Near Term Neutrino Projects –
Physics and Project Status
(MINERνA, NOνA, MicroBooNE)

Deborah Harris
Spring 2009 PAC
March 5, 2009

Acknowledgments: Kevin McFarland, Jorge Morfin,
Dave Schmitz, Bob Flight, Heidi Schellman, Paul Derwent, John Cooper,
Mark Messier, Gary Feldman, Cat James, Bonnie Fleming
Physics Status in 1 slide

• **MINERνA**
  - Precision Neutrino Interaction and ν-N Effects
  - Finishing full-scale prototype this week
  - Planning to install prototype underground, as well as a steel nuclear target just upstream to test vertexing resolution

• **NOνA**
  - $\nu(\mu) \rightarrow \nu(e)$ at 810km, mass hierarchy, CP violation
  - Various prototyping efforts underway (IPND, fibers, extrusions, photo-electron yield)

• **MicroBooNE**
  - Study MiniBooNE low-energy excess, ν-interactions, and Scalable Liquid Argon TPC Detector Technology
  - TPC Mechanical Prototype in preparation

5 March 2009  D. Harris
MINERvA Collaboration

University of Athens
Centro Brasileiro de Pesquisas Físicas
University of California-Irvine
University of Dortmund
Fermi National Accelerator Laboratory,
University of Florida
Universidad de Guanajuato -- Instituto de Fisica
Hampton University
Institute for Nuclear Research, Moscow
James Madison University
Jefferson Lab
Massachusetts College of Liberal Arts

New since 11/08

23 Institutions
113 Scientists and Engineers

University of Minnesota-Duluth
Northwestern University
Otterbein College
Pontificia Universidad Catolica del Peru
University of Pittsburgh
University of Rochester
Rutgers University
University of Texas-Austin
Tufts University
Universidad Nacional de Ingenieria, Lima
The College of William and Mary

5 March 2009
NOvA Collaboration

181 scientists and engineers from 28 institutions

Argonne National Laboratory - University of Athens - California Institute of Technology
University of California, Los Angeles - Fermi National Accelerator Laboratory -
College de France - Harvard University - Indiana University - Institute for Nuclear Research
Lebedev Physical Institute - Michigan State University - University of Minnesota, Duluth
University of Minnesota, Minneapolis - State University of New York, Stony Brook
Northwestern University - Pontifícia Universidade Católica do Rio de Janeiro - University of
South Carolina, Columbia - Southern Methodist University - Stanford University - Texas
A&M University - University of Texas, Austin - University of Texas, Dallas - Tufts University -
University of Virginia, Charlottesville – The College of William and Mary – Wichita State University

New since 11/08
MicroBooNE Collaboration

Brookhaven Laboratory

Columbia University
L. Camilleri, C. Mariani, M. Shaevitz, B. Willis**

Fermi National Accelerator Laboratory
B. Baller, C. James#, S. Pordes, G. Rameika, B. Rebel, R. Schmitt, D. Schmitz, J. Wu

Los Alamos National Laboratory

Massachusetts Institute of Technology
W. Barletta, L. Bugel, J. Conrad, G. Karagiorgi, V. Nguyen

Michigan State University
C. Bromberg, D. Edmunds

Princeton University
K. McDonald, C. Lu, Q. He

St. Marys
P. Nienaber

University of Cincinnati
Randy Johnson

University of Texas at Austin
S. Kopp, K. Lang

Yale University
C. Anderson, B. T. Fleming*, S. Linden, M. Soderberg, J. Spitz

*=Spokesperson, **=Deputy Spokesperson  #=Project Manager

New collaborators and New Institutions

51 scientists from 11 institutions

5 March 2009
Technical Progress

Focus on progress since last PAC meeting
MINERνA Technical Progress, I

• Building full-size prototype
  – Built 24 modules (10 tracker, 10 ECAL, 4 HCAL)
  – Many are good enough for full detector
  – Calibrating PMT’s with Light Injection system
  – mapped detector modules with source for position and attenuation information
  – shown that what we are building meets specifications

• Continuing with Detector Construction, including new plane assembly factory at Fermilab
MINERνA Technical Progress, II

- Taking & Analyzing cosmic ray data in Tracking Prototype (TP) Detector
- Installed stand and mirror plane in NuMI beamline
- Project first TP modules underground on March 16
- Test Beam Preparations
  - Commissioning low momentum beam at MTest (250<p<1000MeV)
  - Adding new Time of Flight counters
  - Commissioning Hyper-CP Chambers in Lab 6
NOvA Technical Progress, I

