A Brief Summary of the BNL Test

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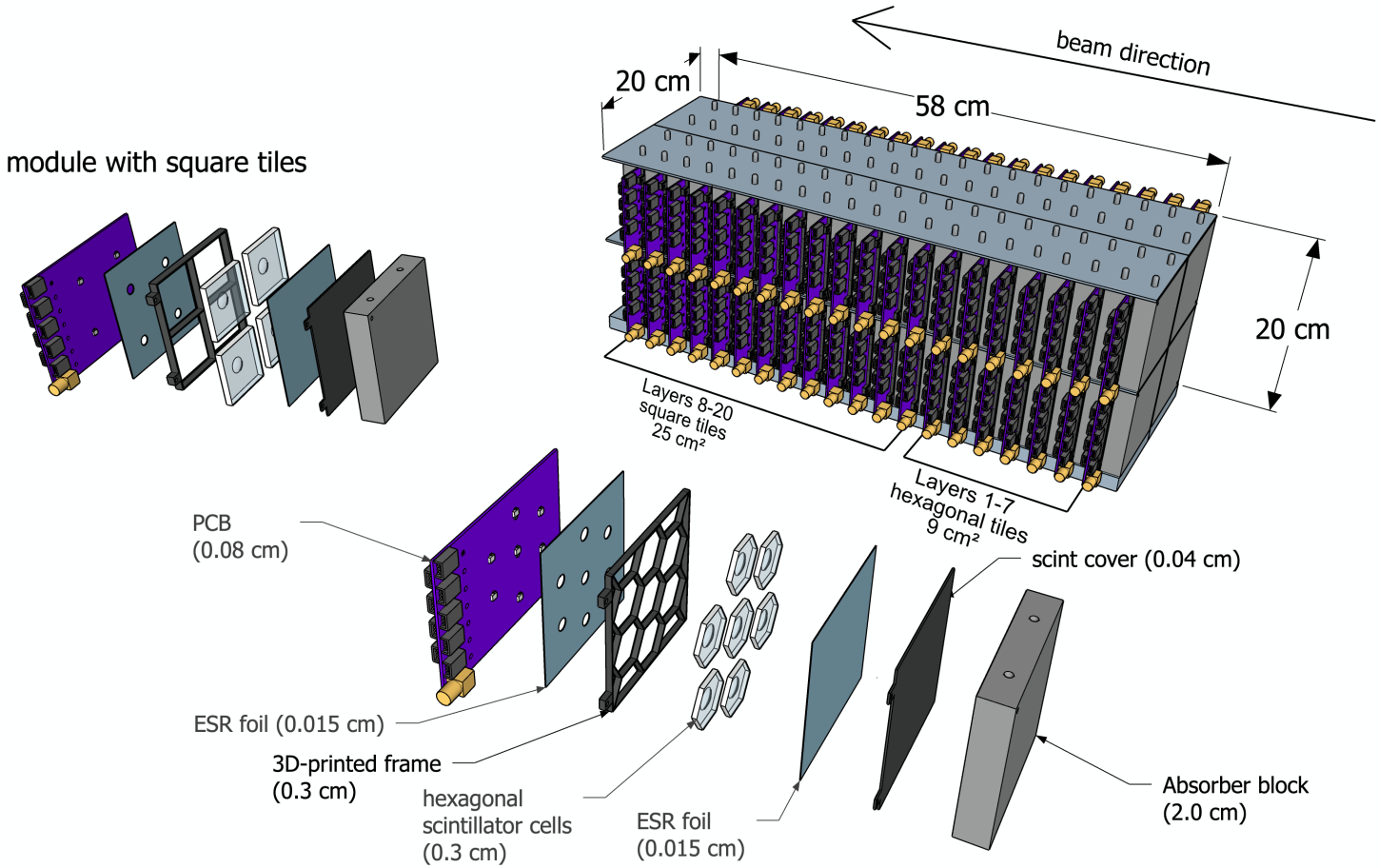
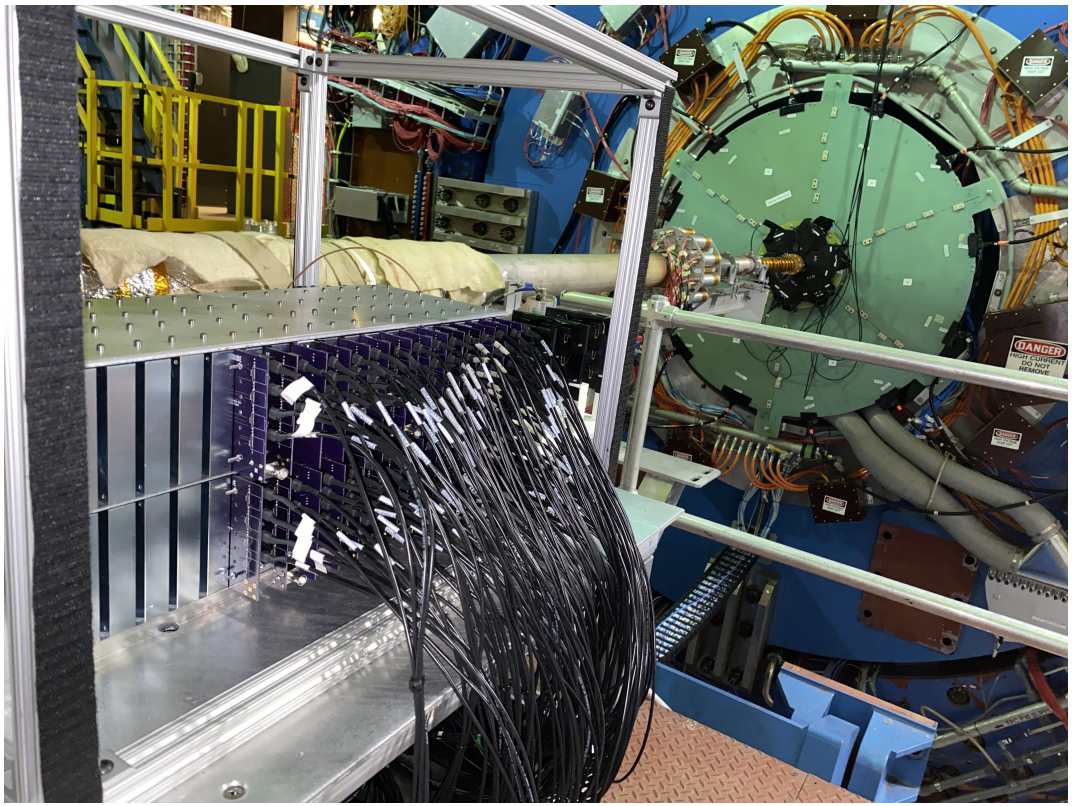
2024-11-06

CALI: Gen-II



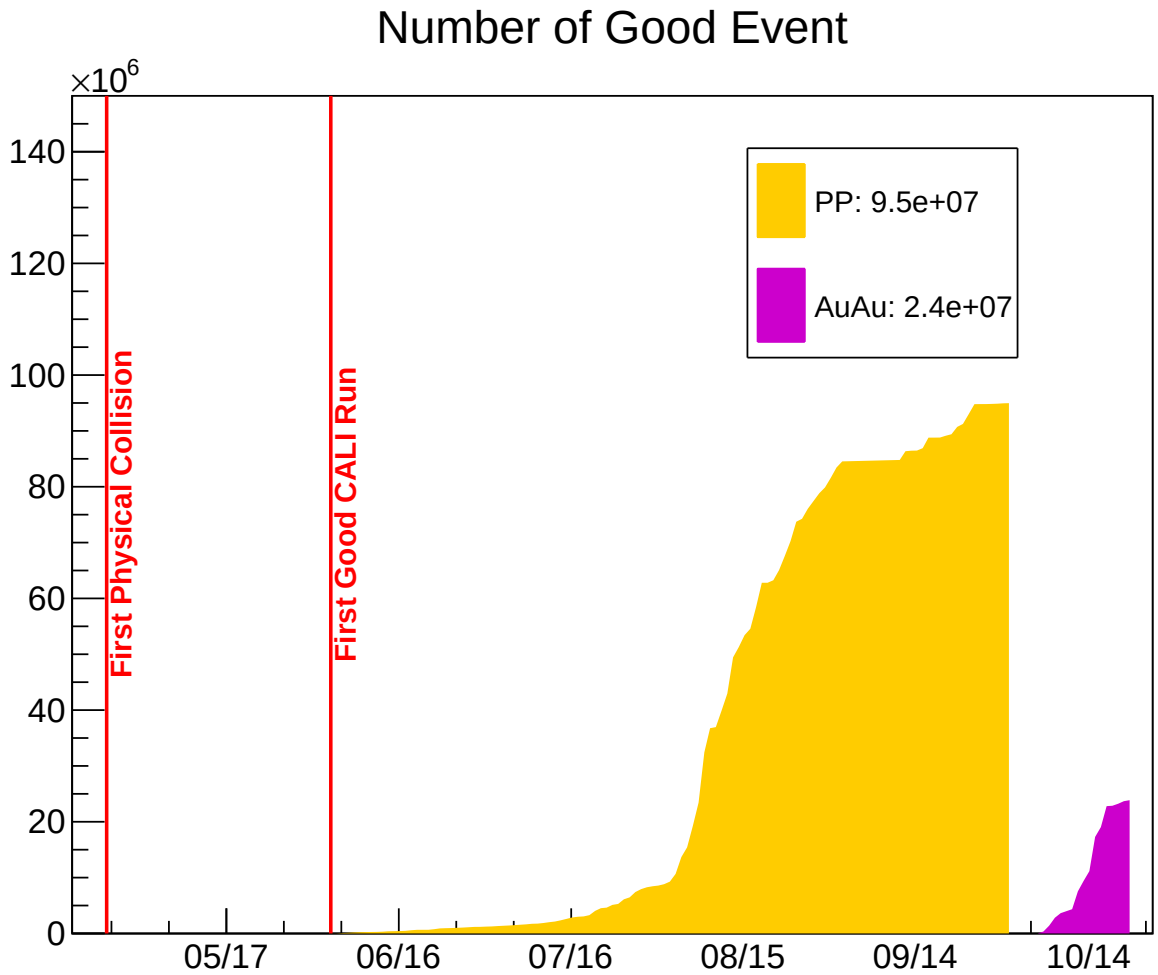
- 20 sampling layers: 4 hexagonal layers + 16 square layers. Half of them activated
- Iron absorber + scintillator tile + SiPM (on tile) + CAEN unit
- 20 cm $\times$ 20 cm transverse active area

