

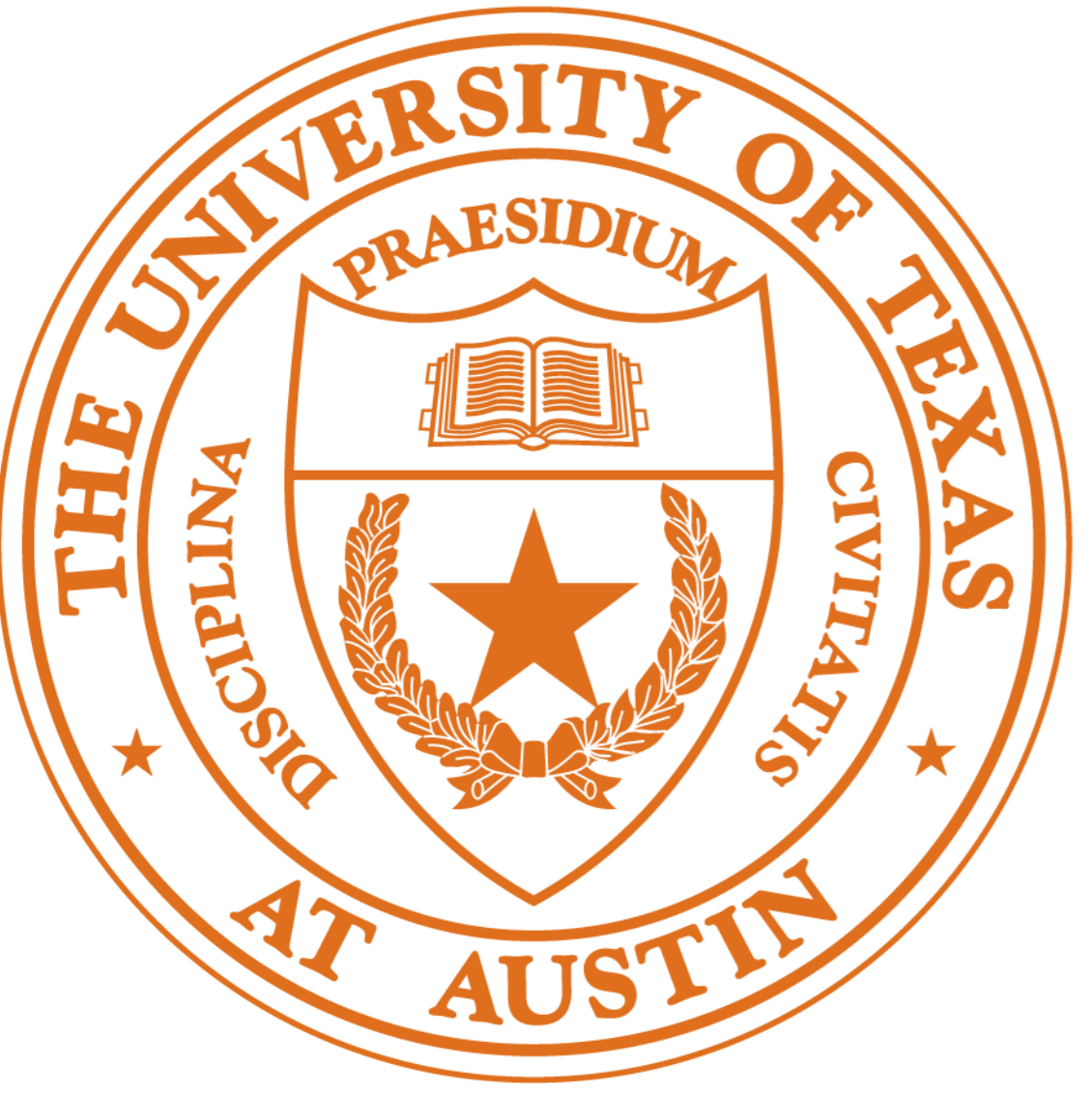


Three Flavor Oscillation Results

from MINOS and MINOS+

