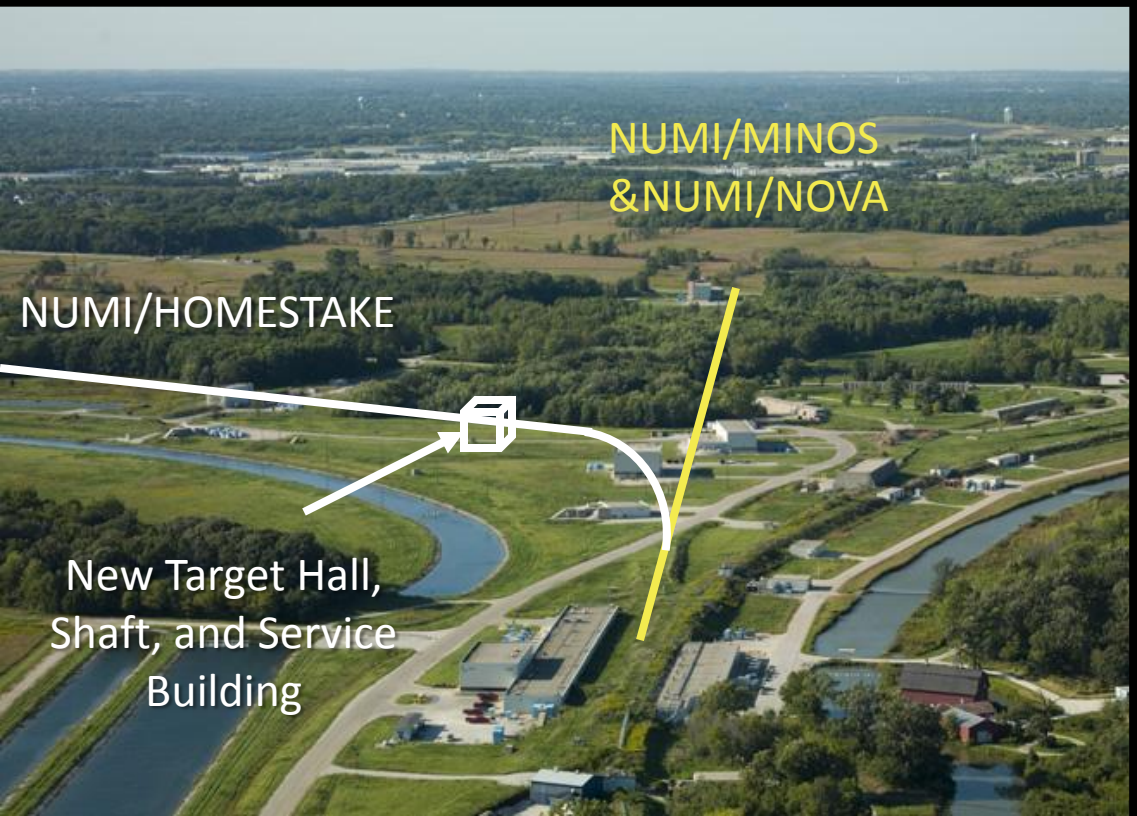
Neutrino Beamline from Fermilab to Homestake Mine

