DEEP UNDERGROUND NEUTRINO EXPERIMENT

MVA-BASED GLOBES CONFIGURATIONS

Elizabeth Worcester

Long-baseline PWG Meeting

February 27, 2017

Status of MVA-based Sensitivities

- MVA ν_e and ν_μ event selections have been presented/ discussed at long-baseline PWG meetings for the past ~year – see two talks this meeting for latest details
- Output of MVA selection has been used as part of NDTF work to produce sensitivity results using LOAF/VALOR
- LBPWG has not had a simple way to perform sensitivity studies using these results other than LOAF scripting framework
  - Format not standard GLoBES, so not useful to outside/ phenomenology collaborators
  - Lots of files to deal with that are not needed for our purposes
  - We wanted something simple with the same format as our CDR GLoBES configurations

New Work at Hack Days

- M. Bass and E. Worcester
- Write python script to extract GLoBES configurations directly from the FDMC “MVASelection” tree
  - Simple “Draw” commands to create histograms of efficiency and purity for different samples
  - Text parsing to write out GLoBES files in required format
  - Resulting GLoBES configurations have same structure as CDR
- Produce event spectra and CPV/MH fits from resulting GLoBES configurations
- Commit code to DUNE github:
  - https://github.com/DUNE/lblpwgtools

MVA Versions

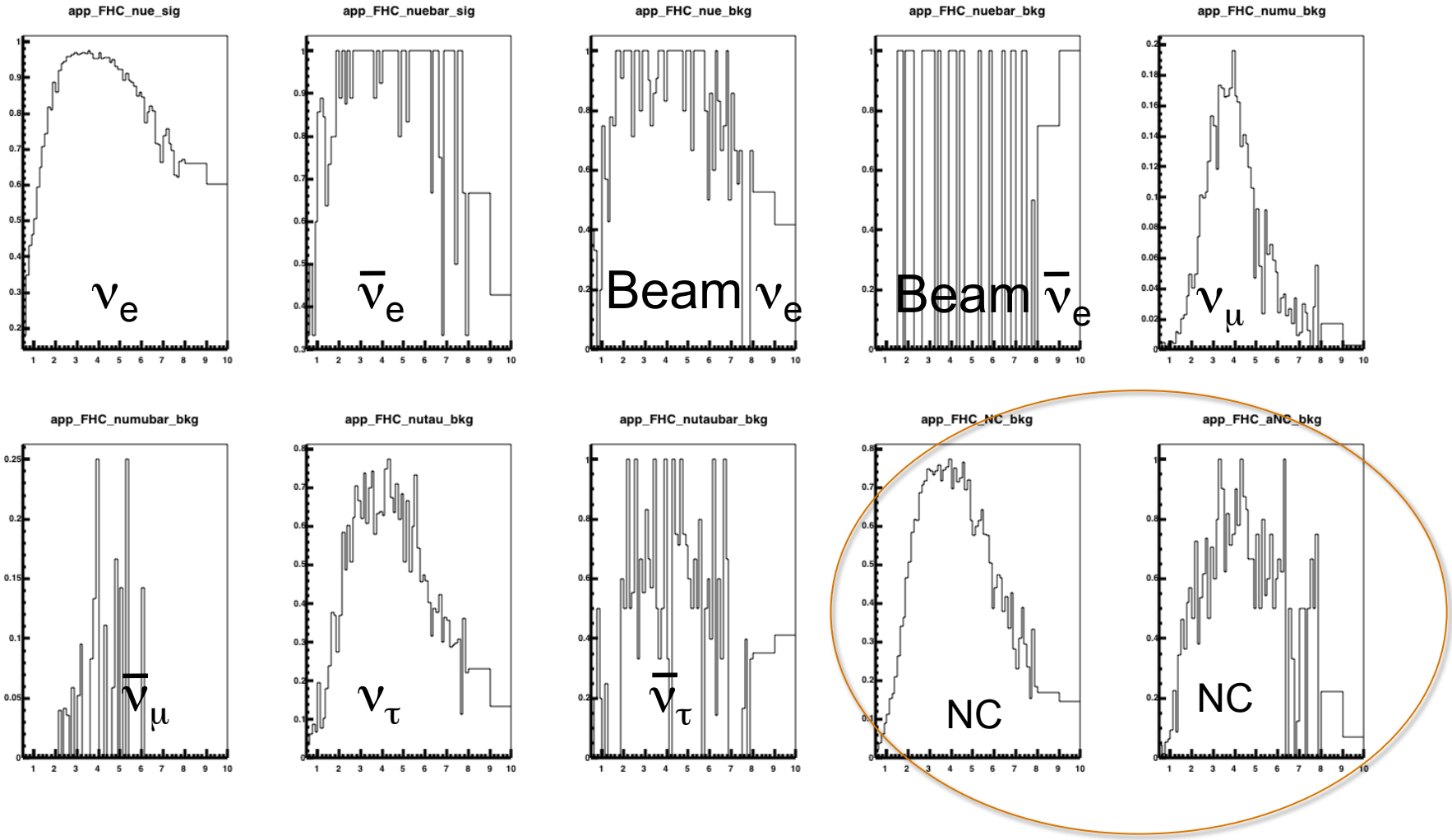
- Work at hack days and most plots here use MVA v2.1
  - MCC7 + Nick's energy reconstruction
  - Generated by Tingjun in preparation for hack days
- Have also looked at v2.2
  - As above but with small bug fix from Tingjun
- And v2.2_3mm
  - As above but with 3 mm wire pitch
- MCC8 (v3) not currently compatible with the energy reconstruction

Efficiencies

- Require MVA result > 0 for both ν_e and ν_μ selections
  - Not currently optimized, easy to choose a different value
- Require MVA result > -1.5 for efficiency normalization
  - Effectively a fiducial cut requiring the neutrino interact in the TPC
- Calculate efficiency as a function of reconstructed energy
- Note low statistics for some less important background and wrong-sign modes. Ok for this level of study. For more detailed studies, would need to run special MC samples to fill out these distributions.

