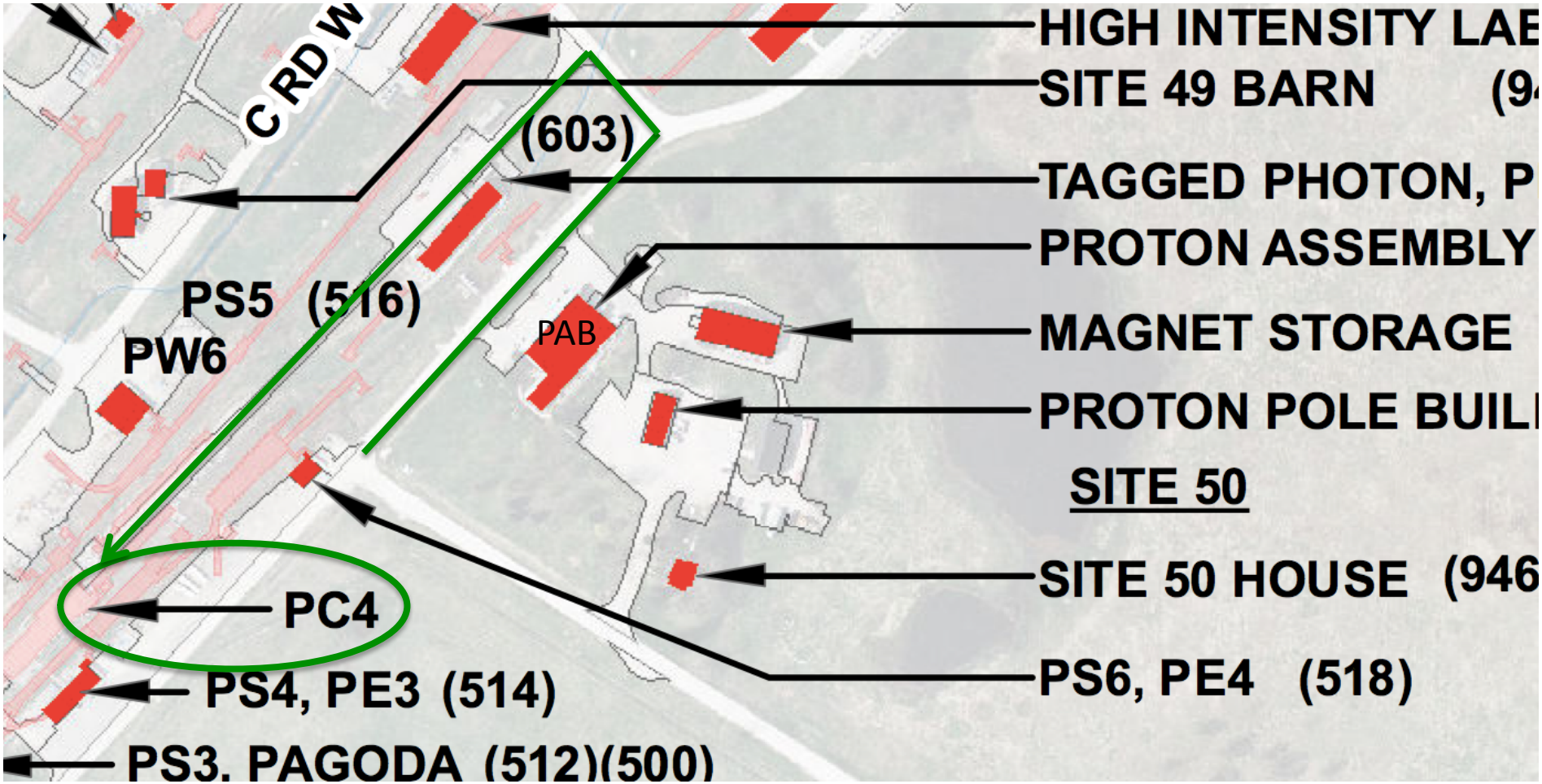
PC4 Facilities: Past Uses and Possible Future Directions

