MINOS
Far Detector Installation, Close Out, and Operations

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Soudan Operations Review
May, 2003

Outline

- Detector Installation
- Soudan Laboratory Staff
- Physicists at Soudan
- Close out
- Operations experience during construction
- Projected needs during operation

Installation Time Line

Soudan 2 installation	('88-'95)
Soudan 2 operations	('95-'01)
Conceptual design of cavern, installation, outfitting	('94-'98)
Facility updates/reconfigurations	('97-'98)
Final cavern design, outfitting design	('98-'00)
Detector prototyping at Fermilab	('99-'01)
Excavation and outfitting oversight	('99-'01)
Installation outfitting, preinstallation set up	('00-'01)
Staff up	(1/01 – 12/01)
Plane Installation	(7/01 – 8/03)
Demobilization	(4/03 – 8/03)

A Scintillator Plane

- Strips assembled into "modules"
- 8 modules cover one far detector steel plane
  - 192 strips per plane

MINOS Materials Handling

- Needed 1200 6-ton loads moved underground safely
  - Just 8 downward loads to go
  - Roughly 20 to surface
  - 1m x 2m aperture
- There are ten different crane & hoist systems used to move materials
- Can move 6 loads down the shaft in a 10-hour shift
  - More if the cage doesn't need to be reassembled




All Hauling on 2nd Shift

- The DNR tourist operations require us to make all trips with large loads on 2nd shift (17:30 – 03:30)
- Work continued all weeks over
- Work subject to weather restrictions
  - Temperature above -25°F
  - Winds below 20 MPH
  - No lightning within rage of lightning detector

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Making a Plane: Steel & Scintillator

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Plane Time Lapse: Parts of 3 Shifts over 2 Days

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The Soudan Mine Crew

- The laboratory currently employs 30 staff
  - 5 support staff and supervisors
  - 10 technicians for receiving and materials handling
  - 8 technicians for plane assembly & erecting
  - 3 welders
  - 3 technicians for testing, survey, and cabling
  - 1 technician for CDMS
  - Many people cross trained in various roles
- 8 physicists (typical) in the photo for good measure

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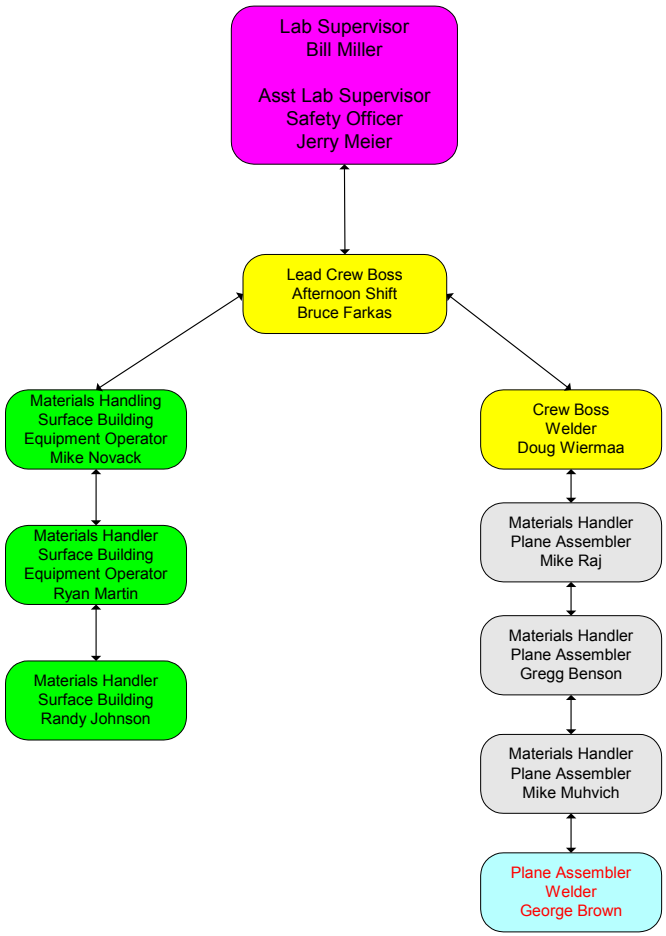
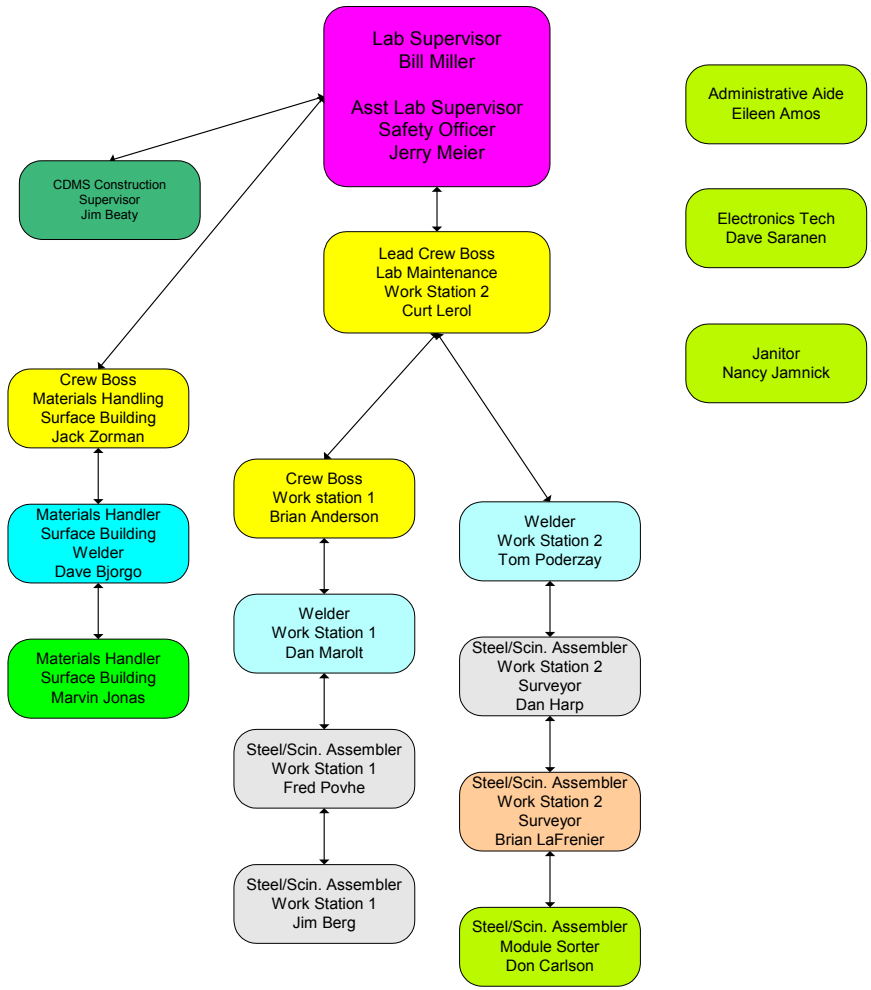
Laboratory Staff Organization (Snapshot from 11/02)

