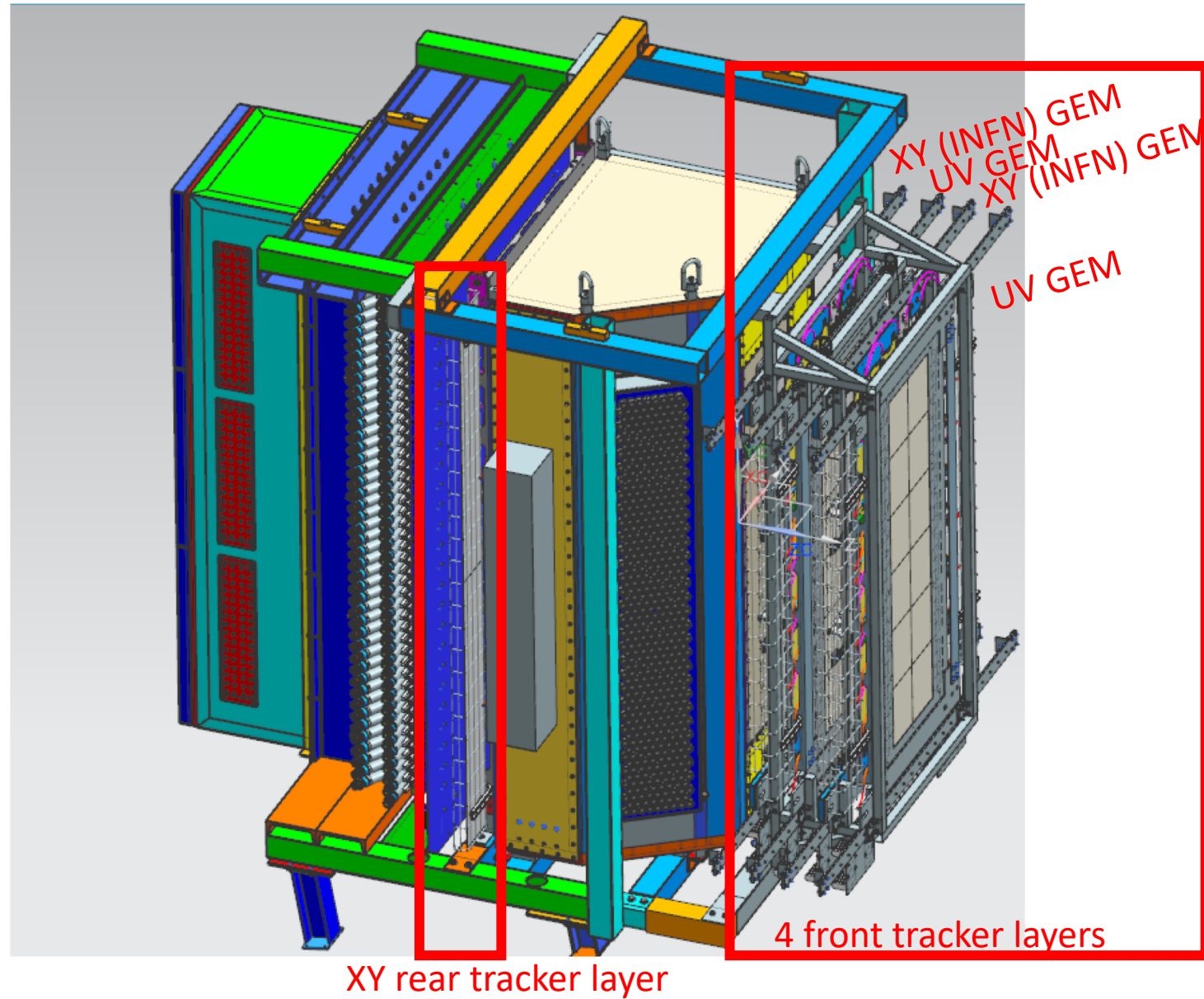


BigBite GEMs

Holly Szumila-Vance

17 Feb 2021

SBS Collaboration Meeting



Overview:

1. Purpose and description of the GEMs in BigBite
2. Status of Hardware
3. Manpower
4. Plans for install
5. Software
6. Documentation status

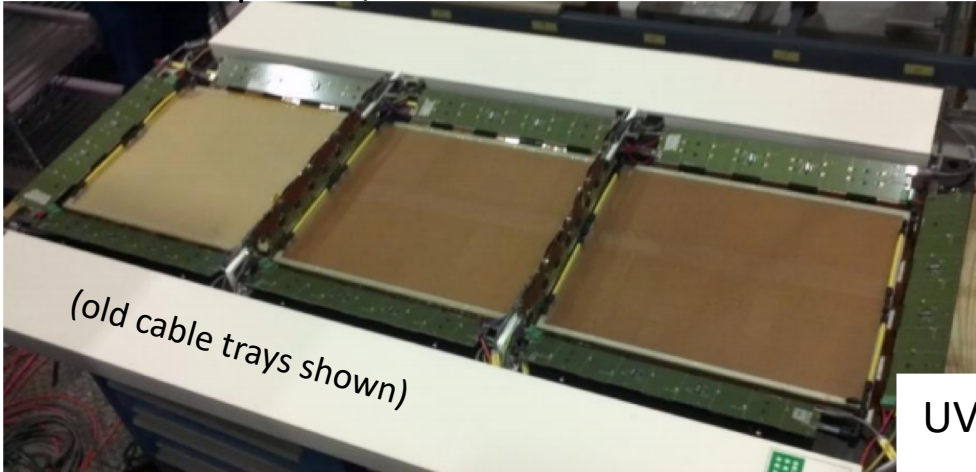
*I'll try to highlight
some "homework"
items in red!*



GEM trackers on BB: cover the large acceptance, tracking at high rates!

- $<100\text{ }\mu\text{m}$ position resolution
- Capable of rates $> \text{MHz}/\text{cm}^2$

