

Status of UVA SBS GEM Activities

SBS Weekly Meeting, Nov 02, 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 X-Y strips GEM layers in EEL124
- ❖ Update on U-V GEM layers assembly @ UVa

UVa GEMs in EEL Clean Room:

Anuruddha Rathnayake, Xinzhan Bai, Malinga Rathnayake, Thir Gautam... Holly Szumila-Vance

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

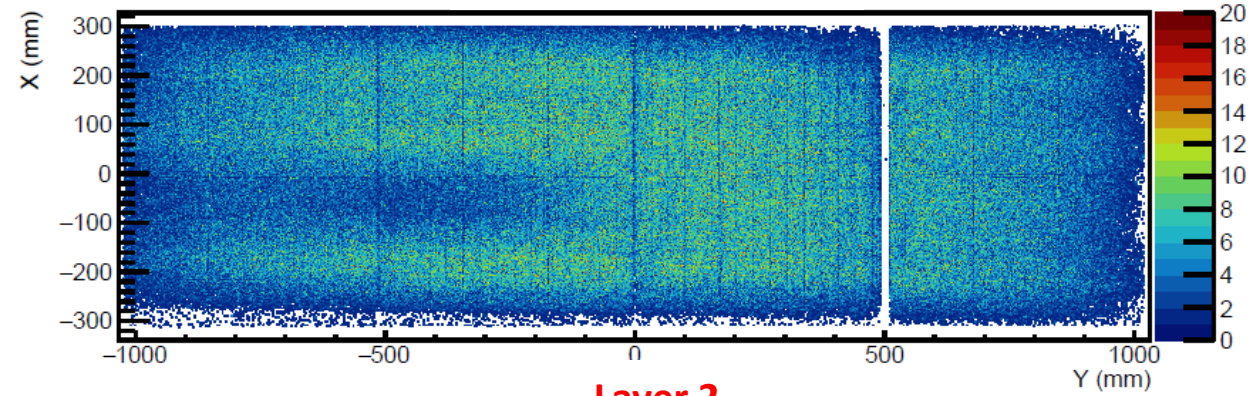
Status of UVa GEM layers assembly in EEL124

- ⇒ **6 of all 11 UVa GEM layers:** tested and validated.
- ⇒ **5 layers are on the cosmic stand:** HV tests performed regularly (no major problems with all 20 modules)
 - ⇒ Need to work on reducing overall noise on APV25 electronics (**Xinzhan** to start with this soon)
 - ⇒ **Some problems with the MPD readout / DAQ stability under investigation (to be discuss in slide later)**
- ⇒ **Layer #3, #4, and #5** assembly are final
 - ⇒ New divider scheme already implemented on layer #3 and 4
- ⇒ **Layer #1 and #2** are going to be taken out later for some modifications on the layer frames
- ⇒ **layer #6 is completed:** On assembly table. HV tests and readout electronics tests OK
 - ⇒ **Will move to cosmic stand only after layer #3 is installed on BB frame**
- ⇒ **Layer #7:** We just started the assembly, expect to be completed in a week or two
 - ⇒ Extended work space in the clean room for this layer
- ⇒ Alu frames for layers 8,9,10 & 11 needs some fixes (requires additional holes for clearances, same for layer 1 & 2)
- ⇒ We need PReX UVa GEMs back from the Hall (**Siyu**) in anticipation for layer 8 & 9 later
- ⇒ **Layer #3** installation into BB frame behind the GRINCH detector in TED building
 - ⇒ Tentative time schedule for the week Nov 30 for the installation
 - ⇒ Response to follow up questions to GEn-RP ERR provided to the committee on Oct. 15
 - ⇒ https://hallaweb.jlab.org/wiki/images/f/f2/ERR_response-15Oct2020-final.pdf

