The Long-Baseline Neutrino Experiment Project

LBNE 35 ton prototype

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Outline

• Introduction
• Membrane Cryostat
• Cryogenic system
• Summary
Introduction

- LBNE wants to build a 10 kton Fiducial Mass Liquid Argon detector (two 5/9.3 kton FM/TM for a total of 19.8 kton).
- Membrane cryostat technology with passive insulation (Polyurethane foam).
- We have built the LBNE 35 ton prototype (the first and only membrane cryostat for scientific purpose and available to scientists) with the goals of:
  - demonstrating the membrane cryostat technology (thermal performance, feasibility for LAr, leak tightness).
  - demonstrating the contractual business model with membrane cryostat supplier for the design and construction of a membrane cryostat → DONE.
  - demonstrating that we can achieve the purity requirements in a membrane cryostat W/O evacuation.
  - achieving and maintaining purity requirements during filling, purification and maintenance mode.
Layout in PC-4

- LBNE 35 ton Cryostat
- Process piping
- LAr/GAr transfer lines
- LAPD
- LAPD/LBNE LAr purification/filtration vessels/system

North
LBNE 35 ton Prototype

• **First and only** membrane cryostat built for scientific purpose (Commercial technology) and available to scientists.
  – Primary Membrane (2 mm SS 304): 2.7m x 2.7m x 4.0m inner dimensions.
  – Secondary/Sub-Secondary Membrane
  – 2 Layers of Polyurethane insulation (Total 400 mm $\to < 15$ W/m$^2$ heat loss).
  – One instrumented top plate with all penetrations.

• IHI: design, procurement, supervision.

• Fermilab: built cryostat according to IHI procedures and training.

• Fermilab/LBNE gained **experience** with legal/technical aspects of the design and fabrication of membrane cryostats:
  – A lot of fit-up and adjustments on-the-field $\to$ need shop, tools and machinist(s) on-site.
  – A lot of **field work**.

• Cryogenic purification system: shared with LAPD $\to$ Mol sieve + Copper (achieved $> 5$ ms lifetime).

• Fermilab: design, procurement, fabrication of the cryogenic system.
Membrane Cryostat
35 ton Prototype – Drawing

- **Insulation**: 1,000 mm, 3,504 mm
- **Membrane**: 2,700 mm, 4,000 mm
- **Concrete**: 4,804 mm, 5,404 mm
- **Plate A**: 3,504 mm, 3,804 mm
- **Plate B**: 4,104 mm

Dimensions:
- Width: 4,000 mm
- Height: 2,700 mm
- Depth: 3,300 mm
35 ton Prototype in Pictures

3 D Model of IHI Tank

Concrete Structure @ PC4

Carbon Steel Vapor Barrier

Two layers of foam (0.4 m)

Top View of Two Layers Foam

SS membrane Insert Begins
35 ton Prototype in Pictures – Inside View
Top view of the completed cryostat
Cryogenic System
Piping runs from 35t to LAPD complete.
Piping connection at LAPD is complete.
Cryogenic System – 2

Top of the Tank with Ar Condenser

Top of the Tank
Close view of the top of the tank

Fabrication of the LN2 line

Top view of the top of the tank

LAr filling lines
Commissioning
Piston Purge

• $O_2$ 21% to 6.6 ppm, $N_2$ 78% to 10.7 ppm, $H_2O$ 540 ppm to 1.2 ppm.
• Total of 10.7 volume exchanges.
• Similar to LAPD results.

![Diagram of LBNE 35T Piston Purge All Instruments]

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Electronics

- All Purity Monitors are working and being commissioned in GAr with Xe flashlight.
- Reading from one of the Purity Monitors.
Summary

• We have completed the installation of the Membrane Cryostat.
• We have completed the installation of the Cryogenic System and the connections to the existing LAPD purification system.
• We have obtained safety and ORC approvals.
• Commissioning is ongoing:
  – Piston purge competed.
  – Tank gas is re-circulated at room temperature thru the mole sieve and oxygen filters in a closed loop.
  – Debugging phase to ensure system integrity and functionality prior to cool down of cryostat.
• Cryostat will then be filled with LAPD liquid argon.
• After the purity tests (Phase 1) we plan to insert TPCs inside the cryostat and take data (Phase 2).
Thanks