



# LArTPC at Fermilab & At Yale




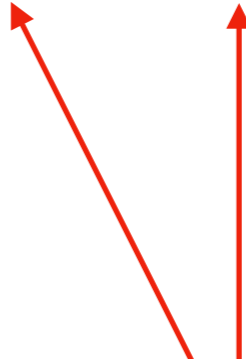
**All-Hands Meeting  
Monday 9:30AM**



# Argon

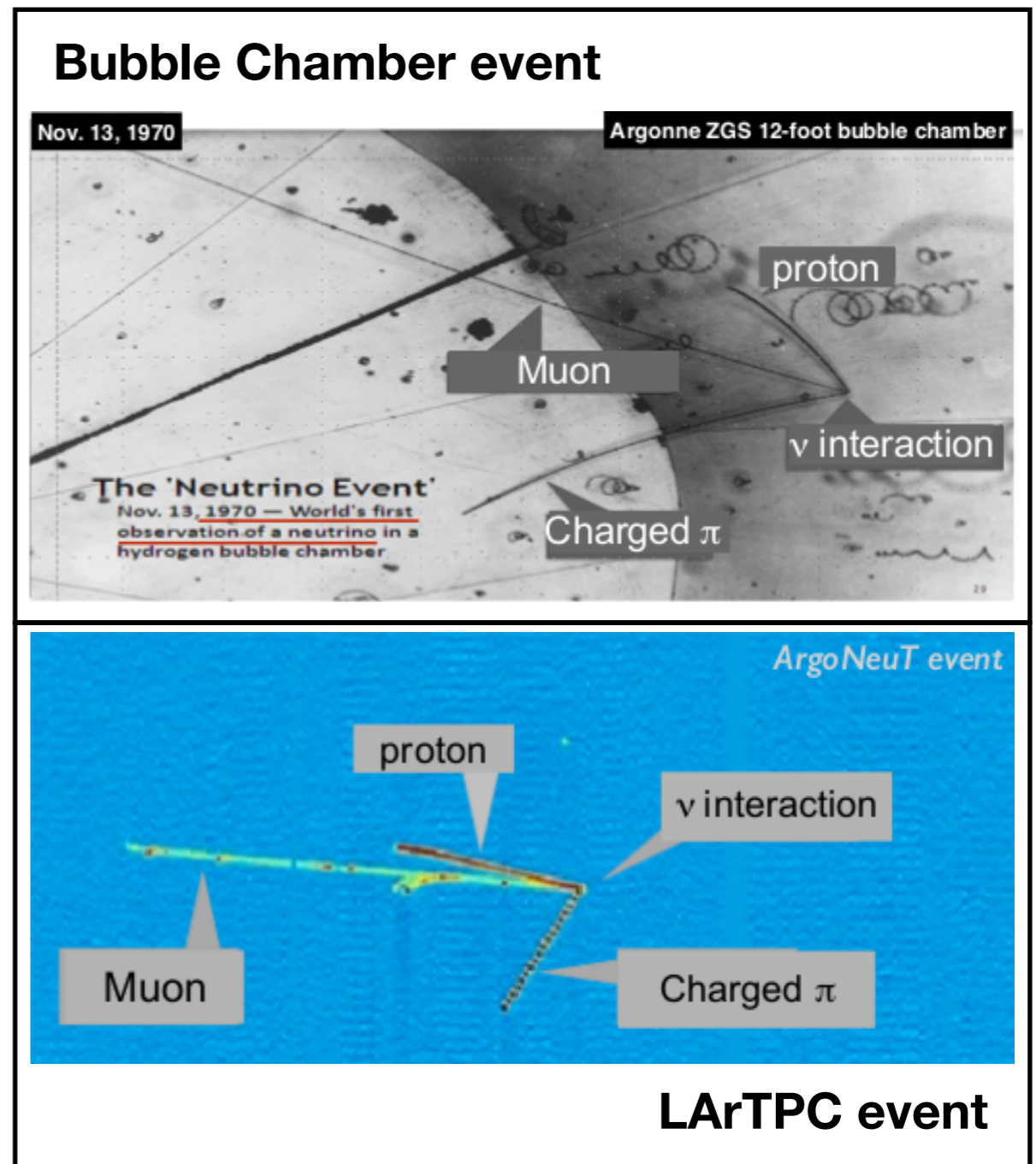
	He	Ne	Ar	Kr	Xe	Water
Boiling Point [K] @ 1 atm	4.2	27.1	87.3	120.0	165.0	373
Density [g/cm <sup>3</sup> ]	0.125	1.2	1.4	2.4	3.0	1
Radiation Length [cm]	755.2	24.0	14.0	4.9	2.8	36.1
dE/dx [MeV/cm]	0.24	1.4	2.1	3.0	3.8	1.9
Scintillation [ $\gamma$ /MeV]	19,000	30,000	40,000	25,000	42,000	
Scintillation $\lambda$ [nm]	80	78	128	150	175	

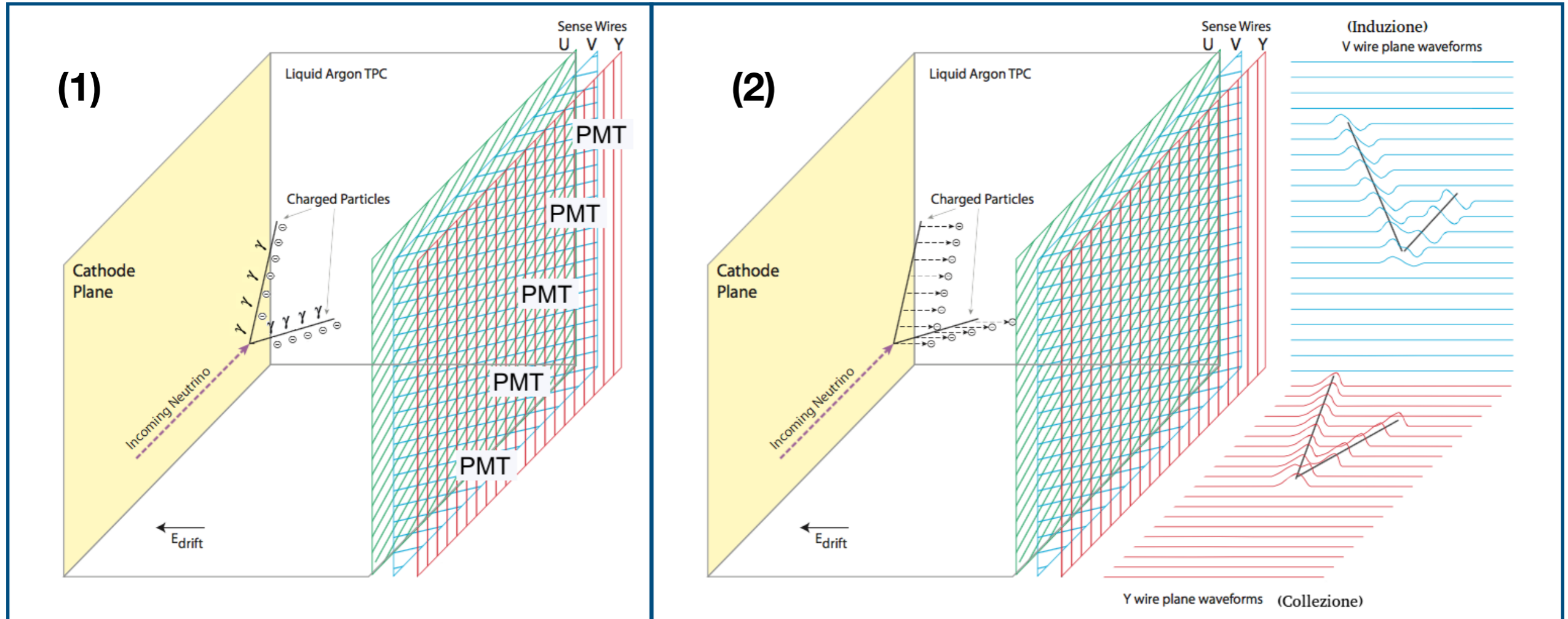
  
 ~1% atm  
 Transparent to its sc. light  
 Reduced cost  
 Can cool it with LN  
 Easily scalable

