

Status of UVA SBS GEM Activities

SBS Weekly Meeting, August 31, 2020

Kondo Gnanvo

Weekly meeting for the commissioning of the GEMs every Wednesday at 10:00 am

Wiki: https://hallaweb.jlab.org/wiki/index.php/GMn_GEM_Commissioning_Meeting

Outline

- ❖ Status of UVa GEM layers assembly in EEL124
- ❖ Update on U-V GEM Layers assembly @ UVa
- ❖ Timeline for installation in BB spectrometer and Gen-RP

UVa GEMs in EEL Clean Room:

Anuruddha Rathnayake, John Matter, Xinzhan Bai, Malinga Rathnayake, Thir Gautam...

U-V Strip GEMs assembly at UVa:

Huong Nguyen, John Boyd, Sean Jeffas ...

GEM APV25-MPD Readout Electronics

Alexandre Camsonne, Ben Raydo, Bryan Moffit, Hanjie Liu, Chandan Gosh ...

Status of UVa GEM layers assembly in EEL124

Summary Table of UVa GEM Module Production

Module 01: ⇒ OK Where: UVa - shelfe Tested at: UVa	Module 11: ⇒ OK Where: EEL-124 - shelfe Tested at: UVa, known fixes	Module 21: ⇒ OK Where: Hall A - PREX Tested at: UVa & JLab	Module 31: ⇒ OK Where: EEL-124 – Layer#6 Tested at: UVa	Module 41: ⇒ OK Where: EEL-124 – layer#4 Tested at: UVa
Module 02: ⇒ OK, 1HV out Where: UVa - shelfe Tested at: UVa	Module 12: ⇒ OK, 1HV out Where: Hall A - PREX Tested at: UVa & JLab	Module 22: ⇒ OK Where: EEL-124 – Layer#3 Tested at: UVa & JLab	Module 32: ⇒ OK Where: EEL-124 – Layer#6 Tested at: UVa	Module 42: ⇒ OK Where: EEL-124 – Layer#3 Tested at: UVa & JLab
Module 03: ⇒ OK Where: UVa - shelfe Tested at: UVa	Module 13: ⇒ OK Where: EEL-124 – Layer#2 Tested at: UVa & JLab	Module 23: ⇒ OK Where: EEL-124 – Layer#6 Tested at: UVa	Module 33: ⇒ OK Where: EEL-124 – Layer#1 Tested at: UVa & JLab	Module 43: ⇒ OK Where: EEL-124 – layer#4 Tested at: UVa
Module 04: ⇒ OK Where: UVa - shelfe Tested at: UVa	Module 14: ⇒ OK Where: Hall A - PREX Tested at: UVa & JLab	Module 24: ⇒ OK Where: UVa - shelfe Tested at: UVa	Module 34: ⇒ Stretch issues Where: UVa - shelfe Tested at: UVa, require fixes	Module 44: ⇒ FAILED Where: UVa - shelfe Tested: under Investigation
Module 05: ⇒ Stretch issues Where: UVa - shelfe Tested at: UVa, require fixes	Module 15: ⇒ OK Where: EEL-124 - shelfe Tested at: UVa	Module 25: ⇒ OK Where: EEL-124 – Layer#2 Tested at: UVa & JLab	Module 35: ⇒ OK, 1HV out? Where: EEL-124 - shelfe Tested at: UVa & JLab	Module 45: ⇒ OK Where: EEL-124 – Layer#3 Tested at: UVa & JLab
Module 06: ⇒ Stretch issues Where: UVa - shelfe Tested at: UVa, require fixes	Module 16: ⇒ OK Where: EEL-124 – Layer#1 Tested at: UVa & JLab	Module 26: ⇒ OK Where: Hall A - PREX Tested at: UVa & JLab	Module 36: ⇒ OK Where: EEL-124 – layer#4 Tested at: UVa	Module 46: ⇒ OK Where: UVa - shelfe Tested at: UVa
Module 07: ⇒ OK Where: EEL-124 - shelfe Tests: UVa, known fixes	Module 17: ⇒ OK Where: EEL-124 – Layer#2 Tested at: UVa & JLab	Module 27: ⇒ OK Where: EEL-124 – Layer#6 Tests: UVa	Module 37: ⇒ OK Where: EEL-124 – layer#5 Tested at: UVa	Module 47: ⇒ OK Where: EEL-124 – Layer#1 Tested at: UVa & JLab
Module 08: ⇒ OK Where: EEL-124 - shelfe Tested at: UVa, known fixes	Module 18: ⇒ OK Where: Hall A - PREX Tested at: UVa & JLab	Module 28: ⇒ OK Where: Hall A - PREX Tested at: UVa & JLab	Module 38: ⇒ OK Where: EEL-124 – layer#5 Tested at: UVa	Module 48: ⇒ OK Where: UVa - shelfe Tested at: UVa
Module 09: ⇒ OK Where: EEL-124 - shelfe Tested at: UVa, known fixes	Module 19: ⇒ OK Where: EEL-124 – Layer#1 Tested at: UVa & JLab	Module 29: ⇒ OK Where: EEL-124 – Layer#3 Tested at: UVa & JLab	Module 39: ⇒ OK Where: EEL-124 – layer#5 Tested at: UVa	Module 49: ⇒ OK Where: UVa - shelfe Tested at: UVa
Module 10: ⇒ OK Where: EEL-124 - shelfe Tested at: UVa, known fixes	Module 20: ⇒ OK Where: EEL-124 – Layer#2 Tested at: UVa & JLab	Module 30: ⇒ OK Where: EEL-124 – layer#4 Tested at: UVa	Module 40: ⇒ OK Where: EEL-124 – layer#5 Tested at: UVa	Module 50: ⇒ OK Where: UVa – shelfe Tested at: UVa

5 layers on cosmic stand

6th layer on assembly table

Modules in PREX in Hall A

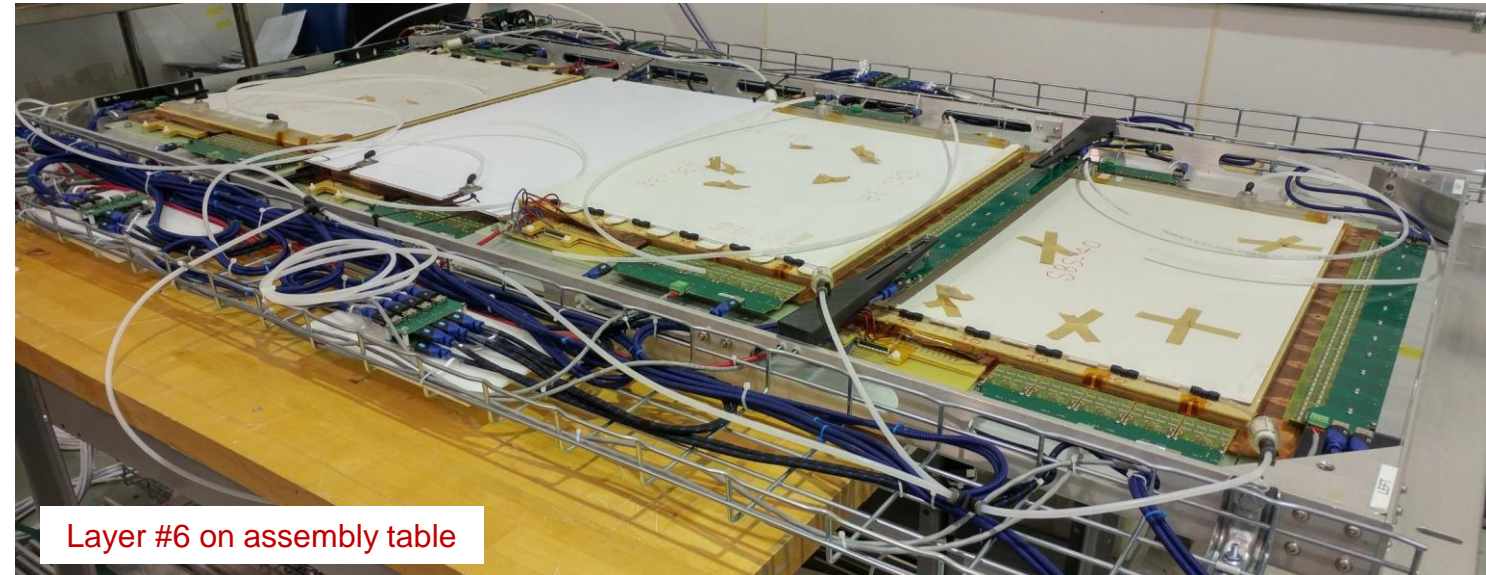
Modules requiring some minor fixes
Under control ⇒ Straight forward fixes

Few modules: have diverse issues i.e. some stretching related instabilities on HV or unexplained shorts
Under investigation