INFN GEM planes, front tracker



54 APVs per layer

$40 \times 150\text{ cm}^2$

3 modules

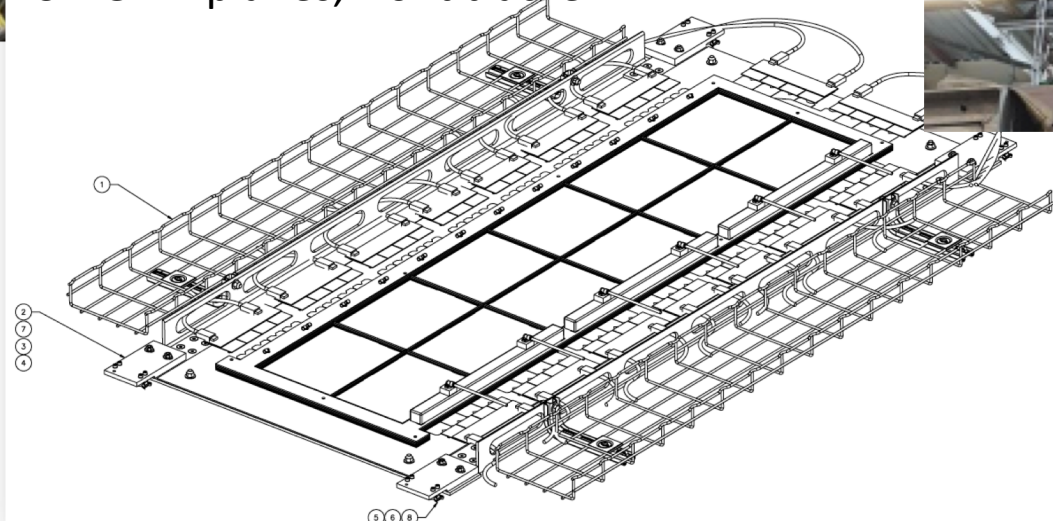
Cable trays have since been swapped

60 APVs per layer

$40 \times 150\text{ cm}^2$

1 big module

UV GEM planes, front tracker



UVa XY rear tracker

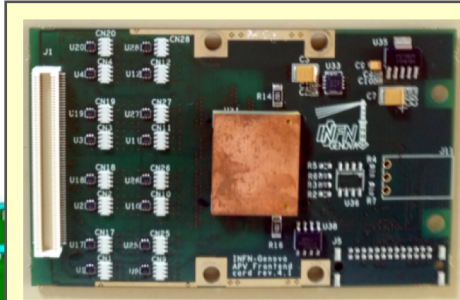


88 APVs per layer

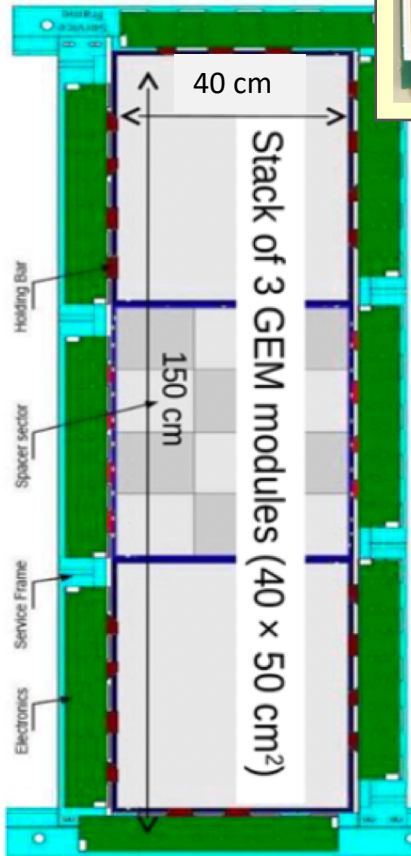
$60 \times 200\text{ cm}^2$

4 modules

APV25 on chamber backplanes



- 128 analog ch / APV25 ASIC
- 3.4 μ s trigger latency (analog pipeline)
- Capable of sampling signal at 40 MHz
- Multiplexed analog output (100 kHz readout rate)



HDMI



Optical fiber to VTP

MPD Main Block

Arriga GX FPGA
128 MB DDR2-RAM
Firmware V4.0 (74% resources):

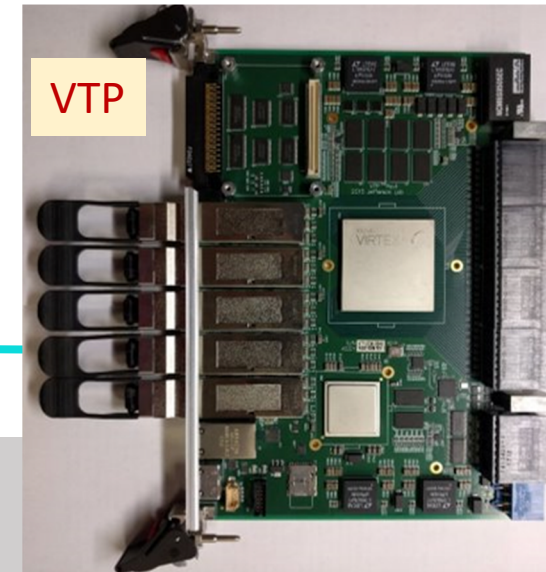
- # Finite-Impulse-Response Filter (16 param)
- # Zero Suppression
- # Common mode and pedestal subtraction
- # Remote config,
- # ≈ 2 ns trigger time resolution

MPD-VTP
Interface

VTP-
Protocol

Aurora
Protocol

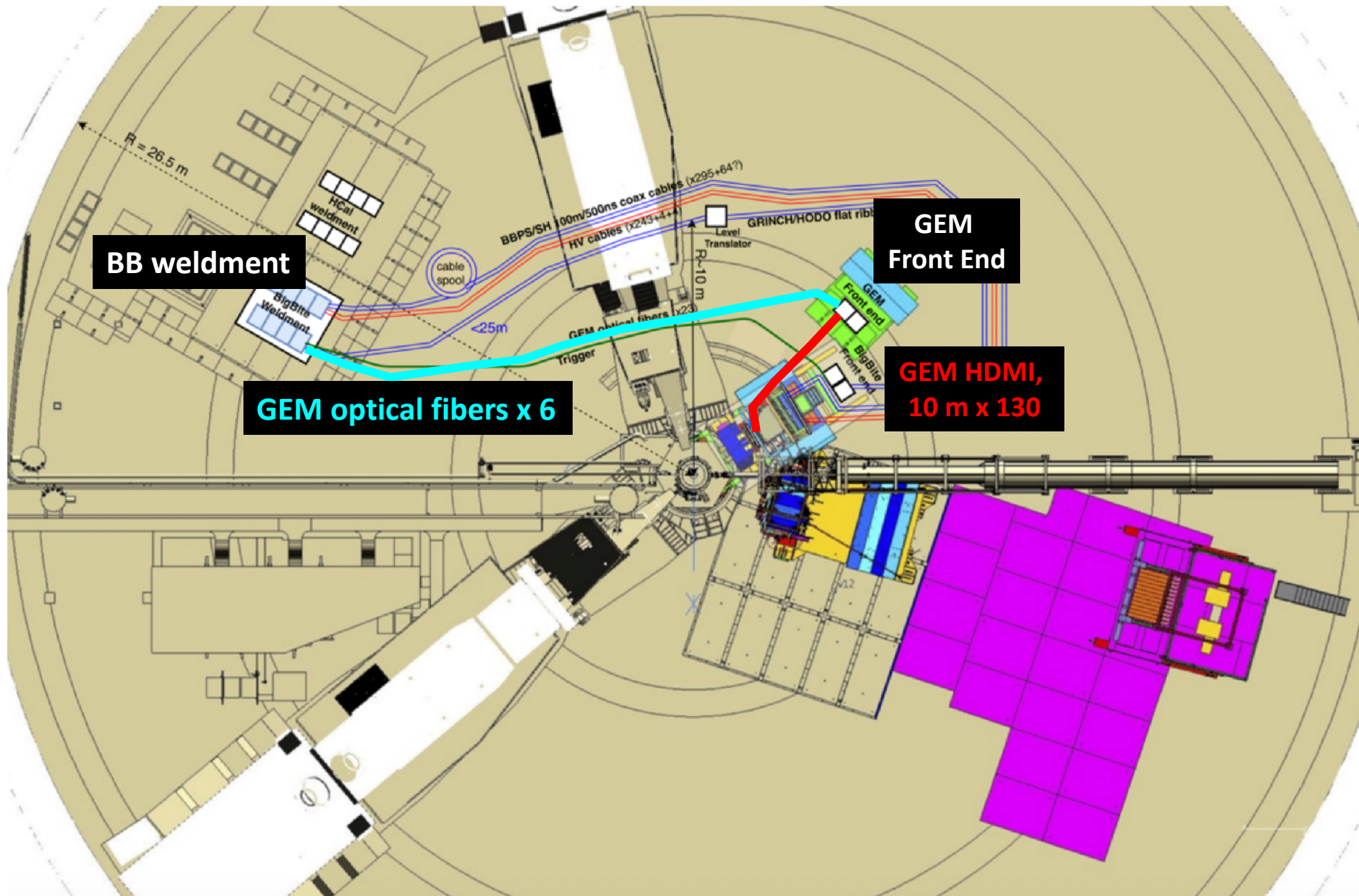
	Channels	APV25	MPDs
UV GEMs	15400	120	8
INFN GEMs	14000	108	8
UVa rear tracker	11300	88	7



