

MaCh3 Summer 17 OA

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for the MaCh3 group

Oscillations at T2K

- Standard PMNS oscillations apply to mass eigenstates as:

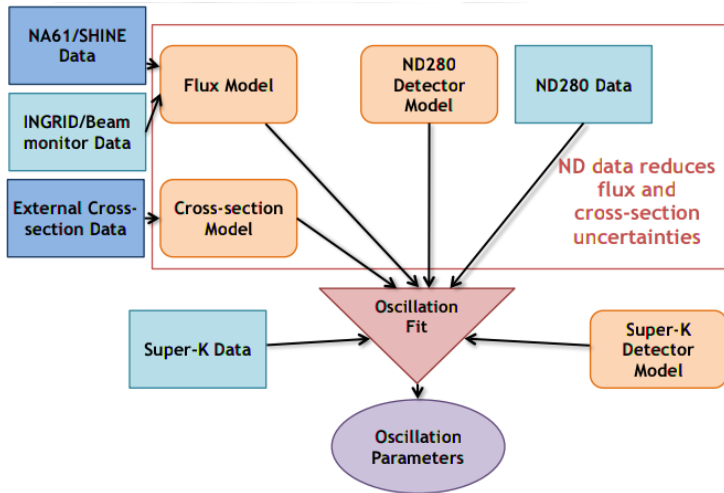
$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{pmatrix} \begin{pmatrix} c_{13} & 0 & s_{13}e^{i\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{-i\delta} & 0 & c_{13} \end{pmatrix} \begin{pmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

- T2K sees disappearance of ν_μ , appearance of ν_e and equivalents for antineutrino
- Gives sensitivity to $\sin^2(\theta_{23})$, $\sin^2(\theta_{13})$, Δm_{23}^2 and δ

MaCh3 introduction

- ▶ MaCh3 is a Bayesian Markov Chain Monte Carlo (MCMC) oscillation fitter
- ▶ Performs MCMC integration to give the posterior probability
- ▶ Choose to fit ND280 and SK simultaneously

What goes into an oscillation fit?



K. Duffy

Updates for Summer OA

- ▶ SK data: Use full Run 1-8 SK data for all 5 samples
 - All analyses fitting in E_{rec} for ν_μ and 2D for ν_e
- ▶ ND280 data: No new data, but new RHC binning
- ▶ New SK reconstruction using fitQun
- ▶ New xsec model

fitQun

- ▶ SK reconstruction with significantly lower mis-ID probability
- ▶ Available for all samples used in OA fit

Maximize:

$$L(\mathbf{x}) = \prod_j^{unhit} P_j(unhit|\mathbf{x}) \prod_i^{hit} \{1 - P_i(unhit|\mathbf{x})\} f_q(q_i|\mathbf{x}) f_t(t_i|\mathbf{x})$$

Track parameters:

particle ID
vertex
direction
momentum

Probability of i^{th}
PMT registering a
hit

Probability of
observing charge
 q at time t in i^{th}
PMT

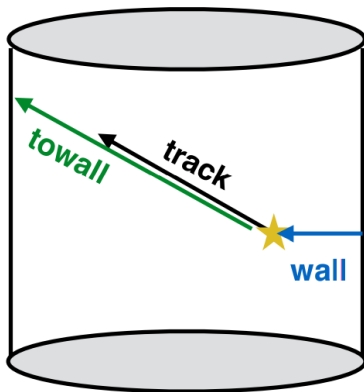
A. Missert

fitQun: Fiducial volume

- ▶ Much lower mis-ID probability allows fiducial volume (FV) to be expanded
- ▶ Optimise 2 variables cut values based on:

$$\sum_i^{\text{bins}} \frac{\left(\frac{dN_i}{d\theta}\right)}{N_i + (\sigma_{\text{syst}}^2)_i}$$

- ▶ Results in 20% larger FV with more events around oscillation max. energy



A. Missert

New xsec model (2017b)

- ▶ Large changes made to this year's cross-section model:
- ▶ Removal of E_B dial
- ▶ 2p2h uncertainty treatment
- ▶ Change to RPA treatment

$$E_B$$

2p2h

BeRPA

Validation progress

- ▶ All of the above changes implemented in MaCh3
- ▶ Event rates validated against p-theta

Validation progress

- ▶ Systematic variations also compared to p-theta

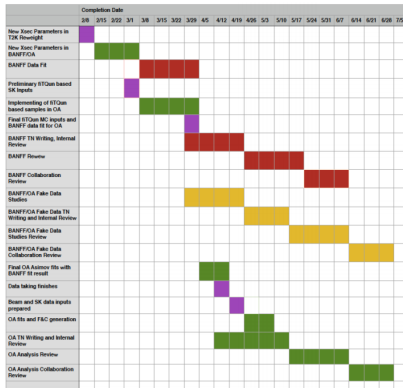
Asimov fits

- ▶ Hot off the presses!
- ▶ woRC Asimov A ($\delta = -1.601$, $\sin^2(\theta_{23}) = 0.523$)

Asimov fits: Comparison with p -theta

Timeline

- ▶ Targeting EPS-HEP: July 5-12
- ▶ Currently on time (just)



Conclusions



Backup