Low gain chambers ⇒ needed to work at higher HV values

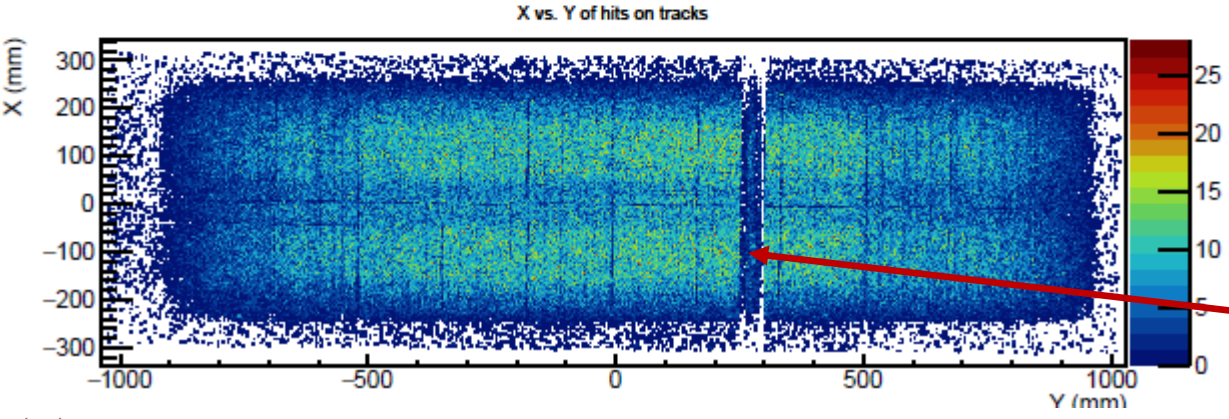
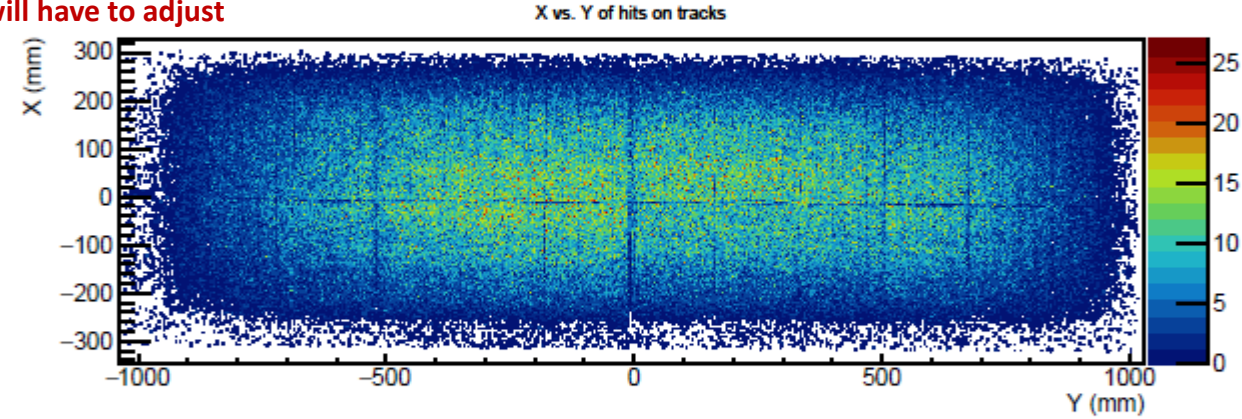
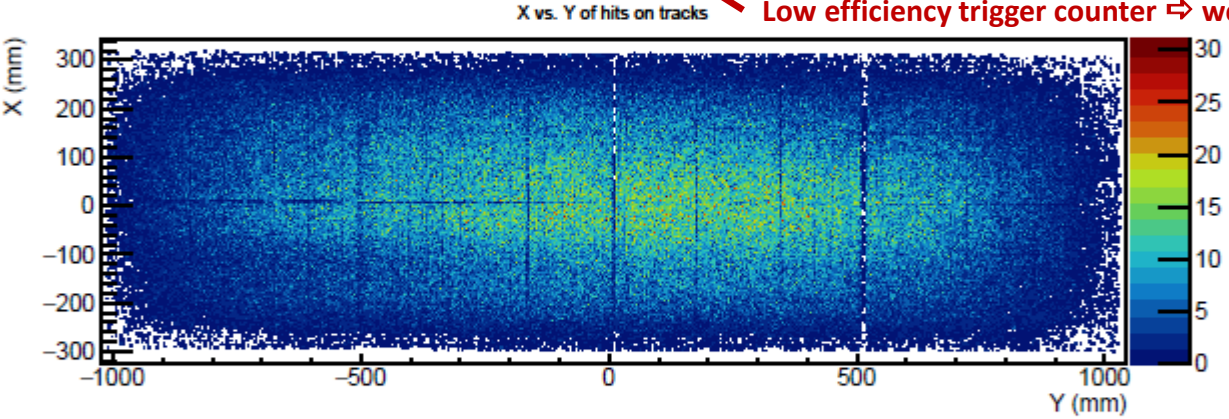
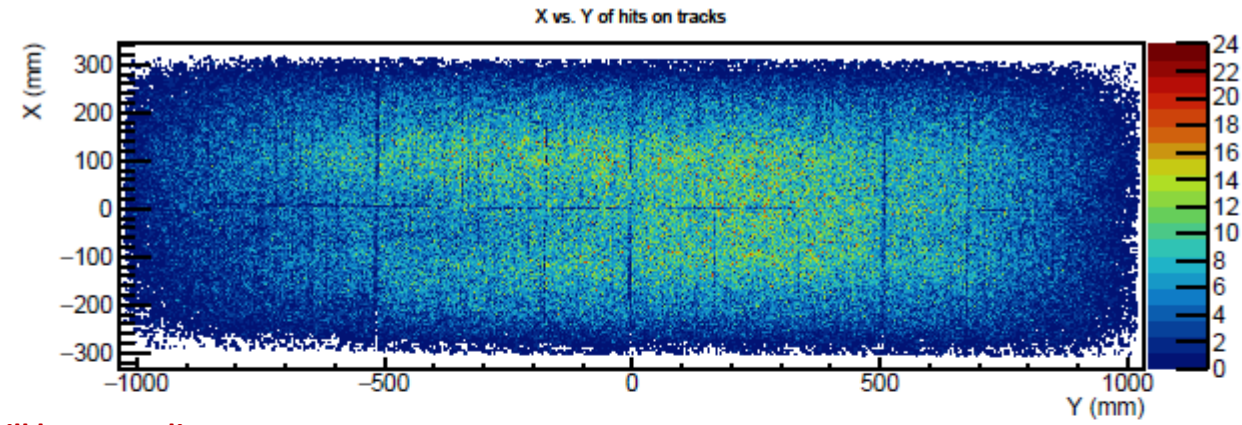
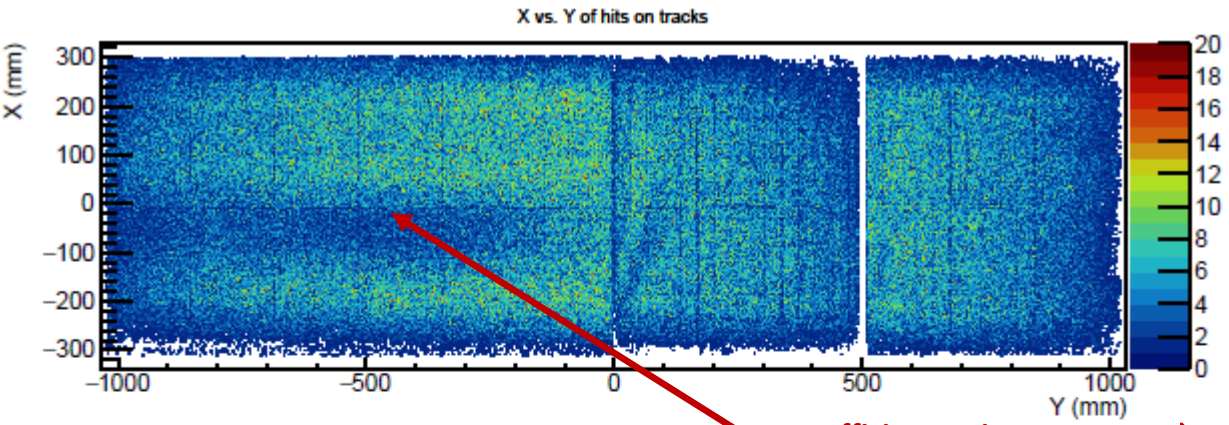
Status of UVa GEM layers assembly in EEL124

- ⇒ **6 of all 11 UVa GEM layers:** tested and validated. (was done before COVID-19 lockdown in March 2020)
- ⇒ **5 layers are on the cosmic stand:** HV tests performed regularly (no major problems with all 20 modules)
 - ⇒ Resume cosmic data taking more than a month ago .
- ⇒ **layer #6 is completed:** On assembly table. HV tests and readout electronics tests OK
 - ⇒ Will move to cosmic stand only after one layer installed on BB frame
- ⇒ **Layer #3, #4, and #5** assembly are final but **Layer #1 and #2** are going to be taken out later for some modifications on the layer frames
- ⇒ Few HV stability issues with some modules during cosmic tests ⇒ Small modifications on the HV divider to minimize this occurrence
- ⇒ Need to work on reducing overall noise on APV25 electronics



