Gyeongsang National University

Belle II Trigger/DAQ workshop 2022

The status of ECLTRG energy calibration

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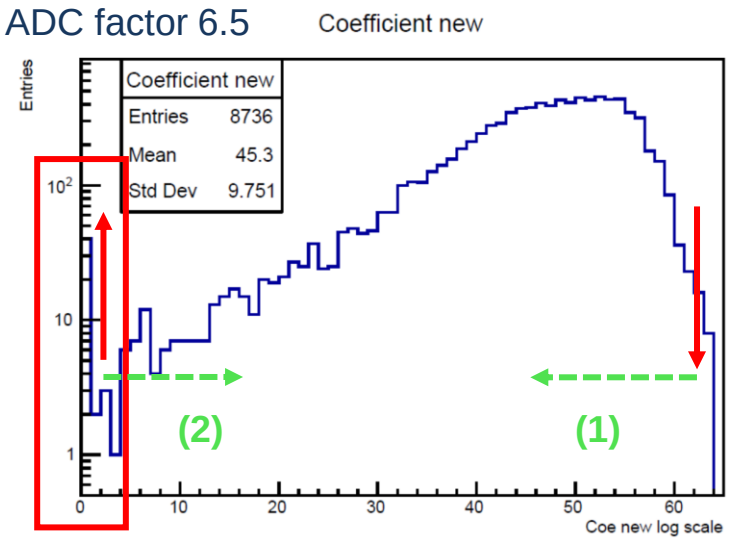
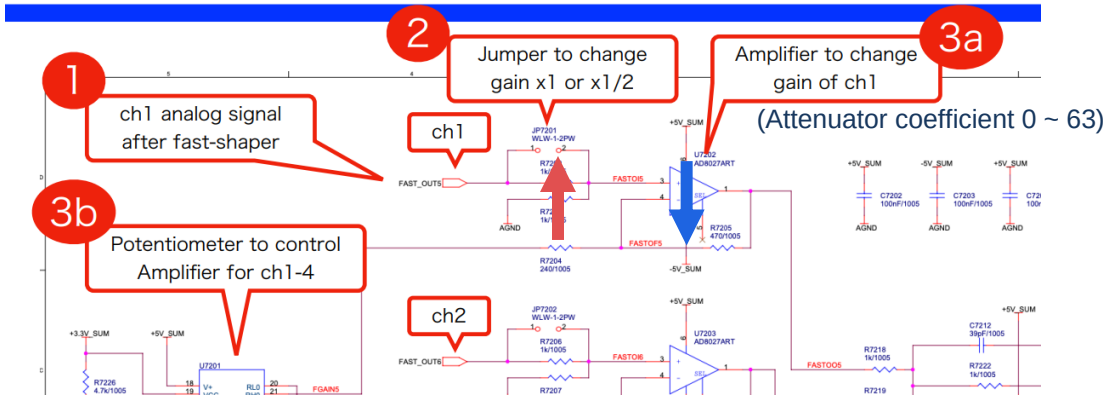
1. Misunderstanding and correction

- Attempted process

ADC factor 6.5



The schematic of ShaperDSP



In fact, **doubling** the gain by using the jumper-change(2) reduces the corresponding attenuator coefficient(3a) **by half**.

(1) Attenuator coefficients are reduced overall by increasing ADC conversion factor. (especially 63)

(2) The low attenuator coefficient close to zero are increased by jumper-change (gain doubles)

We thought we could shift the attenuator coefficients higher according to the jumper change.

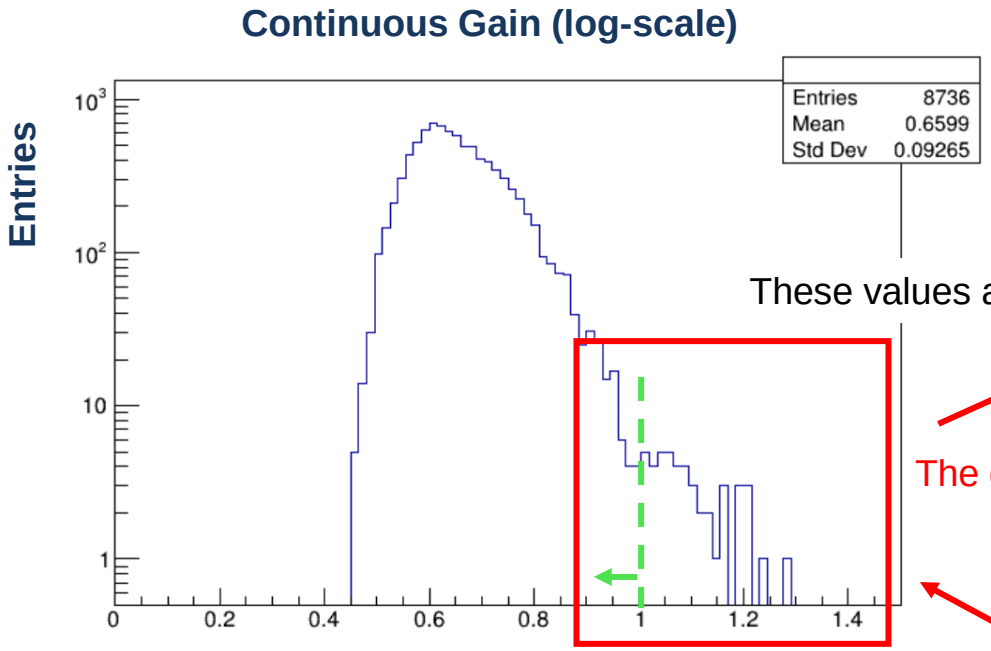
↓

It was wrong, That is, the gain of (2) is halved.

The plot of continuous gain

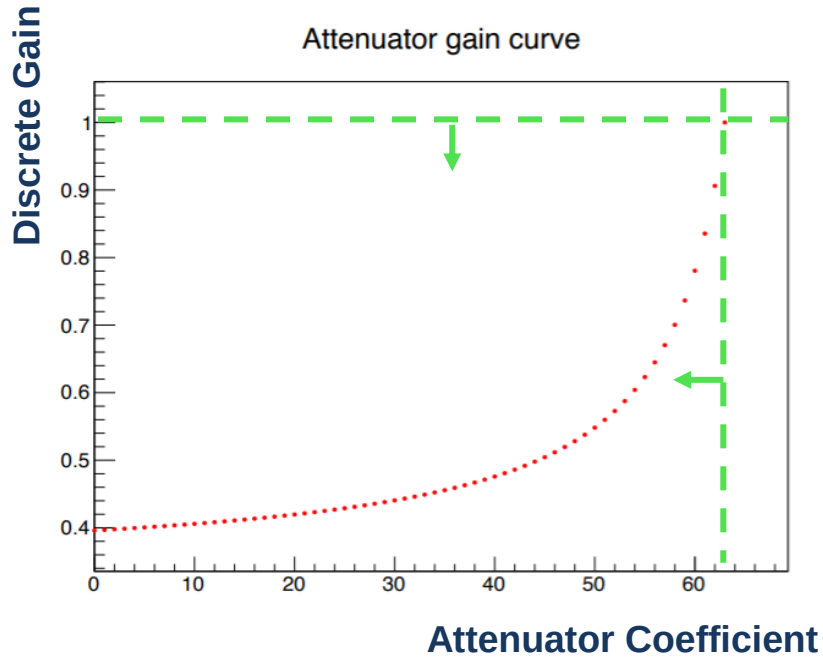
Our purpose for proper calibration (modified plan):

It is to reduce the high attenuator gain ‘exceeding 1’ by doubling the gain of the jumper.



These values are stored in SDSP as 1.

The gain must be moved to a value less than 1 for correct calibration.



