothShape;t,r}$ and $f_{Wshape;t,r}$ have a complicated, often non-linear, dependance on true and reconstructed energy. These are treated in a similar way to the BANFF parameters $f^{banff}_{17;t,r}$ and $f^{banff}_{18;t,r}$ (see Sec. 3.1.2). Event reweighting methods were used to obtain the fractional changes of the number of events, in bins of true and reconstructed neutrino energy, for a range of values (-3.0σ, -2.5σ, -2.0σ, ..., +3.0σ) of the systematic parameters. Again cross-section splines with polynomials of order 3 were used to interpolate between these event weights to obtain the fractional change for any value of these systematic parameters in the (-3.0σ, +3.0σ) range.

Some of these systematics are special cases:

- $f_{SF;t,r}$ is discrete; it can be either off (RFG) or on (SF). Splines are generated with off as nominal, and on as +1.0 sigma. Linear interpolation is done only between the weights for 0 and 1.
- For $f_{Wshape;t,r}$ only $\pm$1.0 sigma errors are evaluated using event reweighting. All other errors are extrapolated or interpolated from these $\pm$1.0 weights.
- For $f_{pi-lessDelta;t,r}$ only $\pm$1.0 sigma errors are evaluated using event reweighting. Weights for tweaks more positive than +1σ are extrapolated from the +1σ weight. Weights more negative than -1σ are taken to be the same as the -1σ weight; this is done since 20% of deltas have a piless decay by default in NEUT, and the error is 20%. For this reason, it is unphysical to tweak $f_{pi-lessDelta;t,r}$ to be more negative than -1σ.

The cross-section splines have 41 bins in reconstructed energy:

- 1 bin from 0-0.3 GeV
- 14 50-MeV bins from 0.3-1.0 GeV
- 20 100MeV bins from 1.0-3.0 GeV
- 2 500-MeV bins from 3.0-4.0 GeV
- 1 bin from 4.0-5.0 GeV
- 1 bin from 5.0-7.0 GeV
- 1 bin from 7.0-10.0 GeV
- 1 bin from 10.0-30.0 GeV

For the ν_μ, $\bar{\nu}_\mu$ and oscillated ν_e samples, they have 11 bins in true energy:

- 1 bin from 0-0.4 GeV
- 3 100-MeV bins from 0.4-0.7 GeV
- 1 bin from 0.7-1.0 GeV
- 1 bin from 1.0-1.5 GeV
- 2 1-GeV bins from 1.5-3.5 GeV
- 1 bin from 3.5-5.0 GeV
- 1 bin from 5.0-7.0 GeV
- 1 bin from 7.0-30.0 GeV

For the ν_e sample, they have 7 bins in true energy:

- 1 bin from 0-0.05 GeV
- 1 bin from 0.5-0.7 GeV

- 1 bin from 0.7-0.8 GeV
- 1 bin from 0.8-1.5 GeV
- 1 bin from 1.5-2.5 GeV
- 1 bin from 2.5-4.0 GeV
- 1 bin from 4.0-30.0 GeV

Finally, for the $\bar{\nu}_e$ sample, they have 2 bins in true energy:

- 1 bin from 0-2.5 GeV
- 1 bin from 2.5-30.0 GeV

An example of a cross-section spline is shown in Fig. 18.

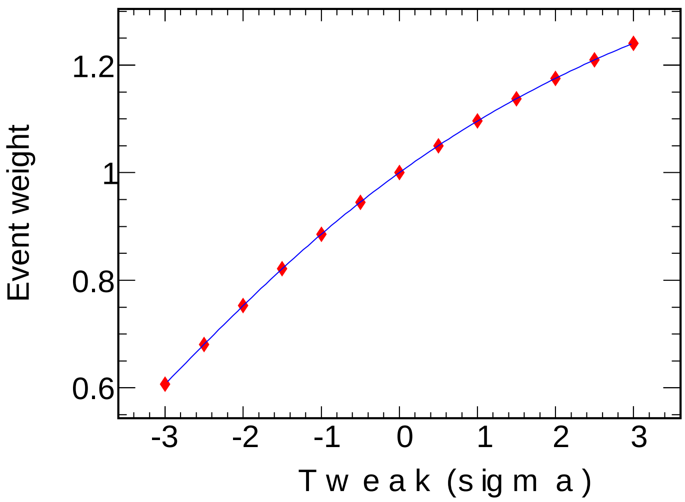

Figure 18: Example of a cross-section spline; this shows the event weights obtained by tweaking M_A^{QE} for ν_μ-CCQE events in the bin with reconstructed energy 0.75-0.8 GeV and true energy 0.6-0.7 GeV.

The 11 uncorrelated cross-section systematics considered in this analysis are summarised in Tab. 4. These cross-section systematics are applied to the MC templates as shown in Tab. 5.

3.1.4. FSI+SI systematics

Intranuclear hadron transport, or final-state interactions (FSI), have significant effects in the T2K energy range and result in event topologies, for scattering on nuclear targets, which are drastically different compared with those created in neutrino scattering on free nucleons. Elastic and inelastic hadron rescattering, secondary pion production, single and double charge exchange and absorption followed by multi-nucleon knockout are typically modelled in neutrino event generators using intranuclear cascades.

Uncertainties due to FSI were estimated by simultaneously varying the NEUT parameters that scale the interaction probabilities for quasi-elastic scattering, absorption, charge exchange and pion production using the method described in Sec. 2 in [12]. The NIWG group produced 16 parameter sets that span the 1σ surface in the parameter space; this was done by varying the NEUT parameters when running the pion scattering simulations, and comparing the results with external pion-carbon scattering data. These 16 parameter sets are shown in Tab. 2 in [12].

Uncertainties due to secondary pion interactions (SI) were also evaluated. The NIWG group adapted the NEUT nuclear cascade model to simulate SI in the SuperK detector simulation (SKDETSIM) and to allow variations in the interaction probabilities. Details of this are given in [15]. The original 11c SKMC files do not contain all the truth information required for reweighting SI, and a second production was made. The two productions contain independent

Parameter	Definition
$f^{FSI}_{0;r}$	ν_μ & $\bar{\nu}_\mu$ CCQE, $E_{reco} < 0.4$ GeV
$f^{FSI}_{1;r}$	ν_μ & $\bar{\nu}_\mu$ CCQE, 0.4 GeV $\leq E_{reco} \leq$ 1.1 GeV
$f^{FSI}_{2;r}$	ν_μ & $\bar{\nu}_\mu$ CCQE, $E_{reco} > 1.1$ GeV
$f^{FSI}_{3;r}$	ν_μ & $\bar{\nu}_\mu$ CCnonQE
$f^{FSI}_{4;r}$	ν_e, $\bar{\nu}_e$ CC
$f^{FSI}_{5;r}$	All NC

Table 8: FSI+SI systematic parameters.

steps (SKDETSIM was rerun on the NEUT files), and there are small differences in the numbers of events between the productions. The second production was used only to produce the FSI+SI covariance matrix, which is shown in Fig. 19. The 1σ fractional errors in the 6 FSI+SI parameters are shown in Fig. 20; these are computed from the square roots of the diagonal elements of the input covariance matrix.

Since the same model is used for FSI and SI, it is possible to evaluate the uncertainties in both FSI and SI simultaneously. This was done by reweighting a single μ-like ring selected SK MC with the 16 FSI parameter sets using T2KReweight. The reweighting method for FSI is described in Sec. 8 in [11]. Variations in the SI interaction probabilities were included for each FSI parameter set. Subsequently a covariance matrix was calculated using equation 1 in [12]; the quantity p in that equation is the average event weight for a FSI parameter set, and the sum is over the parameter sets.

The covariance matrix was made with a 6-bin scheme, as shown in Tab. 8. For ν_μ, $\bar{\nu}_\mu$ CCQE, the FSI+SI binning scheme is identical to that used by SuperK for calculating the ν_μ, $\bar{\nu}_\mu$ CCQE ring-counting efficiency error matrix.

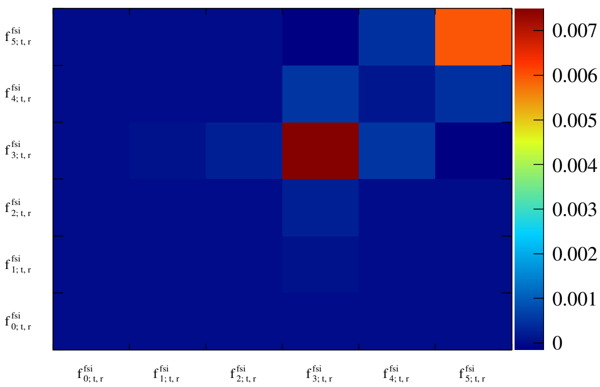

Figure 19: The input FSI+SI covariance matrix. The meaning of each parameter is given in Tab. 8.

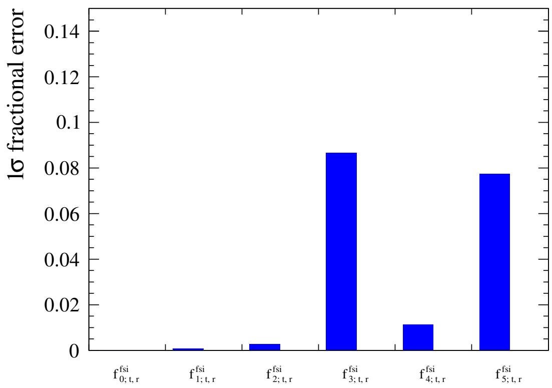

Figure 20: 1σ fractional error for FSI+SI parameters (computed from the square roots of the diagonal elements of the input covariance matrix). The meaning of each parameter is given in Tab. 8.

3.2. *Evaluation of systematic effects on the single μ-like ring reconstructed energy spectrum*

In this section, we present the effects of the systematics described in Secs. 3.1.2, 3.1.3 and 3.1.4 on the expected number of single μ-like ring events and the reconstructed energy spectrum in SuperK. These effects are shown both for no oscillations and for oscillations with $\sin^2 2\theta_{23}$ = 1.0 and $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4. For the oscillation cases, the 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. The normal mass hierarchy is assumed. All results are generated for an integrated exposure of 3.010×10^{20} POT and the BANFF-tuned MC templates are used.

The effects of systematic uncertainties on the expected number of events, both for no oscillations and for oscillations with the typical parameter values given above, is summarised in Tab. 9. In this table, systematic parameters are grouped

Source of uncertainty	$\delta N_{SK}/N_{SK}$ (no oscillation)	$\delta N_{SK}/N_{SK}$ (oscillations with typical parameter values)
SuperK detector	5.57%	10.08%
BANFF (prefit)	24.14%	21.84%
BANFF (postfit)	4.38%	4.15%
Uncorrelated XSec	3.64%	6.26%
FSI+SI	1.87%	3.48%
Total (BANFF prefit)	25.11%	25.10%
Total (BANFF postfit)	8.18%	13.04%

Table 9: Effect of 1σ systematic parameter variation on the number of 1-ring μ-like events, computed for no oscillations and for oscillations with $\sin^2 2\theta_{23}$=1.0 and $|\Delta m^2_{32}|$=2.4$\times10^{-3}$ eV^2/c^4. For the oscillation scenario, the 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. The normal mass hierarchy is assumed. The numbers shown were calculated for an exposure of 3.010$\times10^{20}$ POT and BANFF-tuned MC templates were used.

into a few categories and all parameter correlations are taken into account. Entries for both the BANFF prefit and postfit errors are provided. The effects of each parameter individually are presented in Tab. 10 in which the correlations between parameters are necessarily ignored.

The effects of the combined systematic uncertainties on the reconstructed energy spectrum of single μ-like ring events is shown in Fig. 21, for the typical oscillation scenario used. This plot shows the total error envelope for the 1 μ-like ring event reconstructed energy spectrum; this is calculated as the $\pm1\sigma$ spread of bin contents from 100k toy MC experiments generated with randomized systematic parameters. In Fig. 21, all systematic parameters were considered and their correlations were taken into account.

Error envelopes from the effects of certain groups of systematic parameters are shown in Figs. 22 (SuperK detector systematics only), 23 (BANFF systematics only), 24 (uncorrelated cross-section systematics only), and 25 (FSI+SI systematics only).

Detailed studies showing the effects of individual systematics on the expected number of single μ-like ring events are shown in Appendix E, while their effects on the reconstructed energy spectrum of the single μ-like ring sample are shown in Appendix F.

Source of uncertainty	$\delta N_{SK}/N_{SK}$ (no oscillation)		$\delta N_{SK}/N_{SK}$ (oscillations with typical params)	
	BANFF prefit	BANFF postfit	BANFF prefit	BANFF postfit
$f^{SK}_{E;r}$	0.00	0.00	0.00	0.00
$f^{SK}_{CCQEoth;r}$	1.41	1.41	0.97	0.97
$f^{SK}_{CCQERC0;r}$	0.06	0.06	0.11	0.11
$f^{SK}_{CCQERC1;r}$	2.22	2.22	0.83	0.83
$f^{SK}_{CCQERC2;r}$	0.96	0.96	2.30	2.30
$f^{SK}_{CCnQE;r}$	0.41	0.41	7.75	7.75
$f^{SK}_{NC;r}$	0.18	0.18	5.84	5.84
$f^{SK}_{\nu_e;r}$	0.02	0.02	0.26	0.26
$f^{banff}_{0;t,r}$	0.35	0.28	0.81	0.68
$f^{banff}_{1;t,r}$	1.01	0.82	0.65	0.54
$f^{banff}_{2;t,r}$	1.91	1.51	0.12	0.10
$f^{banff}_{3;t,r}$	2.22	1.69	0.29	0.23
$f^{banff}_{4;t,r}$	3.69	2.71	2.38	1.79
$f^{banff}_{5;t,r}$	1.05	0.80	1.89	1.49
$f^{banff}_{6;t,r}$	0.66	0.46	1.77	1.29
$f^{banff}_{7;t,r}$	0.32	0.22	0.99	0.70
$f^{banff}_{8;t,r}$	0.40	0.33	1.32	1.08
$f^{banff}_{9;t,r}$	0.20	0.14	0.65	0.48
$f^{banff}_{10;t,r}$	0.05	0.04	0.17	0.13
$f^{banff}_{11;t,r}$	0.06	0.05	0.03	0.03
$f^{banff}_{12;t,r}$	0.06	0.05	0.05	0.04
$f^{banff}_{13;t,r}$	0.09	0.08	0.16	0.14
$f^{banff}_{14;t,r}$	0.10	0.08	0.27	0.23
$f^{banff}_{15;t,r}$	0.08	0.07	0.24	0.22
$f^{banff}_{16;t,r}$	21.40	8.35	15.99	6.66
$f^{banff}_{17;t,r}$	2.80	1.86	6.65	4.31
$f^{banff}_{18;t,r}$	7.86	6.46	4.23	3.52
$f^{banff}_{19;t,r}$	1.41	1.06	3.94	2.96
$f^{banff}_{20;t,r}$	0.37	0.31	1.19	1.03
$f^{banff}_{21;t,r}$	3.67	2.14	4.90	2.84
$f^{banff}_{22;t,r}$	1.69	1.02	5.38	3.67
$f_{pF;t,r}$	0.06	0.06	0.11	0.11
$f_{bindE;t,r}$	0.39	0.39	0.18	0.18
$f_{SF;t,r}$	2.49	2.49	0.67	0.67
$f_{\pi-less\Delta;t,r}$	3.16	3.16	5.47	5.47
$f_{CCothShape;t,r}$	0.28	0.28	0.82	0.82
$f_{Wshape;t,r}$	0.11	0.11	0.39	0.39
$f_{CCcoh;t}$	0.56	0.56	0.88	0.88
$f_{NC1\pi^{\pm};t}$	0.26	0.26	0.92	0.92
$f_{NCoth;t}$	0.23	0.23	0.82	0.82
$f_{CC\nu_e;t}$	0.00	0.00	0.00	0.00
$f_{CC\bar{\nu};t}$	1.19	1.19	2.33	2.33
$f^{FSI}_{0;t,r}$	0.00	0.00	0.00	0.00
$f^{FSI}_{1;t,r}$	0.05	0.05	0.02	0.02
$f^{FSI}_{2;t,r}$	0.03	0.03	0.07	0.07
$f^{FSI}_{3;t,r}$	1.83	1.83	3.37	3.37
$f^{FSI}_{4;t,r}$	0.00	0.00	0.00	0.00
$f^{FSI}_{5;t,r}$	0.13	0.13	0.45	0.45

Table 10: Effects of 1σ systematic parameter variations on the number of 1-ring μ-like events, computed for no oscillations and for oscillations with $\sin^2 2\theta_{23}$=1.0 and $|\Delta m^2_{32}|$=2.4$\times 10^{-3}$ eV^2/c^4. Correlations are ignored for this table. For the oscillation scenario, the 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. The normal mass hierarchy is assumed. The numbers shown were calculated for an exposure of 3.010$\times 10^{20}$ POT and BANFF-tuned MC templates were used.

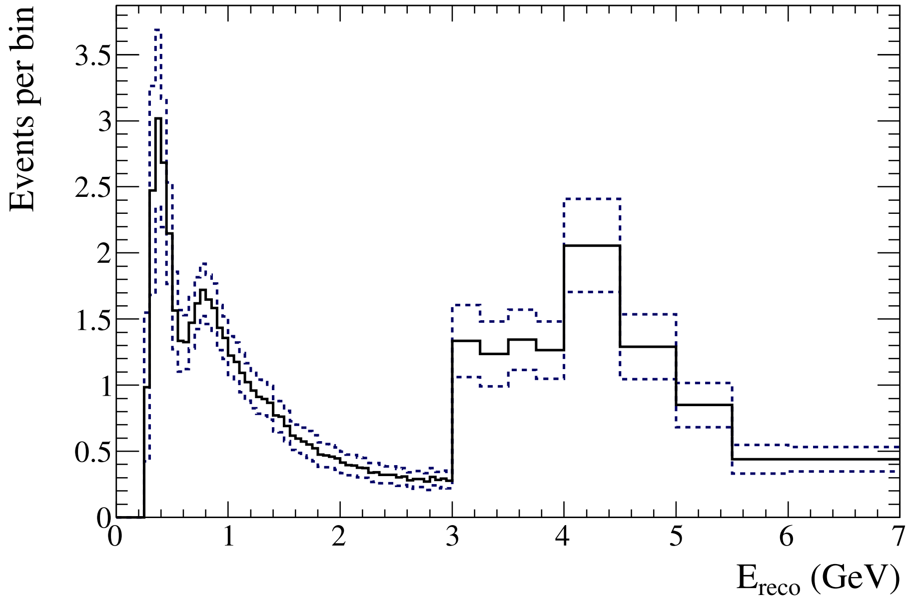

Figure 21: Total error envelope of the 1 μ-like ring event reconstructed energy spectrum, for oscillations with $\sin^2 2\theta_{23}$=1.0 and $|\Delta m^2_{32}|$=2.4$\times 10^{-3}$ eV^2/c^4. The 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. The normal mass hierarchy is assumed. The numbers shown were calculated for an exposure of 3.010$\times 10^{20}$ POT. BANFF-tuned MC templates were used. The error envelope was calculated as the $\pm 1\sigma$ spread of bin contents using an ensemble of 100k toy MC experiments generated with randomized systematic parameters. All systematic parameters were considered and their correlations were taken into account.

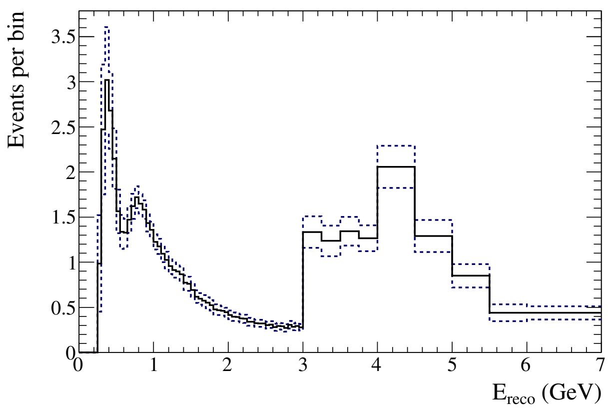

Figure 22: As in Fig. 21, but considering only SuperK detector systematics.

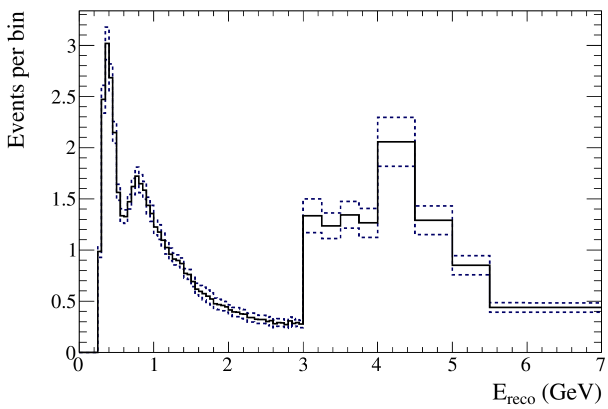

Figure 23: As in Fig. 21, but considering only BANFF systematics.

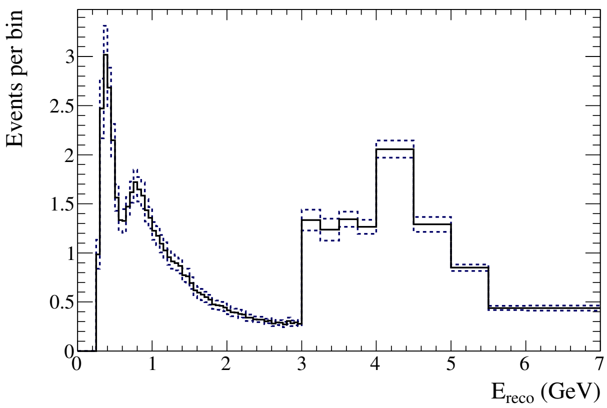

Figure 24: As in Fig. 21, but considering only uncorrelated cross-section systematics.

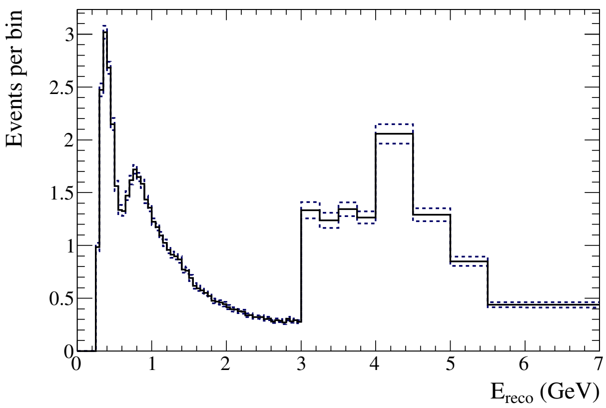

Figure 25: As in Fig. 21, but considering only FSI+SI cross-section systematics.

Parameter	Best-fit	1σ error
Δm^2_{21}	7.5×10^{-5} eV^2/c^4	$\sim$3%
$\sin^2(2\theta_{12})$	0.857	$\sim$3%
$\sin^2(2\theta_{13})$	0.098	$\sim$13%

Table 11: 2012 PDG best-fit values and 1σ range for the measured non-23-sector oscillation parameters [21].

4. Neutrino oscillation fitting

4.1. Fitting methodology

4.1.1. Choice of 23-sector oscillation parameters

Several choices exist for the 23-sector oscillation parameters that could be fitted, and they have been presented in the context of the VaLOR joint 3-flavour oscillation analysis [22]. The mixing parameter typically fitted is $\sin^2 2\theta_{23}$, but $\sin^2\theta_{23}$ is a more natural choice in the context of a 3-flavour analysis, especially one with any sensitivity to resolve the octant degeneracy. The mass-squared difference typically fitted is $|\Delta m^2_{32}|$; this is the largest squared-mass splitting for the inverted mass hierarchy but the second largest for the normal mass hierarchy. It is therefore not correct to compare results obtained under the different mass hierarchy hypotheses. Other choices include fitting for a mass-squared difference whose absolute value is the same for both mass hierarchies, such as $\Delta m^2 = \left(m_3^2 - \frac{m_1^2+m_2^2}{2}\right)$ [37], or fitting for $|\Delta m^2_{32}|$ for the inverted hierarchy and $|\Delta m^2_{31}|$ for the normal hierarchy [38]. All these choices are implemented in the VaLOR oscillation analysis framework, and our analysis can switch between them.

For the Run 1+2+3 datasets, it was agreed that all official T2K ν_μ-disappearance analyses will continue to fit the usual parameters $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$.

The PRL referees requested that we present the result in terms of $\sin^2\theta_{23}$ and $|\Delta m^2_{32}|$, so the result for this variable has been added to the note. The fact that the the center of symmetry (point of maximal disappearance) is not at $\sin^2\theta_{23} = 0.5$ makes this a sensible choice.

4.1.2. Treatment of non-23-sector oscillation parameters

In a 3-flavour ν_μ-disappearance fit, it is also necessary to make a choice for the non-23 oscillation parameters. Possible options for these parameters include

1. All 6 parameters, i.e. $\sin^2(2\theta_{12})$, $\sin^2(2\theta_{13})$, $\sin^2(2\theta_{23})$, Δm^2_{21}, $|\Delta m^2_{32}|$ and δ_{CP} can float freely.
2. All 6 parameters can float freely, but deviations in values of $\sin^2(2\theta_{12})$, $\sin^2(2\theta_{13})$ and Δm^2_{21} from values measured by other experiments are penalised.
3. $\sin^2(2\theta_{23})$ and $|\Delta m^2_{32}|$ can float freely, but $\sin^2(2\theta_{12})$, $\sin^2(2\theta_{13})$, Δm^2_{21} and δ_{CP} are fixed.

In the present analysis, option 3 is used. When finding the best-fit values of $\sin^2(2\theta_{23})$ and $|\Delta m^2_{32}|$, the values of Δm^2_{21}, $\sin^2(2\theta_{12})$ and $\sin^2(2\theta_{13})$ are fixed to the 2012 PDG best-fit values [21] shown in Tab. 11, and δ_{CP} is fixed to 0.

4.1.3. Treatment of systematic parameters

In this analysis, 48 nuisance (systematic) parameters are taken into account in the prediction of the single μ-like ring event reconstructed energy spectrum (see Sec. 3). **The VaLOR group produces oscillation results including all nuisance parameters in the fit**.

At the time of the muon-neutrino disappearance analysis of the Run1+2 dataset, the authors of this analysis (at that time referred to as the Rutherford/Oxford analysis [2]) took the view that, due to low statistics, and in the interest of simplicity and robustness, fitting for all the numerous systematic parameters considered in the analysis was not warranted. It was shown that fitting for no systematics obtained results which were very similar to the ones obtained by fitting for all systematics. It was argued that better services would be provided to the community by focussing our paper on the power of the off-axis technique rather than on statistical gymnastics. Most T2K collaborators shared this view, and the Rutherford/Oxford result was chosen as the primary result shown in the first muon-neutrino disappearance paper [7]. Similar views may be expressed in the context of the present analysis. Due to a two-fold increase of the integrated exposure since the time of the Run1+2 analysis, fitting some of the dominant systematic parameters is now justified. However, again, we express concerns that fitting for all 48 systematic parameters considered in this analysis is not warranted, especially in view of the small effect many of them have compared with the effect of some of the approximations made in this analysis. We have therefore sought to reduce the dimensionsality of our fit while accounting for the full systematic effects on our measurements of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$. **In addition to the result obtained by fitting all systematics, the VaLOR group produces *alternative* oscillation results by allowing only the most important systematics to float in the fit**. A detailed study to select the systematic parameters to include in the fit for the alternative result is presented in Sec. 4.4. We give the VaLOR group viewpoint on which is the preferred result to show publicly in Sec. 5.7, after presenting all the results in detail.

4.1.4. Allowed range of fit parameters

The search for the minimum value of $-2\ln\lambda(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a})$ (see Eq. 5) is performed in the range $0 \leq \sin^2 2\theta_{23} \leq 1$ and $1 \times 10^{-3} eV^2/c^4 \leq |\Delta m^2_{32}| \leq 6 \times 10^{-3} eV^2/c^4$. Values of $\sin^2 2\theta_{23} > 1$ are not permitted; although it is numerically allowed and, occasionally, it yields better fits to data, it has no physical interpretation within the context in which we attempt to interpret the data and causes p.d.f.s to have pathological behaviour.

Systematic parameters included in the oscillation fit are constrained in the range [-5σ_s, +5σ_s] where σ_s is the one standard deviation error assigned to each systematic parameter[7]. Values of systematic parameters that give a negative predicted number of events in any reconstructed energy bin are not allowed. If this scenario arises, the number of events is changed to +1E-8 in that bin. This is done for the sum of all the interaction modes rather than for each mode separately.

4.1.5. Minimization method

The VaLOR disappearance analysis uses a binned likelihood-ratio method. Measurements of the oscillation parameters $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ are obtained by comparing the observed and predicted SuperK reconstructed energy spectra for 1-ring μ-like events. Let N be the number of reconstructed energy bins and $\mathbf{a}$ be a $1 \times N_s$ - dimensional array of systematic (nuisance) parameters that affect the SuperK reconstructed energy spectrum prediction (e.g parameters that control the beam, neutrino interaction simulations and the detector response). Best-fit values are obtained by minimizing:

$$-2\ln\lambda(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a}) = 2 \cdot \sum_{i=0}^{N-1} \Big(n_i^{obs} \cdot ln(n_i^{obs}/n_i^{exp}) + (n_i^{exp} - n_i^{obs}) \Big) + (\mathbf{a} - \mathbf{a_0})^T \cdot \mathbf{C}^{-1} \cdot (\mathbf{a} - \mathbf{a_0}) \quad (5)$$

where $\mathbf{a_0}$ is an $1 \times N_s$ - dimensional array with the default values of the systematics parameters, $\mathbf{a}^T$ is the transpose of $\mathbf{a}$, $\mathbf{C}$ is the systematic parameter covariance matrix of dimension $N_s \times N_s$, n_i^{obs} is the observed number of events in the i^{th} bin, and $n_i^{exp} = n_i^{exp}(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a})$ is the corresponding expected number of events.

The likelihood-ratio method used in this analysis, is equivalent to the extended maximum likelihood method used in the alternative T2K oscillation analysis (see [1, 24] for more details). The advantage of the likelihood ratio method, compared with the extended maximum-likelihood method, is that in the large-sample limit, the quantity $-2\ln\lambda(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a})$ in Eq.5 has a χ^2 distribution and it can therefore be used as a goodness-of-fit test. In this note $-2\ln\lambda(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a})$ and $\chi^2(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a})$ are used interchangeably.

The minimization is performed with Minuit [25], using the Migrad method. If Migrad does not converge, the starting values of the oscillation parameters are re-initialised: the new initial values are randomly drawn from uniform distributions in the ranges $0.80 \leq \sin^2 2\theta_{23} \leq 0.98$, $2 \cdot 10^{-3} \leq |\Delta m^2_{32}| \leq 3 \cdot 10^{-3}$ and the fit is retried. This is repeated 10 times. If the fits still fail to converge, the Simplex algorithm is used. The Hesse algorithm is called after a successful fit to improve Minuit's estimates of the errors on the fitted parameters.

4.1.6. Brief note on out fit labeling scheme

In the following sections, the different fits are labeled as 'I_{osc}+I_{syst}', where I_{osc} and I_{syst} represent, respectively, the number of oscillation and systematic parameters which are allowed to float in the fit. If the symbol N is shown in place of I_{syst}, all of the systematic parameters are allowed to float. If an actual number is shown in place of I_{syst}, this is the number of systematics that is allowed to float.

[7] Such an error is defined for all but one of the systematic parameters considered in this analysis. The exception is the systematic parameter f_{SF} which parameterizes the uncertainty on nuclear modelling, switching between the Relativistic Fermi Gas (RFG) and Spectral Function (SF) models. The allowed range of the parameter f_{SF} in the oscillation fit is [0,1].

Accoring to the above scheme, '2+N' denotes a fit of $\sin^2 2\theta_{23}$, $|\Delta m^2_{32}|$ and all nuisance parameters, '2+8' denotes a fit of $\sin^2 2\theta_{23}$, $|\Delta m^2_{32}|$ and the 8 most important systematic parameters, '0+N' denotes a fit of all nuisance parameters with all oscillation parameters fixed, etc.

4.2. Goodness-of-fit tests

In our ν_μ-disappearance analysis of the Run1+2 datasets, p-values were computed using both a) the rate of single μ-like ring events and b) the rate and reconstructed energy distribution of single μ-like ring events using the likelihood-ratio method [28]. The choice is not unique.

D. Karlen has pointed out that, if the statistics are low, "the use of the distribution is not helpful in forming the p-value. This is directly related to the well known problem that is difficult to define a general goodness-of-fit for sparsely populated distributions. Large bins (or in the extreme a single bin = rate-only) are necessary for small statistics samples" [29].

It was decided by the oscillation analysis group that, for all ν_μ-disappearance analyses, p-values will be calculated using the rate and the reconstructed energy distribution, and that the distribution will use a very coarse binning scheme to ensure that there are sufficient numbers of events in each bin: this scheme has 5 bins from 0-0.4, 0.4-0.7, 0.7-1.0, 1.0-2.0 and 2.0-30.0 GeV.

4.3. Toy Monte Carlo study of fitter performance

The performance of the fitter was evaluated using an ensemble of 10k toy MC experiments, generated with input oscillation parameters $\sin^2 2\theta_{23}$ = 0.9 and $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4 and an exposure of 3.010×10^{20} POT. A further 10k toy MC experiments with the same input oscillation parameters and an exposure of 3.010×10^{22} POT ($100\times$ Run1+2+3 exposure) were also used. These simulated experiments included statistical fluctuations and fluctuations of the 8 dominant systematic parameters only (see Sec. 4.4). The toy MC experiments were fitted using MINUIT and HESSE errors, with a '2+8' fit being used. Residual and pull distributions were studied for oscillation and systematic paraneters. No issue was identified regarding the fitter performance, which was as expected The results are presented in Appendix H[8].

4.4. Systematic analysis

This section describes a study into the effect of systematic uncertainties in the joint estimation of the $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ using the fitting procedure described in Sec. 4.1.5. Only a summary is given here, and the full study is shown in Appendix G.

To quantify the effect of each systematic, toy MC datasets are generated with no statistical fluctuations and with the systematic parameter in question varied by $\pm1\sigma$. A '2+0' fit is performed on each dataset. For correlated systematic parameters, σ is defined as the square root of the corresponding covariance matrix diagonal element. The effect of the systematic parameter on the oscillation parameters, for the given systematic parameter variation and the input true oscillation point, is taken to be the difference between the best-fit and true oscillation points.

Figs. 26-29 show the so-called "star plots", which have arrows plotted for each systematic parameter from the true input point to the best-fit points for both the +1σ and the -1σ fits. These figures show only the "dominant" systematic parameters, which are defined as those having an effect on $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ greater than 25% of the expected statistical error at one or more true oscillation points in the area of interest in the parameter space. The statistical error was evaluated using 10k toy MC datasets with no systematic fluctuations at each input point, with each dataset being fitted with the '2+0' method. The maximum deviation found between the true input and best-fit oscillation parameters for all true oscillation points tested is summarised in Tab. 12. The dominant systematic parameters are highlighted in red in that table.

The purpose of this study was to identify the dominant systematics in order to reduce the dimensionality of the fit. As shown in Tab. 12, only 8 (out of a total of 48) systematic parameters have an effect which is larger than 25% of the expected statistical error anywhere in the oscillation parameter space of interest. These systematic parameters are:

- $f^{SK}_{E;r}$: SuperK reconstructed energy scale systematic.

[8] Fitter performance tests have not been repeated for the fit in terms of $\sin^2\theta_{23}$, however they are available for similar analyses using the same code, in reference [5] for the joint oscillation analysis, fitting for $\sin^2\theta_{23}$ to Run 1-3 POT, and in reference [6] for the disappearance-only analysis, fitting for $\sin^2\theta_{23}$ to Run 1-4a POT. Both of these analyses use a (slightly) different systematic parameter representation, and also fit for some non-23-sector oscillation parameters. No problems have been found with the fitter performance in these cases.

- $f^{SK}_{CCnonQE;r}$: ν_μ, $\bar{\nu}_\mu$ SuperK CCnonQE efficiency systematic. This is a combined systematic parameter which includes the uncertainty on all fiducial volume, ring-counting, reduction chain, OD cut, PID cut, momentum cut and decay electron cut efficiencies.

- $f^{SK}_{NC;r}$: SuperK NC efficiency systematic. This is a combined systematic parameter which includes all sources of uncertainty listed above for $f^{SK}_{CCnonQE;r}$.

- $f^{banff}_{16;t,r}$: CCQE axial mass systematic.

- $f^{banff}_{18;t,r}$: CCQE normalisation systematic in the true energy range 0 - 1.5 GeV.

- $f_{bindE;t,r}$: ^{16}O binding energy systematic.

- $f_{SF;t,r}$: ^{16}O nuclear environment modeling systematic. Switches from Fermi Gas (RFG) to Spectral Function (SF) model.

- $f_{\pi-less\Delta;t,r}$: Systematic parameter taking into account the uncertainty in the fraction of π-less Δ decays is resonance neutrino-production events.

When performing a '2+8' fit, it should be noted that correlations are respected; the 21 BANFF parameters which are not fitted move as a result of changing the 2 BANFF parameters which are fitted, and all BANFF parameters contribute to the fit penalty term. Also, it should be noted that all parameter correlations are taken into account when the toy MC experiments are generated, and this is true for all fit methods.

It was decided to perform a '2+8' oscillation fit in addition to the '2+N' fit, This was done with the underlying assumption that, if the results of the two fits were identical, the '2+8' fit would be the preferred one to present outside T2K due to its simpicity, robustness, economy of assumptions and ease of explanation. It is physically correct and accounts for the full systematic error on our measurements.

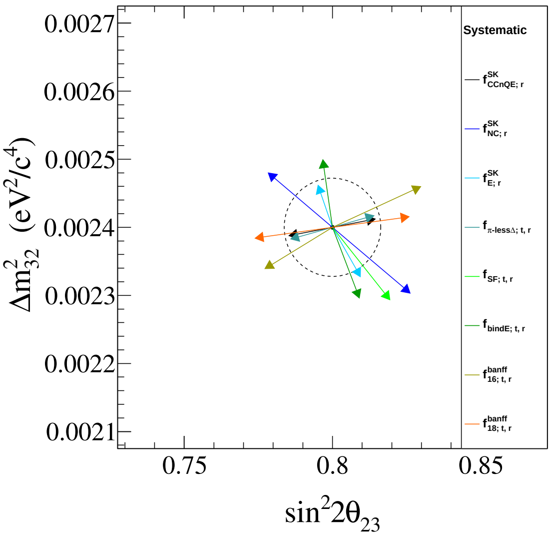

Figure 26: Effects of variation by $\pm 1\sigma$ of the 8 dominant systematic parameters on the oscillation parameters $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$. The method used for estimating the systematic shift is described in Sec. 4.4. The ellipse shown is one quarter the size of the statistical error. The true 23-sector oscillation parameters used are $\sin^2 2\theta_{23}$ = 0.80 and $|\Delta m^2_{32}|$ = $2.4\times10^{-3} eV^2/c^4$. The 2012 PDG values are used for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21}, and δ_{CP}=0. The normal mass hierarchy is assumed.

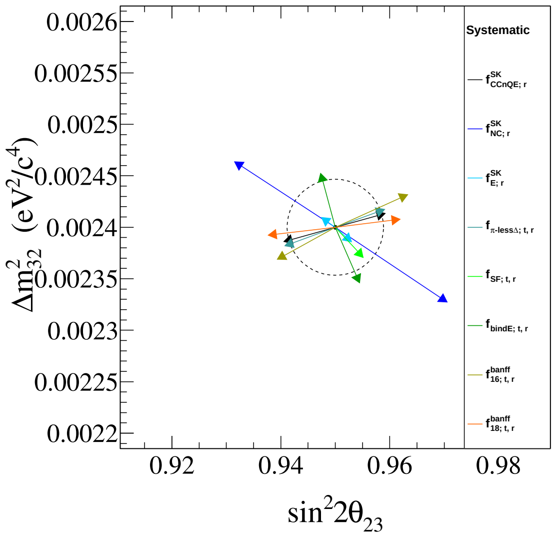

Figure 27: As in Fig. 26, but for true 23-sector oscillation parameters $\sin^2 2\theta_{23}$ = 0.95 and $|\Delta m^2_{32}|$ = $2.4\times10^{-3} eV^2/c^4$.

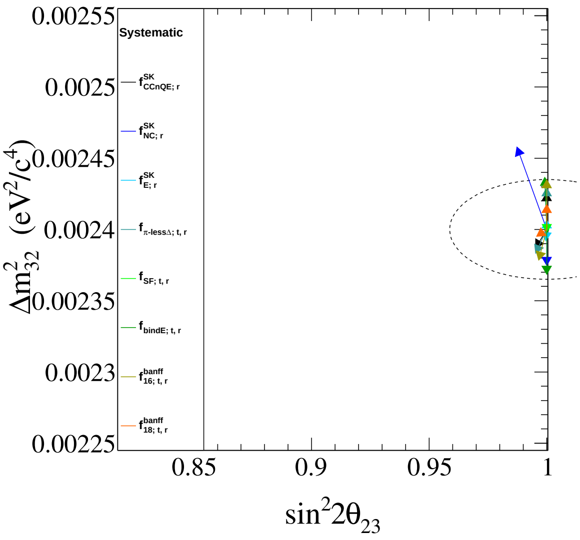

Figure 28: As in Fig. 26, but for true 23-sector oscillation parameters $\sin^2 2\theta_{23}$ = 1.00 and $|\Delta m^2_{32}|$ = $2.4\times10^{-3} eV^2/c^4$.

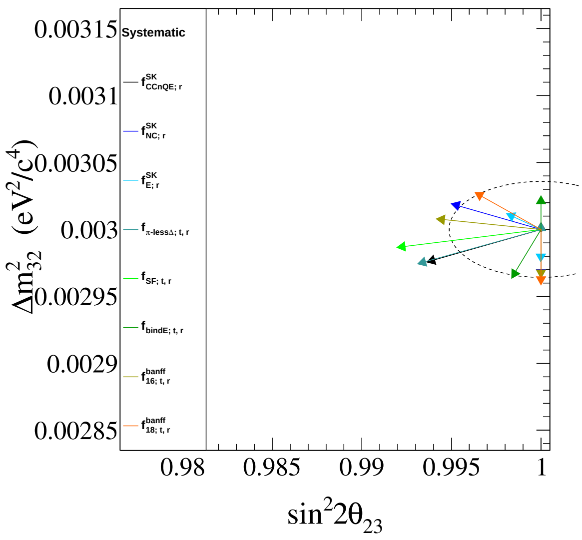

Figure 29: As in Fig. 26, but for true 23-sector oscillation parameters $\sin^2 2\theta_{23}$ = 1.00 and $|\Delta m^2_{32}|$ = $3.0\times10^{-3} eV^2/c^4$.

4.5. Construction of confidence regions

In this analysis, we present confidence regions for all variations of the oscillation fit ('2+N' and '2+8'). Confidence regions are shown with both the constant $\Delta\chi^2$ (see Sec. 4.5.1) and the Feldman and Cousins (see Sec. 4.5.2) methods. A definite recommendation on the preferred methodology for constructing confidence regions was provided by the T2K ν_μ contour committee [30] and it will be reiterated in Sec. 5.7.

The two methods have been described in detail in past T2K technical notes and presentations. For completeness, we summarise both of these methods here and provide definite statements on the exact methodology used for incorporating systematic errors.

The methods differ in the calculation of the critical values of $\Delta\chi^2$, which are used to identify the areas of the parameter space to be included in the allowed region for a given confidence level. This allowed region is

$$\chi^2(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a}) < \chi^2_{min} + \Delta\chi^2{}_{critical} \tag{6}$$

However, the procedure followed for constructing the χ^2 surface itself, as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, is common to both methods. Assuming that N systematic parameters are allowed to float in the oscillation fit, the values of $\chi^2(\sin^2 2\theta_{23}, |\Delta m^2_{32}|; \mathbf{a})$ are calculated via a '0+N' fit at *each* point of the ($\sin^2 2\theta_{23}$, $|\Delta \mathrm{m}^2_{32}|$) 2-dimensional grid, i.e. by fixing the oscillation parameters to the true values for the given grid point and minimising χ^2 with respect to the N systematic parameters.

The following grid spacing is used in all confidence region construction methods: $\delta\sin^2 2\theta_{23} = 5\times10^{-3}$ and $\delta|\Delta m^2_{32}| = 1\times10^{-4} eV^2/c^4$. The $|\Delta m^2_{32}|$ binning is the same as that used in our Run 1+2 analysis, while the $\sin^2 2\theta_{23}$ bin size is reduced by 50% since sensitivity studies showed that the contour was expected to shrink in $\sin^2 2\theta_{23}$ by a similar factor.

4.5.1. Constant $\Delta\chi^2$ method

The constant $\Delta\chi^2$ method for quoting uncertainties on parameters measured jointly ($\sin^2 2\theta_{23}$, $|\Delta m^2_{32}|$ in our analysis) is described in [21] (pp. 390-401). It is a fully frequentist treatment using the Gaussian approximation. One finds the best-fit point and calculates the confidence contours as lines of *constant* $\Delta\chi^2$ from this point[9].

4.5.2. Feldman and Cousins method

The work of Feldman and Cousins [26] uses the freedom which is inherent in the Neyman construction of confidence regions to address cases (in particular, cases with Poisson processes with background and Gaussian errors near a physical boundary) where classical construction of confidence regions produces overcoverage, undercoverage, or in extreme cases, an empty region.

Using the Feldman and Cousins method, construction of the confidence region proceeds as follows: a number of toy MC experiment fits is performed for each point of the ($\sin^2 2\theta_{23}$, $|\Delta \mathrm{m}^2_{32}|$) 2-dimensional grid. For each grid point, the critical value of $\Delta\chi^2$ ($\Delta\chi^2_{critical}$) is found such that α of the toy MC experiments have $\Delta\chi^2_{MC} < \Delta\chi^2_{critical}$, where α is the desired confidence level. The value of $\Delta\chi^2_{MC}$ for each toy MC experiment is calculated as

$$\Delta\chi^2_{MC} = \chi^2(\text{true}) - \chi^2(\text{MC, best fit}) \tag{7}$$

where "true" means that the χ^2 was computed using the true values of the oscillation parameters at that grid point, and "best-fit" means that the χ^2 was computed using the actual best-fit values for that MC experiment. The χ^2 values are calculated using Eq. 5.

The Feldman and Cousins confidence regions for a fit to an actual dataset are drawn such that grid points with $\Delta\chi^2_{data} < \Delta\chi^2_{critical}$ are included within the contour, where $\Delta\chi^2_{data}$ is given by

$$\Delta\chi^2_{data} = \chi^2(\text{true}) - \chi^2(\text{data, best fit}) \tag{8}$$

The principal difference between the Feldman and Cousins and the constant $\Delta\chi^2$ methods is that the former determines the value of $\Delta\chi^2_{critical}$ individually for each grid point, whereas the latter uses the same value for all grid points.

[9]For 1 fit parameter, the critical values of $\Delta\chi^2$ used are 1.00 (68% CL), 2.71 (90% CL), 3.84 (95% CL), 6.63 (99% CL). For 2 parameters fitted simultaneously, the critical values of $\Delta\chi^2$ used are 2.30 (68% CL), 4.61 (90% CL), 5.99 (95% CL), 9.21 (99% CL).

Parameter	$\frac{\delta_{syst} sin^2 2\theta_{23}}{\delta_{stat} sin^2 2\theta_{23}}$	$\frac{\delta_{syst}\|\Delta m^2_{32}\|(eV^2/c^4)}{\delta_{stat}\|\Delta m^2_{32}\|(eV^2/c^4)}$
$f^{SK}_{E;r}$	0.3486	0.3058
$f^{SK}_{CCQEoth;r}$	0.0872	0.0544
$f^{SK}_{CCQERC0;r}$	0.0106	0.0099
$f^{SK}_{CCQERC1;r}$	0.1398	0.1109
$f^{SK}_{CCQERC2;r}$	0.0686	0.0741
$f^{SK}_{CCnQE;r}$	0.3107	0.2134
$f^{SK}_{NC;r}$	1.1500	0.6091
$f^{SK}_{\nu_e;r}$	0.0130	0.0167
$f^{banff}_{0;t,r}$	0.0756	0.0682
$f^{banff}_{1;t,r}$	0.0883	0.1495
$f^{banff}_{2;t,r}$	0.0949	0.1248
$f^{banff}_{3;t,r}$	0.0946	0.0693
$f^{banff}_{4;t,r}$	0.2048	0.1899
$f^{banff}_{5;t,r}$	0.1053	0.0881
$f^{banff}_{6;t,r}$	0.0538	0.0452
$f^{banff}_{7;t,r}$	0.0130	0.0114
$f^{banff}_{8;t,r}$	0.0100	0.0077
$f^{banff}_{9;t,r}$	0.0051	0.0031
$f^{banff}_{10;t,r}$	0.0042	0.0029
$f^{banff}_{11;t,r}$	0.0043	0.0045
$f^{banff}_{12;t,r}$	0.0051	0.0061
$f^{banff}_{13;t,r}$	0.0103	0.0094
$f^{banff}_{14;t,r}$	0.0083	0.0079
$f^{banff}_{15;t,r}$	0.0034	0.0022
$f^{banff}_{16;t,r}$	0.5979	0.4068
$f^{banff}_{17;t,r}$	0.1557	0.1067
$f^{banff}_{18;t,r}$	0.4188	0.2891
$f^{banff}_{19;t,r}$	0.0610	0.0707
$f^{banff}_{20;t,r}$	0.0048	0.0059
$f^{banff}_{21;t,r}$	0.2142	0.1333
$f^{banff}_{22;t,r}$	0.0422	0.0462
$f_{pF;t,r}$	0.0526	0.0592
$f_{bindE;t,r}$	0.3108	0.3597
$f_{SF;t,r}$	0.4914	0.4249
$f_{\pi-less\Delta;t,r}$	0.3358	0.2342
$f_{CCothShape;t,r}$	0.0249	0.0181
$f_{Wshape;t,r}$	0.0653	0.0414
$f_{CCcoh;t}$	0.0348	0.0301
$f_{NC1\pi^{\pm};t}$	0.1282	0.0941
$f_{NCoth;t}$	0.1083	0.0858
$f_{CC\nu_e;t}$	0.0052	0.0022
$f_{CC\bar{\nu};t}$	0.1032	0.0750
$f^{FSI}_{0;t,r}$	0.0056	0.0020
$f^{FSI}_{1;t,r}$	0.0049	0.0024
$f^{FSI}_{2;t,r}$	0.0054	0.0022
$f^{FSI}_{3;t,r}$	0.1223	0.0944
$f^{FSI}_{4;t,r}$	0.0059	0.0100
$f^{FSI}_{5;t,r}$	0.0550	0.0473

Table 12: Maximum deviations, as a fraction of statistical error at the oscillation parameter grid point, from the input values of 2+0 fits to datasets with ± 1 sigma individual systematic variations at a range of oscillation points. The 8 most important systematics are highlighted in red.

The Feldman and Cousins method does not specify how systematics are to be included in the confidence region construction and different choices exist. To construct a 2-dimensional ($\sin^2 2\theta_{23}$, $|\Delta m^2_{32}|$) confidence region, where all N systematic parameters are included in the p.d.f. and all N systematics are allowed to float in the fit, this analysis uses the following methodology: the value of $\Delta\chi^2_{critical}$ at each true ($\sin^2 2\theta_{23}$, $|\Delta m^2_{32}|$) grid point is calculated from an ensemble of toy MC experiments, each one of which is generated with the true oscillation parameters of that point and with all N systematics randomised. For each toy MC experiment, a '2+N' fit is performed to obtain the value of χ^2(MC, best fit) used in Eq. 7. A separate '0+N' fit, with the oscillation parameters fixed to the true values, is performed to obtain the value of χ^2(true), i.e. χ^2 is *independently* minimised, for *each* toy MC experiment, with respect to the systematic parameters. If only a subset M (M $<$ N) of the N systematics is allowed to float in the fit, all N systematics are again randomized in the generation of the datasets, and '2+M' and '0+M' fits are performed to obtain χ^2(MC, best fit) and χ^2(true) respectively

In Fig. 30, we show a Monte Carlo estimation using the Feldman-Cousins method of the $\Delta\chi^2_{critical}$ values used for calculation of the 68% and 90% CL confidence regions for the 3.010×10^{20}-POT 3-flavour ν_μ-disappearance analysis for both the '2+8' and '2+N' fit variants. The surfaces were generated using an ensemble of toy MC experiments which included both randomized systematic variations and statistical fluctuations. Slices of the 2-dimensional distributions shown in Fig. 30, are shown in Figs. 31 and 32. From these $\Delta\chi^2_{critical}$ distributions, we anticipate that the confidence regions produced using the Feldman-Cousins method will be narrower along $|\Delta m^2_{32}|$ at maximal mixing than those made with the $\Delta\chi^2_{critical}$ method. The Feldman-Cousins contours will also be wider along $sin^2 2\theta_{23}$ for values of $|\Delta m^2_{32}|$ near the best fit.

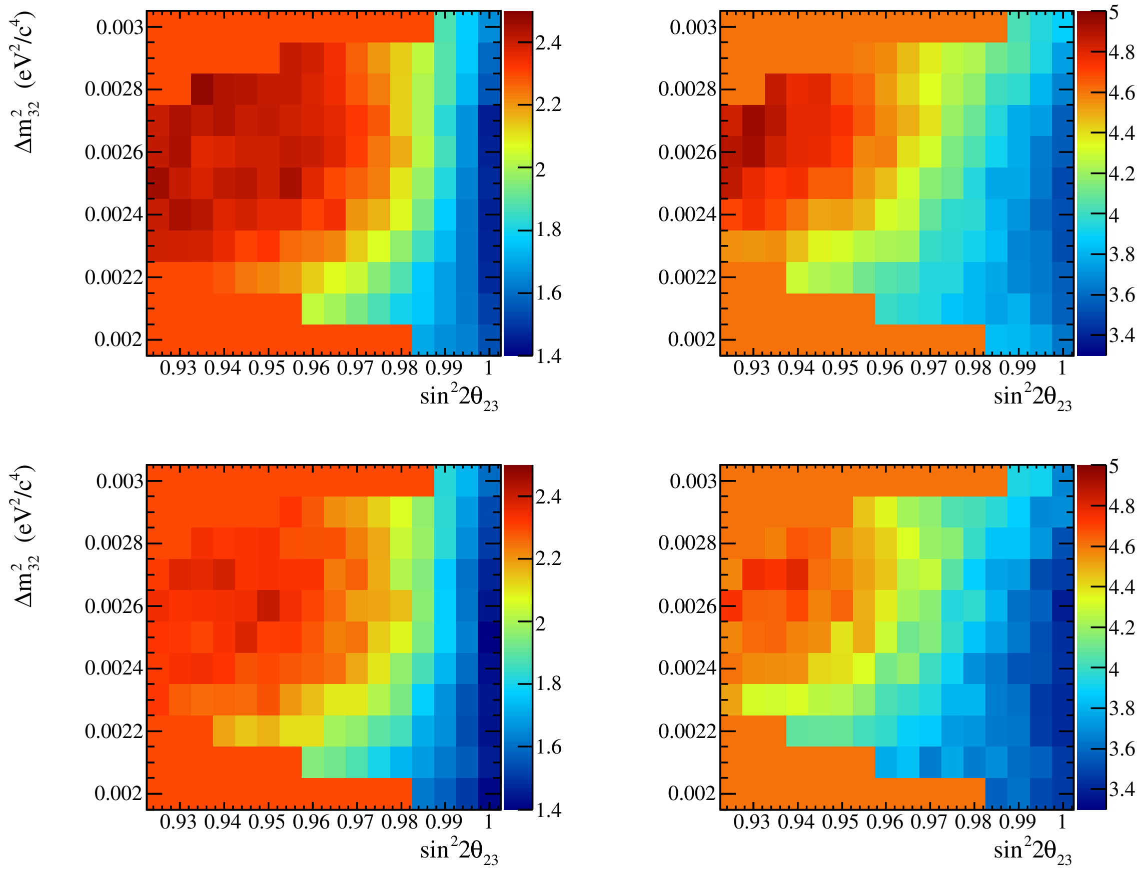

Figure 30: Monte Carlo estimation, according to the method of Feldman and Cousins, of $\Delta\chi^2_{critical}$ values $\Delta\chi^2_{68}$ (left) and $\Delta\chi^2_{90}$ (right) as functions of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, for calculation of the 68% and 90% CL confidence regions for the 3.010 $\times 10^{20}$-POT 3-flavour ν_μ-disappearance analysis. The top row shows $\Delta\chi^2_{critical}$ surfaces calculated using the '2+8' fit, whereas the bottom row shows surfaces calculated using the '2+N' fit. The surfaces were generated from an ensemble of toy-MC experiments including both randomized systematic variations and statistical fluctuations. As expected from [26], the values of $\Delta\chi^2_{critical}$ decrease as the physical boundary at $\sin^2 2\theta_{23}$ = 1 is approached.

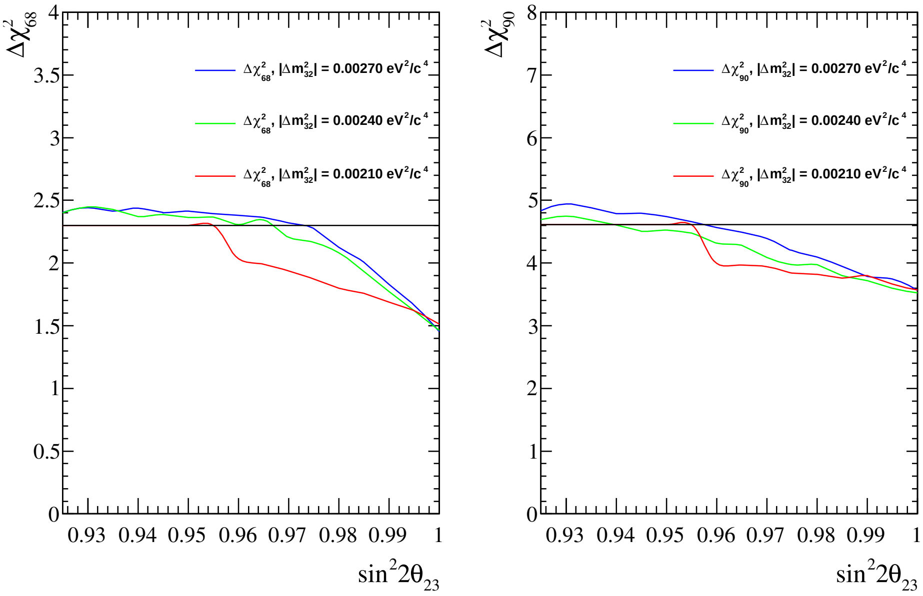

Figure 31: Monte Carlo estimation, according to the method of Feldman and Cousins, of $\Delta\chi^2_{critical}$ values $\Delta\chi^2_{68}$ (left) and $\Delta\chi^2_{90}$ (right), as functions of $\sin^2 2\theta_{23}$ for 3 different values of $|\Delta m^2_{32}|$ (2.1×10^{-3} eV$^2/c^4$, 2.4×10^{-3} eV$^2/c^4$ and 2.7×10^{-3} eV$^2/c^4$). The $\Delta\chi^2_{critical}$ values were calculated from an ensemble of toy-MC experiments, for an exposure of 3.010×10^{20} POT, including both randomized systematic variations and statistical fluctuations. The '2+8' fit was used. For comparison, the canonical value used in the constant $\Delta\chi^2_{critical}$ method is also shown as a horizontal line.

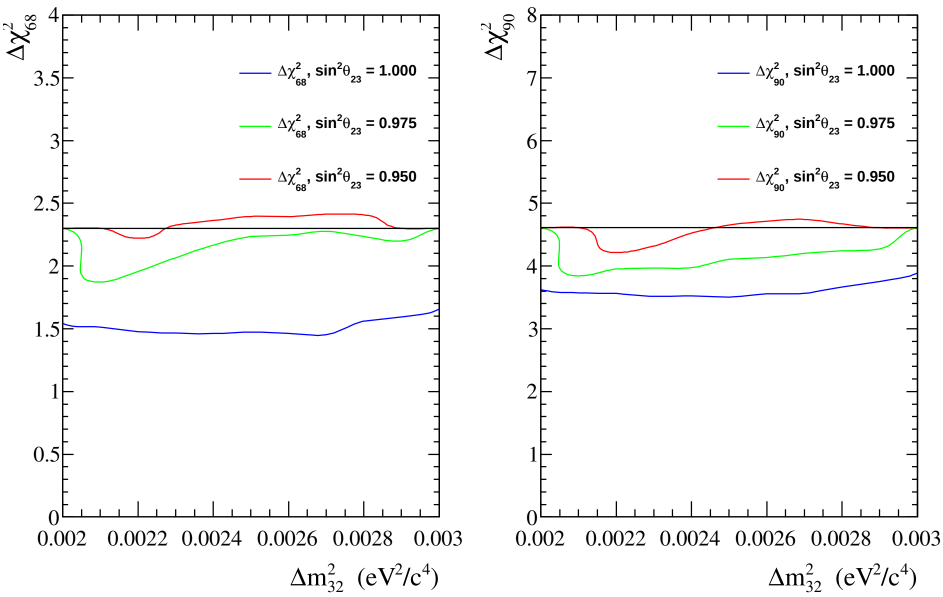

Figure 32: Monte Carlo estimation, according to the method of Feldman and Cousins, of $\Delta\chi^2_{critical}$ values $\Delta\chi^2_{68}$ (left) and $\Delta\chi^2_{90}$ (right), as functions of $|\Delta m^2_{32}|$ for 3 different values of $\sin^2 2\theta_{23}$ (0.950, 0.975 and 1.000). The $\Delta\chi^2_{critical}$ values were calculated from an ensemble of toy MC experiments, for an exposure of 3.010×10^{20} POT, including both randomized systematic variations and statistical fluctuations. The '2+8' fit was used. For comparison, the canonical value used in the constant $\Delta\chi^2_{critical}$ method is also shown as a horizontal line.

5. Results of the disappearance analysis with the Run 1+2+3 (3.010$\times 10^{20}$ POT) dataset

5.1. Best-fit oscillation parameters and systematic parameter pulls

'2+N' and '2+8' 3-flavour ν_μ-disappearance fits were performed using the method described in section 4 on the combined 3.010$\times 10^{20}$ POT Run 1+2+3 dataset and, separately, on the 1.431$\times 10^{20}$ POT Run 1+2 and the 1.579$\times 10^{20}$ POT Run 3 datasets. The first octant is assumed for θ_{23} ($\sin(\theta_{23}) \leq 0.5$) and the fit is for $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ unless explicitly stated otherwise.

Using the '2+N' fit for $\sin^2 \theta_{23}$, this analysis found $|\Delta m^2_{32}|$ = 2.441$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 0.514 to be the best-fit values for the Run 1+2+3 dataset.

Using the '2+N' fit, this analysis found $|\Delta m^2_{32}|$ = 2.443$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 1.000 to be the best-fit values for the Run 1+2+3 dataset. Similar best-fit values were obtained from separate '2+N' fits to subsets of the full dataset. A '2+N' fit to the Run 1+2 dataset gave best-fit values of $|\Delta m^2_{32}|$ = 2.588$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 0.986, while a fit to the Run 3 dataset gave $|\Delta m^2_{32}|$ = 2.383$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 1.000).

Using the '2+N' fit, assuming that θ_{23} is in the second octant, yields a best-fit point almost identical to that assuming the first octant; we found $|\Delta m^2_{32}|$ = 2.441$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 0.999.

The '2+8' fits produced results that are nearly identical to those from the '2+N' fits. Running the '2+8' fit on the combined Run 1+2+3 dataset, we found $|\Delta m^2_{32}|$ = 2.442$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 1.000 as the best-fit values. A '2+8' fit to the Run 1+2 dataset gave best-fit values of $|\Delta m^2_{32}|$ = 2.589$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 0.986, while a '2+8' fit to the Run 3 dataset gave $|\Delta m^2_{32}|$ = 2.385$\times 10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 1.000.

The results of the fits are summarized in Tabs. 13 and 14, for fits to $\sin^2 \theta_{23}$ and $\sin^2 2\theta_{23}$ respectively. In these tables are the best-fit oscillation parameters, the observed and expected number of single μ-like ring events, and the values of χ^2 per degree of freedom at the best-fit. The '2+N' and '2+8' fits give nearly identical best-fit values for the combined Run 1+2+3 dataset and, in fact, for all running periods[10]. Also the best-fit values are nearly identical between assuming the first octant and second octants for θ_{23} for the combined Run 1+2+3 dataset.

Using Eq. 4 and the value $\sin^2(2\theta_{13}) = 0.098$ used in this analysis, the point of maximal disappeance occurs at $\sin^2(2\theta_{23}) = 0.999$ for the second octant, whilst the point of maximal disappearance is $\sin^2(2\theta_{23}) = 1.000$ for the first octant. The result of the 2-flavour fit without the physical boundary show that the fit favours a high amount of disappearance, more than is physically allowed in the 2-flavour framework. Therefore it is not suprising that the '2+N' best-fit points' in the 3-flavour framework, are different, and sit at the point of maximal disappearance, for the given octant assumption.

The pull for each systematic parameter f included in the fit, is calculated as

$$\frac{f_{bf} - f_{nom}}{\sigma_{bf}}, \tag{9}$$

where f_{bf} is the best-fit value of the systematic parameter, f_{nom} is the nominal value of the parameter (corresponding to no systematic variation), and σ_{bf} is the Hesse error output from Minuit.

The pulls of all 48 systematic parameters allowed to float in the '2+N' fit are shown in Fig. 33 for the fit to the Run 1+2+3 dataset using $\sin^2 \theta_{23}$, in Fig. 34 for the fit to the Run 1+2+3 dataset assuming the first octant for θ_{23}, in Fig. 35 for the fit to the Run 1+2+3 dataset assuming the second octant, and in Figs. 36-37 for the fits to the Run 1+2 and Run 3 datasets. From these figures, it is apparent that most systematic parameters barely move from their nominal values. The pulls for the 8 dominant systematic parameters allowed to float in the '2+8' fit are shown in Fig. 38 for the fit to the Run 1+2+3 dataset, and in Figs. 39-40 for the fits to the Run 1+2 and Run 3 datasets. The systematic parameter pulls shown in Fig. 34 for the '2+N' fit are similar to those in Fig. 38 for the '2+8' fit. The systematic parameter pulls shown in Fig. 35 for the '2+N' fit assuming the second octant are similar to those in Fig. 34 for the '2+N' fit assuming the first octant. For the '2+N' case, we note that, although all 48 systematic parameters are allowed to float in the fit, only 6 of them move by more than $\pm 0.1\sigma$, for either octant assumption, and when fitting for $\sin^2 \theta_{23}$.

[10] It is interesting to know what the best-fit values would have been, had $\sin^2(2\theta_{23})$ been allowed to enter into the unphysical region. This question can not be answered in a 3-flavour framework due to the existence of a $\sqrt{1 - sin^2(2\theta_{23})}$ term in the oscillation probabilities, so we performed fits in a simple 2-flavour framework. In the presence of the physical boundary, a '2+8' fit to the Run 1+2+3 dataset yields the following best-fit values: $\sin^2(2\theta_{23})$ = 1.000 and $|\Delta m^2_{32}| = 2.47 \times 10^{-3} eV^2/c^4$. If we do not constrain $\sin^2(2\theta_{23})$ within the physical region, the same fit yields the following best-fit values: $\sin^2(2\theta_{23})$ = 1.025 and $|\Delta m^2_{32}| = 2.47 \times 10^{-3} eV^2/c^4$.

Analysis	$\sin^2\theta_{23}$	Δm^2_{32}	N$_{obs}$	N$_{exp}$	χ^2_{bf}/ndf	p-value
3-flavour $\sin^2 2\theta_{23}$ 1st octant	0.500	2.443 $\cdot 10^{-3}$	58	57.97	56.04/71	0.83
3-flavour $\sin^2 2\theta_{23}$ 2nd octant	0.516	2.441 $\cdot 10^{-3}$	58	57.92	56.03/71	0.82
3-flavour $\sin^2\theta_{23}$	0.514	2.441 $\cdot 10^{-3}$	58	57.92	56.03/71	0.80

Table 13: Summary of best-fit parameters for the combined Run 1+2+3 datasets for '2+N' fits with $\sin^2 2\theta_{23}$ converted to $\sin^2\theta_{23}$ (with both θ_{23} octant assumptions), and a '2+N' fit with $\sin^2\theta_{23}$. The quoted best-fit χ^2 values (χ^2_{bf}) were computed from Eq. 5 with the reconstructed energy binning used in each fit.

Analysis	Run period	$\sin^2 2\theta_{23}$	Δm^2_{32}	N$_{obs}$	N$_{exp}$	χ^2_{bf}/ndf	p-value
2012 / 3-flavour 1st octant / '2+N'	Run 1+2+3	1.000	2.443 $\cdot 10^{-3}$	58	57.97	56.04/71	0.83
2012 / 3-flavour 2nd octant / '2+N'	Run 1+2+3	0.999	2.441 $\cdot 10^{-3}$	58	57.92	56.03/71	0.82
2012 / 3-flavour 1st octant / '2+8'	Run 1+2+3	1.000	2.442 $\cdot 10^{-3}$	58	57.92	56.15/71	0.82
2012 / 3-flavour 1st octant / '2+N'	Run 3	1.000	2.383 $\cdot 10^{-3}$	27	29.58	56.28/71	0.83
2012 / 3-flavour 1st octant / '2+8'	Run 3	1.000	2.385 $\cdot 10^{-3}$	27	29.60	56.32/71	0.63
2012 / 3-flavour 1st octant / '2+N'	Run 1+2	0.986	2.588 $\cdot 10^{-3}$	31	29.04	38.96/71	0.82
2012 / 3-flavour 1st octant / '2+8'	Run 1+2	0.986	2.589 $\cdot 10^{-3}$	31	29.04	39.06/71	0.68
2010 / 2-flavour / '2+0'	Run 1+2	0.98	2.65 $\cdot 10^{-3}$	31	29.18	61.578/198	-

Table 14: Summary of best-fit parameters for the oscillation fits to the Run 1+2, Run 3, and combined Run 1+2+3 datasets. Best-fit values are given for both θ_{23} octants. The 2010 result is taken from the analysis presented in [2]. The quoted best-fit χ^2 values (χ^2_{bf}) were computed from Eq. 5 with the reconstructed energy binning used in each fit. The table also shows the p-values obtained from the goodness-of-fit test of Sec. 4.2 for the '2+N' and '2+8' oscillation fits to the Run 1+2, Run 3, and combined Run 1+2+3 datasets. Again values are given for both θ_{23} octants.

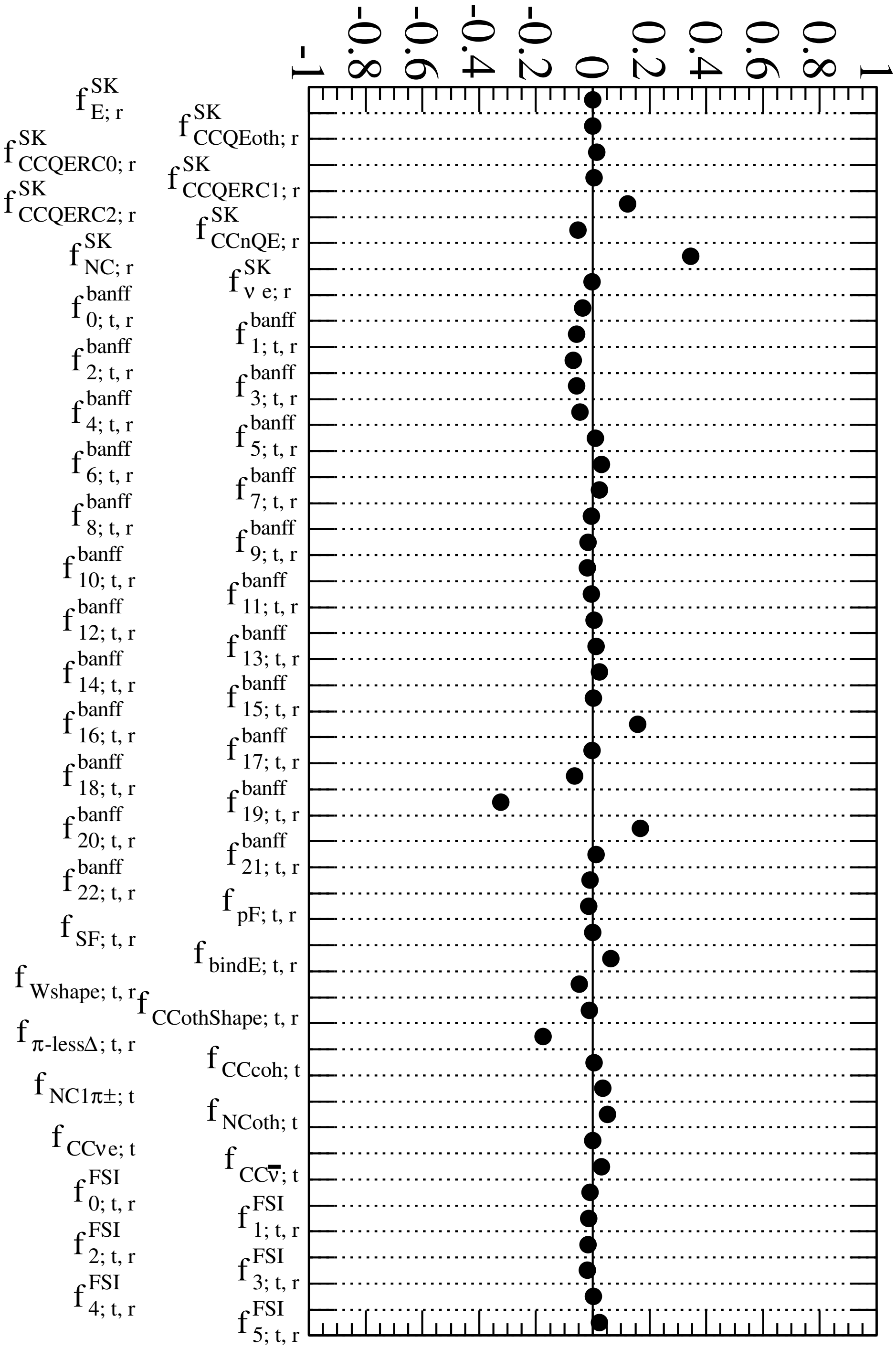

Figure 33: Systematic parameter pulls for the '2+N' $\sin^2\theta_{23}$ fit to the Run 1+2+3 dataset.

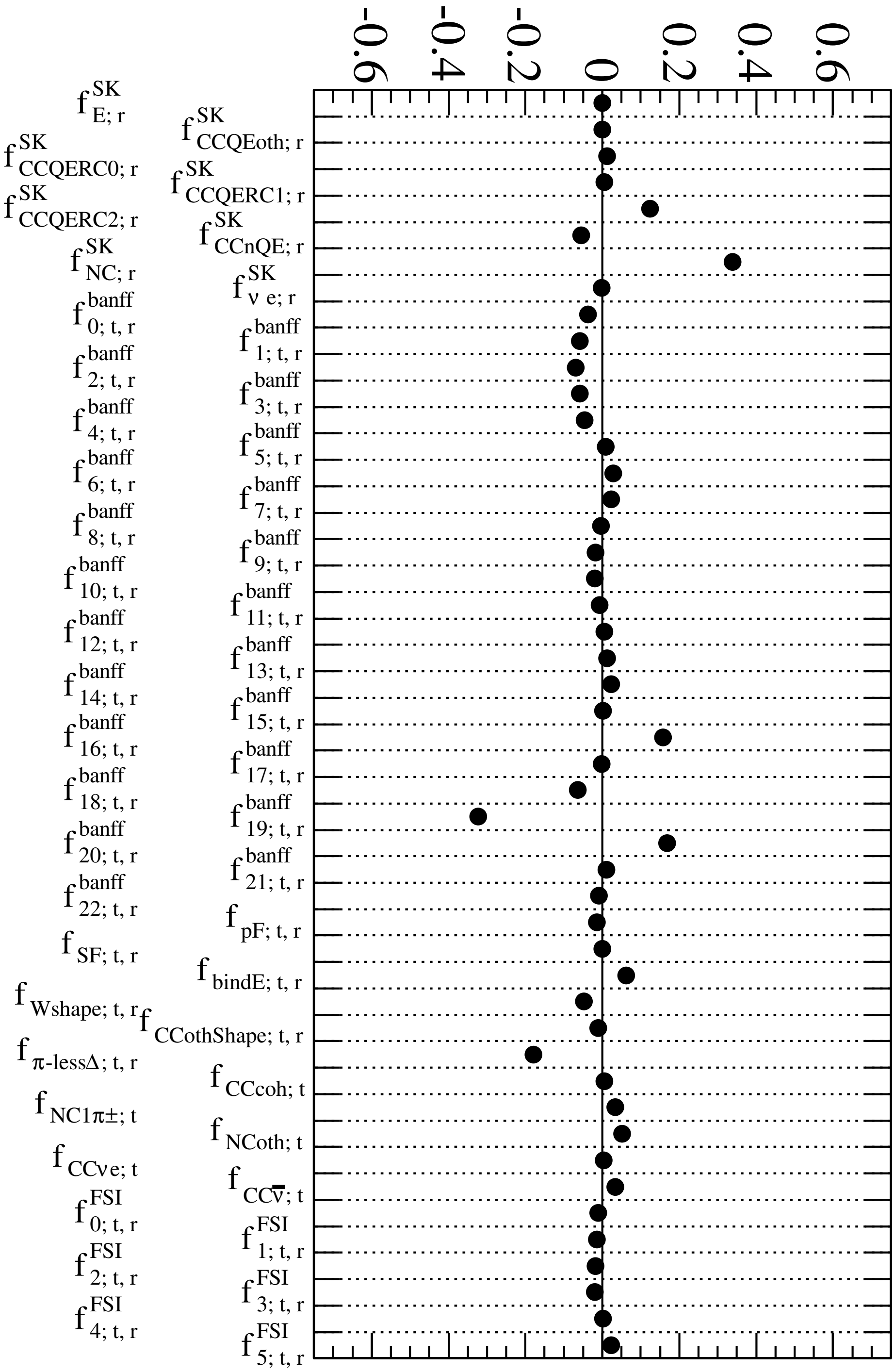

Figure 34: Systematic parameter pulls for the '2+N' fit to the Run 1+2+3 dataset, assuming θ_{23} is in the first octant.

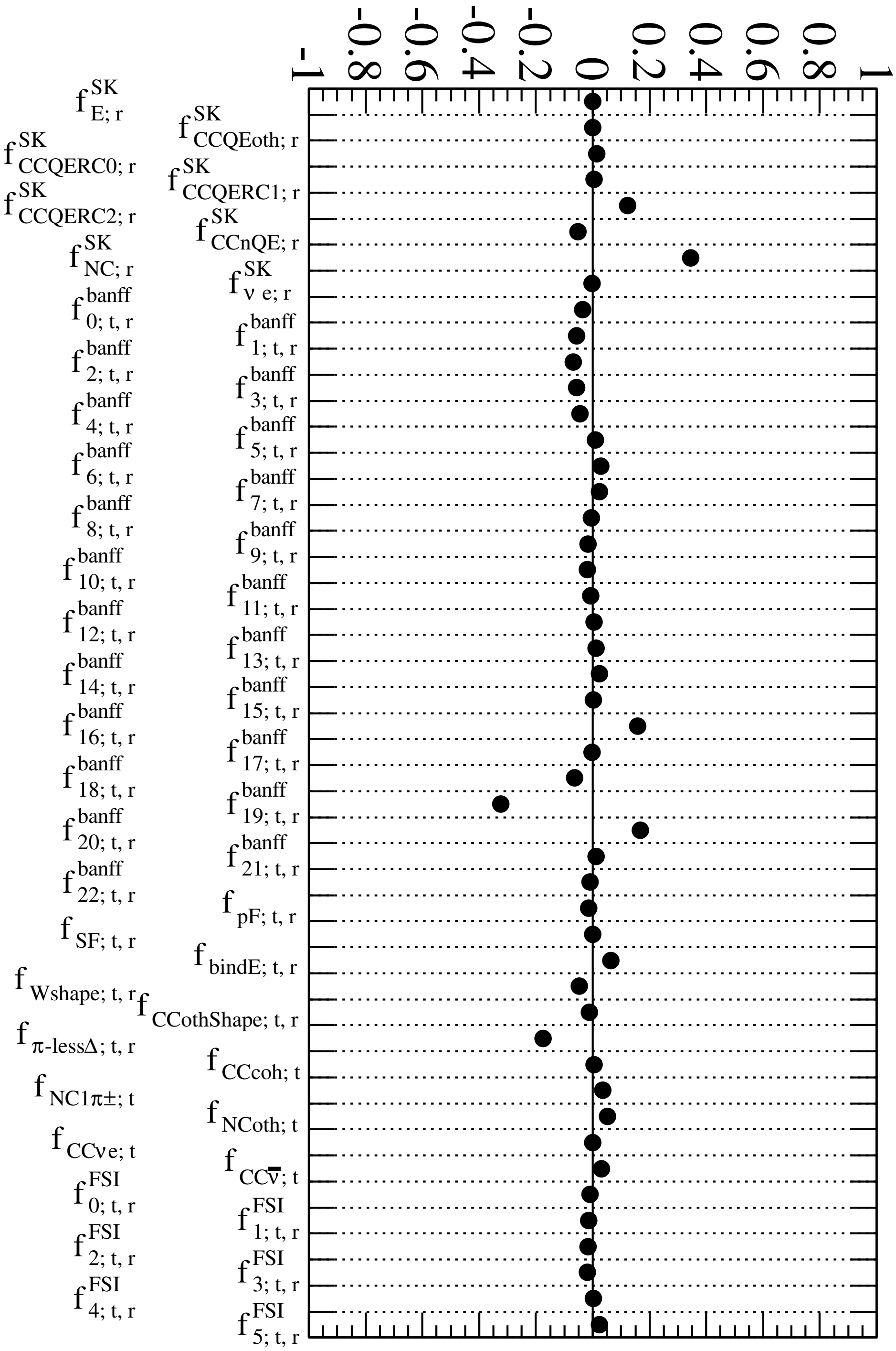

Figure 35: Systematic parameter pulls for the '2+N' fit to the Run 1+2+3 dataset, assuming θ_{23} is in the second octant.

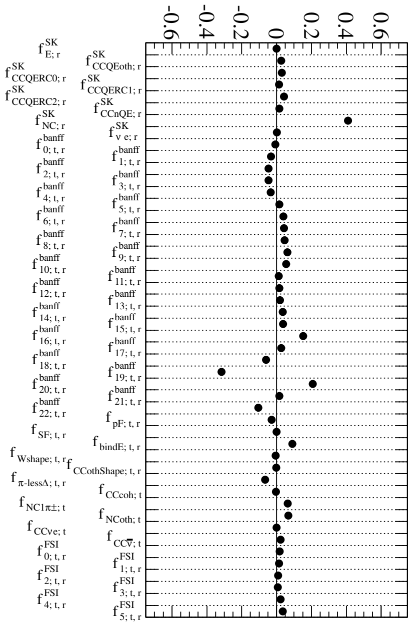

Figure 36: Systematic parameter pulls for the ‘2+N’ fit to the Run 1+2 dataset.

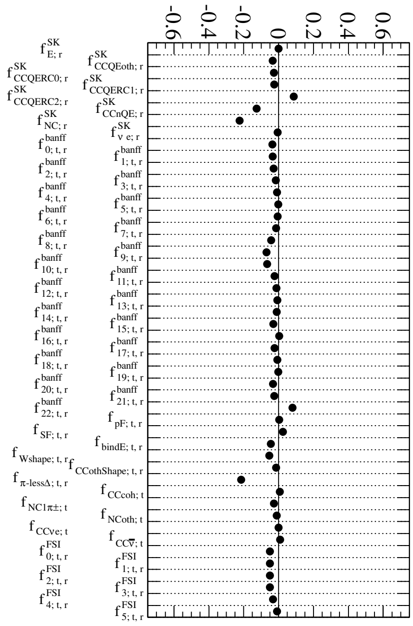

Figure 37: Systematic parameter pulls for the ‘2+N’ fit to the Run 3 dataset.

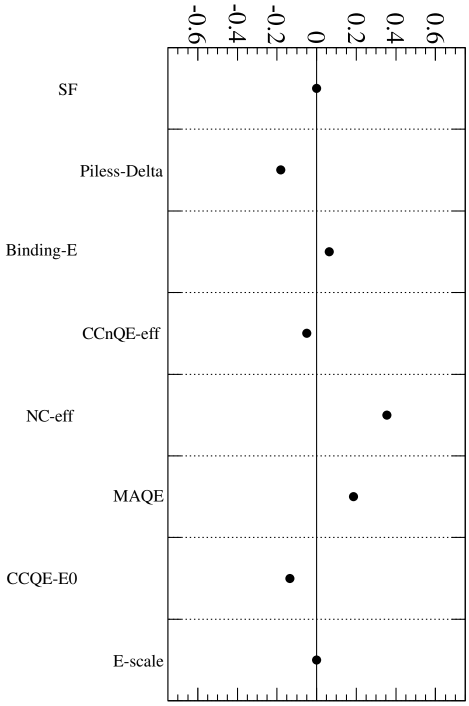

Figure 38: Systematic parameter pulls for the ‘2+8’ fit to the Run 1+2+3 dataset.

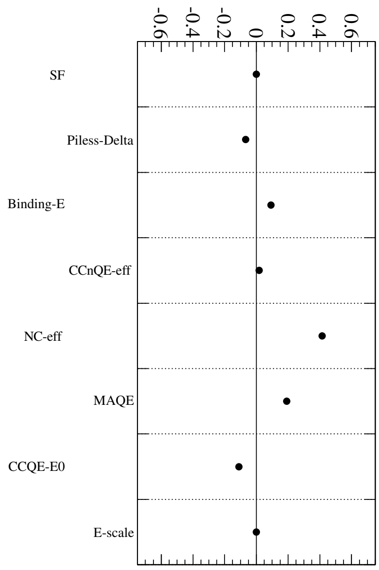

Figure 39: Systematic parameter pulls for the '2+8' fit to the Run 1+2 dataset.

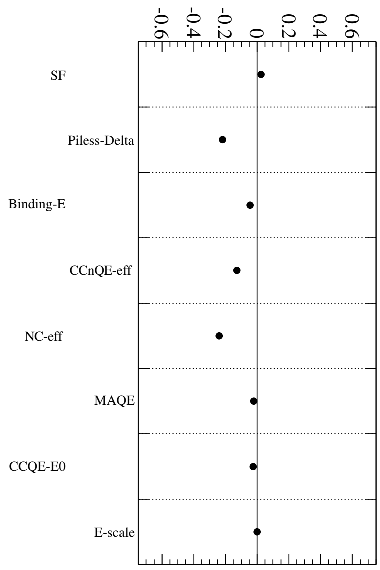

Figure 40: Systematic parameter pulls for the '2+8' fit to the Run 3 dataset.

5.2. *Goodness-of-fit tests*

Goodness-of-fit tests were performed as described in Sec. 4.2, and the p-values for all '2+N' and '2+8' $\sin^2 2\theta_{23}$ fits to the Run 1+2+3, Run 1+2 and Run 3 datasets are shown in Tab. 14. The χ^2 distributions from which the p-values were calculated are shown for the '2+N' fit for $\sin^2\theta_{23}$ in Fig. 41, for the '2+N' fit assuming the first and second octants for θ_{23} for Run 1+2+3 data in Figs. 42 and 43 respectively, and for the '2+8' fit for Run 1+2+3 data in Fig. 44. All fits have a high degree of plausibility.

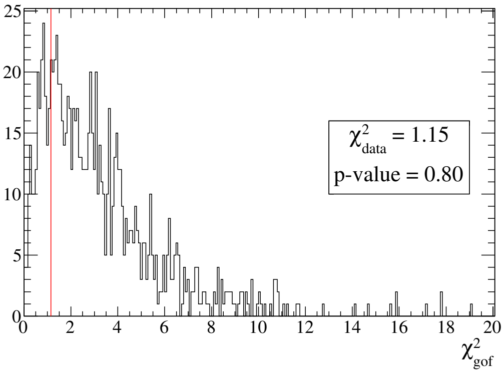

Figure 41: Distribution of χ^2_{gof}, the goodness-of-fit (gof) χ^2, from 1k toy MC experiments generated at the '2+N' $\sin^2\theta_{23}$ Run 1+2+3 best-fit oscillation point. The χ^2_{gof} value for the Run 1+2+3 data (χ^2_{data}) is highlighted.

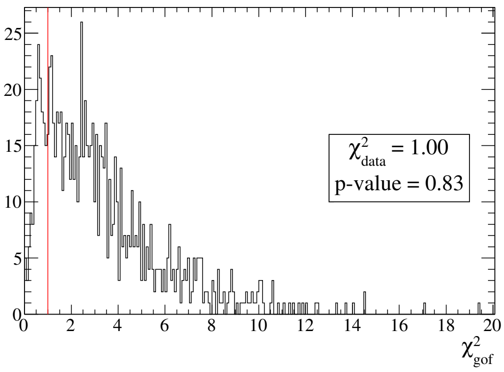

Figure 42: As in Fig. 41, but for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the first octant.

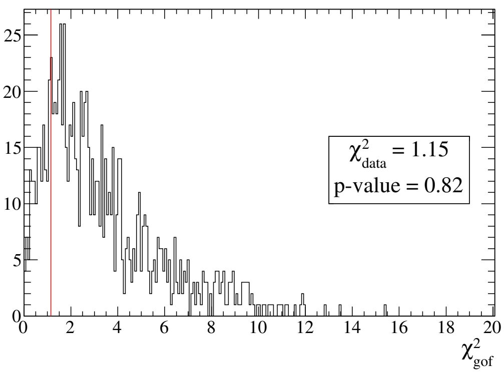

Figure 43: As in Fig. 41, but for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the second octant.

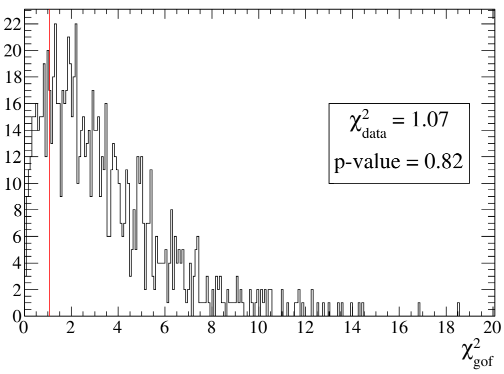

Figure 44: As in Fig. 41, but for the '2+8' fit to the Run 1+2+3 dataset.

5.3. *Best-fit single μ-like ring reconstructed energy spectra*

The reconstructed neutrino energy distribution of the single μ-like ring events in the Run 1+2+3 dataset is shown in Fig. 45 along with the '2+N' $\sin^2\theta_{23}$ best-fit prediction and the prediction made under the no-oscillation hypothesis. Also shown is the ratio between the data and the no-oscillation spectrum and the ratio between the '2+N' $\sin^2\theta_{23}$ best-fit spectrum and the the no-oscillation spectrum; in both of these ratios, the characteristic energy-dependent deficit can be clearly seen. The equivalent spectra for the Run 1+2+3 (assuming θ_{23} is in the first octant), Run 1+2+3 (assuming θ_{23} is in the second octant), Run 1+2 and Run 3 datasets are also shown in Figs. 46, 47, 48 and 49 respectively. All these distribution are shown in the 73-bin scheme in reconstructed neutrino energy that was used in the fitting procedure (see Sec. 2.2.5).

'2+8' fits were also made to the Run 1+2+3, Run 1+2 and Run 3 datasets. The best-fit and no-oscillation spectra are compared with the data in in Figs. 50, 51 and 52. The ratios of the data and best-fit spectra to the no-oscillation spectra are also shown in these figures, and the energy-dependent deficits are once more clearly visible.

Since the reconstructed energy binning used in the fit is relatively fine, it can be beneficial to see the above distributions using a coarser binning. The best-fit spectra obtained for the Run 1+2+3 dataset from the ‘2+N’ fit for $\sin^2\theta_{23}$, the ’2+N’ fit with θ_{23} in the first octant, the ’2+N’ fit with θ_{23} in the second octant and the ‘2+8’ fit with θ_{23} in the first octant are shown using a coarse binning[11] in Figs. 53, 55, 57 and 59 respectively. It is also interesting to see the 28 components of the best-fit spectrum, each of which is calculated separately in this analysis. These components are shown for the ‘2+N’ and ‘2+8’ fits in Figs. 54, 56, 58 and 60 respectively. In these plots, the components of the spectrum are grouped into 5 categories: ν_μ CCQE, ν_μ CCnonQE, $\bar{\nu}_\mu$ CC, $\nu_e/\bar{\nu}_e$ CC and NC.

The ’2+N’ best-fit predictions for $\sin^2\theta_{23}$ and θ_{23} assuming the second octant are compared for the Run 1+2+3 dataset only in Fig. 61, using the 73 reconstructed energy bins used in the fit, and in Fig. 62, using the coarser binning described above. The two best-fit spectra are nearly identical. In the 73-bin scheme used for the fit, the spectra never differ by more than 0.1% in the area below 3 GeV, and they are nearly identical in the area of the first oscillation maximum.

The ’2+N’ best-fit predictions for both θ_{23} octant assumptions are compared for the Run 1+2+3 dataset only in Fig. 63, using the 73 reconstructed energy bins used in the fit, and in Fig. 64, using the coarser binning described above.

Finally, the ‘2+N’ and ‘2+8’ best-fit predictions are compared for the Run 1+2+3 dataset only in Fig. 65, using the 73 reconstructed energy bins used in the fit, and in Fig. 66, using the coarser binning described above. The two best-fit spectra are nearly identical. In the 73-bin scheme used for the fit, the spectra never differ by more than 1.5% in the area below 3 GeV, and they are nearly identical in the area of the first oscillation maximum.

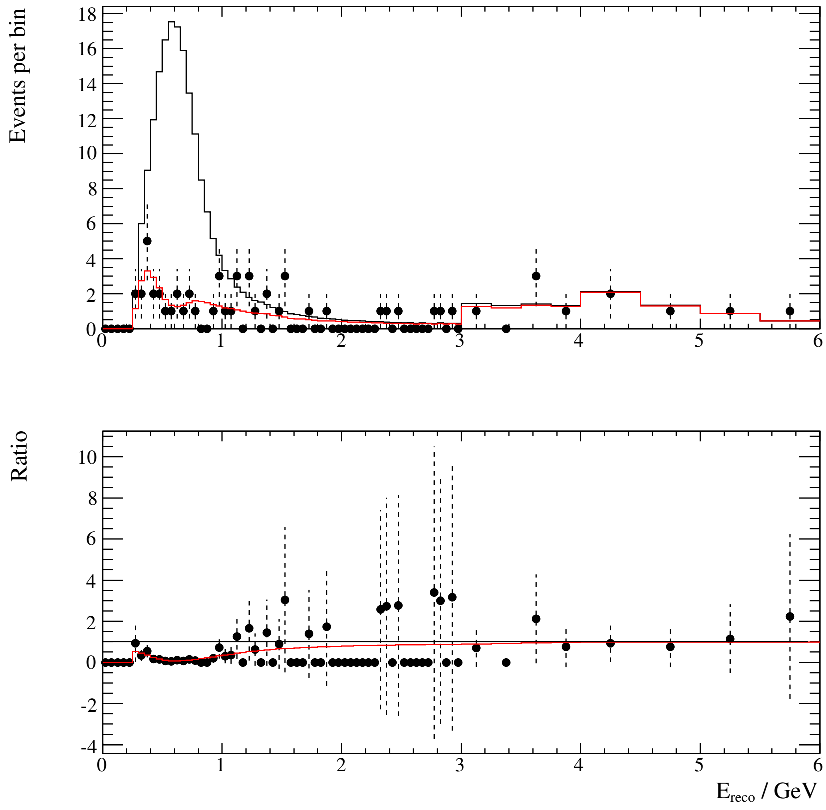

Figure 45: Best-fit reconstructed energy spectrum (top) obtained from the ‘2+N’ $\sin^2\theta_{23}$ fit to the combined Run 1+2+3 dataset. The Run 1+2+3 dataset and the prediction obtained from the no-oscillation hypothesis are also shown. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). The ratio of the data and best-fit distribution to the no-oscillation hypothesis is shown in the bottom plot. The characteristic energy-dependent deficit can be clearly seen.

[11] 16 reconstructed energy bins arranged as follows: 1 0.3-GeV bin in 0 - 0.3 GeV, 8 0.1-GeV bins in 0.3 - 1.1 GeV, 1 0.15-GeV bin in 1.1 GeV - 1.25 GeV, 1 0.25-GeV bin in 1.25 - 1.5 GeV GeV, 1 0.5-GeV bin in 1.5 - 2 GeV, 2 1-GeV bin in 2-4 GeV, 1 2-GeV bin in 4-6 GeV and 1 bin above 6 GeV.

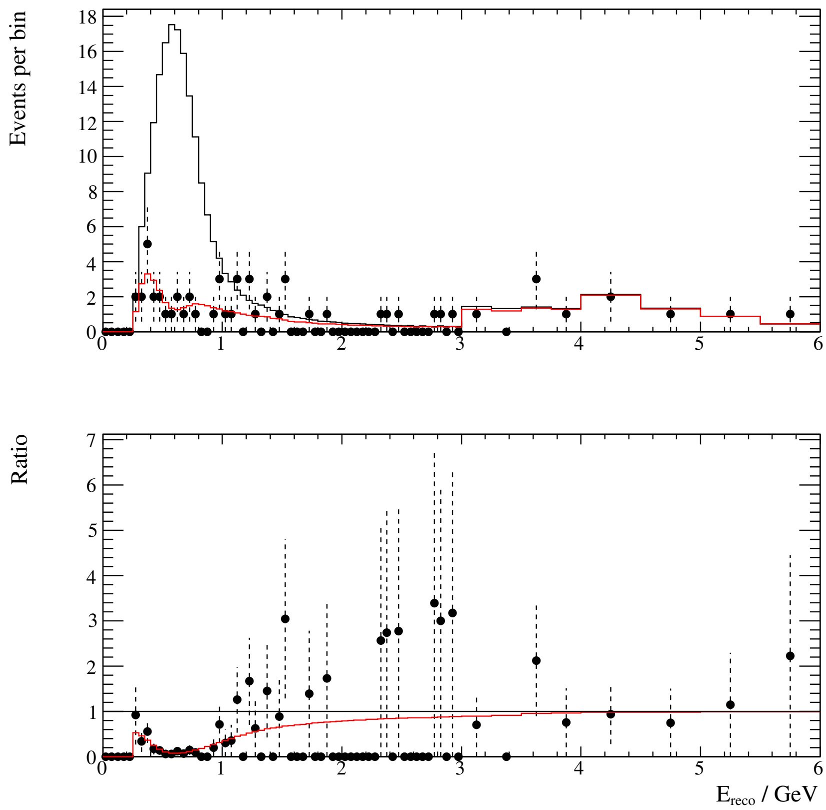

Figure 46: Best-fit reconstructed energy spectrum (top) obtained from the '2+N' fit to the combined Run 1+2+3 dataset. The Run 1+2+3 dataset and the prediction obtained from the no-oscillation hypothesis are also shown. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). The ratio of the data and best-fit distribution to the no-oscillation hypothesis is shown in the bottom plot. The characteristic energy-dependent deficit can be clearly seen.

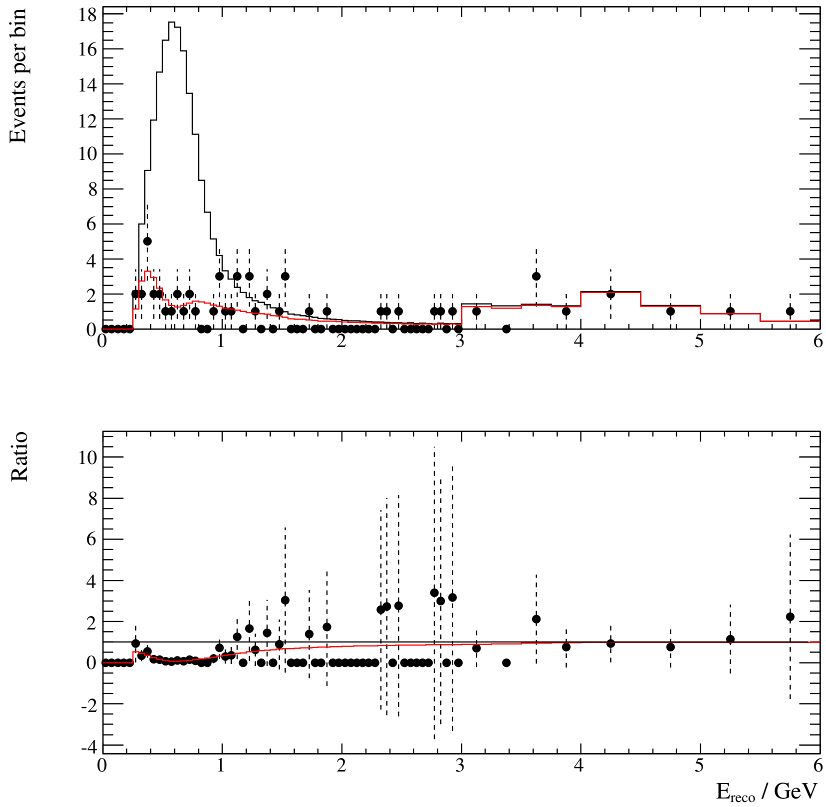

Figure 47: Best-fit reconstructed energy spectrum (top) obtained from the '2+N' fit to the combined Run 1+2+3 dataset, assuming θ_{23} is in the second octant. The Run 1+2+3 dataset and the prediction obtained from the no-oscillation hypothesis are also shown. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). The ratio of the data and best-fit distribution to the no-oscillation hypothesis is shown in the bottom plot. The characteristic energy-dependent deficit can be clearly seen.

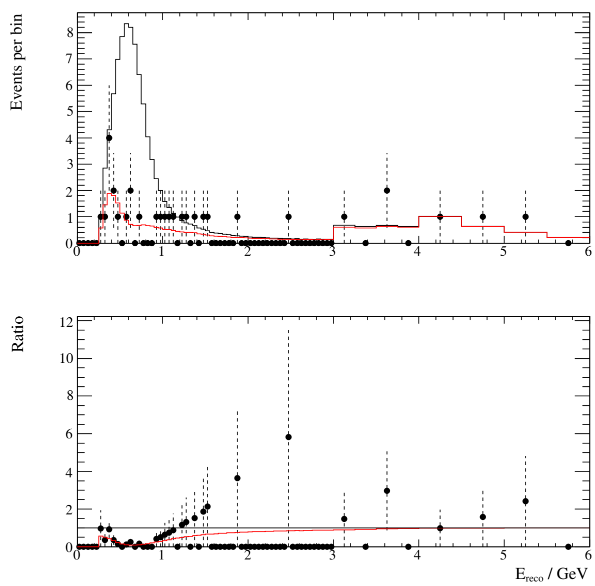

Figure 48: As in Fig. 46, but for the Run 1+2 dataset only.

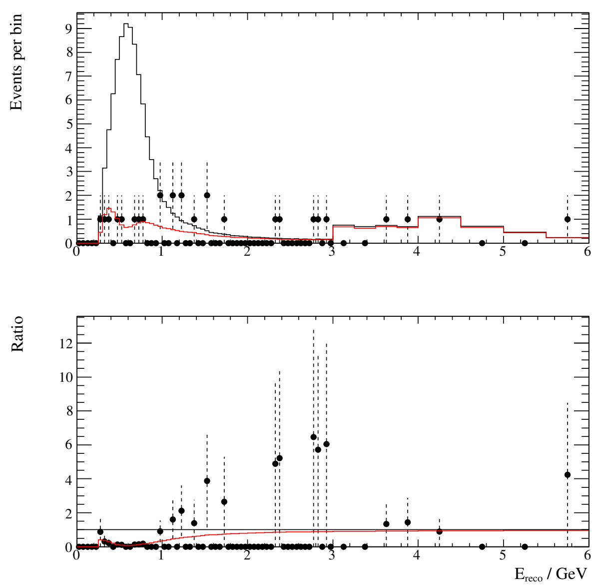

Figure 49: As in Fig. 46, but for the Run 3 dataset only.

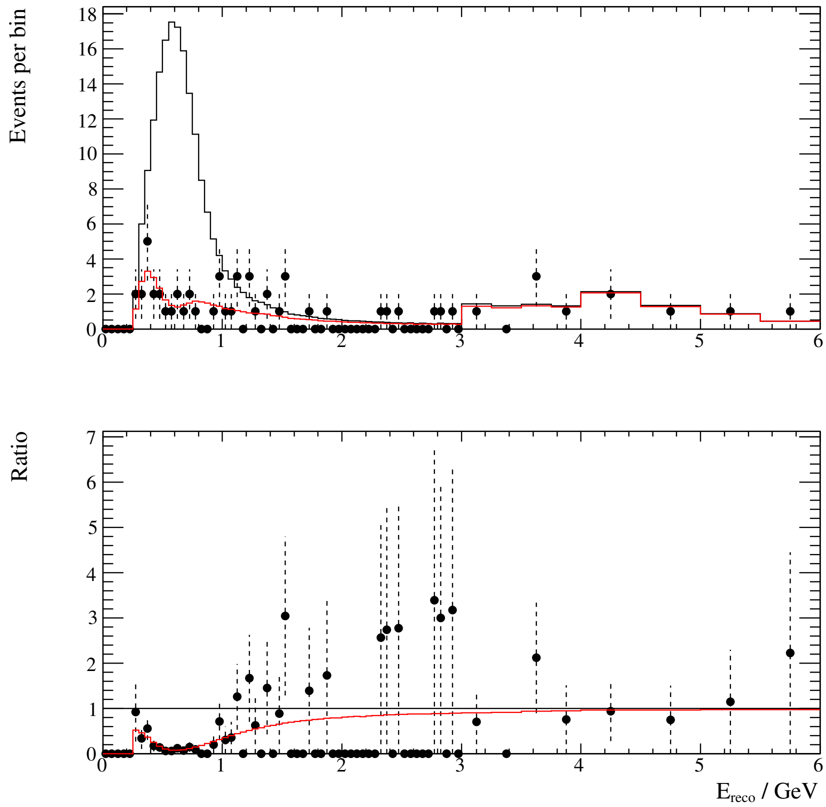

Figure 50: Best-fit reconstructed energy spectrum (top) obtained from the ‘2+8’ fit to the combined Run 1+2+3 dataset. The Run 1+2+3 dataset and the prediction obtained from the no-oscillation hypothesis are also shown. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). The ratio of the data and best-fit distribution to the no-oscillation hypothesis is shown in the bottom plot. The characteristic energy-dependent deficit can be clearly seen.

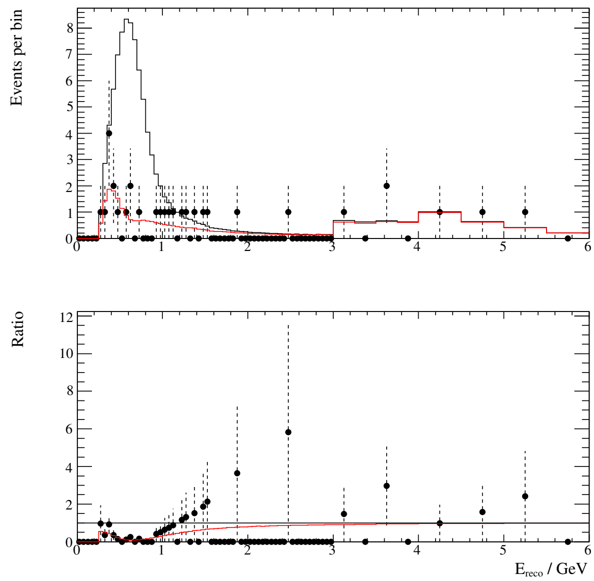

Figure 51: As in Fig. 50, but for the Run 1+2 dataset only.

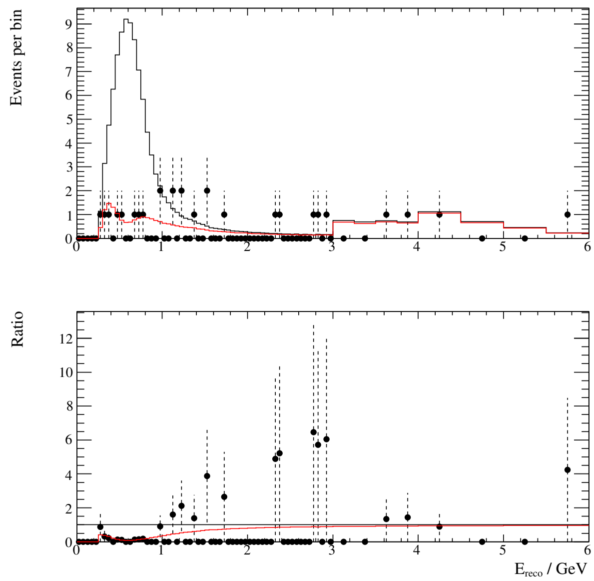

Figure 52: As in Fig. 50, but for the Run 3 dataset only.

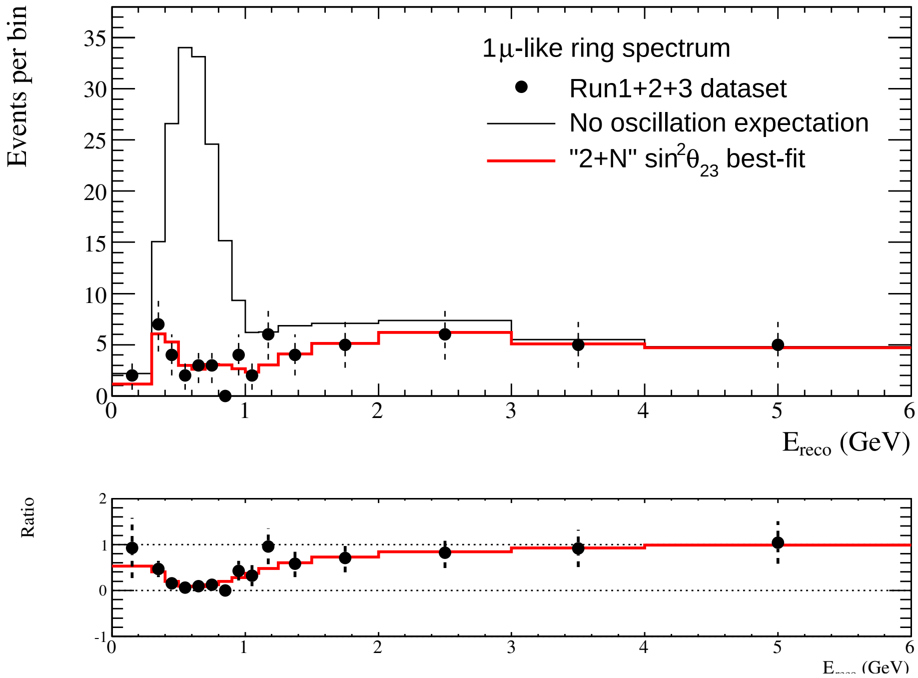

Figure 53: Best-fit reconstructed energy spectrum using the coarse binning scheme (see Sec. 5.3) obtained from the '2+N' $\sin^2\theta_{23}$ fit to the Run 1+2+3 dataset. Also shown are the spectrum obtained under the no-oscillation hypothesis and the ratios of the data and best-fit spectrum to it.

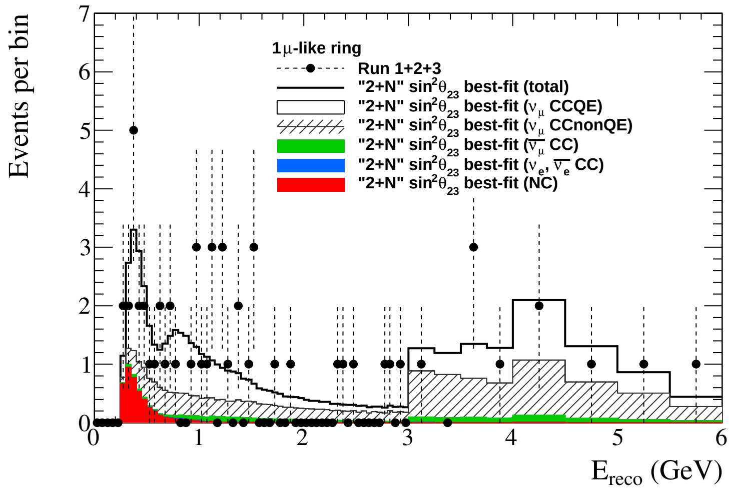

Figure 54: Best-fit reconstructed energy spectrum in the 73-bin scheme used in the fit (see Sec. 2.2.5) and its components obtained from the '2+N' $\sin^2\theta_{23}$ fit to the Run 1+2+3 dataset. The 28 components, each of which is calculated separately, are grouped into just 5 categories: ν_μ CCQE, ν_μ CCnQE, $\bar{\nu_\mu}$ CC, $\nu_e/\bar{\nu_e}$ CC and NC.

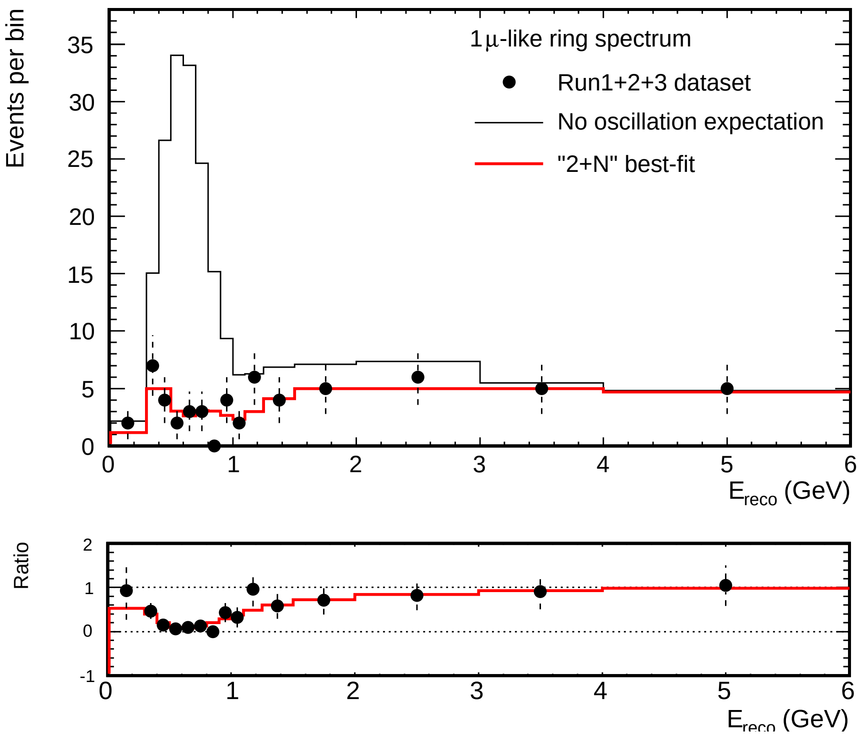

Figure 55: Best-fit reconstructed energy spectrum using the coarse binning scheme (see Sec. 5.3) obtained from the '2+N' fit to the Run 1+2+3 dataset. Also shown are the spectrum obtained under the no-oscillation hypothesis and the ratios of the data and best-fit spectrum to it.

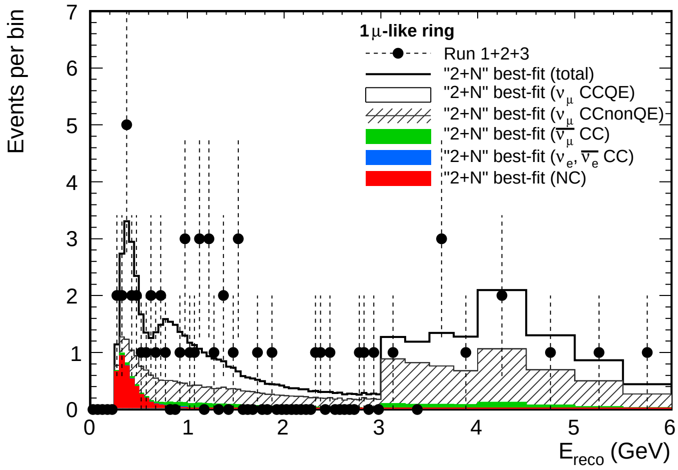

Figure 56: Best-fit reconstructed energy spectrum in the 73-bin scheme used in the fit (see Sec. 2.2.5) and its components obtained from the '2+N' fit to the Run 1+2+3 dataset. The 28 components, each of which is calculated separately, are grouped into just 5 categories: ν_μ CCQE, ν_μ CCnQE, $\bar{\nu_\mu}$ CC, $\nu_e/\bar{\nu_e}$ CC and NC.

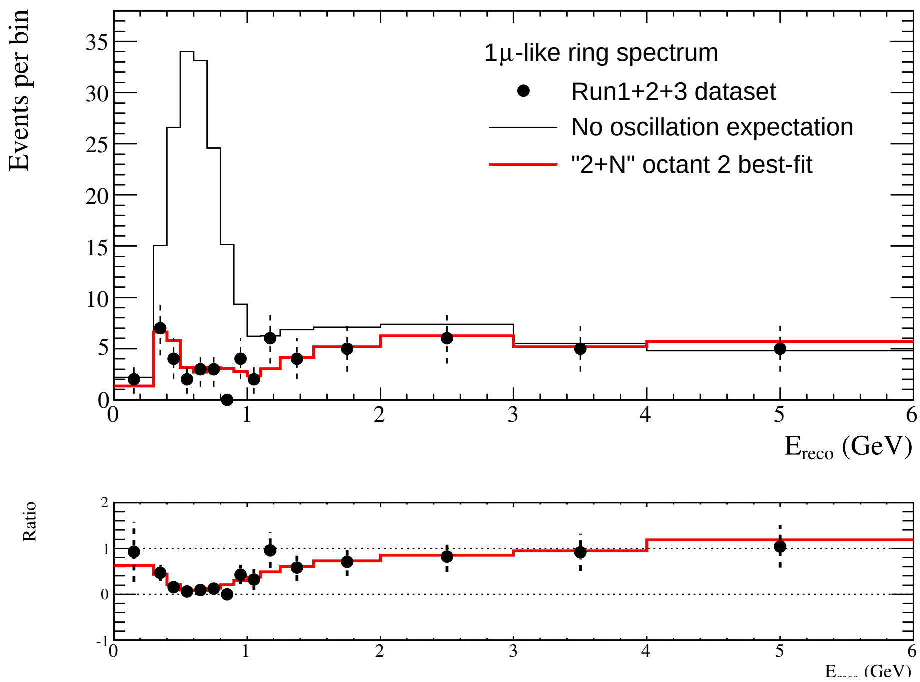

Figure 57: Best-fit reconstructed energy spectrum using the coarse binning scheme (see Sec. 5.3) obtained from the ‘2+N’ fit to the Run 1+2+3 dataset, assuming θ_{23} is in the second octant. Also shown are the spectrum obtained under the no-oscillation hypothesis and the ratios of the data and best-fit spectrum to it.

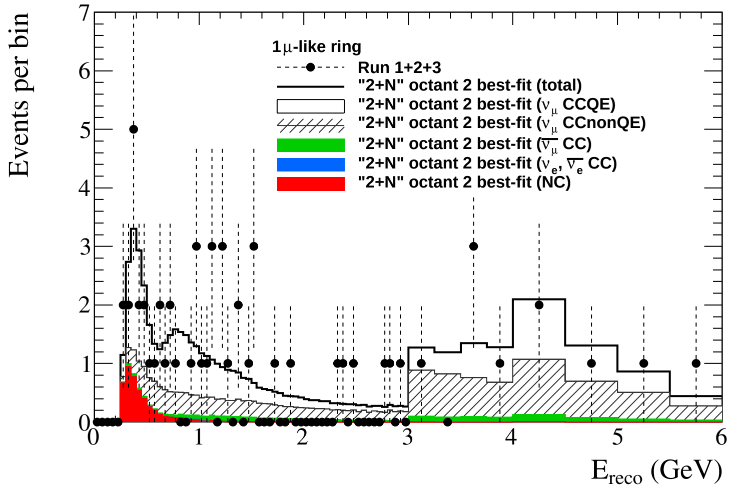

Figure 58: Best-fit reconstructed energy spectrum in the 73-bin scheme used in the fit (see Sec. 2.2.5) and its components obtained from the ‘2+N’ fit to the Run 1+2+3 dataset, assuming θ_{23} is in the the second octant. The 28 components, each of which is calculated separately, are grouped into just 5 categories: ν_μ CCQE, ν_μ CCnQE, $\bar{\nu_\mu}$ CC, $\nu_e/\bar{\nu_e}$ CC and NC.

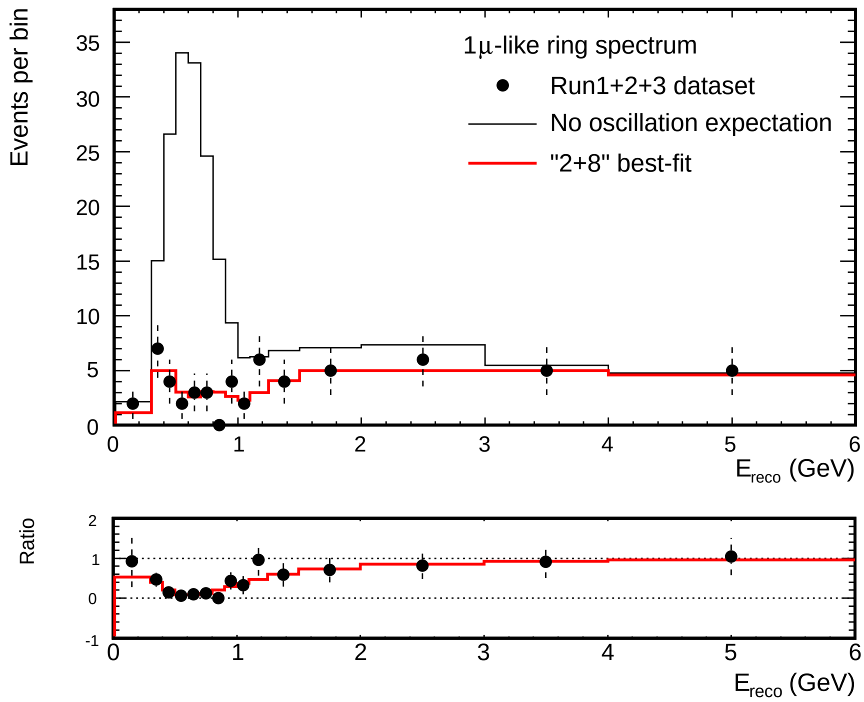

Figure 59: Best-fit reconstructed energy spectrum using the coarse binning scheme (see Sec. 5.3) obtained from the '2+8' fit to the Run 1+2+3 dataset. Also shown are the spectrum obtained under the no-oscillation hypothesis and the ratios of the data and best-fit spectrum to it.

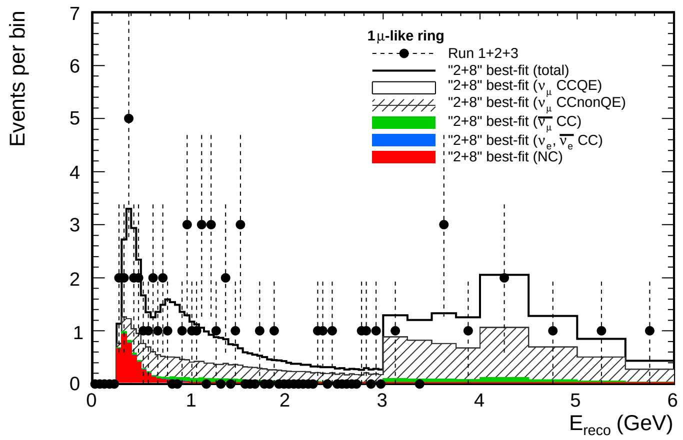

Figure 60: Best-fit reconstructed energy spectrum in the 73-bin scheme used in the fit (see Sec. 2.2.5) and its components obtained from the '2+8' fit to the Run 1+2+3 dataset. The 28 components, each of which is calculated separately, are grouped into just 5 categories: ν_μ CCQE, ν_μ CCnQE, $\bar{\nu_\mu}$ CC, $\nu_e/\bar{\nu_e}$ CC and NC.

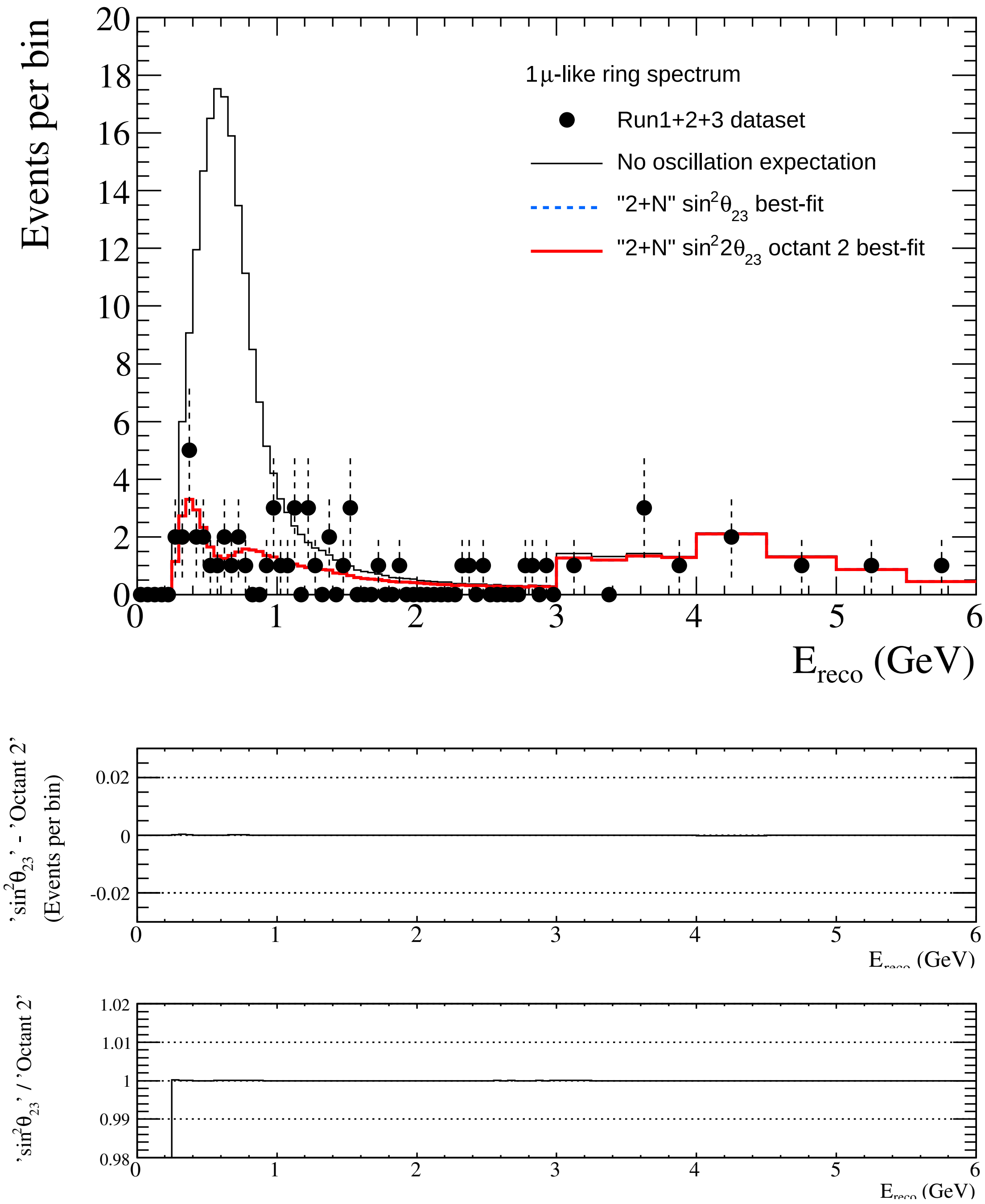

Figure 61: Comparison between best-fit reconstructed energy spectra obtained from the '2+N' fits to the Run 1+2+3 datasets, for the $\sin^2\theta_{23}$ fit, and the $\sin^2(2\theta_{23})$ fit assuming the second octant. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). Also shown are the absolute difference between the '$\sin^2\theta_{23}$' and '$\sin^2(2\theta_{23})$ octant 2' best-fit spectra and the ratio between them.

