University of Sussex

Initial sensitivity contours with resolution binning

Numu group, Sep. 2016

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Version details

Running in development to pick up recent changes

Using FD decafs:

/pnfs/nova/persistent/production/concat/R16-03-03-prod2reco.d/prod_decaf_R16-03-03-prod2reco.e_fd_genie_nonswap_fhc_nova_v08_epoch1-3c_numu_contain_v1_prod2-snapshot.root

/pnfs/nova/persistent/production/concat/R16-03-03-prod2reco.d/prod_decaf_R16-03-03-prod2reco.e_fd_genie_fluxswap_fhc_nova_v08_epoch1-3c_numu_contain_v1_prod2-snapshot.root

Outline

- Description of resolution paramerisation method
- Selections used
- Plot of (neutrino resolution)/(neutrino energy)
- Sensitivity contours for separation into 4 resolution bins
- Bin by bin energy resolution
- Sensitivity to exclusion of maximal mixing for the SA numu result parameters
- Plots used for the neutrino resolution parameterisation are in backup

Energy resolution parameterisation

Using the MC to measure the the abs. resolution (reco-true) of muon and hadronic energy vs. (muon or had.) energy. Fit a polynomial to the res. vs energy plot, the fit is used to “look up” the resolution for a given energy

Absolute neutrino energy resolution is defined for each event as:

$$\sigma_\nu = \sqrt{(\sigma_\mu(E_\mu)^2 + \sigma_{had.}(E_{had.})^2)}$$

(Assuming no correlation)

σ_ν / E_ν is then used to define the energy resolution for each event

Using truth selection for resolution parameterisation

Note: At this stage parameterisation is done without applying oscillations to the FD MC

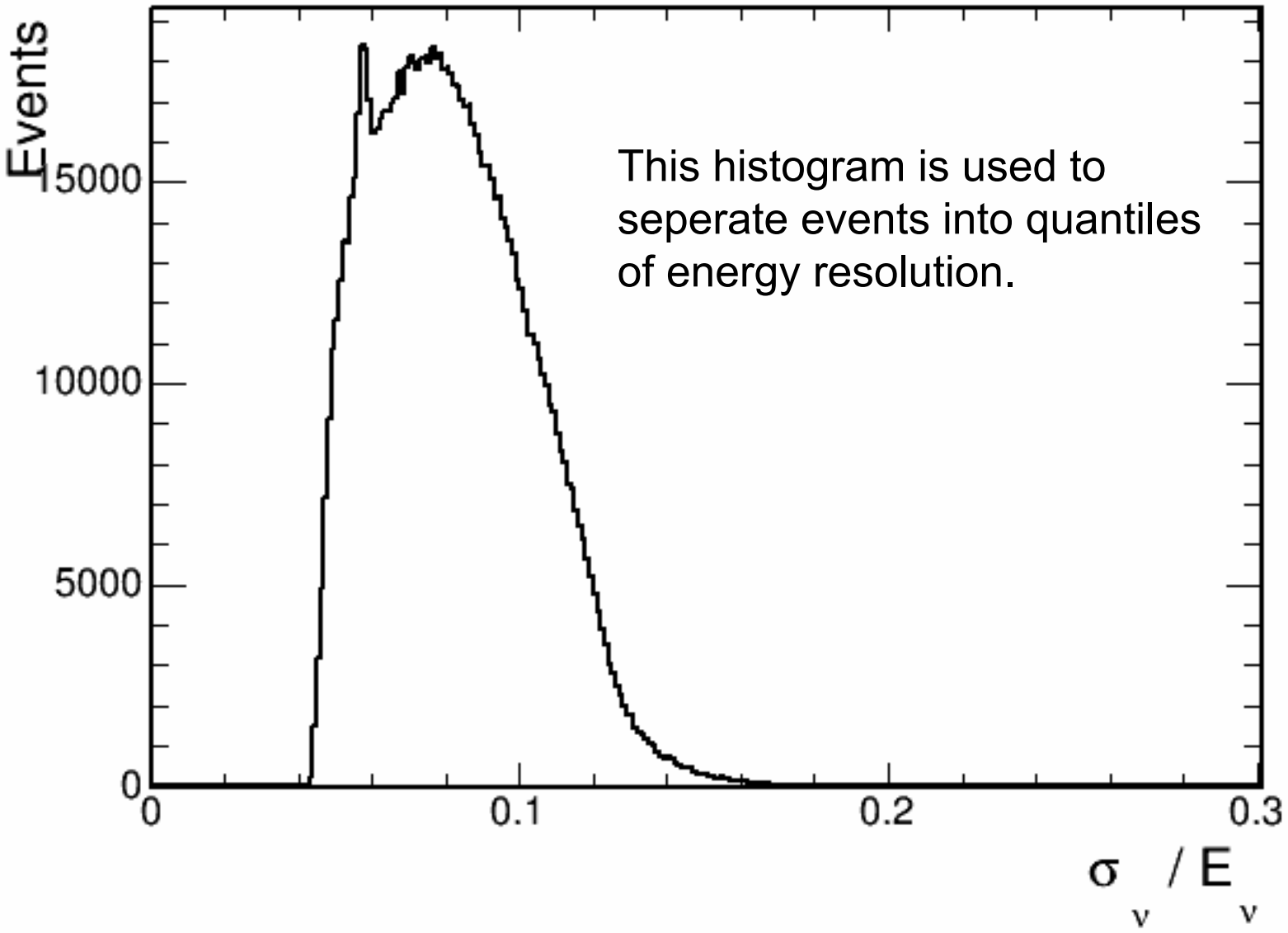
Selection

As mentioned in DocDB (15961) the standard **numu FD selection** (kNumuFD) and also the **truth selection** (kIsNumuCC) are applied to parameterise the neutrino energy.*

The following sensitivities are produced with the standard numu FD selection.

*Use the truth selection to remove troublesome background. In particular the NC events, for which the true muon energy will be zero. That's a problem when we want to measure (reco. E – true E)

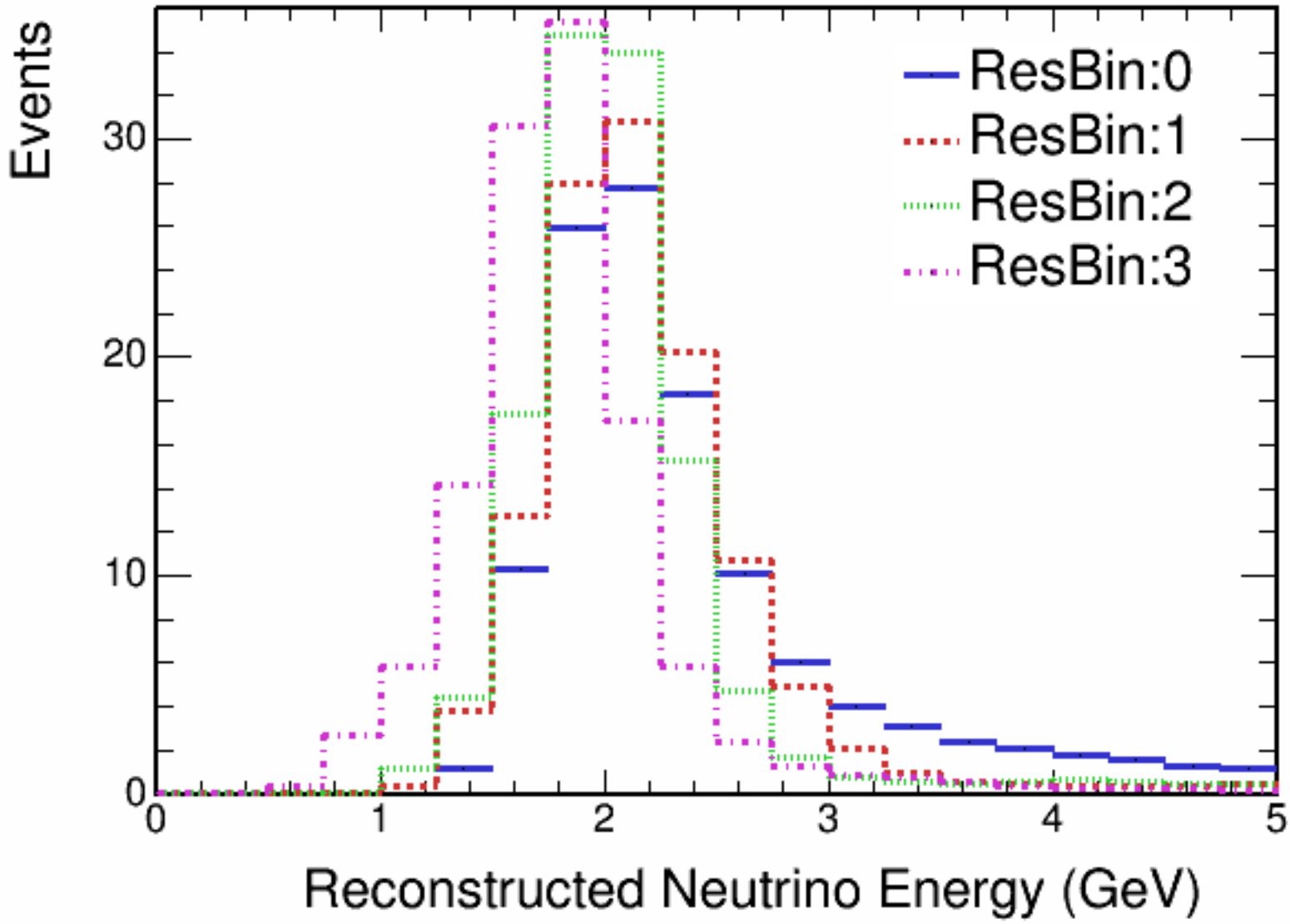
Neutrino energy resolution



First test: separate events into 4 quantile bins and make simple noExtrap sensitivity contours