Layer #6 on assembly table

Preliminary cosmic test results with 5 layers: Hit map @ 4100 V



Low efficiency trigger counter → we will have to adjust

Issue with one APV25 under investigation

Efficiency map with all modules @ 4100 V

Low gain module, will operate at higher HV

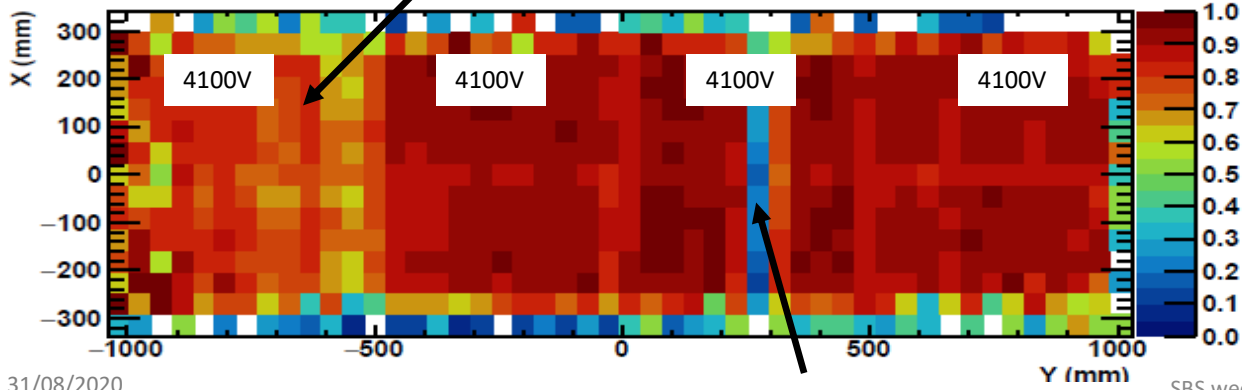
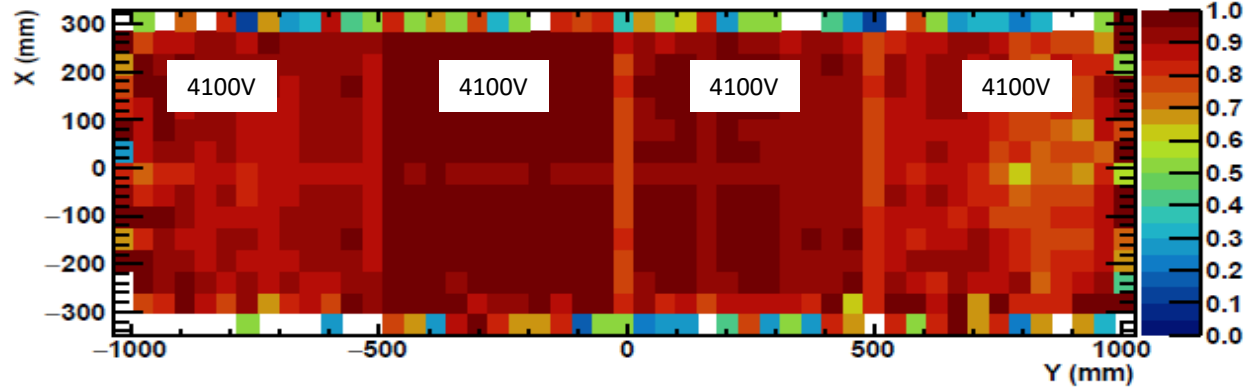
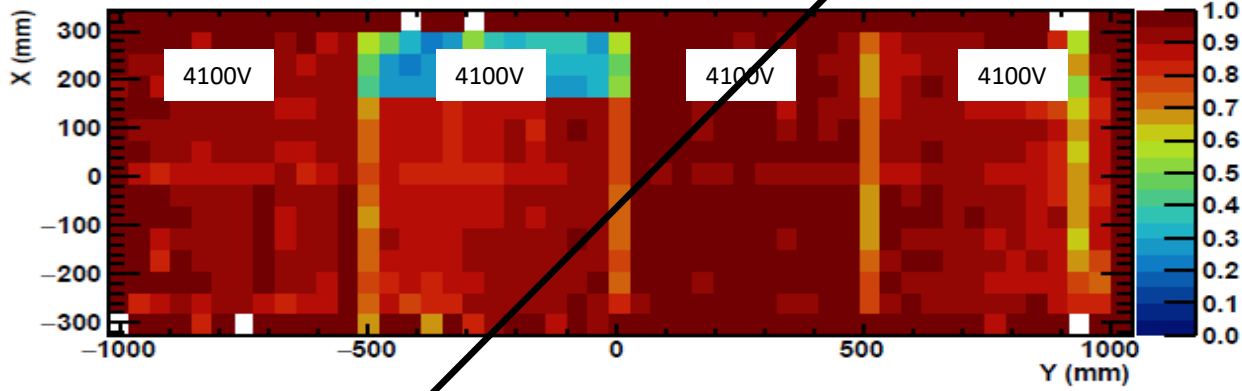
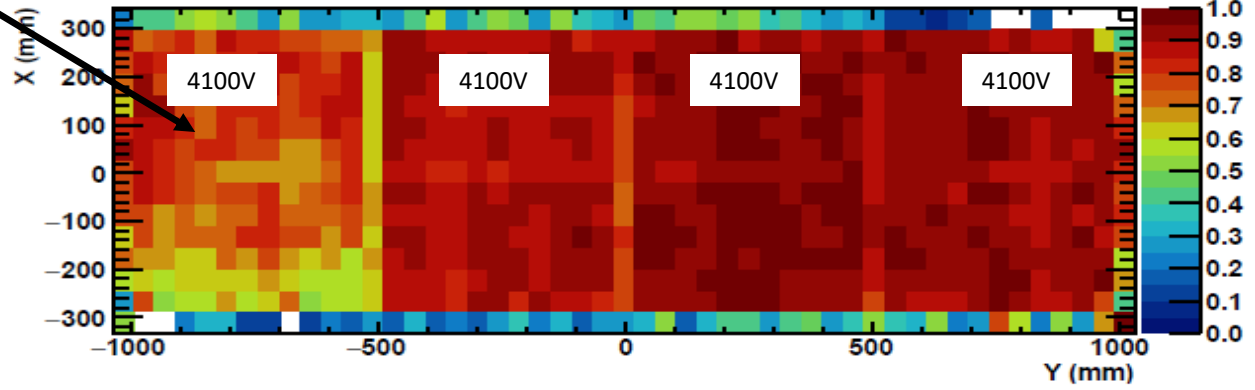
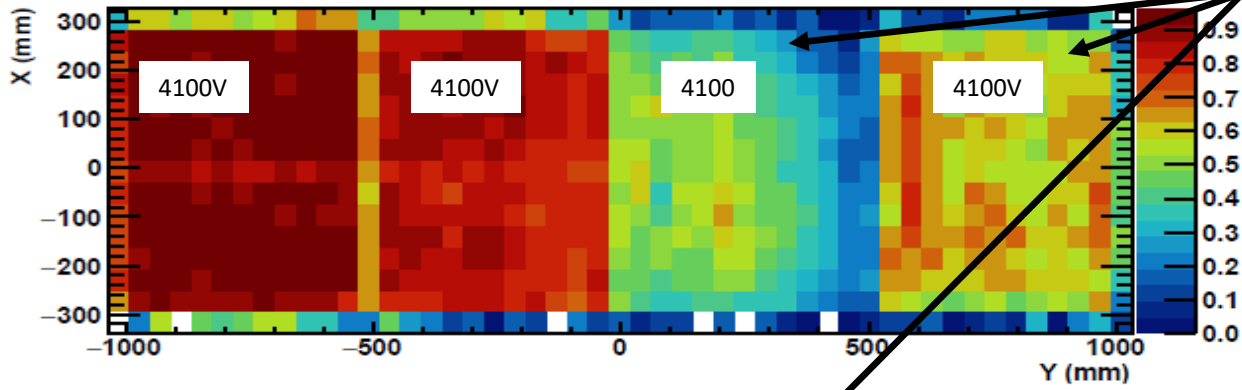
Track-based efficiency, layer 0

Track-based efficiency, layer 1

Track-based efficiency, layer 2

Track-based efficiency, layer 3

Track-based efficiency, layer 4

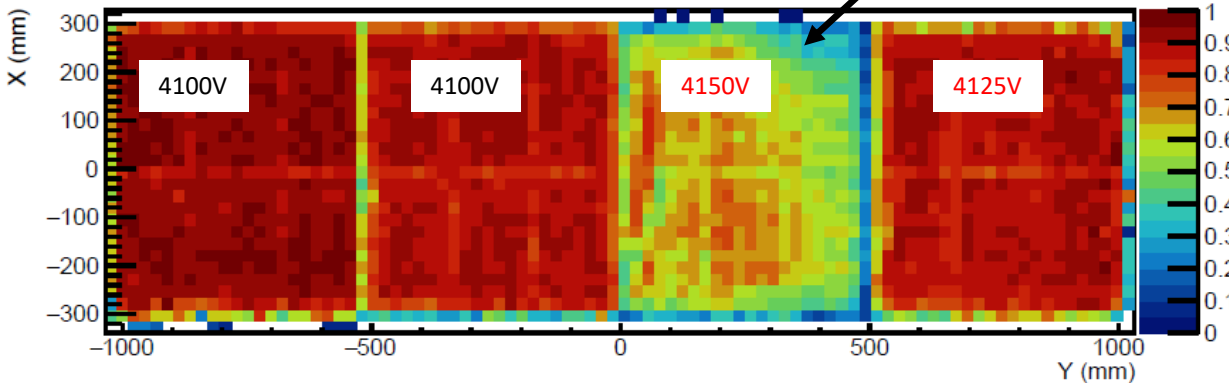


- ⇒ All modules at 4100V except a few with higher voltages 4125 V and 4150V
- ⇒ These modules correspond to the low gain modules that will have to be operated at higher voltage for full efficiency