ADC conversion factor (5.25 MeV/ADC)

$$\sum_n \alpha e^n E_i^n = \sum_n \sum_j \beta_j E_j^n E_i^n$$

ECLTRG energy

ECL energy

Gain ratio = New gain / old gain

- Continuous gain by calculating matrix
- Discrete gain by matching attenuator coefficient

$$Gain = \frac{1 + \frac{470}{2500\left(1 - \frac{Att}{63}\right) + 240}}{1 + \frac{470}{240}}$$

2. Attenuator coefficient check (reference)

- Sample data :

  exp26 (2022a)

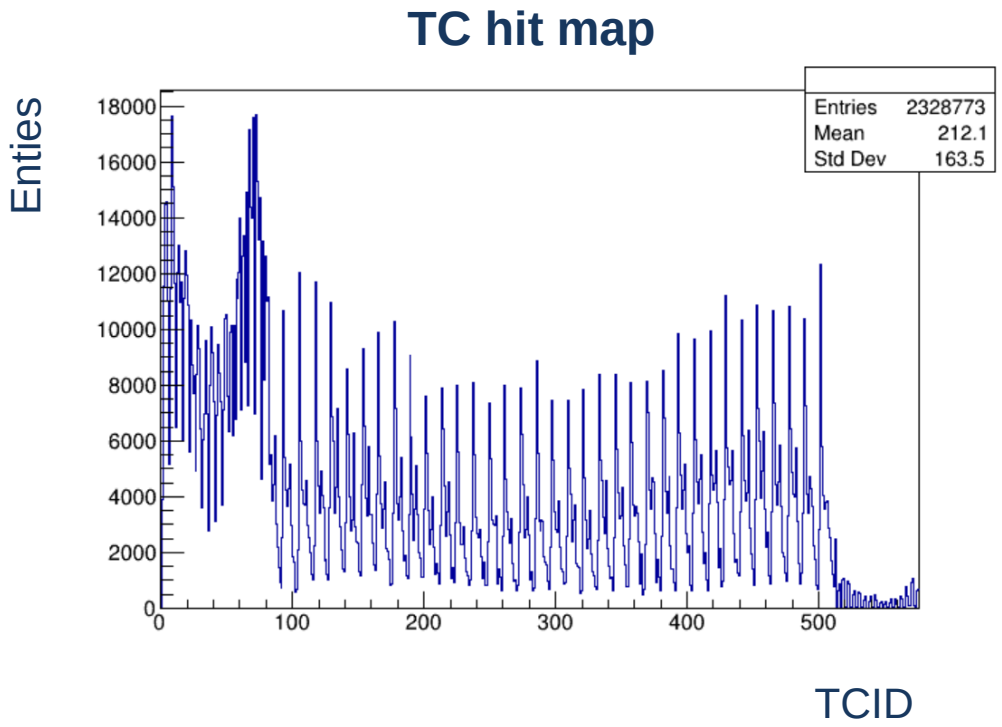
  Beam data (Bhabha + Hadron skim)

  Integrated luminosity: 0.6/fb

  ADC conversion factor : 5.25 MeV/ADC

- Total number of channels for attenuator coefficient 63 : **65**
- The number of channels above gain 1 : **47** / 65

- In barrel*
  - The number of channels for attenuator coefficient 63 : **28**
  - The number of channels above gain 1 : **14** / 28



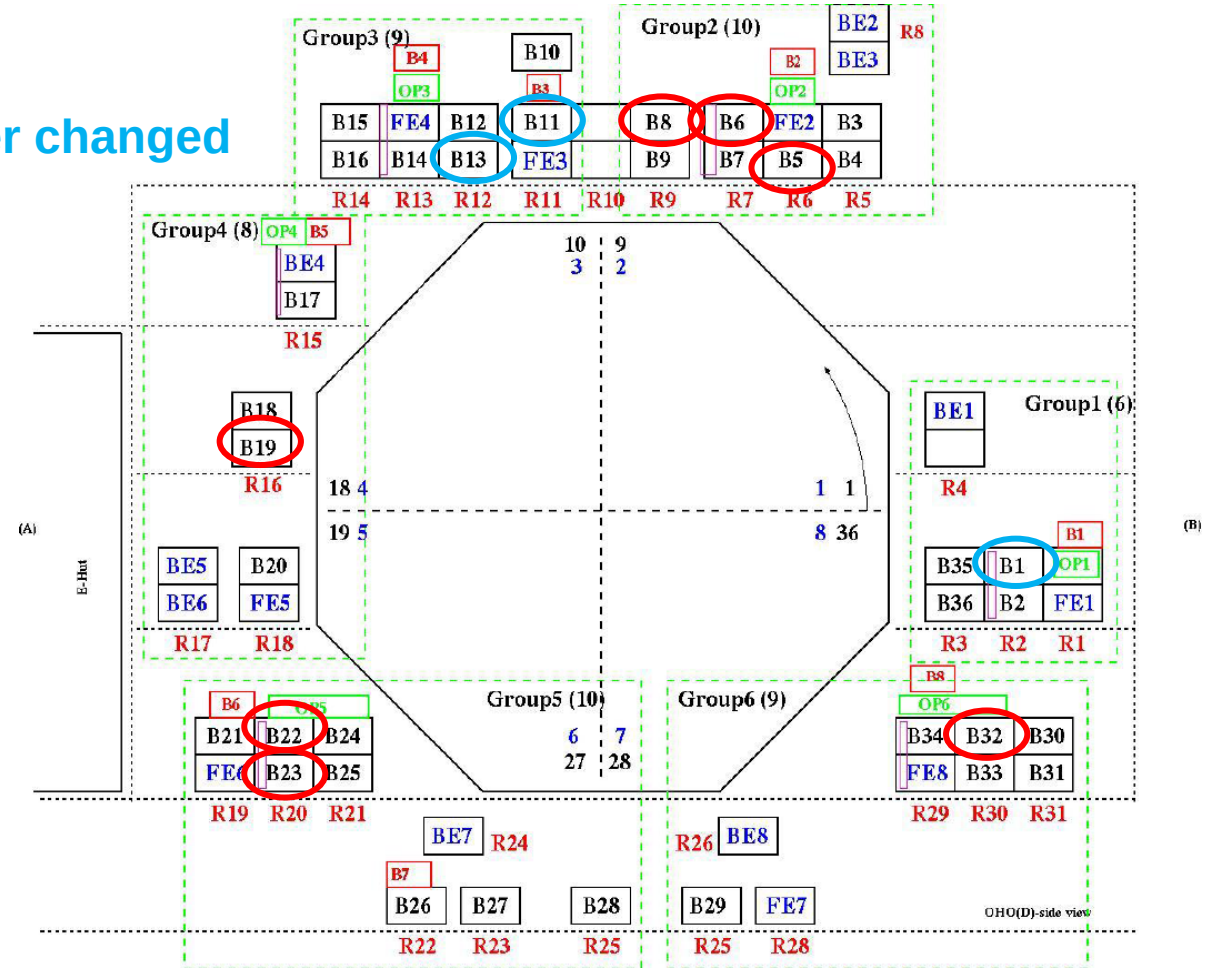
Top 10 gain (continuous) in barrel

We set the Top 10 according to the value of the gain.

Top 10 gain (continuous) out of 28 channels in barrel

	Coefficient	Gain(cont.)	CollectorID	ShaperID	Channel	CellID	TCID
1	63	1.2050	11 (B11)	6	1	4073	206
2	63	1.1641	1 (B1)	6	16	4468	86
3	63	1.1533	19 (B19)	6	12	4539	302
4	63	1.1167	6	6	5	4054	146
5	63	1.0919	23	6	9	4123	350
6	63	1.0877	13	6	8	4514	230
7	63	1.0548	5	6	12	4483	134
8	63	1.0509	8	8	15	5504	172
9	63	1.0498	22	8	15	5560	340
10	63	1.0485	32	6	13	4160	458

Jumper changed



Used data : exp 26 (2022a)

