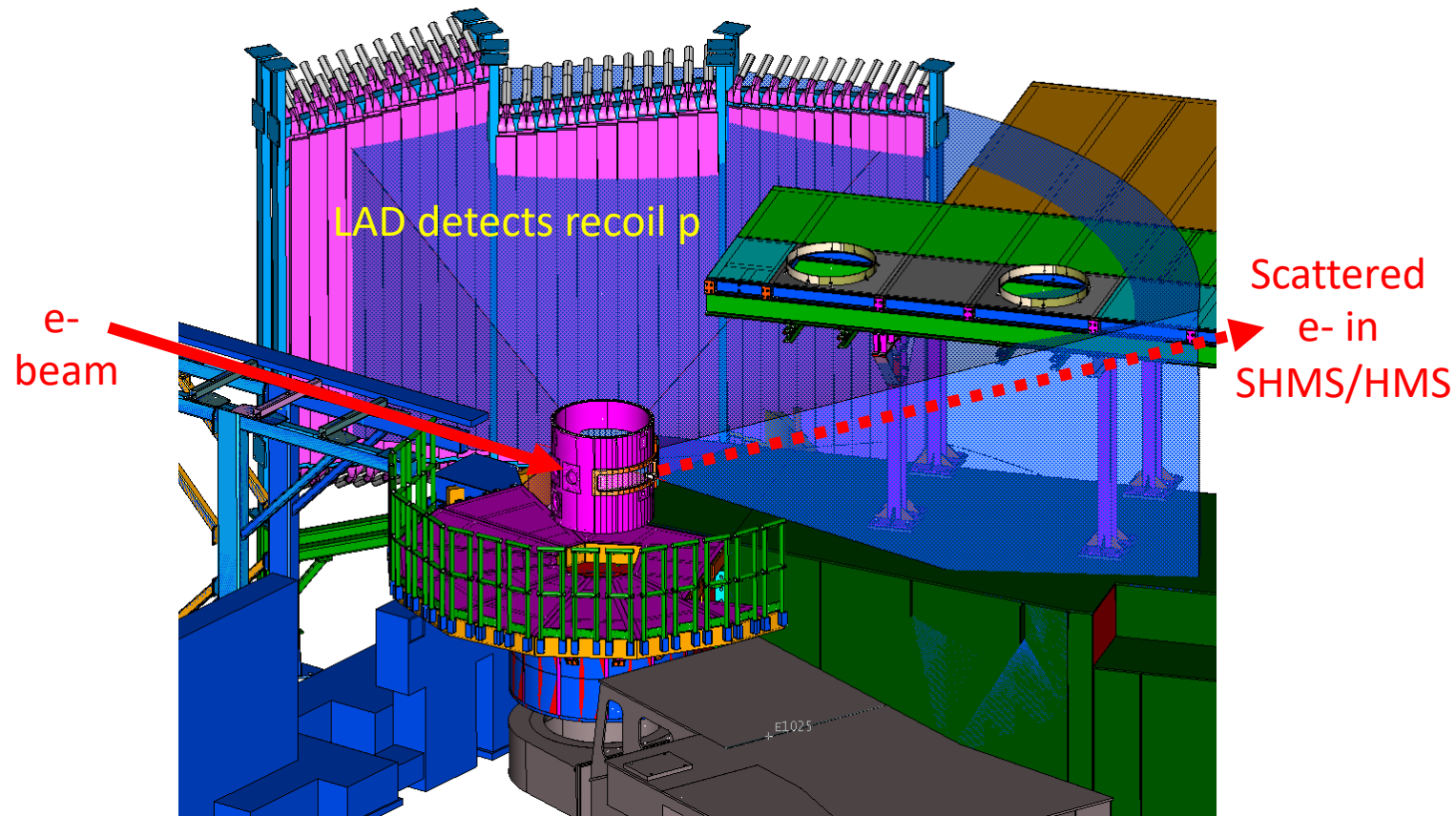


## Status of LAD, GEMs and Hall integration Addressing Charges 1 & 2

1. What are the running conditions for the experiment? Please state clearly the target, detectors, beamline configurations and operation as well as the integration of the LAD (and GEM) detector in Hall C. Has the detectors ownership, maintenance and control during beam operations been defined?
2. What is the status/performance requirements of the LAD and GEMs detector? If not completed, what are the completion/commissioning schedules, tasks and user commitment?

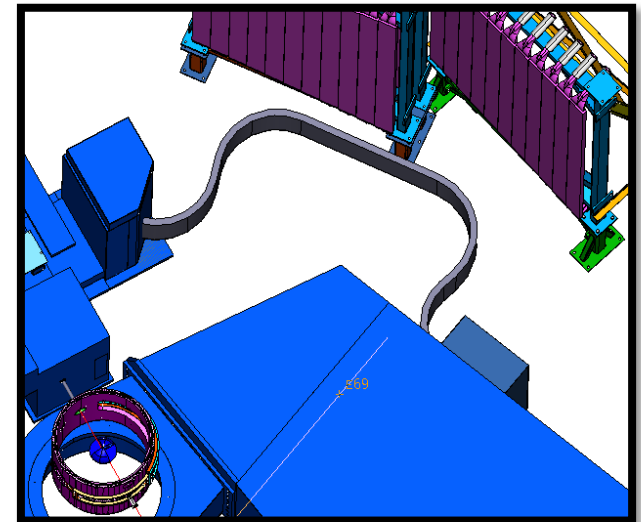
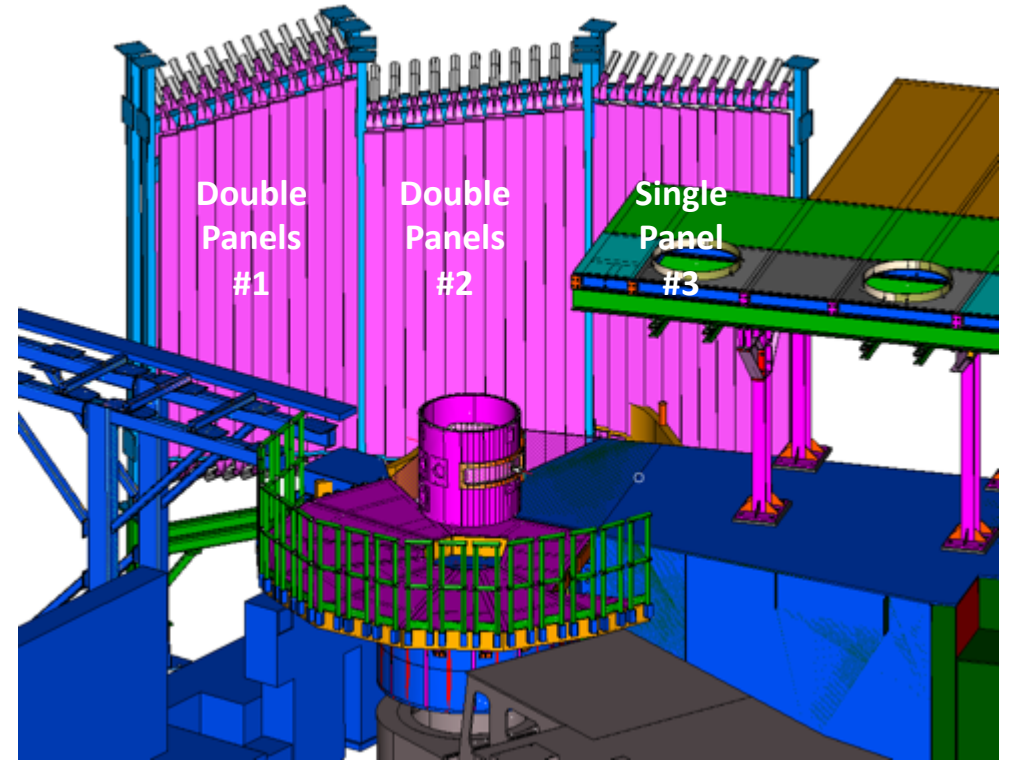
1. What are the running conditions for the experiment? Please state clearly the target, **detectors**, beamline configurations and operation as well as the **integration** of the LAD (and GEM) detector in Hall C. Has the detectors ownership, maintenance and control during beam operations been defined?

