



Studies of SAC crystals relative gains with cosmic and beam

F. Oliva on behalf of the PADME Lecce group

OVERVIEW

Calibration Strategy

1. CR calibration

Gain for each channel obtained using CR

[SAC_EnergyCalibration_4.txt](#)

Comparison between DATA taken in July 2019 $E_{\text{beam}}=490$ MeV and MC 550 MeV

2. Beam and MC calibration

Gain for each channel obtained using 490 MeV beam data taken in July with full setup data acquisition in comparison with ideal shape from MC

[SAC_EnergyCalibration_6.txt](#)

SAC Cosmic Rays Calibration

SAC.cfg

AmplThrLow 0.1
AmplThrHigh 0.1

Minimum Threshold for peak search

Cosmic RUN

```
run_0000000_20190724_205350
```

```
SETUP target_sac_cosmic_201907
```

2 triggers

TriggerMask =2 -> CR

TriggerMask =64 -> auto trigger

HV 1100 V for all SACChannels

Pedestal from July* in develop used

Mean of the first 80 samples

The energy of the hit (in MeV) is calculated as usual..

DigitizerChannelSAC

```
pCMeV= 3.2E5*2*1.67E-7;
```

```
//Nominal Gain at 1500 x npe/MeV x echarge (in pC) needs tuning by calibration
```

```
// Double_t pCMeV= 1.; //Nominal Gain at 1500 x npe/MeV x echarge (in pC)
```

*check last slides for pedestals considerations

Even if 1100 V

4	14	24	34	44
3	13	23	33	43
2	12	22	32	42
1	11	21	31	41
0	10	20	30	40

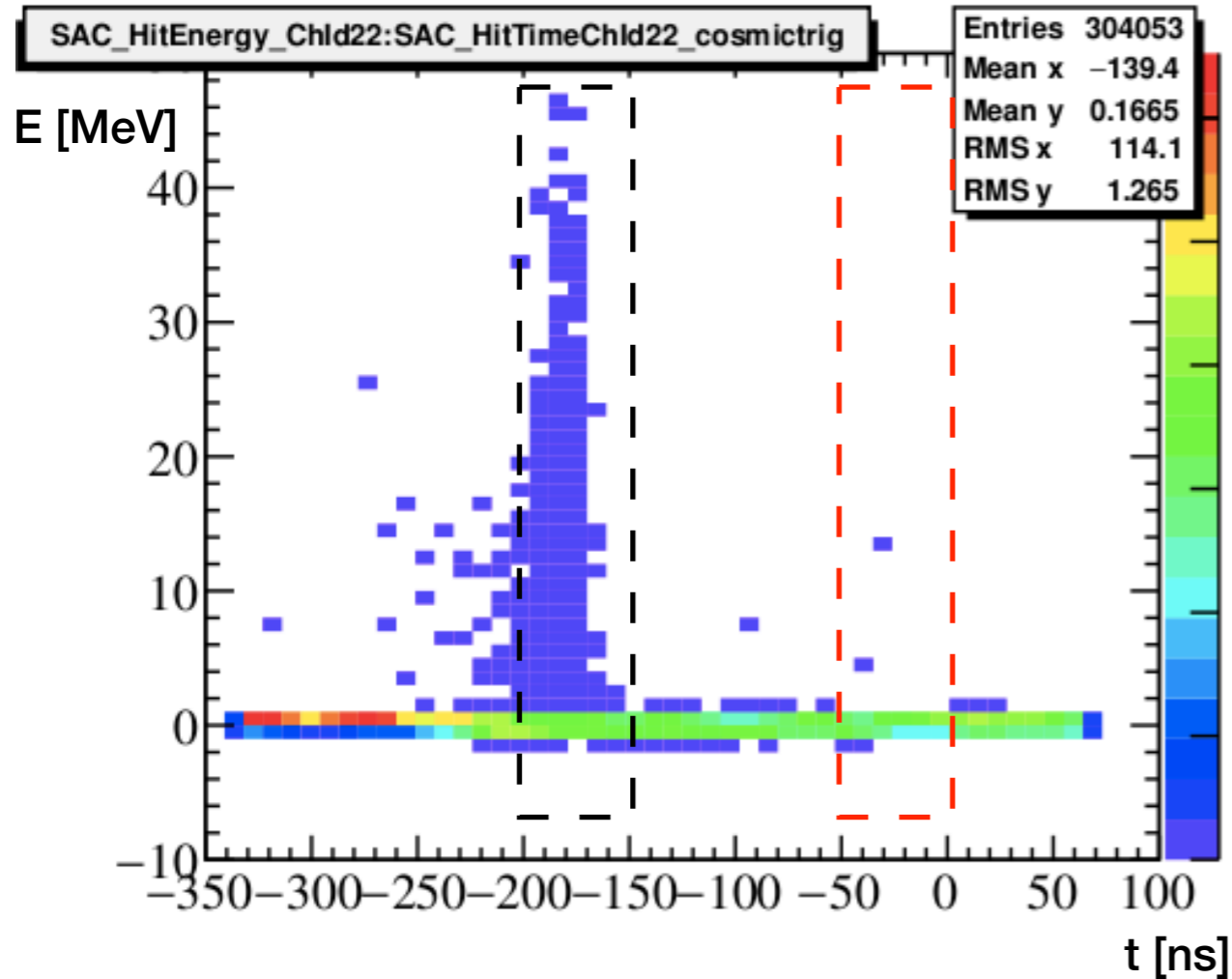
View from the back,
PADME frame

Hit Energy vs Hit Time

TriggerMask =2

Channel Id 22

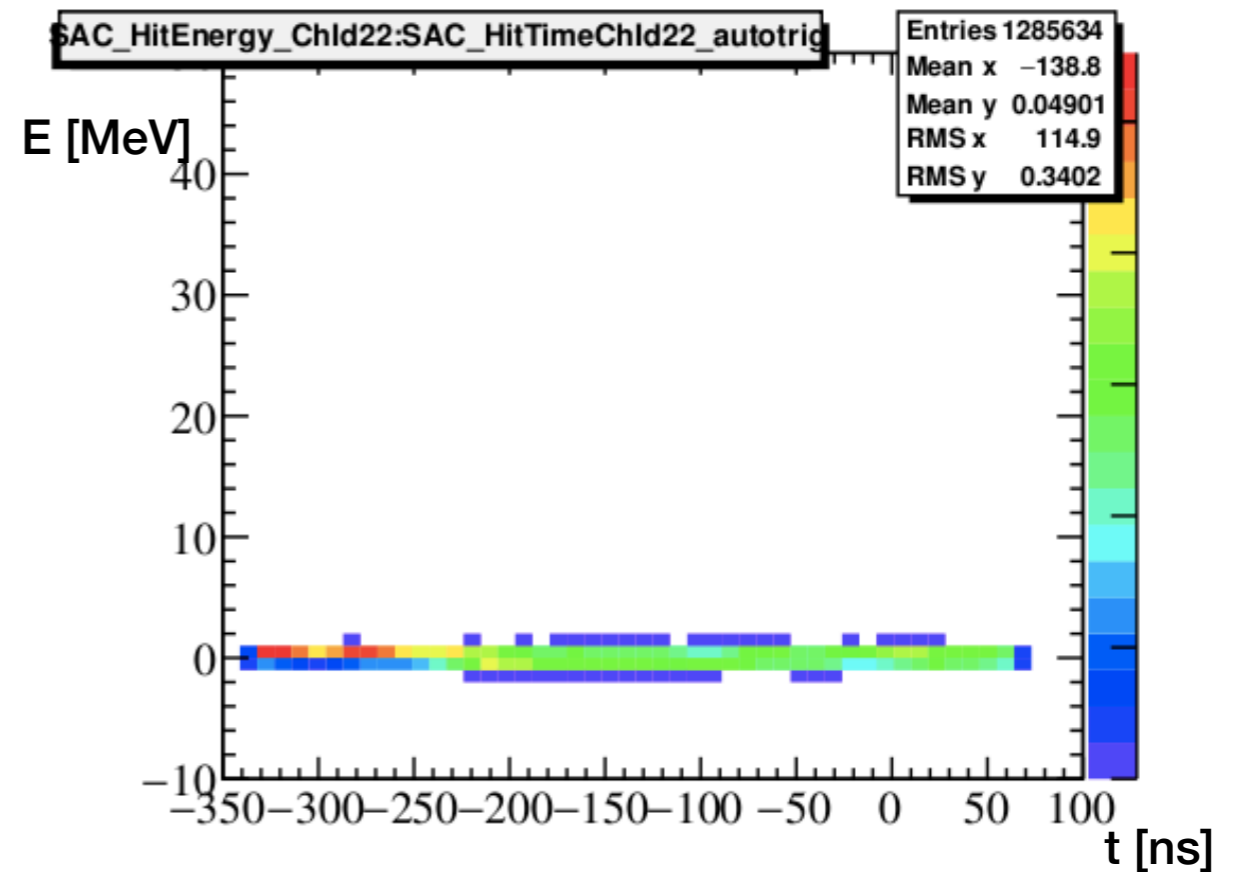
run_0000000_20190724_205350
300000 events



