

TPOt overview

Hugo Pereira Da Costa (LANL)
TPOt technical review - July 20, 2022



TPOT = TPc Outer Tracker

Mission:

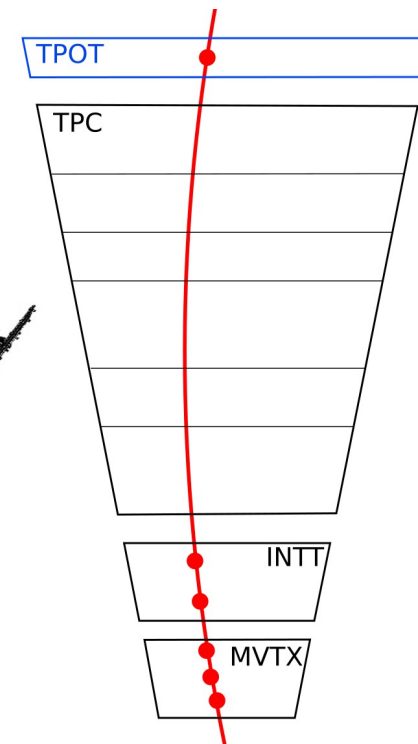
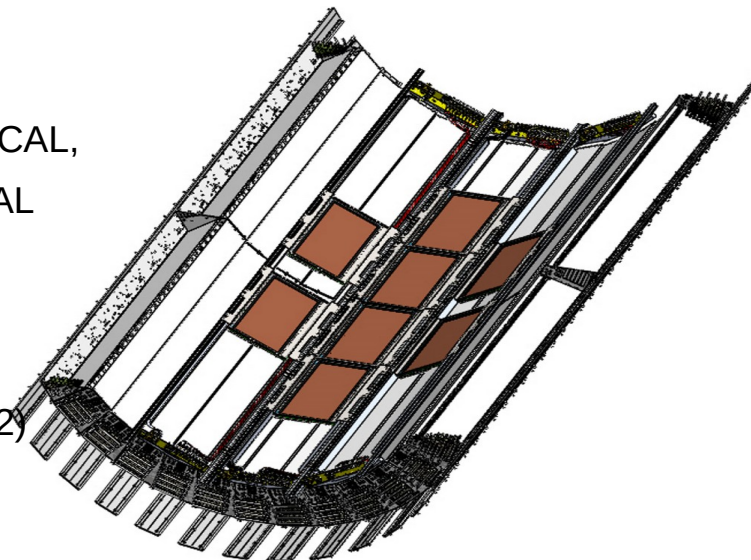
provide an additional space point on the outside of the sPHENIX TPC, in a fraction of the acceptance, to calibrate the TPC (i.e. **beam-induced space charge distortions**)

Concept:

- 8 identical modules of Micromegas detectors (2x1D detectors each),
- Located at the bottom of the TPC, above the EMCAL,
- Attached to picture frames mounted on the I-HCAL

Outline:

- TPOT highlights since last ALD review (Jan. 2022)
- Cost and schedule
- Summary



Saclay	LANL	MIT	BNL
Maxence Vandembroucke Stephan Aune Arnaud Bonenfant Audrey Francisco Cyril Goblin Aude Grabas Irakli Mandjavidize Ana Wills	Walter Sondheim Eric Renner Hubert van Hecke Dave Lee Bade Sayki H.P.	Jim Kelsey, Christopher Vidal	John Haggerty Takao Sakaguchi Bob Azmoun John Kuczewski Rob Pisani consulting from: Dan Cacace Connor Miraval Rich Ruggiero, etc.
12 FTE.month (engineering) 15 FTE.month (technician)	4 FTE.month (engineering)	4 FTE.month (engineering)	2 FTE.month (all)

Micromegas production at Saclay (1/3)



pressing resist. strips on PCB



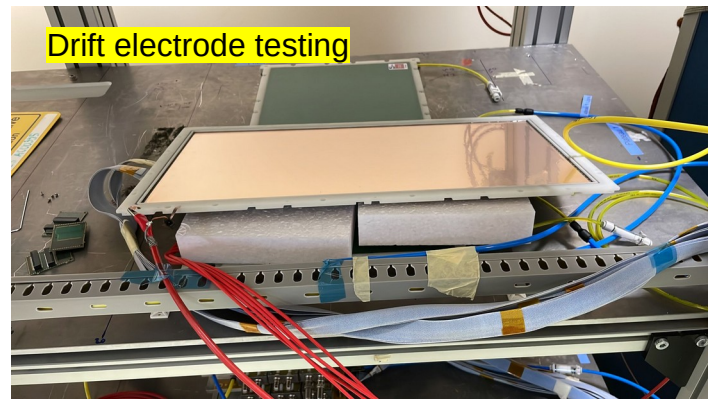
bulk process



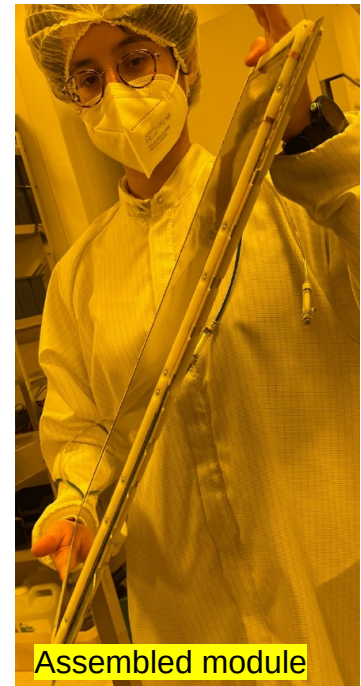
HV station at Saclay



Drift electrode



Drift electrode testing



Assembled module

Micromegas production at Saclay (2/3)

