GEM-MuCh Update

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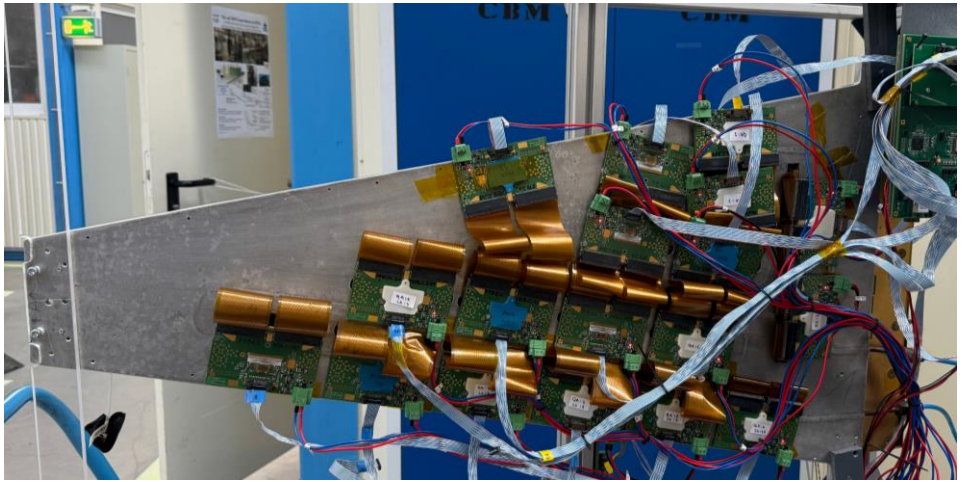
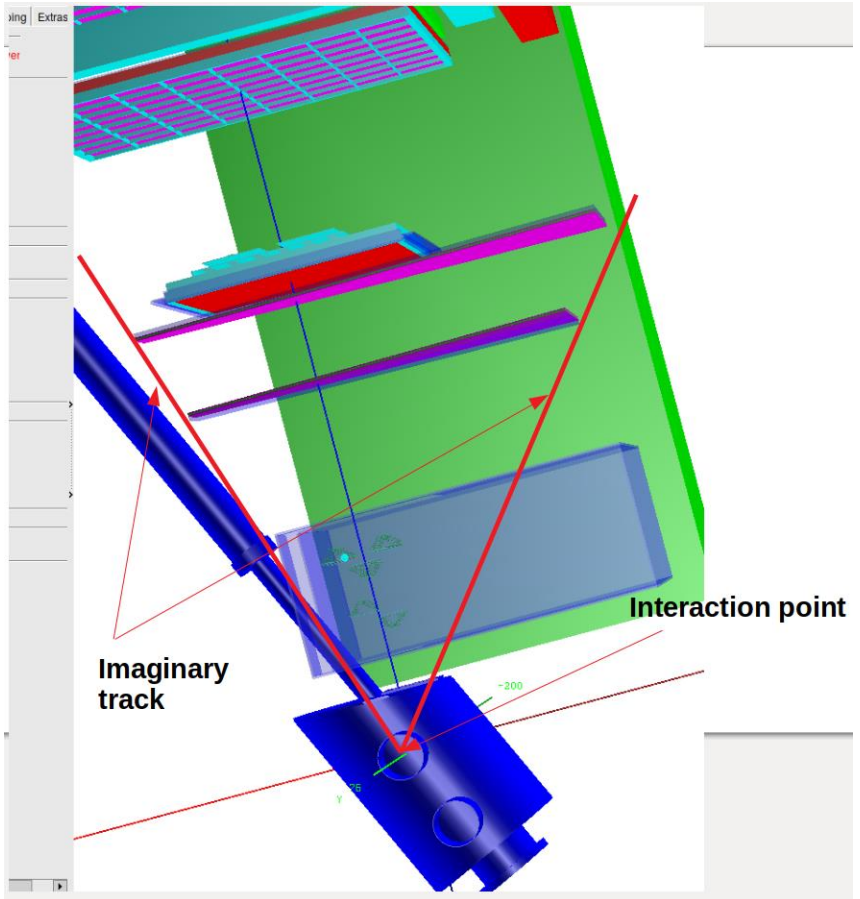
Outline

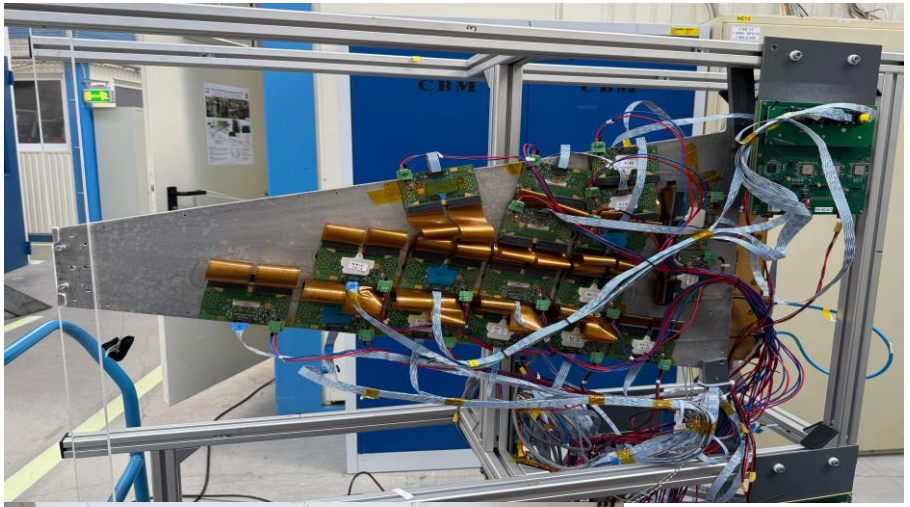
1. mCBM tests
2. GEM Station-1 Production – PRR, Assembly protocols
3. X-ray based QA tests
4. GEM for Station-2 : indigenous fabrication and plans
5. Summary

GEM1 (Station-1)



GEM2 (Station-2)





Fri May 16 11:35:02 2025
1st run: run 3859
- **26-Fe(25+)** at 1.7AGeV (18.4Tm)
- **thick Ni target (4mm)**
- approx. **10^7 per 10s** spill
Common start at 2025-05-16 11:18:26
Common stop at 2025-05-16 12:18:27

C.Sturm General info Switched to 209-Bi(68+) 1.1 AGeV
1st run: 3902 209-Bi(68+) at **1.1 Age, 2.5 mm Au target**
- **1.5x10^7 per 10s** spill

→ GEM1 and GEM2 identical Configuration, except :
GEM2 slightly larger & its OC
Layout slightly different.

→ Moulded Al plate used for the first time for cooling.

This installation and tests in 2025 could not have been successful without the support of David, Jenz and C. Sturm, besides other GSI colleagues. In 4 days were ready for dry test.

GEM-1

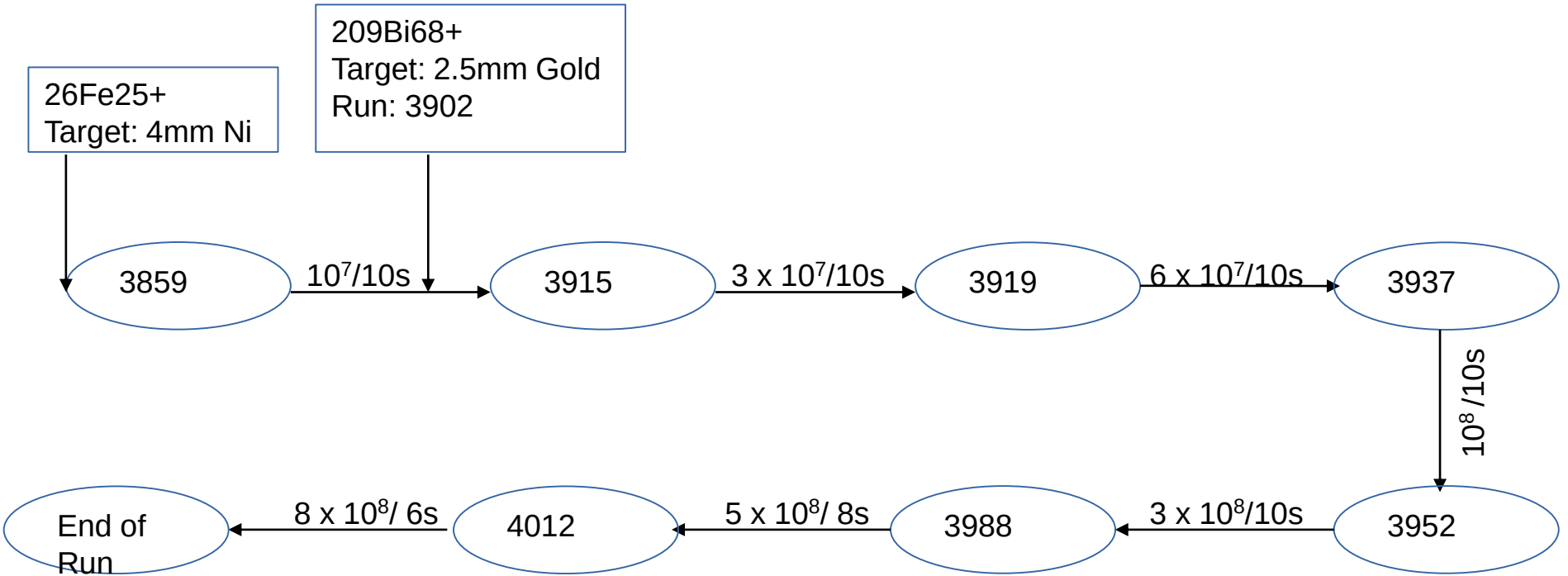
	3700 V, 1371 .5 uA	3800 V, 1408 .6 uA	3825 V 1443 .05	3850 V 1442 .85	3875 V 1461 .75	3900 V, 1445 .7 uA	3925 V 1480 .85	3950 V, 1464 .2 uA	3960 V 1445 .1uA	3975 V 1499 .4	4000 V, 1482 .75 uA	4025 V 1518 .5	4050 V, 1501 .4 uA	4075 V, 1487 .81	4100 V, 1519 .9 uA	4125 V, 1527 .8 uA	4148 V 1537 .35 uA	4150 V, 1538 .35 uA	4175 V, 1547 .7 uA	4200 V, 1555 .8 uA
I = 10^7 / 10s	3890	3889				3883 3891		3884			3885 3893 upto 3898		3886 3875		3887 3876			3888 3877	3878	3892
I = 3 x 10^7 / 10s											3916				3917 3918					
I = 6 x 10^7 / 10s						3930 3936		3935			3919 3928 3934				3920 3929	3932		3921 3931		3922 3924
I = 10^8 / 10s						3937		3941			3939		3943 3944 3945		3938		3940			
I = 3 x 10^8 / 10s						3952 3959			3969 3970 3971 3972		3960 3987		3961	3968 3973	3962 3963 3966 3981 3982	3965 3967		3964 3975 3979 3980	3976 3977 3978	
I = 5 x 10^8 / 8s						3990	3991 4008	3992		3993 4007	3994 3988 3989	3995 4005 4006	3996	3997 4004	3998 upto 4003					
I = 8 x 10^8 / 6s		4014	4015	4016	4017	4018	4019	4020		4021	4022	4023		4024	4025 upto 4037					

GEM-2

	3700 V, 1371 .5 uA	3750 V, 1371 .05	3800 V, 1410 .1 1413 .4	3825 V 1443 .05 1419 .2	3850 V 1407 .56 1428 .5	3875 V 1461 .75 1439 .7	3900 V, 1447 .6	3925 V 1480 .85 1456 .35	3950 V, 1445 .21 1465 .85	3960 V 1445 .1uA	3975 V 1499 .4 1474 .95	4000 V, 1462 .75 1484 .6	4025 V 1518 .5 1493 .6	4050 V, 1480 .86 1503 .05	4075 V, 1487 .81	4100 V, 1499 .4 1521 .7	4125 V, 1527 .8 1530 .8	4148 V 1537 .35 uA	4150 V, 1517 .66 uA	4175 V, 1547 .7 uA	4200 V, 1559 .2 uA
I = 10^7 / 10s		3890	3894		3889		3876 3891		3877 3883			3878 3884 3893		3885		3886 3917			3887		3888 3892
I = 3 x 10^7 / 10s							3916														
I = 6 x 10^7 / 10s			3930				3919 3936		3931 3935			3920 3929 3934		3921 3933		3922 3924 3928	3932				
I = 10^8 / 10s			3937				3938 3939 3942 3943 3944		3941			3940		3945 upto 3951							
I = 3 x 10^8 / 10s					3962 3963 3964		3952 to 3961 and 3965 to 3972 3987		3976 3978 3979 3982			3973 3975									
I = 5 x 10^8 / 8s			3990	3991 4008	3992	3993 4007	3994 3988 3989	3995 4005 4006	3996		3997 4004	3998	3999 upto 4003								
I = 8 x 10^8			4014	4015	4016	4017	4018	4019	4020		4021		4022	4023 4024							

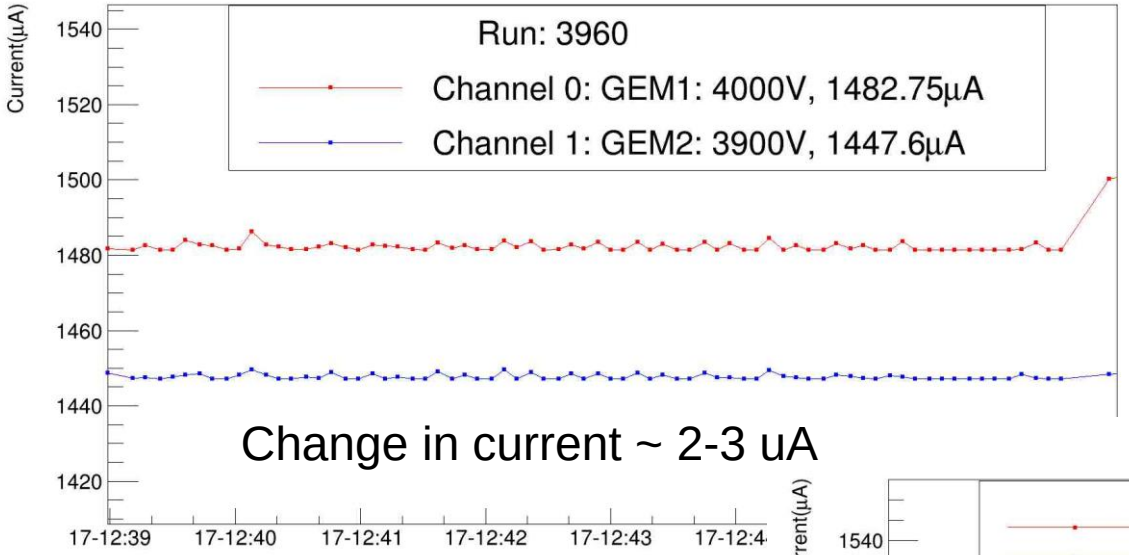
Response to varying intensity

mCBM 2025, May Beamtime Run details



Data Analysis : Carried out by Chandrasekhar Ghosh

Variation of HV Divider Current with time

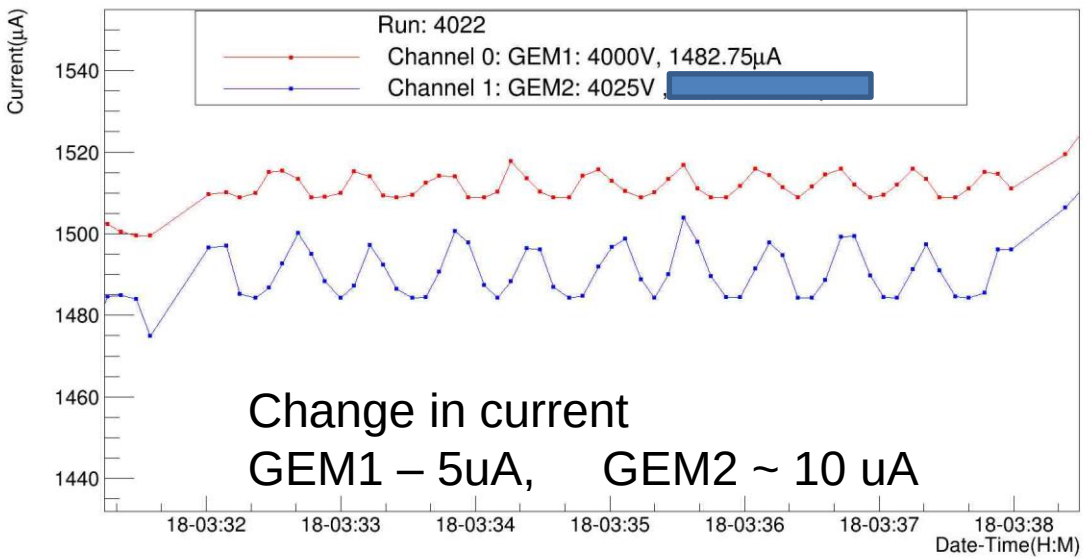


Change in current ~ 2-3 uA

1 x 10**7/spill(10s)

HV Module used : CAEN NDT1471,
(thanks to Uli Frankenfield, GSI)

8 x 10**8/spill(6s)



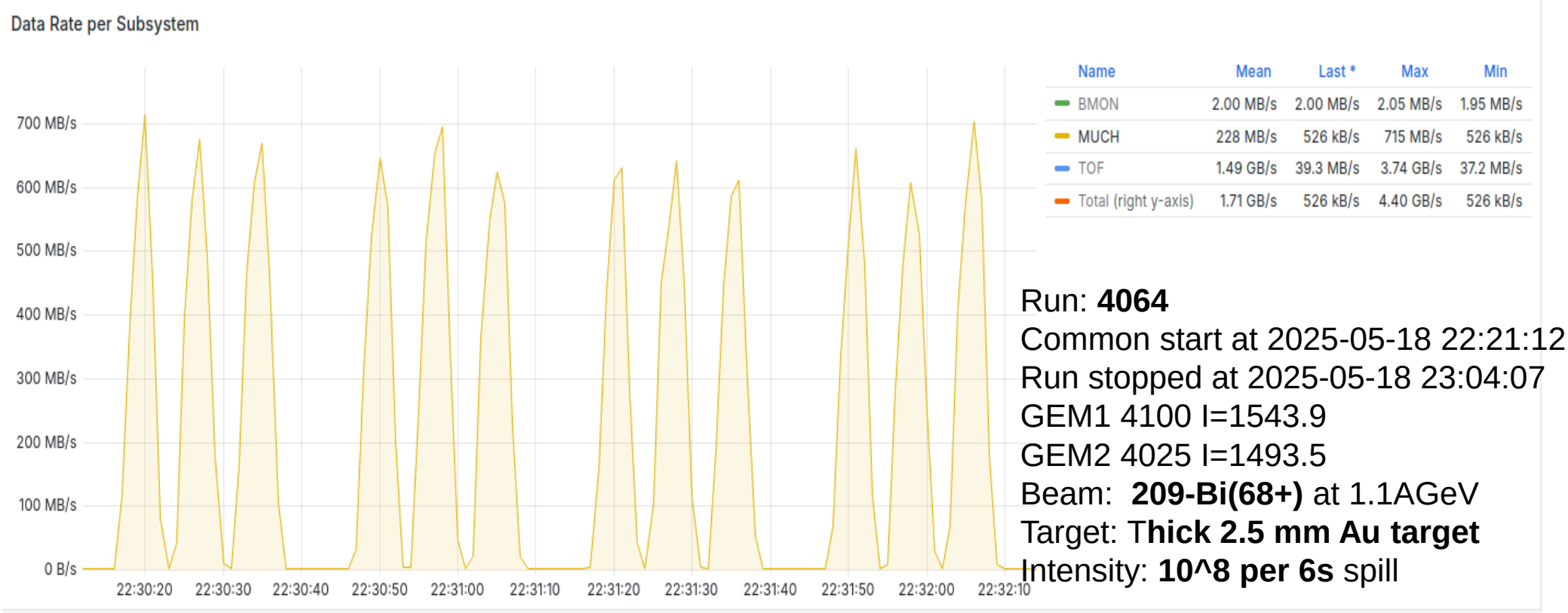
Change in current
GEM1 – 5uA, GEM2 ~ 10 uA

(Rajesh Rath, HBNI-VECC)

Run: **3938**

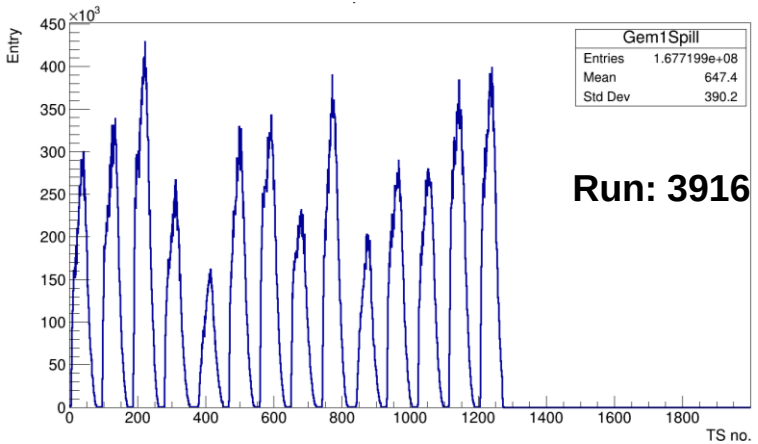
Common start at 2025-05-17 09:38:31
Run stopped at 2025-05-17 09:40:55
GEM1 4100 I=1518.6
GEM2 3900 I=1447.6
Beam: **209-Bi(68+)** at 1.1AGeV
Target: T**hick 2.5 mm Au target**
Intensity: **10^8 per 10s** spill

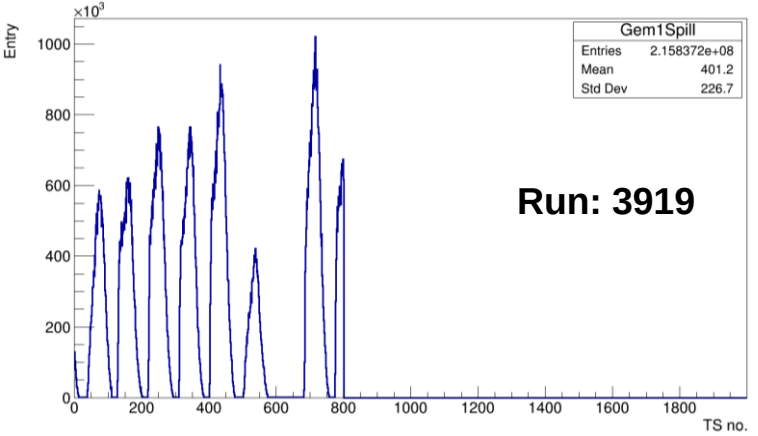
MuCh Data Rate

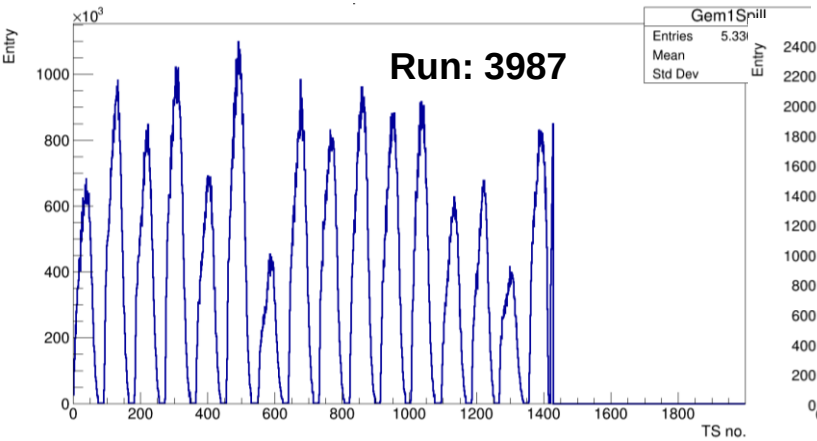


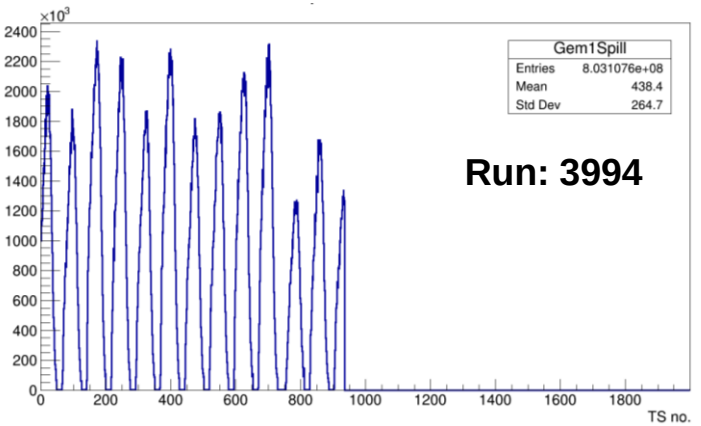
Run: **4064**
Common start at 2025-05-18 22:21:12
Run stopped at 2025-05-18 23:04:07
GEM1 4100 I=1543.9
GEM2 4025 I=1493.5
Beam: **209-Bi(68+)** at 1.1AGeV
Target: T**hick 2.5 mm Au target**
Intensity: **10^8 per 6s** spill