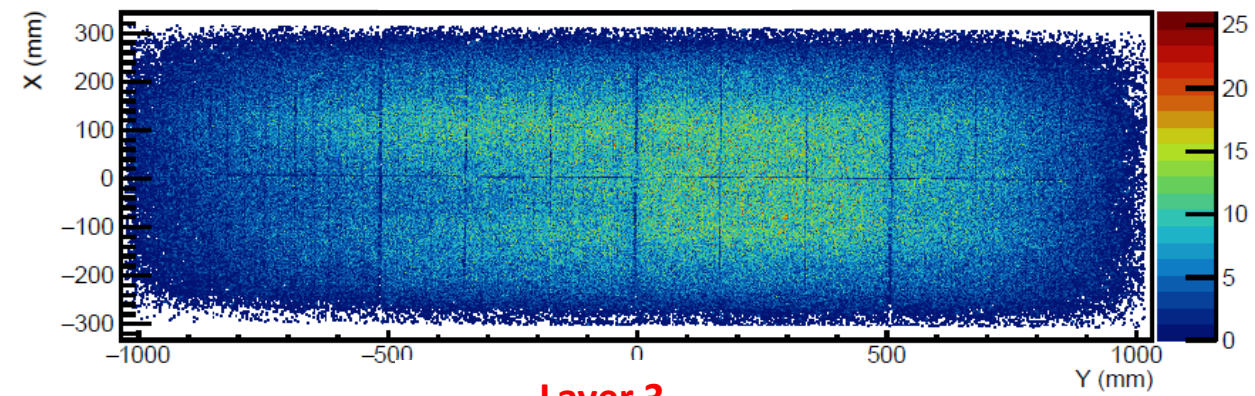


Preliminary cosmic test results with 5 layers: Hit map @ 4100 V

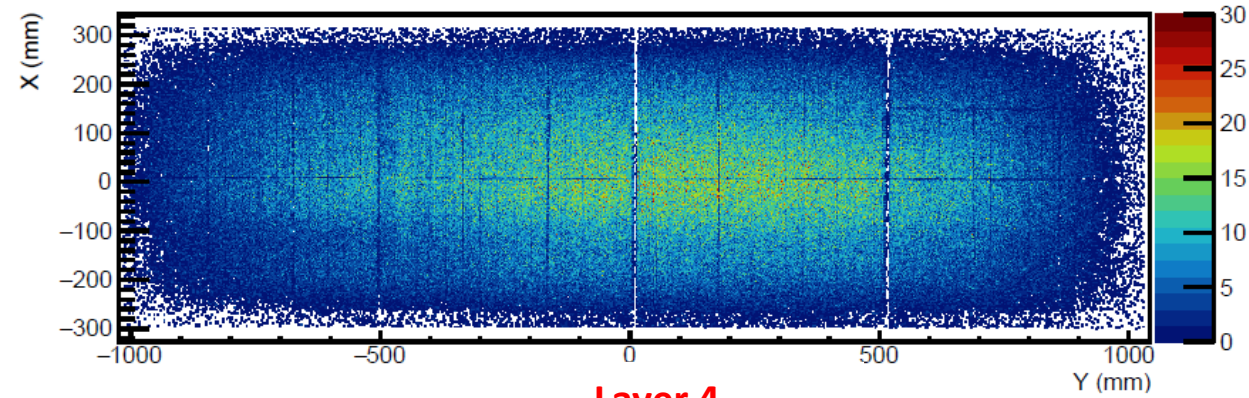
Layer 0



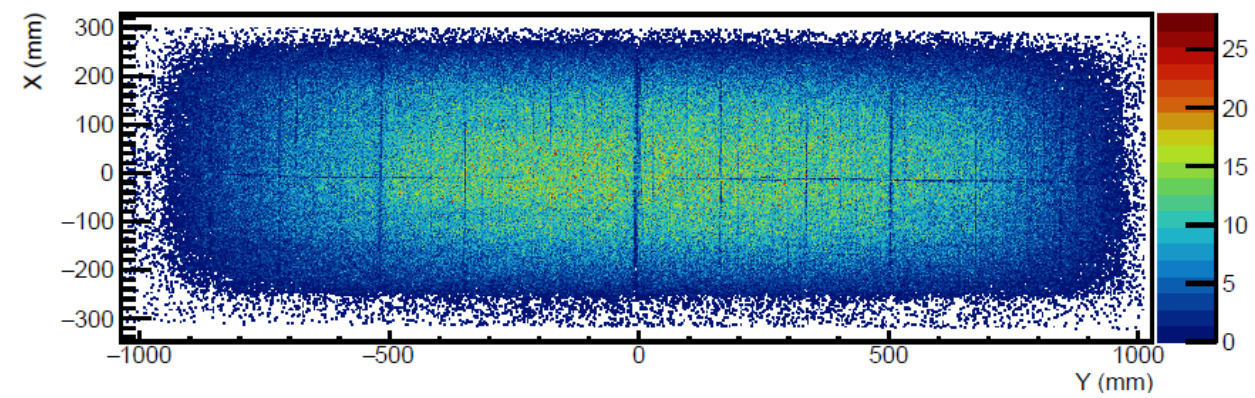
Layer 1



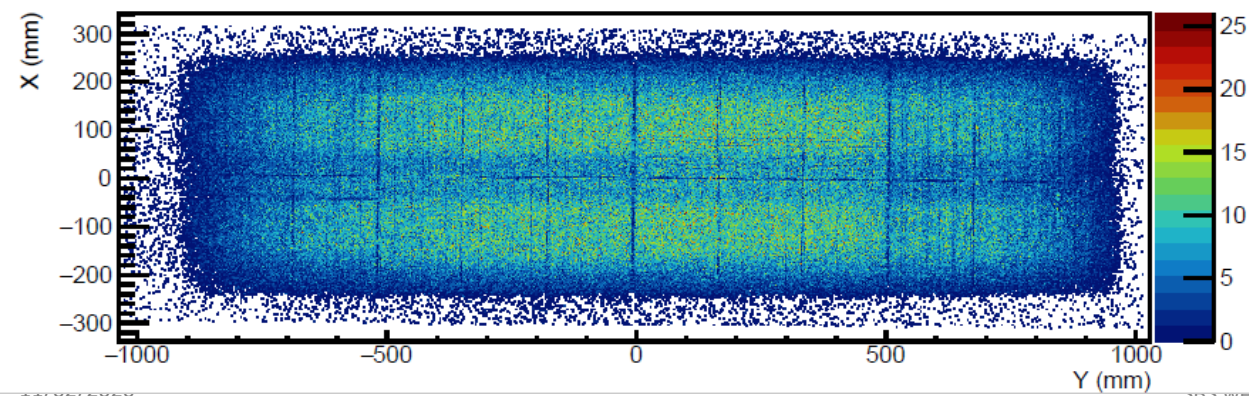
Layer 2



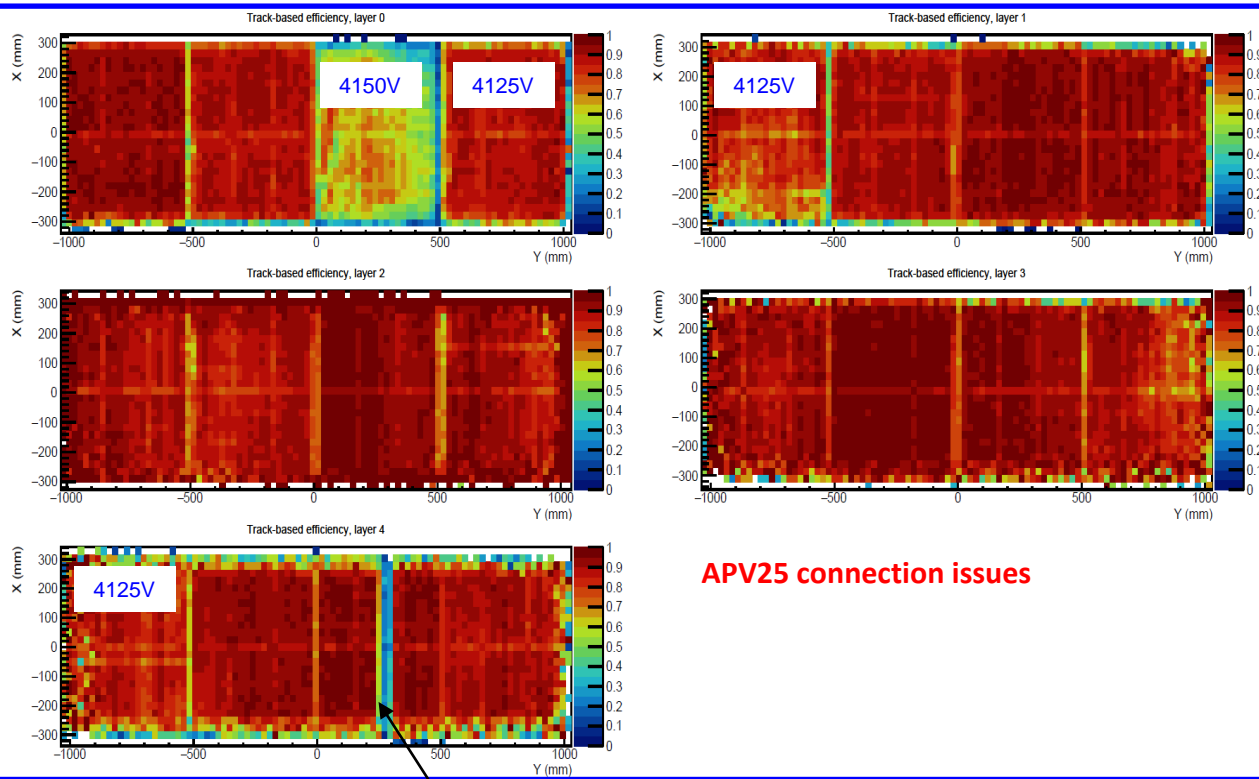
Layer 3



Layer 4



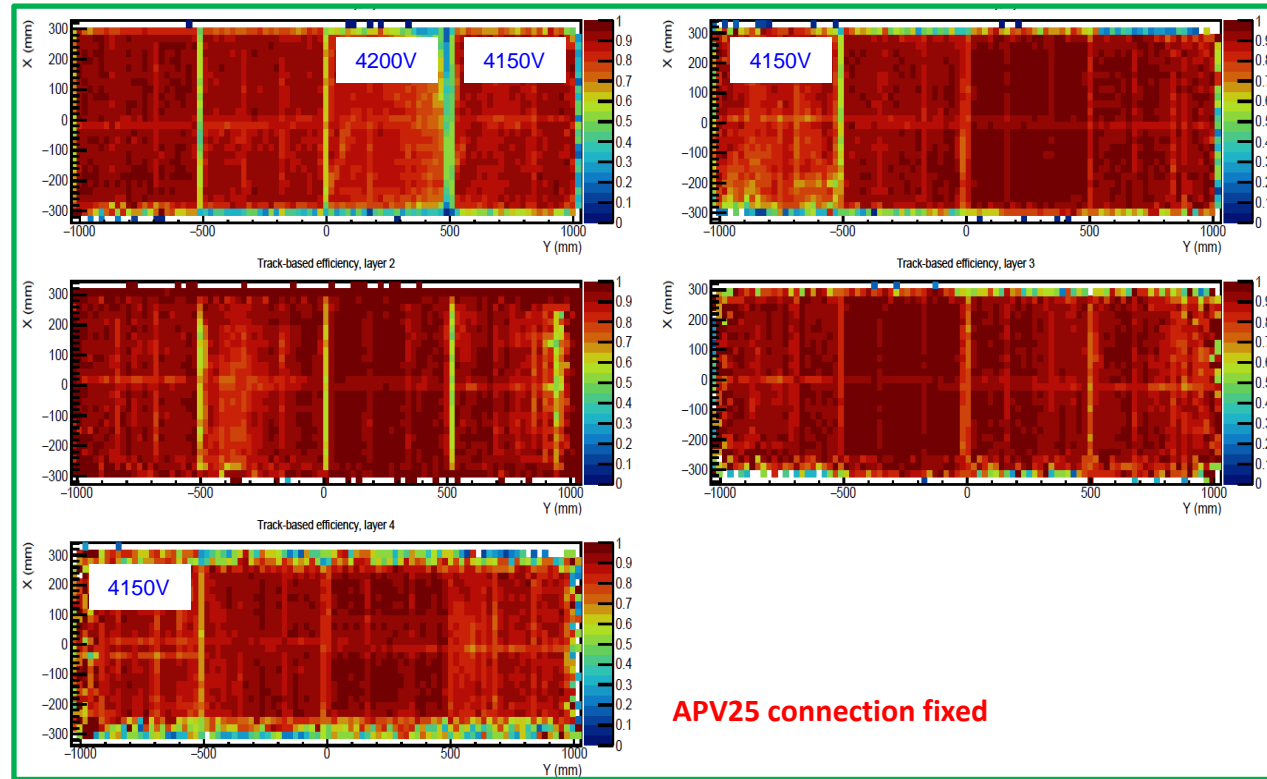
shown @ SBS weekly meeting at August 31st