5th ANL-UC-FNAL Collaboration Meeting
Monday, Feb. 2, 2009 at Argonne

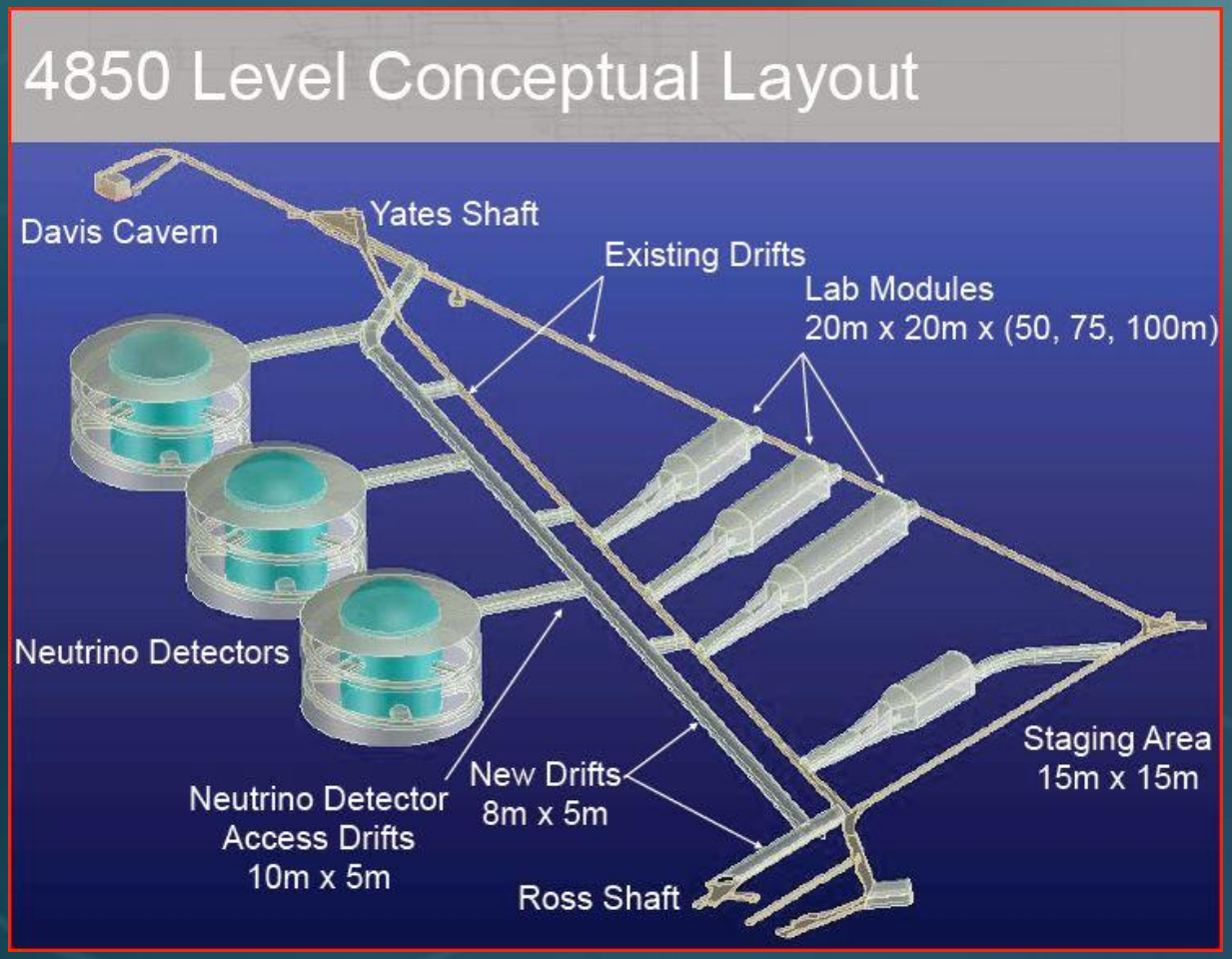
Mike Martens, Fermilab

Neutrino Beamline Fermilab to Homestake 1290 km



Beamline, Target Hall, and Near Detector fit on Fermilab Site

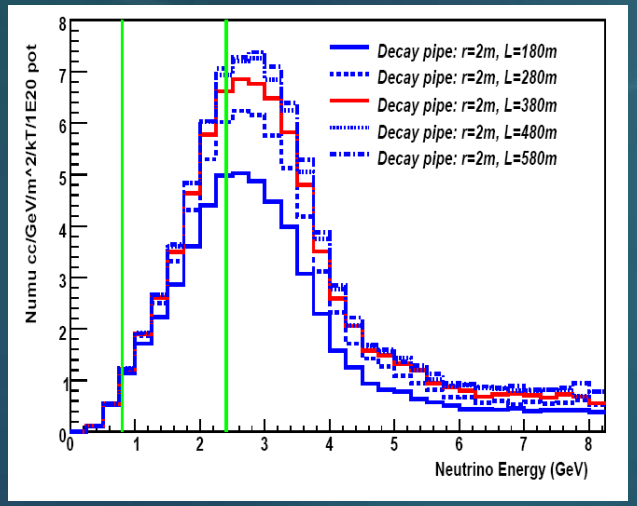
Detector at Homestake Mine



Several 100 kT water Cherenkov or Li Argon equivalent detector

Beamline Requirements*

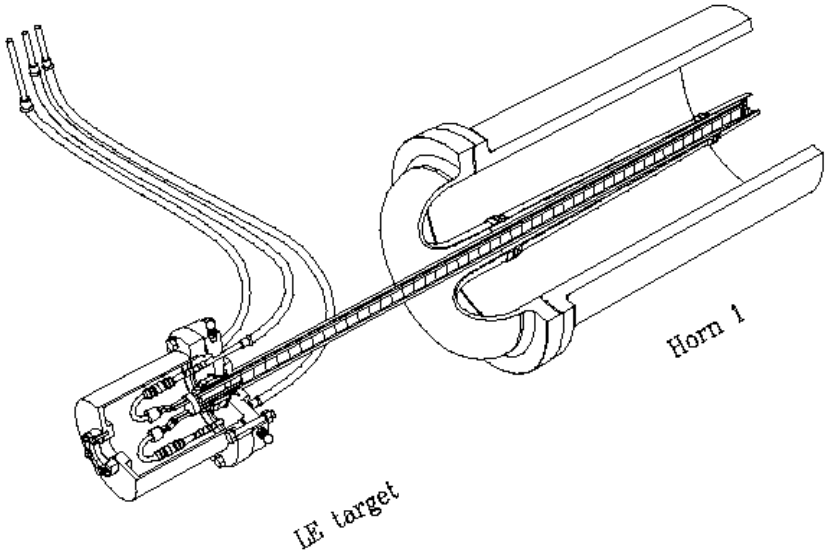
- Large Flux of Neutrinos
  - 700 kW $\Rightarrow$ 2.3 MW proton beam power on target
