

NuMI-X: Effects of NuMI Beam Shifts and Beam Divergence

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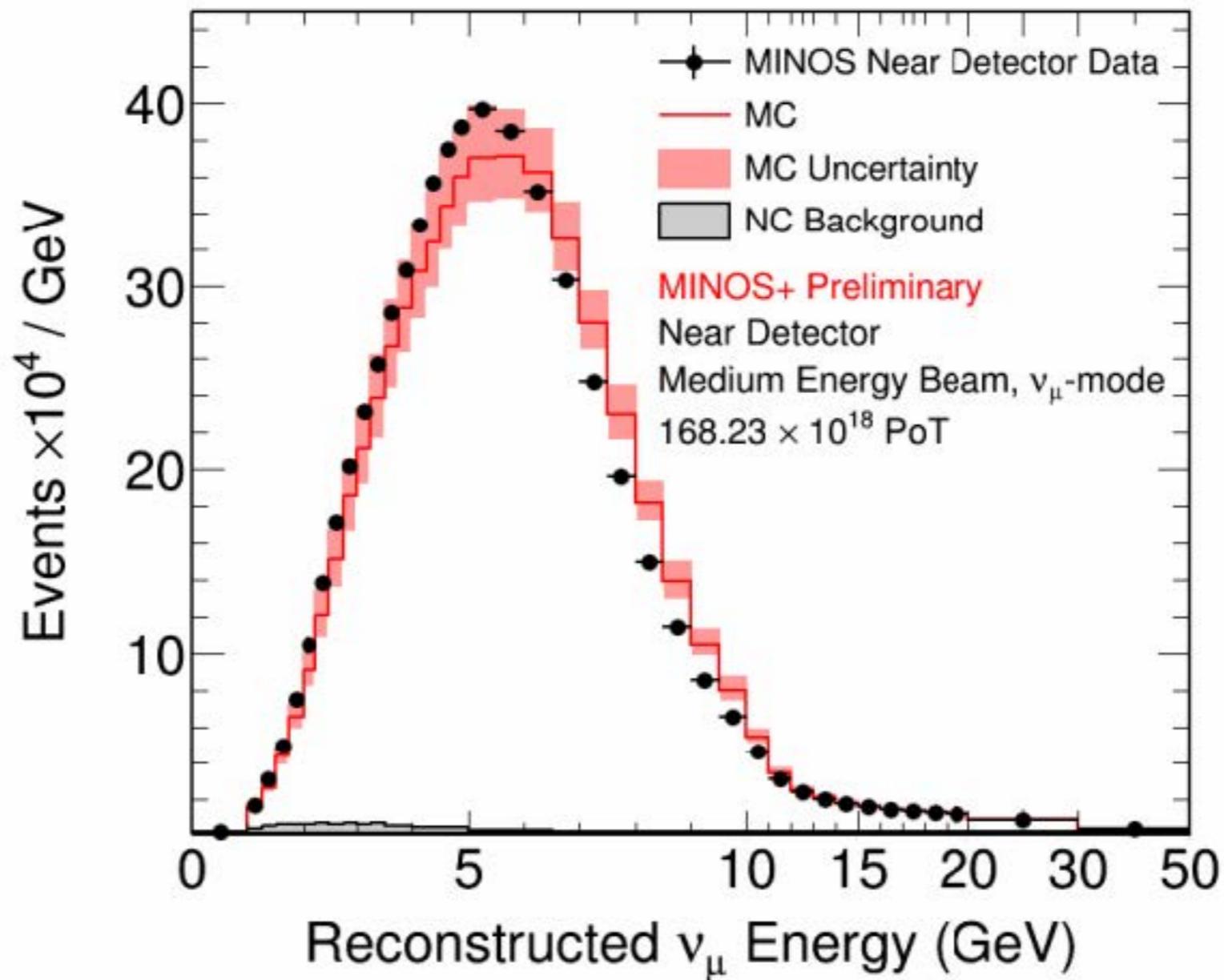
October 31, 2014