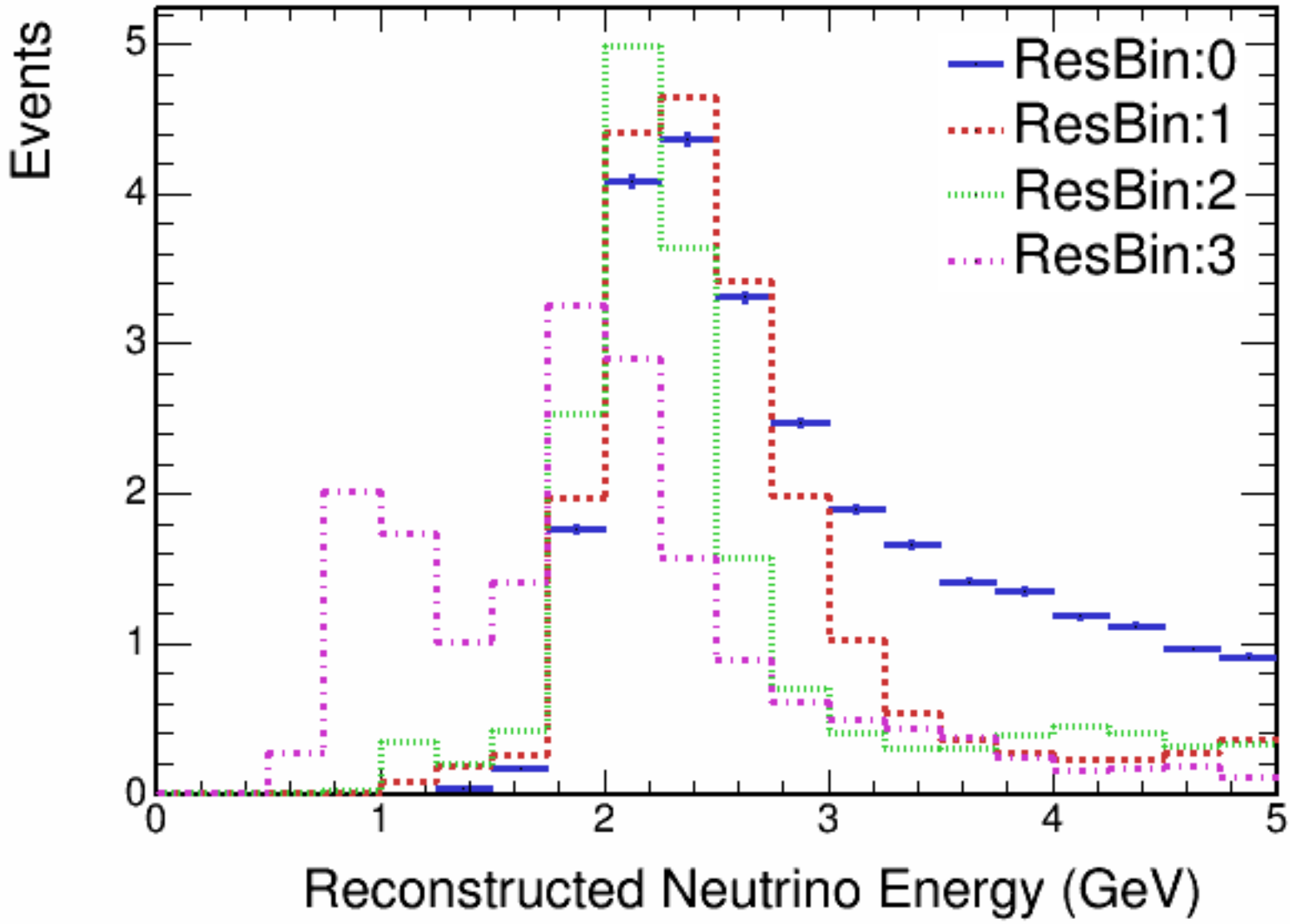
Note: using PredictionNoExtrap throughout this talk and also ignoring systematics for now

No oscillation predictions



Clear sign of energy dependence of current energy resolution paremterisation.
Energy spectrum shifts to higher energies for better resolved events.

~Max mixing (ssqth23 = 0.5) predictions



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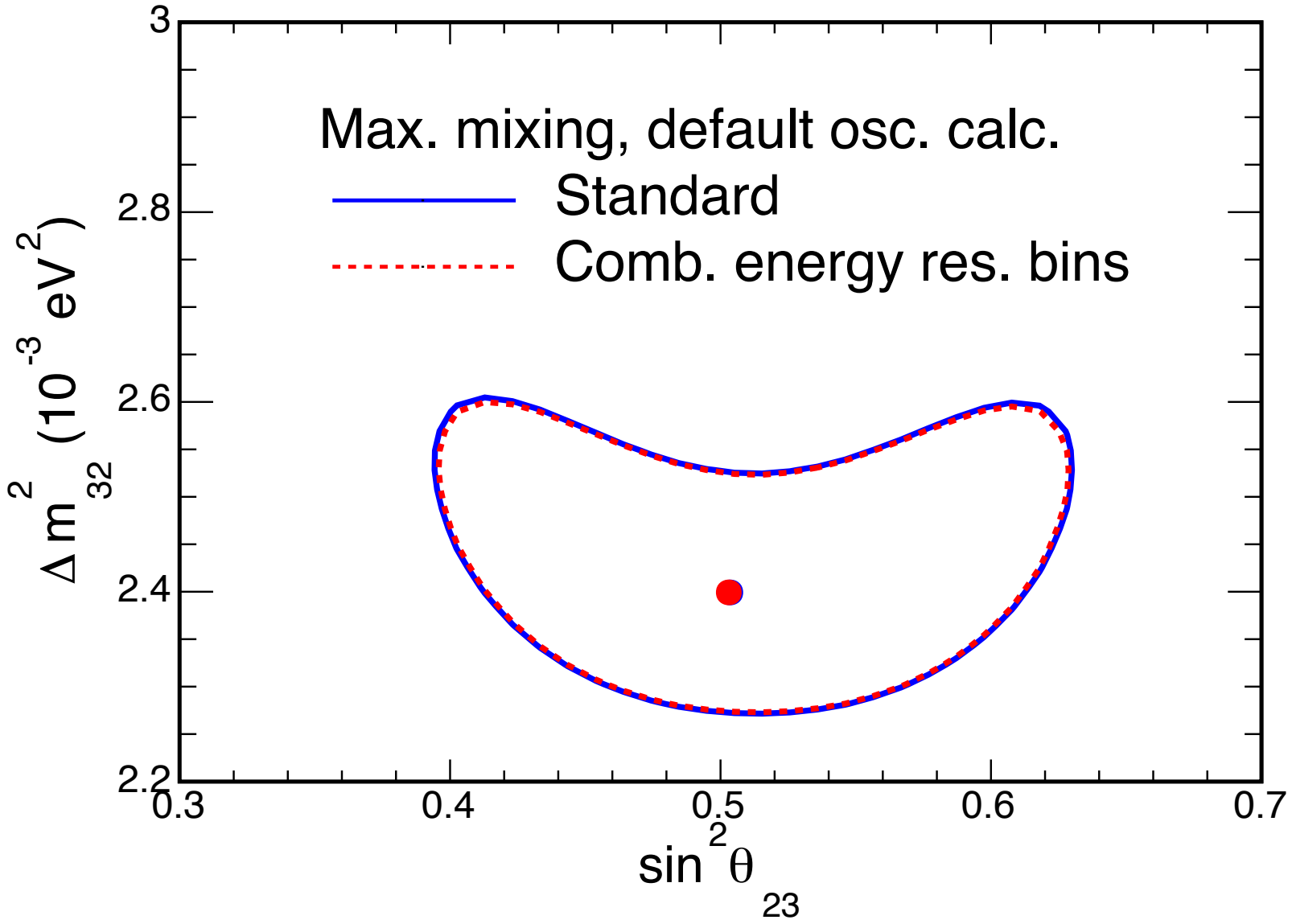
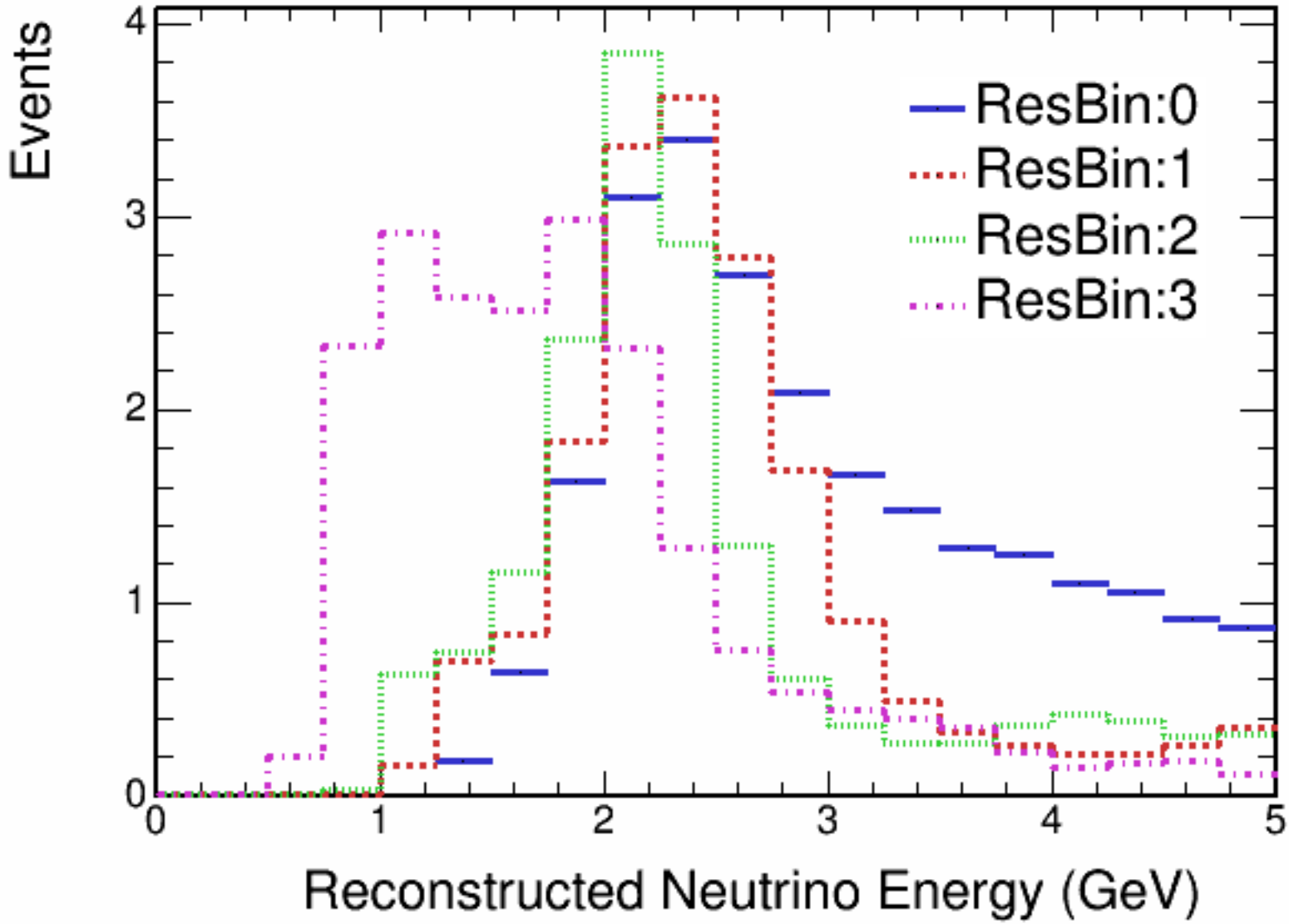


