

High-Rate Beam Test

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SoLID Collaboration Meeting

12/16/2021

SOLENOIDAL LARGE INTENSITY DEVICE

Motivation for High-Rate Beam Test

- Discussion at the Director's Review (2021) noted that
 - Only Cherenkov prototype detector tested under high-rate (2020)
 - https://solid.jlab.org/DocDB/0003/000300/001/solid_col_meeting_oct20_malace.pdf
 - Pre- R&D: identified need to test Cherenkov and DAQ
 - ECal and GEM have not been tested in conditions comparable to those expected by SoLID
 - Ecal Fermi Lab Beam Test (January 2021) focused on energy and position calibration
https://solid.jlab.org/DocDB/0003/000319/002/SoLID_EC_Jan2021.pdf
- A successful test utilizing the above subsystems would provide further confidence in their functionality at the expected SoLID experimental conditions
- **Plan is to perform high-rate beam test parasitically in Hall C during spring / summer run (2022)**
 - Utilize full detector subsystems (ECal, Cherenkov and GEM)

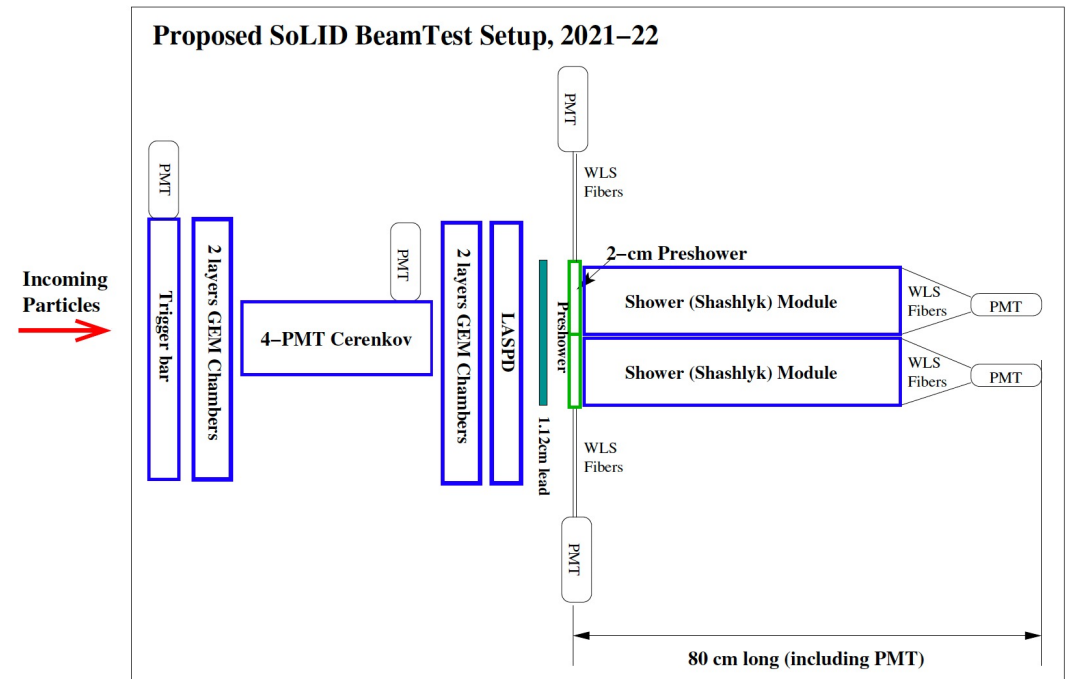
Goals and Objectives

- Perform beam test under similar experimental environment and conditions as SoLID
- Check performance of prototype detectors in high background environment
 - Scintillator and ECal operation with high trigger rates
 - Study GEM chamber performance in high-rate environment
 - Necessity of shielding?
- Investigate the effects of radiation to each system
- Tilted orientation of detector system

