

A New Oscillation Fitter

Tom Junk, Tingjun Yang
Fermilab

Code can be found in the `dune1bl` repository

`lfit/lfit.C`

`lfit/lfit.h`

An example which reads in Tingjun's trees is available on request and will be checked in when I get the normalizations right.

Features

- Uses the oscillation model Prob3++
- User inputs for each channel ("sample" in some parlances – may change the name if there's enough user demand)
 - Detector efficiency histograms (1D as functions of true neutrino energy)
 - Flux histograms (1D, as functions of true neutrino energy) and a POT number
Flux models are specified by channel because some channels are FHC, others RHC, and it's not clear each sample will have the same exposure. Certainly the different FD modules will come online at different times and detector characteristics may change over time, requiring definition of new channels.
 - Cross Section histograms by neutrino species and contribution type
 - Ereco (2D for now) histograms. Ereco vs. Etrue put in. Considering 3D – Ereco vs MVA vs. Etrue. Maybe not needed. Hard to validate a 3D histogram.
 - Background histograms are separate
 - No assumption that NC is equal for all neutrino species
- Channels are grouped into detector models
 - detector model specifies an oscillation model.
 - no oscillation
 - Barger propagator
 - todo: atmospheric oscillation model
 - combining atmospherics and beam samples requires defining instances of the detector model as the oscillation model is different
- A fit model consists of a set of detector models and a list of parameters to fit.
MINUIT is used to fit.
For the case of Mass Hierarchy, two fits are done and the best fit is kept. You don't have to let MH float in the fit, though, it is an option. TODO– allow for unequal priors for the two MH values.

Features

Systematic uncertainties

- Expressed as alternative histograms, for each named nuisance parameter and for each value of the variation. Tevatron: used to have just "up" and "down" uncertainties. Now you can have a whole list: -2, -1.7, -1.5, 0, 1, 2 sigma variations in a list for each uncertainty.
- Interpolation is done with a cubic spline in each bin of
flux
efficiency
cross section
ereco
- Lots of printout and plots:
All input histograms can be plotted to check
Ratios of unvaried to varied systematics
- Asimov and Poisson pseudodata generation.
With and without systematic variation
And of course experimental data
- Nuisance parameter variation
Central constraints arbitrarily specifiable (a la LHC fits)
Gaussian prior (for now) – todo: beta, custom priors.
NP constraints – some NP's might be functions of other NP's: todo.