DUNE-PRISM Workshop Preparation

Mike Wilking

October 30th, 2017

ND Decision Roadmap

- Explained by Mark Thomson at the DUNE ND meeting
  - https://indico.fnal.gov/event/15025/contribution/1/material/slides/0.pdf

4) PRISM Concept

- At this point in time, the scientific benefits of a movable detector (PRISM concept) have not been quantified. The Near Detector Concept Study is asked to demonstrate the document the benefits
  - **November workshop:** The ND Concept study is asked to define and document a program of studies to demonstrate quantitatively the physics case for the PRISM concept. In addition, the ND Concept study should agree the layout and footprint of the PRISM concept for further study.
  - **December:** the Co-Spokespersons will work with LBNF to understand the cost implications.
  - **January:** the ND Concept Study leaders will draft a short report describing the proposed layout and results from any initial studies.
  - **January workshop:** the ND Concept Study is asked to make a recommendation on whether to continue to pursue the PRISM concept. This recommendation should take account of the physics case and the cost implications for the Near Site facilities. The recommendation will be considered by the EC.
- The following steps are contingent on a positive recommendation:
  - **March 2018:** draft a report giving quantitative results elucidating the benefits of PRISM concept, assuming the previously agreed layout.
  - **March workshop:** the ND Concept Study is asked to make a recommendation on the PRISM concept, based on the scientific merits as documented in the report. The report, including any recommendations, will be delivered to the EC.
  - **April 2018:** the EC will consider the recommendations of ND Concept Study.

ND Decision Summary

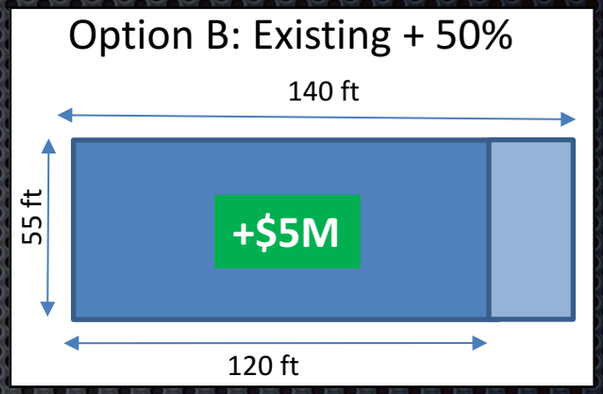
- Next week, the DUNE ND group should “agree on the layout and footprint of of the PRISM concept for further study”
- In December, the cost implications of the required near detector hall will be determined in consultation with LBNF engineers
- Next week we also define a set of physics studies needed by January to demonstrate the need for DUNE-PRISM
- By January, the results of these physics studies, but mostly the result of the cost estimation, will result in a decision on whether to proceed
  - If so, we must produce a final report by the “March ND workshop”, which will then receive a recommendation and be delivered to the EC