SA numu result paramters (ssqth23 = 0.4022) prediction



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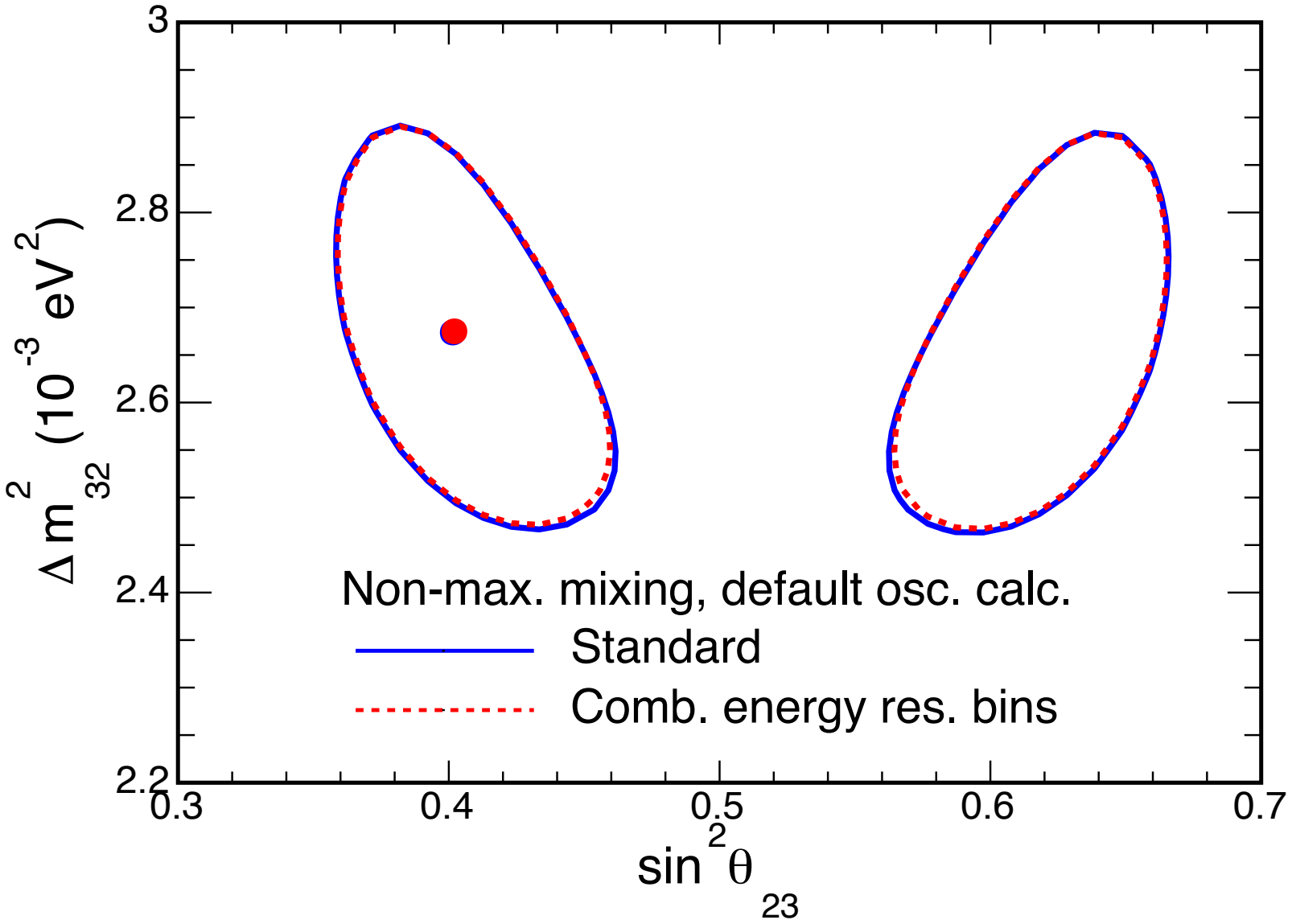

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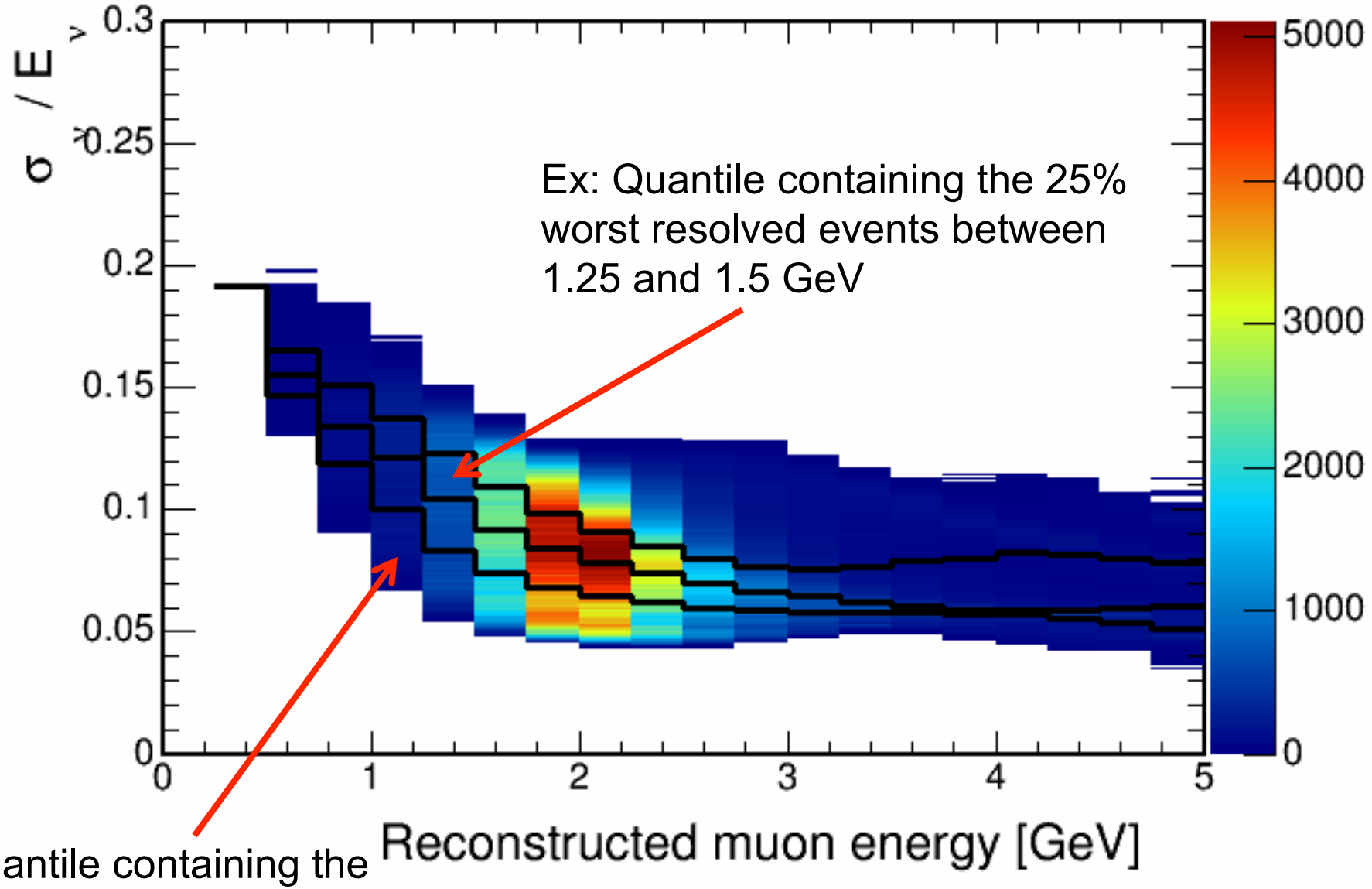
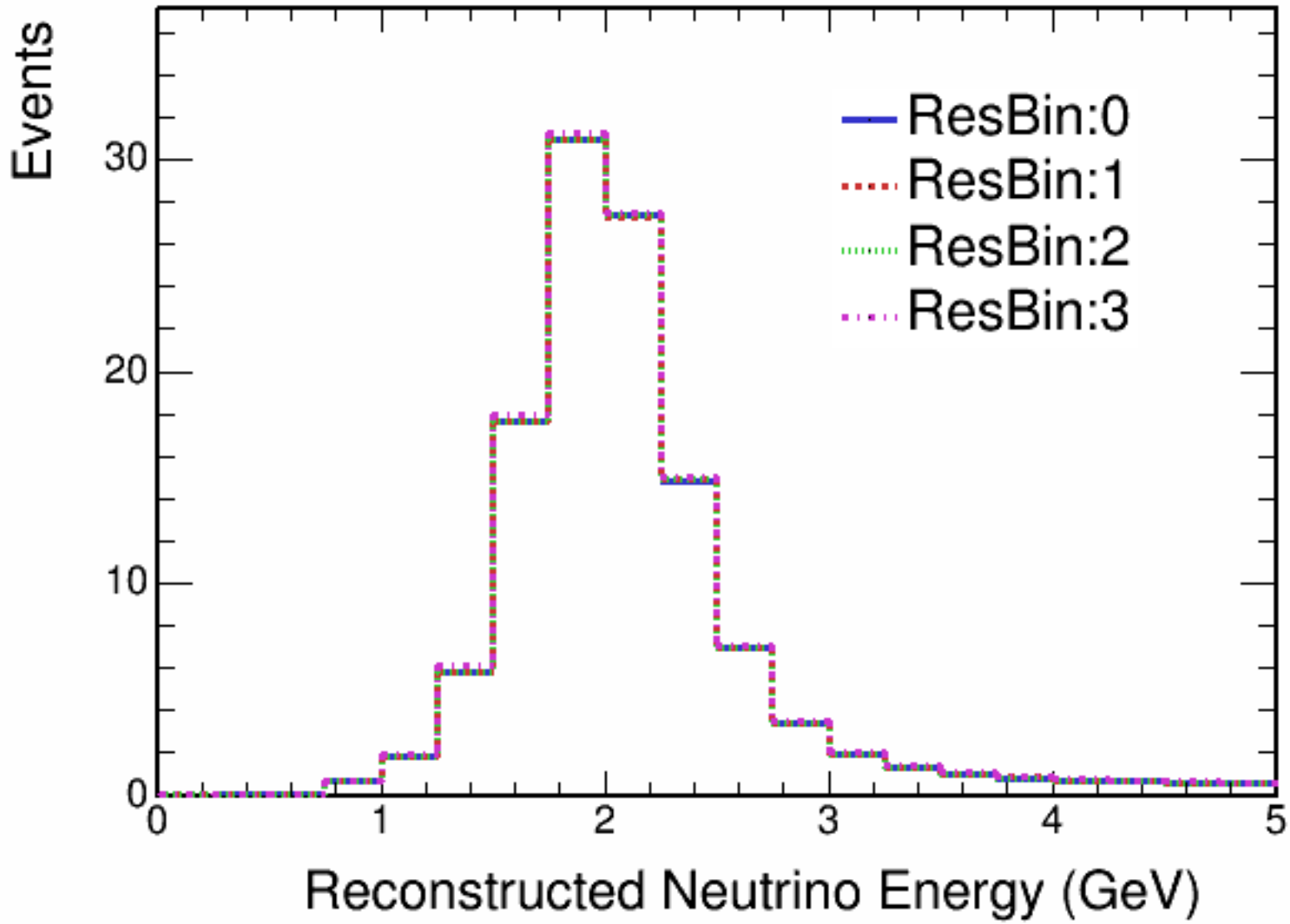
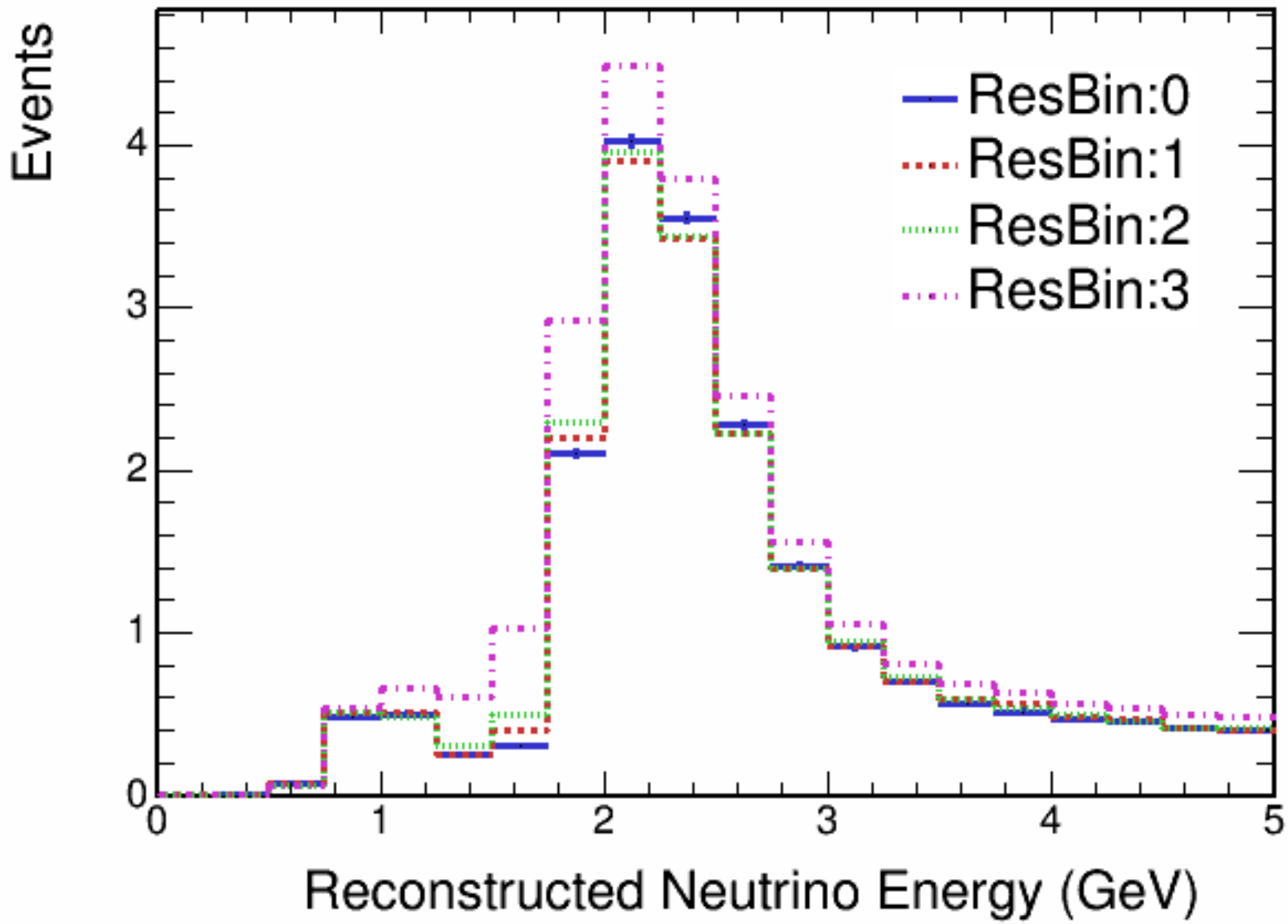