- Maximum CC events at 1st and 2nd oscillation nodes
  - 2.4 GeV and 0.8 GeV
  - ν cross-sections scale with energy $\Rightarrow$ larger flux at lower E
- For $\nu_\mu \rightarrow \nu_e$ minimize NC contamination at lower energy
  - Minimize the flux of neutrinos with E > 5 GeV
- High purity ν_μ beam
  - Reduce background from beam generated ν_e



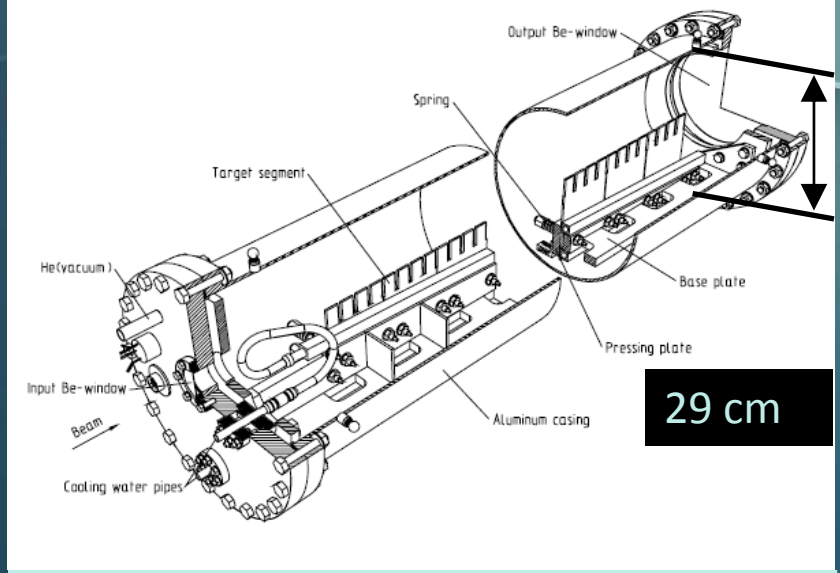
*From "Simulation of a Wide-Band Low-Energy Neutrino Beam for Very Long Baseline Neutrino Oscillation Experiments", Bishai, Heim, Lewis, Marino, Viren, Yumiceva