Alan Hahn

Fermilab

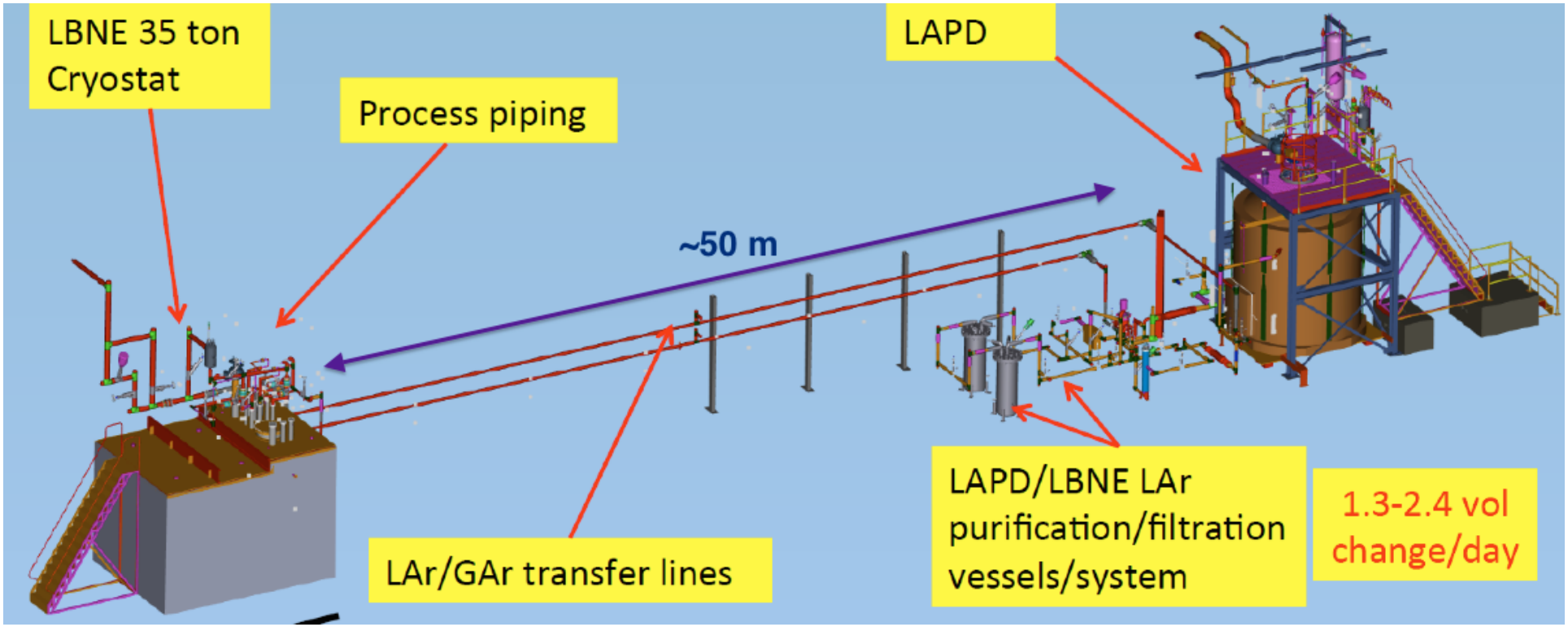
PC4—where are we?

The Wilds of the Proton Beam Area



PC4 – What awaits down the stairs

Two Cryostats, the 30 Ton LAPD and the 35 Ton “Prototype”



$L_{iquid}A_{rgon}P_{urity}D_{emonstrator}$

- Motivation to build LAPD
  - Realization that future affordable multi-kTon cryostats were NOT capable of being evacuated.
  - Wanted to show that a "reasonable" (multi-ton) sized cryostat could achieve LAr purities without being initially pumped down to reduce O_2 and H_2O levels to requisite purity levels.
- LAPD is a low pressure industrial tank
  - 3m diameter, 3 meter cylindrical height, 4.76 mm thick SS
  - Outside has foam/fiberglass insulation
- LAPD has had two runs.
  - One in 2012 where 30% of the cryostat was filled with LAr,
  - Second run in 2013 (~9 months)
    - Filled to full 30 tons
    - The addition of "Long Bo" a 2 m long, 25 cm wide TPC.
  - In both runs the level of purity needed for > 2m e^- drifts was achieved (see later slides).
  - LAPD pioneered the Piston Purge and Gas Recirculation method of reducing O_2, N_2, and H_2O –starting with air—to levels that are lower than the specifications of vendor-delivered LAr.