History

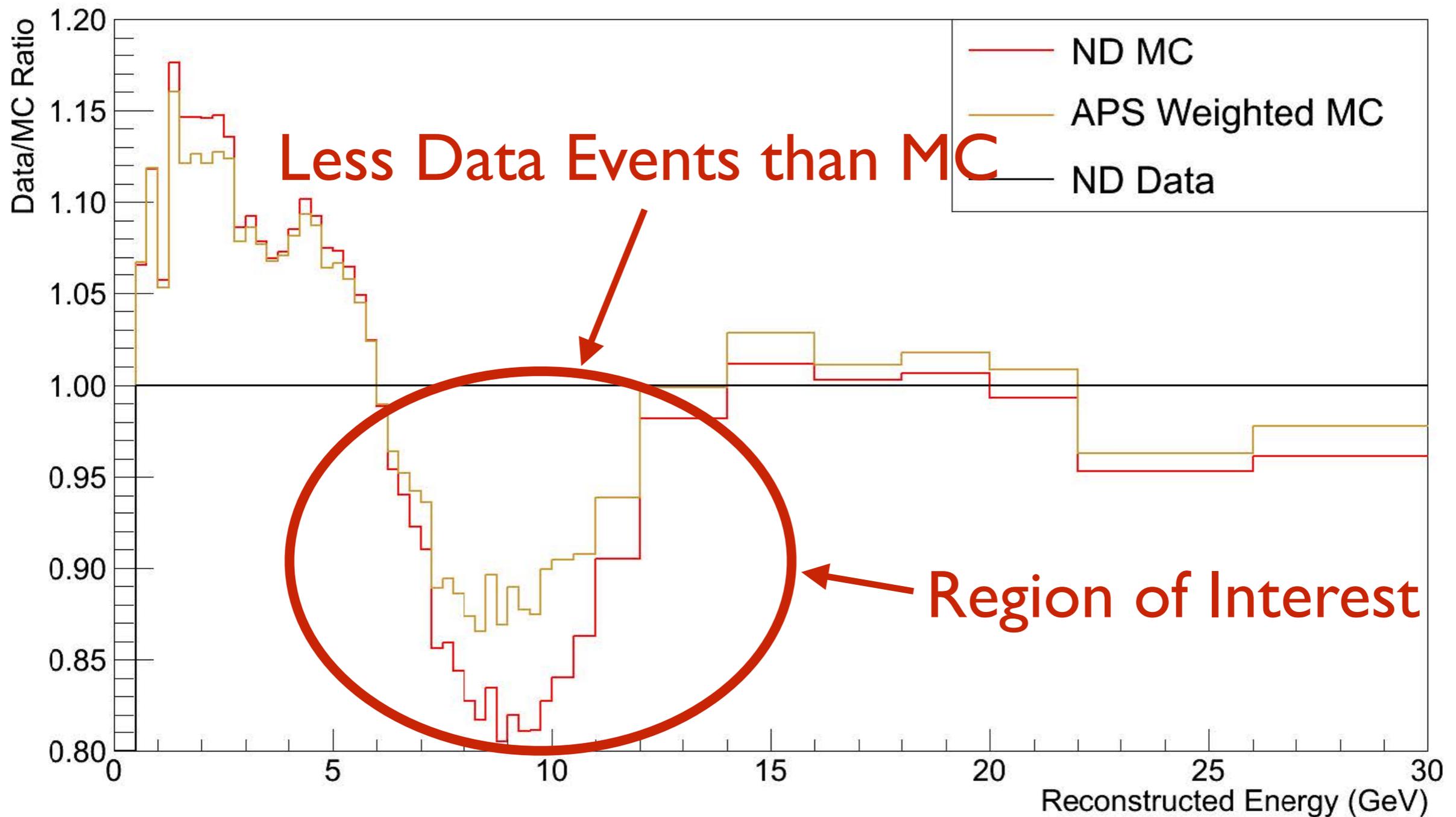
- I have investigated the effects of shifting the NuMI target up and down stream
 - ✦ See MINOS doc 10758
- New Tasks: Simulate changes in the beam position, beam spot size and divergence to see how the agreement between Monte Carlo and data would be affected

The Disagreement:



The Disagreement:

Data and MC Spectra



Notes on Beam Position Simulations

- Using FLUKA 08
- Compared all beam shifts to a target at -20 cm with the beam at (0,0) in the xy-plane
 - ◆ shifted positions: $y = -0.5$ mm, $y = +0.5$ mm, $x = -0.5$ mm, $x = +0.5$ mm
- Horn current was set to 200 kA

