



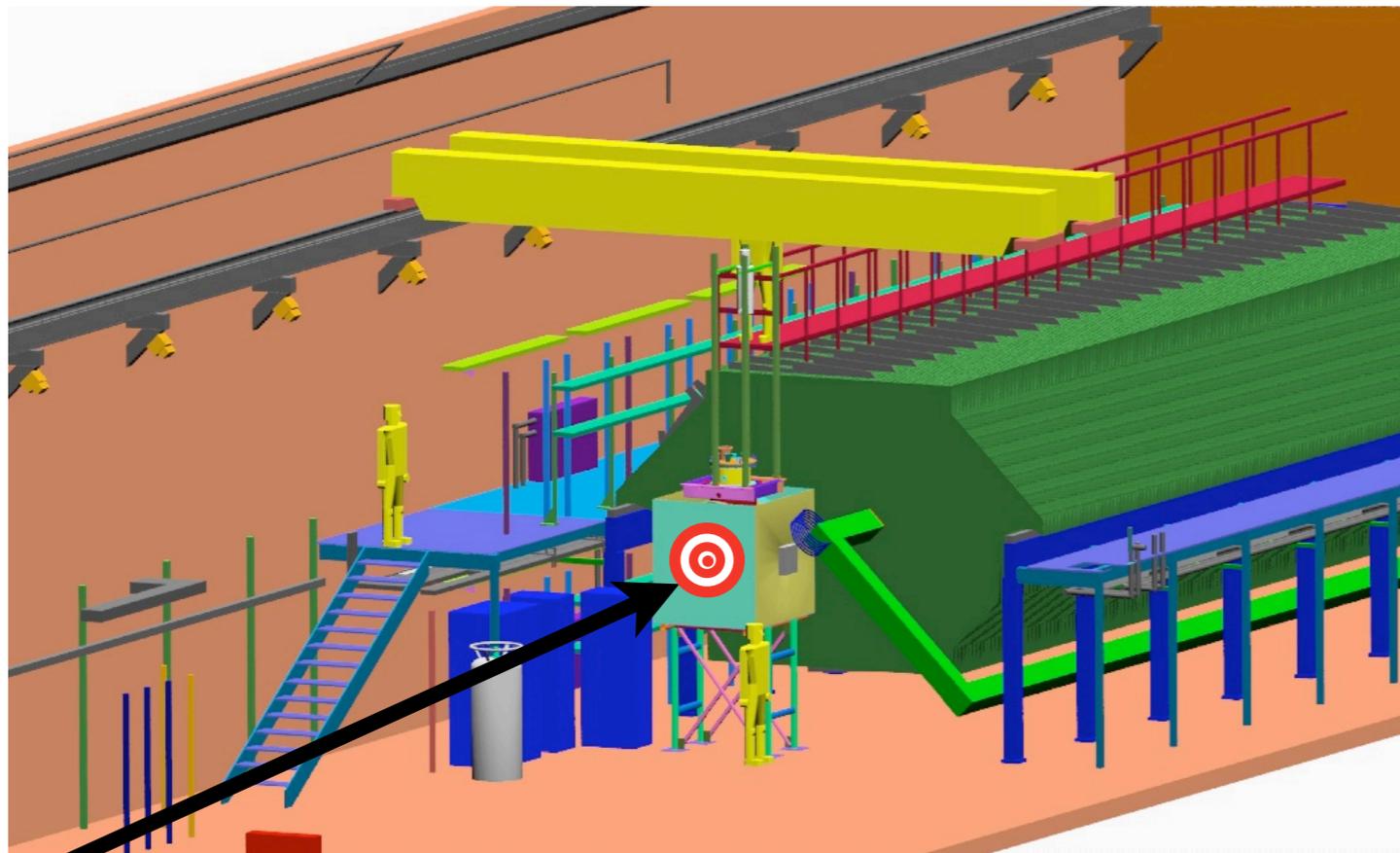
# ArgoNeuT Status

Mitch Soderberg

June 3, 2008

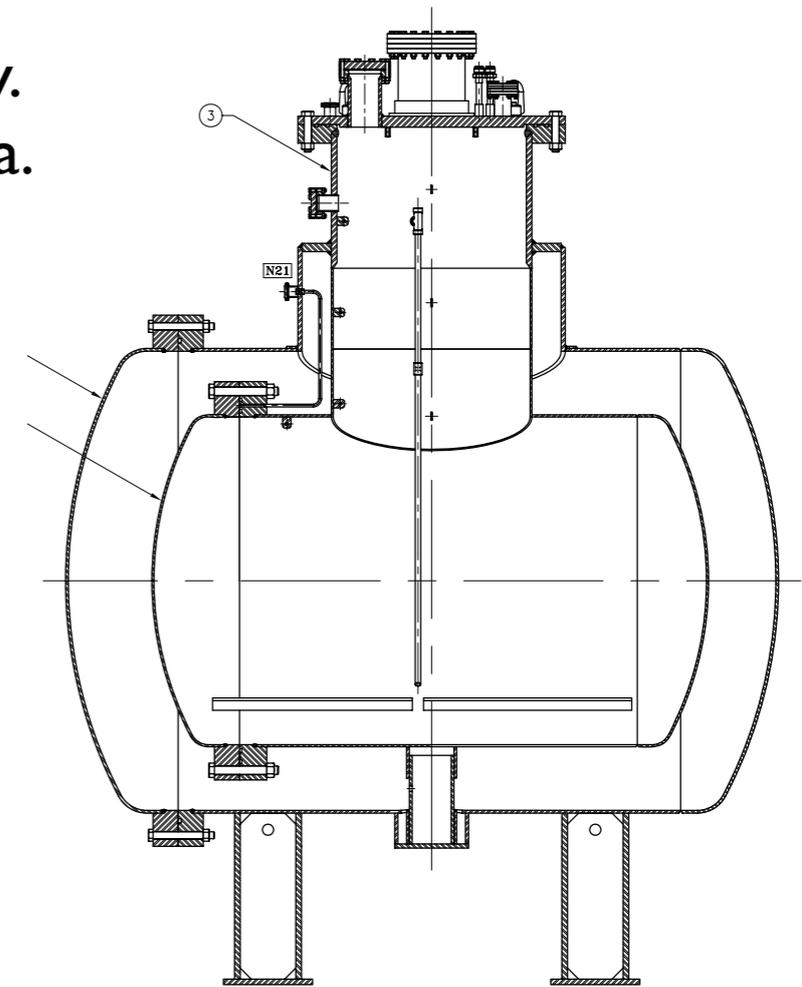
# Introduction

- ArgoNeuT (a.k.a. - test experiment T962) is a ~175 liter LArTPC
- Will sit in front of MINOS near detector in NuMI beamline. Use MINOS as a range stack.
- Jointly funded by NSF/DOE.
- Goals:
  - ▶ Gain experience building/running LArTPCs.
  - ▶ Accumulate a sample of neutrino events.
  - ▶ Confront all aspects of underground running and safety.
  - ▶ Develop simulation of LArTPCs and compare with data.



