

The Long-Bo TPC in the Liquid Argon Purity Demonstrator

Tingjun Yang (FNAL)
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Why Liquid Argon?

- Bright scintillator (40,000 photons/MeV)
- Free electrons drift meters under electric fields of ~ kV/cm
- density of 1.4 t/m³
- readily available
- Boiling point of 87K at STP, possible to liquify with liquid nitrogen.

Neutrino Interactions

Studying the properties of neutrinos will shed light on the origin of the matter/antimatter asymmetry in the universe

The next generation of experiments requires a large mass (10-100 kt) that serves as both target and detector.

Liquid Argon Time Projection Chambers (LArTPC) can produce 3D event images with topology and ionization density

- Identify particle (e, μ, p, γ, ...)
- Measure particle trajectory
- Measure particle energy

Challenges to Scale LArTPC

- Achieve high liquid Argon purity without evacuating the tank first
 - The mechanical strength required to resist the external pressure of evacuation becomes prohibitively costly for larger tanks.
- Demonstrate the electron signals after long drift
 - Develop high voltage feedthrough, upgrade electronics

PURITY DEMONSTRATOR

All existing LArTPC detectors have been evacuated before filling. Not practical for kiloton detectors.

- Goal: Demonstrate good purity (life-time) in an industrial vessel without evacuation.
- First multi-ton purification system designed and built at Fermilab.

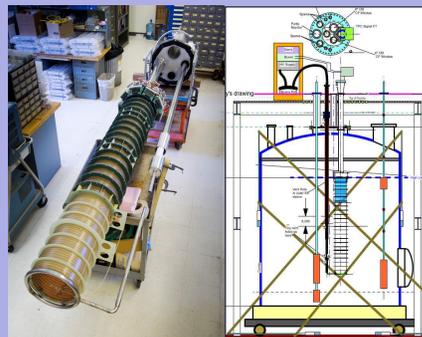
- Stage 1 (2011) bare tank and instrumentation
- Sniffers for evolution of gas purge
 - Analyzers for O₂, N₂, and H₂O levels
 - RTDs – for temperature (gradients)
 - Purity Monitors for drift-lifetime



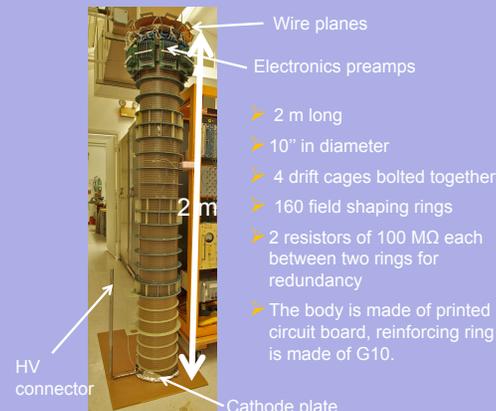
2011: SUCCESS! Measured electron drift lifetime >3 ms (Contaminants <100 ppt O₂ equivalent)
See Benton Pahlka's poster on LAPD for more details

LONG DRIFT DEMONSTRATION

- Stage 2 (Winter 2012-13)
- 120 kV feedthrough voltage already achieved
 - The response of a 2m long TPC to cosmic ray muons is a sensitive purity measurement
 - Fully characterize filter sizing and material performance
 - Study the effect of varying the recirculation rate on the drift lifetime
 - Perform studies of how quickly lifetimes can be recovered from (intentional) poisoning of the Argon
 - Start insertion in Oct. 2012

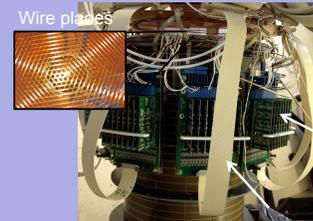


TPC – Long-Bo



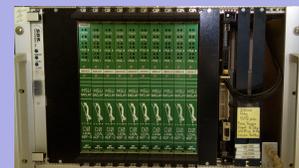
Electronics

Michigan State University
Gold electronics



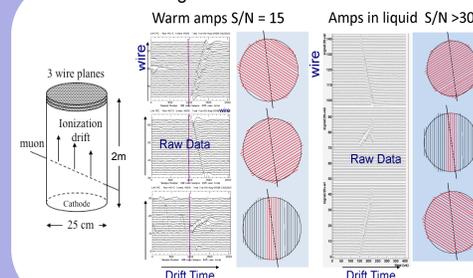
All electronic components tested at cryogenic temperatures

Frontend electronics



- 10 ADF2 cards
- 4096 samples per reading
- Sampling rate is 400 ns per sample
- Record length is 1.6 ms – accommodate drift time for 2 m.

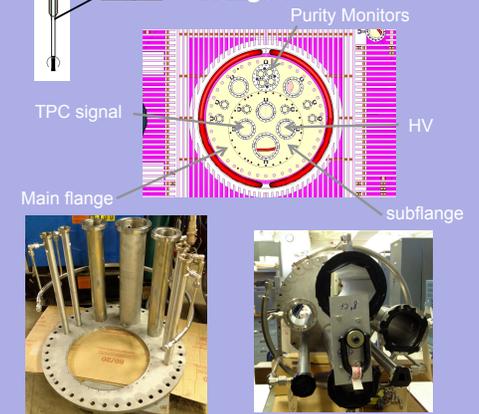
Much higher S/N ratio in cold electronics.



High Voltage Feedthrough



Flanges



Trigger for Cosmic Ray Muons