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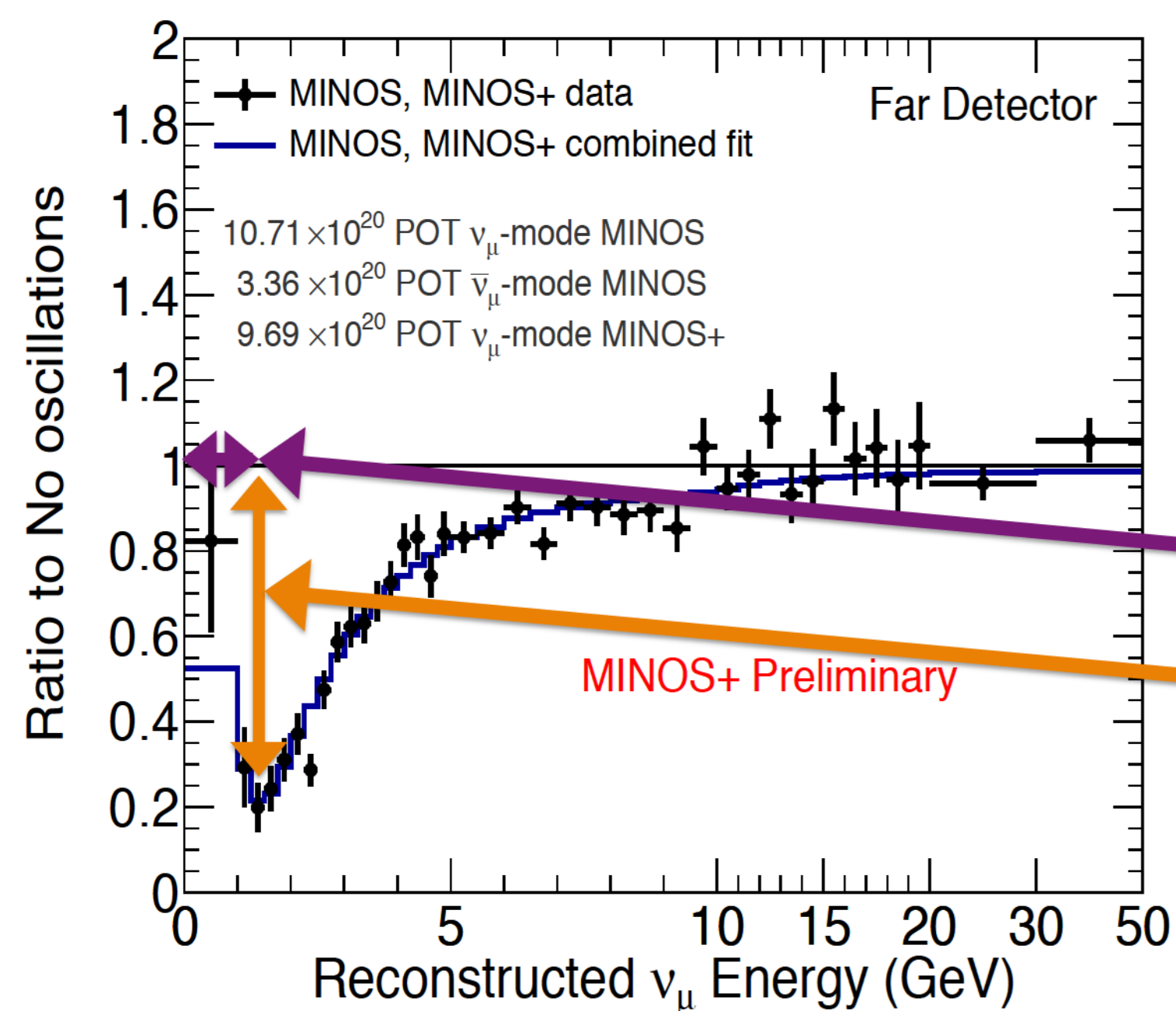
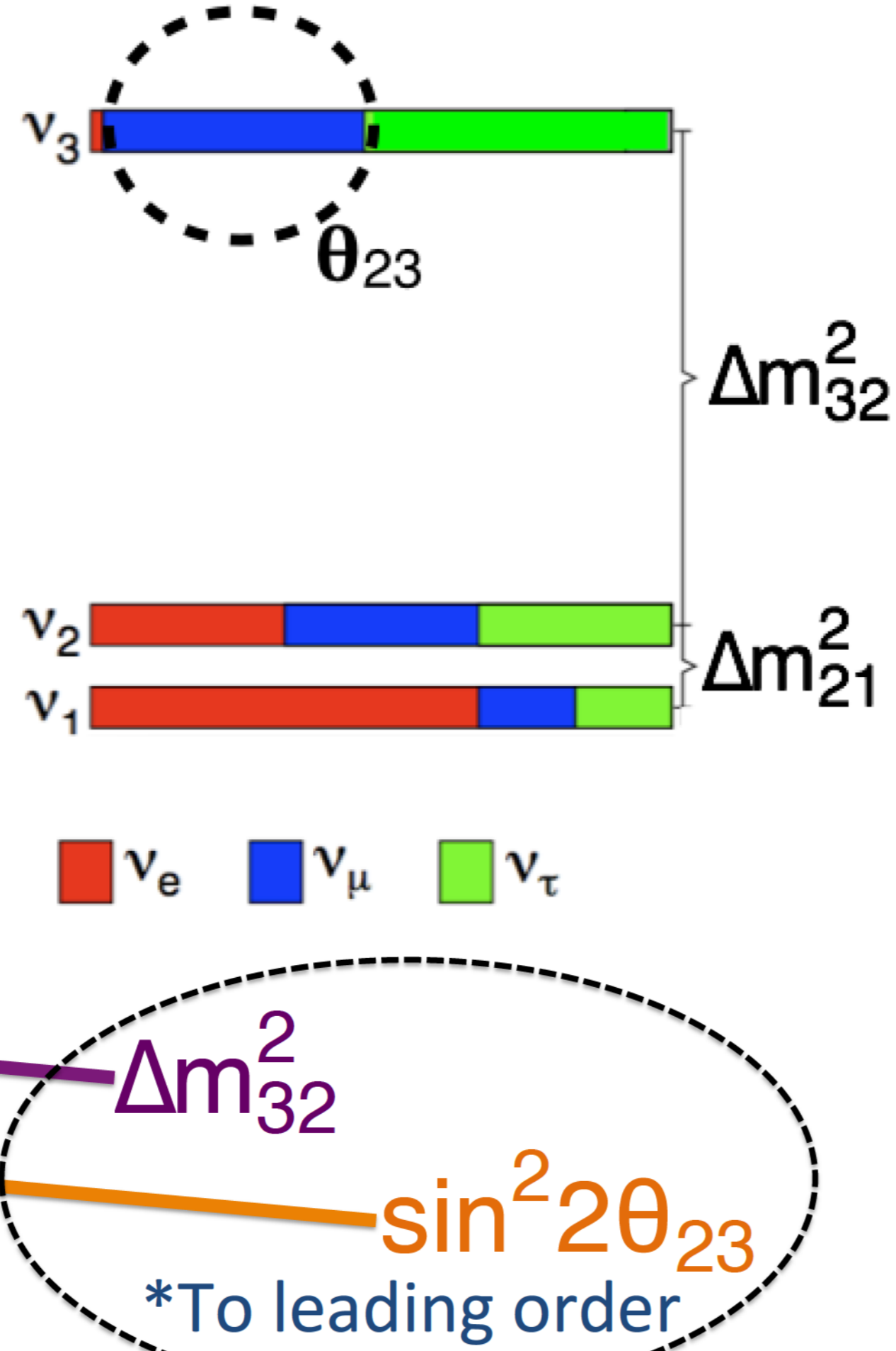
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²Lancaster University, ³University of Dallas
 On behalf of the MINOS+ Collaboration