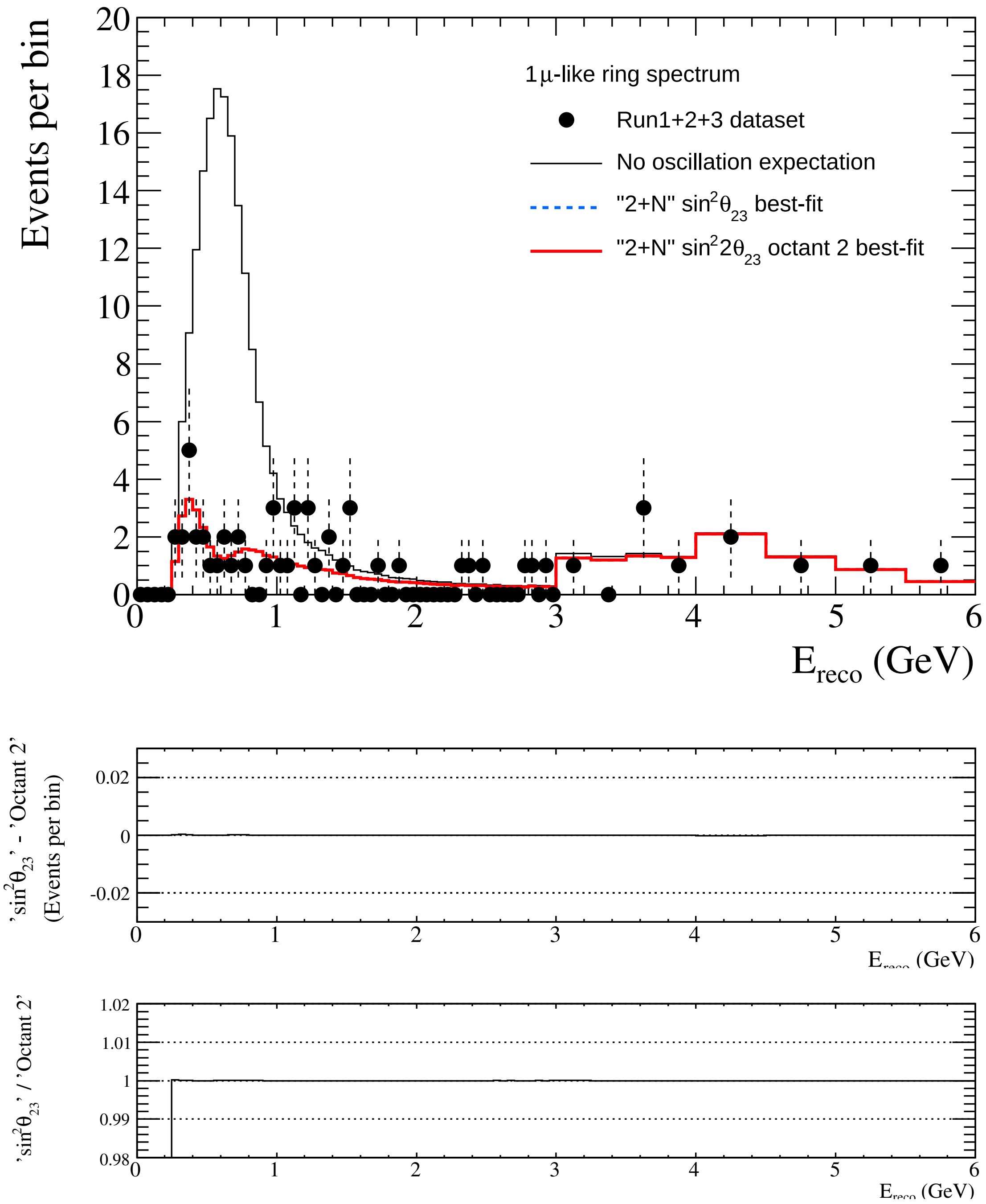

Figure 62: Comparison between best-fit reconstructed energy spectra obtained from the '2+N' fits to the Run 1+2+3 datasets, for the $\sin^2\theta_{23}$ fit, and the $\sin^2(2\theta_{23})$ fit assuming the second octant. scheme (see Sec. 5.3). Also shown are the absolute difference between the '$\sin^2\theta_{23}$' and '$\sin^2(2\theta_{23})$ octant 2' best-fit spectra and the ratio between them.

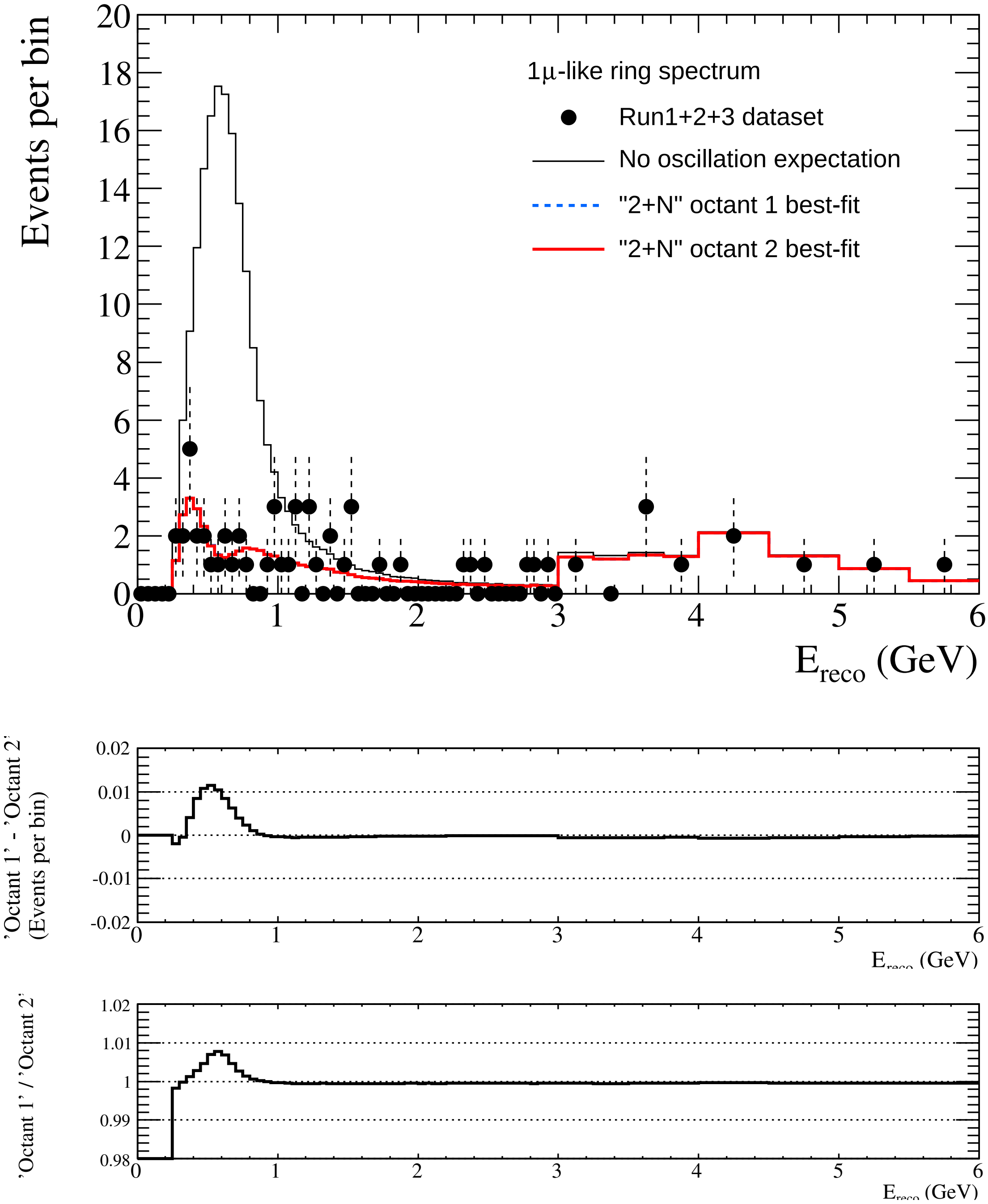

Figure 63: Comparison between best-fit reconstructed energy spectra obtained from the '2+N' fits to the Run 1+2+3 datasets, for both θ_{23} octant assumptions. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). Also shown are the absolute difference between the 'θ_{23} octant 1' and 'θ_{23} octant 2' best-fit spectra and the ratio between them.

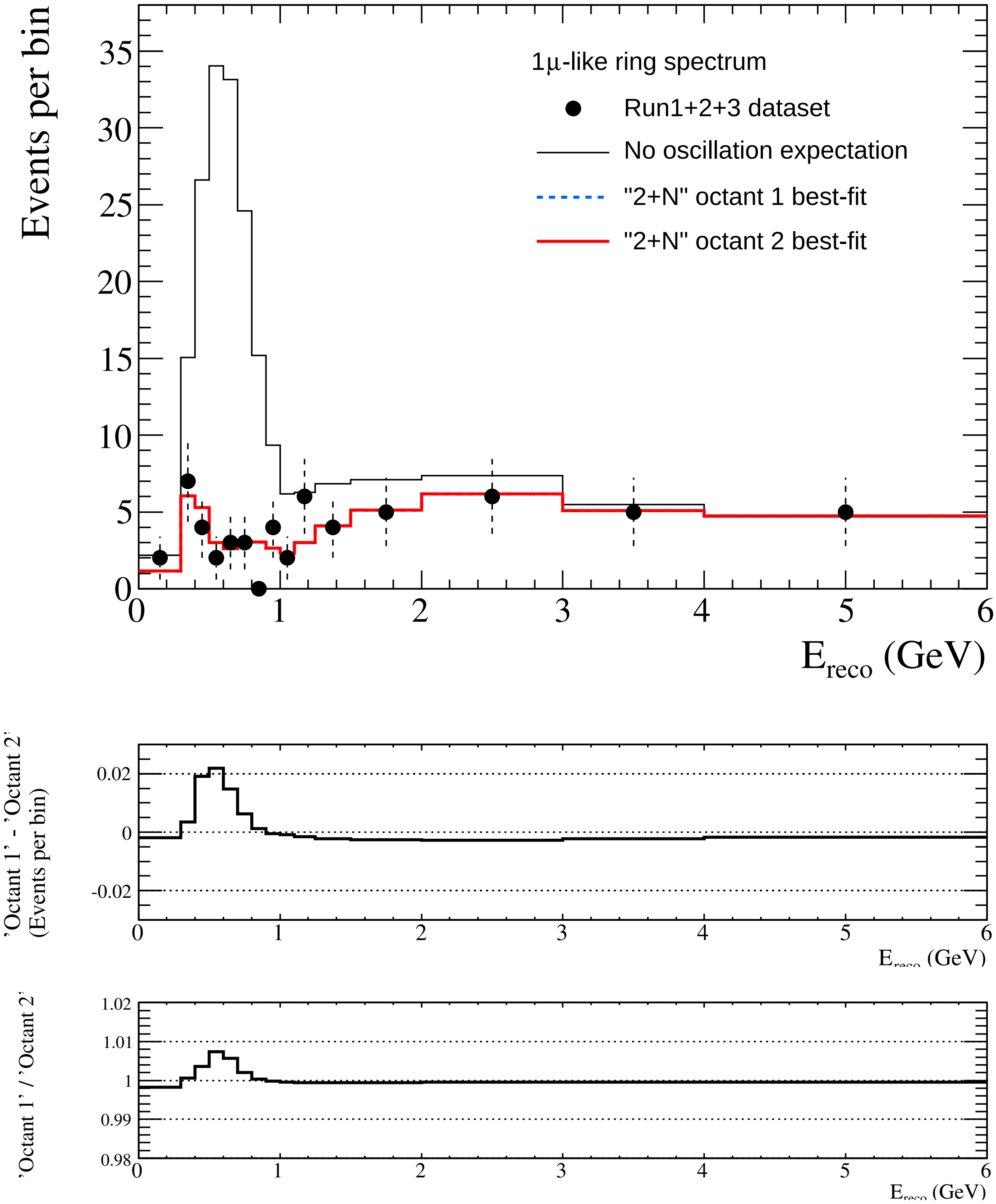

Figure 64: Comparison between best-fit reconstructed energy spectra obtained from the '2+N' fits to the Run 1+2+3 datasets, for both θ_{23} octant assumptions, using the coarse binning scheme (see Sec. 5.3). Also shown are the absolute difference between the 'θ_{23} octant 1' and 'θ_{23} octant 2' best-fit spectra and the ratio between them.

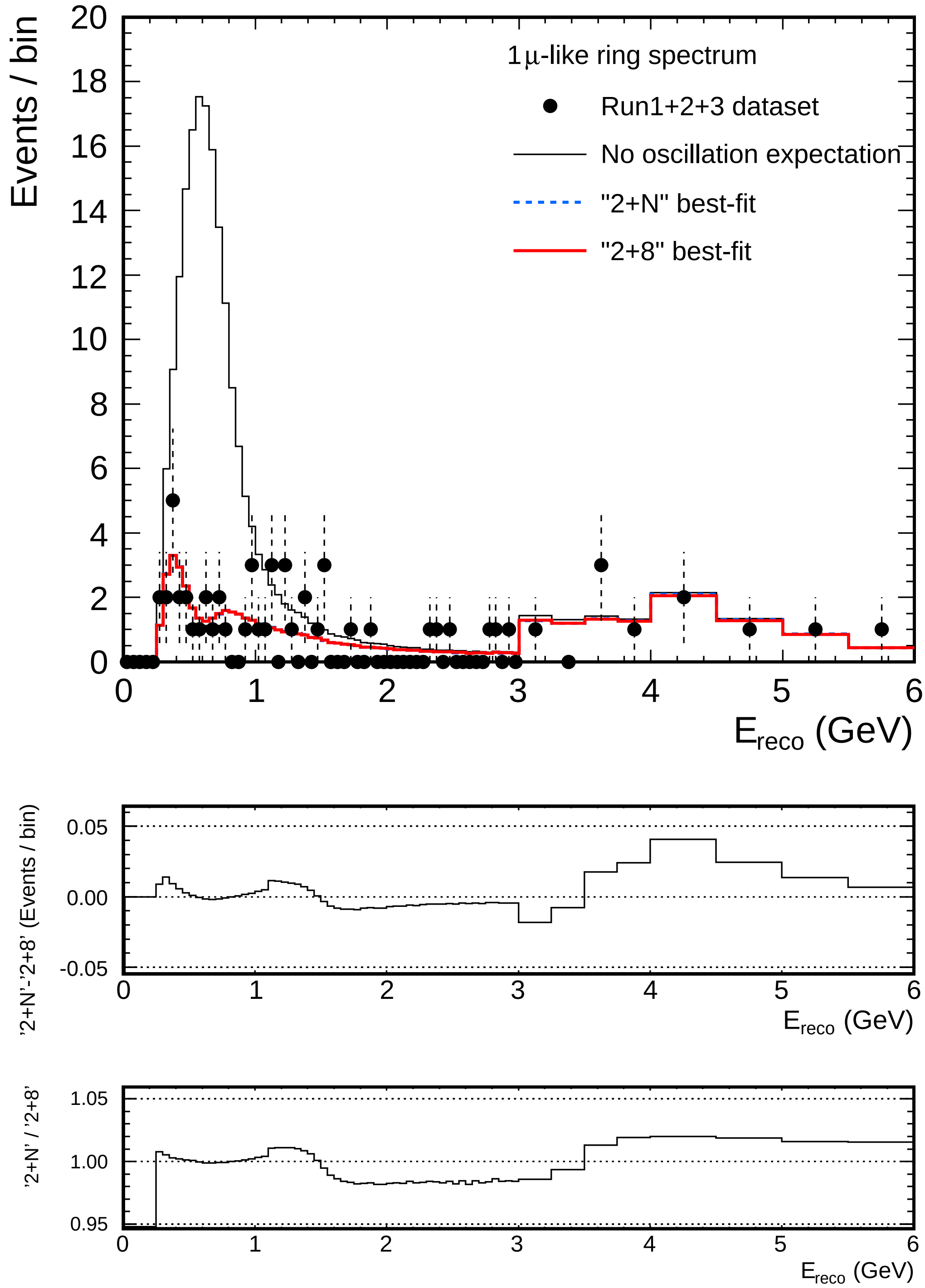

Figure 65: Comparison between best-fit reconstructed energy spectra obtained from the ‘2+N’ and ‘2+8’ fits to the Run 1+2+3 datasets. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). Also shown are the absolute difference between the ’2+N’ and ’2+8’ best-fit spectra and the ratio between them.

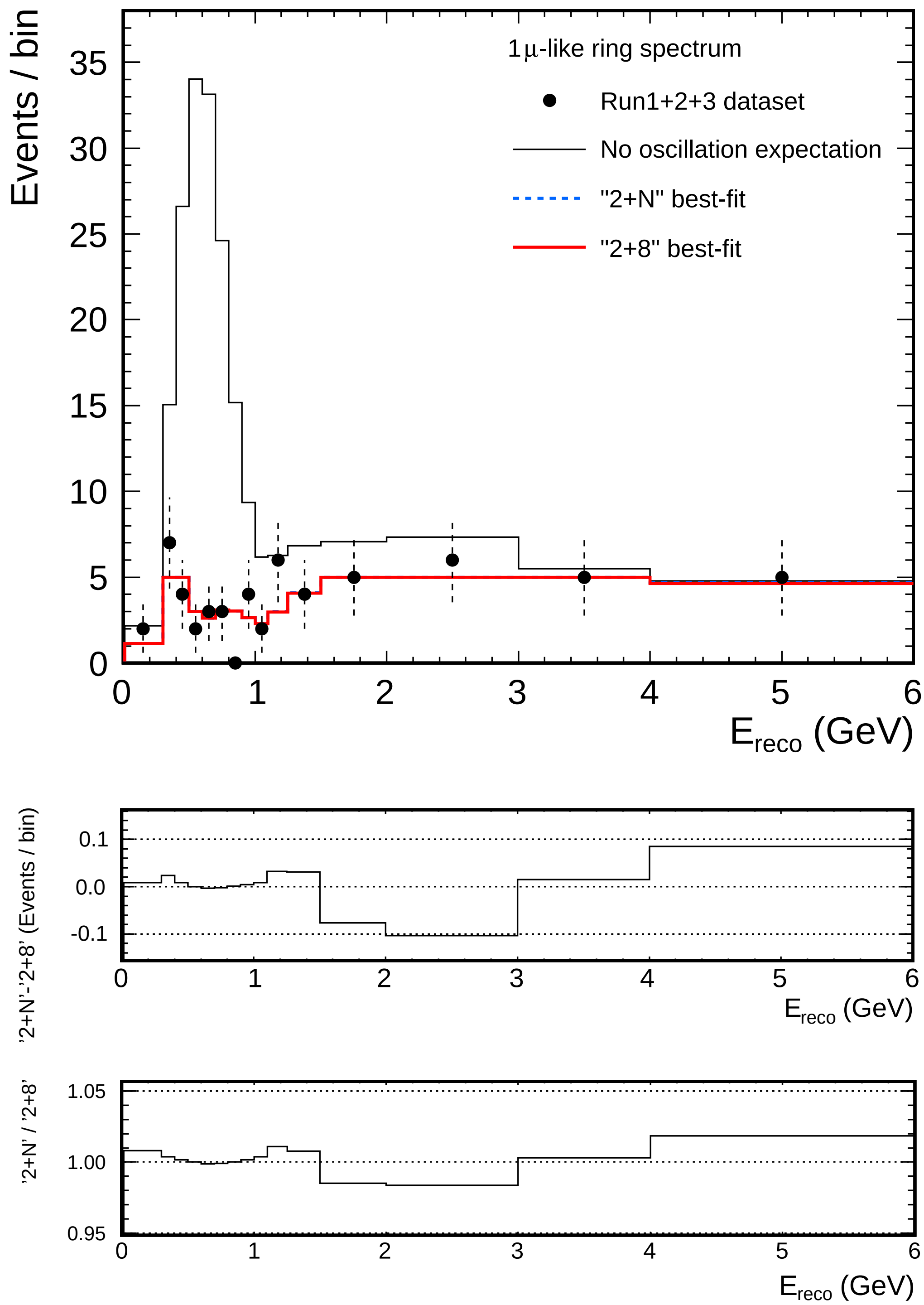

Figure 66: Comparison between best-fit reconstructed energy spectra obtained from the '2+N' and '2+8' fits to the Run 1+2+3 datasets using the coarse binning scheme (see Sec. 5.3). Also shown are the absolute difference between the '2+N' and '2+8' best-fit spectra and the ratio between them.

5.4. *Confidence limits*

The first step in calculating confidence limits for a single oscillation parameter is to calculate the values of $\Delta\chi^2$ for each value of that oscillation parameter. For each value of $\sin^2 2\theta_{23}$, a '1+N' fit is done with $|\Delta m^2_{32}|$ and all the systematic parameters allowed to float and $\sin^2 2\theta_{23}$ fixed. Then $\Delta\chi^2$ is calculated for that value of $\sin^2 2\theta_{23}$ by subtracting the '2+N' best-fit value of χ^2 over the whole 2D oscillation parameter grid (which is listed in Tab. 14). The 68% and 90% confidence intervals in $\sin^2 2\theta_{23}$ are found using the constant-$\Delta\chi^2$ method, as described in Sec. 4.5.1, and are given by the values for which χ^2 increases from the minimum by 1.00 and 2.71 respectively. Then this procedure is repeated for $|\Delta m^2_{32}|$[12].

The constant-$\Delta\chi^2$ method is used for the 1D confidence limits since there is a problem in using the Feldman-Cousins method. There is no obvious way of choosing the true value(s) of $|\Delta m^2_{32}|$ as inputs to the toy MC experiments to find the critical values of $\Delta\chi^2$ for the 1D confidence interval in $\sin^2 2\theta_{23}$. The same difficulty arises when choosing the true values of $\sin^2 2\theta_{23}$ to find the critical values of $\Delta\chi^2$ for the 1D confidence interval in $|\Delta m^2_{32}|$.

The $\Delta\chi^2$ distributions for $\sin^2\theta_{23}$ and $|\Delta m^2_{32}|$ for the '1+N' fit to the Run 1+2+3 dataset are shown in Figs. 67 and 68 respectively, along with the 68% and 90% constant-$\Delta\chi^2$ critical values. These provide the 68% errors $\sin^2\theta_{23} = 0.514 \pm 0.082$ and $|\Delta m^2_{32}| = 2.44^{+0.17}_{-0.15}\times 10^{-3}$ eV^2/c^4, and the limits of $0.397 < \sin^2\theta_{23} < 0.630$ and 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| <$ 2.72×10^{-3} eV^2/c^4 at 90% C.L.

The $\Delta\chi^2$ distributions for $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for the '1+N' fit to the Run 1+2+3 dataset are shown in Figs. 69 and 70 respectively, along with the 68% and 90% constant-$\Delta\chi^2$ critical values. Results are shown for θ_{23} in both the first and second octants. For the first octant, these provide the 68% errors $\sin^2 2\theta_{23} = 1.000^{+0.000}_{-0.019}$ and $|\Delta m^2_{32}| = 2.44^{+0.17}_{-0.15}\times 10^{-3}$ eV^2/c^4, and the limits of $\sin^2 2\theta_{23} > 0.958$ and 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| < 2.72\times 10^{-3}$ eV^2/c^4 at 90% C.L. For the second octant, these provide the 68% errors $\sin^2 2\theta_{23} = 0.999^{+0.001}_{-0.036}$ and $|\Delta m^2_{32}| = 2.44^{+0.17}_{-0.15}\times 10^{-3}$ eV^2/c^4, and the limits of $\sin^2 2\theta_{23} > 0.931$ and 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| < 2.72\times 10^{-3}$ eV^2/c^4 at 90% C.L. The 1D limits for the second octant are identical to those for the first octant for $|\Delta m^2_{32}|$, but much wider for $\sin^2 2\theta_{23}$. This can be understood from Eq. 3 since the center of symmetry (point of maximal disappearance) is in the second octant.

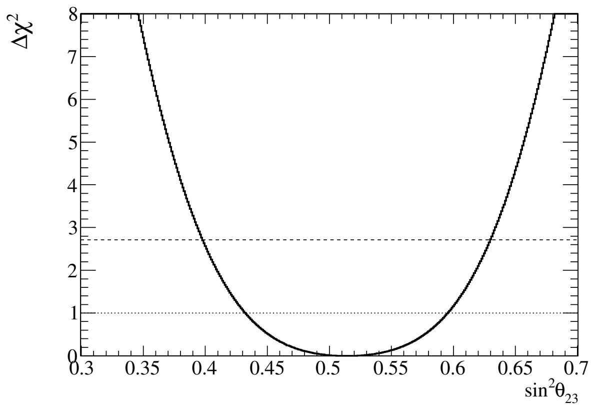

Figure 67: $\Delta\chi^2$ as a function of $\sin^2\theta_{23}$ for the '1+N' fit to the Run 1+2+3 dataset. The 68% and 90% constant-$\Delta\chi^2$ critical values are shown as dotted and dashed lines respectively.

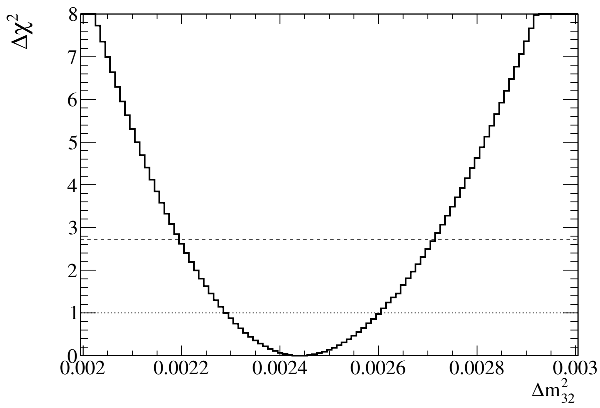

Figure 68: $\Delta\chi^2$ as a function of $|\Delta m^2_{32}|$ for the '1+N' fit to the Run 1+2+3 dataset. The 68% and 90% constant-$\Delta\chi^2$ critical values are shown as dotted and dashed lines respectively.

[12]The procedure is equivalent for the limits with $\sin^2\theta_{23}$, just with a different fit parameter.

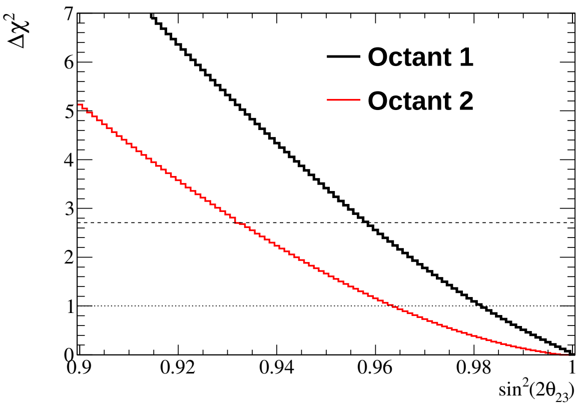

Figure 69: $\Delta\chi^2$ as a function of $\sin^2 2\theta_{23}$ for the '1+N' fit to the Run 1+2+3 dataset. Results are shown for θ_{23} in for both octants. The 68% and 90% constant-$\Delta\chi^2$ critical values are shown as dotted and dashed lines respectively.

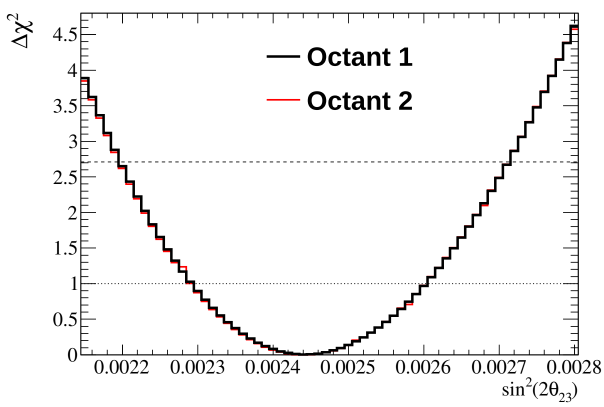

Figure 70: $\Delta\chi^2$ as a function of $|\Delta m^2_{32}|$ for the '1+N' fit to the Run 1+2+3 dataset. Results are shown for θ_{23} in both octants. The 68% and 90% constant-$\Delta\chi^2$ critical values are shown as dotted and dashed lines respectively.

5.5. *Confidence regions*

The first step in constructing confidence contours in the oscillation parameters $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ is to calculate the values of $\Delta\chi^2$ for each point in a 2-dimensional grid in the oscillation parameter space. This is done as described in Sec. 4.5.1 for the constant-$\Delta\chi^2$ method and in Sec. 4.5.2 for the Feldman-Cousins method.

The $\Delta\chi^2$ surface for the the '2+N' fit for $\sin^2\theta_{23}$ to the Run 1+2+3 dataset is shown in Fig. 71, as a function of $\sin^2\theta_{23}$ and $|\Delta m^2_{32}|$.

The $\Delta\chi^2$ surface for the the '2+N' fit to the Run 1+2+3 dataset is shown in Figs. 72 and 73 for θ_{23} in the first and second octants respectively, as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$. For comparison, the corresponding $\Delta\chi^2$ surfaces for the '2+N' fits to the Run 1+2 and Run 3 datasets are shown in Figs. 74 and 75 respectively. The same $\Delta\chi^2$ range is used in all colour plots to allow comparison. Marginalized $\Delta\chi^2$ distributions are also shown as a function of either $\sin^2 2\theta_{23}$ or $|\Delta m^2_{32}|$ for the '2+N' fits to the Run 1+2+3, Run 1+2 and Run 3 datasets in Figs. 76 and 77 respectively.

The corresponding plots for the '2+8' fits are shown in Fig. 78 for the Run 1+2+3 datset, Fig. 79 for the Run 1+2 dataset and Fig. 80 for the Run 3 dataset. Meanwhile the marginalized $\Delta\chi^2$ distributions are shown for all the datasets as a function of $\sin^2 2\theta_{23}$ in Fig. 82 and as a function of $|\Delta m^2_{32}|$ in Fig. 81.

Comparisons were made between the '2+N' $\Delta\chi^2$ distributions for θ_{23} in the first and second octants. The fractional difference between the $\Delta\chi^2$ surfaces obtained from the '2+N' fits, assuming the first and second octant, to the Run 1+2+3 dataset is shown in Fig. 83.

Comparisons were made between the '2+N' and '2+8' $\Delta\chi^2$ distributions. The fractional difference between the $\Delta\chi^2$ surfaces obtained from the '2+N' and '2+8' fits to the Run 1+2+3 dataset is shown in Fig. 84. The marginalized $\Delta\chi^2$ distributions for the '2+N' and '2+8' fits to the Run 1+2+3 dataset are compared as a function of $|\Delta m^2_{32}|$ in Fig. 86 and as a function of $\sin^2 2\theta_{23}$ in Fig. 87. As shown in these figures, the '2+N' and '2+8' marginalized $\Delta\chi^2$ distributions are almost identical, even in areas of the parameter space that exceed the 99% CL region ($\Delta\chi^2 < 6.63$ for a single parameter).

Confidence regions were constructed using both the constant-$\Delta\chi^2$ method described in Sec. 4.5.1 and the Feldman-Cousins method described in Sec. 4.5.2 for both the '2+N' and the '2+8' fits. Confidence contours were drawn using the constant-$\Delta\chi^2$ method for each of the Run 1+2+3, Run 1+2 and Run 3 datasets. Using the Feldman-Cousins method, however, they were drawn only for the Run 1+2+3 dataset due to the large amount of CPU time needed. All confidence regions presented below include the effect of systematic uncertainties.

The 68% and 90% CL regions for the '2+N' $\sin^2\theta_{23}$ fit to the Run 1+2+3 dataset are shown using the constant-$\Delta\chi^2$ method in Fig. 88. The corresponding constant-$\Delta\chi^2$ contours for the Run 1+2+3 dataset (assuming θ_{23} is in the first octant), the Run 1+2+3 dataset (assuming θ_{23} is in the second octant), and the Run 1+2 and Run 3 datasets are shown in Figs. 89, 90, 91 and 92 respectively. The constant-$\Delta\chi^2$ contours for the '2+8' fits are shown in Fig. 93 for Run 1+2+3, in Fig. 94 for Run 1+2 and in Fig. 95 for Run 3.

The Feldman-Cousins 68% and 90% CL regions for the fits to the Run 1+2+3 dataset are shown in Fig. 96 for the '2+N' fit (assuming θ_{23} is in the first octant), in Fig. 97 for the '2+N' fit (assuming θ_{23} is in the second octant), and in Fig. 98 for the '2+8' fit. The boundary of the 68% '2+N' contour assuming θ_{23} is in the first octant includes the points ($\sin^2(2\theta_{23})$,$|\Delta m^2_{32}|$) = (1.000,2.64$\times10^{-3}$ eV^2/c^4), (0.964,2.50$\times10^{-3}$ eV^2/c^4) and (1.000,2.26$\times10^{-3}$ eV^2/c^4).

We have accomplished our goal, which was to present the confidence regions constructed using various methods, and for different fits and datasets. In the next section, detailed comparisons are presented of the confidence regions obtained using different construction methods for the same fit, and using different fitting methods for the same construction method. The contours from different running periods are compared, and we also compare our contours from the fits to the combined Run 1+2+3 dataset with recent measurements from MINOS and SuperK and T2K 3.010$\times10^{20}$-POT sensitivity contours. Finally, a more critical view of the 5 different results obtained by this analysis is presented in Sec. 5.7.

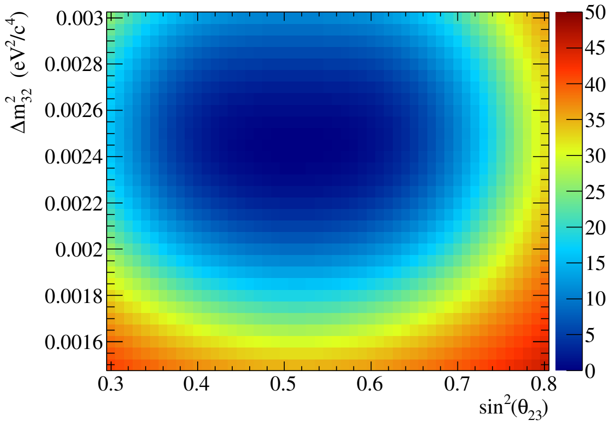

Figure 71: $\Delta\chi^2$ surface for the '2+N' $\sin^2\theta_{23}$ fit to the Run 1+2+3 dataset.

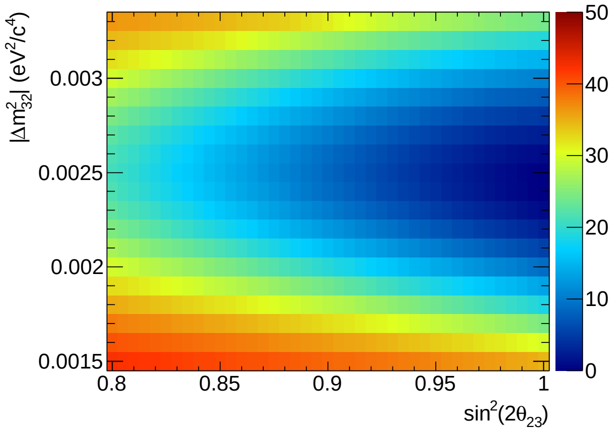

Figure 72: $\Delta\chi^2$ surface for the '2+N' fit to the Run 1+2+3 dataset, assuming θ_{23} is in the first octant.

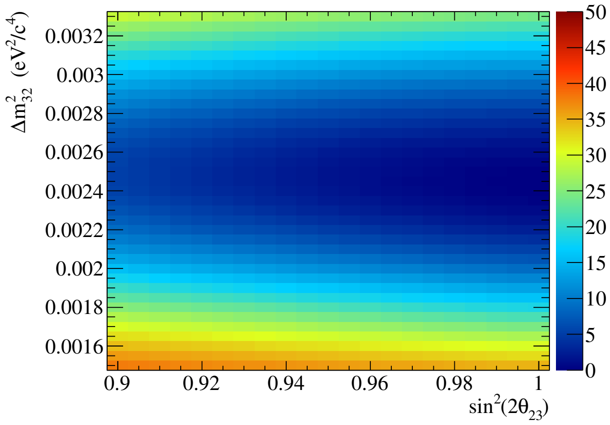

Figure 73: $\Delta\chi^2$ surface for the '2+N' fit to the Run 1+2+3 dataset, assuming θ_{23} is in the second octant.

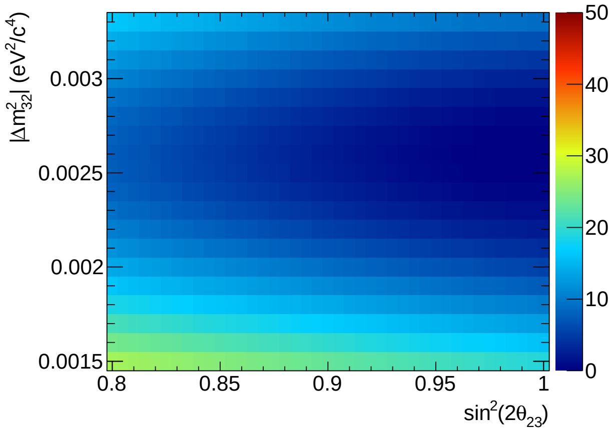

Figure 74: $\Delta\chi^2$ surface for the '2+N' fit to the Run 1+2 dataset.

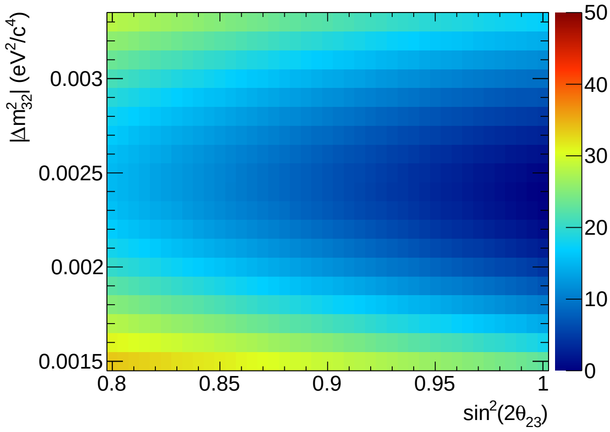

Figure 75: $\Delta\chi^2$ surface for the '2+N' fit to the Run 3 dataset.

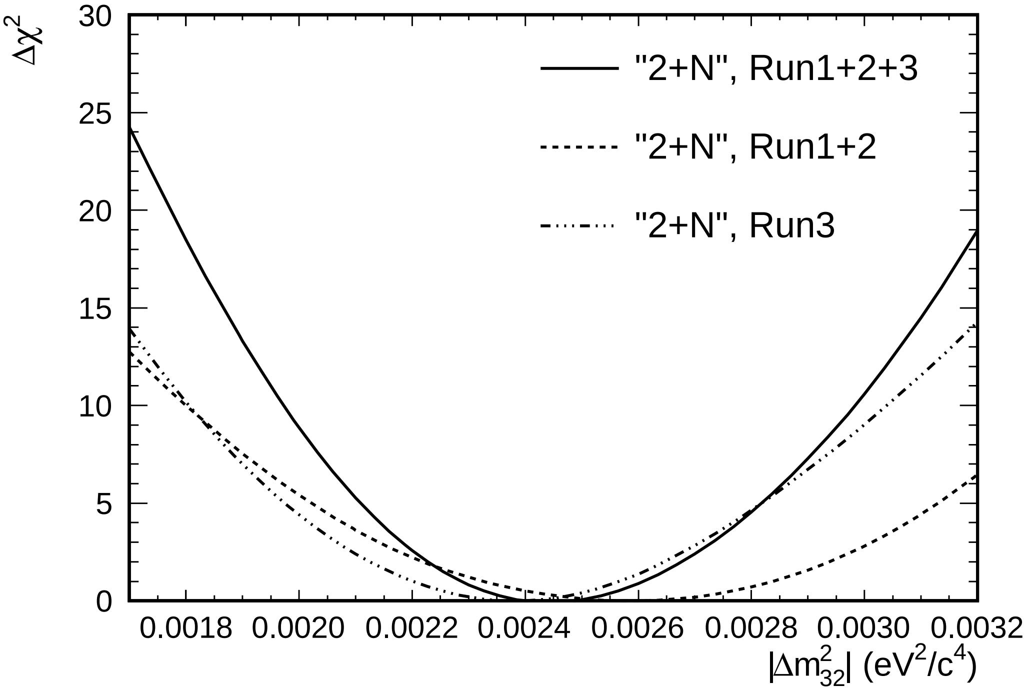

Figure 76: Marginalized $\Delta\chi^2$, as a function of $|\Delta m^2_{32}|$, for the four '2+N' fits to the Run 1+2+3, Run 1+2 and Run 3 datasets.

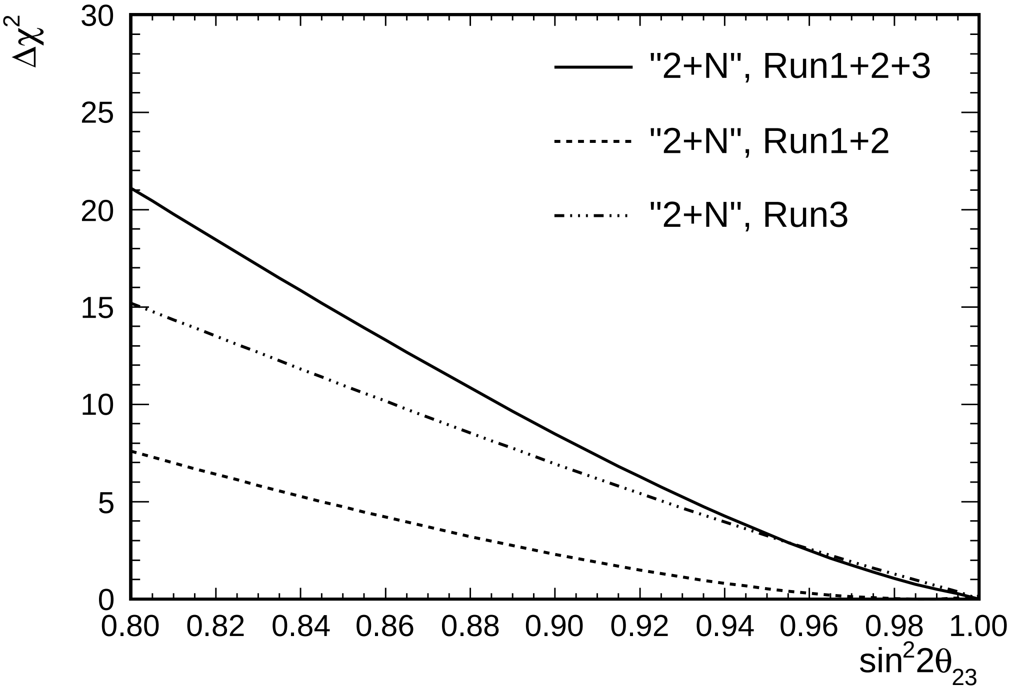

Figure 77: Marginalized $\Delta\chi^2$, as a function of $\sin^2 2\theta_{23}$, for the three '2+N' fits to the Run 1+2+3, Run 1+2 and Run 3 datasets.

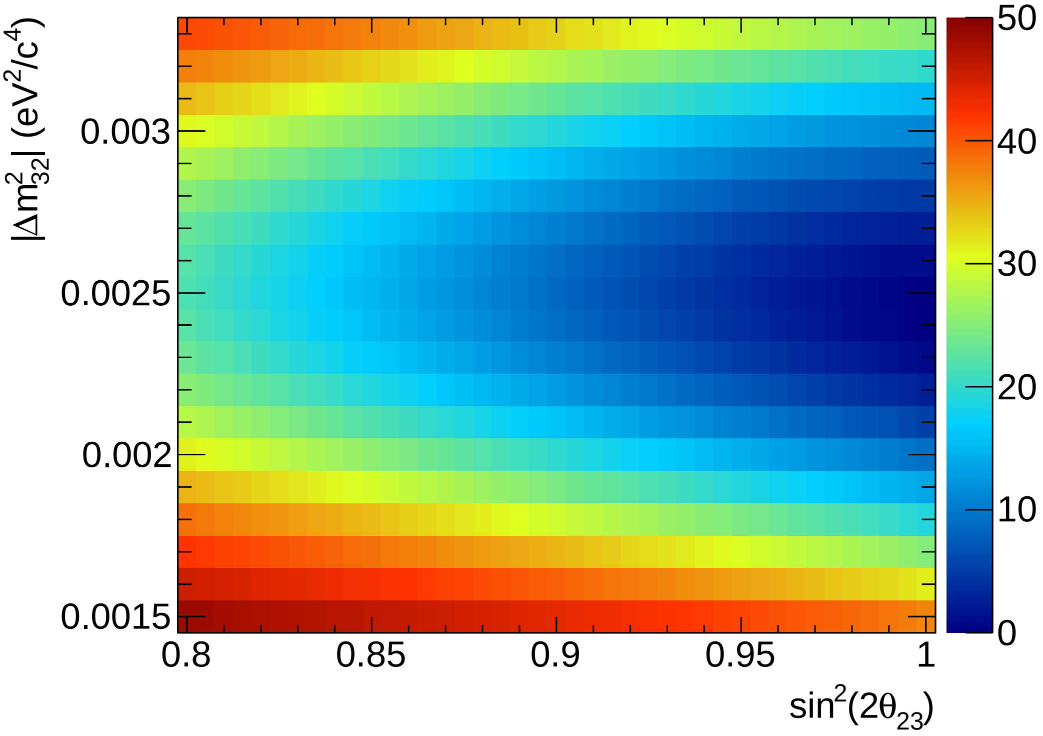

Figure 78: $\Delta\chi^2$ surface for the '2+8' fit to the Run 1+2+3 dataset.

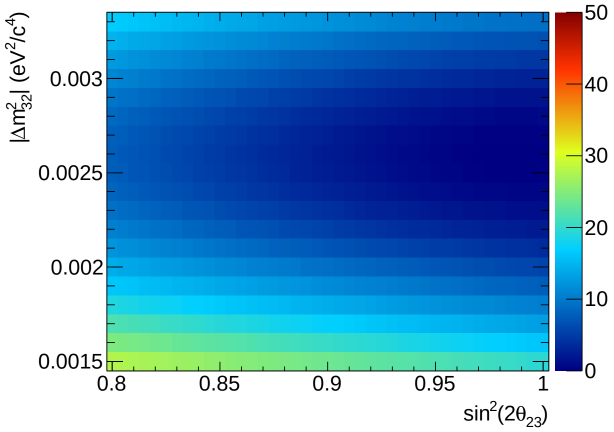

Figure 79: $\Delta\chi^2$ surface for the '2+8' fit to the Run 1+2 dataset.

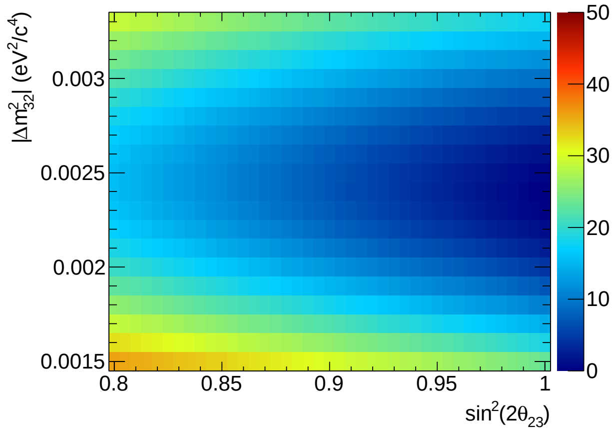

Figure 80: $\Delta\chi^2$ surface for the '2+8' fit to the Run 3 dataset.

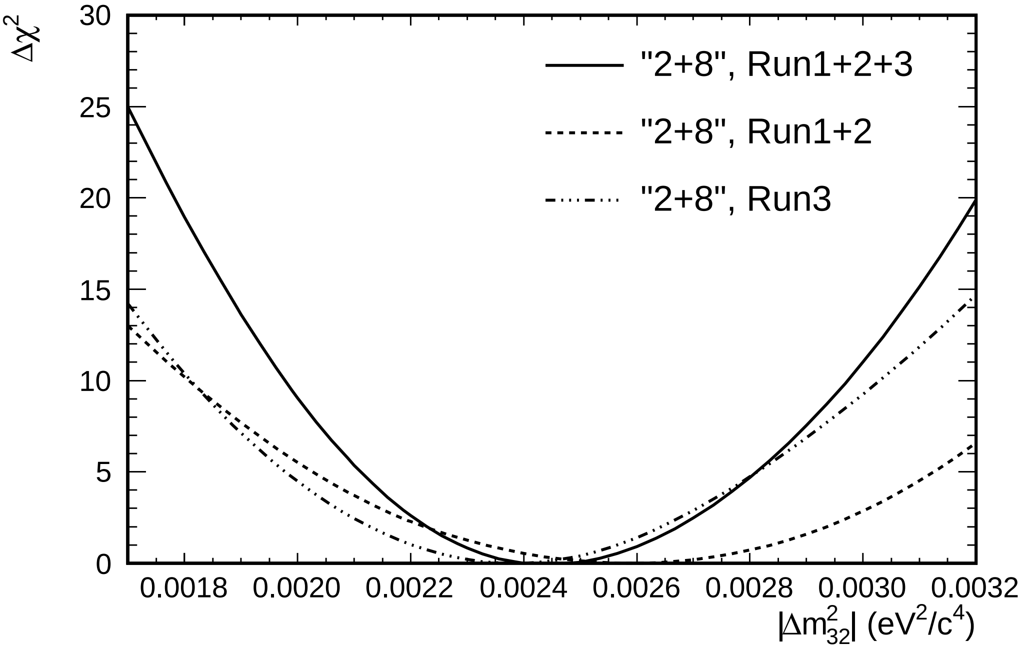

Figure 81: Marginalized $\Delta\chi^2$, as a function of $|\Delta m^2_{32}|$, for the three '2+8' fits to the Run 1+2+3, Run 1+2 and Run 3 datasets.

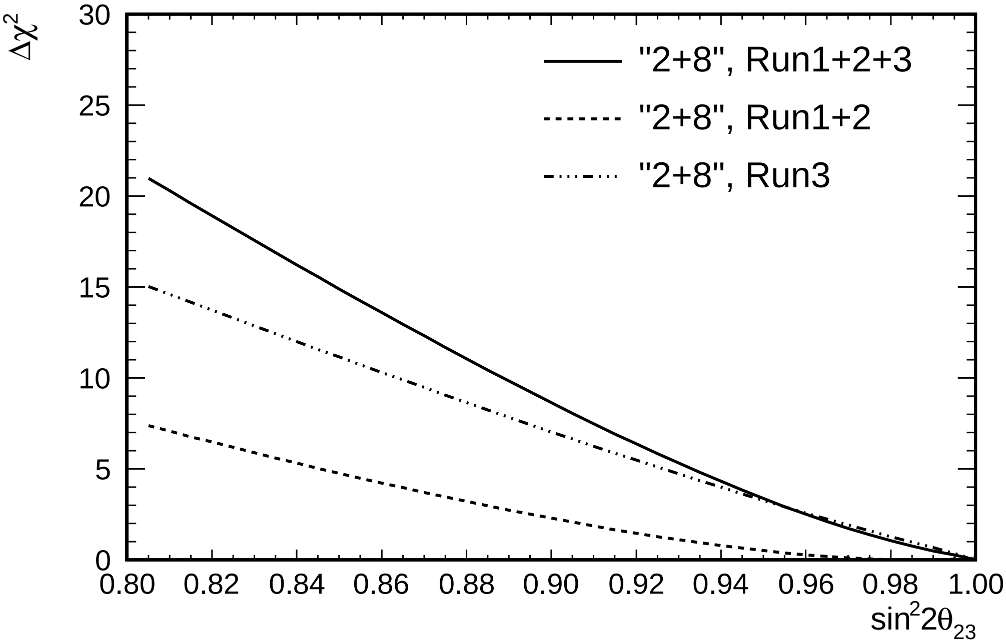

Figure 82: Marginalized $\Delta\chi^2$, as a function of $\sin^2 2\theta_{23}$, for the three '2+8' fits to the Run 1+2+3, Run 1+2 and Run 3 datasets.

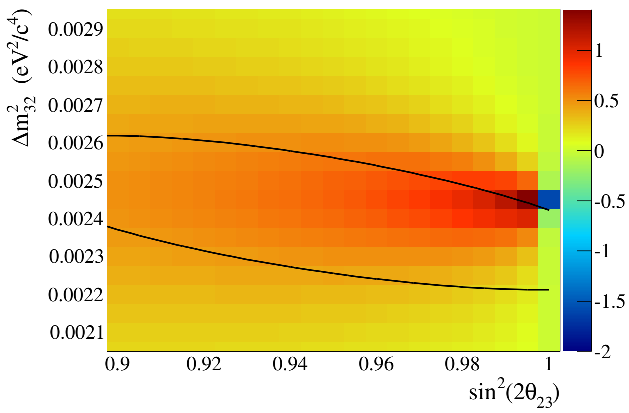

Figure 83: Fractional difference between the $\Delta\chi^2$ surfaces obtained from the '2+N' fits to the Run 1+2+3 dataset assuming θ_{23} is in the first and second octants and shown in Figs. 72 and 73. The fractional difference is calculated as 2 × ($\Delta\chi^2$(octant 1)-$\Delta\chi^2$(octant 2)) / $\Delta\chi^2$(octant 1)+$\Delta\chi^2$(octant 2)). The 2012 MINOS 90% CL region is shown for reference. The large difference at the minimum of the $\Delta\chi^2$ maps is due to the best fit point in the second octant case being further away from a bin center.

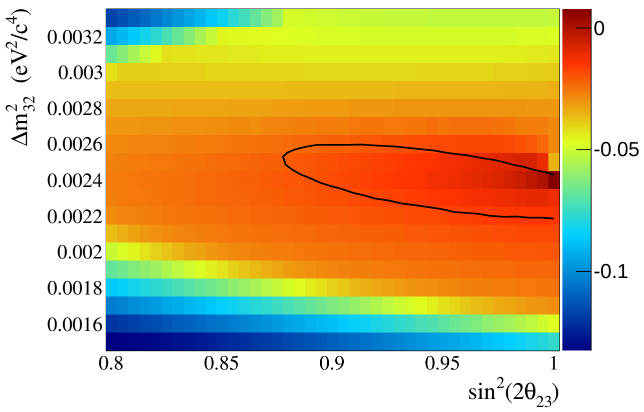

Figure 84: Fractional difference between the $\Delta\chi^2$ surfaces obtained from the '2+N' and '2+8' fits to the Run 1+2+3 dataset and shown in Figs. 72 and 78. The fractional difference is calculated as 2 × ($\Delta\chi^2$('2+N')-$\Delta\chi^2$('2+8')) / $\Delta\chi^2$('2+N')+$\Delta\chi^2$('2+8')). The 2012 MINOS 90% CL region is shown for reference.

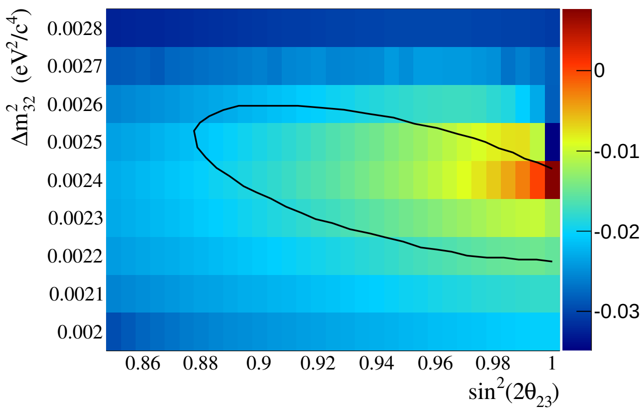

Figure 85: As on the left but zoomed into the area of the 2012 MINOS 90% CL region.

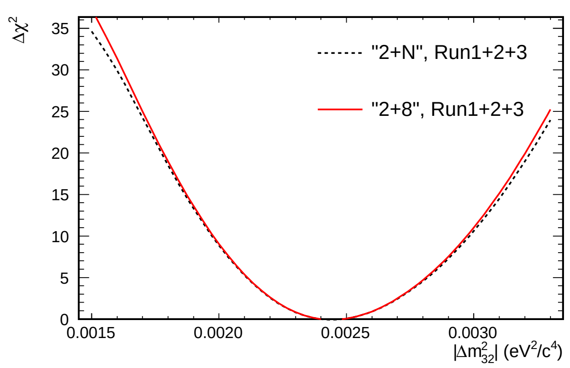

Figure 86: Comparison of marginalized $\Delta\chi^2$ as s function of $|\Delta m^2_{32}|$, for the '2+N' and '2+8' fits to the Run 1+2+3 dataset.

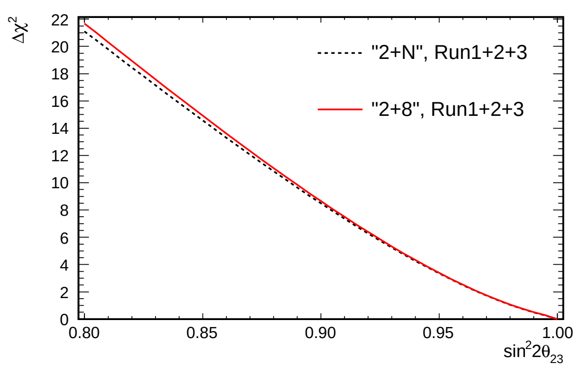

Figure 87: Comparison of marginalized $\Delta\chi^2$ as a function of $\sin^2 2\theta_{23}$, for the '2+N' and '2+8' fits to the Run 1+2+3 dataset.

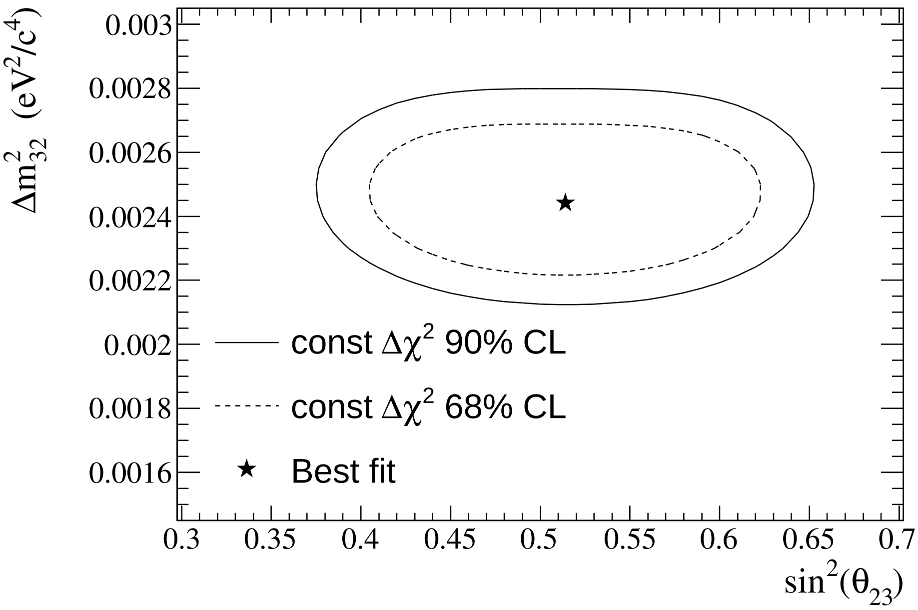

Figure 88: 68% CL and 90% CL allowed region (including systematics), constructed with the constant-$\Delta\chi^2$ method, for the '2+N' $\sin^2\theta_{23}$ fit to the Run 1+2+3 dataset. The '2+N' best-fit point is also shown.

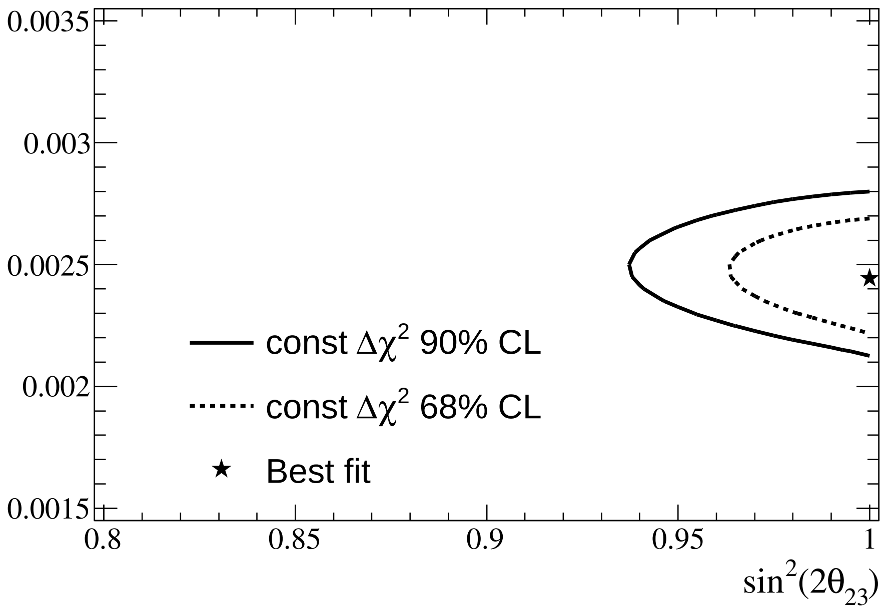

Figure 89: 68% CL and 90% CL allowed region (including systematics), constructed with the constant-$\Delta\chi^2$ method, for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the first octant. The '2+N' best-fit point is also shown.

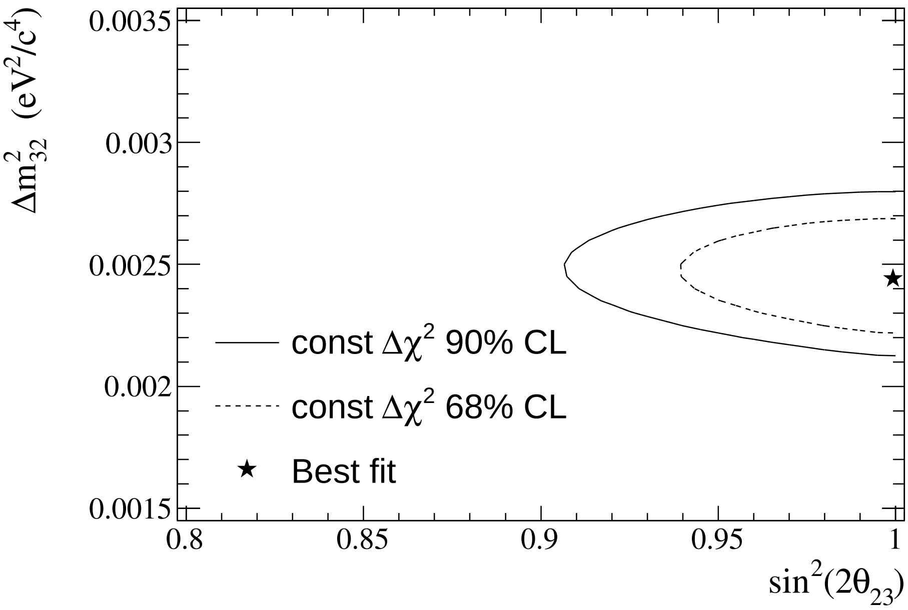

Figure 90: 68% CL and 90% CL allowed region (including systematics), constructed with the constant-$\Delta\chi^2$ method, for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the second octant. The '2+N' best-fit point is also shown.

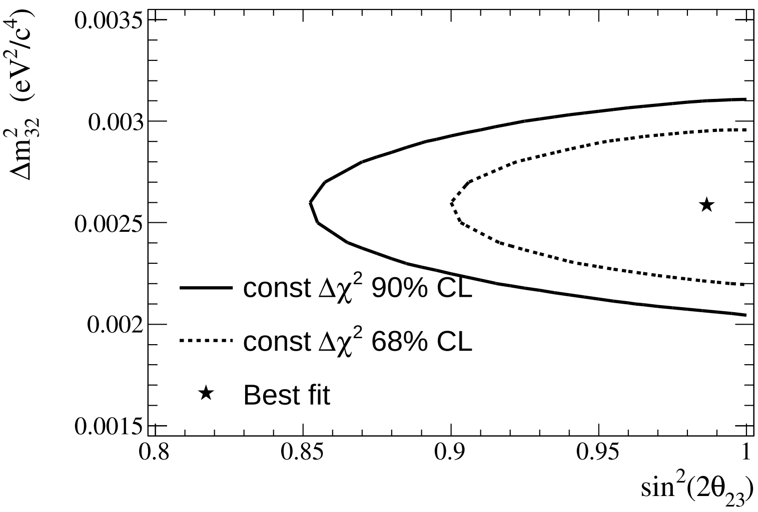

Figure 91: As in Fig. 89, but for the Run 1+2 dataset only.

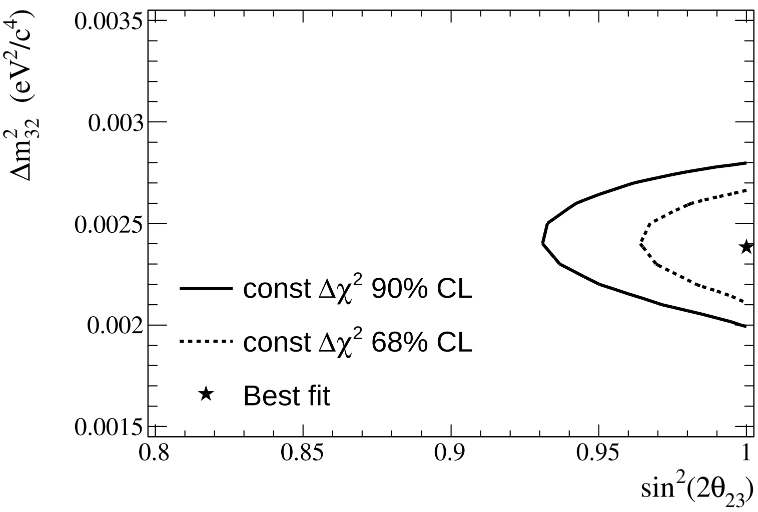

Figure 92: As in Fig. 89, but for the Run 3 dataset only.

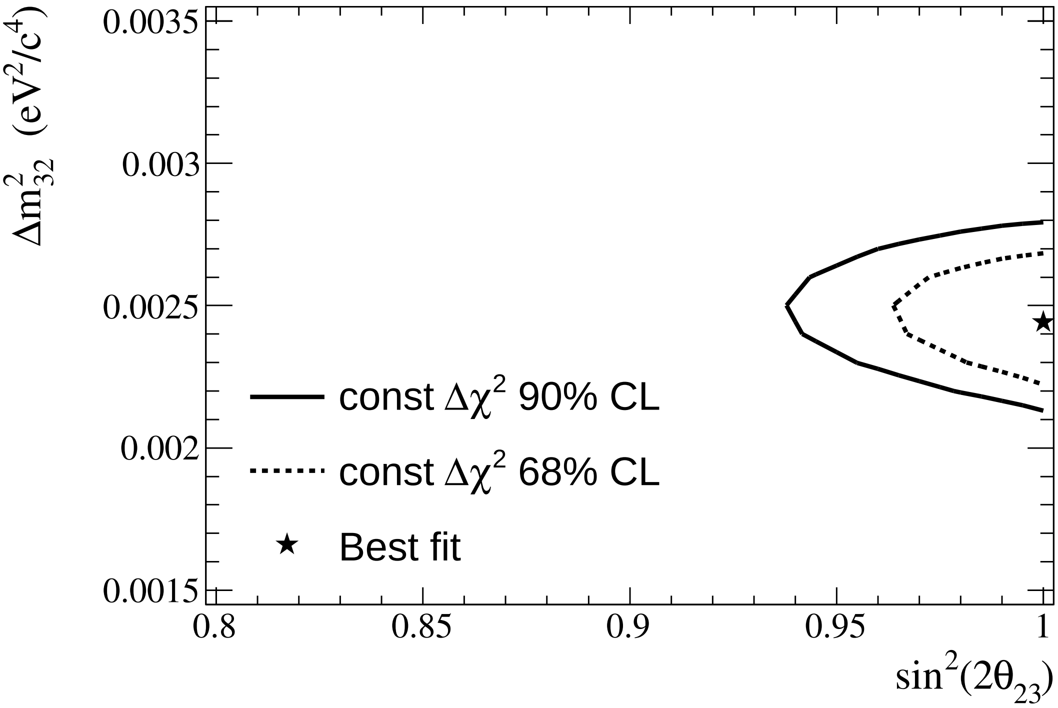

Figure 93: 68% CL and 90% CL allowed region (including systematics), constructed with the constant-$\Delta\chi^2$ method, for the '2+8' fit to the Run 1+2+3 dataset. The '2+8' best-fit point is also shown.

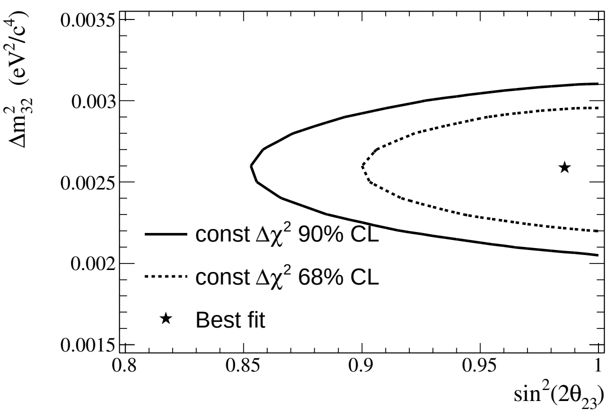

Figure 94: As in Fig. 93, but for the Run 1+2 dataset only.

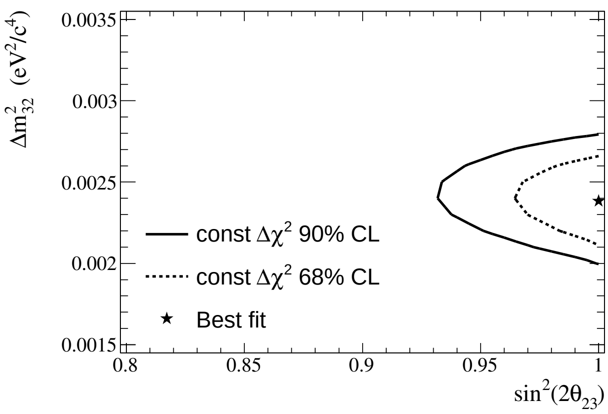

Figure 95: As in Fig. 93, but for the Run 3 dataset only.

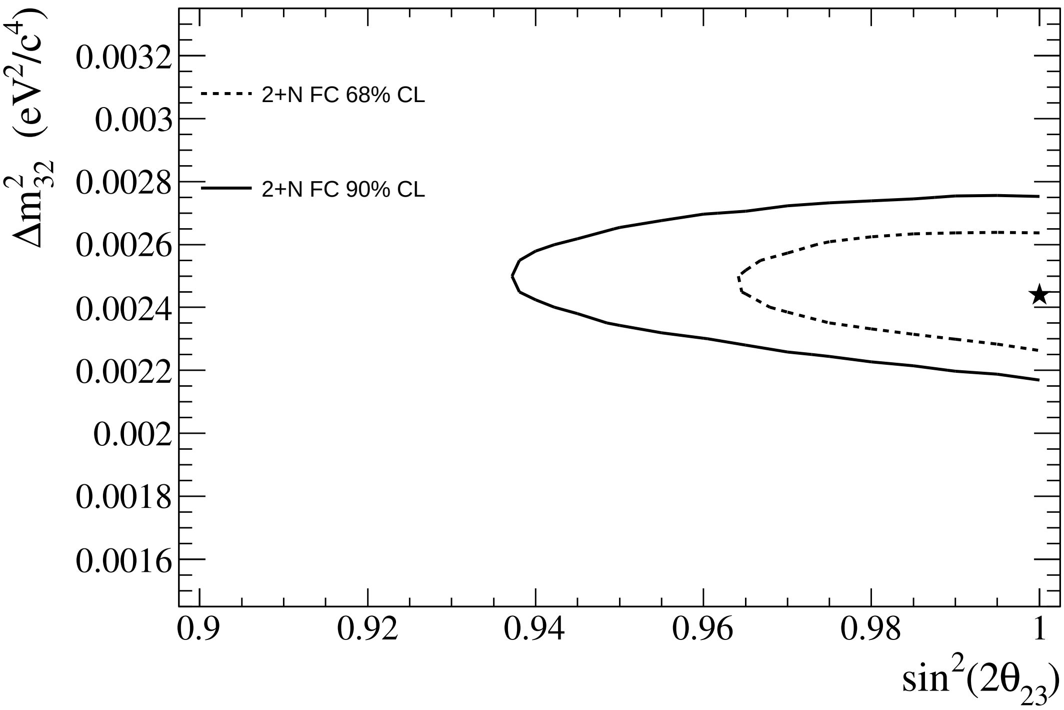

Figure 96: 68% CL and 90% CL allowed region (including systematics), constructed with the method of Feldman and Cousins, for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the first octant. The '2+N' best-fit point is also shown.

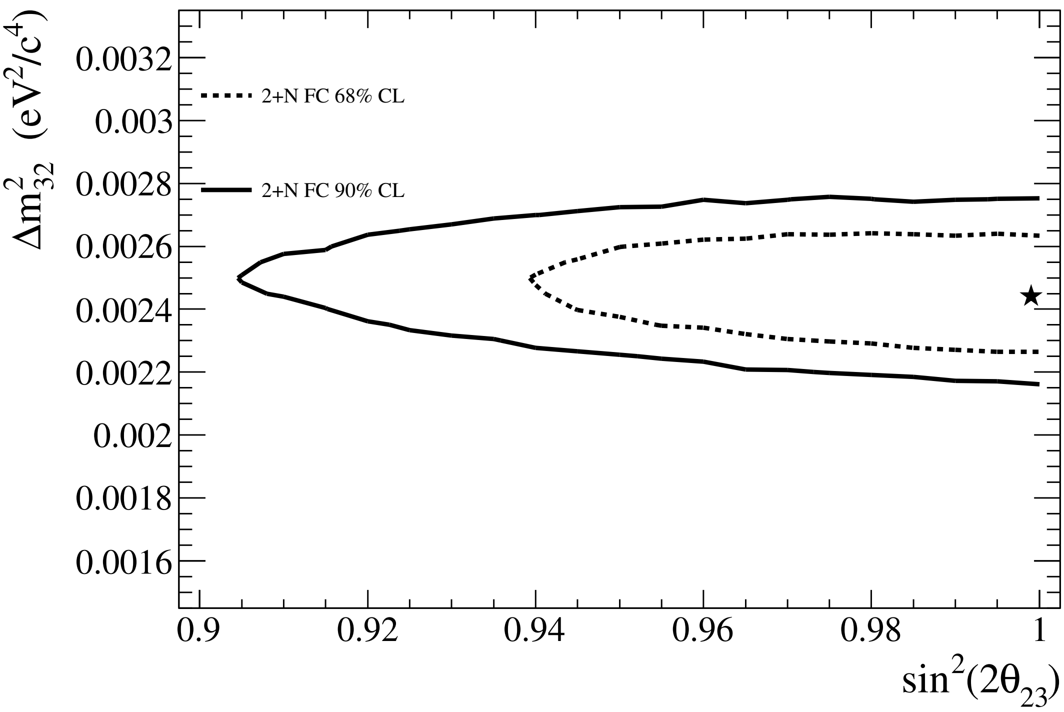

Figure 97: 68% CL and 90% CL allowed region (including systematics), constructed with the method of Feldman and Cousins, for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the second octant. The '2+N' best-fit point is also shown.

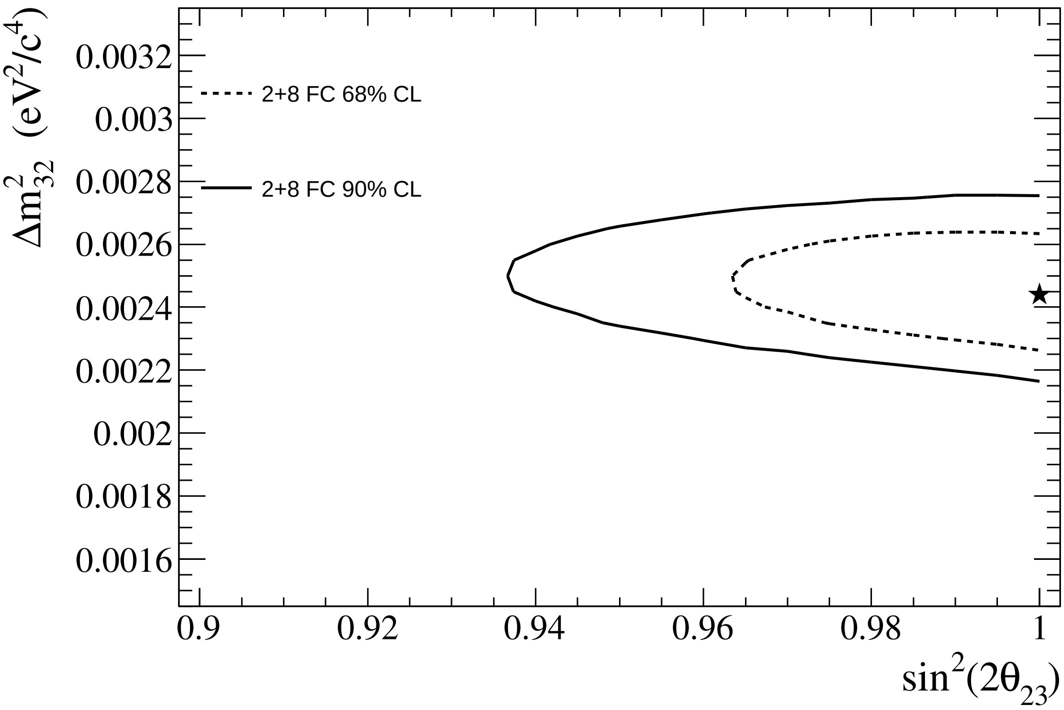

Figure 98: 68% CL and 90% CL allowed region (including systematics), constructed with the method of Feldman and Cousins, for the '2+8' fit to the Run 1+2+3 dataset. The '2+8' best-fit point is also shown.

5.6. *Confidence region comparisons*

5.6.1. *Comparisons between the '2+N' contours assuming θ_{23} is in the first and second octants*

Comparisons were made between the allowed regions obtained using the different fits to the Run 1+2+3 dataset, A comparison between θ_{23} octant assumptions for the '2+N' regions constructed using the constant-$\Delta\chi^2$ method is shown in Fig. 99. A comparison between θ_{23} octant assumptions for the '2+N' regions constructed using the method of Feldman and Cousins is shown in Fig. 100. The contours are visibly different; this is due to the next-to-leading order term in Eq. 3.

Constant $\Delta\chi^2$ contours for both θ_{23} octant assumptions are converted into $\sin^2\theta_{23}$-$|\Delta m^2_{32}|$ space in Fig. 101. They are compared with the fit to $\sin^2\theta_{23}$. The contours are identical, showing that the difference between contours from different θ_{23} octant assumptions shown in Fig. 99 is what is expected. The best-fit values in $\sin^2\theta_{23}$ of the 3 fits are given in Tab. 13.

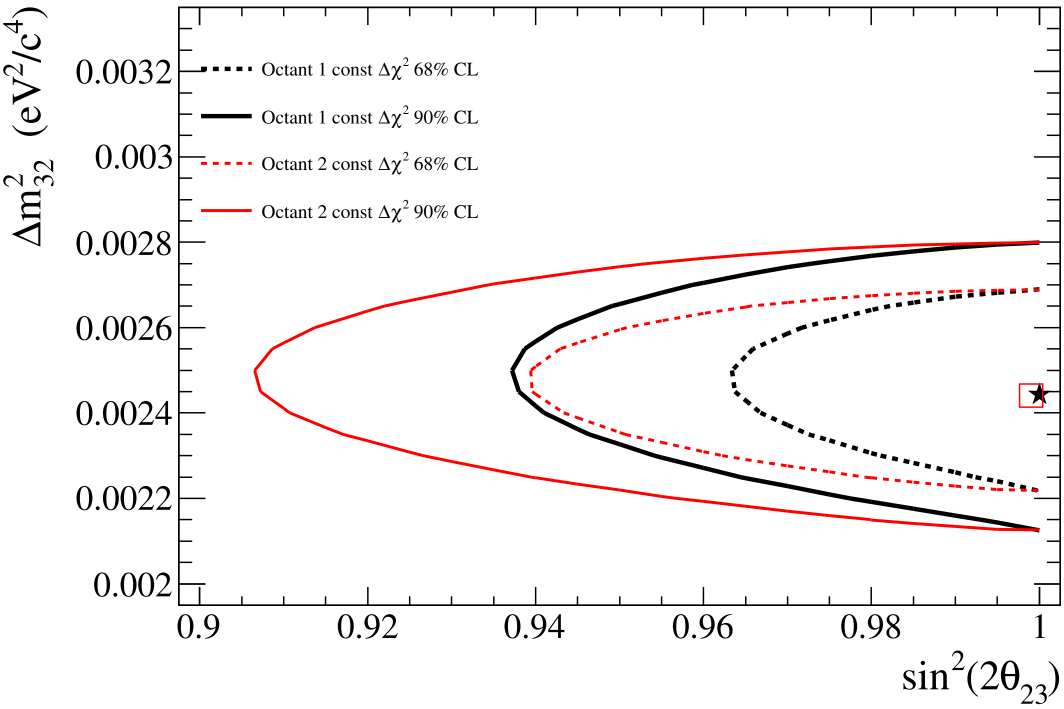

Figure 99: Comparison between the '2+N' 68% CL and 90% CL allowed regions for θ_{23} in the first and second octants obtained using the constant-$\Delta\chi^2$ method. The comparison is shown for the fits to the Run 1+2+3 dataset.

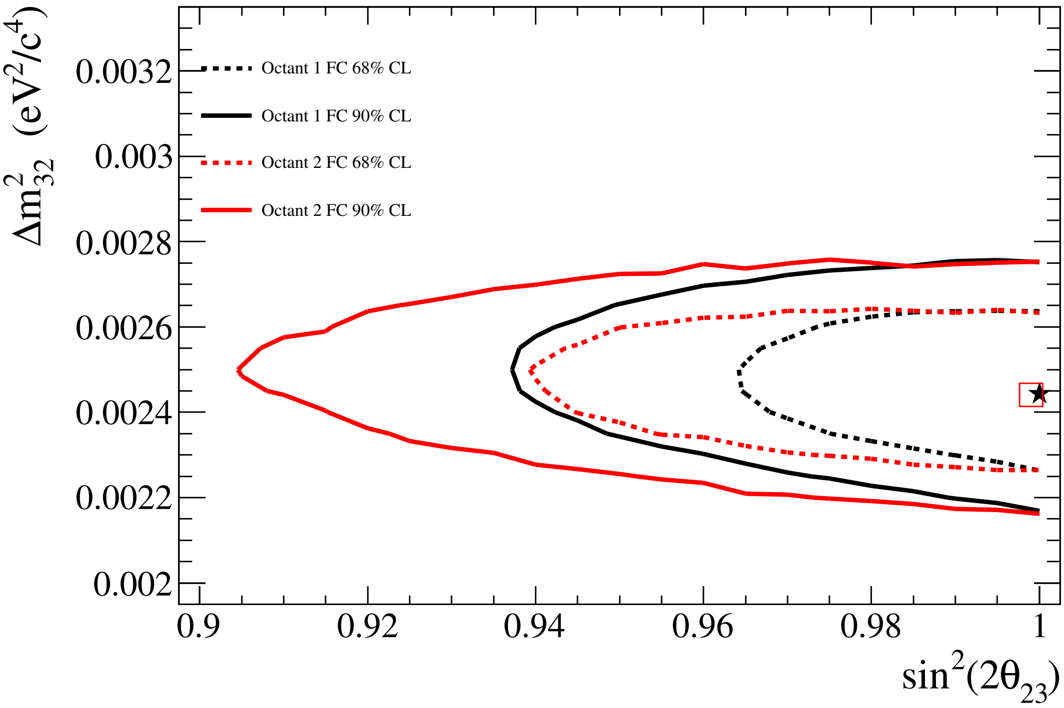

Figure 100: Comparison between the '2+N' 68% CL and 90% CL allowed regions for θ_{23} in the first and second octants obtained using the method of Feldman and Cousins. The comparison is shown for the fits to the Run 1+2+3 dataset.

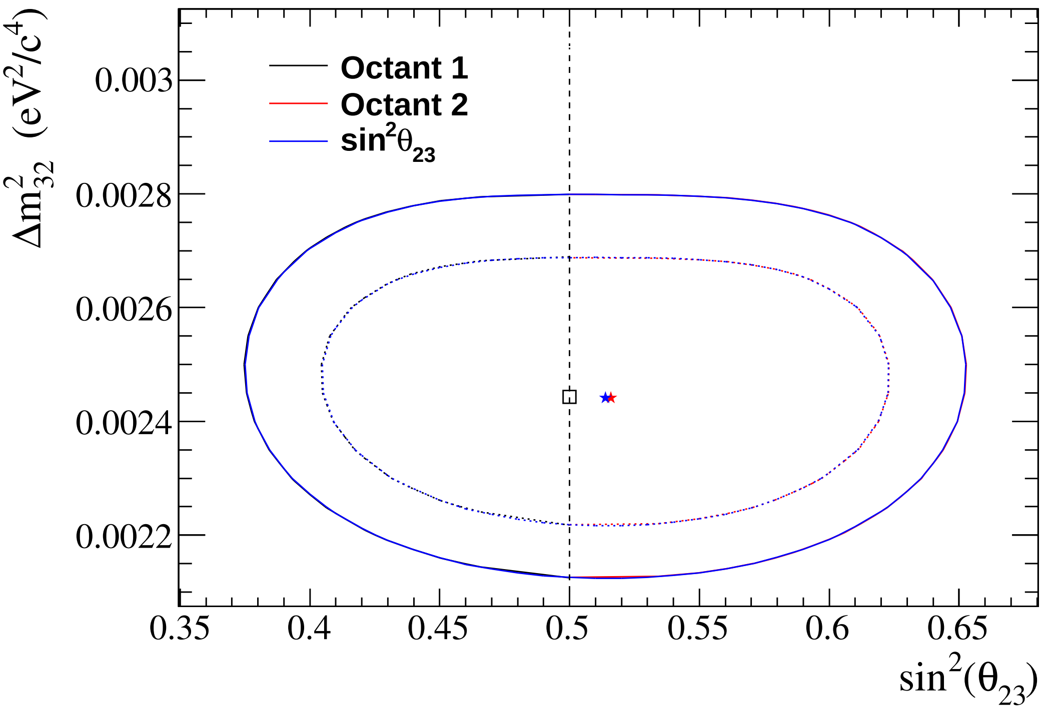

Figure 101: Comparison between the '2+N' 68% CL and 90% CL allowed regions for θ_{23} in the first and second octants obtained using the constant-$\Delta\chi^2$ method, and with the x-axis converted from $\sin^2 2\theta_{23}$ to $\sin^2 \theta_{23}$ after the fit. A '2+N' fit using $\sin^2 \theta_{23}$ directly is also shown. The vertical line is the boundary between the octants to help guide the reader's eye. The comparison is shown for the fits to the Run 1+2+3 dataset.

5.6.2. Comparisons between the '2+N' and '2+8' contours

Comparisons were made between the allowed regions obtained using the different fits to the Run 1+2+3 dataset, A comparison between the '2+N' and '2+8' regions constructed using the constant-$\Delta\chi^2$ method is shown in Fig. 102. A comparison between the '2+N' and '2+8' regions constructed using the method of Feldman and Cousins is shown in Fig. 103. For a given contour construction method, the '2+N' and '2+8' contours are almost identical.

Fig. 104 shows a comparison between the '2+N' and '2+8' regions, constructed using the constant-$\Delta\chi^2$ method, with the corresponding results for '2+0'. The '2+0' fit results in smaller contours. The plot illustrates that, while with the present statistics fitting for systematics is warranted ('2+0' contours smaller than '2+8' and '2+N'), the full effect of the systematics on the contour is encapsulated by allowing only the the 8 dominant to float in the fit.

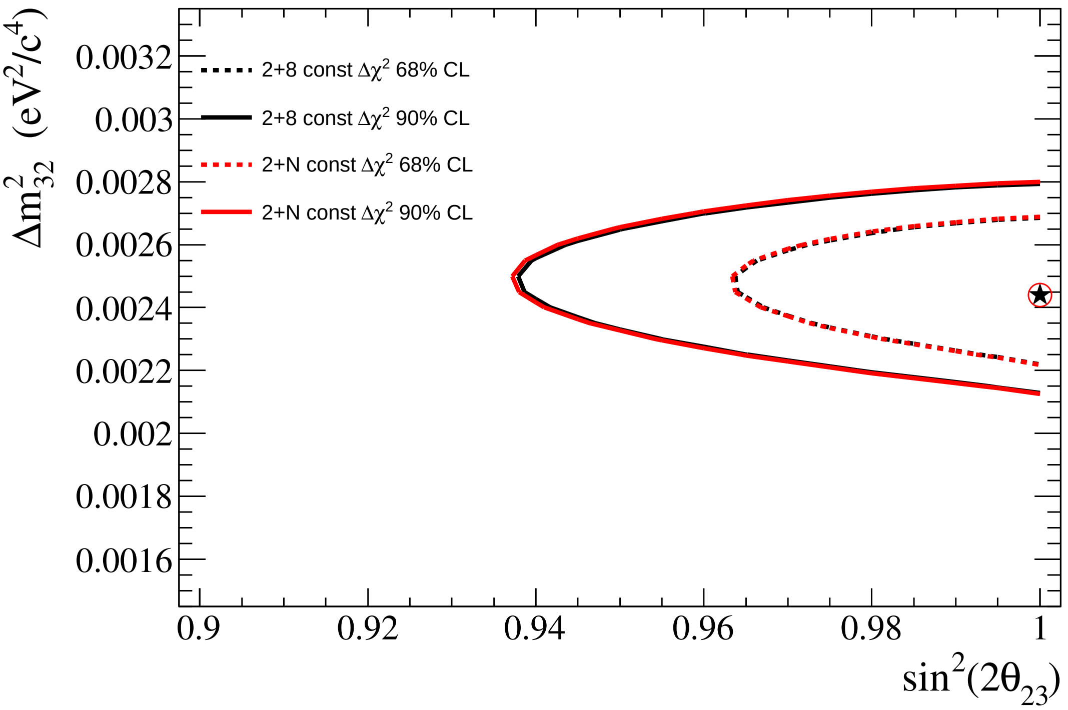

Figure 102: Comparison between the '2+N' and '2+8' 68% CL and 90% CL allowed regions obtained using the constant-$\Delta\chi^2$ method. The comparison is shown for the fits to the Run 1+2+3 dataset. The '2+N' and '2+8' confidence regions are identical.

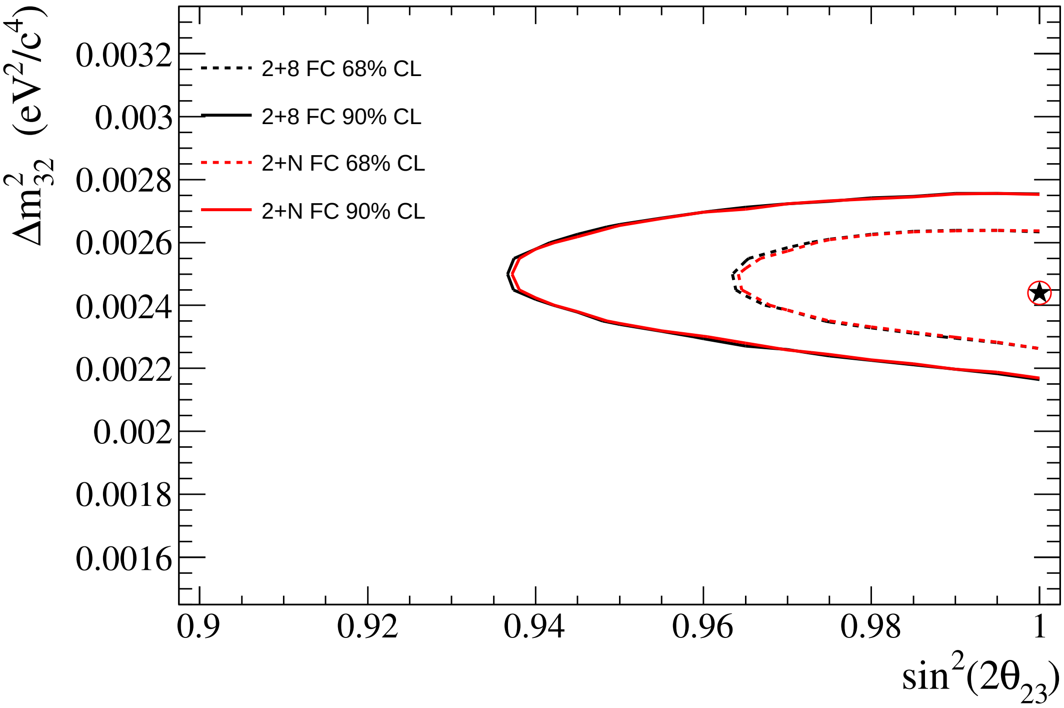

Figure 103: Comparison between the ‘2+N’ and ‘2+8’ 68% CL and 90% CL allowed regions obtained using the method of Feldman and Cousins. The comparison is shown for the fits to the Run 1+2+3 dataset.

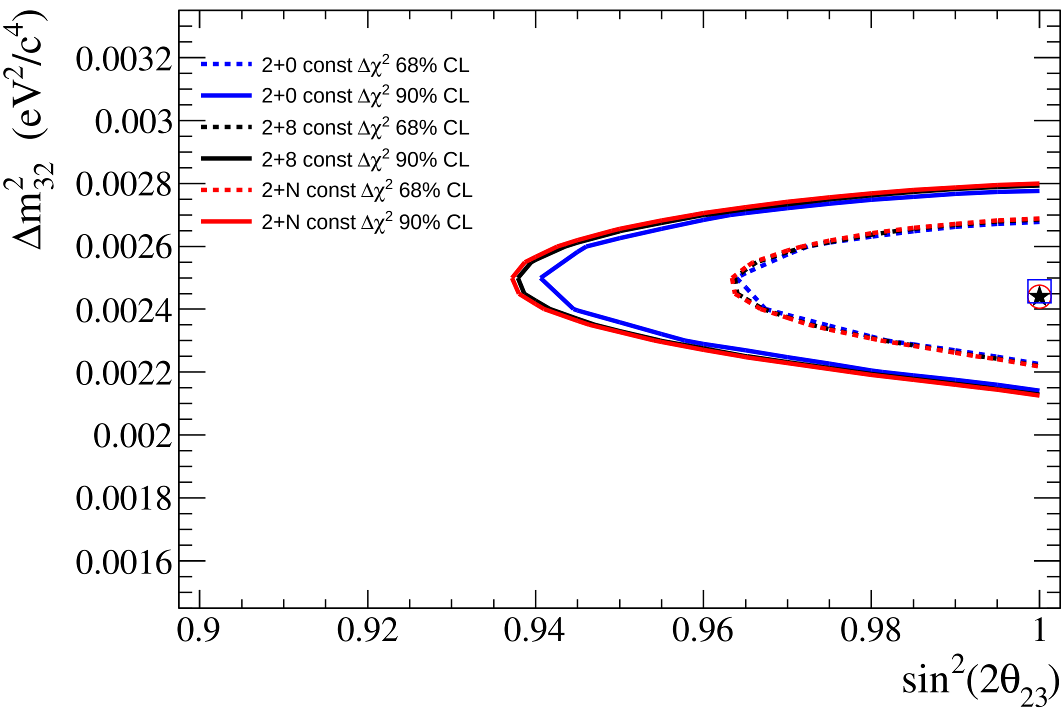

Figure 104: Comparison between the ‘2+N’, ‘2+8’ and ‘2+0’ 68% CL and 90% CL allowed regions obtained using the constant-$\Delta\chi^2$ method. The comparison is shown for the fits to the Run 1+2+3 dataset.

5.6.3. *Comparisons between the constant-$\Delta\chi^2$ and Feldman-Cousins contours*

The confidence regions obtained using the same fit variant but different contour construction methods were also compared. In Fig. 105, a comparison between the contours obtained using the constant-$\Delta\chi^2$ and Feldman-Cousins methods is shown for the '2+N' fit to the Run 1+2+3 dataset. In Fig. 106, the same comparison is shown for the '2+N' fit assuming θ_{23} is in the second octant. In Fig. 107, the same comparison is shown for the '2+8' fit.

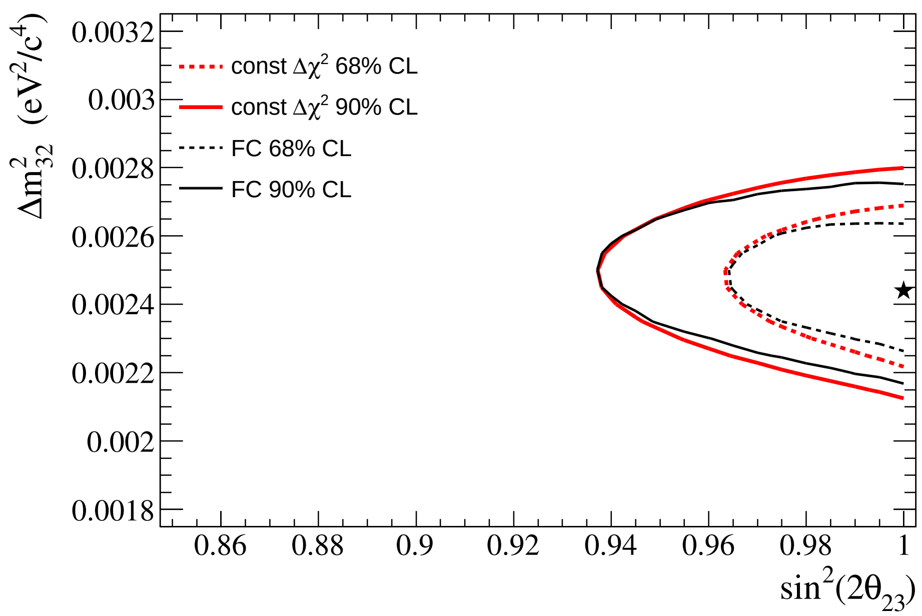

Figure 105: Comparison between the 68% CL and 90% CL allowed regions obtained using the constant-$\Delta\chi^2$ and Feldman-Cousins methods for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the first octant.

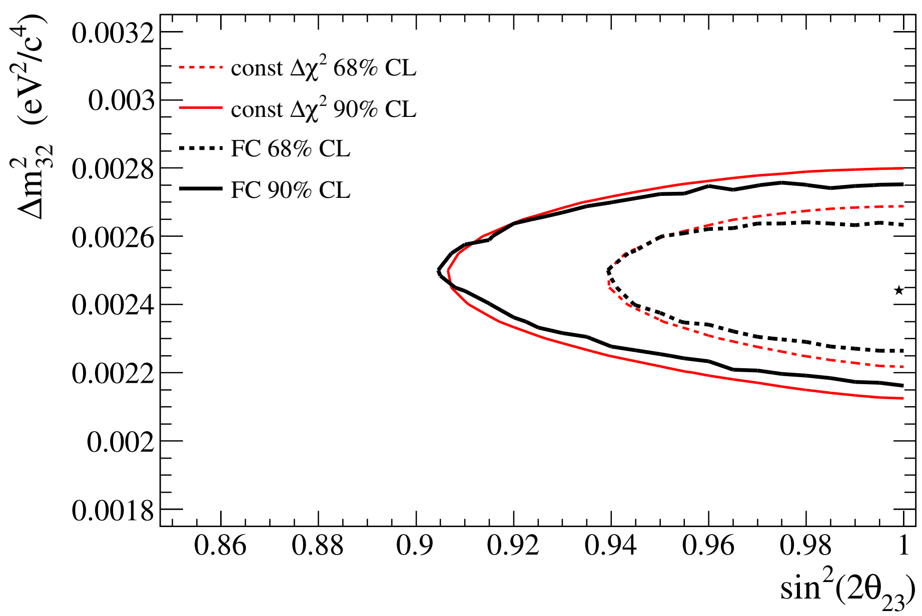

Figure 106: Comparison between the 68% CL and 90% CL allowed regions obtained using the constant-$\Delta\chi^2$ and Feldman-Cousins methods for the '2+N' fit to the Run 1+2+3 dataset assuming θ_{23} is in the second octant.

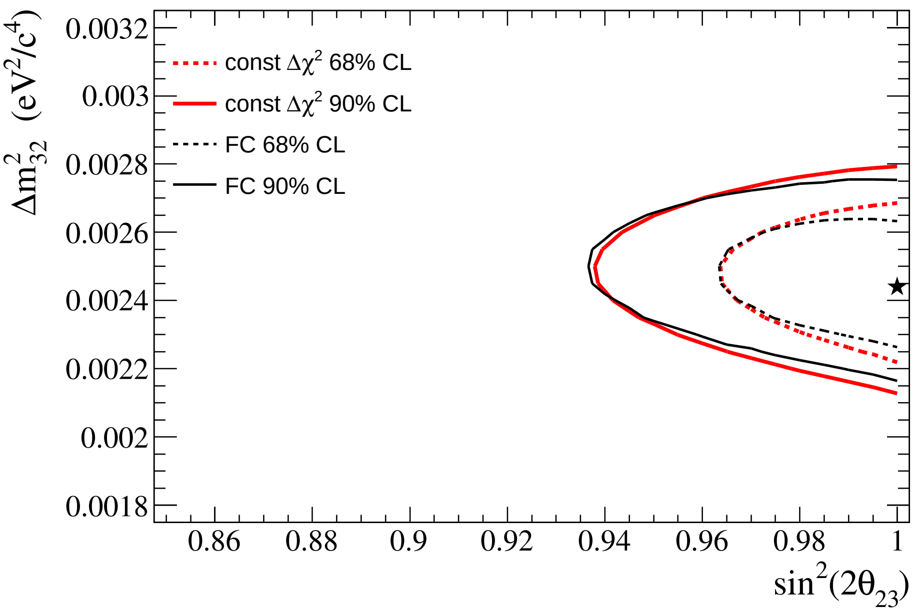

Figure 107: Comparison between the 68% CL and 90% CL allowed regions obtained using the constant-$\Delta\chi^2$ and Feldman-Cousins methods for the '2+8' fit to the Run 1+2+3 dataset.

5.6.4. *Comparisons with recent measurements from MINOS and SuperK*

Comparisons were produced between our Run 1+2+3 results and the updated results from MINOS 2013 (3-flavour analysis) [32] and SuperK 2012 atmospherics (3-flavour zenith-angle analysis) [33]. The comparison is shown in Fig. 108 for the '2+N' fit for $\sin^2\theta_{23}$.

Comparisons were produced between our Run 1+2+3 results and the updated (2012) results from MINOS [31] and SuperK atmospherics (both the 2-flavour L/E and 3-flavour zenith-angle analyses) [33]. The comparison is shown in Fig. 109 for the '2+N' fit assuming θ_{23} is in the first octant, in Fig. 110 for the '2+N' fit assuming it is in the second octant, and in Fig. 111 for the '2+8' fit. A comparison of '2+N' FC contours with the external data is shown in Fig. 112 for both octant assumptions.

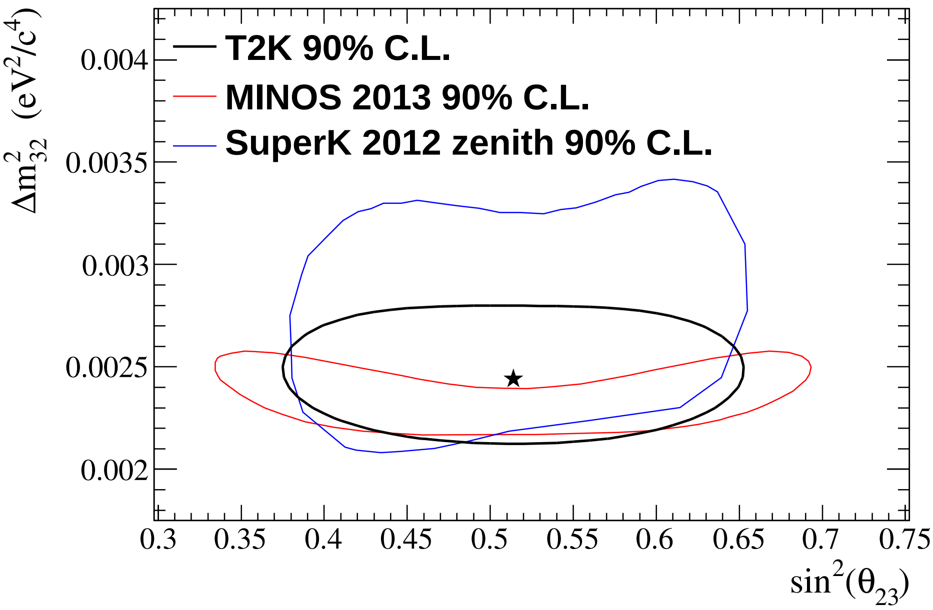

Figure 108: Comparison between 90% CL allowed regions from MINOS [32] and SuperK atmospherics [33], and the 90% CL region obtained from the VaLOR '2+N' $\sin^2\theta_{23}$ fit to the Run 1+2+3 dataset, using the constant-$\Delta\chi^2$ method.

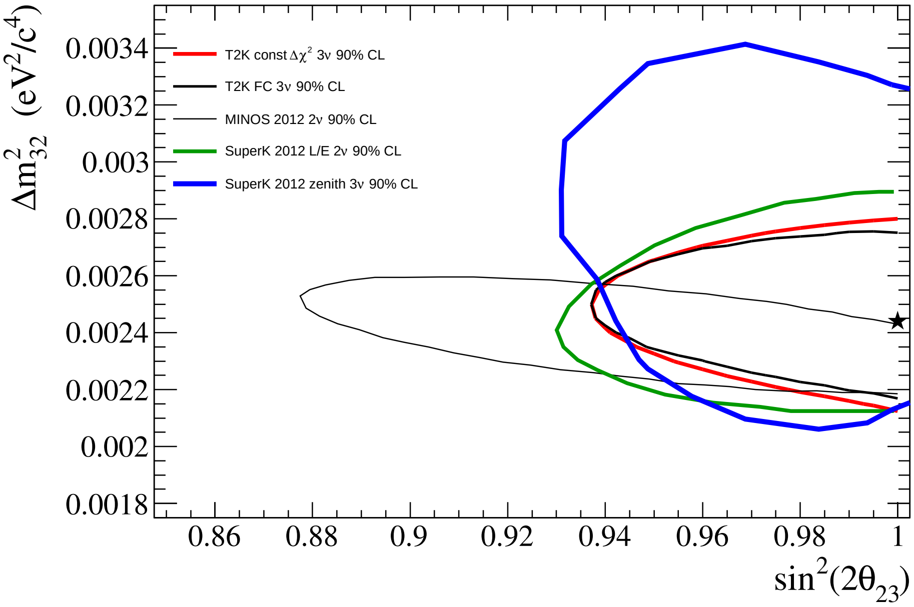

Figure 109: Comparison between 90% CL allowed regions from MINOS [31] and SuperK atmospherics [33], and the 90% CL regions obtained from the VaLOR '2+N' fit to the Run 1+2+3 dataset. Contours obtained using both the constant-$\Delta\chi^2$ and Feldman-Cousins methods are shown.

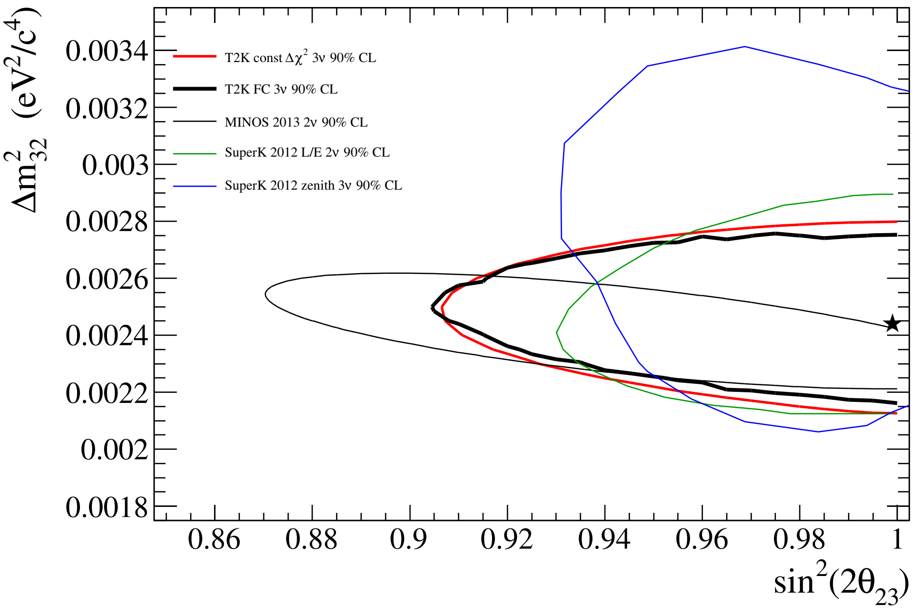

Figure 110: As in Fig. 109, but for the '2+N' fit assuming θ_{23} is in the second octant.

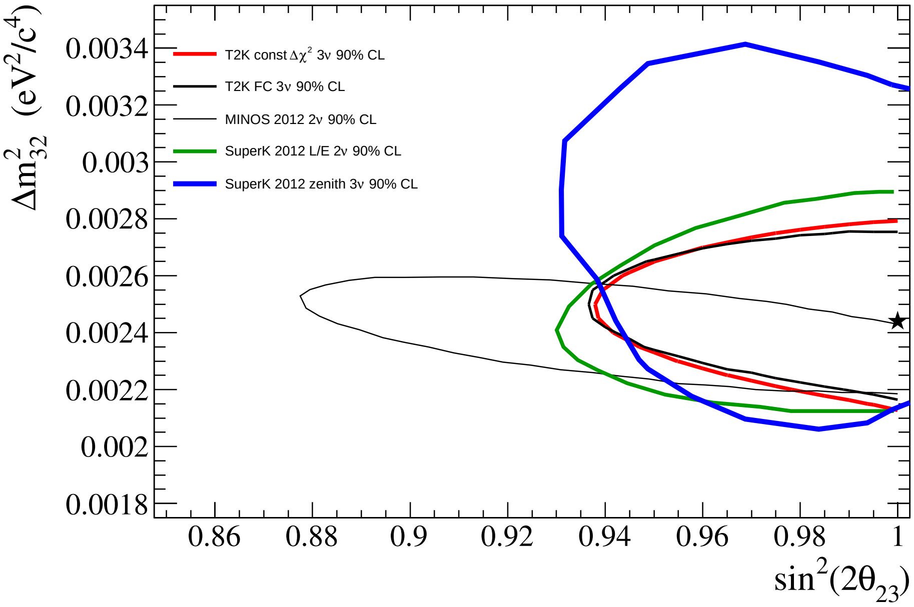

Figure 111: As in Fig. 109, but for the '2+8' fit.

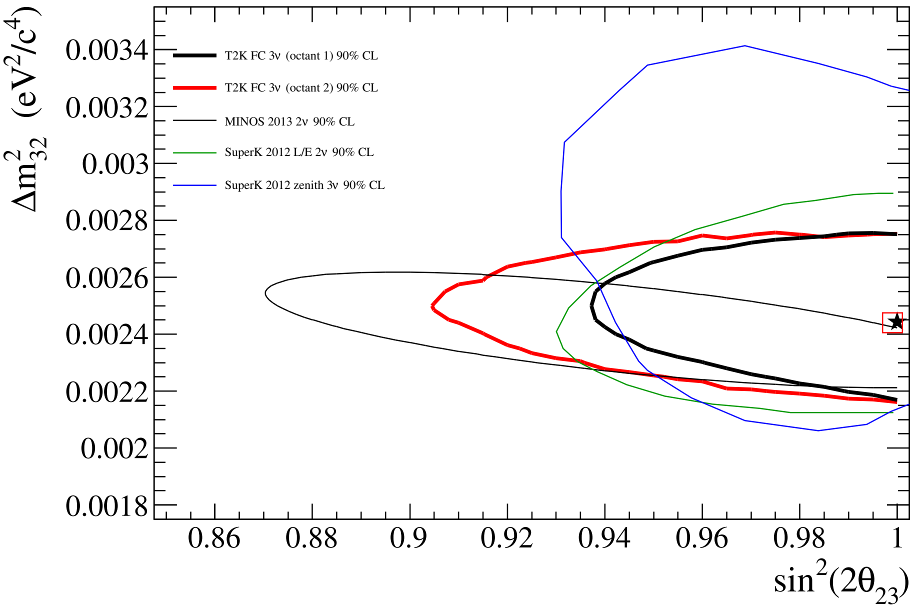

Figure 112: Comparison between 90% CL allowed regions from MINOS [31] and SuperK atmospherics [33], and the 90% CL regions obtained from the VaLOR '2+N' fit to the Run 1+2+3 dataset. Contours obtained using both θ_{23} octant assumptions are shown.

5.6.5. *Comparisons with sensitivity*

In Fig. 113, a comparison is shown between the Run 1+2+3 allowed regions obtained using the '2+8' fit and the constant-$\Delta\chi^2$ method, and the T2K 3.010×10^{20} POT sensitivity contours produced at the '2+8' best-fit point for the Run 1+2+3 dataset. The sensitivity contours were computed by averaging the contours of 1k toy-MC experiments generated with statistical fluctations and all systematic parameters randomized. The plot indicates that the Run 1+2+3 dataset, is a "favourable" fluctuation allowing us to quote confidence regions which are more restrictive than those that would be expected given our sensitivity. This favourable fluctuation is not unlikely as shown in Fig. 114.

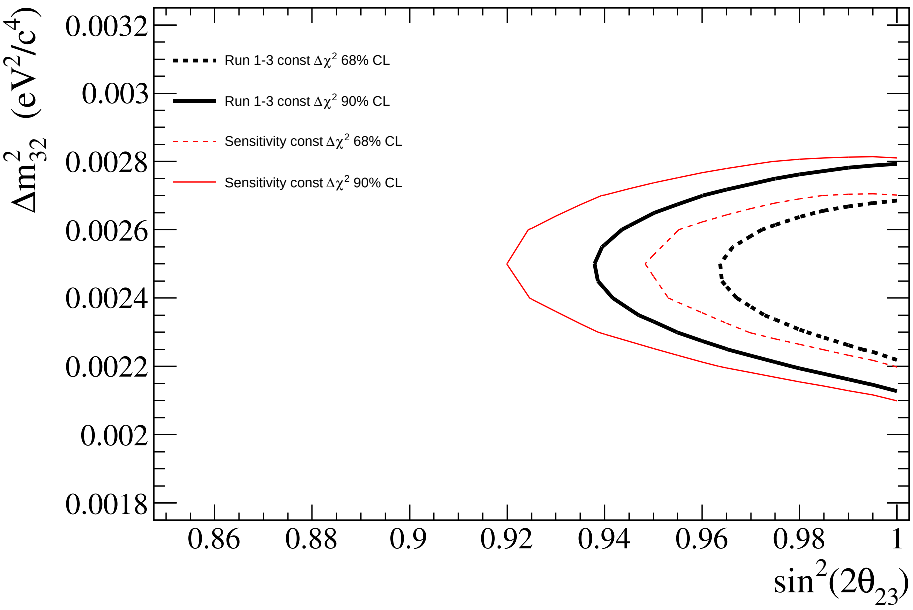

Figure 113: Comparison between the 68% CL and 90% CL allowed regions using the constant-$\Delta\chi^2$ method for the '2+8' fit to the Run 1+2+3 dataset and the result of a sensitivity study at the '2+8' best-fit point for Run 1+2+3.

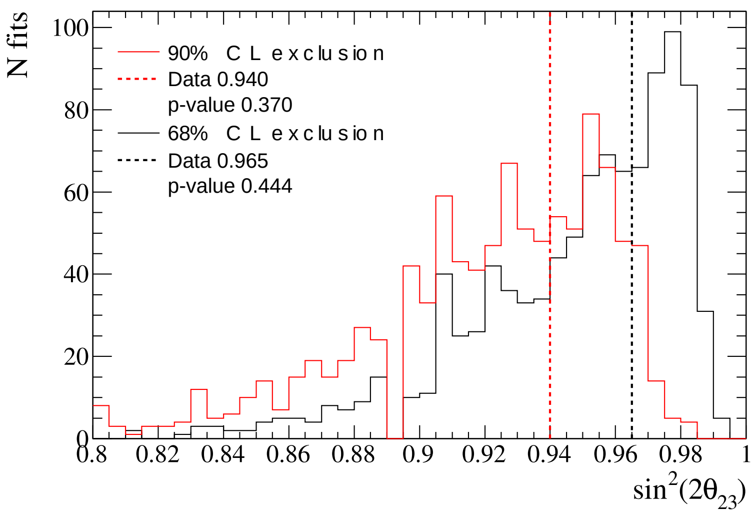

Figure 114: Distribution of minimum excluded value of $\sin^2 2\theta_{23}$, for both 68% CL and 90% CL. The dashed lines show the minimum excluded value for the '2+8' fit to the Run 1+2+3 dataset, using the constant-$\Delta\chi^2$ method (68% CL in black and 90% CL in red).

5.6.6. *Comparisons of individual run periods*

A comparison between the confidence regions obtained by three separate '2+N' analyses of the Run 1+2+3, Run 1+2 and Run 3 datasets is shown in Fig. 115. The corresponding plot for the '2+8' fit is shown in Fig. 116. The contours from the different running periods are consistent.

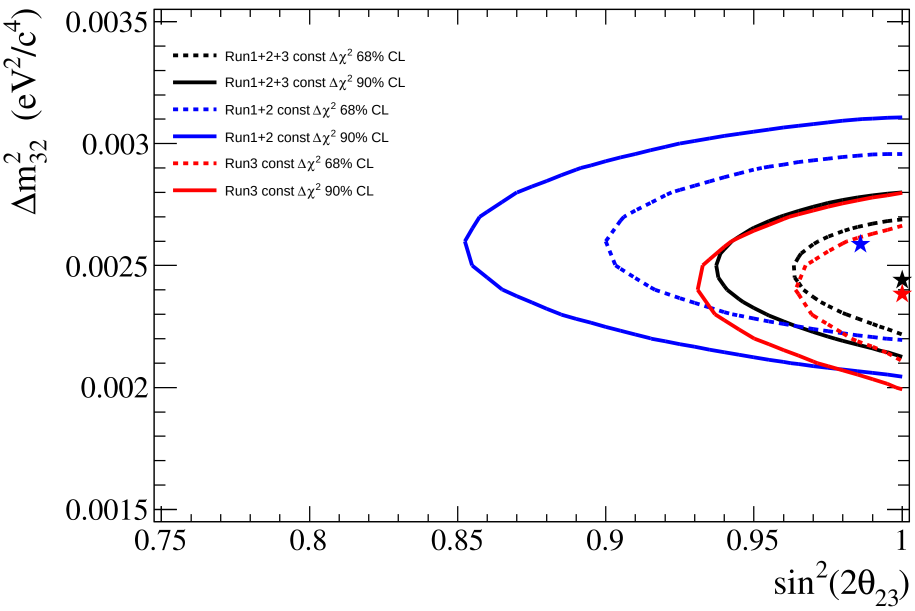

Figure 115: Comparison between the 68% CL and 90% CL allowed regions obtained from separate '2+N' analyses of the Run 1+2+3, Run 1+2 and Run 3 datasets. All contours shown were calculated with the constant-$\Delta\chi^2$ method.

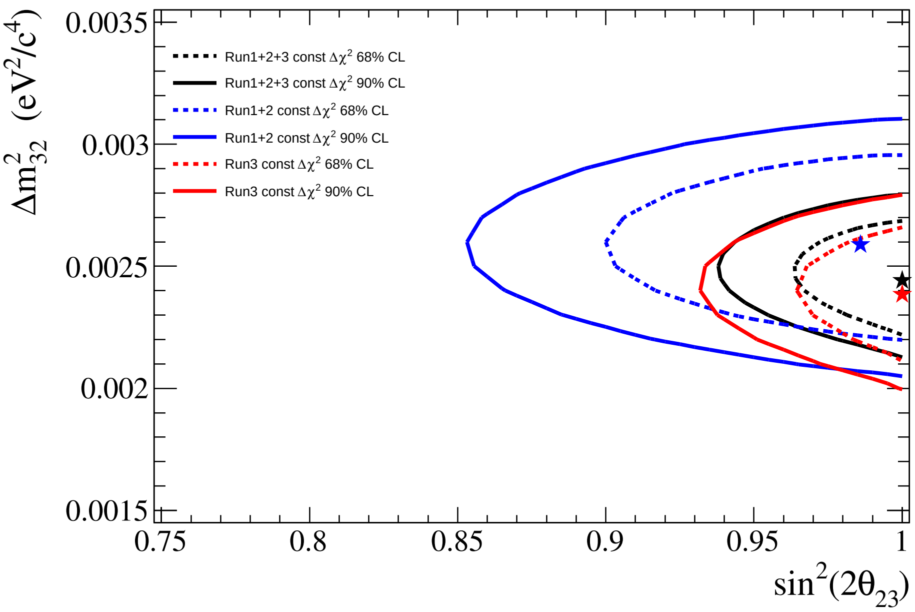

Figure 116: Comparison between the 68% CL and 90% CL allowed regions obtained from separate '2+8' analyses of the Run 1+2+3, Run 1+2 and Run 3 datasets. All contours shown were calculated with the constant-$\Delta\chi^2$ method.

5.7. The VaLOR group perspective on the choice of primary result

Four separate ν_μ-disappearance results have been produced by this analysis for the Run 1+2+3 dataset; this is because we have used two fitting methods ('2+N' and '2+8') and two methods for constructing confidence regions (constant-$\Delta\chi^2$ and Feldman-Cousins).

This analysis used contours produced with the constant-$\Delta\chi^2$ method quite extensively, especially during its development and for the sensitivity studies. We considered that producing Feldman-Cousins contours at an early stage would not be the best use of our time or of the CPU resources available to us. In that respect, the constant-$\Delta\chi^2$ contours were invaluable as a tool for developing the analysis. The constant-$\Delta\chi^2$ contours meet some, but not all of the requirements set by the muon-neutrino contour committee: they should have correct coverage, they should be standard in the field and easy to explain, they should avoid paradoxical results and should be computationally feasible [30]. However our group has been a strong advocate of the use of the Feldman-Cousins method from the time of the Run 1 analysis. Since the best-fit value of $\sin^2 2\theta_{23}$ is at the physical boundary, the constant-$\Delta\chi^2$ contours do not have correct coverage with present statistics and we do not consider them as contenders for our primary result.

This leaves only two options to consider: The '2+N' and the '2+8' Feldman-Cousins contours. As shown in this paper, no real difference exists between the '2+N' and the '2+8' results:

- The best-fit points are identical for the combined Run 1+2+3 dataset (and nearly identical for the separate fits to the Run 1+2 and Run 3 datasets), as shown in Tab. 14.
- The p-values for the fits to the combined Run 1+2+3 dataset are identical, as shown in Tab. 14.
- Although all 48 systematic parameters are allowed to float in the '2+N' fit, only 6 parameters have best-fit values which are more that $\pm 0.1\sigma$ away from their corresponding nominal values, as shown in Fig. 34. Thus the vast majority of the systematic parameters included in the '2+N' fit have, in fact, a negligible effect on the fit.
- The best-fit spectra are indistinguishable when superimposed on the same plot, as shown in Fig. 65. The best-fit spectra (binned using the same scheme used in the fit) never differ by more than 1.5% in the area below 3 GeV, and they are nearly identical in the area of the first oscillation maximum.
- The 68% and 90% CL regions for the two fits are identical, as shown in Figs. 102 and 103. Indeed, the '2+N' and '2+8' marginalized $\Delta\chi^2$ distributions for are identical for both $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$, even in areas of the oscillation parameter space outside the 99% CL region (this is defined by $\Delta\chi^2 < 6.63$ for a single parameter). This is shown in Figs. 86 and 87.

Given the marked similarity of the results of the '2+8' and '2+N' fits, it is difficult to make a choice between them. However the VaLOR group prefers the simpler '2+8' fit since it has fewer floating parameters. The choice of the 8 floating parameters in this fit was made with an extremely careful study which is presented in Sec. 4.4.

Ockham's razor states that "Pluralitas non est ponenda sine neccesitate" or "Plurality should not be posited without necessity" [39]. The plurality of the additional floating parameters in the '2+N' fit is unnecessary since it does not change the values of the oscillation parameters we seek to measure. Furthermore, the simpler fit is easier to explain to a wider audience. For these reasons, we feel strongly that the '2+8' result should be the one presented as the official result outside the T2K collaboration.

6. Summary

In this technical note, we have presented the results of a 3-flavour ν_μ-disappearance analysis, performed by the Valencia-Lancaster-Oxford-Rutherford (VaLOR) group, on the combined Run1+2+3 (3.010$\times10^{20}$ POT) dataset. This analysis is an update of the work presented in Refs. [1], [2] and [3] with improved methods and an enlarged dataset.

This analysis predicts 204.75 $\pm$ 16.75 (syst) 1 μ-like ring events in SuperK in the absence of any oscillation, but only 58 were observed. The observed deficit has a strong energy dependence; the ratio of observed to expected, under the no oscillation hypothesis, is $\sim$30% $<$ 0.5 GeV, $\sim$10% between 0.5 and 1 GeV and $\sim$75% $>$ 1 GeV.

A ν_μ-disappearance analysis was performed in a framework of 3-flavour oscillations including matter effects in constant-density matter. A total of 48 efficiency, energy scale, neutrino flux, neutrino cross-section, initial-state nuclear environment and final-state rescattering systematics was taken into account. The effect of these systematic uncertainties on the expected number of 1 μ-like ring events, on their reconstructed energy spectrum and on our oscillation measurement were presented in great detail.

Two versions of the oscillation fit were performed: the '2+N' fit allowed all 48 systematics considered in this analysis to float, whereas the '2+8' fit allowed only the 8 most dominant systematics to float. The dominant systematics are those identified as having an effect on the measured oscillation parameters that is greater than 25% of the expected statistical error, for at least one set of true oscillation parameters in the area of interest. The '2+N' 3-flavour ν_μ-disappearance fit to the observed reconstructed energy spectrum of 1 μ-like ring events of the combined Run1+2+3 dataset, for $\sin^2\theta_{23}$ yield $|\Delta m^2_{32}|$ = 2.441$\times10^{-3}$ eV^2/c^4 and $\sin^2\theta_{23}$ = 0.514 as the best-fit values (p-value = 0.80). For the '2+N' fit assuming the first octant ($\sin^2 2\theta_{23} \geq 0.5$), with $sin^2 2\theta_{23}$ constrained to the physical region, the best-fit values are almost identical at $|\Delta m^2_{32}|$ = 2.443$\times10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 1.000 (p-value = 0.83). For the '2+N' fit assuming the second octant ($\sin^2 2\theta_{23} \geq 0.5$), the best-fit values are almost identical at $|\Delta m^2_{32}|$ = 2.441$\times10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23}$ = 0.999 (p-value = 0.82). For the '2+8' fit, the best-fit values are almost identical. All fits used the 2012 PDG values for $\sin^2 2\theta_{13}$, $\sin^2 2\theta_{12}$ and Δm^2_{21} [21], and assumed δ_{CP}=0 and the normal mass hierarchy.

Confidence regions obtained using both the constant-$\Delta\chi^2$ method and the method of Feldman and Cousins were presented for both the '2+N' and '2+8' fits. Using the results of the '1+N' fits, and the constant-$\Delta\chi^2$ method, the 90% CL allowed region, for the '2+N' fit for $\sin^2\theta_{23}$, can be summarized as 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| < 2.72\times10^{-3}$ eV^2/c^4 and $0.397 < \sin^2\theta_{23} < 0.630$. The corresponding limits for the '2+N' fit assuming the first octant, can be summarized as 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| < 2.72\times10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23} >$ 0.958. The corresponding limits for the '2+N' fit assuming the second octant, can be summarized as 2.19×10^{-3} eV^2/c^4 $< |\Delta m^2_{32}| < 2.72\times10^{-3}$ eV^2/c^4 and $\sin^2 2\theta_{23} >$ 0.931.

Numerous comparisons were made of the best-fit values and spectra, of the systematic parameter pulls, and of the χ^2 surfaces obtained by the different fit methods and for different running periods. Detailed comparisons were presented of the confidence regions obtained by using different construction methods, for the same fit, and by using different fitting methods, for the same construction method. The contours from different running periods were compared. Comparisons of our contours with recent measurements from MINOS and SuperK and the T2K 3.010$\times10^{20}$-POT sensitivity were also made. Finally, a more critical view of the 4 different results obtained by this analysis was presented in Sec. 5.7.

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[44] Prob3++ 3-flavour oscillation probability software, http://www.phy.duke.edu/ raw22/public/Prob3++/

A. VaLOR 3-flavour oscillation probability calculations

In this analysis, 3-flavour neutrino oscillation probabilities in constant density matter are used. Vacuum 3-flavour oscillation probabilites are also calculated, but these are used only to estimate the accuracy of the 3-flavour probabilities in matter (see section A.6). The method of calculation of the vacuum probabilities is given in section A.1, while the calculation of the probabilities in constant density matter is described in section A.2. The code that makes these calculations has been integrated into the VaLOR oscillation analysis package. In section A.4, comparisons are given between 2-flavour and 3-flavour (in matter) oscillation probabilities, and between 3-flavour oscillation probabilities in vacuum and matter. Validation of the code is described in section A.5: the vacuum probabilities were validated by comparing their values with those obtained from an alternative formulation in the PDG review. Several validation checks of the probabilities in constant density matter are made as they are calculated, and the values of the probabilities were checked by comparing them with those given by an independently-written program. Finally, an estimate of the accuracy of the oscillation probabilities in matter is given in section A.6.

A.1. 3-flavour neutrino oscillation probabilities in vacuum

The 3-flavour neutrino oscillation probabilities in vacuum are calculated from equation 11 in [40]:

$$P(\nu_\alpha \to \nu_\beta) = \delta_{\alpha\beta} - 4\sum_{i>j} Re(U^*_{\alpha i}U_{\beta i}U_{\alpha j}U^*_{\beta j})\sin^2\left(\frac{\Delta m^2_{ij}L}{4E}\right) + 2\sum_{i>j} Im(U^*_{\alpha i}U_{\beta i}U_{\alpha j}U^*_{\beta j})\sin\left(\frac{\Delta m^2_{ij}L}{2E}\right) \quad (10)$$

In equation 10, Δm^2_{ij} = m^2_j - m^2_i, L is the distance from the neutrino target in Tokai to Super-K (295 km), E is the neutrino energy, and U is the PMNS matrix in vacuum:

$$U = \begin{pmatrix} c_{12}c_{13} & c_{13}s_{12} & s_{13}e^{-i\delta} \\ -c_{23}s_{12} - s_{13}s_{23}c_{12}e^{i\delta} & c_{12}c_{23} - s_{12}s_{13}s_{23}e^{i\delta} & c_{13}s_{23} \\ s_{12}s_{23} - s_{13}c_{12}c_{23}e^{i\delta} & -s_{23}c_{12} - s_{12}c_{23}s_{13}e^{i\delta} & c_{13}c_{23} \end{pmatrix} \quad (11)$$

with $s_{12} = \sin(\theta_{12})$, $c_{12} = \cos(\theta_{12})$, etc. $P(\bar{\nu}_\alpha \to \bar{\nu}_\beta)$ is calculated by changing the sign of the third term in equation 10 (this assumes that CPT is conserved).

A.2. 3-flavour neutrino oscillation probabilities in constant density matter

All three neutrino flavours undergo neutral-current interactions with protons, neutrons and electrons in matter. These neutral-current interactions have identical amplitudes for all three flavours, and they produce no observable effects on the probabilities of oscillation between one flavour and another. However the oscillation probabilities are changed by coherent forward scattering of electron neutrinos in charged-current interactions with electrons in matter [40].

