

# FTBF Committee Report

Peter Wittich  
For the FTBF Committee  
11/11/2016

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Cornell University  
Laboratory for  
Elementary-Particle Physics

# Committee Membership

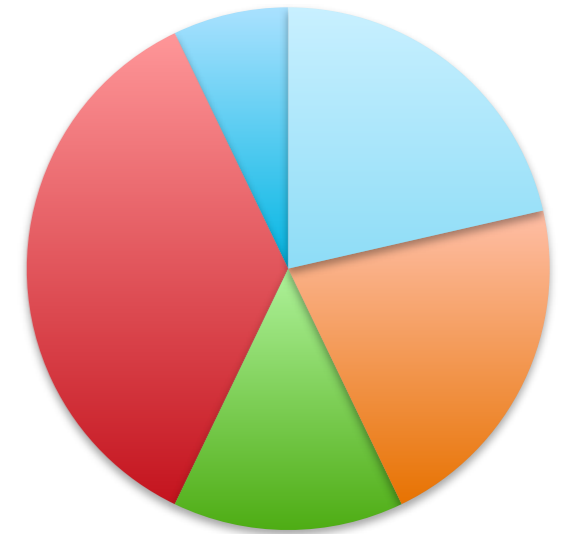
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- Mayly Sanchez (Iowa State)
- Jen Raaf (FNAL)
- Ron Lipton (FNAL)
- Peter Wittich (Cornell)
- Guy Savard (ANL)
- Carsten Hast (SLAC)
- Henric Wilkens (CERN)
- Mandy Rominsky (FNAL, ex officio)
- Membership from the university community, from FNAL and from the ANL, CERN and SLAC test beam leadership.
- Forum for test beam coordinators

# The Fermilab Test Beam Facility

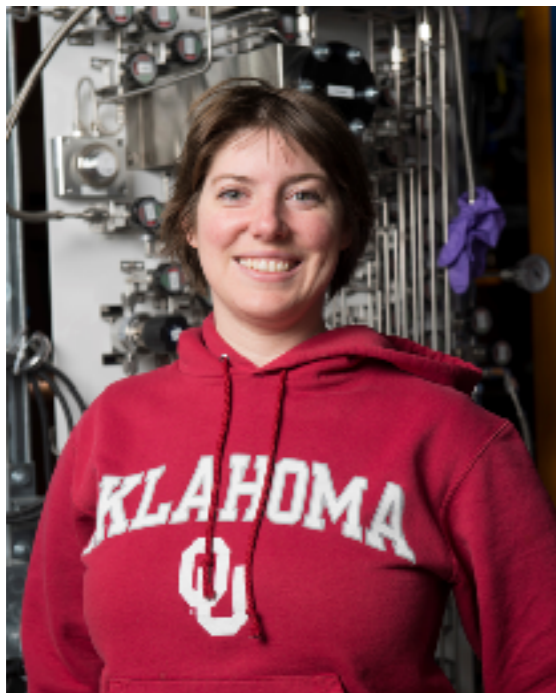
- Since 2005, FTBF has hosted more than 1000 users from 177 institutions and 30 countries
  - Broad range of research topics, not just HEP
- Two beamlines
  - MTest: 120 GeV protons, 2-80 GeV mix
  - MCenter: 200 MeV to 80 GeV mix

● Neutrino  
● Collider  
● Muon  
● Gen R&D  
● Outreach

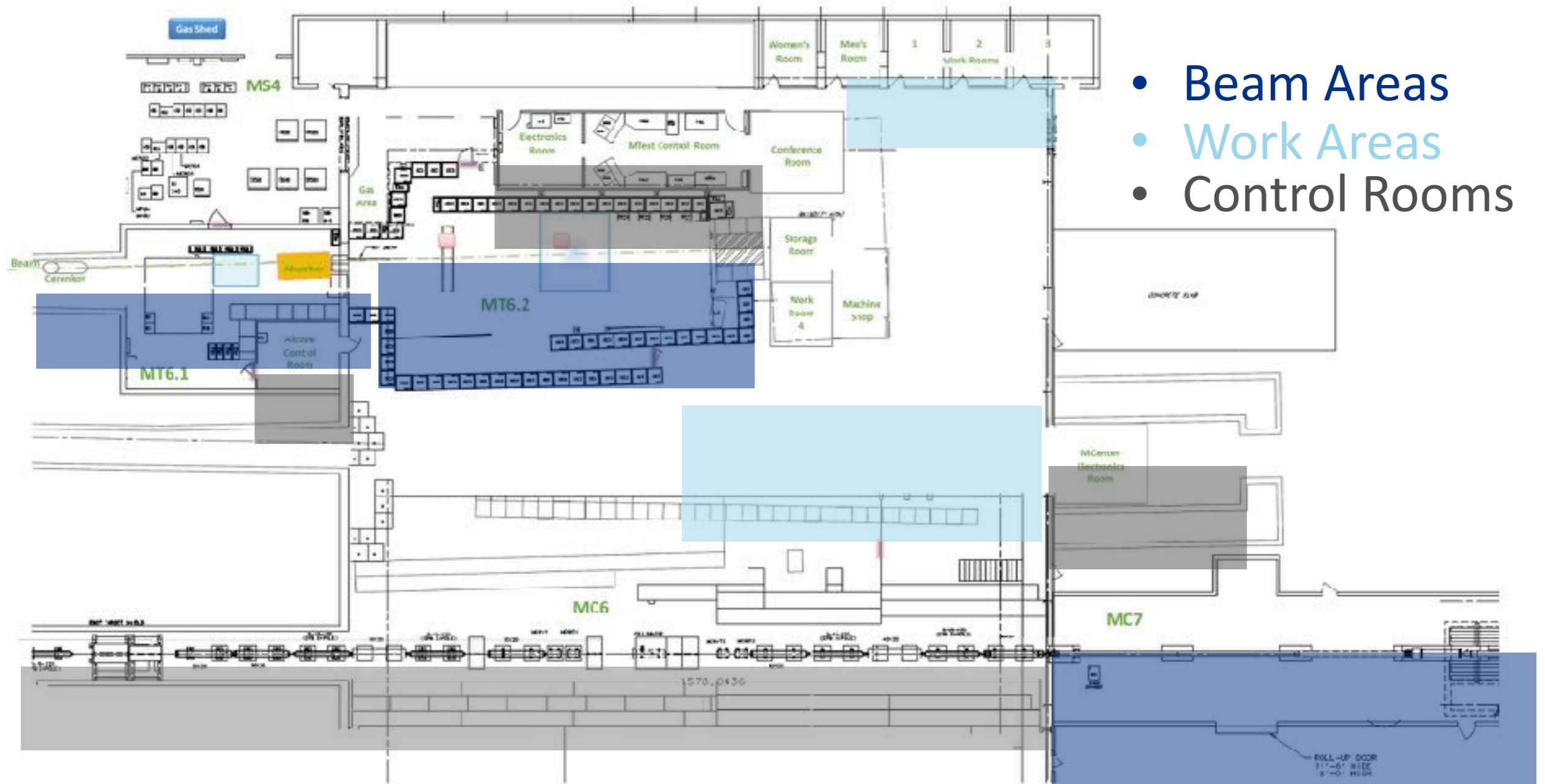


# Core FTBF Staff

- Mandy Rominsky
- JJ Schmidt
- Ewa Skup
- Todd Nebel
  
- Great staff, doing a lot with a little!



