



Fermilab Test Beam and Irradiation Facilities

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Fermilab Users Meeting

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Introduction

- Fermilab Test Beam Facility (FTBF) – Supports a wide program of research and detector R&D
 - 2 Beamlines (MTest and MCenter) – can provide particles from 120 GeV protons to secondaries of ~ 200 MeV
- Irradiation Test Area (ITA) –
 - Low energy (400 MeV protons), high rate ($\sim 2.2 \times 10^{15}$ protons/hr)
- Beam is available ~ 8 months a year (roughly November through June)



Where are FTBF and ITA?



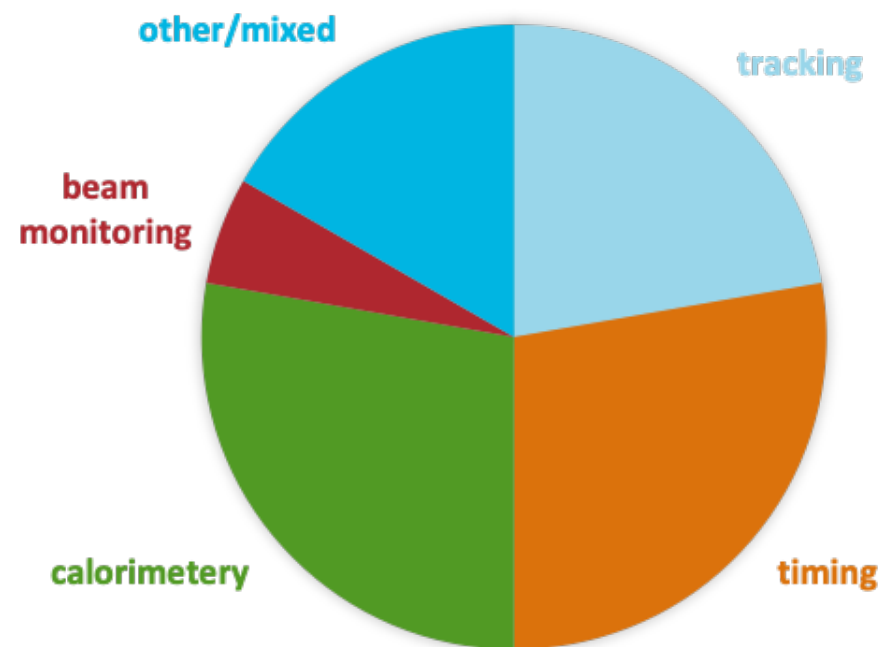
FTBF –
Meson
Detector
Building

ITA –
Irradiation
Test Area

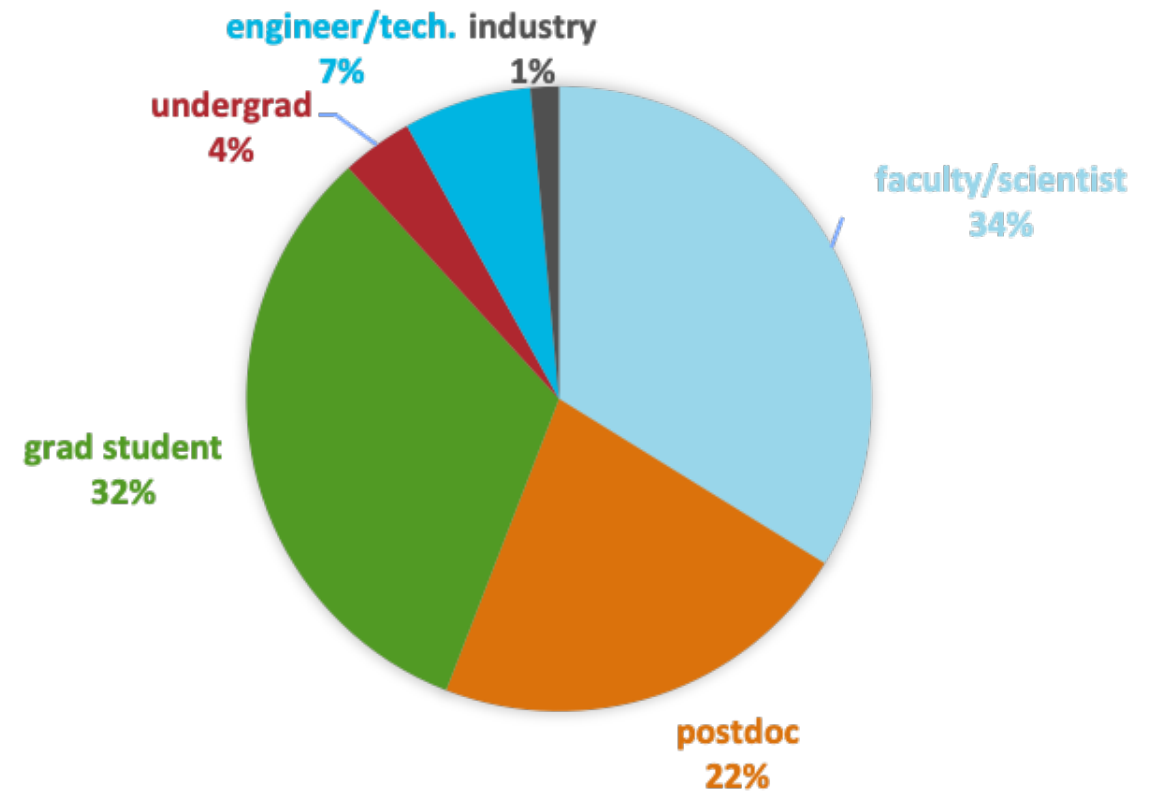
Who uses FTBF?