Using natural units with $\hbar$ = c = 1, the time evolution of neutrino flavour states in vacuum is described by the Schrödinger equation:

$$i\frac{\partial\psi}{\partial t} = H_F\psi \quad (12)$$

where

$$\psi = \begin{pmatrix} \psi_e \\ \psi_\mu \\ \psi_\tau \end{pmatrix} \quad (13)$$

and H_F is the effective Hamiltonian in the flavour-state basis

$$H_F = \frac{1}{2E}UMU^\dagger \quad (14)$$

with M defined by

$$M = \begin{pmatrix} 0 & 0 & 0 \\ 0 & \Delta m^2_{21} & 0 \\ 0 & 0 & \Delta m^2_{31} \end{pmatrix} \quad (15)$$

The calculation of oscillation probabilities requires neutrino flight time to be converted to distance travelled, and this conversion assumes that neutrinos are highly relativistic. In this calculation, $UMU^\dagger$ is used for neutrinos, but its complex conjugate is used for antineutrinos. For neutrinos, the effects of the charged-current interactions between electron neutrinos and electrons are taken into account by adding the potential $2E\sqrt{2}G_F N_e$ to the real part of the first diagonal element of $UMU^\dagger$, where E is the neutrino energy, G_F is the Fermi coupling constant, and N_e is the number density of electrons in matter. For antineutrinos, this potential is subtracted from the real part of the first diagonal element of the complex conjugate of $UMU^\dagger$ (for further details see section 9.2 in [41]).

After the addition or subtraction of this potential, $UMU^\dagger$ (or its complex conjugate) is diagonalised. The eigenvalues of a Hermitian matrix are always real; they are calculated by solving the (cubic) characteristic equation using the method of del Ferro, Tartaglia and Cardano as described in [42]. The differences between the eigenvalues are the effective mass-squared differences in matter. The eigenvectors are calculated using an algebraic method: one of the components is set to be 1.0 (real), and the other two components are calculated using two of the three simultaneous equations in $UMU^\dagger - \lambda I = 0$, where the λ are the eigenvalues. After being normalised, the three eigenvectors become the columns of the effective mixing matrix in matter.

The initial flavour state of the neutrino is represented by a 1×3 column vector whose entries are complex; if, for example, the initial flavour state is a muon neutrino, this column vector is

$$\begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$$

The vector representing the initial flavour state is then multiplied by the Hermitian conjugate of the matter mixing matrix to convert it to another 1×3 complex column vector representing the initial mass states. These mass states are propagated to Super-K by multiplying the jth initial mass state by $\exp\left(\frac{-i\Delta m^2_{j1}L}{2E}\right)$, where the Δm^2_{j1} are the mass-squared differences in matter, i.e. the differences between the eigenvalues of $UMU^\dagger$. This gives a new 1×3 complex column vector representing the final mass states, and these are converted to the final flavour states by multiplying by the matter mixing matrix. The entries of the resulting 1×3 complex column vector represent the amplitudes of each flavour at Super-K, and the corresponding oscillation probabilities are calculated as the moduli squared of these amplitudes.

A.3. Inputs to the 3-flavour neutrino oscillation probability calculations

When calculating the 3-flavour oscillation probabilities, the mixing angles can be input either in the form $\sin^2(2\theta_{ij})$ or as $\sin^2(\theta_{ij})$. $\sin(\theta_{ij})$ and $\cos(\theta_{ij})$ are calculated from the input values, and these are used in turn to calculate the elements of U. The "solar" mass-squared difference is input as Δm^2_{21}, and this is > 0 for both mass hierarchies. The "atmospheric" mass-squared difference is input either as $|\Delta m^2_{32}|$ or using a definition introduced by G. Fogli, E. Lisi et al. in [**?**]:

$$\Delta m^2_{FL} = m^2_3 - \frac{m^2_2 + m^2_1}{2} \tag{16}$$

The quantity denoted Δm^2_{FL} is useful since its absolute value is the same for both mass hierarchies, and only its sign changes. If the atmospheric mass-squared difference is input as Δm^2_{32}, the mass hierarchy is set using the sign of Δm^2_{32}; this is positive for the normal mass hierarchy (NH) and negative for the inverted mass hierarchy (IH). In this case, Δm^2_{31} is not input but is calculated as Δm^2_{31} = Δm^2_{21} + Δm^2_{32} for both hierarchies. If the atmospheric mass-squared difference is input as Δm^2_{FL}, the mass hierarchy is set using the sign of Δm^2_{FL}. Then Δm^2_{32} and Δm^2_{31} are calculated from the input values of Δm^2_{FL} and Δm^2_{21}.

A.4. Results of the 3-flavour neutrino oscillation probability calculations

A comparison of 2-flavour and 3-flavour (in matter) ν_μ-survival probabilities is given in figure 117. In this figure, the nominal probabilities are calculated with $\sin^2(2\theta_{12})$ = 0.87, $\sin^2(2\theta_{13})$ = 0.1, $\sin^2(2\theta_{23})$ = 1.0, Δm^2_{21} = 7.6 $\times10^{-5}$ eV^2/c^4, $|\Delta m^2_{32}|$ = 2.32 $\times$ 10^{-3} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3. The bands represent the maximum and minimum 3-flavour probabilities from 4000 random variations of the non-23 oscillation parameters within their uncertainties at each energy with the same values of $\sin^2(2\theta_{23})$ and $|\Delta m^2_{32}|$ being used. The uncertainties in $\sin^2(2\theta_{12})$ and Δm^2_{21} are taken from KamLAND combined with solar experiments [34], while those in $\sin^2(2\theta_{13})$ are computed as a weighted average of measurements from Daya Bay [35] and Reno [36].

The effect of $\sin^2(2\theta_{13})$ on the 3-flavour ν_μ-survival probability in matter is shown in figure 118: there is a small increase in P($\nu_\mu \to \nu_\mu$) at all energies as $\sin^2(2\theta_{13})$ increases. Also shown in figure 119 is the effect of δ_{CP} on the

Energy (GeV)	P($\nu_\mu \rightarrow \nu_\mu$) for $\sin^2(2\theta_{12})$ = 0.870, Δm^2_{21} = 7.6 $\times 10^{-5}$ eV^2/c^4	P($\nu_\mu \rightarrow \nu_\mu$) for $\sin^2(2\theta_{12})$ = 0.906, Δm^2_{21} = 7.6 $\times 10^{-5}$ eV^2/c^4	P($\nu_\mu \rightarrow \nu_\mu$) for $\sin^2(2\theta_{12})$ = 0.833, Δm^2_{21} = 7.6 $\times 10^{-5}$ eV^2/c^4	P($\nu_\mu \rightarrow \nu_\mu$) for $\sin^2(2\theta_{12})$ = 0.870, Δm^2_{21} = 7.8 $\times 10^{-5}$ eV^2/c^4	P($\nu_\mu \rightarrow \nu_\mu$) for $\sin^2(2\theta_{12})$ = 0.870, Δm^2_{21} = 7.4 $\times 10^{-5}$ eV^2/c^4
0.3	0.95703	0.95809	0.95608	0.95733	0.95674
0.4	0.35053	0.35247	0.34877	0.35135	0.34971
0.5	0.037395	0.038009	0.036842	0.037663	0.037129
0.6	0.010963	0.010692	0.011212	0.010841	0.011086
0.7	0.094387	0.093711	0.095004	0.094083	0.094691
0.8	0.20453	0.20371	0.20528	0.20416	0.20490
0.9	0.31099	0.31015	0.31175	0.31061	0.31137
1.0	0.40463	0.40383	0.40535	0.40427	0.40499
1.1	0.48414	0.48340	0.48481	0.48380	0.48447
1.2	0.55080	0.55013	0.55141	0.55050	0.55111
1.3	0.60656	0.60594	0.60711	0.60628	0.60683
1.4	0.65329	0.65274	0.65380	0.65304	0.65354
1.5	0.69265	0.69215	0.69311	0.69243	0.69288
1.6	0.72599	0.72554	0.72640	0.72579	0.72620
1.7	0.75440	0.75399	0.75478	0.75421	0.75459
1.8	0.77876	0.77839	0.77910	0.77859	0.77893
1.9	0.79978	0.79943	0.80009	0.79962	0.79993
2.0	0.81801	0.81770	0.81830	0.81787	0.81815

Table 15: Effects of uncertainties in $\sin^2(2\theta_{12})$ and Δm^2_{21} on the 3-flavour P($\nu_\mu \rightarrow \nu_\mu$) in matter; this is for the normal mass hierarchy, $\sin^2(2\theta_{23})$ = 1.0, $|\Delta m^2_{32}|$ = 2.32 $\times$ 10^{-3} eV^2/c^4, $\sin^2(2\theta_{13})$ = 0.1 and δ_{CP} = 0.

3-flavour ν_μ-survival probability in matter: as δ_{CP} increases from 0 to π, P($\nu_\mu \rightarrow \nu_\mu$) increases above the oscillation maximum and decreases below it for the NH, with these changes being reversed for the IH. The effects of uncertainties in $\sin^2(2\theta_{12})$ and Δm^2_{21} on the 3-flavour P($\nu_\mu \rightarrow \nu_\mu$) in matter are shown for the NH in table 15. At 0.6 GeV, uncertainties in $\sin^2(2\theta_{12})$ change P($\nu_\mu \rightarrow \nu_\mu$) by $\approx$ 0.00025 and uncertainties in Δm^2_{21} change it by $\approx$ 0.0001.

For the NH, the 3-flavour P($\nu_\mu \rightarrow \nu_\mu$) is increased below the oscillation maximum and decreased above it compared with the 2-flavour probability, while for the IH these changes are reversed. The oscillation maximum is at lower energy for the IH than for the NH, and this can be understood more easily by considering the vacuum probabilities. In equation 10, the imaginary terms are zero if α = β, and only the 3 real terms contribute to the vacuum P($\nu_\mu \rightarrow \nu_\mu$). If the atmospheric mass-squared difference is input as Δm^2_{32}, the terms $|U_{\mu 1}|^2$, $|U_{\mu 2}|^2$, $|U_{\mu 3}|^2$, $sin^2\left(\frac{\Delta m^2_{21} L}{4E}\right)$ and $\sin^2\left(\frac{\Delta m^2_{32} L}{4E}\right)$ are identical for the two hierarchies, and the only term that changes between them is $\sin^2\left(\frac{\Delta m^2_{31} L}{4E}\right)$. Since Δm^2_{31} is lower for the IH than for the NH, $\sin^2\left(\frac{\Delta m^2_{31} L}{4E}\right)$ has its maximum at a lower energy for the IH than for the NH. The vacuum P($\nu_\mu \rightarrow \nu_\mu$) depends on 1 - 4 $|U_{\mu 1}|^2 |U_{\mu 3}|^2$ $\sin^2\left(\frac{\Delta m^2_{31} L}{4E}\right)$, which means that its minimum is at a lower energy for the IH than for the NH.

Referring to the bands in figure 117, the highest ν_μ-survival probabilities for the NH are for low values of $\sin^2(2\theta_{12})$, high values of $\sin^2(2\theta_{13})$ and δ_{CP} near π above the oscillation maximum, while below the maximum they are for high values of $\sin^2(2\theta_{12})$ and $\sin^2(2\theta_{13})$ and δ_{CP} near 0. For the IH, the highest probabilities are for high values of $\sin^2(2\theta_{12})$ and $\sin^2(2\theta_{13})$ and δ_{CP} near 0 above the oscillation maximum, but for low values of $\sin^2(2\theta_{12})$, high values of $\sin^2(2\theta_{13})$ and δ_{CP} near π below it.

Comparisons of ν_μ oscillation probabilities in vacuum and matter are given for the NH in table 16 and for the IH in table 17. At 0.6 GeV, P($\nu_\mu \rightarrow \nu_e$) is increased by $\approx$ 0.004 and P($\nu_\mu \rightarrow \nu_\tau$) is decreased by $\approx$ 0.004 in matter compared with vacuum for the NH, while for the IH the changes are once more reversed. The ν_μ-survival probability is relatively unaffected by the passage of ν_μ through matter, and is changed by only $\approx$ 0.0001 compared with the vacuum probability at 0.6 GeV.

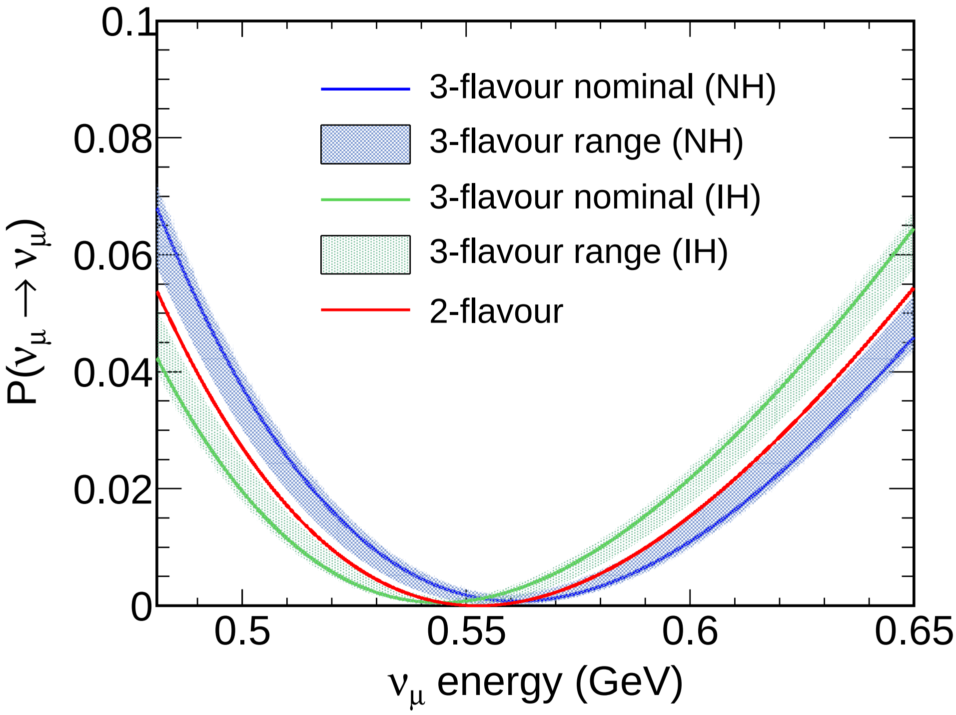


Figure 117: Comparison of P($\nu_\mu \to \nu_\mu$) for 2-flavour and 3-flavour (in matter) oscillations, NH = normal mass hierarchy, IH = inverted mass hierarchy. The nominal probabilities are calculated with $\sin^2(2\theta_{12})$ = 0.87, $\sin^2(2\theta_{13})$ = 0.1, $\sin^2(2\theta_{23})$ = 1.0, Δm^2_{21} = 7.6 $\times 10^{-5}$ eV^2/c^4, $|\Delta m^2_{32}|$ = 2.32 $\times$ 10^{-3} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3. The bands represent the maximum and minimum 3-flavour probabilities from 4000 random variations of the non-23 oscillation parameters within their uncertainties at each energy with the same values of $\sin^2(2\theta_{23})$ and $|\Delta m^2_{32}|$ being used.

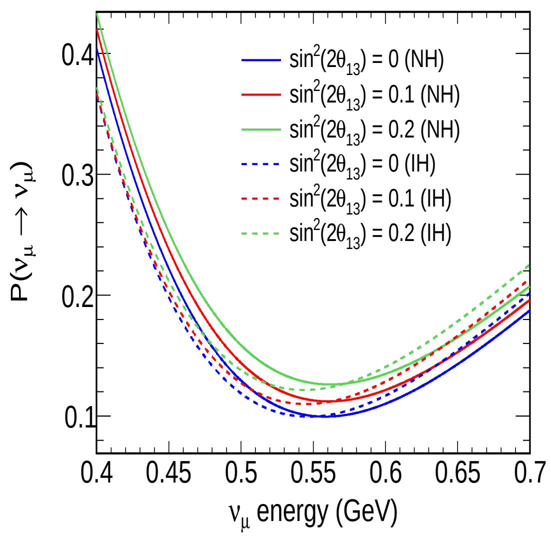


Figure 118: Effect of $\sin^2(2\theta_{13})$ on P($\nu_\mu \to \nu_\mu$) for 3-flavour oscillations in matter; NH = normal mass hierarchy, IH = inverted mass hierarchy, $\sin^2(2\theta_{12})$ = 0.87, $\sin^2(2\theta_{23})$ = 1.0, Δm^2_{21} = 7.6 $\times 10^{-5}$ eV^2/c^4, $|\Delta m^2_{32}|$ = 2.32 $\times$ 10^{-3} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3.

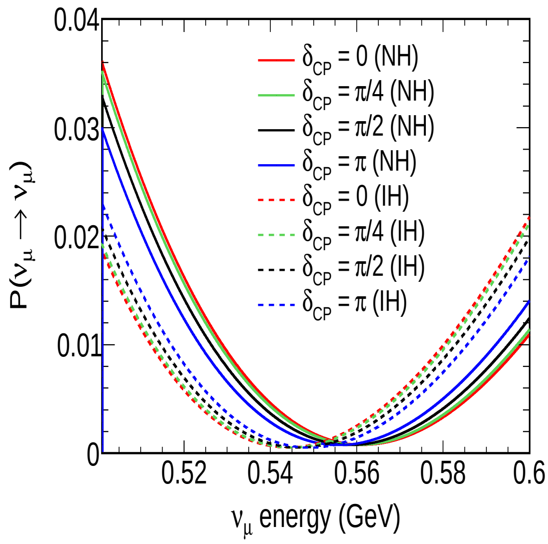


Figure 119: Effect of δ_{CP} on P($\nu_\mu \to \nu_\mu$) for 3-flavour oscillations in matter; NH = normal mass hierarchy, IH = inverted mass hierarchy, $\sin^2(2\theta_{12})$ = 0.87, $\sin^2(2\theta_{13})$ = 0.1, $\sin^2(2\theta_{23})$ = 1.0, Δm^2_{21} = 7.6 $\times 10^{-5}$ eV^2/c^4, $|\Delta m^2_{32}|$ = 2.32 $\times$ 10^{-3} eV^2/c^4 and Earth crust density = 2.6 g/cm^3.

Energy (GeV)	P($\nu_\mu \to \nu_e$)		P($\nu_\mu \to \nu_\mu$)		P($\nu_\mu \to \nu_\tau$)	
	Vacuum	Matter	Vacuum	Matter	Vacuum	Matter
0.3	0.00054403	0.00016981	0.95496	0.95703	0.044501	0.042796
0.4	0.024253	0.029051	0.34954	0.35053	0.62621	0.62042
0.5	0.046291	0.051402	0.037071	0.037395	0.91664	0.91120
0.6	0.051975	0.056108	0.010883	0.010963	0.93714	0.93293
0.7	0.049739	0.052871	0.094385	0.094387	0.85588	0.85274
0.8	0.044830	0.047181	0.20455	0.20453	0.75062	0.74829
0.9	0.039478	0.041256	0.31101	0.31099	0.64951	0.64776
1.0	0.034502	0.035865	0.40464	0.40463	0.56085	0.55951
1.1	0.030139	0.031200	0.48415	0.48414	0.48571	0.48466
1.2	0.026403	0.027241	0.55081	0.55080	0.42279	0.42196
1.3	0.023233	0.023905	0.60656	0.60656	0.37021	0.36954
1.4	0.020548	0.021093	0.65329	0.65329	0.32616	0.32562
1.5	0.018268	0.018715	0.69266	0.69266	0.28908	0.28863
1.6	0.016325	0.016696	0.72599	0.72599	0.25769	0.25731
1.7	0.014661	0.014971	0.75440	0.75440	0.23094	0.23063
1.8	0.013228	0.013491	0.77876	0.77876	0.20801	0.20775
1.9	0.011988	0.012211	0.79977	0.79978	0.18824	0.18801
2.0	0.010908	0.011100	0.81801	0.81801	0.17108	0.17089

Table 16: Comparison of ν_μ oscillation probabilities in vacuum and matter for the normal mass hierarchy, Earth crust density = 2.6 g/cm^3, $\sin^2(2\theta_{12})$ = 0.87, $\sin^2(2\theta_{13})$ = 0.1, $\sin^2(2\theta_{23})$ = 1.0, Δm^2_{21} = 7.6 $\times$ 10^{-5} eV^2/c^4, $|\Delta m^2_{32}|$ = 2.32 $\times$ 10^{-3} eV^2/c^4 and δ_{CP} = 0.

Energy (GeV)	P($\nu_\mu \to \nu_e$)		P($\nu_\mu \to \nu_\mu$)		P($\nu_\mu \to \nu_\tau$)	
	Vacuum	Matter	Vacuum	Matter	Vacuum	Matter
0.3	0.016651	0.012718	0.91243	0.91427	0.070915	0.073016
0.4	0.047961	0.041880	0.28695	0.28747	0.66509	0.67065
0.5	0.052910	0.047892	0.019598	0.019587	0.92749	0.93252
0.6	0.047803	0.044104	0.021900	0.021756	0.93030	0.93414
0.7	0.040787	0.038101	0.11802	0.11787	0.84120	0.84403
0.8	0.034297	0.032325	0.23236	0.23222	0.73335	0.73545
0.9	0.028857	0.027381	0.33905	0.33895	0.63210	0.63367
1.0	0.024433	0.023306	0.43123	0.43115	0.54434	0.54555
1.1	0.020858	0.019980	0.50865	0.50859	0.47049	0.47143
1.2	0.017960	0.017265	0.57310	0.57305	0.40894	0.40969
1.3	0.015595	0.015037	0.62672	0.62669	0.35768	0.35828
1.4	0.013649	0.013194	0.67151	0.67148	0.31485	0.31533
1.5	0.012034	0.011657	0.70911	0.70909	0.27886	0.27926
1.6	0.010681	0.010366	0.74089	0.74087	0.24843	0.24876
1.7	0.0095379	0.0092726	0.76792	0.76791	0.22254	0.22282
1.8	0.0085654	0.0083395	0.79107	0.79105	0.20037	0.20061
1.9	0.0077316	0.0075376	0.81101	0.81010	0.18126	0.18146
2.0	0.0070119	0.0068441	0.82829	0.82829	0.16470	0.16487

Table 17: Comparison of ν_μ oscillation probabilities in vacuum and matter for the inverted mass hierarchy, Earth crust density = 2.6 g/cm^3, $\sin^2(2\theta_{12})$ = 0.87, $\sin^2(2\theta_{13})$ = 0.1, $\sin^2(2\theta_{23})$ = 1.0, Δm^2_{21} = 7.6 $\times$ 10^{-5} eV^2/c^4, $|\Delta m^2_{32}|$ = 2.32 $\times$ 10^{-3} eV^2/c^4 and δ_{CP} = 0.

A.5. *Validation of the 3-flavour oscillation probabilities*

The 3-flavour oscillation probabilities in vacuum were checked using an alternative formulation in equations 13.13 and 13.14 in the PDG review [21]:

$$P(\nu_\alpha \to \nu_\beta) = \sum_j |U_{\beta j}|^2 |U_{\alpha j}|^2 + 2\sum_{j>k} |U_{\beta j} U^*_{\alpha j} U_{\alpha k} U^*_{\beta k}| \cos\left(\frac{\Delta m^2_{jk} L}{2E} - \phi_{\beta\alpha;jk}\right) \tag{17}$$

where $\phi_{\beta\alpha;jk}$ = arg$(U_{\beta j} U^*_{\alpha j} U_{\alpha k} U^*_{\beta k})$. $P(\bar{\nu}_\alpha \to \bar{\nu}_\beta)$ is calculated by changing the sign of $\phi_{\beta\alpha;jk}$ in the argument of the cosine. The probabilities calculated from equation 17 agreed with those calculated from equation 10 to 14 significant figures.

Several checks of the oscillation probabilities in constant density matter are written into the code that calculates them:

1. The eigenvalues of $UMU^\dagger$ are checked by comparing their sum with the trace of the matrix.
2. Each normalised eigenvector is multiplied in turn by each of the 3 matrices formed by subtracting the eigenvalues from the real parts of the diagonal elements of $UMU^\dagger$, and a check is made of the differences between these products and a zero vector.
3. A check is made that the normalised eigenvectors of $UMU^\dagger$ are orthogonal by calculating the scalar product between them (the scalar product of two complex vectors is the product of the first vector with the complex conjugate of the second vector).
4. A check is also made that the Hermitian conjugate of the mixing matrix in matter is equal to the inverse of the matrix. This is done by multiplying the mixing matrix in matter by its Hermitian conjugate, and checking the differences between the product and an identity matrix.

The values of the oscillation probabilities in constant density matter were checked by comparing them with equivalent probabilities calculated by an independently-written Fortran program [43]. This Fortran program uses different algorithms, and calculates numerically the eigenvalues and eigenvectors of $UMU^\dagger$. Nevertheless there was very good agreement between the two calculations of the probabilities, with the fractional differences being $\approx 2 \times 10^{-6}$.

The values of the matter oscillation probabilities were also compared with those given by Prob3++ [44], and the fractional differences were $\approx$ 1-5 $\times\ 10^{-4}$. The comparison plots can be seen in the next Appendix.

A.6. *Accuracy of the 3-flavour oscillation probabilities*

As stated in section A.5, the 3-flavour oscillation probabilities in vacuum agreed to 14 significant figures between the two formulations.

An estimate of the accuracy of the 3-flavour oscillation probabilities in constant density matter was made in three separate ways:

1. The matter probabilities for zero density were compared with the vacuum probabilities; there was good agreement, with the fractional differences being $\approx$ 2-5 $\times\ 10^{-6}$.
2. The probabilites given when calculating the eigenvectors with simultaneous equations 1 and 2 in $UMU^\dagger - \lambda I = 0$ were compared with the probabilities given when calculating the eigenvectors with simultaneous equations 2 and 3. The fractional differences between these two calculations were again $\approx$ 2-5 $\times\ 10^{-6}$.
3. The sum of three matter probabilities, for example P($\nu_\mu \to \nu_e$) + P($\nu_\mu \to \nu_\mu$) + P($\nu_\mu \to \nu_\tau$), was compared with 1.0; again there was good agreement, and the differences were $\approx 2 \times 10^{-6}$.

This means that the matter oscillation probabilities should be considered to be accurate to 5 decimal places. The accuracy of the matter probabilities is less than that of the vacuum probabilities due to the method of calculation of the eigenvectors. This involves calculations of the form

$$\frac{(ab - cd)}{(ef - gh)}$$

where a, b, c, etc. are elements of $UMU^\dagger - \lambda I$. Frequently ab is close in value to cd, which means that (ab - cd) is much smaller than ab or cd, and the same applies to (ef - gh). However the advantage of the method of calculation of the eigenvectors described in section A.2 is that it allows the worst of these cancellation errors to be avoided; this can be done by calculating the eigenvectors using different pairs of simultaneous equations in $UMU^\dagger - \lambda I = 0$ for different combinations of the oscillation parameters. In practice, the eigenvectors are nearly always calculated using equations 1 and 2 in $UMU^\dagger - \lambda I = 0$, but equations 2 and 3 are used when $3.10 < \delta_{CP} < 3.18$ and $\sin^2(2\theta_{13}) > 10^{-8}$ in order to avoid such cancellation errors.

B. Detailed comparison of VaLOR and Prob3++ oscillation probabilities

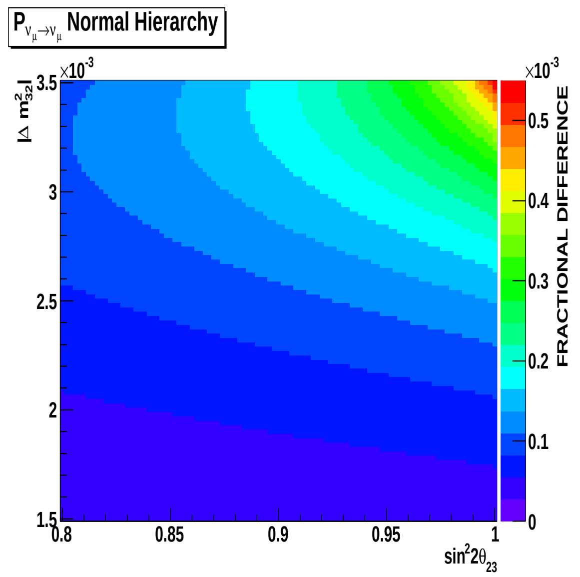


Figure 120: Comparison of the VaLOR $\nu_\mu \to \nu_\mu$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for E_ν = 1 GeV; normal mass hierarchy, $\sin^2 2\theta_{13}$ = 0.1, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3.

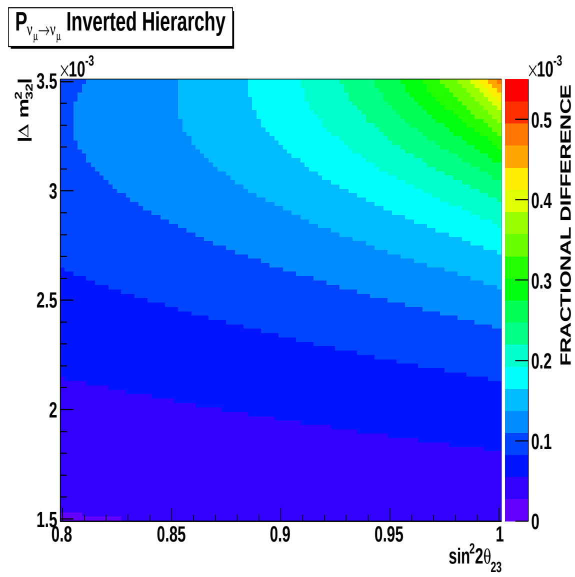


Figure 121: Comparison of the VaLOR $\nu_\mu \to \nu_\mu$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for E_ν = 1 GeV; inverted mass hierarchy, $\sin^2 2\theta_{13}$ = 0.1, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3.

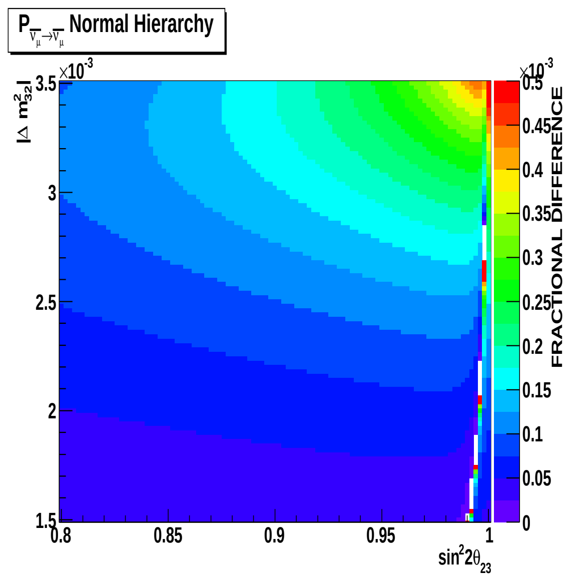


Figure 122: Comparison of the VaLOR $\bar\nu_\mu \to \bar\nu_\mu$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for E_ν = 1 GeV; normal mass hierarchy, $\sin^2 2\theta_{13}$ = 0.1, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3.

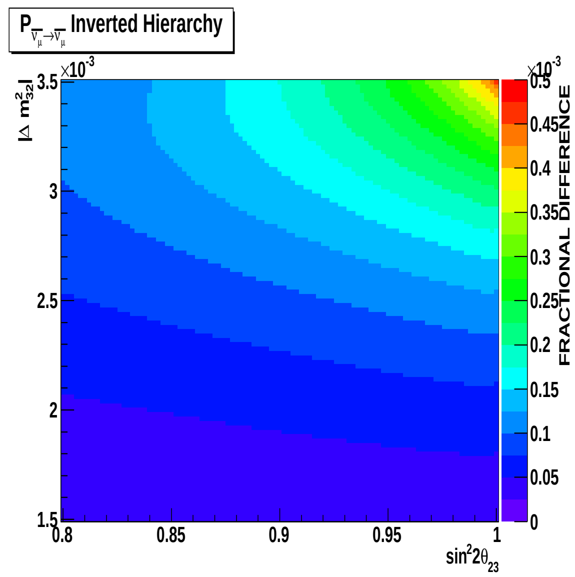


Figure 123: Comparison of the VaLOR $\bar\nu_\mu \to \bar\nu_\mu$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for E_ν = 1 GeV; inverted mass hierarchy, $\sin^2 2\theta_{13}$ = 0.1, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3.

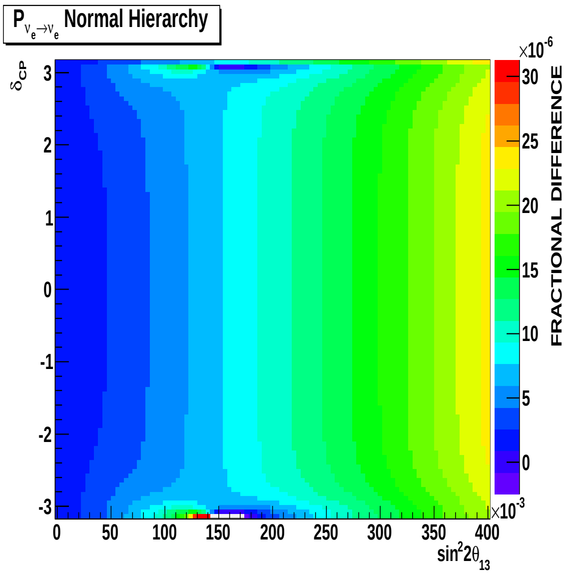


Figure 124: Comparison of the VaLOR $\nu_e \to \nu_e$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{13}$ and δ_{CP} for E$_\nu$ = 1 GeV; normal mass hierarchy, $\sin^2 2\theta_{23}$ = 1.0, $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4 and Earth crust density = 2.6 g/cm^3.

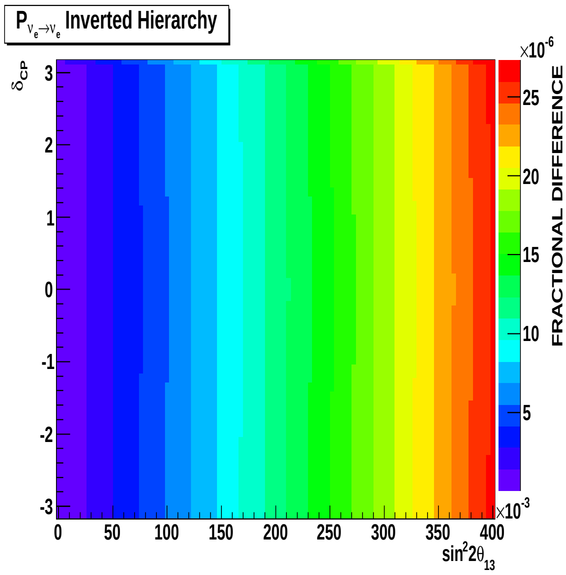


Figure 125: Comparison of the VaLOR $\nu_e \to \nu_e$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{13}$ and δ_{CP} for E$_\nu$ = 1 GeV; inverted mass hierarchy, $\sin^2 2\theta_{23}$ = 1.0, $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4 and Earth crust density = 2.6 g/cm^3.

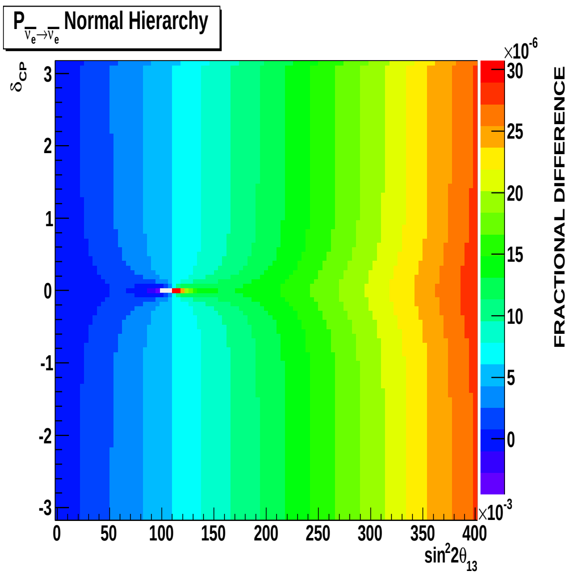


Figure 126: Comparison of the VaLOR $\bar{\nu}_e \to \bar{\nu}_e$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{13}$ and δ_{CP} for E$_\nu$ = 1 GeV; normal mass hierarchy, $\sin^2 2\theta_{23}$ = 1.0, $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4 and Earth crust density = 2.6 g/cm^3.

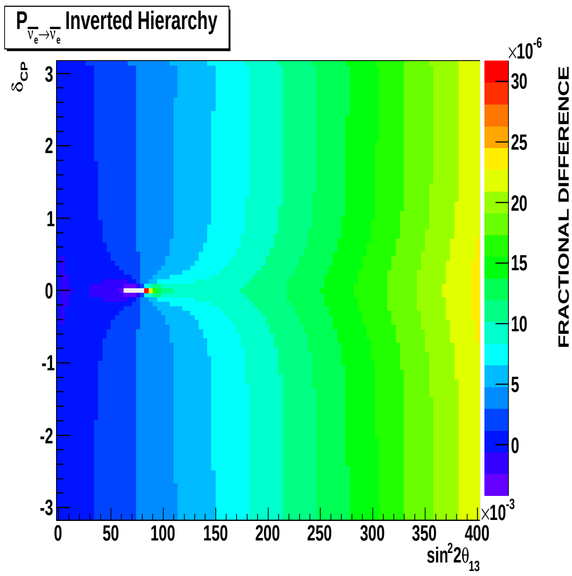


Figure 127: Comparison of the VaLOR $\bar{\nu}_e \to \bar{\nu}_e$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{13}$ and δ_{CP} for E$_\nu$ = 1 GeV; inverted mass hierarchy, $\sin^2 2\theta_{23}$ = 1.0, $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6×10^{-5} eV^2/c^4 and Earth crust density = 2.6 g/cm^3.

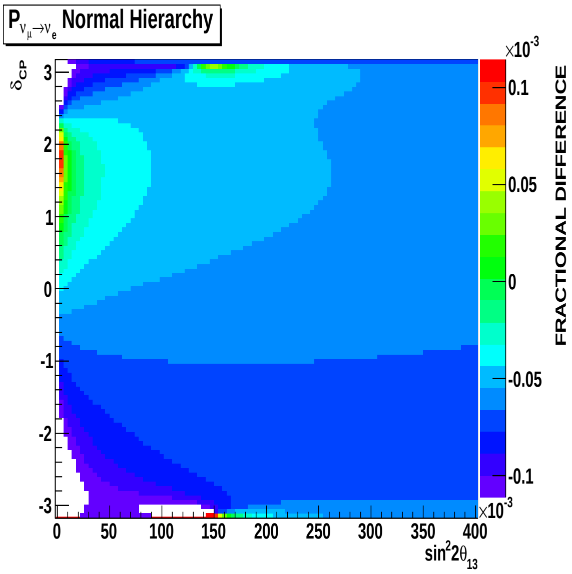


Figure 128: Comparison of the VaLOR $\nu_\mu \to \nu_e$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{13}$ and δ_{CP} for E$_\nu$ = 1 GeV; normal mass hierarchy, $\sin^2 2\theta_{23}$ = 1.0, $|\Delta m^2_{32}|$ = 2.4$\times$10^{-3} eV^2/c^4, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6$\times$10^{-5} eV^2/c^4 and Earth crust density = 2.6 g/cm^3.

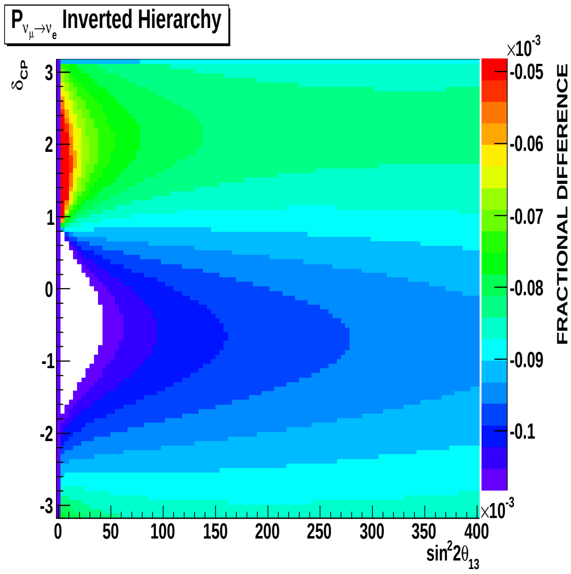


Figure 129: Comparison of the VaLOR $\nu_\mu \to \nu_e$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{13}$ and δ_{CP} for E$_\nu$ = 1 GeV; inverted mass hierarchy, $\sin^2 2\theta_{23}$ = 1.0, $|\Delta m^2_{32}|$ = 2.4$\times$10^{-3} eV^2/c^4, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6$\times$10^{-5} eV^2/c^4 and Earth crust density = 2.6 g/cm^3.

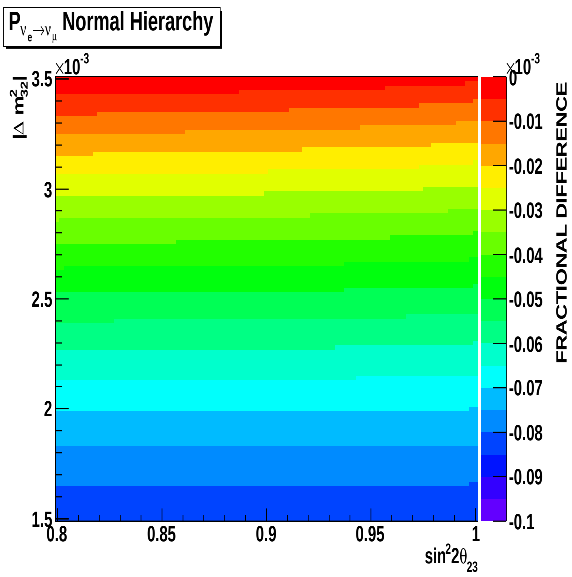


Figure 130: Comparison of the VaLOR $\nu_e \to \nu_\mu$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for E$_\nu$ = 1 GeV; normal mass hierarchy, $\sin^2 2\theta_{13}$ = 0.1, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6$\times$10^{-5} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3.

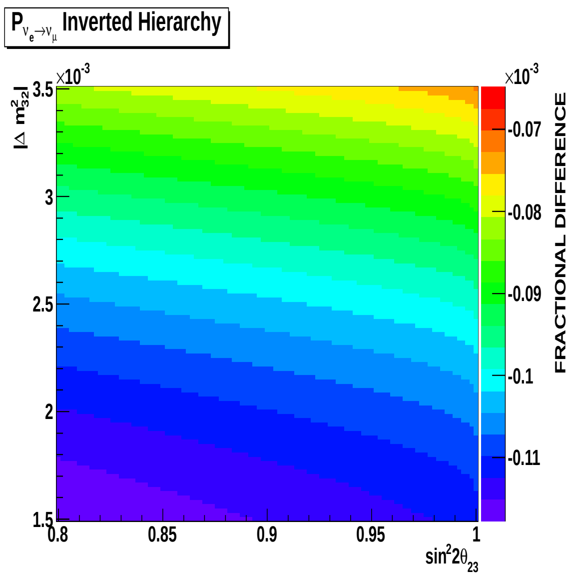


Figure 131: Comparison of the VaLOR $\nu_e \to \nu_\mu$ oscillation probabilities in matter with those obtained from Prob3++ as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$ for E$_\nu$ = 1 GeV; inverted mass hierarchy, $\sin^2 2\theta_{13}$ = 0.1, $\sin^2 2\theta_{12}$ = 0.8704, Δm^2_{21} = 7.6$\times$10^{-5} eV^2/c^4, δ_{CP} = 0 and Earth crust density = 2.6 g/cm^3.

C. Sensitivity study for the 3.010$\times 10^{20}$ POT ν_μ-disappearance analysis

A sensitivity study was performed at various points around the MINOS 2012 best-fit values [31]. These points are shown in Fig. 132, and have the following values of $\sin^2 2\theta_{23}$:

1. 1.0 (maximal)
2. 0.957 (2012 MINOS best-fit value)
3. 0.877 (smallest value in the 2012 MINOS 90% confidence region)

The sensitivity study points have the following values of Δm^2_{32}:

1. 2.09$\times 10^{-3}$ eV^2/c^4 (2012 MINOS best-fit value - 3σ),
2. 2.29$\times 10^{-3}$ eV^2/c^4 (2012 MINOS best-fit value - 1σ),
3. 2.39$\times 10^{-3}$ eV^2/c^4 (2012 MINOS best-fit value),
4. 2.48$\times 10^{-3}$ eV^2/c^4 (2012 MINOS best-fit value + 1σ),
5. 2.66$\times 10^{-3}$ eV^2/c^4 (2012 MINOS best-fit value + 3σ).

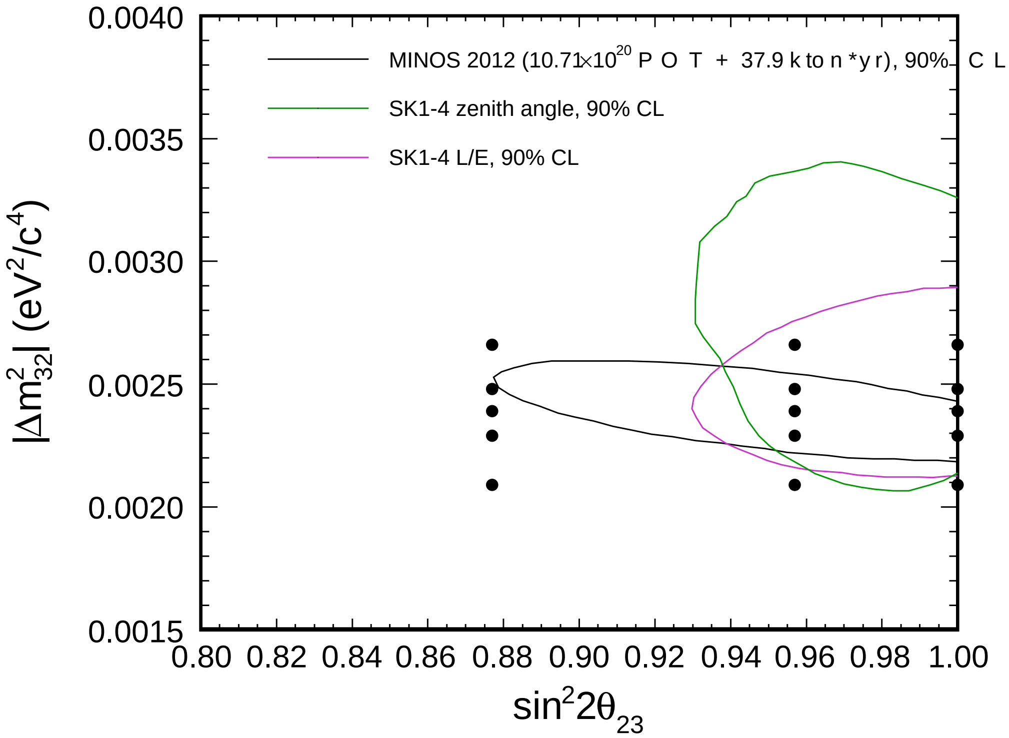


Figure 132: True oscillation parameters points considered in our T2K sensitivity study. The grid was constructed using the 2012 MINOS best-fit Δm^2_{32} value and $\pm 1\sigma$, $\pm 3\sigma$ variations, and using $\sin^2 2\theta_{23}$ values of 1 (maximal), 0.957 (2012 MINOS best-fit value) and 0.877 (smallest value in the 2012 MINOS 90% confidence region).

An average χ^2 surface was constructed as a function of $\sin^2 2\theta_{23}$ and Δm^2_{32} by averaging the χ^2 surfaces obtained by '2+8' fits to 1K toy MC experiments. In each of these toy experiments, the systematic parameters were randomized and statistical fluctuations were included. The confidence contours were then drawn using the constant-$\Delta\chi^2$ method as described in Sec. 4.5.1.

The results of the sensitivity study are shown in Figs. 133-137.

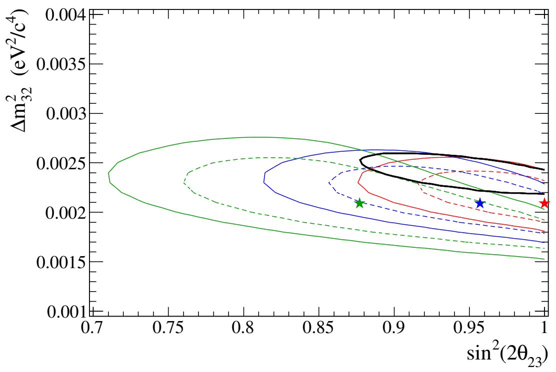


Figure 133: T2K 68% CL and 90% CL sensitivity contours, for 3.010×10^{20} POT, computed using the '2+8' fit. The input ($\sin^2 2\theta_{23}$, Δm^2_{32} (in eV^2/c^4)) points shown in red, blue and green are, respectively, (1.000, 0.00209), (0.957, 0.00209), (0.877, 0.00209). The 2012 MINOS 90% CL region is shown in black.

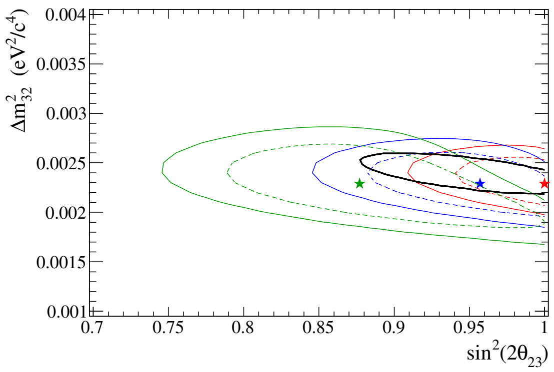


Figure 134: T2K 68% CL and 90% CL sensitivity contours, for 3.010×10^{20} POT, computed using the '2+8' fit. The input ($\sin^2 2\theta_{23}$, Δm^2_{32} (in eV^2/c^4)) points shown in red, blue and green are, respectively, (1.000, 0.00229), (0.957, 0.00229), (0.877, 0.00229). The 2012 MINOS 90% CL region is shown in black.

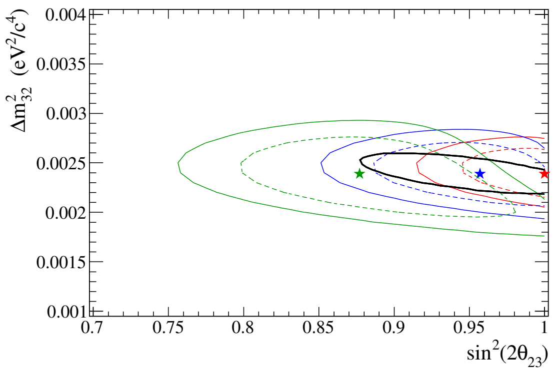


Figure 135: T2K 68% CL and 90% CL sensitivity contours, for 3.010×10^{20} POT, computed using the '2+8' fit. The input ($\sin^2 2\theta_{23}$, Δm^2_{32} (in eV^2/c^4)) points shown in red, blue and green are, respectively, (1.000, 0.00239), (0.957, 0.00239), (0.877, 0.00239). The 2012 MINOS 90% CL region is shown in black.

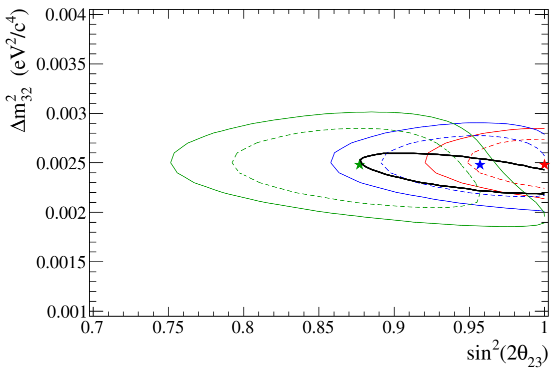


Figure 136: T2K 68% CL and 90% CL sensitivity contours, for 3.010×10^{20} POT, computed using the '2+8' fit. The input ($\sin^2 2\theta_{23}$, Δm^2_{32} (in eV^2/c^4)) points shown in red, blue and green are, respectively, (1.000, 0.00248), (0.957, 0.00248), (0.877, 0.00248). The 2012 MINOS 90% CL region is shown in black.

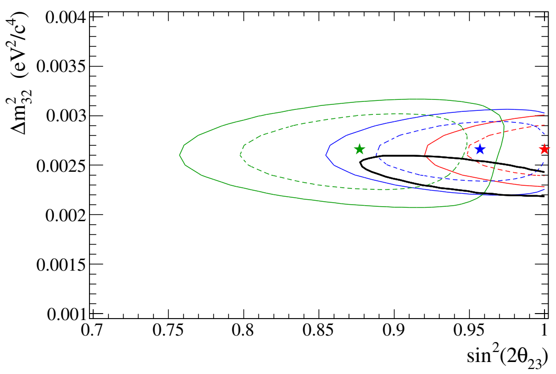


Figure 137: T2K 68% CL and 90% CL sensitivity contours, for 3.010×10^{20} POT, computed using the '2+8' fit. The input ($\sin^2 2\theta_{23}$, Δm^2_{32} (in eV^2/c^4)) points shown in red, blue and green are, respectively, (1.000, 0.00266), (0.957, 0.00266), (0.877, 0.00266). The 2012 MINOS 90% CL region is also shown in black.

D. Example toy MC fits

Six toy MC SuperK datasets were created with a POT corresponding to the Run 1+2+3 data; two datasets were created by each of the KIT, VaLOR and MuSiC groups. Each dataset included random variations of all of the systematic parameters, with these variations and the true oscillation parameters being unknown to the analysers in the groups that did not create the datasets. Each dataset was fitted using both a 2+8 and a 2+N fit, and the value of chisq (from equation 5) was obtained at the best-fit point for each fit. All these fits were made with the coarse binning scheme discussed in Sec.4.2.

Goodness-of-fit tests were carried out on these six toy datasets. The best-fit values of $\sin^2 2\theta_{23}$ and Δm^2_{32} obtained in the 5-bin fit to the first dataset were then used as input true oscillation parameters to create 1000 additional toy MC datasets. Both statistical and systematic variations were included in these additional datasets. Each additional dataset was fitted using a 5-bin 2+8 fit to find the value of chisq at the best-fit point. The p-value for the first of the original datasets was then calculated as the ratio of the number of additional datasets whose best-fit chisq was greater than that of the original dataset to the total number of additional datasets. This calculation of the p-value was then repeated for each of the other 5 original datasets.

Fake data set	Analysis	$\sin^2 2\theta_{23}$	$\lvert\Delta m^2_{32}\rvert$ (eV^2/c^4)	N$_{SK}$	$\chi^2_{bestfit}$/ndf	Systematics
		1.000	**2.250×10^{-3}**	**63**	-	**Nominal**
0	'2+N'	1.000	2.130×10^{-3}	66.09	82.30/71	See Fig. 144
	'2+8'	1.000	2.133×10^{-3}	65.88	82.45/71	See Fig. 138
		0.880	**2.500×10^{-3}**	**95**	-	f^{SK}_{NC}**: +100%**
1	'2+N'	0.943	2.243×10^{-3}	85.13	84.96/71	See Fig. 145
	'2+8'	0.938	2.241×10^{-3}	83.55	86.40/71	See Fig. 139
		0.950	**3.000×10^{-3}**	**65**	-	f_{pF}**:** $+1\sigma$**,** f^{banff}_{16}**: 1.0**
2	'2+N'	0.966	2.861×10^{-3}	64.27	73.00/71	See Fig. 146
	'2+8'	0.966	2.859×10^{-3}	64.60	73.22/71	See Fig. 140
		1.000	**2.200×10^{-3}**	**66**	-	f^{SK}_{E}**:** -1.0σ
3	'2+N'	1.000	2.228×10^{-3}	63.82	66.36/71	See Fig. 147
	'2+8'	1.000	2.226×10^{-3}	63.71	66.57/71	See Fig. 141
		0.850	**2.700×10^{-3}**	**82**	-	$f^{banff}_{0} - f^{banff}_{3}$**: +5%**
4	'2+N'	0.837	2.600×10^{-3}	82.89	70.27/71	See Fig. 148
	'2+8'	0.838	2.600×10^{-3}	82.90	70.48/71	See Fig. 142
		0.800	**2.000×10^{-3}**	**77**	-	**Nominal**
5	'2+N'	0.828	2.176×10^{-3}	82.68	67.25/71	See Fig. 149
	'2+8'	0.826	2.201×10^{-3}	83.33	67.48/71	See Fig. 143

Table 18: True input (shown in bold) and VALOR '2+8' and '2+N' best-fit values for the test ensemble of 6 toy-MC experiments fit by all 3 disappearance analyses.

D.1. Systematic parameter pulls

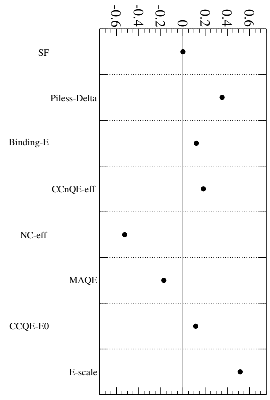


Figure 138: Systematic pulls for the 2+8 fit to fake data set 0.

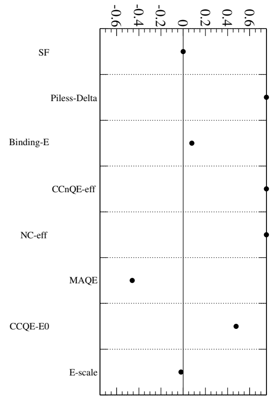


Figure 139: Systematic pulls for the 2+8 fit to fake data set 1.

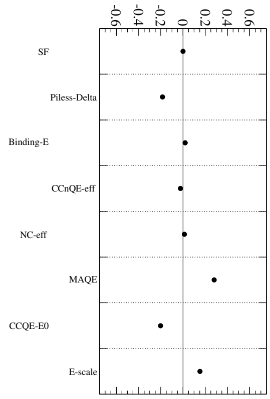


Figure 140: Systematic pulls for the 2+8 fit to fake data set 2.

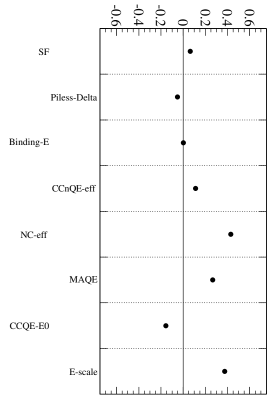


Figure 141: Systematic pulls for the 2+8 fit to fake data set 3.

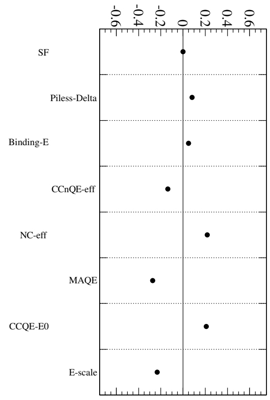


Figure 142: Systematic pulls for the 2+8 fit to fake data set 4.

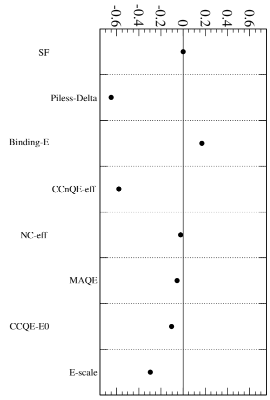


Figure 143: Systematic pulls for the 2+8 fit to fake data set 5.

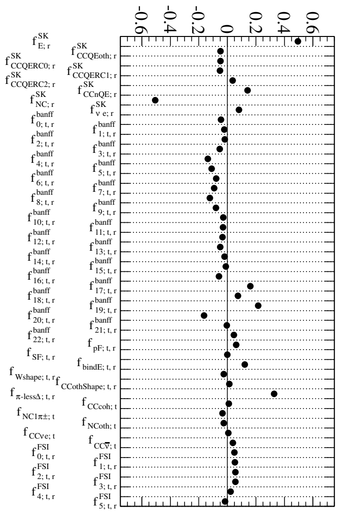


Figure 144: Systematic pulls for the 2+N fit to fake data set 0.

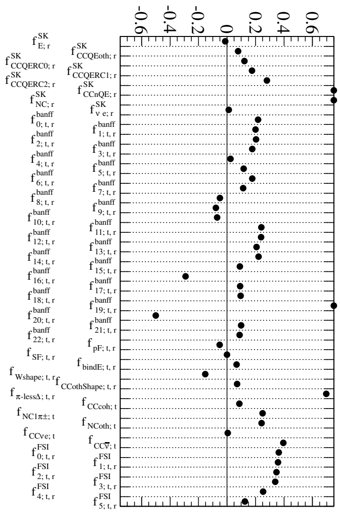


Figure 145: Systematic pulls for the 2+N fit to fake data set 1.

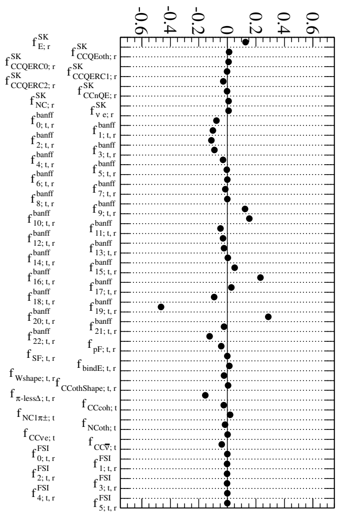


Figure 146: Systematic pulls for the 2+N fit to fake data set 2.

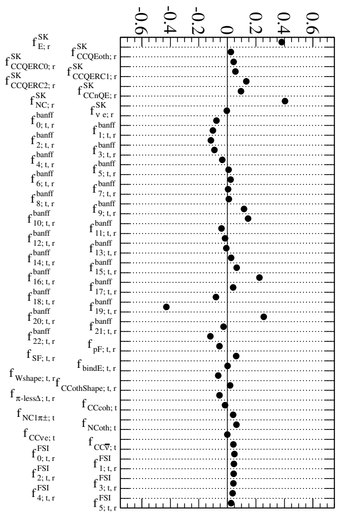


Figure 147: Systematic pulls for the 2+N fit to fake data set 3.

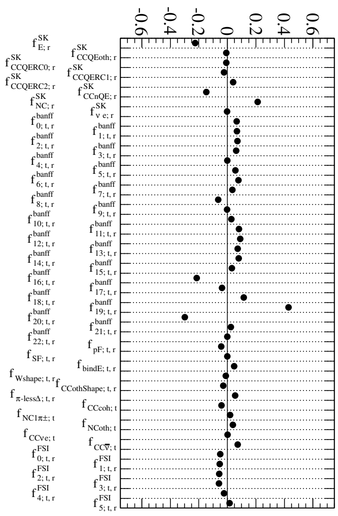


Figure 148: Systematic pulls for the 2+N fit to fake data set 4.

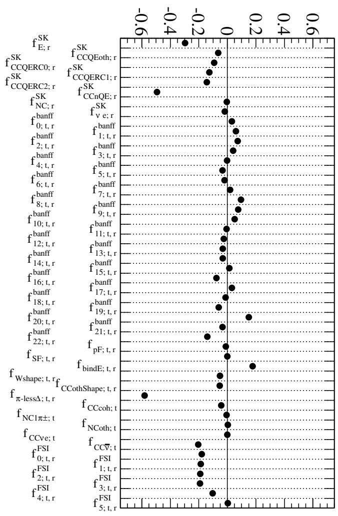


Figure 149: Systematic pulls for the 2+N fit to fake data set 5.

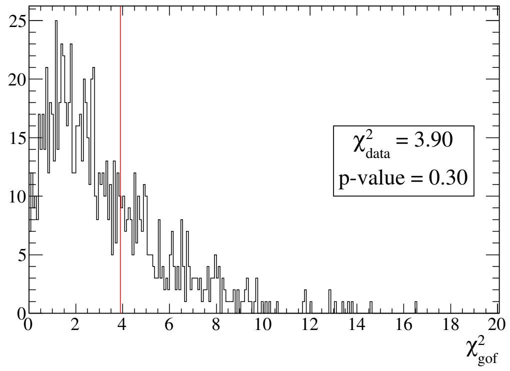


Figure 150: Distribution of χ^2_{gof} from 1000 toy MC datasets at the best-fit oscillation point for the 2+8 fit to fake data set 0. The χ^2_{gof} for data is highlighted.

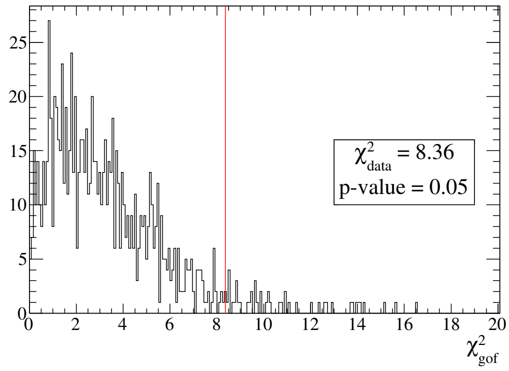


Figure 151: Distribution of χ^2_{gof} from 1000 toy MC datasets at the best-fit oscillation point for the 2+8 fit to fake data set 1. The χ^2_{gof} for data is highlighted.

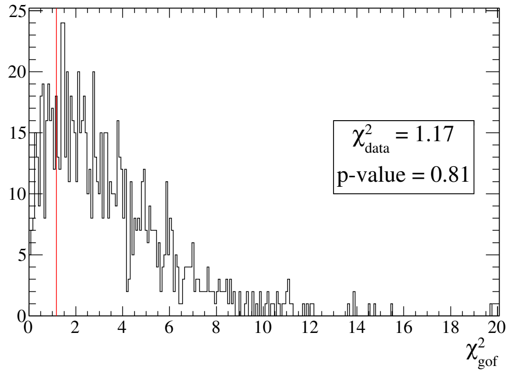


Figure 152: Distribution of χ^2_{gof} from 1000 toy MC datasets at the best-fit oscillation point for the 2+8 fit to fake data set 2. The χ^2_{gof} for data is highlighted.

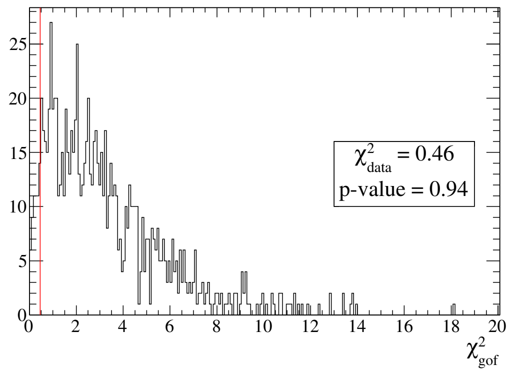


Figure 153: Distribution of χ^2_{gof} from 1000 toy MC datasets at the best-fit oscillation point for the 2+8 fit to fake data set 3. The χ^2_{gof} for data is highlighted.

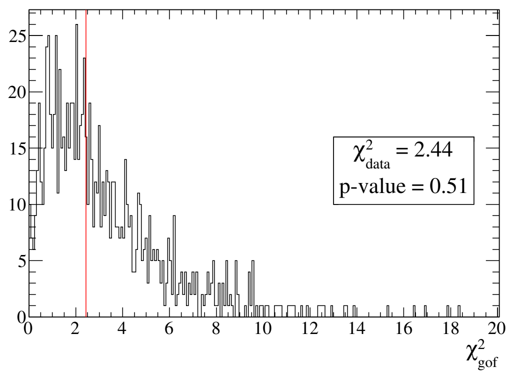


Figure 154: Distribution of χ^2_{gof} from 1000 toy MC datasets at the best-fit oscillation point for the 2+8 fit to fake data set 4. The χ^2_{gof} for data is highlighted.

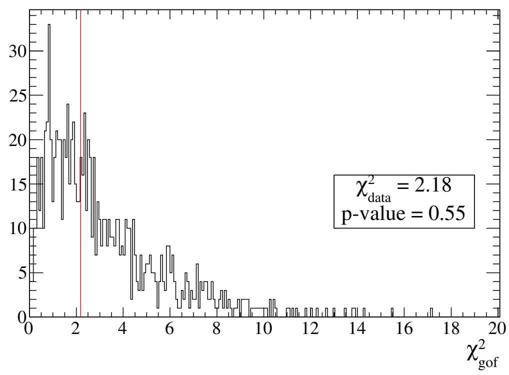


Figure 155: Distribution of χ^2_{gof} from 1000 toy MC datasets at the best-fit oscillation point for the 2+8 fit to fake data set 5. The χ^2_{gof} for data is highlighted.

D.3. Best-fit spectra

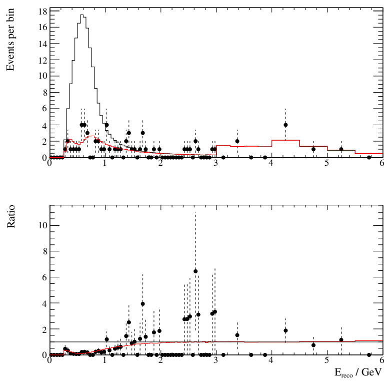


Figure 156: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+N fit to fake data set 0

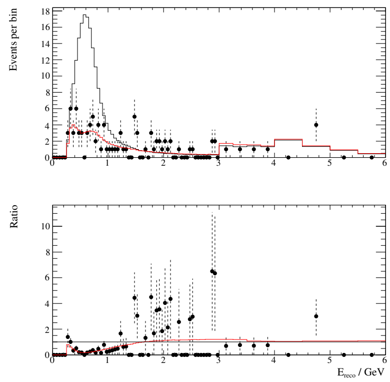


Figure 157: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+N fit to fake data set 1

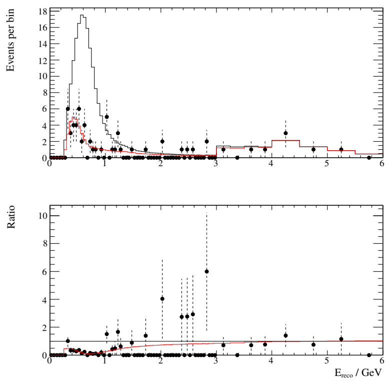


Figure 158: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+N fit to fake data set 2

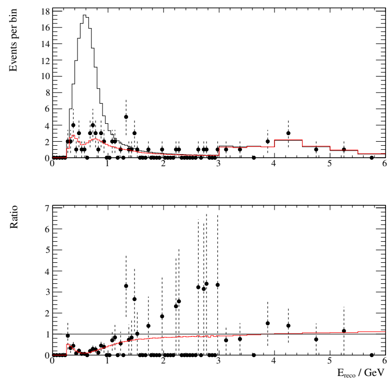


Figure 159: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+N fit to fake data set 3

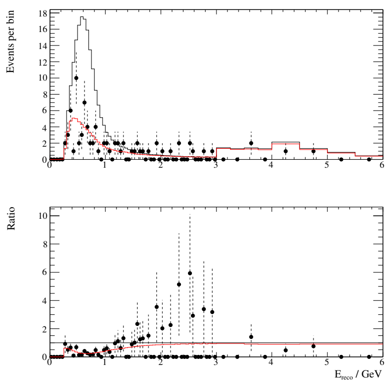


Figure 160: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+N fit to fake data set 4

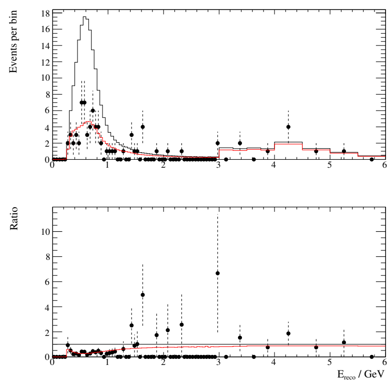


Figure 161: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+N fit to fake data set 5

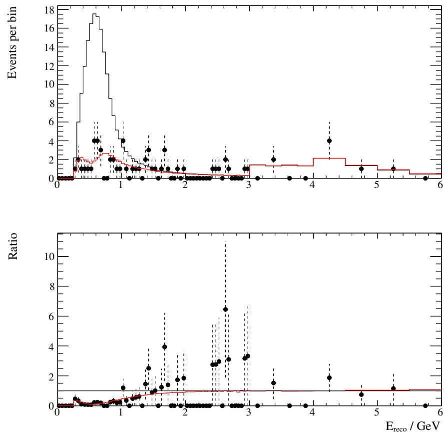


Figure 162: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+8 fit to fake data set 0

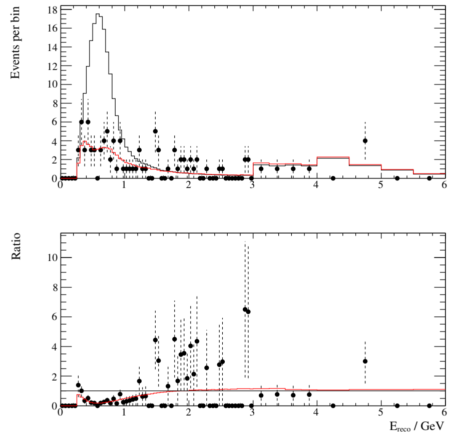


Figure 163: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+8 fit to fake data set 1

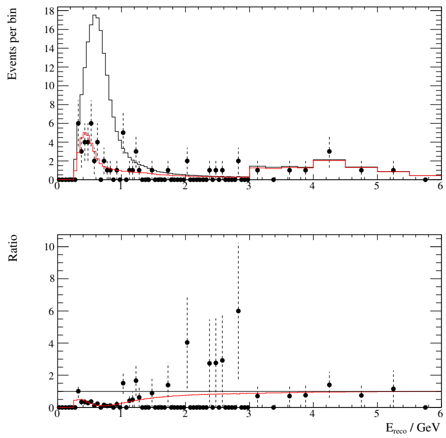


Figure 164: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+8 fit to fake data set 2

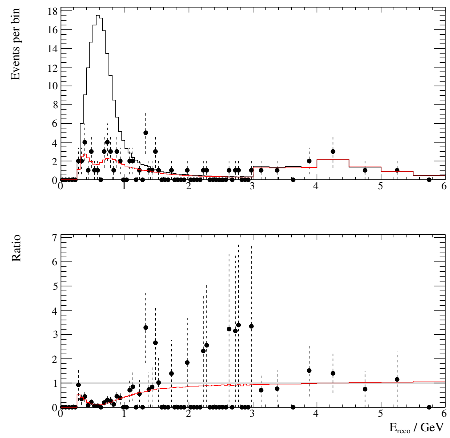


Figure 165: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+8 fit to fake data set 3

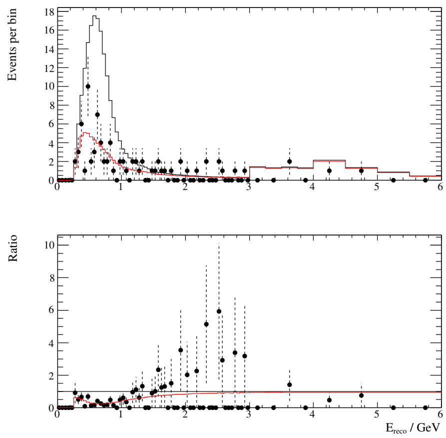


Figure 166: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+8 fit to fake data set 4

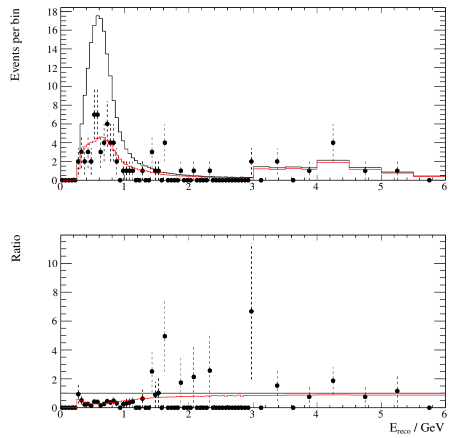


Figure 167: Best-fit spectrum (top) and ratios of data and best-fit spectrum to predicted spectrum for no oscillations (bottom) for the 2+8 fit to fake data set 5

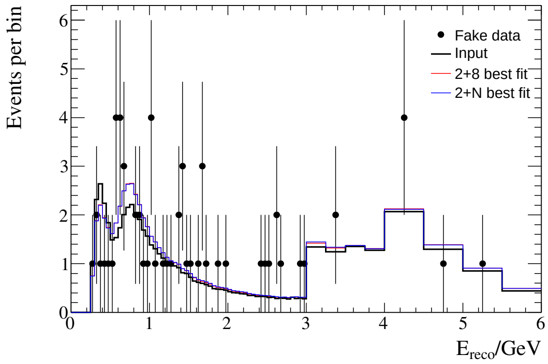


Figure 168: Comparisons of the 2+8 and 2+N best-fit spectra with the input distribution for fake data set 0

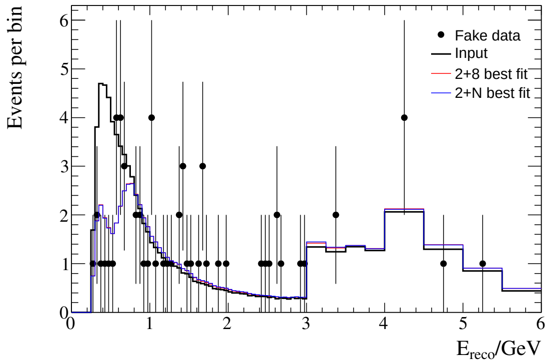


Figure 169: Comparisons of the 2+8 and 2+N best-fit spectra with the input distribution for fake data set 1

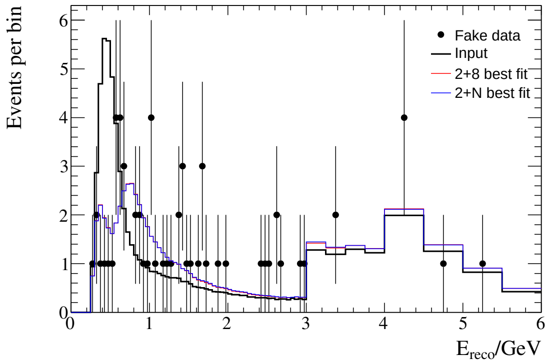


Figure 170: Comparisons of the 2+8 and 2+N best-fit spectra with the input distribution for fake data set 2

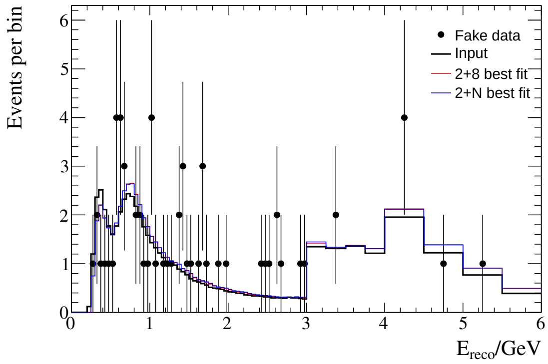


Figure 171: Comparisons of the 2+8 and 2+N best-fit spectra with the input distribution for fake data set 3

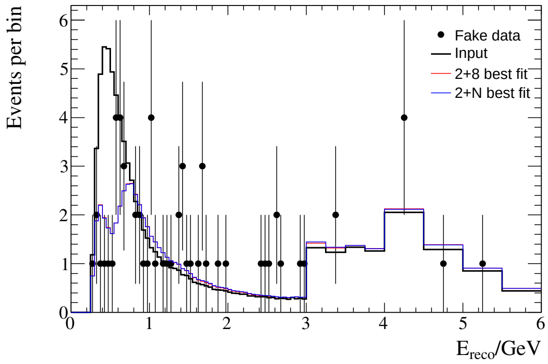


Figure 172: Comparisons of the 2+8 and 2+N best-fit spectra with the input distribution for fake data set 4

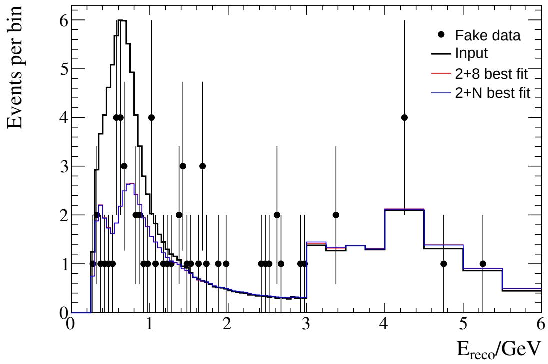


Figure 173: Comparisons of the 2+8 and 2+N best-fit spectra with the input distribution for fake data set 5

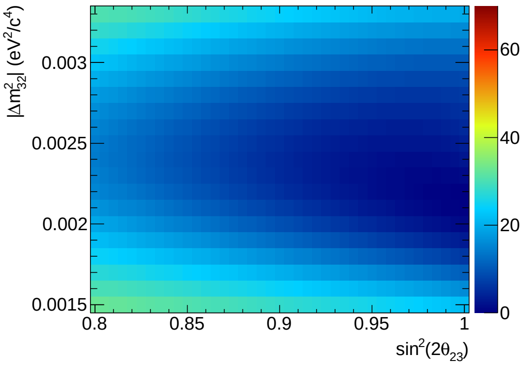


Figure 174: $\Delta\chi^2$ surface for the 2+N fit to fake data set 0

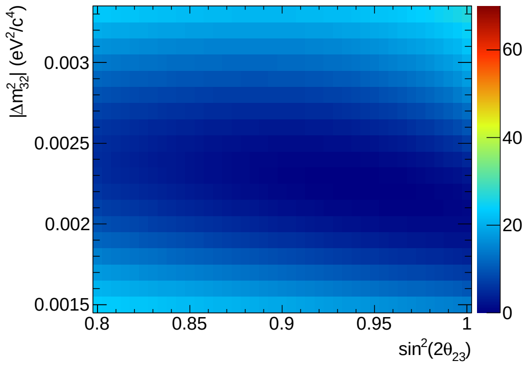


Figure 175: $\Delta\chi^2$ surface for the 2+N fit to fake data set 1

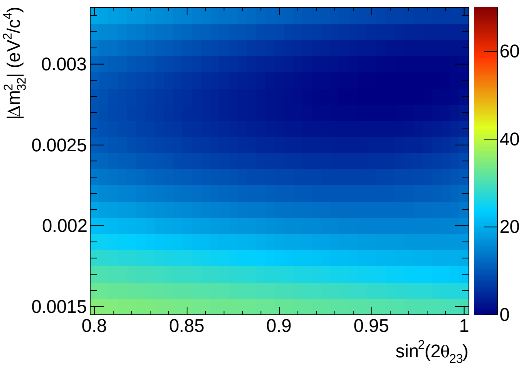


Figure 176: $\Delta\chi^2$ surface for the 2+N fit to fake data set 2

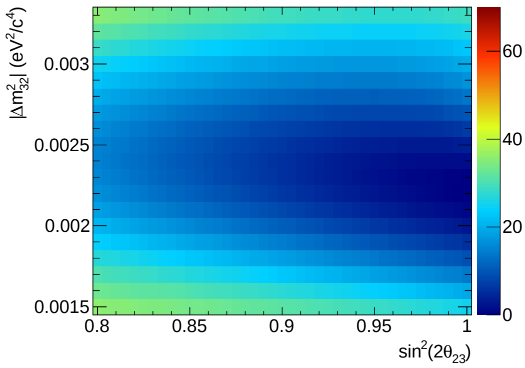


Figure 177: $\Delta\chi^2$ surface for the 2+N fit to fake data set 3

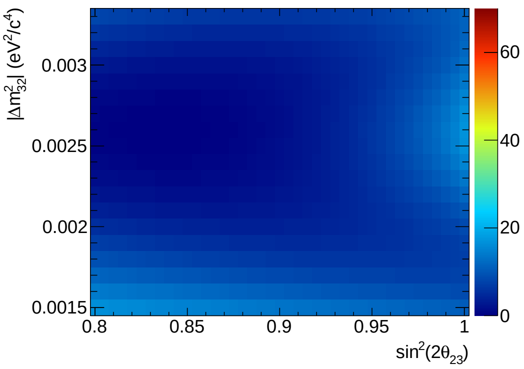


Figure 178: $\Delta\chi^2$ surface for the 2+N fit to fake data set 4

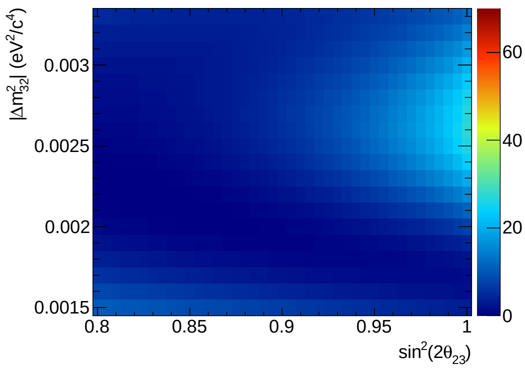


Figure 179: $\Delta\chi^2$ surface for the 2+N fit to fake data set 5

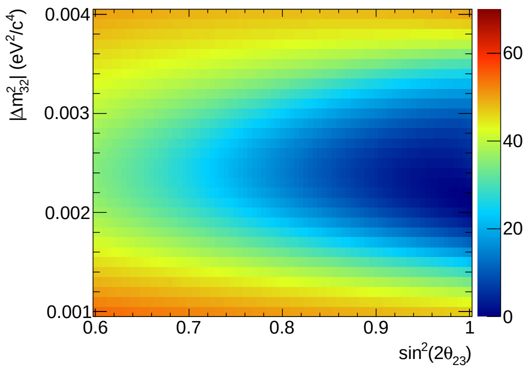


Figure 180: $\Delta\chi^2$ surface for the 2+8 fit to fake data set 0

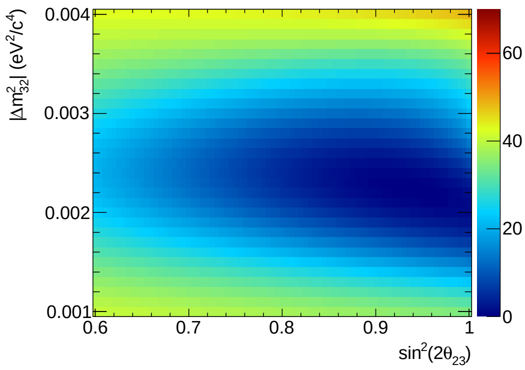


Figure 181: $\Delta\chi^2$ surface for the 2+8 fit to fake data set 1

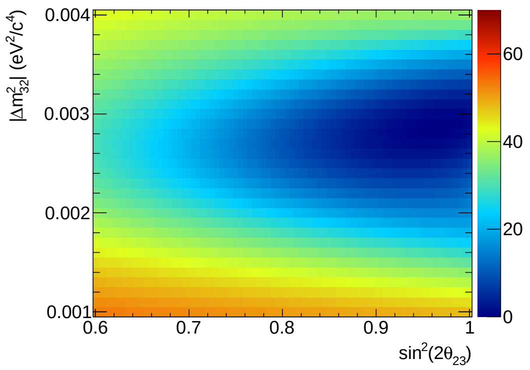


Figure 182: $\Delta\chi^2$ surface for the 2+8 fit to fake data set 2

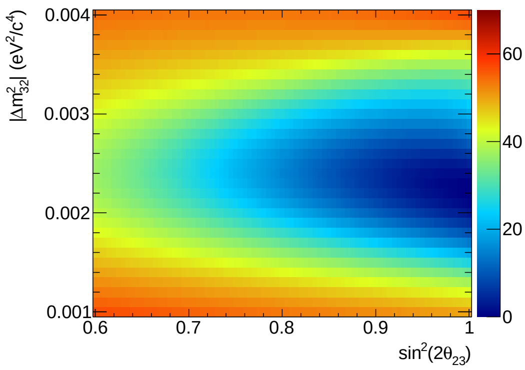


Figure 183: $\Delta\chi^2$ surface for the 2+8 fit to fake data set 3

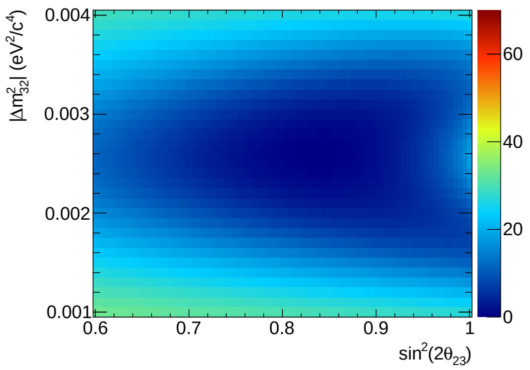


Figure 184: $\Delta\chi^2$ surface, for the 2+8 fit to fake data set 4

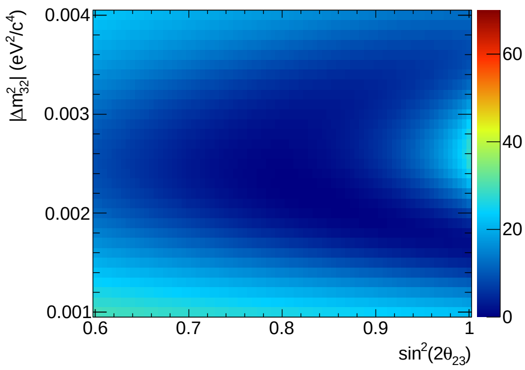


Figure 185: $\Delta\chi^2$ surface for the 2+8 fit to fake data set 5

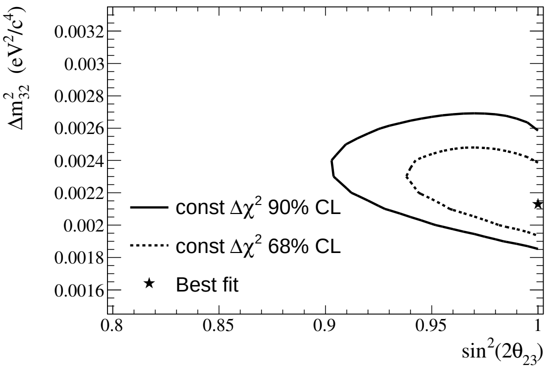


Figure 186: 68% and 90% confidence regions for the 2+N fit to fake data set 0

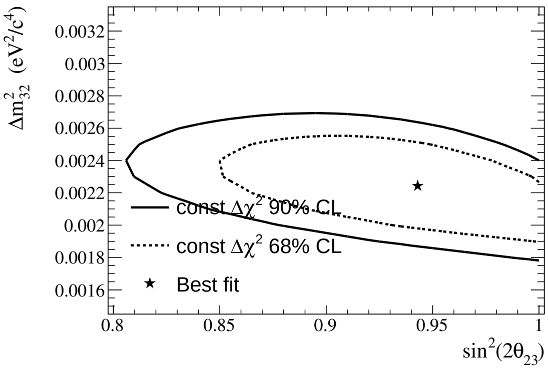


Figure 187: 68% and 90% confidence regions for the 2+N fit to fake data set 1

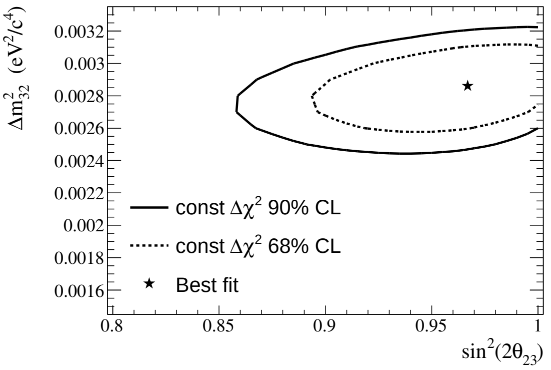


Figure 188: 68% and 90% confidence regions for the 2+N fit to fake data set 2

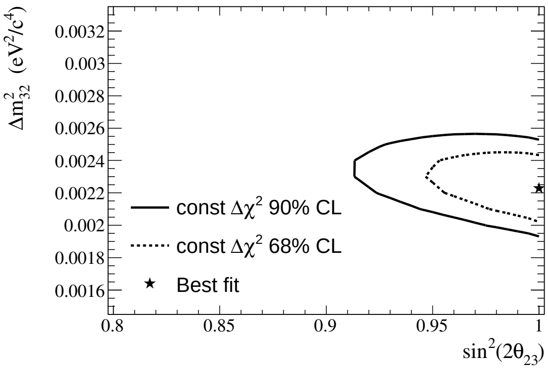


Figure 189: 68% and 90% confidence regions for the 2+N fit to fake data set 3

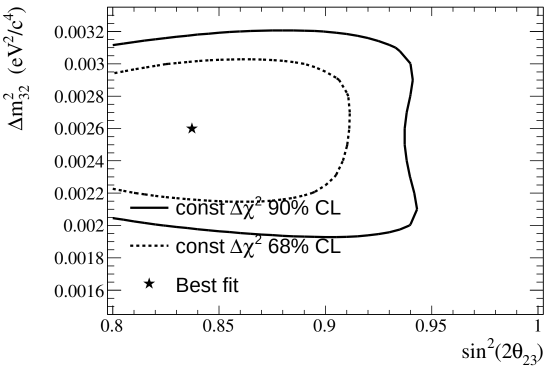


Figure 190: 68% and 90% confidence regions for the 2+N fit to fake data set 4

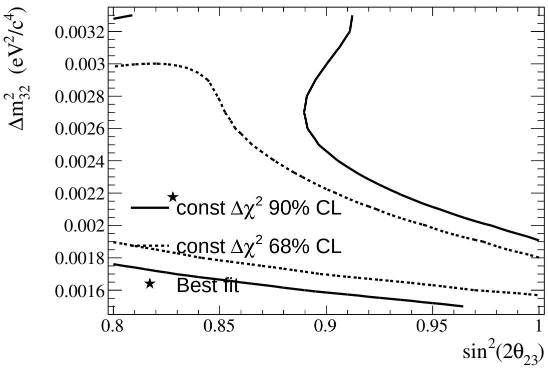


Figure 191: 68% and 90% confidence regions for the 2+N fit to fake data set 5

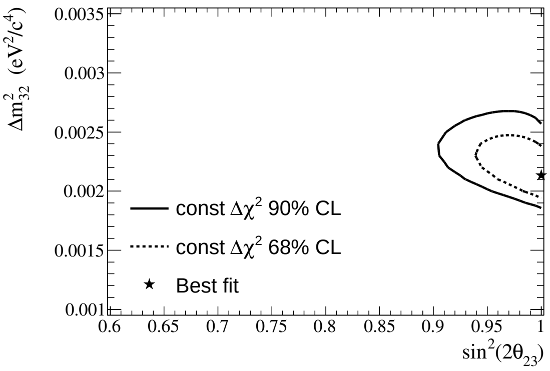


Figure 192: 68% and 90% confidence regions for the 2+8 fit to fake data set 0

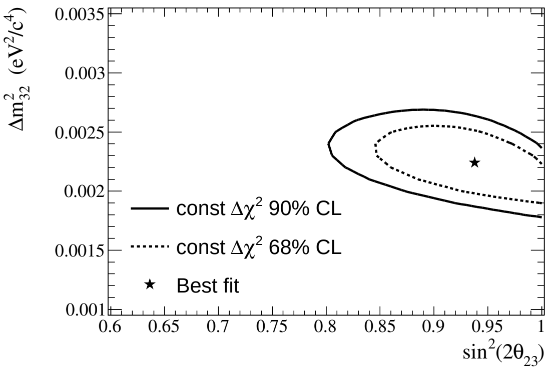


Figure 193: 68% and 90% confidence regions for the 2+8 fit to fake data set 1

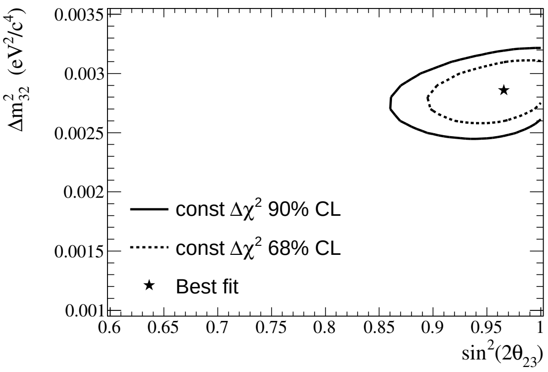


Figure 194: 68% and 90% confidence regions for the 2+8 fit to fake data set 2

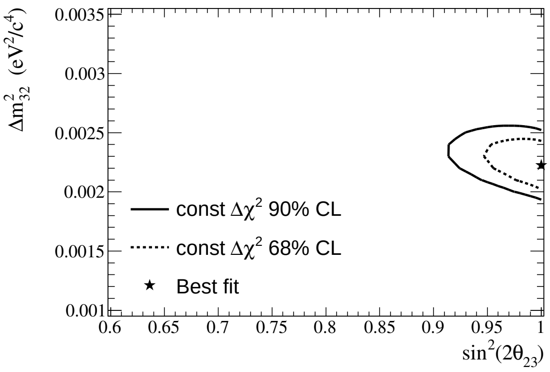


Figure 195: 68% and 90% confidence regions for the 2+8 fit to fake data set 3

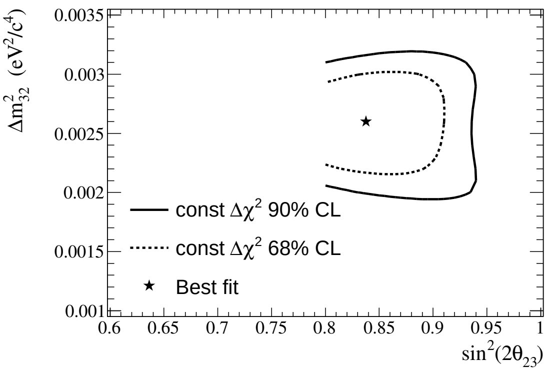


Figure 196: 68% and 90% confidence regions for the 2+8 fit to fake data set 4

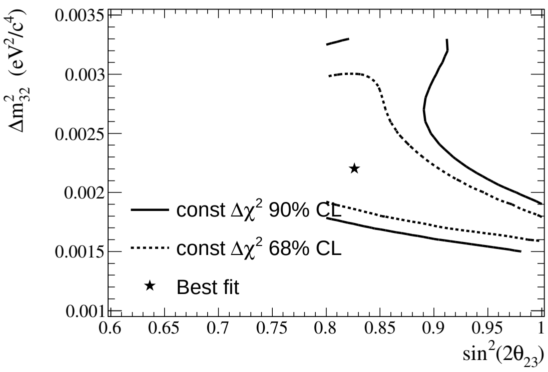


Figure 197: 68% and 90% confidence regions for the 2+8 fit to fake data set 5

E. Detailed study of the effect of systematics on the predicted number of 1 μ-like ring events

In this section, the effect of systematics on the predicted number of events in SuperK is presented in a number of tables. Each table shows the pre- and post-BANFF tuning nominal N_{SK} for every SuperK MC mode considered in the analysis, and the BANFF-tuned N_{SK} for $\pm 1\sigma$ deviations of a single systematic parameter. For correlated systematic parameters, σ is defined as the square root of the corresponding diagonal entry in the covariance matrix. For certain systematics, the modes are broken into E_{reco} or E_{true} bins, to show the energy dependence of that systematic (where relevant). Tabs. 20-67 show the effect of systematics on the unoscillated N_{SK}. Tabs. 68-115 show the effect of systematics on the N_{SK} with 3-flavour oscillations in matter, using the following values of the oscillation parameters:

- $\sin^2 2\theta_{12} = 0.857$
- $\sin^2 2\theta_{13} = 0.098$
- $\sin^2 2\theta_{23} = 1.0$
- $\delta_{CP} = 0$
- $\Delta m^2_{21} = 7.5\times10^{-5}$ eV^2/c^4
- $|\Delta m^2_{32}| = 2.4\times10^{-3}$ eV^2/c^4

The percentage uncertainties in the systematic parameters are summarised in Tab. 19 (parameters whose effects are evaluated using splines are not included in this table).

Systematic	Expected change
$f^{SK}_{E;r}$	0 % (movement in Ereco)
$f^{SK}_{CCQEoth;r}$	1.8 %
$f^{SK}_{CCQERC0;r}$	1.7 %
$f^{SK}_{CCQERC1;r}$	3.5 %
$f^{SK}_{CCQERC2;r}$	9.3 %
$f^{SK}_{CCnQE;r}$	20 %
$f^{SK}_{NC;r}$	111 %
$f^{SK}_{\nu_e;r}$	100 %
$f^{banff}_{0;t,r}$	9.283 %
$f^{banff}_{1;t,r}$	9.757 %
$f^{banff}_{2;t,r}$	8.974 %
$f^{banff}_{3;t,r}$	8.457 %
$f^{banff}_{4;t,r}$	10.5 %
$f^{banff}_{5;t,r}$	9.26 %
$f^{banff}_{6;t,r}$	8.113 %
$f^{banff}_{7;t,r}$	7.279 %
$f^{banff}_{8;t,r}$	8.362 %
$f^{banff}_{9;t,r}$	10.77 %
$f^{banff}_{10;t,r}$	14.12 %
$f^{banff}_{11;t,r}$	11.03 %
$f^{banff}_{12;t,r}$	9.867 %
$f^{banff}_{13;t,r}$	10.33 %
$f^{banff}_{14;t,r}$	11.08 %
$f^{banff}_{15;t,r}$	10.91 %
$f^{banff}_{18;t,r}$	9.012 %
$f^{banff}_{19;t,r}$	29.57 %
$f^{banff}_{20;t,r}$	16.7 %
$f^{banff}_{21;t,r}$	14.9 %
$f^{banff}_{22;t,r}$	27.74 %
$f_{CCcoh;t}$	100 %
$f_{NC1\pi^{\pm};t}$	30 %
$f_{NCoth;t}$	30 %
$f_{CC\nu_e;t}$	3 %
$f_{CC\bar{\nu};t}$	40 %
$f^{FSI}_{23;t,r}$	0.00363 %

Table 19: Summary table showing the magnitude of errors in the systematic parameters. The numbers should be compared with the changes in N_{SK} in the other tables in this appendix. Systematics with complicated energy dependence are treated with response functions, and are not shown.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.7	-5.553e-14 %	204.7	-6.941e-14 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 20: Effect of $f^{SK}_{E;r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	207.6	1.398 %	201.9	-1.398 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	157.8	1.8 %	152.3	-1.8 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	197.9	1.43 %	192.3	-1.43 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.053	1.8 %	3.91	-1.8 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.266	1.157 %	6.123	-1.157 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 21: Effect of $f^{SK}_{CCQEoth;r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.9	0.0636 %	204.6	-0.0636 %
N_{SK} (1 μ-like ring): ν_{μ} CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.646	1.7 %	7.39	-1.7 %
N_{SK} (1 μ-like ring): ν_{μ} CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_{μ} CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_{μ} CCQE	166.4	155	155.2	0.08243 %	154.9	-0.08243 %
N_{SK} (1 μ-like ring): ν_{μ} CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_{μ} CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_{μ} CC other (ν_{μ} disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_{μ} CC all	200.6	195.1	195.3	0.06549 %	195	-0.06549 %
N_{SK} (1 μ-like ring): ν_{μ}/ν_{τ} NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_{μ}/ν_{τ} NC other (ν_{μ} app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_{μ} NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1438	1.7 %	0.139	-1.7 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CCQE	4.46	3.981	3.984	0.06039 %	3.979	-0.06039 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CC other (ν_{μ} disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ CC all	6.37	6.194	6.197	0.03881 %	6.192	-0.03881 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}/\bar{\nu_{\tau}}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}/\bar{\nu_{\tau}}$ NC other (ν_{μ} app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_{\mu}}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_{μ} disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_{μ} app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_{μ} disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_{μ} app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_{μ} app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 22: Effect of $f^{SK}_{CCQERC0;r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	209.3	2.226 %	200.2	-2.226 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	132.8	3.5 %	123.8	-3.5 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	159.5	2.897 %	150.6	-2.897 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	199.6	2.302 %	190.6	-2.302 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.939	3.5 %	1.808	-3.5 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.047	1.647 %	3.916	-1.647 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.26	1.058 %	6.129	-1.058 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 23: Effect of $f^{SK}_{CCQERC1;r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	206.7	0.9614 %	202.8	-0.9614 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r <$ 1.1 GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq$ 1.1 GeV)	21.78	19.2	20.98	9.3 %	17.41	-9.3 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	156.8	1.152 %	153.3	-1.152 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	196.9	0.915 %	193.4	-0.915 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r <$ 1.1 GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq$ 1.1 GeV)	2.331	1.967	2.15	9.3 %	1.784	-9.3 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.164	4.594 %	3.799	-4.594 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.377	2.953 %	6.012	-2.953 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 24: Effect of $f^{SK}_{CCQERC2;r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	213.2	4.133 %	196.3	-4.133 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	41.93	20 %	27.96	-20 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	1.14	20 %	0.7602	-20 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	5.038	20 %	3.359	-20 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	203.2	4.109 %	187.1	-4.109 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	2.115	20 %	1.41	-20 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2434	20 %	0.1622	-20 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2974	20 %	0.1982	-20 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.637	7.145 %	5.752	-7.145 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 25: Effect of $f^{SK}_{CCnQE;r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	208.5	1.832 %	201	-1.832 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	3.43	111 %	-0.1788	-111 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	3.094	111 %	-0.1613	-111 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	6.524	111 %	-0.3401	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1908	111 %	-0.009946	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.1638	111 %	-0.008538	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.3546	111 %	-0.01848	-111 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.1043	111 %	-0.005436	-111 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.1217	111 %	-0.006345	-111 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.226	111 %	-0.01178	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.01248	111 %	-0.0006508	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.01256	111 %	-0.0006549	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.02505	111 %	-0.001306	-111 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 26: Effect of $f^{SK}_{NC;r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.8	0.01695 %	204.7	-0.01695 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.03252	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.02625	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.000867	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.006101	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.06574	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.001581	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.001491	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	0.0001467	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000438	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.003656	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 27: Effect of $f^{SK}_{\nu_e;r}$ for no oscillations (all mixing parameters set to 0)..

Component	**Nominal**	**BANFF tuned**	**BANFF tuned +1σ**		**BANFF tuned -1σ**	
N_{SK} (1 μ-like ring)	210.5	204.7	205.3	0.2811 %	204.2	-0.2811 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.6	0.3711 %	154.5	-0.3711 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9504	0.01391 %	0.9501	-0.01391 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.7	0.2949 %	194.6	-0.2949 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	6.443	6.2	6.775	9.283 %	5.624	-9.283 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	0	0	0	0 %	0	0 %

Table 28: Effect of $f^{banff}_{0;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned $+1\sigma$		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	206.4	0.8147 %	203.1	-0.8147 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	156.7	1.07 %	153.4	-1.07 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0.01178 %	34.94	-0.01178 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9529	0.2779 %	0.9476	-0.2779 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	196.8	0.8535 %	193.5	-0.8535 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.628	0.1273 %	1.623	-0.1273 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.467	0.02926 %	1.466	-0.02926 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.094	0.0808 %	3.089	-0.0808 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	17.43	17.1	18.76	9.757 %	15.43	-9.757 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	0	0	0	0 %	0	0 %

Table 29: Effect of $f^{banff}_{1;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	**Nominal**	**BANFF tuned**	**BANFF tuned +1σ**		**BANFF tuned -1σ**	
N_{SK} (1 μ-like ring)	210.5	204.7	207.8	1.495 %	201.7	-1.495 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	158	1.911 %	152.1	-1.911 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	35.02	0.2235 %	34.87	-0.2235 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9594	0.9618 %	0.9411	-0.9618 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	198.2	1.563 %	192.1	-1.563 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.634	0.5066 %	1.617	-0.5066 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.468	0.09125 %	1.465	-0.09125 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.102	0.3096 %	3.082	-0.3096 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	37.16	8.974 %	31.04	-8.974 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 30: Effect of $f_{2;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	208.2	1.707 %	201.3	-1.707 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	158.2	2.02 %	151.9	-2.02 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	35.28	0.9572 %	34.61	-0.9572 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.962	1.235 %	0.9385	-1.235 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0.001422 %	4.198	-0.001422 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	198.6	1.782 %	191.7	-1.782 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.64	0.9105 %	1.611	-0.9105 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.469	0.1885 %	1.464	-0.1885 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.11	0.568 %	3.074	-0.568 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	42.48	41.33	44.82	8.457 %	37.83	-8.457 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	0	0	0	0 %	0	0 %

Table 31: Effect of $f^{banff}_{3;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	210.3	2.706 %	199.2	-2.706 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	159.4	2.8 %	150.7	-2.8 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	36.07	3.211 %	33.82	-3.211 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9765	2.763 %	0.924	-2.763 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.201	0.06811 %	4.196	-0.06811 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	200.6	2.815 %	189.6	-2.815 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.663	2.336 %	1.588	-2.336 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.476	0.6316 %	1.457	-0.6316 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.139	1.528 %	3.045	-1.528 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	58.31	10.5 %	47.22	-10.5 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 32: Effect of $f^{banff}_{4;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	206.4	0.8026 %	203.1	-0.8026 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	156	0.6332 %	154.1	-0.6332 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	35.54	1.693 %	34.35	-1.693 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.96	1.024 %	0.9405	-1.024 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.222	0.5606 %	4.175	-0.5606 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	196.7	0.8233 %	193.5	-0.8233 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.646	1.242 %	1.605	-1.242 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.483	1.129 %	1.45	-1.129 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.129	1.189 %	3.055	-1.189 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	19.39	9.26 %	16.1	-9.26 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 33: Effect of $f^{banff}_{5;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	**Nominal**	**BANFF tuned**	**BANFF tuned +1σ**		**BANFF tuned -1σ**	
N_{SK} (1 μ-like ring)	210.5	204.7	205.7	0.4662 %	203.8	-0.4662 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.4	0.2321 %	154.7	-0.2321 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	35.43	1.386 %	34.46	-1.386 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9602	1.049 %	0.9403	-1.049 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.254	1.317 %	4.143	-1.317 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	196	0.4662 %	194.2	-0.4662 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC $1\pi^{+/-}$	1.697	1.625	1.646	1.255 %	1.605	-1.255 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.491	1.672 %	1.442	-1.672 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.137	1.453 %	3.047	-1.453 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	12.43	11.77	12.72	8.113 %	10.81	-8.113 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC $1\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC $1\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC $1\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	0	0	0	0 %	0	0 %

Table 34: Effect of $f^{banff}_{6;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205.2	0.217 %	204.3	-0.217 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.2	0.08886 %	154.9	-0.08886 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	35.16	0.6044 %	34.73	-0.6044 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.956	0.5999 %	0.9446	-0.5999 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.259	1.443 %	4.138	-1.443 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.6	0.2128 %	194.7	-0.2128 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.636	0.6523 %	1.615	-0.6523 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.485	1.262 %	1.448	-1.262 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.121	0.9416 %	3.063	-0.9416 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.55	7.279 %	5.661	-7.279 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 35: Effect of $f^{banff}_{7;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205.4	0.3229 %	204.1	-0.3229 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.3	0.1541 %	154.8	-0.1541 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	35.2	0.7295 %	34.69	-0.7295 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9579	0.8063 %	0.9426	-0.8063 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.313	2.726 %	4.084	-2.726 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.8	0.3157 %	194.5	-0.3157 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC $1\pi^{+/-}$	1.697	1.625	1.644	1.11 %	1.607	-1.11 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.494	1.848 %	1.439	-1.848 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.137	1.46 %	3.047	-1.46 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	7.037	7.906	8.567	8.362 %	7.245	-8.362 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC $1\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC $1\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC $1\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	0	0	0	0 %	0	0 %

Table 36: Effect of $f^{banff}_{8;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205	0.1407 %	204.5	-0.1407 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.1	0.04339 %	155	-0.04339 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	35.05	0.2995 %	34.84	-0.2995 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9535	0.3444 %	0.947	-0.3444 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.283	2.018 %	4.114	-2.018 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.4	0.1332 %	194.9	-0.1332 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.635	0.6108 %	1.616	-0.6108 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.485	1.237 %	1.448	-1.237 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.12	0.908 %	3.064	-0.908 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.459	2.675	2.963	10.77 %	2.387	-10.77 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	0	0	0	0 %	0	0 %

Table 37: Effect of $f_{9;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.8	0.03743 %	204.7	-0.03743 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0.003211 %	155	-0.003211 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.96	0.04319 %	34.93	-0.04319 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9507	0.04195 %	0.9499	-0.04195 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.233	0.8297 %	4.164	-0.8297 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.2	0.02834 %	195.1	-0.02834 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.633	0.458 %	1.618	-0.458 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.48	0.9469 %	1.453	-0.9469 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.113	0.6899 %	3.071	-0.6899 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.6195	14.12 %	0.4662	-14.12 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 38: Effect of $f_{10;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.9	0.05254 %	204.6	-0.05254 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.082	2.517 %	3.881	-2.517 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.767	0.2412 %	1.758	-0.2412 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2056	1.397 %	0.2	-1.397 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.302	1.732 %	6.087	-1.732 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09066	0.265 %	0.09018	-0.265 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07766	0.06249 %	0.07757	-0.06249 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1683	0.1715 %	0.1677	-0.1715 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.147	0.139	0.1544	11.03 %	0.1237	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.2075	0.1984	0.2203	11.03 %	0.1765	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.2899	0.281	0.312	11.03 %	0.25	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.3624	0.3572	0.3966	11.03 %	0.3178	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	0	0	0	0 %	0	0 %

Table 39: Effect of $f^{banff}_{11;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.9	0.05333 %	204.6	-0.05333 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ $<$ 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ $<$ 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ $<$ 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ $<$ 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ $<$ 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ $<$ 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ $<$ 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ $<$ 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ $<$ 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ $<$ 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ $<$ 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.067	2.154 %	3.896	-2.154 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.781	1.047 %	1.744	-1.047 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2067	1.947 %	0.1988	-1.947 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2479	0.05166 %	0.2477	-0.05166 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.303	1.748 %	6.086	-1.748 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09112	0.7694 %	0.08973	-0.7694 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07781	0.2482 %	0.07742	-0.2482 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1689	0.5287 %	0.1671	-0.5287 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ $<$ 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ $<$ 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ $<$ 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ $<$ 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ $<$ 1GeV)	1.118	1.107	1.216	9.867 %	0.9974	-9.867 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ $<$ 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ $<$ 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ $<$ 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ $<$ 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ $<$ 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ $<$ 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ $<$ 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ $<$ 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ $<$ 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ $<$ 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ $<$ 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ $<$ 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ $<$ 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ $<$ 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ $<$ 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ $<$ 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ $<$ 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ $<$ 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ $<$ 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ $<$ 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ $<$ 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ $<$ 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ $<$ 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ $<$ 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ $<$ 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ $<$ 30GeV)	0	0	0	0 %	0	0 %

Table 40: Effect of $f^{banff}_{12;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.9	0.07621 %	204.6	-0.07621 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.086	2.628 %	3.877	-2.628 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.804	2.377 %	1.721	-2.377 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2083	2.736 %	0.1973	-2.736 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2492	0.5542 %	0.2464	-0.5542 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.348	2.477 %	6.041	-2.477 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09208	1.833 %	0.08876	-1.833 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07855	1.211 %	0.07667	-1.211 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1706	1.546 %	0.1654	-1.546 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	1.492	1.51	1.666	10.33 %	1.354	-10.33 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	0	0	0	0 %	0	0 %

Table 41: Effect of $f^{banff}_{13;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.9	0.08094 %	204.6	-0.08094 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.058	1.914 %	3.905	-1.914 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.834	4.085 %	1.69	-4.085 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2084	2.775 %	0.1972	-2.775 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2543	2.63 %	0.2413	-2.63 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.355	2.588 %	6.034	-2.588 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09337	3.26 %	0.08747	-3.26 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08005	3.141 %	0.07518	-3.141 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1734	3.205 %	0.1627	-3.205 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.661	11.08 %	1.329	-11.08 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 42: Effect of $f_{14;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.9	0.06796 %	204.6	-0.06796 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.33	0 %	41.33	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	52.77	0 %	52.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	17.75	0 %	17.75	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	11.77	0 %	11.77	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.106	0 %	6.106	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	7.906	0 %	7.906	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.675	0 %	2.675	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.036	1.38 %	3.927	-1.38 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.815	2.984 %	1.71	-2.984 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2064	1.755 %	0.1992	-1.755 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2668	7.68 %	0.2288	-7.68 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.325	2.101 %	6.064	-2.101 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09463	4.654 %	0.08621	-4.654 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08243	6.204 %	0.0728	-6.204 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1771	5.37 %	0.159	-5.37 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6886	10.91 %	0.5531	-10.91 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.5247	10.91 %	0.4215	-10.91 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1689	10.91 %	0.1357	-10.91 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.03202	10.91 %	0.02572	-10.91 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004275	0 %	0.004275	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02869	0 %	0.02869	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03927	0 %	0.03927	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03646	0 %	0.03646	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01921	0 %	0.01921	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 43: Effect of $f_{15;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	220.2	7.536 %	186.4	-8.968 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	170	9.648 %	137.1	-11.56 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	210.1	7.666 %	177.2	-9.186 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.449	11.75 %	3.546	-10.93 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.662	7.554 %	5.759	-7.024 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.0181	11.31 %	0.01416	-12.91 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03471	5.596 %	0.03077	-6.386 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0008931	12.99 %	0.0006939	-12.21 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001931	5.616 %	0.001732	-5.281 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 44: Effect of $f^{banff}_{16;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	208.5	1.839 %	200.9	-1.887 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	38.15	9.179 %	31.61	-9.546 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.235	0.8785 %	4.163	-0.8539 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	198.4	1.663 %	191.8	-1.728 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.827	12.39 %	1.426	-12.28 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.534	4.608 %	1.405	-4.178 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.361	8.699 %	2.831	-8.438 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.978	12.21 %	1.565	-11.18 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2508	1.204 %	0.2448	-1.213 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.413	3.523 %	5.994	-3.23 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1061	17.33 %	0.07576	-16.21 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08173	5.309 %	0.0739	-4.788 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1878	11.78 %	0.1497	-10.94 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.0143	8.924 %	0.01192	-9.191 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003074	0.7756 %	0.003029	-0.7203 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03406	3.635 %	0.03164	-3.737 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.05699	15.32 %	0.04206	-14.89 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.06045	4.798 %	0.0552	-4.312 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1174	9.652 %	0.09726	-9.193 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0008425	13.04 %	0.0006614	-11.27 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.0002201	0.4931 %	0.0002179	-0.5038 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001926	5.376 %	0.001743	-4.653 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.007048	19.13 %	0.00488	-17.51 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.006334	6.376 %	0.005635	-5.356 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01338	12.73 %	0.01052	-11.41 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 45: Effect of $f_{17;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	218.1	6.514 %	191.4	-6.514 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	154.8	145.2	158.3	9.012 %	132.1	-9.012 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	9.007	6.329	6.329	0 %	6.329	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.498	3.518	3.518	0 %	3.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	168.1	8.439 %	142	-8.439 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	21.94	27.92	27.92	0 %	27.92	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.942	7.03	7.03	0 %	7.03	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	208.2	6.705 %	182.1	-6.705 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	2.959	2.791	3.042	9.012 %	2.539	-9.012 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.317	0.9346	0.9346	0 %	0.9346	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.184	0.2562	0.2562	0 %	0.2562	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.233	6.316 %	3.73	-6.316 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.9707	1.28	1.28	0 %	1.28	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4747	0.482	0.482	0 %	0.482	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.446	4.06 %	5.943	-4.06 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01415	0.01394	0.0152	9.012 %	0.01269	-9.012 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002513	0.001883	0.001883	0 %	0.001883	0 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003079	0.0004323	0.0004323	0 %	0.0004323	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01752	7.728 %	0.015	-7.728 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.008235	0.01137	0.01137	0 %	0.01137	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001697	0.001754	0.001754	0 %	0.001754	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03413	3.823 %	0.03161	-3.823 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004675	0.0004589	0.0005003	9.012 %	0.0004176	-9.012 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002641	0.000197	0.000197	0 %	0.000197	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.541e-05	0.0001345	0.0001345	0 %	0.0001345	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0008318	5.232 %	0.0007491	-5.232 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003538	0.0004898	0.0004898	0 %	0.0004898	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002475	0.0002555	0.0002555	0 %	0.0002555	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001869	2.262 %	0.001787	-2.262 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 46: Effect of $f_{18;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	206.9	1.049 %	202.6	-1.049 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	154.8	145.2	145.2	0 %	145.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	9.007	6.329	8.201	29.57 %	4.458	-29.57 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.498	3.518	3.518	0 %	3.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	156.9	1.207 %	153.2	-1.207 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	21.94	27.92	27.92	0 %	27.92	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.942	7.03	7.03	0 %	7.03	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	197	0.9591 %	193.3	-0.9591 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	2.959	2.791	2.791	0 %	2.791	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.317	0.9346	1.211	29.57 %	0.6583	-29.57 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.184	0.2562	0.2562	0 %	0.2562	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.258	6.942 %	3.705	-6.942 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.9707	1.28	1.28	0 %	1.28	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4747	0.482	0.482	0 %	0.482	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.471	4.462 %	5.918	-4.462 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01415	0.01394	0.01394	0 %	0.01394	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002513	0.001883	0.00244	29.57 %	0.001326	-29.57 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003079	0.0004323	0.0004323	0 %	0.0004323	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01682	3.424 %	0.0157	-3.424 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.008235	0.01137	0.01137	0 %	0.01137	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001697	0.001754	0.001754	0 %	0.001754	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03343	1.694 %	0.03231	-1.694 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004675	0.0004589	0.0004589	0 %	0.0004589	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002641	0.000197	0.0002553	29.57 %	0.0001388	-29.57 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.541e-05	0.0001345	0.0001345	0 %	0.0001345	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0008487	7.37 %	0.0007322	-7.37 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003538	0.0004898	0.0004898	0 %	0.0004898	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002475	0.0002555	0.0002555	0 %	0.0002555	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001886	3.187 %	0.00177	-3.187 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 47: Effect of $f_{19;t,r}^{banff}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205.4	0.3079 %	204.1	-0.3079 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	154.8	145.2	145.2	0 %	145.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	9.007	6.329	6.329	0 %	6.329	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.498	3.518	4.105	16.7 %	2.93	-16.7 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.6	0.3789 %	154.5	-0.3789 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	21.94	27.92	27.92	0 %	27.92	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.942	7.03	7.03	0 %	7.03	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.7	0.3011 %	194.6	-0.3011 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	2.959	2.791	2.791	0 %	2.791	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.317	0.9346	0.9346	0 %	0.9346	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.184	0.2562	0.299	16.7 %	0.2134	-16.7 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	4.024	1.075 %	3.939	-1.075 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.9707	1.28	1.28	0 %	1.28	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4747	0.482	0.482	0 %	0.482	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.237	0.6909 %	6.152	-0.6909 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01415	0.01394	0.01394	0 %	0.01394	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002513	0.001883	0.001883	0 %	0.001883	0 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003079	0.0004323	0.0005045	16.7 %	0.0003601	-16.7 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01633	0.4441 %	0.01619	-0.4441 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.008235	0.01137	0.01137	0 %	0.01137	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001697	0.001754	0.001754	0 %	0.001754	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03294	0.2197 %	0.0328	-0.2197 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004675	0.0004589	0.0004589	0 %	0.0004589	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002641	0.000197	0.000197	0 %	0.000197	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.541e-05	0.0001345	0.0001569	16.7 %	0.000112	-16.7 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0008129	2.842 %	0.000768	-2.842 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003538	0.0004898	0.0004898	0 %	0.0004898	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002475	0.0002555	0.0002555	0 %	0.0002555	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001851	1.229 %	0.001806	-1.229 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 48: Effect of $f^{banff}_{20;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	209.1	2.125 %	200.4	-2.125 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	154.8	145.2	145.2	0 %	145.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	9.007	6.329	6.329	0 %	6.329	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.498	3.518	3.518	0 %	3.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	21.94	27.92	32.07	14.9 %	23.76	-14.9 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.942	7.03	7.03	0 %	7.03	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	39.1	11.9 %	30.79	-11.9 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	199.3	2.131 %	191	-2.131 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC $1\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	2.959	2.791	2.791	0 %	2.791	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.317	0.9346	0.9346	0 %	0.9346	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.184	0.2562	0.2562	0 %	0.2562	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.9707	1.28	1.471	14.9 %	1.09	-14.9 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4747	0.482	0.482	0 %	0.482	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.953	10.82 %	1.572	-10.82 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.385	3.079 %	6.004	-3.079 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC $1\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01415	0.01394	0.01394	0 %	0.01394	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002513	0.001883	0.001883	0 %	0.001883	0 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003079	0.0004323	0.0004323	0 %	0.0004323	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.008235	0.01137	0.01307	14.9 %	0.009677	-14.9 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001697	0.001754	0.001754	0 %	0.001754	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01482	12.91 %	0.01143	-12.91 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03456	5.154 %	0.03118	-5.154 %
N_{SK} (1 μ-like ring): ν_e NC $1\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004675	0.0004589	0.0004589	0 %	0.0004589	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002641	0.000197	0.000197	0 %	0.000197	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.541e-05	0.0001345	0.0001345	0 %	0.0001345	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003538	0.0004898	0.0005628	14.9 %	0.0004168	-14.9 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002475	0.0002555	0.0002555	0 %	0.0002555	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0008183	9.79 %	0.0006723	-9.79 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001901	3.992 %	0.001755	-3.992 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC $1\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 49: Effect of $f^{banff}_{21;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	206.8	1.018 %	202.7	-1.018 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	154.8	145.2	145.2	0 %	145.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	9.007	6.329	6.329	0 %	6.329	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.498	3.518	3.518	0 %	3.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	21.94	27.92	27.92	0 %	27.92	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.942	7.03	8.98	27.74 %	5.08	-27.74 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	36.9	5.58 %	33	-5.58 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	197.1	0.9993 %	193.2	-0.9993 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	2.959	2.791	2.791	0 %	2.791	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.317	0.9346	0.9346	0 %	0.9346	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.184	0.2562	0.2562	0 %	0.2562	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.9707	1.28	1.28	0 %	1.28	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4747	0.482	0.6158	27.74 %	0.3483	-27.74 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.896	7.587 %	1.629	-7.587 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.328	2.159 %	6.061	-2.159 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01415	0.01394	0.01394	0 %	0.01394	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002513	0.001883	0.001883	0 %	0.001883	0 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003079	0.0004323	0.0004323	0 %	0.0004323	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.008235	0.01137	0.01137	0 %	0.01137	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001697	0.001754	0.00224	27.74 %	0.001267	-27.74 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01361	3.707 %	0.01264	-3.707 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03336	1.48 %	0.03238	-1.48 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004675	0.0004589	0.0004589	0 %	0.0004589	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002641	0.000197	0.000197	0 %	0.000197	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.541e-05	0.0001345	0.0001345	0 %	0.0001345	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003538	0.0004898	0.0004898	0 %	0.0004898	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002475	0.0002555	0.0003264	27.74 %	0.0001846	-27.74 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0008162	9.51 %	0.0006744	-9.51 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001899	3.877 %	0.001757	-3.877 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 50: Effect of $f^{banff}_{22;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.9	0.06749 %	204.7	-0.04195 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.2	0.08902 %	155	-0.05531 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.3	0.07073 %	195.1	-0.04395 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ $<$ 0.4GeV)	6.443	6.2	5.952	-3.992 %	6.412	3.419 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ $<$ 0.5GeV)	17.43	17.1	16.91	-1.081 %	17.21	0.6798 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ $<$ 0.6GeV)	34.52	34.1	34.14	0.1264 %	34.02	-0.2378 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ $<$ 0.7GeV)	42.48	41.33	41.36	0.08597 %	41.26	-0.1577 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ $<$ 1GeV)	55.91	52.77	52.87	0.1938 %	52.75	-0.0275 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ $<$ 1.5GeV)	17.65	17.75	17.9	0.8537 %	17.67	-0.4186 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ $<$ 2.5GeV)	12.43	11.77	11.87	0.858 %	11.69	-0.6746 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ $<$ 3.5GeV)	6.888	6.106	6.156	0.818 %	6.072	-0.5442 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ $<$ 5GeV)	7.037	7.906	7.986	1.015 %	7.845	-0.7706 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ $<$ 7GeV)	2.459	2.675	2.682	0.2585 %	2.67	-0.2 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ $<$ 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ $<$ 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ $<$ 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ $<$ 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ $<$ 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ $<$ 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ $<$ 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ $<$ 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ $<$ 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ $<$ 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ $<$ 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ $<$ 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01642	0.9615 %	0.01613	-0.7929 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03303	0.4756 %	0.03274	-0.3922 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ $<$ 0.5GeV)	0.004443	0.004347	0.004286	-1.395 %	0.004382	0.8008 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ $<$ 0.7GeV)	0.007368	0.007722	0.007776	0.7016 %	0.00767	-0.6719 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ $<$ 0.8GeV)	0.003958	0.004275	0.004294	0.453 %	0.004263	-0.2681 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ $<$ 1.5GeV)	0.02699	0.02869	0.02877	0.302 %	0.02863	-0.2155 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ $<$ 2.5GeV)	0.03865	0.03927	0.03931	0.0953 %	0.03924	-0.08852 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ $<$ 4GeV)	0.03615	0.03646	0.03648	0.0411 %	0.03645	-0.02834 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ $<$ 30GeV)	0.01889	0.01921	0.01921	0.02287 %	0.01922	0.03394 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ $<$ 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ $<$ 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ $<$ 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ $<$ 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ $<$ 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ $<$ 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ $<$ 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ $<$ 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ $<$ 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ $<$ 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ $<$ 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ $<$ 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ $<$ 30GeV)	0	0	0	0 %	0	0 %

Table 51: Effect of $f_{pF;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ	BANFF tuned -1σ
N_{SK} (1 μ-like ring)	210.5	204.7	199.7 -2.466 %	
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	150 -3.255 %	
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95 0 %	
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503 0 %	
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199 0 %	
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	190.1 -2.587 %	
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625 0 %	
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466 0 %	
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092 0 %	
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	6.443	6.2	6.615 6.69 %	
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	17.43	17.1	16.59 -2.954 %	
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	34.52	34.1	33.94 -0.4548 %	
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	42.48	41.33	38.88 -5.915 %	
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	55.91	52.77	50.41 -4.468 %	
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	17.65	17.75	17.75 0 %	
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	12.43	11.77	11.77 0 %	
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.888	6.106	6.106 0 %	
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	7.037	7.906	7.906 0 %	
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.459	2.675	2.675 0 %	
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5239	0.5428	0.5428 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	4.46	3.981	3.981 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.445	1.762	1.762 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.2111	0.2028	0.2028 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2539	0.2478	0.2478 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	6.37	6.194	6.194 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.07761 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.168 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0 $\leq E_t <$ 0.4GeV)	0.147	0.139	0.139 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.4 $\leq E_t <$ 0.5GeV)	0.2075	0.1984	0.1984 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.5 $\leq E_t <$ 0.6GeV)	0.2899	0.281	0.281 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.6 $\leq E_t <$ 0.7GeV)	0.3624	0.3572	0.3572 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.7 $\leq E_t <$ 1GeV)	1.118	1.107	1.107 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (1 $\leq E_t <$ 1.5GeV)	1.492	1.51	1.51 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (1.5 $\leq E_t <$ 2.5GeV)	1.635	1.495	1.495 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (2.5 $\leq E_t <$ 3.5GeV)	0.71	0.6208	0.6208 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (3.5 $\leq E_t <$ 5GeV)	0.4132	0.4731	0.4731 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (5 $\leq E_t <$ 7GeV)	0.1389	0.1523	0.1523 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (7 $\leq E_t <$ 30GeV)	0.02833	0.02887	0.02887 0 %	
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01531 -5.827 %	
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313 0 %	
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335 0 %	
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051 0 %	
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03192 -2.883 %	
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942 0 %	
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768 0 %	
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071 0 %	
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004443	0.004347	0.004135 -4.863 %	
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.007368	0.007722	0.007157 -7.31 %	
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003958	0.004275	0.004164 -2.585 %	
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02699	0.02869	0.02863 -0.2129 %	
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03865	0.03927	0.03927 0 %	
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03615	0.03646	0.03646 0 %	
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.01921	0.01921 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.000827	0.0007905	0.0007905 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0006013	0.0007453	0.0007453 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.333e-05	7.333e-05	7.333e-05 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001721	0.001828	0.001828 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.005954 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01187 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all (0 $\leq E_t <$ 2.5GeV)	0.005279	0.005397	0.005397 0 %	
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all (2.5 $\leq E_t <$ 30GeV)	0.008164	0.008302	0.008302 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	0	0	0 0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	0	0	0 0 %	

Table 52: Effect of $f_{SF;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205	0.1026 %	204.5	-0.1175 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.753	7.821 %	1.49	-8.335 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.522	3.763 %	1.395	-4.898 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.274	5.896 %	2.885	-6.705 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	17.43	17.1	17.09	-0.03214 %	17.11	0.05487 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	34.52	34.1	34.08	-0.05275 %	34.12	0.07633 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	42.48	41.33	41.3	-0.06448 %	41.37	0.09443 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	55.91	52.77	52.76	-0.01004 %	52.77	0.01788 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	17.65	17.75	17.78	0.1911 %	17.7	-0.2373 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	12.43	11.77	11.83	0.5512 %	11.69	-0.6864 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.888	6.106	6.149	0.7171 %	6.054	-0.85 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	7.037	7.906	7.96	0.6778 %	7.843	-0.8 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.459	2.675	2.703	1.037 %	2.64	-1.317 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5239	0.5428	0.5567	2.551 %	0.5249	-3.301 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1036	14.54 %	0.07507	-16.98 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08124	4.668 %	0.07302	-5.917 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1848	9.981 %	0.1481	-11.87 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.2075	0.1984	0.1983	-0.02255 %	0.1985	0.04166 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.2899	0.281	0.2808	-0.06753 %	0.2813	0.09648 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.3624	0.3572	0.3571	-0.01382 %	0.3571	-0.02639 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	1.118	1.107	1.106	-0.012 %	1.107	0.02884 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	1.492	1.51	1.513	0.1804 %	1.507	-0.2209 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.635	1.495	1.501	0.3731 %	1.489	-0.444 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.71	0.6208	0.6247	0.6242 %	0.6161	-0.7585 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.4132	0.4731	0.4763	0.673 %	0.4694	-0.7809 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1389	0.1523	0.1535	0.791 %	0.1508	-0.9624 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02833	0.02887	0.02949	2.151 %	0.02819	-2.348 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.05687	15.07 %	0.04059	-17.87 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05983	3.724 %	0.05482	-4.967 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1167	8.961 %	0.09541	-10.92 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004443	0.004347	0.004323	-0.5563 %	0.00438	0.7586 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.007368	0.007722	0.007502	-2.844 %	0.008042	4.147 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003958	0.004275	0.004193	-1.915 %	0.004415	3.288 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02699	0.02869	0.02978	3.826 %	0.02722	-5.098 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03865	0.03927	0.043	9.486 %	0.03457	-11.98 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03615	0.03646	0.0399	9.42 %	0.03242	-11.09 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.01921	0.02087	8.669 %	0.01723	-10.31 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.007015	18.57 %	0.004631	-21.72 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.006256	5.079 %	0.005584	-6.213 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01327	11.81 %	0.01022	-13.94 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005279	0.005397	0.00586	8.593 %	0.004844	-10.24 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008164	0.008302	0.009239	11.29 %	0.007199	-13.28 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	0	0	0	0 %	0	0 %

Table 53: Effect of $f_{W shape;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205.3	0.2799 %	204.2	-0.2799 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.737	12.83 %	3.66	-12.83 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.7	0.276 %	194.6	-0.276 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	17.43	17.1	17.1	0 %	17.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	34.52	34.1	34.1	0 %	34.1	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	42.48	41.33	41.33	0.0009852 %	41.33	-0.0009852 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	55.91	52.77	52.78	0.0228 %	52.75	-0.0228 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	17.65	17.75	17.83	0.4463 %	17.67	-0.4463 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	12.43	11.77	11.9	1.168 %	11.63	-1.168 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.888	6.106	6.217	1.826 %	5.994	-1.826 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	7.037	7.906	8.037	1.657 %	7.775	-1.657 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.459	2.675	2.73	2.038 %	2.621	-2.038 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5239	0.5428	0.5553	2.291 %	0.5304	-2.291 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2818	13.72 %	0.2138	-13.72 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.228	0.549 %	6.16	-0.549 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	1.118	1.107	1.107	0.05007 %	1.106	-0.05007 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	1.492	1.51	1.514	0.2717 %	1.506	-0.2717 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.635	1.495	1.507	0.7845 %	1.483	-0.7845 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.71	0.6208	0.629	1.311 %	0.6127	-1.311 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.4132	0.4731	0.4794	1.327 %	0.4668	-1.327 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1389	0.1523	0.1549	1.705 %	0.1497	-1.705 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02833	0.02887	0.02947	2.093 %	0.02826	-2.093 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003523	15.47 %	0.002579	-15.47 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03334	1.436 %	0.0324	-1.436 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004443	0.004347	0.004347	0 %	0.004347	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.007368	0.007722	0.007722	0 %	0.007722	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003958	0.004275	0.004281	0.1605 %	0.004268	-0.1605 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02699	0.02869	0.02879	0.3448 %	0.02859	-0.3448 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03865	0.03927	0.03943	0.4084 %	0.03911	-0.4084 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03615	0.03646	0.03661	0.3997 %	0.03632	-0.3997 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.01921	0.01927	0.3127 %	0.01915	-0.3127 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.0002482	13.31 %	0.0001899	-13.31 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001857	1.595 %	0.001799	-1.595 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005279	0.005397	0.00541	0.2464 %	0.005383	-0.2464 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008164	0.008302	0.008317	0.191 %	0.008286	-0.191 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	0	0	0	0 %	0	0 %

Table 54: Effect of $f_{CCothShape;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	212	3.553 %	197.5	-3.553 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	42.44	21.46 %	27.45	-21.46 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	202.6	3.843 %	187.6	-3.843 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.317	-18.97 %	1.934	18.97 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.379	-5.958 %	1.554	5.958 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	2.696	-12.8 %	3.488	12.8 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	6.443	6.2	6.2	0 %	6.2	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	17.43	17.1	17.09	-0.01126 %	17.1	0.01126 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	34.52	34.1	34.19	0.2545 %	34.01	-0.2545 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	42.48	41.33	41.98	1.586 %	40.67	-1.586 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	55.91	52.77	54.75	3.757 %	50.78	-3.757 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	17.65	17.75	19.19	8.149 %	16.3	-8.149 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	12.43	11.77	13.18	12.05 %	10.35	-12.05 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.888	6.106	6.834	11.92 %	5.377	-11.92 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	7.037	7.906	8.521	7.777 %	7.291	-7.777 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.459	2.675	2.829	5.744 %	2.521	-5.744 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5239	0.5428	0.5632	3.745 %	0.5225	-3.745 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.969	11.72 %	1.556	-11.72 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.401	3.336 %	5.988	-3.336 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.07284	-19.45 %	0.108	19.45 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07297	-5.987 %	0.08226	5.987 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1458	-13.23 %	0.1903	13.23 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.2075	0.1984	0.1984	0.008401 %	0.1984	-0.008401 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.2899	0.281	0.282	0.3366 %	0.2801	-0.3366 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.3624	0.3572	0.3585	0.3668 %	0.3559	-0.3668 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	1.118	1.107	1.124	1.539 %	1.09	-1.539 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	1.492	1.51	1.546	2.364 %	1.474	-2.364 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.635	1.495	1.574	5.265 %	1.416	-5.265 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.71	0.6208	0.6514	4.931 %	0.5902	-4.931 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.4132	0.4731	0.4892	3.389 %	0.4571	-3.389 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1389	0.1523	0.1559	2.38 %	0.1487	-2.38 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02833	0.02887	0.02927	1.403 %	0.02846	-1.403 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01394	6.182 %	0.01231	-6.182 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03368	2.468 %	0.03206	-2.468 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.0398	-19.46 %	0.05904	19.46 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.0548	-4.999 %	0.06057	4.999 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.0946	-11.67 %	0.1196	11.67 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004443	0.004347	0.004321	-0.6039 %	0.004373	0.6039 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.007368	0.007722	0.007632	-1.158 %	0.007811	1.158 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003958	0.004275	0.004103	-4.003 %	0.004446	4.003 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02699	0.02869	0.02612	-8.948 %	0.03125	8.948 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03865	0.03927	0.03543	-9.787 %	0.04311	9.787 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03615	0.03646	0.03311	-9.196 %	0.03982	9.196 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.01921	0.01757	-8.537 %	0.02085	8.537 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007734	3.767 %	0.0007172	-3.767 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001856	1.536 %	0.0018	-1.536 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.004761	-19.52 %	0.007071	19.52 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005621	-5.585 %	0.006287	5.585 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01038	-12.53 %	0.01336	12.53 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005279	0.005397	0.004841	-10.3 %	0.005953	10.3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008164	0.008302	0.007398	-10.88 %	0.009205	10.88 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	0	0	0	0 %	0	0 %

Table 55: Effect of $f_{\pi-less\Delta;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	203.9	-0.418 %	205.5	0.3589 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	154.2	-0.5519 %	155.8	0.4739 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	194.3	-0.4385 %	195.9	0.3765 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	6.443	6.2	6.919	11.59 %	5.536	-10.71 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	17.43	17.1	18.3	7.015 %	15.91	-6.912 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	34.52	34.1	34.97	2.548 %	33.11	-2.893 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	42.48	41.33	40.64	-1.656 %	41.82	1.184 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	55.91	52.77	50.37	-4.542 %	55.22	4.65 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	17.65	17.75	17.29	-2.59 %	18.25	2.843 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	12.43	11.77	11.69	-0.6316 %	11.85	0.7101 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.888	6.106	6.098	-0.1303 %	6.116	0.1728 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	7.037	7.906	7.889	-0.2169 %	7.929	0.2951 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.459	2.675	2.672	-0.0984 %	2.677	0.08414 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5239	0.5428	0.5428	0 %	0.5428	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.147	0.139	0.139	0 %	0.139	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.2075	0.1984	0.1984	0 %	0.1984	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.2899	0.281	0.281	0 %	0.281	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.3624	0.3572	0.3572	0 %	0.3572	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	1.118	1.107	1.107	0 %	1.107	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	1.492	1.51	1.51	0 %	1.51	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.635	1.495	1.495	0 %	1.495	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.71	0.6208	0.6208	0 %	0.6208	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.4132	0.4731	0.4731	0 %	0.4731	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1389	0.1523	0.1523	0 %	0.1523	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02833	0.02887	0.02887	0 %	0.02887	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.0162	-0.388 %	0.01633	0.421 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03281	-0.1919 %	0.03294	0.2083 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004443	0.004347	0.004701	8.153 %	0.004005	-7.869 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.007368	0.007722	0.00769	-0.4125 %	0.007733	0.1377 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003958	0.004275	0.004176	-2.312 %	0.004373	2.302 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02699	0.02869	0.02844	-0.8739 %	0.02895	0.9161 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03865	0.03927	0.03924	-0.06955 %	0.0393	0.07402 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03615	0.03646	0.03646	-0.01529 %	0.03647	0.0171 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.01921	0.01921	-0.01682 %	0.01921	0.01744 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005279	0.005397	0.005397	0 %	0.005397	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008164	0.008302	0.008302	0 %	0.008302	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	0	0	0	0 %	0	0 %

Table 56: Effect of $f_{bindE;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205.9	0.5634 %	203.6	-0.5634 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	1.901	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	196.1	0.487 %	194.2	-0.487 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.4056	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.397	3.274 %	5.992	-3.274 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.000867	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.0333	1.319 %	0.03244	-1.319 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	0.0001467	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001901	4.011 %	0.001755	-4.011 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 57: Effect of $f_{CCcoh;t}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205.3	0.2595 %	204.2	-0.2595 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	2.113	30 %	1.138	-30 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.58	15.77 %	2.604	-15.77 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1175	30 %	0.0633	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1952	16.14 %	0.1409	-16.14 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.06425	30 %	0.03459	-30 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1219	13.84 %	0.09228	-13.84 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.007691	30 %	0.004141	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01365	14.95 %	0.0101	-14.95 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 58: Effect of $f_{NC1\pi^{\pm};t}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205.2	0.2356 %	204.3	-0.2356 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.906	30 %	1.027	-30 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.532	14.23 %	2.652	-14.23 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.1009	30 %	0.05433	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1913	13.86 %	0.1448	-13.86 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.07499	30 %	0.04038	-30 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1244	16.16 %	0.0898	-16.16 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.00774	30 %	0.004168	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01366	15.05 %	0.01008	-15.05 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 59: Effect of $f_{NCoth;t}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.7	0.0005084 %	204.7	-0.0005084 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01675	3 %	0.01577	-3 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01352	3 %	0.01273	-3 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004465	3 %	0.0004205	-3 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003142	3 %	0.002959	-3 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03386	3 %	0.03188	-3 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0008142	3 %	0.0007667	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007677	3 %	0.000723	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.553e-05	3 %	7.113e-05	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.0002256	3 %	0.0002125	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001883	3 %	0.001773	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 60: Effect of $f_{CC\nu_e;t}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	207.2	1.211 %	202.3	-1.211 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	5.574	40 %	2.389	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	2.467	40 %	1.057	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2839	40 %	0.1217	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.3469	40 %	0.1487	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	8.672	40 %	3.717	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.001107	40 %	0.0004743	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.001043	40 %	0.0004472	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	0.0001027	40 %	4.4e-05	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.0003066	40 %	0.0001314	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.002559	40 %	0.001097	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 61: Effect of $f_{CC\bar{\nu};t}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.7	0.0001358 %	204.7	-0.0001358 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0.00363 %	7.518	-0.00363 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0.000176 %	155	-0.000176 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0.0001399 %	195.1	-0.0001399 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0.00363 %	0.1414	-0.00363 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0.000129 %	3.981	-0.000129 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	8.289e-05 %	6.194	-8.289e-05 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 62: Effect of $f^{FSI}_{0;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.8	0.04533 %	204.7	-0.04533 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	128.4	0.07128 %	128.2	-0.07128 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.1	0.059 %	155	-0.059 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.2	0.04687 %	195	-0.04687 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.874	0.07128 %	1.872	-0.07128 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.983	0.03353 %	3.98	-0.03353 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.196	0.02155 %	6.193	-0.02155 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 63: Effect of $f^{FSI}_{1;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.8	0.02872 %	204.7	-0.02872 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.25	0.2778 %	19.15	-0.2778 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155.1	0.0344 %	155	-0.0344 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.2	0.02733 %	195.1	-0.02733 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC $1\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.972	0.2778 %	1.961	-0.2778 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.987	0.1372 %	3.976	-0.1372 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.2	0.08821 %	6.189	-0.08821 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC $1\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC $1\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC $1\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 64: Effect of $f^{FSI}_{2;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	208.4	1.79 %	201.1	-1.79 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	37.97	8.66 %	31.92	-8.66 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	1.033	8.66 %	0.868	-8.66 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.562	8.66 %	3.835	-8.66 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	198.6	1.779 %	191.7	-1.779 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.915	8.66 %	1.61	-8.66 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2204	8.66 %	0.1852	-8.66 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2693	8.66 %	0.2263	-8.66 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.386	3.094 %	6.003	-3.094 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 65: Effect of $f_{3;t,r}^{FSI}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	204.7	0.0001911 %	204.7	-0.0001911 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01644	1.128 %	0.01608	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01327	1.128 %	0.01298	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004384	1.128 %	0.0004286	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003085	1.128 %	0.003016	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03324	1.128 %	0.0325	-1.128 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007994	1.128 %	0.0007815	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007537	1.128 %	0.0007369	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.415e-05	1.128 %	7.25e-05	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.0002215	1.128 %	0.0002166	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001849	1.128 %	0.001808	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 66: Effect of $f^{FSI}_{4;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	210.5	204.7	205	0.1277 %	204.5	-0.1277 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_r < 0.4 GeV)	7.784	7.518	7.518	0 %	7.518	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r$ < 1.1 GeV)	136.8	128.3	128.3	0 %	128.3	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq$ 1.1 GeV)	21.78	19.2	19.2	0 %	19.2	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	166.4	155	155	0 %	155	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	28.88	34.95	34.95	0 %	34.95	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	1.006	0.9503	0.9503	0 %	0.9503	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	4.315	4.199	4.199	0 %	4.199	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	200.6	195.1	195.1	0 %	195.1	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.751	7.737 %	1.5	-7.737 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.58	7.737 %	1.353	-7.737 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.331	7.737 %	2.853	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_r < 0.4 GeV)	0.1497	0.1414	0.1414	0 %	0.1414	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r$ < 1.1 GeV)	1.979	1.873	1.873	0 %	1.873	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq$ 1.1 GeV)	2.331	1.967	1.967	0 %	1.967	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	4.46	3.981	3.981	0 %	3.981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.445	1.762	1.762	0 %	1.762	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.2111	0.2028	0.2028	0 %	0.2028	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2539	0.2478	0.2478	0 %	0.2478	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	6.37	6.194	6.194	0 %	6.194	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09742	7.737 %	0.08343	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08362	7.737 %	0.07161	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.181	7.737 %	0.155	-7.737 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01697	0.01626	0.01626	0 %	0.01626	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009932	0.01313	0.01313	0 %	0.01313	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004335	0.0004335	0.0004335	0 %	0.0004335	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003048	0.003051	0.003051	0 %	0.003051	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.03039	0.03287	0.03287	0 %	0.03287	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.05324	7.737 %	0.0456	-7.737 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.06215	7.737 %	0.05322	-7.737 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1154	7.737 %	0.09882	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.000827	0.0007905	0.0007905	0 %	0.0007905	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0006013	0.0007453	0.0007453	0 %	0.0007453	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.333e-05	7.333e-05	7.333e-05	0 %	7.333e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002189	0.000219	0.000219	0 %	0.000219	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001721	0.001828	0.001828	0 %	0.001828	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.006374	7.737 %	0.005458	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.006415	7.737 %	0.005493	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01279	7.737 %	0.01095	-7.737 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0	0	0	0 %	0	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0	0	0	0 %	0	0 %

Table 67: Effect of $f^{FSI}_{5;t,r}$ for no oscillations (all mixing parameters set to 0)..