- 10.9 GeV beam at 1  $\mu\text{A}$ 
  - No raster
  - Need position lock
- HMS and SHMS measure  $e^-$
- LAD detectors detect recoil  $p$
- GEMs close to target for tracking

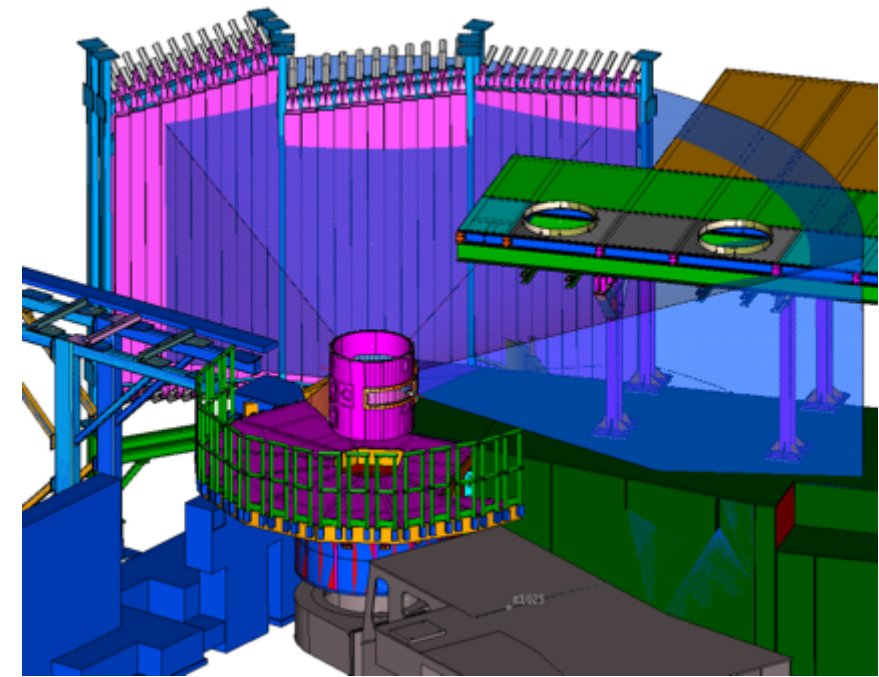
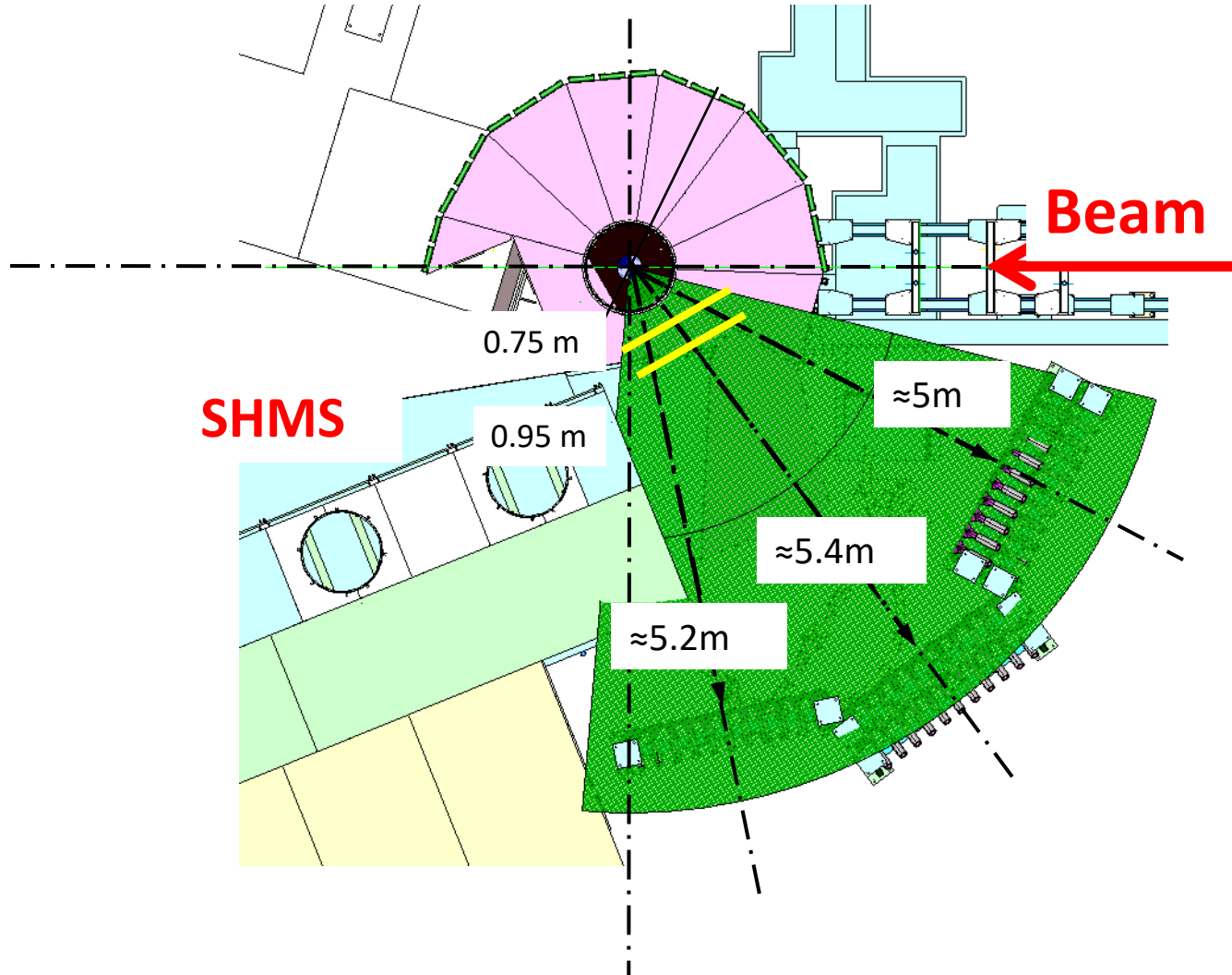


## LAD detector

- Refurbished CLAS TOF Scintillators
- 5 Panels with total 110 3inch-PMTs
- Readout with 7 FADCs and 1 TDC (128channel)
- Electronics in SHMS hut (1 VME and 1 HV crate)
- Laser calibration system
- Position of LAD between SHMS and beamline (90° - 157° degrees)
- Installation: 2-3 days inclusive crane work