Signal Region $-200 \text{ ns} < \text{Time} < -150 \text{ ns}$

Noise Region $-50 \text{ ns} < \text{Time} < 0 \text{ ns}$

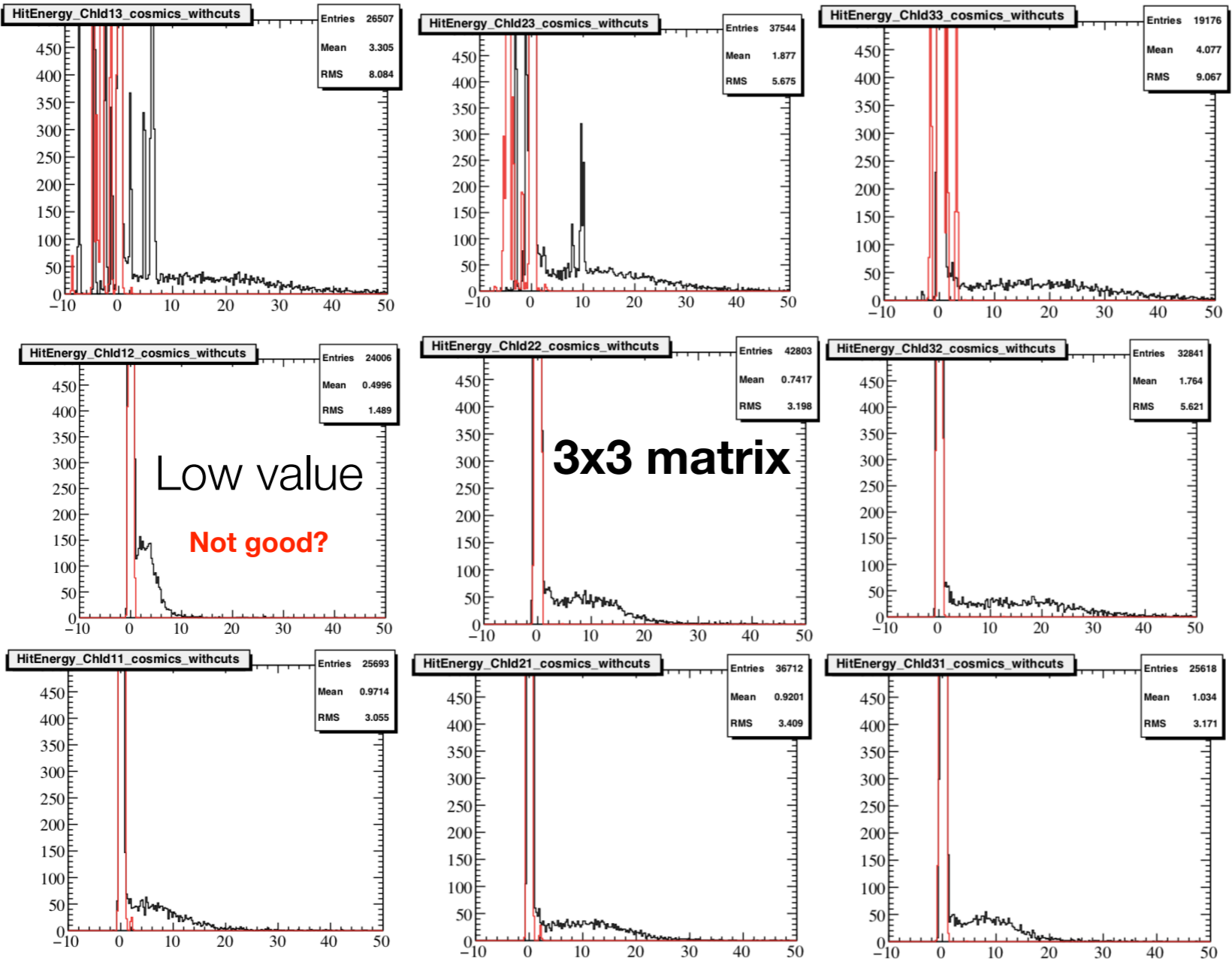
TriggerMask =64



Example of HitEnergy for a few Chlds

Signal Region $-200 \text{ ns} < \text{Time} < -150 \text{ ns}$
Noise Region $-50 \text{ ns} < \text{Time} < 0 \text{ ns}$

Energy in MeV



Only cosmic trigger
TRIGGER MASK= 2

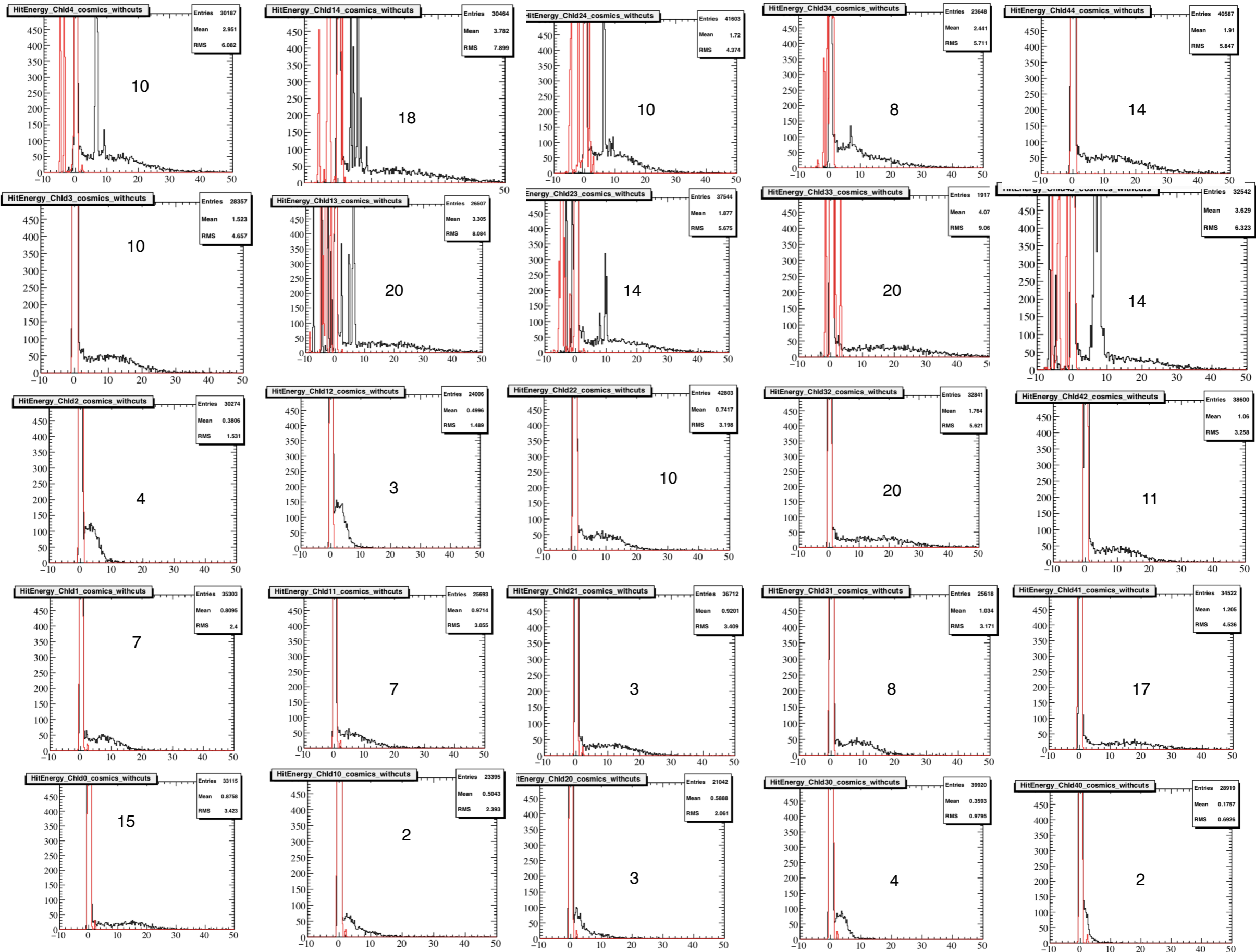
Not so simple to extract calibration constants
 ↓
 First estimation of the calibration constants without any fit

Focusing on $E < 50 \text{ MeV}$

For more details..

SAC Calibration 4thOctober2019/DATAqualitySAC 1D 300kevents run 0000000 20190724 205350 LowThr.pdf

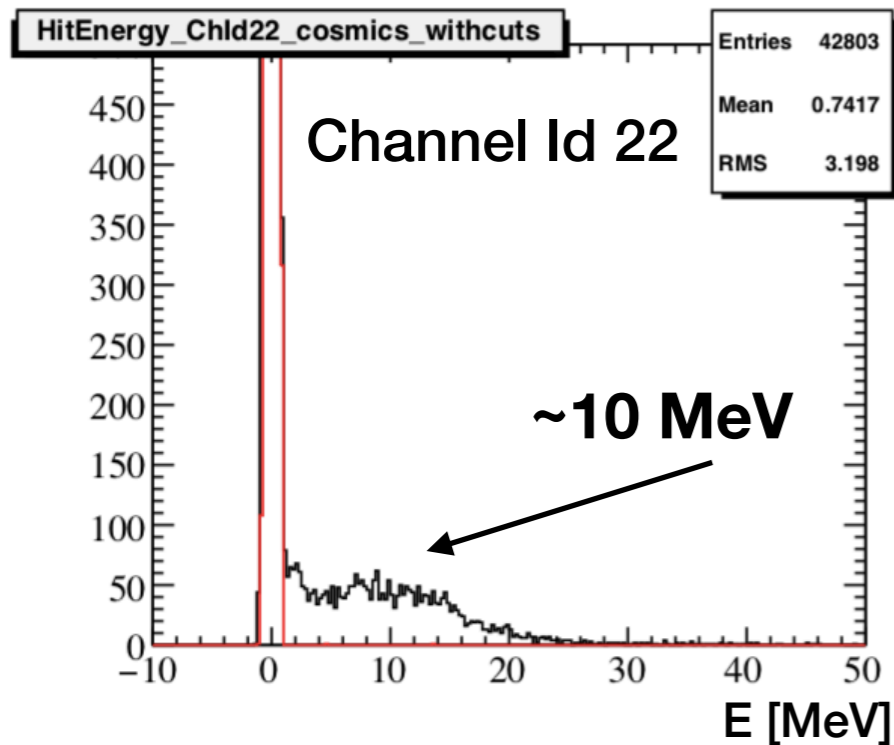
Chosen energy value in MeV for each ChId in every box



How to extract calibration constants

STEP BY STEP

1.



