Double gain study

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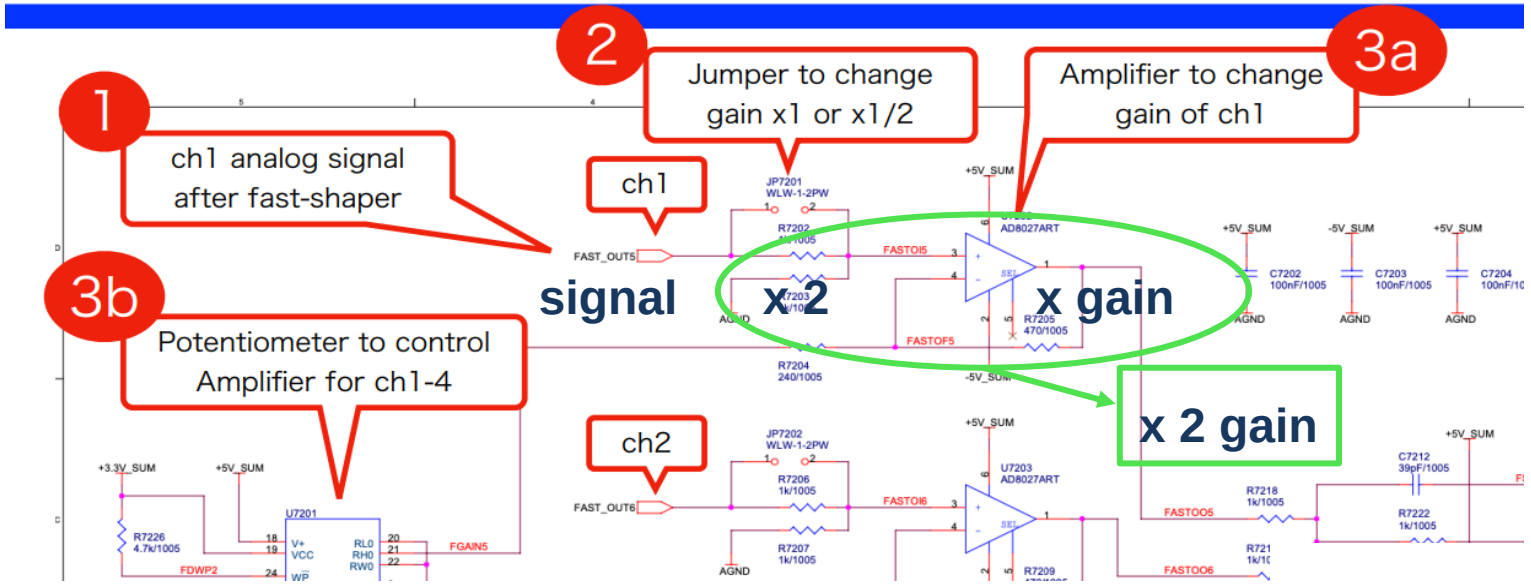
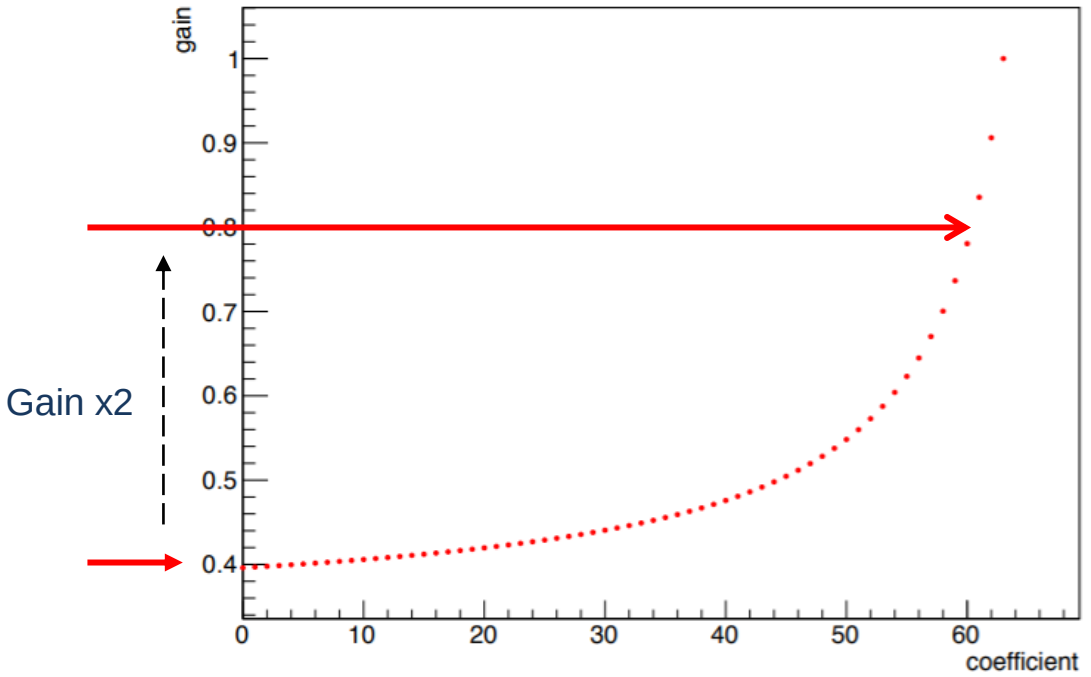
Review



Attenuator gain curve



In order to get rid of Attenuator coefficient 0, through Jumper,

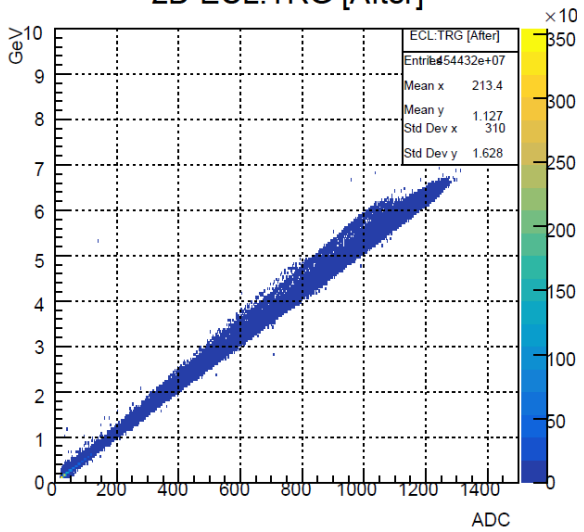
Try to do “energy x gain → energy **x 2** x gain”

In the other words, gain =0.3960111 when coefficient=0.

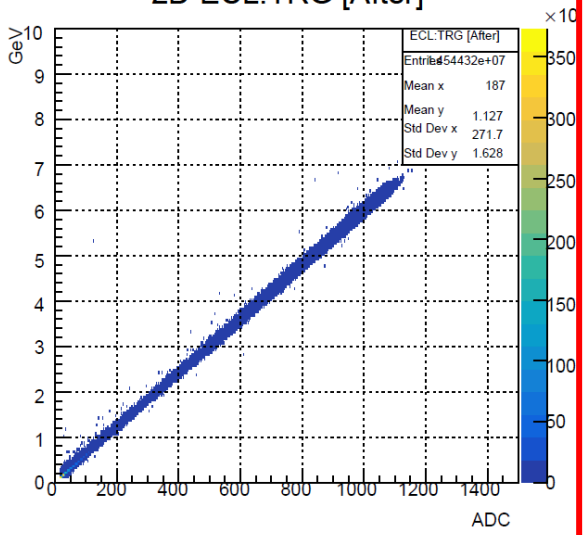
The correction is made as follows : energy x 0.7920222

