



# Status of the Fermilab Test Beam Facility

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FTBF Committee Meeting

24 October 2016

# Outline

- Status of committee recommendations from last year
- FY16:Year in Review
  - What users we had
  - Physics at the test beam
- Plans for the next year
  - FY17 users so far
  - Facility projects

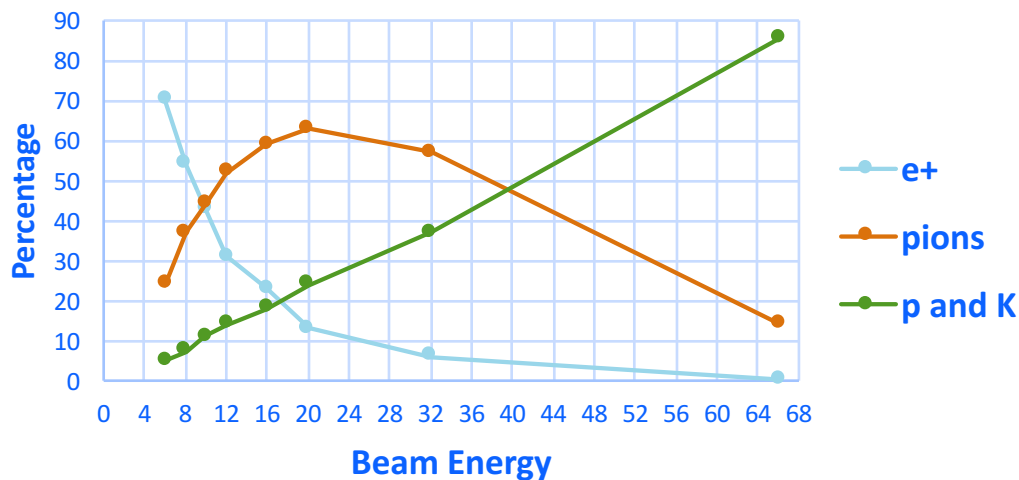
# Recommendation: Beam Characterization

- “Prioritize future planning and spending towards better beam characterization... The characterization should include energy spread/resolution as a function of energy and beam particle composition, again as a function of beam energy....”
  - Create a detailed plan on what is to be measured in the beam studies.
  - Understand the beam usage by particle and energy, to better understand what users want.
- Progress on recommendation: Significant progress was made on the particle composition for various beam energies. We ]looked at historical usage of the beam to prioritize the most used beam first.

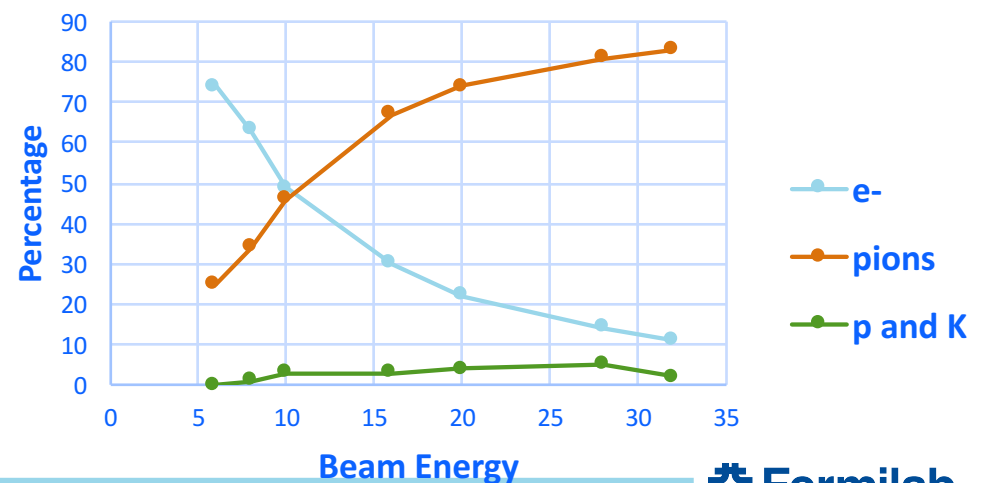
# Beam Studies: Particle Composition

- Beam composition studies – carried out using the Cherenkov detectors ( filled with Nitrogen)