Homestake beamline compared to NuMI

- Power is 3-5 times the NuMI design power
  - More shielding, cooling, rad component handling
  - NuMI Horn 1 could reach ~400 R/hr @ 700 kW
- High target power and low energy neutrinos
  - (See next slide)
- Decay pipe
  - ~400 meters versus 675 meters for NuMI
  - Radius of ~2 meters versus 1 meter for NuMI
- Downward bend of 5.8° versus 3.3°
  - Shaft will be deeper?
  - Enter the Galena-Plattville Rock?
- Near Detector Hall
  - More rate means smaller detector

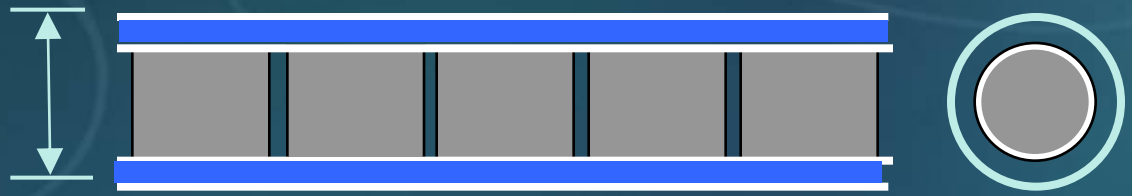


MINOS 400 kW
LE Target OD = 30 mm
Horn ID = 18 mm @ Neck



NOνA 700 kW
ME Target
External to Horn

IHEP 2 MW
Conceptual Design
Needs to fit within neck



Annular channel for water cooling

Target material? Graphite? Carbon Composite? (BNL working this.)
Cooling? Can we get adequate cooling? Water cooling OK? How to fit within the Horn?

Decisions Needed

- Primary Beam Energy
  - 60 - 120 GeV is possible; choice affects the primary beam transport, beam losses, etc.
- Target-Horn Configuration
  - Affects Target Hall dimensions; shielding arrangement….
- Decay Pipe Length and Radius
  - BIG impact : excavation and shielding
- Need for muon monitoring stations
  - Prove they are needed
- Near Detector technology and size

