



Status of the MINOS experiment

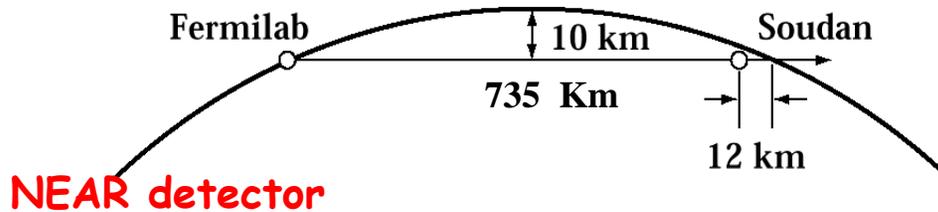
N. Saoulidou, Fermilab
APS April Meeting 2004

Outline

- Experiment overview
- Neutrino Beam
- MINOS Detectors
 - Far Detector
 - Near Detector
- Physics Goals
- Summary & Conclusions

MINOS Experiment

- MINOS (**M**ain **I**njector **N**eutrino **O**scillation **S**earch) is a two detector long baseline neutrino oscillation experiment.
- Its goal is to study the region of parameter space indicated by atmospheric neutrino experiments.



- Measure & study the unoscillated neutrino beam composition and energy spectra.

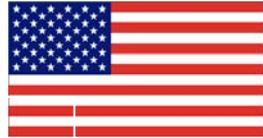
- Serve mainly as a reference to the FAR detector in order to minimize dependence on Monte Carlo.

FAR detector

Study the oscillated neutrino beam composition and energy spectra.

Comparison between Near/Far measurements will establish the oscillation signal and characteristics

