Studying the impact of neutrino cross-section mismodelling on the T2K oscillation analysis

Poster #48

T2K Oscillation Analysis

T2K oscillation analysis aims to extract oscillation probability from a rate of event in the Super-K detector.

Need to modelize neutrino flux and interaction.

Cross-section — Osc. Probability

$$N^{FD}_{\nu_\beta}(E_\nu) = \boxed{\Phi^{FD}_{\nu_\beta}(E_\nu)} \times \boxed{\sigma^{FD}_{\nu_\beta}(E_\nu)} \times \boxed{\varepsilon^{FD}(E_\nu)} \times \boxed{P_{\nu_\alpha \to \nu_\beta}(E_\nu)}$$

Flux — Det. Efficiency

External data

Build some flux and cross-section models with external data sets (NA61/SHINE, MINERvA, MiniBooNE…)

ND280 data

Constrain those models with un-oscillated neutrino data at the near detector

Super-K data

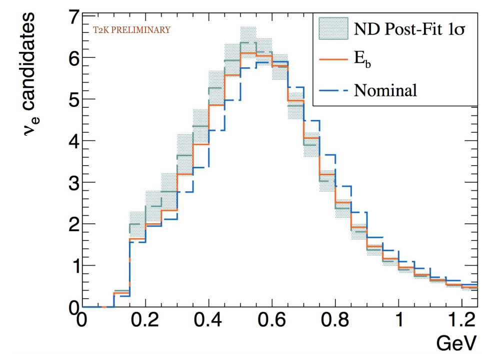
Fit those models to the Super-K data to extract the oscillation parameters of interest : θ_{23} Δm^2_{32} θ_{13} δ_{CP}

How to evaluate ?

Cross-section mismodelling could introduce biases on the final values of oscillation parameters.

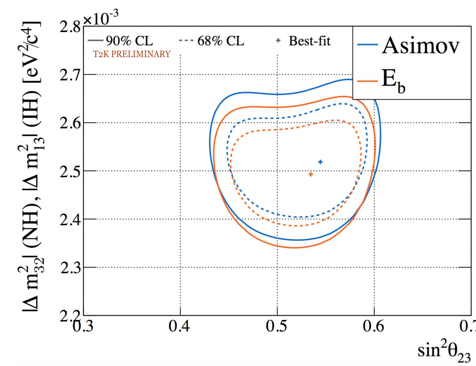
➤ **Need to evaluate this**

1) Build simulated data at ND280 and SK with alternative models.



2) Fit at ND280 with nominal model.

3) Propagate at SK and fit SK simulated data.



4) Compare the result with a fit to the nominal MC.

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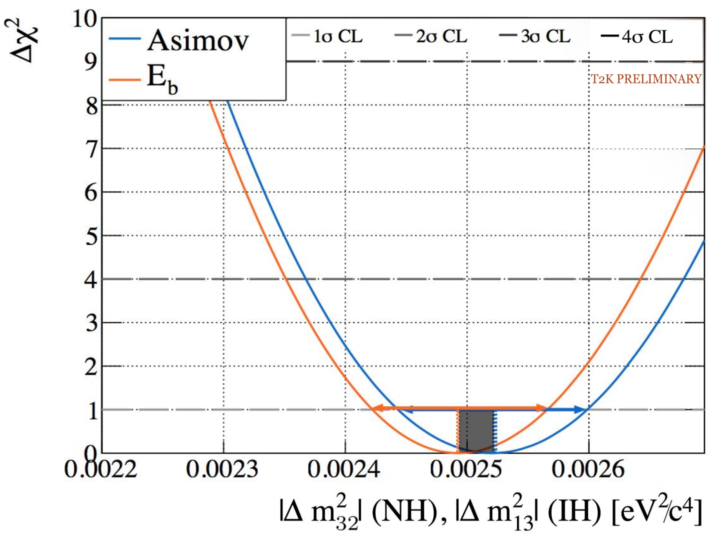
What's the impact on the analysis ?

We can quantify this effect by comparing 1D oscillation parameters likelihood curves.



$$\text{bias} = \frac{\text{mean}_{\text{SD}} - \text{mean}_{\text{MC}}}{\sigma_{\text{MC}}}$$

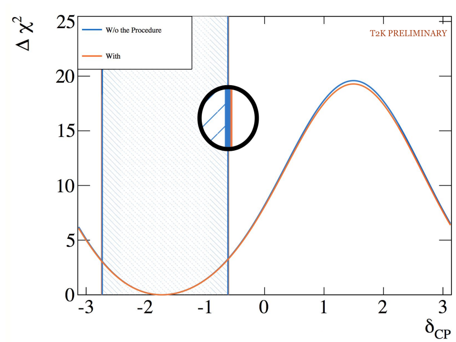
We get bias for all the alternative models and oscillation parameters.

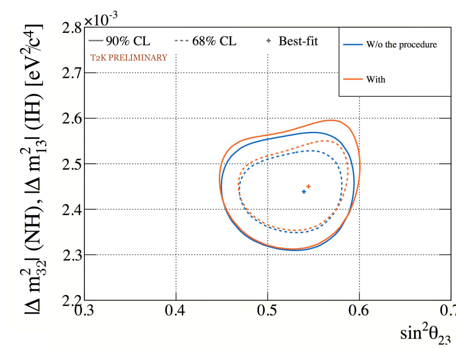
We can define if biases are acceptable.

An additional uncertainty

The biases being too large, defined a procedure based on the results of the study to have an additional uncertainty.

- ➤ Additional parameter being able to absorb shape effects.
- ➤ Smearing of the oscillation parameters likelihood.





This additional uncertainty impacts mainly the disappearance parameters θ_{23} Δm^2_{32}