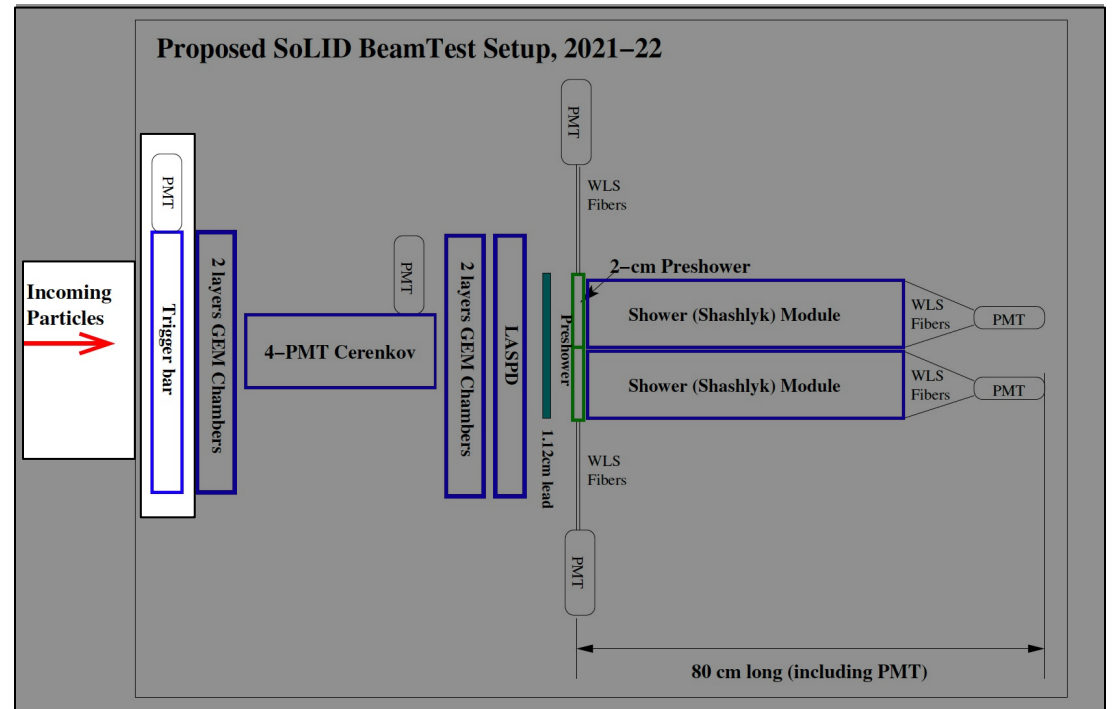
Setup of High-Rate Test

- Design, planning, and detector setup effort contributed by
 - Xinzhan Bai, Alexandre Camsonne, David Flay, Nilanga Liyanage, Michael Nycz, Jixie Zhang, Xiaochao Zheng