NuMI Beam

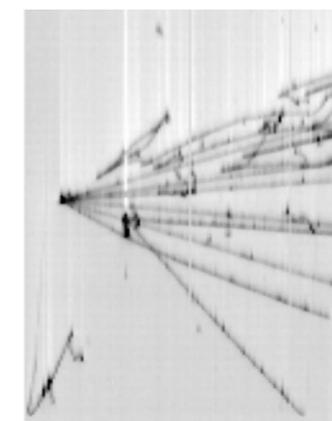
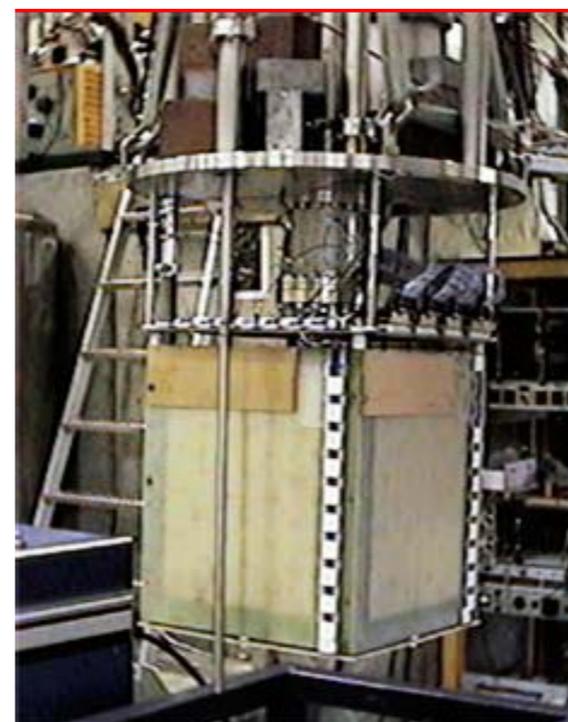
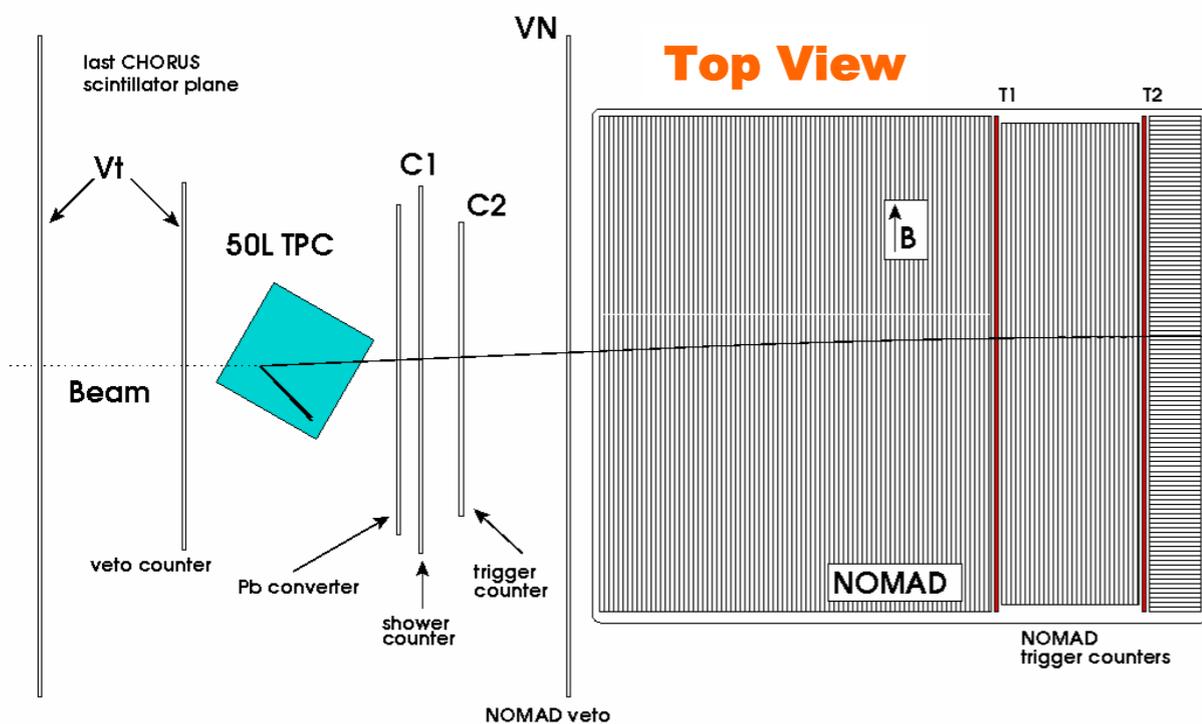
NuMI Tunnel



ArgoNeuT

# Test Stand Approach

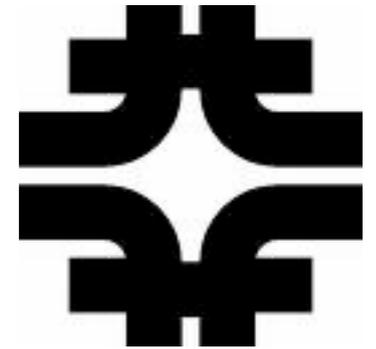
- Small detectors setups allow us to study LArTPC performance.
- Learned significant amount by doing Yale TPC test for cosmic rays (see Stephen's talk).
- Only previous LArTPC to see neutrino beam was 50L TPC at CERN WANF beam in 1997.
  - Collected  $\sim 10000 \nu_{\mu}$  CC events



“A Study of Q.E. neutrino interactions with a 50L TPC at the WANF beam” - Alberto Martinez de la Ossa

- **ArgoNeuT will improve over the 50L TPC in several aspects:**
  - ▶ larger size (x3)
  - ▶ more events (45000 events in 180 days)
  - ▶ lower energy beam ( $\sim 3$  GeV vs  $\sim 25$  GeV)
  - ▶ stable running for many months.