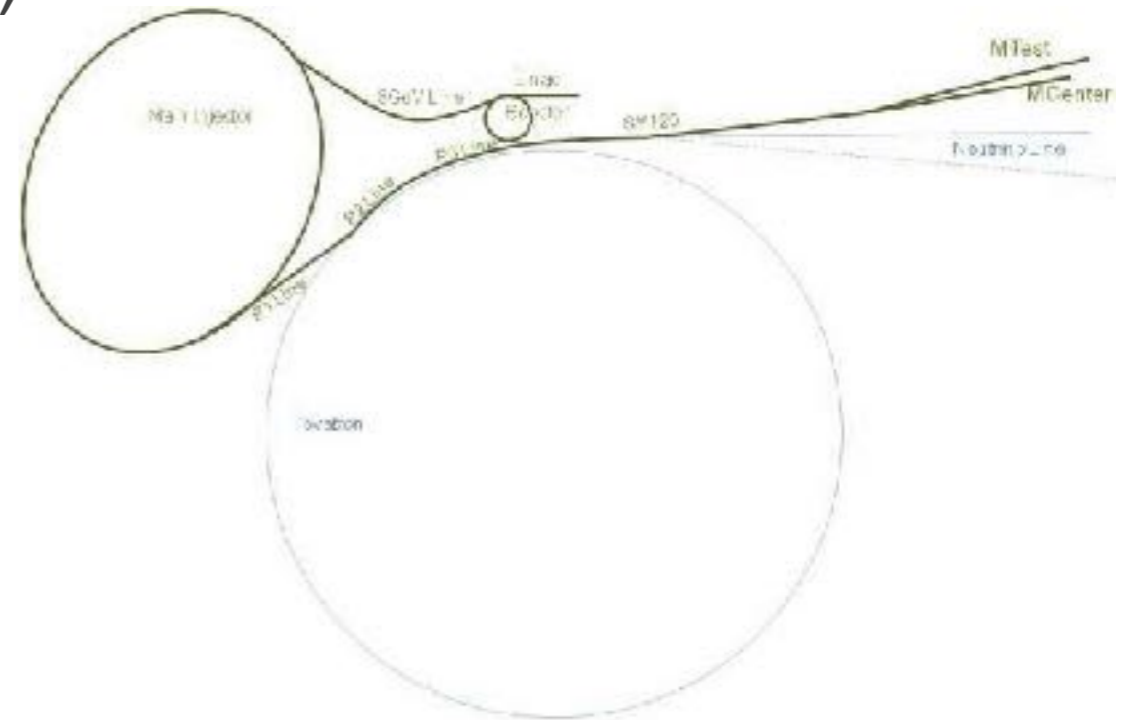
# Facility Layout



- Beam Areas
- Work Areas
- Control Rooms

# Facility beams

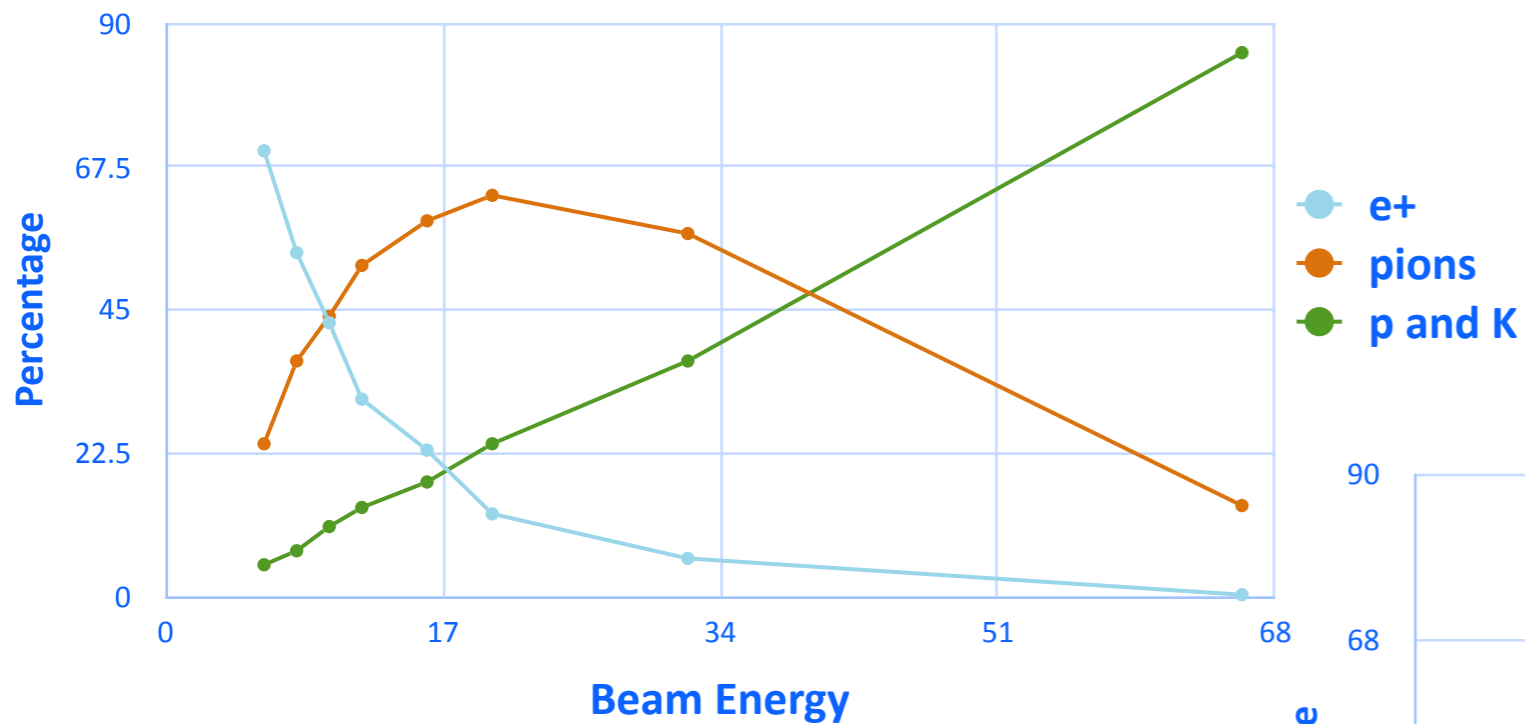
- Full description can be found [online](#)
  - 4 sec spill every 60 seconds
  - Tunable rate (100 Hz – 100,000 Hz)
  - Beam available 24/7
- MTest Beam line
  - 120 GeV protons (primary)
  - 1 – 60 GeV secondary beam
  - Spot size about 2cm
- MCenter Beam line
  - Tertiary beamline down to 200 MeV
  - Currently have cryogenic support for LArIAT (Liquid Argon In A Test Beam)



