Opportunity for Near Detector Test at NUMI

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Off-Axis Beams

- Exploits kinematics of meson decay to produce a narrow-band beam
- To 0\textsuperscript{th} order, beam spectrum is a function of angle and meson count
  - Allows for a relatively straightforward prediction of relative flux at different angles (energies)
  - Can be checked by near on-axis detector (MINOS or other)
  - \textit{Absolute} flux has larger uncertainty than relative flux at different energies
Off-Axis Beams

• Illustration at NUMI near detector site
  – Peak energy shifts lower
  – Width decreases
  – High energy tail suppressed
  – Rate significantly decreased
• Mimics far detector flux at some angle…
Possible Sites

(NEW since EOI)

• We have investigated possible locations within the NUMI TBM drifts. No new tunneling required...
  - Thanks to Rob Plunkett for navigational assistance!
Site 1: 5-10 meters Off-Axis

- Located in near hall access tunnel
  - Wide, with personnel access to near hall
  - Flat floor, easy access to shaft
- Relatively easy to bring utilities to site
Site 1: Interaction Rates

- Simple to move detector. $<E_n> \sim 2-3+ \text{ GeV}$
  - 5m gives $<E_n> \sim 2.8 \text{ GeV}$; can go higher but spectrum is broad
  - Ditch at upstream end; getting 15m off-axis (1.5 GeV) difficult
Site 2: 15 meters Off-Axis

- Located just upstream of shaft
  - Wide. Sloped floor (9%).
  - Close to shaft and utility source
  - Hard to move to Site 1?
  - No separate access to absorber, muon alcoves
  - $<E_\nu> \approx 1.5$ GeV
Site 2: Interaction Rates

Shaft
Near Hall

Absorber

LE+, 15m
ME+, 15m

Solid, $\nu_\mu$ events
Dashed, $\mu$ induced $\nu$ (bar), events x100
Dotted, $K$ induced $\nu$ (bar), events x100

numuCC, L= 912.m, R= 15.m, events/200MeV/1ton/3.8E

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Site 3: 5-15 meters Off-Axis

- Located upstream of absorber
  - Wide, unfinished tunnel.
  - Sloped floor (9% grade).

- Not an attractive site
  - Far from shaft and utility source
  - Interferes with absorber utilities? Radiation?
  - $<E_v> \sim 1.5-3+ \text{ GeV}$
Site 3: Interaction Rates

- Near Hall
- Shaft
- Absorber

- LE+, 11m
- ME+, 11m
- LE+, 13m
- ME+, 13m
- LE+, 9m
- ME+, 9m
- LE+, 15m
- ME+, 15m

Graphs showing interaction rates at different distances from the Near Hall, Shaft, and Absorber.
NUMI Site Summary

- Appropriate sites exist in the NUMI TBM tunnels
  - Energy Range $\langle E_\nu \rangle \sim 1.5-3+ \text{ GeV}$
  - Details…
    - occupancy after NUMI installation (early 05?)
    - NUMI maintenance, operations conflicts?
    - utilities and outfitting
    - movable detector to vary angle and therefore energy
  - It appears possible to avoid new excavation
Alternate Sites

- K2K “SciBar” Detector
  - Similar detector
  - Lower rates by about an order of magnitude
  - $<E_\nu> \sim 1.2$ GeV

K2K SciBar Event Rates
~20K Events/10 tons fid.
(courtesy C. McGrew)

NUMI Near Off-Axis Event Rates/ton
Alternate Sites

- **BooNE**
  - Running now!
  - $<E_\nu> \sim 0.9$ GeV
  - Much lower rates at miniBooNE detector
    - $\sim 10^3$/ton/3E20 protons
    - 100m from Target on-axis, rates and energies similar to NUMI at 1km from target, 20m OA
    - $3 \times 10^4$/ton/3E20 POT
      (B. Fleming, NP02 talk)