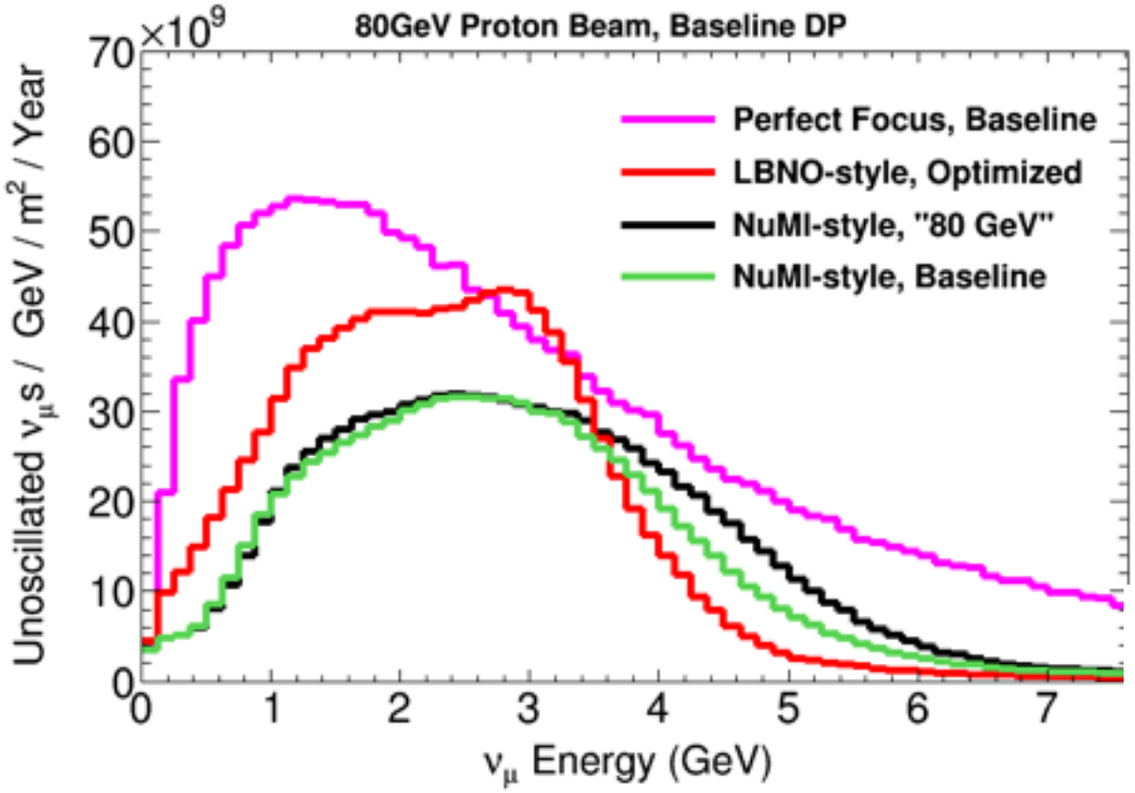
Fluxes and Sensitivities for CDR

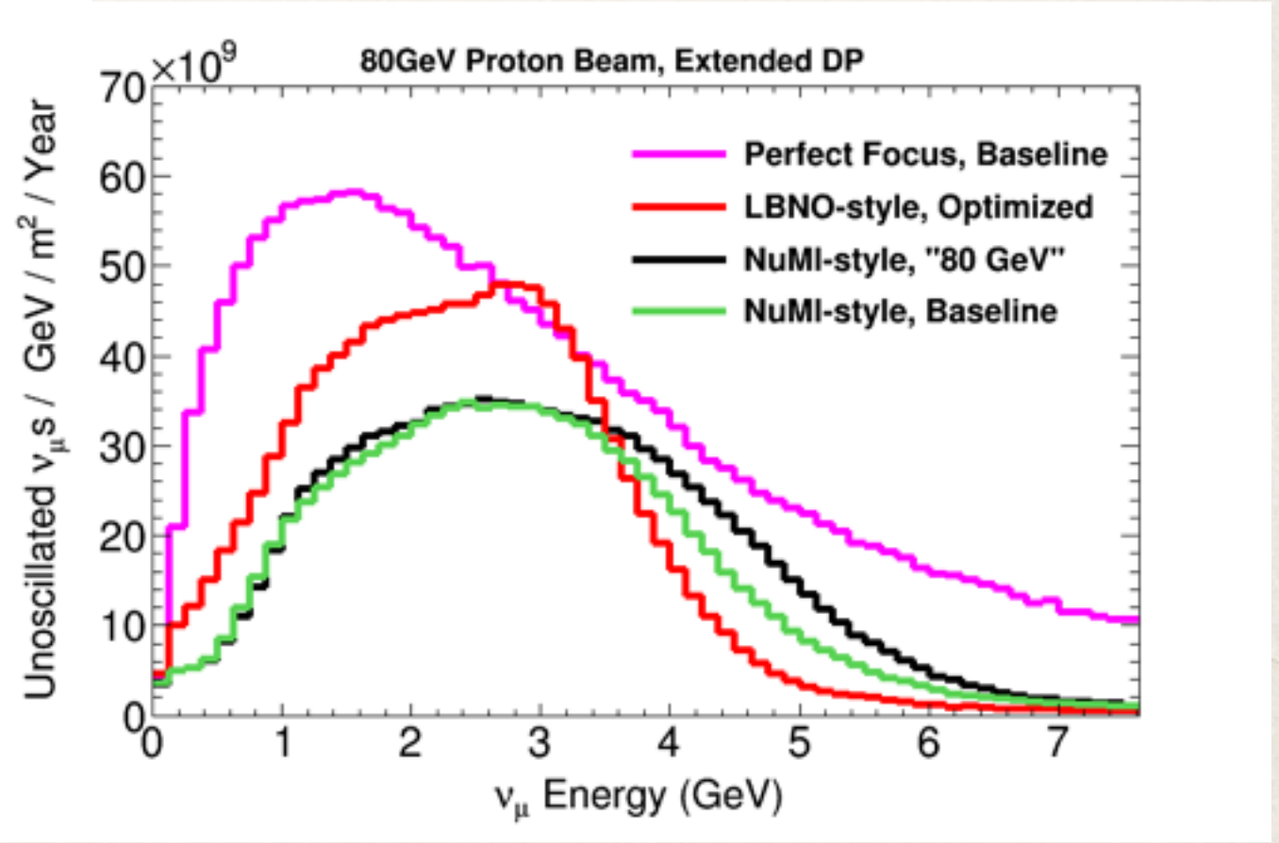
Laura Fields
Elizabeth Worcester

13 April 2015

Review of Last Week



- Recall: I simulated a bunch of fluxes for the CDR



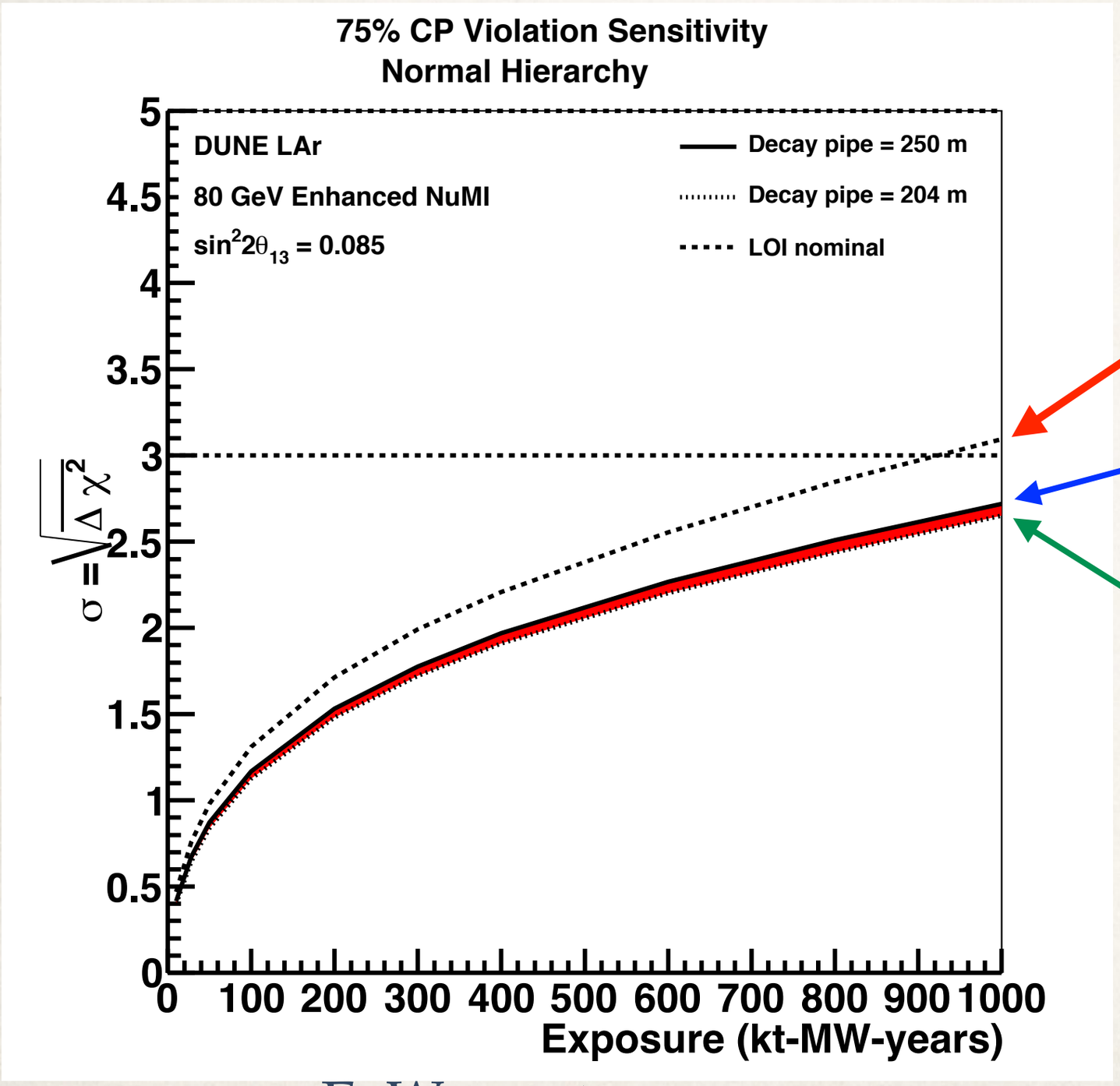
Estimated CP 75% Sensitivity

	Baseline DP	Extended DP
LBNO Optimized	1.84	1.91
80 GeV	1.51	1.55
Baseline	1.49	1.54

