Progress on Recommendations from Previous Meeting

Evan Niner

FTBF Committee Meeting

19 November 2019

Responses to Recommendations

- **The FNAL computing division should consider putting resources into the FTBF to get a working DAQ system.**
- **Work with CD to get otsDAQ integrated into an overall system that is transparent to the users.**

We have done a lot of work with otsDAQ in FY19. The silicon strip telescope, running otsDAQ, is under heavy use and supported by Lorenzo Uplegger with groups from CMS, LHCb, and sPHENIX making use. We have integrated the MWPCs and Cherenkov telescope into the system. For MWPCs track analysis software was ported into otsDAQ and now writes beam profile information to the ECL and ACNET where it can be used by accelerator operators. We had summer students helping with DAQ projects this year. One effort involved testing a data server to transparently stream beamline data collected in otsDAQ to a memory segment that can be accessed by external DAQs. We will be ironing out, documenting, and presenting features to users in FY20.

Responses to Recommendation

- **Consider developing a unified slow control system. Consider ACNET, iFix or SYN- OPTIC before rolling your own.**

Work was done in FY19 and is ongoing to overhaul the monitoring system for the gas shed. New IFIX computer, UPS, controls for monitoring gases. System can be expanded in the future. New Weiner MPods (LV and HV) and crate purchased.

Responses to Recommendation

- **Dedicate resources to publishing the FTBF paper.**

We have started drafting a paper. We have a shared document and outline and have been populating sections. To complete the paper we want to carry out some beam performance studies. Looking to do this in January when time for facility studies should be possible. Doing these studies will exercise the DAQ system. Working to get this paper out the door.

Responses to Comment

- **Develop a clear accounting for the actual fraction of protons that are sent to the facility compared to the total available to the physics program. Ensure that this fraction is used to describe the impact of the FTBF on the physics program (the "proton tax") rather than the maximum 10%.**

We have an accounting of FTBF beam pulses, not fully translated back to proton impact on neutrino program. We took ~125,000 pulses. When NuMI is running the slow spill is ~4.6 NuMI pulses. Assuming 4e13 POT per NuMI pulse is 2.3e19 POT. NOvA took 5.56e20 POT last year. FTBF was approximately a 4% effect. We work with users to use the beam efficiently and communicate downtimes to the MCR to remove the slow spill from the accelerator timeline. SpinQuest starts commissioning in the spring and will then run in FY21 in a steady state on the same SY120 timeline as FTBF.

Responses to Comments

- **Continue to prepare and plan for a spike in requests at the FTBF during the next long CERN shutdown. The period during 2019/2020 will be crucial for the LHC HL-LHC upgrades, and a time where the CERN facility will be unavailable.**
- **Work with ATLAS and CMS to ensure that the requests for beam from those experiments are prioritized by the experiments.**

We have been in communication with these groups. We have so far been able to satisfy the requests received and these groups are prioritizing their requests.

Responses to Comments

- **Continue to track the number of papers, conference talk, conference proceedings and internal notes generated based on data taken at the FTBF, to accurately account for the impact of the FTBF.**
- **Write the standard paragraph to be included in papers and conference proceedings and hand it to the experiments when they arrive on site.**

There is a paragraph from the technical publications group (http://techpubs.fnal.gov/) to be included in papers. We communicate with all groups on publications.

Responses to Comment

- **In light of the shut-down, remember that the FTBF advisory committee is a resource that you can call on to prioritize, if there is oversubscription for beam time.**

So far we have been able to accommodate all users. Groups have made good efforts to run cooperatively and been flexible with running dates. The schedule is full and already a shorter beam period than typical years, any reduction in accelerator operations similar to FY19 would have significant impact.

Responses to Comment

- **We watch with interest the development of the jolly green giant magnet.**

The JGG was tested in November 2018 and ground faulted twice just under operational current. Work was done following that to repair the faults, but subsequent testing has not been performed. The JGG power supply is currently being used to run the analyzing magnet for NOvA. Testing can resume in summer 2020 after NOvA run.

Questions?

FY19 FTBF Report

Evan Niner

FTBF Committee Meeting

19 November 2019

Running Conditions

- 51 MTest User weeks + NOvA in MCenter (~4 weeks beam commissioning)
  - 32 beam weeks. User groups except three weeks around holidays, some facility studies

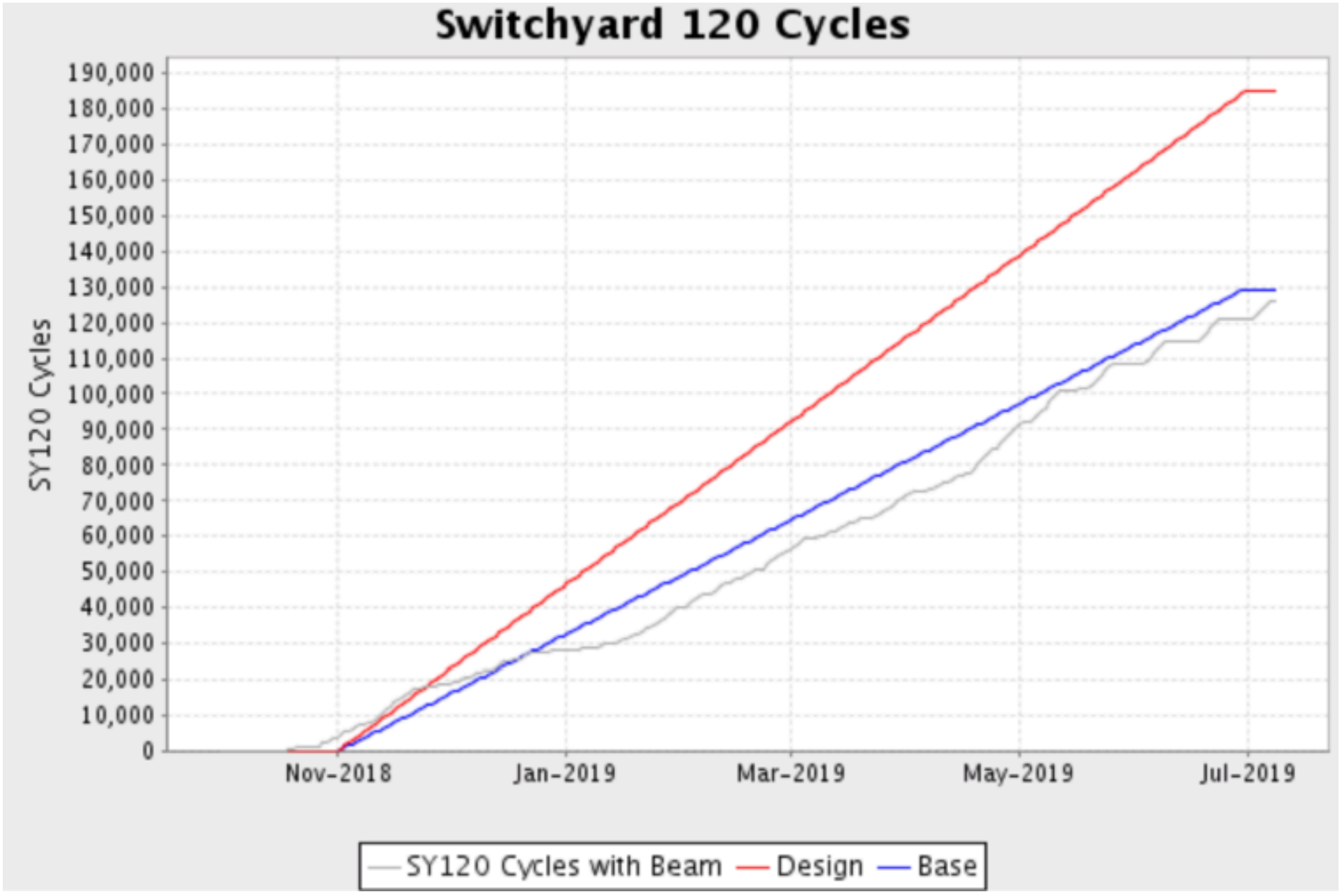
- 21 Experimental efforts

- 36 days of beam lost in May-July when accelerator switched to 5 day on - 9 day off running due to funding
  - 10 groups effected and received reduced requests
  - groups cooperated very well and all were able to make use of limited time. Installed on off-weeks so there was little down time when beam was available

- Otherwise downtime mostly <1 day.
  - Magnet change outs in November and March.
  - Dedicated booster study days coordinated with experimental changeovers

- User installation and transitions went smoothly

Running Conditions



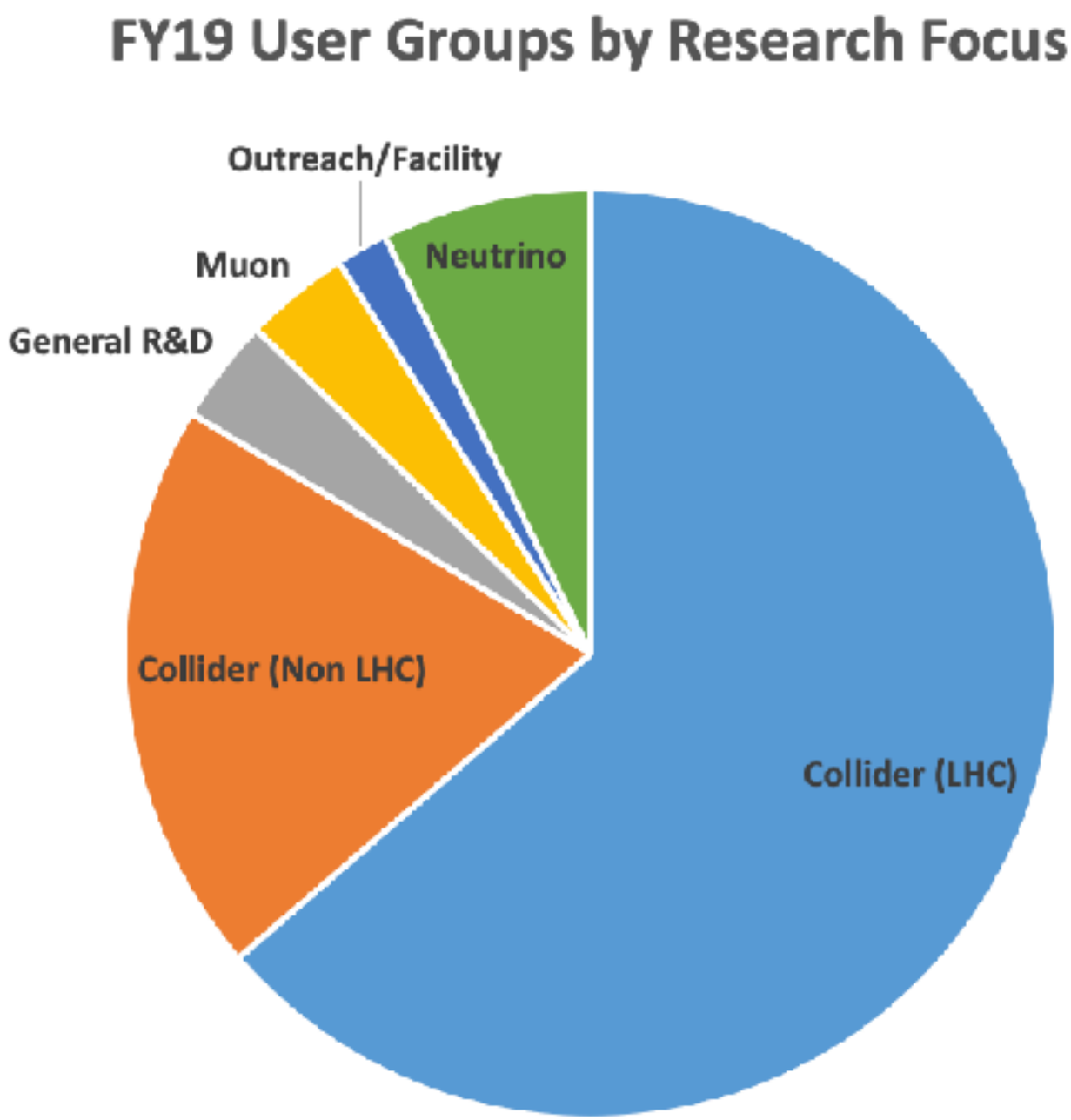
Does not differentiate between MTest and MCenter. 5-9 structure visible in May-July.

