TallBo User Experience

Bruce Howard, Stuart Mufson, Denver Whittington

Neutrino Detector R&D Facilities Workshop

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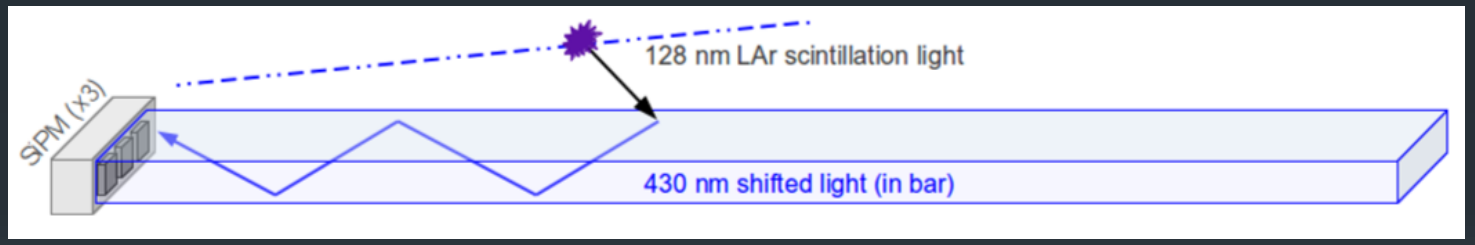
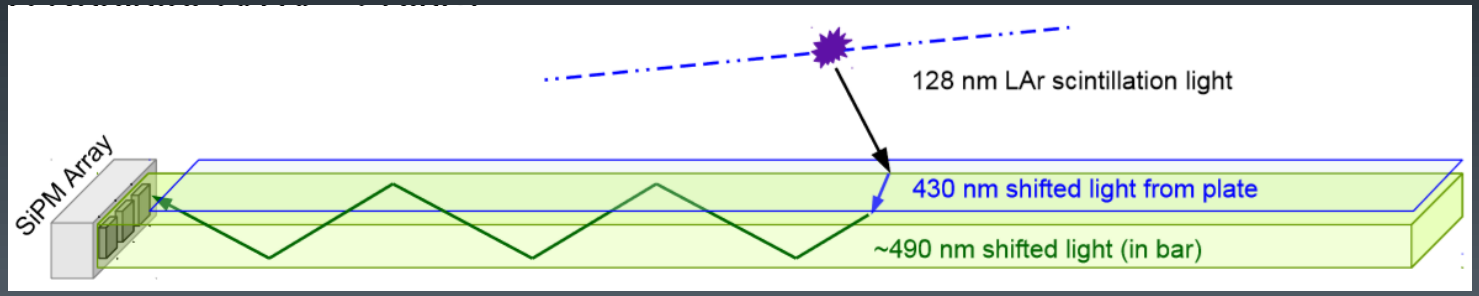
Our R&D efforts

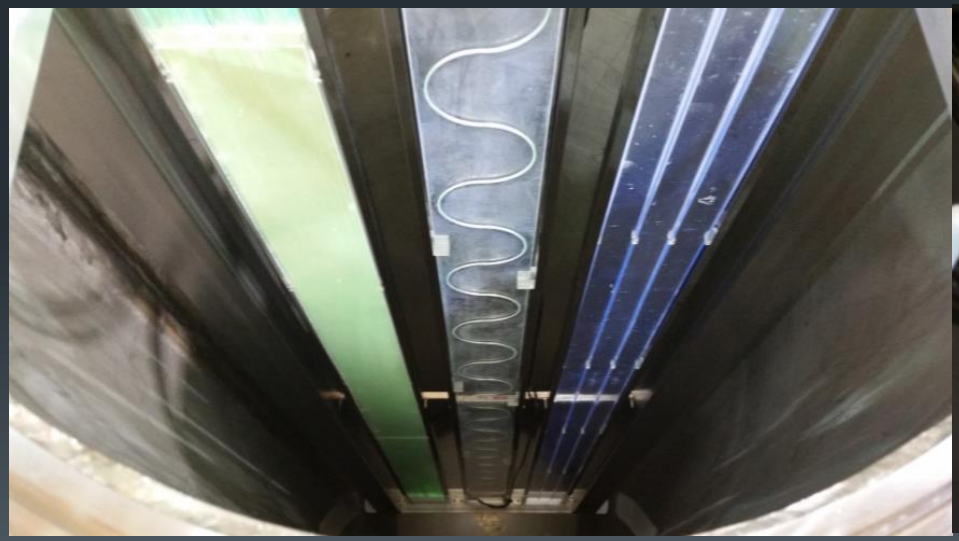
- Involved in the development of a photon detection system for the Deep Underground Neutrino Experiment (DUNE)
  - Light guide-based designs
- Have a (relatively small compared to TallBo) dewar at our lab in Indiana that we use to ensure prototype designs have potential