# ArgoNeuT Collaboration



F. Cavanna

*University of L'Aquila*

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*Fermi National Accelerator Laboratory*

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*Michigan State University*

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*The University of Texas at Austin*

C. Anderson, B. Fleming\*, S. Linden, M. Soderberg, J. Spitz, T. Wongjirad

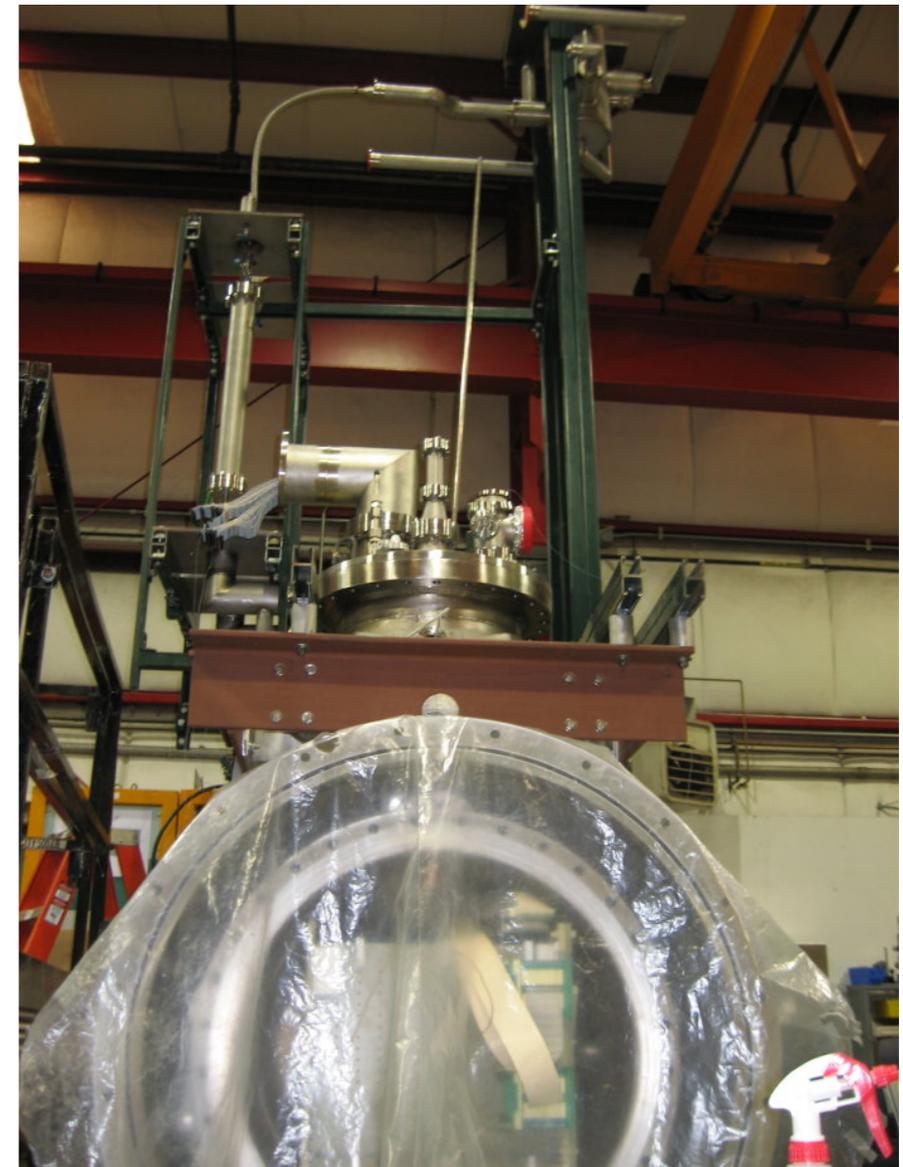
*Yale University*

# Cryostat

- Worked with Bartoszek Engineering to design.
- Built by PHPK of Columbus, Ohio
- Vacuum jacketed stainless steel cryostat with ~550 liter capacity.
- “Chimney” is used to make all vacuum penetrations.