## Positive Beams

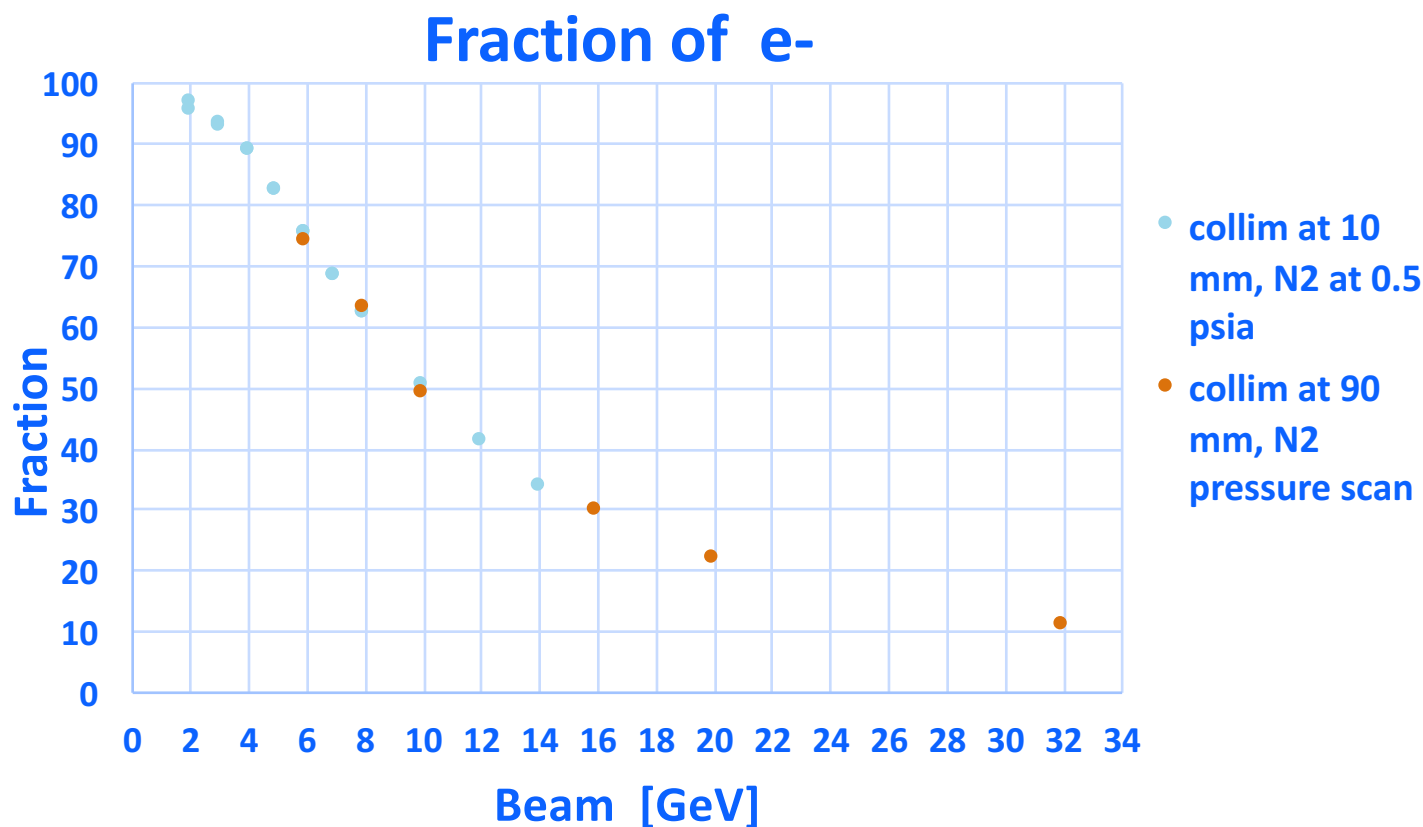


## Negative Beams



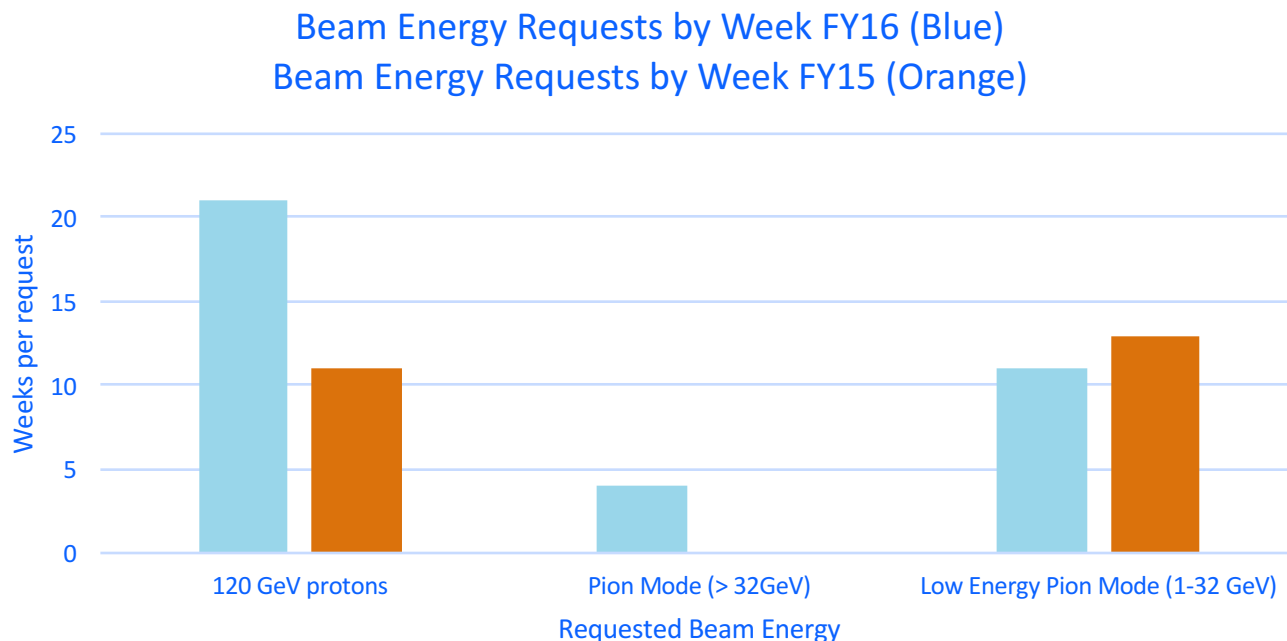
# Beam Studies: Electron Content

- In addition to our own studies, one user did a scan at different energies. We were able to use their data to check our studies
- Determine positron fractions in the fall



