# Saturation correction using electron data

## Using DWC and AHCAL

**Olin Pinto**
**DESY, 18th December 2018**

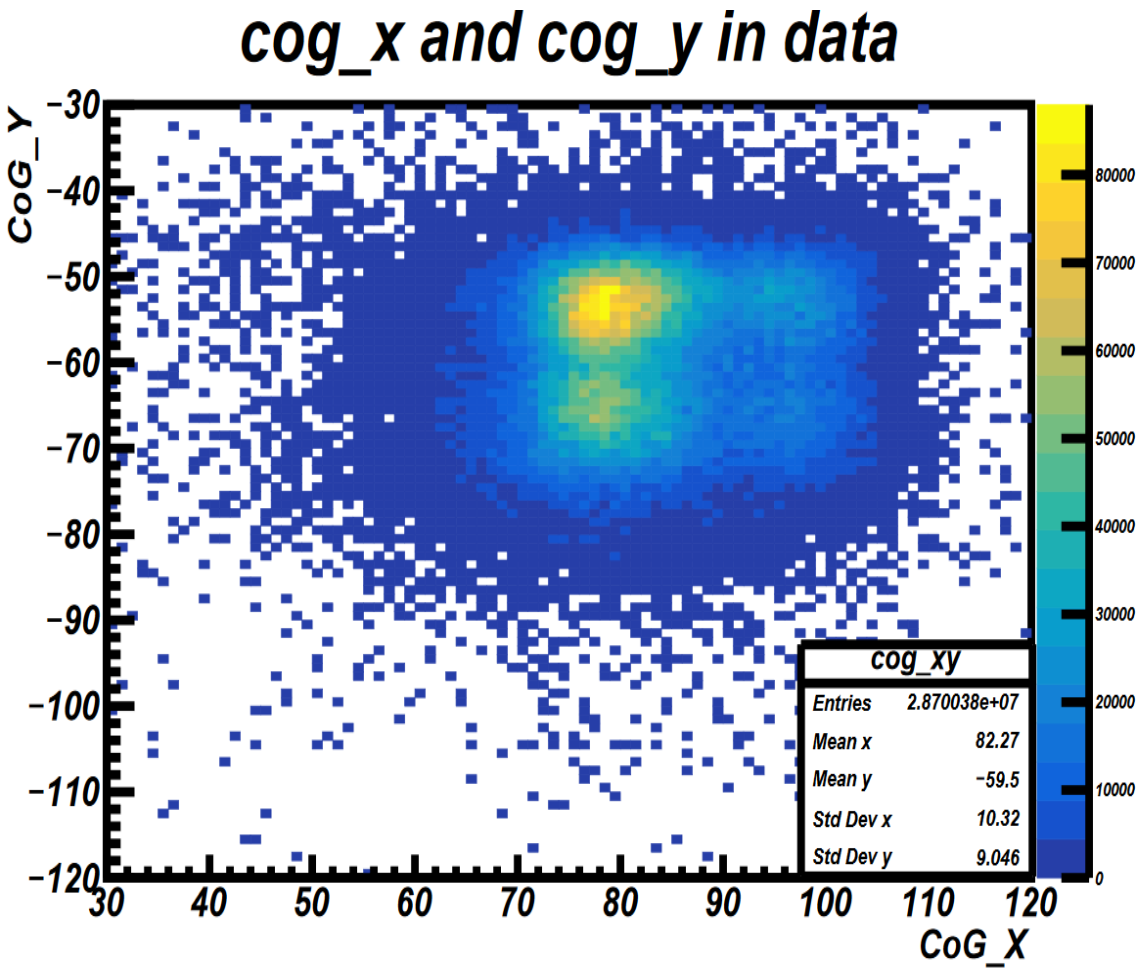
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

DESY.

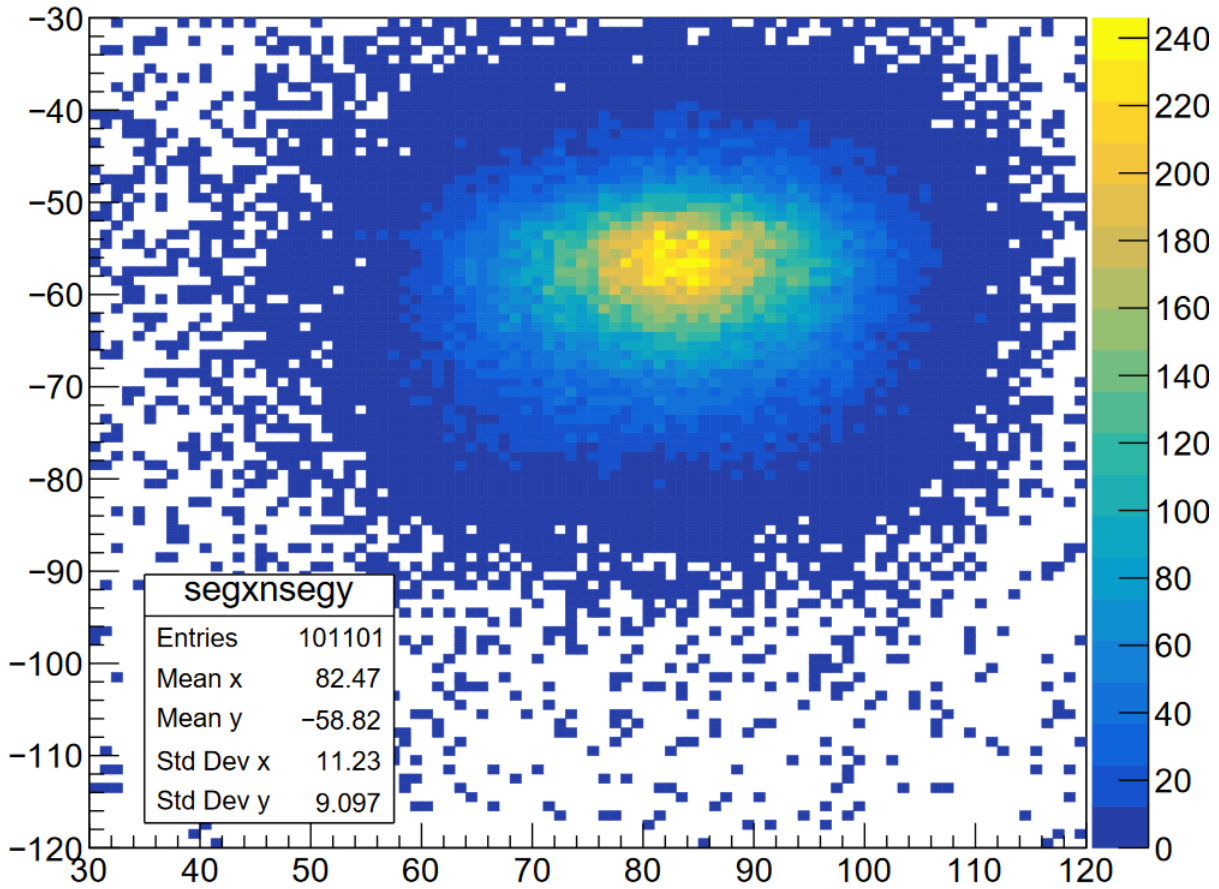
# Selection: Centre of gravity

## Basic cuts: Data and Simulation for 80GeV electron




From Wire Chamber

segxnsegy



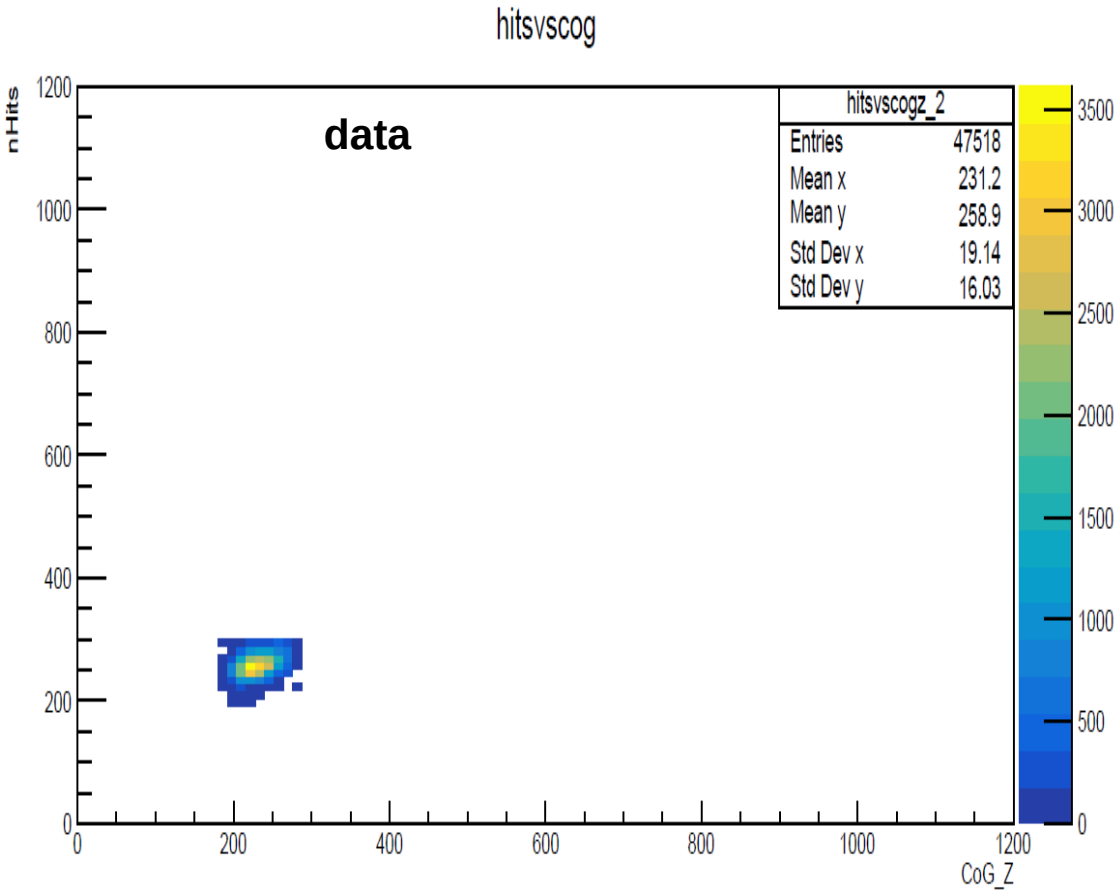

**Centre of gravity X: Between 70 mm to 80 mm**

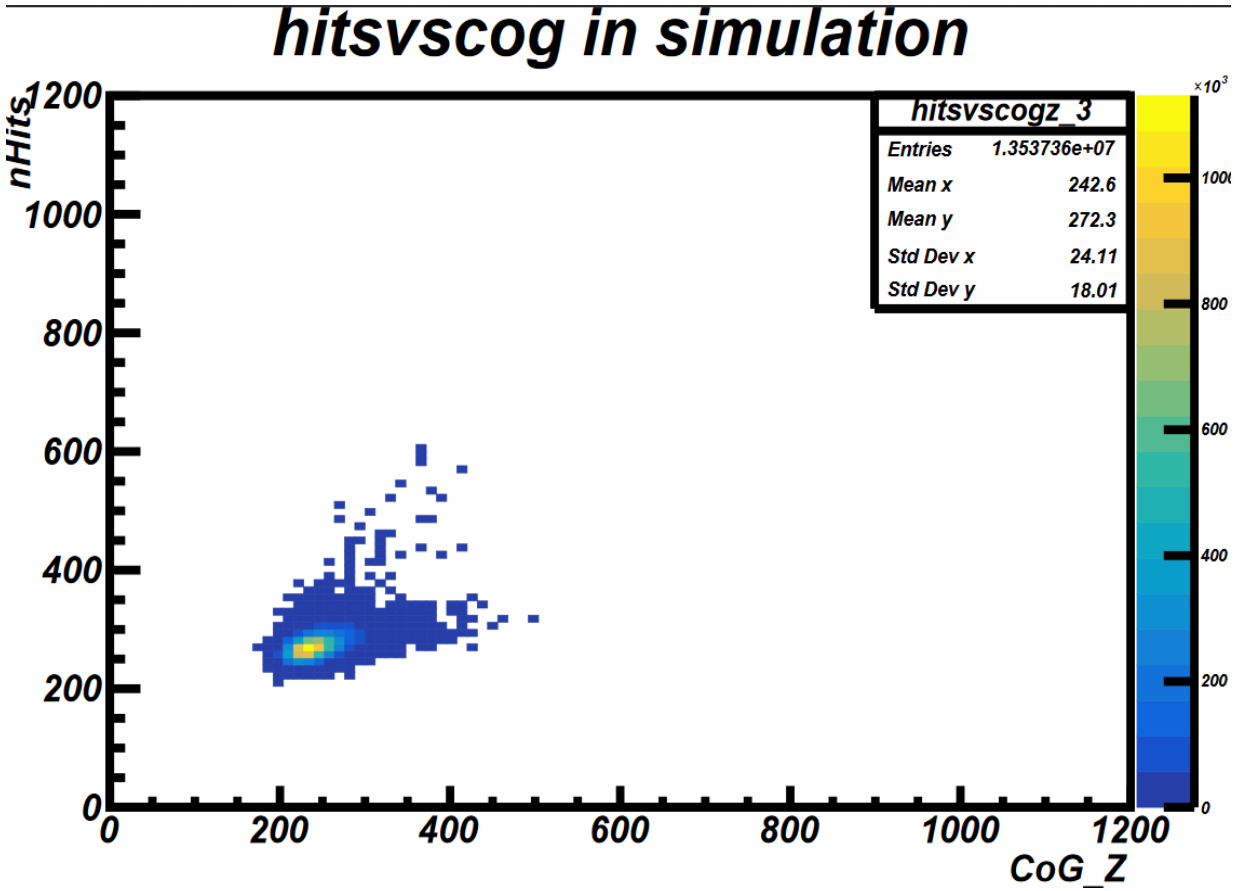
**Centre of gravity Y: Between -50 mm to -40 mm**