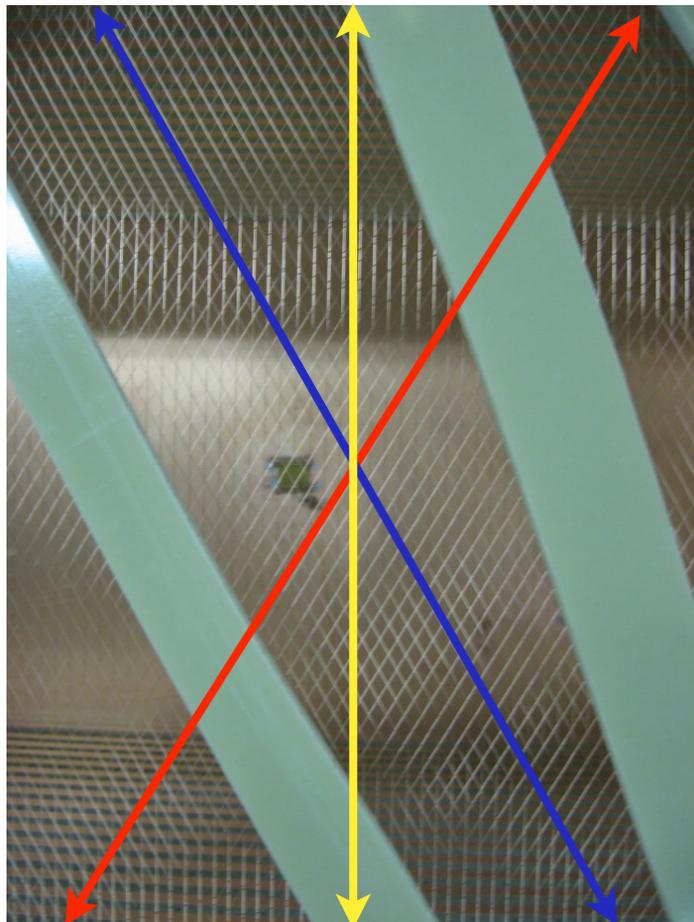
Arrival at FNAL



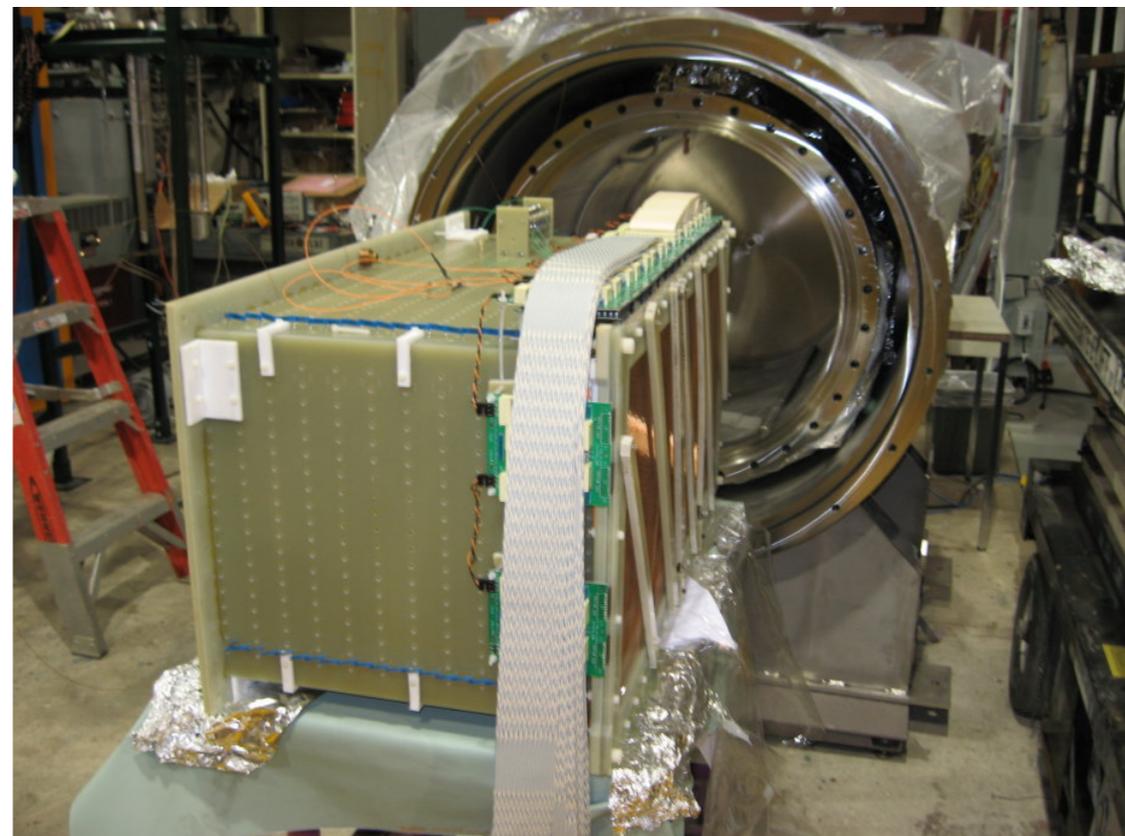
At PAB

# TPC

- 175 liter active volume, 480 channels of signal.
- Collection, Induction2, Induction1 planes. Induction1 plane not read out.
- 4mm wire pitch, 4mm plane spacing.
- 500V/cm electric field.
- Max. drift of ~50cm.
- Bias voltage distribution boards located directly on TPC.
- 0.15mm diameter BeCu wire. Cu-clad G10 used for field cage.