Beam Position Shift Ratio Plots

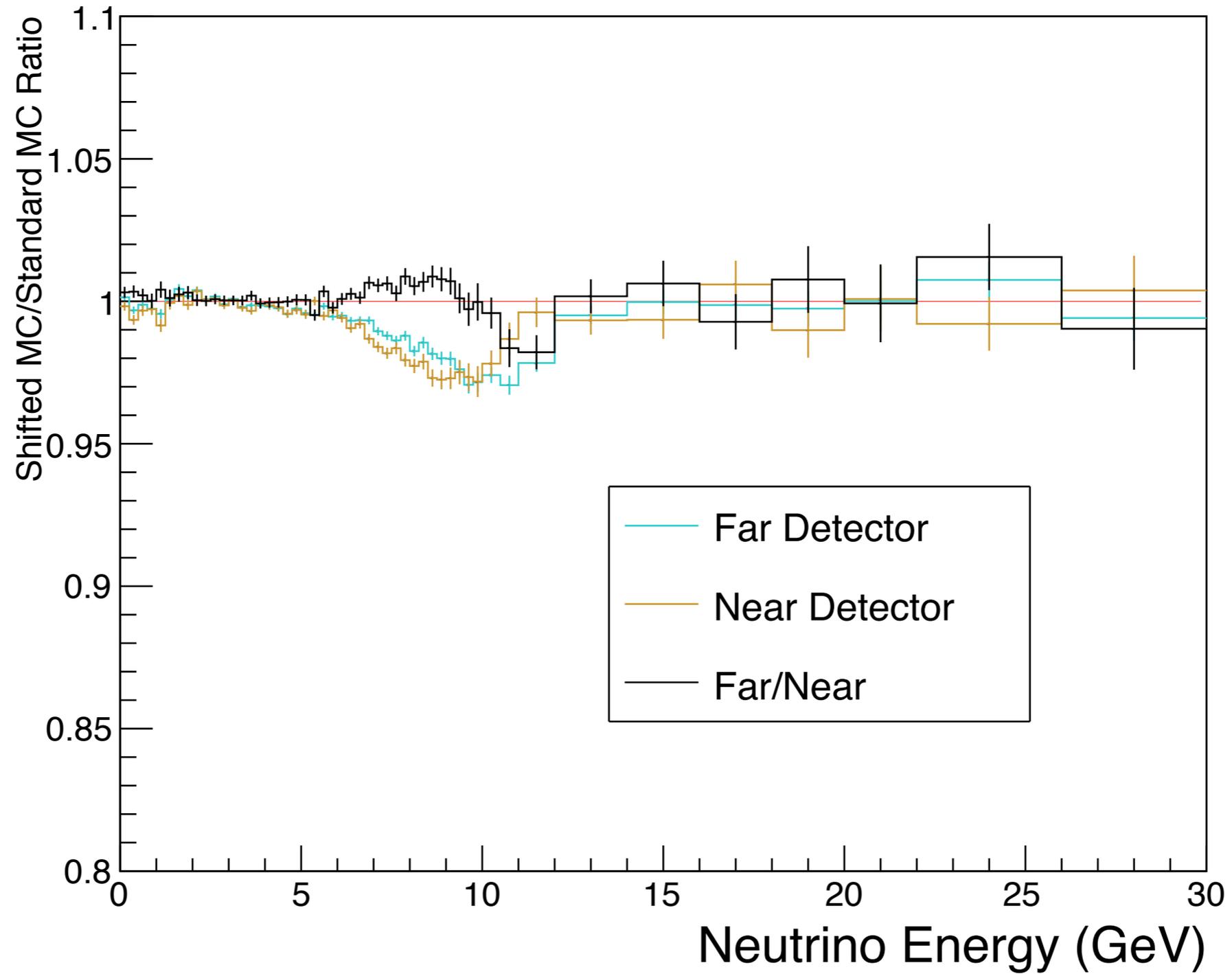
Understanding the legend:

$$\text{Far Detector} = \frac{\text{Shifted Far Spectrum}}{\text{Standard Far Spectrum}}$$