Results of calibration : 2D plot for ECL and ECLTRG TC E

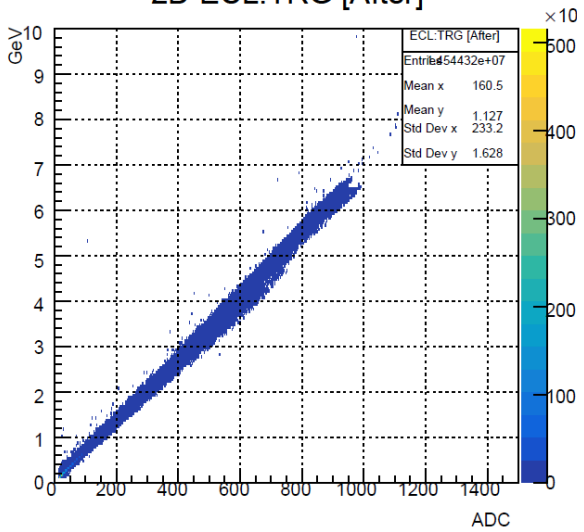
ADC conversion factor 5.25



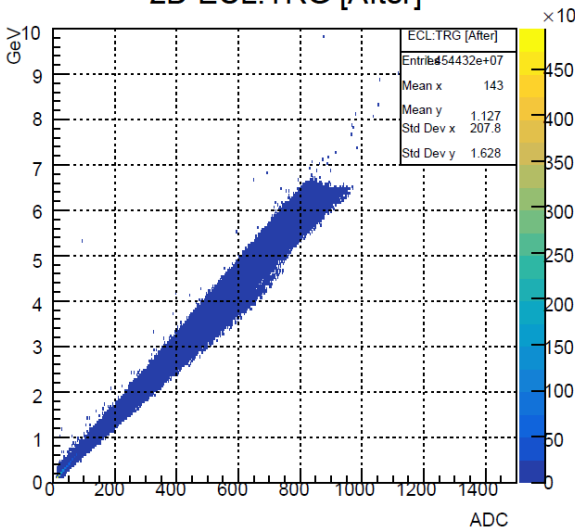
6.0

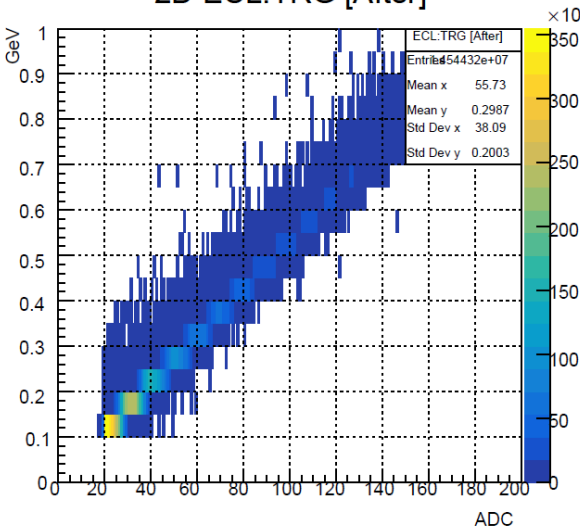


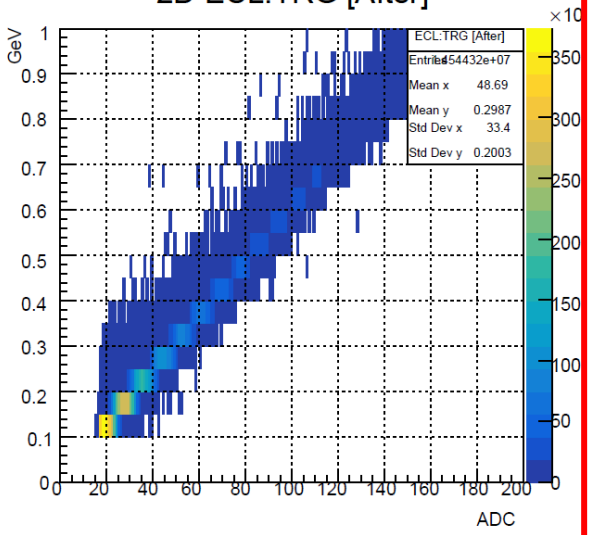
TEST 7.0

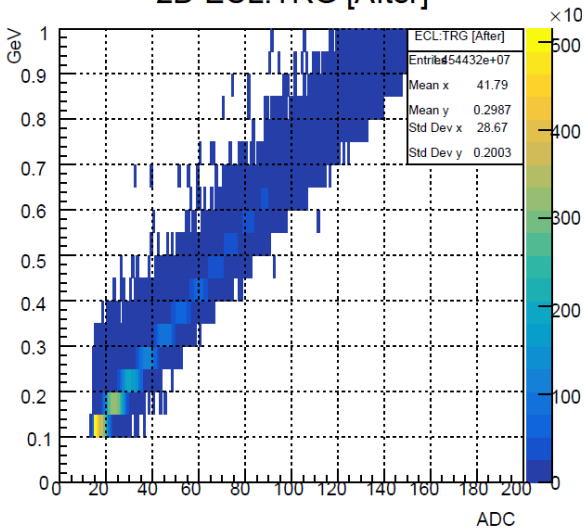


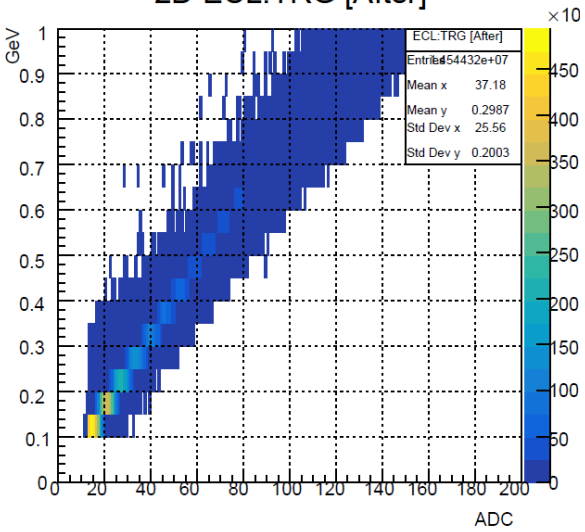
8.0









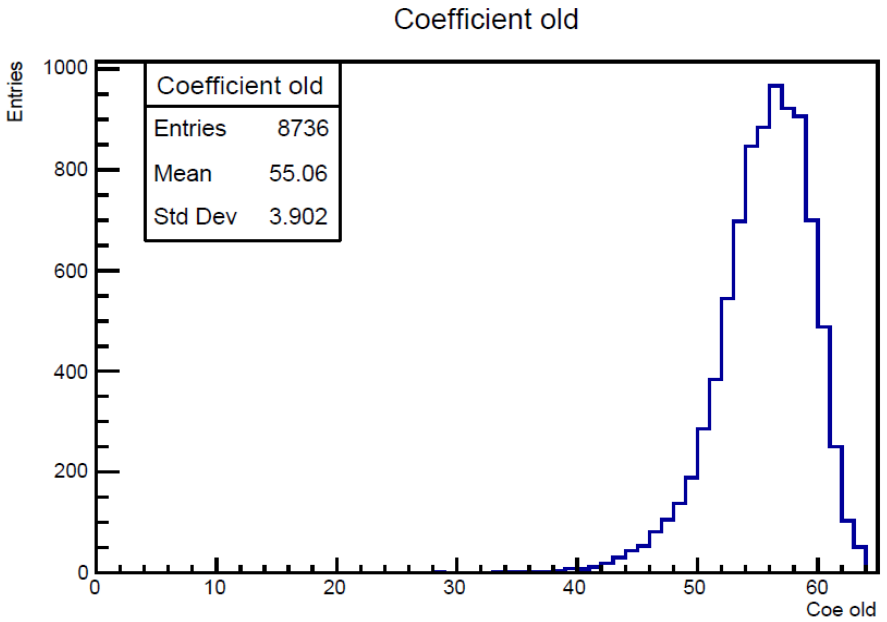


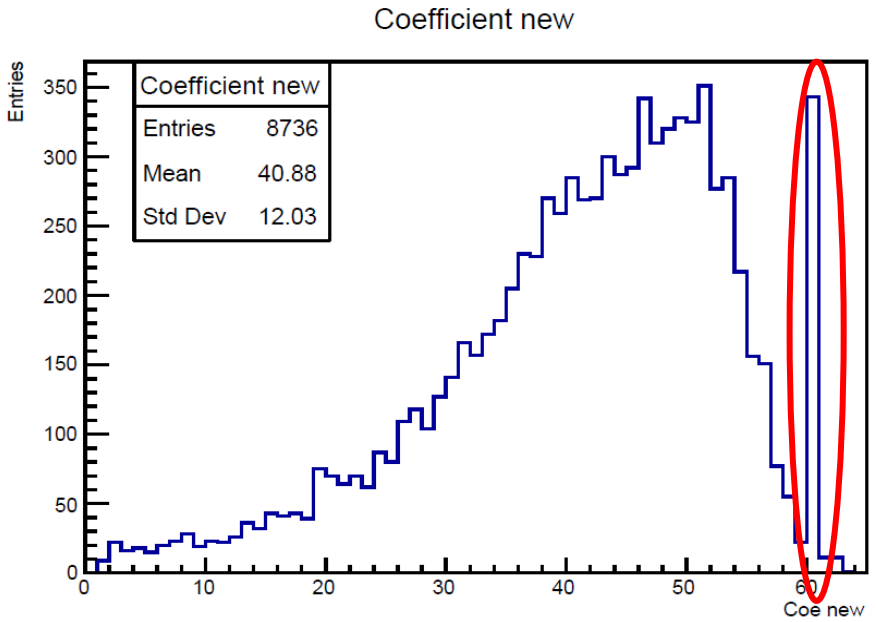
How to get new-new Attenuator coefficient

1. 5.25 ADC facto를 사용했던 기존 raw data 를 7.0 ADC factor를 이용하여 보정. (exp21 run9999)

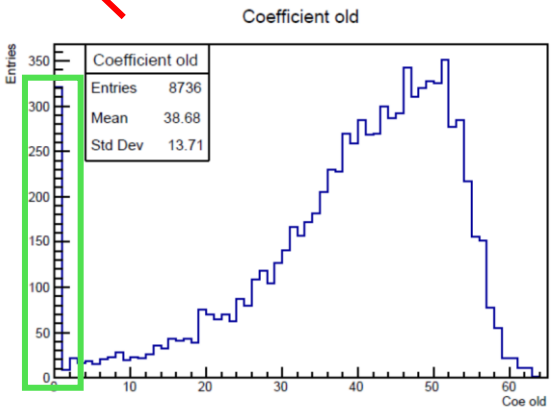
2. 1의 결과에서 Attenuator coefficient가 약 300개 가량에서 0이 나옴. (exp21 run9999)
   그 계수들에게 jumper를 적용한다고 가정하고, new Att coef가 0인 값들을 두배 시켜 줌. (exp24 run994)

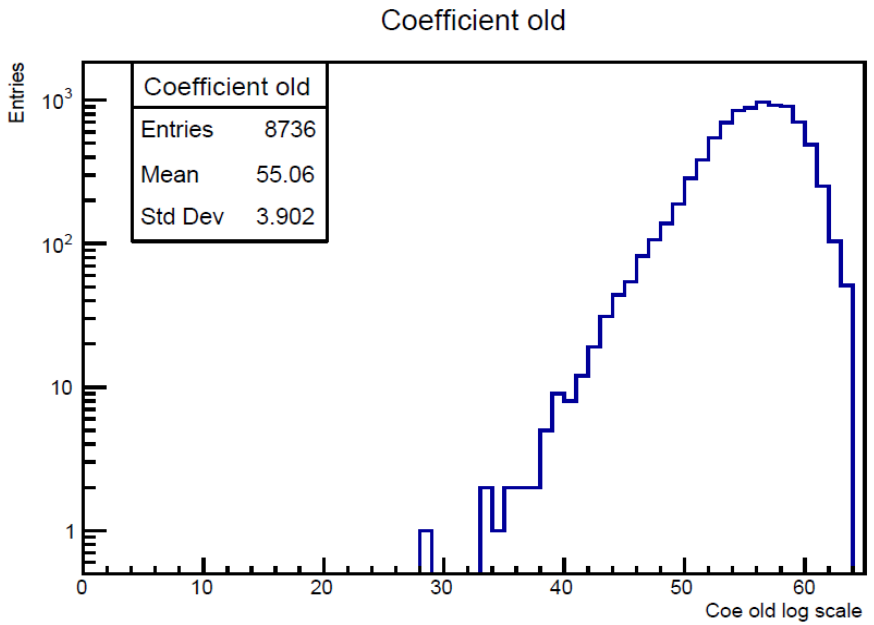
3. 1의 결과에서 0인 계수를 2배 해준 최종 결과의 보정 계수를 가지고
   1을 통해서 보정된 결과값을 한번 더 보정 시킴.