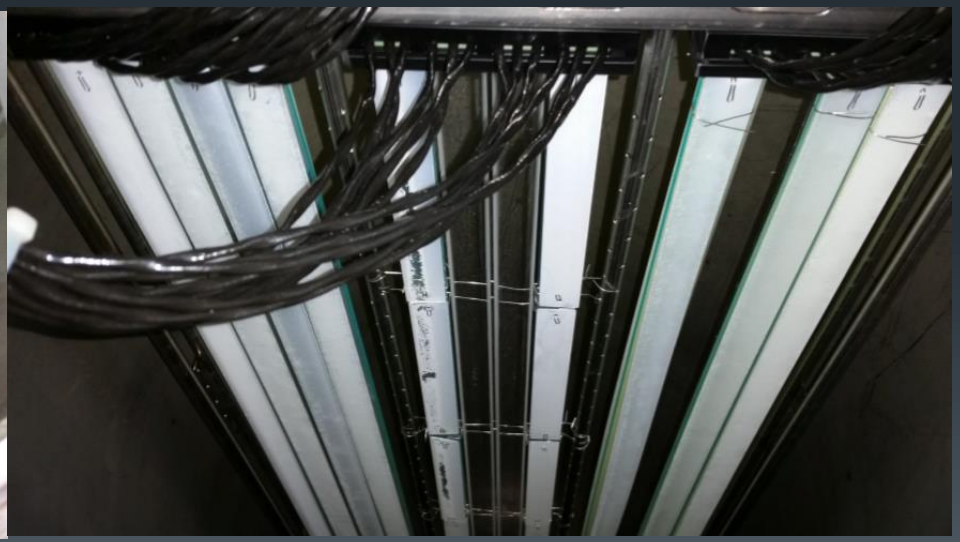




Our efforts at Tall Bo

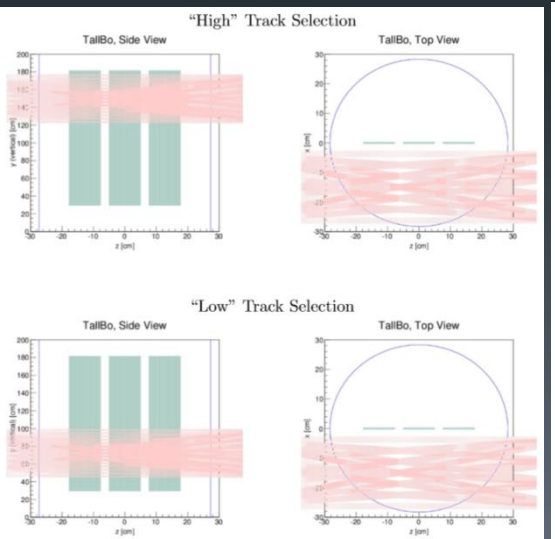
- We wish to perform a well-controlled study on many bars to directly compare the performance of various prototypes. TallBo facility at Proton Assembly Building (PAB) is the right fit
  - Have been using facility since late 2013
  - Side-by-side test of multiple light guide technologies at once

