ν_e-Bar Appearance at T2K with VALOR

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On behalf of the T2K collaboration

Outline

Presented here are studies performed to study the effect of sampling of the nuisance parameter space to generate a distribution of the test statistic given the null hypothesis of no ν_eBar appearance

P Value:

The probability to make a measurement as or more extreme than seen in data given the null hypothesis is true.

Null Hypothesis:

No ν_eBar appearance (β = 0)

($P_{osc}(\nu_\mu Bar \rightarrow \nu_e Bar) = \beta\ P_{osc}(PMNS)$)

P Value

(1) Generate a fake data set T for null hypothesis

(2) Compute test statistic S for T

(3) Fill distribution with ensemble of statistics S_i

(4) Calculate data statistic S_D

(5) Compare S_D with S_i

Priors: Asimov:

Parameter(s)	Prior	Range
$\sin^2\theta_{23}$	uniform	[0.3; 0.7]
$\sin^2 2\theta_{13}$ ($\sin^2\theta_{13}$) reactors	gauss	0.085 ± 0.005
$\sin^2 2\theta_{12}$	gauss	0.846 ± 0.021
$\lvert\Delta m^2_{32}\rvert$ (NH) / $\lvert\Delta m^2_{31}\rvert$ (IH)	uniform	$[2; 3] \times 10^{-3}$ eV^2/c^4
Δm^2_{21}	gauss	$(7.53 \pm 0.18) \times 10^{-5}$ eV^2/c^4
δ_{CP}	uniform	$[-\pi; +\pi]$
Mass Hierarchy	uniform	0.5 for NH and IH

T2K Run1-4 Best fit + 2015

T2K

- Long baseline ν oscillation experiment
- 4 sample fit (e-like/μ-like ν/νBar)
- Flux and x-sec constrained by ND

- Oscillation parameters = nuisance
- e-like/μ-like ν and μ-like νBar constrain nuisance parameters
- ND fit -> Prior for Super-K fit
- Nuisance marginalised out

Q: What are the variations of my null?

Rate only analysis

"Data" = Asimov (MC) data

(1) Throw expectation T_{exp} from priors (nuisance parameter fluctuations)

(2) Likelihood weight $L = L(T_{data}|T_{exp})$

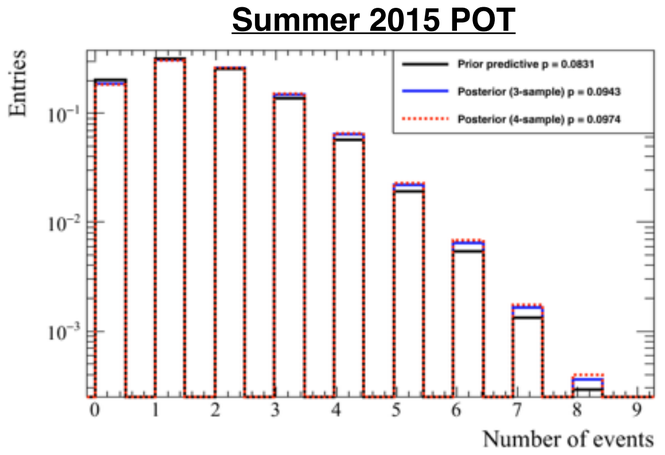
(3) Statistical fluctuation of T_{exp}: T_{obs}