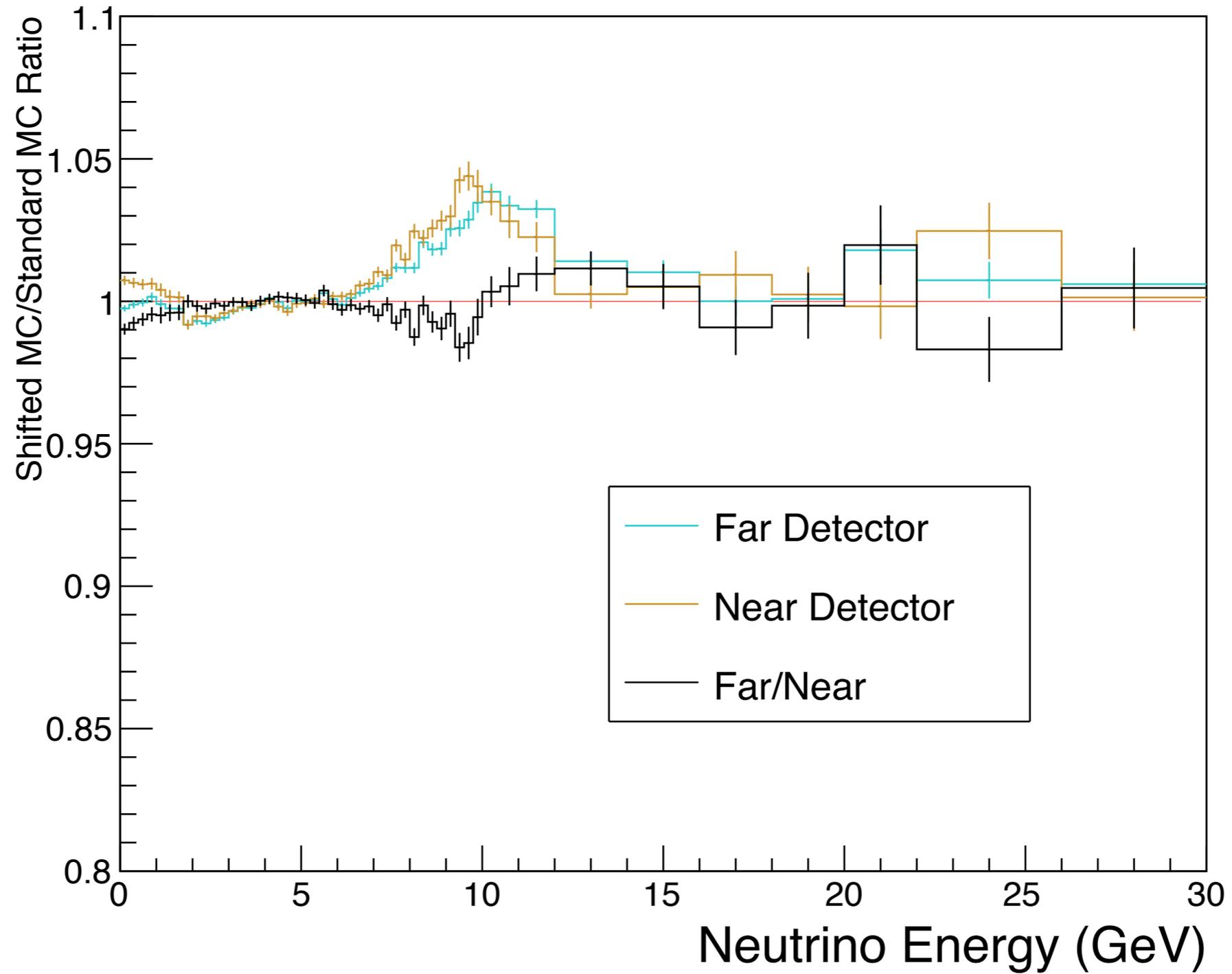
$$\text{Near Detector} = \frac{\text{Shifted Near Spectrum}}{\text{Standard Near Spectrum}}$$

$$\text{Far/Near} = \frac{\text{Shifted Far Spectrum} / \text{Near Spectrum}}{\text{Standard Far Spectrum} / \text{Near Spectrum}}$$