Focusing on $E < 50$ MeV

NOT yet inserted in any branch

SAC_EnergyCalibration_4.txt

Signal Region $-200 \text{ ns} < \text{Time} < -150 \text{ ns}$

Noise Region $-50 \text{ ns} < \text{Time} < 0 \text{ ns}$

2.

properties of lead fluoride (PbF_2) *

Minimum ionization	1.206	MeV g ⁻¹ cm ²	9.373	MeV cm ⁻¹
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As Clara suggested during her last talk

*http://pdg.lbl.gov/2019/AtomicNuclearProperties/HTML/lead_fluoride.html

For 3 cm crystals $\sim 28,119$ MeV

3.

Calibration Constant = $28.119 / \text{MeanValue ChId}$

0	1.875
10	14.060
20	9.373
30	7.030
40	14.060
1	4.017
11	4.017
21	2.163
31	3.515
41	1.654
2	7.030
12	9.373
22	2.812
32	1.406
42	2.556
3	2.812
13	1.406
23	2.009
33	1.406
43	2.009
4	2.812
14	1.562
24	2.812
34	3.515
44	2.009

For Channel Id 22 ~ 2.812

Comparison between DATA CR SAC calibrated and MC

DATA

Reco-run_0000000_20190724_152634

SETUP: full201907_nozsup

10000 events

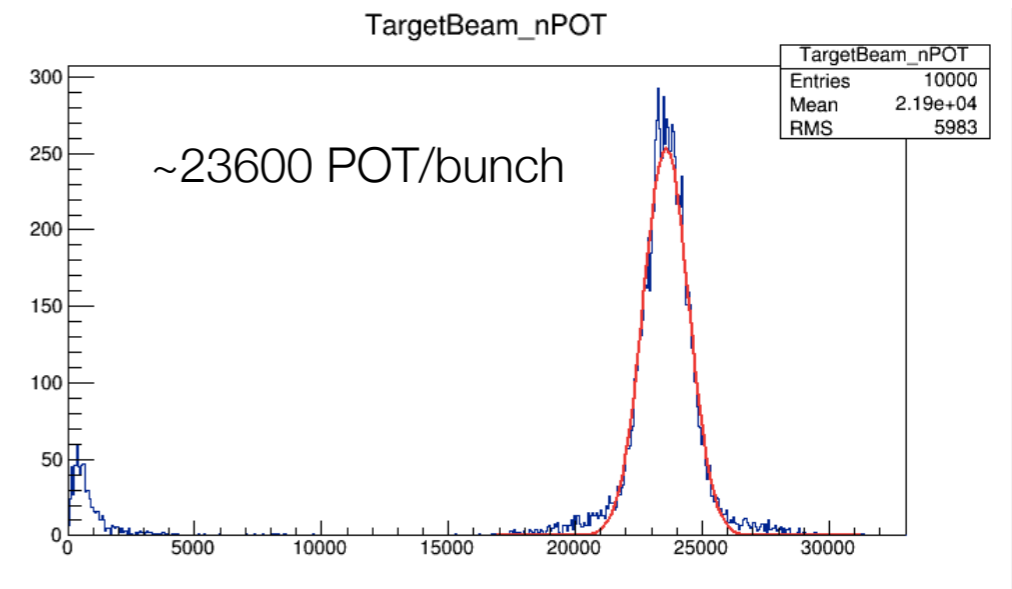
Data Calibration 0

Data Calibration 4, CR calibration set

MC 20000 POT , Beam Line NoBeW