LAPD Cryostat at PC4 before Insulation was attached to sides and top

LAPD installed with Filtration in foreground

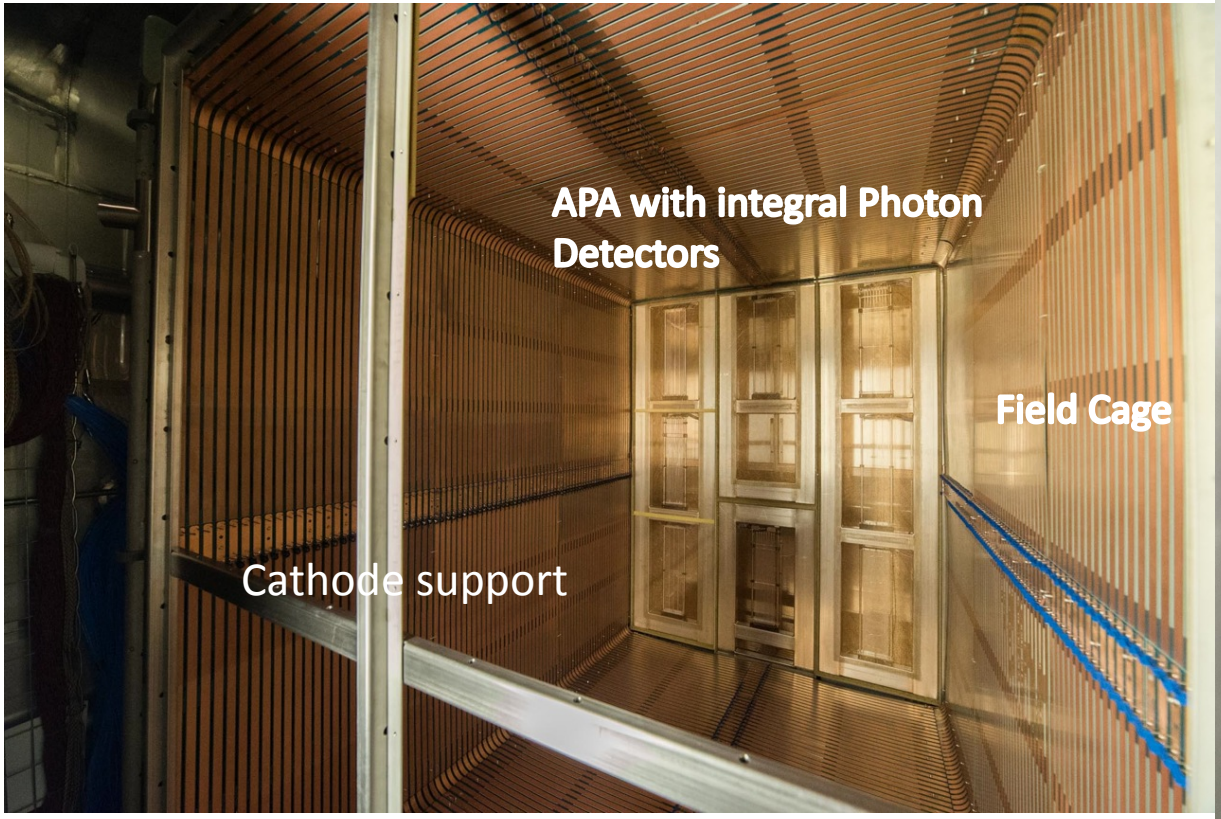
35 Ton Prototype Cryostat

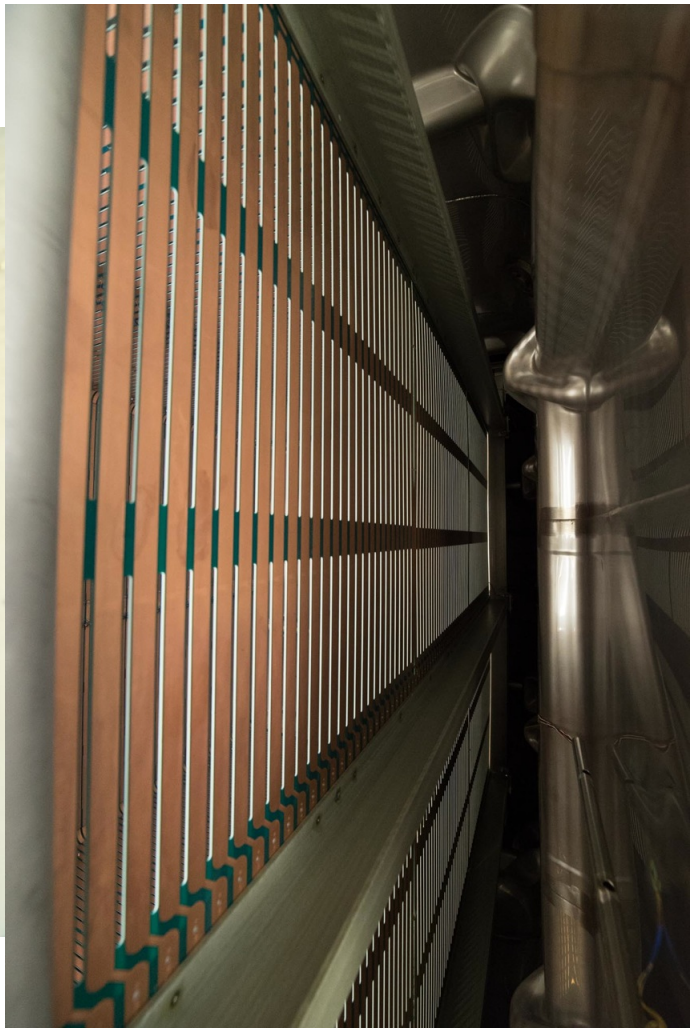
- A demonstration project to show suitability of membrane technology for LAr detector cryostats.
  - This was the technology of choice for the multi kTon Single Phase LAr TPC Cryostats.
- PC4 was chosen as the location to take advantage of the LAPD filtration facilities and instrumentation.
- First Run was Cryo Run (no TPC) in ~ Jan 2014.
- The Phase 2 Run expects to begin cooldown and filling next week.
  - Phase 2 includes reduced-scale version of the DUNE Detector (TPC and Photon Detectors)