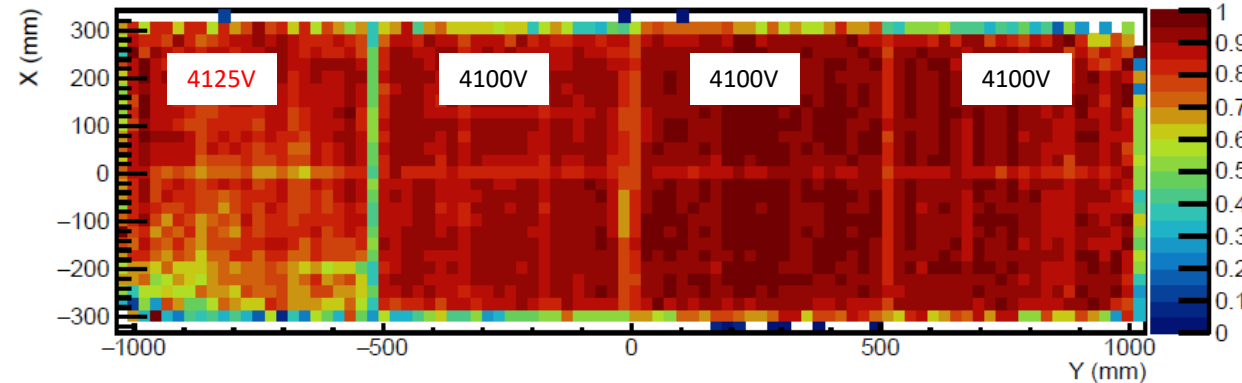
Slight increase the voltage on low efficiency modules

One modules still low gain, will operate at higher HV ~ 4250

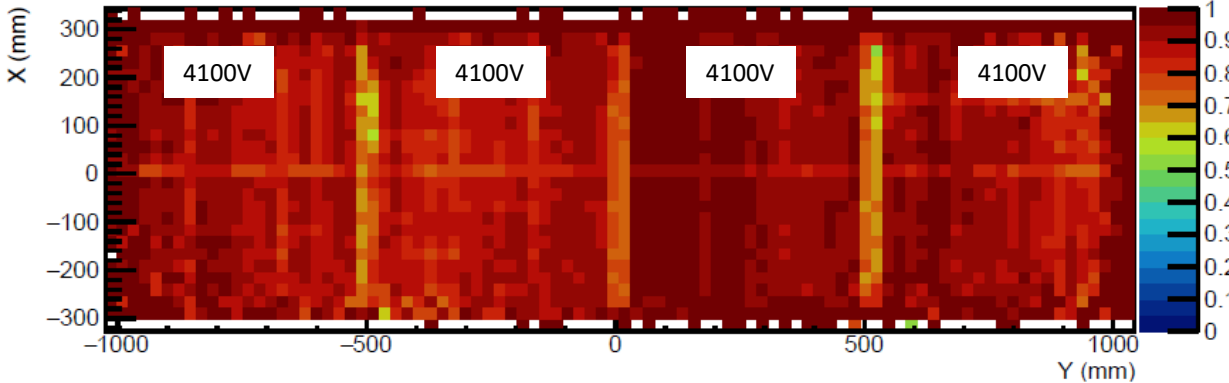
Track-based efficiency, layer 0



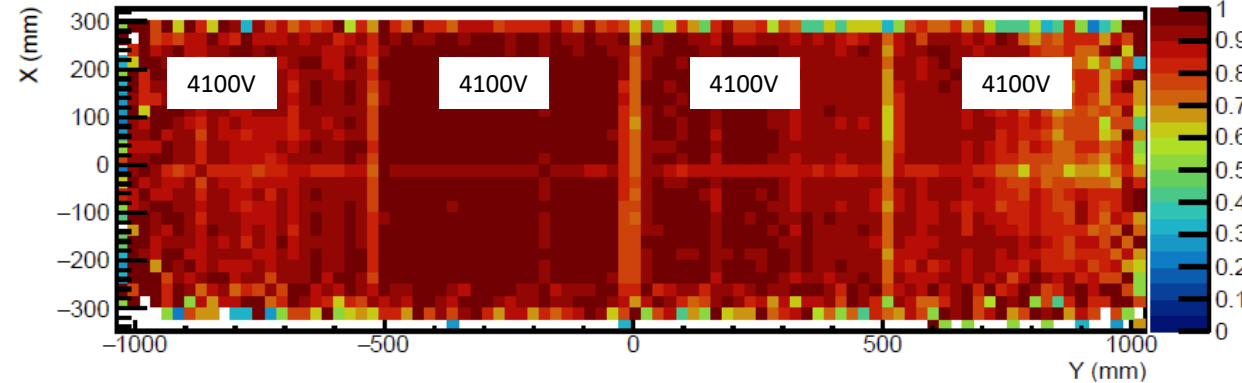
Track-based efficiency, layer 1



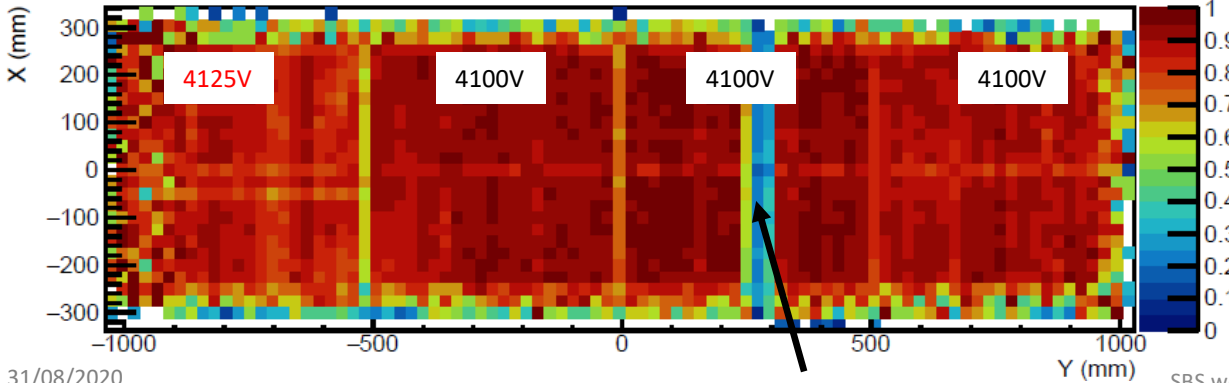
Track-based efficiency, layer 2



Track-based efficiency, layer 3



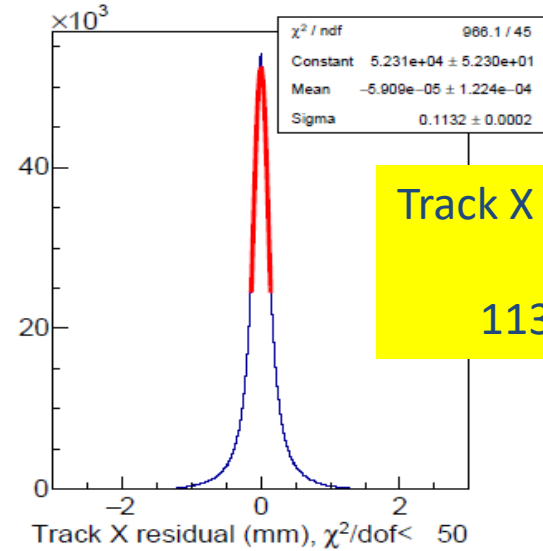
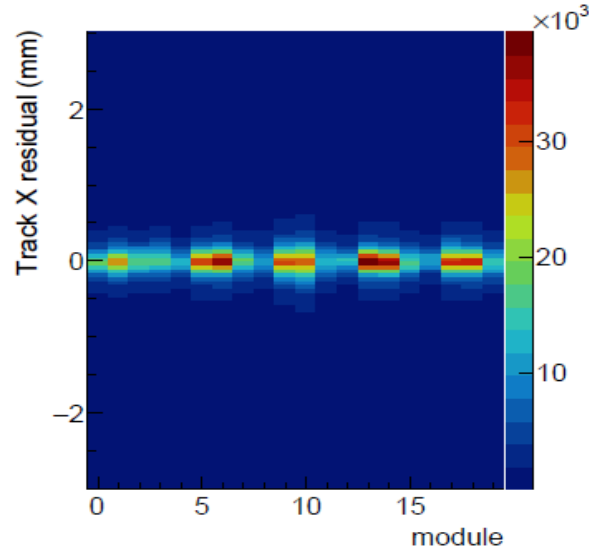
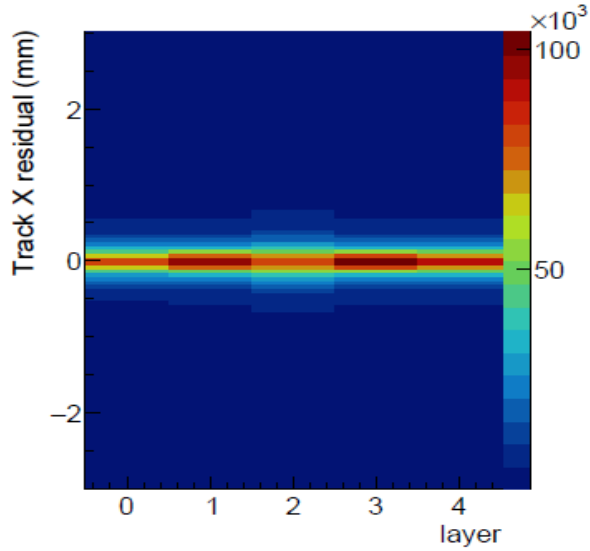
Track-based efficiency, layer 4