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.37	-1.217e-14 %	58.37	-2.435e-14 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 68: Effect of $f^{SK}_{E;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.95	0.9923 %	57.79	-0.9923 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.83	1.8 %	29.74	-1.8 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.93	1.061 %	50.84	-1.061 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.925	1.8 %	1.857	-1.8 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.482	0.9873 %	3.414	-0.9873 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 69: Effect of $f^{SK}_{CCQEoth;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.43	0.1091 %	58.3	-0.1091 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_r < 0.4 GeV)	3.802	3.653	3.715	1.7 %	3.591	-1.7 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r < 1.1$ GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.35	0.2051 %	30.22	-0.2051 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.45	0.1209 %	51.33	-0.1209 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09464	1.7 %	0.09147	-1.7 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.893	0.08365 %	1.89	-0.08365 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.449	0.04589 %	3.446	-0.04589 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 70: Effect of $f^{SK}_{CCQERC0;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} =$ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.86	0.8477 %	57.87	-0.8477 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($0.4 \leq E_r < 1.1$ GeV)	14.98	13.78	14.26	3.5 %	13.3	-3.5 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.77	1.592 %	29.8	-1.592 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.87	0.9384 %	50.91	-0.9384 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($0.4 \leq E_r < 1.1$ GeV)	0.3816	0.3585	0.371	3.5 %	0.3459	-3.5 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.904	0.6634 %	1.879	-0.6634 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.46	0.3639 %	3.435	-0.3639 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 71: Effect of $f^{SK}_{CCQERC1;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	59.7	2.278 %	57.04	-2.278 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r < 1.1$ GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq$ 1.1 GeV)	14.5	12.85	14.05	9.3 %	11.66	-9.3 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	31.48	3.947 %	29.09	-3.947 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	52.58	2.326 %	50.19	-2.326 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq$ 1.1 GeV)	1.71	1.44	1.573	9.3 %	1.306	-9.3 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	2.025	7.08 %	1.757	-7.08 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.581	3.883 %	3.314	-3.883 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 72: Effect of $f^{SK}_{CCQERC2;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	62.9	7.764 %	53.84	-7.764 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	20.32	20 %	13.55	-20 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4797	20 %	0.3198	-20 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	4.525	20 %	3.017	-20 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	55.61	8.213 %	47.17	-8.213 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.474	20 %	0.9824	-20 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1301	20 %	0.08676	-20 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.2641	20 %	0.176	-20 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.759	9.029 %	3.136	-9.029 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 73: Effect of $f^{SK}_{CCnQE;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	62.12	6.426 %	54.62	-6.426 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	3.43	111 %	-0.1788	-111 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	3.094	111 %	-0.1613	-111 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	6.524	111 %	-0.3401	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1908	111 %	-0.009946	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.1638	111 %	-0.008538	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.3546	111 %	-0.01848	-111 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.1043	111 %	-0.005436	-111 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.1217	111 %	-0.006345	-111 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.226	111 %	-0.01178	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.01248	111 %	-0.0006508	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.01256	111 %	-0.0006549	-111 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.02505	111 %	-0.001306	-111 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 74: Effect of $f^{SK}_{NC;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	**Nominal**	**BANFF tuned**	**BANFF tuned +1σ**		**BANFF tuned -1σ**	
N_{SK} (1 μ-like ring)	59.41	58.37	58.52	0.2629 %	58.21	-0.2629 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.03014	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.02485	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0008072	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.006014	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.06181	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.001511	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.001447	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	0.0001406	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0004335	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.003532	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.1658	100 %	0	-100 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.07054	100 %	0	-100 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.003897	100 %	0	-100 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.001343	100 %	0	-100 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.2415	100 %	0	-100 %

Table 75: Effect of $f^{SK}_{\nu_e;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.76	0.6702 %	57.98	-0.6702 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.68	1.291 %	29.89	-1.291 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3998	0.01628 %	0.3996	-0.01628 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.78	0.761 %	51	-0.761 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	4.38	4.212	4.603	9.283 %	3.821	-9.283 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08305	0.1982 %	0.08272	-0.1982 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03528	0.01083 %	0.03527	-0.01083 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1209	0.1392 %	0.1206	-0.1392 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0.001862	0.001811	0.001979	9.283 %	0.001642	-9.283 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 76: Effect of $f_{0;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5$e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.68	0.5385 %	58.05	-0.5385 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.6	1.023 %	29.98	-1.023 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0.003059 %	16.93	-0.003059 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4001	0.09224 %	0.3993	-0.09224 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.7	0.6045 %	51.08	-0.6045 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.628	0.1273 %	1.623	-0.1273 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.467	0.02926 %	1.466	-0.02926 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.094	0.0808 %	3.089	-0.0808 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	3.276	3.209	3.522	9.757 %	2.896	-9.757 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08392	1.248 %	0.08185	-1.248 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03539	0.3301 %	0.03515	-0.3301 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.00196	0.5705 %	0.001937	-0.5705 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1219	0.9619 %	0.1196	-0.9619 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0.01178	0.01191	0.01307	9.757 %	0.01075	-9.757 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 77: Effect of $f_{1;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = $ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.42	0.09415 %	58.31	-0.09415 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.33	0.1385 %	30.24	-0.1385 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0.002884 %	16.93	-0.002884 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3998	0.03394 %	0.3996	-0.03394 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.43	0.08285 %	51.35	-0.08285 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.634	0.5066 %	1.617	-0.5066 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.468	0.09125 %	1.465	-0.09125 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.102	0.3096 %	3.082	-0.3096 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.6332	8.974 %	0.5289	-8.974 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.0851	2.676 %	0.08066	-2.676 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03581	1.529 %	0.03473	-1.529 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001999	2.597 %	0.001898	-2.597 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1236	2.325 %	0.118	-2.325 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.0341	8.974 %	0.02848	-8.974 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 78: Effect of $f_{2;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.5	0.2285 %	58.23	-0.2285 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.39	0.3297 %	30.19	-0.3297 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.94	0.07373 %	16.92	-0.07373 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4001	0.09391 %	0.3993	-0.09391 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	9.566e-05 %	3.771	-9.566e-05 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.5	0.2193 %	51.28	-0.2193 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.64	0.9105 %	1.611	-0.9105 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.469	0.1885 %	1.464	-0.1885 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.11	0.568 %	3.074	-0.568 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	1.578	1.54	1.671	8.457 %	1.41	-8.457 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08506	2.631 %	0.0807	-2.631 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03613	2.421 %	0.03442	-2.421 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.002003	2.773 %	0.001895	-2.773 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1239	2.557 %	0.1177	-2.557 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0.03551	0.03652	0.03961	8.457 %	0.03343	-8.457 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 79: Effect of $f_{3;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	59.41	1.79 %	57.32	-1.79 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	31.05	2.525 %	29.52	-2.525 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	17.16	1.322 %	16.71	-1.322 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4046	1.222 %	0.3948	-1.222 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.772	0.02109 %	3.77	-0.02109 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	52.38	1.935 %	50.39	-1.935 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.663	2.336 %	1.588	-2.336 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.476	0.6316 %	1.457	-0.6316 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.139	1.528 %	3.045	-1.528 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	10.46	9.917	10.96	10.5 %	8.876	-10.5 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.0848	2.317 %	0.08096	-2.317 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03675	4.199 %	0.03379	-4.199 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.002003	2.792 %	0.001894	-2.792 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006903	2.782 %	0.0006529	-2.782 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1242	2.877 %	0.1173	-2.877 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0.0326	0.03309	0.03656	10.5 %	0.02961	-10.5 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 80: Effect of $f^{banff}_{4;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	59.24	1.494 %	57.5	-1.494 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.79	1.666 %	29.78	-1.666 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	17.24	1.842 %	16.62	-1.842 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4048	1.277 %	0.3946	-1.277 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.784	0.3535 %	3.758	-0.3535 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	52.22	1.625 %	50.55	-1.625 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.646	1.242 %	1.605	-1.242 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.483	1.129 %	1.45	-1.129 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.129	1.189 %	3.055	-1.189 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	9.362	9.414	10.29	9.26 %	8.542	-9.26 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08302	0.1619 %	0.08275	-0.1619 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03556	0.8165 %	0.03498	-0.8165 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001956	0.3875 %	0.001941	-0.3875 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006862	2.173 %	0.000657	-2.173 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1212	0.3679 %	0.1203	-0.3679 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0.004319	0.004798	0.005243	9.26 %	0.004354	-9.26 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 81: Effect of $f^{banff}_{5;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	59.12	1.295 %	57.61	-1.295 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.56	0.9214 %	30.01	-0.9214 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	17.31	2.243 %	16.55	-2.243 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4076	1.962 %	0.3919	-1.962 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.815	1.172 %	3.727	-1.172 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	52.1	1.383 %	50.68	-1.383 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.646	1.255 %	1.605	-1.255 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.491	1.672 %	1.442	-1.672 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.137	1.453 %	3.047	-1.453 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	9.824	9.316	10.07	8.113 %	8.56	-8.113 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.0829	0.02133 %	0.08286	-0.02133 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03532	0.1449 %	0.03522	-0.1449 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.00195	0.08788 %	0.001947	-0.08788 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006872	2.323 %	0.000656	-2.323 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1209	0.07129 %	0.1207	-0.07129 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.001024	0.001061	0.001147	8.113 %	0.0009753	-8.113 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 82: Effect of $f^{banff}_{6;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.77	0.6953 %	57.96	-0.6953 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.41	0.4119 %	30.16	-0.4119 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	17.12	1.132 %	16.74	-1.132 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4049	1.296 %	0.3945	-1.296 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.826	1.461 %	3.716	-1.461 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.76	0.733 %	51.01	-0.733 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.636	0.6523 %	1.615	-0.6523 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.485	1.262 %	1.448	-1.262 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.121	0.9416 %	3.063	-0.9416 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.285	5.575	5.981	7.279 %	5.169	-7.279 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0.002569 %	0.08288	-0.002569 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0.01036 %	0.03527	-0.01036 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0.03316 %	0.001948	-0.03316 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006781	0.9627 %	0.0006651	-0.9627 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0.01068 %	0.1208	-0.01068 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0.000191	0.0001771	0.00019	7.279 %	0.0001642	-7.279 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 83: Effect of $f^{banff}_{7;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} =$ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	59	1.082 %	57.74	-1.082 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.51	0.7511 %	30.06	-0.7511 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	17.17	1.434 %	16.69	-1.434 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.407	1.827 %	0.3924	-1.827 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.88	2.893 %	3.662	-2.893 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.97	1.142 %	50.8	-1.142 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.644	1.11 %	1.607	-1.11 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.494	1.848 %	1.439	-1.848 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.137	1.46 %	3.047	-1.46 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	6.729	7.556	8.188	8.362 %	6.924	-8.362 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0 $\leq E_t$ < 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.4 $\leq E_t$ < 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.5 $\leq E_t$ < 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.6 $\leq E_t$ < 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (0.7 $\leq E_t$ < 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (1 $\leq E_t$ < 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (1.5 $\leq E_t$ < 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (2.5 $\leq E_t$ < 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (3.5 $\leq E_t$ < 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (5 $\leq E_t$ < 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all (7 $\leq E_t$ < 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all (0 $\leq E_t$ < 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all (2.5 $\leq E_t$ < 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0.001208 %	0.08288	-0.001208 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0.006287 %	0.03527	-0.006287 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006748	0.4766 %	0.0006684	-0.4766 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0.005315 %	0.1208	-0.005315 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	7.323e-05	7.676e-05	8.318e-05	8.362 %	7.035e-05	-8.362 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 84: Effect of $f_{8;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.65	0.4833 %	58.09	-0.4833 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.35	0.2171 %	30.22	-0.2171 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	17.03	0.604 %	16.83	-0.604 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4029	0.8002 %	0.3965	-0.8002 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.854	2.196 %	3.688	-2.196 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.64	0.4943 %	51.13	-0.4943 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.635	0.6108 %	1.616	-0.6108 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.485	1.237 %	1.448	-1.237 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.12	0.908 %	3.064	-0.908 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.408	2.62	2.902	10.77 %	2.338	-10.77 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0 \leq E_t < 0.4$GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.4 \leq E_t < 0.5$GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.5 \leq E_t < 0.6$GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.6 \leq E_t < 0.7$GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.7 \leq E_t < 1$GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($1 \leq E_t < 1.5$GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($1.5 \leq E_t < 2.5$GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($2.5 \leq E_t < 3.5$GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($3.5 \leq E_t < 5$GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($5 \leq E_t < 7$GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($7 \leq E_t < 30$GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all ($0 \leq E_t < 2.5$GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all ($2.5 \leq E_t < 30$GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0.001879 %	0.08288	-0.001879 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0.001583 %	0.03527	-0.001583 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0.01309 %	0.001948	-0.01309 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006732	0.2415 %	0.00067	-0.2415 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0.003306 %	0.1208	-0.003306 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	3.281e-05	3.708e-05	4.108e-05	10.77 %	3.309e-05	-10.77 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 85: Effect of $f_{9;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} =$ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.44	0.1303 %	58.29	-0.1303 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0.01625 %	30.28	-0.01625 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.95	0.08816 %	16.92	-0.08816 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4001	0.0986 %	0.3993	-0.0986 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.806	0.9139 %	3.737	-0.9139 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.44	0.1065 %	51.33	-0.1065 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.633	0.458 %	1.618	-0.458 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.48	0.9469 %	1.453	-0.9469 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.113	0.6899 %	3.071	-0.6899 %
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5198	0.5386	0.6146	14.12 %	0.4625	-14.12 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0 \leq E_t < 0.4$GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.4 \leq E_t < 0.5$GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.5 \leq E_t < 0.6$GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.6 \leq E_t < 0.7$GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($0.7 \leq E_t < 1$GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($1 \leq E_t < 1.5$GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($1.5 \leq E_t < 2.5$GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($2.5 \leq E_t < 3.5$GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($3.5 \leq E_t < 5$GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($5 \leq E_t < 7$GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ all ($7 \leq E_t < 30$GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all ($0 \leq E_t < 2.5$GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ all ($2.5 \leq E_t < 30$GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0.0003308 %	0.08288	-0.0003308 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0.001054 %	0.03527	-0.001054 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006718	0.03317 %	0.0006714	-0.03317 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0.0007191 %	0.1208	-0.0007191 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	5.487e-06	6.152e-06	7.02e-06	14.12 %	5.283e-06	-14.12 %

Table 86: Effect of $f^{banff}_{10;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} =$ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	**Nominal**	**BANFF tuned**	**BANFF tuned +1σ**		**BANFF tuned -1σ**	
N_{SK} (1 μ-like ring)	59.41	58.37	58.39	0.02962 %	58.35	-0.02962 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.908	0.8853 %	1.874	-0.8853 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0.01074 %	1.228	-0.01074 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1086	0.1181 %	0.1083	-0.1181 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.465	0.4932 %	3.431	-0.4932 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09066	0.265 %	0.09018	-0.265 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07766	0.06249 %	0.07757	-0.06249 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1683	0.1715 %	0.1677	-0.1715 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.1108	11.03 %	0.08881	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.04316	11.03 %	0.03459	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.005562	11.03 %	0.004457	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01456	11.03 %	0.01167	-11.03 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 87: Effect of $f_{11;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.39	0.0437 %	58.34	-0.0437 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.91	1.015 %	1.872	-1.015 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.233	0.3667 %	1.223	-0.3667 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1093	0.8169 %	0.1076	-0.8169 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.2201	0.01781 %	0.22	-0.01781 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.472	0.714 %	3.423	-0.714 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09112	0.7694 %	0.08973	-0.7694 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07781	0.2482 %	0.07742	-0.2482 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1689	0.5287 %	0.1671	-0.5287 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.284	9.867 %	0.233	-9.867 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 88: Effect of $f^{banff}_{12;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.45	0.1456 %	58.28	-0.1456 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.947	2.951 %	1.835	-2.951 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.251	1.859 %	1.205	-1.859 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1114	2.717 %	0.1055	-2.717 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.2208	0.358 %	0.2193	-0.358 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.53	2.389 %	3.365	-2.389 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09208	1.833 %	0.08876	-1.833 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07855	1.211 %	0.07667	-1.211 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1706	1.546 %	0.1654	-1.546 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	0.8119	0.8223	0.9073	10.33 %	0.7373	-10.33 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 89: Effect of $f^{banff}_{13;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.5	0.2249 %	58.24	-0.2249 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.951	3.144 %	1.832	-3.144 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.285	4.624 %	1.171	-4.624 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1128	4.046 %	0.1041	-4.046 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.2253	2.379 %	0.2148	-2.379 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.573	3.651 %	3.322	-3.651 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09337	3.26 %	0.08747	-3.26 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08005	3.141 %	0.07518	-3.141 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1734	3.205 %	0.1627	-3.205 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.315	11.08 %	1.053	-11.08 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 90: Effect of $f^{banff}_{14;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.5	0.2232 %	58.24	-0.2232 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.54	0 %	1.54	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.917	0 %	9.917	0 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.414	0 %	9.414	0 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.316	0 %	9.316	0 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.575	0 %	5.575	0 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.556	0 %	7.556	0 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.62	0 %	2.62	0 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.942	2.702 %	1.84	-2.702 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.277	3.981 %	1.179	-3.981 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1117	3.039 %	0.1051	-3.039 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.238	8.172 %	0.2021	-8.172 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.569	3.517 %	3.326	-3.517 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09463	4.654 %	0.08621	-4.654 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08243	6.204 %	0.0728	-6.204 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1771	5.37 %	0.159	-5.37 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.6262	10.91 %	0.5029	-10.91 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.5008	10.91 %	0.4022	-10.91 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1654	10.91 %	0.1329	-10.91 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.03176	10.91 %	0.02551	-10.91 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.004002	0 %	0.004002	0 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02808	0 %	0.02808	0 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.03916	0 %	0.03916	0 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03644	0 %	0.03644	0 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.0192	0 %	0.0192	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 91: Effect of $f^{banff}_{15;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	62.07	6.349 %	54.31	-6.954 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	33.74	11.39 %	26.46	-12.63 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	54.84	6.714 %	47.56	-7.443 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	2.137	13.01 %	1.669	-11.75 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.694	7.137 %	3.225	-6.445 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01678	11.38 %	0.01312	-12.95 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03262	5.549 %	0.02895	-6.312 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0008544	13.1 %	0.0006627	-12.28 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001865	5.603 %	0.001673	-5.254 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.09093	9.704 %	0.07303	-11.89 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1288	6.66 %	0.1109	-8.162 %

Table 92: Effect of $f^{banff}_{16;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	60.91	4.363 %	55.87	-4.272 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	18.98	12.09 %	14.91	-11.93 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.805	0.8981 %	3.738	-0.8685 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	53.47	4.048 %	49.33	-3.995 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.827	12.39 %	1.426	-12.28 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.534	4.608 %	1.405	-4.178 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.361	8.699 %	2.831	-8.438 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.388	13.03 %	1.084	-11.75 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.2228	1.252 %	0.2173	-1.256 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.61	4.721 %	3.301	-4.265 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1061	17.33 %	0.07576	-16.21 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08173	5.309 %	0.0739	-4.788 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1878	11.78 %	0.1497	-10.94 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01355	9.079 %	0.01127	-9.324 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.00303	0.7741 %	0.002986	-0.718 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03206	3.726 %	0.02972	-3.819 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.05699	15.32 %	0.04206	-14.89 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.06045	4.798 %	0.0552	-4.312 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1174	9.652 %	0.09726	-9.193 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0008187	13.14 %	0.0006416	-11.34 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002178	0.489 %	0.0002157	-0.4995 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001862	5.444 %	0.001683	-4.708 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.007048	19.13 %	0.00488	-17.51 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.006334	6.376 %	0.005635	-5.356 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01338	12.73 %	0.01052	-11.41 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03667	3.974 %	0.03361	-4.704 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006779	0.9377 %	0.0006653	-0.9318 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1222	1.166 %	0.1191	-1.379 %

Table 93: Effect of $f^{banff}_{17;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	60.42	3.512 %	56.32	-3.512 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	23.56	21.77	23.73	9.012 %	19.8	-9.012 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	7.324	5.153	5.153	0 %	5.153	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.39	3.366	3.366	0 %	3.366	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	32.25	6.477 %	28.32	-6.477 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	8.121	10.34	10.34	0 %	10.34	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.508	6.593	6.593	0 %	6.593	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	53.35	3.817 %	49.43	-3.817 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE (E_t < 1.5 GeV)	0.9457	0.8864	0.9663	9.012 %	0.8065	-9.012 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.069	0.7597	0.7597	0 %	0.7597	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE ($E_t \geq$ 3.5 GeV)	0.1759	0.245	0.245	0 %	0.245	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	2.191	1.891	1.971	4.224 %	1.811	-4.224 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π (E_t < 2.5 GeV)	0.5917	0.78	0.78	0 %	0.78	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4412	0.448	0.448	0 %	0.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	3.562	3.448	3.527	2.317 %	3.368	-2.317 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$/$\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01298	0.01279	0.01394	9.012 %	0.01164	-9.012 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002466	0.001848	0.001848	0 %	0.001848	0 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003071	0.0004311	0.0004311	0 %	0.0004311	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01622	7.649 %	0.01392	-7.649 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.007737	0.01069	0.01069	0 %	0.01069	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001683	0.00174	0.00174	0 %	0.00174	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03206	3.729 %	0.02975	-3.729 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE (E_t < 1.5 GeV)	0.0004358	0.0004278	0.0004663	9.012 %	0.0003892	-9.012 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002594	0.0001935	0.0001935	0 %	0.0001935	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE ($E_t \geq$ 3.5 GeV)	9.515e-05	0.0001341	0.0001341	0 %	0.0001341	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.0007903	0.0007554	0.000794	5.103 %	0.0007169	-5.103 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π (E_t < 2.5 GeV)	0.0003394	0.0004699	0.0004699	0 %	0.0004699	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002458	0.0002537	0.0002537	0 %	0.0002537	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001662	0.001766	0.001805	2.183 %	0.001728	-2.183 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0.08705	0.08261	0.09005	9.012 %	0.07516	-9.012 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0003506	0.0002471	0.0002471	0 %	0.0002471	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	2.006e-05	2.838e-05	2.838e-05	0 %	2.838e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.09033	8.982 %	0.07544	-8.982 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0.02723	0.03519	0.03519	0 %	0.03519	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	8.409e-05	8.452e-05	8.452e-05	0 %	8.452e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1282	6.164 %	0.1133	-6.164 %

Table 94: Effect of $f^{banff}_{18;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	60.12	2.997 %	56.62	-2.997 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	23.56	21.77	21.77	0 %	21.77	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	7.324	5.153	6.677	29.57 %	3.63	-29.57 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.39	3.366	3.366	0 %	3.366	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	31.81	5.032 %	28.76	-5.032 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	8.121	10.34	10.34	0 %	10.34	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.508	6.593	6.593	0 %	6.593	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	52.91	2.965 %	49.86	-2.965 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	0.9457	0.8864	0.8864	0 %	0.8864	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.069	0.7597	0.9843	29.57 %	0.5351	-29.57 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.1759	0.245	0.245	0 %	0.245	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	2.116	11.88 %	1.666	-11.88 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.5917	0.78	0.78	0 %	0.78	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4412	0.448	0.448	0 %	0.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.672	6.516 %	3.223	-6.516 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01298	0.01279	0.01279	0 %	0.01279	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002466	0.001848	0.002394	29.57 %	0.001301	-29.57 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003071	0.0004311	0.0004311	0 %	0.0004311	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01561	3.626 %	0.01452	-3.626 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.007737	0.01069	0.01069	0 %	0.01069	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001683	0.00174	0.00174	0 %	0.00174	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03145	1.768 %	0.03036	-1.768 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004358	0.0004278	0.0004278	0 %	0.0004278	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002594	0.0001935	0.0002508	29.57 %	0.0001363	-29.57 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.515e-05	0.0001341	0.0001341	0 %	0.0001341	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0008127	7.576 %	0.0006982	-7.576 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003394	0.0004699	0.0004699	0 %	0.0004699	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002458	0.0002537	0.0002537	0 %	0.0002537	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001823	3.24 %	0.001709	-3.24 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0.08705	0.08261	0.08261	0 %	0.08261	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0003506	0.0002471	0.0003202	29.57 %	0.0001741	-29.57 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	2.006e-05	2.838e-05	2.838e-05	0 %	2.838e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08296	0.08817 %	0.08281	-0.08817 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0.02723	0.03519	0.03519	0 %	0.03519	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	8.409e-05	8.452e-05	8.452e-05	0 %	8.452e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0.06051 %	0.1207	-0.06051 %

Table 95: Effect of $f^{banff}_{19;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5\text{e-}05$; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.97	1.033 %	57.76	-1.033 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	23.56	21.77	21.77	0 %	21.77	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	7.324	5.153	5.153	0 %	5.153	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.39	3.366	3.928	16.7 %	2.804	-16.7 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.85	1.856 %	29.72	-1.856 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	8.121	10.34	10.34	0 %	10.34	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.508	6.593	6.593	0 %	6.593	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.95	1.094 %	50.83	-1.094 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	0.9457	0.8864	0.8864	0 %	0.8864	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.069	0.7597	0.7597	0 %	0.7597	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.1759	0.245	0.2859	16.7 %	0.2041	-16.7 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.932	2.164 %	1.85	-2.164 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.5917	0.78	0.78	0 %	0.78	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4412	0.448	0.448	0 %	0.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.488	1.187 %	3.407	-1.187 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01298	0.01279	0.01279	0 %	0.01279	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002466	0.001848	0.001848	0 %	0.001848	0 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003071	0.0004311	0.0005032	16.7 %	0.0003591	-16.7 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01514	0.4779 %	0.015	-0.4779 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.007737	0.01069	0.01069	0 %	0.01069	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001683	0.00174	0.00174	0 %	0.00174	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03098	0.233 %	0.03083	-0.233 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004358	0.0004278	0.0004278	0 %	0.0004278	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002594	0.0001935	0.0001935	0 %	0.0001935	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.515e-05	0.0001341	0.0001565	16.7 %	0.0001117	-16.7 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007778	2.965 %	0.0007331	-2.965 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003394	0.0004699	0.0004699	0 %	0.0004699	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002458	0.0002537	0.0002537	0 %	0.0002537	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001789	1.268 %	0.001744	-1.268 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0.08705	0.08261	0.08261	0 %	0.08261	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0003506	0.0002471	0.0002471	0 %	0.0002471	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	2.006e-05	2.838e-05	3.311e-05	16.7 %	2.364e-05	-16.7 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08289	0.005718 %	0.08288	-0.005718 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0.02723	0.03519	0.03519	0 %	0.03519	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	8.409e-05	8.452e-05	8.452e-05	0 %	8.452e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0.003924 %	0.1208	-0.003924 %

Table 96: Effect of $f^{banff}_{20;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	60.03	2.85 %	56.7	-2.85 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t $<$ 1.5 GeV)	23.56	21.77	21.77	0 %	21.77	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq$ E_t $<$ 3.5 GeV)	7.324	5.153	5.153	0 %	5.153	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t $\geq$ 3.5 GeV)	2.39	3.366	3.366	0 %	3.366	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t $<$ 2.5 GeV)	8.121	10.34	11.88	14.9 %	8.798	-14.9 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t $\geq$ 2.5 GeV)	6.508	6.593	6.593	0 %	6.593	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	18.47	9.097 %	15.39	-9.097 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	52.93	2.997 %	49.85	-2.997 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t $<$ 1.5 GeV)	0.9457	0.8864	0.8864	0 %	0.8864	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq$ E_t $<$ 3.5 GeV)	1.069	0.7597	0.7597	0 %	0.7597	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t $\geq$ 3.5 GeV)	0.1759	0.245	0.245	0 %	0.245	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t $<$ 2.5 GeV)	0.5917	0.78	0.8962	14.9 %	0.6638	-14.9 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t $\geq$ 2.5 GeV)	0.4412	0.448	0.448	0 %	0.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.344	9.463 %	1.112	-9.463 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.564	3.371 %	3.331	-3.371 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t $<$ 1.5 GeV)	0.01298	0.01279	0.01279	0 %	0.01279	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq$ E_t $<$ 3.5 GeV)	0.002466	0.001848	0.001848	0 %	0.001848	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t $\geq$ 3.5 GeV)	0.0003071	0.0004311	0.0004311	0 %	0.0004311	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t $<$ 2.5 GeV)	0.007737	0.01069	0.01228	14.9 %	0.009094	-14.9 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t $\geq$ 2.5 GeV)	0.001683	0.00174	0.00174	0 %	0.00174	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01402	12.81 %	0.01083	-12.81 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0325	5.151 %	0.02931	-5.151 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t $<$ 1.5 GeV)	0.0004358	0.0004278	0.0004278	0 %	0.0004278	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq$ E_t $<$ 3.5 GeV)	0.0002594	0.0001935	0.0001935	0 %	0.0001935	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t $\geq$ 3.5 GeV)	9.515e-05	0.0001341	0.0001341	0 %	0.0001341	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t $<$ 2.5 GeV)	0.0003394	0.0004699	0.0005399	14.9 %	0.0003999	-14.9 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t $\geq$ 2.5 GeV)	0.0002458	0.0002537	0.0002537	0 %	0.0002537	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007937	9.674 %	0.0006536	-9.674 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001836	3.964 %	0.001696	-3.964 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t $<$ 1.5 GeV)	0.08705	0.08261	0.08261	0 %	0.08261	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq$ E_t $<$ 3.5 GeV)	0.0003506	0.0002471	0.0002471	0 %	0.0002471	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t $\geq$ 3.5 GeV)	2.006e-05	2.838e-05	2.838e-05	0 %	2.838e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t $<$ 2.5 GeV)	0.02723	0.03519	0.04043	14.9 %	0.02994	-14.9 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t $\geq$ 2.5 GeV)	8.409e-05	8.452e-05	8.452e-05	0 %	8.452e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.04051	14.86 %	0.03003	-14.86 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.126	4.34 %	0.1155	-4.34 %

Table 97: Effect of $f_{21;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	60.32	3.347 %	56.41	-3.347 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_t < 1.5 GeV)	23.56	21.77	21.77	0 %	21.77	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	7.324	5.153	5.153	0 %	5.153	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_t \geq$ 3.5 GeV)	2.39	3.366	3.366	0 %	3.366	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π (E_t < 2.5 GeV)	8.121	10.34	10.34	0 %	10.34	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π ($E_t \geq$ 2.5 GeV)	6.508	6.593	8.422	27.74 %	4.764	-27.74 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	18.76	10.8 %	15.1	-10.8 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	53.22	3.559 %	49.56	-3.559 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_t < 1.5 GeV)	0.9457	0.8864	0.8864	0 %	0.8864	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	1.069	0.7597	0.7597	0 %	0.7597	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_t \geq$ 3.5 GeV)	0.1759	0.245	0.245	0 %	0.245	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π (E_t < 2.5 GeV)	0.5917	0.78	0.78	0 %	0.78	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.4412	0.448	0.5722	27.74 %	0.3237	-27.74 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.352	10.12 %	1.104	-10.12 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.572	3.605 %	3.323	-3.605 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (E_t < 1.5 GeV)	0.01298	0.01279	0.01279	0 %	0.01279	0 %
N_{SK} (1 μ-like ring): ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.002466	0.001848	0.001848	0 %	0.001848	0 %
N_{SK} (1 μ-like ring): ν_e CCQE ($E_t \geq$ 3.5 GeV)	0.0003071	0.0004311	0.0004311	0 %	0.0004311	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π (E_t < 2.5 GeV)	0.007737	0.01069	0.01069	0 %	0.01069	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π ($E_t \geq$ 2.5 GeV)	0.001683	0.00174	0.002222	27.74 %	0.001257	-27.74 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01291	3.884 %	0.01194	-3.884 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03139	1.562 %	0.03042	-1.562 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (E_t < 1.5 GeV)	0.0004358	0.0004278	0.0004278	0 %	0.0004278	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0002594	0.0001935	0.0001935	0 %	0.0001935	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE ($E_t \geq$ 3.5 GeV)	9.515e-05	0.0001341	0.0001341	0 %	0.0001341	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π (E_t < 2.5 GeV)	0.0003394	0.0004699	0.0004699	0 %	0.0004699	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π ($E_t \geq$ 2.5 GeV)	0.0002458	0.0002537	0.0003241	27.74 %	0.0001833	-27.74 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.000794	9.727 %	0.0006533	-9.727 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001837	3.985 %	0.001696	-3.985 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (E_t < 1.5 GeV)	0.08705	0.08261	0.08261	0 %	0.08261	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE (1.5 $\leq E_t$ < 3.5 GeV)	0.0003506	0.0002471	0.0002471	0 %	0.0002471	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE ($E_t \geq$ 3.5 GeV)	2.006e-05	2.838e-05	2.838e-05	0 %	2.838e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π (E_t < 2.5 GeV)	0.02723	0.03519	0.03519	0 %	0.03519	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π ($E_t \geq$ 2.5 GeV)	8.409e-05	8.452e-05	0.000108	27.74 %	6.107e-05	-27.74 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03529	0.06647 %	0.03525	-0.06647 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0.01941 %	0.1208	-0.01941 %

Table 98: Effect of $f^{banff}_{22;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5\text{e-}05$; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.45	0.1368 %	58.36	-0.01948 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.36	0.2604 %	30.28	-0.03448 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.47	0.1535 %	51.38	-0.02032 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	4.38	4.212	4.023	-4.496 %	4.376	3.888 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	3.276	3.209	3.163	-1.446 %	3.241	0.9892 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	0.5893	0.5811	0.5791	-0.35 %	0.5822	0.1908 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	1.578	1.54	1.542	0.08115 %	1.539	-0.1143 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	10.46	9.917	9.944	0.2715 %	9.91	-0.08004 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	9.362	9.414	9.495	0.8618 %	9.371	-0.4521 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	9.824	9.316	9.395	0.8475 %	9.254	-0.6598 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.285	5.575	5.621	0.8127 %	5.545	-0.5411 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	6.729	7.556	7.632	1.01 %	7.498	-0.767 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.408	2.62	2.627	0.2579 %	2.615	-0.1995 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01521	0.9551 %	0.01495	-0.7809 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03105	0.4657 %	0.03079	-0.3808 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004149	0.004058	0.003999	-1.466 %	0.004093	0.865 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.006751	0.007069	0.007117	0.686 %	0.007022	-0.6567 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003714	0.004002	0.00402	0.439 %	0.003992	-0.2601 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02648	0.02808	0.02816	0.2899 %	0.02802	-0.2069 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03854	0.03916	0.03919	0.09375 %	0.03912	-0.08711 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03613	0.03644	0.03645	0.04073 %	0.03643	-0.02808 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.0192	0.01921	0.02281 %	0.01921	0.03387 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08371	0.9973 %	0.08207	-0.9817 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1216	0.6844 %	0.12	-0.6737 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0.001862	0.001811	0.001786	-1.378 %	0.001818	0.4177 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0.01178	0.01191	0.01188	-0.2625 %	0.01191	0.04628 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0.0301	0.03129	0.03148	0.5952 %	0.03109	-0.6541 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0.03551	0.03652	0.03678	0.7113 %	0.03626	-0.7098 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0.0326	0.03309	0.03347	1.162 %	0.03277	-0.9728 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0.004319	0.004798	0.004843	0.9202 %	0.004764	-0.7067 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.001024	0.001061	0.001068	0.6336 %	0.001056	-0.5061 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0.000191	0.0001771	0.0001782	0.5877 %	0.0001759	-0.7071 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	7.323e-05	7.676e-05	7.723e-05	0.6132 %	7.637e-05	-0.5165 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 99: Effect of $f_{pF;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ
N_{SK} (1 μ-like ring)	59.41	58.37	57.98	-0.6702 %	
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	29.9	-1.269 %	
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51	-0.7477 %	
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	
N_{SK} (1 μ-like ring): ν_μ all ($0 \leq E_t < 0.4$GeV)	4.38	4.212	4.389	4.203 %	
N_{SK} (1 μ-like ring): ν_μ all ($0.4 \leq E_t < 0.5$GeV)	3.276	3.209	2.967	-7.541 %	
N_{SK} (1 μ-like ring): ν_μ all ($0.5 \leq E_t < 0.6$GeV)	0.5893	0.5811	0.5473	-5.814 %	
N_{SK} (1 μ-like ring): ν_μ all ($0.6 \leq E_t < 0.7$GeV)	1.578	1.54	1.504	-2.363 %	
N_{SK} (1 μ-like ring): ν_μ all ($0.7 \leq E_t < 1$GeV)	10.46	9.917	9.668	-2.512 %	
N_{SK} (1 μ-like ring): ν_μ all ($1 \leq E_t < 1.5$GeV)	9.362	9.414	9.414	0 %	
N_{SK} (1 μ-like ring): ν_μ all ($1.5 \leq E_t < 2.5$GeV)	9.824	9.316	9.316	0 %	
N_{SK} (1 μ-like ring): ν_μ all ($2.5 \leq E_t < 3.5$GeV)	6.285	5.575	5.575	0 %	
N_{SK} (1 μ-like ring): ν_μ all ($3.5 \leq E_t < 5$GeV)	6.729	7.556	7.556	0 %	
N_{SK} (1 μ-like ring): ν_μ all ($5 \leq E_t < 7$GeV)	2.408	2.62	2.62	0 %	
N_{SK} (1 μ-like ring): ν_μ all ($7 \leq E_t < 30$GeV)	0.5198	0.5386	0.5386	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0 \leq E_t < 0.4$GeV)	0.1056	0.09981	0.09981	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.4 \leq E_t < 0.5$GeV)	0.04076	0.03888	0.03888	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.5 \leq E_t < 0.6$GeV)	0.005182	0.005009	0.005009	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.6 \leq E_t < 0.7$GeV)	0.01328	0.01312	0.01312	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($0.7 \leq E_t < 1$GeV)	0.2604	0.2585	0.2585	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1 \leq E_t < 1.5$GeV)	0.8119	0.8223	0.8223	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($1.5 \leq E_t < 2.5$GeV)	1.292	1.184	1.184	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($2.5 \leq E_t < 3.5$GeV)	0.6451	0.5646	0.5646	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($3.5 \leq E_t < 5$GeV)	0.3945	0.4515	0.4515	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($5 \leq E_t < 7$GeV)	0.1361	0.1492	0.1492	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all ($7 \leq E_t < 30$GeV)	0.02811	0.02864	0.02864	0 %	
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.0142	-5.74 %	
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03004	-2.799 %	
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	
N_{SK} (1 μ-like ring): ν_e all ($0 \leq E_t < 0.5$GeV)	0.004149	0.004058	0.003859	-4.919 %	
N_{SK} (1 μ-like ring): ν_e all ($0.5 \leq E_t < 0.7$GeV)	0.006751	0.007069	0.006564	-7.136 %	
N_{SK} (1 μ-like ring): ν_e all ($0.7 \leq E_t < 0.8$GeV)	0.003714	0.004002	0.003902	-2.506 %	
N_{SK} (1 μ-like ring): ν_e all ($0.8 \leq E_t < 1.5$GeV)	0.02648	0.02808	0.02802	-0.2157 %	
N_{SK} (1 μ-like ring): ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.03854	0.03916	0.03916	0 %	
N_{SK} (1 μ-like ring): ν_e all ($2.5 \leq E_t < 4$GeV)	0.03613	0.03644	0.03644	0 %	
N_{SK} (1 μ-like ring): ν_e all ($4 \leq E_t < 30$GeV)	0.01889	0.0192	0.0192	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($0 \leq E_t < 2.5$GeV)	0.005225	0.005338	0.005338	0 %	
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all ($2.5 \leq E_t < 30$GeV)	0.008161	0.008298	0.008298	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.07678	-7.358 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1147	-5.05 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($0 \leq E_t < 0.4$GeV)	0.001862	0.001811	0.001759	-2.848 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.4 \leq E_t < 0.5$GeV)	0.01178	0.01191	0.01165	-2.146 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.5 \leq E_t < 0.6$GeV)	0.0301	0.03129	0.02883	-7.86 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.6 \leq E_t < 0.7$GeV)	0.03551	0.03652	0.03413	-6.534 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($0.7 \leq E_t < 1$GeV)	0.0326	0.03309	0.03214	-2.858 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($1 \leq E_t < 1.5$GeV)	0.004319	0.004798	0.004798	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($1.5 \leq E_t < 2.5$GeV)	0.001024	0.001061	0.001061	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($2.5 \leq E_t < 3.5$GeV)	0.000191	0.0001771	0.0001771	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($3.5 \leq E_t < 5$GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($5 \leq E_t < 7$GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	
N_{SK} (1 μ-like ring): oscillation ν_e all ($7 \leq E_t < 30$GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	

Table 100: Effect of $f_{SF;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5$e-05; $\Delta m^2_{32} = 0.0024$.

Component	**Nominal**	**BANFF tuned**	**BANFF tuned +1σ**		**BANFF tuned -1σ**	
N_{SK} (1 μ-like ring)	59.41	58.37	58.58	0.3599 %	58.13	-0.4122 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.753	7.821 %	1.49	-8.335 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.522	3.763 %	1.395	-4.898 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.274	5.896 %	2.885	-6.705 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.204	-0.1712 %	3.219	0.2923 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.5631	-3.095 %	0.6071	4.479 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.514	-1.73 %	1.579	2.534 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.912	-0.05341 %	9.927	0.09512 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.448	0.3603 %	9.372	-0.4473 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.381	0.6963 %	9.235	-0.867 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.619	0.7853 %	5.523	-0.9308 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.609	0.7092 %	7.493	-0.8371 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.648	1.059 %	2.585	-1.345 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5524	2.571 %	0.5207	-3.327 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1036	14.54 %	0.07507	-16.98 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08124	4.668 %	0.07302	-5.917 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1848	9.981 %	0.1481	-11.87 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.03883	-0.1151 %	0.03896	0.2126 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.00482	-3.788 %	0.00528	5.412 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01307	-0.3764 %	0.01302	-0.7186 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.2584	-0.05136 %	0.2588	0.1235 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.825	0.3313 %	0.8189	-0.4057 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.19	0.4711 %	1.178	-0.5606 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.5684	0.6864 %	0.5598	-0.8341 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.4547	0.7053 %	0.4478	-0.8183 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1504	0.8077 %	0.1477	-0.9826 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.02926	2.168 %	0.02796	-2.367 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.05687	15.07 %	0.04059	-17.87 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05983	3.724 %	0.05482	-4.967 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1167	8.961 %	0.09541	-10.92 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004034	-0.5959 %	0.004091	0.8125 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.006849	-3.107 %	0.007389	4.531 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.003921	-2.045 %	0.004143	3.511 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02918	3.908 %	0.02662	-5.208 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.04288	9.514 %	0.03445	-12.01 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03987	9.427 %	0.03239	-11.1 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.02087	8.671 %	0.01722	-10.31 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.007015	18.57 %	0.004631	-21.72 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.006256	5.079 %	0.005584	-6.213 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01327	11.81 %	0.01022	-13.94 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005802	8.687 %	0.004786	-10.35 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.009236	11.3 %	0.007196	-13.29 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.03309	0 %	0.03309	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004798	0 %	0.004798	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001061	0 %	0.001061	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.0001771	0 %	0.0001771	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	7.676e-05	0 %	7.676e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 101: Effect of $f_{W shape;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} =$ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	**Nominal**	**BANFF tuned**	**BANFF tuned +1σ**		**BANFF tuned -1σ**	
N_{SK} (1 μ-like ring)	59.41	58.37	58.85	0.8194 %	57.89	-0.8194 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	4.22	11.91 %	3.322	-11.91 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.84	0.8741 %	50.94	-0.8741 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.209	0 %	3.209	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.5811	0 %	0.5811	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.54	0.001597 %	1.54	-0.001597 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.921	0.03359 %	9.914	-0.03359 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.459	0.4748 %	9.369	-0.4748 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.425	1.174 %	9.206	-1.174 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.677	1.817 %	5.474	-1.817 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.681	1.652 %	7.431	-1.652 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.673	2.034 %	2.567	-2.034 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5509	2.284 %	0.5263	-2.284 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.2484	12.9 %	0.1916	-12.9 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.476	0.8236 %	3.419	-0.8236 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.2587	0.06552 %	0.2583	-0.06552 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.8246	0.2852 %	0.8199	-0.2852 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.194	0.7922 %	1.175	-0.7922 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.5719	1.308 %	0.5572	-1.308 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.4575	1.325 %	0.4455	-1.325 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1517	1.701 %	0.1466	-1.701 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.02924	2.086 %	0.02804	-2.086 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003469	15.36 %	0.002545	-15.36 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03137	1.494 %	0.03044	-1.494 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004058	0 %	0.004058	0 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.007069	0 %	0.007069	0 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.004009	0.1562 %	0.003996	-0.1562 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02818	0.3352 %	0.02799	-0.3352 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.03931	0.4012 %	0.039	-0.4012 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03658	0.3965 %	0.03629	-0.3965 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.01926	0.3118 %	0.01915	-0.3118 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002455	13.25 %	0.0001881	-13.25 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001795	1.626 %	0.001737	-1.626 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005351	0.2427 %	0.005325	-0.2427 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.008314	0.1899 %	0.008282	-0.1899 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0008655	28.87 %	0.0004777	-28.87 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.121	0.1605 %	0.1206	-0.1605 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.01191	0 %	0.01191	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.03129	0 %	0.03129	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03652	0 %	0.03652	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.03317	0.244 %	0.03301	-0.244 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004852	1.113 %	0.004745	-1.113 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001104	4.052 %	0.001018	-4.052 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.000189	6.701 %	0.0001653	-6.701 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	8.059e-05	4.981 %	7.294e-05	-4.981 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.806e-05	2.624 %	3.611e-05	-2.624 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.222e-06	1.134 %	6.082e-06	-1.134 %

Table 102: Effect of $f_{CCothShape;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	61.98	6.184 %	54.76	-6.184 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	20.83	23 %	13.04	-23 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	55.28	7.578 %	47.49	-7.578 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.317	-18.97 %	1.934	18.97 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.379	-5.958 %	1.554	5.958 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	2.696	-12.8 %	3.488	12.8 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t$ < 0.4GeV)	4.38	4.212	4.212	0 %	4.212	0 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t$ < 0.5GeV)	3.276	3.209	3.205	-0.1297 %	3.213	0.1297 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t$ < 0.6GeV)	0.5893	0.5811	0.5635	-3.031 %	0.5987	3.031 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t$ < 0.7GeV)	1.578	1.54	1.531	-0.6329 %	1.55	0.6329 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t$ < 1GeV)	10.46	9.917	10.24	3.291 %	9.591	-3.291 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t$ < 1.5GeV)	9.362	9.414	10.14	7.675 %	8.691	-7.675 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t$ < 2.5GeV)	9.824	9.316	10.39	11.56 %	8.238	-11.56 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t$ < 3.5GeV)	6.285	5.575	6.228	11.71 %	4.922	-11.71 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t$ < 5GeV)	6.729	7.556	8.137	7.69 %	6.975	-7.69 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t$ < 7GeV)	2.408	2.62	2.77	5.708 %	2.47	-5.708 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t$ < 30GeV)	0.5198	0.5386	0.5585	3.705 %	0.5186	-3.705 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.374	11.86 %	1.082	-11.86 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.593	4.223 %	3.302	-4.223 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.07284	-19.45 %	0.108	19.45 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07297	-5.987 %	0.08226	5.987 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1458	-13.23 %	0.1903	13.23 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t$ < 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t$ < 0.5GeV)	0.04076	0.03888	0.03886	-0.04908 %	0.0389	0.04908 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t$ < 0.6GeV)	0.005182	0.005009	0.004841	-3.351 %	0.005177	3.351 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t$ < 0.7GeV)	0.01328	0.01312	0.01289	-1.73 %	0.01334	1.73 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t$ < 1GeV)	0.2604	0.2585	0.261	0.9679 %	0.256	-0.9679 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t$ < 1.5GeV)	0.8119	0.8223	0.8389	2.016 %	0.8057	-2.016 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t$ < 2.5GeV)	1.292	1.184	1.243	4.959 %	1.125	-4.959 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t$ < 3.5GeV)	0.6451	0.5646	0.5916	4.788 %	0.5375	-4.788 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t$ < 5GeV)	0.3945	0.4515	0.4665	3.329 %	0.4365	-3.329 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t$ < 7GeV)	0.1361	0.1492	0.1527	2.352 %	0.1457	-2.352 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t$ < 30GeV)	0.02811	0.02864	0.02903	1.361 %	0.02825	-1.361 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.0132	6.198 %	0.01166	-6.198 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03168	2.492 %	0.03013	-2.492 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.0398	-19.46 %	0.05904	19.46 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.0548	-4.999 %	0.06057	4.999 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.0946	-11.67 %	0.1196	11.67 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t$ < 0.5GeV)	0.004149	0.004058	0.004033	-0.6155 %	0.004083	0.6155 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t$ < 0.7GeV)	0.006751	0.007069	0.006962	-1.51 %	0.007175	1.51 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t$ < 0.8GeV)	0.003714	0.004002	0.003825	-4.428 %	0.00418	4.428 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t$ < 1.5GeV)	0.02648	0.02808	0.0255	-9.186 %	0.03066	9.186 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.03854	0.03916	0.03531	-9.825 %	0.04301	9.825 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t$ < 4GeV)	0.03613	0.03644	0.03308	-9.209 %	0.03979	9.209 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t$ < 30GeV)	0.01889	0.0192	0.01756	-8.539 %	0.02084	8.539 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007506	3.723 %	0.0006967	-3.723 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001793	1.526 %	0.001739	-1.526 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.004761	-19.52 %	0.007071	19.52 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005621	-5.585 %	0.006287	5.585 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01038	-12.53 %	0.01336	12.53 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t$ < 2.5GeV)	0.005225	0.005338	0.004781	-10.43 %	0.005895	10.43 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t$ < 30GeV)	0.008161	0.008298	0.007395	-10.89 %	0.009202	10.89 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03634	3.035 %	0.0342	-3.035 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1218	0.8862 %	0.1197	-0.8862 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t$ < 0.4GeV)	0.001862	0.001811	0.001811	0 %	0.001811	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t$ < 0.5GeV)	0.01178	0.01191	0.01179	-0.9772 %	0.01202	0.9772 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t$ < 0.6GeV)	0.0301	0.03129	0.03075	-1.723 %	0.03183	1.723 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t$ < 0.7GeV)	0.03551	0.03652	0.03693	1.117 %	0.03611	-1.117 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t$ < 1GeV)	0.0326	0.03309	0.03357	1.45 %	0.03261	-1.45 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t$ < 1.5GeV)	0.004319	0.004798	0.005418	12.91 %	0.004179	-12.91 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t$ < 2.5GeV)	0.001024	0.001061	0.001282	20.78 %	0.0008408	-20.78 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t$ < 3.5GeV)	0.000191	0.0001771	0.0001695	-4.337 %	0.0001848	4.337 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t$ < 5GeV)	7.323e-05	7.676e-05	8.485e-05	10.53 %	6.868e-05	-10.53 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t$ < 7GeV)	3.281e-05	3.708e-05	3.579e-05	-3.496 %	3.838e-05	3.496 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t$ < 30GeV)	5.487e-06	6.152e-06	5.494e-06	-10.7 %	6.81e-06	10.7 %

Table 103: Effect of $f_{\pi-less\Delta;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.34	-0.05097 %	58.5	0.2182 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.26	-0.09564 %	30.41	0.4186 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.36	-0.05637 %	51.51	0.2467 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): ν_μ all (0 $\leq E_t <$ 0.4GeV)	4.38	4.212	4.718	12.01 %	3.747	-11.04 %
N_{SK} (1 μ-like ring): ν_μ all (0.4 $\leq E_t <$ 0.5GeV)	3.276	3.209	3.456	7.691 %	2.969	-7.485 %
N_{SK} (1 μ-like ring): ν_μ all (0.5 $\leq E_t <$ 0.6GeV)	0.5893	0.5811	0.6	3.256 %	0.5609	-3.482 %
N_{SK} (1 μ-like ring): ν_μ all (0.6 $\leq E_t <$ 0.7GeV)	1.578	1.54	1.511	-1.871 %	1.563	1.499 %
N_{SK} (1 μ-like ring): ν_μ all (0.7 $\leq E_t <$ 1GeV)	10.46	9.917	9.459	-4.626 %	10.4	4.83 %
N_{SK} (1 μ-like ring): ν_μ all (1 $\leq E_t <$ 1.5GeV)	9.362	9.414	9.184	-2.443 %	9.666	2.681 %
N_{SK} (1 μ-like ring): ν_μ all (1.5 $\leq E_t <$ 2.5GeV)	9.824	9.316	9.259	-0.6097 %	9.379	0.6832 %
N_{SK} (1 μ-like ring): ν_μ all (2.5 $\leq E_t <$ 3.5GeV)	6.285	5.575	5.568	-0.1285 %	5.585	0.171 %
N_{SK} (1 μ-like ring): ν_μ all (3.5 $\leq E_t <$ 5GeV)	6.729	7.556	7.539	-0.2166 %	7.578	0.2944 %
N_{SK} (1 μ-like ring): ν_μ all (5 $\leq E_t <$ 7GeV)	2.408	2.62	2.617	-0.09818 %	2.622	0.08395 %
N_{SK} (1 μ-like ring): ν_μ all (7 $\leq E_t <$ 30GeV)	0.5198	0.5386	0.5386	0 %	0.5386	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0 $\leq E_t <$ 0.4GeV)	0.1056	0.09981	0.09981	0 %	0.09981	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.4 $\leq E_t <$ 0.5GeV)	0.04076	0.03888	0.03888	0 %	0.03888	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.5 $\leq E_t <$ 0.6GeV)	0.005182	0.005009	0.005009	0 %	0.005009	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.6 $\leq E_t <$ 0.7GeV)	0.01328	0.01312	0.01312	0 %	0.01312	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (0.7 $\leq E_t <$ 1GeV)	0.2604	0.2585	0.2585	0 %	0.2585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1 $\leq E_t <$ 1.5GeV)	0.8119	0.8223	0.8223	0 %	0.8223	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (1.5 $\leq E_t <$ 2.5GeV)	1.292	1.184	1.184	0 %	1.184	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (2.5 $\leq E_t <$ 3.5GeV)	0.6451	0.5646	0.5646	0 %	0.5646	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (3.5 $\leq E_t <$ 5GeV)	0.3945	0.4515	0.4515	0 %	0.4515	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (5 $\leq E_t <$ 7GeV)	0.1361	0.1492	0.1492	0 %	0.1492	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ all (7 $\leq E_t <$ 30GeV)	0.02811	0.02864	0.02864	0 %	0.02864	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01501	-0.3628 %	0.01513	0.405 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03085	-0.1769 %	0.03097	0.1975 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): ν_e all (0 $\leq E_t <$ 0.5GeV)	0.004149	0.004058	0.004391	8.205 %	0.003737	-7.91 %
N_{SK} (1 μ-like ring): ν_e all (0.5 $\leq E_t <$ 0.7GeV)	0.006751	0.007069	0.00704	-0.4042 %	0.007078	0.1358 %
N_{SK} (1 μ-like ring): ν_e all (0.7 $\leq E_t <$ 0.8GeV)	0.003714	0.004002	0.003913	-2.239 %	0.004092	2.228 %
N_{SK} (1 μ-like ring): ν_e all (0.8 $\leq E_t <$ 1.5GeV)	0.02648	0.02808	0.02785	-0.8333 %	0.02833	0.8735 %
N_{SK} (1 μ-like ring): ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.03854	0.03916	0.03913	-0.0683 %	0.03919	0.07268 %
N_{SK} (1 μ-like ring): ν_e all (2.5 $\leq E_t <$ 4GeV)	0.03613	0.03644	0.03643	-0.01515 %	0.03644	0.01695 %
N_{SK} (1 μ-like ring): ν_e all (4 $\leq E_t <$ 30GeV)	0.01889	0.0192	0.0192	-0.01678 %	0.01921	0.0174 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (0 $\leq E_t <$ 2.5GeV)	0.005225	0.005338	0.005338	0 %	0.005338	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ all (2.5 $\leq E_t <$ 30GeV)	0.008161	0.008298	0.008298	0 %	0.008298	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08215	-0.8807 %	0.08337	0.5927 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.12	-0.6044 %	0.1213	0.4068 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0 $\leq E_t <$ 0.4GeV)	0.001862	0.001811	0.001972	8.897 %	0.001654	-8.668 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.4 $\leq E_t <$ 0.5GeV)	0.01178	0.01191	0.0125	5.011 %	0.0113	-5.07 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.5 $\leq E_t <$ 0.6GeV)	0.0301	0.03129	0.0316	0.9744 %	0.03085	-1.415 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.6 $\leq E_t <$ 0.7GeV)	0.03551	0.03652	0.03592	-1.637 %	0.037	1.31 %
N_{SK} (1 μ-like ring): oscillation ν_e all (0.7 $\leq E_t <$ 1GeV)	0.0326	0.03309	0.032	-3.291 %	0.03418	3.31 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1 $\leq E_t <$ 1.5GeV)	0.004319	0.004798	0.004698	-2.099 %	0.004913	2.382 %
N_{SK} (1 μ-like ring): oscillation ν_e all (1.5 $\leq E_t <$ 2.5GeV)	0.001024	0.001061	0.001057	-0.4298 %	0.001067	0.5779 %
N_{SK} (1 μ-like ring): oscillation ν_e all (2.5 $\leq E_t <$ 3.5GeV)	0.000191	0.0001771	0.0001768	-0.2112 %	0.0001773	0.06669 %
N_{SK} (1 μ-like ring): oscillation ν_e all (3.5 $\leq E_t <$ 5GeV)	7.323e-05	7.676e-05	7.667e-05	-0.1223 %	7.691e-05	0.1913 %
N_{SK} (1 μ-like ring): oscillation ν_e all (5 $\leq E_t <$ 7GeV)	3.281e-05	3.708e-05	3.708e-05	0 %	3.708e-05	0 %
N_{SK} (1 μ-like ring): oscillation ν_e all (7 $\leq E_t <$ 30GeV)	5.487e-06	6.152e-06	6.152e-06	0 %	6.152e-06	0 %

Table 104: Effect of $f_{bindE;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.88	0.8748 %	57.86	-0.8748 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.7994	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.79	0.7778 %	50.99	-0.7778 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.2169	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.556	3.146 %	3.339	-3.146 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0008072	100 %	0	-100 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03131	1.306 %	0.0305	-1.306 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	0.0001406	100 %	0	-100 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001836	3.979 %	0.001696	-3.979 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.003897	100 %	0	-100 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1227	1.613 %	0.1188	-1.613 %

Table 105: Effect of $f_{CCcoh;t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5\text{e-}05$; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.9	0.9104 %	57.84	-0.9104 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	2.113	30 %	1.138	-30 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.58	15.77 %	2.604	-15.77 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.1175	30 %	0.0633	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.1952	16.14 %	0.1409	-16.14 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.06425	30 %	0.03459	-30 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1219	13.84 %	0.09228	-13.84 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.007691	30 %	0.004141	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01365	14.95 %	0.0101	-14.95 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 106: Effect of $f_{NC1\pi^{\pm};t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.85	0.8264 %	57.89	-0.8264 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.906	30 %	1.027	-30 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.532	14.23 %	2.652	-14.23 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.1009	30 %	0.05433	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.1913	13.86 %	0.1448	-13.86 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.07499	30 %	0.04038	-30 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1244	16.16 %	0.0898	-16.16 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.00774	30 %	0.004168	-30 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01366	15.05 %	0.01008	-15.05 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 107: Effect of $f_{NCoth;t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5\text{e-}05$; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.37	0.007887 %	58.36	-0.007887 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01552	3 %	0.01462	-3 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.0128	3 %	0.01205	-3 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004157	3 %	0.0003915	-3 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003097	3 %	0.002917	-3 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03183	3 %	0.02998	-3 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007781	3 %	0.0007328	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007454	3 %	0.0007019	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.239e-05	3 %	6.817e-05	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002233	3 %	0.0002103	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001819	3 %	0.001713	-3 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08537	3 %	0.0804	-3 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03633	3 %	0.03421	-3 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.002007	3 %	0.00189	-3 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006917	3 %	0.0006515	-3 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1244	3 %	0.1172	-3 %

Table 108: Effect of $f_{CC\nu_e;t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} =$ 7.5e-05; $\Delta m^2_{32} =$ 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	59.75	2.364 %	56.99	-2.364 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	2.648	40 %	1.135	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.719	40 %	0.7368	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1518	40 %	0.06507	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.3081	40 %	0.132	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	4.827	40 %	2.069	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.001058	40 %	0.0004533	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.001013	40 %	0.0004342	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	9.839e-05	40 %	4.217e-05	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0003035	40 %	0.0001301	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.002473	40 %	0.00106	-40 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 109: Effect of $f_{CC\bar{\nu};t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} =$ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.37	0.000233 %	58.37	-0.000233 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.654	0.00363 %	3.653	-0.00363 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r < 1.1$ GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq$ 1.1 GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0.0004379 %	30.29	-0.0004379 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0.0002581 %	51.39	-0.0002581 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09306	0.00363 %	0.09305	-0.00363 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq$ 1.1 GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0.0001786 %	1.891	-0.0001786 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	9.799e-05 %	3.448	-9.799e-05 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 110: Effect of $f_{0;t,r}^{FSI}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.38	0.01726 %	58.36	-0.01726 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r < 1.1$ GeV)	14.98	13.78	13.79	0.07128 %	13.77	-0.07128 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.3	0.03243 %	30.28	-0.03243 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.4	0.01911 %	51.38	-0.01911 %
N_{SK} (1 μ-like ring): $\nu_\mu/\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): $\nu_\mu/\bar{\nu}_\tau$ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE (0.4 $\leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3587	0.07128 %	0.3582	-0.07128 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE ($E_r \geq 1.1$ GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CCQE	2.191	1.891	1.891	0.01351 %	1.891	-0.01351 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ CC all	3.562	3.448	3.448	0.007411 %	3.447	-0.007411 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu/\bar{\nu}_\tau$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_\mu$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu}_e$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 111: Effect of $f^{FSI}_{1;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.41	0.06803 %	58.33	-0.06803 %
N_{SK} (1 μ-like ring): ν_μ CCQE (E_r < 0.4 GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r$ < 1.1 GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq$ 1.1 GeV)	14.5	12.85	12.89	0.2778 %	12.82	-0.2778 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.32	0.1179 %	30.25	-0.1179 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.42	0.06949 %	51.35	-0.06949 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (E_r < 0.4 GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r$ < 1.1 GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq$ 1.1 GeV)	1.71	1.44	1.444	0.2778 %	1.436	-0.2778 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.895	0.2115 %	1.887	-0.2115 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.452	0.116 %	3.444	-0.116 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}/\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 112: Effect of $f^{FSI}_{2;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	60.33	3.362 %	56.41	-3.362 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r < 1.1$ GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	18.4	8.66 %	15.47	-8.66 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.4343	8.66 %	0.3651	-8.66 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	4.098	8.66 %	3.444	-8.66 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	53.22	3.556 %	49.56	-3.556 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.334	8.66 %	1.122	-8.66 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1178	8.66 %	0.09905	-8.66 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.2391	8.66 %	0.201	-8.66 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.582	3.91 %	3.313	-3.91 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 113: Effect of $f^{FSI}_{3;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.37	0.002964 %	58.37	-0.002964 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r < 1.1$ GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq 1.1$ GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.625	0 %	1.625	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.466	0 %	1.466	0 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.092	0 %	3.092	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq 1.1$ GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09042	0 %	0.09042	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.07761	0 %	0.07761	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.168	0 %	0.168	0 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01524	1.128 %	0.0149	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01257	1.128 %	0.01229	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004082	1.128 %	0.0003991	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003041	1.128 %	0.002973	-1.128 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.03125	1.128 %	0.03056	-1.128 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.04942	0 %	0.04942	0 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.05768	0 %	0.05768	0 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1071	0 %	0.1071	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.000764	1.128 %	0.0007469	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007318	1.128 %	0.0007155	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.107e-05	1.128 %	6.949e-05	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002192	1.128 %	0.0002143	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001786	1.128 %	0.001746	-1.128 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.005916	0 %	0.005916	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.005954	0 %	0.005954	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01187	0 %	0.01187	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08382	1.128 %	0.08195	-1.128 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03567	1.128 %	0.03487	-1.128 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001971	1.128 %	0.001927	-1.128 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006792	1.128 %	0.000664	-1.128 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1221	1.128 %	0.1194	-1.128 %

Table 114: Effect of $f^{FSI}_{4;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

Component	Nominal	BANFF tuned	BANFF tuned +1σ		BANFF tuned -1σ	
N_{SK} (1 μ-like ring)	59.41	58.37	58.63	0.4479 %	58.11	-0.4479 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r < 0.4$ GeV)	3.802	3.653	3.653	0 %	3.653	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE (0.4 $\leq E_r < 1.1$ GeV)	14.98	13.78	13.78	0 %	13.78	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE ($E_r \geq$ 1.1 GeV)	14.5	12.85	12.85	0 %	12.85	0 %
N_{SK} (1 μ-like ring): ν_μ CCQE	33.28	30.29	30.29	0 %	30.29	0 %
N_{SK} (1 μ-like ring): ν_μ CC 1π	14.63	16.93	16.93	0 %	16.93	0 %
N_{SK} (1 μ-like ring): ν_μ CC coherent	0.4206	0.3997	0.3997	0 %	0.3997	0 %
N_{SK} (1 μ-like ring): ν_μ CC other (ν_μ disap)	3.862	3.771	3.771	0 %	3.771	0 %
N_{SK} (1 μ-like ring): ν_μ CC all	52.19	51.39	51.39	0 %	51.39	0 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC 1$\pi^{+/-}$	1.697	1.625	1.751	7.737 %	1.5	-7.737 %
N_{SK} (1 μ-like ring): ν_μ/ν_τ NC other (ν_μ app)	1.522	1.466	1.58	7.737 %	1.353	-7.737 %
N_{SK} (1 μ-like ring): ν_μ NC all	3.218	3.092	3.331	7.737 %	2.853	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r < 0.4$ GeV)	0.09866	0.09305	0.09305	0 %	0.09305	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE (0.4 $\leq E_r < 1.1$ GeV)	0.3816	0.3585	0.3585	0 %	0.3585	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE ($E_r \geq$ 1.1 GeV)	1.71	1.44	1.44	0 %	1.44	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CCQE	2.191	1.891	1.891	0 %	1.891	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC 1π	1.033	1.228	1.228	0 %	1.228	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC coherent	0.1129	0.1084	0.1084	0 %	0.1084	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC other (ν_μ disap)	0.2251	0.22	0.22	0 %	0.22	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ CC all	3.562	3.448	3.448	0 %	3.448	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC 1$\pi^{+/-}$	0.09198	0.09042	0.09742	7.737 %	0.08343	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$/$\bar{\nu_\tau}$ NC other (ν_μ app)	0.07958	0.07761	0.08362	7.737 %	0.07161	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_\mu}$ NC all	0.1716	0.168	0.181	7.737 %	0.155	-7.737 %
N_{SK} (1 μ-like ring): ν_e CCQE	0.01575	0.01507	0.01507	0 %	0.01507	0 %
N_{SK} (1 μ-like ring): ν_e CC 1π	0.009421	0.01243	0.01243	0 %	0.01243	0 %
N_{SK} (1 μ-like ring): ν_e CC coherent	0.0004036	0.0004036	0.0004036	0 %	0.0004036	0 %
N_{SK} (1 μ-like ring): ν_e CC other (ν_μ disap)	0.003005	0.003007	0.003007	0 %	0.003007	0 %
N_{SK} (1 μ-like ring): ν_e CC all	0.02858	0.0309	0.0309	0 %	0.0309	0 %
N_{SK} (1 μ-like ring): ν_e NC 1$\pi^{+/-}$	0.04865	0.04942	0.05324	7.737 %	0.0456	-7.737 %
N_{SK} (1 μ-like ring): ν_e NC other (ν_μ app)	0.05741	0.05768	0.06215	7.737 %	0.05322	-7.737 %
N_{SK} (1 μ-like ring): ν_e NC all	0.1061	0.1071	0.1154	7.737 %	0.09882	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CCQE	0.0007903	0.0007554	0.0007554	0 %	0.0007554	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC 1π	0.0005852	0.0007237	0.0007237	0 %	0.0007237	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC coherent	7.028e-05	7.028e-05	7.028e-05	0 %	7.028e-05	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC other (ν_μ disap)	0.0002167	0.0002168	0.0002168	0 %	0.0002168	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ CC all	0.001662	0.001766	0.001766	0 %	0.001766	0 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC 1$\pi^{+/-}$	0.005805	0.005916	0.006374	7.737 %	0.005458	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC other (ν_μ app)	0.005918	0.005954	0.006415	7.737 %	0.005493	-7.737 %
N_{SK} (1 μ-like ring): $\bar{\nu_e}$ NC all	0.01172	0.01187	0.01279	7.737 %	0.01095	-7.737 %
N_{SK} (1 μ-like ring): oscillation ν_e CCQE	0.08742	0.08288	0.08288	0 %	0.08288	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC 1π	0.02732	0.03527	0.03527	0 %	0.03527	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC coherent	0.002039	0.001949	0.001949	0 %	0.001949	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC other (ν_μ app)	0.0007229	0.0006716	0.0006716	0 %	0.0006716	0 %
N_{SK} (1 μ-like ring): oscillation ν_e CC all	0.1175	0.1208	0.1208	0 %	0.1208	0 %

Table 115: Effect of $f_{5;t,r}^{FSI}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

F. Detailed study of the effect of systematics on the predicted reconstructed energy spectrum of 1 μ-like ring events

In this section, the effect of systematics on the predicted reconstructed energy spectrum in SuperK is presented in a number of figures. Each figure shows the total nominal predicted spectrum (the sum of all SuperK MC modes) and the total spectra resulting from -3, -1, +1, and +3σ variations of a single systematic parameter. For correlated systematic parameters, σ is defined as the square root of the diagonal entry in the corresponding covariance matrix.

Figs. 198-245 show the effects of systematics on the SuperK E_{reco} spectrum with no oscillations applied (all mixing angles set to zero). Figs. 246-293 show the effect of systematics on the SuperK E_{reco} spectrum with 3-flavour oscillations in matter, using the following values of the oscillation parameters:

- $\sin^2 2\theta_{12} = 0.857$
- $\sin^2 2\theta_{13} = 0.098$
- $\sin^2 2\theta_{23} = 1.0$
- $\delta_{CP} = 0$
- $\Delta m^2_{12} = 7.5{\times}10^{-5}$ eV^2/c^4
- $\Delta m^2_{32} = 2.4{\times}10^{-3}$ eV^2/c^4

It should be noted that, for ease of comparison, there are only two vertical axis scales used in the lower 'ratio' plots. For systematics with a small effect, the vertical axis runs from 0.75 to 1.25; for systematics with a larger effect, the vertical axis runs from 0.25 to 1.75.

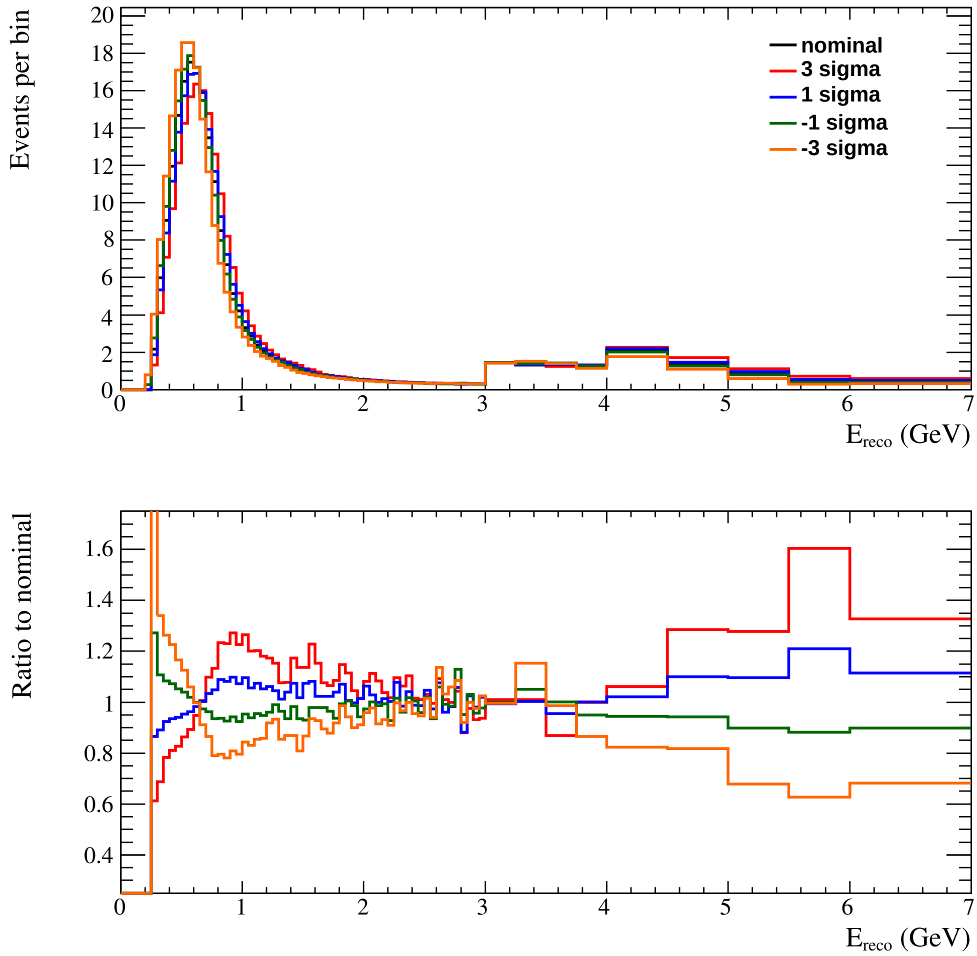


Figure 198: Effect of $f_{E;r}^{SK}$ for no oscillations (all mixing angles set to 0).

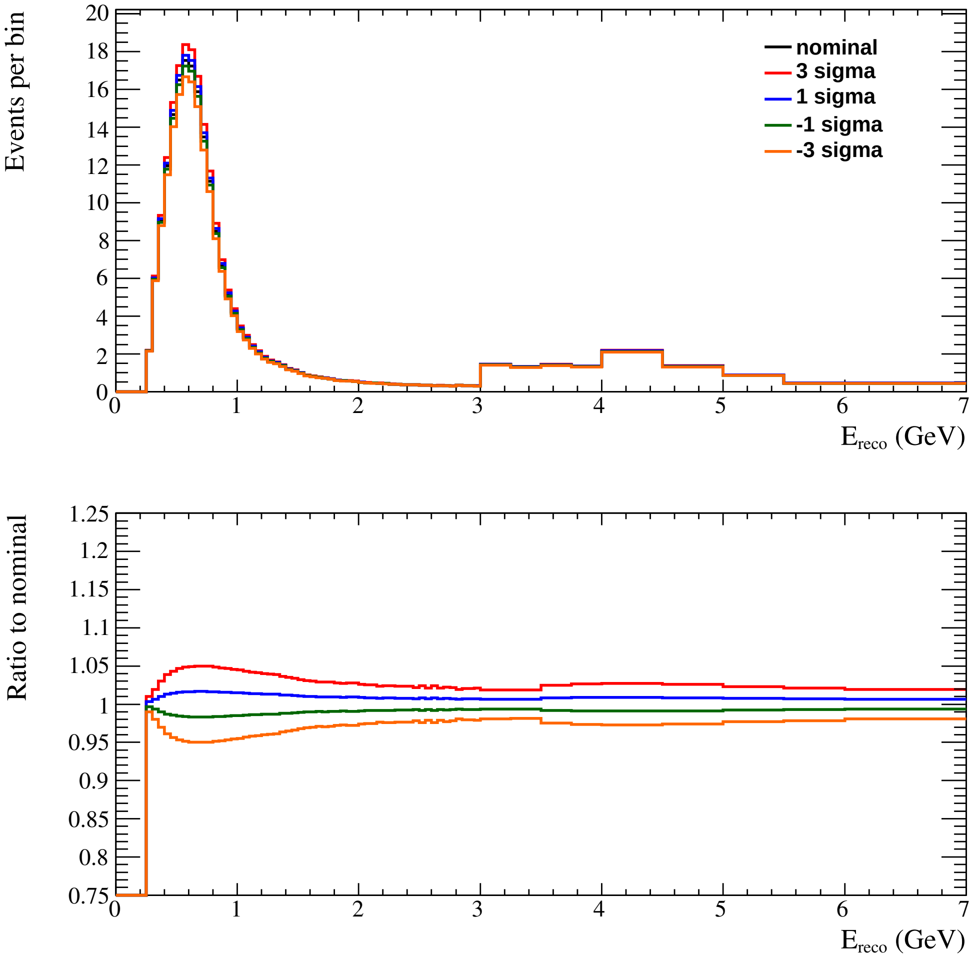


Figure 199: Effect of $f^{SK}_{CCQEoth;r}$ for no oscillations (all mixing angles set to 0).

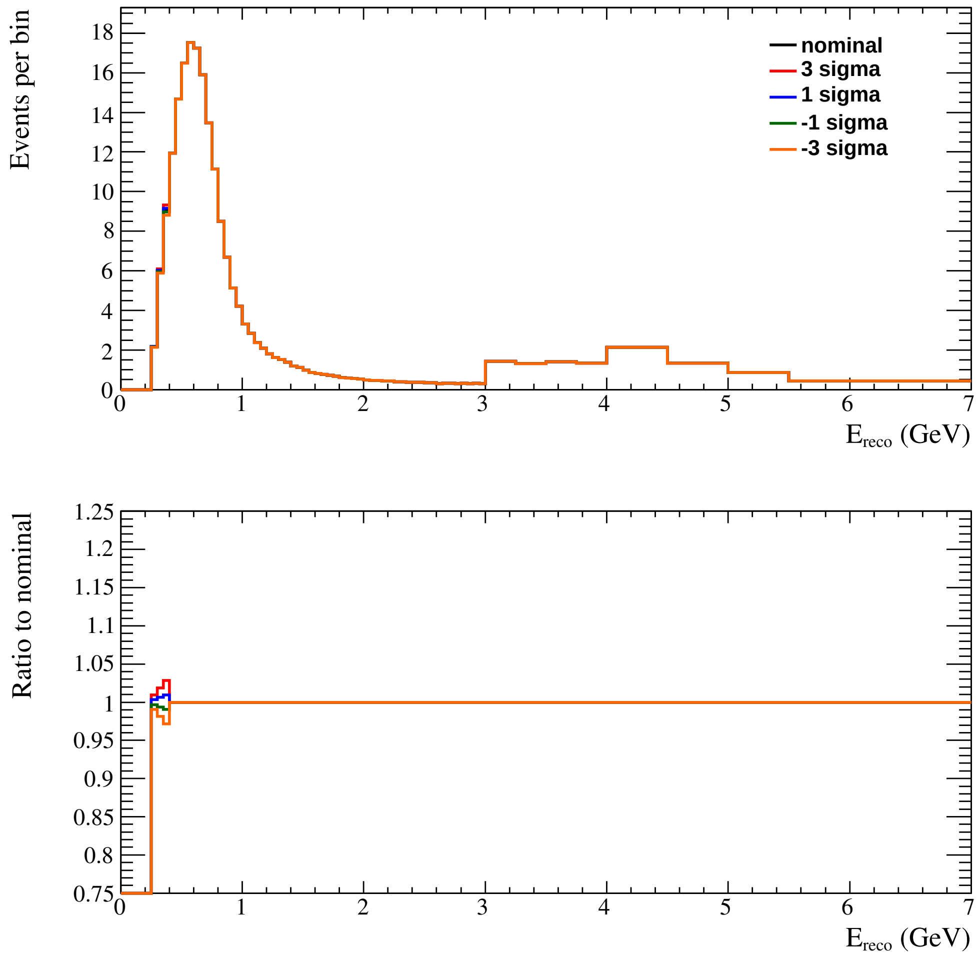


Figure 200: Effect of $f^{SK}_{CCQERC0;r}$ for no oscillations (all mixing angles set to 0).

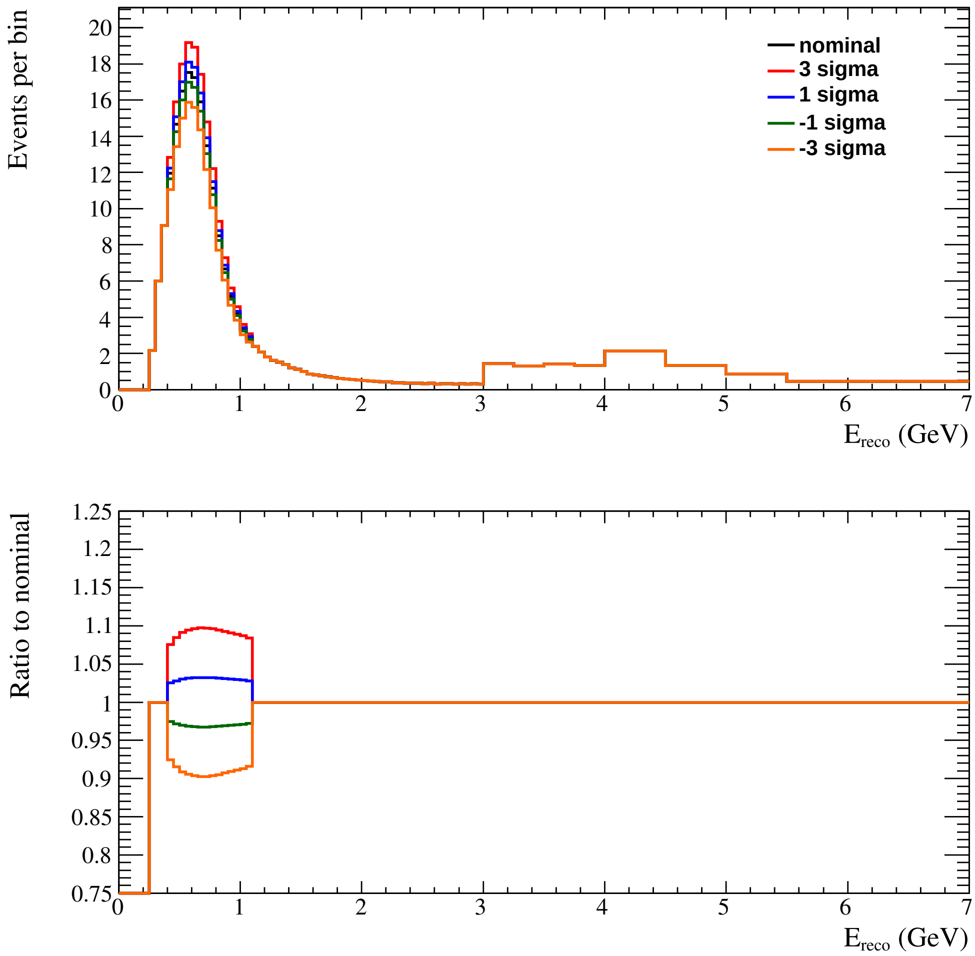


Figure 201: Effect of $f^{SK}_{CCQERC1;r}$ for no oscillations (all mixing angles set to 0).

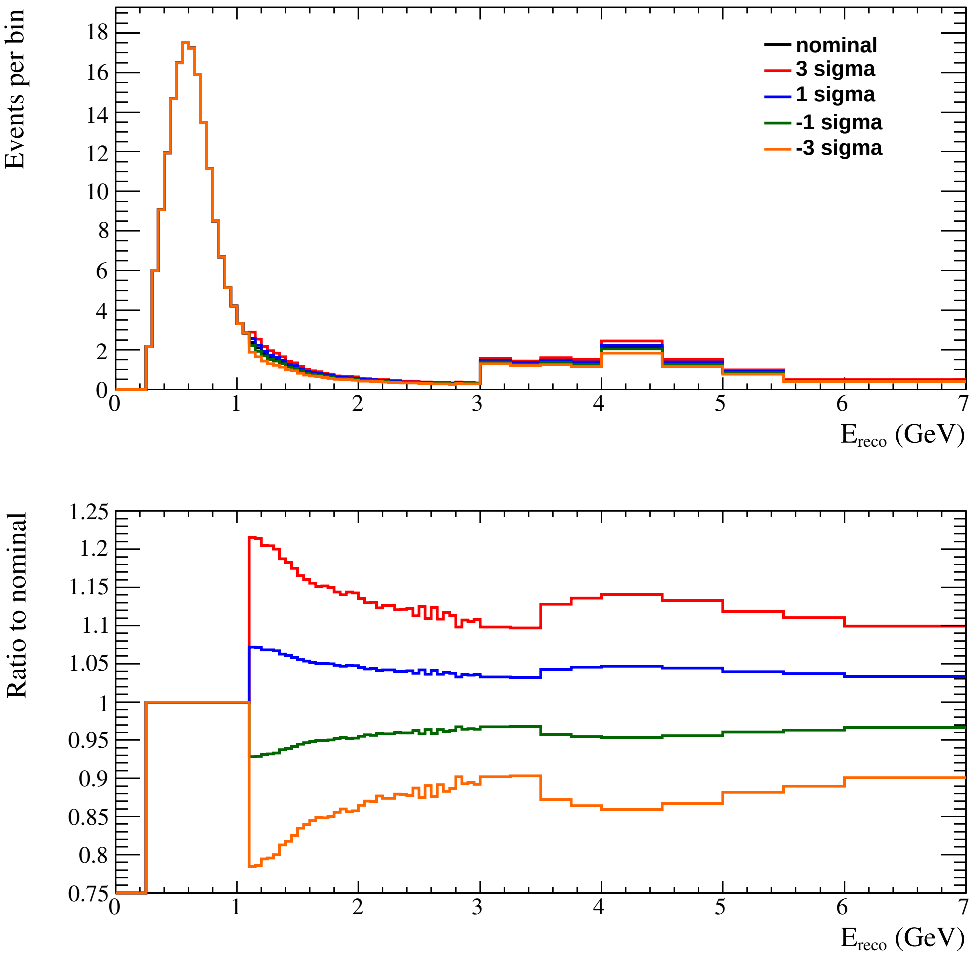


Figure 202: Effect of $f^{SK}_{CCQERC2;r}$ for no oscillations (all mixing angles set to 0).

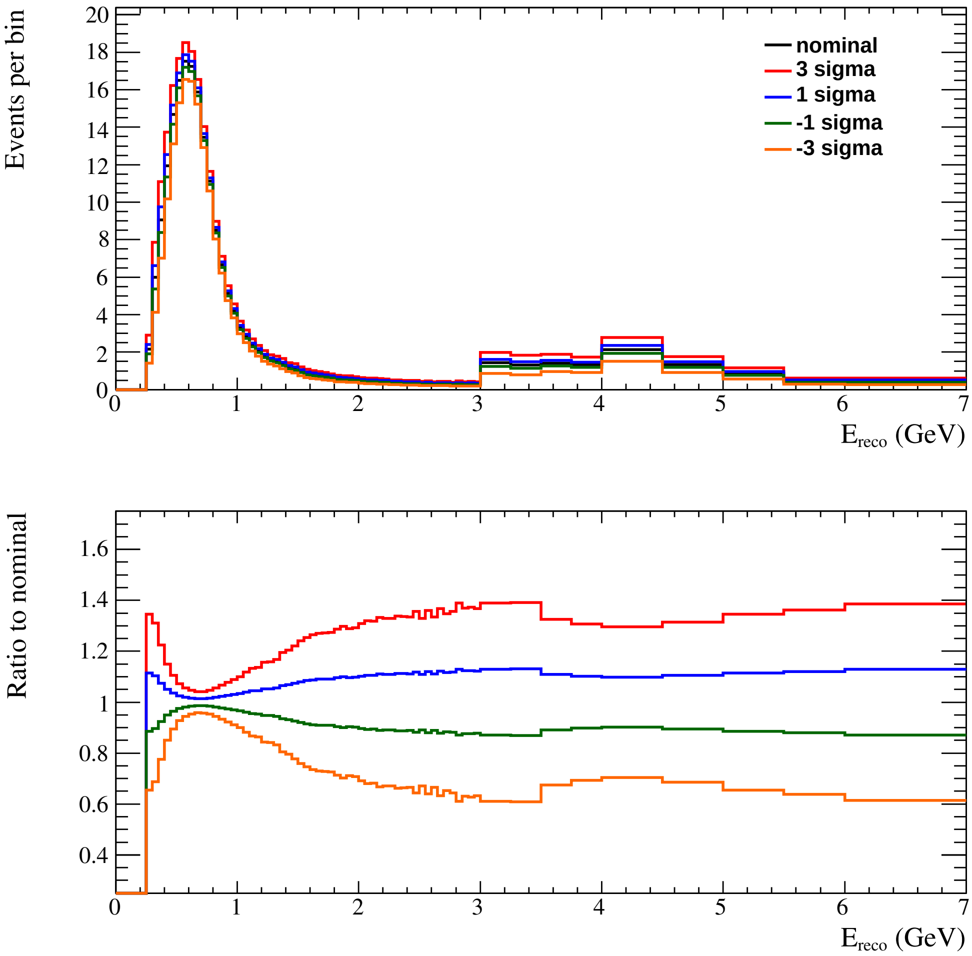


Figure 203: Effect of $f^{SK}_{CCnQE;r}$ for no oscillations (all mixing angles set to 0).

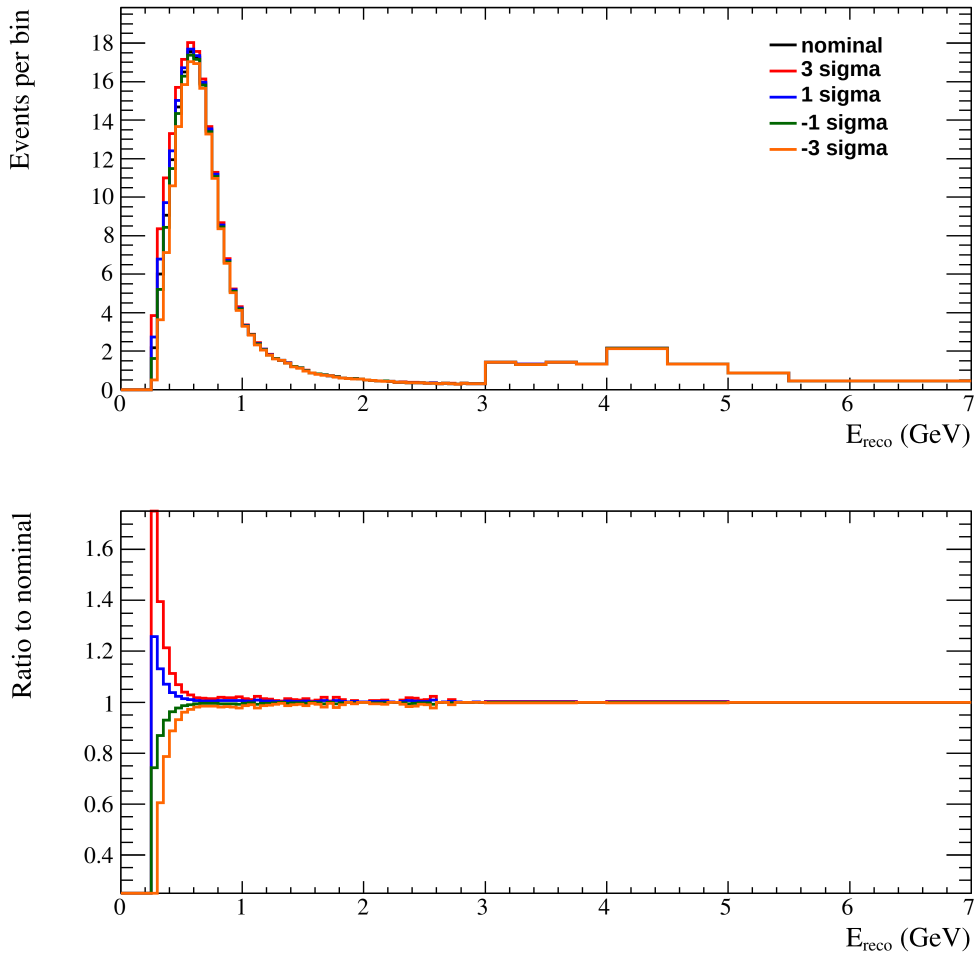


Figure 204: Effect of $f^{SK}_{NC;r}$ for no oscillations (all mixing angles set to 0).

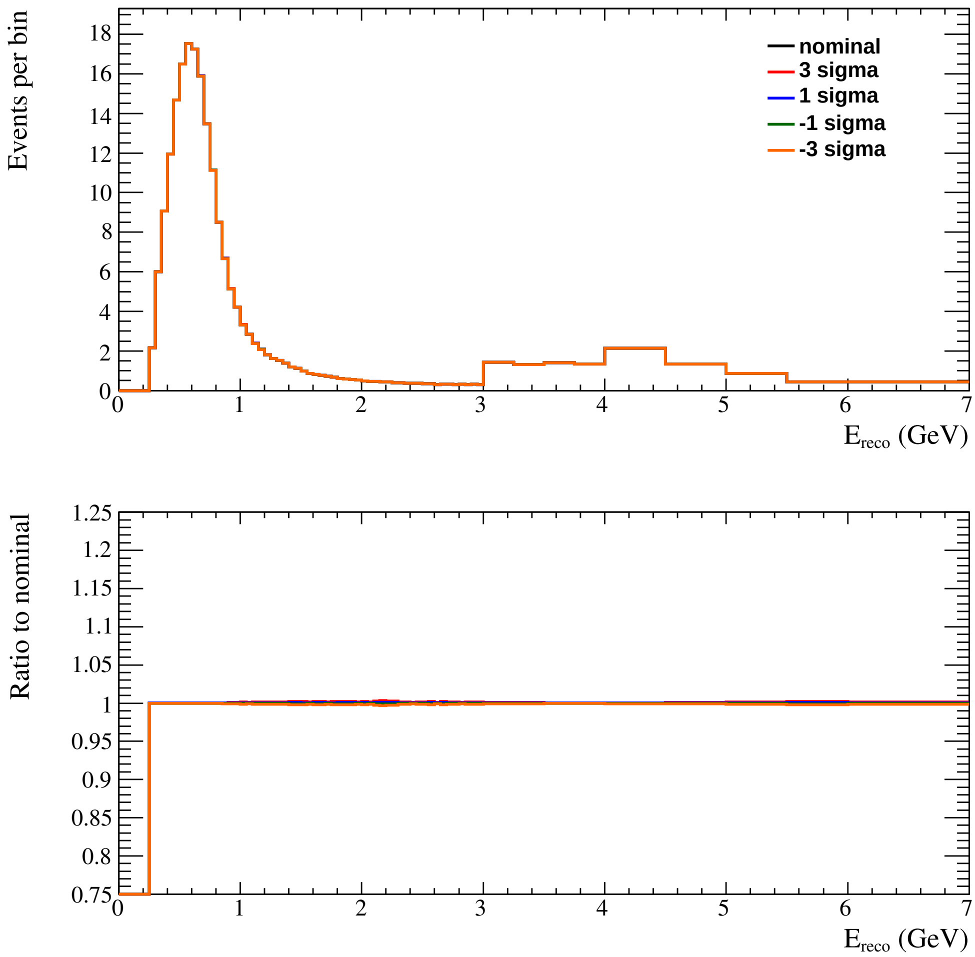


Figure 205: Effect of $f^{SK}_{\nu_e;r}$ for no oscillations (all mixing angles set to 0).