Fermilab

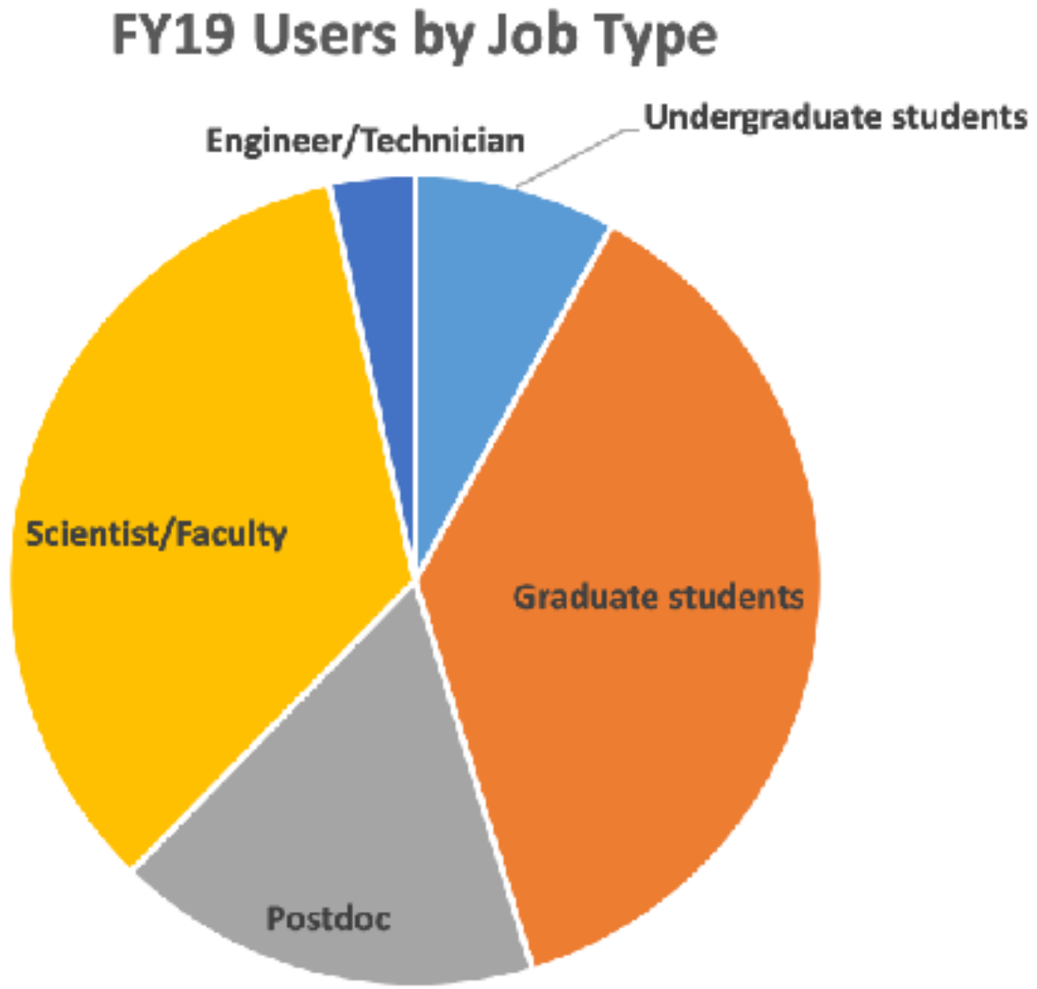
Summary: User groups

- Mostly LHC
- Three new groups in MTest, one in MCenter

Experiment	Beam weeks
Collider (LHC)	35
Collider (Non LHC)	11
General R&D	2
Muon	2
Outreach/Facility	1
Neutrino	4
Total	55



Summary: Users



Professional group	Number
Undergraduate students	19
Graduate students	88
Postdoc	40
Scientist/Faculty	81
Engineer/Technician	8
Total	236

Publications

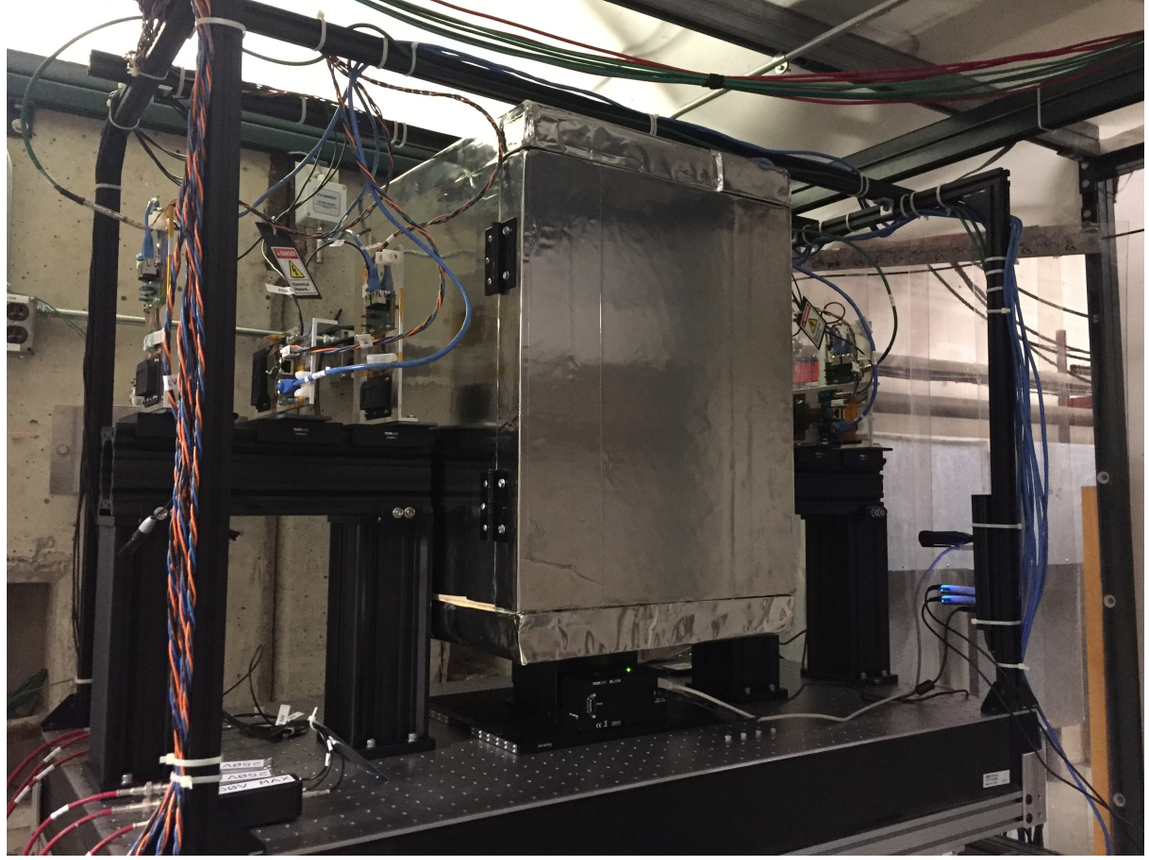
- T1429: B. Azmoun, et al.,“Results From a Prototype Combination TPC Cherenkov Detector With GEM Readout”, IEEE Trans. Nucl. Sci. Vol 66, No.8 (2019) 1984-1992.
- LArIAT
  - G. Pulliam, “π^+ Cross Section on Argon for the LArIAT Experiment.,” FERMILAB- THESIS-2019-10.
  - W.M.Foreman,“ADemonstrationofLight-AugmentedCalorimetryForLow-Energy Electrons in Liquid Argon.,” FERMILAB-THESIS-2019-01.
  - E. Gramellini, “Measurement of the Negative Pion and Positive Kaon Total Hadronic Cross Sections on Argon at the LArIAT Experiment,” FERMILAB-THESIS-2018-24.
- T1224 (In preparation)
  - Argonne Pixel Telescope V. Bhopatkar, et al.
  - RD53A Test Beam Characterization with FELIX Data Acquisition J. Lambert, et al.
  - Timing Characterization of Low Gain Amplifying Detectors with 120 GeV Protons M. Jadhav, et al.
- T1409: Results featured in CMS MTD Technical Design Report

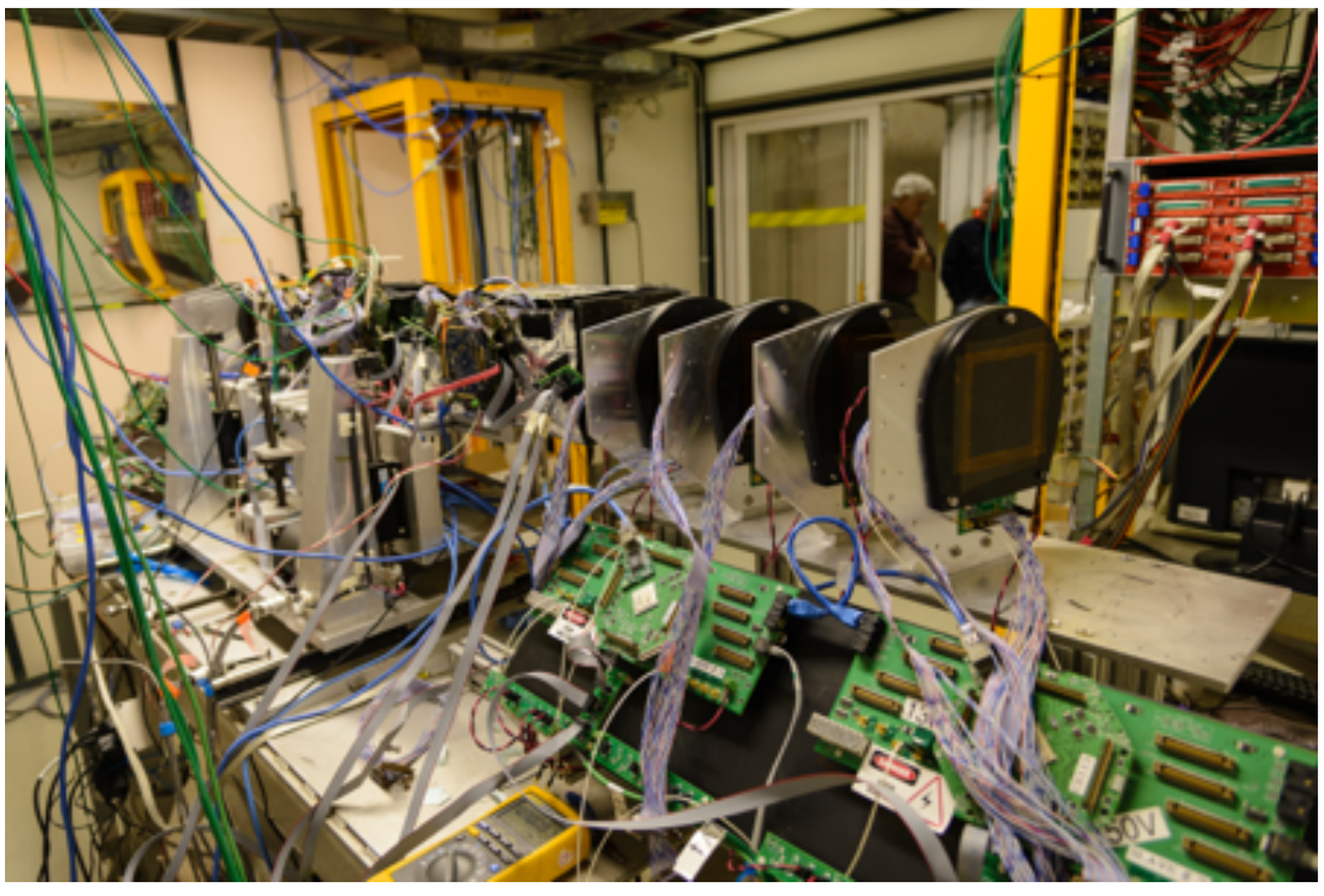
- All groups have publications in preparation. Results featured in conference talks and posters. Many results featured in TDRs and reviews and played key roles in production designs

