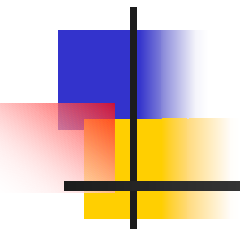
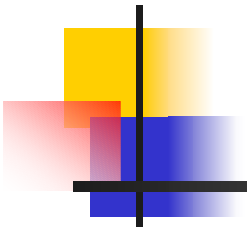
Soudan Operations Review
MINOS Overview



May 14, 2003

Stan Wojcicki

Stanford University

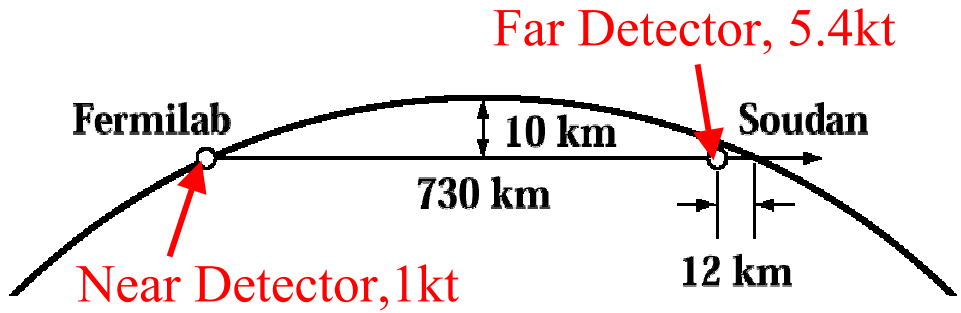


Outline

- Overview of the experiment
- Current status
- Few comments about operations
- Possible future issues

MINOS Experiment

(Main Injector Neutrino Oscillation Study)



The neutrino beam is produced at Fermilab near Chicago. The main detector is located in a former mine in Soudan,MN, about 735 km away

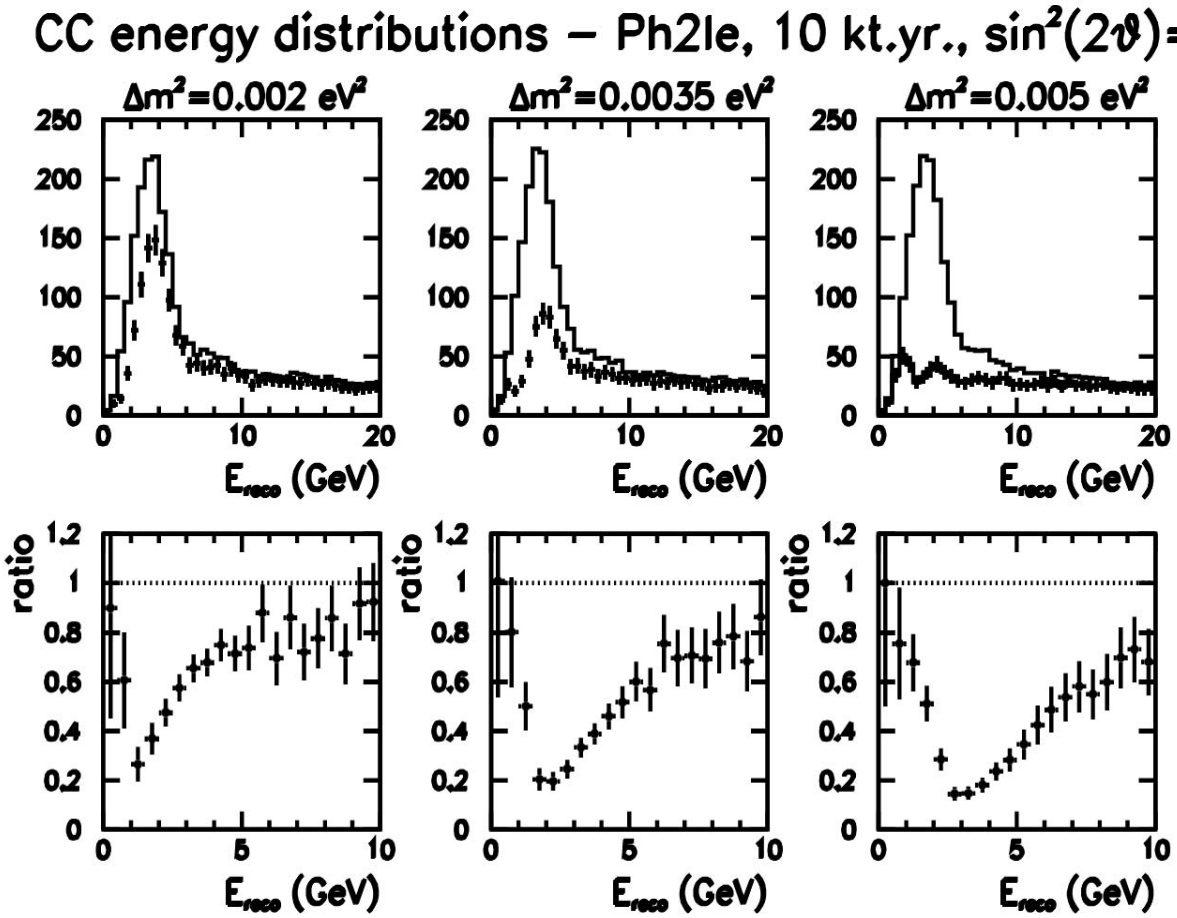
The experiment has thus bthree essential components: the neutrino beam, the near detector and the far detector