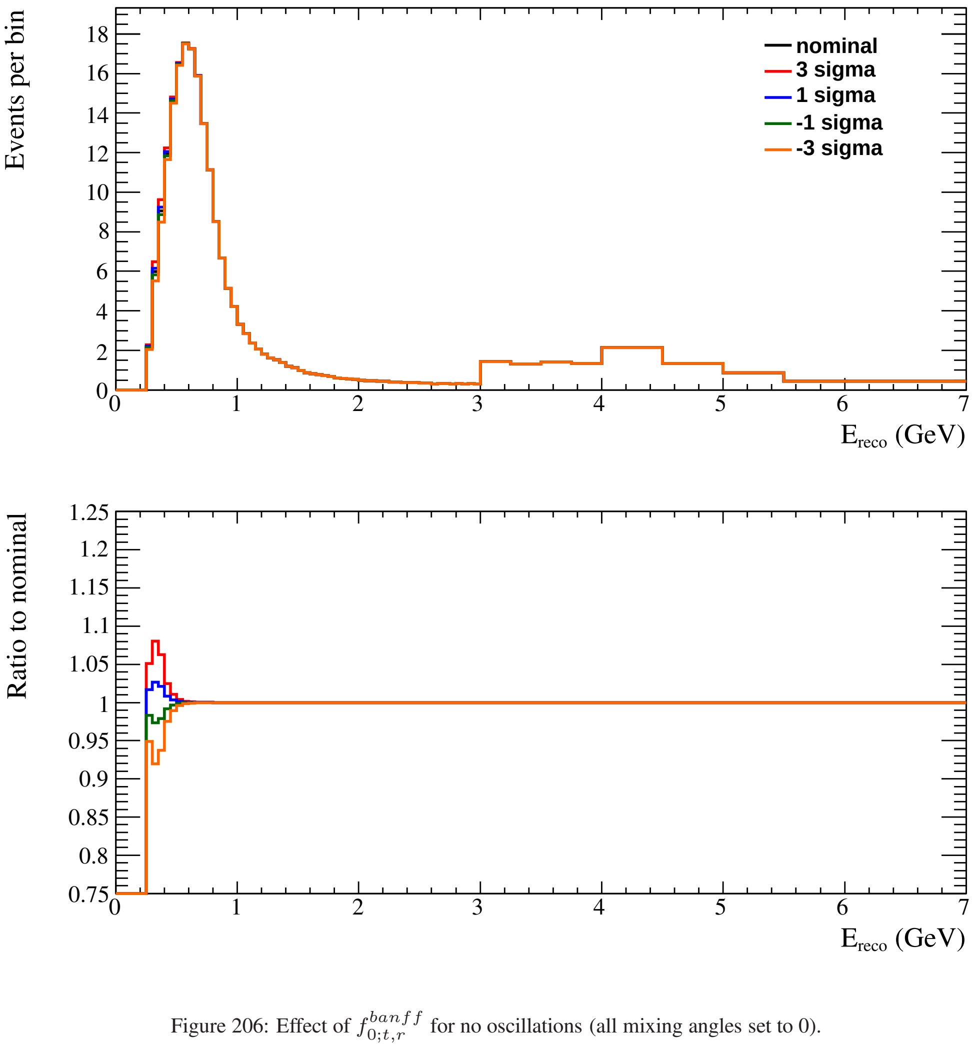


Figure 206: Effect of $f_{0;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

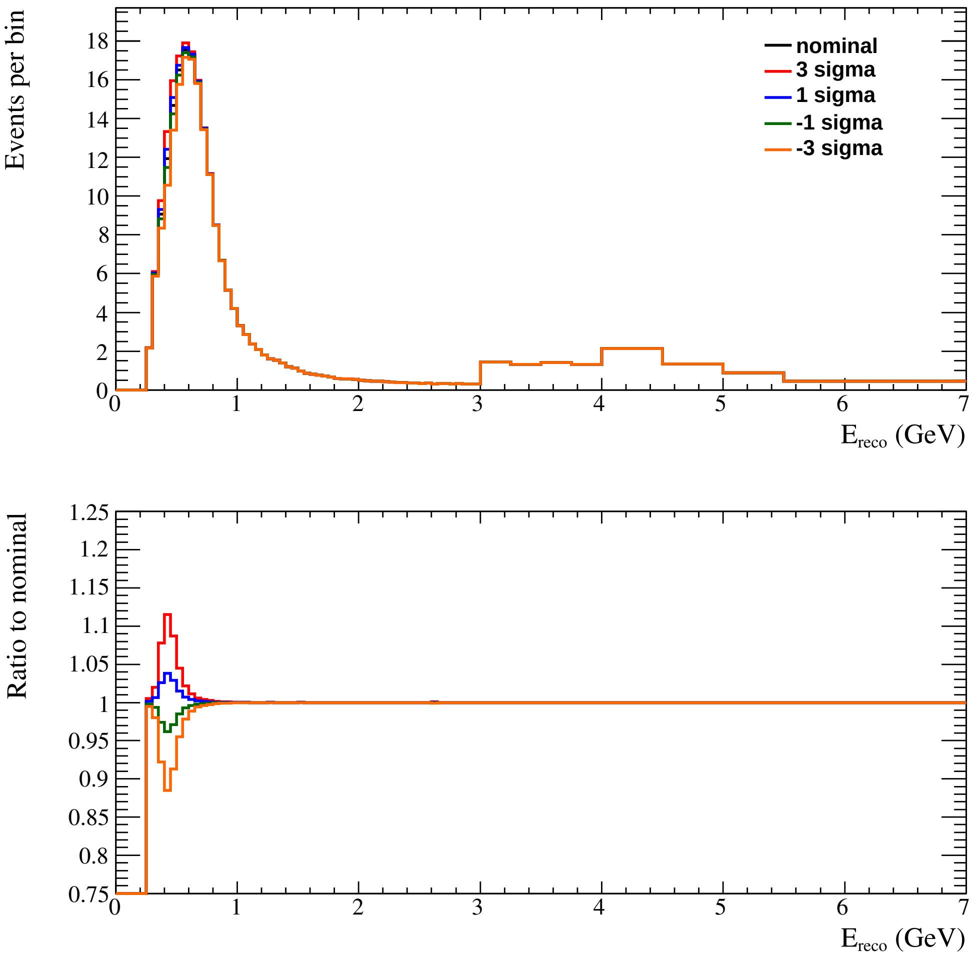


Figure 207: Effect of $f_{1;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

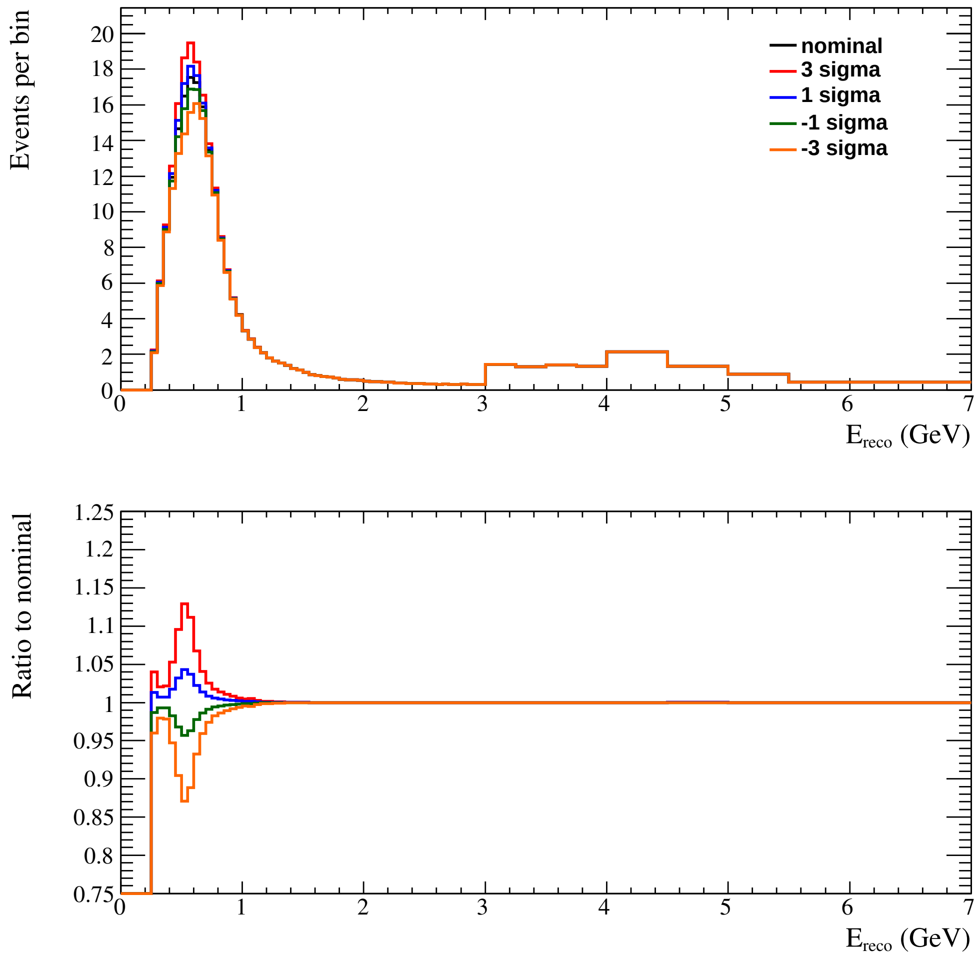


Figure 208: Effect of $f_{2;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

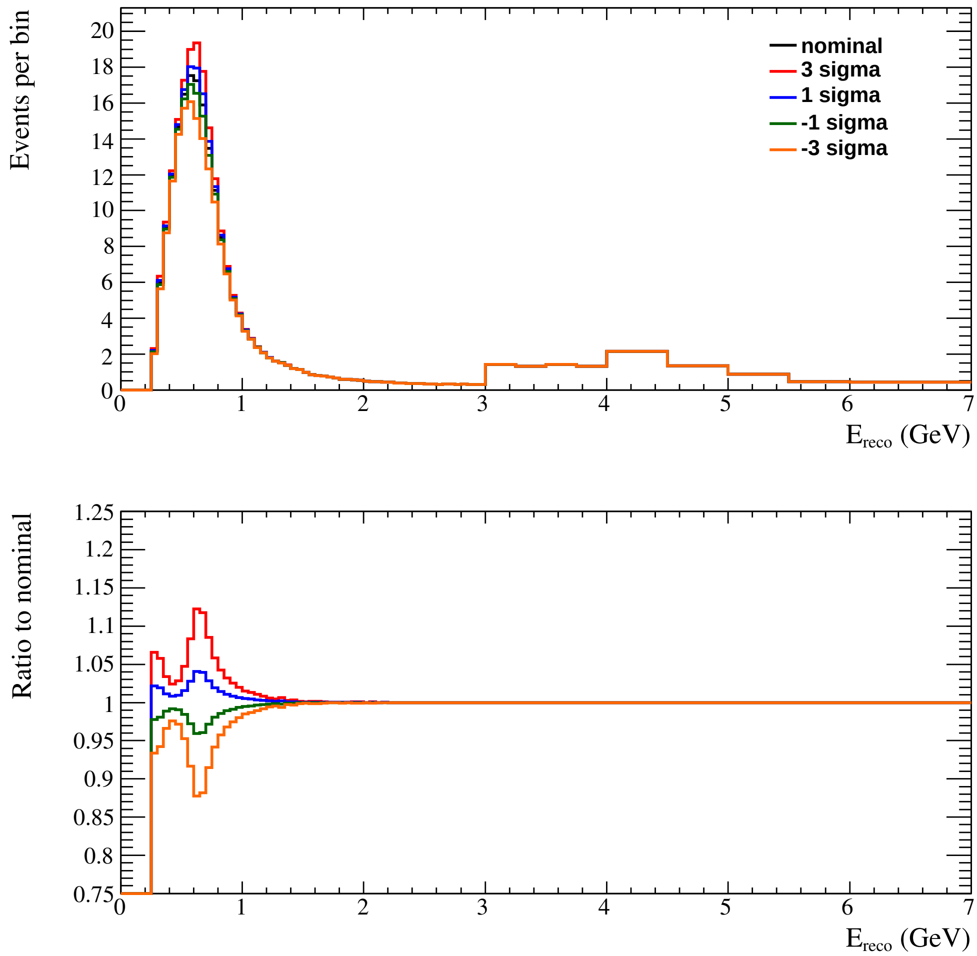


Figure 209: Effect of $f_{3;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

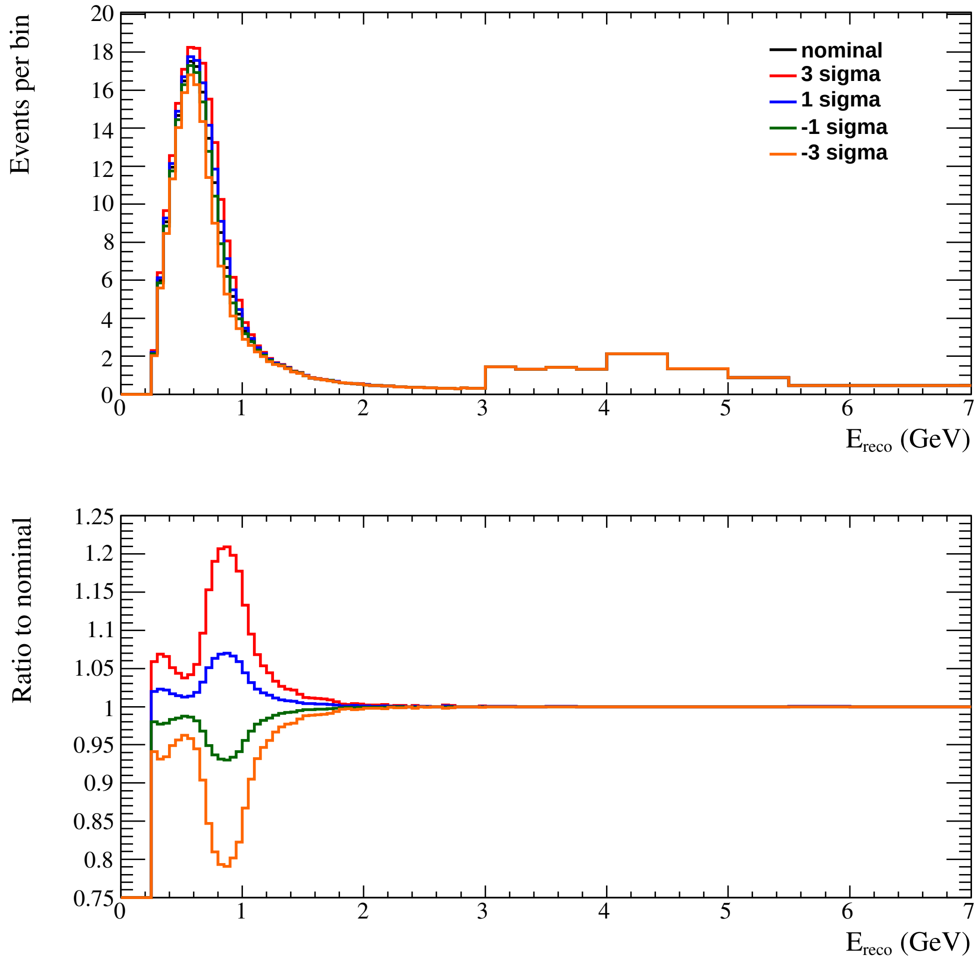


Figure 210: Effect of $f_{4;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

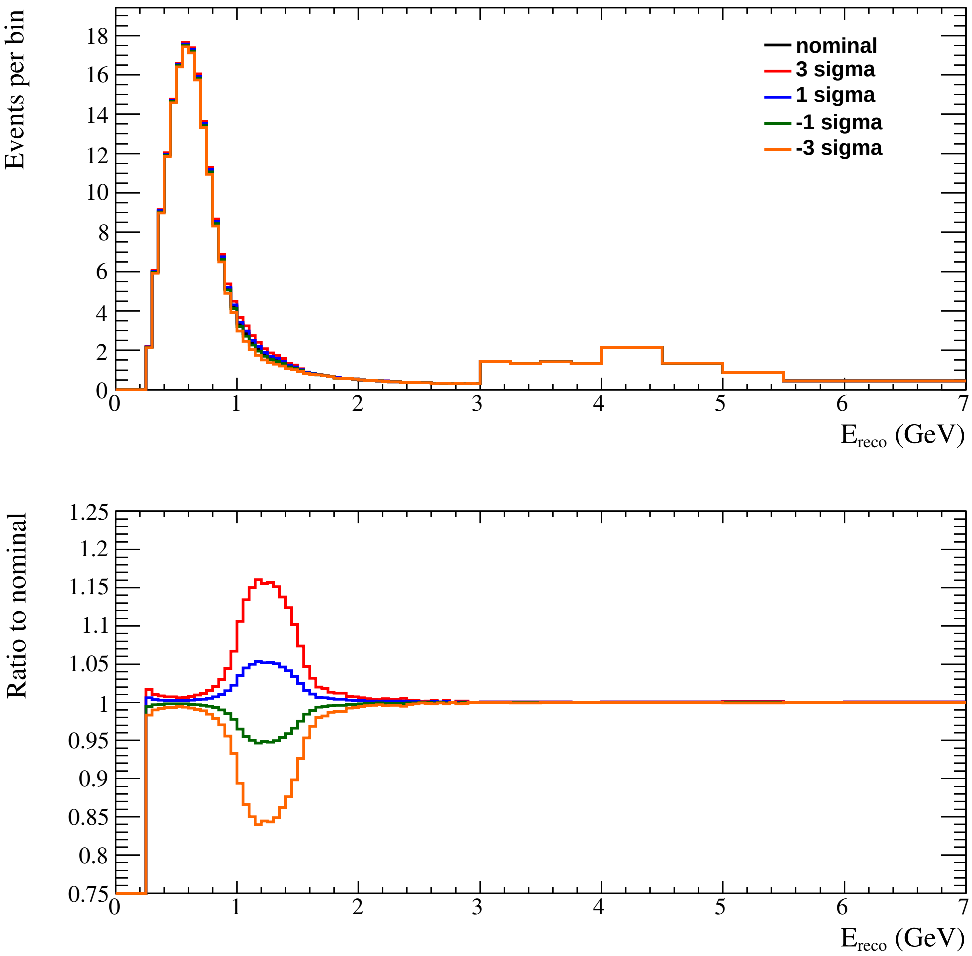


Figure 211: Effect of $f_{5;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

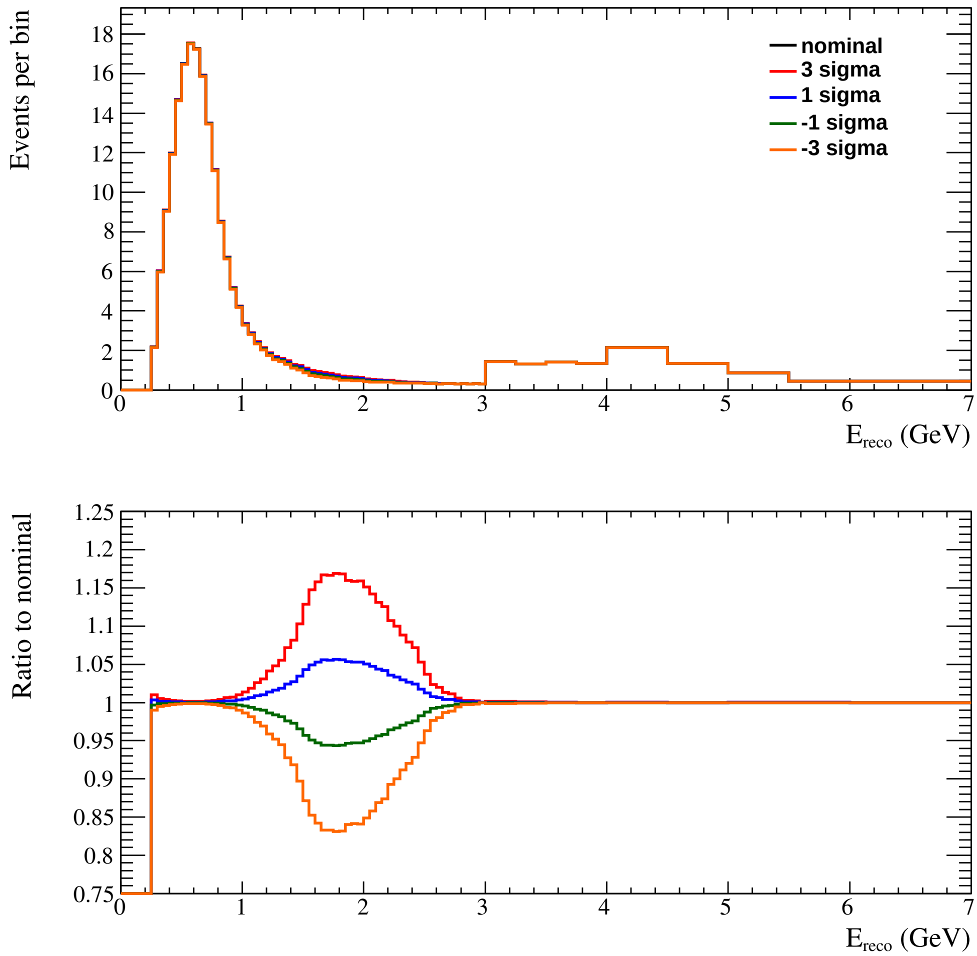


Figure 212: Effect of $f_{6;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

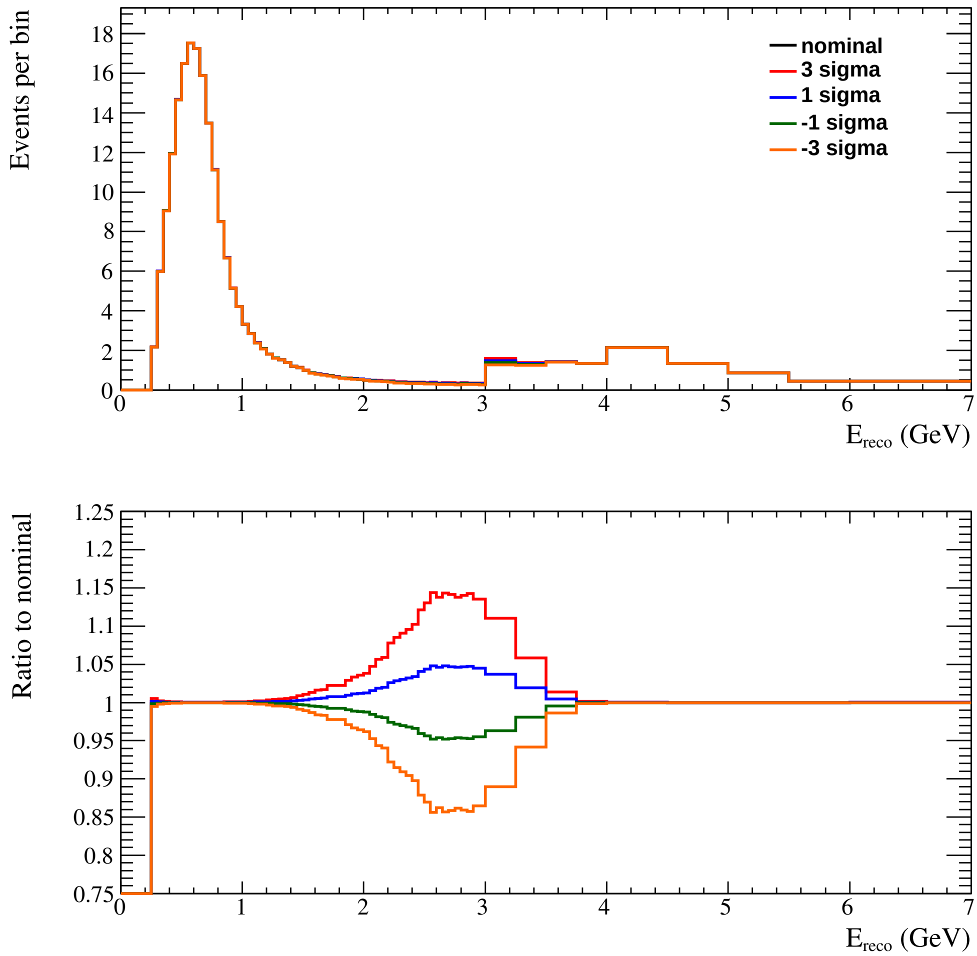


Figure 213: Effect of $f_{7;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

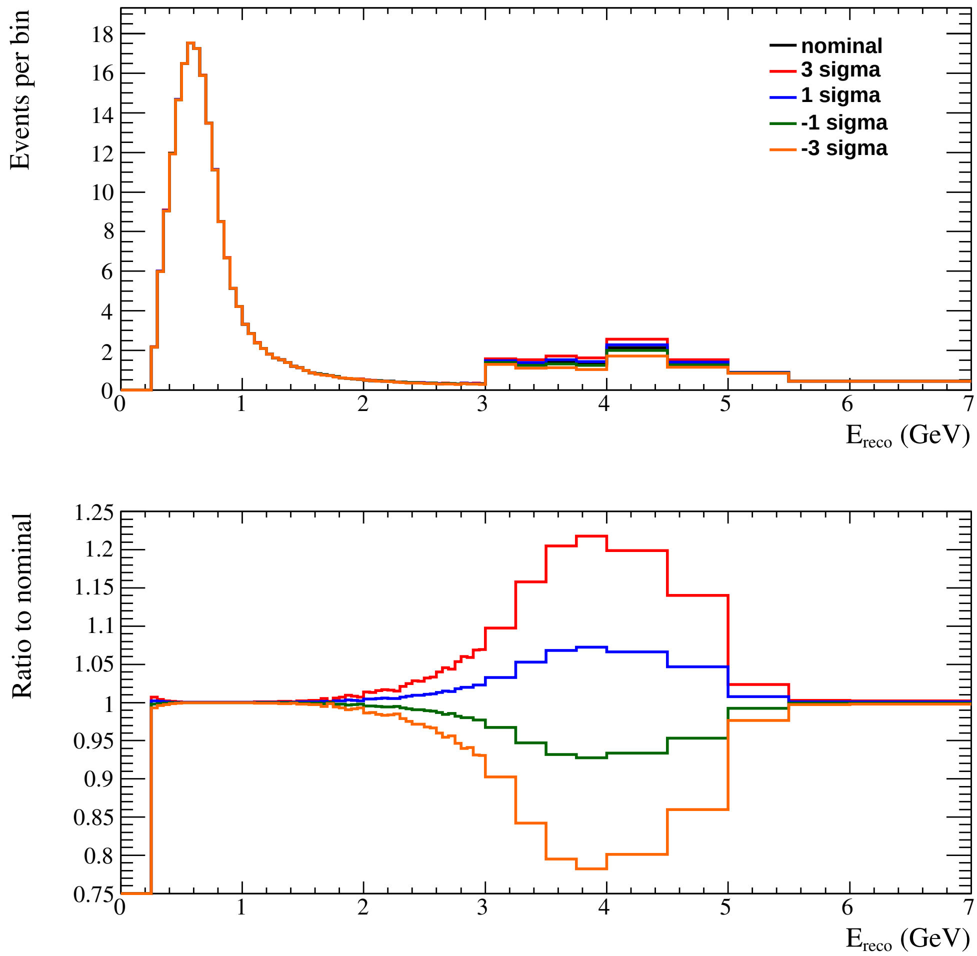


Figure 214: Effect of $f_{8;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

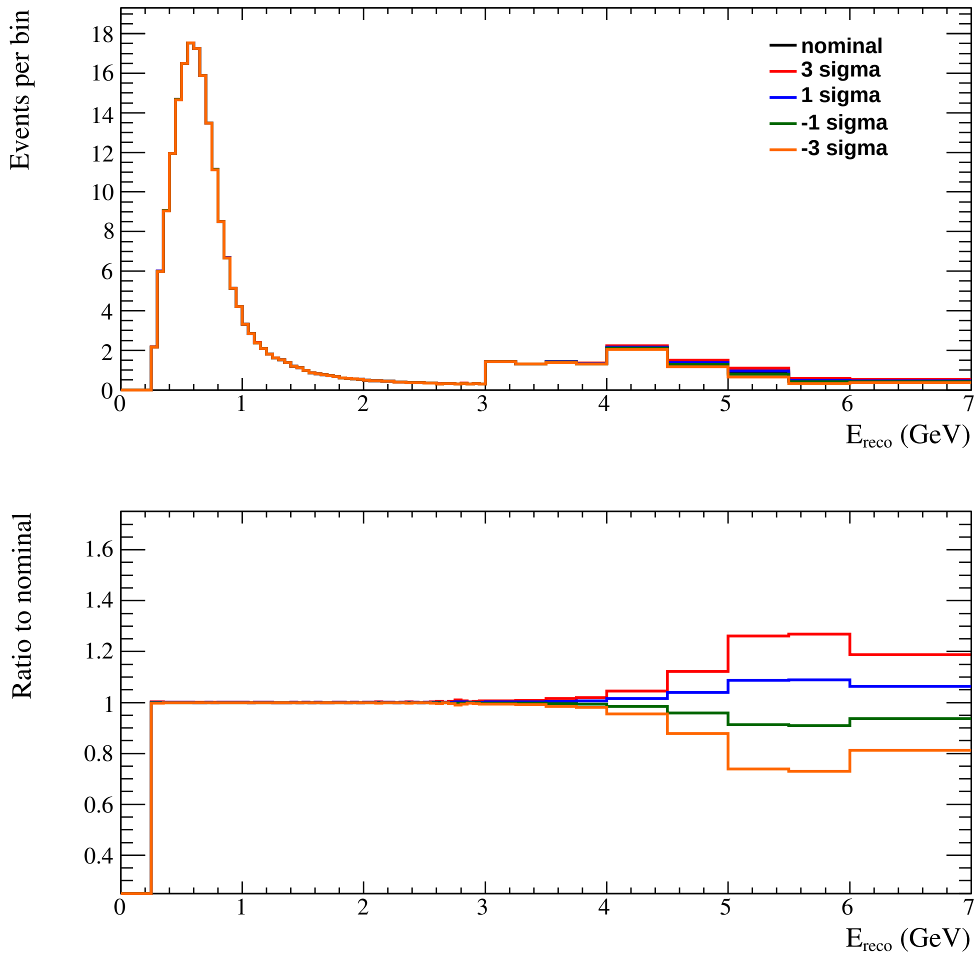


Figure 215: Effect of $f_{9;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

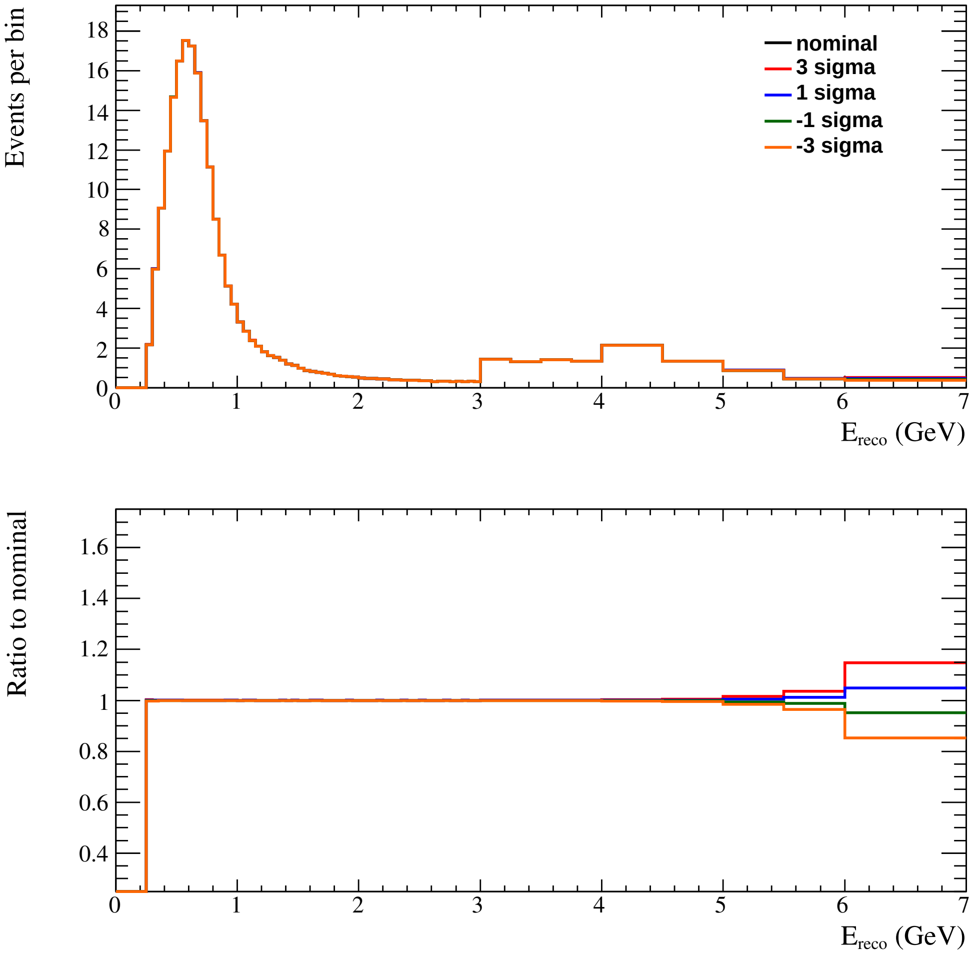


Figure 216: Effect of $f_{10;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

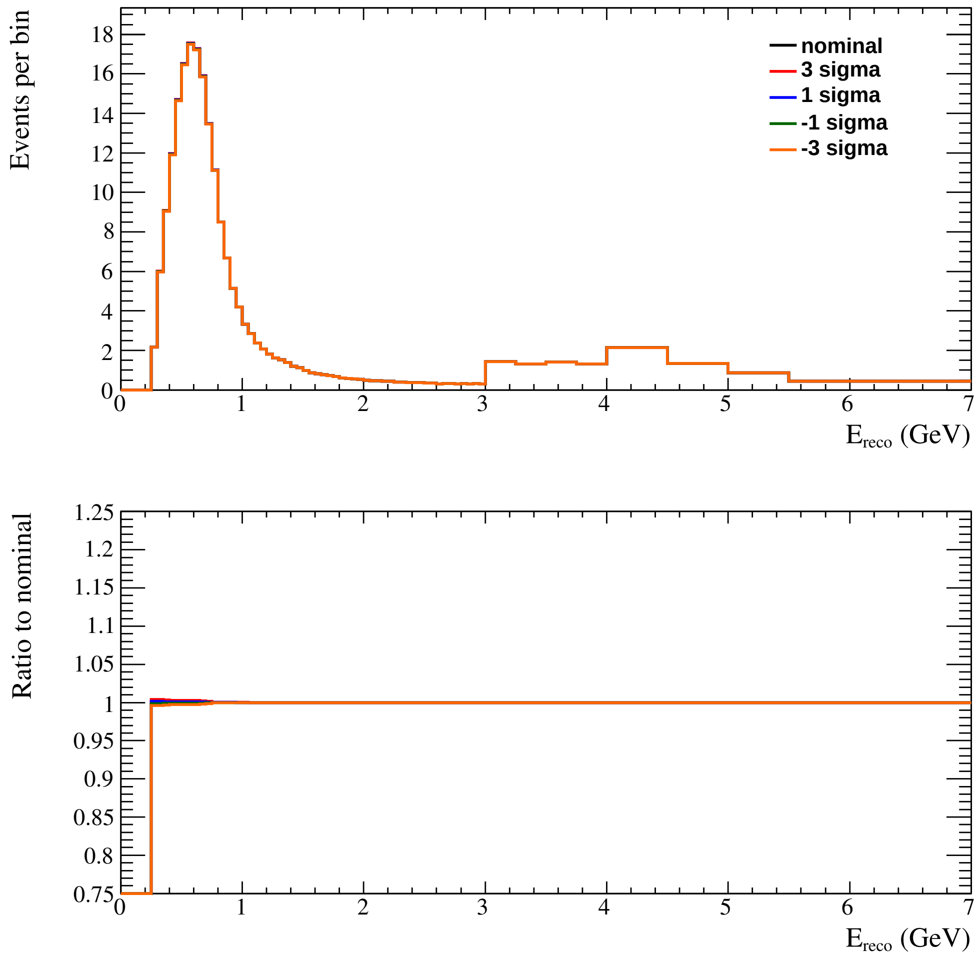


Figure 217: Effect of $f_{11;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

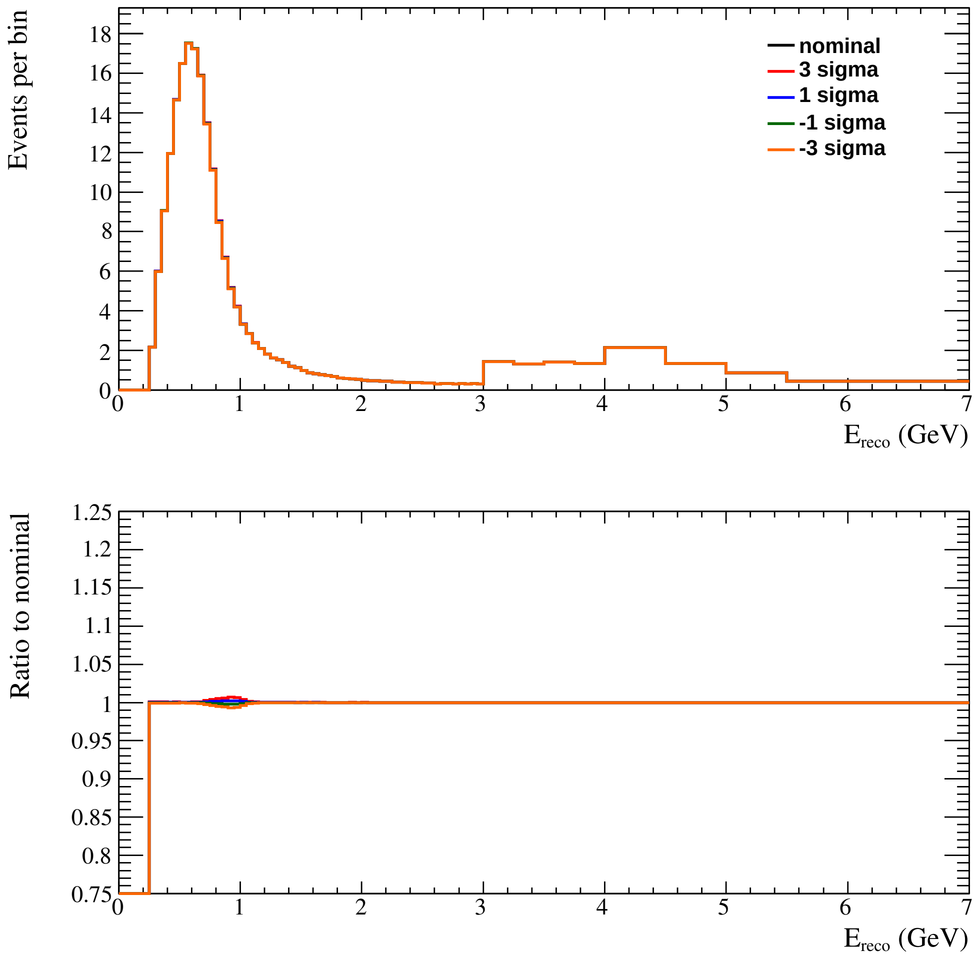


Figure 218: Effect of $f_{12;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

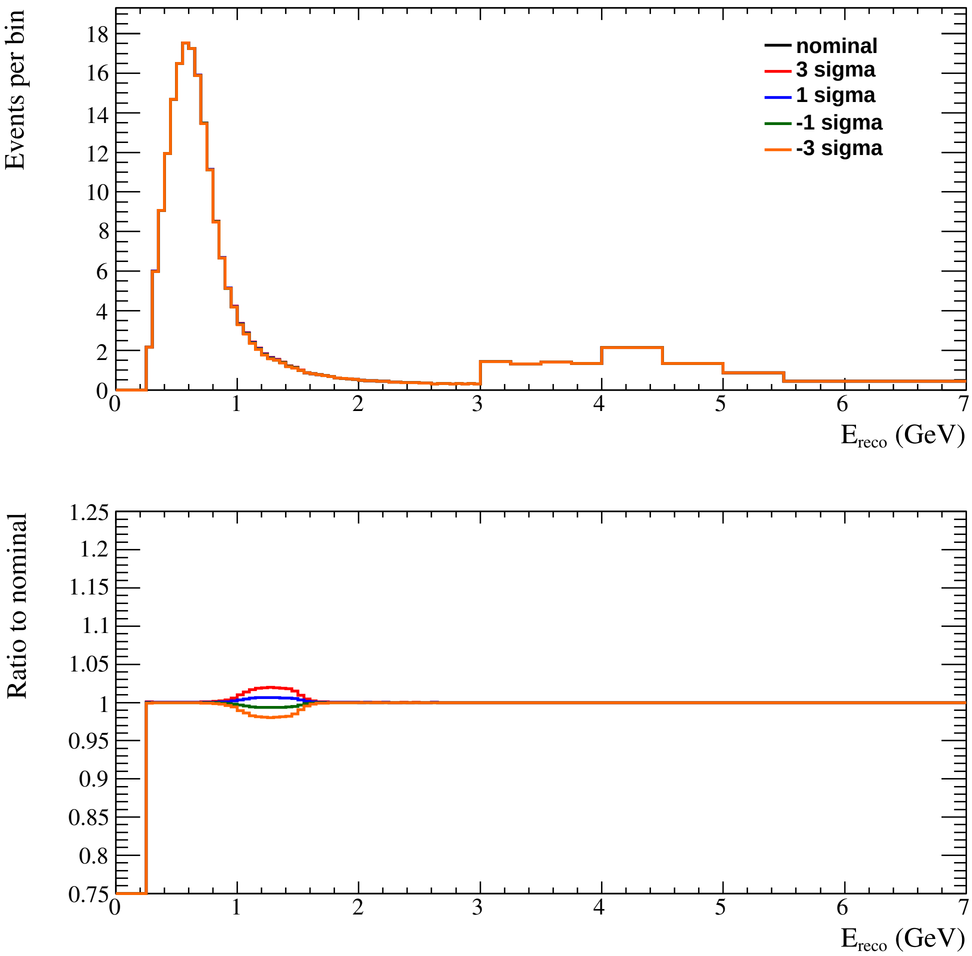


Figure 219: Effect of $f_{13;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

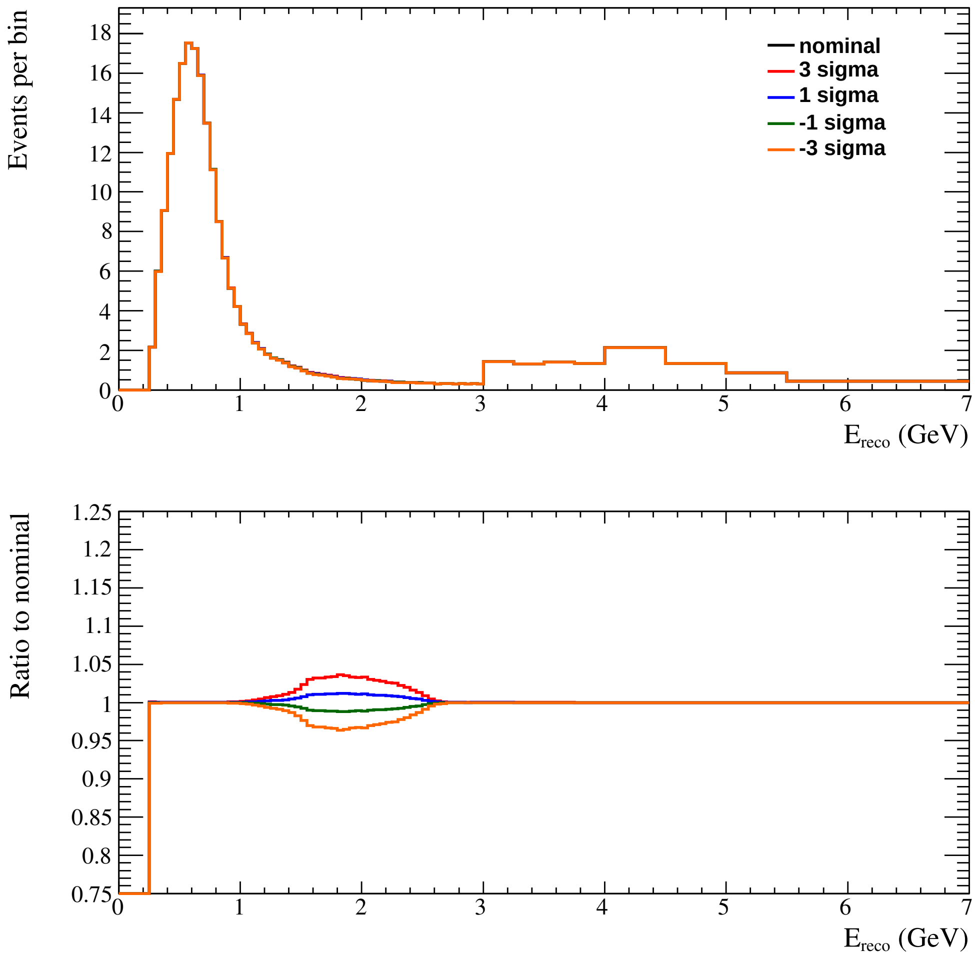


Figure 220: Effect of $f_{14;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

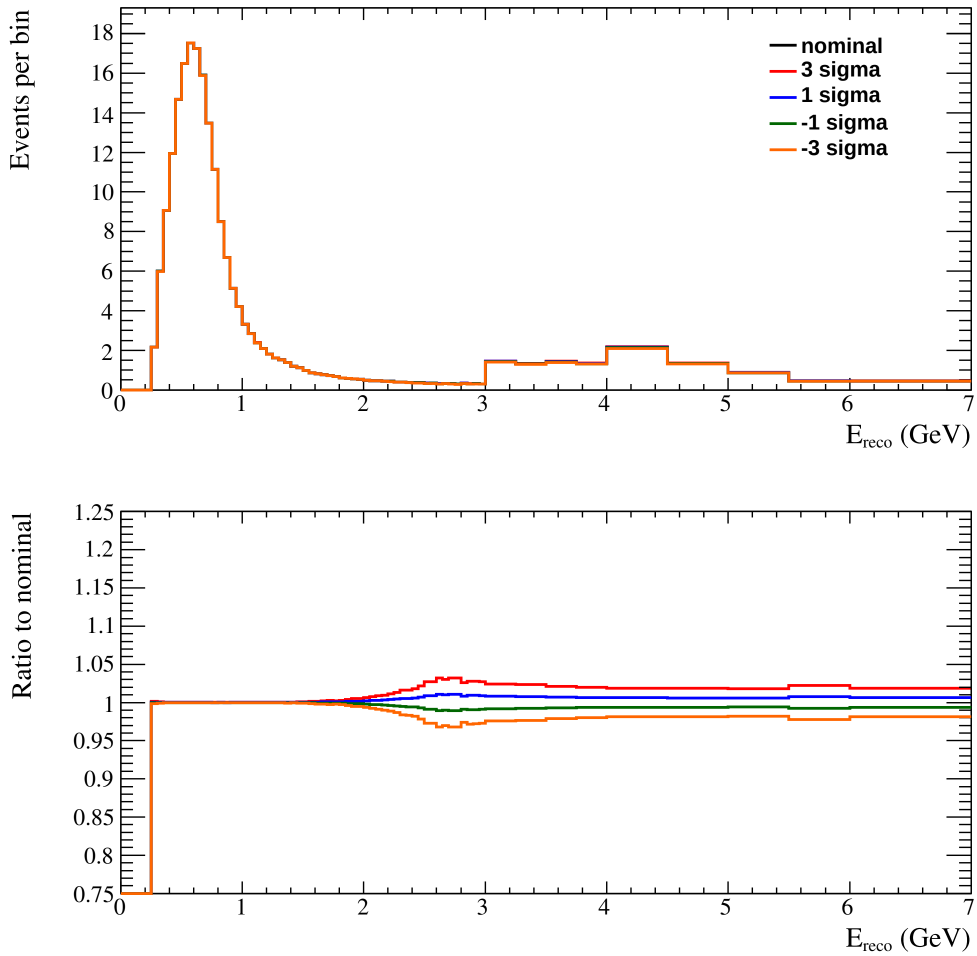


Figure 221: Effect of $f_{15;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

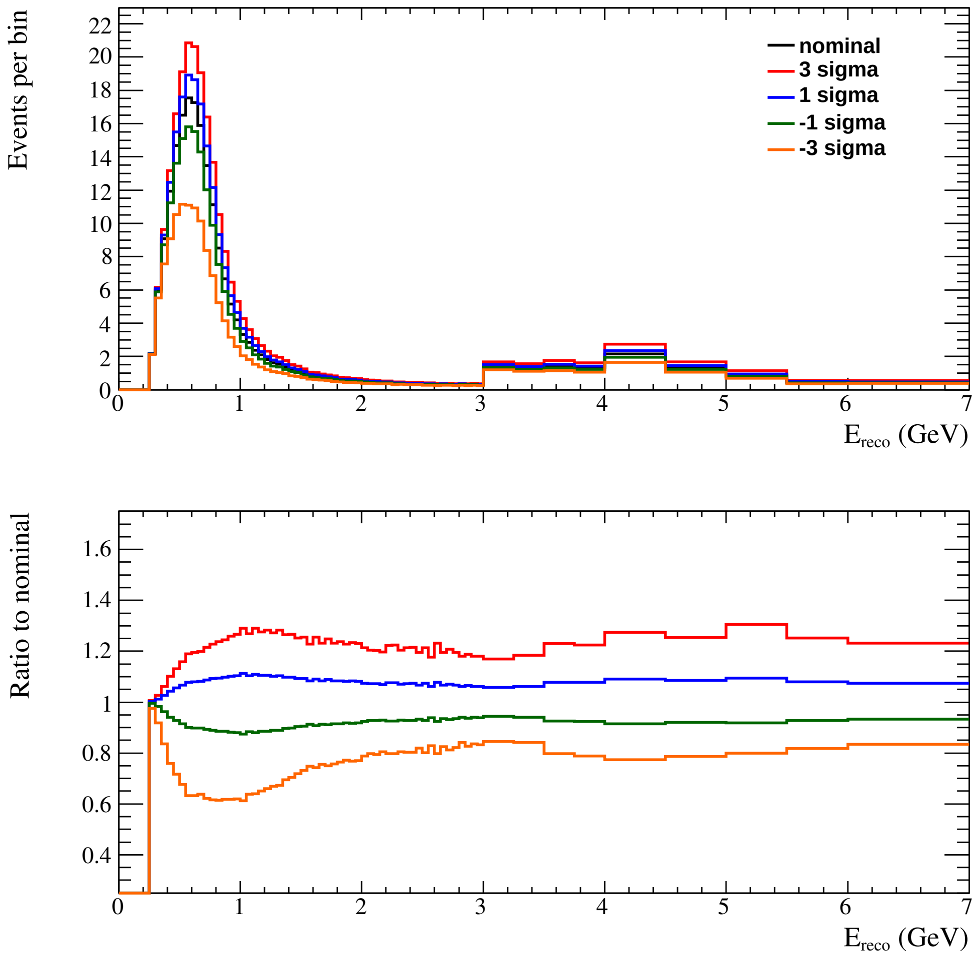


Figure 222: Effect of $f^{banff}_{16;t,r}$ for no oscillations (all mixing angles set to 0).

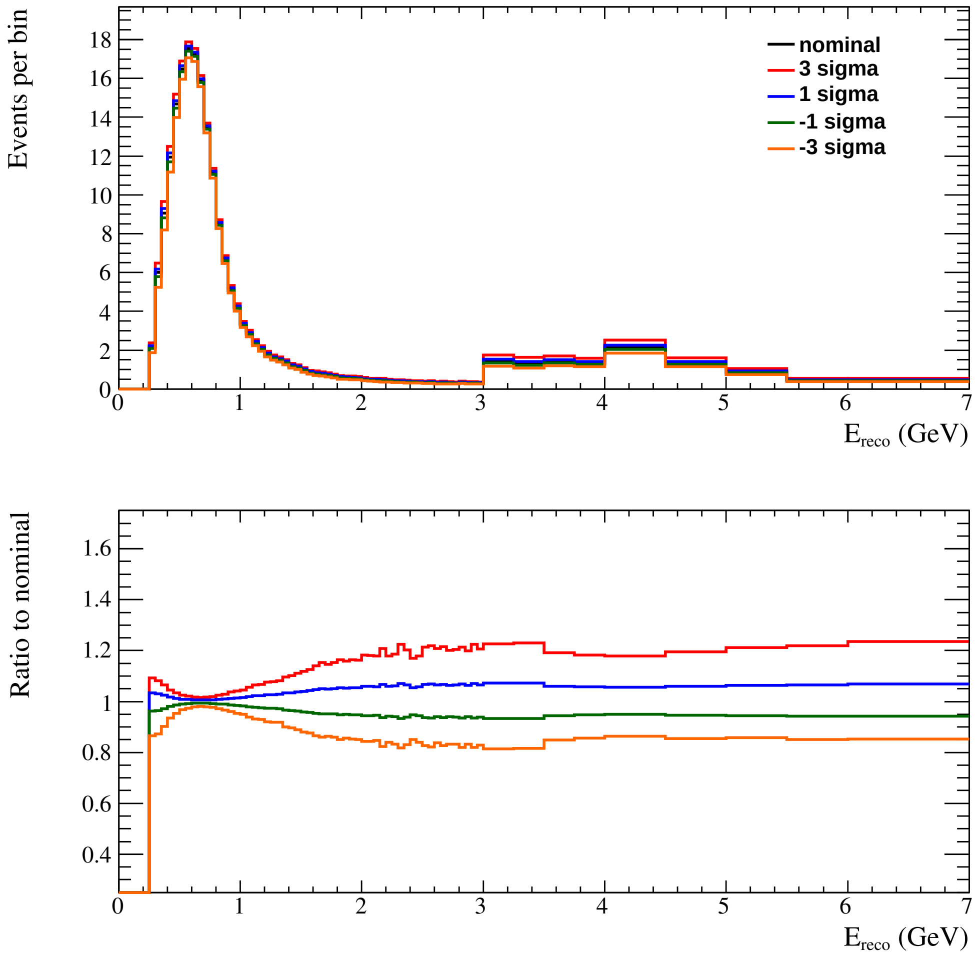


Figure 223: Effect of $f_{17;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

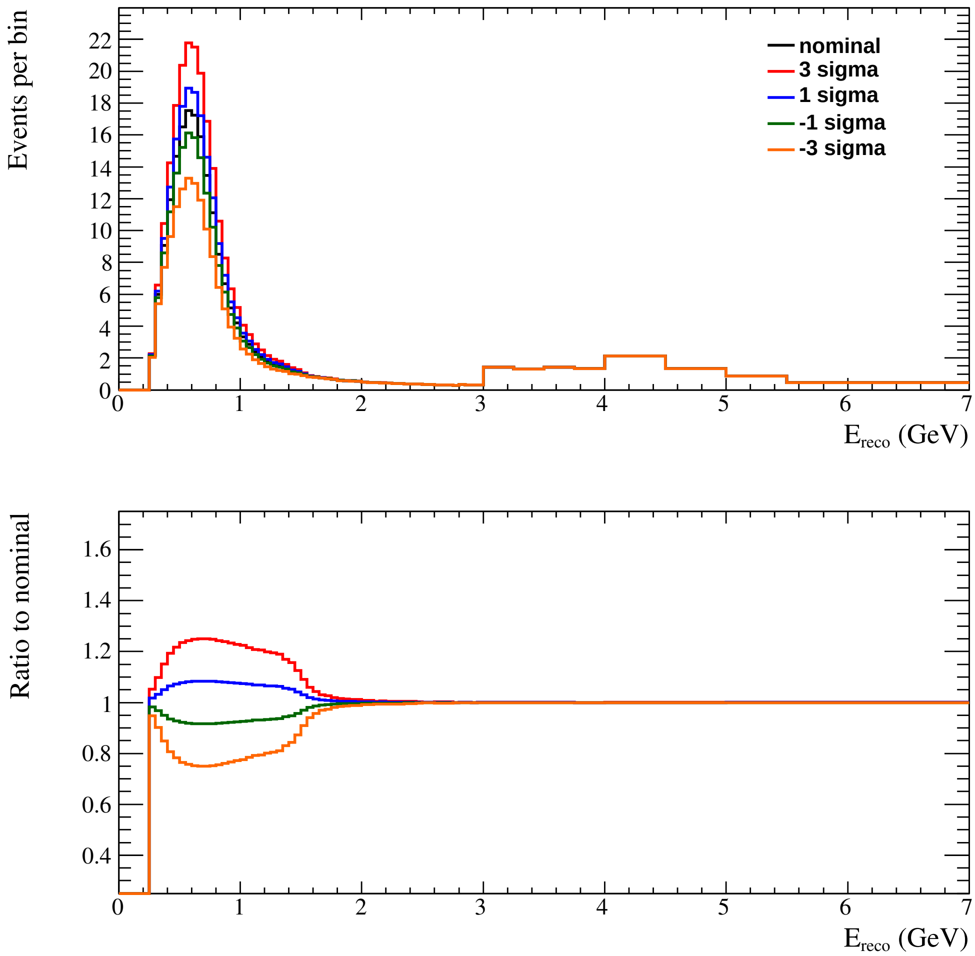


Figure 224: Effect of $f_{18;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

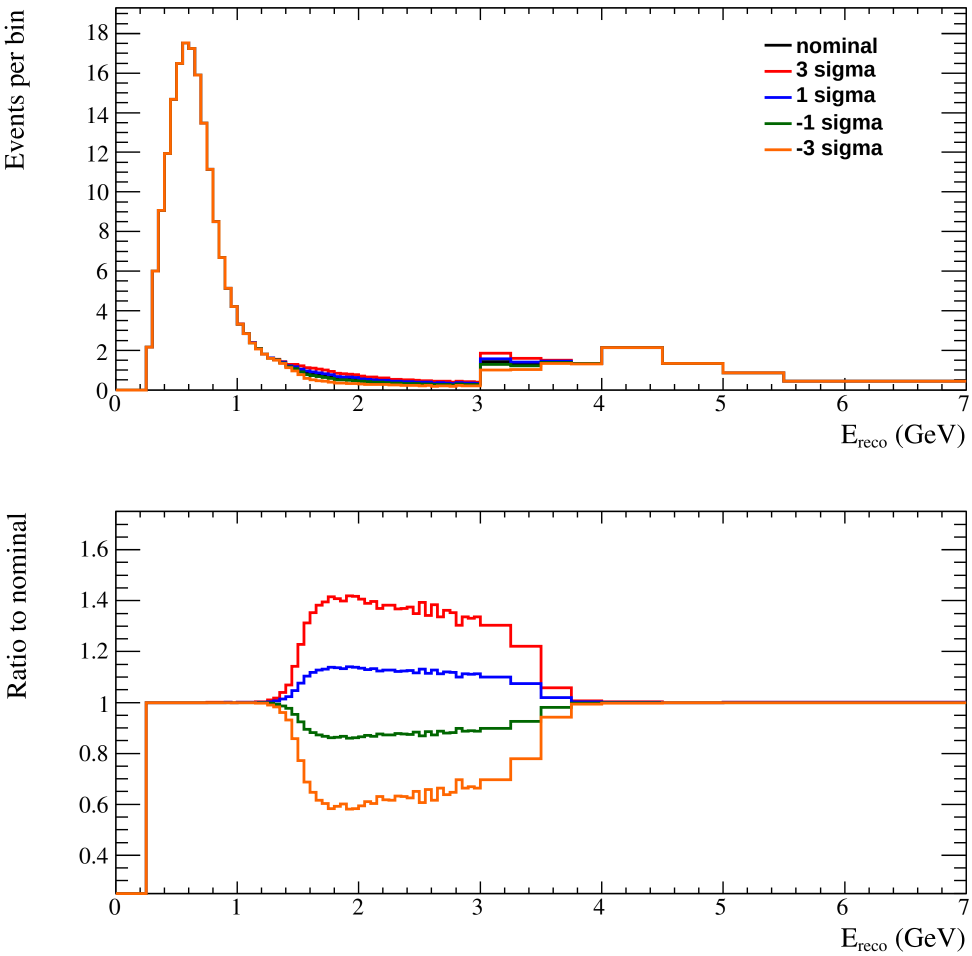


Figure 225: Effect of $f^{banff}_{19;t,r}$ for no oscillations (all mixing angles set to 0).

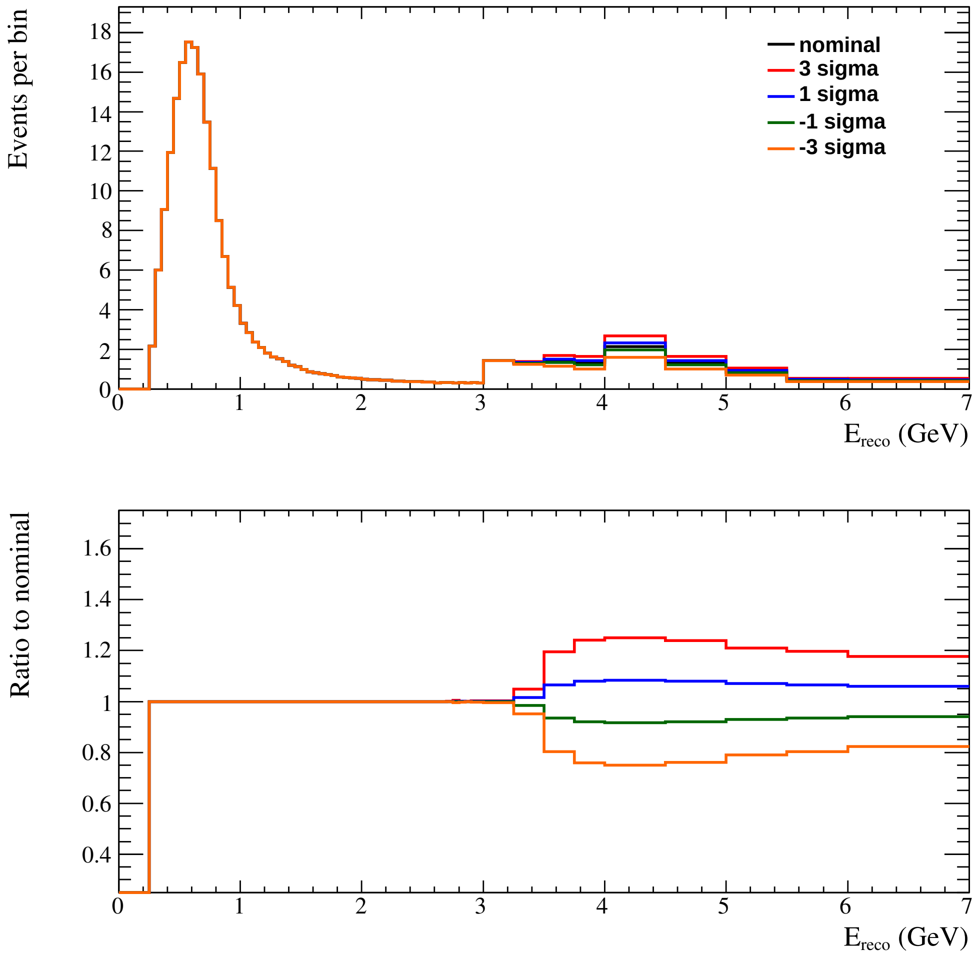


Figure 226: Effect of $f_{20;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

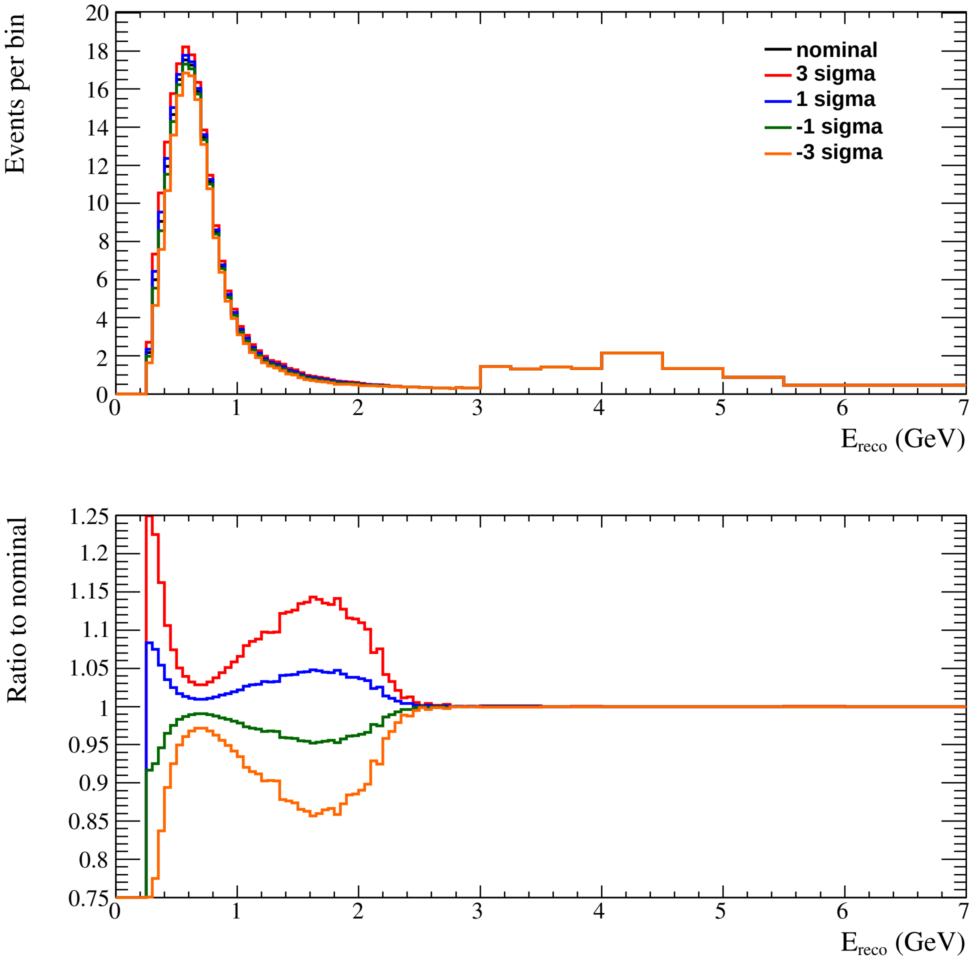


Figure 227: Effect of $f_{21;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

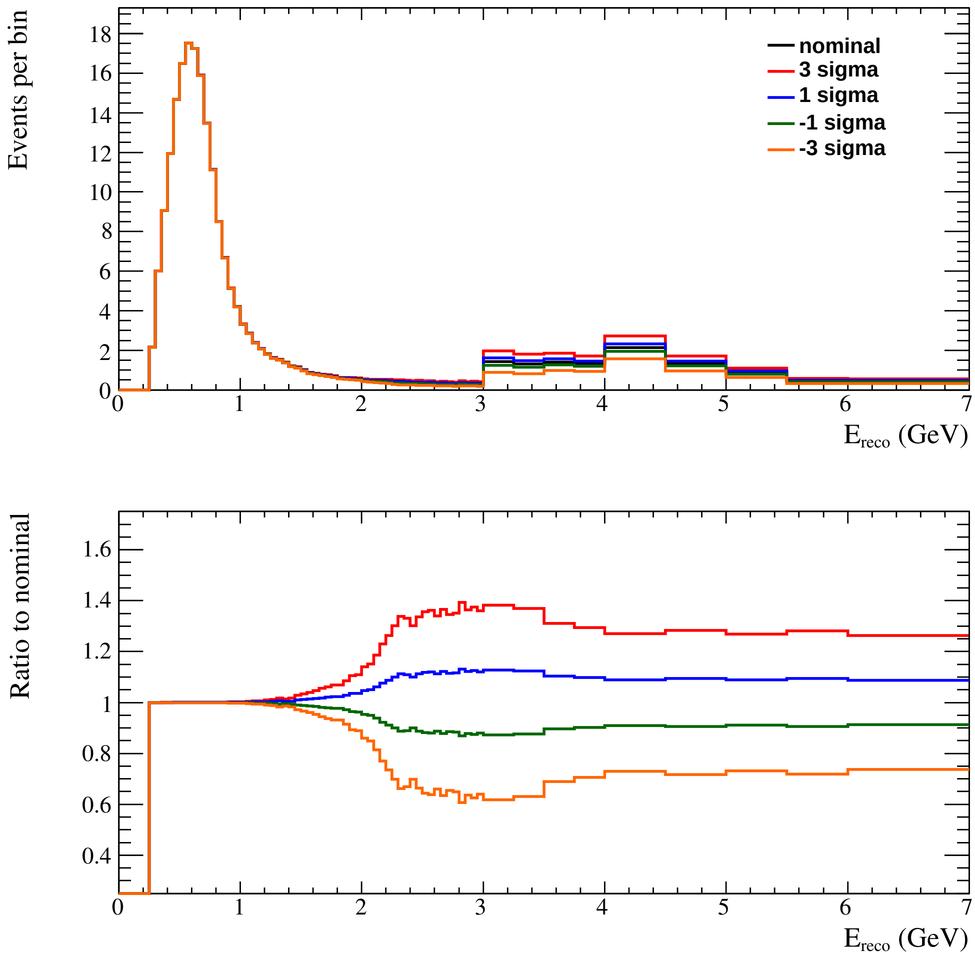


Figure 228: Effect of $f_{22;t,r}^{banff}$ for no oscillations (all mixing angles set to 0).

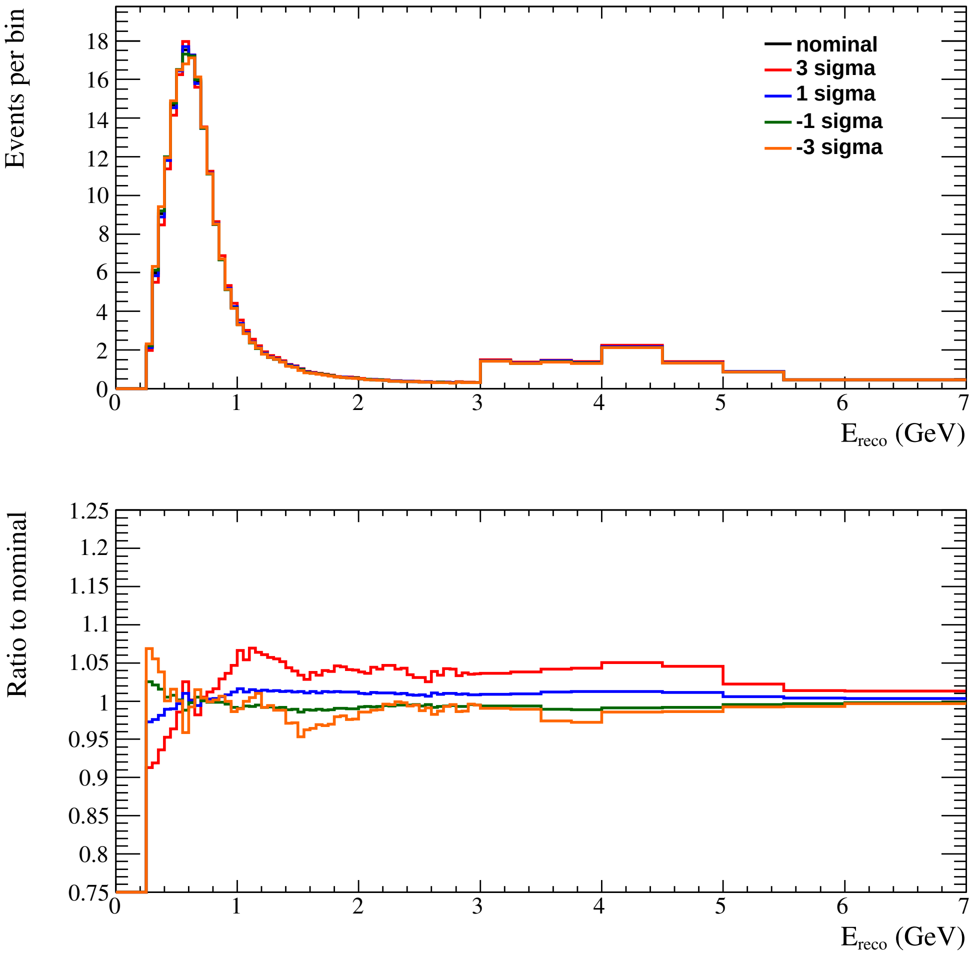


Figure 229: Effect of $f_{pF;t,r}$ for no oscillations (all mixing angles set to 0).

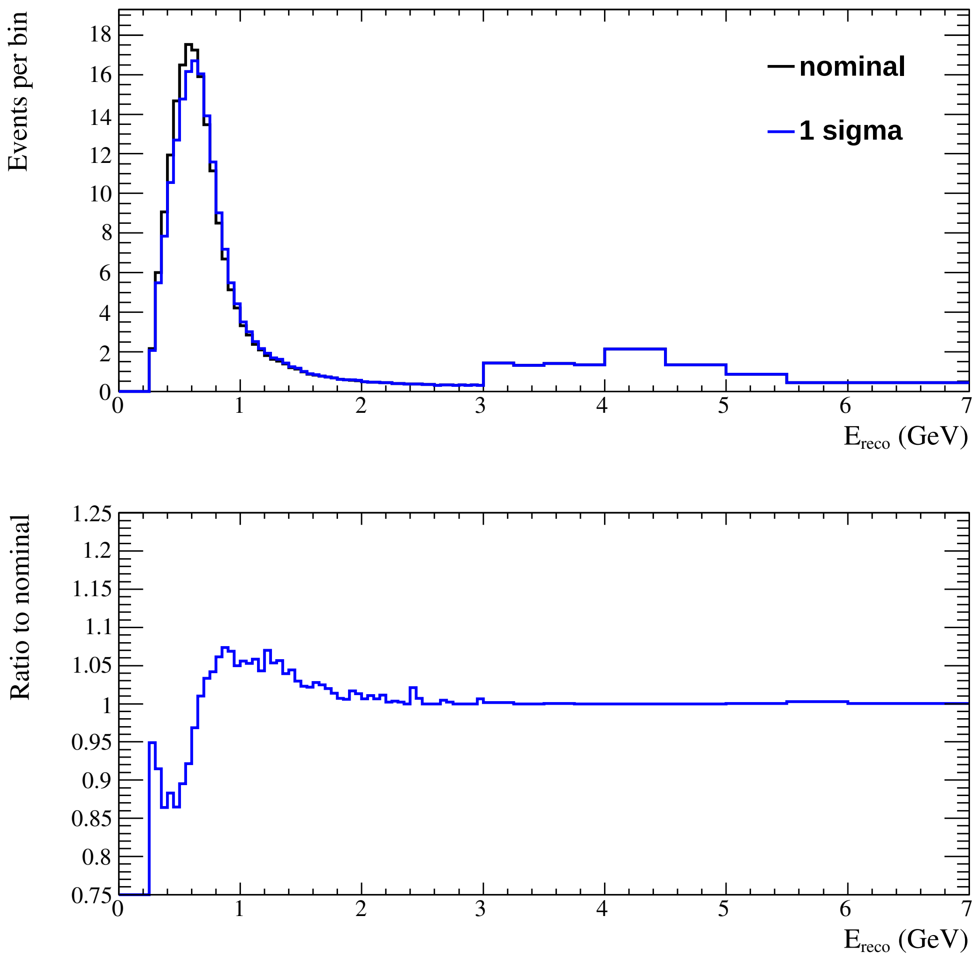


Figure 230: Effect of $f_{SF;t,r}$ for no oscillations (all mixing angles set to 0).

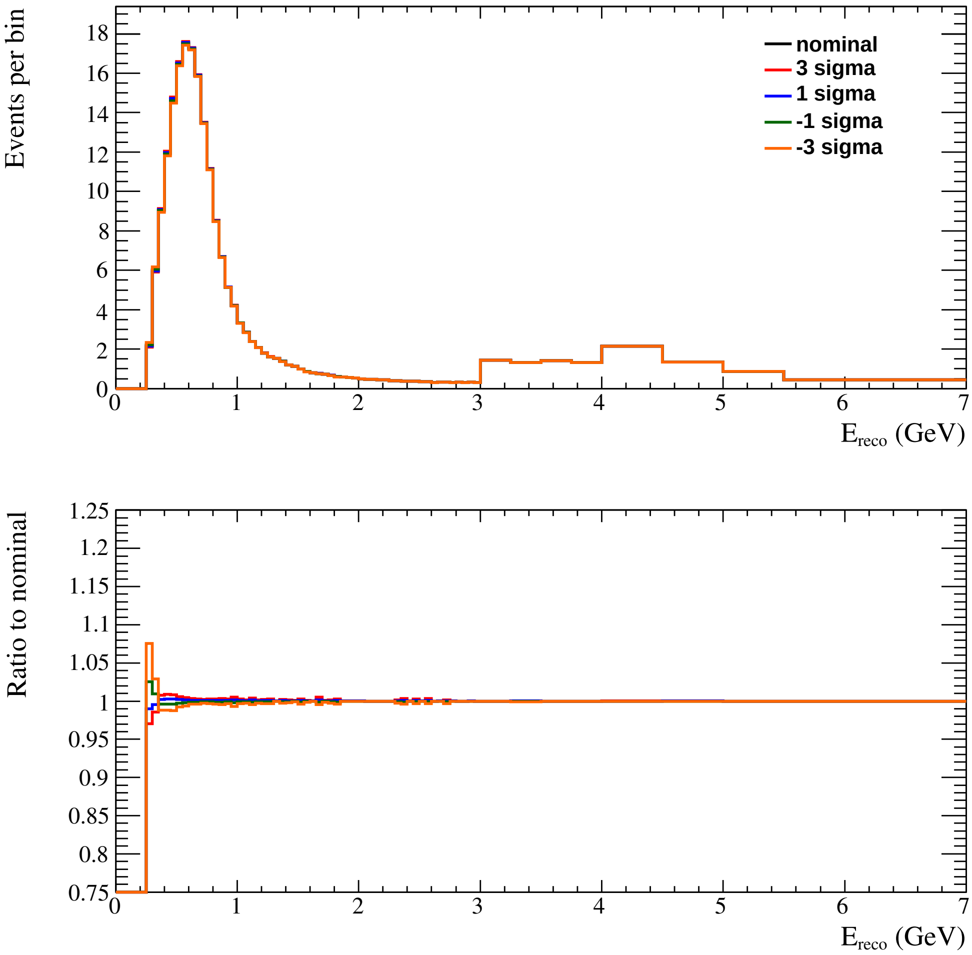


Figure 231: Effect of $f_{W shape;t,r}$ for no oscillations (all mixing angles set to 0).

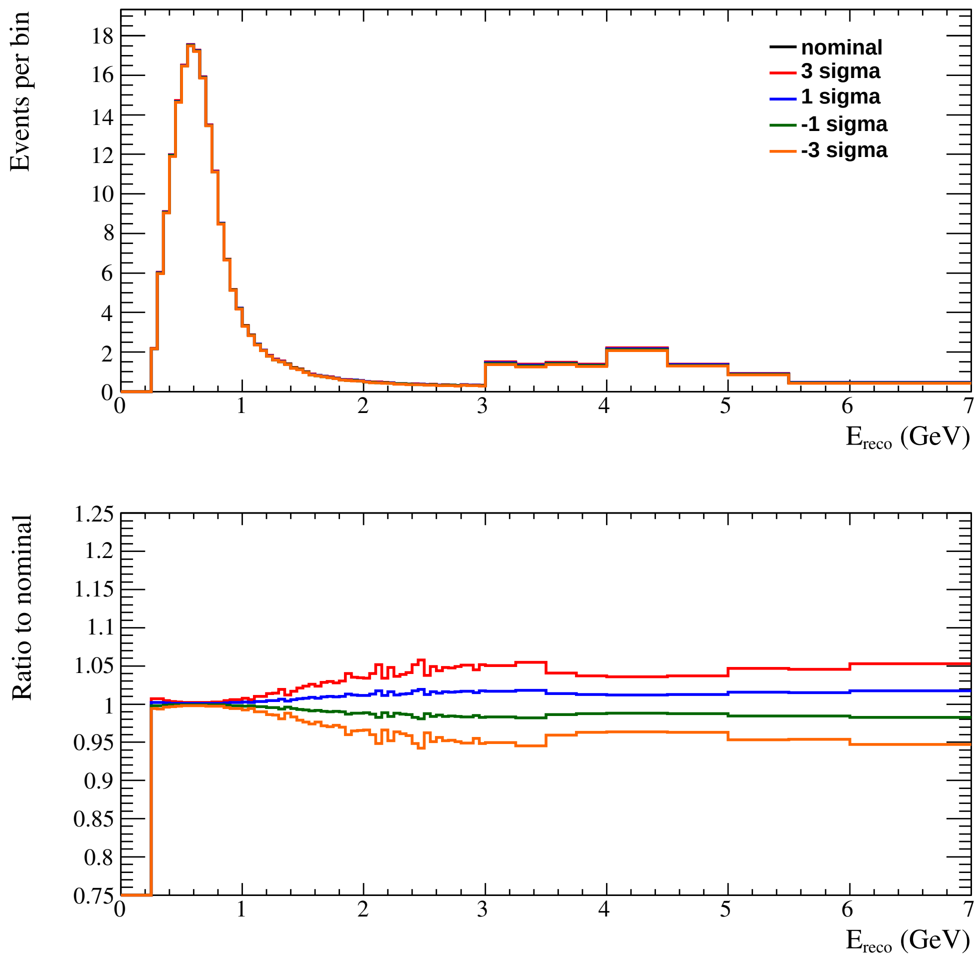


Figure 232: Effect of $f_{CCothShape;t,r}$ for no oscillations (all mixing angles set to 0).

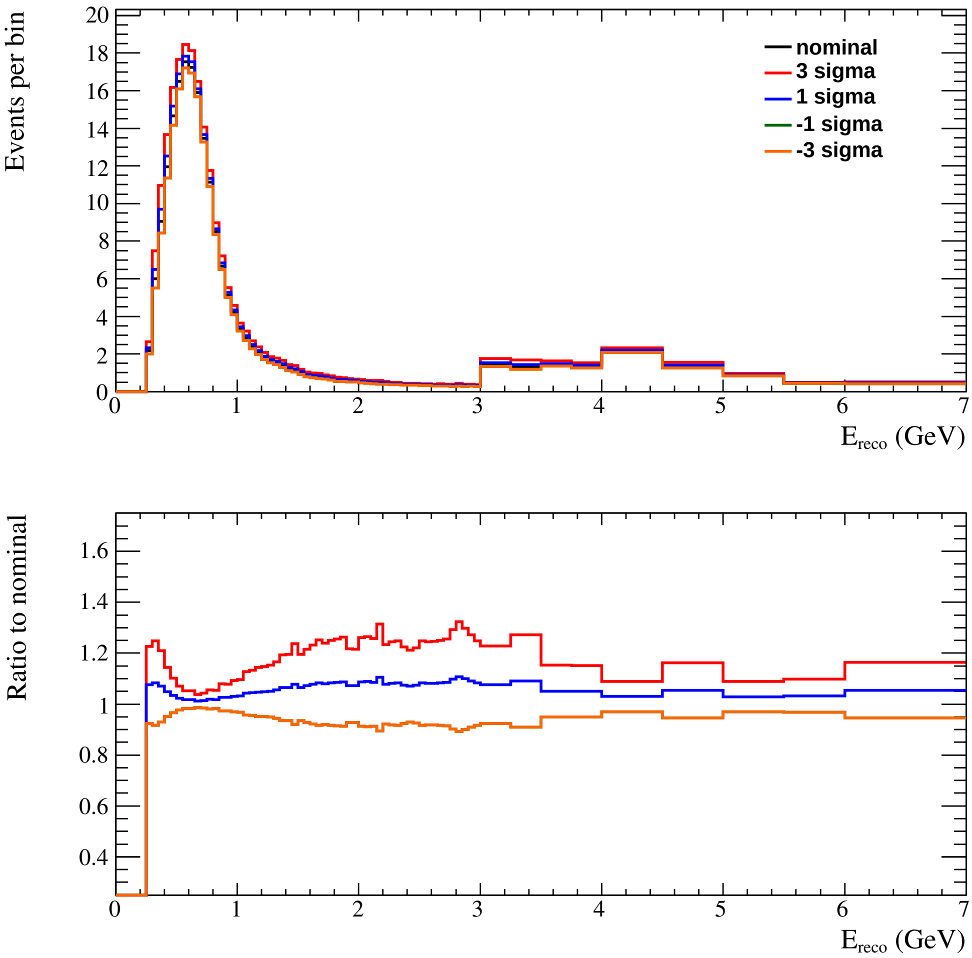


Figure 233: Effect of $f_{\pi-less\Delta;t,r}$ for no oscillations (all mixing angles set to 0).

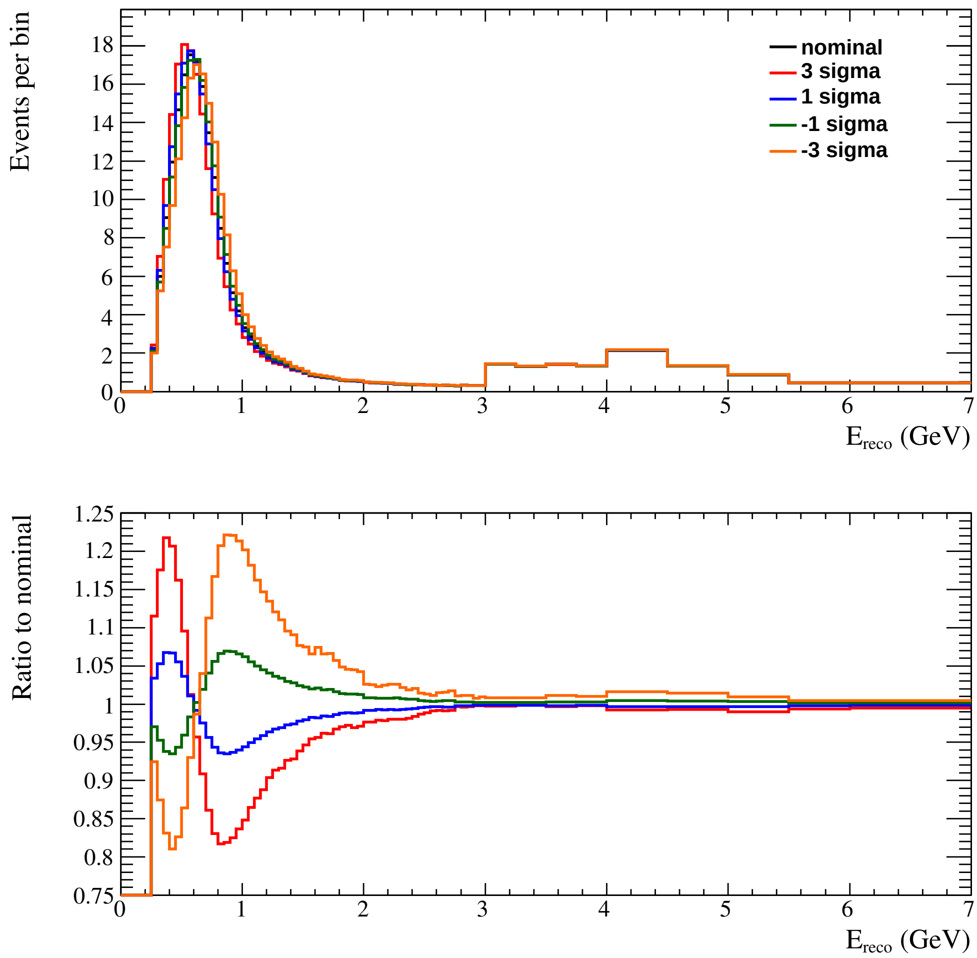


Figure 234: Effect of $f_{bindE;t,r}$ for no oscillations (all mixing angles set to 0).

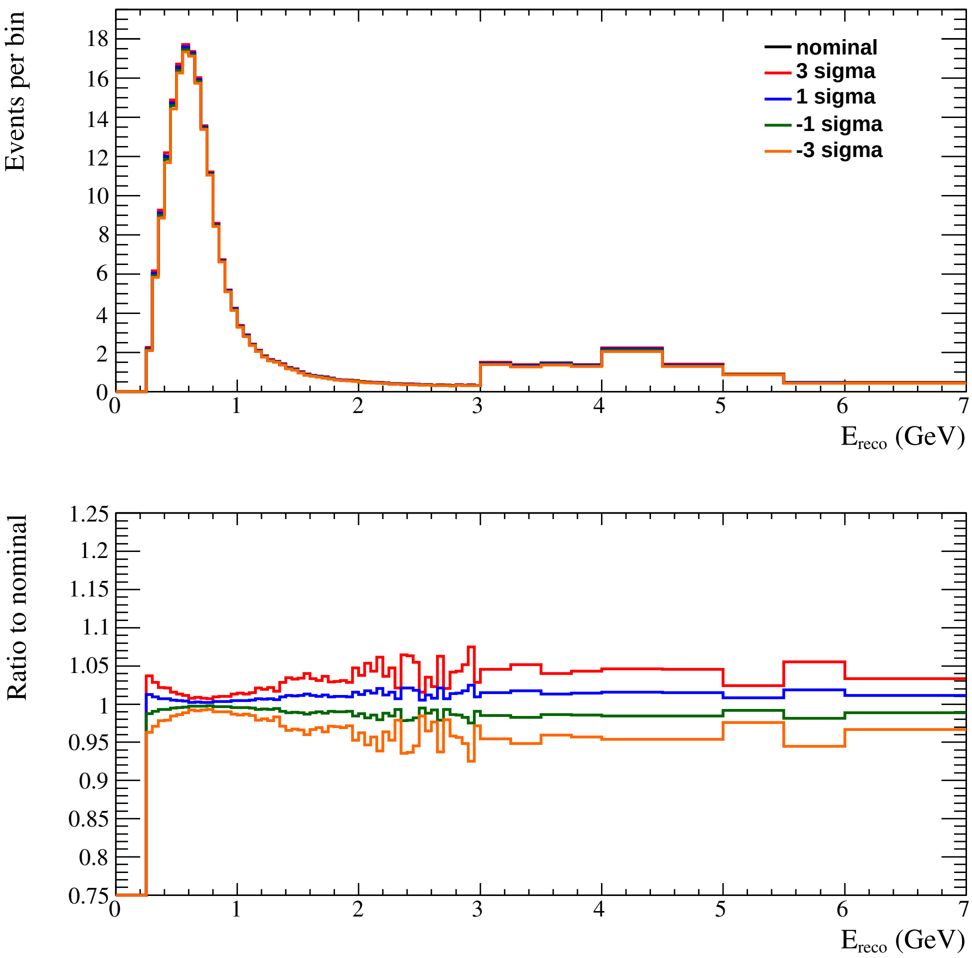


Figure 235: Effect of $f_{CCcoh;t}$ for no oscillations (all mixing angles set to 0).

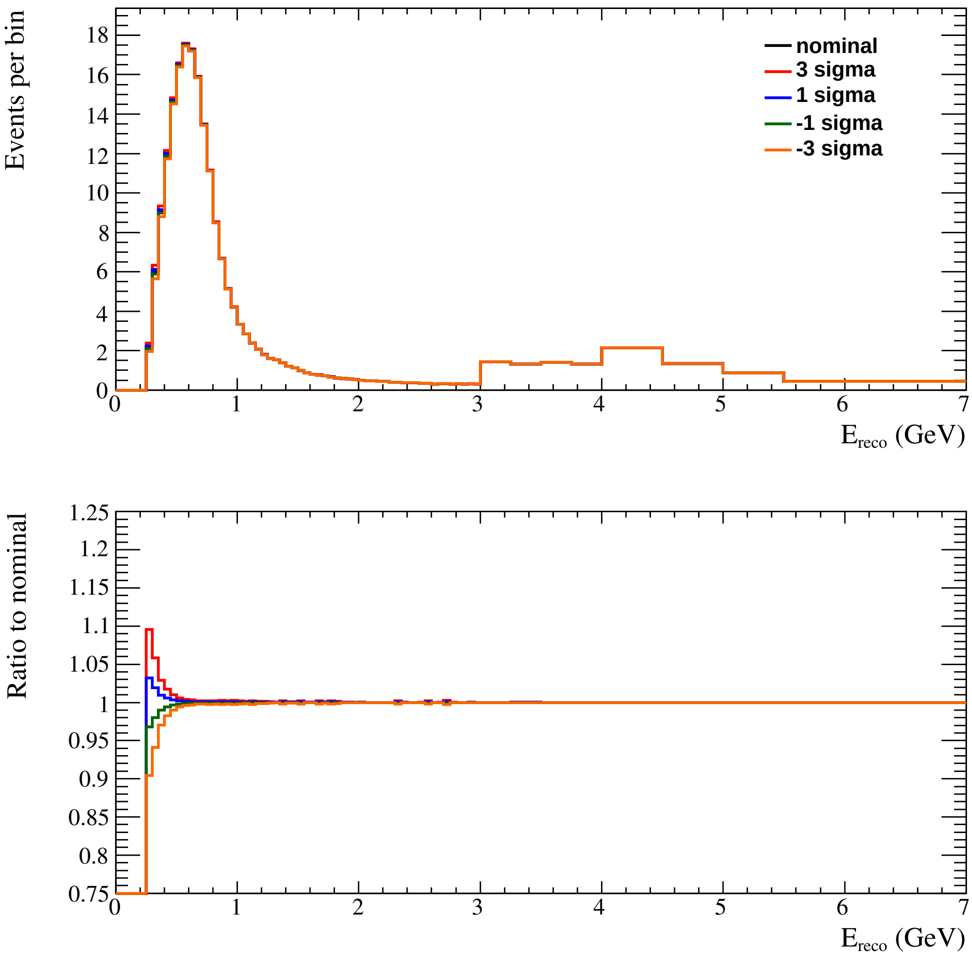


Figure 236: Effect of $f_{NC1\pi^{\pm};t}$ for no oscillations (all mixing angles set to 0).

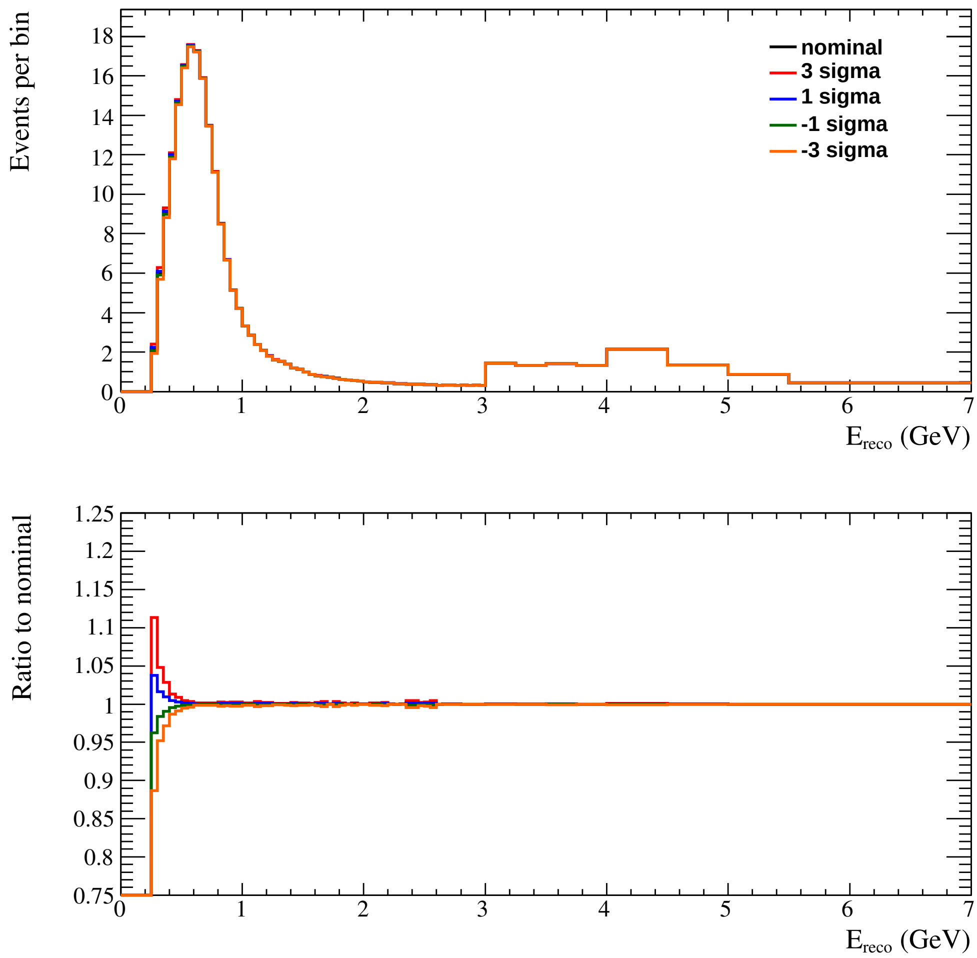


Figure 237: Effect of $f_{NCoth;t}$ for no oscillations (all mixing angles set to 0).

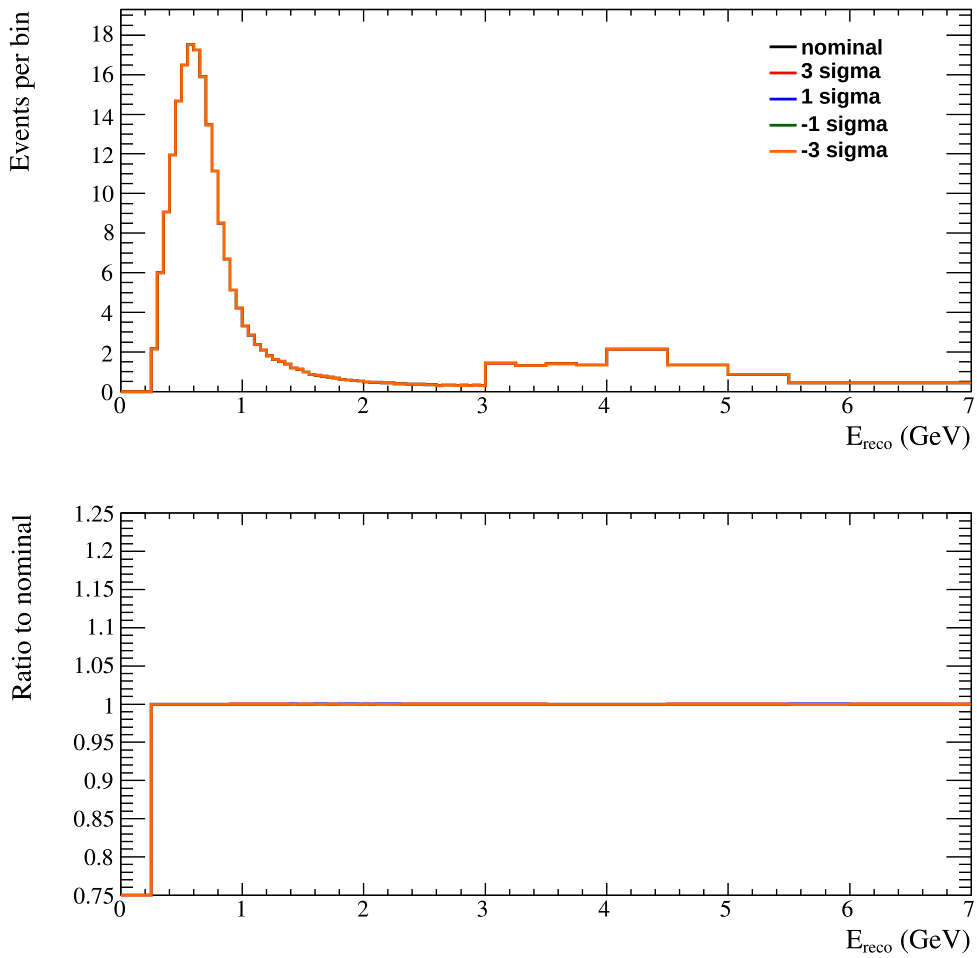


Figure 238: Effect of $f_{CC\nu_e;t}$ for no oscillations (all mixing angles set to 0).

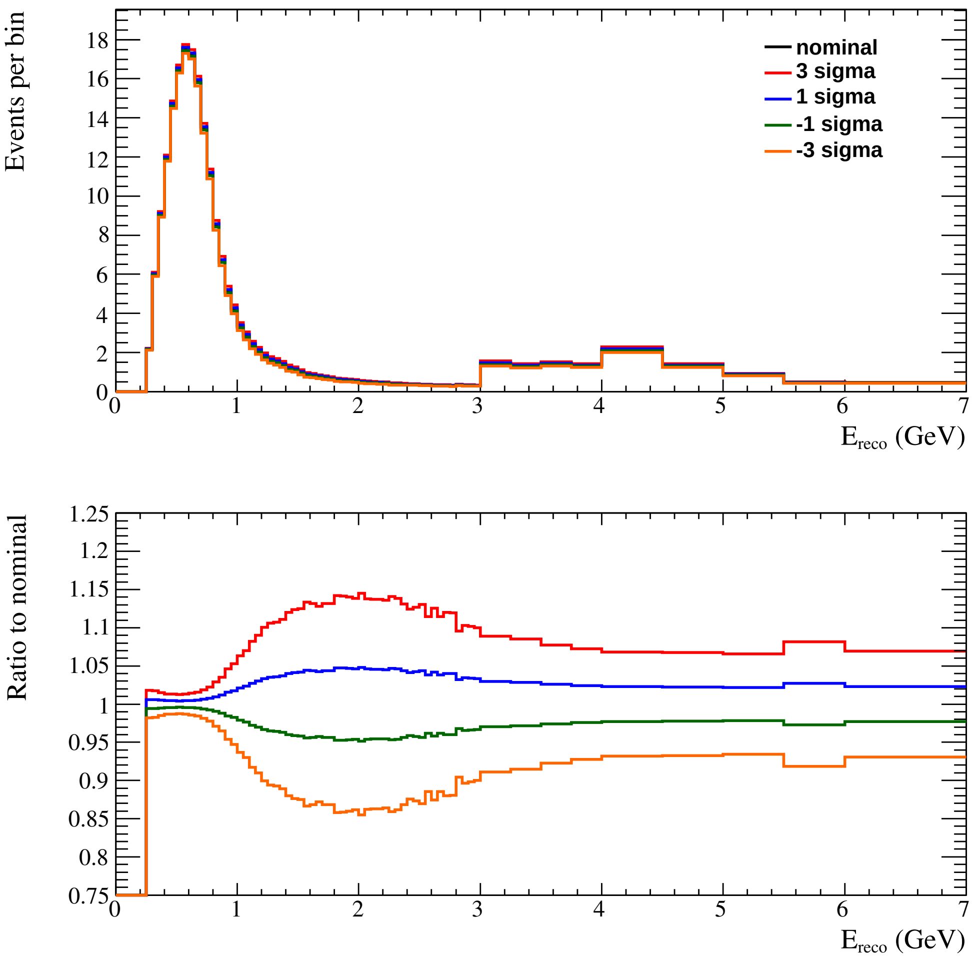


Figure 239: Effect of $f_{CC\bar{\nu};t}$ for no oscillations (all mixing angles set to 0).

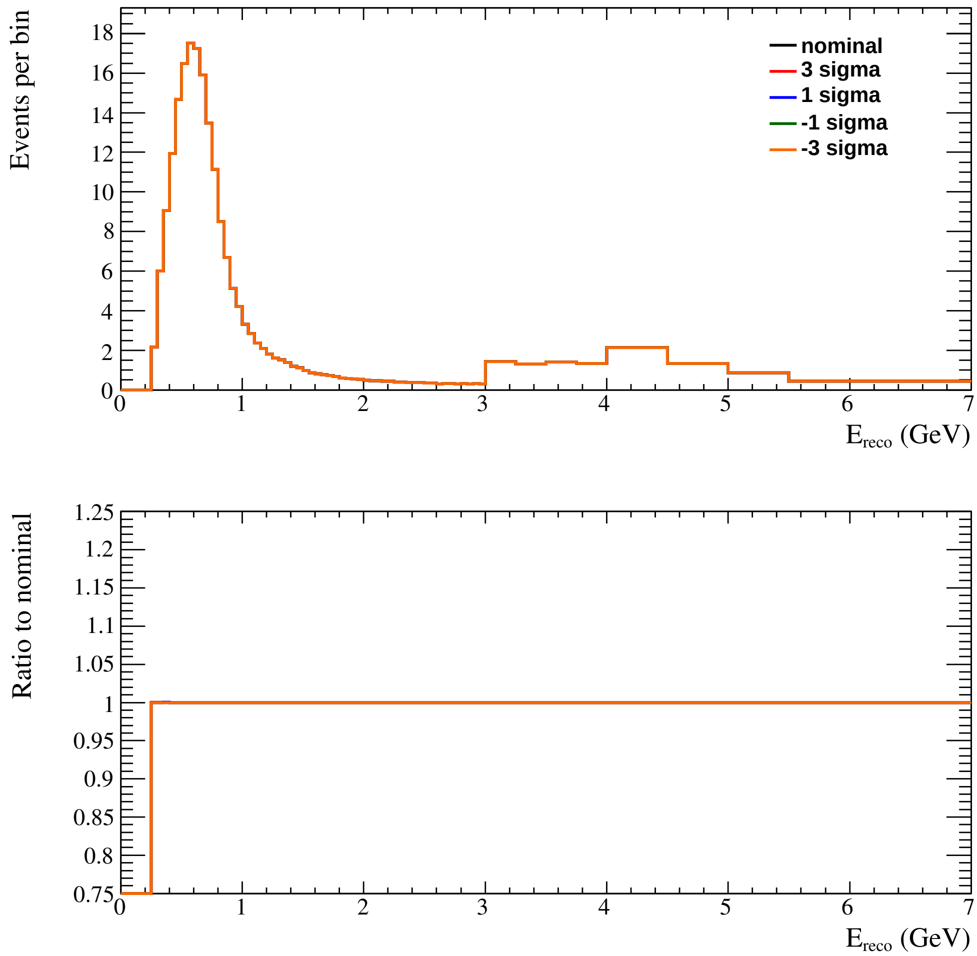


Figure 240: Effect of $f^{FSI}_{0;t,r}$ for no oscillations (all mixing angles set to 0).

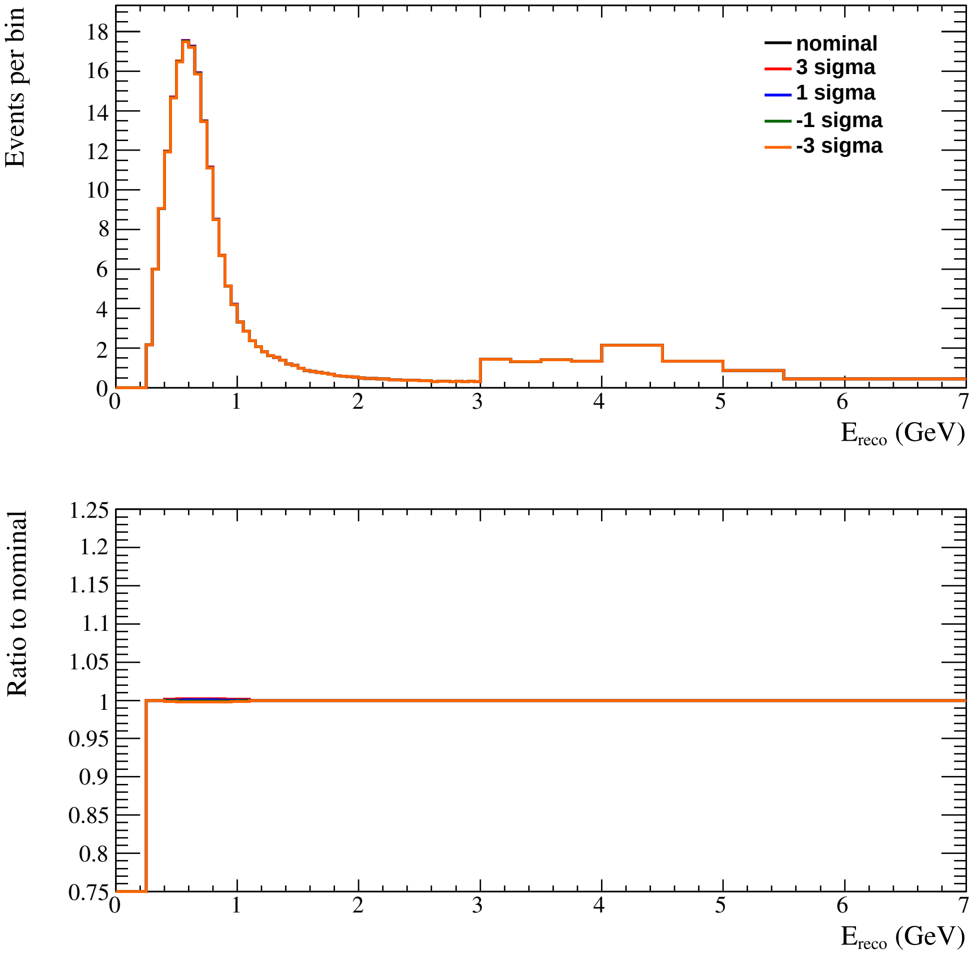


Figure 241: Effect of $f_{1;t,r}^{FSI}$ for no oscillations (all mixing angles set to 0).

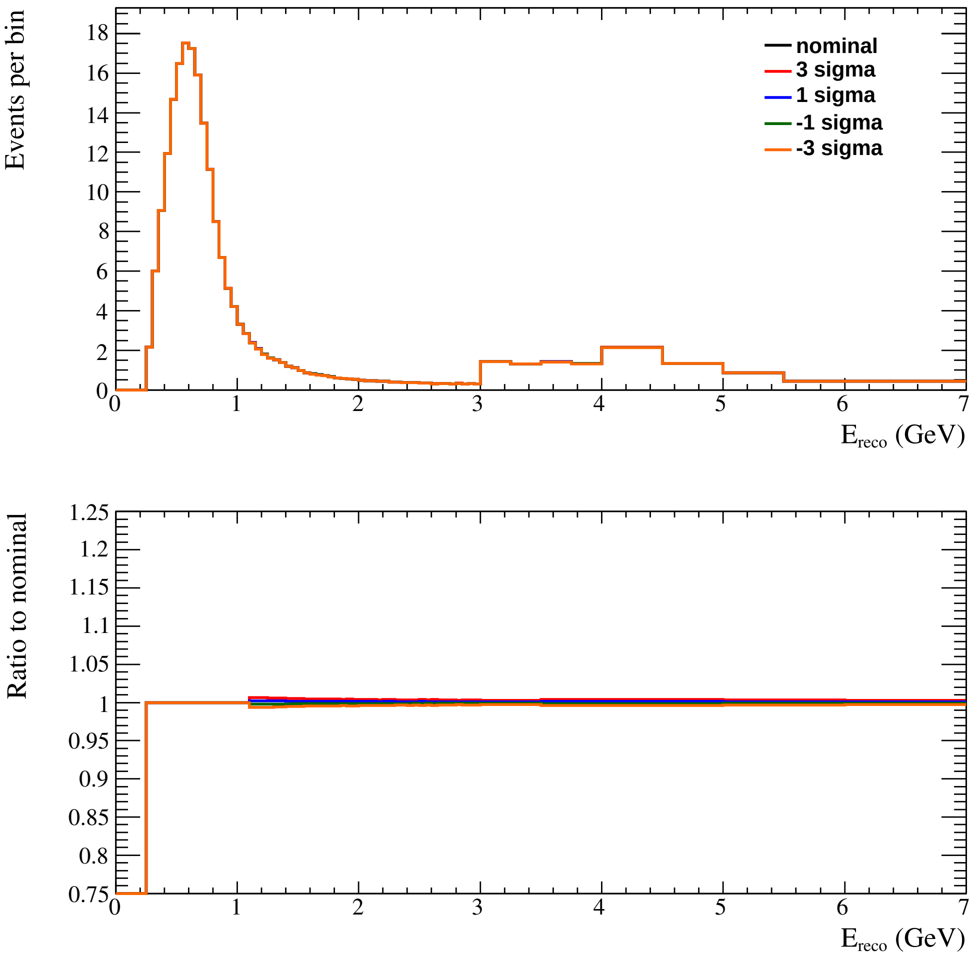


Figure 242: Effect of $f_{2;t,r}^{FSI}$ for no oscillations (all mixing angles set to 0).

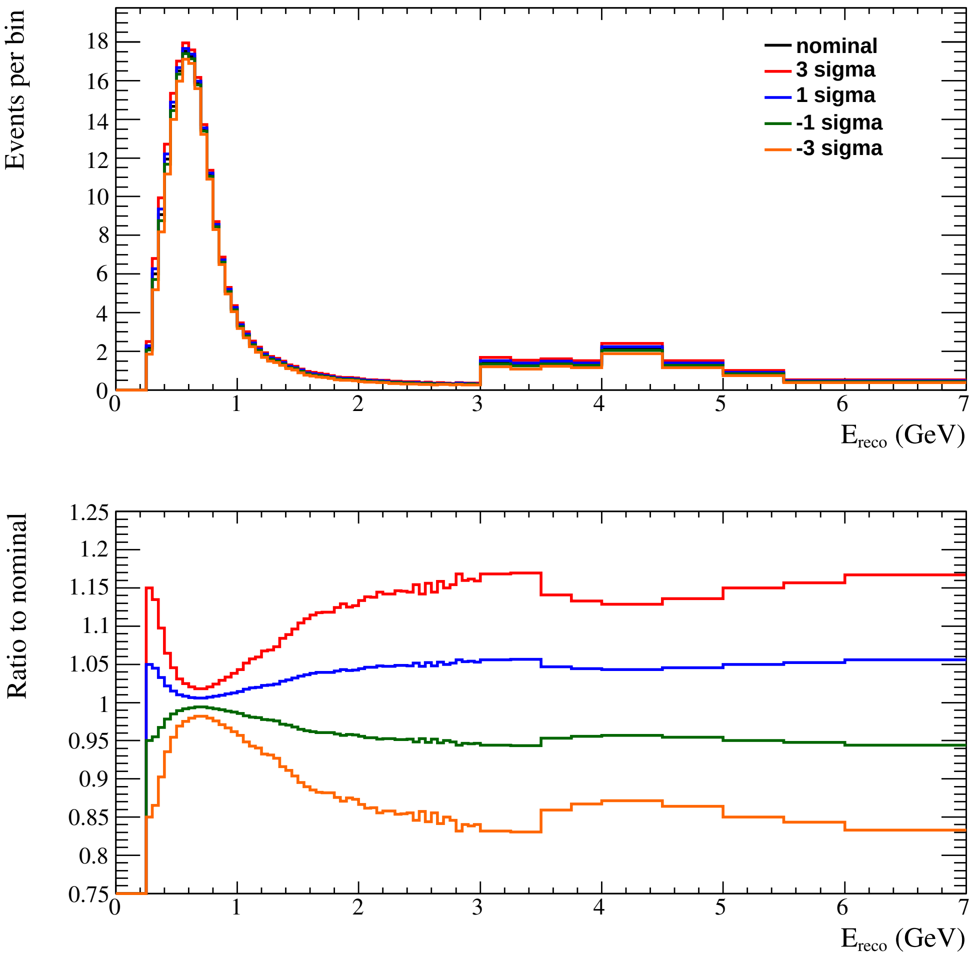


Figure 243: Effect of $f^{FSI}_{3;t,r}$ for no oscillations (all mixing angles set to 0).

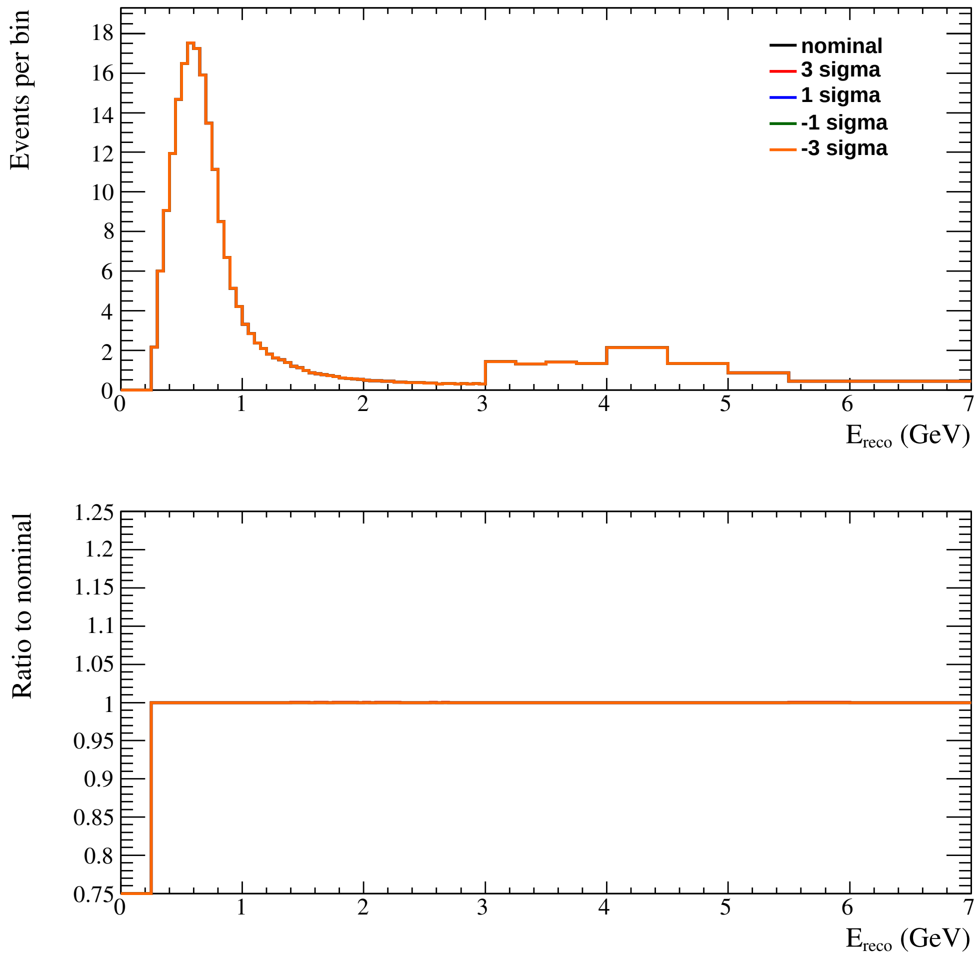


Figure 244: Effect of $f_{4;t,r}^{FSI}$ for no oscillations (all mixing angles set to 0).

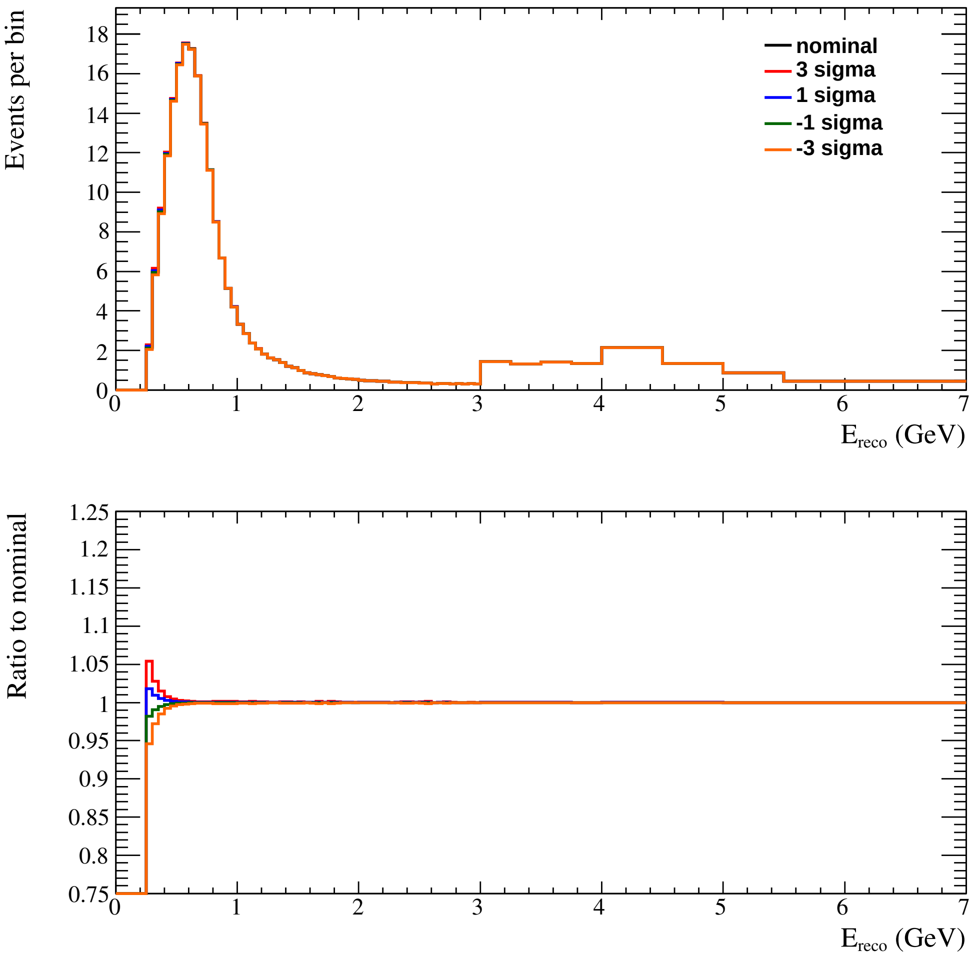


Figure 245: Effect of $f_{5;t,r}^{FSI}$ for no oscillations (all mixing angles set to 0).

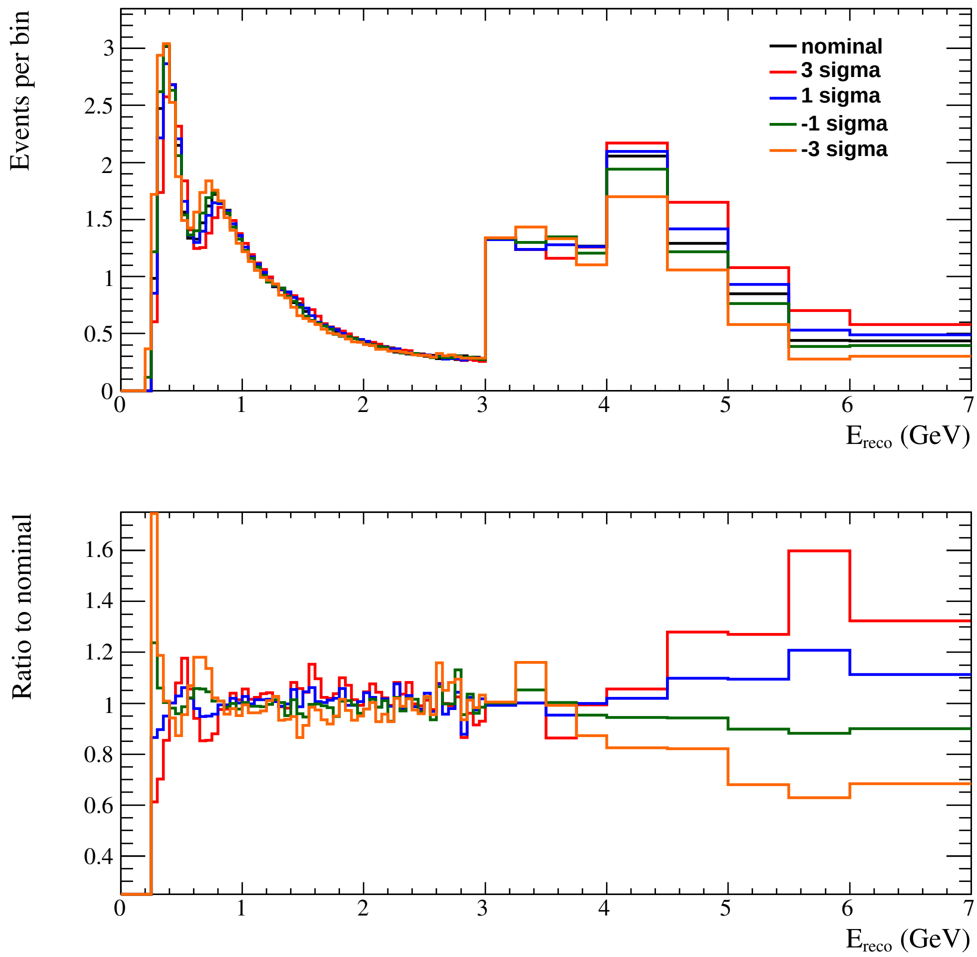


Figure 246: Effect of $f_{E;r}^{SK}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

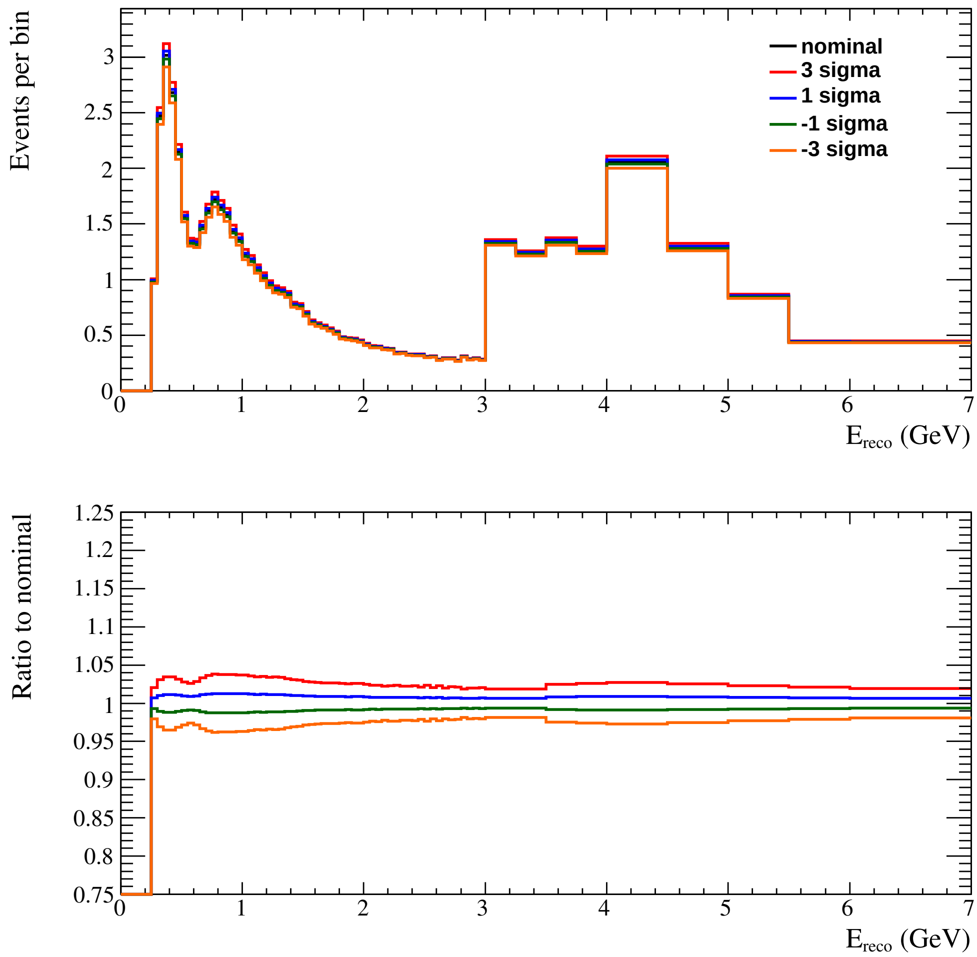


Figure 247: Effect of $f^{SK}_{CCQEoth;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

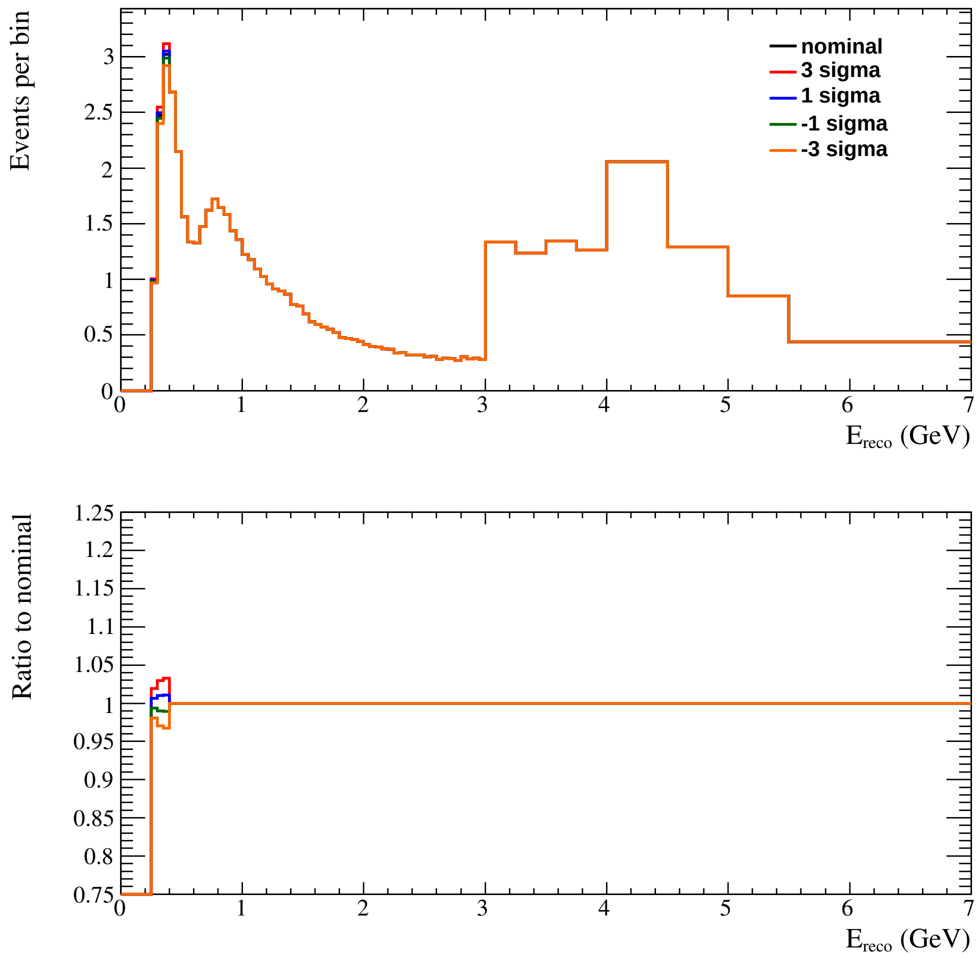


Figure 248: Effect of $f^{SK}_{CCQERC0;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

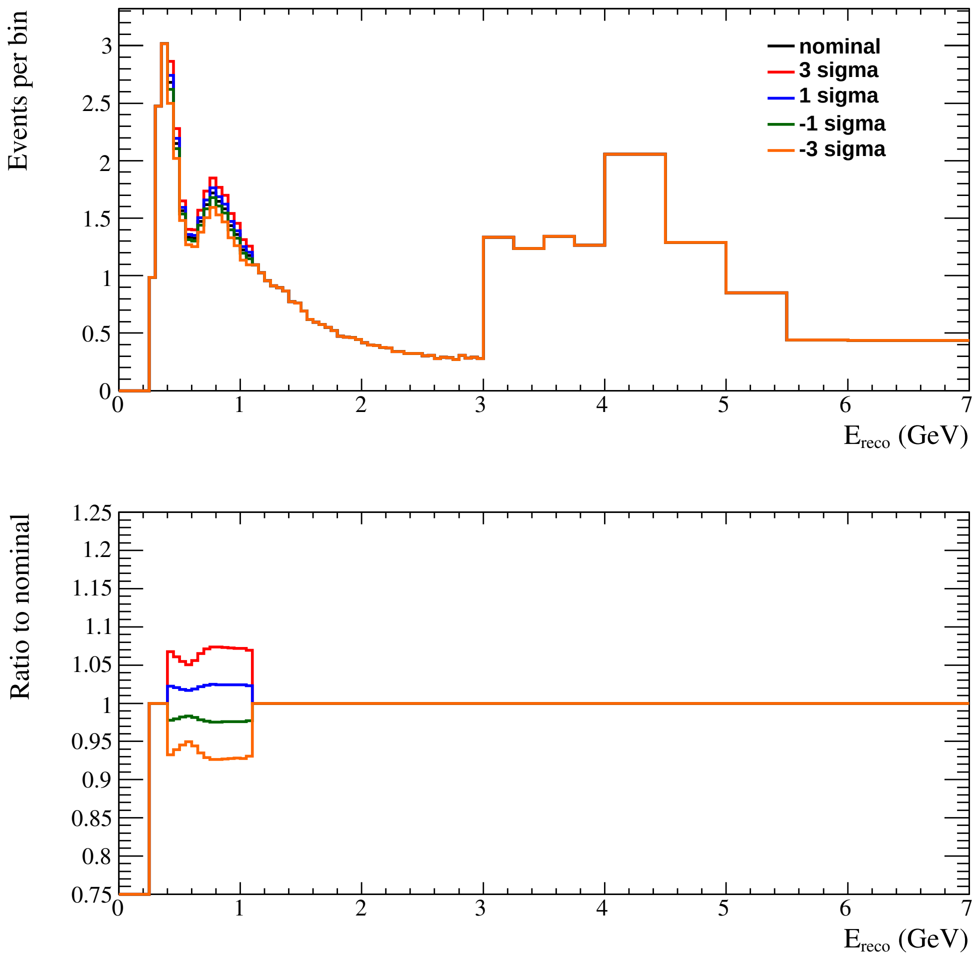


Figure 249: Effect of $f^{SK}_{CCQERC1;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

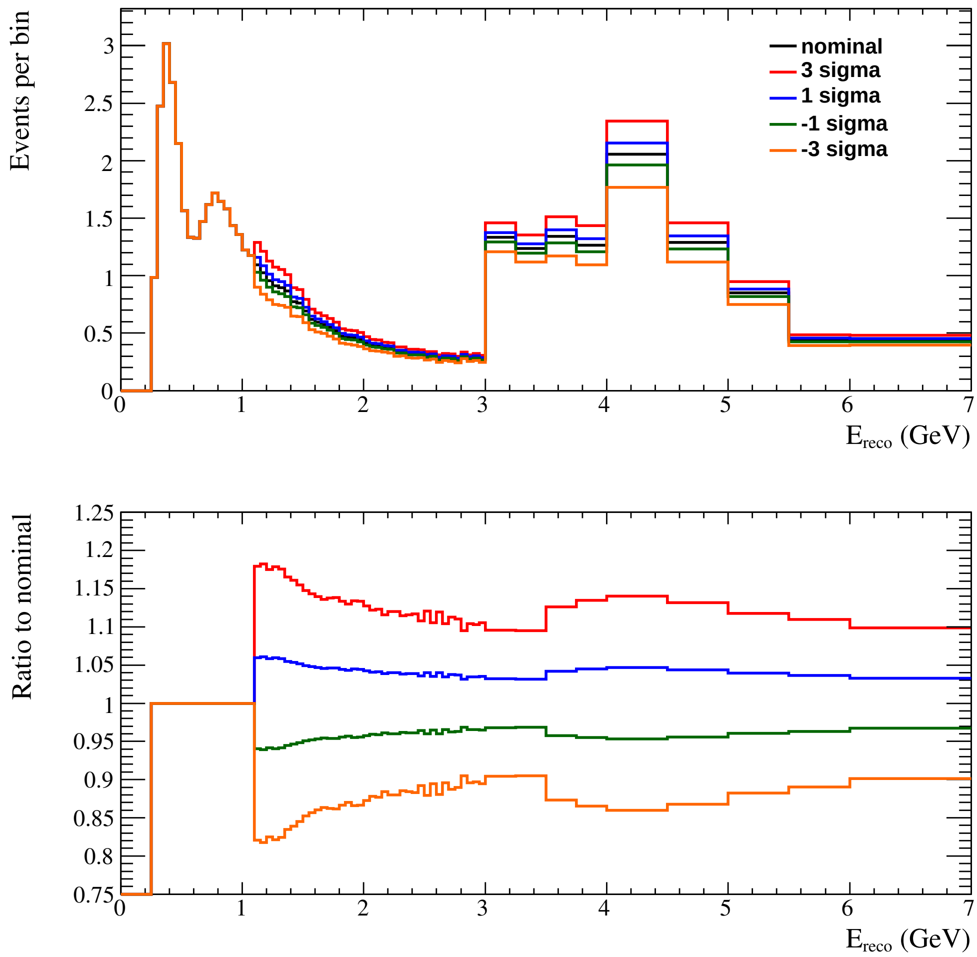


Figure 250: Effect of $f^{SK}_{CCQERC2;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

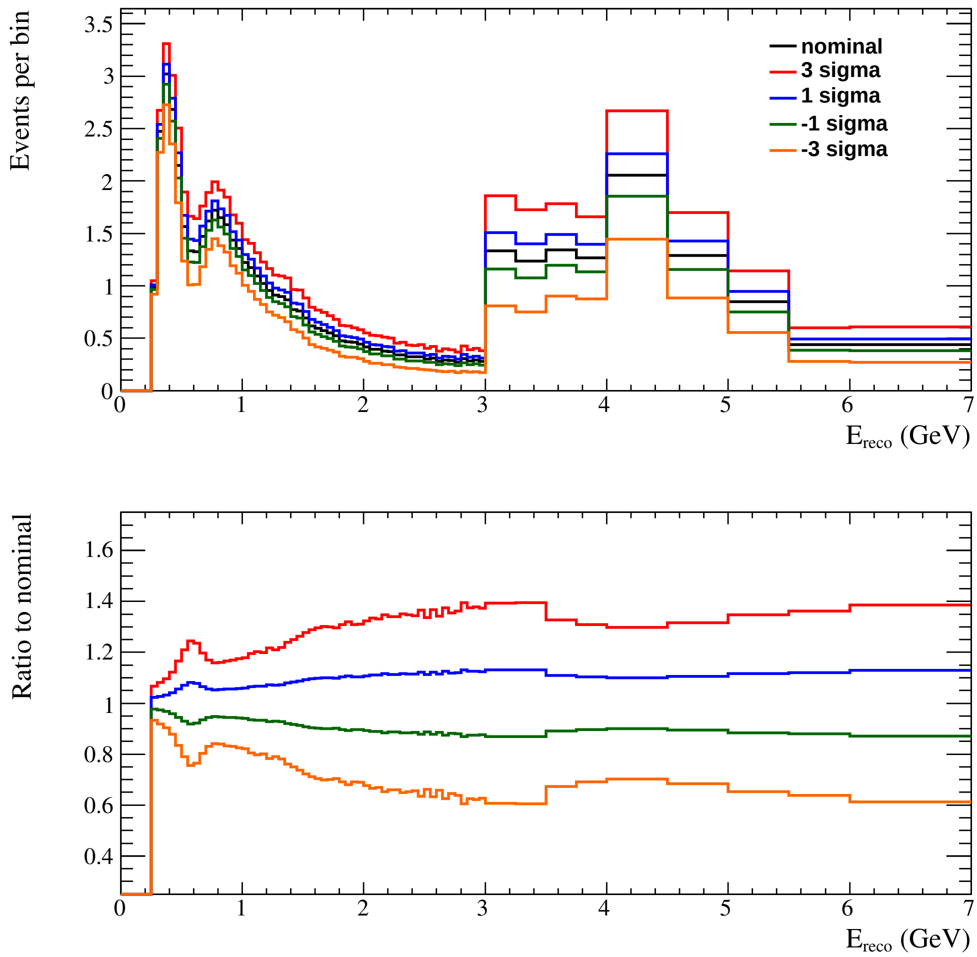


Figure 251: Effect of $f^{SK}_{CCnQE;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

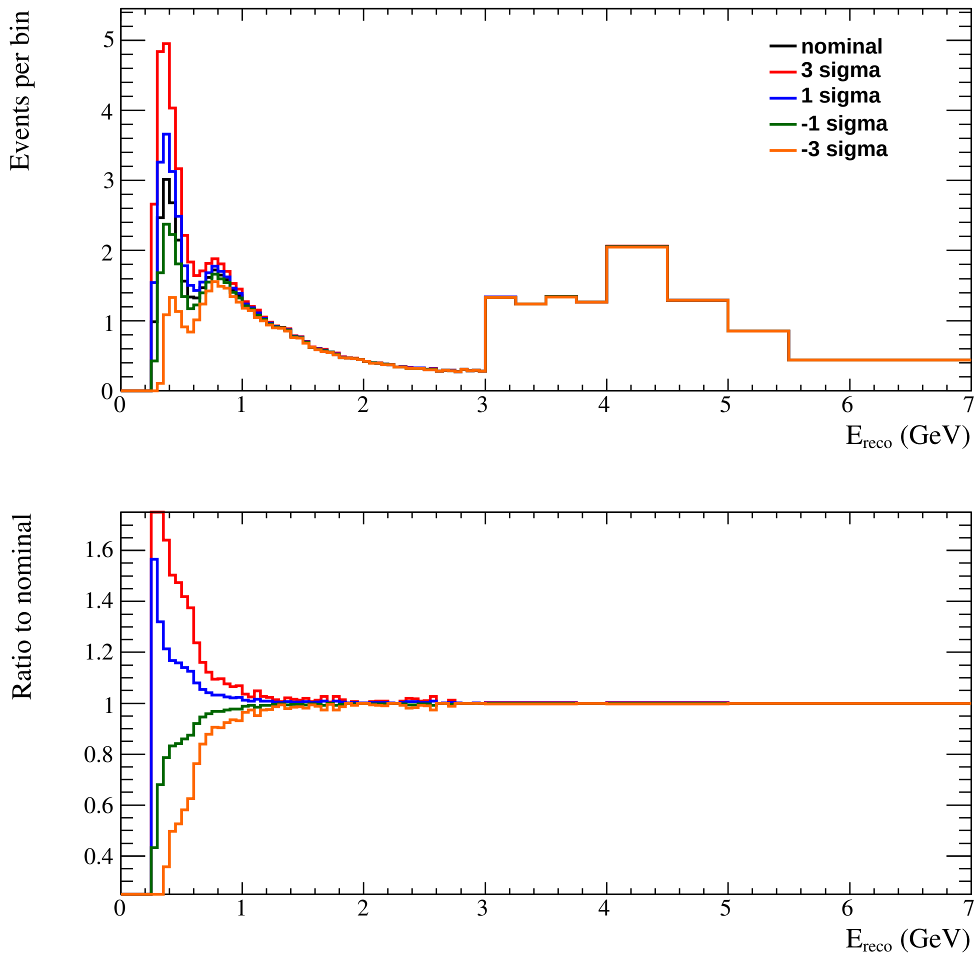


Figure 252: Effect of $f^{SK}_{NC;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

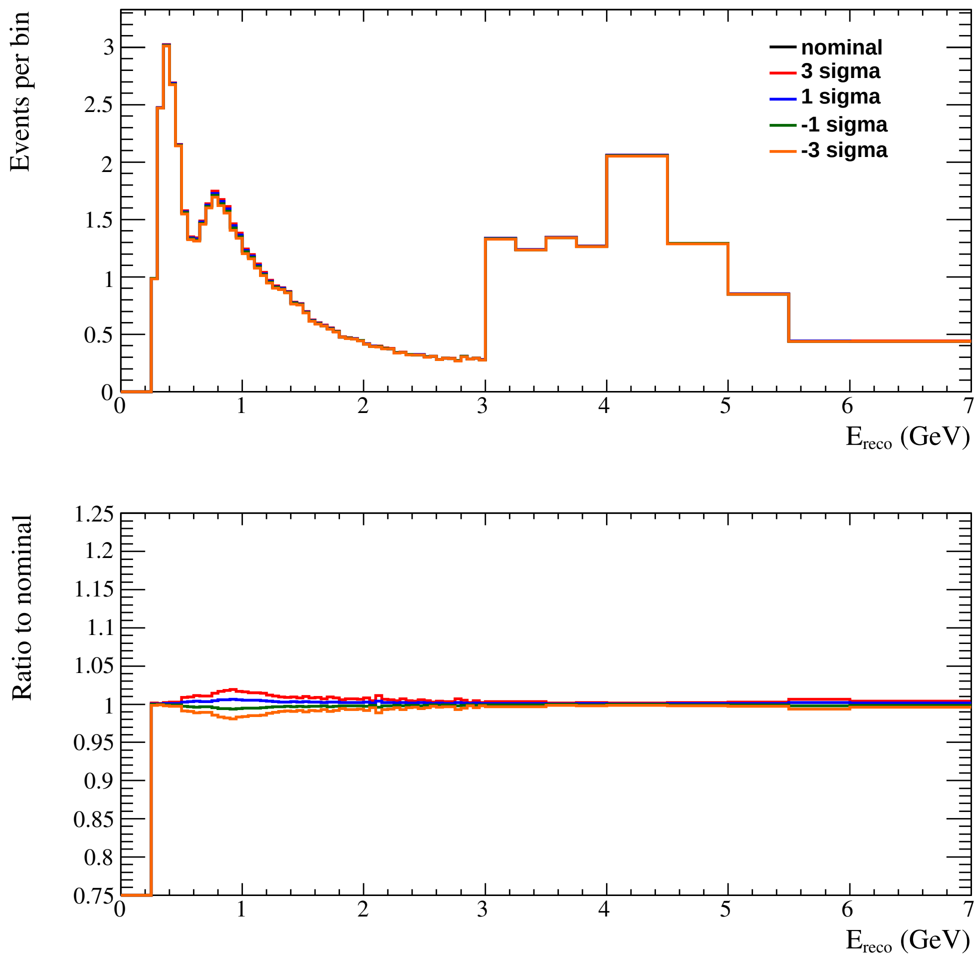


Figure 253: Effect of $f^{SK}_{\nu_e;r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