CALI Installation



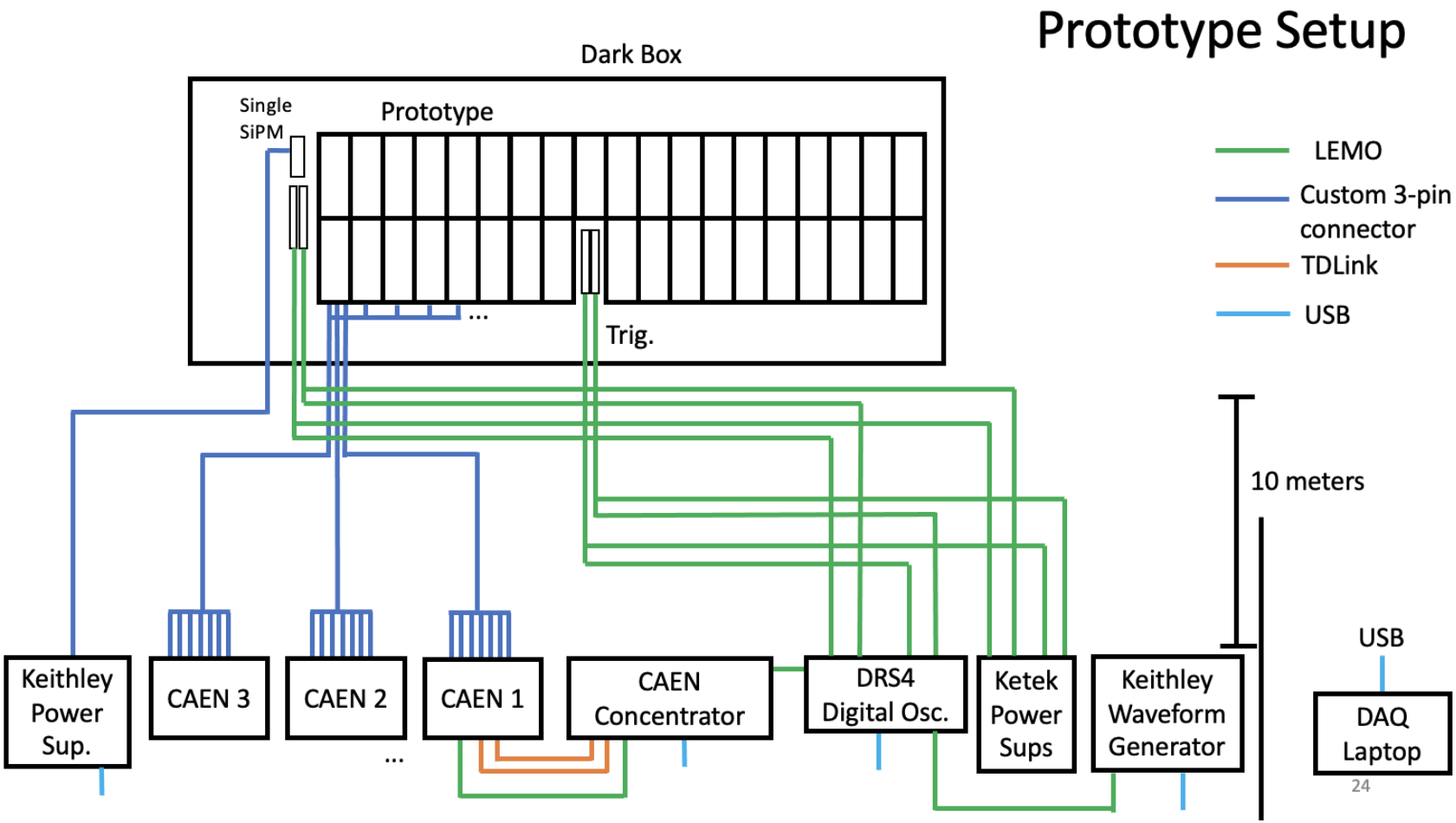
- 192 channels (ch 5, 27, 32, 50, 128-135 were dead)
- 3 CAEN A5202 units + 1 CAEN concentrator

RHIC Run25



- PP collision at 100 GeV/proton: April - September
- AuAu collision at 100 GeV/nucleon: three weeks in October
- Collection more than 100 M good CALI events

Trigger Setup



Trigger Configurations

PP

T1	0.001	1	| T2	0.001	1	| T3	0.001	5
T1	0.002	1	| T2	0.002	1	| T3	0.002	1
T1	0.005	1	| T2	0.005	1	| T3	0.005	12
T1	0.01	1	| T2	0.01	2	| T3	0.01	3
T1	0.02	2	| T2	0.02	27	| T3	0.015	1
T1	0.03	1	| T2	0.03	1	| T3	0.02	69
T1	0.04	1	| T2	0.05	2	| T3	0.03	1
T1	0.05	2	| T2	0.08	1	| T3	0.05	2
T1	0.08	11	| T2	0.1	2	| T3	0.06	1
T1	0.1	17	| T2	0.015	1	| T3	0.07	1
T1	0.2	19	| T2	0.2	1	| T3	0.08	2
T1	0.3	1	| T2	0.5	1	| T3	0.09	1
T1	0.5	1	|			| T3	0.1	22
			|			| T3	0.15	1
			|			| T3	0.2	41
			|			| T3	0.3	32
			|			| T3	0.4	1

T1&&T2	0.001	0.001	13	| T1&&T3	0.02	0.02	7
T1&&T2	0.01	0.01	19	| T1&&T3	0.02	0.03	17
T1&&T2	0.04	0.04	52	| T1&&T3	0.03	0.03	17
T1&&T2	0.05	0.05	63	| T1&&T3	0.03	0.04	16
				| T1&&T3	0.03	0.05	16
				| T2&&T3	0.005	0.005	6
T1||T2	0.03	0.03	1	| T2&&T3	0.01	0.01	1
				| T2&&T3	0.015	0.015	1
				| T2&&T3	0.02	0.02	1
				| T2&&T3	0.1	0.05	2

T1&&T2&&T3	0.0005	0.0005	0.0005	22
T1&&T2&&T3	0.0006	0.0006	0.0006	13
T1&&T2&&T3	0.0008	0.0008	0.0008	106
T1&&T2&&T3	0.001	0.001	0.02	23
T1&&T2&&T3	0.008	0.008	0.008	44
T1&&T2&&T3	0.01	0.01	0.01	80
T1&&T2&&T3	0.015	0.015	0.015	15
T1&&T2&&T3	0.02	0.02	0.01	68
T1&&T2&&T3	0.02	0.02	0.02	319
T1&&T2&&T3	0.03	0.03	0.01	4
T1&&T2&&T3	0.03	0.03	0.02	24
T1&&T2&&T3	0.03	0.03	0.03	30
T1&&T2&&T3	0.1	0.1	0.1	14

T1||T2||(T3&&T4)	0.005	0.005	0.005	9

~

AuAu

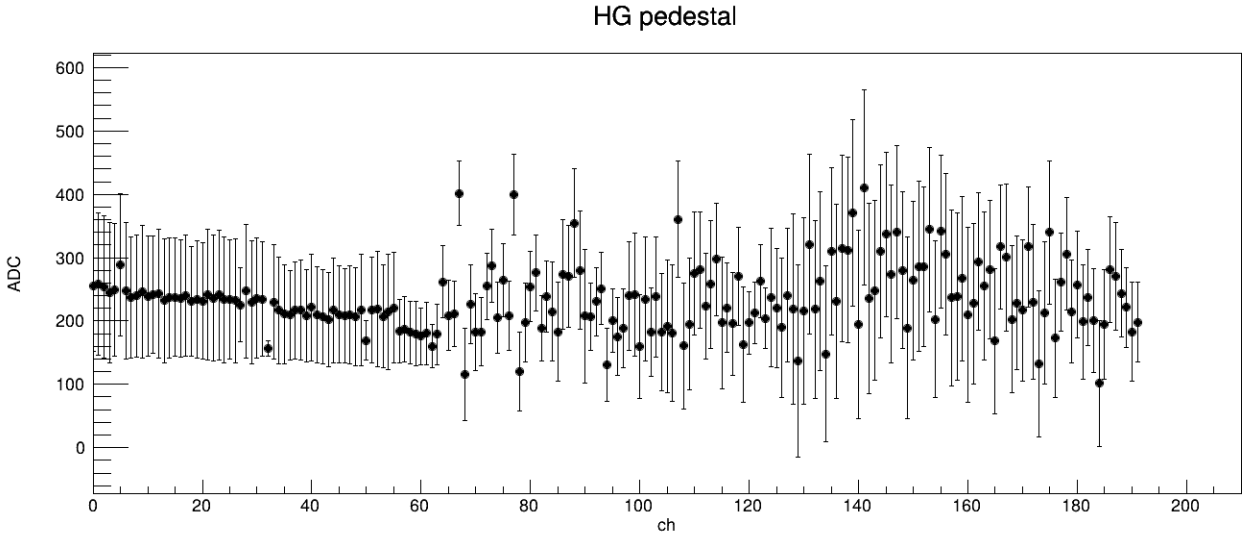
T1	0.002	1	| T3	0.02	12
T1	0.005	1	| T3	0.03	10
T1	0.006	1	| T3	0.1	1
T1	0.007	1	| T3	0.15	1
T1	0.01	1	| T3	0.2	22
T1	0.07	1	| T3	0.3	6
T1	0.1	7	| T3	0.4	7
T1	0.15	7	| T3	0.15	1
T1	0.2	7	|		