# Beam Studies: Particle Composition

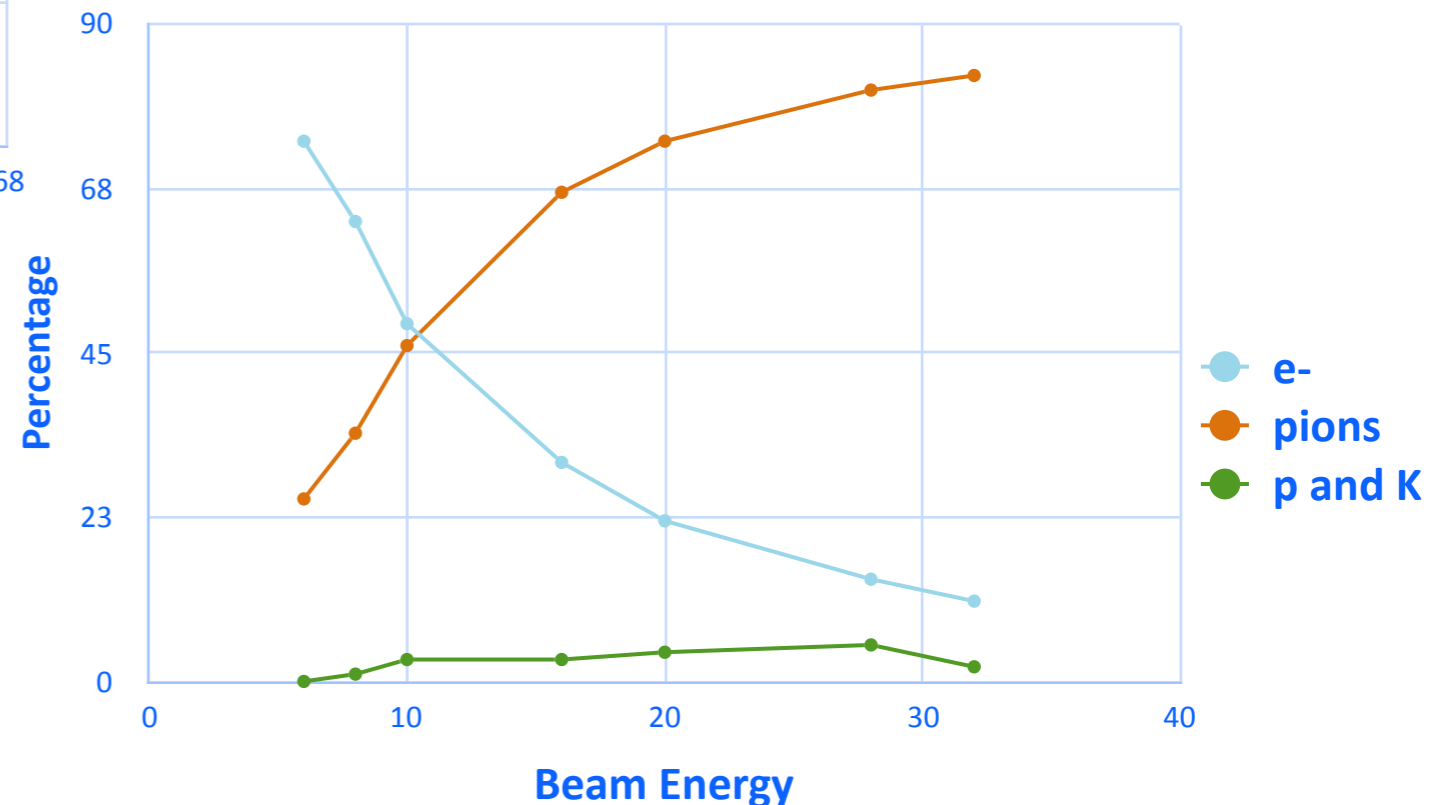
- Beam composition studies – carried out using the Cherenkov detectors ( filled with Nitrogen)

Positive Beams



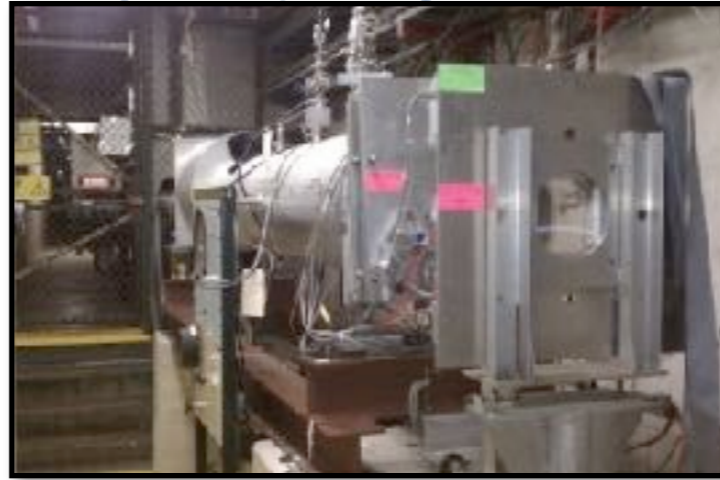
Studies done by E. Skup and D. Jensen

Negative Beams



# Facility Instrumentation

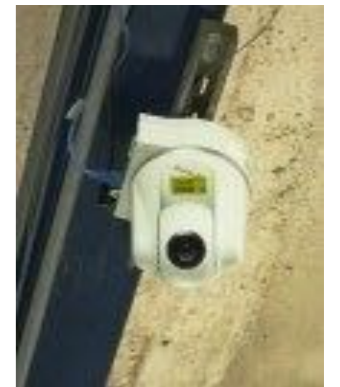
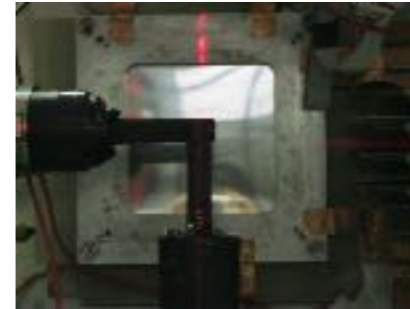
- 2 Cerenkov Detectors
- 1 Pixel Telescope
- 4 MWPC Tracking Chambers
- Lead Glass Calorimeters
- Assorted Trigger scintillators





# Infrastructure at MTest

- ACNET controlled Motion Tables
- Laser Alignment
- Helium Tubes
- Web-based Cameras
- Crane Coverage (30 tons)
- Climate controlled Huts
- Gas Patch panels
- Signal, Network, & High Voltage cable patch panels