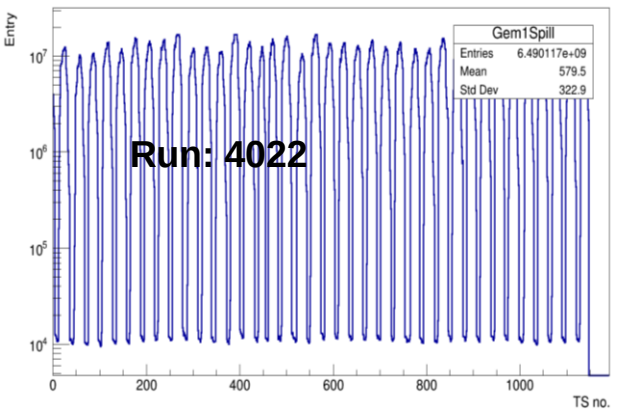
GEM1 Spill





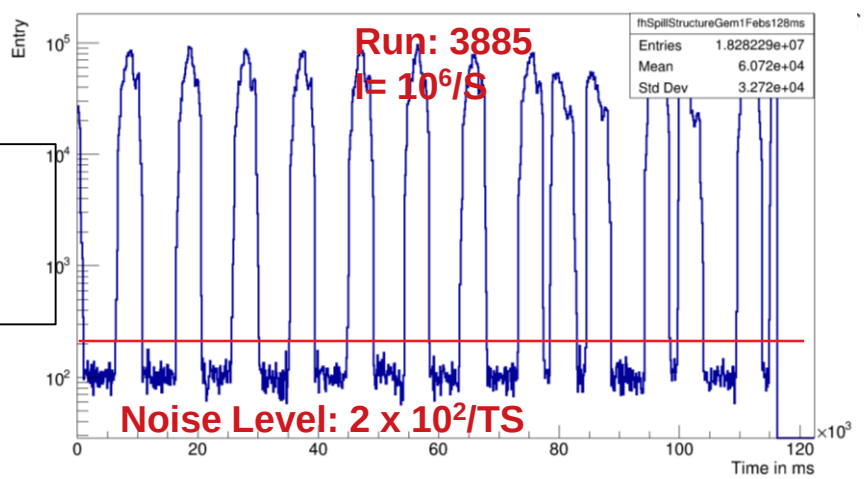


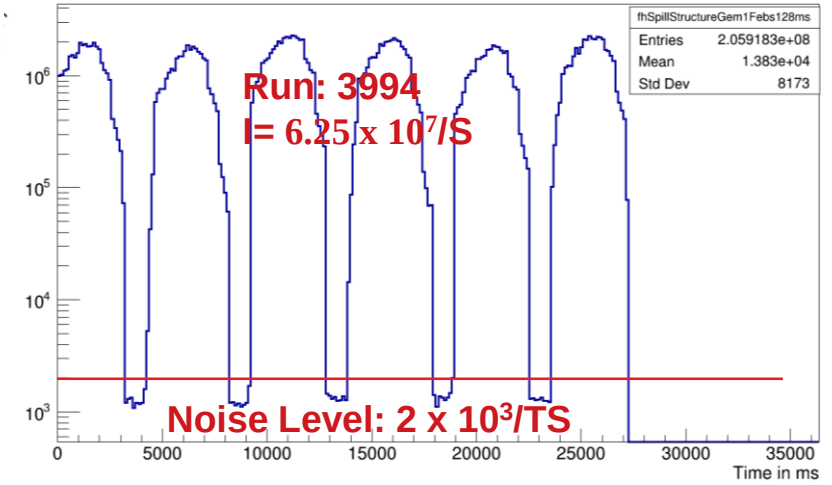




All these plots are generated after noise substraction: NoisyChList_3888_280725_50Hz.txt

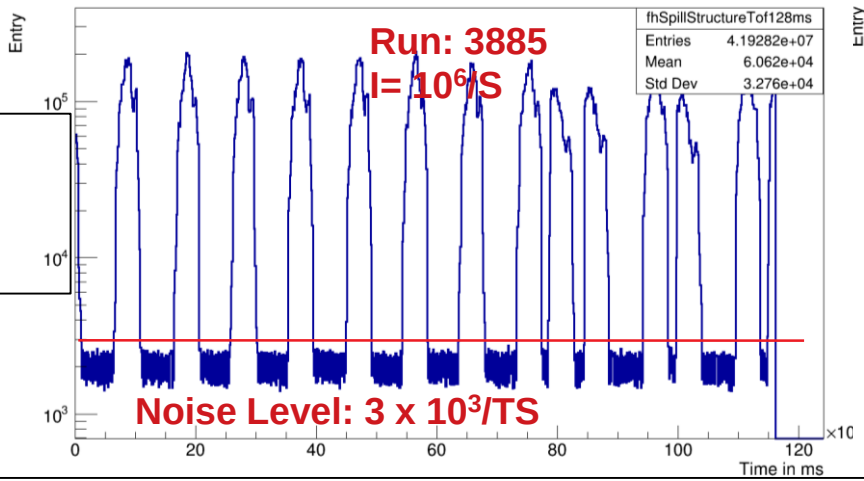
GEM1 Noise Level

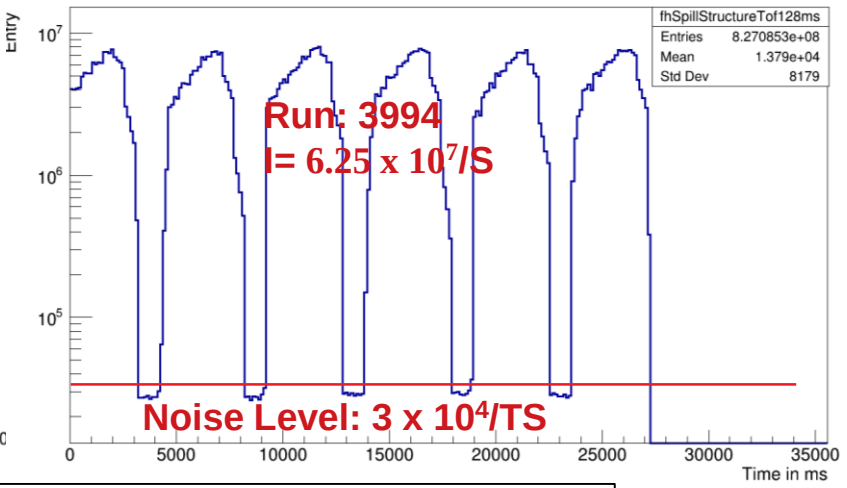




At High intensity the baseline shifts upward

TOF Noise Level





All these plots are generated after noise substraction: NoisyChList_3888_280725_50Hz.txt

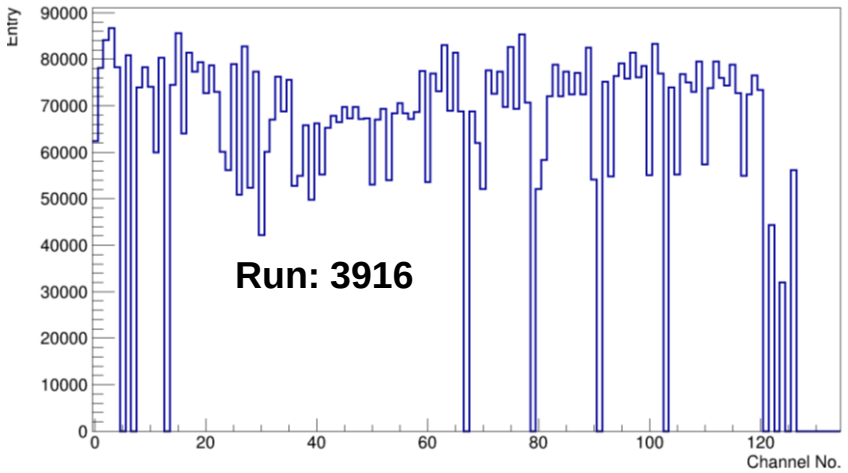
GEM1 Nx=0 Analysis results(HV=4000V)
(Root file: DigiPerOnSpill_v2_161025_*.root)

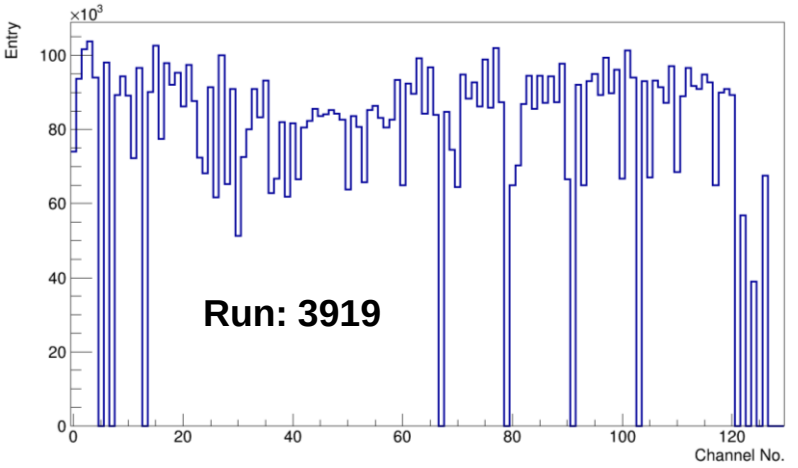
Intensity/ Spill	Runs	No. Of Spills	Total Digi in all the spills for nx=0	Digi/Spill for nx=0	Remarks
$I = 10^7$ / 10s	3885	14			Fe Run, so Not taken
$I = 3 \times 10^7$ / 10s	3916	14	8153896	582421	
$I = 6 \times 10^7$ / 10s	3919	7	9885101	1412157	
$I = 3 \times 10^8$ / 10s	3987	15	45293946	3019596	
$I = 5 \times 10^8$ / 8s	3994	11	58516805	5319709	
$I = 8 \times 10^8$ / 6s	4022	38	128878105	3391529	Confusion with Spill Length

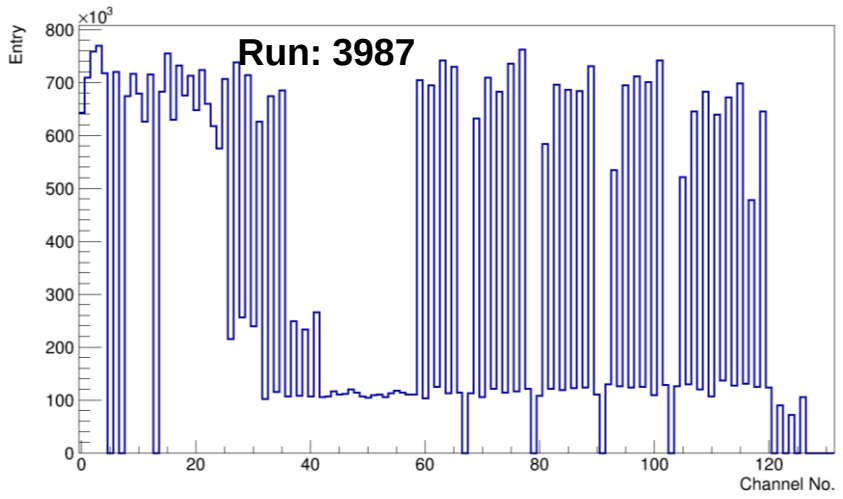
As the Detector acceptance is not same in all the Runs, So, Data From the innermost Zone is taken for comparison.

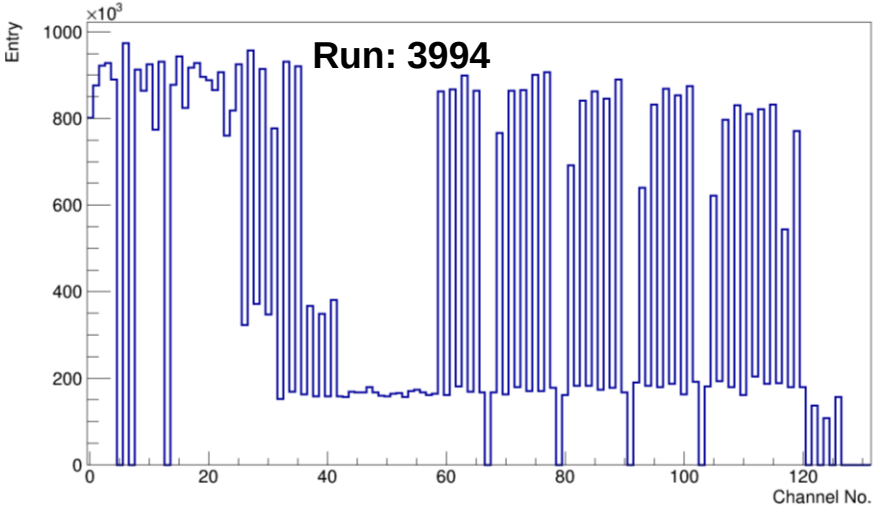
FEB (nx=0)
--> Highest Flux

GEM1, Nx=0 Channel map for the runs

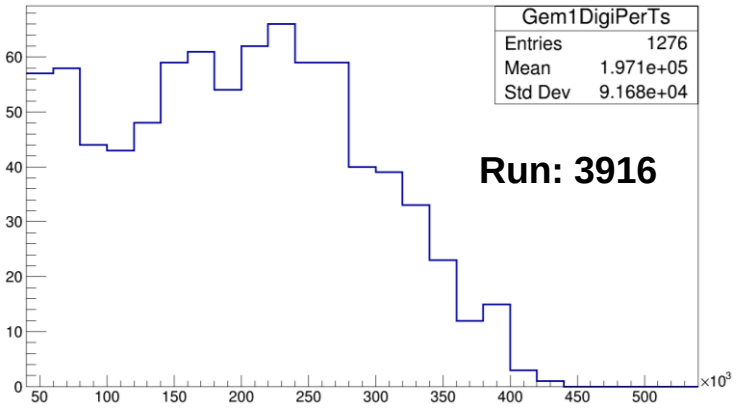


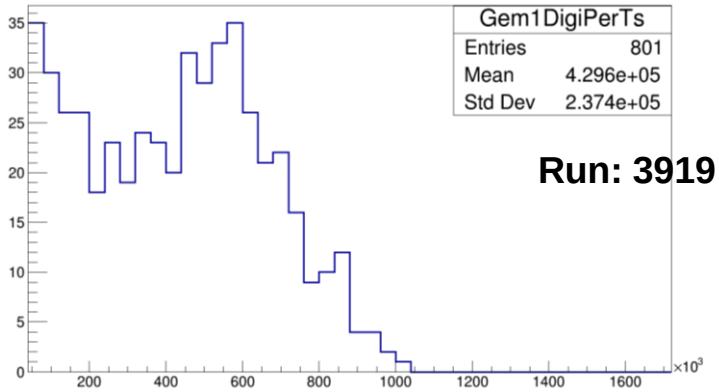


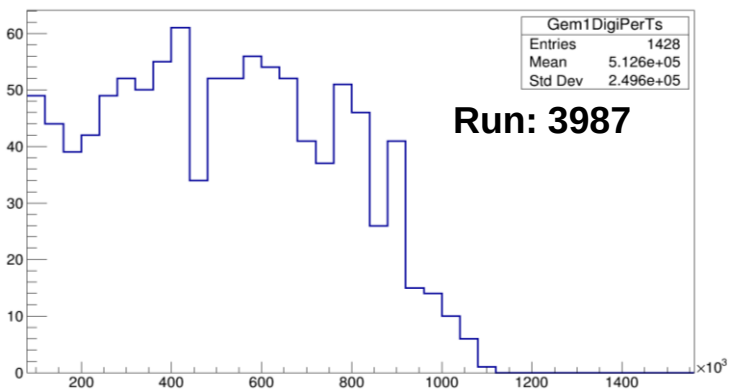


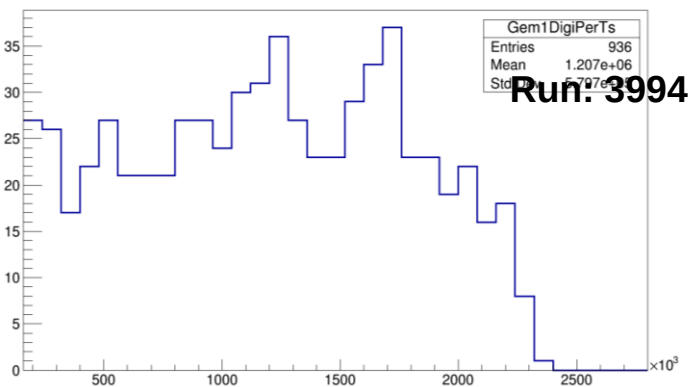


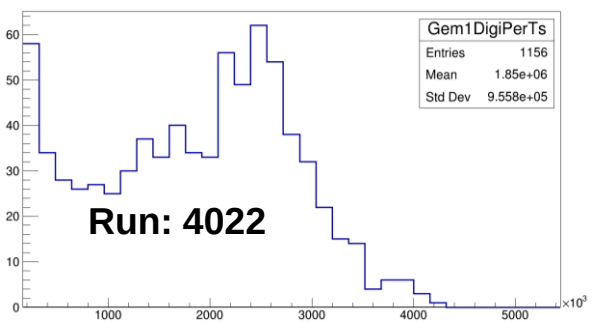
GEM1 Digi/TS: (Root file: DigiPerTS_040925_*.root)



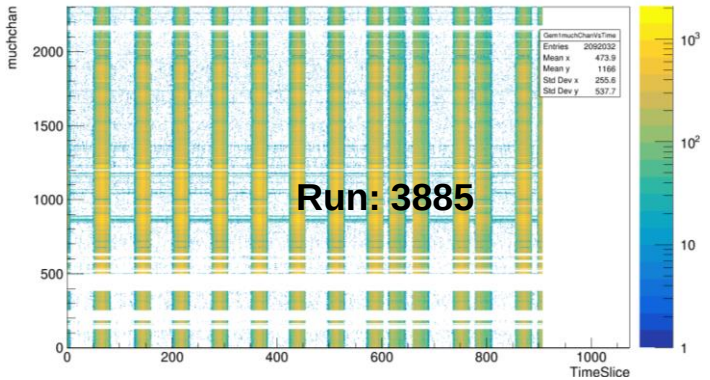


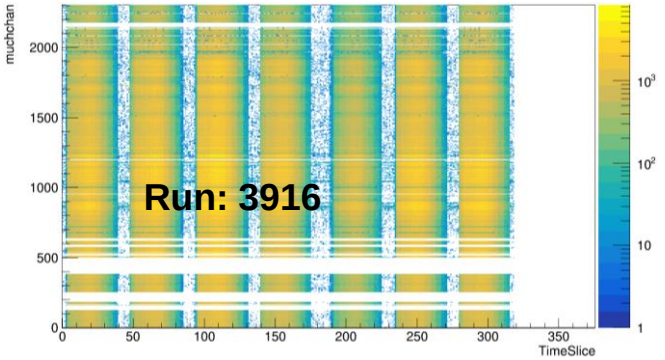


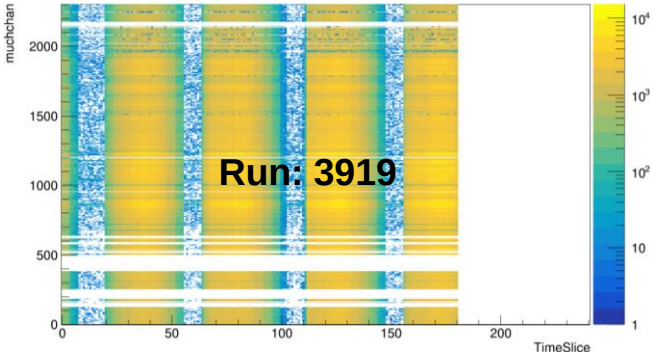


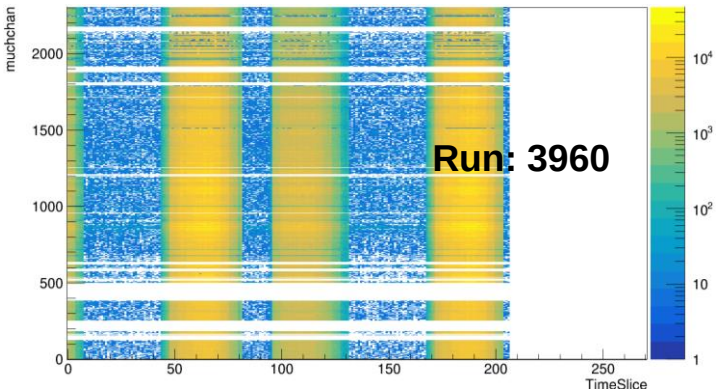


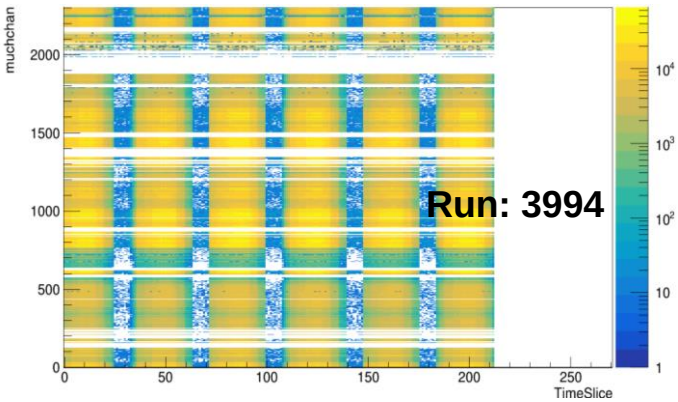
GEM1 Rate(Hz/ Channel): (Root file: DigiPerTS_040925_*.root)