  
 Not So Much

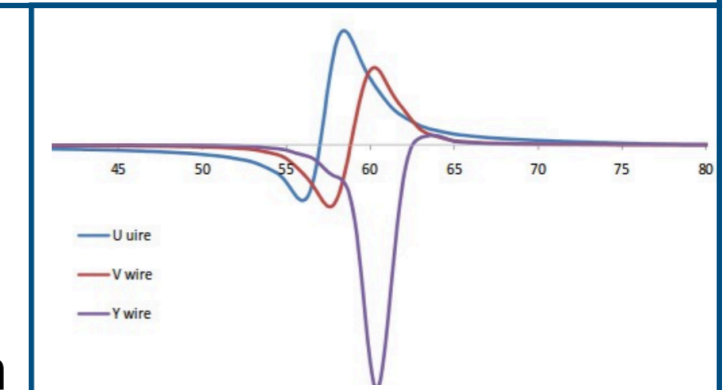
### Liquid Argon Time Projection Chambers:

- $4\pi$  solid angle
- Tracks of charged particles
- Reconstruct 3D image of the event
- Calorimetric information (dE/dx info)
- Particle identification



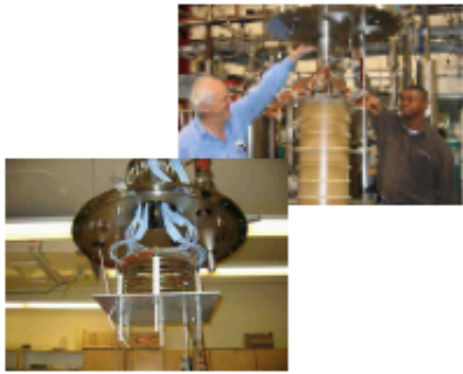


- 1) Neutrino interacts, charged particles travel and excite/ionize argon
- 2) Light: gives event timing, Charge: drifts, gives deposited energy info



## A rich R&D and physics program\*

R&D



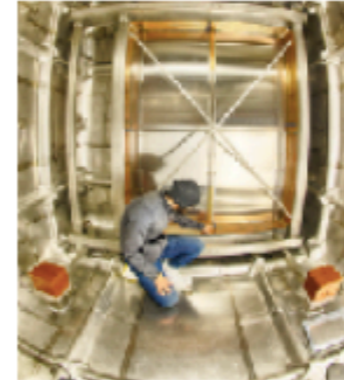
**Yale TPC and Bo**  
(2008-2009)  
Proof of Concept



**LUKE**  
(2008)  
Material Teststand



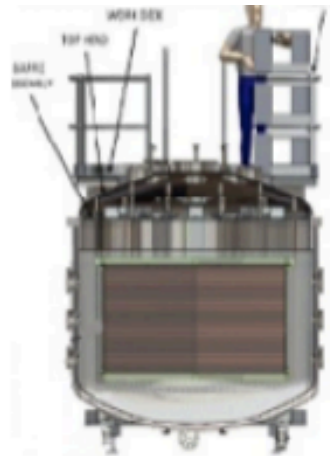
**LAPD**  
(2011)  
LAr Purity



**35Ton**  
(2013)  
Cryostat Purity

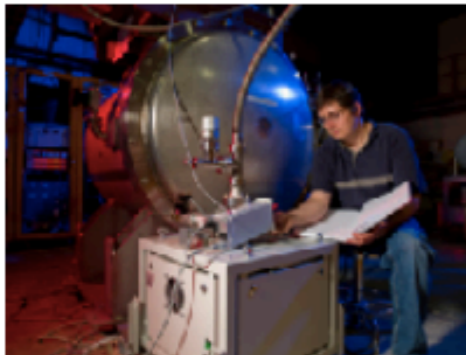


**LArIAT**  
(2015)  
LArTPC  
Calibration

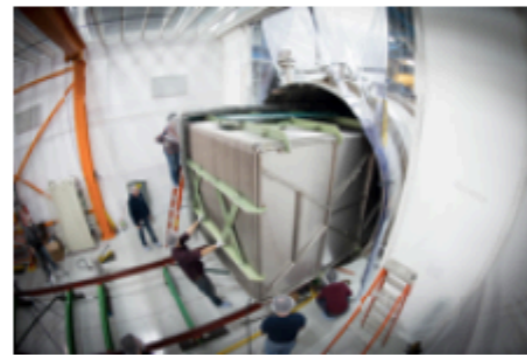


**CAPTAIN**  
LArTPC  
Calibration

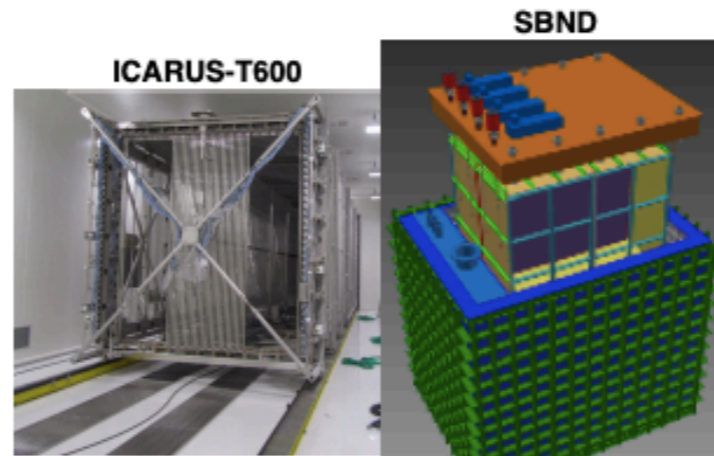
Physics



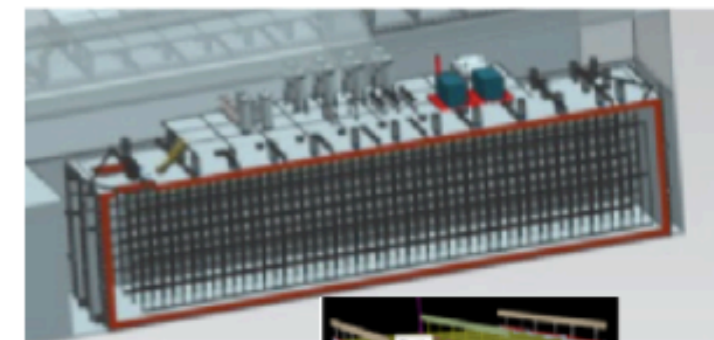
**ArgoNeuT**  
(2009 - 2010)  
v-Ar Cross Sections