# Procedure for Getting Beamline Setup

Active outreach to user community

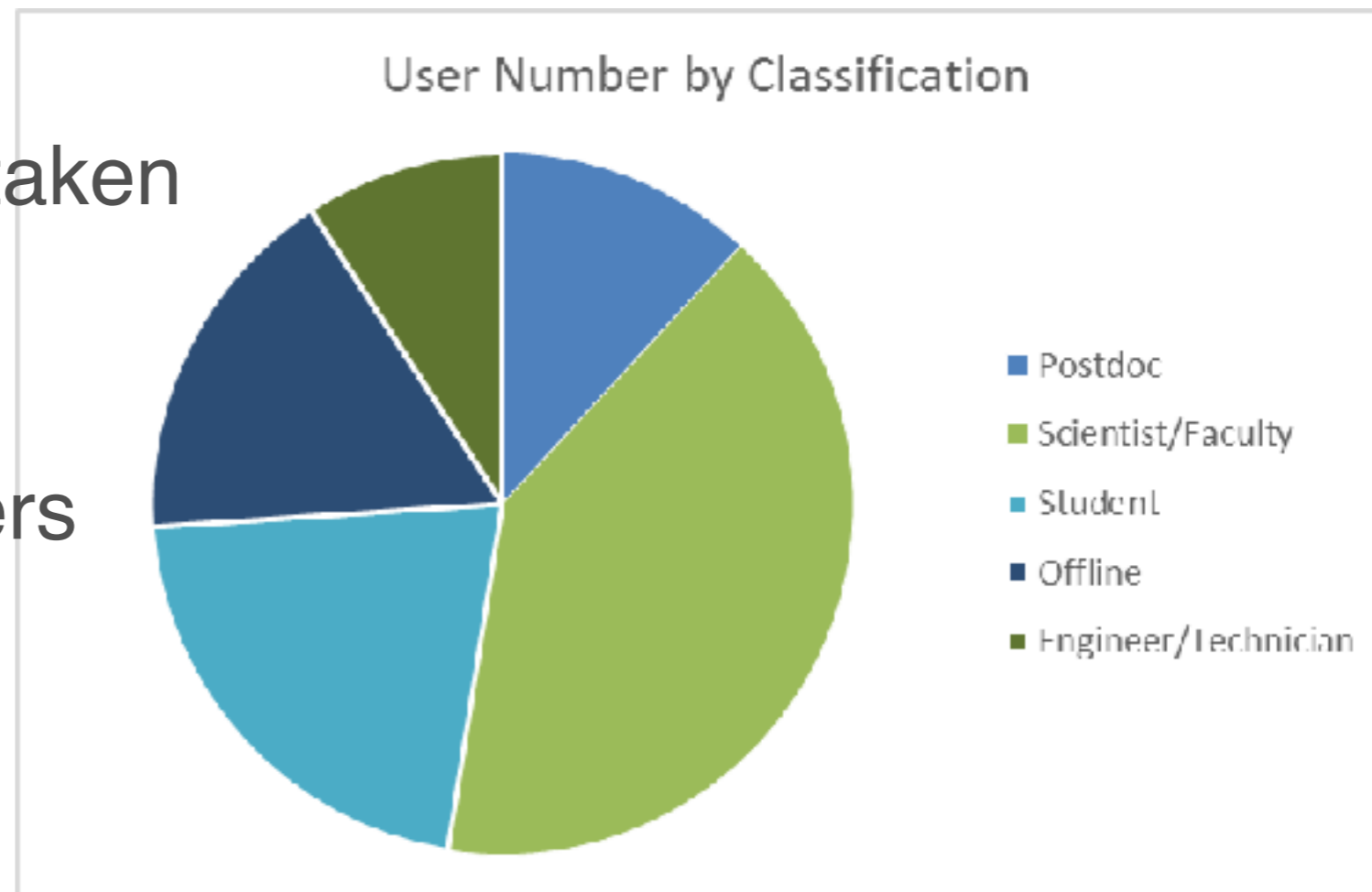
- First step is to write the TSW (Technical Scope of Work) and contact facility manager (me)
  - Agreement between test beam collaboration and the lab over what resources are used.
    - Do you need significant engineering or tech support? Computing support?
    - Will you have enough users to cover your shifts?
  - TSW information can be found here: <http://ftbf.fnal.gov/tsw-how-to-write/>
    - Can be a broad document, cover multiple years and uses
    - Approval process typically takes 4-6 weeks, but can be faster, depending on needs.
  - **My job is to help you with this, don't hesitate to ask**
    - We are currently redoing this process to make it easier on everyone involved. Final product should be out later this year.

# FY16 Users

>1000 users since inception

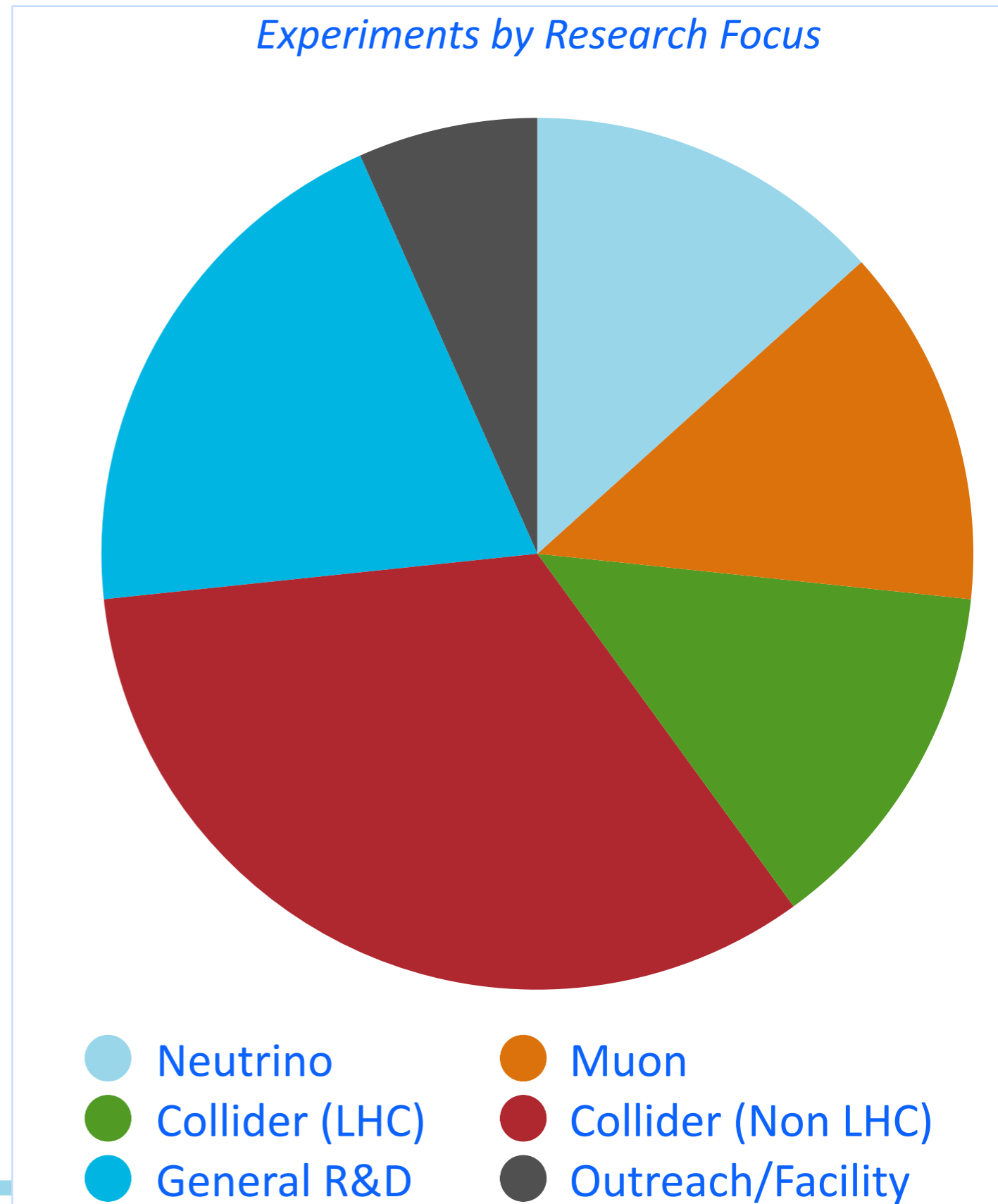
- In FY16, 261 people participated in the test beam.
  - 31 institutions and 6 countries represented
  - Significant number of people look at test beam data off-site than come to the Meson hall
  - Majority of users are senior scientists/faculty members

- 11 publications from data taken
  - 4 more in progress
- 4-5 conference talks/posters