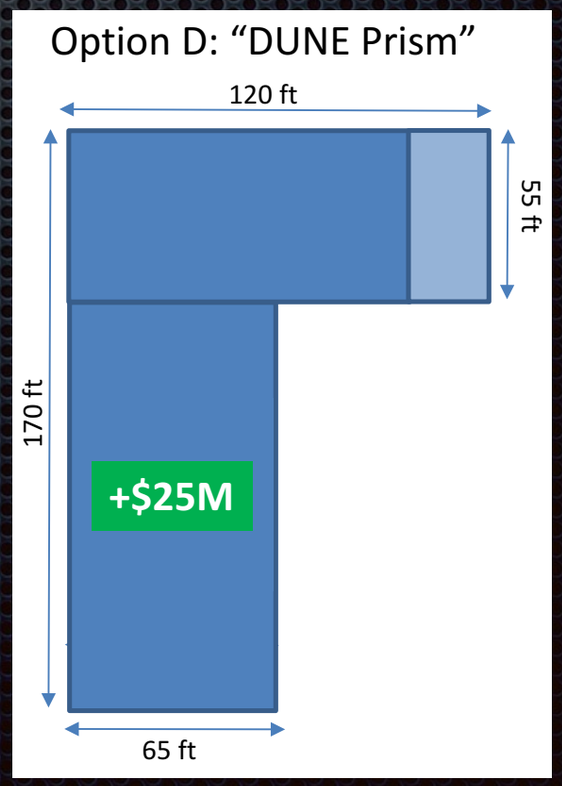
Workshop Agenda

- DUNE-PRISM Facility Options M. Wilking
  - Focus on proposed ND halls needed for DUNE-PRISM
  - Content outline later in this talk
- DUNE-PRISM Sensitivity Studies G. Yang
  - Latest Cafana fit studies
    - Goal for the workshop is to show bias in oscillation parameters with a reasonable ND fit, but with a bad fit at an off-axis location
- DUNE-PRISM Event Rates L. Pickering
  - Show event rates at different positions to demonstrate a reasonable run plan for DUNE-PRISM numu measurements, and to provide event rates for other processes of interest to the DUNE ND group (e.g. nu-e scattering)
- DUNE-PRISM Flux Fitting C. Vilela
  - Linear combination studies for Gaussian fits and oscillated fluxes using the NuPRISM software framework tools

Basic ND Hall Parameters

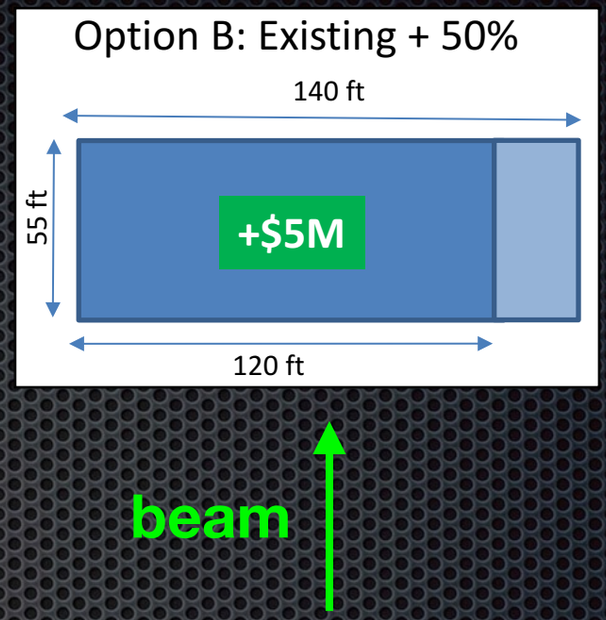
- Currently planned ND consists of a 7 m cryostat with an “integrated” ~6 m magnet / low density tracker (both dimensions given along the beam direction)
  - This implies a ~13 m long apparatus along the beam direction
  - Additional muon range detectors, etc. may also need to be added
- The currently planned hall (option B) is 140/120 ft x 55 ft (= 42.7/36.6 m x 16.8 m)
  - 5 ft of the 55 ft dimension is reserved for an access hallway (safety)
    - This leaves 15.2 m in the beam direction for the detector, if the entire detector is made moveable
  - Wider halls have been explored, but the exact width of the hall will depend on the quality of the rock (geological survey required)
    - The width is limited to ~the height of good-quality bedrock above the ceiling of the cavern without requiring enhanced reinforcement (which increases cost)