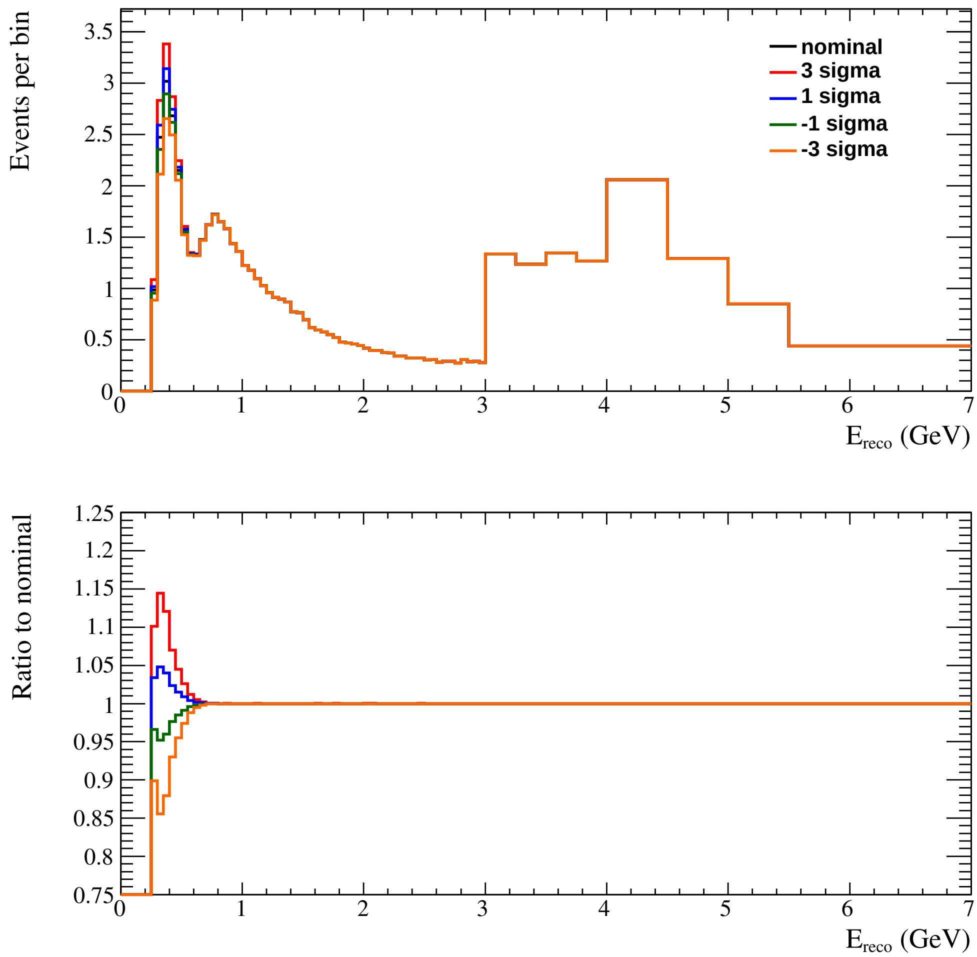


Figure 254: Effect of $f_{0;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

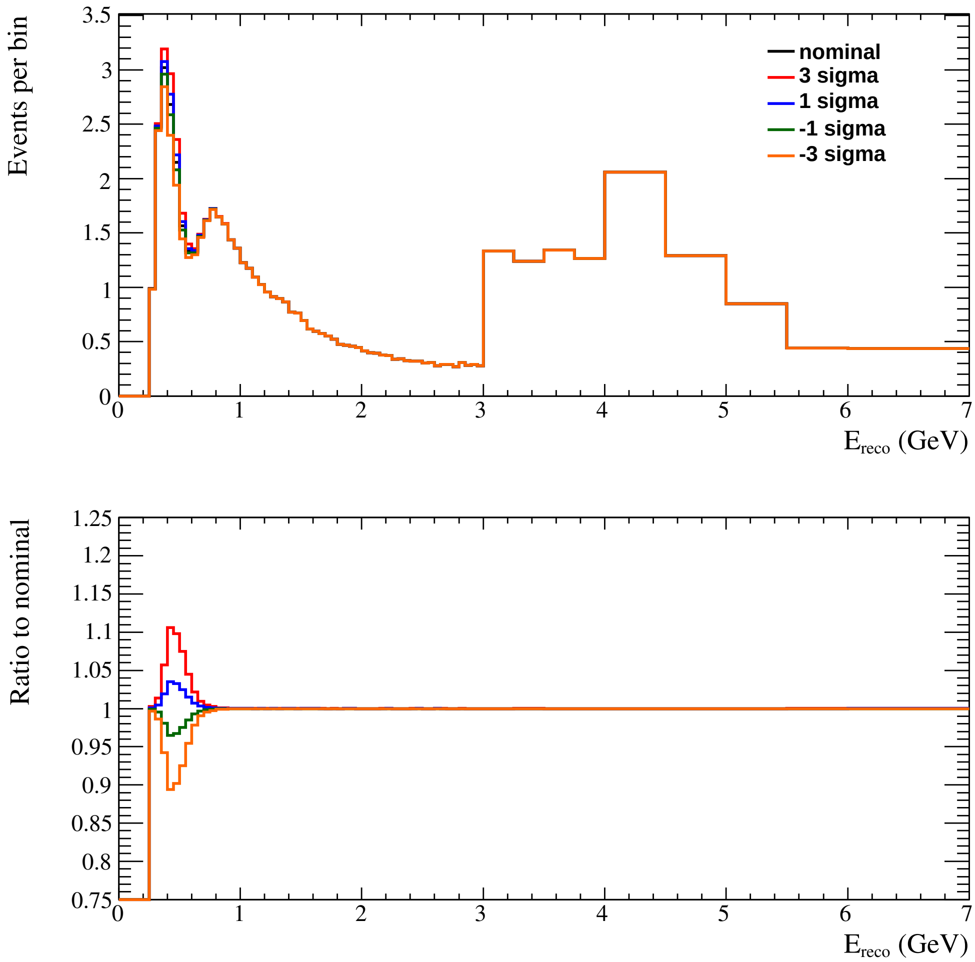


Figure 255: Effect of $f^{banff}_{1;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

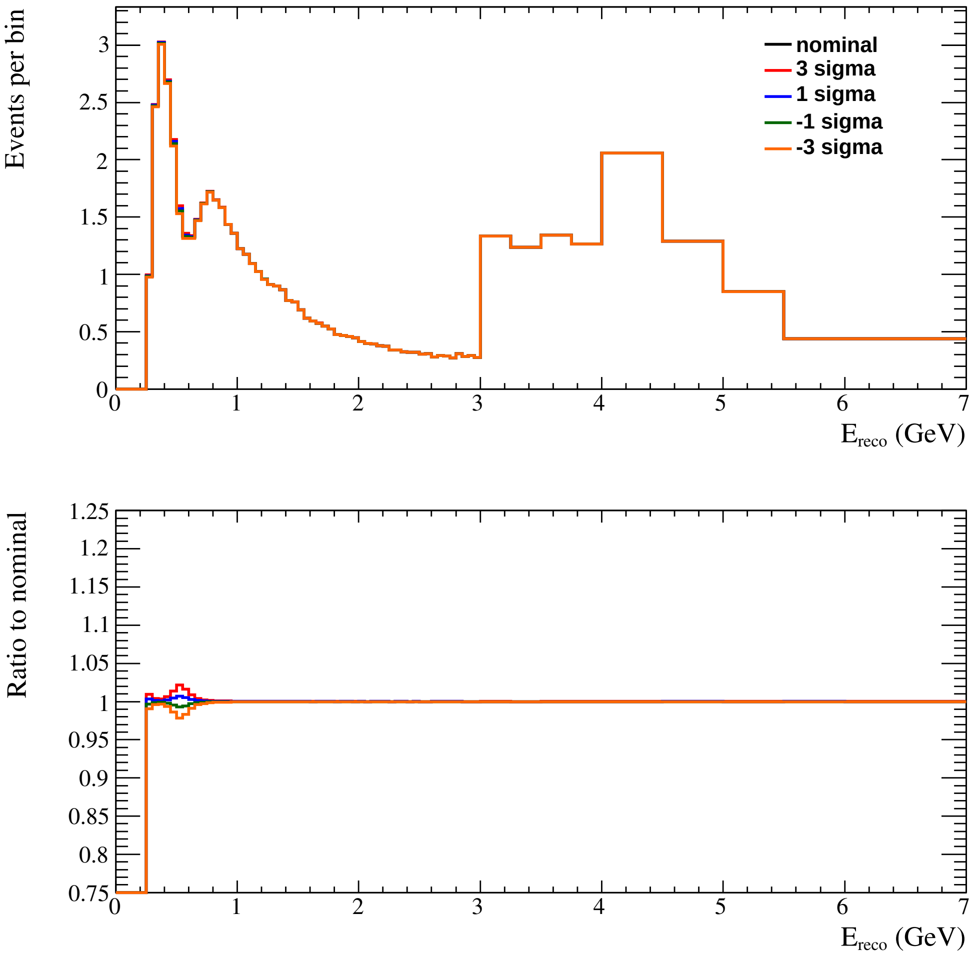


Figure 256: Effect of $f_{2;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

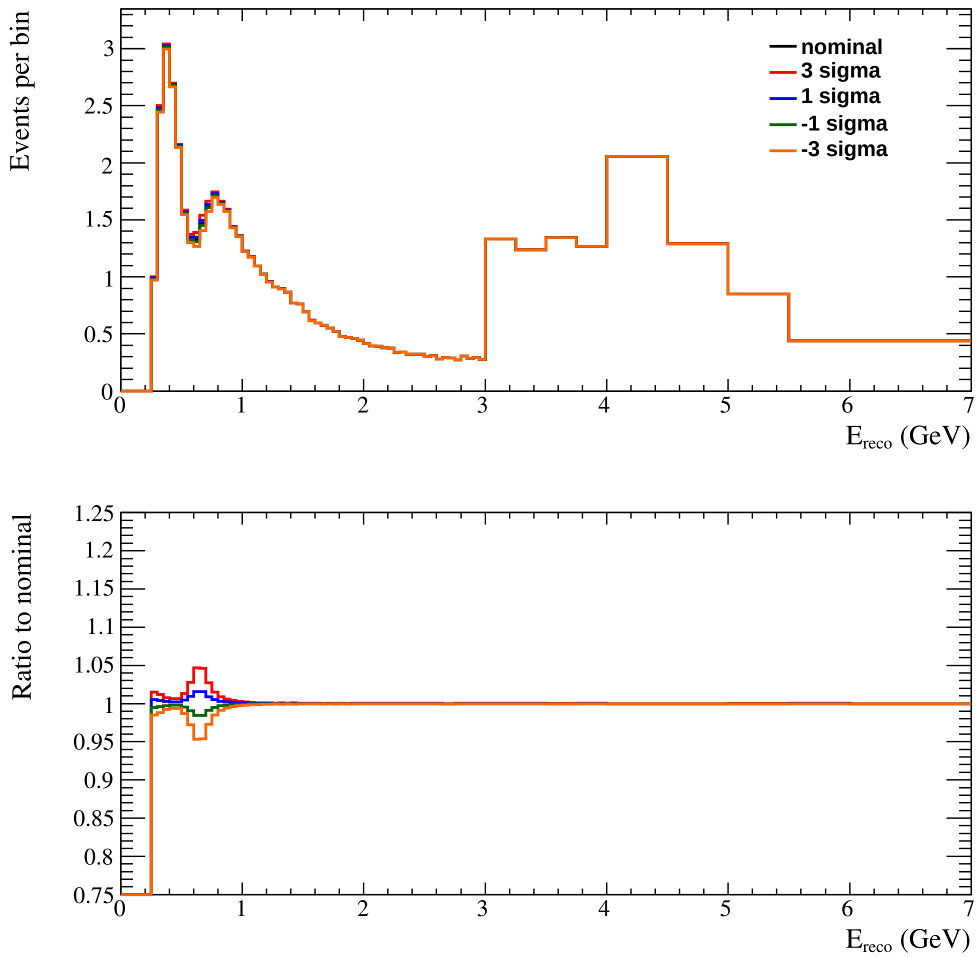


Figure 257: Effect of $f_{3;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

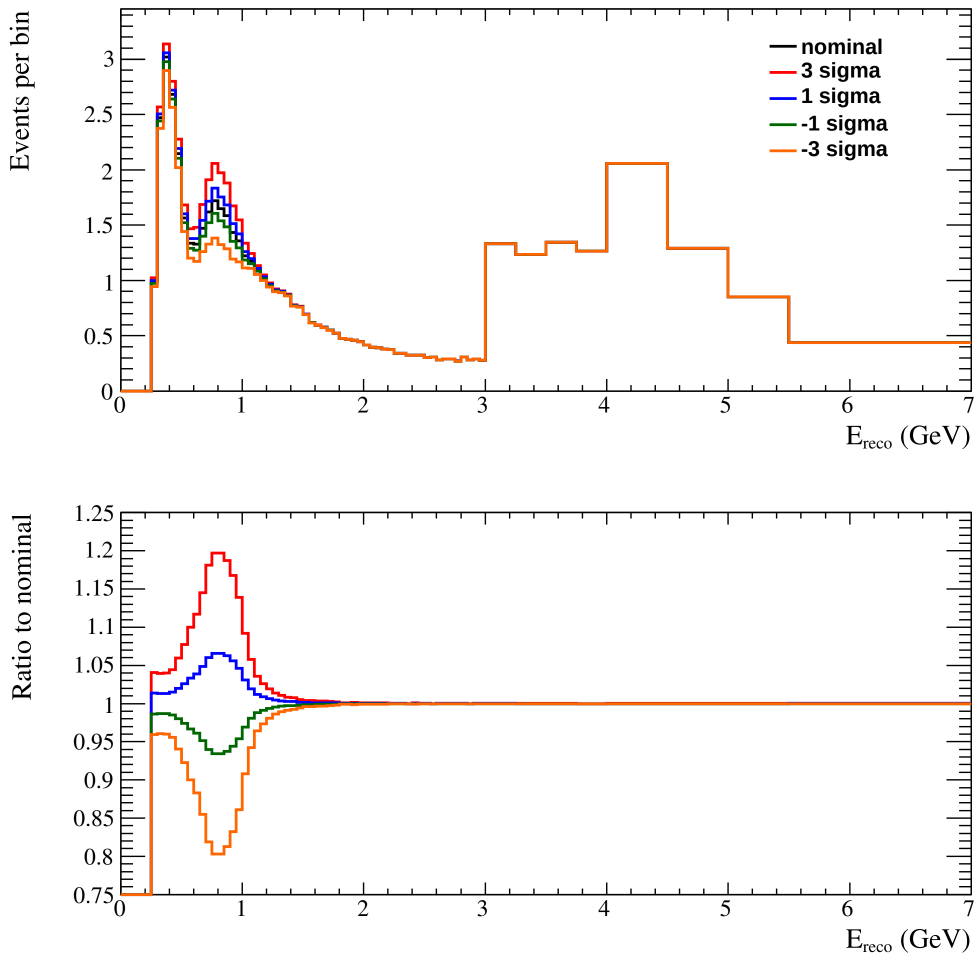


Figure 258: Effect of $f_{4;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

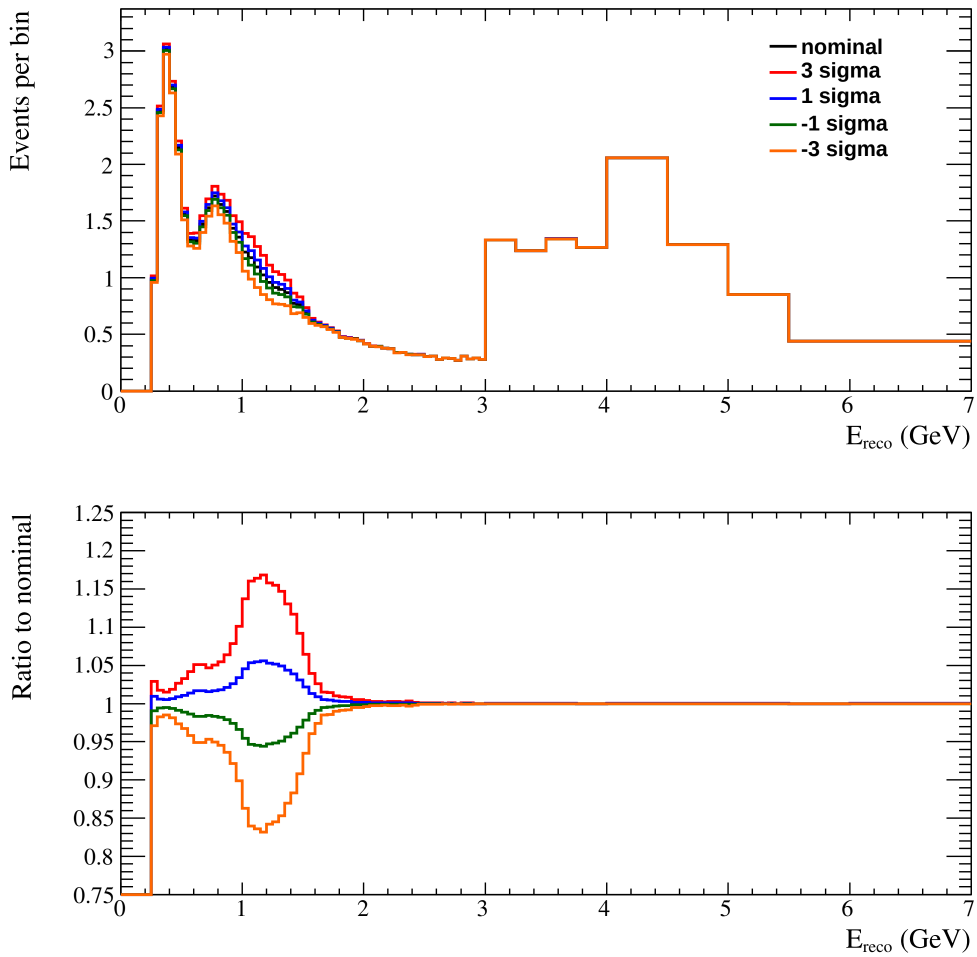


Figure 259: Effect of $f^{banff}_{5;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

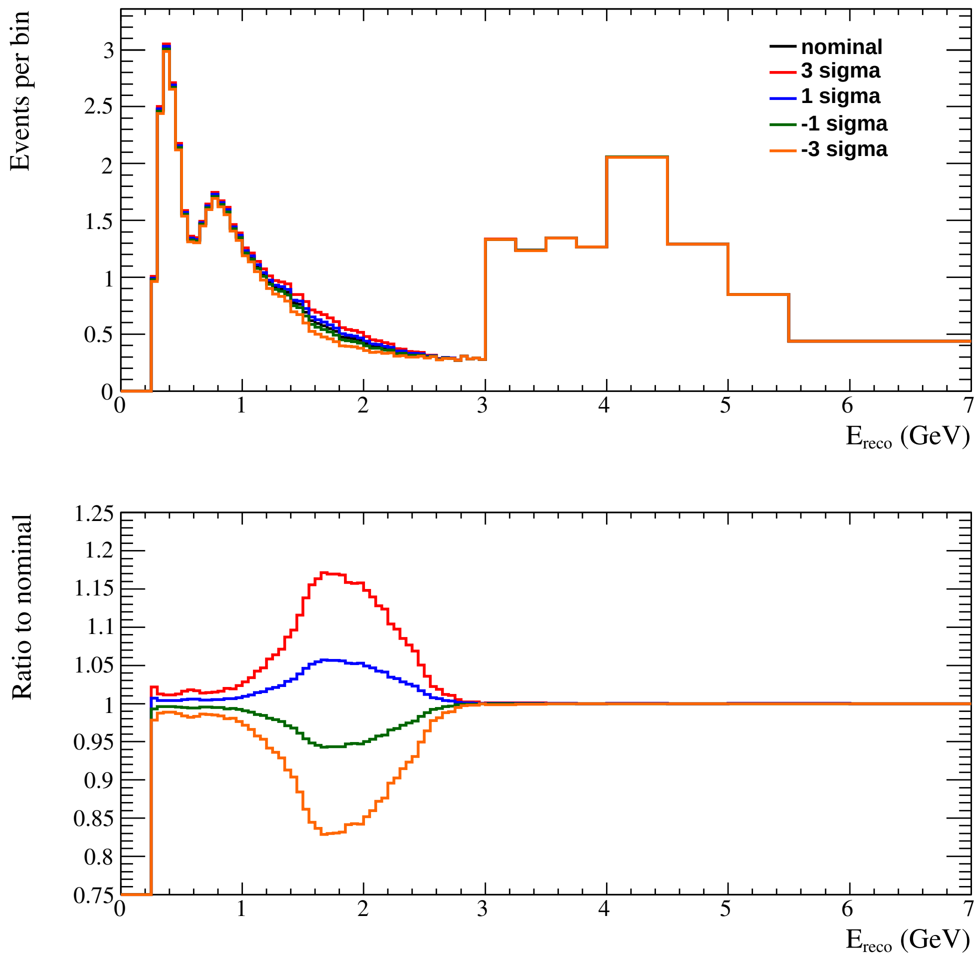


Figure 260: Effect of $f_{6;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

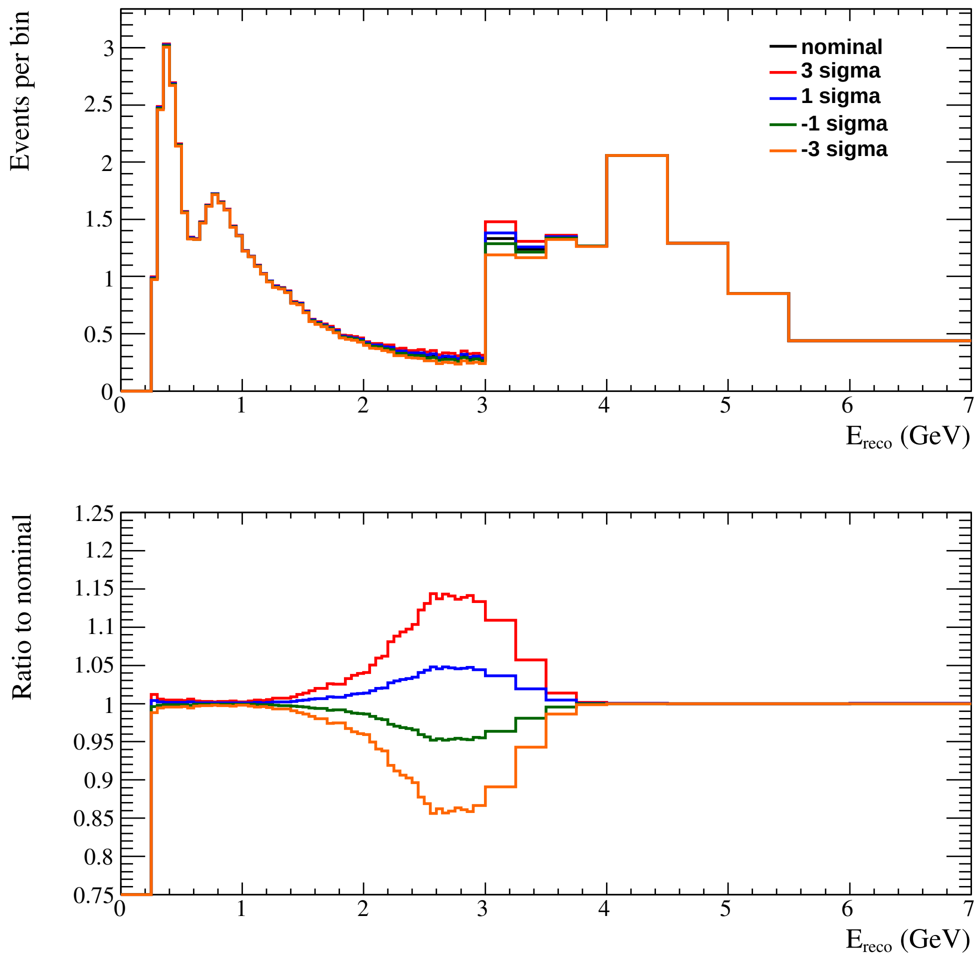


Figure 261: Effect of $f_{7;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

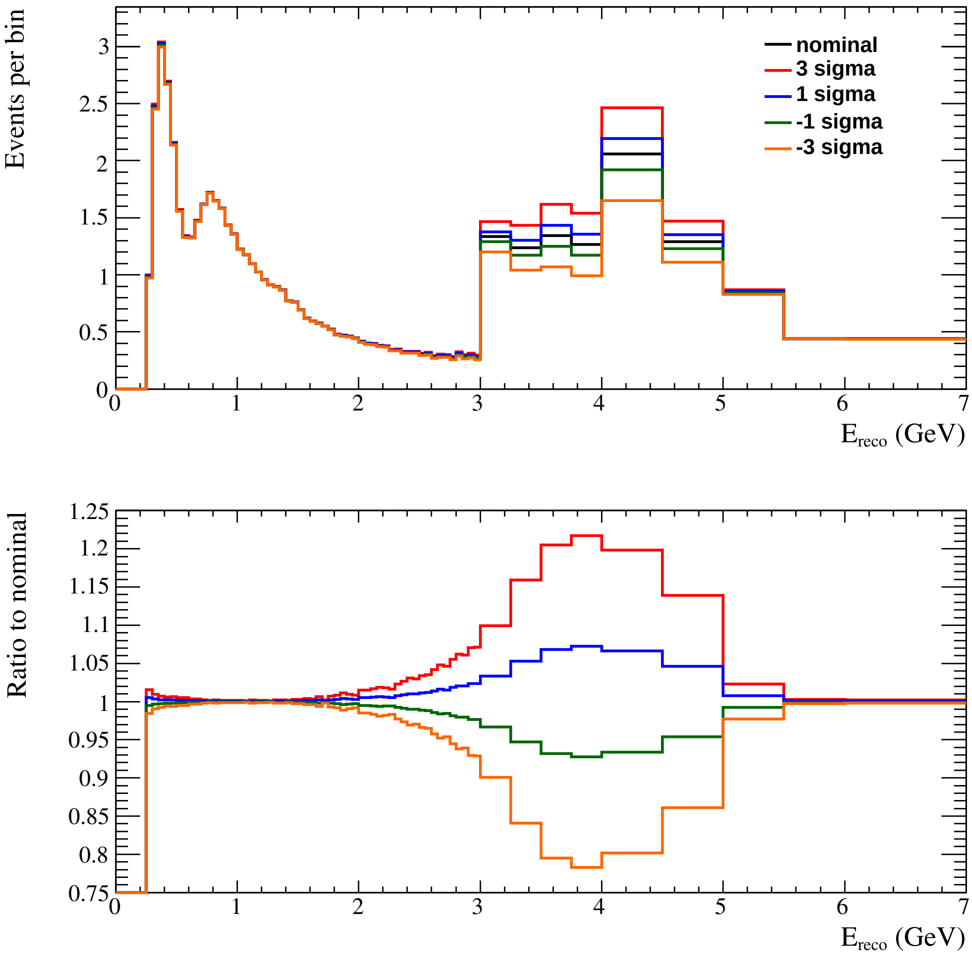
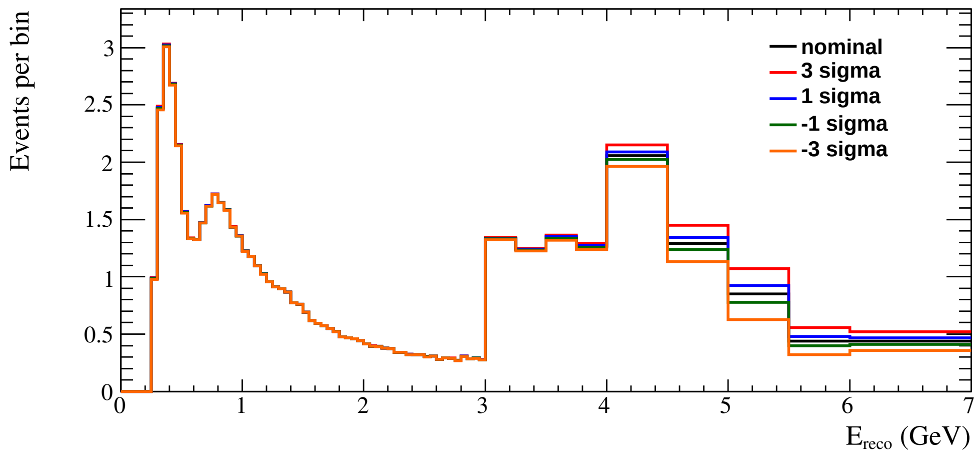


Figure 262: Effect of $f_{8;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.



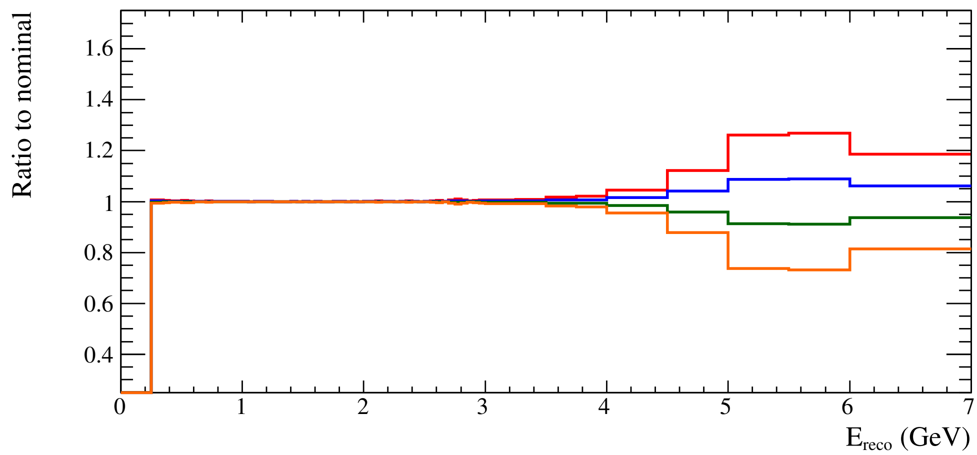


Figure 263: Effect of $f_{9;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

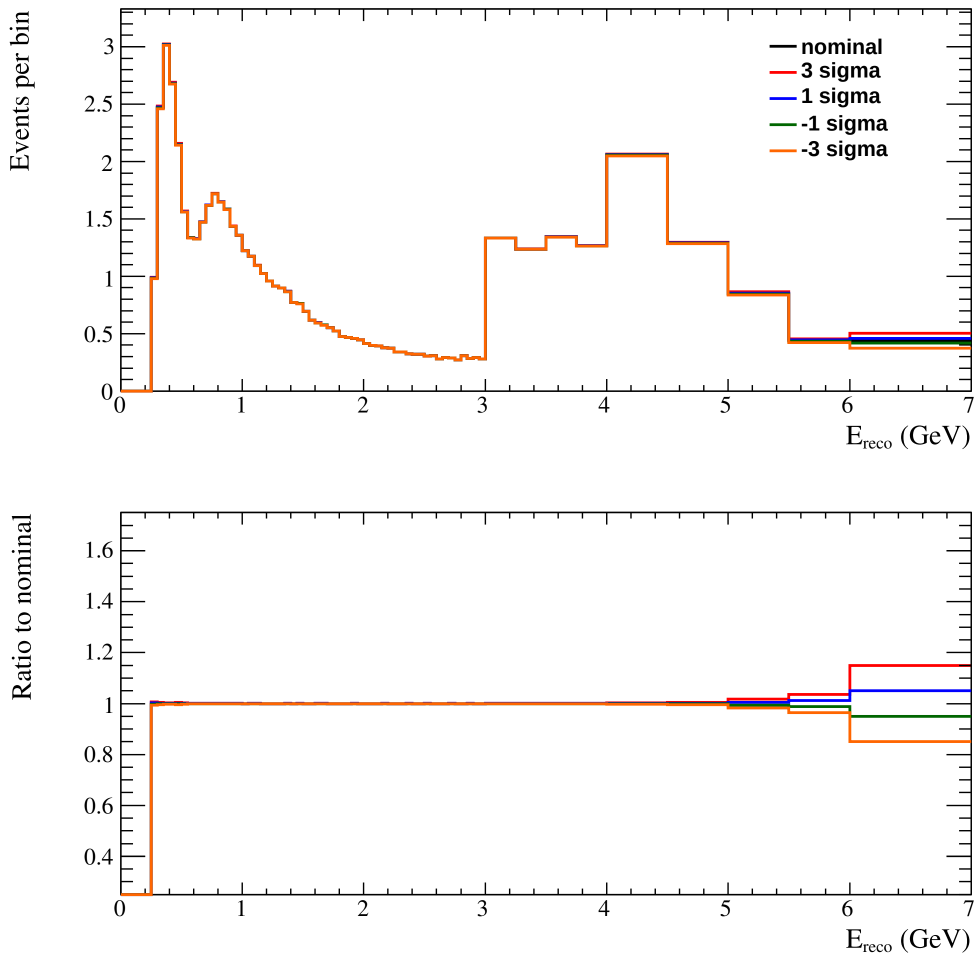


Figure 264: Effect of $f^{banff}_{10;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

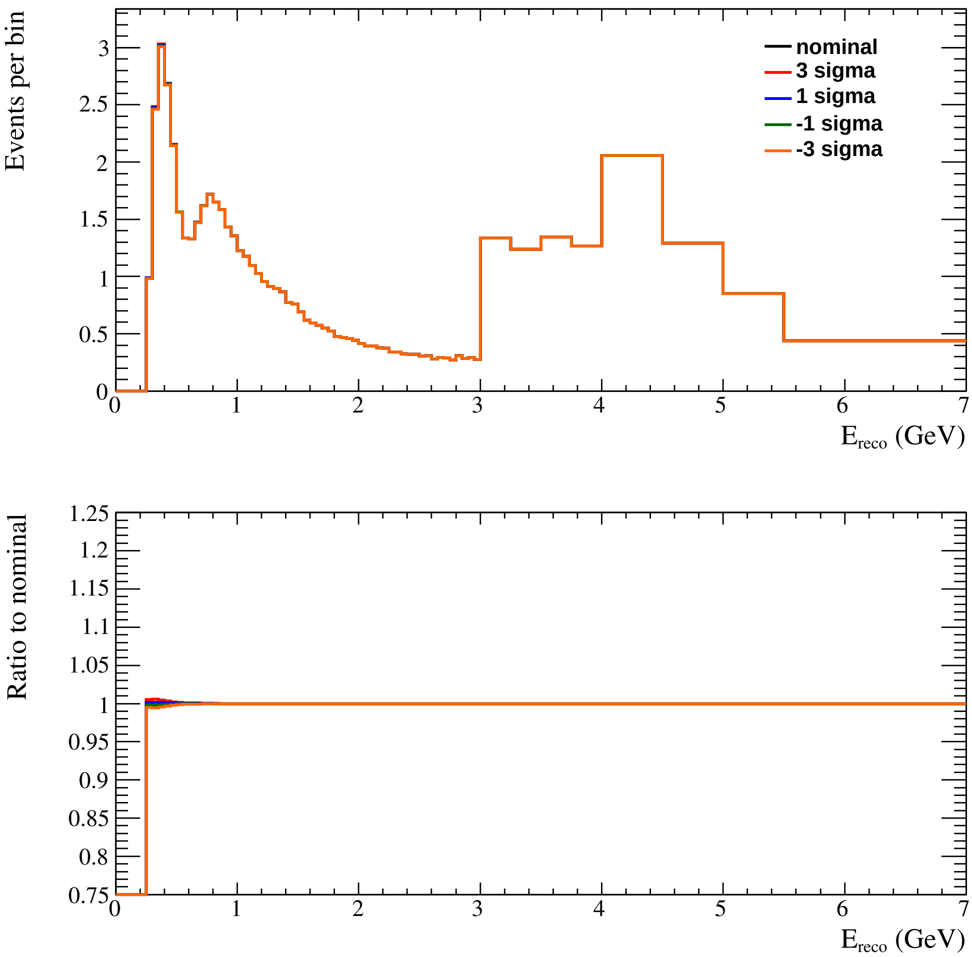


Figure 265: Effect of $f_{11;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

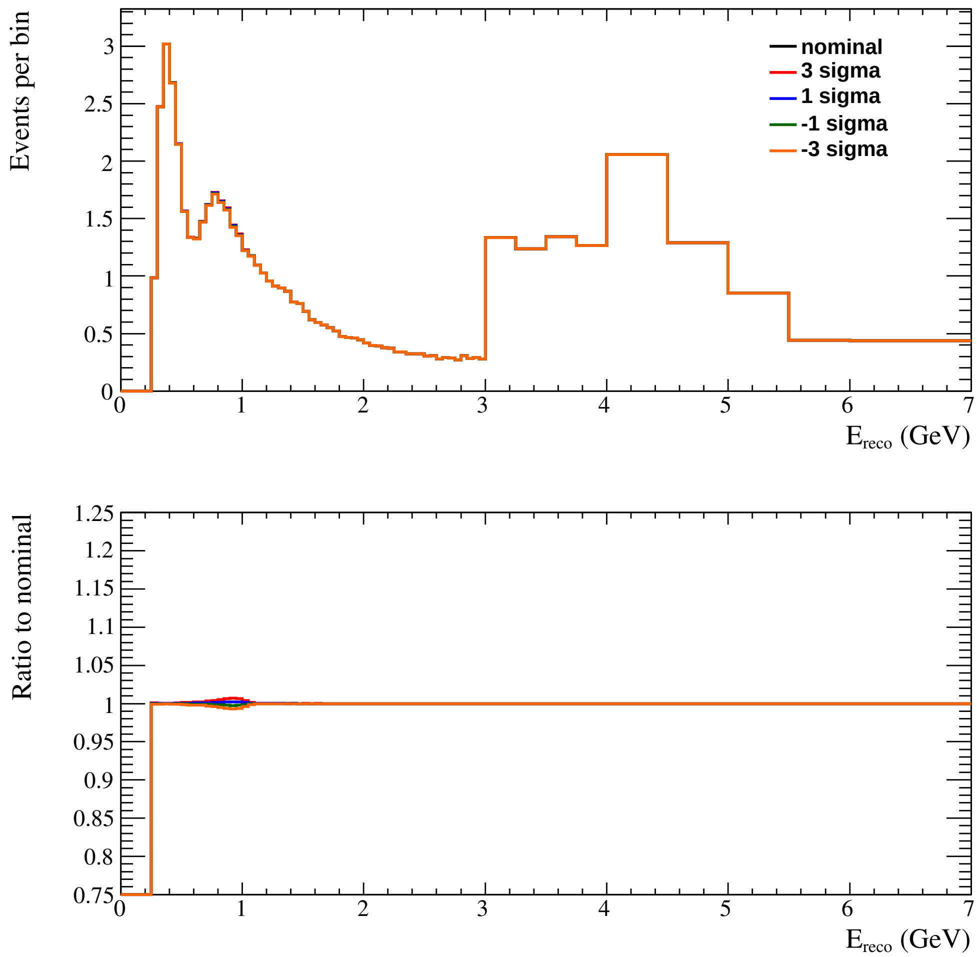


Figure 266: Effect of $f^{banff}_{12;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

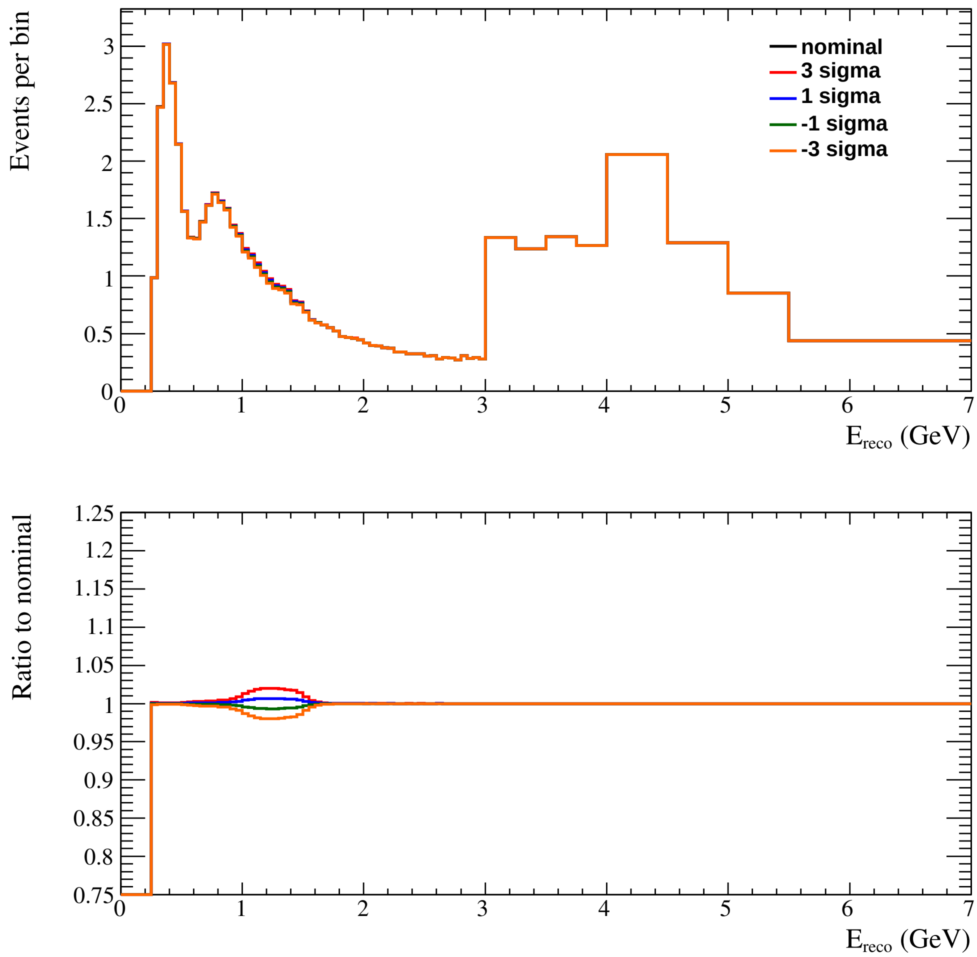


Figure 267: Effect of $f_{13;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

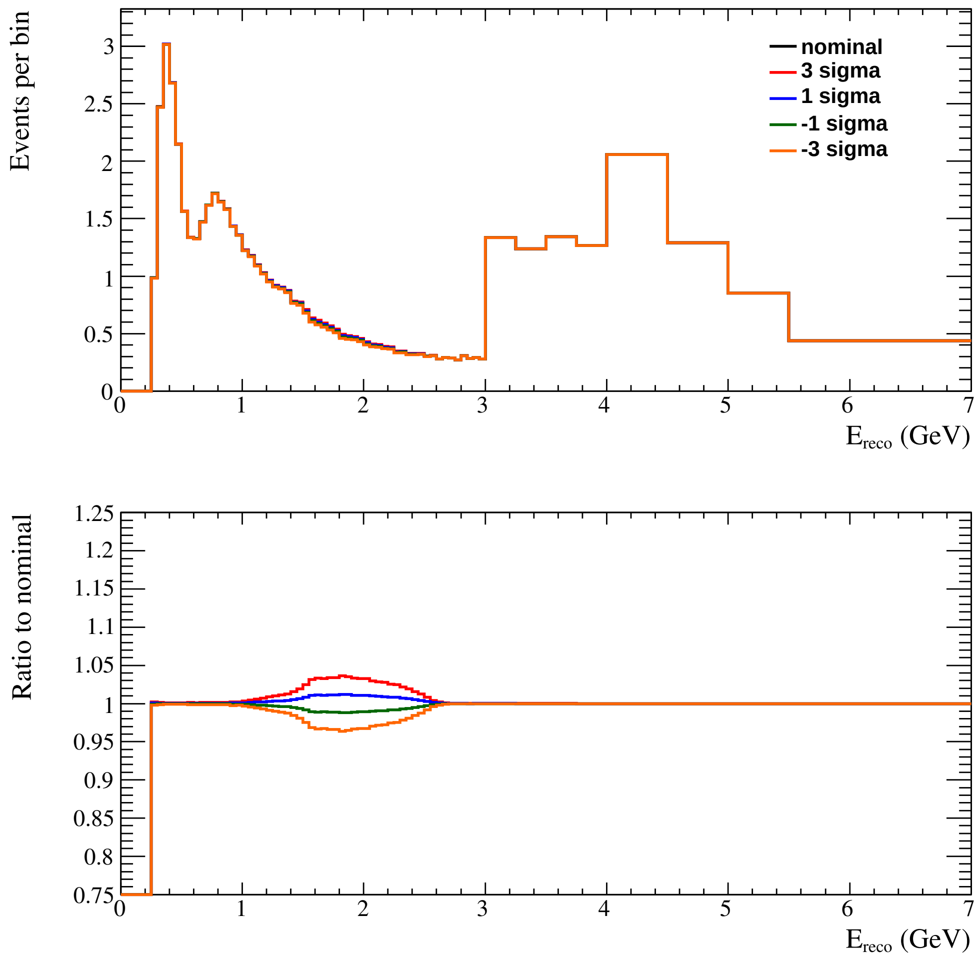


Figure 268: Effect of $f^{banff}_{14;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

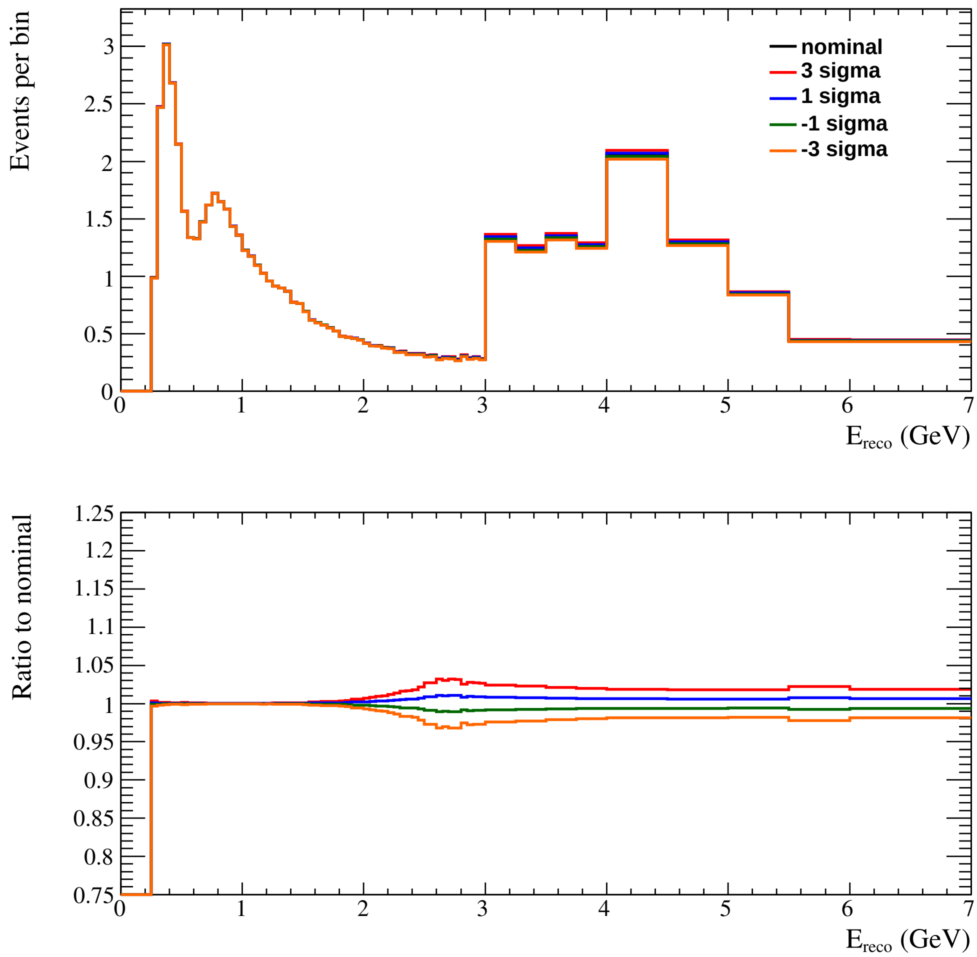


Figure 269: Effect of $f_{15;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

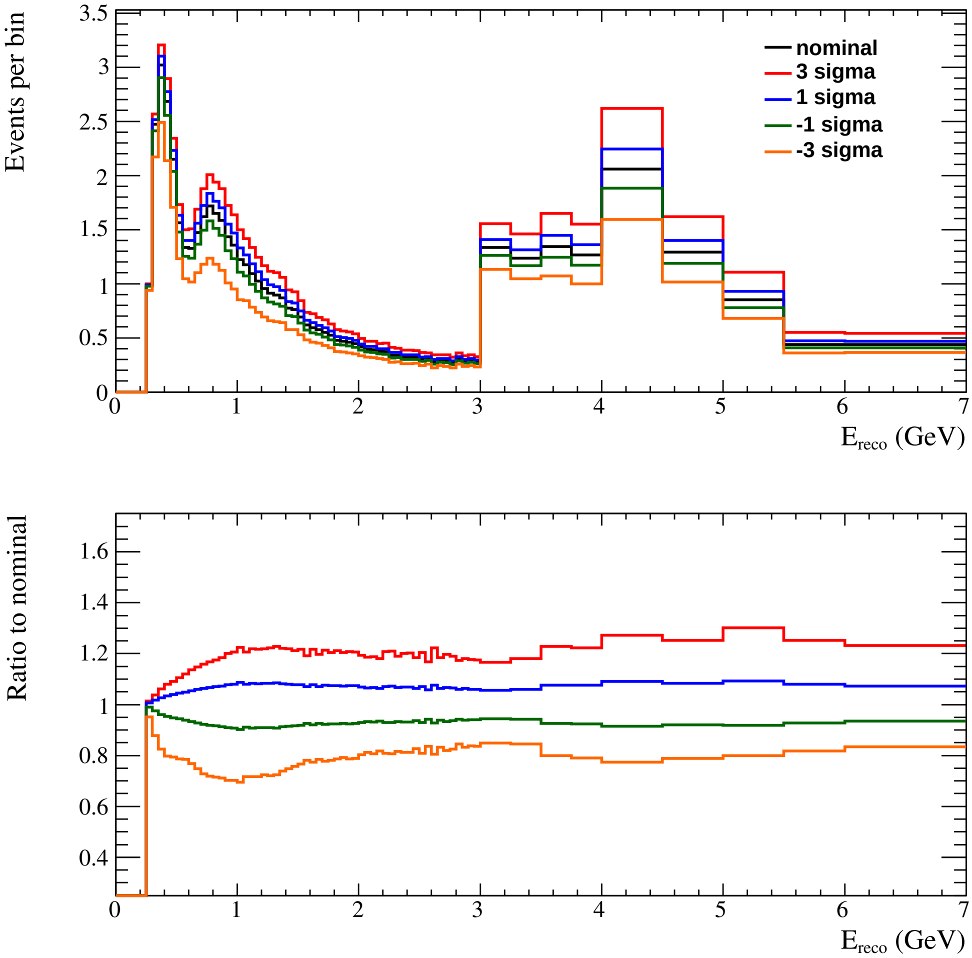


Figure 270: Effect of $f^{banff}_{16;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

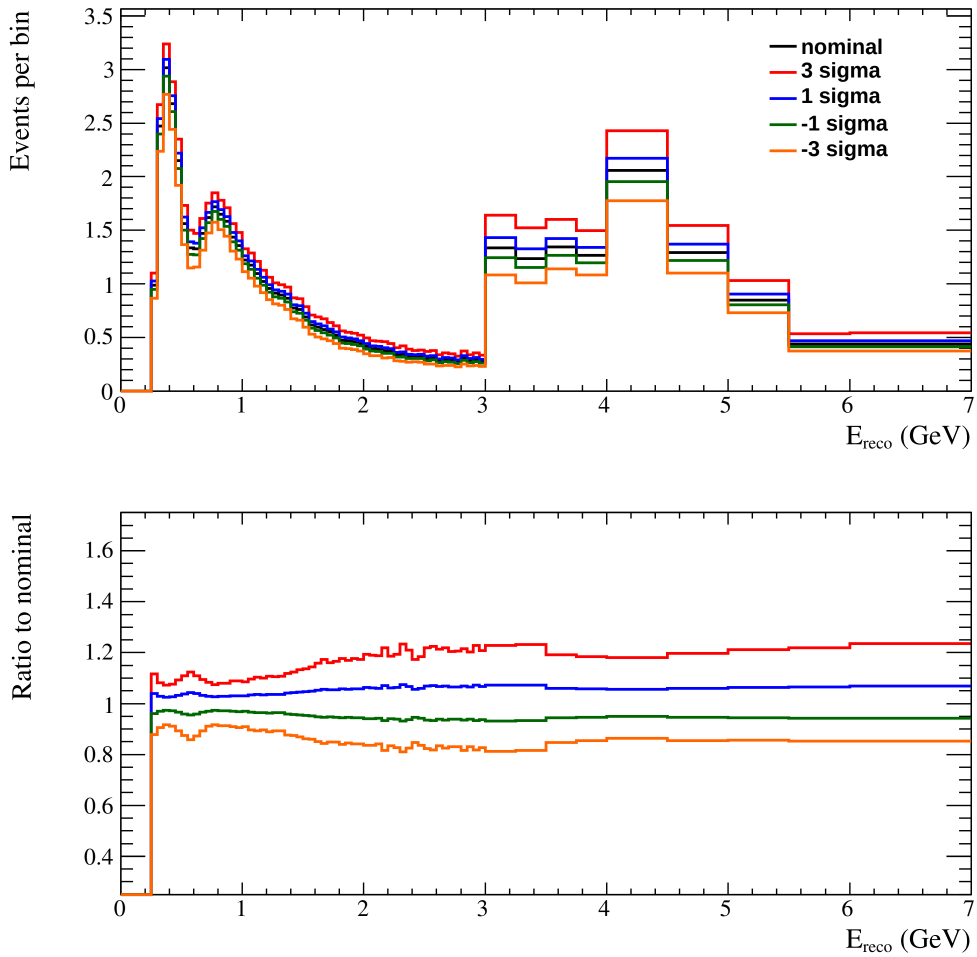


Figure 271: Effect of $f^{banff}_{17;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

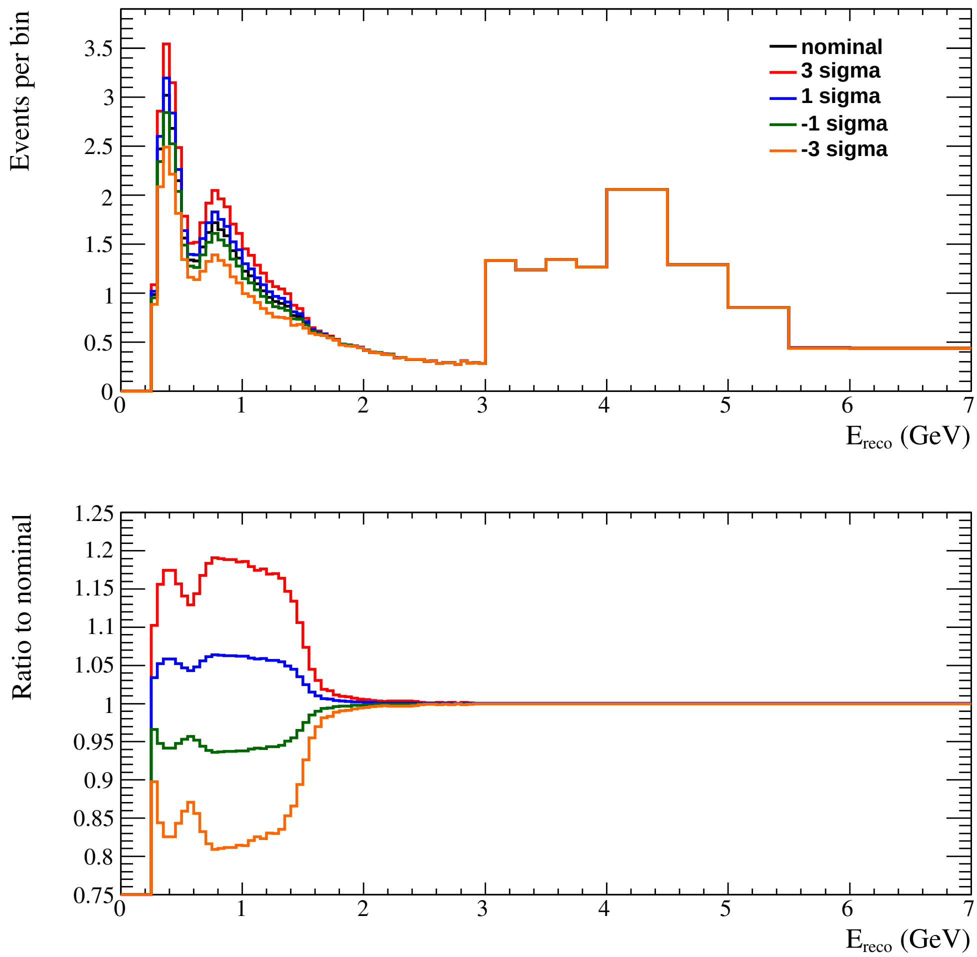


Figure 272: Effect of $f^{banff}_{18;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

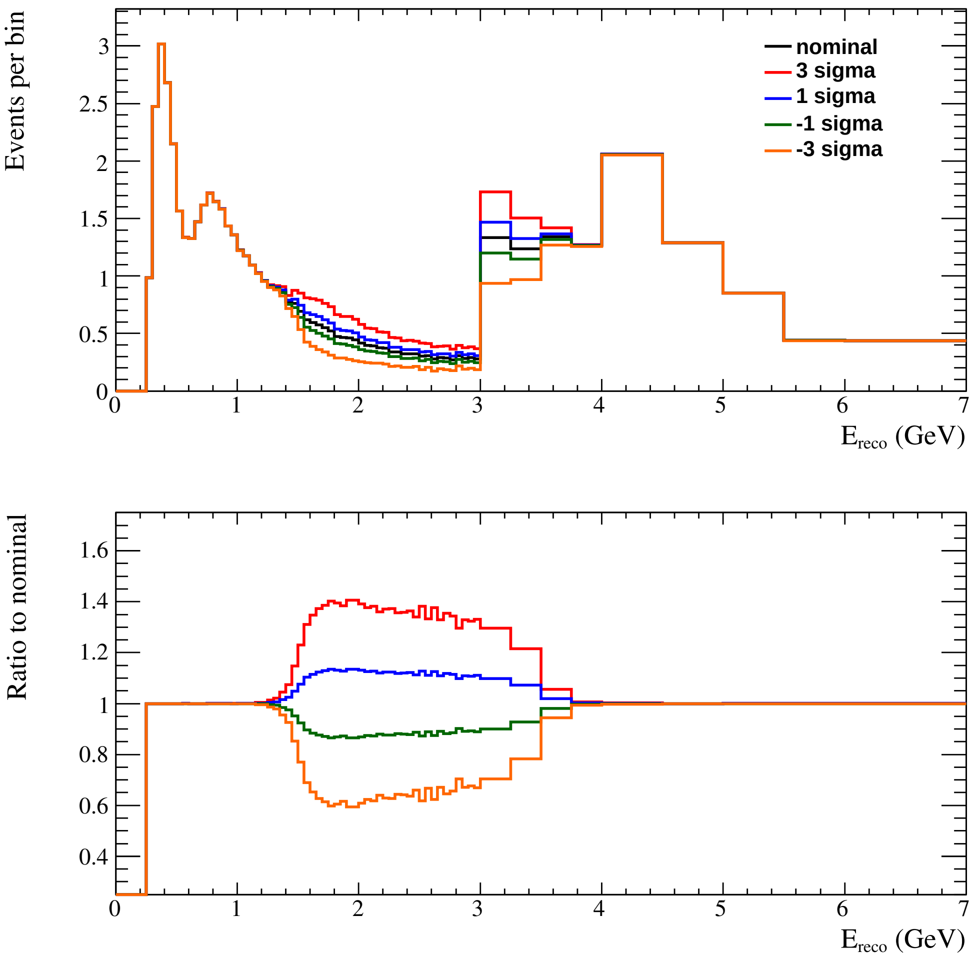


Figure 273: Effect of $f^{banff}_{19;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

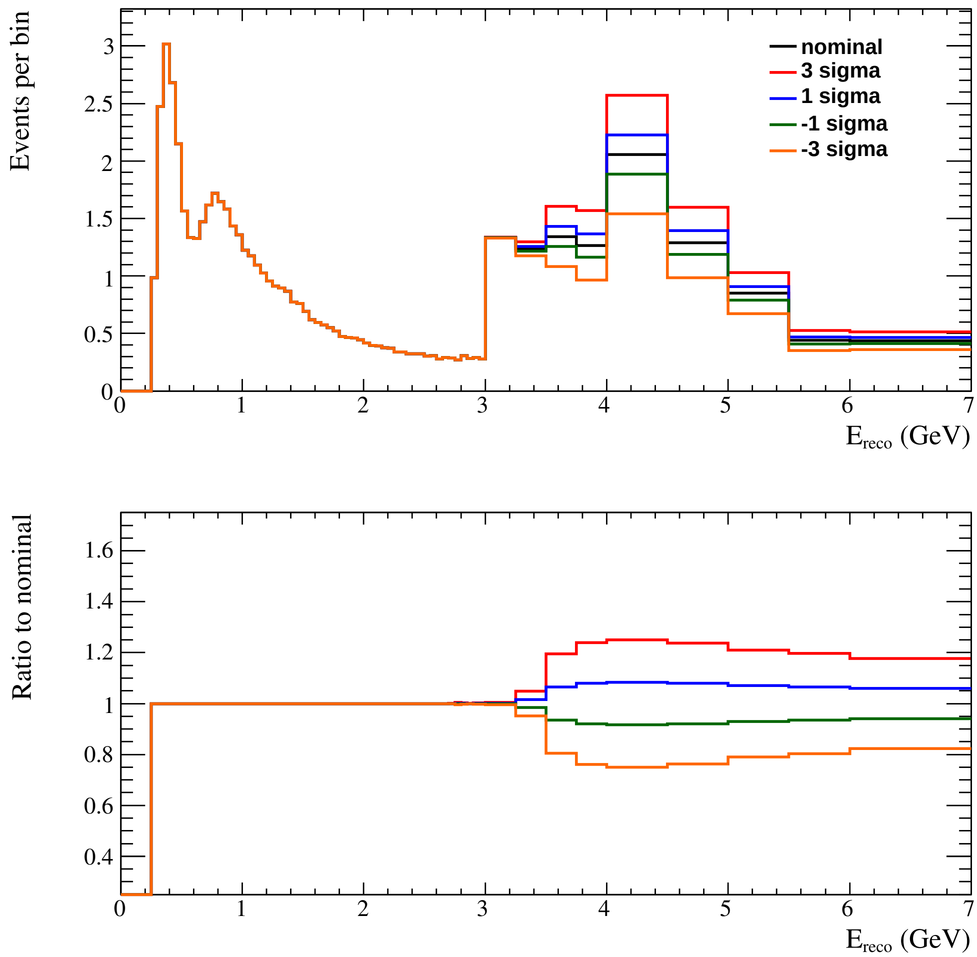


Figure 274: Effect of $f_{20;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

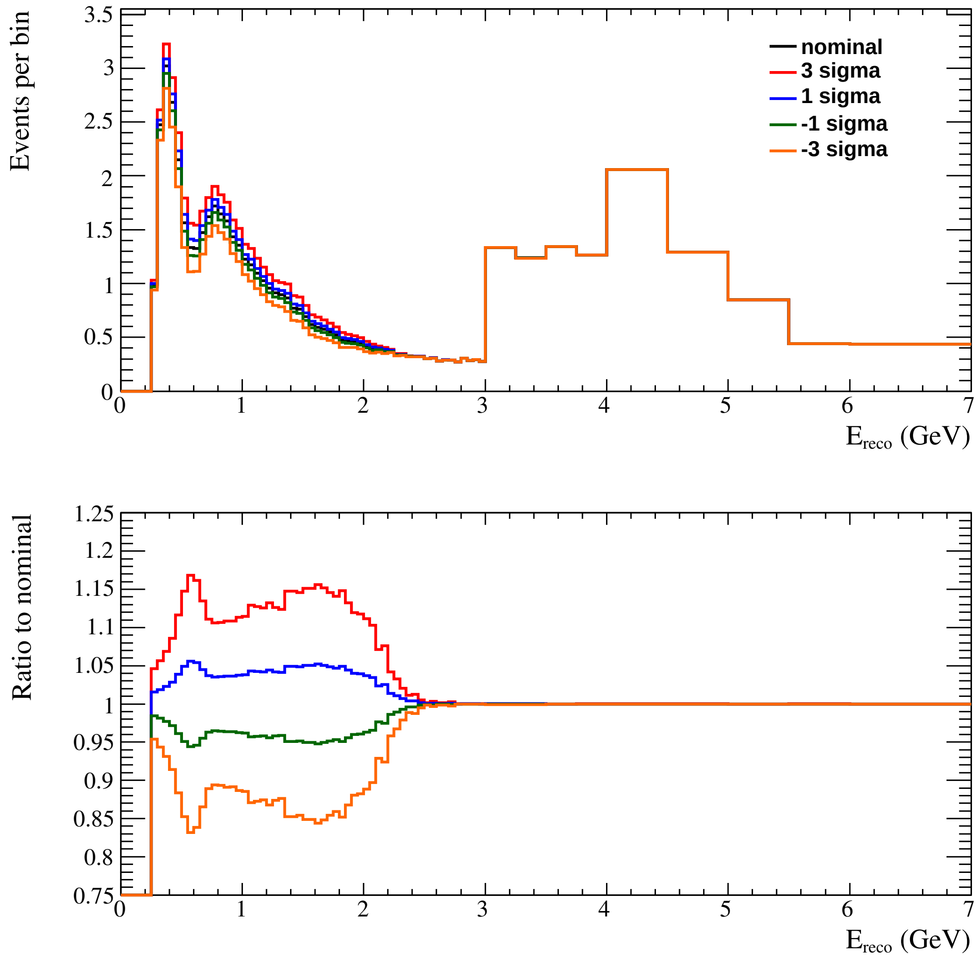


Figure 275: Effect of $f_{21;t,r}^{banff}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

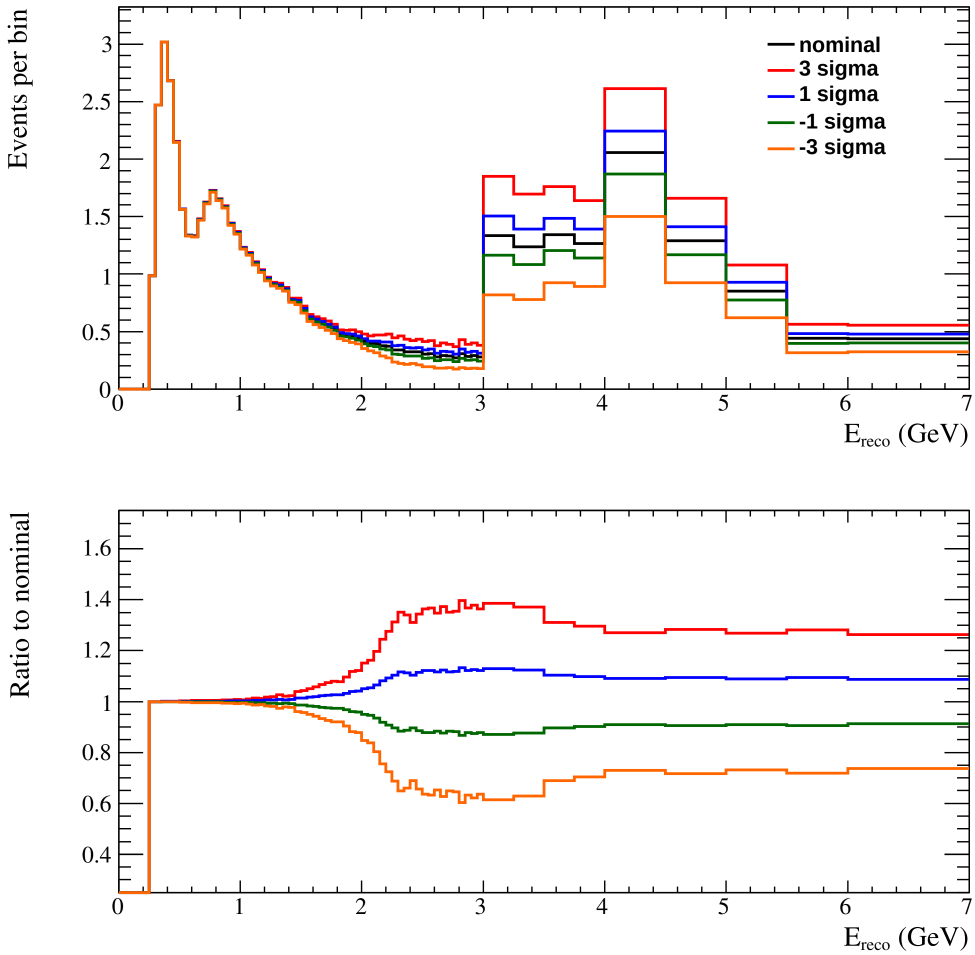


Figure 276: Effect of $f^{banff}_{22;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

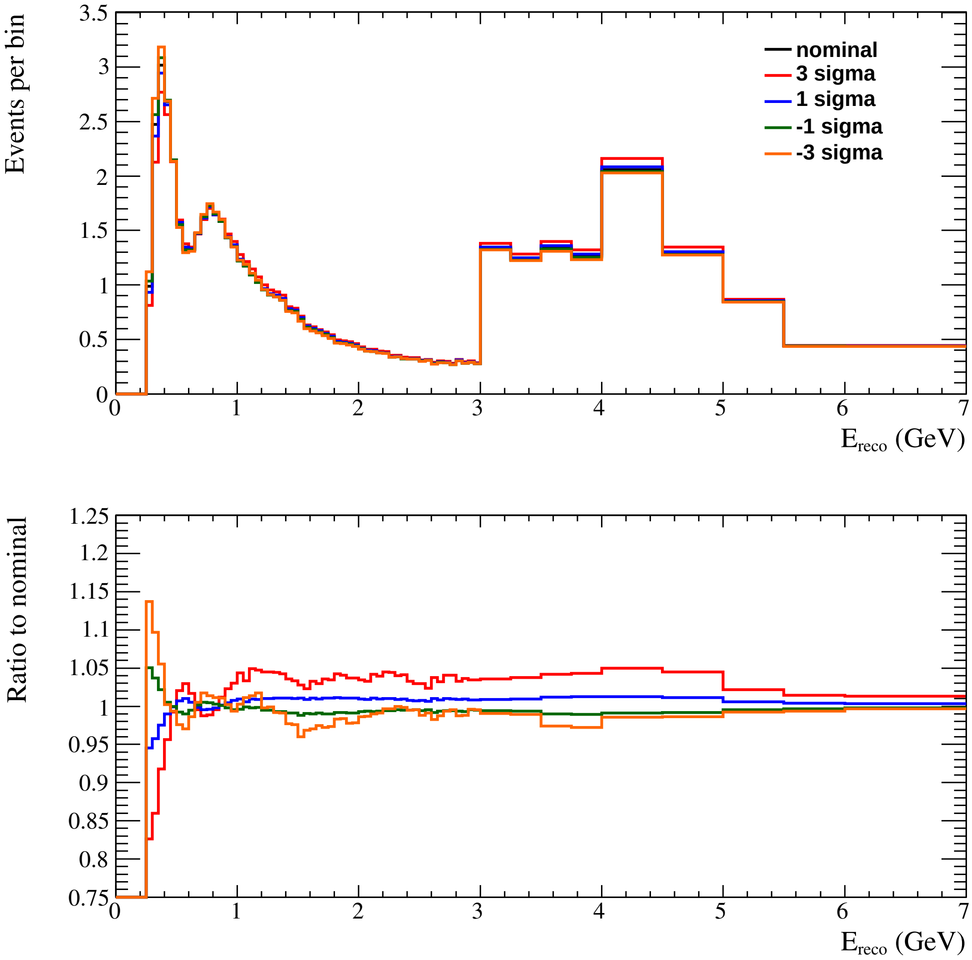


Figure 277: Effect of $f_{pF;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

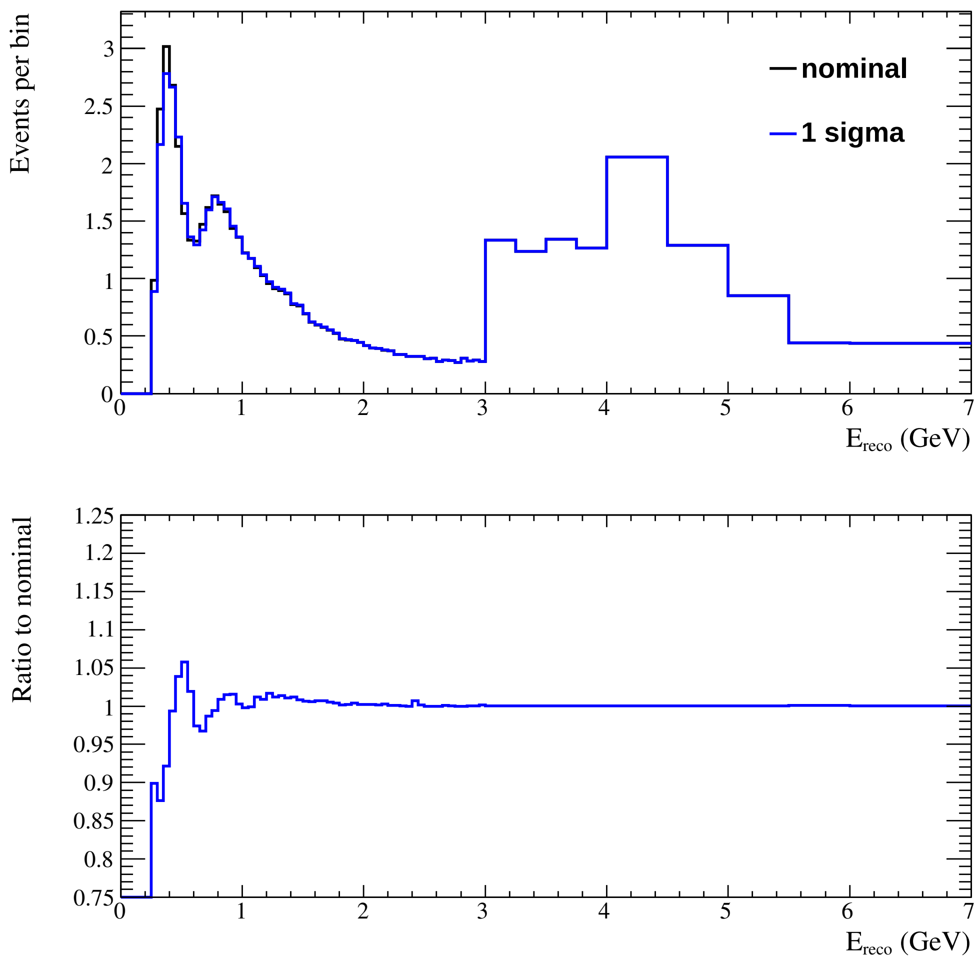


Figure 278: Effect of $f_{SF;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

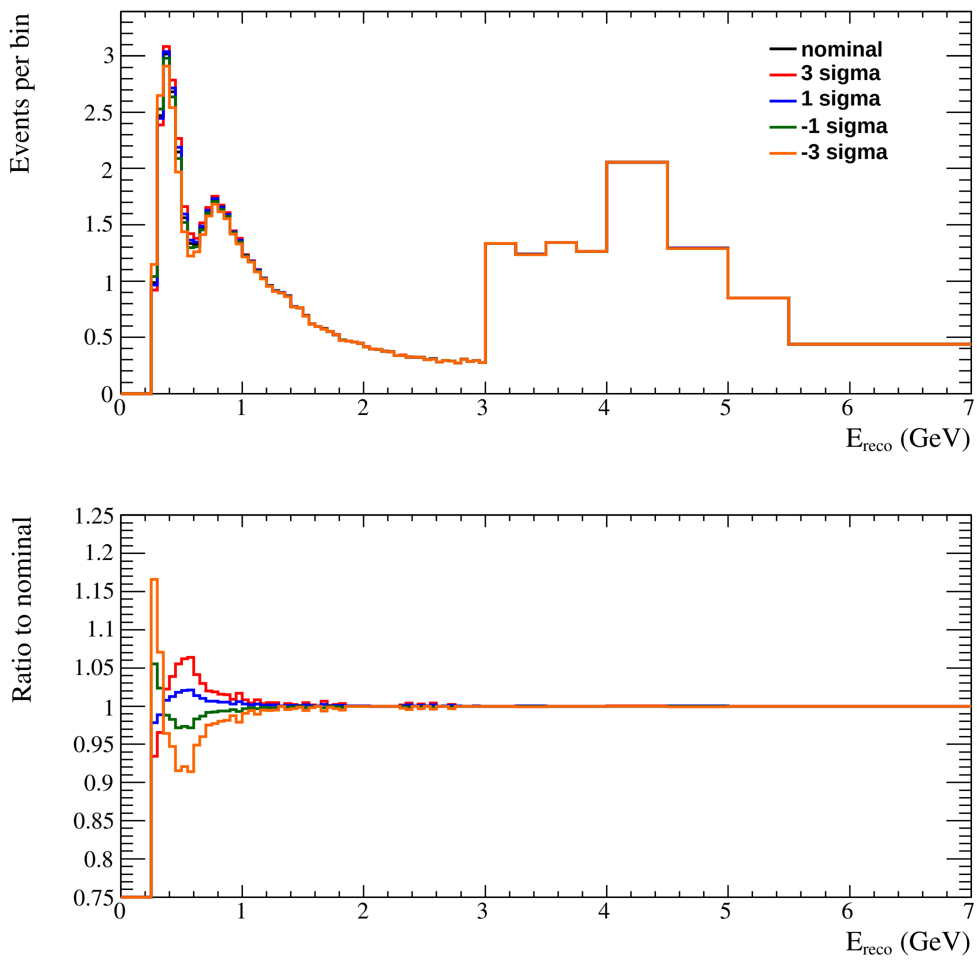


Figure 279: Effect of $f_{Wshape;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

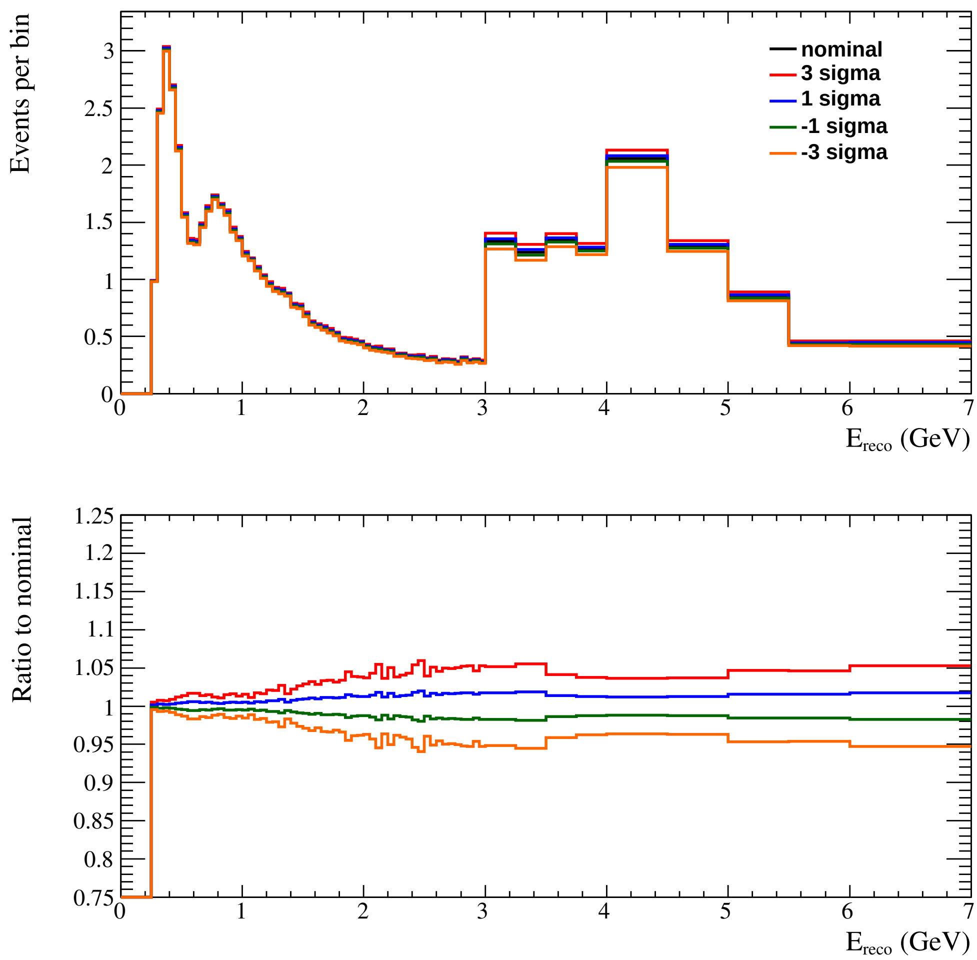


Figure 280: Effect of $f_{CCothShape;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

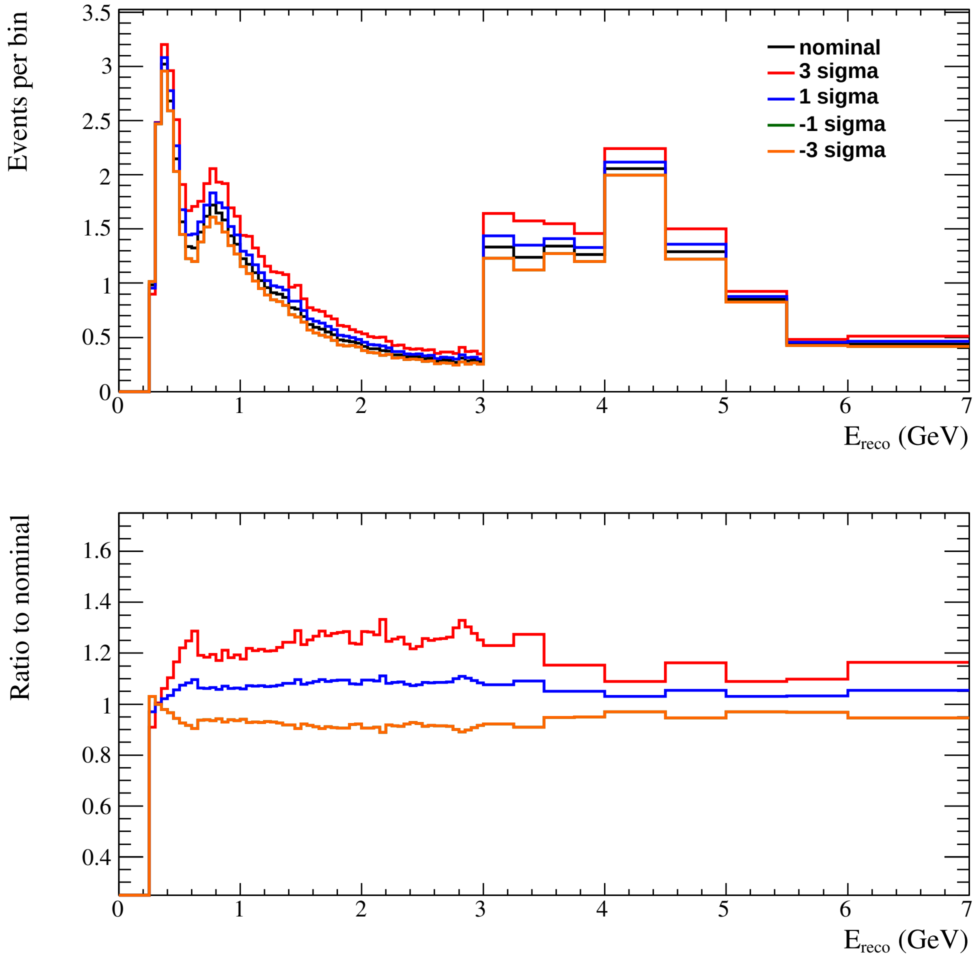


Figure 281: Effect of $f_{\pi-less\Delta;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

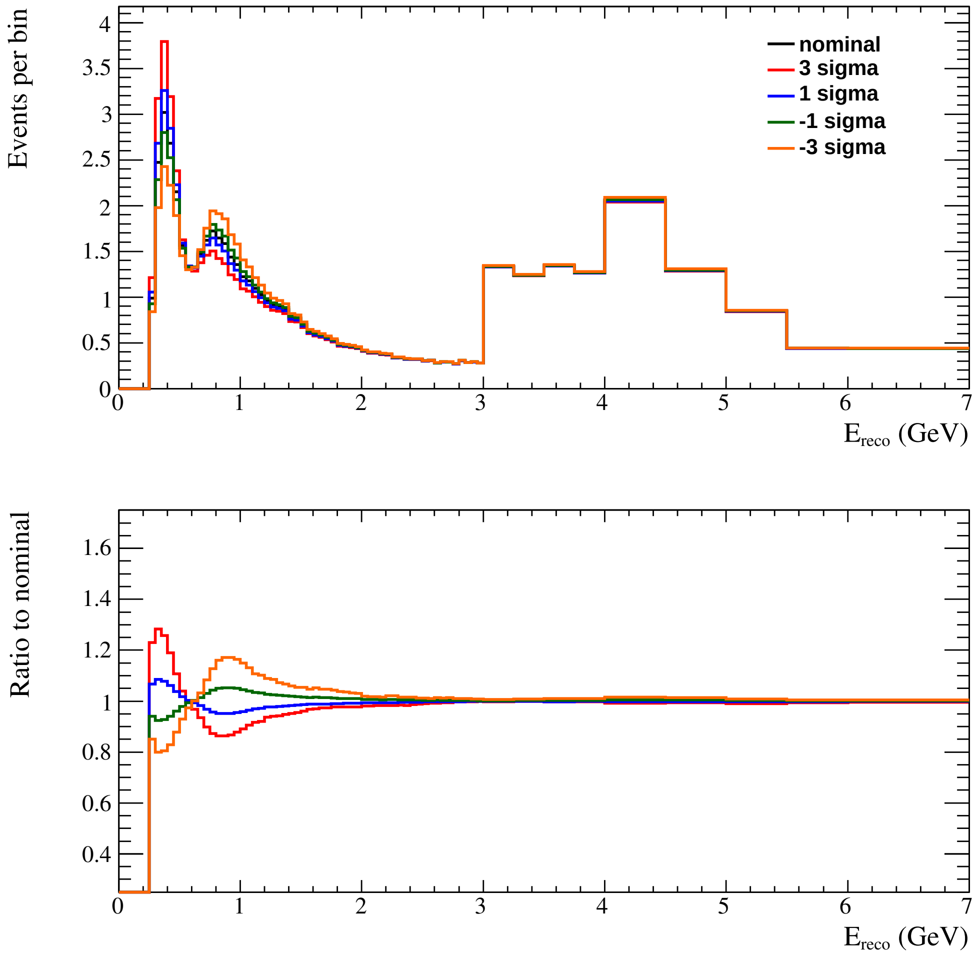


Figure 282: Effect of $f_{bindE;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = $ 7.5e-05; $\Delta m^2_{32} = 0.0024$.

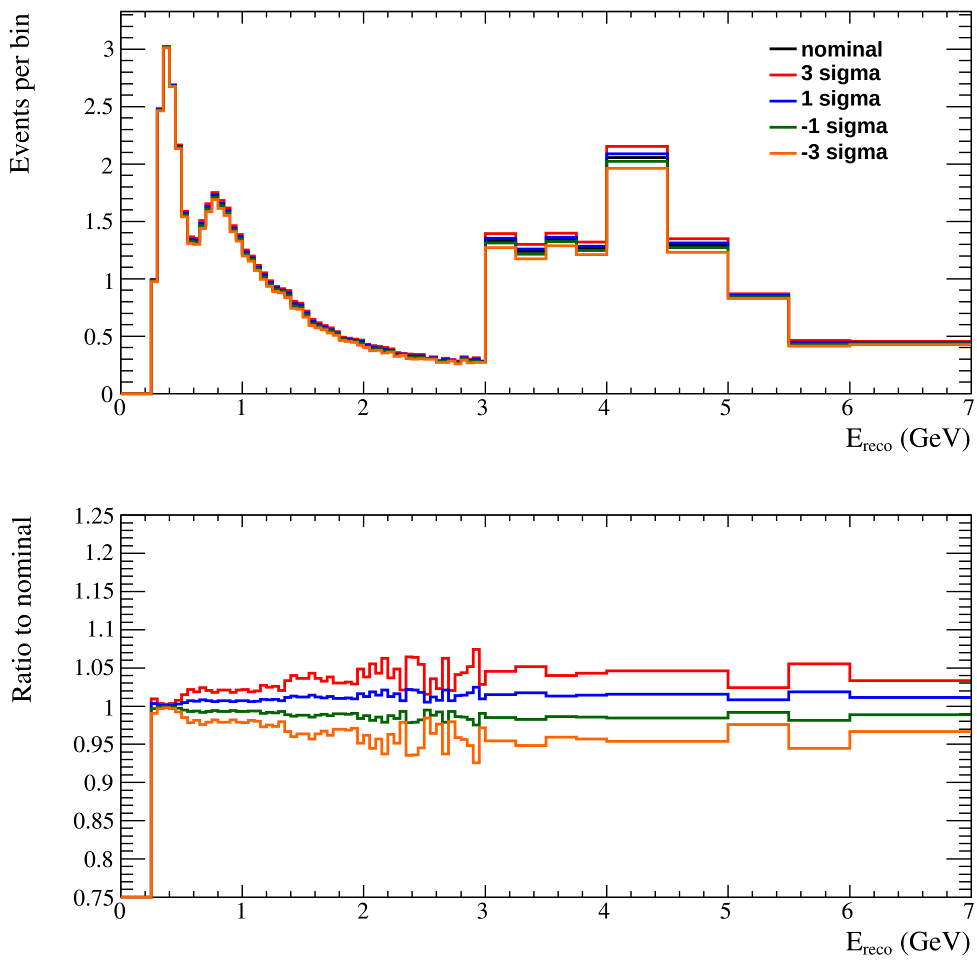


Figure 283: Effect of $f_{CCcoh;t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5\text{e-}05$; $\Delta m^2_{32} = 0.0024$.

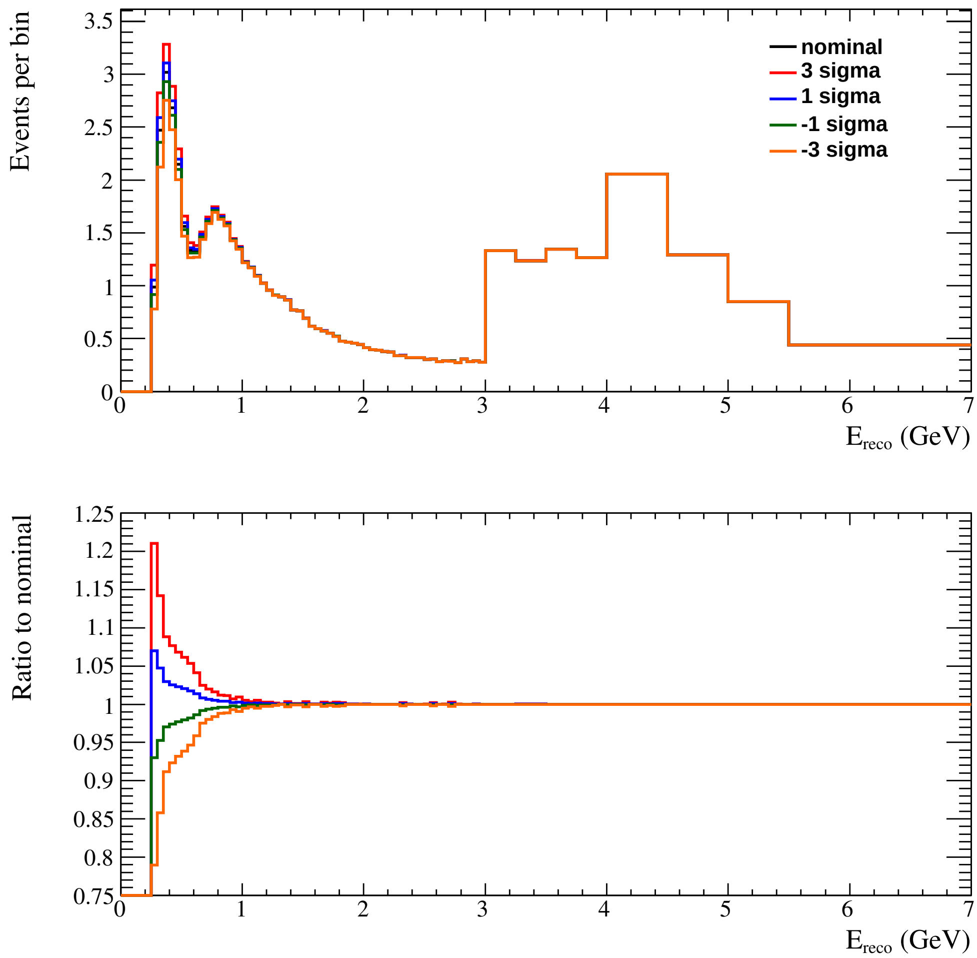


Figure 284: Effect of $f_{NC1\pi^{\pm};t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

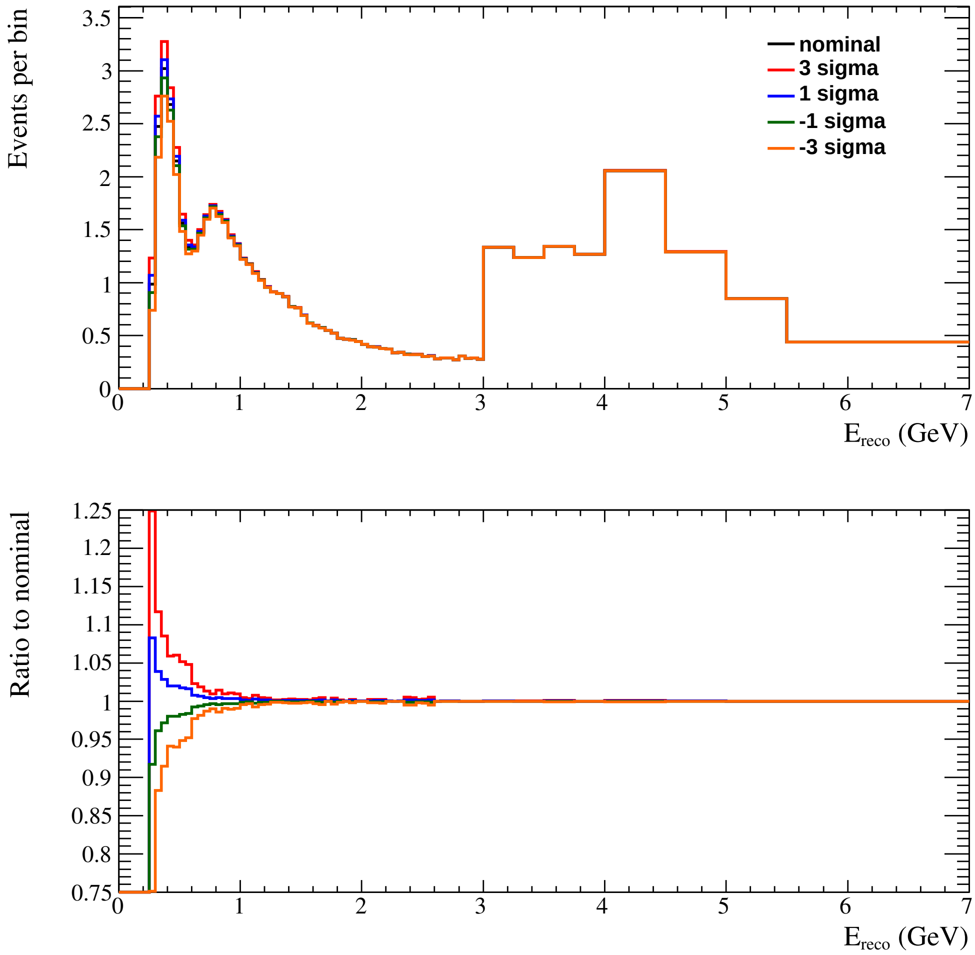


Figure 285: Effect of $f_{NCoth;t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5\text{e-}05$; $\Delta m^2_{32} = 0.0024$.

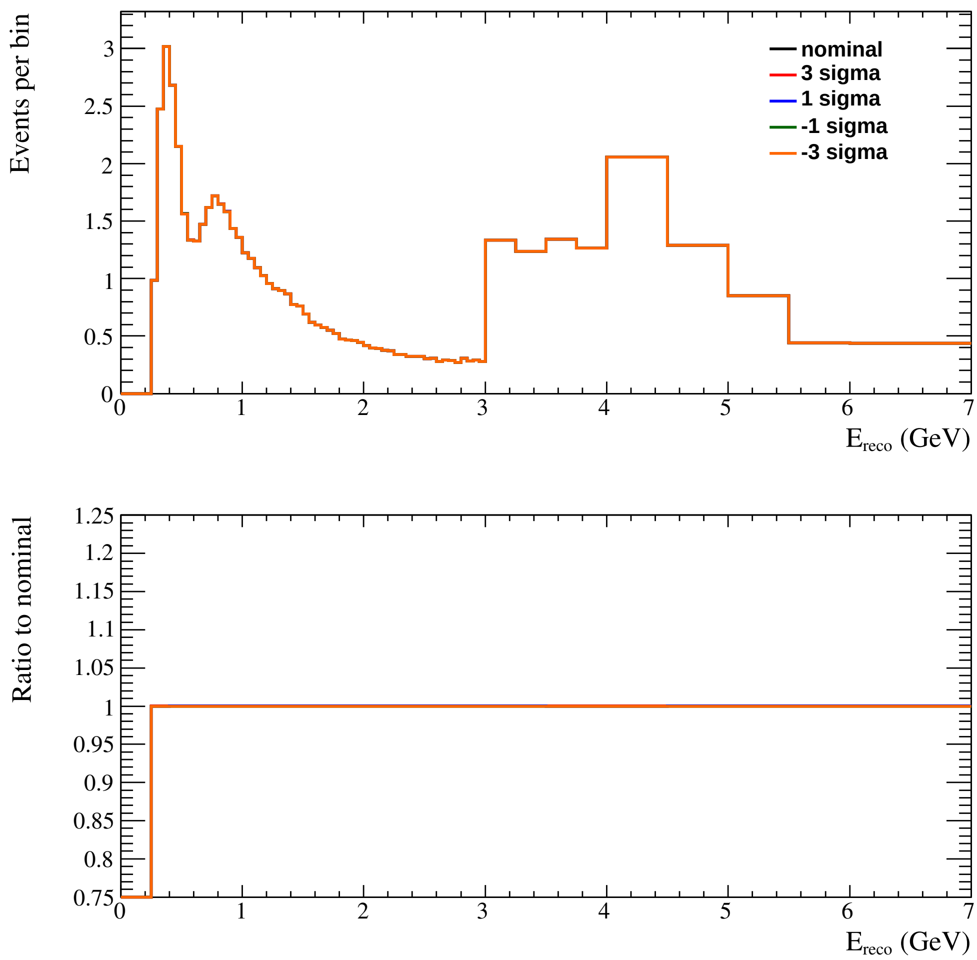


Figure 286: Effect of $f_{CC\nu_e;t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{12} = 7.5\text{e-}05$; $\Delta m^2_{32} = 0.0024$.

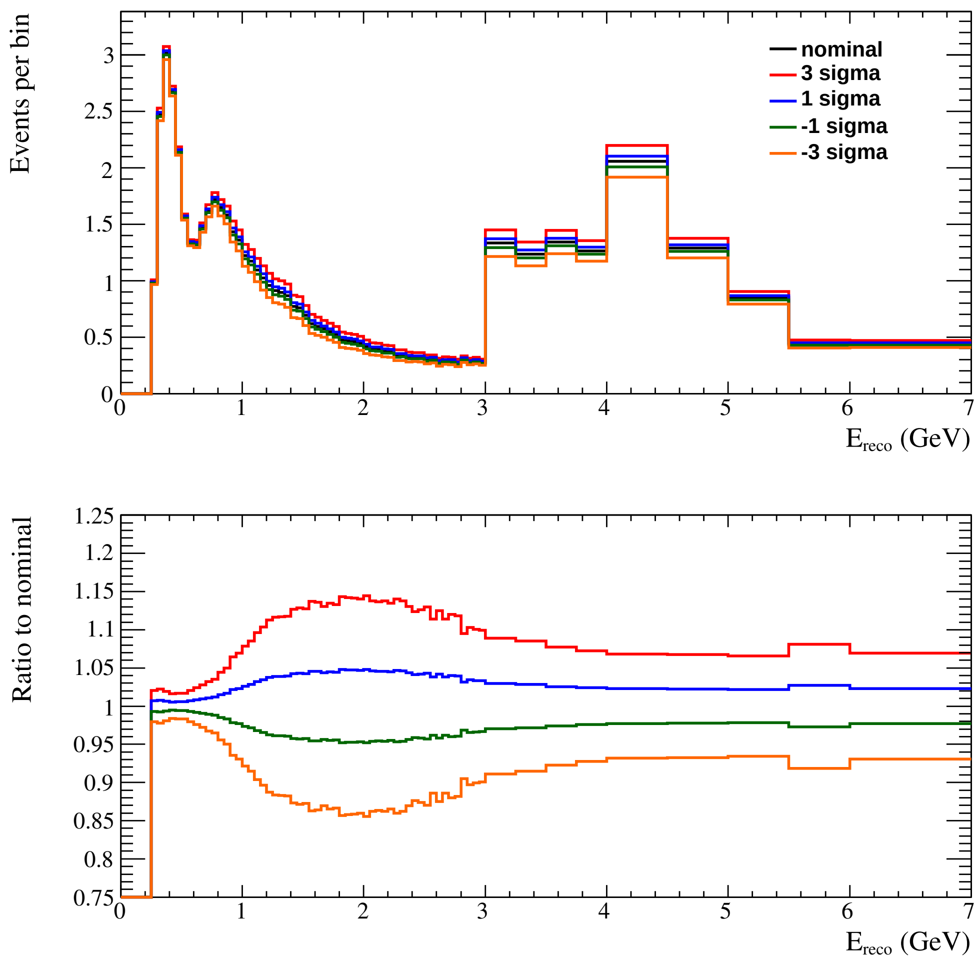


Figure 287: Effect of $f_{CC\bar{\nu};t}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

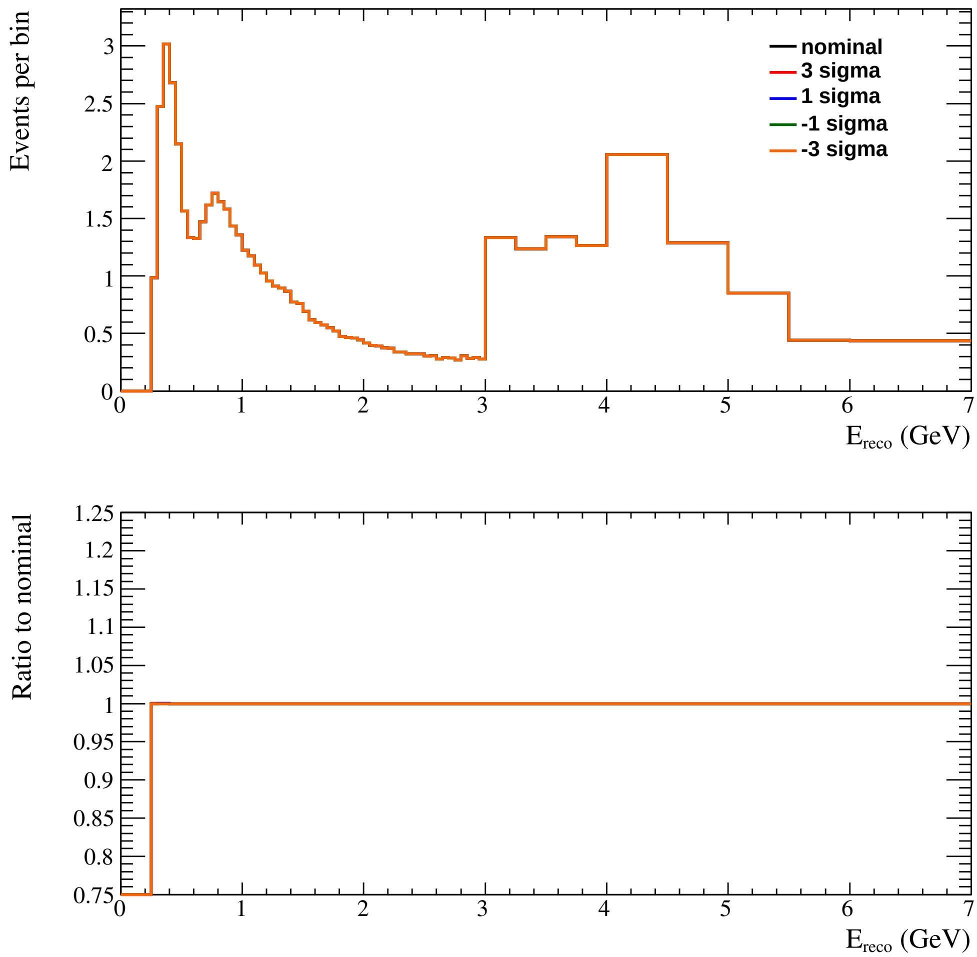


Figure 288: Effect of $f^{FSI}_{0;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

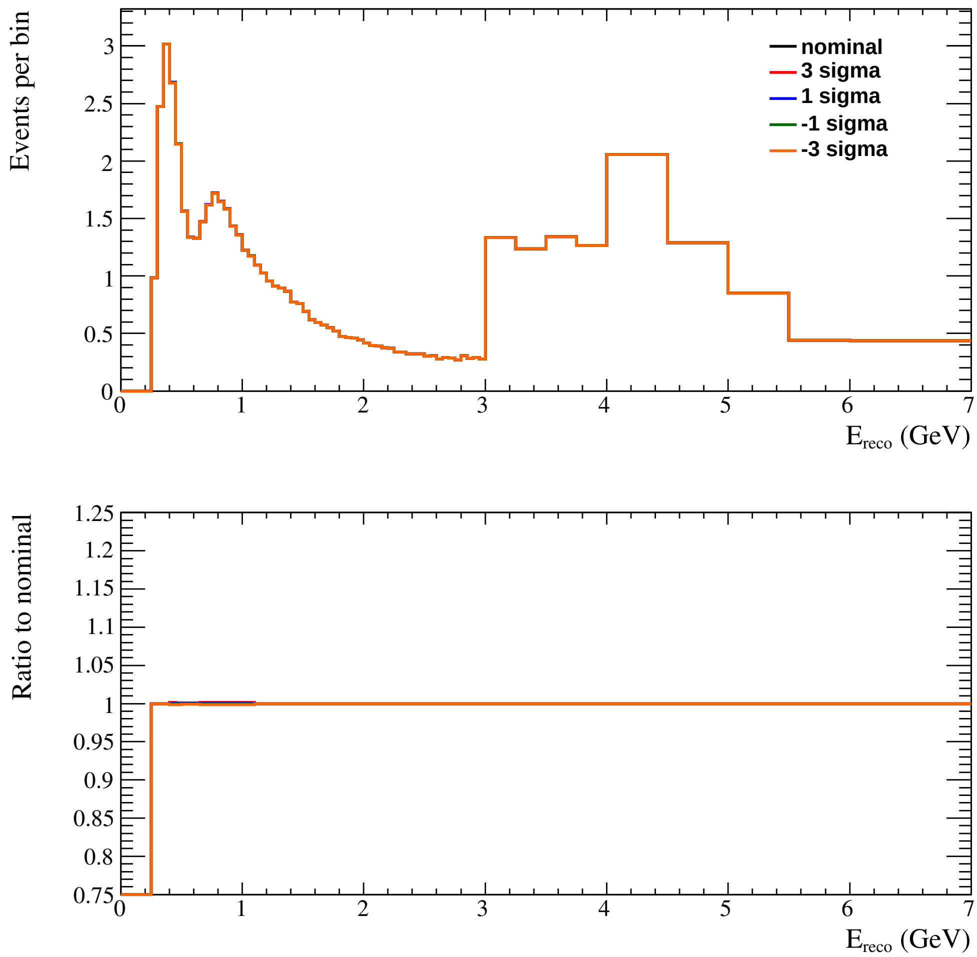


Figure 289: Effect of $f^{FSI}_{1;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

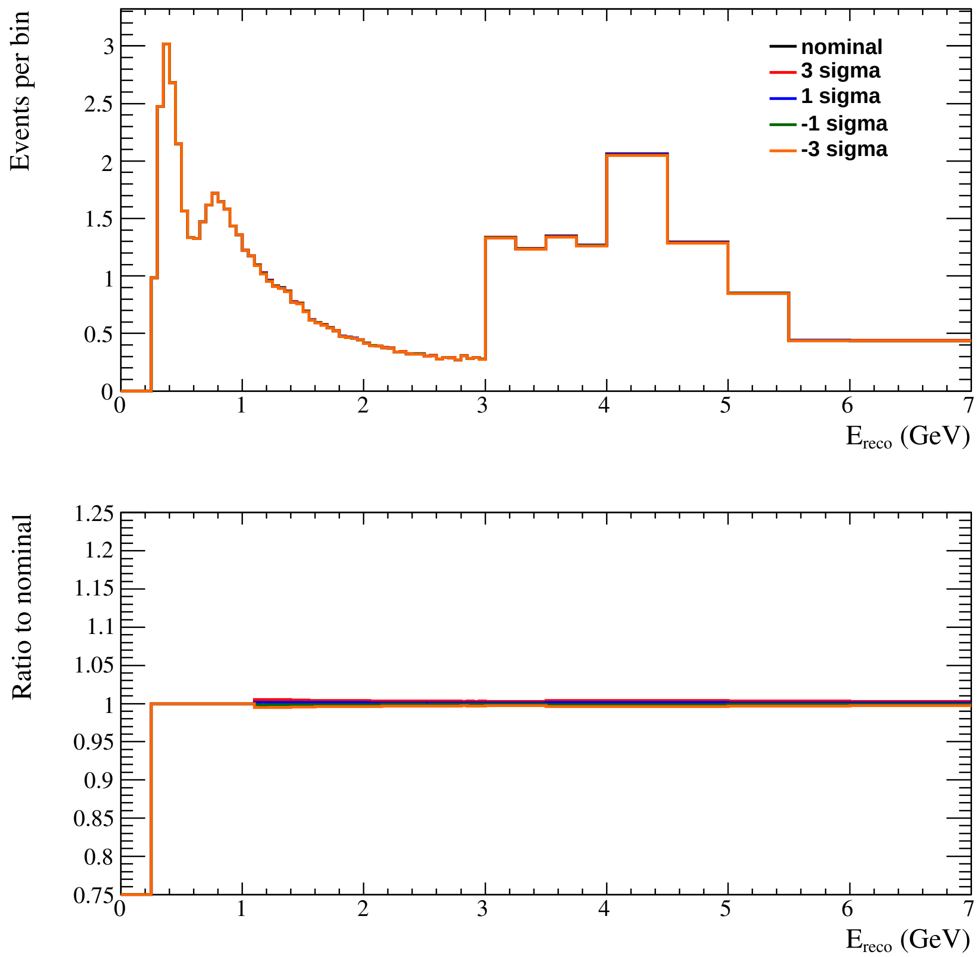


Figure 290: Effect of $f^{FSI}_{2;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

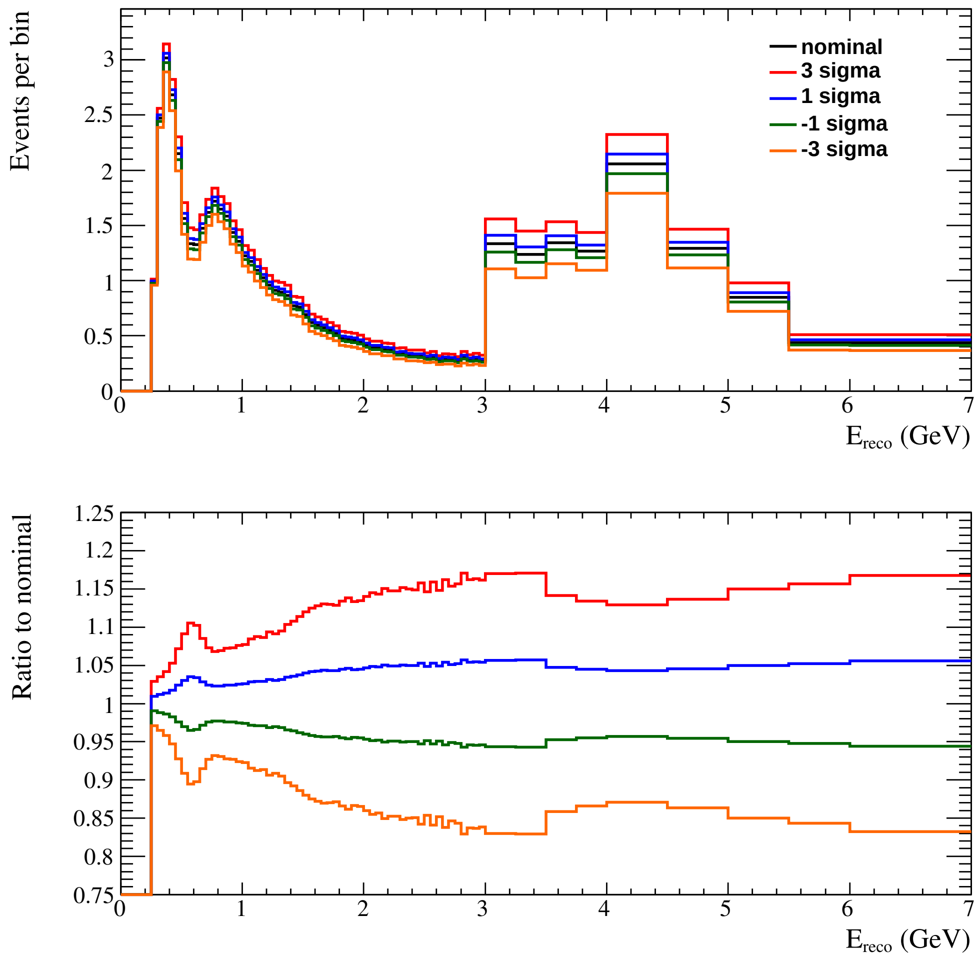


Figure 291: Effect of $f^{FSI}_{3;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

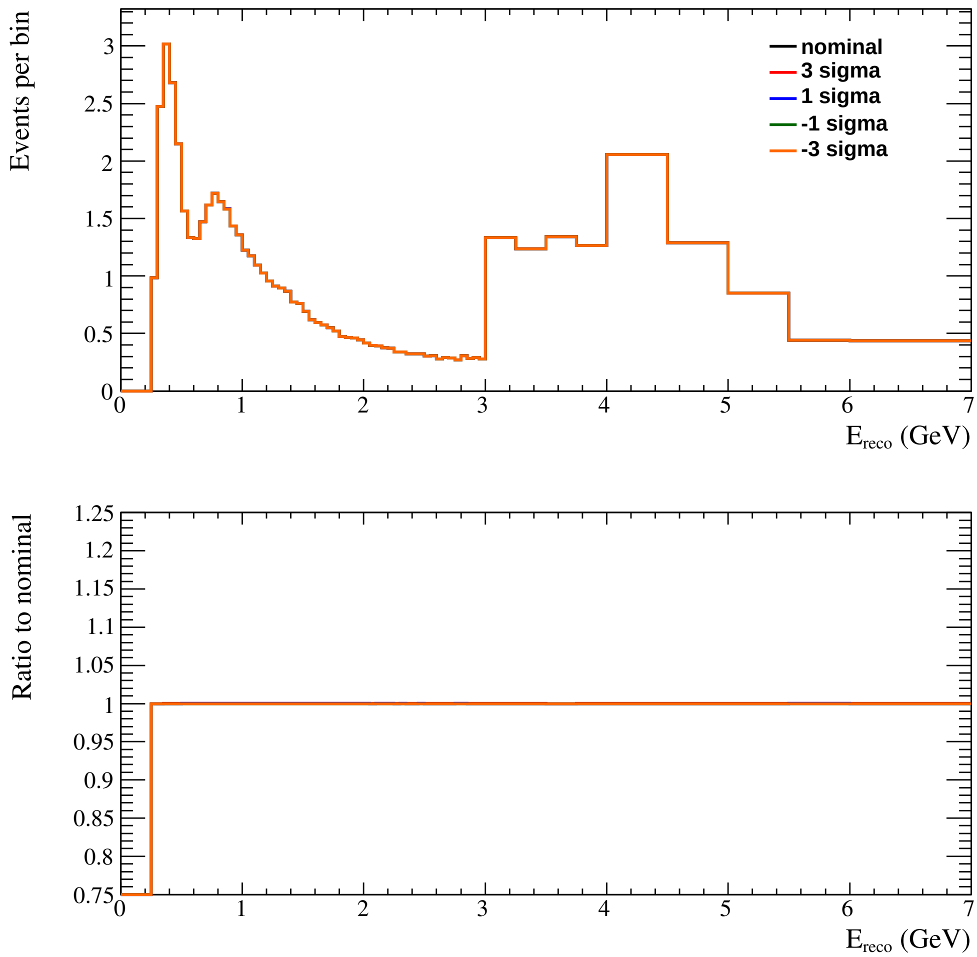


Figure 292: Effect of $f_{4;t,r}^{FSI}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

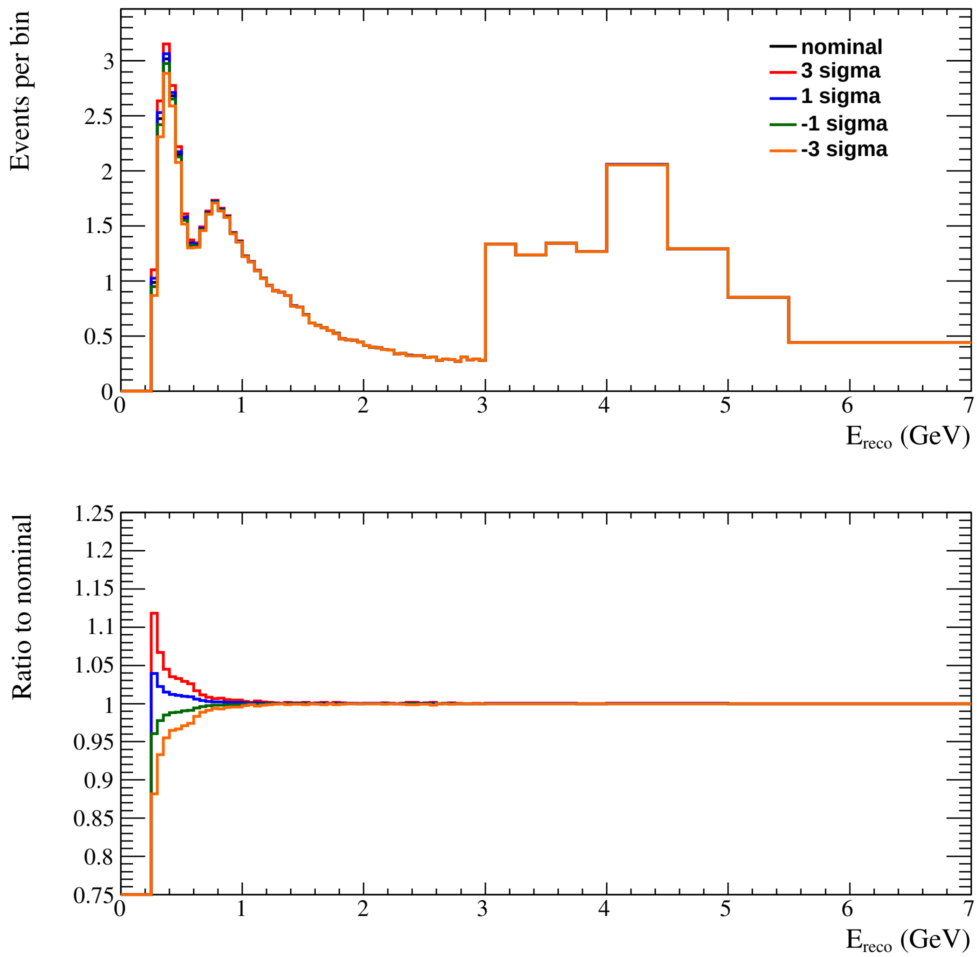


Figure 293: Effect of $f^{FSI}_{5;t,r}$ for 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

G. Detailed study of the effect of systematics on the best-fit oscillation parameters

This section describes a study into the effect of systematics on the best-fit oscillation parameters. It was used to determine which systematic parameters to include in the 2+8 fit. Before doing the study, it was decided to include a systematic if its effect on the best-fit oscillation parameters is greater than one-quarter the size of the statistical error at one or more oscillation parameter points. The statistical error was evaluated using 2+0 fits of 10000 toy experiments with no systematic fluctuations at each oscillation parameter point. The oscillation parameter points used in this study are shown in Fig. 294.

In the study, a 2+0 fit was done on a toy MC experiment created without statistical fluctuations and with a single systematic parameter tweaked by $\pm 1\sigma$. For correlated systematic parameters, σ was defined as the square root of the corresponding covariance matrix diagonal entry. The best-fit values of the oscillation parameters from the 2+0 fit are plotted as an arrow whose origin is at the input point of the study. For ease of reading, no more than 11 systematics are included on a single plot; for this reason, the plots are split into the following categories:

- parameters used in the 2+8 fit, Figs. 295-308;
- SuperK detector parameters, Figs. 309-322;
- BANFF ν_μ flux parameters, Figs. 323-336;
- BANFF $\bar{\nu_\mu}$ flux parameters, Figs. 337-350;
- BANFF cross section parameters, Figs. 351-364;
- uncorrelated cross section parameters, Figs. 365-378;
- FSI+SI parameters, Figs. 379-392;
- non-23 sector oscillation parameters, Figs. 393-406.

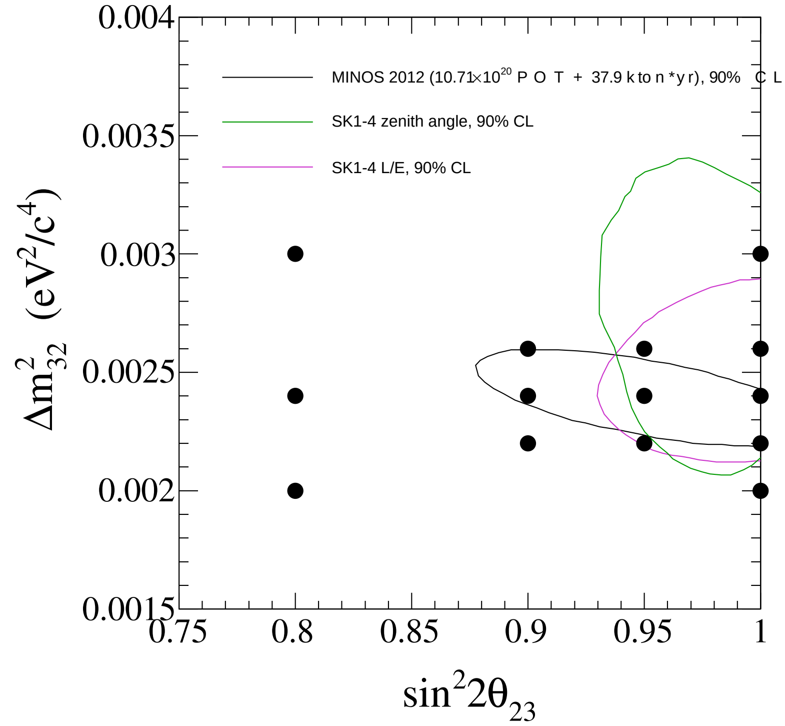


Figure 294: True oscillation parameter points used in the study on the effect of systematics on the best-fit oscillation parameters.