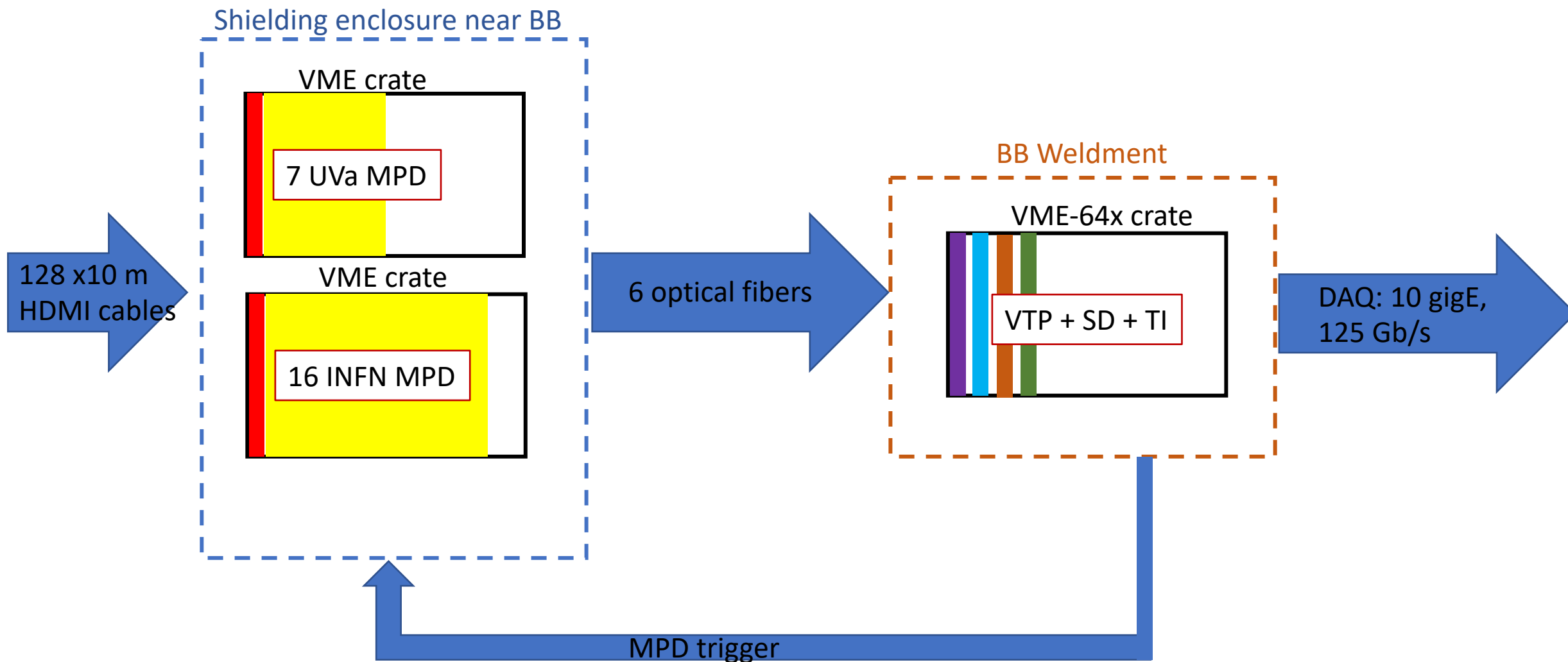
See DAQ talk by Alexandre
(4:50 pm today)

See Ben's talk on GEM high rate
MPD readout (5:30pm today)

Schematic of Hall Setup with components highlighted



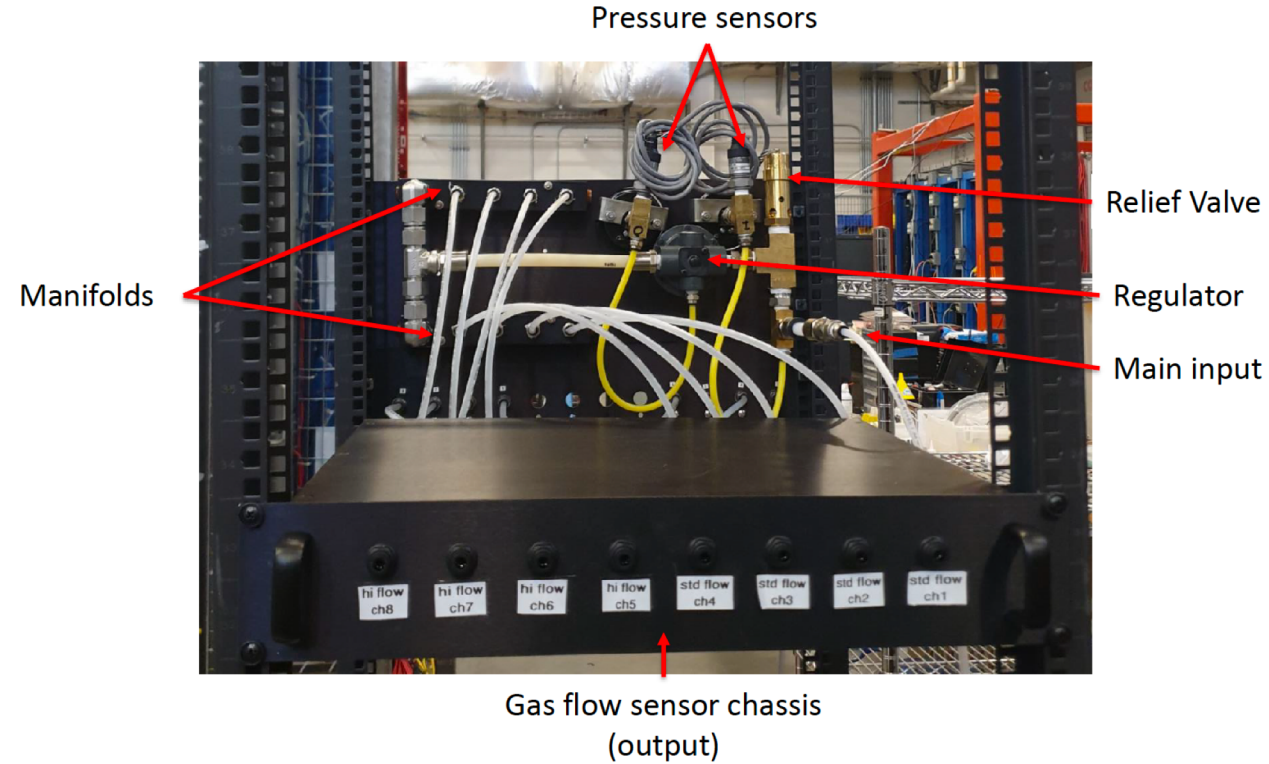
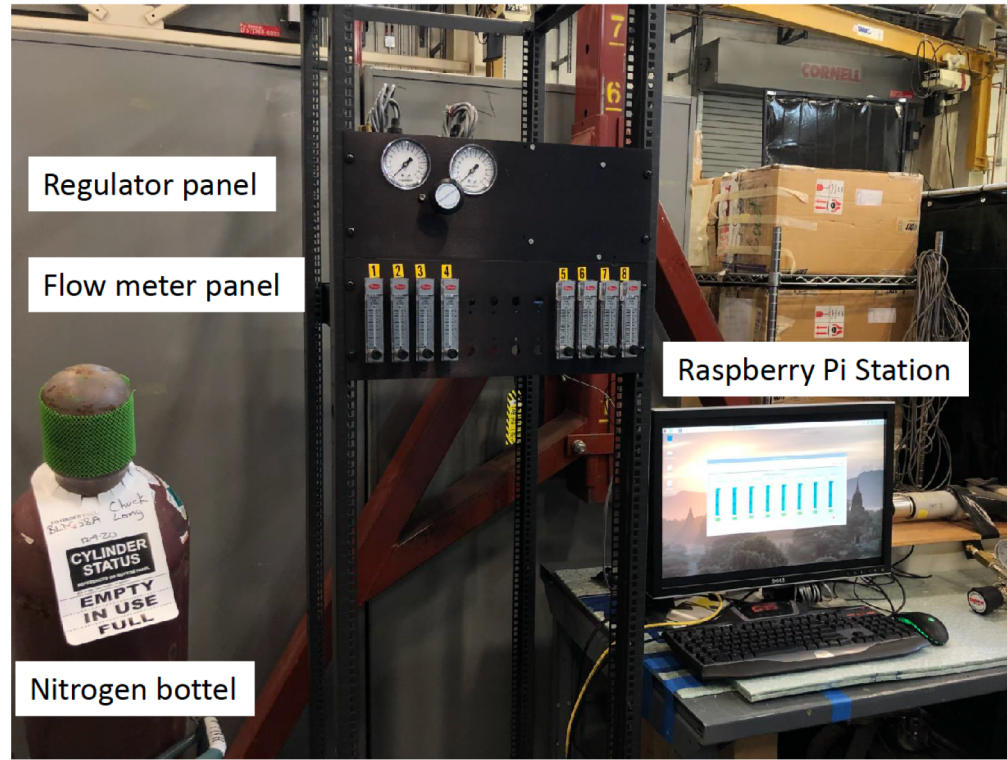
GEM Front End electronics shielding hut (location and shielding) is being coordinated with Jack Segal