APV25 connection issues

APV25 connection issues

More recent results

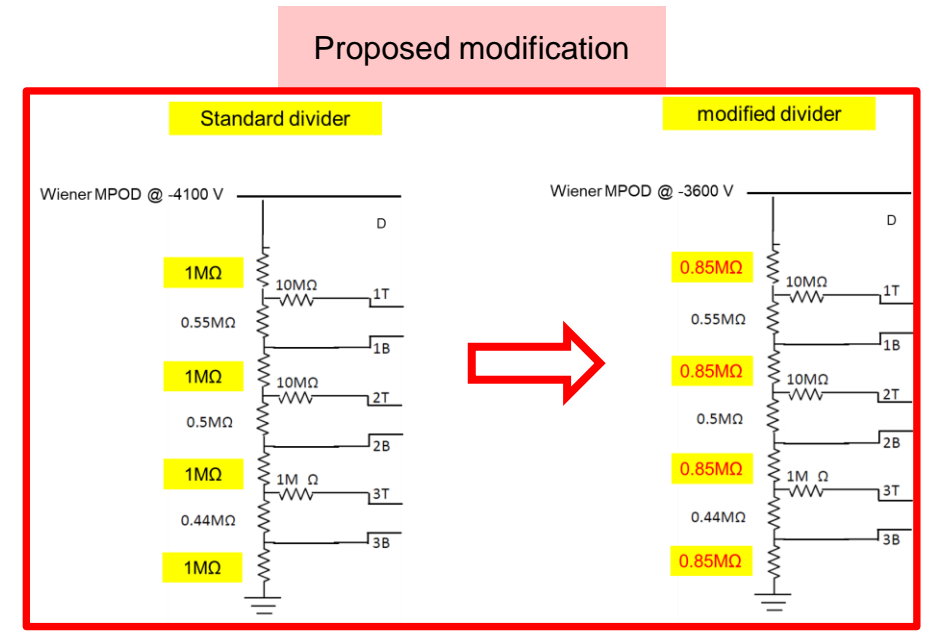
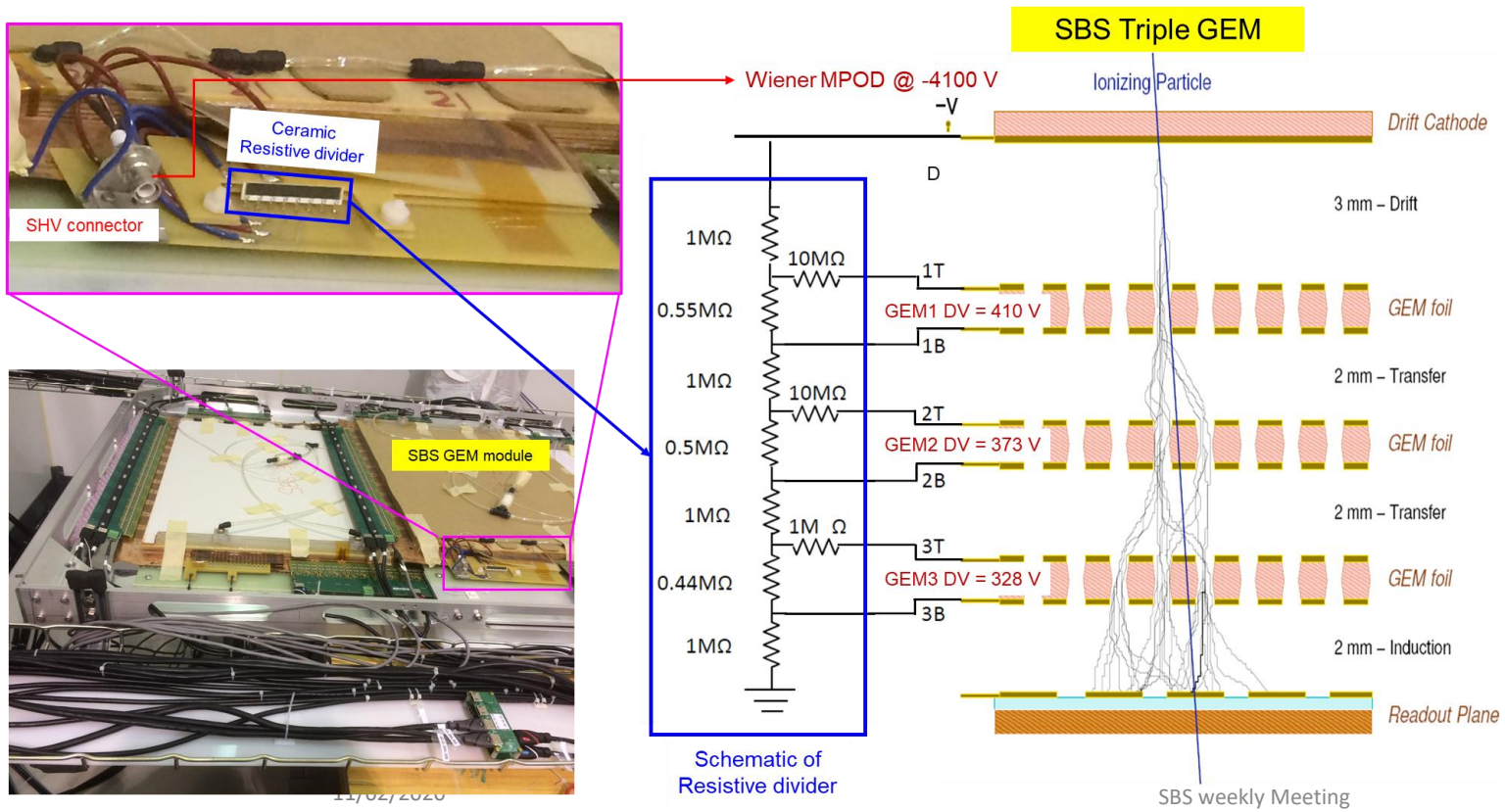


APV25 connection fixed

- ⇒ All modules at 4100V except a few with higher voltages 4150 V and 4200V
- ⇒ These modules correspond to the low gain modules that will have to be operated at higher voltage for full efficiency
- ⇒ With the new divider, we will be able to safely operate all the modules at full efficiency