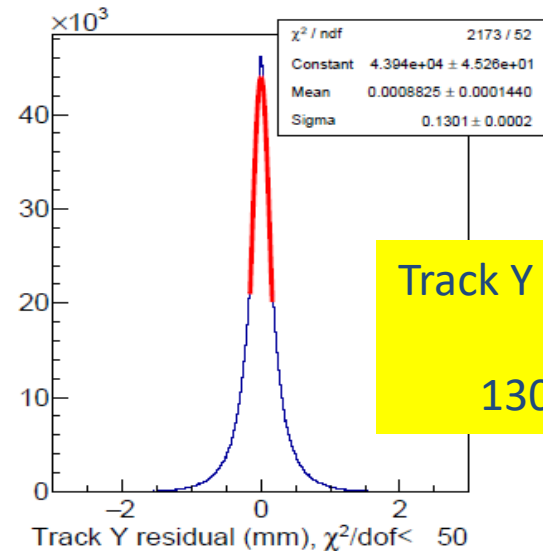
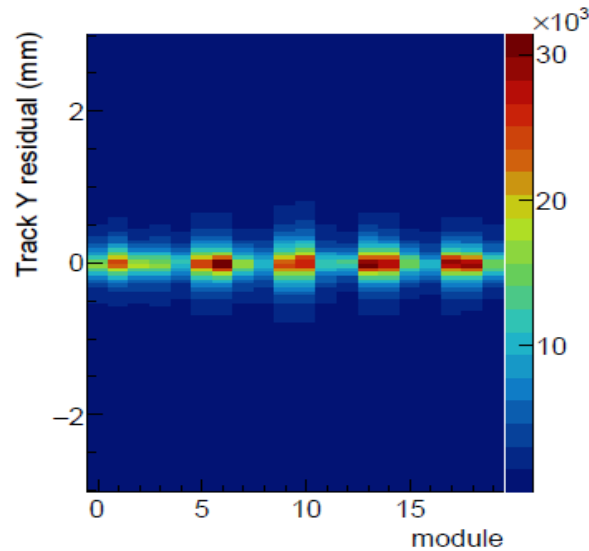
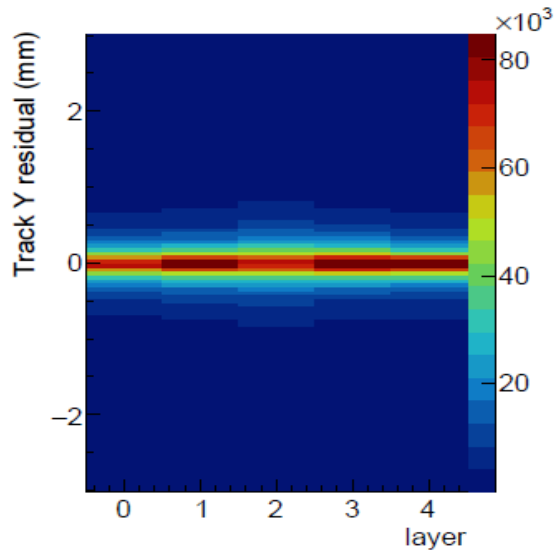
- ⇒ All modules at 4100V except a few with higher voltages 4125 V and 4150V
- ⇒ These modules correspond to the low gain modules that will have to be operated at higher voltage for full efficiency

Issue with one APV25 under investigation

Preliminary cosmic test results with 5 layers: Residual plots @ 4100 V



Track X residual
=
113 μm



Track Y residual
=
130 μm

ELOG: last 1M run with 5 layers: <https://hallaweb.jlab.org/dvcslog/SBS/315>

Cosmic Run Conditions of week 08/03/2020 - 08/07/2020

EEL 124 Cosmic stand- UVa GEMs

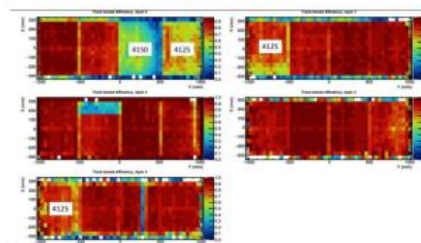
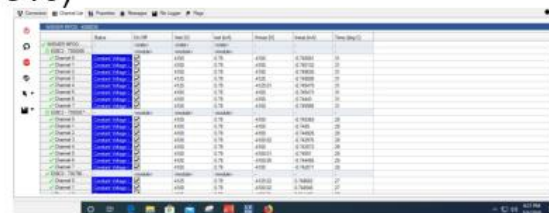
Thursday (08/06) & Friday (08/07); Run Numbers 1511,1512,1513,and 1515(pedestal -> 1510)

- Ar/CO2 (75/25) -> 15 /module
- HV
 - L#1, G_2 (Prod ID: 16) = 4150 V
 - L#1, G_3 (Prod ID: 19) = 4125 V
 - L#2, G_0 (Prod ID: 13) = 4125 V
 - L#5, G_0 (Prod ID: 40) = 4125 V
 - All other modules = 4100 V
- 1511 -> ~300K trigger events || 1512 -> ~406K || 1513 -> ~100K || 1515 -> ~200K

Wednesday (08/05); Run Number 1477 (Pedestal -> 1466)