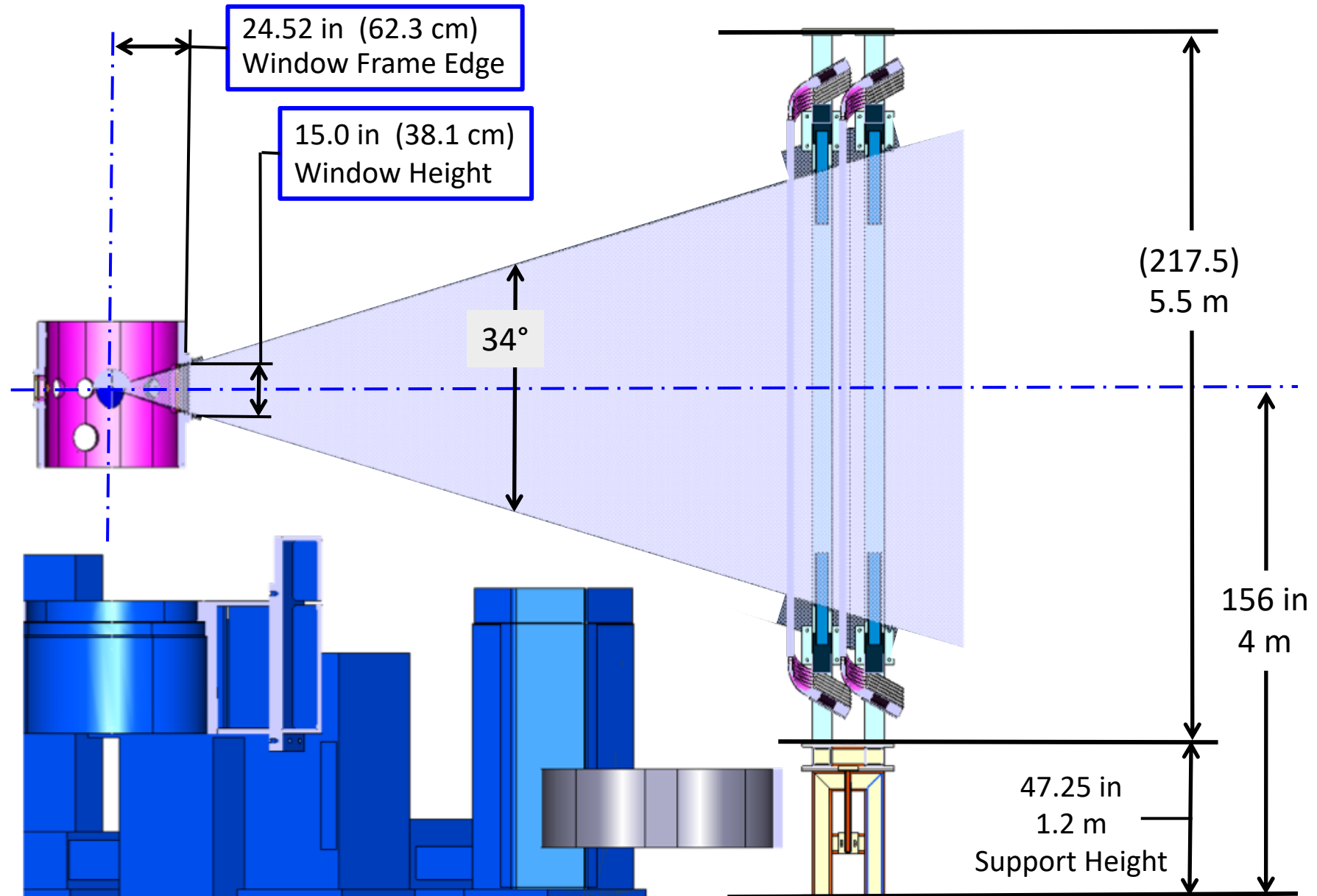


# LAD Position

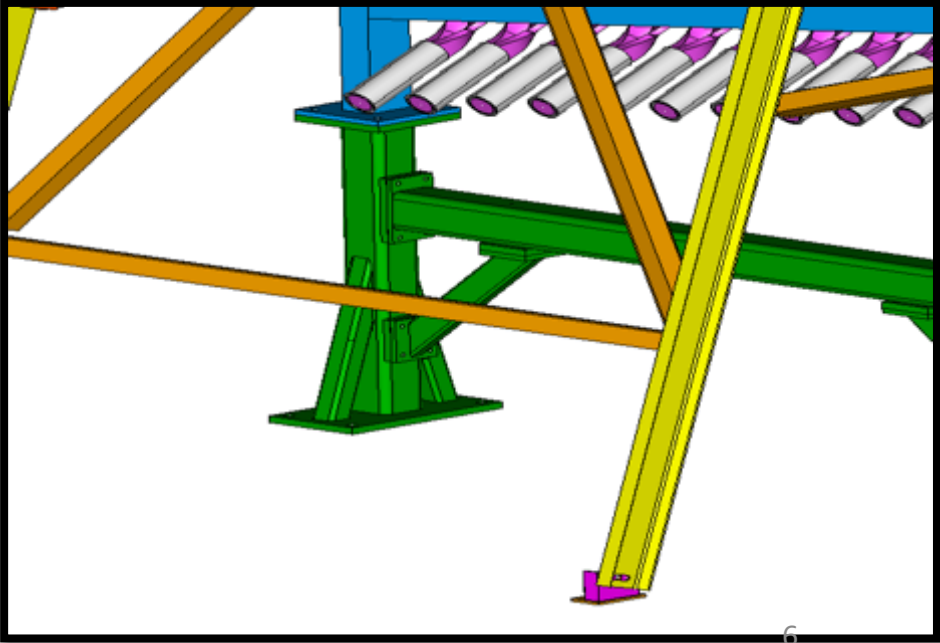
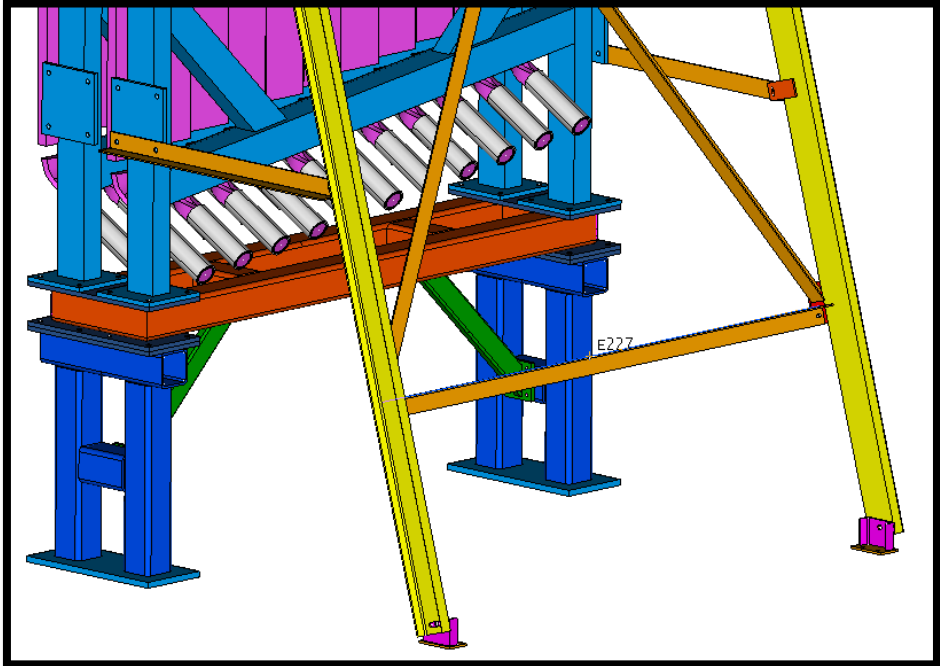
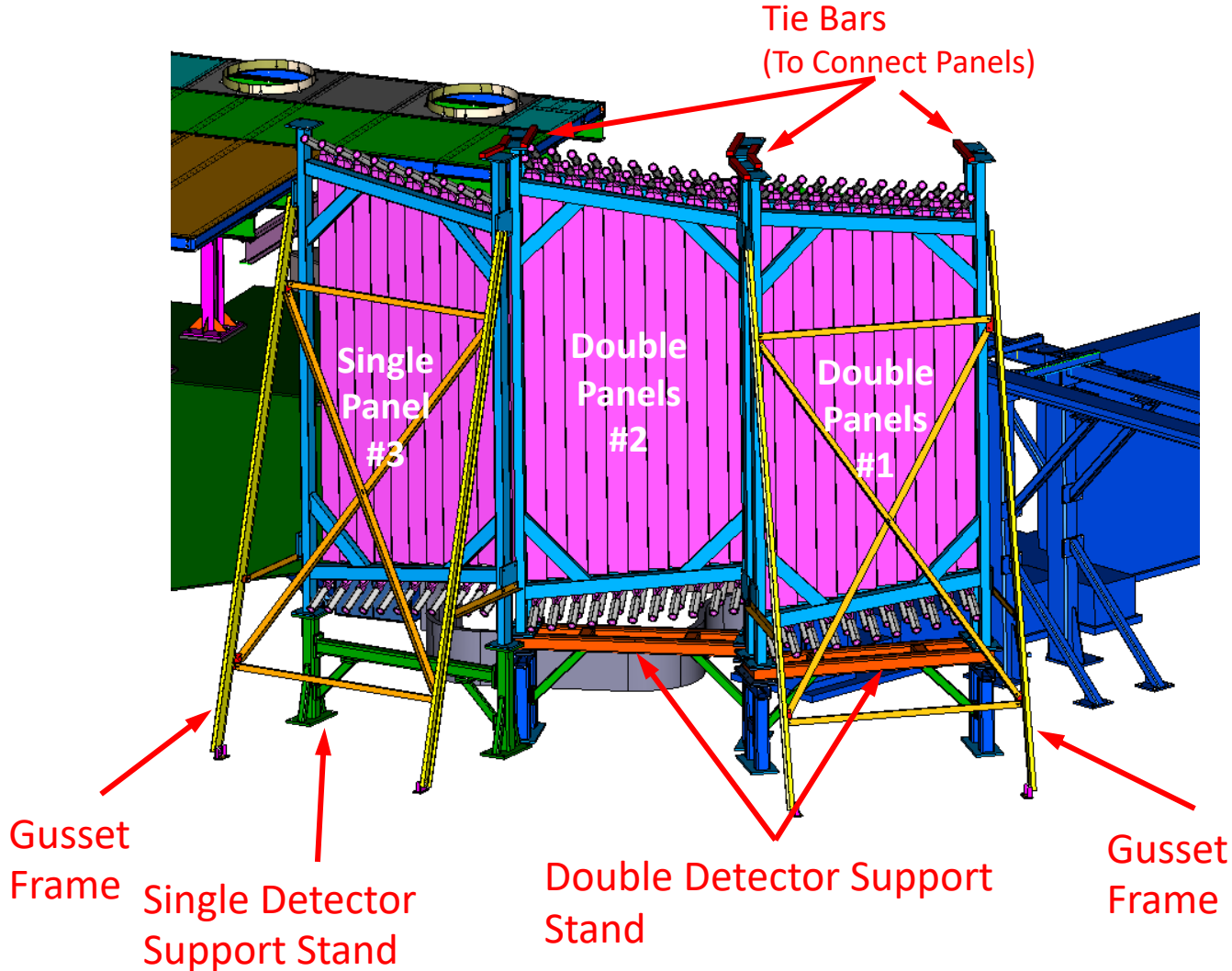


- LAD between 5.2 and 6.2m away from the target
- Out-of-plane angular coverage is +/- 17° for most of the LAD, angle is limited around 90° through the SHMS support structure
- SHMS cable tray has to be changed (HallC work)

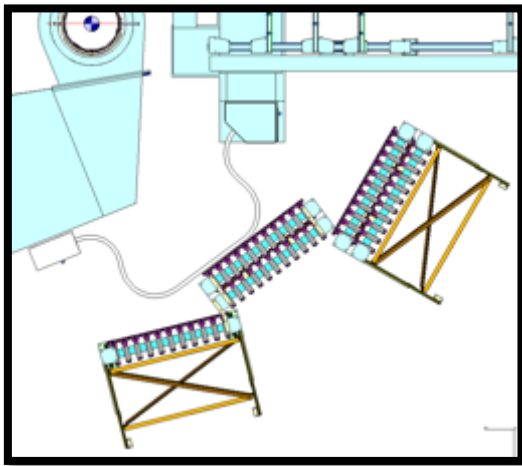
# LAD Position (side view)



