LArIAT: Liquid Argon In A Test-beam

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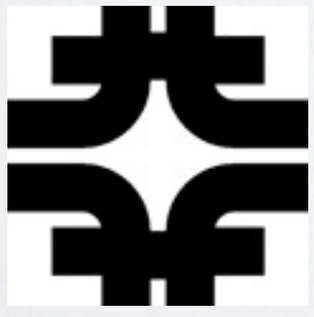
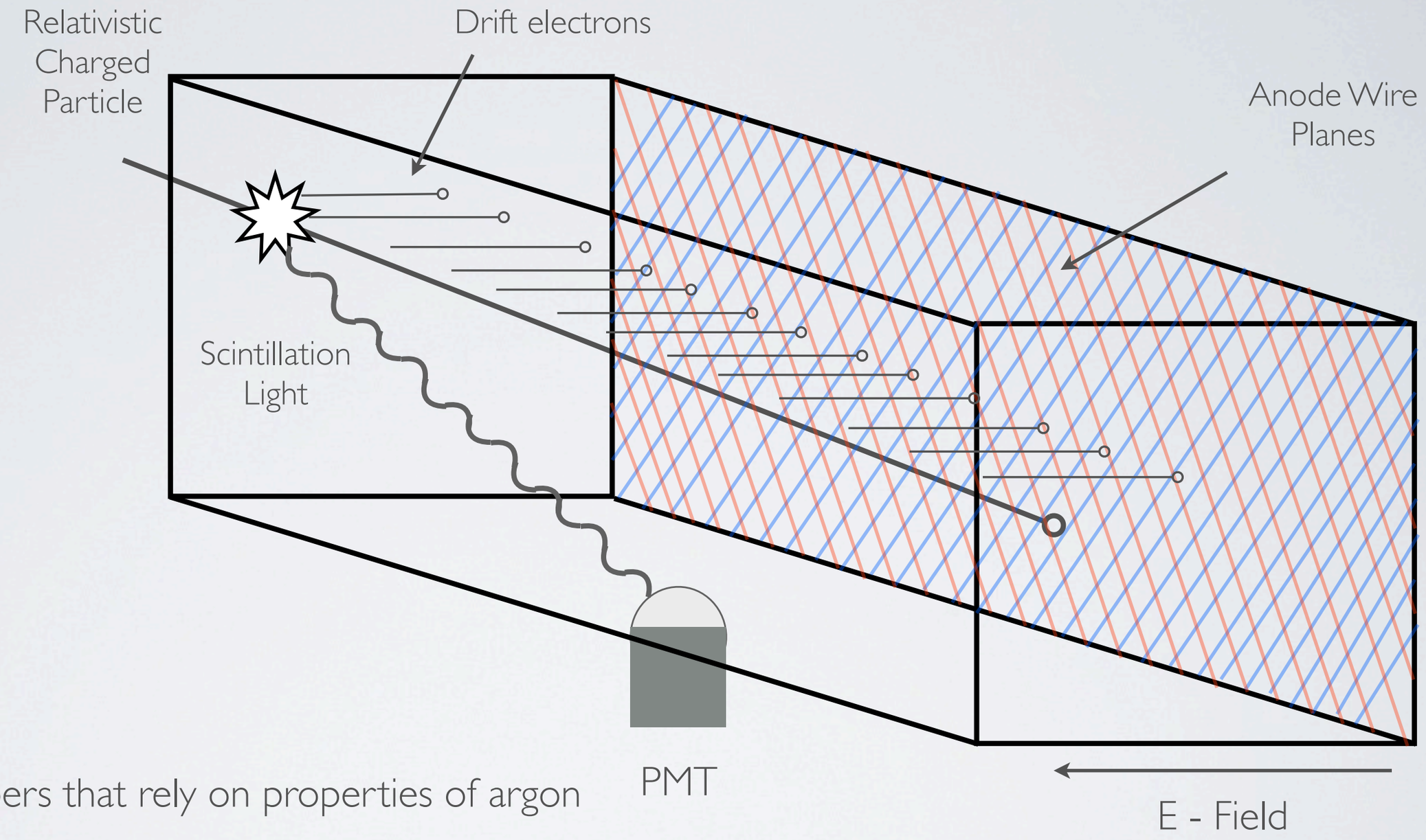
on behalf of the LArIAT Collaboration
at Fermilab



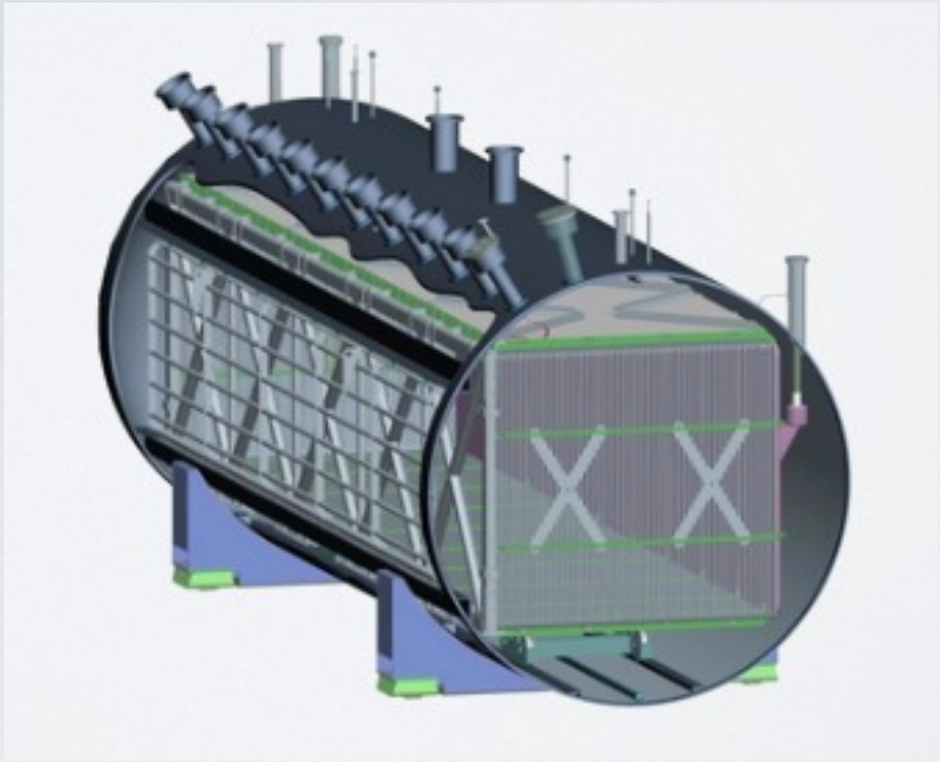
LArTPCs: Liquid Argon Time Projection Chambers