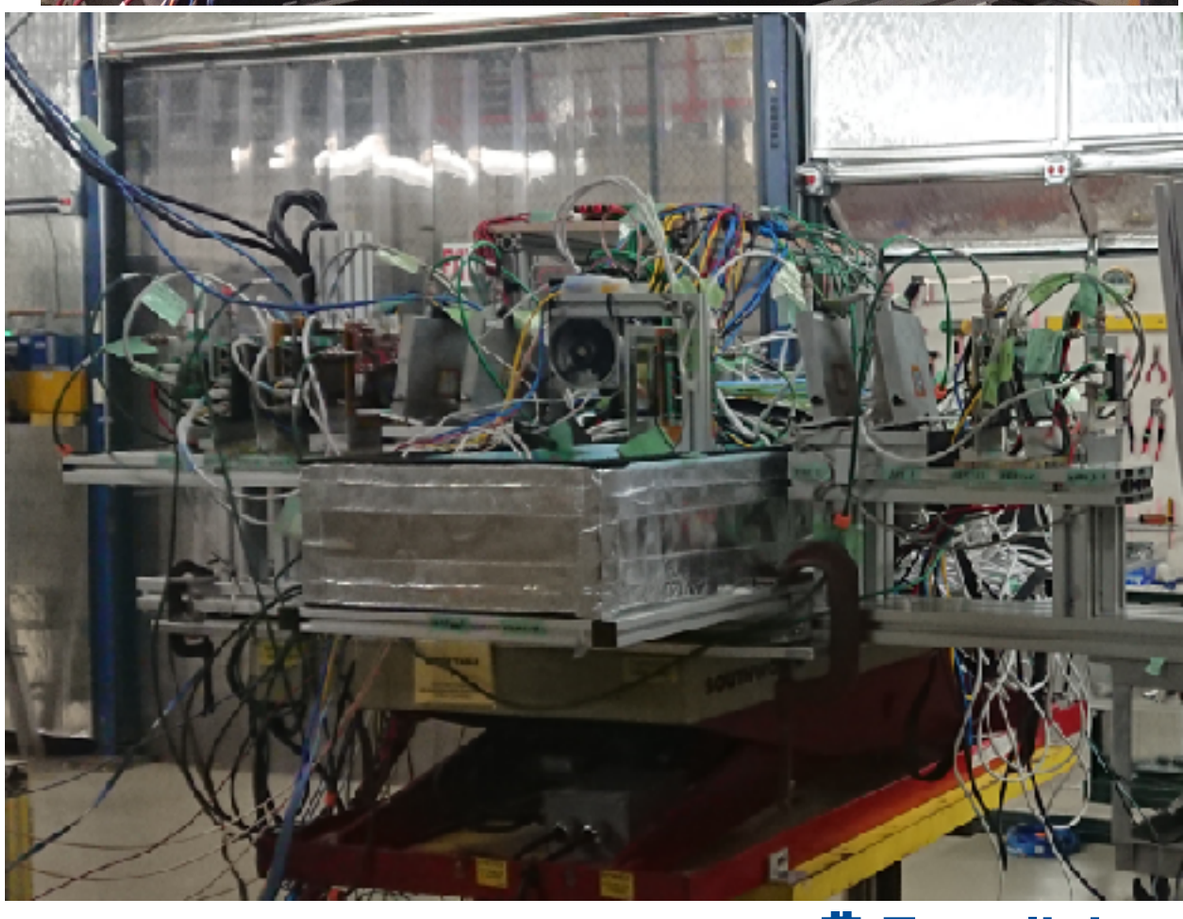
CMS and ATLAS

- Testing new DAQs, ROCs, sensors, irradiation sudies, timing detectors

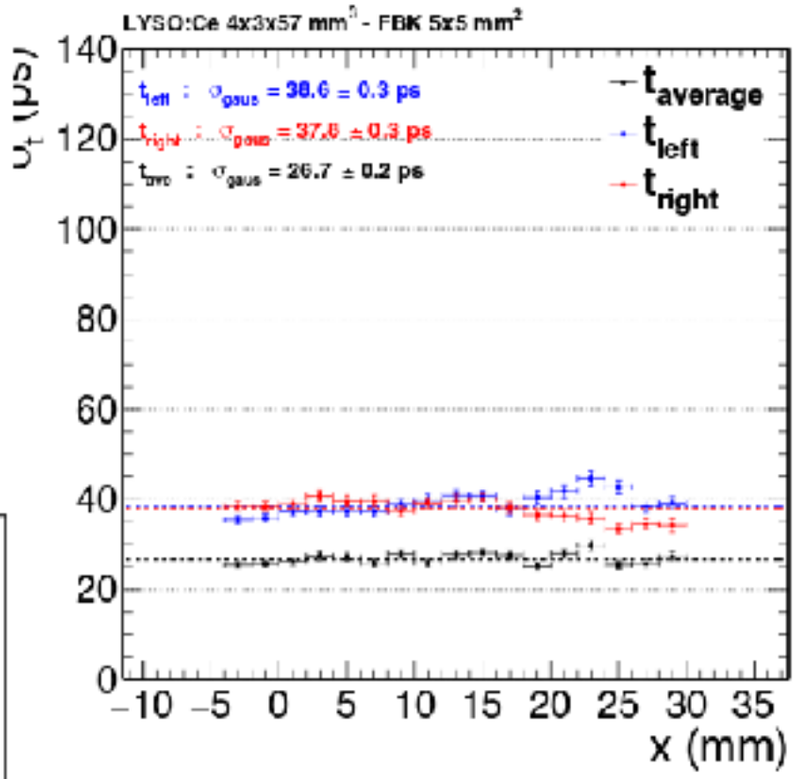
- Three telescope setups, frequent users