# LAD Holder (designed by JLab)

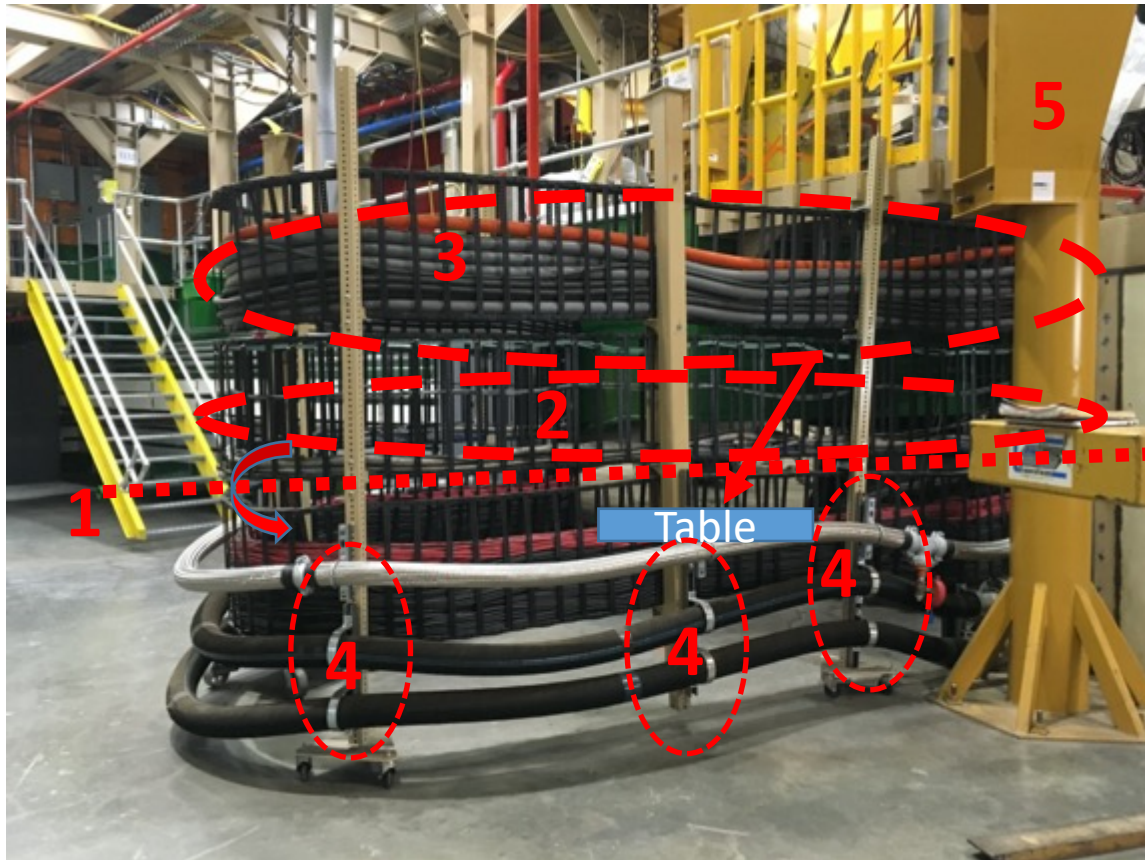
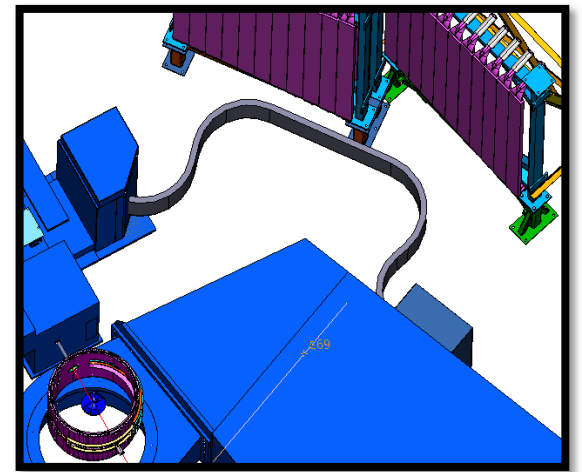






# SHMS Cable Tray:

Estimated worktime 1 week with 3 people, depending on man-power in parallel to scattering chamber

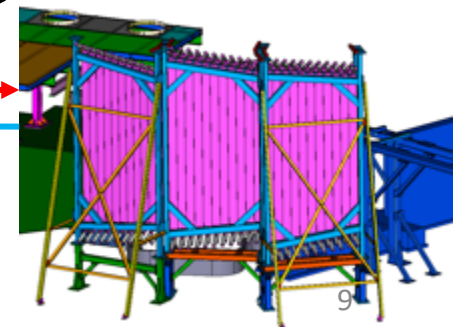
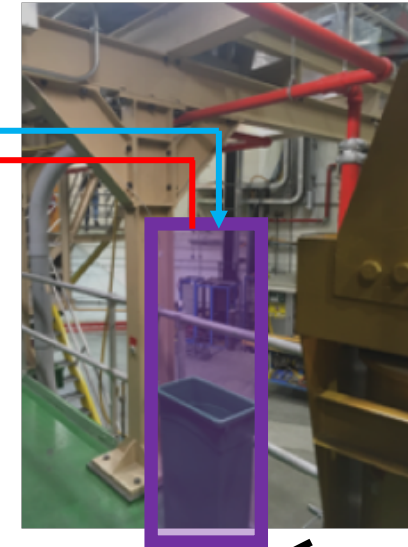
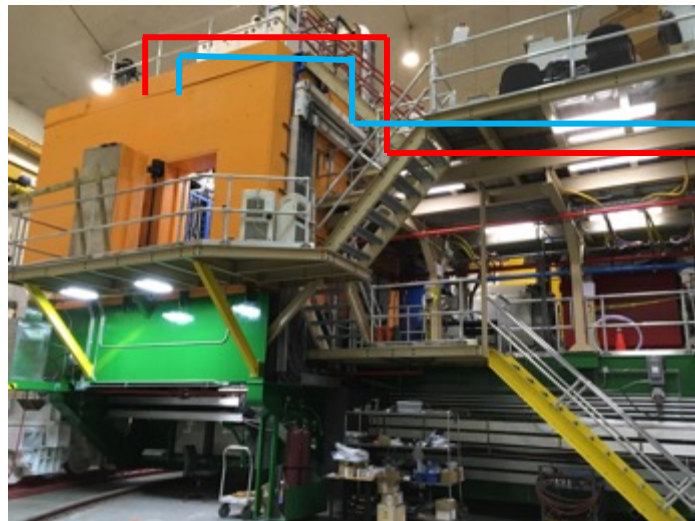
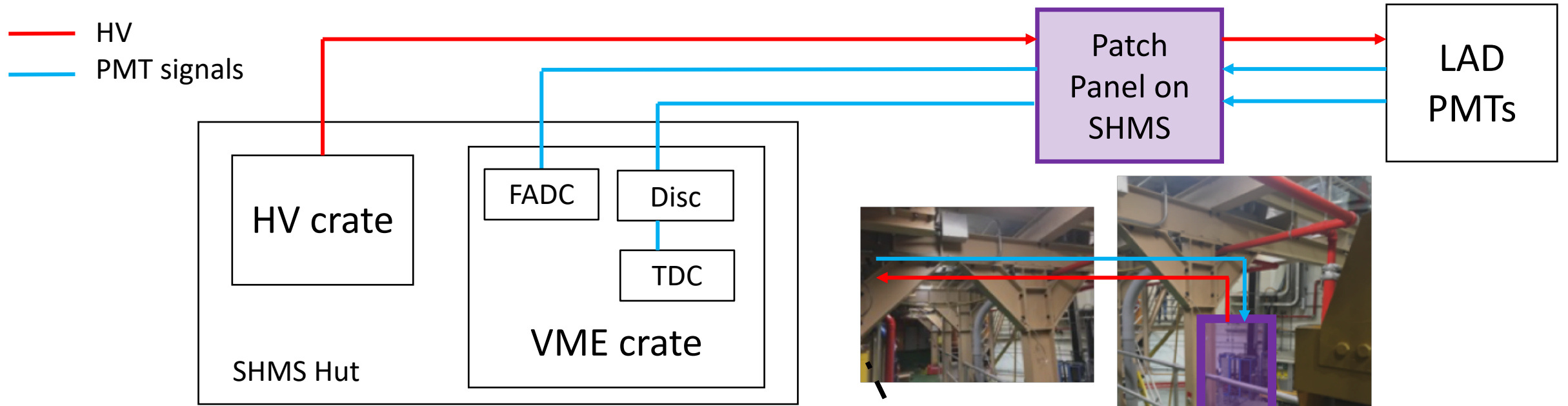


## Plan for cable tray (developed with W. Kellner)

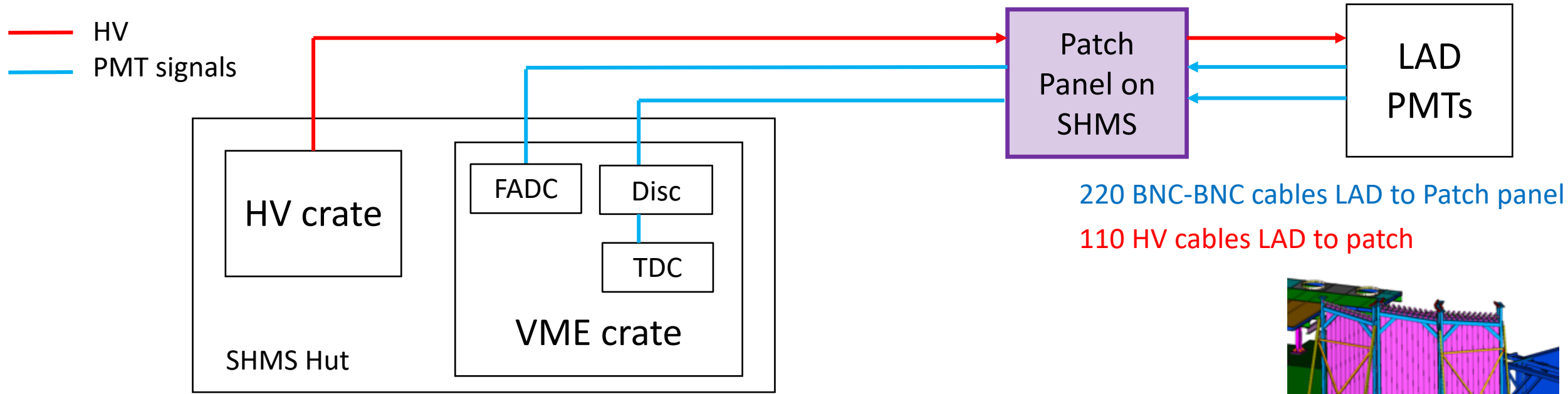
1. Lower cable tray support poles will be replaced temporarily with shorter ones (less than LAD height)
2. Middle cable tray will be disassembled and middle cables will be tied with cable binder to lower tray
3. Upper cable tray will be disassembled and the cables in the tray will be placed on a table (as support) at the ground next to the pivot
4. The temporary support poles (5 pieces) will have support brackets to hold the 3 flexible hoses
5. The crane which holds one of the current support poles will be removed