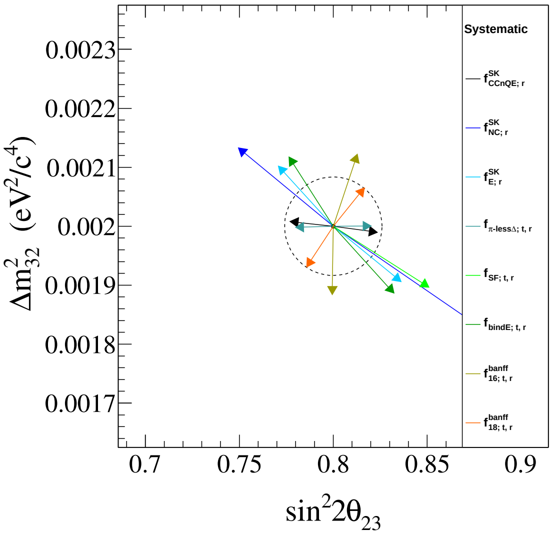


Figure 295: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

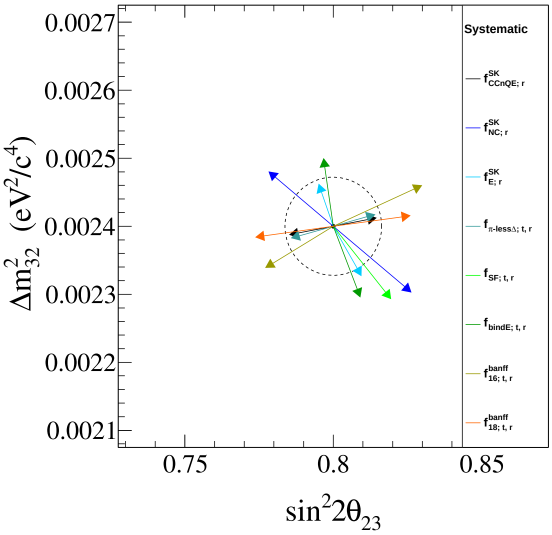


Figure 296: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

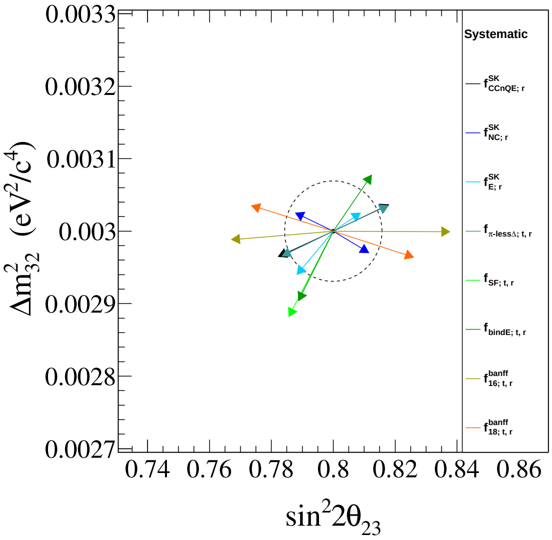


Figure 297: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

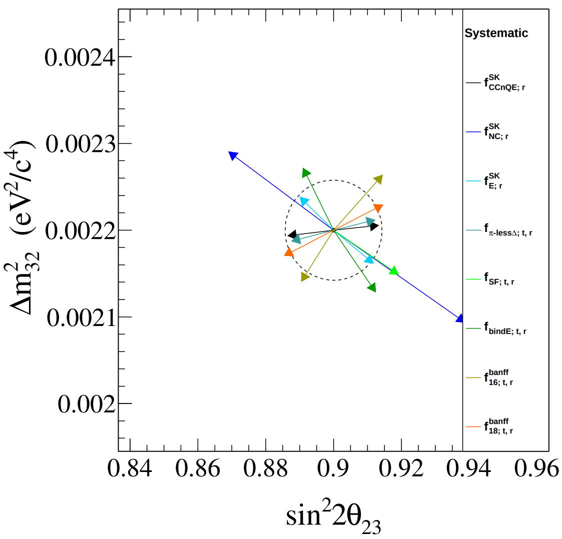


Figure 298: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

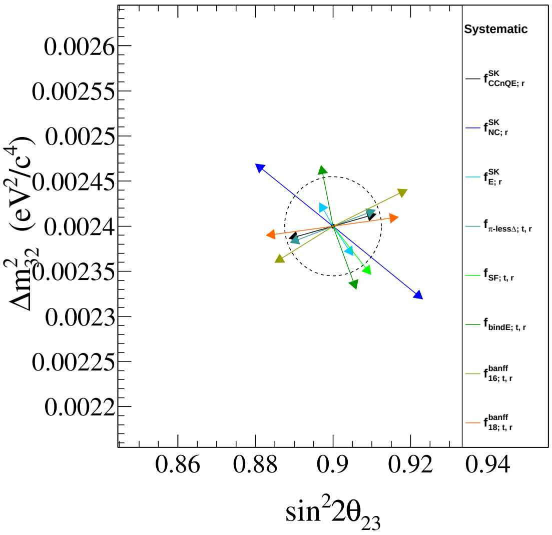


Figure 299: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

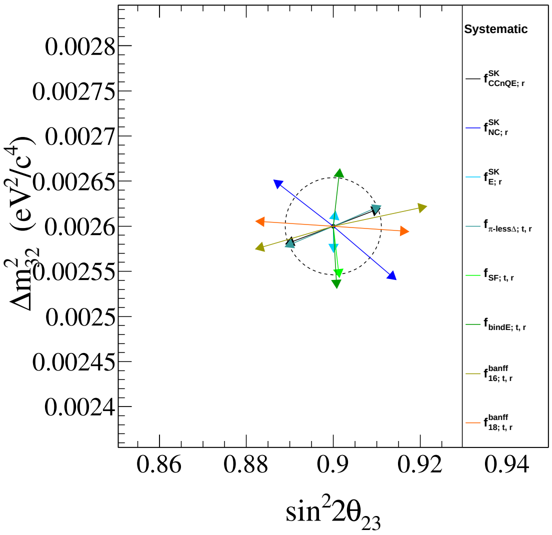


Figure 300: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

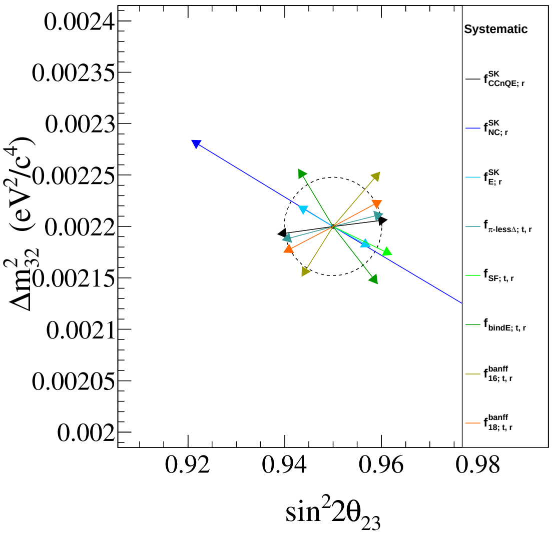


Figure 301: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

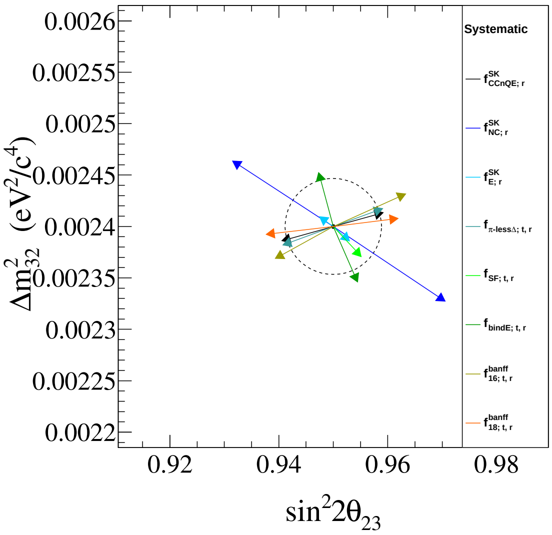


Figure 302: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

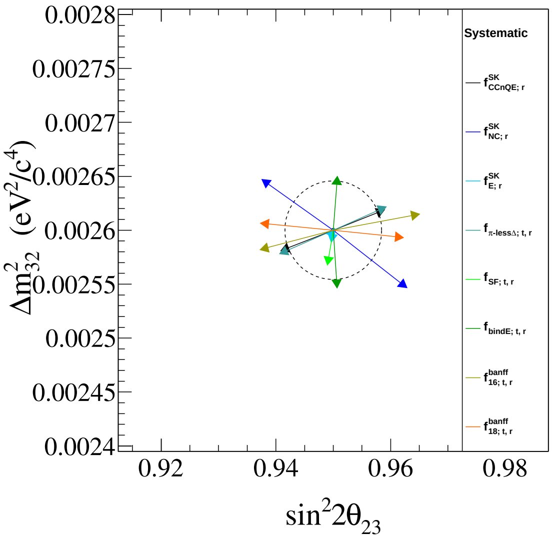


Figure 303: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

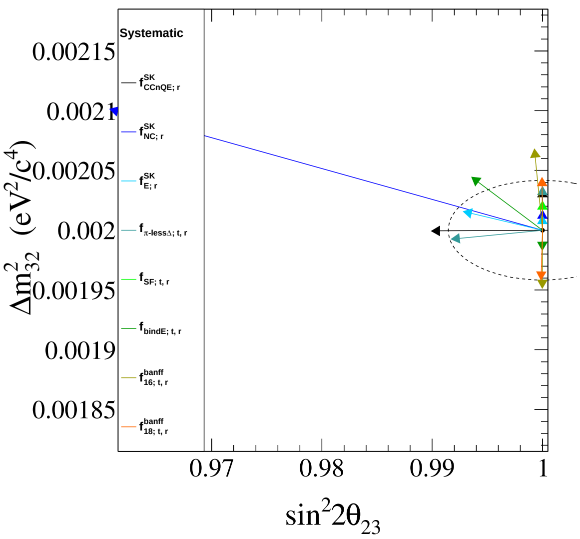


Figure 304: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

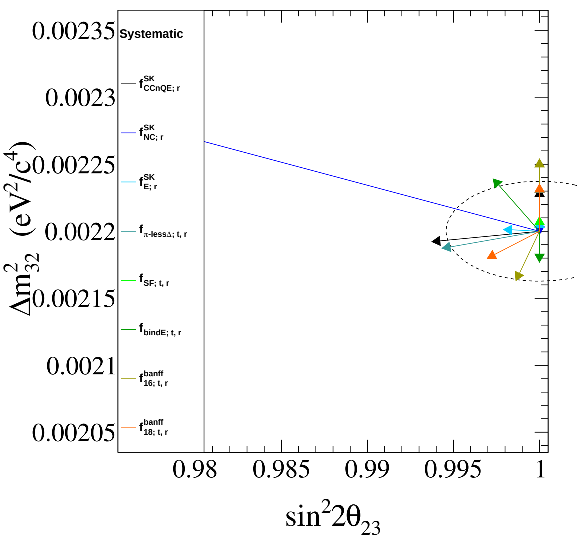


Figure 305: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

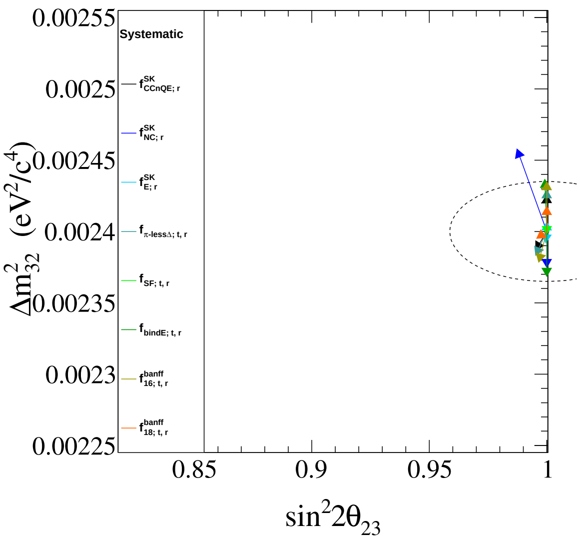


Figure 306: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

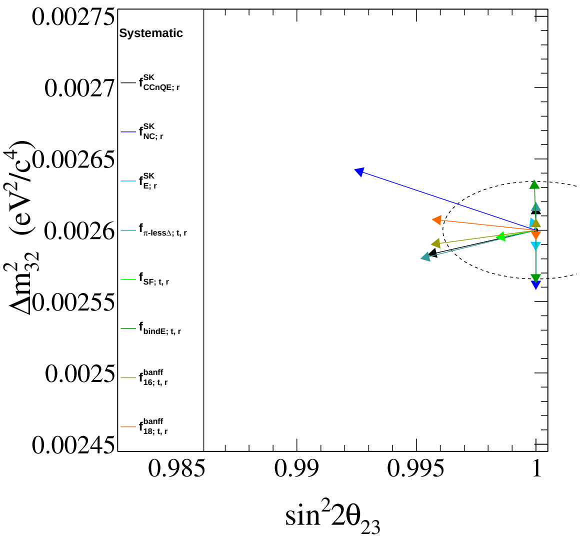


Figure 307: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

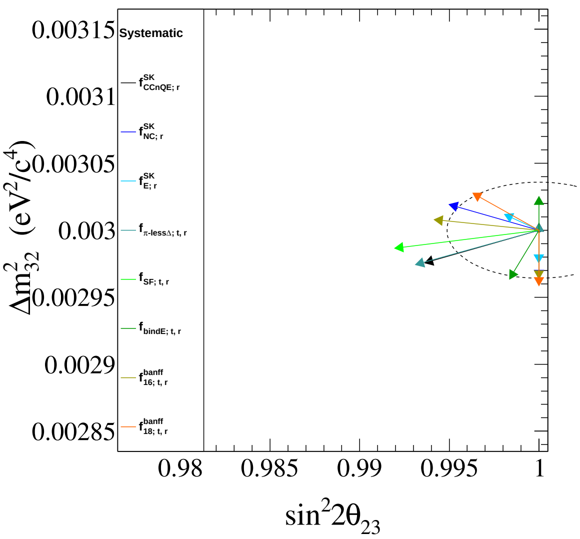


Figure 308: Effect of parameters used in the 2+8 fit on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

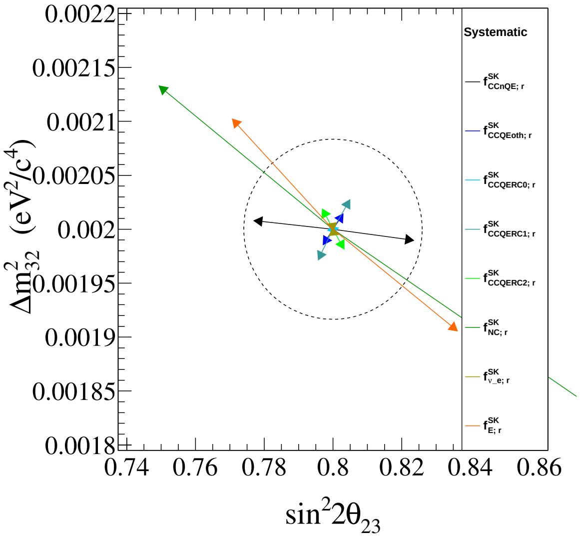


Figure 309: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

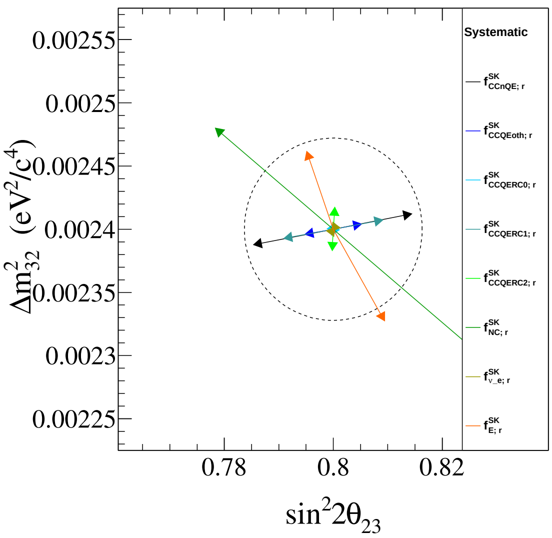


Figure 310: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

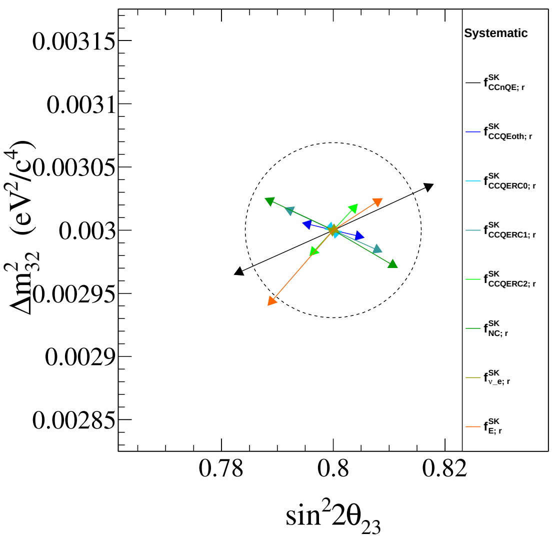


Figure 311: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

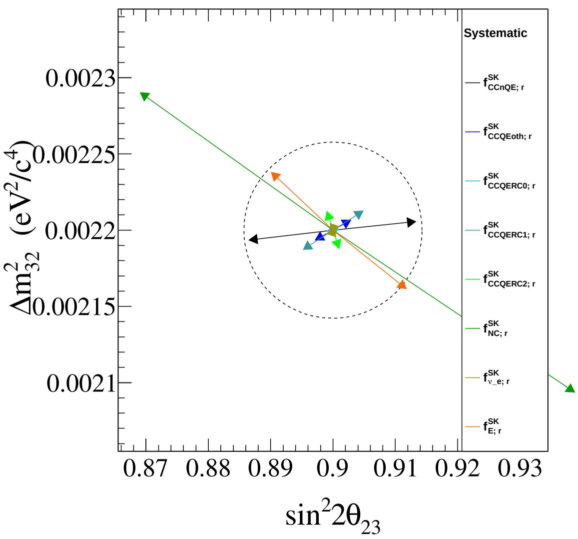


Figure 312: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

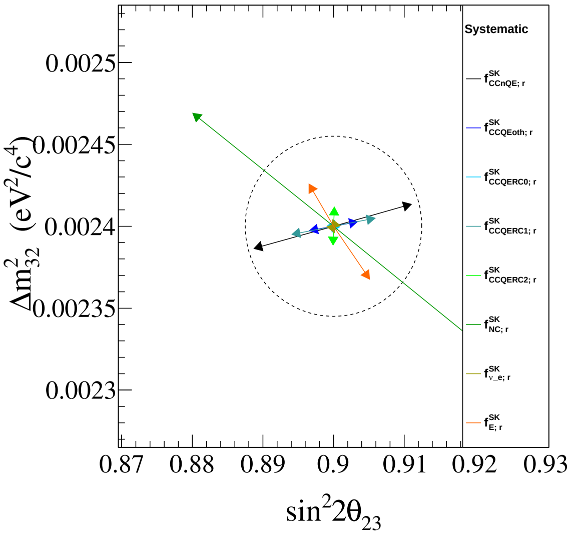


Figure 313: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

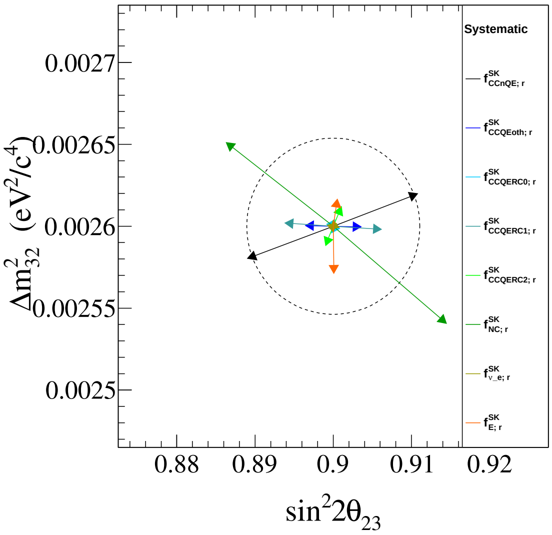


Figure 314: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

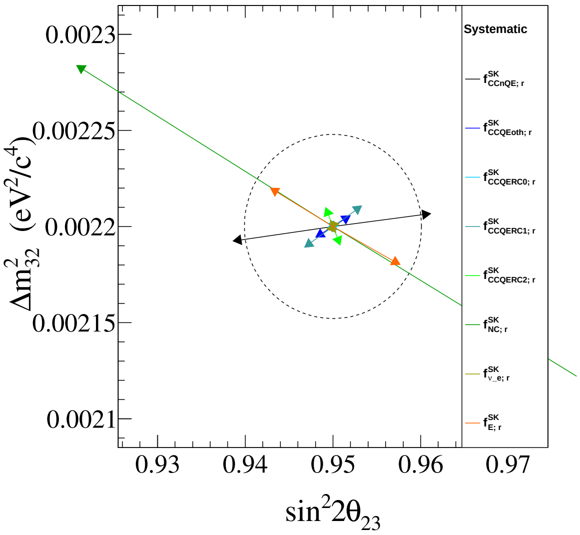


Figure 315: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

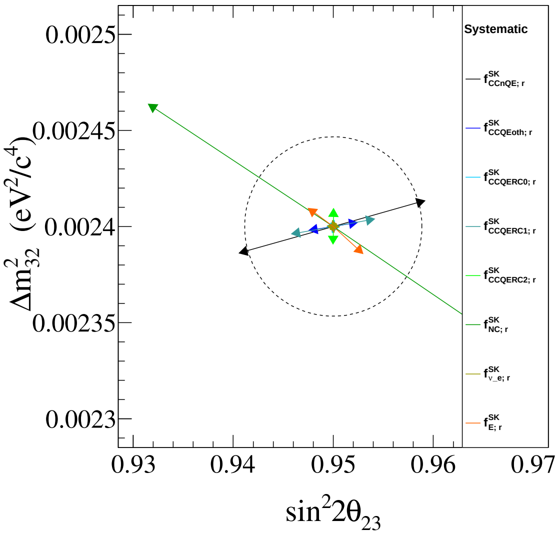


Figure 316: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

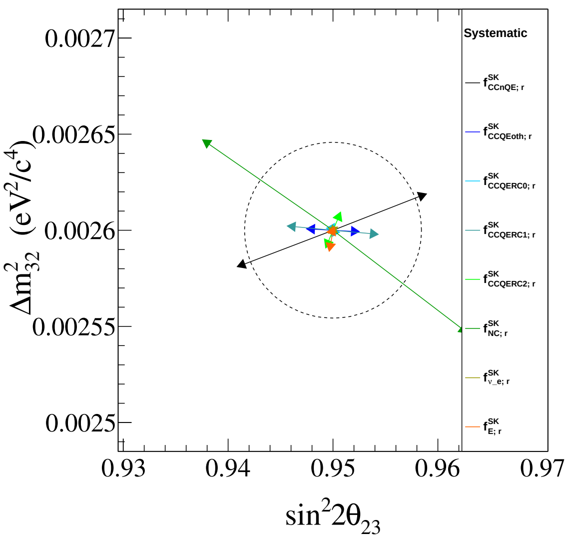


Figure 317: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0026.

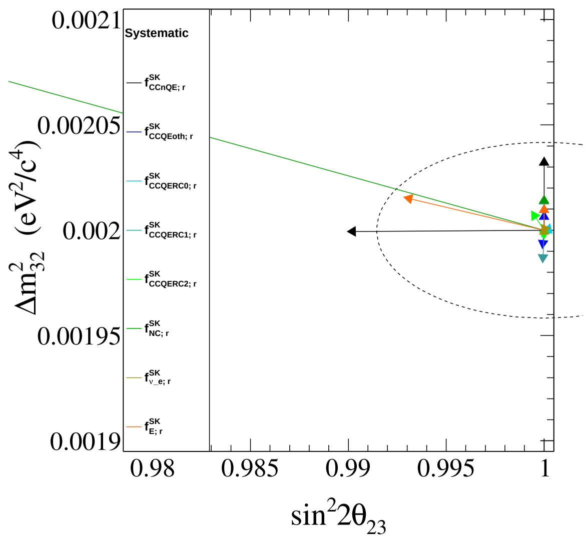


Figure 318: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.002.

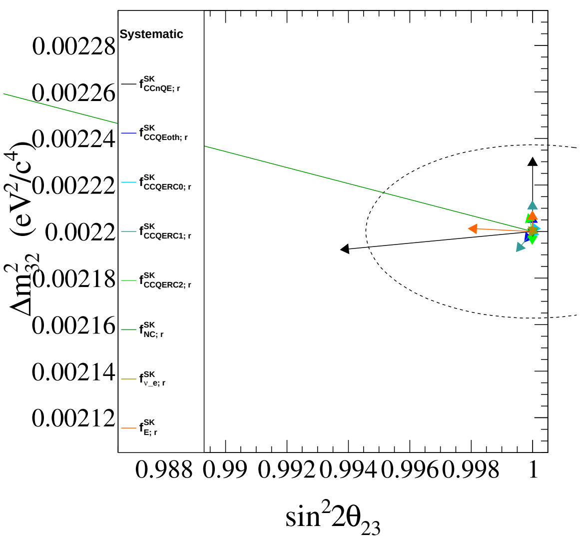


Figure 319: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0022.

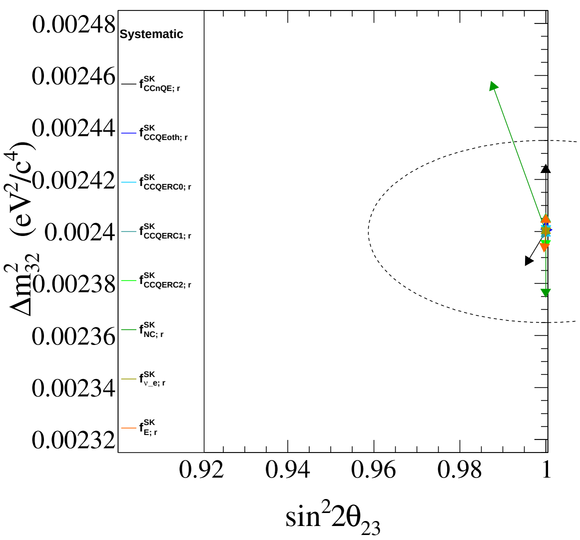


Figure 320: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

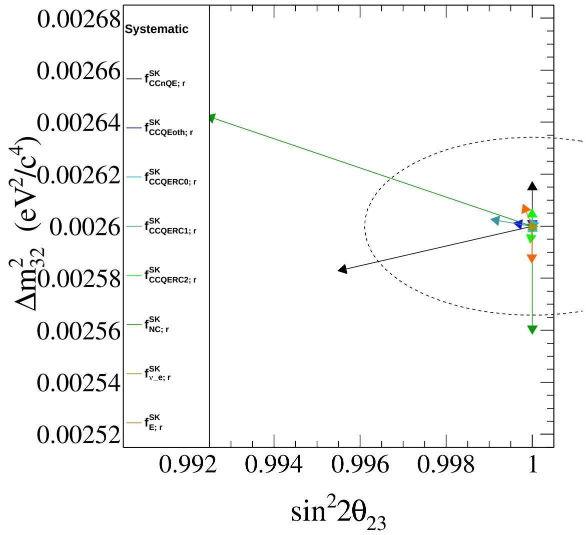


Figure 321: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

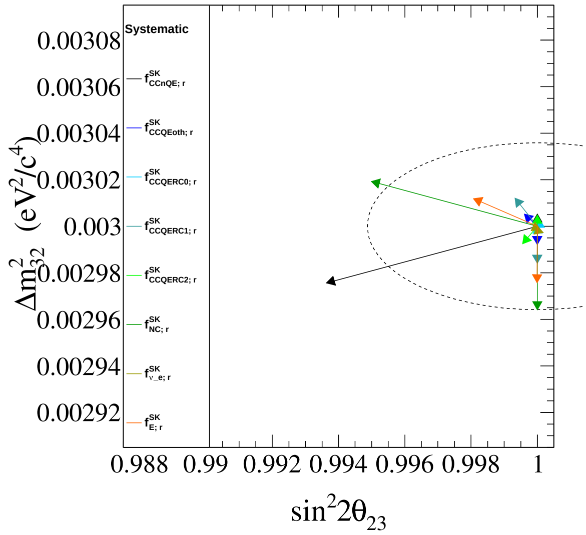


Figure 322: Effect of SuperK detector parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

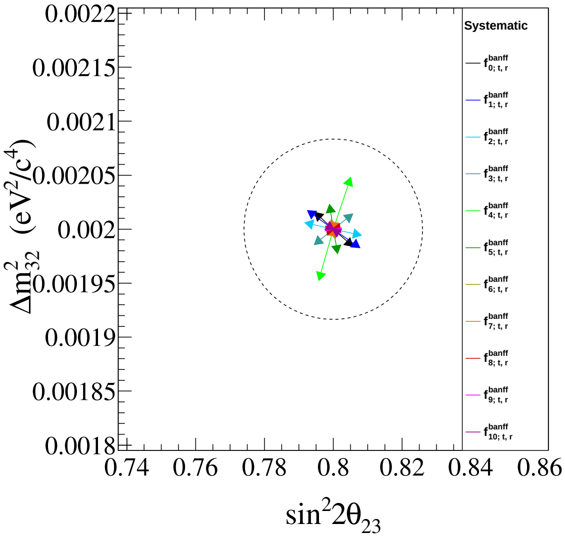


Figure 323: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

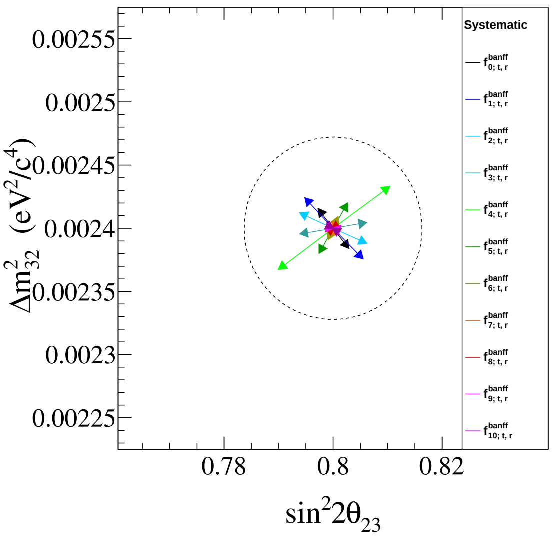


Figure 324: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

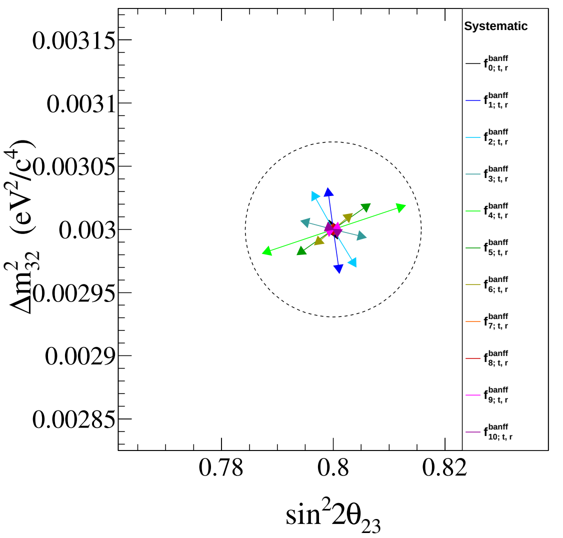


Figure 325: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

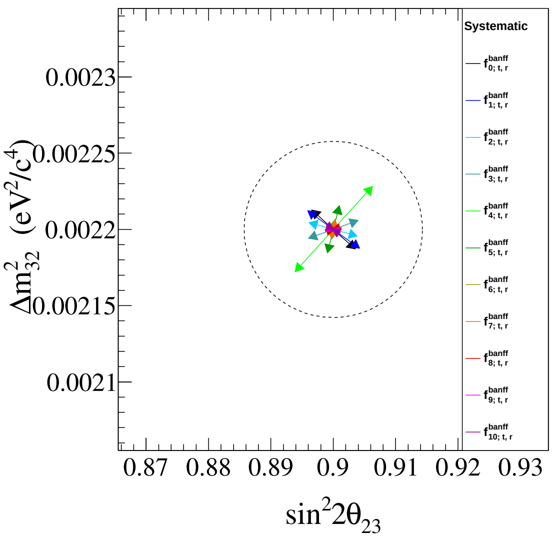


Figure 326: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

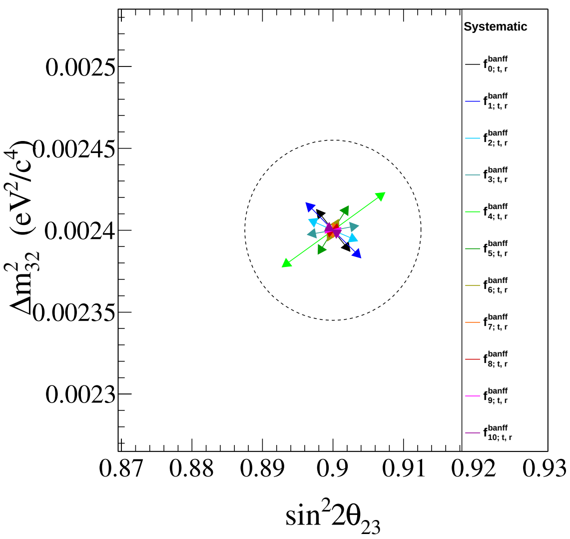


Figure 327: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

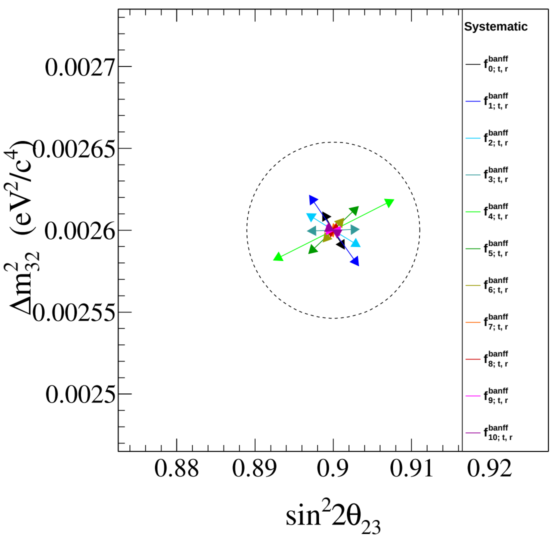


Figure 328: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

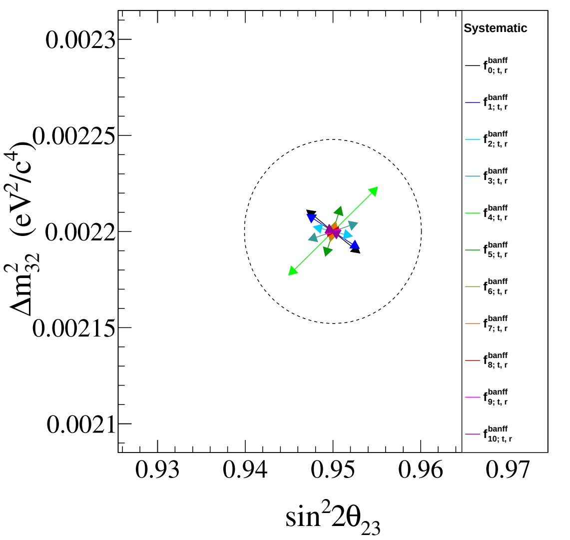


Figure 329: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

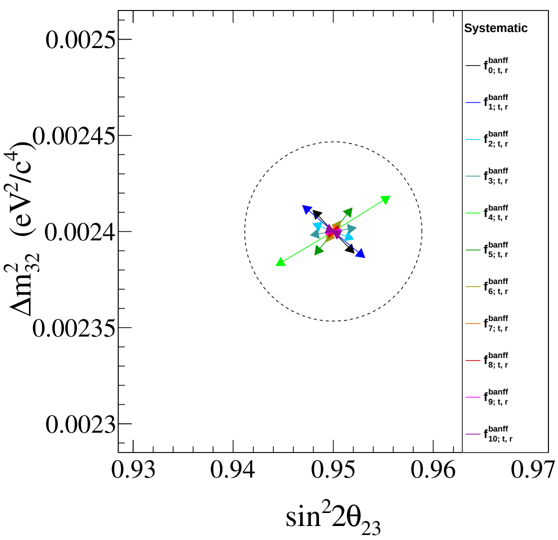


Figure 330: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

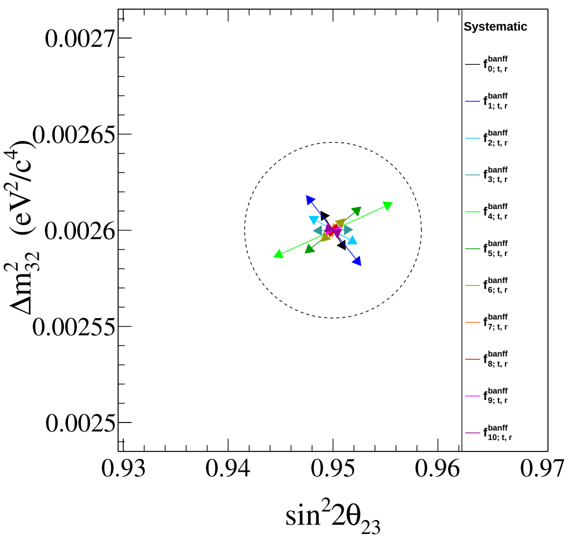


Figure 331: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

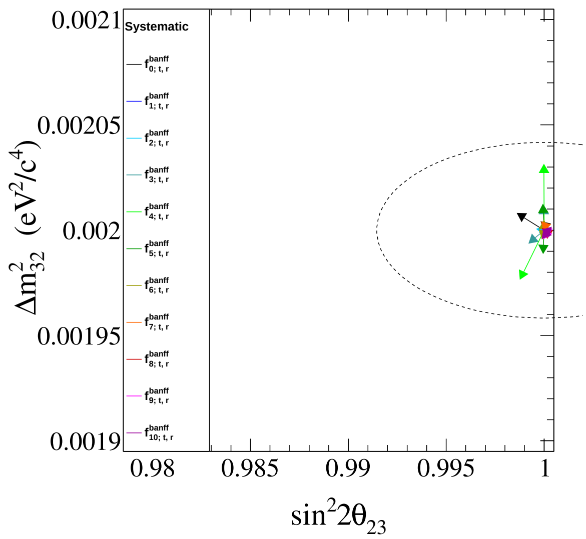


Figure 332: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

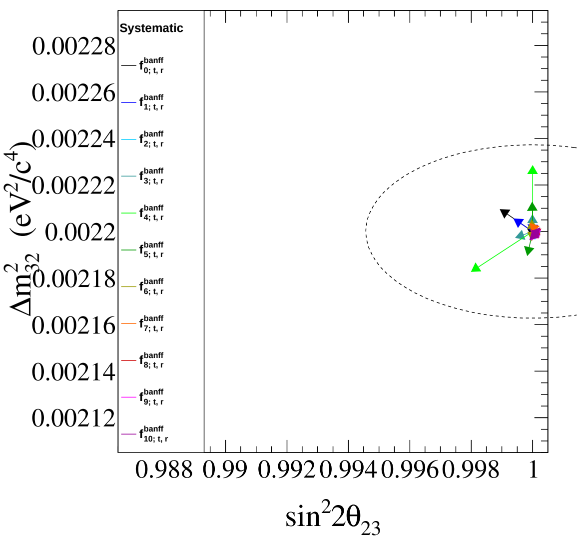


Figure 333: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

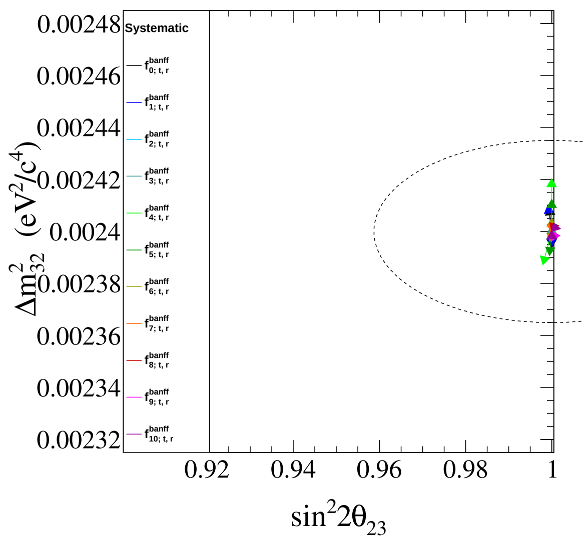


Figure 334: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

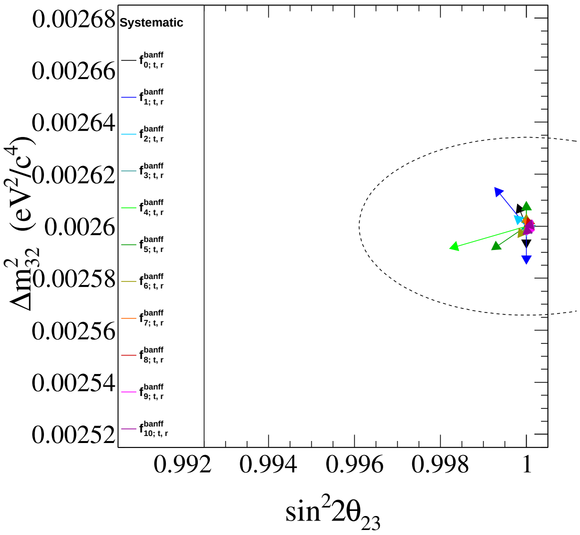


Figure 335: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

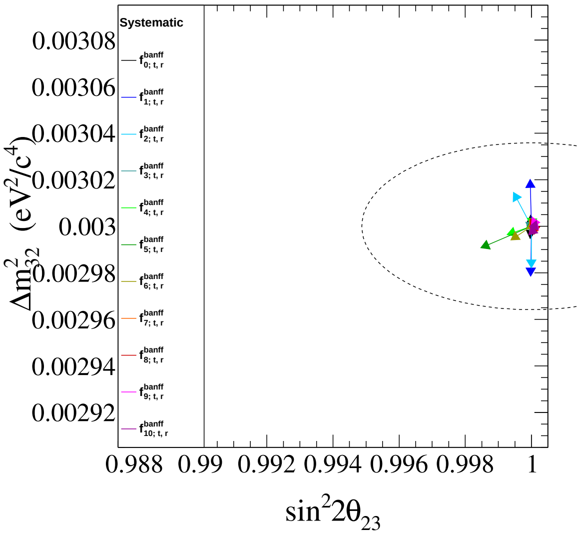


Figure 336: Effect of BANFF ν_μ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

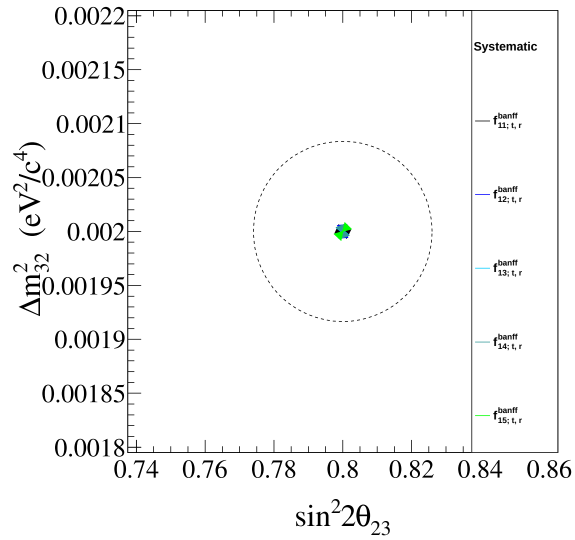


Figure 337: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

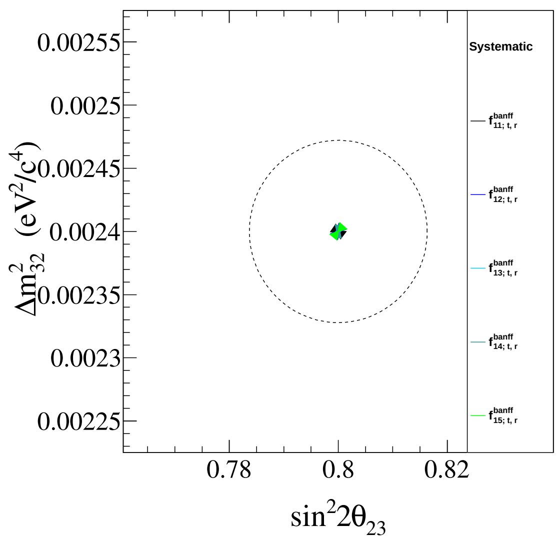


Figure 338: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

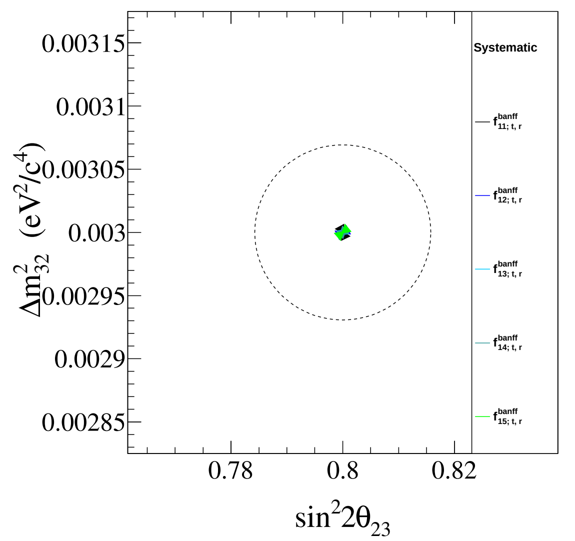


Figure 339: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

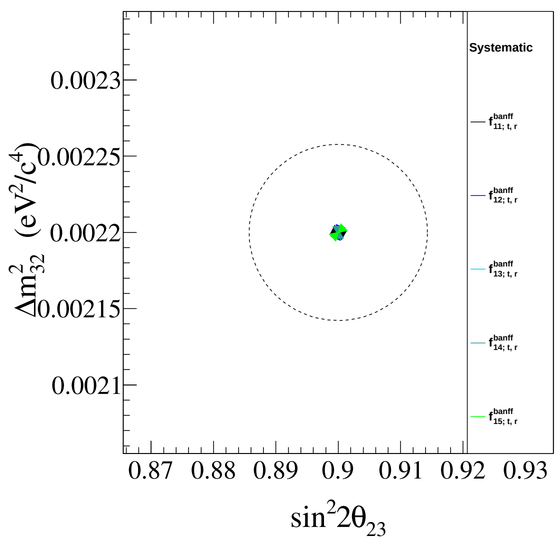


Figure 340: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

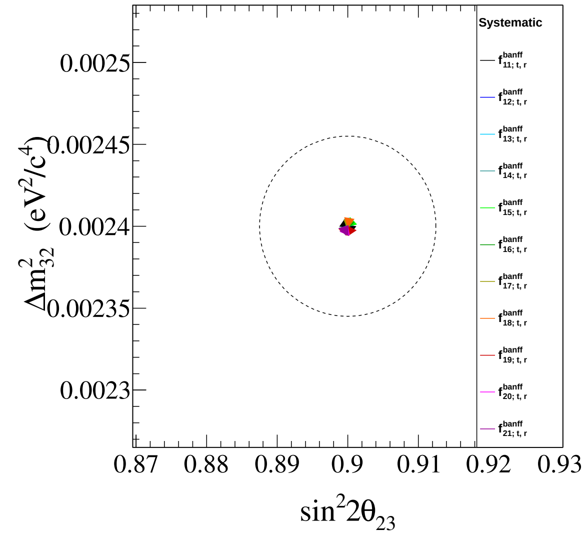


Figure 341: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

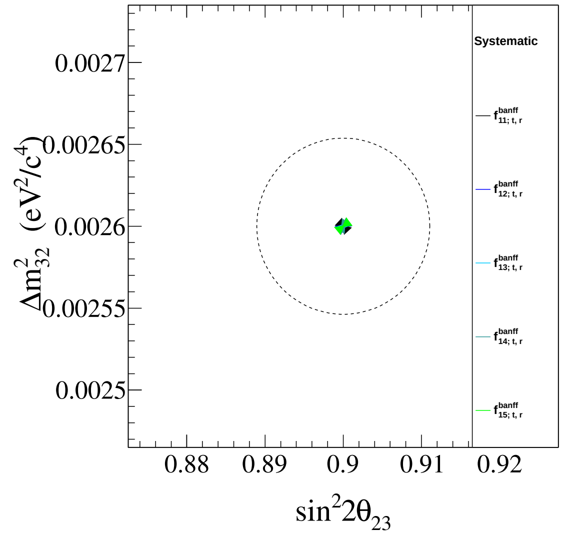


Figure 342: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0026.

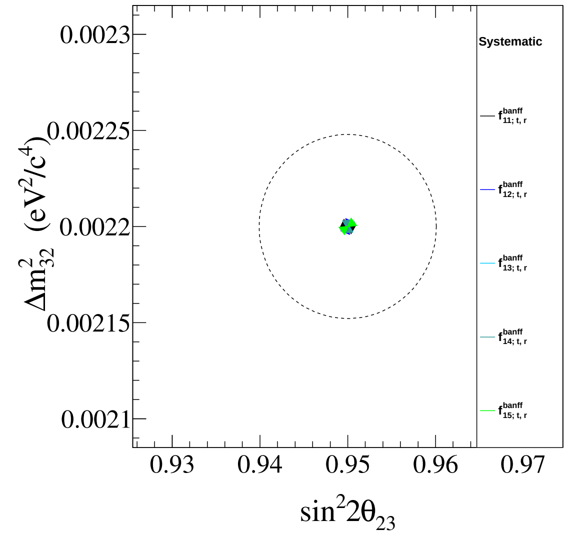


Figure 343: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0022.

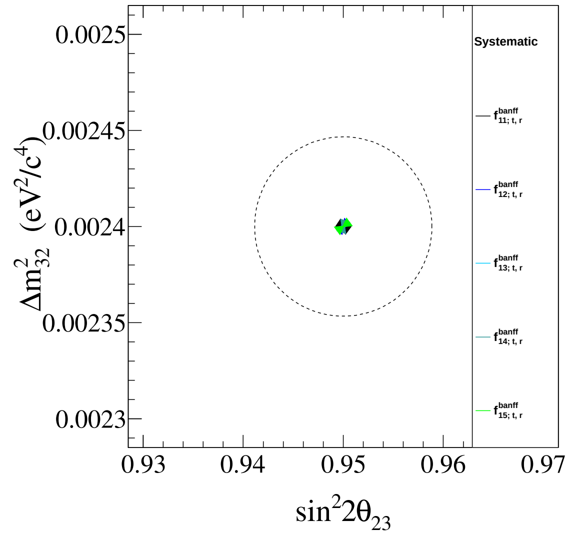


Figure 344: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

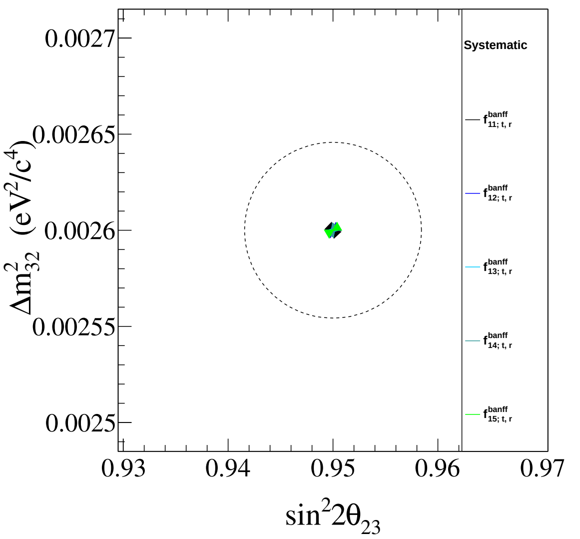


Figure 345: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0026.

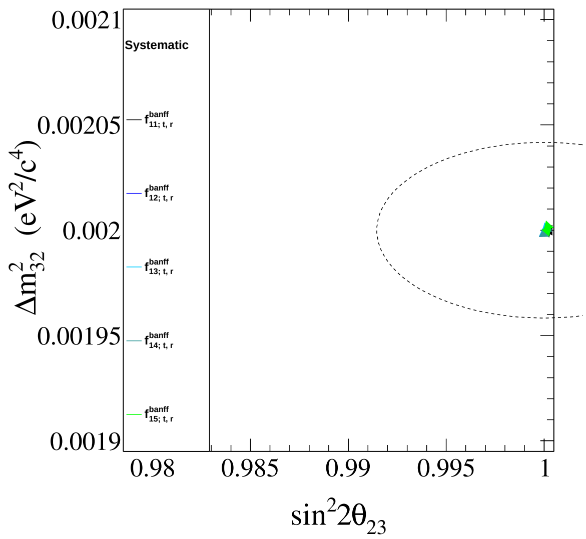


Figure 346: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.002.

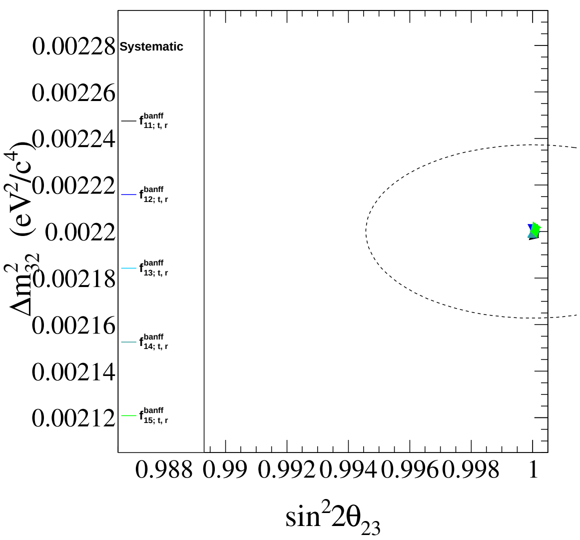


Figure 347: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0022.

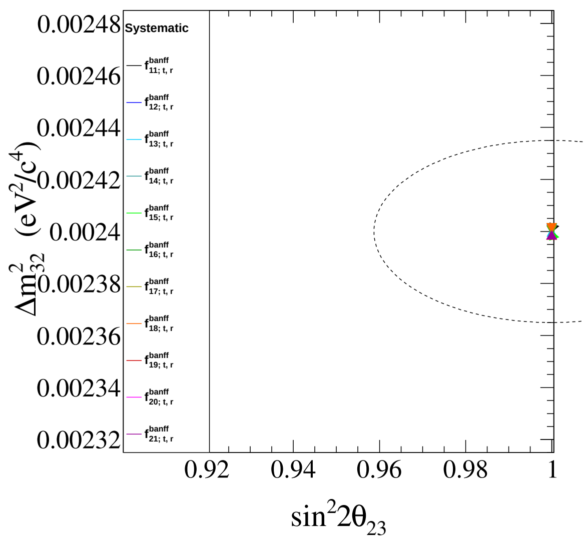


Figure 348: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

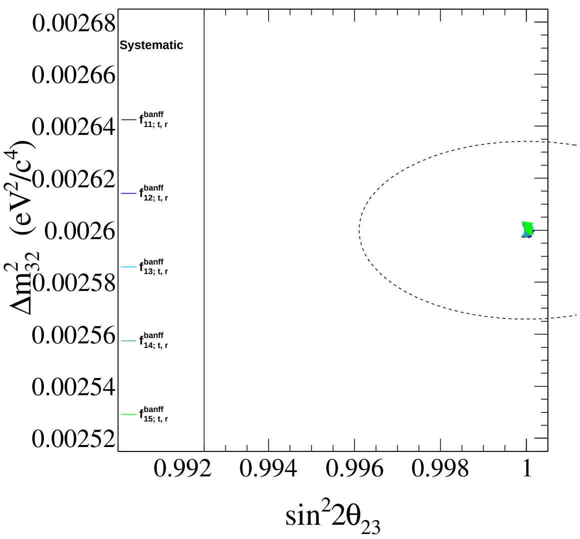


Figure 349: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0026.

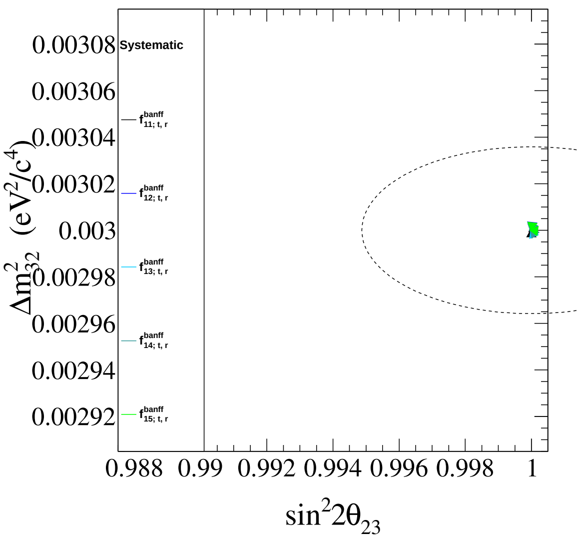


Figure 350: Effect of BANFF $\bar{\nu_\mu}$ flux parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.003.

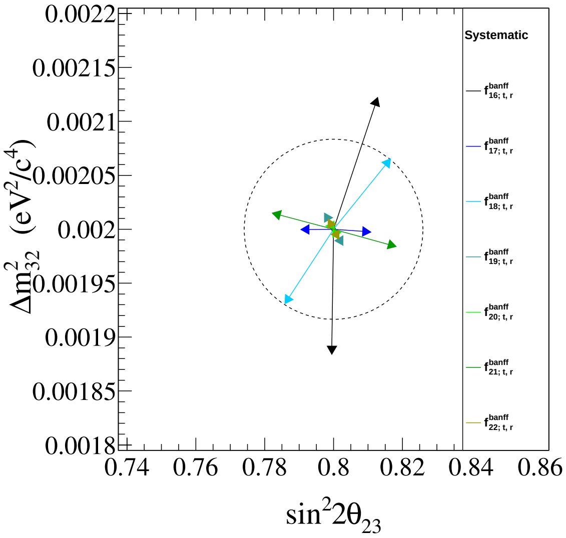


Figure 351: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

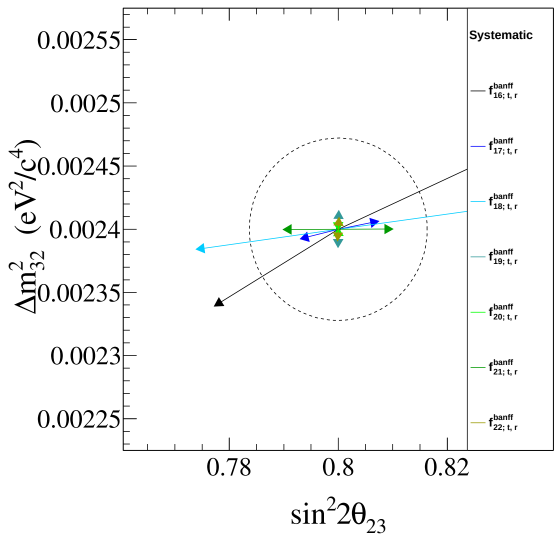


Figure 352: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

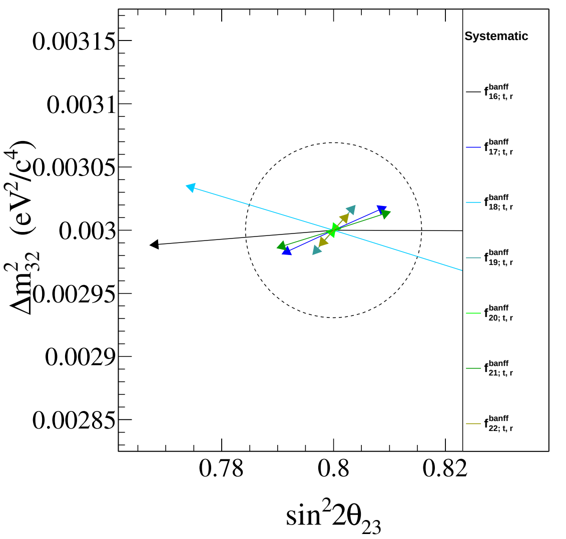


Figure 353: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

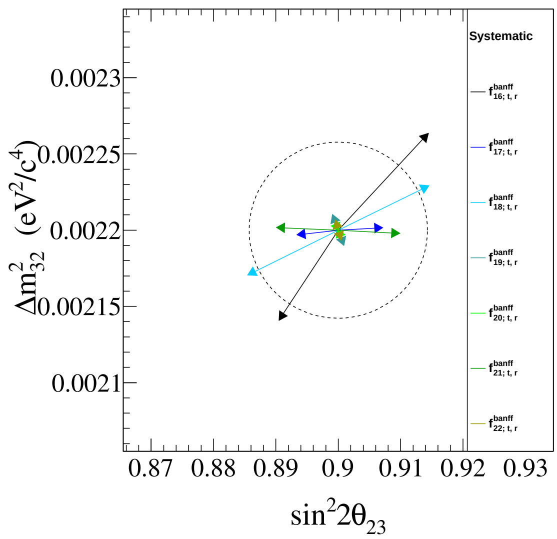


Figure 354: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

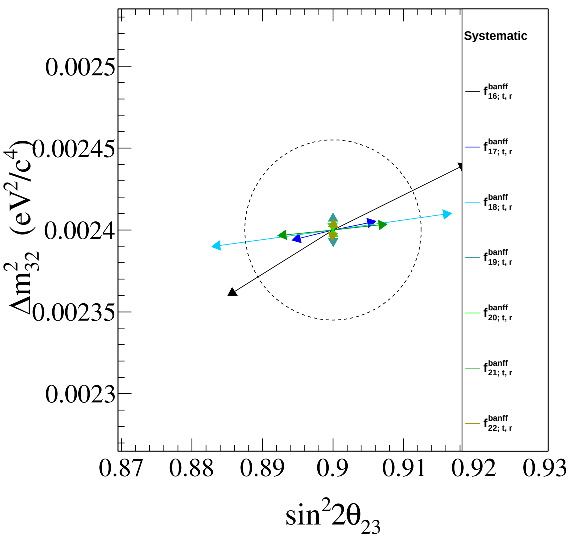


Figure 355: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

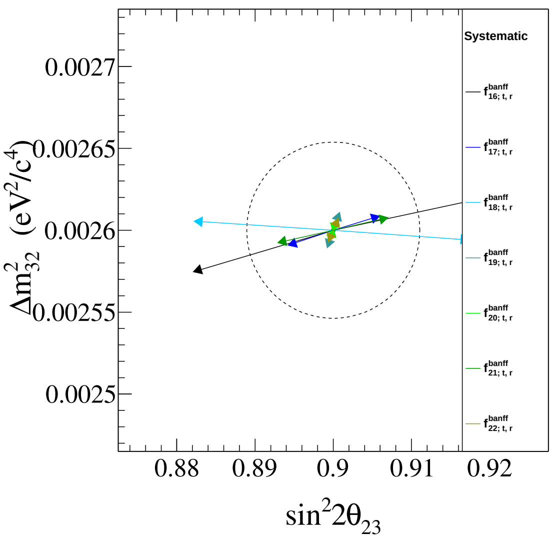


Figure 356: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

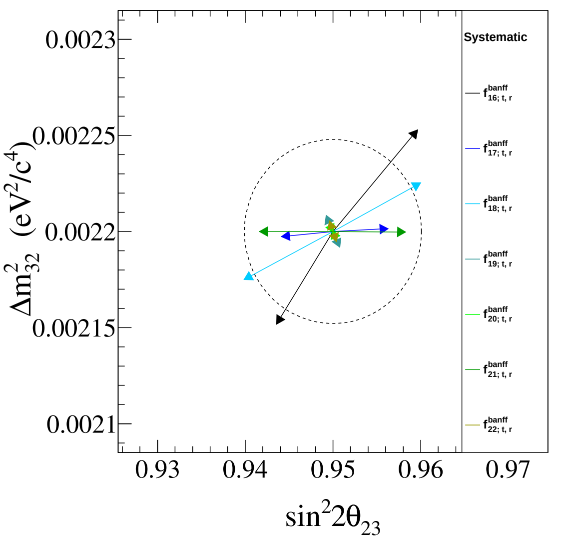


Figure 357: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

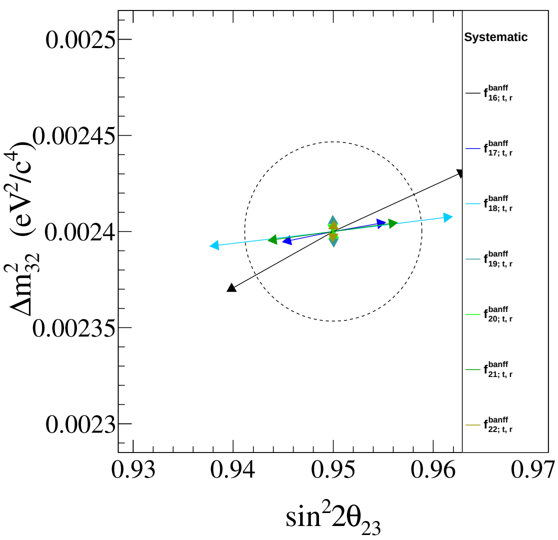


Figure 358: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

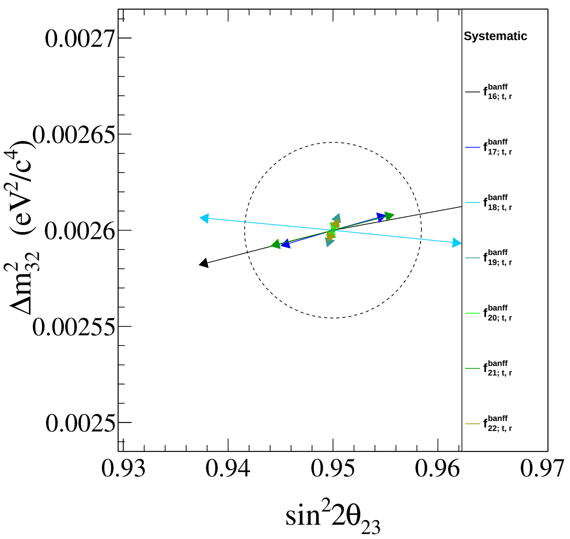


Figure 359: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

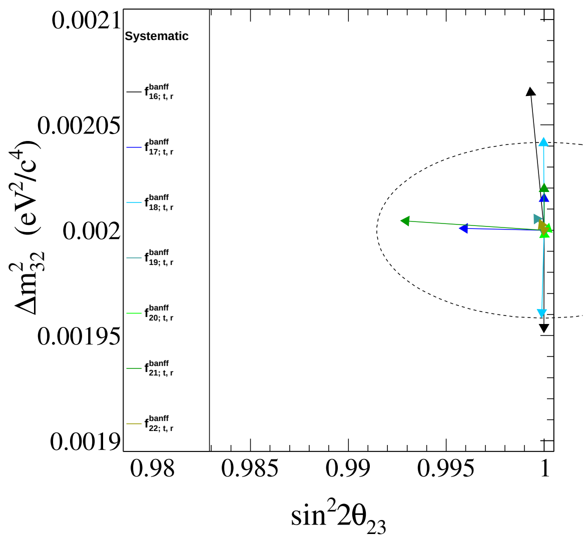


Figure 360: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

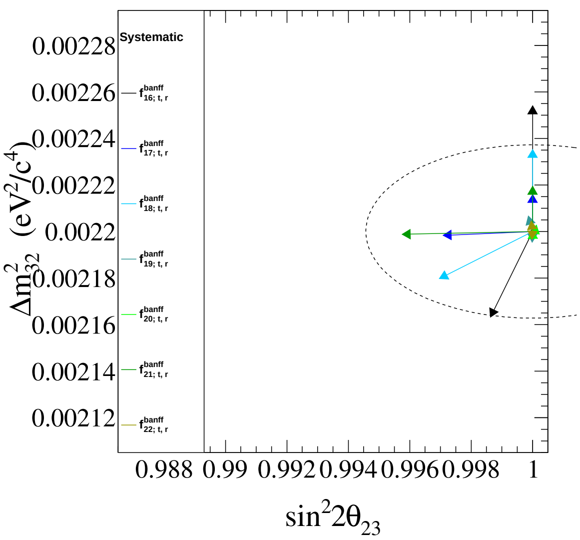


Figure 361: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

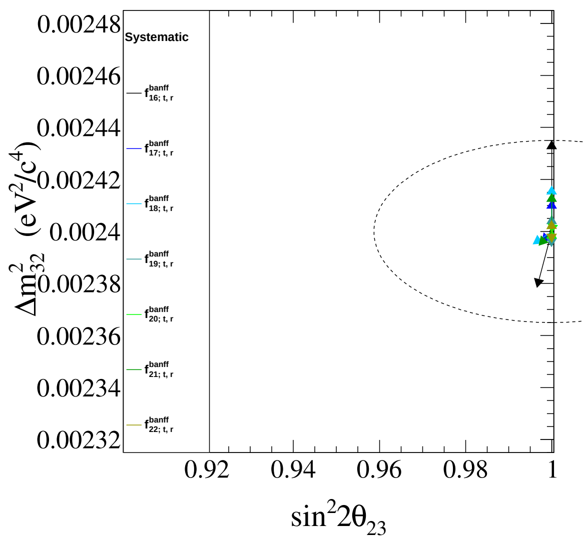


Figure 362: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

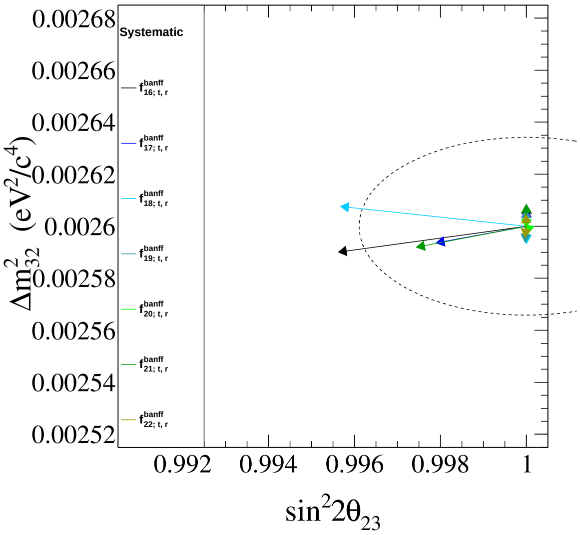


Figure 363: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

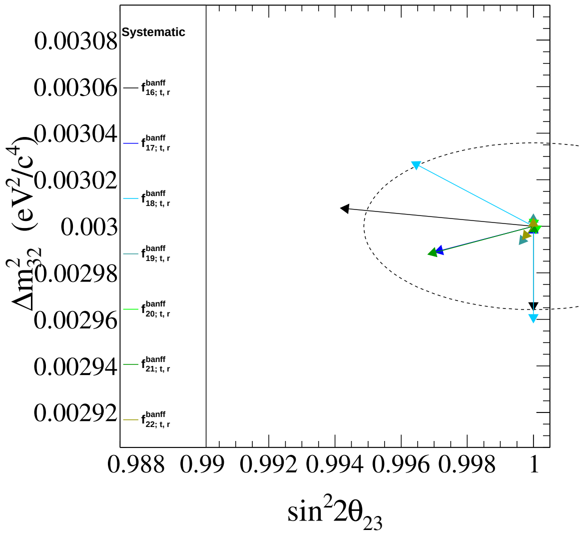


Figure 364: Effect of BANFF cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

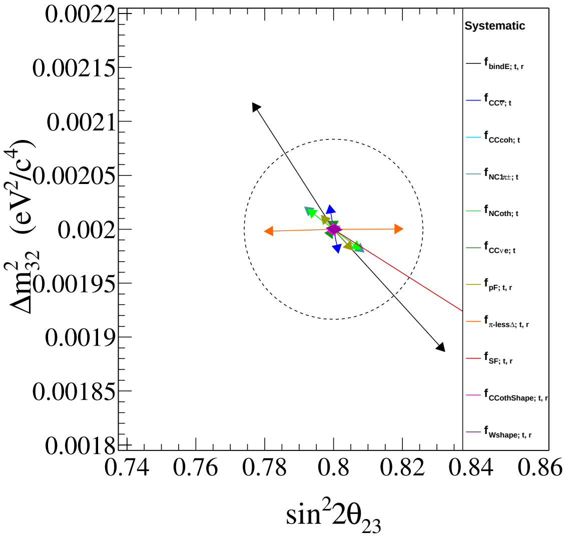


Figure 365: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

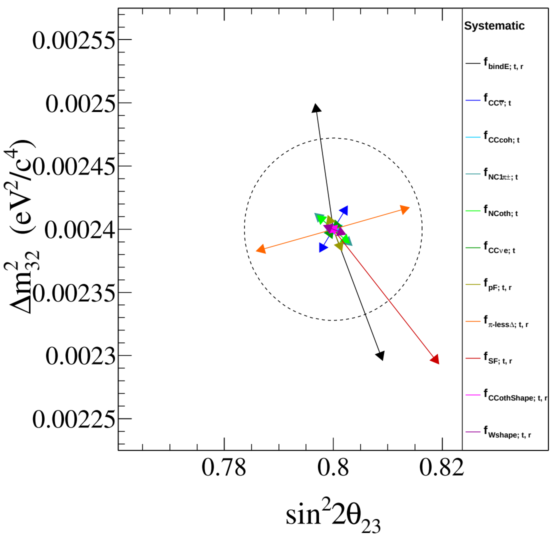


Figure 366: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

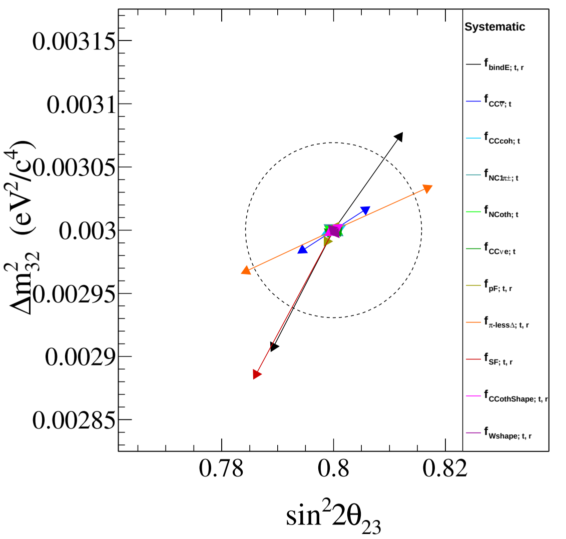


Figure 367: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

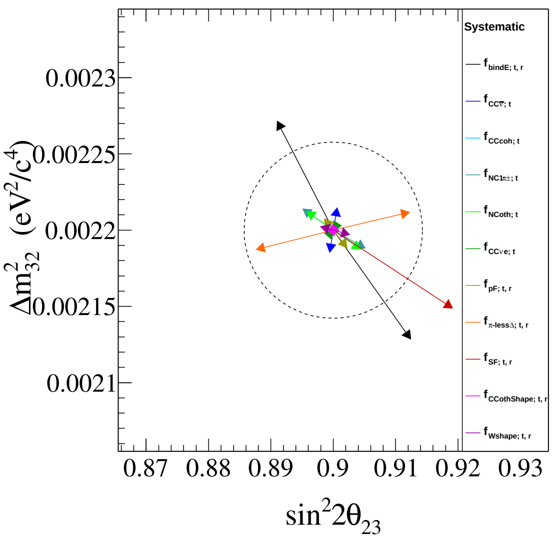


Figure 368: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

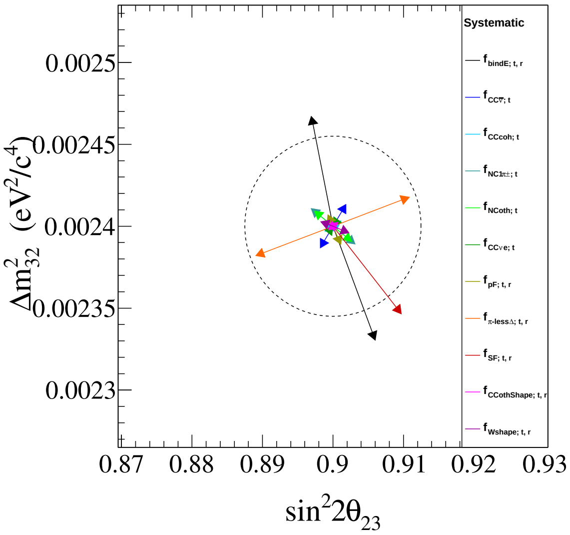


Figure 369: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.

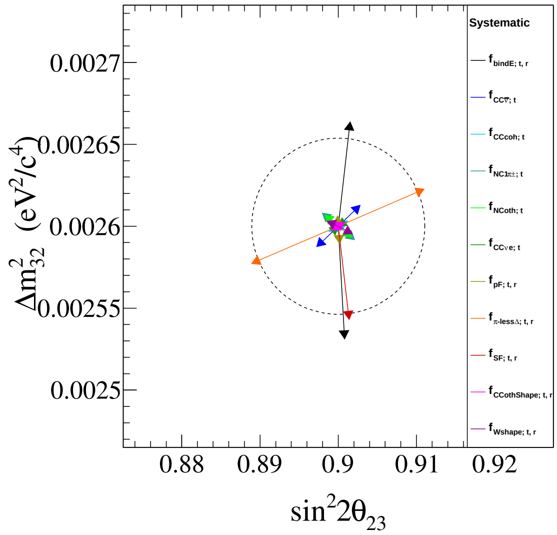


Figure 370: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0026.

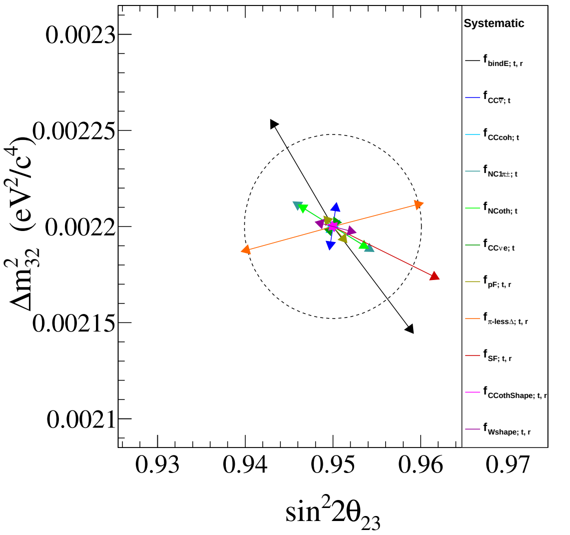


Figure 371: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0022.

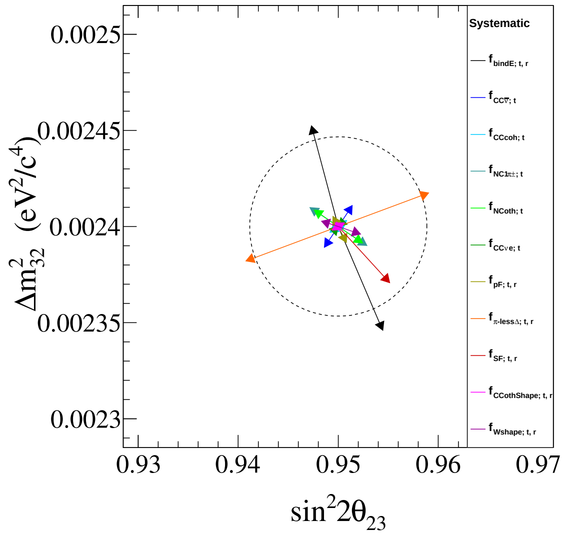
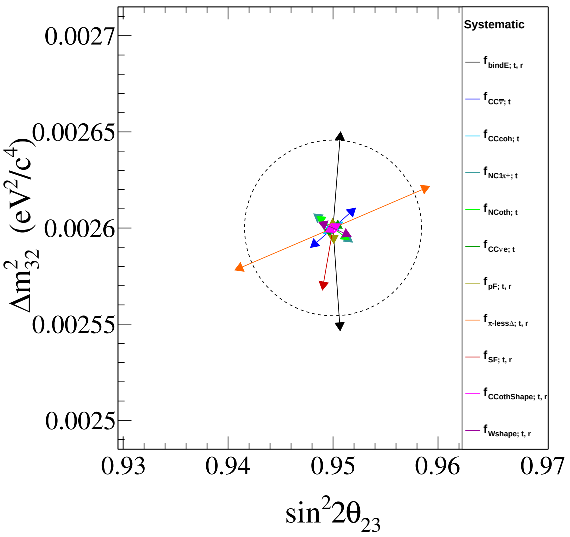


Figure 372: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0024.



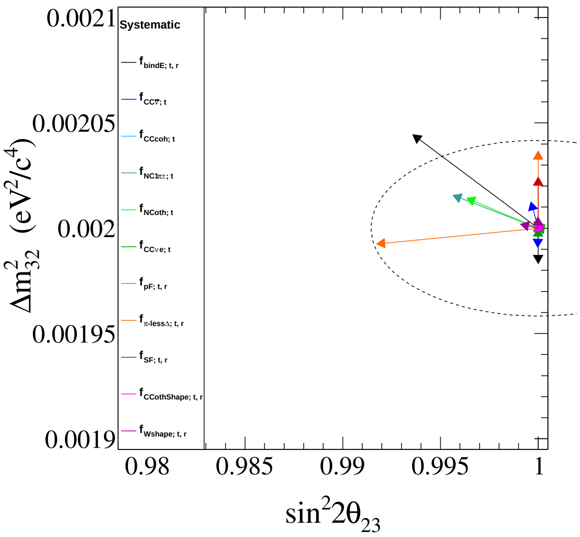
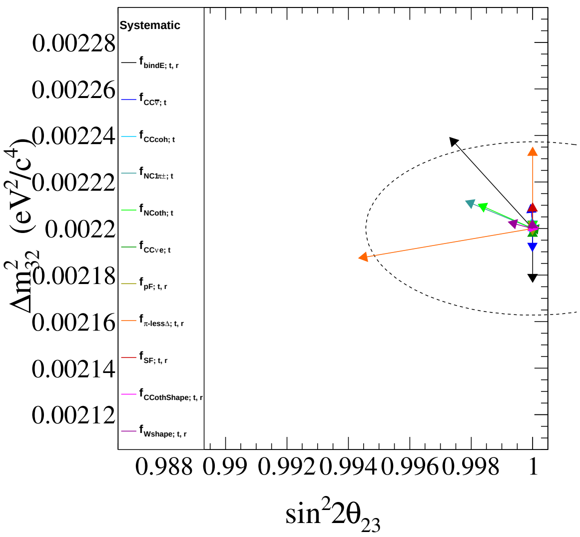


Figure 373: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

Figure 374: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.



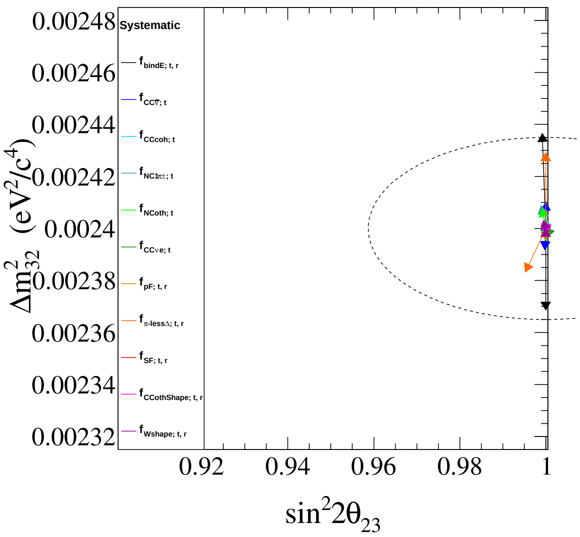


Figure 375: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

Figure 376: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

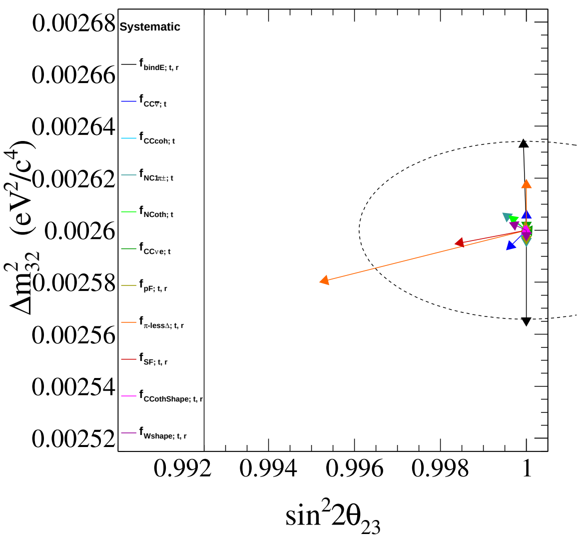


Figure 377: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

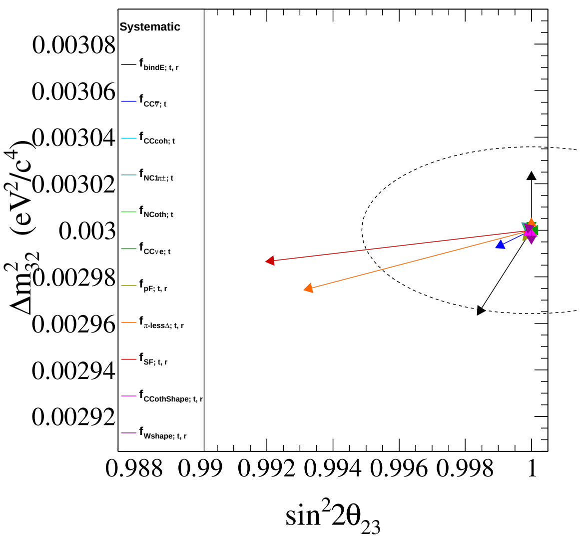


Figure 378: Effect of uncorrelated cross section parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

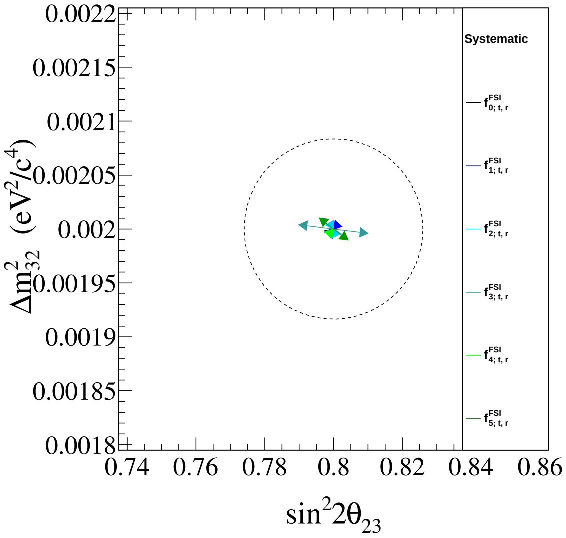


Figure 379: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

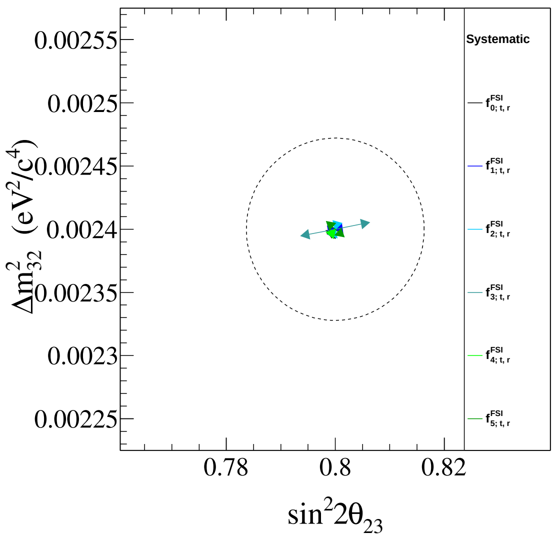


Figure 380: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

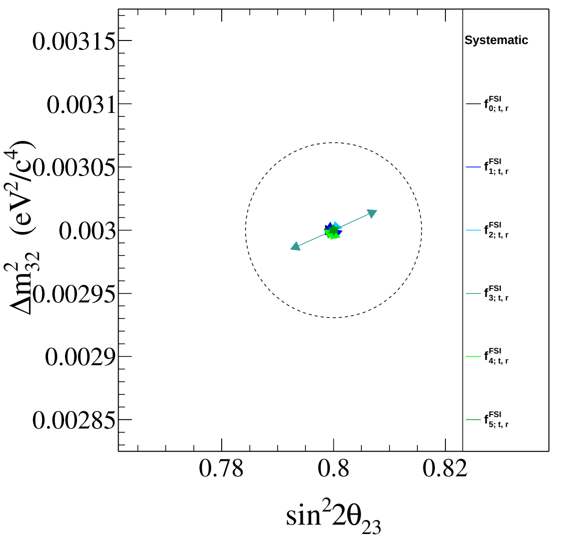


Figure 381: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

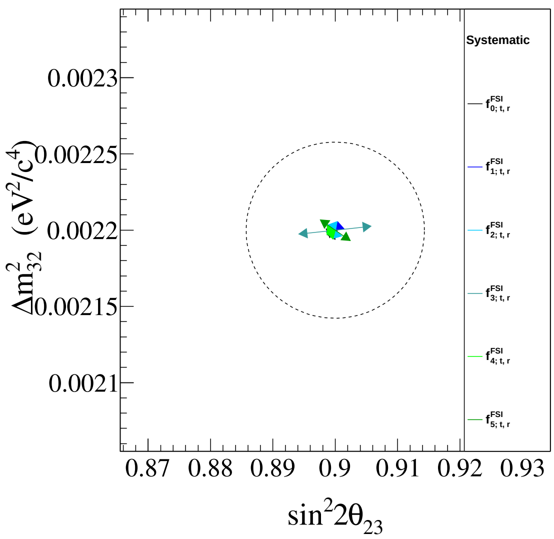


Figure 382: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

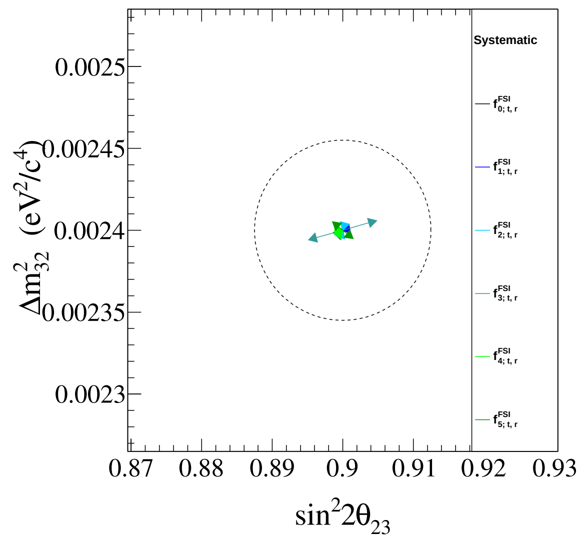


Figure 383: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

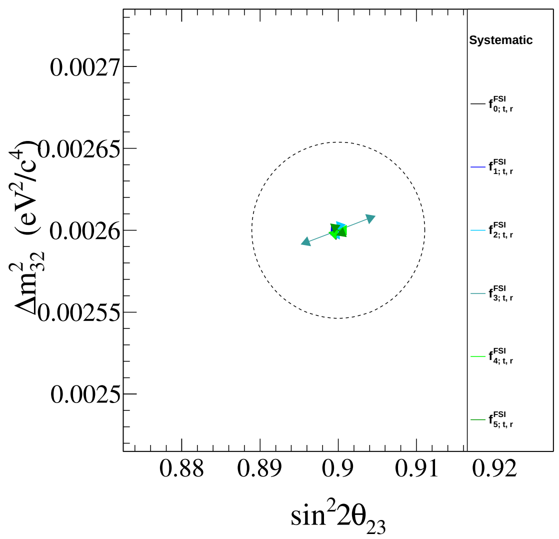


Figure 384: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

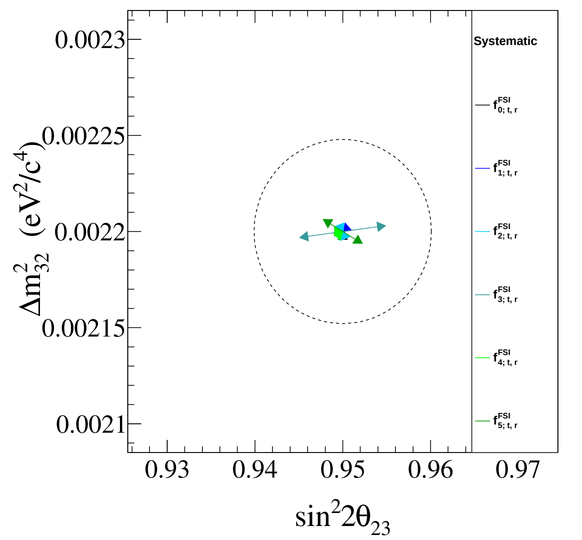


Figure 385: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

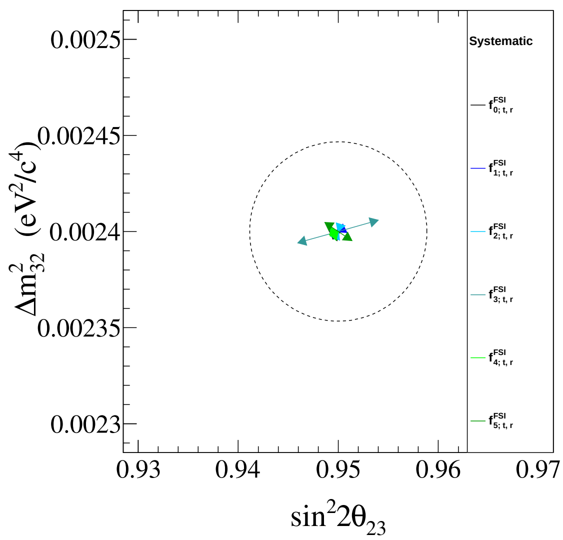


Figure 386: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

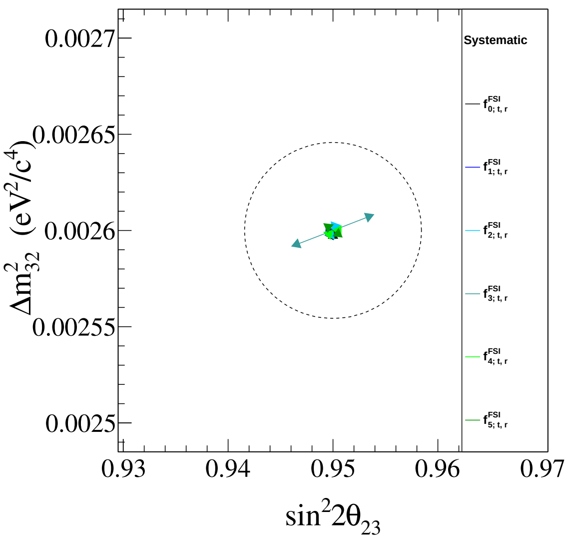


Figure 387: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

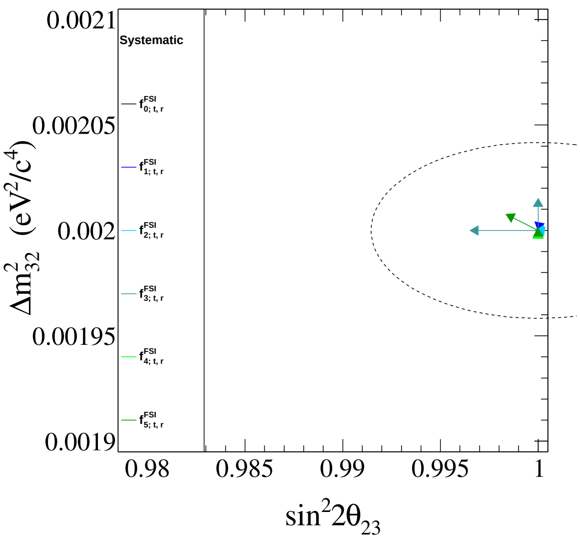


Figure 388: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

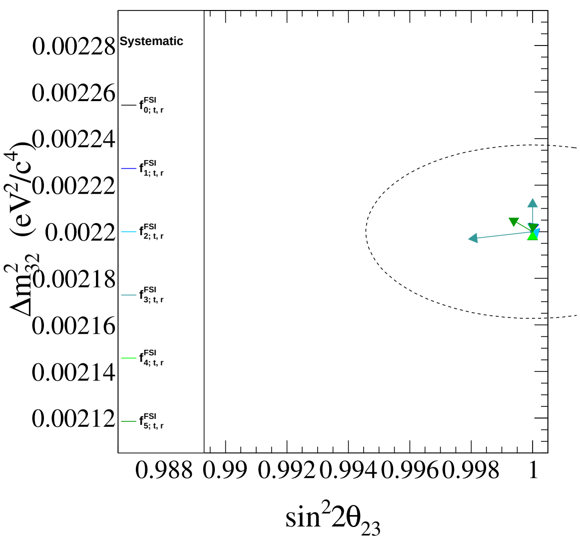


Figure 389: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

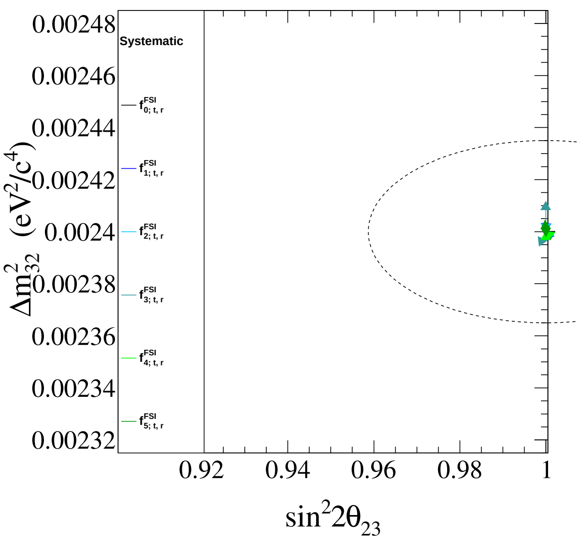


Figure 390: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

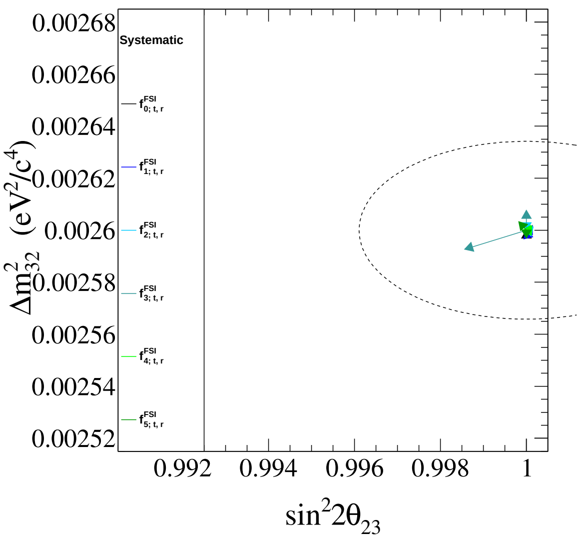


Figure 391: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

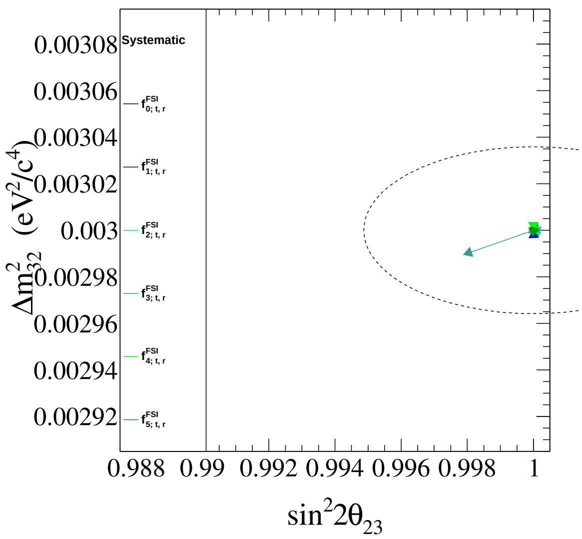


Figure 392: Effect of FSI+SI parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

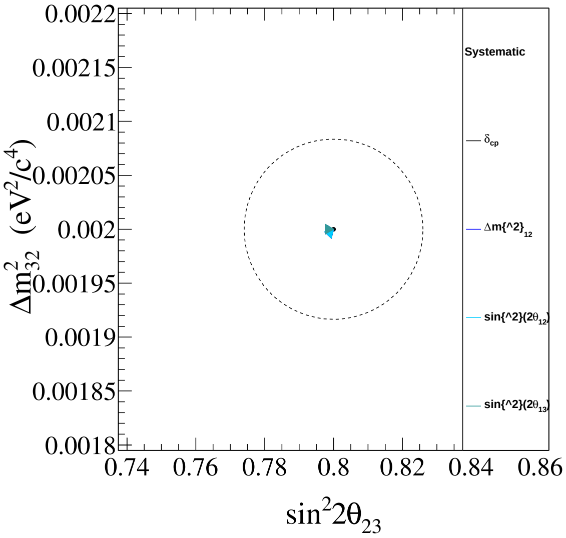


Figure 393: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

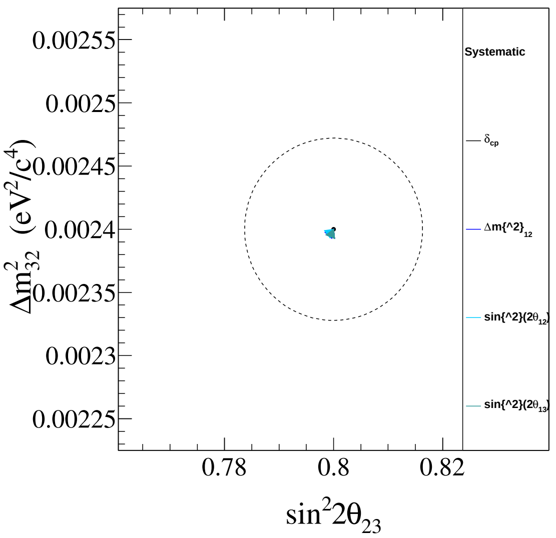


Figure 394: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

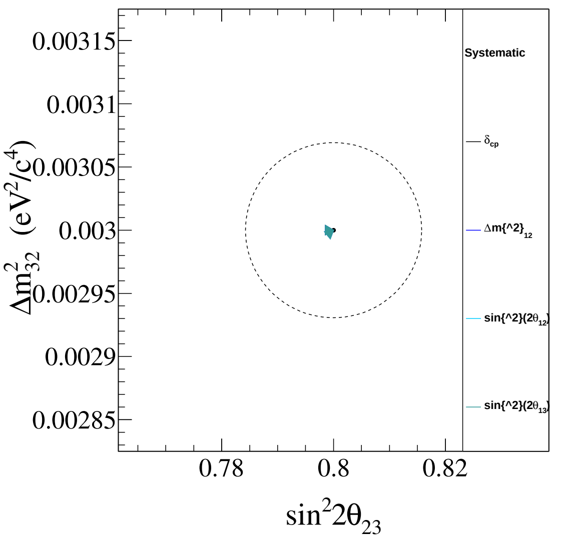


Figure 395: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.8; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.003$.

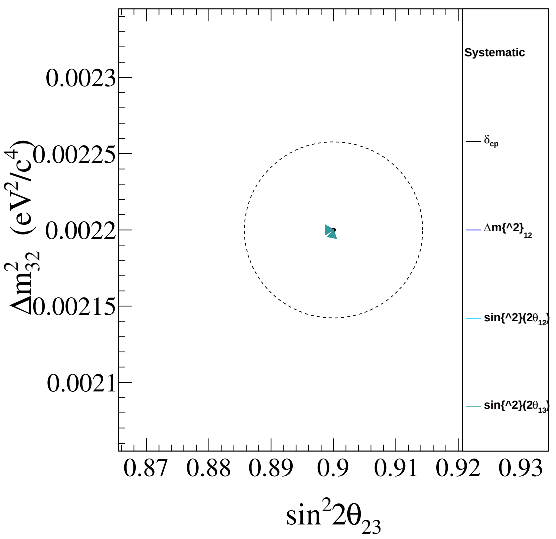


Figure 396: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

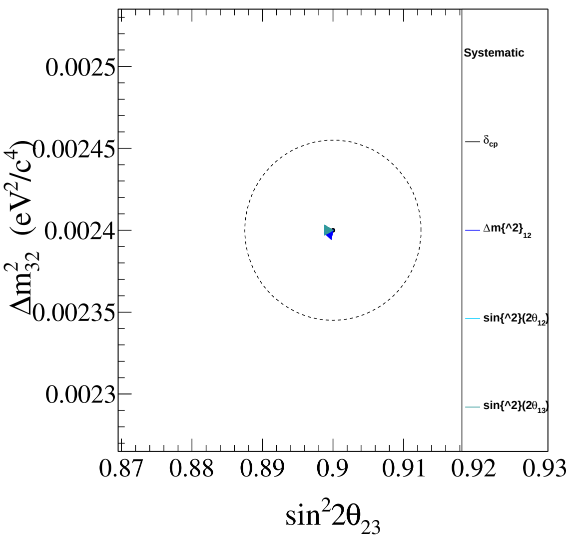


Figure 397: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

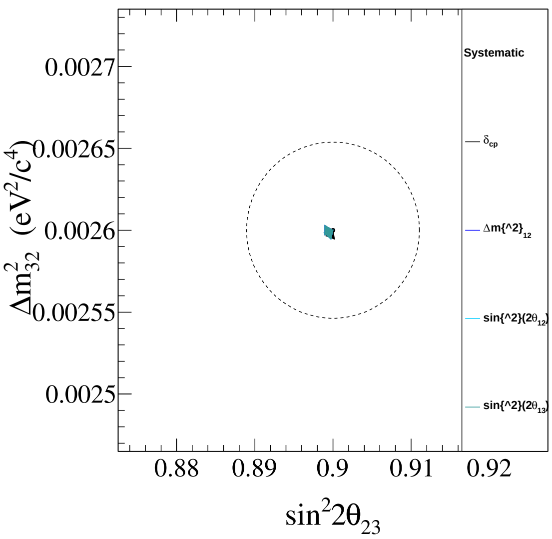


Figure 398: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

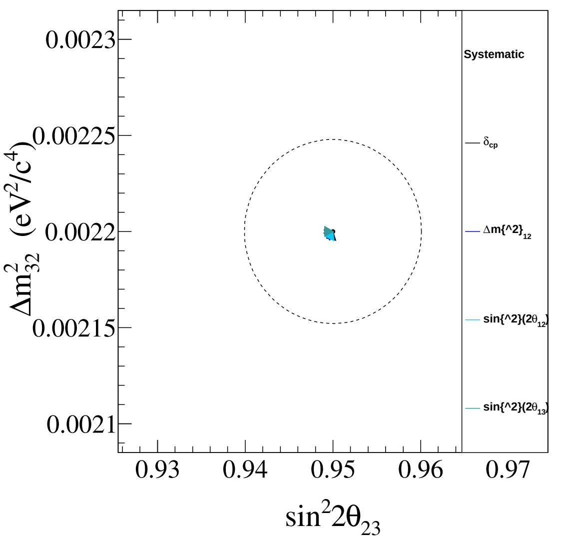


Figure 399: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

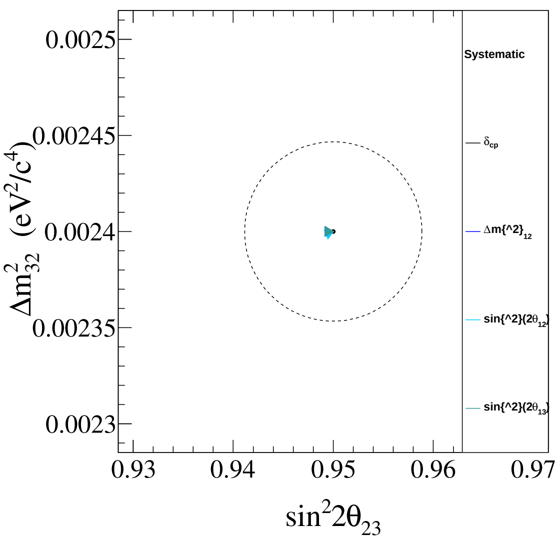


Figure 400: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

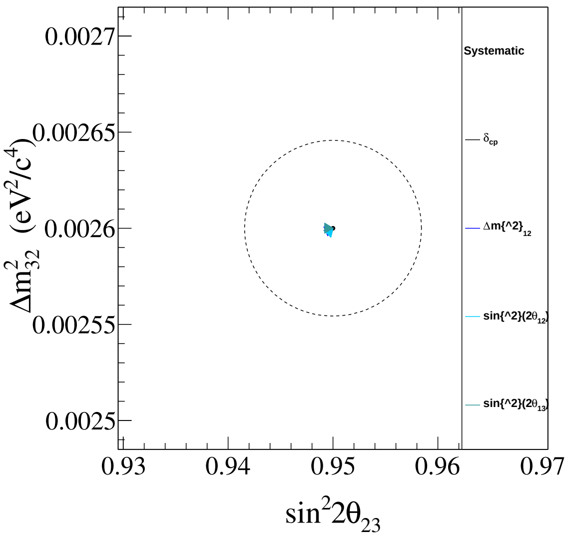


Figure 401: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.95; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0026$.

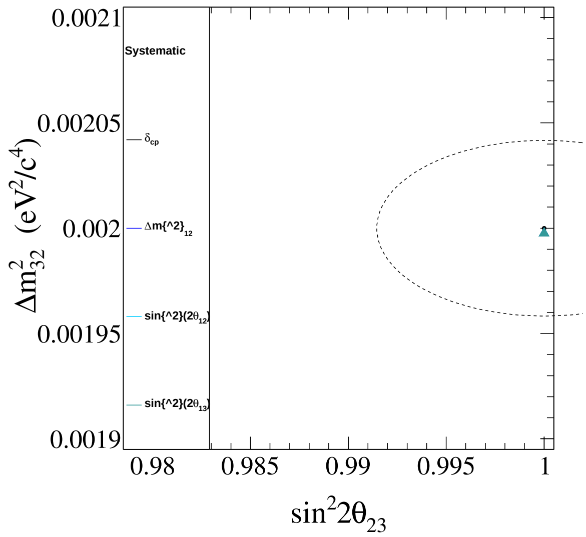


Figure 402: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.002$.

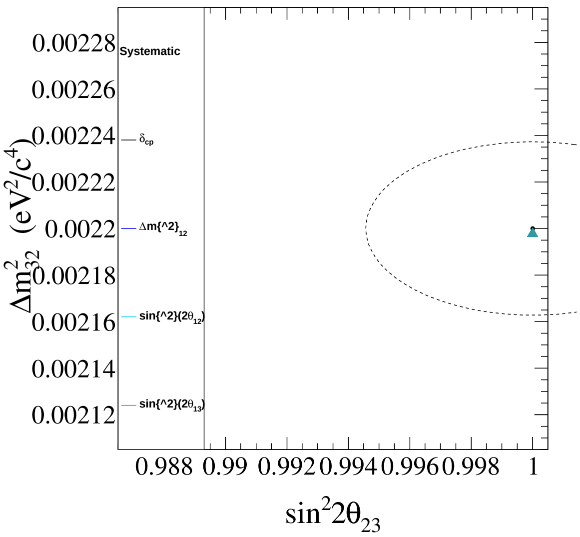


Figure 403: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0022$.

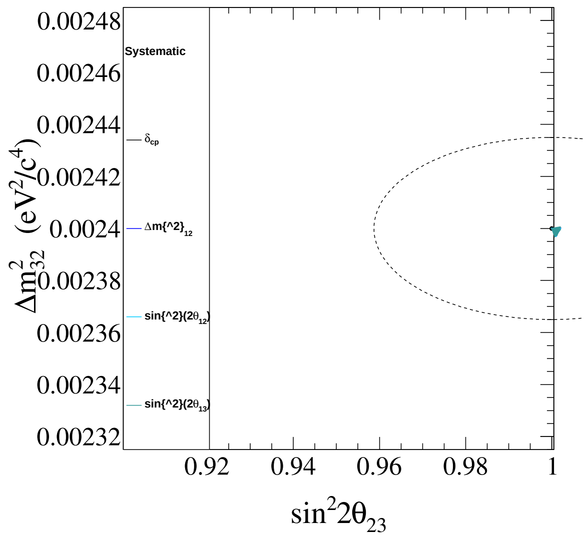


Figure 404: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ± 1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; $\Delta m^2_{32} = 0.0024$.

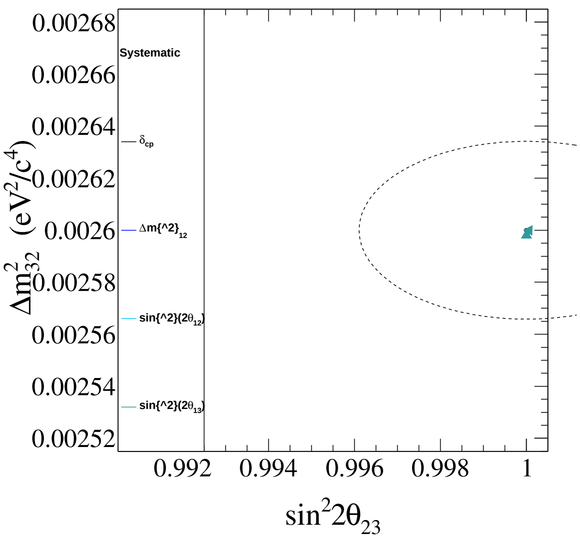


Figure 405: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.0026.

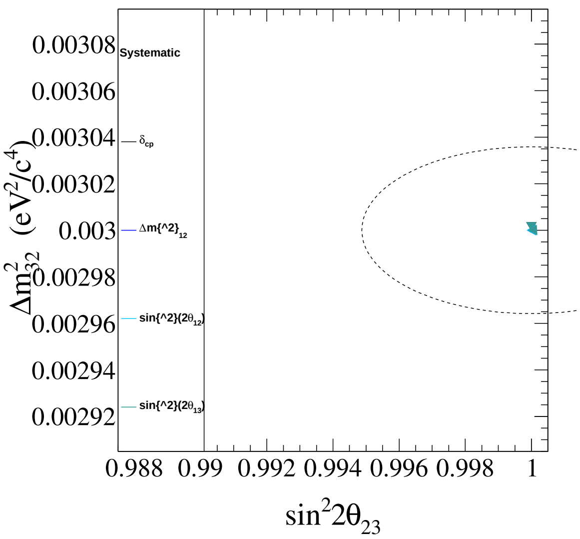


Figure 406: Effect of non-23 sector oscillation parameters on the best fit point, using a 2+0 fit, with a single systematic changed by ±1 sigma. The ellipse shown is one quarter the size of the statistical error. For 3 flavour oscillations, using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{12} = 7.5e-05; Δm^2_{32} = 0.003.

H. Fitter performance

The performance of the fitter has been evaluated at various oscillation points, using various POT, various levels of throwing systematics, and various fitters. For each study, 10000 toy datasets were created, and were fitted using MINUIT. Residual and pull distributions are presented in the following sections. The following three pull definitions are used:

$$\mathrm{Pull}_1 = \frac{\text{(best-fit parameter) - (input parameter)}}{\sigma_{\text{fit}}} \tag{18}$$

$$\mathrm{Pull}_2 = \frac{\text{(best-fit parameter) - (input parameter)}}{\sqrt{\sigma_{\text{prior}}^2 - \sigma_{\text{fit}}^2}}, \tag{19}$$

and

$$\mathrm{Pull}_3 = \frac{\text{(best-fit parameter) - (nominal parameter)}}{\sigma_{\text{fit}}} \tag{20}$$

where σ_{fit} is output MINUIT/HESSE error and σ_{prior} is the prior assumed error. When Pull_2 is shown for a correlated systematic parameter, σ_{prior} is defined as the square root of the corresponding diagonal element of the covariance matrix.

The various pull definitions are used as shown below

- Definition 1 is used for the pulls of both oscillation and systematic parameters in toy-MC studies.
- Definition 2 is used for the pulls of systematic parameters in toy-MC studies.
- Definition 3 is used for the pulls of systematic parameters both in toy-MC studies and for the fit to the actual data.

H.1. '2+0' fit, no systematic fluctations

Figs. 407-408 show the pull and fitted values of $\sin^2 2\theta_{23}$. Figs. 409-410 show the corresponding plots for $|\Delta m^2_{32}|$. The input values are $\sin^2 2\theta_{23}$ = 0.9, $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4. A bias towards higher $\sin^2 2\theta_{23}$ can be seen, which is present even when the pileup near the physical boundary is removed. This bias is due to low statistics at 3.01×20 POT. When Poisson fluctuations are made of a small number of events in a bin of the reconstructed energy distribution, a downward fluctuation is more likely than an upward fluctuation. For example, a Poisson distribution with mean 3 has P(1) = 0.149 and P(2) = 0.224, whereas P(4) = 0.168 and P(5) = 0.101. A downward fluctuation in a few bins around the oscillation maximum increases the fitted value of $\sin^2(2\theta_{23})$, and this is the reason for the bias towards high values of this parameter.

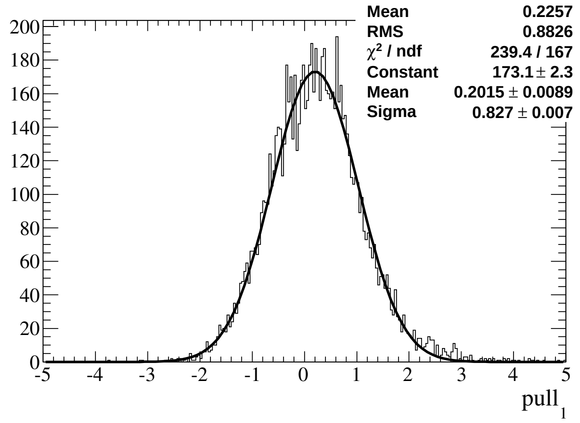


Figure 407: Pull$_1$ of $\sin^2 2\theta_{23}$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

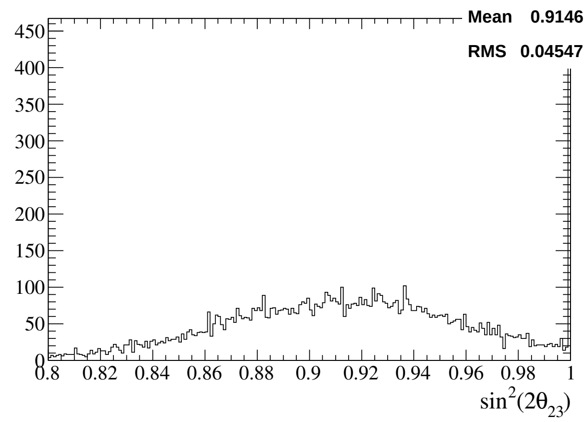


Figure 408: Fitted value of $\sin^2 2\theta_{23}$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

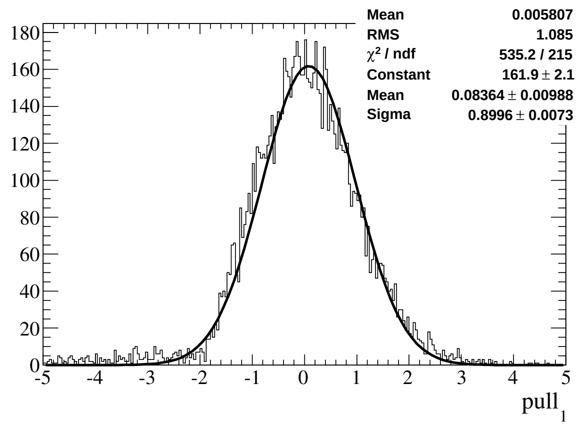


Figure 409: Pull$_1$ of $|\Delta m^2_{32}|$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

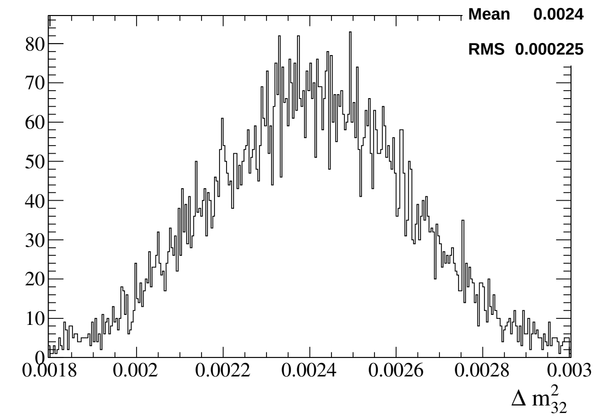


Figure 410: Fitted value of $|\Delta m^2_{32}|$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

H.2. '2+0' fit, no systematic fluctations, 100× RunI-III POT

Figs. 411-412 show the pull and fitted values of $\sin^2 2\theta_{23}$. Figs. 413-414 show the corresponding plots for $|\Delta m^2_{32}|$. The input values are $\sin^2 2\theta_{23}$ = 0.9, $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4. The bias in $\sin^2 2\theta_{23}$ seen at current POT has gone.

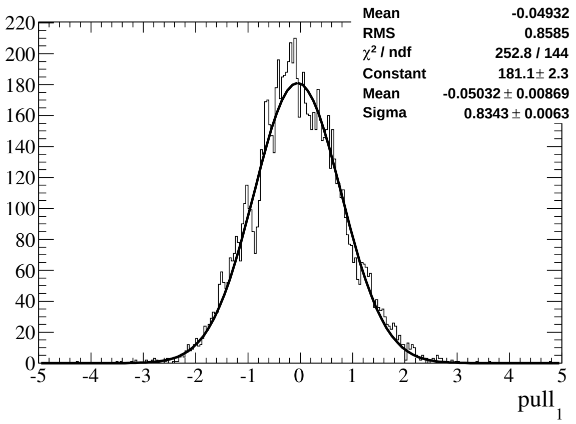


Figure 411: Pull$_1$ of $\sin^2 2\theta_{23}$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{22} POT. No systematic fluctuations are included.

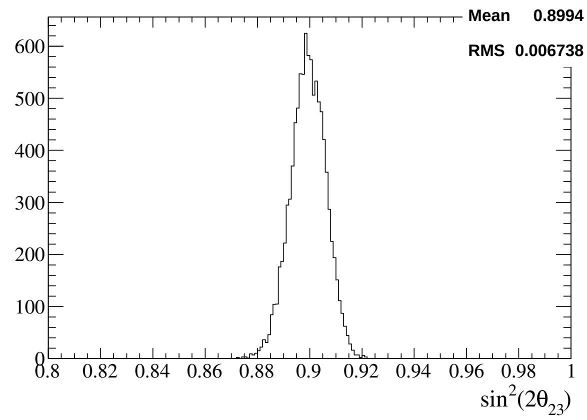


Figure 412: Fitted value of $\sin^2 2\theta_{23}$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{22} POT. No systematic fluctuations are included.

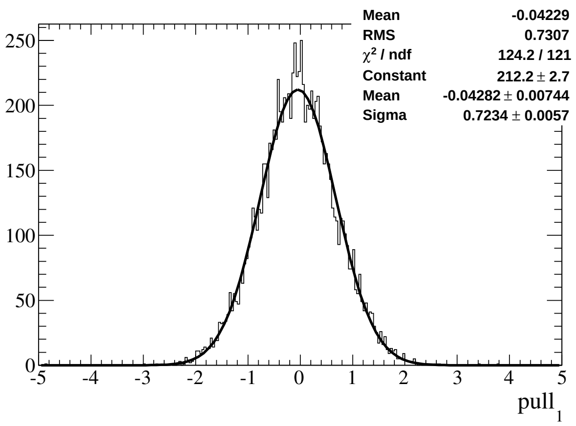


Figure 413: Pull$_1$ of $|\Delta m^2_{32}|$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{22} POT. No systematic fluctuations are included.

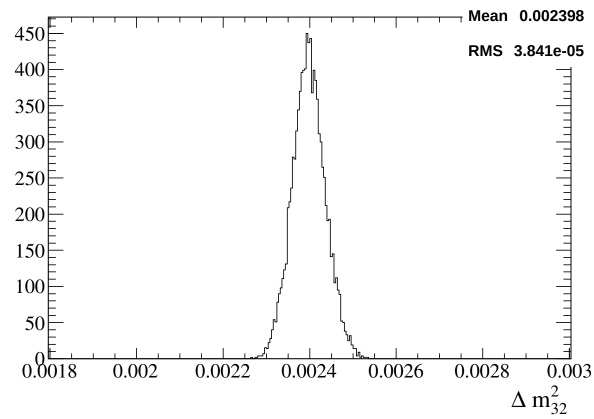


Figure 414: Fitted value of $|\Delta m^2_{32}|$ for a 2+0 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{22} POT. No systematic fluctuations are included.

H.3. '2+8' fit, no systematic fluctations

Figs. 415-416 show the pull and fitted values of $\sin^2 2\theta_{23}$. Figs. 417-418 show the corresponding plots for $|\Delta m^2_{32}|$. The input values are $\sin^2 2\theta_{23}$ = 0.9, $|\Delta m^2_{32}|$ = $2.4 \times 10^{-3}\ eV^2/c^4$. The results are similar to the '2+0' case (a bias towards higher $\sin^2 2\theta_{23}$ can be seen, which is present even when the pileup near the physical boundary is removed) but no additional biases are present. Therefore, adding systematics to the fit does not cause significant changes to the performance of the oscillation part of the fit.

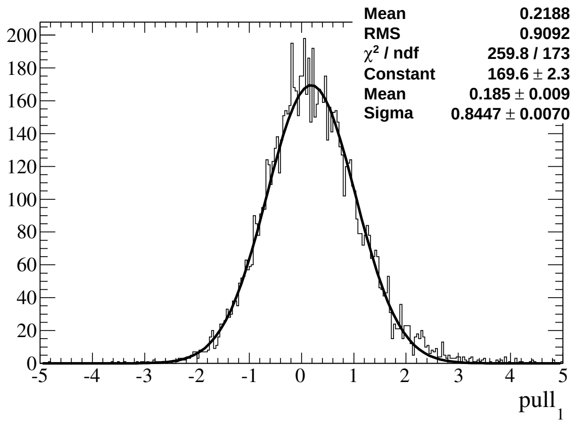


Figure 415: Pull$_1$ of $\sin^2 2\theta_{23}$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

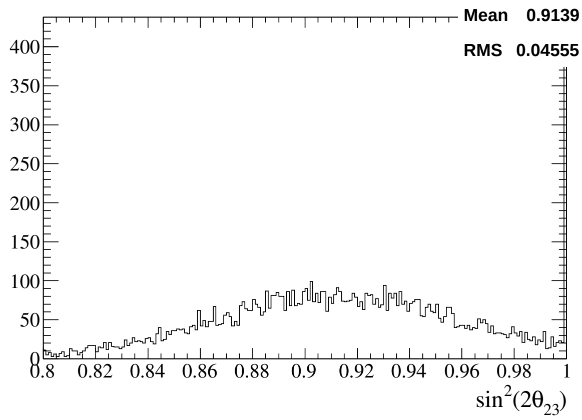


Figure 416: Fitted value of $\sin^2 2\theta_{23}$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

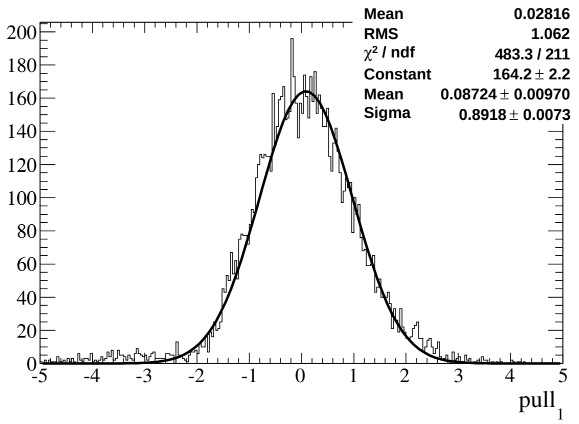


Figure 417: Pull$_1$ of $|\Delta m^2_{32}|$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

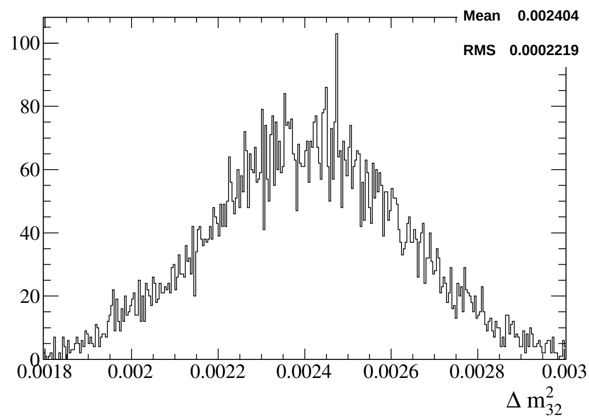


Figure 418: Fitted value of $|\Delta m^2_{32}|$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. No systematic fluctuations are included.

H.4. '2+8' fit, dominant systematic fluctations

Figs. 419-420 show the pull and fitted values of $\sin^2 2\theta_{23}$. Figs. 421-422 show the corresponding plots for $|\Delta m^2_{32}|$. The input values are $\sin^2 2\theta_{23}$ = 0.9, $|\Delta m^2_{32}|$ = 2.4×10^{-3} eV^2/c^4. The bias in $\sin^2 2\theta_{23}$ is still present.

Fig. 423 shows the residuals of the systematic parameters. Figs. 424-426 show the pulls distributions of the systematic parameters. Some of the distributions are wide, but there are no unexpected features in the plots. $f^{SK}_{E;r}$ in Fig. 424 is non-Gaussian, but this in not unexpected; the energy scale systematic has a discontinuous derivative, leading to issues with the Hesse error. It should be noted that the spectral function is not expected to give a Gaussian distribution since the throws are uniform between 0 and 1, and the fitted value is strictly confined to the range [0,1]. The plots show that a best-fit value of 0 is favoured.

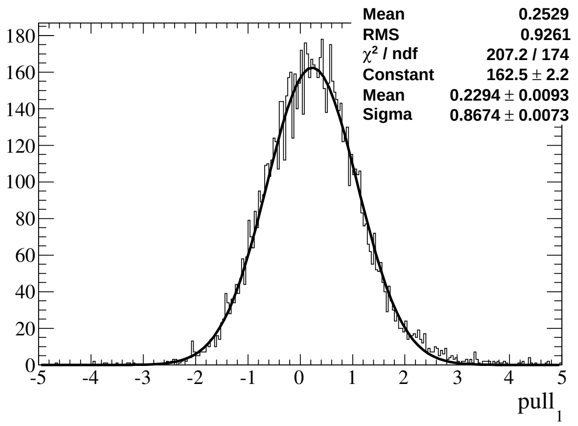


Figure 419: Pull$_1$ of $\sin^2 2\theta_{23}$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. The 8 dominant systematics are fluctuated.

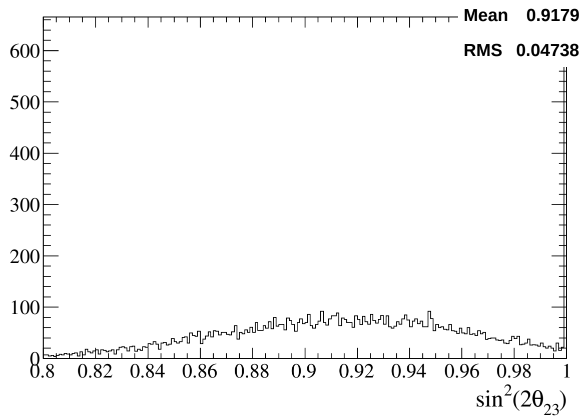


Figure 420: Fitted value of $\sin^2 2\theta_{23}$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. The 8 dominant systematics are fluctuated.

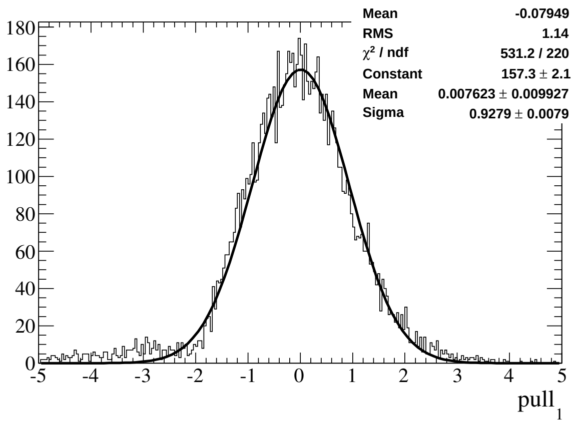


Figure 421: Pull$_1$ of $|\Delta m^2_{32}|$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. The 8 dominant systematics are fluctuated.

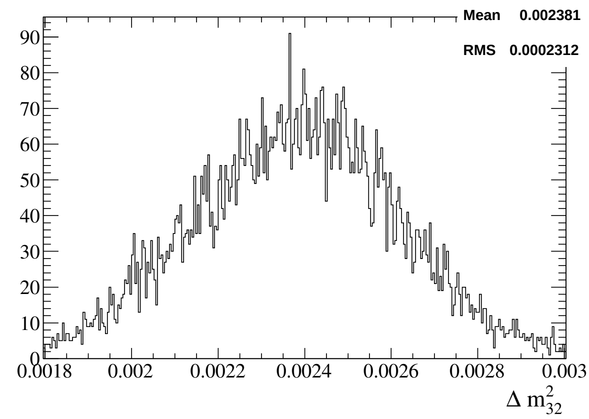


Figure 422: Fitted value of $|\Delta m^2_{32}|$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. The 8 dominant systematics are fluctuated.