T1&&T3	0.01	0.01	77
T1&&T3	0.01	0.02	17
T1&&T3	0.01	0.03	16
T1&&T3	0.02	0.02	15

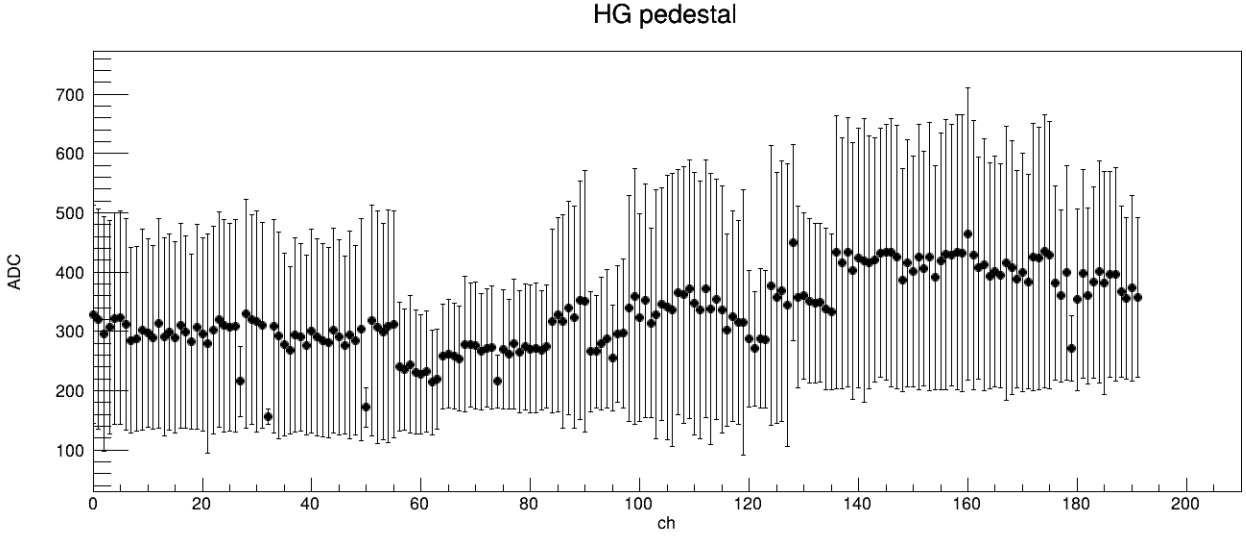
T1||T2||T3	0.008	0.008	0.008	3

Pedestal

Run 572 (2024-06-05)



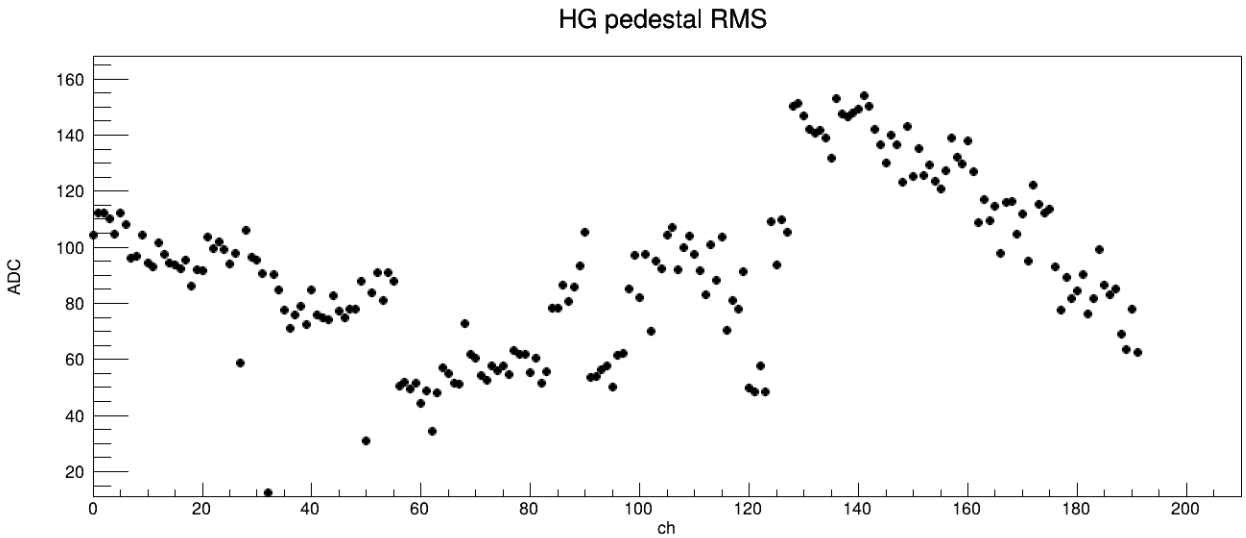
Run 2578 (2024-10-20)



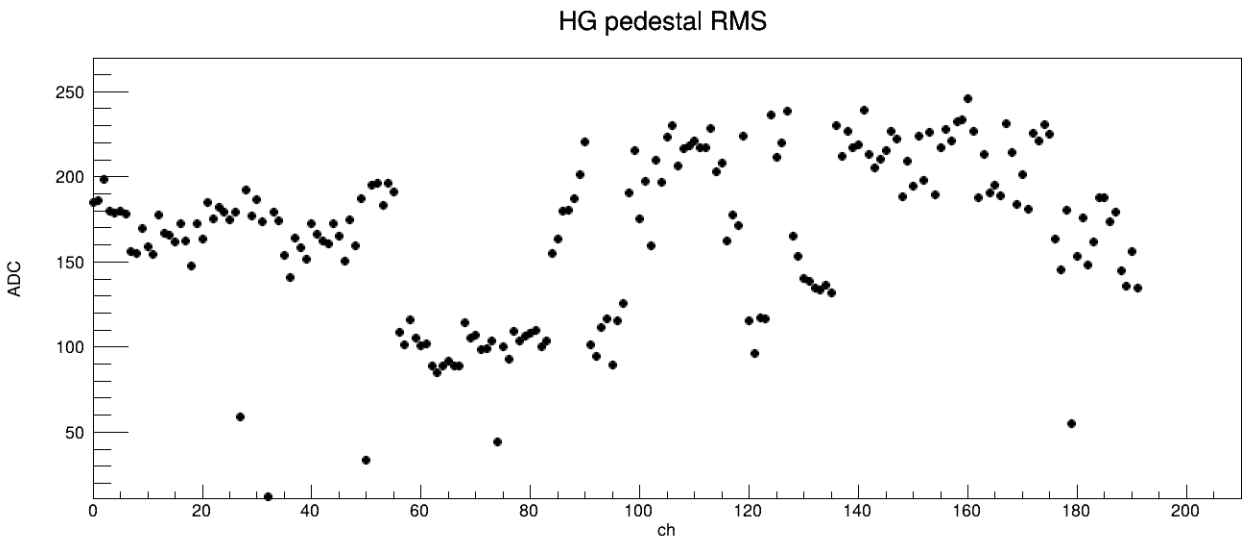
- Stable pedestal along time

Pedestal Width

Run 572 (2024-06-05)

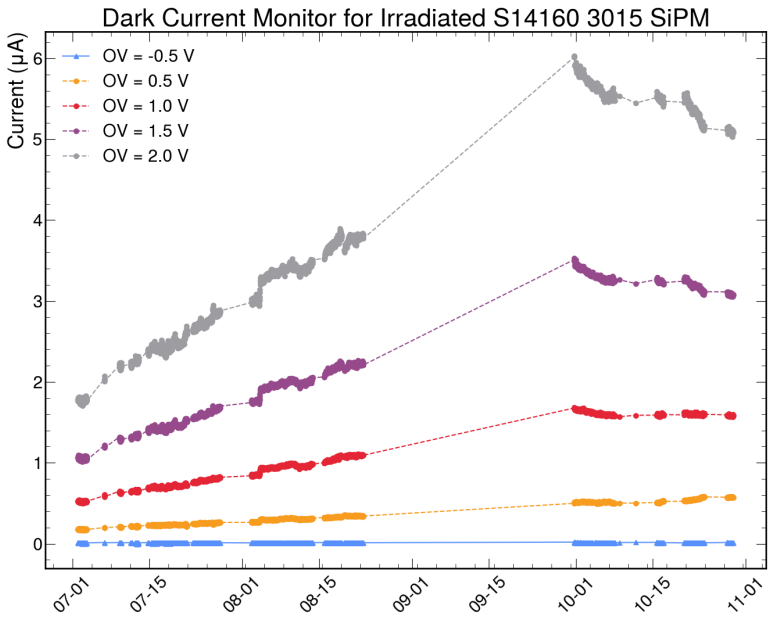


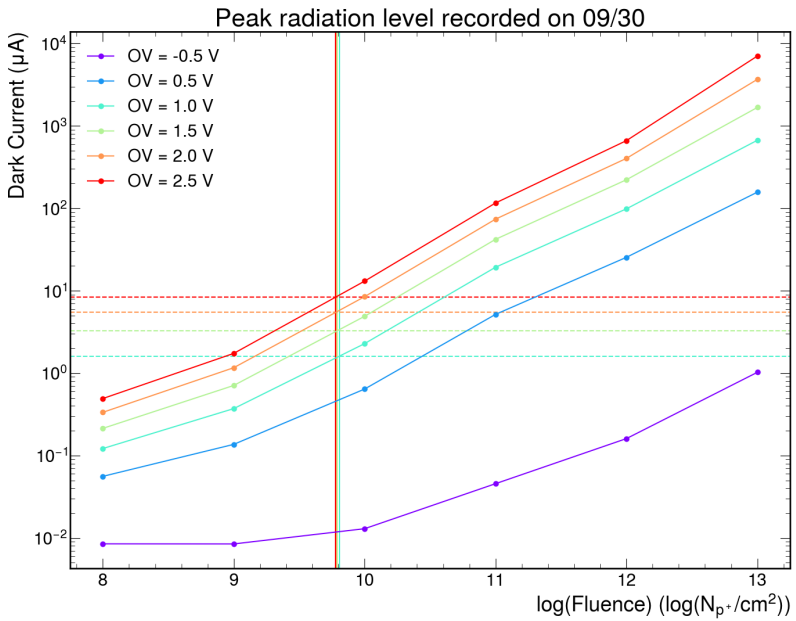
Run 2578 (2024-10-20)



- Increasing pedestal width along time

Radiation Level



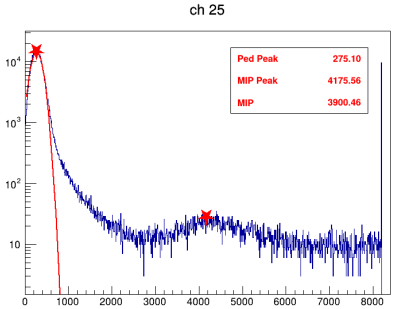


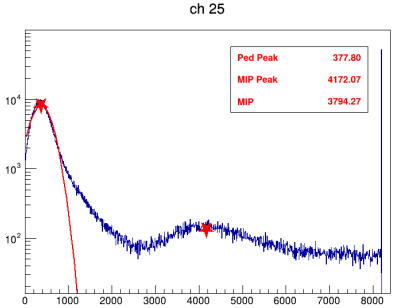
- Highest radiation level at about $10^{9.8}$ p^+/cm on Sep 30th
- Room temearature annealing effect observed