# LAD Electronics and Cables (1)



# LAD Electronics and Cables (2)



1 VME crate in SHMS hut

1 TI board (for trigger interface)

1 SD card for the FADCs

7 FADCs w/ 16 channels

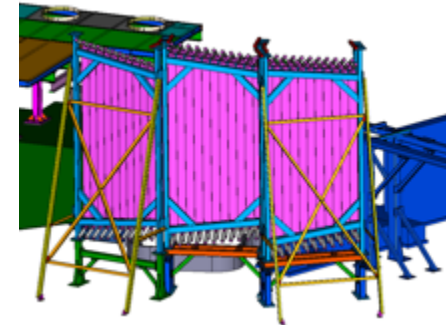
1 128 channel TDC Caen 1190 (100ps reso.)\*

7 discriminators/scalers boards (Jlab design) w/ 16 channels (loaning from Hall B/D)\*

1 Caen HV crate in SHMS with 12 HV boards. Max. PMT Current  $\sim 0.5\text{mA}$

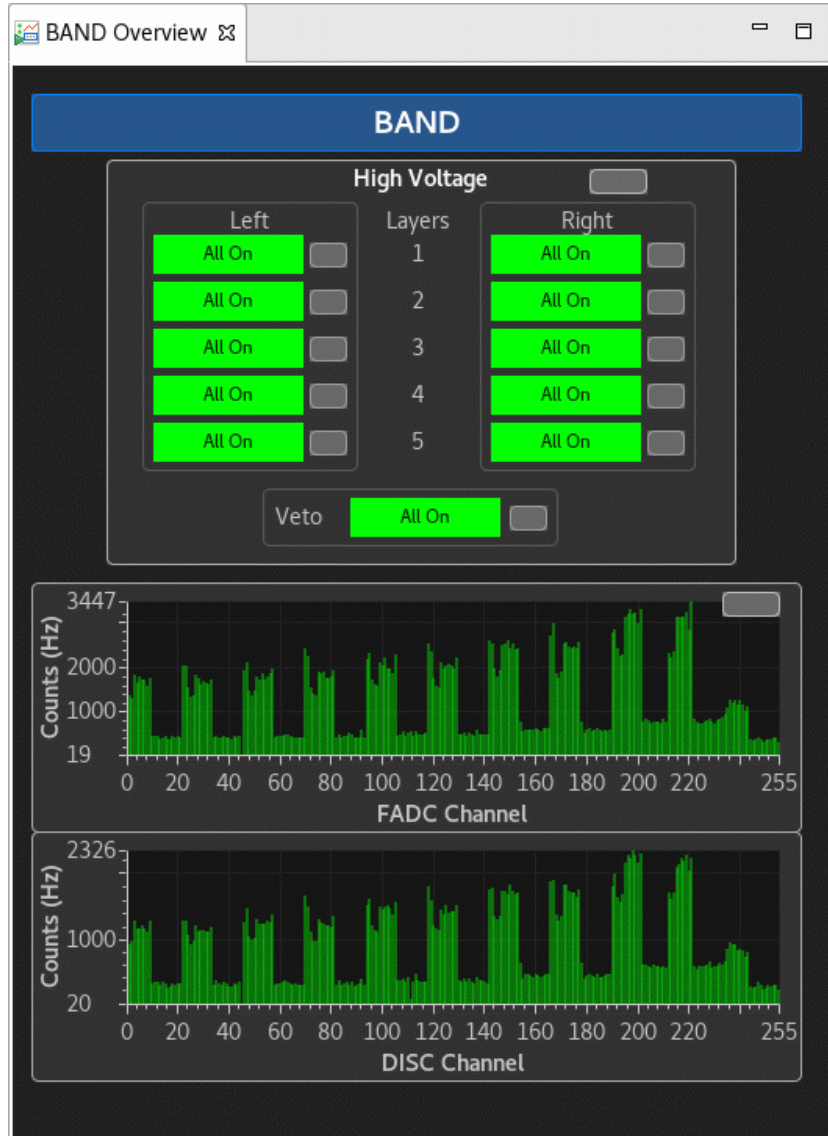
220 BNC-Lemo cables patch panel to SHMS hut