35 Ton Cryostat Construction

Carbon Steel
Vapor Barrier

View of 35 Ton Phase 2 TPC Anode Plane Assemblies

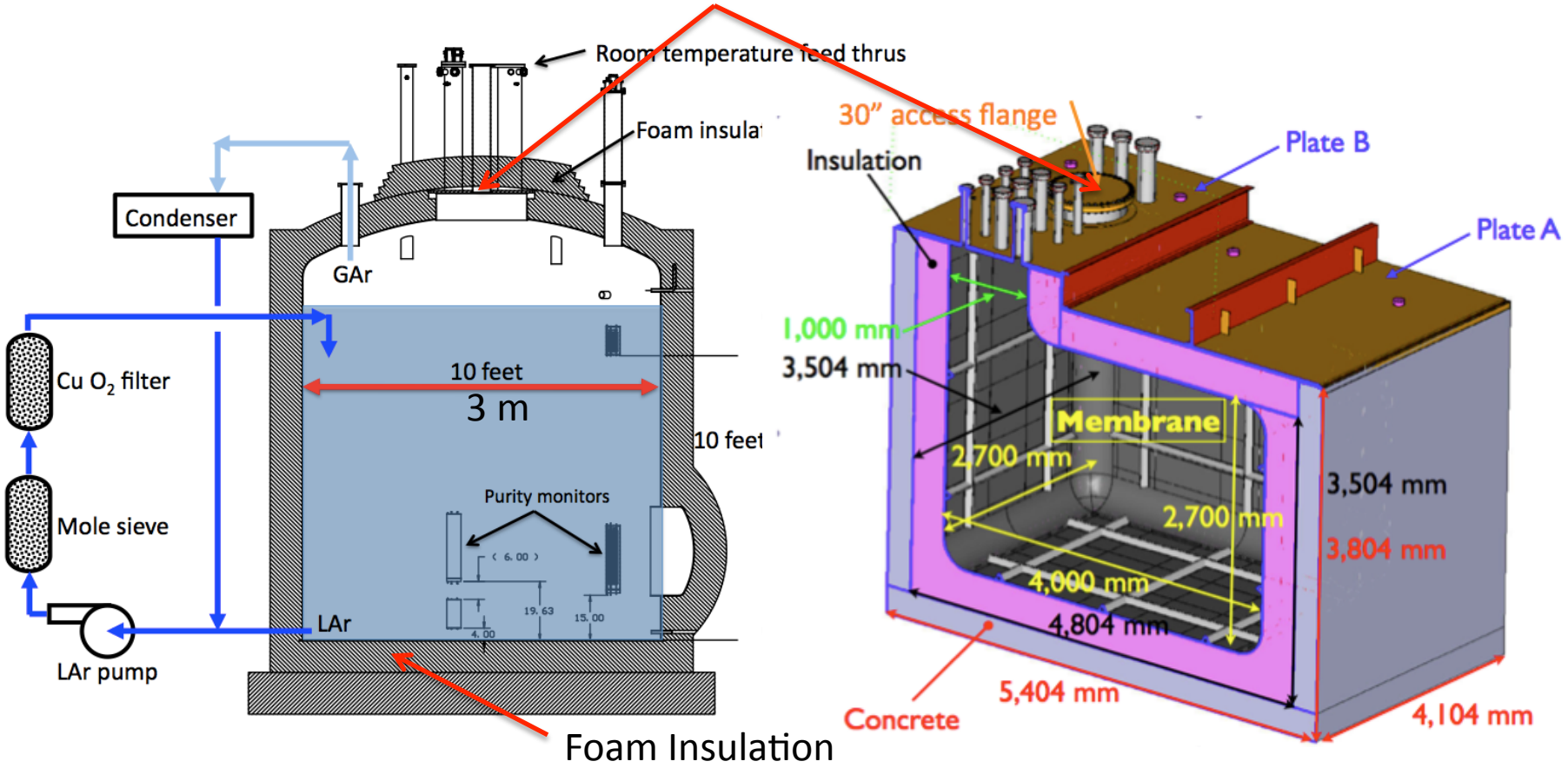




Field cage next to SS membrane

Comparison LAPD to 35 Ton

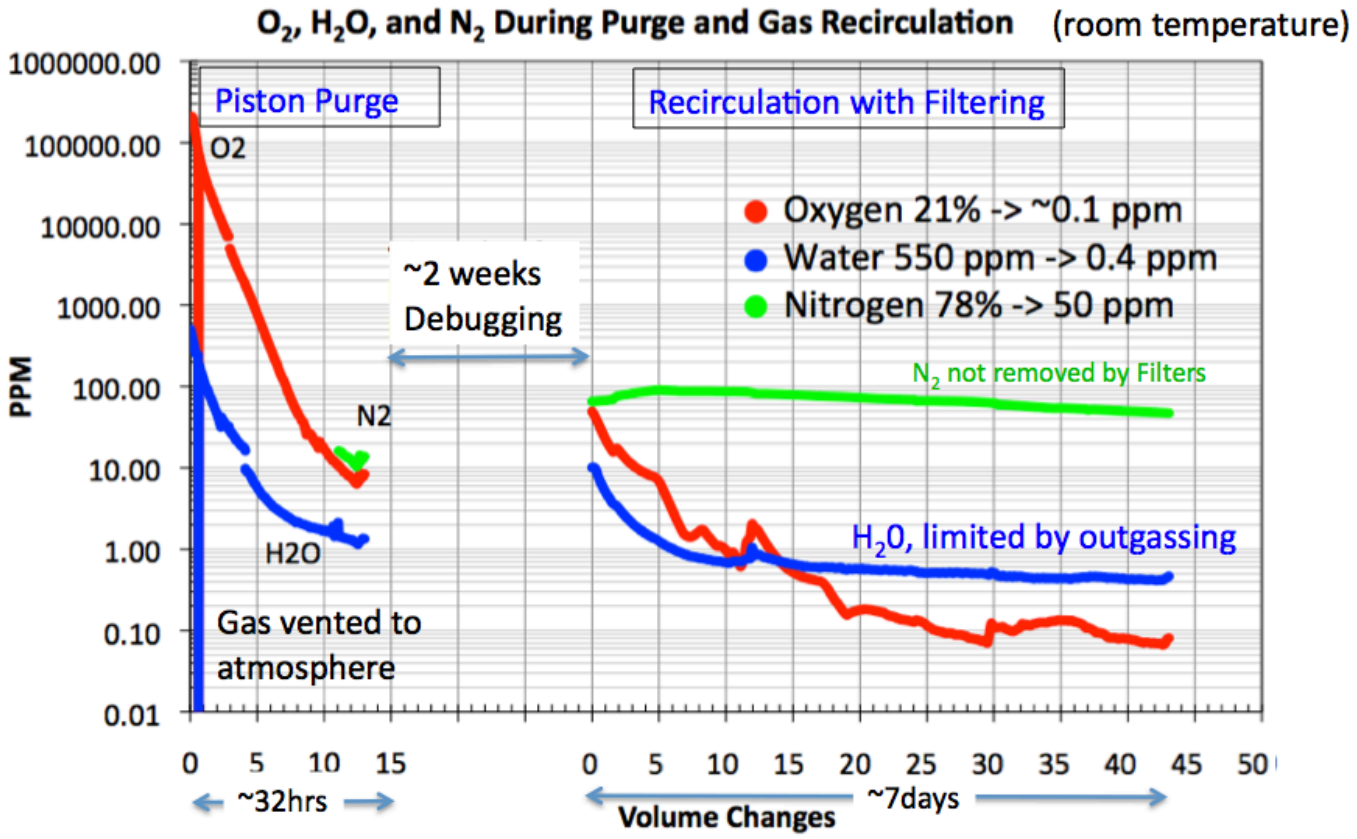
- Volumes are similar (~30 ton vs 35 ton)
- Both run slightly pressurized (1-2 psi) wrt Atmospheric Pressure
- Cooling is accomplished by condensation of evaporating LAr and returning (eventually) to the volume.
- Both have ~ 76 cm diameter Access points to inside