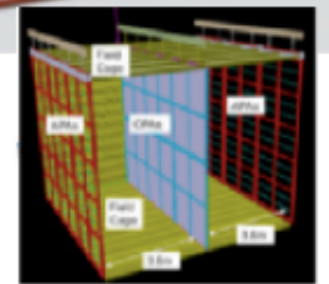
**MicroBooNE**  
(2015 - 2018)  
MiniBooNE  
Low Energy Excess



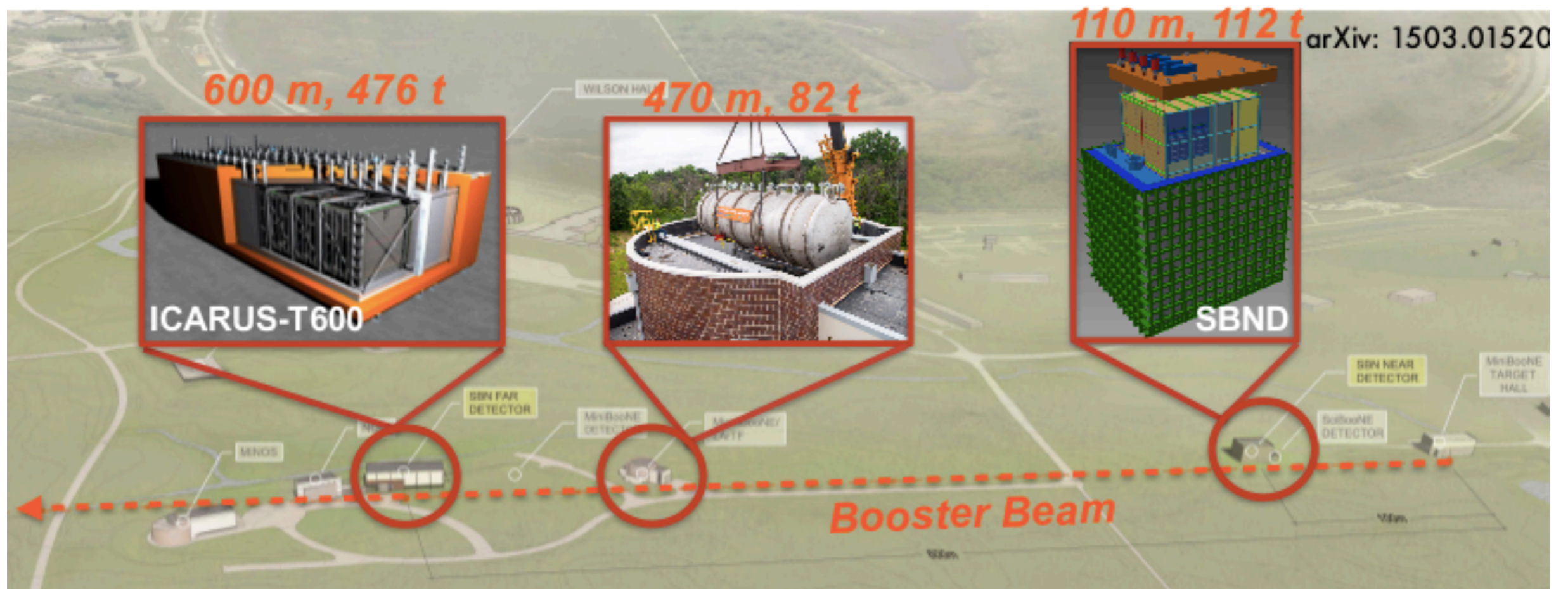
**SBND**  
(2018 - 2021)  
Searches for  
Sterile Neutrino Oscillations



**ProtoDUNE-DUNE**  
(2018) (2023+)



\*More exist



### Physics goals:

- Search for neutrino oscillations  $\nu_\mu \rightarrow \nu_e$  appearance and  $\nu_\mu \rightarrow \nu_x$  disappearance.
- Resolve MiniBooNE Low Energy Excess
- Search for sterile neutrinos at the eV mass-scale
- Study of neutrino-argon interactions
- R&D technology for future long-baseline neutrino program (DUNE)