- 160 users from 18 different experimental efforts in FY22
- 18 Experimental efforts, 4 new efforts

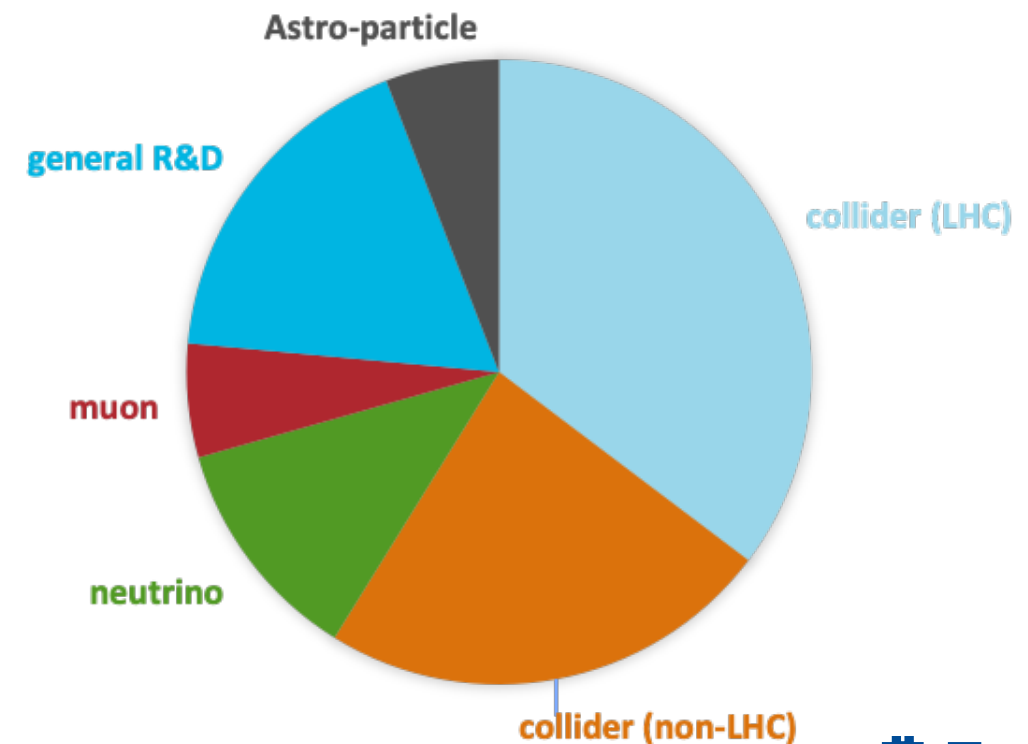
Experiment by detector



Users by professional category



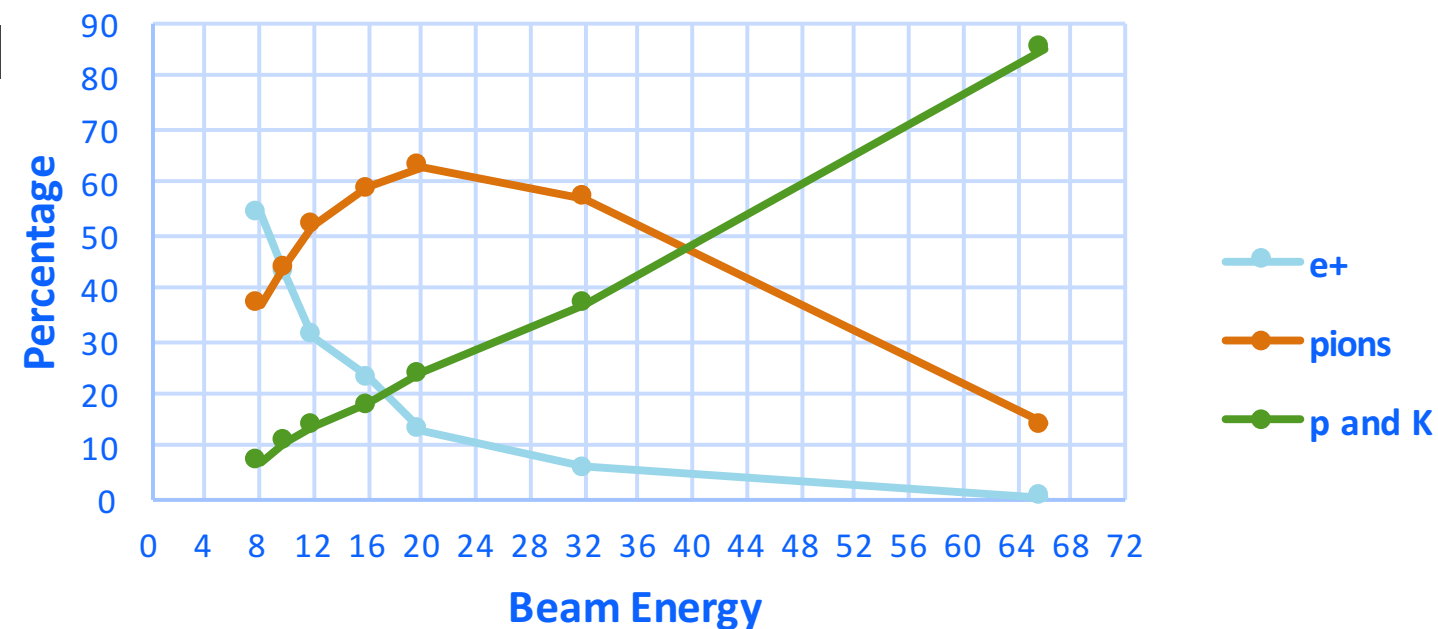
Experiment by research focus



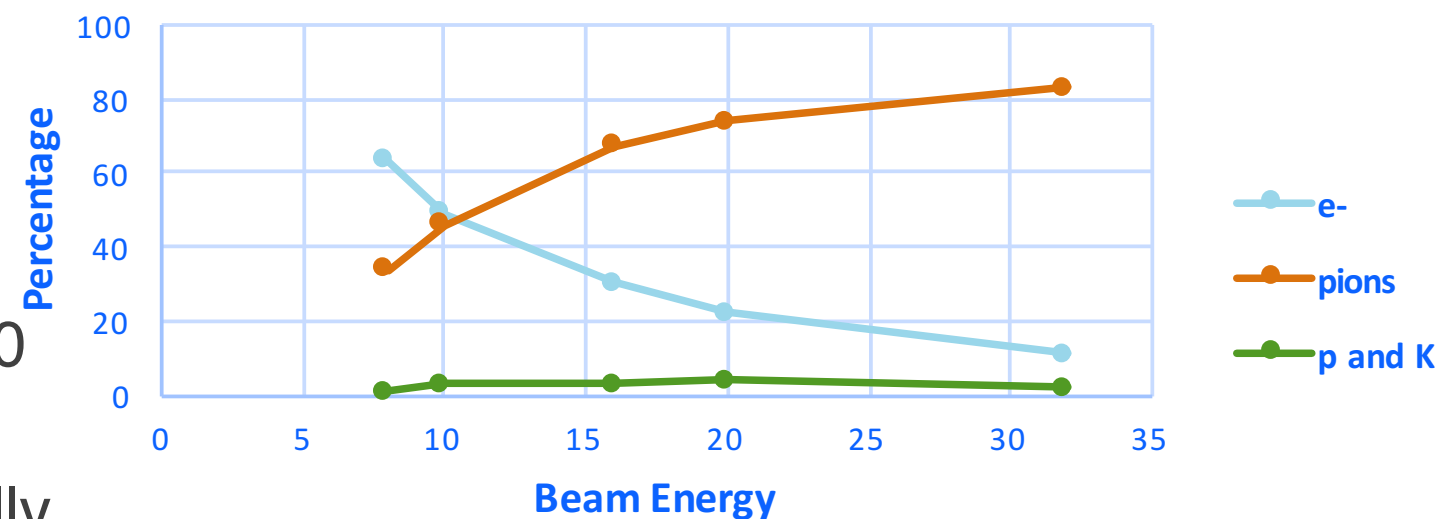
Beam Details

- 4 second slow extraction beam spill every 60 seconds from Main Injector
- ~1000 to 900,000 particles per spill
- MTest
 - 120 GeV primary protons
 - 1-66 GeV secondary beam
 - ~2cm spot size
 - typically 1-4 week runs
- MCenter
 - Secondary beam
 - Two tertiary beam stations down to 200 MeV
 - Refurbished large aperture magnet Jolly Green Giant
 - Longer term experiments