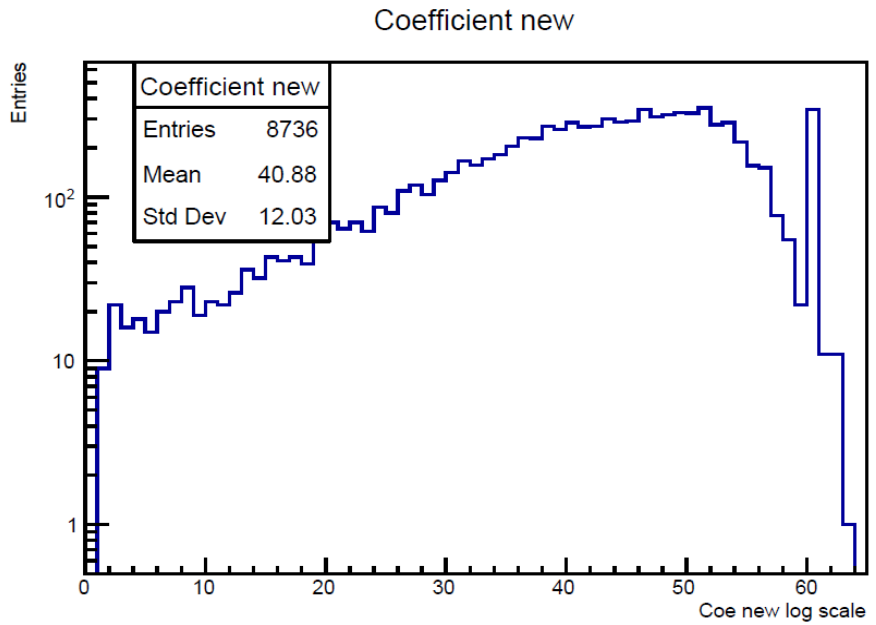

Coefficient old
Coefficient old
Entries 8736
Mean 55.06
Std Dev 3.902
Entries
Coe old

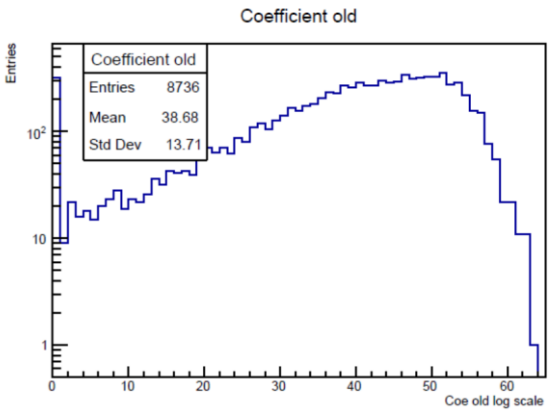

Coefficient new
Coefficient new
Entries 8736
Mean 40.88
Std Dev 12.03
Entries
Coe new

Doubled

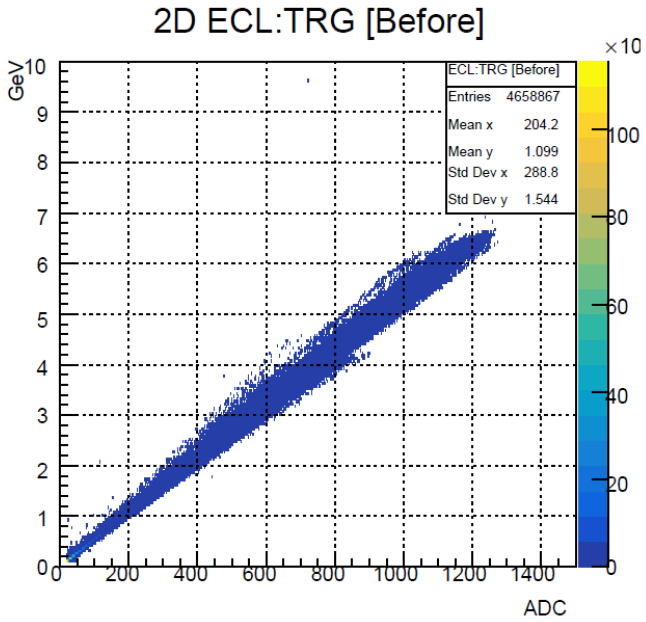

Coefficient old
Coefficient old
Entries 8736
Mean 38.68
Std Dev 13.71
Entries
Coe old

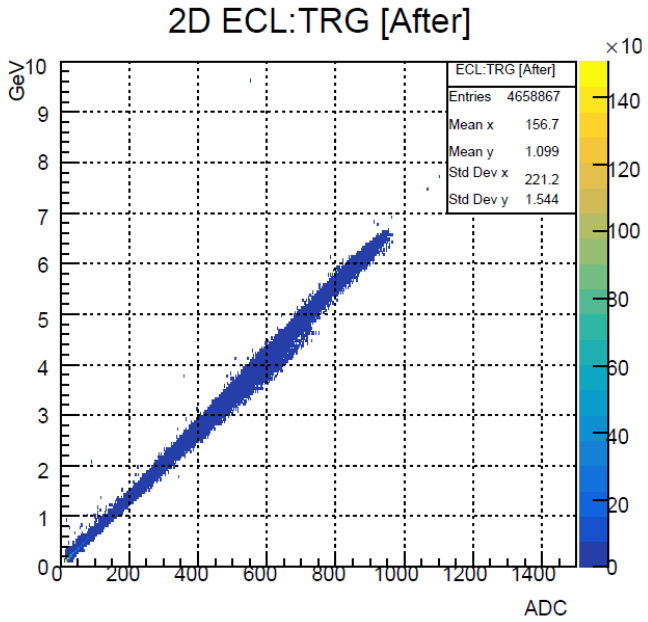

Coefficient old
Coefficient old
Entries 8736
Mean 55.06
Std Dev 3.902
Entries
Coe old log scale

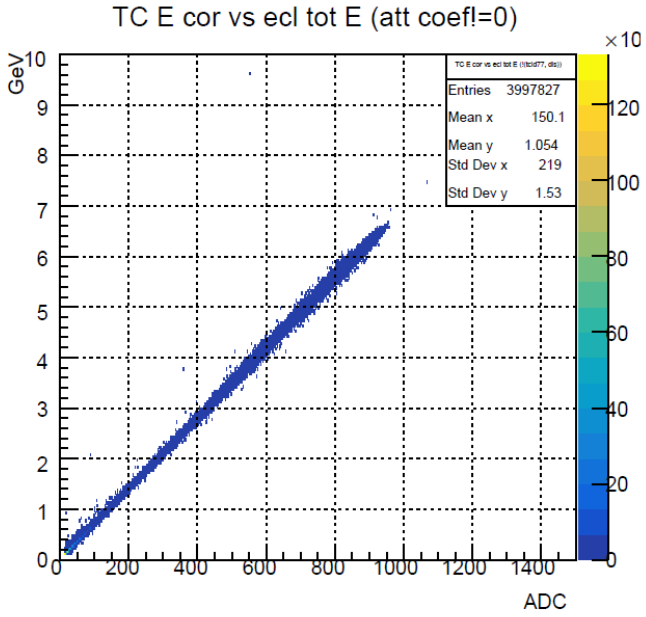

Coefficient new
Coefficient new
Entries 8736
Mean 40.88
Std Dev 12.03
Entries
Coe new log scale

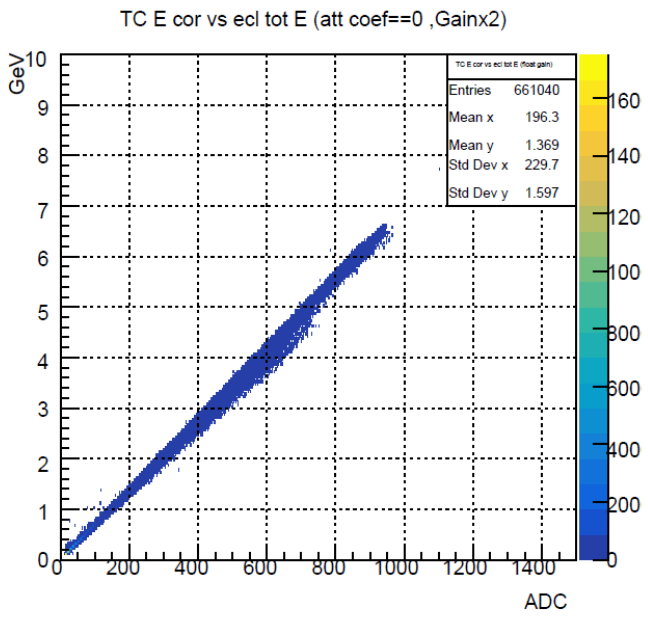

Coefficient old
Coefficient old
Entries 8736
Mean 38.68
Std Dev 13.71
Entries
Coe old log scale

