Status of Sensitivities for CDR

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DUNE Local Meeting

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Choosing the Reference Beam

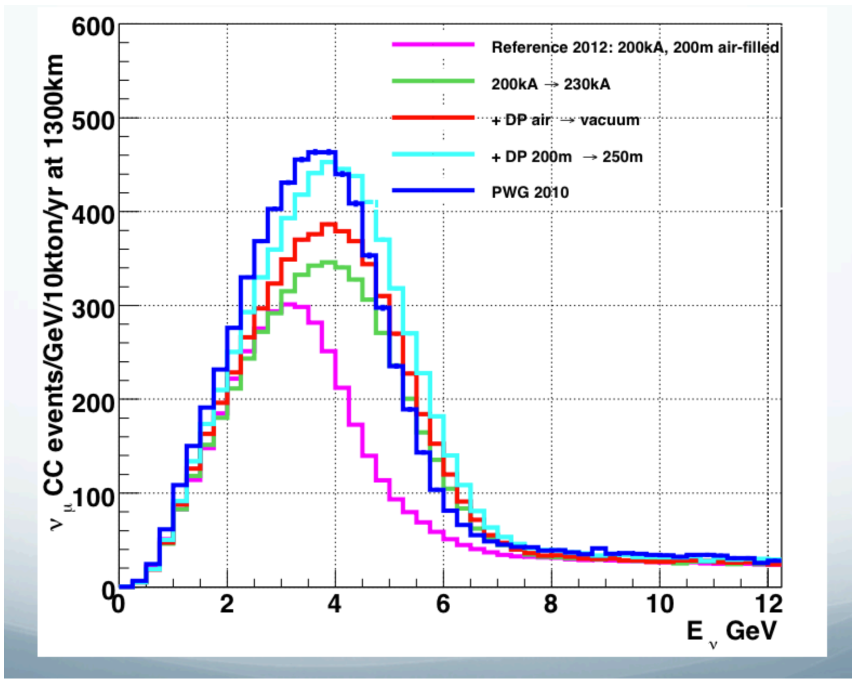
- Goals
  - Single “reference” beam for physics section with only beam variations coming in beam design section
  - Consistent with “reference” beam described in the physics section
  - Good performance – does not underestimate DUNE sensitivity

Table 1: Summary of design choices in LBNF Reference beam and the “80-GeV” beam that was used for LBNE Science Book and ELBNF LOI physics studies.

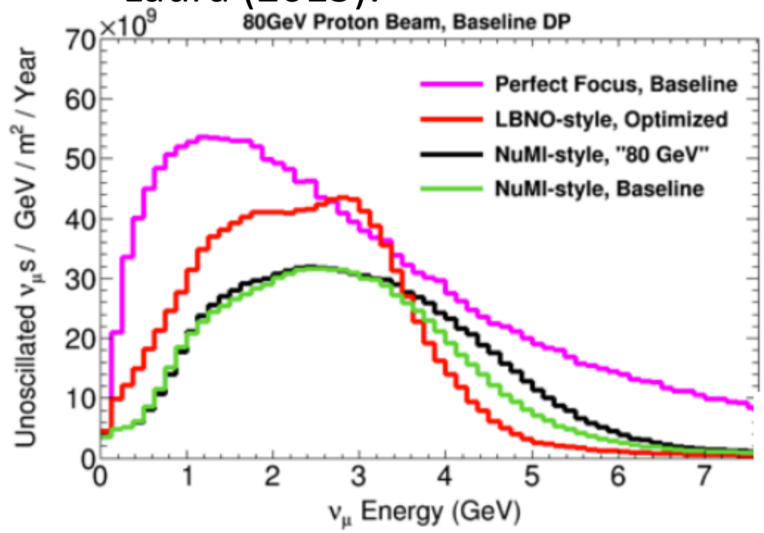
Feature	LBNF Reference Beam	“80-GeV” Beam
Proton Energy	120 GeV	80 GeV
Target Distance from horn 1	-45 cm	-25 cm
Horn Current	200 kA	230 kA
Decay Pipe Diameter	4 m	6 m
Decay Pipe Length	204 m	250 m
Decay Pipe Atmosphere	Helium	Helium