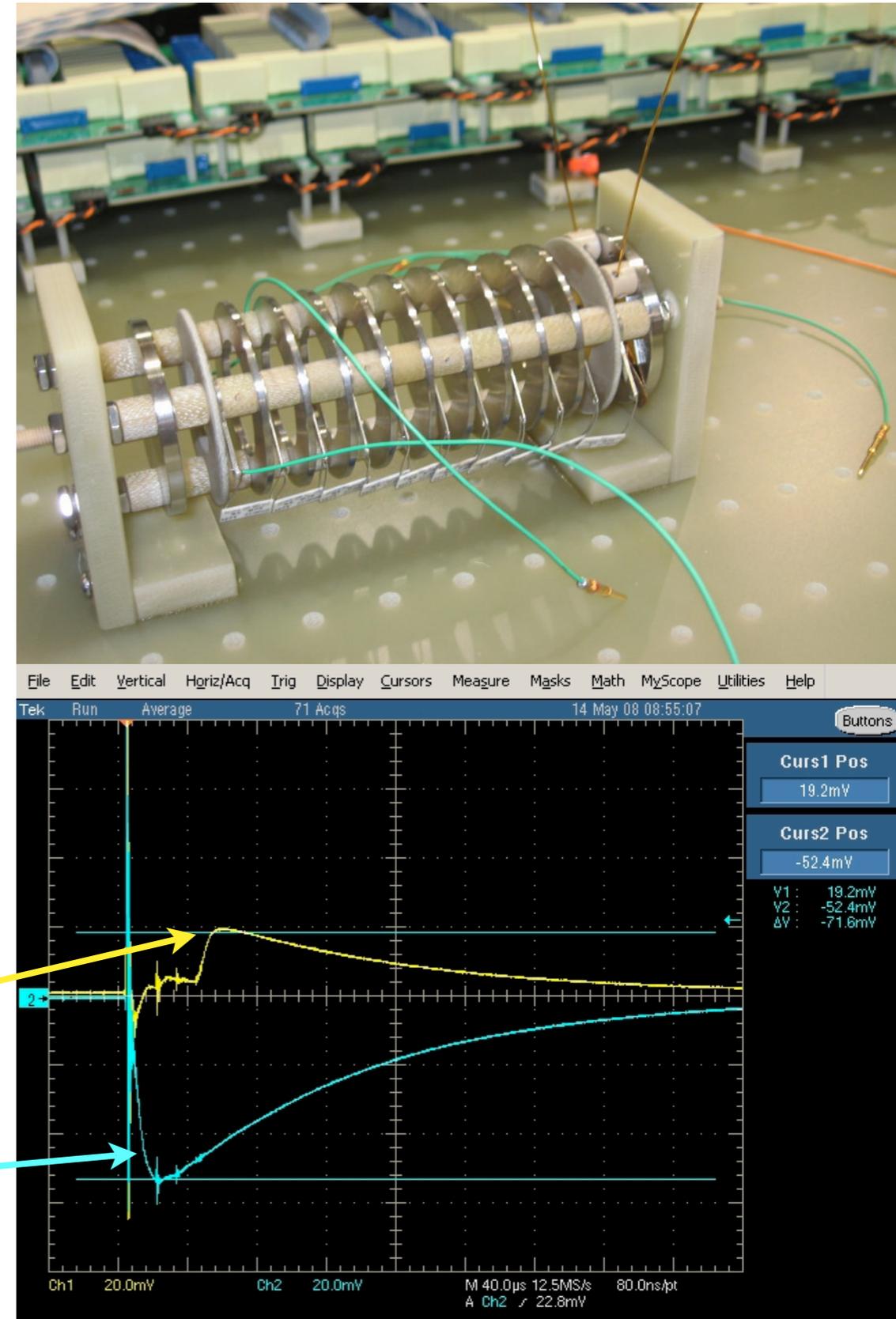
Wire Orientations



TPC About to Enter Cryostat

# Purity Monitor

- Based on ICARUS design.
- Xenon flashlamp supplies light to photocathode, via two redundant  $600\mu\text{m}$  quartz non-solarizable fibers.
- Smaller than typical purity monitor due to space constraints.
- Mounts directly on TPC.
- Photocathode is gold coated aluminum substrate.
- Fibers are difficult to deal with in these cryogenic systems...would like to study/improve this in future phase of ArgoNeuT.

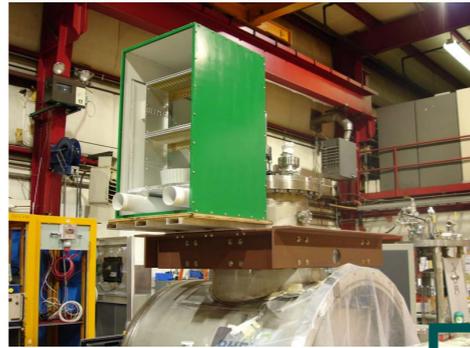


Anode Signal

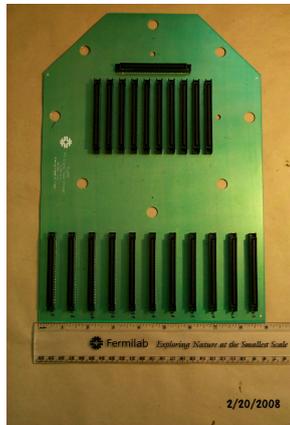
Cathode Signal

# Electronics

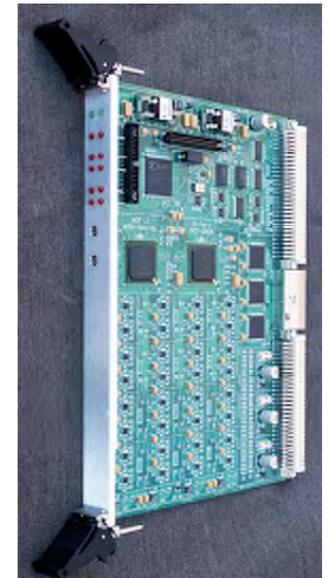
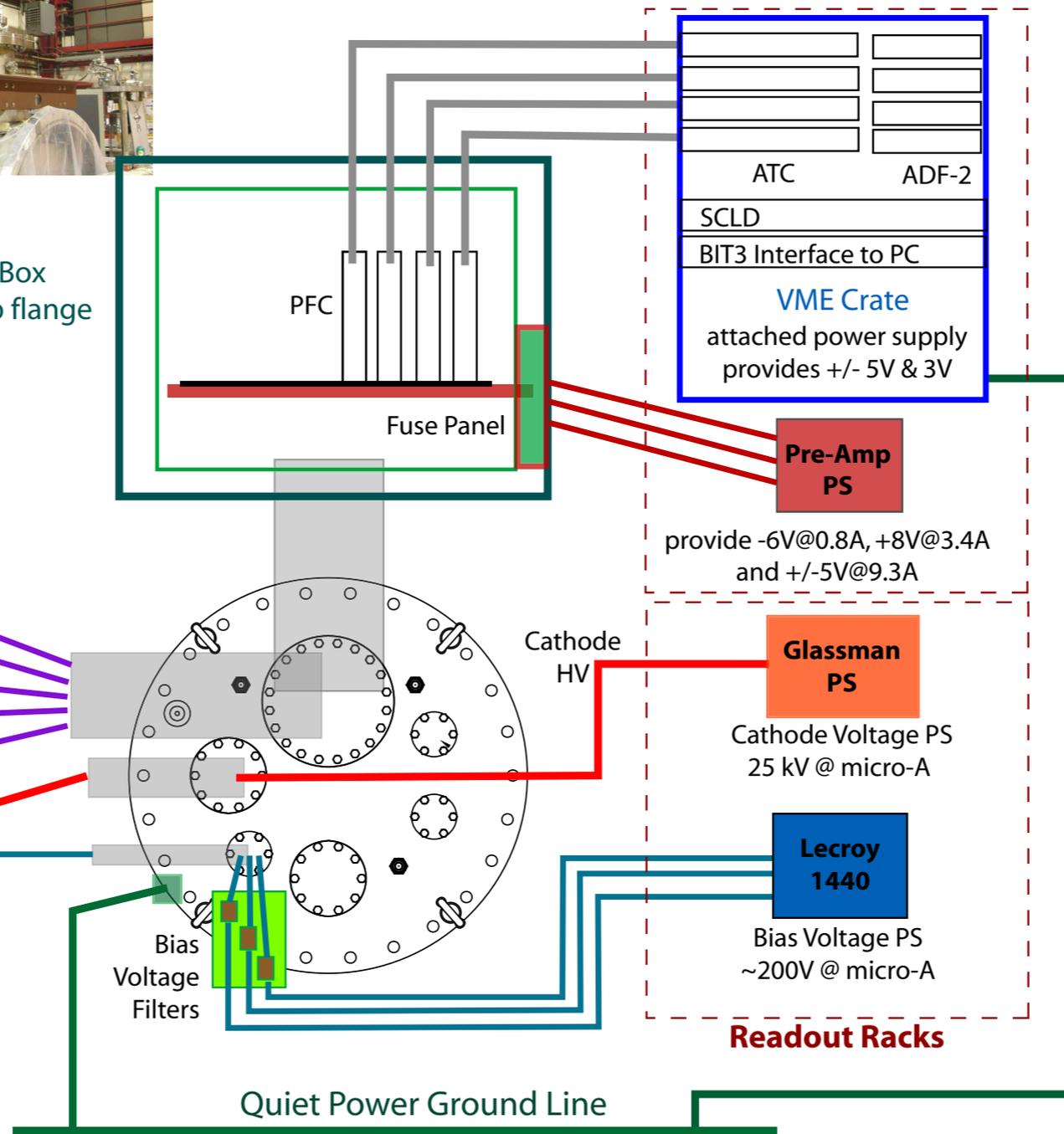
- 480 channels built by MSU
- Big step for U.S. to have home brewed electronics.