# Selection: Nhits and Cog_Z

## Basic cuts: Data and Simulation for 80GeV electron

**Number of hits: Between 200 to 300 hits**
**Center of gravity along Z: 180 mm to 280 mm**



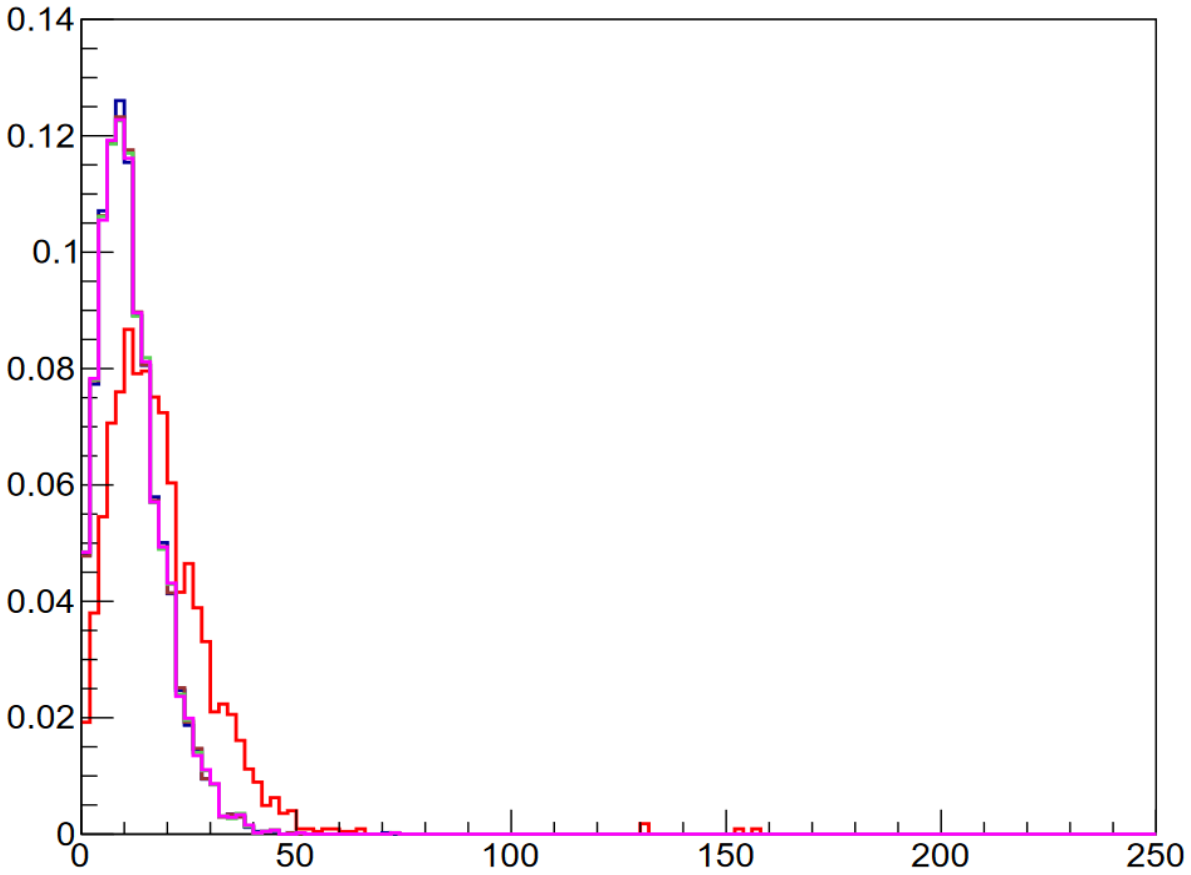



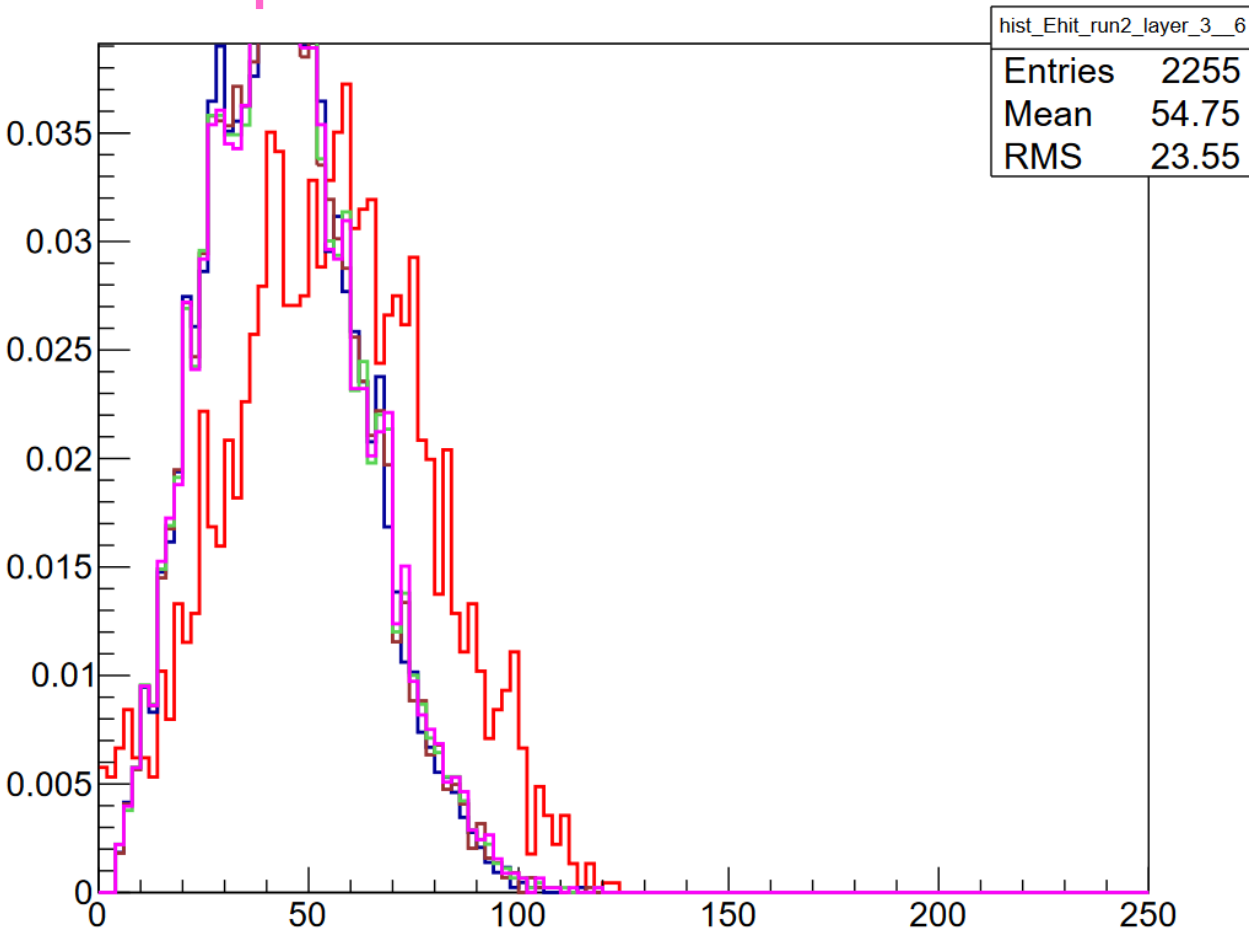
# Layer wise pixels comparison

**80 GeV electron**

## Layer 2 and 3

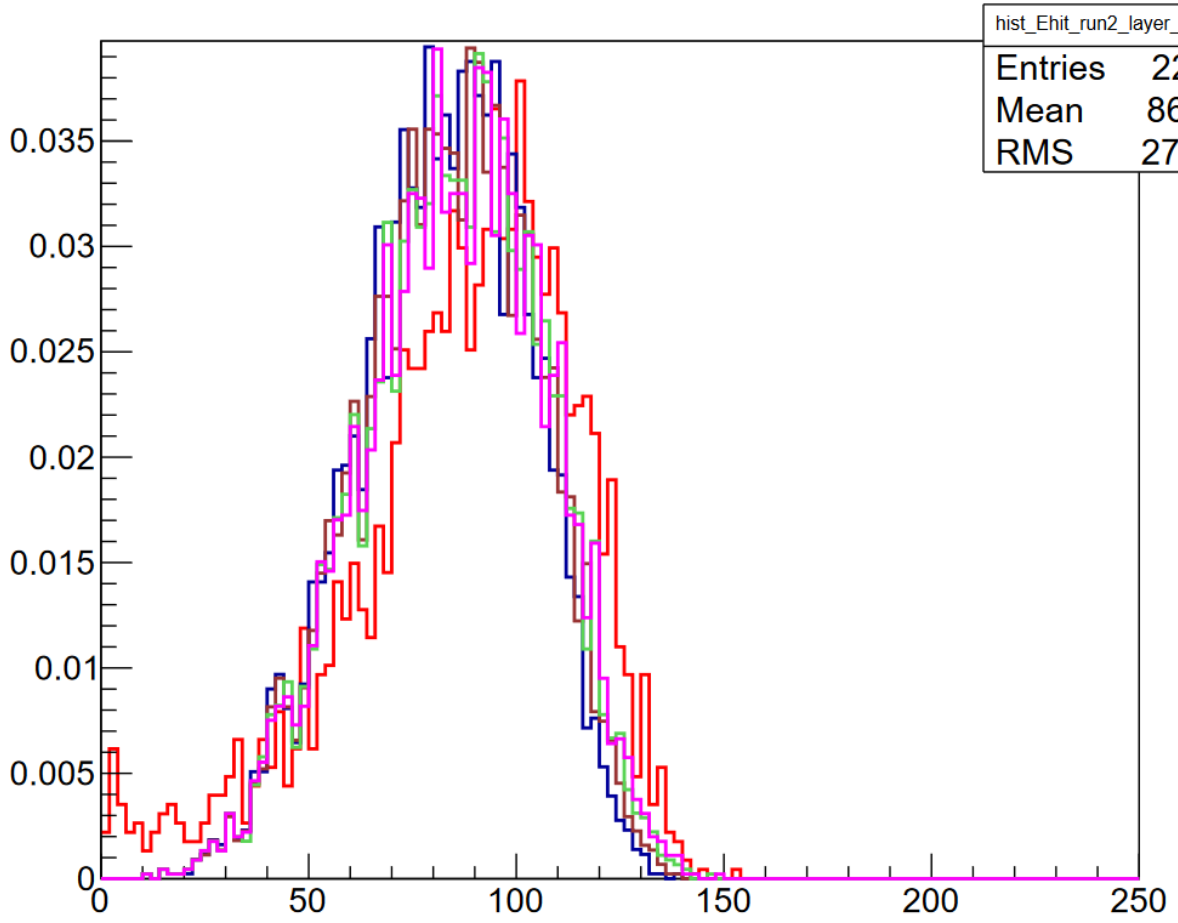
**Red: Data without de-saturation**
**Blue: 2433 pixels without de-saturation**
**Brown: 2533 pixels without de-saturation**
**Green: 2633 pixels without de-saturation**
**Pink: 2668 pixels without de-saturation**

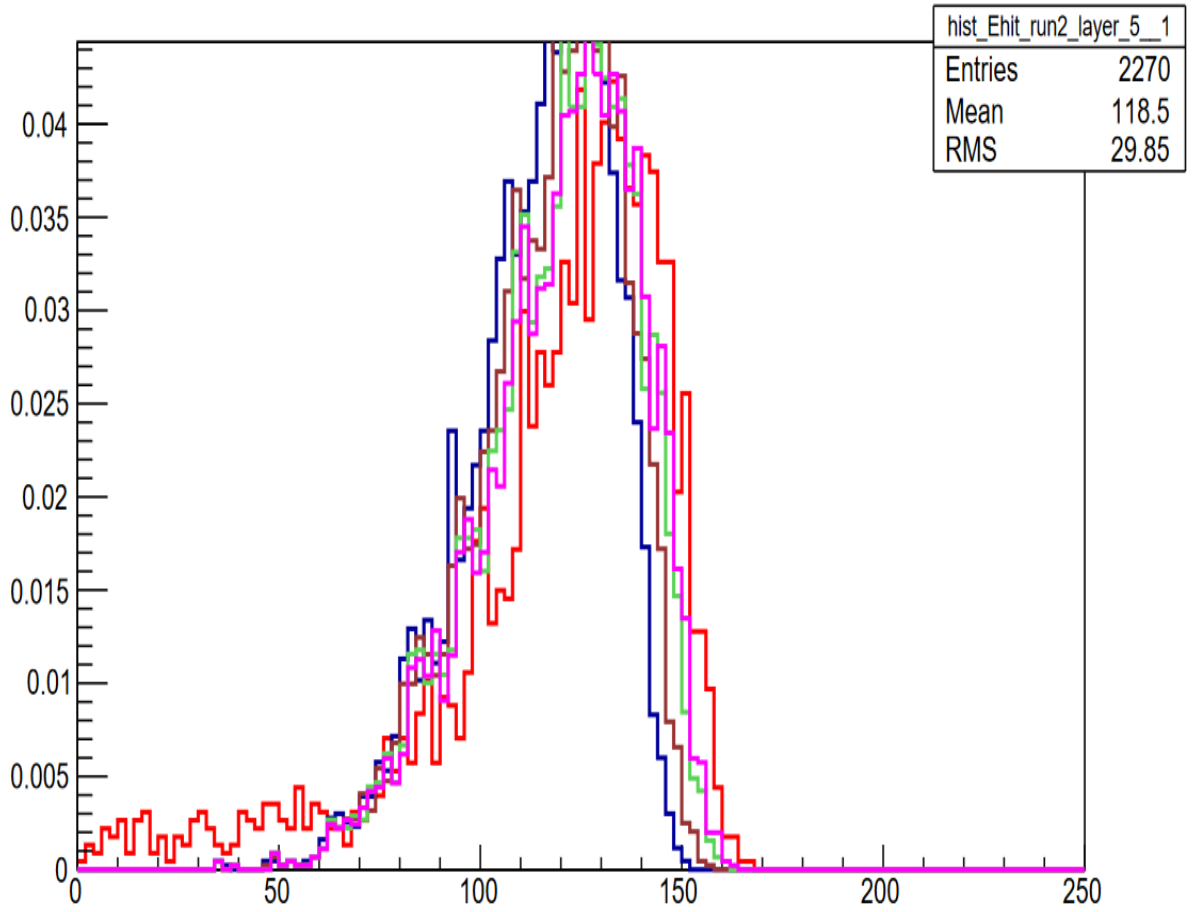


## Layer 4 and 5

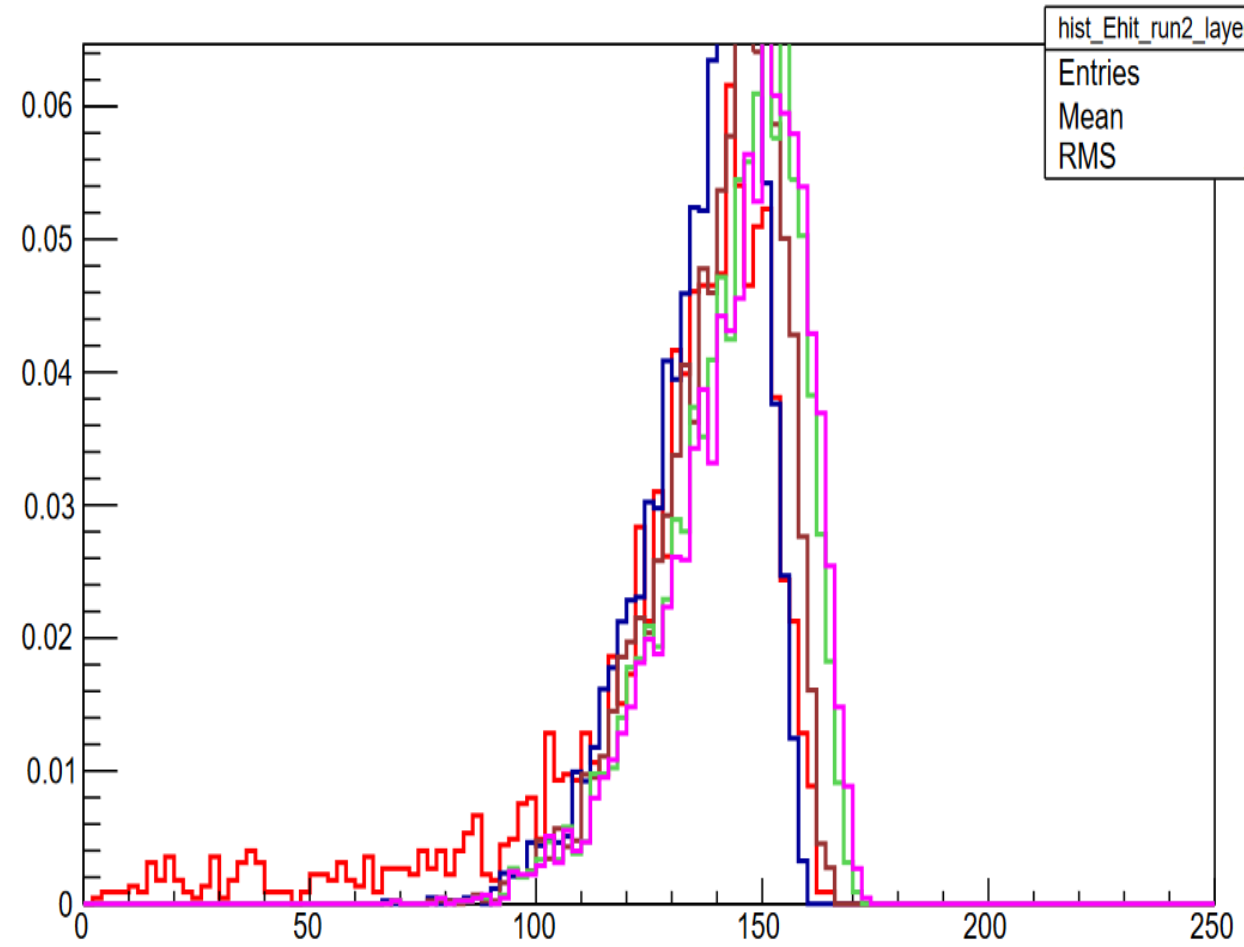
**Red: Data without de-saturation**
**Blue: 2433 pixels without de-saturation**
**Brown: 2533 pixels without de-saturation**
**Green: 2633 pixels without de-saturation**
**Pink: 2668 pixels without de-saturation**