(4) Distribution: 10k T_{obs} from 100k T_{exp}

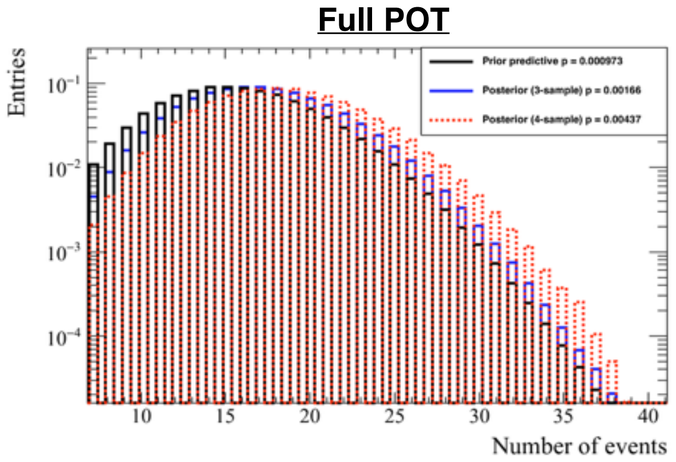
(5) T_{obs} weighted by L

Statistic: #Events in ν_eBar sample

Summer 2015 POT



Full POT

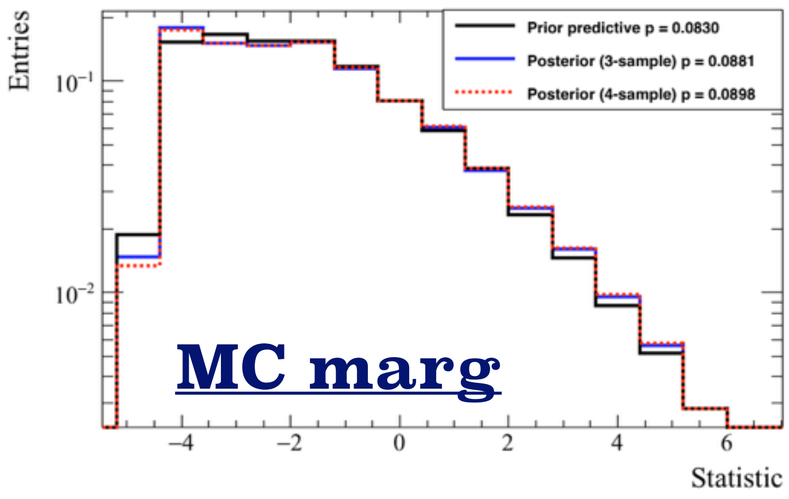


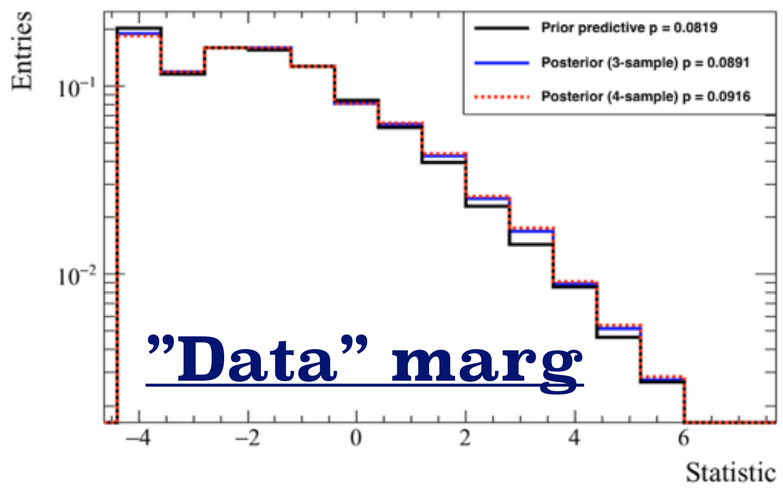
Rate + shape

"Data" = Asimov (MC) data

- Test: same as rate-only
- Toy weight from real data
- Marginalisation penalty?
  - "Real data"
  - MC throw data (T_{data})

Statistic: $\Delta\chi = \chi^2(\beta{=}1) - \chi^2(\beta{=}0)$ (marginalised)





Summary

- Little effect with current statistics
- Significant at larger POT
- νBar e-like posterior = conservative

References

- physics.rockefeller.edu/luc/proceedings/phystat2007.pdf
- https://arxiv.org/abs/1605.01626 - NuFact2015 K. Duffy