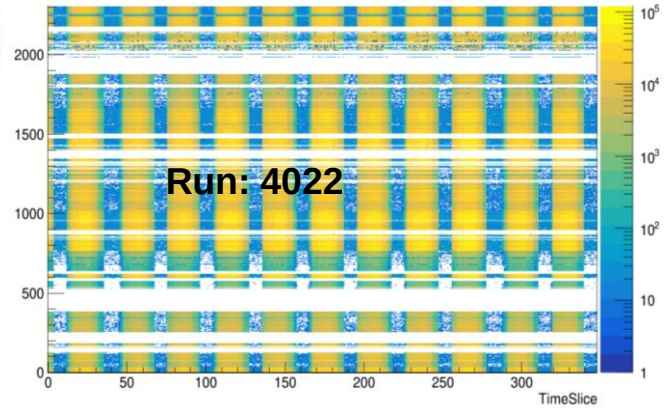






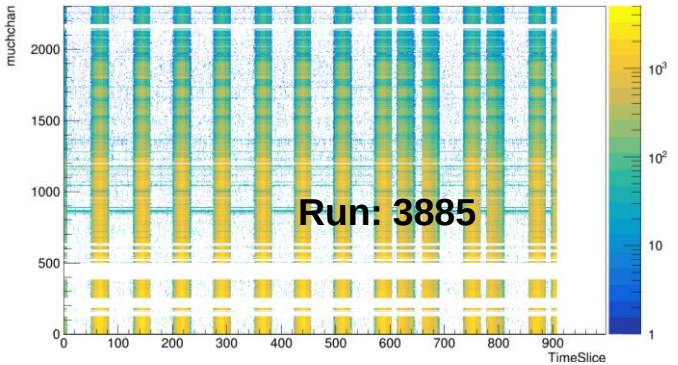


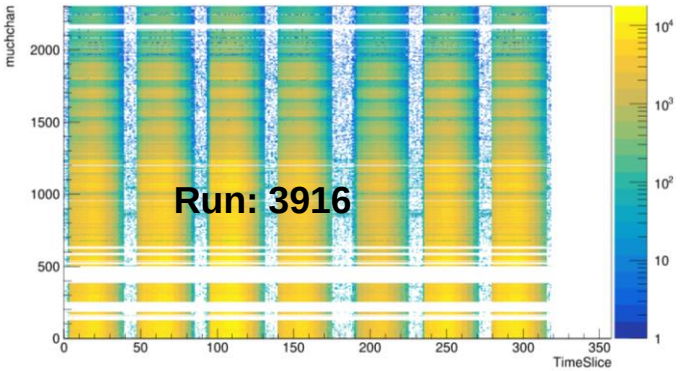


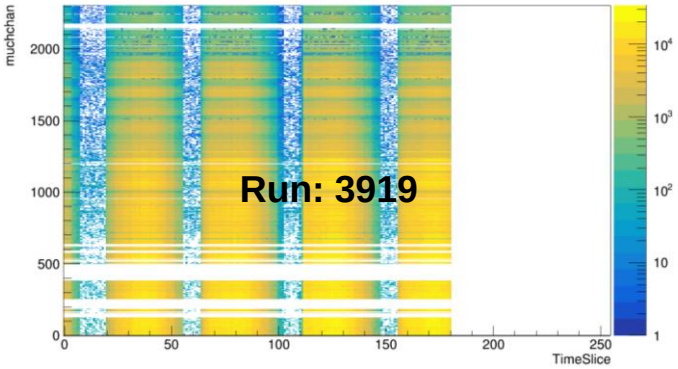


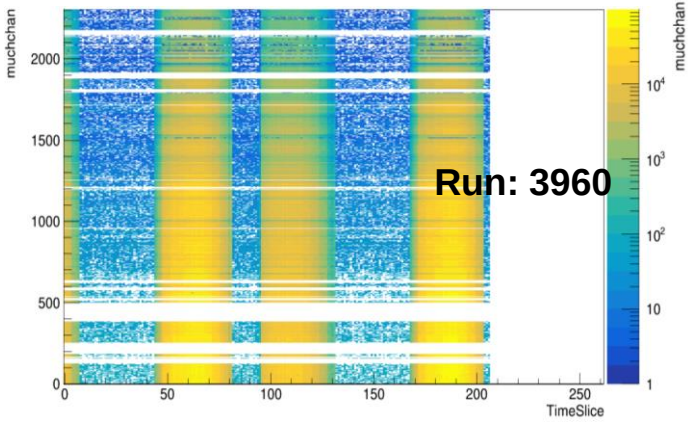
Reaches upto ~ 100 KHz/Pad

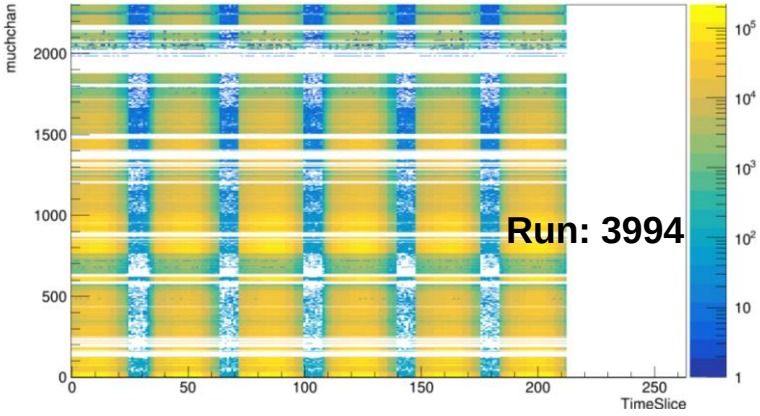
GEM1 Rate per channel (Hz/ cm2): (Root file: DigiPerTS_040925_*.root)

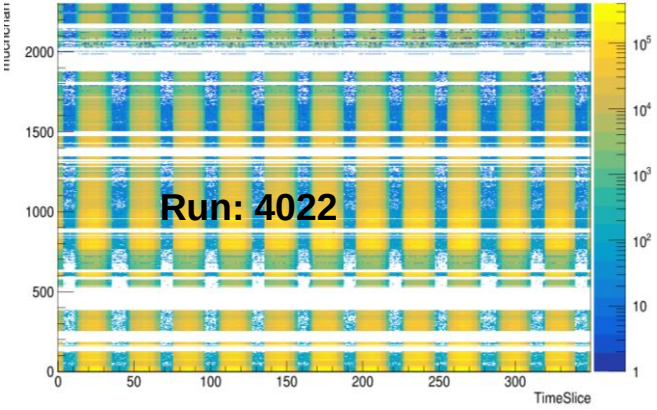






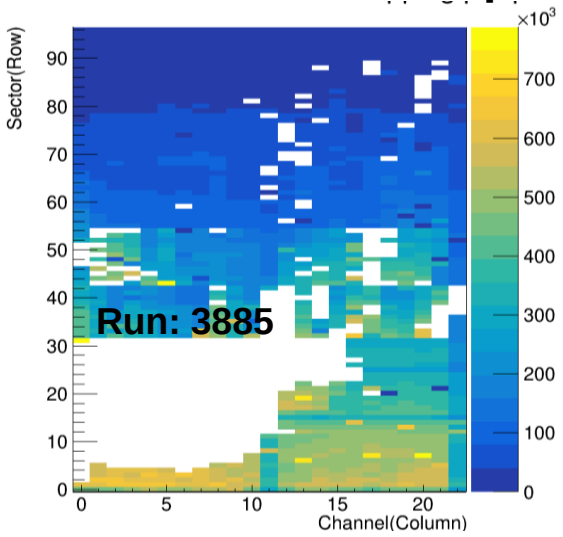


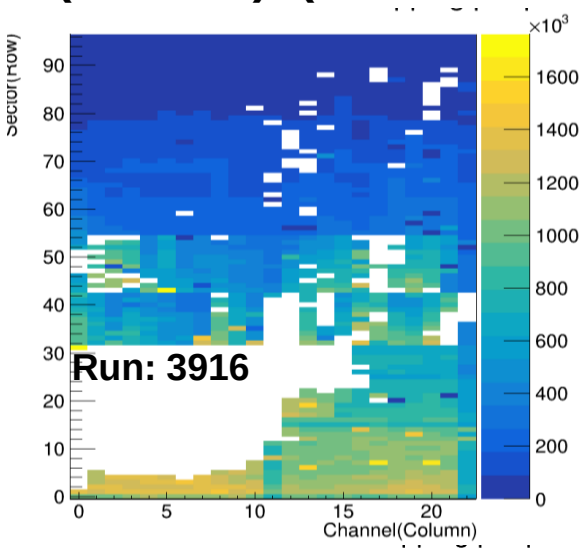


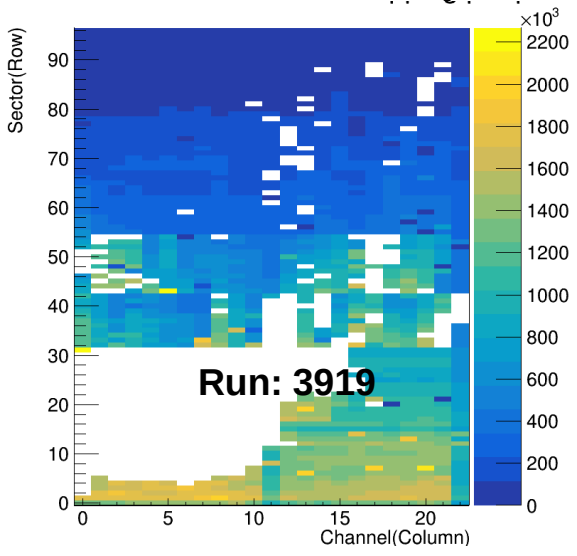


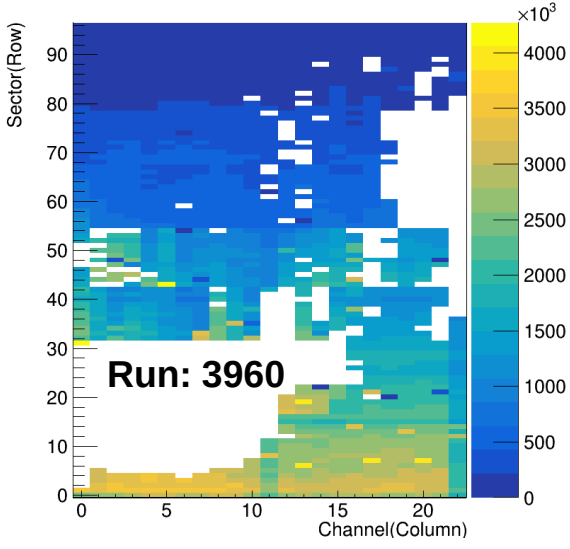
Reaches upto ~ 400 KHz/Cm2

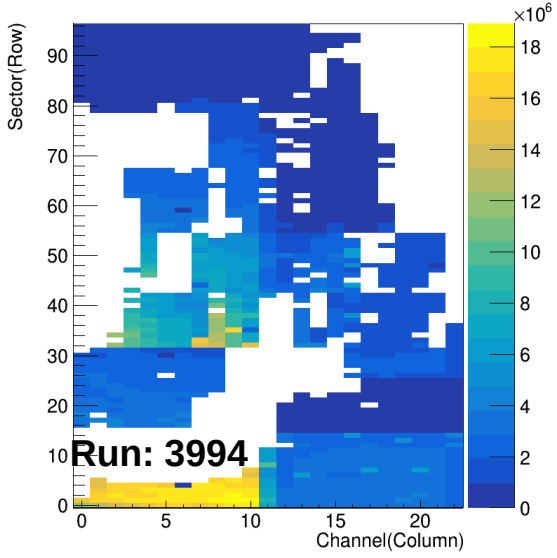
GEM1 Rate per pad (Hz/ cm2): (Root file: DigiPerTS_040925_*.root)

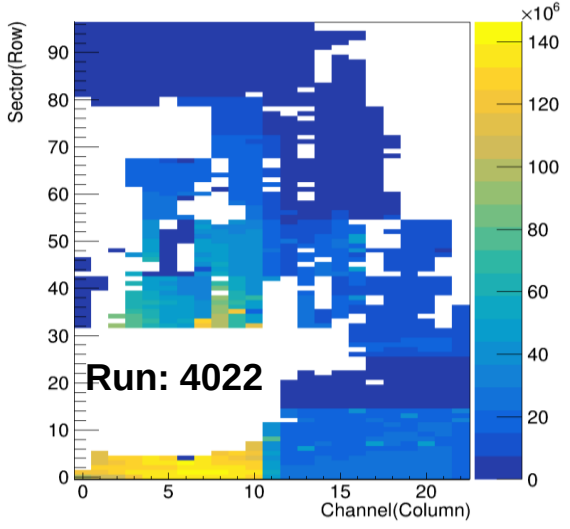






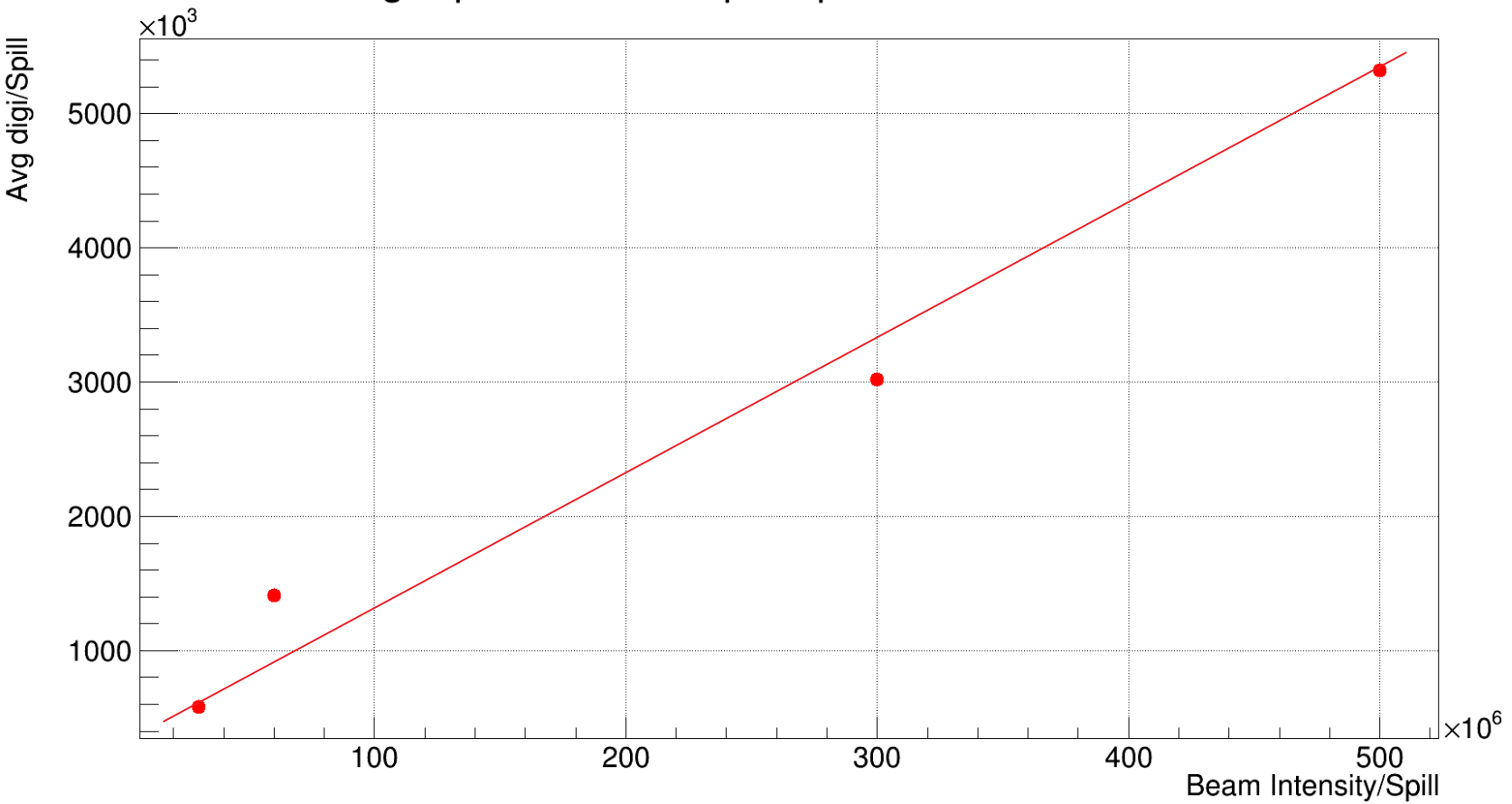






Particle rate decreases gradually as we go away from beampipe.

plotting for the FEB in narrow zone only, nx=0



GEM2 Results
(MuCh Second Station)

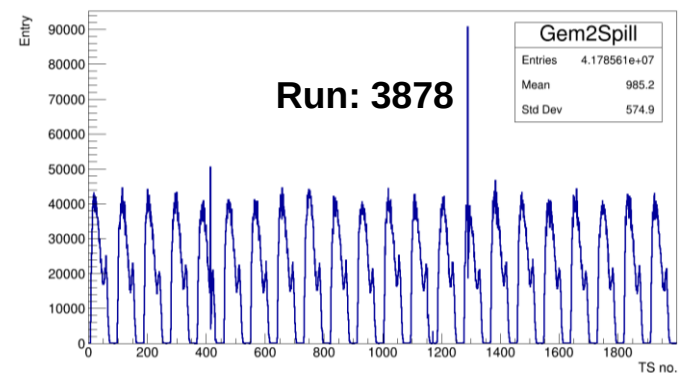
GEM2. Nx=0 (HV=4000V)(Root file: DigiPerOnSpill_v2_161025_*.root)

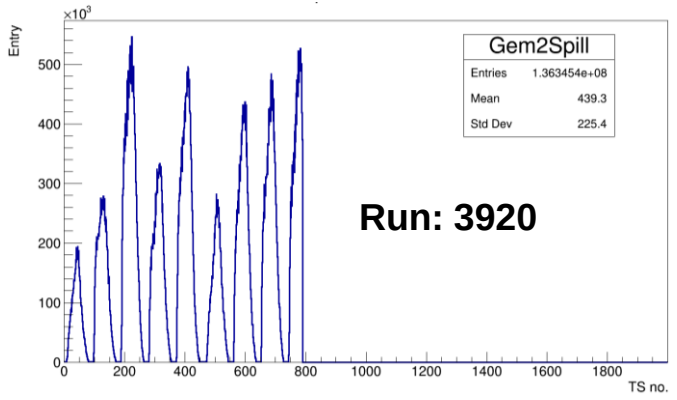
Intensity	Runs	No. Of Spills	Total Digi in all the spills nx=0	Digi/Spill nx=0	Remarks
$I = 10^7$ / 10s	3878	22	1597535		Fe Run
$I = 3 \times 10^7$ / 10s					
$I = 6 \times 10^7$ / 10s	3920	9	6163191	684799	
$I = 10^8$ / 10s	3940	6	10960714	1826785	
$I = 3 \times 10^8$ / 10s	3973	7	33160954	4737279	
$I = 5 \times 10^8$ / 8s	3998	9	129998507	14444278	
$I = 8 \times 10^8$ / 6s	4022 **(at 4025V)**	38	244729923	6440261	Spill lengths are confusing

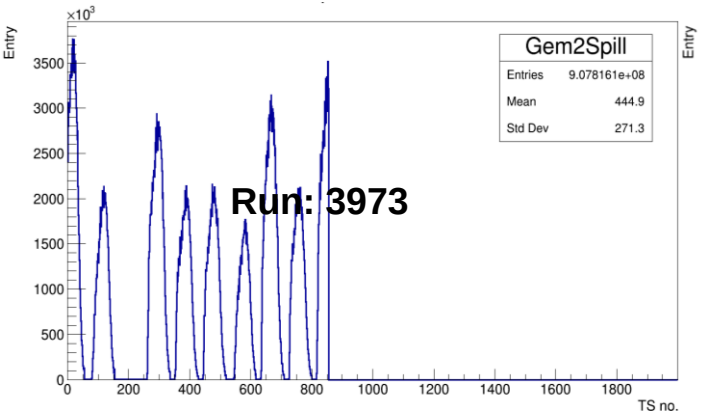
As the Detector acceptance is not same in all the Runs, So, Data From the innermost Zone is taken for comparison.

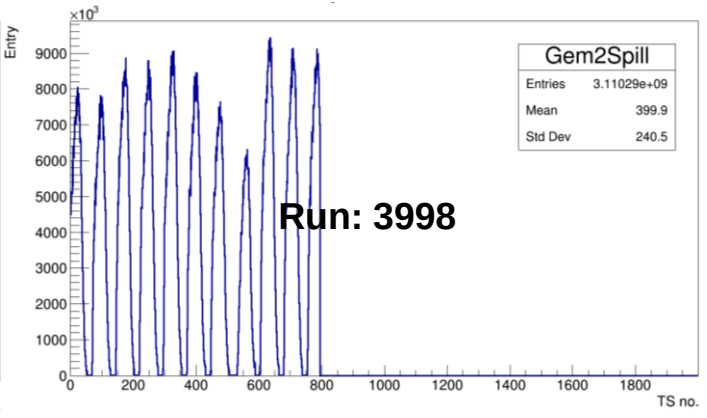
FEB (nx=0)
--> Highest Flux

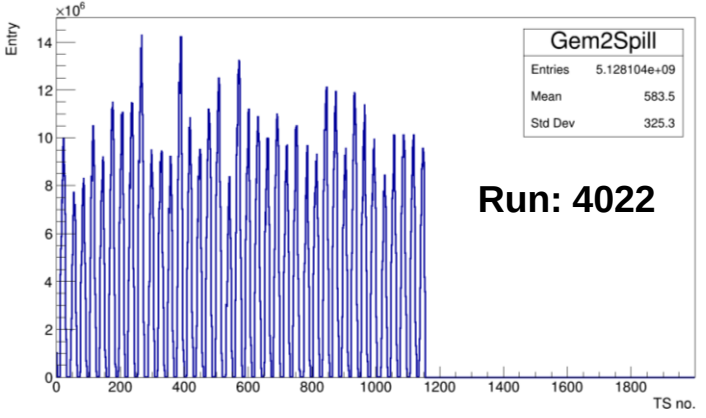
GEM2 Spill: (Root file: DigiPerTS_040925_*.root)



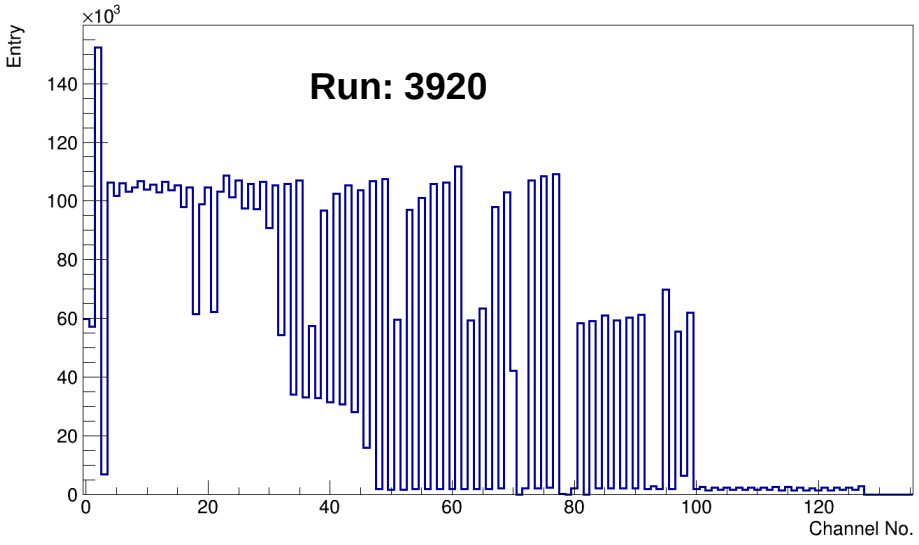


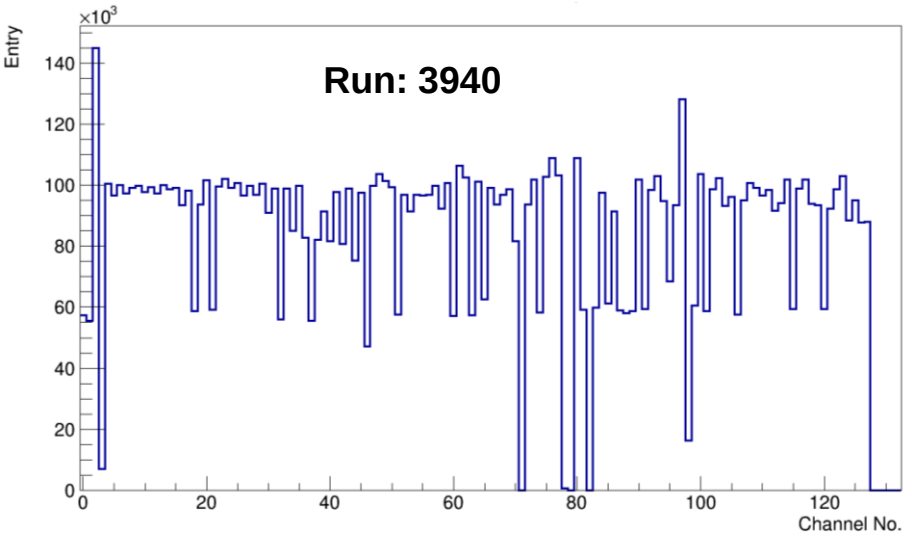


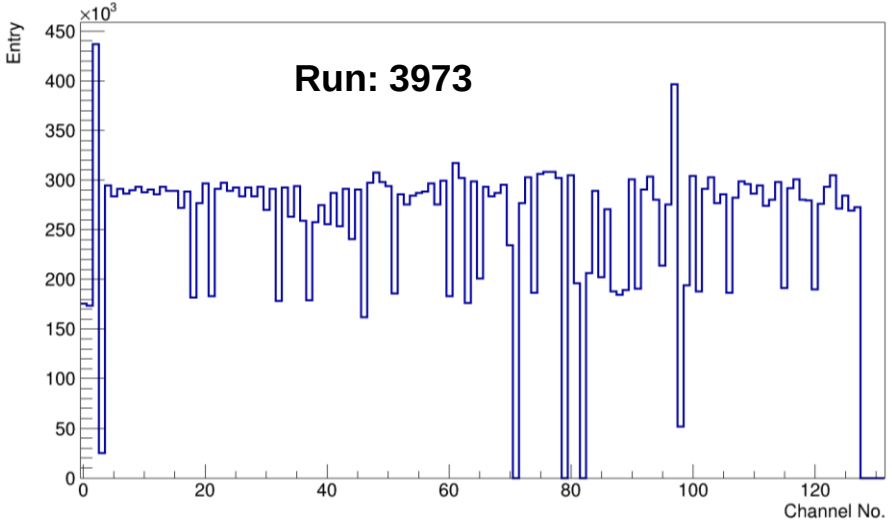


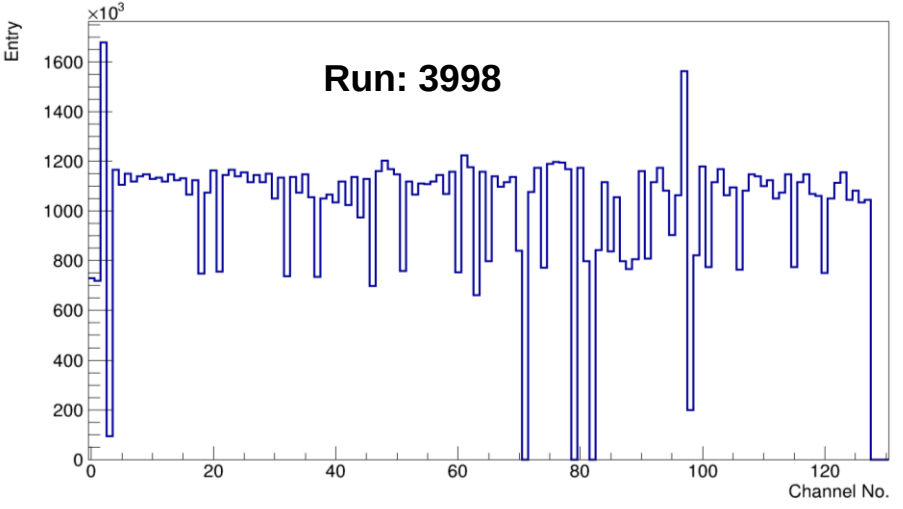


All these plots are generated after noise substraction: NoisyChList_3888_280725_50Hz.txt

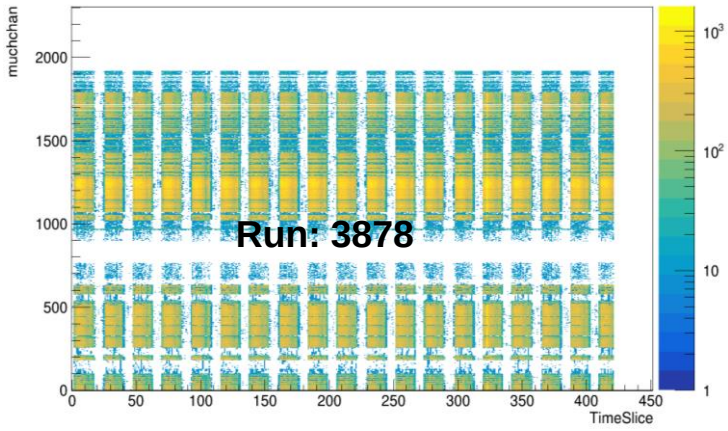

Run: 3920
Entry
×10³
Channel No.

