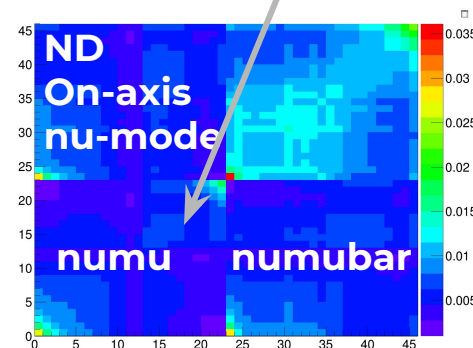
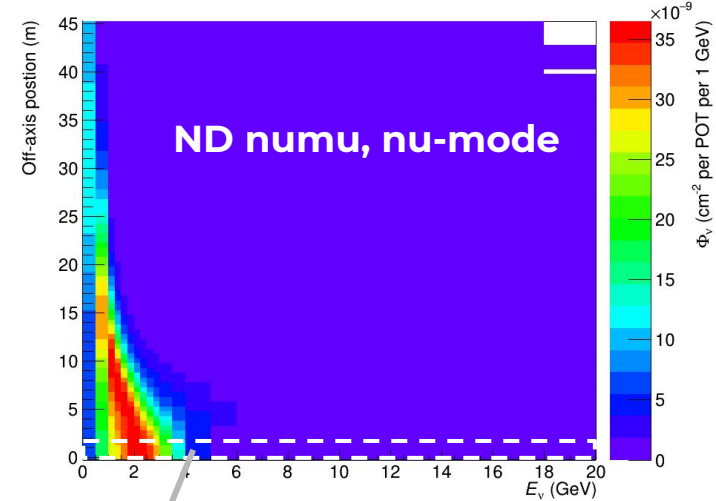


Off-axis Flux Uncertainties

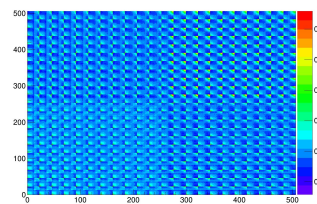
Luke Pickering
Long Baseline Physics
2018-10-22

Off-axis Flux Predictions

- For any analysis including off-axis positions, need new correlated flux uncertainties.
- Can introduce very many columns to flux matrix:
 - E.g. 20 energy bins, 50 cm flux windows, 0-33 m, 4 species, 2 beam modes, + FD: ~10kx10k flux matrix.
- 'Standard' procedure is to distribute flux matrix and let analysers choose how to use:
 - Prior-constrained energy bin weights
 - Effect flux parameters from matrix decomposition.

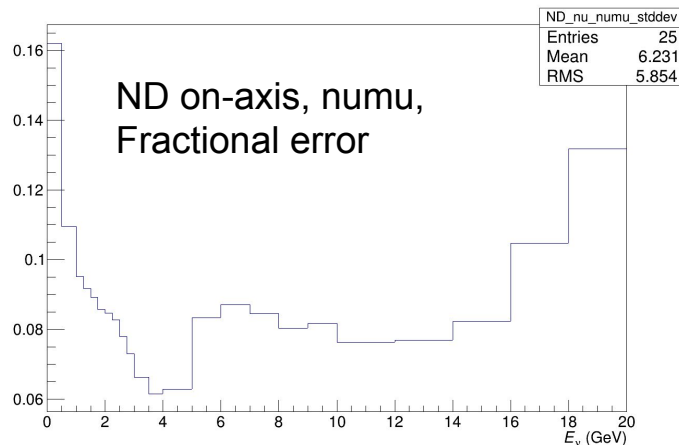
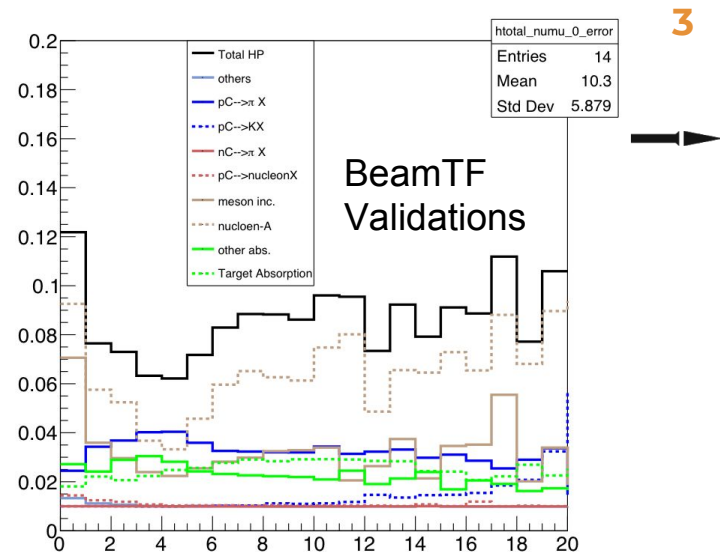