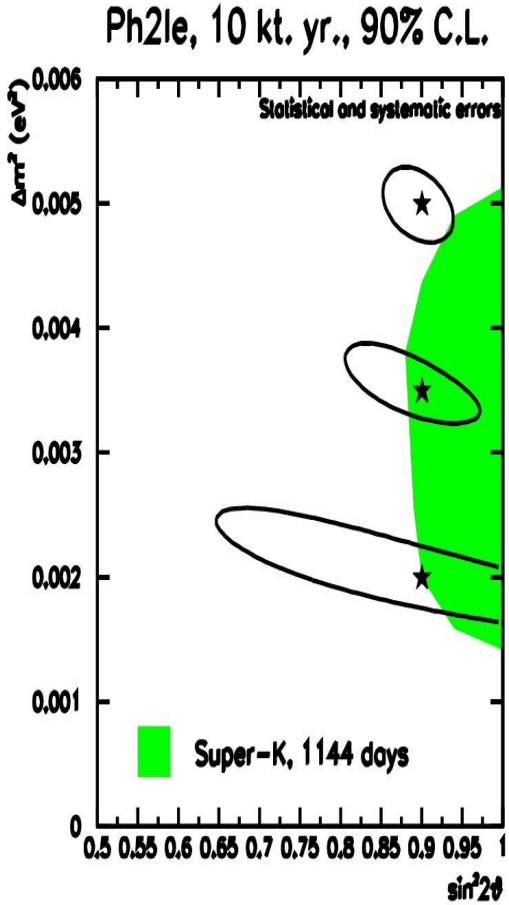
The goal of the experiment is to study transitions between neutrino flavors as the beam propagates over a long distance

MINOS Physics Goals

- Demonstrate Oscillation Behavior
  - –Precise measurement of CC energy distribution between near and far detector (2-4% sys. uncertainty in E_ν per 2 GeV bin).
  - –"Standard" or non-standard oscillations?
    - •Can we see clear "oscillatory" behavior from the first osc. max?
    - •Are there features in the energy spectrum not well described by a standard oscillation?
- Precise Measurement of Oscillation Parameters
- Precise Determination of Flavor Participation
  - –No of CC ν_μ events far/near ~1-2%: Probability for $\nu_\mu - \nu_x$ oscillation (systematics or statistics limited???). Spectrum ratio measurement.
  - –No of CC ν_e events far/near: probability for $\nu_\mu - \nu_e$ oscillation down to about 2% (statistics limited in 10kT-y).
  - –No of NC events far/near: probability for $\nu_\mu - \nu_{sterile}$ oscillation down to about 4% (statistics limited in 10 kT-y).
  - – ν_μ's which disappear but don't appear as ν_e or disappear to $\nu_{sterile}$ must be ν_τ!