- Bhabha + hadron skim (0.6 /fb)
- 5.25 ADC conversion factor

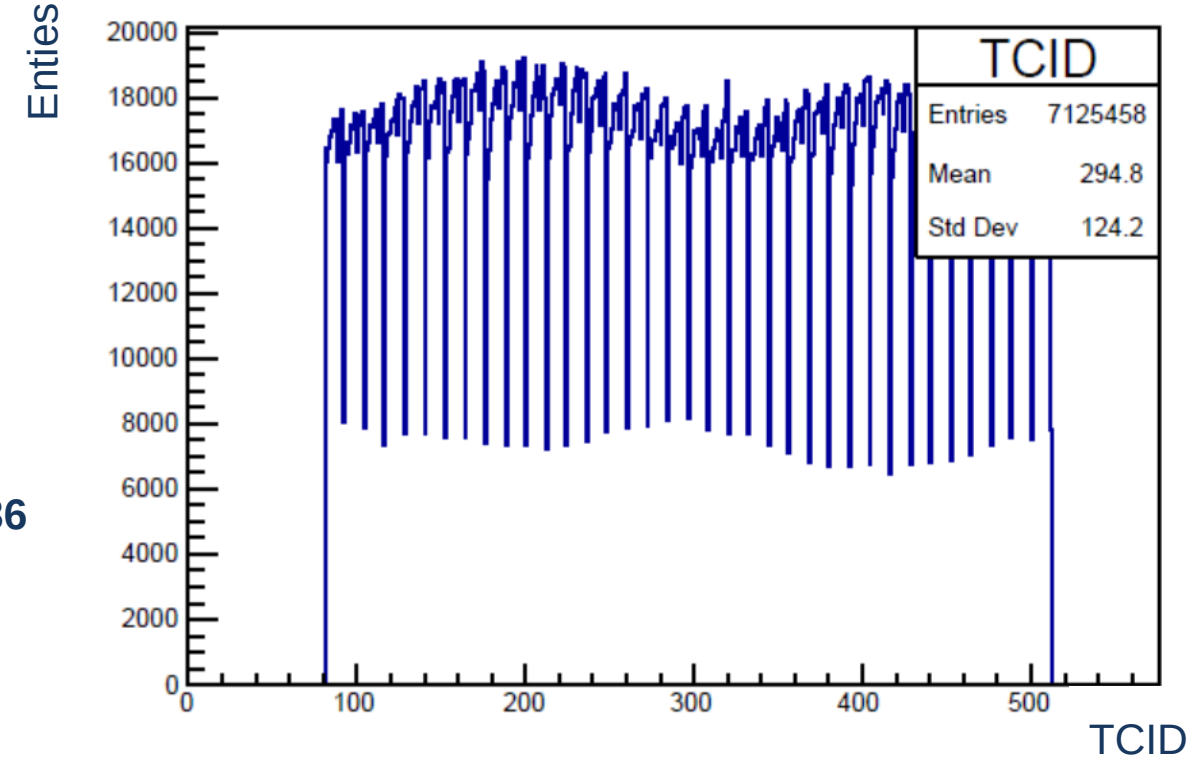
TOP 10 TCID 2D plot with Att coef 63 in barrel (cosmic)

Data information:

- exp 27 cosmic run (2022/Oct.)
- 3600k events
- 5.25 ADC conversion factor

- In barrel
  - The number of channels for attenuator coefficient 63 : **36**
  - The number of channels above gain 1 : **14** / 36

TC hit map



The result of gain after jumper change

1

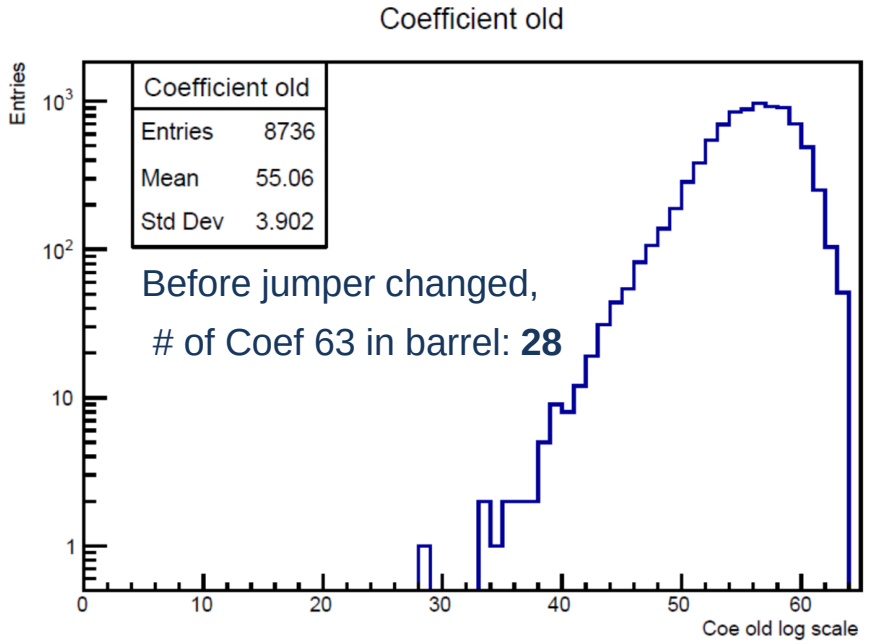
Cell ID 4073 (TCID 206)	Gain (float)	Coefficient
Before	1.2050	63
After	0.6495	56

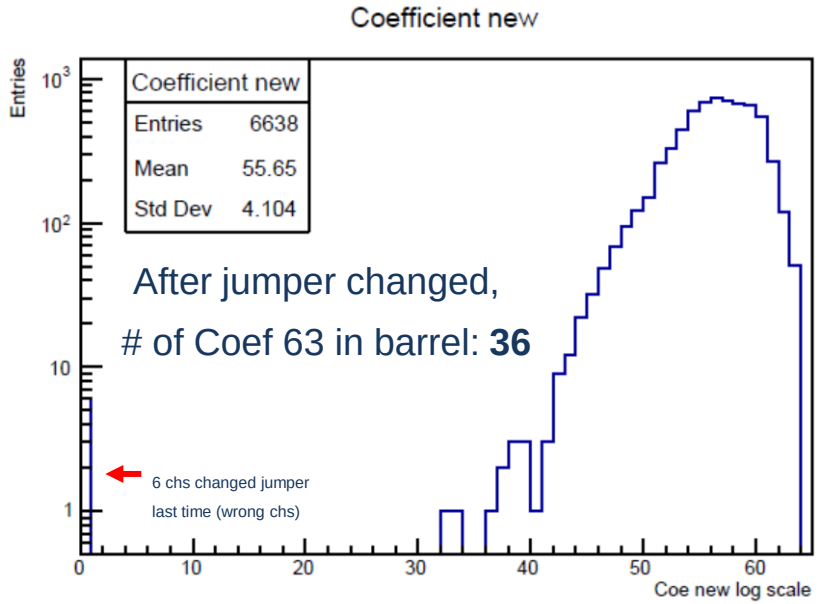
2

Cell ID 4468 (TCID 86)	Gain (float)	Coefficient
Before	1.1641	63
After	0.6376	56

3

Cell ID 4514 (TCID 230)	Gain (float)	Coefficient
Before	1.0877	63
After	0.6045	54





2D plot “zoom-in” [300ADC : 1.5 GeV] with changed chs

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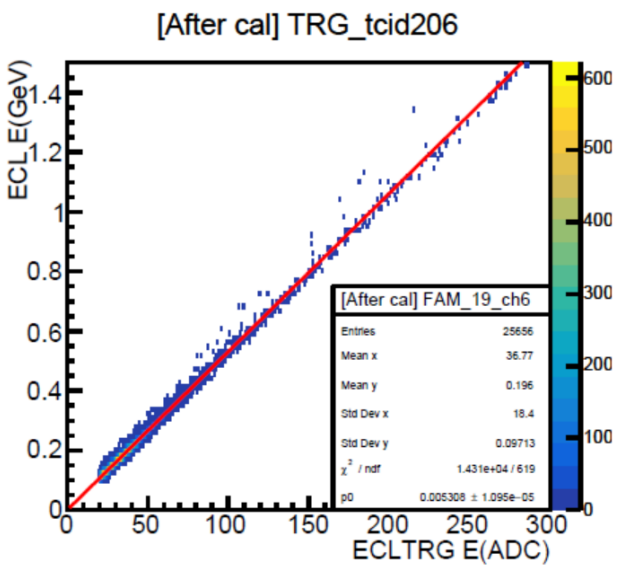
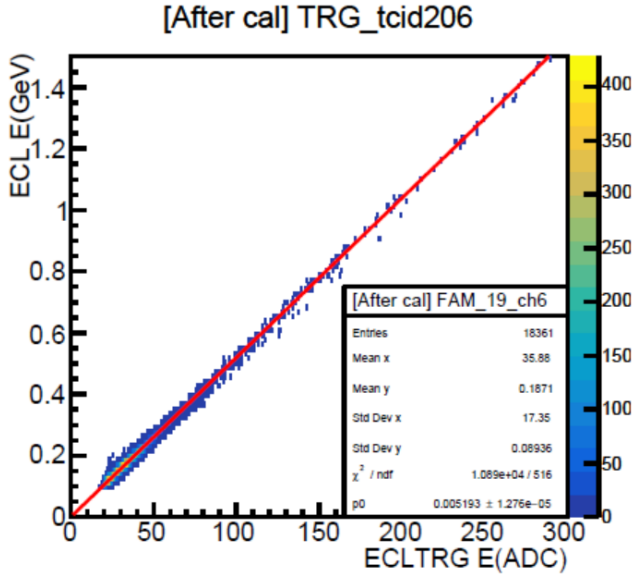
1