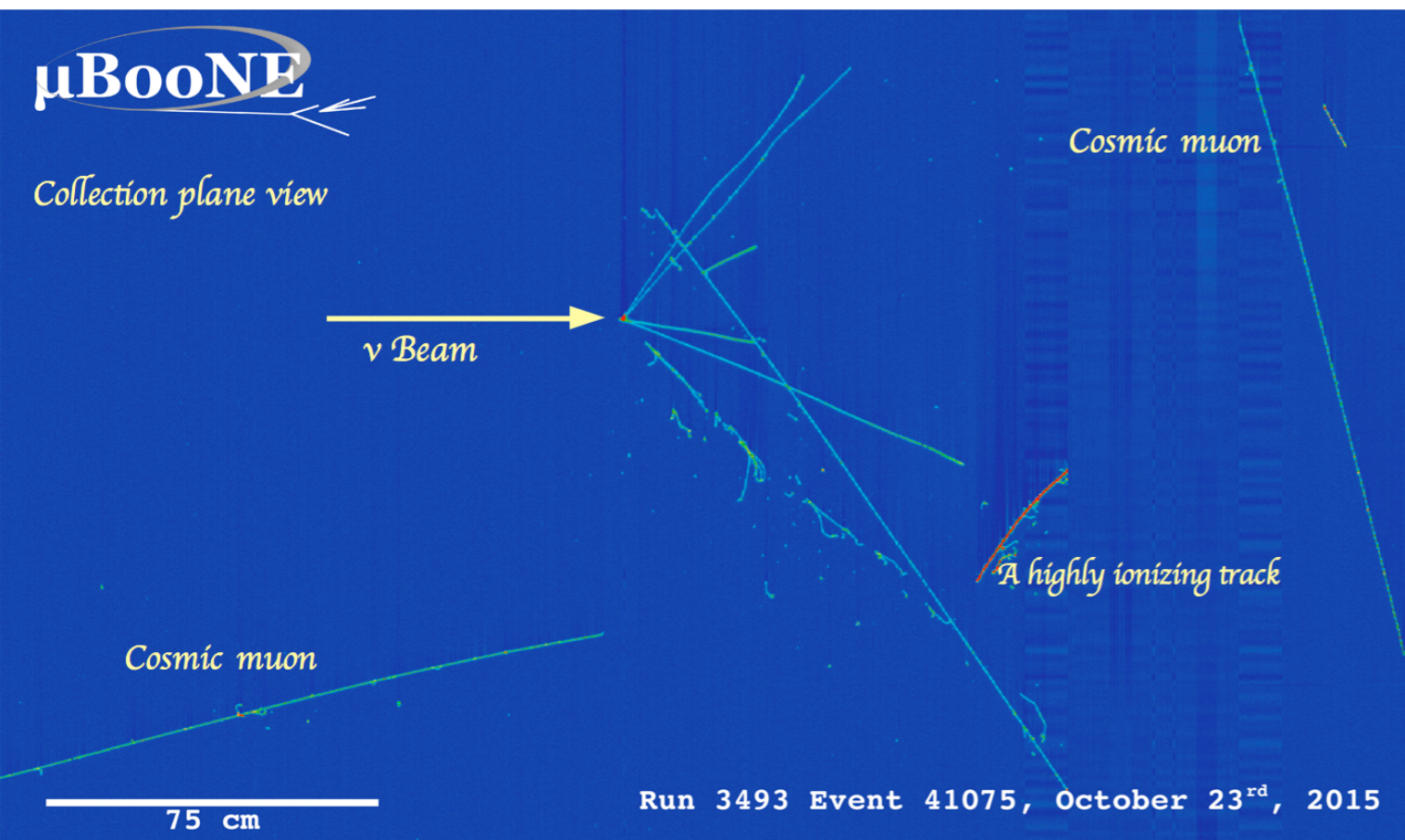
**2.56 m × 2.32 m × 10.36 m**

**~85 tons of LAr active TPC**

**32 8" PMT**

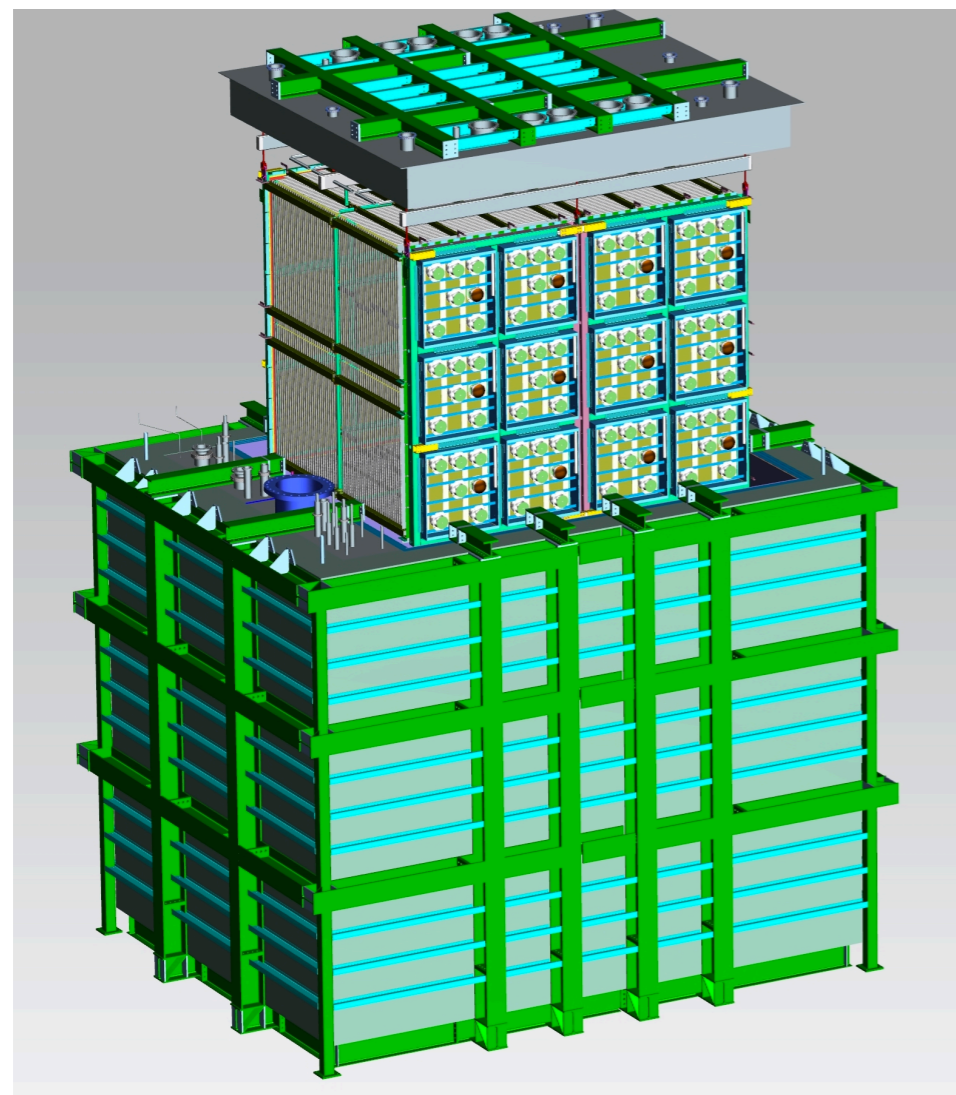
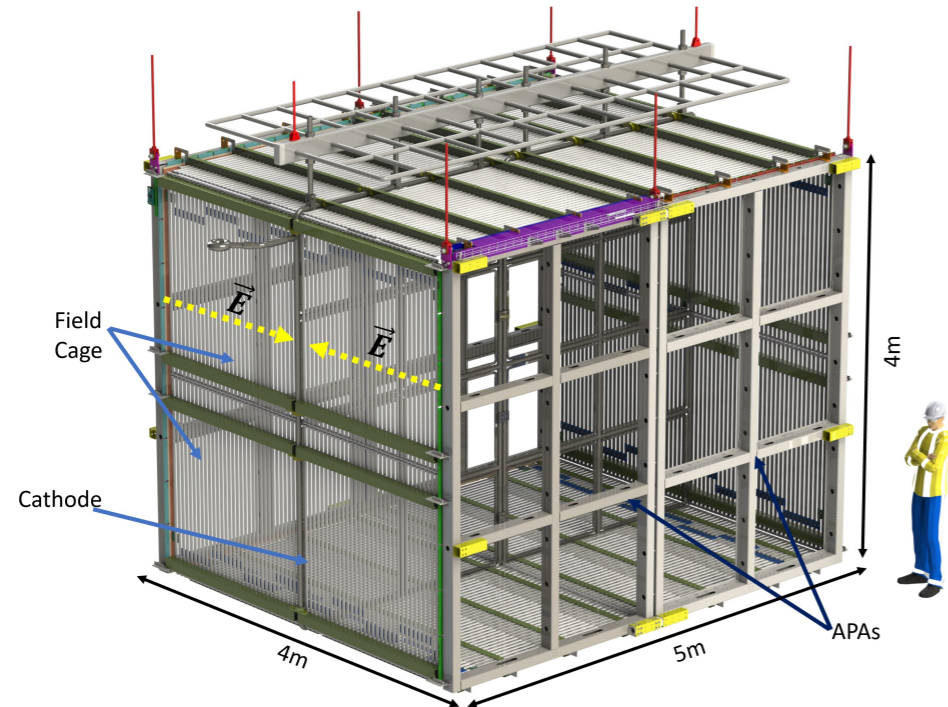
**3 Planes of wires (3mm)**