Study of Oscillations (ν_μ CC)





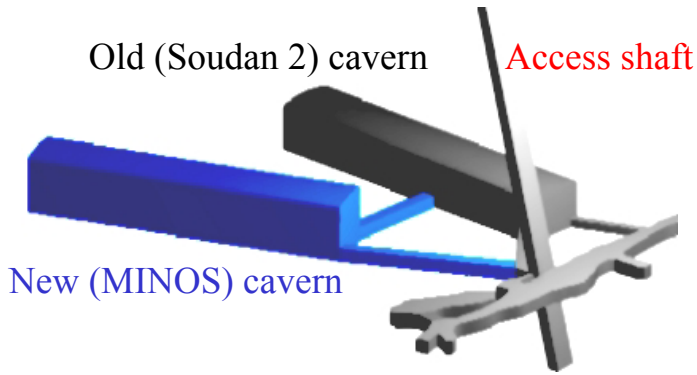
Soudan Underground Lab

Some Relevant Constraints

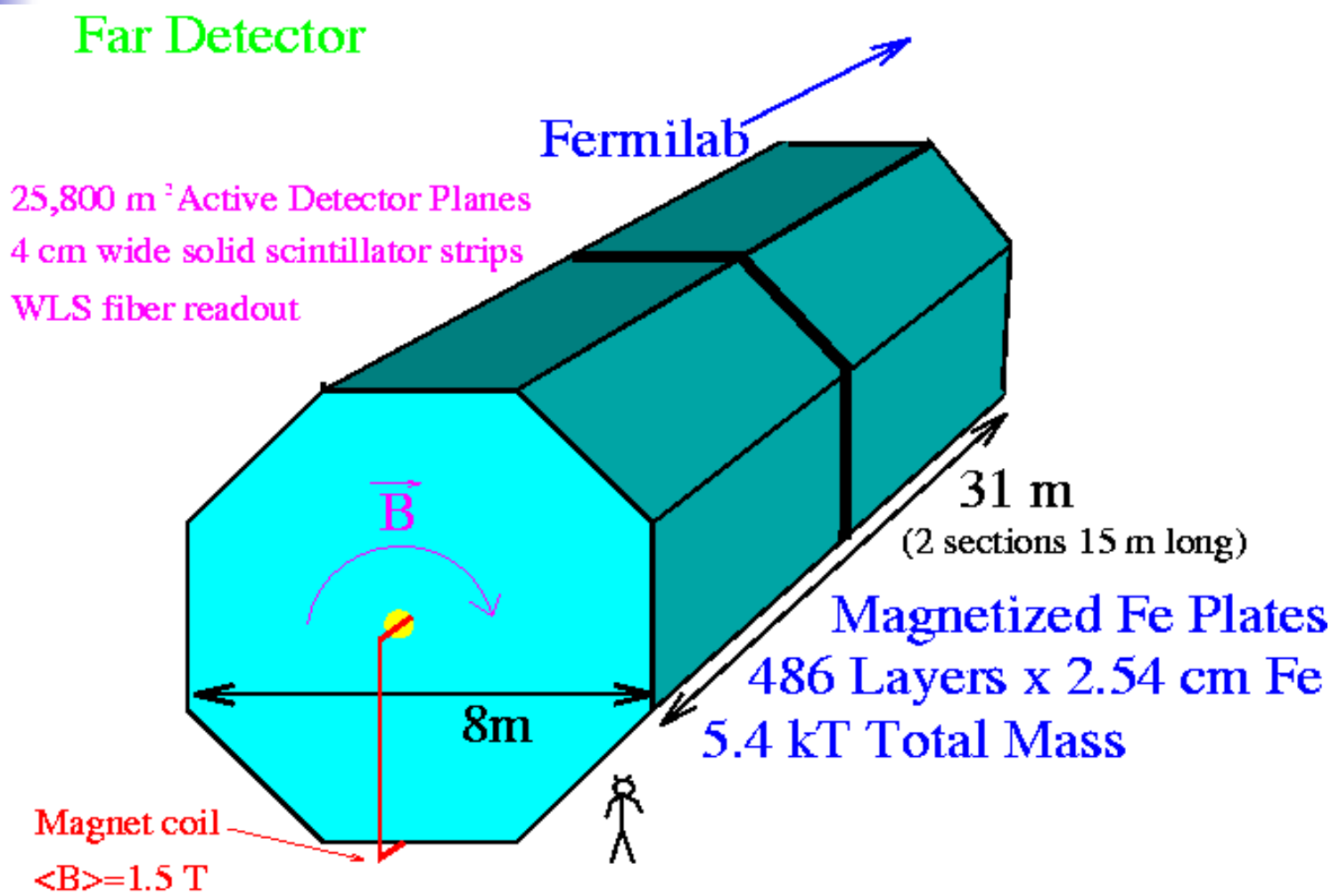
a) The site is remote - minimum 5-6 hours from Fermilab