MIP Calibration

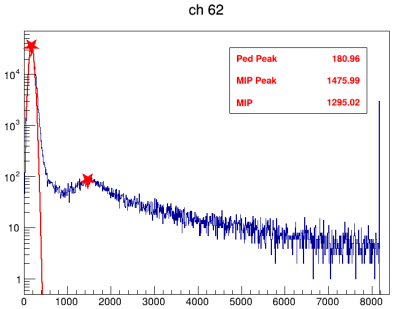
Run 1032 (2024-07-02, top) vs Run 2580 (2024-10-20, bottom)

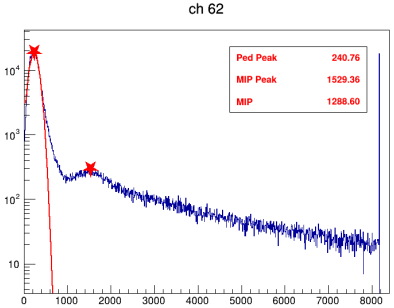
Hex tile + 3 mm SiPM



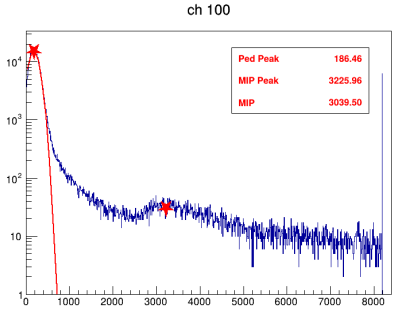


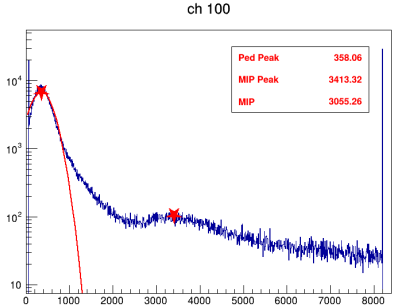
Hex tile + 1.3 mm SiPM



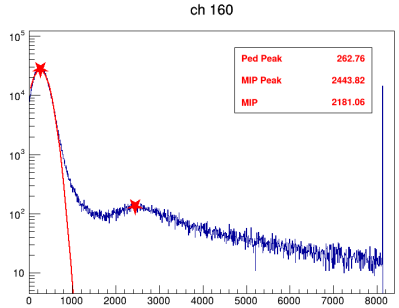


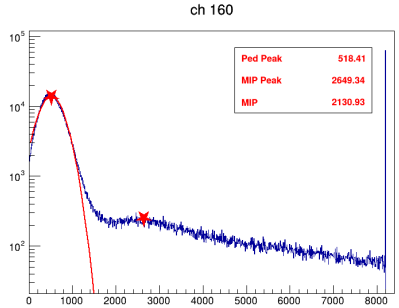
Square tile + 3 mm SiPM





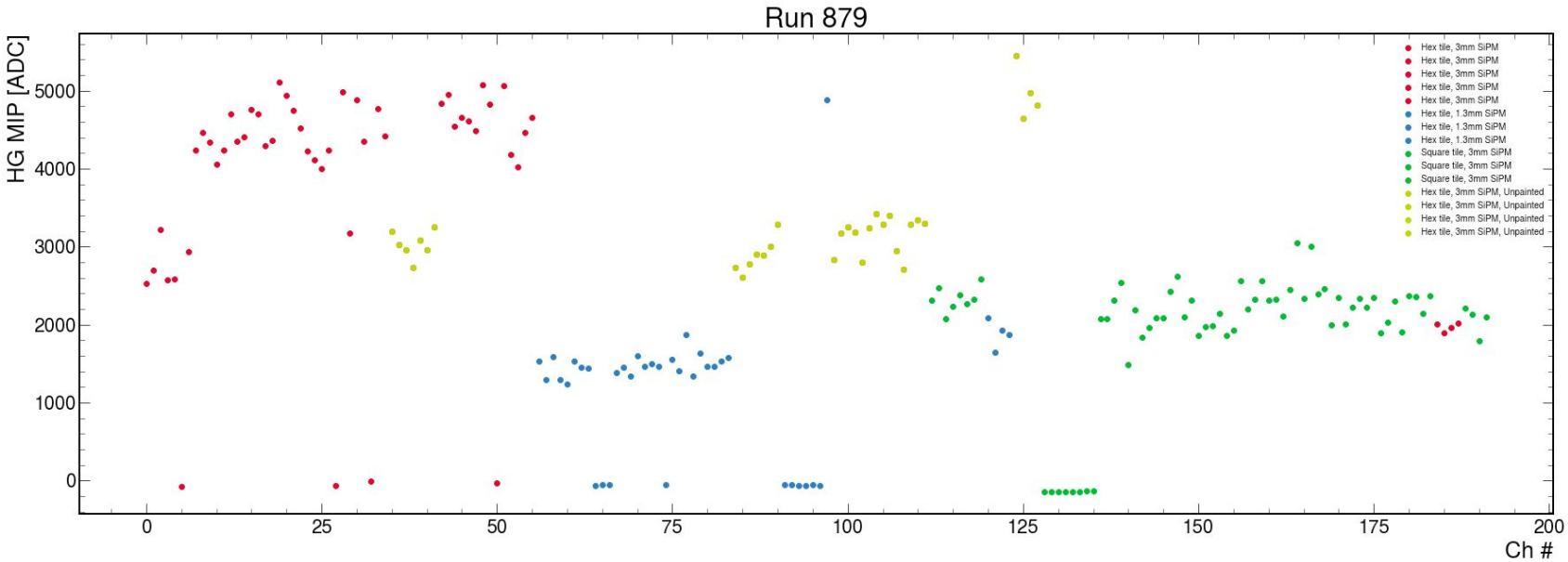
Hex tile + 3 mm SiPM (unpainted)