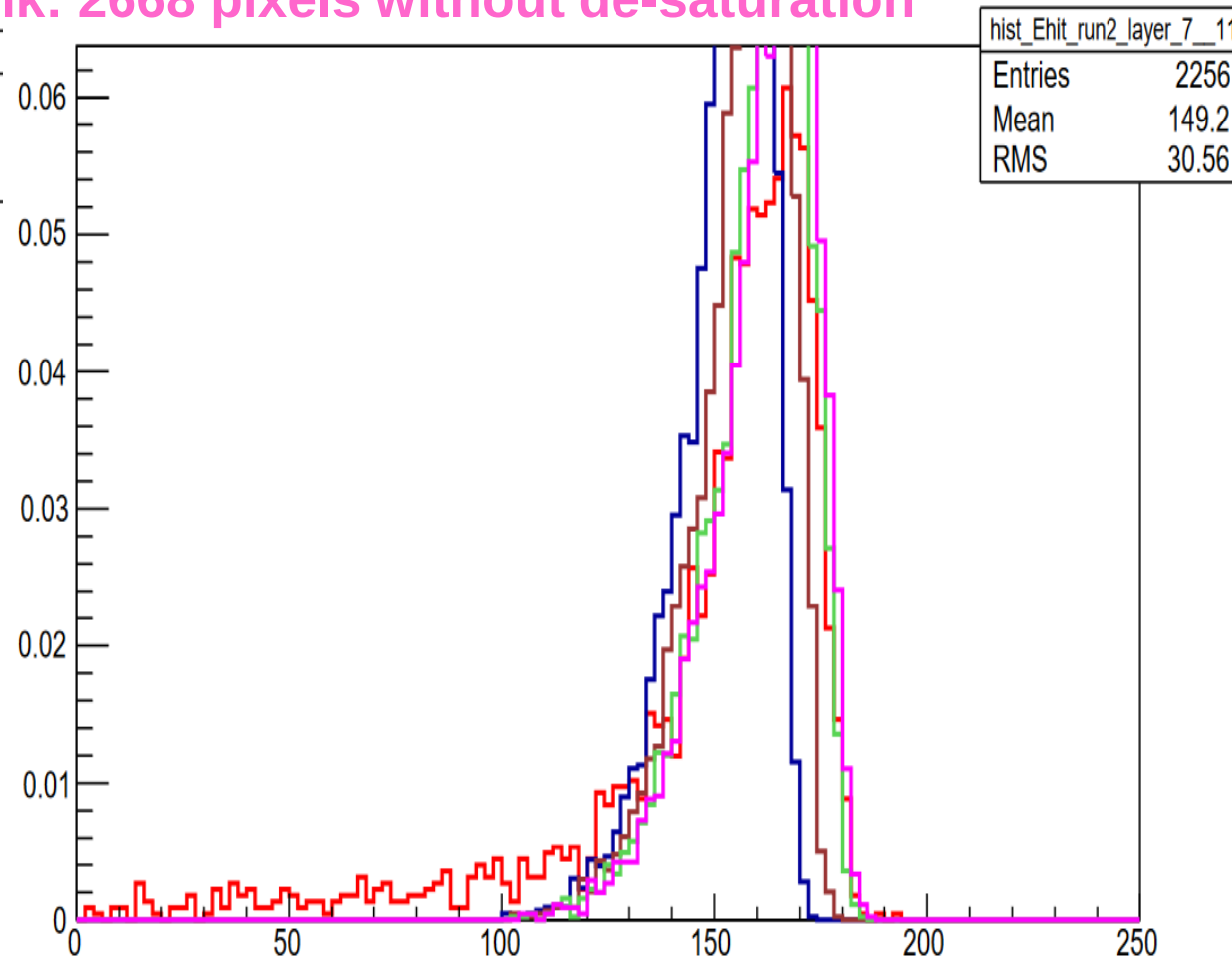


## Layer 6 and 7

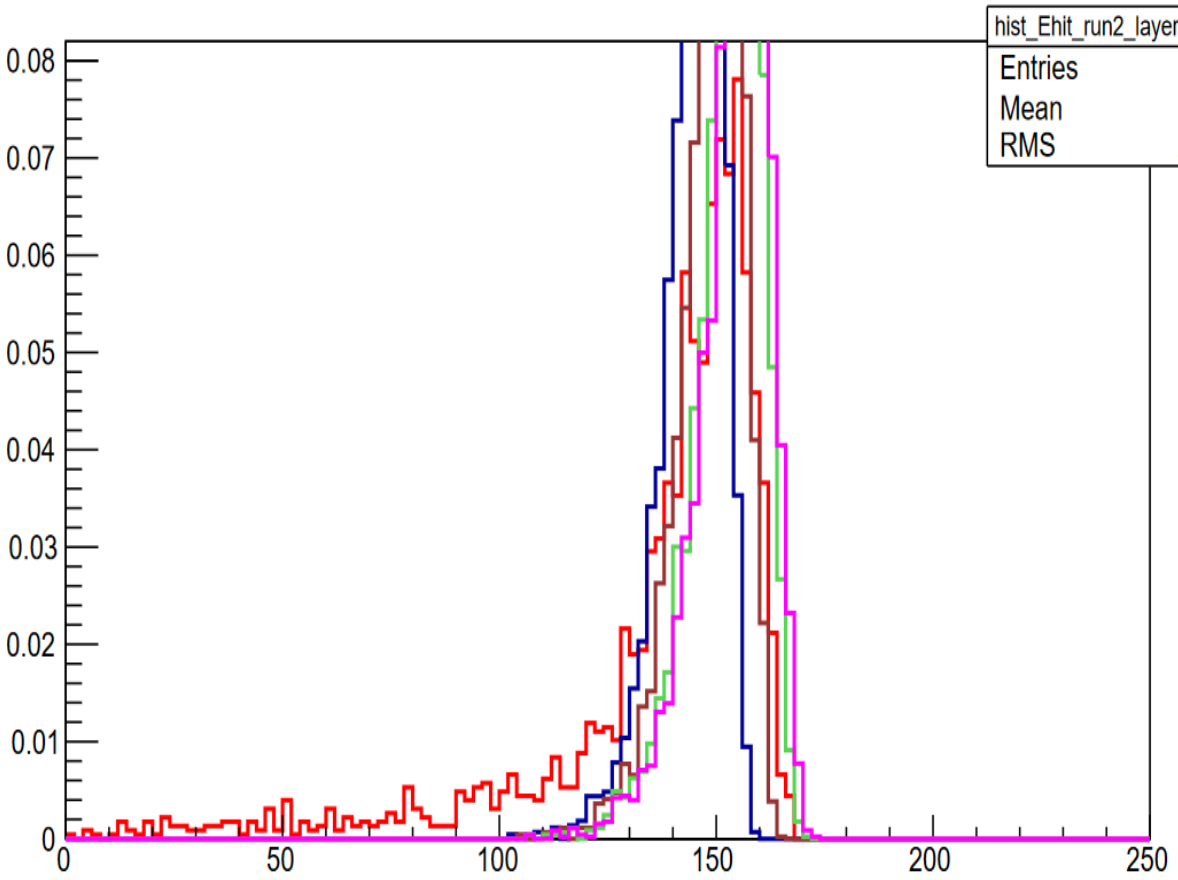
**Red: Data without de-saturation**
**Blue: 2433 pixels without de-saturation**
**Brown: 2533 pixels without de-saturation**
**Green: 2633 pixels without de-saturation**
**Pink: 2668 pixels without de-saturation**

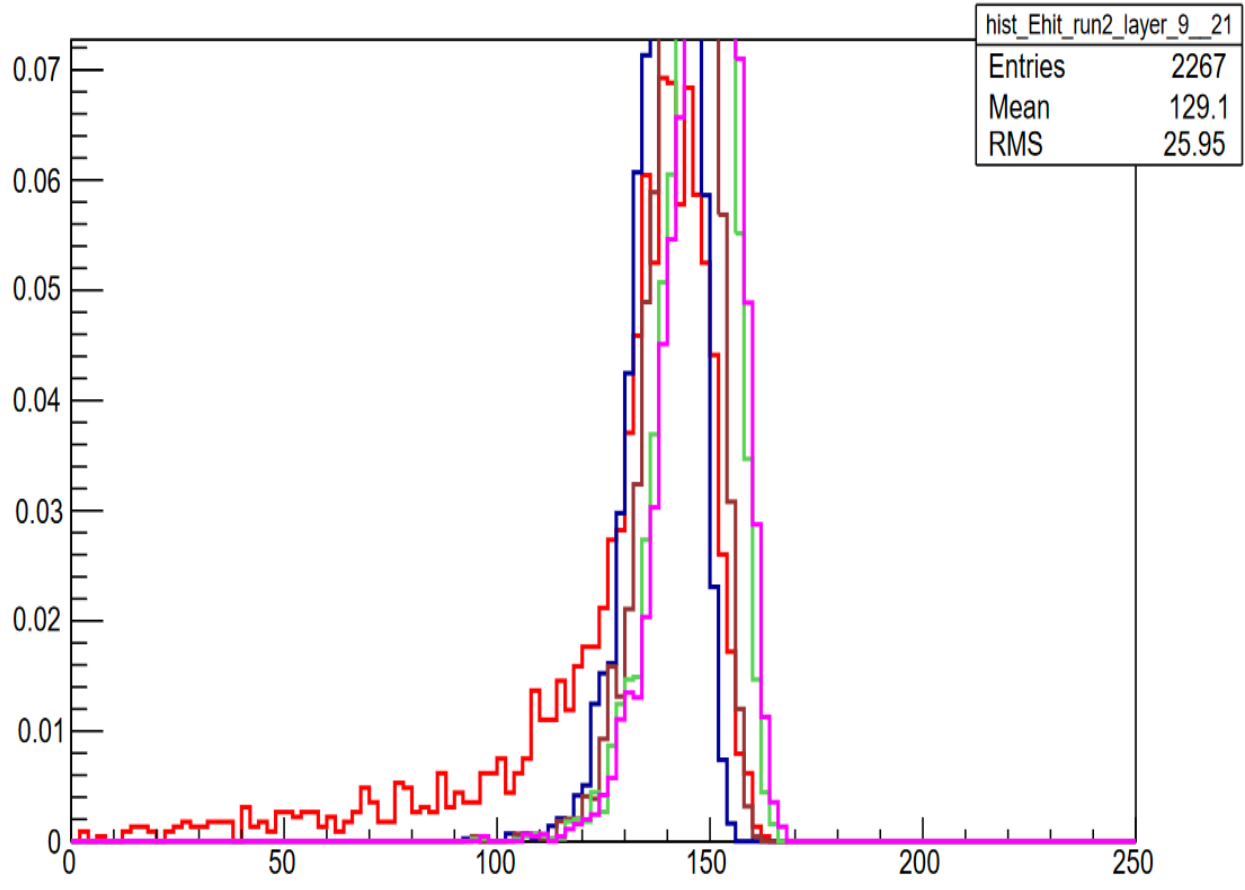


## Layer 8 and 9

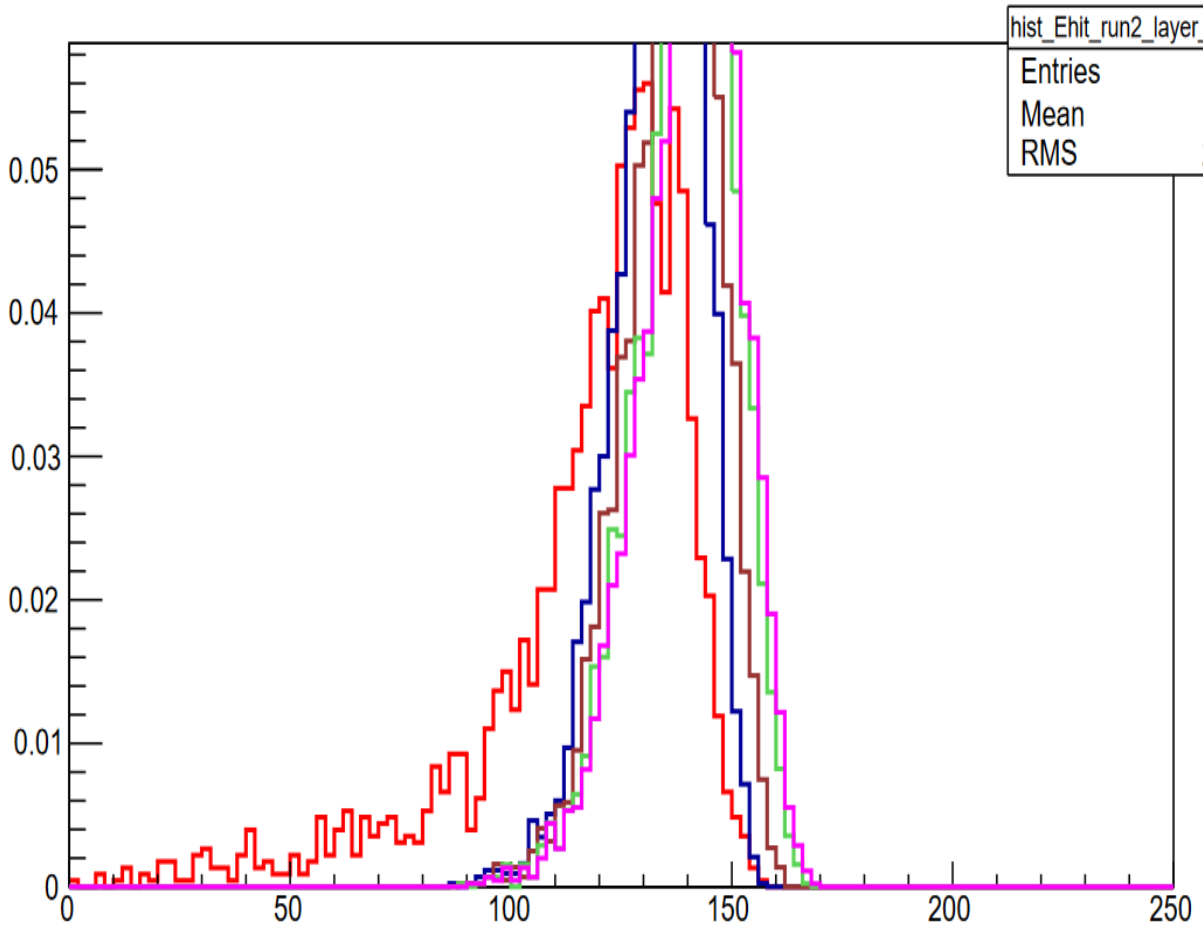
**Red: Data without de-saturation**
**Blue: 2433 pixels without de-saturation**
**Brown: 2533 pixels without de-saturation**
**Green: 2633 pixels without de-saturation**
**Pink: 2668 pixels without de-saturation**

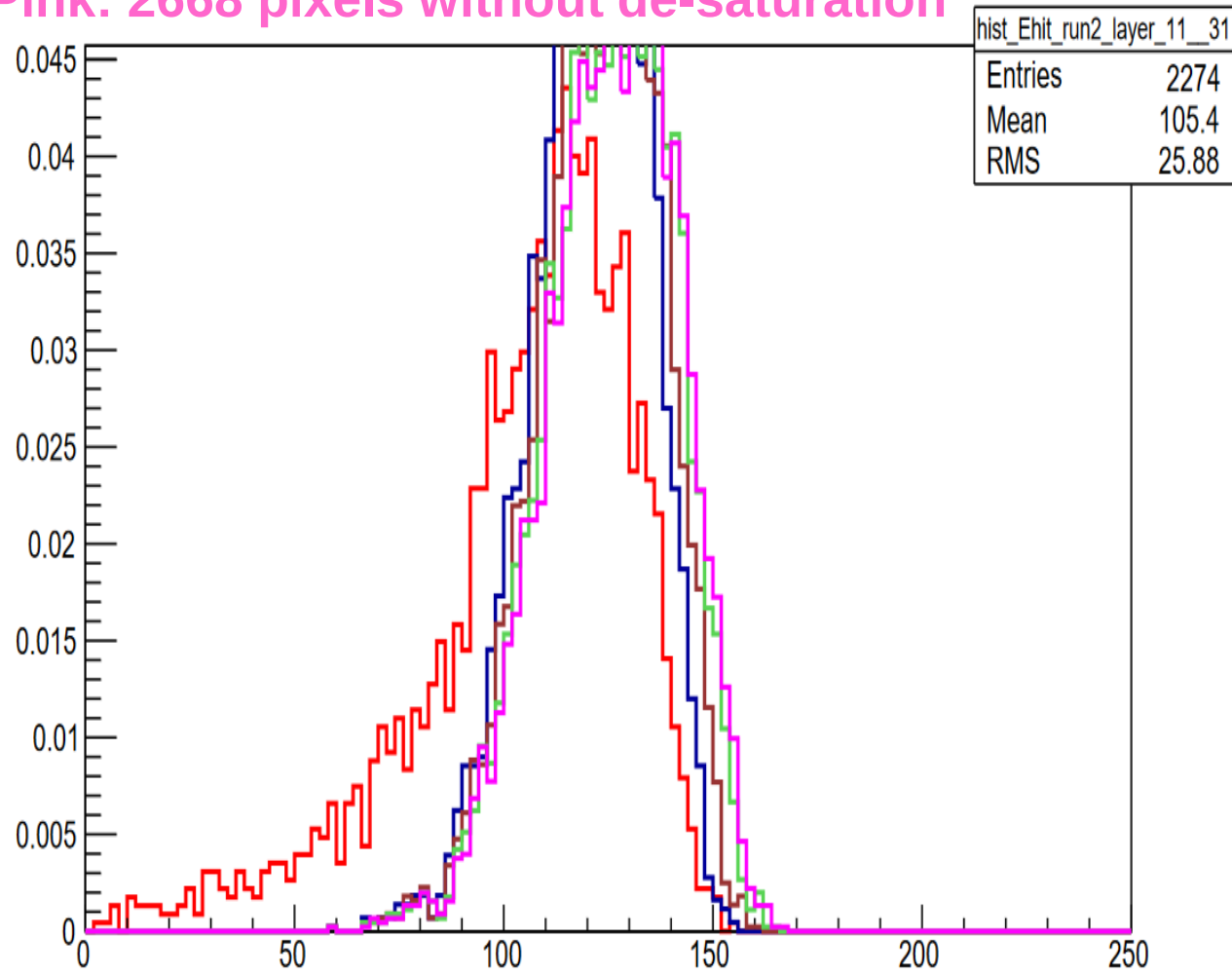


## Layer 10 and 11

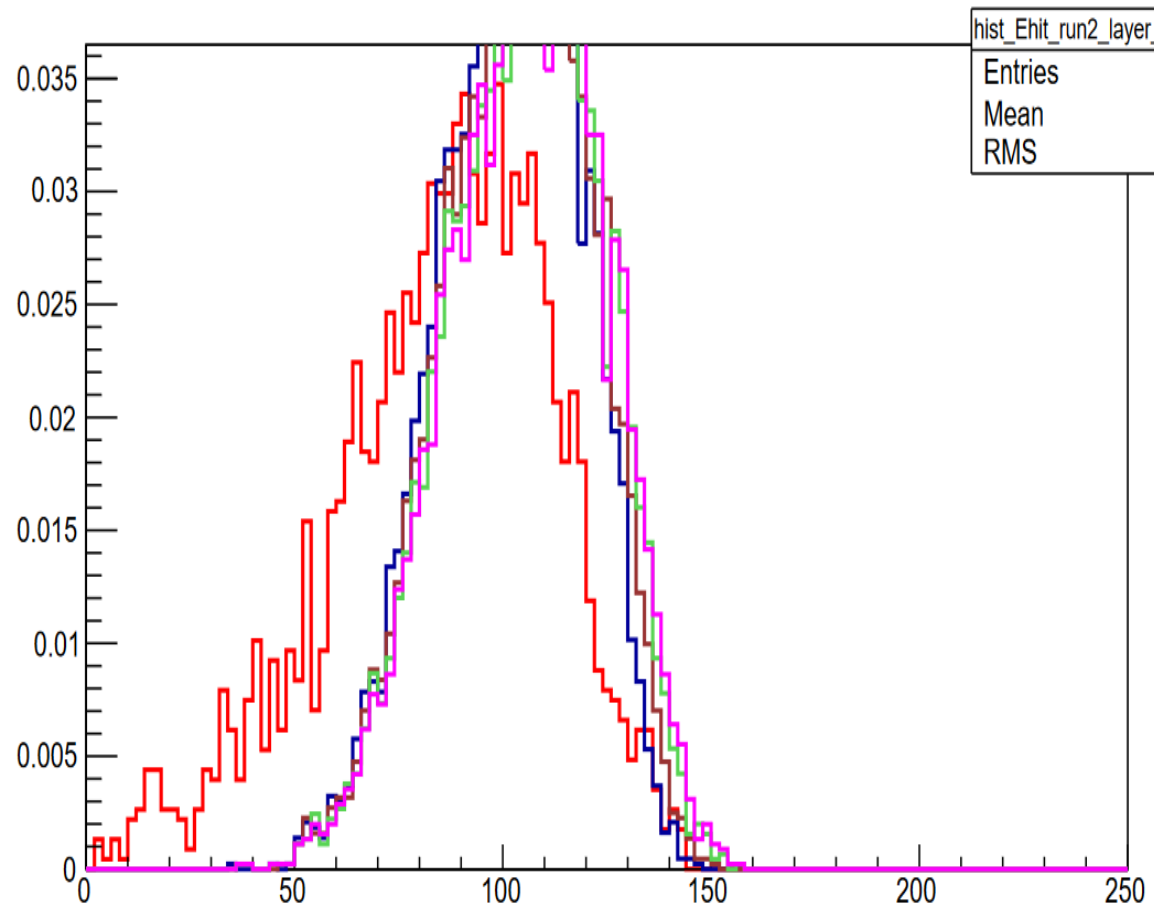
**Red: Data without de-saturation**
**Blue: 2433 pixels without de-saturation**
**Brown: 2533 pixels without de-saturation**
**Green: 2633 pixels without de-saturation**
**Pink: 2668 pixels without de-saturation**