9 out of 10 Micromegas modules produced

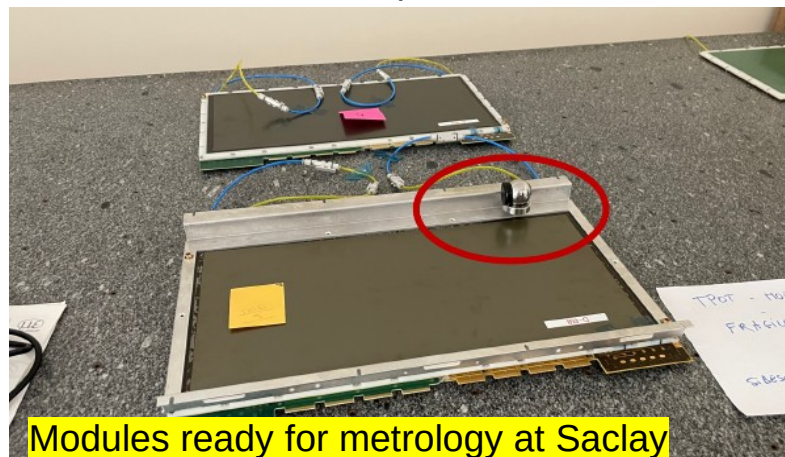
8 out of 10 modules are validated

one module available at BNL since May 2022, all other modules at Saclay

Work to go:

- finish last module (module 10)
- validate the last two modules
- assemble modules on detector trays
- metrology
- ship to BNL (exp. by July 25, if the detectors are hand-carried)

See presentation by Audrey



Modules ready for metrology at Saclay

Cosmic test bench at Saclay (MCube)



Micromegas detectors - performances

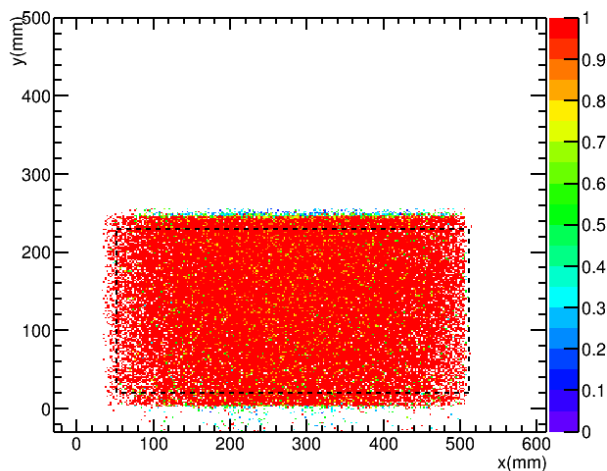


TPOT Key Performance Parameters

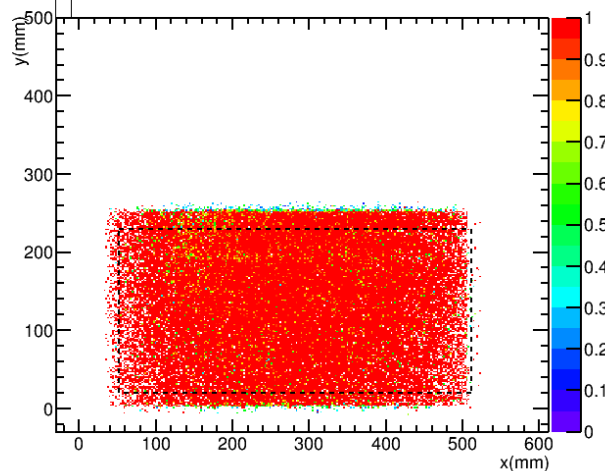
Radiation length (bare detector)	$< 10\% x_0$	✓
Active strips	$> 90\%$	✓
Hit efficiency	$> 90\%$	✓
Hit resolution	$< 200\ \mu\text{m}$ (Φ layer), $< 300\ \mu\text{m}$ (z layer)	✓

Efficiency Z

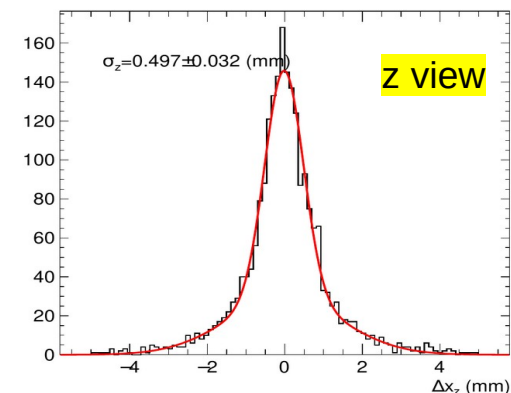
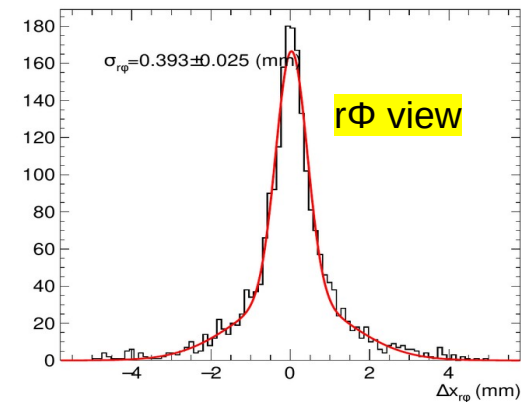
Efficiency Maps



Efficiency RPhi



See presentation by Audrey

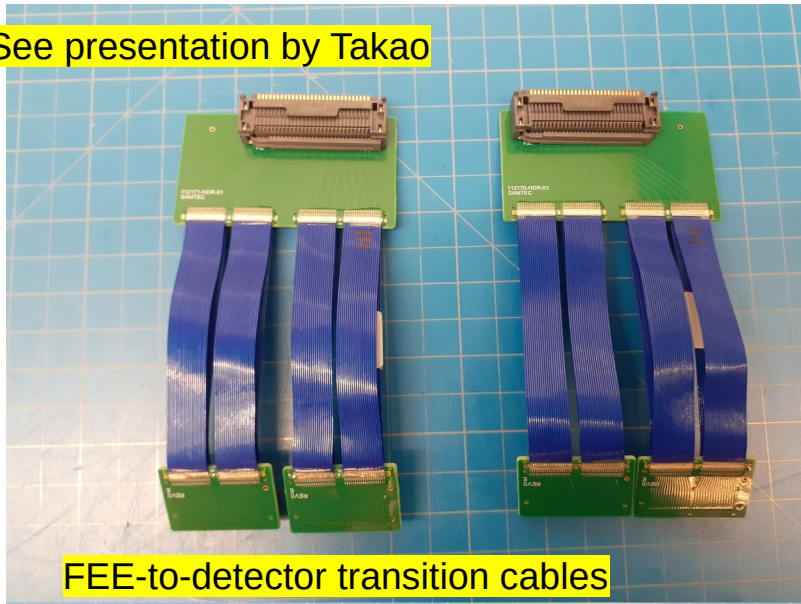


Hit resolution measurement, limited by large contribution from tracks

All parts at hand at BNL. Needed performance fully achieved

- All FEE boards needed for TPOT are available and tested
- Being assembled to support structure at BNL, together with gap pad and cooling plate (60% done)
- FEE-to-detector transition cables (SAMTEC) received and tested