Muon Neutrino Disappearance

In the 3-flavor model:

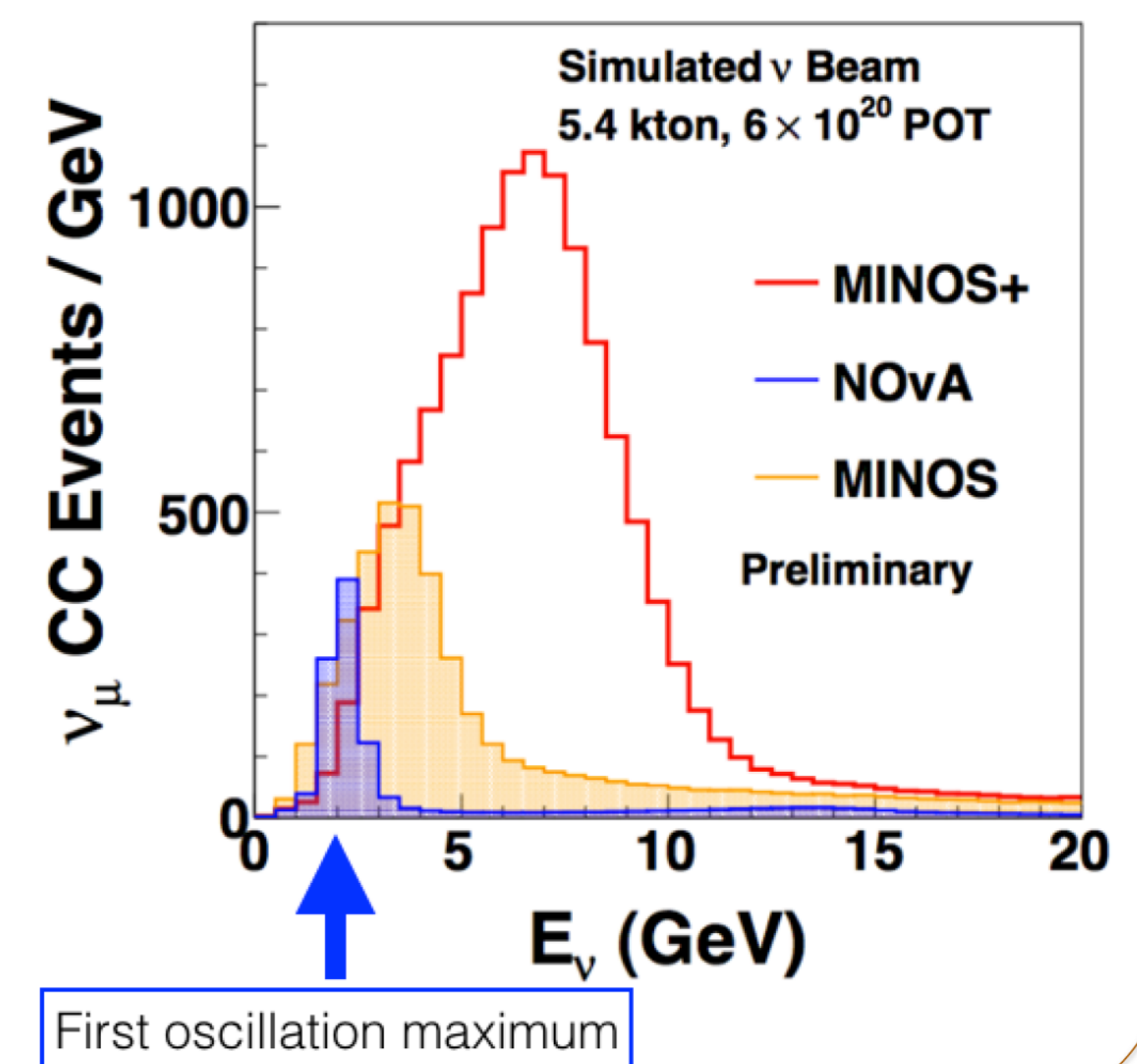
- Six parameters describe oscillation probabilities
- Muon neutrino disappearance is sensitive to Δm_{32}^2 and θ_{23}
- Seen through the survival probability