Afternoon Shift Organization Chart

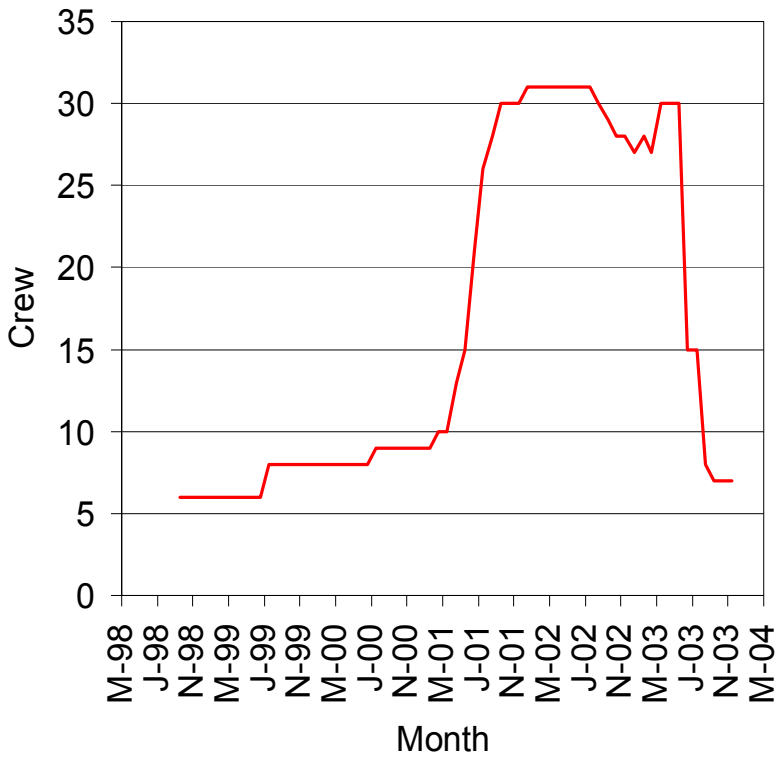


Day Shift Organization Chart



Staffing Profile During the Project

- Job Market in northern Minnesota
  - Down turn in iron mining in early '00/'01
    - The LTV taconite facility in nearby Aurora (MN) shuts down laying off 1200 workers in 2/01.
  - We were able to hire some very experienced millwrights & operators for the installation crew
  - Some mines started limited hiring
    - We lost one person per month Summer 02 to spring 03
- We replaced these losses with seasonal temporary workers (largely construction trades) to maintain efficiency
  - Adding new crew had safety, quality & efficiency implications during training period
  - We did not take this lightly and the associated cross training was successful