ND, nu-mode,
Numu, numubar,
0-33 m



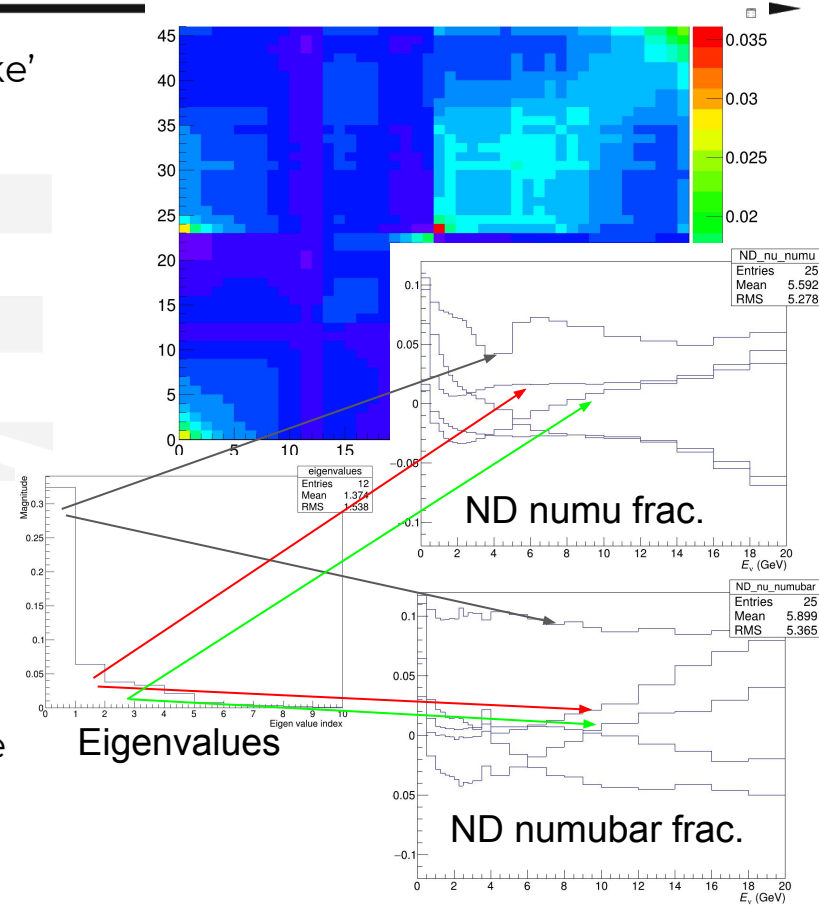
Since last time: PPFX

- Previously shown off-axis flux errors from three most important focussing sources.
- PPFX, used for hadron-production uncertainties had not been updated to work with the Nov2017Engineered geometry.
- Got the soon-to-be-committed code from A. Bashyal, so now have PPFX universe weights for hadron-parents.
 - Preliminary low-stats comparisons look like I'm using them sensibly.