b) The access is by the cage in the shaft - requires DNR people

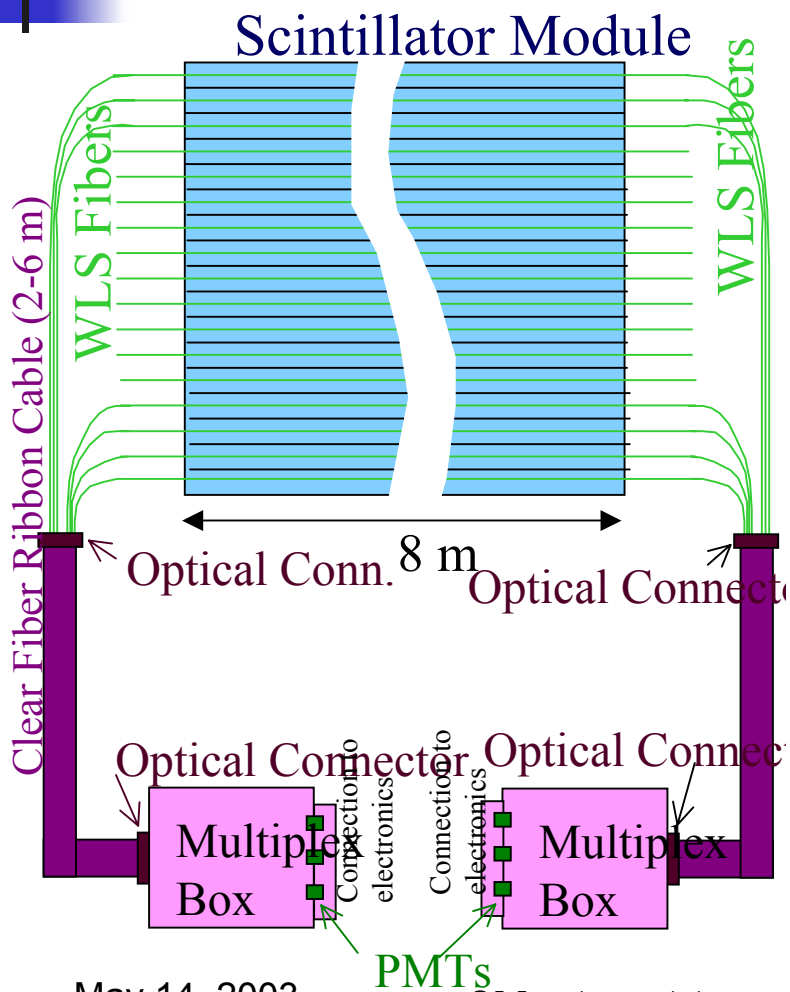
c) For safety reasons people cannot be underground alone