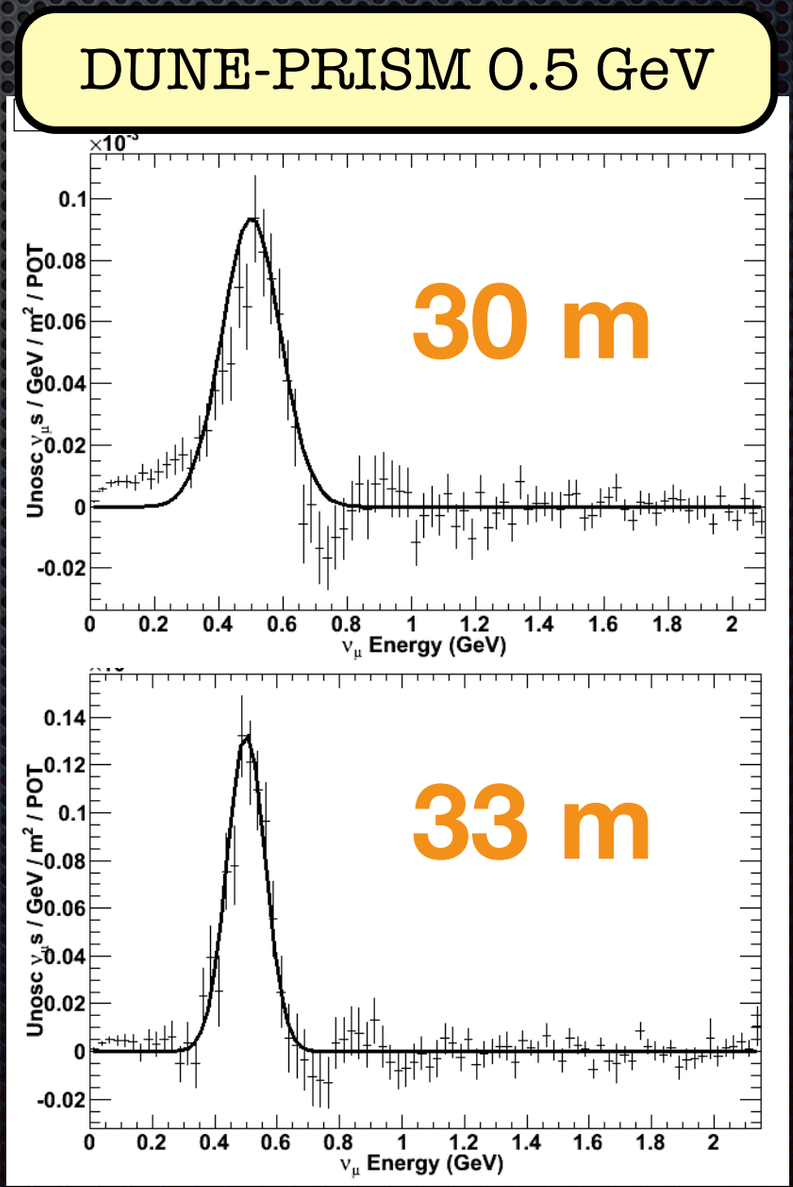




Hall Length

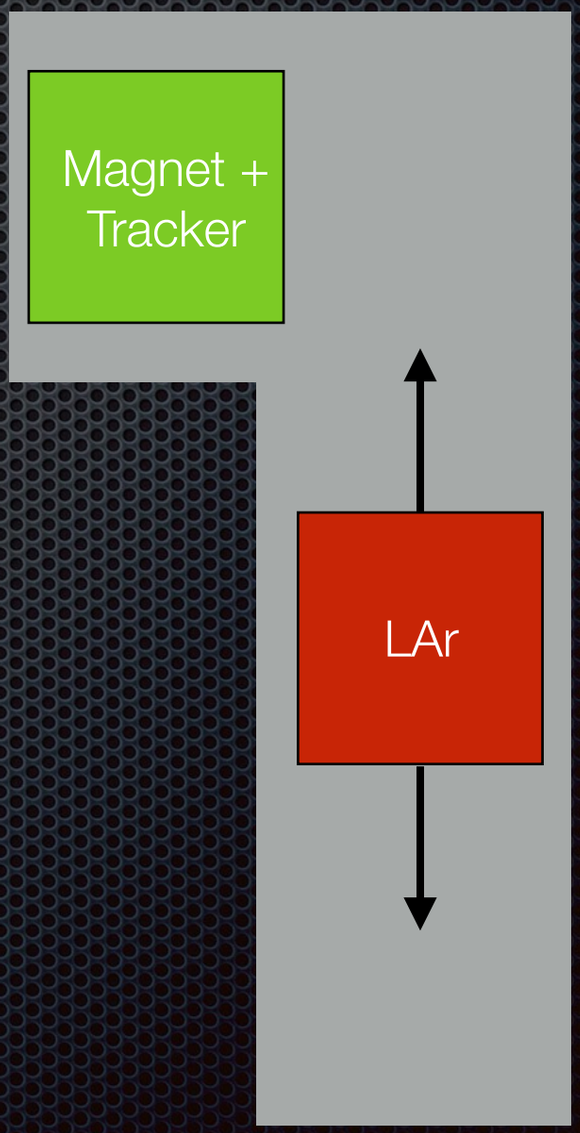
- An off-axis spanning detector is able to constrain neutrino interactions down to 500 MeV (i.e. below the 2nd oscillation maximum) with a range of around 30 m
- In principle, the hall cost is proportional to the hall length
  - Significant extra reinforcement is not needed to make the hall longer, since the width (i.e. the cost-limiting dimension) remains fixed
- There is likely not much motivation, even for DUNE-PRISM, to extend the hall beyond the currently planned 42.7/36.6 m