Hardware Component Status

Item	Status
1 VXS crate	In hand
2 VME crates	In hand
1 TI	In hand
1 VTP	To be identified (HCal or SoLID)
23 MPDs	In hand
3 slots HV	In hand
Trigger supervisor	In hand
3 VME CPU	In hand
6 long 10 Gbps optical fibers	In hand
130 HDMI cables, 10 m long	In hand
Gas system	In hand but being modified

Gas system: prototype in TEDF



Prototype in TEDF working well

Advancements in remote monitoring of regulator pressures and exhaust readout is progressing

Flow →
Sensor status →

BB GEM Flow Readout							
Std Flow Ch01	Std Flow Ch02	Std Flow Ch03	Std Flow Ch04	Hi Flow Ch05	Hi Flow Ch06	Hi Flow Ch07	Hi Flow Ch08
81 sccm	81 sccm	83 sccm	78 sccm	0 sccm	0 sccm	0 sccm	-0 sccm
Status: good	Status: good	Status: good	Status: good	Status: good	Status: good	Status: good	Status: good

DSG developing gas system for Hall A (slides from G. Jacobs)

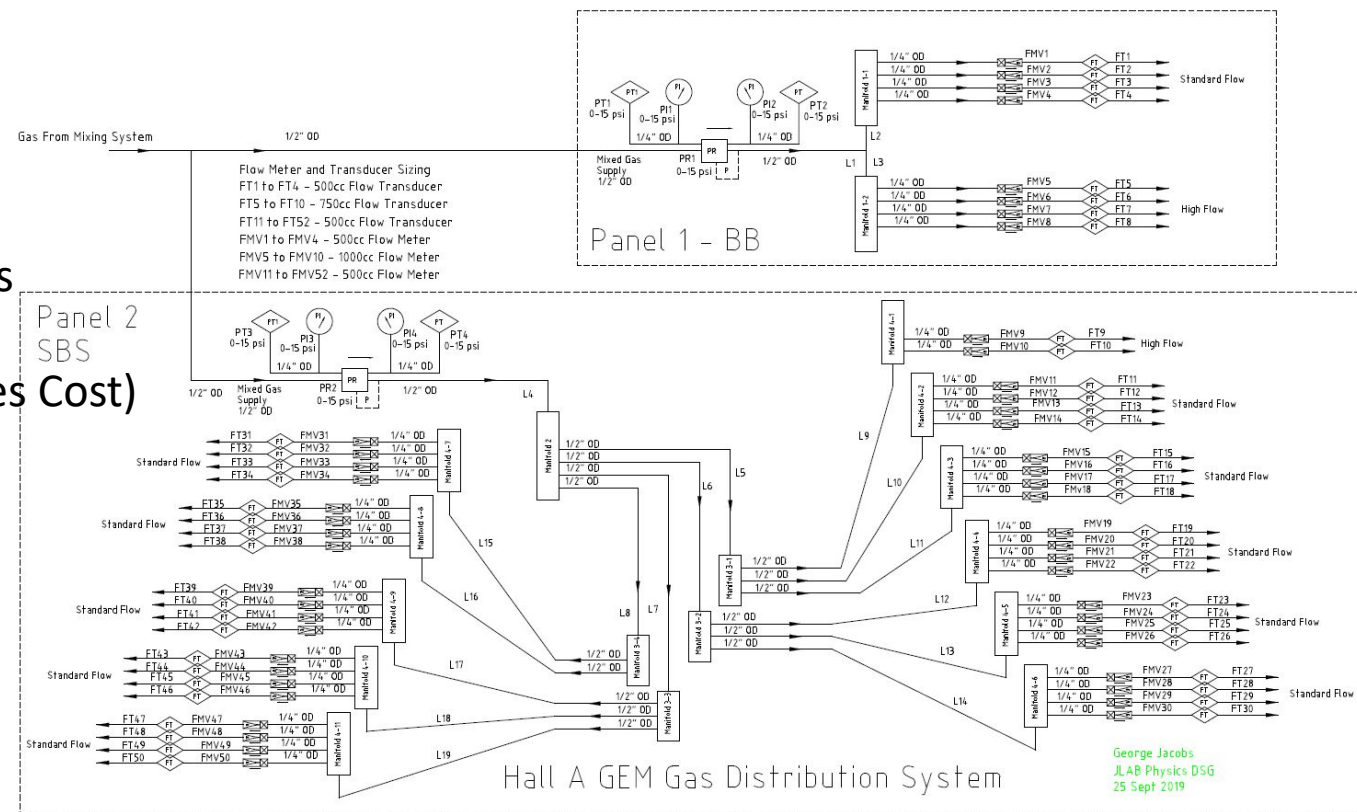
Portable High Density 2 rack layout:

- Front Panel Location For all Pressure and Flow Controls
- Rear Panel Location For all Gas Line Connections
- Layout Minimizes Tubing and Cable Lengths (Minimizes Cost)

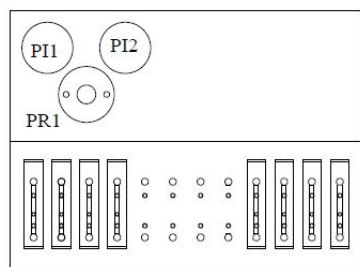
Provides 50 Total Gas Supply Channels

- 6 High Flow (100-1000 sccm) Channels
 - 4 on BB Panel and 2 on SBS
- 44 Standard Flow (50-500 sccm) Channels
 - 4 on BB Panel and 40 on SBS

BB GEM Gas Distribution Rack:

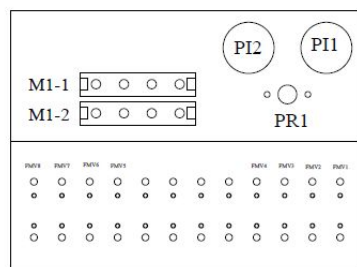


Hall A GEM BB Gas Distribution FRONT Panel



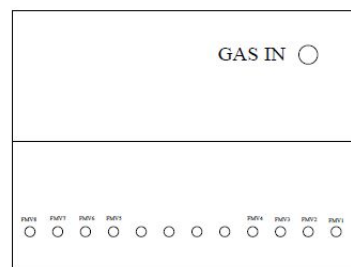
External FRONT Panel

Panel 1 - BB
 George Jacobs
 JLAB Physics DSG
 17 Feb 2020



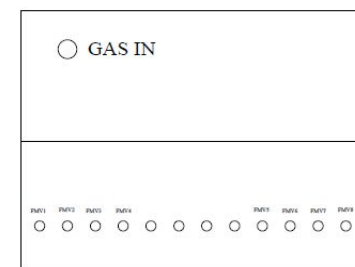
Internal FRONT Panel

Hall A GEM BB Gas Distribution REAR Panel



External BACK Panel

Panel 1 - BB
 George Jacobs
 JLAB Physics DSG
 17 Feb 2020



Internal BACK Panel

Manpower

UVa GEMs:	FTE	Roles
Kondo Gnanvo		leading
Nilanga Liyanage		supporting
Michael Kohl		supporting
John Boyd	student (1)	UV layer production, testing, and commissioning
Sean Jeffas	student (1)	DAQ, monitoring, analysis, commissioning
Xinzhan Bai	postdoc (0.5)	DAQ, analysis, commissioning, monitoring
Salina Ali	postdoc (0.5)	UV layer production, testing, and commissioning
Vimuthi Gamage	student (1)	Starting June
Bhashitha Dharmasena	student (1)	Starting June
Anu Rathanyake	student (0.1)	supporting
Malinga Rathnayake	student (0.1)	supporting
Thir Gautam	postdoc (0.1)	supporting
Manjukrishna Suresh	Student (0.5)	DAQ, monitoring, analysis, commissioning



JLab-side coordination of install efforts: Holly (0.6)

INFN GEMs:	FTE	Roles
Roberto		Leading and supporting
Evaristo		Leading and supporting
Ezekiel Wertz	student (1)	Analysis, tracking, hardware, and commissioning
Tracking and software:	FTE	Roles
Andrew Puckett	user (0.3)	tracking
Sean Jeffas	student	online monitoring, event displays
Weizhi Xiong	0.4	tracking and simulation
GEM readout and DAQ:	FTE	Roles
Alexandre	staff (0.3)	Leading all DAQ
Paolo Musico		Leading design and developer, MPD support
Holly	staff	Leading GEM DAQ
Ben Raydo	staff (0.3)	High rate, VTP
Bryan Moffit	staff (0.25)	High rate, DAQ
Xinzhan Bai	postdoc	DAQ, data quality
Sean Jeffas	student	DAQ, data quality

Total:

Students = 7

Postdocs = 3

Staff = 4

Other Users = 7

A: Let's look at how far we still have to go....(by May 15)

- Vertical tests with INFN chambers (by end of Feb)
- Install 2 INFN chambers (J0 and J2) into TEDF stack, cable (by March 5)
- INFN+UVa: LV testing during nitrogen flush (by March 12)
- INFN+UVa: HV testing with cosmics (by April)
- Install 2 UV chambers into TEDF stack (available to install mid-March)
- UV: LV testing during nitrogen flush (by March 12)
- UV: HV testing with cosmics (by April)

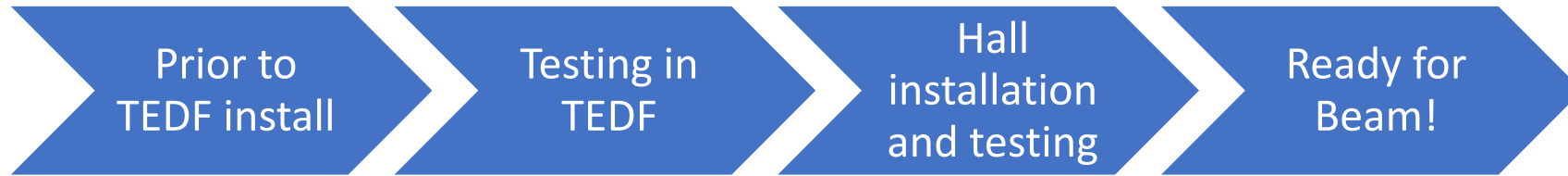
B: Looking at where we've come from since January 2021

- Developed procedure to replace drilled carbon fiber boards on INFN chambers with minimal electronics disruption
- Completed assembly of BB GEM frame
- Horizontal tests with INFN and UV frames
- Installed BB GEM frame in TEDF
- Reconnected and verified readout of INFN GEM chambers
- Setup DAQ readout of UVa chamber
 - Backup VME readout
 - LV testing: APV readout, pedestal and common mode subtraction, debug MPD firmware
 - HV + cosmic testing: analysis in progress, improve cosmic trigger

How are we doing?

- If **A = work to be completed before May 15 for Hall** and **B = work accomplished since Jan 2021**
- Assembly and HV test and evaluation on cosmic stand of UVa UV layers at UVa:
 $A=4, B=2 \rightarrow A/B = 2$
- Install INFN and UVa chambers in TEDF:
 $A=2, B=2, A/B = 1$
- Test INFN chambers in TEDF with cosmics:
 $A=2, B=1, A/B = 2$
- Test UVa chambers in TEDF with cosmics:
 $A = 2, B=1, A/B = 2$
- **We increase effort due to increased number of chambers, but we have spent this past month setting up install procedures and de-bugging TEDF setup so there's some cancellation here.**