(a) Before jumper change (exp18)

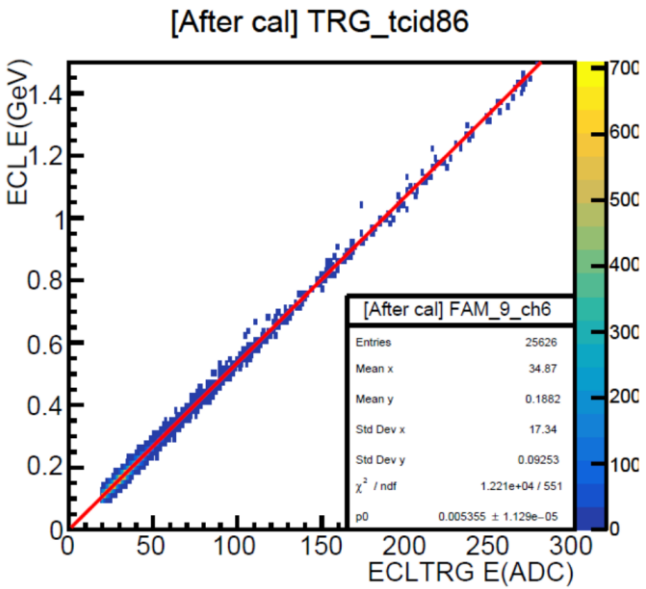


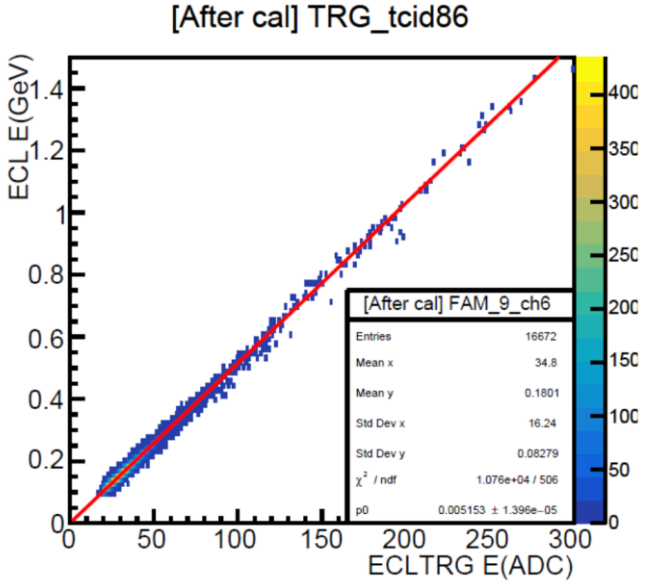
(b) After jumper change (exp27)



Cell ID 4073 (TCID 206)	Gain (float)	Coefficient
Before	1.2050	63
After	0.6495	56

2





Cell ID 4468 (TCID 86)	Gain (float)	Coefficient
Before	1.1641	63
After	0.6376	56

2D plot “zoom-in” [300ADC : 1.5 GeV] with changed chs

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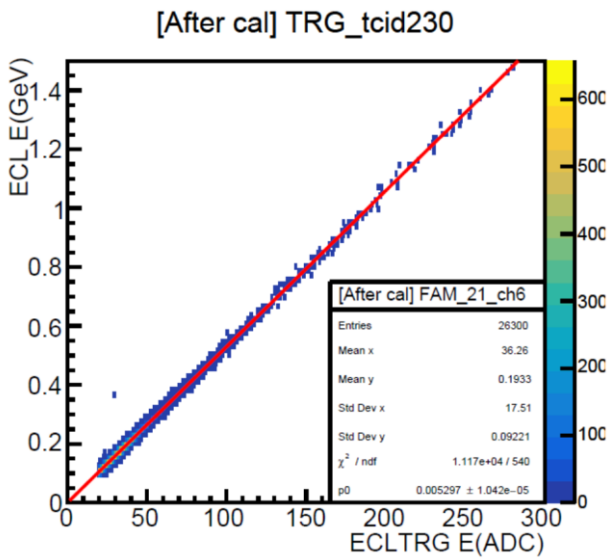
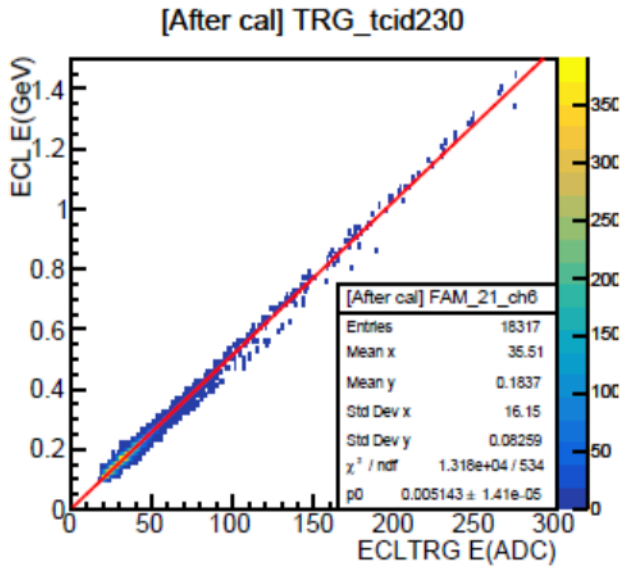
3

(a) Before jumper change (exp18)



(b) After jumper change (exp27)



Cell ID 4514 (TCID 230)	Gain (float)	Coefficient
Before	1.0877	63
After	0.6045	54

→ We confirmed that the jumper-change works well in test.

3. List of ‘Attenuator coefficient 63’ in barrel for consistency check

Before changing jumper

[e27 local cosmic vs e21 physics]

	CellID	TCID	Gain_float (cosmic)	Coefficient	Coefficient old (before cal.)	Gain_float (beam)	**gain ratio (cosmic/beam)**
1	4073	206	1.1906	63	63	1.2054	**0.9878**
2	4539	302	1.1696	63	63	1.1698	**0.9998**
3	4862	411	1.1481	63	61	0.8589	**1.3367**
4	4054	146	1.1352	63	63	1.1225	**1.0112**
5	4468	86	1.1328	63	63	1.1781	**0.9616**
6	4034	86	1.1230	63	62	0.9564	**1.1741**
7	5560	340	1.1099	63	63	1.0642	**1.0430**
8	4514	230	1.1060	63	63	0.9395	**1.1773**
9	4123	350	1.1023	63	63	1.1005	**1.0016**
10	4483	134	1.0797	63	63	1.0638	**1.0150**
11	5504	172	1.0786	63	63	1.0656	**1.0122**
12	3973	337	1.0600	63	58	0.7235	**1.4649**
13	1775	214	1.0585	63	60	0.7706	**1.3736**
14	6878	414	1.0517	63	63	1.0420	**1.0093**
15	4160	458	1.0482	63	63	1.0531	**0.9954**

After changing jumper

[e27 local cosmic vs e21 physics]

	CellID	TCID	Gain_float (cosmic)	Coefficient	Coefficient old (before cal.)	Gain_float (beam)	**gain ratio (cosmic/beam)**
1	4054	146	1.4740	63	63	1.1225	**1.3131**
2	4483	134	1.2868	63	63	1.0638	**1.2097**
3	4539	302	1.1672	63	63	1.1698	**0.9978**
4	4123	350	1.0989	63	63	1.1005	**0.9986**
5	5560	340	1.0766	63	63	1.0642	**1.0117**
6	5504	172	1.0698	63	63	1.0656	**1.0040**
7	4197	146	1.0682	63	63	1.0271	**1.0400**
8	4160	458	1.0558	63	63	1.0531	**1.0025**
9	6852	330	1.0520	63	63	1.0416	**1.0100**
10	6878	414	1.0485	63	63	1.0420	**1.0062**
11	4015	457	1.0416	63	63	1.0238	**1.0173**
12	4280	386	1.0092	63	62	0.9742	**1.0360**
13	4039	98	1.0067	63	63	0.9982	**1.0085**
14	4182	98	1.0058	63	63	0.9863	**1.0198**
15	4117	338	0.9994	63	63	0.9887	**1.0108**

[e18 global cosmic vs e21 physics]