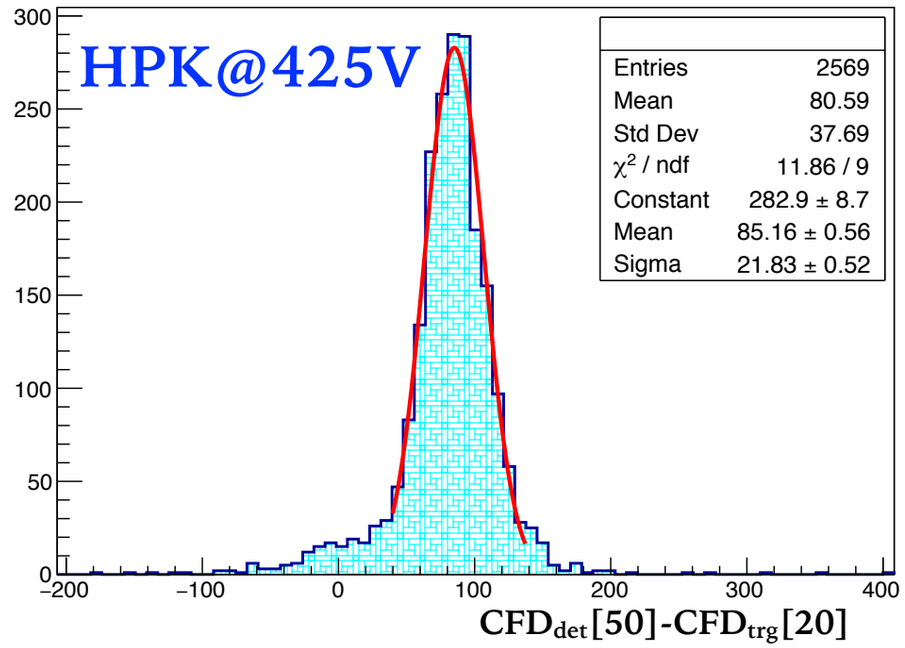


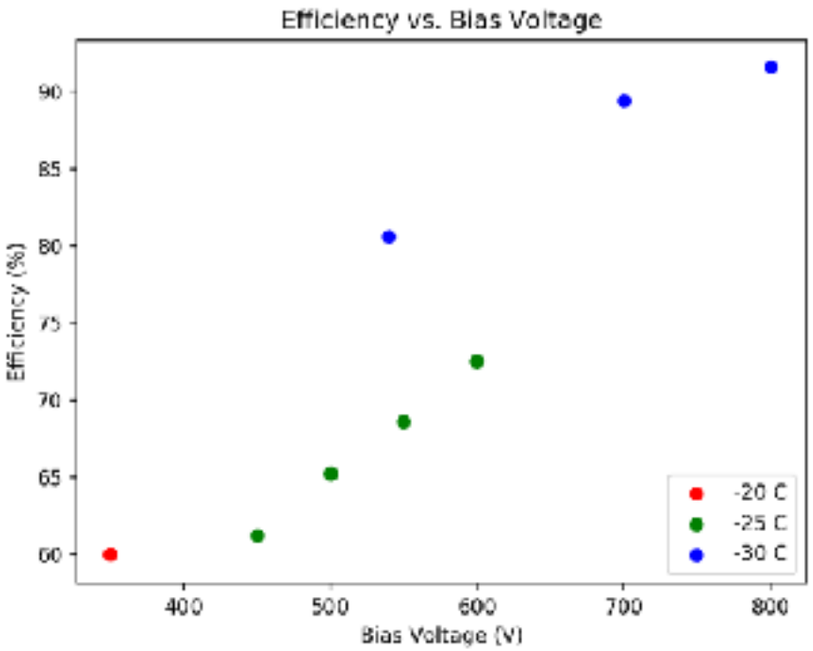


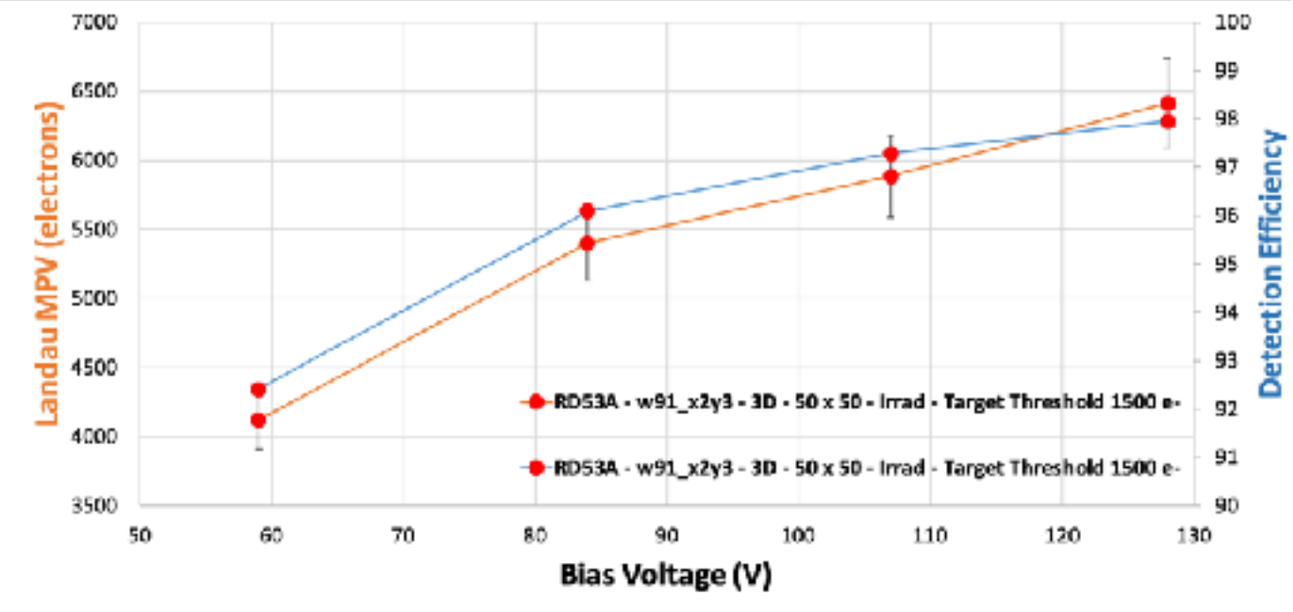


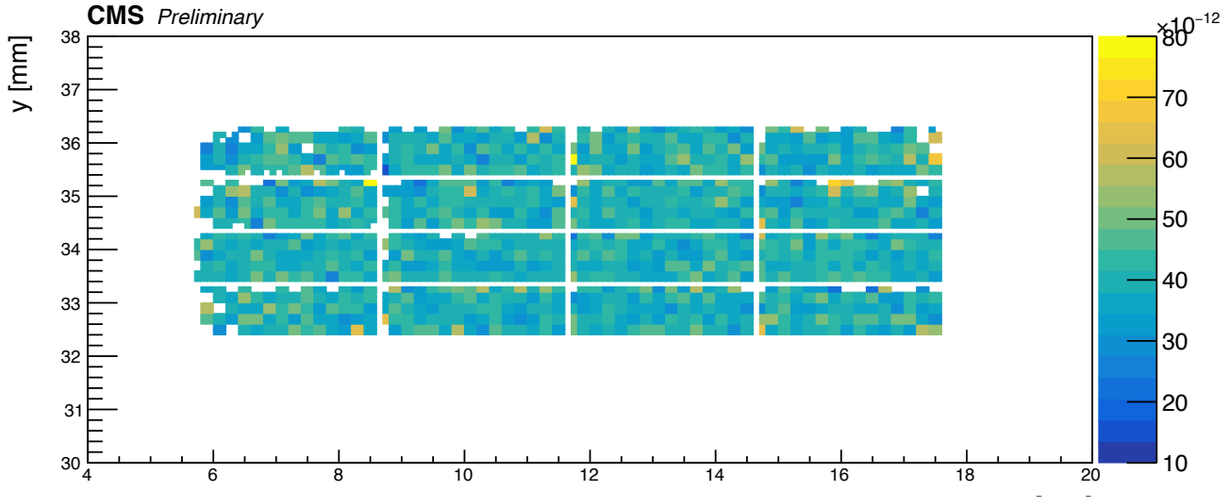
CMS and ATLAS

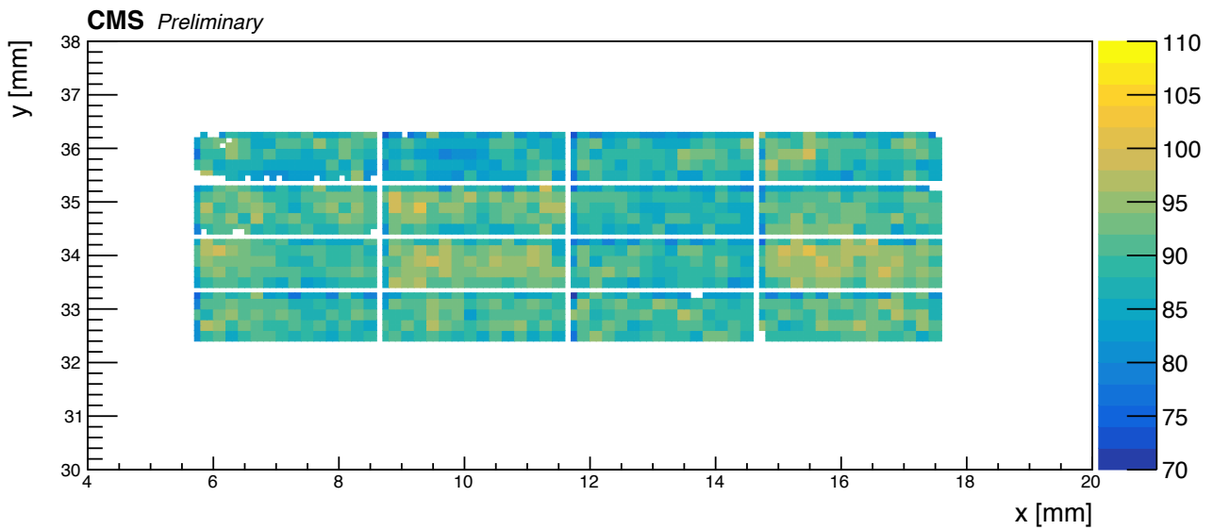






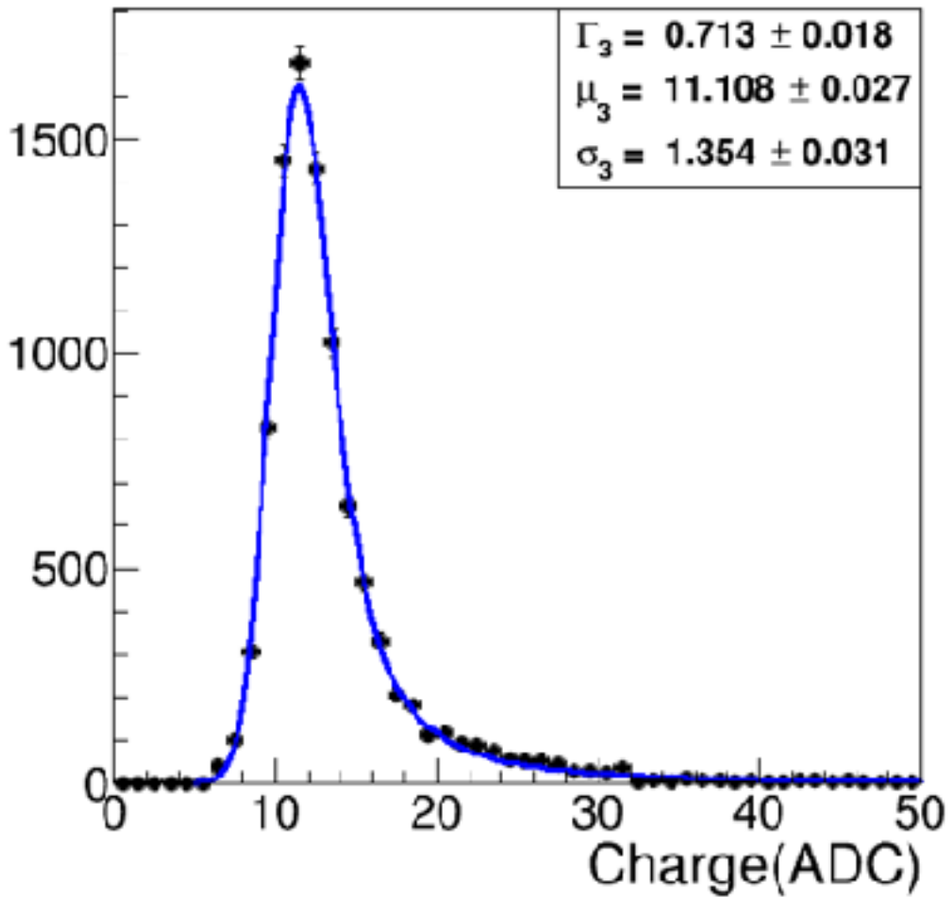






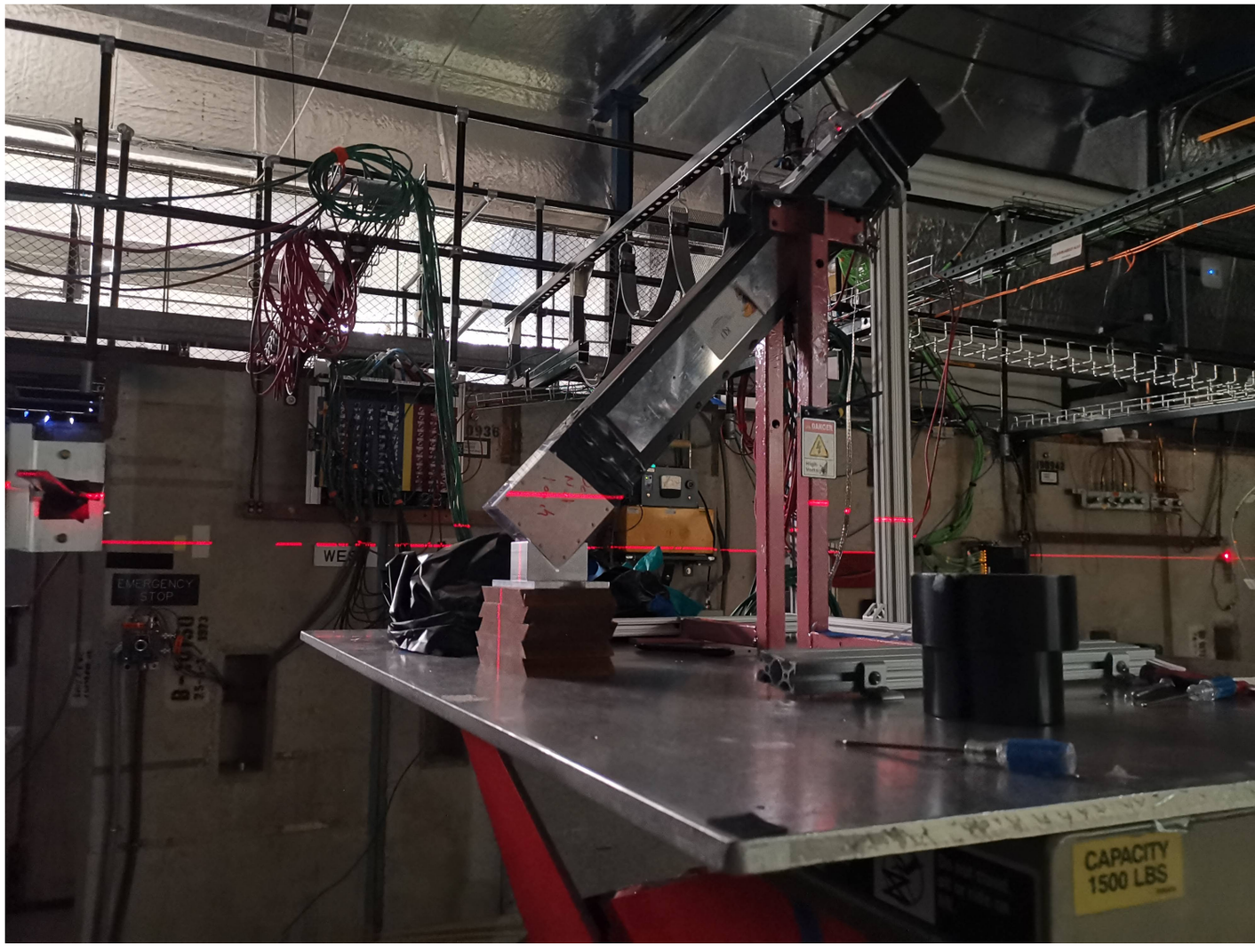
LHCb

- New Effort
- Test SALT ASIC with production sensor for LHCb UT tracker
- Interfaced with 6.1a silicon strip telescope



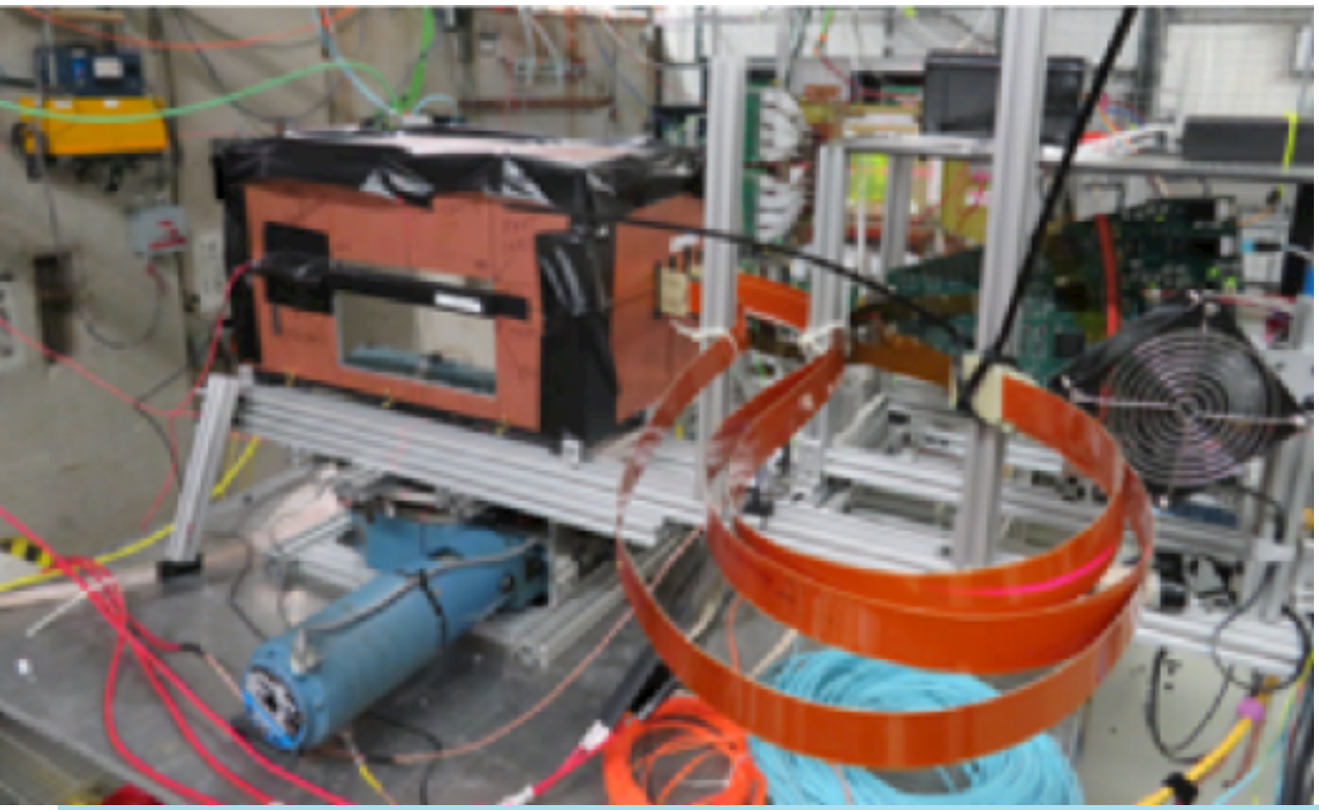
Joint zero degree calorimeter

- New Effort
- Tungsten absorber with fused-silica rods
- Characterize electromagnetic shower containment and detector response