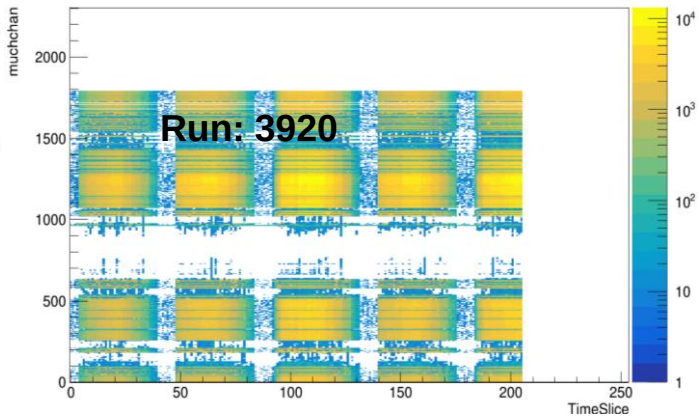

Run: 3940
Entry
×10³
Channel No.

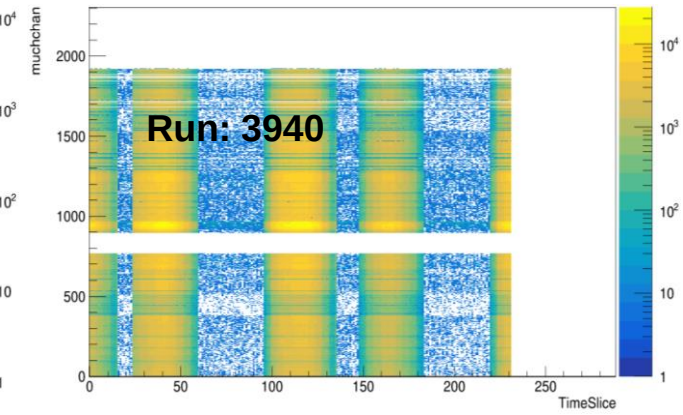

Run: 3973
Entry
×10³
Channel No.

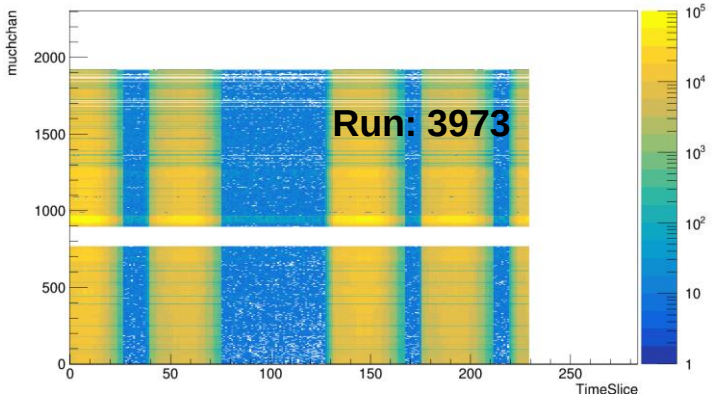

Run: 3998
Entry
×10³
Channel No.

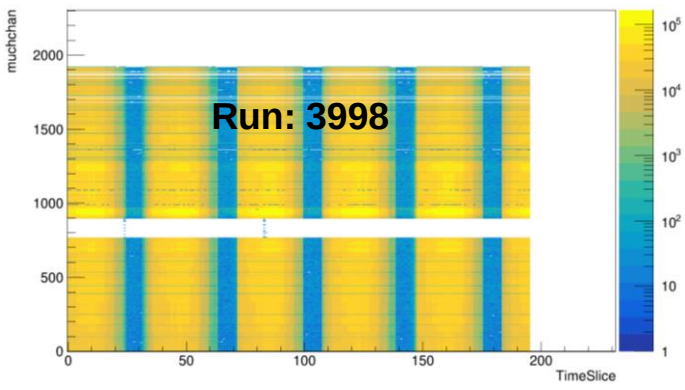
GEM2 Rate(Hz/ Channel): (Root file: DigiPerTS_040925_*.root)

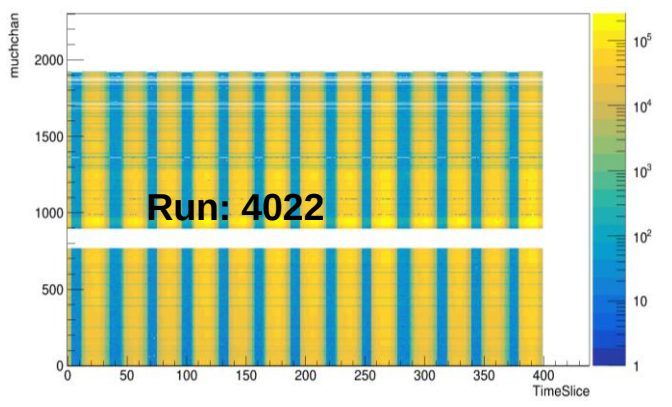




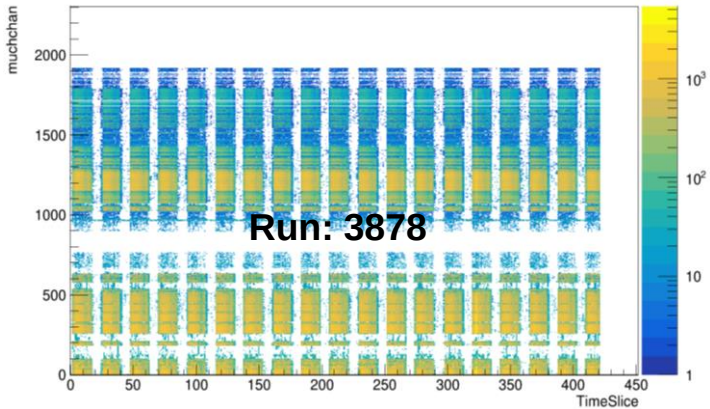


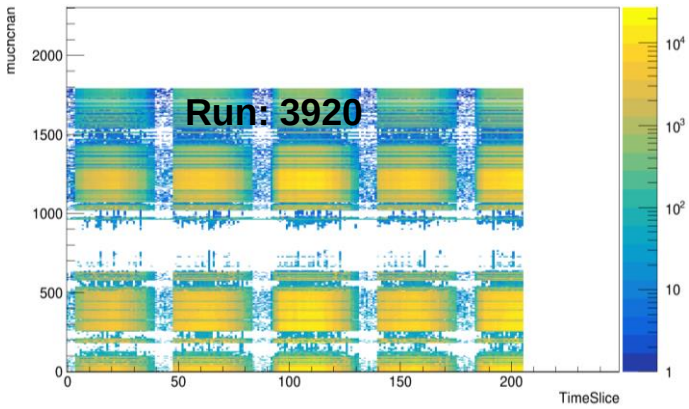


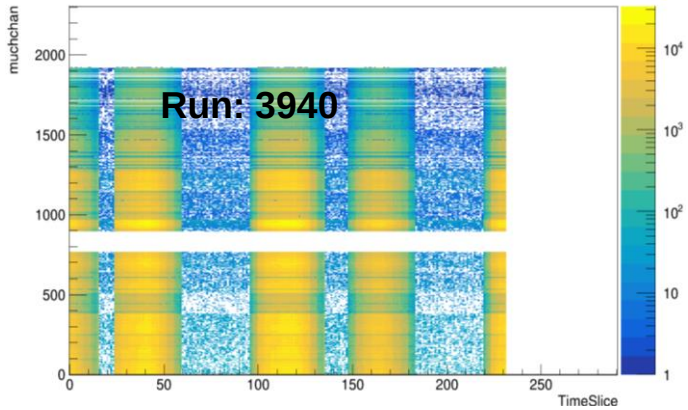


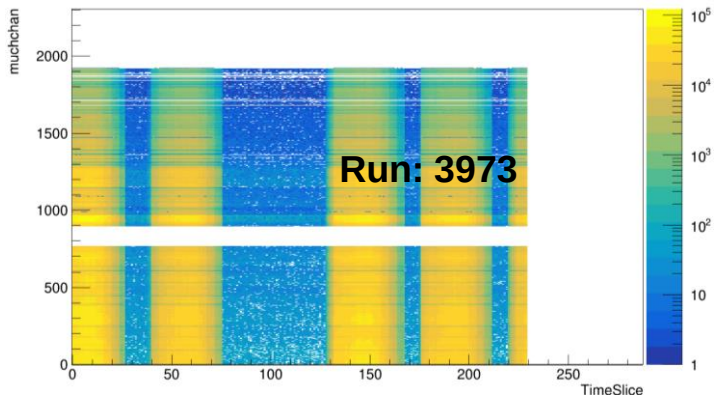


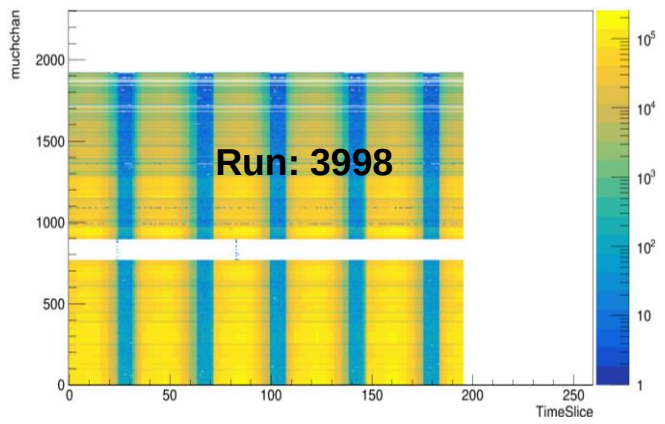
GEM2 Rate per channel (Hz/ cm2): (Root file: DigiPerTS_040925_*.root)

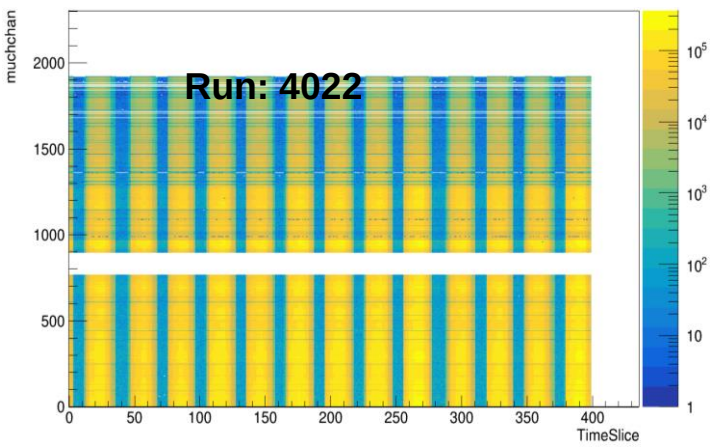






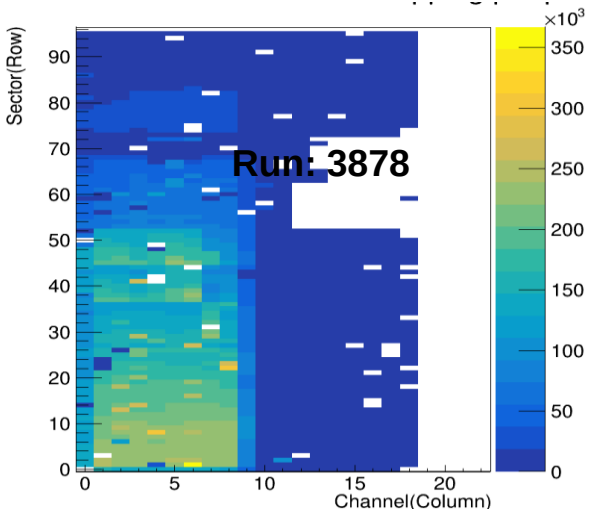


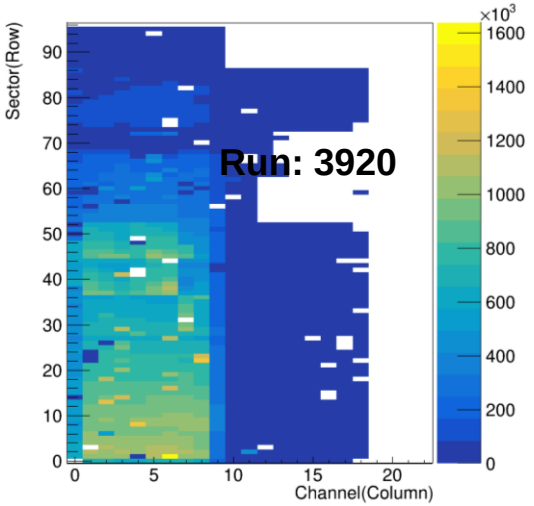


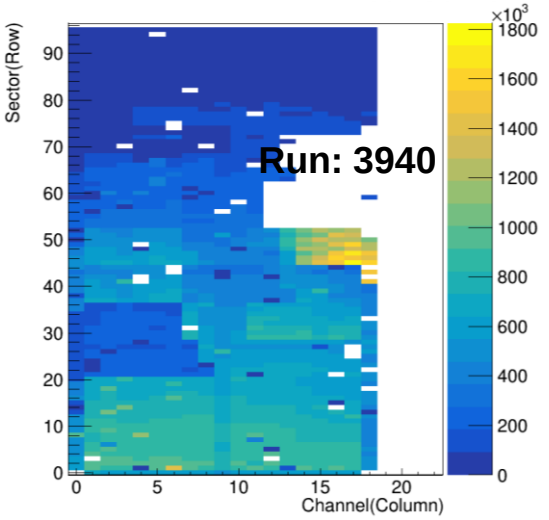


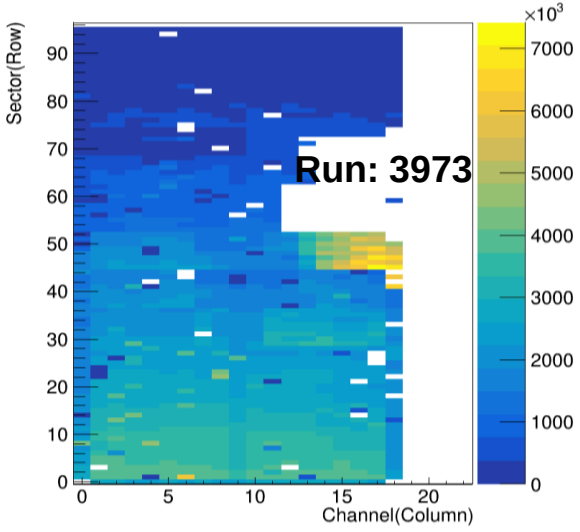
Reaches upto ~ 300 KHz/Cm2

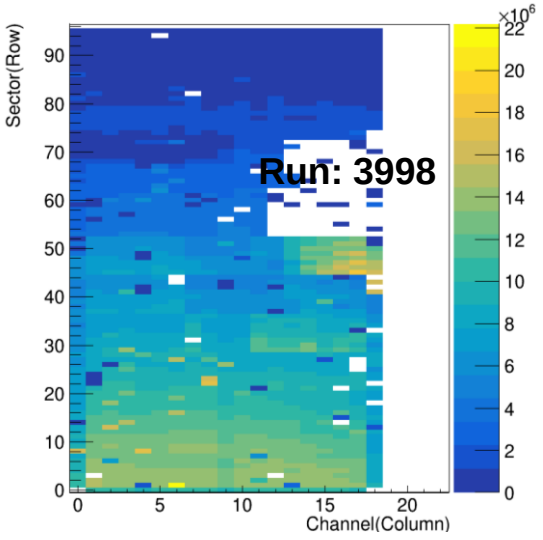
GEM2 Rate per pad (Hz/ cm2): (Root file: DigiPerTS_040925_*.root)

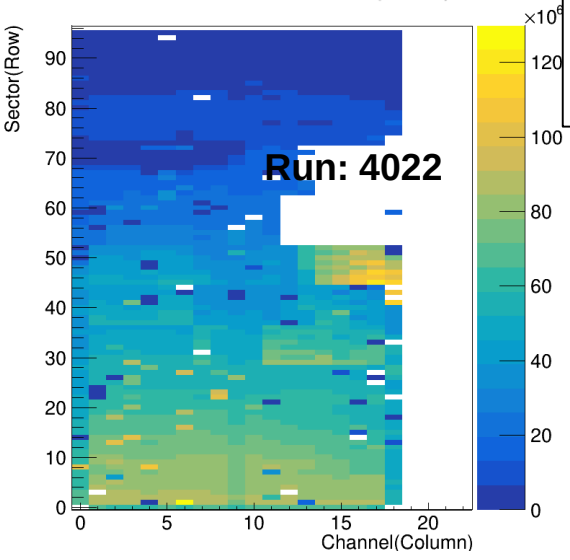






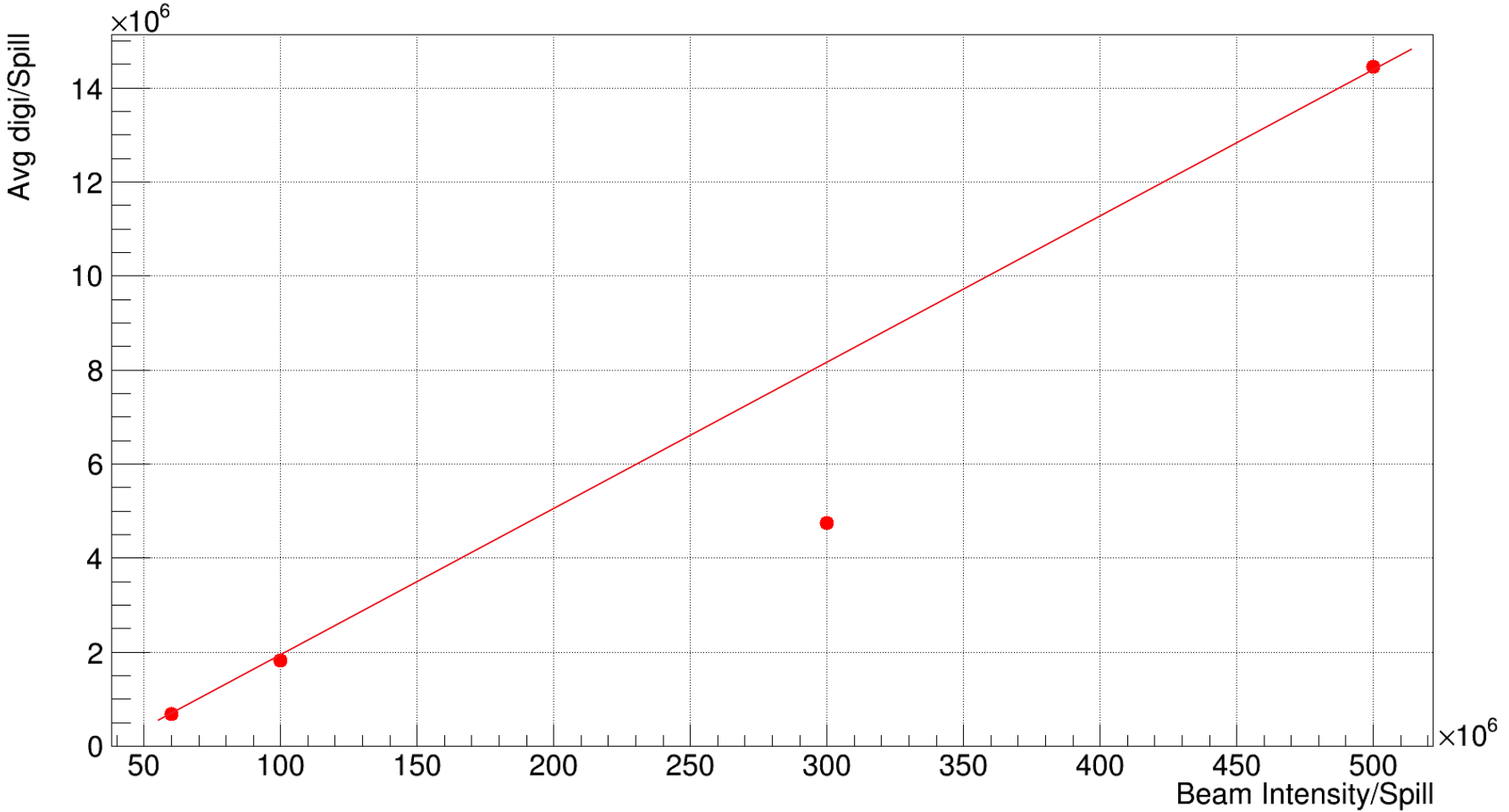




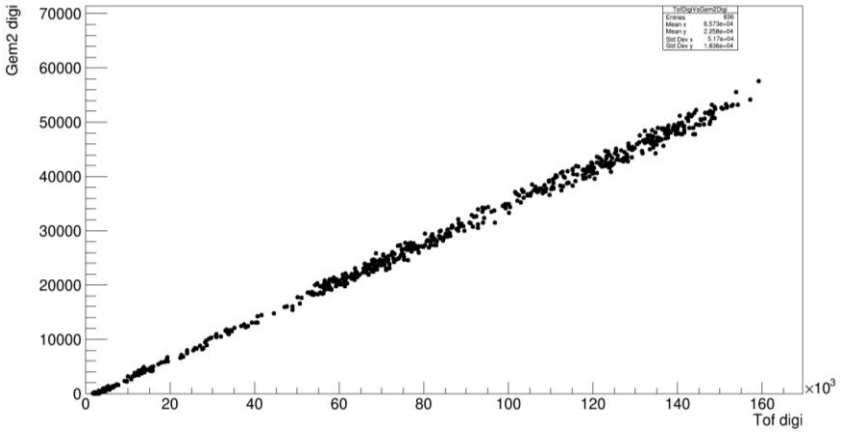


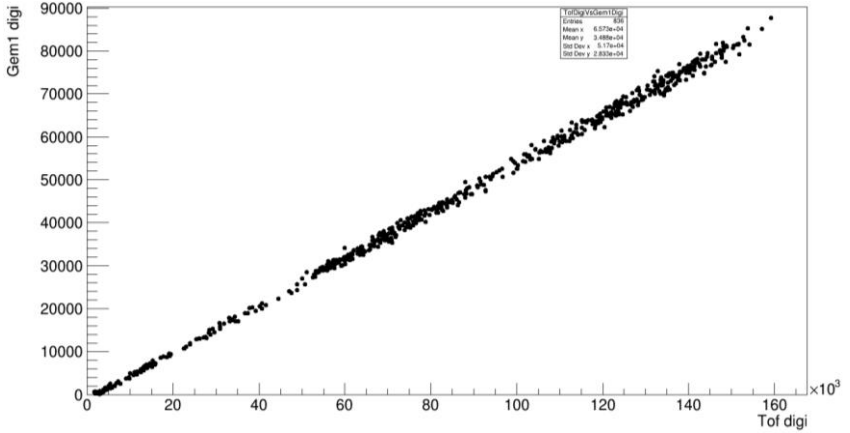
Particle rate decreases gradually as we go away from beampipe.