Instrumentation @ PC4

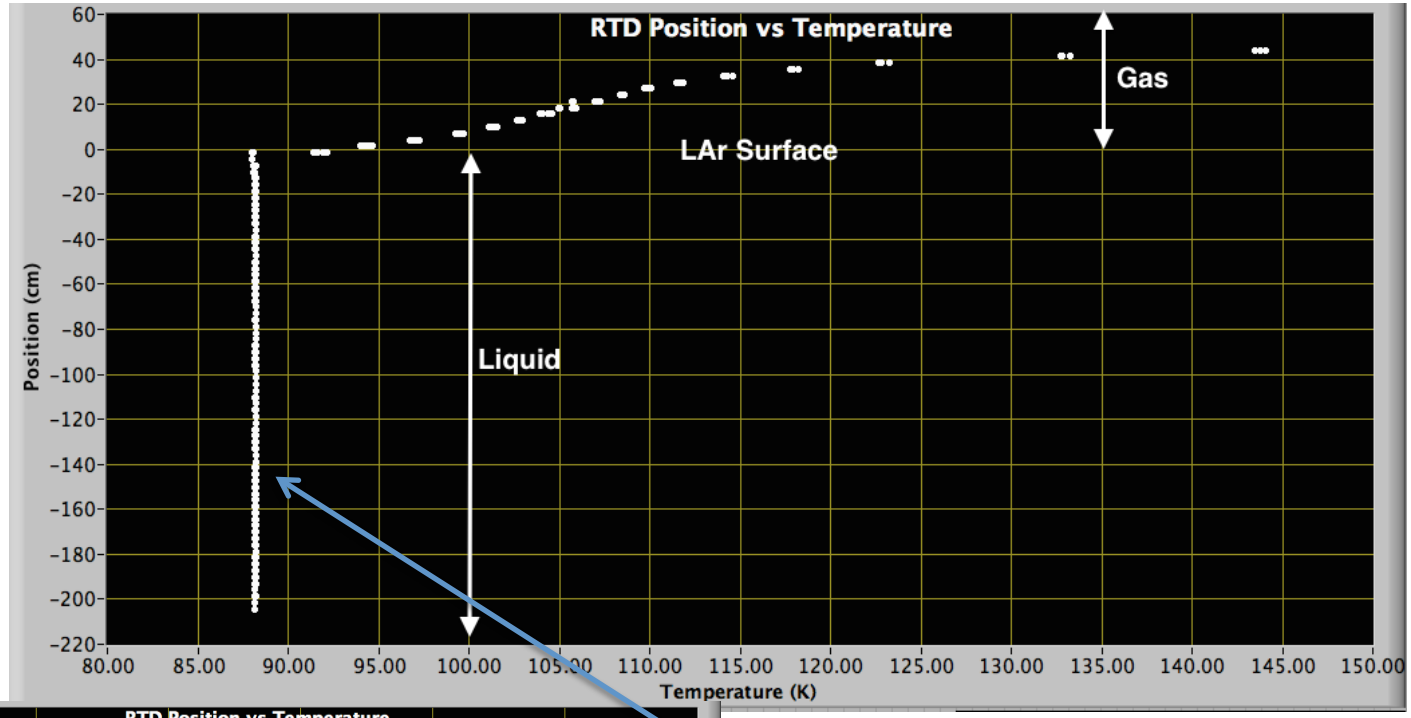
- Various Gas Analyzers for O_2, H_2O, and N_2
  - Ranges from % to < ppb
  - Invaluable for system diagnostics
- Purity Monitors
  - Two Short (16 cm drift) and three Long (47 cm drift) lengths.
  - Based on ICARUS design.
- Translating RTD (aka RTD Spooler)
  - 3 RTDs on pcb that translate vertically through Cryostat measuring the temperature profile in both the LAr and GAr
- Note that this instrumentation is portable, so one shouldn't expect it to be left in place unless there would be plans to use it.