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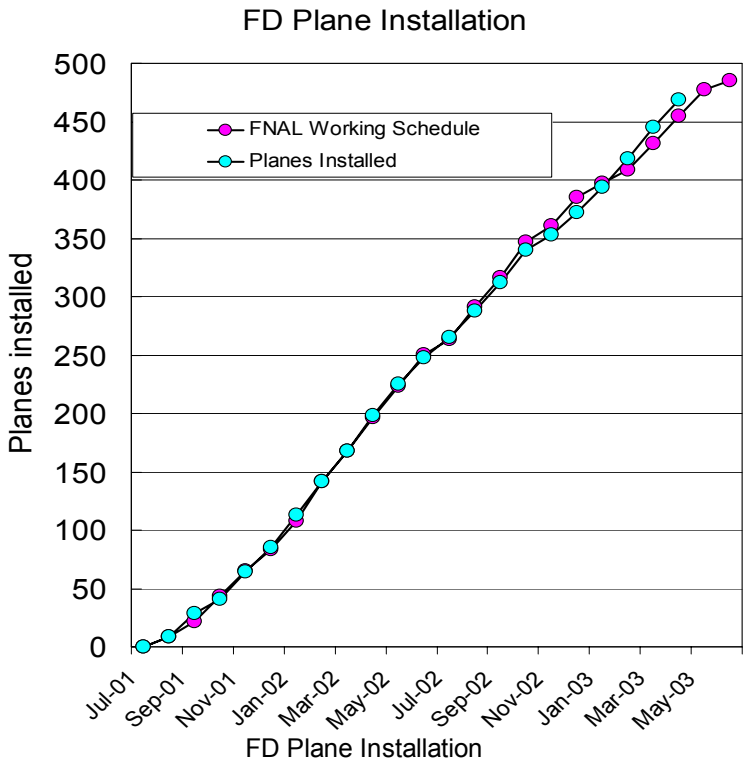
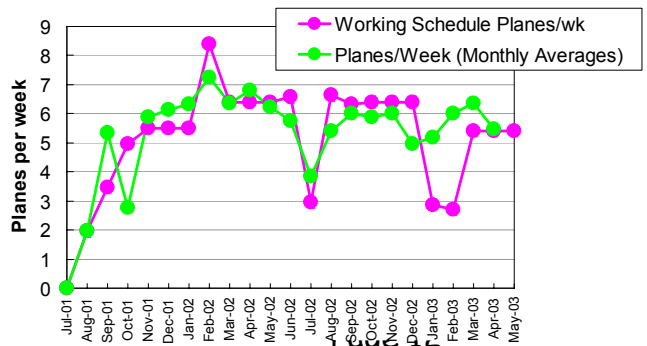
Installation Schedule

- We have averaged 5.9 planes per week (PPW) since installation reached full efficiency in 11/01
  - Baselined at 5.5. PPW
  - Plots show
    - Current FNAL working schedule
      - Includes some instantaneous corrections for projected schedule
    - Actual installation
- Currently **10** days ahead of the FNAL working schedule
- A small drop off in SM2 rate associated with
  - Workers accumulated vacation time and decided to use some of it
  - Some early attrition in staffing
- We project
  - Plane installation complete on 6/02
  - Fully complete in July





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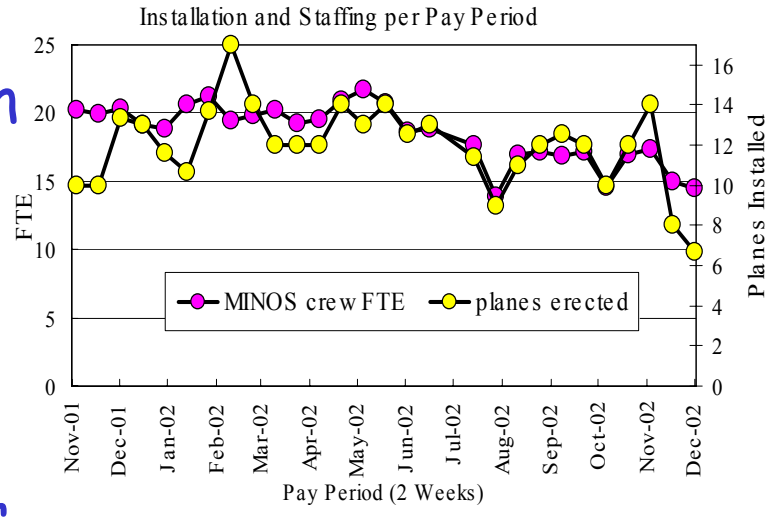
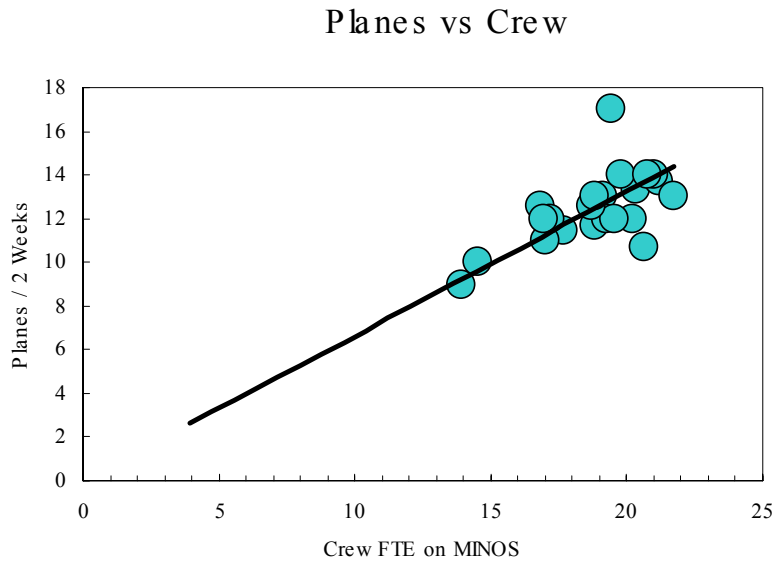
Staffing Levels & Efficiency