# Beam Studies: User requests

- Mined data from previous test beam reports
  - About half of all requests are for 120 GeV protons
  - Majority of the rest are for low energy pion mode beam
    - Also note this is for positive beam energies. Not many requests for negative, but there are some.



# Beam Studies: Plans for the Future

- When beam returns in November 2017
  - Positron studies
  - Install ToF system
  - Install Spectrometer
- Once a spectrometer is installed
  - Measure momentum spread as a function of beam energy starting with the lower momentum range
  - Continue to fully characterize the beam.
- Provide monitoring of the intensity and beam conditions
  - Have a monitor currently with spill count, hits on the counters, and status of lead absorbers

# Recommendation: Facility Upgrades

- “For facility upgrades, Develop a solid plan for modernizing infrastructure, esp beam-line instrumentation. This plan should be explicitly prioritized, and future presentations should refer to progress with respect to the plan and/or changes of plan goals.”
  - Provide a detailed timeline for getting the Si telescope online.
  - Provide a list of work for the 2016. What are the priorities? This will allow the staff and the committee to measure year-to-year progress and understand the context of the work done each year.
  - In the next meeting, describe the progress with respect to these goals.

# Recommendation: Facility Upgrades

- Silicon Telescope is online and available for users
  - The Si Telescope is still under the control of the CMS test beam group, as they are continuing their program
  - Paper describing the telescope to be published in NIM
  - Experimenters in FY16 used the telescope for precise tracking (T1037), in addition to T992 studies.
  - Working together to create readout for general use
- Continued improvements
  - Spectrometer for momentum spread studies (locating magnet currently)
  - ToF system (separate particles in the 2-5 GeV range)

# Recommendation: Safety Concerns

- The committee was encouraged by the presentation of the safety staff. As it was described, the role of the FTBF staff should be to make the ES&H visit as smooth as possible.
  - Work with ORC to establish that if FTBF staff shows it can satisfy the requirements w/o explicit oversight that the responsibility is given to FTBF for routine safety procedures.
- While it's unlikely we'll get to the point of no inspections, we have implemented practices to reduce the amount of time safety walkthroughs and signatures take.
  - “Pre-ORC” checklist performed by the facility staff
  - New ORC/TSW system (next slide)

## Recommendation: Safety concerns

- New online system for Technical Scope of Work (TSW) and Operation Readiness Clearance (ORC) aims to improve access to facilities for users as well as speed up the process
  - Now a lab-wide procedure
  - Paperwork is commensurate with size of project
  - Provides opportunity for feedback on items before installation and allows us to head off any issues
  - *Caveat: Brand new system, so surely some kinks to work out in this first year*

# Recommendations: Input from Users

- Improve access to information relevant for the users.
- Decisions should involve more input from the users. Ask users what they want. For example, for the DAQ, what single platform should be supported?
- Develop a reference analysis that takes raw data, puts them into objects and analyzes these data. Provide this for users
- Spent much of this year connecting to past users, current users and potential users about needs and wants for the facility
  - No coherent DAQ request, but everyone agrees this is necessary
  - Computer programmable HV system important to all
  - Some analysis tools exist, but not widely distributed.

# Recommendation: Input from Users

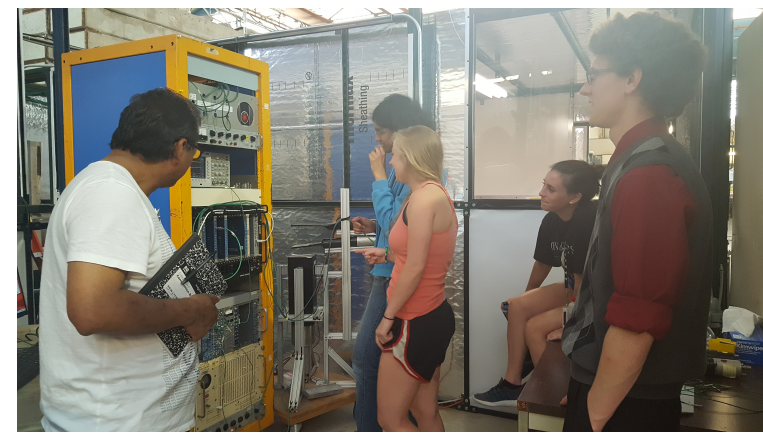
- For code: utilize GIT repository and provide instructions
  - Will work on this during the upcoming year
- Provided a notebook with information on various systems, this will continue to be updated
  - Also working to update the website
  - Will include the new beam studies
- DAQ: Installed MIDAS over the shutdown
  - Will pursue a solution to allow users to connect their DAQ and our instruments
  - Highest priority for the coming year

# Recommendations

- Be specific about your plans for the next year, so that they can be turned into proposed M&S budget numbers that can be included in the FNAL budgeting process.
  - We have turned in budget requests that reflect our operating needs and include requests for HV system and money to buy instrumentation
- As proposed, we encourage you to write a paper, to be submitted to a refereed journal, to describe the FTBF facility.
  - Draft is progress. Goal is to finish this year (FY17)
- Working with students. The committee encourages the FTBF to continue its out-reach to students. However, their use should be kept to non-critical-path items.

