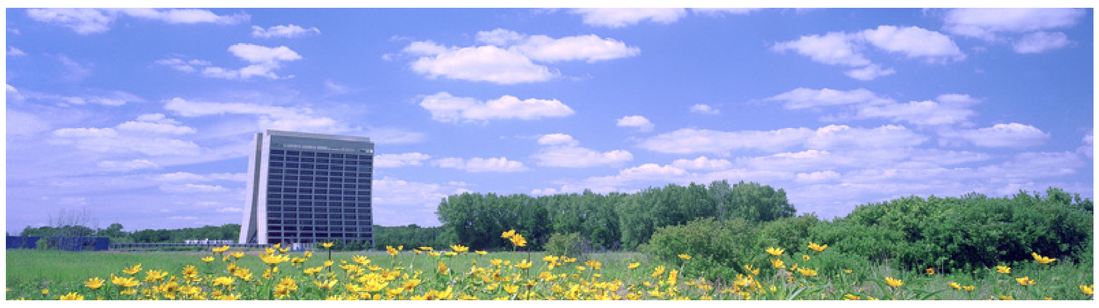
LArIAT

***L**iquid **Ar**gon*
Time Projection Chamber
***I**n **A** **T**estbeam (FNAL:T-1034)*

The Vision

A long-term facility at Fermilab's MCenter for physics of interactions in Liquid Argon (LAr) TPCs studying detector response and calibration using a well characterized beam



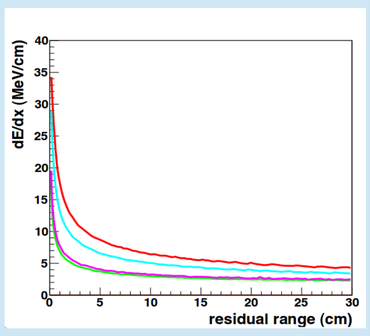
Phase- I:
Repurpose the ArgoNeuT detector (FNAL: T962) in the upstream end of the beamline *(described this poster)*

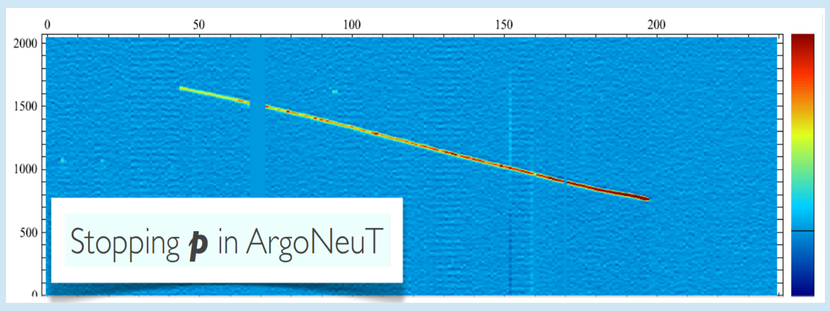
Phase- II:
Build a larger LArTPC further downstream for new goals *(time-projected into the future)*

Science Goals

Optimization of Particle Identification

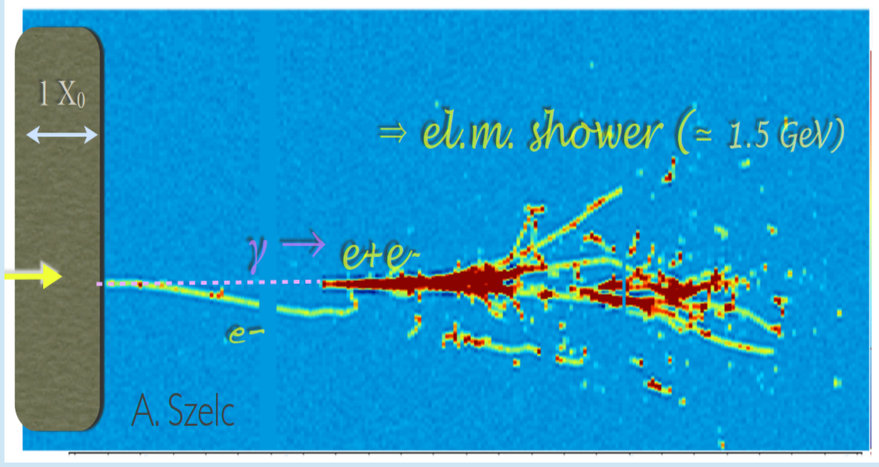
High-statistics test beam will allow LArIAT to **determine experimentally**:
- Proton ID, *p*-to-*K* separation (Rejection/Efficiency)
- Kaon ID, *K*-to-*p*/μ separation (Rejection/Efficiency)
- dE/dx vs Residual Range for contained tracks





