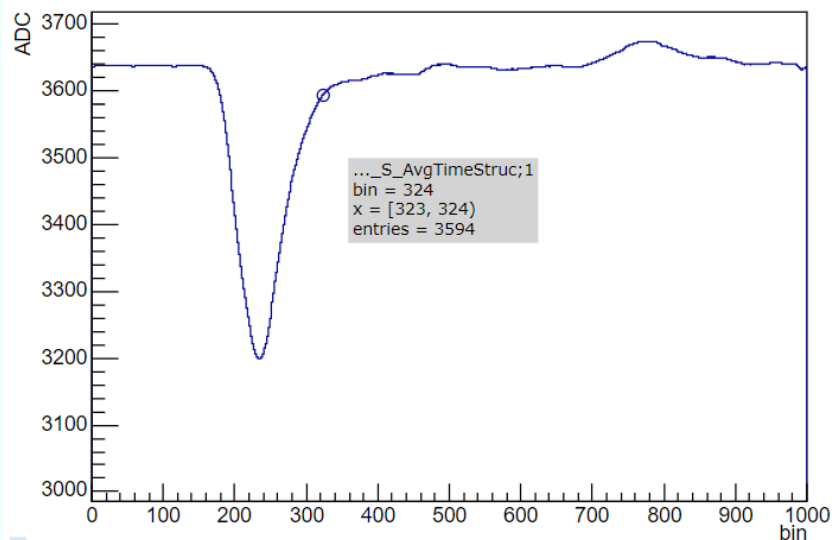


# Winter Workshop

TB2023

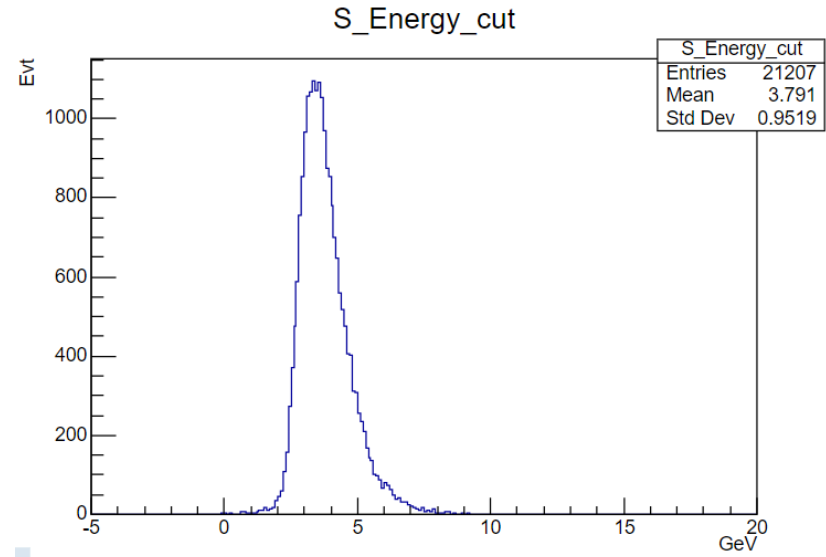
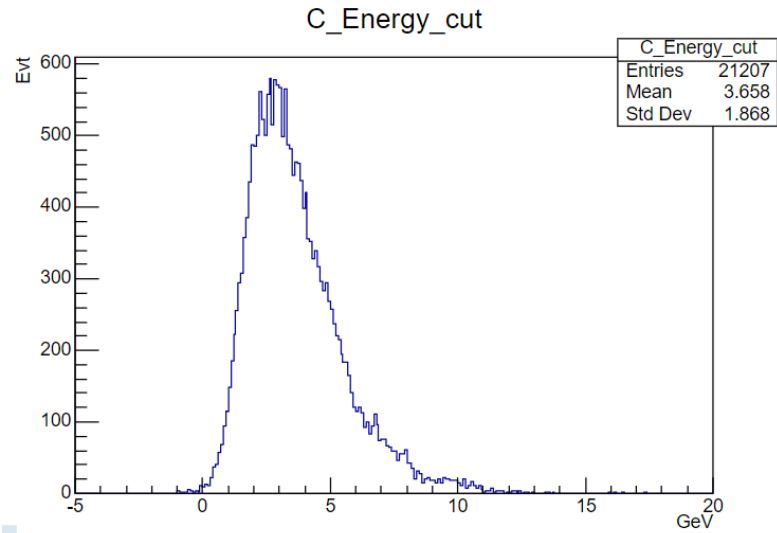
정진룡

L\_4\_S\_AvgTimeStruc

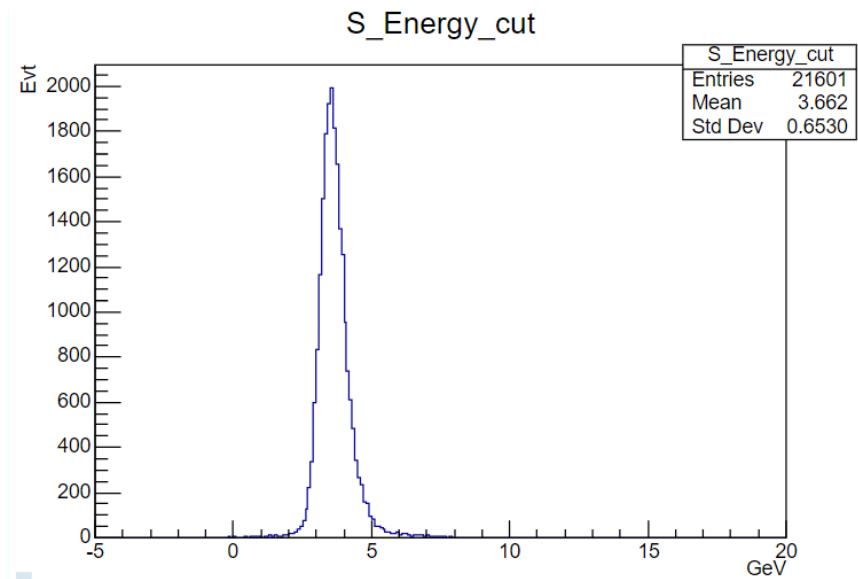
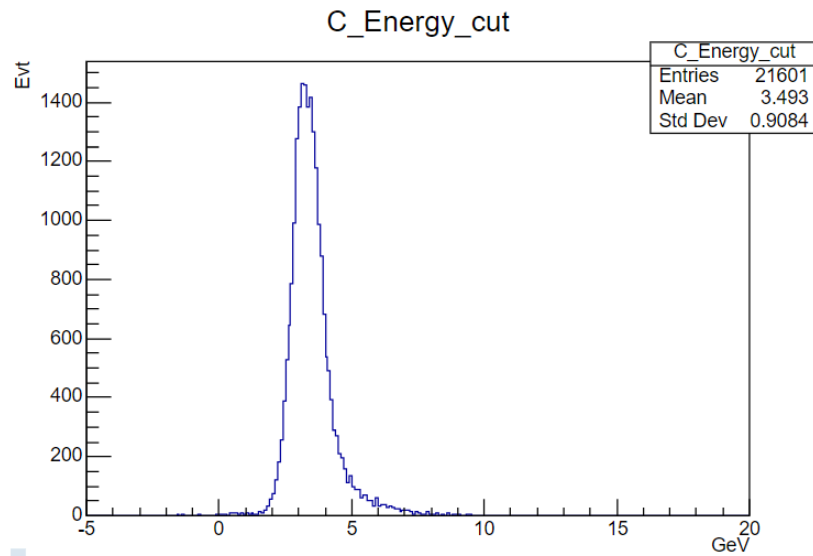


Run	Target tower	Ch	Mean	EvtPedMean	Tmp const	EvtPedconst	Beam E	E deosit	Equalization const	EvtPedEqConst
4173	3D	S	68274	68120	0.0000585875	0.0000587199	4	73.66	0.0000431555	0.0000432531
		C	33639	33478	0.0001189096	0.0001194815	4	73.66	0.0000875888	0.0000880100
	3D - W1	S	12645	12447	0.0003163306	0.0003213626	4	1.38	0.0000043654	0.0000044348
		C	7840	7677	0.0005102041	0.0005210369	4	1.38	0.0000070408	0.0000071903
	3D - W2	S	6912	6815	0.0005787037	0.0005869406	4	0.82	0.0000047454	0.0000048129
		C	1560	1460	0.0025641026	0.0027397260	4	0.82	0.0000210256	0.0000224658
3D - W3	S	6687	6510	0.0005981756	0.0006144393	4	0.82	0.0000049050	0.0000050384	
	C	2105	1987	0.0019002375	0.0020130851	4	0.82	0.0000155819	0.0000165073	
4175	HW	S	80631	80549	0.0000496087	0.0000496592	4	82.14	0.0000407486	0.0000407901
		C	47547	47398	0.0000841273	0.0000843917	4	82.14	0.0000691022	0.0000693194
4177	H1	S	94132	94064	0.0000424935	0.0000425242	4	82.36	0.0000349977	0.0000350230
		C	55183	55028	0.0000724861	0.0000726903	4	82.36	0.0000596995	0.0000598677
4181	H2	S	89085	88949	0.0000449009	0.0000449696	4	82.32	0.0000369625	0.0000370190
		C	56847	56689	0.0000703643	0.0000705604	4	82.32	0.0000579239	0.0000580853
4179	H3	S	85809	85785	0.0000466152	0.0000466282	4	78.3	0.0000364997	0.0000365099
		C	48630	48550	0.0000822538	0.0000823893	4	78.3	0.0000644047	0.0000645108
4176	L1	S	66013	65907	0.0000605941	0.0000606916	4	71.2	0.0000431430	0.0000432124
		C	39723	39580	0.0001006973	0.0001010611	4	71.2	0.0000716965	0.0000719555
4182	L2	S	109945	100464	0.0000363818	0.0000398153	4	71.33	0.0000259512	0.0000284002
		C	6761	5821	0.0005916285	0.0006871672	4	71.33	0.0004220086	0.0004901563
4178	L3	S	58615	58383	0.0000682419	0.0000685131	4	67.66	0.0000461725	0.0000463560
		C	35503	35728	0.0001126665	0.0001119570	4	67.66	0.0000762302	0.0000757501
4180	L4	S	38438	38189	0.0001040637	0.0001047422	4	68.14	0.0000709090	0.0000713713
		C	19811	19658	0.0002019080	0.0002034795	4	68.14	0.0001375801	0.0001386509

run4183

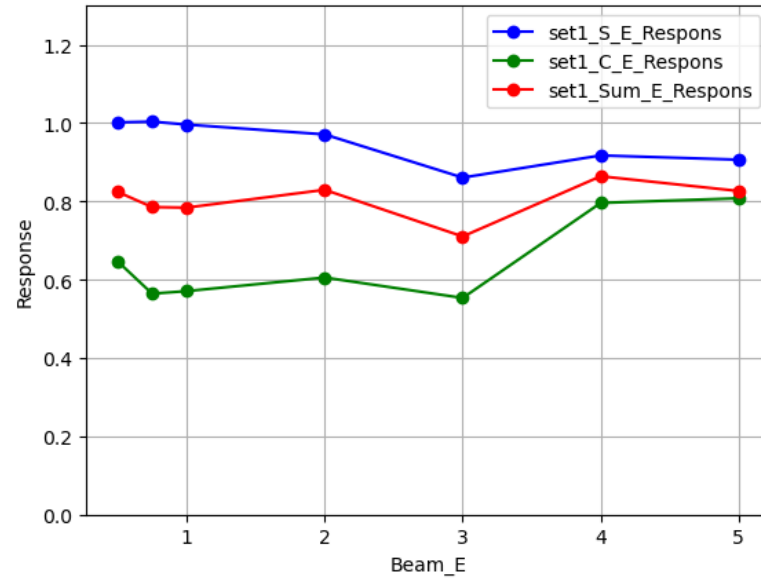
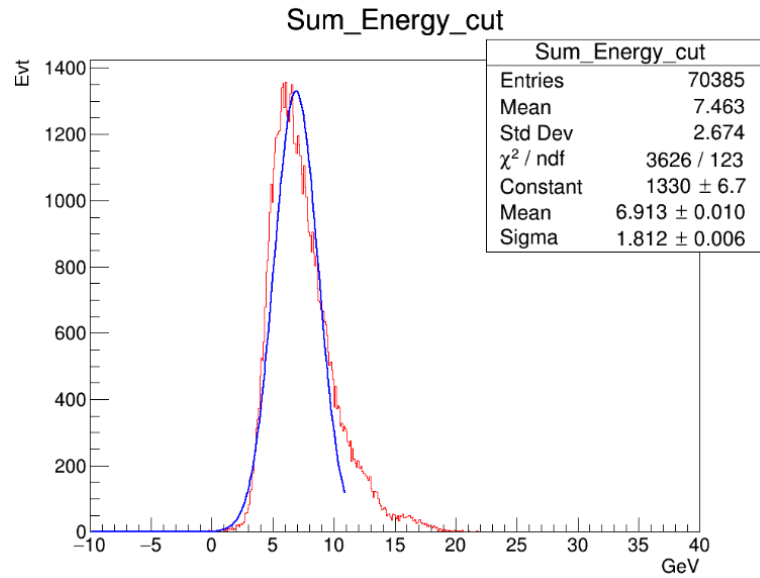


Run pedestal

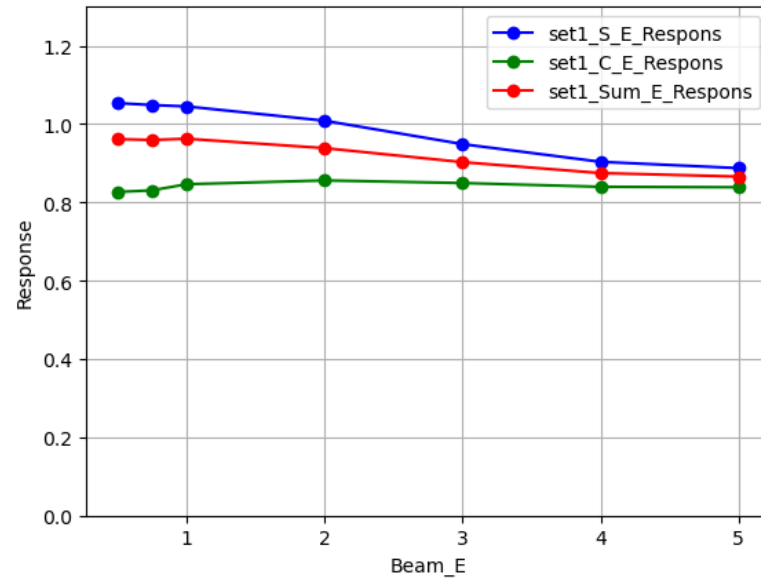
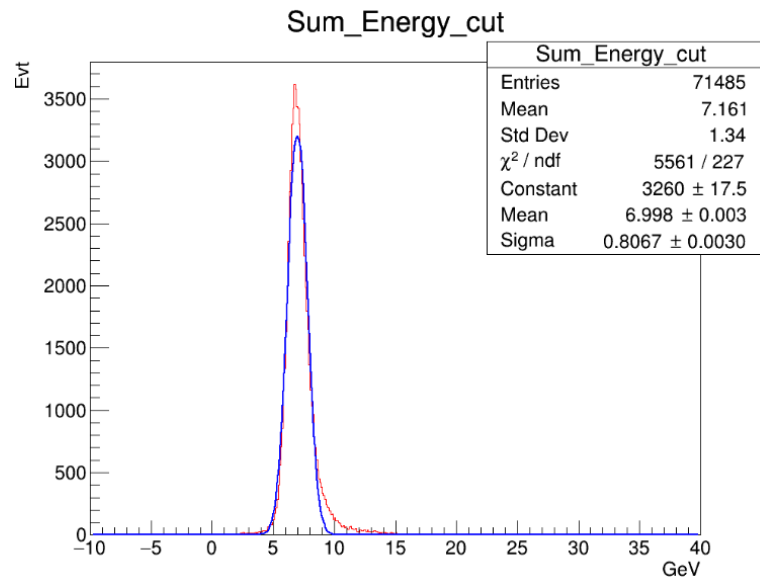


Event pedestal

# 4GeV



Run pedestal



Event pedestal









Monday, February 19, 2024

# GWNU KFCW data analysis of TB2023

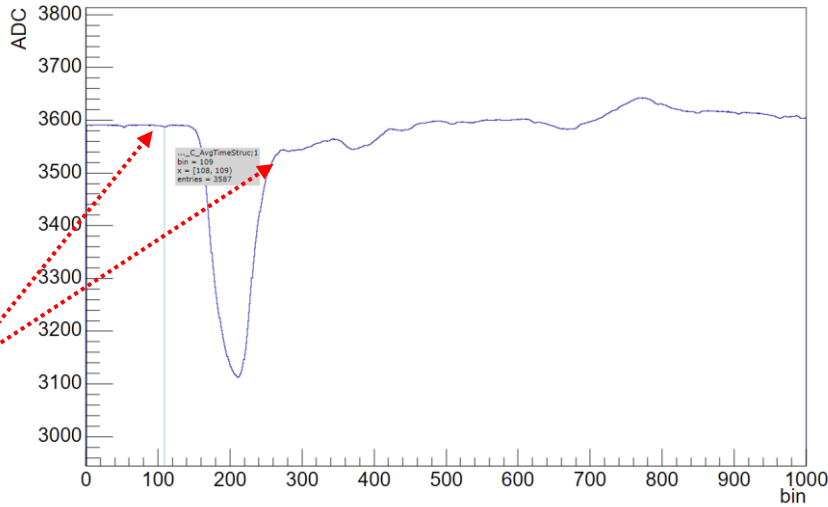
---

YoonJun Jang Department of Physics

Hadamard		$\frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$
Pauli- $X$		$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$
Pauli- $Y$		$\begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix}$
Pauli- $Z$		$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$
Phase		$\begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$
$\pi/8$		$\begin{bmatrix} 1 & 0 \\ 0 & e^{i\pi/4} \end{bmatrix}$

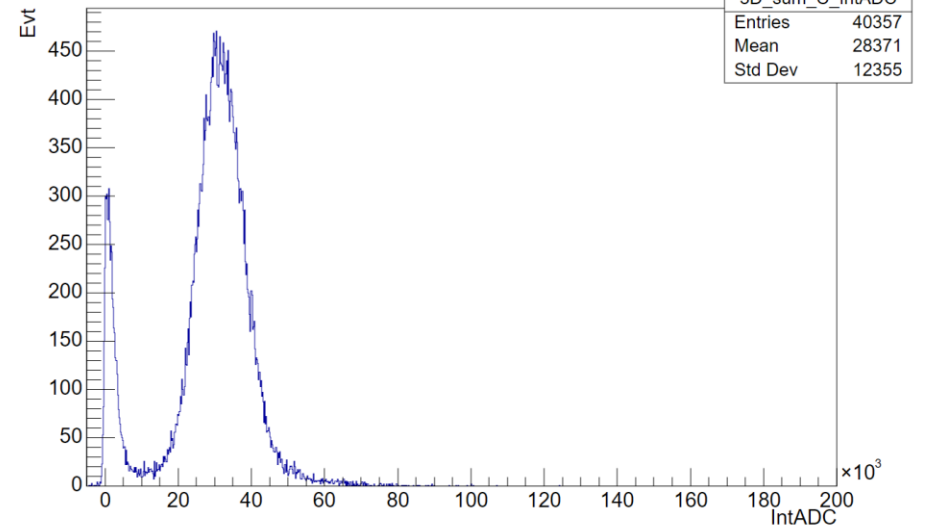
# Reading Plot 1

MCP\_sum\_C\_AvgTimeStruc

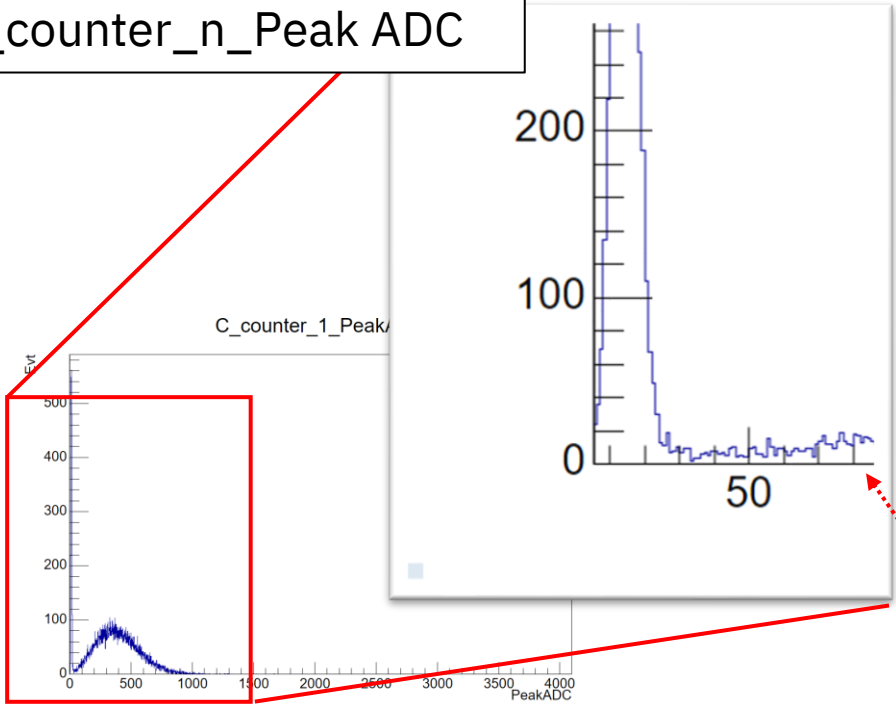


Time [start, bin]  
값 추출

3D\_sum\_C\_IntADC

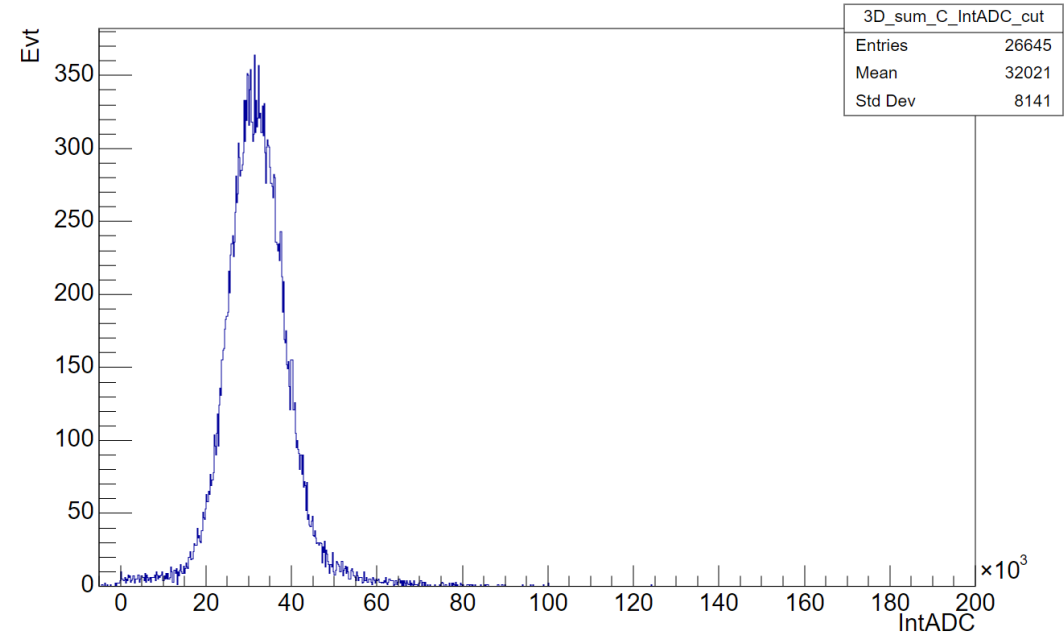


C\_counter\_n\_Peak ADC

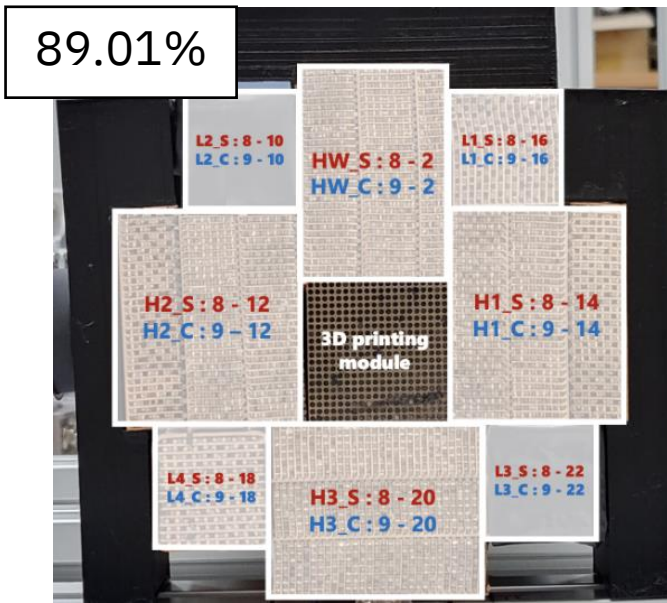


C\_1, 100~120  
C\_2, 80~90

3D\_sum\_C\_IntADC\_cut



# Reading Plot 2



$$Sim\_Energy = 4.0 * 0.8901$$

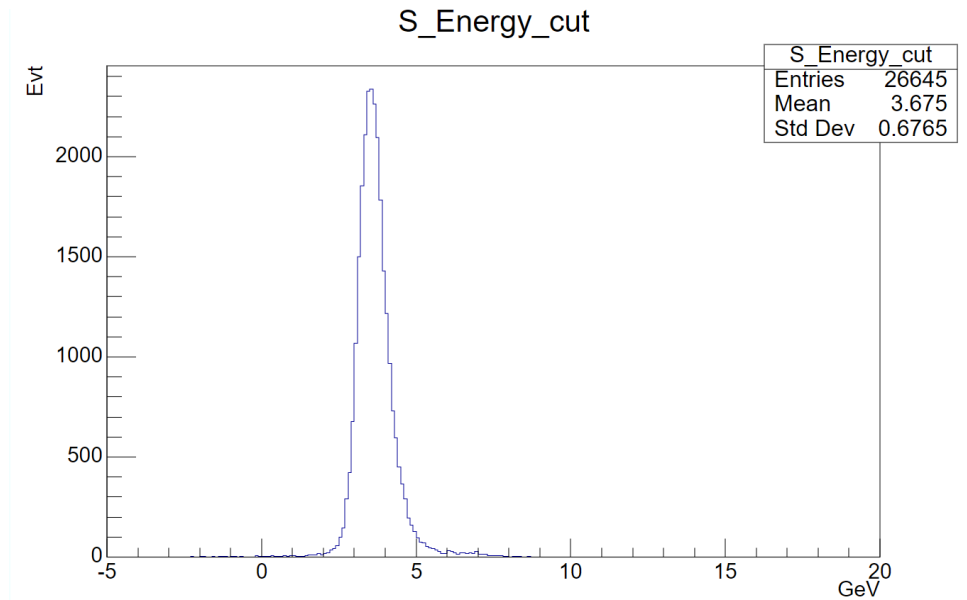
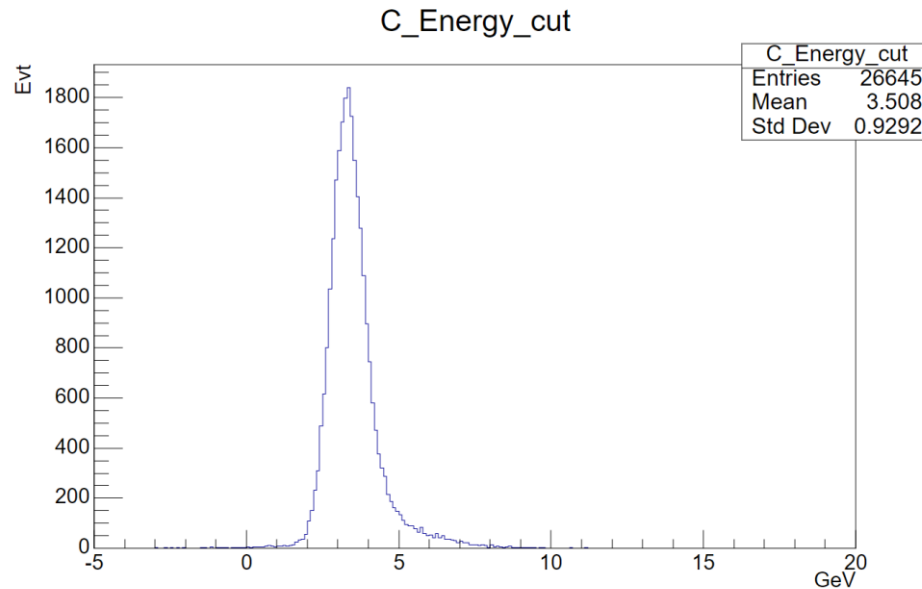
$$C\_Energy\_cut = 3.508$$



Float Scale\_C

1.014937286 ...

Run	Target tower	Ch	Mean	Tmp const	Beam E	E deosit	Equalization const
4209	3D	S	68598	0.0000583107	4	73.66	0.0000429517
		C	32230	0.0001241080	4	73.66	0.0000914179
	3D - W1	S	11383	0.0003514012	4	1.38	0.0000048493
		C	7939	0.0005038418	4	1.38	0.0000069530
	3D - W2	S	6610	0.0006051437	4	0.82	0.0000049622
		C	1704	0.0023474178	4	0.82	0.0000192488
3D - W3	S	5550	0.0007207207	4	0.82	0.0000059099	
	C	1998	0.0020020020	4	0.82	0.0000164164	





# Final Plotting

iPix)	
Run	Energy (GeV)
4207	4
4208	4
4209	4

$$x = E[i]$$

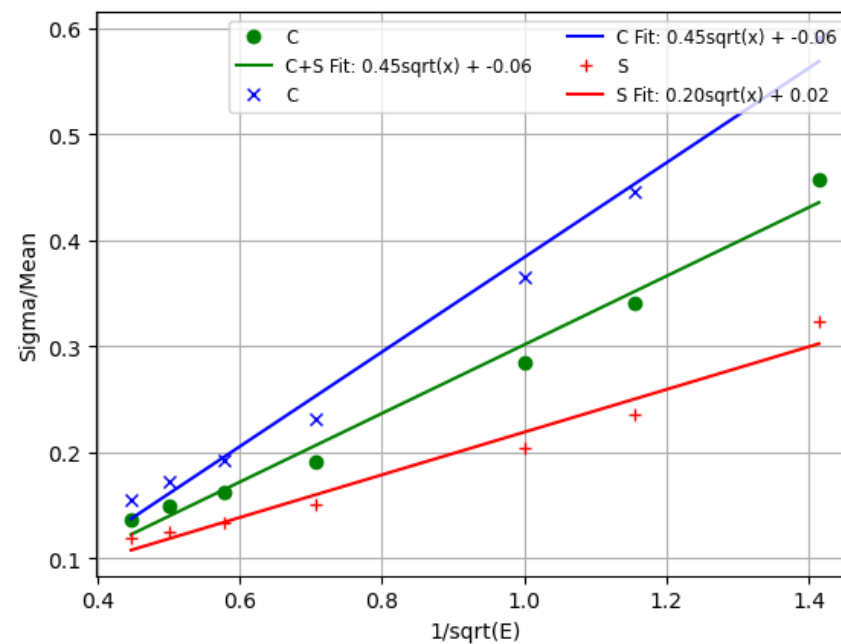
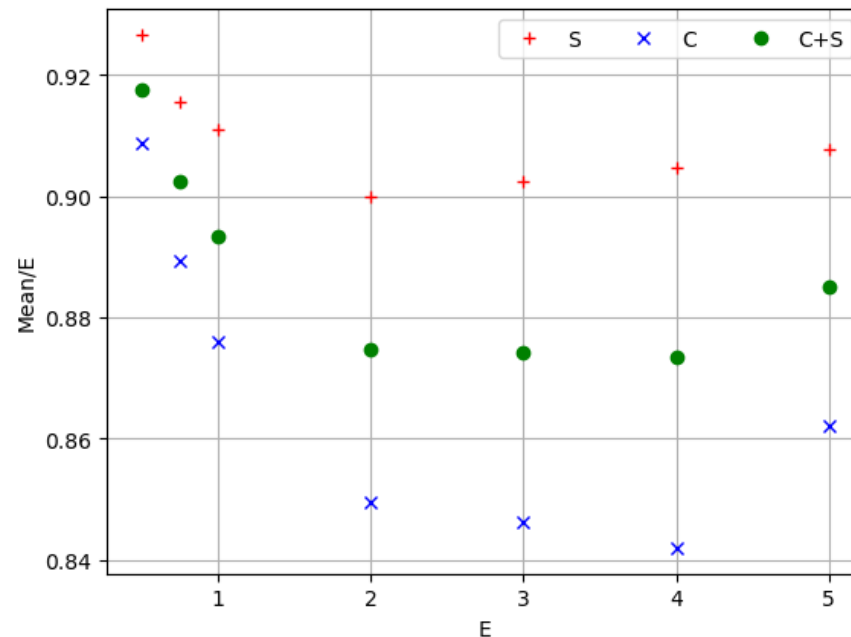
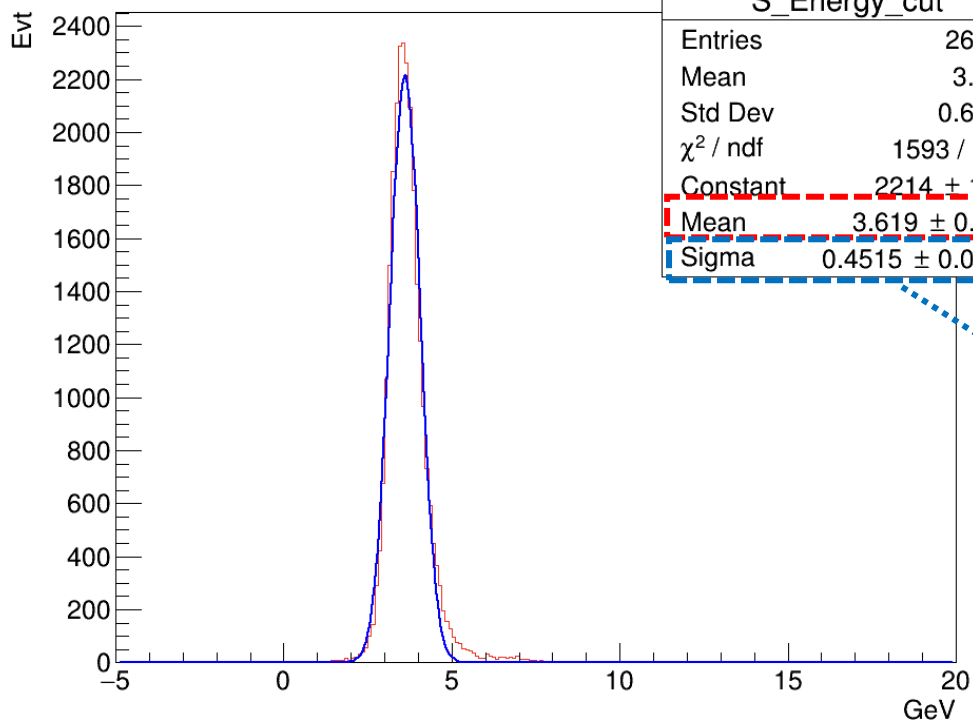
$$y = \frac{\text{Mean}[i]}{E[i]}$$

S\_Energy\_cut

S_Energy_cut	
Entries	26645
Mean	3.675
Std Dev	0.6765
$\chi^2 / \text{ndf}$	1593 / 108
Constant	2214 ± 18.9
Mean	3.619 ± 0.003
Sigma	0.4515 ± 0.0026

$$x = \frac{1}{\sqrt{E[i]}}$$

$$y = \frac{\text{Sigma}[i]}{\text{Mean}[i]}$$

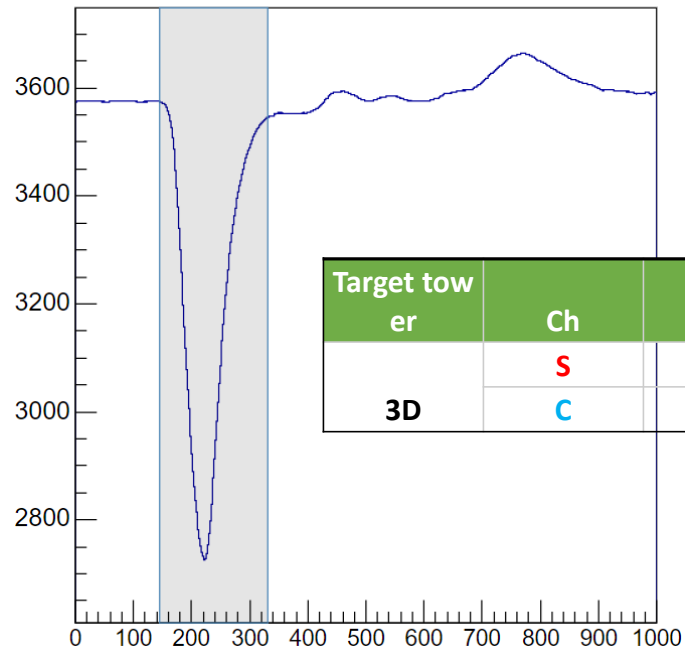


# Day 1

```
C:\Users\user>ssh dream01@idream.knu.ac.kr
dream01@idream.knu.ac.kr's password:
```

Run	Wave	Energy (GeV)	Beam Target	Detail
4173	10009		3D	
4175	10010		HW	
4176	10951		L1	

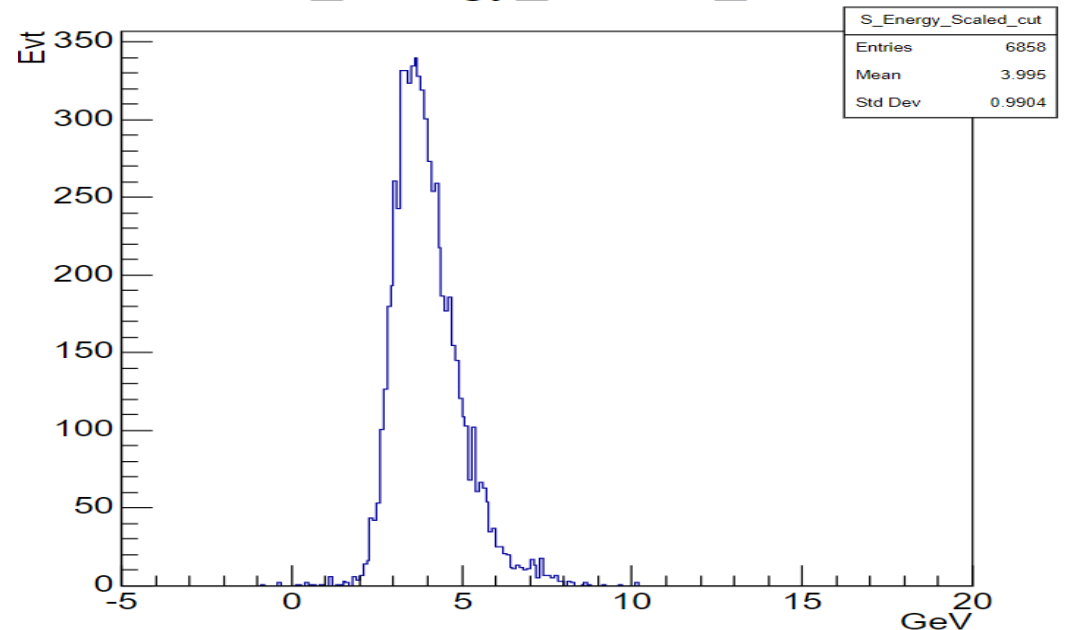
MCP\_sum\_S\_AvgTimeStruc



Target tower	Ch	Start	End
3D	S	130	310
	C	130	270

Target tower	Ch	Mean	Tmp const	Beam E	E deosit	Equalization const
3D	S	69312	0.0000577 101	4	73.66	0.0000425 092
	C	33724	0.0001186 099	4	73.66	0.0000873 680

S\_Energy\_Scaled\_cut



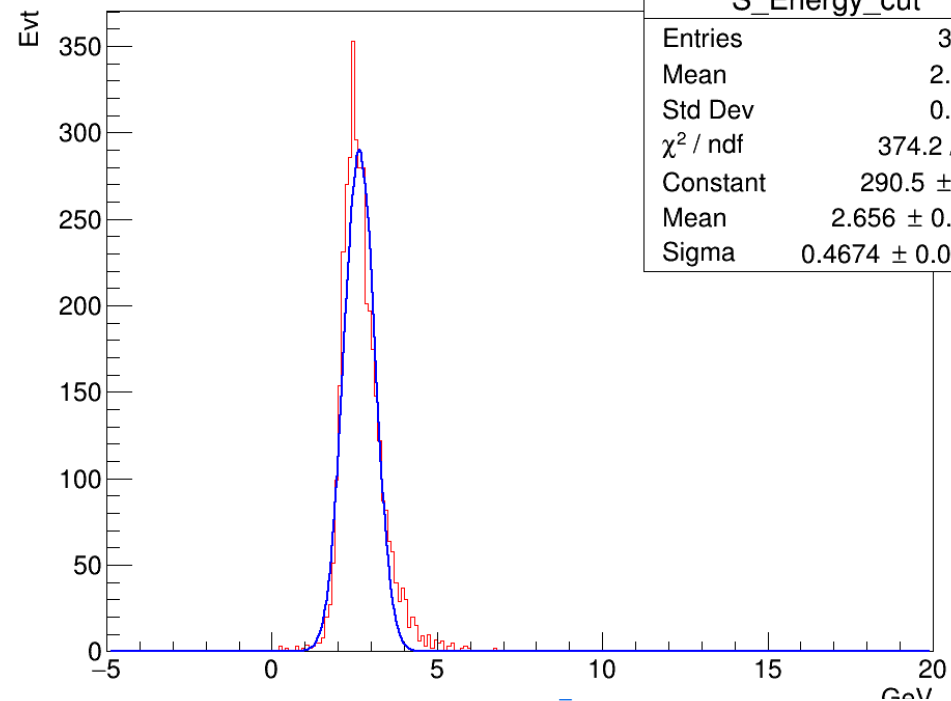
# Day 2

Energy scan set-3 (1.5mm collimator, no angle, no AstroPix)

Run	Wave	Trigger	Collimator	Rotation (deg)	Tilt (deg)	Particle	Energy (GeV)	Beam Target	Detail
4234	5015	Using Trigger-1, Trigger-2	1.5 mm ( $\pm 0.7\%$ momentum spread)	x	x	e+	5	3D	e+ energy scan runs (1.5mm collimator, w/o angle, w/o AstroPix)
4235	5039						4		
4236	5060						3		
4237	5058						2		
4238	5005						1		
4239	1001						0.75		
4240	1001						0.5		
4241	501						0.5		
4242	504	2	0.75						

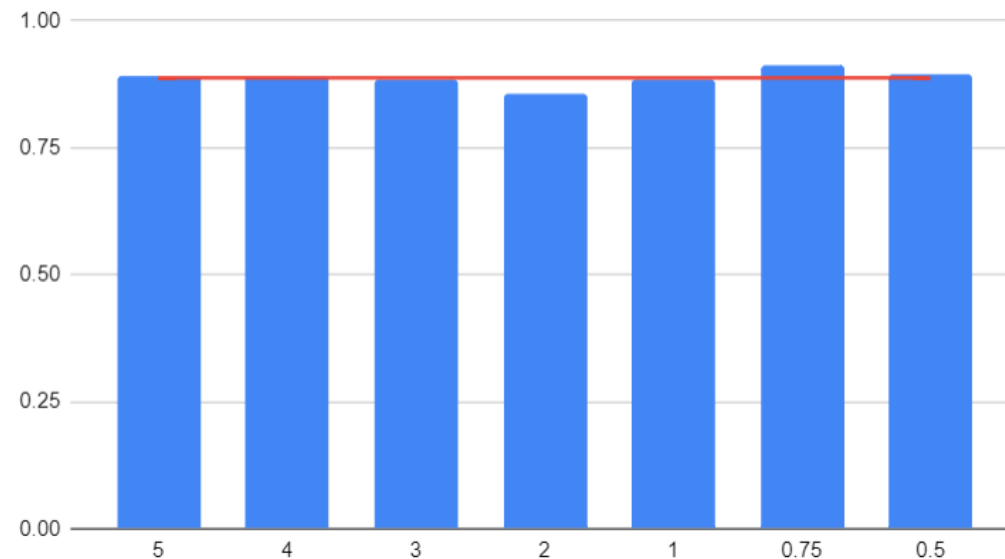
Run	Beam E (GeV)	Fit E (GeV)	Response
4234	5	4.448	0.8896
4235	4	3.565	0.89125
4236	3	2.656	0.8853333333
4237	2	1.71	0.855
4238	1	0.8855	0.8855
4239/4242	0.75	0.6832	0.9109333333
4240/4242	0.5	0.4474	0.8948

S\_Energy\_cut



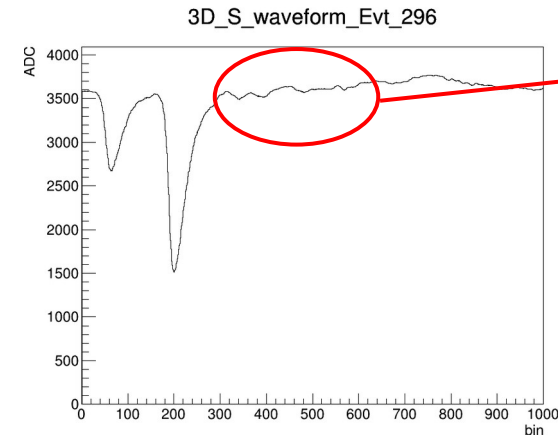
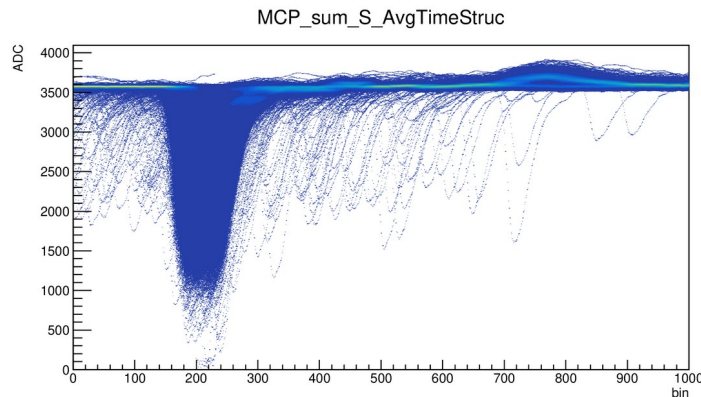
S_Energy_cut	
Entries	3778
Mean	2.725
Std Dev	0.642
$\chi^2 / \text{ndf}$	374.2 / 59
Constant	$290.5 \pm 6.9$
Mean	$2.656 \pm 0.010$
Sigma	$0.4674 \pm 0.0076$

Response avg.response



# IntADC vs PeakADC

- IntADC
  - Represent charge  $Q (= V * t)$
  - Include DAQ noises (x-talk, ground problem, etc ...)
  - With 6 mm collimator, one more particles enter the DRC within time window.
- PeakADC
  - Represent voltage  $V$
  - Assume time width of signal is not changed significantly.

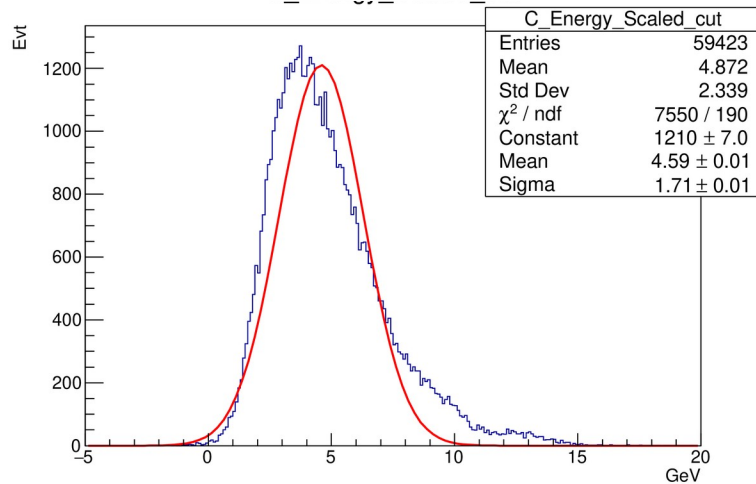


DAQ noise

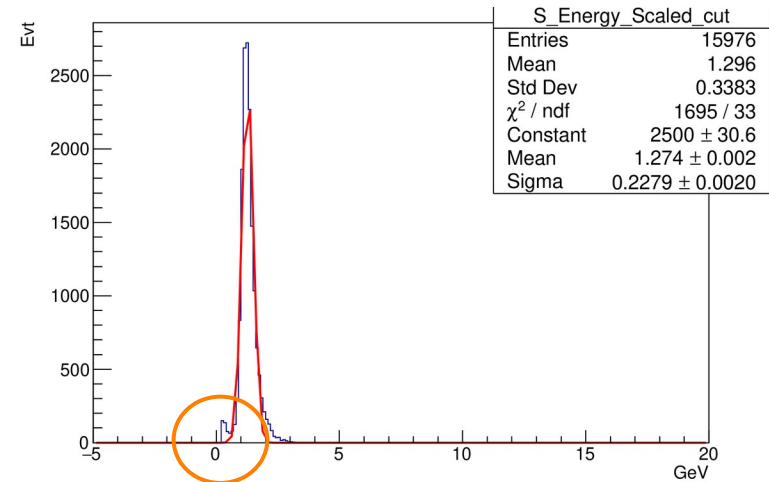
# Method

- Select integral & peak search range.
- Calibration evt-ped and run-ped, respectively
- With run-ped & intADC, energy distribution is **not fitted with gaussian**
  - Use the mean and std of energy distribution
- Under 1 GeV runs, the Scint channel has **strange peak on 0 GeV**.
  - In resolution, the energy points over 2 GeV are fitted.