Setup of High-Rate Test



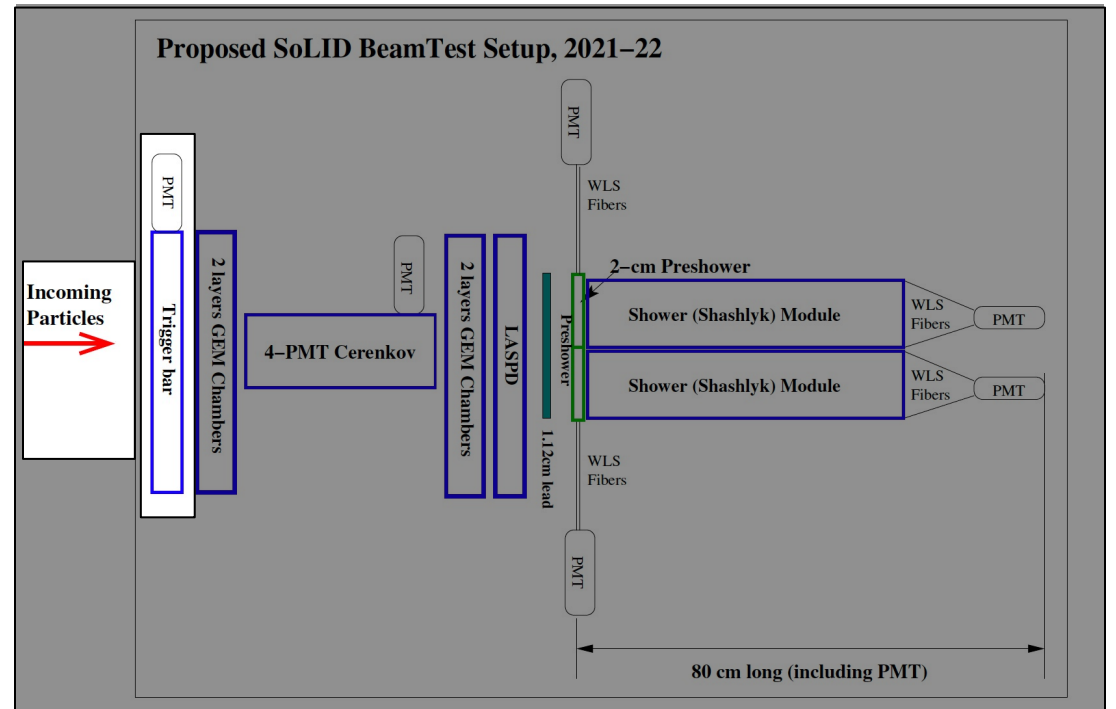
Setup of High-Rate Test



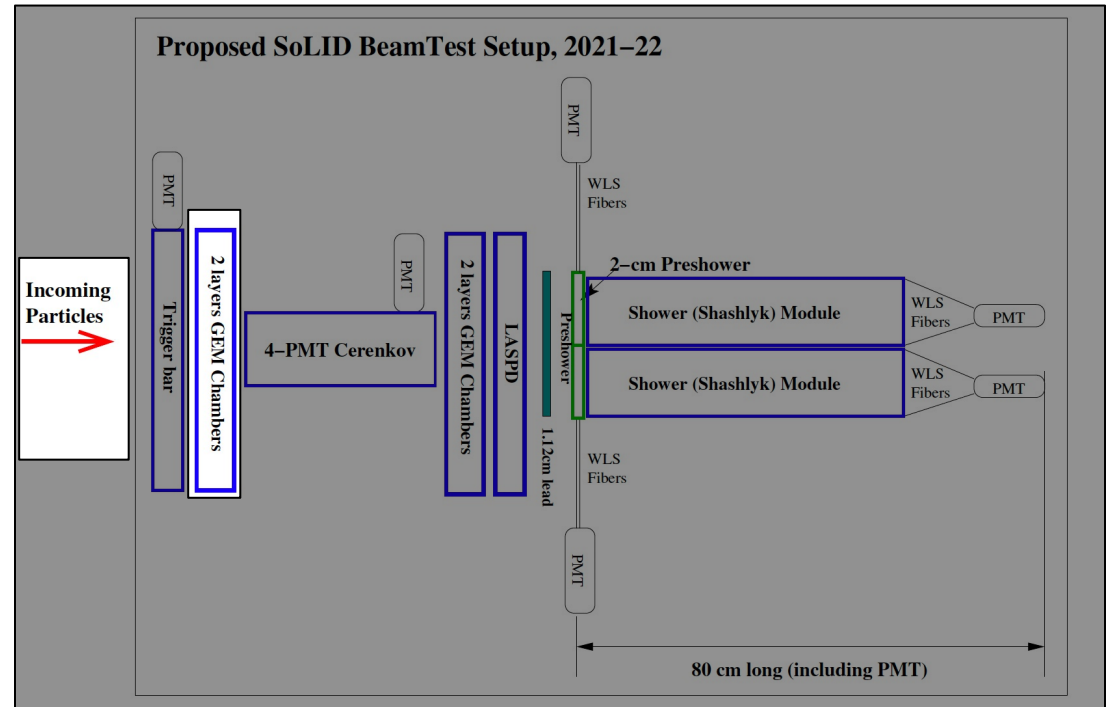
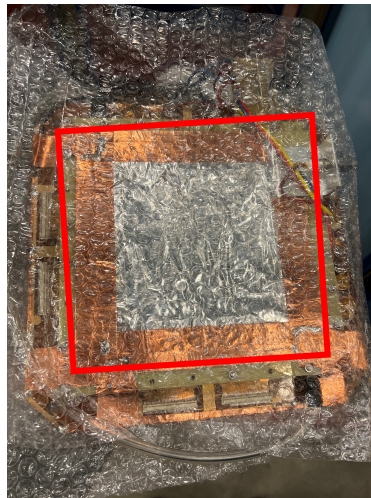
Setup of High-Rate Test