# Recommendation: Students

- Working with students. The committee encourages the FTBF to continue its out-reach to students. However, their use should be kept to non-critical-path items.
- Very successful summer program this year
  - Supported 4 interns from various programs, including underrepresented groups
  - Little to no programming experience among them
  - They all built their own scintillating paddles and tested with cosmic rays
  - Developed intuition about data taking
  - Worked to install and develop MIDAS



# Discussion on Recommendations

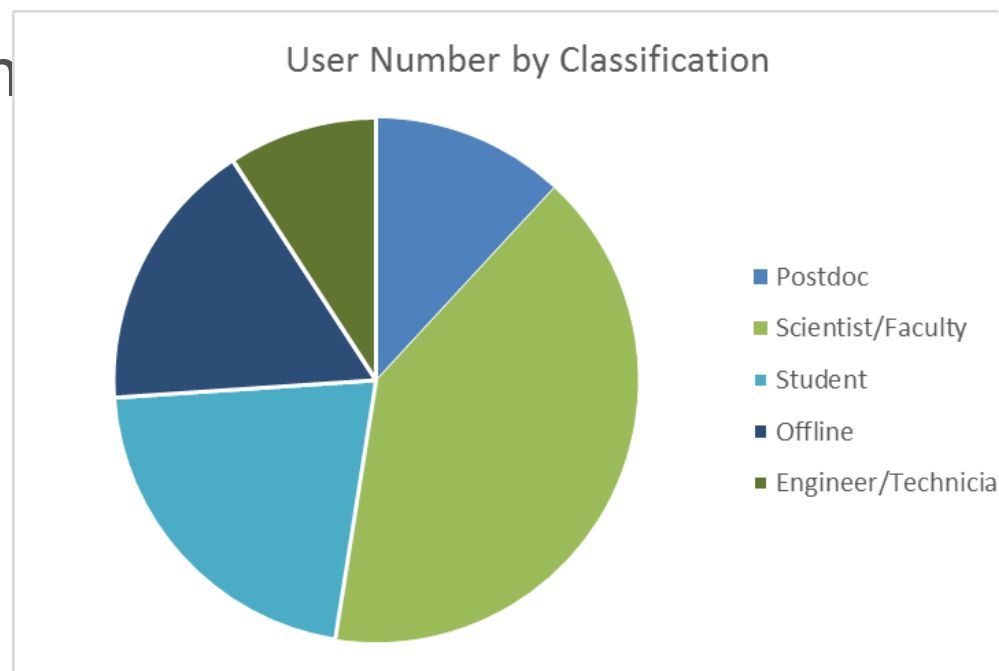
# FY16 in Review

- In FY16, 34 weeks were available for beam
- Major downtime: 6 weeks due to ICW work
- Beginning of the summer shutdown delayed to August 2016
  - Allowed us to fill in last minute requests
- Were fully booked, still able to accommodate last minute groups
- Used about 6 weeks total for beam studies and repairs

Experiment Number	Description
T1041	CMS Forward Calorimetry R&D
T0992	Radiation Hard Sensors for the HL-LHC
T1015	Dual Readout Calorimetry with Glasses
T1065	Secondary Emitters Study
T1068	Beam Tests of the SVX4 Telescope
T1043	Mu2e Cosmic Ray Veto Detector
T1044	sPHENIX Calorimetry Tests
T1048	EIC PID
T1037	FLYSUB Consortium Tracking & RICH
T1018	UCLA Spacordion Tungsten Powder Calorimeter
T1042	g-2 Straw Tracker Vacuum Tests
T1073	Precision Timing Profile Monitor
T1072	Muon Strips for Future Colliders
T0979	Fast Timing Counters for PSEC
T1075	Large Area ToF for ProtoDUNE
T1034	LArIAT: Liquid Argon in a Test Beam