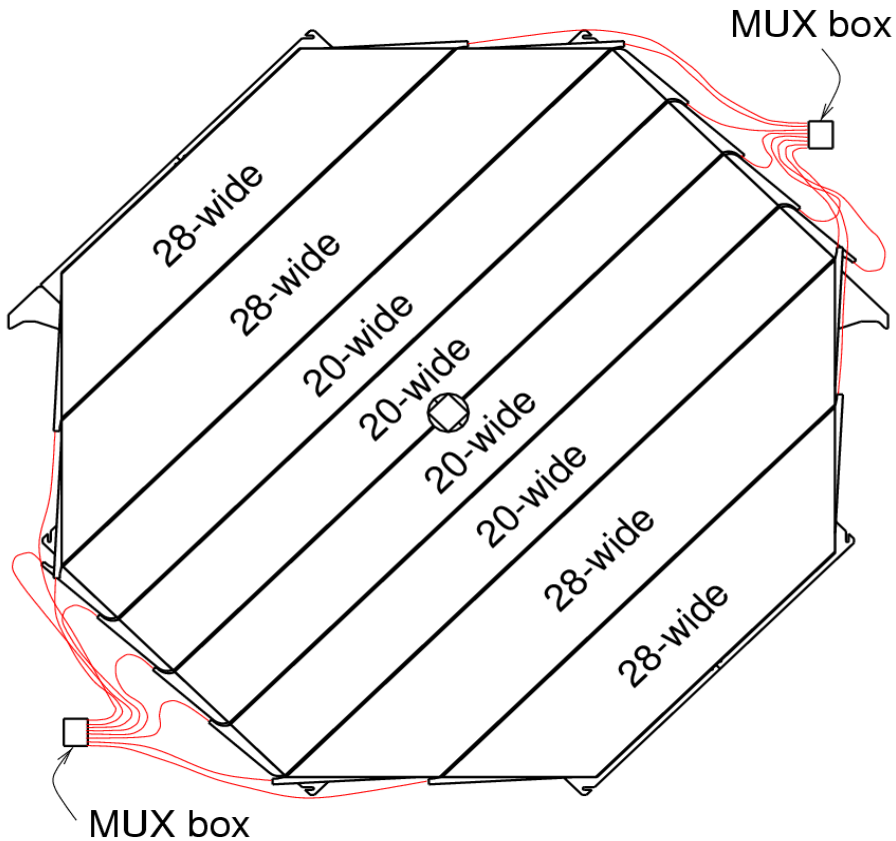


MINOS Far Detector



Detector Technology





Objects not to scale

MINOS Far Detector

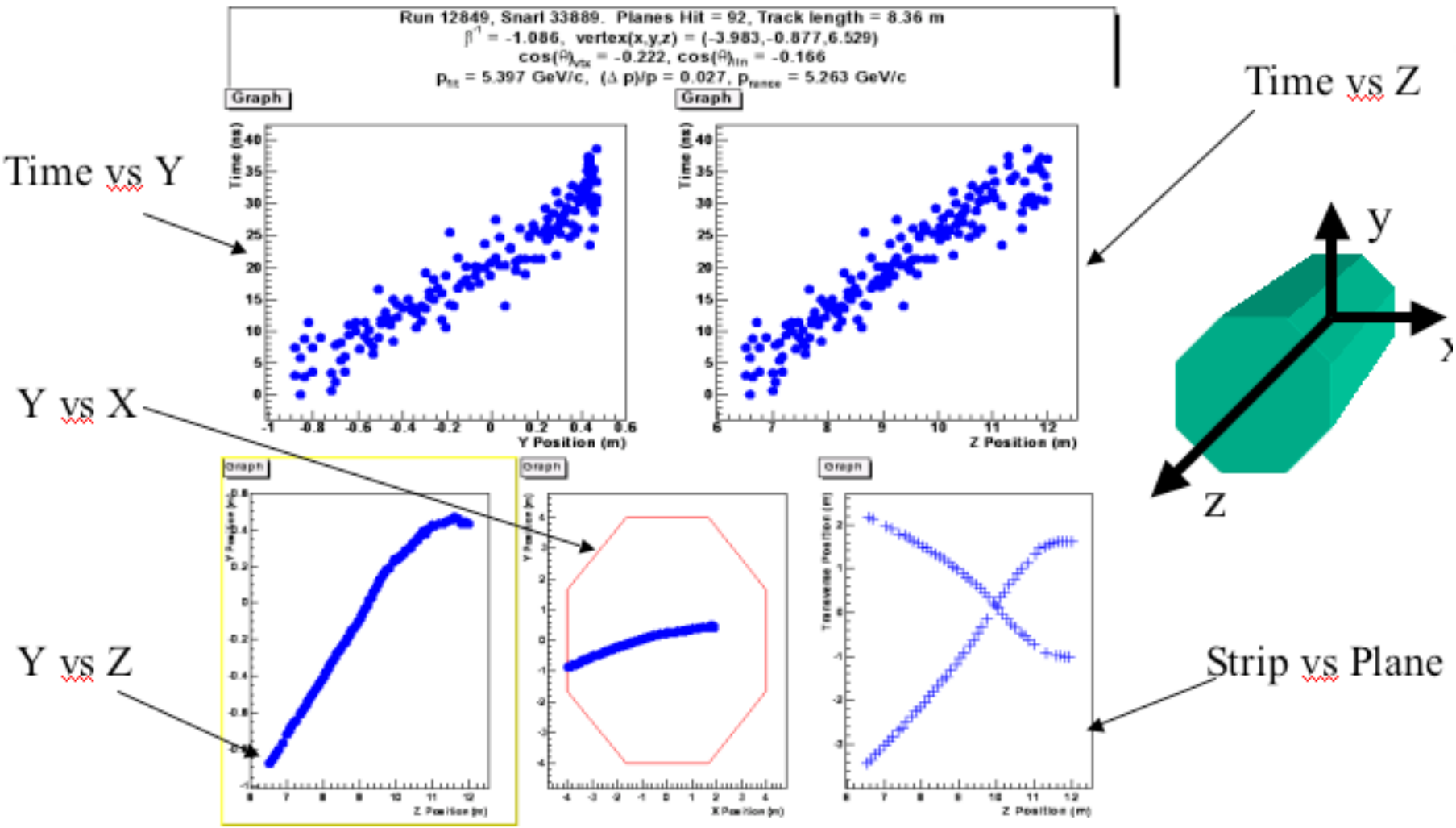
Two early views of the detector.
We have now ~475 planes (out of planned 485) up and taking data