**At surface  
(~26 cosmic rays in each event)**



**@ Wright Lab**

**\* Cross section measurement  
\* LEE analysis**



**4 m × 4 m × 5 m**

**~112 tons of LAr active TPC**

**2 drift regions**

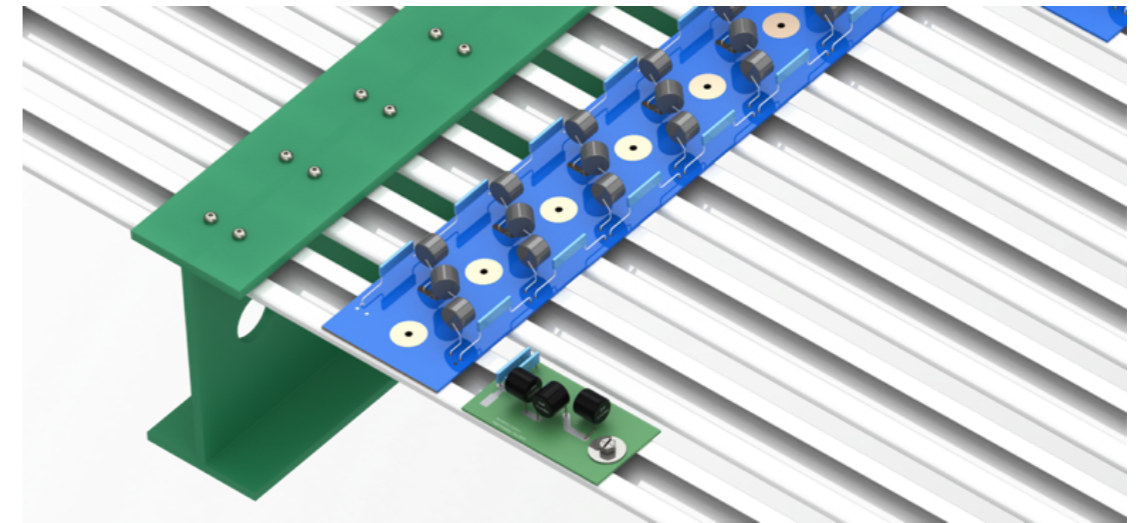
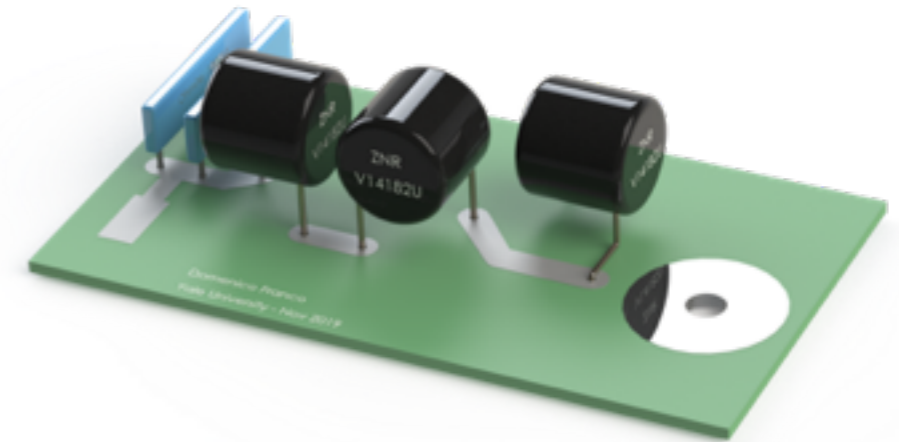
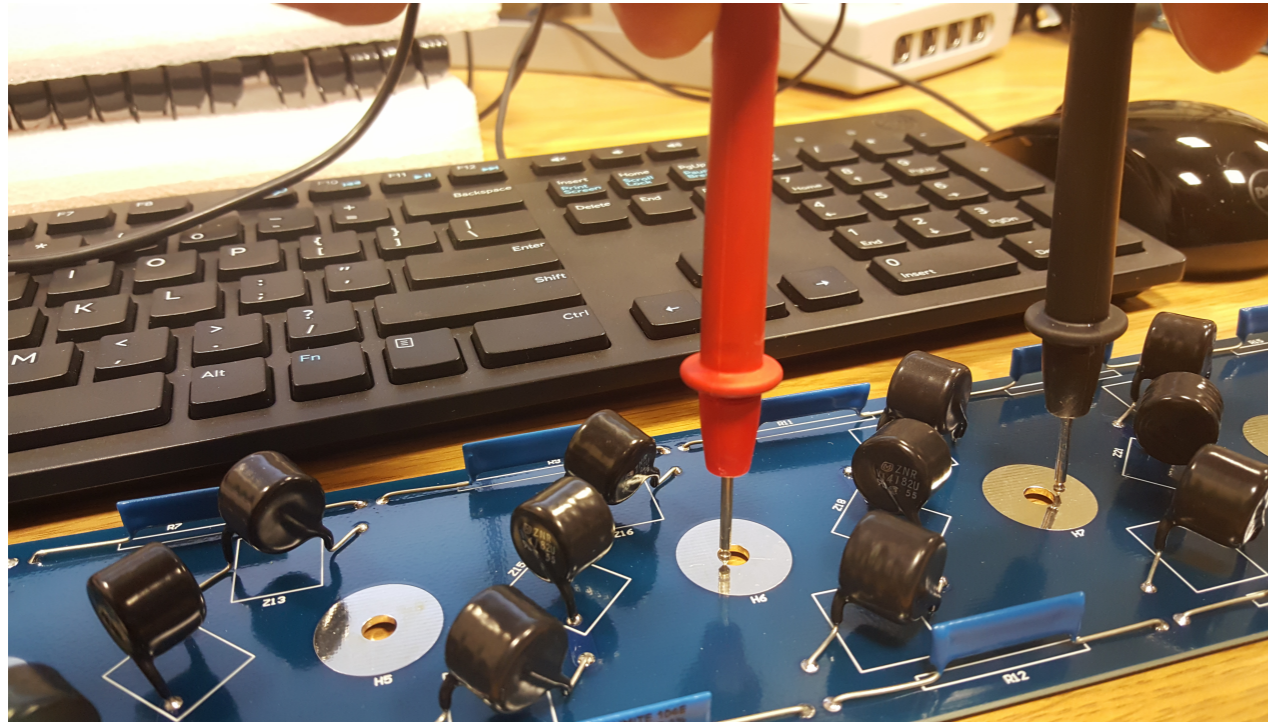
**(5 8" PMT) × 12 × 2  
+ ARAPUCAs & SiPMs**