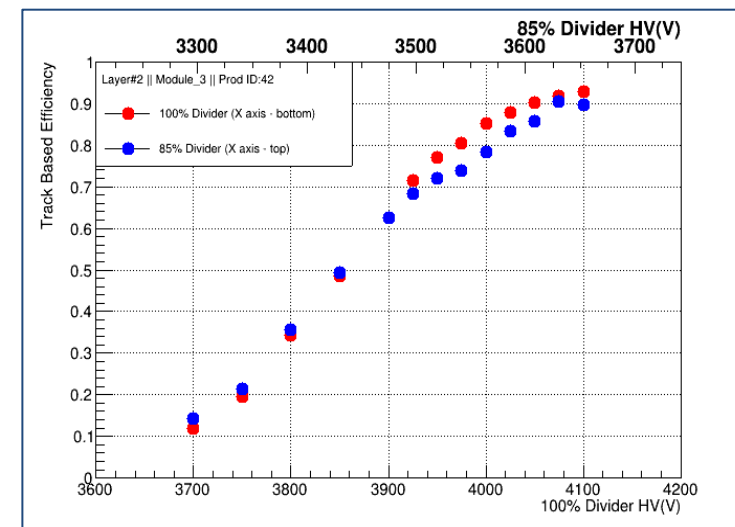
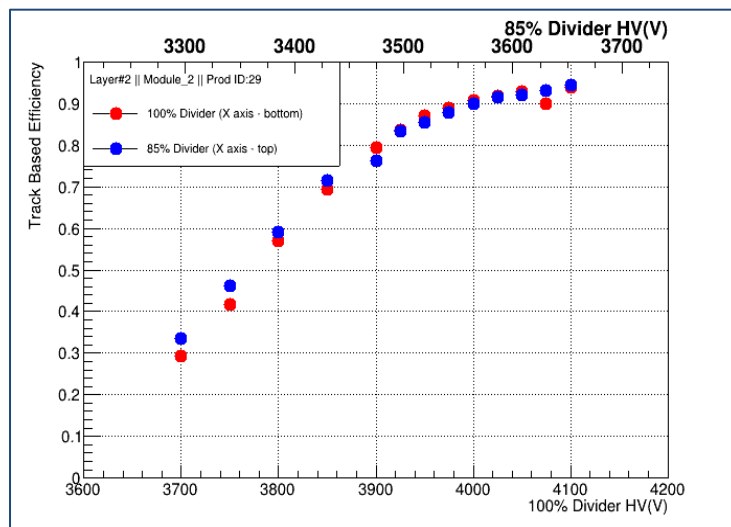
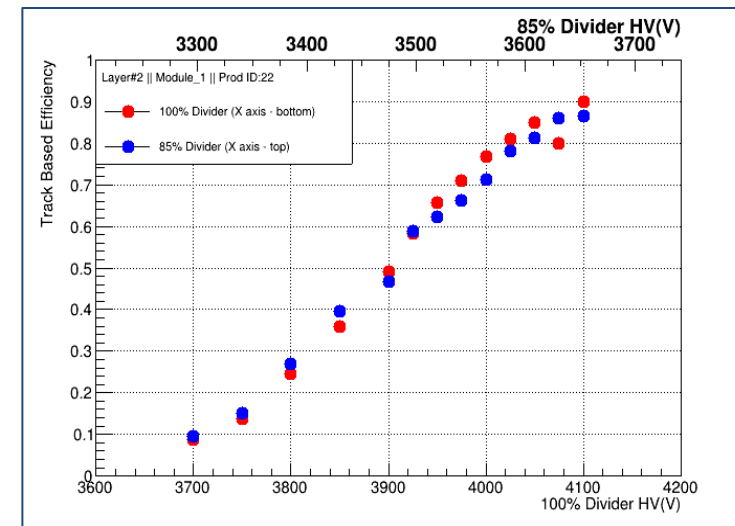
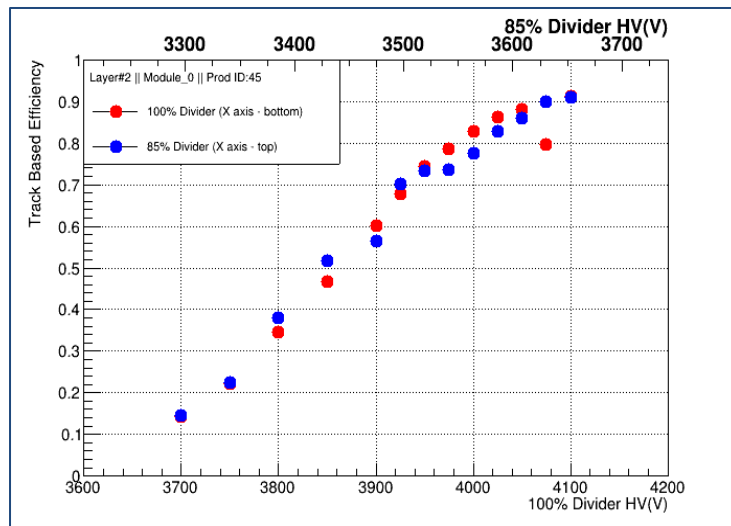
Modification of the HV divider (presented @ SBS weekly meeting at August 31st)

- ⇒ 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 mitigate the problem by slightly reducing the E-field between GEM foils while 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 then the layers will be ready for installation



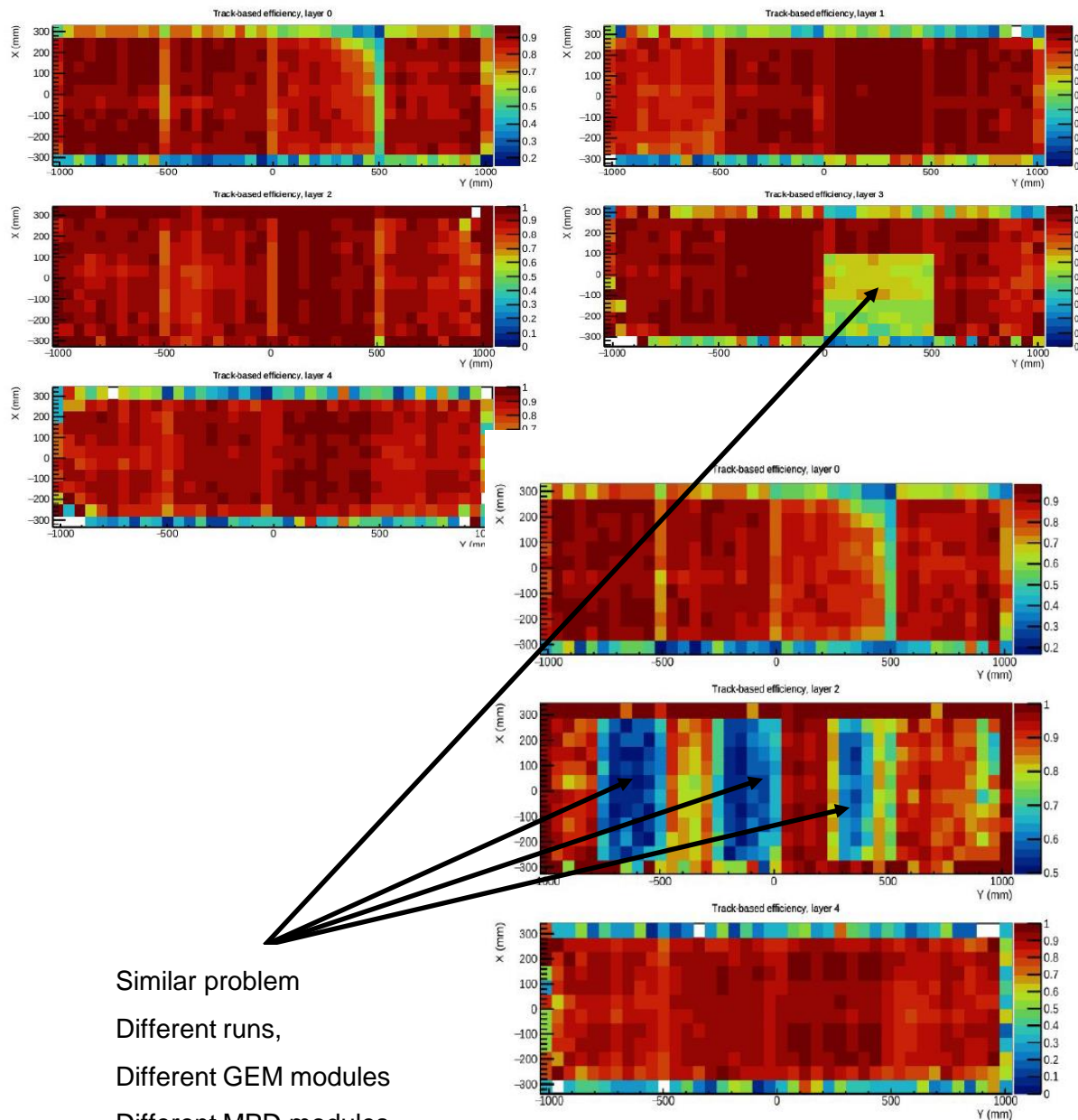
Comparison of the performances with the modified HV divider on layer #3 modules

