Recent Progress on LArIAT

Jason St. John - University of Cincinnati - for the LArIAT collaboration

March 21st, 2013 - Liquid Argon TPC R&D Workshop - Fermilab
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Scientific Goals

Phased program for comprehensive characterization of LArTPC performance for the range of energies relevant to upcoming experiments like MicroBooNE and LBNE

Phase-I: Modified ArgoNeuT detector
Single-track calibration (recombination/charge-to-energy calibration)
Experimental measurement of e/gamma separation
Optimization of particle ID methods
Development of criteria for charge-sign determination

Phase-II: Larger volume TPC (TBD)
Reconstruction of collective topologies (detected-to-incident energy calibration)
Characterization of EM and hadronic showers
Timeline

MicroBooNE construction & installation

35-ton Phase-1 (purity run)

LBNE milestone: CD-1 review

MicroBooNE

35-ton Phase-2 (LBNE-like TPC + cold electronics)

LBNE milestone: CD-2 approval (Spring 2016)

LArIAT Phase I
Install | Pilot run
Physics Run I | Physics Run II

LArIAT Phase II
design, construction, data-taking and analysis

MicroBooNE


Recent Progress for Phase-1: From Beam to Data

* Beamline layout
* Triggering schemes
* Cryostat preparations
* PMT’s and Light Yield
* Readout Electronics
* TPC simulation & Reconstruction
Beam Optics Layout

8 GeV Proton beam

Target

Steel Collimator @ 16°

Wire Chambers

Large-Aperture Bending Magnets

D. Jensen, FNAL

J. St. John, U. Cincinnati

Ti Window
Beam Optics Layout

8GeV Proton beam

25” quadrupole pair

Target

Steel Collimator @ 16°

Wire Chambers

Large-Aperture Bending Magnets

Ti Window

J. St. John, U. Cincinnati
Testbeam Triggering Progress

M. Kordosky, William & Mary

Time of Flight
Cherenkov
Halo veto
PMTs
Testbeam Triggering Progress

Time of Flight

Cherenkov

Halo veto

PMTs

Punchthrough
Testbeam Triggering Progress

Beamspill, pileup, busy signal

Randy Johnson, U. Cincinnati
Detailed Beam Spill Structure

One Batch from the booster in the MI
data from the resistive wall monitor in the MI
this is a set of data during acceleration

D. Jensen, FNAL
Cryostat Modifications

- Work being done at PHPK

MODIFICATION 02
Add custom head to existing flanged head

M2 Excluder must also be calculated as a torispherical head with to check the thickness requirement based on pressure on the convex side of the head — this is done using an external pressure of 45psig.
Cryostat Modifications

- Work being done at PHPK, continued.
Light Readout Tests

Regenerated Cu filter
Commissioned vacuum system

W. Foreman, D. Schmitz, A. Szelc
Optical Model

P. Kryczynski,
U. Chicago
Readout Electronics

C. Bromberg, MSU
M. Stancari, FNAL

Argoneut Electronics:
* Warm &
* Accessible only by complete disassembly

Upgrade for LArIAT:
* Cold (great Signal/Noise)
* MicroBooNE ASIC (BNL) on a mezzanine

Using proven, existing parts
Cost estimates and proposed work schedules generated and on the table
Readout Electronics & DAQ

DAQ rate must be increased by factor \( \geq 5 \)

Existing ArgoNeuT DAQ rate: \( \sim 1 \) Hz

Expected good-trigger rate at FTBF: \( \sim 5 \) Hz

(\( \sim 20 \) particles/spill in 4 second spill once per minute)

Two planned improvements to reach up to 32x rate increase:

- ADF2 digitizer firmware upgrade for improved VME readout speed
- Replace “bit-3” PC-VME interface with Motorola SBCs (which we can get from CDF or D0)

ArgoNeuT warm electronics can be used again, but we strongly prefer to instead upgrade to cold electronics (improved signal-to-noise)

Maybe not feasible with available FNAL funding...

Looking for external funds for this
Simulation & Reconstruction

A. Szelc, Yale

Modified geometry now in Geant

Possible shower-inducer for studying e/γ discrimination

Reconstruction simulation given realistic electronics noise
Thank You!
Summary

LArIAT scientific goals:
• Direct/experimental proof of e/γ separation in LArTPCs
• Detailed measurements of recombination factors
  p, K, π, μ PID and accurate calorimetry
• Direct measurement of energy resolutions
  for EM and hadronic showers
• Fine-tuning software for offline analysis

Phase-I effort is well underway
  Working hard to be ready for beam startup (Summer 2013)

Phase-II simulation & planning has begun

Plenty of opportunities for new members to contribute!
Fermilab Test Beam Facility

http://www-ppd.fnal.gov/MTBF-w/

MISSION
The goal of the Fermilab Test Beam Program is to provide flexible, equal, and open access to test beams for all detector tests, with relatively low bureaucratic overhead and a guarantee of safety, coordination, and oversight.

MTest and MCenter configurable for:

Primary beam
Proton Mode: ~66–120 GeV protons

Secondary beam
Pion Mode: 8–66 GeV beam
Low Energy Pion Mode: 1–32 GeV beam
Muon Mode: Same energy range as above

Tertiary beam
Low Energy Pion Mode: 200 MeV – 3 GeV
**Closer Look at FTBF**

**MTest:**
Continue to use for short-term experiments (few weeks to months)

**MCenter:**
Create a facility for long-term LAr calibration and R&D with “generic” cryogenic plant in MC7/8 that will service upcoming experiments (LArIAT–I and –II) and any future LAr R&D in this beam.
Closer Look at MC7

- 410.99 [34'-3"]
- TIME OF FLIGHT #1
- (4) TRACKING CHAMBER
- (2) TRIM MAGNETS
- TIME OF FLIGHT #2
- 41.210 [1 m 47 mm]
- 114.790 [2 m 92 cm]
- 85.790 [2 m 179 mm]
- 419.997 [35'-0"]
- 138.00 [11'-6”]
- ROLL-UP DOOR
  11'-6" WIDE
  8'-0" HIGH
- 909.50 [75'-9 1/2"]

LArIAT Detector
Argoneut at MC7

ArgoNeuT gaseous Ar recirculation system
(40.58” taller than MC7 ceiling height, must be modified)

Taller ceiling section

ArgoNeuT stand, must be shortened to position center of TPC in beamline
Cryogenics and LAr Purification

“Generic” purification system under discussion/design now. Plan to be reusable for Phase-II (and any other future needs)
Target and Shielding

D. Jensen, FNAL