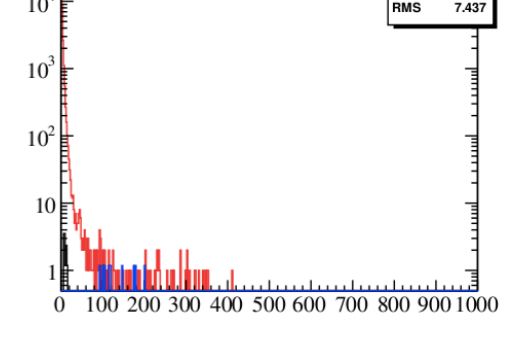
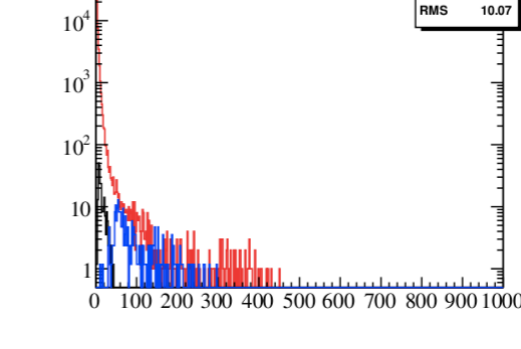
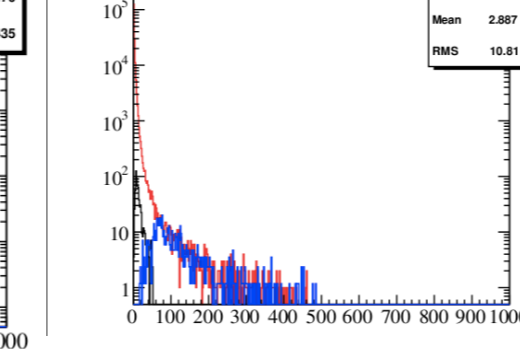
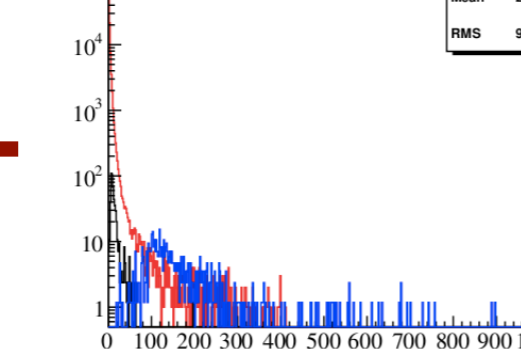
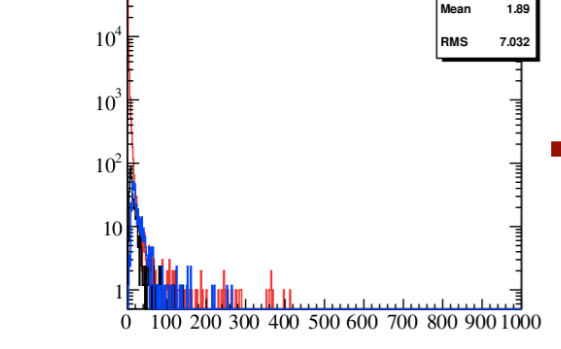
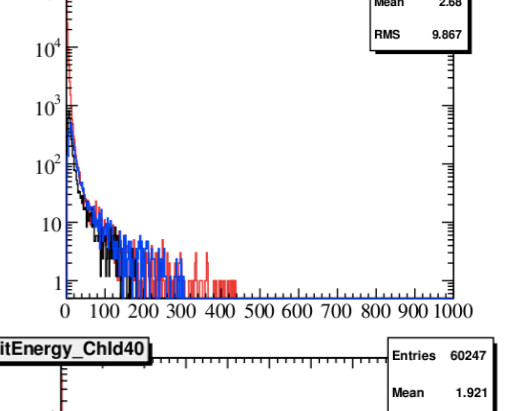
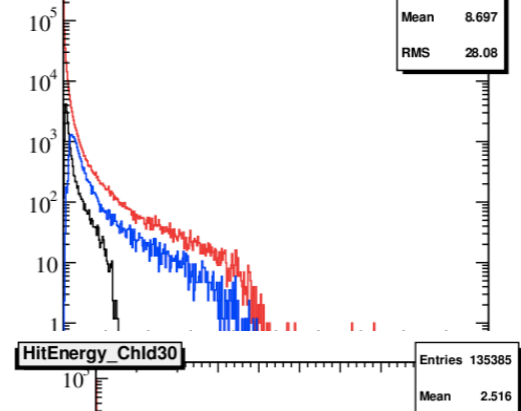
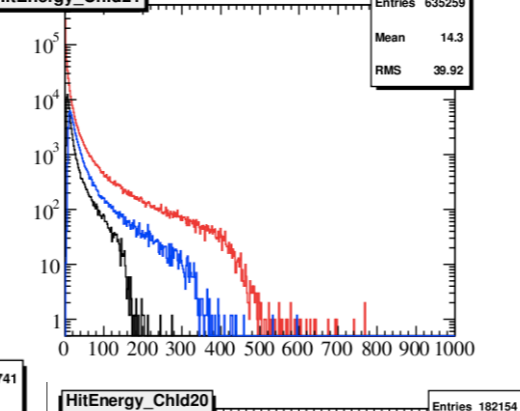
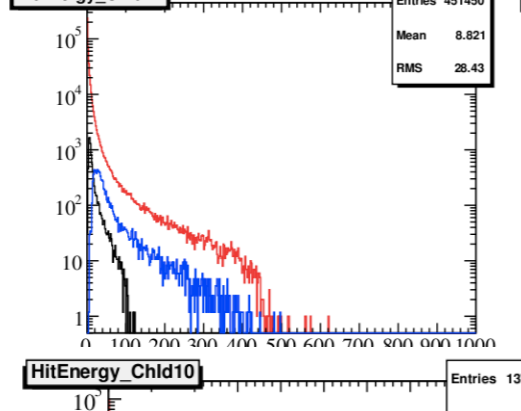
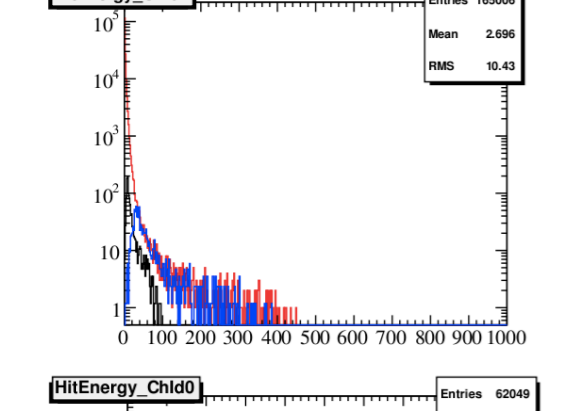
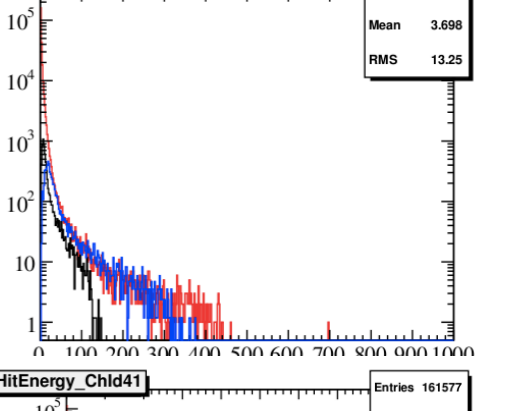
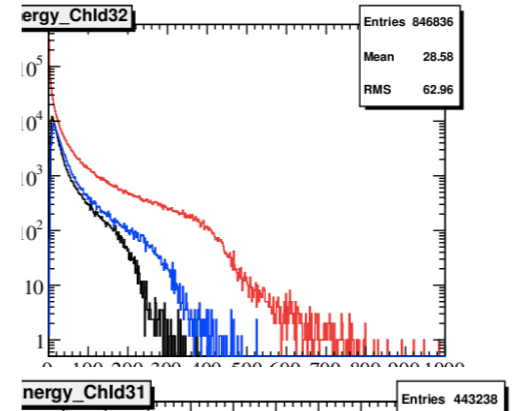
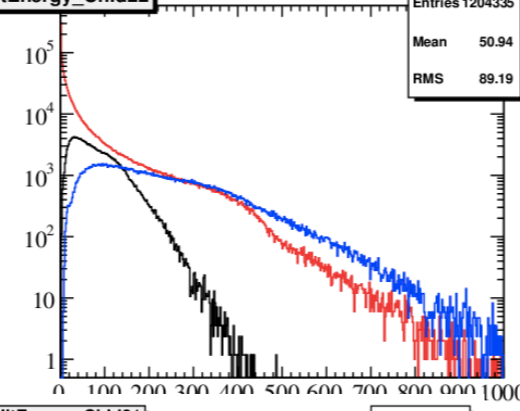
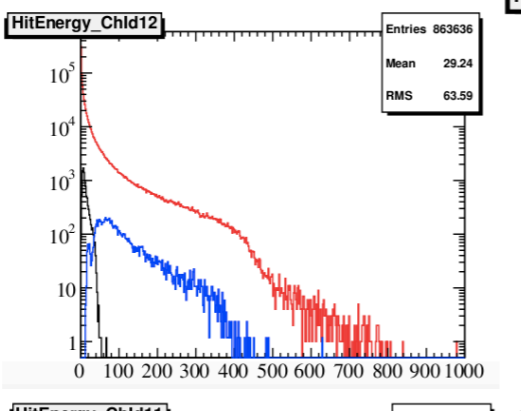
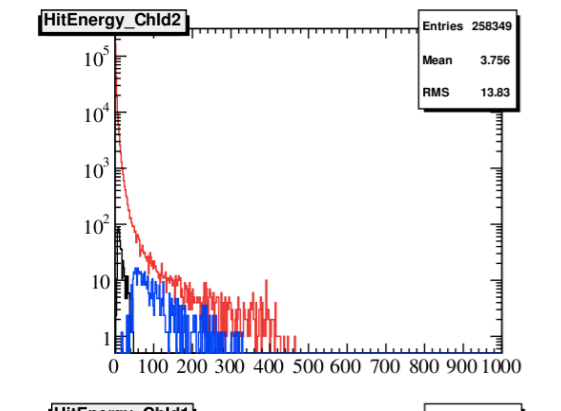
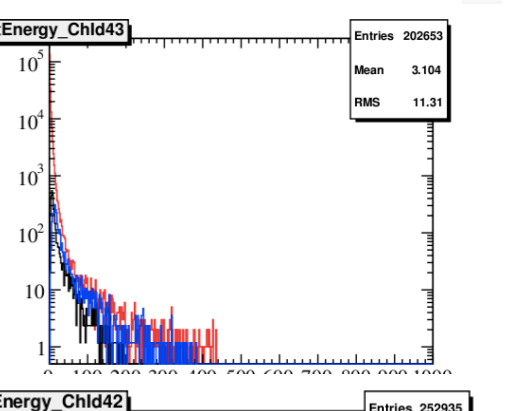
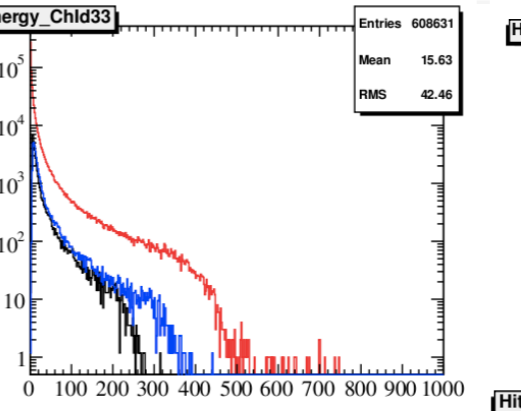
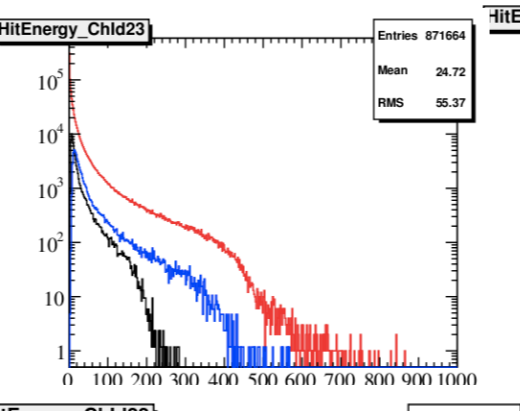
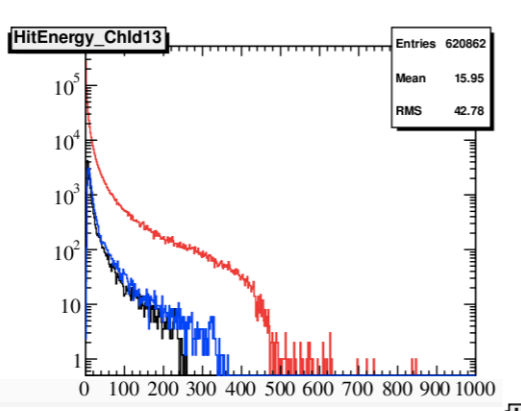
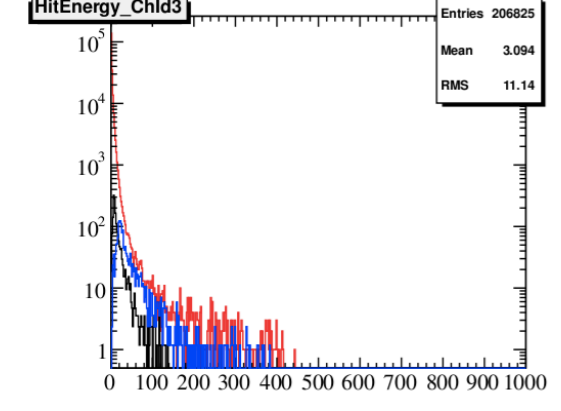
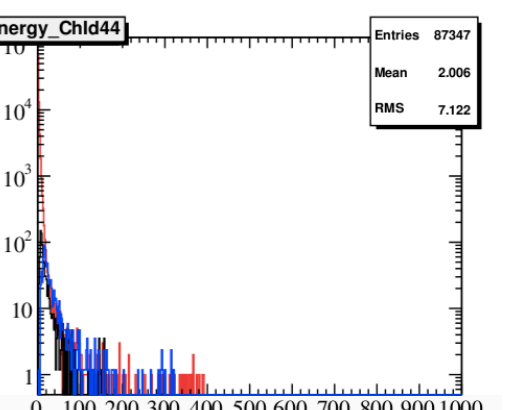
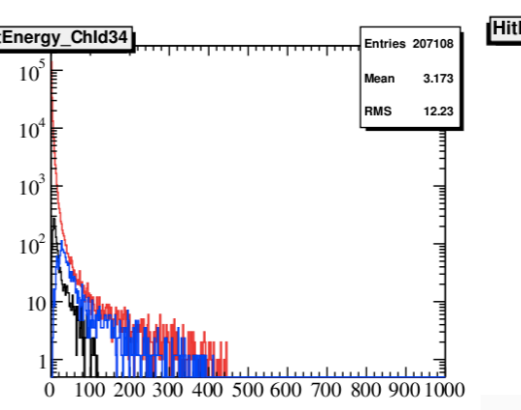
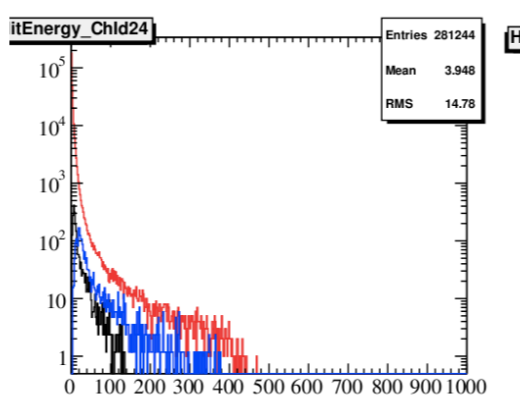
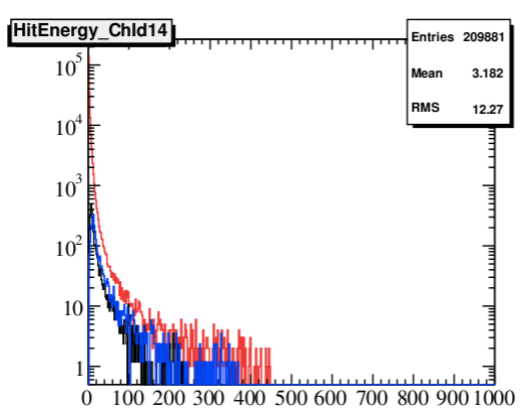
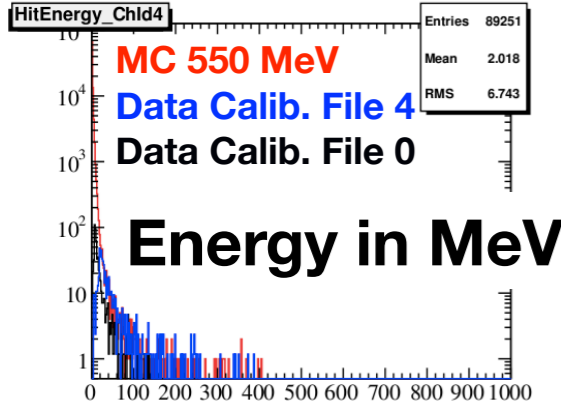
MC_smbkg_BeamlineNoBeW_spot1mm2_20000POTOnBunch_MomentumSpred1_5MeV