- **Accelerator Upgrades:** Kicker work proceeding
  - 1\textsuperscript{st} “NOvA” kicker [off-project] will be used during MINOS running as a gap-clearing kicker to limit radiation losses in the Main Injector
    - Prototype under test since November
    - Install production model in 2009 shutdown
  - Injection line magnet rework has begun (permanent magnets)

- **Site & Building:** Road & Building design package ready for bid
  - Wetlands Permit issued 12/08
  - Bid process begun at U of MN, plan Notice to Proceed in April 09

- **Near Detector:** Initial cavern studies done
  - Contract for design complete, received two cost estimates, looks affordable
NOνA Technical Progress, II

• Integration Prototype Near Detector: gearing up for Spring 2010
  – Scintillator Oil: Mixed 3800 gallons, QA tools converging
  – Fiber: 1st 100 km delivered in Feb 2009
  – PVC: Have final PVC resin mix with anatase TiO2, reflectivity good, ~ 23 tons extruded
  – Will start assembling Integration Prototype modules in April
  – Electronics & DAQ: Vertical Slice Test confirms photoelectron yield > 27(35) photoelectrons with minimum (best) specification mineral oil
    • Custom ASIC amplifier in hand and tested, IPND APDs ordered (1st 20 arrive in June-July)
    • Concern: DAQ software effort lost in FY08 budget, but new team has been constituted.

• Far Detector Assembly: Full size prototype, at ANL in April
  – Adhesive machine & vacuum lifter being assembled
    • Concern: This work slowed by FY08 budget, results needed for CD-3b review (7/21/09)
MicroBooNE Technical Progress

- Prototyping different aspects of detector
  - Wire Plane Prototype
  - TPC Mechanical Prototype

Signal electrodes
- 2 induction planes at ± 60°
- 1 vertical collection plane
- Electrodes: 150 mm gold plated SS
- Total of ~10k channels

Wire tensioning measurement using prototyping apparatus for half-length wire stringing tests. Wire lengths are between 2.5 – 2.8 meter in the final detector

TPC mechanical prototype in fabrication at Yale
“NanoBooNE”: 0.5m x 0.5m x 1m
Project Status
Try to put current steps in perspective

Ted Lavine on FNAL Site Visit for MINERvA and NOvA, 9/8/2008
Photo Credit: Steve Webster
MINERvA Project Status

• Approvals:
• MIE Funds FY08-FY10
• Project Status: see Physics Status!
• 11.1M Obligated out of 16.8M total Project Cost
• Detector complete baseline: 4/2010, CD-4 9/2010

MINERvA Schedule: Incrementally Install Detector 3/15/09-4/15/10
Commission during installation (can be anti-neutrinos)
Data in Low Energy Neutrino Beam
(5.2E20 requested)
Data in Medium Energy Beam with NOvA
NOvA Project Status


• October, 2008: FY09 Continuing Resolution gave NOvA 11.4M$
  • Only 3M$ for building construction while first phase takes ~ 11M$ in a 3-year phased procurement
  • Only 5M$ for Detector and Accelerator construction
  • CD-3a authorizes 23.9M$ worth of items in above categories

• 20M$ Obligated out of 278M$ Total Project Cost

• Now: FRA EVMS certification in progress
  • NOvA is the “poster project” for Earned Value Management Systems Certification
  • Nominally need certification for NOvA CD-3b

• Money in FY09 budget that left the house: 28M$ (=37-9)
• CD-3b Review: Scheduled for July 21-23, 2009 (approval forecast 10/09)
NOvA Schedule (estimated)

• April 21, 2009: Notice to Proceed for Ash River, Minnesota Building
• June, 2009: Director’s Review for CD-3b
• July 21, 2009: DOE Review for CD-3b
• October, 2009: CD-3b Approval
• Spring, 2010: Integration Prototype operational in MINOS Service Building

• Following dates depend on ARRA (Stimulus), FY09 budget, and FY10-13 budgets
• ~ May 2011: Beneficial Occupancy of Far Detector Building at Ash River
• ~ July 2011: 10-12 month Accelerator shutdown
  » for Recycler installation of NOvA Recycler components
  » Note impact if there is 2011 Collider Running
  » Near Detector Cavern Excavated
• ~ Aug 2012: 1st 2.5 kt of Far Detector Online
• early 2013: 3 month Accelerator shutdown for NOvA NuMI upgrades
  » “Capable” of 700 kW after shutdown, commissioning begins
• ~ Dec 2013: Full Far Detector (14 kt) complete
MicroBooNE Project Status

• Developing WBS, cost and schedule
• Project Manager: Cat James
• Assigning Cost Account Managers (CAM’s)
• Discussions with DOE on the Mission Need document have begun
• Preparing for CD-1