	CellID	TCID	Gain_float (cosmic)	Coefficient	Coefficient old (before cal.)	Gain_float (beam)	**gain ratio (cosmic/beam)**
1	4073	206	1.2007	63	63	1.2054	**0.9961**
2	4539	302	1.1641	63	63	1.1698	**0.9951**
3	4468	86	1.1596	63	63	1.1781	**0.9843**
4	4054	146	1.1087	63	63	1.1225	**0.9877**
5	4123	350	1.0985	63	63	1.1005	**0.9982**
6	4514	230	1.0872	63	63	1.0880	**0.9993**
					...		
15	3977	349	1.0108	63	61	0.8581	**1.1780**
16	4504	194	1.0013	63	59	0.7709	**1.2988**
					...		
22	6246	245	0.9743	63	58	0.7132	**1.3660**
23	4055	146	0.9706	63	63	0.9781	**0.9923**
24	5923	137	0.9695	63	59	0.7685	**1.2615**
25	6870	390	0.9674	63	62	0.9876	**0.9795**
26	4429	410	0.9618	63	61	0.8616	**1.1163**

[e24 physics vs e21 physics]

	CellID	TCID	Gain float (cosmic)	Coefficient	Coefficient old (before cal.)	Gain_float (beam)	**gain ratio (beam/beam)**
1	4073	206	1.2025	63	63	1.2053	**0.9976**
2	4468	86	1.1683	63	63	1.1780	**0.9917**
3	4539	302	1.1615	63	63	1.1697	**0.9929**
4	4054	146	1.1206	63	63	1.1225	**0.9983**
5	4123	350	1.091	63	63	1.1005	**0.9920**
6	4514	230	1.0901	63	63	1.0880	**1.0019**
7	5504	172	1.0629	63	63	1.0655	**0.9975**
8	5560	340	1.0611	63	63	1.0641	**0.9972**
9	4483	134	1.0575	63	63	1.0637	**0.9941**
10	4160	458	1.0481	63	63	1.0531	**0.9952**
11	6852	330	1.0402	63	63	1.0415	**0.9987**
12	6878	414	1.0385	63	63	1.0419	**0.9966**
13	4015	457	1.0324	63	63	1.0238	**1.0084**
14	4197	146	1.0248	63	63	1.0271	**0.9978**
15	4039	98	0.9996	63	63	0.9982	**1.0013**

“We have to decide **consistently** which channels to change the jumper setting.”

- It was confirmed that the difference in gain between local/global cosmic and beam run was up to 1.46.
- However, the results of the gain shift compared between beams were almost identical to 1.
- A coefficient consistency study is required to know the exact reason.

[1] Sufficient statistics to obtain consistent coefficients

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TOP 10 for beam data **exp21**

#	Gain Ratio	Coefficient new	Gain	Gain float	Coefficient old	Gain old	CellID	TCID	Entries
1	1	63	1	1.205	63	1	4073	206	16672
2	1	63	1	1.178	63	1	4468	86	21399
3	1	63	1	1.170	63	1	4539	302	15949
4	1	63	1	1.123	63	1	4054	146	21106
5	1	63	1	1.101	63	1	4123	350	17170
6	1	63	1	1.088	63	1	4514	230	14871
7	1	63	1	1.066	63	1	5504	172	10030
8	1	63	1	1.064	63	1	5560	340	8689
9	1	63	1	1.064	63	1	4483	134	22248
10	1	63	1	1.053	63	1	4160	458	21001

TOP 10 for beam data **exp26**

#	Gain Ratio	Coefficient new	Gain	Gain float	Coefficient old	Gain old	CellID	TCID	Entries
1	1	63	1	1.205	63	1	4073	206	3975
2	1	63	1	1.164	63	1	4468	86	6181
3	1	63	1	1.153	63	1	4539	302	3856
4	1	63	1	1.117	63	1	4054	146	6290
5	1	63	1	1.092	63	1	4123	350	4336
6	1	63	1	1.088	63	1	4514	230	2910
7	**1**	**63**	**1**	**1.055**	**63**	**1**	**4483**	**134**	**7146**
8	**1**	**63**	**1**	**1.051**	**63**	**1**	**5504**	**172**	**2049**
9	**1**	**63**	**1**	**1.050**	**63**	**1**	**5560**	**340**	**1506**
10	1	63	1	1.049	63	1	4160	458	6309

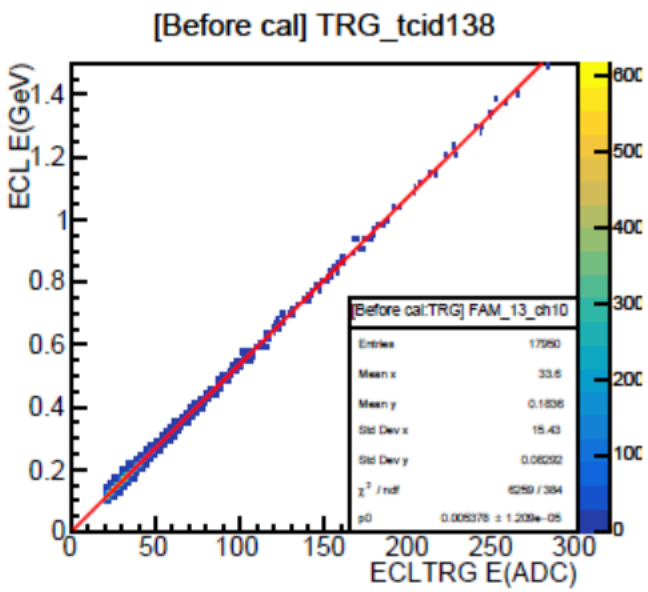
TOP 10 for beam data **exp24**

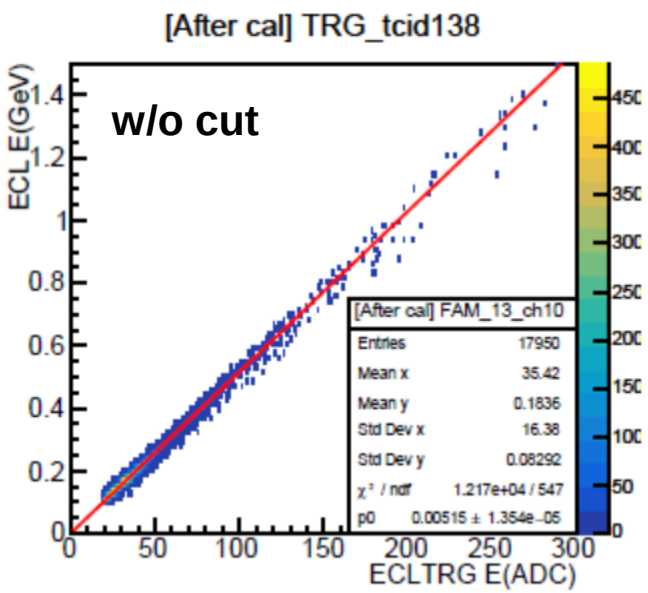
#	Gain Ratio	Coefficient new	Gain	Gain float	Coefficient old	Gain old	CellID	TCID	Entries
1	1	63	1	1.203	63	1	4073	206	15399
2	1	63	1	1.168	63	1	4468	86	17910
3	1	63	1	1.162	63	1	4539	302	14540
4	1	63	1	1.121	63	1	4054	146	17376
5	1	63	1	1.092	63	1	4123	350	15063
6	1	63	1	1.090	63	1	4514	230	14665
7	1	63	1	1.063	63	1	5504	172	13967
8	1	63	1	1.061	63	1	5560	340	12459
9	1	63	1	1.058	63	1	4483	134	17504
10	1	63	1	1.048	63	1	4160	458	17341

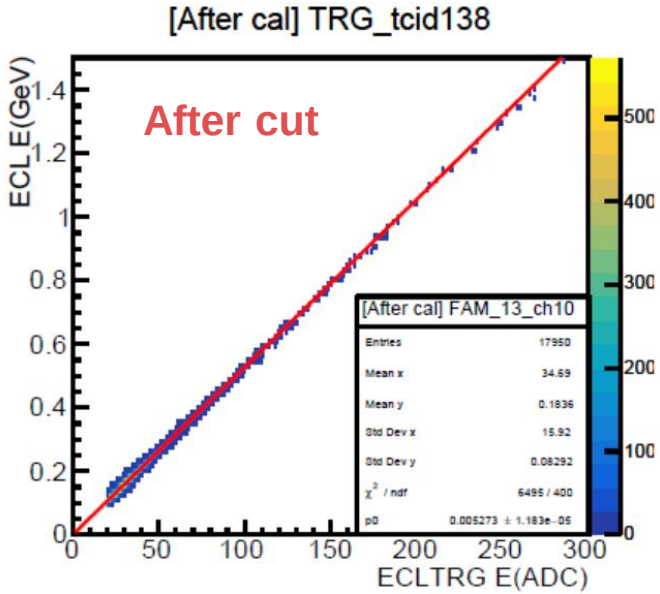
- The gain is inconsistent because the statistics are different for each run.
- It shows same results of cosmic run as well as Beam data.
- Sufficient statistics should be used

  to obtain stable coefficient values through calibration.