MINOS Collaboration



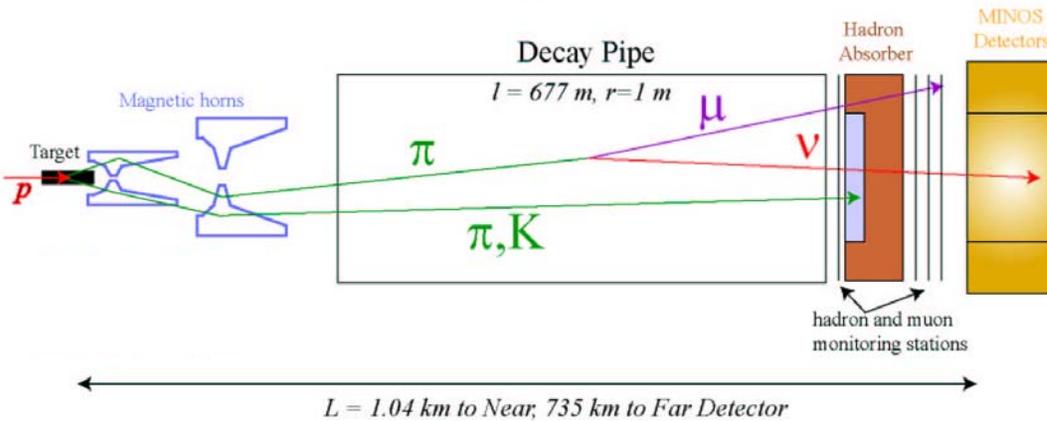
31 institutions
175 physicists



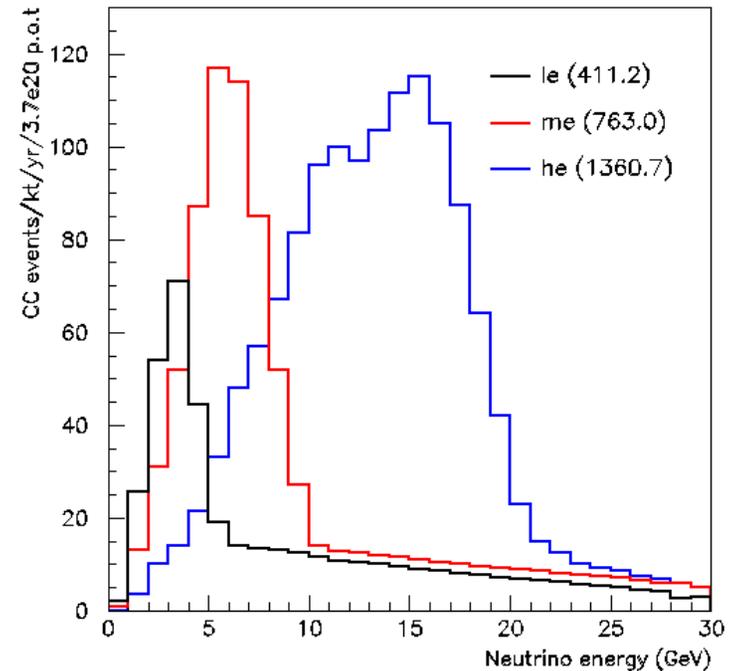
Argonne • Athens • Brookhaven • Caltech • Cambridge • Campinas • Fermilab
College de France • Harvard • IIT • Indiana • ITEP-Moscow • Lebedev • Livermore
Minnesota-Twin Cities • Minnesota-Duluth • Oxford • Pittsburgh • Protvino • Rutherford
Sao Paulo • South Carolina • Stanford • Sussex • Texas A&M
Texas-Austin • Tufts • UCL • Western Washington • William & Mary • Wisconsin

NUMI Neutrino Beam

- 120 GeV/c protons strike graphite target
- Magnetic horns focus charged mesons (pions and kaons)
- Pions and kaons decay giving neutrinos



PH2 beam spectra



- 120 GeV protons strike the graphite target
- 10 μs spill with 1.9 second cycle time
- 4×10^{13} protons/pulse
- Initial intensity $\sim 2.5 \times 10^{20}$ protons/year

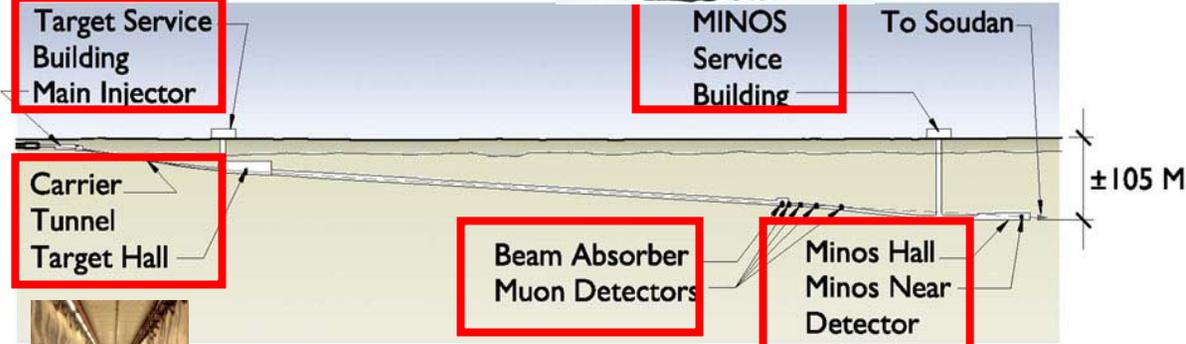
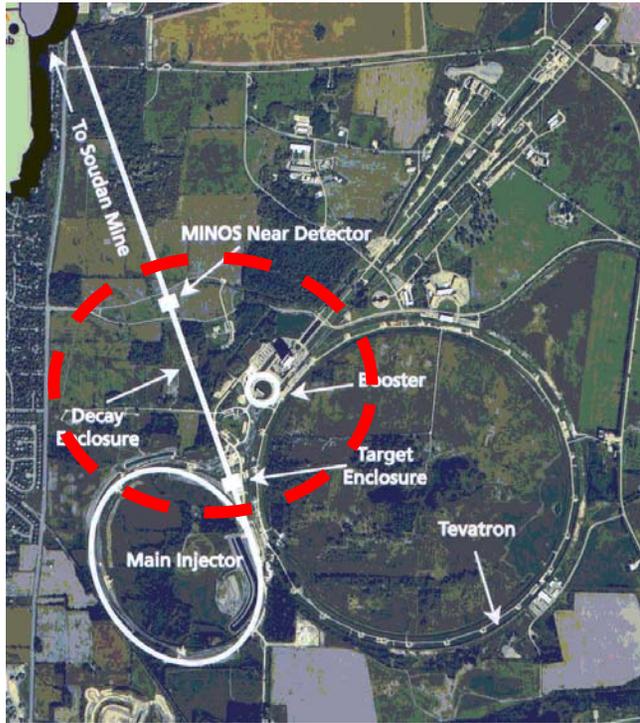
Details on monitoring the neutrino beam on D. Indurthy's talk : session J2