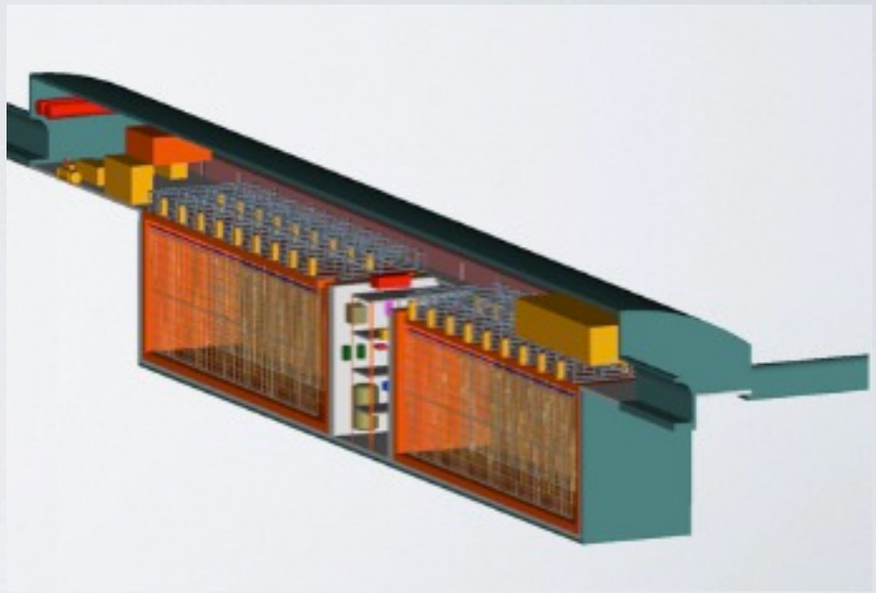
Ionization chambers that rely on properties of argon
- Scintillation
- Inert element

Excellent 3D spatial and calorimetric reconstruction
- "Electronic bubble chamber"