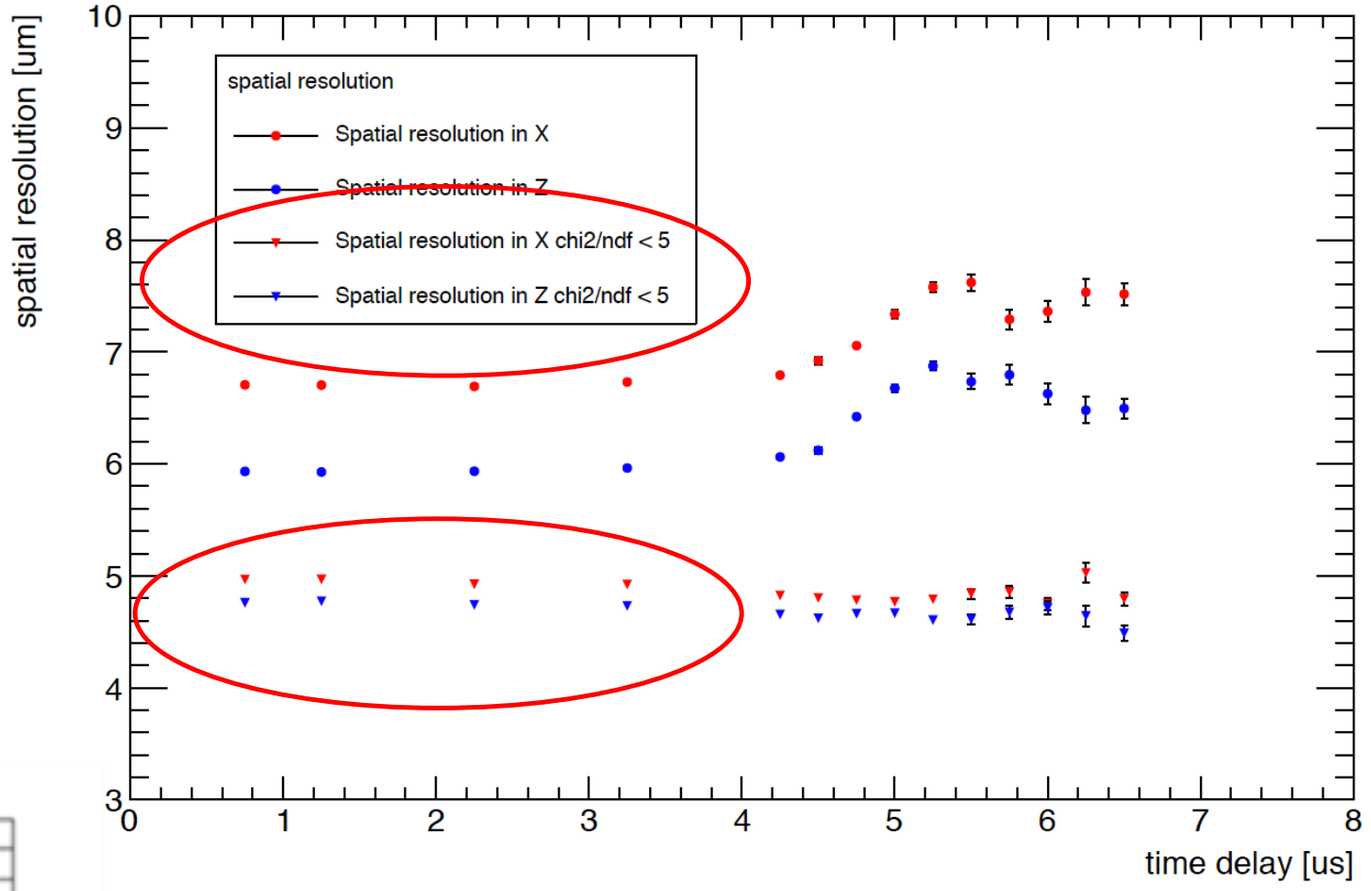


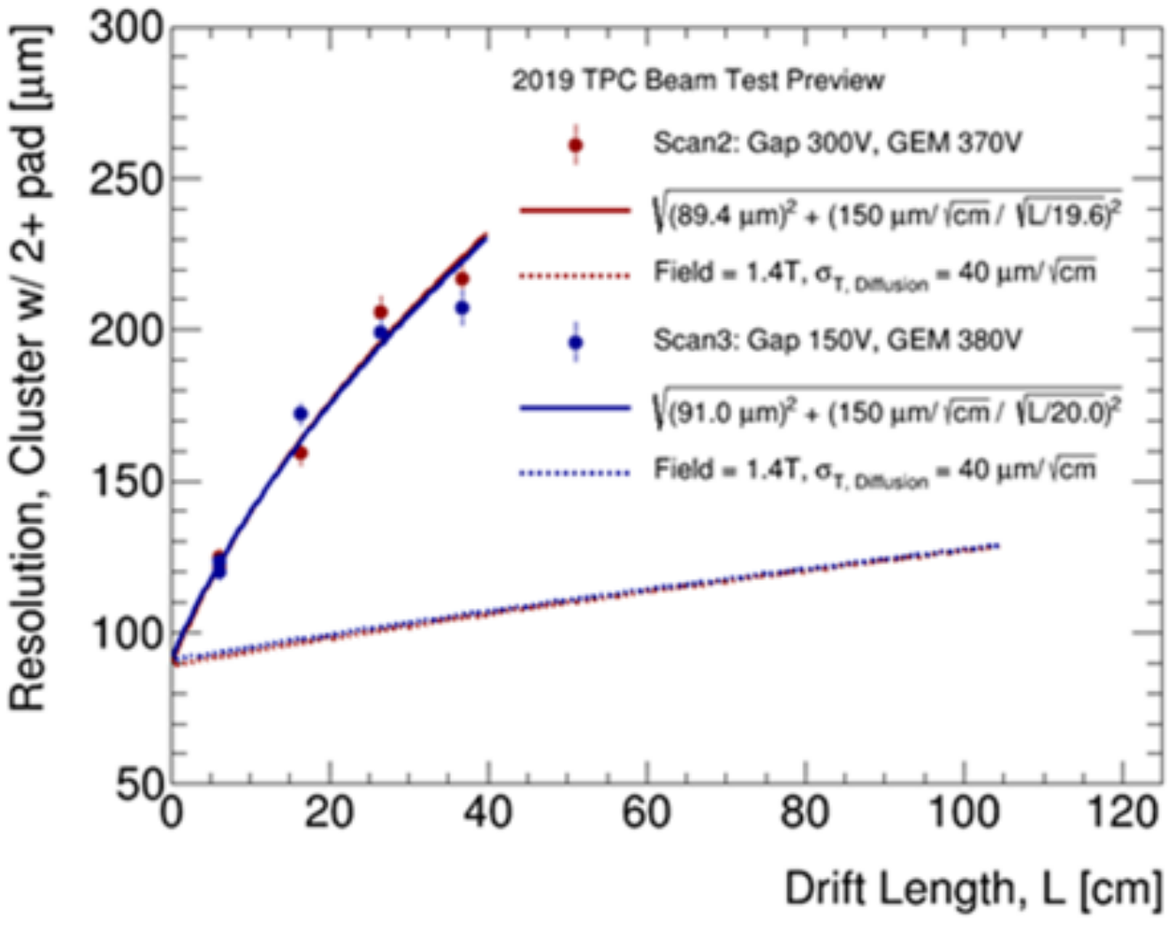
sPHENIX

- vertex detector, TPC, silicon strips
- All in beam together



sPHENIX





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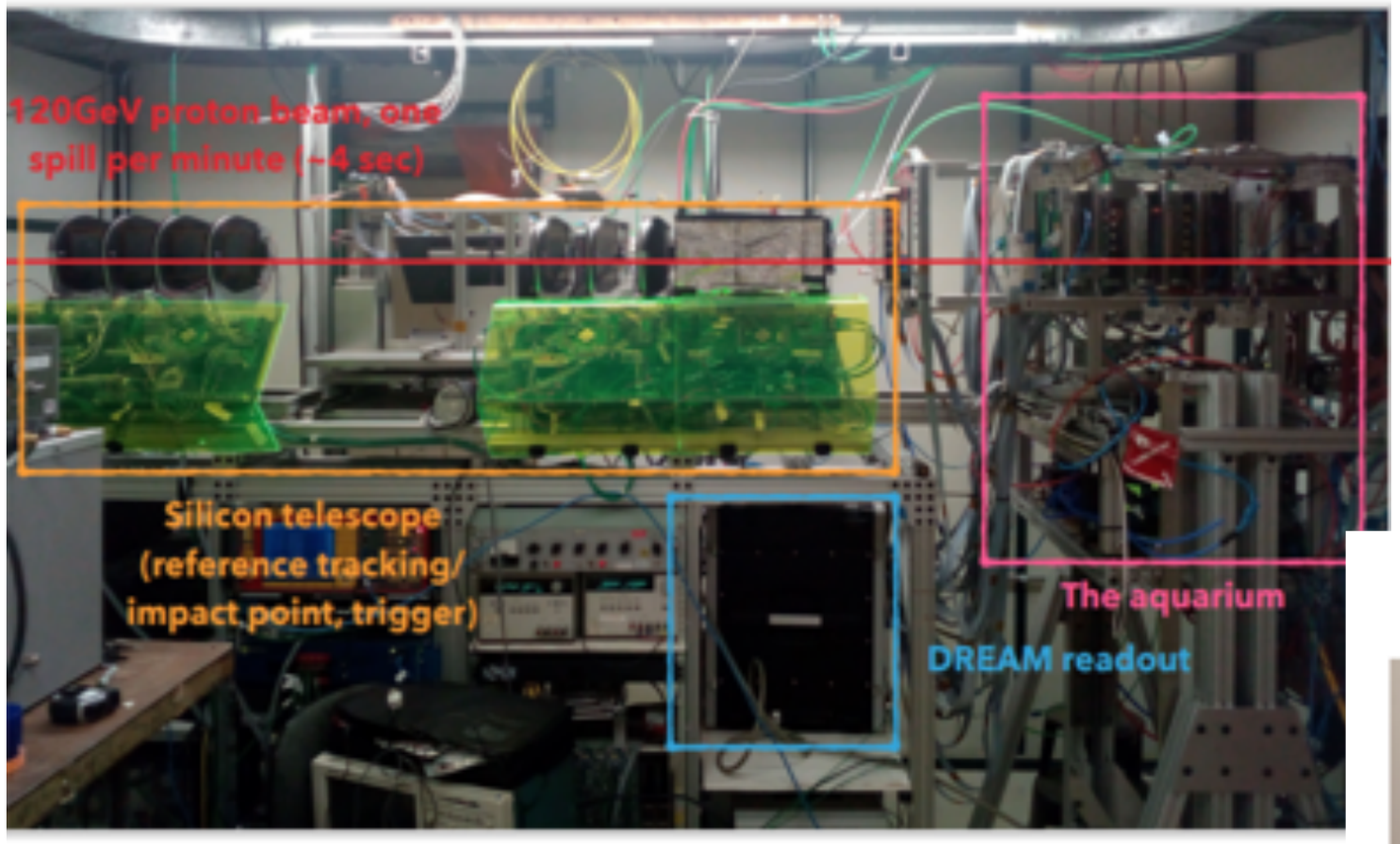
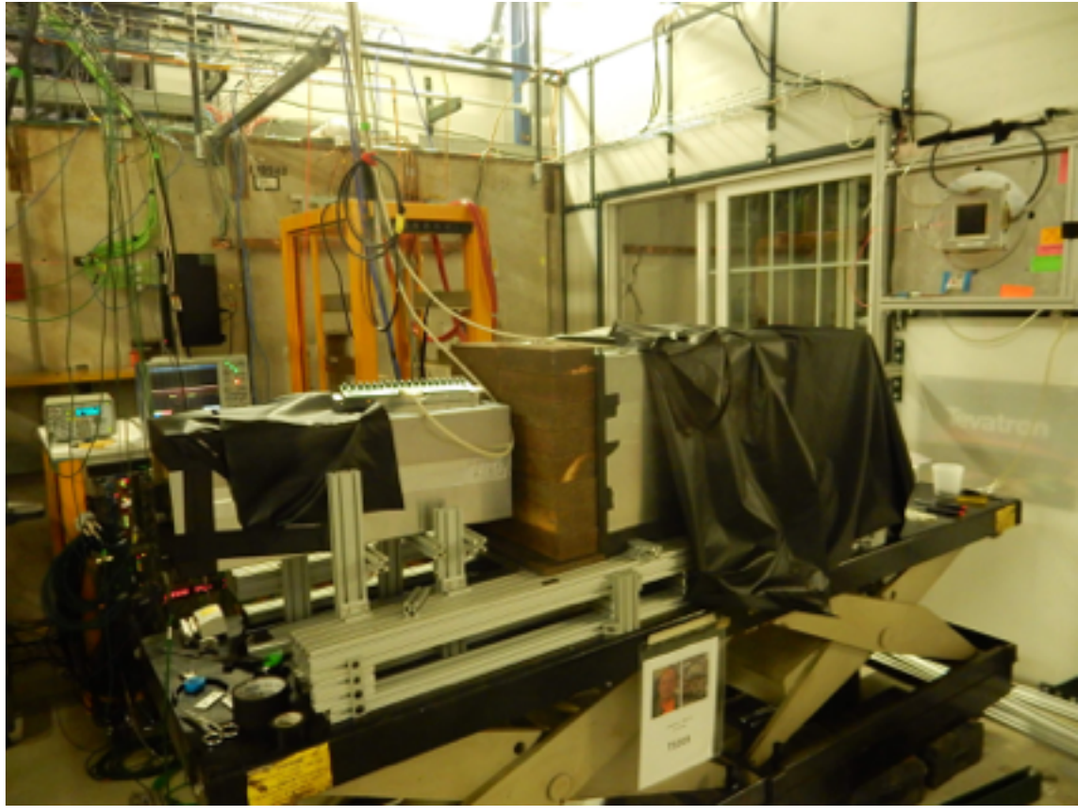
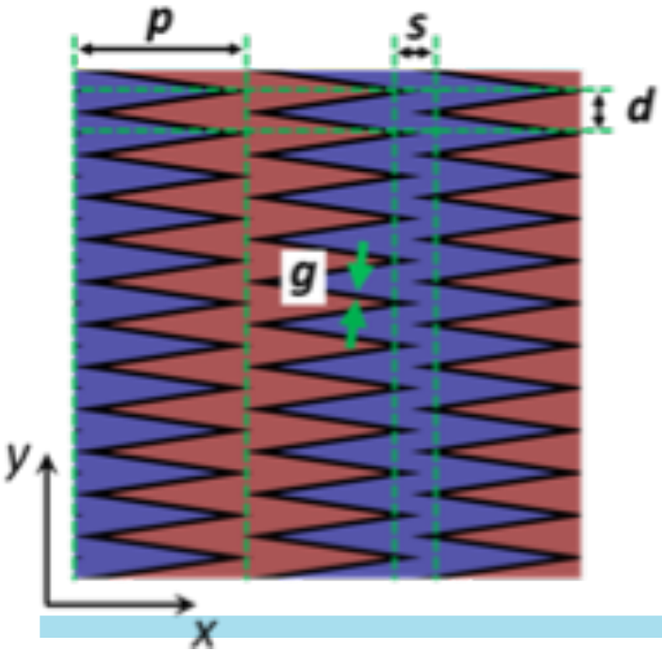
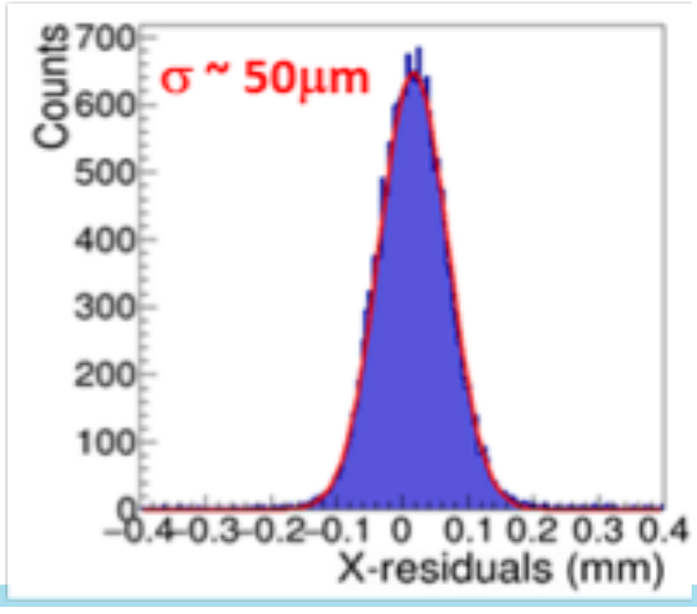
EIC R&D