Positive Beams Composition, Open Collimators 2016



Negative Beams Composition, Open Collimators 2016

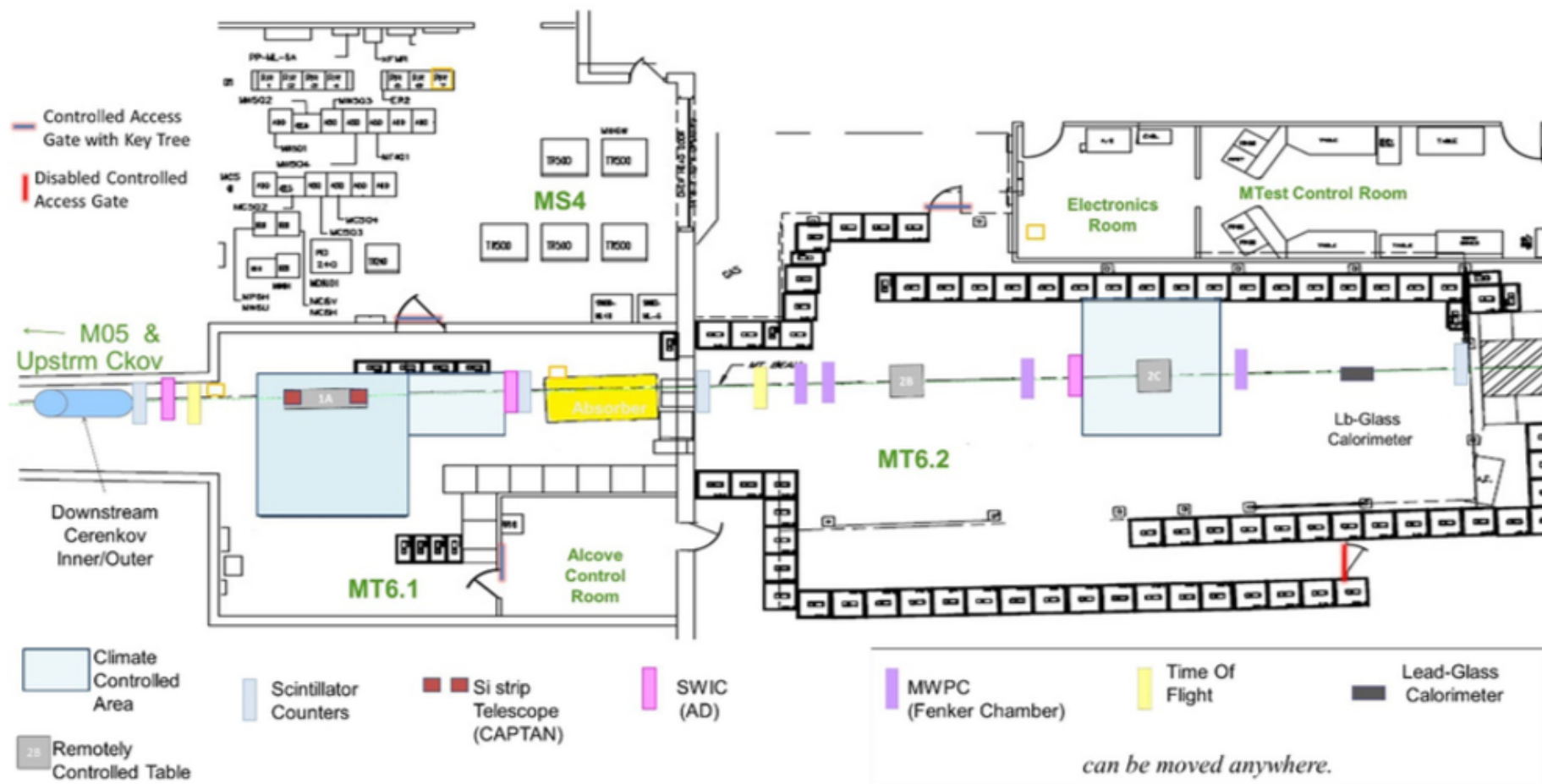


<https://ftbf.fnal.gov/beam-overview/>

FTBF Layout



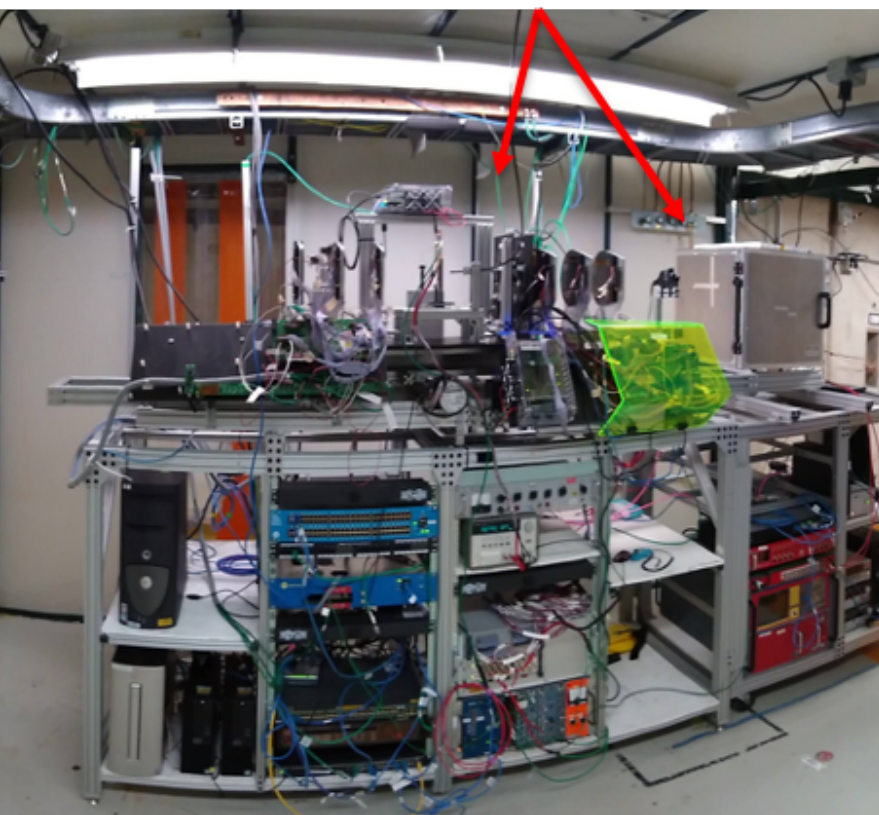
Instrumentation Layout - MTest



Experiments at MTest

- FY23 MTest users have included experiments from the CMS, ATLAS, EIC, neutrino, and general R&D communities

CMS timing
ATLAS pixel
Redtop calorimeter
Nanowire tracking
CMS timing
RPC timing
Facility LAPPD



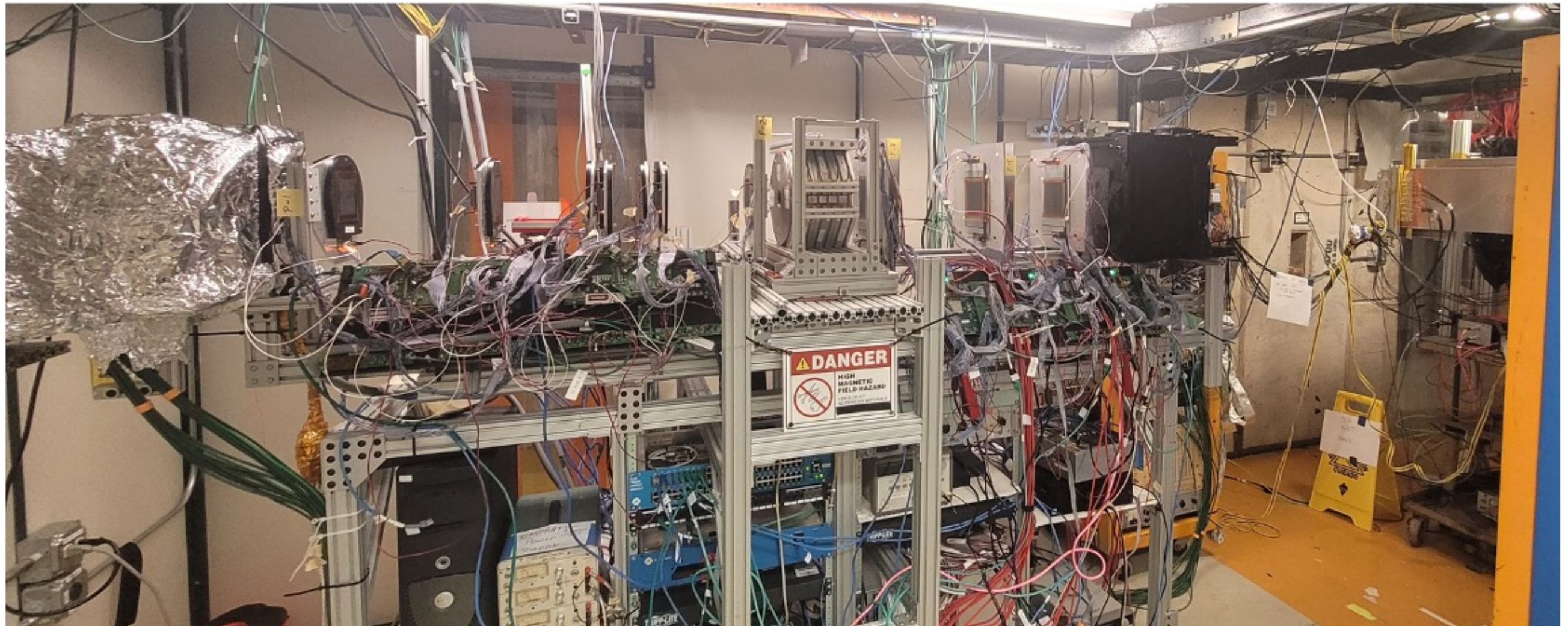
MT6.1



MT6.2

Experiments at MTest

- EMPHATIC experiment
 - Small scale experiment measuring hadron interaction cross sections to improve systematics on neutrino measurements



MCenter Activities

- “Jolly Green Giant” magnet has been refurbished
 - 0.7 T magnet field
 - Large Bore ($> 1\text{m}$ diameter)
- Two new detectors in progress in MCenter for DUNE R&D
 - TOAD: High pressure gas TPC with MCPs will be tested
 - Commissioning underway
 - ArCS: liquid argon TPC will be operated in the Jolly Green Giant magnet
 - Planning for FY24
- Next phase of EMPHATIC with NuMI horn and target being planned for MCenter



