LArIAT Beamline and Auxiliary Detectors

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LArIAT Operational Readiness Review - Fermilab - 2015.10.13

Outline

1. Accelerator & Beamline

- a. Primary
- b. Secondary
- c. Tertiary
- 2. Beamline Challenges

-----Into the Experimental Hall------

- 3. Tertiary Beam & Instrumentation
 - a. Collimators, Analyzing Magnets, Geometry
 - b. Slow control and monitoring
 - c. Beam Instrumentation and performance

Accelerator Overview



120 GeV Primary Beam Target and Shielding





Secondary Beamline 4-80 GeV



MCenter Beam Profiles



Main Injector Bunch Structure



Intensity Variations Throughout the Spill



- QXR feedback loop tuning and quadrupole tuning is needed for most intensity variations within the Main Injector
- Momentum variations throughout the cycle along with dispersion in the beamline can cause position variations across either split or on the primary beam target
- Power supply regulation problems can cause undesired steering throughout the cycle
- Outside temperature
- Variations in line voltage

Unexpected Challenges of the test beamline TPC Drift time 350 uSec!!!!

- 11 uSec per Main Injector orbit
- 588 Buckets per Main Injector Orbit
- 18709 buckets within a 350 uSec Drift time

Particles Can Overwhelm the TPC!!!!



Solving it Together

- Lariat has installed a system of scintillators including a portable system that can be located in various temporary locations which provide immediate feedback to Accelerator Division experts and operators.
- F:MC7U09 Lariat Cosmic Accidental detector (to minimize)
 F:MC7U10 Lariat Tertiary beam halo detector (to minimize)
 F:MC7U11 Lariat TPC Readout Trigger (to maximize)
 F:MC7U12 Lariat Fast Trigger (to maximize)
- Strong relationship between operations and Lariat

Example of Incremental Progress

Open Up the Momentum Collimator coupled with a small tweak in Focus using 2 Quads

Increased MC7U11 and U12

MC7WC1 FS 46.3% FS 47.1% MC7WC1 FS 48.7% MC7WC2







Future Improvements

Idea credit goes fully to Doug Jensen



Comparison of FLUX in TPC region of MC7using MARS runs with 120,000 Protons on Target

Plans are Underway to Test Additional Shielding



Portable halo counter to position in secondary beam line hall for measurements



Into the Experimental Hall

Tertiary Beamline - Installation & Safety Checks

Installation at FTBF MC-7 allowed dry run (no TPC, no cryostat)

- Characterized beam
- Commissioned instruments

- TPC and cryosystem got full focus when commissioned

Operational Readiness Clearance MC7 Facility (Beam tune Configuration) 12 Dec 2014

AUTHORIZATION TO CONTINUE WITH THE REMOTE OPERATION OF Lariat (new configuration) IN MC7

REVIEWED AND APPROVED BY:

Particle Physics Division Head

Comments/Exceptions:

Accelerator Division Head

Comments/Exceptions:

Accelerator Division Operations Department Head Comments/Exceptions:

Accelerator Division Badiation Safety Officer Comments/Exceptions:

Particle Physics Senior Safety Officer

Comments/Exceptions:

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Comments/Exceptions:

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Fermilab Test Beam Coordinator Comments/Exceptions:

Jason St. Joh

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Operational Readiness Clearance LAraiT in MC7

21 Apr 2015

AUTHORIZATION FOR THE REMOTE OPERATION OF LAraiT IN MC7

REVIEWED AND APPROVED BY:

4/22/15

DATE

Neutrino Division Head Comments/Exceptions:

Particle Physics Division Head Comments/Exceptions:

Tan C Garanalo for Accelerator Division Head Comments/Exceptions:

Accelerator Division Operations Department Head

Accelerator Division Radiation Safety Officer Comments/Exceptions:

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Submitted By:

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Comments/Exceptions:

12/12/14

DATE

12/12/14

12/12/12

our dart

4/22/2015

4/22/2015

4-22-2015

122/2015

12/12/2014

12 Dec 2014

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Signals sent to trigger logic and to data stream.

LARIAT TEST-BEAM OVERVIEW





Tertiary Beamline - monitoring



Detailed monitoring by subsystem to understand alarms

← Time
 of Flight
 PMTs

ACNET control where possible

← Wire Chambers

Analyzing Magnets→









MWPCs + bending magnet

Charge-selected beam
 200 - 1200 MeV/c



Momentum windows in excellent agreement with simulation



Secondary Particles produced by neutrino interaction at BNB (charged pions)



MWPCs + bending magnet

Full and Half momentum settings/magnet currents cover MicroBooNE neutrino event secondary momentum range





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Aerogel Cherenkov counters for further PID π vs. μ discrimination

Effective for TPC-contained π/μ range: 230-400 MeV/c







Muon range stack for discrimination of throughgoing muons/pions

Effective for high-p π/μ range: 400+ MeV/c

Some commissioning still ongoing



Cosmic tagger paddles for

triggering on diagonal cosmic-ray muons

 April 30, 2015 – TPC turned on, first cosmic-triggered



Conclusion

The beamline is ready and has been demonstrated to produce physics-quality beam. This is true of the beamline instruments as well.

Passed Operational Readiness Checks following first installation and following each significant change along the way.

Extensive, helpful interaction with AD, BD, PPD, FTBF, and ND.

Resources provided by the lab:

- ACNET, IFIX, Synoptic, Cryo engineering, Cryo controls, engineering & technician time

The necessary detectors are in place for triggering online and event-by-event particle ID offline. Already performing well.



Tertiary Beamline - monitoring cryostat & TPC