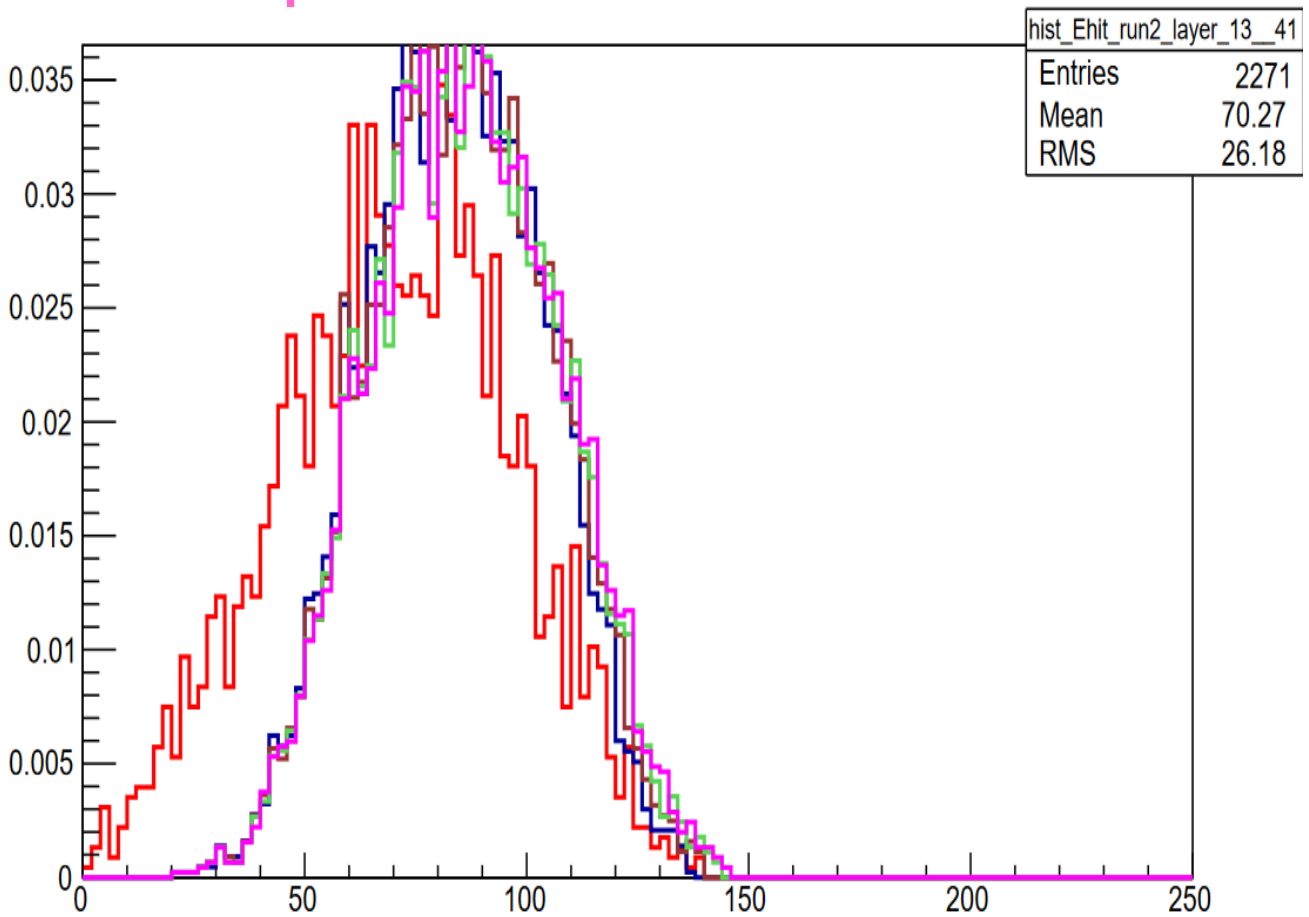


## Layer 12 and 13

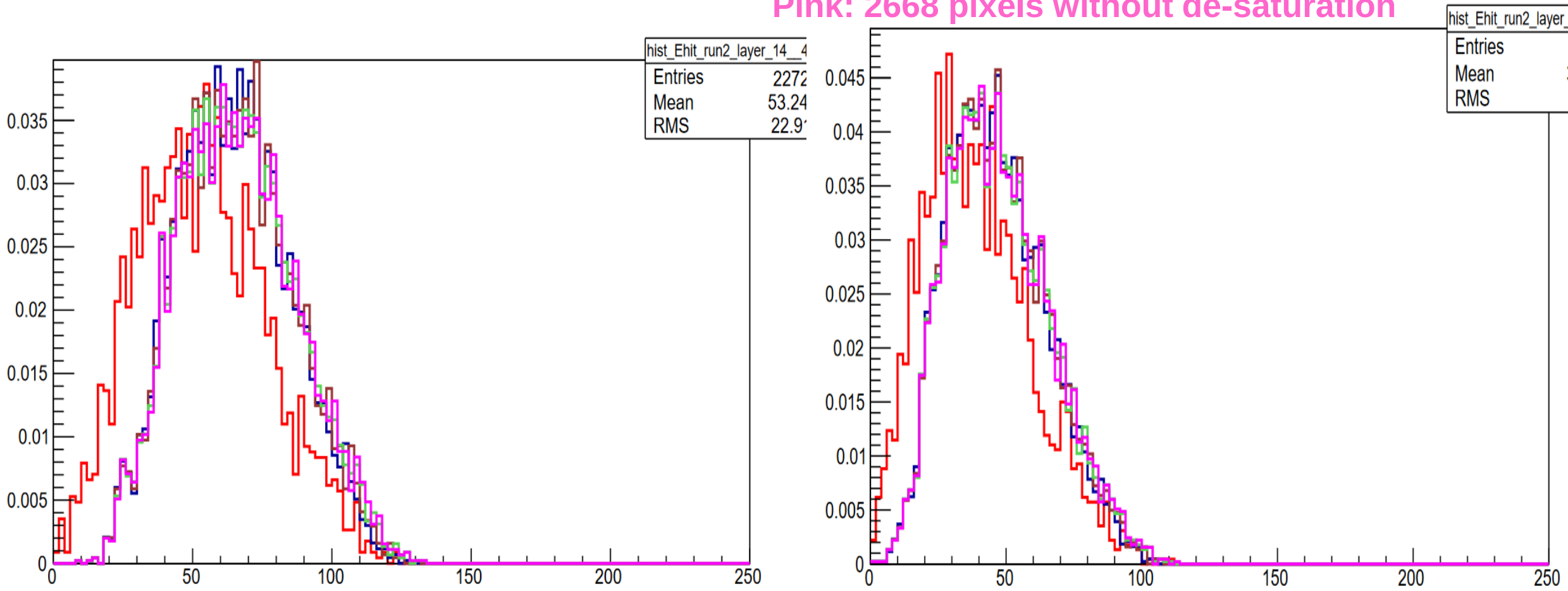
**Red: Data without de-saturation**
**Blue: 2433 pixels without de-saturation**
**Brown: 2533 pixels without de-saturation**
**Green: 2633 pixels without de-saturation**
**Pink: 2668 pixels without de-saturation**



## Layer 14 and 15

**Red: Data without de-saturation**
**Blue: 2433 pixels without de-saturation**
**Brown: 2533 pixels without de-saturation**
**Green: 2633 pixels without de-saturation**
**Pink: 2668 pixels without de-saturation**



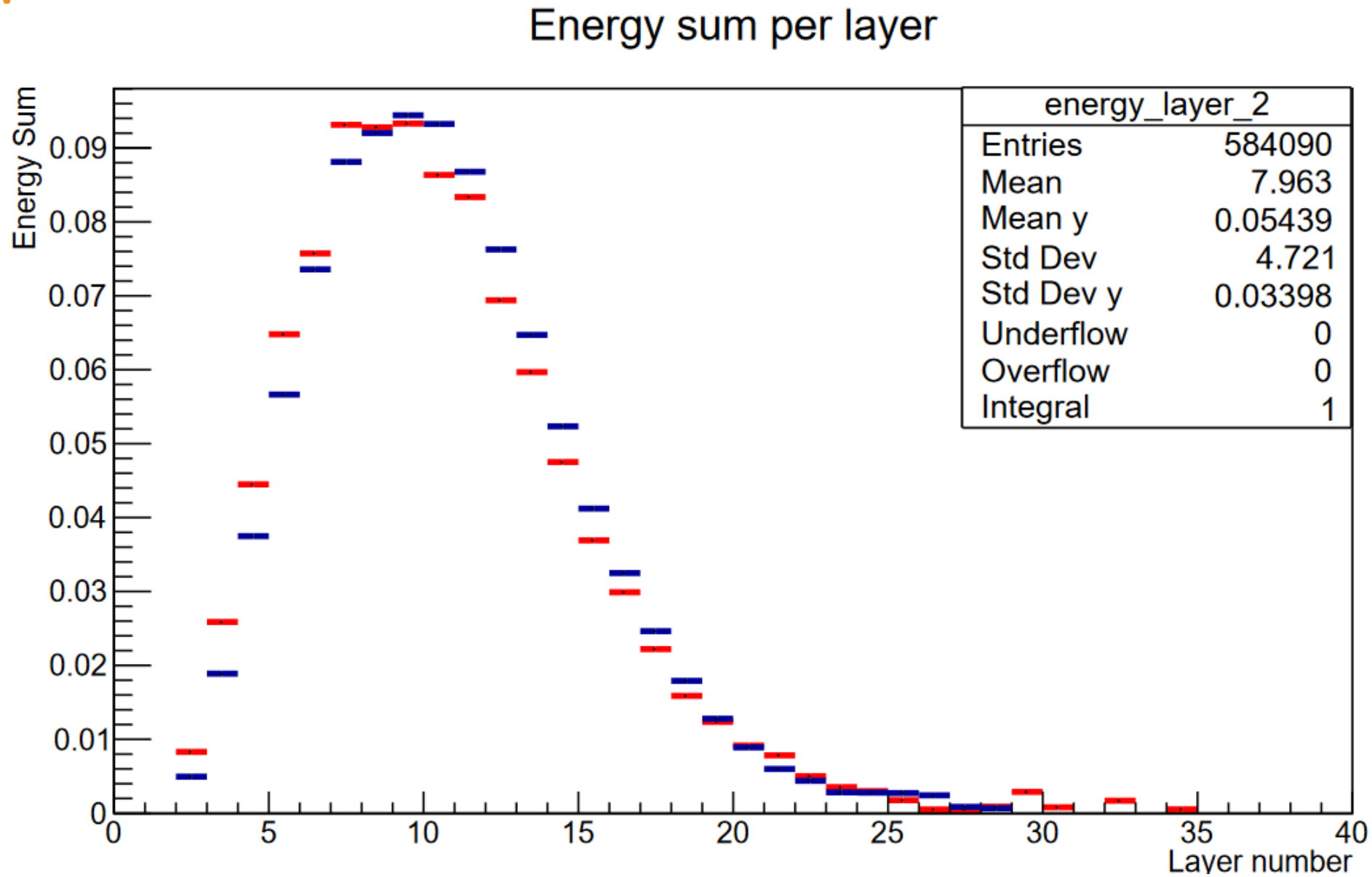

**No definite number of pixel agree well for all layers**

# Energy Sum Layer wise

## 80 GeV

**Red: Data**

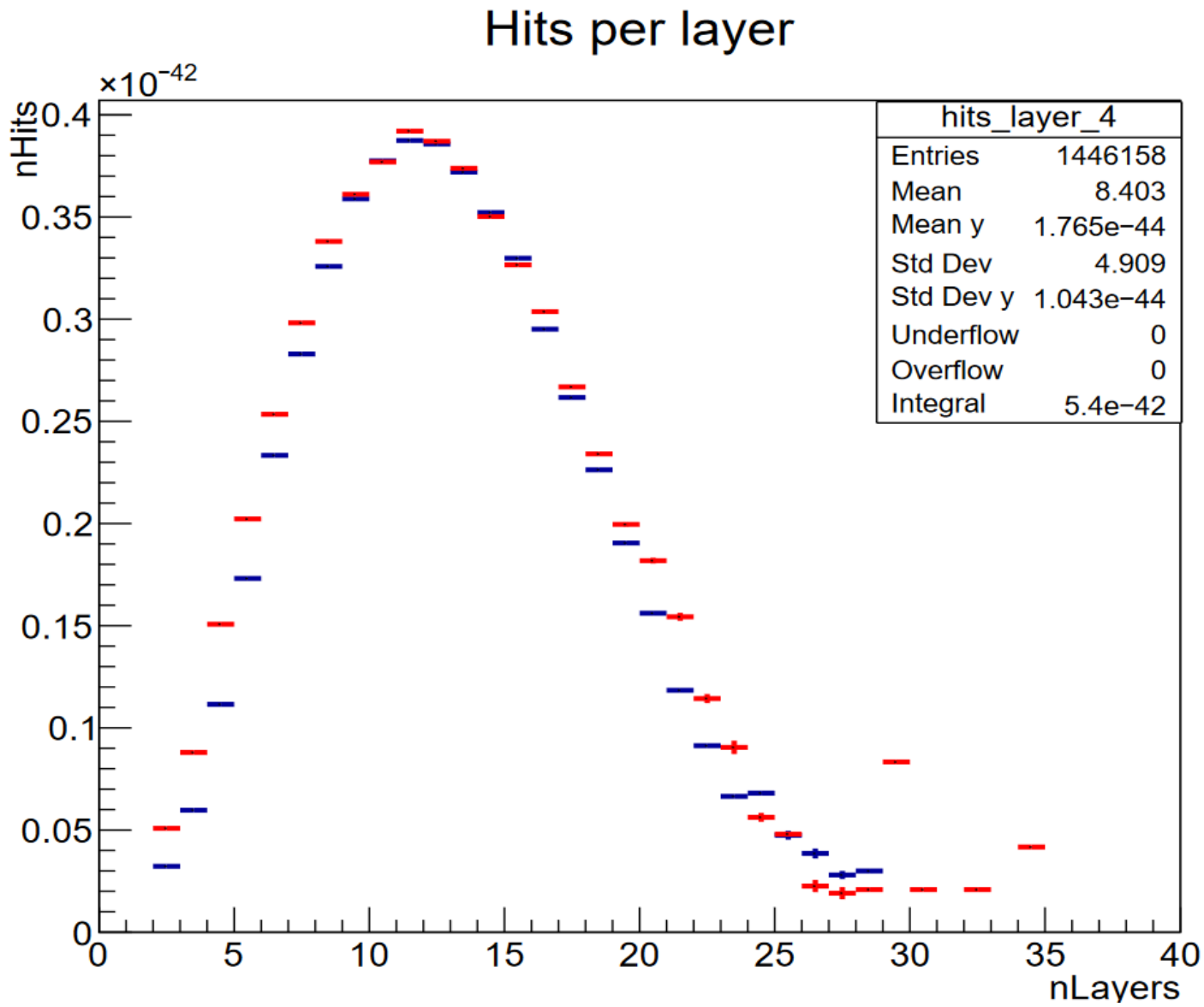
**Blue: Simulation 2533 pixels without de-sat**



# nHits layer-wise

**Red: Data**

**Blue: Simulation 2533 pixels without de-sat**



# To do:

- Change the beam gun to -50m – taking in account the scintillator position.
- From nHits/layer: Investigate the layer 29 – check if there is hit in only one channel by looking into the hit map.
- Perform the similar study of SiPM with de-saturation “note if any changes occur”.
- Perform the study for different electron energies (100,90,70,60,50,40,30-GeV).
- Energy distribution in Pre-shower.

- For light yield compare at channel level with Mainz data.

Further plan : Work on shower shapes for different particles (both lateral and transverse study).