- Stable MIP calibration

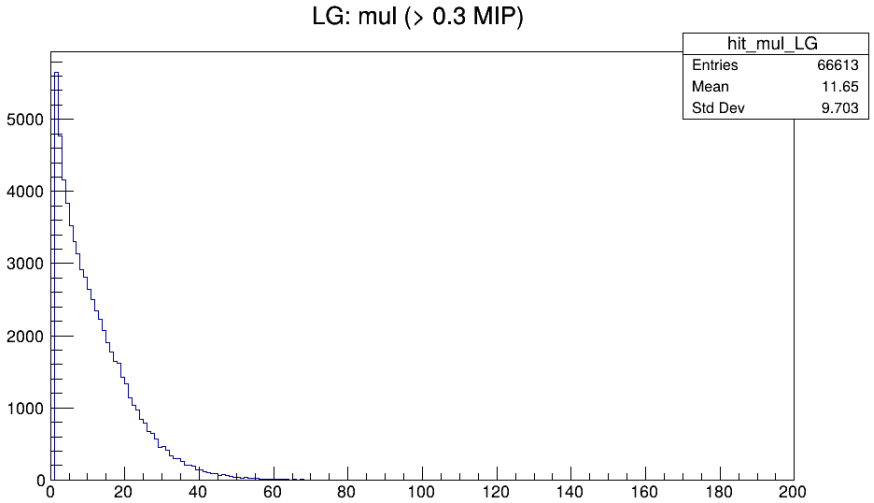
MIP Calibration

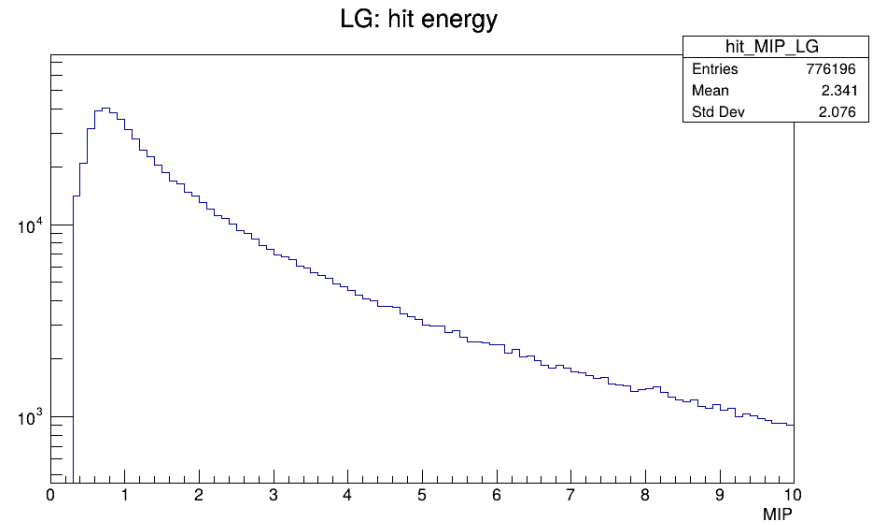


- Clear 4 sets of MIPs values

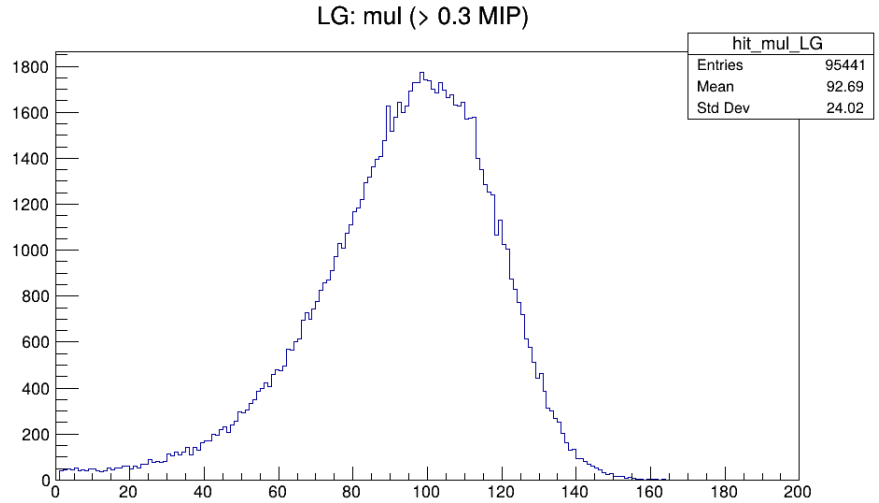
PP vs AuAu: Hit Multiplicity and Energy

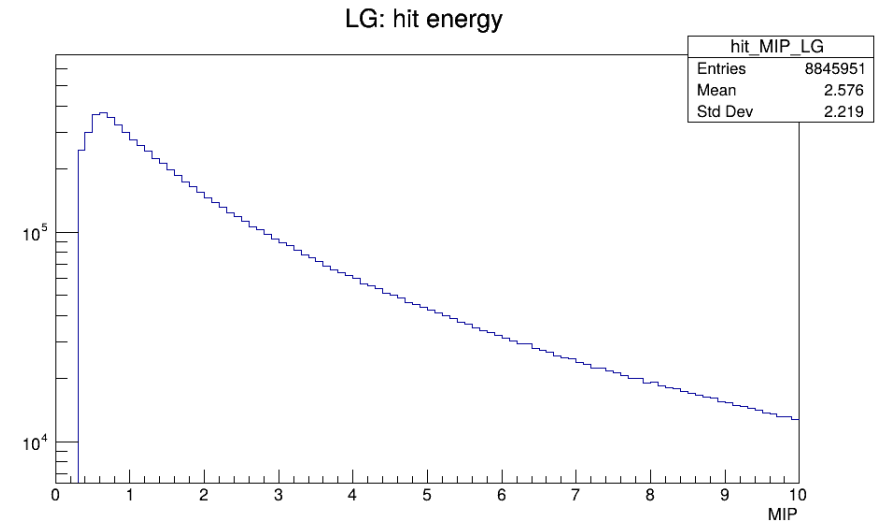
PP (Run 1390)





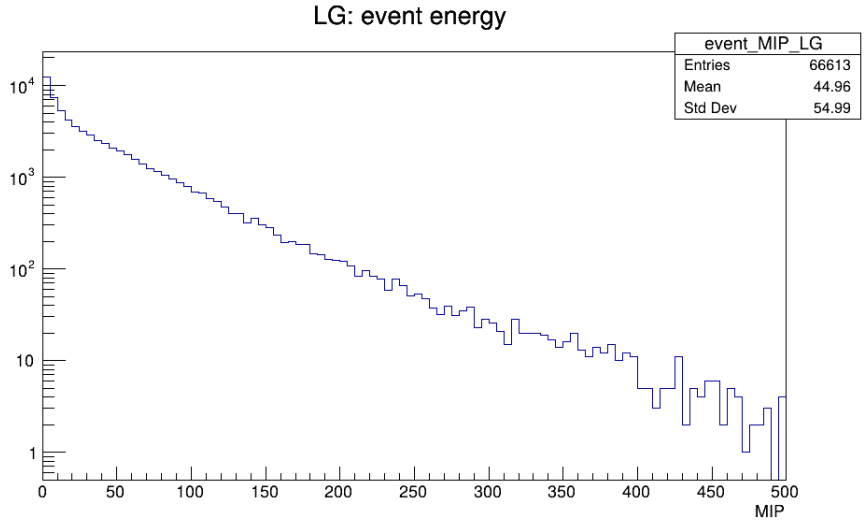
AuAu (Run 2371)

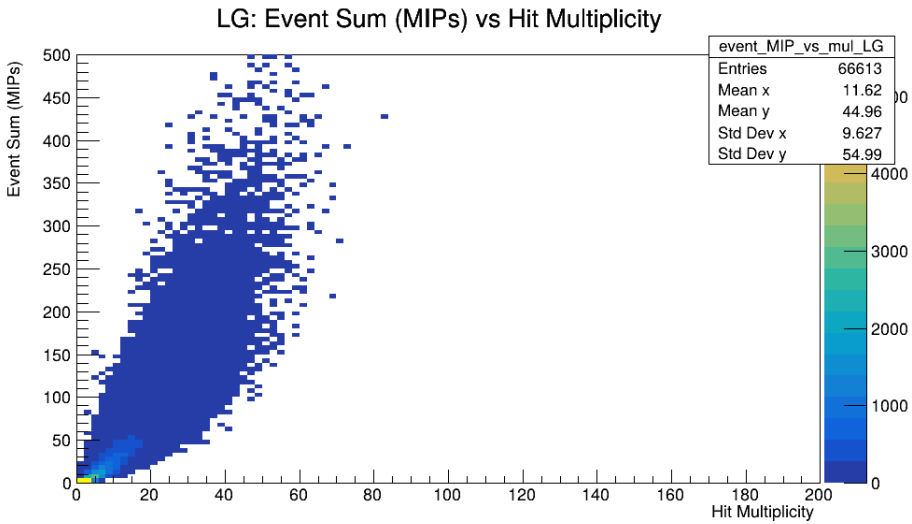




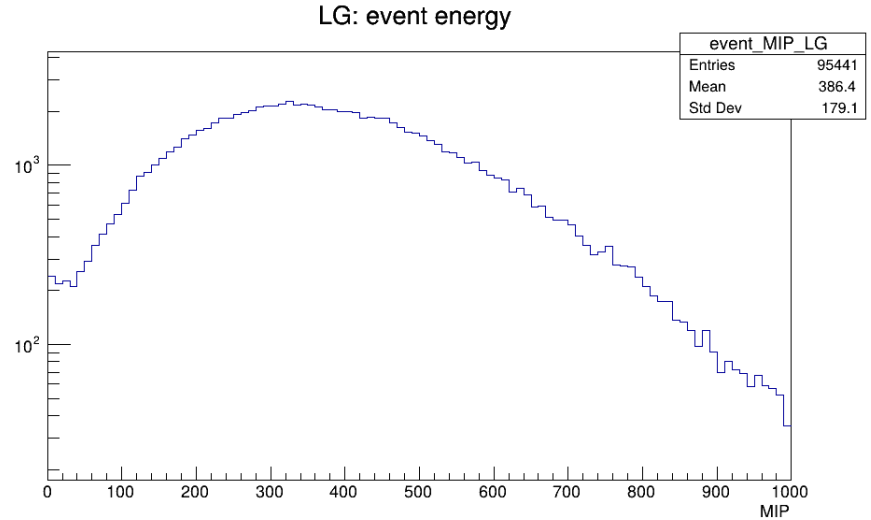
PP vs AuAu: Event Energy

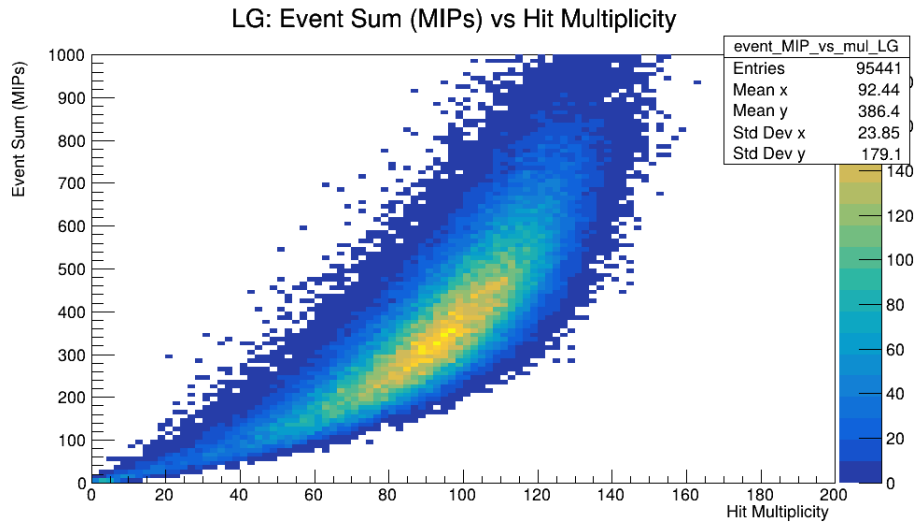
PP (Run 1390)



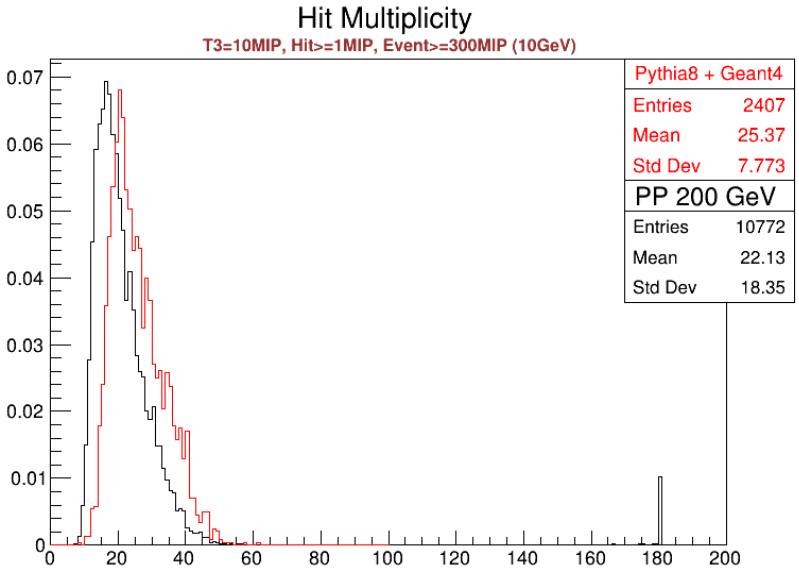


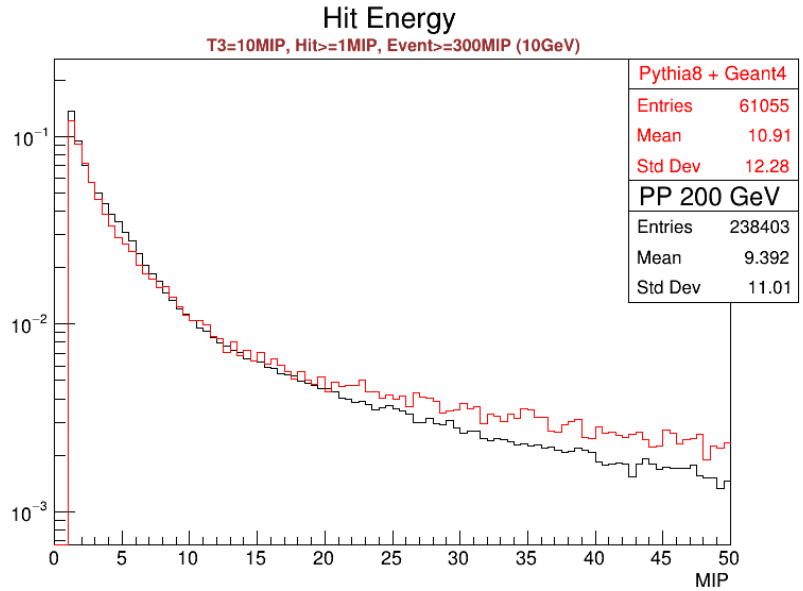
AuAu (Run 2371)