**intADC run-ped 5 GeV Ceren**

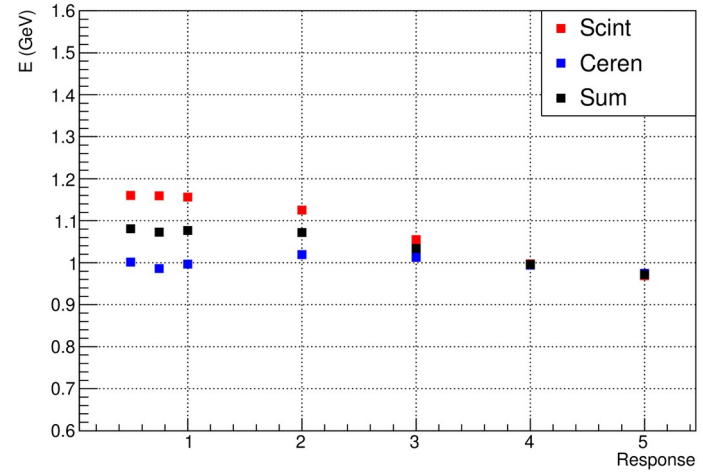
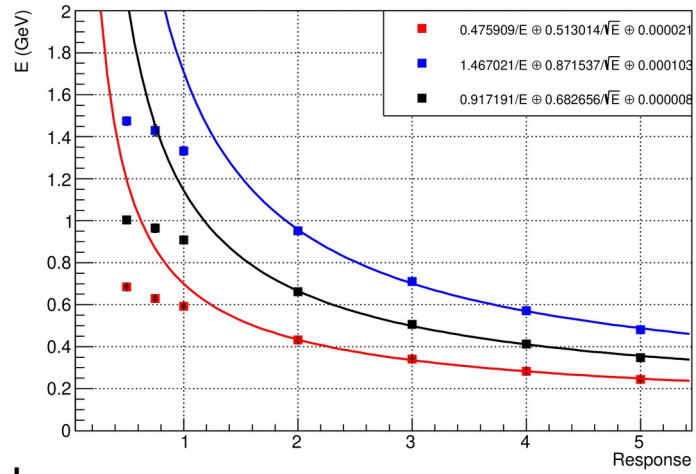


**peakADC run-ped 1 GeV Scint**

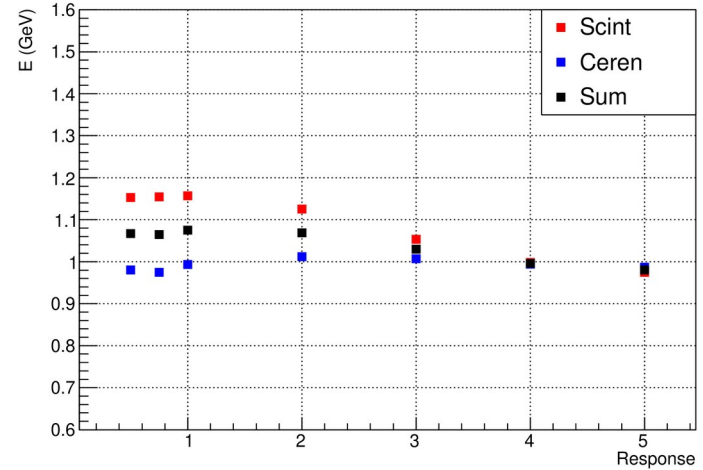
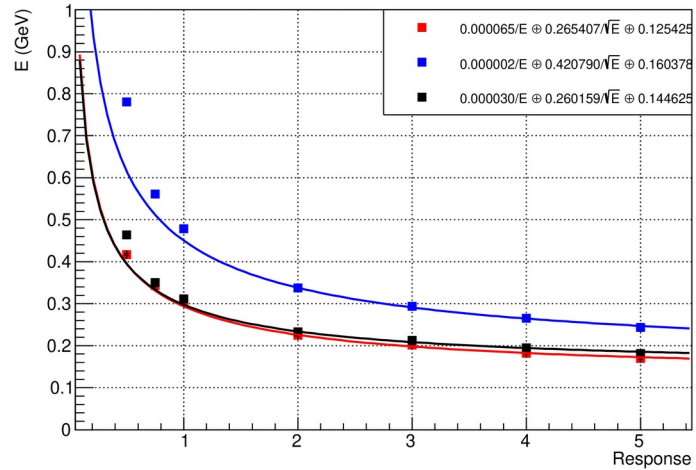


# IntADC

run-ped

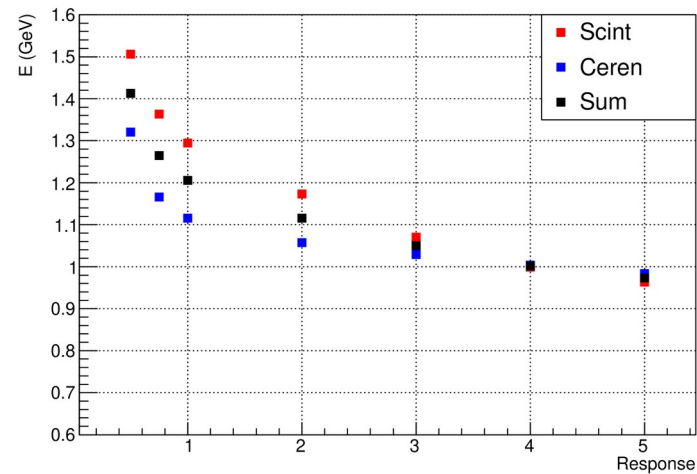
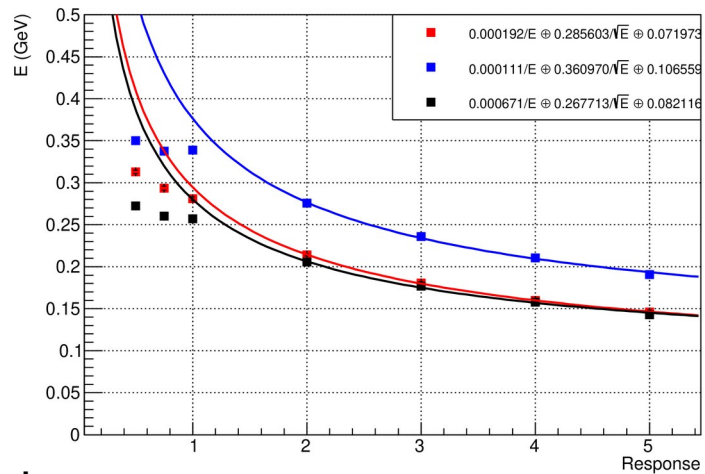


evt-ped

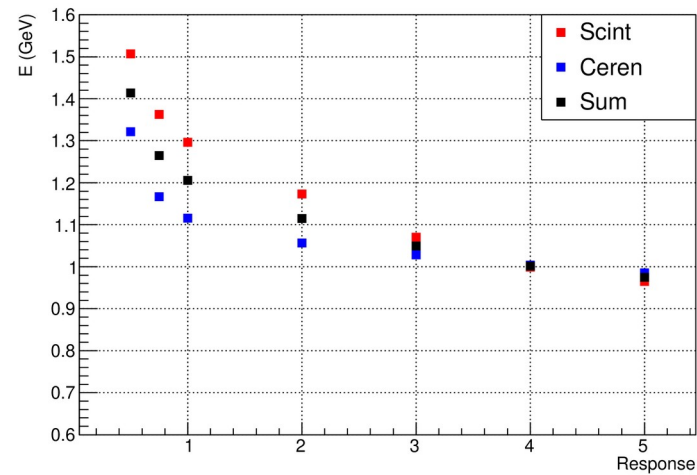
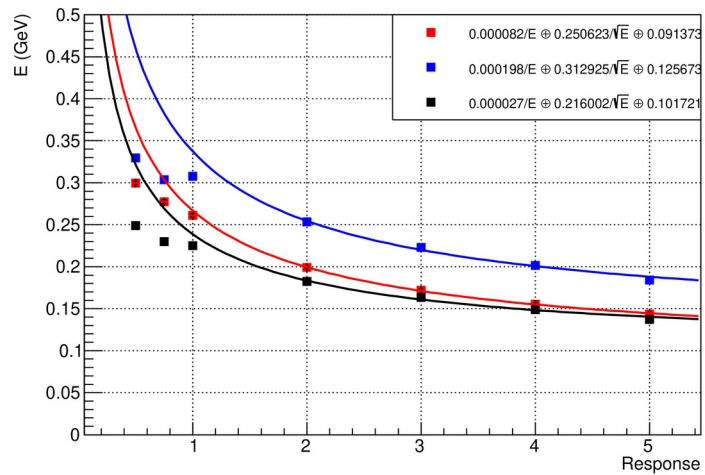


# PeakADC

run-ped



evt-ped



2024 DRC tutorial

# **Pedestal Analysis of Scintillator for 3D Module in Run 4213**

**Joonsuk Bae**

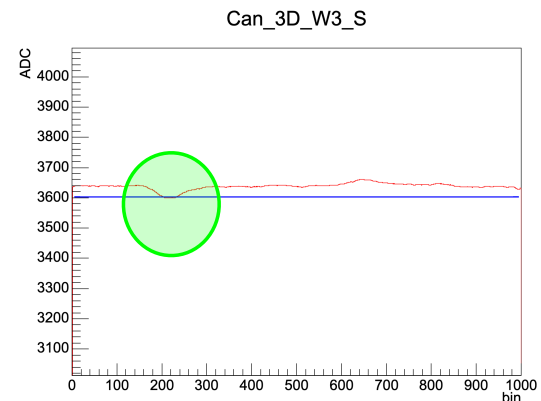
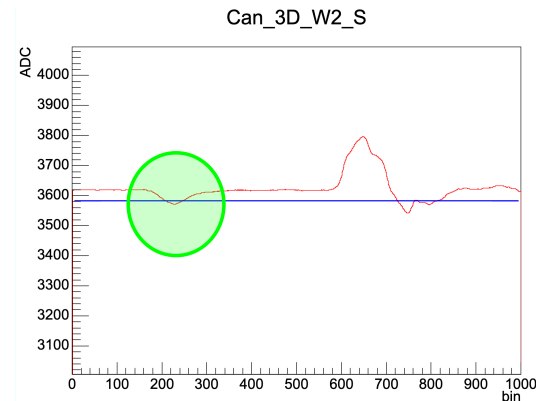
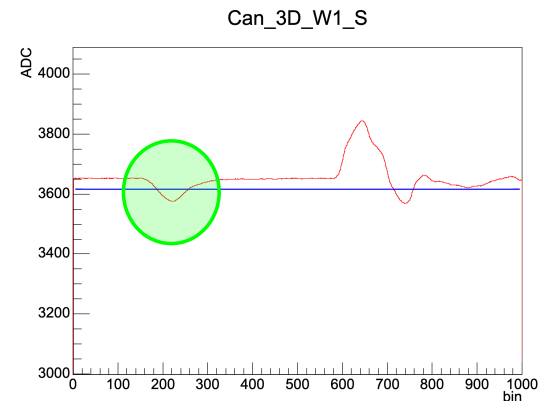
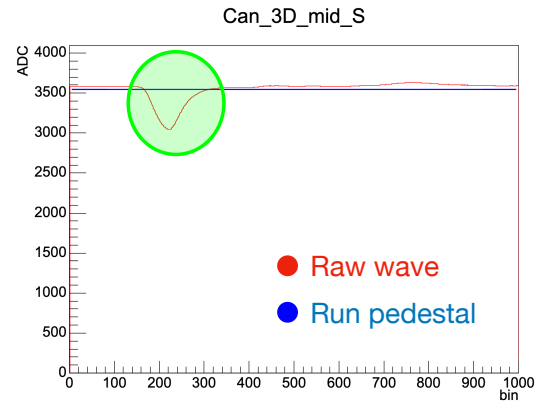
Sungkyunkwan University

February 19, 2024



# Motivation

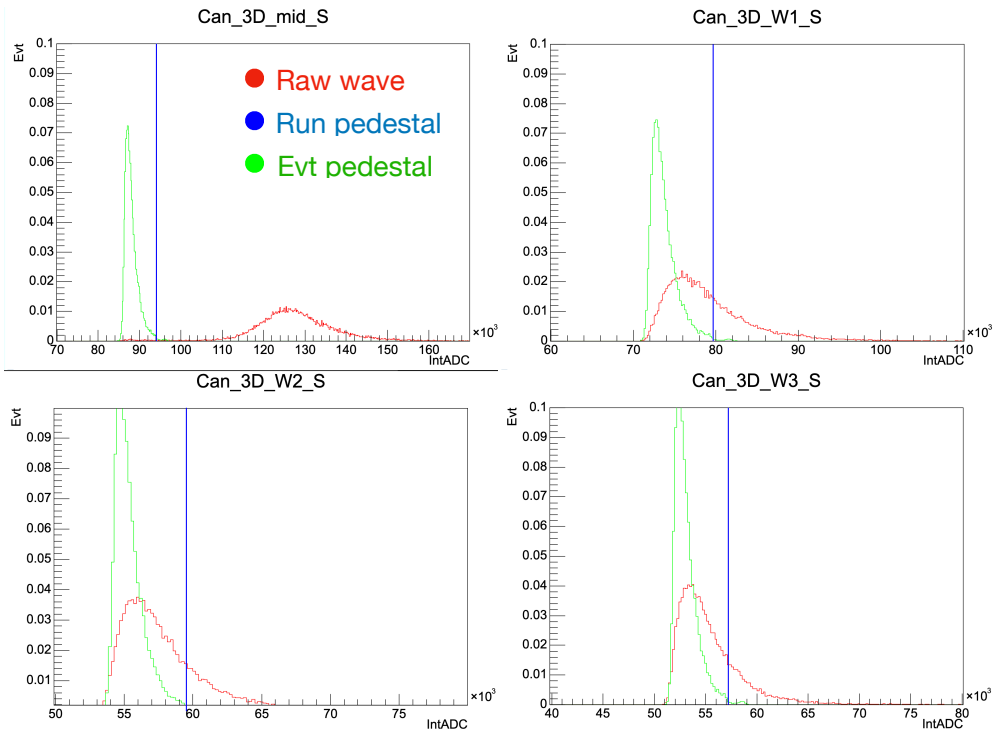
Deposit E		3D_sum_C	3D_W1_C	3D_W2_C	3D_W3_C	3D_sum_S	3D_W1_S	3D_W2_S	3D_W3_S
4207	Mean	2.933	0.05489	0.03243	0.03226	2.934	0.05549	0.03353	0.03204
4207	Std. dev.	0.736	0.05036	0.04542	0.0513	0.5951	0.04368	0.03316	0.03256
4208	Mean	2.93976	0.0539399	0.0314306	0.0310168	2.94904	0.0548128	0.034306	0.0312685
4208	Std. dev.	0.734116	0.0487607	0.0447764	0.0518998	0.598892	0.0439925	0.0349857	0.0324778
4209	Mean	2.93825	0.0540797	0.0322488	0.0316756	2.94321	0.0547324	0.033976	0.0315548
4209	Std. dev.	0.735127	0.0501178	0.0464437	0.0520095	0.588573	0.0433508	0.0319352	0.0328898
4210	Mean	2.23242	0.0394645	0.0244963	0.0226604	2.35058	0.0402978	0.0253697	0.0230472
4210	Std. dev.	0.620275	0.0407766	0.0408611	0.0403874	0.518058	0.035099	0.0263984	0.0259034
4211	Mean	2.23071	0.0397913	0.024402	0.0235093	2.36442	0.0404988	0.0253657	0.0234186
4211	Std. dev.	0.626196	0.0400474	0.0397794	0.0443853	0.527923	0.0348623	0.0267814	0.0269315
4212	Mean	2.23811	0.0398993	0.0251221	0.0238962	2.37221	0.0405943	0.0256937	0.0234287
4212	Std. dev.	0.62739	0.0399361	0.041496	0.0439514	0.533293	0.0349255	0.0269553	0.0268159
4213	Mean	1.48574	0.0252291	0.0161538	0.0142479	1.45081	0.00121508	<b>-0.0162104</b>	<b>-0.0170177</b>
4213	Std. dev.	0.494397	0.0304242	0.0337351	0.0325825	0.461437	0.0250949	0.0199878	0.0202329
4214	Mean	1.49011	0.0248597	0.0159081	0.0143311	1.71104	0.0255804	0.0164825	0.014543
4214	Std. dev.	0.501658	0.0302588	0.0335326	0.0334506	0.462586	0.0246482	0.0202822	0.019481
4215	Mean	1.48089	0.0250454	0.0160176	0.0143026	1.70016	0.0256535	0.0163551	0.0145835
4215	Std. dev.	0.496528	0.0303087	0.0329272	0.0326107	0.463231	0.0245681	0.0202967	0.01978
4216	Mean	3.63771	0.0681596	0.0407281	0.0398545	3.55599	0.068837	0.0431101	0.0396657
4216	Std. dev.	0.819753	0.0566449	0.0502893	0.0567973	0.65509	0.0502564	0.0386974	0.0370993
4217	Mean	3.63515	0.068622	0.0407871	0.0399033	3.55764	0.0692138	0.0433238	0.0399472
4217	Std. dev.	0.831257	0.0582648	0.0501999	0.0563399	0.670685	0.0527542	0.0370411	0.0363281
4218	Mean	3.64044	0.0677887	0.0407821	0.0402036	3.57317	0.0683227	0.0426033	0.0398785
4218	Std. dev.	0.83262	0.056228	0.0501389	0.0561644	0.66561	0.050254	0.037793	0.0357485
4219	Mean	0.710085	0.0104045	0.00812785	0.00620462	0.869877	0.0112189	0.00771444	0.00576387
4219	Std. dev.	0.32482	0.0186583	0.0246295	0.0209736	0.33311	0.0139962	0.0123473	0.0113731
4220	Mean	0.517671	0.00718975	0.00552427	0.00445344	0.641511	0.00761312	0.00494134	0.00441281
4220	Std. dev.	0.258678	0.0132008	0.0201232	0.0155073	0.269794	0.0106226	0.00884873	0.00913749
4221	Mean	0.337647	0.00434062	0.00358766	0.00277494	0.426446	0.0045787	0.00300601	0.00261502
4221	Std. dev.	0.20659	0.0128716	0.0131341	0.011437	0.213989	0.0072601	0.00668756	0.00620275
4222	Mean	0.521032	0.0077144	0.00546658	0.00447612	0.649755	0.00776183	0.00484406	0.0042867
4222	Std. dev.	0.279521	0.0145655	0.020932	0.0164081	0.285119	0.0111528	0.00893593	0.00821292
4223	Mean	3.78568	0.0677544	0.0399391	0.0402727	3.67342	0.0674635	0.0430477	0.040038
4223	Std. dev.	0.868699	0.0573161	0.050791	0.0589461	0.704303	0.0504808	0.0392232	0.0362732



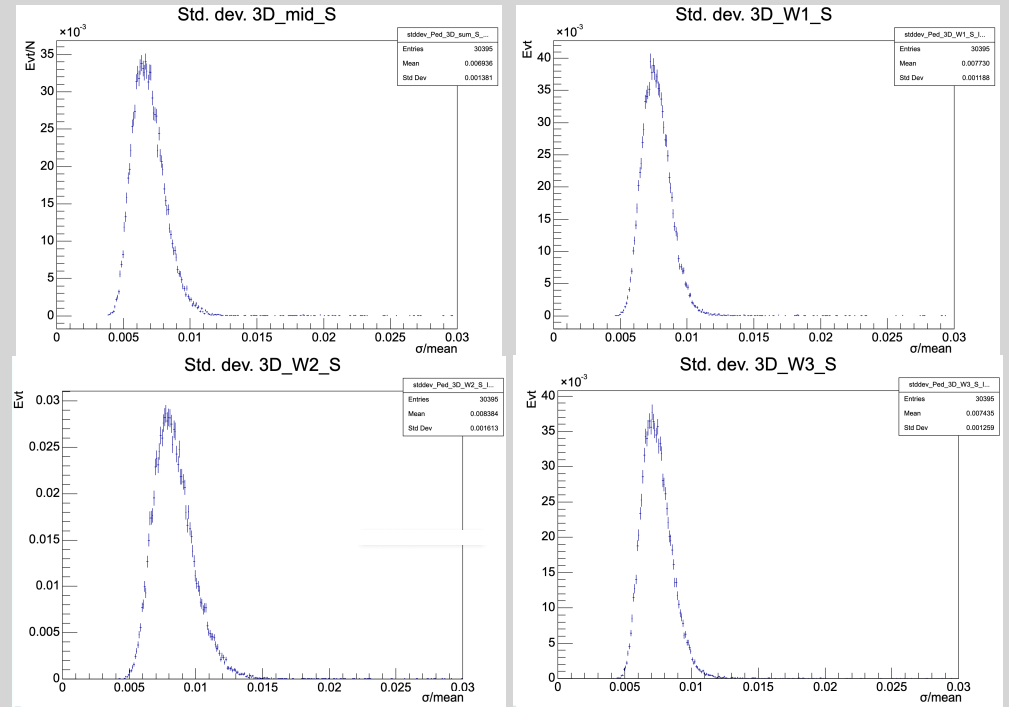
- Original goal: Set-2 Energy Calibration
- Run 4213: Negative E in Wing Towers after Calibration
- Ineffective Run Pedestal

# Analysis

Run: 4213  
N\_evt: 40,000



Pedestals vs Wave



SV of event pedestal

- Discrepancies: Run vs. Event Pedestals.
- Run Pedestals: Exceed wave means.
- Event Pedestals: Effective subtraction.

# Solutions & Limits

- **Event Pedestal:**

Fine-tuning per event, risks over-precision.

- **Range Adjustment:**

Bias risk, limited effectiveness.

- **Event Selection Criteria:**

Positive means post-subtraction, bias potential, trigger  $\neq$  wing activation.

# Backup

# Energy Calibration

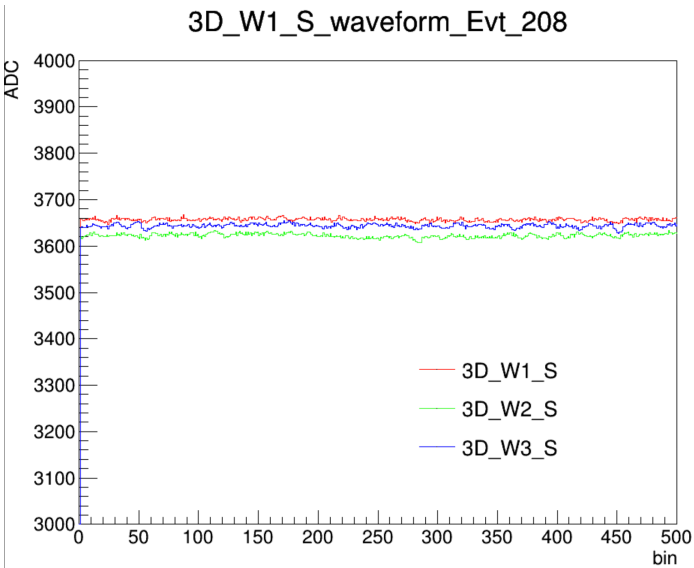
Run	Target	Ch	Mean	Tmp	Beam E	E deosit	Eq const
4173	3D	S	69100	5.79E-05	4	73.66	4.26E-05
		C	37060	1.08E-04	4	73.66	7.95E-05
	3D - W1	S	12946	3.09E-04	4	1.38	4.26E-06
		C	8799	4.55E-04	4	1.38	6.27E-06
	3D - W2	S	7637	5.24E-04	4	0.82	4.29E-06
		C	1832	2.18E-03	4	0.82	1.79E-05
	3D - W3	S	7030	5.69E-04	4	0.82	4.67E-06
		C	2159	1.85E-03	4	0.82	1.52E-05
4175	HW	S	83592	4.79E-05	4	82.14	3.93E-05
		C	50891	7.86E-05	4	82.14	6.46E-05
4177	H1	S	95728	4.18E-05	4	82.36	3.44E-05
		C	57617	6.94E-05	4	82.36	5.72E-05
4181	H2	S	91128	4.39E-05	4	82.32	3.61E-05
		C	58797	6.80E-05	4	82.32	5.60E-05
4179	H3	S	87456	4.57E-05	4	78.3	3.58E-05
		C	50032	7.99E-05	4	78.3	6.26E-05
4176	L1	S	67496	5.93E-05	4	71.2	4.22E-05
		C	42634	9.38E-05	4	71.2	6.68E-05
4182	L2	S	111229	3.60E-05	4	71.33	2.57E-05
		C	7906	5.06E-04	4	71.33	3.61E-04
4178	L3	S	61265	6.53E-05	4	67.66	4.42E-05
		C	37920	1.05E-04	4	67.66	7.14E-05
4180	L4	S	40720	9.82E-05	4	68.14	6.69E-05
		C	20577	1.94E-04	4	68.14	1.32E-04

Deposit E		3D_sum_C	3D_W1_C	3D_W2_C	3D_W3_C	3D_sum_S	3D_W1_S	3D_W2_S	3D_W3_S
4207	Mean	2.933	0.05489	0.03243	0.03226	2.934	0.05549	0.03353	0.03204
4207	Std. dev.	0.736	0.05036	0.04542	0.0513	0.5951	0.04368	0.03316	0.03256
4208	Mean	2.93976	0.0539399	0.0314306	0.0310168	2.94904	0.0548128	0.034306	0.0312685
4208	Std. dev.	0.734116	0.0487607	0.0447764	0.0518998	0.598892	0.0439925	0.0349857	0.0324778
4209	Mean	2.93825	0.0540797	0.0322488	0.0316756	2.94321	0.0547324	0.033976	0.0315548
4209	Std. dev.	0.735127	0.0501178	0.0464437	0.0520095	0.588573	0.0433508	0.0319352	0.0328898
4210	Mean	2.23242	0.0394645	0.0244963	0.0226604	2.35058	0.0402978	0.0253697	0.0230472
4210	Std. dev.	0.620275	0.0407766	0.0408611	0.0403874	0.518058	0.035099	0.0263984	0.0259034
4211	Mean	2.23071	0.0397913	0.024402	0.0235093	2.36442	0.0404988	0.0253657	0.0234186
4211	Std. dev.	0.626196	0.0400474	0.0397794	0.0443853	0.527923	0.0348623	0.0267814	0.0269315
4212	Mean	2.23811	0.0398993	0.0251221	0.0238962	2.37221	0.0405943	0.0256937	0.0234287
4212	Std. dev.	0.62739	0.0399361	0.041496	0.0439514	0.533293	0.0349255	0.0269553	0.0268159
4213	Mean	1.48574	0.0252291	0.0161538	0.0142479	1.45081	0.00121508	-0.0162104	-0.0170177
4213	Std. dev.	0.494397	0.0304242	0.0337351	0.0325825	0.461437	0.0250949	0.0199878	0.0202329
4214	Mean	1.49011	0.0248597	0.0159081	0.0143311	1.71104	0.0255804	0.0164825	0.014543
4214	Std. dev.	0.501658	0.0302588	0.0335326	0.0334506	0.462586	0.0246482	0.0202822	0.019481
4215	Mean	1.48089	0.0250454	0.0160176	0.0143026	1.70016	0.0256535	0.0163551	0.0145835
4215	Std. dev.	0.496528	0.0303087	0.0329272	0.0326107	0.463231	0.0245681	0.0202967	0.01978
4216	Mean	3.63771	0.0681596	0.0407281	0.0398545	3.55599	0.068837	0.0431101	0.0396657
4216	Std. dev.	0.819753	0.0566449	0.0502893	0.0567973	0.65509	0.0502564	0.0386974	0.0370993
4217	Mean	3.63515	0.068622	0.0407871	0.0399033	3.55764	0.0692138	0.0433238	0.0399472
4217	Std. dev.	0.831257	0.0582648	0.0501999	0.0563399	0.670685	0.0527542	0.0370411	0.0363281
4218	Mean	3.64044	0.0677887	0.0407821	0.0402036	3.57317	0.0683227	0.0426033	0.0398785
4218	Std. dev.	0.83262	0.056228	0.0501389	0.0561644	0.66561	0.050254	0.037793	0.0357485
4219	Mean	0.710085	0.0104045	0.00812785	0.00620462	0.869877	0.0112189	0.00771444	0.00576387
4219	Std. dev.	0.32482	0.0186583	0.0246295	0.0209736	0.33311	0.0139962	0.0123473	0.0113731
4220	Mean	0.517671	0.00718975	0.00552427	0.00445344	0.641511	0.00761312	0.00494134	0.00441281
4220	Std. dev.	0.258678	0.0132008	0.0201232	0.0155073	0.269794	0.0106226	0.00884873	0.00913749
4221	Mean	0.337647	0.00434062	0.00358766	0.00277494	0.426446	0.0045787	0.00300601	0.00261502
4221	Std. dev.	0.20659	0.0128716	0.0131341	0.011437	0.213989	0.0072601	0.00668756	0.00620275
4222	Mean	0.521032	0.0077144	0.00546658	0.00447612	0.649755	0.00776183	0.00484406	0.0042867
4222	Std. dev.	0.279521	0.0145655	0.020932	0.0164081	0.285119	0.0111528	0.00893593	0.00821292
4223	Mean	3.78568	0.0677544	0.0399391	0.0402727	3.67342	0.0674635	0.0430477	0.040038
4223	Std. dev.	0.868699	0.0573161	0.050791	0.0589461	0.704303	0.0504808	0.0392232	0.0362732

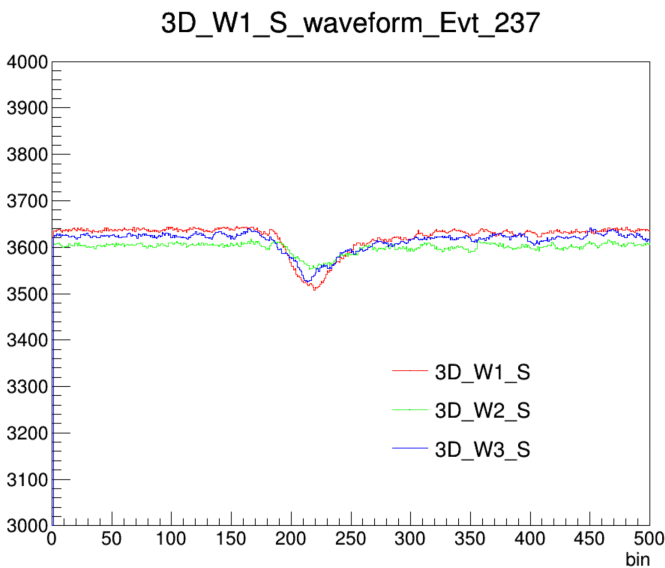
- Equilization Constant

- Deposit Energy

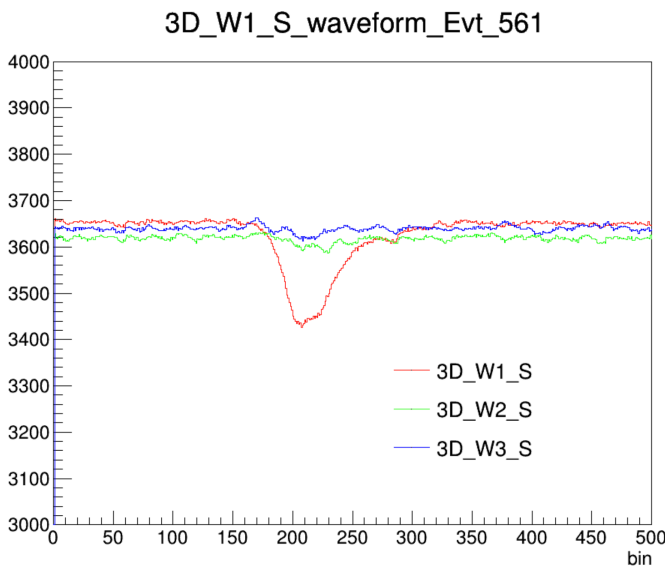
# Waveforms



• No signal



• Full signal



• Partial signal

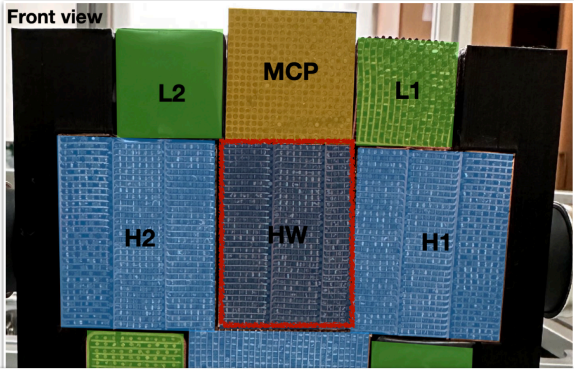
# DRC winter workshop 2024

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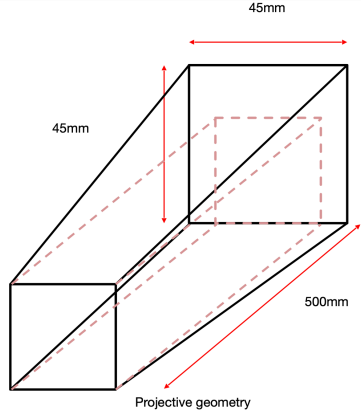
SKKU  
Hyungjun Lee



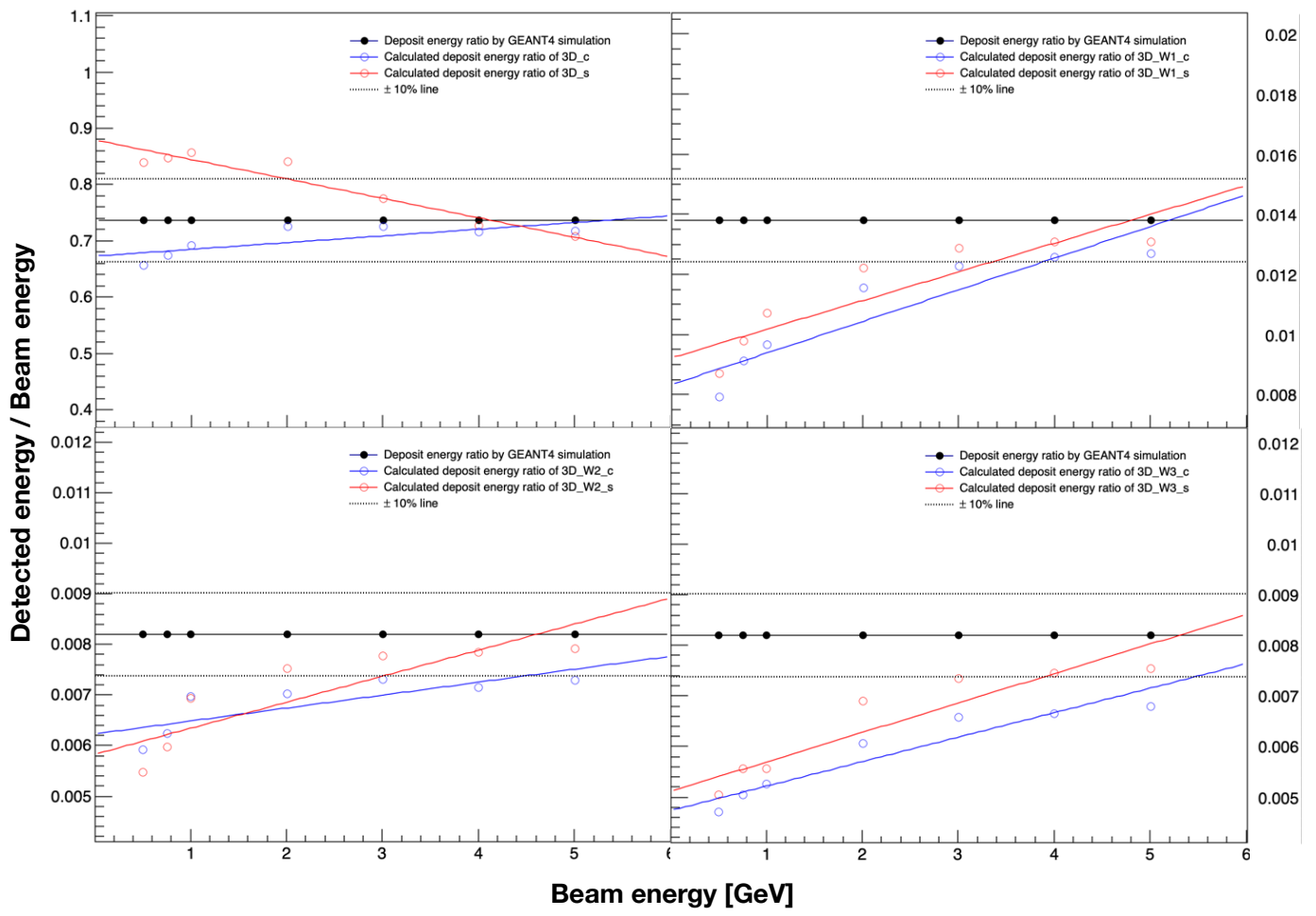
# 2024 TB Set 2



Energy scan set-2 (6mm collimator, no angle, with AstroPix)									
Run	Wave	Trigger	Collimator	Rotation (deg)	Tilt (deg)	Particle	Energy (GeV)	Beam Target	Detail
4207	30267						4		
4208	30234						4		
4209	40357						4		
4210	30611						3		
4211	30269						3		
4212	40425						3		
4213	42658						2		
4214	30314	Using Trigger-1, Trigger-2	6 mm (± 2% momentum spread)	x	x	e+	2	3D	e+ energy scan runs (using wide collimator, without angle, with AstroPix)
4215	30328						2		
4216	30416						5		
4217	30299						5		
4218	40890						5		
4219	50017						1		
4220	4013						0.75		
4221	10016						0.5		
4222	6014						0.75		
4223	10332						5		



# Linearity

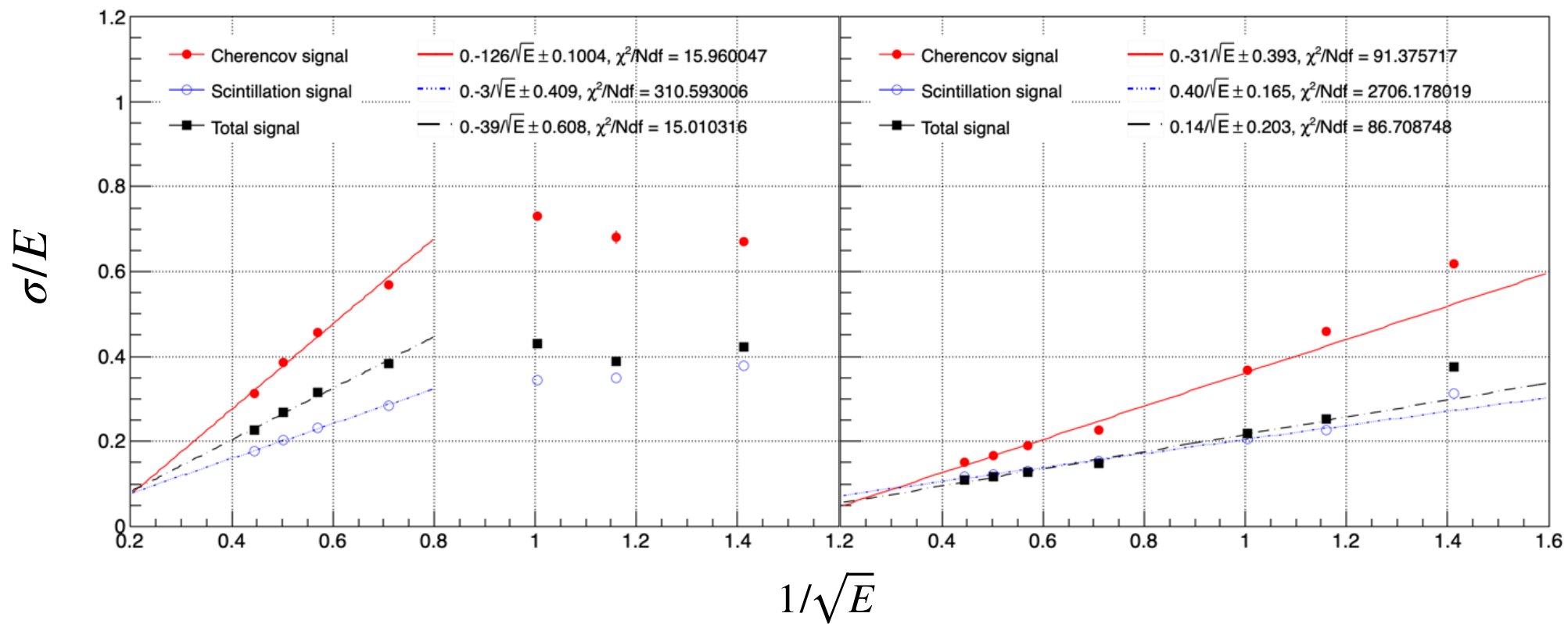


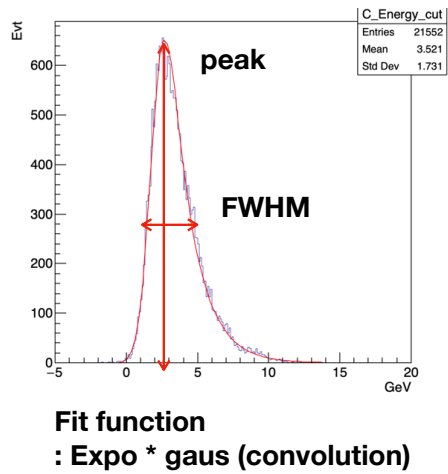


# Energy resolution

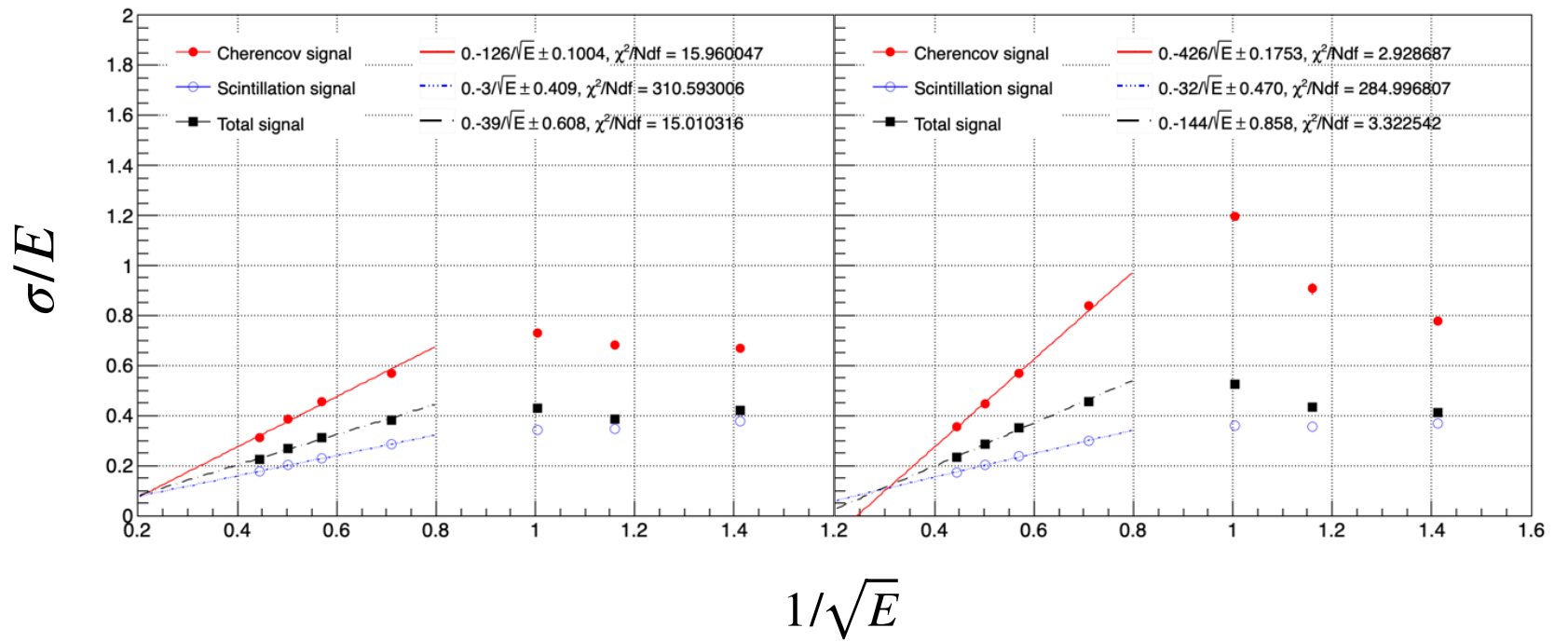
## Run pedestal

## Event pedestal

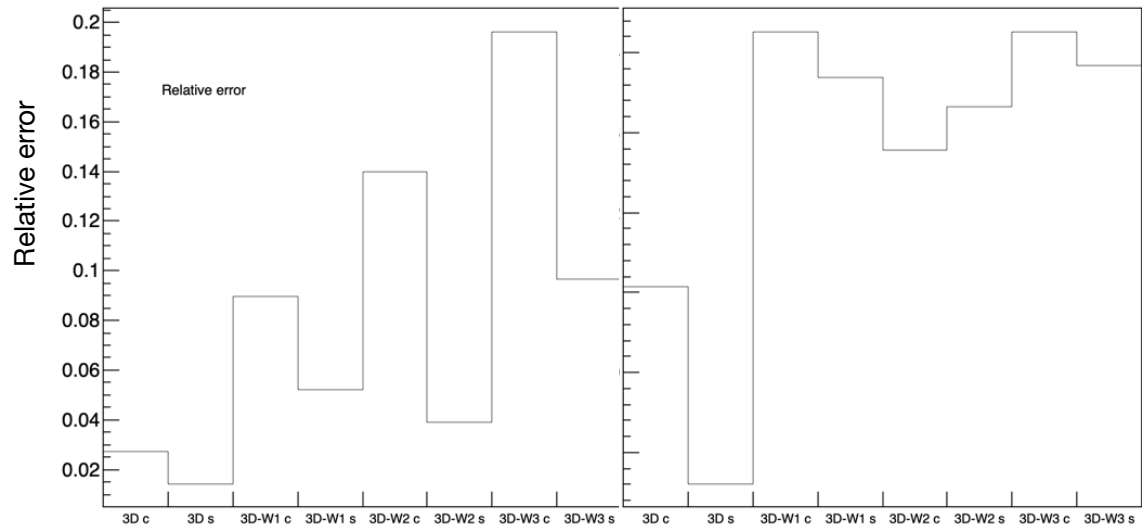
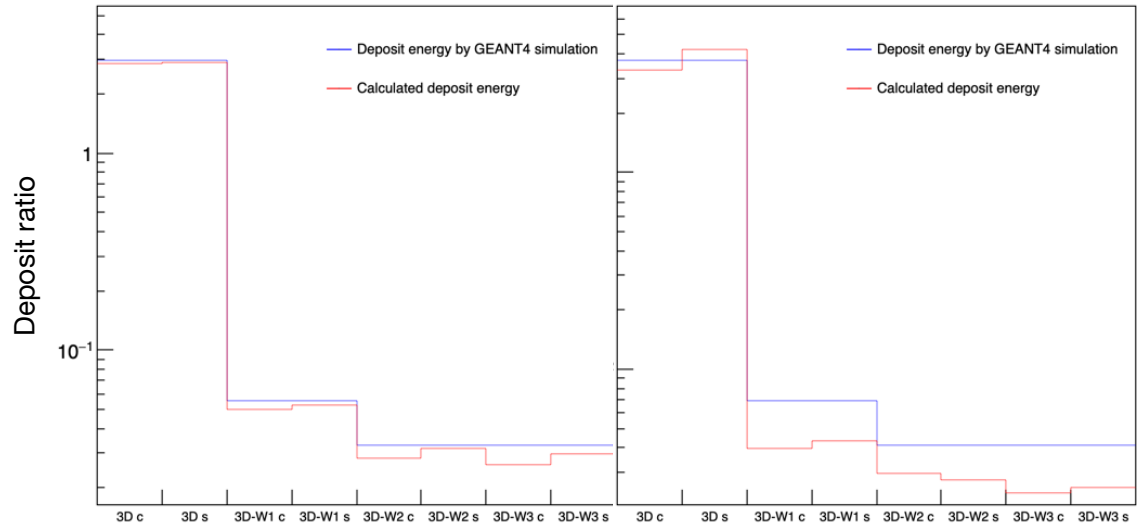