App Efficiency vs Ereco (FHC)

Working plots…



App Efficiency vs Ereco (RHC)

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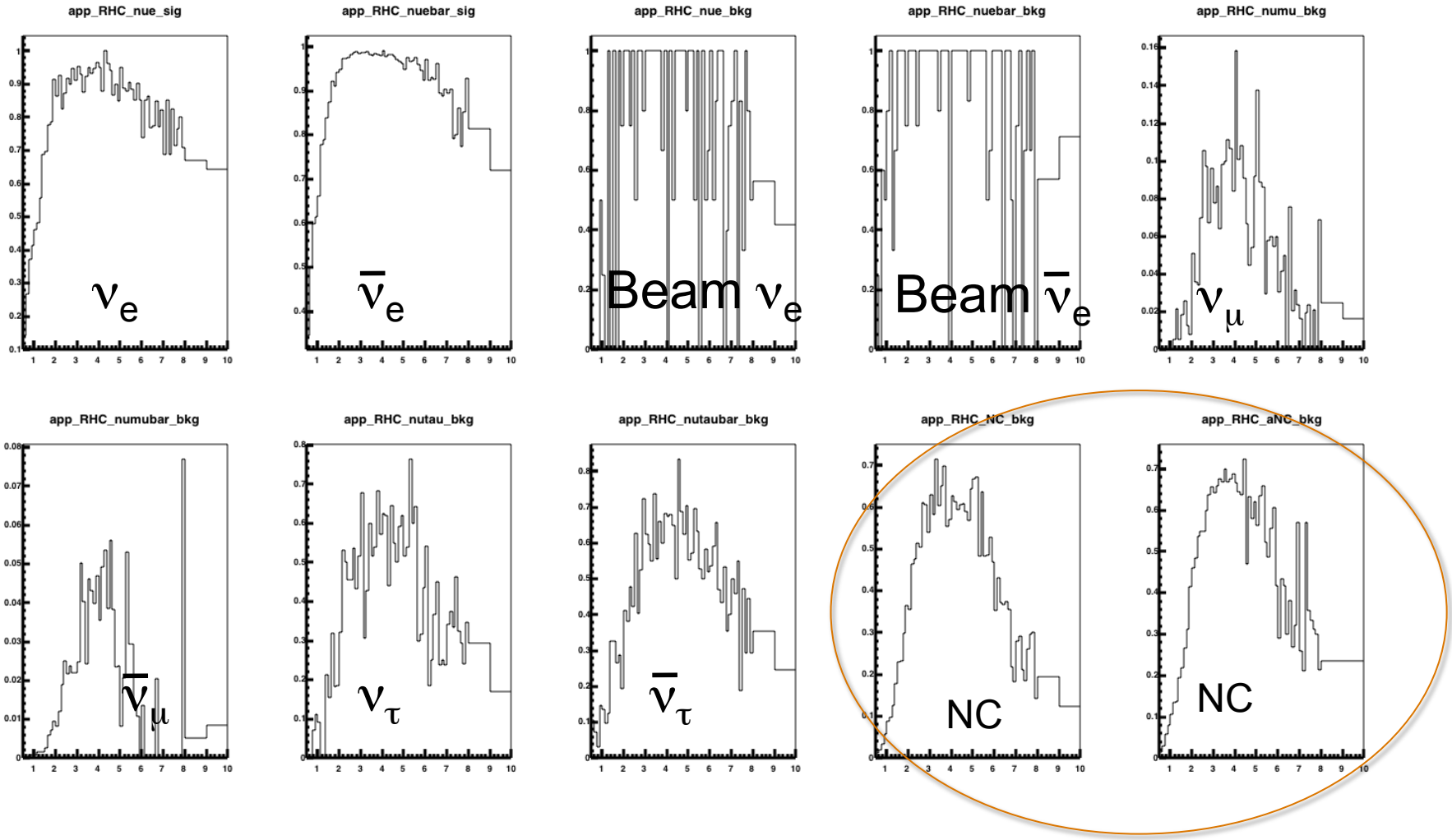
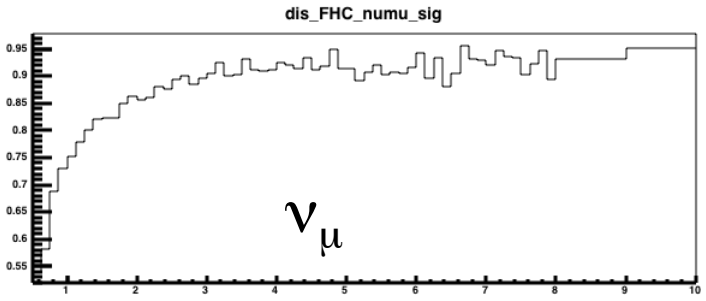
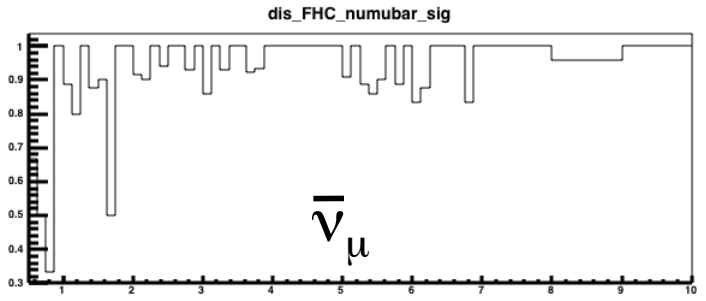
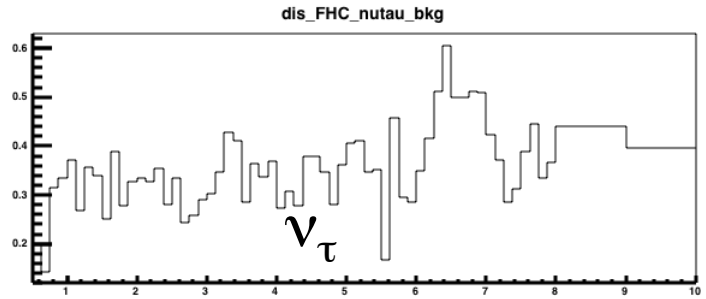


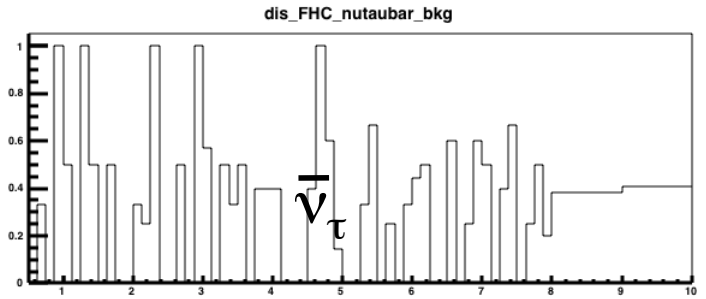
Dis Efficiency vs Ereco (FHC)