20k POT/bunch, Ebeam=550 MeV, 1mm x 1mm spot, 1.5% E spread, source before the position of the berillium window, DHSTB02 simulated, NO Be window



For more details..

[SAC Calibration 4thOctober2019/DATAqualitySAC MCDATA ChIdPlots calib4 MC550MeV.pdf](#)



Another approach to calibrate SAC

extrapolating the calibration constants looking at the cut off energy of the shape of the hit energy not calibrated and the ideal shape of MC

Same DATA run and MC used before

Reco-run_0000000_20190724_152634

SETUP: full201907_nozsup

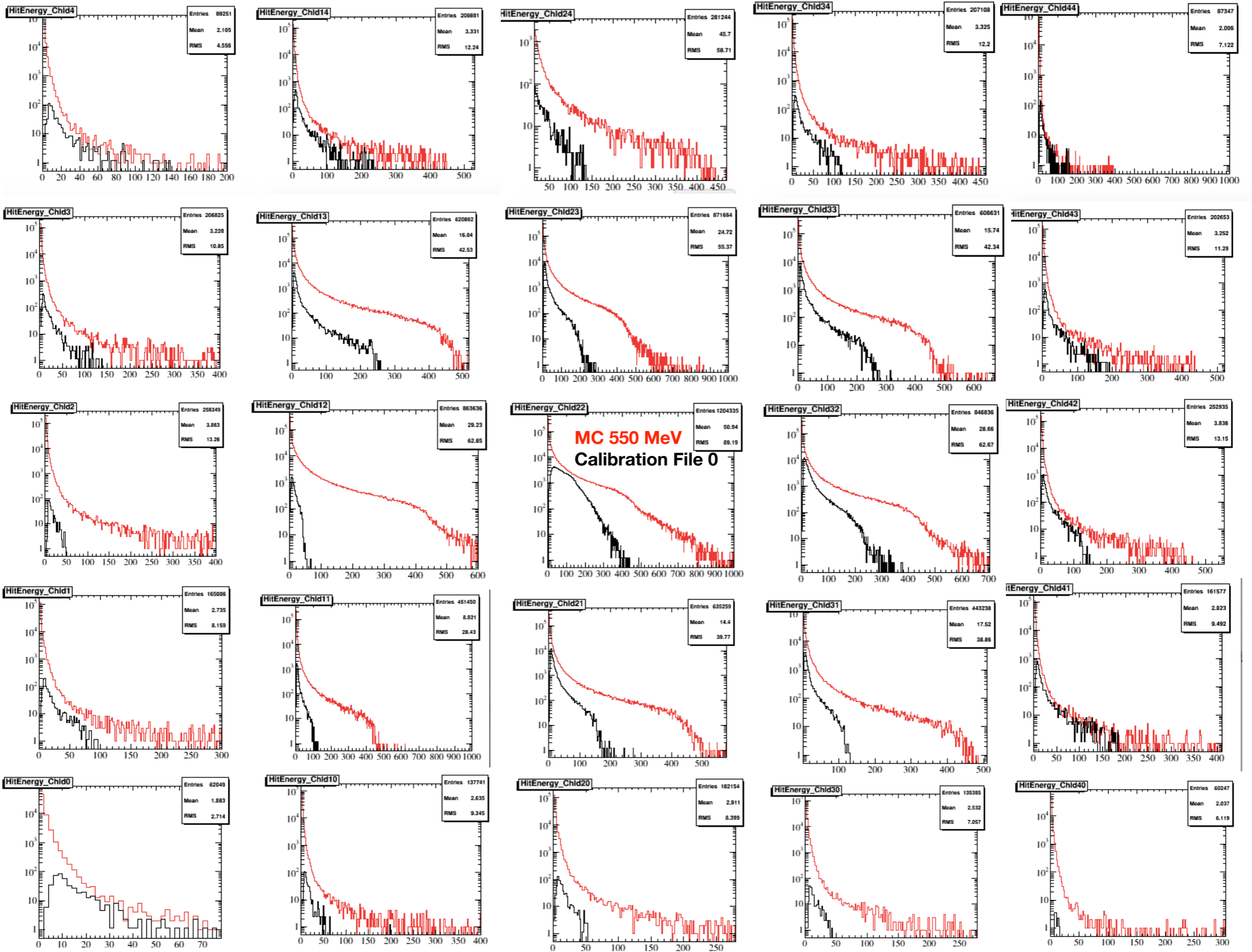
10000 events

Data Calibration 0

MC 20000 POT , Beam Line NoBeW

MC_smbkg_BeamlineNoBeW_spot1mm2_20000POTOnBunch_MomentumSpred1_5MeV

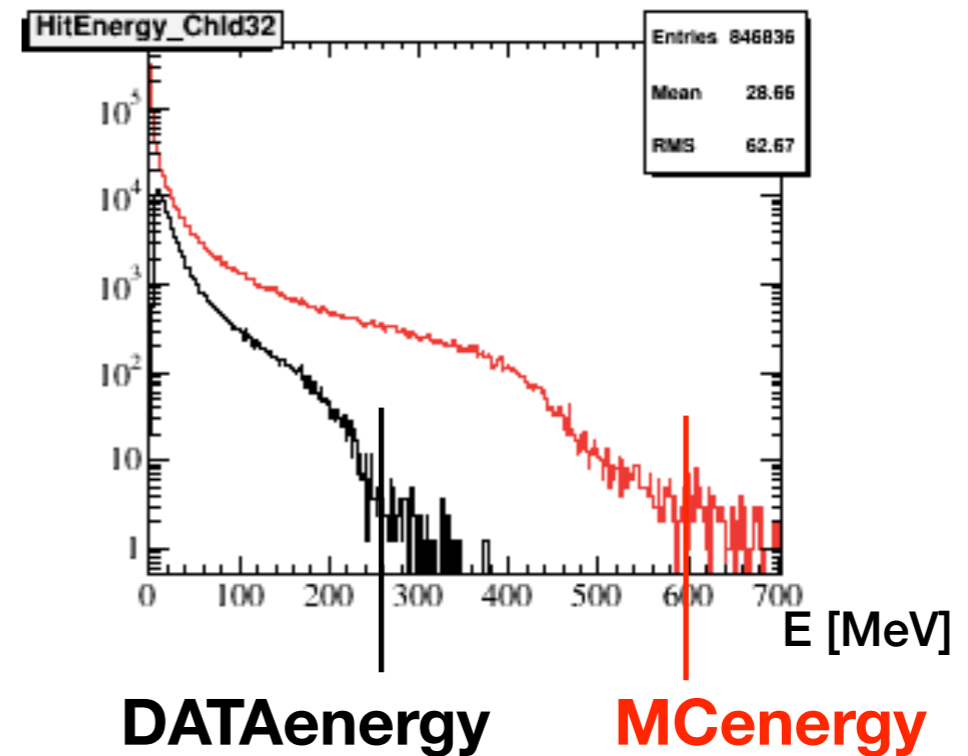
Let's look at the hit energy spectra for each Channel Id..