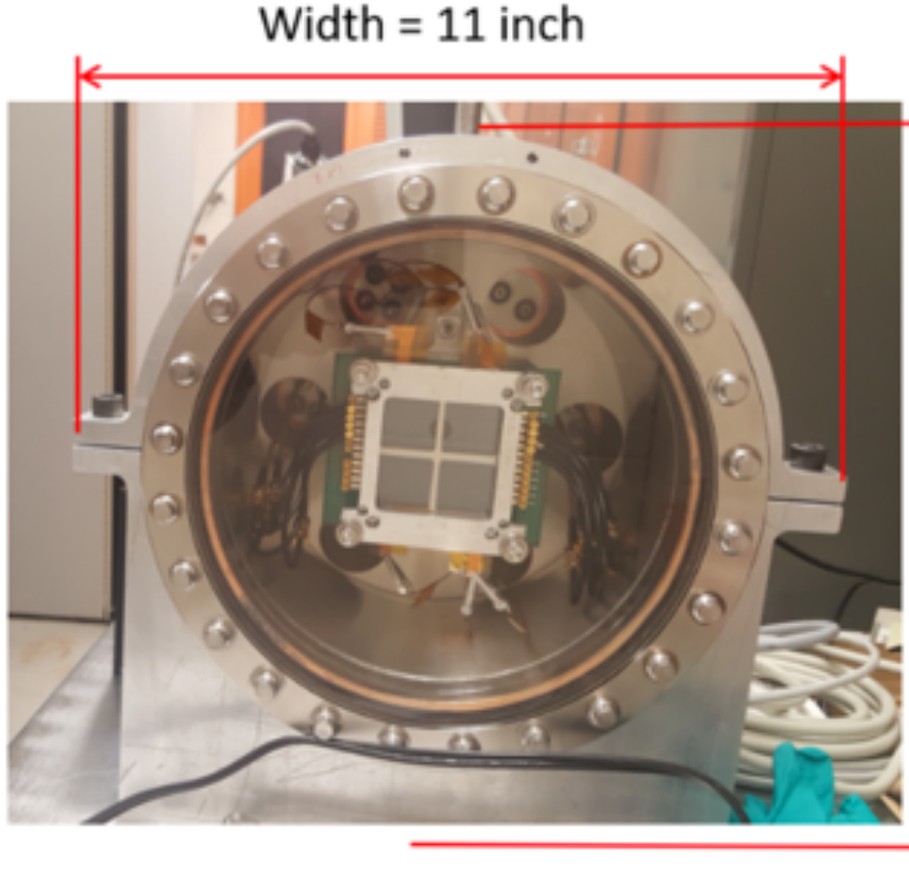
- Tungsten powder calorimeter, MCP-PMTs, zig-zag patterns for GEM and Micromegas









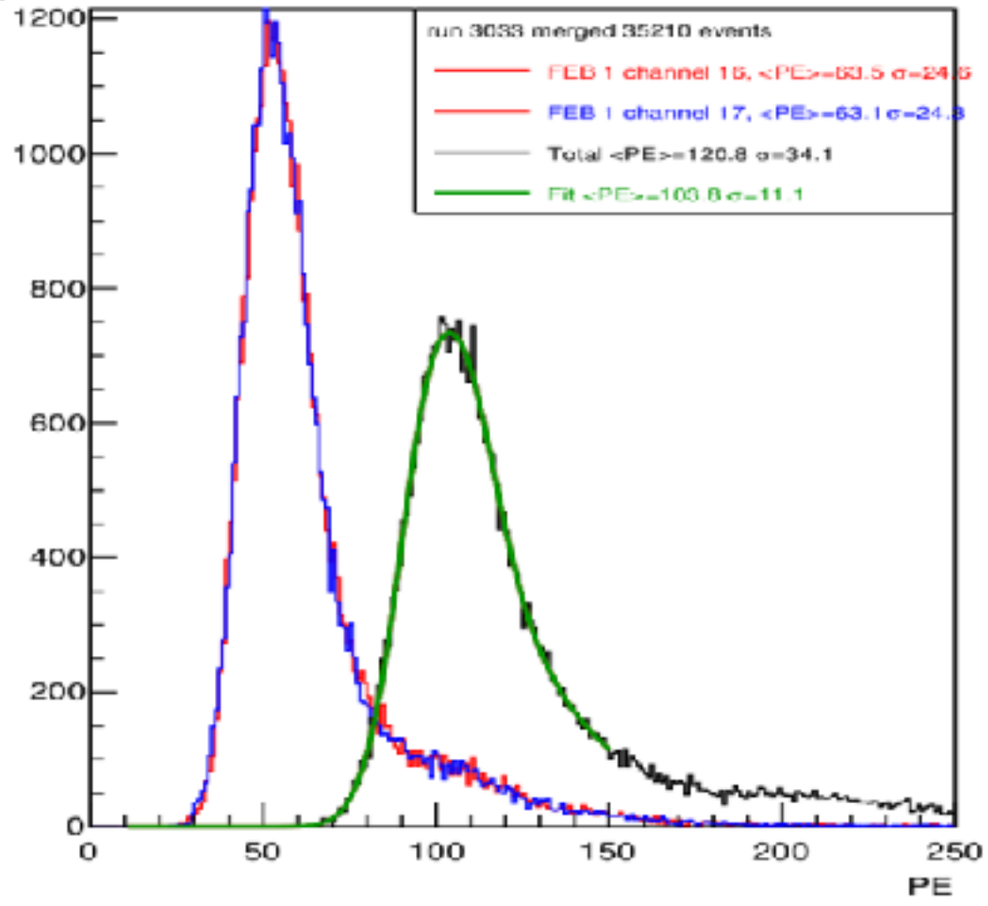


Fermilab

Mu2E

- Testing prototype counters for cosmic ray veto system

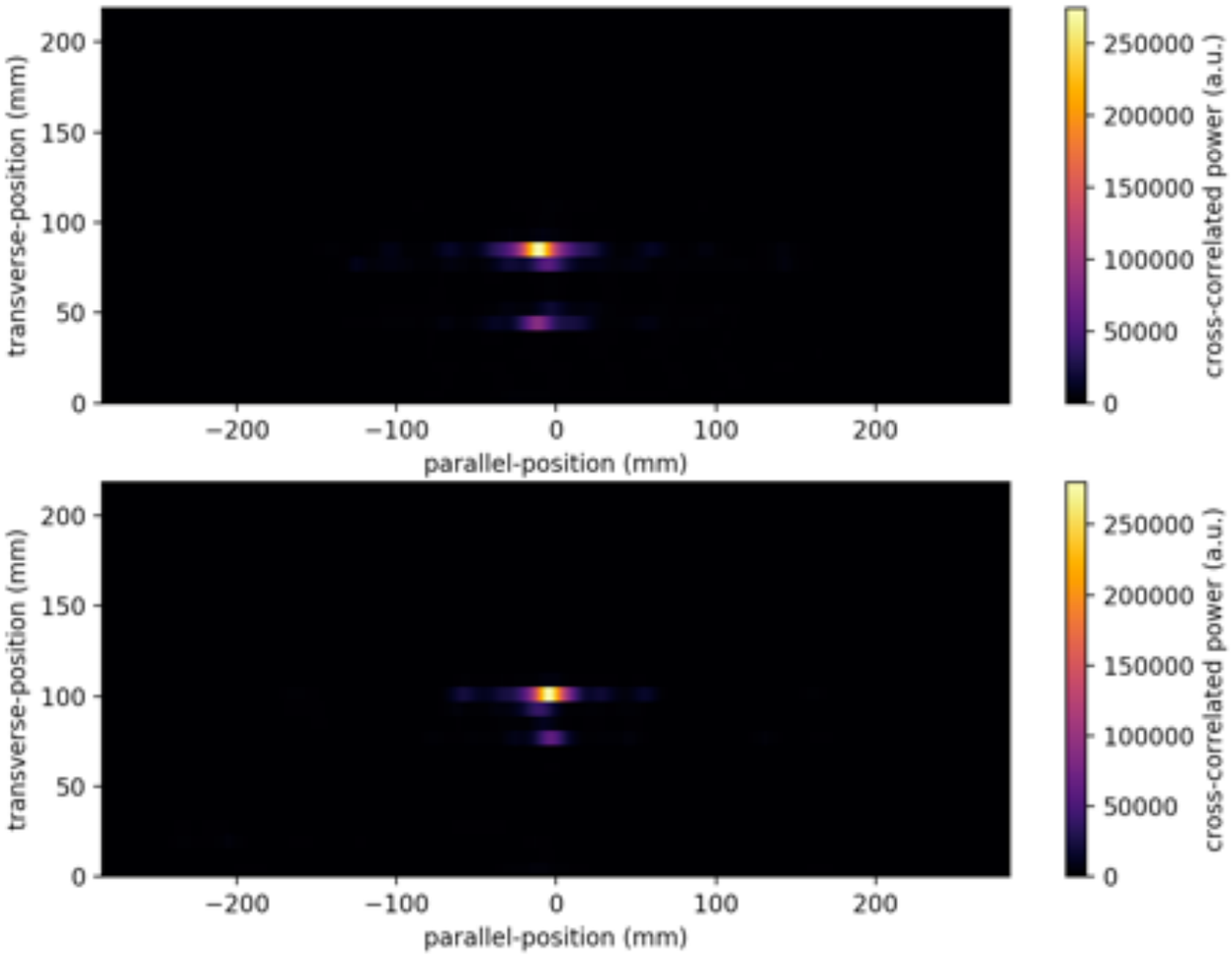
- Brought prototype straw tracker to facility, debugged noise in setup



Fermilab

LAPPD

- New effort
- Prototype precision Time-of-flight system for FTBF with commercial LAPPDs



