Available online at www.sciencedirect.com

SciVerse ScienceDirect

Nuclear Physics B (Proc. Suppl.) 229–232 (2012) 435

NUCLEAR PHYSICS B PROCEEDINGS SUPPLEMENTS

www.elsevier.com/locate/npbps

Track and Shower Energy Resolution in the MINOS Charged Current Analysis

C. Backhouse[a], J. Mitchell[b], for the MINOS Collaboration

[a] *Subdepartment of Particle Physics, University of Oxford, Oxford OX1 3RH, United Kingdom.*
[b] *Cavendish Laboratory, University of Cambridge, J.J Thomson Avenue, CB3 0HE, United Kingdom.*

Abstract

We present analysis improvements made for the MINOS 2010 ν_μ disappearance measurement. These consist of an improved shower energy estimator, and a parametrisation of the event energy resolution. The parametrisation is used to divide the Far Detector energy spectrum into bins of resolution. The sensitivity gain from these improvements is equivalent to 10^{20} protons-on-target of additional data taking.

Keywords: neutrino oscillations, charged current, energy resolution, MINOS

The MINOS 2010 ν_μ analysis, in addition to the further 3.73×10^{20} protons-on-target collected since the previous result [1], implements several analysis improvements, two of which are presented here.

A new energy estimator using kNN techniques has replaced the previous calorimetric method used by MINOS to determine the hadronic energy in an event. A 3-dimensional space is defined using the number of planes in the primary shower, the shower energy within one metre of the track vertex, and the total calorimetric energy in the primary and secondary showers. For each data event, the nearest Monte Carlo events in this space are found and the average of their true energies is taken as the reconstructed shower energy. Compared to the calorimetric estimator, the kNN method achieves significantly better resolution at low energies.

Additionally, oscillation sensitivity can be improved by separating Far Detector data events by energy resolution. Monte Carlo simulation is used to obtain distributions of reconstructed minus true energies of events in bins of reconstructed energy. The widths of these distributions provide a parameterized form of the resolution as a function of reconstructed energy:

$$\sigma_{\rm shw}/E = 40.4\%/\sqrt{E} \oplus 8.6\% \oplus 257{\rm MeV}/E$$
$$\sigma_{\rm trk}/E = 5.1\%/\sqrt{E} \oplus 6.9\%$$

Selected data events are divided into five quantiles of resolution according to $\sigma^2_{\rm tot} \equiv \sigma^2_{\rm shw} + \sigma^2_{\rm trk}$ by cuts trained as a function of energy.

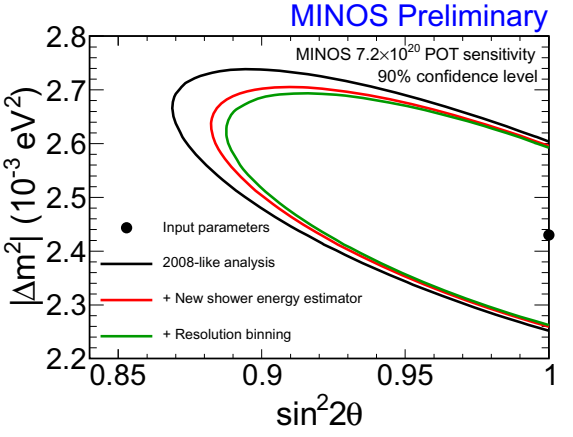

Figure 1: Sensitivity improvement from successive analysis improvements: the kNN shower energy estimator (red), and the further improvement obtained by fitting the Far Detector energy spectra divided into bins of energy resolution (green).

The improvement in oscillation sensitivity resulting from the kNN shower energy, and the further improvement from binning in resolution are shown in Figure 1. The total improvement in Δm^2 is equivalent to 10^{20} protons-on-target of additional data taking.

[1] P. Adamson et al.(MINOS) Phys. Rev. Lett. **101** 131802 (2008)

0920-5632/$ – see front matter
doi:10.1016/j.nuclphysbps.2012.09.072