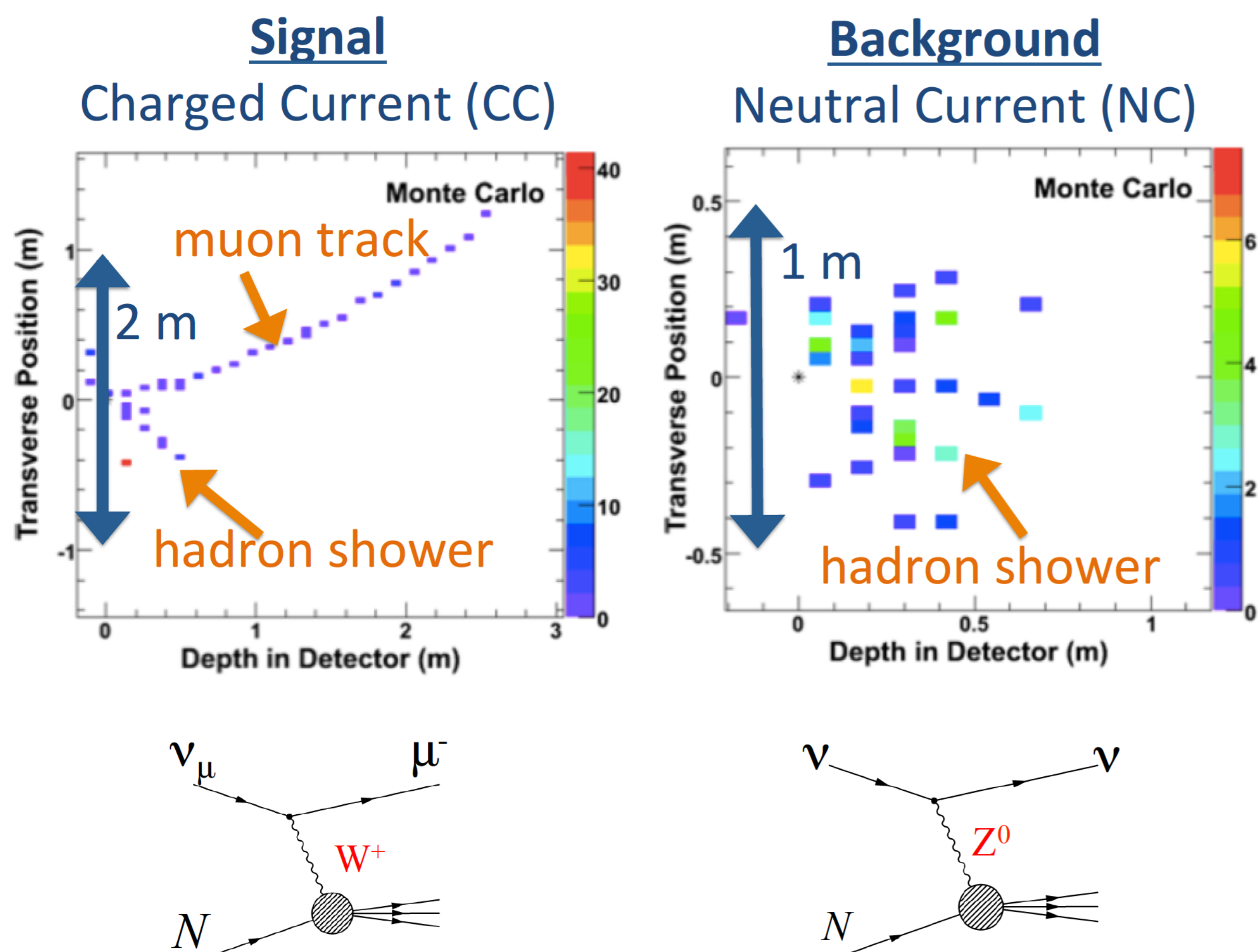
MINOS+



- Long-baseline neutrino oscillation experiment (on-axis)
- MINOS detectors in the medium energy NuMI beam
- Two magnetized steel-scintillator tracking sampling calorimeters