Outline

- New today:
  - How are these fluxes different than the fluxes used in the LOI
- Discussion of an alternate target design
- Latest sensitivities from Elizabeth

Sensitivities



The flux used for the LOI

The "enhanced NuMI" beam we are proposing to use for physics studies in the CDR

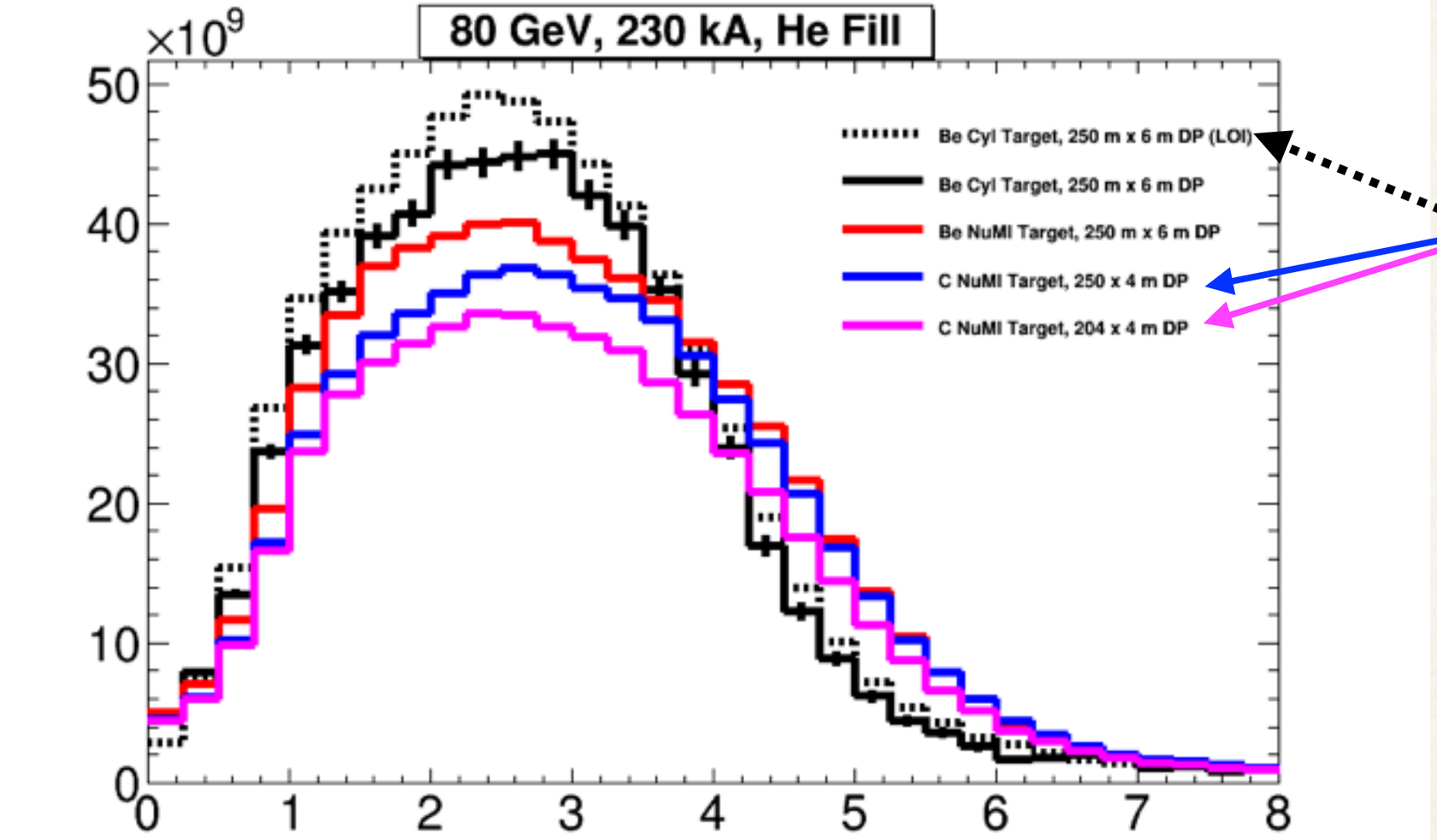
A variant of our proposal with a shorter decay pipe

