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Measurement of the Muon Charge Ratio in MINOS

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MINOS is the first large underground detector with a magnetic field. Thus it will be the first experiment to have large statistical measurement of the charge ratio relevant to high energy (TeV) muons.

1. Introduction

The MINOS far detector in the Soudan mine is the first large neutrino detector underground that also has a magnetic field. As such, it is the first detector capable of measuring the muon charge ratio underground. With a minimum overburden of 2070 MWE, the relevant muon energy at the surface corresponds to $p_\mu > 400$ GeV. At energies below 10 GeV, the muon charge ratio has been measured to be 1.2 to 1.25, with more positives since the primary cosmic ray is usually a positively charged proton. At higher energies there are many measurements, most recently at LEP(L3+Cosmics)[1], but error bars are 10% or higher due to the difficulty in measuring the charge at high momentum. Since MINOS will detect more than 10 million muons per year, and the overburden acts as a momentum filter, we will be able to measure the charge ratio at these high momenta with unprecedented accuracy.

2. The MINOS detector

MINOS is a long-baseline neutrino oscillation experiment designed to study ν_μ disappearance and $\nu_\mu \rightarrow \nu_\tau$ oscillations. It uses protons from the Fermilab Main Injector, and put into the new NuMI beamline which began operations in 2005. The MINOS detectors consist of a one kiloton near detector, located at Fermilab, and a 5.4 kiloton iron magnetized calorimeter operating at the Soudan mine in northern Minnesota. It is described in more detail in References [2] and [3].

3. Analysis

The analysis of cosmic ray muons is underway, and a preliminary measurement of the charge ratio will be available soon. Initial distributions of cosmic ray muons agree well with simulations.[4]

References

[1] $http://l3cosmics.cern.ch:8000/l3c\_www/paper/presentation/tc\_erice\_2000\_trans.pdf$
[2] A. Habig & E.W. Grashorn, for the MINOS collaboration, "The MINOS Detectors", these proceedings.
[3] Douglas Michael, Nuclear Physics B (Proc Suppl.) 118 (2003).
[4] Brian Rebel, "Neutrino-Induced Muons in the MINOS Far Detector," Ph.D. Thesis, Indiana University, August 2004.