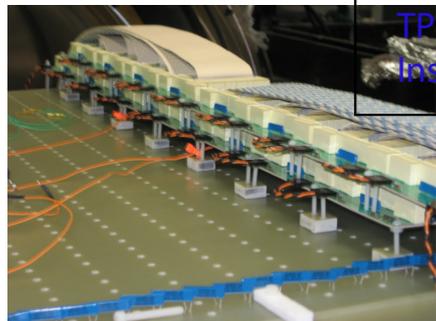
Electronics Box attached to top flange



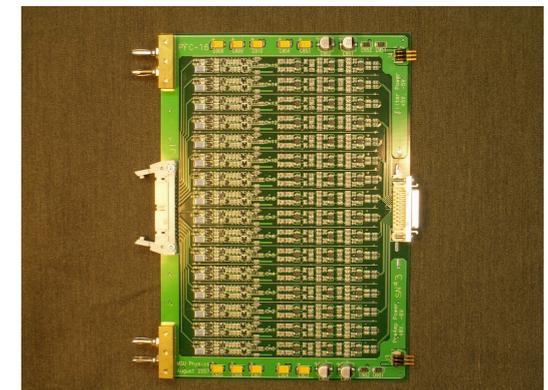
Vacuum Feedthrough (FNAL designed)



Digitization



TPC Inside Cryostat

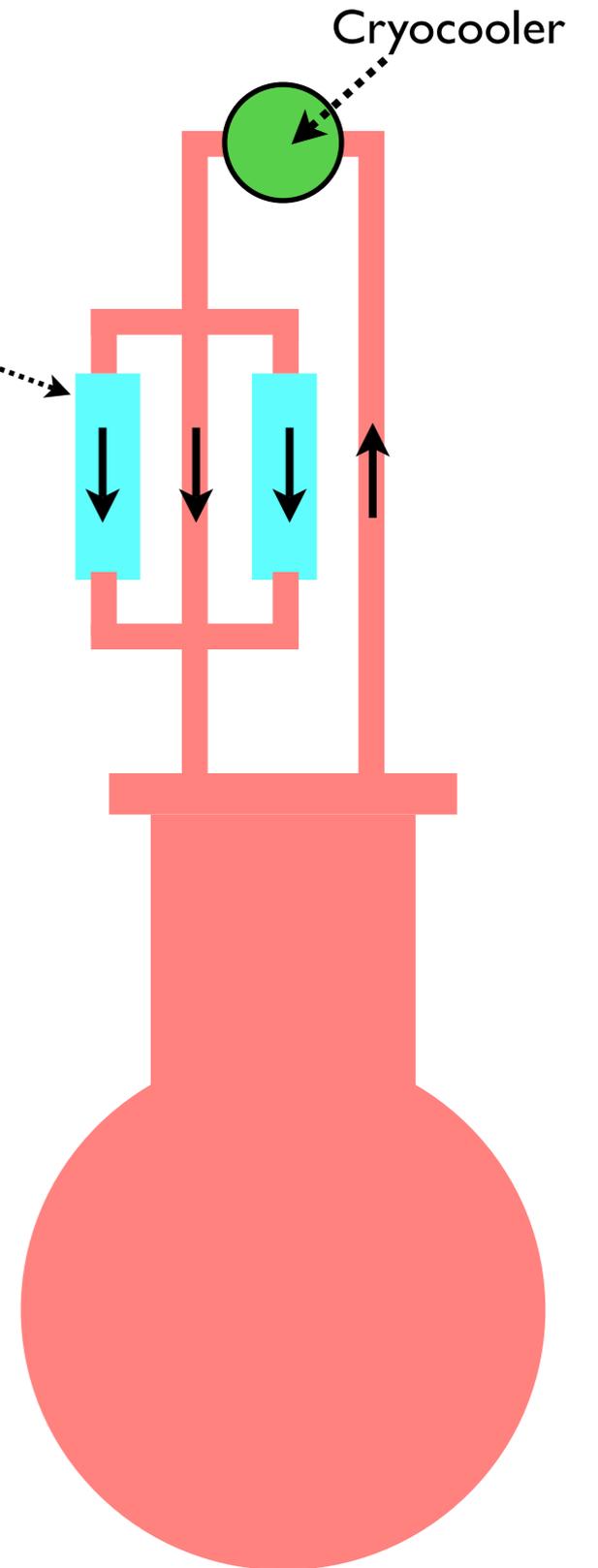


Preamp Card

Bias voltage/filtering on TPC: Improvement over ICARUS

# Cryogenics

- Self-contained system.
- Recirculate argon through Trigon filter.
- Cryocooler used to condense boil-off gas.
- Multiple relief paths to achieve safe running.