LArTPC Use in Physics



MicroBooNE



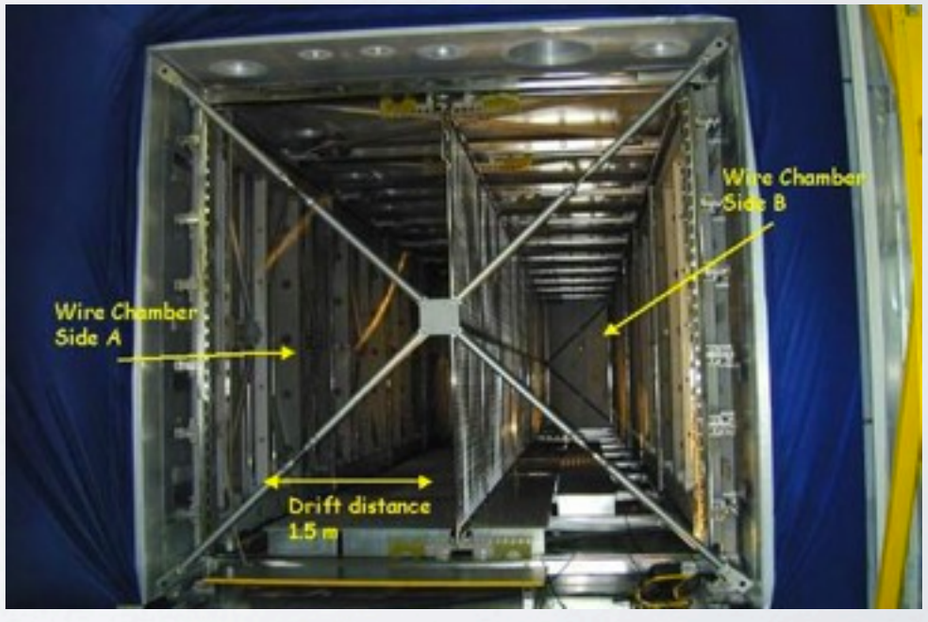
DUNE

LArTPCs are useful in neutrino and rare-decay physics

- Enable large-mass sensitive volumes

- Cost is manageable

Current and future detector examples: ICARUS, MicroBooNE, and DUNE



ICARUS

Need to Study LArTPC Performance

- e^-/ion recombination

- scintillation light production and detection

- dE/dx resolution

- e^-/γ shower separation

- physics of hadron-Ar interactions

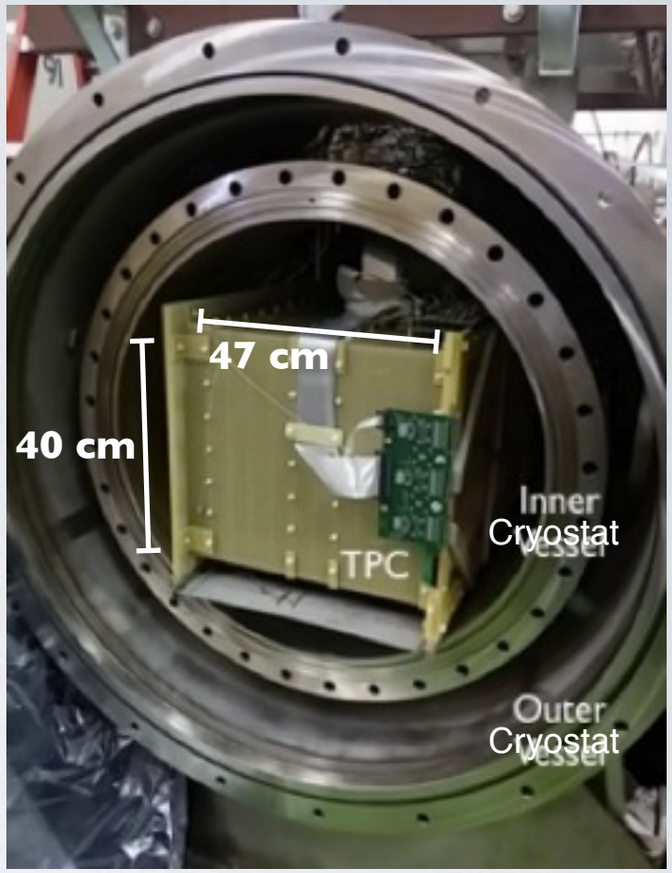
LArIAT: Liquid Argon In A Test-beam

LArTPC

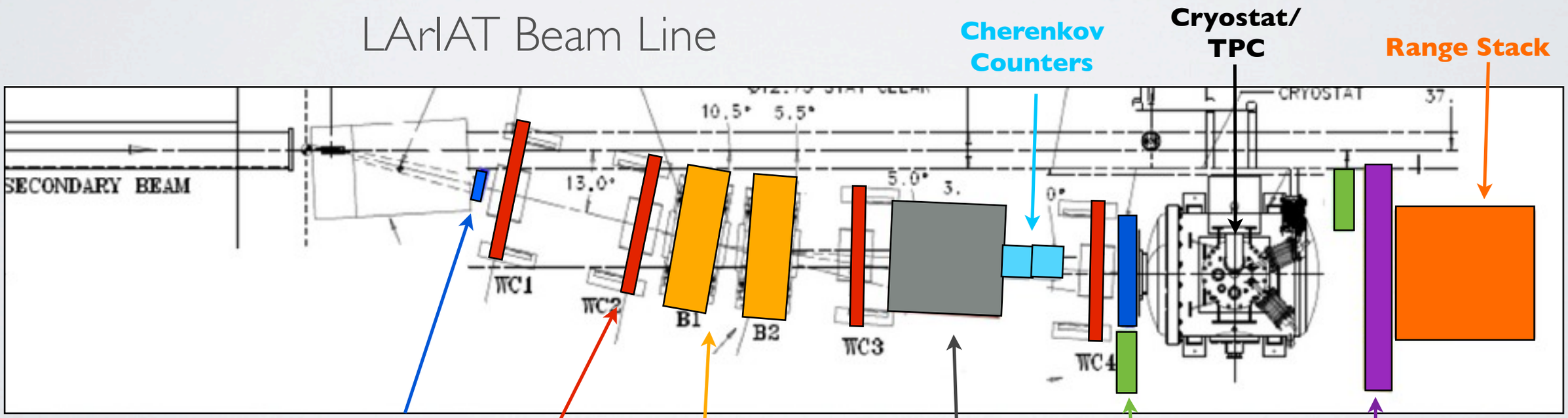
- Upgraded ArgoNeuT TPC/Cryostat
- Sensitive volume: 47cm x 40cm x 90cm = 169 L
- 2 anode wire planes, 240 wires each
- Drift E-field: ~0.5 kV/cm -- subject to study

... in a charged particle test beam

- Beam line detectors give momentum, particle ID



LArIAT Beam Line

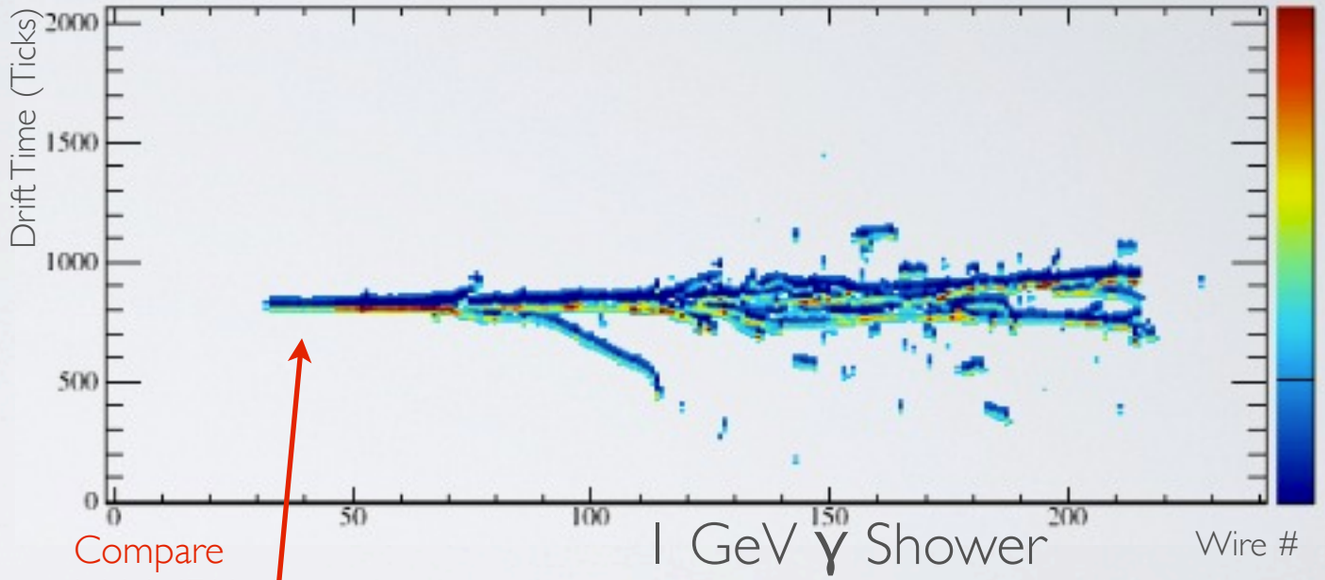


LArIAT Goal Example 1: e^-/γ Shower Separation

CC/NC neutrino interactions
both produce EM showers:

Want a way to distinguish e^- and γ showers based on initial charge deposition.

