

Miguel Angel Hernandez Morquecho, 08/17/2021

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LARIAT IN 10 MINUTES



What is a LArTPC?

LArTPCs are charged particle detectors

- When a charged particle passes through liquid argon, scintillation photons are produced and are used as a trigger
- Charged particles ionize, as a result, free electrons are produced
- Using an electric field, ionized electrons are drifted, signals are formed first on the wires of induction plane and then on collection plane
- Using two planes information and the drift time, a 3D reconstruction could be made.

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What is LArIAT?

Liquid Argon In A Testbeam An experiment to perform a precise calibration of LArTPC detectors.

LArIAT is focused in the study of charged particles that could emerge from neutrino argon interaction this is not a neutrino detector

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LArIAT cryostat with TPC, image from <u>arxiv:1911.10379</u>



LArIAT light detection system



LArIAT is a TPC that uses 2 different channel triggers Scintillation trigger **Beamline trigger**

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Photodetection system located beyond the collection plane, scintillation VUV light is shifted with a layer of TPB

Images from <u>arxiv:1909.07920</u>

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LArIAT in the test beam facility

LArIAT was taking data at the TestBeam Facility from 2015 to 2017



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Image from Blaszczyk, F. (2018, May). The LArIAT experiment: first measurement of the inclusive total pion cross-section in Argon. In Journal of Physics: Conference Series (Vol. 1029, No. 1, p. 012002). IOP Publishing.







Momentum between **J.3 GeV/c to 1.4 GeV/**

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LArIAT in the test beam facility



Wire chamber in the LArIAT beam (Testbeam Facility) Image from <u>arxiv:1911.10379</u>

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A LArTPC to study pions, protons, electrons and muons Why we want to study this kind of events?

- LArTPCs are the detectors chosen for next generation neutrino detectors (DUNE)
- Calorimetry is used to do PID
- LArIAT is used to calibrate LArTPCs (interaction between liquid argon and the final products for neutrino interactions) the understanding of this hadrons with argon is essential to improve and take advantage of the next generation neutrino detectors.
- LArIAT could be use to explore new analysis techniques to improve PID



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LArIAT event display

LArIAT TPC readout Run 6073; Spill 153; Event 0; 2015-06-09 01:29:32



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Time tick

Induction plane

Collection plane



LArIAT event display





Candidates for pion-argon interaction topologies as seen in the LArIAT data Elastic Scattering on the left, Inelastic Scattering on the middle and Absorption on the right.

Images from <u>arxiv:2108.00040</u>

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Cross section

π^- Total cross section on liquid argon 2.5 Total (π ⁻,Ar) Hadronic Cross Section per 50 MeV [barn] LArIAT Run II Data **Negative Polarity** Low Energy Tune High Energy Tune Geant4.10.03.p1, FTFP BERT Elastic Angles > 5 deg .5 0.5 600 0 100 200 300 400 500 700 Kinetic Energy [MeV]

Image from <u>arxiv:2108.00040</u>

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K^- Total cross section on liquid argon

Novel measurements First π^- and K^+ total cross section on liquid argon in energy range measurements.



Image from <u>fermilab-thesis-2018-24</u>





- rest
- interactions



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- Blips are small, spatially-isolated energy depositions from MeVscale gamma rays
- Pions and muons captured at rest transfer different amounts of energy to nucleus
 - Pions transfer all energy to nucleus; muons transfer some energy to neutrinos
 - Result: different blip activity





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Blip activity study



Images from <u>arxiv:2006.14675</u>



- Blips are small, spatially-isolated energy depositions from MeVscale gamma rays
- Pions and muons captured at rest transfer different amounts of energy to nucleus
 - Pions transfer all energy to nucleus; muons transfer some energy to neutrinos
 - Result: different blip activity
- Studying blip activity for different particles will demonstrate if it is possible to do PID and sign determination for pions/muons

Blip activity study

We want to use LArIAT instead of Proto DUNE because in LArIAT we have low energy, needed for capture at rest

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Image from <u>arxiv:1911.10379</u>

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Summary

- A charged particle beam is used to understand the products of neutrino interactions in liquid Argon.
- LARIAT is a small LARTPC in the beam line used to calibrate short and long baseline detectors like SBND and DUNE.
- Development of novel and exciting new methods for particle ID are made with LArIAT.
- If we could demonstrate the particle ID with blip activity we could make a good improvement for future LArTPCs like DUNE and SBND.

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Thanks (Gracias)

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