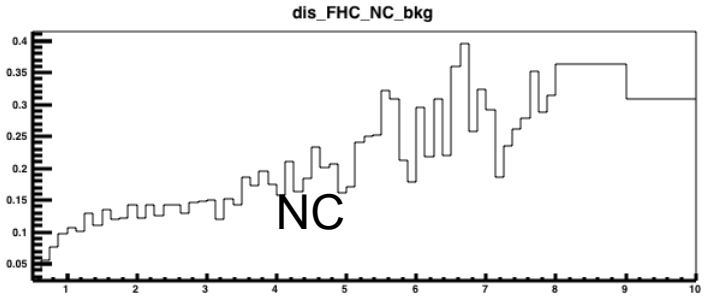
Working plots…

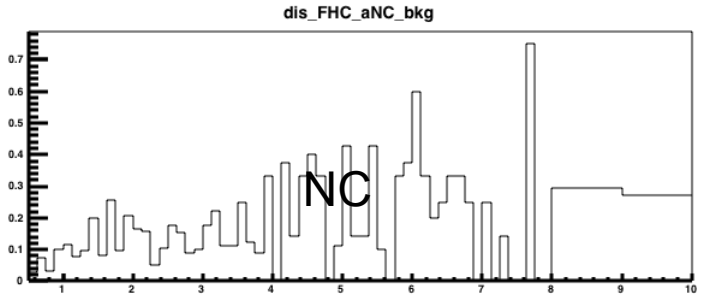












Dis Efficiency vs Ereco (RHC)

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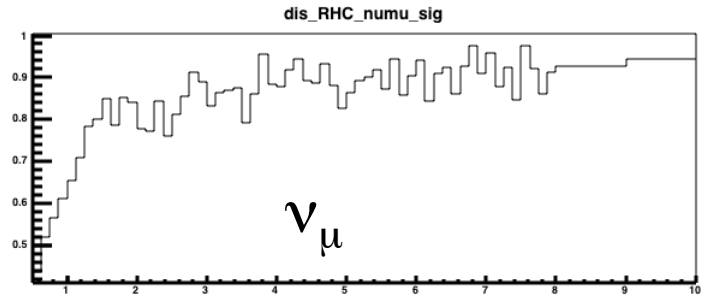
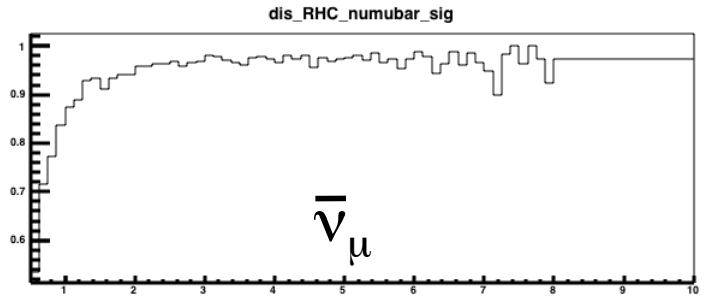
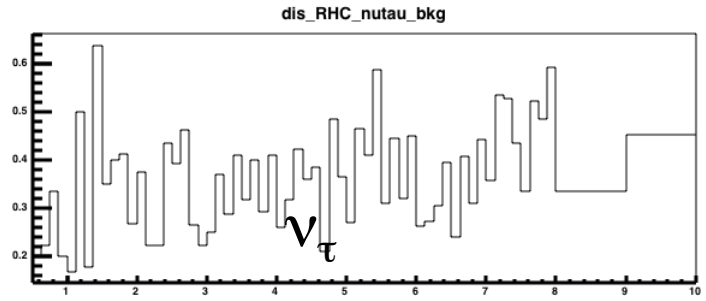
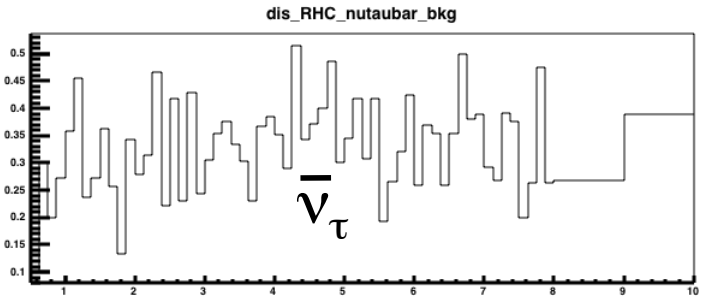
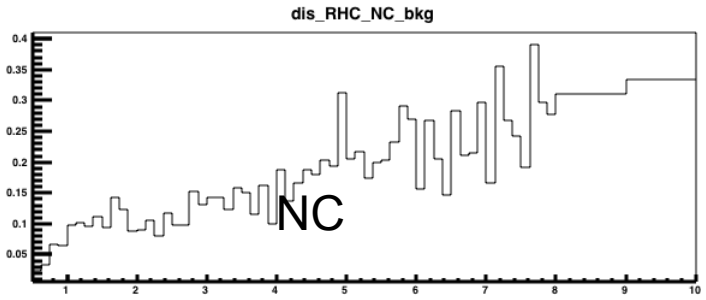
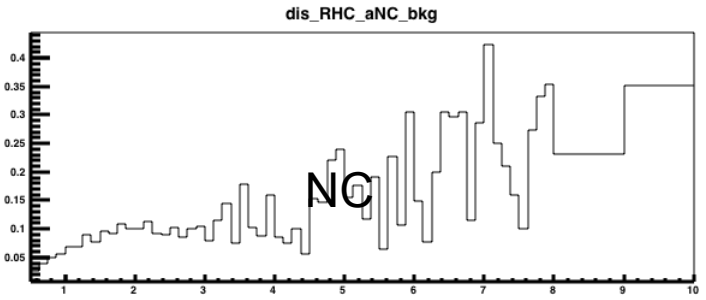