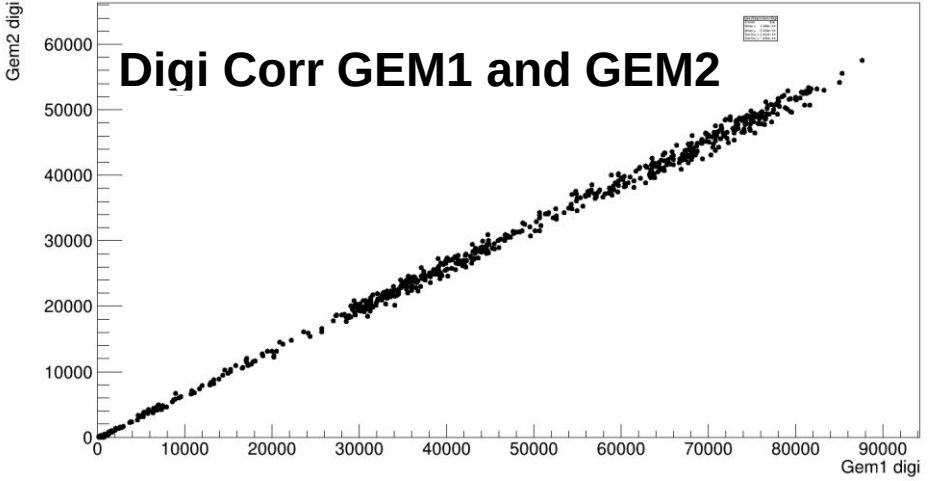
Now we plot for narrower zone only, nx=0, Digi/Spill Vs intensity.



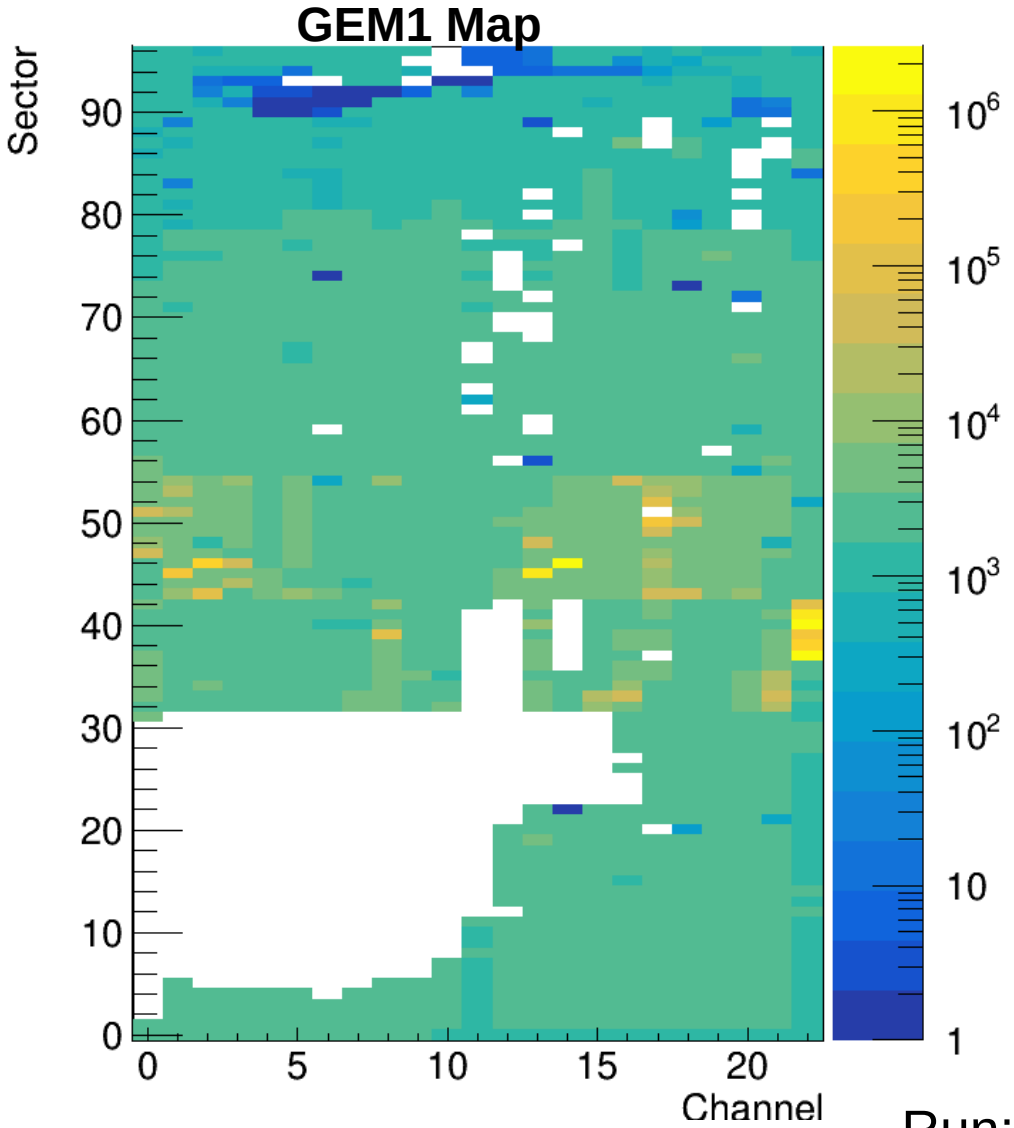
Digi Corr with TOF Run: **3887**

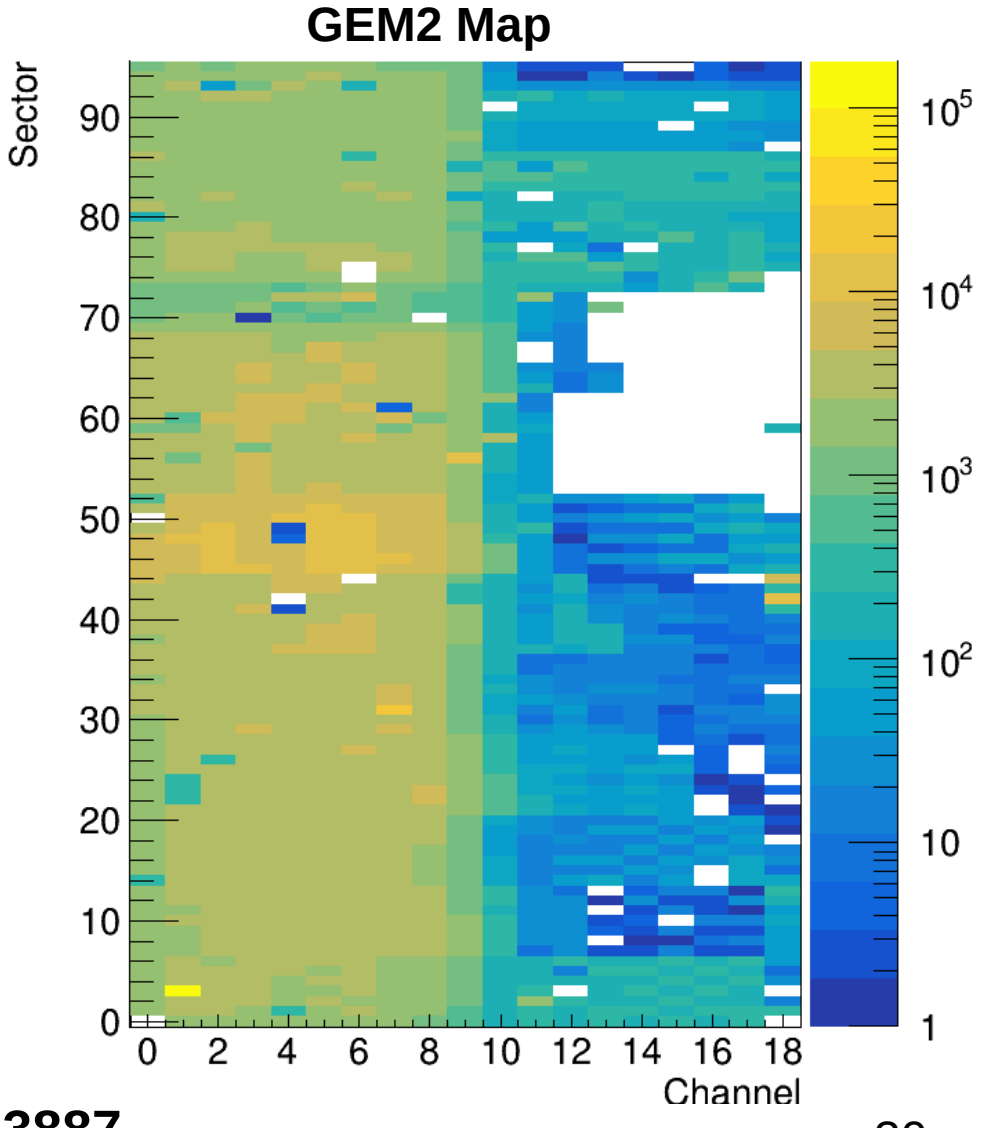




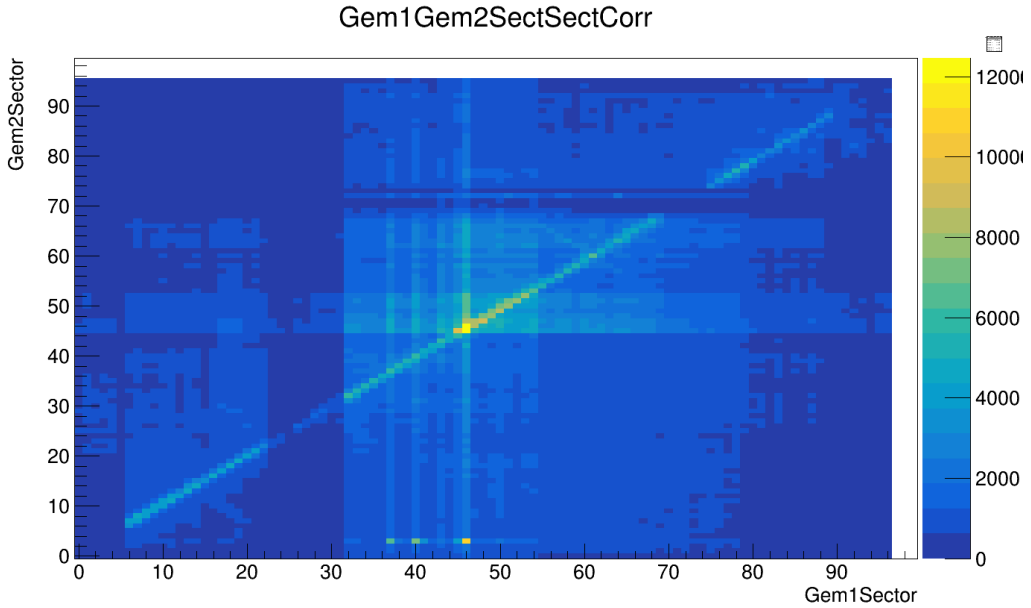


XX, YY and time Correlation

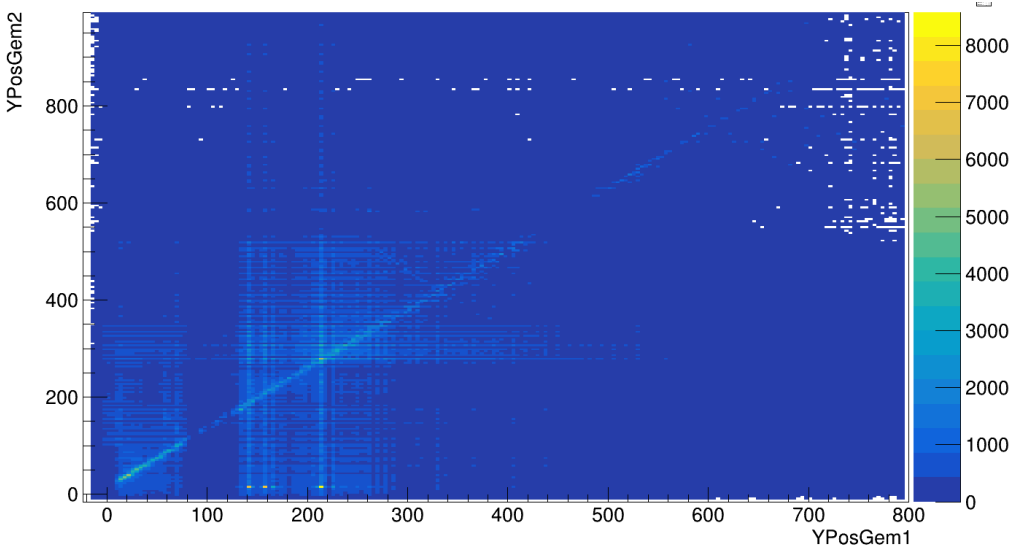

GEM1 Map
Sector
Channel
0
10
20
30
40
50
60
70
80
90
0
5
10
15
20
10^6
10^5
10^4
10^3
10^2
10
1


GEM2 Map
Sector
Channel
0
10
20
30
40
50
60
70
80
90
0
2
4
6
8
10
12
14
16
18
10^5
10^4
10^3
10^2
10
1

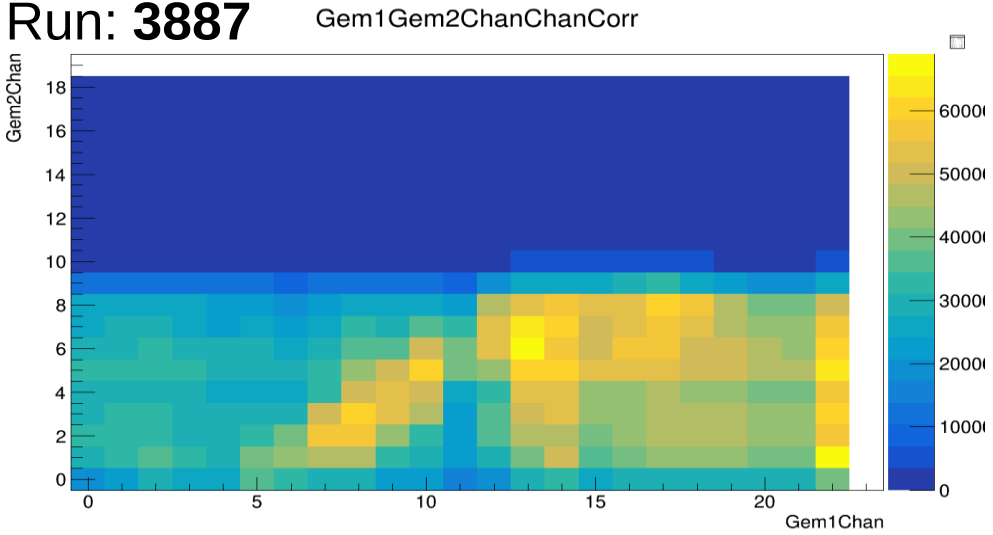
Run: **3887**

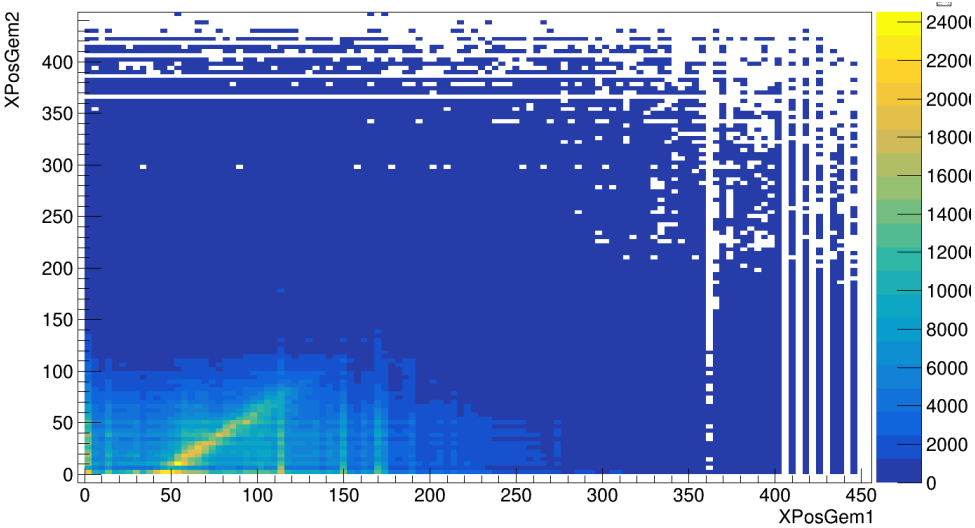


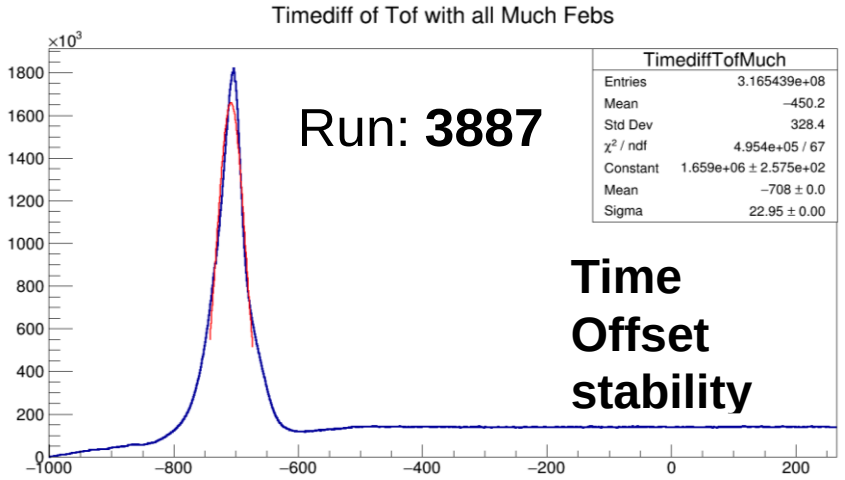
In mm scale

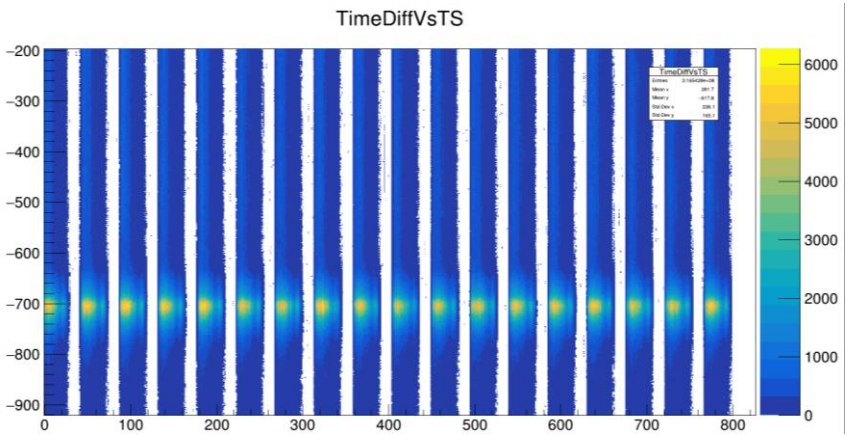


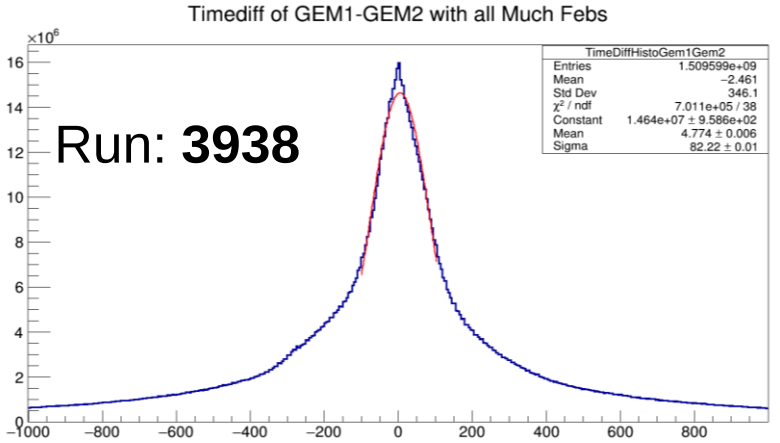
Run: **3887**

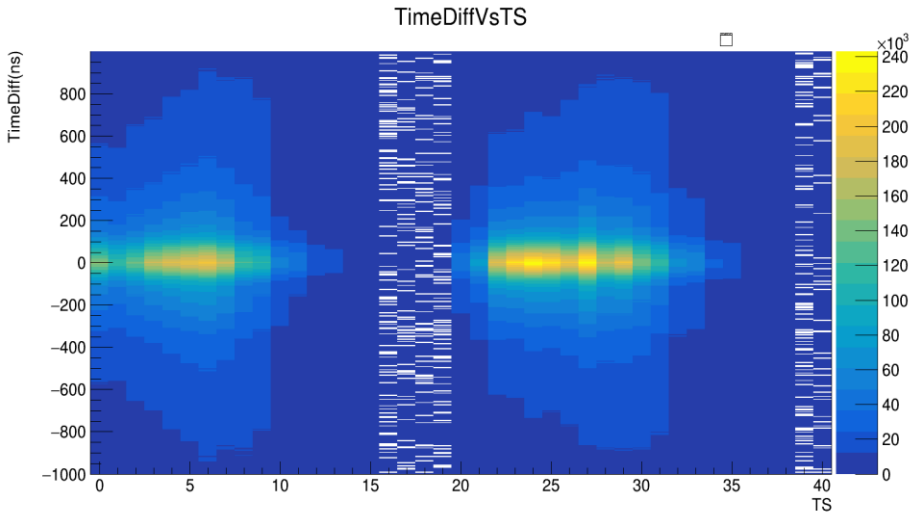


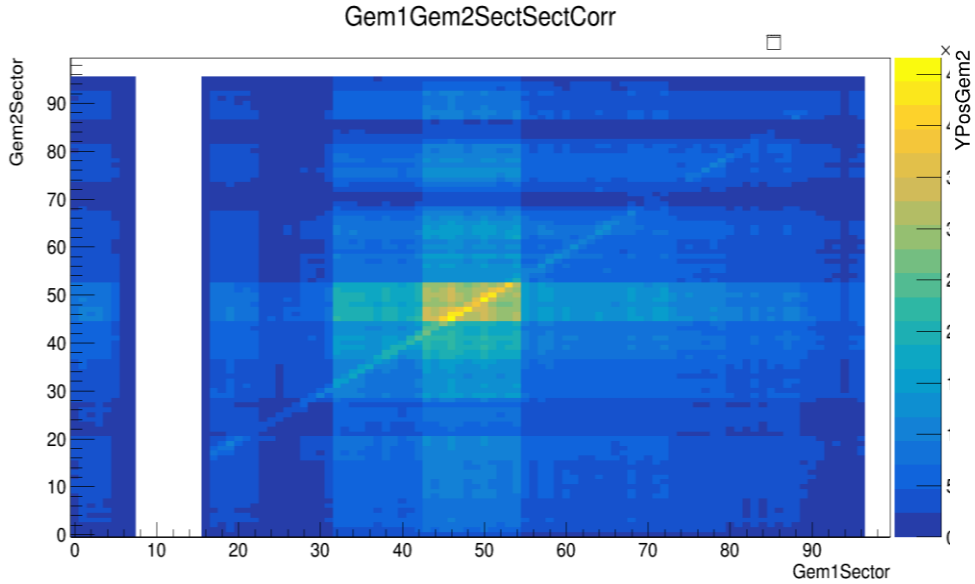


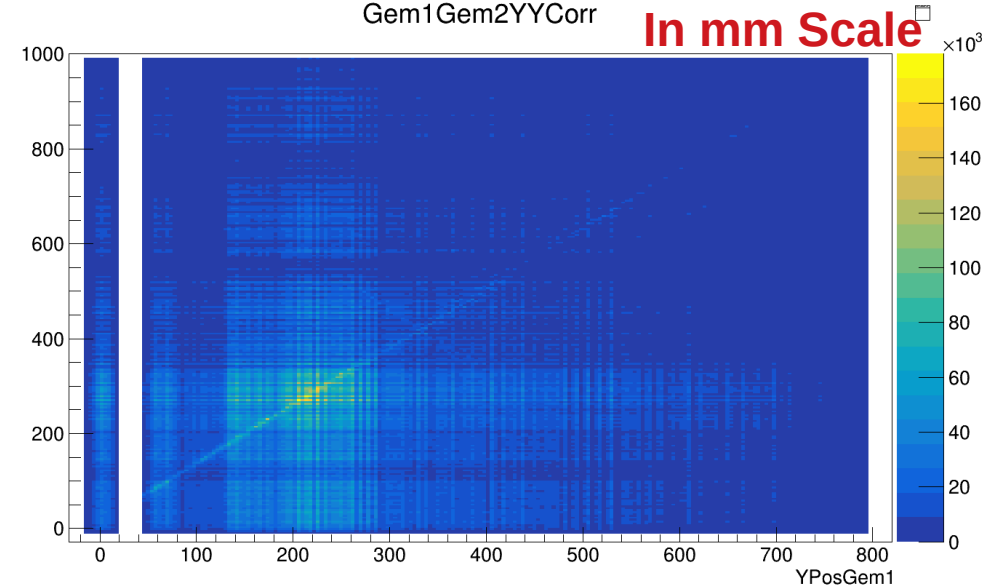

Timediff of Tof with all Much Febs
TimediffTofMuch
Entries 3.165439e+08
Mean −450.2
Std Dev 328.4
χ² / ndf 4.954e+05 / 67
Constant 1.659e+06 ± 2.575e+02
Mean −708 ± 0.0
Sigma 22.95 ± 0.00
Run: 3887
Time Offset stability