SAC_EnergyCalibration_6.txt

0	1.40
10	3.00
20	4.40
30	3.75
40	5.33
1	2.86
11	7.50
21	2.63
31	3.67
41	1.47
2	6.4
12	11.60
22	2.11
32	2.14
42	2.92
3	2.50
13	1.83
23	2.75
33	1.69
43	2.14
4	1.67
14	2.08
24	4.00
34	4.25
44	1.50

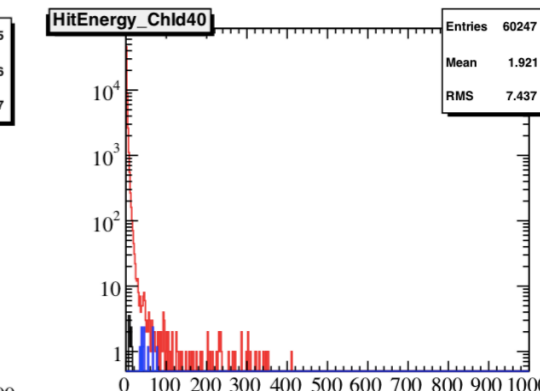
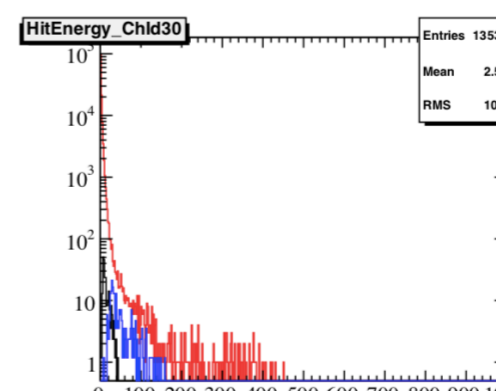
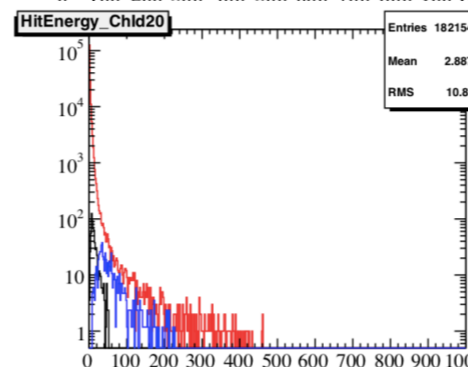
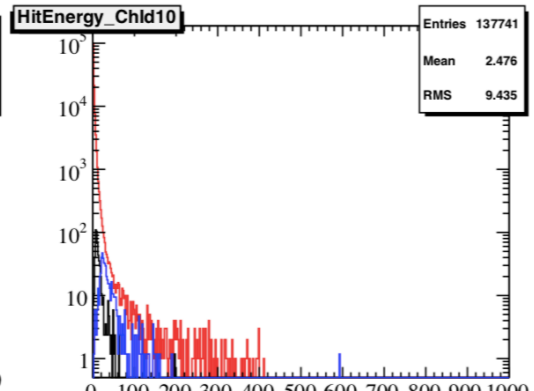
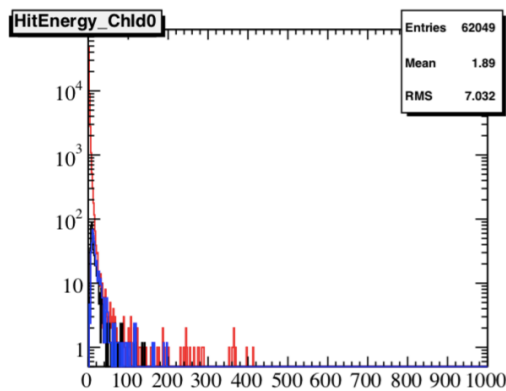
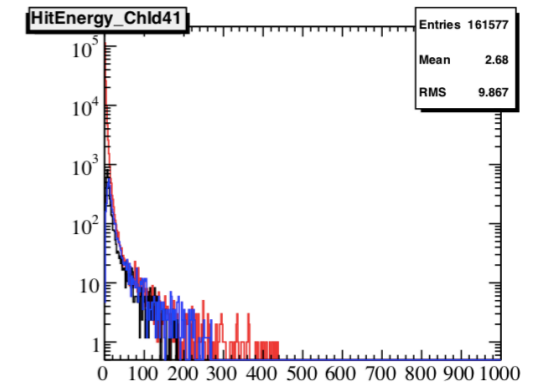
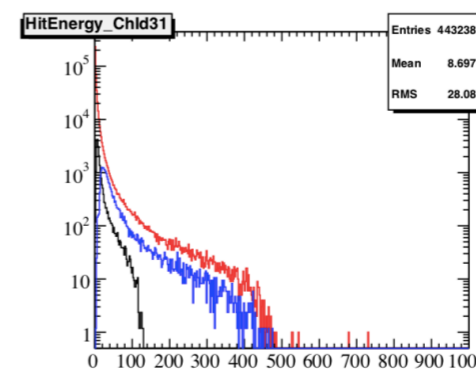
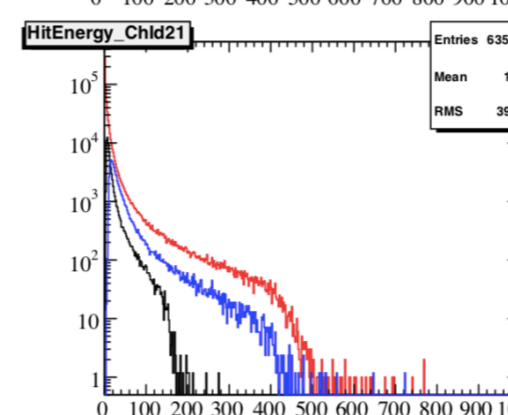
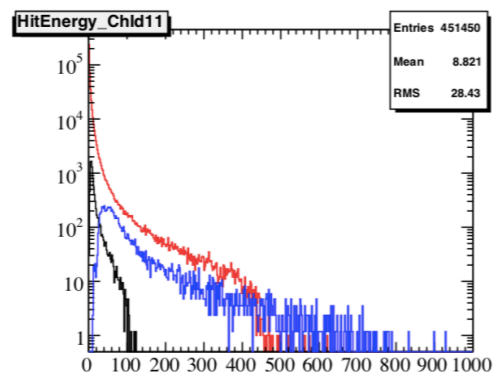
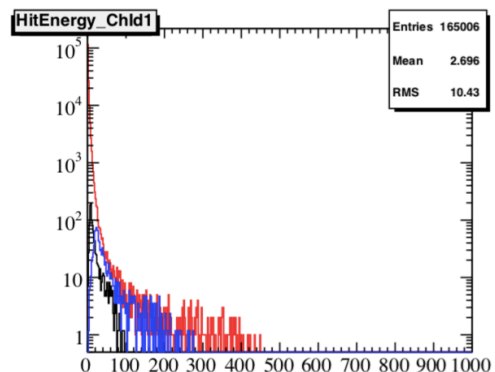
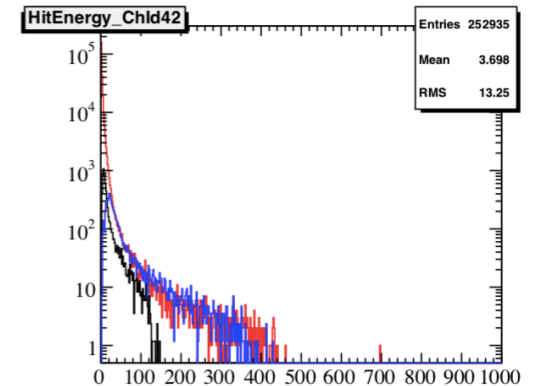