Used recently in Ecal Fermi Lab beam test



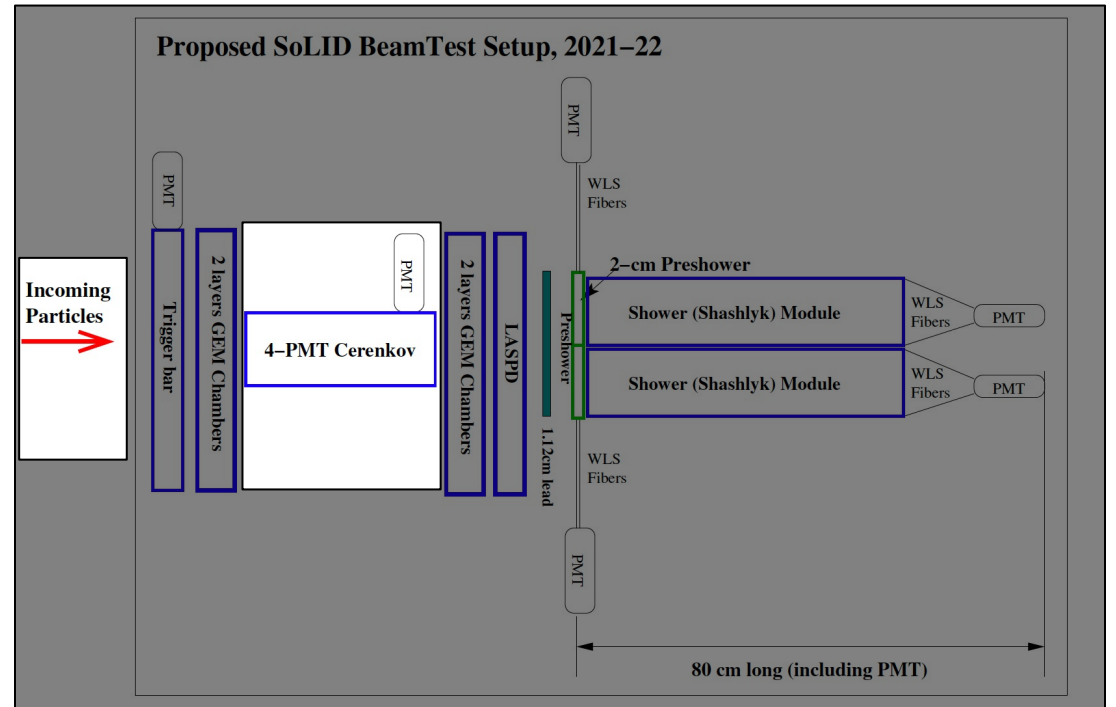
Setup of High-Rate Test



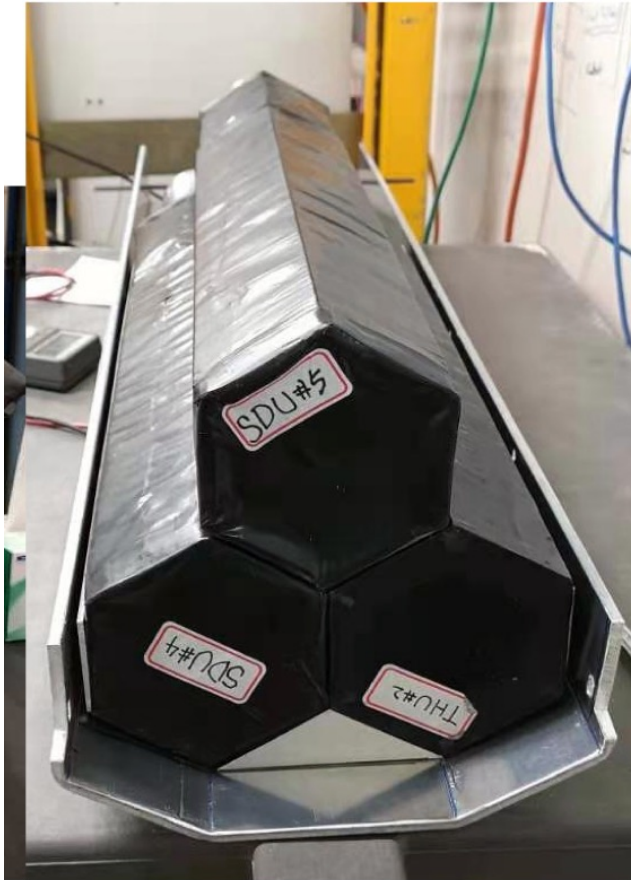
Setup of High-Rate Test



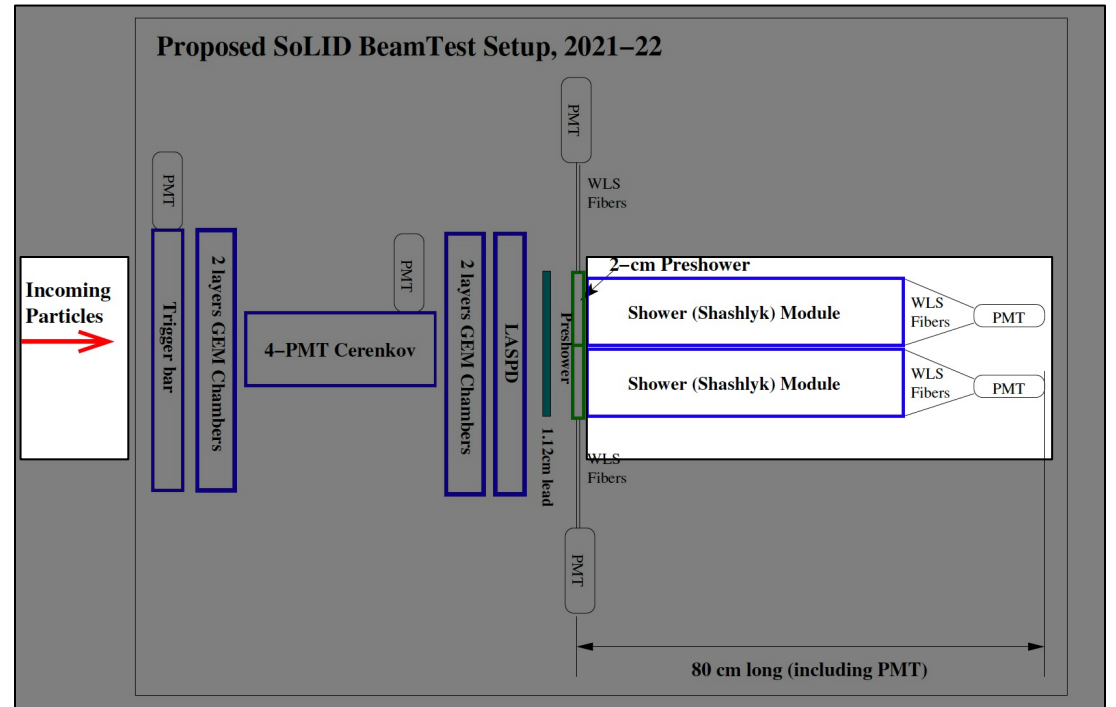
The “smaller” LGC prototype (2x2 tile of MaPMTs)