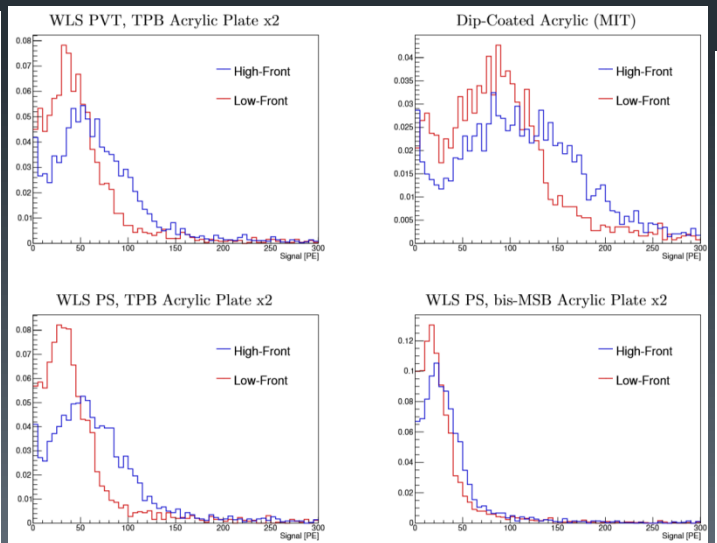


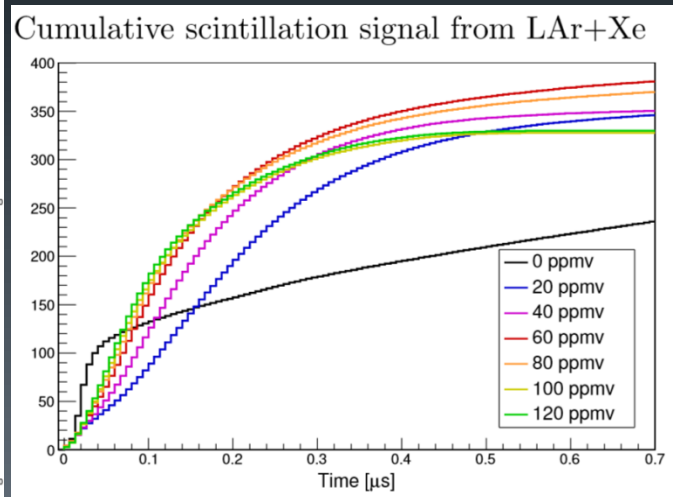


Our efforts at Tall Bo (cont.)

- Also learning more about the scintillation of liquid nobles
  - Data from a previous TallBo experiment have been used to characterize the components of liquid argon (LAr) scintillation
    - Article submitted to JINST, viewable on arXiv: 1408.1763v3 (FERMILAB-PUB-15-488-ND-PPD)
  - In most recent TallBo run, added amounts of Xe to the LAr, in stages
    - See also, e.g., P. Peiffer et. al., *Pulse shape analysis of scintillation signals from pure and xenon-doped liquid argon..., JINST* **3** (2008) P08007.
- Will conduct another round of testing light guides starting in a few weeks. Further work with Xe in this run as well.