110 HV cables to SHMS hut



**All electronics and cables from NPS except \***

# LAD Monitoring: Similar to BAND in Hall B



**BAND FADC - Layer 1**

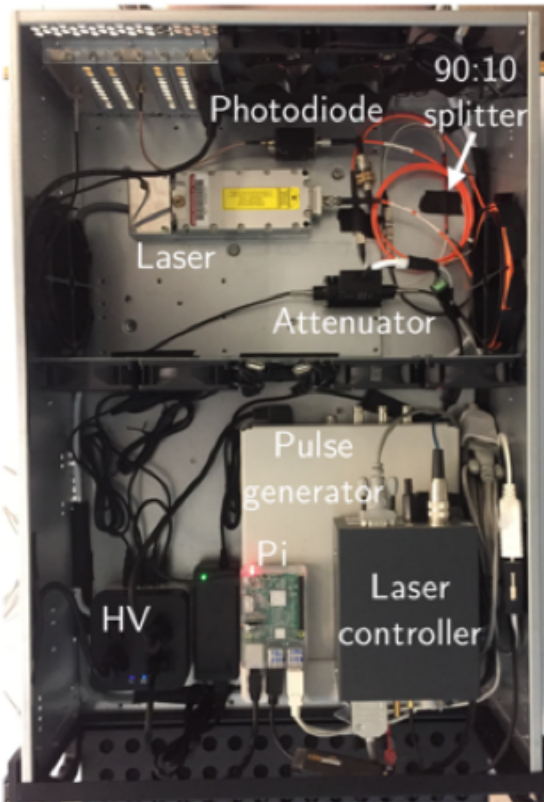
Layers

**BAND FADC Scalers - Layer1**

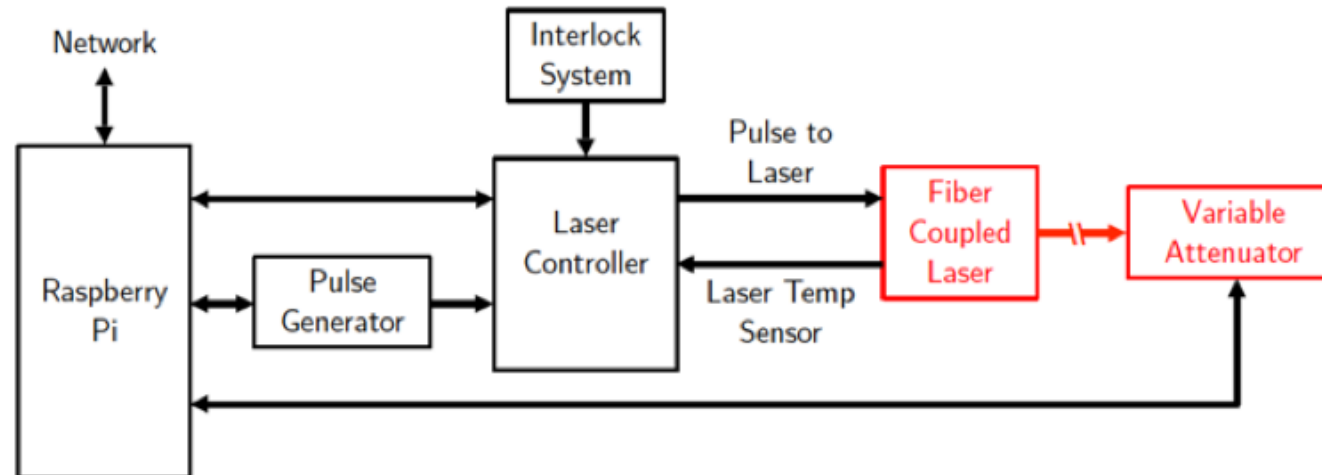
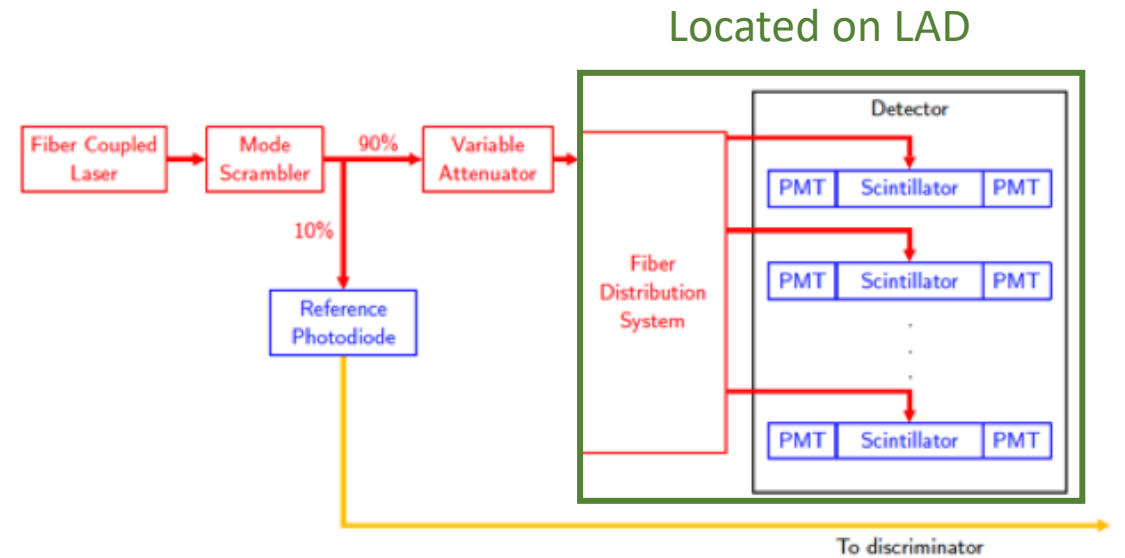
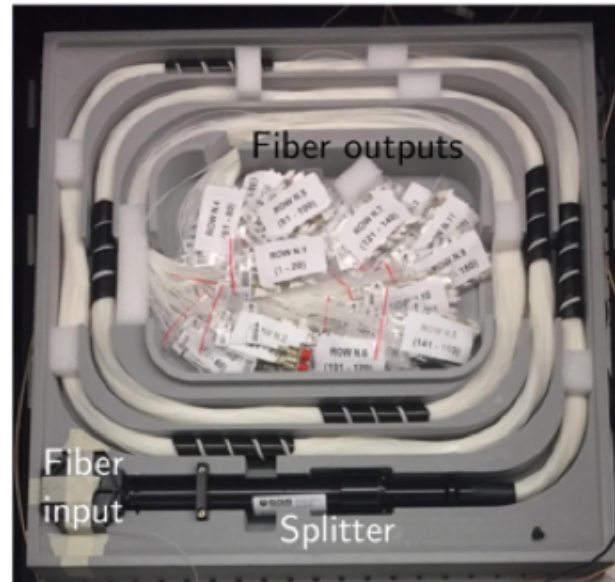
101_L	B_HW_ADCBAND1_S103_Ch00:c	2730	101_R	B_HW_ADCBAND1_S113_Ch00:c	2732
102_L	B_HW_ADCBAND1_S103_Ch05:c	2393	102_R	B_HW_ADCBAND1_S113_Ch05:c	2327
103_L	B_HW_ADCBAND1_S103_Ch10:c	2490	103_R	B_HW_ADCBAND1_S113_Ch10:c	2552
104_L	B_HW_ADCBAND1_S104_Ch00:c	3217	104_R	B_HW_ADCBAND1_S114_Ch00:c	3208
105_L	B_HW_ADCBAND1_S104_Ch05:c	3006	105_R	B_HW_ADCBAND1_S114_Ch05:c	3185
106_L	B_HW_ADCBAND1_S104_Ch10:c	3150	106_R	B_HW_ADCBAND1_S114_Ch10:c	2935
107_L	B_HW_ADCBAND1_S105_Ch00:c	2961	107_R	B_HW_ADCBAND1_S115_Ch00:c	2992
108_L	B_HW_ADCBAND1_S105_Ch05:c	3117	108_R	B_HW_ADCBAND1_S115_Ch05:c	3077
109_L	B_HW_ADCBAND1_S105_Ch10:c	2980	109_R	B_HW_ADCBAND1_S115_Ch10:c	3078
110_L	B_HW_ADCBAND1_S106_Ch00:c	3384	110_R	B_HW_ADCBAND1_S116_Ch00:c	3340
111A_L	B_HW_ADCBAND1_S106_Ch05:c	722	111A_R	B_HW_ADCBAND1_S108_Ch00:c	681
111B_L	B_HW_ADCBAND1_S118_Ch00:c	658	111B_R	B_HW_ADCBAND1_S116_Ch05:c	735
112A_L	B_HW_ADCBAND1_S106_Ch10:c	749	112A_R	B_HW_ADCBAND1_S108_Ch05:c	796
112B_L	B_HW_ADCBAND1_S118_Ch05:c	692	112B_R	B_HW_ADCBAND1_S116_Ch10:c	677
113A_L	B_HW_ADCBAND1_S107_Ch00:c	736	113A_R	B_HW_ADCBAND1_S108_Ch10:c	662
113B_L	B_HW_ADCBAND1_S118_Ch10:c	659	113B_R	B_HW_ADCBAND1_S117_Ch00:c	648
114A_L	B_HW_ADCBAND1_S107_Ch05:c	650	114A_R	B_HW_ADCBAND1_S109_Ch00:c	692
114B_L	B_HW_ADCBAND1_S119_Ch00:c	739	114B_R	B_HW_ADCBAND1_S117_Ch05:c	720
115A_L	B_HW_ADCBAND1_S107_Ch10:c	739	115A_R	B_HW_ADCBAND1_S109_Ch05:c	741
115B_L	B_HW_ADCBAND1_S119_Ch05:c	809	115B_R	B_HW_ADCBAND1_S117_Ch10:c	807
116A_L	B_HW_ADCBAND1_S110_Ch00:c	759	116A_R	B_HW_ADCBAND1_S109_Ch10:c	706
116B_L	B_HW_ADCBAND1_S119_Ch10:c	794	116B_R	B_HW_ADCBAND1_S120_Ch00:c	22
117_L	B_HW_ADCBAND1_S110_Ch04:c	3825	117_R	B_HW_ADCBAND1_S120_Ch04:c	3606
118_L	B_HW_ADCBAND1_S110_Ch08:c	3532	118_R	B_HW_ADCBAND1_S120_Ch08:c	3571

# LAD Laser System

- Similar to BAND (Denniston, NIM A, 973 164177(2020))
- Control via web interface
- Laser light contained within fibers



Contained in SHMS hut



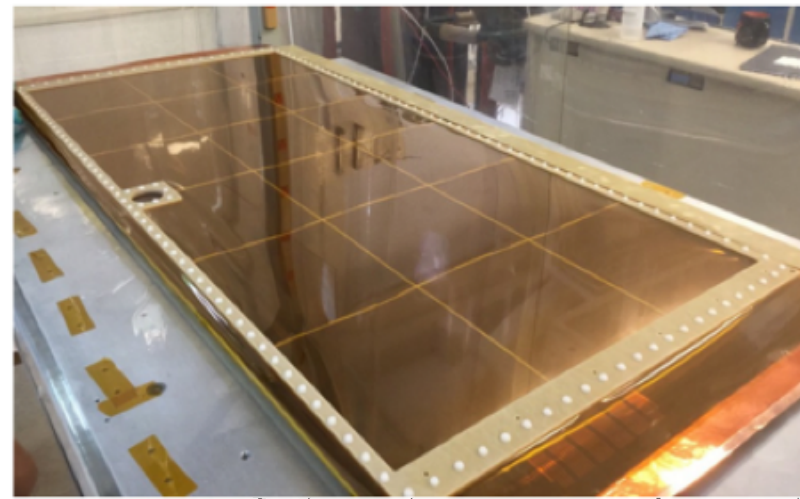
Laser GUI for remote control:

Laser		Generator		Attenuator	
Times		Select Channel		Handling by dB	
Supply Time	3689:1 [H:M]	Channel 1	Channel 2	Current dB	0.00 [dB]
Emitting	3688:52 [H:M]	Channel 1		Set dB	
Temperatures		Wave	PULSE	-0.1[dB]	+0.1[dB]
Diode	34.00 [°C]	Amplitude	5 [V]	-1[dB]	+1[dB]
Crystal	28.01 [°C]	Offset	2.5 [V]	Handling by Transference (OUT/IN)%	
Electronic Sink	44.00 [°C]	Frequency	1000 [Hz]	Current Transference %	100.0 [%]
Heat Sink	23.00 [°C]	Duty	10 [%]	Set %	
Temperature Control		Pulse Width	0.0001 [S]	-1[%]	+1[%]
Control TEC 1	ON	Rise	2.68e-08 [S]	-10[%]	+10[%]
Control TEC 2	ON	Fall	1.68e-08 [S]	Handling by Step	
Errors and Informations		Output	OFF	Current Position Step	2640 [Step]
Error 1	0	Get Current		Set Position	
Error 2	0	Load Default		-1	+1
Error 2	0	Set Parameters		-10	+10
Info 1	12	Turn ON		Last Command	
Info 2	133	Turn OFF		DB	
Info 3	47	Update		Update	