# Who comes to FTBF (FY2016 example)

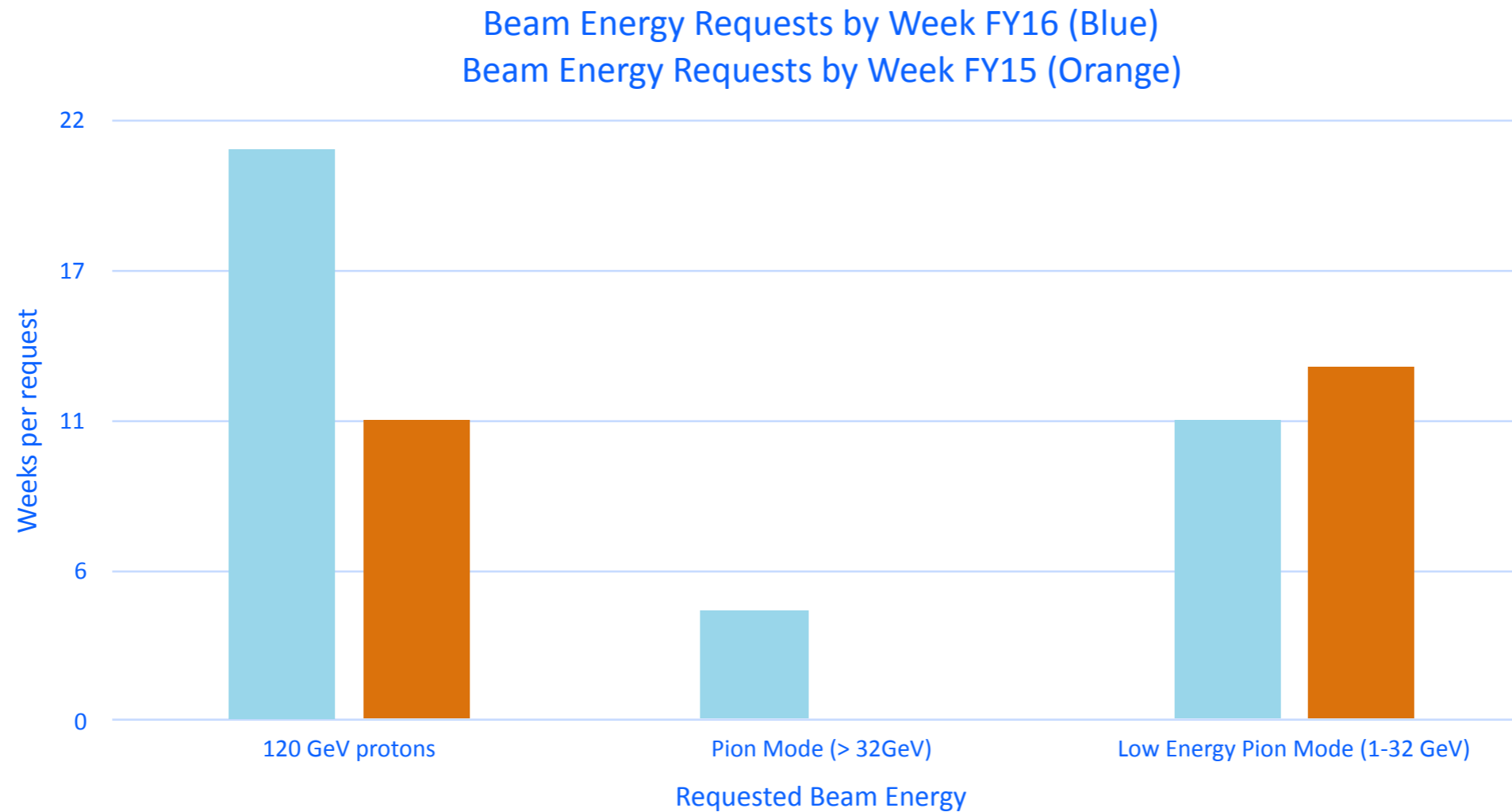
- FTBF supports a broad range of physics topics.
- Groups from ATLAS, CMS, RHIC, general R&D for future colliders, LAr program
- Future will include more neutrinos (NOVA)
- Novel uses of the test beam (muon strip detectors)
- Even some non-beam users
  - Cosmic telescope
  - g-2 (for flammable gas)



# What beams do users need?

uniquely at FNAL in US

- *About half of all requests are for 120 GeV protons*
- Majority of the rest are for low energy pion mode beam



# FY16 experiments at FTBF

a sample

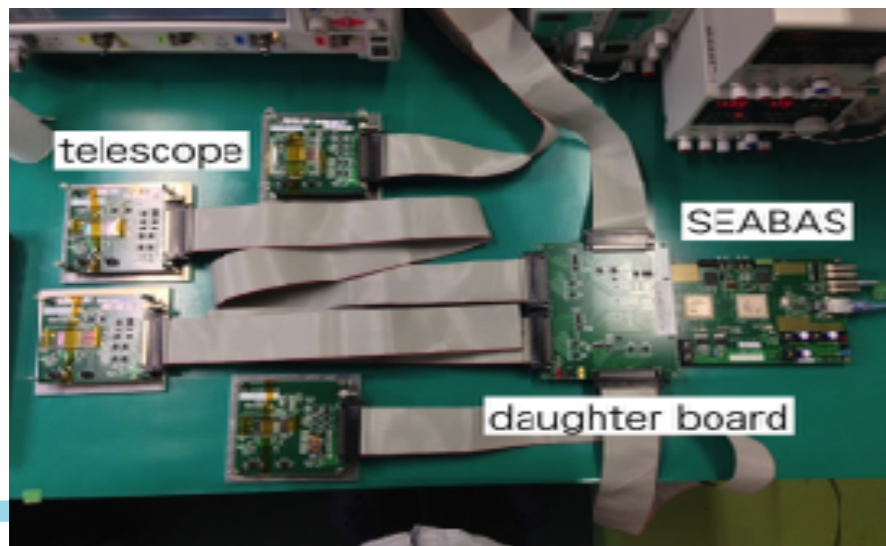
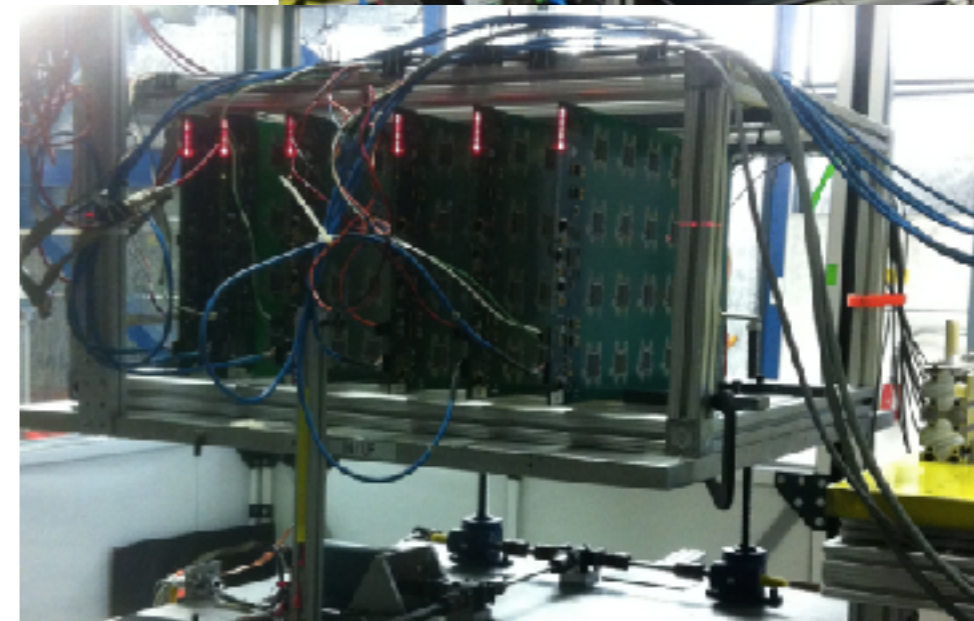
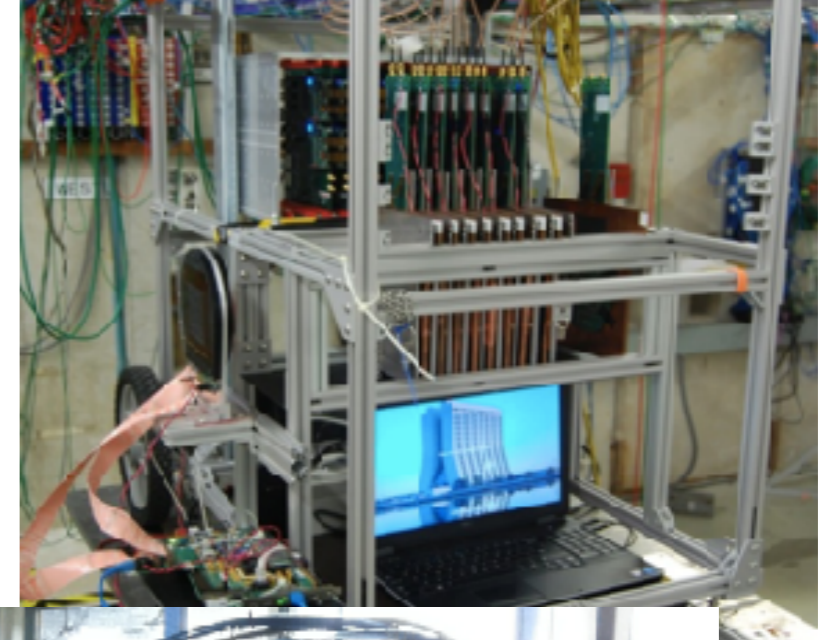
## FY16 in Review