[2] Cut condition for getting reliable gain







First try,

Cut to get new att. coef. :

ECL TC E < 0.15 GeV

&& TRG TC E < 30 ADC

After calibration **w/o cut**

Gain Ratio (new/old)	Coefficient	Gain	Gain_float	Coefficient old
1.000	60	**0.781**	**0.771**	60
1.060	60	0.781	0.787	59
1.254	59	0.736	0.745	53
0.981	49	0.538	0.542	50
1.294	62	0.906	0.906	58
1.159	58	0.700	0.706	54

After calibration **w/ cut**

Out of 16 chs in 1 TC

Gain Ratio (new/old)	Coefficient	Gain	Gain_float	Coefficient old	Gain old	CellID	TCID
1.070	61	0.835	0.816	60	0.781	6355	138
1.060	60	0.781	0.789	59	0.736	6356	138
1.028	54	0.604	0.602	53	0.588	6499	138
1.045	52	0.573	0.572	50	0.548	6500	138
1.051	59	0.736	0.753	58	0.700	6641	138
1.068	56	0.645	0.636	54	0.604	6642	138

→ By giving a TC E cut, the large gain ratio after correction was reduced, and the calibration result shows better.

Conclusion

1. The modified study was successful.

   →[first step] The gain value above 1 is reduced by half by using jumper-change.
2. The results of the 3 ‘jumper-changed’ channels for testing were consistent with expectations and well calibrated.
3. We are checking consistency with beam/global cosmic/local cosmic data,

   after that, we would like to discuss which jumpers of channels have to be changed.

- Conditions of channels which are needed Jumper setting change during LS1
  - Channels with gain ~ 0.9 (att. Coeff. 61) or higher (← need to discussion)
  - Consistency check : those channels should be consistently gain values

    independent of any data (beam/local cosmic/global cosmic)

    → If the gain ratio between two different data has ~1.0, channels are consistent.
  - any other requirement ?

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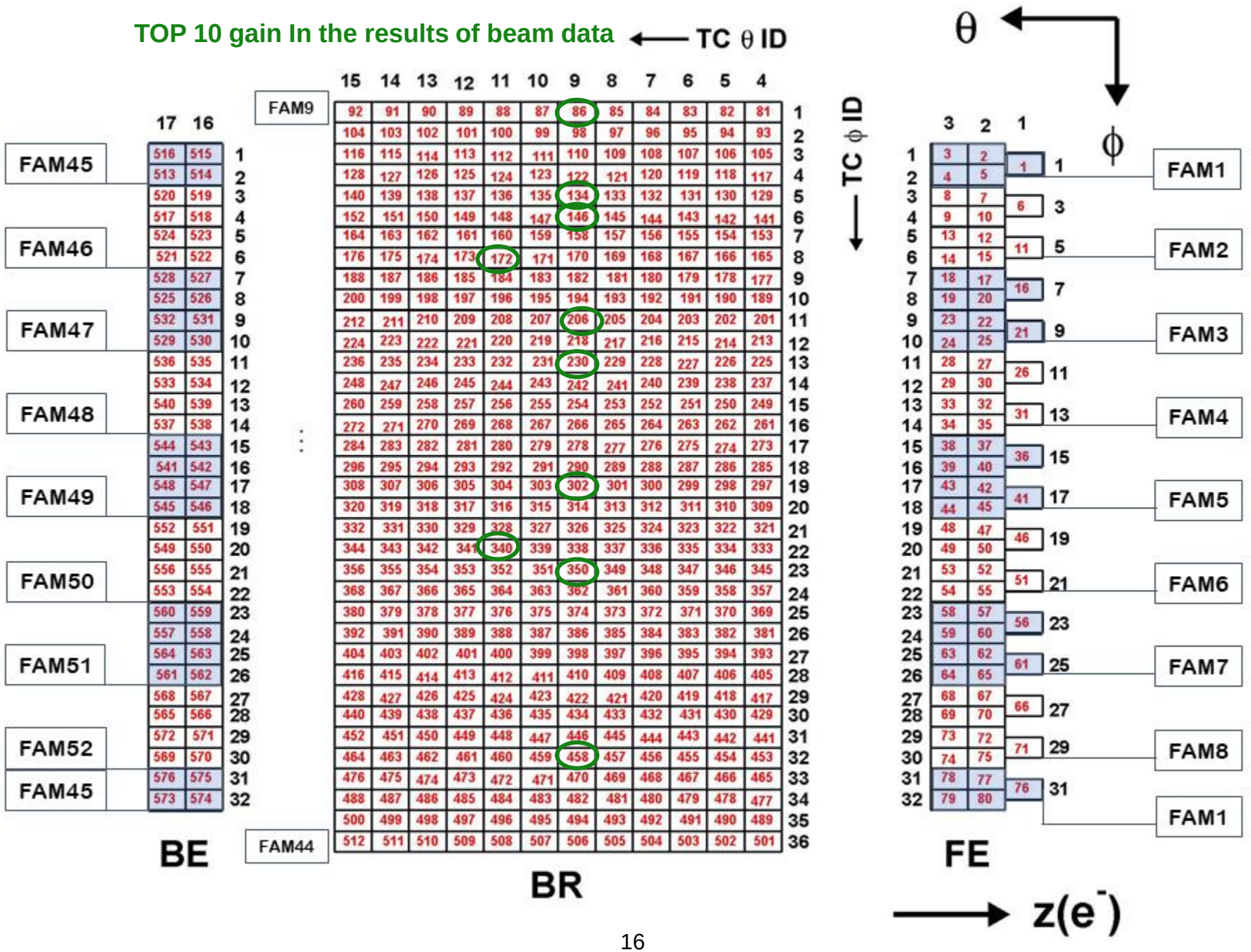
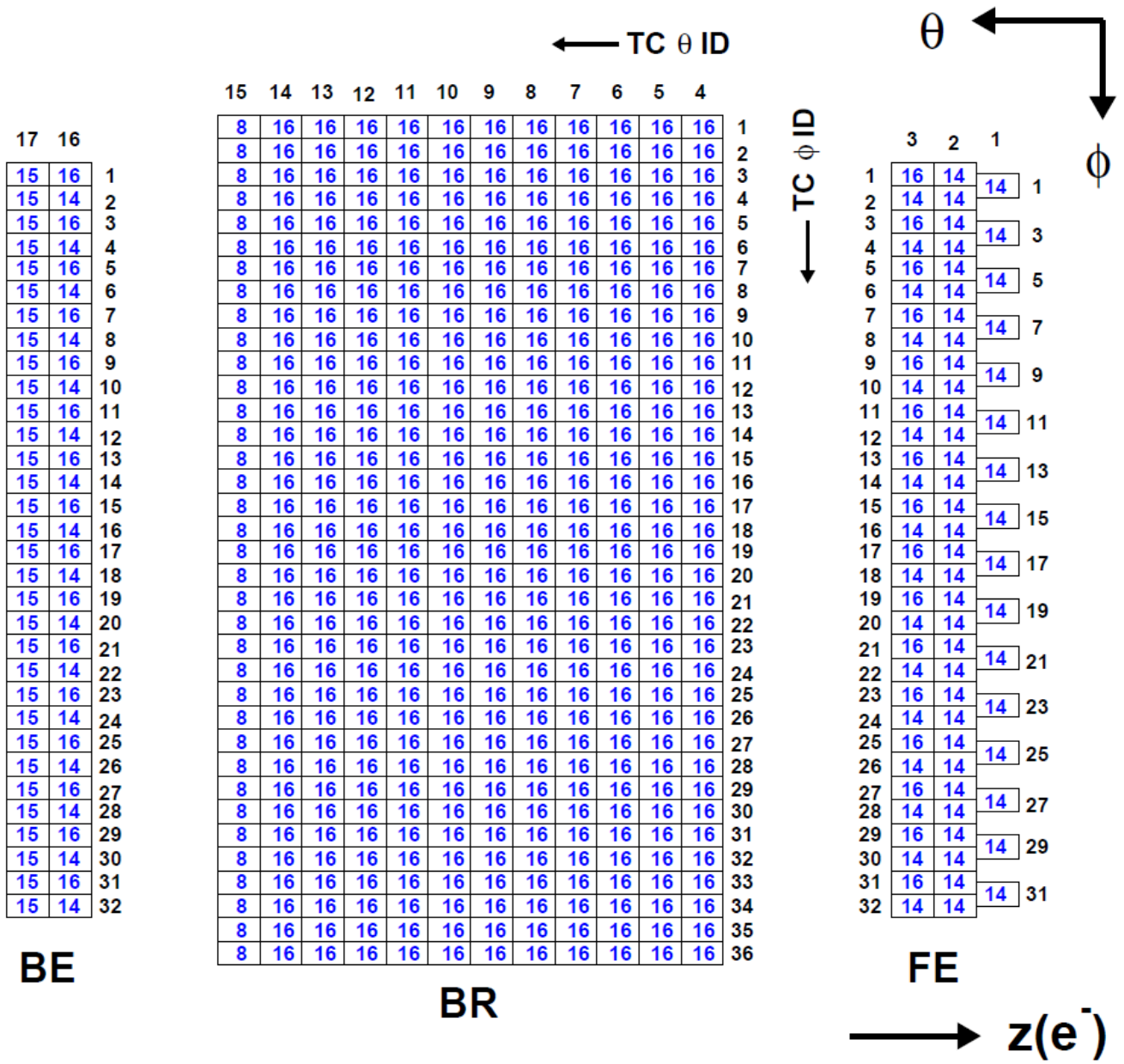
Backup