- ⇒ Modification was implemented on the 4 modules of layer #3
- ⇒ HV scan comparison between old and new dividers
 - ⇒ Red dots are old divider that we call 100% ⇒ HV value on bottom horizontal scale
 - ⇒ Blue dots are the modify divider 85% (e-field strength between GEM foils relative to the old divider) ⇒ equivalent HV value on top horizontal scale
- ⇒ No noticeable difference in efficiency performance with the modified divider for equivalent HV (meaning same amplification gain for the GEM foils)
- ⇒ Modification for done for layer #4 as well
 - ⇒ We will proceed with HV scan for this layer as well this coming week to confirm the trend
 - ⇒ We will then deploy the new divider to all the modules



Some issues with the MPD readout / DAQ under investigation

- ⇒ We have seen issues with low efficiency in some modules for some runs
- ⇒ This seems like a random problem. For some runs everything is fine and for other the problem will appear
- ⇒ It doesn't seem to be specific to a given MPDs
 - ⇒ It happens this randomly with different GEM modules and therefore different MPDs
- ⇒ Cause of the problem still not clearly identify
 - ⇒ Not related to the GEM modules
 - ⇒ Low efficiency region correspond to a given set of APVs each times



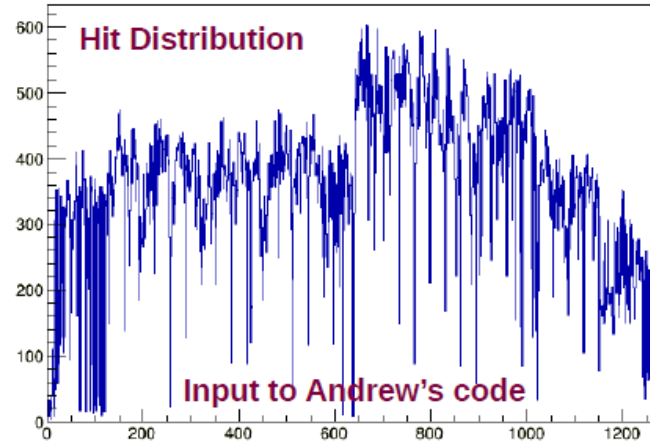
Similar problem
 Different runs,
 Different GEM modules
 Different MPD modules

Readout errors with crate0 MPD14 and crate1 MPD12
 Crate0 MPD14 => right 3*5 slot 3rd layer
 Crate1 MPD12 => 12 slot attached to the 3rd module of 4th layer

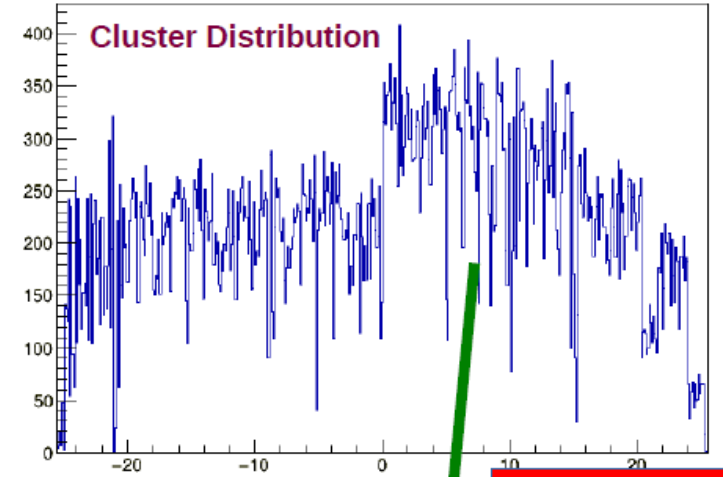
Some issues with the MPD readout / DAQ under investigation

- ⇒ 1D strip hit count distribution or hit position (from cluster) distribution do not show a dip in the distribution
- ⇒ Actually shows an excess count
- ⇒ The problem appear in the 2D hit map so basically somehow with the 2D clusterization of the data
- ⇒ This might have to do with the cut or algorithm used to form the 2D event
- ⇒ Still under investigation

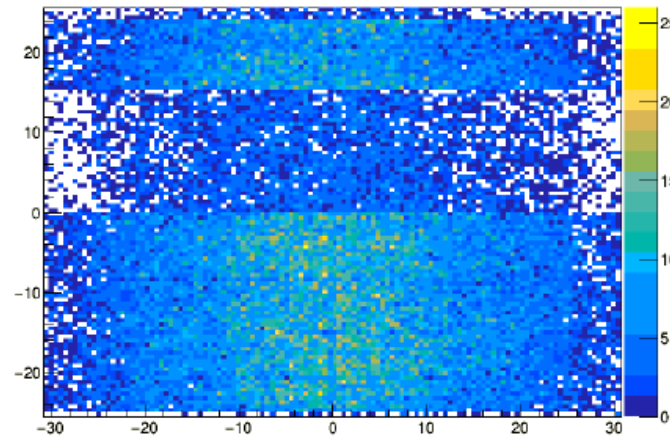
Y side Hit Distributions module_10



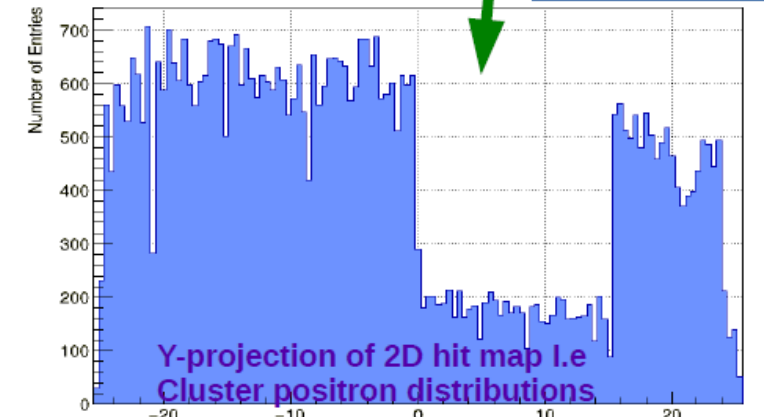
Y side Cluster Distributions module_10



2D hit map Cluster Distributions module_10



ProjectionY of binx=[23,200] x=-



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 chambers delivered (March 2020)

⇒ Procurement of 3 more GEM foils for the 4th chamber (by INFN Collab. E. Cisbani) ⇒ done, delivery expected end January 2021

⇒ 4 U-V readout boards & 4 drift cathode foils delivered (March 2020)

⇒ Complete set off frames for 3 chambers delivered (July 2020)

⇒ Procurement of a set for the 4th chamber (paid by U. Glasgow D. Hamilton & R. Montgomery) ⇒ done, delivery expected early January 2021

⇒ Varnish chemical (from Mader Switzerland) for the GEM support frames were delivered mid August