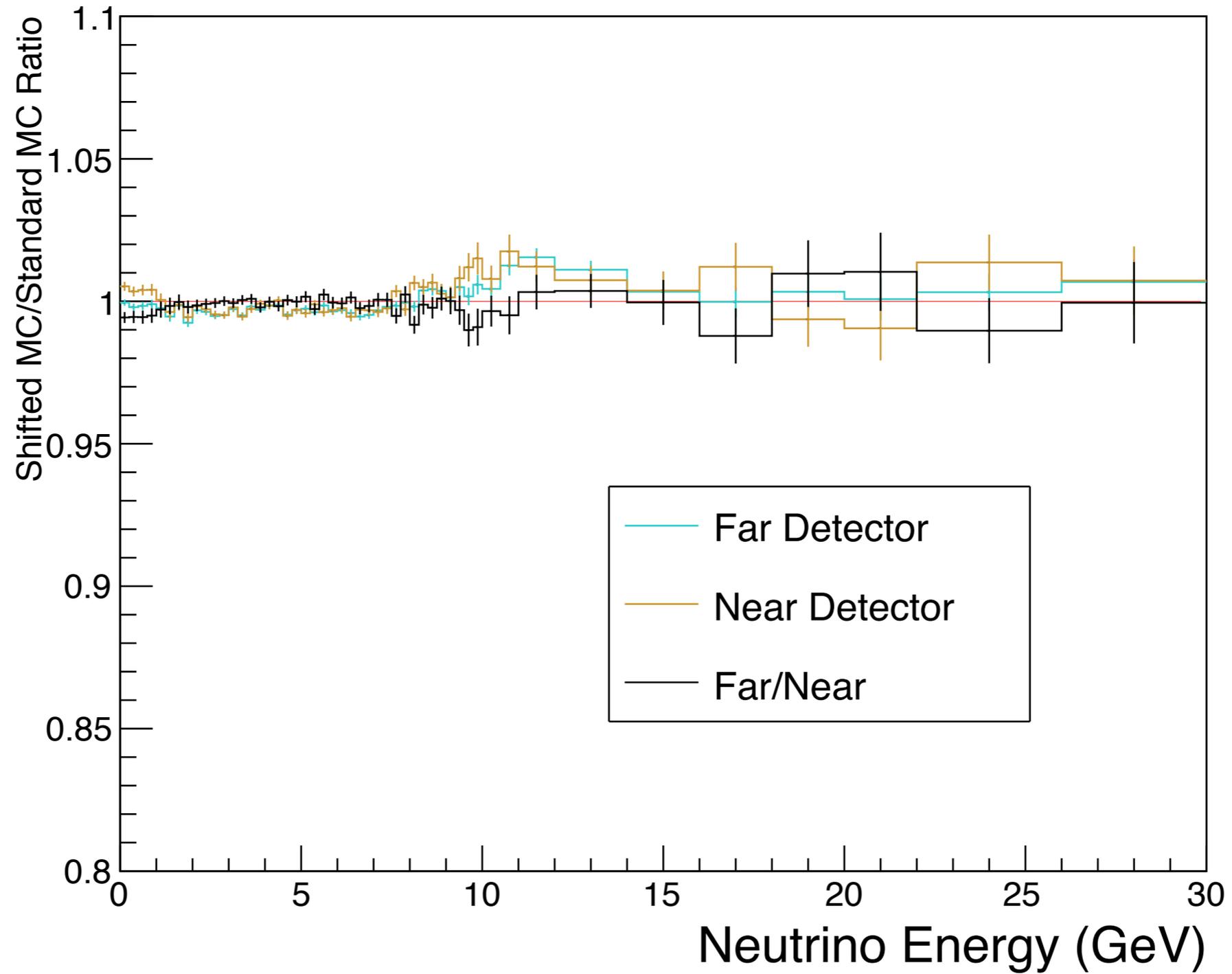
Beam Shifted $y = -0.5\text{mm}$ Relative to Standard