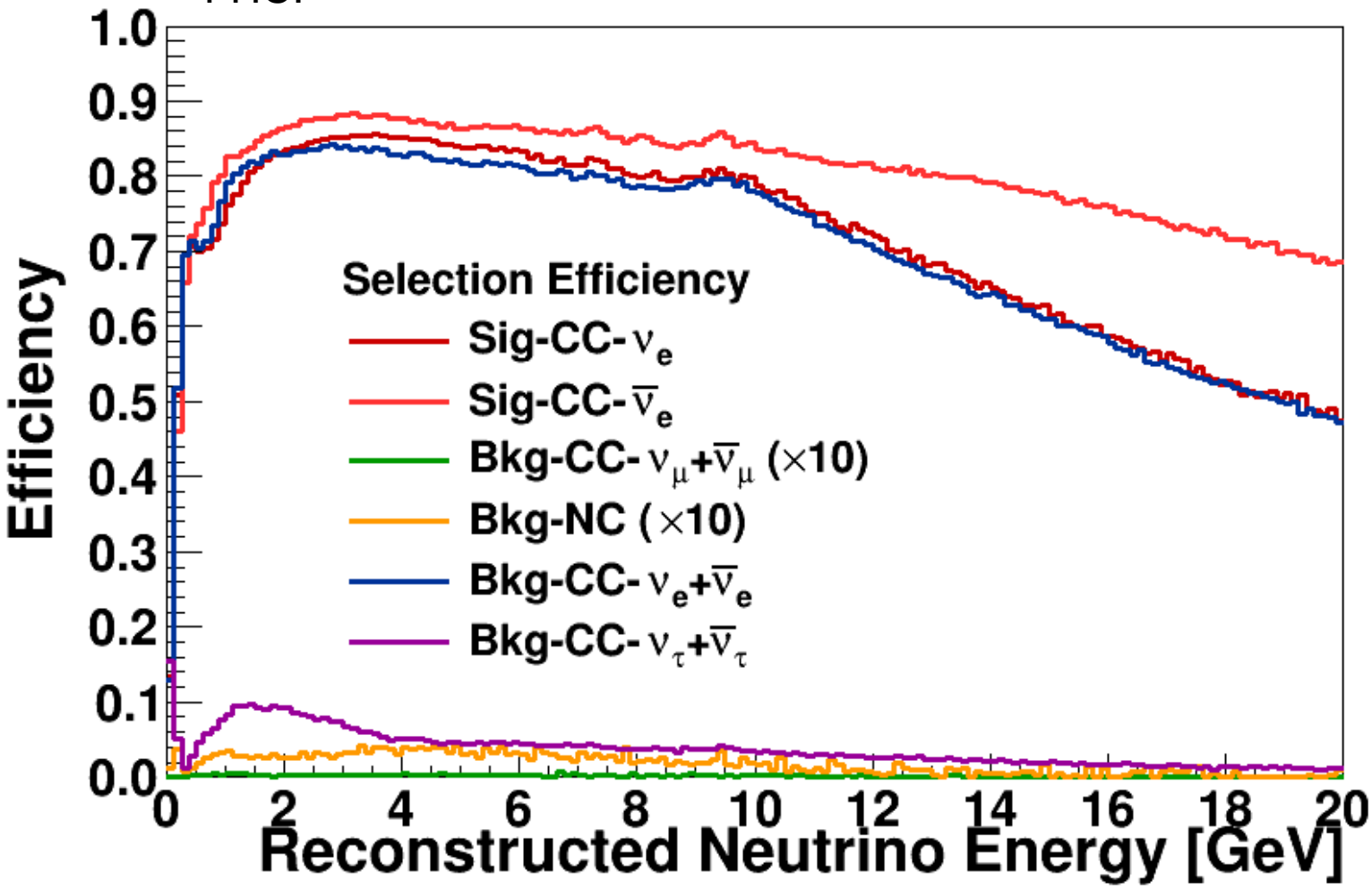






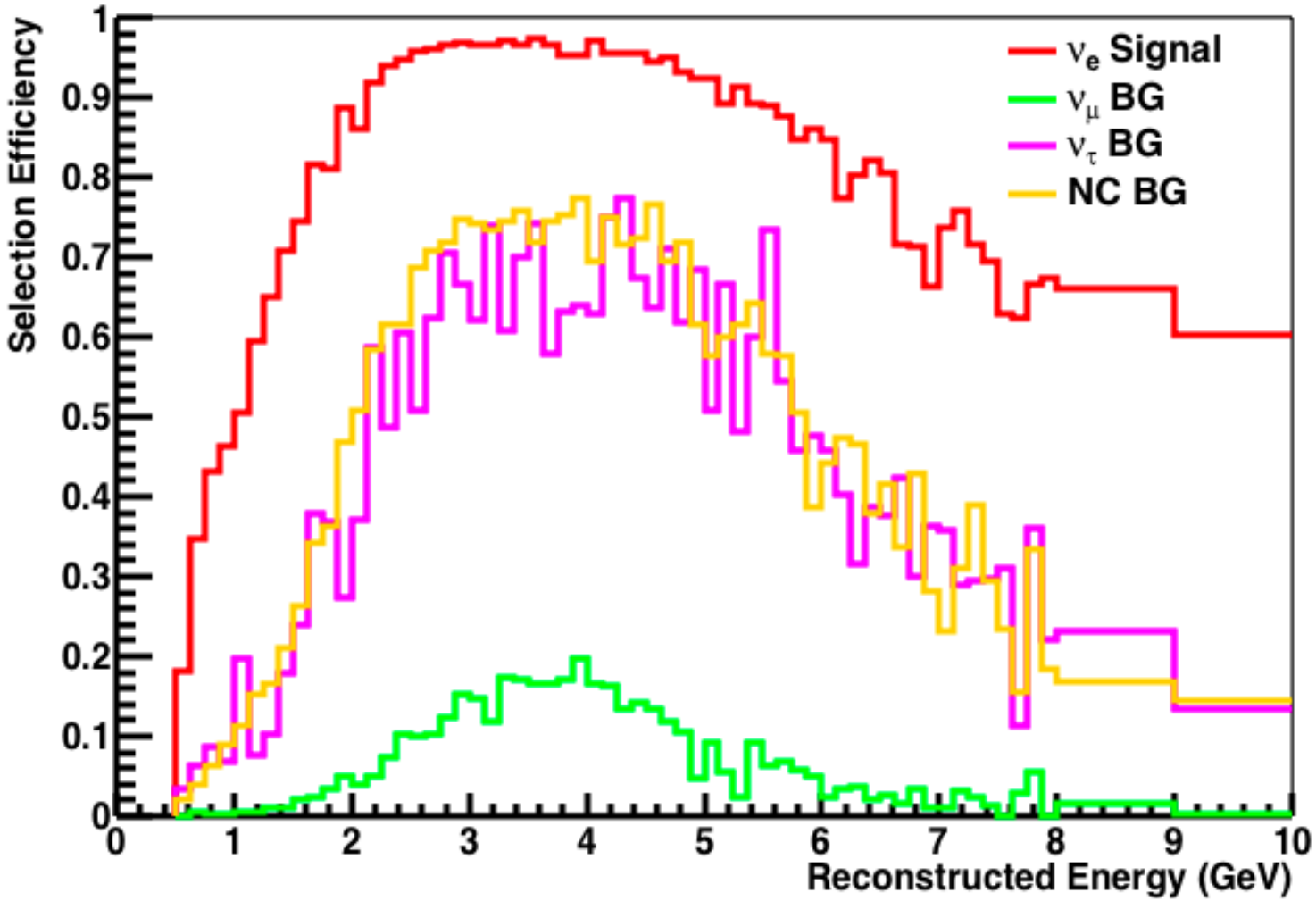
Reminder of CDR Efficiency

FHC:



MVA Efficiency

FHC:



App Smearing (FHC+RHC)