# FY16 Users

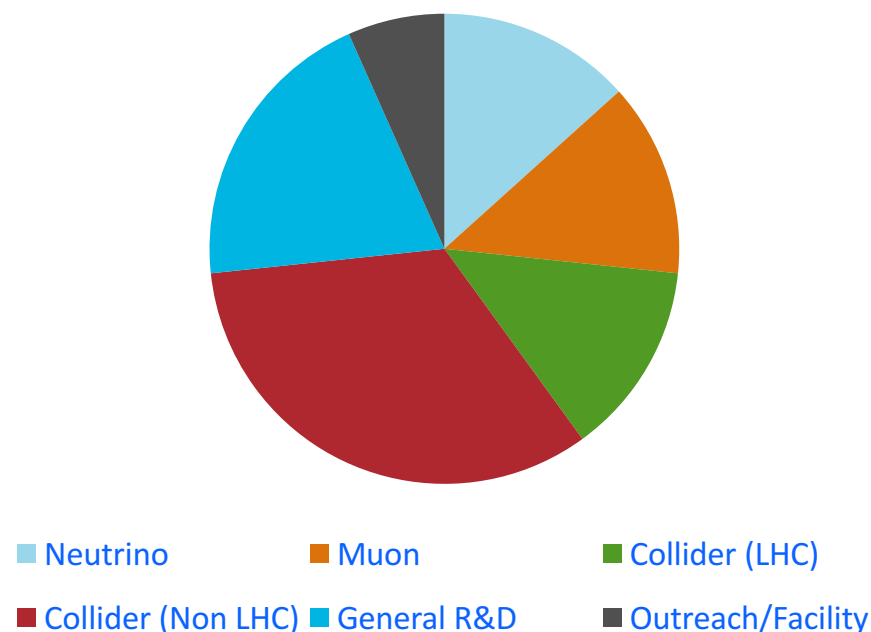
- In FY16, 261 people came to the test beam.
  - 31 institutions and 6 countries represented
  - Interesting to note that a large percentage didn't come, but are using test beam data.
  - Majority of users are senior scientists/faculty members
- 11 publications from data taken
  - 4 more in progress
- 4-5 conference talks/posters



# FY16 Physics Review

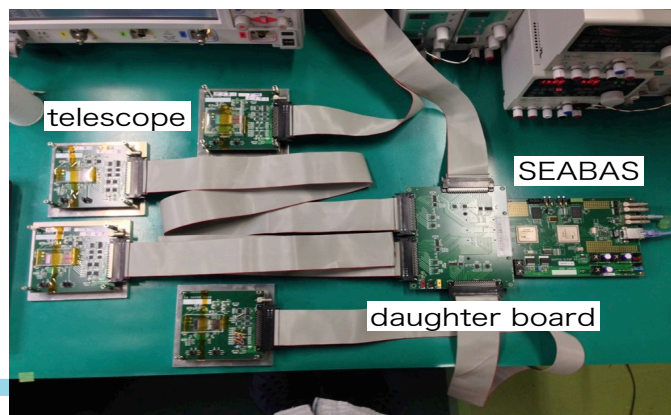
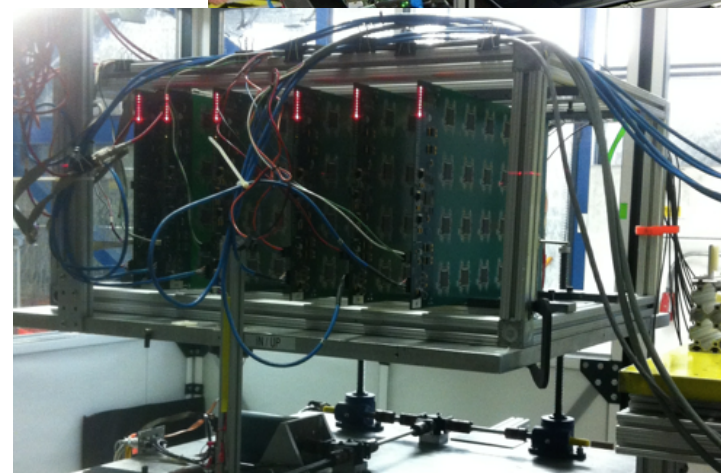
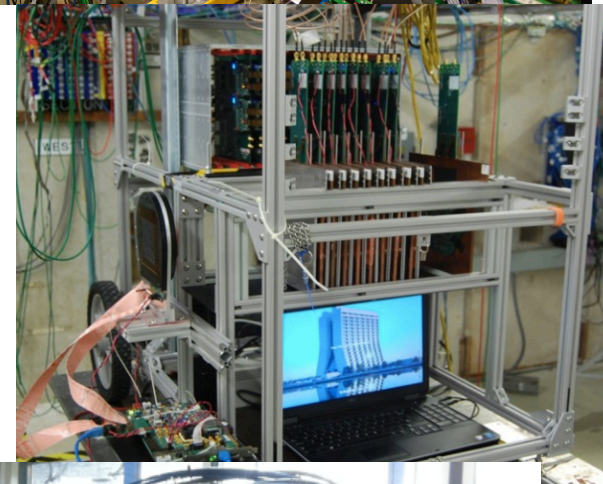
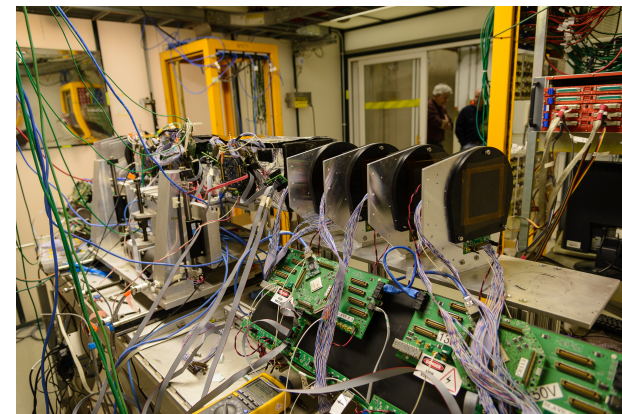
- We continue to support a broad range of physics topics.
- Supported groups from ATLAS, CMS, RHIC, General R&D for future colliders
- Novel uses of the test beam (muon strip detectors)
- Non beam users
  - Cosmic telescope
  - Flammable gas