TC map

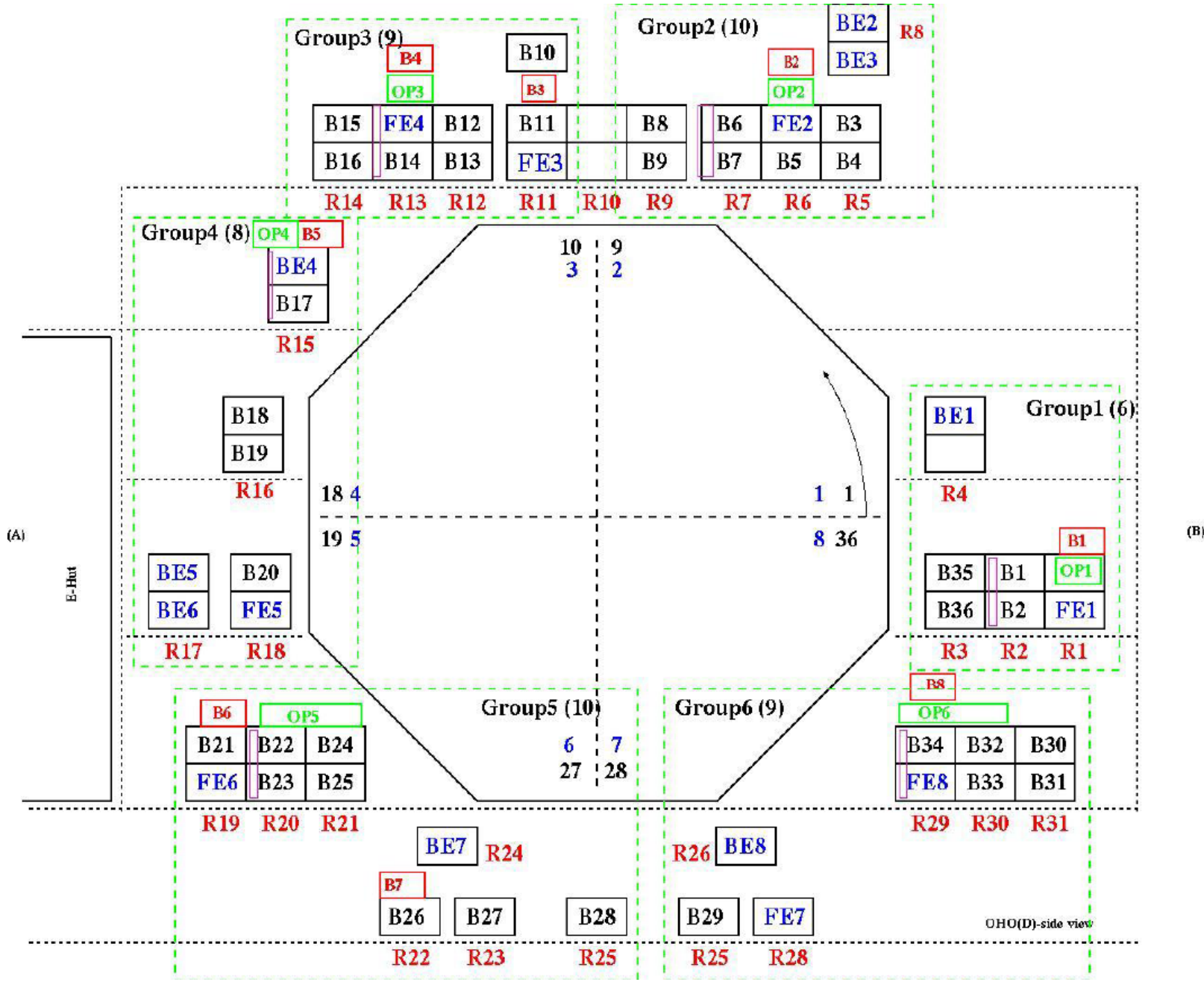
TOP 10 gain In the results of beam data



TC map with number of xtal

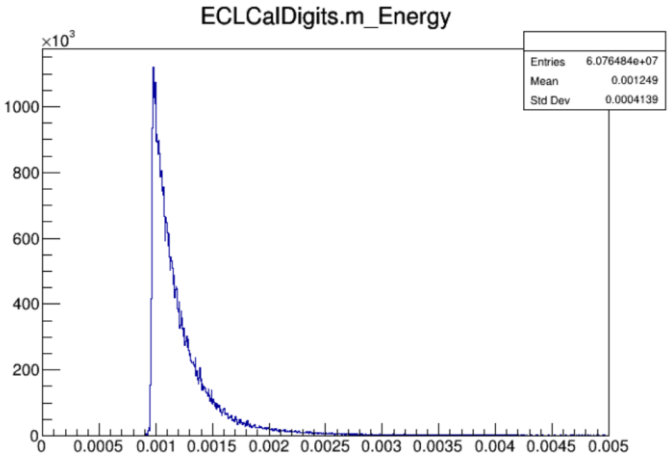


Crate map


Group3 (9)
B4
OP3
B15
FE4
B12
B16
B14
B13
R14
R13
R12
B10
B3
B11
FE3
B8
B9
R11
R10
Group2 (10)
BE2
BE3
R8
B2
OP2
B6
FE2
B3
B7
B5
B4
R9
R7
R6
R5
Group4 (8)
OP4
B5
BE4
B17
R15
B18
B19
R16
BE5
BE6
B20
FE5
R17
R18
10
3
9
2
18
4
19
5
1
1
8
36
(A)
(B)
E-Hut
BE1
Group1 (6)
R4
B1
OP1
B35
B1
B36
B2
FE1
R3
R2
R1
B6
OP5
B21
B22
B24
FE6
B23
B25
R19
R20
R21
Group5 (10)
6
7
27
28
Group6 (9)
B8
OP6
B34
B32
B30
FE8
B33
B31
R29
R30
R31
BE7
R24
B7
B26
B27
B28
R22
R23
R25
R26
BE8
B29
FE7
R25
R28
OHO(D)-side view

ECL xtal E check

Global cosmic(e18r3027)

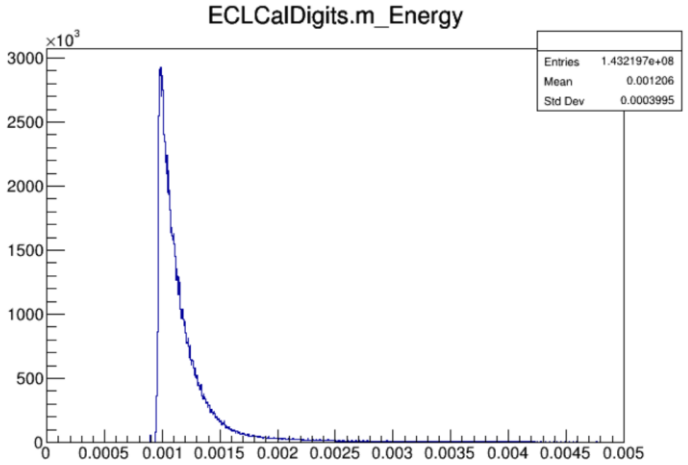


TRY cut :