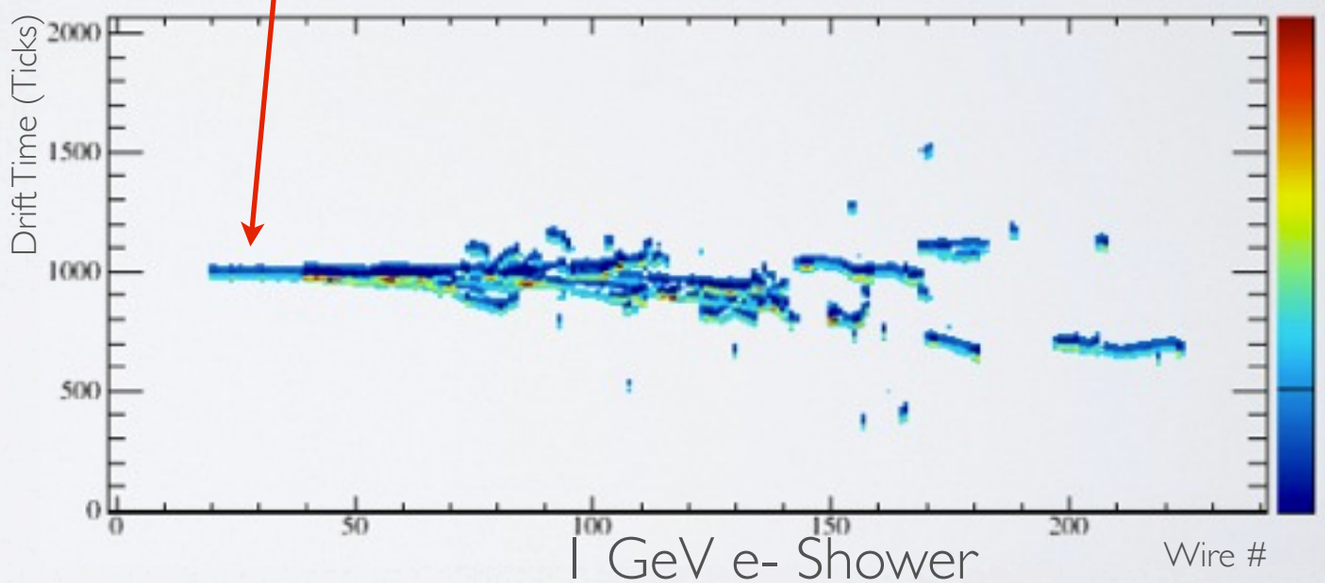
1.) EM Shower from bremsstrahlung photon



1 GeV γ Shower

Compare initial dE/dx

2.) EM Shower directly from beam electron

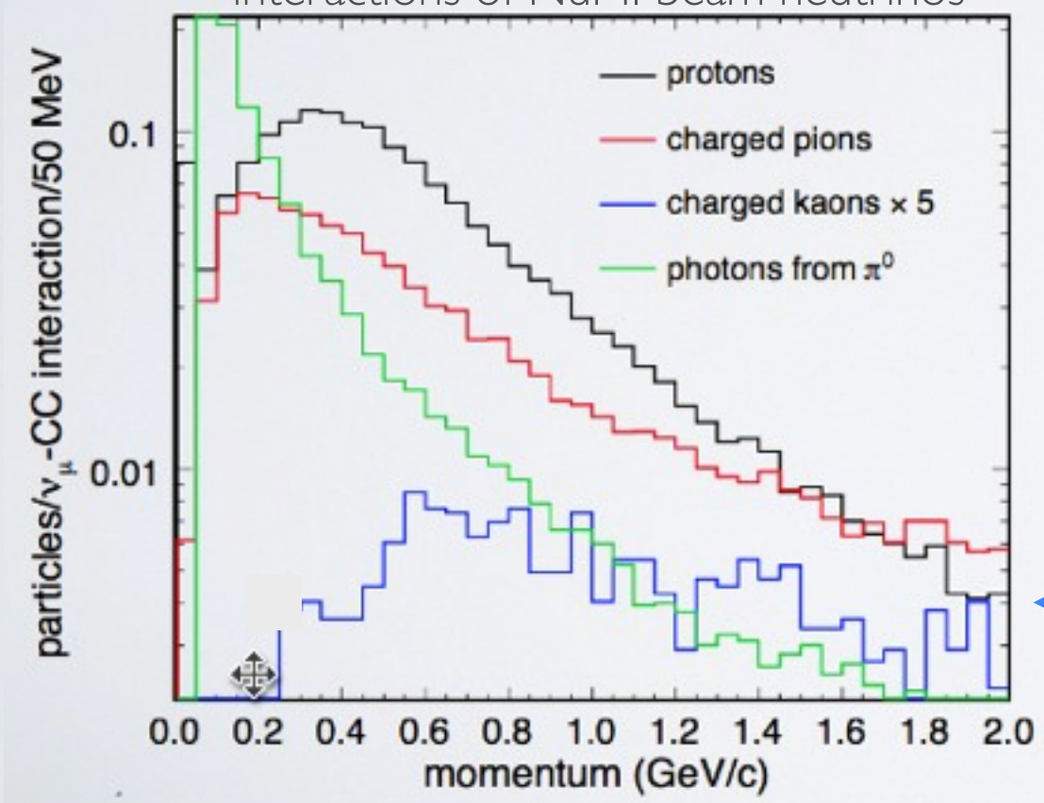


1 GeV e- Shower

LArIAT Goal Example 2: Pion and Kaon Interaction Modes

Want to measure cross sections of the pions and kaons emerging from CC interactions of NuMI beam neutrinos:

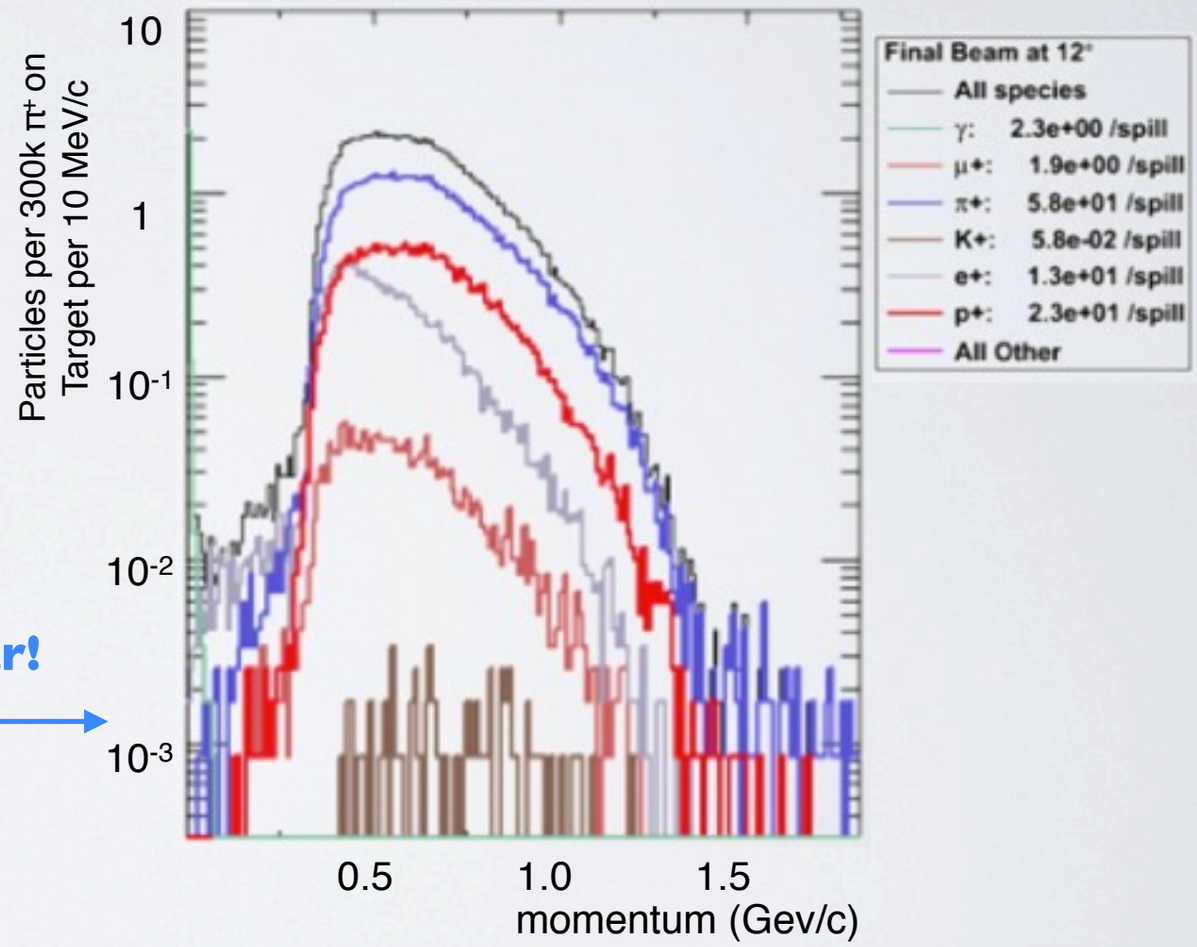
Spectra of particles emerging from ν_μ-CC interactions of NuMI beam neutrinos



Similar!

LArIAT Beam has similar momentum spectra!

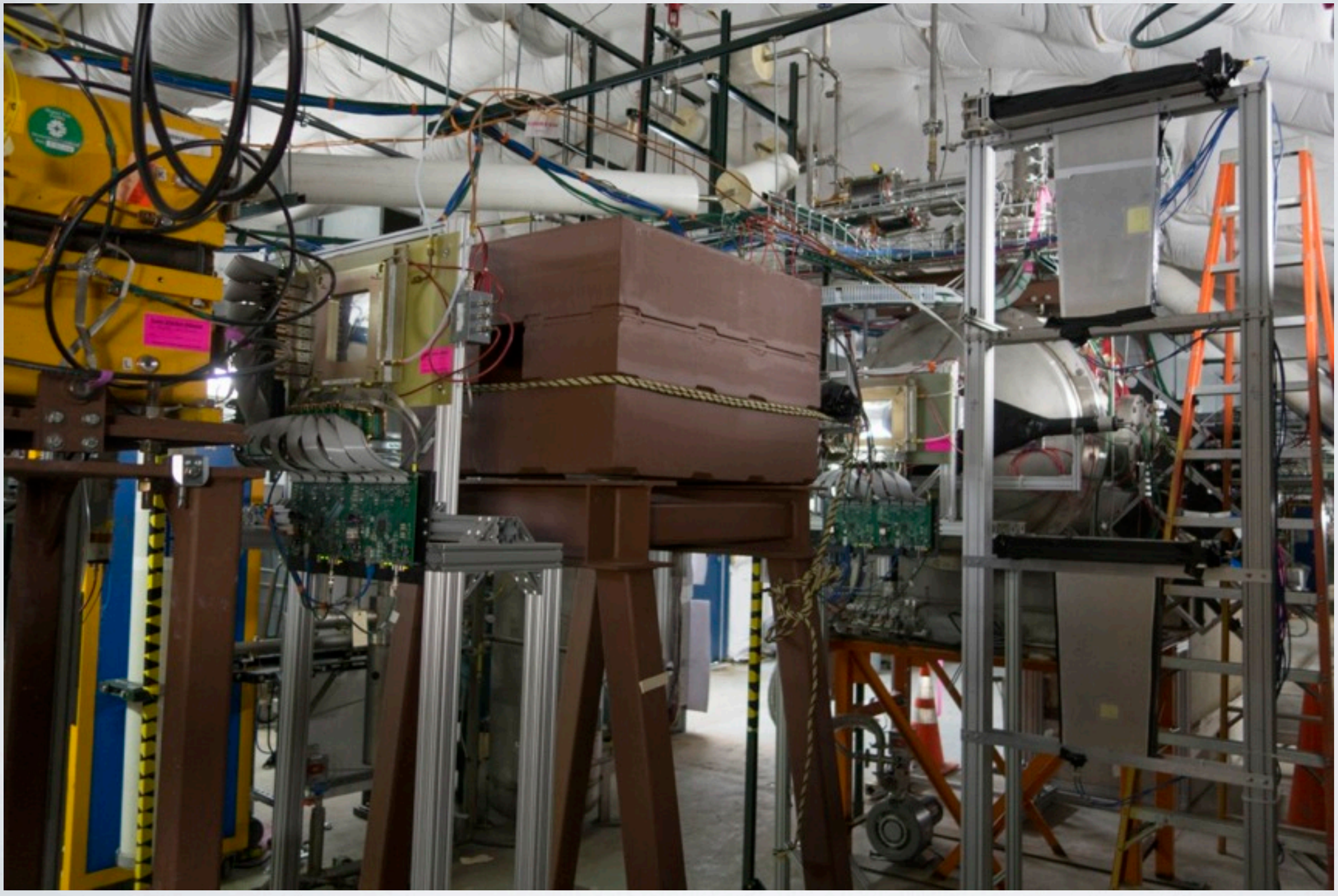
Final Beam at 12°, 08 GeV 2ndary, +0.35 Tesla Field