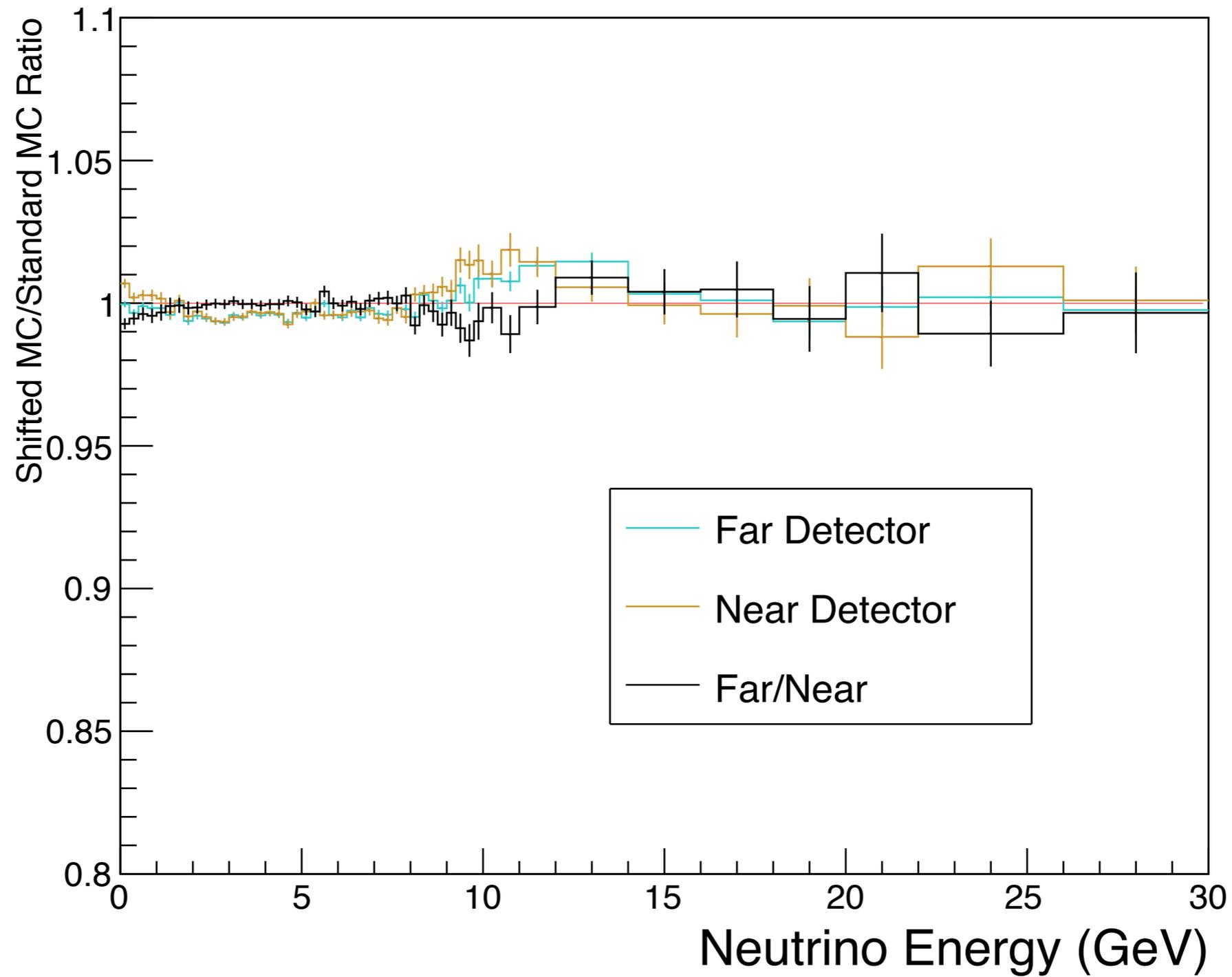
Beam Shifted $y = +0.5\text{mm}$ Relative to Standard