TimeDiffVsTS

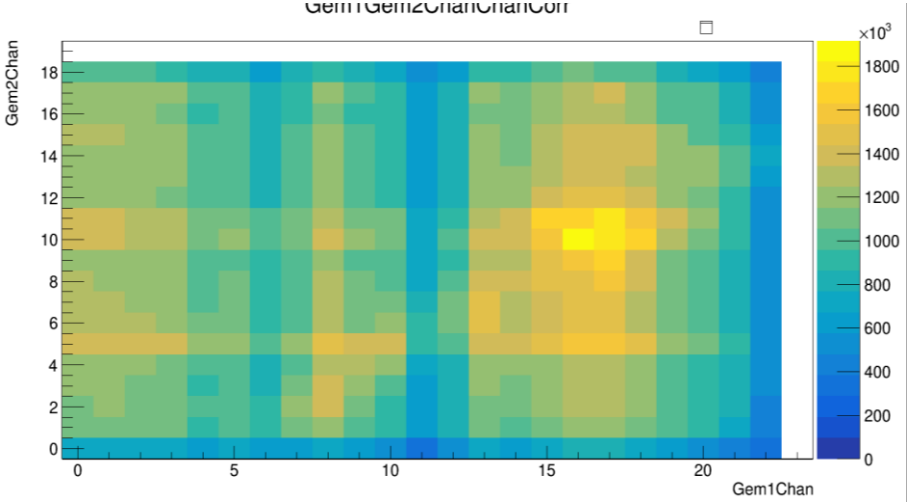

Timediff of GEM1-GEM2 with all Much Febs
TimeDiffHistoGem1Gem2
Entries 1.509599e+09
Mean −2.461
Std Dev 346.1
χ² / ndf 7.011e+05 / 38
Constant 1.464e+07 ± 9.586e+02
Mean 4.774 ± 0.006
Sigma 82.22 ± 0.01
Run: 3938

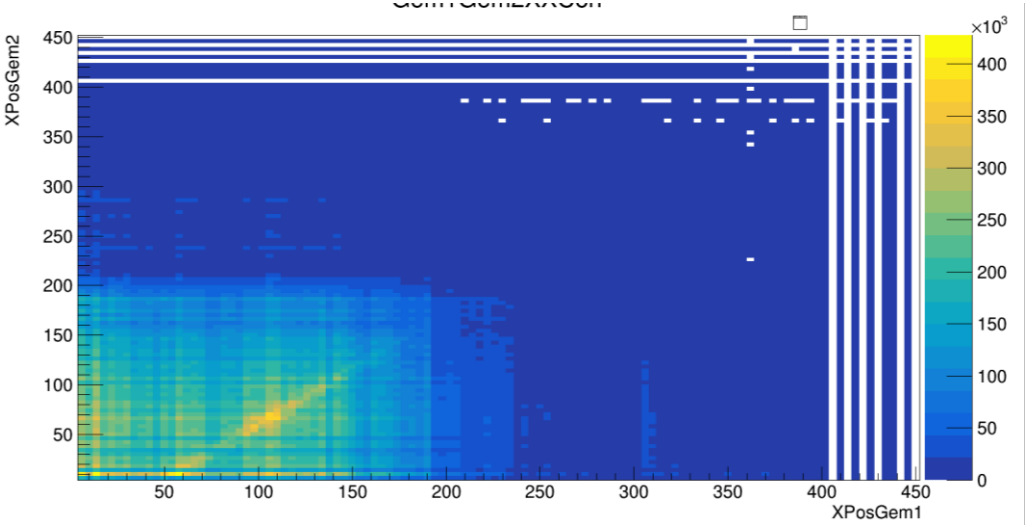

TimeDiffVsTS
TimeDiff(ns)
TS





In mm Scale

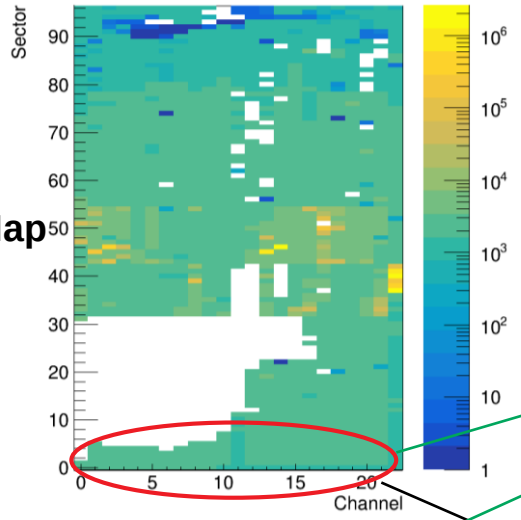




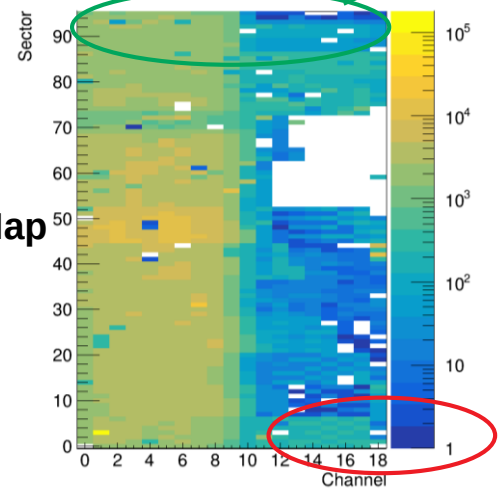
Run: **3938**

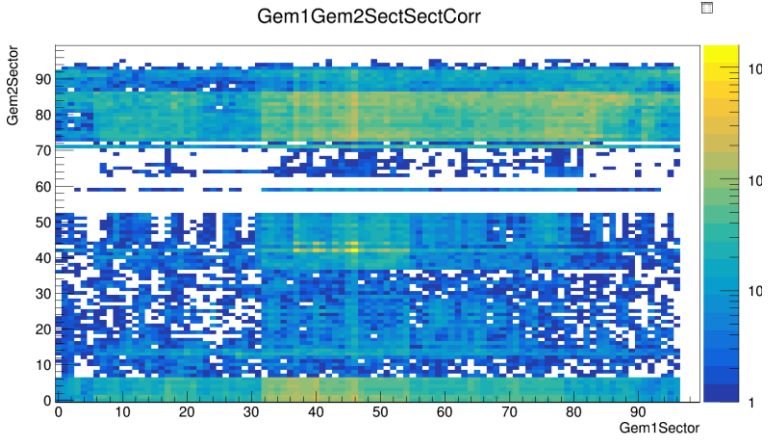
Run: **3887**

GEM1 Map



GEM2 Map





Summary:

1. first prototype of CBM-MuCh second station GEM (Gas Electron Multiplier) module along with a newly fabricated cooling plate for the cooling of the readout electronics, tested.

2. MuCh shows clear time correlation with reference detectors like TOF (Time of Flight) and Bmon.

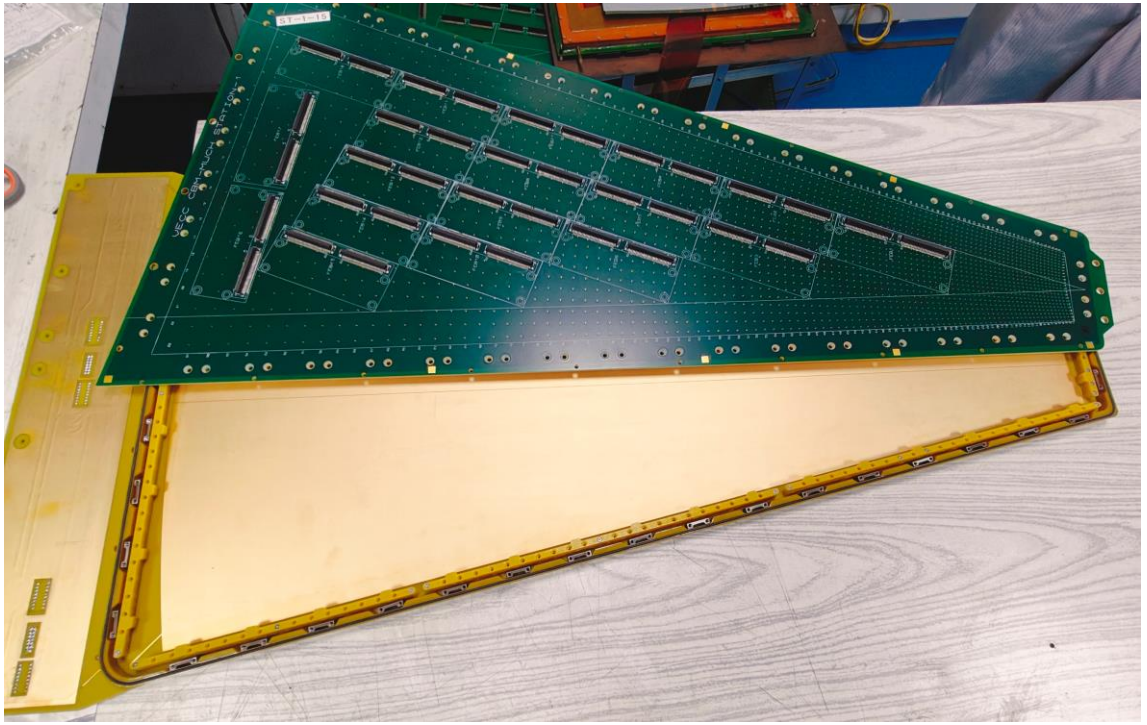
3. Digi rate upto 400 KHz/cm^2 has been observed in GEM1.

4. Further analysis on L1 tracking is ongoing.

MuCh-GEM – Production:
Fabrication procedured and QA tests

MuCh station-1, GEM Production : Main steps and Protocols

1. Preparation and tests of Drift PCB
2. Preparation and tests of Readout PCB
3. Preparation of inner spacers stack and O-ring based edge frame
4. GEM foil leakage current tests
5. Assembly of the GEM stack.
6. Nozzle fitting and Gas tightness check, using flow meter/oxygen sensors
7. Tests with X-rays or radioactive sources
8. Stacking the GEM modules on a stand and nitrogen flushing



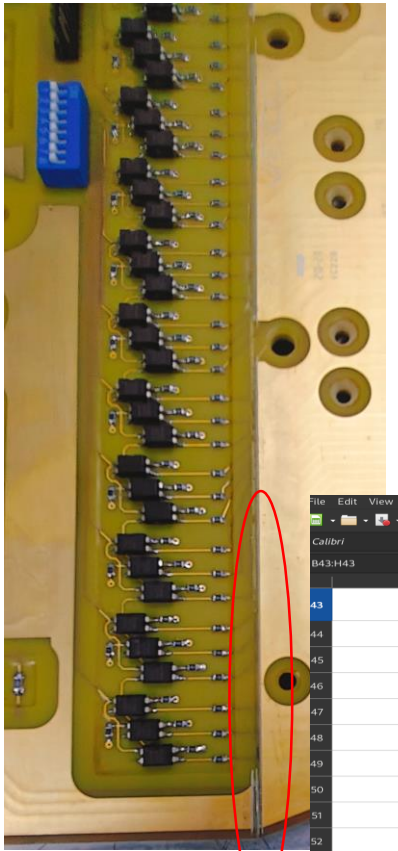
Drift PCBs

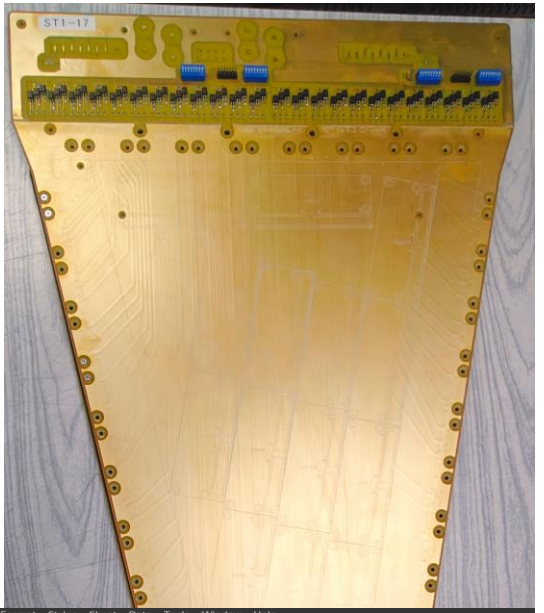
- Physical Inspection and checked divider circuit points.
- Optocoupler 72 No soldered
- Dip switch FPGA connectors
- Resistors soldering

After all soldering and cleaning, HV applied up to 4500 V and divider current measured.

Good PCB: In hour-long test Shows a current fluctuation of around 0.1 uA

-- learning during production : The Divider currents of some of the boards were fluctuating
-- Solution: 2 mm peeling around the joining line



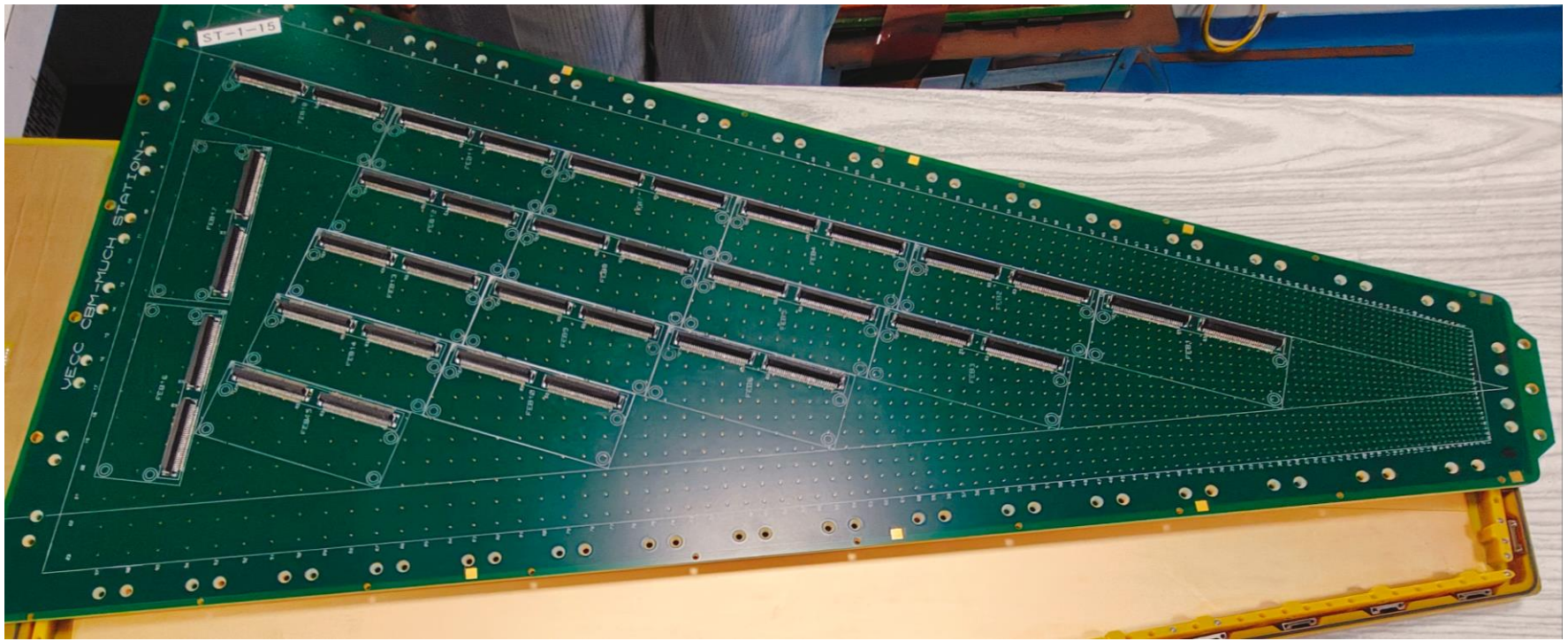


HIGH VOLTAGE TEST

HV(V)	Current(μ	Remarks
100	35.65	
500	180.75	
1000	362.5	
1500	544.7	
2000	727.35	
2500	910.2	
3000	1093.25	
3500	1276.3	
4000	1459.4	
4050	1477.7	
4100	1495.9	
4150	1514.35	
4200	1532.5	Looking from

Readout PCB

-- physical inspection
-- Soldering of 10 ohm protection resistors
-- Soldering of 18 connectors
-- Pad to connector connectivity checks
-- Check list prepared for each module



Logsheet

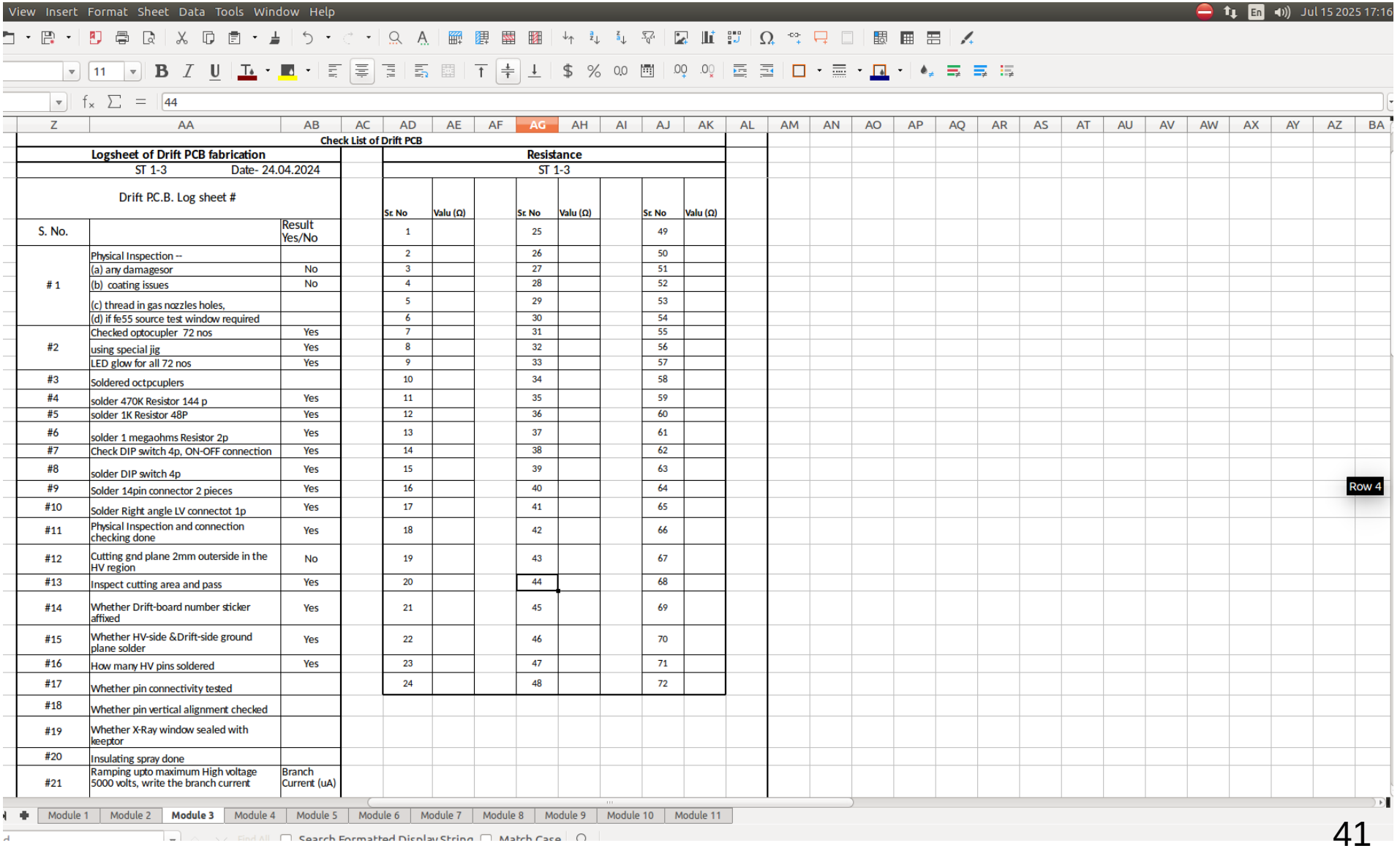
ST1-5

Drift P.C.B. Log sheet #		
Job coad		Result Yes/No
# 1	Physical Inspection -- (a) any damagesor (b) coating issues (c) thread in gas nozzles holes, (d) if fe55 source test window required	yes NO NO
#2	Checked optocupler 72 nos -- using special jig -- LEDs glow for all 72 nos	yes yes
#3	soldered all 72 optpcuplers	yes
#4	solder 470K Resistor 144 p	yes
#5	solder 1K Resistor 48P	yes
#6	solder 1 megaohms Resistor 2p	yes
#7	Check DIP switch 4p, ON-OFF connection	Yes
#8	solder DIP switch 4p (with proper orientation)	Yes
#9	Solder 14pin connector 2 pieces	Yes
#10	Solder Right angle LV connectot 1p	Yes
#11	Physical Inspection and connection checking	yes
#12	Cutting gnd plane 2mm outerside in the HV region	yes
#13	Inspect cutting area and pass	yes
#14	Ramping upto maximum High voltage 5000 volts, write the branch current	Branch Current (uA)
#15	Whether Drift-board number stickker affixed	

← Day Brushcleaning
21/11/24
24/11/24

ST 1 - 17 Date - 07/07/25, 11/07/25

Drift P.C.B. Log sheet #		
Job coad		Result Yes/No
# 1	Physical Inspection & checking divider circiit points-- (a) any damagesor (b) coating issues (c) thread in gas nozzles holes, (d) if fe55 source test window required	 NO NO
#2	Checked optocupler 72 nos using special jig LEDs glow for all 72 nos	Yes Yes Yes
#3	soldered all 72 optpcuplers	Yes
#4	solder 470K Resistor 144 p	Yes
#5	solder 1K Resistor 48P	Yes
#6	solder 1 megaohms Resistor 2p	Yes
#7	Check DIP switch 4p, ON-OFF connection	Yes
#8	solder DIP switch 4p	Yes
#9	Solder 14pin connector 2 pieces	Yes
#10	Solder Right angle LV connectot 1p	Yes
#11	Physical Inspection and connection checking	Yes
#12	Cutting gnd plane 2mm outerside in the HV region	Yes
#13	Inspect cutting area and pass	Yes
#14	Whether Drift-board number stickker affixed	Yes
#15	Whether HV-side &Drift-side ground plane solder	
#16	How many HV pins solder	
#17	Whetherpin connectivity tested	
#18	Whether pin vertical alignment checked	
#19	Whether X-Ray windon sealde with keeptor	
#20	Insulating Spray done	
#21	Ramping upto maximum High voltage 5000 volts, write the branch current	Branch Current (uA)
#22	Check the wire soldering from drift to readout gnd and from drift to HV shielding gnd	
	Signature 11/07/25	