## Run pedestal



Backup



Detector type

# GWNU Winter Workshop

# TB2023 Data Analysis

## - Energy Scan Set3 -

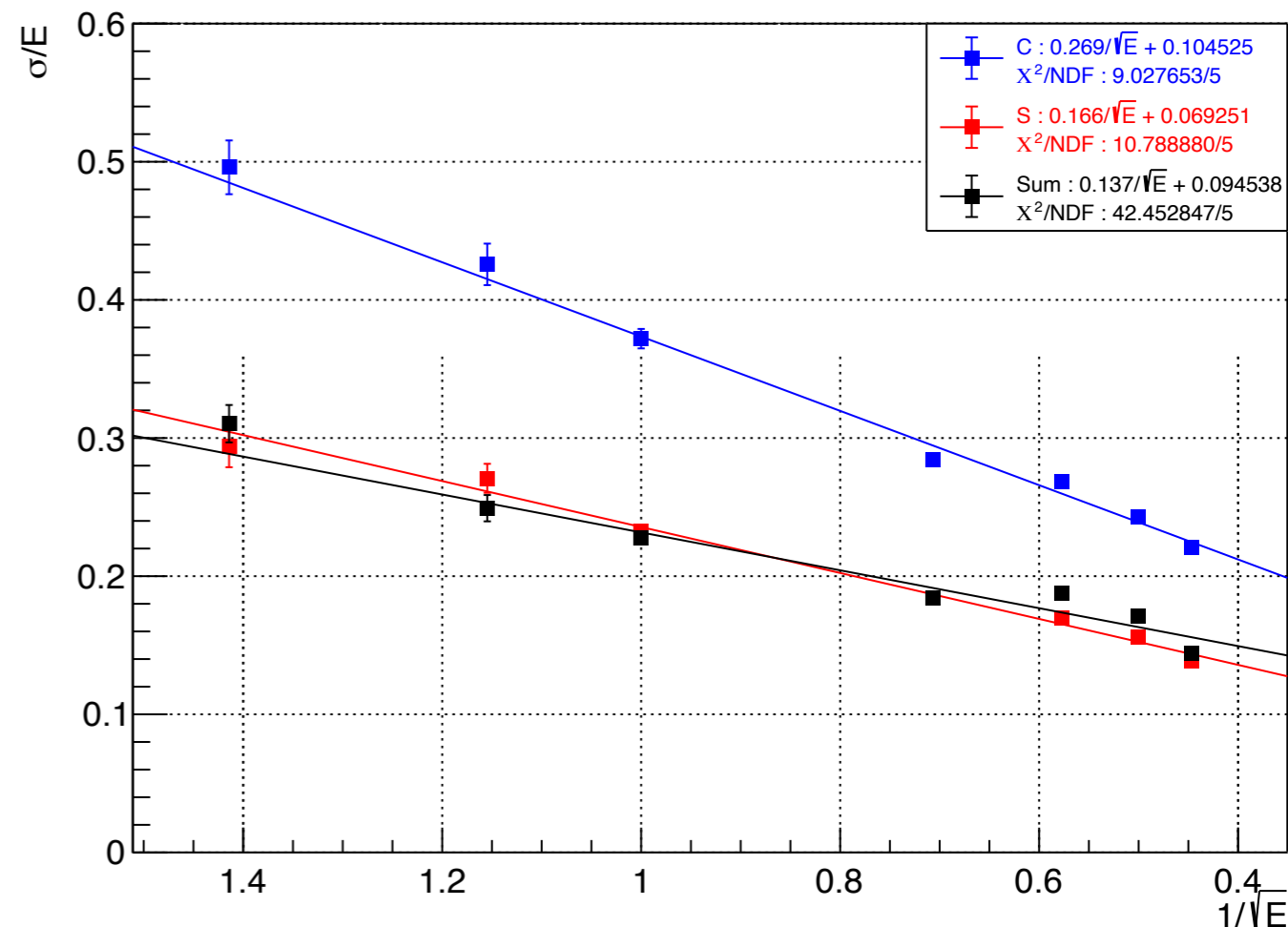
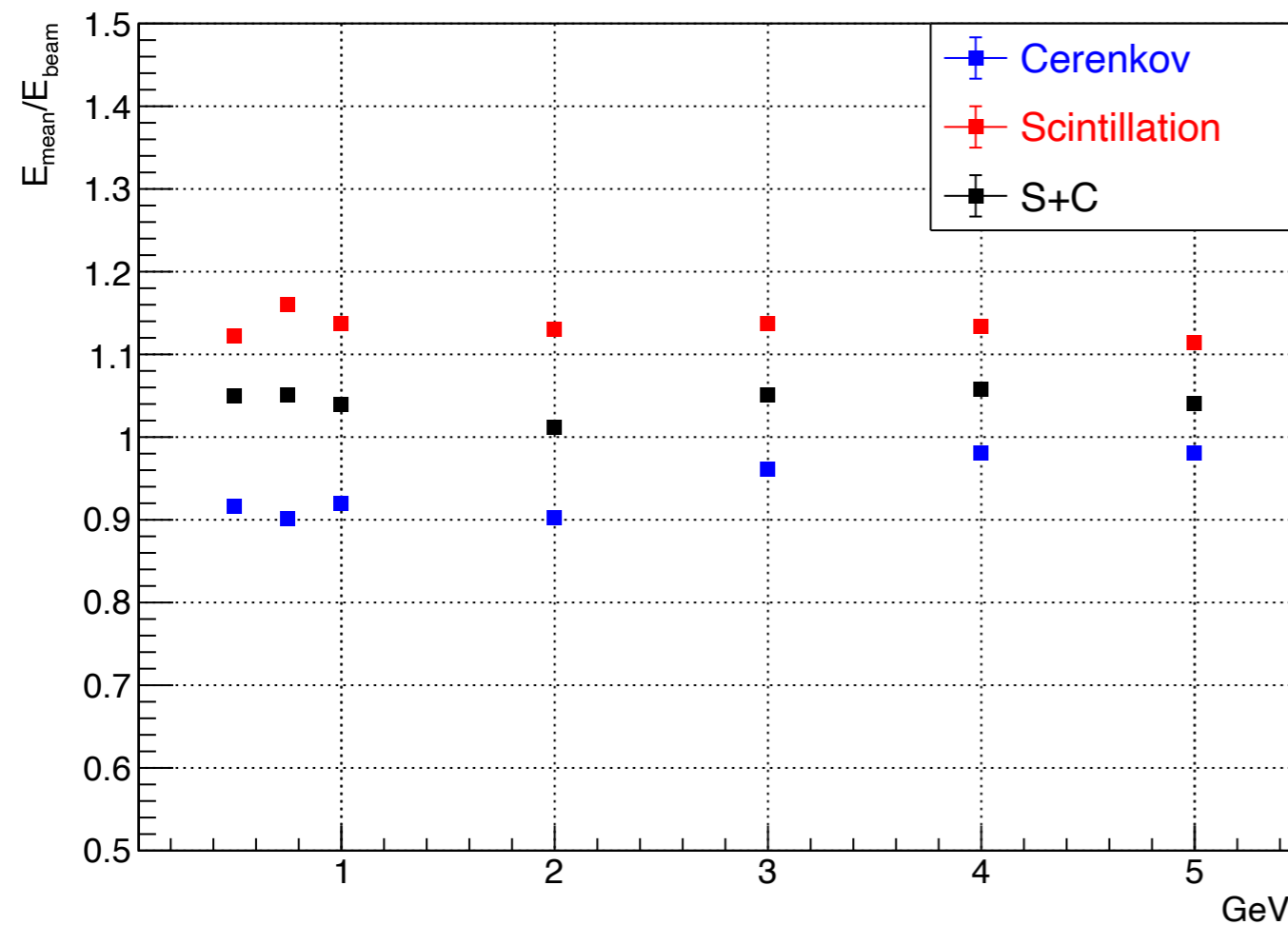
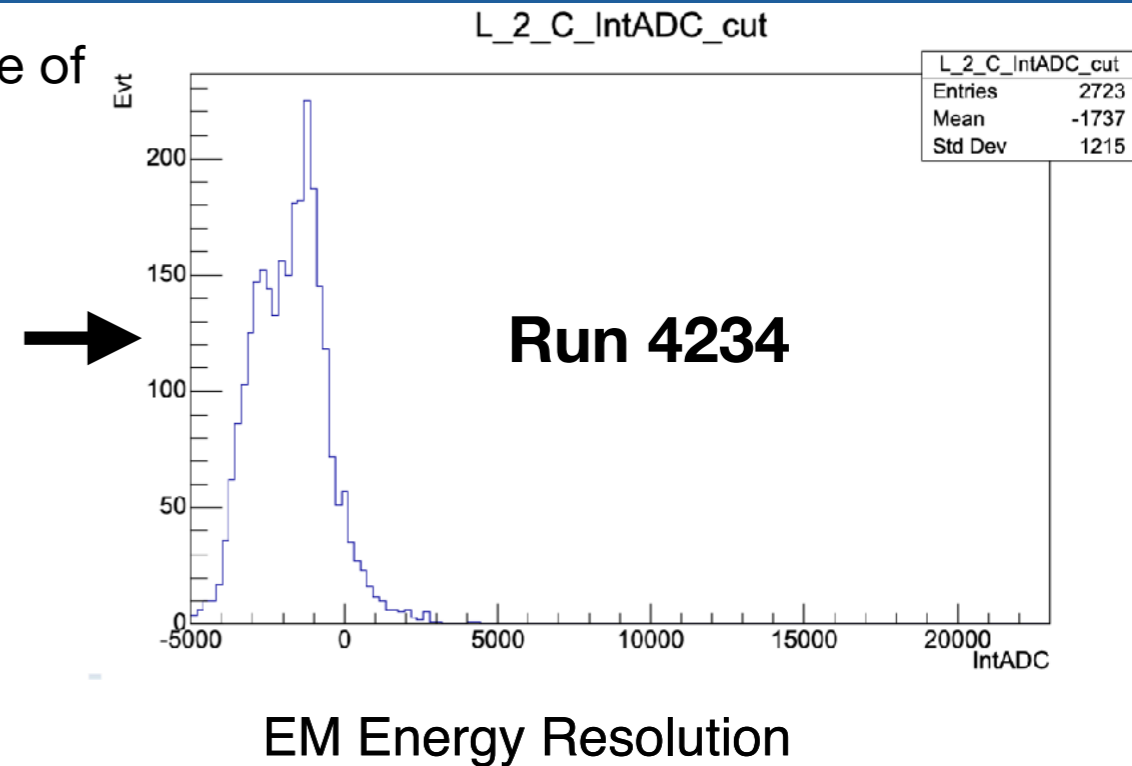
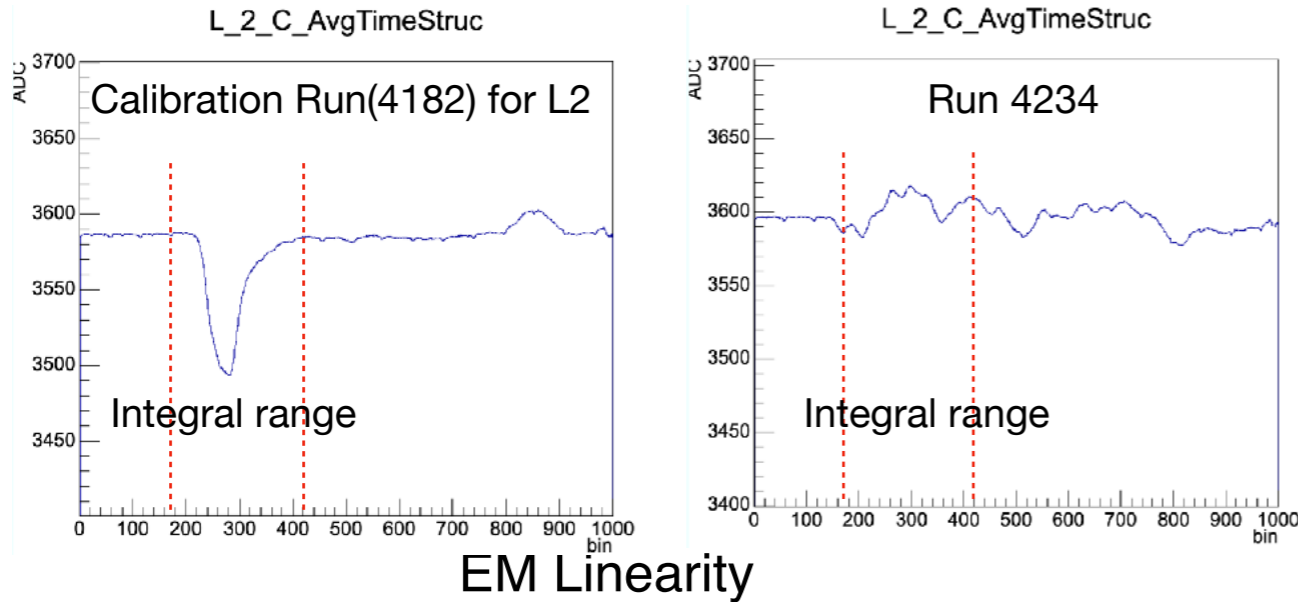
Guk Cho (Yonsei Univ.)

Energy scan set-3 (1.5mm collimator, no angle, no AstroPix)									
Run	Wave	Trigger	Collimator	Rotation (deg)	Tilt (deg)	Particle	Energy (GeV)	Beam Target	Detail
4234	5015	Using Trigger-1, Trigger-2	1.5 mm ( $\pm 0.7\%$ momentum spread)	x	x	e+	5	3D	e+ energy scan runs (1.5mm collimator, w/o angle, w/o AstroPix)
4235	5039						4		
4236	5060						3		
4237	5058						2		
4238	5005						1		
4239	1001						0.75		
4240	1001						0.5		
4241	501						0.5		
4242	504						0.75		

- e+ beam
- GeV range: 0.5, 0.75, 1, 2, 3, 4, 5
- 1.5mm collimator
- No angle
- No AstroPix

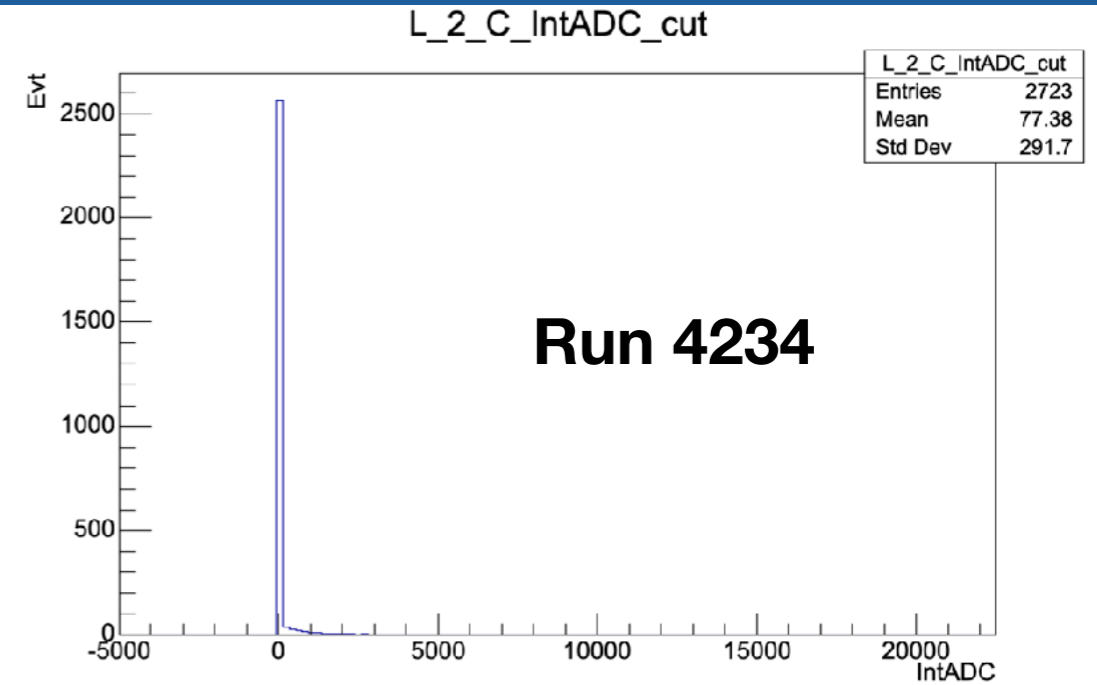
# Linearity & Energy Resolution: Run Pedestal (i)

- There is negative IntADC values in Lego-like modules because of fluctuation in integral range

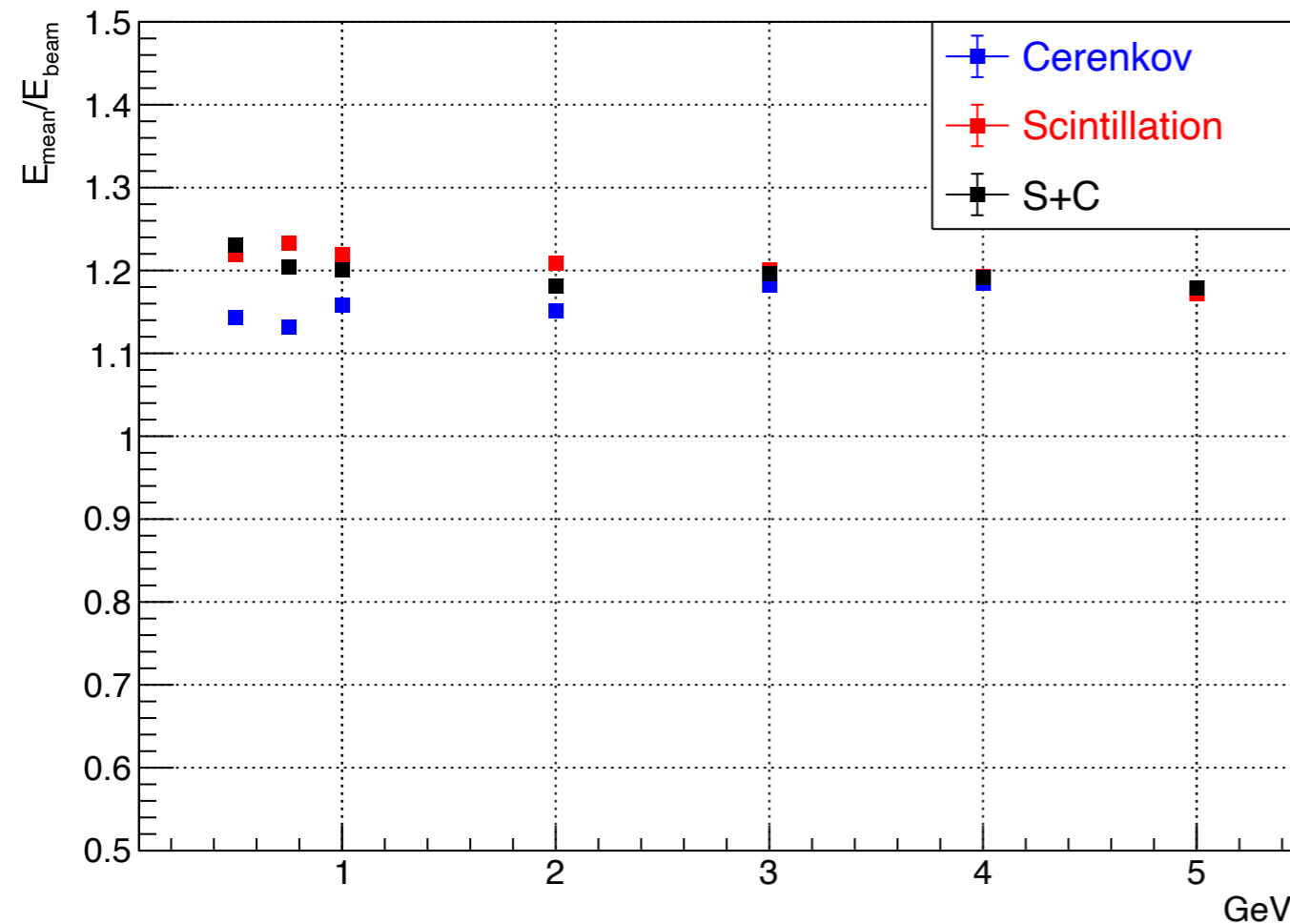


# Linearity & Energy Resolution: Run Pedestal (ii)

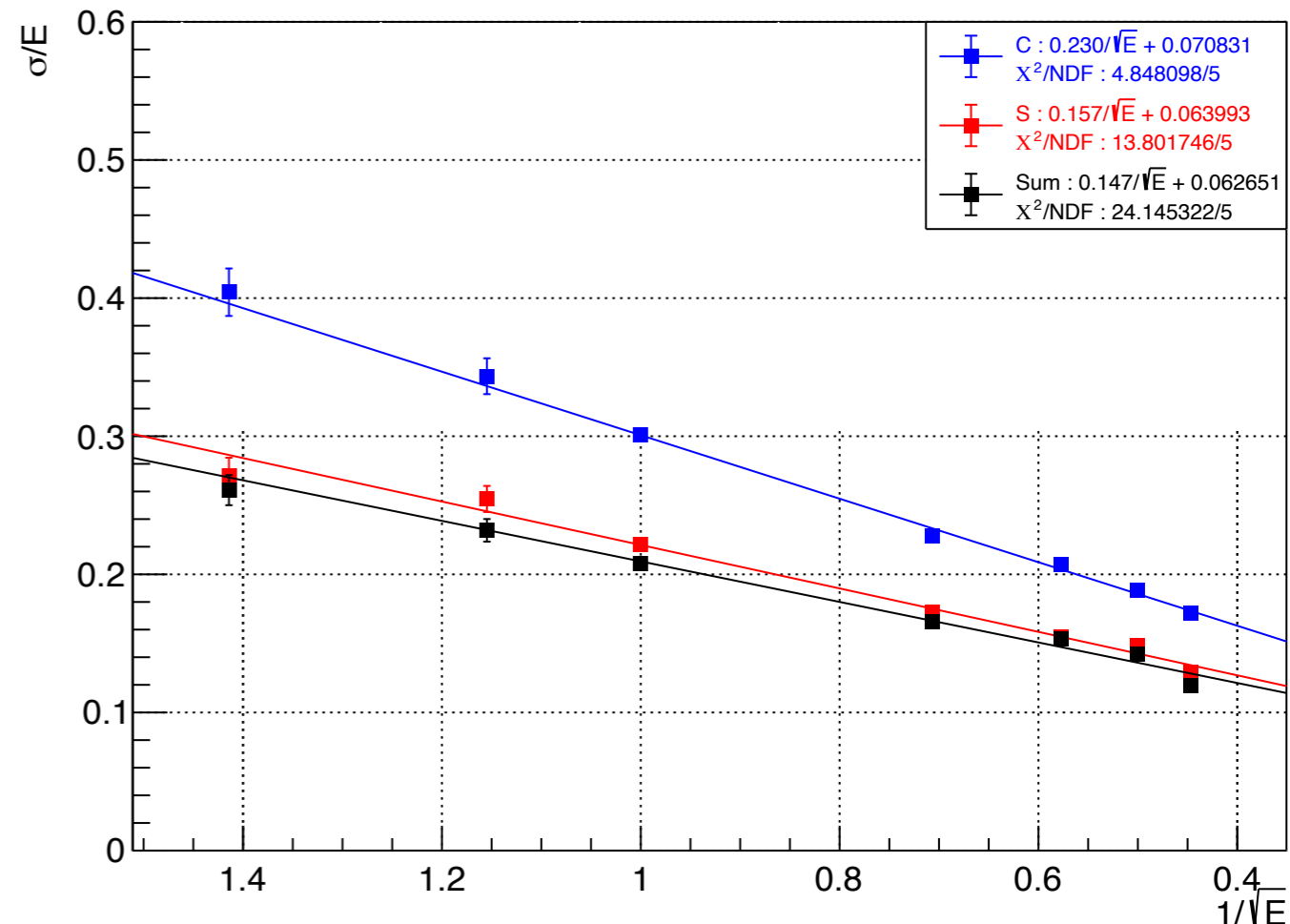
- Negative IntADC value of all module is set to 0 value
- Linearity and energy resolution is better



EM Linearity



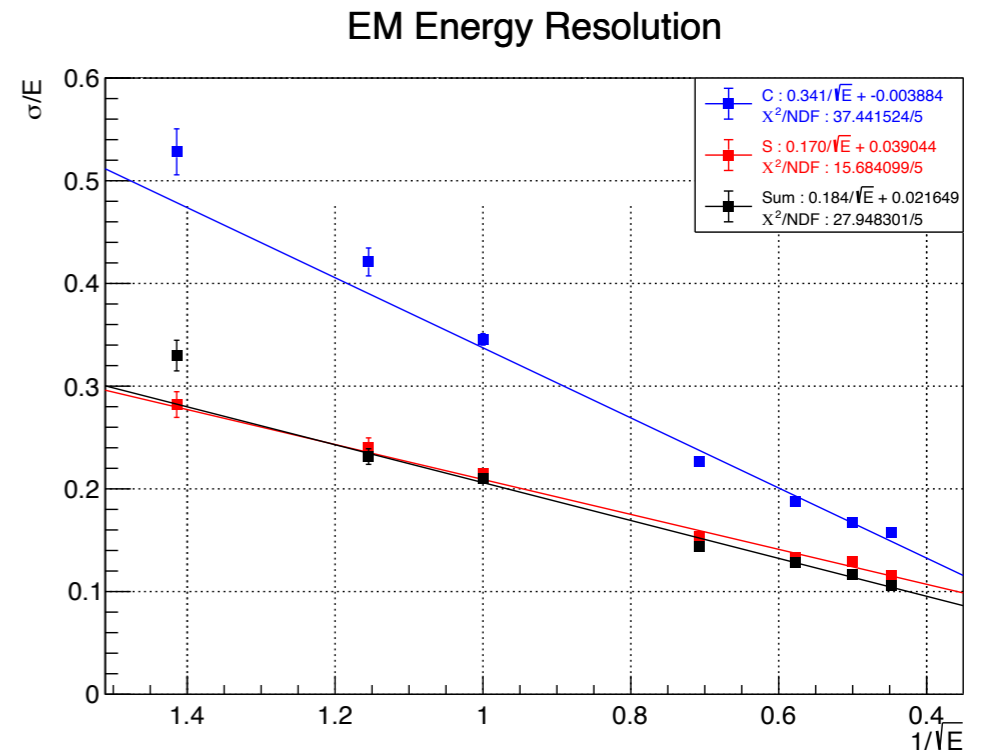
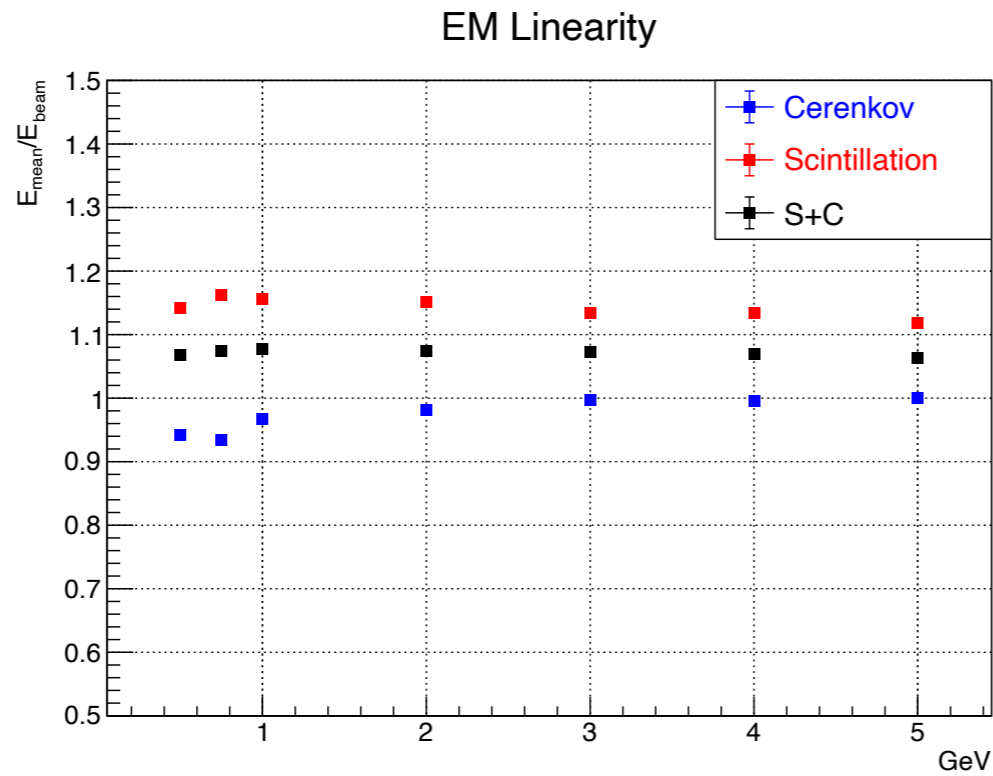
EM Energy Resolution



# Linearity & Energy Resolution: Event Pedestal

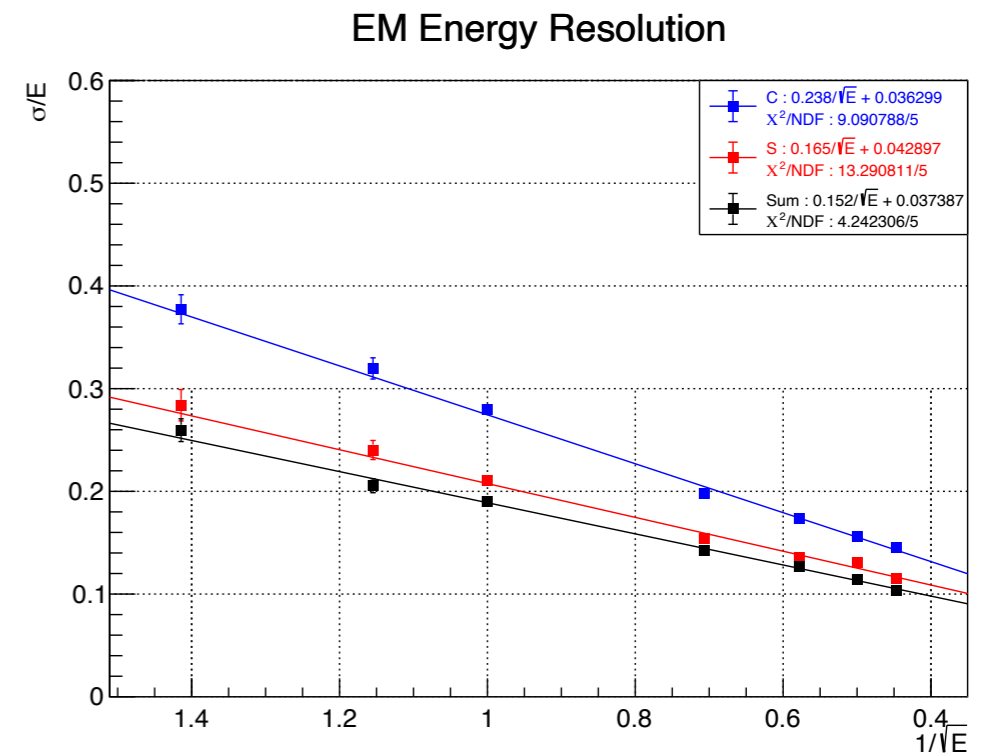
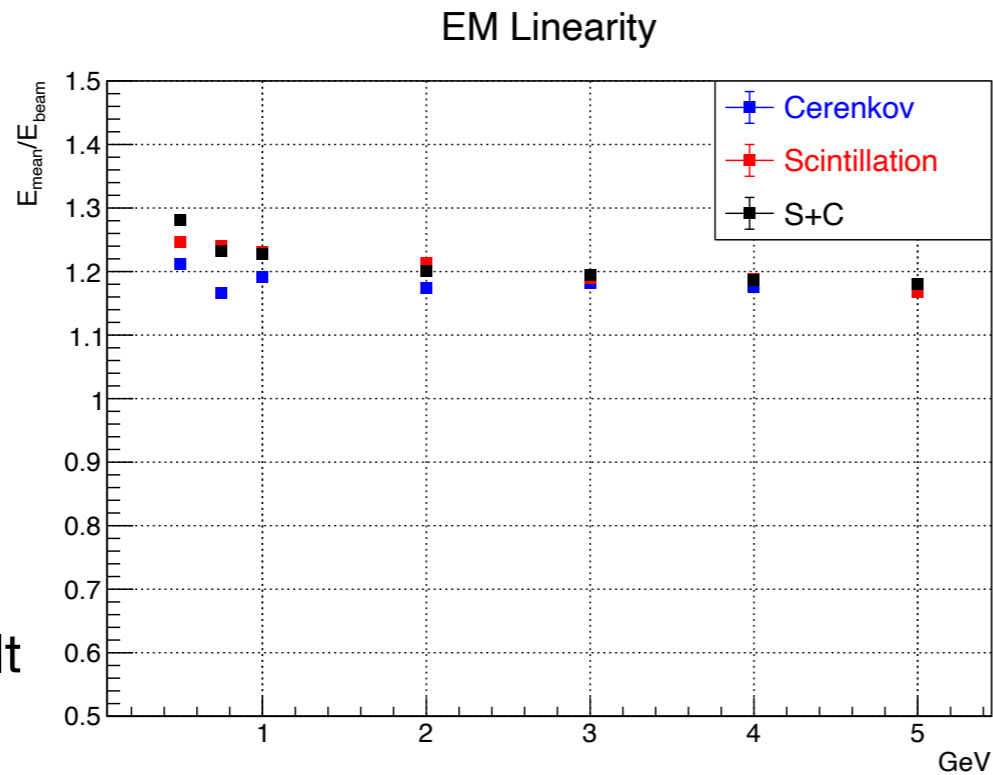
- Apply event pedestal

1. Negative IntADC value



2. No Negative IntADC value

- (Negative value is set to 0)



- This is the best result



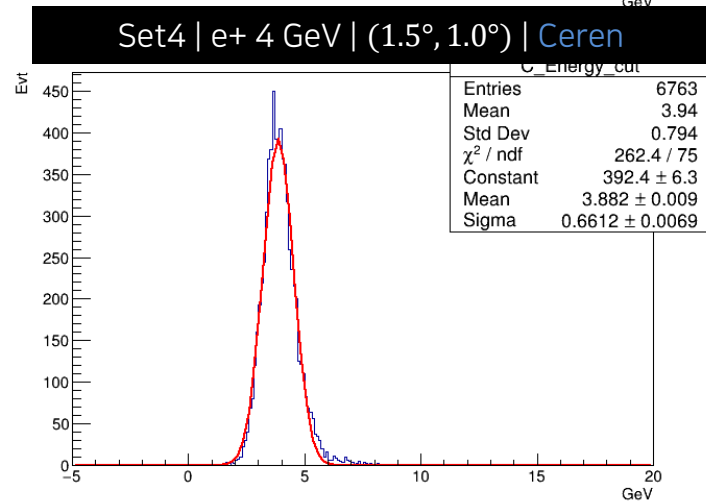
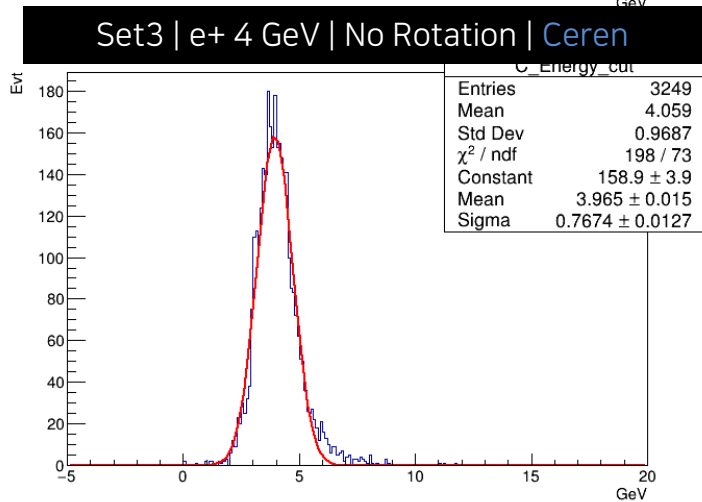
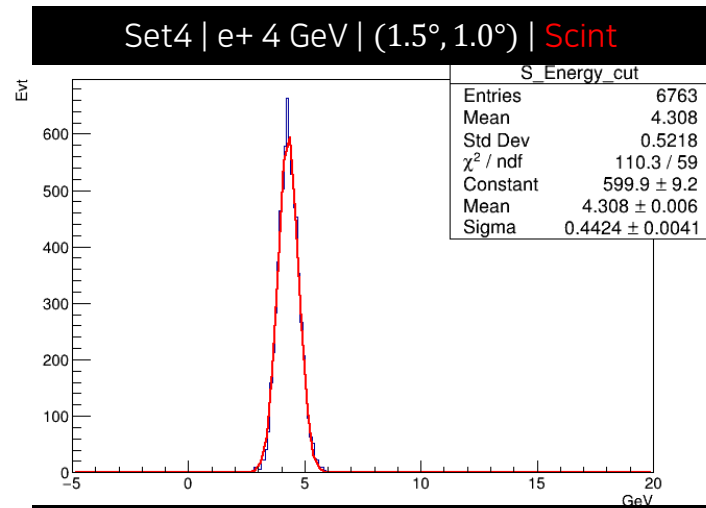
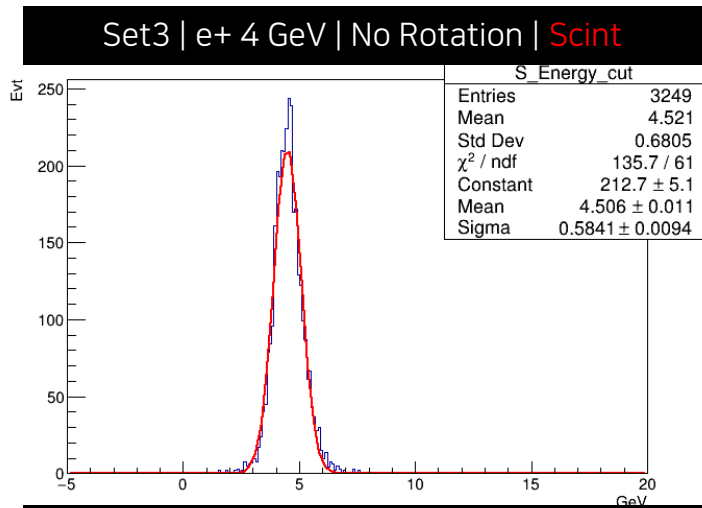
TB2023 W.W.

2024 .02 .18

Seoyun Jang

# Energy Resolution Set 3,4

## 4GeV positron, reconstructed energy

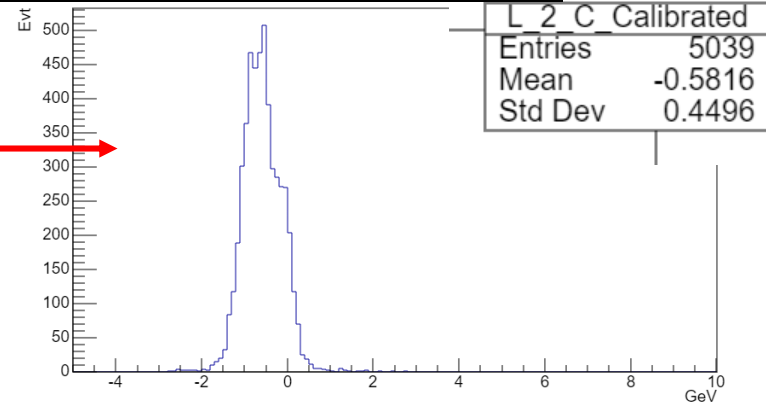
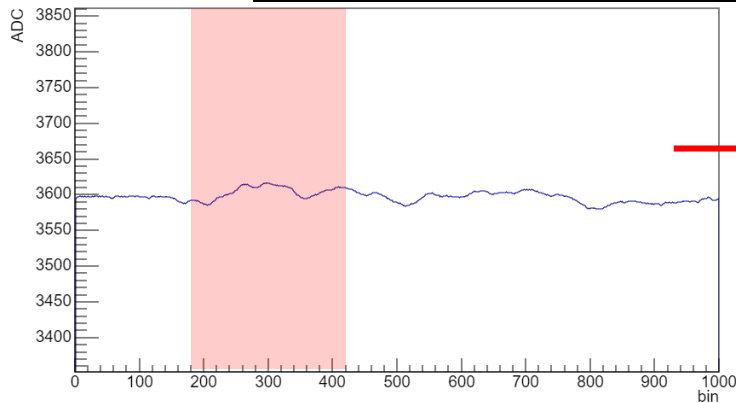


- Compared energy resolution set3, 4, which the only difference is rotation.
- All runs are taken at 1.5mm collimator ( $\pm 0.7\%$  momentum spread), 3D module center.

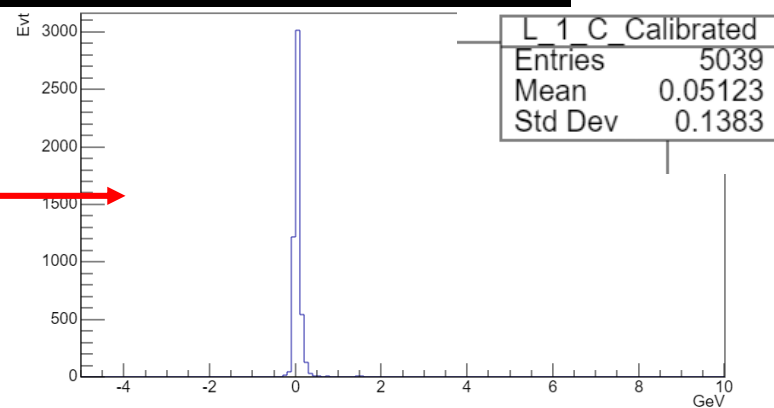
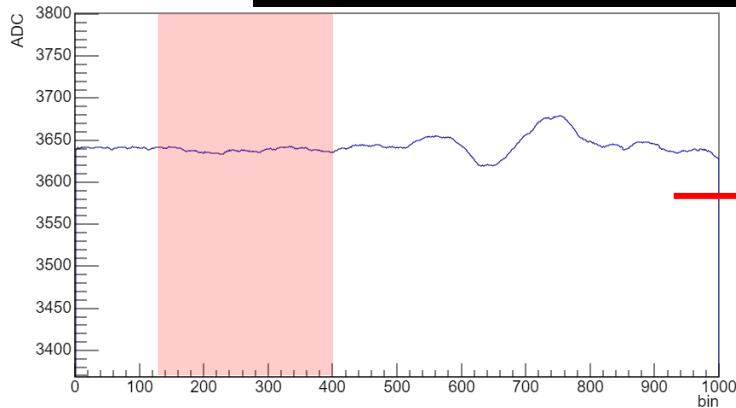
# Energy Resolution Set 3,4

## Lego-Like module issue

Run 4235 L2 Cerenkov (e+ 4GeV) (No rotation)



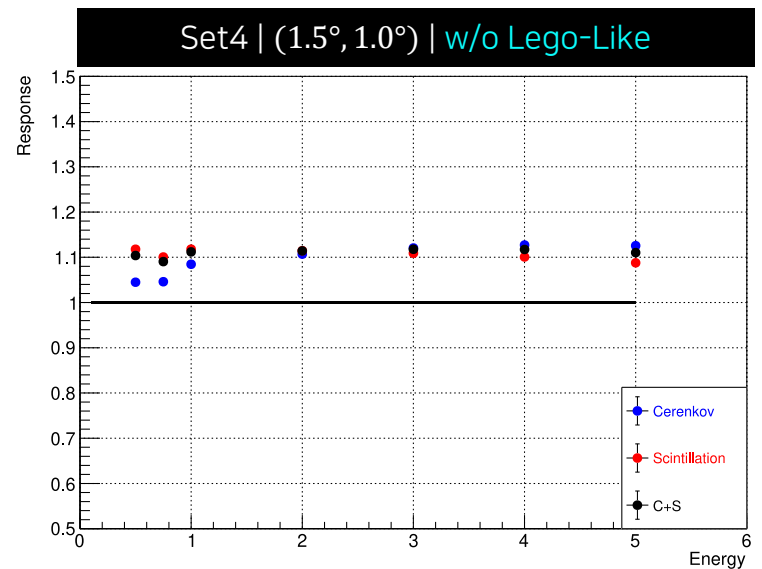
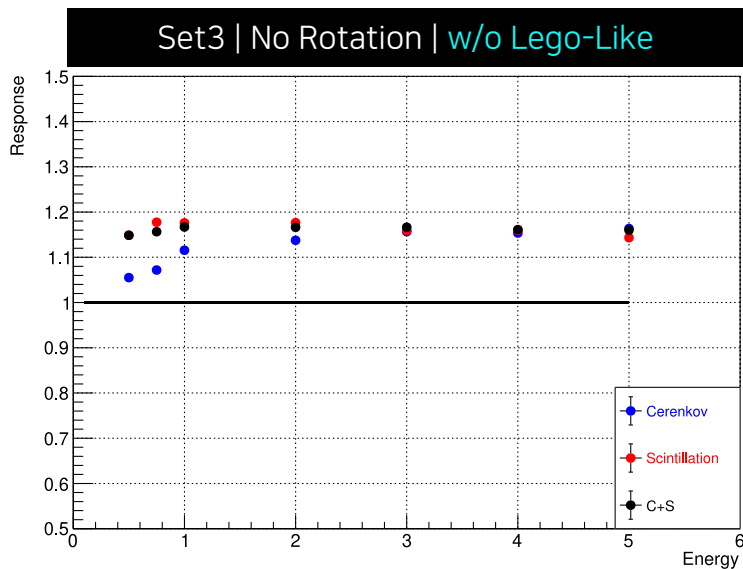
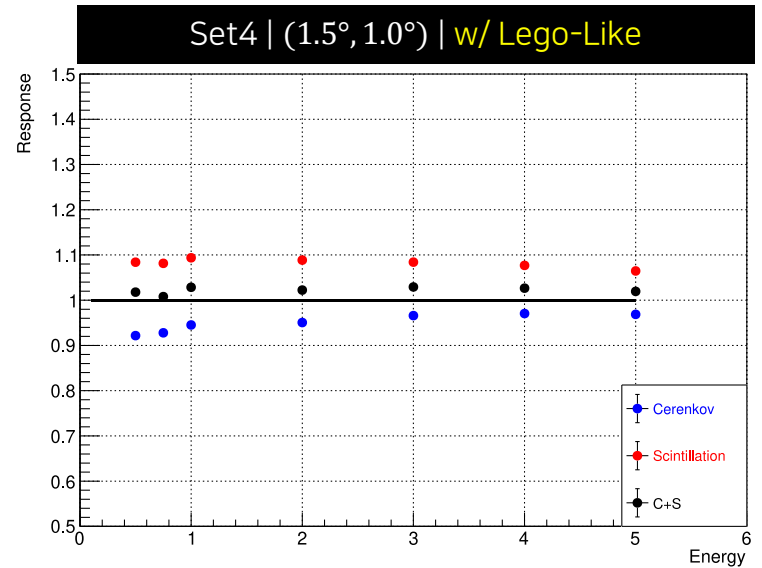
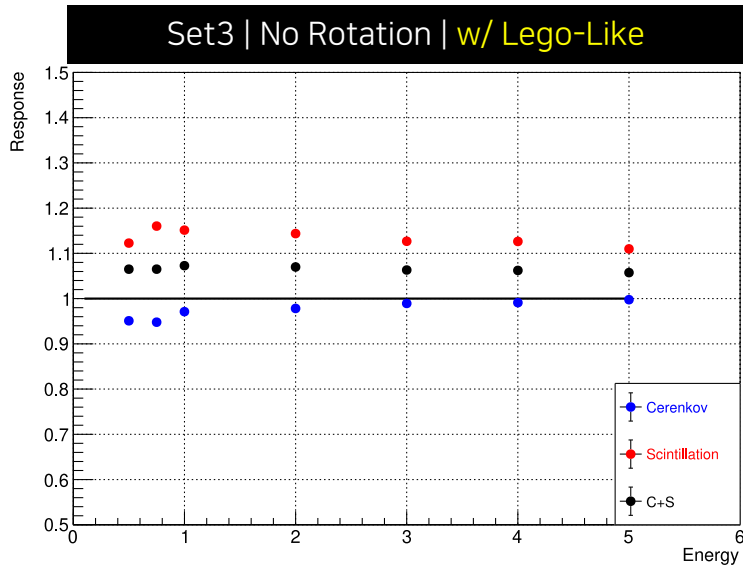
Run 4235 L1 Cerenkov (e+ 4GeV) (No rotation)



- L2 module, which we used different PMT type, gives strange-unphysical shape.
- This result effects linearity and resolution of total summed data.
- So also compared results between w/, w/o Lego-Like module signals.