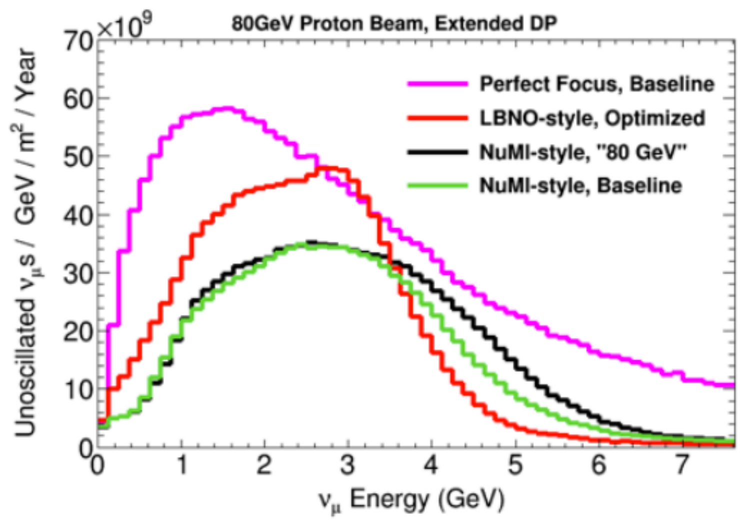
Flux Differences

Mary (2012):



Laura (2015):





What Changed?

- Update to G4LBNE geometry – more accurate material description
- Wider target (to accommodate 1.2 MW beam)
- Larger target-horn1 distance (required by wider target)
- All changes push flux to higher energy

Beam Design for 1.2 MW

The simplest TARGET modification for 1.2 MW

Reduce stress by increasing the beam spot size, spread out beam

- Implies making target wider so protons don't miss target
- For higher power, also must increase size of water cooling line
- Scoping calc.: for same proton flux at center, 1.3 mm RMS -> 1.7 mm RMS.