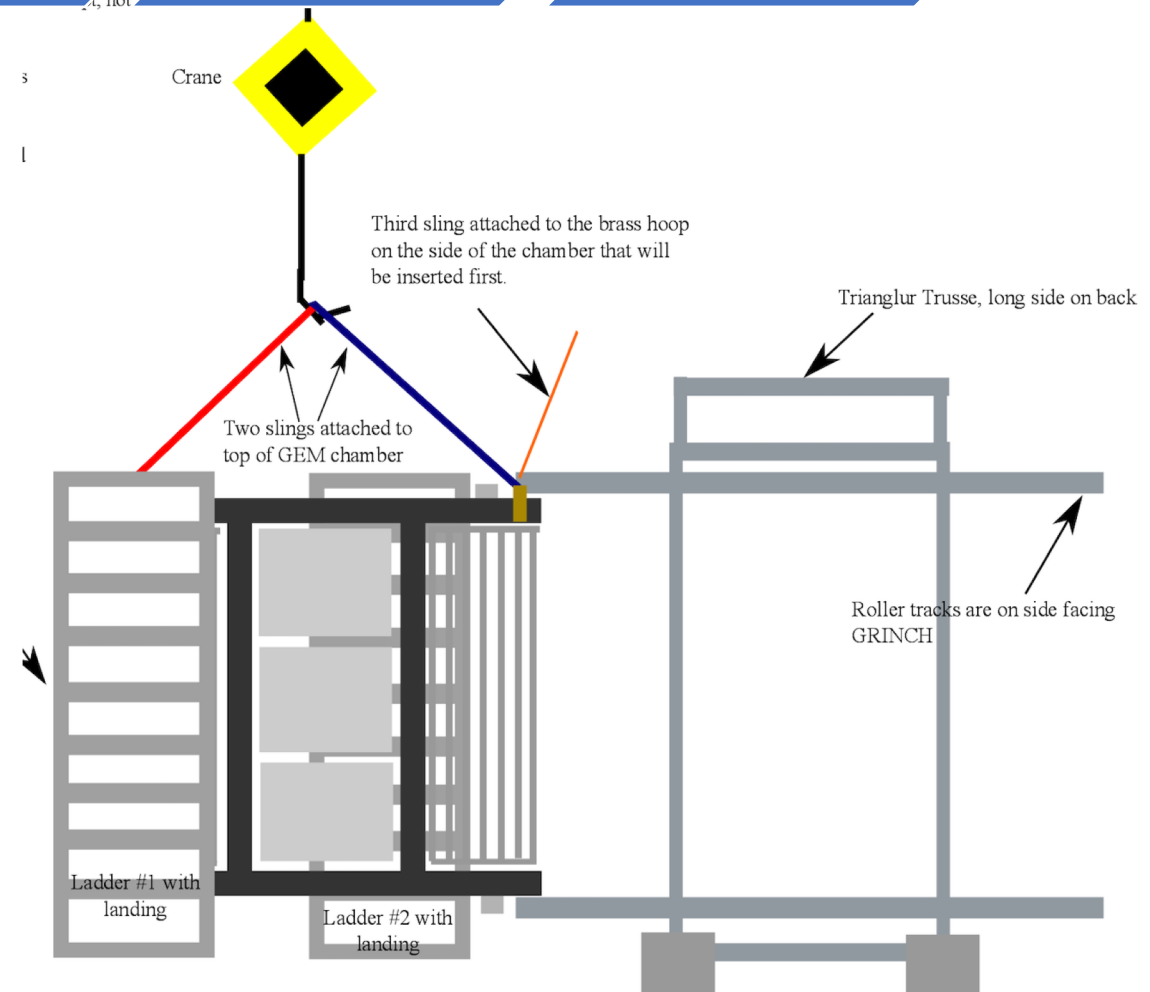
Plans for detector movement to Hall (a.k.a. What are we doing in the imminent future?)



Plans for detector movement to Hall (a.k.a. What are we doing in the imminent future?)



- INFN testing and noise reduction, cosmics (now)
- UV testing at UVa with DAQ and cosmics (now – mid March)
- Chamber installation plan to be tested with dummy frames and cranes. Jessie developing a load plan and coordinating safety with us.



Plans for detector movement to Hall (a.k.a. What are we doing in the imminent future?)



- Install INFN chambers (Feb 22+)
 - Test procedure and check frames by first installing a dummy frame
- Install UV chambers (mid-March projected)
- Installs require crane use and 1 day of install followed by 1 day of cabling
- TEDF testing plans: (ideally 1 month)
 - 1 day nitrogen
 - LV
 - Tests on DAQ and APVs-MPD setup
 - Ar/CO2 flow
 - HV tests to study cosmics
 - DAQ rate studies throughout

Plans for detector movement to Hall (a.k.a. What are we doing in the imminent future?)



- De-cable the GEMs
- Remove GEMs from frame
- Transport frame to Hall and stack
- Install GEMs in frame
- Cable all GEM layers
- Run optical fibers in Hall and setup DAQ
- Testing:
 - Nitrogen flow, LV, APV-MPD checkout
 - Ar/CO2 flow, HV, cosmics (ideally 1 month)