Beam Shifted $x = -0.5\text{mm}$ Relative to Standard



Beam Shifted $x= +0.5\text{mm}$ Relative to Standard



Beam Position

Conclusions

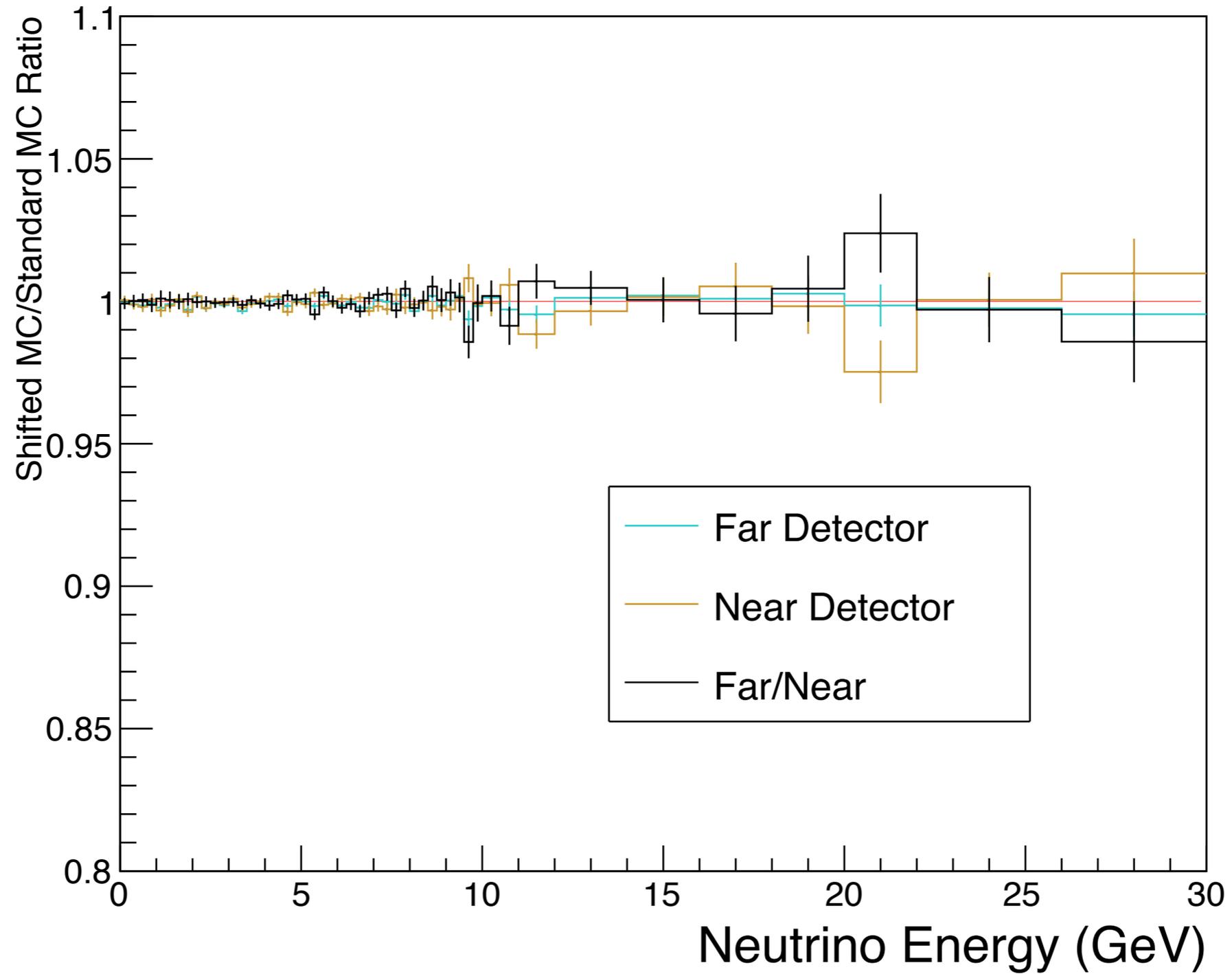
- Y-Direction: a shift to $y = -0.55\text{mm}$ produces a deficit in the right region but it is not significant enough to account for that seen in data
- ◆ See a small excess in between 5 and 12 GeV for a shift to $y = +0.55\text{mm}$
- X-Direction: Little difference between shifts as expected due to the target's symmetry about the y-axis.