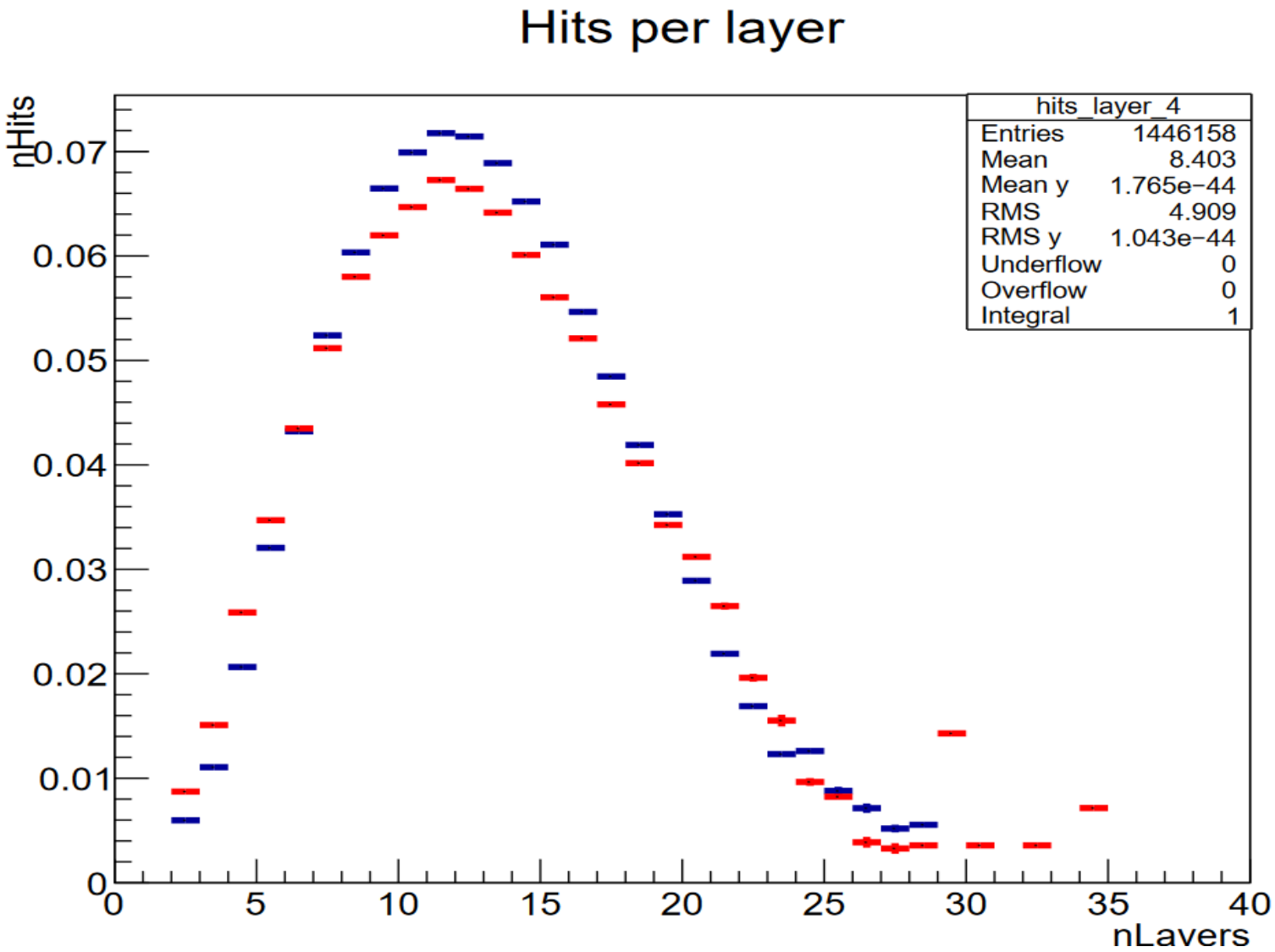
# Thank you

# BACKUP

# nHits layer-wise

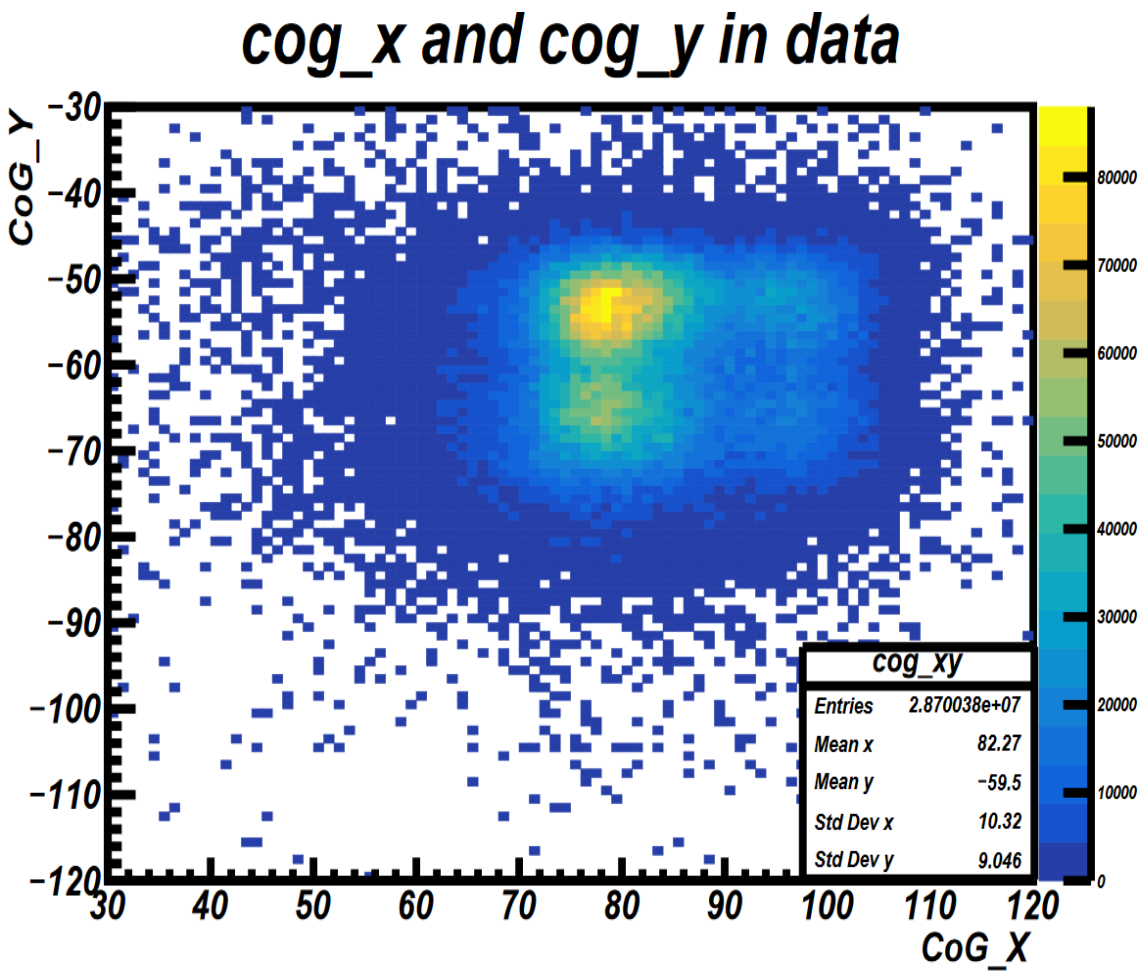
**Red: Data**

**Blue: Simulation 2533 pixels without de-sat**

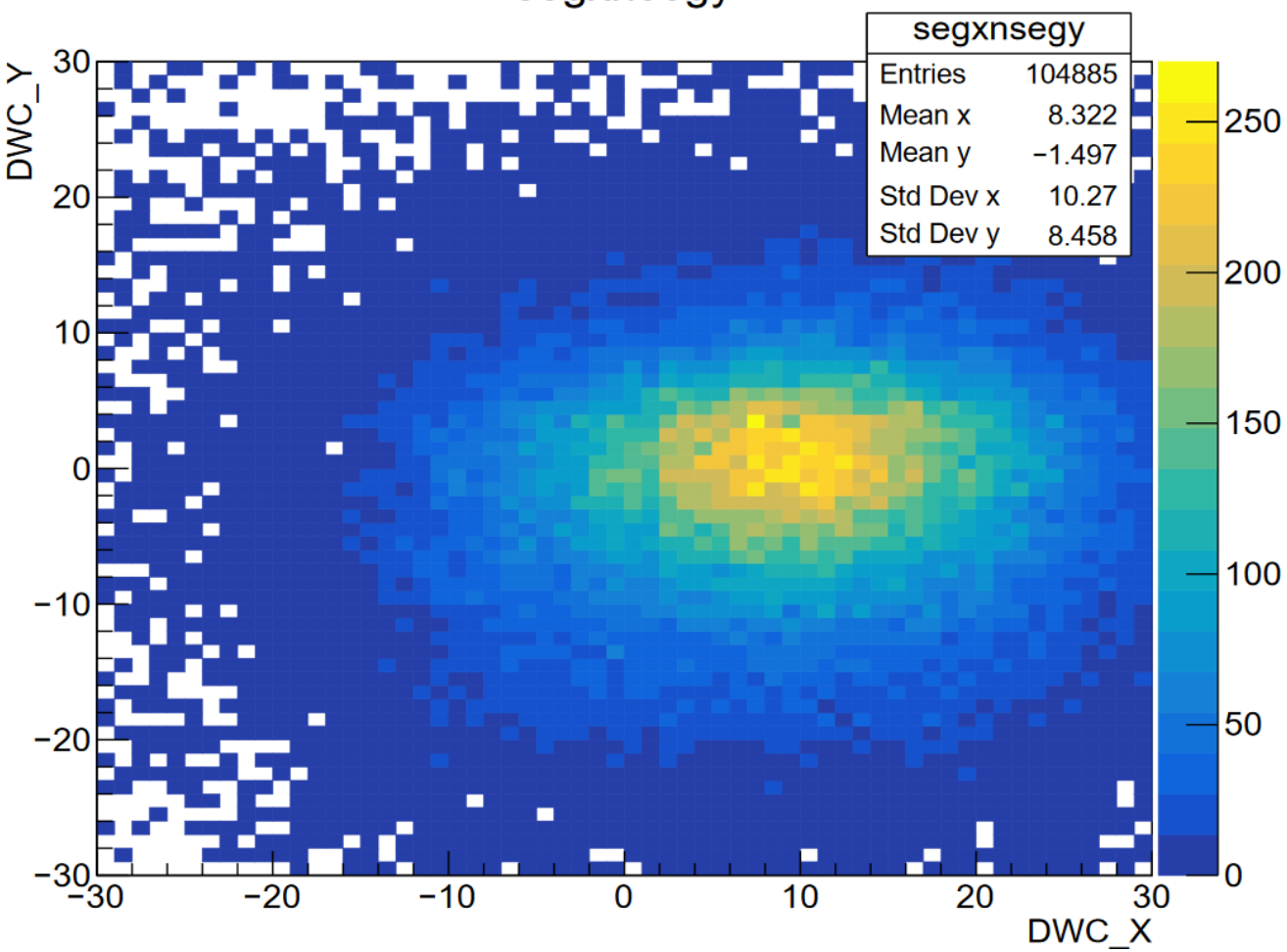


# Centre of gravity

## Run number: 61156

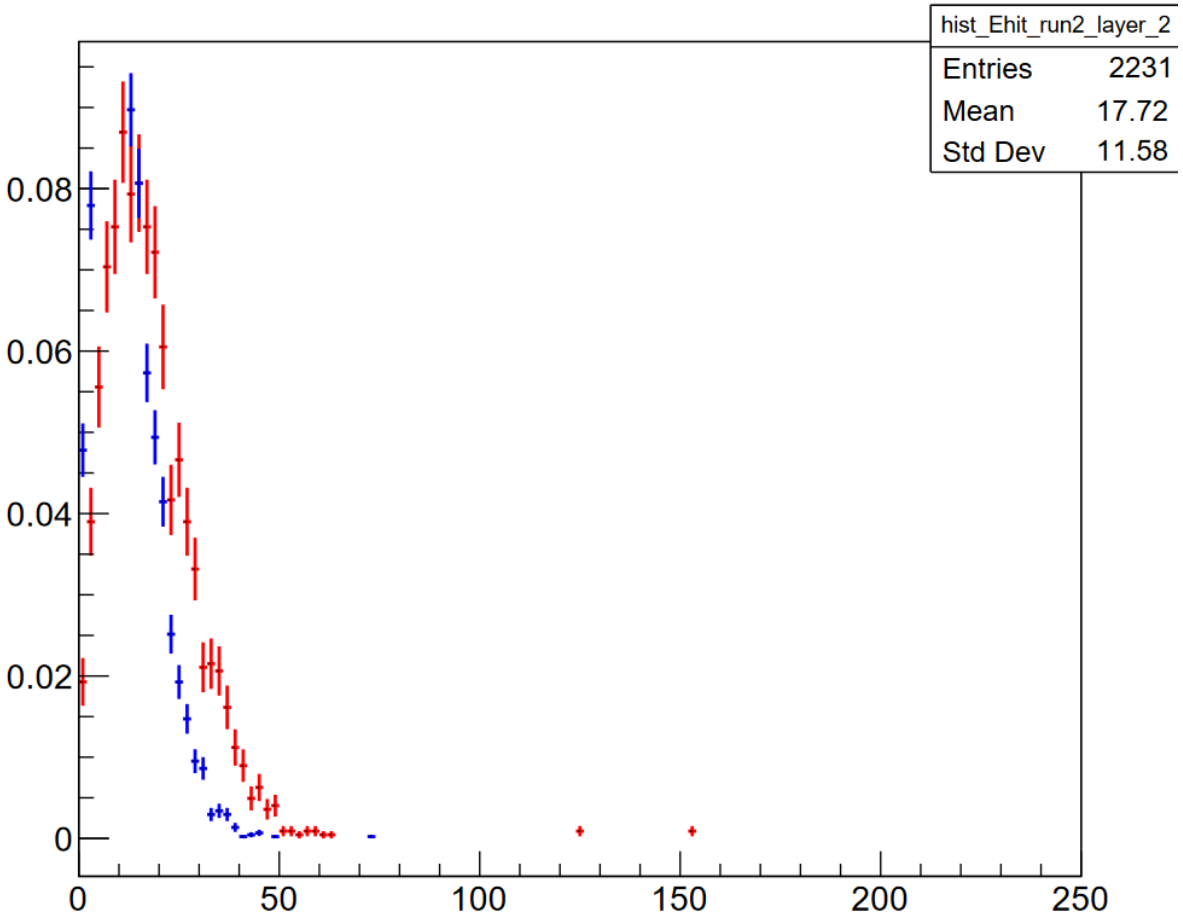


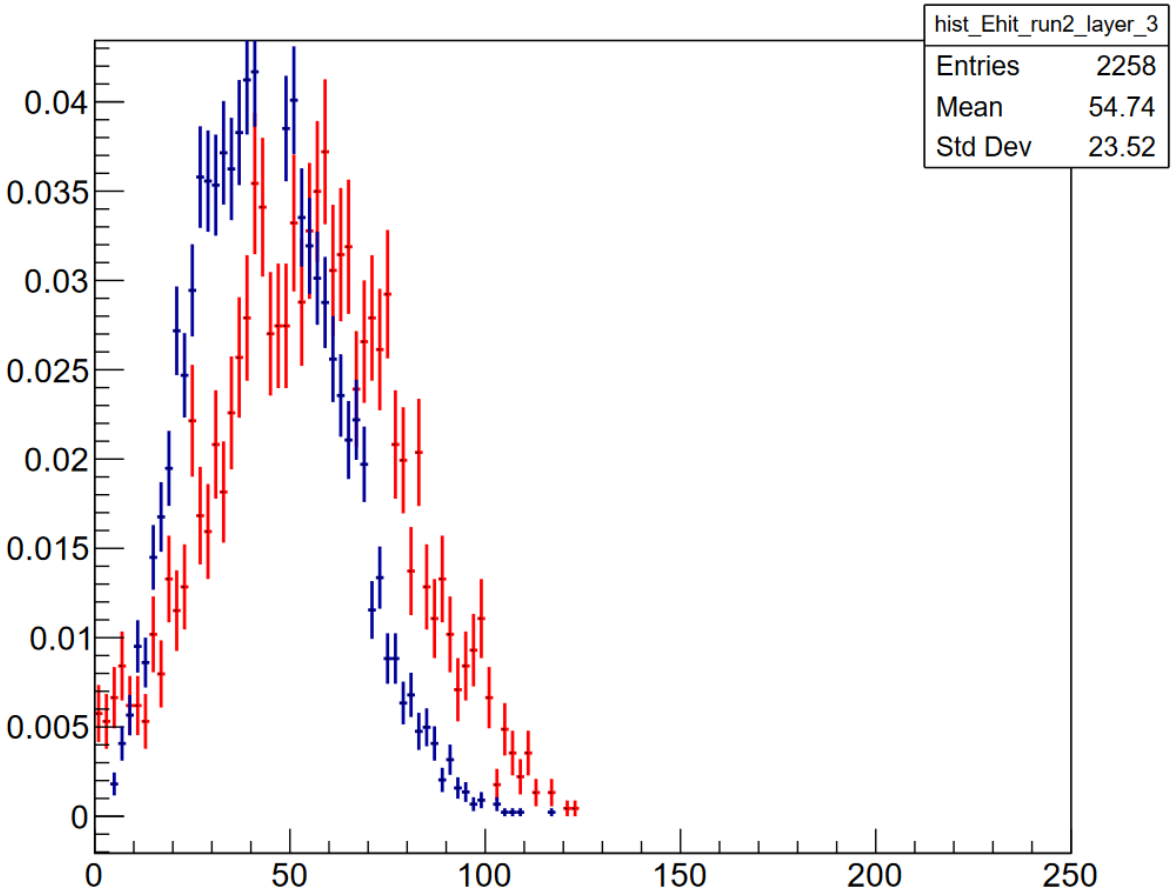

**From Wire Chamber**



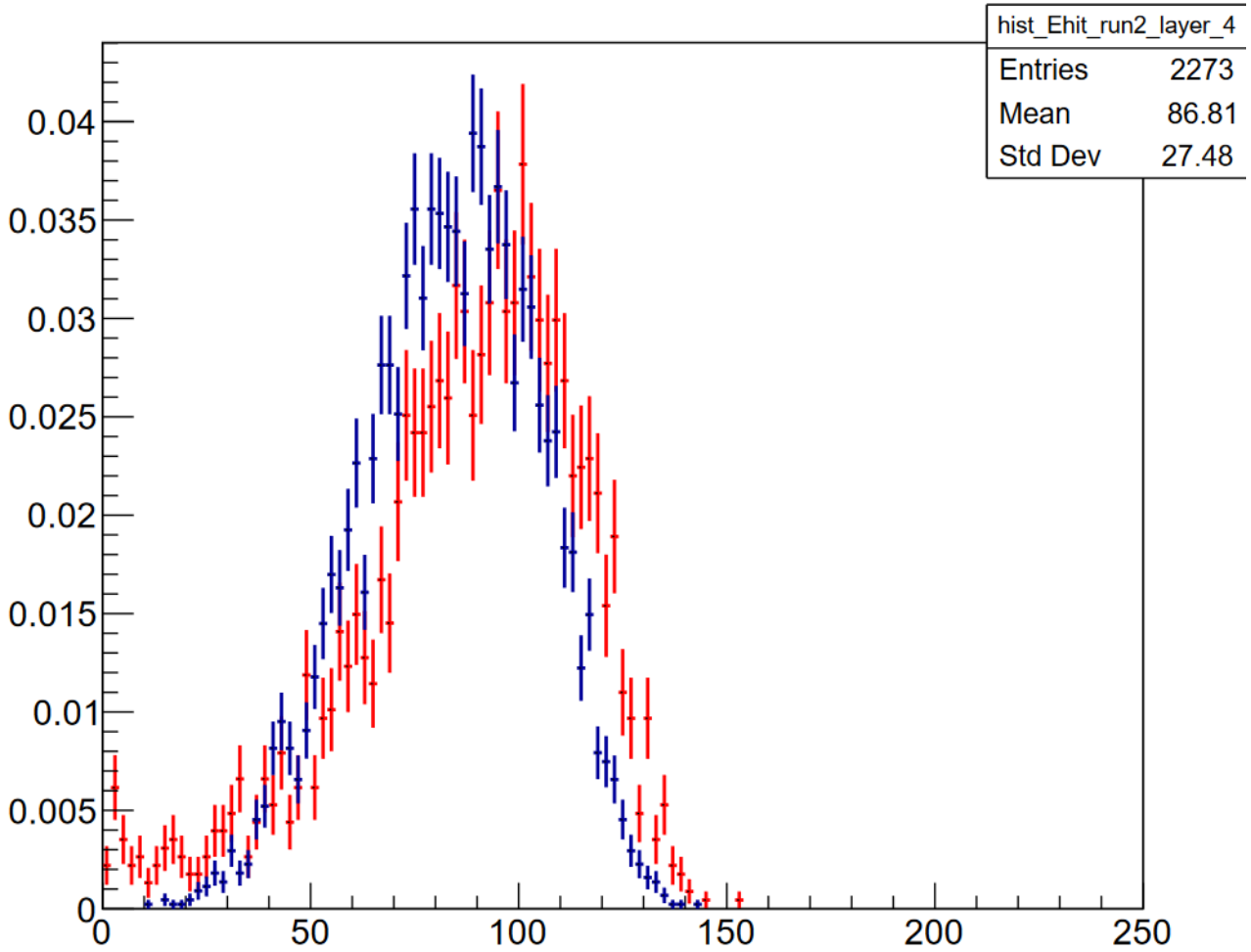
# Hit Energy: Layer-wise Comparative study

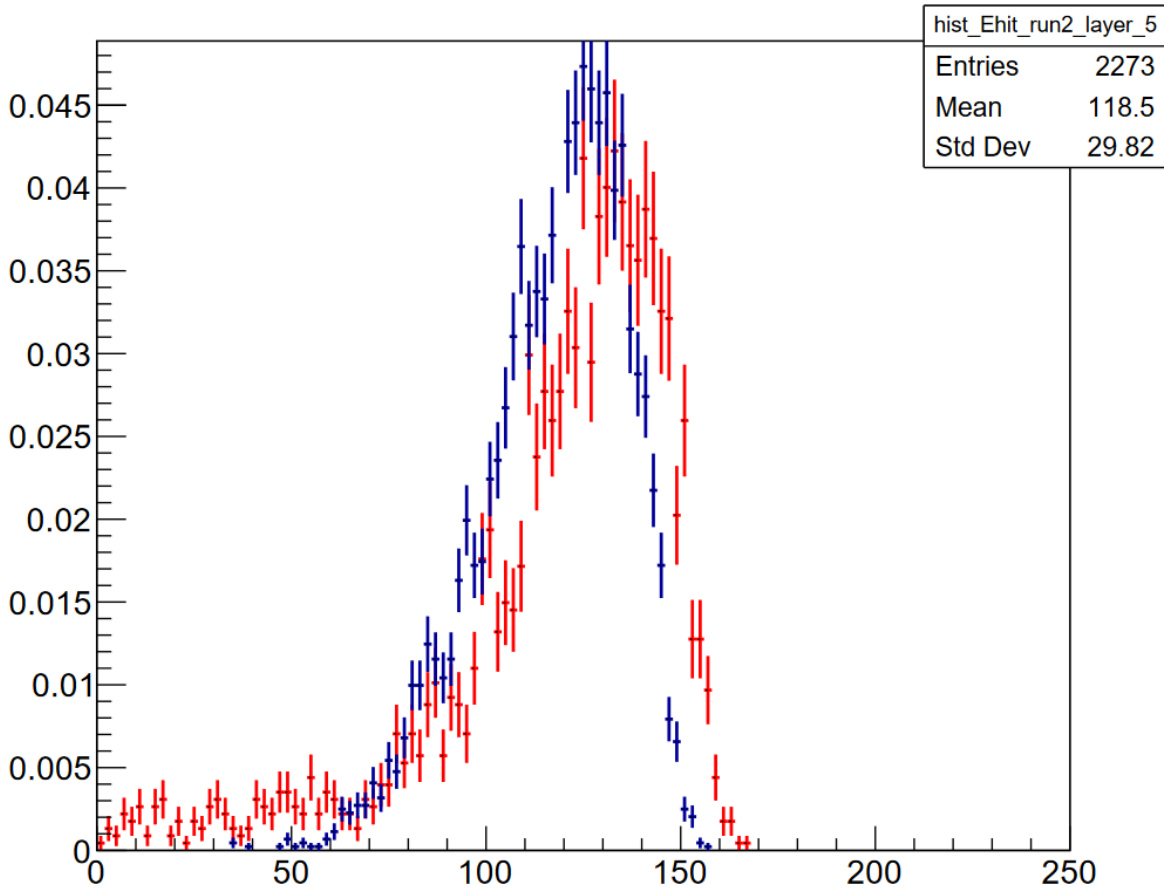
# Layer 2 and 3


hist_Ehit_run2_layer_2
Entries 2231
Mean 17.72