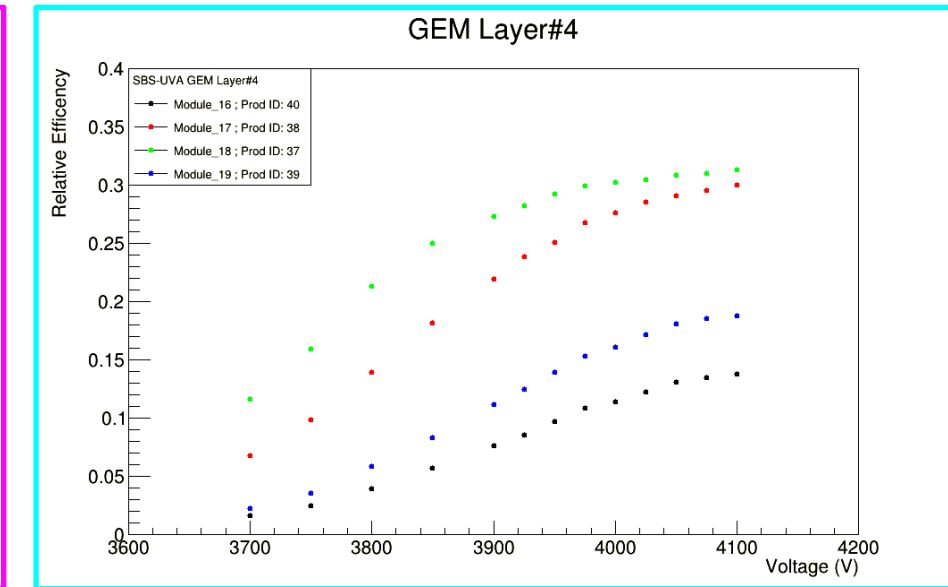
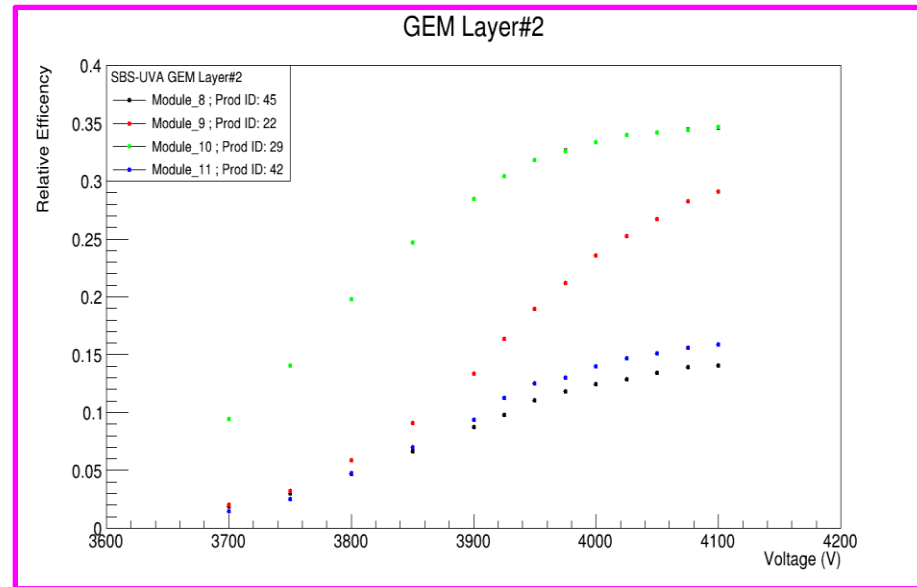
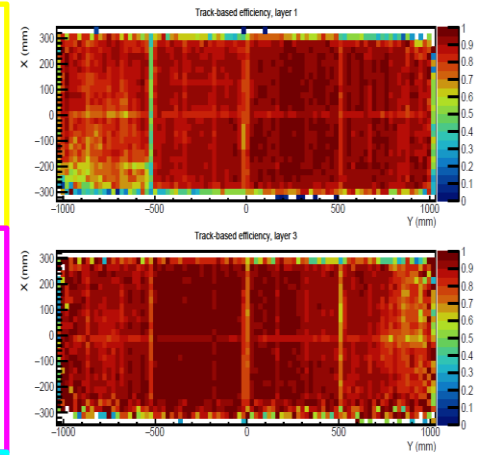
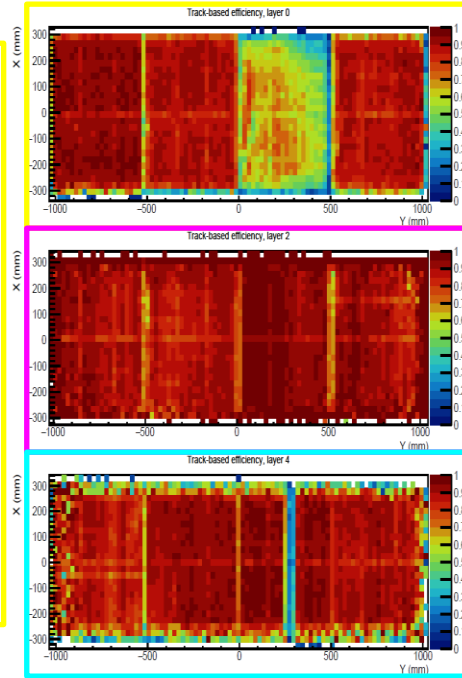
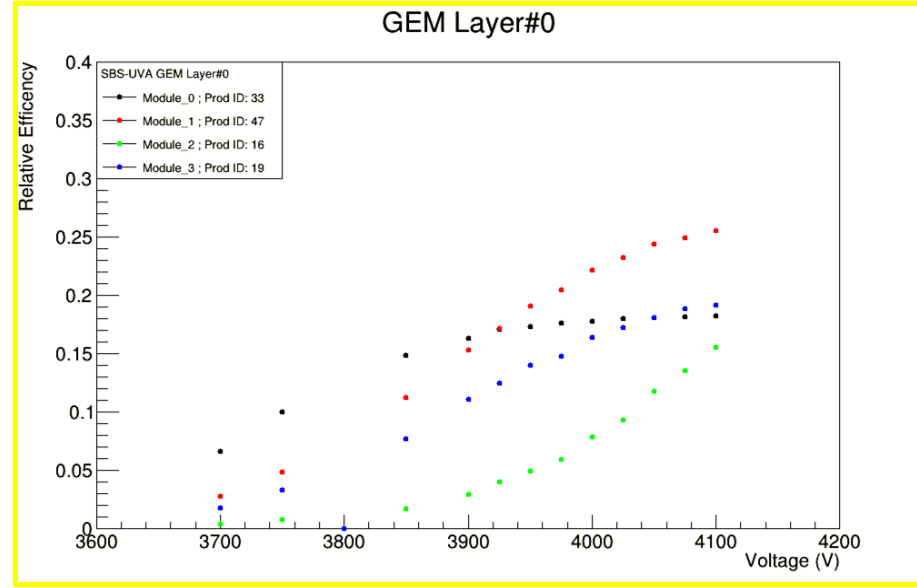
- Ar/CO2 (75/25) -> 15/module
- HV -> 4.1 KV in all 20 modules (5 layers)
- Crate3 MPd11apv8 & crate 3 MPD16apv1 have very high ADC value
- ~160K events collected

HV GUI; Run Numbers 1511,1512,1513, and 1515 (pedestal -> 1510)



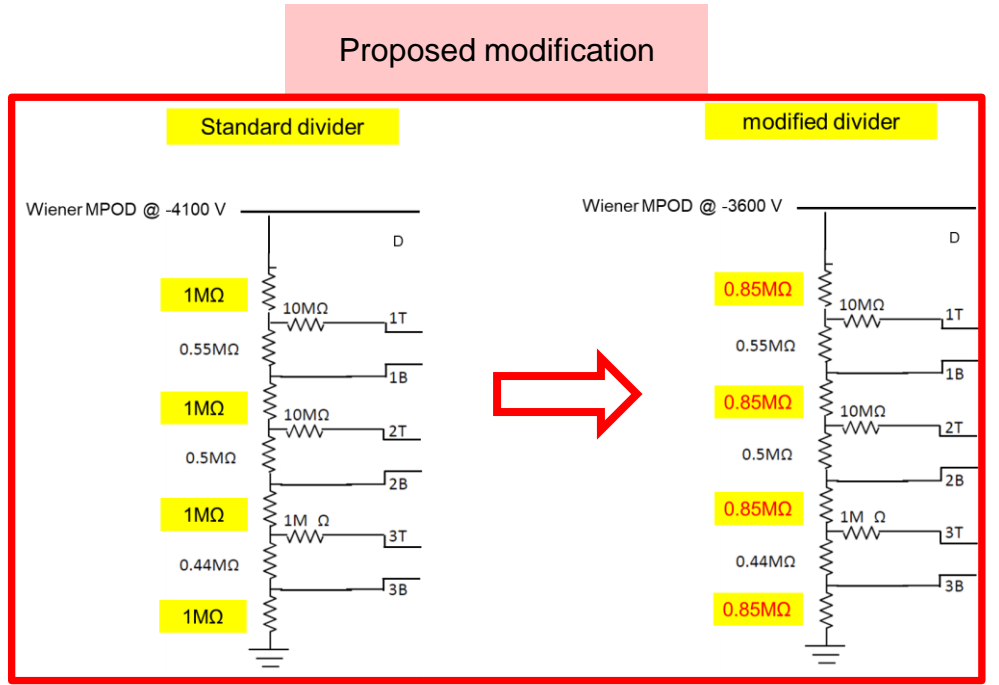
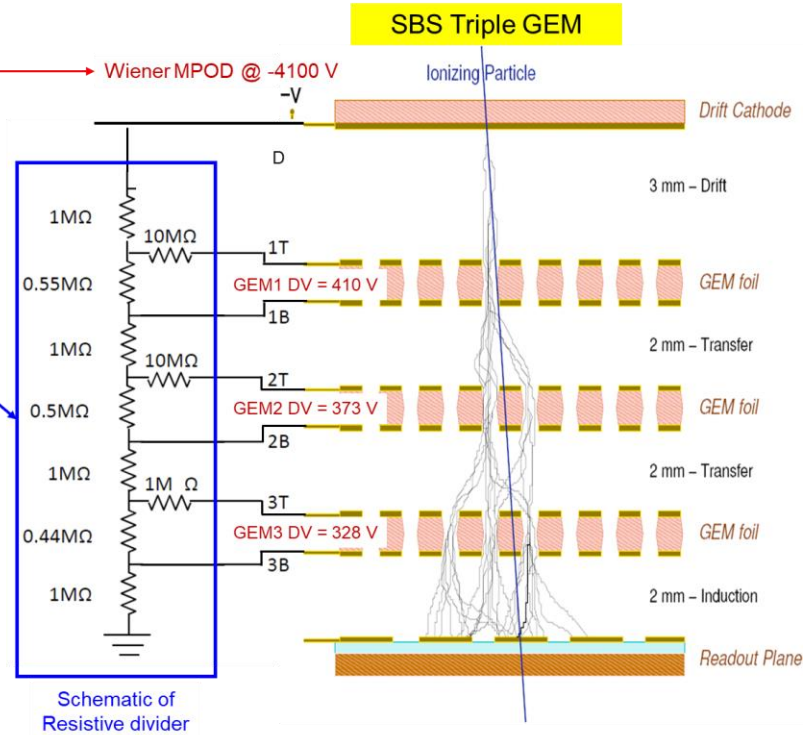
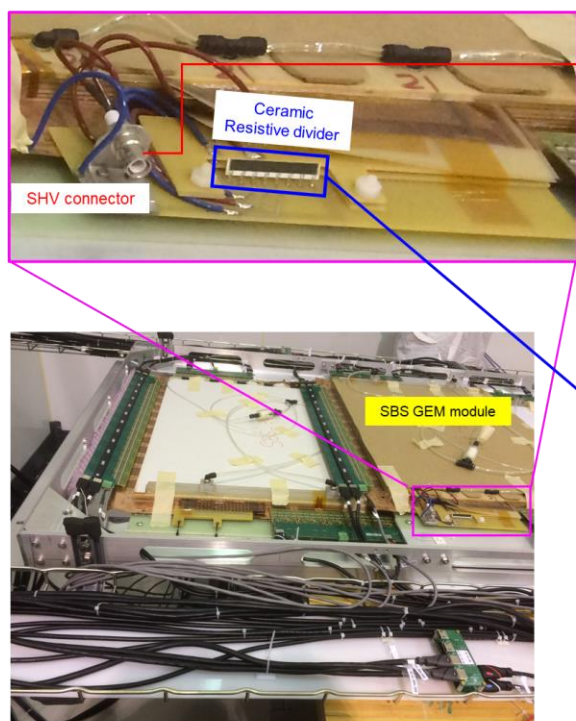
HV Scan for Efficiency Plateau Studies