- 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
  - Snuck in more users last-min
- FTBF was fully booked, still able to accommodate last minute groups by doubling up
- Used about 6 weeks total for beam studies and repairs

T1041	CMS Forward Calorimetry R&D
T0992	Rad-hard Sensors for the HL-LHC
T1015	Dual Readout Calorimetry with Glasses
T1065	Secondary Emitters Study (g-2)
T1068	Beam Tests of the SVX4 Telescope
T1043	Mu2e Cosmic Ray Veto Detector
T1044	sPHENIX Calorimetry Tests
T1048	EIC PID (eRHIC)
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

# LHC studies

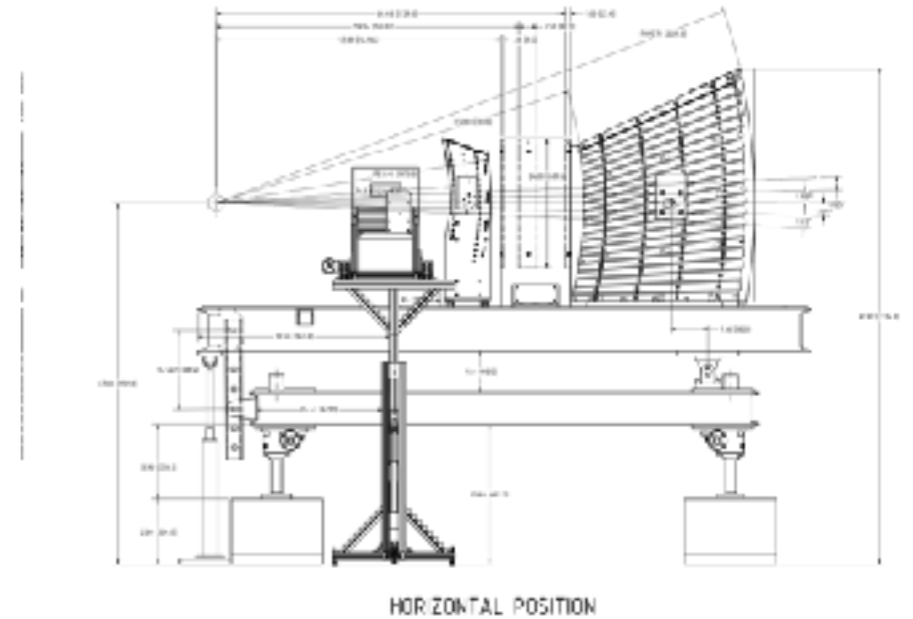
- CMS (T992, T1041)
  - T992: Testing rad hard sensors for the HL-LHC
  - T1041: Multiple groups testing calorimeters and testing resistive plate chambers
- ATLAS (T1068)
  - Testing telescopes for future radiated samples tests
  - Have runs scheduled in FY17





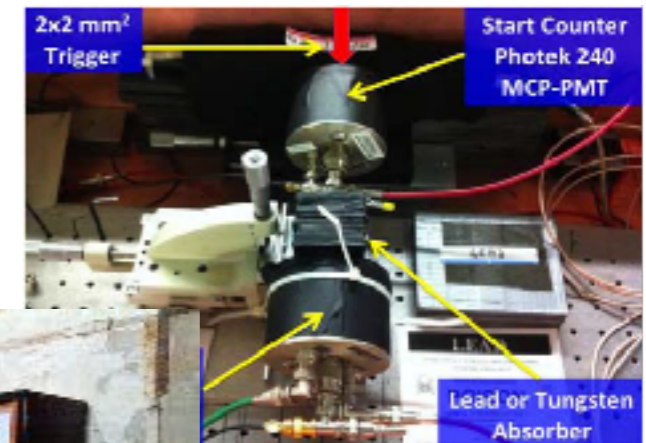
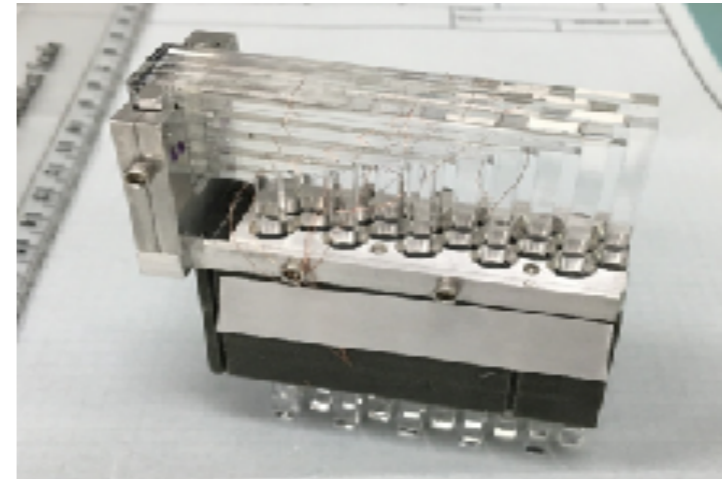
# Collider studies – non LHC

- sPHENIX (T1044)
  - Large group testing calorimeter for RHIC
  - Will continue to use test beam over the next few years
- Electron-ion Studies (T1037, T1048, T1018) - eRHIC
  - T1048 studying 3 ToF detectors to determine which is best suited
  - T1037 studying combination of TPC and Cherenkov detector
  - T1018 exploring W powder SciFi calorimeters