Irradiation Facility

- Counting house in service building next to beam enclosure.
 - Set of $\sim 50'$ penetrations connect the two spaces for cabling.
- Beam line is approved for a maximum intensity of $2.7e15$ particles per hour per the current shielding.
 - Typical rates are around $2.2e15$ particles per hour
- Number and duration of individual pulses has some adjustment
- Nominal beam spot is a ~ 1 cm 1 sigma 2D gaussian



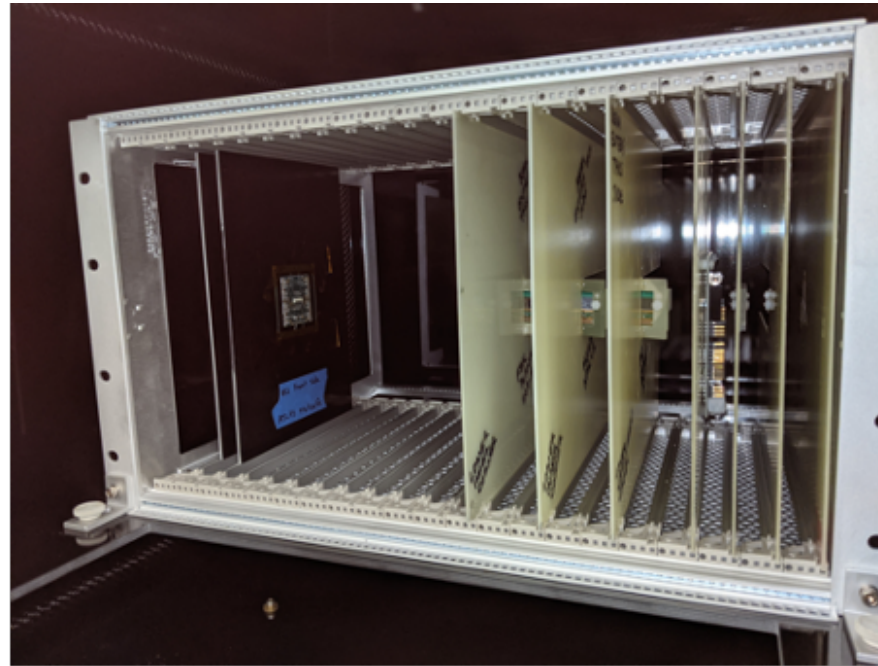
Experimental Hall



Irradiation Infrastructure



Photo courtesy Abhishek Bakshi



Very first samples from CMS and ATLAS ready for irradiation. Photo courtesy Corrinne Mills



Photo courtesy Todd Nebel



Irradiation Experiments

- Current demand from CMS and ATLAS upgrade projects to measure radiation effects of detector components
- Passive irradiations to measure total ionizing dose (TID) and non-ionizing energy loss (NIEL) and active testing of electronics

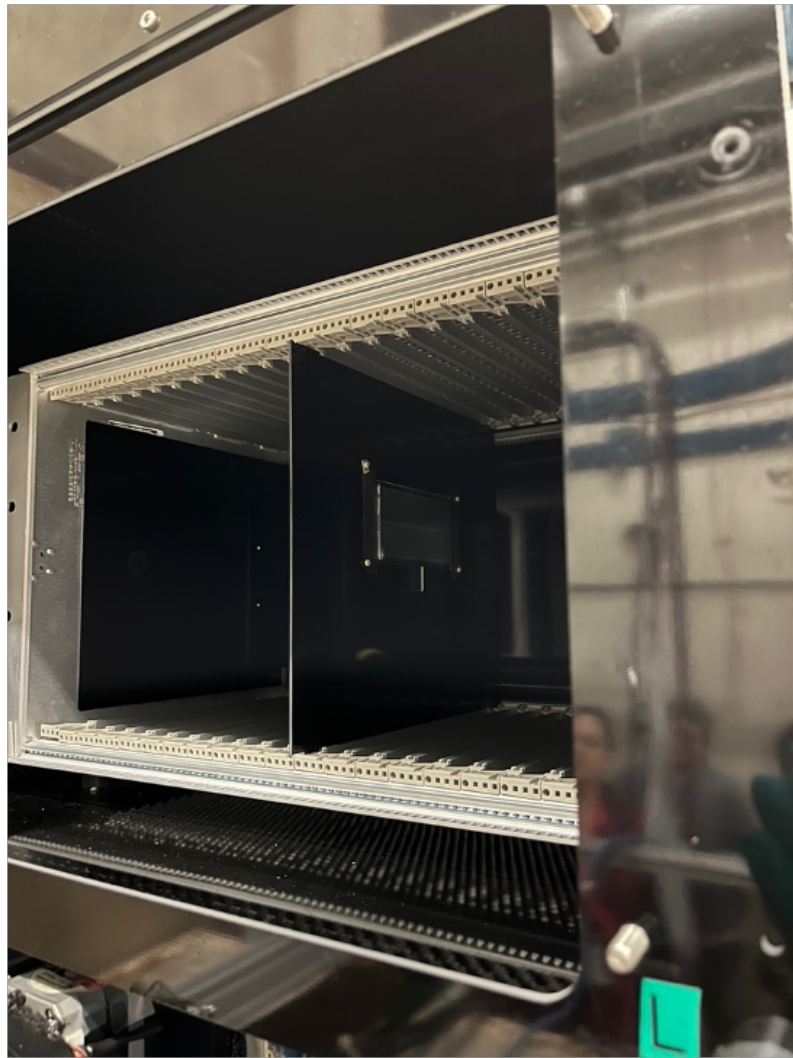


Photo by Jennet Dickinson



CMS ECON-T ASIC irradiation. Photo courtesy D. Noonan (FNAL).