300W Cryocooler



Cryocooler Housing

# Underground

Many safety issues addressed to prepare for move underground and maintain ODH-0 rating of tunnel:

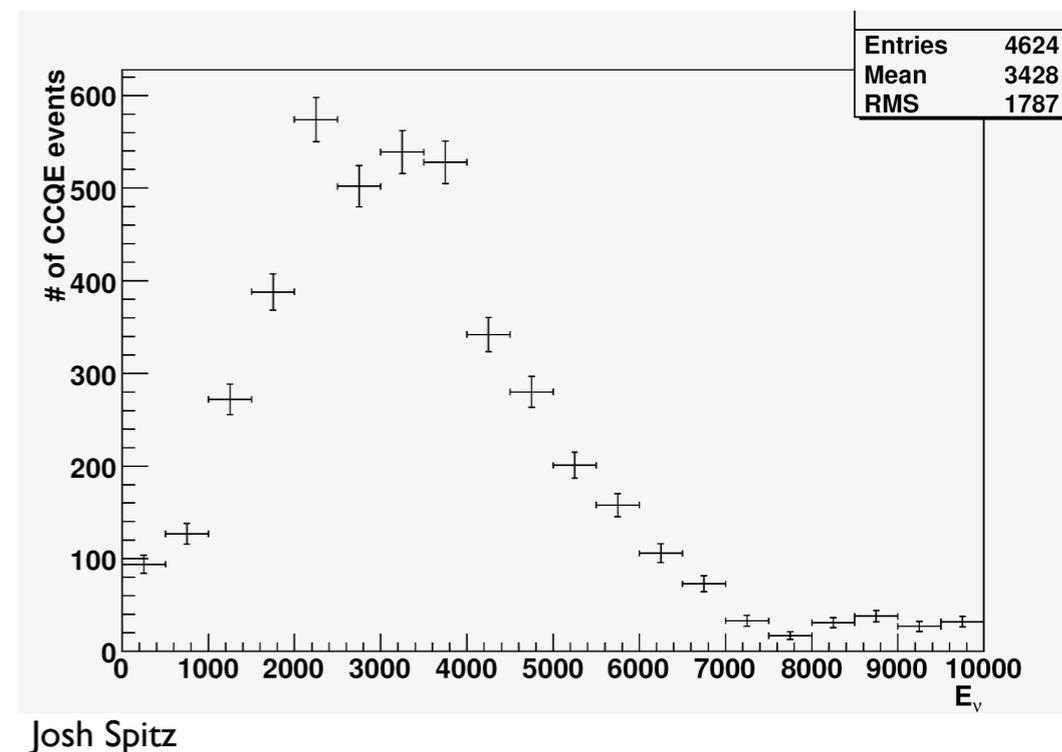
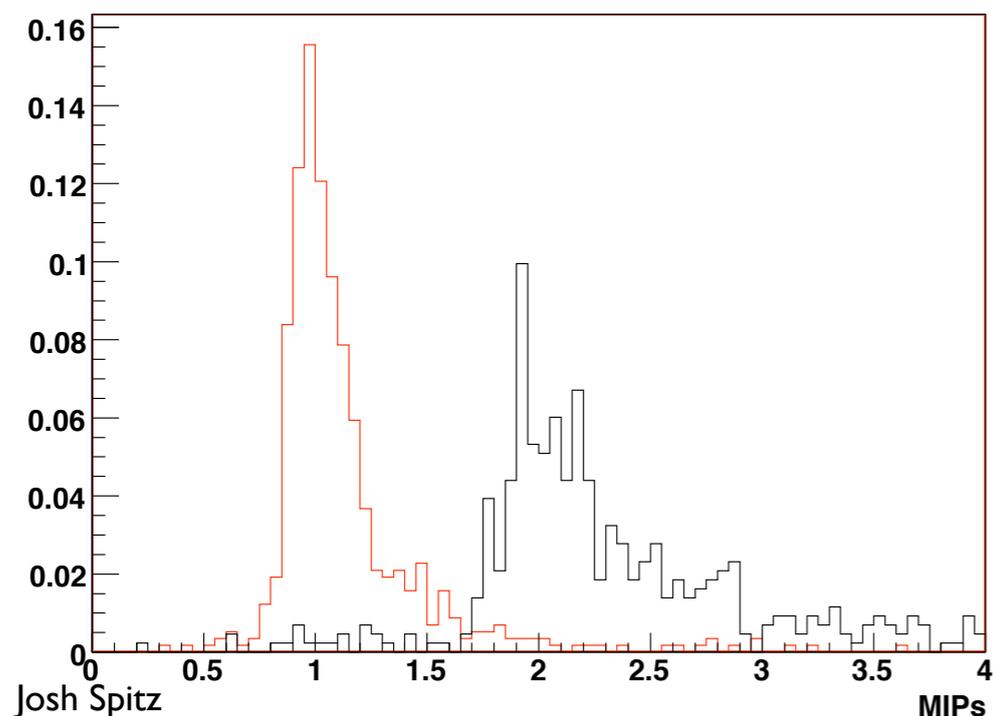
- ArgoNeuT sits in a bathtub, which acts as tertiary containment in case both cryostats fail.
- Relief piping is routed to vent line (runs up and out shaft), to ensure no argon released in tunnel.
- 2 ODH monitors to alarm if leak is detected.
- Slow control system mirrored on screens in tunnel and surface building, and online, to alert of any ODH hazards before entering tunnel.