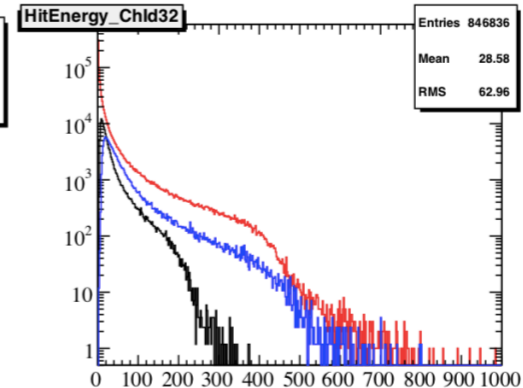
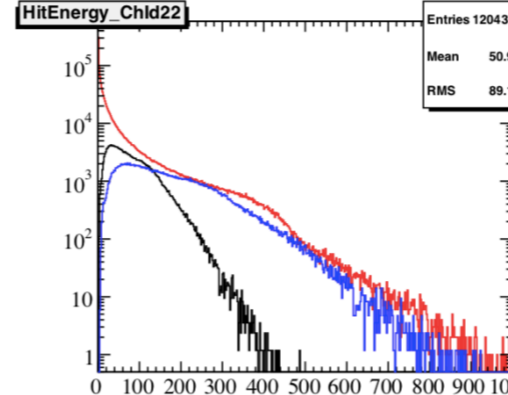
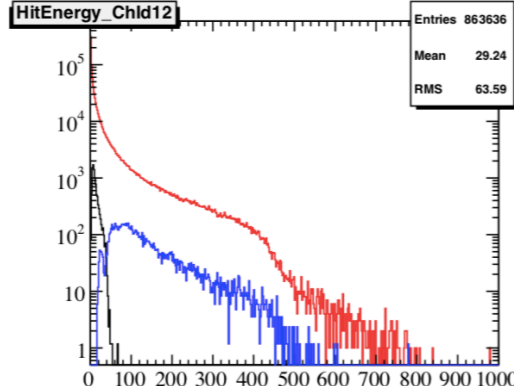
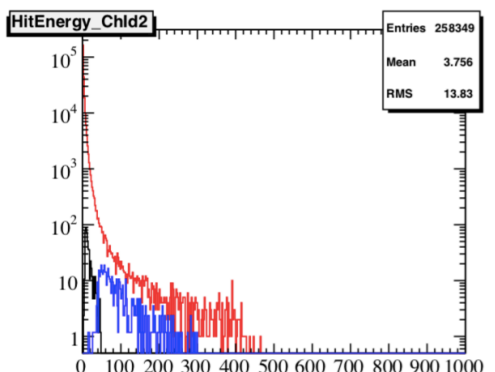
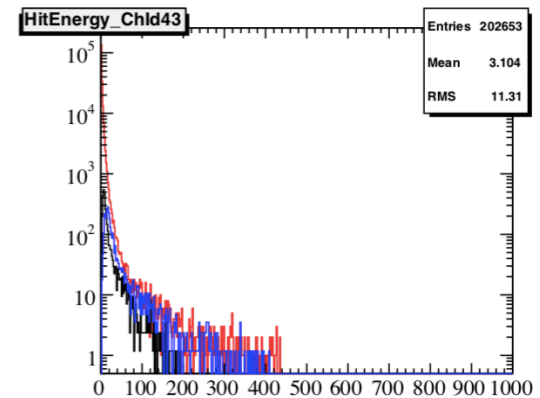
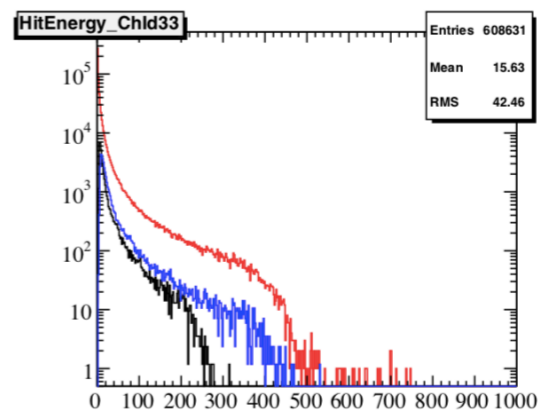
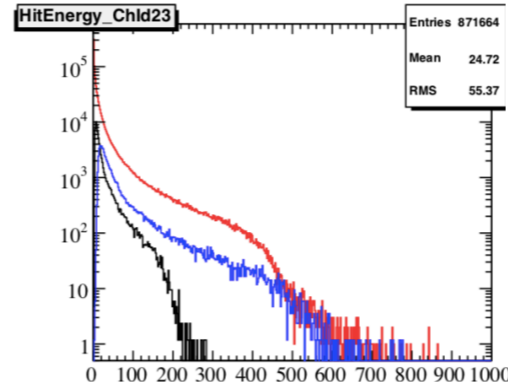
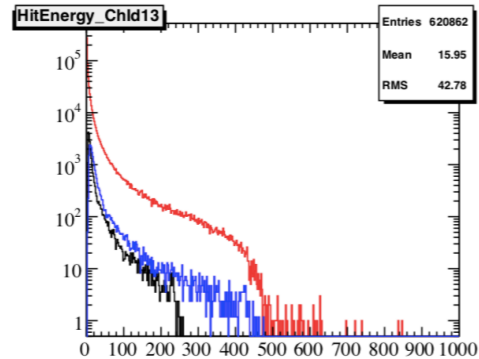
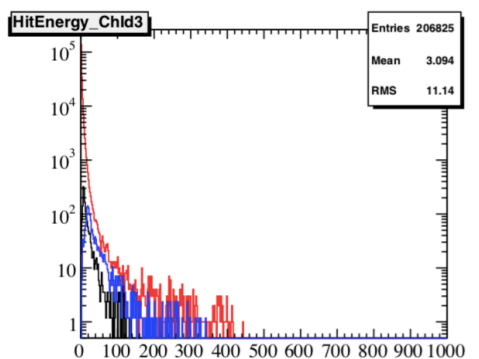
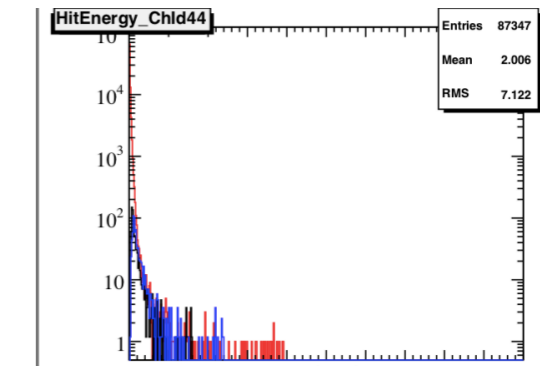
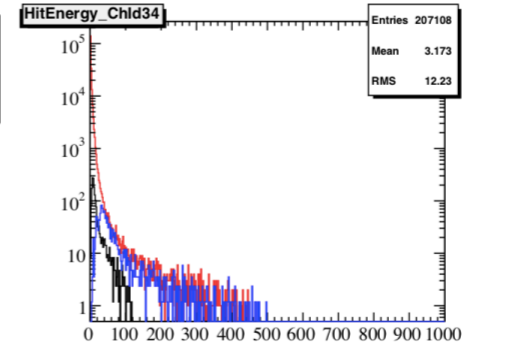
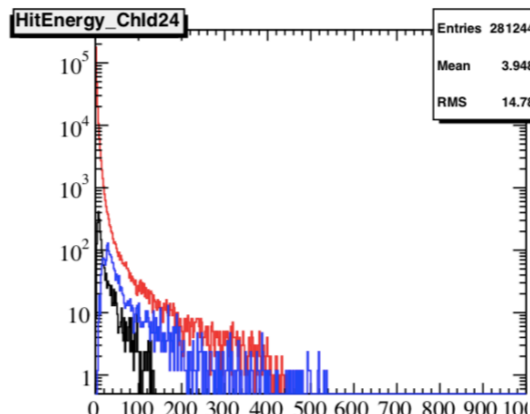
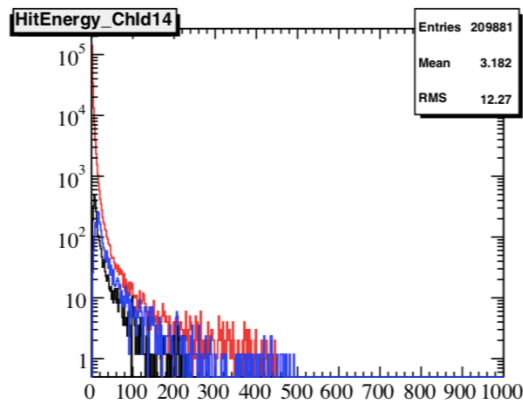
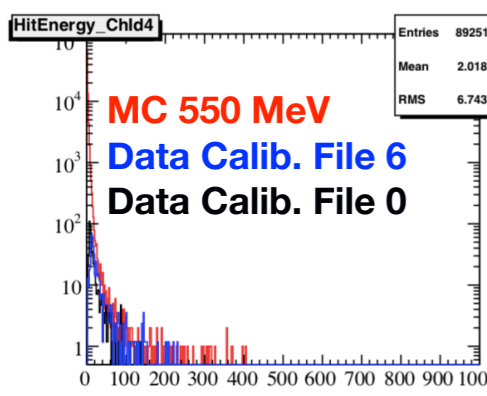
Calculated from the ratio between
the cut off energy value of MC and DATA



