R&D for the Off Axis Experiment

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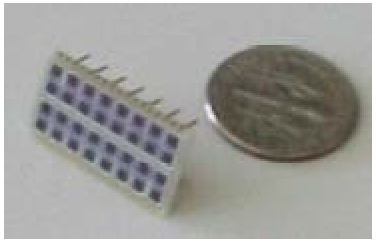
Jan. 12, 2004

Overview

- First goal is to be ready to select an optimal technology in ~one year.
  - Demonstrate that fundamental technologies are ready. This limits the options to scintillator and RPCs.
  - Improve understanding of construction techniques, risks and associated costs sufficient to decide between technologies.
  - We have set a baseline, not made a technology decision.
- Demonstrate that surface operation will have sufficiently small cosmic-ray induced background.
- Value engineering for full detector construction.
- Physics optimization for a given cost.
- Production of “prototype” to function as a near detector.

Issues for Scintillator

- Photodetector
  - APDs integrated together with electronics are intrinsic to making a low cost scintillator readout system
    - Tests of intrinsic noise levels combined with electronics
    - Broaden use experience with our systems



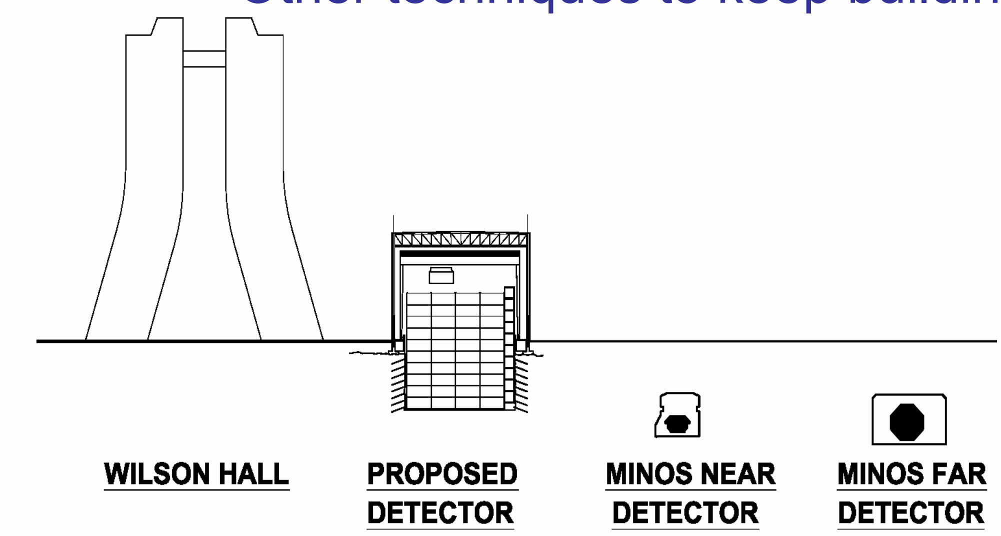
- Stability
  - Bent fibers in liquid scintillator
  - Light output stability
- Cost Engineering
  - Light output (TiO_2 loading of extrusions and resulting light output of assemblies)
  - Construction and assembly of scintillator modules
  - Construction and assembly of absorber system
  - Liquid production and handling
  - Building systems and integration with detector
  - Electronics/APD integration and cooling systems (APD noise requires operation around -20^{o} C)