- primarily $\pi^{+/-}$, but also some $K^{+/-}$

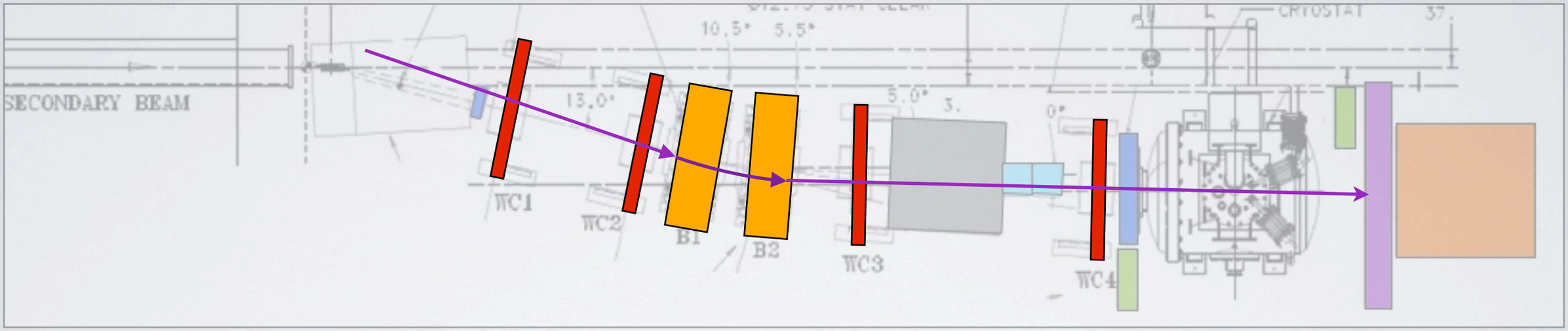
How Close Are We to Our Goals?

Most beam line elements up and running:
- PID, momentum reconstruction being performed



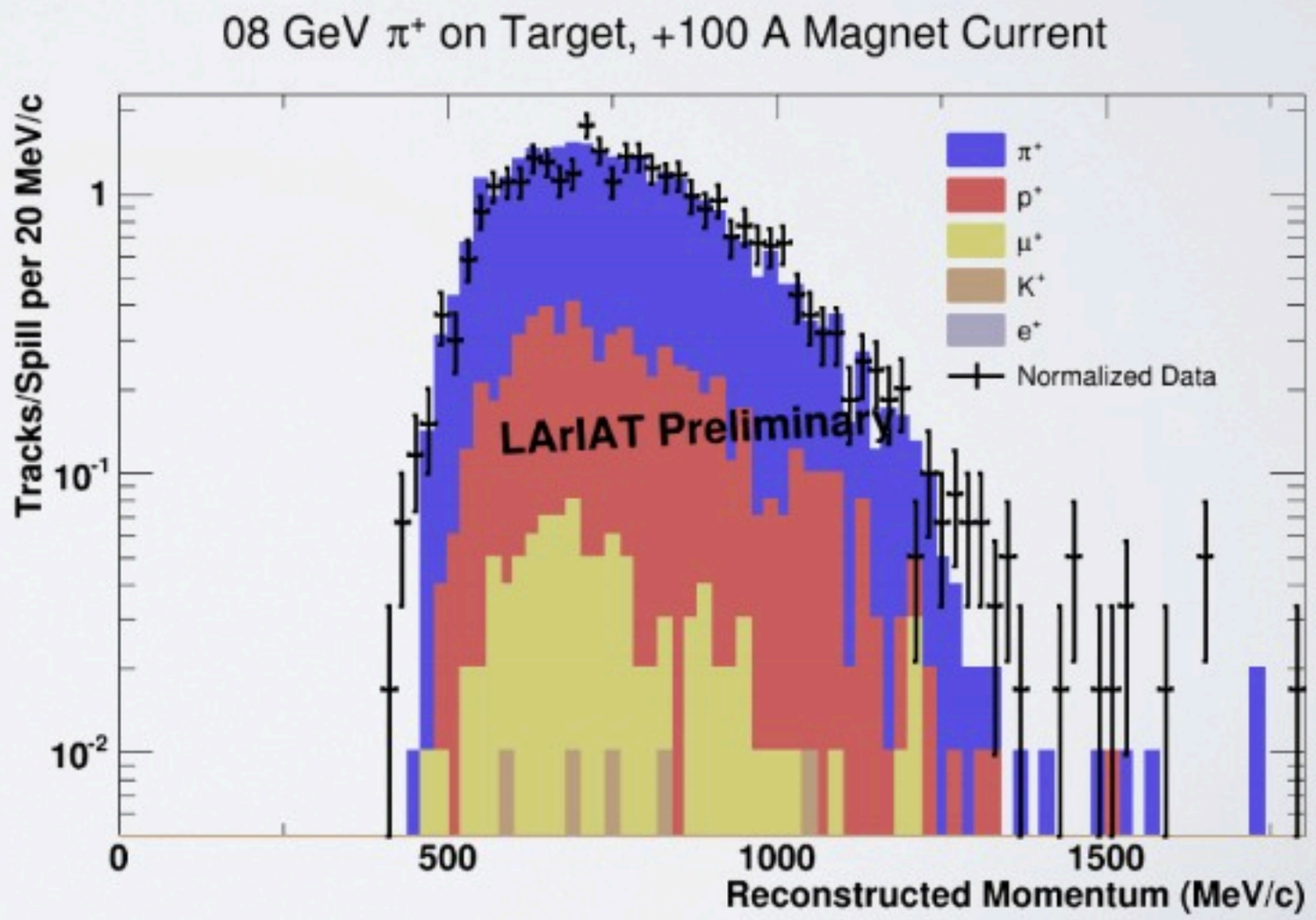
Beam Line Elements: Momentum Reconstruction