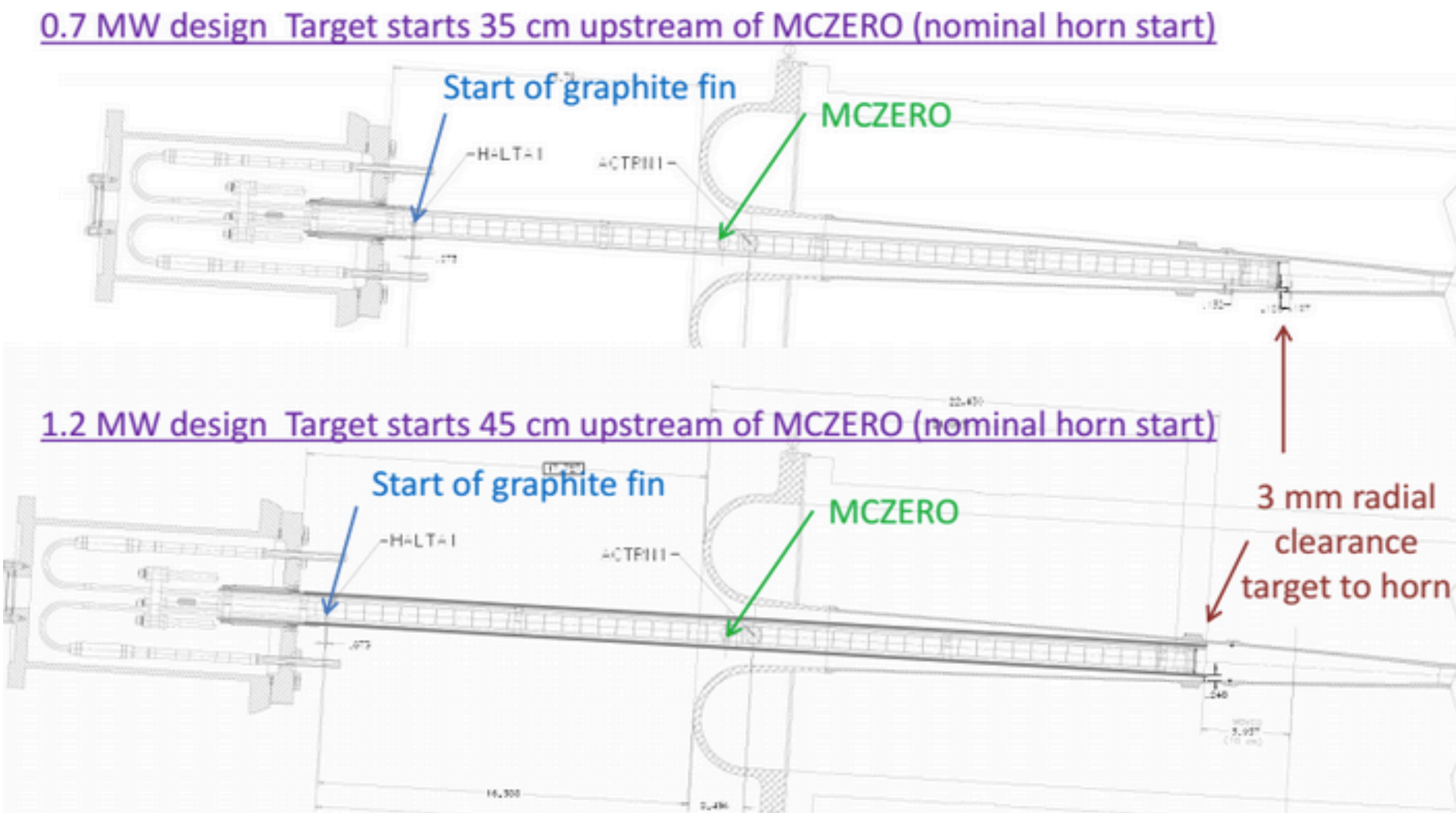
Some expected advantages of increasing beam/target size

- Reduces stress in center of target
- Reduces radiation damage rate at center of target <-- targets last longer !

Some expected dis-advantages of increasing beam/target size

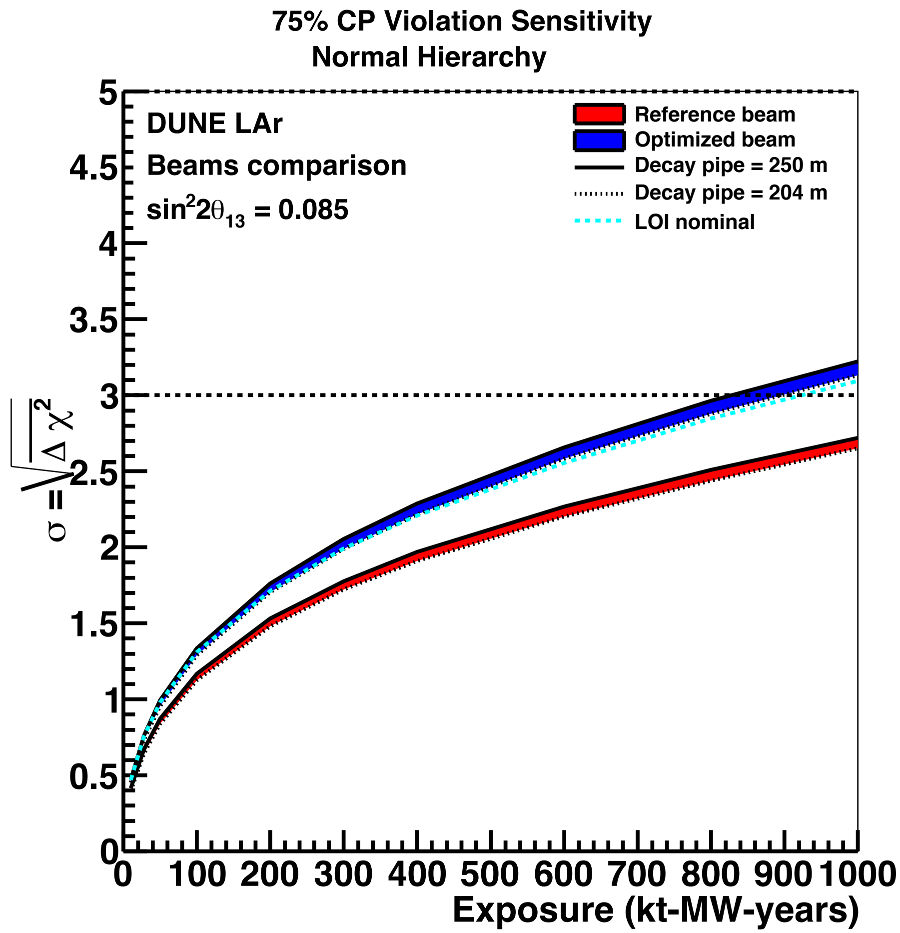
- Extra showering in target may lose some flux at low energy
- Extra showering deposits more beam heating in horn inner conductor
- Larger beam spot -> making hole in water-line-protection-baffle larger
  -> moving water lines to larger radius -> target does not fit as far into horn