No oscillations prediction



$Sin^2\theta_{23}$=0.5 prediction



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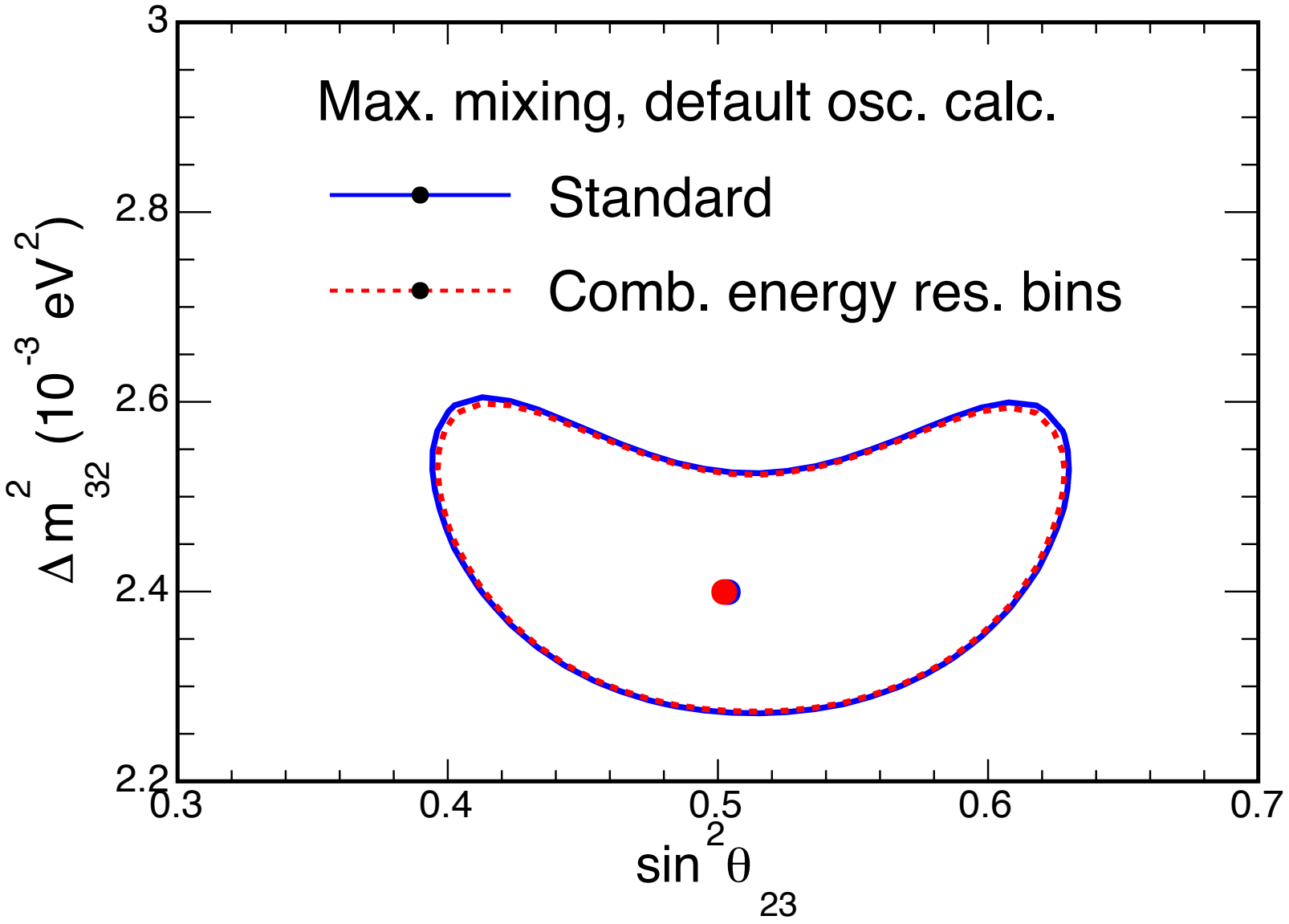