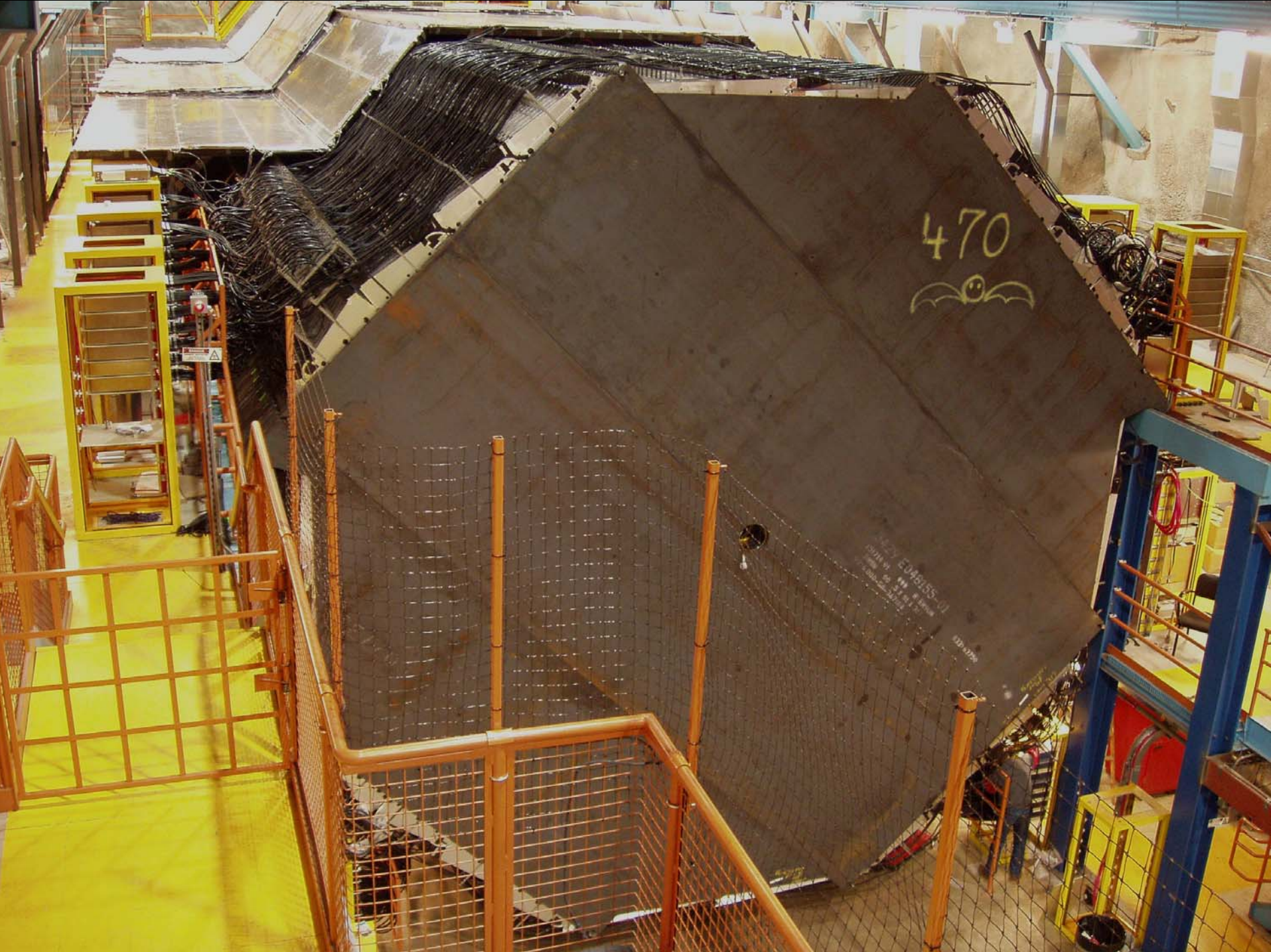
- History of MINOS installation hours & plane installation
- Fit shows that a plane technician accounts for roughly 0.25 planes/week over a reasonable range of levels
  - Some significant drop off in efficiency expected at levels below 14 FTE