Beam Design for 1.2 MW



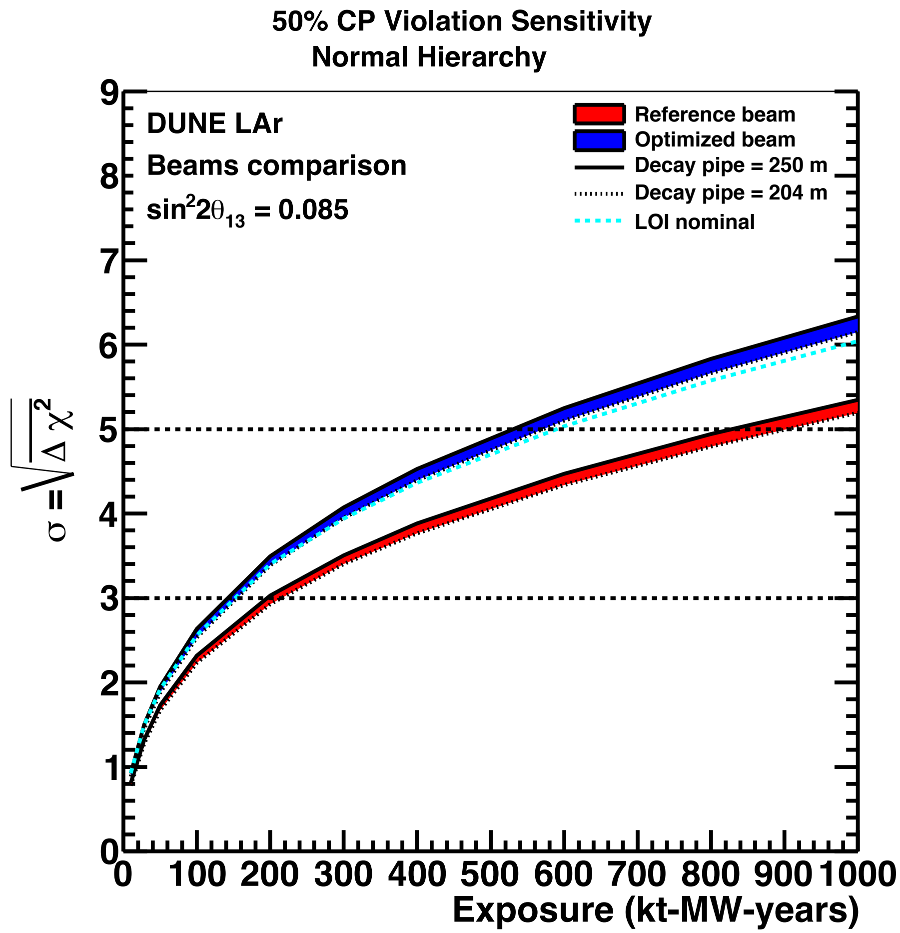
CPV Sensitivity Results

“Old GLoBES setup”