Details on the status of the NUMI neutrino beam on B. Zwaska's talk : session J2

- MINOS will start taking beam data with the low energy configuration.

- For 2.5×10^{20} protons/year we expect $\sim 1600 \nu_{\mu}$ CC events/year in the FAR detector.

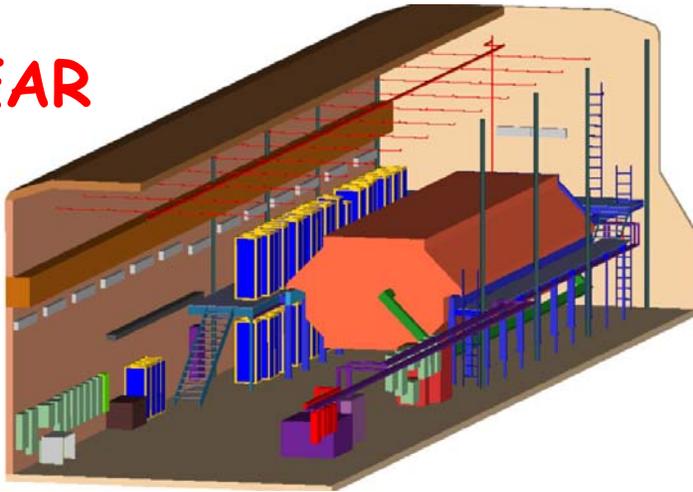
NUMI Beamline Civil Construction Status



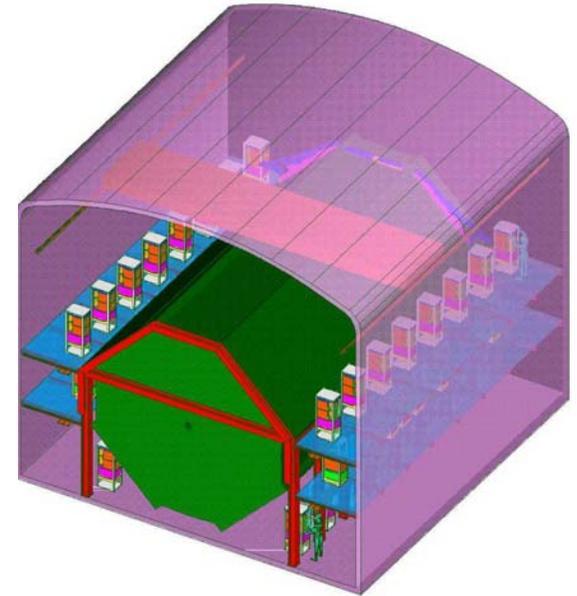
- Extraction room carrier tunnel : Complete June 2003
- Target service building (MI-65) : Complete October 2003
- Target hall, pre target, support rooms : Complete >> >>
- Absorber hall & Access tunnel, Muon Alcoves : Complete >> >>
- MINOS service Building : Complete February 2004
- MINOS Shaft, MINOS Hall : Complete February 2004
- **MINOS NEAR DETECTOR INSTALLATION : Started APRIL 2004 !**