Tentative U-V GEM assembly schedule

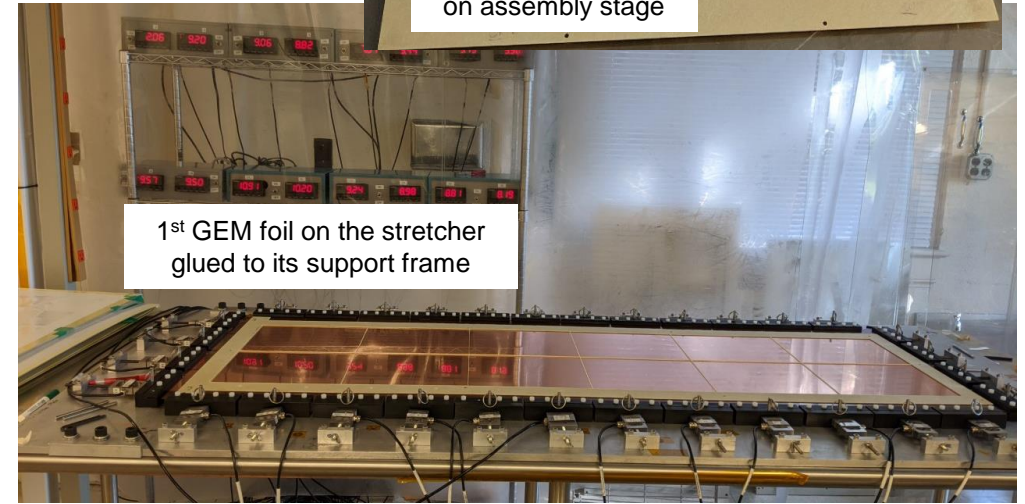
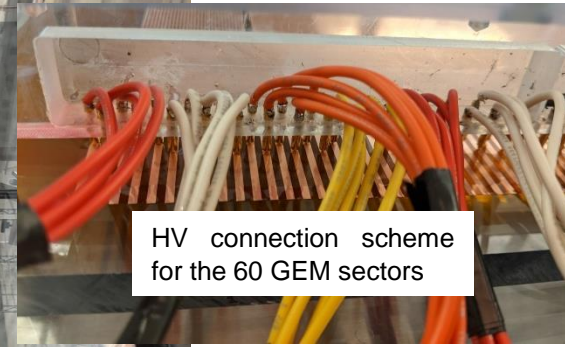
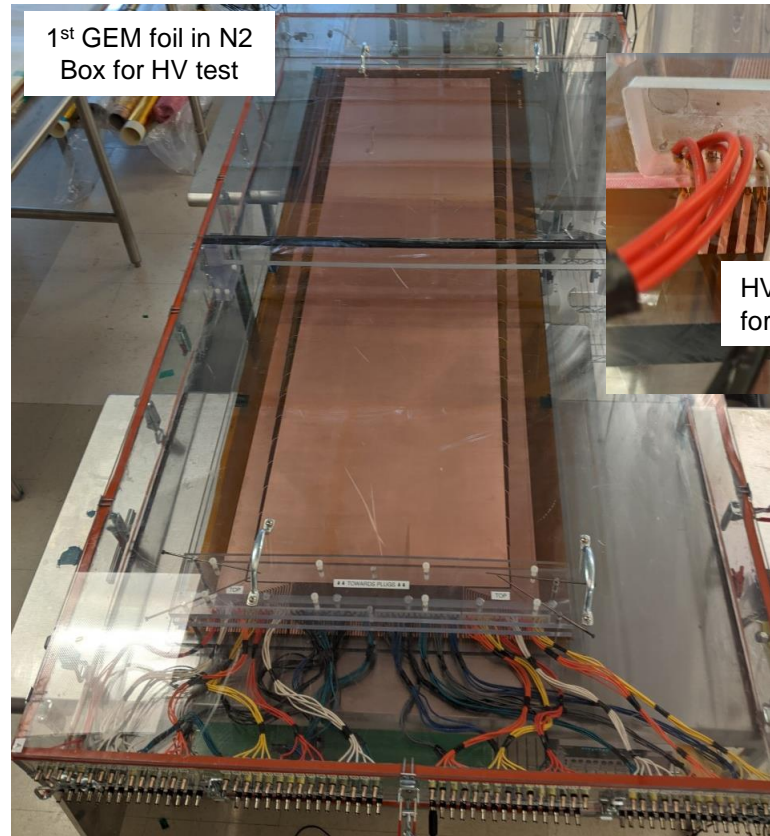
⇒ Assembly of the first chamber ongoing ⇒ expected to be completed by the first half of November (in 2 weeks from now)

⇒ Assembly Second U-V GEM layer is expected to start right after and to be completed by December before Christmas

⇒ Layer #3 assembly timeline will depend on the UVa crew schedule (Huong, John and Sean), ideally before Xmas break but it is not a requirement,
or likely planned together with layer #4

⇒ 4th layers assembly will probably start after January when the all parts for layer 4 are delivered

Assembly of the first U-V Strips GEM Layers



- ⇒ First 2 GEM foils have been HV tested successfully before stretching and gluing of the support frame
 - ⇒ All 60 sectors of each foil good
- ⇒ First 2 GEM foils already stretched and framed
 - ⇒ All 60 sector of first framed foil successfully tested again in the N2 box ⇒ ready for gluing to the readout board
 - ⇒ Second framed foil will be HV tested this week
- ⇒ 3rd foil will be HV tested and framed this week
- ⇒ The readout layer already glued to the chamber base support plate
 - ⇒ This is the first step of the chamber assembly
 - ⇒ First 2 GEM foils will then be glued to the R/O (probably this week) and we will continue with this flow
- ⇒ **With this schedule, the clean room part of the assembly could reasonably be completed in the next two weeks**

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

	Need for 4 layers	In hand / available	Procurement	Production cost	Alternative option
APV25 cards (UVa version with Panasonic connector)	4 × 60 = 240 cards	~ 100 from M. Kohl (enough for the first 2 chambers)	~ 110 APV25 chips available with EES	~ 90\$ / card (based on 2016 production cost) ~10k\$	Use INFN APV25 cards (with ZIF connector) with ZIF-to-Panasonic adapter
MPD cards	4 × 4 = 16 cards	Yes will use INFN MPDs	N/A	N/A	N/A
4-slot backplanes	4 × 12 = 48 planes	No but few cards produced by Dustin McNulty for PREX (that we can borrow maybe)	Technical drawings of the plane available => need to launch production	~ 100\$ /plane (based on 2016 production cost of 5-slot BP) ~ 5k\$ for 4 chambers	N/A
3-slot backplanes	4 × 6 = 16 planes	No	No drawings but should be straight forward modification of 4-slots BP	~ 100\$ / plane (based on 2016 production cost of 5-slot BP) ~ 1.5k\$ for 4 chambers	N/A
Digital patch Panel	4 × 4 = 16 cards	Yes will use INFN MPDs	N/A	N/A	N/A
Analog patch Panel	Not needed	N/A	N/A	N/A	N/A
HDMI cables	96 short cables (< 2m) 72 long cables (~10 m)	Yes will use INFN cables and spare UVa cables we should have more than enough	N/A	N/A	N/A
Low voltage regulator board	4 × 4 = 16 boards (32 LDO chips)	No	Chips to be procured from CERN (Need to do it quickly) Nilanga is OK to pay for it	~1k\$ for 50 LDO chips + ~1k\$ for 50 boards	N/A