# Energy Resolution Set 3,4

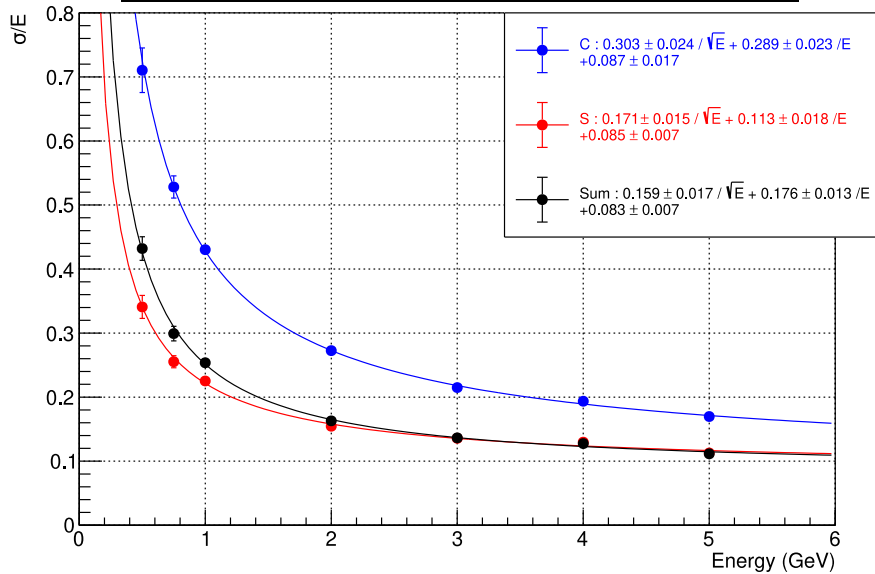
## e+ Energy Linearity



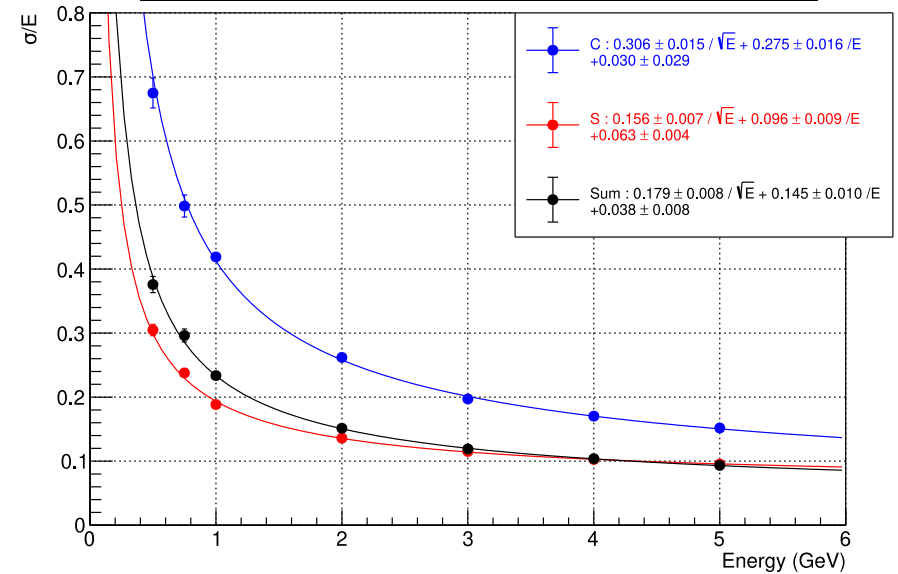
# Energy Resolution Set 3,4

## e+ Energy Resolution

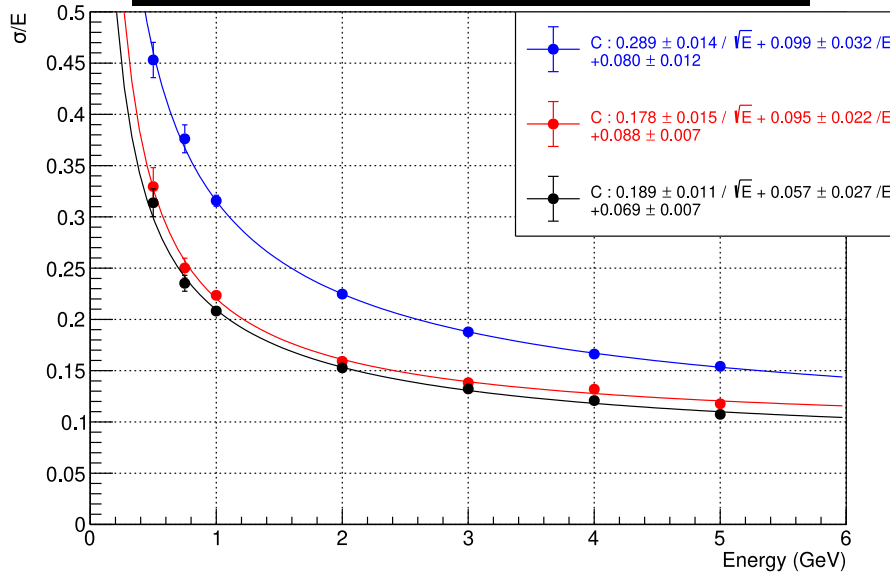
Set3 | No Rotation | w/ Lego-Like



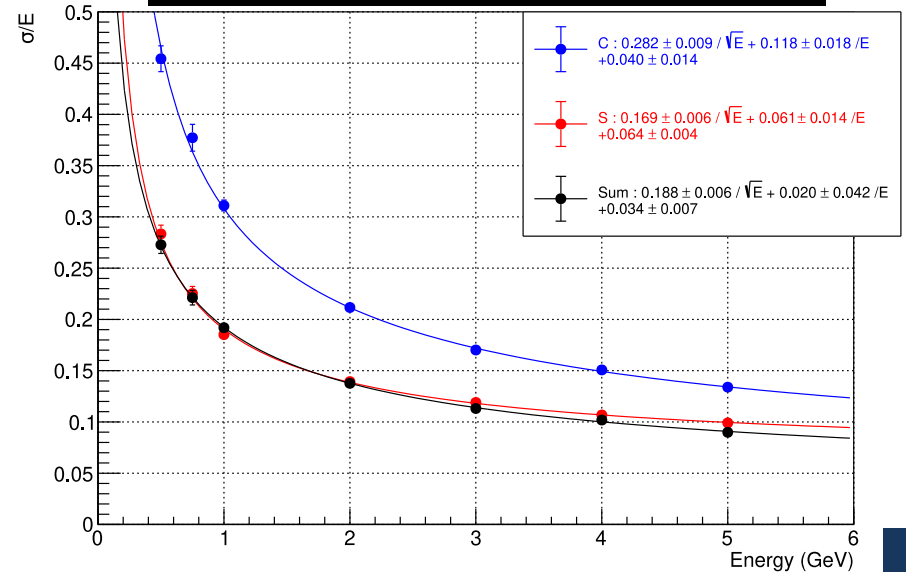
Set4 | (1.5°, 1.0°) | w/ Lego-Like



Set3 | No Rotation | w/o Lego-Like



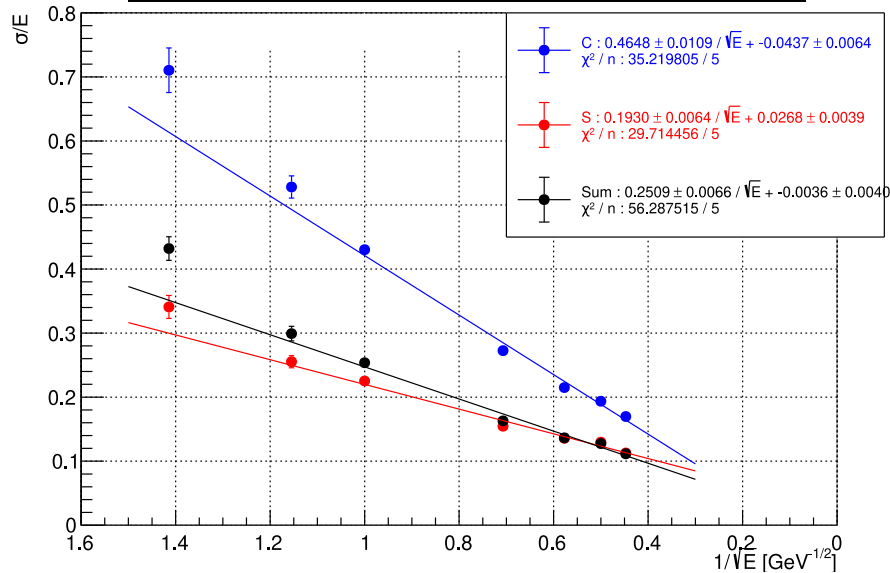
Set4 | (1.5°, 1.0°) | w/o Lego-Like



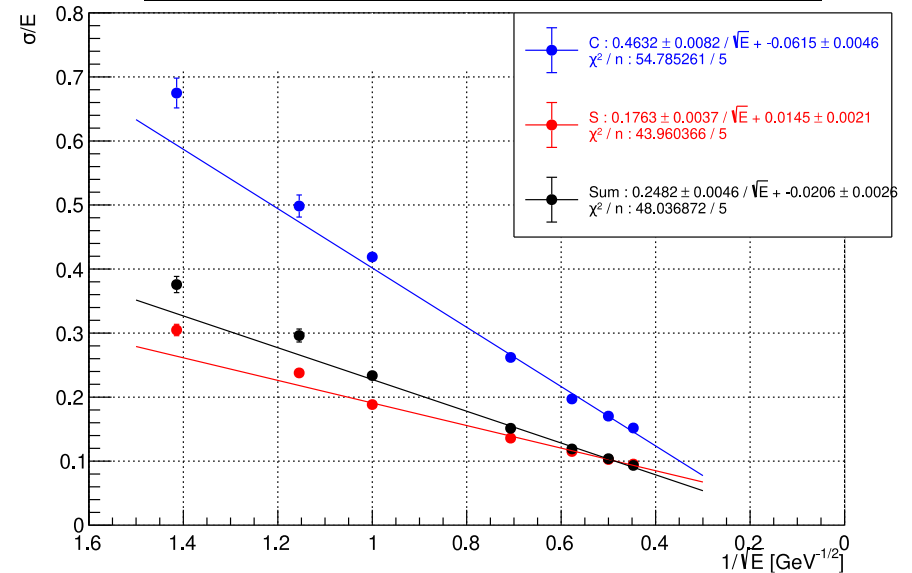
# Energy Resolution Set 3,4

## e+ Energy Resolution

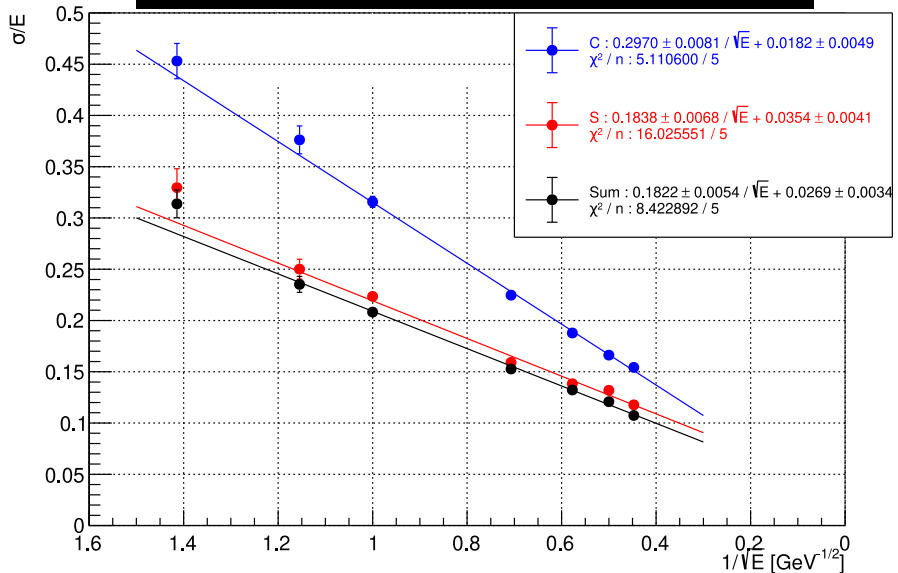
Set3 | No Rotation | w/ Lego-Like



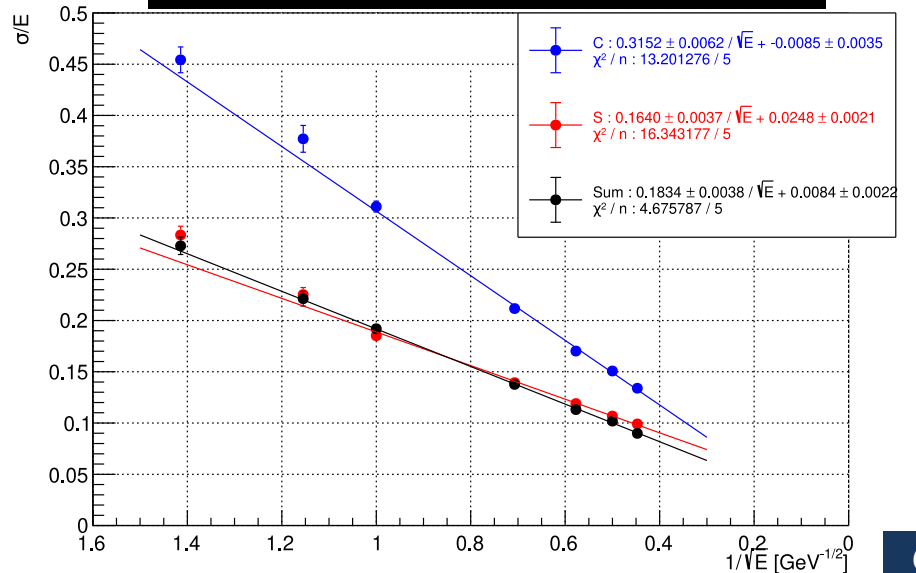
Set4 | (1.5°, 1.0°) | w/ Lego-Like



Set3 | No Rotation | w/o Lego-Like



Set4 | (1.5°, 1.0°) | w/o Lego-Like

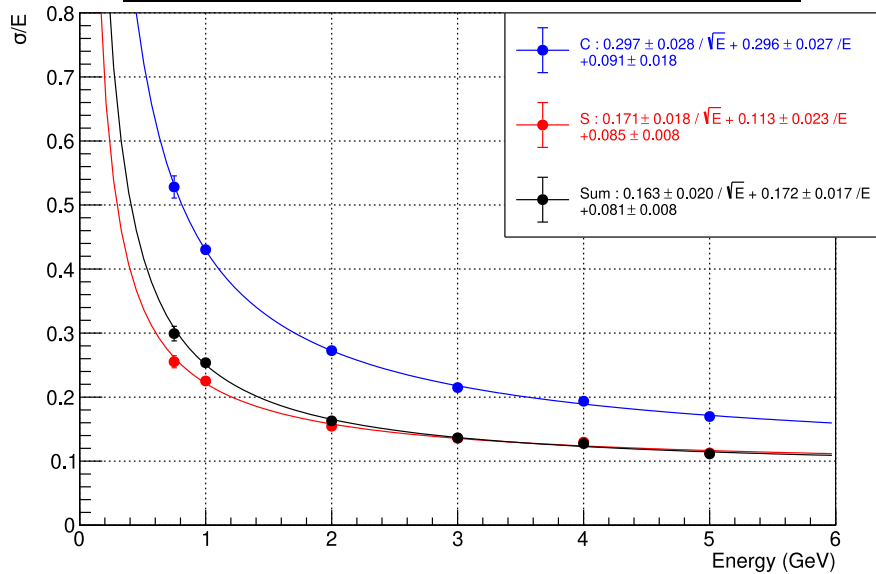


**Backup**

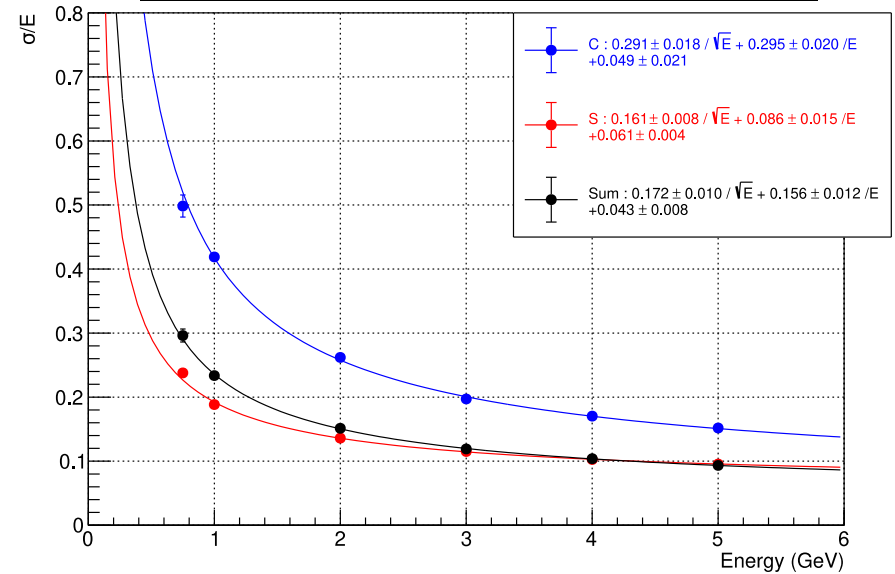
# Energy Resolution Set 3,4

## e+ Energy Resolution w/o 0.5 GeV point

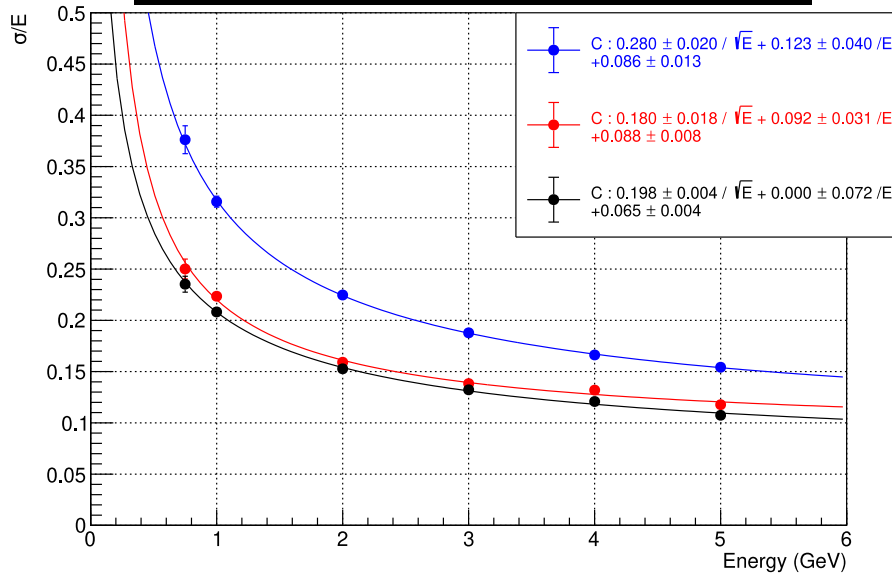
Set3 | No Rotation | w/ Lego-Like



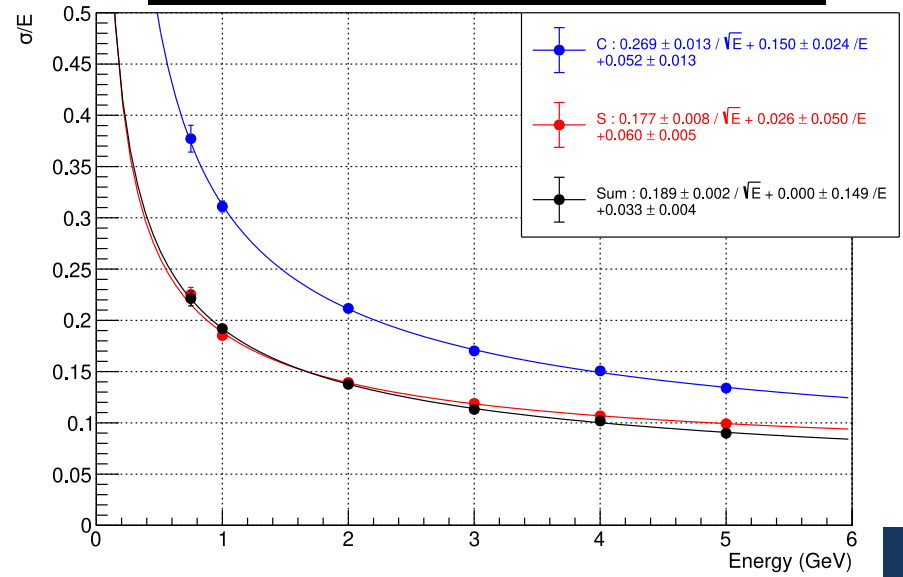
Set4 | (1.5°, 1.0°) | w/ Lego-Like



Set3 | No Rotation | w/o Lego-Like



Set4 | (1.5°, 1.0°) | w/o Lego-Like

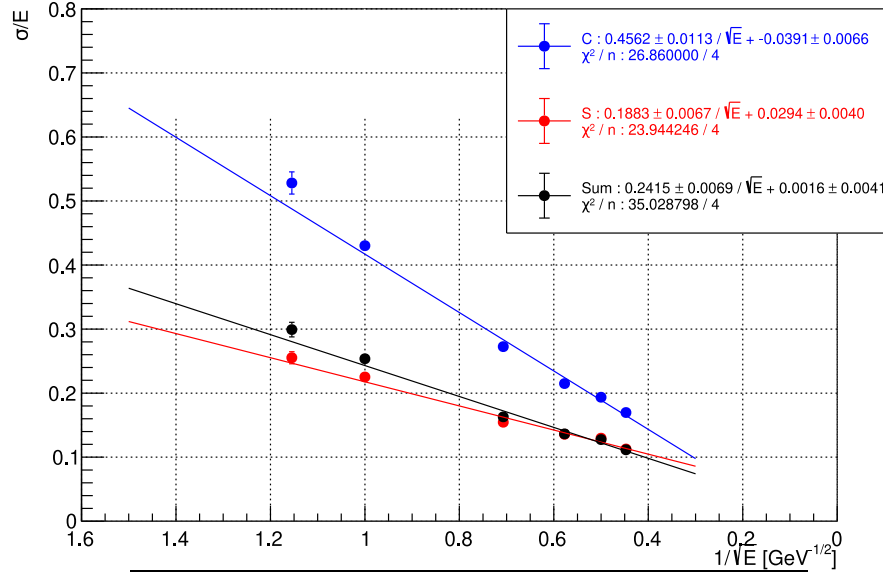




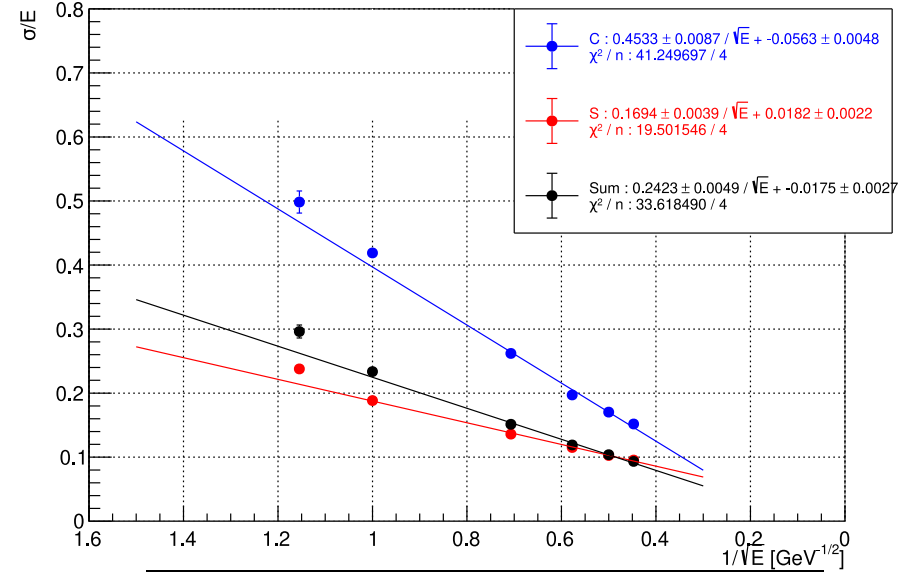
# Energy Resolution Set 3,4

## e+ Energy Resolution w/o 0.5 GeV point

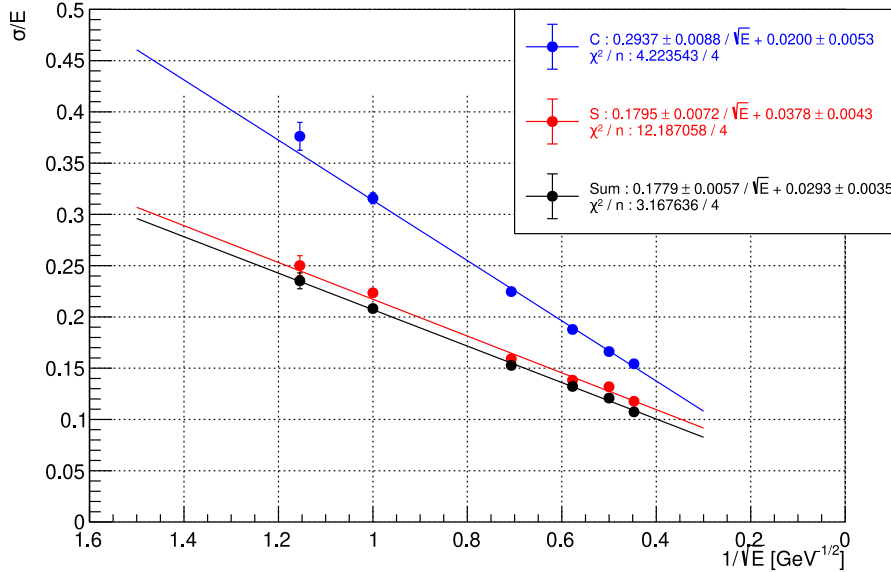
Set3 | No Rotation | w/ Lego-Like



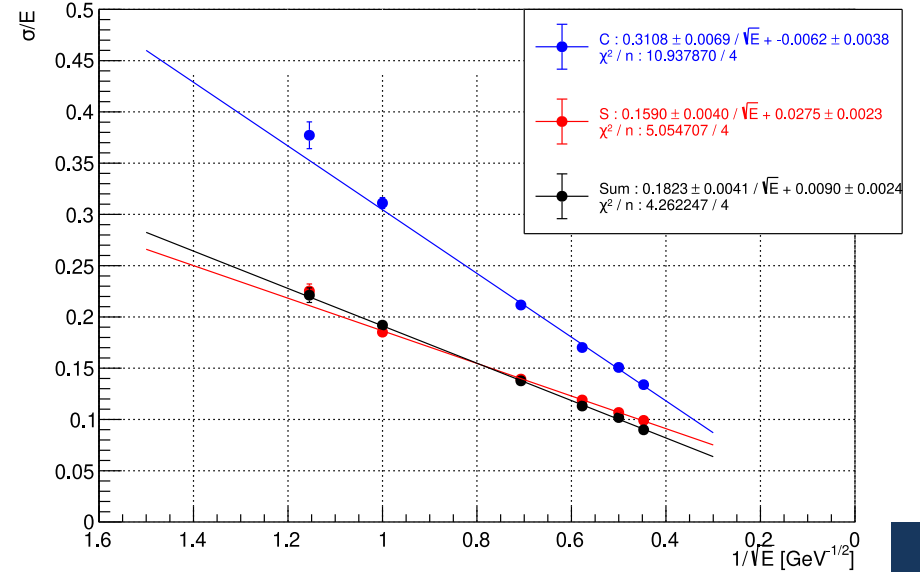
Set4 | (1.5°, 1.0°) | w/ Lego-Like



Set3 | No Rotation | w/o Lego-Like



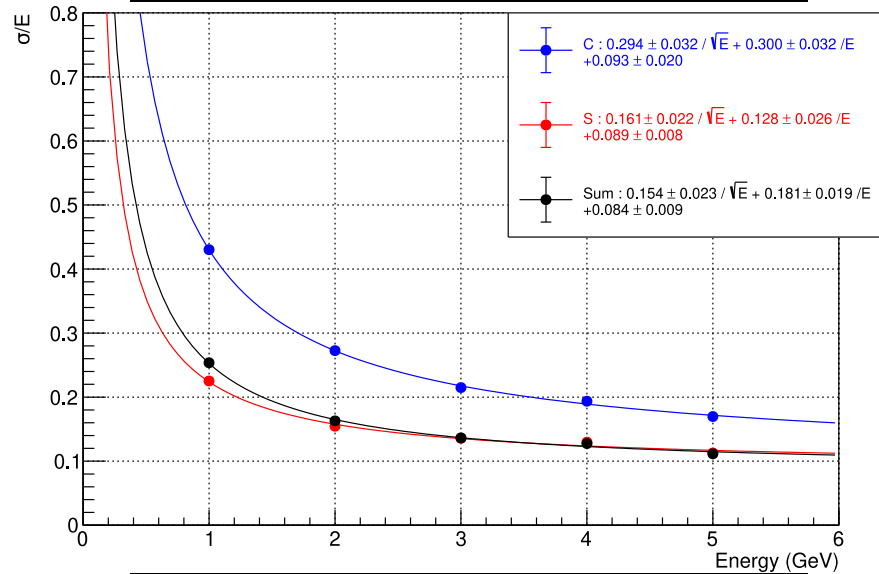
Set4 | (1.5°, 1.0°) | w/o Lego-Like



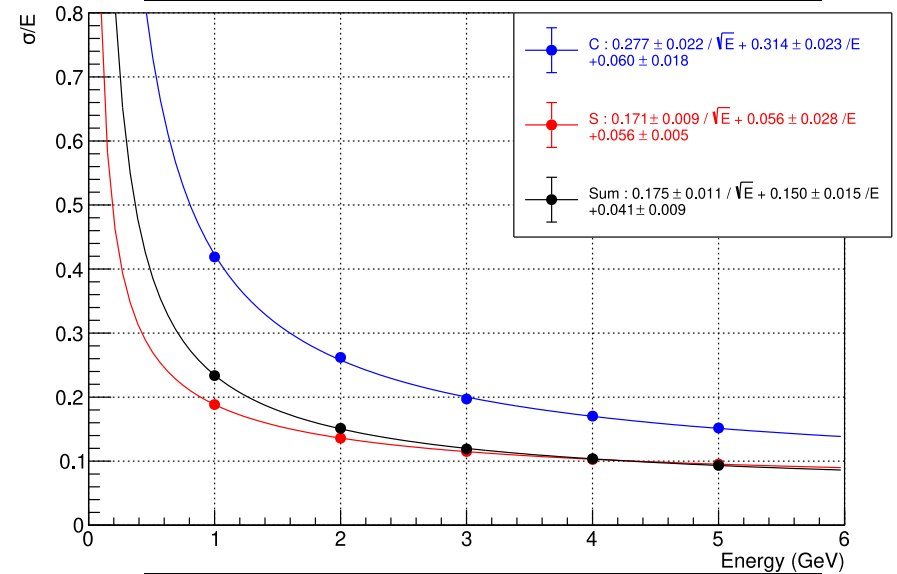
# Energy Resolution Set 3,4

## e+ Energy Resolution w/o under 0.75 GeV point

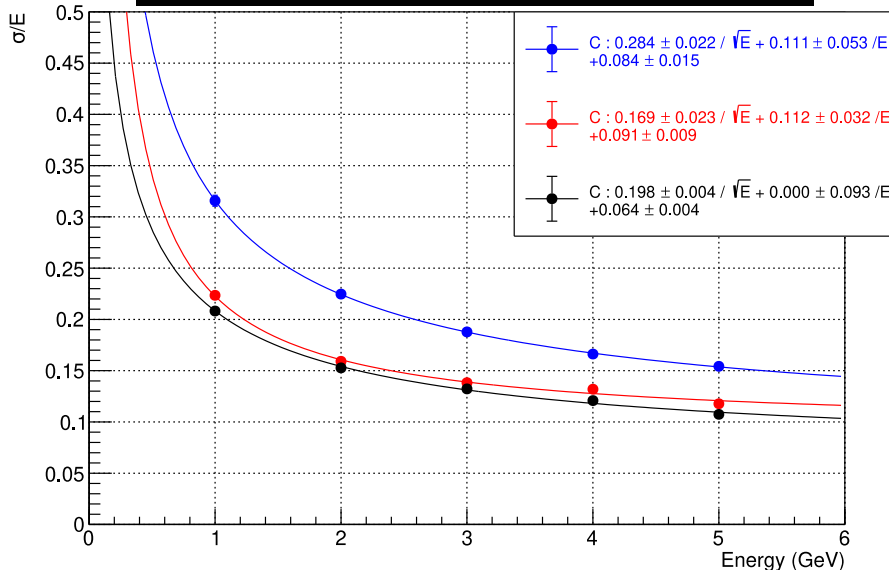
Set3 | No Rotation | w/ Lego-Like



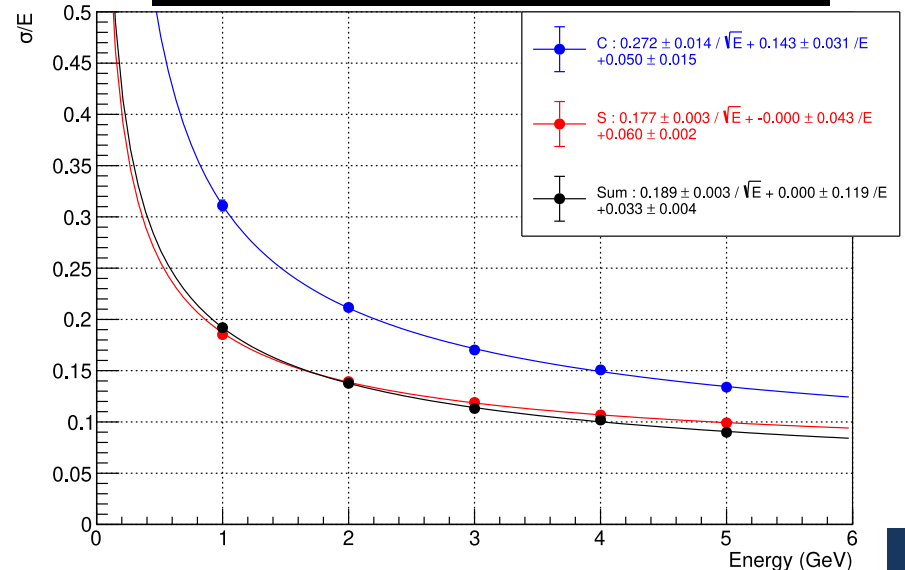
Set4 | (1.5°, 1.0°) | w/ Lego-Like



Set3 | No Rotation | w/o Lego-Like



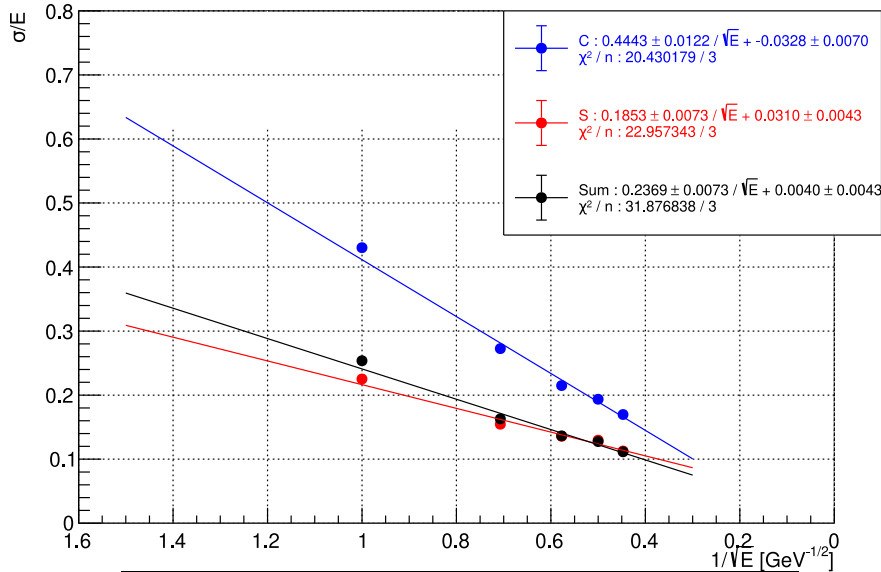
Set4 | (1.5°, 1.0°) | w/o Lego-Like



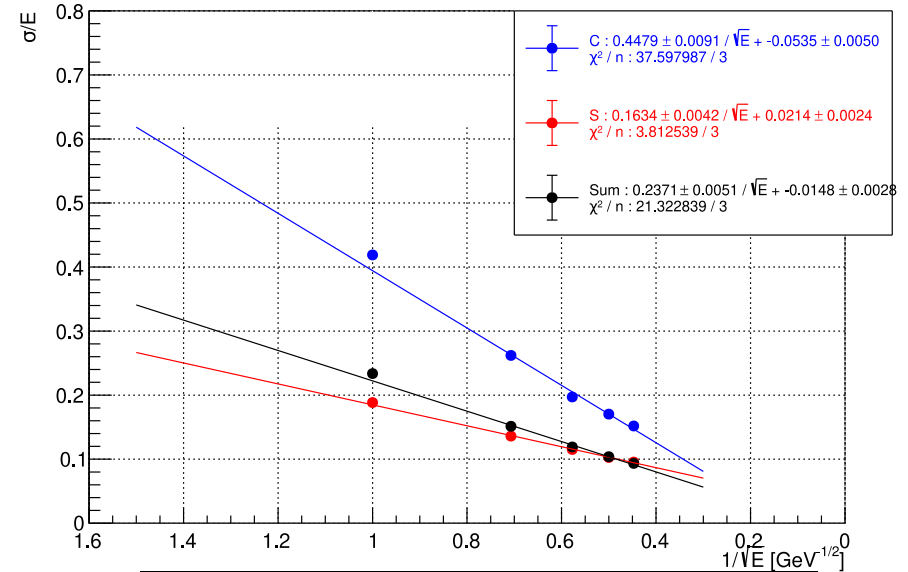
# Energy Resolution Set 3,4

## e+ Energy Resolution w/o under 0.75 GeV point

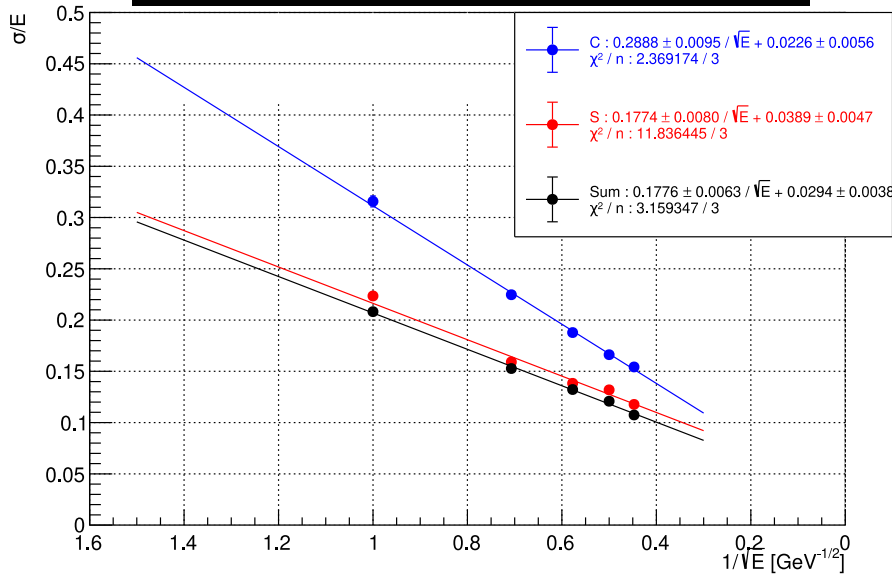
Set3 | No Rotation | w/ Lego-Like



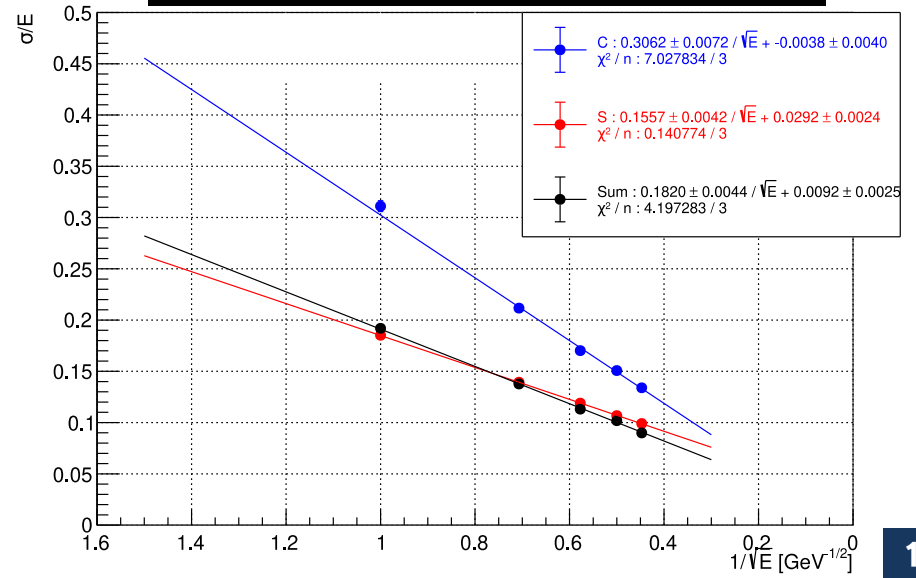
Set4 | (1.5°, 1.0°) | w/ Lego-Like



Set3 | No Rotation | w/o Lego-Like



Set4 | (1.5°, 1.0°) | w/o Lego-Like



# **Report of 2024\_GWNU workshop**

2024. 02. 19.

Dongwoon Kim

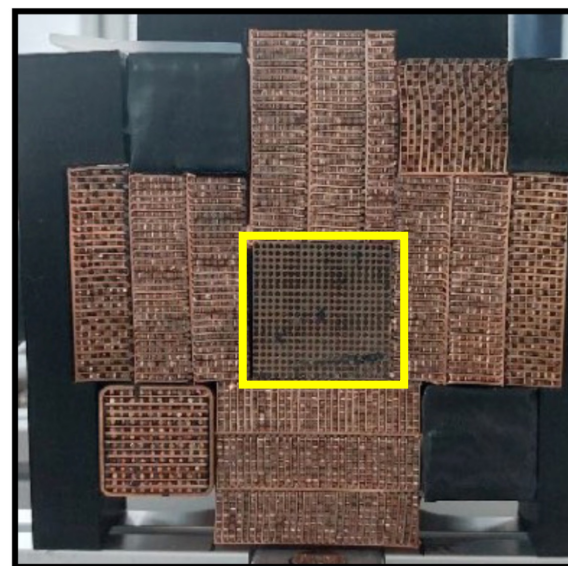
# Report of GWNU workshop

For Calculate the Linearity & Energy resolution (0.75 ~ 5GeV 6-point), used below setup information.

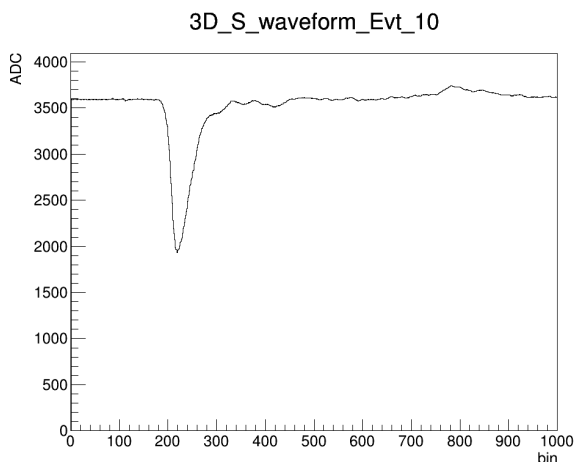
## Energy scan set-5 (setup-3)

Run	Wave	Trigger	Collimator	Rotation (deg)	Tilt (deg)	Particle	Energy (GeV)	Beam Target	Detail
4504	1048	Using Trigger-1, Trigger-2, Trigger-3	1.5 mm ( $\pm 0.7\%$ momentum spread)	x	x	e+	4	3D	energy scan with setup-3
4505	4043						4		
4506	5030						5		
4507	5013						3		
4508	5001						2		
4509	5002						1		
4510	2733						0.75		

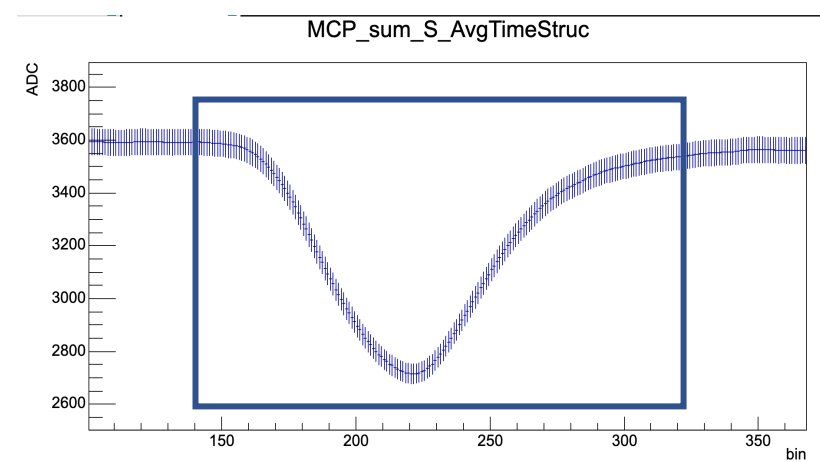
Date	Run #	# of evts	Beam	Program	Notes
23.07.11	Set 1				
	4471 - 4475		e+ (4 GeV)	HV scan : MCP-PMT after changing PMTs each other	- collimator : $\pm 6$ mm during these runs - The runs after T4 (fiber trigger) is installed. - run 4475 : fixed HV. (S : 1500 V , C : 2720 V) -> but they are changed after this run.
	4476 - 4504		e+ (4 GeV)	Position scan : 3D printing by 3mm	- collimator : $\pm 6$ mm during these runs - run 4490 : changed HV of S ch (1500 V -> 1650 V) - run 4504 : changed HV of C ch (2720 V -> 2700 V) - run 4504 : fixed 3D printing center after changing HV (hori : -0.409, ver : -0.673)
	4505	4k	e+ (4 GeV)	Energy resolution scan : 3D printing	
	4506	5k	e+ (5 GeV)		
	4507	5k	e+ (3 GeV)		
	4508	5k	e+ (2 GeV)		
	4509	5k	e+ (1 GeV)		
	4510	2.7k	e+ (0.75 GeV)		



# Report of GWNU workshop



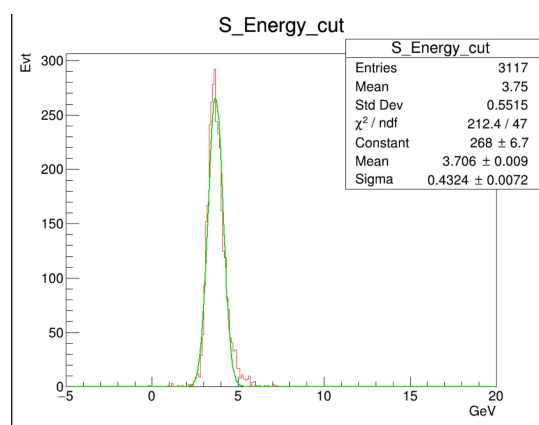
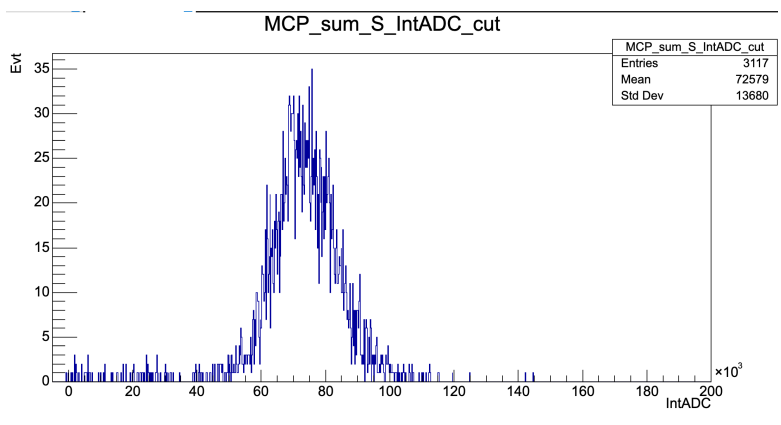
check waveform



Check average time structure & set integral range

Run	Target tower	Ch	Start	End
4504 & 4505	3D	S	160	280
		C	150	240
	3D - W1	S	160	260
		C	150	250
	3D - W2	S	160	270
		C	160	240
3D - W3	S	160	270	
	C	150	230	

-> 4504, 4505 합쳐서 진행

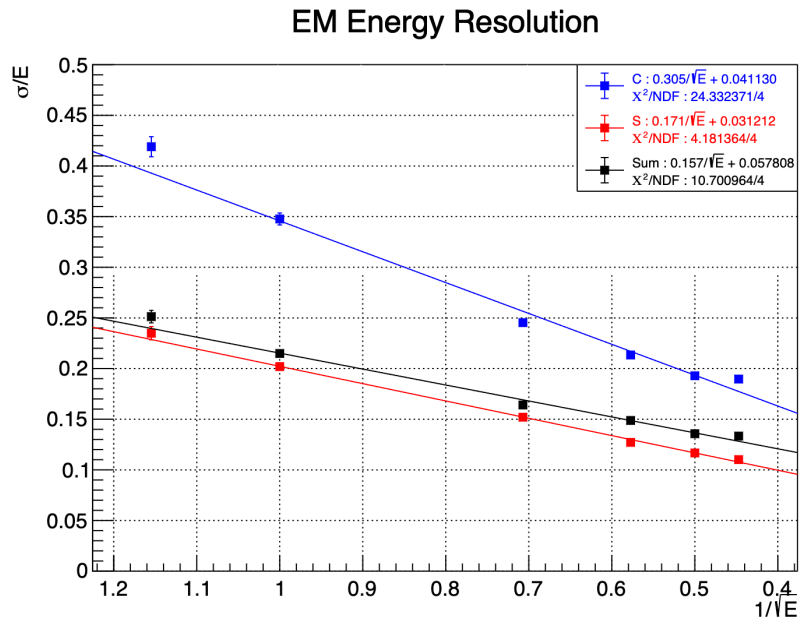
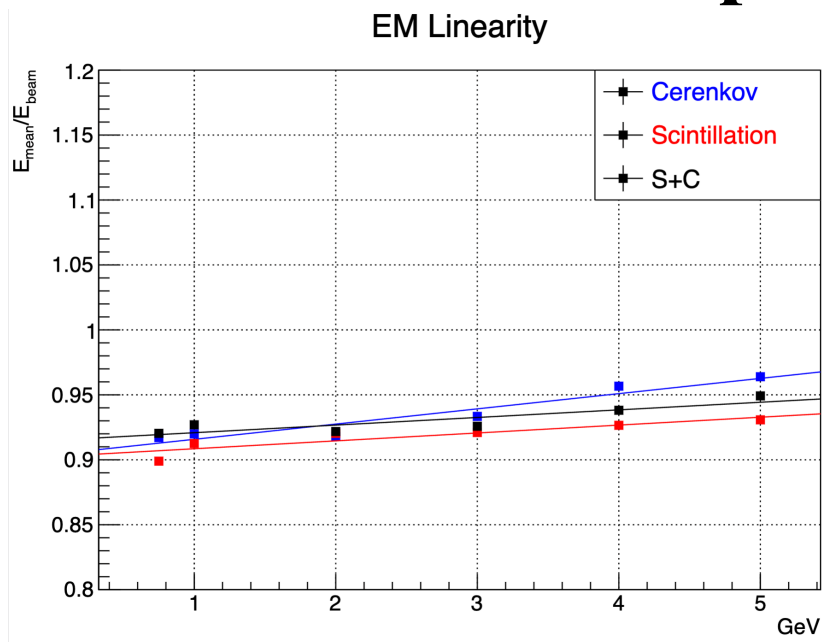


Run	Target tower	Ch	Mean	Tmp const	Beam E	E deosit	Equalization const
4504 & 4505	3D	S	72580	0.0000551116	4	73.66	0.0000405952
		C	7000	0.0005714286	4	73.66	0.0004209143
	3D - W1	S	5716	0.0006997901	4	1.38	0.0000096571
		C	4081	0.0009801519	4	1.38	0.0000135261
	3D - W2	S	5660	0.0007067138	4	0.82	0.0000057951
		C	1300	0.0030769231	4	0.82	0.0000252308
3D - W3	S	4691	0.0008526967	4	0.82	0.0000069921	
	C	1601	0.0024984385	4	0.82	0.0000204872	

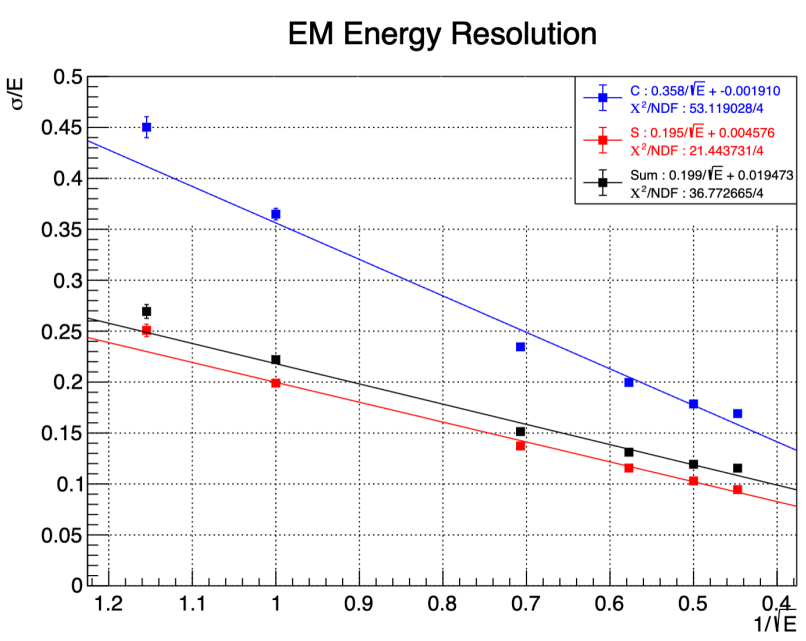
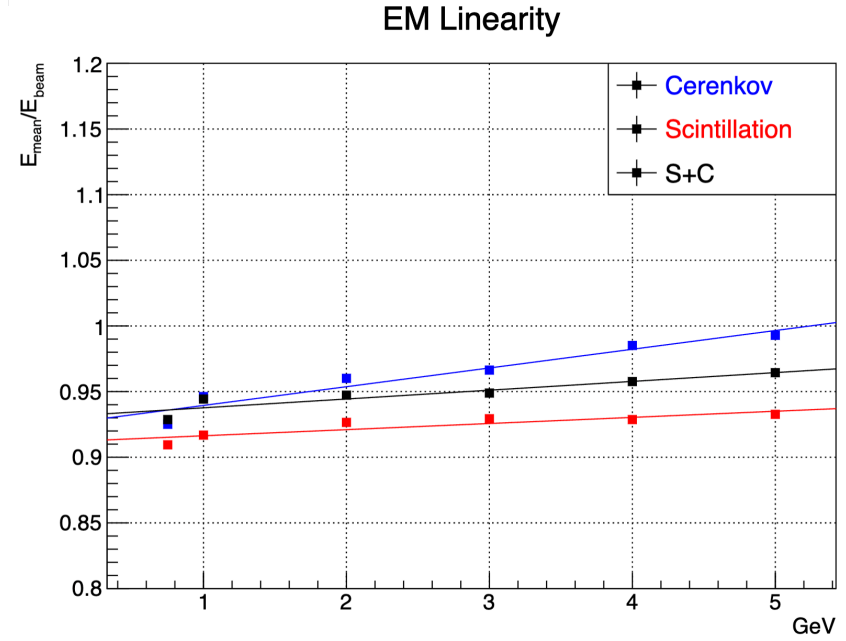
Convert Integrated ADC to Energy using Equalization const -> Calibration used 4GeV rub