Assembly & Commissioning

- 475 of 485 planes installed
  - 98% completed
  - 5.3 ktons
- 473 planes commissioned this week
  - All electrical and optical cabling verified correct up to plane 457
- All commissioned planes are collecting calibration, cosmic ray, and atmospheric data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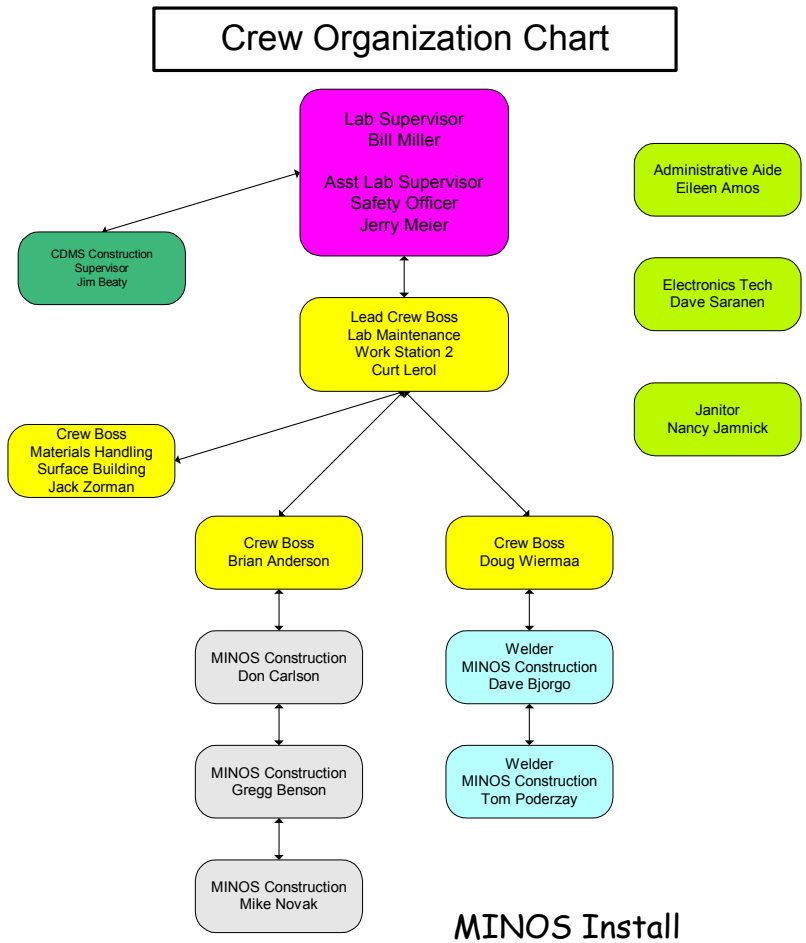
Staffing Down

- On June 2nd, 15 laboratory technicians and work crew bosses will be laid off
  - This is the end of moving large object in the shaft & all (or most) of the planes installed
- In June and July the crew will install the SM2 coil, the last shield section, and demobilize
  - Single shift operations for the first time since '99
- On August 8th, seven additional technicians, work crew bosses, and support staff will be laid off
- Remaining crew level consistent with operations model for the facility and experiments

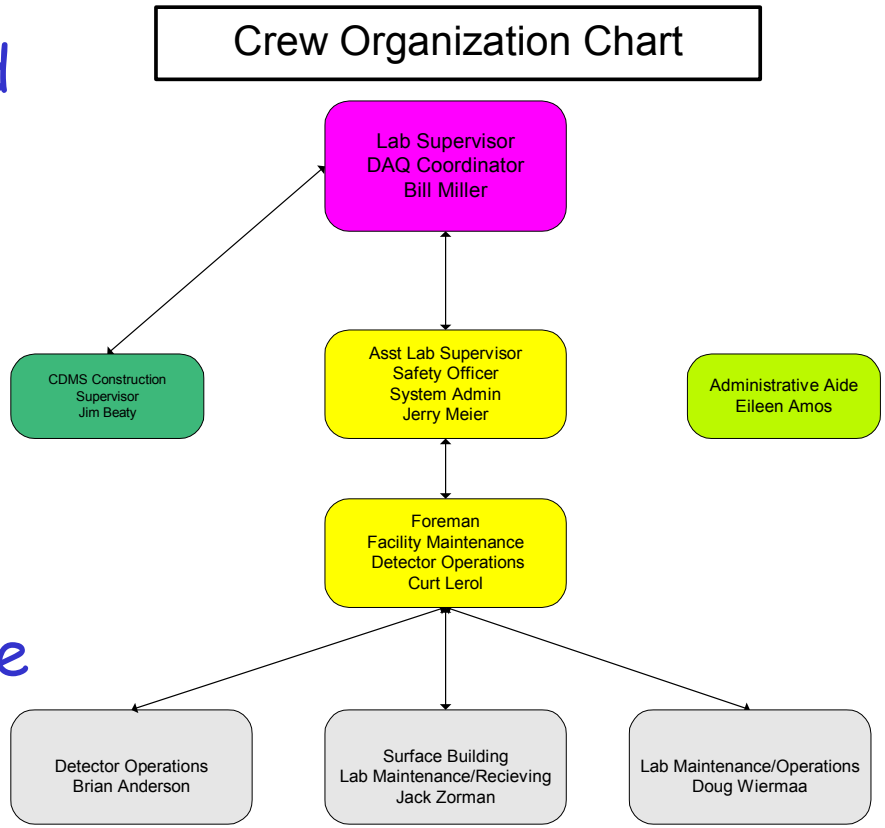


Quality Assurance

- Of the 80,000 scintillator strips
  - 0.17% scintillator strips with one-ended readout
  - None (!) with zero-ended readout
  - 8 pixels not reading out (out of 50k)
  - No channels lost to bad cables & no cabling errors
  - Maintenance status as of last night
    - 1 pmt readout hole, 2 LEDs missing, 1 light injection channel
- Meets specifications on
  - Light yield (9pe/MIP vs 4.5)
  - Timing & charge calibration (>18 sigma up/down separation)
  - Alignment (<3mm RMS absolute; <1.5mm muon alignment)
  - Field strength (consistent with raw FEA to <5%)
  - Gain stability (gain drift less that 1.5% per month)