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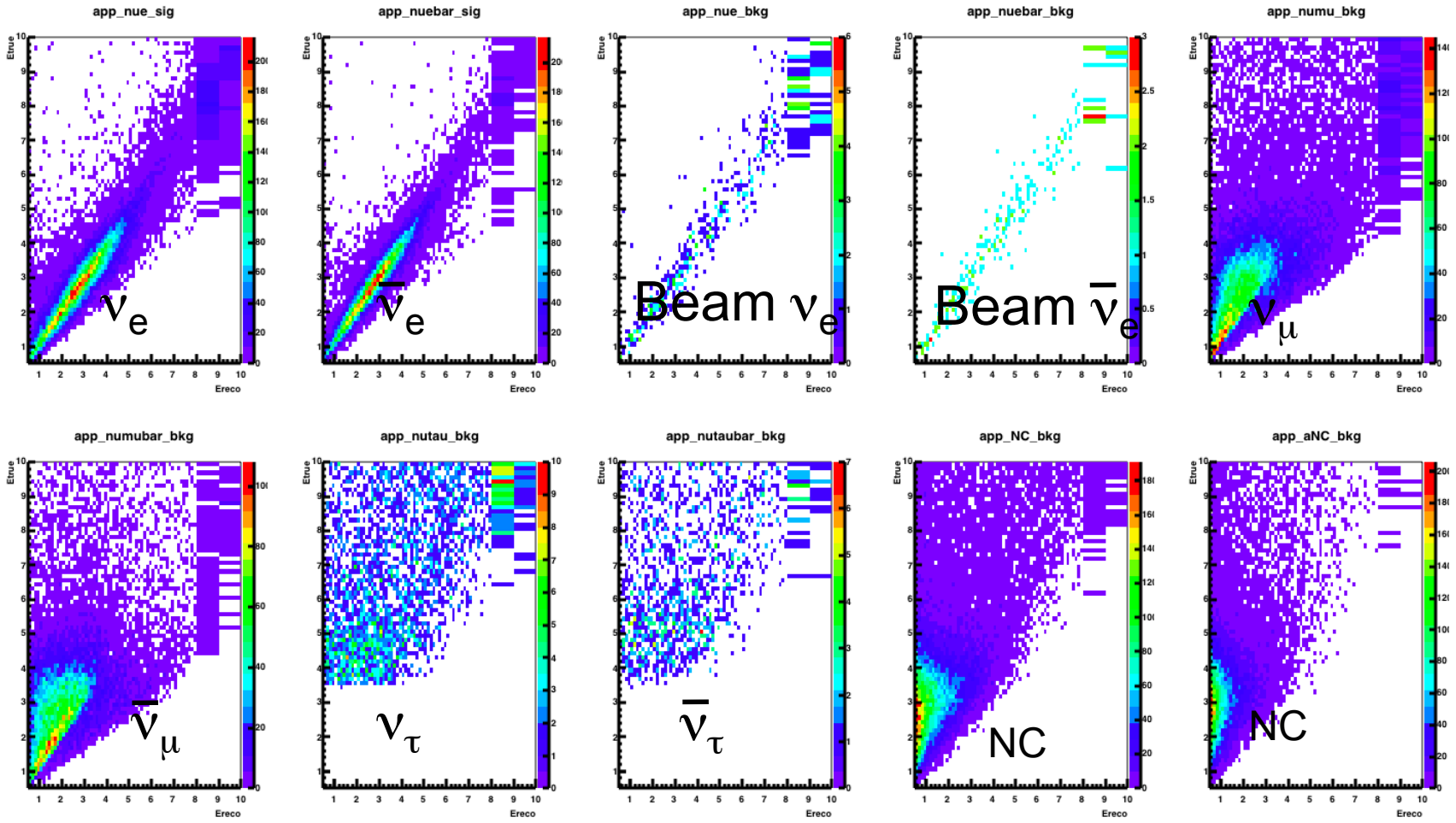
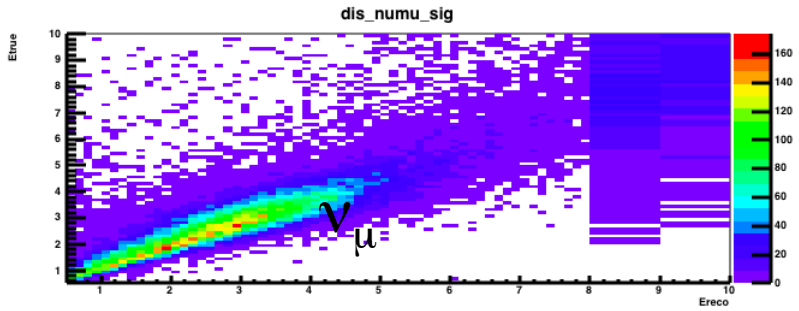
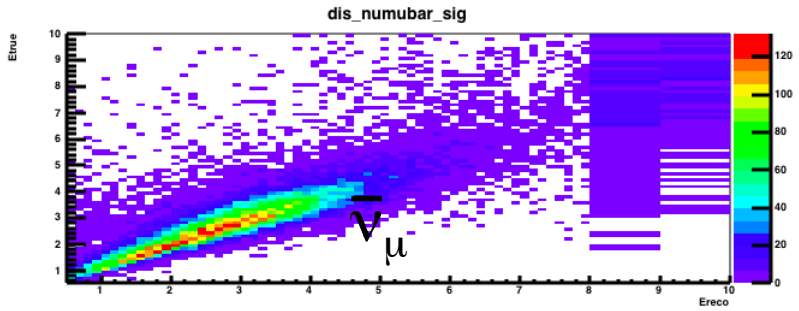
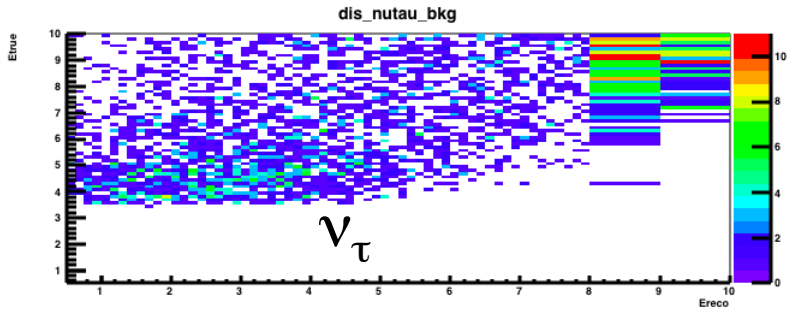
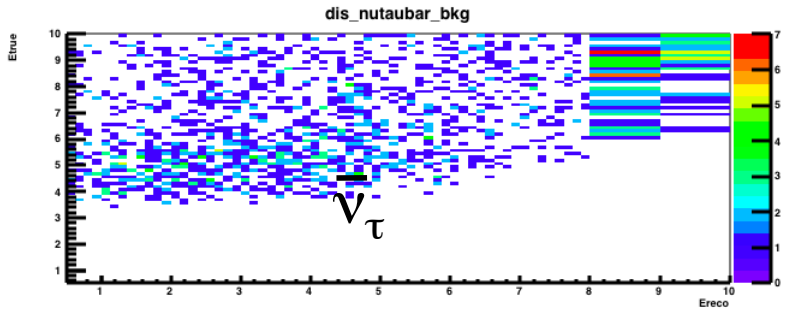