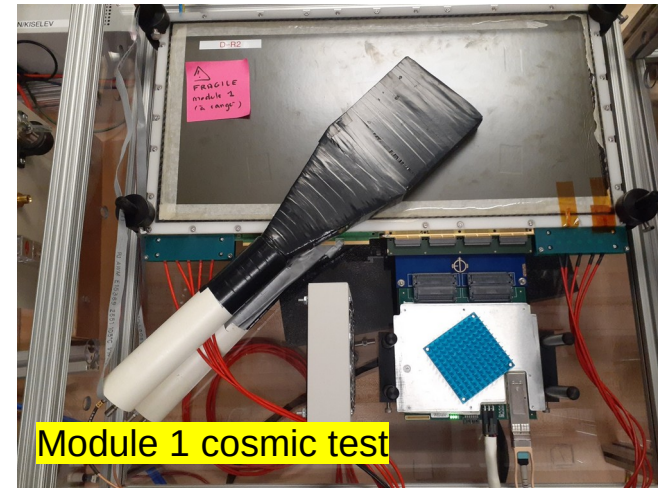
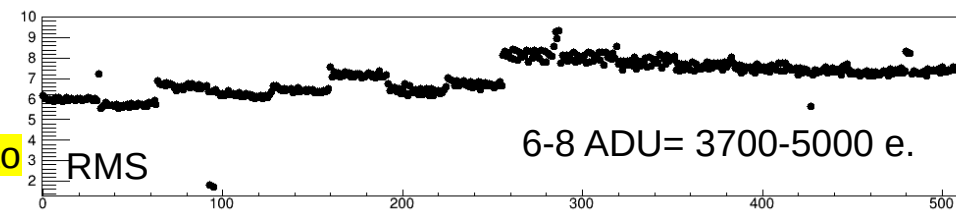
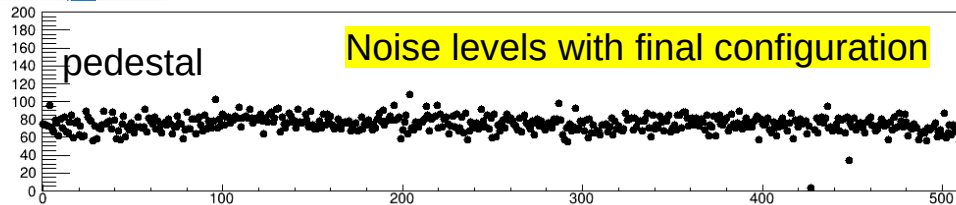
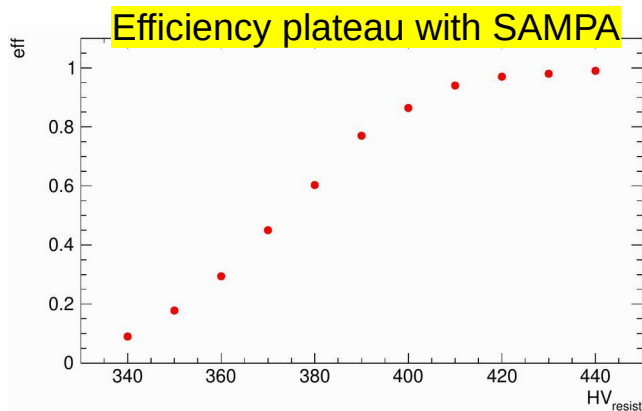
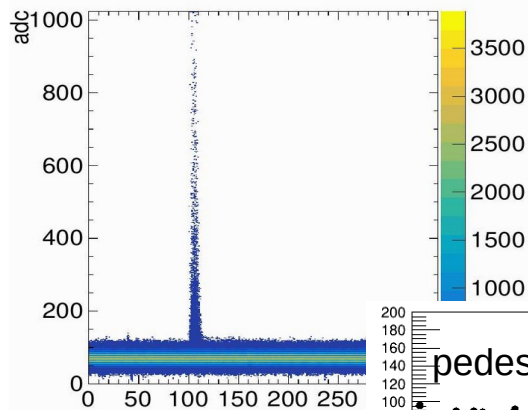
See presentation by Takao



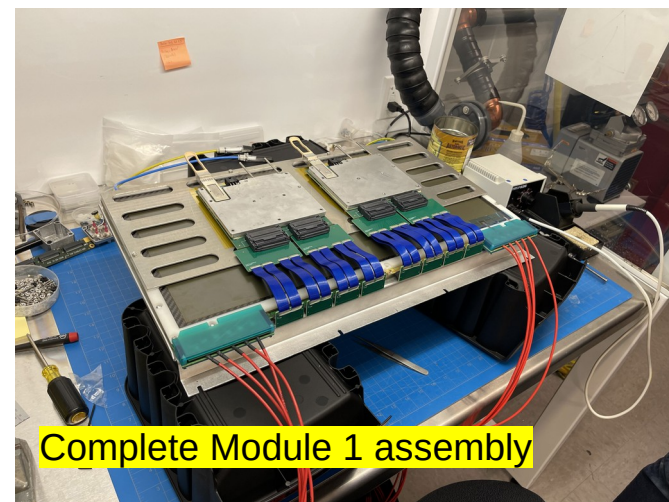
Electronics (cont.)