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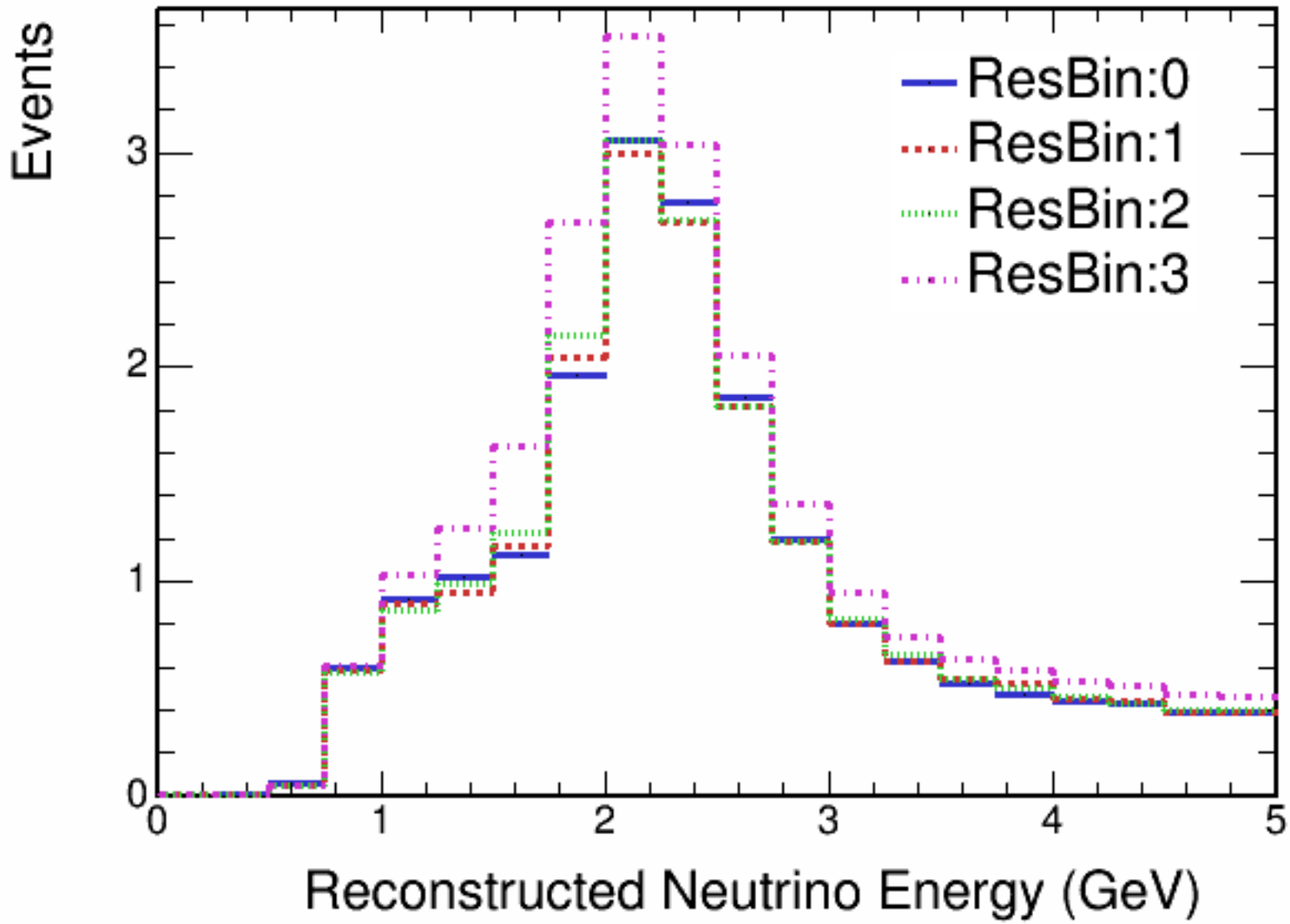

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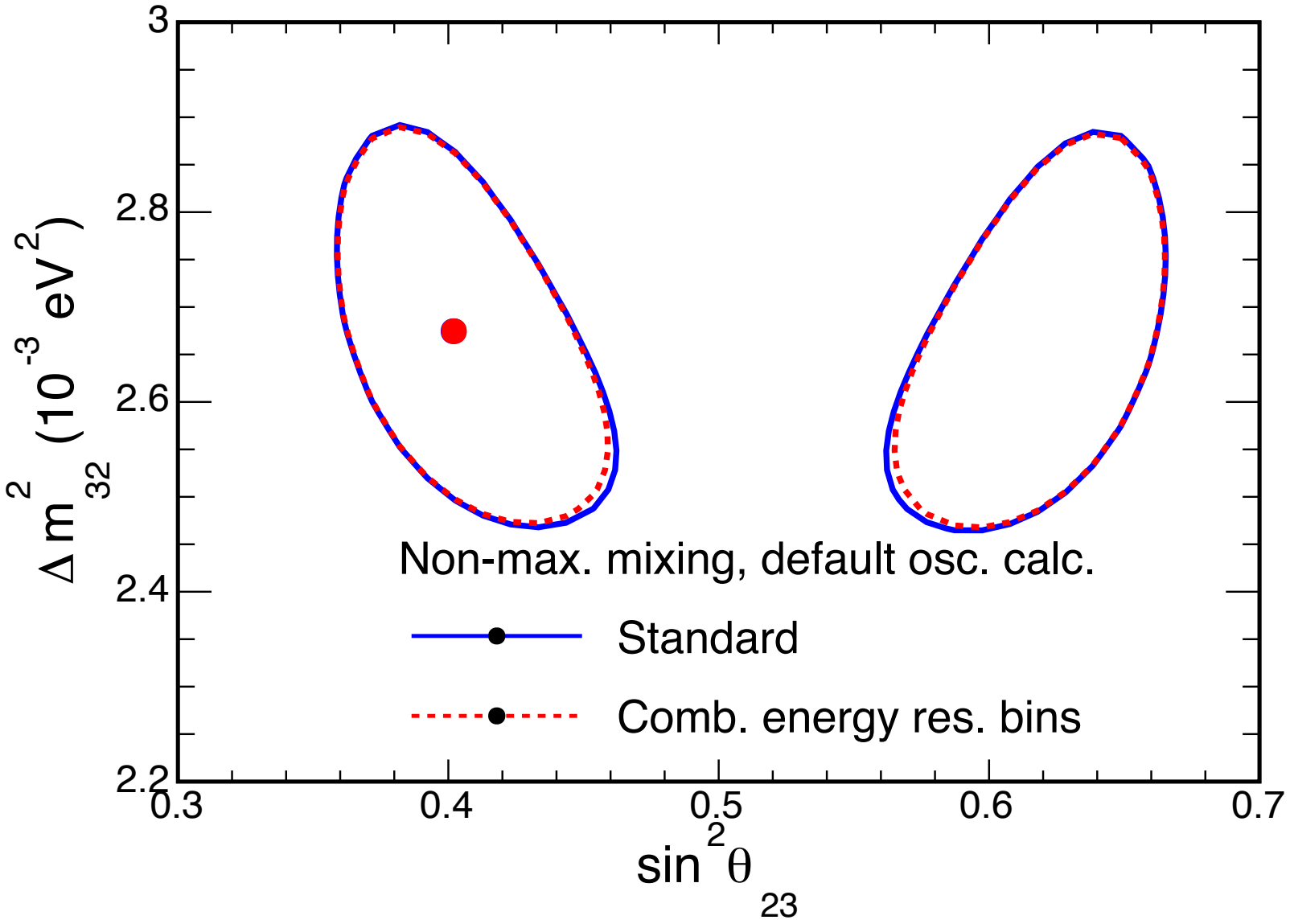

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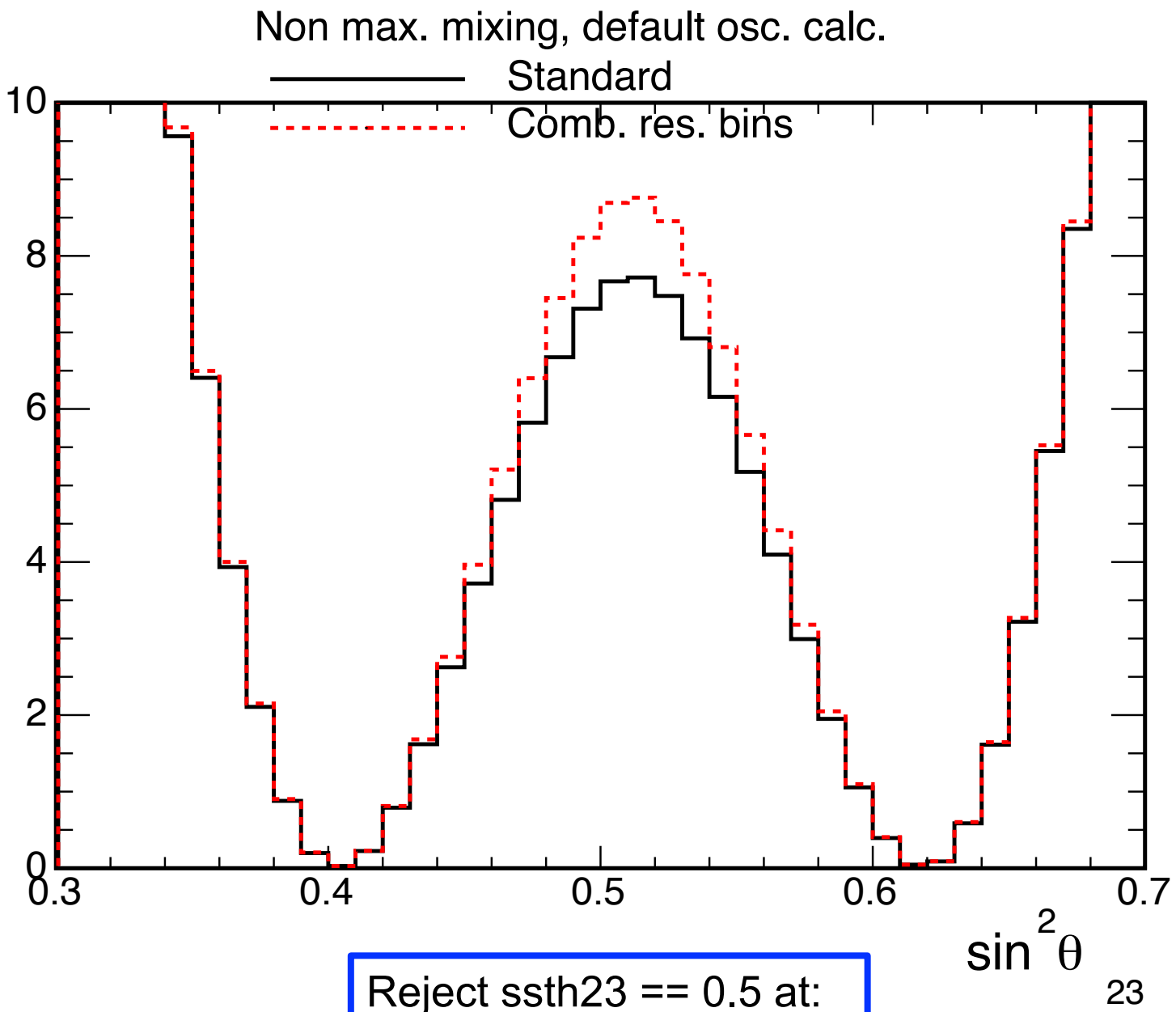


Reject ssth23 == 0.5 at:

- **2.73 sigma**
- **2.90 sigma**

Summary

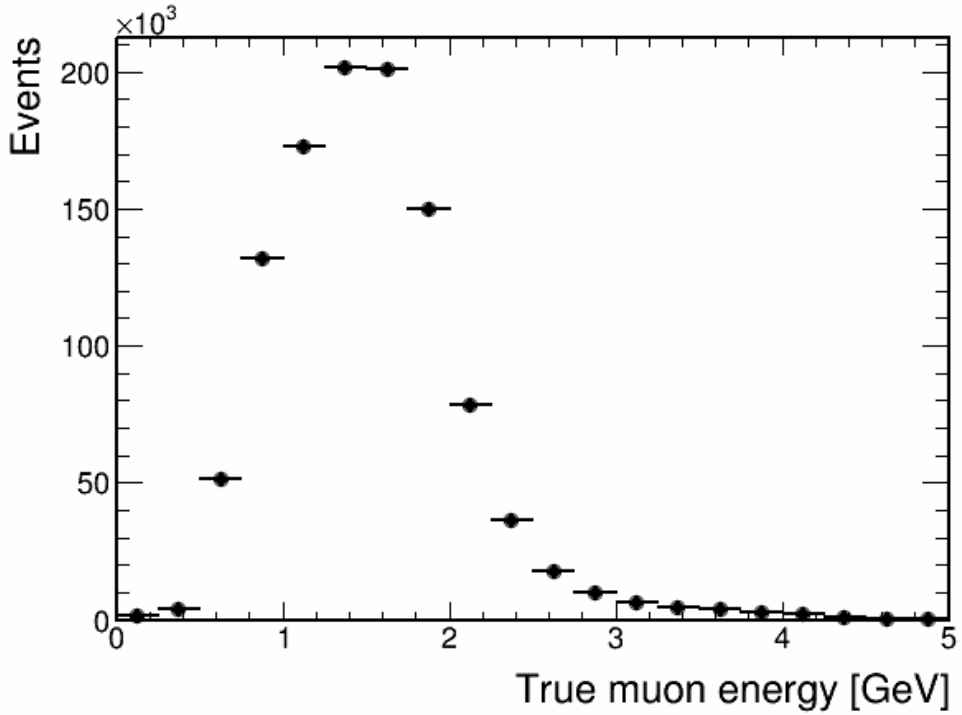
- Prelimanary stage, no extrapolation or oscillations at this stage
- Sensitivity for ssth23=0.5 and for the SA numu parameters is improved slightly with a simple 4 bin resolution separation
- Sensitivity further improved with introduction of reco. E bin-by-bin energy resolution separation
  - rejection of maximal mixing increased from 2.73 to 2.90 σ

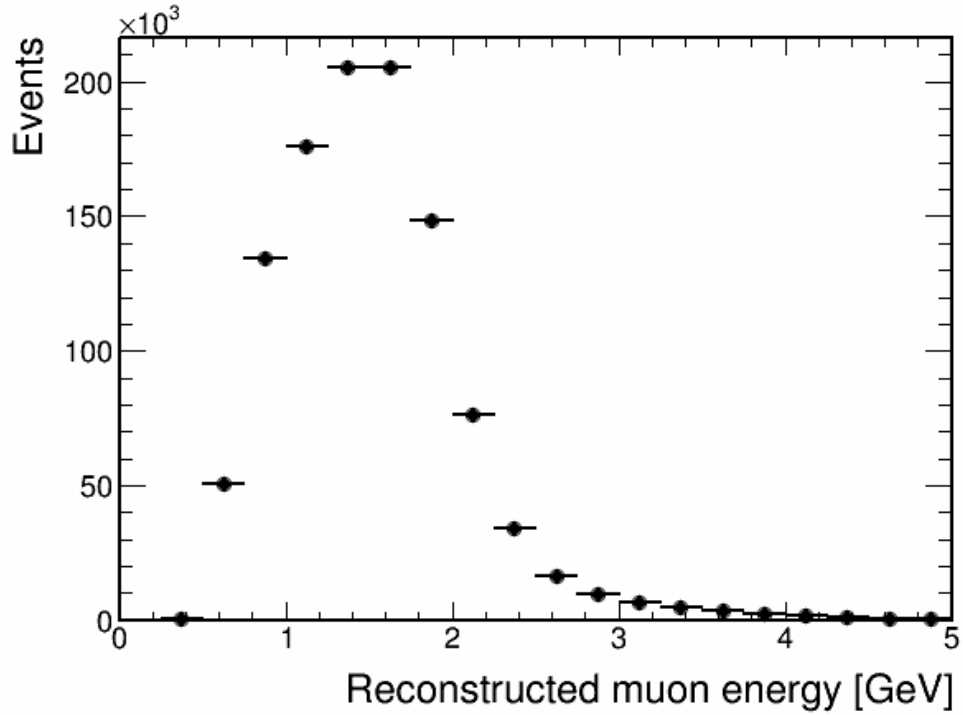
Future plan

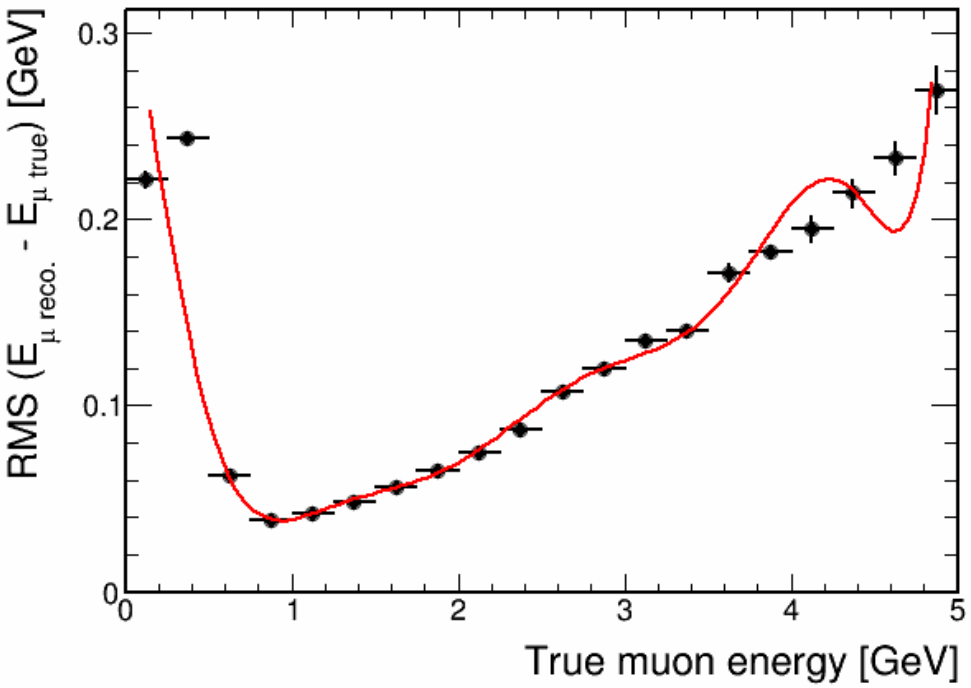
- Repeat study including extrapolation and systematics
- Optimise number of energy resolution bins for rejection of maximal mixing