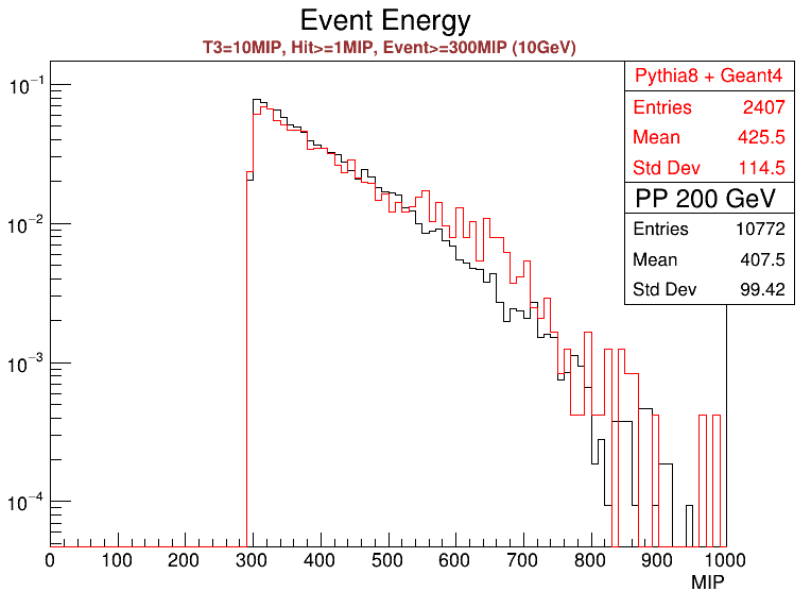




Simulation

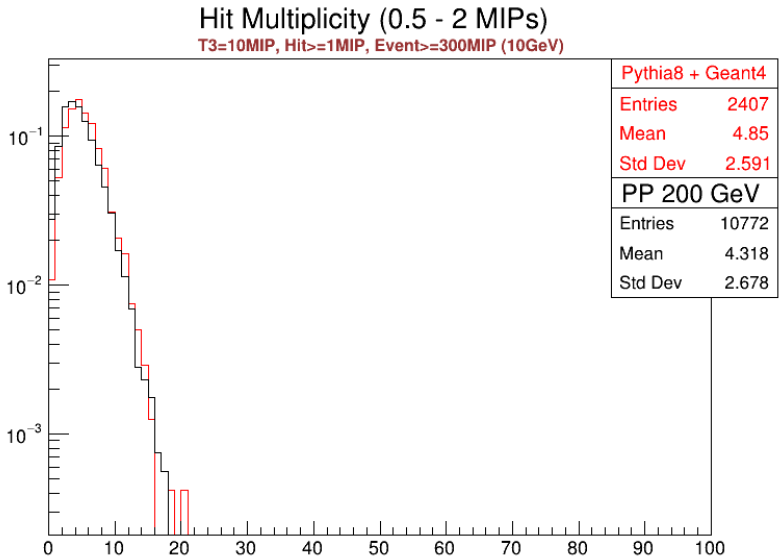


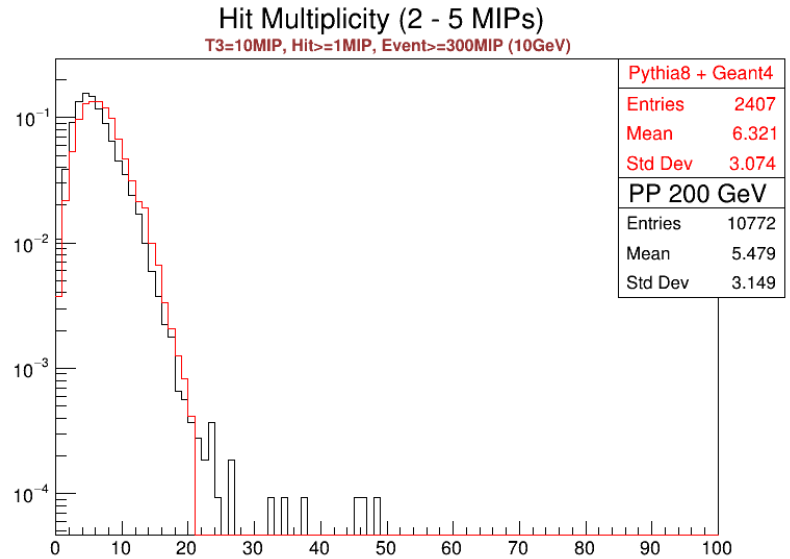


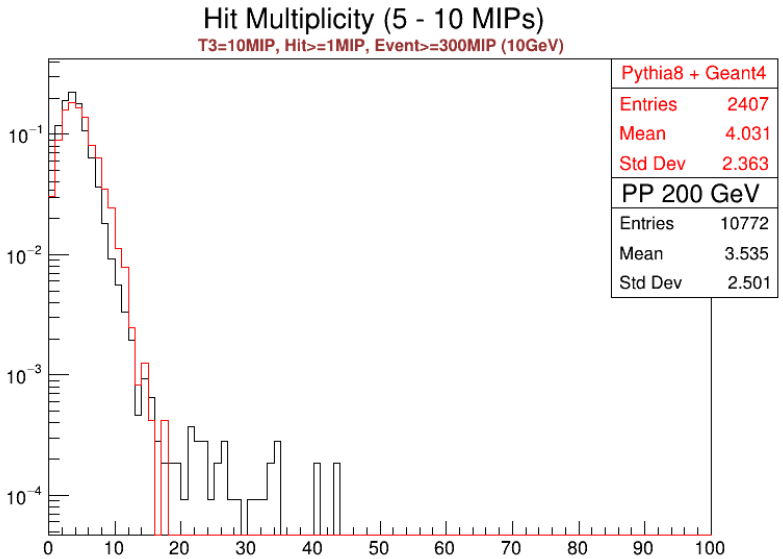


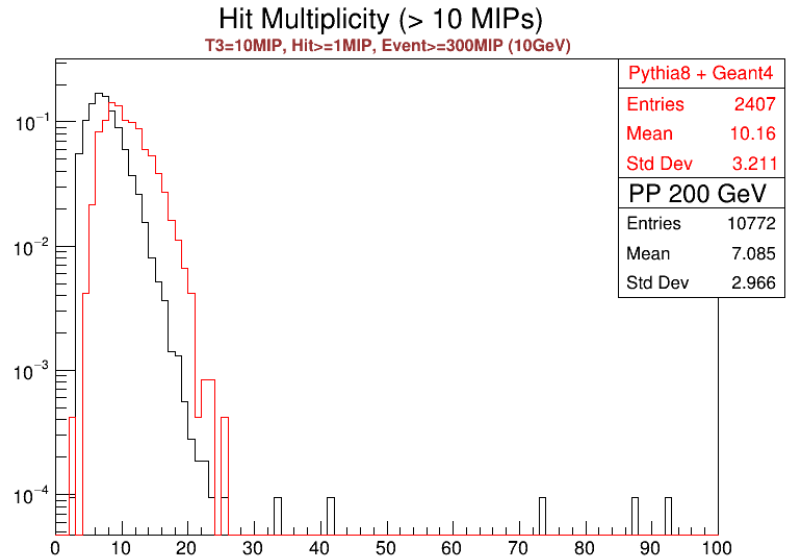
- Simulation: PP with Pythia8 + Geant4 (ddsim) at 200 GeV
- Lower energy region is less well described