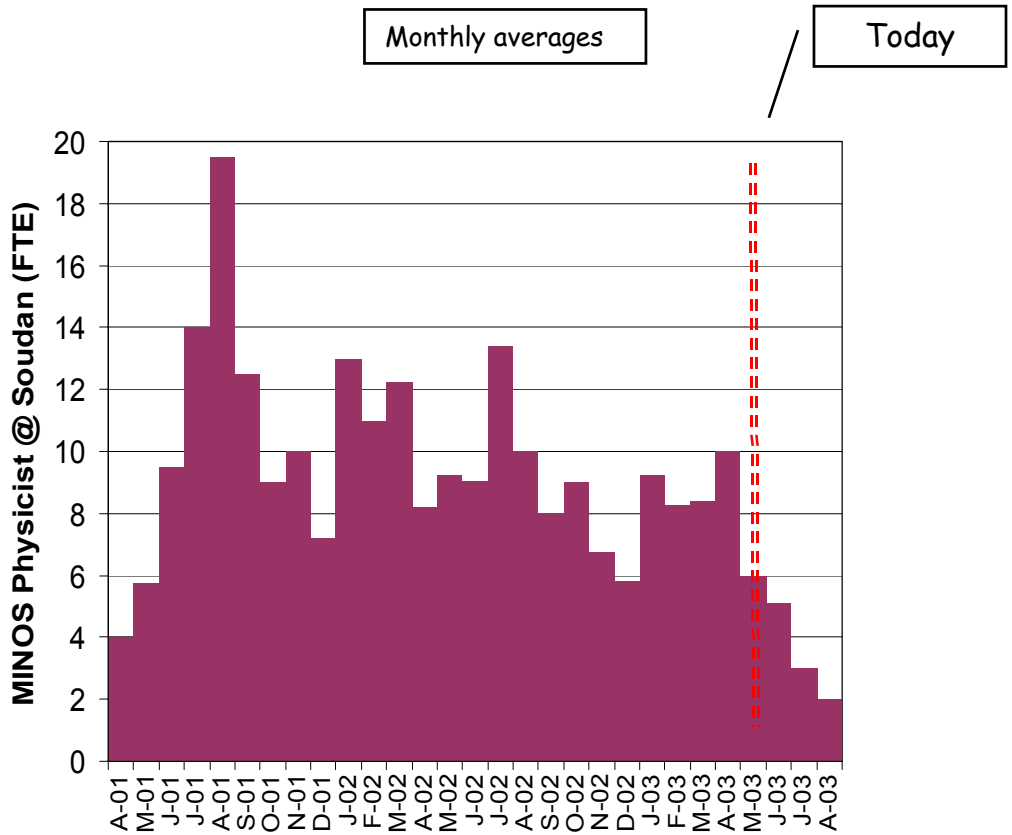
Operations Crew

- Starting in September the crew will be reduced to its operations levels
- The crew will maintain both detectors, the facility, and man off-hours support for both detectors
- The operations crew will begin receiving extensive training on MINOS & CDMS this summer
- Much more on this my talk tomorrow



Physicists & Installation

- A running total of 20.8 physicist years at Soudan on MINOS installation tasks
- 3 Categories
  - Shift leaders
    - Faculty and senior Postdocs
  - Systems experts
    - Postdocs and students
  - Short term visitors (aka T'weekers)
    - Students, laboratory staff, and senior faculty



Physicist Management

- Laboratory Director, support staff, run coordinator, and installation manager
  - Coordinate physicists visits and infrastructure
- Physicist Shift Leaders (PSLs)
  - Senior physicists (Boehnlein - FNAL, Barrett - WWU, Peterson - UMN, Webb - TAMU)
  - Senior postdocs (Avvakumov - Stanford, Bergfeld - USC)
  - Coordinate day-to-day detector priorities
  - Primary interface between crew and physicists
- DAQ coordinator (DAQC)
- Many systems experts and inexperienced visitors
- Local housing and network access were crucial for our successful operation in this mode

Installation Budget & Management

- Manager history
  - Dave Ayres/Bill Miller ('96-'01)
    - Defined schemes and baselined the task
  - Jeff Nelson ('01-'03)
    - Assisted during staff up and ramped up over summer/fall of '01
- Crew more efficient that estimated
  - 3 crews instead of 4
  - 5.8 planes per week instead of 5.5
  - 50% more efficient materials handling
  - Little or no standing army dues to supply shortages

Financial

- Over the last 3 fiscal year (the start of detector installation funding at Soudan), the SOW budgets at Soudan were:
  - $1,592,566 (FY01)
  - $2,883,464 (FY02)
  - $1,223,543 (FY03, Q1-2)
- Running Delta of $20,675 (0.36%) due to an SOW error in last FY01
- Additional minor budgets for PSL travel, housing, and management expenses at Fermilab