Setup of High-Rate Test



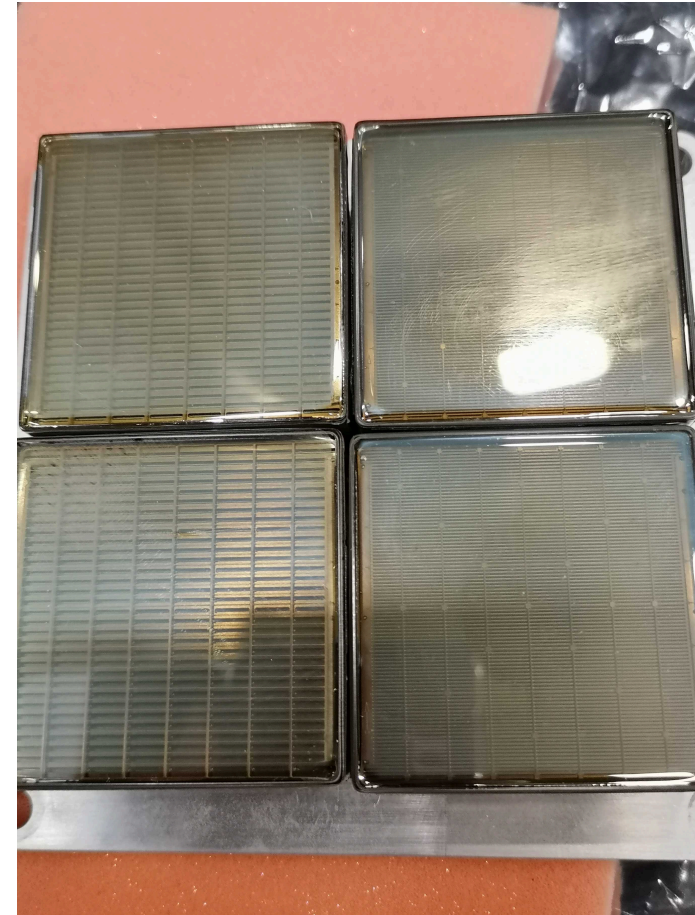
Used recently in Ecal Fermi Lab beam test



Status of Detectors and Materials

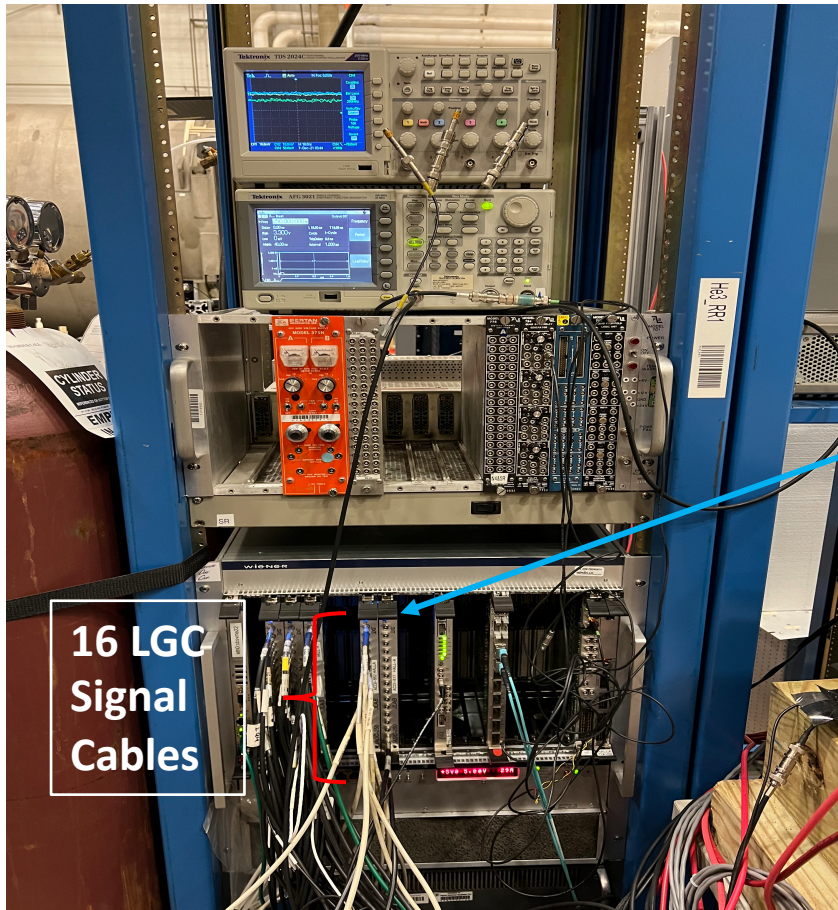
1.	Data Acquisition System	✓
	• Using Duke's setup for PMT tests	
2.	Gas System	✓
	• Connected and working	
3.	Scintillator paddles	✓
	• Used in Fermi Lab beam test (Jan. 2021)	
4.	Cherenkov prototype (Temple)	✓
	• PMTs were recoated with WLS (Temple / Argonne)	
	• Assembled and working	
5.	Ecal	✓
	• On site	
	• Used at Fermi Lab beam test (2021)	
6.	GEM (UVa)	✓
	• Setup in process	
7.	Analyzer / Decoder	✓
8.	Long Signal & HV Cables	✓
9.	Test Stand	

Using previously tested prototype detectors and systems!