Electron (e) / Photon (γ) Shower Separation

LarIAT's large e-tagged event sample will **experimentally measure** separation efficiency and sample purity for e-induced vs. γ-induced showers in a liquid argon TPC:



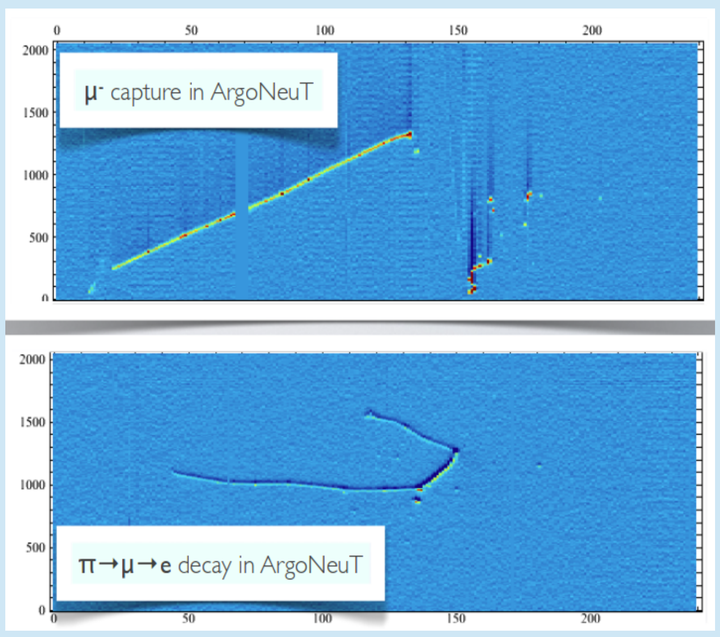
- e/γ separation is a key feature of LArTPC technology

- Only initial part of the shower is necessary for e-γ separation, making LArIAT Phase-I an ideal place to measure separation power experimentally and compare to simulation

Development of Charge Sign Determination

Systematic study of μ-**capture in LArTPC's has never been performed** and charge sign determination capability has never been explored

Beams with selectable polarity will provide data for direct measurement of sign separation capability

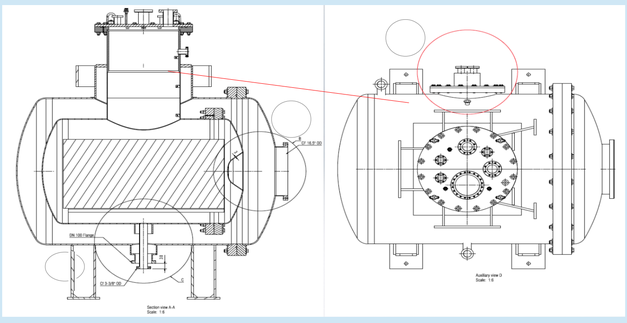


Investigatory Goals of First Physics Run

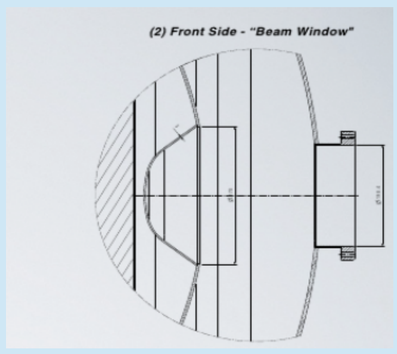
PARTICLE TYPES	MOMENTUM RANGE (FOR PARTICLES STOPPING INSIDE TPC VOLUME)	ELECTRIC FIELD SETTINGS	NUM TRIGGERS (PER SETTING)	PHYSICS STUDIES
μ+, π+, K+, p	~300-900 MeV/c	0.3, 0.5, 0.8 kV	μ: 5k π: 10k K: 2k p: 20k	All particles: dE/dx [recombination, PID] μ: decay at rest [sign ID] π: decay at rest [sign ID] K: decay topology reconstruction p: hadron interaction topology
μ-, π-, K-, pbar	~300-900 MeV/c	0.3, 0.5, 0.8 kV	μ: 5k π: 10k K: 2k pbar: 0.5k (or as many as possible)	All particles: dE/dx [recombination, PID] μ: capture at rest [sign ID] π: capture at rest [sign ID] pbar: annihilation at rest
e+ (e-)	TBD MeV/c	0.5 kV	10 k	dE/dx [e-to-γ shower separation]
γ	from e-brems	0.5 kV	5 k	dE/dx [e-to-γ shower separation]