Experiments by Research Focus



# LHC studies

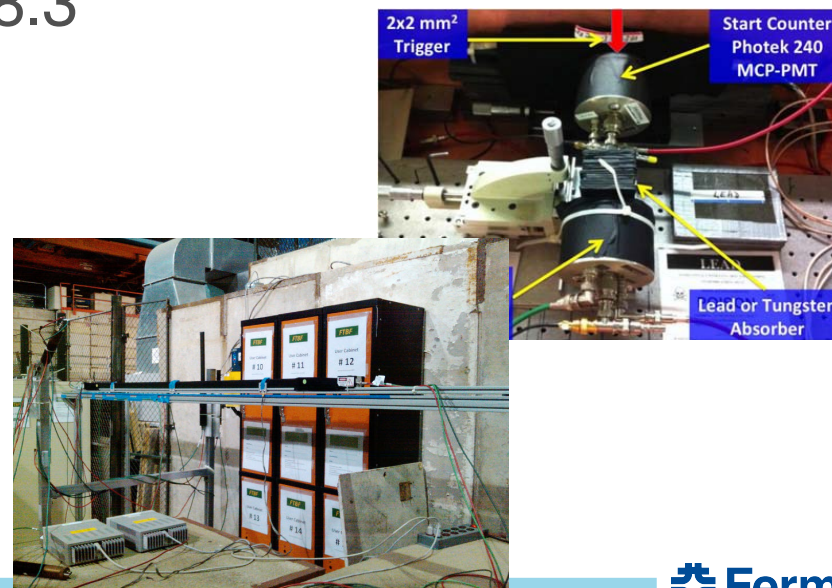
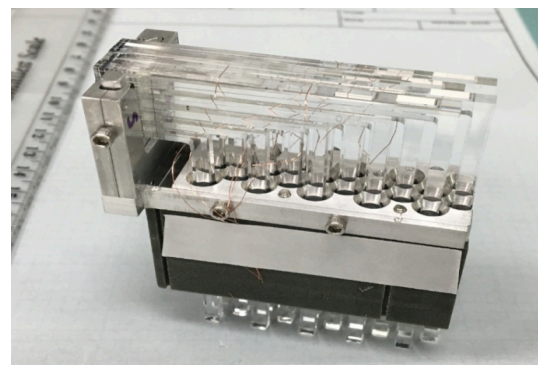
- CMS (T992, T1041)
  - T992: Testing rad hard sensors for the HL-LHC
  - T1041: Multiple groups testing calorimeters and testing resistive plate chambers
- ATLAS (T1068)
  - Testing telescopes for future radiated samples tests
  - Have runs scheduled in FY17





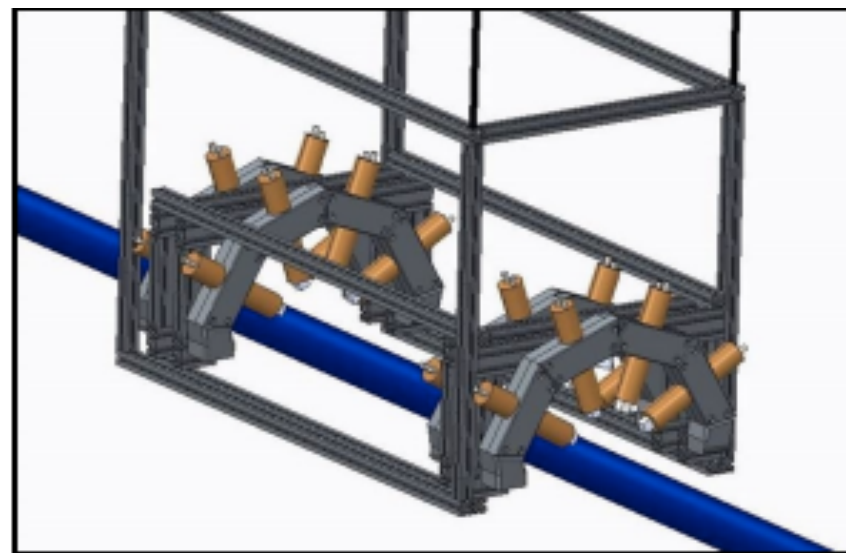
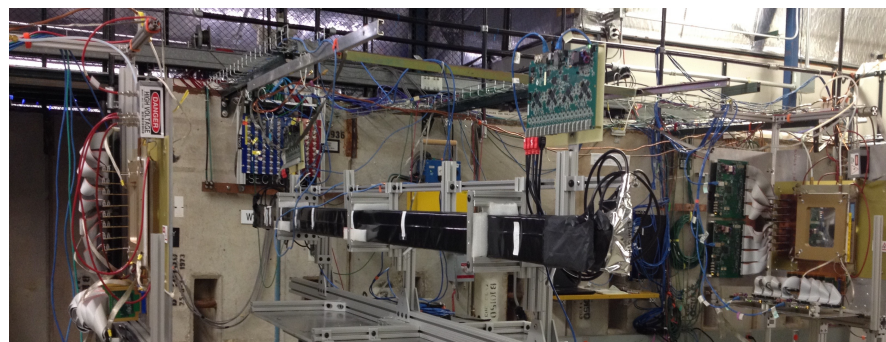
# General R&D