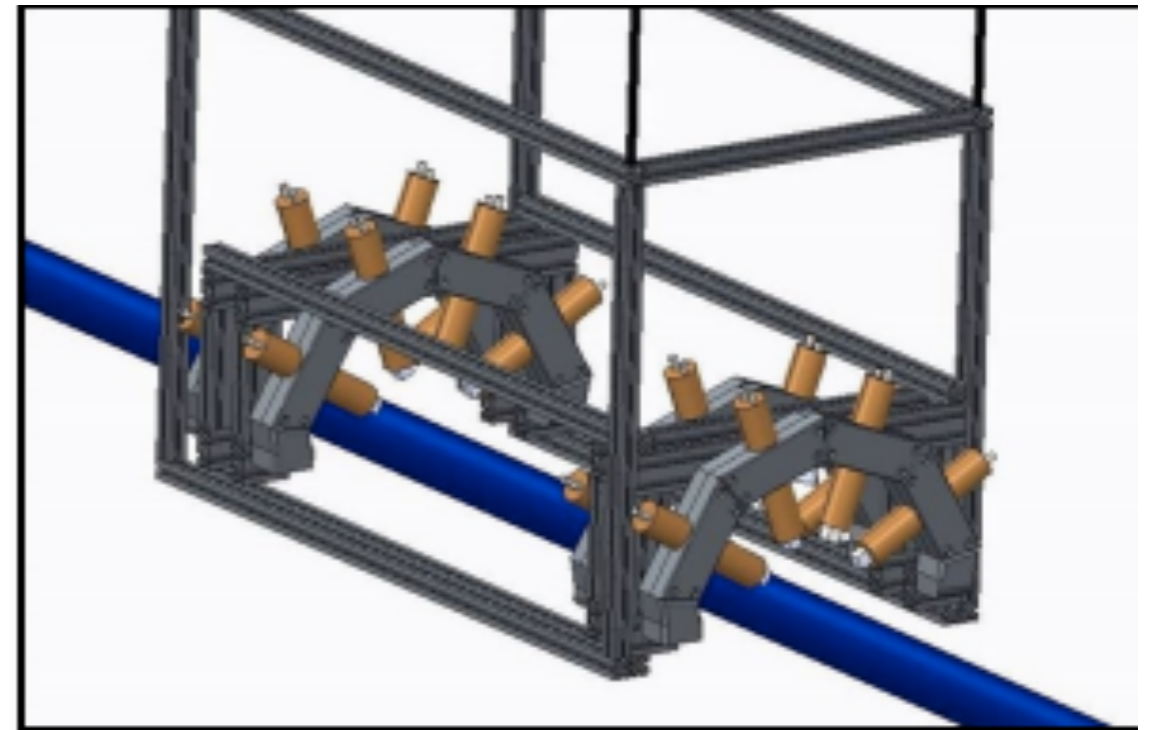
# General R&D

- 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



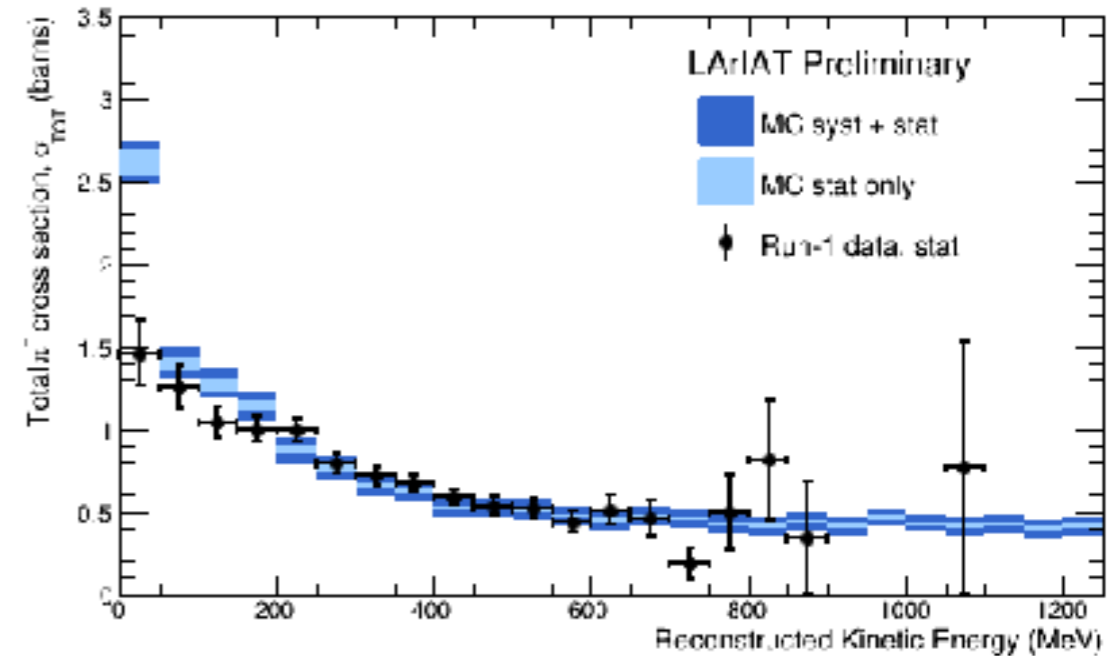
# Muon Physics

- 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



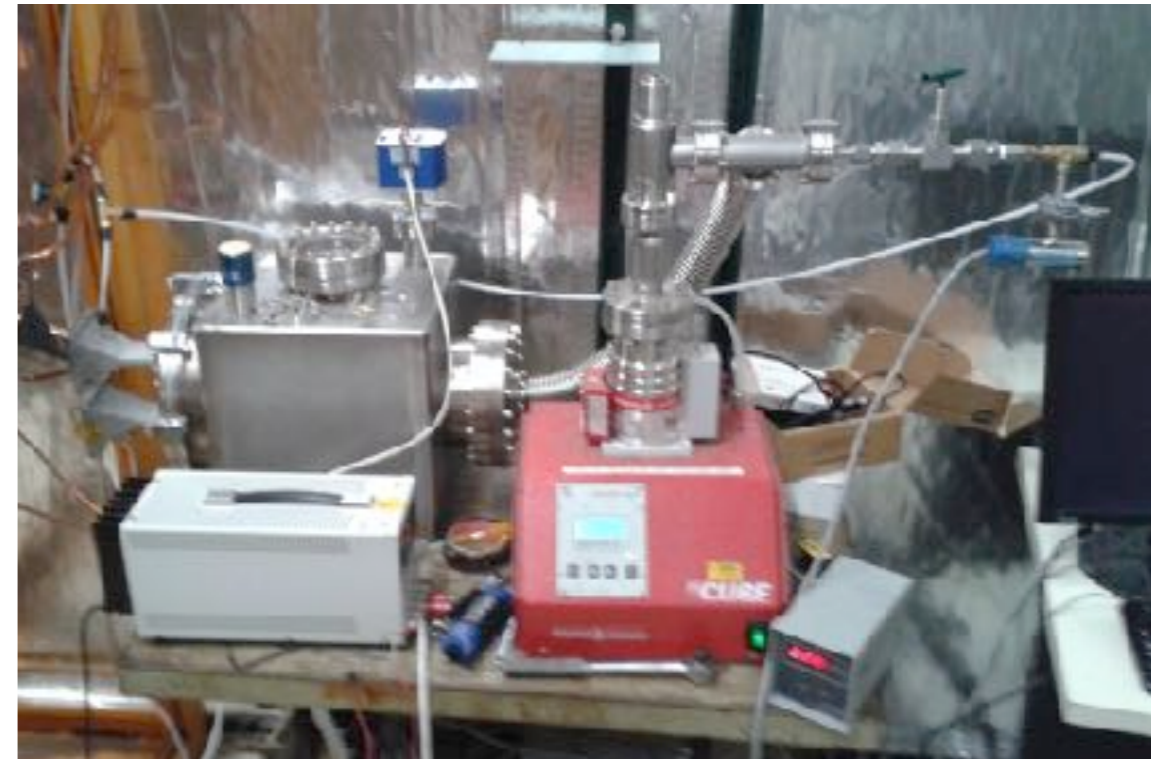
# Neutrino Physics

- 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.