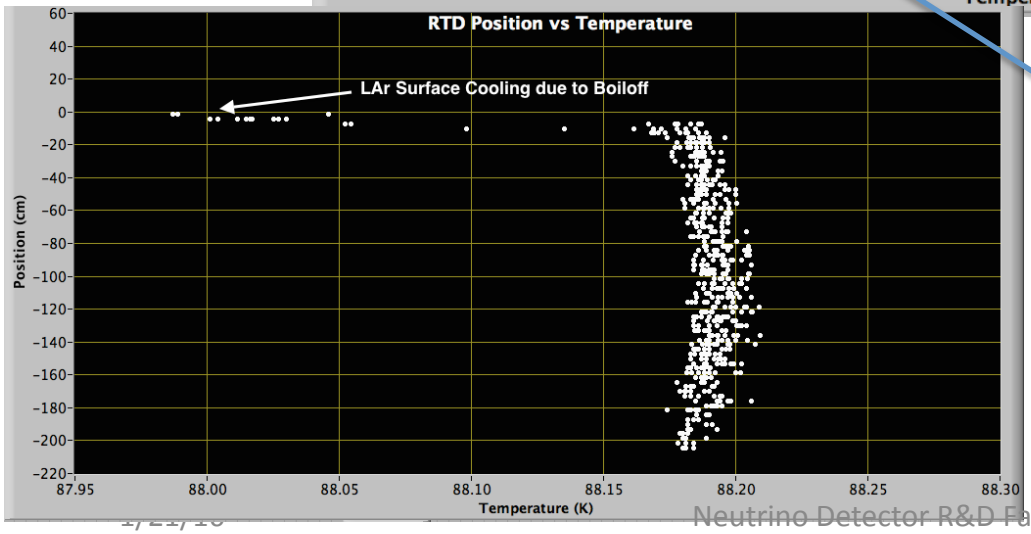
Example of Measurements—gas analyzers



35 T Phase 1 run

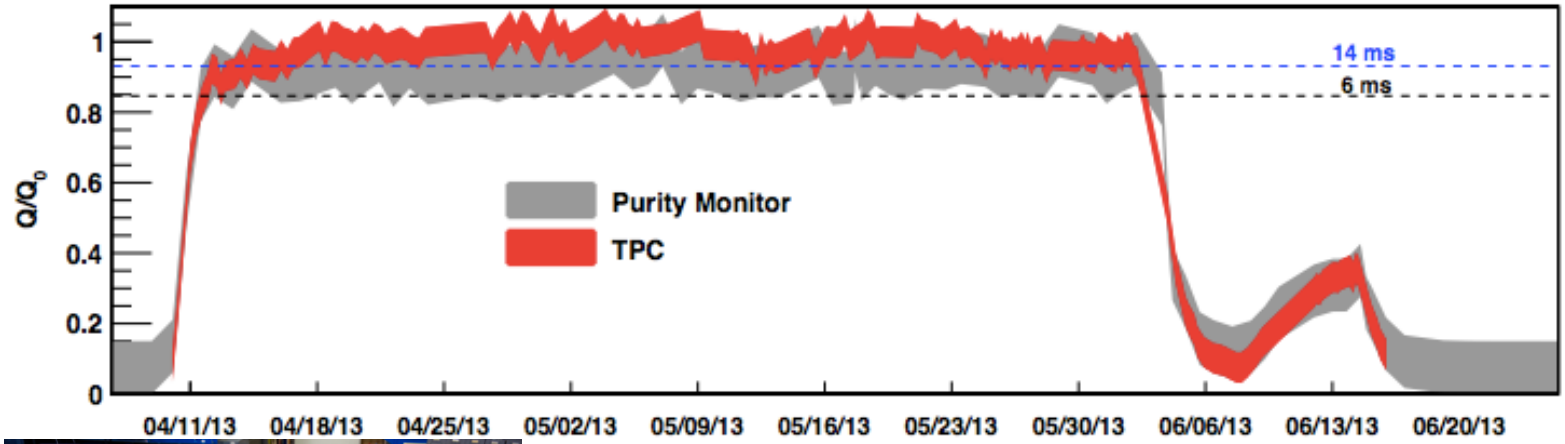
Example of Measurements (RTD Spooler)