Detector and Facilities

Repurposing the ArgoNeuT Cryostat

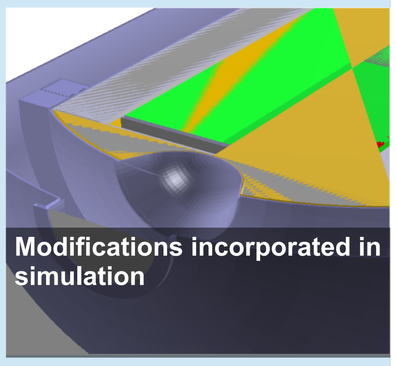


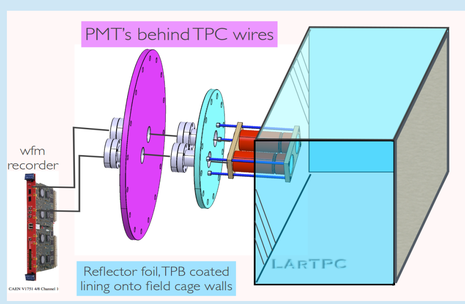
The ArgoNeuT device* is the Phase-I detector



Upstream Port

Modifications have reduced the material upstream of the TPC's sensitive volume



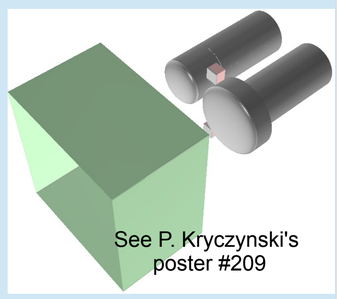


*2012 JINST 7 P10019

PMT Trigger

A new side port introduces PMTs and SiPMs for triggering. Light-yield simulations are underway in parallel

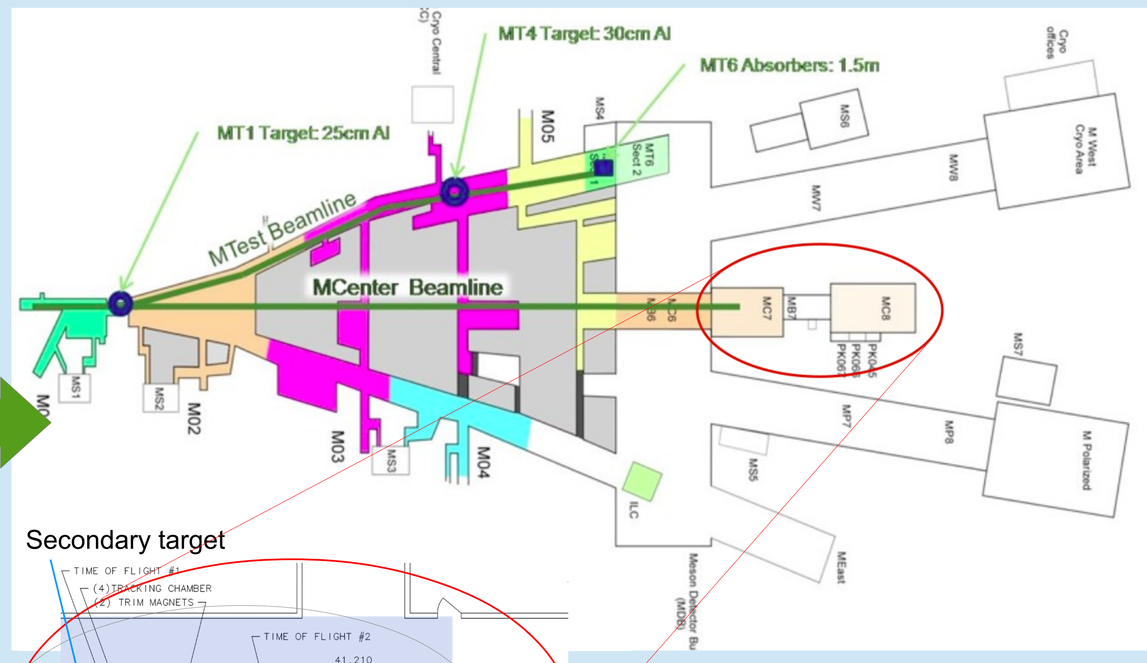
TPB** on the inner surface of the TPC convert scintillation photons to match PMT response