## Recent Improvements of the facility

- Staff has made major upgrades to the facility in the last years
  - Si tracking telescope can now be used
  - central DAQ being developed for turn-key operation (MIDAS chosen)
  - VMs for users distributed to ease access to FNAL facilities
  - Beamline Geant4 model under development for users
- Future
  - event-by-event momentum measurement (spectrometer)
  - TOF for PID
  - Programmable HV system

# Projected use at the Test Beam over few Years

- HL-LHC:
    - CMS ~ 16 wks/ year
    - ATLAS ~ 2 wks/year
    - eRHIC upgrades ~ 9 weeks/year
    - Neutrino general R&D: 2wks/year
    - **Total: 29wks/year**
  - **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: 22 weeks/year**
  - **Projects:**
    - Mu2e and g-2 about 2-3 weeks/year
    - Sporadic use by LBNF groups (1 week/year)
- Need to coordinate for CERN shutdowns
- About 56 requested beam-weeks total per year, normally we have about 36 weeks of beam time

# Committee Feedback

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- Committee has worked with FTBF staff since 4/2014
- Settled to a rhythm of annual meetings
- Consistently, the *committee is impressed with what the facility provides to the user community at low cost and low impact to FNAL resources*
  - “[FTBF] is a **valuable resource** for the HEP community. It provides a US-based facility for developing new detectors, which is used by many in the HEP community, including parties not otherwise heavily represented at FNAL (e.g., ATLAS and PHENIX collaborations.)”
- Continued evolution of the facility in the last years
  - Better understanding of the beams and user needs
  - Improved, streamlined approvals process (users and for staff)
  - Upgraded facilities (Si Telescope)
- With ***minimal additional resources***, could better serve the community
  - More dedicated physicist labor
  - M&S budget for upgrades



# Community Support

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- In the context of the annual review, we received letters of support from **mu2e**, **CMS**, and the **sPHENIX** collaborations
  - The FTBF is “**essential for the first stages [of the CMS HGCAL program] and will be very important for [CMS] in the immediate and long-term future**,” according to CMS collaborators Jim Freeman, Roger Rusack and Dave Barney. Additionally, “the results of [tests at the FTBF] will be essential for the [CMS HGCAL] Technical Design Report that [CMS] will submit to the LHCC in late 2017.”
  - The PHENIX letter, by Joh Haggerty, Eric Mannel, and Craig Woody, of BNL, states that “**[PHENIX] ... will continue to rely on the availability of test beams at FTBF to test our prototype detectors.**”
- NOVA submitted a letter of intent to use the FNAL test beam to help reduce its systematic uncertainties. M. Messier and P. Shanahan write that
  - “a charged-particle test beam run will be **key to minimizing the systematic uncertainties associated with non-linearity of scintillator response, hadronic and electromagnetic absolute energy scales, and charged particle signatures.**”

## Roadmap/future users/cross-facility dialogue

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- With the HL-LHC upgrades on the horizon and the LS shutdowns at CERN, we anticipate many users of the FTBF facilities in the coming years
  - FTBF is working with CERN to ensure we have a coherent plan
- Staff has established contact with test beam staff at SLAC, CERN and ANL
  - Learn best practices and cross-fertilize ideas
  - understand the landscape of beams across the community

## FY 2016 test beam publications to date

### Listing of Test Beam Publications

1. *Test Beam Studies of Silicon Timing for Use in Calorimetry*. A. Apresyan, G. Bolla, A. Bornheim, H. Kim, S. Los, C. Pena, E. Ramberg, A. Ronzhin, M. Spiropulu, and S. Xie. NIM, A825 (2016) 62–68.
2. *High time resolution photo-detectors for PET applications*, Anatoly Ronzhin, invited by NIM editor article, Special Medical Edition. NIM, A809 (2016), 53-57.
3. *Direct tests of micro channel plates as the active element of a new shower maximum detector*, A. Ronzhin, S. Los, E. Ramberg, A. Apresyan, S. Xie, M. Spiropulu, H. Kim. NIM, A795 (2015), 52-57.
4. *Study of the timing performance of micro channel plate photomultiplier for use as an active layer in a shower maximum detector*, A. Ronzhin, S. Los, E. Ramberg, A. Apresyan, S. Xie, M. Spiropulu, H. Kim, NIM, A795 (2015), 288-292.
5. *A feasibility study of a PET/MRI insert detector using strip-line and waveform sampling data acquisition*, H. Kim, C.-T. Chen, N. Eclov, A. Ronzhin, P. Murat, E. Ramberg, S. Los, Alice M Wyrwicz, Limin Li, C.-M. Kao, NIM, A784 (2015), 557-564.
6. *On Timing Properties of LYSO-based Calorimeters*, D. Anderson, A. Apresyan, A. Bornheim, J. Duarte, C. Pena, A. Ronzhin, M. Spiropulu, J. Trevor, S. Xie, NIM, A794 (2015) 7–14.
7. *Precision timing measurements for high energy photons*, Dustin Anderson, Artur Apreysan, Adi Bornheim, Javier Duarte, Harvey Newman, Cristian Pena, Anatoly Ronzhin, Maria Spiropulu, Jason Trevor, Si Xie, Ren-Yuan Zhu, NIM, A787 (2015) 94–97.
8. *Development of a new fast shower maximum detector based on microchannel plate photomultipliers (MCP-PMT) as an active elements*, A. Ronzhin, S. Los, E. Ramberg, A. Apresyan, S. Xie, M. Spiropulu, H. Kim, A. Zatserklyaniy, NIM, A759 (2014), 63-73.
9. *Status of ADRIANO R&D in T1015 Collaboration*, C. Gatto et al. 2015 J. Phys.: Conf. Ser. 587 012060.
10. *Preliminary Results from a Test Beam of ADRIANO Prototype*, C. Gatto et al. 2012 J. Phys.: Conf. Ser. 404 012030

# Conclusion

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- FTBF is a valuable resource for the HEP community and beyond
  - neutrino, collider all use this facility
  - Critical for the construction of new projects and improvement of science of critical lab projects
  - Science is also being done with this beam
- Important to continue to support this project
  - Neutrino community, HL-LHC, eRHIC are counting on it

# Committee Charge

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The testbeam facilities at Fermilab are a valuable resource for the HEP community. In the past it has been customary to approve all test beam experiments that have scientific merit. However, the Fermilab testbeam facilities **have become oversubscribed**, making it necessary to **make programmatic choices**, which may determine which experiments run, the beam-time they get, and the order in which they run.

The committee is asked to give advice to the Fermilab Directorate on the programmatic choices needed to optimize both community use of the testbeam facility and its scientific impact. The committee chair is expected to **define**, in consultation with the Testbeam Coordinator, **what decisions are needed** and on what timescale.

The committee should meet as needed, and produce a brief **bi-annual report** documenting the advice. The report should be submitted to the Office of Program Planning. The Testbeam Coordinator will use the advice to guide week-by-week scheduling decisions.

Although the primary purpose of the committee is to give programmatic advice, the Directorate will welcome other comments about **utilization of the facility and the need for enhancements**.