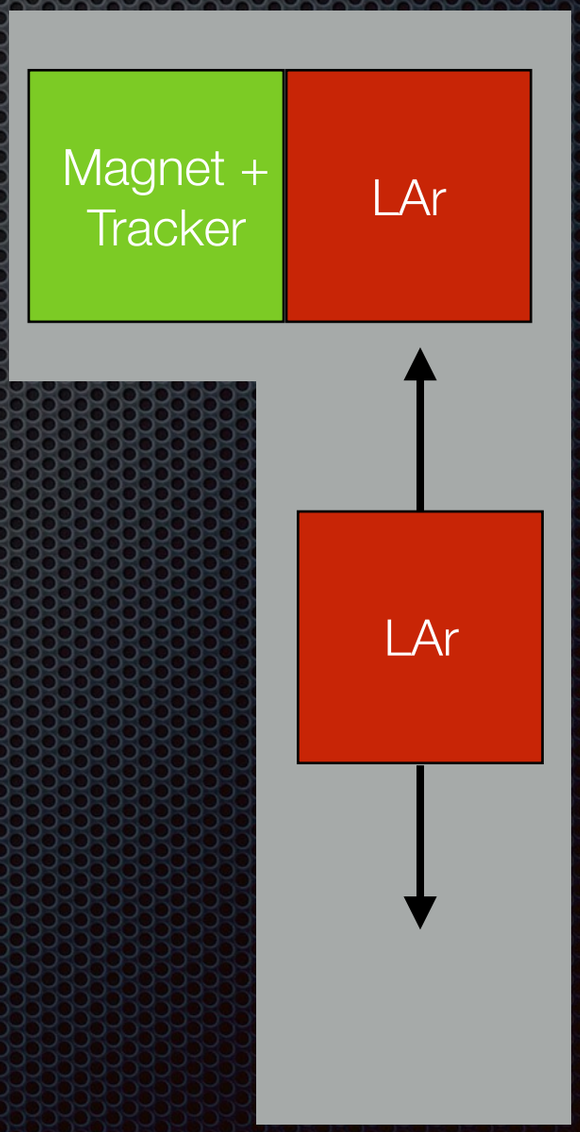
“Integrated” LAr + Tracker

- The ND group is currently pursuing a integrated LAr + tracker system
  - However, given the cryostat wall, magnet yoke, and possibly pressure vessel between the 2 detectors, it may be difficult to achieve integration in an effective manner
    - If so, it may be necessary to integrate (magnetized) muon range detectors directly with the LAr
- In such a case, the LAr could be decoupled from the downstream tracker, and only the LAr component would need to move to make effective DUNE-PRISM measurements
  - In this scenario, the width of the hall could be made even smaller (<10 m?) than the current design