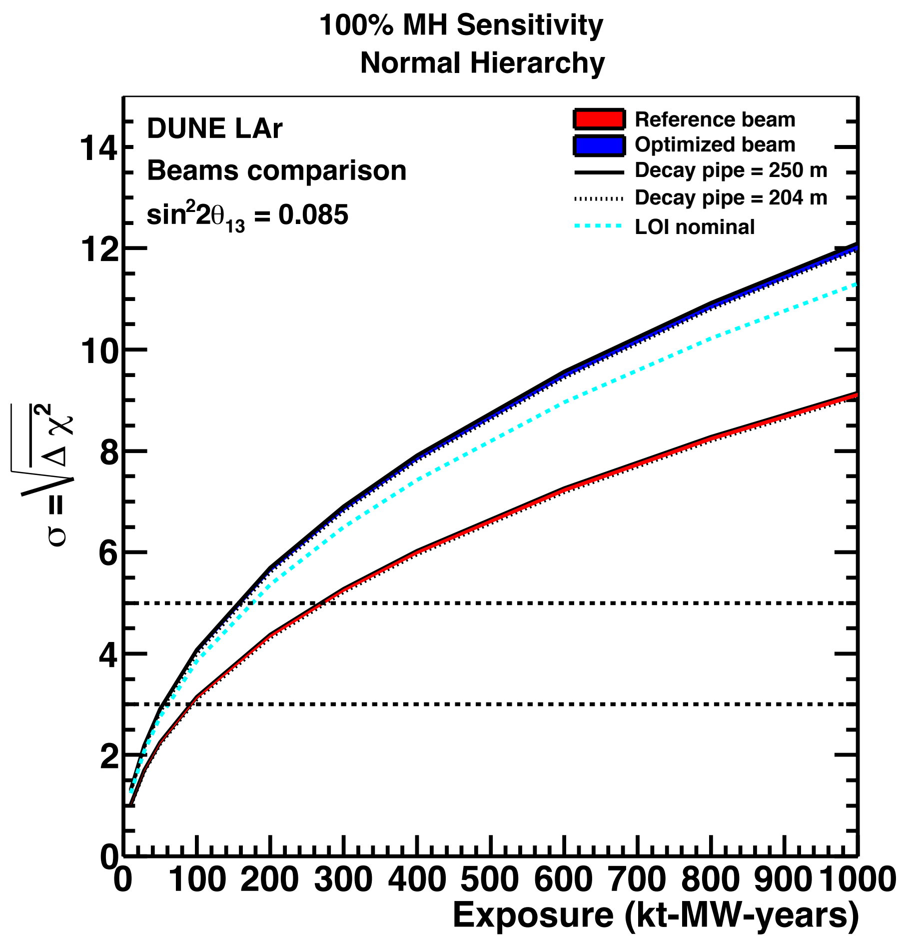
CPV Sensitivity Results

"Old GLoBES setup"