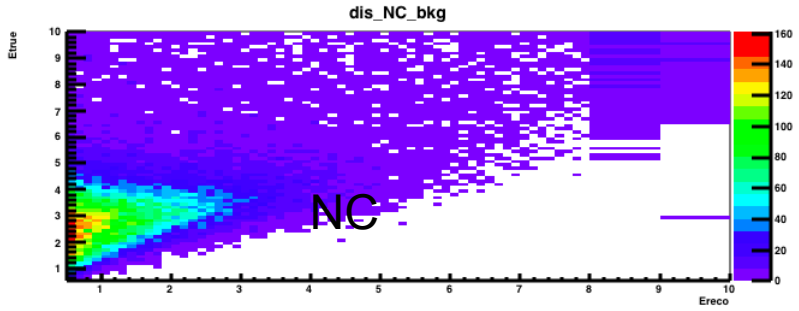
Dis Smearing (FHC+RHC)

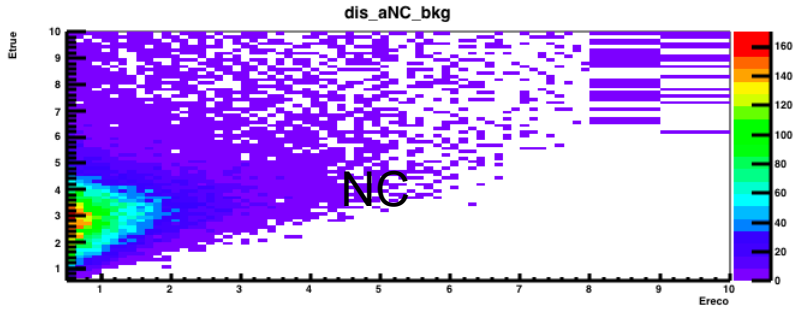












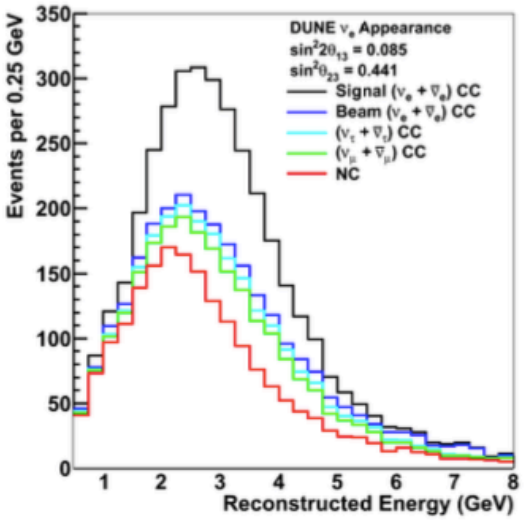
GLoBES Inputs

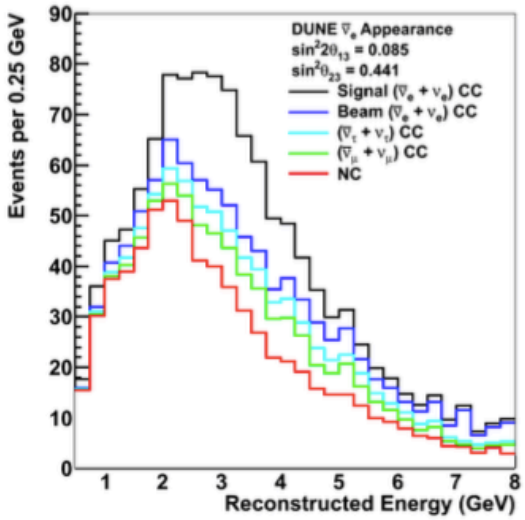
- Efficiencies and smearing matrices directly from MVA as described in earlier slides
- Exposure 3.5 + 3.5 years, 1.07 MW (1.47E21 POT/yr), 40 kt
- Oscillation parameters: NuFit 2016
- Flux: CDR Optimized (identical to CDR)
- Systematics treatment: identical to CDR
  - 2% norm. unc. on ν_e and $\bar{\nu}_e$ (uncorrelated between FHC/RHC)
  - 5% norm. unc. on ν_μ and $\bar{\nu}_\mu$ (uncorrelated between FHC/RHC)

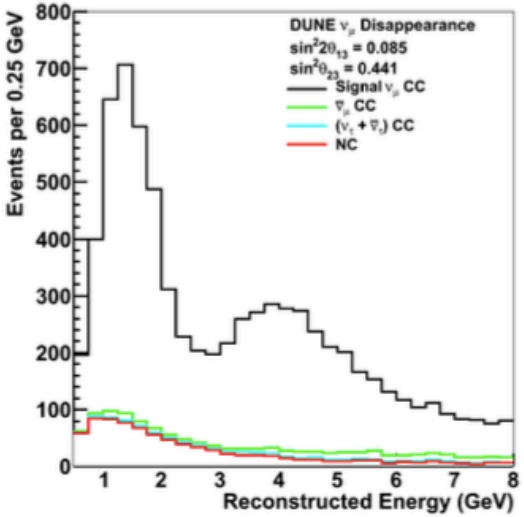
Background	Normalization Uncertainty	Correlations
For $\nu_e/\bar{\nu}_e$ appearance:		
Beam ν_e	5%	Uncorrelated in ν_e and $\bar{\nu}_e$ samples
NC	5%	Correlated in ν_e and $\bar{\nu}_e$ samples
ν_μ CC	5%	Correlated to NC
ν_τ CC	20%	Correlated in ν_e and $\bar{\nu}_e$ samples
For $\nu_\mu/\bar{\nu}_\mu$ disappearance:		
NC	5%	Uncorrelated to $\nu_e/\bar{\nu}_e$ NC background
ν_τ	20%	Correlated to $\nu_e/\bar{\nu}_e$ ν_τ background