- ⇒ Voltage scan from 3700 V to 4100V ⇒ efficiency plateau for each individual module
- ⇒ We scan 4 modules of one layer at the time by keeping the voltage constant on the other 4 layers constant at 4100V
- ⇒ **Relative efficiency = number of hit in chamber / number of triggered events** ⇒ trigger acceptance, expect different hit count for different modules depending where they are located in the cosmic stand
- ⇒ 3 layers completed so far (see plots) ⇒ Most module at or near plateau at 4100 V as expected, low gain modules have low efficiency at 4100 V as expected
- ⇒ We will redo and complete the voltage scan with the new modified divider ⇒ **individual optimal operating voltage for each module**



Modification of the HV divider

- ⇒ Few modules has shown some stabilities issues with the HV hat we can associate to maybe at 4.2kV, some vibrations between GEM foils cause the chamber to discharge
- ⇒ The problem disappear at lower voltage and / or if we reduce the gas flow rate from 5 Vol changes / hour to ~ 4 Vol changes / hour
- ⇒ We can avoid this problem by slightly reducing the E-field between GEM foil while we maintain the GEM amplification ⇒ **Same overall GEM gain = same overall performance**
 - ⇒ Modification of the divider shown above tested on several modules & prototypes at UVa
 - ⇒ Implementation on the production modules at JLab ⇒ Anuruddha is getting trained at UVa to learn about the modification and implementation on the modules in EEL124
- ⇒ After all the modules are modified with the new divider, we will run another HV scan for efficiency plateau determination then the layers will be ready for installation



- ⇒ **B. Raydo & A. Camsonne**: working on the high rate SSP-based implementation of the MPD readout
 - ⇒ Currently setting up the optical readout in INFN clean room to test the system
 - ⇒ Ben had identified some issues for high rate that is under investigations
 - ⇒ I understand that he is in discussion with Paolo for the fixes ...
- ⇒ **Hanjie** from UMass is joining the effort and she will learn the system and later help with the integration for the BB and SBS setup
- ⇒ **Chandan** from UMass will be in charge of the coordination between the collaboration and JLab engineers to prepare the GEM electronics huts for both BB and SBS GEMs for GMn and GEn-RP (and later for Gep-5 as well)

Update on Front Trackers GEMs with U-V Strips Readout

Procurements of the detector parts completed for 3 layers

- ⇒ 9 GEM foils for 3 GEM layers delivered (March 2020)
 - ⇒ order for 3 more GEM foils for the 4th layer is in the process (paid by INFN Collab. E. Cisbani)
- ⇒ 4 U-V readout boards & 4 drift cathode foils delivered (March 2020)
- ⇒ Complete setoff frames for 3 layers delivered (July 2020)
 - ⇒ order for a set for the 4th layer is in the process (paid by U. Glasgow D. Hamilton)
- ⇒ Varnish chemical (from Mader Switzerland) for the GEM support frames were delivered mid August

Clean room Equipment and Pre-assembly activities

- ⇒ Mechanical stretcher almost entirely refurbished to accommodate the detector size, New nitrogen box for HV of the GEM foils completed
- ⇒ Sanding and cleaning of the GEM support frames have started ⇒ Next step is to apply the varnish
- ⇒ 3 Honeycomb based support plate for the GEM layers have been assembled ⇒ Next step: Glue the R/O layers on the base support frames

Tentative U-V GEM assembly schedule

- ⇒ We plan to start assembly of first layer in two weeks from now (Mid September) .
- ⇒ With a aggressive schedule and manpower availability, we expect to complete one layer in 6 weeks ⇒ first U-V GEM layer by end October
- ⇒ Second U-V GEM layer is expected to be completed by December before Christmas

Not clear yet for the two remaining layers: The plans and timeline for construction depends very much on how many U-V strips GEM we are expecting to have ready for GMn & GEn-RP runs

U-V Strips GEM Layers assembly Task Schedule

Stage & Color Key								
P: Preparation								
A: Assembly								
T: Test								
					Sum [hrs]:			
					380			
Stage	Task	Sub-Task	Time [hrs]	Multiplier	Total Time [hrs]	Notes	Frames/Chambers Finished	Done?
P	Honeycomb and film onto ROB Frame	Cut honeycomb	0.5	3	1.5		3 honeycombs	Yes
		Glue films onto frames	3	3	9			
P	Inspect RO board		5	1	5			
P	Inspect GEM foils		3	1	3			
P	Sand and dry-clean Frames		20	3	60			
P	Build frame dryer rack				0			
P	Wash Frames	Set up washer/washing area		1	0			
		Gather/change de-ionized water	5	2	10			
		Washing the frame	3	3	9			
P	Varnish/Paint Frames		10	3	30			
T	Test Stretcher	Prepare test foil/kapton	3	1	3			
		Prep test frame	0.5	1	0.5			
P	Clean Room Preparation	Add Surfaces/Tables			0			
		Move old frames/foils/equip. out			0			
		Sweep and Vacuum	1	1	1			
		Wipe down surfaces	2	1	2			
T	Test Drift Cathode (????) - <i>Not necessary</i>				0			
T	Test UV GEM foils in HV box		3.5	9	31.5	2 mins per sector. 60 Sectors. Plus added setup & clean-up.		
A	Stretch and glue Kapton Windows to Top Layer/Entrance Window		3	3	9	Top Layer/Entrance Window		
A	Stretch and glue UV GEMs & Cathodes to frames (GEM/Frame Assembly)		4	12	48	Entrance Window, Drift Cathode, GEM Support, GEM Support, RO Support		
T	Test GEM/Frame Assembly (HV Box)		3.5	9	31.5			
A	Glue GEM/Frame Assemblies together		2.5	15	37.5	Top Layer, Entrance Window, Drift Cathode, GEM Support, GEM Support, RO Support		
T	Test Assembled GEM Chamber		12	3	36	2 mins per sector. 60 sectors. 3 Layers. 3 Chambers. Plus added setup & clean-up.		
A	Glue on ROB and ROB Main Support (Completes frame assembly)		2.5	3	7.5			
A	Seal GEM chamber		2	3	6			
A	Install HV Distributors		12	3	36			
A	Install gas parts/components		1	3	3			
T	Test fully-assembled chamber				0			
T	Cosmic Ray Tests	Build Stand for GEM chamber			0			
		Modify config/mapping			0			
		Set up tests (APVs, MPDs, CODA, etc.)			0			
		Take data			0			
		Analyze			0			
T	X-Ray Tests (???????)	Build stand/modify box			0			
		Take data			0			
		Analyze			0			
A	Finish and "ship"				0			

APV25-MPD Readout **needs** for U-V strips layers

⇒ 4 MPDs per U-V strips GEM layer:

- ⇒ if U-V layer is substituting an existing INFN or UVa SBS layer, then the MPD is available
- ⇒ not sure if these layers are in addition to the exiting SBS layers

⇒ 60 APV25 FE cards per layer:

- ⇒ U-V GEM layer used Panasonic connectors like UVa SBS GEM layers, INFN GEM layers use ZIF connectors
- ⇒ When we will run Gen-RP, there won't be any spare APV25 cards for U-V strip GEM layers
 - ⇒ **We need to procure 60 additional cards for each layer**