E. Worcester

What has changed since the LOI

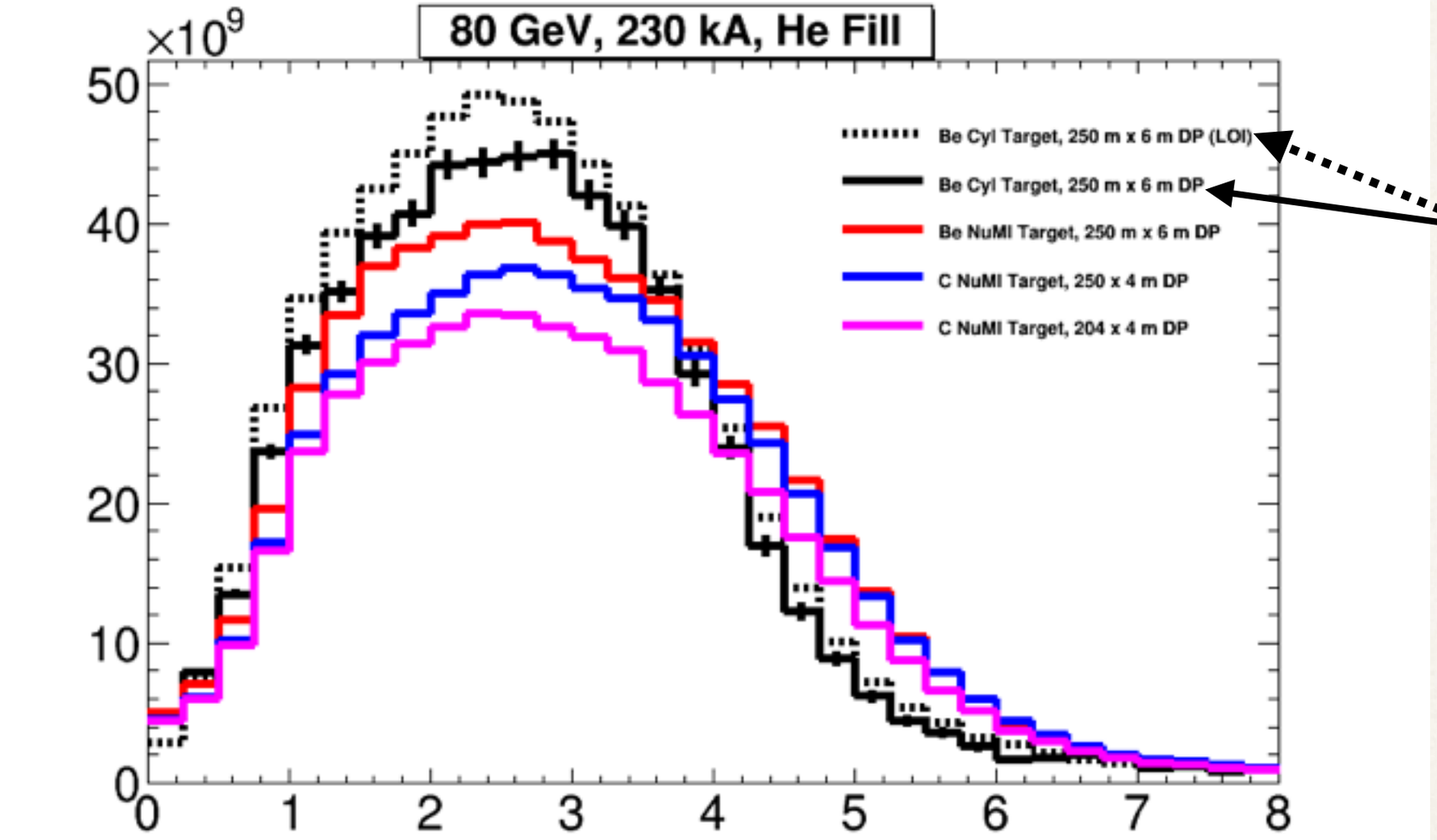
- Differences between proposed flux and LOI
  - Proposed fluxes use a newer, more accurate beam simulation, with a more detailed description of material in the horns
    - More material means less flux
- The LOI had two improvements that our proposed beam does not:
  - A cylindrical beryllium target starting at -25 cm from MCZERO
  - A 6 meter diameter decay pipe