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<th>Working Groups</th>
<th>Conveners</th>
<th>CAM’s</th>
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<tr>
<td>Active Detectors</td>
<td>Bo Yu</td>
<td>Bonnie Fleming</td>
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<td>Electronics</td>
<td>Teppei Katori, Hucheng Chen,</td>
<td>Mitch Soderberg</td>
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<td>Leslie Camilleri</td>
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<td>DAQ</td>
<td>Kirk McDonald</td>
<td>Kirk McDonald</td>
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<td>Cryostat/Cryogenics and Purification</td>
<td>Stephen Pordes, Dave Schmitz</td>
<td>Brian Rebel</td>
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<td>Beam</td>
<td>Sacha Kopp</td>
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<td>Building and Infrastructure</td>
<td>Cat James</td>
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<td>Analysis Tools</td>
<td>Mike Shaevitz, Brian Rebel</td>
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<td>Physics Analysis</td>
<td>Janet Conrad, Mitch Soderberg</td>
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Actual MicroBooNE Schedule: Still Under Construction
“Technically Driven Schedule: 1 year design, 1 year construction, ½ year installation, 2 year run”
Workshop on Computing for Neutrino Experiments

• March 12-13 2009 at Fermilab

• Purpose:
  – To bring present and future neutrino experiments at Fermilab together to share information on infrastructure and offline computing. The format will be
    • Reports from experiments
    • Overviews of specific topics by experts from the Computing Division.

• Deliverables:
  – Summary of infrastructures and computing strategies from running and future experiments.
  – Identify the contact people for each experiment

• Long Term Goal: Strategic Plan for Computing Division to provide support for ν Experiments

[Link to presentation or document]

http://www.nuhep.northwestern.edu/~schellma/neutrino_computing_09/

5 March 2009
D. Harris
Summary

• 3 projects, 3 different detector technologies, 3 different stages of construction
• We are commiserating with learning from each other as we go

– Project Management
– Neutrino Event Generators (GENIE workshop)
– Neutrino Experiment Computing Needs

• Many exciting milestones just around the corner
Backup Slides
MINERvA: What and Why?
Main INjector ExpeRiment v-A

- MINERvA is a compact, fully active neutrino detector designed to study neutrino-nucleus interactions in unprecedented detail
- The detector will be placed in the NuMI beam line
- MINERvA... unique role
  - The NuMI intensity provides
    » Opportunity for precision neutrino interaction measurements
    » Wide range of $\nu$ energies (1-20GeV)
  - Detector with several different nuclear targets allows 1st study of neutrino nuclear effects: He, C, Fe, Pb
  - Crucial input to current and future oscillation measurements

Design:
Segmented scintillator tracker surrounded by calorimeters
Excellent Photon Reconstruction
$\nu_\mu p \rightarrow \nu_\mu \pi^0 p$ is a major background to future $\nu_\mu \rightarrow \nu_e$ experiments
See:  http://minerva.fnal.gov
NOvA Overview ($\nu_\mu$ from NuMI oscillate to $\nu_\text{e}$)

- **Experiment overview at** [http://www-nova.fnal.gov/](http://www-nova.fnal.gov/)
- **Beam**
  - 700 kW = $36 \times 10^{20}$ protons delivered to NuMI target in a 6 year data run
  - Convert Recycler to proton storage ring
  - New injection and extraction beam lines
- **Near Detector**
  - Small new cavern at Fermilab, 300 ft underground
  - Measures the beam composition before oscillations (about half the background is $\nu_\text{e}$ in the beam)
- **Far Detector**
  - 14,000 metric tons (14 kilotons)
  - 930 alternating crossed planes of liquid scintillator contained in PVC cells, glued together
  - Readout with wavelength shifting fiber and Avalanche Photodiodes (APDs)
- **Baseline**
  - Far Detector is 810 km away in Northern Minnesota at Ash River just south of Voyageurs National Park
  - New building on greenfield site
- **Integration Prototype Near Detector (IPND)** is the R&D goal for early 2010
  - 90 tons, same PVC, liquid scintillator, fiber, and electronics

- 5,000 tons of PVC plastic
- 3 million gallons of scintillator
- 12,000 kilometers of fiber
- 357,000 channels of APDs
MicroBooNE Detector

TPC:
• 2.5 x 2.5 x 12m
• 100 tons active
• 70 tons fiducial

Cryostat:
• 4m diameter
• 14m long
• 170 tons LAr

Detector size
• As small as possible while being able to use MicroBooNE to learn about the next steps
• As big as possible to construct in industry and transport over roadways to FNAL.
• The right size to be sensitive to the low energy excess and to have sizable samples for low energy cross section measurements