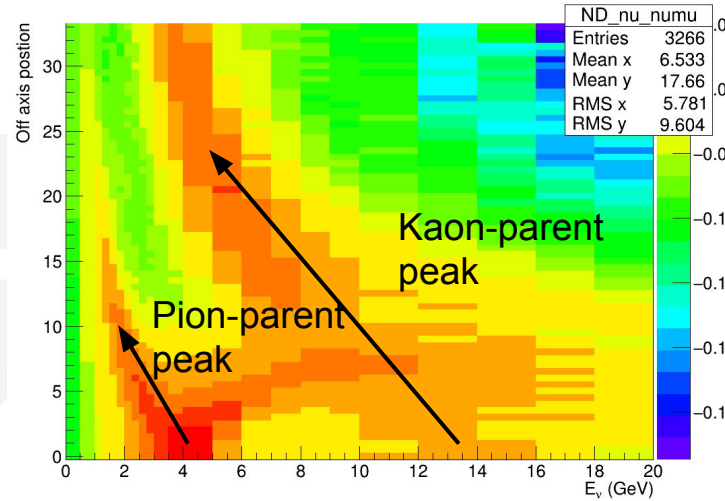


My Idea for Error Distribution v2

- Not $N_k \times N_k$ DOF in beam simulation: Making up 'fake' DOF by putting all bins in as parameters.
- Dealing with $N_k \times N_k$ matrix in fitters is not feasible:
 - Standard decomposition techniques take $O(\text{hours})$ to decompose.
- 'Power iteration' techniques find most important X eigenvalues and associated eigenvectors.
 - Can set minimum total variance retained limit to choose X , $\text{Sum}(\text{Eval}) = \text{Trace}(\text{covmat})$.
 - Distribute just the pre-decomposed $\text{sqrt}(\text{eval}) * \text{evec}$ -- become X uncorrelated effective flux parameters.
 - These are 'easy' to intuitively look at, unlike the full flux matrix.



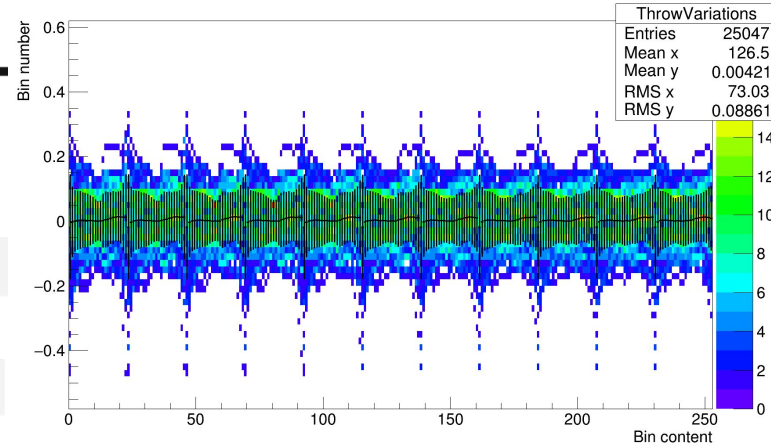
Example: PPFX-only



- Part of the Eigenvector of largest Eigenvalue for ND numu, nu-mode.
- Will get a part for each detector/beam-mode/species.
- Each tied to the same eigenvalue, when moving Eff Param 1, must apply all of the relevant weights.

Gaussianity

- Covariance matrix inherently gaussian.
- Multi-universe weights need to make ~gaussian responses in flux bin content.
- How to handle discrete errors: e.g. HC?
 - No need to put in covmat and take out again (but doing so ensures uncorrelatedness of all flux parameters)
 - Can generate $\pm 1,3,5$ 'sigma' predictions, using standard math will take gaussian approximation of the response.
 - Can handle discrete errors separately in fitters with interpolated $\pm 1,3,5$ 'sigma' predictions,



//TODO

- Throw other focussing/alignment uncertainties.
- Get feedback from BIWG.
- Integrate with CAFAna:
 - They read in pre-decomposed effective uncertainties anyway... so this shouldn't take very long (FLW).

Thanks for listening