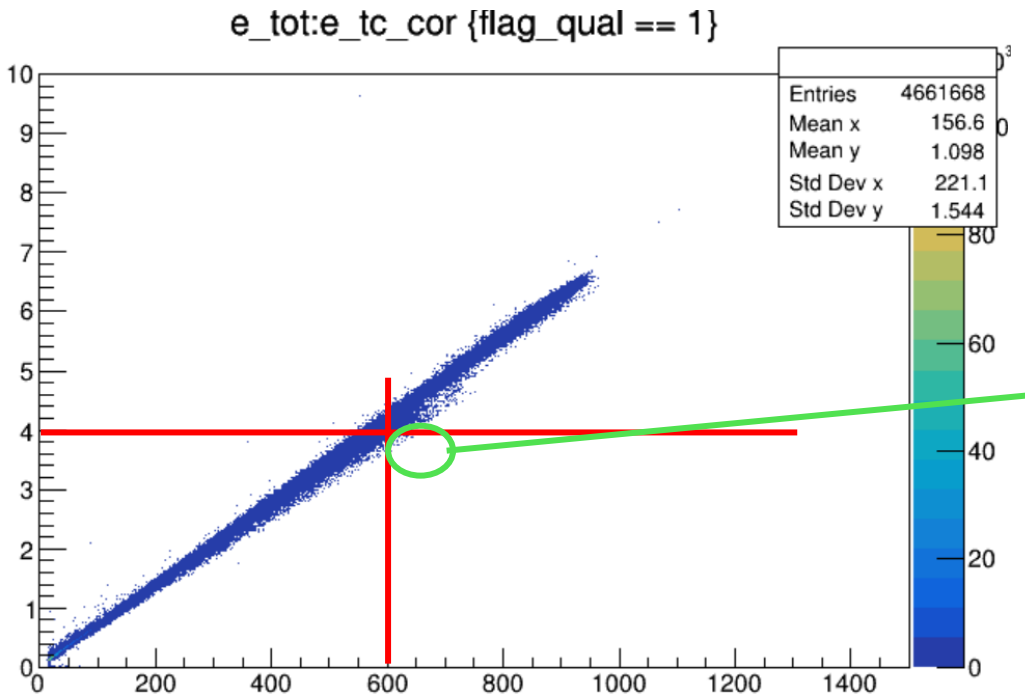
Results of the calibration

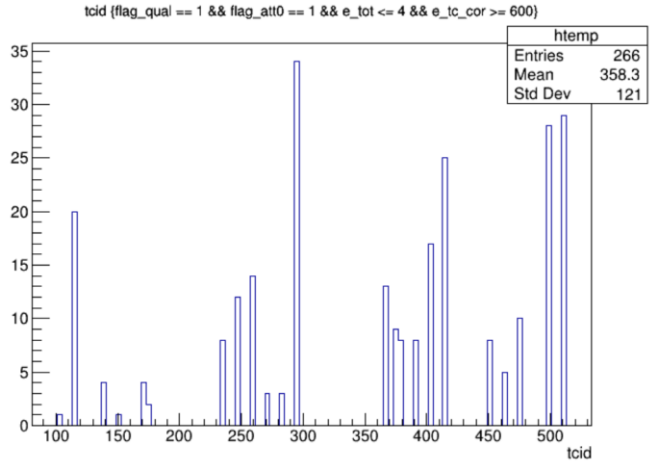






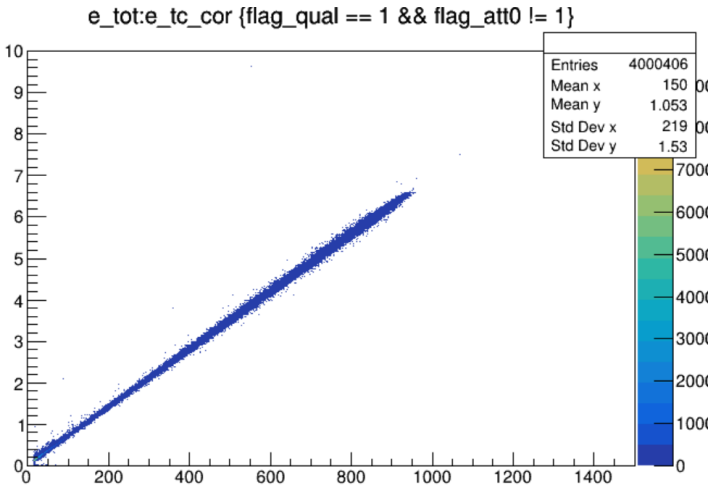


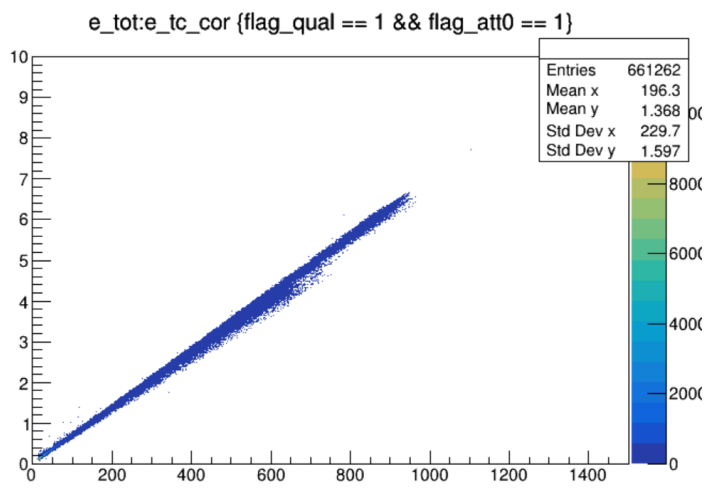




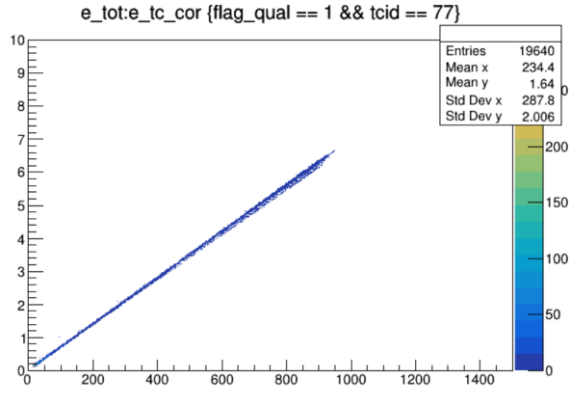
Problematic TCIDs (#23) with 0 of Att coef :
103, 115, 139, 151, 172, 174, 235, 247,
258, 259, 271, 283, 296, 367, 379, 391, 403, 415, 451

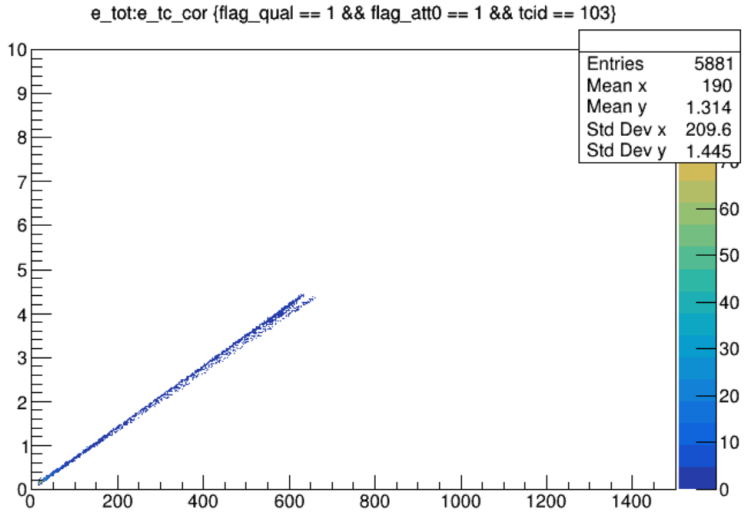
"flag_att0" means that Att coef is 0.