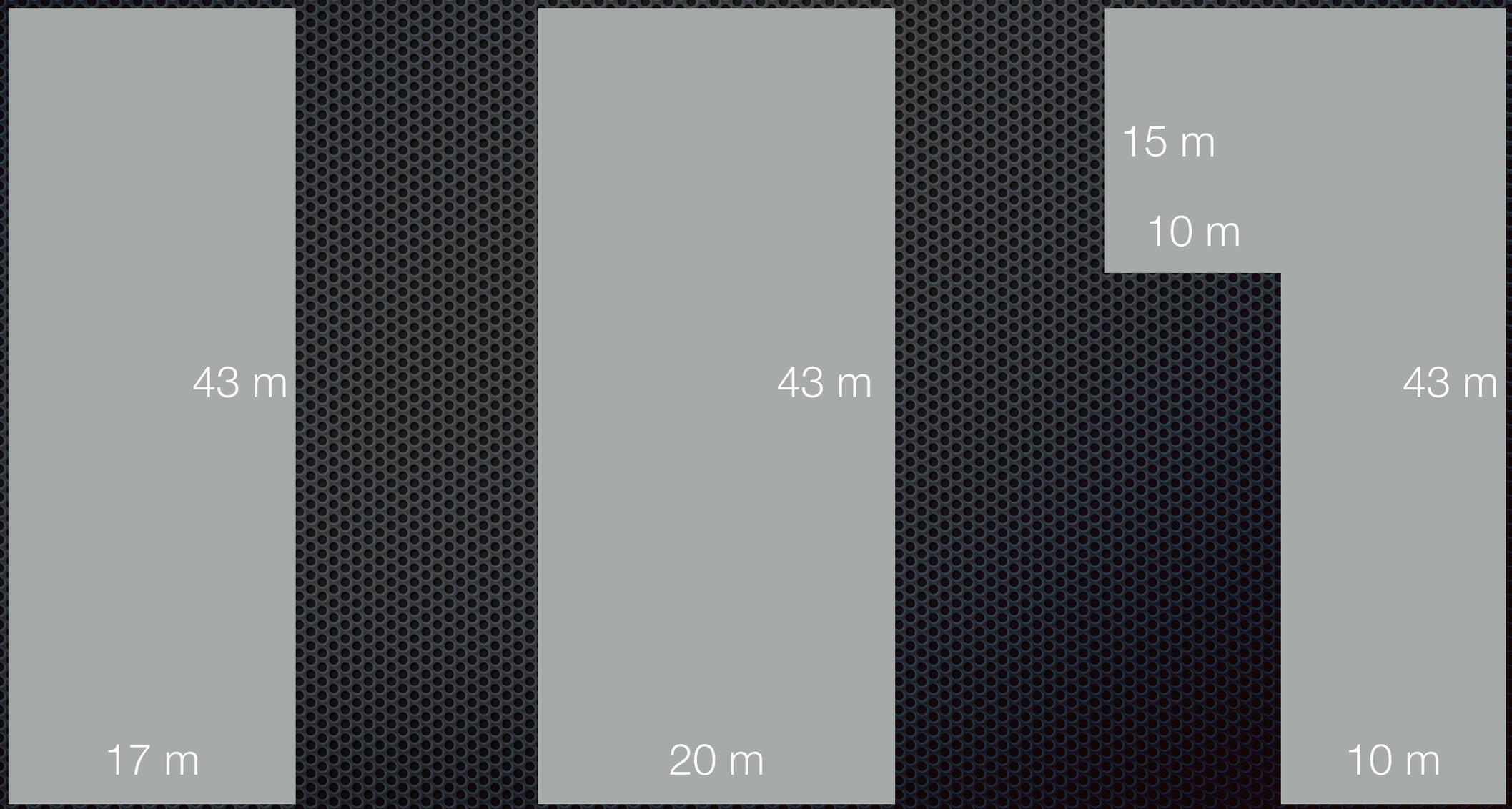
2 Detector Solution

- If integration is still desired, it may be possible to construct a separate LAr detector with an integrated muon range detector that moves
  - Need to understand the relative benefits of a (magnetized) muon range detector, integrated into the LAr, to a downstream tracker with significant material between the detectors
- This allows for a simultaneous traditional + DUNE-PRISM measurements (with added ND fiducial volume)



Proposal

- Produce cost estimates for 3 hall sizes:



Suppplement

Ceiling Height

- Current height of LAr fiducial volume is limited by hall ceiling height
  - Need to place ArgonCubes into the top of the cryostat
- If the LAr is on a moveable platform