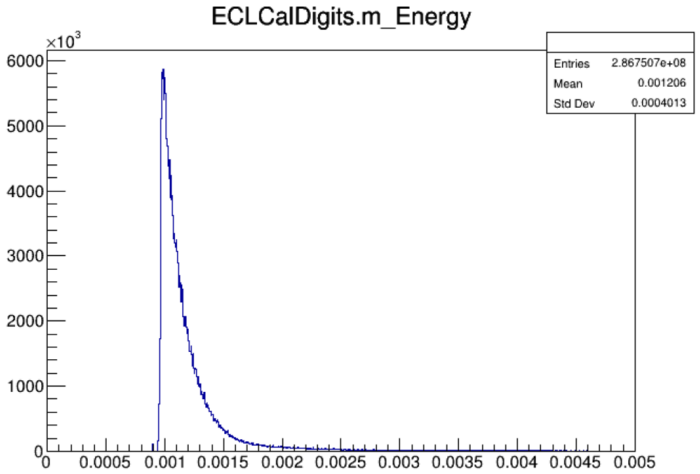
ECL TC E < 0.15 GeV

TRG TC E < 30 ADC

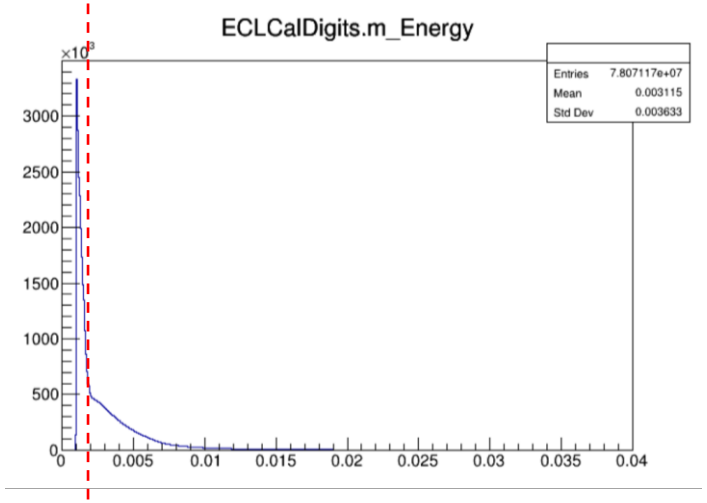
Local cosmic(e21r1206)



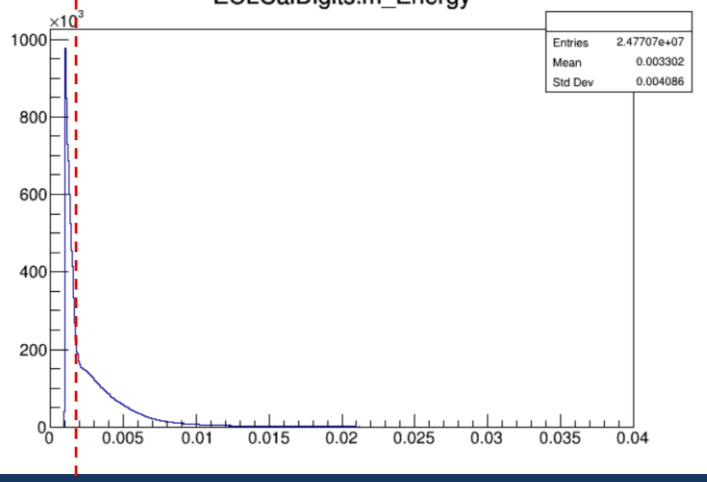
Local cosmic(e21r1228)



Physics-bhabha(e21r480)

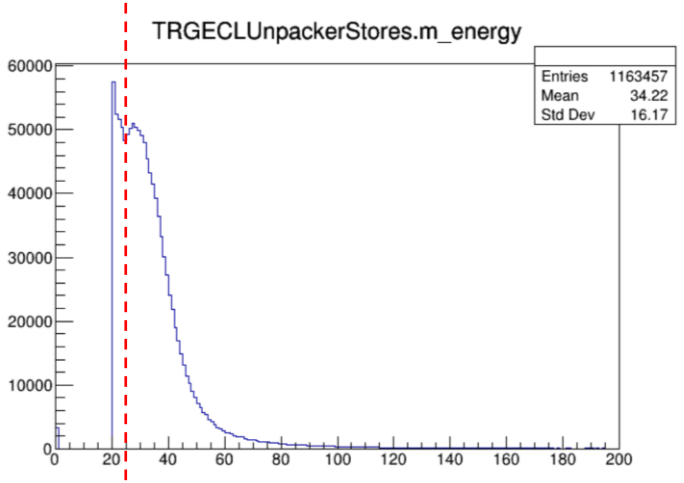


Physics-hadron(e21r480)



ECLTRG TC E check

Global cosmic(e18r3027)

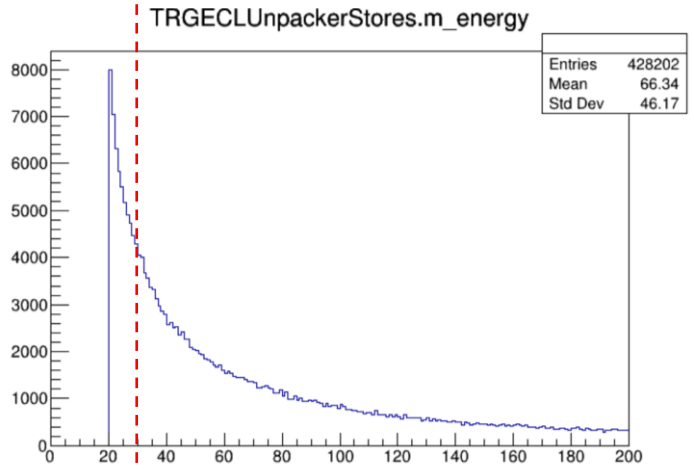


TRY cut :

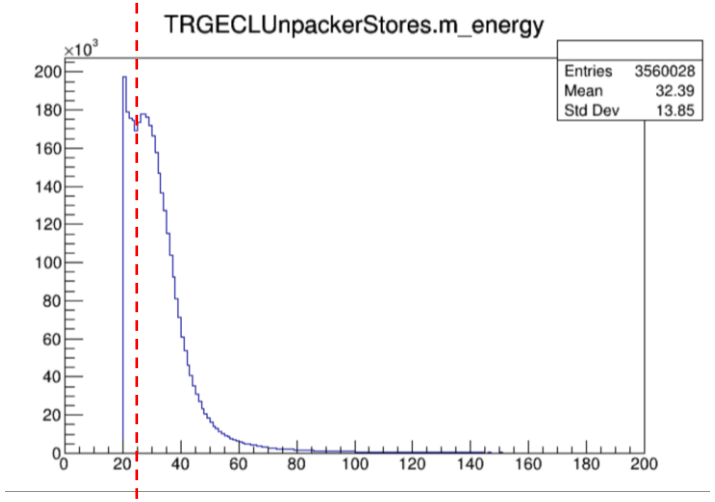
ECL TC E < 0.15 GeV

TRG TC E < 30 ADC

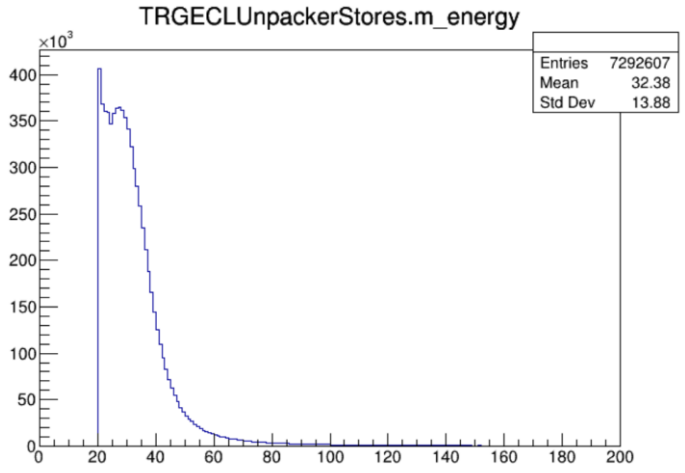
Physics-bhabha(e21r480)



Local cosmic(e21r1206)



Local cosmic(e21r1228)



Physics-hadron(e21r480)