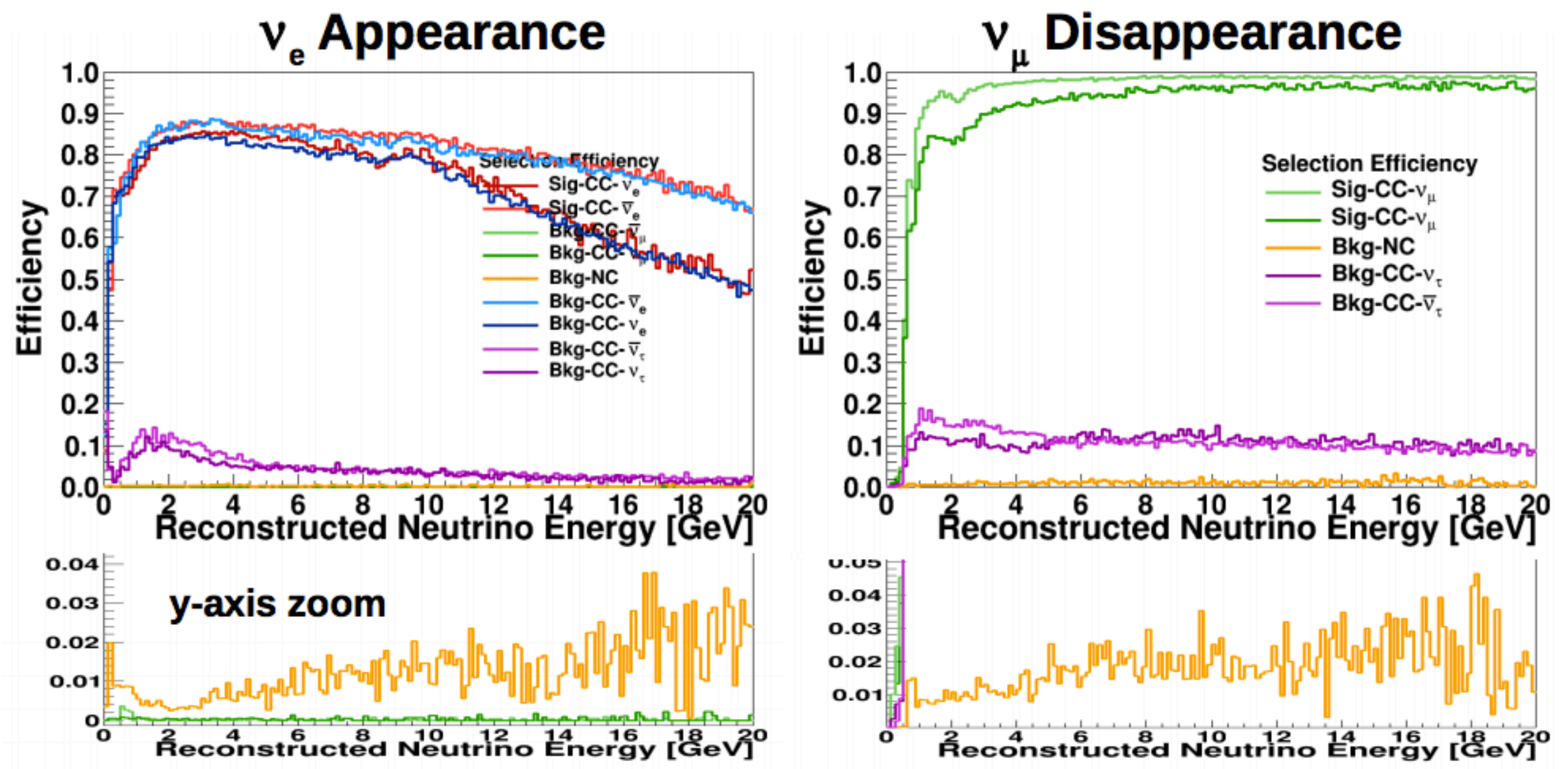


MH Sensitivity Results

"Old GLoBES setup"