Detector is about 98% complete.
Will be finished end of May '03

MINOS Current Status

- The detector installation went well, ahead of schedule, and is almost complete (more details in next talk)
- Physics data taking commenced when the first supermodule was energized
- We are accumulating a good data sample of cosmic ray events and upward going muons, which can be readily identified
- We have also decided to add a veto shield above the detector to reduce the cosmic ray background in contained event atmospheric neutrino sample

Data are being taken (example of an upward muon)



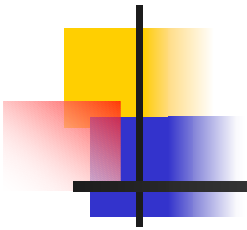
Upward going, and stopping, and through the coil hole

MINOS Schedule

- May, 2003 - last plane installed
- June, 2003 - installation of 2nd coil
- July, 2003 - December, 2004 - data taking with atmospheric neutrinos and cosmic rays utilizing full Far Detector
- January 2005 - start of accelerator neutrino program; continuation of non-accelerator data taking
- Spring 2010 - end of initial MINOS run

Relevant MINOS Features

- MINOS is a relatively simple detector
- There is no gas system
- There are no cryogens
- There are no tapes or equivalent to mount and dismount
- Good data can still be taken with a small fraction (~1%) of the channels non-operating



Operational Goals

- Our aim is for high (>95%) operational efficiency
- We want to take data on 24/7 basis, even when Fermilab accelerator complex is not operating
- One would like to have minimum physicist presence at the Soudan site

History so far

- For the past year or so we have been operating the detector in a mixed physics/installation mode
- Thus it is not surprising that the physics operating efficiency was well below our goals
- Most common reasons for down time:
  - PMT/base failures (?)
  - High Voltage trips
  - Scheduled down time for continuing development of some systems (DAQ, electronics, light injection)

Thoughts re Future Operations

- The period of 1 1/2 yrs of data taking on non-accelerator physics will help us to define optimum mode for eventual operation
- We plan to have remote monitoring/operation capabilities at Fermilab and UK
- Shift physicists (away from Soudan) will have the responsibility to monitor the data and a capability for limited control of operations