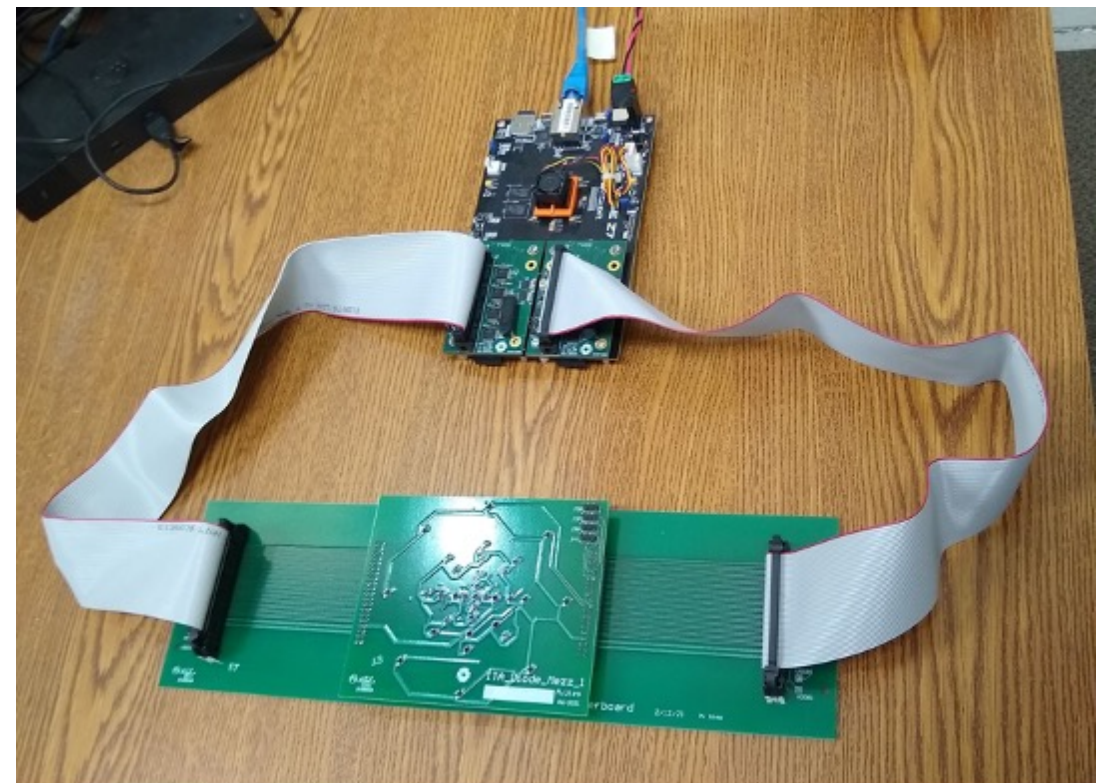
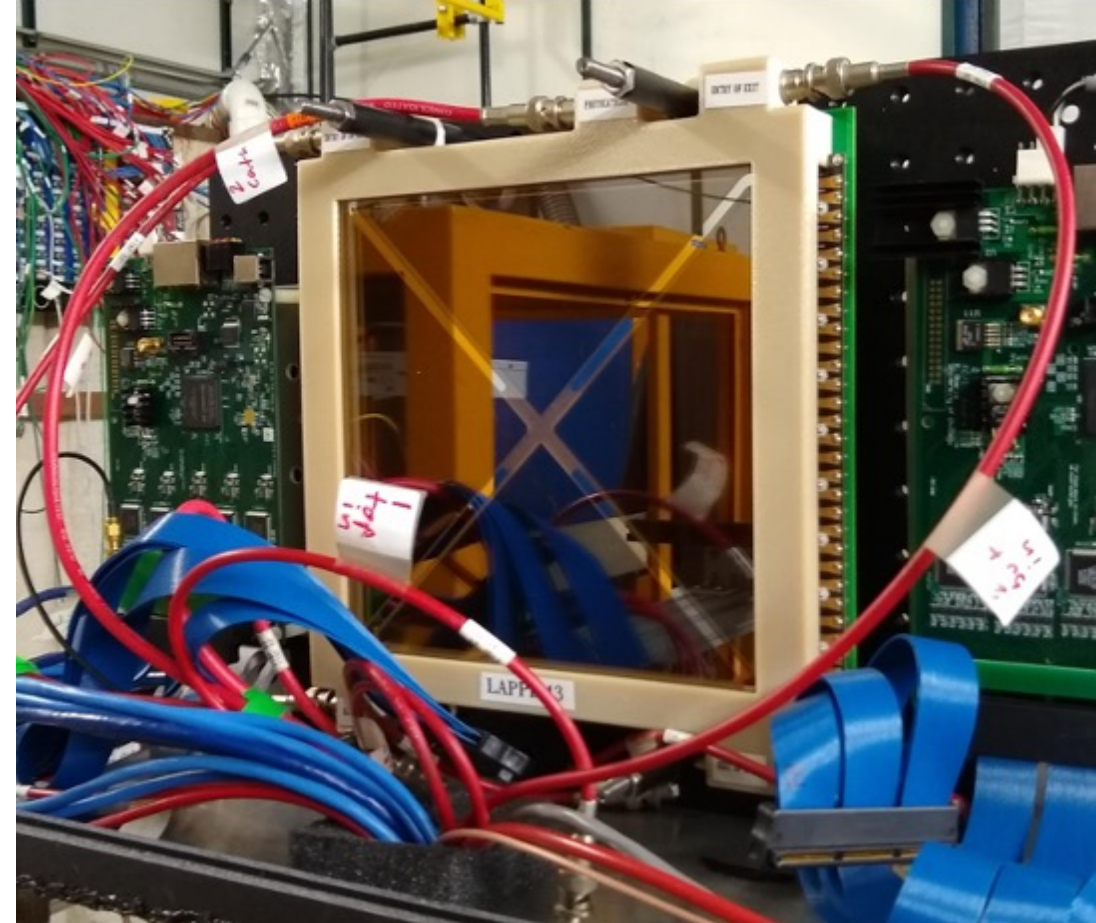
Becoming a User