Effect of these changes on the Flux



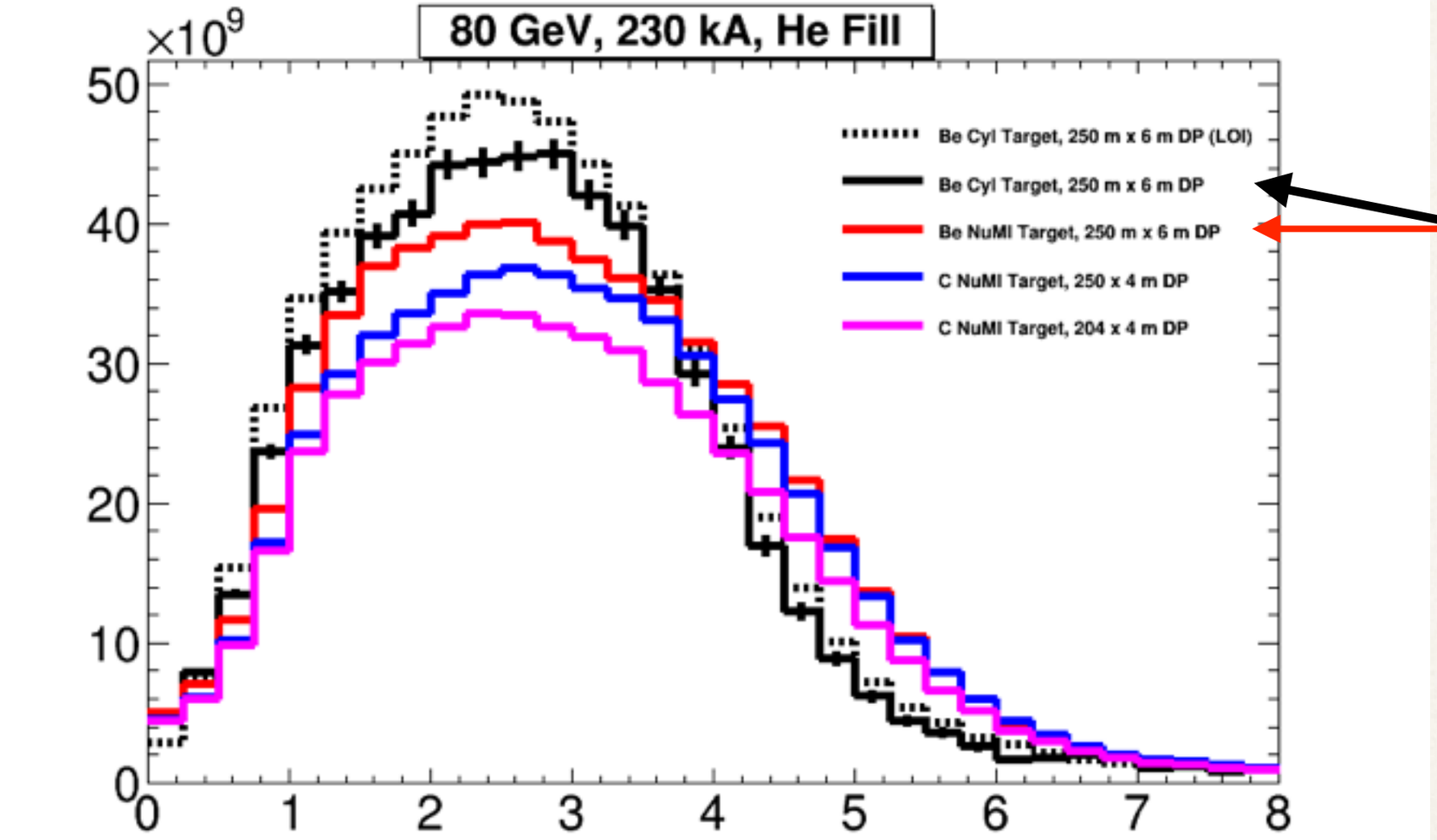
These are the three fluxes used to make Elizabeth's sensitivity plot

Effect of these changes on the Flux



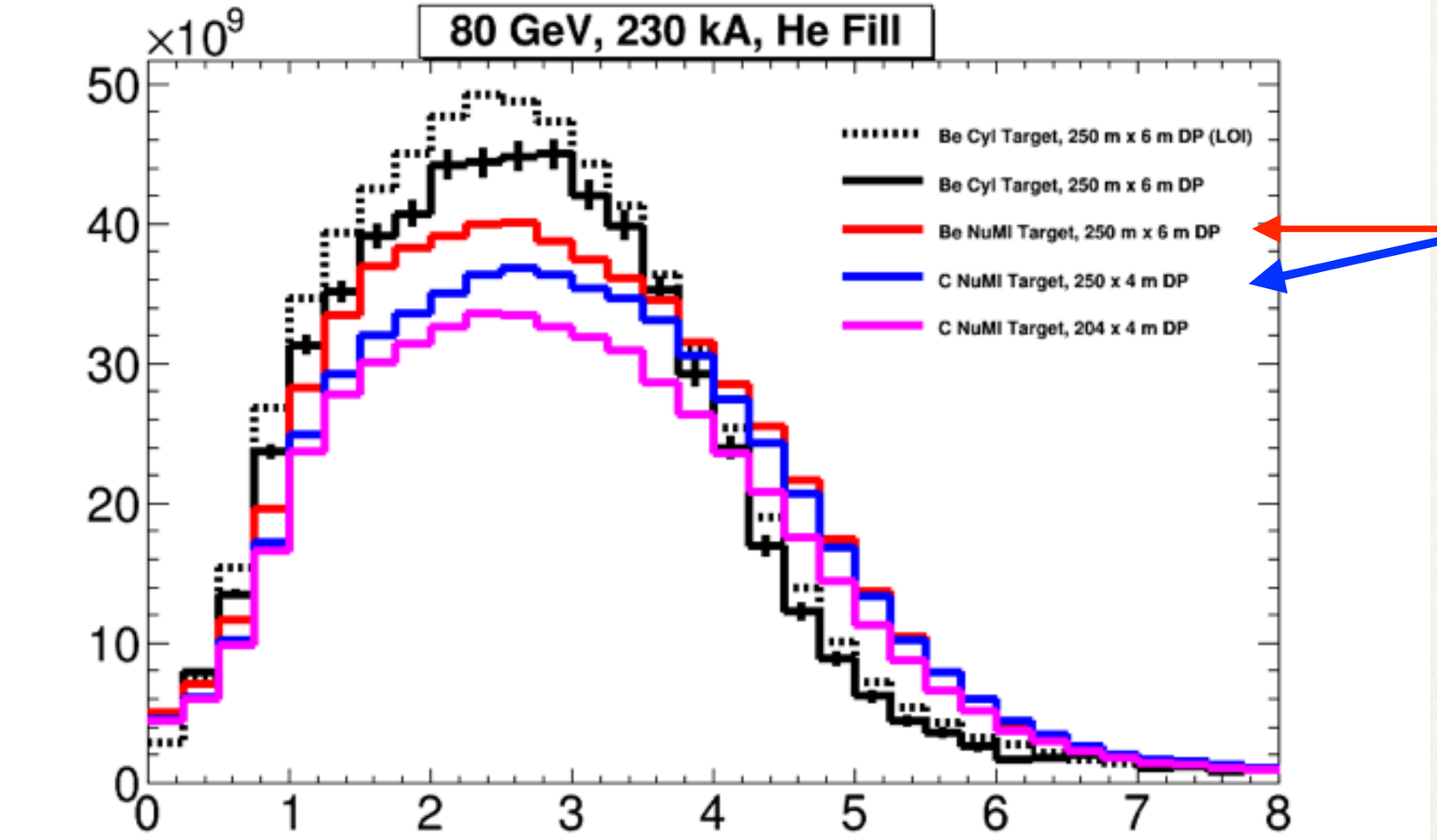
Comparing these two lines shows you the change in flux due to updates to the beam simulation (more accurate horn shapes and amount of material)

Effect of these changes on the Flux



These two show the difference between a cylindrical target at -25 cm and a NuMI target at -45 cm (both Beryllium)

Effect of these changes on the Flux



These show the change in flux due to changing the target material and shrinking the decay pipe radius

Should we consider a cylindrical Be Target?