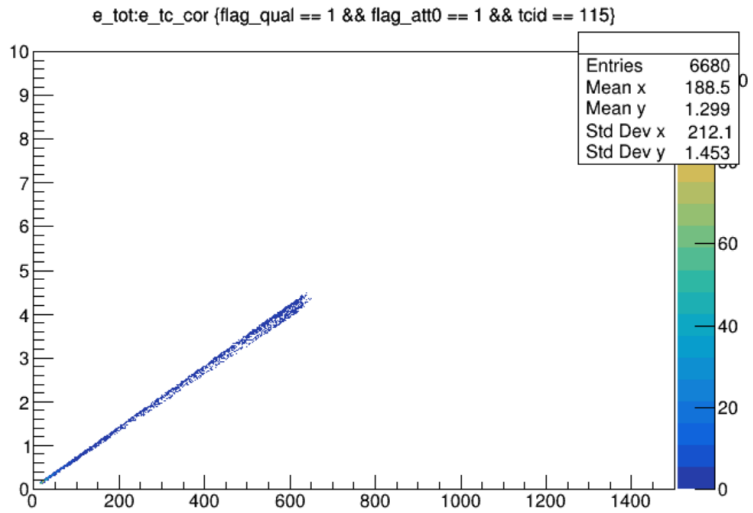


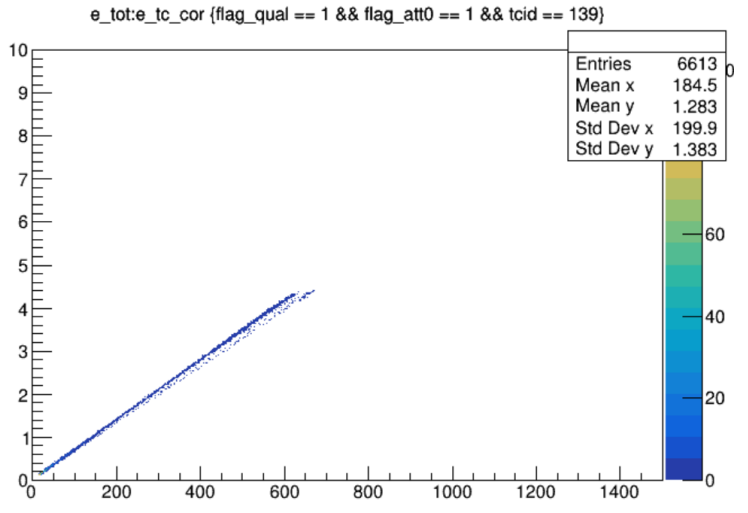


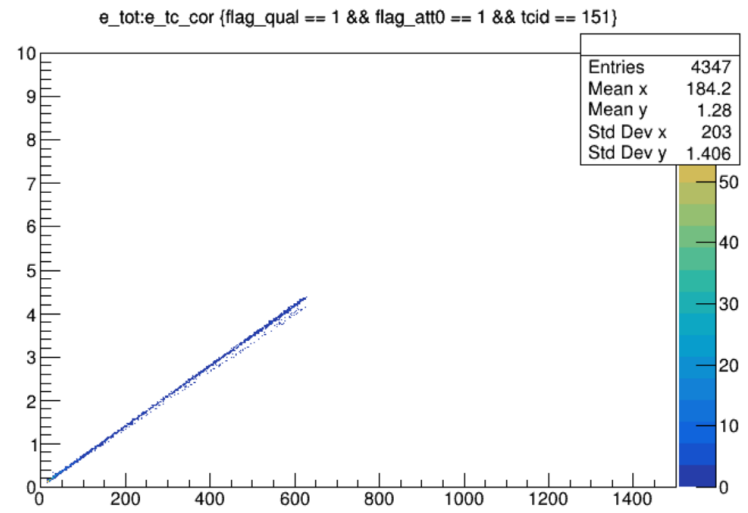
Tcid 77 is well calibrated.

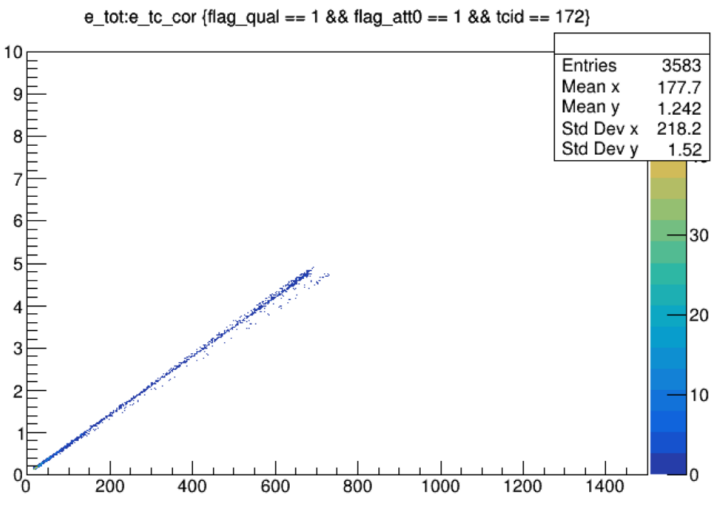


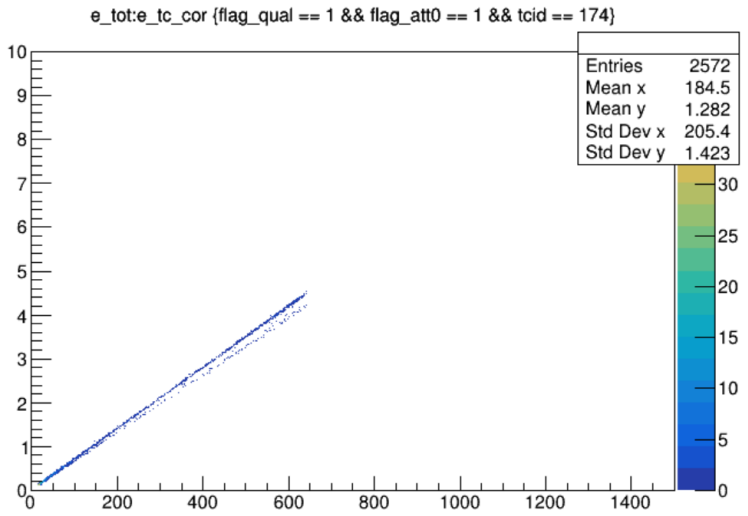

e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 103}
Entries 5881
Mean x 190
Mean y 1.314
Std Dev x 209.6
Std Dev y 1.445

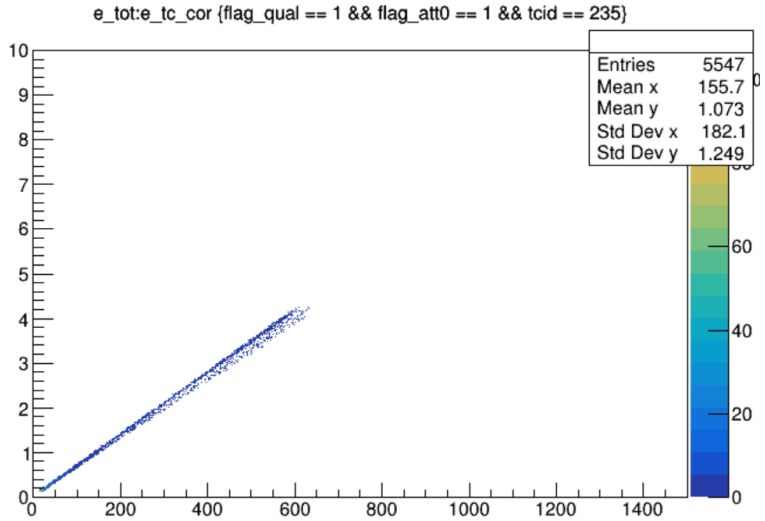

e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 115}
Entries 6680
Mean x 188.5
Mean y 1.299
Std Dev x 212.1
Std Dev y 1.453

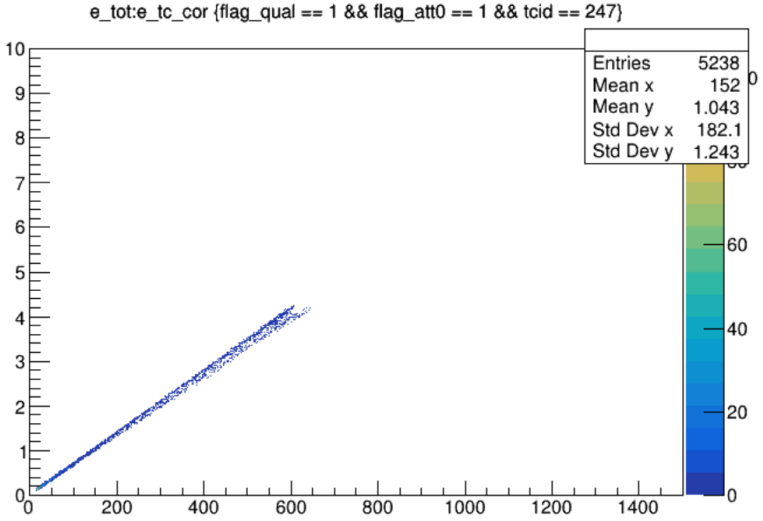

e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 139}
Entries 6613
Mean x 184.5
Mean y 1.283
Std Dev x 199.9
Std Dev y 1.383

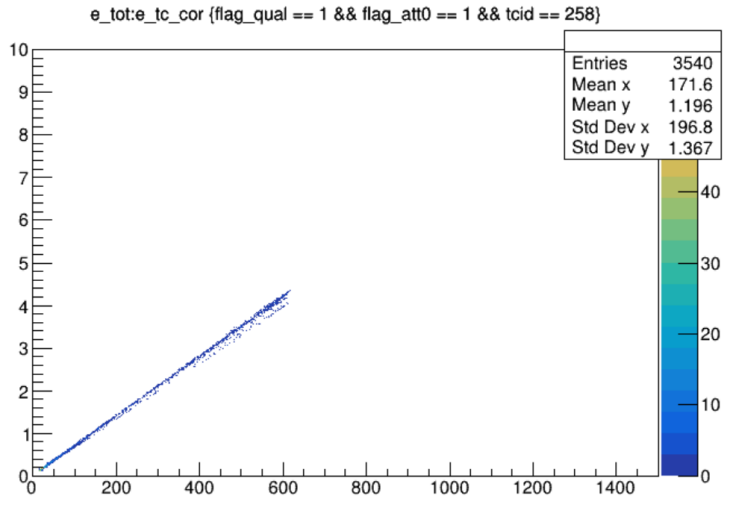

e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 151}
Entries 4347
Mean x 184.2
Mean y 1.28
Std Dev x 203
Std Dev y 1.406

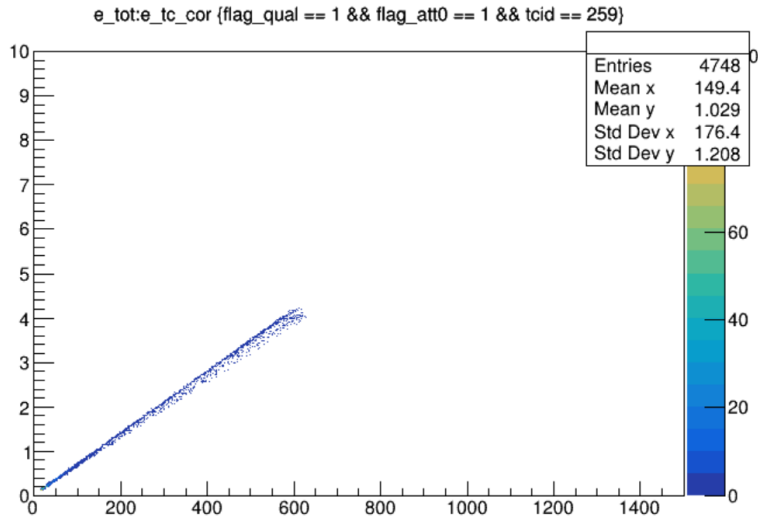

e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 172}
Entries 3583
Mean x 177.7
Mean y 1.242
Std Dev x 218.2
Std Dev y 1.52