# Report of GWNU workshop

Used Run Pedestal



Used event Pedestal



# Energy resolution & linearity study with TB 2023 data

Yunjae Lee

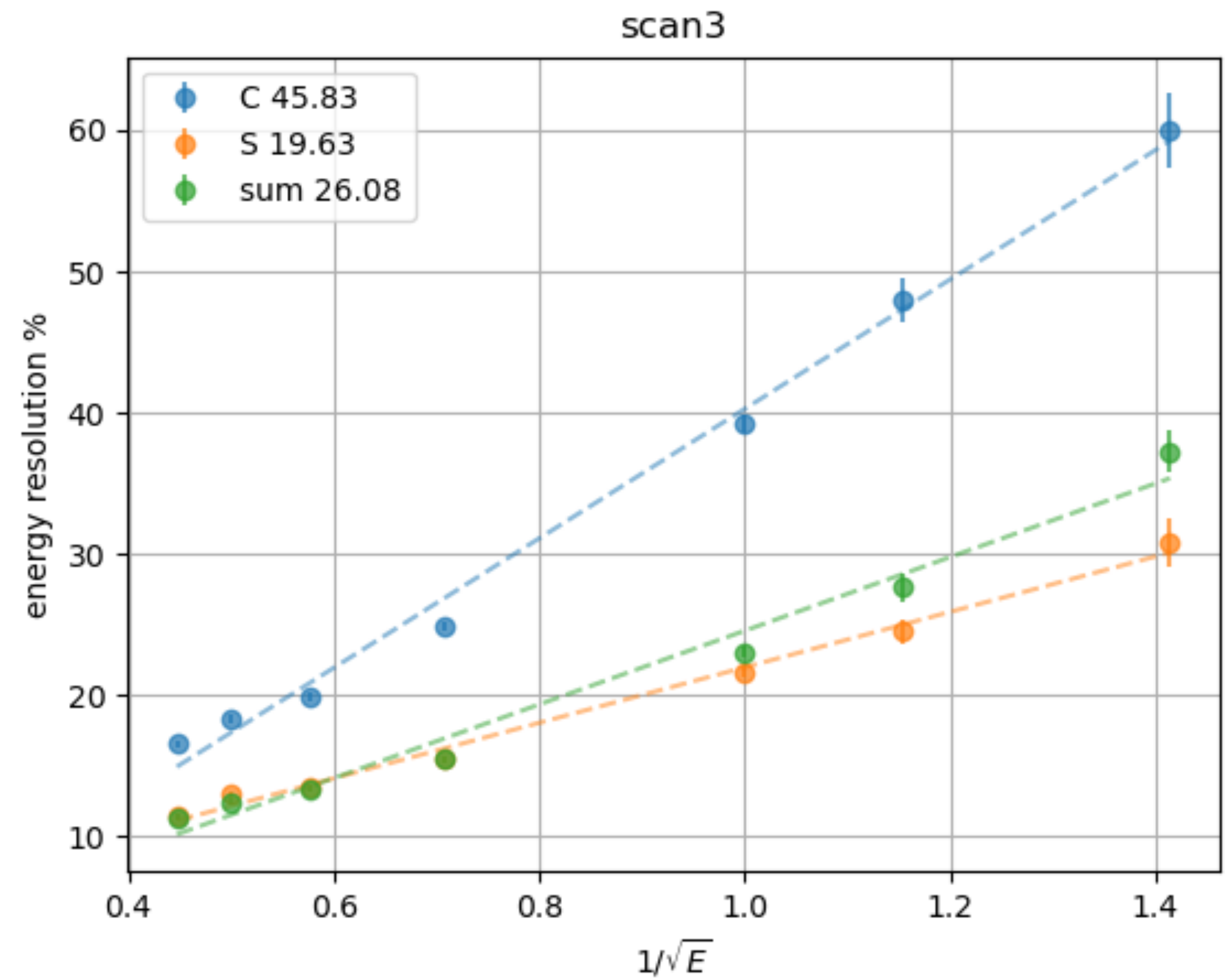
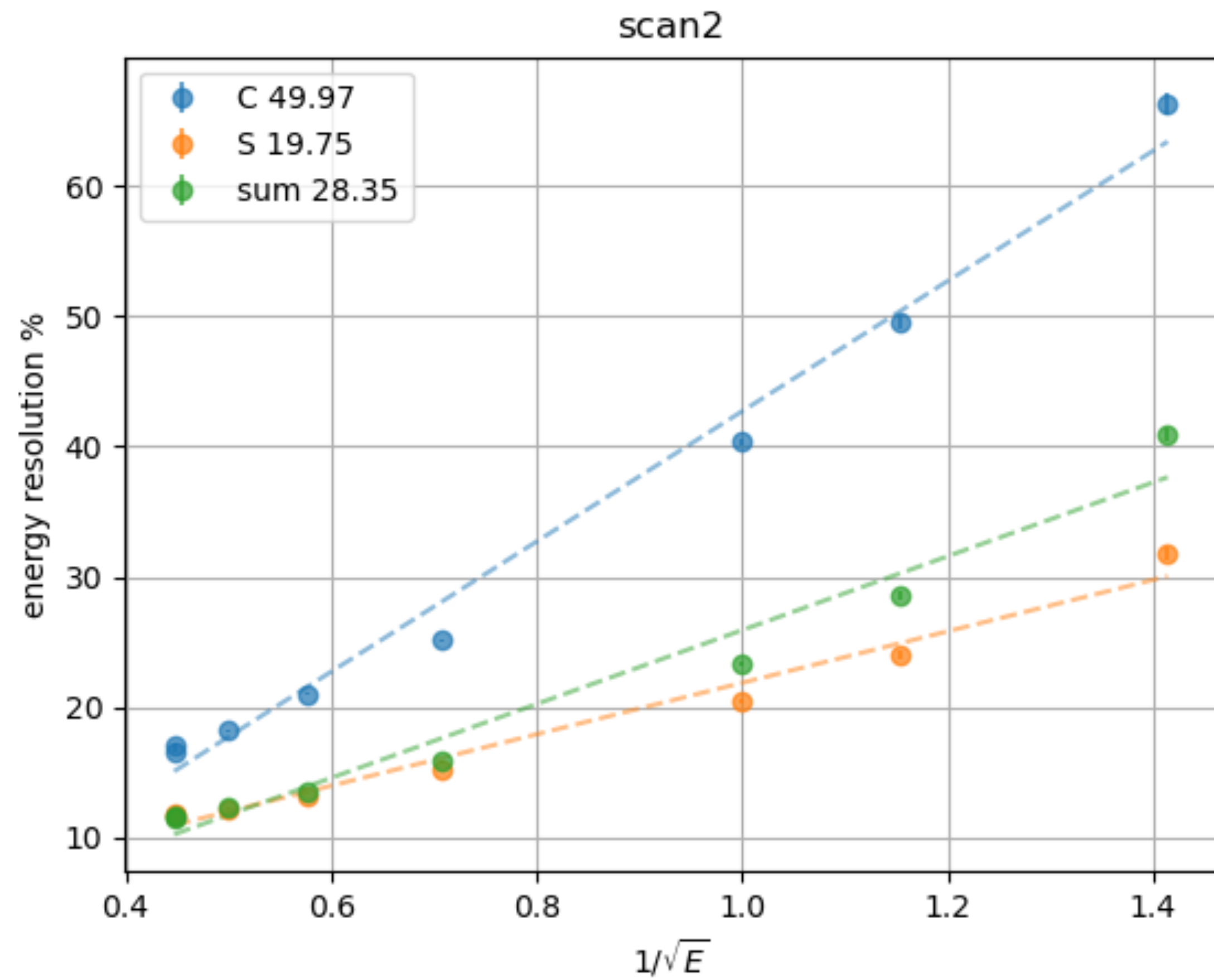
UoS

TB2023 analysis workshop @ GWNU

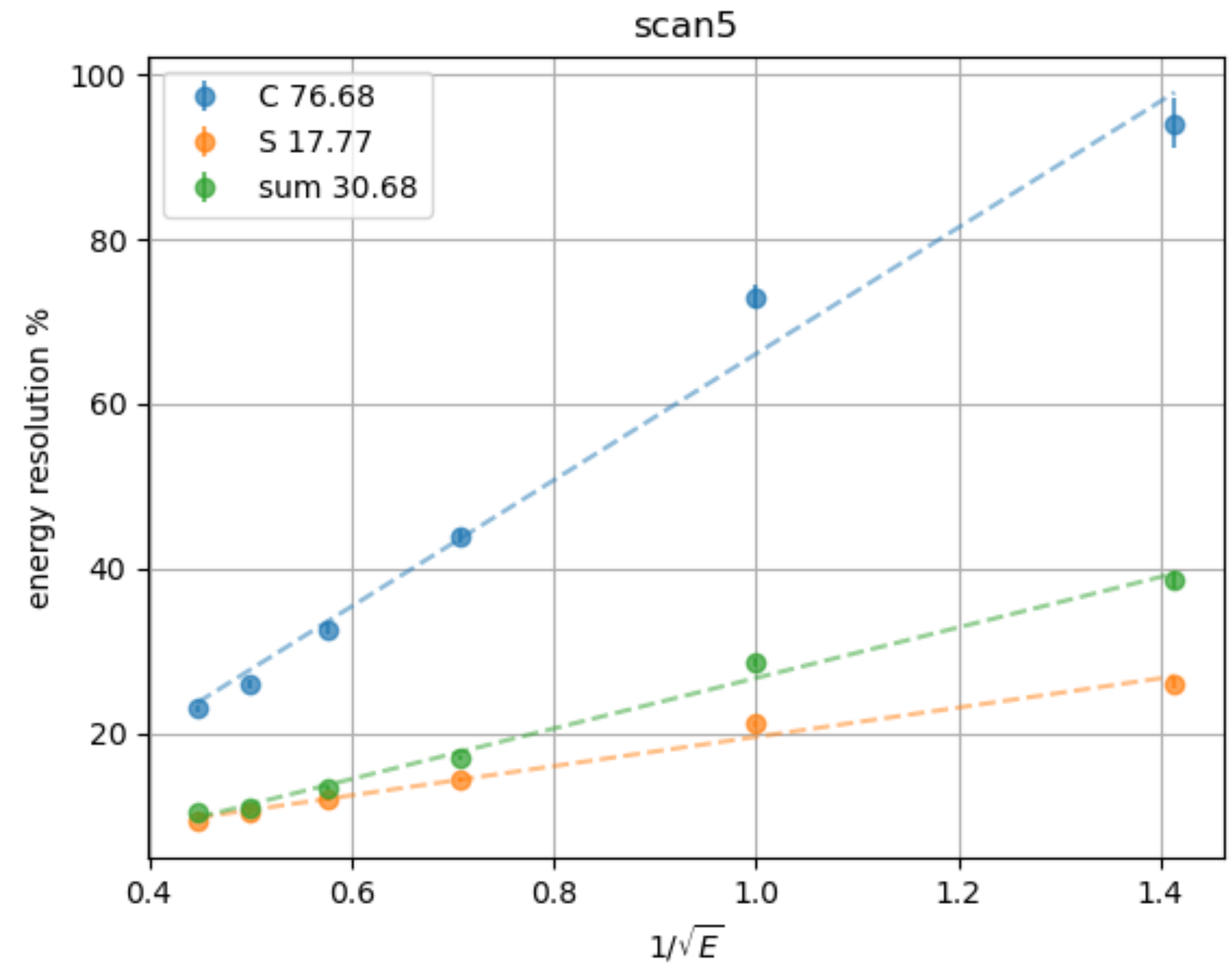
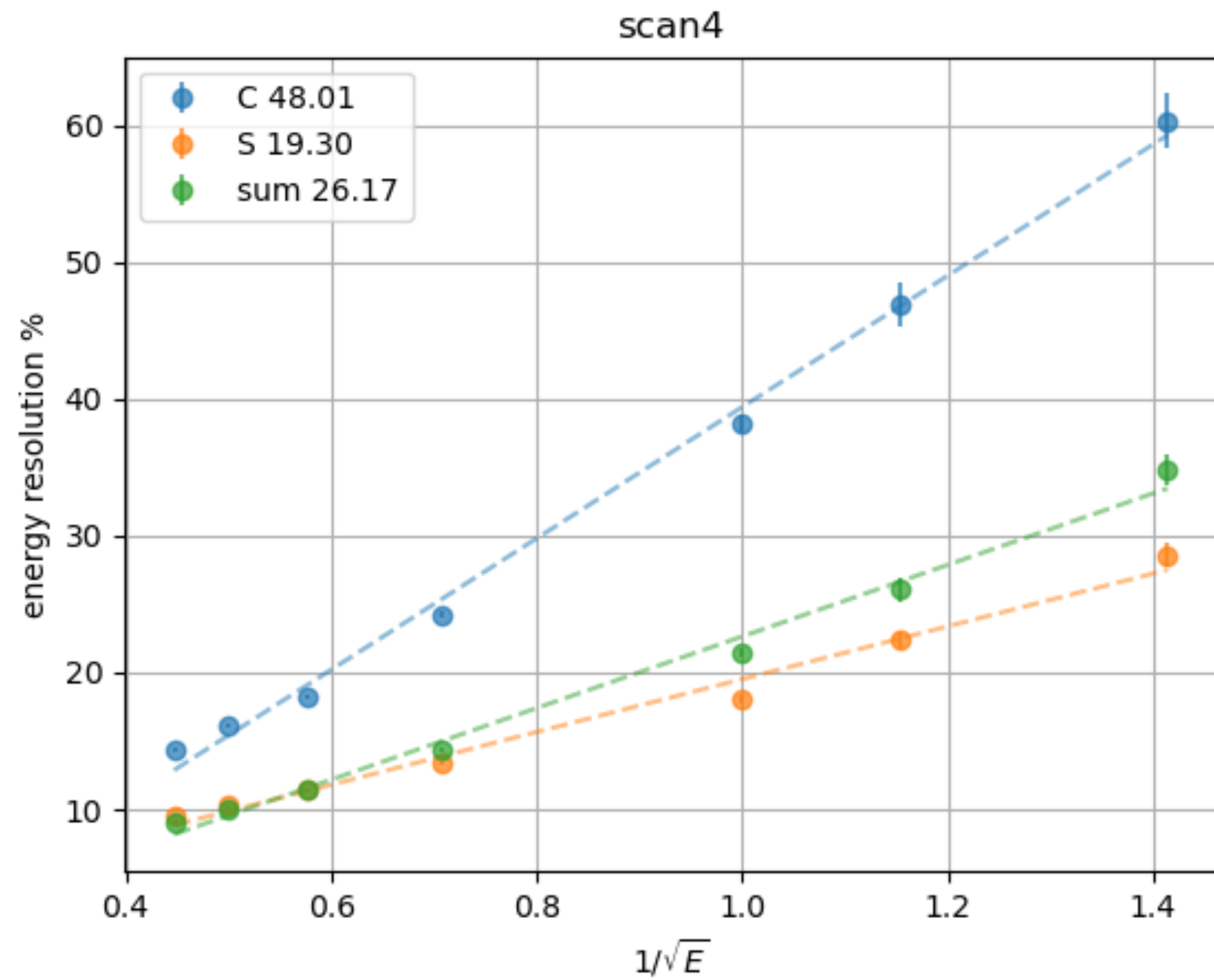
19 Feb 2024



# Energy scan study



# Energy scan study





# Energy resolution & linearity study with TB 2023 data

Sungwon Kim

Yonsei university

TB2023 analysis workshop @ GWNU

19 Feb 2024

# Energy scan study

## Conditions of each set

- **Set 1** : Wide collimator ( $\pm 2\%$  momentum spread)
- **Set 2** : Wide collimator + AstroPix
- **Set 3** : Narrow collimator ( $\pm 0.7\%$ )
- **Set 4** : Narrow collimator + Module rotation & tilting
- **Set 5** : Narrow collimator + Swap MCP-PMTs + Add shielding + Add black paint

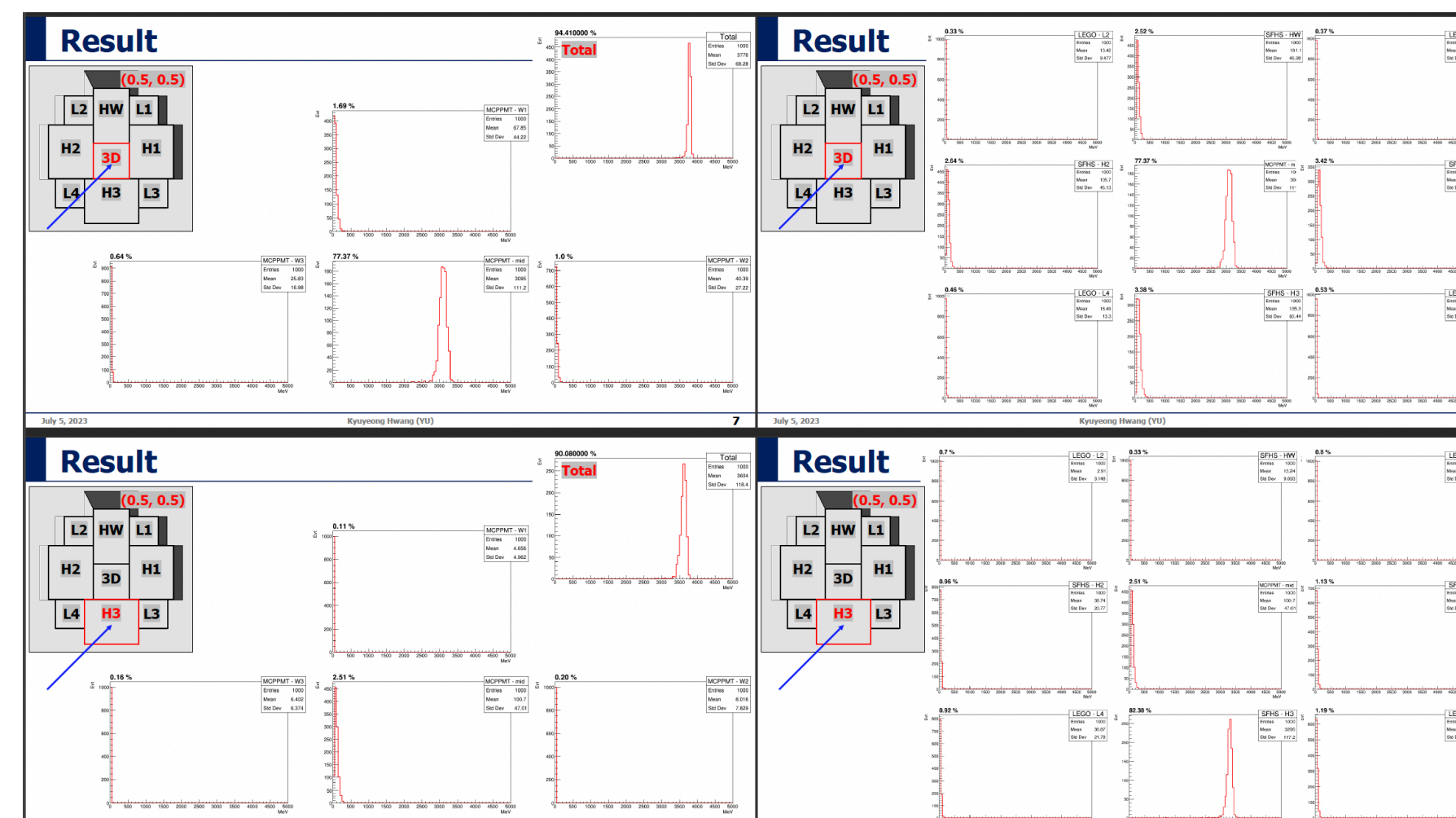
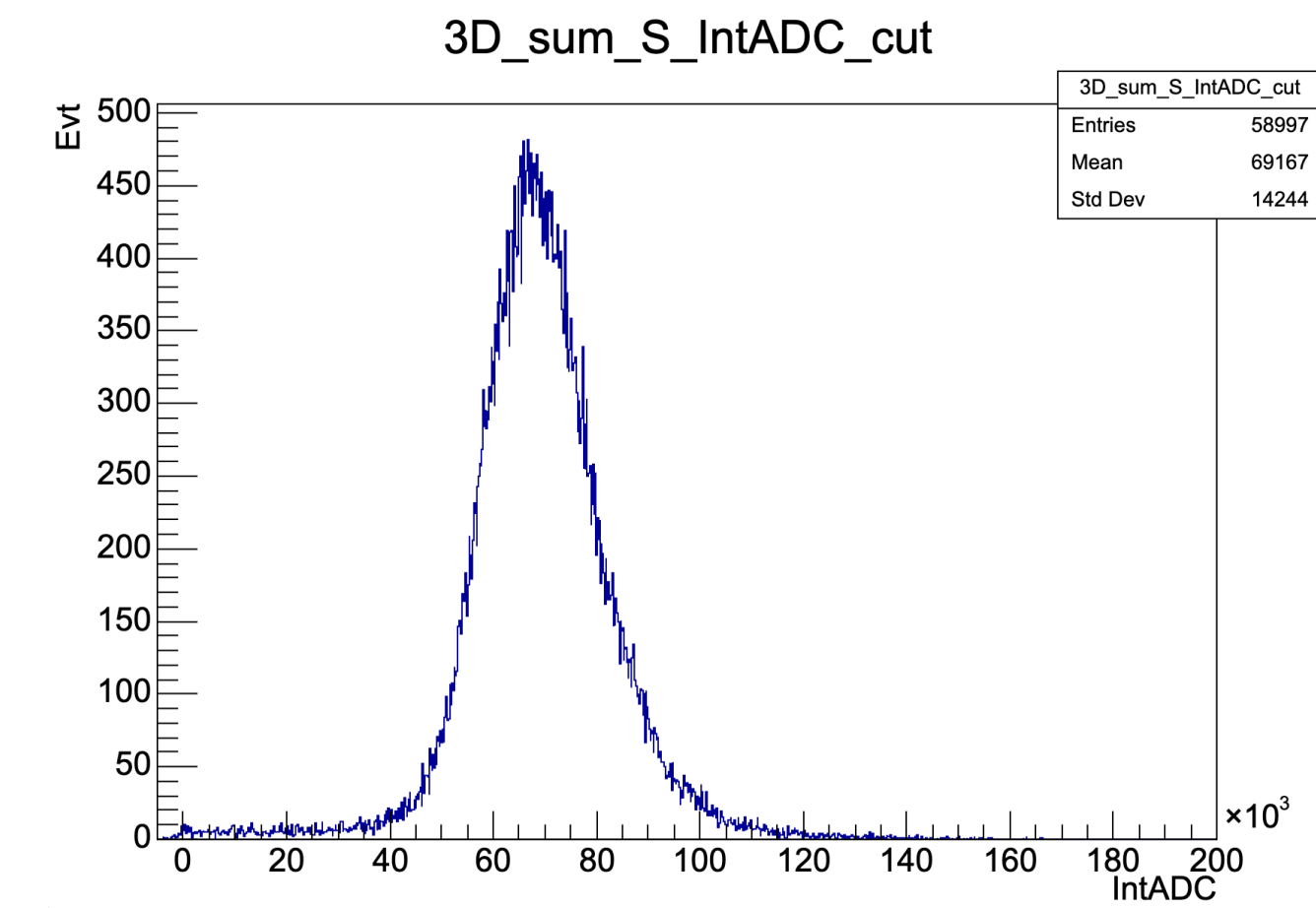
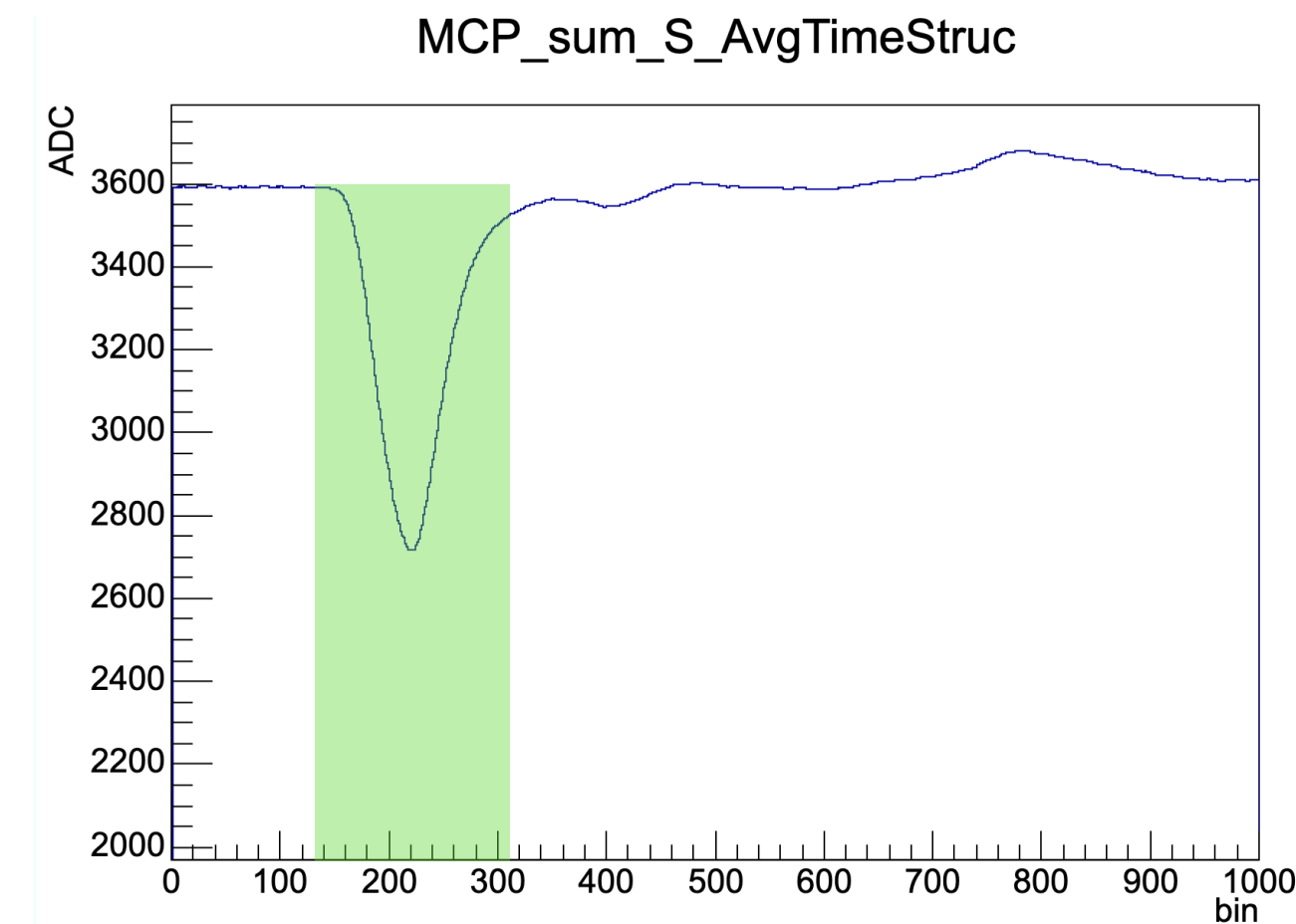
## Analysis procedure

- Determine integral range using Avg. time structure
- Calculate equalization constants  

$$(Equ. const = \frac{4 GeV \times Edep(\%) }{IntADC})$$
- Calculate & draw energy linearity & resolution plots

## Additional tests

- Tested both **run-by-run** & **event-by-event** pedestal
- Tested **removing negative energy** contribution



calib_3D_S	: 4.26116e-05
calib_w1_S	: 4.24575e-06
calib_w2_S	: 4.57459e-06
calib_w3_S	: 4.774e-06
calib_HW_S	: 3.98233e-05
calib_H1_S	: 3.45898e-05
calib_H2_S	: 3.6435e-05
calib_H3_S	: 3.63885e-05
calib_L1_S	: 4.21441e-05
calib_L2_S	: 2.56059e-05
calib_L3_S	: 4.59059e-05
calib_L4_S	: 6.94395e-05
calib_3D_C	: 8.72407e-05
calib_w1_C	: 6.654e-06
calib_w2_C	: 1.85825e-05
calib_w3_C	: 1.50882e-05
calib_HW_C	: 6.7764e-05
calib_H1_C	: 5.95106e-05
calib_H2_C	: 5.7843e-05
calib_H3_C	: 6.41484e-05
calib_L1_C	: 6.86816e-05
calib_L2_C	: 0.000384696
calib_L3_C	: 7.39723e-05
calib_L4_C	: 0.000136583

# Energy scan results set-1

- **Set 1** : Wide collimator ( $\pm 2\%$  momentum spread)
- Both results using RunPed & EvtPed
- Results w/ negative-energy events

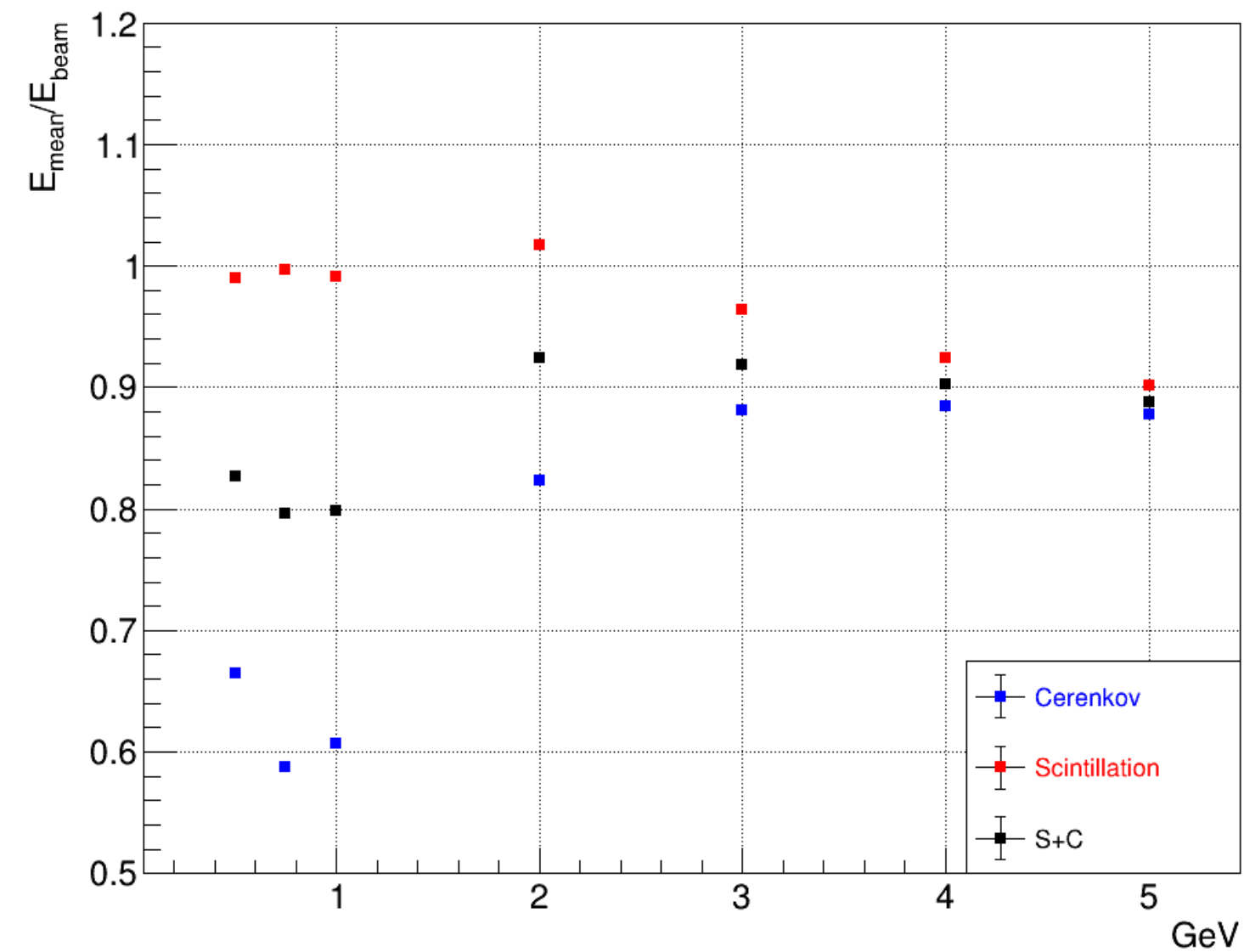
## RunPed

- $\pm 6\%$ ,  $\pm 15\%$ ,  $\pm 7\%$
- $33.4 \oplus 3.5$ ,  $68.8 \oplus 2.9$ ,  $40.5 \oplus 6.5$

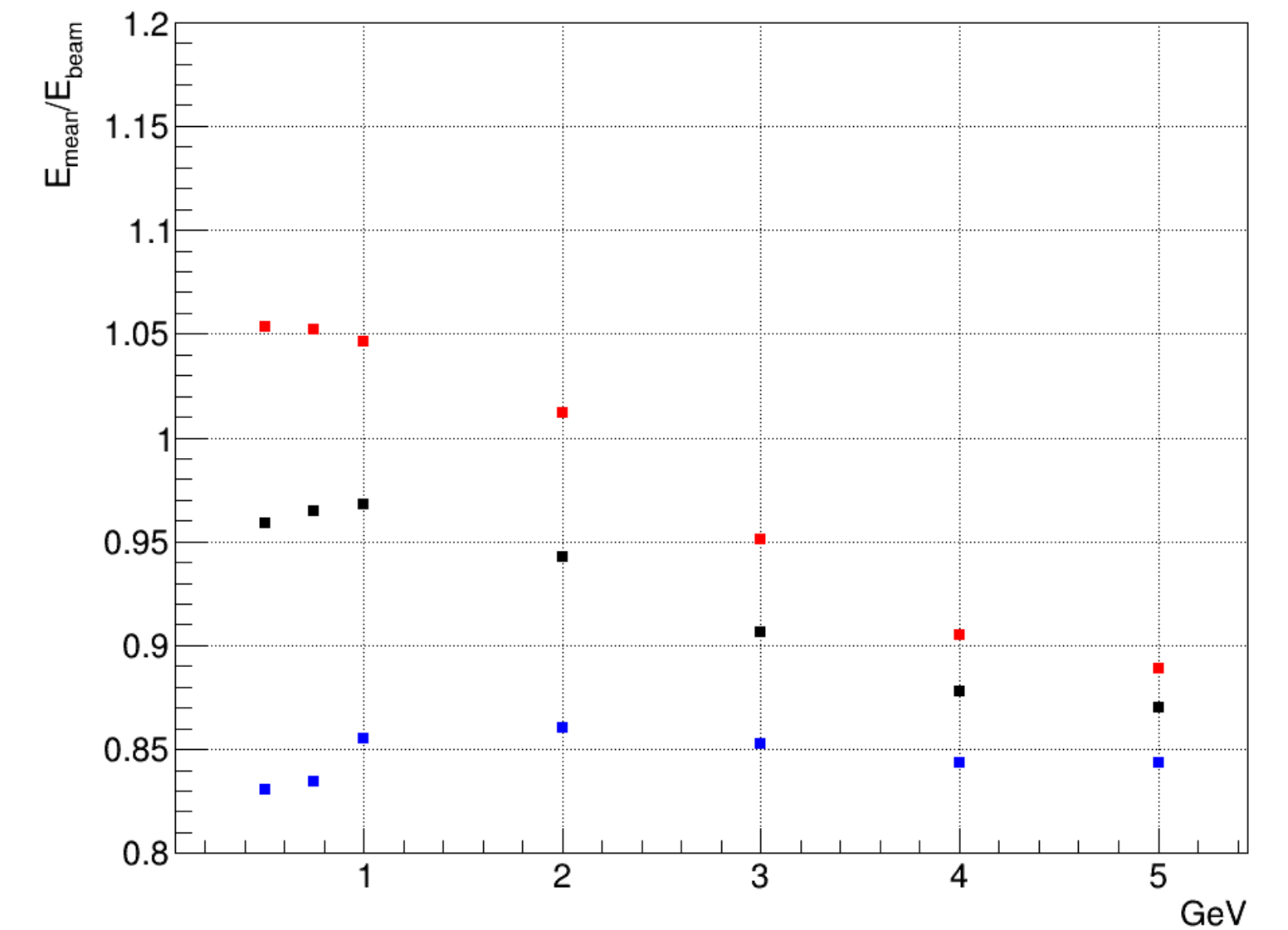
## EvtPed

- $\pm 8\%$ ,  $\pm 1.5\%$ ,  $\pm 5\%$
- $15.8 \oplus 4.4$ ,  $35.2 \oplus -1$ ,  $18.7 \oplus 2.3$

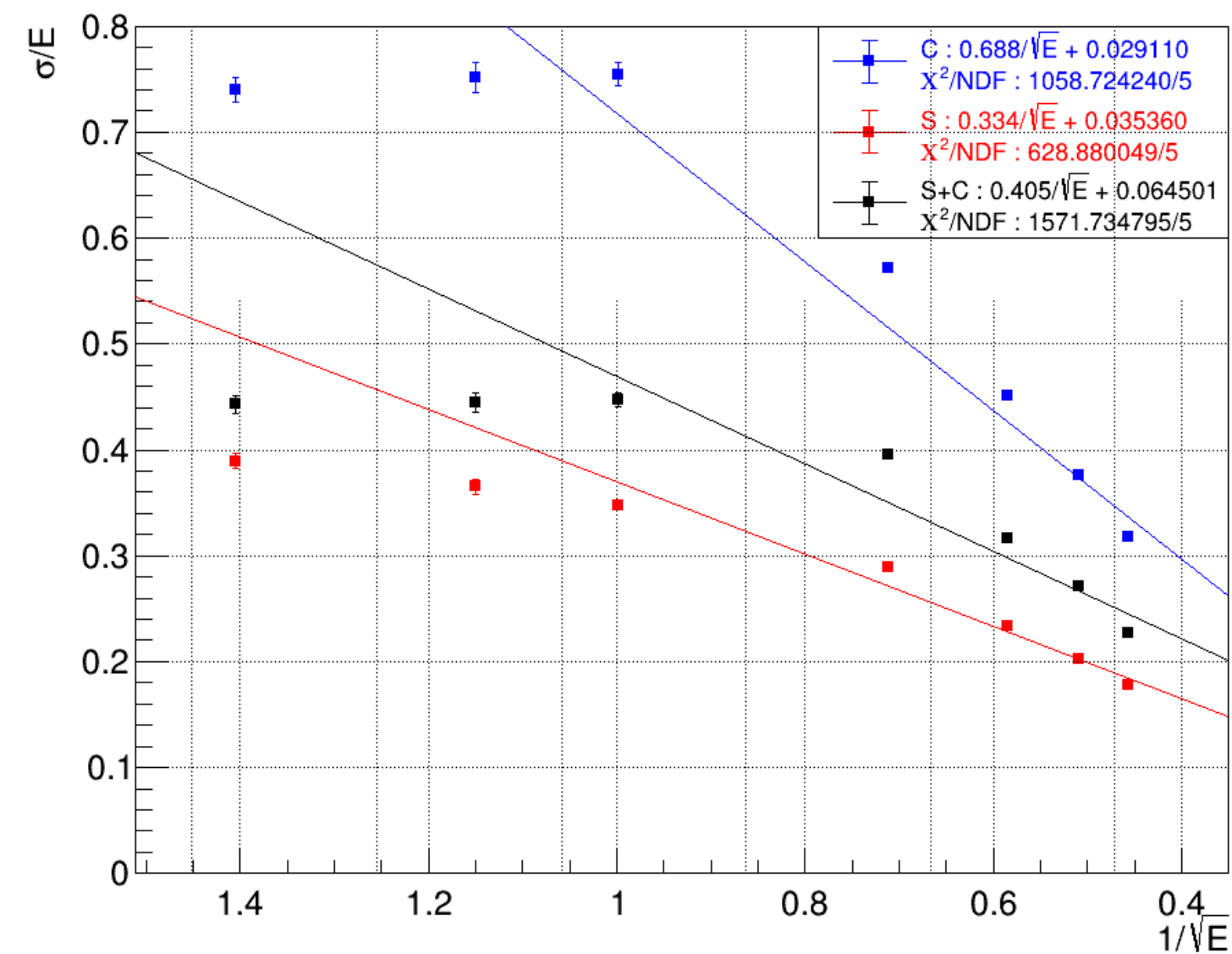
EM Linearity (Set 1, RunPed)



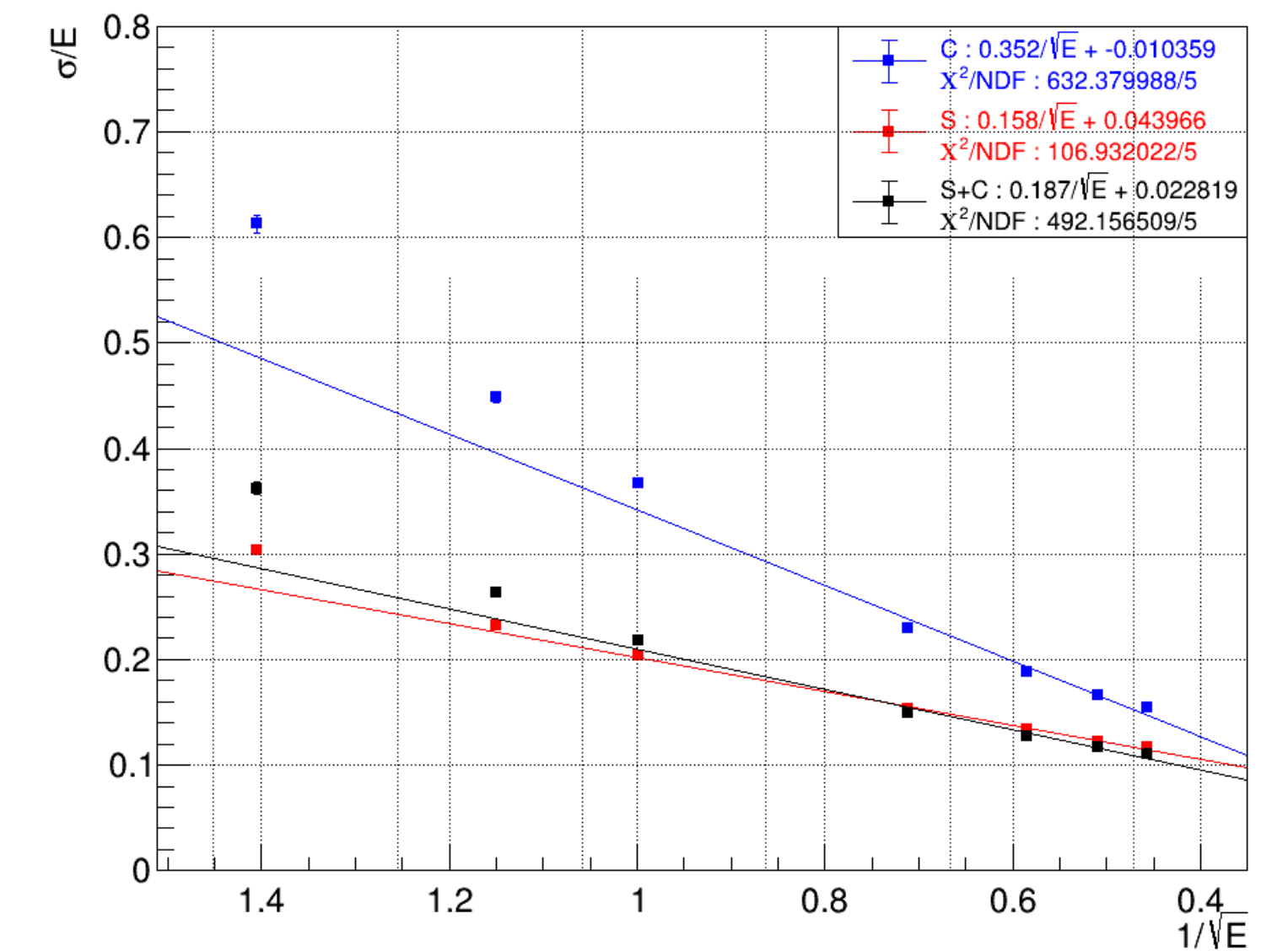
EM Linearity (Set 1, EvtPed)



Energy resolution (Set 1, RunPed)



Energy resolution (Set 1, EvtPed)



# Energy scan results set-1

- **Set 1** : Wide collimator ( $\pm 2\%$  momentum spread)
- Both results using RunPed & EvtPed
- Results **w/o** negative-energy events

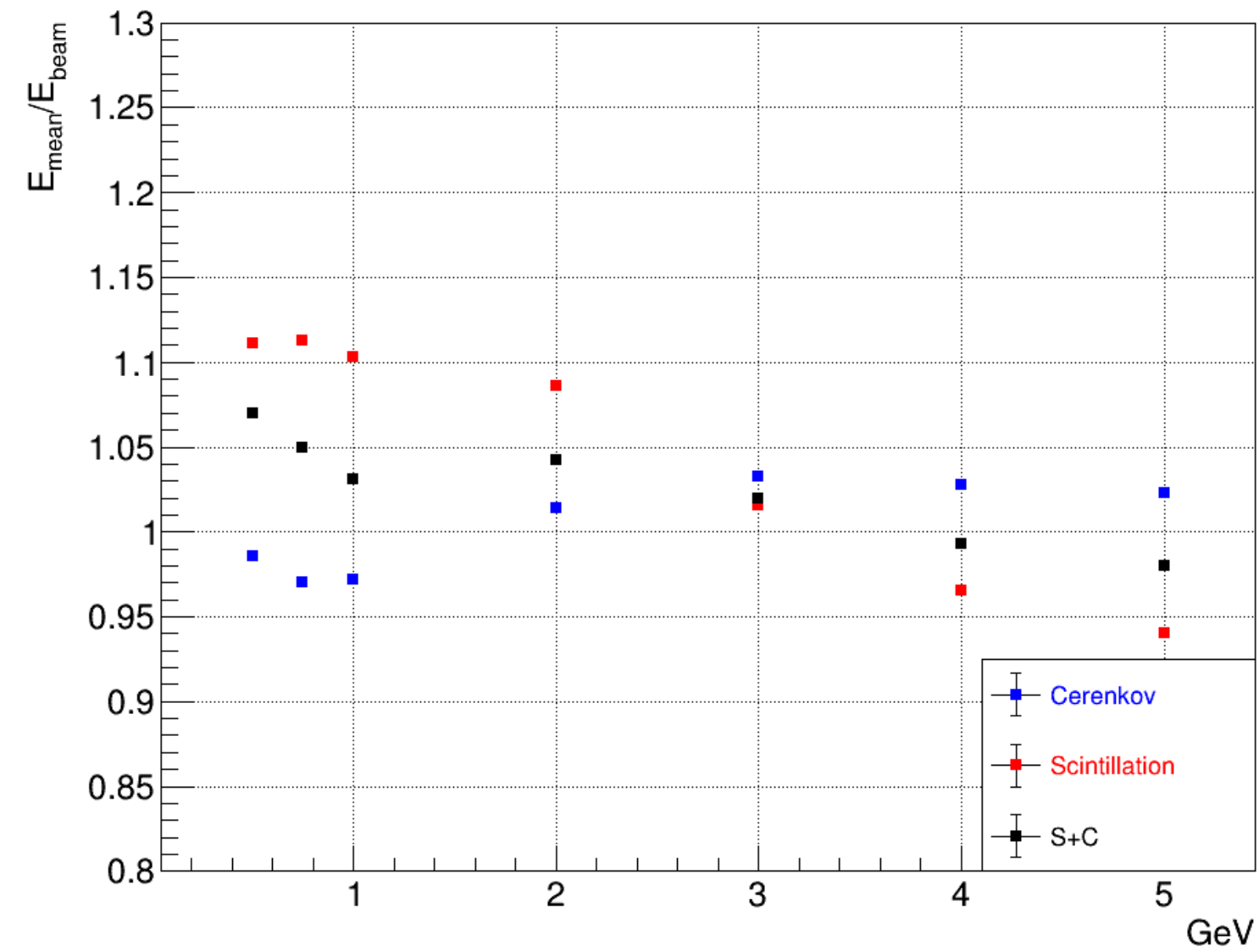
## RunPed

- $\pm 8.5\%$ ,  $\pm 3\%$ ,  $\pm 5\%$
- $21.8 \oplus 5.6$ ,  $29.9 \oplus 6.3$ ,  $18.1 \oplus 7.8$

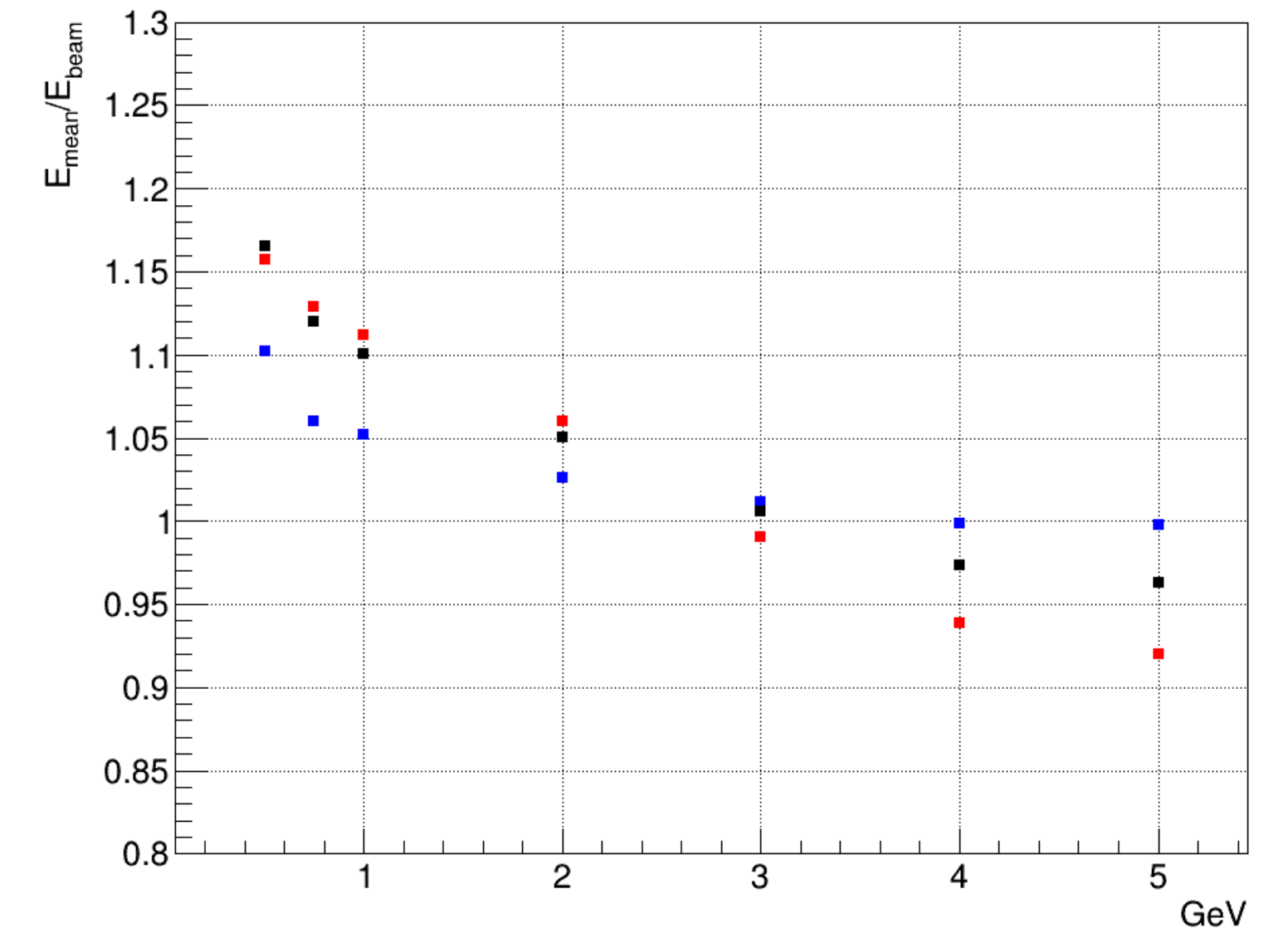
## EvtPed

- $\pm 12.5\%$ ,  $\pm 5\%$ ,  $\pm 10\%$
- $14.5 \oplus 5$ ,  $22.6 \oplus 4.1$ ,  $13.6 \oplus 4.6$