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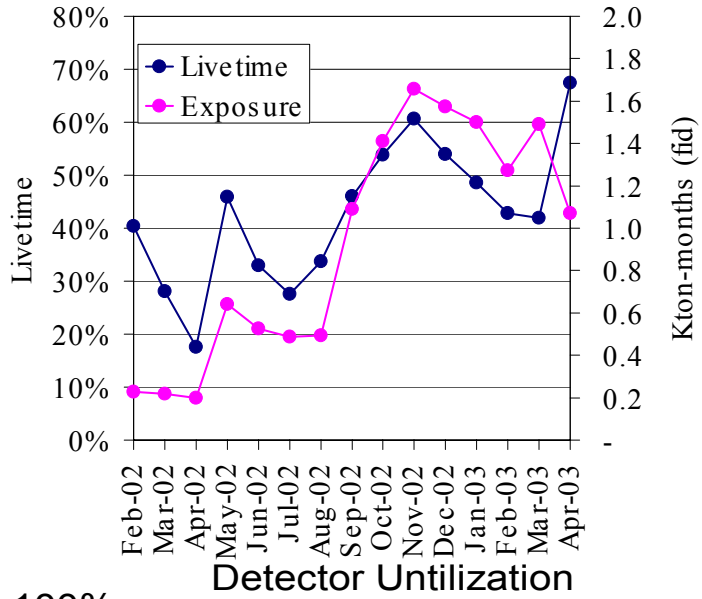
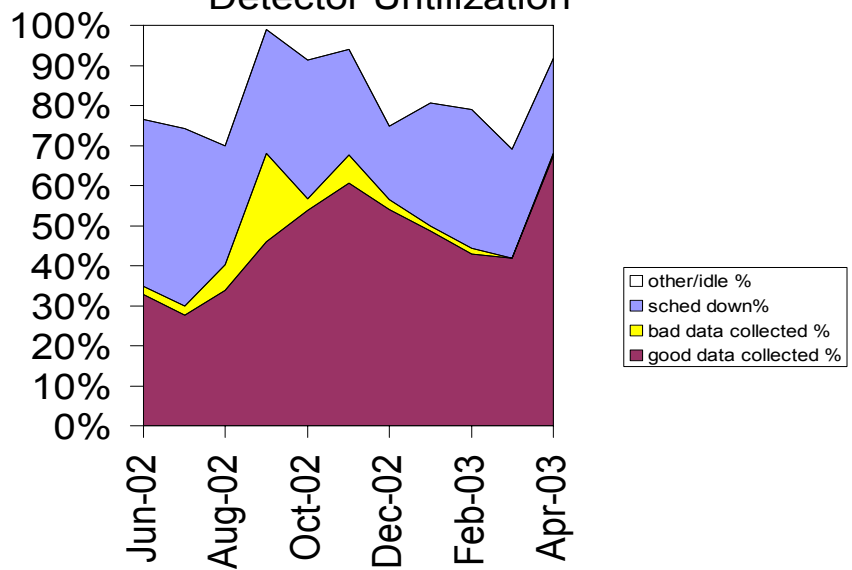
Detector Operations During Installation

- Since last summer we have been collecting data for calibration and cosmic rays
- We have also been working to increase the "good" live time
- Addressing potential impediments
  - Monitoring & control improved
  - Optimizing automatic recovery hardware & software
  - Extra UPS units
  - Some electronics firmware upgrades
  - Improvements in online diagnostics
- Most weeks are scheduled for a subset of system upgrades
  - Most day shifts the detector is offline for development, commissioning, and shakedown
- 125 days of magnetized data in SM1
  - 54% live time since 8/1/02