The MINOS Detectors

NEAR



FAR



- **Basic Idea : Two detectors "identical" in all their important features.**
- Both detectors are tracking calorimeters composed of interleaved planes of steel and scintillator
 - 2.54 cm thick steel planes
 - 1 cm thick & 4.1 cm wide scintillator strips
 - 1.5 T toroidal magnetic field.
 - Multi-Anode Hamamatsu PMTs (M16 Far & M64 Near)
 - Energy resolution: $55\%/\sqrt{E}$ for hadrons, $23\%/\sqrt{E}$ for electrons
 - Muon momentum resolution $< 6\%$ from range ($< 12\%$ from curvature or range)

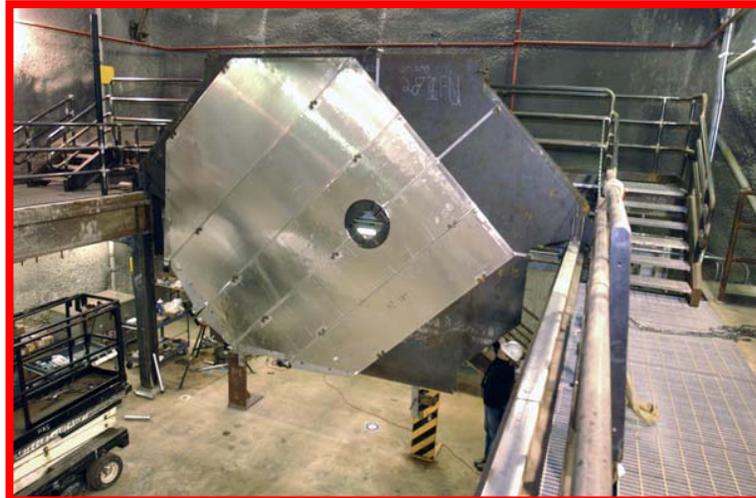
MINOS Far Detector



- 5.4 kton
- 710 m underground
- 486 8m octagonal steel planes
- 484 8m octagonal scintillator planes with double ended readout
- 2 SM, each 15m long

• The FAR detector (along with the cosmic ray veto shield) is **COMPLETE**, has been commissioned using cosmic muons and is now taking atmospheric neutrino data (Details on B. Rebel's talk on upward going muons : session B10).

MINOS NEAR Detector Installation



- 1 kton
- 100 m underground
- 282 3.8m x 4.8m 'squeezed' octagonal steel planes
- 153 scintillator planes with single ended readout
- 1 Module, 16m long

• The **NEAR** detector **installation** has just started (a few weeks ago) and is expected to finish at **October 2004**. The coil installation is expected to finish at **November 2004** and the first neutrino beam is expected at **December 2004**.