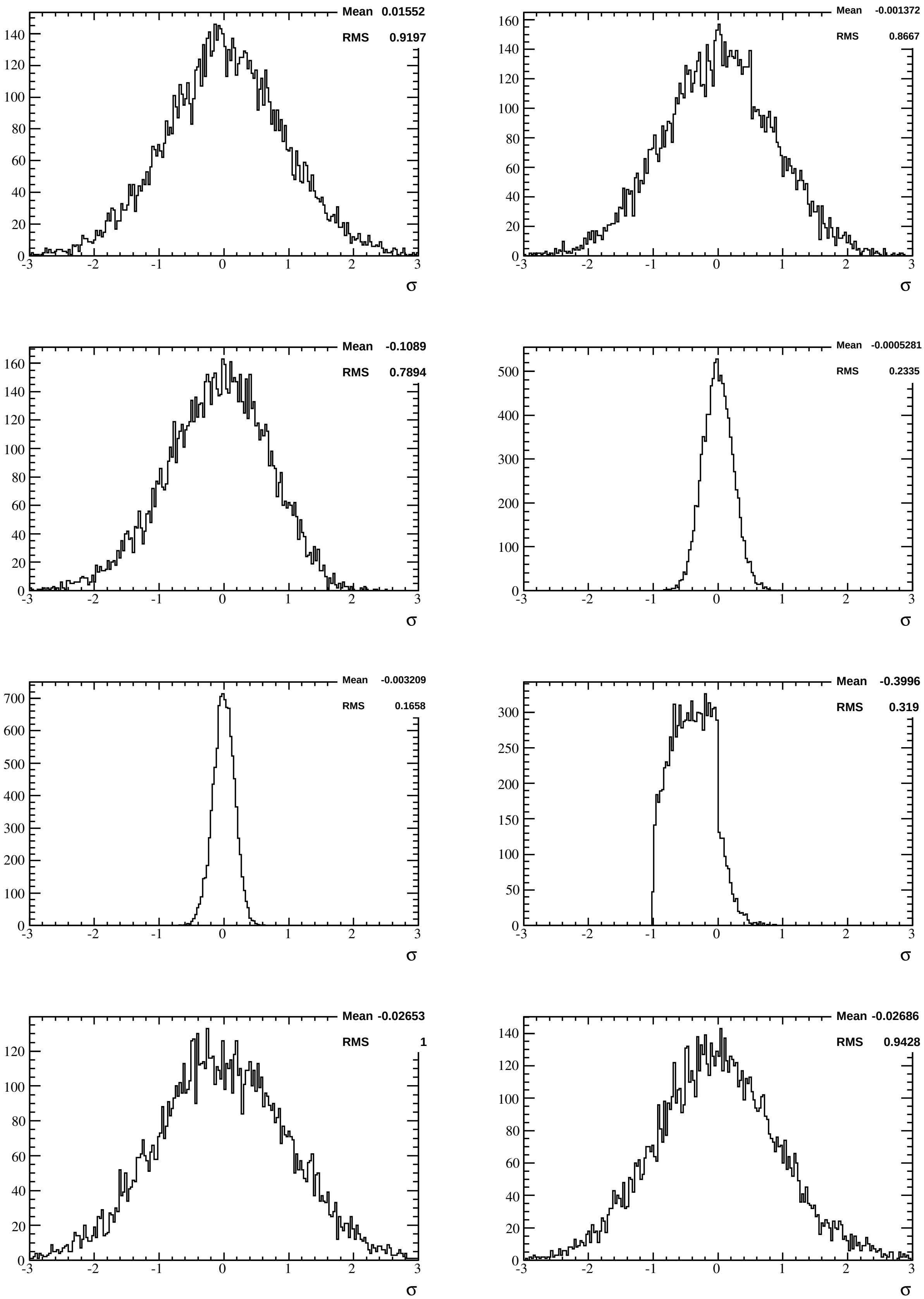


Figure 423: Residuals of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times10^{20}$ POT. The 8 dominant systematics are fluctuated. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t,r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

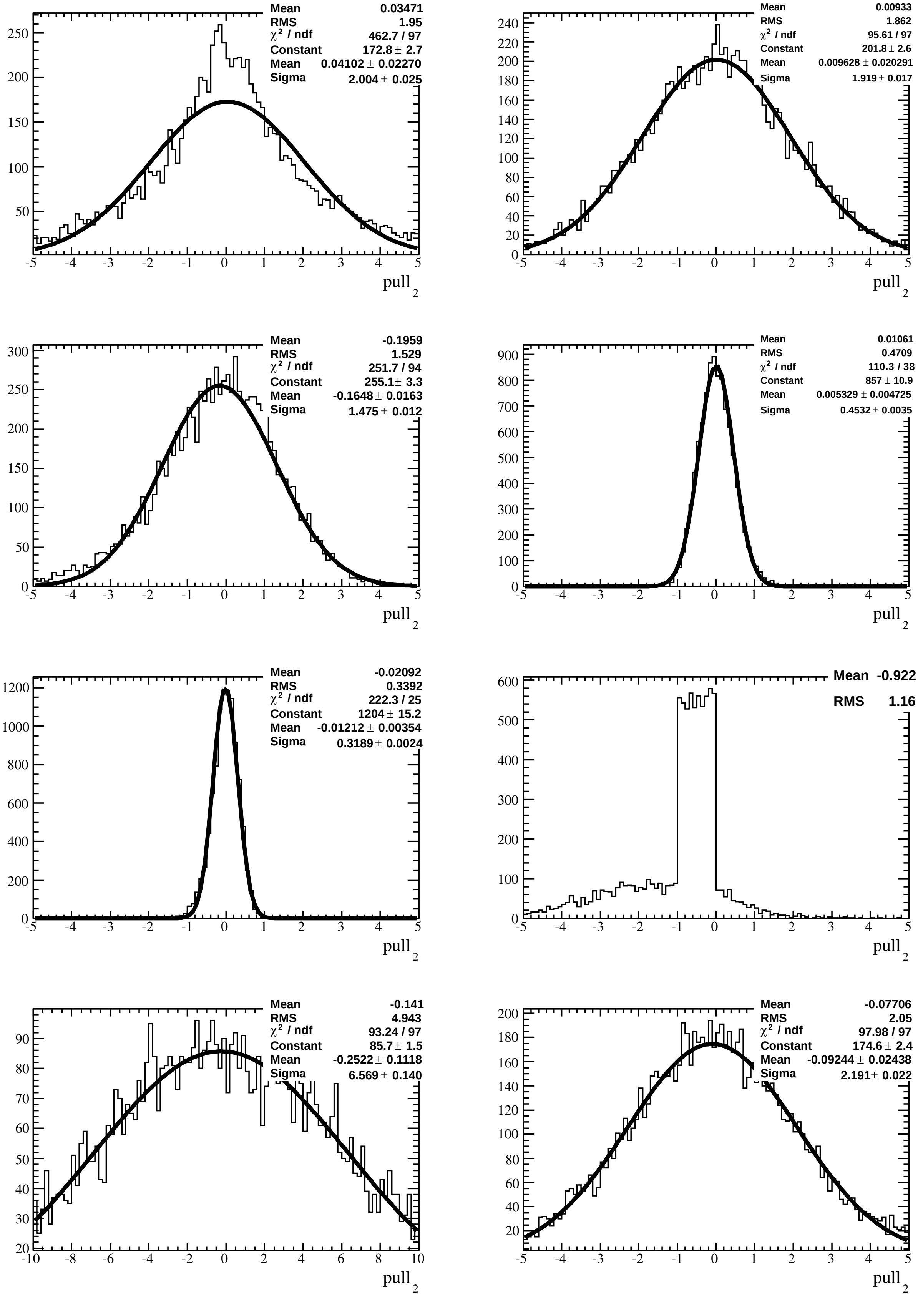


Figure 424: Pull$_2$ of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. The 8 dominant systematics are fluctuated. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t;r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

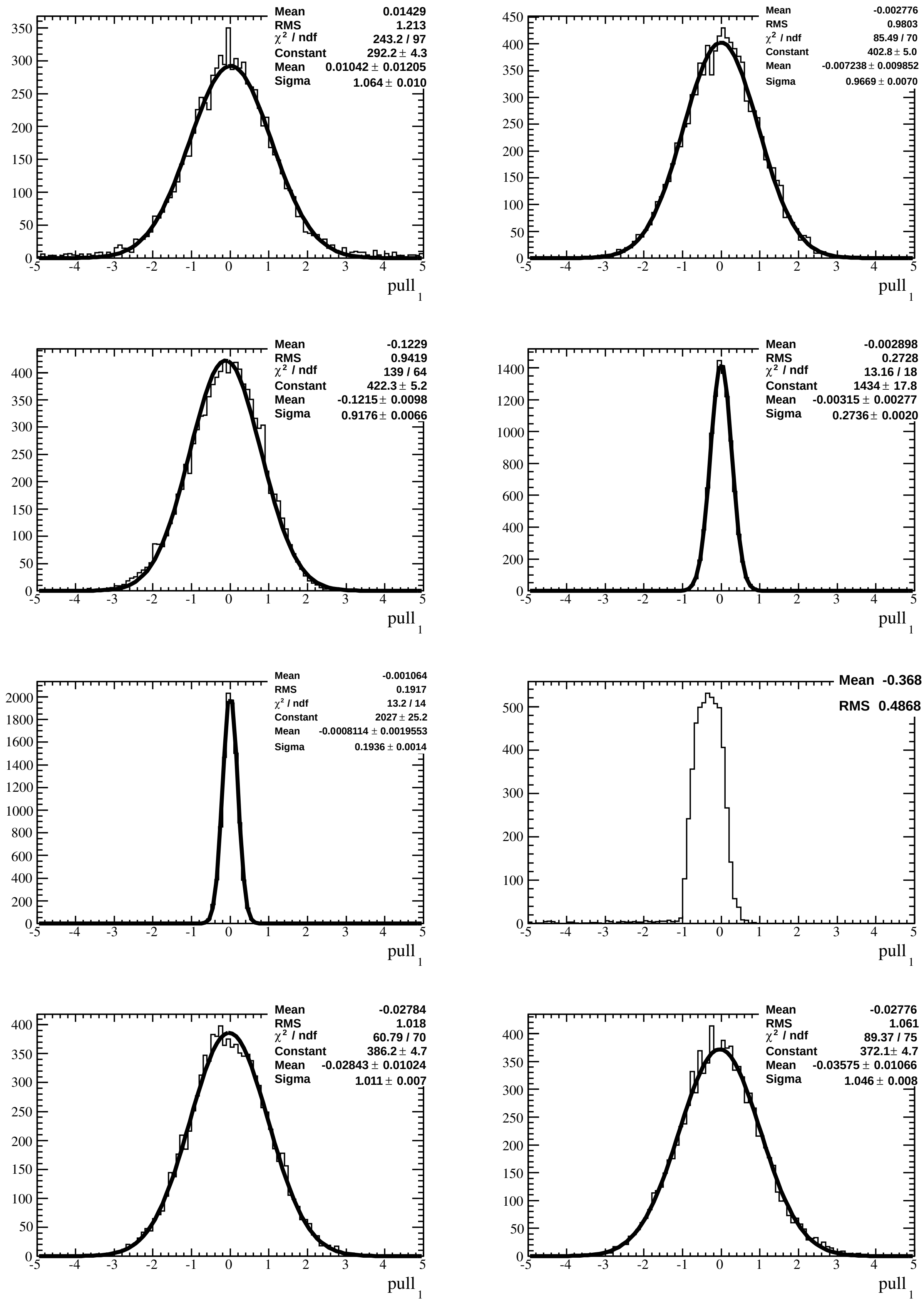


Figure 425: Pull$_1$ of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. The 8 dominant systematics are fluctuated. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t;r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

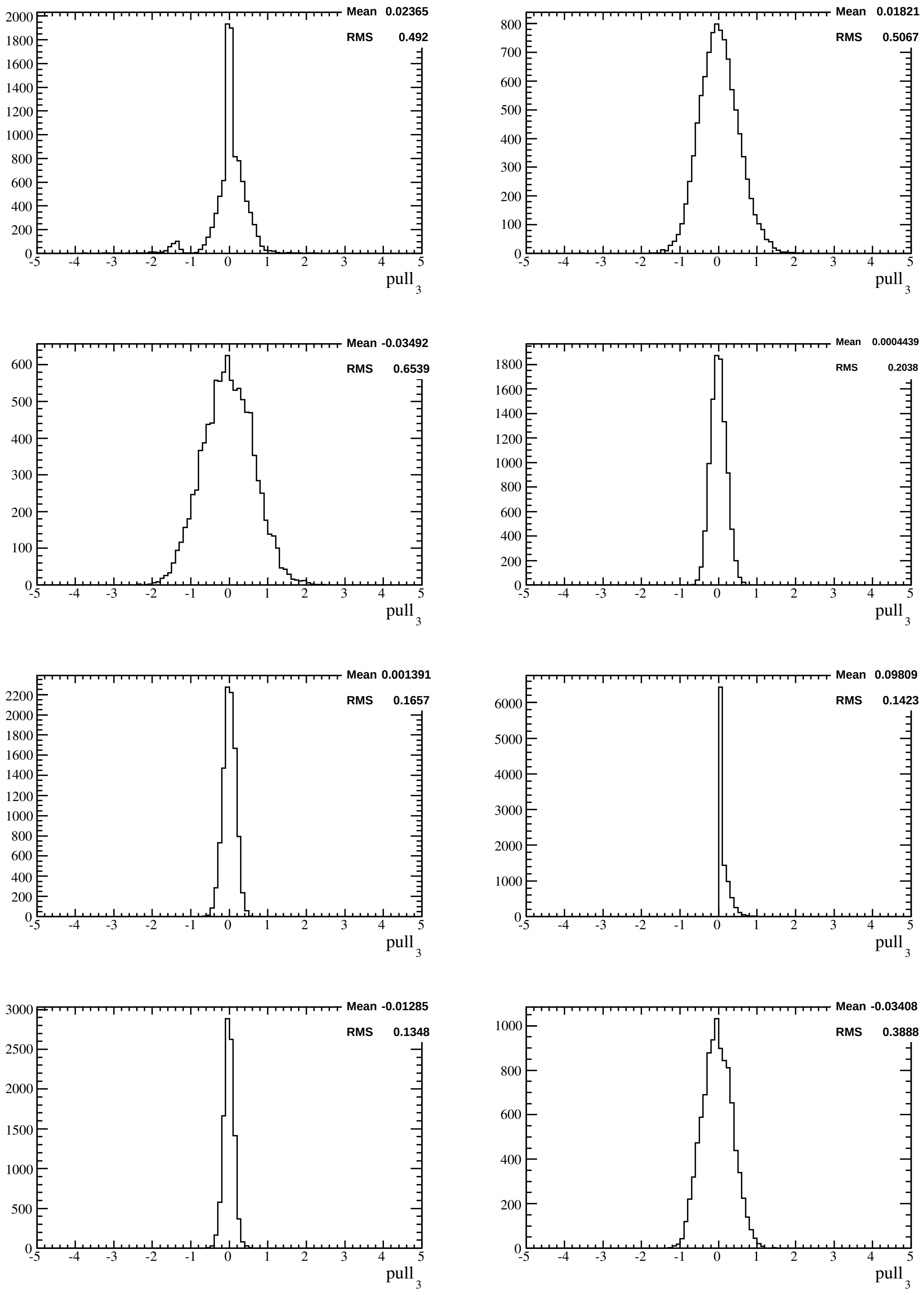


Figure 426: Pull$_3$ of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. The 8 dominant systematics are fluctuated. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t,r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

H.5. '2+8' fit, all systematic fluctations

Figs. 427-428 show the pull and fitted values of $\sin^2 2\theta_{23}$. Figs. 429-430 show the corresponding plots for $|\Delta m^2_{32}|$. The input values are $\sin^2 2\theta_{23}$ = 0.9, $|\Delta m^2_{32}|$ = $2.4 \times 10^{-3}\ eV^2/c^4$. The bias in $\sin^2 2\theta_{23}$ is still present.

Fig. 431 shows the residuals of the systematic parameters. Figs. 432-434 show the pull distributions of the systematic parameters. The distributions have widened, but this is as to be expected (the parameters that are thrown but not fitted are *absorbed* by the parameters that are fitted). There are still no unexpected features.

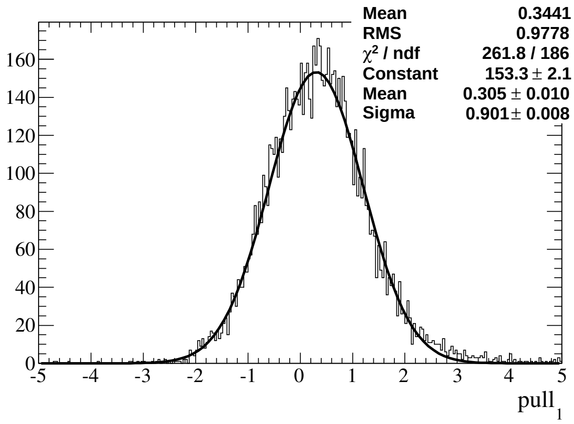


Figure 427: Pull$_1$ of $\sin^2 2\theta_{23}$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. All systematic fluctuations are included.

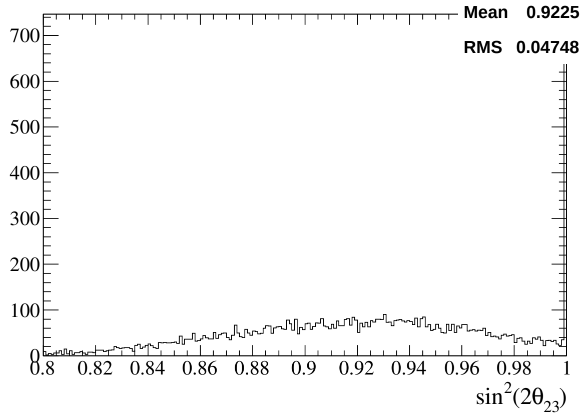


Figure 428: Fitted value of $\sin^2 2\theta_{23}$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. All systematic fluctuations are included.

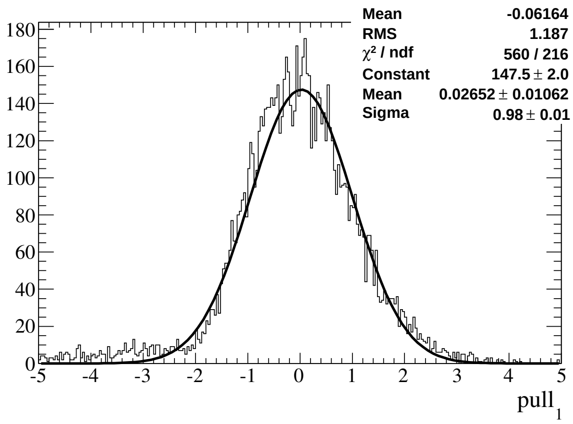


Figure 429: Pull$_1$ of $|\Delta m^2_{32}|$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. All systematic fluctuations are included.

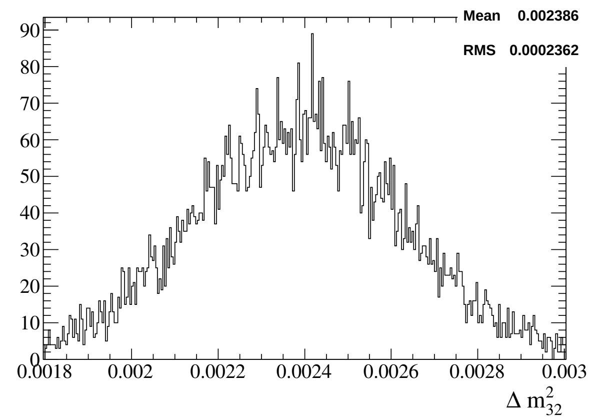


Figure 430: Fitted value of $|\Delta m^2_{32}|$ for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. All systematic fluctuations are included.

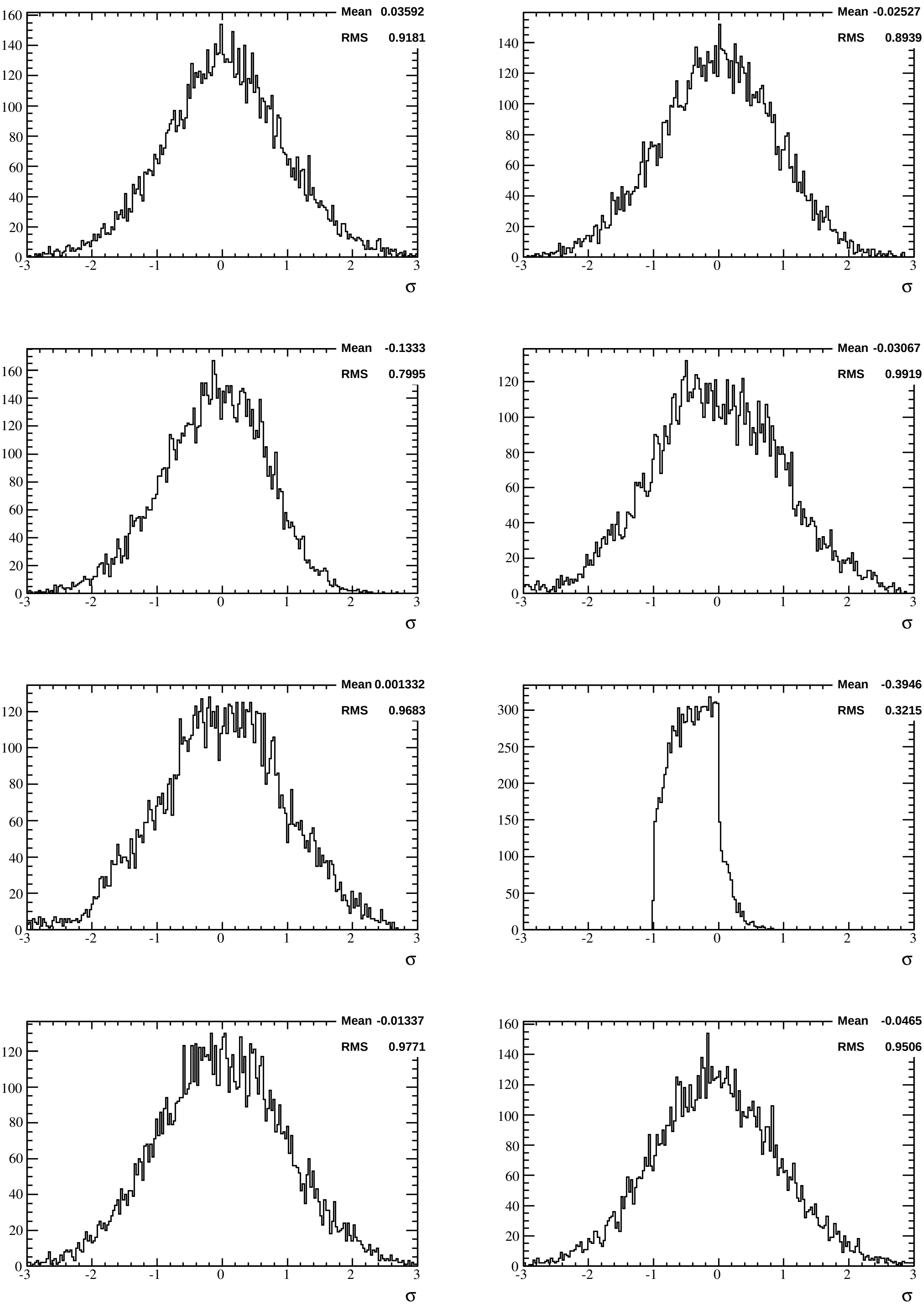


Figure 431: Residual of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. All systematic fluctuations are included. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t,r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

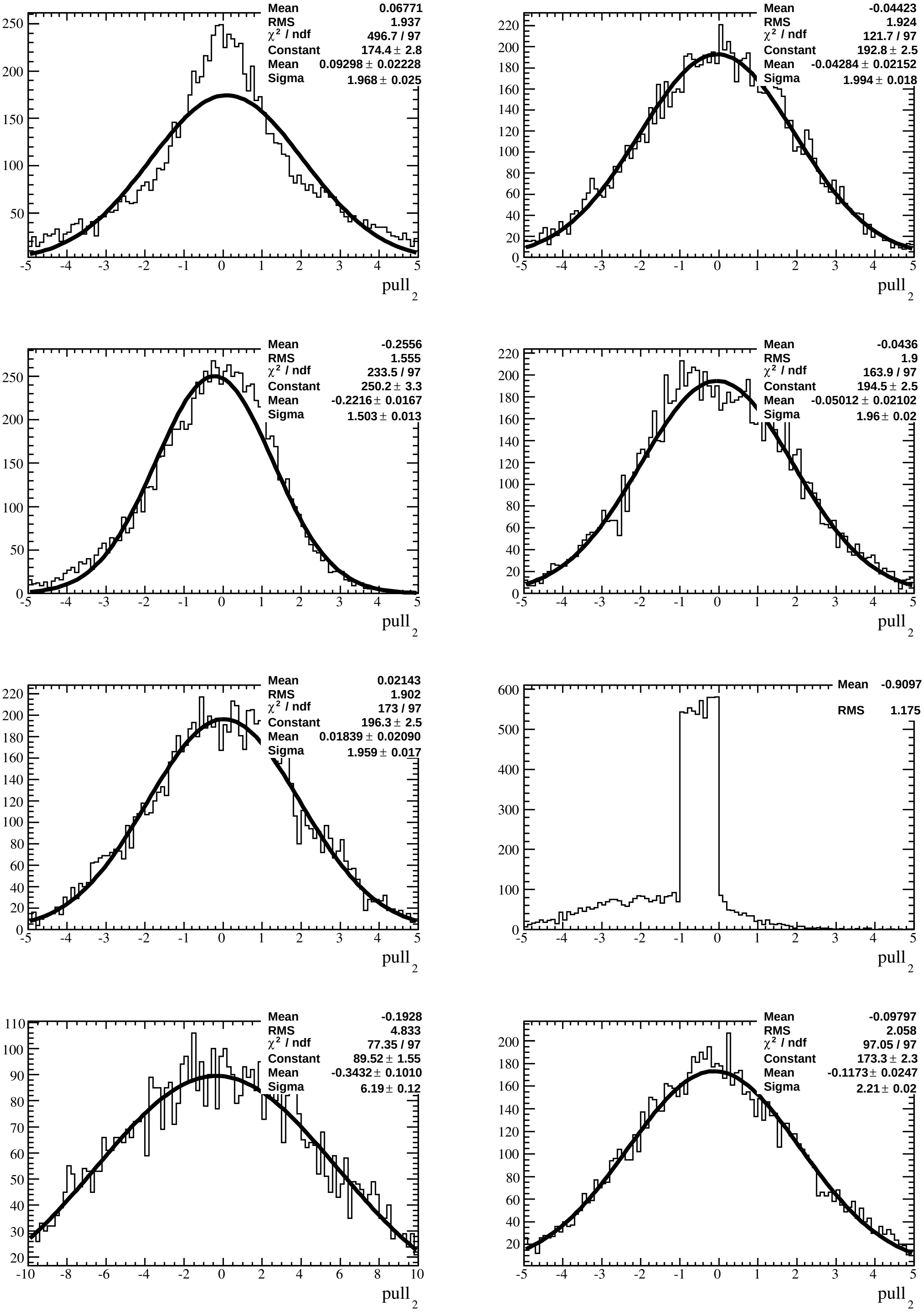


Figure 432: Pull$_2$ of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. All systematic fluctuations are included. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t;r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

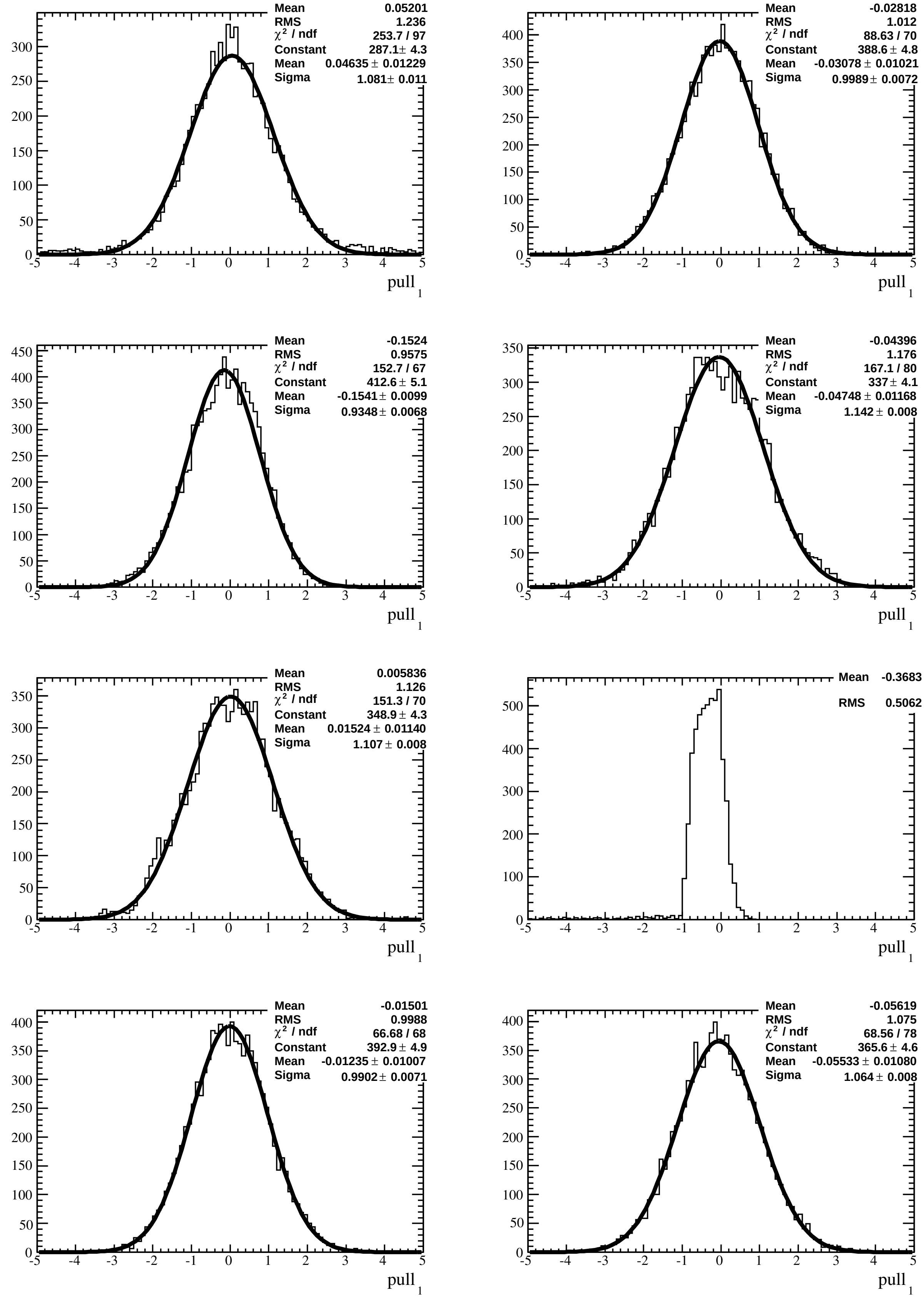


Figure 433: Pull$_1$ of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010×10^{20} POT. All systematic fluctuations are included. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t;r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

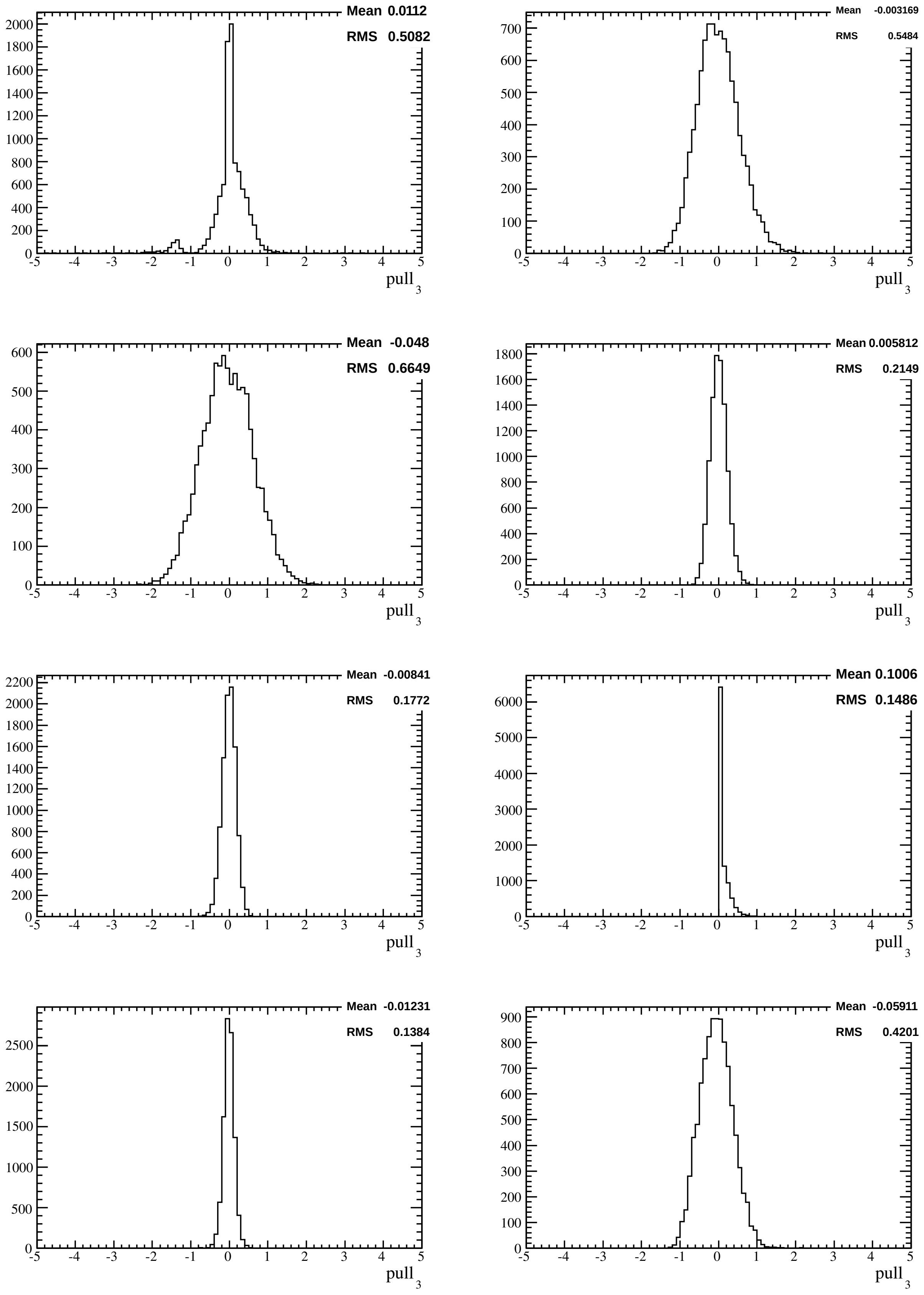


Figure 434: Pull$_3$ of the systematic parameters for a 2+8 fit, with oscillation parameters $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =0.9; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4 and for an exposure of 3.010$\times 10^{20}$ POT. All systematic fluctuations are included. The plots correspond to (line by line, left to right): $f^{SK}_{E;r}$; $f^{SK}_{CCnonQE;r}$; $f^{SK}_{NC;r}$; $f^{banff}_{16;t;r}$ (M$_A$QE); $f^{banff}_{18;t,r}$ (CCQE norm < 1.5 GeV); $f_{SF;t,r}$; $f_{bindE;t,r}$; $f_{\pi-less\Delta;t,r}$.

I. Binning studies

I.1. True energy binning

The chosen true neutrino energy binning scheme needs to have enough granularity for precise application of oscillation probabilities and of systematic parameter response functions (with the former proven to be the primary consideration). The chosen 84-bin scheme is described in Section 2.2.5. This binning scheme was selected as a trade-off between CPU efficiency and accuracy, as oscillation probabilities are calculated at the centre of each true energy bin. Single μ-like ring event reconstructed energy spectra obtained with the chosen binning scheme were compared against spectra obtained with an alternative, much finer, binning scheme. The alternative scheme uses 780 bins as follows: 200 5-MeV bins in 0-1 GeV and 580 50-MeV bins in 1-30 GeV. Figs. 435-454 show the ratio of indiviual SuperK MC mode E_{reco} spectra, made with 84-bin E_{true} and 780-bin E_{true}. While there are some $>1\%$ differences, these occur in modes that are a small contribution to the total E_{reco} spectrum. This is reiterated in Fig. 455, which shows the same ratio, but for the total E_{reco} spectrum.

I.2. Reconstructed energy binning

The chosen reconstructed neutrino energy binning scheme needs to have sufficient granularity (considering the experimental reconstructed neutrino energy resolution and the current statistics) to allow a precise determination of neutrino oscillation parameters while, at the same time, a reasonable CPU efficiency is retained. The binning also needs to be fine enough to allow the precise application of systematic parameter response functions in the p.d.f. (discussed in Appendix I.4). The selected reconstructed neutrino energy binning scheme (73 bins) is shown in Appendix 2.2.5. A sensitivity study (see Appendix C for details) at the MINOS 2012 best fit point has been performed with an alternative, much finer, reconstructed energy binning scheme: 600 50 MeV bins, 0 - 30 GeV. The result can be seen in Fig. 456. The plot shows that the chosen 73-bin scheme is sufficient.

I.3. SuperK MC templates in the chosen binning

The nominal SuperK MC templates, in the chosen binning, are shown in Figs. 457-461.

I.4. True and reconstructed energy binning for systematic parameter response functions

Systematic parameter response functions (cubic splines) were constructed in bins of true and reconstructed energy. This binning is given in Sec. 3.1.3. A study was performed to check the effect of this binning. This was done by creating tweaked single μ-like ring event reconstructed energy spectra using the splines, and comparing them with the equivalent tweaked spectra made with event-by-event reweighting (the latter being too CPU-demanding to be used in the oscillation parameter fit). Both the spline spectra and the event-by-event spectra were made for no oscillations. The 73-bin scheme for the Monte Carlo templates given in Sec. 2.2.5 was used. Some examples of the ratios of the spline spectra to the event-by-event reweighted spectra are shown in Figs. 462-468. They show that the ratios are very close to 1.0 for the ν_μ and $\bar{\nu}_\mu$ spectra, which comprise the bulk of the total predicted single μ-like ring spectrum.

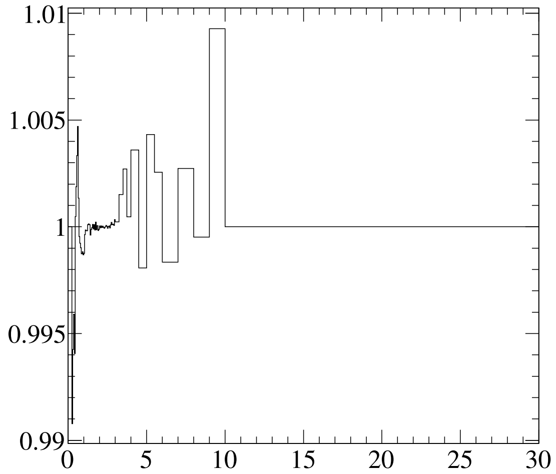


Figure 435: Ratio of SuperK MC E_{reco} spectra, for mode ν_μ CCQE made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

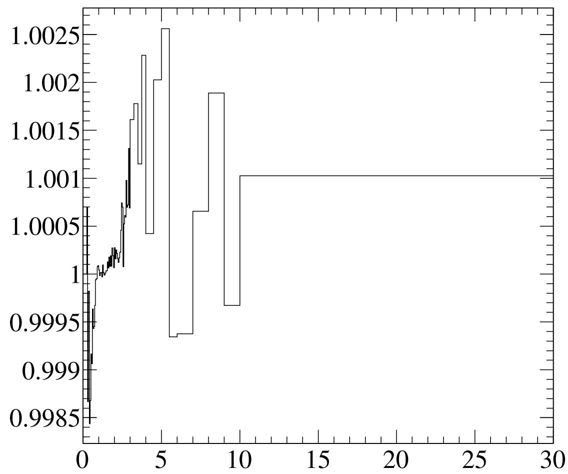


Figure 436: Ratio of SuperK MC E_{reco} spectra, for mode ν_μ CC 1π made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

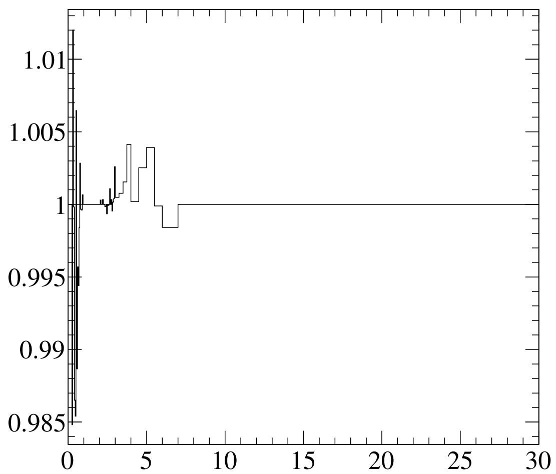


Figure 437: Ratio of SuperK MC E_{reco} spectra, for mode ν_μ CC coherent made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

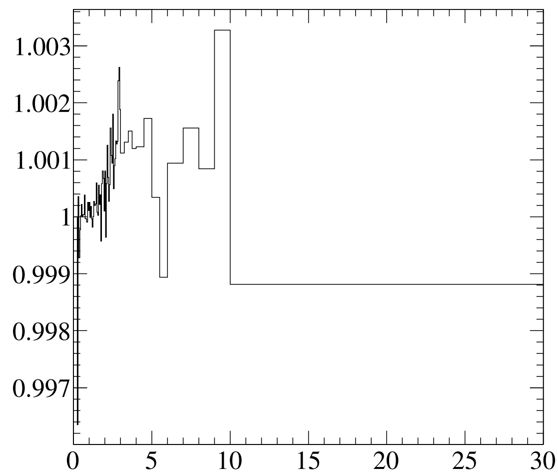


Figure 438: Ratio of SuperK MC E_{reco} spectra, for mode ν_μ CC other (ν_μ disap) made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

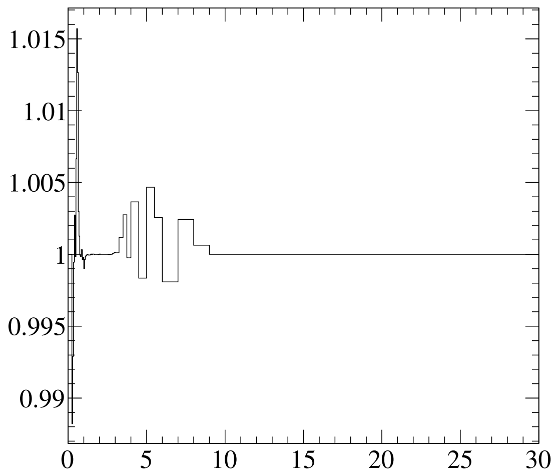


Figure 439: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_{\mu}}$ CCQE made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

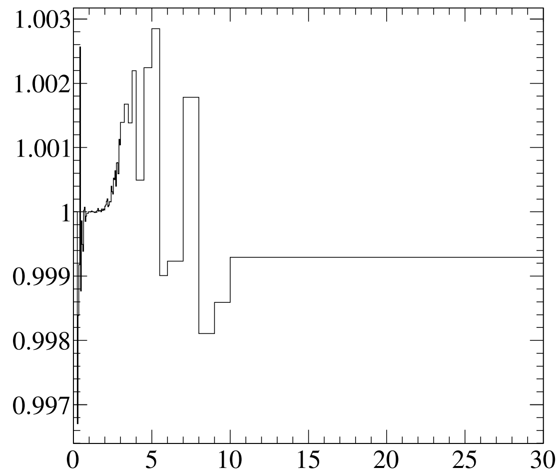


Figure 440: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_{\mu}}$ CC 1π made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

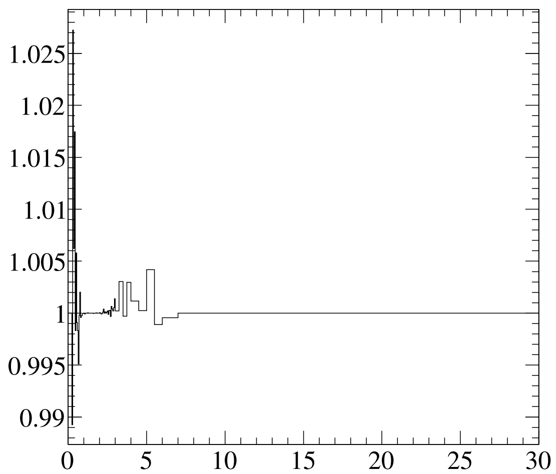


Figure 441: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_{\mu}}$ CC coherent made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

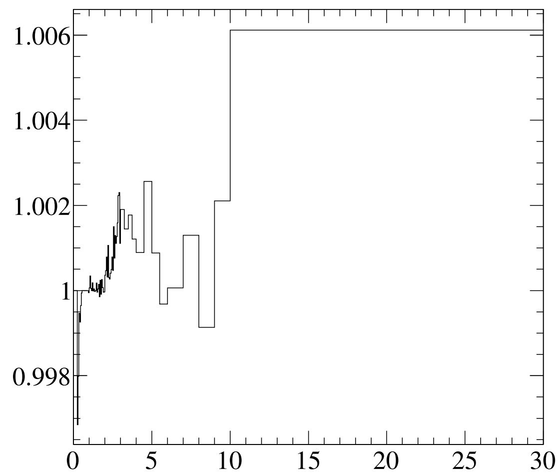


Figure 442: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_{\mu}}$ CC other (ν_{μ} disap) made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

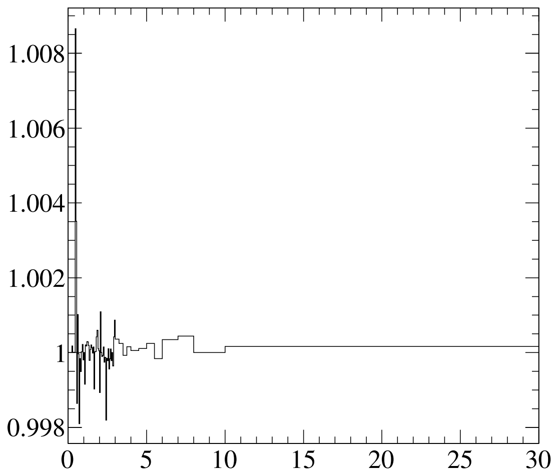


Figure 443: Ratio of SuperK MC E_{reco} spectra, for mode ν_e CCQE made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

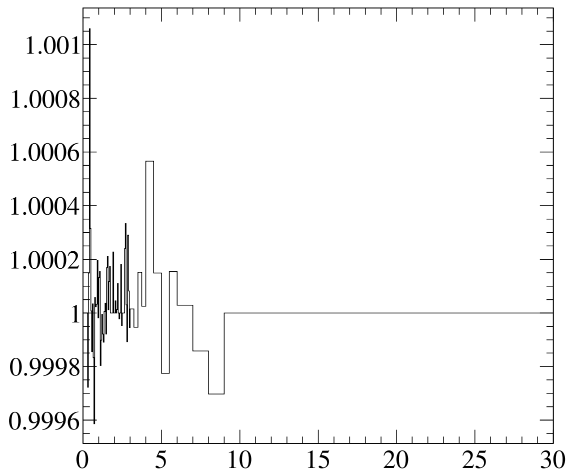


Figure 444: Ratio of SuperK MC E_{reco} spectra, for mode ν_e CC 1π made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

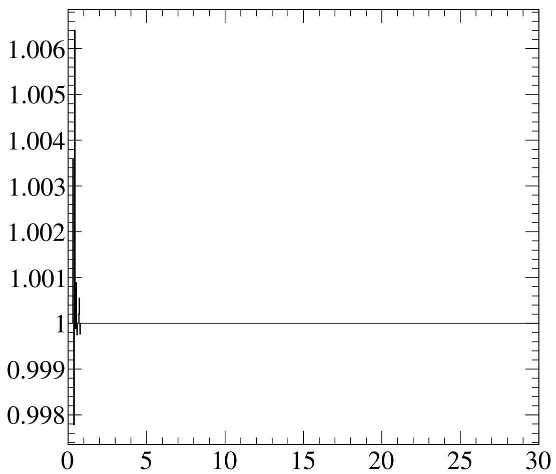


Figure 445: Ratio of SuperK MC E_{reco} spectra, for mode ν_e CC coherent made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

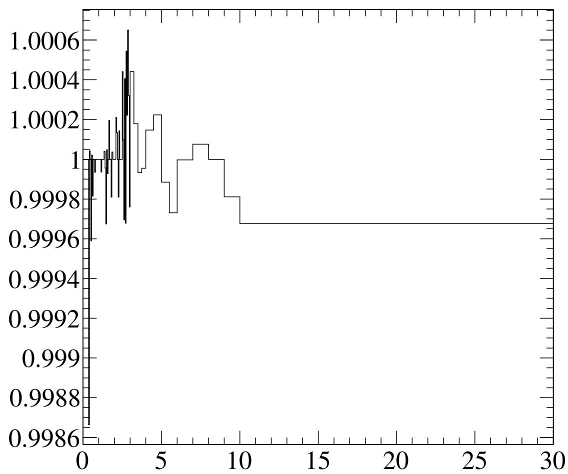


Figure 446: Ratio of SuperK MC E_{reco} spectra, for mode ν_e CC other (ν_μ disap) made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

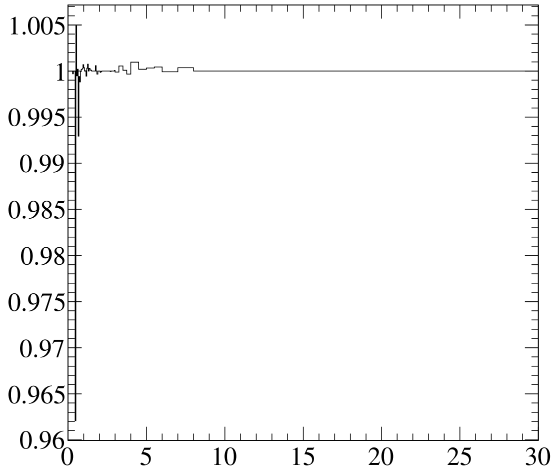


Figure 447: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_e}$ CCQE made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

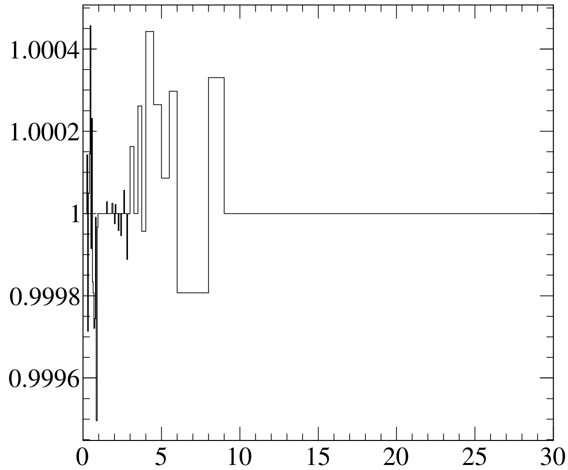


Figure 448: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_e}$ CC 1π made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

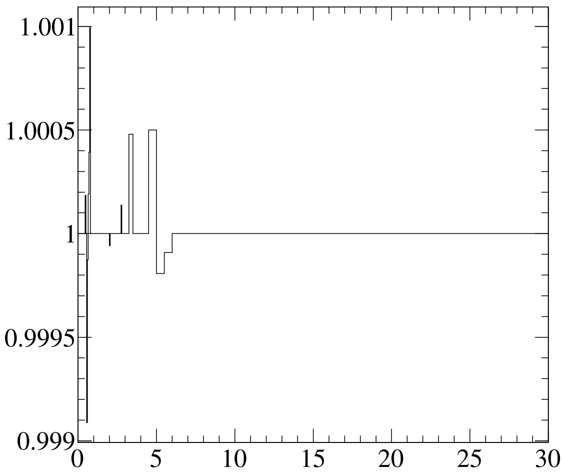


Figure 449: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_e}$ CC coherent made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

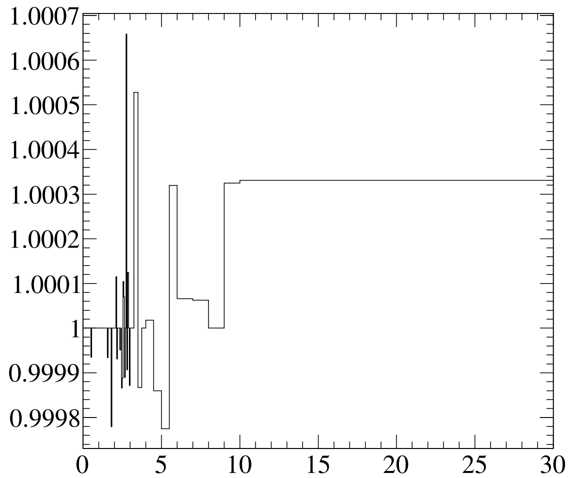


Figure 450: Ratio of SuperK MC E_{reco} spectra, for mode $\bar{\nu_e}$ CC other (ν_μ disap) made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of 3.010$imes$10^{20} POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

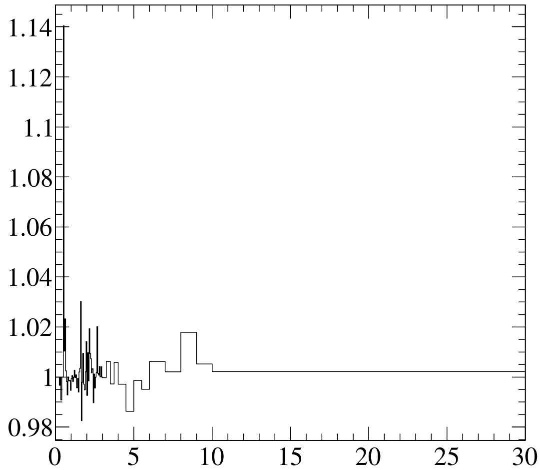


Figure 451: Ratio of SuperK MC E_{reco} spectra, for mode oscillation ν_e CCQE made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of $3.010imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

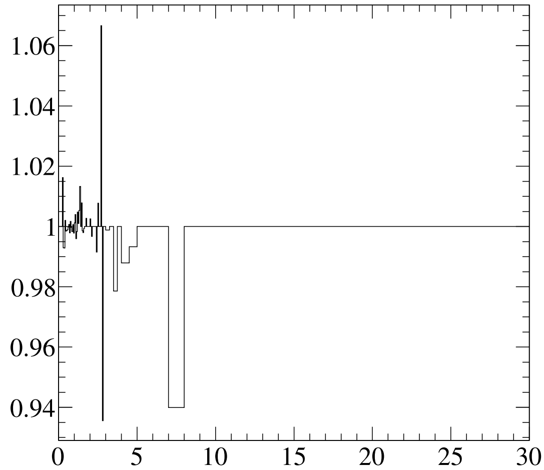


Figure 452: Ratio of SuperK MC E_{reco} spectra, for mode oscillation ν_e CC 1π made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of $3.010imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

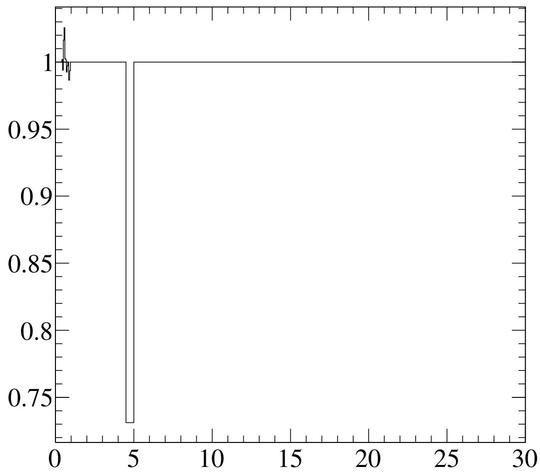


Figure 453: Ratio of SuperK MC E_{reco} spectra, for mode oscillation ν_e CC coherent made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of $3.010imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}|$ = 0.0024 eV^2/c^4.

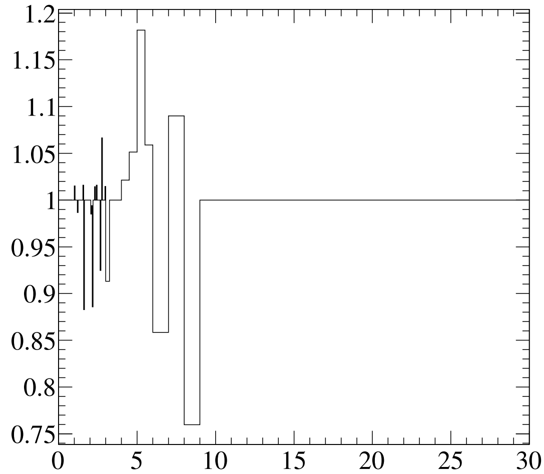


Figure 454: Ratio of SuperK MC E_{reco} spectra, for mode oscillation ν_e CC other (ν_μ app) made with 84 bin E_{true} and 780 bin E_{true}, for an exposure of $3.010imes10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates.Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; δ_{CP} = 0; Δm^2_{21} = 7.5e-05 eV^2/c^4; Δm^2_{32} = 0.0024 eV^2/c^4.

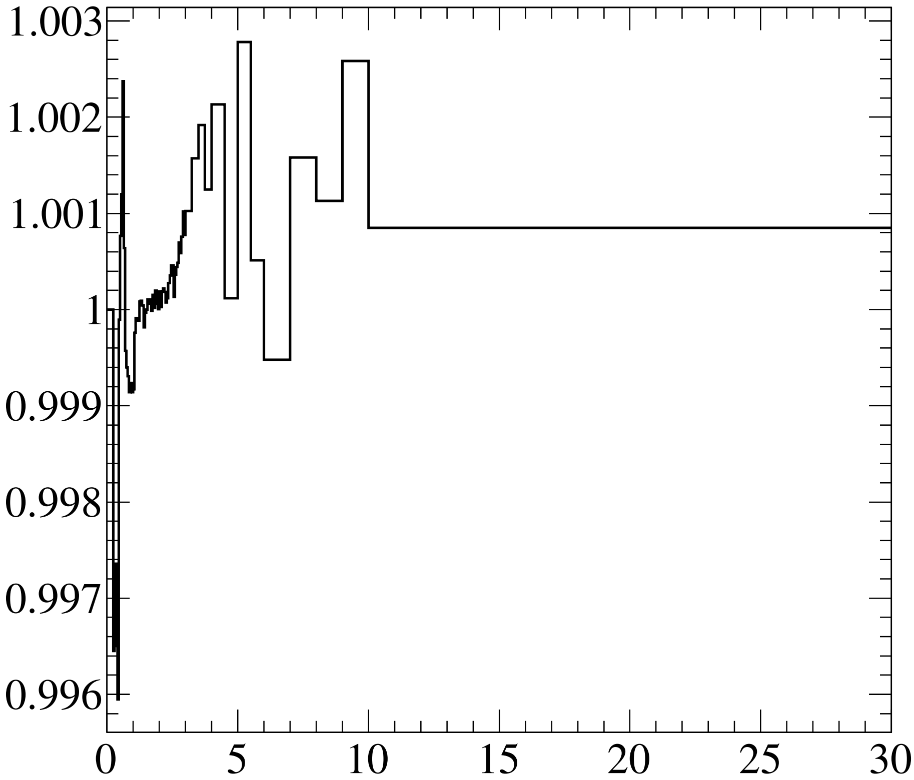


Figure 455: Ratio of total SuperK MC E_{reco} spectra, made with 84-bin E_{true} and 780-bin E_{true}, for an exposure of 3.010$\times 10^{20}$ POT. The number of events was calculated using the BANFF-tuned MC templates. Using oscillation parameters: $\sin^2 2\theta_{12}$ =0.857; $\sin^2 2\theta_{13}$ =0.098; $\sin^2 2\theta_{23}$ =1; $\delta_{CP} = 0$; $\Delta m^2_{21} =$ 7.5e-05 eV^2/c^4; $|\Delta m^2_{32}| =$ 0.0024 eV^2/c^4.

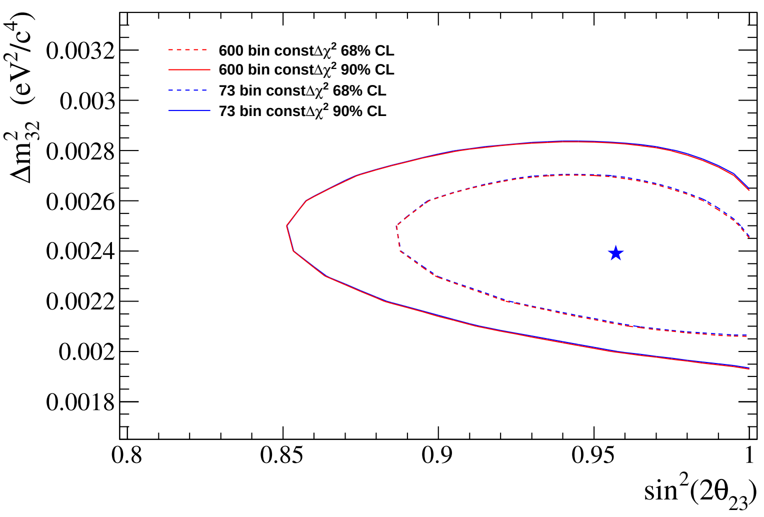


Figure 456: Sensitivity study using the 2+8 constant $\Delta\chi^2$ method. The 68% and 90% CL contours are shown. The input point is ($\sin^2 2\theta_{23}$, $|\Delta m^2_{32}|$) = (0.957, 0.00239 eV^2/c^4). The sensitivity has been calculated for both the *normal* 73 E_{reco} binning, as well as for 600 50 MeV bins from 0 - 30 GeV.

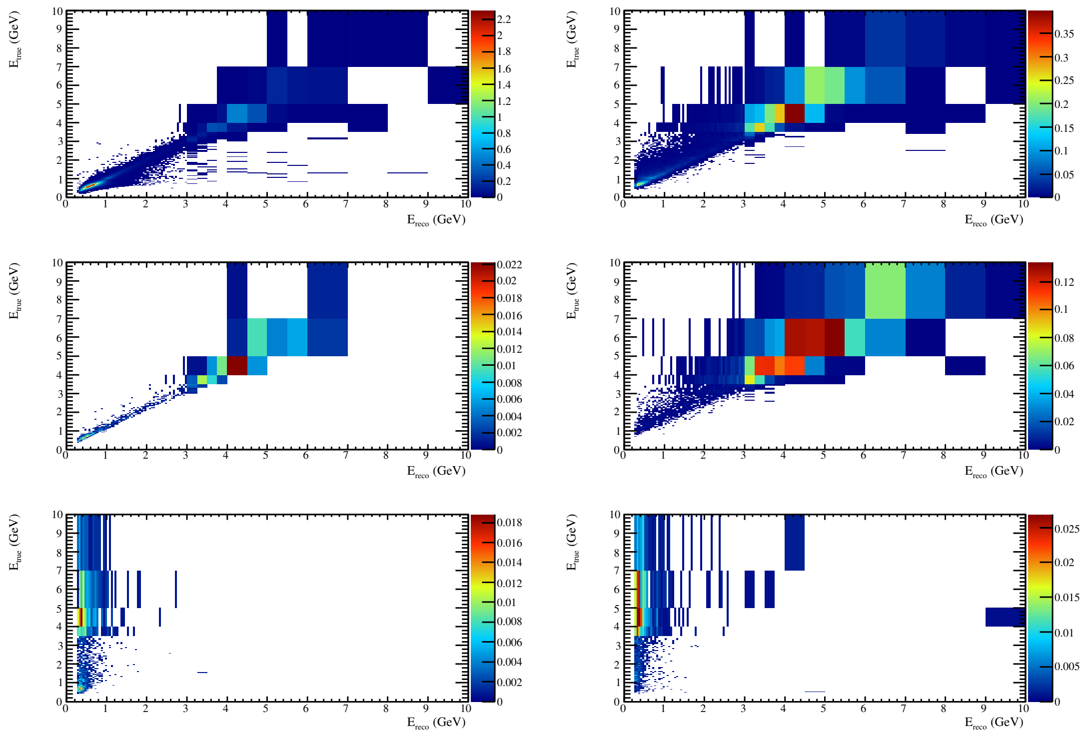


Figure 457: Nominal (E_t, E_r) 1-ring μ-like MC templates. The templates are shown for ν_μ CCQE (1) ν_μ CC1π (2), ν_μ CC coherent (3), ν_μ CC other (4), ν_μ NC1$\pi^\pm$ (5), ν_μ NC other (6).

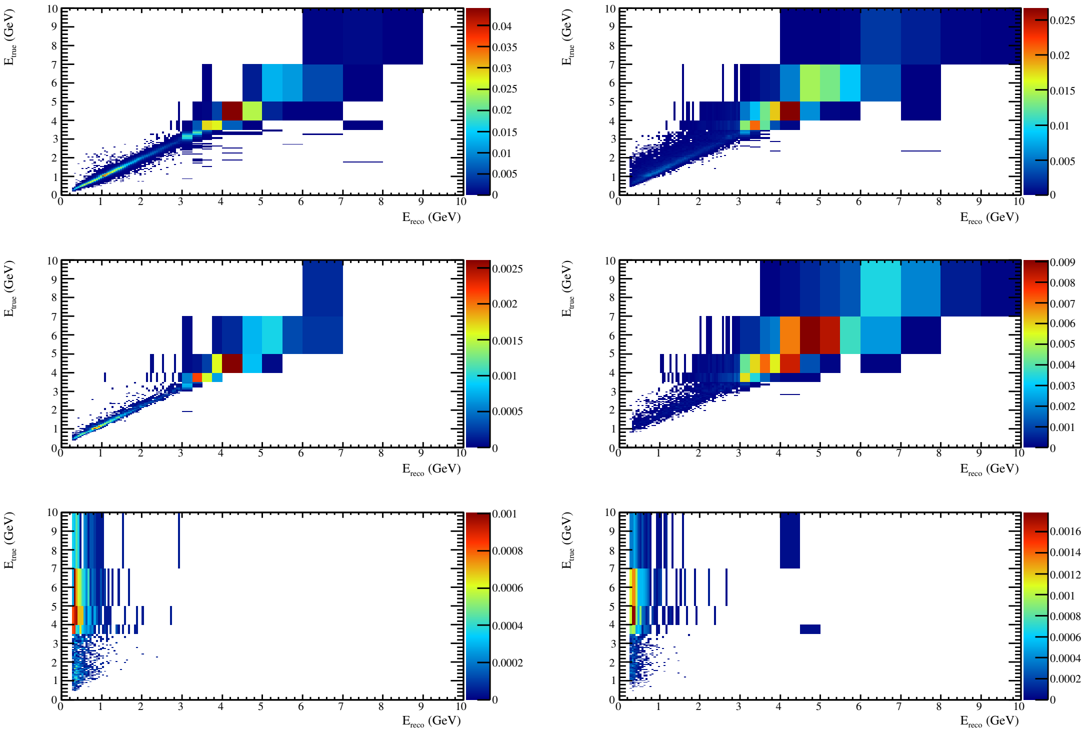


Figure 458: Nominal (E_t, E_r) 1-ring μ-like MC templates. The templates are shown for $\bar{\nu_\mu}$ CCQE (7), $\bar{\nu_\mu}$ CC1π (8), $\bar{\nu_\mu}$ CC coherent (9), $\bar{\nu_\mu}$ CC other (10), $\bar{\nu_\mu}$ NC1$\pi^\pm$ (11), $\bar{\nu_\mu}$ NC other (12).

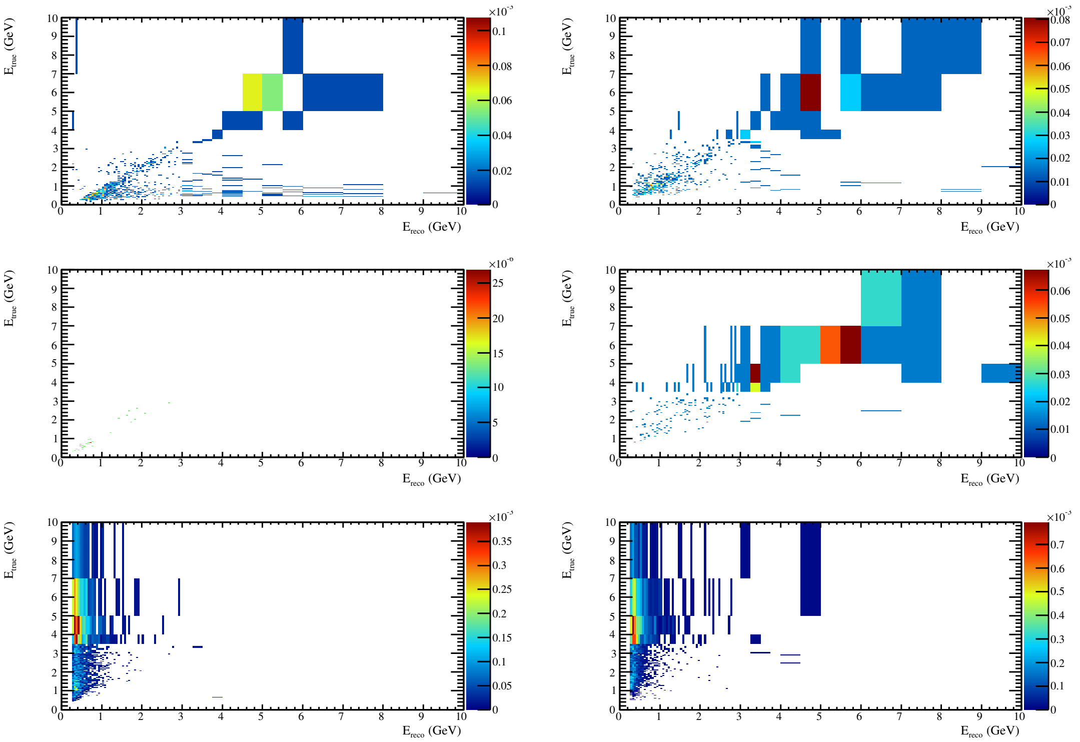


Figure 459: Nominal (E_t, E_r) 1-ring μ-like MC templates. The templates are shown for ν_e CCQE (13), ν_e CC1π (14), ν_e CC coherent (15), ν_e CC other (16), ν_e NC1$\pi^\pm$ (17), ν_e NC other (18).

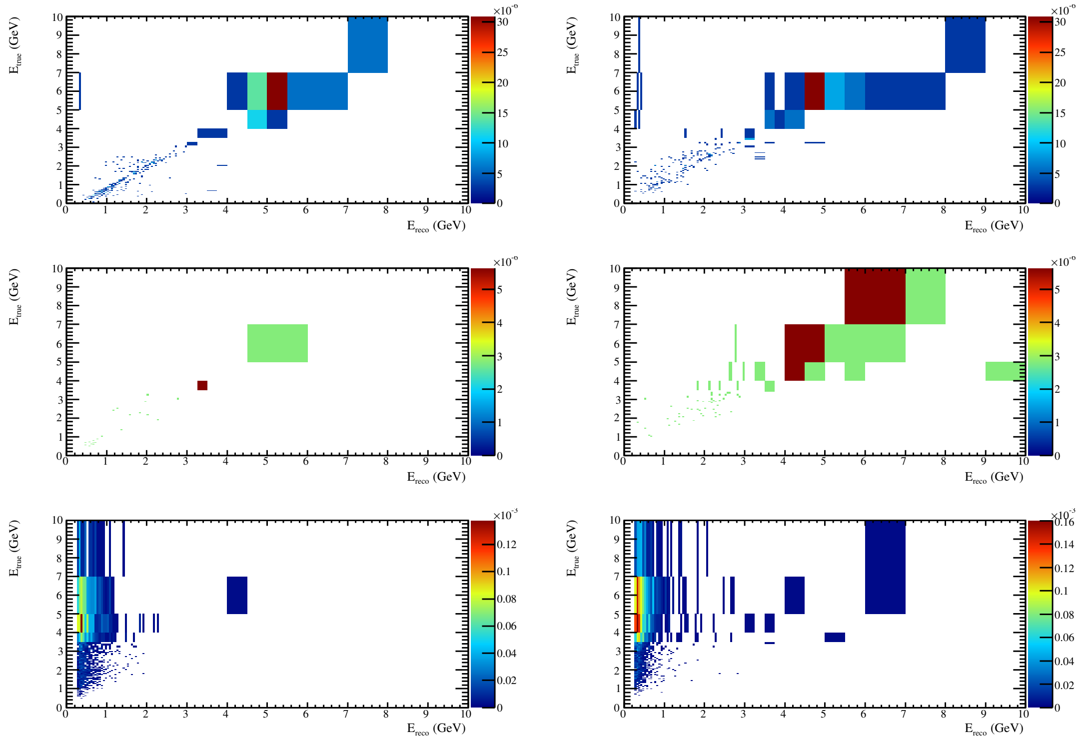


Figure 460: Nominal (E_t, E_r) 1-ring μ-like MC templates. The templates are shown for $\bar{\nu_e}$ CCQE (19), $\bar{\nu_e}$ CC1π (20), $\bar{\nu_e}$ CC coherent (21), $\bar{\nu_e}$ CC other (22), $\bar{\nu_e}$ NC1$\pi^{\pm}$ (23), $\bar{\nu_e}$ NC other (24).

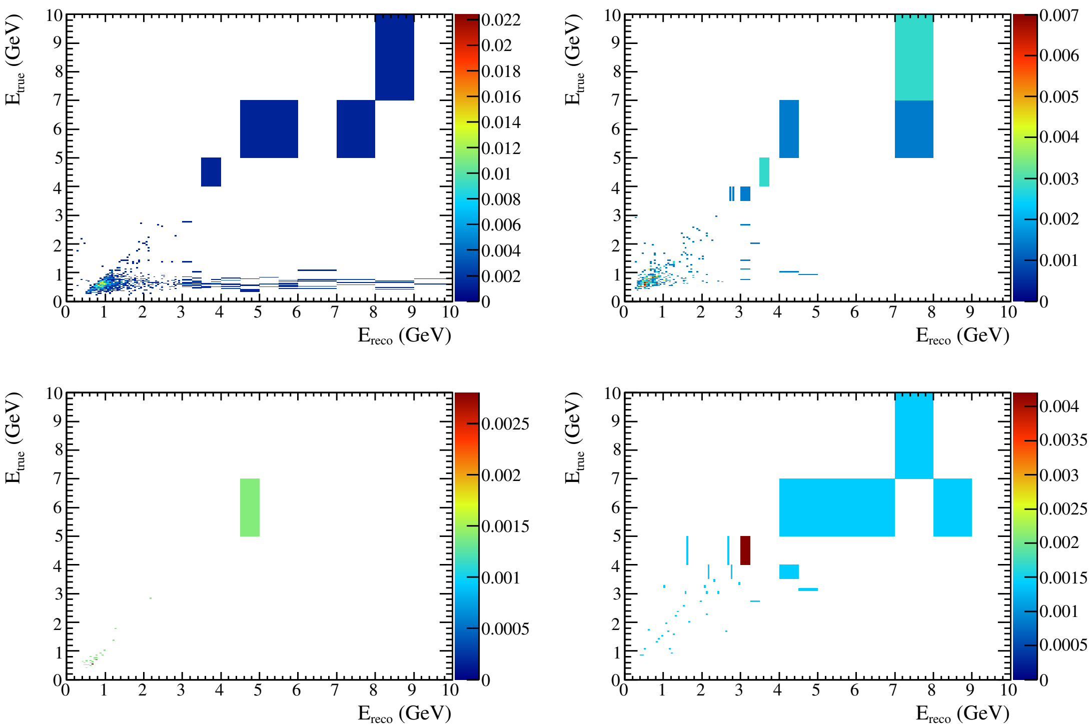


Figure 461: Nominal (E_t, E_r) 1-ring μ-like MC templates. The templates are shown for osc. ν_e CCQE (25), osc. ν_e CC1π (26), osc. ν_e CC coherent (27) and osc. ν_e CC other (28).

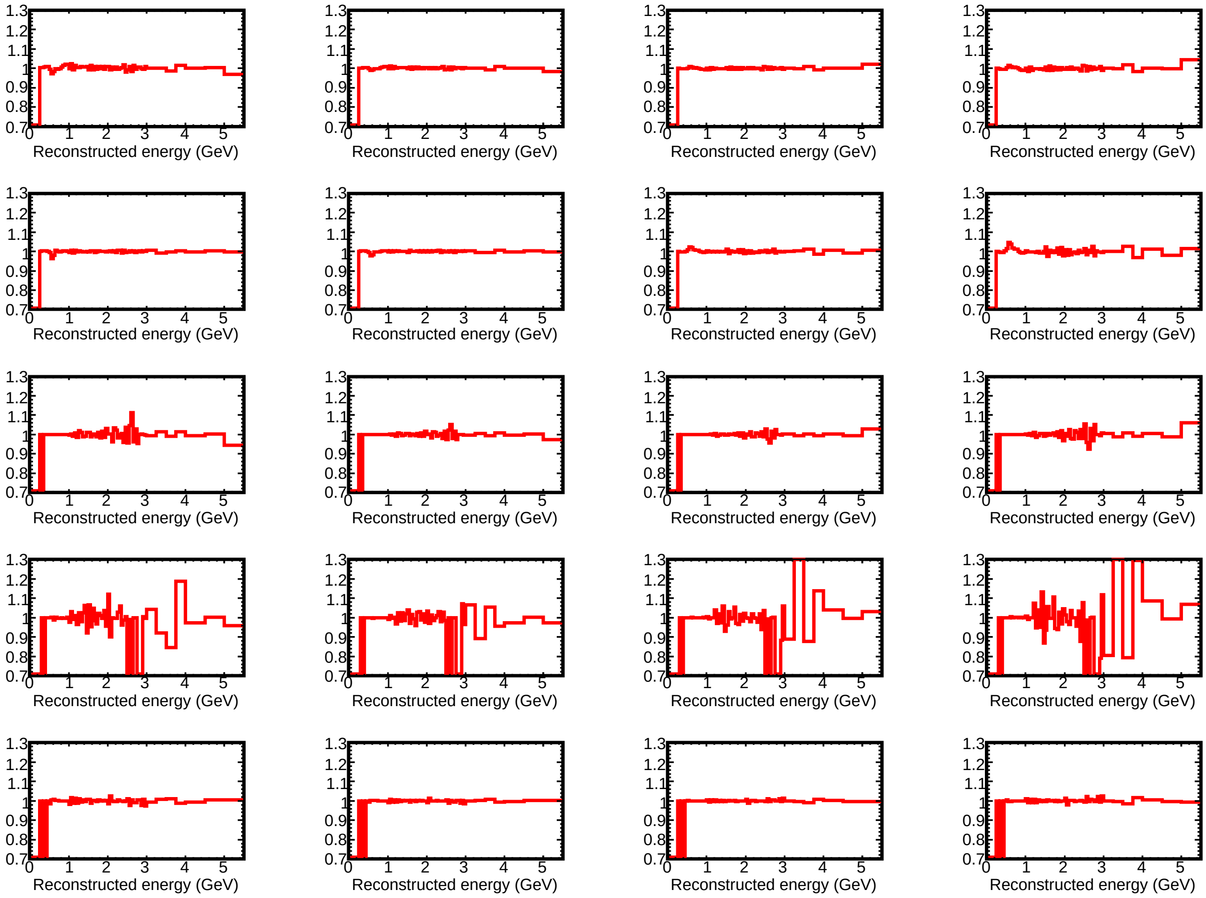


Figure 462: Ratios of non-oscillated tweaked total SuperK MC E_{reco} spectra made with the cross-section splines to those made with event-by-event reweighting for MaQE. Each row represents one neutrino species, and these are ν_μ, $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ and oscillated ν_e in that order. Each column represents a tweak value, and these are -2σ, -1σ, +1σ and +2σ in that order. Both the spline spectra and the event-by-event spectra are made with the 73-bin scheme given in Sec. 2.2.5.

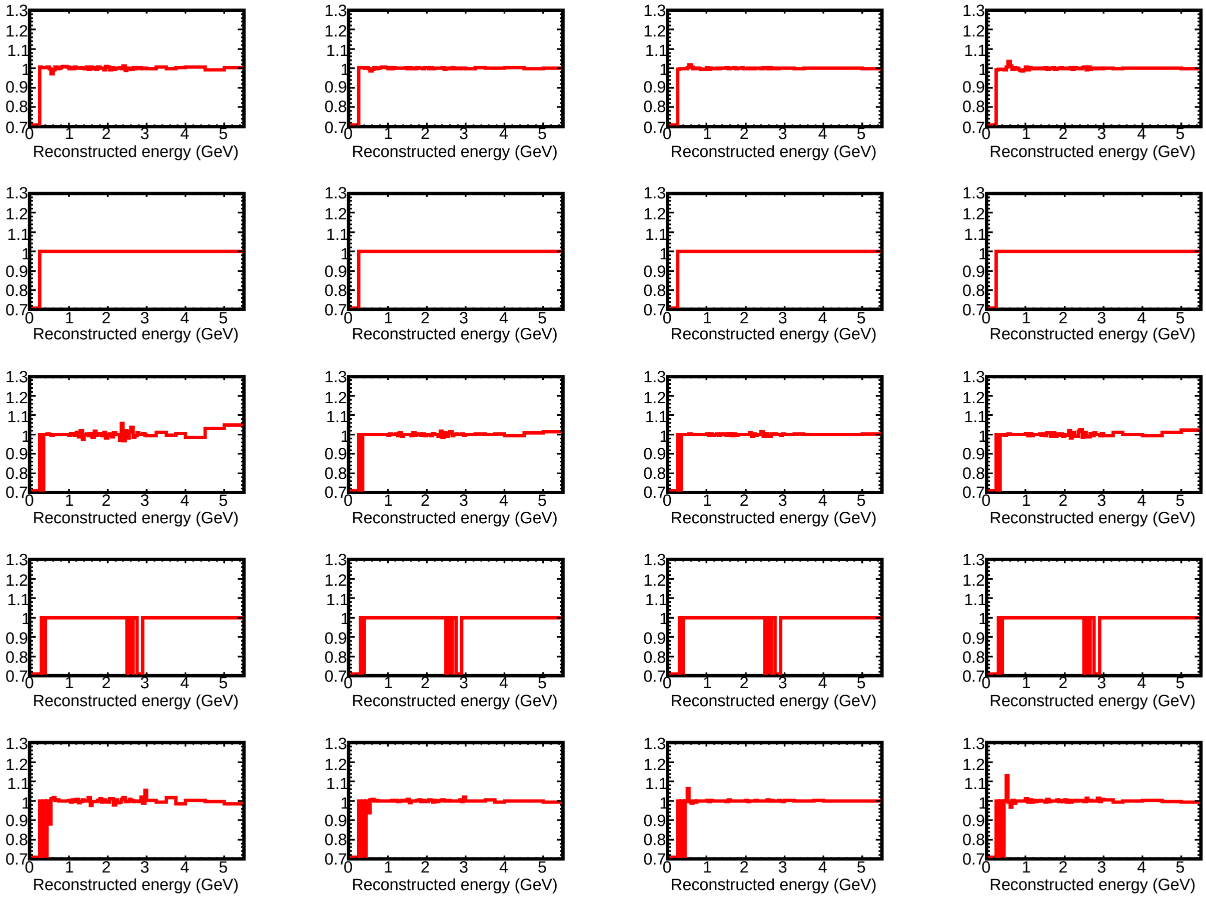


Figure 463: Ratios of non-oscillated tweaked total SuperK MC E_{reco} spectra made with the cross-section splines to those made with event-by-event reweighting for the Fermi momentum. Each row represents one neutrino species, and these are ν_μ, $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ and oscillated ν_e in that order. Each column represents a tweak value, and these are -2σ, -1σ, +1σ and +2σ in that order. Both the spline spectra and the event-by-event spectra are made with the 73-bin scheme given in Sec. 2.2.5.

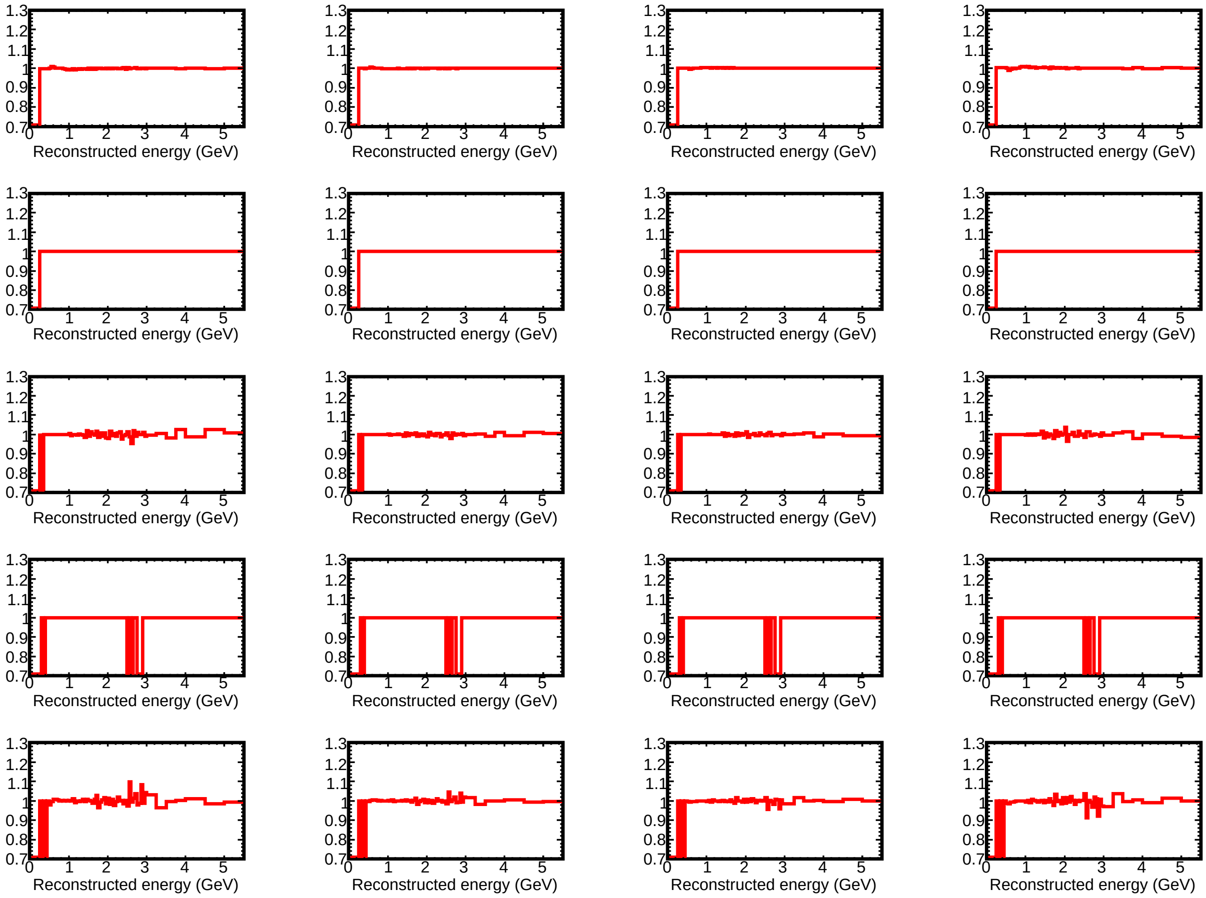


Figure 464: Ratios of non-oscillated tweaked total SuperK MC E$_{reco}$ spectra made with the cross-section splines to those made with event-by-event reweighting for the binding energy. Each row represents one neutrino species, and these are ν_μ, $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ and oscillated ν_e in that order. Each column represents a tweak value, and these are -2σ, -1σ, +1σ and +2σ in that order. Both the spline spectra and the event-by-event spectra are made with the 73-bin scheme given in Sec. 2.2.5.

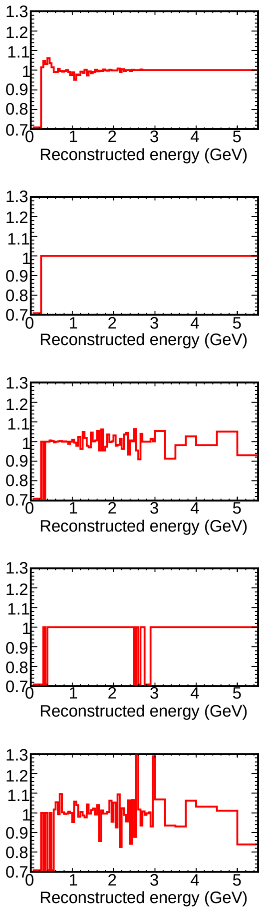


Figure 465: Ratios of non-oscillated tweaked total SuperK MC E_{reco} spectra made with the cross-section splines to those made with event-by-event reweighting for the spectral function. Each histogram represents one neutrino species, and these are ν_μ, $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ and oscillated ν_e in that order. Both the spline spectra and the event-by-event spectra are made with the 73-bin scheme given in Sec. 2.2.5.

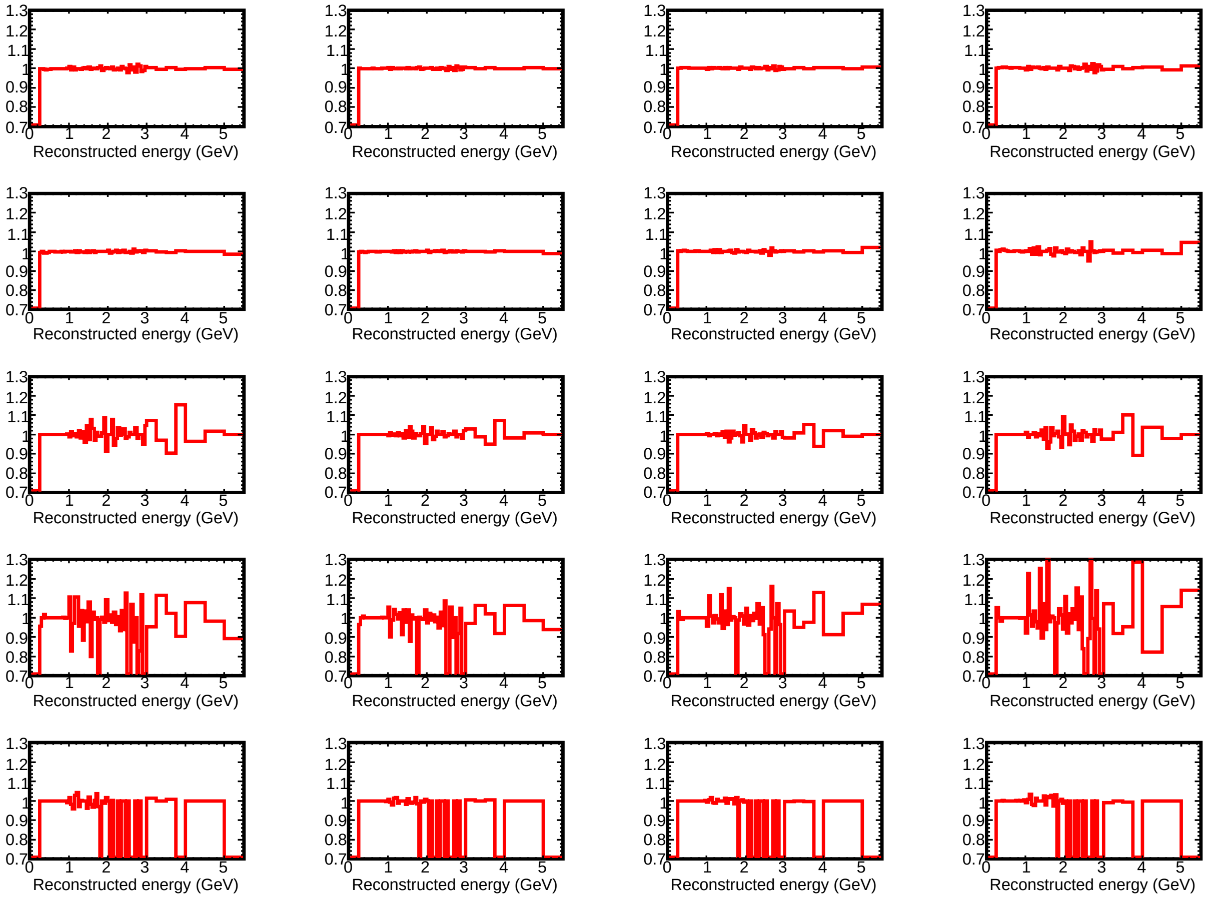


Figure 466: Ratios of non-oscillated tweaked total SuperK MC E$_{reco}$ spectra made with the cross-section splines to those made with event-by-event reweighting for MaRes for CC1π interactions. Each row represents one neutrino species, and these are ν_μ, $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ and oscillated ν_e in that order. Each column represents a tweak value, and these are -2σ, -1σ, +1σ and +2σ in that order. Both the spline spectra and the event-by-event spectra are made with the 73-bin scheme given in Sec. 2.2.5.

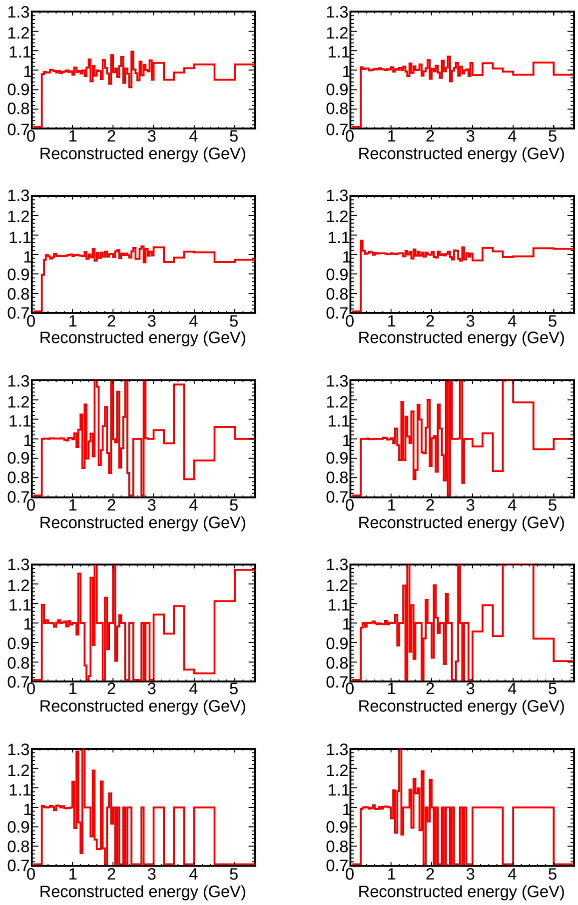


Figure 467: Ratios of non-oscillated tweaked total SuperK MC E_{reco} spectra made with the cross-section splines to those made with event-by-event reweighting for the piless delta systematic for CC1π interactions. Each row represents one neutrino species, and these are ν_{μ}, $\bar{\nu}_{\mu}$, ν_e and $\bar{\nu}_e$ and oscillated ν_e in that order. Each column represents a tweak value, and these are -1σ, and +1σ in that order. Both the spline spectra and the event-by-event spectra are made with the 73-bin scheme given in Sec. 2.2.5.

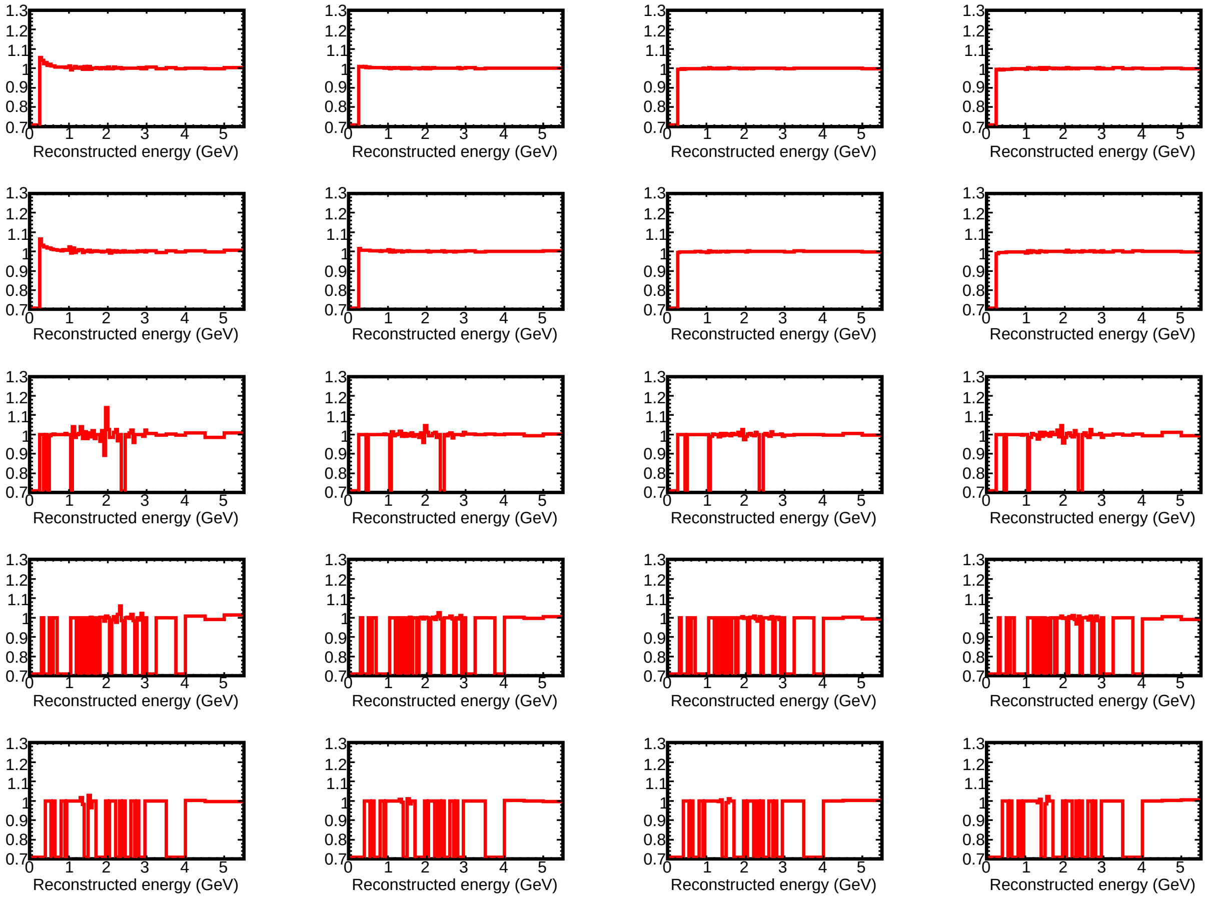


Figure 468: Ratios of non-oscillated tweaked total SuperK MC E_{reco} spectra made with the cross-section splines to those made with event-by-event reweighting for the CC other shape systematic. Each row represents one neutrino species, and these are ν_μ, $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ and oscillated ν_e in that order. Each column represents a tweak value, and these are -2σ, -1σ, +1σ and +2σ in that order. Both the spline spectra and the event-by-event spectra are made with the 73-bin scheme given in Sec. 2.2.5.

J. 2-flavour results

‘2+N’ ν_μ-disappearance fits were performed on the combined $3.010{\times}10^{20}$ POT Run 1+2+3 dataset using the method described in section 4 and the 2-flavour approximation for the oscillation probabilities. This analysis found $|\Delta m^2_{32}|$ = $2.475{\times}10^{-3}\ eV^2/c^4$ and $\sin^2 2\theta_{23}$ = 1.000 to be the best-fit values. At the best-fit point, N$_{exp}$ is 57.87 and χ^2_{bf}/ndf = 56.03/71.

The pulls, defined in Eq. 9, of all 48 systematic parameters allowed to float in the fit are shown in Fig. 469. From this figure, it is apparent that most systematic parameters barely move from their nominal values.

The reconstructed neutrino energy distribution of the single μ-like ring events in the Run 1+2+3 dataset is shown in Fig. 470 along with the ‘2+N’ 2-flavour best-fit prediction and the prediction made under the no-oscillation hypothesis. Also shown is the ratio between the data and the no-oscillation spectrum and the ratio between the ‘2+N’ 2-flavour best-fit spectrum and the the no-oscillation spectrum; in both of these ratios, the characteristic energy-dependent deficit can be clearly seen. These distributions are shown in the 73-bin scheme in reconstructed neutrino energy that was used in the fitting procedure (see Sec. 2.2.5). Fig. 471 shows the same distributions in the coarse binning scheme (see Sec. 5.3).

The $\Delta\chi^2$ surface for the the ‘2+N’ 2-flavour fit to the Run 1+2+3 dataset is shown in Fig. 472, as a function of $\sin^2 2\theta_{23}$ and $|\Delta m^2_{32}|$.

The 68% and 90% CL regions for the ‘2+N’ 2-flavour fit to the Run 1+2+3 dataset are shown using the constant-$\Delta\chi^2$ method in Fig. 473.

A comparison is shown in Fig. 474 between 90% C. L. constant-$\Delta\chi^2$ method contours for the 2-flavour fit and 3-flavour fits assuming θ_{23} to be in the first and second octants.

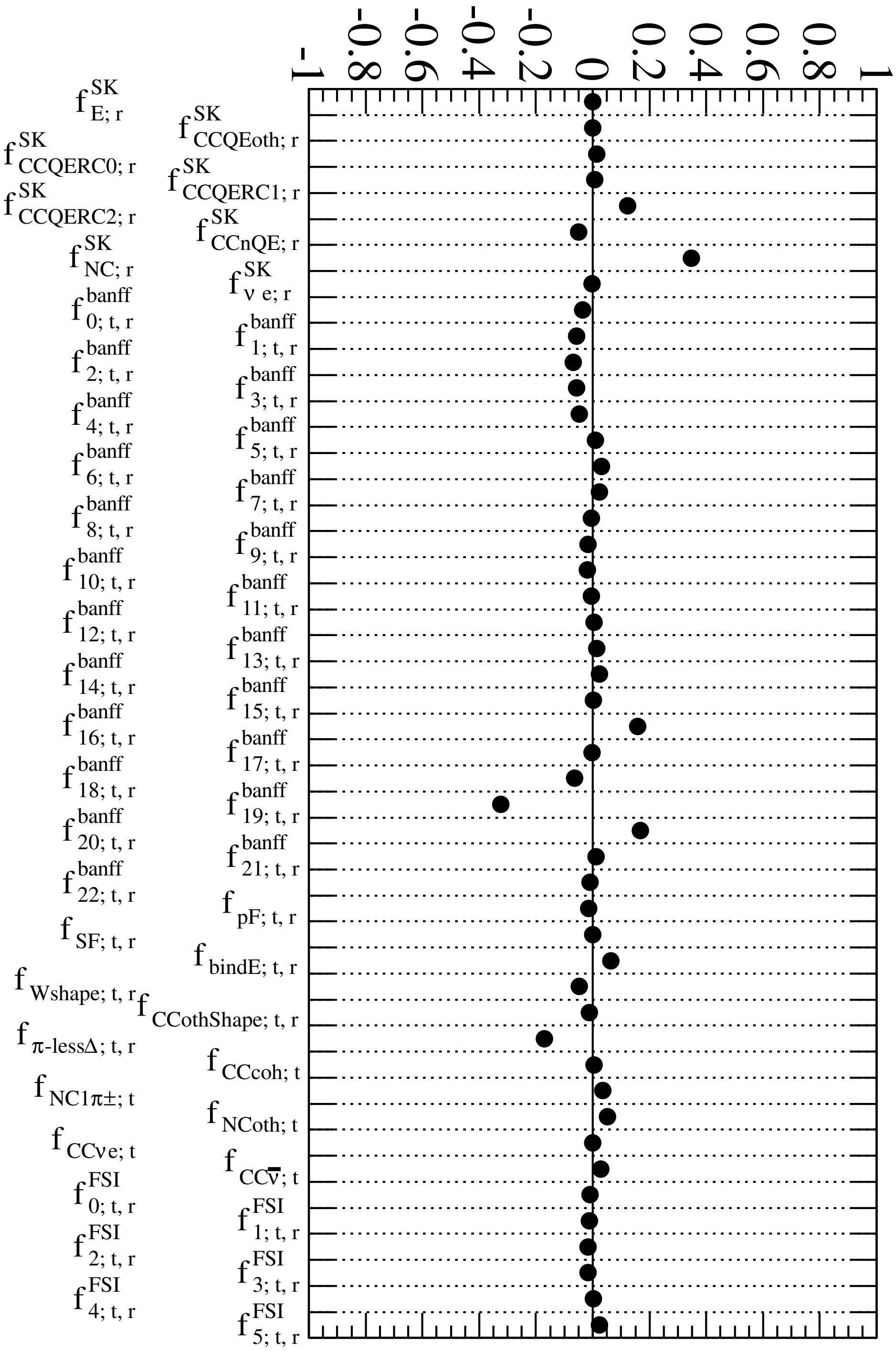


Figure 469: Systematic parameter pulls for the ‘2+N’ 2-flavour fit to the Run 1+2+3 dataset.

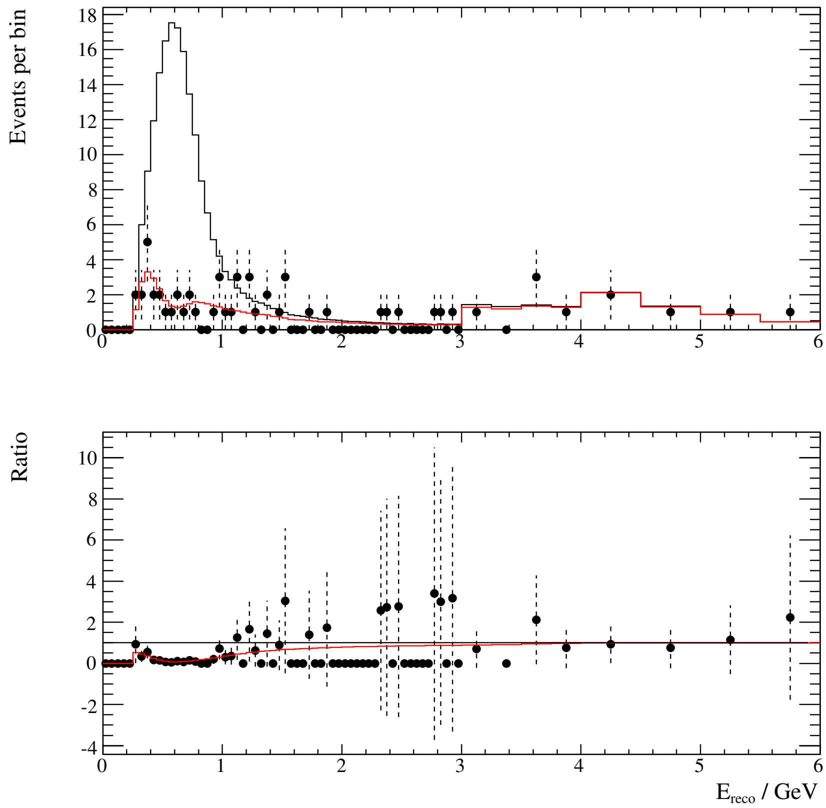


Figure 470: Best-fit reconstructed energy spectrum (top) obtained from the '2+N' 2-flavour fit to the combined Run 1+2+3 dataset. The Run 1+2+3 dataset and the prediction obtained from the no-oscillation hypothesis are also shown. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). The ratio of the data and best-fit distribution to the no-oscillation hypothesis is shown in the bottom plot. The characteristic energy-dependent deficit can be clearly seen.

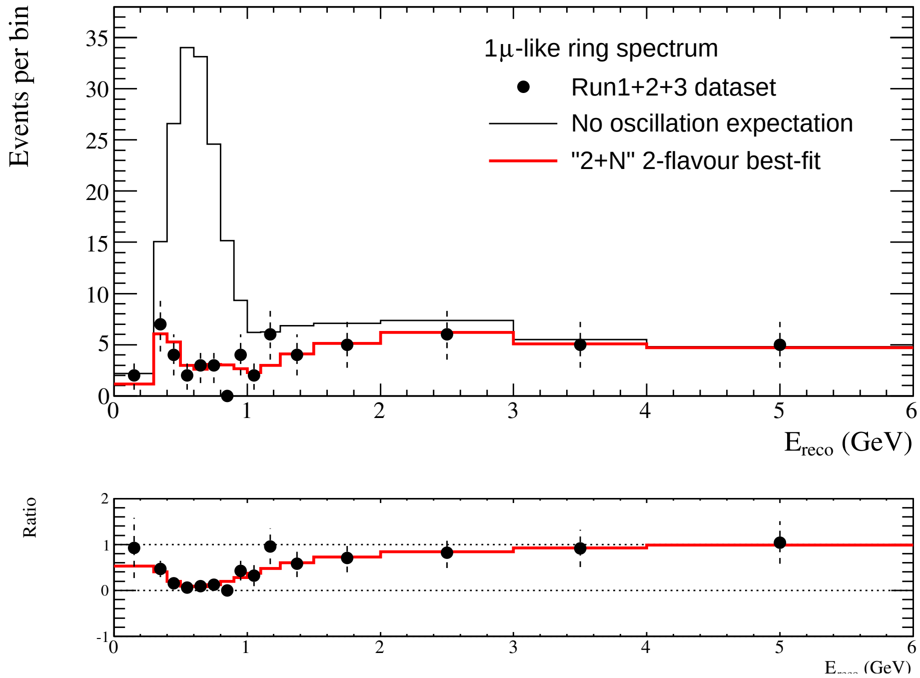


Figure 471: Best-fit reconstructed energy spectrum using the coarse binning scheme (see Sec. 5.3) obtained from the ‘2+N’ 2-flavour fit to the Run 1+2+3 dataset. Also shown are the spectrum obtained under the no-oscillation hypothesis and the ratios of the data and best-fit spectrum to it.

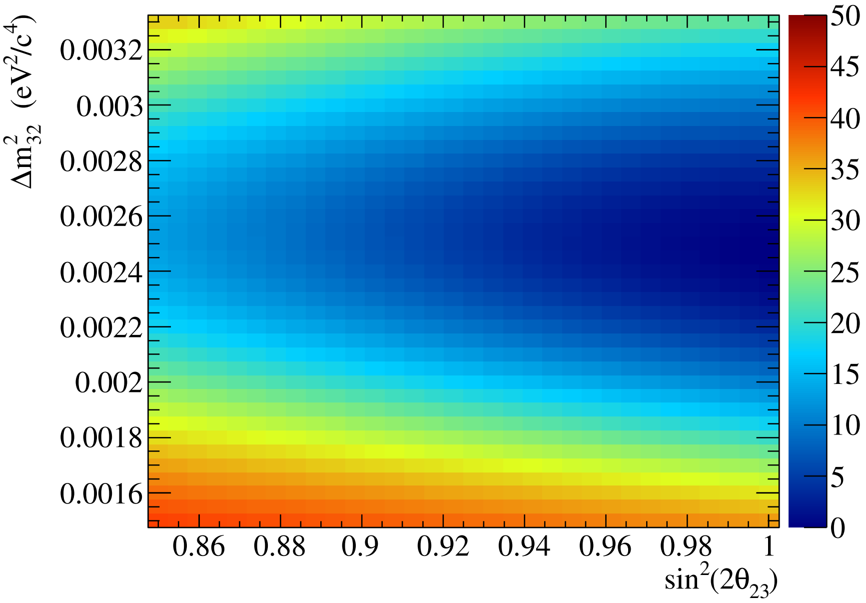


Figure 472: $\Delta\chi^2$ surface for the ‘2+N’ 2-flavour fit to the Run 1+2+3 dataset.

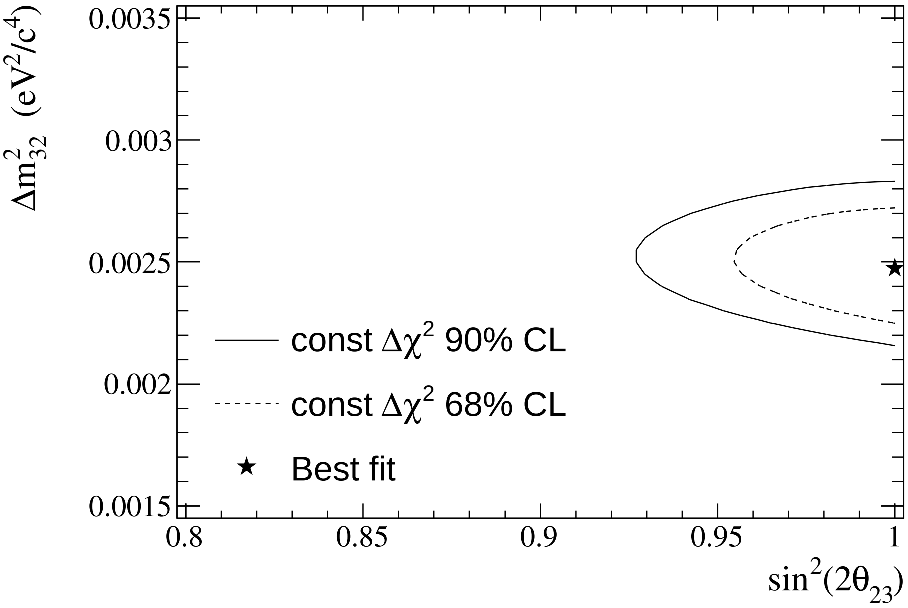


Figure 473: 68% CL and 90% CL allowed region (including systematics), constructed with the constant-$\Delta\chi^2$ method, for the '2+N' 2-flavour fit to the Run 1+2+3 dataset. The '2+N' best-fit point is also shown.

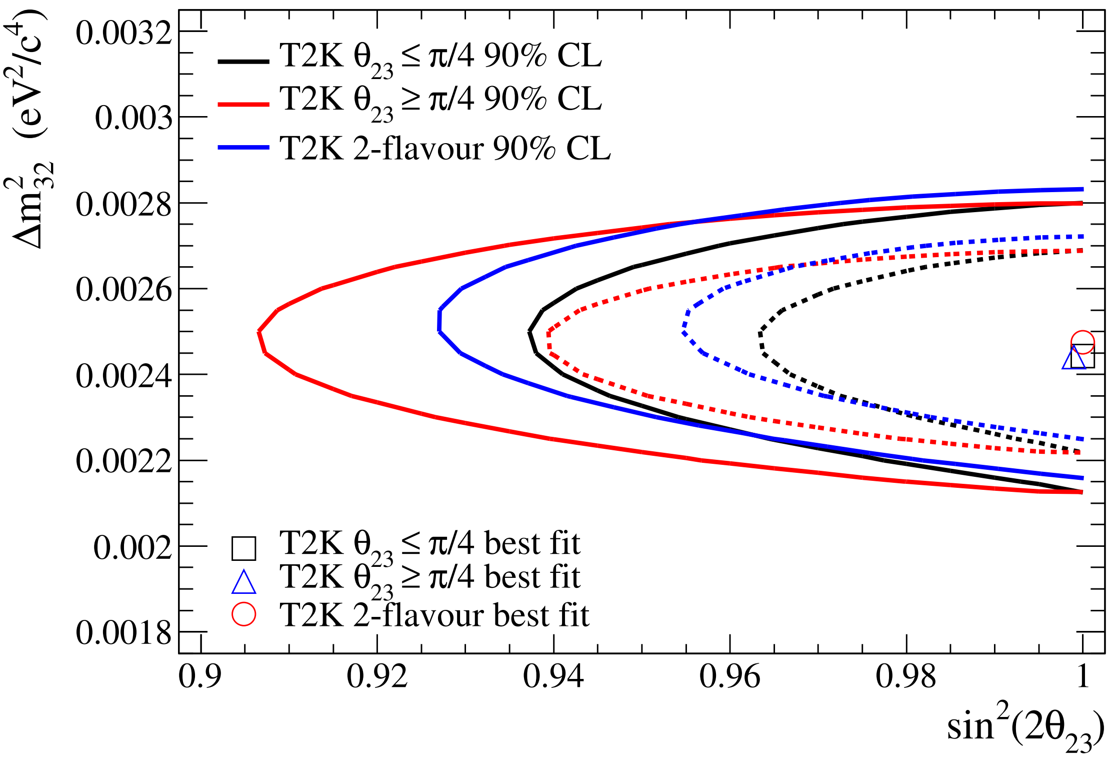


Figure 474: Comparison between the '2+N' 68% CL and 90% CL allowed regions for 3-flavour fits with θ_{23} in the first and second octants, and the 2-flavour fit, obtained using the constant-$\Delta\chi^2$ method. The comparison is shown for the fits to the Run 1+2+3 dataset.

K. Results for $\sin^2\theta_{23}$ and vacuum oscillation probabilities

'2+N' 3-flavour ν_μ-disappearance fits were performed on the combined 3.010×10^{20} POT Run 1+2+3 dataset using the method described in section 4, $\sin^2\theta_{23}$ instead of $\sin^2 2\theta_{23}$, and 3-flavour oscillation probabilities in vacuum instead of matter. This analysis found $|\Delta m^2_{32}|$ = 2.442×10^{-3} eV^2/c^4 and $\sin^2\theta_{23}$ = 0.513 to be the best-fit values. At the best-fit point, N_{exp} is 57.90 and χ^2_{bf}/ndf = 56.03/71.

The pulls, defined in Eq. 9, of all 48 systematic parameters allowed to float in the fit are shown in Fig. 475. From this figure, it is apparent that most systematic parameters barely move from their nominal values.

The reconstructed neutrino energy distribution of the single μ-like ring events in the Run 1+2+3 dataset is shown in Fig. 476 along with the '2+N' $\sin^2\theta_{23}$ in vacuum best-fit prediction and the prediction made under the no-oscillation hypothesis. Also shown is the ratio between the data and the no-oscillation spectrum and the ratio between the '2+N' $\sin^2\theta_{23}$ in vacuum best-fit spectrum and the the no-oscillation spectrum; in both of these ratios, the characteristic energy-dependent deficit can be clearly seen. These distributions are shown in the 73-bin scheme in reconstructed neutrino energy that was used in the fitting procedure (see Sec. 2.2.5). Fig. 477 shows the same distributions in the coarse binning scheme (see Sec. 5.3).

The $\Delta\chi^2$ surface for the the '2+N' $\sin^2\theta_{23}$ in vacuum fit to the Run 1+2+3 dataset is shown in Fig. 478, as a function of $\sin^2\theta_{23}$ and $|\Delta m^2_{32}|$.

The 68% and 90% CL regions for the '2+N' $\sin^2\theta_{23}$ in vacuum fit to the Run 1+2+3 dataset are shown using the constant- $\Delta\chi^2$ method in Fig. 479.

A comparison between the $\sin^2\theta_{23}$ contours assuming vacuum and matter using the constant-$\Delta\chi^2$ method is shown in Fig. 480.

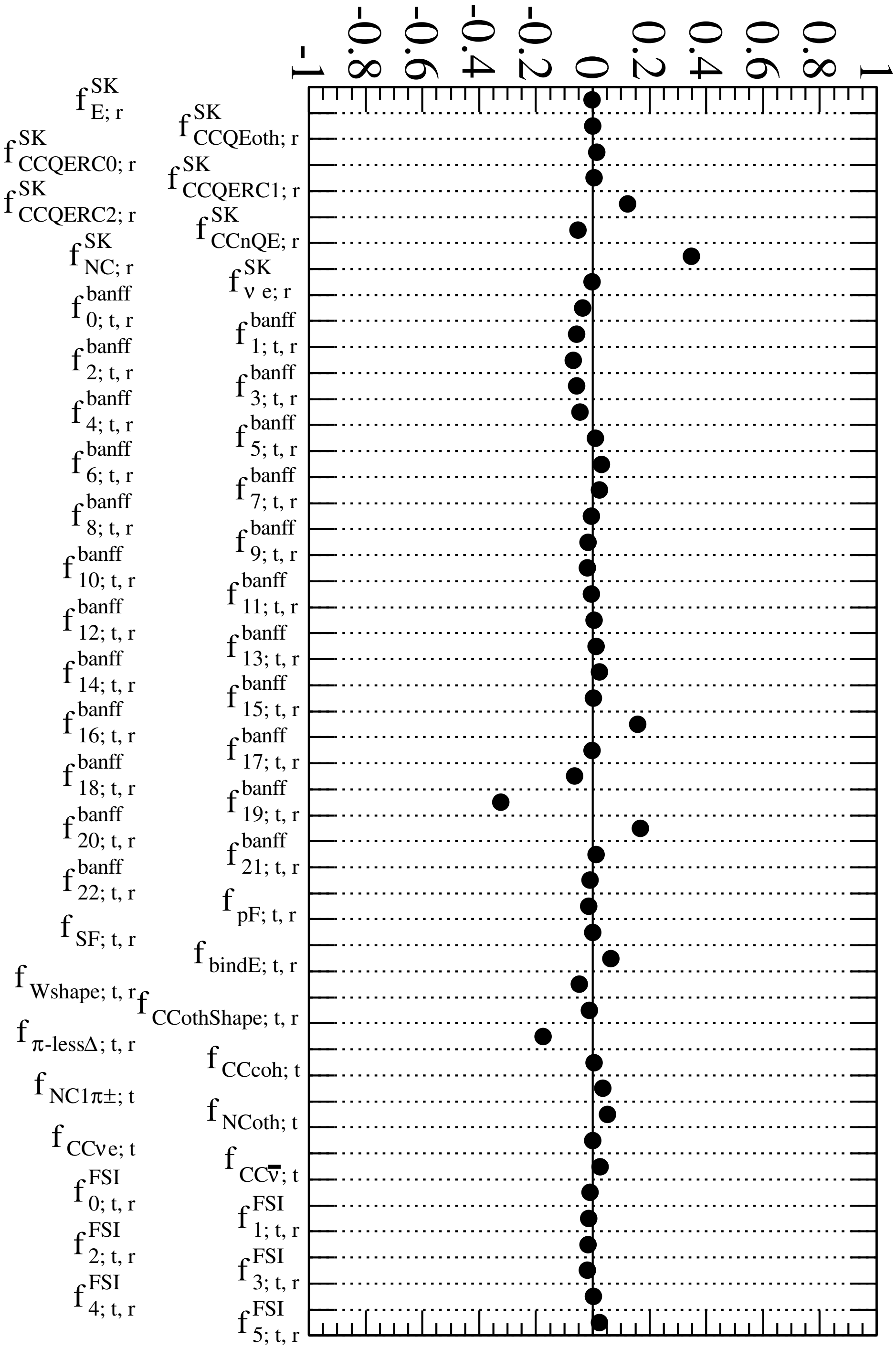


Figure 475: Systematic parameter pulls for the '2+N' $\sin^2\theta_{23}$ in vacuum fit to the Run 1+2+3 dataset.

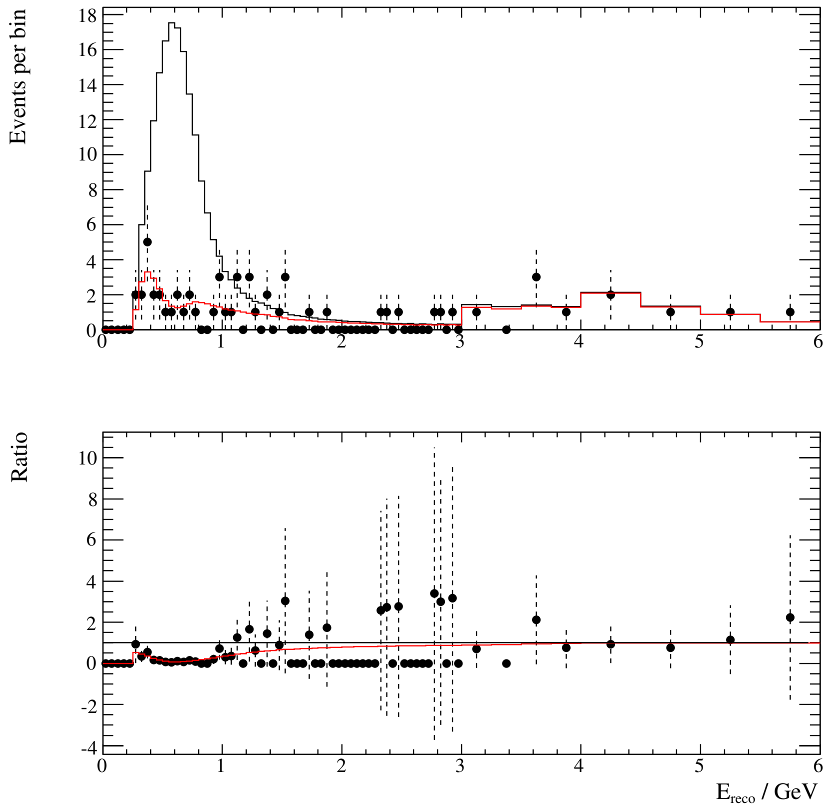


Figure 476: Best-fit reconstructed energy spectrum (top) obtained from the '2+N' $\sin^2\theta_{23}$ in vacuum fit to the combined Run 1+2+3 dataset. The Run 1+2+3 dataset and the prediction obtained from the no-oscillation hypothesis are also shown. The spectra are shown using the 73 bins used in the fit (see Sec. 2.2.5). The ratio of the data and best-fit distribution to the no-oscillation hypothesis is shown in the bottom plot. The characteristic energy-dependent deficit can be clearly seen.

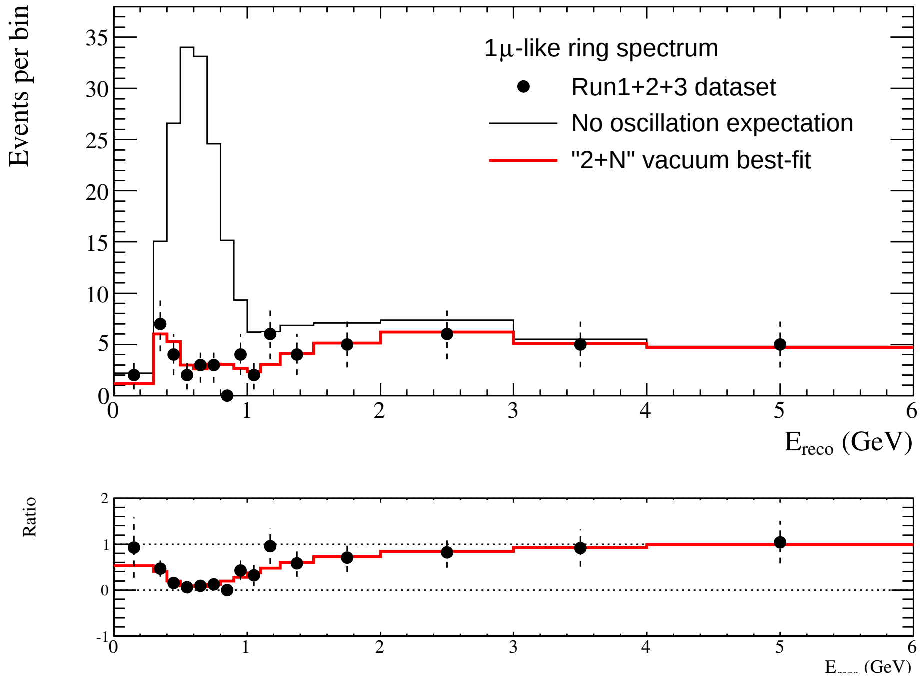


Figure 477: Best-fit reconstructed energy spectrum using the coarse binning scheme (see Sec. 5.3) obtained from the '2+N' $\sin^2\theta_{23}$ in vacuum fit to the Run 1+2+3 dataset. Also shown are the spectrum obtained under the no-oscillation hypothesis and the ratios of the data and best-fit spectrum to it.

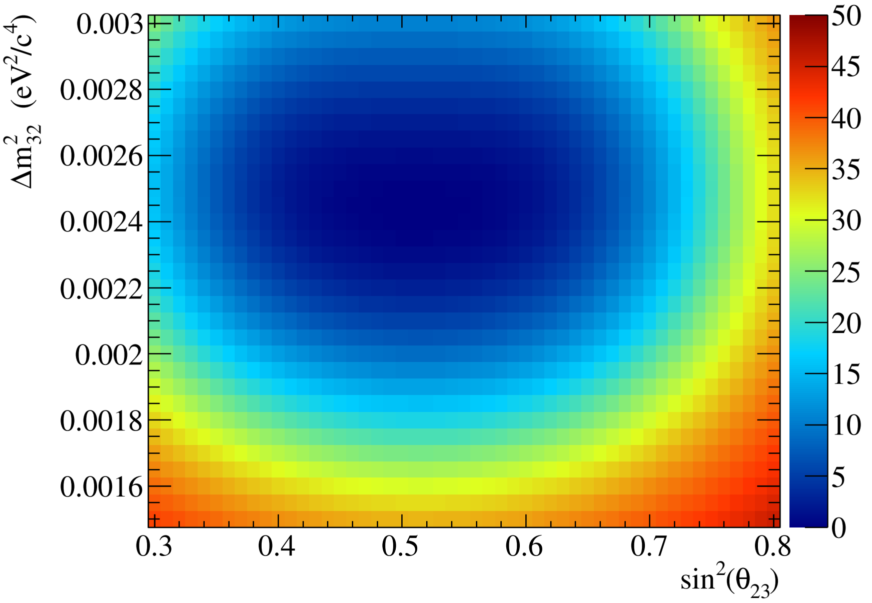


Figure 478: $\Delta\chi^2$ surface for the '2+N' $\sin^2\theta_{23}$ in vacuum fit to the Run 1+2+3 dataset.

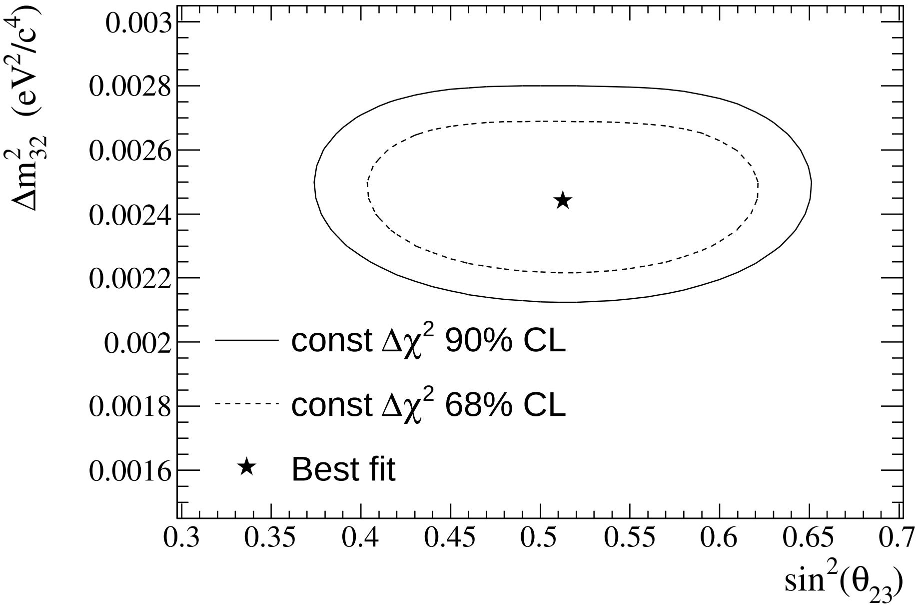


Figure 479: 68% CL and 90% CL allowed region (including systematics), constructed with the constant-$\Delta\chi^2$ method, for the '2+N' $\sin^2\theta_{23}$ in vacuum fit to the Run 1+2+3 dataset. The '2+N' best-fit point is also shown.

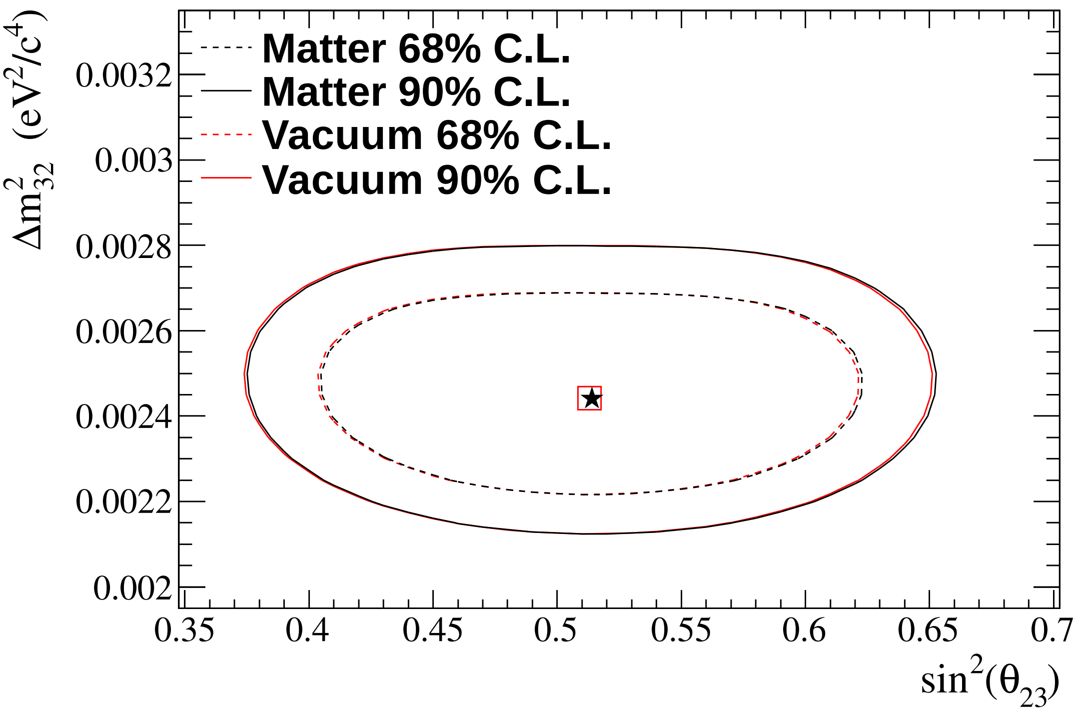


Figure 480: Comparison between the '2+N' 68% CL and 90% CL allowed regions for the $\sin^2\theta_{23}$ in vacuum and $\sin^2\theta_{23}$ in matter fits obtained using the constant-$\Delta\chi^2$ method. The comparison is shown for the fits to the Run 1+2+3 dataset.