- June 2022: successful test of TPOT Module 1 + final electronics at BNL
- July 2022: First complete module assembly with FEE board, cooling plates mechanics

First signal observation with SAMPA



Module 1 cosmic test



Complete Module 1 assembly

See presentation by Takao

Mechanical integration and installation



See presentation by Walter

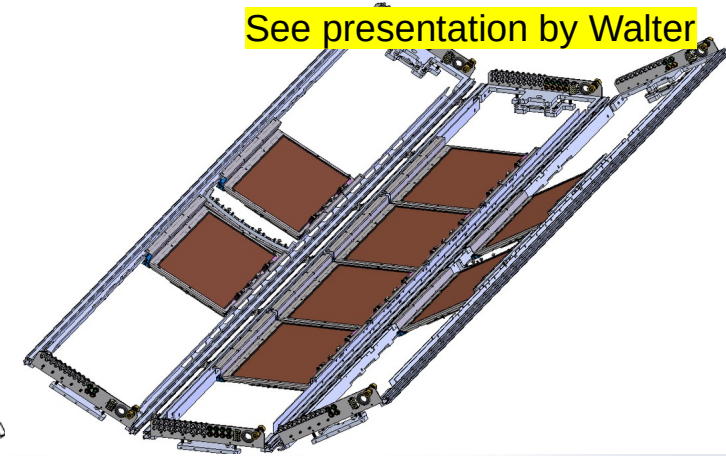
TPOT support structure

Design finalized. FDR on May 18

All parts ordered. Expected lead time: August 12 at BNL

Assembly has already begun:

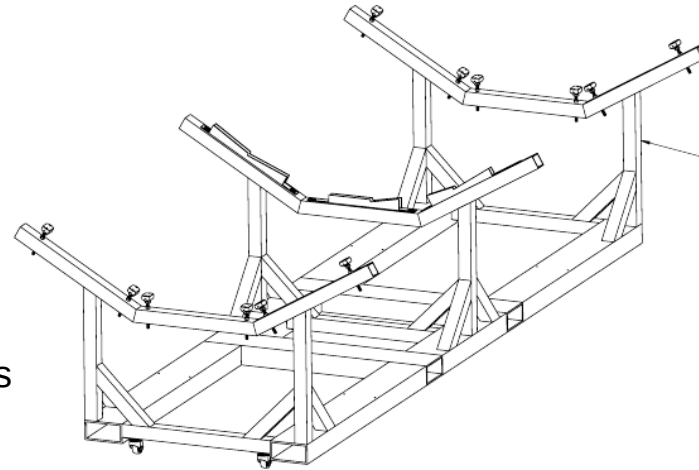
- detectors on tray (at Saclay)
- FEE + Gap pad + cooling plate on support (BNL)



TPOT transportation cart

Will be built at MIT/Bates

Lead time: mid August

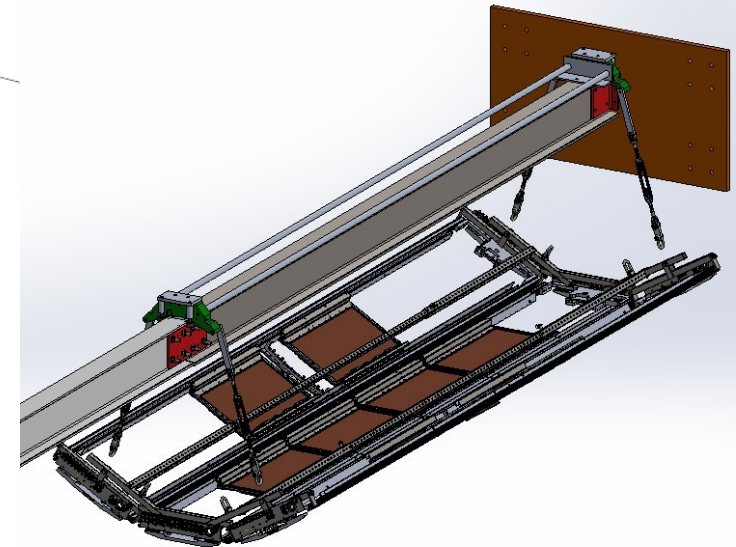


TPOT lifting

Lifting fixtures will be built at MIT/Bates

Lead time: mid September

Lifting/installation plan is being finalized with Russ Feder and sPHENIX Technical coordination



High Voltage

- HV Power Supply received and tested
- Work to go: HV cable definition and order

Low Voltage

- all cables ordered
- LV Power Supply follow sPHENIX schedule (will use free slots in TPC LV-PS)

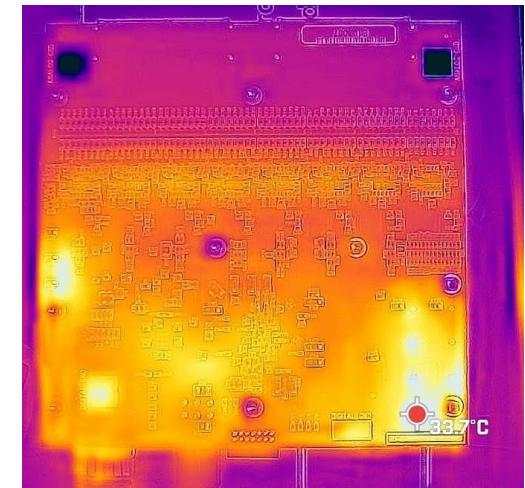
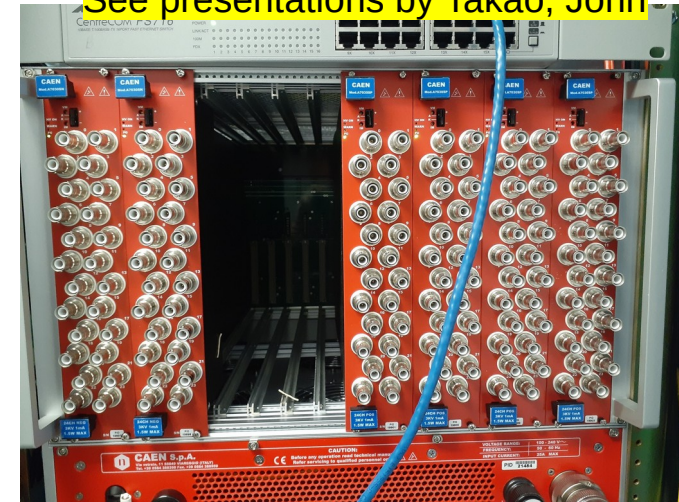
Fibers