A cylindrical target originally designed by IHEP Protvino was described in the pre-reconfiguration CDR

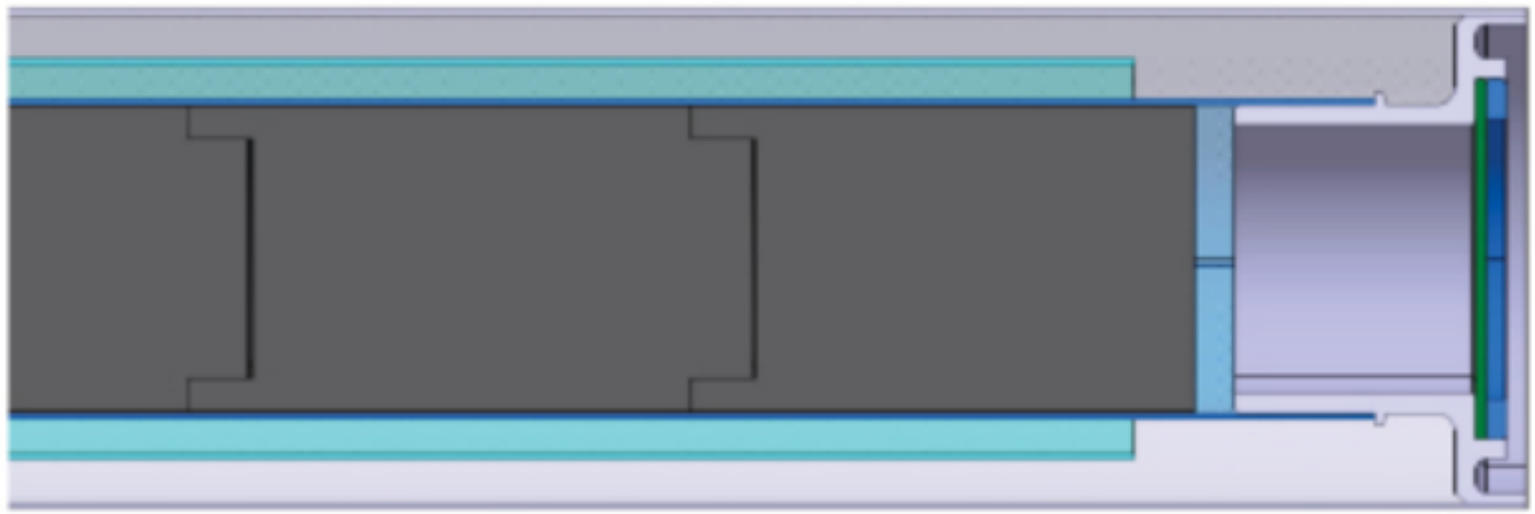


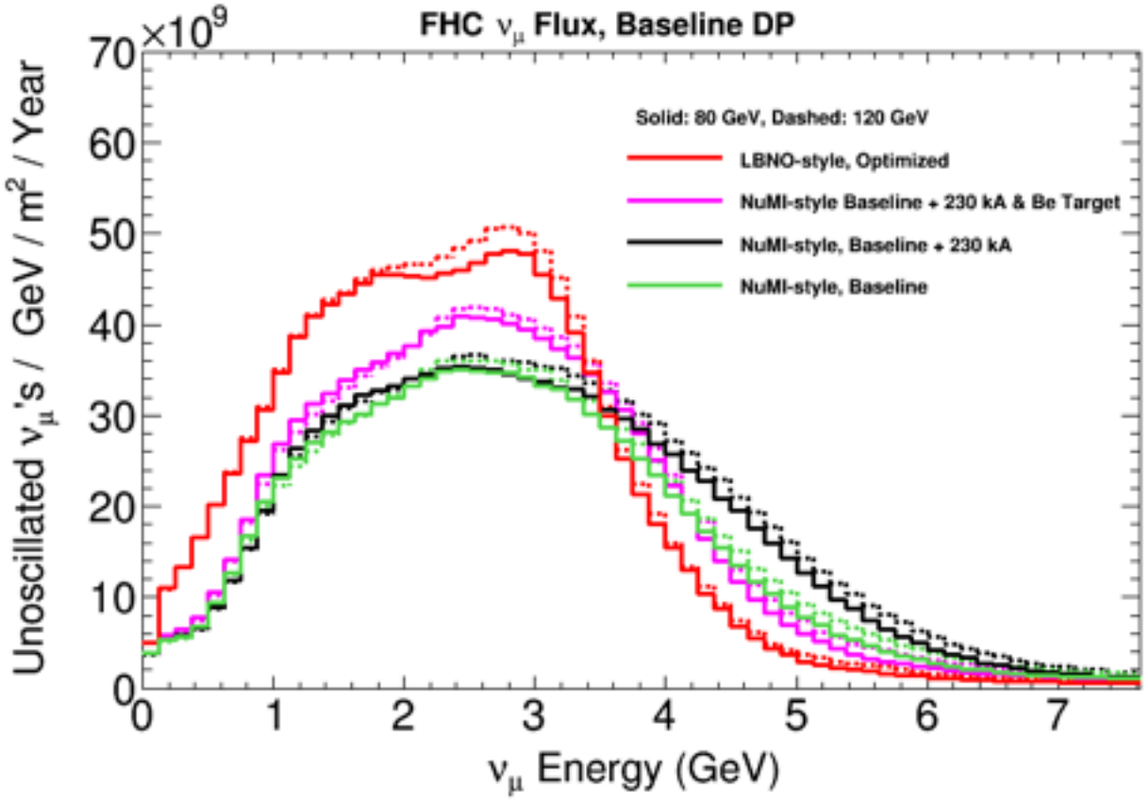
Figure 3–9: Downstream portion of the conceptual target. The beam exits the core of the target through a beryllium window. The cylindrical graphite segments (gray) are surrounded by the water-cooled stainless jackets (light blue).

This target was graphite, and was surrounded by 5 mm of water that is not included in any of the fluxes on previous slides

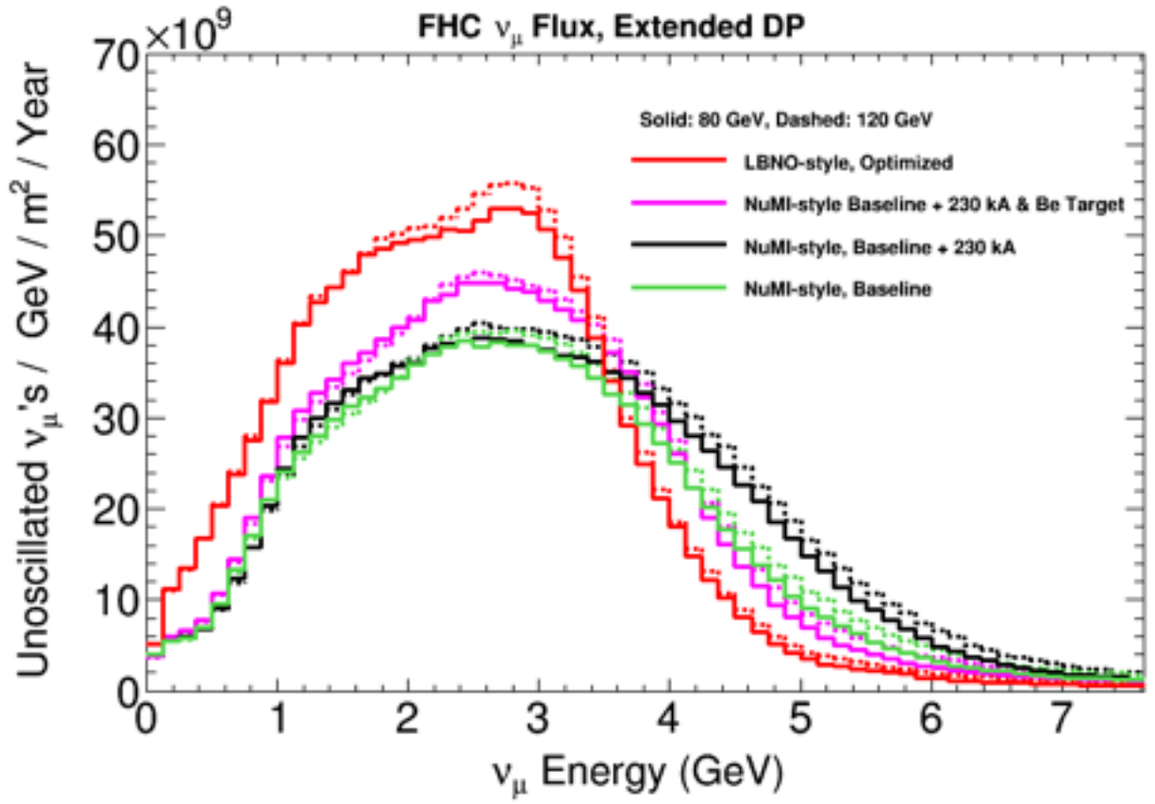
Should we consider a cylindrical Be Target?