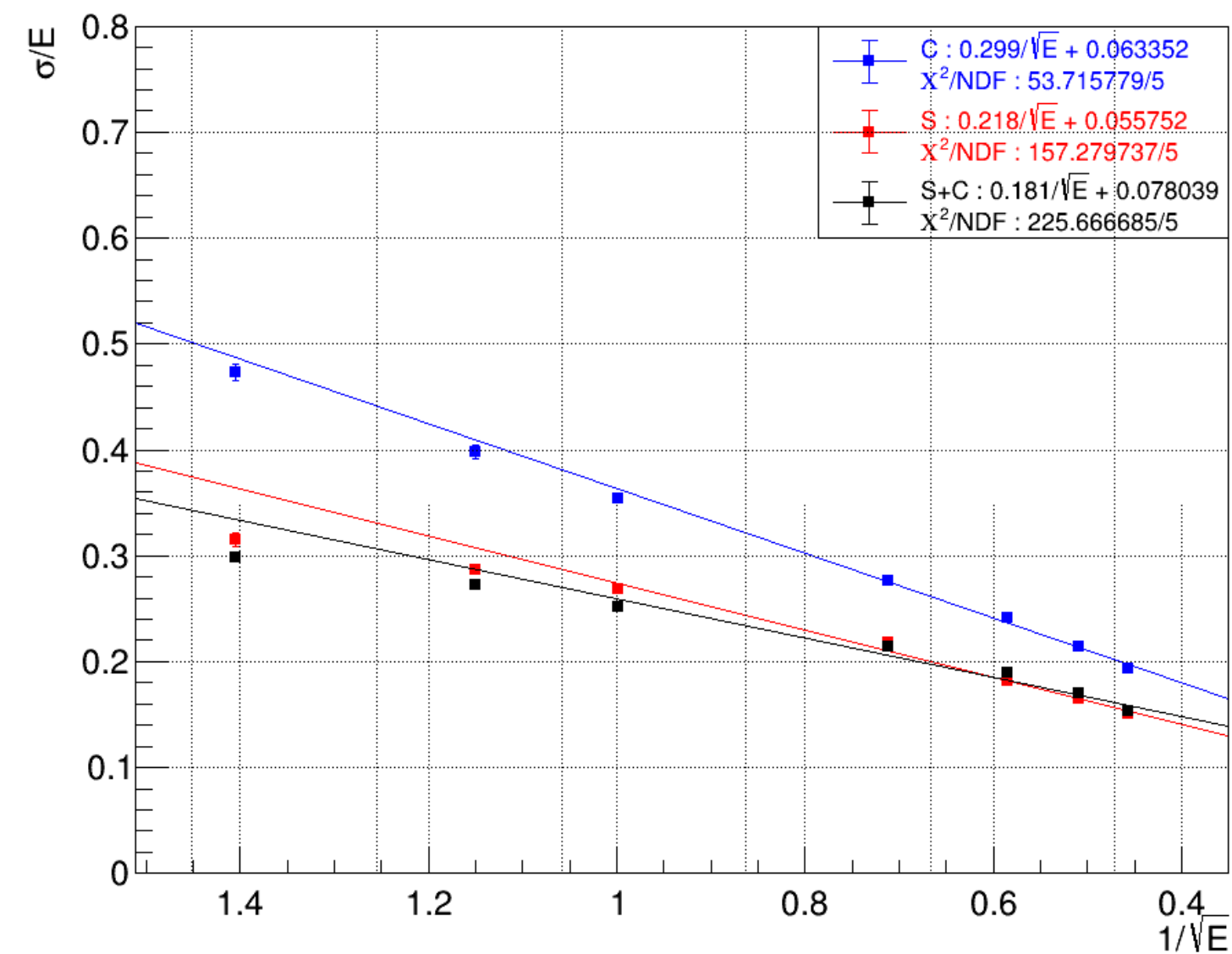
EM Linearity (Set 1, RunPed)



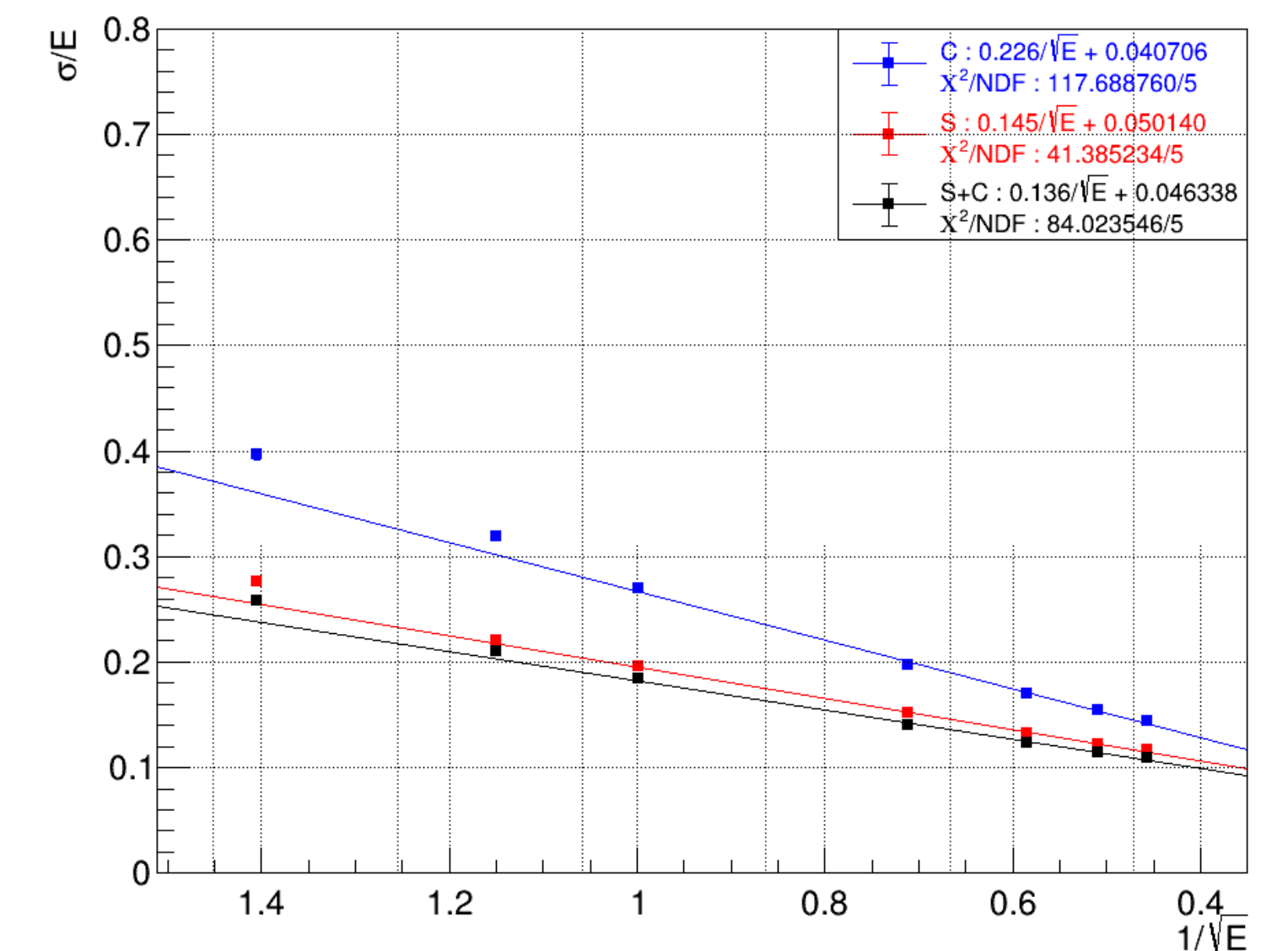
EM Linearity (Set 1, EvtPed)



Energy resolution (Set 1, RunPed)



Energy resolution (Set 1, EvtPed)



# Energy scan results set-2

- **Set 2** : Wide collimator + AstroPix
- Both results using RunPed & EvtPed
- Results **w/o** negative-energy events

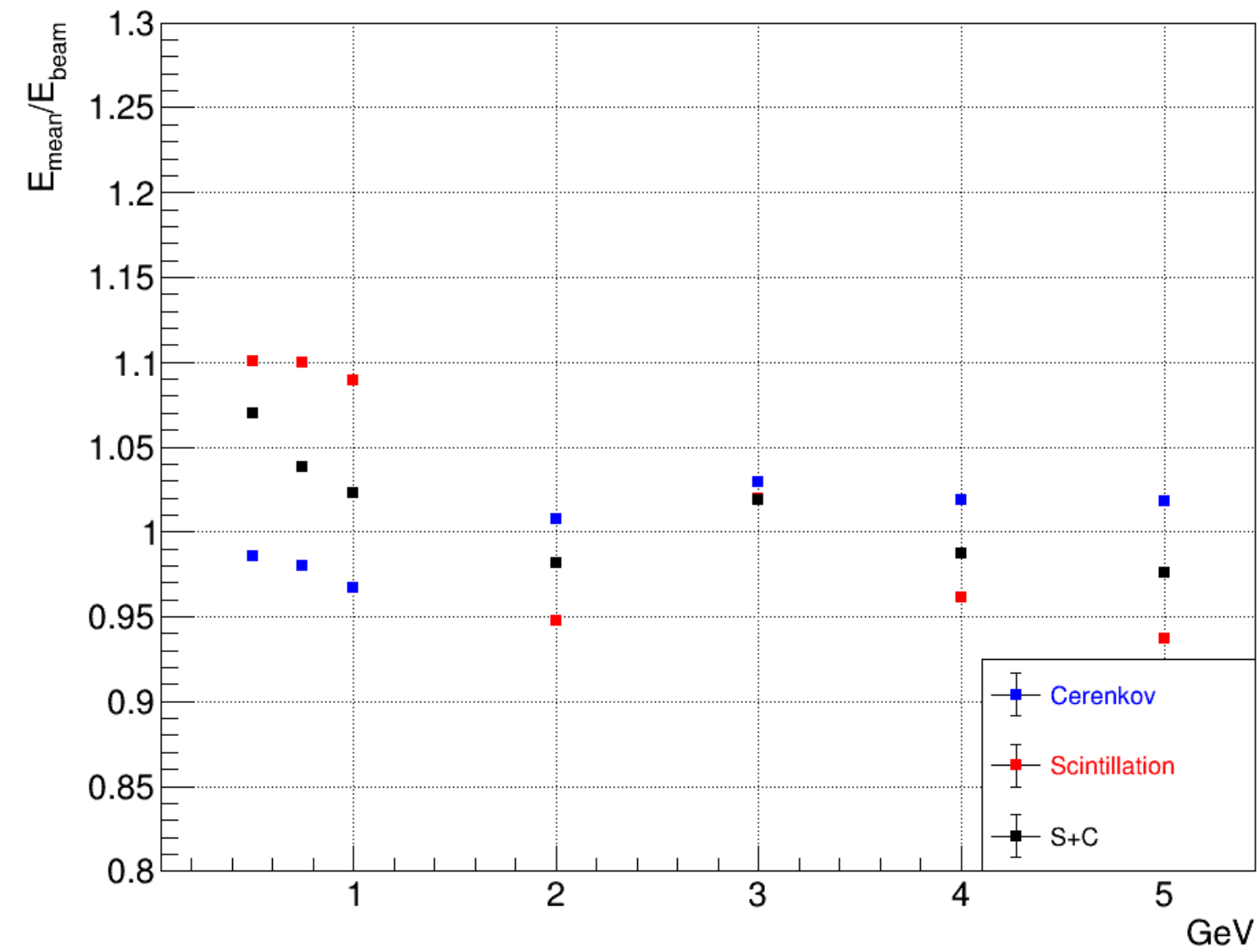
## RunPed

- $\pm 8\%$ ,  $\pm 3\%$ ,  $\pm 5\%$
- $26.9 \oplus 3.2$ ,  $27.6 \oplus 7.4$ ,  $18 \oplus 7.8$

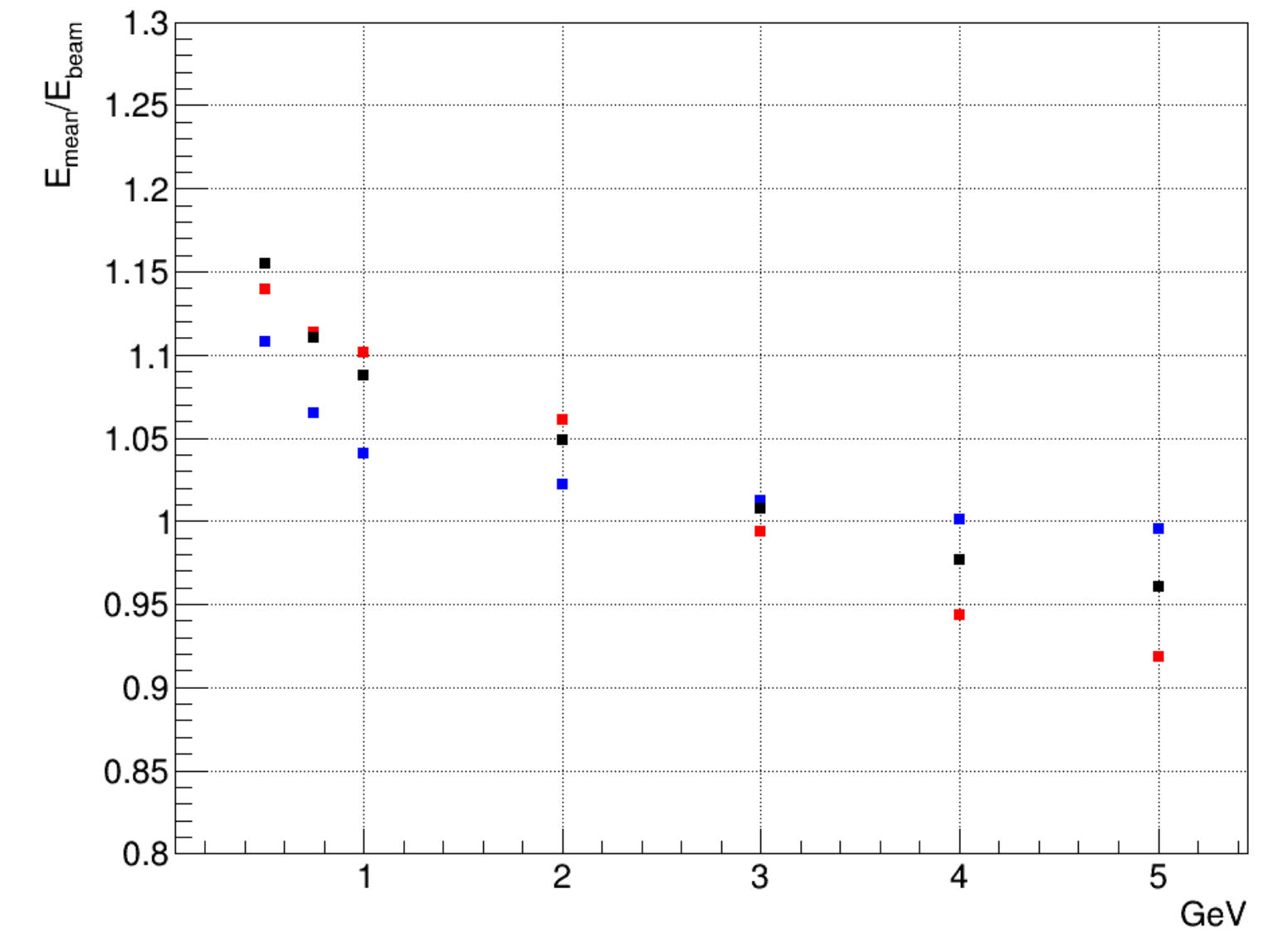
## EvtPed

- $\pm 11.5\%$ ,  $\pm 5.5\%$ ,  $\pm 10\%$
- $14.6 \oplus 5$ ,  $22.2 \oplus 4.2$ ,  $13.4 \oplus 4.6$

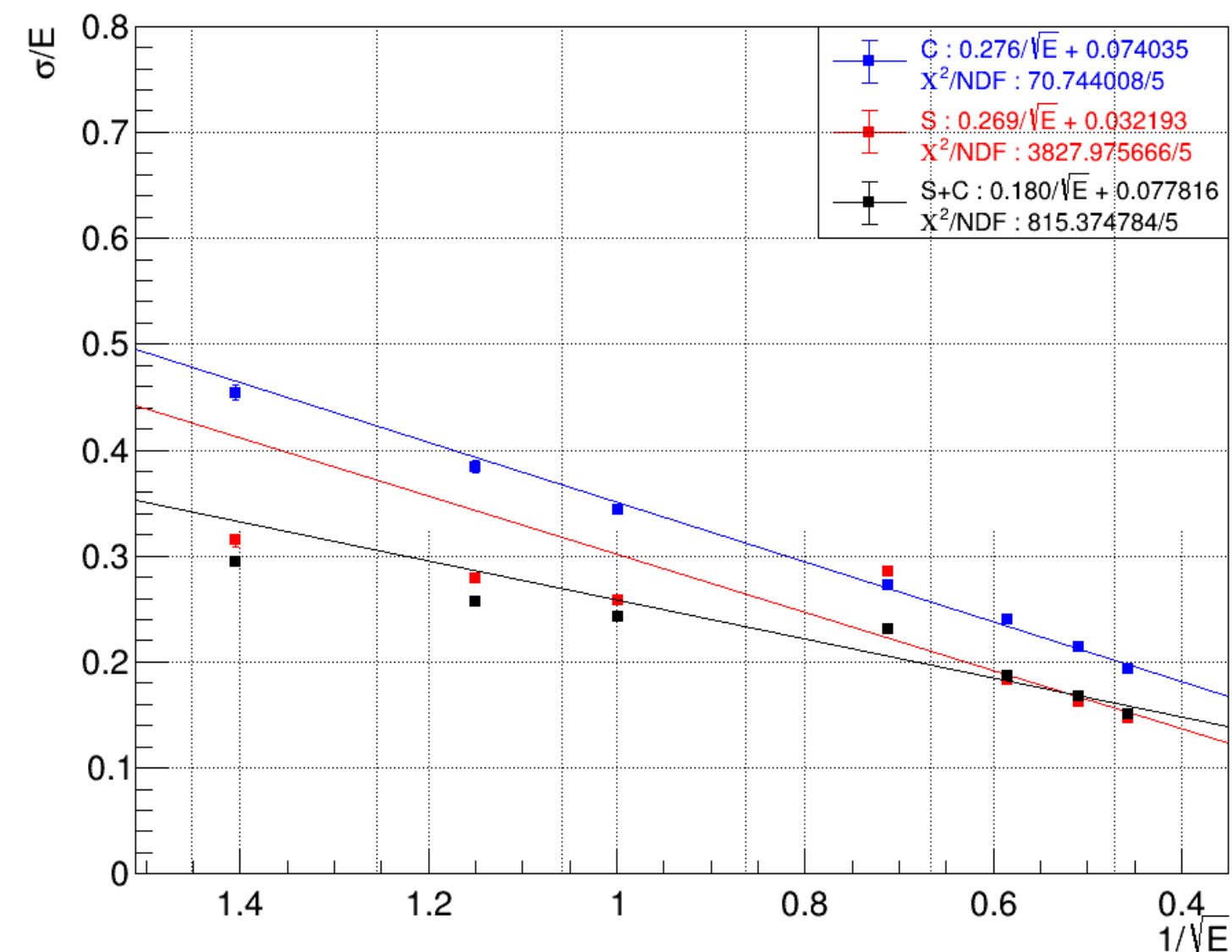
EM Linearity (Set 2, RunPed)



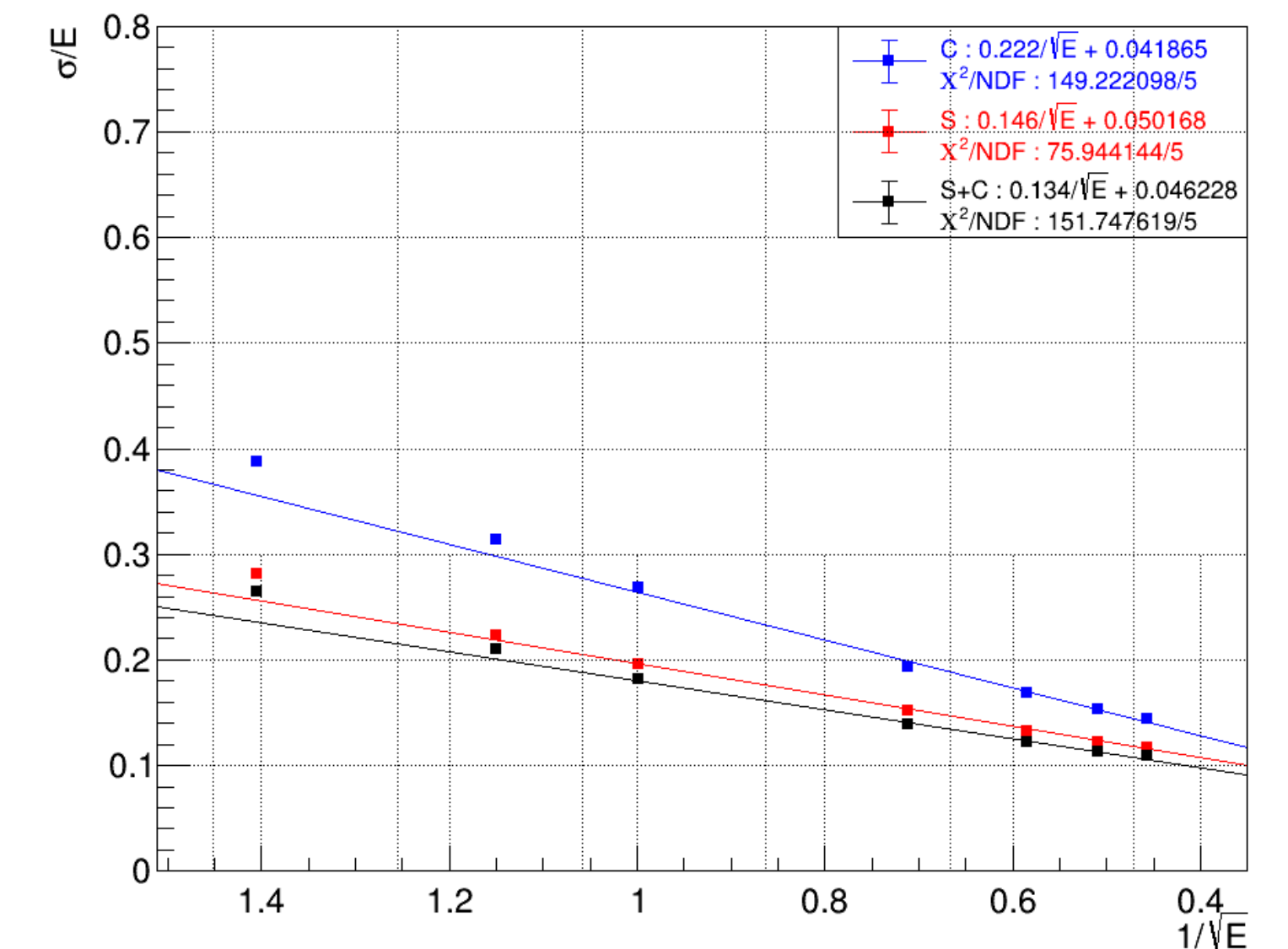
EM Linearity (Set 2, EvtPed)



Energy resolution (Set 2, RunPed)



Energy resolution (Set 2, EvtPed)



# Energy scan results set-3

- **Set 3** : Narrow collimator ( $\pm 0.7\%$ )
- Both results using RunPed & EvtPed
- Results **w/o** negative-energy events

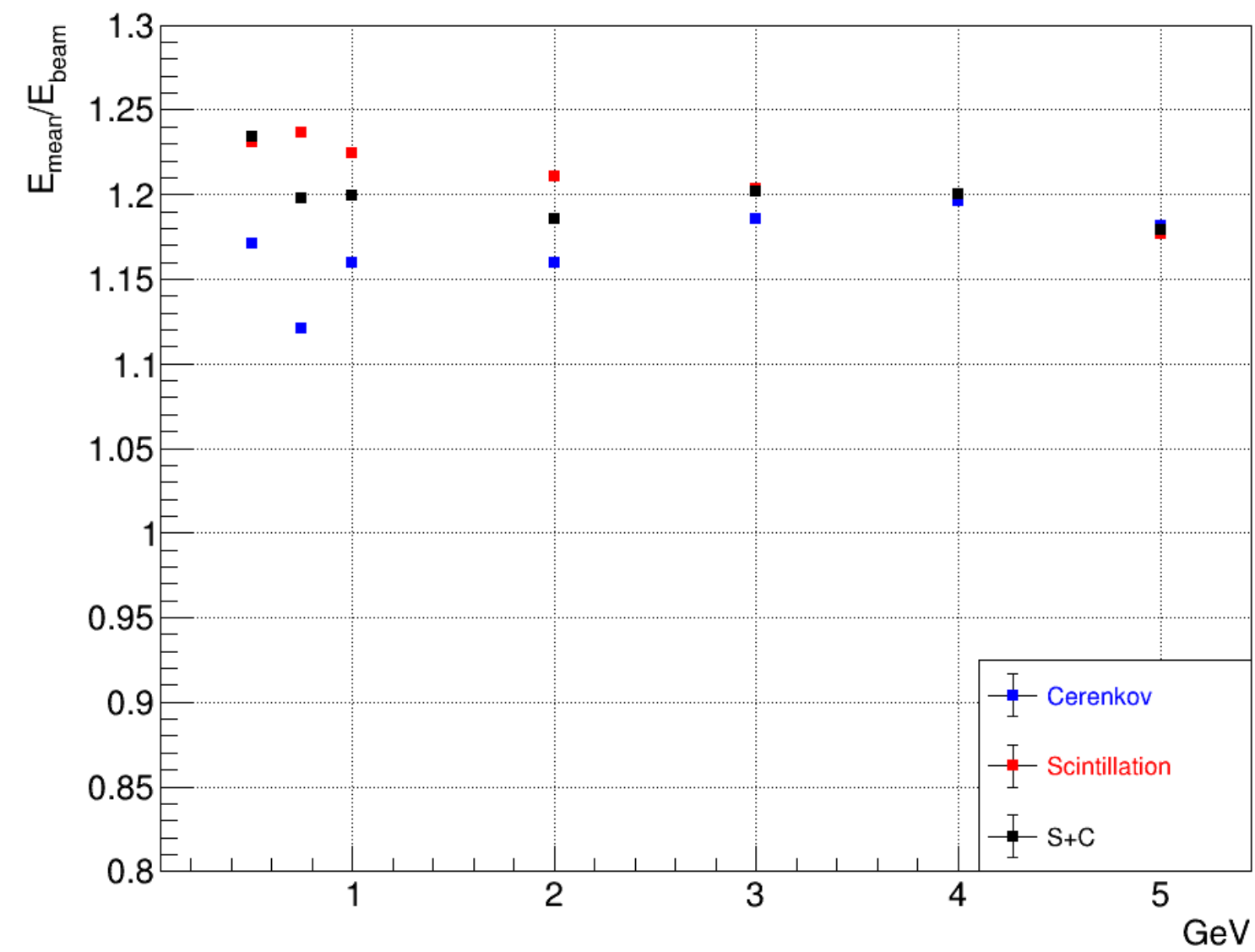
## RunPed

- $\pm 3.5\%$ ,  $\pm 4\%$ ,  $\pm 3\%$
- $15.7 \oplus 6.5$ ,  $23.3 \oplus 6.7$ ,  $14.6 \oplus 6.2$

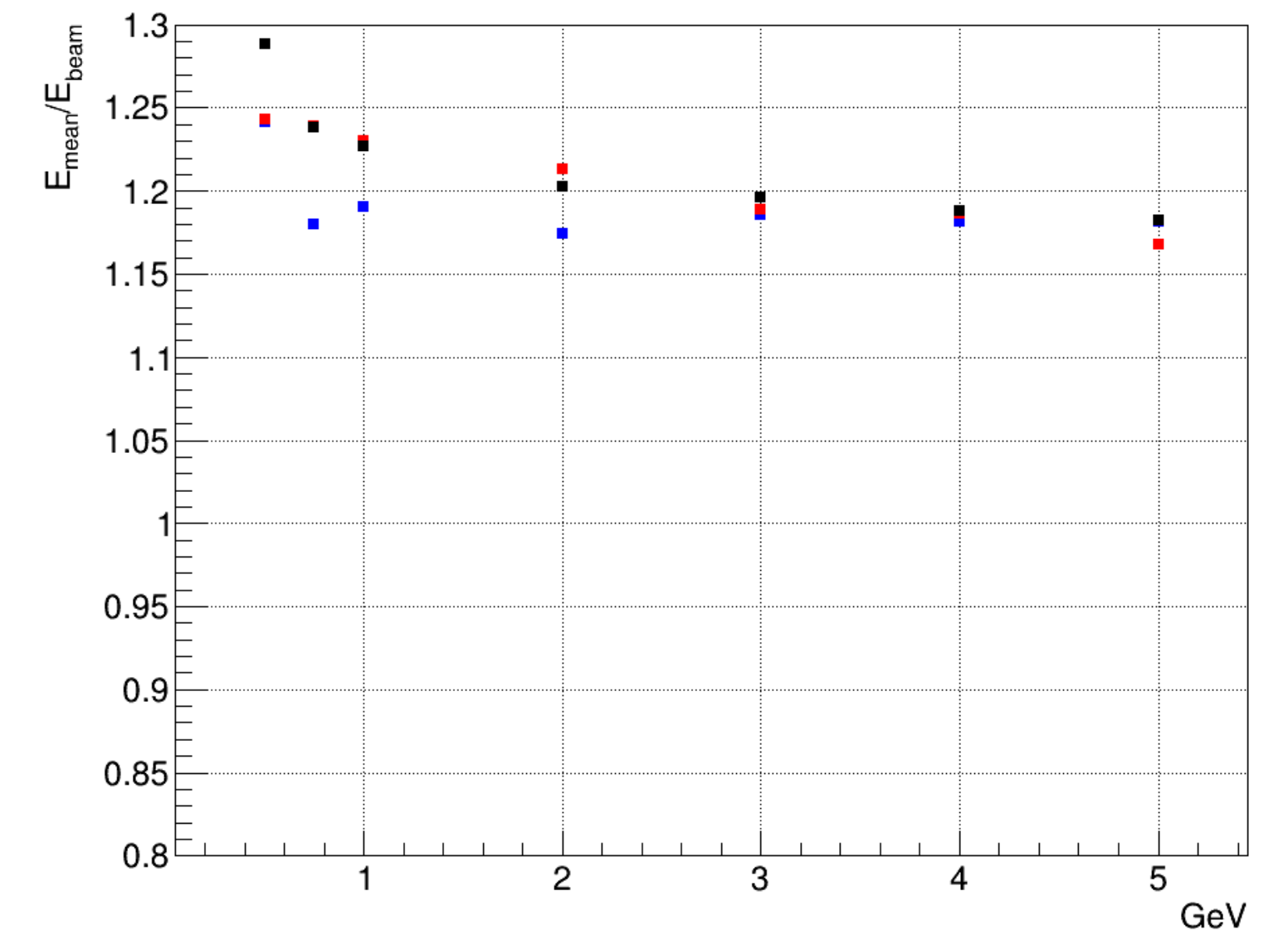
## EvtPed

- $\pm 4\%$ ,  $\pm 1\%$ ,  $\pm 5\%$
- $16.6 \oplus 4.3$ ,  $23.9 \oplus 3.7$ ,  $14.8 \oplus 4$

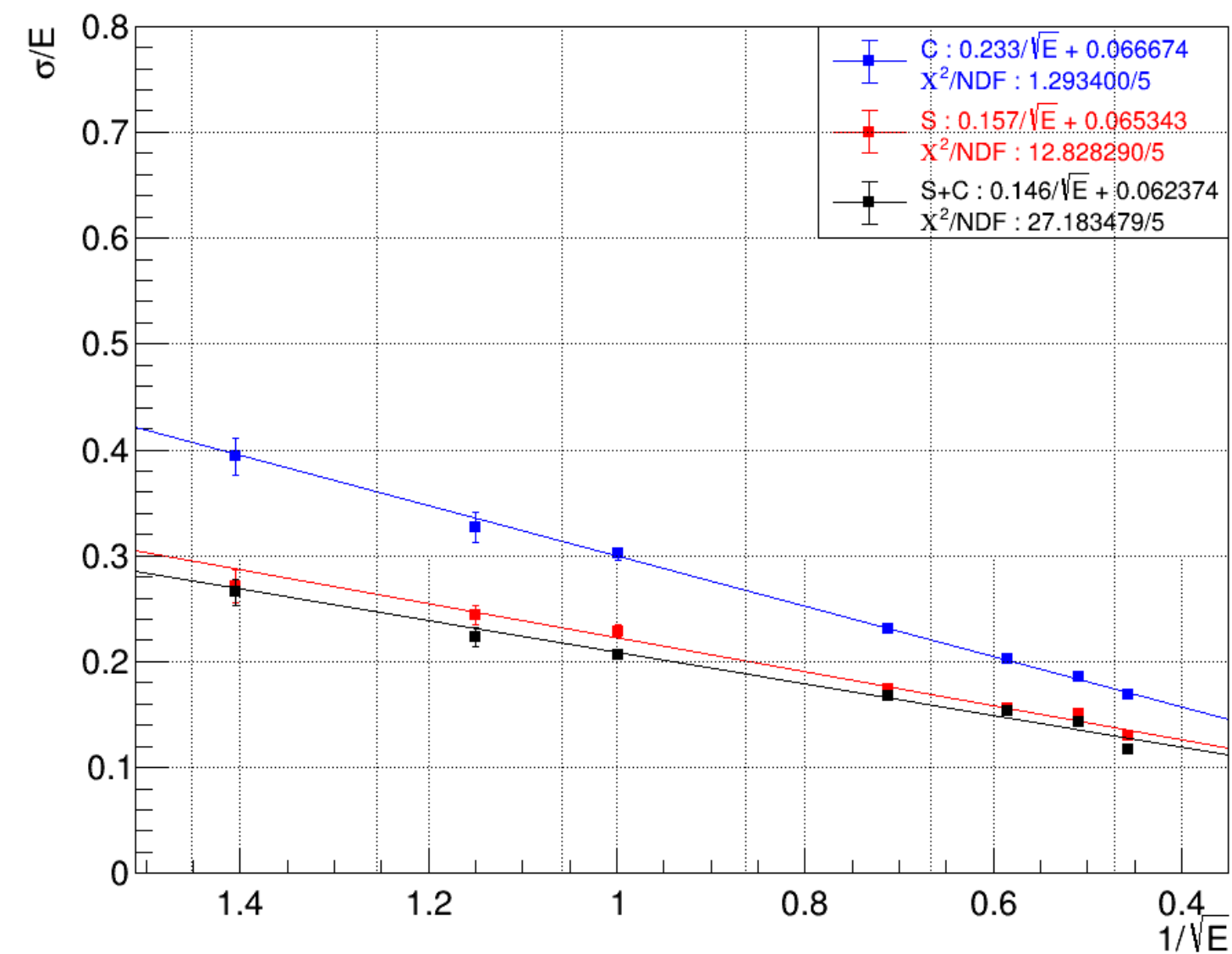
EM Linearity (Set 3, RunPed)



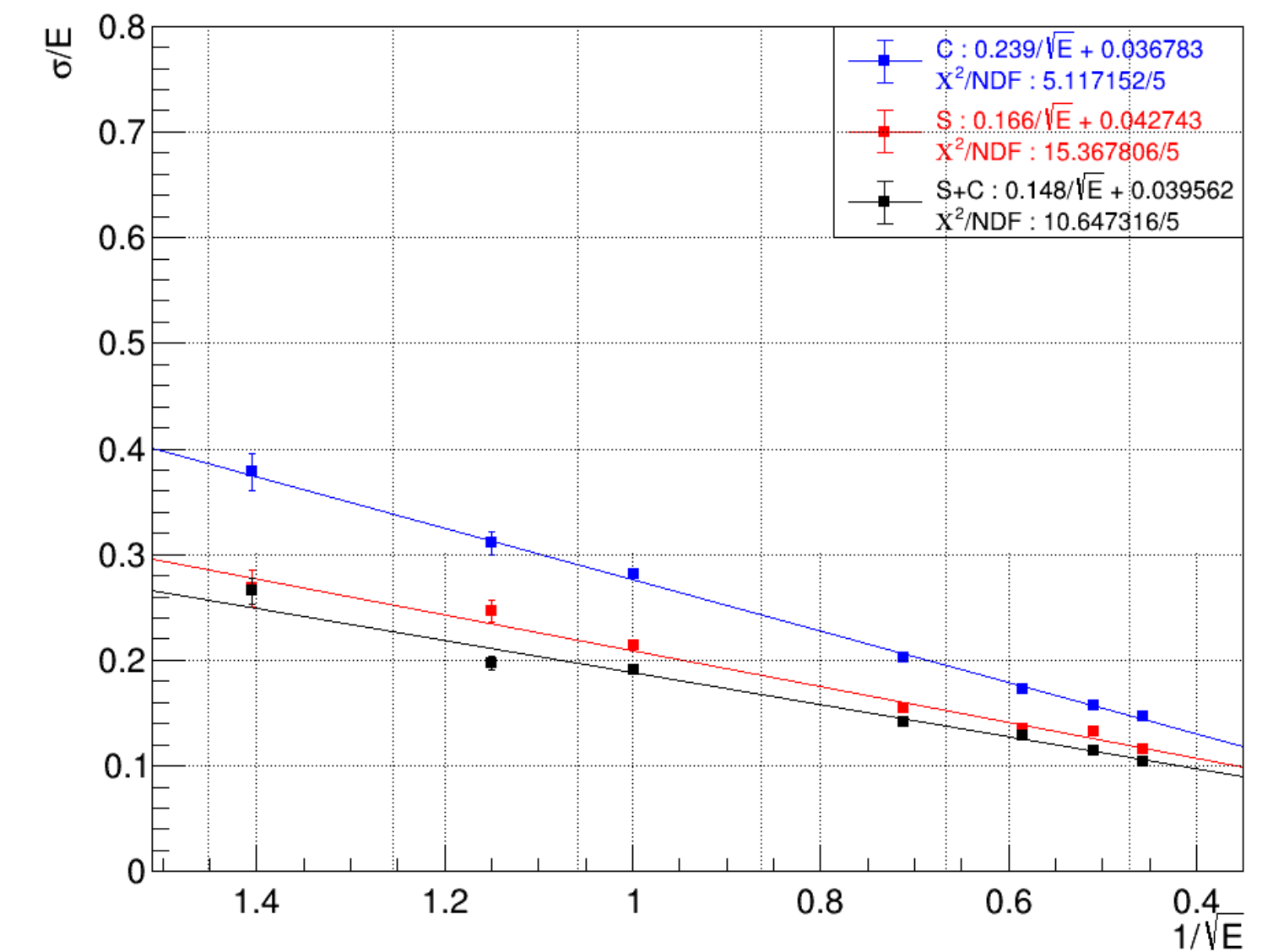
EM Linearity (Set 3, EvtPed)



Energy resolution (Set 3, RunPed)



Energy resolution (Set 3, EvtPed)





# Energy scan results set-4

- **Set 4** : Narrow collimator + Module rotation & tilting
- Both results using RunPed & EvtPed
- Results **w/o** negative-energy events

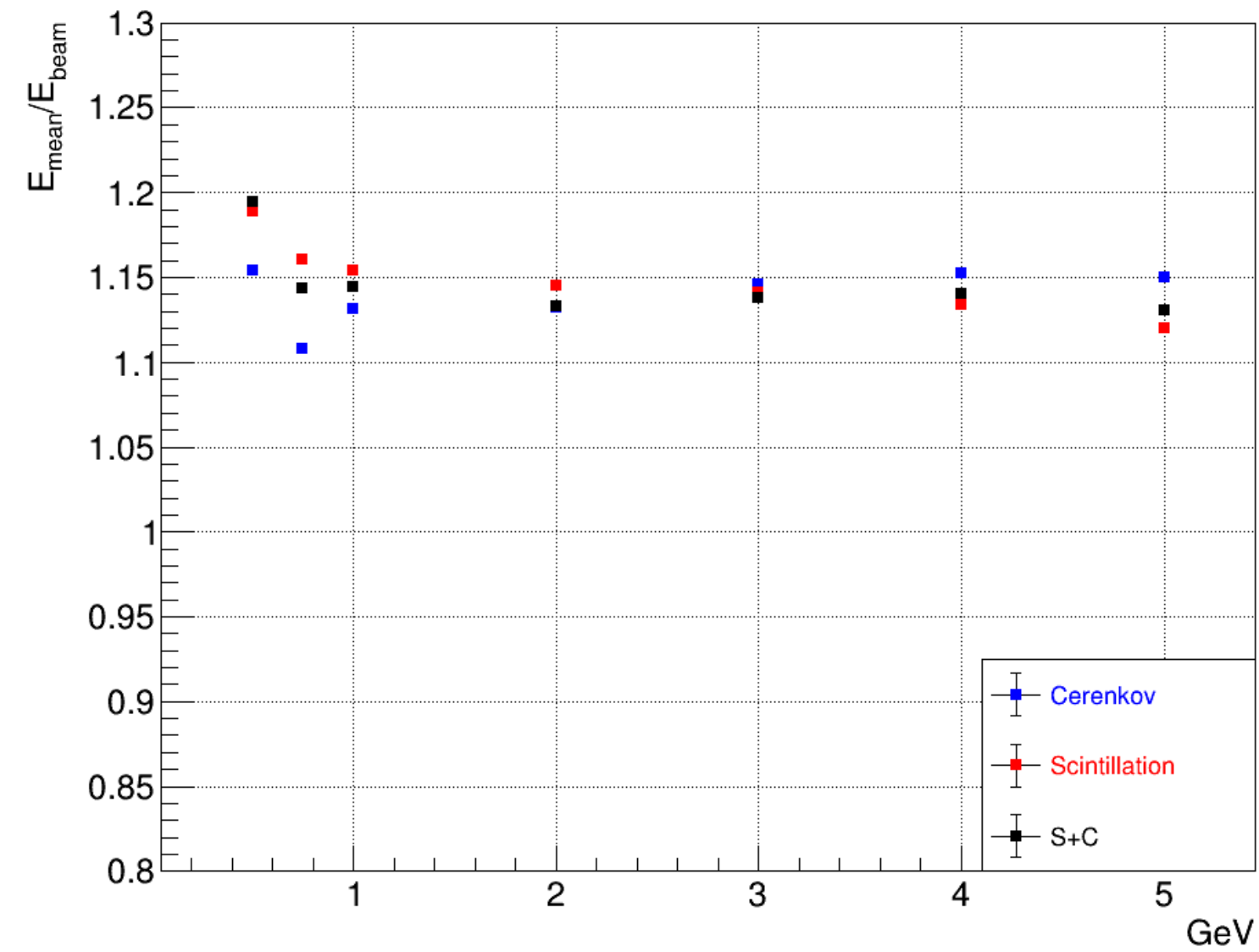
## RunPed

- $\pm 3.5\%$ ,  $\pm 2.5\%$ ,  $\pm 3.5\%$
- $15.1 \oplus 4.4$ ,  $25.1 \oplus 3.9$ ,  $14.7 \oplus 4.2$

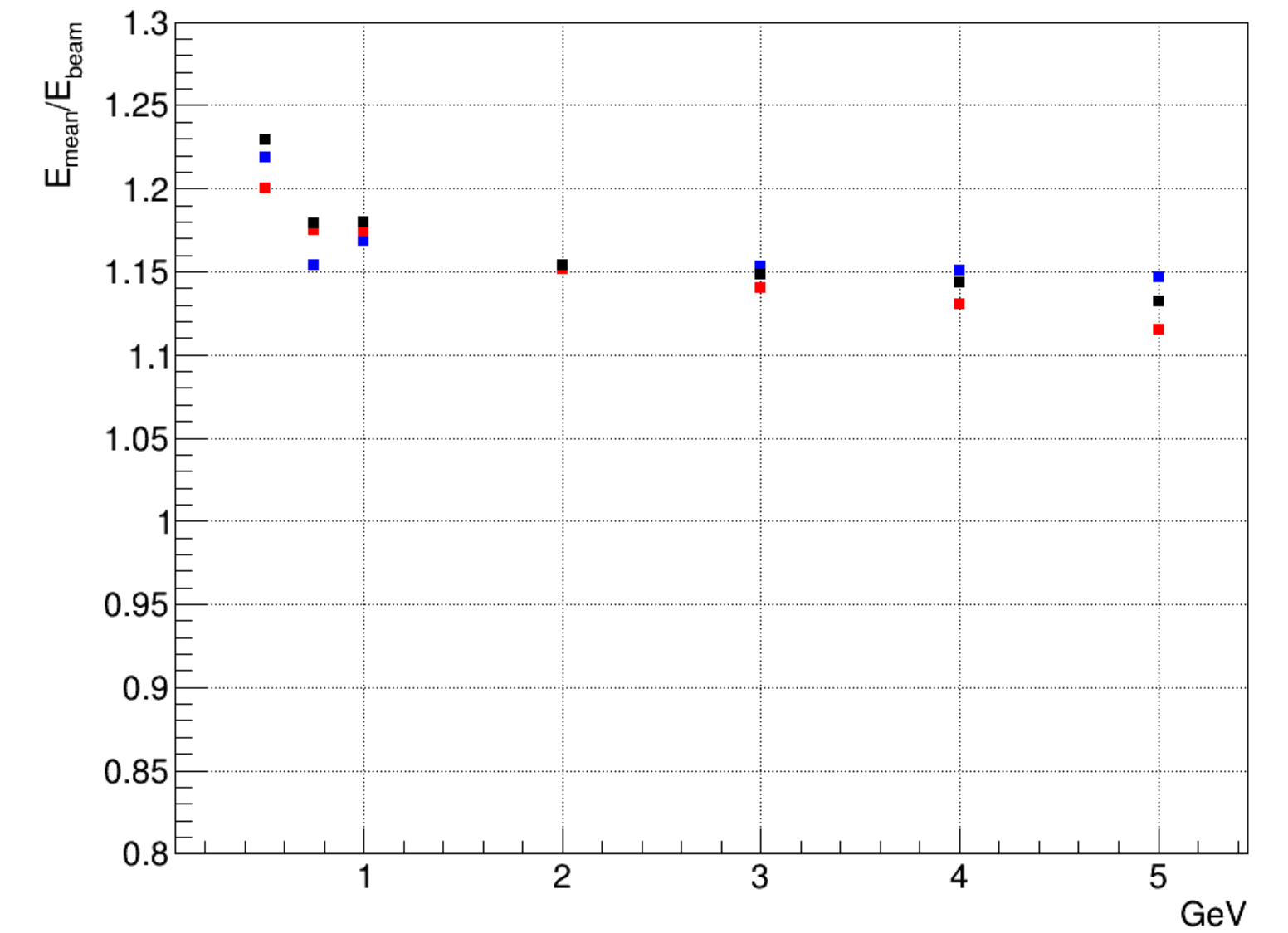
## EvtPed

- $\pm 4\%$ ,  $\pm 3.5\%$ ,  $\pm 5\%$
- $14.6 \oplus 3$ ,  $26.1 \oplus 0.6$ ,  $14.9 \oplus 2$

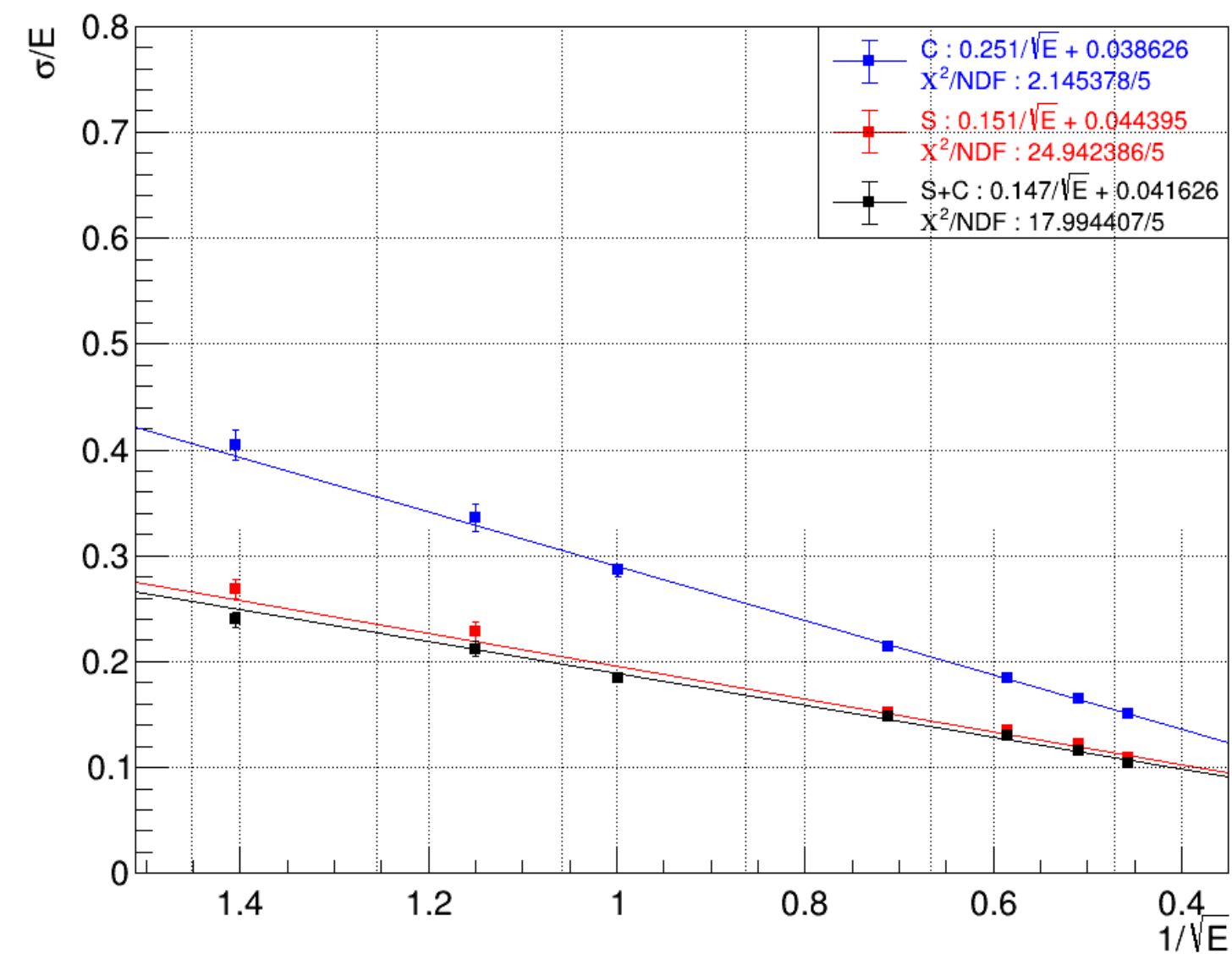
EM Linearity (Set 4, RunPed)