Simulation: Hit Multiplicity





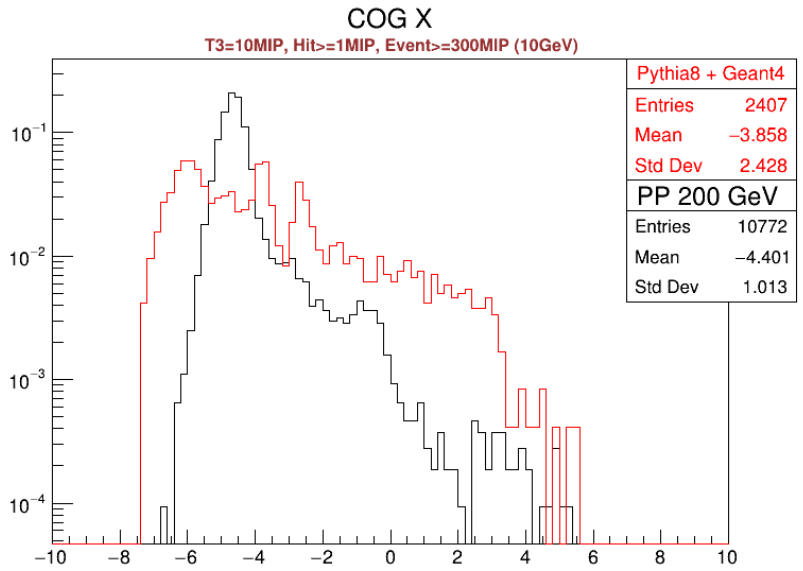


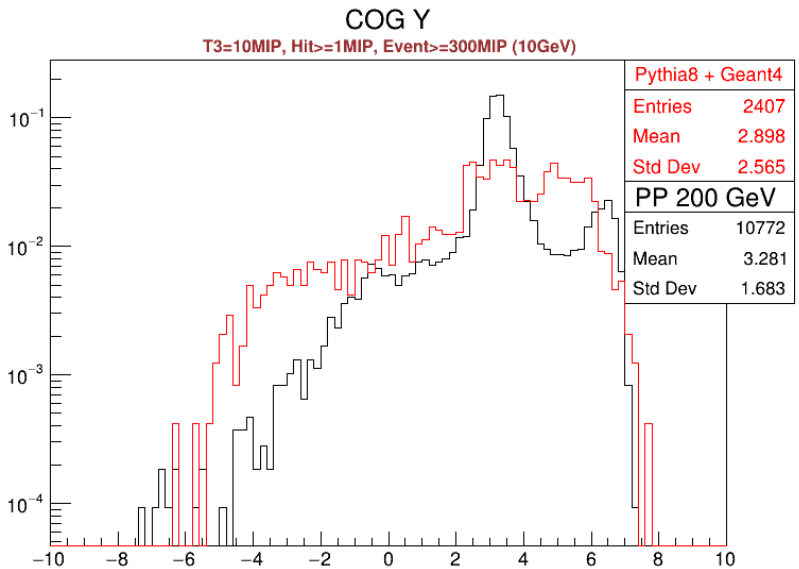


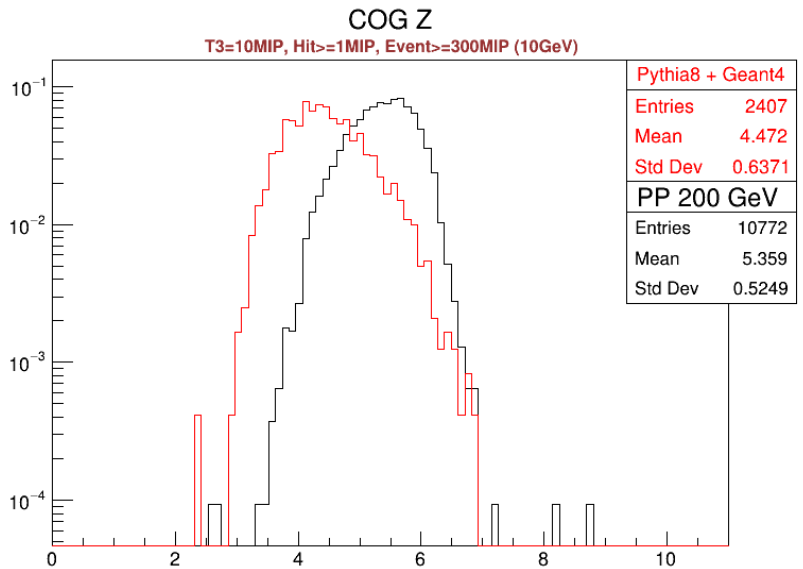
- The main difference comes from high energy hits

Simulation: Center-Of-Gravity

$$\mathrm{COG} = \frac{\sum_i E_i \cdot \vec{X}}{\sum_i E_i}$$







- Not so good COG match due to inaccurate SiPM positions
- Need further investigation in terms of COG Z mismatch

Summary

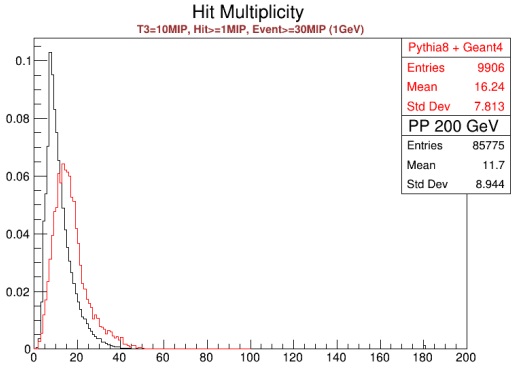
- The first operation of a SiPM-on-tile calorimeter in a collider ever
- Simulation shows good match with data

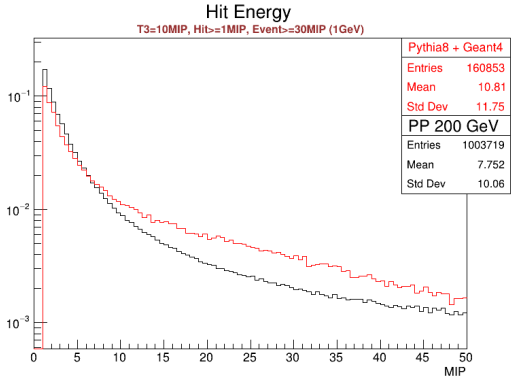
Next Step

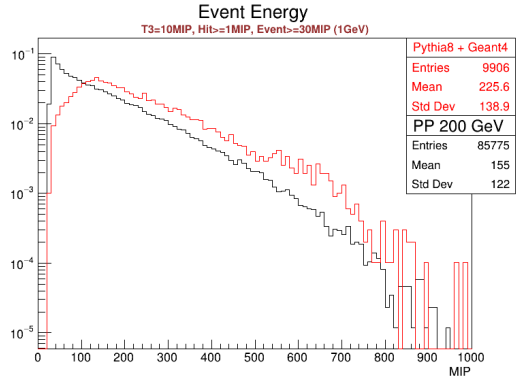
- Refine simulation
- Showershape analyse and π^0 calibration with eicrecon

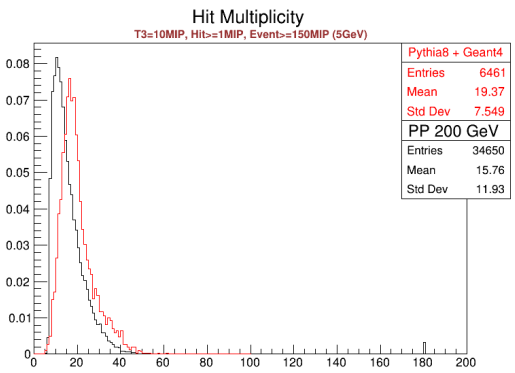
Backup

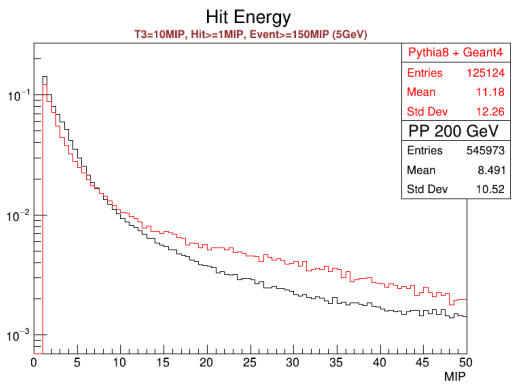
Simulation

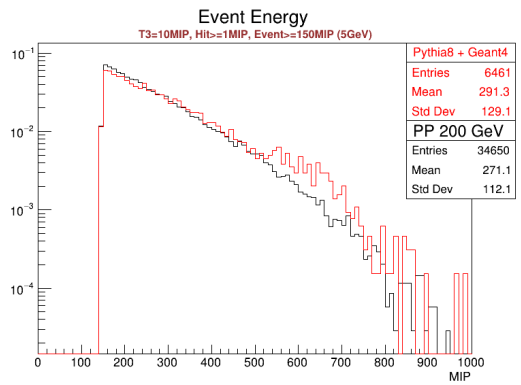

Hit Multiplicity
T3=10MIP, Hit>=1MIP, Event>=30MIP (1GeV)
Pythia8 + Geant4
Entries 9906
Mean 16.24
Std Dev 7.813
PP 200 GeV
Entries 85775
Mean 11.7
Std Dev 8.944


Hit Energy
T3=10MIP, Hit>=1MIP, Event>=30MIP (1GeV)
Pythia8 + Geant4
Entries 160853
Mean 10.81
Std Dev 11.75
PP 200 GeV
Entries 1003719
Mean 7.752
Std Dev 10.06
MIP

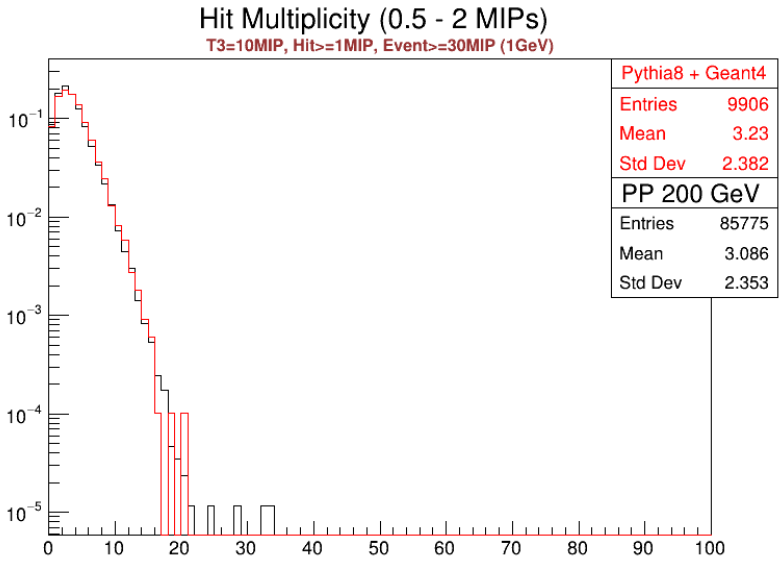

Event Energy
T3=10MIP, Hit>=1MIP, Event>=30MIP (1GeV)
Pythia8 + Geant4
Entries 9906
Mean 225.6
Std Dev 138.9
PP 200 GeV
Entries 85775
Mean 155
Std Dev 122
MIP

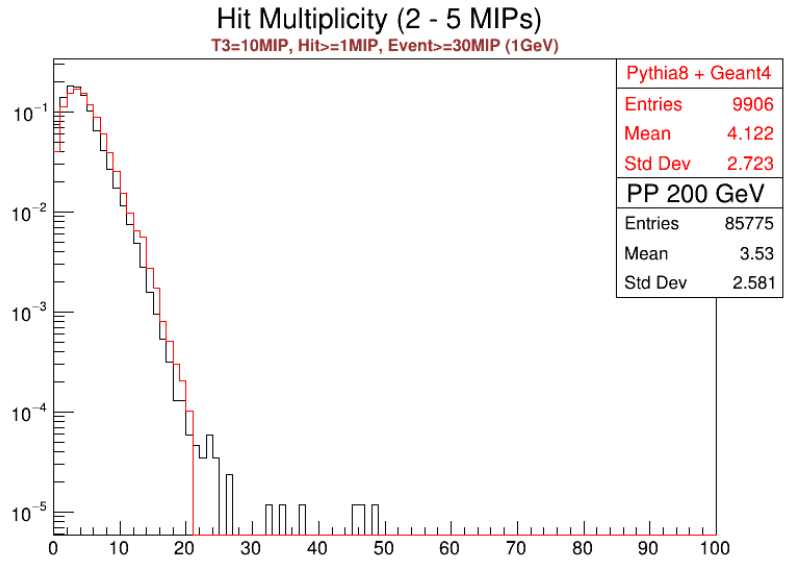

Hit Multiplicity
T3=10MIP, Hit>=1MIP, Event>=150MIP (5GeV)
Pythia8 + Geant4
Entries 6461
Mean 19.37
Std Dev 7.549
PP 200 GeV
Entries 34650
Mean 15.76
Std Dev 11.93