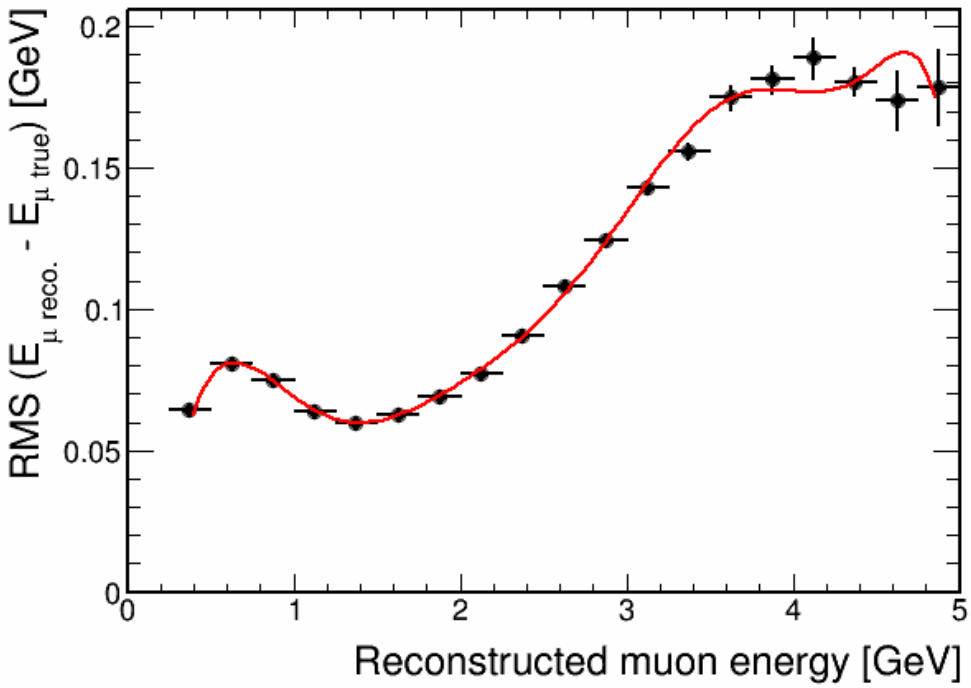
Backup

Muon energy resolution

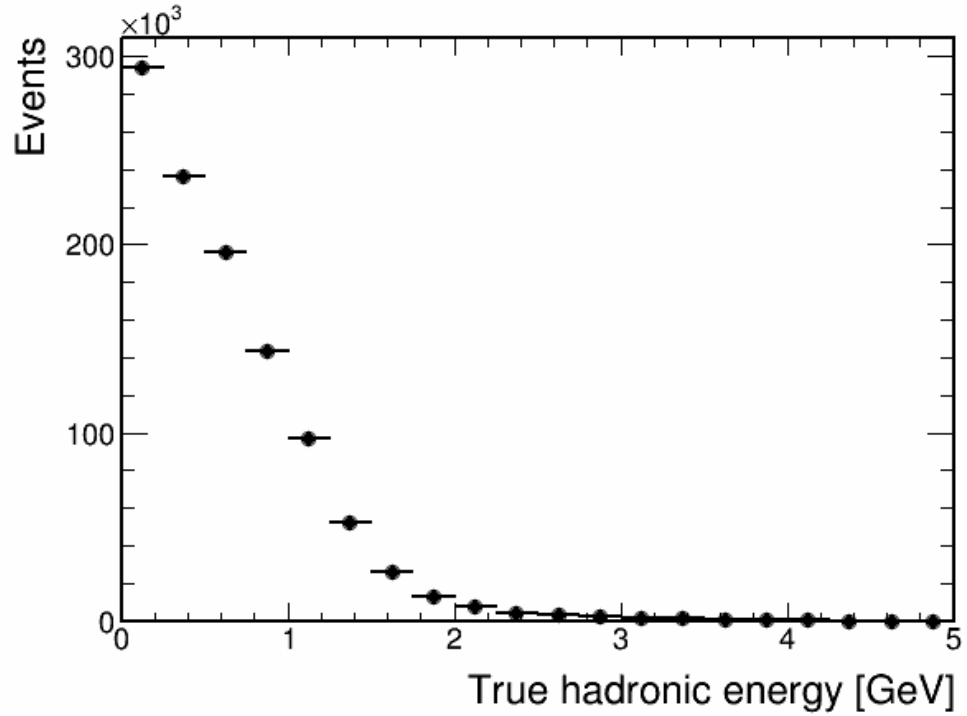


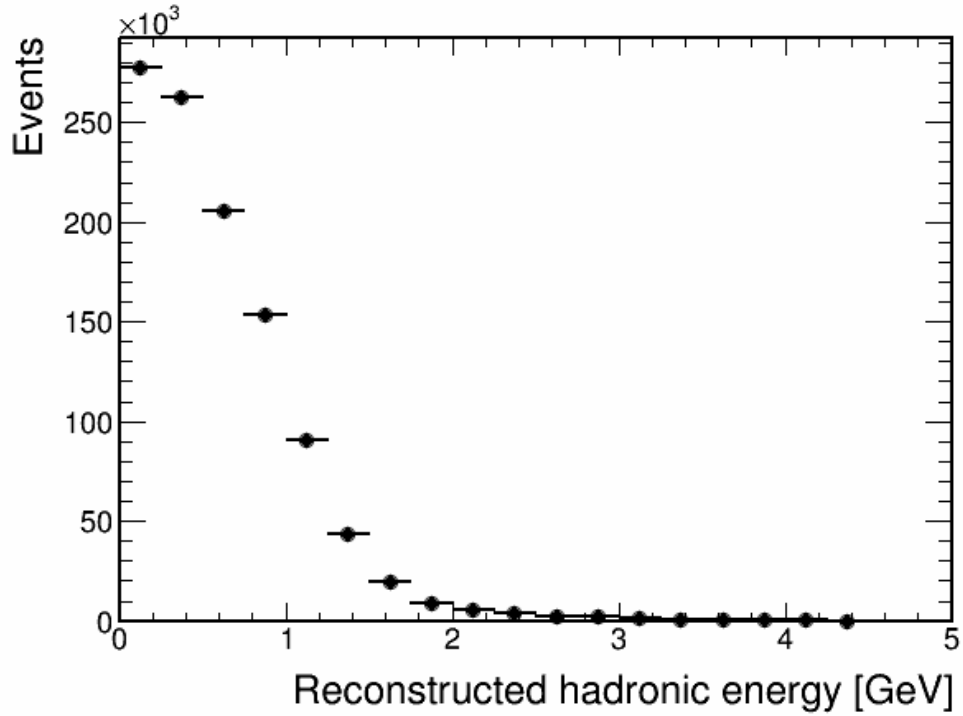


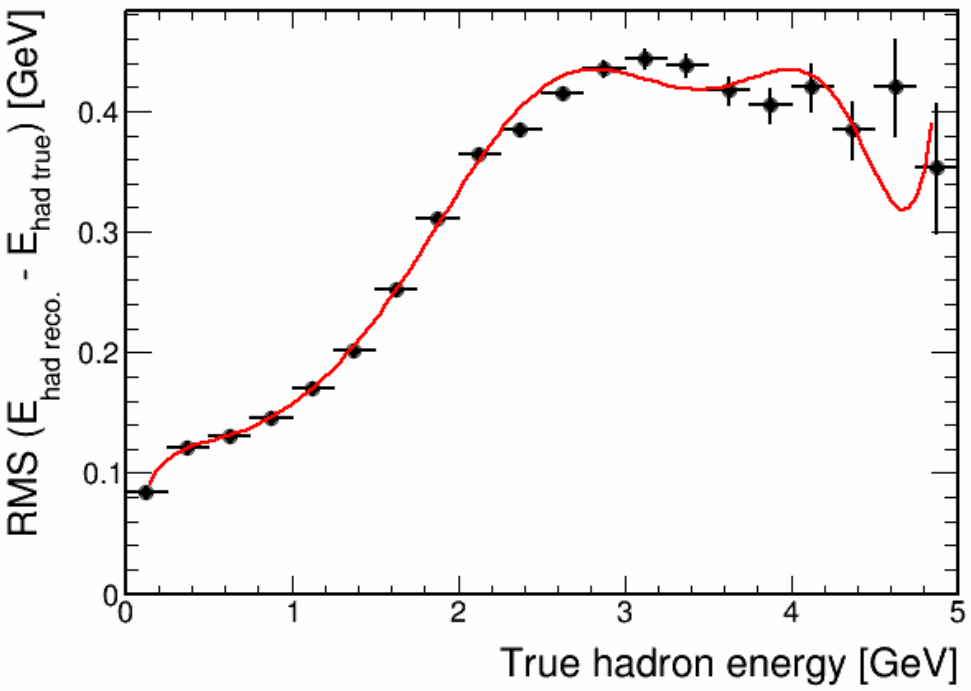


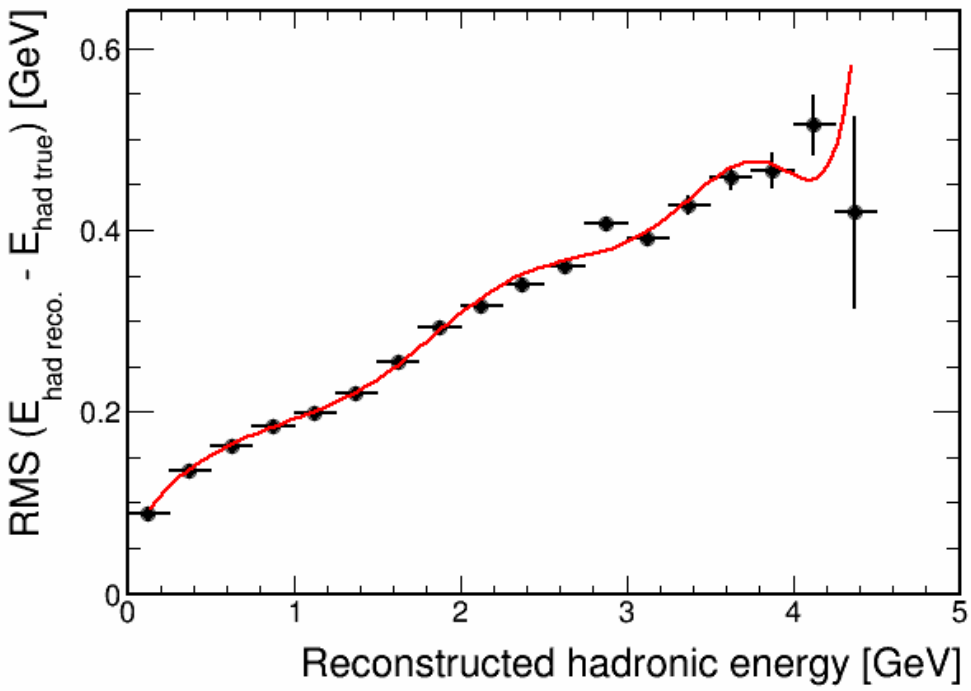


Hadronic energy resolution

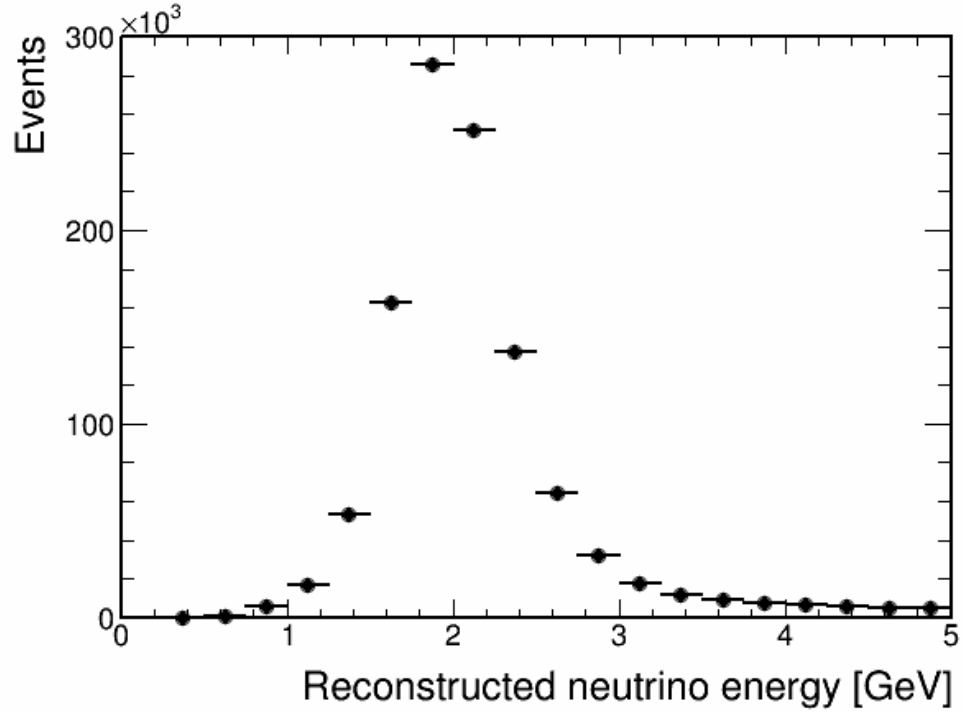