- First step is to contact the facility staff and write the TSW (Technical Scope of Work)
 - 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?
 - Document can be broad and cover multiple years and uses
- TSW information can be found here: http://programplanning.fnal.gov/tsw_orc/
 - Email us: ftbf_co@fnal.gov
 - Approvals typically take 4-6 weeks, depends on needs
- Scheduling for FY24 beam year at FTBF and ITA will start this summer but reach out anytime!
 - FTBF was more than 100% booked last summer and unable to accommodate all requests, please get in touch well in advance
 - MTest requests for typically 1-4 week periods with 12 hours of primary beam use, many groups can be accommodated at once
 - MCenter requests at lower energies, often longer periods, single user

Looking Toward the Future

New Instrumentation

- Large Area Picosecond Photodiode (LAPPD) based time of flight system
 - Concept tested in 2019
 - Angelico, Evan. doi:10.2172/1637600.
 - Making use of ANNIE readout electronics, modified for use at FTBF
 - Measured time uncertainty of 19 ps
- Developing new radiation hard beam profile monitors for ITA



FTBF Trends

- More user weeks of beam requested than available each year, ~10-20% oversubscribed
- Switchyard line is more than a mile long and rapidly aging with multiple components that have no viable spares.
 - Heroic efforts from accelerator team to get the beam we do have
 - 10+ weeks of major downtime in both FY22 and FY23 beam years which has led to some experiments receiving no beam.
- Heavy demand from CMS and ATLAS upgrade projects presently, EIC efforts ramping up. Multiple neutrino related projects making use of MCenter (TOAD, ArCS, EMPHATIC, NOvA)
- Increasing demand for clean low energy secondary beam (muons, electrons) that are difficult for current facility to accommodate

Future Facilities at FNAL

- ITA will end if the LINAC does not operate in the PIP-II era
- As the accelerator complex evolves there is a great opportunity for a new test beam facility
 - PIP-II linac will provide high intensity source of 800 MeV protons
 - New location closer to accelerators makes facility more convenient and have less beamline to maintain
 - 4-6 beamlines
 - 120 GeV from MI (slow extraction)
 - 8 GeV from booster
 - High intensity 800 MeV irradiation area ($>10^{18}$ protons total dose on samples)
 - Clean secondary lines for Electrons, Muons, and Pions
 - Collocate test beam and irradiation facilities
 - Dedicated infrastructure for control rooms, experimental staging, facility infrastructure
 - Room for small medium/long term experiments
- Snowmass white paper



Courtesy T. Kobilarchik

Last Update 21/04/2023	
Running	1
Winter/Summer Shutdown	2
Longer Shutdown	3
Unclear	4
Likely	5
Pending Approval	6

Pending Approval



Summary

- The Fermilab Test Beam Facility and Irradiation Test Area are user-oriented facilities aimed at providing high energy/intensity particle beams for applications in particle, nuclear, and beyond.
- We are always working to improve the facility and our user's experience, suggestions are welcome!
- A big part of our mission is outreach, we encourage students to come and we support interns over the summer (now restarted in person).
- We are planning for the future of the FTBF and ITA facilities.
- For more information and scheduling please get in touch:
 - Email: ftbf_co@fnal.gov
 - Slack Team: [fnal-testbeam](#)
 - Webpages: ftbf.fnal.gov and ita.fnal.gov
 - Listserv: test_beam@fnal.gov