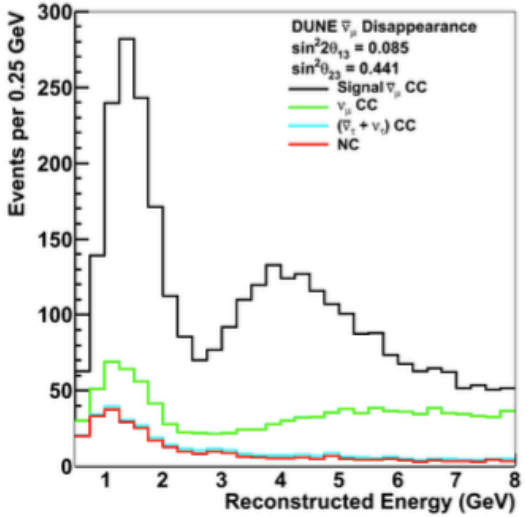
Spectra

V2.1
*Note
stacked
histograms



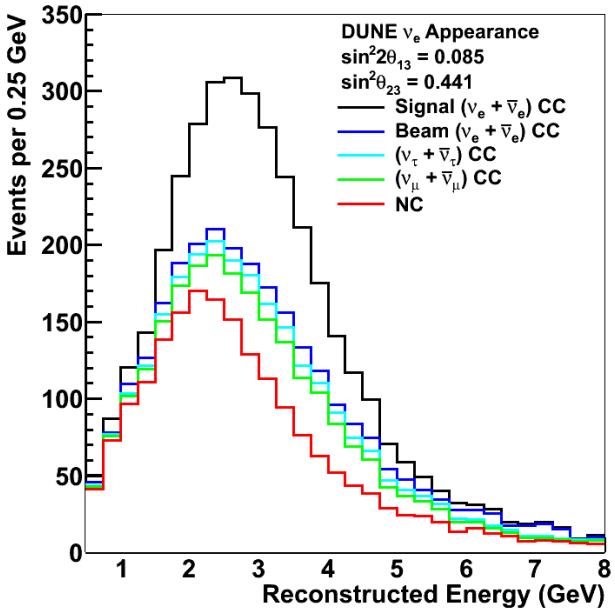




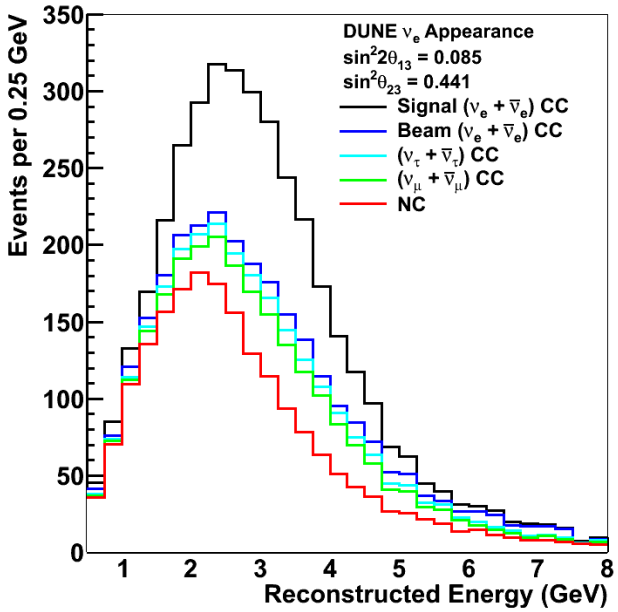


FHC Appearance

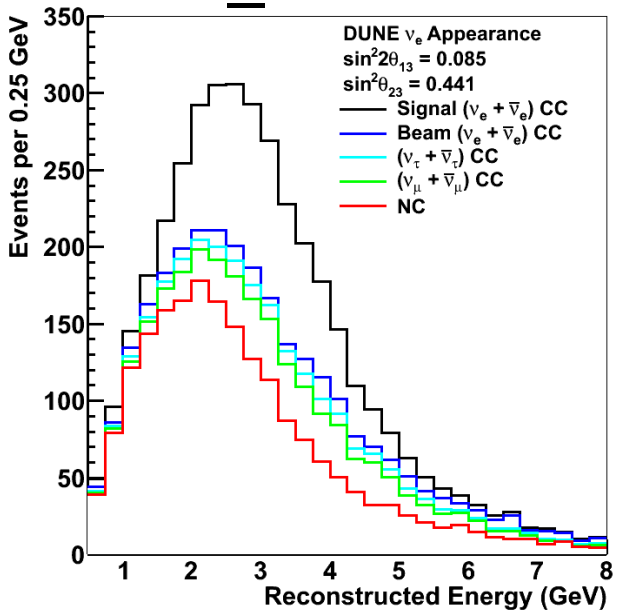
v2.1:



v2.2:



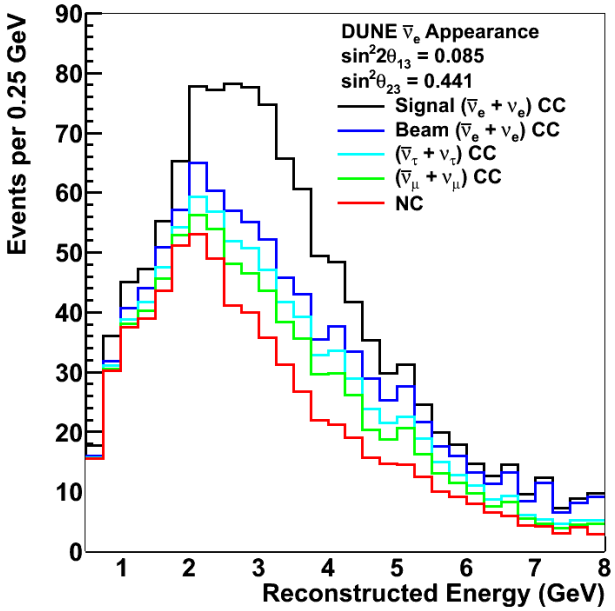
v2.2_3mm:



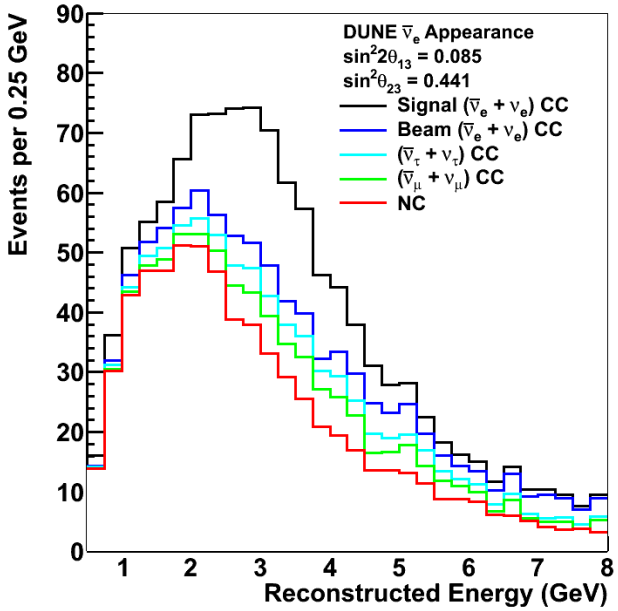
	V2.1	V2.2	V2.2_3mm
Signal	1023	1039	1027
NC	1923	2047	2030
νμ	478	488	503
ντ	135	139	147
Beam νe	228	270	278