Cherenkov Prototype MaPMTs
after recoating at Temple

Current Set up in Test Lab and Preparation

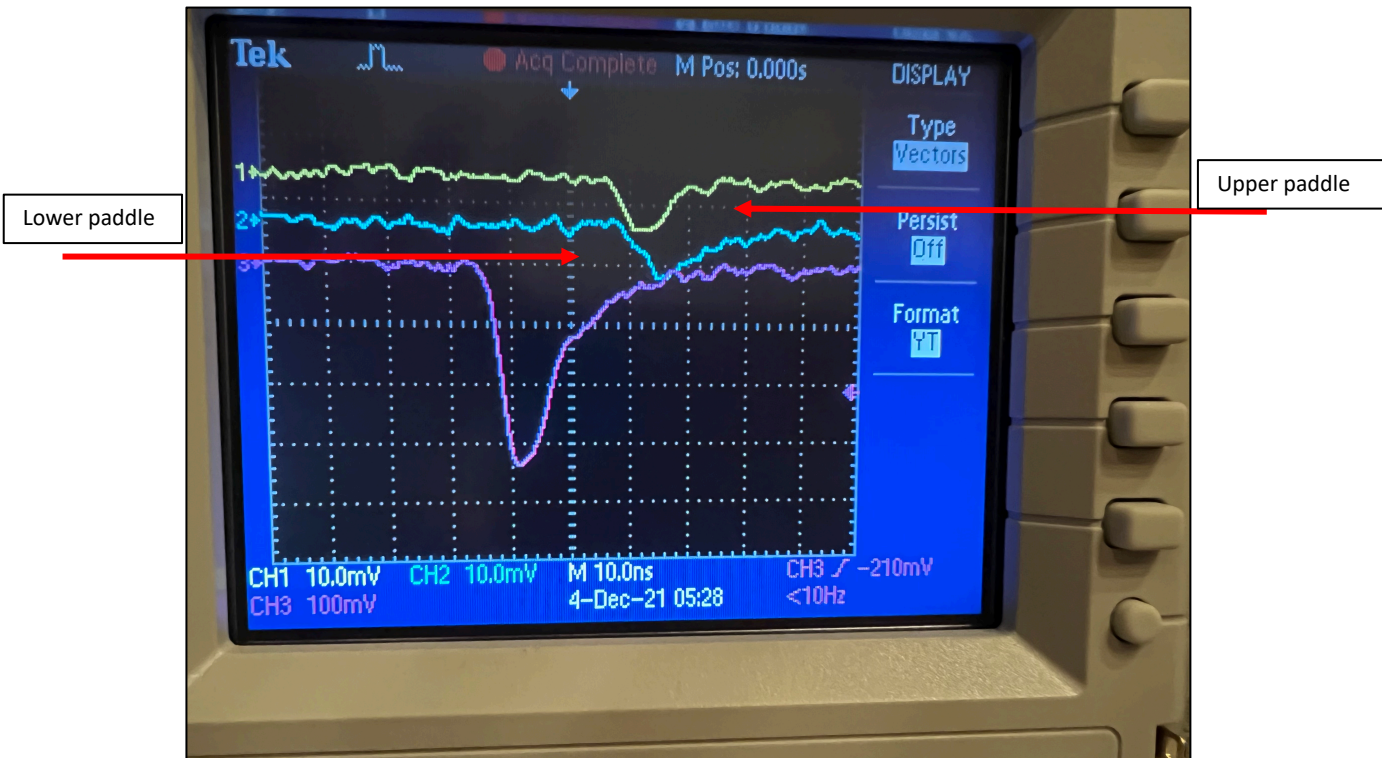


- Scintillator paddles
- Gas System
- DAQ (2 Flash ADC)
- LGC
 - Filled with N_2 gas