Timeline and Status of the GEM layers for GEN-RP

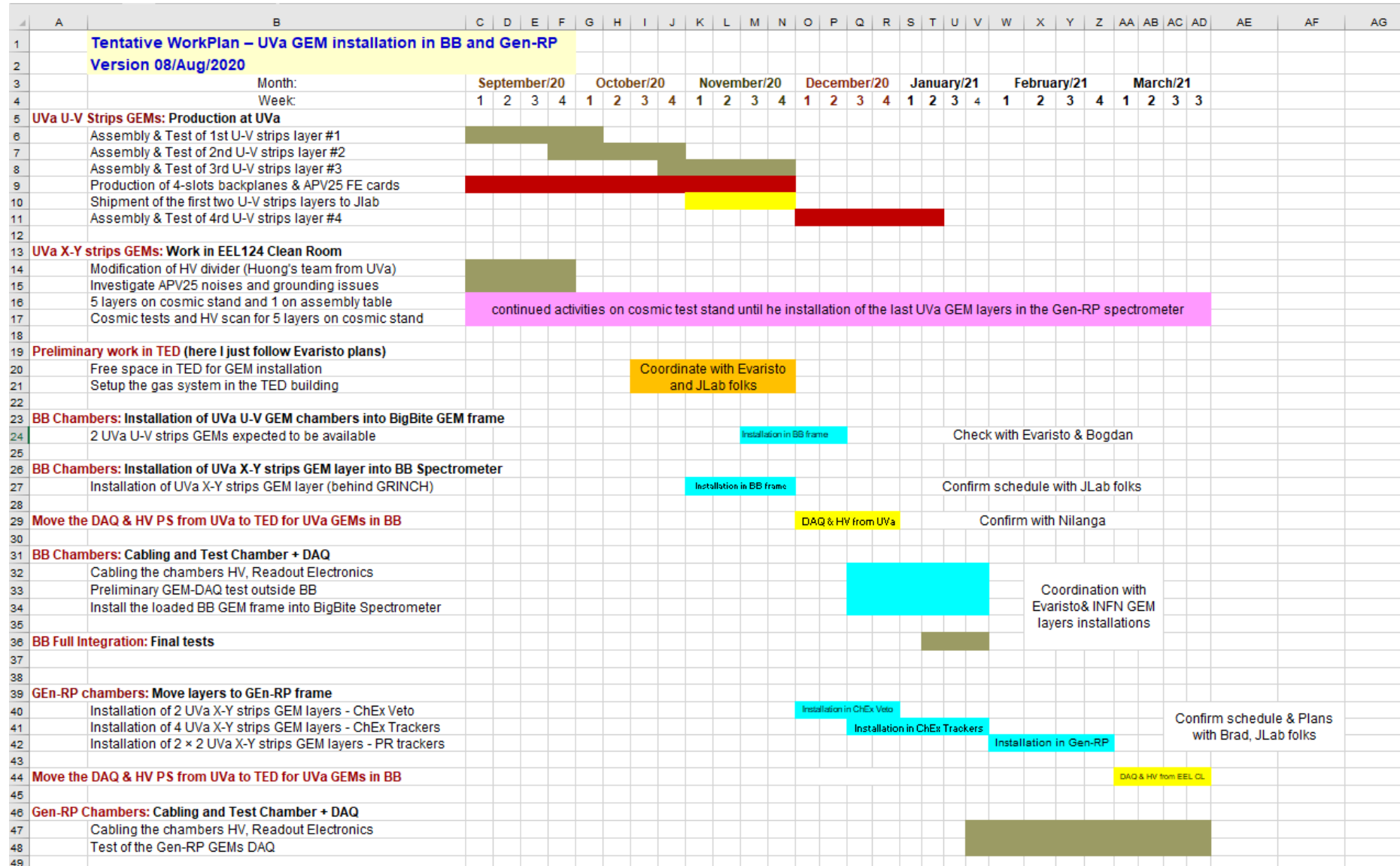
Layer	Assembled Date	Tested HV	Tested Cosmics	Ready for Installation	Comments
INFN 1	Done	Y	Y	Feb, 2021	Cosmic re-tested before installation, see plan
INFN 2	Jan 2021	N	N	Feb, 2021	
UVa 1	Done	Y	Y	Mar 2021 (*)	Al frame mod. needed (assigned to SBS GEN-RP)
UVa 2	Done	Y	Y	Mar 2021 (*)	Al frame mod. needed (assigned to SBS GEN-RP)
UVa 3	Done	Y	Y	Nov 2020	Assigned to BigBite GMn
UVa 4	Done	Y	Y	Nov 2020 (*)	Almost ready, assigned to SBS GEN-RP
UVa 5	Done	Y	Y	Nov 2020 (*)	Almost ready, assigned to SBS GEN-RP
UVa 6	Done	Y	N	Nov 2020 (*)	Almost ready, assigned to SBS GEN-RP
UVa 7	Oct 2020 (*)	Y	N	Dec 2020 (*)	Assigned to SBS GEN-RP
UVa 8	Nov 2020 (*)	Y	N	Dec 2020 (*)	Assigned to SBS GEN-RP
UVa 9	Dec 2020 (*)	Y	N	Jan 2021 (*)	Assigned to SBS GEN-RP
UVa 10	Jan 2021 (*)	Y	N	Feb 2021 (*)	Assigned to SBS GEN-RP
UVa 11	Feb 2021 (*)	Y	N	Feb 2021 (*)	Assigned to SBS GEN-RP

Table 1: Overview of GEM layer assembly and testing status. Dates with (*) are milestone targets. The Al frame modifications noted for UVa 1 and UVa 2 are discussed in Section 3.4. Note that an ‘extra’ layer, UVa 3, is included in the above table. That layer is complete and is discussed in some of the discussions in Section 3. However, it is presently allocated to the BigBite stack and is not part of the 10 UVa layers needed for GEN-RP.

https://hallaweb.jlab.org/wiki/images/f/f2/ERR_response-15Oct2020-final.pdf

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

Backup

Development of High Rate APV25-MPD readout

- ⇒ **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)

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

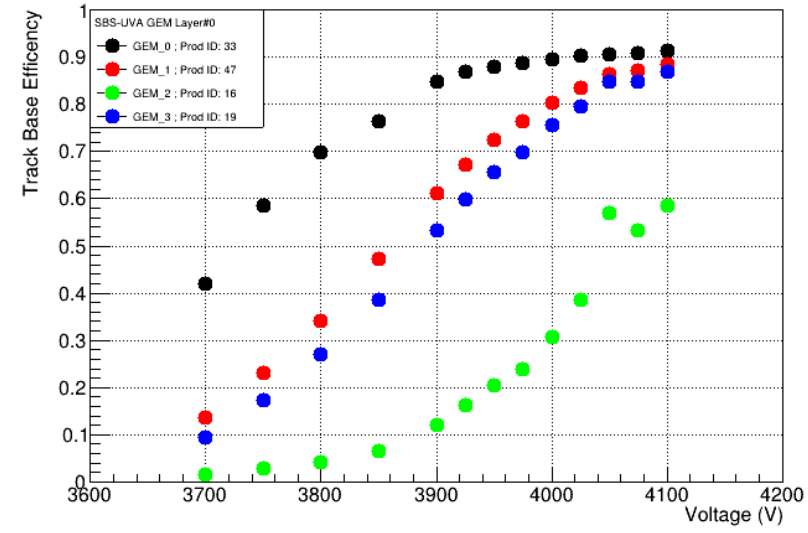
Few modules: have diverse issues i.e. some stretching related instabilities on HV or unexplained shorts
Under investigation

Low gain chambers ⇒ needed to work at higher HV values

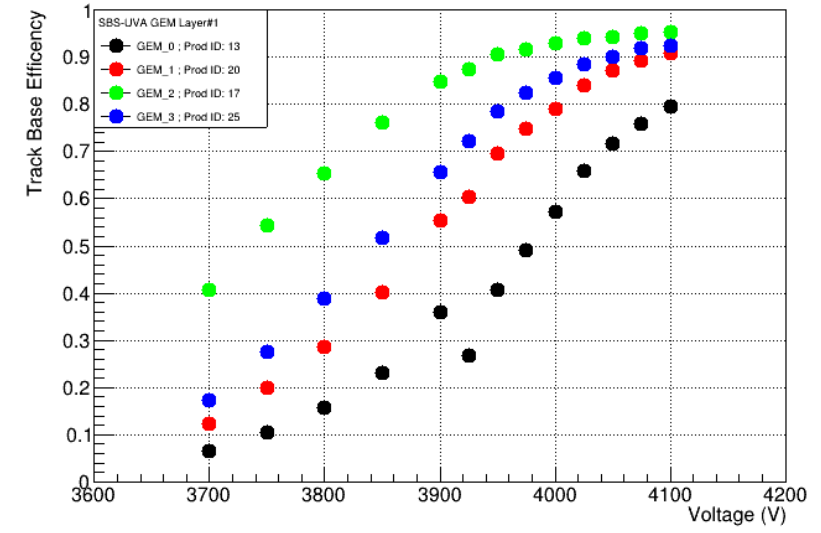
HV Scan for Efficiency Plateau Studies

- ⇒ Voltage scan from 3700 V to 4100V ⇒ efficiency plateau for each individual module for all 5 layers
- ⇒ We scan 4 modules of one layer at the time by keeping the voltage constant on the other 4 layers constant at 4100V
- ⇒ **Efficiency:** Curve derived from the efficiency map data
- ⇒ Most module at (or near) plateau at 4100 V, expected a few modules. These modules require higher HV for full efficiency.
- ⇒ We will resume and complete the voltage scan after the modified divider is implemented on all modules ⇒ **individual optimal operating voltage for each module**