# Physics Goals

Event Type	# in ArgoNeuT/day ( $0.8 \times 10^{17}$ )
$\nu_\mu$ CC	160
$\bar{\nu}_\mu$ CC	14
$\nu_e$ CC	3
NC	54
Total	231

Energy loss in the first 24mm of track: 250 MeV electrons vs. 250 MeV gammas

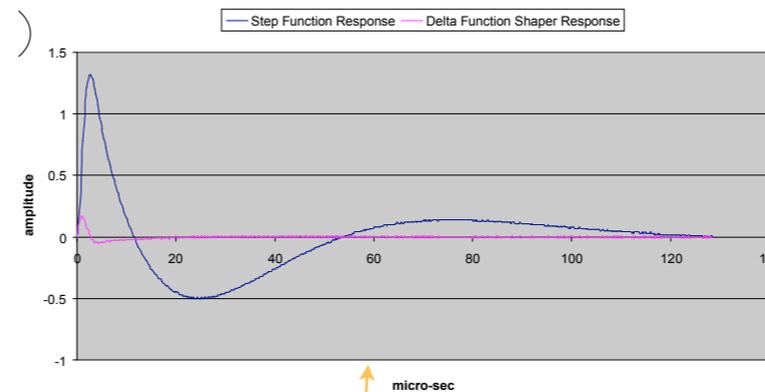
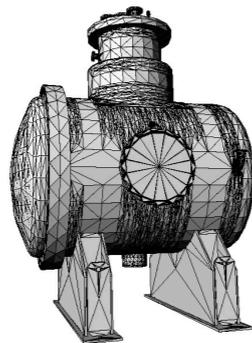


- Electron/gamma separation - Prove claims about superior separation ability of LArTPCs using dE/dx tag.
- Collect large sample of CCQE events, measure cross-section

# Simulation

- ArgoNeuT members (M. Antonello, B. Baller, Yale group, etc...) developing GEANT3/4 simulations for LArTPCs
- Simulation is general purpose for future LArTPCs.
- Goal is automated event reconstruction

CAD geometry in GEANT4



Neutrino Generator Interface

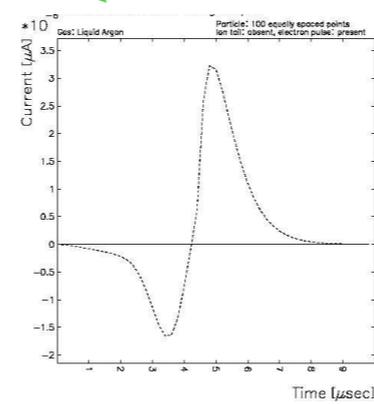
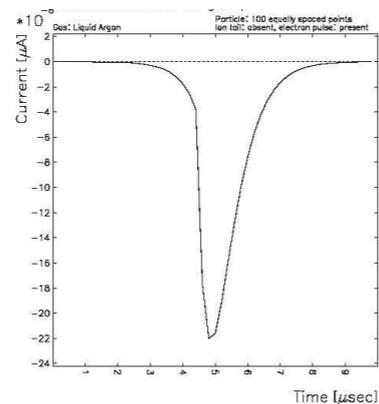
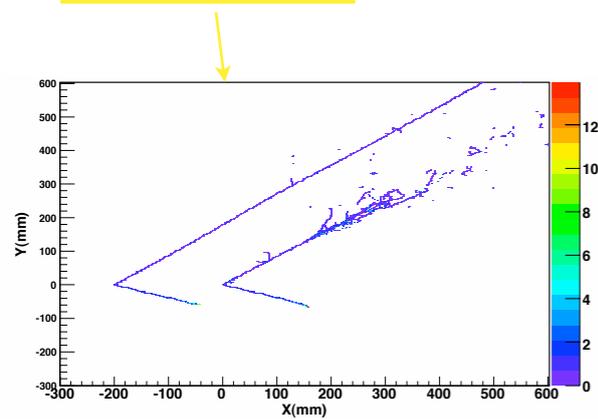
Geometry Description

Pulse Formation

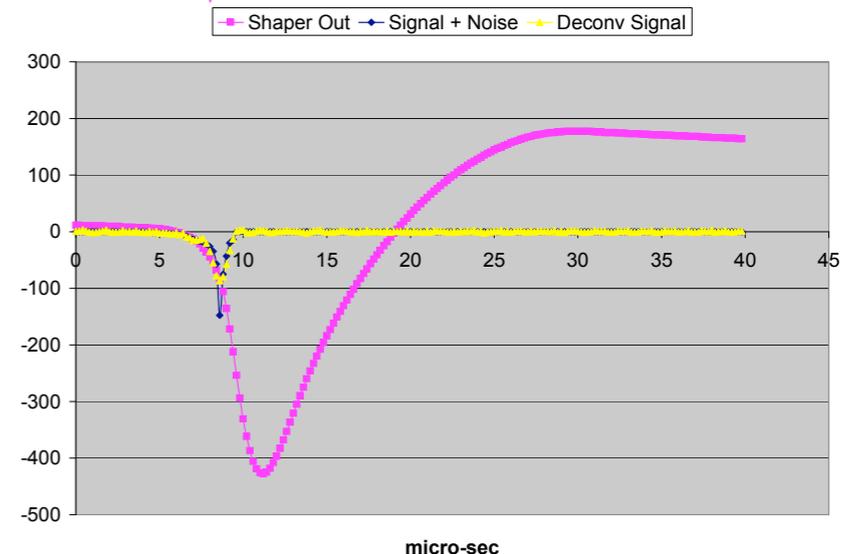
Electronics Simulation

Signal Processing

Automated Reconstruction



Collection/Induction Signals



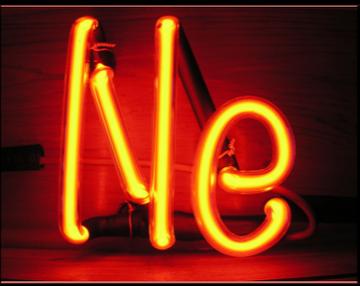
# Conclusion

- ArgoNeuT is an important milestone in the U.S. for LArTPC development.
- Real data/experience will be invaluable in substantiating the case for LArTPCs in the U.S.
- Hope to be running very soon!

**BACK UP SLIDES**

# Noble Liquids: Properties

- Ionization and scintillation light used for detection (transparency to own scintillation).
- Ionization electrons can be drifted over long distances in these liquids.
- Very good dielectric properties allow high-voltages in detector.
- Argon is cheap and easy to obtain (1% of atmosphere).

						
Boiling Point [K] @ 1 atm	373	4.2	27.1	87.3	120.0	165.0
Density [g/cm <sup>3</sup> ]	1	0.125	1.2	1.4	2.4	3.0
Radiation Length [cm]	36.1	755.2	24.0	14.0	4.9	2.8
Scintillation [ $\gamma$ /MeV]	-	19,000	30,000	40,000	25,000	42,000
dE/dx [MeV/cm]	1.9		1.4	2.1	3.0	3.8
Scintillation $\lambda$ [nm]		80	78	128	150	175