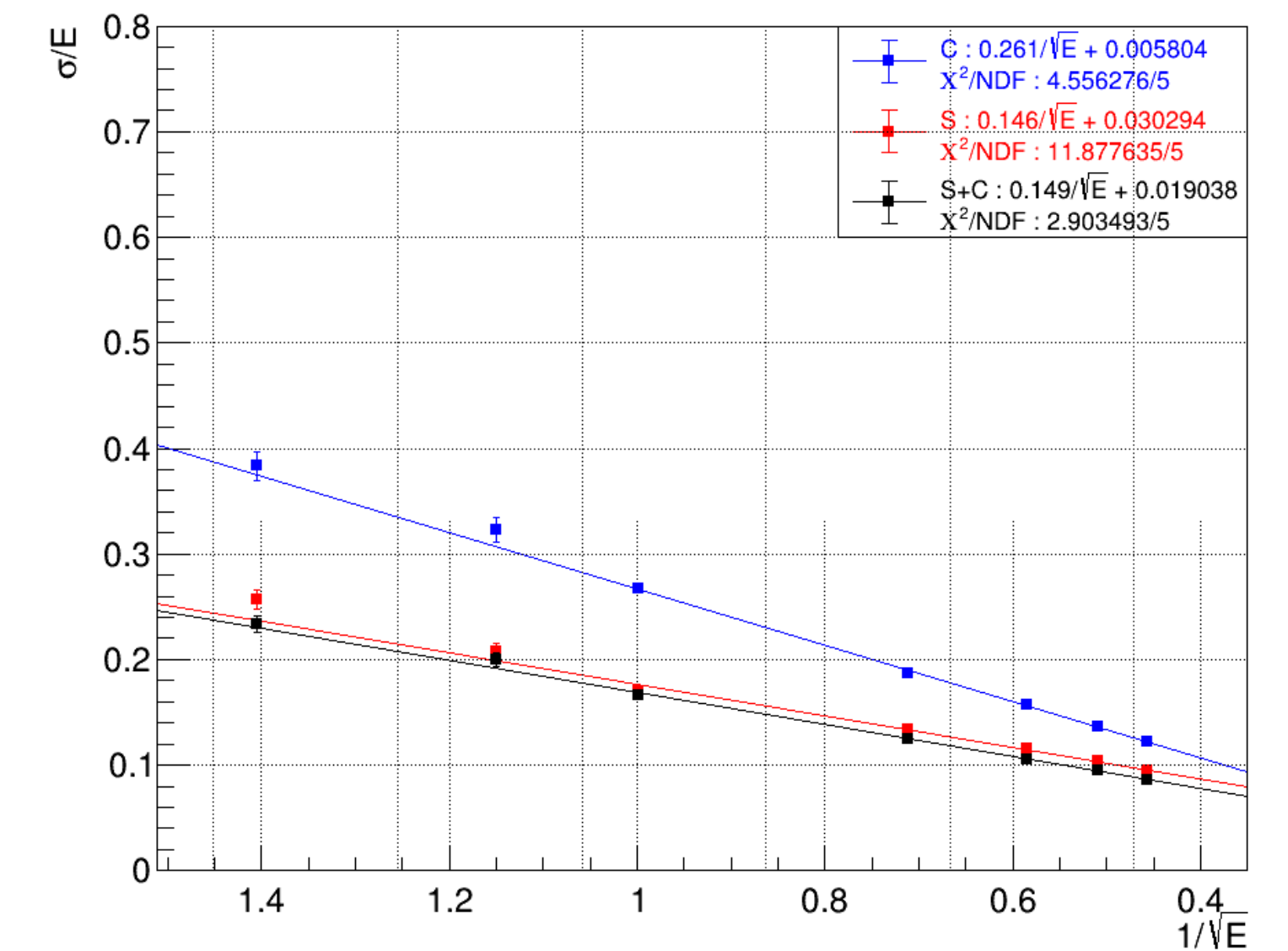
EM Linearity (Set 4, EvtPed)



Energy resolution (Set 4, RunPed)



Energy resolution (Set 4, EvtPed)



# Energy scan results set-5

- **Set 5** : Narrow collimator + Swap MCP-PMTs + Add shielding + Add black paint
- Both results using RunPed & EvtPed
- Results **w/o** negative-energy events

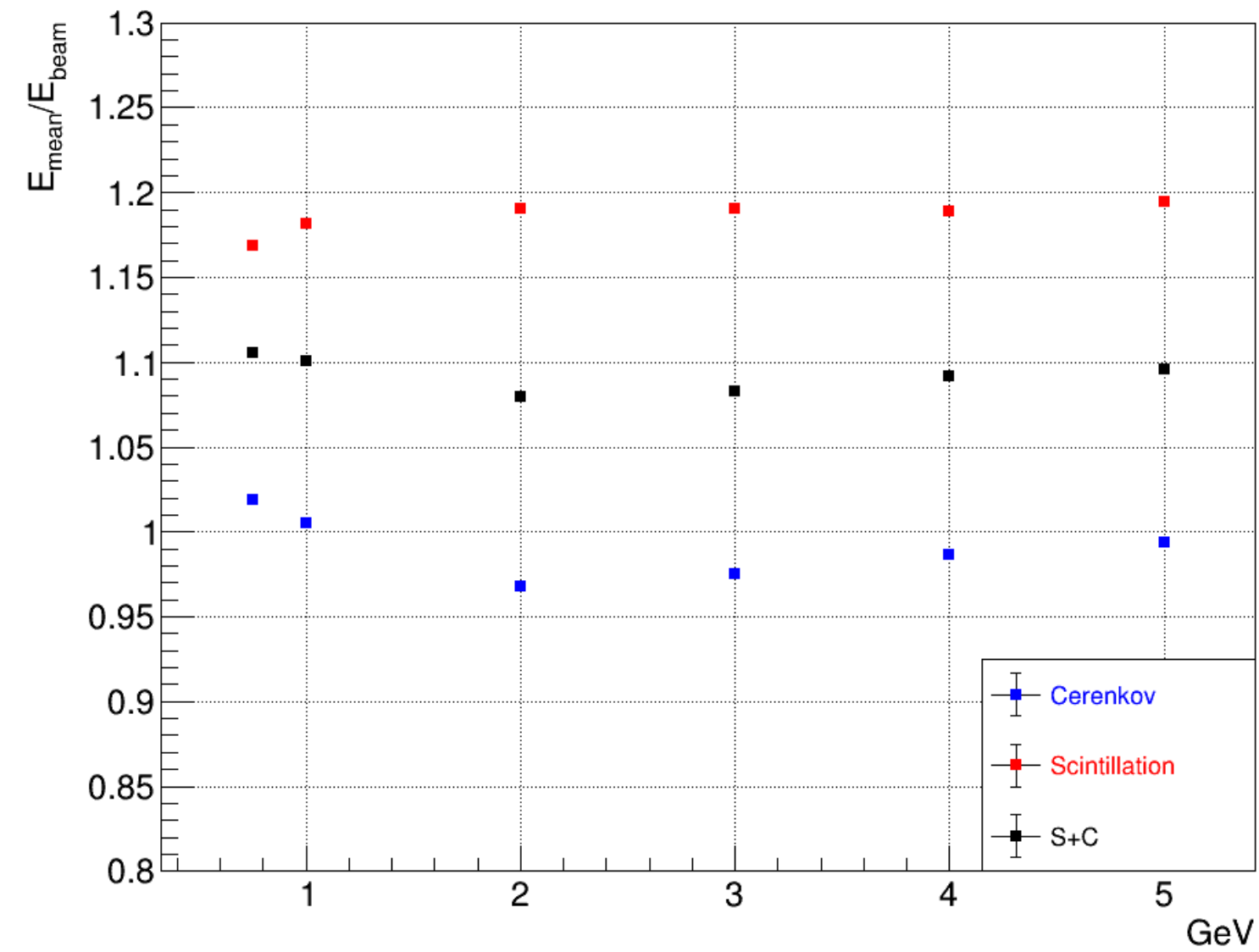
## RunPed

- $\pm 1.5\%$ ,  $\pm 3\%$ ,  $\pm 1.5\%$
- $16.9 \oplus 3.2$ ,  $26.4 \oplus 3.7$ ,  $14.2 \oplus 4.8$

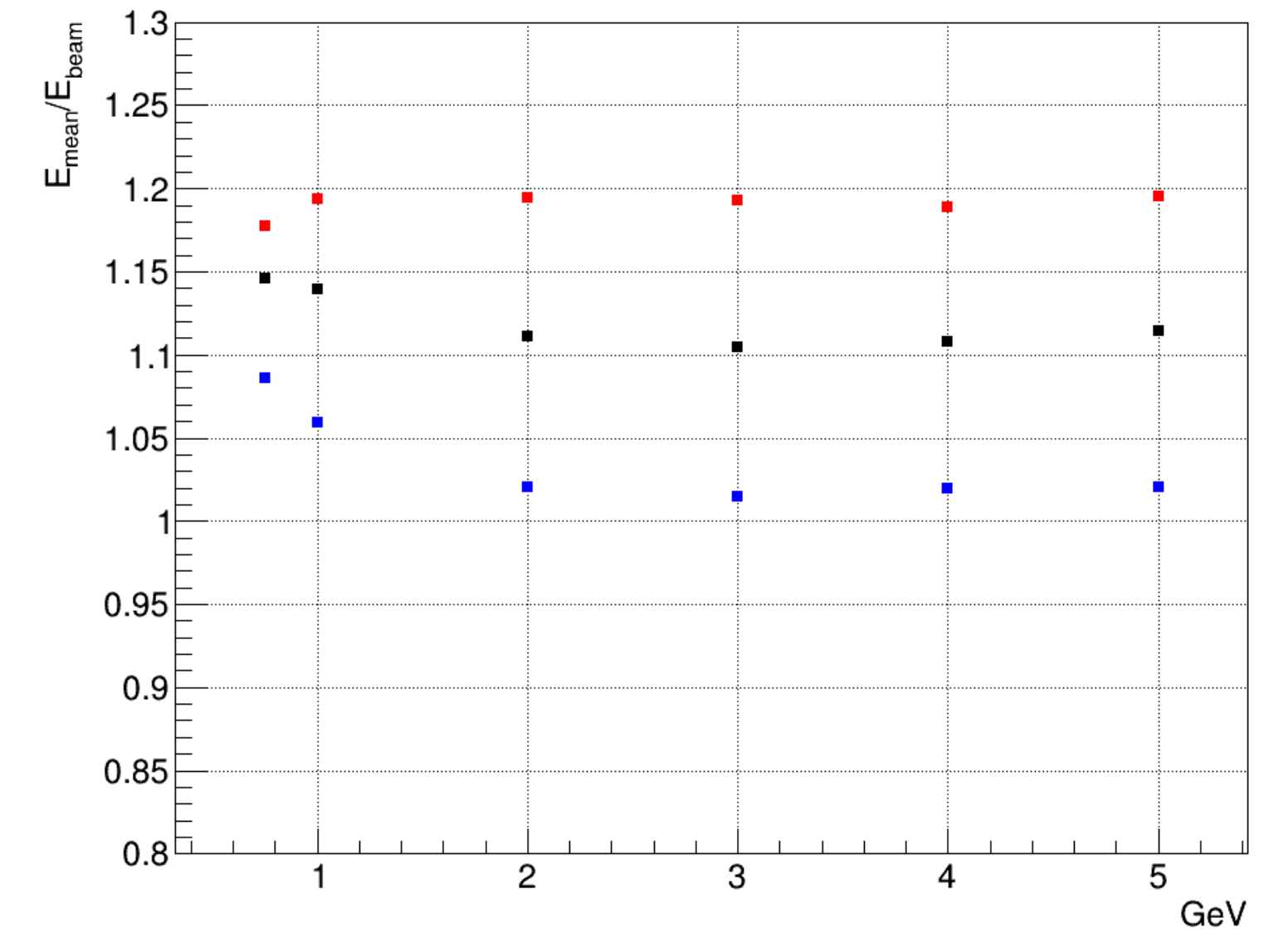
## EvtPed

- $\pm 2\%$ ,  $\pm 4\%$ ,  $\pm 2.5\%$
- $18.1 \oplus 1.5$ ,  $27.9 \oplus 0.7$ ,  $16.4 \oplus 1.9$

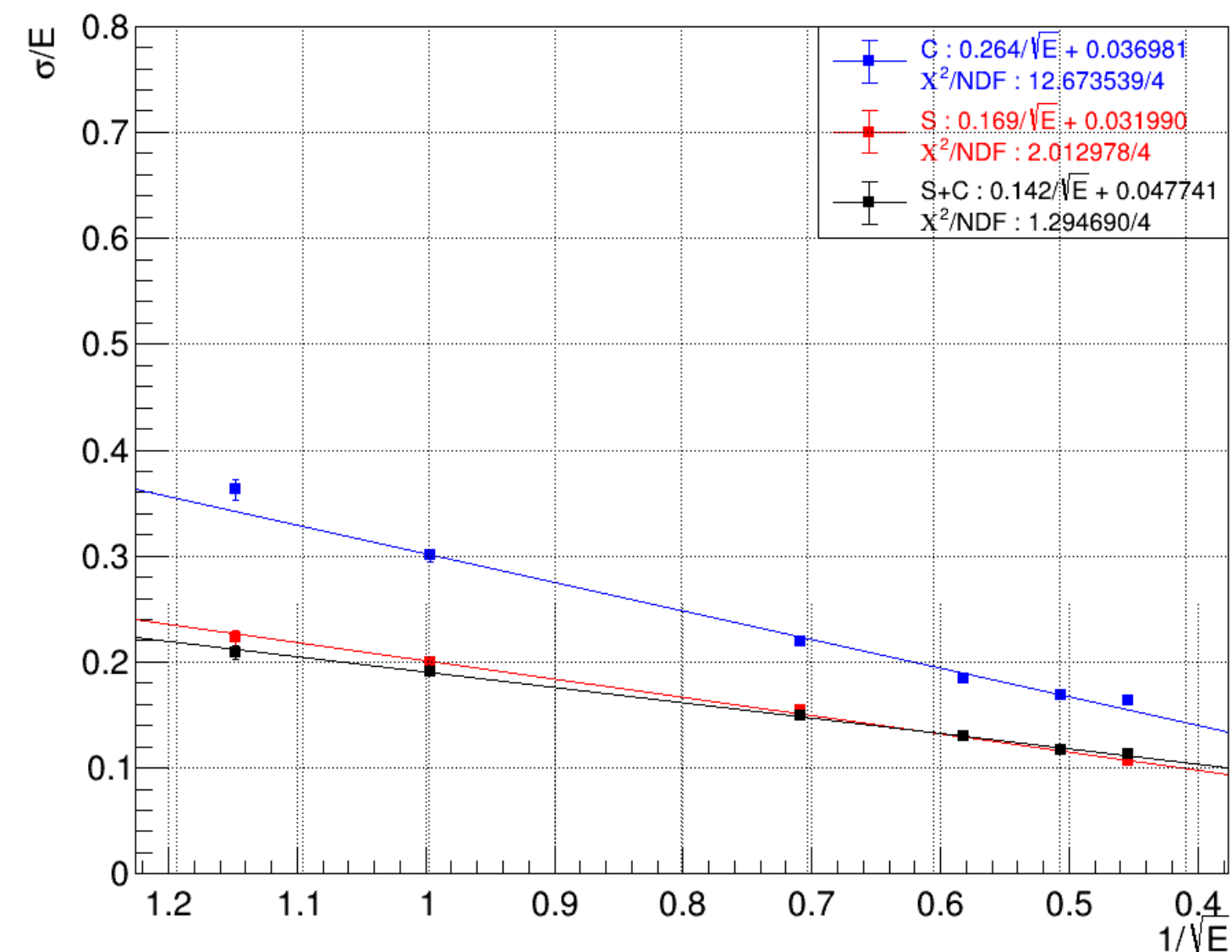
EM Linearity (Set 5, RunPed)



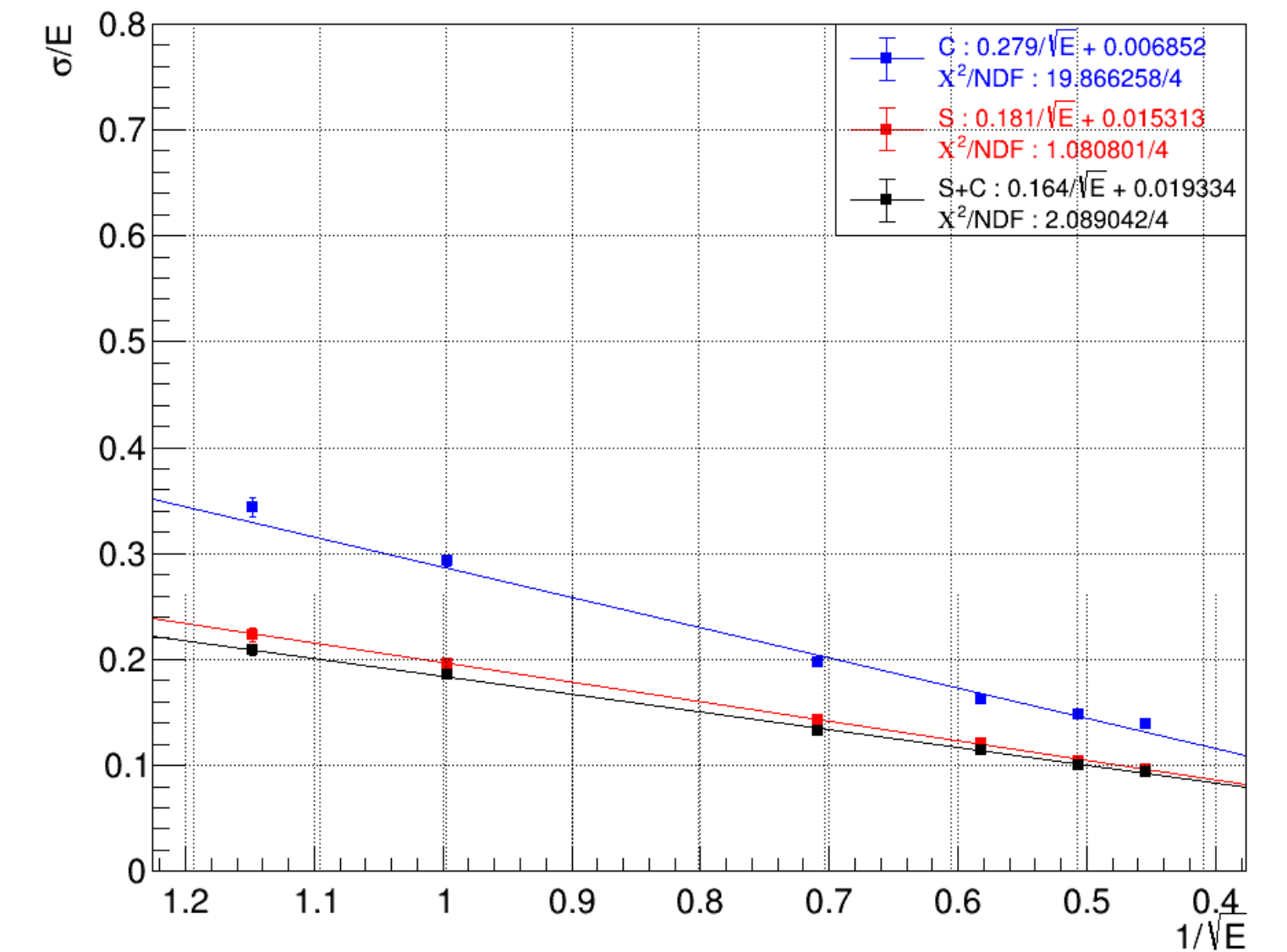
EM Linearity (Set 5, EvtPed)



Energy resolution (Set 5, RunPed)

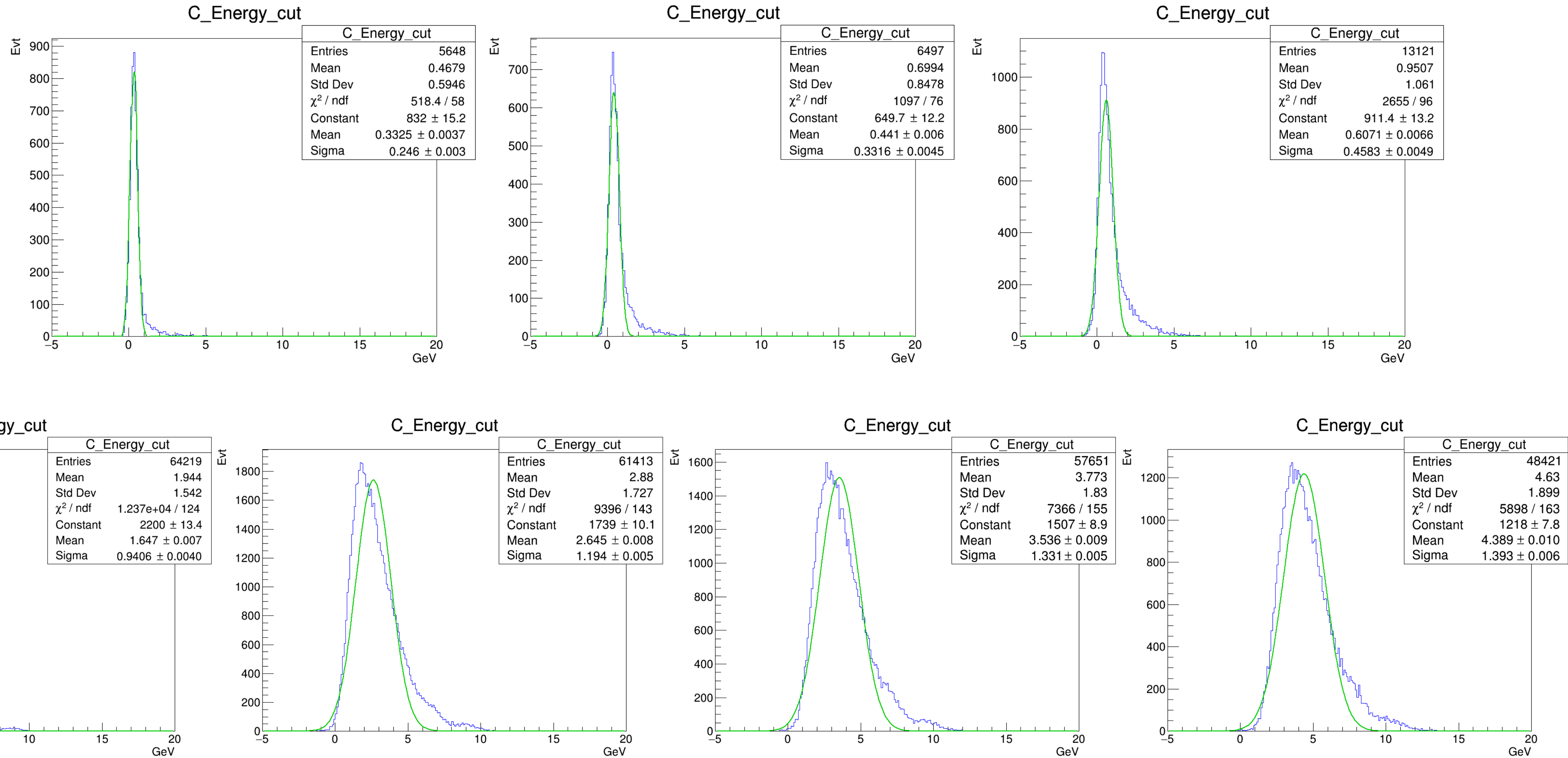


Energy resolution (Set 5, EvtPed)

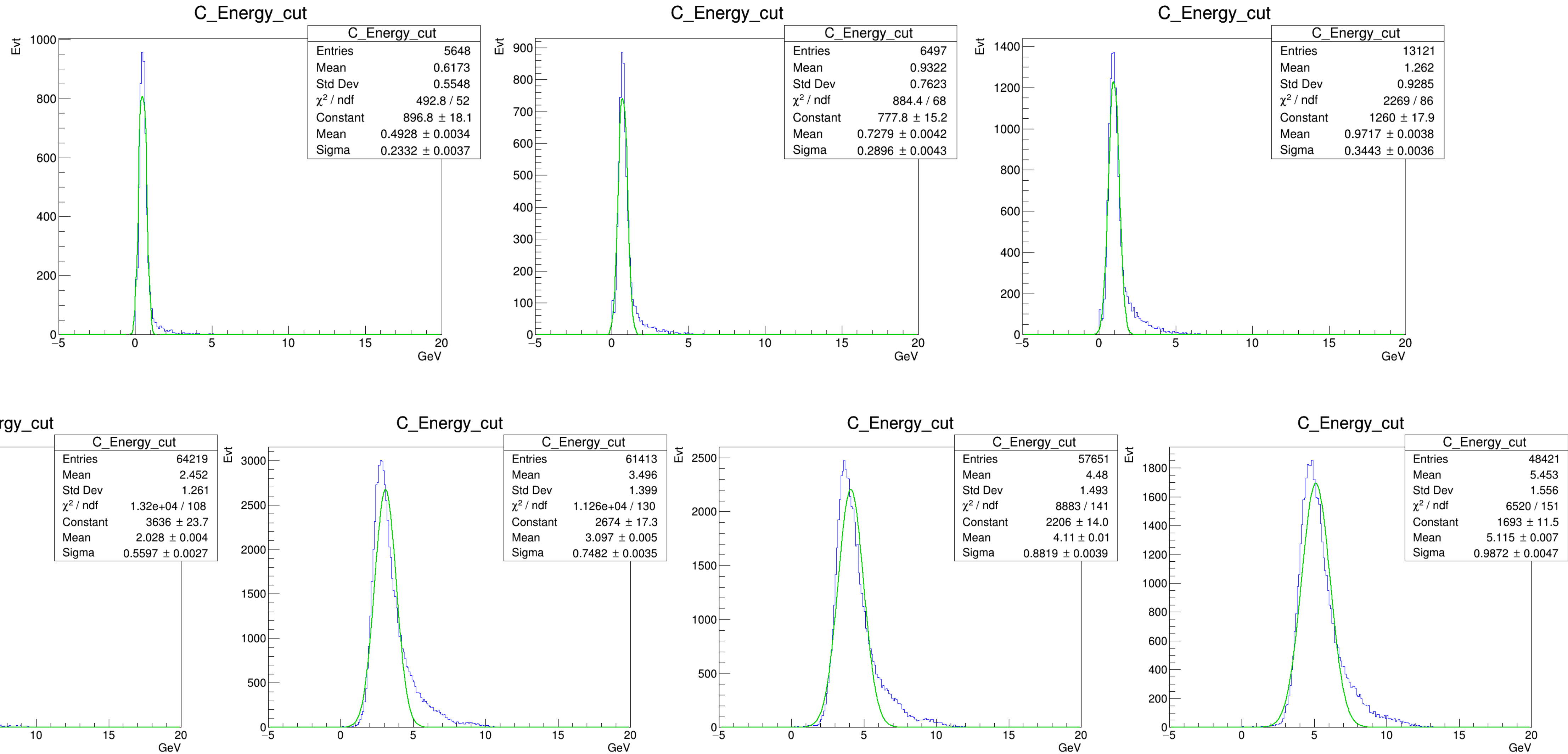


# Backup

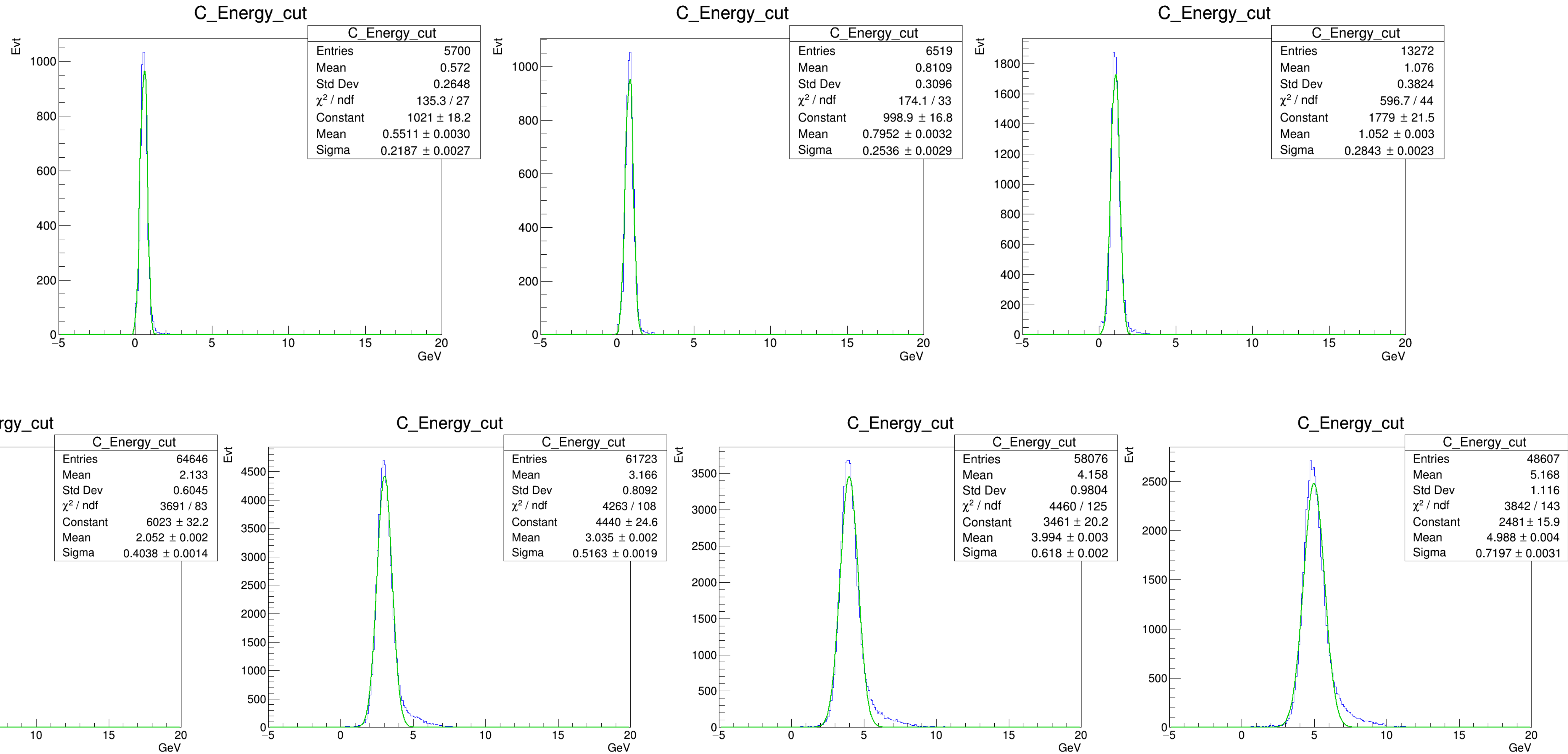
# Energy scan results set-1



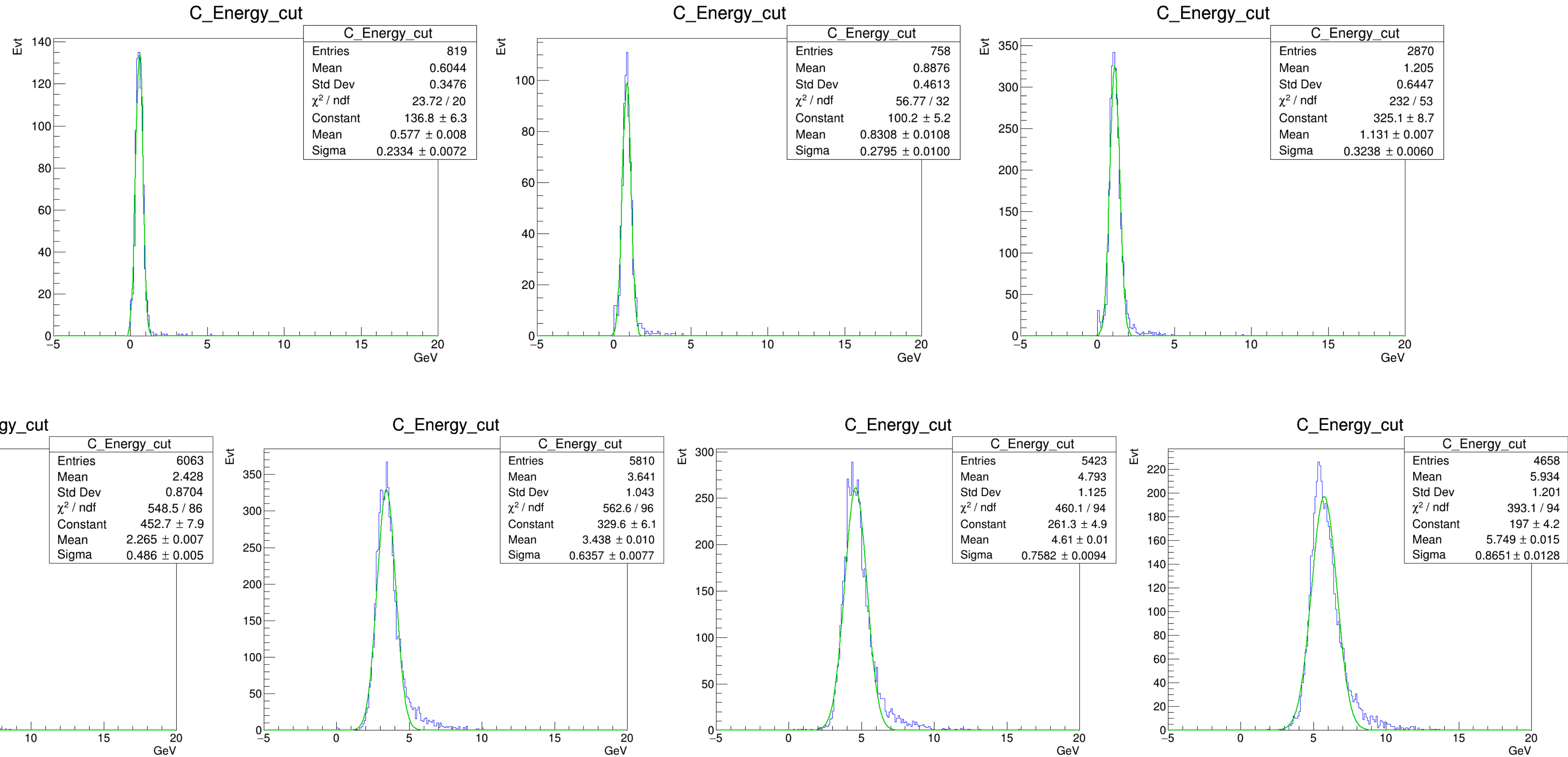
# Energy scan results set-1



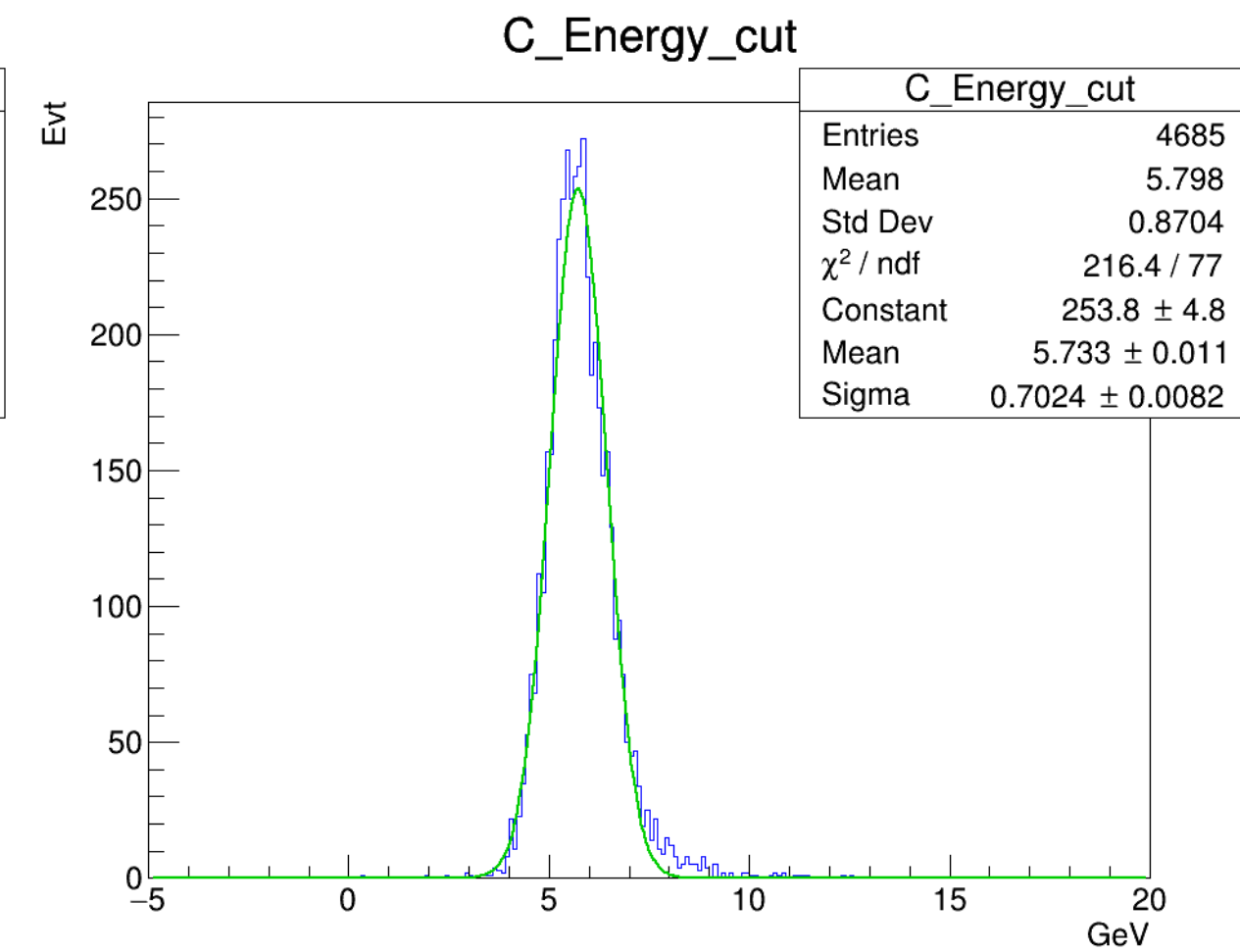
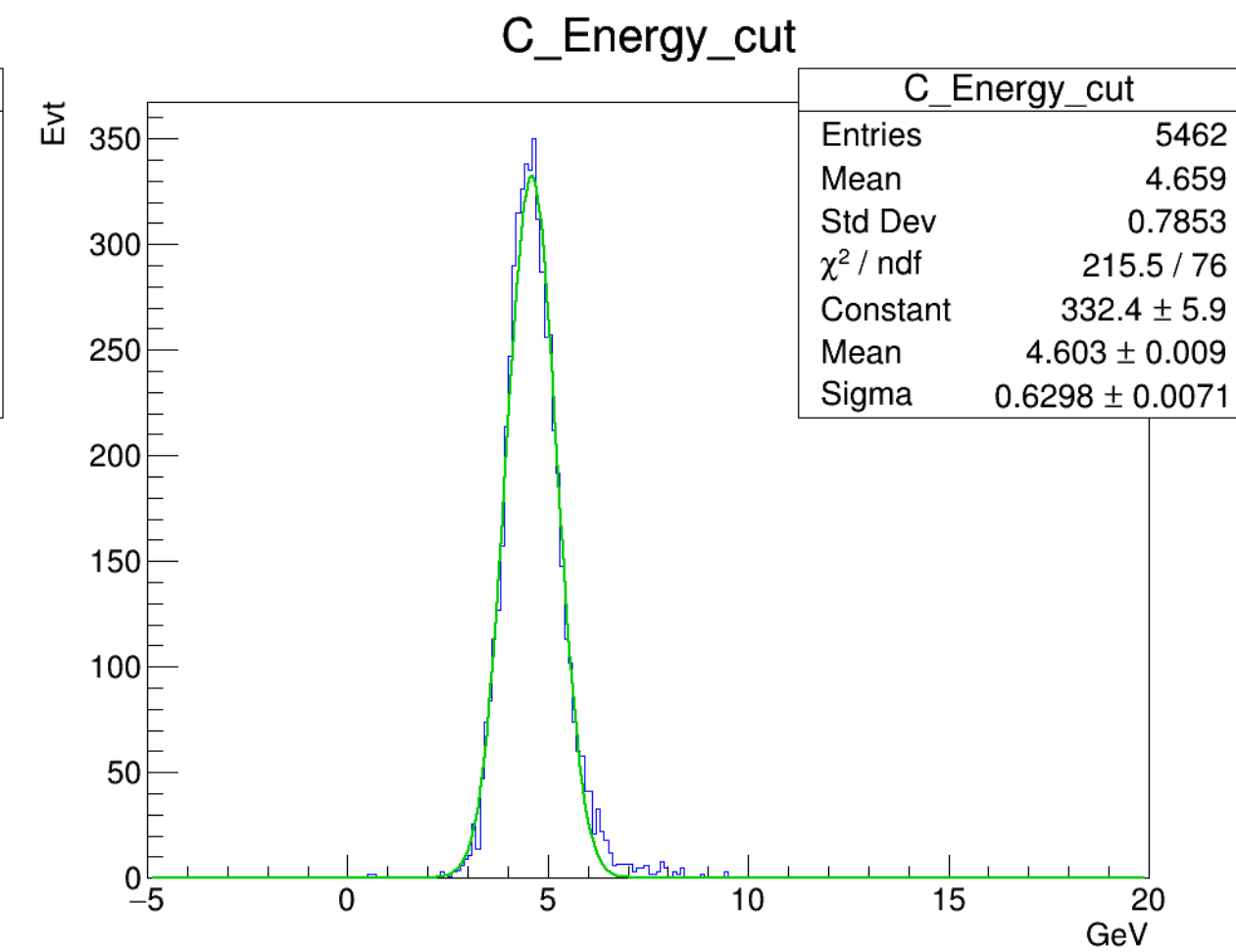
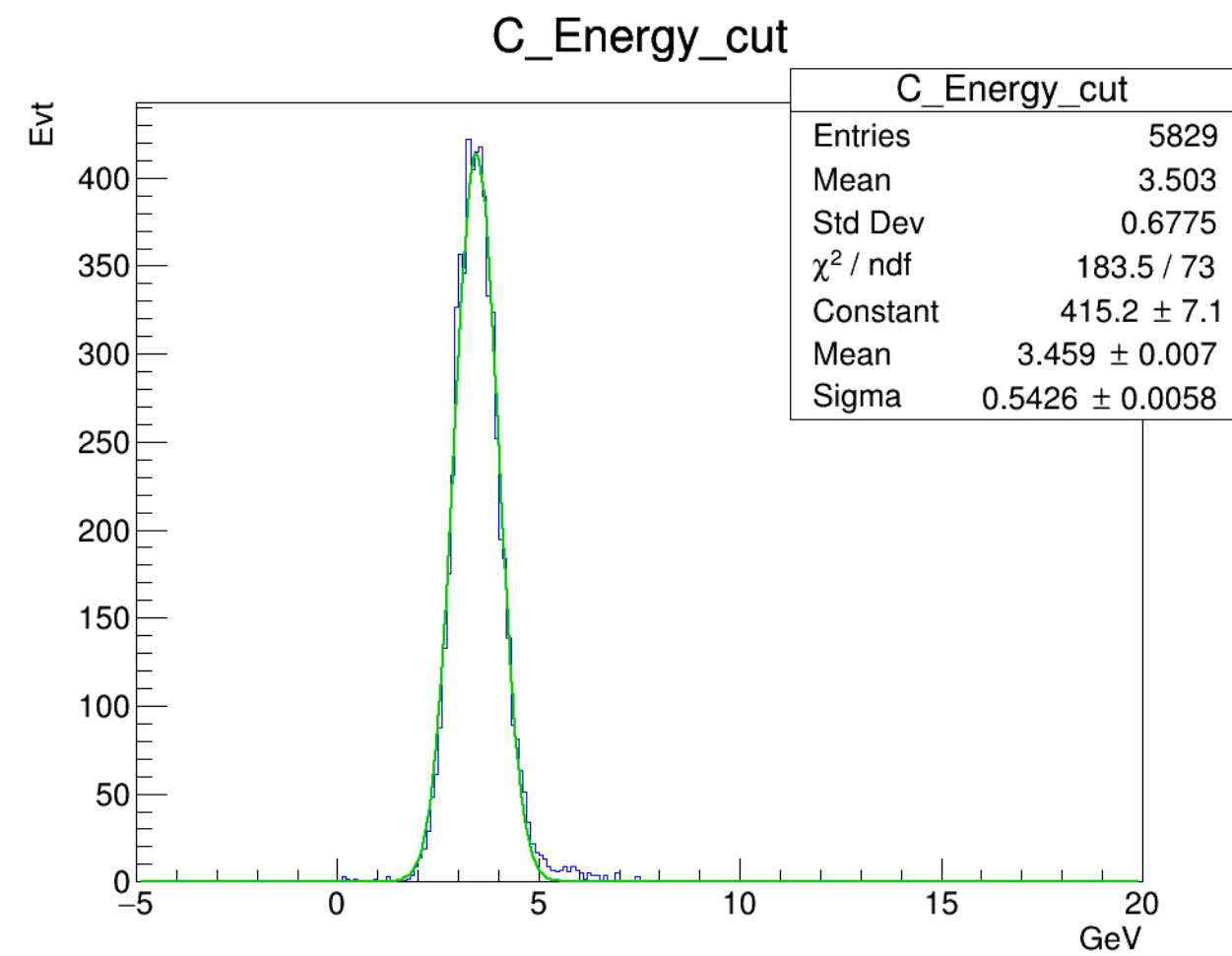
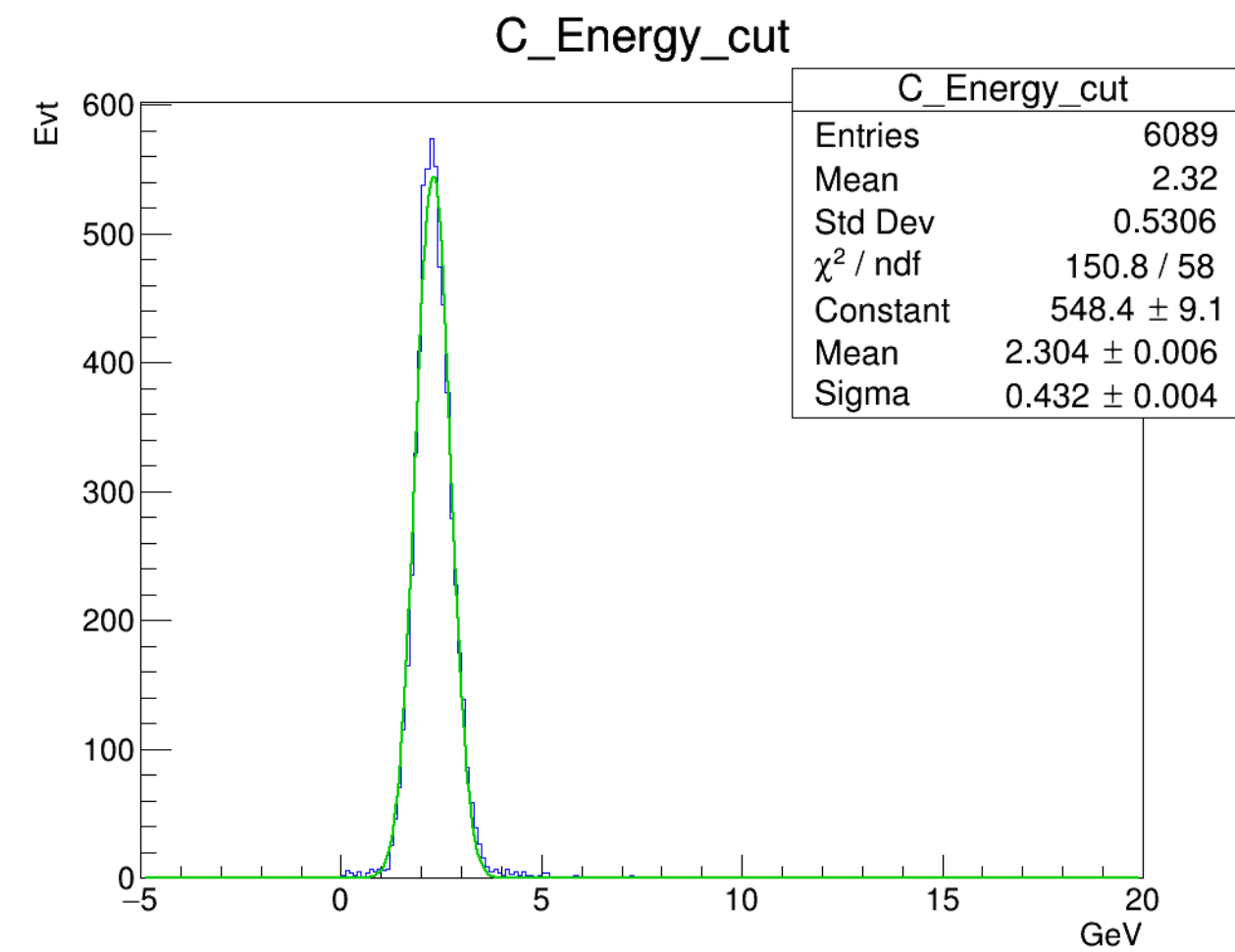
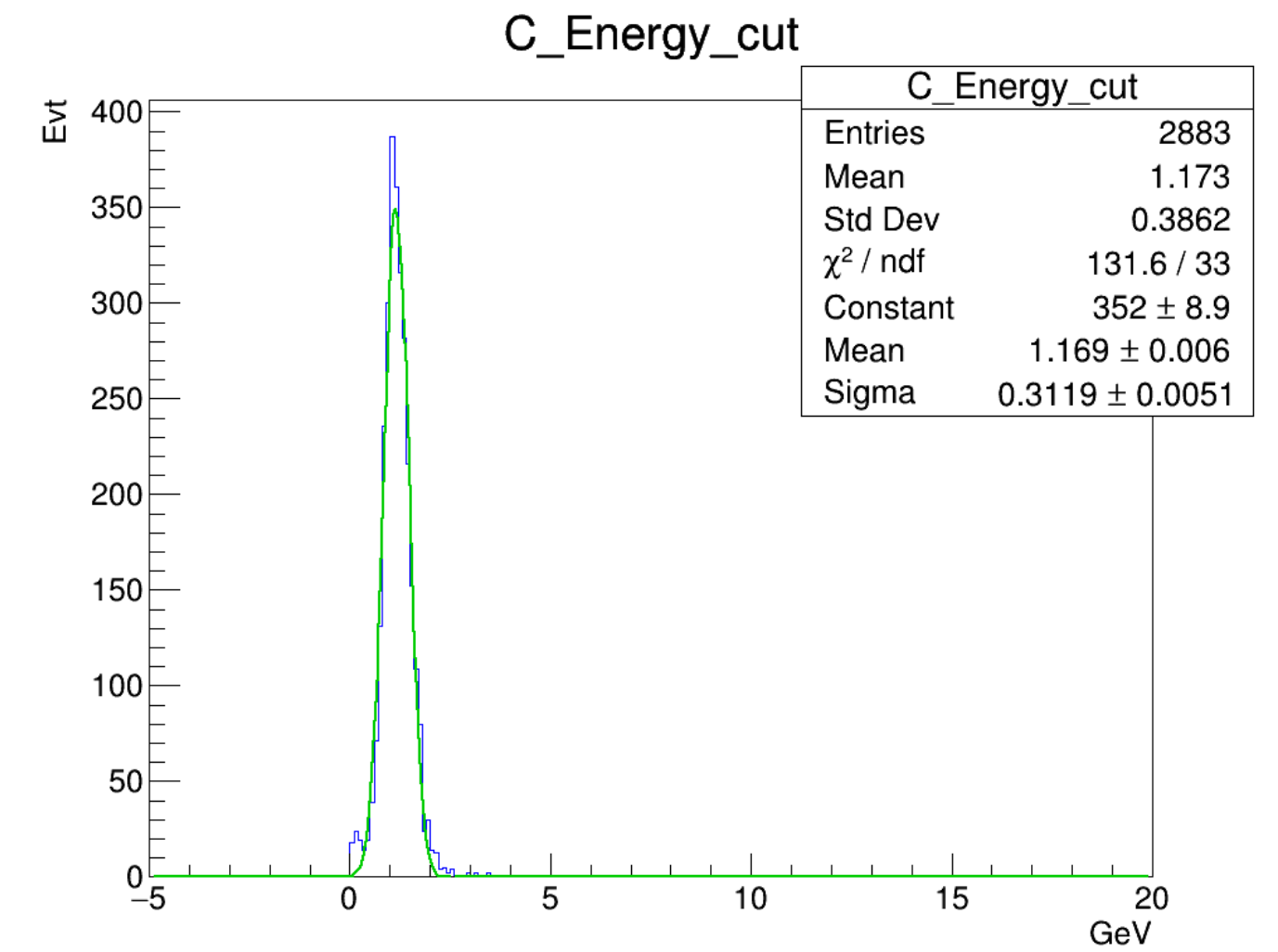
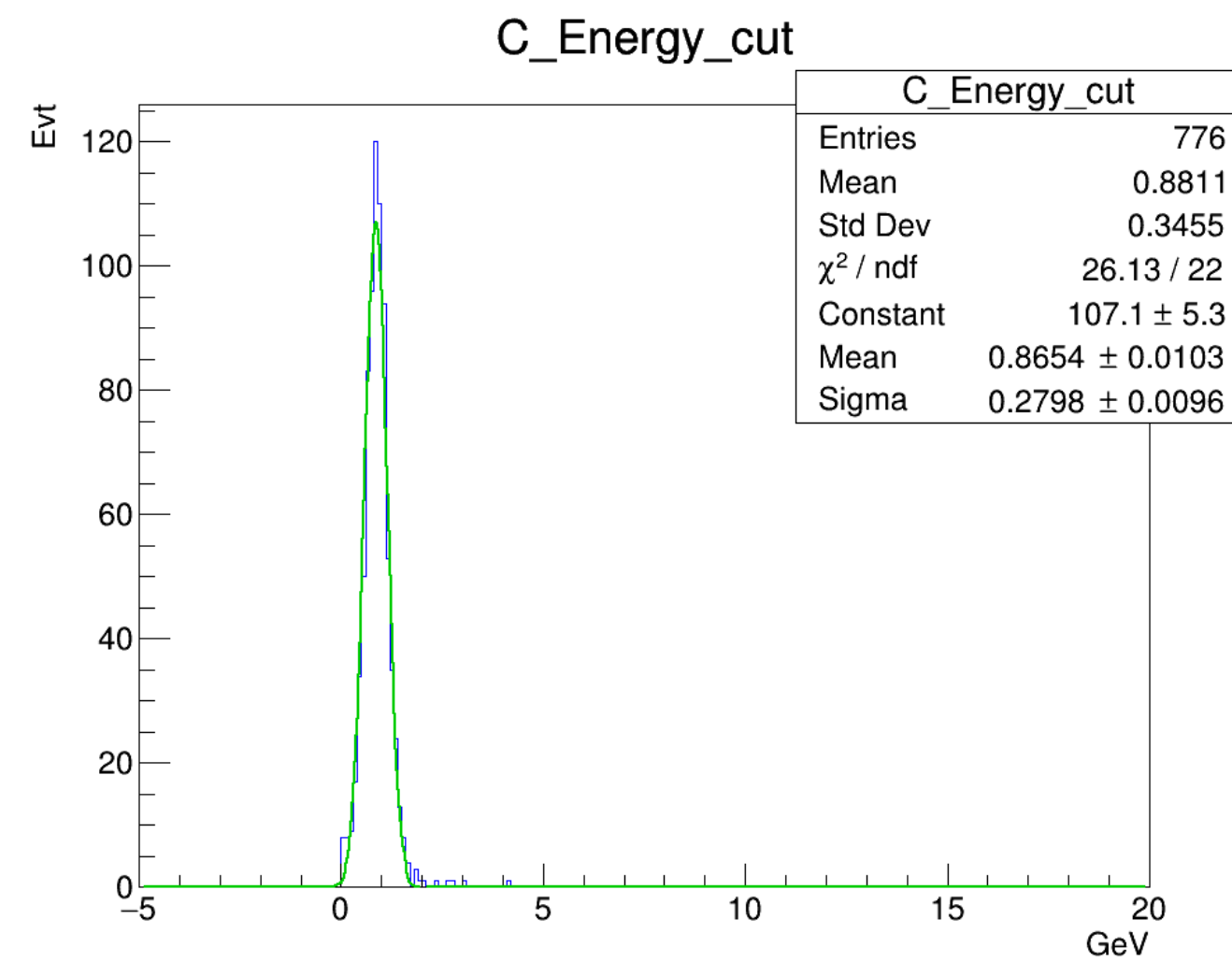
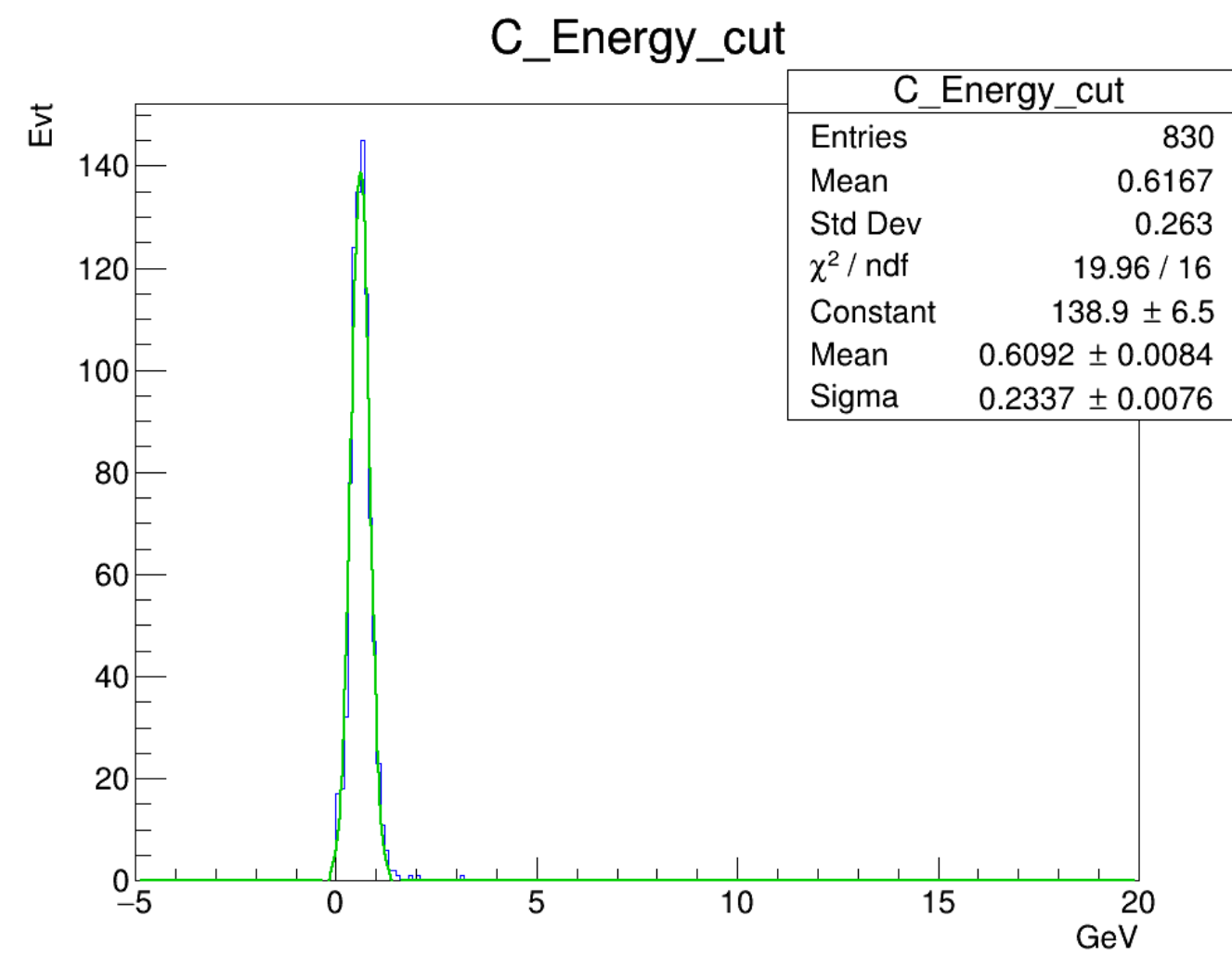
# Energy scan results set-1