- ordered fibers from sort-out box to patch panel
- work to go: define and order fibers from patch panel to detector

Cooling:

- FEE cooling plates received and tested
- will use same chiller as TPC
- work to go: tubing from chiller to detector

See presentations by Takao, John



See presentations by Takao, John

Gas

- ESRC review on June 21st
- will use pre-mix Ar/iC₄H₁₀ 95/5 rather than doing the mix ourselves
- No additional flammable gas detection needed
- will use modified PHENIX TOFW gas system

New !



Calibration needs

TPOT is but a small addition in scope wrt to TPC. It has very little calibration needs: pedestal and threshold, alignment

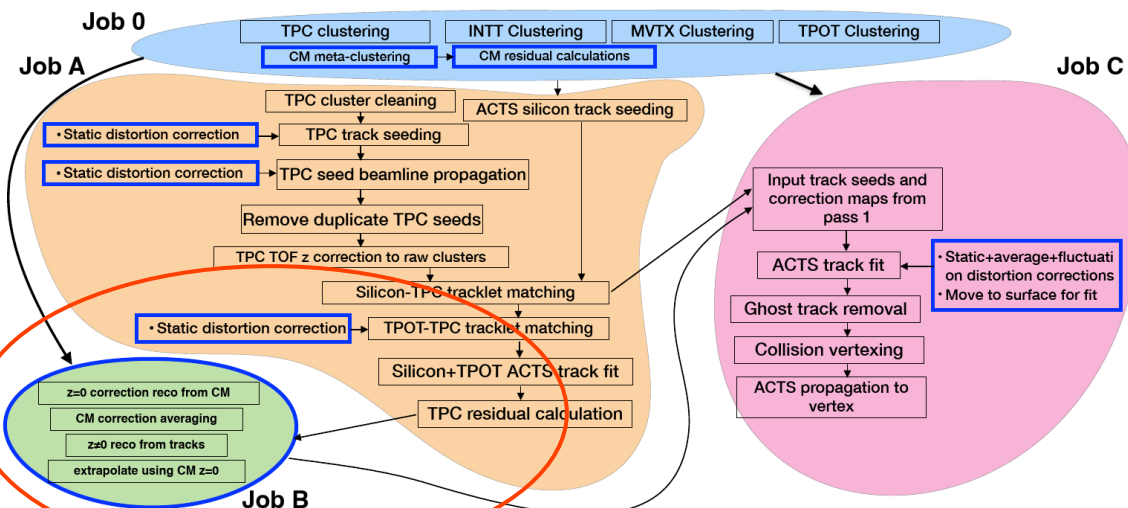
Code for pedestal and threshold easily adaptable from what is used for existing tests

TPOT geometrical implementation in sPHENIX is ready for sPHENIX alignment implementation (ACTS+millepede, ongoing)

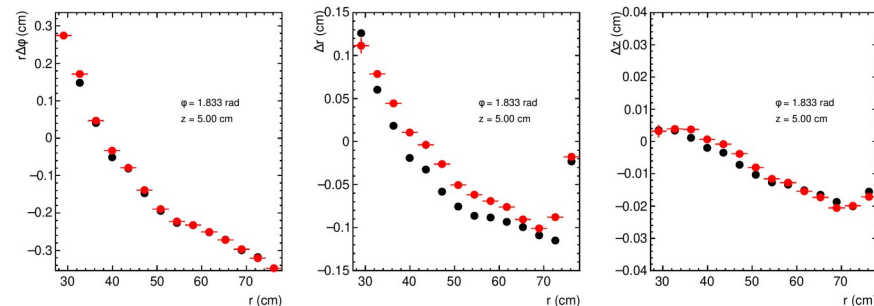
Reconstruction readiness

TPOT fully integrated in sPHENIX reconstruction software and in the TPC distortion reconstruction chain since 2021

SPHENIX reconstruction workflow (S&C review, 05/16)