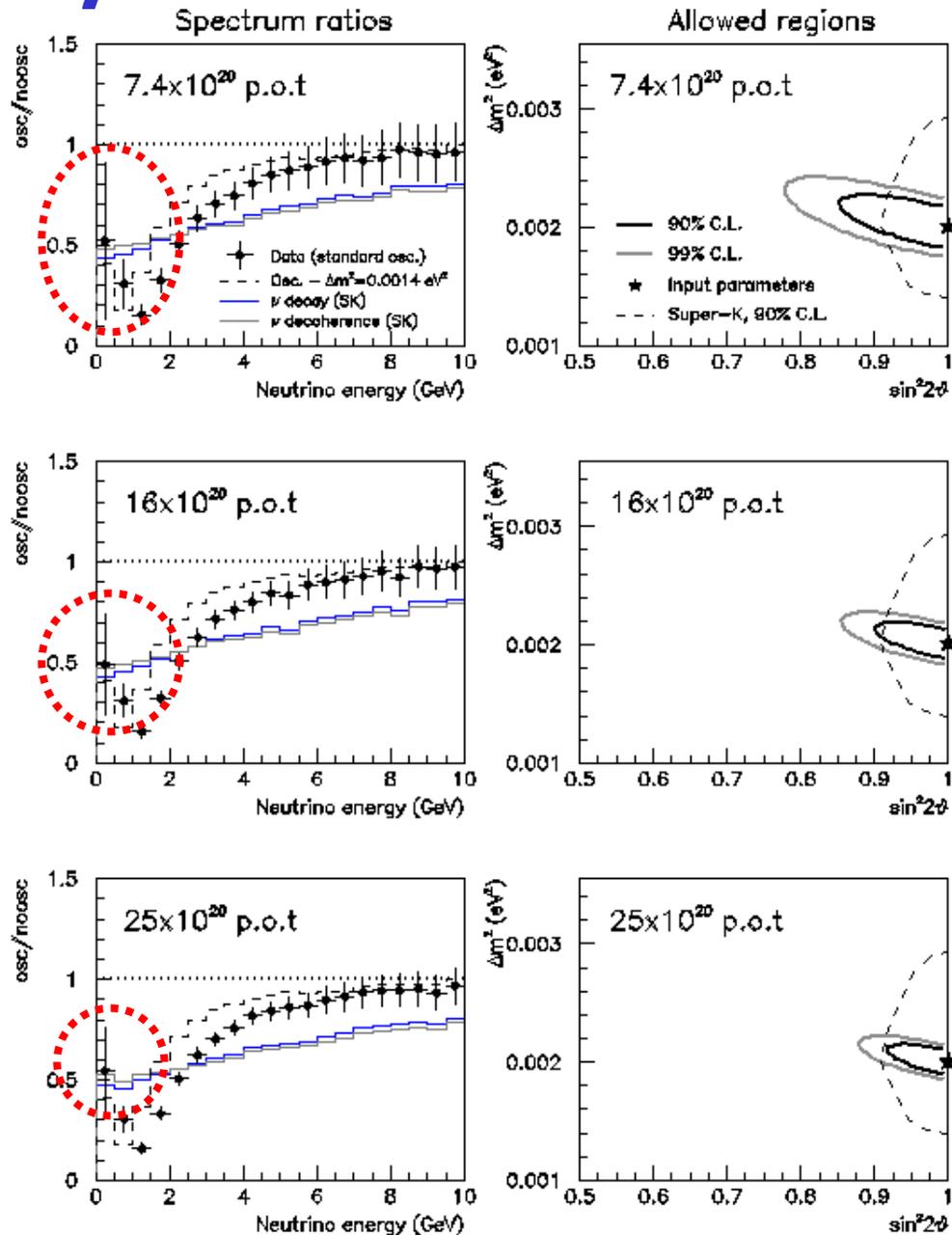
MINOS Physics Goals

- The study and comparison of ν_μ CC interactions between the NEAR and FAR detector will allow us to:

- Demonstrate the oscillation phenomenon (ν_μ disappearing from the beam)

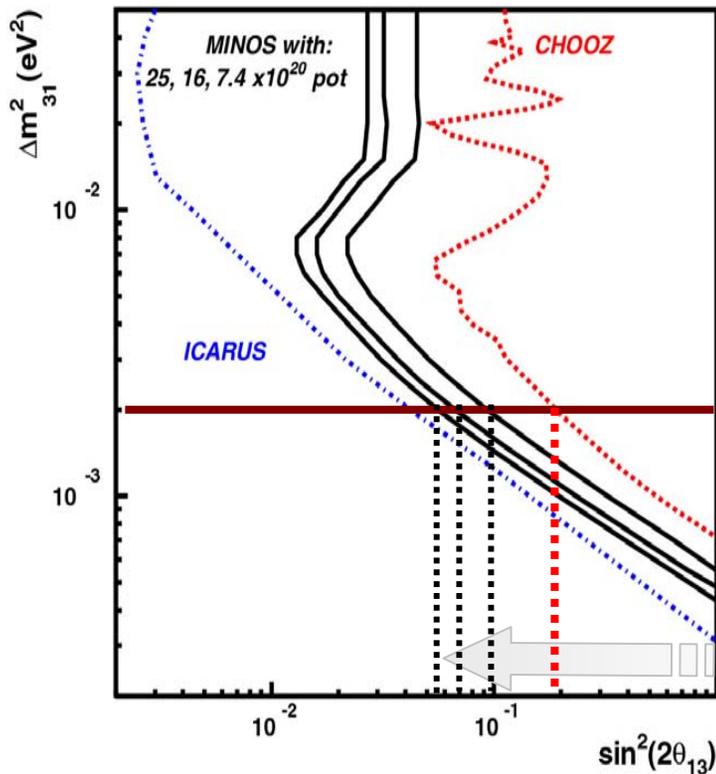
- Obtain precise measurements of the oscillation parameters, Δm_{23}^2 and $\sin^2 2\theta_{23}$ ($< 10\%$)