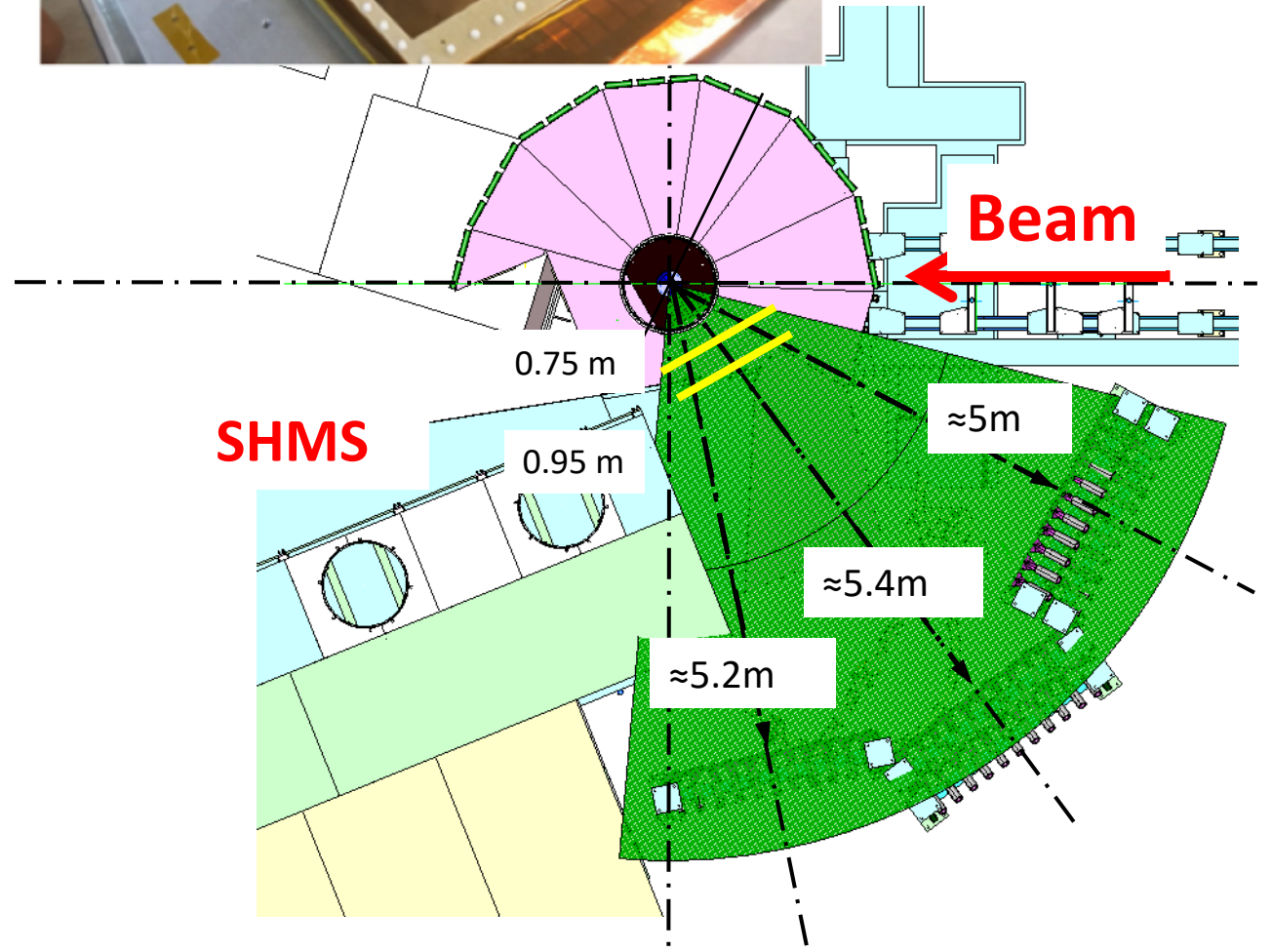
See **LOSP**: [https://hallcweb.jlab.org/wiki/images/8/83/LOSP\\_for\\_LAD.pdf](https://hallcweb.jlab.org/wiki/images/8/83/LOSP_for_LAD.pdf)

# GEMs

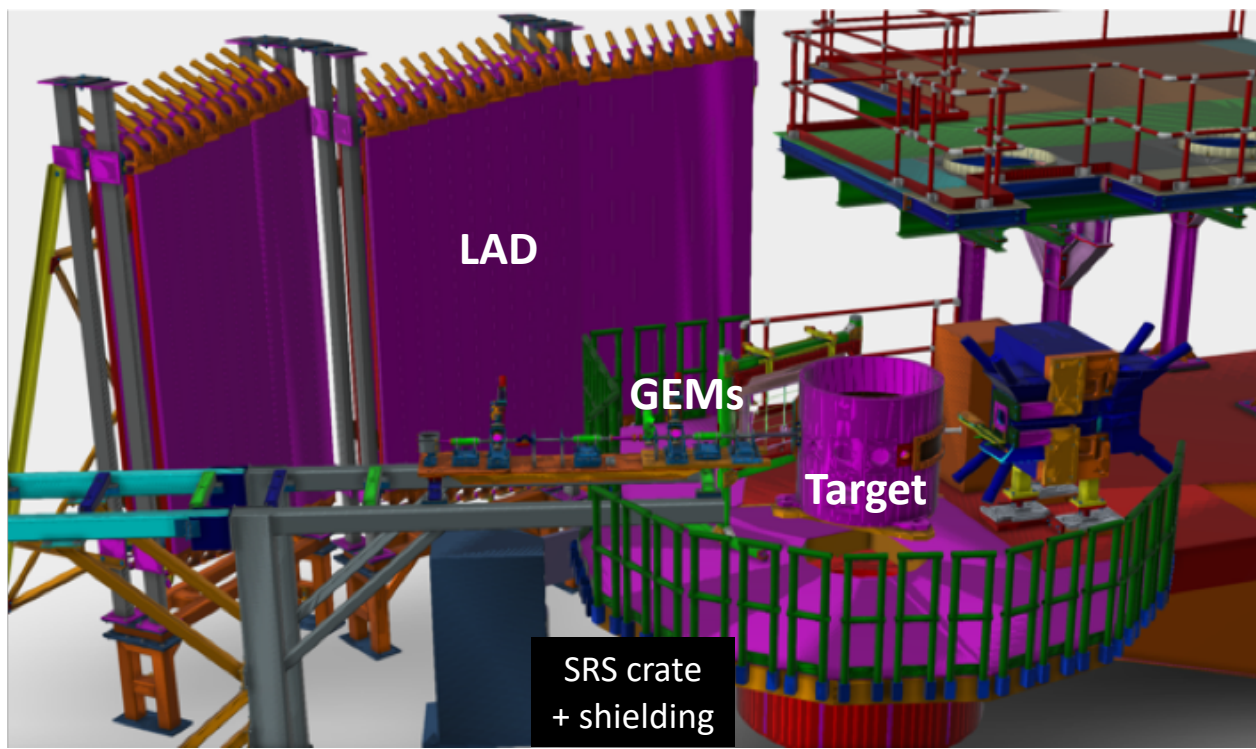
- 2 GEMs next to scattering chamber (127 deg off beamline)
- Active area: 120 x 55 cm<sup>2</sup>
- Separated by 20cm
- Coverage:
  - In-plane 67 degrees
  - Out-of-plane 34 degrees
- 1st Chamber:
  - Distance to target 0.75m
- 2nd Chamber:
  - Distance to target 0.95m



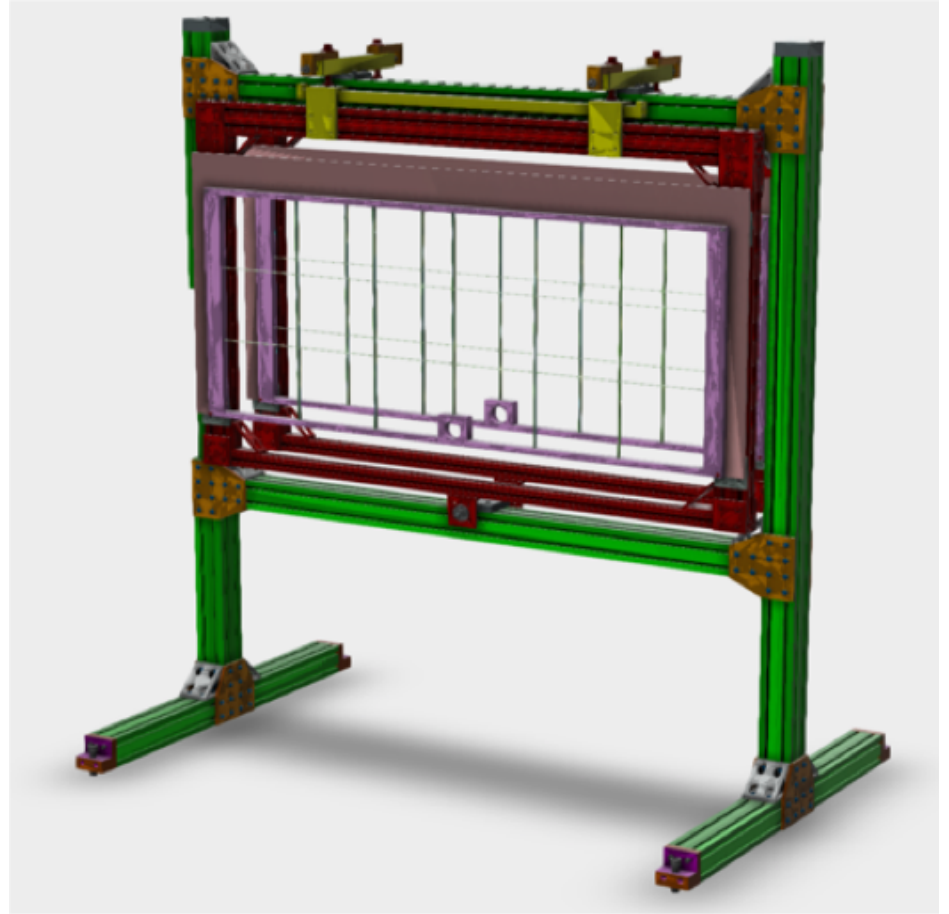
GEMs from PRAD  
120 x 55 cm<sup>2</sup>