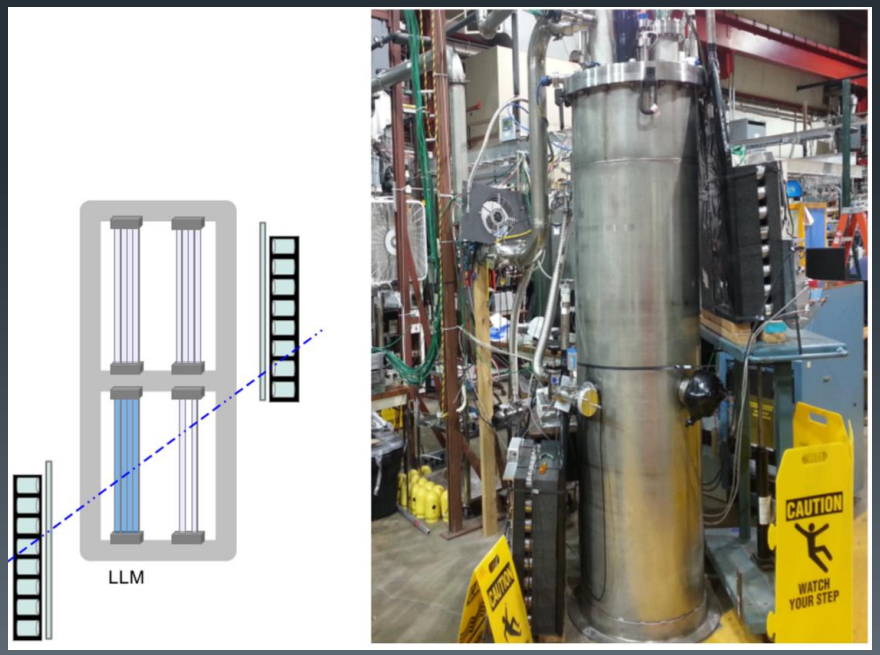






Working at Fermilab

- Good location and fosters communication
  - Many dedicated neutrino physics experiments of various detector technologies
  - Work done is for the DUNE far detector, but the results are potentially of interest to other Fermilab experiments
    - Example: SBND
  - Flow of information between groups of physicists
    - Communicate heavily with Brian Rebel and MIT group for example