View Insert Format Sheet Data Tools Window Help

Jul 15 2025 17:16

11

44

Check List of Drift PCB

Logsheet of Drift PCB fabrication			
ST 1-3	Date- 24.04.2024		
Drift P.C.B. Log sheet #			
S. No.		Result Yes/No	
# 1	Physical Inspection --		
	(a) any damagesor	No	
	(b) coating issues	No	
	(c) thread in gas nozzles holes,		
	(d) if fe55 source test window required		
#2	Checked optocupler 72 nos	Yes	
	using special jig	Yes	
	LED glow for all 72 nos	Yes	
#3	Soldered octpcuplers		
#4	solder 470K Resistor 144 p	Yes	
#5	solder 1K Resistor 48P	Yes	
#6	solder 1 megaohms Resistor 2p	Yes	
#7	Check DIP switch 4p, ON-OFF connection	Yes	
#8	solder DIP switch 4p	Yes	
#9	Solder 14pin connector 2 pieces	Yes	
#10	Solder Right angle LV connectot 1p	Yes	
#11	Physical Inspection and connection checking done	Yes	
#12	Cutting gnd plane 2mm outerside in the HV region	No	
#13	Inspect cutting area and pass	Yes	
#14	Whether Drift-board number sticker affixed	Yes	
#15	Whether HV-side &Drift-side ground plane solder	Yes	
#16	How many HV pins soldered	Yes	
#17	Whether pin connectivity tested		
#18	Whether pin vertical alignment checked		
#19	Whether X-Ray window sealed with keeptor		
#20	Insulating spray done		
#21	Ramping upto maximum High voltage 5000 volts, write the branch current	Branch Current (uA)	

Resistance ST 1-3							
Sr. No	Valu (Ω)		Sr. No	Valu (Ω)		Sr. No	Valu (Ω)
1			25			49	
2			26			50	
3			27			51	
4			28			52	
5			29			53	
6			30			54	
7			31			55	
8			32			56	
9			33			57	
10			34			58	
11			35			59	
12			36			60	
13			37			61	
14			38			62	
15			39			63	
16			40			64	
17			41			65	
18			42			66	
19			43			67	
20			44			68	
21			45			69	
22			46			70	
23			47			71	
24			48			72	

Row 4

Module 1 | Module 2 | Module 3 | Module 4 | Module 5 | Module 6 | Module 7 | Module 8 | Module 9 | Module 10 | Module 11

Find All | Search Formatted Display String | Match Case

GEM Foil testing in Clean Room

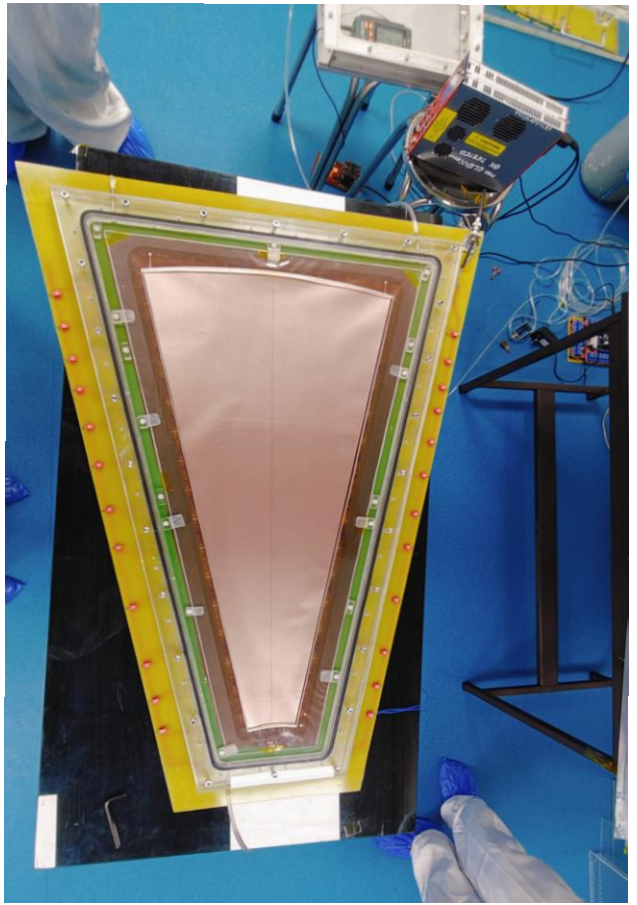
1. Leakage Current of Module 3

	Top	Date-21.03.2025			Middle	Date			Bottom	Date-23.03.202		
Section	Voltage	Leakage Current (nA)		Remarks	Section	Voltage	Leakage Current (nA)	Remarks	Section	Voltage	Leakage Current (nA)	Remarks
1	550/580	0.00		H-49%	1	580			1	550/580	0.00	
2	550/580	0.00		T-17°C	2	580		T-16°C	2	550/580	0.00	T-18°C
3	550/580	0.00			3	580			3	550/580	0.00	
4	550/580	0.00			4	580			4	550/580	0.00	
5	550/580	0.00			5	580			5	550/580	0.00	
6	550/580	0.00			6	580			6	550/580	0.00	
7	550/580	0.00			7	580			7	550/580	0.00	
8	550/580	0.00			8	580			8	550/580	0.00	
9	550/580	0.00			9	580			9	550/580	0.00	
10	550/580	0.00			10	580			10	550/580	0.00	
11	550/580	0.00			11	580			11	550/580	0.00	
12	550/580	0.00			12	580			12	550/580	0.00	
13	550/580	0.00			13	580			13	550/580	0.00	
14	550/580	0.00			14	582			14	550/580	0.00	
15	550/580	0.00			15	580			15	550/580	0.00	
16	550/580	0.00			16	580			16	550/580	0.00	
17	550/580	0.00			17	580			17	550/580	0.00	
18	550/580	0.00			18	580			18	550/580	0.00	
19	550/580	0.00			19	580			19	550/580	0.00	
20	550/580	0.00			20	580			20	550/580	0.00	
21	550/580	0.00			21	580			21	550/580	0.00	
22	550/580	0.00			22	580			22	550/580	0.00	
23	550/580	0.00			23	580			23	550/580	0.00	
24	550/580	0.00			24	580			24	550/580	0.00	

Structure

L	R
1	24
2	23
3	22
4	21
5	20
6	19
7	18
8	17
9	16
10	15
11	14
12	13

Module 1 | Module 2 | Module 3 | Module 4 | Module 5 | Module 6 | Module 7 | Module 8 | Module 9 | Module 10 | Module 11

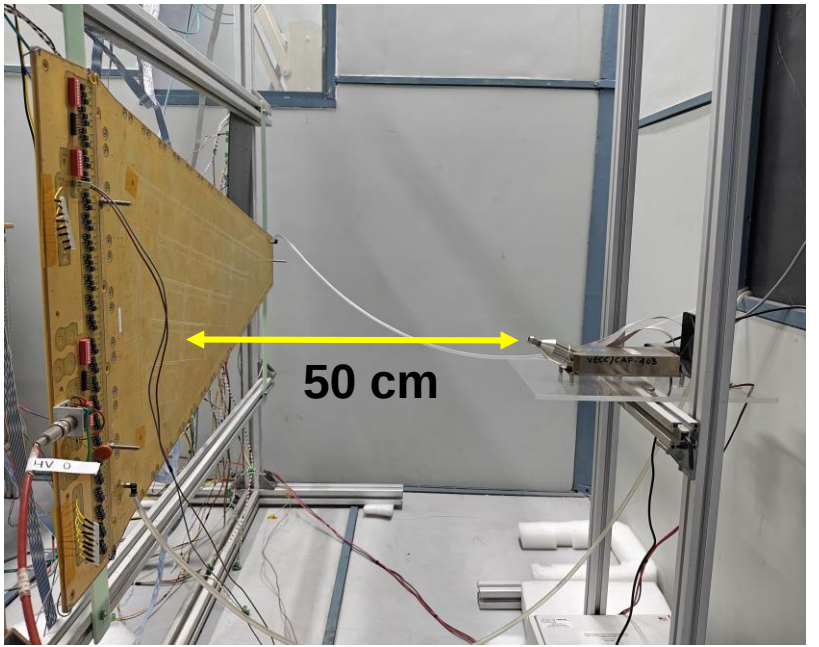


Testing in gas tight chamber

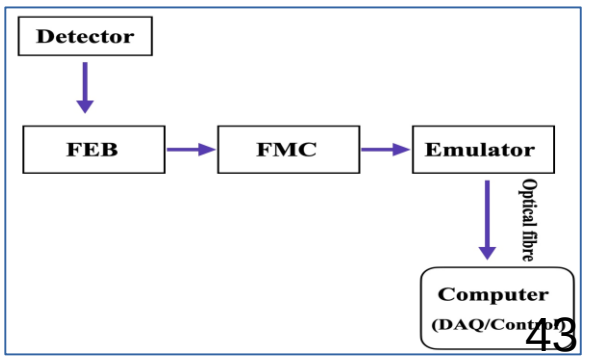
For Module 4, GEM-top was left at 400 V for two hours in gas, due to two leaky Segments and it got cured.

MUCH QA tests with high intensity X-rays at VECC

1. Uniformity tests
2. Stability tests -- High intensity exposure tests
3. Linearity tests



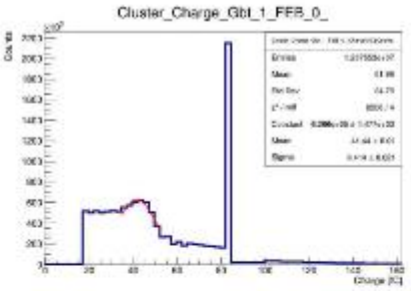
- Uniformity: HV:3700, I:1373.30 μA, Gas: 70/30(Ar/CO)
- X-Ray: 40KV/150μA, Flux: 3.24 * 10^{6} counts/s/mm²
- Z= 50 cm : entire module lies within 120 degrees cone.
- @nominal voltage of operation ≥ 4000 V, the signal falls in saturation region (≥ 31 ADC),
- –> So we chose 3700 V for gain uniformity study.

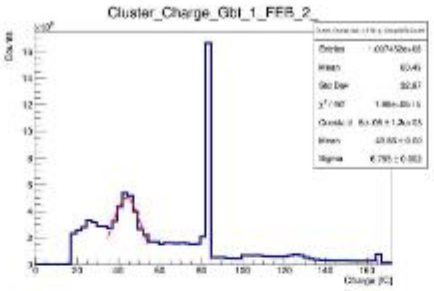


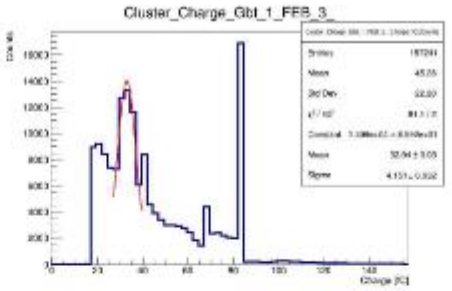
GERI-EMULATOR based DAQ

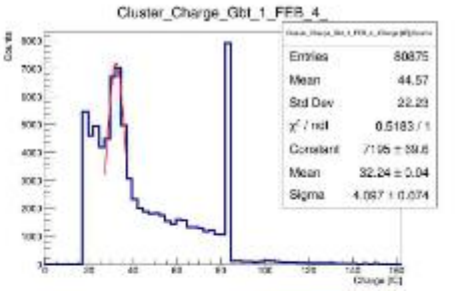
(Rajeshranjan Ratha, et. Al, VECC)

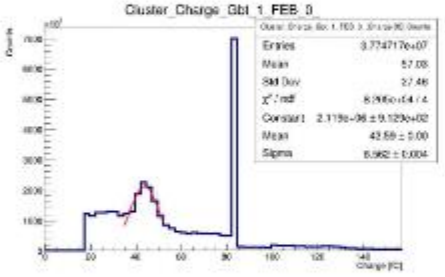
Cluster Peak

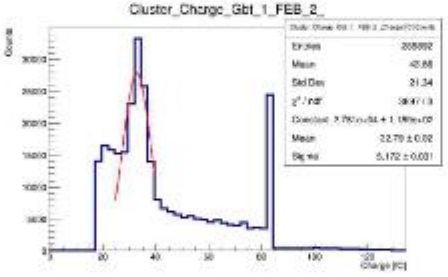


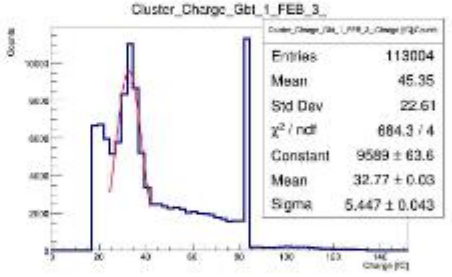


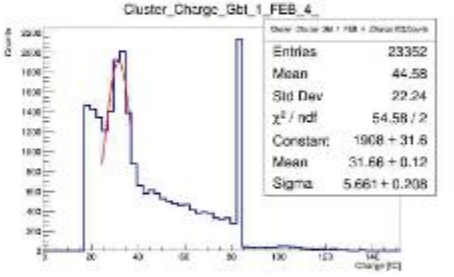


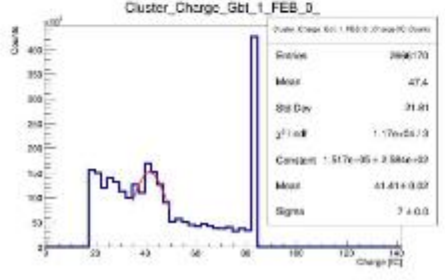


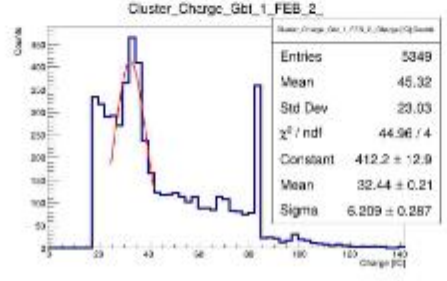


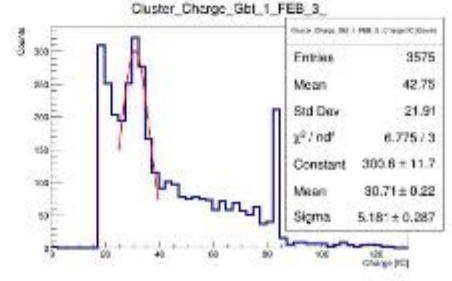


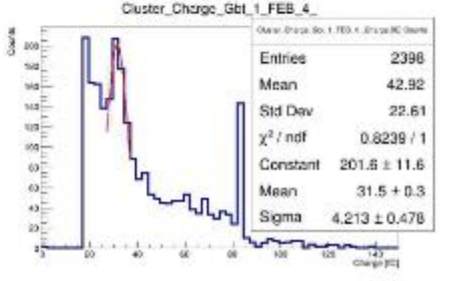






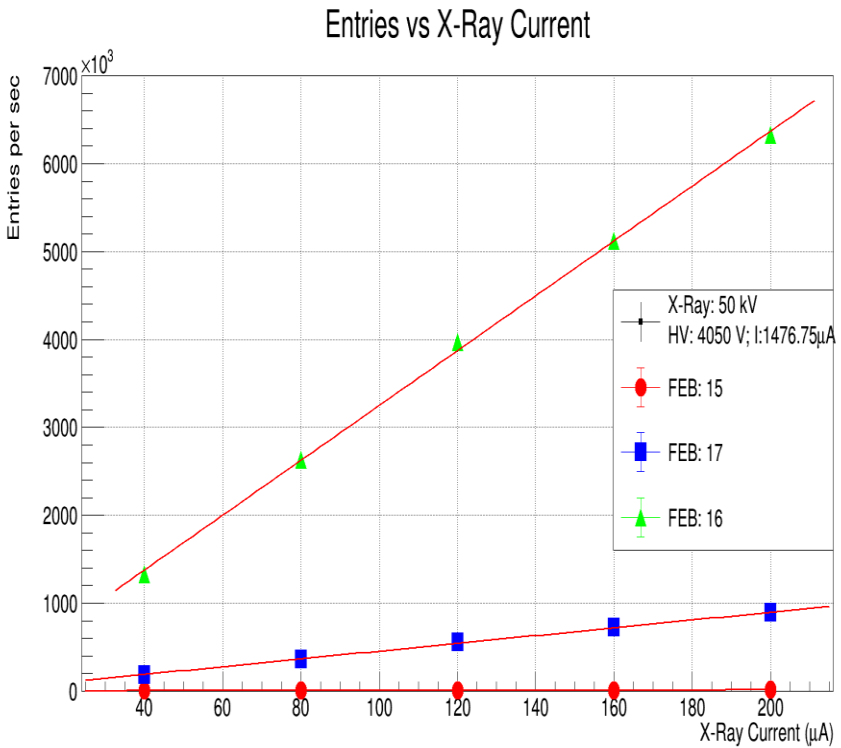


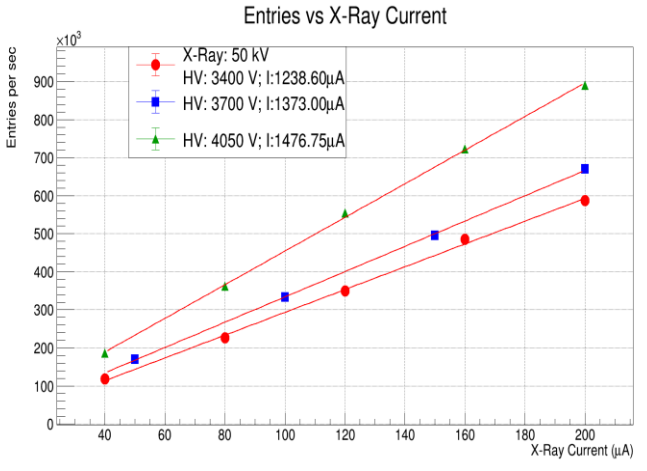


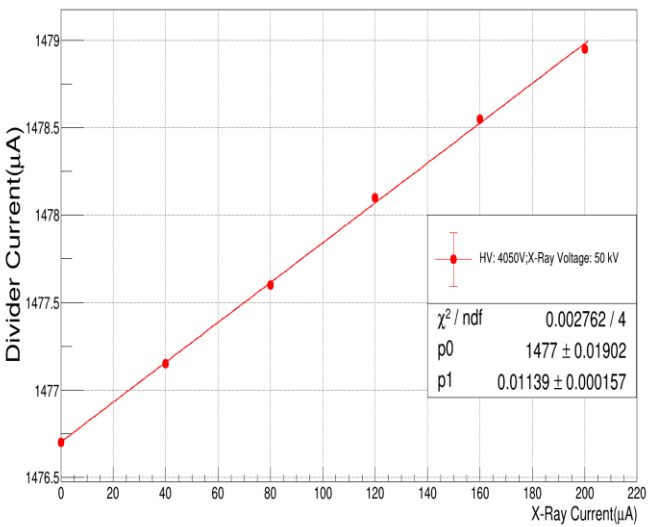


High Intensity Scan – Linearity Check

- HV: 4050 V
- I: 1476.70 µA (this is the nominal range)
- Gas: 70/30(Ar/CO)
- Z= 50 cm



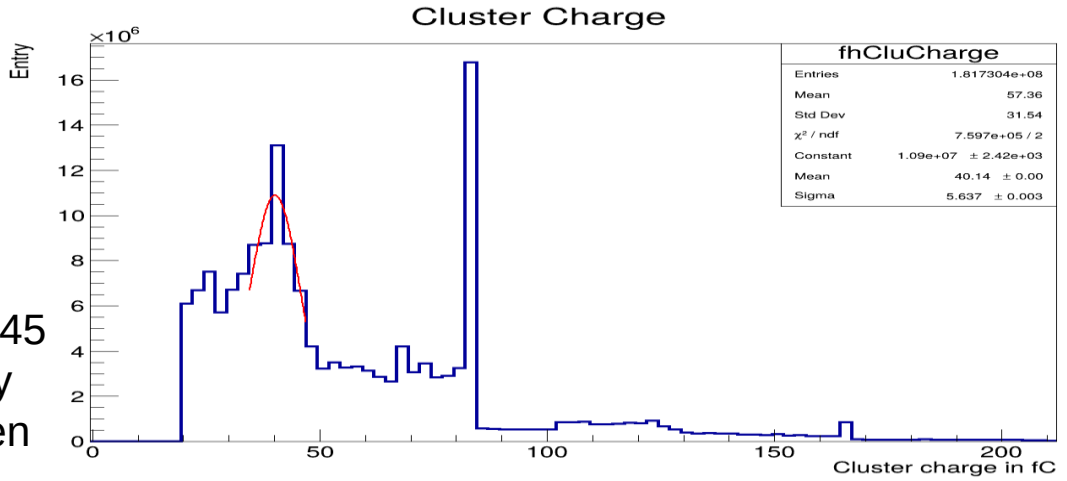


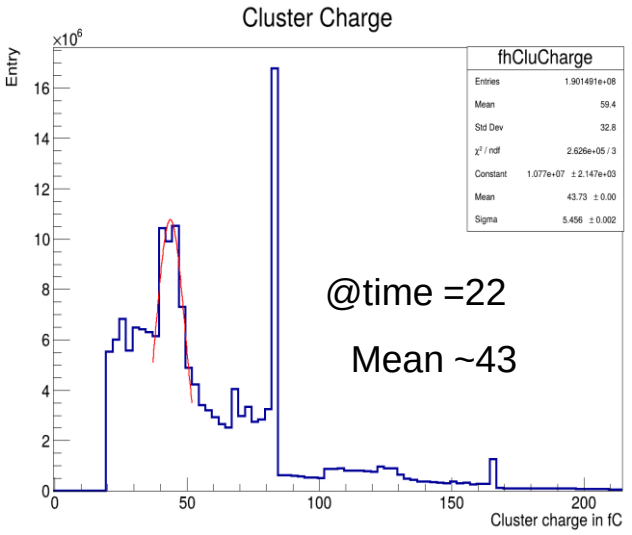


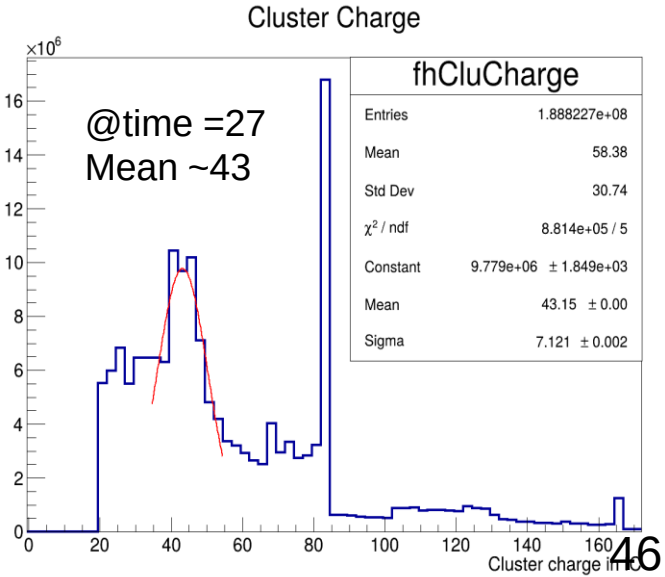
Stability test: Exposing X-Ray at high intensity for long time

- Gas: 70/30(Ar/CO), **Z= 30 cm,**
- X-Ray: 50kV/200 µA
- **HV= 3700 V, I = 1349.55 µA**
-
- Module irradiated at intensity @4200V ; I=1531.45 µA (with X-ray ON, it was ~6 uA more than X-ray OFF condition, equivalent to current change seen at GIF++).
-
- Then lowered the voltage
- to 3700 V for gain
- measurements.
-
- Gains remained unchanged
- within uncertainty
- of 1 bin(2.5 fC)

@time=0, HV=3700 V







Summary

- mCBM 2025 : Successfully tested Station-1 and Station-2 Final GEM modules with high intensity beams. Detectors stable all throughout. No offset-jump noticed in the high intensity data. HV trip observed at very high voltage.
  mMuCH modules acquired data upto 600 MB/s. nDigis/spill vs. spill-intensity looks linear.
  Divider currents for GEM2 at the highest intensity and nominal voltage : increasdy by 10 uA
  Further analysis on L1 tracking is ongoing.
- High intensity X-ray tests at VECC – First uniformity plots obtained, further tuning ongoing
  GERI+Emulator based DAQ used.
- Production Status : 2 complete modules assembled and are under tests. 20 Drift + 20 Readout boards ready
  some delay caused due to missing components. Our target to finish 60 modules by the end of next year.