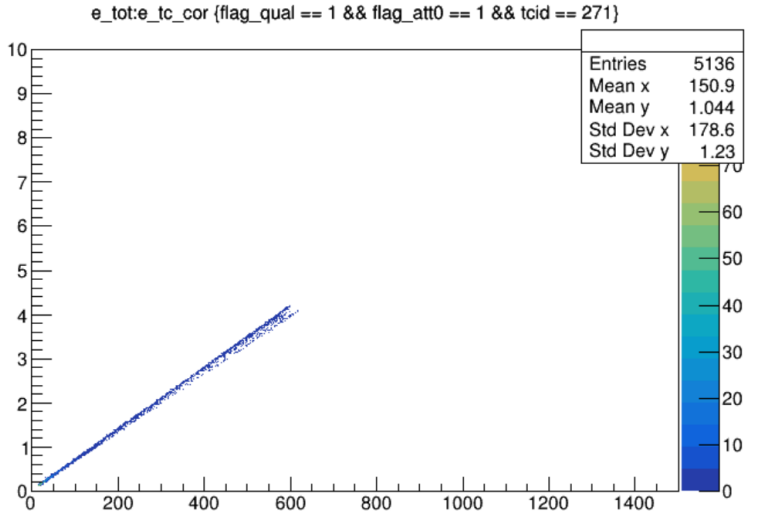

e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 174}
Entries 2572
Mean x 184.5
Mean y 1.282
Std Dev x 205.4
Std Dev y 1.423

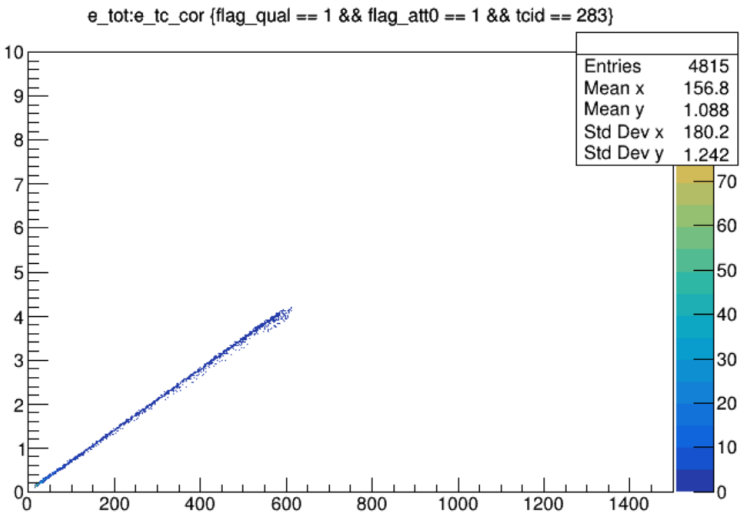

e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 235}
Entries 5547
Mean x 155.7
Mean y 1.073
Std Dev x 182.1
Std Dev y 1.249


e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 247}
Entries 5238
Mean x 152
Mean y 1.043
Std Dev x 182.1
Std Dev y 1.243


e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 258}
Entries 3540
Mean x 171.6
Mean y 1.196
Std Dev x 196.8
Std Dev y 1.367


e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 259}
Entries 4748
Mean x 149.4
Mean y 1.029
Std Dev x 176.4
Std Dev y 1.208


e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 271}
Entries 5136
Mean x 150.9
Mean y 1.044
Std Dev x 178.6
Std Dev y 1.23


e_tot:e_tc_cor {flag_qual == 1 && flag_att0 == 1 && tcid == 283}
Entries 4815
Mean x 156.8
Mean y 1.088
Std Dev x 180.2
Std Dev y 1.242

Backup

Attenuator Calibration Algorithm

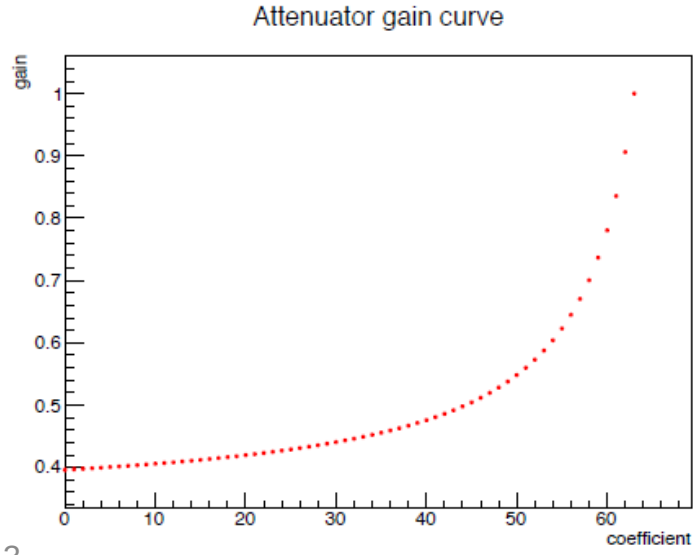
$$f(E^n, E_i^n; p_i) \equiv \sum_n (aE^n - \sum_i p_i E_i^n)^2 \rightarrow min$$

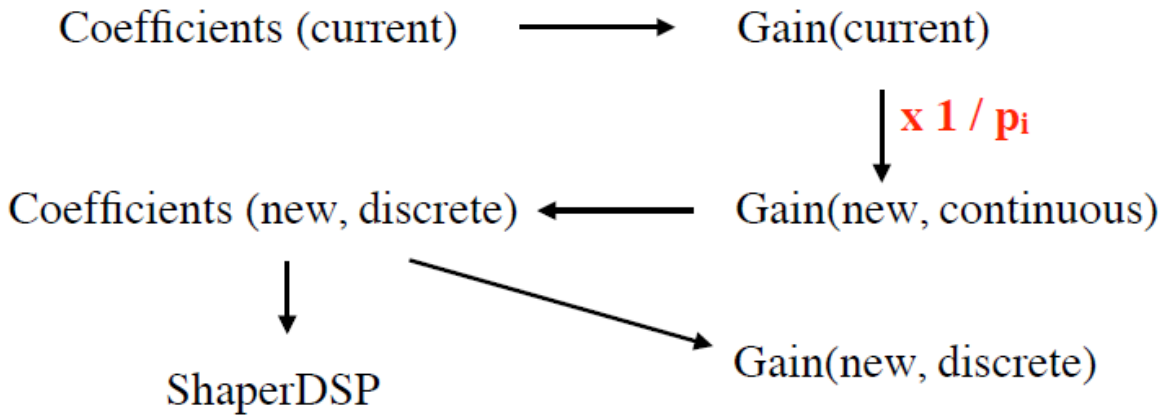
$$\frac{\partial f}{\partial p_i} = \sum_n (-2)(aE^n - \sum_j p_j E_j^n) E_i^n = 0$$

$$\rightarrow \sum_n aE^n E_i^n = \sum_n \sum_j p_j E_j^n E_i^n$$

- Energy gain by attenuator coefficients is
- $gain = \frac{1+\frac{470}{240+(2500-\frac{Att\times 2500}{63})}}{1+\frac{470}{240}}$
- where Att is attenuator coefficient

n : event index
i, j : crystal index in TC
E^n : TC energy
E^n_i : crystal energy in TC
p_i : Attenuator gain ratio (current / new)
a : calibration factor (5.25 MeV / ADC)





```
(long long) 25
root [3] tree->Scan("Gain_float:Gain_current:GainRatio_float")
************************************************
*    Row   * Gain_floa * Gain_curr * GainRatio *
************************************************
*        0 * 0.6714629 * 0.6230228 * 1.0777501 *
*        1 * 0.6394202 * 0.6230228 * 1.0263190 *
*        2 * 0.7048327 * 0.7004110 * 1.0063130 *
*        3 * 0.6093151 * 0.7004110 * 0.8699394 *
*        4 * 0.6077165 * 0.5875050 * 1.0344022 *
*        5 * 0.6094725 * 0.6040838 * 1.0089205 *
*        6 * 0.5206835 * 0.7004110 * 0.7433971 *
*        7 * 0.6077323 * 0.7004110 * 0.8676795 *
*        8 * 0.5508638 * 0.6040838 * 0.9118997 *
*        9 * 0.5293230 * 0.6703327 * 0.7896422 *
*       10 * 0.6120457 * 0.6703327 * 0.9130476 *
*       11 * 0.5318860 * 0.6703327 * 0.7934656 *
*       12 * 0.3907958 * 0.6040838 * 0.6469232 *
*       13 * 0.5726813 * 0.7004110 * 0.8176360 *
*       14 * 0.6152665 * 0.7364761 * 0.8354194 *
*       15 * 0.4215946 * 0.6040838 * 0.6979074 *
*       16 * 0.5626377 * 0.7004110 * 0.8032966 *
*       17 * 0.5512648 * 0.6703327 * 0.8223748 *
*       18 * 0.5762410 * 0.7364761 * 0.7824299 *
*       19 * 0.5806250 * 0.7004110 * 0.8289775 *
*       20 * 0.6421000 * 0.8354940 * 0.7685273 *
*       21 * 0.6692367 * 0.7805133 * 0.8574315 *
*       22 * 0.6023062 * 0.6703327 * 0.8985183 *
*       23 * 0.6842819 * 0.7805133 * 0.8767075 *
*       24 * 0.6216528 * 0.8354940 * 0.7440541 *
```

$$\frac{0.6714629}{0.6230228} = 1.0777501 \qquad \frac{New\ gain}{Old\ gain} = Gain\ ratio$$