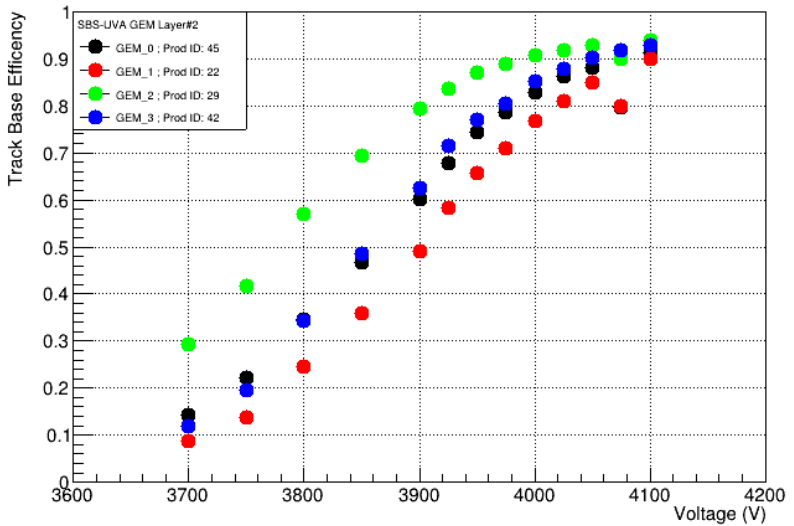
GEM Layer#0



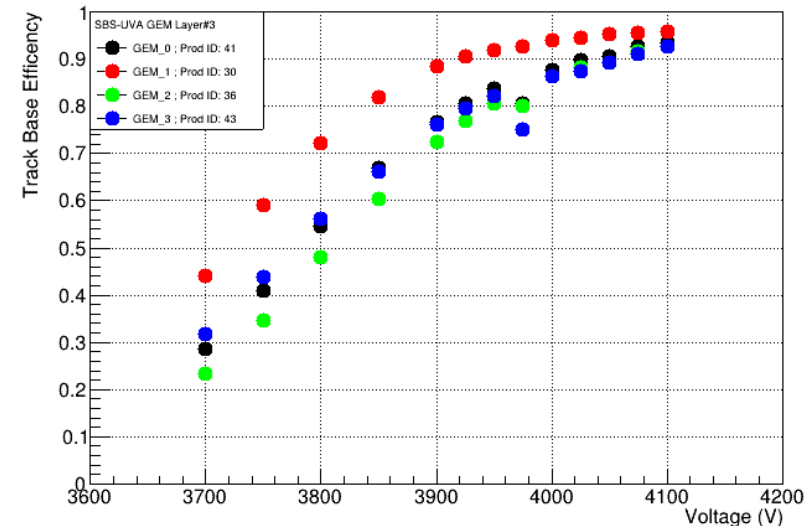
GEM Layer#1



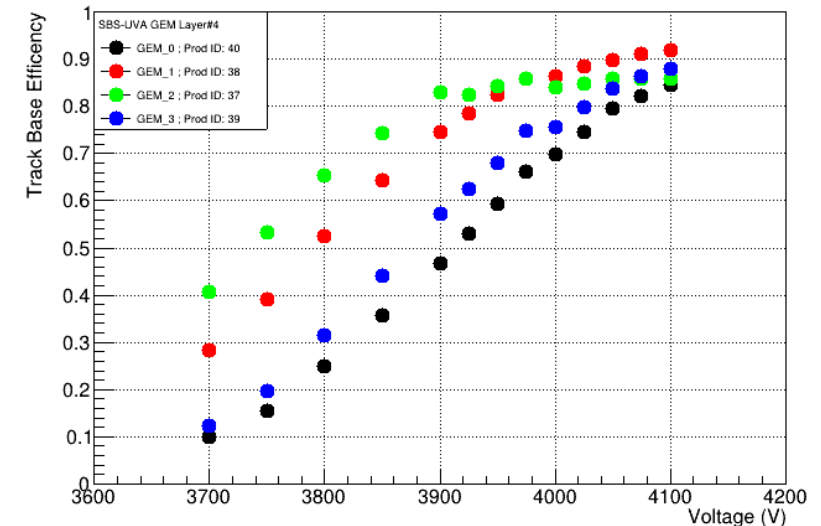
GEM Layer#2



GEM Layer#3



GEM Layer#4



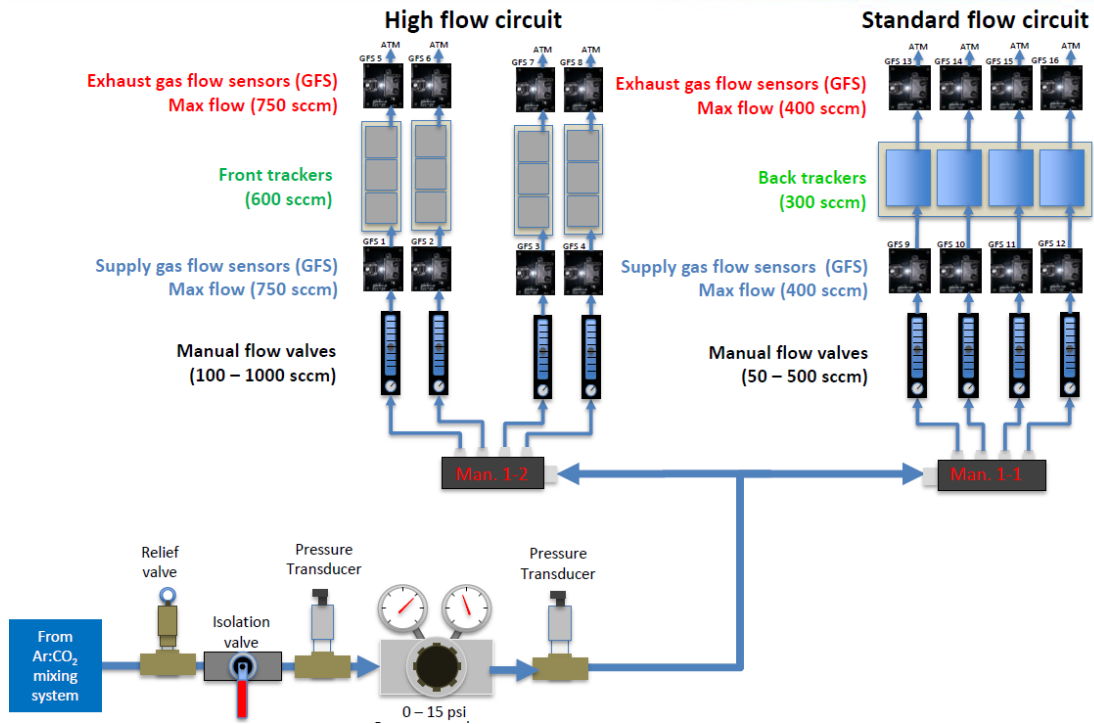
DSG Group (MarcMcMullen) are working the Gas distribution system for SBS GEMs

⇒ 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