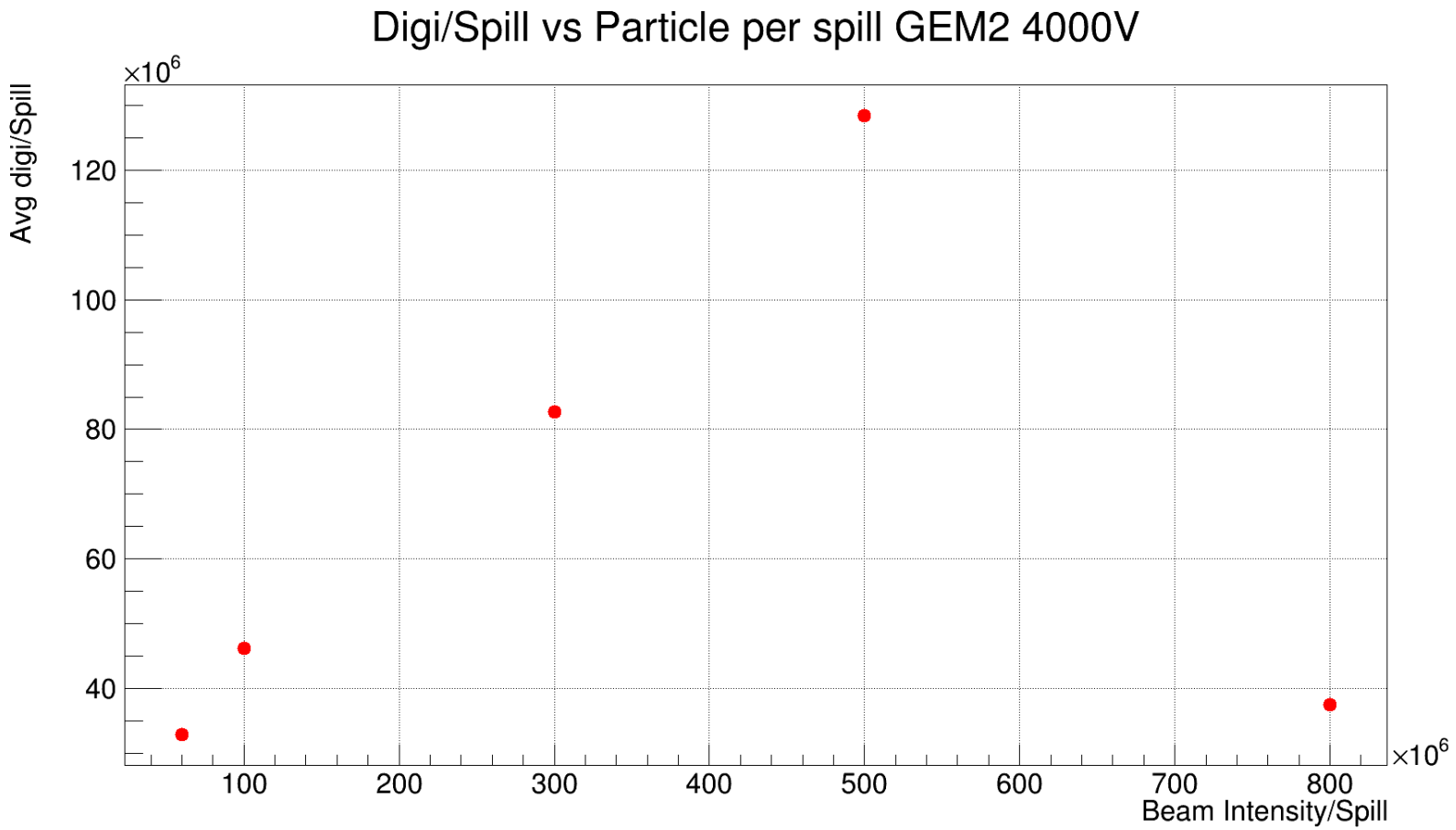
- Next steps : Finalizing QA tests procedure for GEM station-1 modules, PRR completion.
  Testing of full detector with 18 FEE boards with multiple emulator boards.
  Testing with actual HVDB interface for the first time, Implementing the FPGA based control on Optocoupers on the HV side. Also testing with the latest LVDB board.
  Ordering/Indenting : set of moulded Al-plates, MuCh FEB PCBs, Gas sensors, GEM foils, etc.

  Station-2 : First indigenous fabrication of station-2 modules – PO released. Foils ordered from CERN
  Start evaluating HV PS option : R1470ETD – 8channels per module, 8 kV/3 mA (9W), 19”

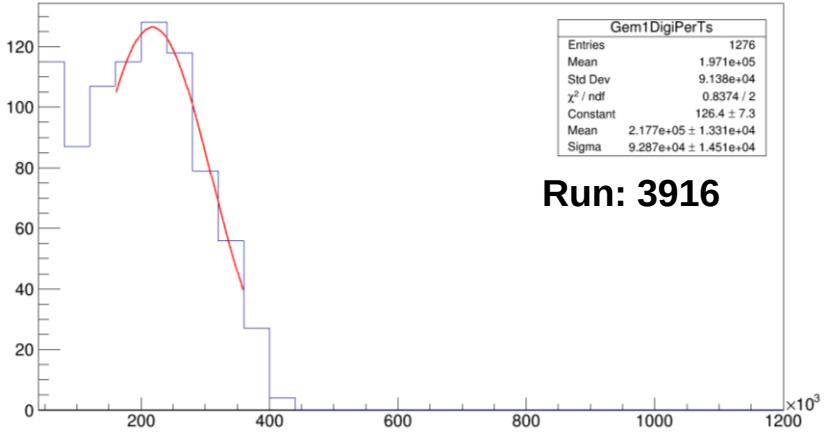
- **Open issues**
  → MuCh Mechanics -- related to movement and support structures, patch panel
  → Absorber fabrication, MuCh Gas system, Cooling for MuCh stations
  → Availability of CBM funds locally – critical for ordering of 2nd station foils from CERN.

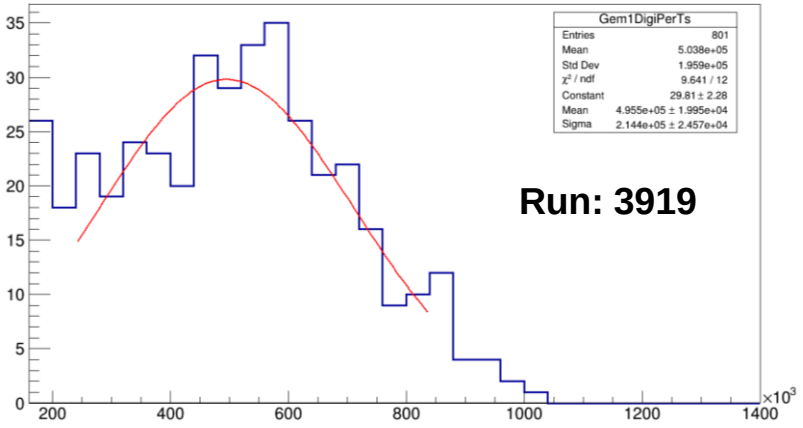
Backups

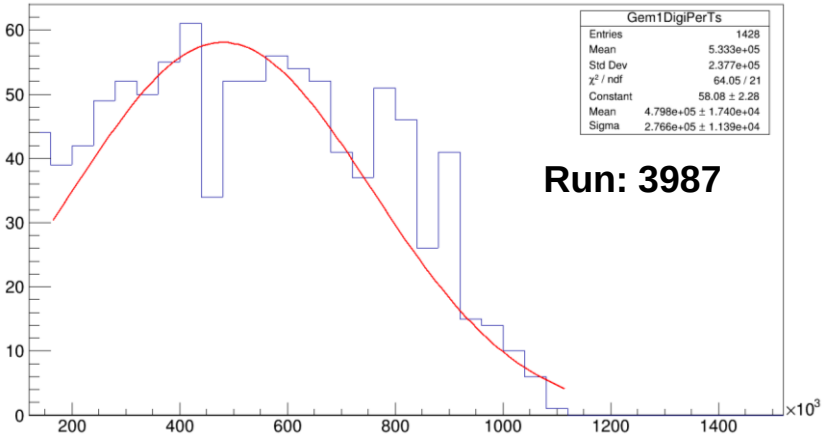
As the beam intensity is defined as No. of particles per Spill, So we tried to plotted average no. of digis per spill for GEM2 w.r.t no. of beam particles per spill.

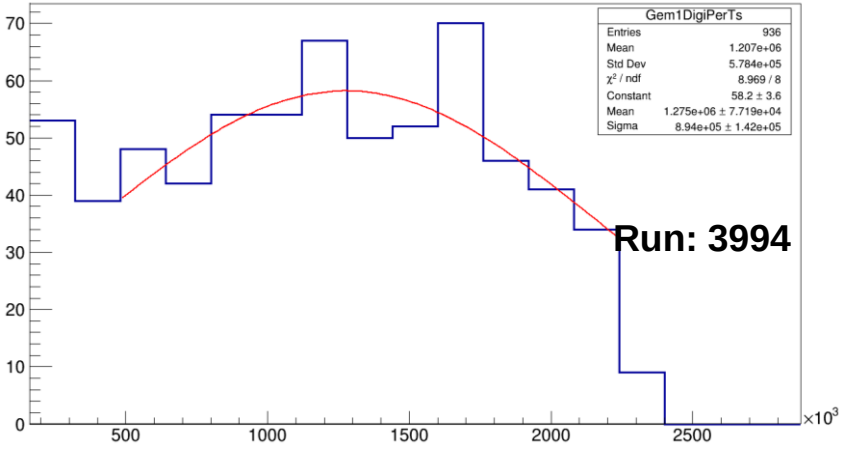


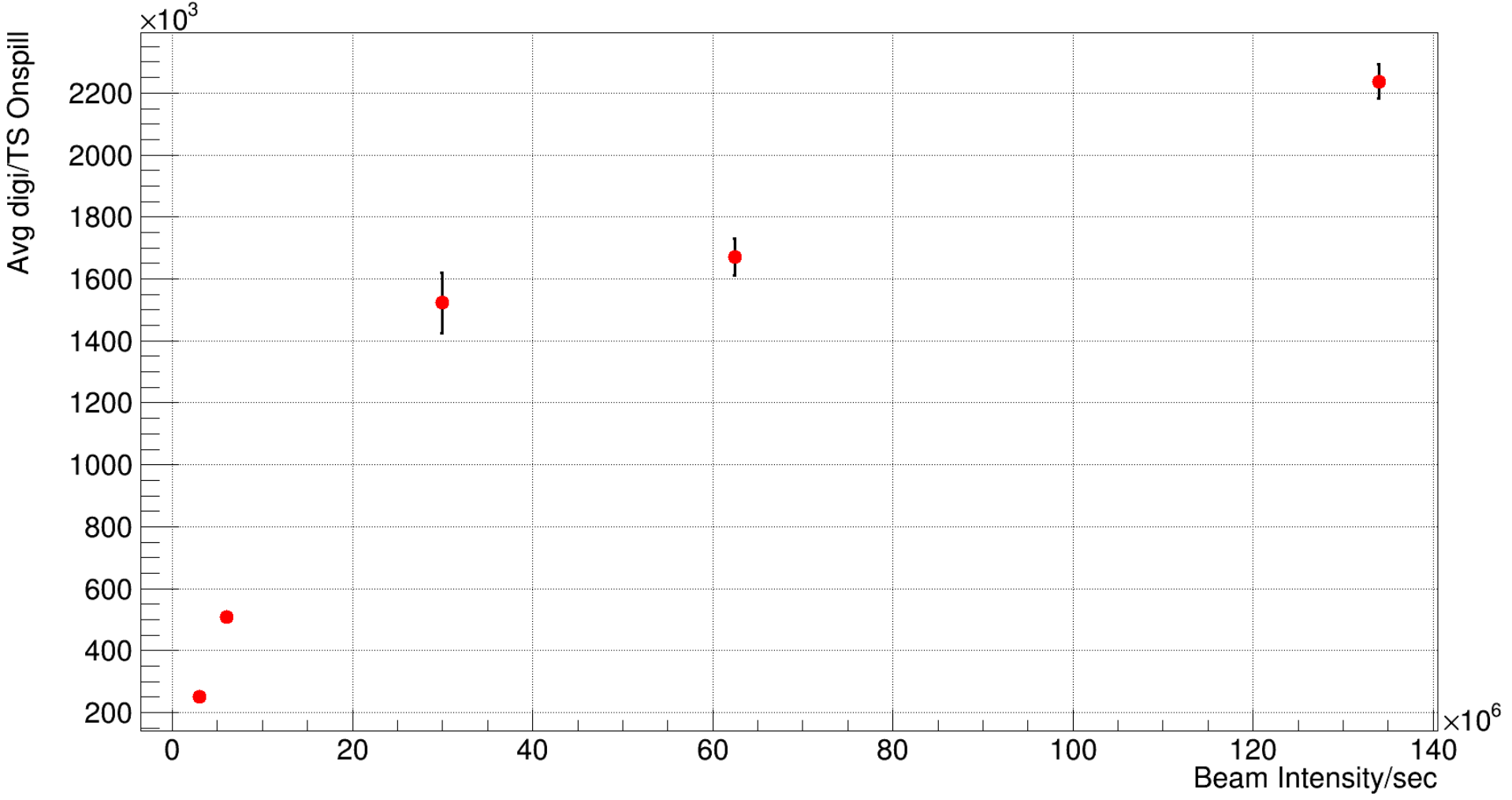
GEM1 Digi/TS: (Root file: DigiPerTS_040925_*.root)



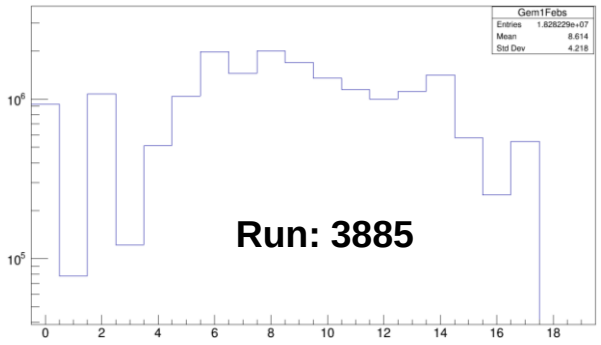


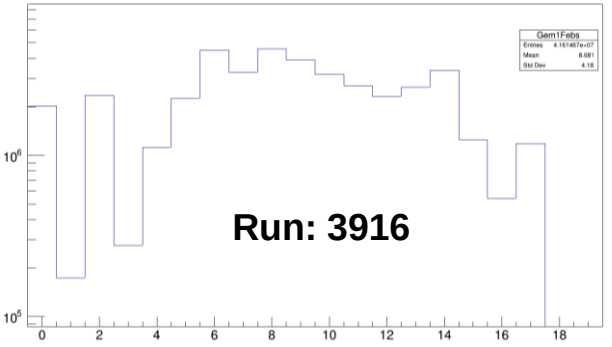


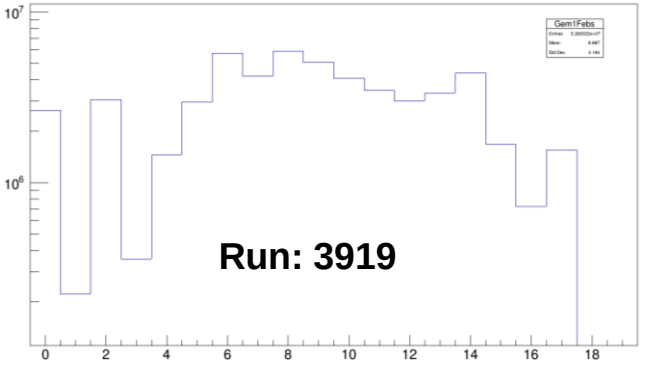


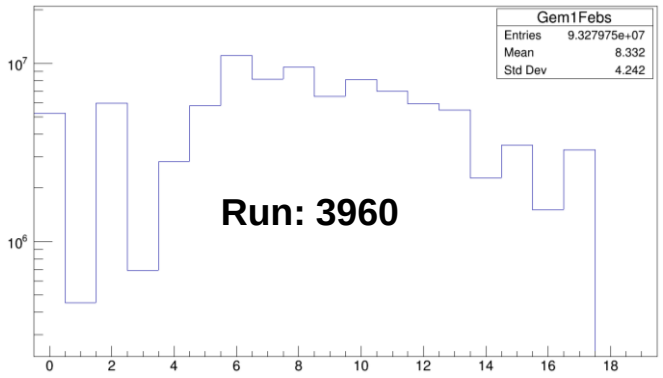

Digi/TS vs Intensity GEM1 4000V
×10^3
Avg digi/TS Onspill
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
20
40
60
80
100
120
140
×10^6
Beam Intensity/sec

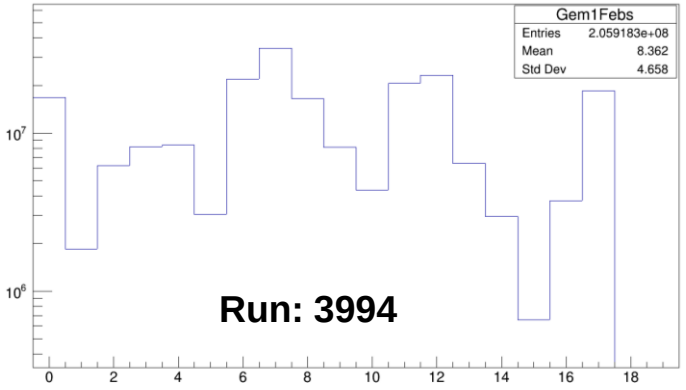
GEM1 FEBs used for the Digi/TS vs Intensity plot runwise

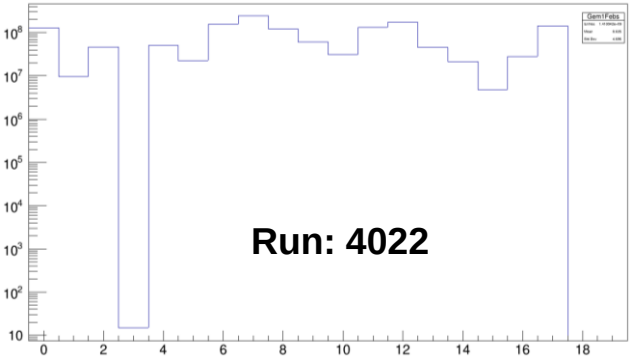










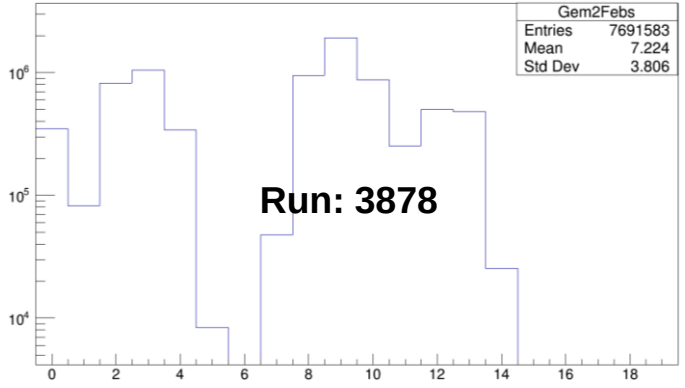


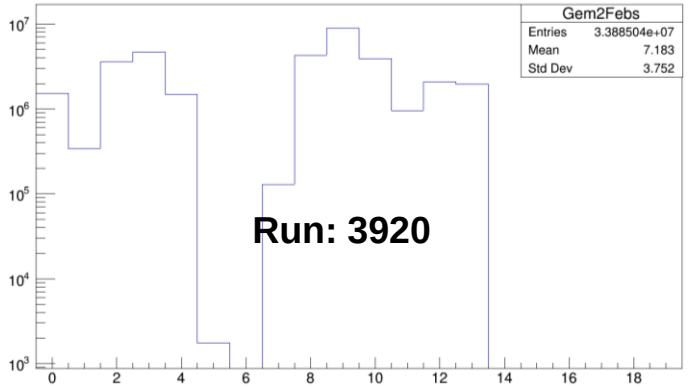
All these plots are generated after noise substraction: NoisyChList_3888_280725_50Hz.txt

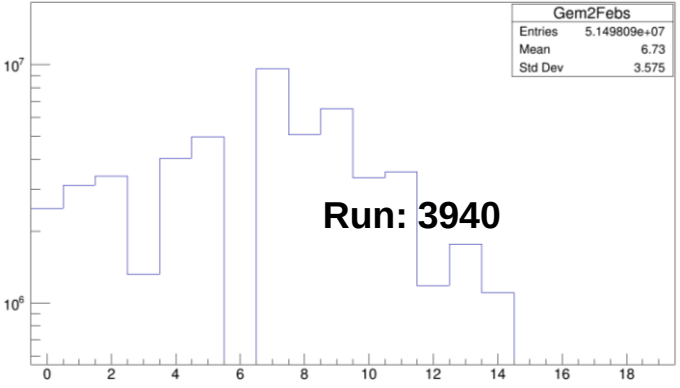
Root file: DigiPerTS_040925_*.root

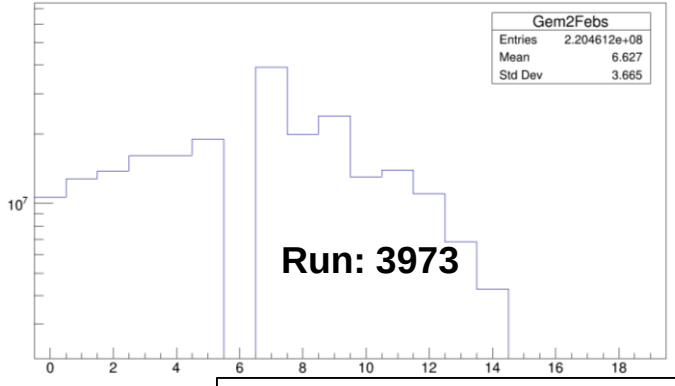
GEM2 FEBs used for the Digi/TS vs Intensity plot runwise

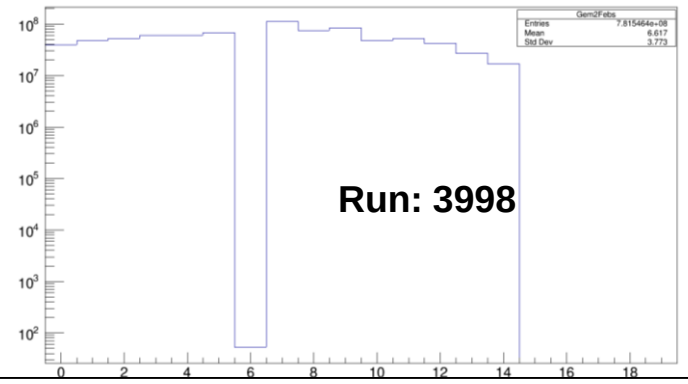
Root file: DigiPerTS_040925_*.root

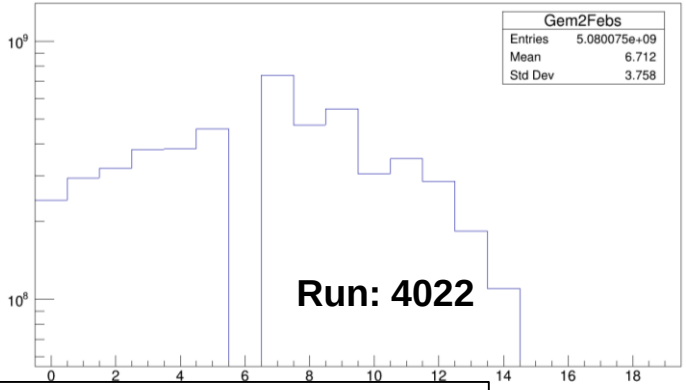












All these plots are generated after noise substraction: NoisyChList_3888_280725_50Hz.txt

Summary on Production readiness :

1. Fabrication Protocols finalized

2. X-ray based QA tests :
   Gain unifortmity demonstrated with one detector module

3. The component shortage still exists, once they arrive, we
   Would straightway go ahead with production.

Expected engagement time for the following activites :

1. Foil inspection and leakage test measurement
   – 60 min to couple of hours per foil

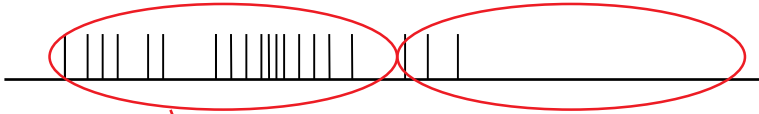
2. dimension check :
--> inner frames + edge frames : 1 day by two persons.
--> brass studs 50 pieces – this can be done much in advance.

3. Spring contacts soldering, 76 points : 2 day per module

4. gas tightness check – 1 day dedicated

5. Preparing Ready Readout PCB – 7 days

XX and YY Correlation of GEM1 and GEM2



50 digis from GEM1 and GEM2

Run: **3887**