Solve matrix (β) = $\frac{Old\ gain}{New\ gain}$

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

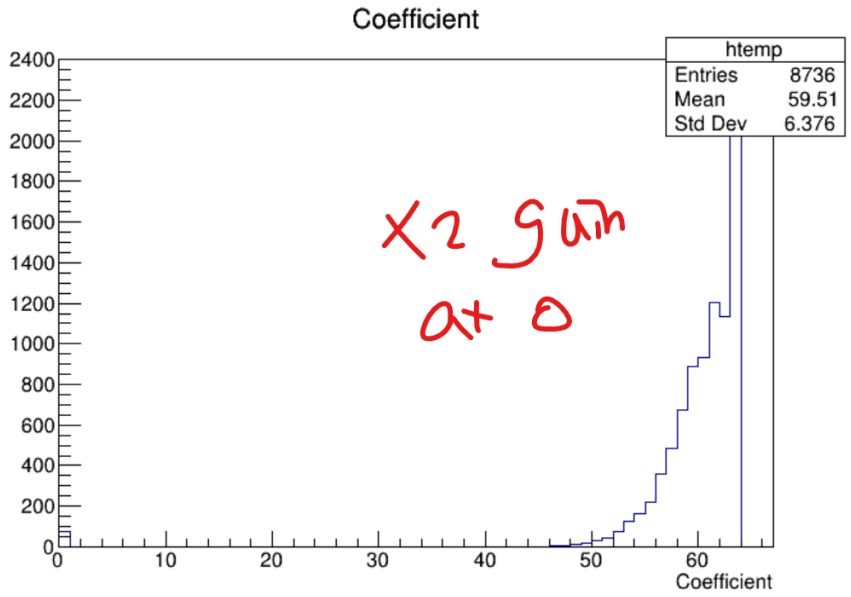
data (old value)

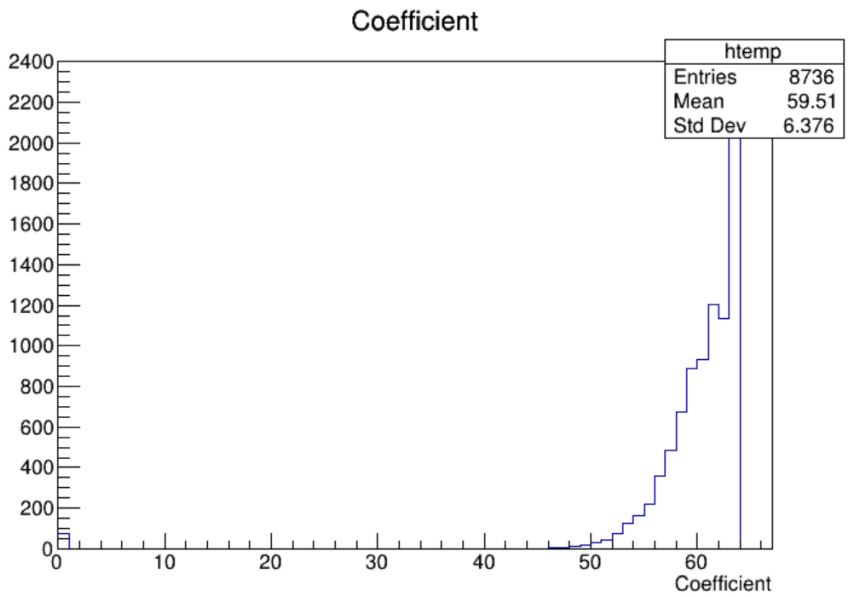
Simulation (new value)

V = β * M

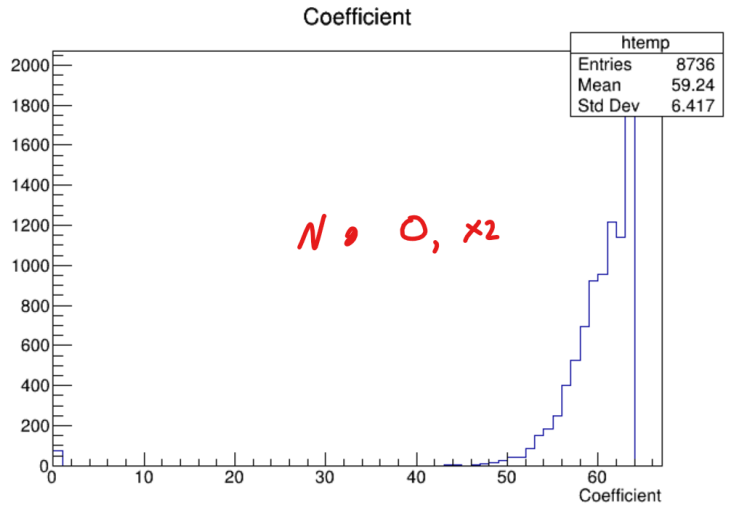
β= (M)^(-1) * v

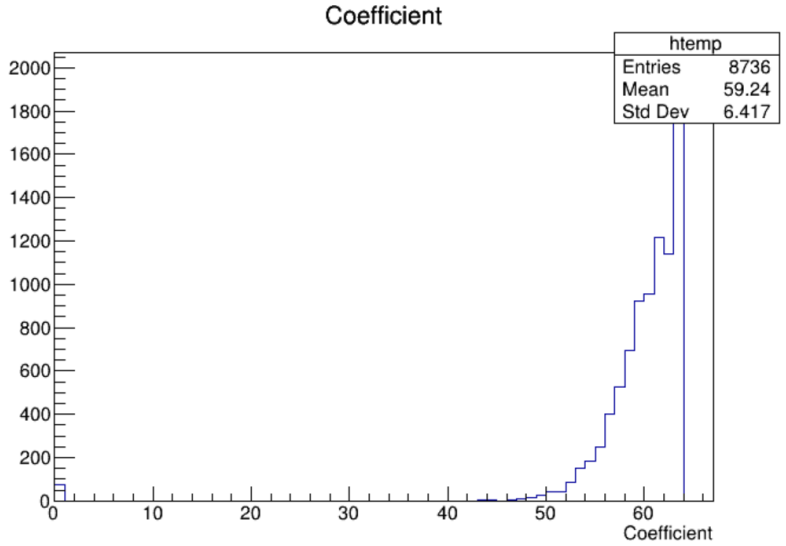
```
(long long) 50
root [4] tree->Scan("Solve:Gain_current:Gain_float")
************************************************
*    Row   *      Solve * Gain_curr * Gain_floa *
************************************************
*        0 * 0.9278588 * 0.6230228 * 0.6714629 *
*        1 * 0.9743559 * 0.6230228 * 0.6394202 *
*        2 * 0.9937265 * 0.7004110 * 0.7048327 *
*        3 * 1.1495053 * 0.7004110 * 0.6093151 *
*        4 * 0.9667419 * 0.5875050 * 0.6077165 *
*        5 * 0.9911583 * 0.6040838 * 0.6094725 *
*        6 * 1.3451759 * 0.7004110 * 0.5206835 *
*        7 * 1.1524992 * 0.7004110 * 0.6077323 *
*        8 * 1.0966117 * 0.6040838 * 0.5508638 *
*        9 * 1.2663962 * 0.6703327 * 0.5293230 *
*       10 * 1.0952331 * 0.6703327 * 0.6120457 *
*       11 * 1.2602939 * 0.6703327 * 0.5318860 *
*       12 * 1.5457783 * 0.6040838 * 0.3907958 *
*       13 * 1.2230380 * 0.7004110 * 0.5726813 *
*       14 * 1.1970034 * 0.7364761 * 0.6152665 *
*       15 * 1.4328547 * 0.6040838 * 0.4215946 *
*       16 * 1.2448701 * 0.7004110 * 0.5626377 *
*       17 * 1.2159904 * 0.6703327 * 0.5512648 *
*       18 * 1.2780696 * 0.7364761 * 0.5762410 *
*       19 * 1.2063052 * 0.7004110 * 0.5806250 *
*       20 * 1.3011898 * 0.8354940 * 0.6421000 *
*       21 * 1.1662738 * 0.7805133 * 0.6692367 *
*       22 * 1.1129433 * 0.6703327 * 0.6023062 *
*       23 * 1.1406312 * 0.7805133 * 0.6842819 *
*       24 * 1.3439882 * 0.8354940 * 0.6216528 *
Type <CR> to continue or q to quit ==> q
************************************************

(long long) 25
root [5] .q
```