- Future lepton collider experiments (T1015)
  - Dual readout for calorimeters
- Timing detectors (T979)
  - Initial use at CMS, but would be applicable in other cases
- Timing detectors (T1065)
  - World's best timing resolution (8.3 ps for ToF resolution)
- Muon strip detectors
  - For future colliders
  - Stayed outside the enclosure



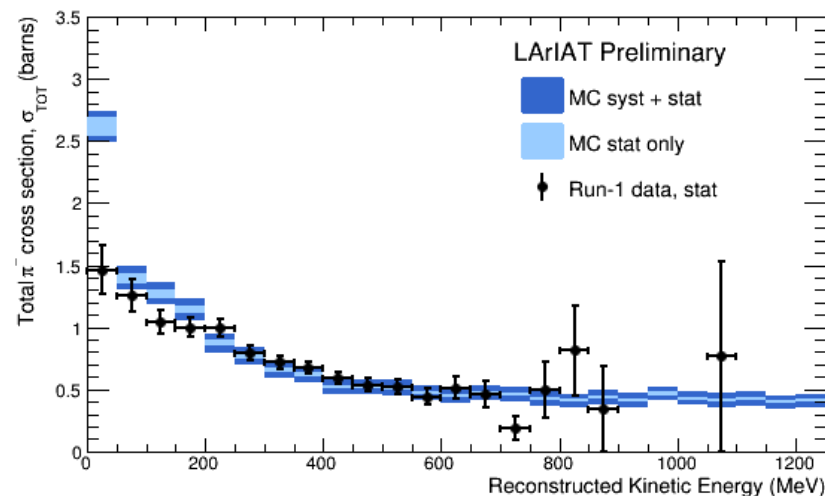
# Muon Physics

- Cosmic Ray Veto Tests (T1043)
  - Testing PE yields for a variety of configurations
  - Results shown at conferences
  - Will continue to test this year
- Beam Monitor Studies (T1073)
  - Beam monitor for Mu2e, basis for LDRD work
  - Measuring quartz Cherenkov radiators exposed to proton beam
  - Continuing work at the test beam on their DAQ



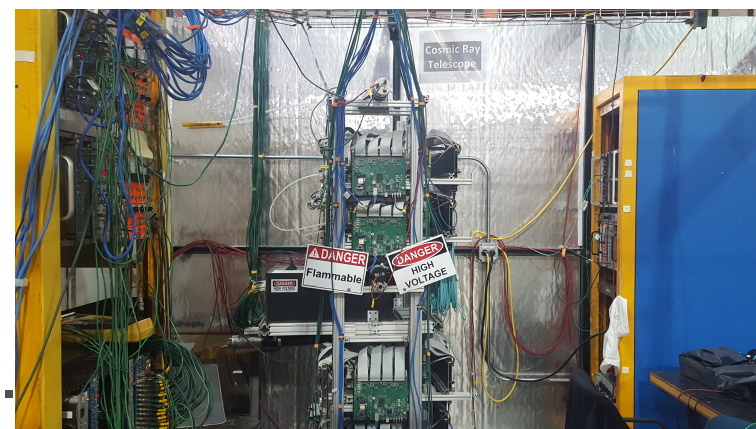
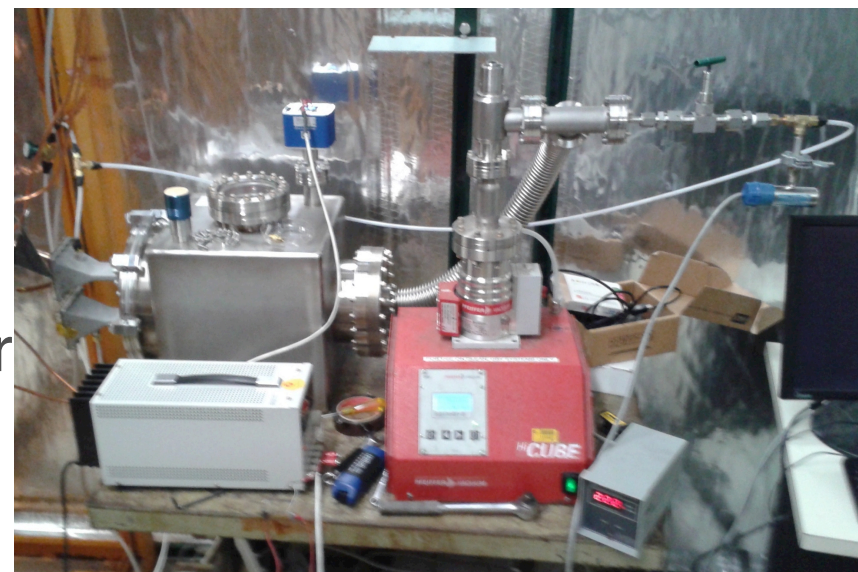
# Neutrino Physics