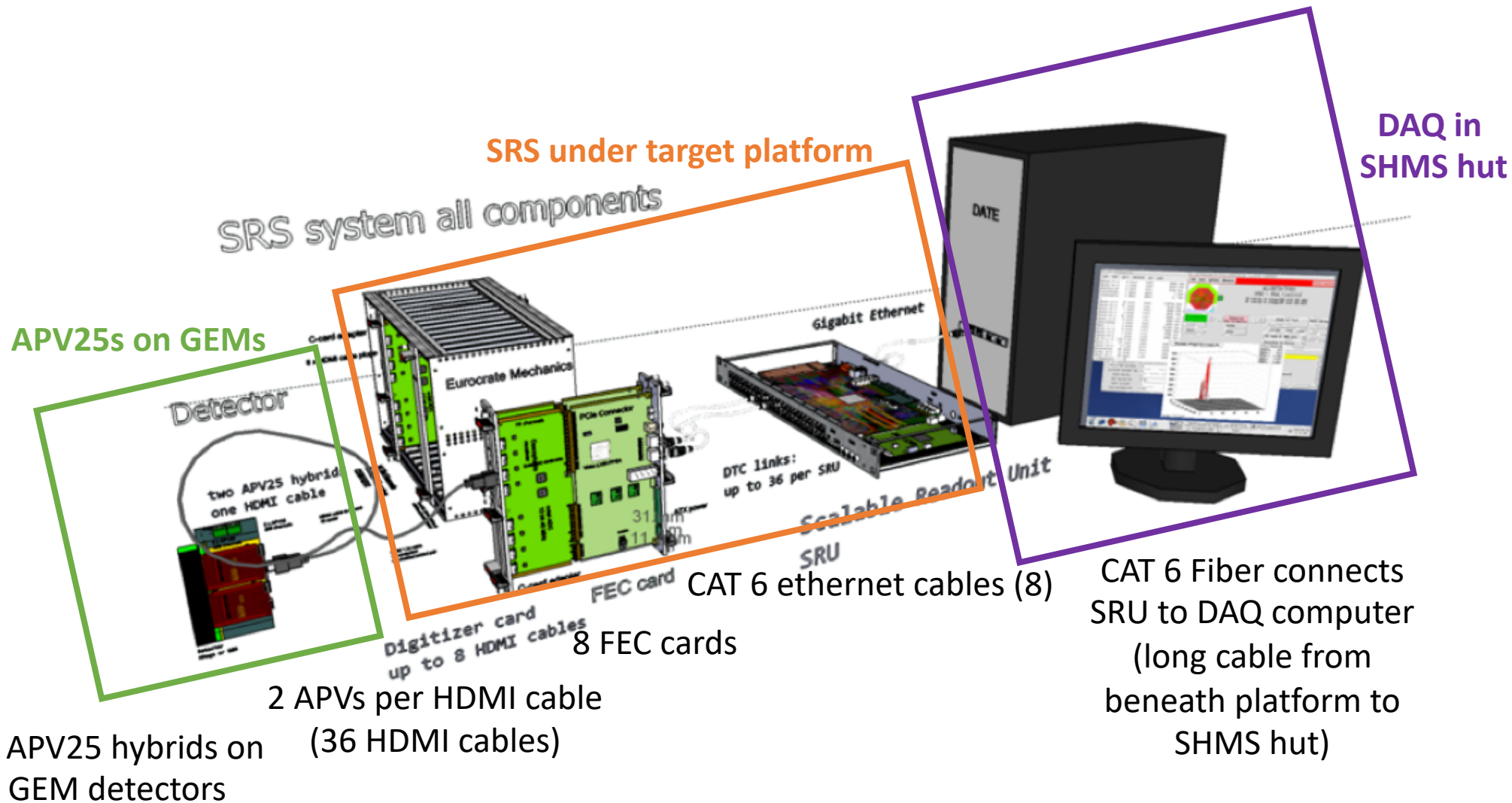
# Stands for GEM detectors designed by Hall C Engineers



SRS crate will be located beneath the target platform with shielding blocks.



# GEMs: Electronics and Cables



$$550 \text{ (bytes per APV)} \times 72 \text{ (APVs)} \times 2 \text{ kHz (trigger rate, upper limit)} = 80 \text{ Mb/s}$$



# Experts and Responsibilities:

## SHMS, HMS:

- Experts: Holly Szumila-Vance (lead\*), Hall C staff and collaborators
- Responsibilities: Calibration, monitoring, analysis, on-call support

## LAD:

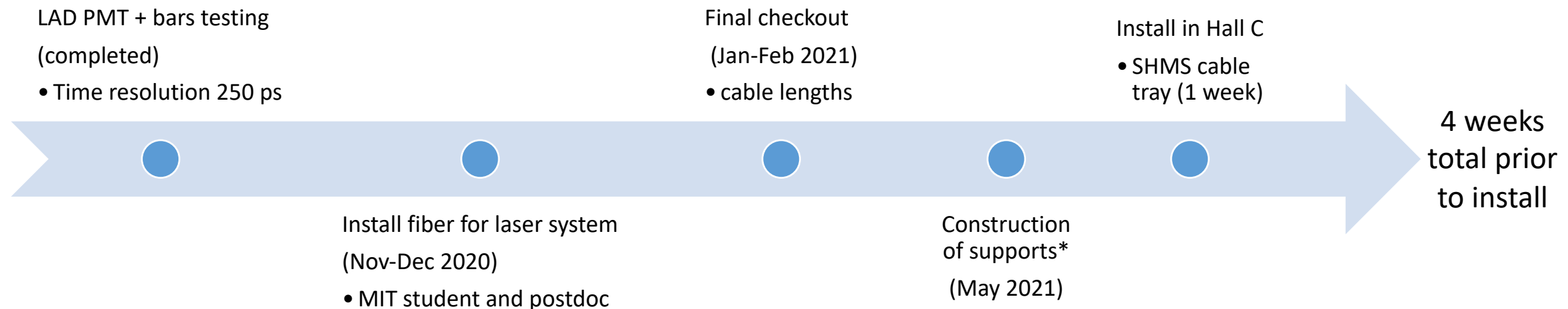
- Experts: Florian Hauenstein (lead\*), Tyler Kutz (backup\*)
- Responsibilities: Installation, testing, commissioning, monitoring, on-call support

## GEMs:

- Experts: Xinzhan Bai (lead\*), Andrew Denniston (backup\*), Tyler Kutz
- Responsibilities: Installation, testing, commissioning, monitoring, on-call support

## 2. What is the status/performance requirements of the LAD detector? If not completed, what are the completion/commissioning schedules, tasks and user commitment?

- LAD currently in the ESB
- Electronics and cables from NPS



## 2. What is the status/performance requirements of the LAD detector? If not completed, what are the completion/commissioning schedules, tasks and user commitment?

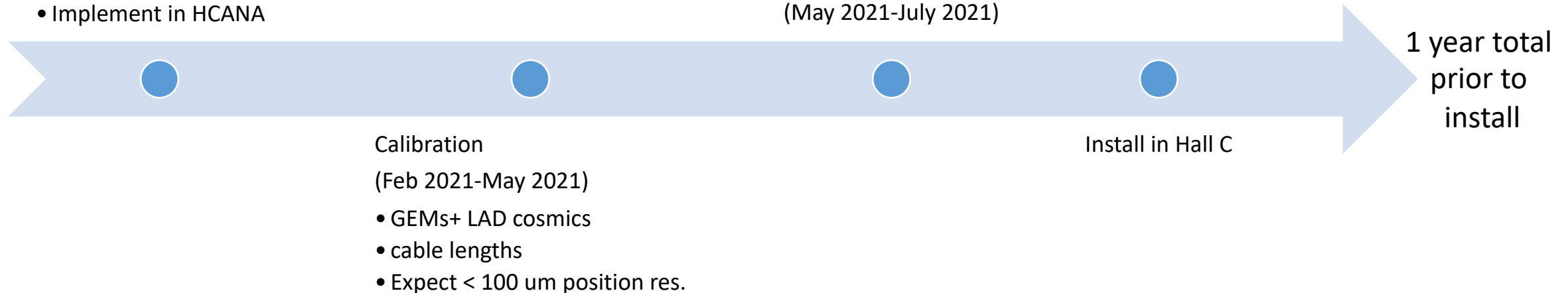
- GEMs currently in clean room in the test lab
- Student and postdoc with PRAD GEM expert

### GEM testing

(Aug 2020 - Feb 2021)

- Power on, test
- Verify readout system\*
- Implement in HCANA

Construction of  
supports\*\*  
(May 2021-July 2021)



\*Budget preparation between UVa and MIT for potential refurbishment, est. 15-20k

\*\*Supports designed, simple construction, est. <3k

## Summary:

1. *What are the running conditions for the experiment? Please state clearly the target, detectors, beamline configurations and operation as well as the integration of the LAD detector in Hall C. Has the detectors ownership, maintenance and control during beam operations been defined?*

**10.9 GeV beam on LH2 and LD2 targets in rotated scattering chamber assembly. Standard HMS and SHMS spectrometers to detect electrons. Additional installation of LAD and GEMs to measure recoil particles. Standard single arm electron triggers. Detector experts identified.**

2. *What is the status/performance requirements of the LAD detector? If not completed, what are the completion/commissioning schedules, tasks and user commitment?*

**LAD and GEMs at Jlab. Students, postdocs, and staff support identified to assist in final testing and assembly with frames. Requires 1 year of preparation before installation.**