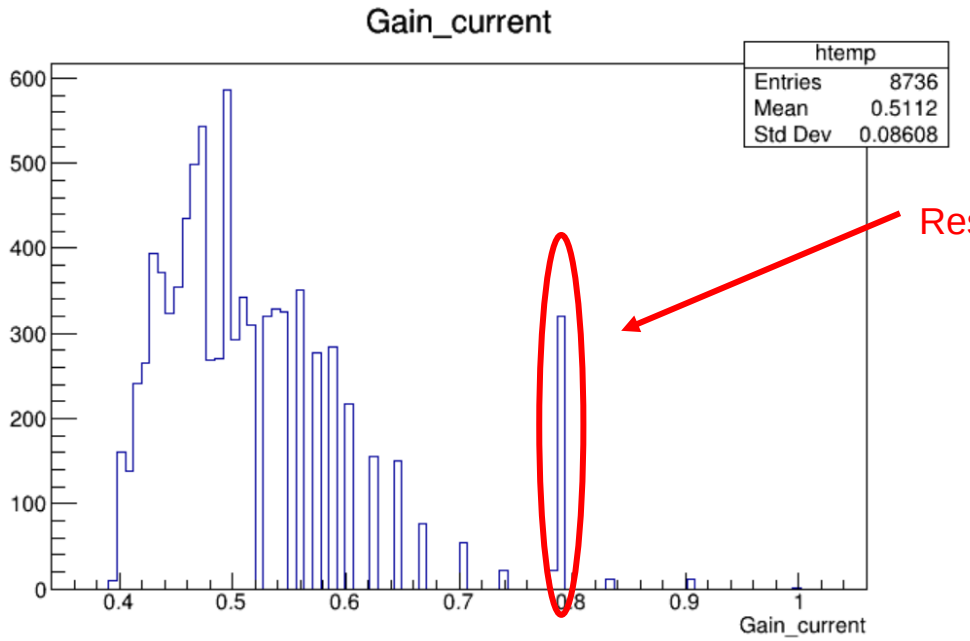




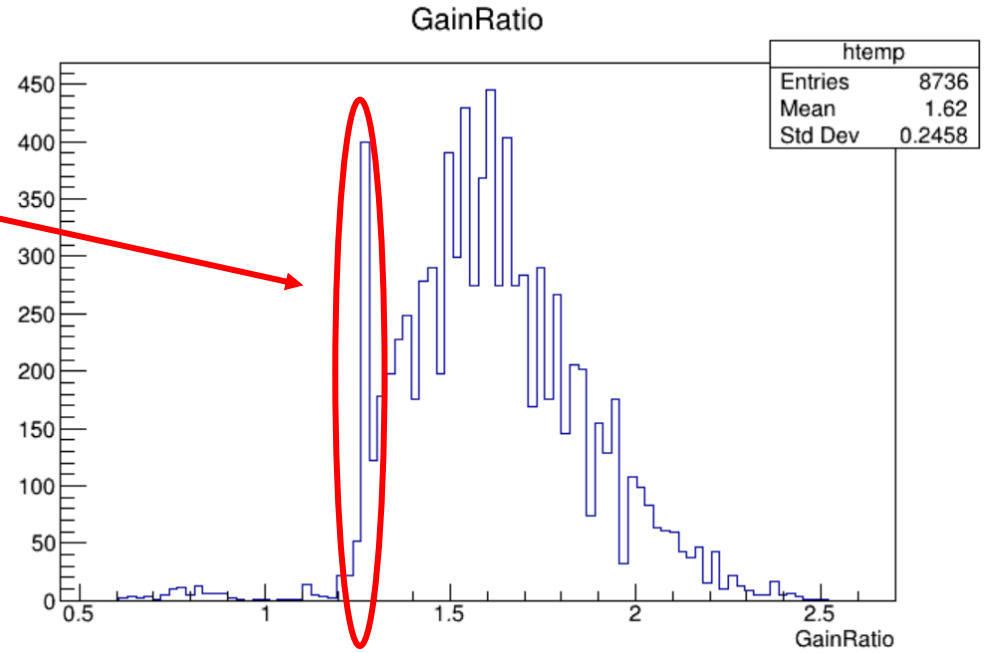
그래서 위 그래프가 coef 63이 약 300개 정도 더 많다

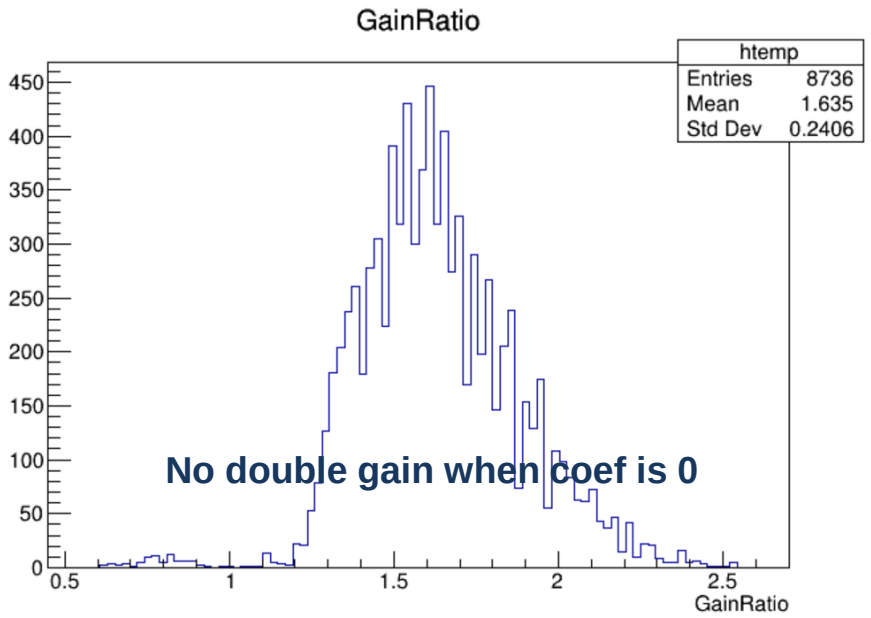




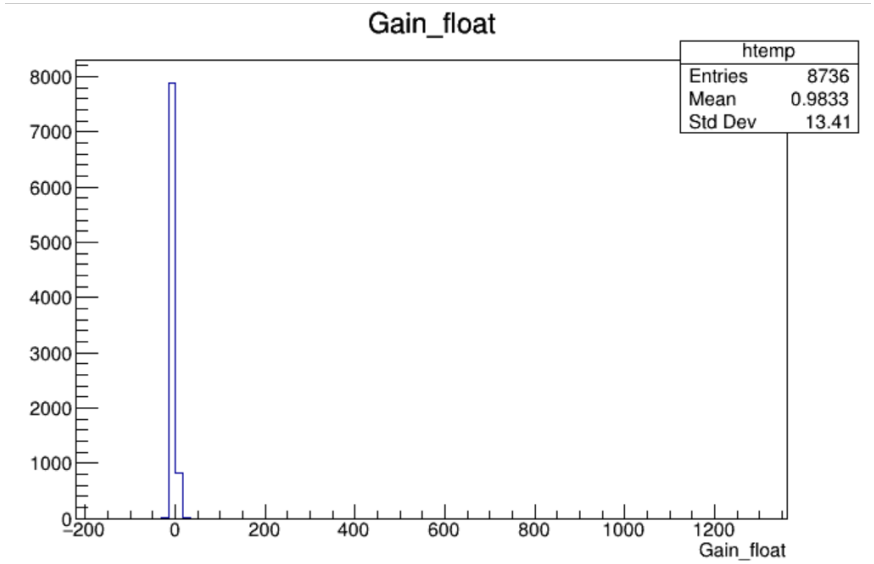


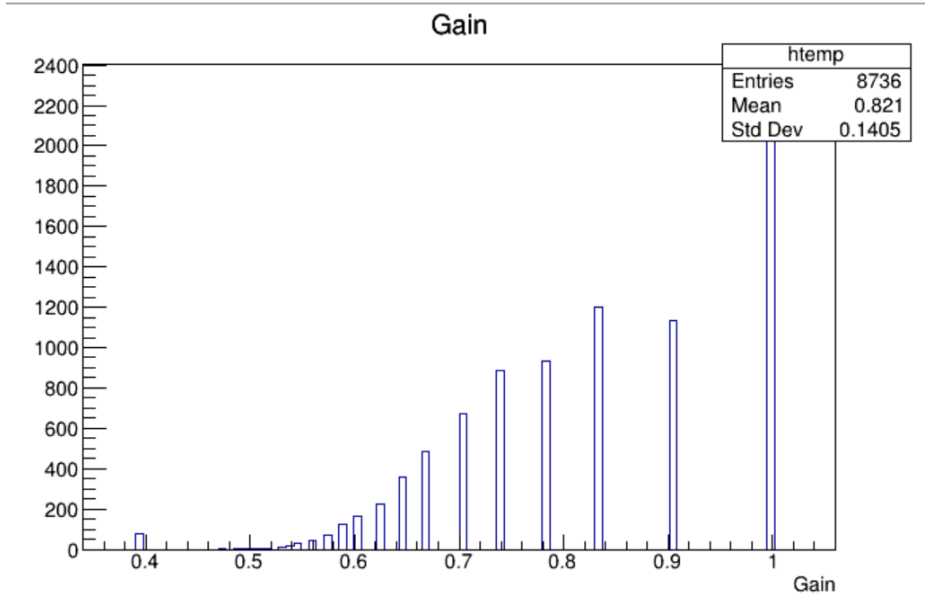
Results of double gain

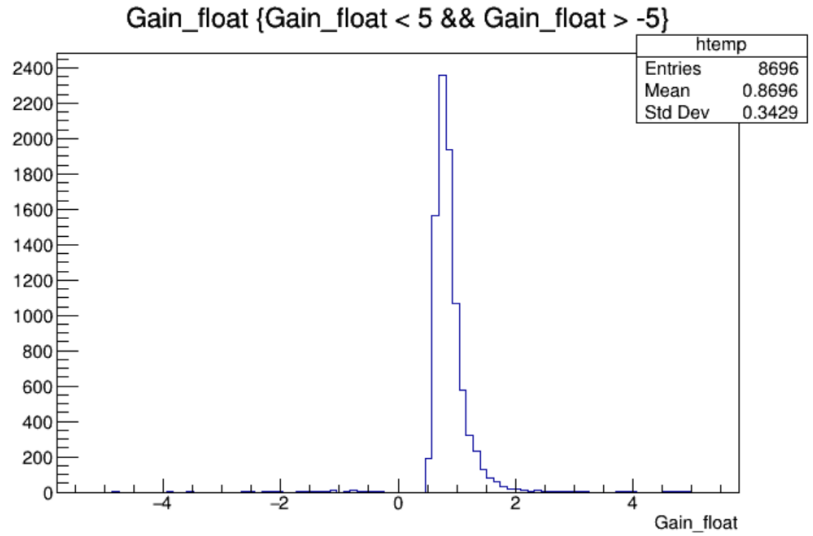




No double gain when coef is 0


Gain_float
htemp
Entries 8736
Mean 0.9833
Std Dev 13.41
8000
7000
6000
5000
4000
3000
2000
1000
0
−200
0
200
400
600
800
1000
1200
Gain_float


Gain
htemp
Entries 8736
Mean 0.821
Std Dev 0.1405
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0.4
0.5
0.6
0.7
0.8
0.9
1
Gain


Gain_float {Gain_float < 5 && Gain_float > -5}
htemp
Entries 8696
Mean 0.8696
Std Dev 0.3429
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
−4
−2
0
2
4
Gain_float