**3 Planes of wires (3mm)**

**At surface**

**@ Wright Lab**

- \* Testing**
- \* Building**

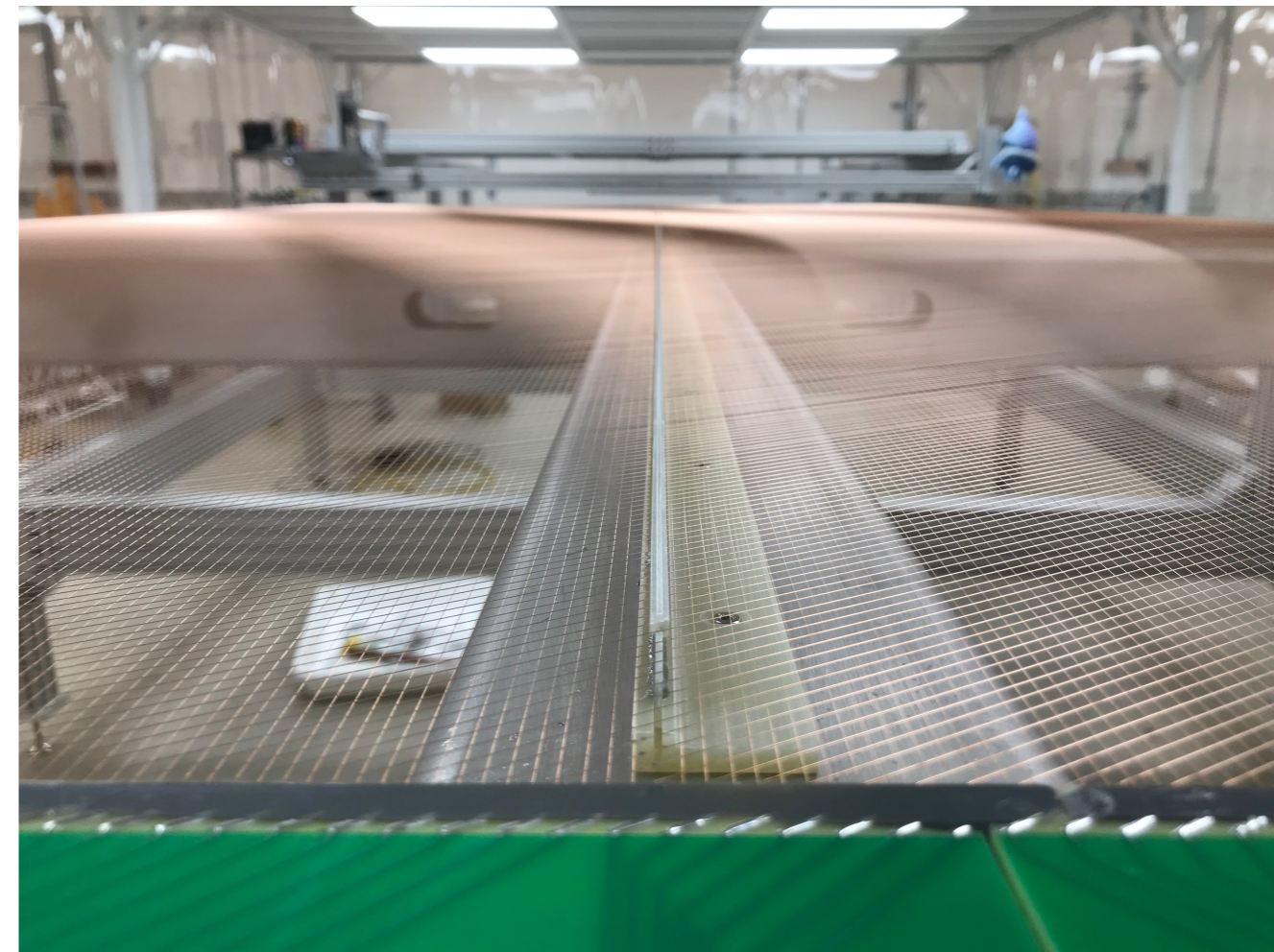


**Tested components,  
built HV divider boards**

**Assembled FC  
modules**



↑  
**Tested  
HV feedthrough (CERN)  
HV filter (Here)**



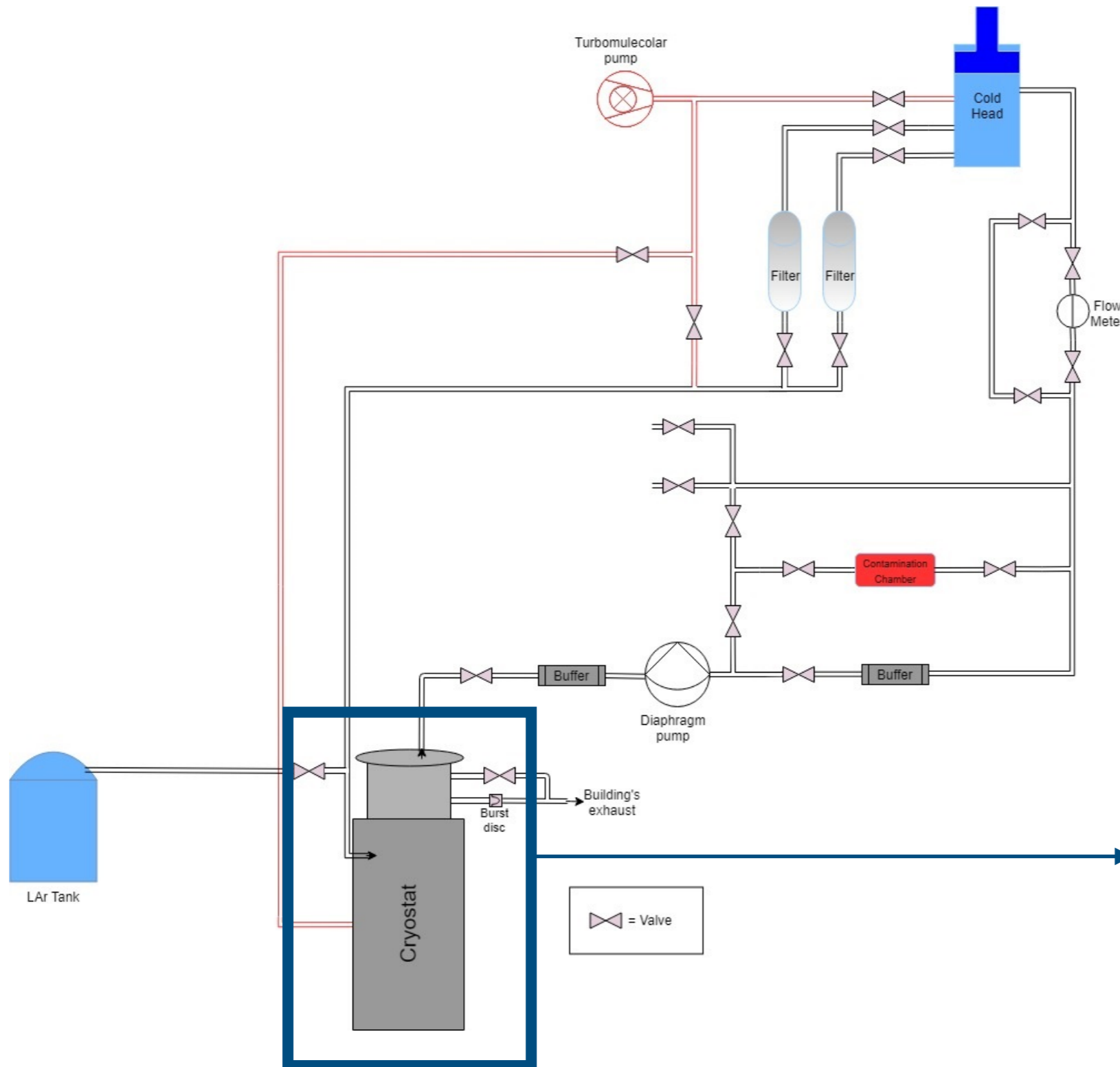
↑  
**Contribution to  
2 anode frames wiring**