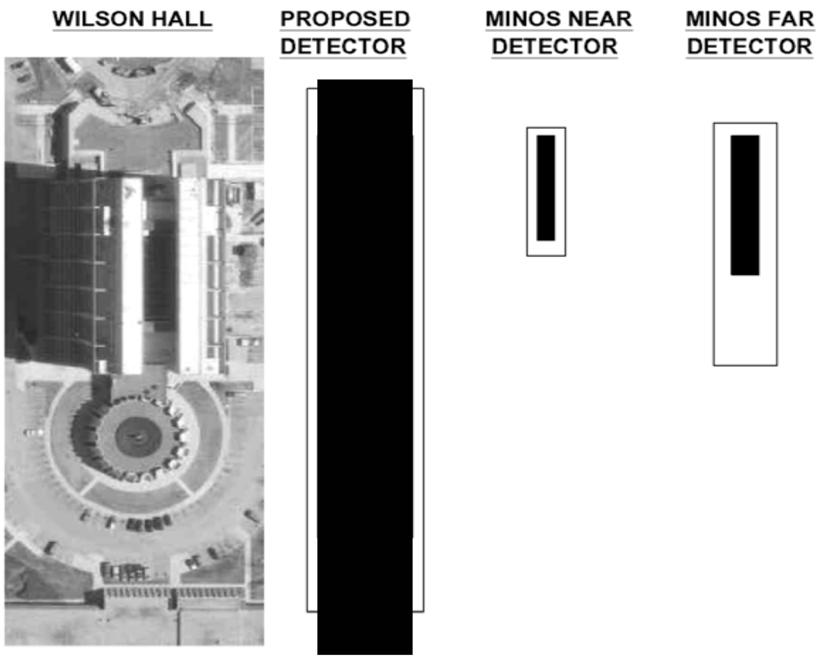
Issues for RPCs

- Stability:
  - Many questions have been raised on the long-term stability of RPCs. Mostly, answers have been provided for the specific technology which we are investigating; glass RPCs as used in the Belle Experiment.
    - Belle chambers have maintained stable efficiency for several years of operation.
    - Keep same basic construction techniques
    - Use the same gas mixture: Essential to keep water vapor out of the system
    - We still want to demonstrate stability in systems built and operated as we plan for Off Axis
  - Value Engineering
    - Reduction in manpower and pieces in construction steps (Current construction has ~100 pieces per chamber).
    - Industrial fabrication of strips and connection to electronics
    - Very low cost digital electronics (3.7M channels!)
    - Stable but low cost gas system (86,000 separate chambers to connect!)
    - Modular construction system
    - Distribution of production skills (86,000 chambers to build!)

Mechanical and Building Issues

- Construction techniques/plan of the wood infrastructure.
- Building requirements and design
  - Will the backgrounds be sufficiently low with no overburden? Test by construction of a small surface array (recall that the beam duty factor is 10^{-5}). This can be done with either technology and the current plan is to do it with RPCs (+MINOS Caldet modules?) Work is already underway at Fermilab.
  - Other techniques to keep building costs down.





What About Water or Liquid Argon?

- Monolithic water Cerenkov detectors do not appear to be a good match to this experiment.
  - Backgrounds are relatively high and difficult to predict for neutrinos with energies above a GeV.
  - Due to the open geometry, operation on the surface is likely difficult. A new, deep(ish) cavern would have to be built. For this experiment, this would more than offset possible cost savings.
- Liquid argon appears to offer attractive physics response, but development times appear longer than our time scale.
  - Because it is somewhat more efficient for nu_e identification than sampling calorimeters, a somewhat smaller detector may be possible.
  - But even a 20 kT detector is a very substantial extrapolation and suggests a new construction approach.
  - We think this looks like an interesting possibility for a next phase in the off-axis experiment, but believe pursuing it for the first phase would slow the construction progress.

Some planned involvement

- We have submitted a 3-year proposal to NSF for detector R&D and engineering
  - 1st year: Work aimed at detector technology selection. Surface operation demonstration.
  - 2nd year: Expand value engineering and design work on selected technology. Additional distribution of production capabilities.
  - 3rd year: Construction of adequate detector for a near “prototype” detector to be run in the MINOS near detector hall. Production of a “full-scale” prototype for the far detector.
  - Still waiting for a budget to be set! Some positive feedback.
- We have also requested funds from Fermilab for further engineering and detector development.
- Some groups involved or planning R&D efforts:
  - Fermilab, Argonne, RAL
  - Caltech, Harvard, Indiana, Michigan State, Minnesota, Rochester, Stanford, Texas, Tufts, UCLA, Virginia Tech., William and Mary
- We invite additional participation in these development efforts. The production of this detector will be an enormous activity that will require many participants.