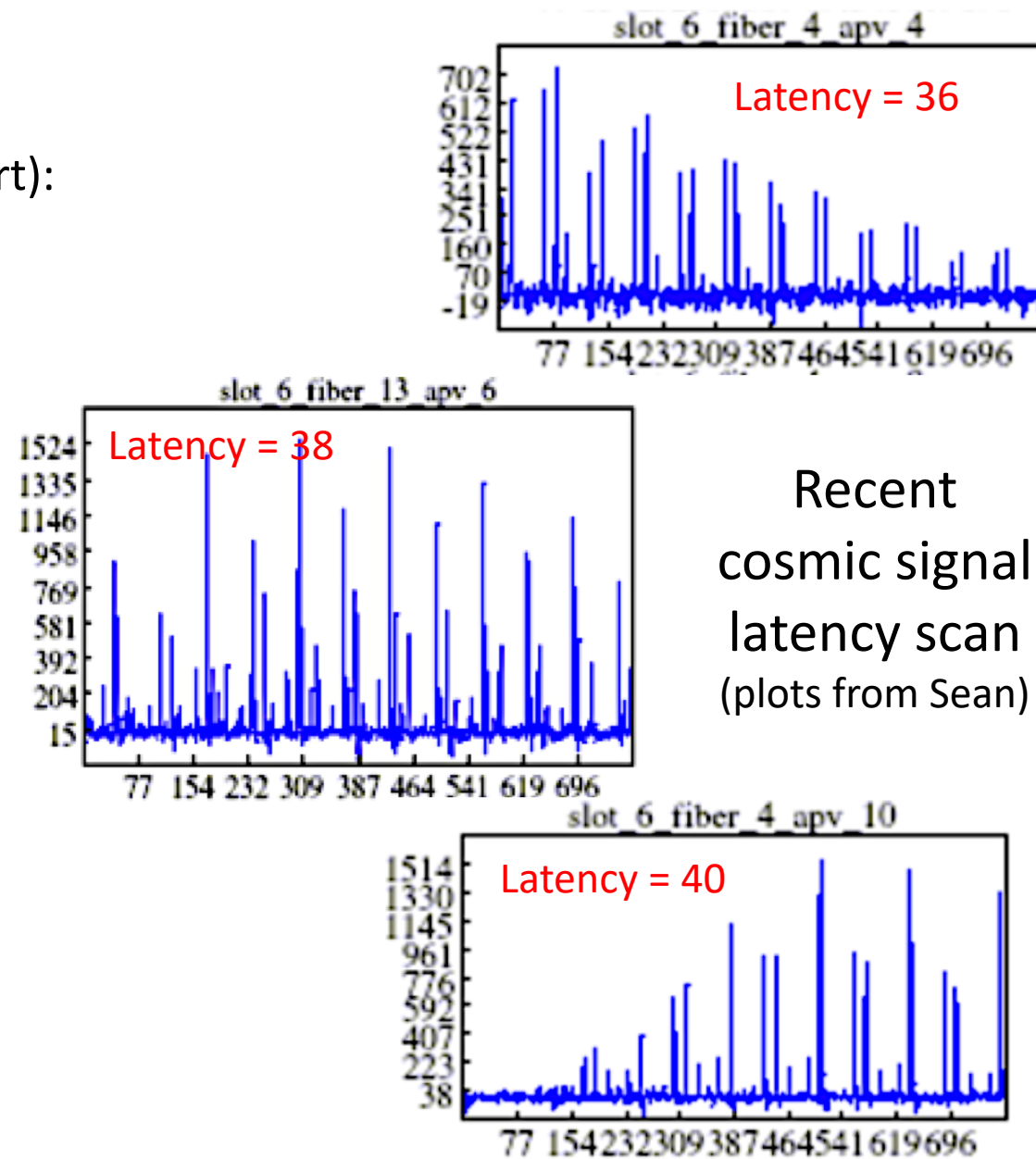
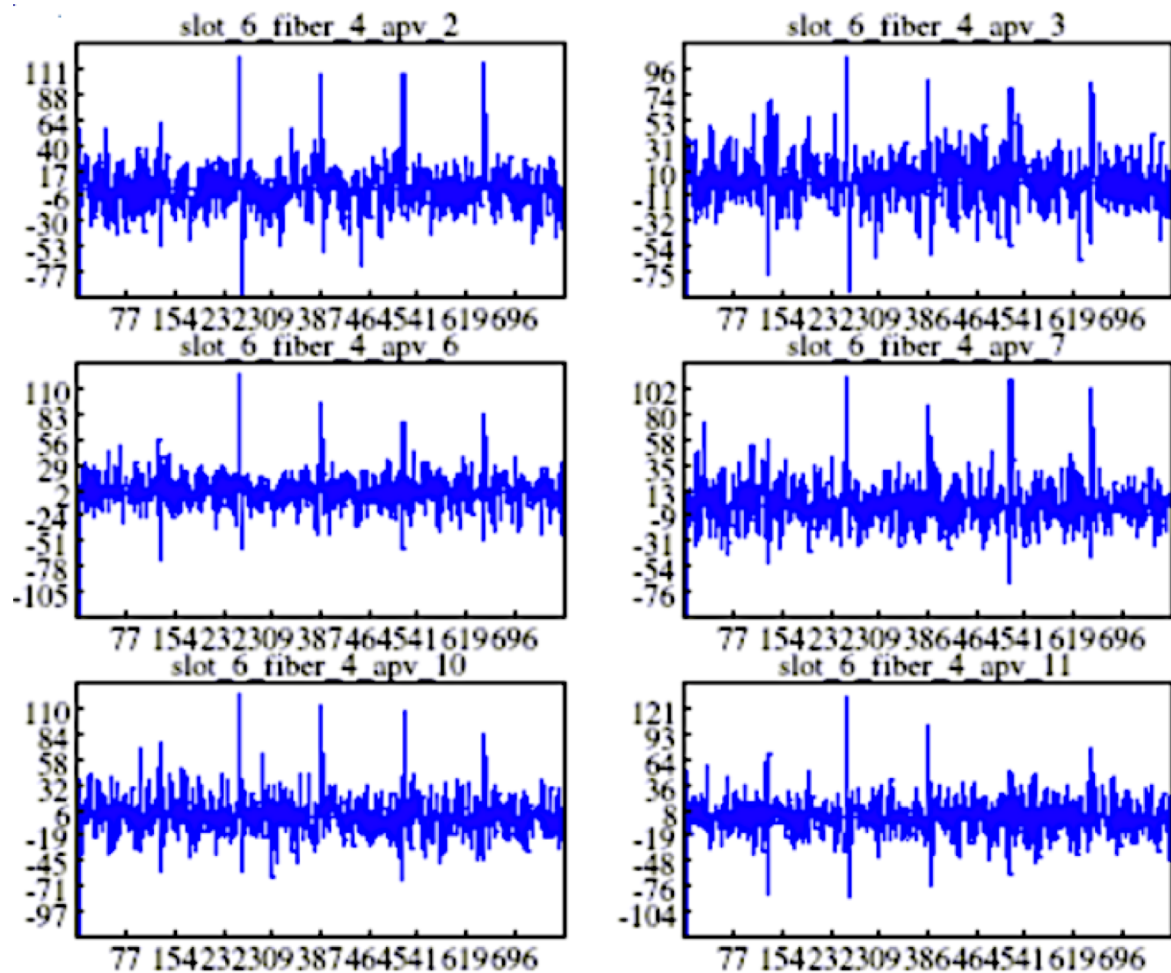
Commissioning and calibrating the GEMs with beam

- Low luminosity runs with magnet off (straight tracks, low rate)
- Low luminosity runs with magnet on (nominal tracks, low rate)
- *Benchmarks for moving toward high rate tracking:*
 - *Tracking accuracy*
 - *Pedestal and common mode subtraction*
 - *Zero suppression*

Software

Low level decoding software and monitoring (ongoing effort):

- Xinzhao Bai and Sean Jeffas



Recent
cosmic signal
latency scan
(plots from Sean)