# LArTPC Running @ Yale



LArRY\*

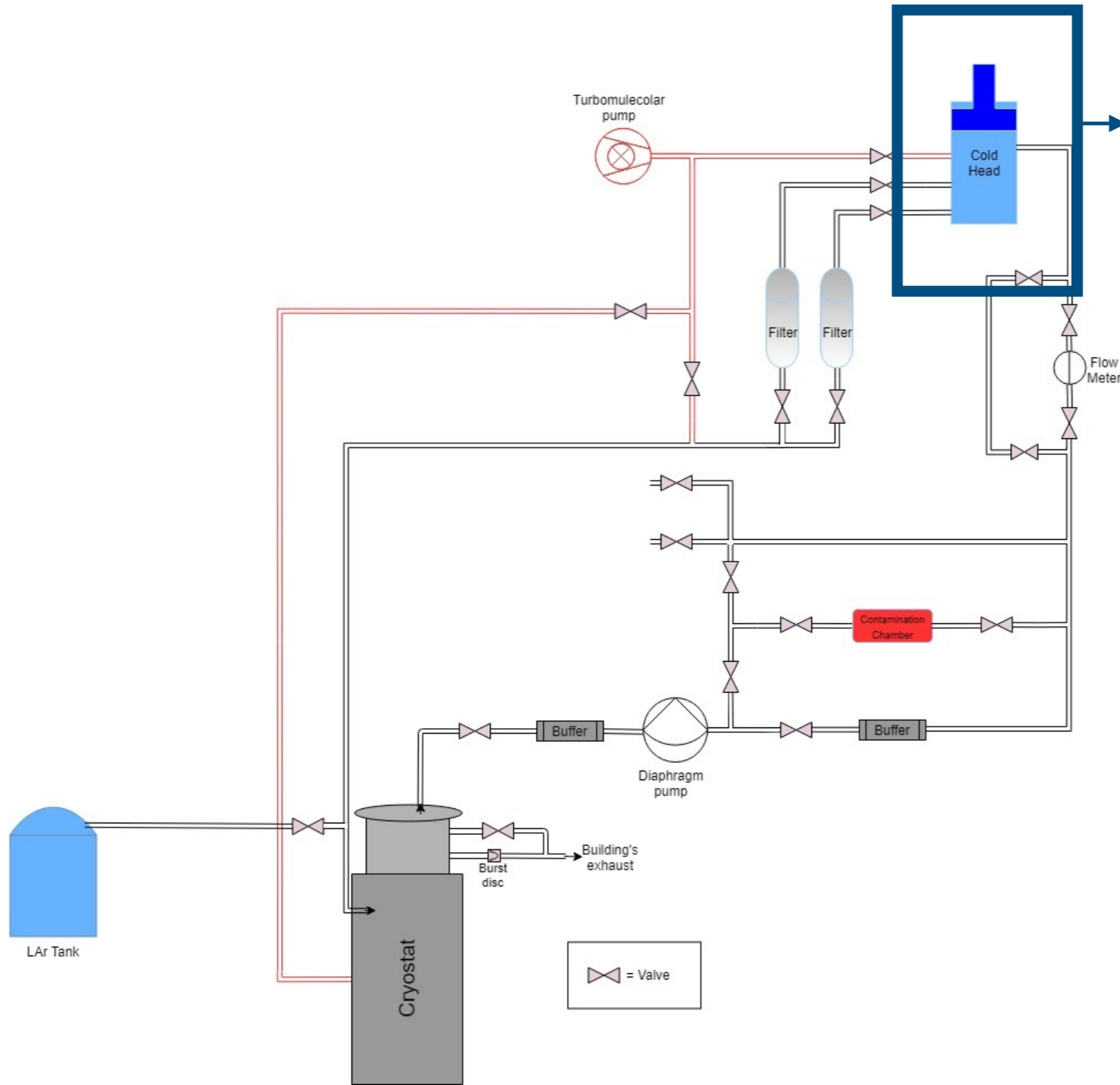
\* Name has not been decided, just for now