Detector Untilization



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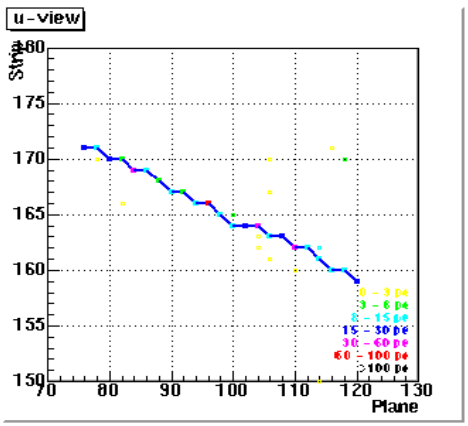
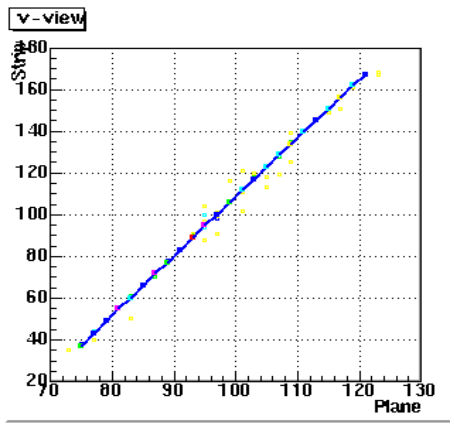
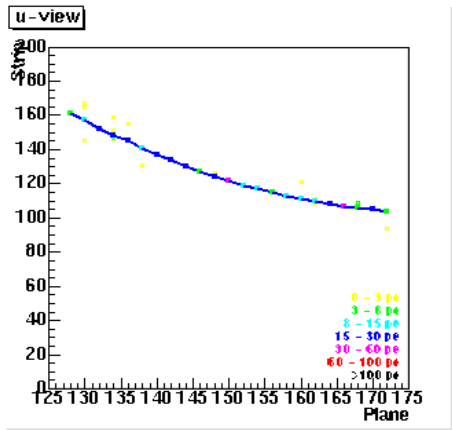
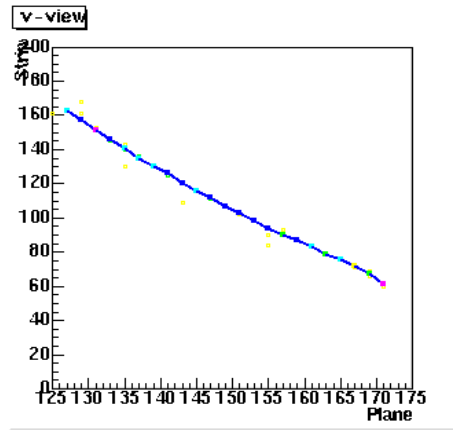
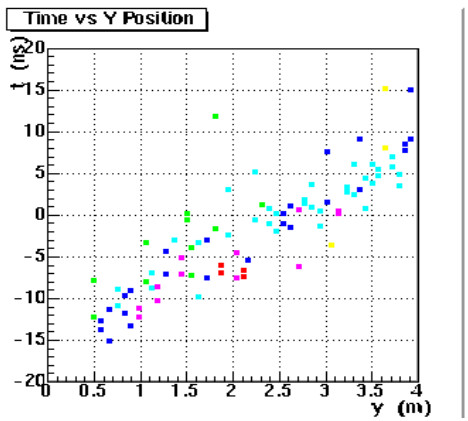
Some Far Detector Events

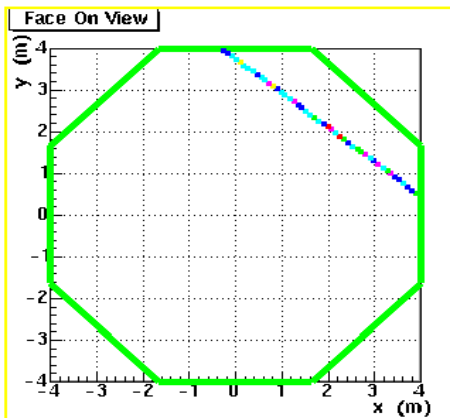


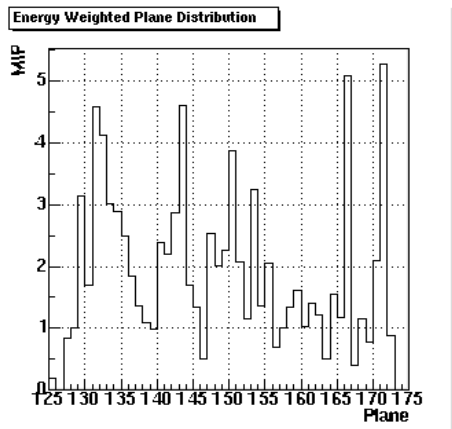


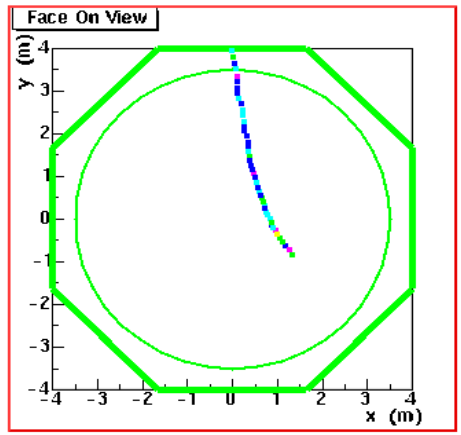












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Operations Plan Starting this Summer

- We are going to test operating for max live time (e.g. like we plan when in beam operations)

  Goal is >>95%

- Our plan is to staff during 5 days shifts underground
- We will have two crew (+ hoistman) on call for underground access 24/7 in case of situations that are not remotely rectifiable
  - Will be used by CDMS and MINOS
- We will operate with local shifts when underground and remote shifts (FNAL) for other hours
  - Soudan physicists, crew DAQC, and crew sys admin on call as needed for remote shifts

MINOS Support & Maintenance

- Since the beginning of March there were 40 detector "accesses"
- 11 of these required "laying of hands" to revive part (or all) of the detector for data collection
- The problem rate has continued to improve over the last 10 months but is still non-trivial

MINOS Far Detector Repair, Maintenance & Support

- DAQ hardware – RAL
  - Soudan crew for routine swaps and updates
- FEE/VME – FNAL/PREP
  - Local test stand for initial diagnosis/simple repairs
- PMTs/bases – Texas
  - Local test stand for initial diagnosis/simple repairs
- Networking – UMN/FNAL
  - Local support and FNAL Help Desk

Summary

- Now 97% complete and operating
- Will finish this summer
- Will shift into operations late this summer
  - > Operations staffing, roles, and evolved
  - > More on this in my talk tomorrow
    - Crew job descriptions
    - DNR M&S and SWF
    - Crew SWF