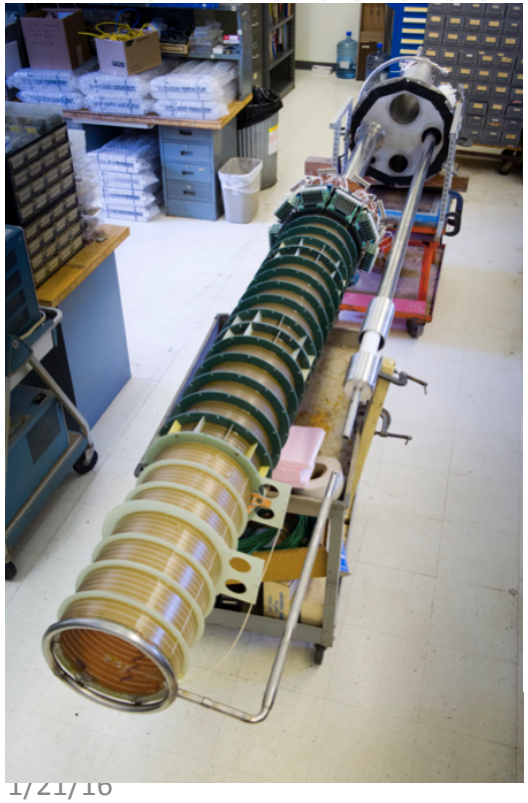


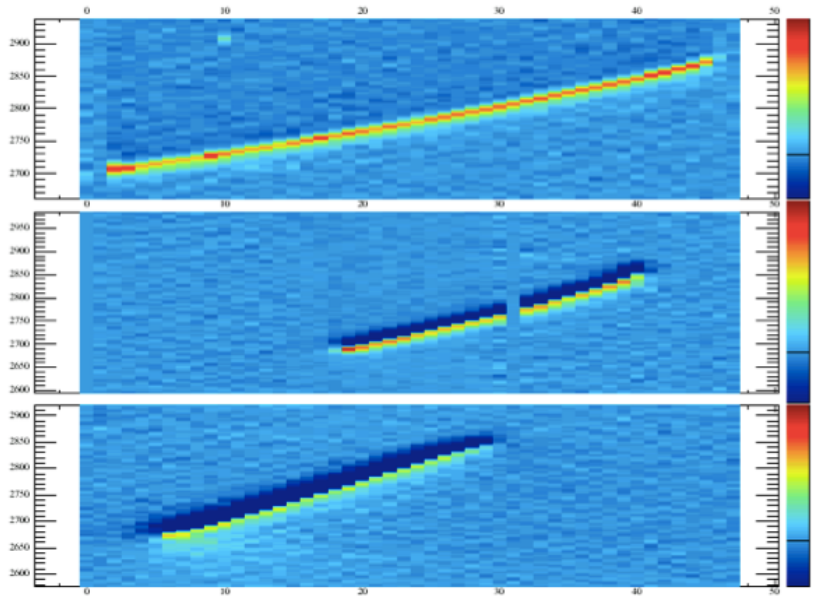


Blowup of LAr Vertical profile

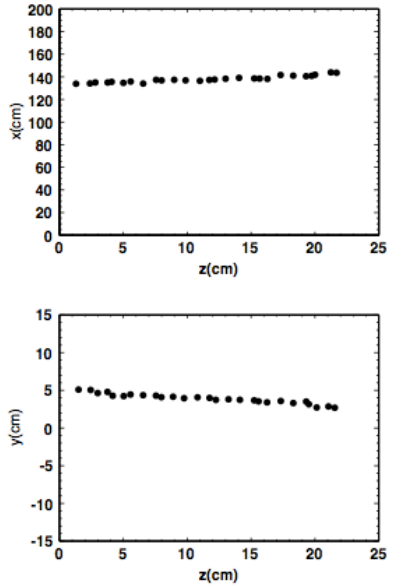
LAPD Electron Lifetime from Purity Monitors and muon tracks as measured in Long Bo TPC







(a) Raw data



(b) Reconstructed track

Muon Track in Long Bo

Possible Future Uses

- LAPD and 35 Ton are relatively large compared to most R&D cryostats
  - Advantage
    - Can build relatively large assemblies
      - As long as pieces fit through 76 cm diameter entry.
  - But size is also disadvantage
    - LAr Fill costs ~$50k for < 5 ppm O_2 and N_2 impurities specs.
      - Actual deliveries < 1 ppm
    - Operation costs ~$10k/month (T. Tope)
- Could also consider non-cryogenic uses
  - For example, as Faraday Cage for testing low noise electronics.
- As far as I know, there are no plans to use LAPD or the 35 T cryostats after the completion of the 35 T Phase 2 run.
  - 35 T Phase 2 is using the LAPD Cryostat as a holding vessel to buffer LAr deliveries.