Used for HV breakdown test  
in liquid argon

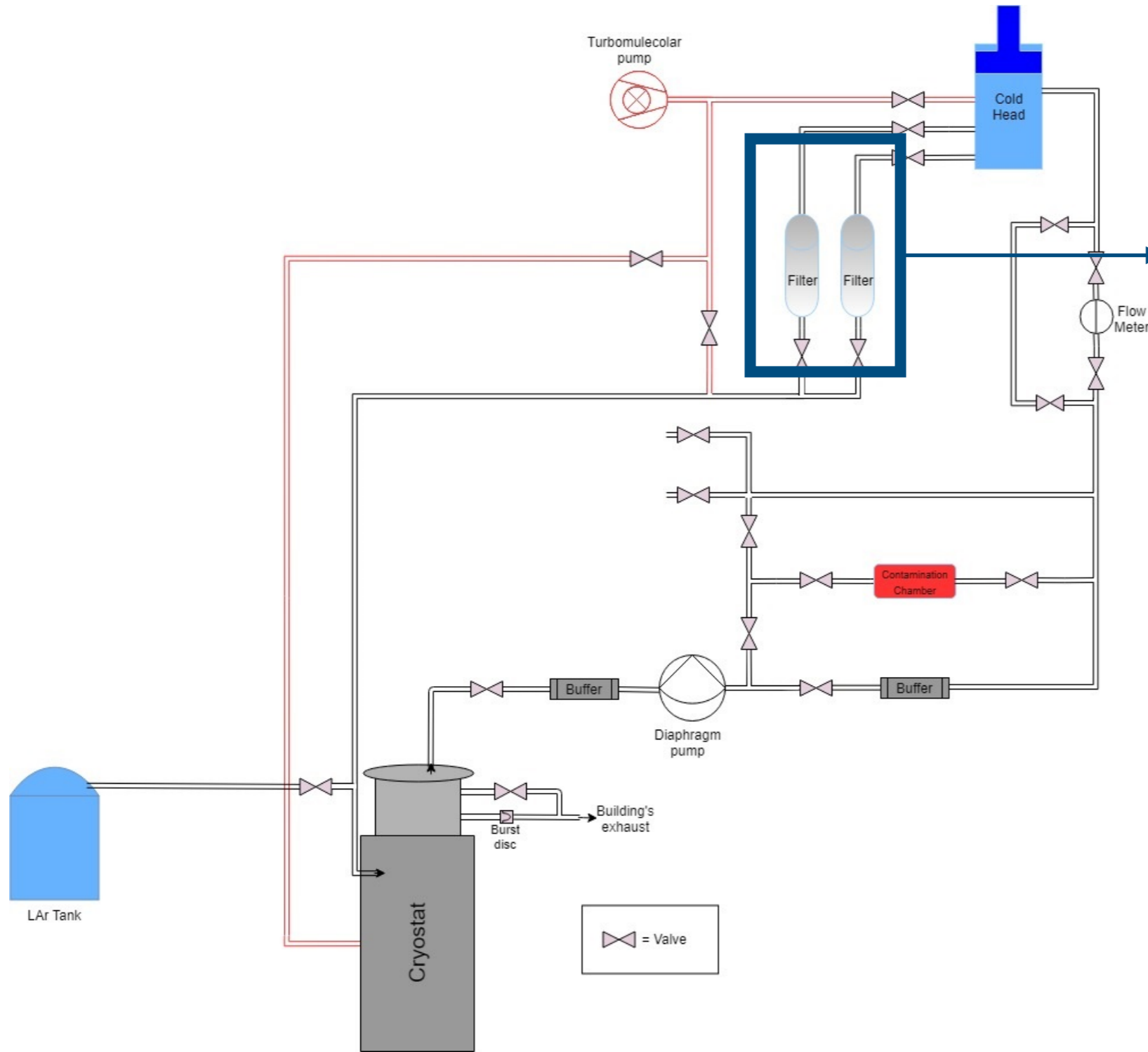


# LArRY ?



## Used for ArgoNeuT

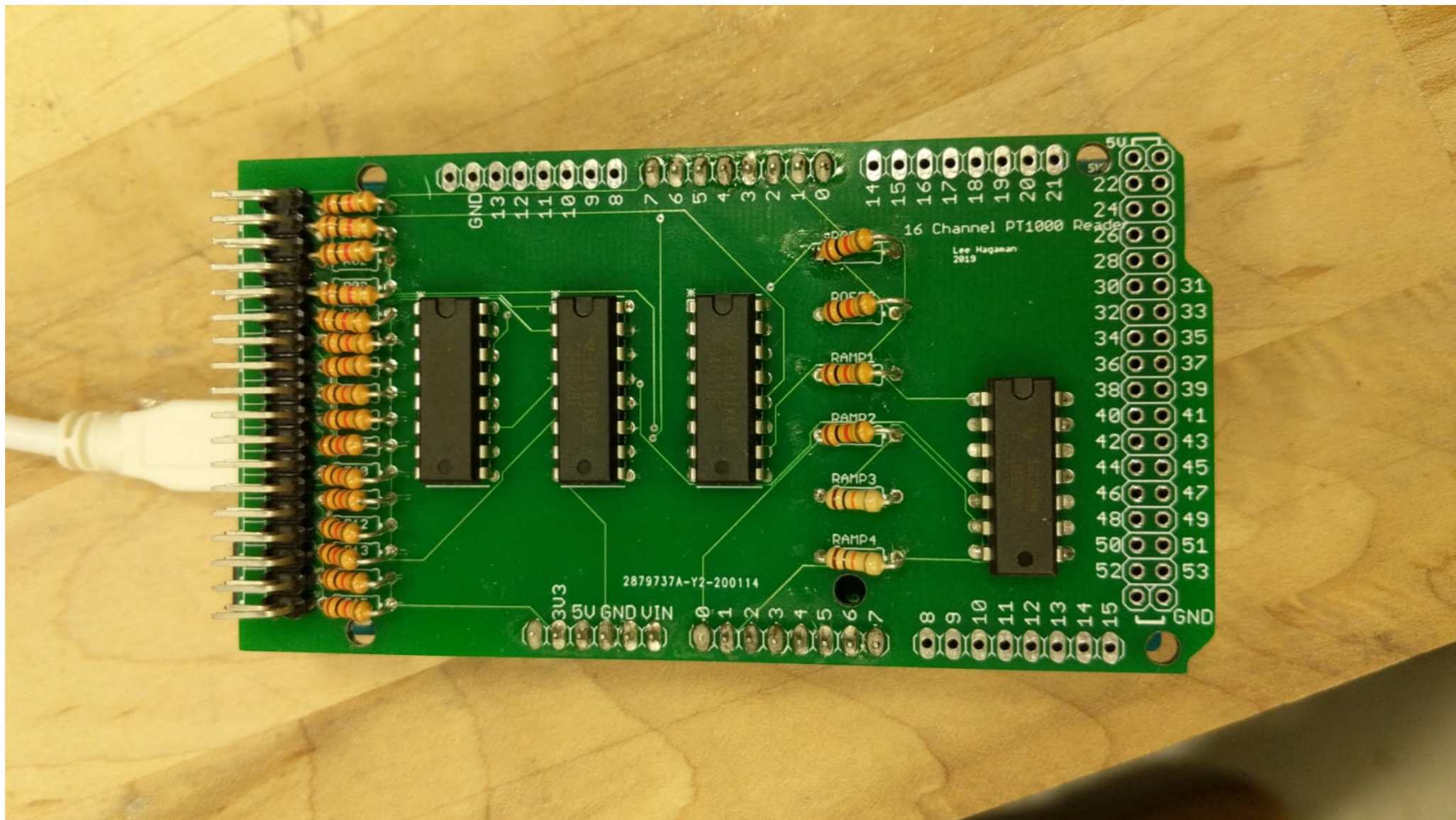




## Used for ArgoNeuT

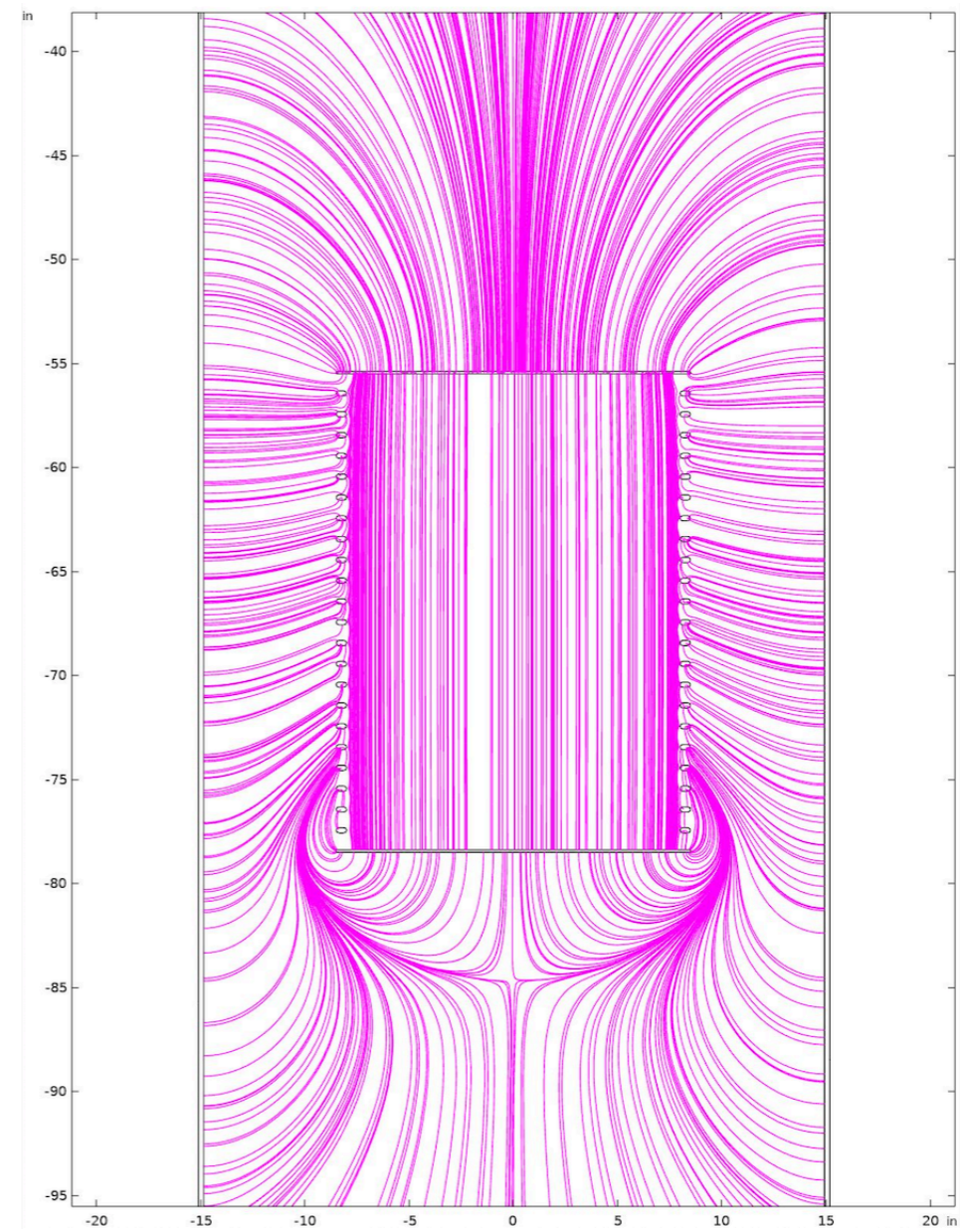


# 8 temperature readers using PT1000 and Arduino by Lee Hagaman





### E-field lines



**22 aluminum rings**  
**Diameter: 17" ext, 16" int**

**Anode & Cathode: mesh**

**24" drift region**

**E-field ~500 V/cm**

**No wired planes, only light detection (for now)**



**Scientific Program:**

**Single PE rate measurement  
(observed by MicroBooNE and ProtoDUNE)**

**R&D Test (X-Arapuca light trap)**

**Xe doping (instead of TPB)**

**Didactical purpose**