- I have simulated a variant of our enhanced NuMI beam that has a Beryllium cylindrical target with radius 8.7 mm (6 mm of original design, plus 2.7 additional mm of Beryllium to stand in for the 5 mm of cooling water)
  - Results on next slide
- These fluxes have been added to the FMC flux area:
  - $FMC_FLUX_FILES/v3r2p4b/NuMI_Improved_Be_120GeV_StandardDP/
  - $FMC_FLUX_FILES/v3r2p4b/NuMI_Improved_Be_80GeV_StandardDP/
  - $FMC_FLUX_FILES/v3r2p4b/NuMI_Improved_Be_120GeV_ExtendedDP/
  - $FMC_FLUX_FILES/v3r2p4b/NuMI_Improved_Be_80GeV_ExtendedDP/

Fluxes w/ Beryllium Target



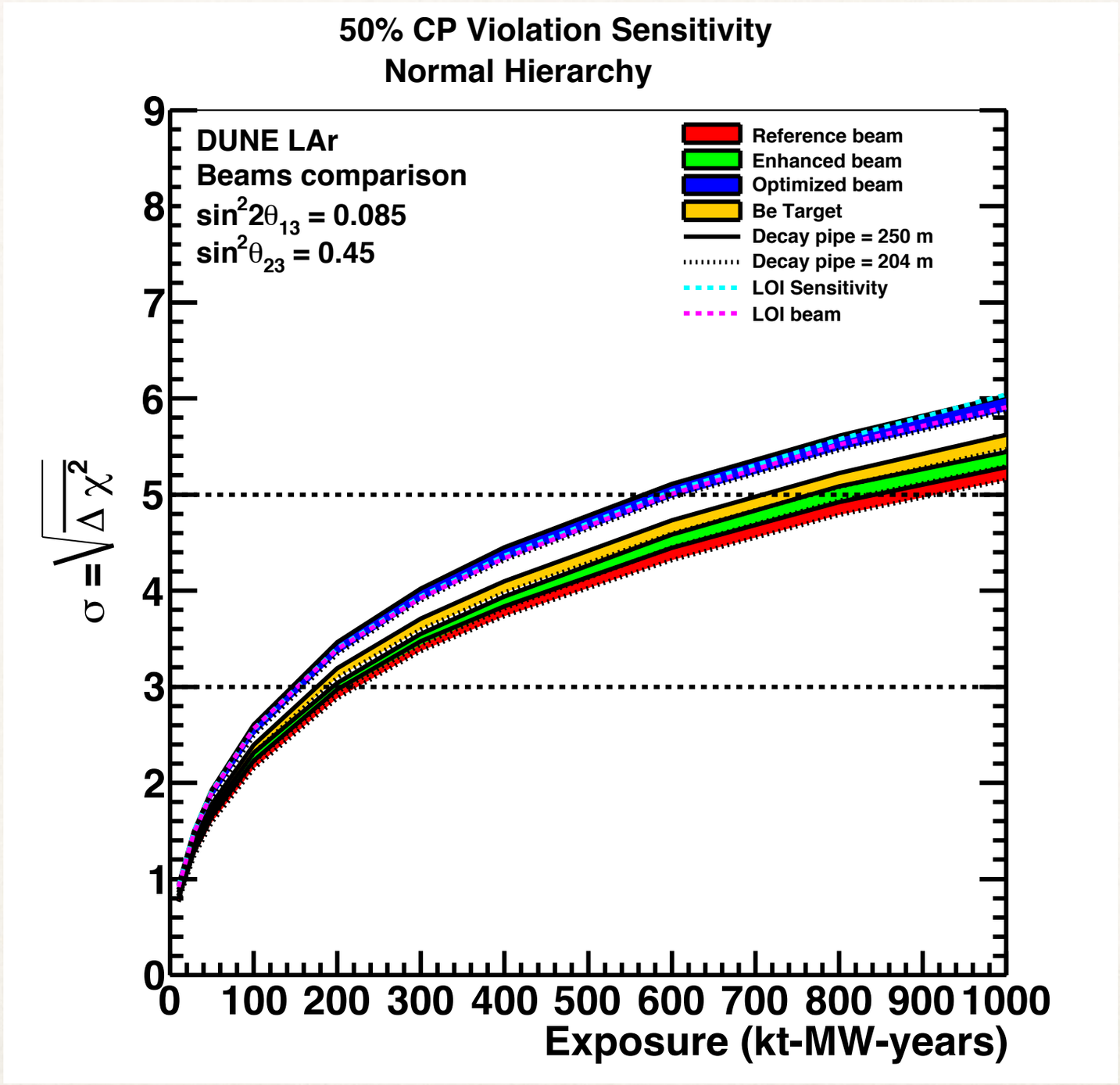
Neutrino Mode
Muon Neutrino Fluxes



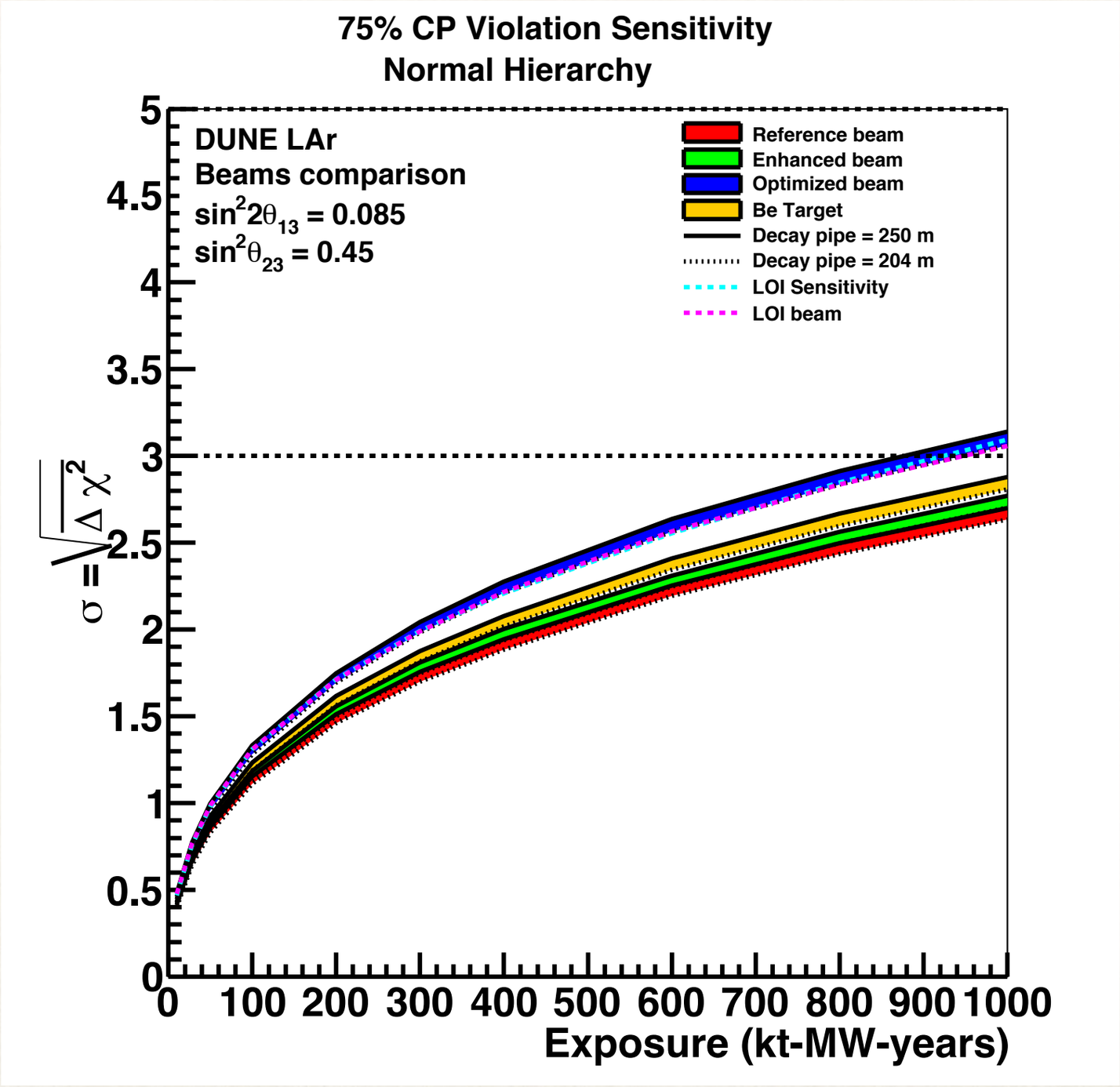
Estimated 75% CP Sensitivity (3+3 years, 34 kTon)

	Baseline DP 80 GeV	Extended DP 80 GeV	Baseline DP 120 GeV	Extended DP 120 GeV
LBNO-style	1.84	1.91	1.84	1.91
Baseline+230kA +Be Target	1.62	1.67	1.58	1.63
Baseline+230kA	1.51	1.55	1.48	1.52
Baseline	1.49	1.54	1.46	1.50