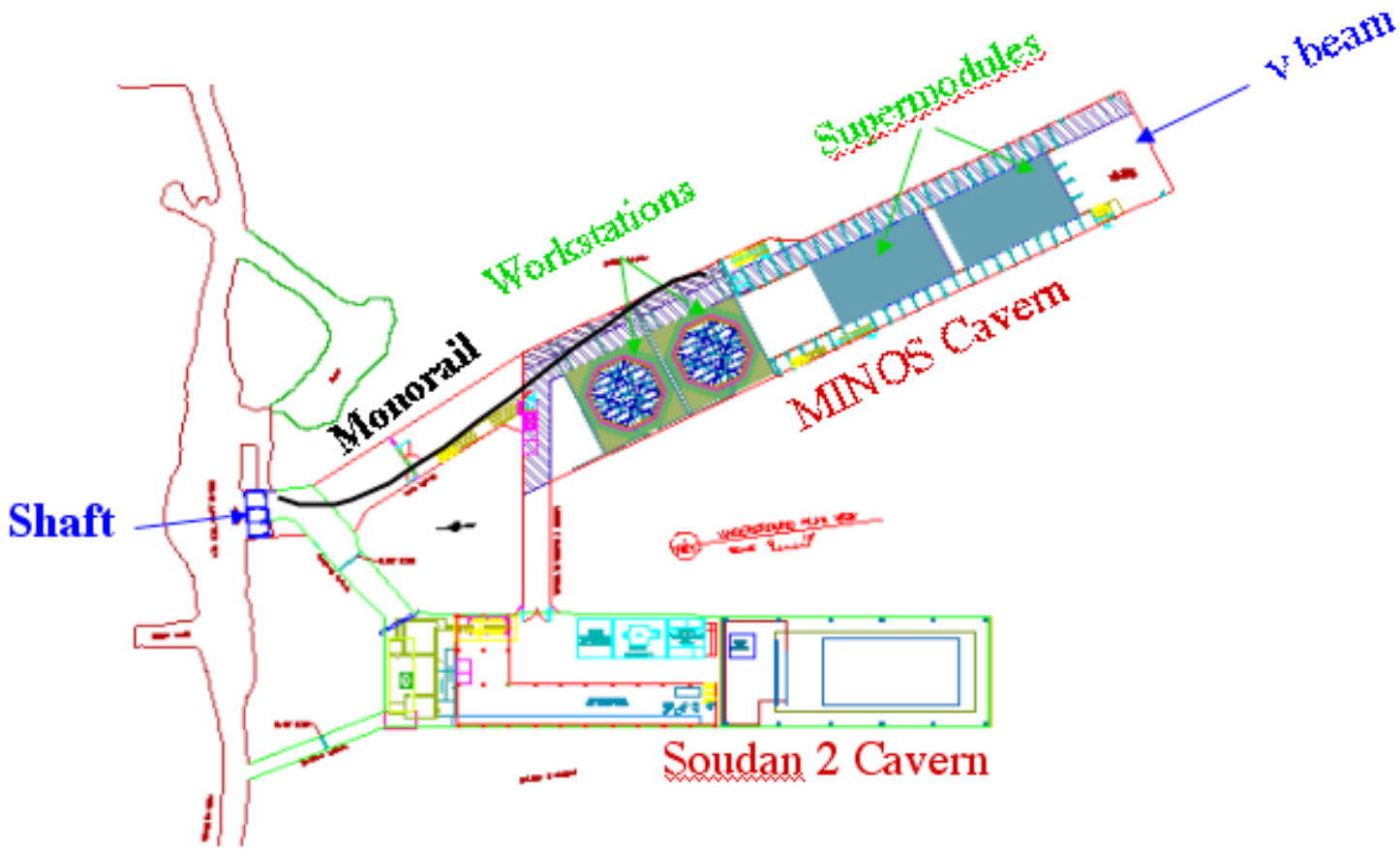
Future Operations (ctd)

- Initially, at least, it will be necessary to have limited physicist presence at Soudan
- Eventually, most of the routine or semi-routine (recovery after thunderstorms) operations can be taken over by the mine crew
- Good “cookbook” style documentation will need to be provided
- There will need to be designated experts who are on call to deal with (remotely or on site) with the more complex problems

Potential Future Additional Activities

- Completion of MINOS construction will release significant amount of space
  - New initiatives are possible to take advantage of this available real estate
  - This will be shaped by the evolution of physics

Soudan Lab Underground



Potential Future Expansion

- Completion of MINOS construction will release significant amount of space
  - New initiatives are possible to take advantage of this available real estate
- Soudan 2 detector is currently mothballed
  - There is some interest, on the part of some MINOS participants, to reactivate the detector
  - So far, there has not been a strong physics case made for it
  - Should this happen, it would significantly increase the complexity of operations