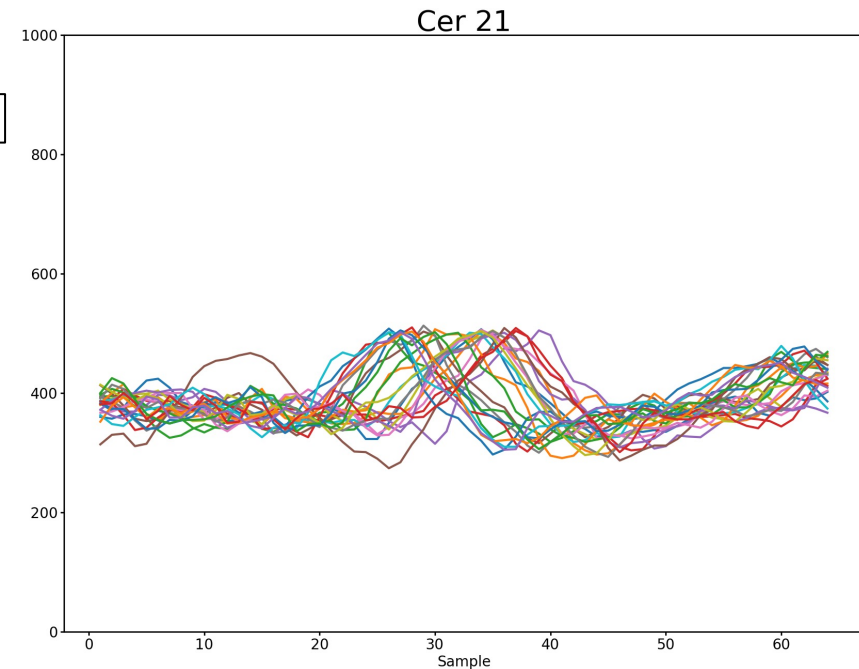
Scintillator and Cherenkov Signals

Scintillators



- Upper paddle is noisy
- Possible replacement using Hall A RHRS paddles

Cherenkov

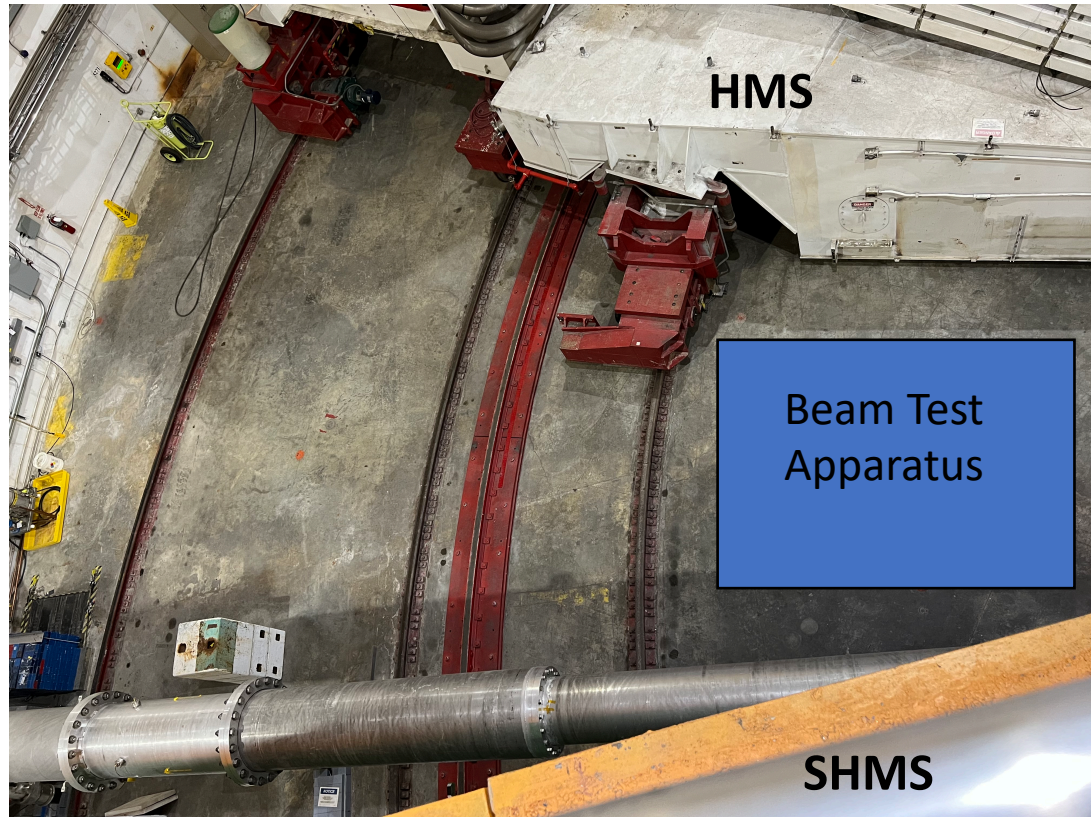


- Debugging of Flash ADC configuration ongoing

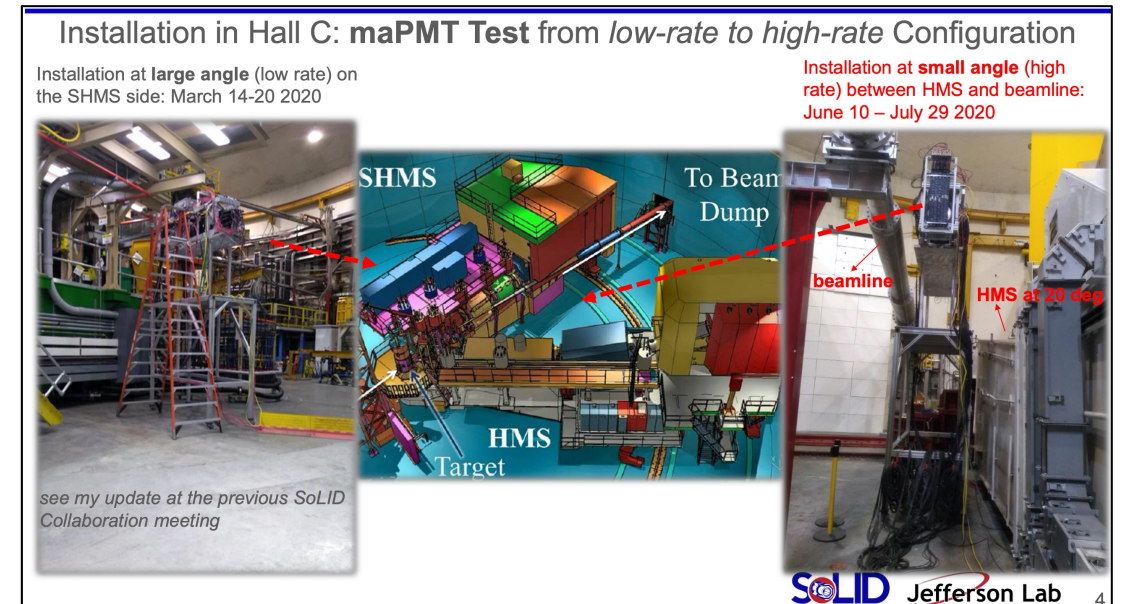
Preparation and Installation

- Continue with testing before installation in hall
- Low-rate test originally set for January has been delayed
 - Important for testing setup before high-rate configuration
 - Limited time for installation between the ending of current run and resumption in January
 - Will be done at the beginning of the June 2022 run period
- Remaining tasks
 - Test and integrate better scintillator paddles
 - Design and fabricate stand for high-rate test
 - Finalize location of high-rate test position with upcoming experiments
 - Need a clear plan to move from low-rate to high-rate

Proposed Hall C High-Rate Test Position(s)



Need to coordinate with upcoming experiments for moving from low-rate to high-rate position in Hall C



- Low-rate test at large angle (SHMS)
- Similar position as in the LGC beam test in Hall C (2020)

Summary

- Director's review highlighted the need for a high-rate beam test
- Setup currently in Test Lab
 - LGC prototype assembled and being tested with cosmics
 - GEM assembly finished shortly
 - DAQ and gas system working
- Due to time constraints, the low-rate test in January 2022 has been postponed
- Low-rate and high-rate test will both be done during spring/summer 2022 run period on schedule
- Completion of data analysis by end of 2022
 - (Contingent on schedule)

Thank you to the Hall A/C staff, techs, and engineers for help their help with Hall layout plans, locating materials, and many helpful suggestions!

Discussion: Hall C 2022

- E12-17-005 (CaFe)
 - 06/08/2022 – 06/15/2022
 - Beam Current: 25-60 μA (11 GeV)