# Energy scan results set-4



# Energy scan results set-4





# Calibration for single channels of MCP

Haeun Jang

# Calibration for single channels of MCP

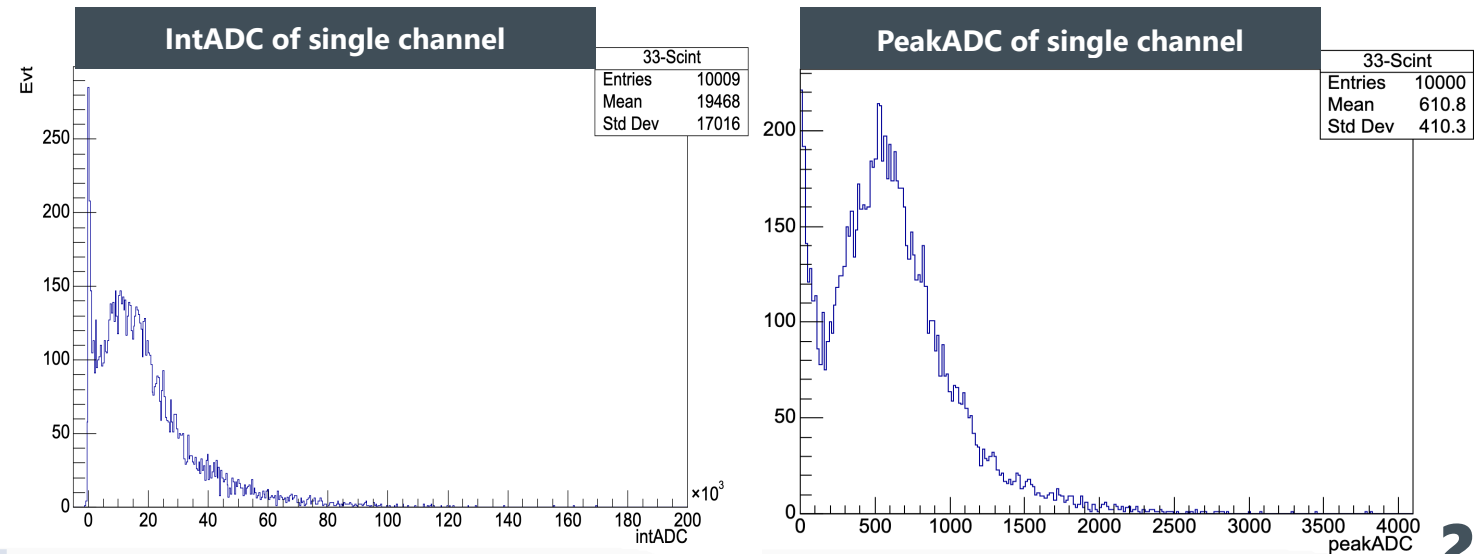
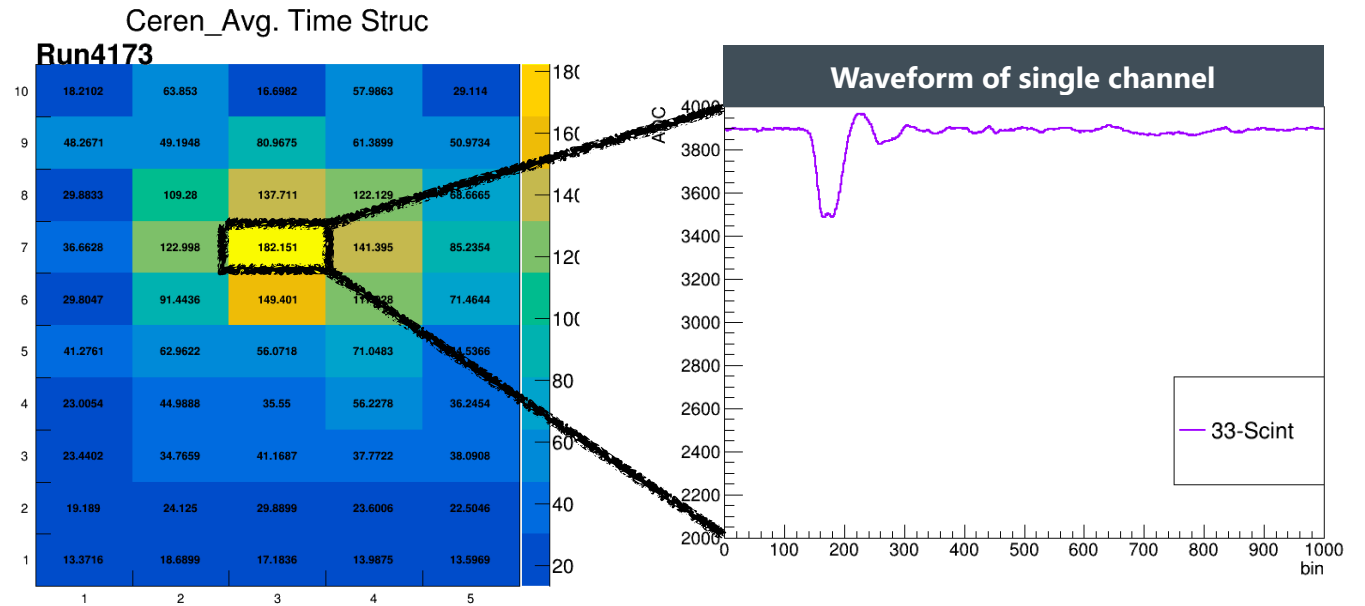
## • Data and Method

### ▪ Data

- 4 GeV e- run for a calibration.
- 10k evts before cut → 7k evts after cut
- Used **PeakADC** due to the difficulty in selecting an integration range.

### ▪ Calibration Method

- Since each cell has a **different response and optical contact** each other, we should calibrate them accordingly.
- As we don't have a data positioning a beam to all cells, we need to find proper method.



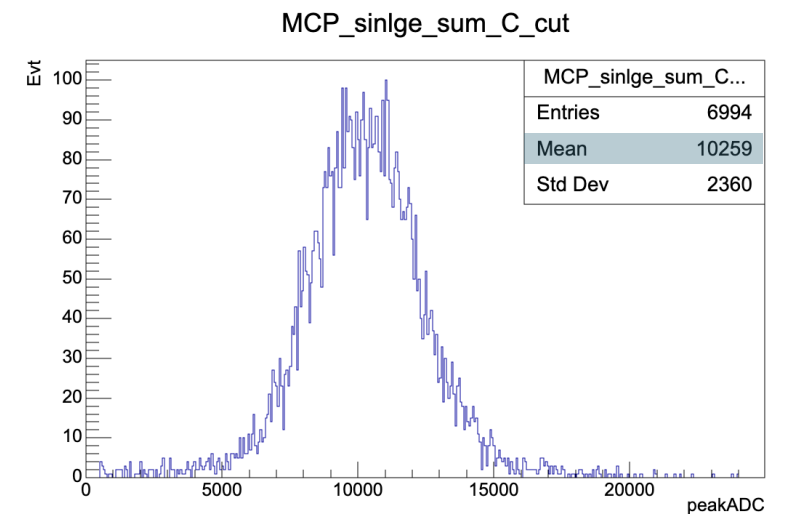
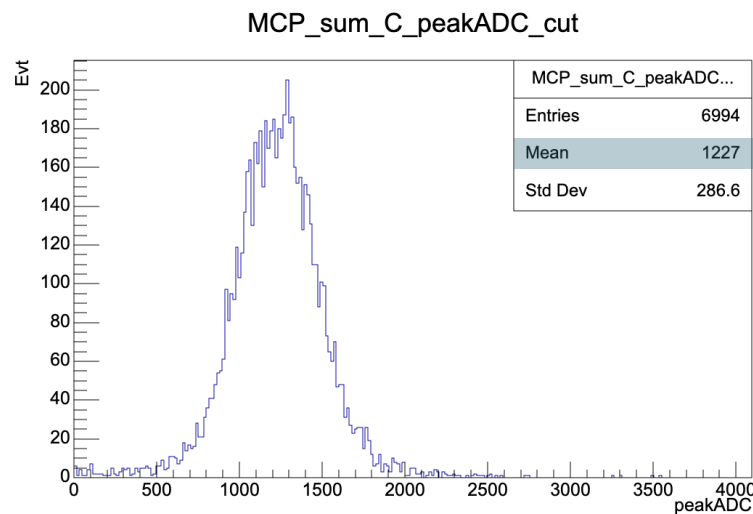
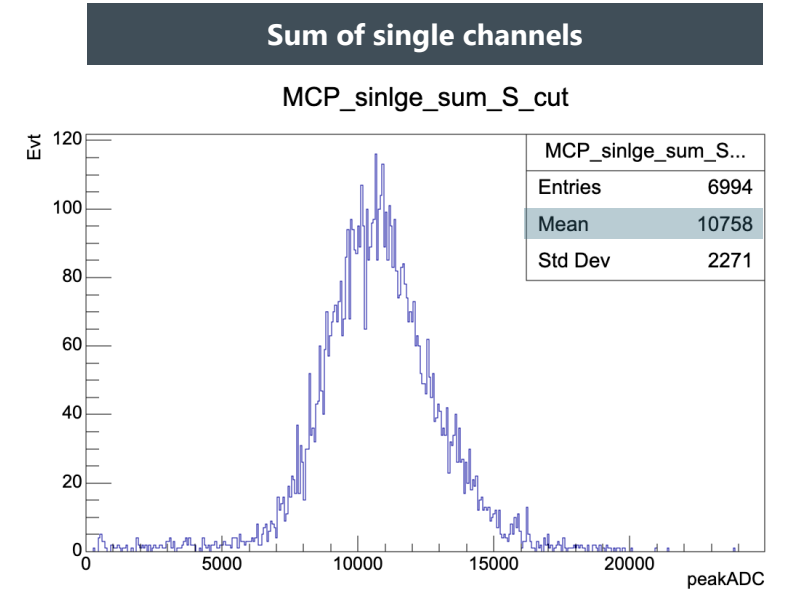
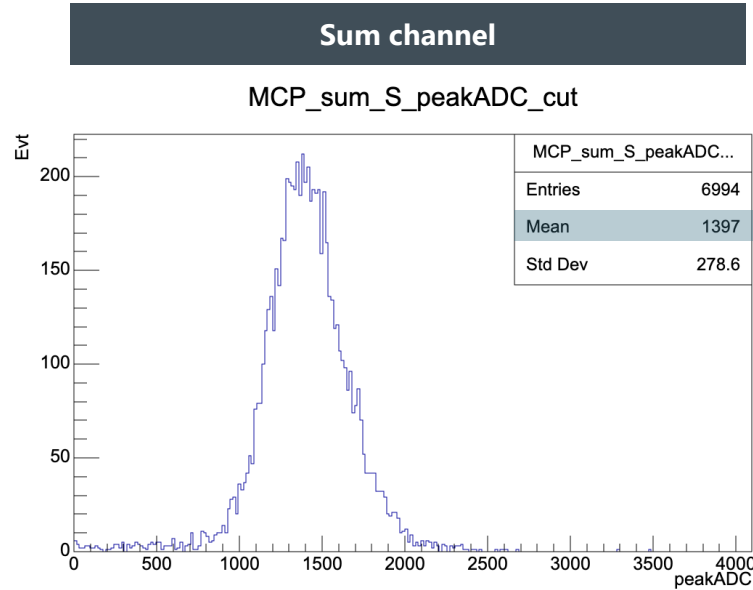
# Calibration for single channels of MCP

- Sum vs. Single channel

- Compared a sum channel and a sum of single channels.
- The sum of single channels are **~8 times bigger** than the sum channel.

	Sum	Sum of singles
Scint	1,397	10,758
Ceren	1,227	10,259

[PeakADC]

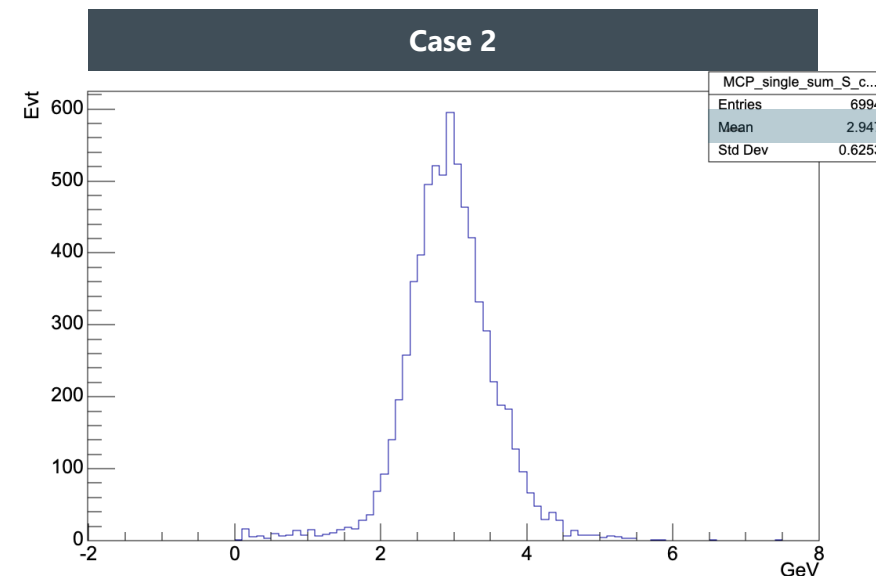
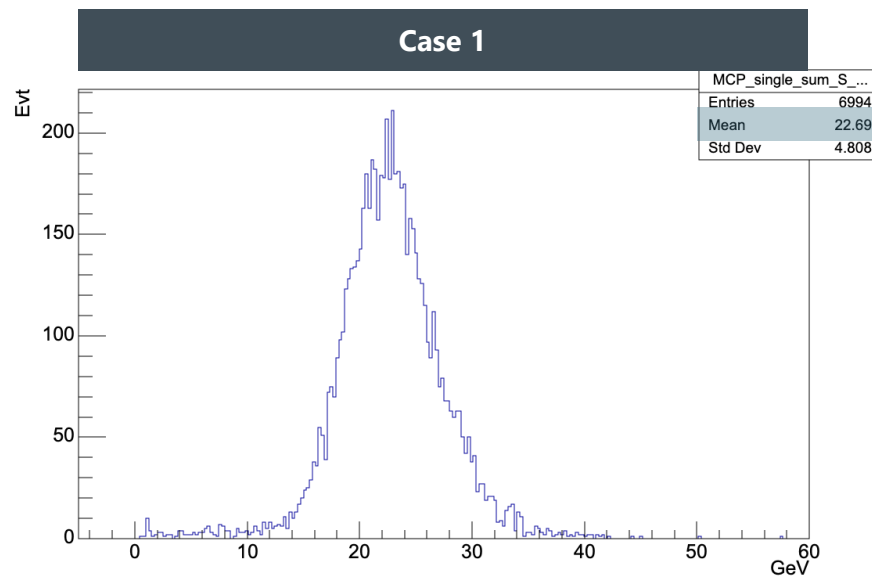


# Calibration for single channels of MCP

- Calibration with single value

- About 2.95 GeV is deposited on 3D printing module when having 4 GeV. (73.66 %)
- There are two cases for getting a single calibration constant.
  - Case 1 - Calibration constant from the sum channel
  - Case 2 - Calibration constant from the sum of the single channels
- After getting a constant from these, product a constant and each single channels, and then sum them.

	Cal.Const from Sum	Cal.Const from singles
Cal.Const	0.0021091	0.00027388
Sum of singles	22.69 GeV	2.947 GeV



# Backup

# Backup

# **TB2023 - Uniformity study**

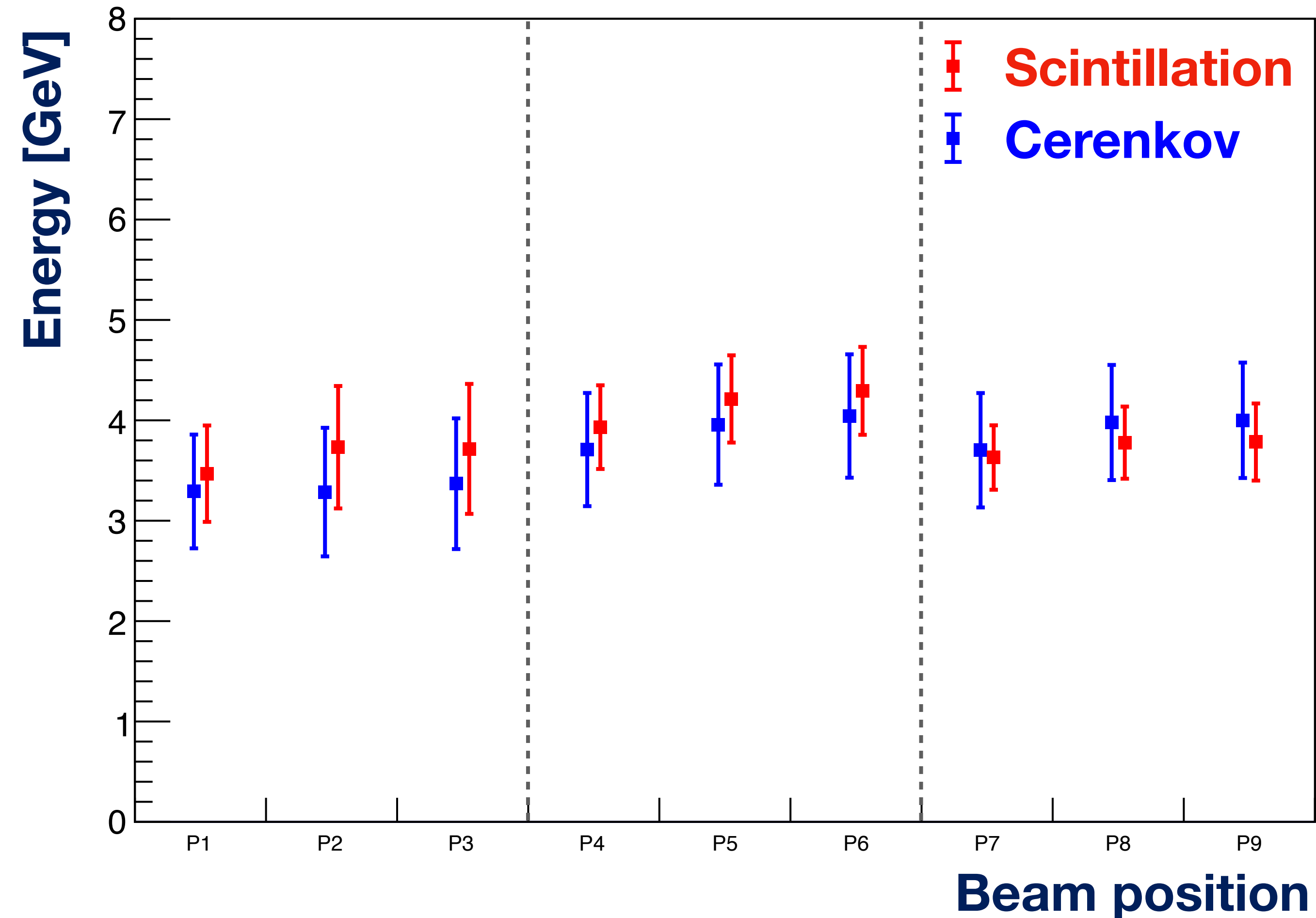
**Kyuyeong Hwang**

**GWNU TB2023 Workshop**

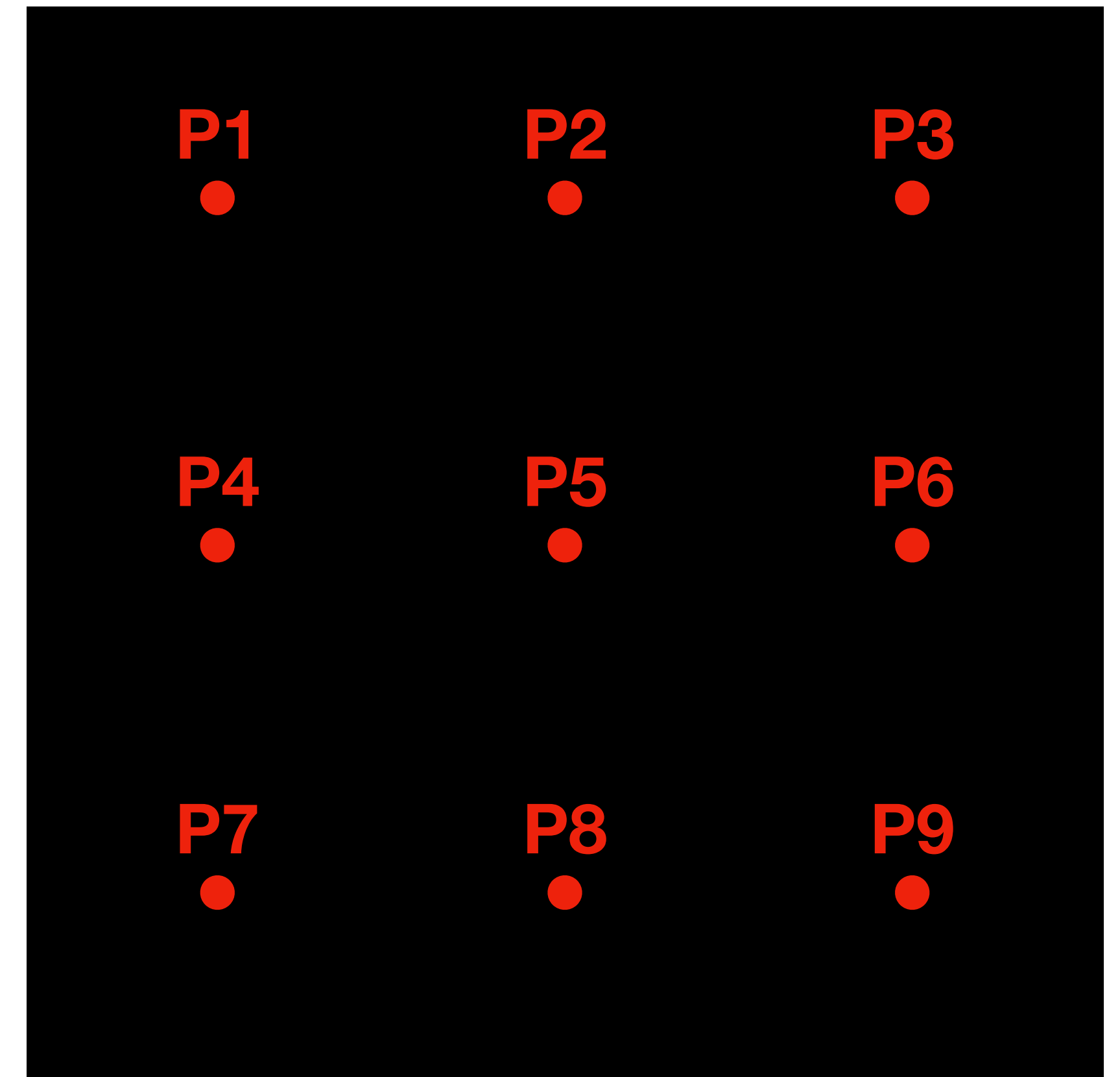
**Feb. 19, 2024**

# Uniformity study

1. 3D-Printing module with beam inclination (rot, tilt) = (1.5°, 1.0°)



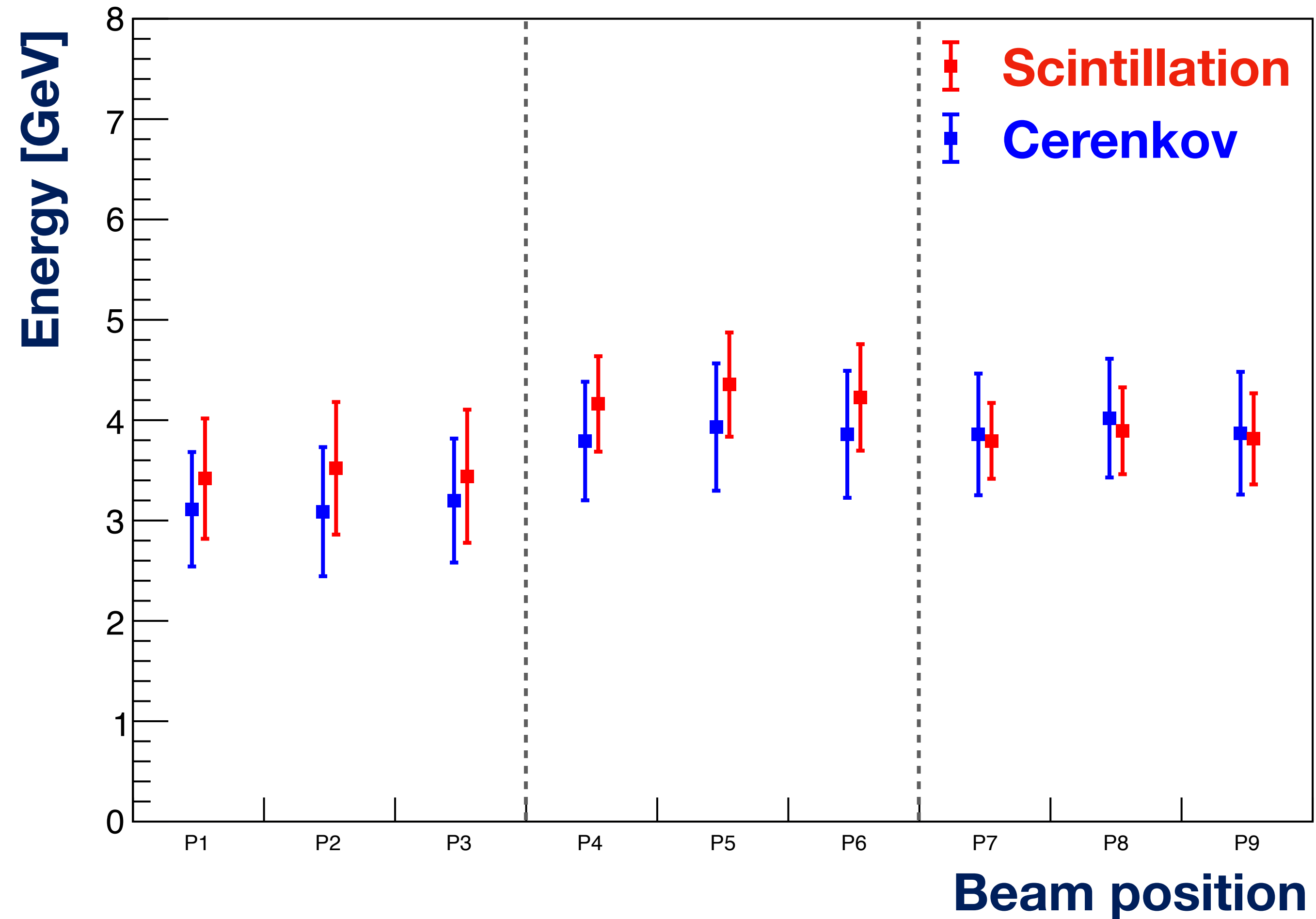
3D printing module front view



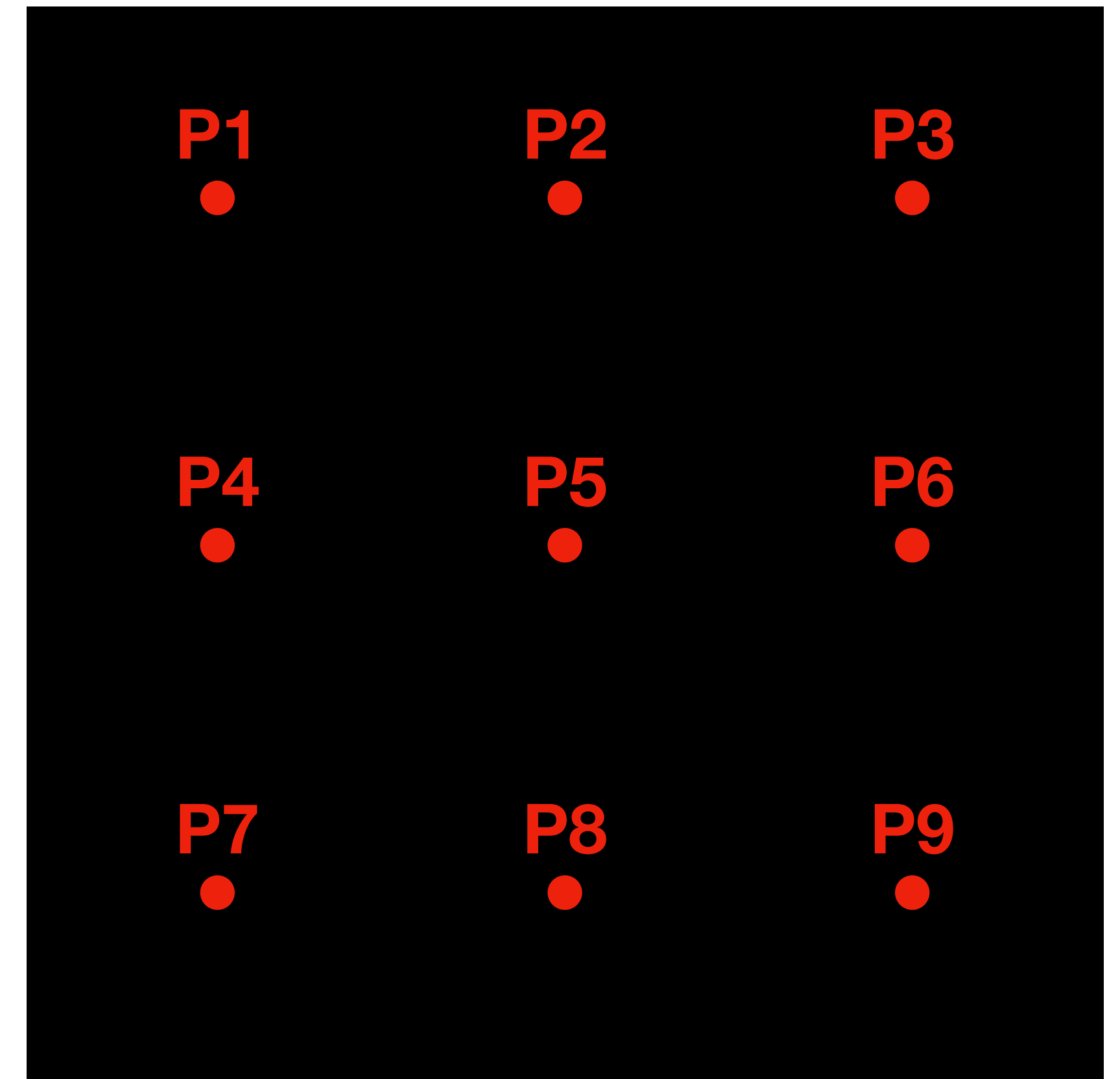


# Uniformity study

## 2. 3D-Printing module **without beam inclination**

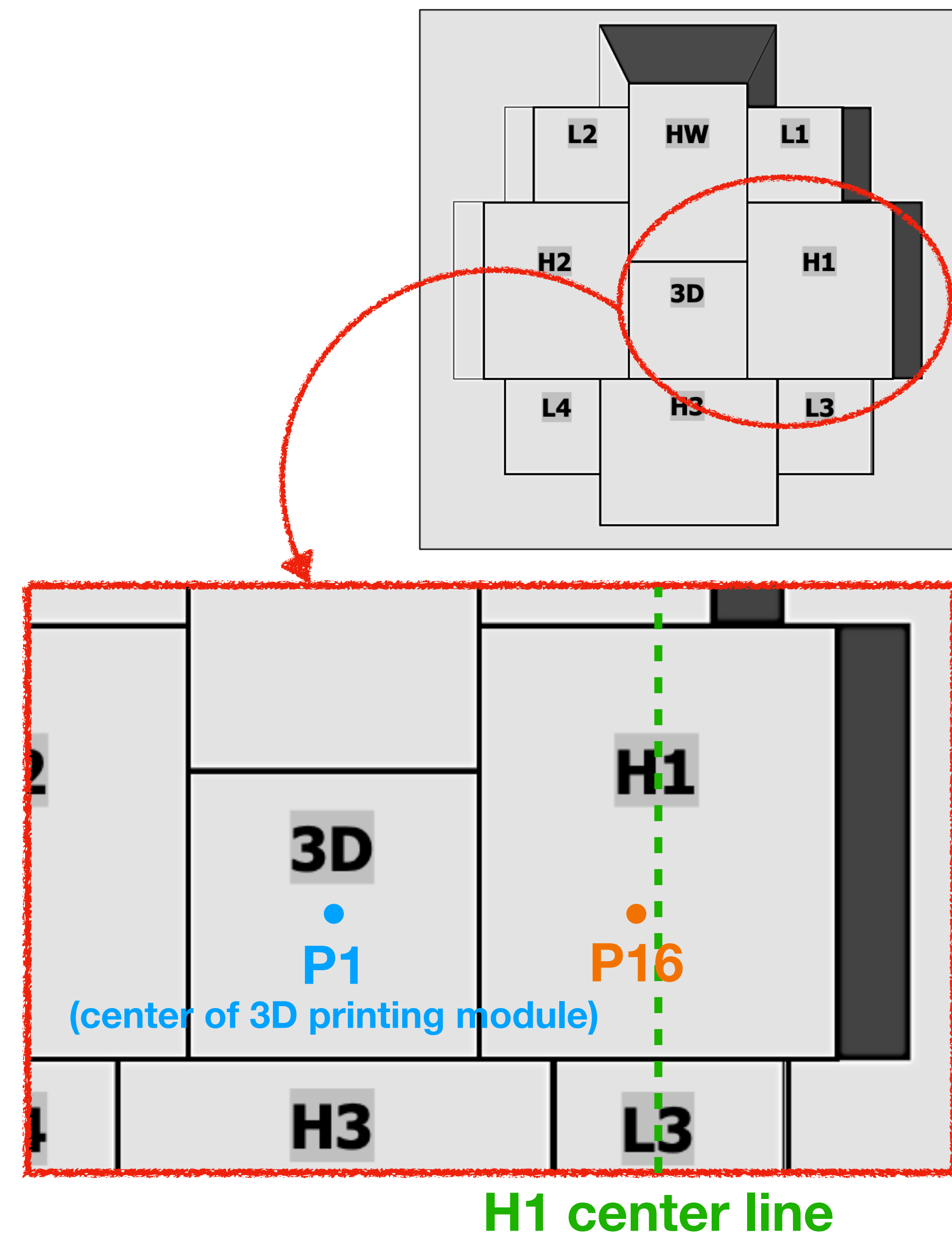
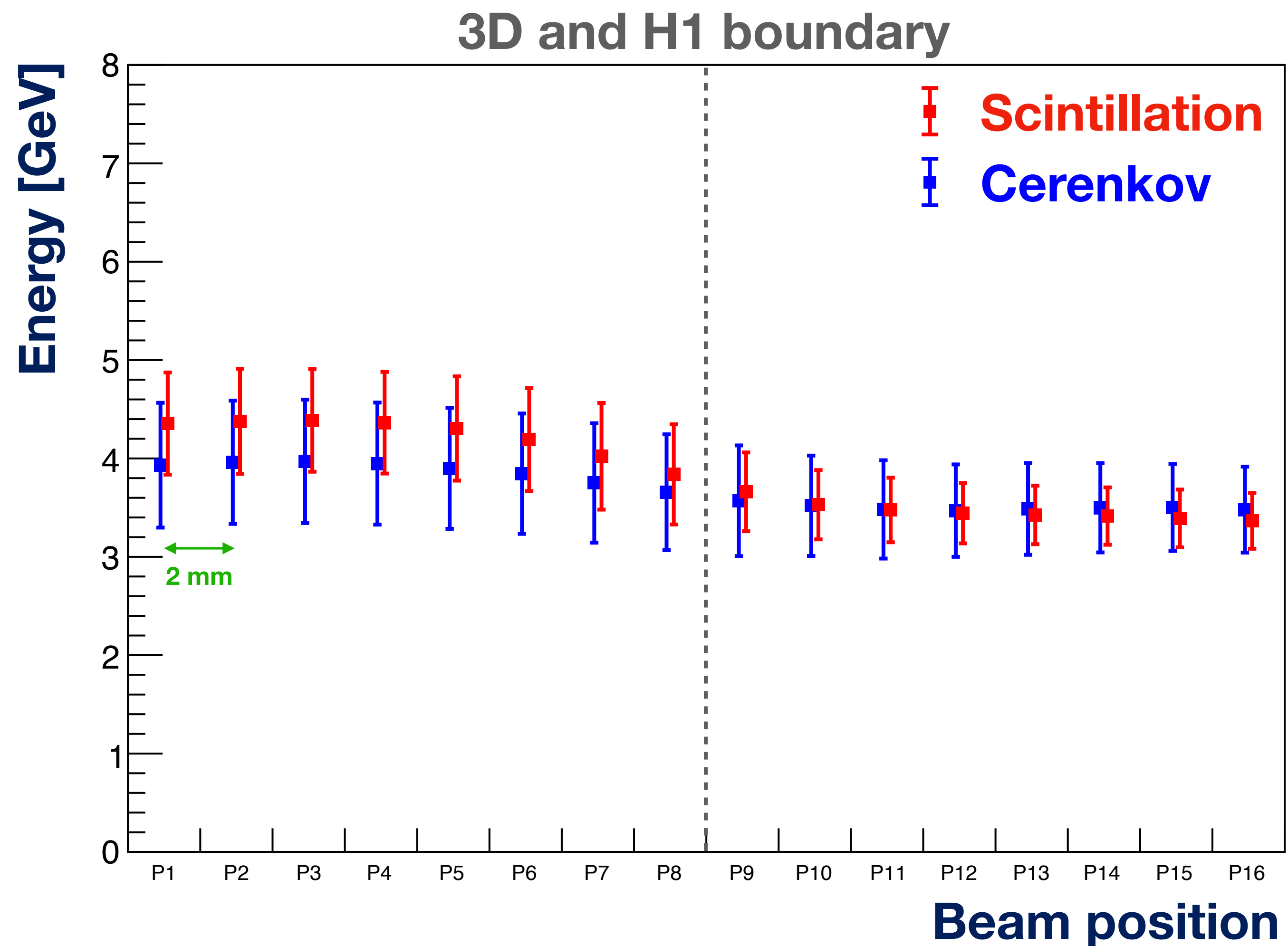


## 3D printing module front view



# Uniformity study

## 3. From center of 3D printing module to H1 SFHS module



Back Resolution up

# Integration range and calibration constant

Module	Scint	Ceren
<b>3D - MCP</b>	125 – 400	125 – 332
<b>W1</b>	118 – 380	118 – 340
<b>W2</b>	120 – 350	120 – 280
<b>W3</b>	120 – 355	120 – 260
<b>HW</b>	110 – 390	110 – 330
<b>H1</b>	130 – 360	130 – 350
<b>H2</b>	120 – 360	120 – 350
<b>H3</b>	120 – 388	120 – 312
<b>L1</b>	138 – 373	138 – 358
<b>L2</b>	190 – 520	190 – 387
<b>L3</b>	130 – 365	130 – 342
<b>L4</b>	130 – 390	130 – 335

Module	Calibration constant [GeV / ADC]	
	Cerenkov	Scintillation
3D	7.90E-05	4.08.E-05
W1	6.39E-06	4.17.E-06
W2	2.04E-05	4.44.E-06
W3	1.63E-05	4.84.E-06
HW	6.47E-05	3.84.E-05
H1	5.70E-05	3.38.E-05
H2	5.58E-05	3.57.E-05
H3	6.08E-05	3.36.E-05
L1	6.72E-05	4.13.E-05
L2	3.75.E-04	2.31.E-05
L3	7.13E-05	4.44.E-05
L4	1.31.E-04	6.65.E-05