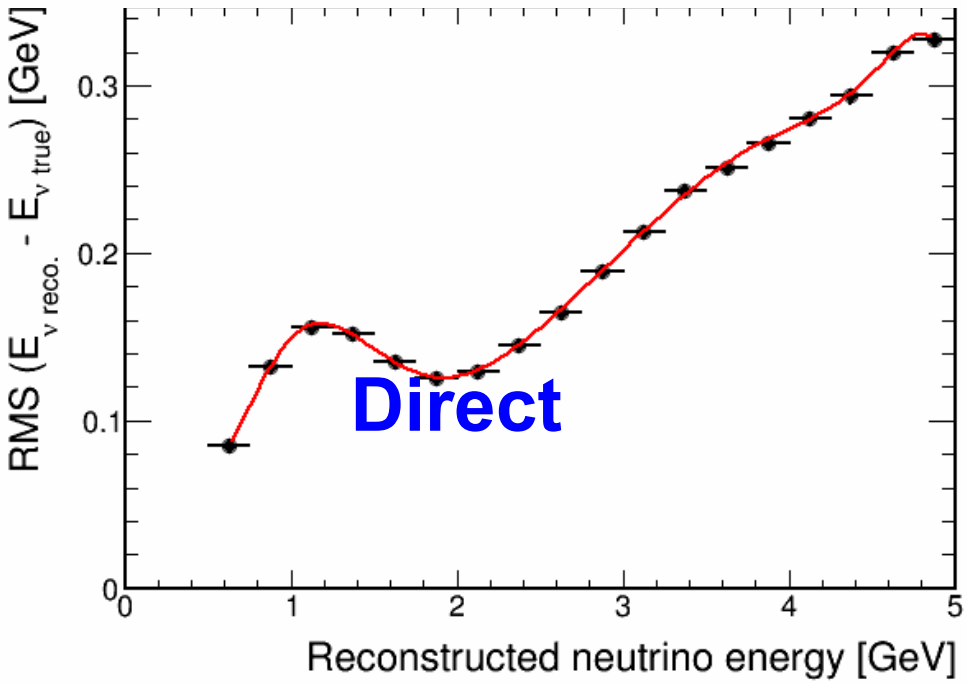


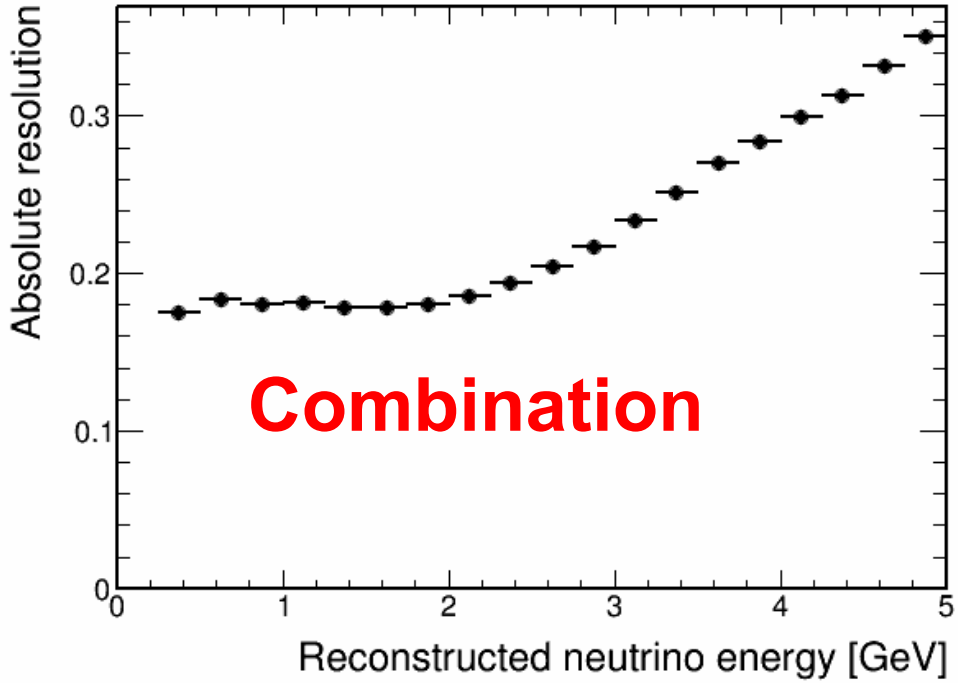




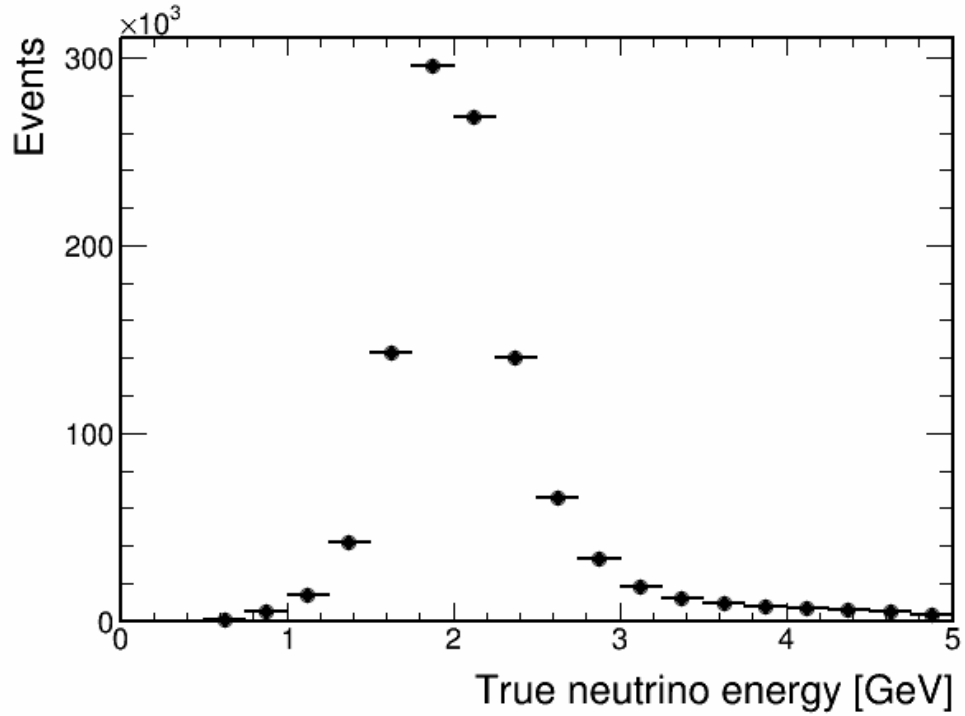
Neutrino energy resolution

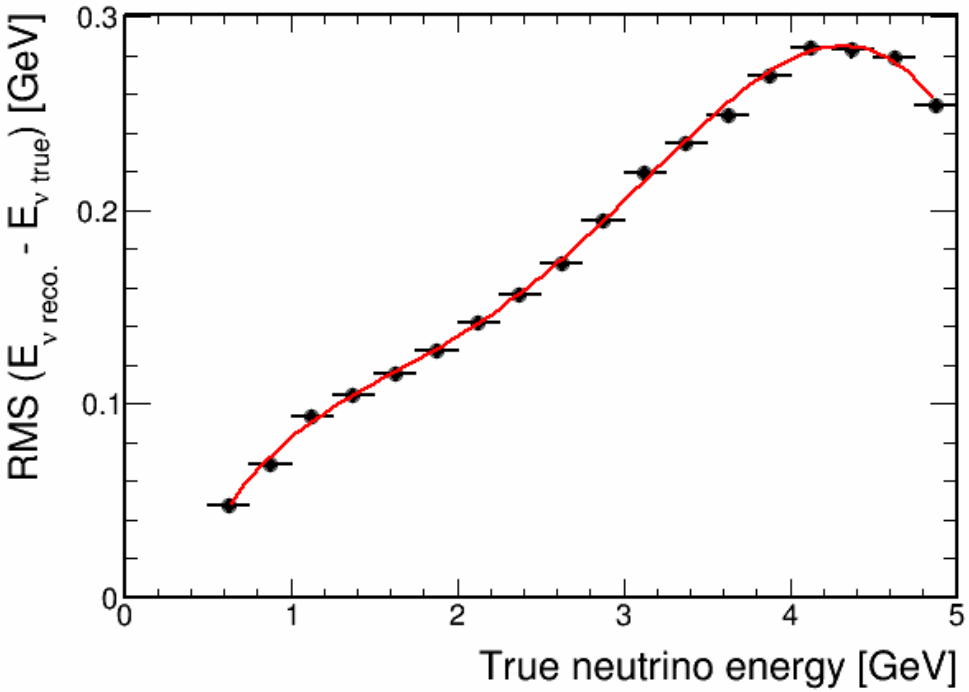


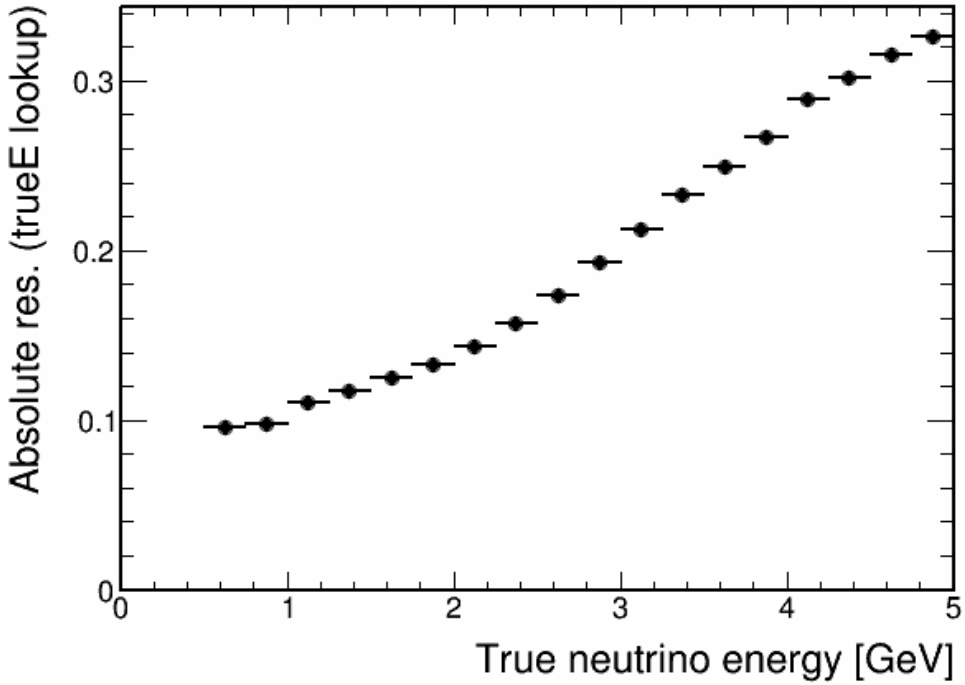




True neutrino energy resolution







Neutrino energy resolution