RHC Appearance

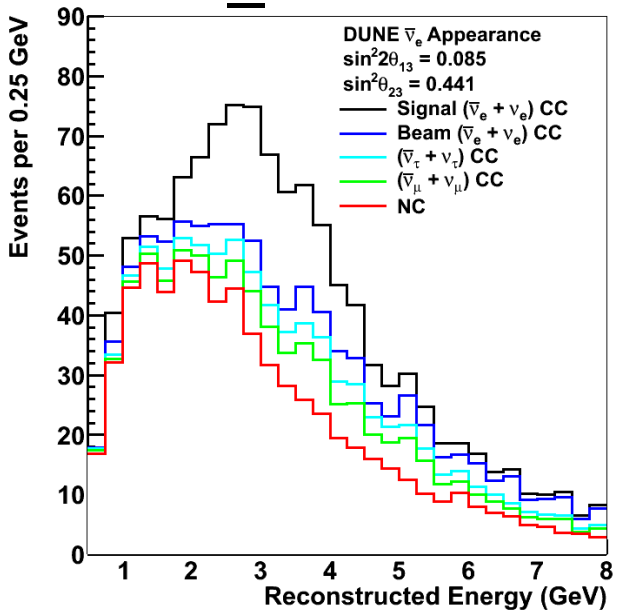
v2.1:



v2.2:

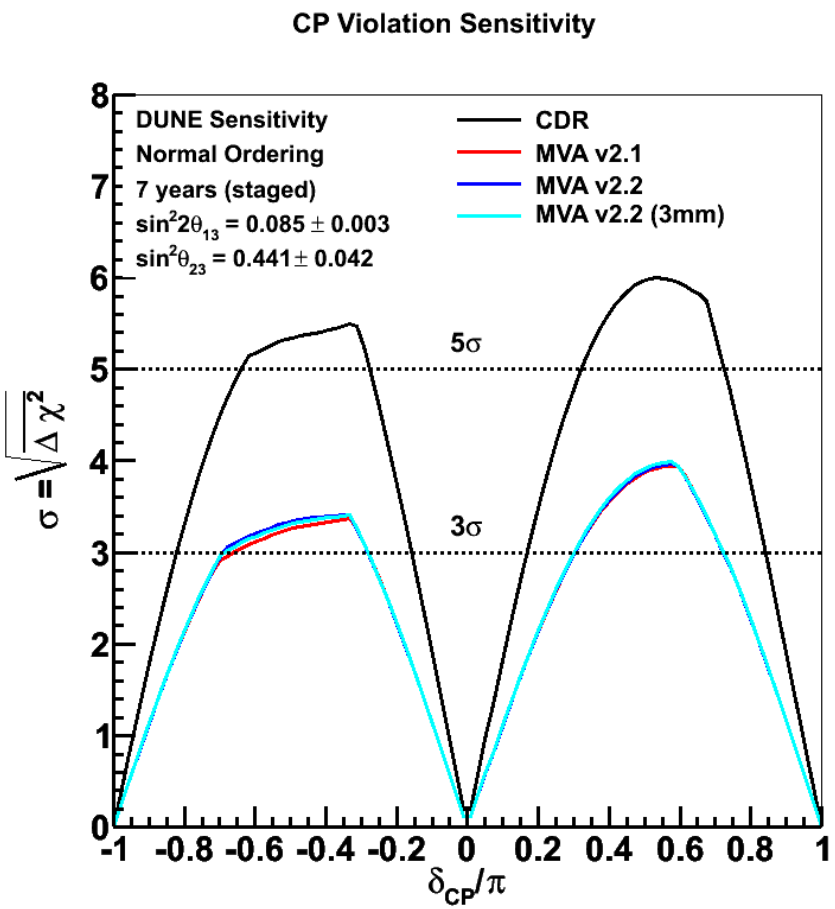


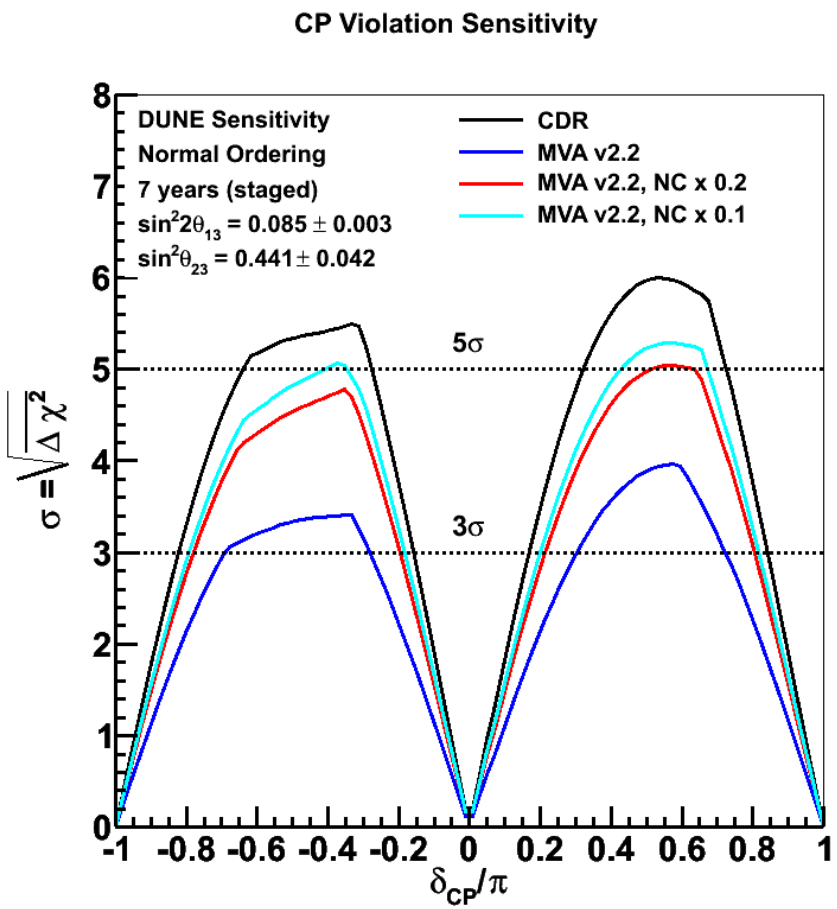
v2.2_3mm:



	V2.1	V2.2	V2.2_3mm
Signal	228	228	226
NC	687	702	700
νμ	118	102	124
ντ	64	64	66
Beam νe	135	162	159

CPV Sensitivity





Using the code

- DUNE github: https://github.com/DUNE/lblpwgtools
  - Elizabeth or Matt can add you if you want access to this repository
- Code in: lblpwgtools/code/MVAtoGLoBES
  - Brief instructions in ReadME
  - make_configs.py
    - Top level script takes arguments <path to MVA root trees> <label>
    - Creates GLoBES configs using data from MVA root trees
    - Places configs in lblpwgtools/inputs/MVAtoGLoBES/<label>/
- Configs not committed to github by default. I have committed configs for v2.1 and v2.2 so far.

Summary

- These results will be used in FDTF report
- Clearly improvements in reconstruction/selection are needed.
- This tool allows easy comparison among different fitters… already some cross-checks with CAFAna and VALOR (see discussion on Slack)
- This tool allows us to easily check impact of future improvements to reconstruction and event selection.
- Hack days was very useful!