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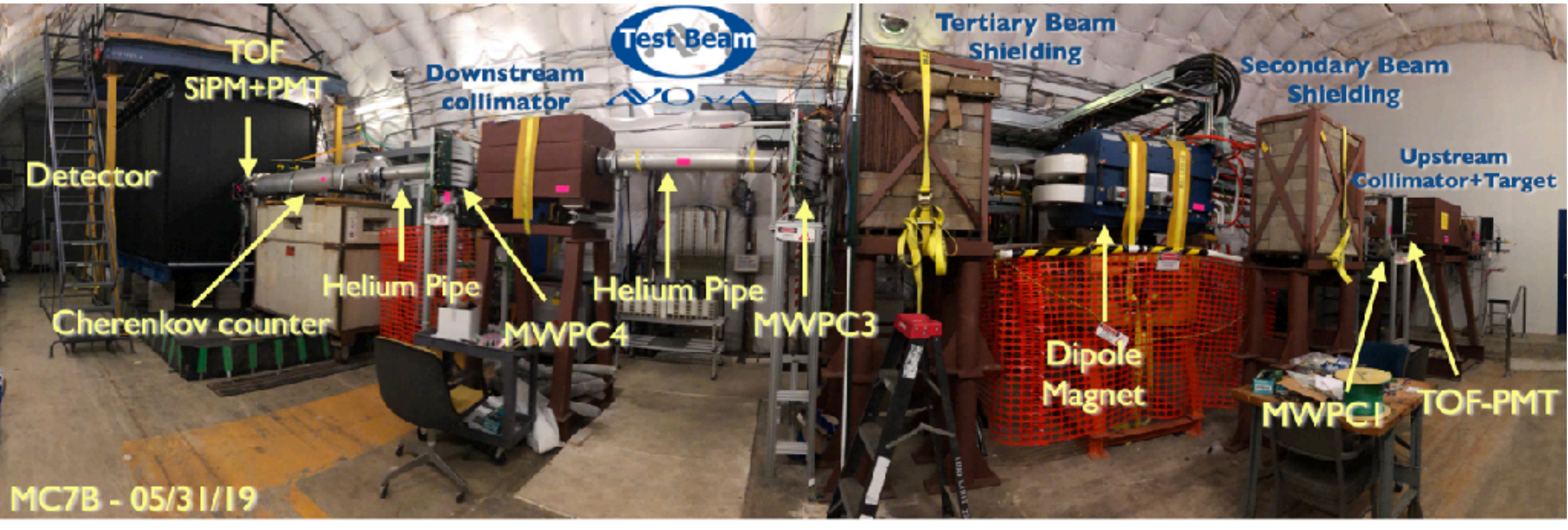
NOvA

- Constructed detector and beam line instrumentation in MC7b
- One month commissioning run in FY19 with half detector and full beam line
- Fully instrumented physics run in FY20
- Reduction of energy scale uncertainties for primary NOvA detectors validation/training of reconstruction algorithms



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Facility Activities

- Documentation and communication
  - Slack team for communication with experiments and operations support
  - Dedicated FTBF docdb, populating with policies and procedures
  - Audit and update of website information
  - Documentation and knowledge transfer from instrumentation specialist Ewa Skup (retired in July)
  - Writing FTBF paper
- DAQ
  - Continued efforts to integrate otsDAQ into facility readout.
  - Improve FTBF beam line information visible to MCR operators (MWPCs -> otsDAQ -> ACNET)
  - Integration of otsDAQ with facility instrumentation and streaming of data to external DAQs
  - Worked with SCD personnel on bug fixes and testing
  - Three summer student projects
- Audit and documentation of cable delays and electronics maps in counting house (1 summer student)
- Updates to gas shed and IFIX system and new power supplies
- ITA coordination (more later)

Questions?

FY20 Plans and Beam Request

Evan Niner

FTBF Committee Meeting

19 November 2019

FY20 Users

- **26 beam weeks (Dec 4 - May 31)** Driven by TLM calibration at startup and early shutdown for LBNF prep
- **MTest**
  - 15 weeks with 2+ users
  - 5 weeks with 1 user (24 hours)
  - 5 weeks with 1 user (12 hours)
  - 1 week unscheduled (over holidays)
  - 19 groups and counting so far
  - Mostly CMS/ATLAS. Also sPHENIX, Mu2E, EMPHATIC, general R&D
- **MCenter**
  - NOvA will run in MC7b December - June with fully instrumented detector
- **ITA**
  - Construction and commissioning, beam to users expected in spring (more later)

FY20 Projects

- DAQ
  - Integrate facility beam line information into MCR monitoring, document, finish infrastructure to stream data transparently to external DAQ
- Cable mapping
  - Translate summer student work mapping counting house into website, verify timing with beam
- Slow Controls
  - Continue update to gas shed systems, install new LV and HV MPods. Work toward unified system
- Magnets
  - Testing of JGG after NOvA completes
- Documentation
  - Continue to update facility website and populate docdb with procedures and policies
- Computing
  - Starting to transition control room machines to SL7 and look at updating DAQ. Continue to replenish older machines.

FY20 Projects: Beam studies

- Planning to carry out facility studies to characterize beam performance
  - Momentum spreads at various energies
  - beam spot size
  - particle composition
  - multiple scattering

- Studies serve multiple purposes
  - Results for facility paper, modern beam performance information on facility website
  - Documentation and calibration of instrumentation, knowledge transfer from instrumentation experts
  - Characterize alignment of instrumentation and beam magnets
  - Testing of otsDAQ and user documentation

Facility Projects

- In need of funding
  - Card readers to secure doors
  - Prefab plant floor offices
  - External upgrades to parking areas

Questions?

Irradiation Test Area

Evan Niner, Borrowed heavily from past material from Petra Merkel and Mandy

FTBF Committee Meeting

19 November 2019

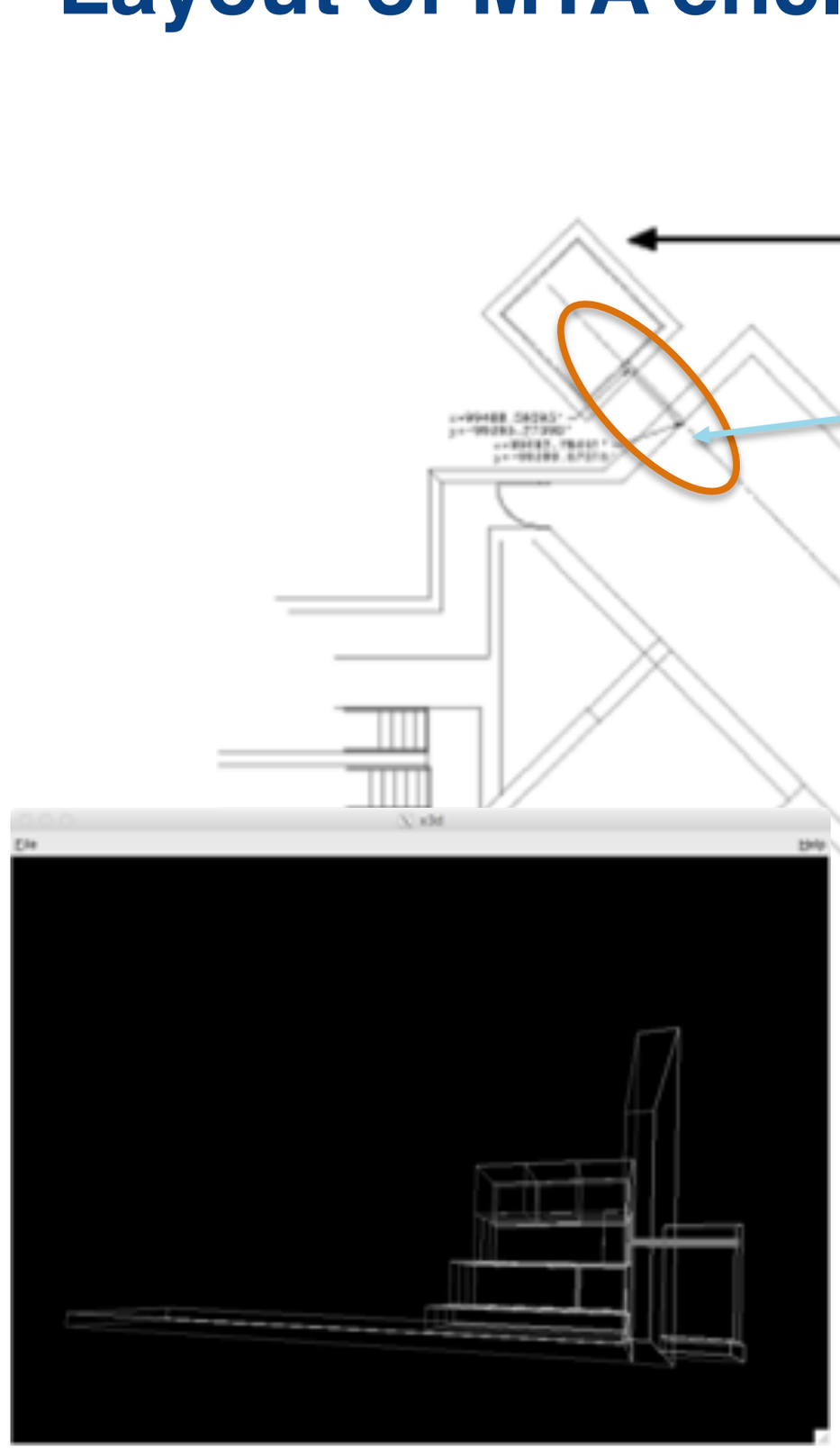
ITA Status

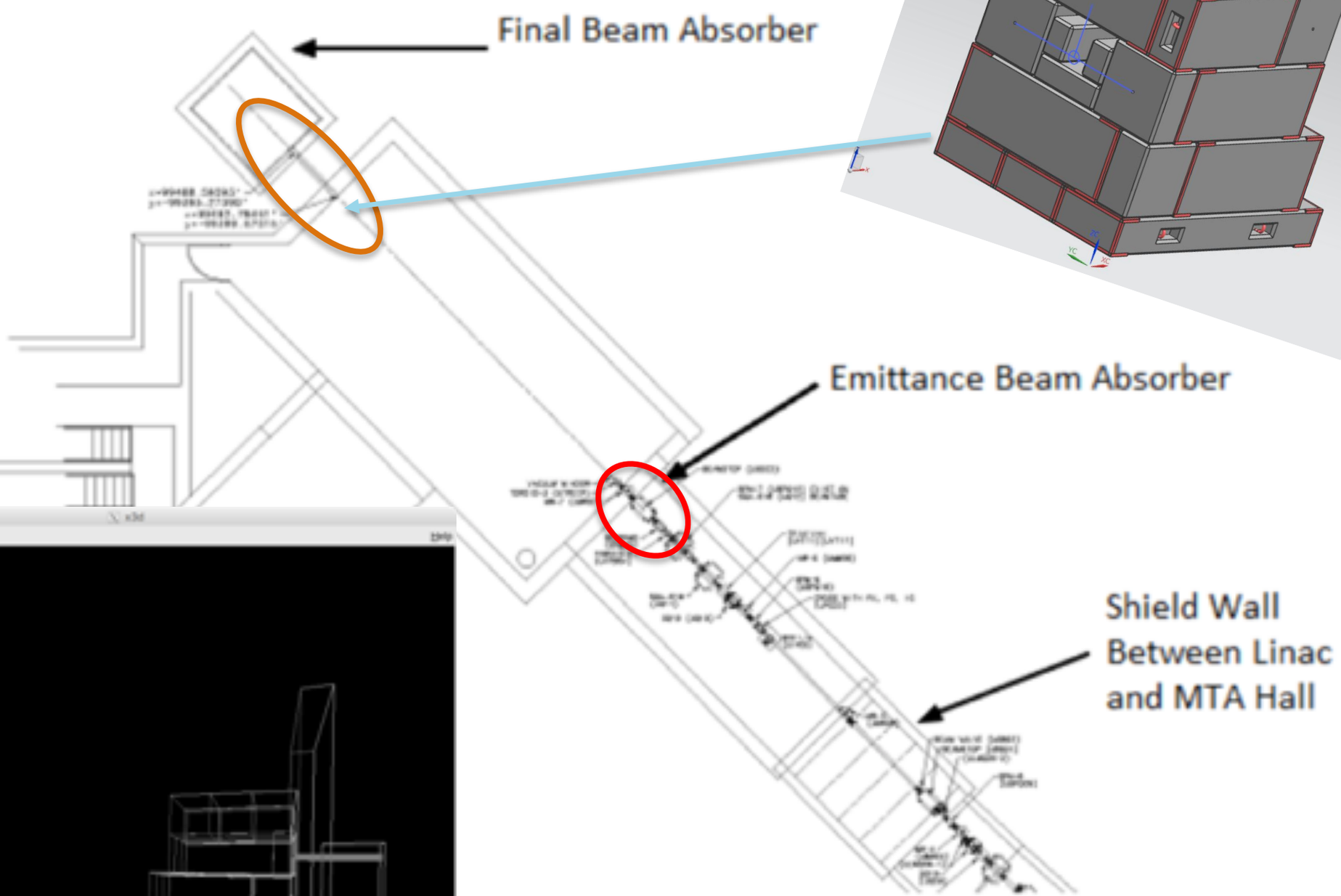
- Strong support from CMS, ATLAS, sPHENIX, and DOE reviewers
- Funding has been received to construct ITA
- Enclosure has been cleaned out from previous equipment. Construction and planning underway
- Personnel: Petra Merkel, Mandy, Evan, Jason St. John (AD beam line physicist)
- Targeting beam to users in spring 2020