$$\text{Calibration Constant} = \text{MCenergy} / \text{DATA energy}$$

For more details..

[SAC Calibration 4thOctober2019/DATAqualitySAC MCDATA ChIdPlots calib6 MC550MeV.pdf](#)



MC beam energy 550 MeV
DATA beam energy 490 MeV



Both the sets of calibration constants
need to be rescaled

$$CC_{490\text{MeV}} = (490/550) CC_{550\text{MeV}} \sim 0.89 CC_{550\text{MeV}}$$

calibration with MC
SAC_EnergyCalibration_6.txt

beam@550 MeV

0	1.40
10	3.00
20	4.40
30	3.75
40	5.33
1	2.86
11	7.50
21	2.63
31	3.67
41	1.47
2	6.4
12	11.60
22	2.11
32	2.14
42	2.92
3	2.50
13	1.83
23	2.75
33	1.69
43	2.14
4	1.67
14	2.08
24	4.00
34	4.25
44	1.50



beam@490 MeV

0	1.25
10	2.67
20	3.92
30	3.34
40	4.75
1	2.54
11	6.68
21	2.34
31	3.26
41	1.31
2	5.70
12	10.32
22	1.87
32	1.91
42	2.60
3	2.23
13	1.63
23	2.45
33	1.51
43	1.91
4	1.48
14	1.85
24	3.56
34	3.78
44	1.34

CR calibration

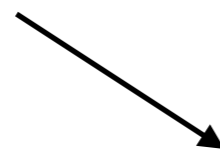
Calibration with MC

Rescaled for beam@490 MeV

SAC_EnergyCalibration_4.txt

SAC_EnergyCalibration_6.txt

0	1.875
10	14.060
20	9.373
30	7.030
40	14.060
1	4.017
11	4.017
21	2.163
31	3.515
41	1.654
2	7.030
12	9.373
22	2.812
32	1.406
42	2.556
3	2.812
13	1.406
23	2.009
33	1.406
43	2.009
4	2.812
14	1.562
24	2.812
34	3.515
44	2.009



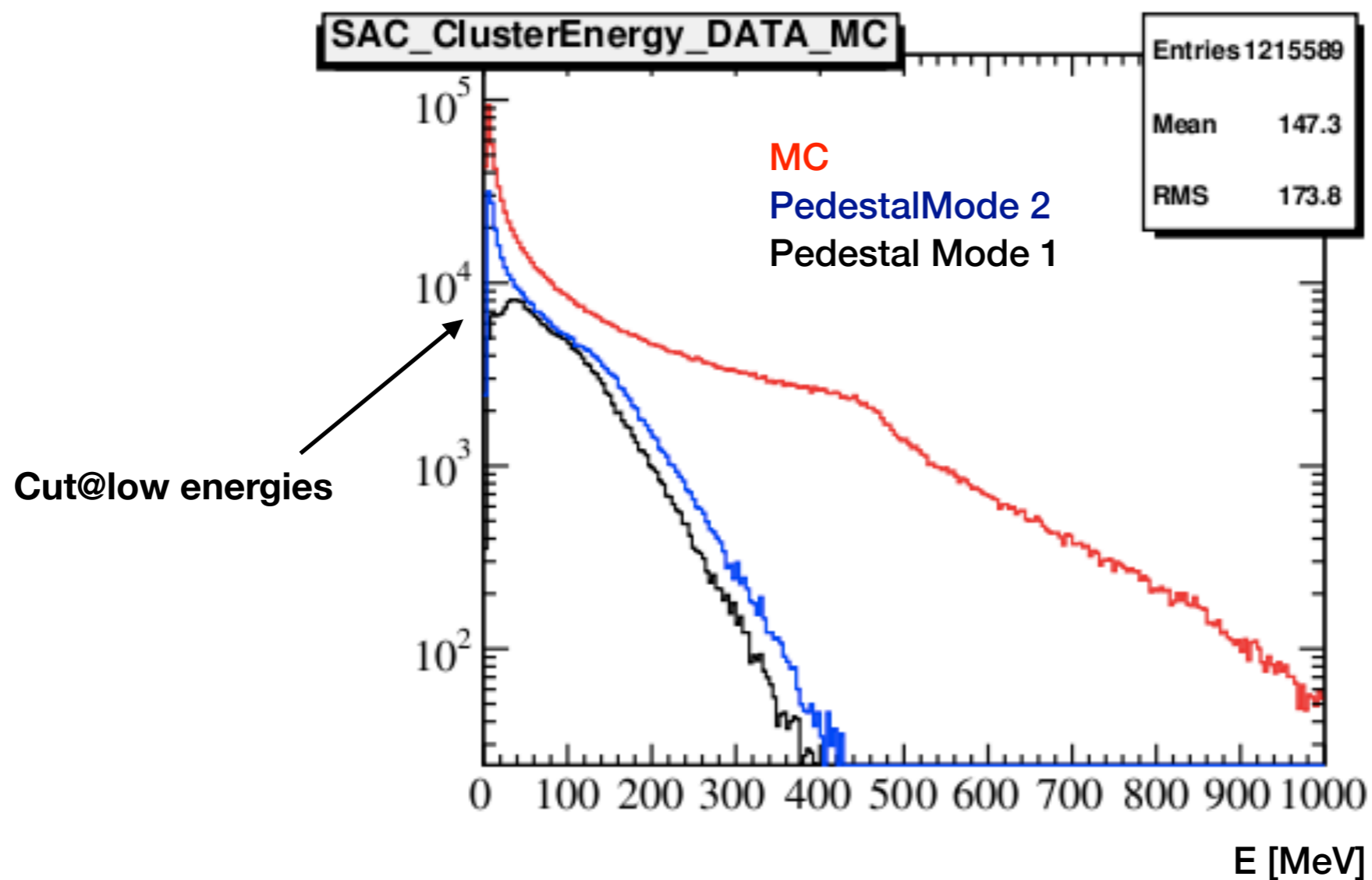
Could we trust the calibration for these Chlds?

0	1.25
10	2.67
20	3.92
30	3.34
40	4.75
1	2.54
11	6.68
21	2.34
31	3.26
41	1.31
2	5.70
12	10.32
22	1.87
32	1.91
42	2.60
3	2.23
13	1.63
23	2.45
33	1.51
43	1.91
4	1.48
14	1.85
24	3.56
34	3.78
44	1.34

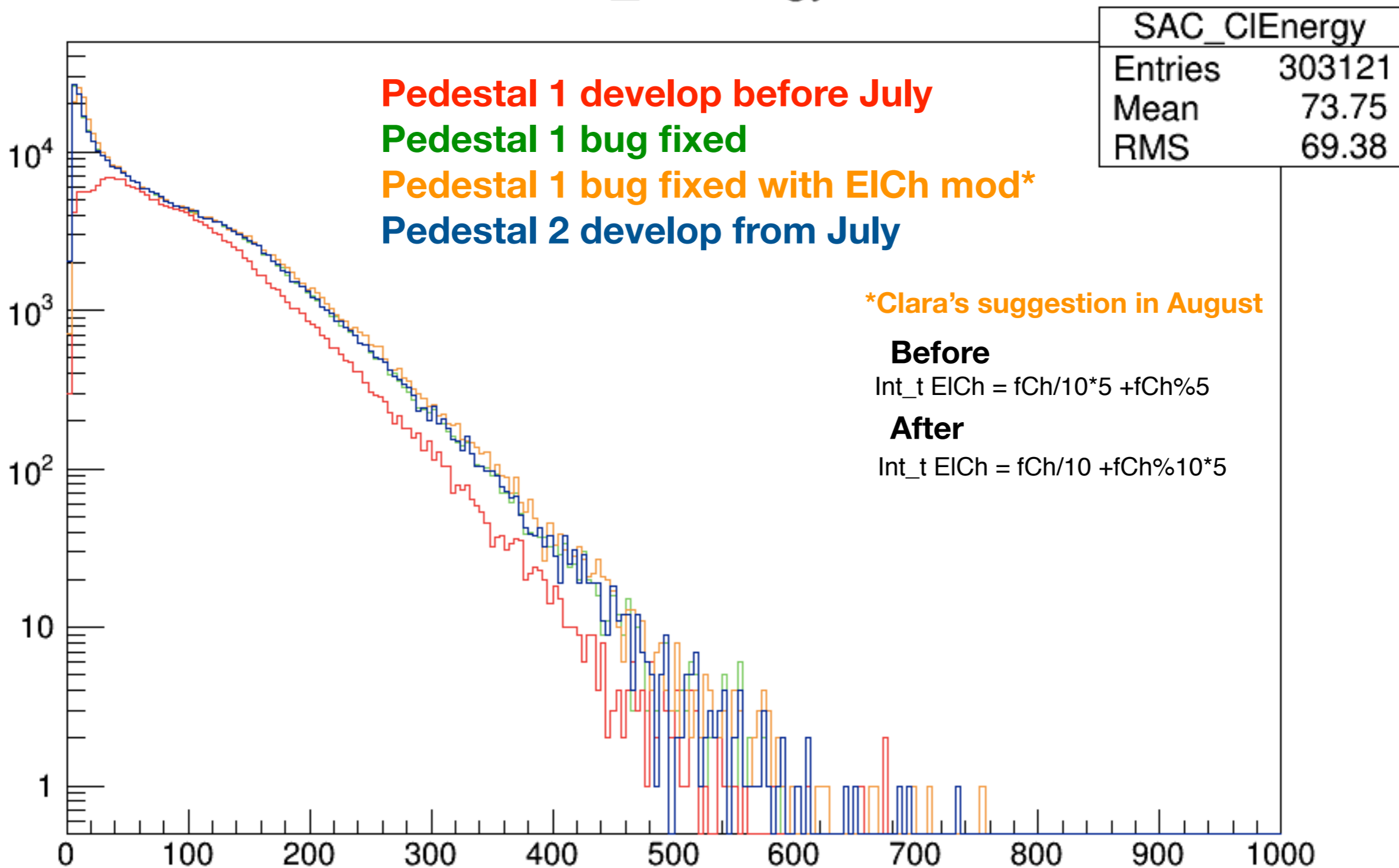
Some Considerations on SAC Pedestals

Using a flag Pedestal Mode, a comparison between the calculation of the pedestal before and after the change of July was made

PedestalMode 2 #1 [originalPedestalbeforeJuly] 2 [mean80samples, pedestalFromJuly2019]



SAC_CIEnergy



First conclusions

About CR calibration

A first set of calibration constants with fixing a very low threshold were presented

Calibration using the comparison DATA MC

A new approach of extracting the calibration constants trusting MC shapes were presented

The energy calibrations constants extracted until now have no ambition to be exact.
The work is still on going, to give another point of view about the SAC energy calibration.