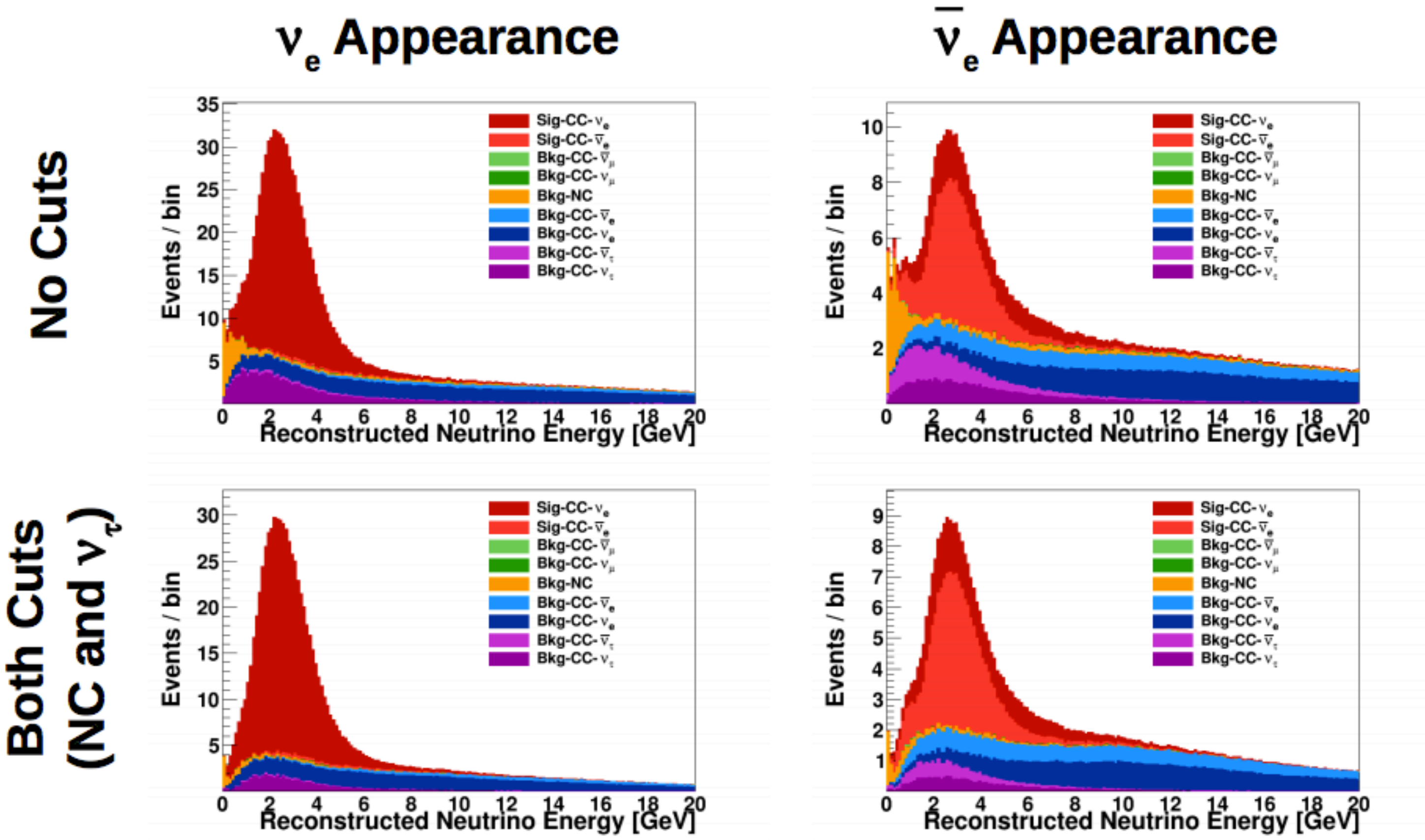


FMC Efficiencies for GLoBES



FMC BG Rejection

Use transverse momentum cuts (kNN based discriminant)



Systematics Treatment

- Signal normalization uncertainty
  - 2% on ν_e: uncorrelated with all other
  - 5% on ν_μ: uncorrelated with all other
- Background normalization uncertainty
  - 5% NC, ν_μ CC: correlated among appearance samples
  - 10% NC: correlated among disappearance samples
  - 5% beam ν_e: uncorrelated FHC/RHC
  - 20% ν_τ: correlated among all samples
  - Difference in sensitivity very small compared to previous treatment

"New" GLoBES version allows separate uncertainties for different backgrounds