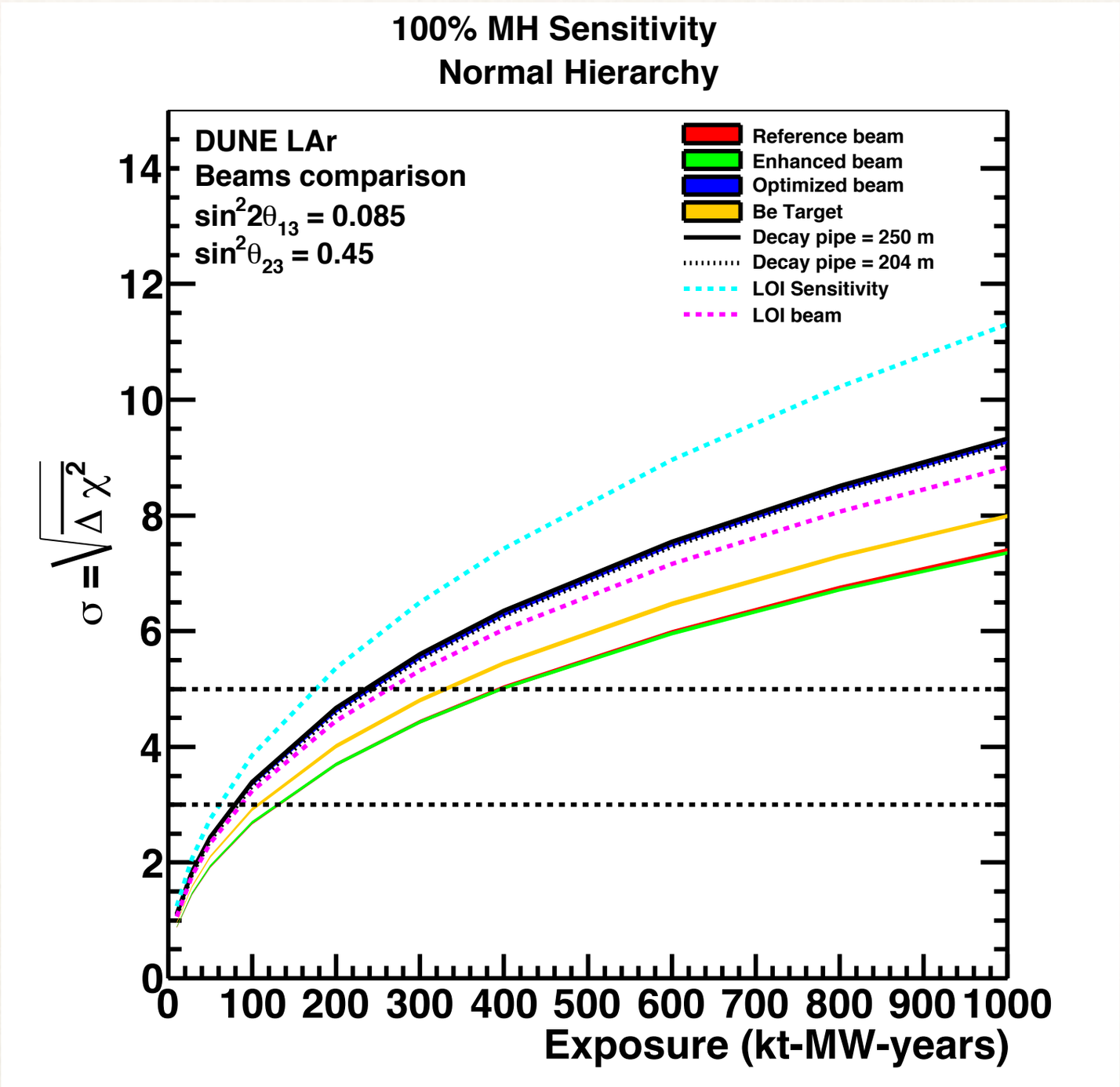
Sensitivities from Elizabeth



Sensitivities from Elizabeth

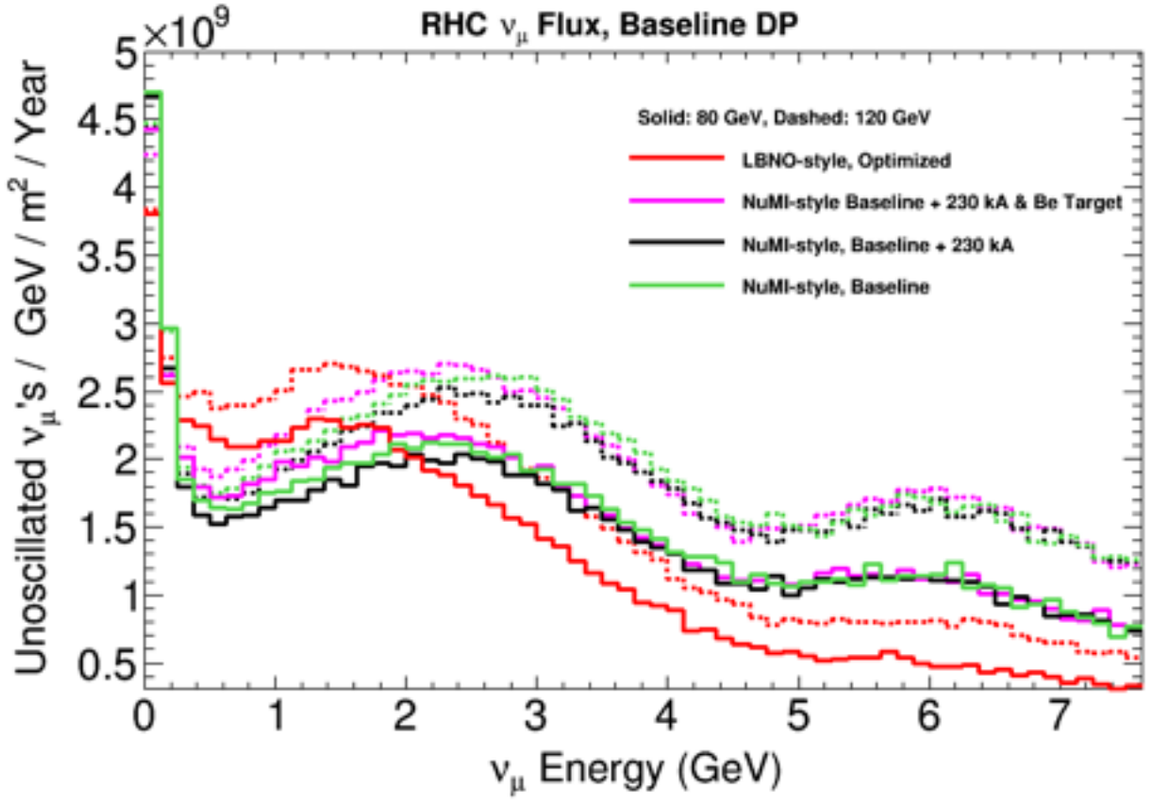


Sensitivities from Elizabeth

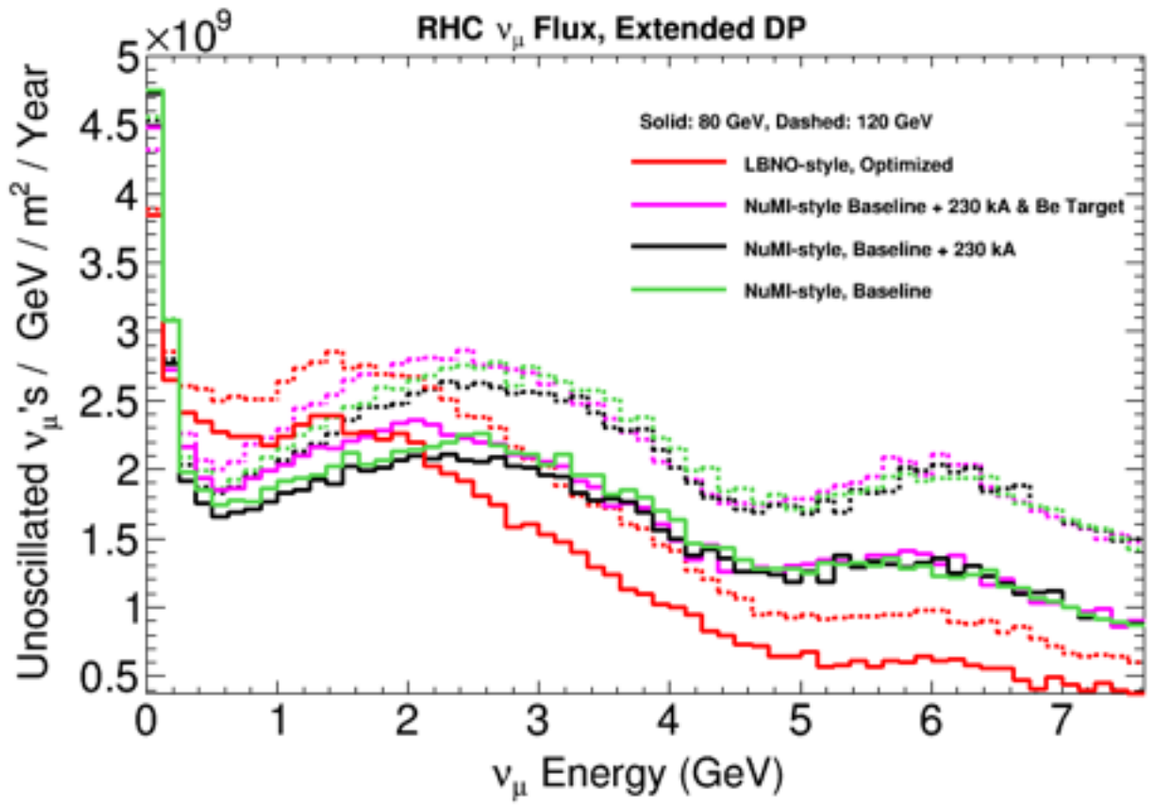


The End

Fluxes w/ Beryllium Target



Neutrino Mode
Muon Neutrino Fluxes
("wrong sign background")



These are hard to see. My interpretation:

- Current sensitivity studies indicate that it is most critical that we control wrong sign backgrounds above 2 GeV.
- LBNO-style configuration has much lower wrong-sign background above 2 GeV (but higher below 2 GeV).
- In all configurations, 80 GeV has lower wrong-sign background than 120 GeV