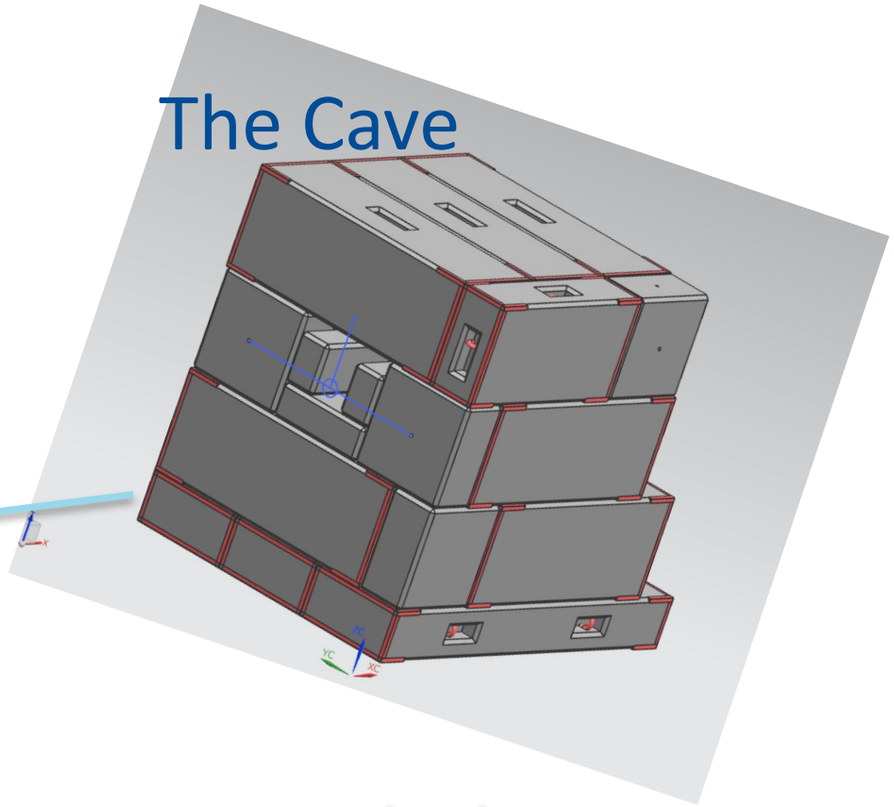
Existing Facilities

	Particle Type	Beam Energy	Beam Size	Time to $2x10^{16}/cm^2$	SEE Tests	Availability
CERN	protons	24 GeV	0.5-1.5 cm	111h	yes	LS2 shutdown
Birmingham	protons	40 MeV	1 cm	1h	yes	
Louvain	heavy ions	100s MeV		not feasible	yes	Being built
Ljubljana	neutrons	-	-	1.4h	no	
KIT (operated by ZAG company)	protons	23.5 MeV	0.5 cm	1.5h	(yes) too expensive	4h/week 6 week turnaround
Rhode Island	neutrons	-	-		no	limited
ANL (LEAF)	electrons neutrons	55 MeV 0.5 MeV		7h		Might be planned
BNL (BLIP)	protons+ neutrons	65-200 MeV		20h	no	Might be planned
TRIUMF	protons	5-500 MeV	0.5-1 cm	not feasible	yes	
FSU	protons	17 MeV				limited
LANL	protons	800 MeV		72h	no	2x/year
FNAL ITA	protons	400 MeV	1-7 cm	0.7h	yes	40x/year

Layout of MTA enclosure





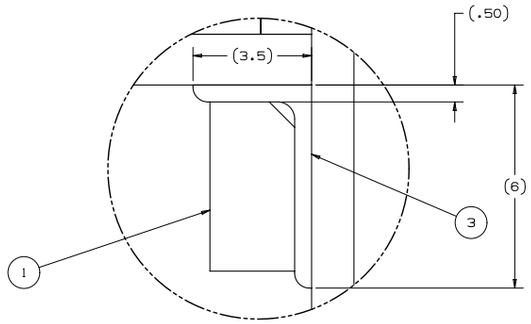


Fermilab

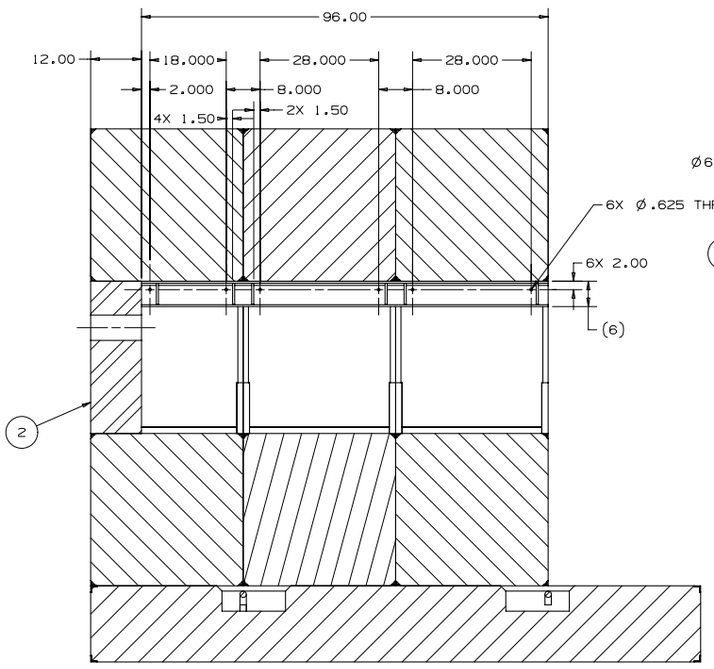
Final Cave Drawing

DESCRIPTION: KILMER CONCRETE BLOCK LAYOUT 2
PROJECT: Mech-BeamlineEquipment
CATEGORY: LAYOUT

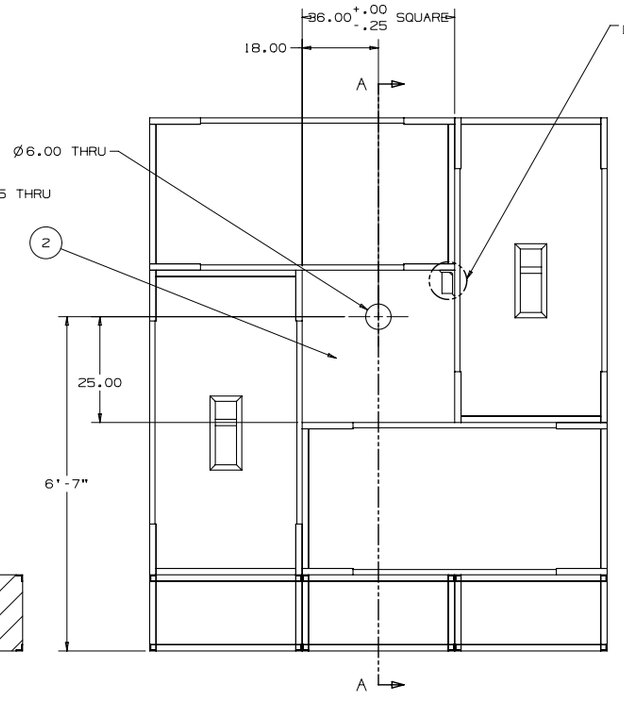
REV	REVISION CONTROL DOCUMENT	DATES	SIGNATURES
-	F10104402---RCD		DRAWN
			APPROVED

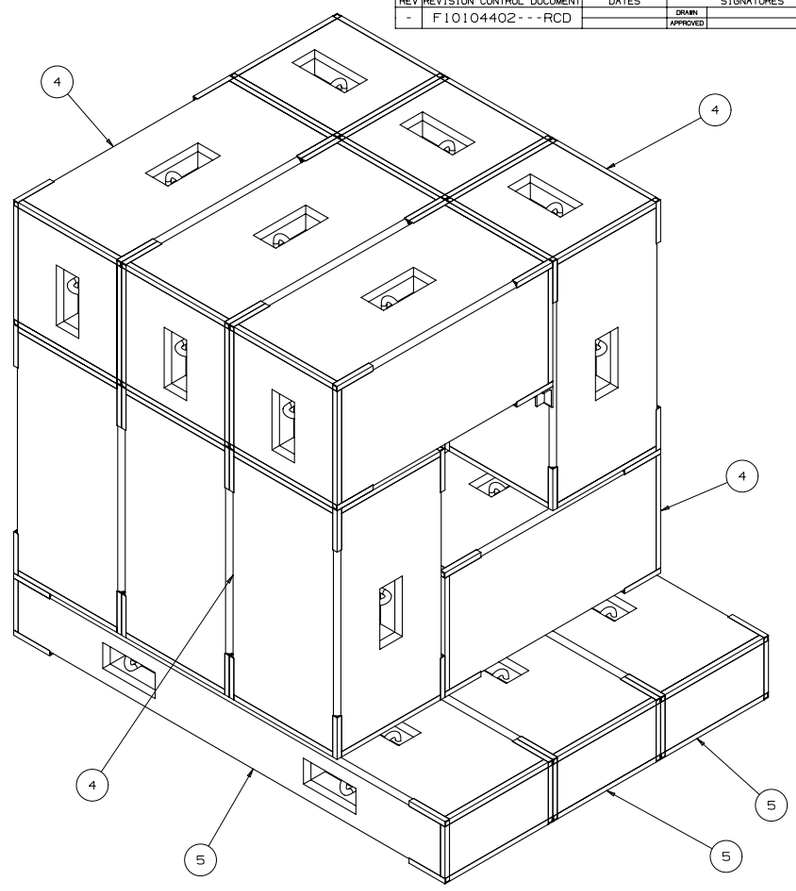


DETAIL B
SCALE 1:2



SECTION A - A





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4		FC0022822	CONCRETE SHIELDING-C B100#	12
3		F10128330	ANGLE, 6X3.5X.375X96LG MATL. A36	1
2		F10128332	SHIELD - 36IN-SQ X 12IN THICK WITH 6IN HOLE, LOW CARBON STEEL	1
1		F10128336	BAR - .5 X 2.5 X 5, MATL. LOW CARBON STEEL	6

UNLESS OTHERWISE SPECIFIED
±.X ±.XX ±.XXX ±X/X ±X°
.1 .06 .031 1/8 1°
BREAK ALL SHARP EDGES, MAX: .03
DO NOT SCALE DRAWING
DIMENSIONS BASED ON: ASME Y14.5-2009
MAX MACHINE ALL SURFACES: 500
DRAWING UNITS: INCHES
THIRD ANGLE PROJECTION

DRAWN	G.SMITH	DATE 31-May-2018
CHECKED		DATE
APPROVED		DATE
USED ON		
MATERIAL	SEE PARTS LIST	
GROUP: Particle Physics Mechanical Support CAGE CODE: 0U5R6		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

NAME: KILMER CONCRETE BLOCK LAYOUT 2

SCALE	SIZE	DRAWING NUMBER	SHEET	REV
1:16 OR NOTED	D	F10104402	1 of 1	-

TEMPLATE VERSION 2019.12.03

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Beam extraction in Fermilab LINAC

- "Pulses" from the LINAC can be extracted during the 6 second flattop of the SY120 spill and thus have minimal effect on Neutrino pulses
- By running the Irradiation Test Area simultaneously with FTBF, we have no impact on the rest of the program:
  - NuMI requires the Main Injector, as does FTBF.
  - G-2 and FTBF share a common section of beamline, and cannot run simultaneously.
  - BNB is rate limited.
  - Conservative estimate is 40 pulses available.

- A "standard" we have been using consists of
  - Single pulse of 5E12 protons per LINAC batch, 400 MeV
  - Nominally 15 Hz
  - 12 hours availability one day per week
  - A typical run would have beam impacting on 4.7 cm of Si (10%Λ)
  - Cooldown period of 1 day
  - One user per week.
  - 40 weeks/year

Table 1: Beam parameters to be expected at the DUT (Device Under Test)

Beam Specifications	Min	Max
Beam Size (±3σ) at DUT	1 cm	5-7 cm
Beam Divergence (±3σ) at DUT	0.1 mr	1 mr
Number of Proton/pulse	0.3×10^{12}	7.5×10^{12}
Pulse Duration	2 μs	50 μs

10/1/18

MTA cleaned out

Before

NearlyAfter (June 2019)

MTA space largely cleared out

Photos courtesy J. St. John

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ITA Timeline

- Shimming and blocks for irradiation cave being moved into hall to begin construction today. Once in place shielding wall outside MTA doors will be reconstructed. Moving blocks as soon as possible before weather worsens
- Dose monitoring and trolleys for sample movement in progress
- Beamline assembly
  - Move and align quad magnets
  - Stripping station
  - Wire chambers and beam monitoring
  - Beam pipe construction
  - Magnet testing
- Shielding assessment
  - Schedule driver. Simulations underway, submit to committee in December
- Restore fire suppression system
- Fill holes from ODH fan penetrations
- Airborne and chipmunk monitoring. Interlocks and system tests
- Procedures for sample handling
- Commissioning and coordination with accelerator complex, ~4 weeks

Scheduling

- Scheduling and coordination with users will be done through FTBF, many users will use both facilities
- Beam to users is in spring 2020 for a couple month run before summer shutdown.
- Initial run will be only silicon samples. Likely without cooling or power to streamline construction.
- Summer 2020 shielding assessment expanded to encompass additional materials, infrastructure enhanced for more complex device testing
- Scheduling has not begun, but we have been in contact with likely early users

Questions?