Std Dev 11.58
0.08
0.06
0.04
0.02
0
0
50
100
150
200
250

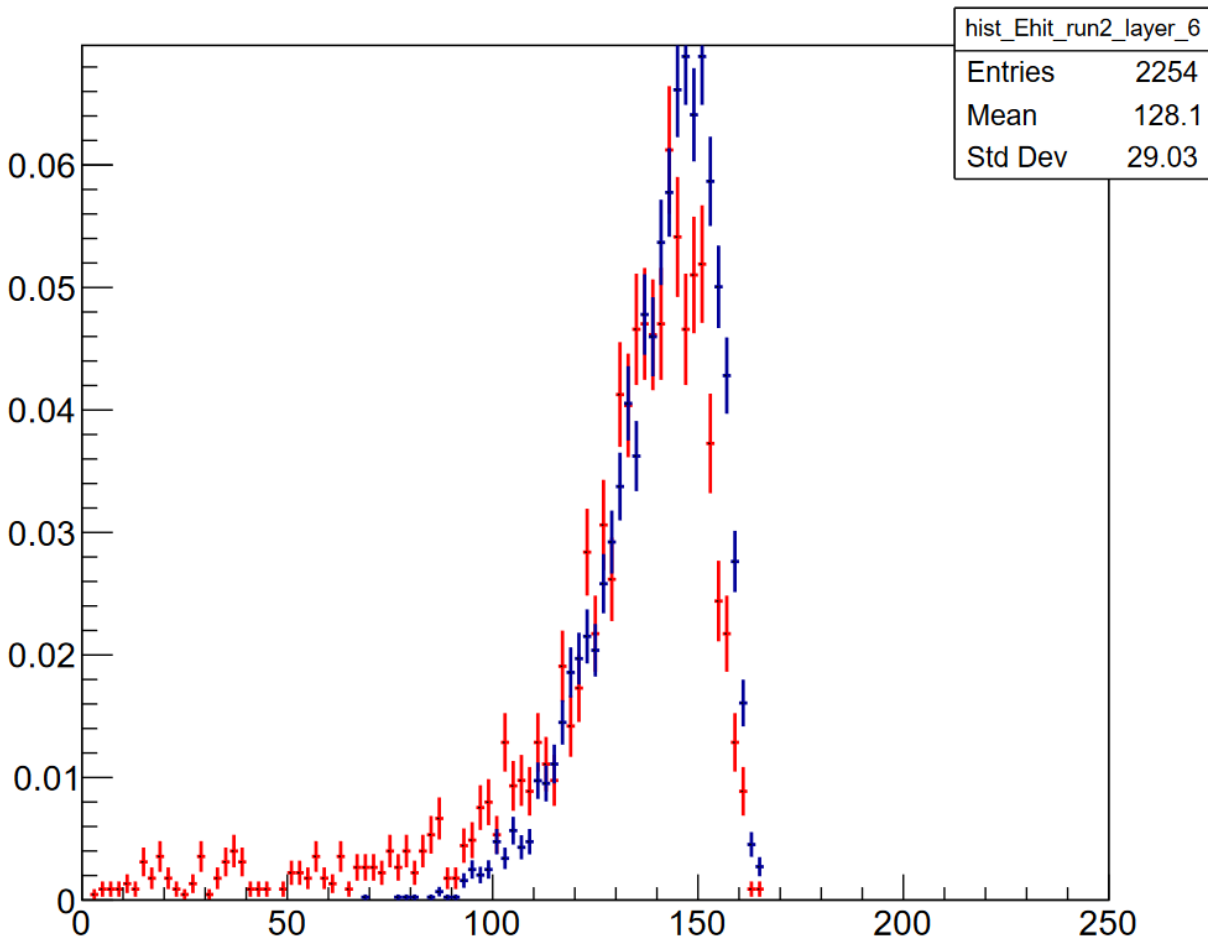

hist_Ehit_run2_layer_3
Entries 2258
Mean 54.74
Std Dev 23.52
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250

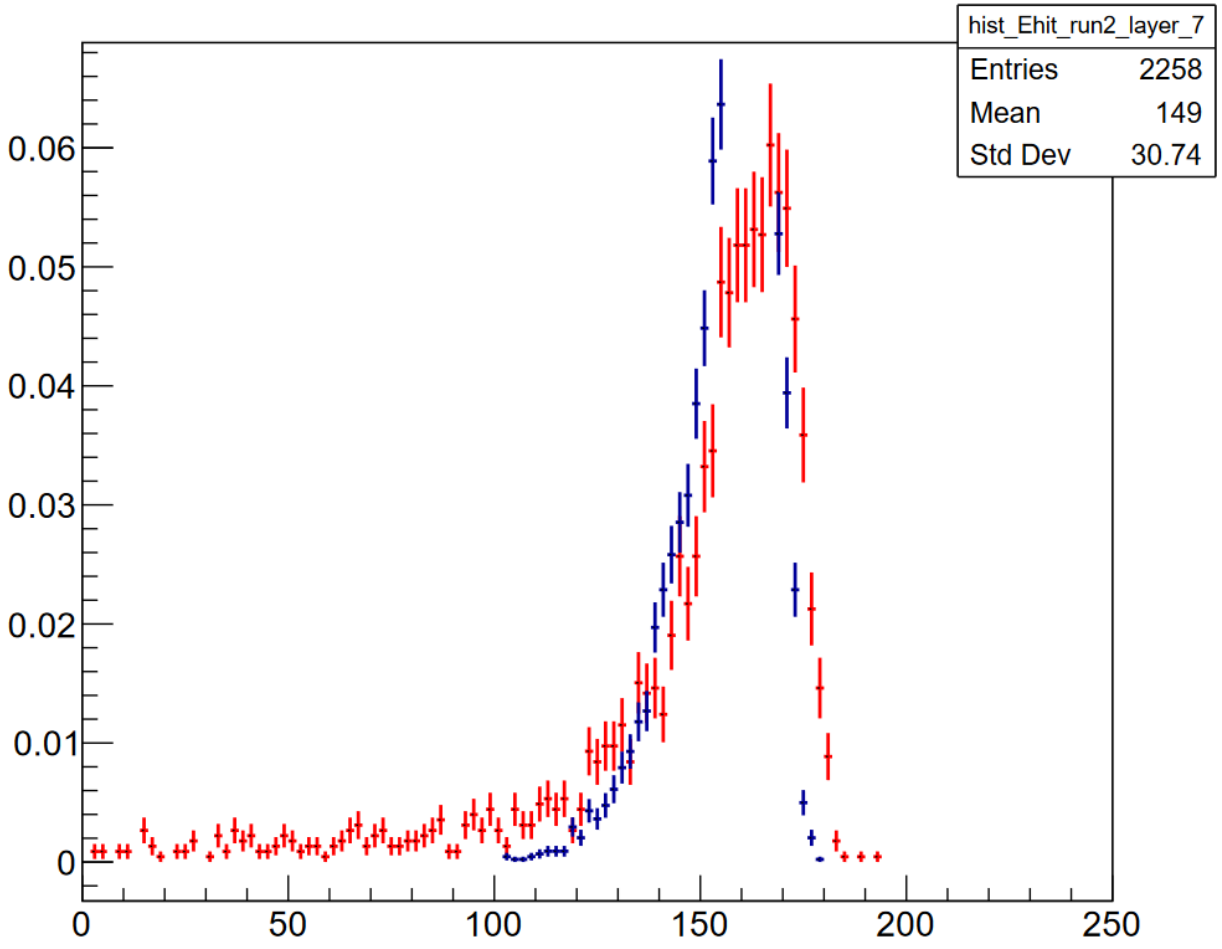
## Layer 4 and 5


hist_Ehit_run2_layer_4
Entries 2273
Mean 86.81
Std Dev 27.48
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250

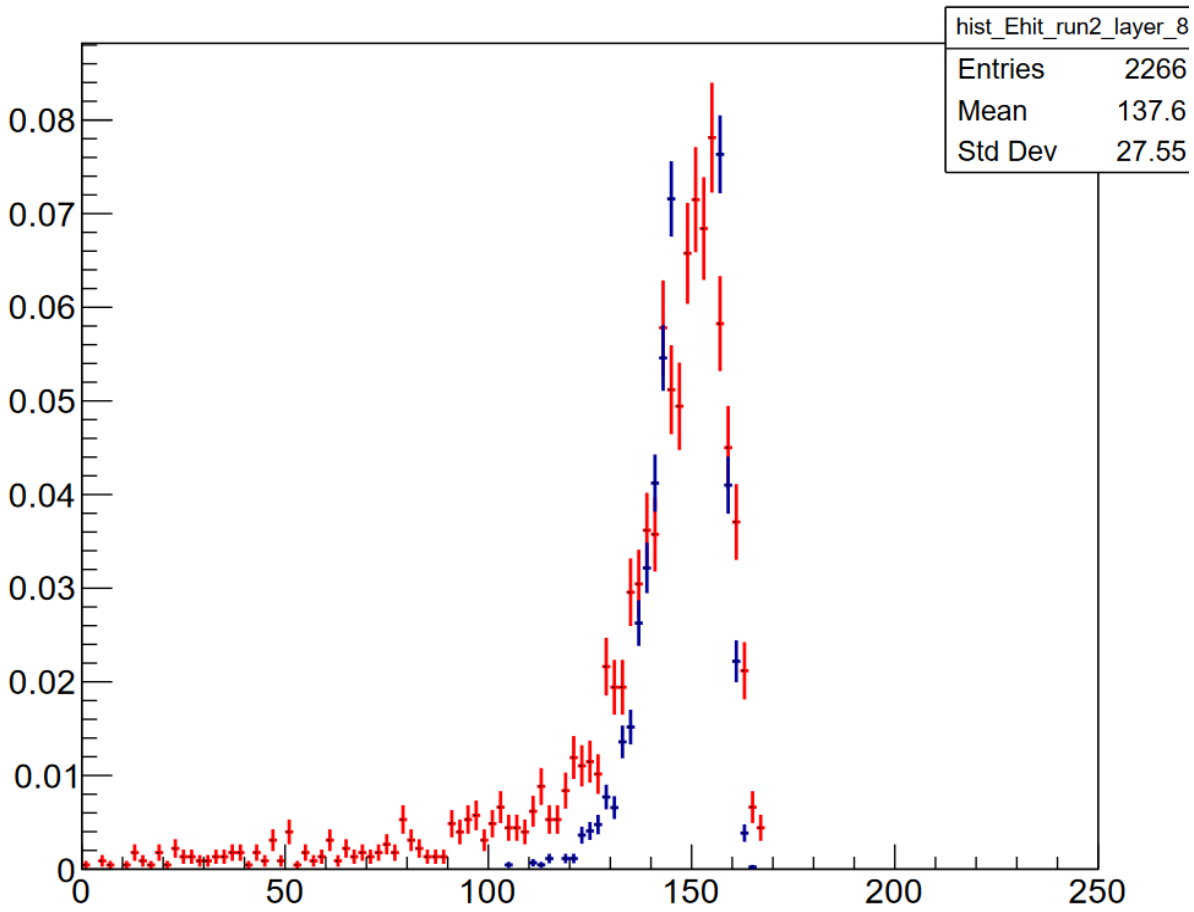

hist_Ehit_run2_layer_5
Entries 2273
Mean 118.5
Std Dev 29.82
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
50
100
150
200
250