Notes on Divergence Simulations

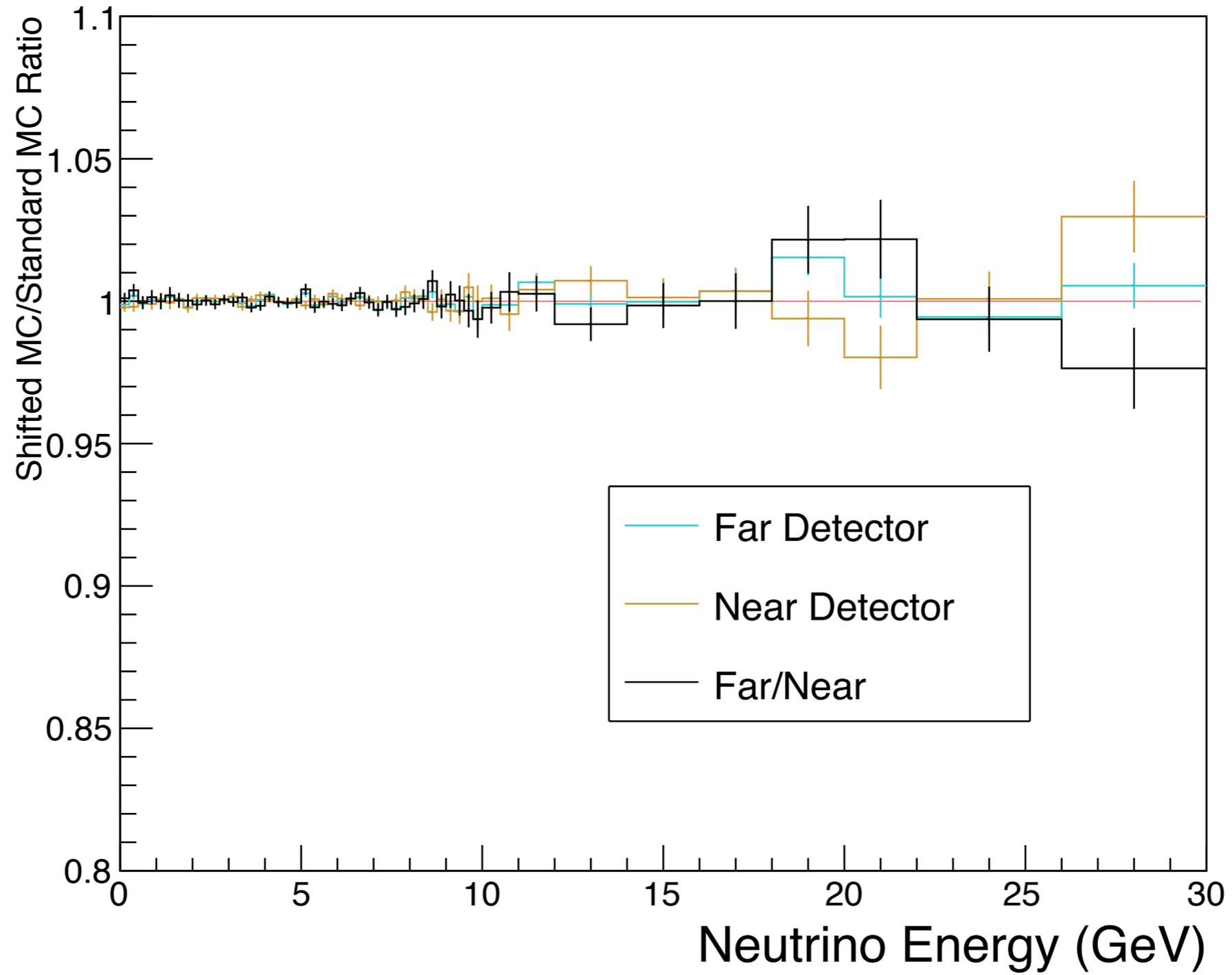
- Using FLUKA 08
- Horn current was set to 200 kA
- All targets were at $z = -20\text{cm}$
- Standard Beam Spot = 1.3×1.3
- Standard Divergence = -0.02355
- Simulated Divergence = -0.017
- Second Simulated Beam Spot = 1.1×1.1

Divergence Ratio Plots

1.3x1.3 Beam Spot and Div = -0.017 Relative to Standard



1.1x1.1 Beam Spot and Div = -0.017 Relative to 1.1x1.1 Beam Spot and Div = -0.02355



Divergence Conclusions

- There is no significant difference due to changing the divergence, and below 13 GeV the spectra of equal spot size but different divergence are nearly identical.