TABLE I: Proposed kinematics of the beam time for the measurement.

E_{Beam} GeV	E'_e GeV	θ_e	$ \mathbf{p}_p $ GeV/c	θ_p	p_{miss} GeV/c	Q^2 GeV ²
11	9.85	8.0°	1.43	63.0°	0.40	2.1
11	9.85	8.0°	2.01	44.5°	0.15	1.8

SHMS

HMS

- Commissioning done at high p_{miss} setting (20 -60 μA)
- Experimental data: (25-40 μA)

- E12-10-008 (EMC)
 - 06/16/2022 – 07/26/2022
 - Beam Current: 11 – 80 μA (11 GeV)

Target	35 deg (SHMS)	20 deg (HMS)	25 deg (HMS)	30 deg (HMS)	40 deg (HMS)	40deg (SHMS)	total HMS time	total SHMS time
¹ H	39.6	2.8	5.4	15.7	40.1	24.6	64.0	64.2
² H	28.2	2.6	3.9	10.8	29.5	19.0	46.8	47.2
³ He	35.0	1.9			46.2	14.4	48.1	49.4
⁴ He	18.0	1.8					1.8	18.0
⁶ Li		5.4					5.4	
⁷ Li	82.9	4.5					4.5	82.9
⁹ Be		1.6					1.6	
¹⁰ B	18.8							18.8
¹¹ B	18.8							18.8
¹² C	18.8	1.6	1.6	5.3	16.7	6.8	25.2	25.6
⁴⁰ Ca	34.7							34.7
⁴⁸ Ca	24.3							24.3
⁶³ Cu		1.6					1.6	
Total	319	24	11	32	132.5	65	199	383.9

Li targets @ 15 μA
Ca targets @ 30 μA

remaining
30 μA > I_c < 80 μA

Commissioning?

- E12-06-105 ($x > 1$)
- 07/26/2022 – 09/30/2022
- Same targets as E12-10-008
 - Beam Current: 11 – 80 μA (11 GeV)

The experimental set-up for measurements with a 11 GeV beam would be performed using the existing HMS and the new SHMS which is part of the base equipment package for the 12 GeV upgrade. The HMS would be used for the highest Q^2 measurements at large angles and the SHMS would be used for the intermediate angles, $\lesssim 30^\circ$ providing the intermediate Q^2 measurements for $x \lesssim 1.5$, and the modest Q^2 but very large x measurements. Data would be taken in the HMS spectrometer using the existing detector package which includes a threshold gas Čerenkov counter and a lead glass shower counter for rejection of pion background. The SHMS will have a similar package of nearly identical performance.

- E12-19-006
- 10/01/2022 – 12/03/2022