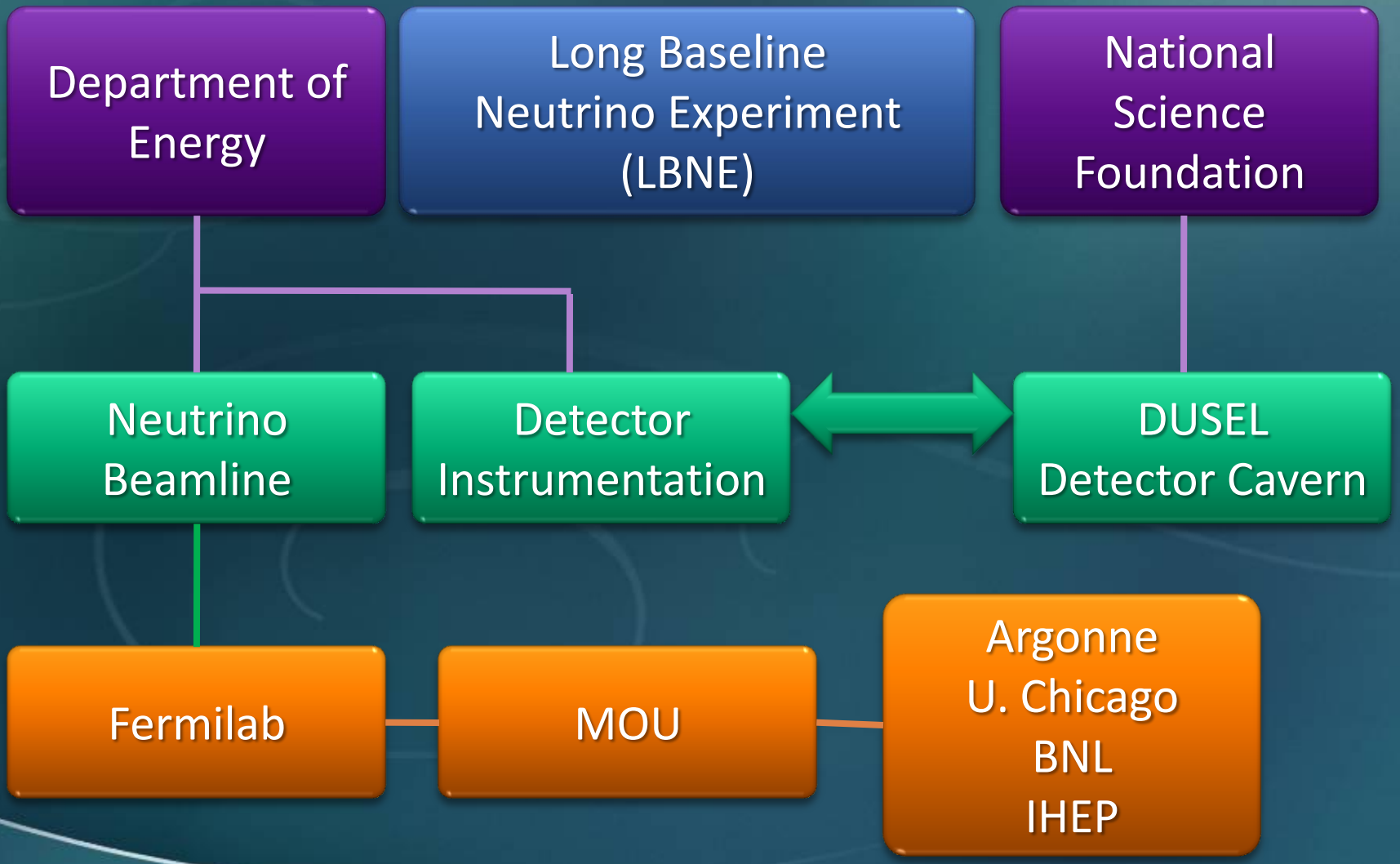
High Priority R&D Work

- Design of 2-3 MW Target and Horn
  - Optimize Target/Horn/Decay Pipe Configuration
- Radiological Shielding and Control
  - Environmental Protection
  - Remote Component Handling
- Design of Hadron Absorber and Muon Monitor
- Primary Beamline
  - Specify beamline from MI/NuMI pointing to Homestake
- Project Definition Report for tunnels, halls, SB&O
  - Needed for an updated cost estimate
- Geological Core Samples

Timeline

- Awaiting CD-0
  - DOE Agency Document
- Project Definition Phase (CD-0 to CD-1)
  - Prepare a Conceptual Design Report
  - Would take 12-18 months
  - Several $M in FY2010 for development
- CD-3 to Completion
  - 5 Years
  - Complete in ~2020
  - TEC in the $300M to $400M range

Possible Organization



Summary

- Able to Fit Beamline on Fermilab Site
- Preliminary Horn-Target Configuration
  - Shows we can get reasonable ν spectrum
- 3-5 × Power $\Rightarrow$ New Challenges
  - Targetry, Radioactive Component Handling, ES&H,
- Awaiting CD-0
- Significant R&D Work Required
- Will Require Collaborative Effort