TPOT ability to reconstruct SC distortions in the TPC



Cost, Schedule, testing and installation plans

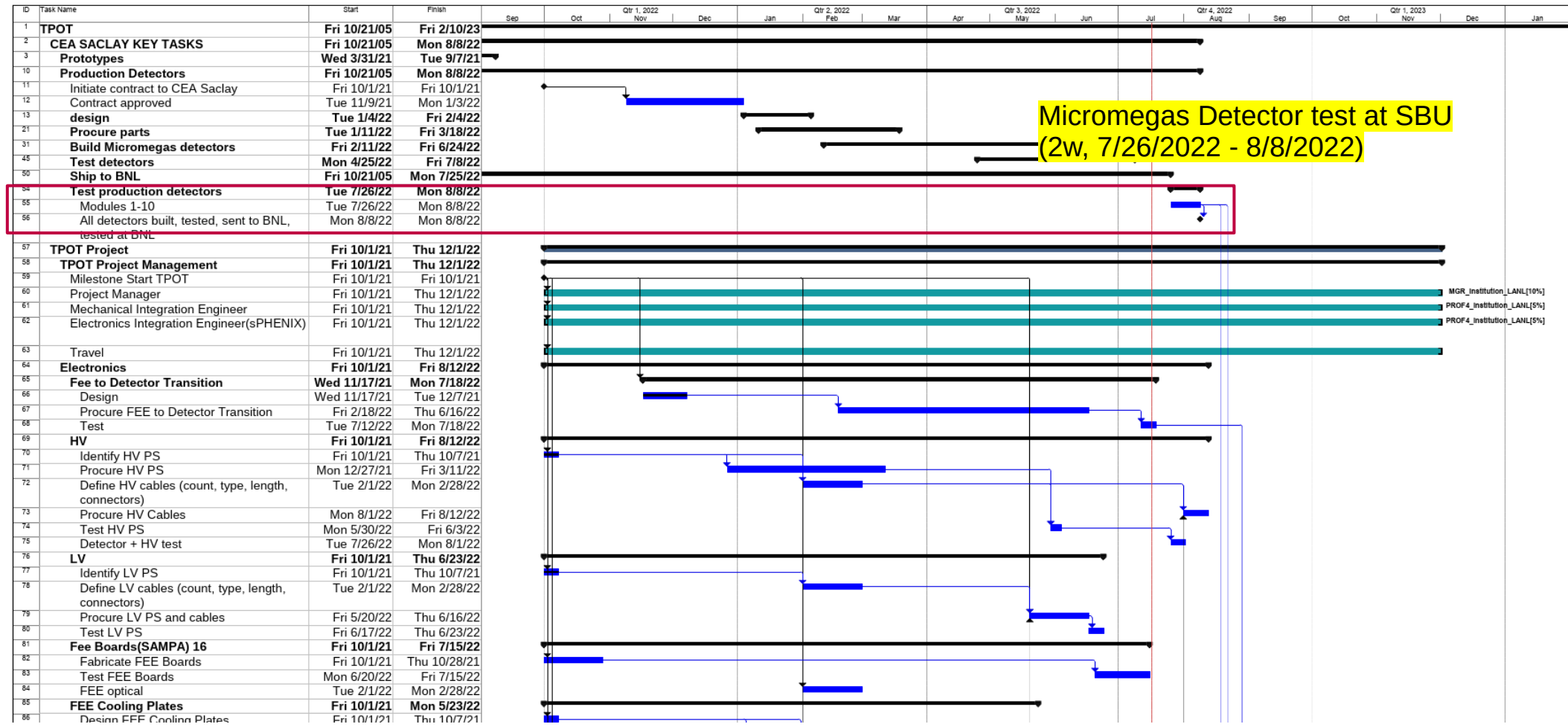
	Projected (\$)	Projected + contingency (\$)	Spent (\$)	Remaining (\$)	Remaining
Production Contract with Saclay	291,000	349,200	337,500	0	
FEE transition board	16,000	19,200	20,880	0	
HV Power Supply and cables	22,000	26,400	37,300	17,000	HV cables
LV Power Supply and cables	1,700	2,040	0	0	
FEE boards + Fibers	5,608	6,910	0	3,000	Fibers patch-panel to detector
FEE cooling plates	6,400	8,960	3,600	0	
FEE Backend (FELIX, EBDC, mighty-JACK, sort-out box)	14,000	16,800	0	0	
Mechanics	75,000	115,000	66,000	20,000	hardware, installation mechanics
Gas system	10,000	13,000	0	5,000	tubing
Cooling system	10,000	13,000	0	5,000	tubing
Total	451,708	570,510	465,280	50,000	

BNL agreed to cover all TPOT fixed costs, including production contract, up to \$600k

Spending are under control, consistent with projections. We have spent ~90% of what we need.