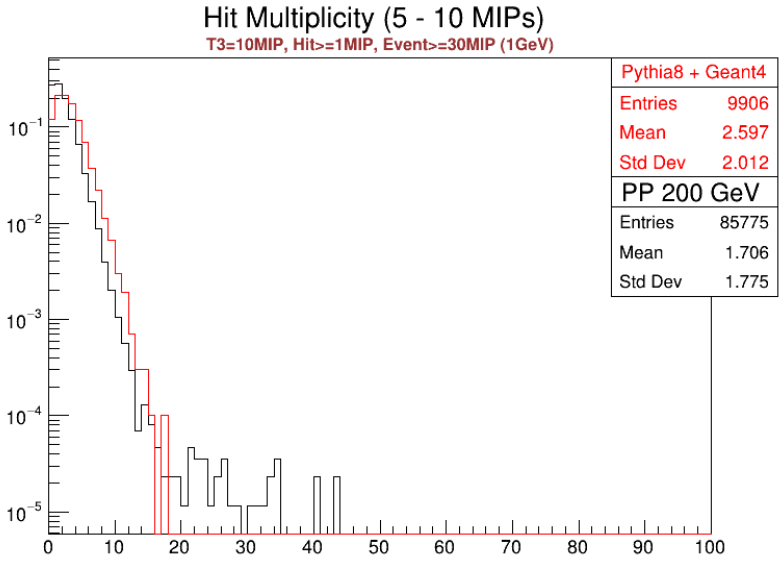

Hit Energy
T3=10MIP, Hit>=1MIP, Event>=150MIP (5GeV)
Pythia8 + Geant4
Entries 125124
Mean 11.18
Std Dev 12.26
PP 200 GeV
Entries 545973
Mean 8.491
Std Dev 10.52
MIP

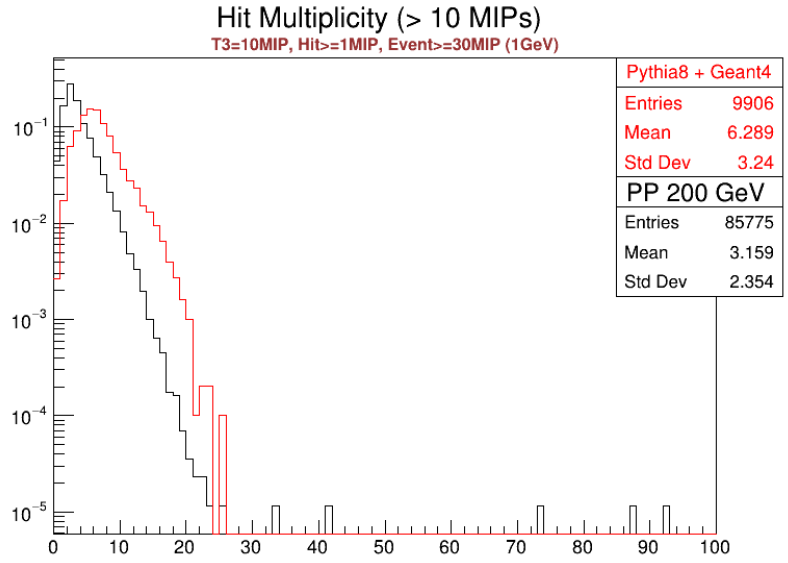

Event Energy
T3=10MIP, Hit>=1MIP, Event>=150MIP (5GeV)
Pythia8 + Geant4
Entries 6461
Mean 291.3
Std Dev 129.1
PP 200 GeV
Entries 34650
Mean 271.1
Std Dev 112.1
MIP

Simulation: Hit Multiplicity at 30 MIPs

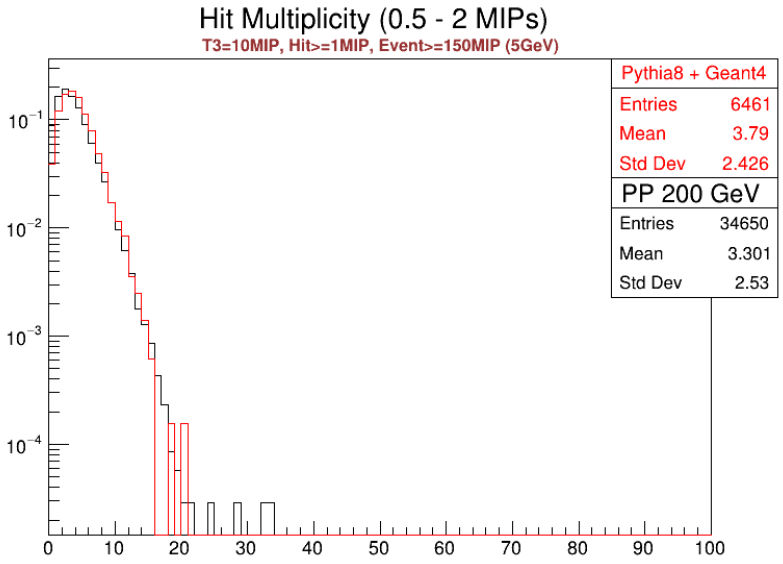


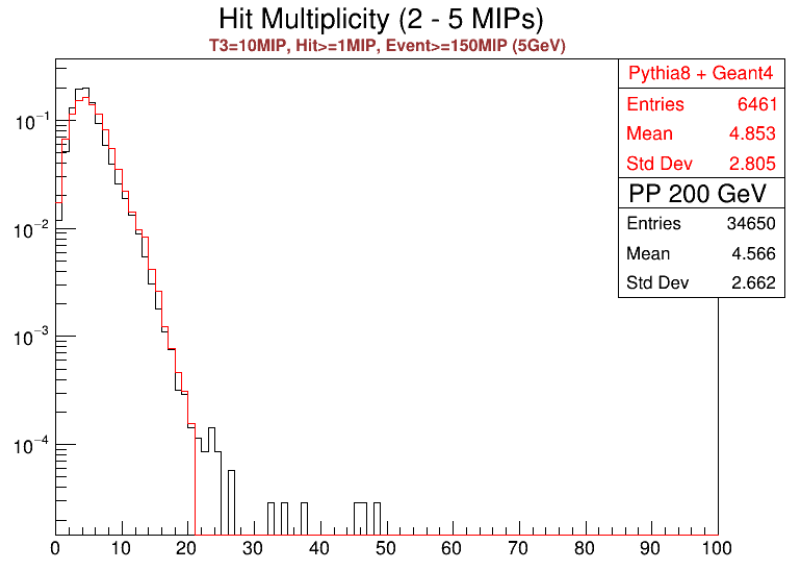


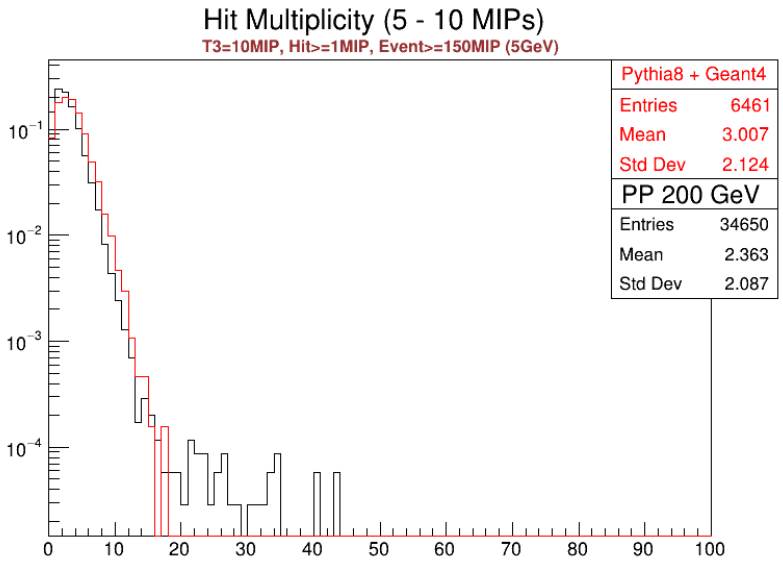


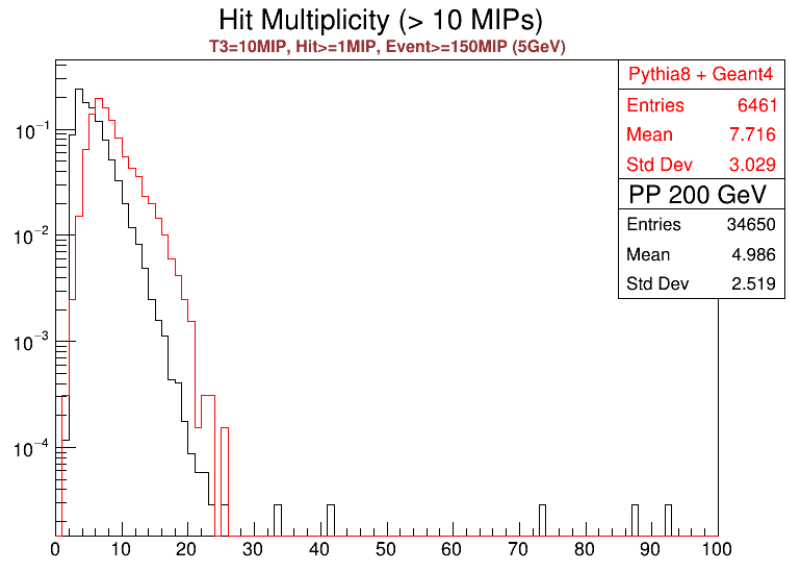


Simulation: Hit Multiplicity at 150 MIPs









Simulation: Center-Of-Gravity