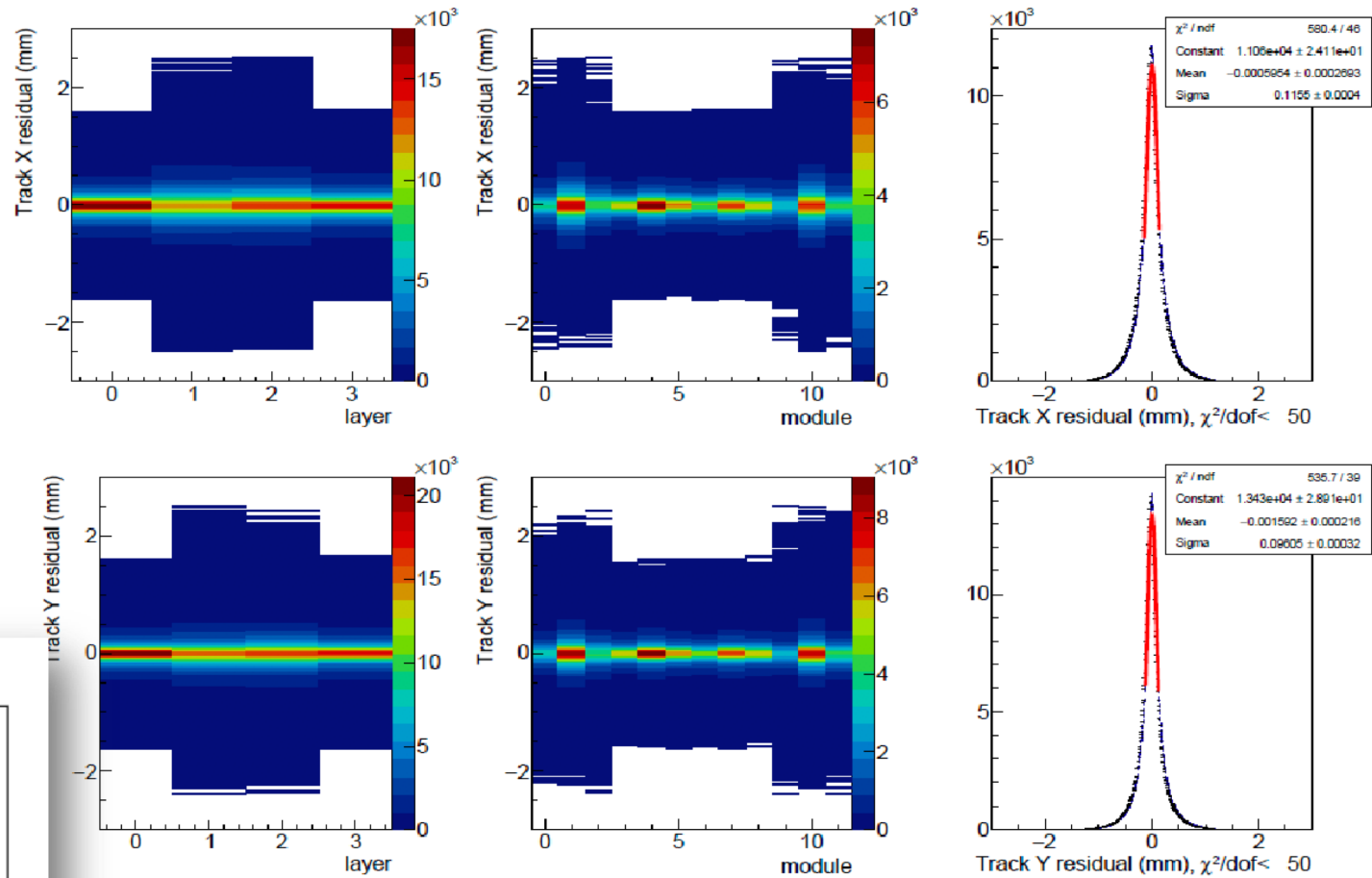
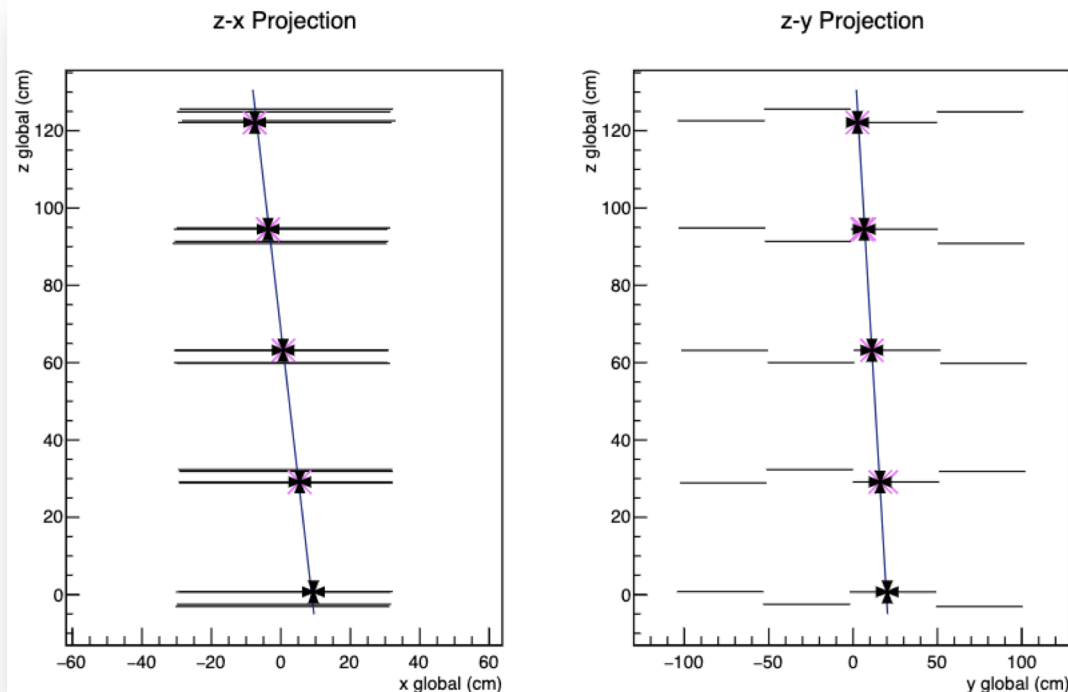
Software

Tracking software (ongoing effort):

- Andrew Puckett's "legacy" tracking code
- Ezekiel is developing and improving
- Tracking requires more layers installed
- Implement GEM decoding in Podd-Analyzer

Online monitoring and event displays:

- Sean developing event displays
- *Need to think about online monitoring*



Tracking residuals courtesy of Ezekiel
(see talk tomorrow 9:10)

Excerpt from Sean's event display (see talk tomorrow 11:45)

Documentation Status

Link to GEM operations manuals:

- INFN GEMs: <https://pandora.infn.it/public/3b9827>
- UVa GEMs (in progress):
<https://www.overleaf.com/project/60280700719b746c97e92524>

THA and OSP for GEMs (submitted):

https://misportal.jlab.org/mis/apps/mis_forms/operational_safety_procedure_form.cfm?entry_id=113037

Still in development:

- *Established benchmarks for beam commissioning*
- *How-to for shift workers*

Person: Szumila-Vance, Holly (hazsumila@jlab.org)		Status: WAPPR	
Org: PHALLA		Saved: 2/15/2021 10:49:21 AM	
		Submitted: 2/15/2021 10:49:21 AM	
Jefferson Lab <small>Thomas Jefferson National Accelerator Facility</small>			
Operational Safety Procedure Review and Approval Form # 113037 (See ES&H Manual Chapter 3310 Appendix T1 Operational Safety Procedure (OSP) and Temporary OSP Procedure for Instructions)			
Type:	OSP Click for OSP/TOSP Procedure Form Click for LOSP Procedure Form Click for LTT-Individual Information Click for LTT-Group Information		
Serial Number:	(Assigned after final approval)		
Issue Date:	(Assigned after final approval)		
Expiration Date:	< Approximately 2/15/2024 >		
Title:	GEM detectors for the SBS experiment		
Location: (where work is being performed)	101 - Experimental Hall A Building Floor Plans	Location Detail: (specifies about where in the selected location(s) the work is being performed)	BigBite and SBS detector stacks
Risk Classification: (See ES&H Manual Chapter 3310 Appendix T1 Risk Code Assignment)	Without mitigation measures (3 or 4):		3
	With mitigation measures in place (N, 1, or 2):		1
Reason:	This document is written to mitigate hazard issues that are : Determined to have an unmitigated Risk code of 3 or 4		
Owning Organization:	PHALLA		
Document Owner(s):	Szumila-Vance, Holly (hazsumila@jlab.org) Primary		
Supplemental Technical Validations <input type="checkbox"/>			

Summary

- UV chambers in testing at UVa
- Rear tracker installed in TEDF and being studied with cosmics
- INFN chambers will be moved to TEDF soon
- TEDF setup will allow us to further refine the DAQ setup and understand detector signals with cosmics, pulser rate studies

Noted items:

- *Clearly define benchmarks and plans for commissioning and calibration*
- *Develop monitoring software and implement in Analyzer*
- *Develop documentation for shift crews*