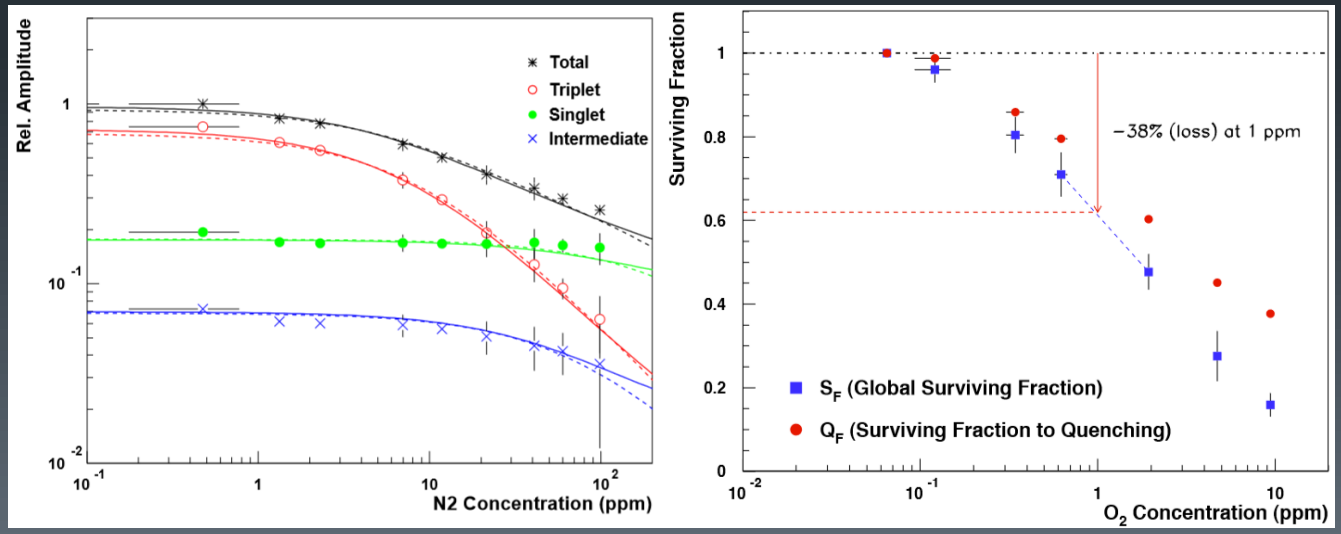


Dedicated staff at PAB

- Thanks!
- Staff at PAB accommodate our desires and help us
  - They are present during our setup and are available if needed
  - Deal with operating TallBo
  - Are active and prompt in fixing errors that arise
    - During one phase of our last TallBo run, the turbomolecular pump experienced a fairly catastrophic failure. They were timely in resolving the situation
- We have people at PAB during setup and tear-down, but during the actual running of the experiment we are back in Indiana
  - Tie our computer running the experimental equipment into Fermilab's network so we can remotely start and stop data taking
  - Granted we are close and can travel back as needed, but the dedicated staff relieves the need to be there every day

Facility well-understood/contained

- Very important, since scintillation photons are highly sensitive to contamination levels
- Use a high purity LAr and pass it through molecular sieve and copper filter to remove contaminants as it fills
- Closed system
  - Condenser setup to stop boiling off from quickly lowering level
    - Level monitor allows us to track the changing of the volume of LAr
  - Can maintain a high level of LAr for long enough to conduct studies
- Contamination monitoring



R. Acciarri et al., *Effects of nitrogen contamination in liquid argon*, *JINST* **5** (2010) P06003

R. Acciarri et al., *Oxygen contamination in liquid Argon: combined effets on ionization electron charge and scintillation light*, *JINST* **5** (2010) P05003

Engineering staff on-hand

- Having an engineering staff with dedicated detector experience can only be an asset
- Injecting LXe into LAr proves tricky
  - When we decided to do a study with LXe, a Fermilab engineer consulted and designed an injection system
    - Thanks to Michael Geynisman, a Fermilab engineer working on liquid argon projects!

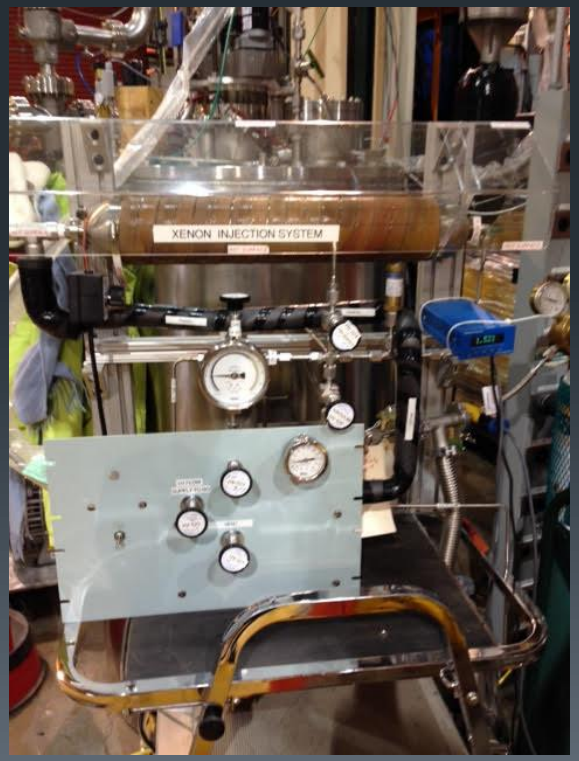


Photo courtesy of Brian Rebel

Ideas for further use

- Could put a small-scale wire plane prototype with photon detectors
  - Make a mock-up of a DUNE-style APA plane
  - For studies outside the scale of 35ton, perhaps in preparation for ProtoDUNE
    - 35ton is using older generation of photon detectors
- In-situ Ar-39 measurements
  - With a small-scale TPC to tag event topologies
- Rayleigh scattering measurements
  - Tall dewar provides a reasonable path length for scattering studies
- More work with LAr dopants
  - We have seen very clear effects from doping LAr with Xe, as have other groups
  - Will do more with Xe in a few weeks, but perhaps more work with Xe or other dopants could prove useful
  - Other dopants as well: Trimethylamine (TMA), etc.
  - Want to get the maximal sensitivity to rare processes
- Dual phase detector studies