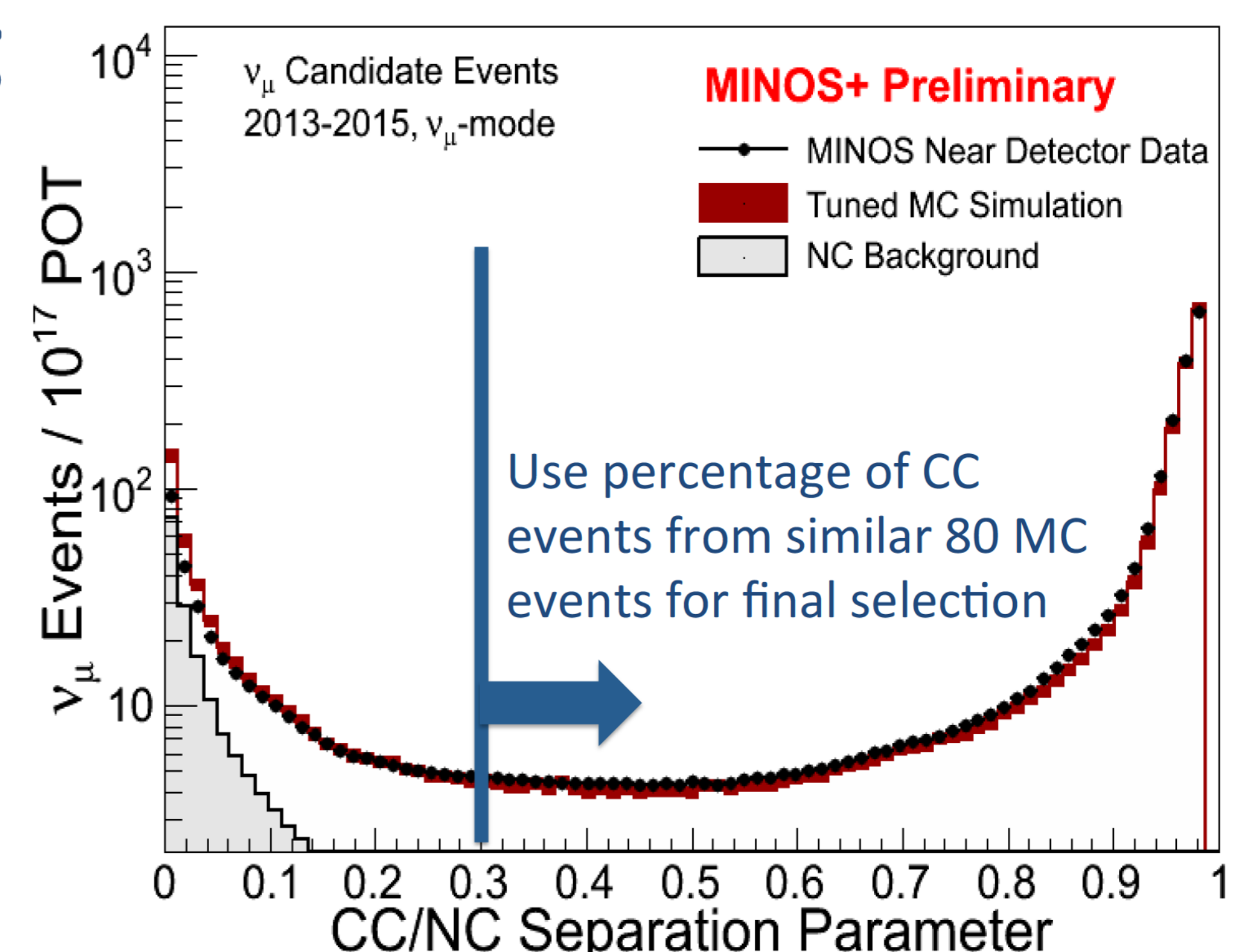
Event Selection



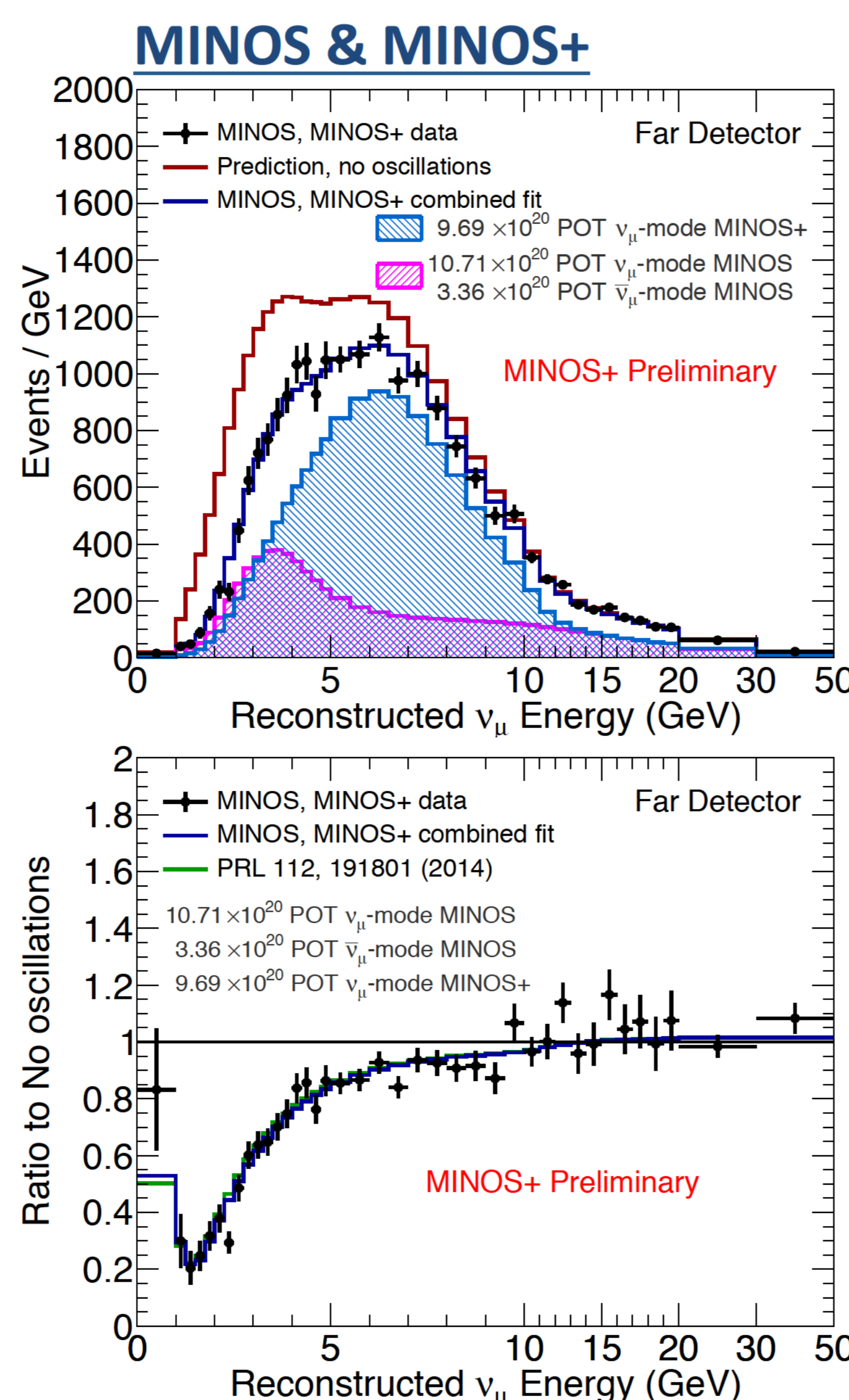
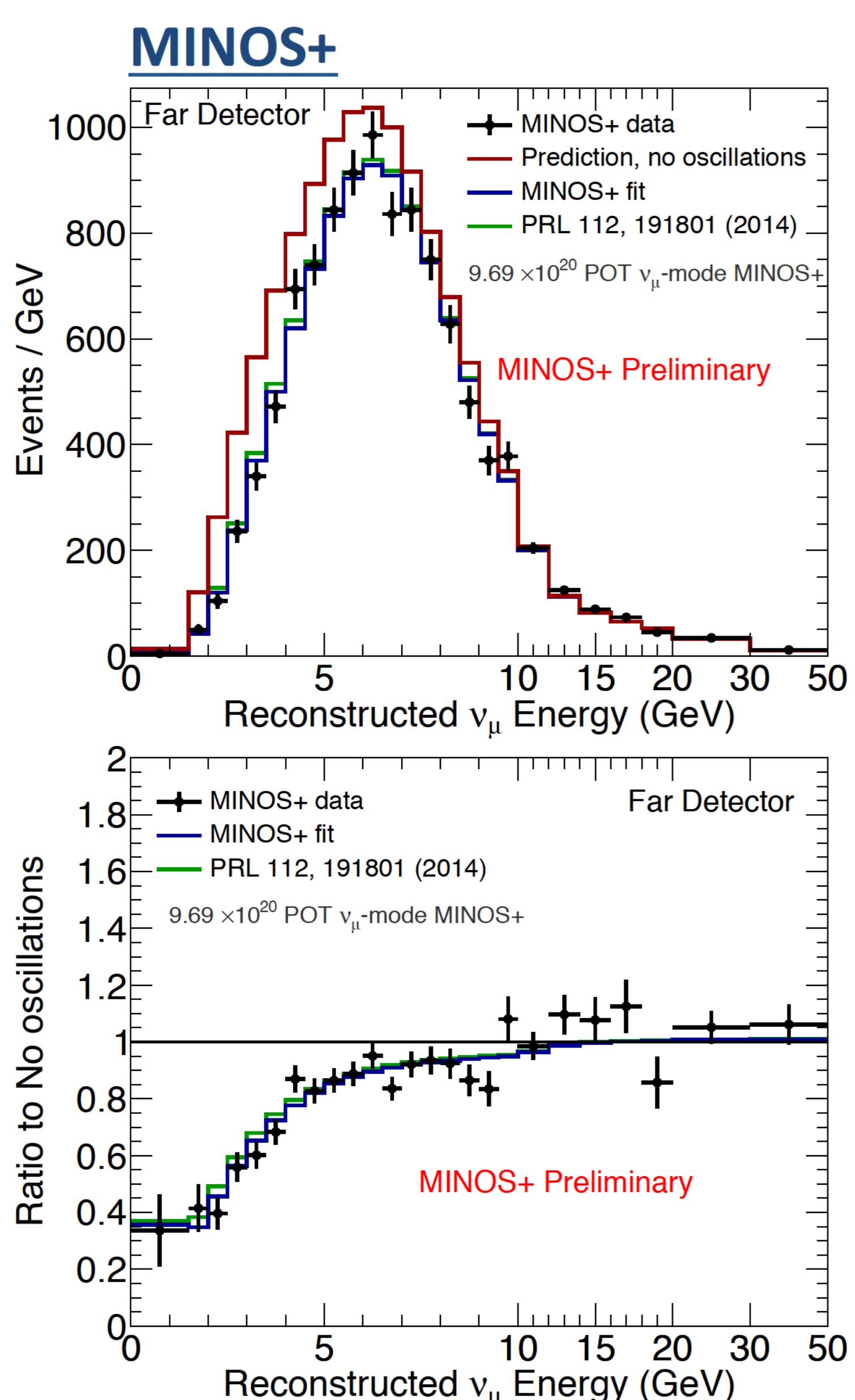
Events are selected using a multivariate k-nearest-neighbor algorithm

Comparison Variables

- Energy profile
- Number of active planes
- Track energy fluctuation
- Average track pulse-height per plane



New Results



Best Fit

Normal Hierarchy
 $\Delta m_{32}^2 = 2.42 \times 10^{-3} \text{ eV}^2$
 $\text{Sin}^2\theta_{23} = 0.42$

Confidence Limits

Mass Splitting ($\times 10^{-3} \text{ eV}^2$)

NH: $2.33 < \Delta m_{32}^2 < 2.50$

IH: $2.38 < \Delta m_{32}^2 < 2.55$

Mixing Angle

NH: $0.37 < \text{Sin}^2\theta_{23} < 0.65$

IH: $0.36 < \text{Sin}^2\theta_{23} < 0.65$

Preferences ($\Delta\chi^2$)

Normal Hierarchy: 0.06

Lower Octant: 0.65

Non-Maximal Mixing: 1.27