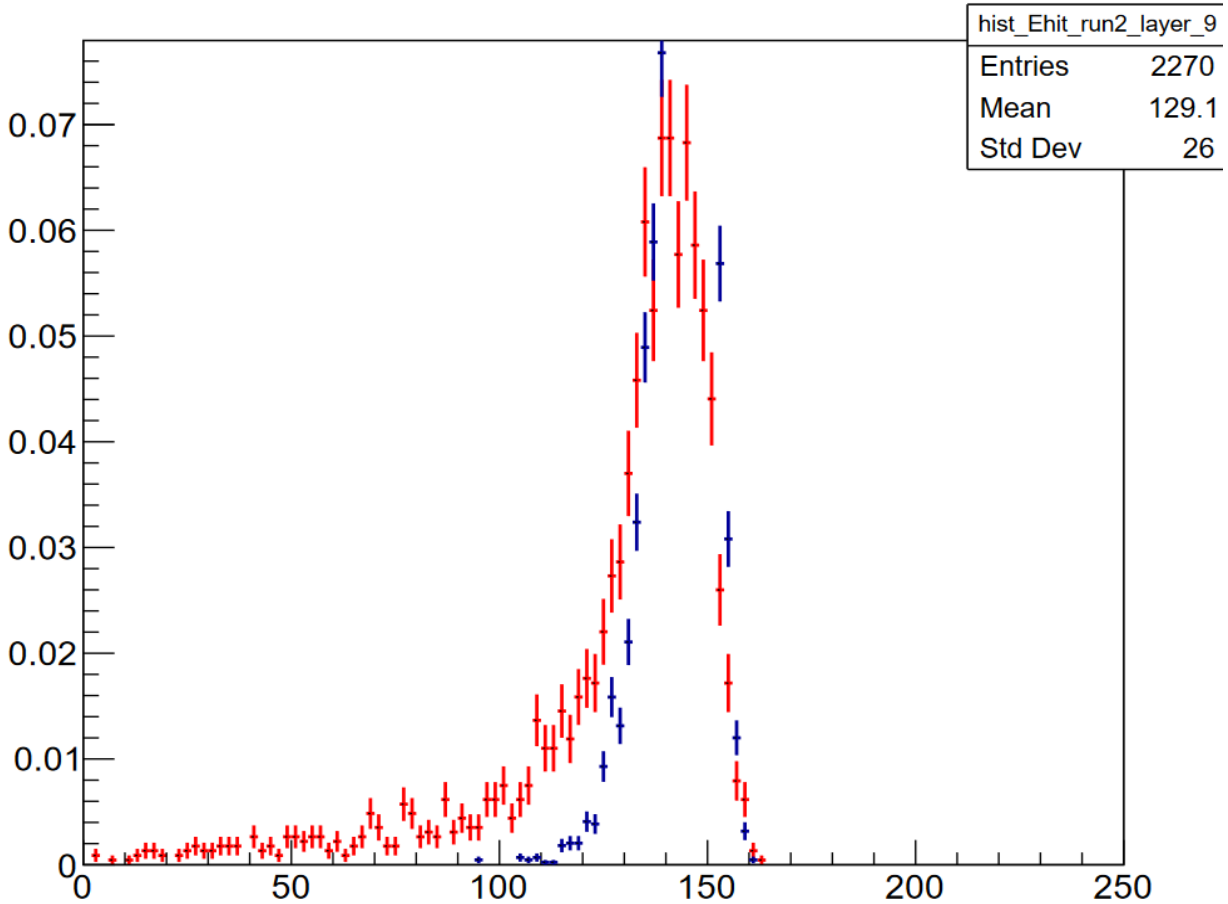
# Layer 6 and 7


hist_Ehit_run2_layer_6
Entries 2254
Mean 128.1
Std Dev 29.03
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250

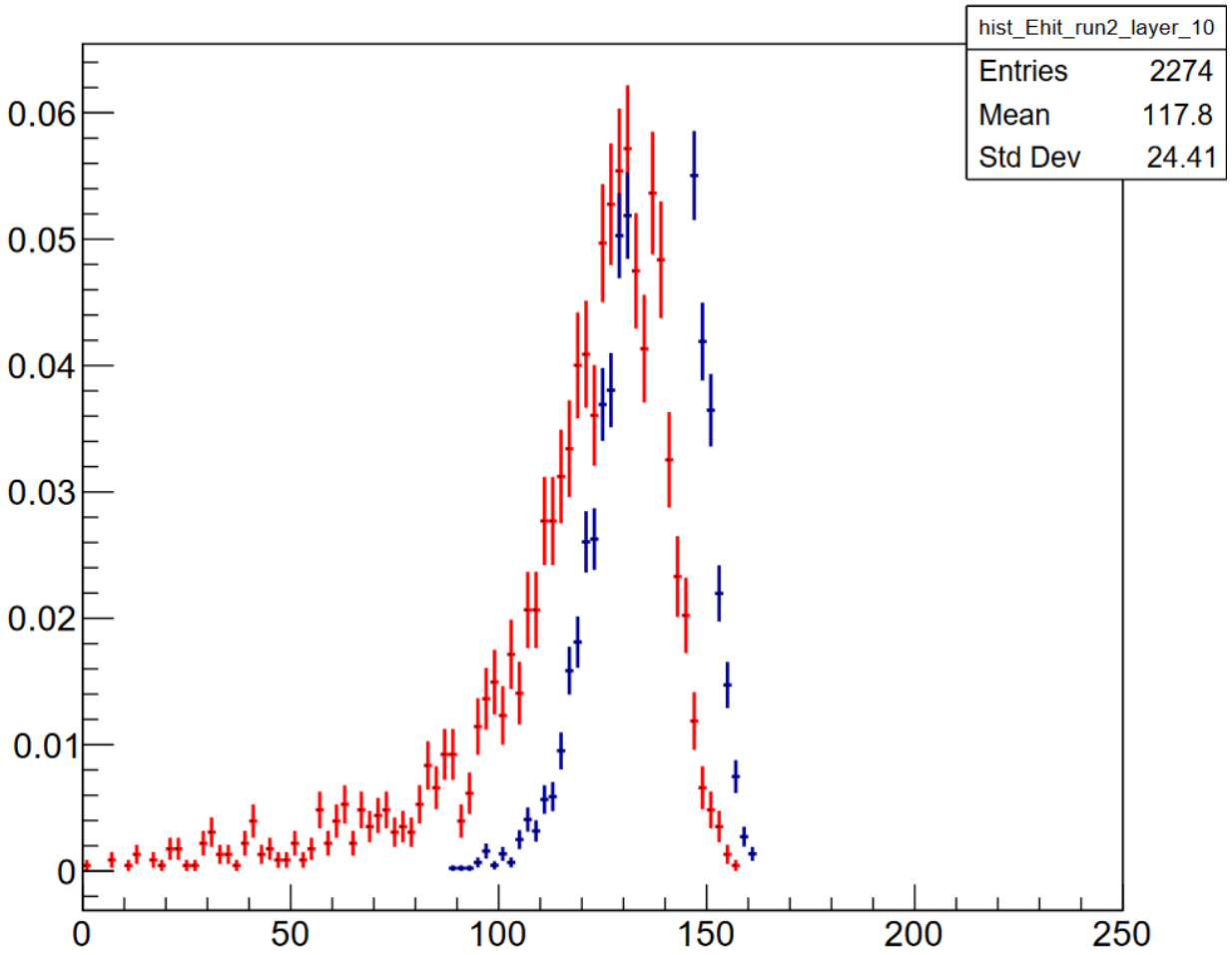

hist_Ehit_run2_layer_7
Entries 2258
Mean 149
Std Dev 30.74
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250

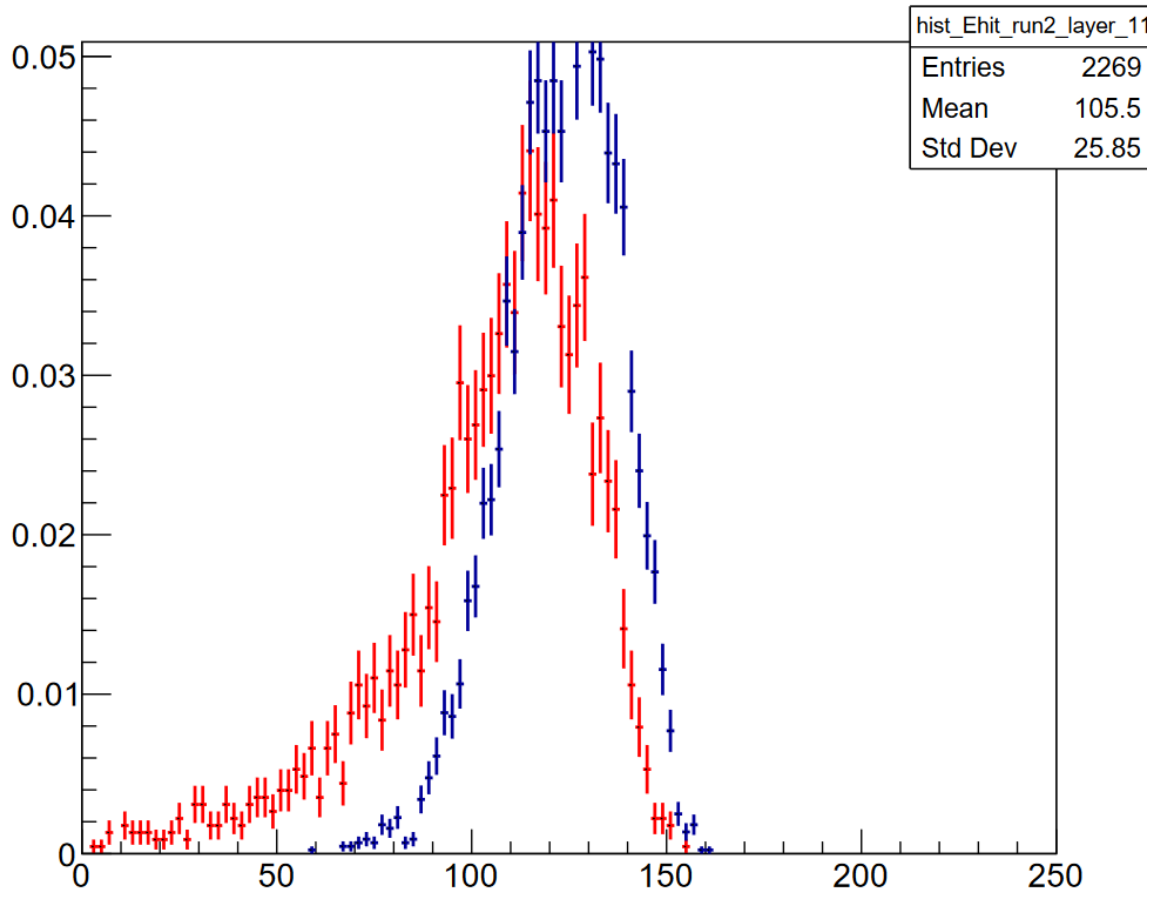
# Layer 8 and 9


hist_Ehit_run2_layer_8
Entries 2266
Mean 137.6
Std Dev 27.55
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250

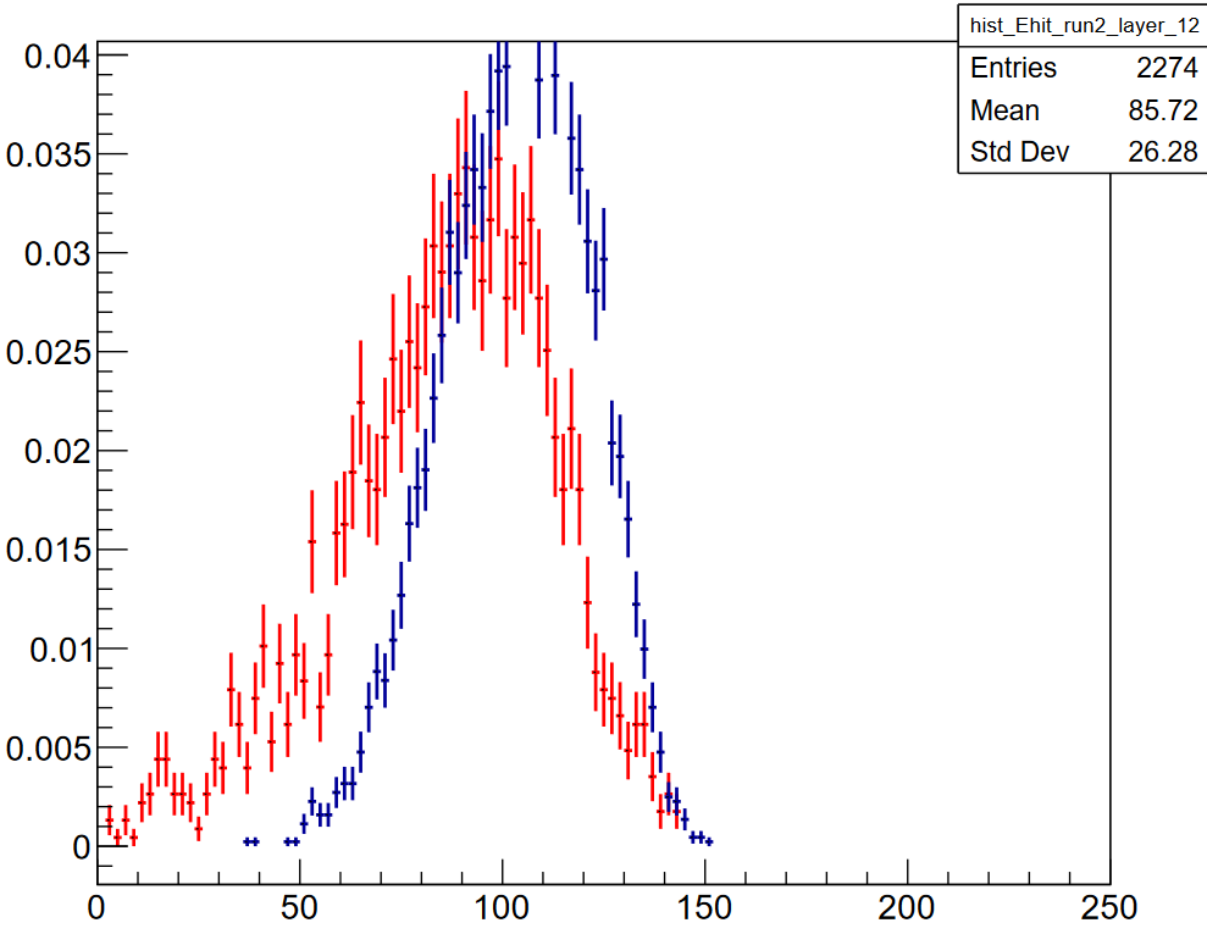

hist_Ehit_run2_layer_9
Entries 2270
Mean 129.1
Std Dev 26
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250