** *Ask me!*

Fermilab Testbeam Facility (FTBF)

Configurable and Powerful
Fermilab Main Injector protons at 120 GeV impinge on the FTBF primary target, producing a secondary beam with tunable momentum range and composition.

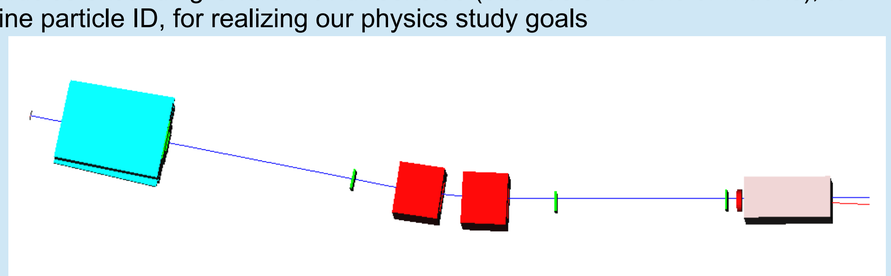


Tertiary Beam

At the MC7 hall, the LArIAT target converts the secondary beam into a tertiary beam of particle species for characterization by beamline instruments and by the LAr TPC

The LArIAT beam instrumentation measures time of flight and particle momentum. A cosmic tagger makes it possible to collect long, straight tracks for TPC drift calibration

In dedicated runs or additionally, further instruments tag beam excursion, punch-though, particles exceeding Cherenkov thresholds (such as electrons or muons), to further refine particle ID, for realizing our physics study goals



The LArIAT Collaboration: *(Spokes † Phase I, ‡ Phase II)*
Argonne: Jon Paley **Boston U.**: Dan Gastler, Ed Kearns **Caltech**: Ryan Patterson **U. Chicago**: Will Foreman, Johnny Ho, Dave Schmitz **U. Cincinnati**: Randy Johnson, Jason St. John **Fermilab:** Roberto Acciarri, Phil Adamson, Michael Backfish, Bruce Baller, Alan Hahn, Doug Jensen, Hans Jostlein, Tom Junk, Mike Kirby, Tom Kobilarcik, Pawel Krycyzynski, Hugh Lippincott, Sarah Lockwitz, Alberto Marchionni, Ko Nishikawa, Jennifer Raaf†, Erik Ramberg, Brian Rebel‡, Michelle Stancari, Sam Zeller **Imperial College London**: Morgan Wascko**KEK**: Eito Iwai, Takasumi Maruyama **LANL**: Christopher Mauger **Louisiana State University**: Flor de Maria Blaszczyk, Martin Tzanov, Jieun Yoo **U. Manchester**: Justin Evans, Pawel Guzowski **Michigan State University**: Carl Bromberg, Dan Edmunds, Dean Shooltz **U. Minnesota, Duluth**: Rik Gran, Alec Habig, Karl Kaess **U. Pittsburgh**: Steve Dytman **Syracuse University**: Jonathan Asaadi, Jessica Esquivel, Mitch Soderberg **U. Texas, Arlington**: Amir Farbin, Seongtae Park, Timothy Watson, Andy White, Jae Yu **U. Texas, Austin**: Junting Huang, Karol Lang **University College London**: Anna Holin, Ryan Nichol, Jenny Thomas **William & Mary**: Mike Kordosky‡, Matthew Stephens, Patricia Vahle **Yale University**: Flavio Cavanna†, Eric Church, Bonnie Fleming, Elena Gramellini, Ornella Palamara, Andrzej Szelc