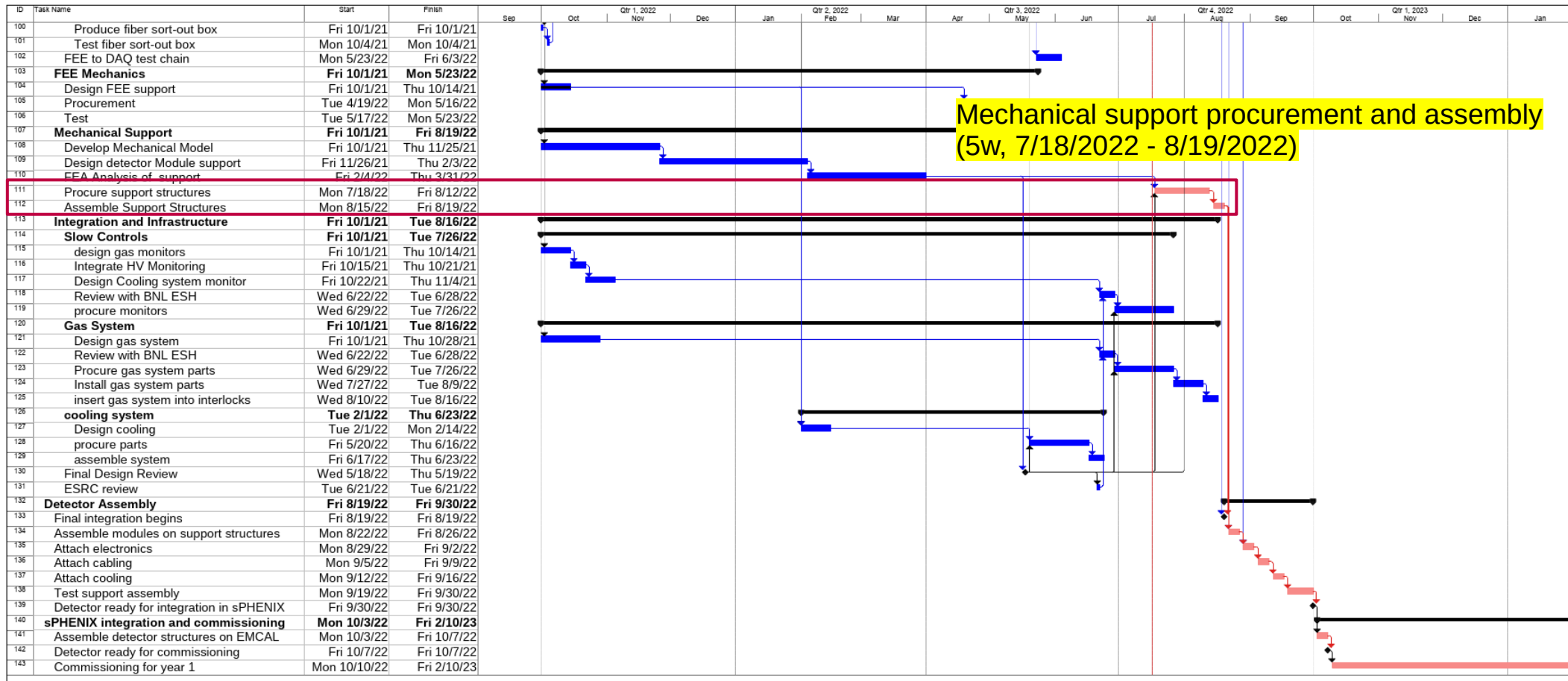
Carefully monitored

Schedule



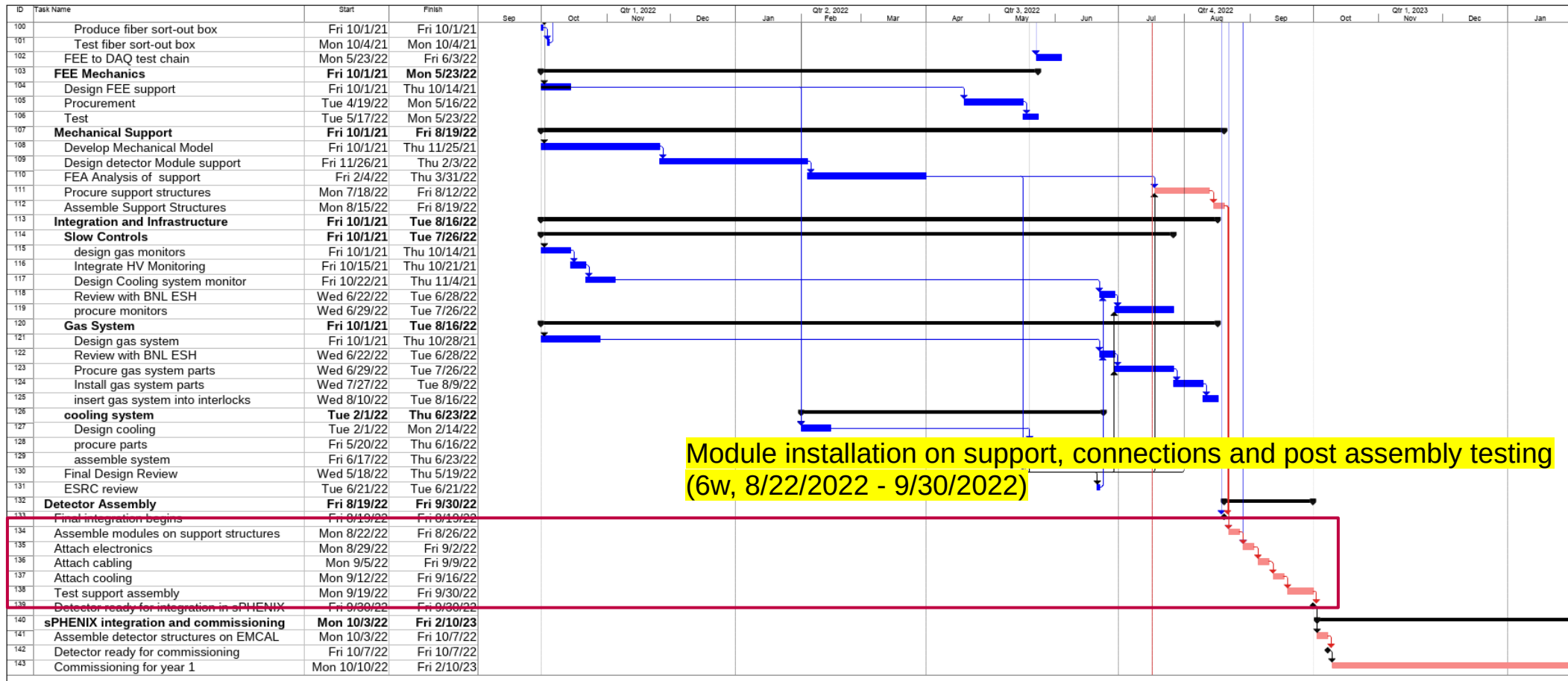
Micromegas Detector test at SBU (2w, 7/26/2022 - 8/8/2022)

Schedule



Mechanical support procurement and assembly (5w, 7/18/2022 - 8/19/2022)

Schedule



Module installation on support, connections and post assembly testing (6w, 8/22/2022 - 9/30/2022)

(see schedule summary in the backup)

High level milestones



Milestone	date	Status	risk
FEA analysis finished and reviewed	18/05/22	FDR happened. more FEA analyses requested. Agreed with Russ Feder to move forward	done
First batch of 5 TPOT Modules assembled & tested (Saclay)	07/06/22	6 modules assembled, test ongoing	done
FEE to detector fabricated and tested	07/18/22	cables/boards received on 6/21	done
HV system tested	06/16/22	happened on Week 21 (May 23)	done
Second batch of 5 TPOT modules assembled & tested (Saclay)	07/22/22		low
Characterization of all TPOT modules at SBU	08/08/22	(modules arrive at BNL on 7/25)	moderate
Gas system designed, ES&H reviewed and tested	07/07/22 → ?	designed and ESRC reviewed on 6/21	low
TPOT mechanical support assembled	08/19/22		moderate
installation of modules 1-4 on support structures	08/26/22		moderate
installation of modules 5-8 on support structures	08/26/22	same date. In parallel to modules 1-4	moderate
End of TPOT assembly	09/30/22		moderate
Installation of TPOT in sPHENIX	10/07/22	(also depends on sPHENIX schedule)	moderate

Detector characterization at SBU

what:

Duplicate the cosmic setup at BNL

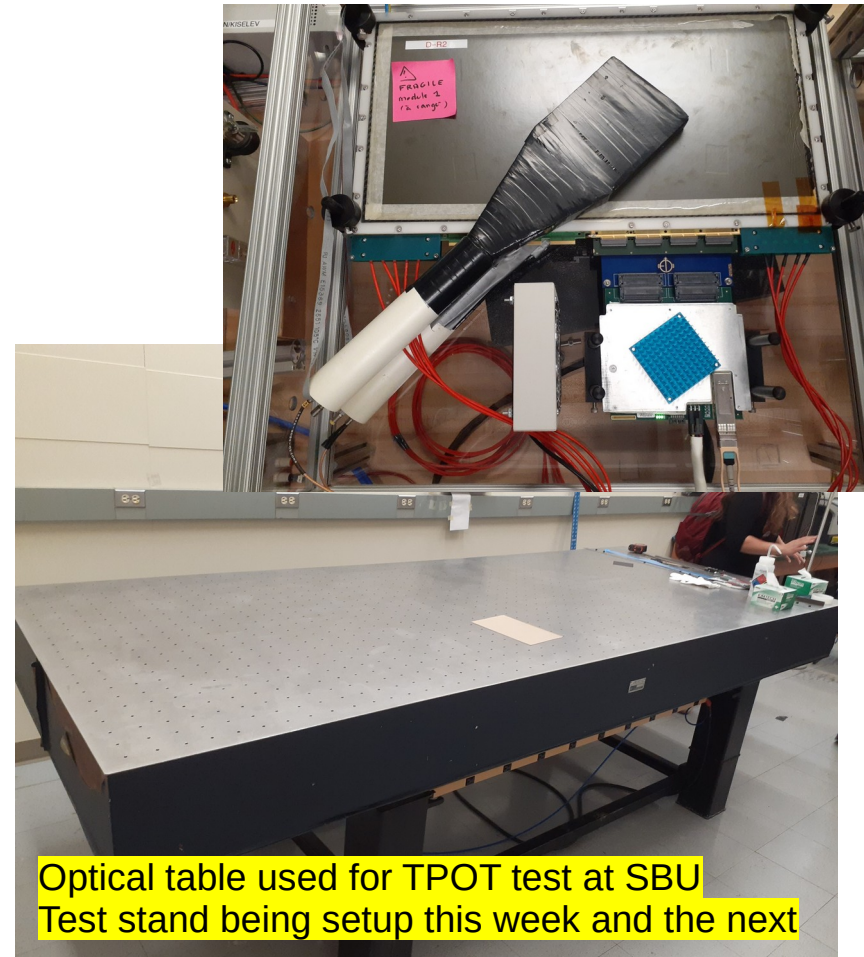
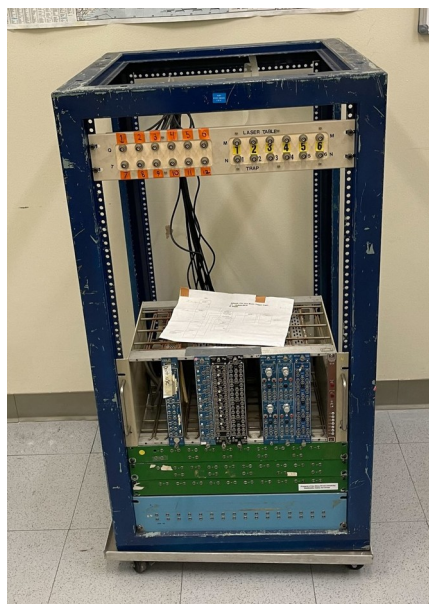
Make sure detectors have not been damaged during transportation

- check HV and currents, gas tightness
- check noise level and efficiency on cosmics

when: July 25 - August 8 (2w)

where: SBU (room S118)

who: Bade, Hugo, Takao, Audrey, Maxence (remotely)



TPOT assembly at BNL



What:

Assemble support structure on transportation cart. Assemble detector on support structure. Connect all services from detector to patch panel

When:

Support structure: Aug. 15 to Aug. 19 (1w)

Detector on structure: Aug. 22 to Sept 16 (4w)

Where: Building 912

Who:

Stefan Aune (1w, 10d max), Arnaud Bonenfant, Cyril Goblin, Maxence, Audrey from Saclay

Walter Sondheim, Eric Renner (LANL), Hugo, Bade

+ technical support from BNL

What:

Test that everything is connected properly and alive once TPOT is assembled and before it is installed in EMCAL

- gas tightness
- FEE cooling tightness
- all LV connected to FEE boards
- all HV connected to detectors
- leakage currents
- all electronic channels responding
- noise levels
- detector survey on structure

When: Sept 19 to Sept 30 (2w), depending on sPHENIX magnet mapping schedule

Where: Building 912 or (more likely) 1008

Who: Hugo, Bade Sayki, Takao, + support from BNL (John H., John K., Rob.) + support from Saclay

TPOT project is well underway

- Detector production is nearly complete, fulfills KPP
- Everything is ordered to start detector assembly. Some assembly has already begun
- Almost everything ordered for interface to sPHENIX
- Costs are under control
- Schedule is tight, carefully monitored

Charge

1. Are all the components for TPOT for installation and integration into sPHENIX produced and within specifications?
2. Are the quality control tests, acceptance tests, and characterization of TPOT modules within specifications?
3. Is the schedule of the TPOT sufficiently well understood and matched to the plan for installation in sPHENIX?
4. Are the risks introduced by the TPOT upgrade into the successful operation of sPHENIX well understood, and are sufficient plans to mitigate these risks in place?
5. Are the interfaces and integration with sPHENIX and RHIC well understood?
6. Is the gas system properly understood, including safety reviews, as needed for operation in sPHENIX?
7. Is the ES&H properly managed?
8. Is the software for calibrations for TPOT and production software for utilizing TPOT for TPC calibrations in place?

Agenda

- TPOT Overview - H.P. #1, 3, 8
- Micromegas detector - Audrey Francisco #3,6
- Electronic and LV - Takao Sakaguchi #1,3,5
- Mechanical support and installation - Walter Sondheim #1,5
- Services, slow control, ES&H - John Haggerty #1,5,6, 7
- Risk assessment and mitigation, summary - H.P #4

Backup

Simplified schedule



Task	Start date	End date
Micromegas detector test at SBU	7/26/22	8/8/22
TPOT support structure procurement	7/18/22	8/12/22
TPOT support structure assembly	8/15/22	8/19/22
Module installation on support, connection	8/22/22	9/16/22
Post assembly commissioning	9/19/22	9/30/22
TPOT installation on EMCAL	10/3/22	10/7/22

First signal observation with SAMPA