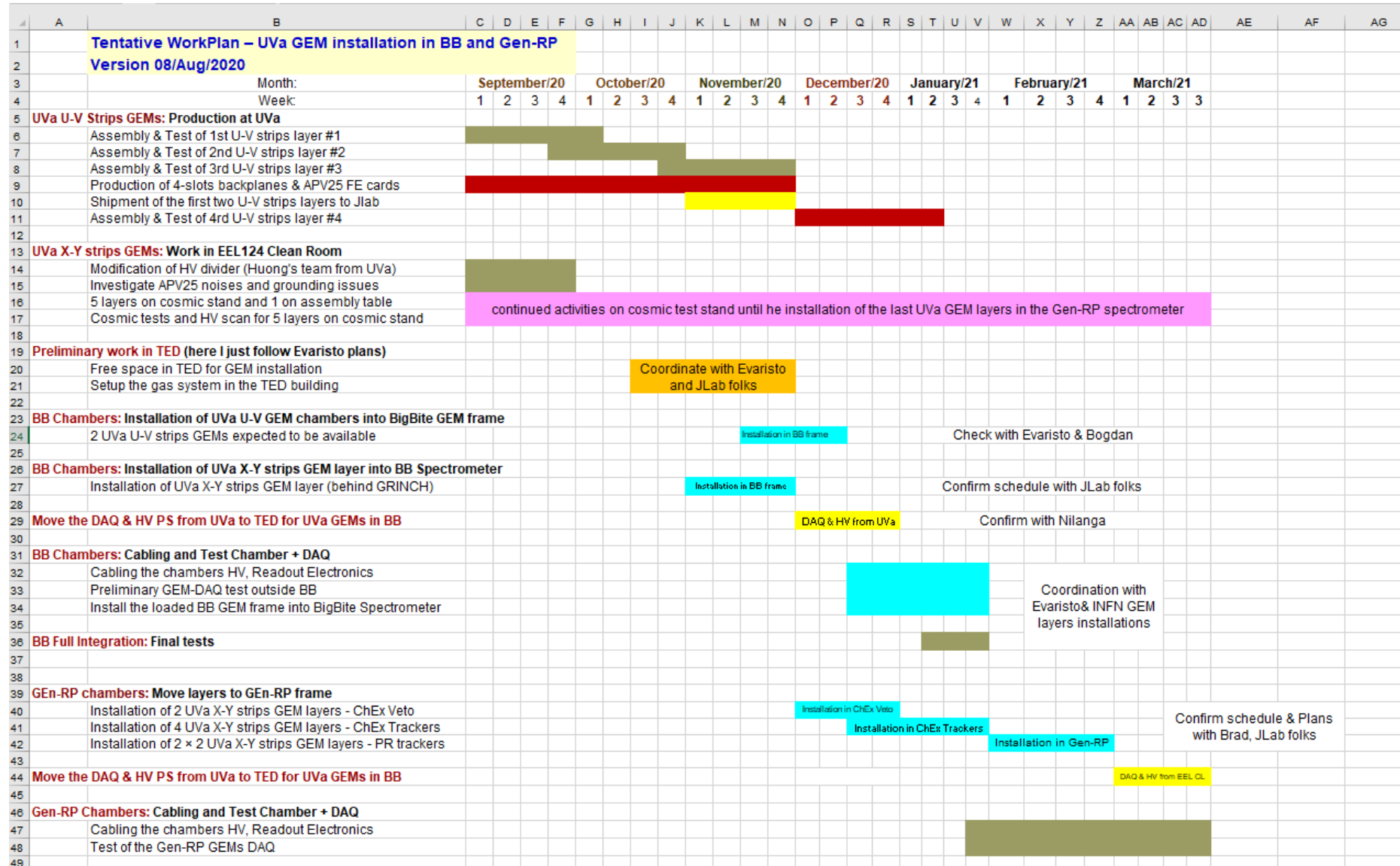
⇒ Backplanes, Patch Panel & HDMI cables:

- ⇒ We would need to procure 4 × 3-slots back planes and 12 × 4-slots back plane for each layer
 - ⇒ Total: 16 × 3-slots and 48 × 4-slots for all 4 layers
- ⇒ Need 4 × 4-to-2 patch panel for the digital lines per layer, no patch panel needed for the analog lines
 - ⇒ Available if we substituting layers INFN or UVa layers with U-V strip layers
- ⇒ Low Voltage regulators boards: ⇒ Available if we substituting layers INFN or UVa layers with U-V strip layers

The discussion on APV-MPD readout availability depends very much on how many U-V strips GEM we are expecting to have ready for GMn & GEn-RP runs

Timeline for installation in BB spectrometer and Gen-RP

Tentative UVa GEM Installation Plans for GMn & GEn-RP (X-Y and U-V strips GEMs)



This is a timeline I sent to Brad a few weeks ago

⇒ Might be a little bit too optimistic for the U-V strips GEMs though

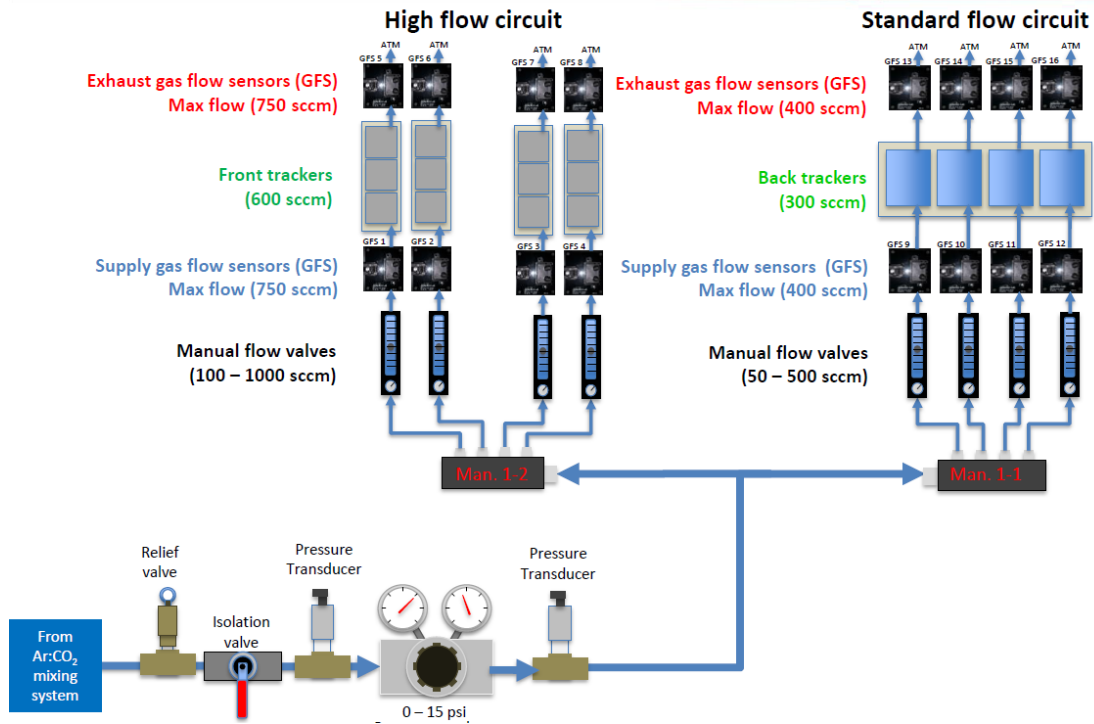
DSG Group (MarcMcMullen) are working the Gas distribution system for SBS GEMs

⇒ We (Evaristo, Brad, Nilanga, myself) have regular meeting with the group othe update or the development

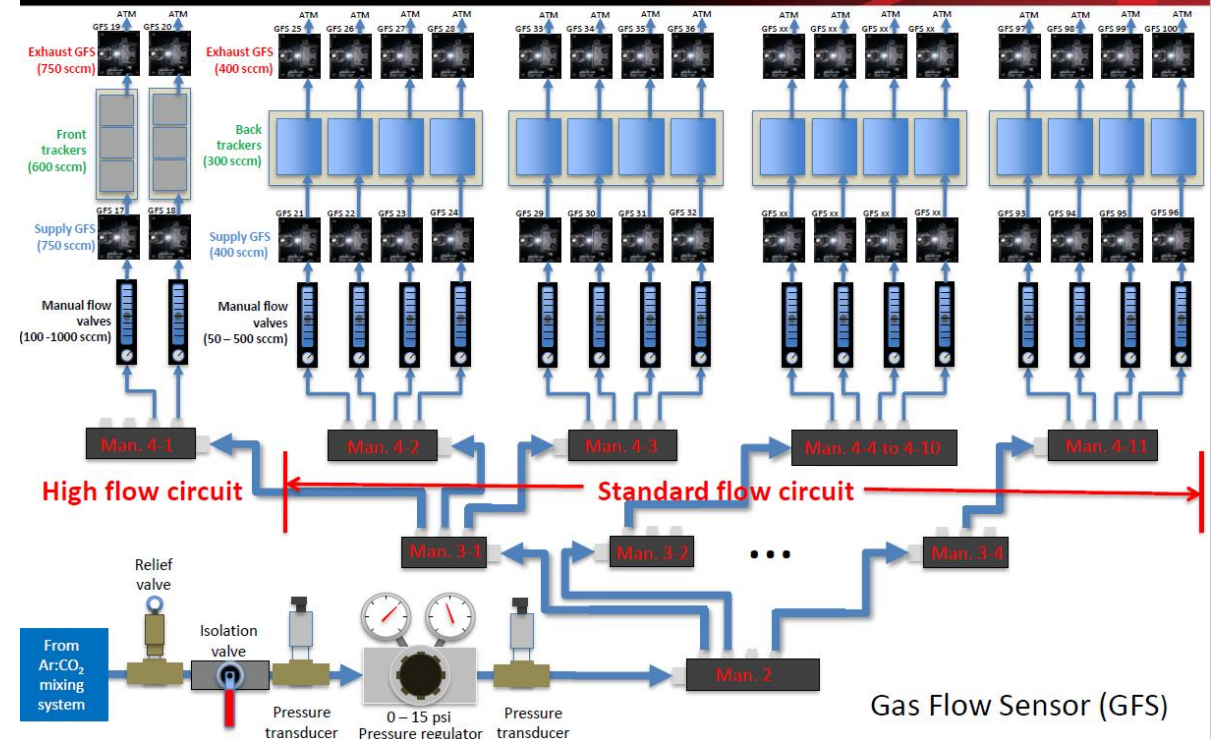
⇒ Details of the status in Marc talk:

https://www.jlab.org/sites/default/files/dsg/techDocs/Talks/Gas%20Distribution%20and%20Monitoring%20System%20for%20the%20GEM%20detectors_final.pdf

DSG Design of Gas Distribution for GEMs in BigBite



DSG Design of Gas Distribution for GEMs in Super BigBite



Backup