2 Bending magnets and 4 MWPC's



Two tracks made with up/downstream sets of MWPCs, angle found between them used to find momentum

Reconstructed momentum distribution (black) is very similar to Monte Carlo (color)!



Beam Line Elements: Particle ID

Time of Flight

2 Scintillation counters:

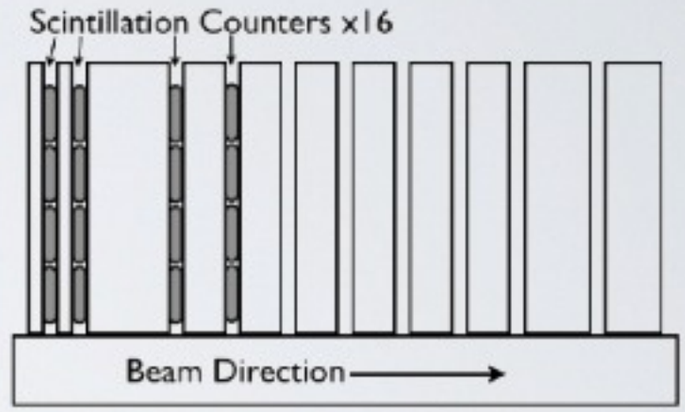
- One right after the secondary target, one right before the TPC

Good discrimination for particles not too close in mass:

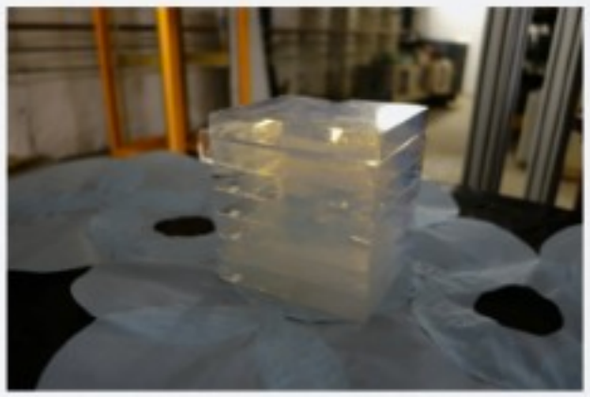
- i.e. p/π, but not π/μ

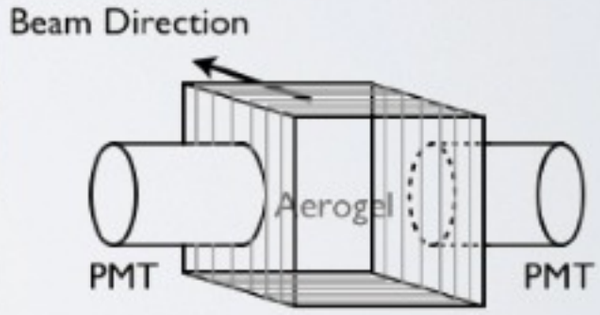
Cherenkov + Range Stack

(Still in preparation phase, but almost operational)



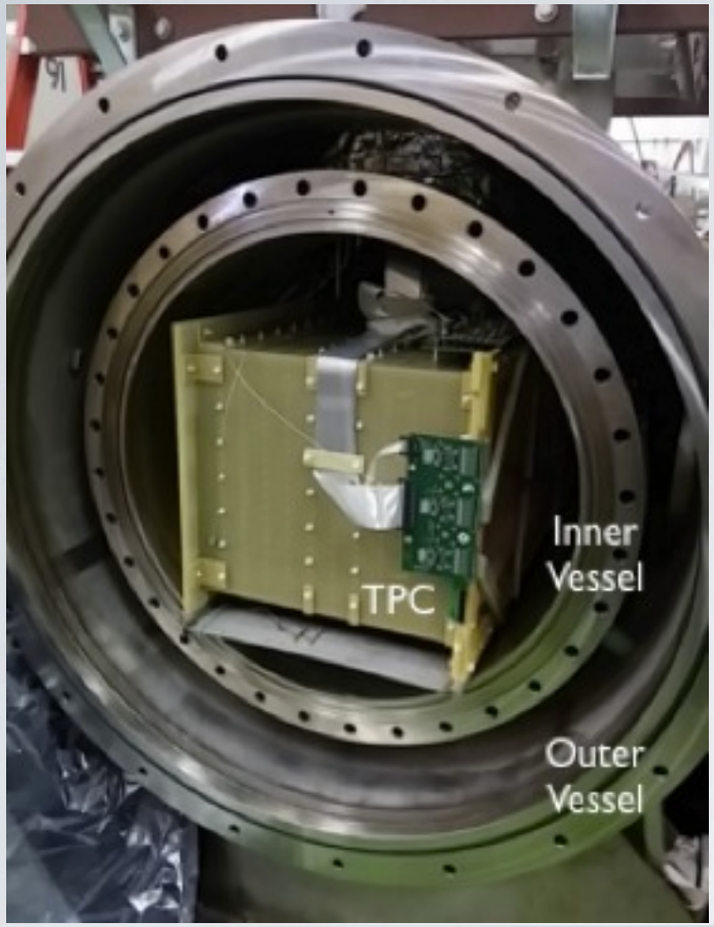
Range stack: Thick iron to stop π but not μ passing completely through TPC (for ≳ 500 MeV/c)