- LArIAT (T1034)
  - Continued their physics programs
  - Will run until summer shutdown
  - Publication in progress
- pLAPPDs for ProtoDUNE (T1075)
  - Short test at the end of summer to measure efficiency, timing, and position resolution
  - Will continue to test in MCenter, MTest and also the cosmic telescope



# Non Beam users

- Rate of Rise test for g-2 (T1042)
  - Testing the rate of rise in straws
  - Didn't need the beam, needed our flammable gas
- Cosmic ray telescope working
  - Users testing pLAPPDs
  - Testing a calorimeter prototype
- Mu2e continuing to develop DAQ system for use in future Mu2e runs.



# FY17 and Beyond Plans

- FY17 we still have weeks available for users
  - Will take 2 weeks for the EDIT school
  - 5 weeks for nuclear physics program
  - T1041 will put in request for beam
  - T1043, T992, T1068 are all returning
  - 2 new users so far
  - Fully expect more groups to come though
- MCenter is becoming a useful 2<sup>nd</sup> test beam. Mostly supporting longer term neutrino tests
  - NOvA blocks being installed
  - Recent meeting between interested groups to discuss plans and timeline: <https://indico.fnal.gov/conferenceDisplay.py?confId=13042>
- Will focus on DAQ and analysis software this year

# Projected use at the Test Beam over Three Years

- HL-LHC:
  - CMS ~ 16 wks/ year
  - ATLAS ~ 2 wks/year
  - EIC upgrades ~ 9 weeks/year
  - Neutrino general R&D: 2wks/year
  - **Total: 29wks/year**

Does not include any planning based on LS2 at CERN

- **Experiments:**
  - IceCube: 2-3 weeks in 2017
  - Water based liquid scintillator:
    - 15 months over the next 3 years
  - Hadron production with emulsion detectors:
    - 2-3 months / year over the next 3 years
  - LArIAT: 2-3 weeks /year after running for 5 months in FY17
  - **Total: 22weeks/year**
- **Projects:**
- Mu2e and g-2 about 2-3 weeks/year
- Sporadic use by LBNF groups (1 week/year)

About 56 weeks total per year,  
normally we have about 36  
weeks of beam time

# Projects: DAQ

- No clear winner when asked among groups
  - Art DAQ possible
  - MIDAS was chosen, but not ideal
- Reaching out to groups at the lab to come up with universal solution
  - Create packets that easily assimilate into anyone's DAQ system
  - Also allows facility to take data
  - Meeting later this week to discuss options with possible collaborators

# Projects: Analysis Software

- D. Jensen has put a lot of work and effort into G4Beamline and analysis code for the Cherenkov, wire chambers, and lead glass detectors
- G4Beamline needs documenting, but could be used by experimenters
- Analysis code needs work
  - Will be the priority this year
- Monitoring
  - Some monitoring tools exist that show counters and time until the next spill
  - Will work with computing division to add more information during the year.

# Manpower at the Test Beam – Current Situation

- Two of our longtime technicians retired
  - One had been part of our group
  - One was “on loan” when we could get his help
- One of our staff has gone to part time status
  - Possibly another staff member will go to part time status in the coming year.
- Two members were transferred to another group indefinitely
  - One had mechanical experience
  - One had programming experience
- Left with 3 full time people and 1 part time person
  - Of that group, we have non overlapping skill sets.
    - Reduces how much work can be done in programming tasks, for example
- Generally able to call on DDOD when we need immediate help, but not for long term projects and at the discretion of the management

# FTBF Budget

- FY17 M&S is 55k
  - Consists of operating costs
    - Gases
    - Computer licenses
    - Computers and peripherals
    - General supplies
  - Some portion used to upgrade electronics
    - Purchased DRS4 boards for ToF and to have as scopes
    - Put in request for HV system (pending)
    - Request for general funds to spend on detector development
      - Such as magnets for spectrometer
      - Crystals for ToF system
- FY17 Manpower: 6.5 FTEs
  - Will be used to help with construction, alignment, electrical engineers as needed for users.

## Prioritized list for FY17

- Continue to develop a DAQ solution
  - Integrate Si Telescope
  - Cost: manpower
- Take existing analysis and simulation code and make more accessible
  - GIT and create packages for users
  - Cost: manpower
- Build Spectrometer (momentum measurements)
  - Cost: manpower and ~4k in materials
- Build ToF (low energy particle identification)
  - Cost: Manpower and ~5k in materials
- Acquire programmable HV unit
  - Cost: 25k (Wiener) and manpower for installation

# Conclusions

- Last year we completed a successful program with 261 users that produced numerous papers and conference presentations
- As a facility, we continued to improve infrastructure, including reducing paperwork
  - Worked on accessibility projects such as simple ways to access Fermilab machines without spending days implementing this at home institutions.
- In FY17 we will
  - Provide an integrated DAQ system
  - Provide analysis tools
  - Finish building ToF and spectrometer
  - Continue to solicit feedback from the community