- The more protons on target we get, the more precise the measurement of the oscillation parameters will be!

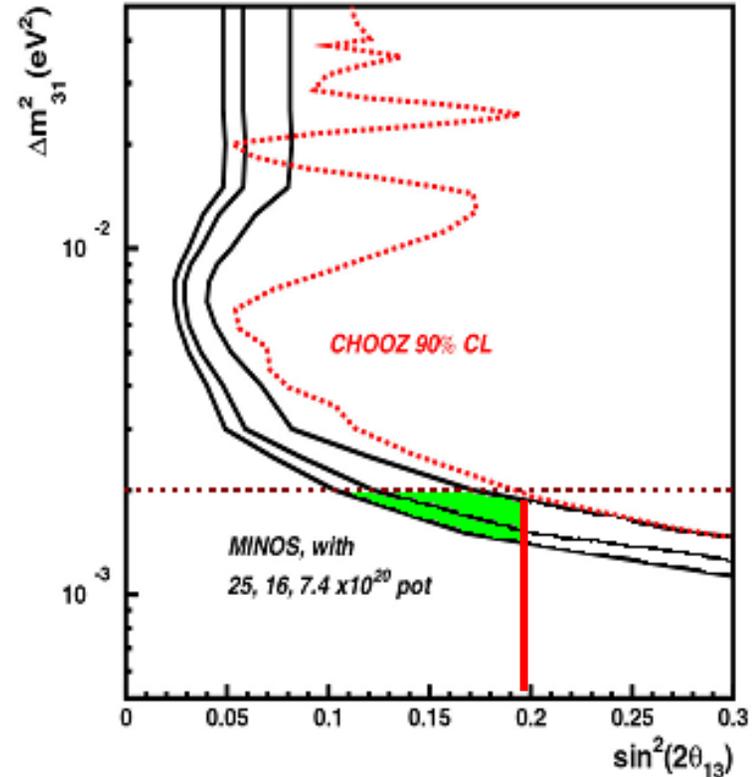


MINOS Physics Goals

90 % CL exclusion plot



3 σ sensitivity plot



• The study and comparison of ν_e CC interactions in the NEAR and FAR detector :

- Will allow us to improve the current limit of $\sin^2 2\theta_{13}$ by a factor of 2-3...

- Or observe $\nu_\mu \rightarrow \nu_e$

MINOS Physics Goals

- MINOS far detector is collecting **atmospheric neutrino data** for which we can measure:
 - Charge and momentum for muons of 0.5-100 GeV /c, using B field and range.
 - Direction, using timing information.
 - Neutrino flavor & interaction type .

and therefore examine whether ν_μ and $\bar{\nu}_\mu$ oscillate in the same way \iff **test of CPT invariance**

Summary & Conclusions

- The **Far detector** is **complete** and accumulates cosmic ray and atmospheric neutrino data.
- The **NUMI beamline civil construction** is **complete** and the installation is underway.
- The **installation** of the **Near detector** has **started** and is expected to finish at November 2004.
- Lots of **work** on
 - **Calibration** (Details on J.Hartnell's talk session B10) and **MC tuning**.
 - Development and improvement of the **reconstruction software**, and **analysis techniques**.
 - Atmospheric neutrino data **analysis**
 - **Increasing** the **proton intensity**.
- First protons on target expected December 2004 and physics data taking starts in April 2005.