Aerogel Cherenkov counter (x2): π/μ separation in momentum range 229 -398 MeV/c

LArIAT's TPC

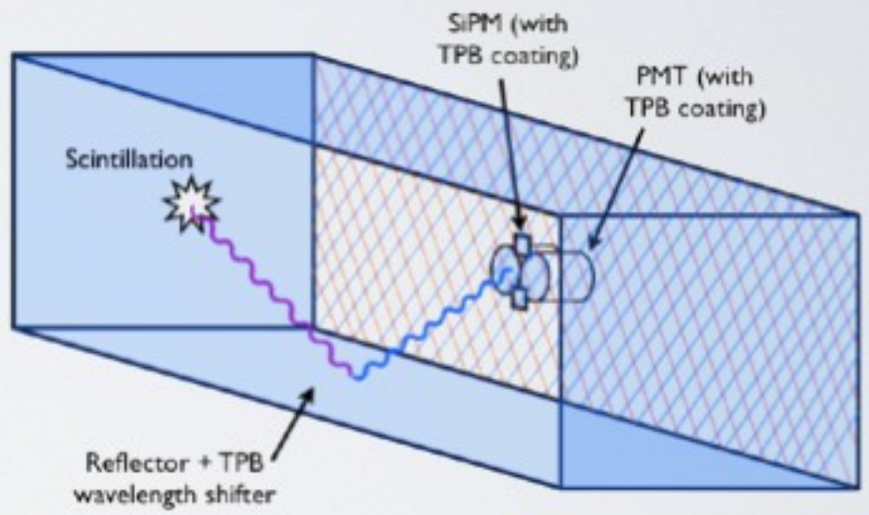


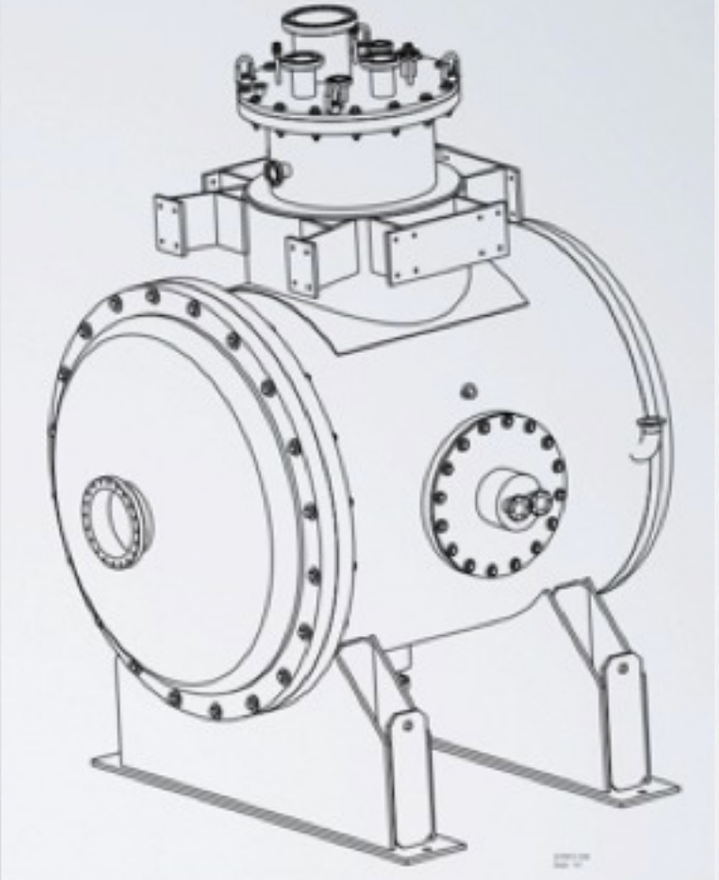
Functional, but not filled with LAr yet

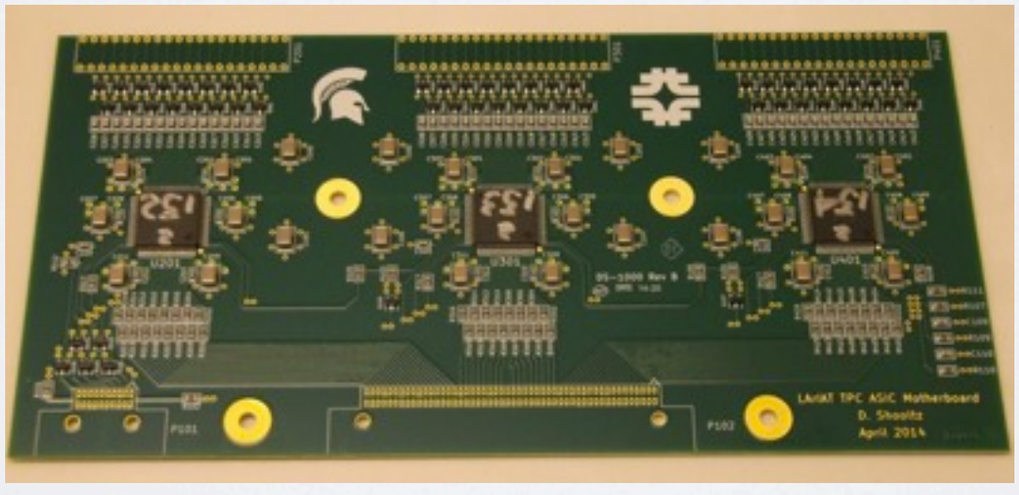
- Filled with gaseous argon, searching for coherent noise on wire planes
- Will be filling with LAr within the next few weeks.

A few features:

- Reflector-based light collection system for increased scintillation light collection







- Cold preamplifiers to reduce ambient noise amplification

Summary: The Past, Present, and Future

LArIAT is intended to study properties of LArTPCs.

Currently have beam line elements operational, giving:
- Momentum reconstruction
- Particle ID

LAr data taking with the TPC should start within the next few weeks.

Thanks for listening!

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