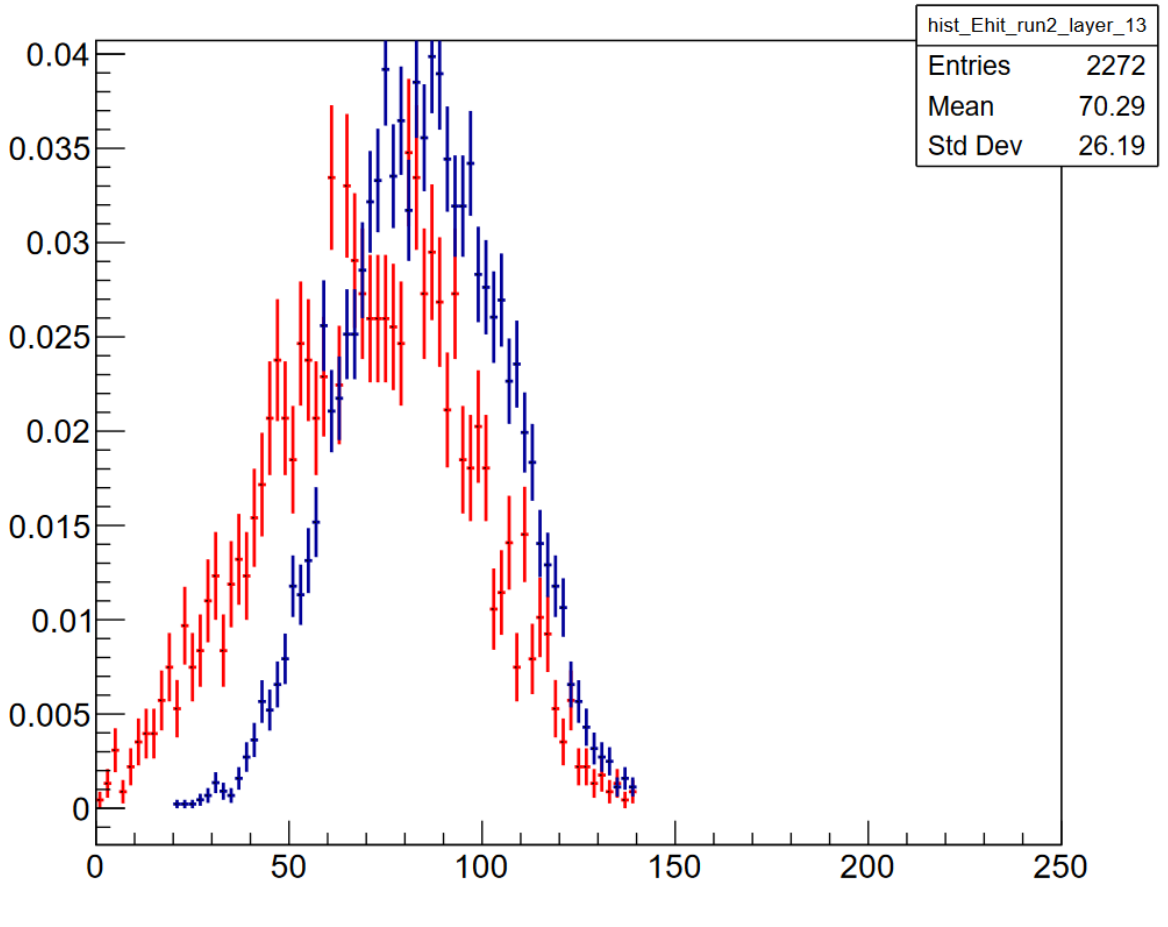
# Layer 10 and 11



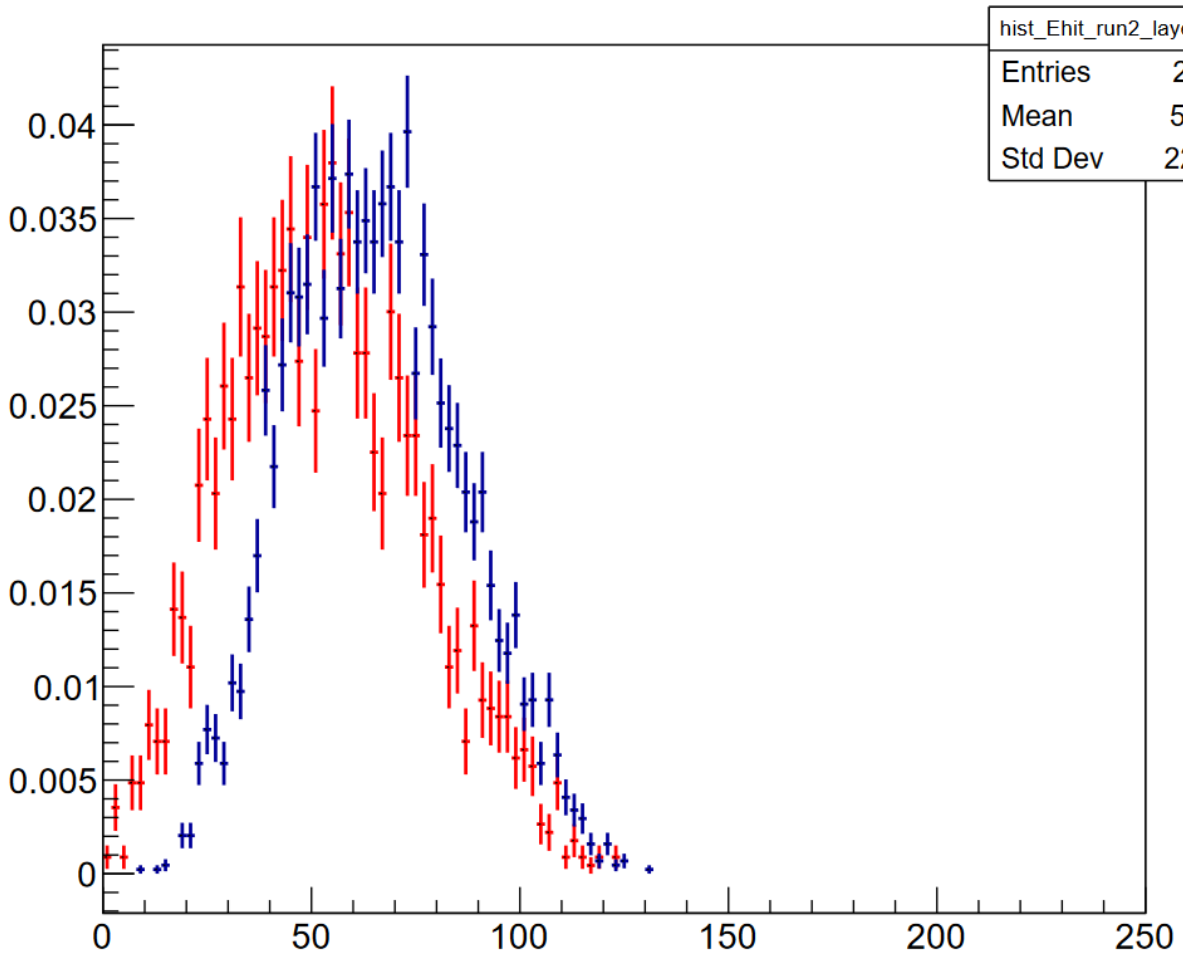



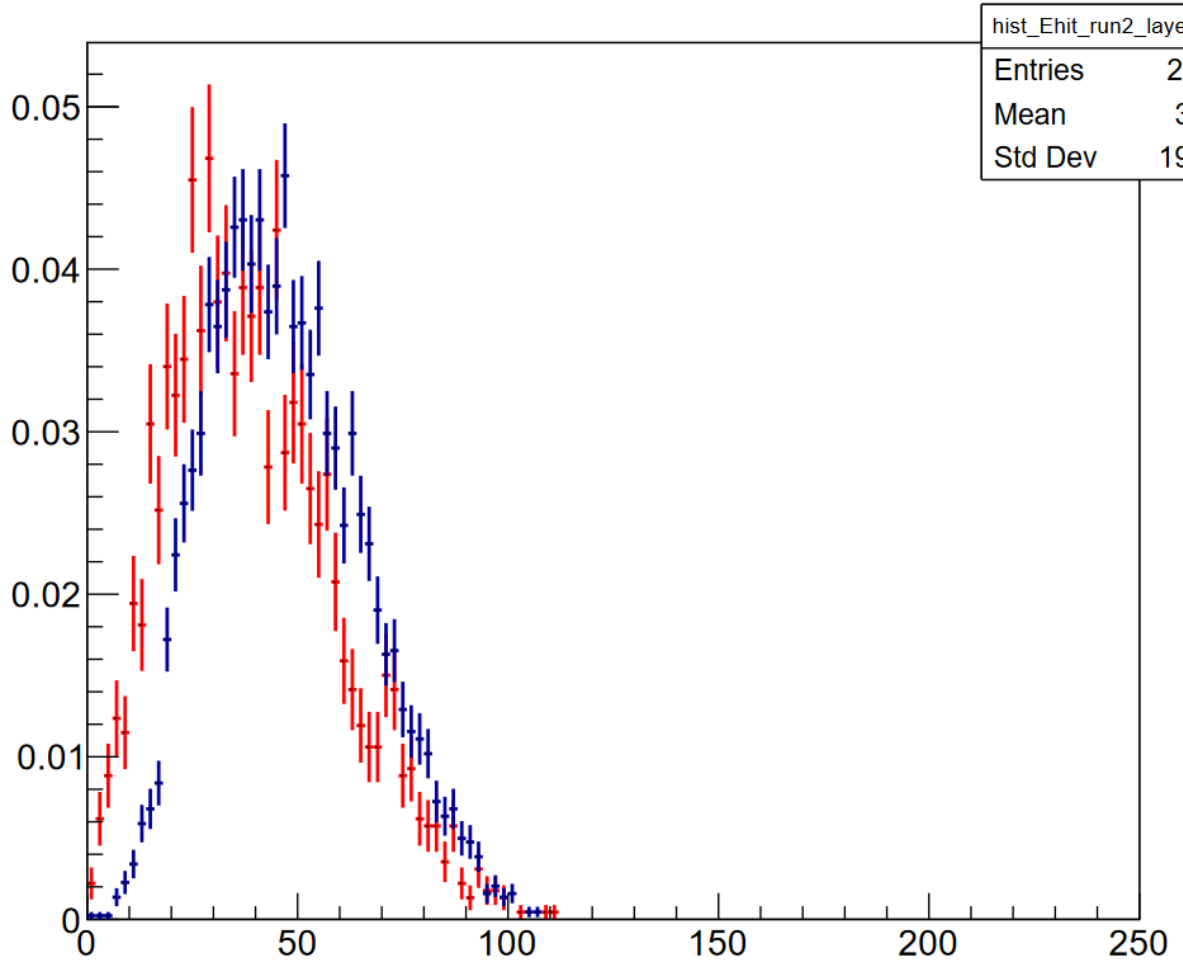
# Layer 12 and 13



## Layer 14 and 15

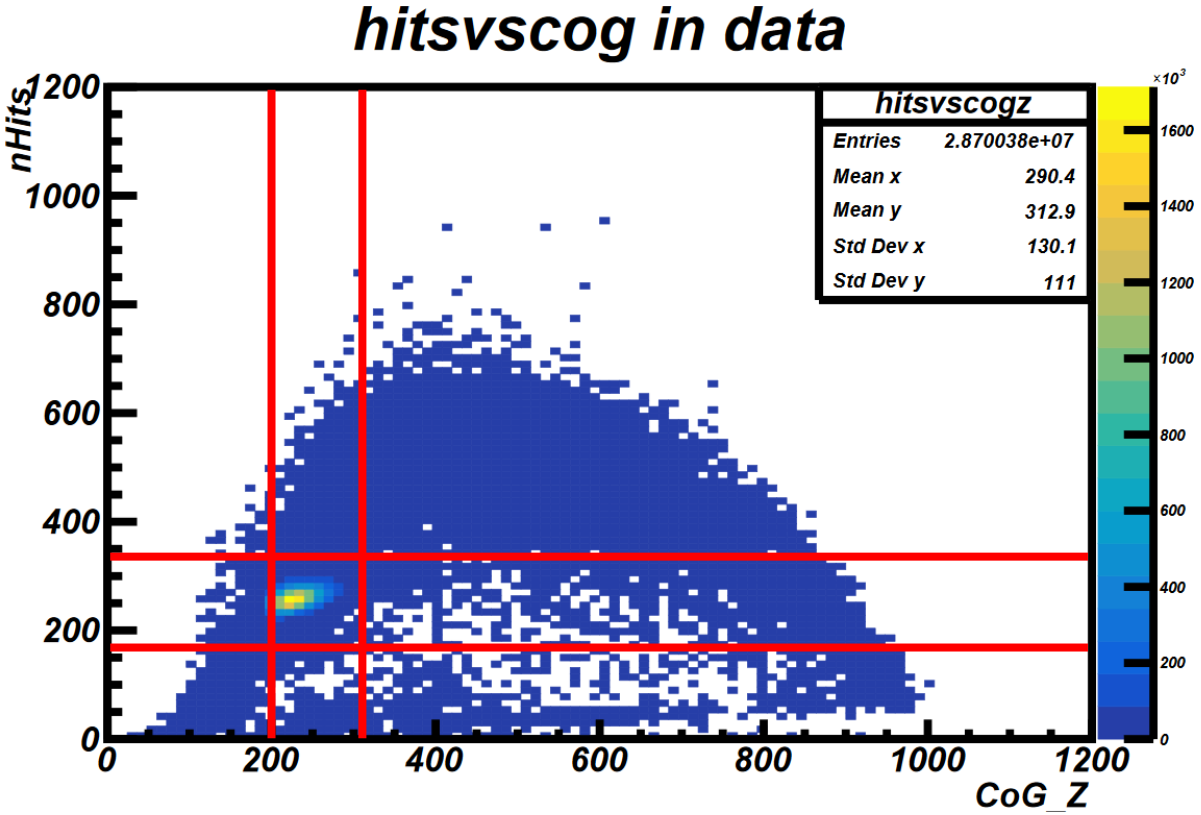


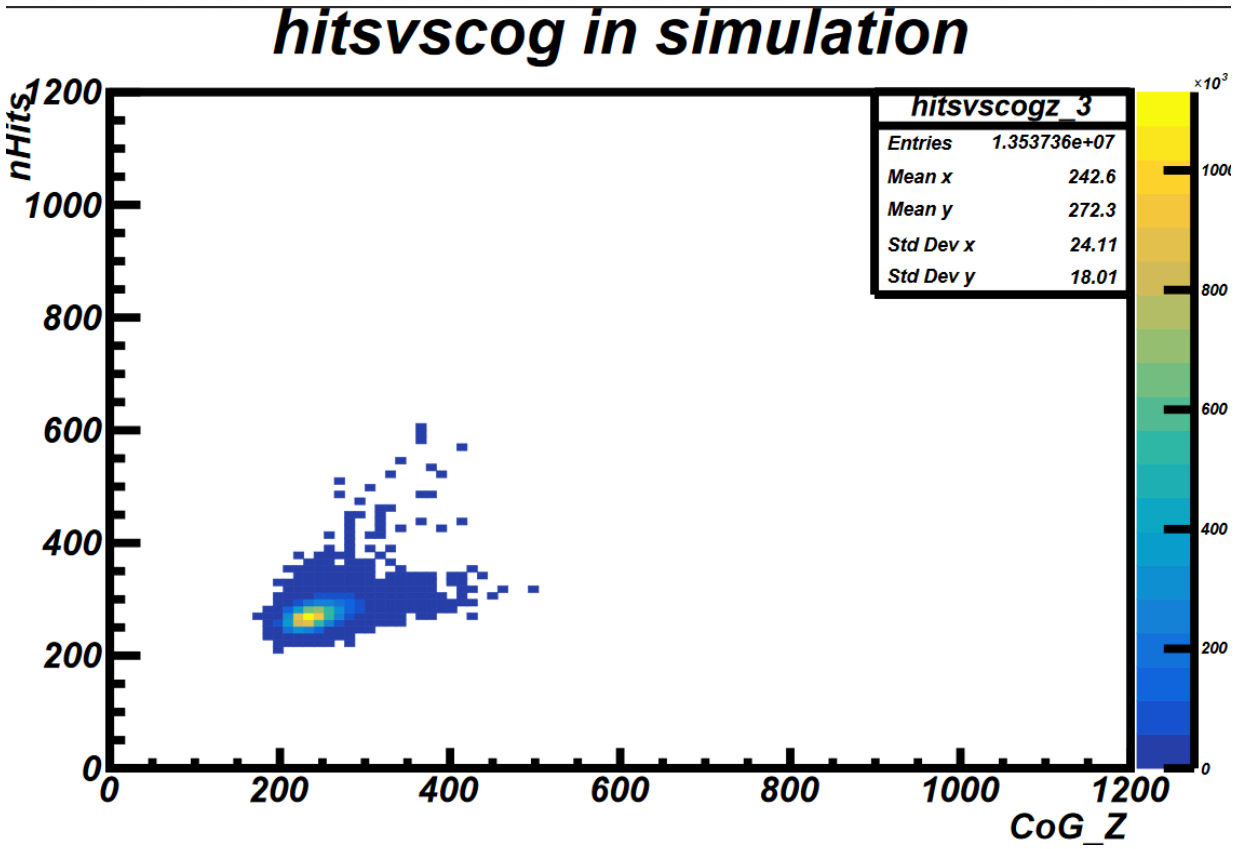



# Basic event selection for 80 GeV electron – June 2018 data

## Run number: 61156

- Number of hits: Between 200 to 300 hits
- Center of gravity along Z: 180 mm to 280 mm



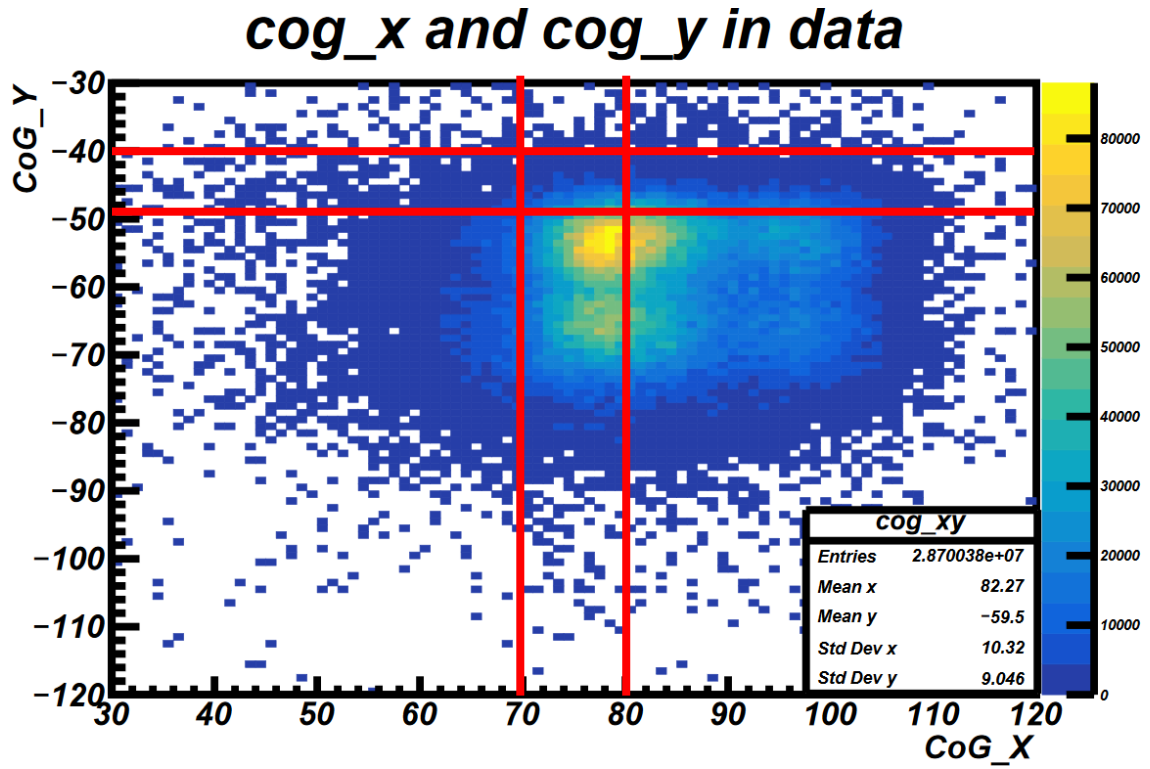
# Basic event selection for 80 GeV electron – June 2018 data

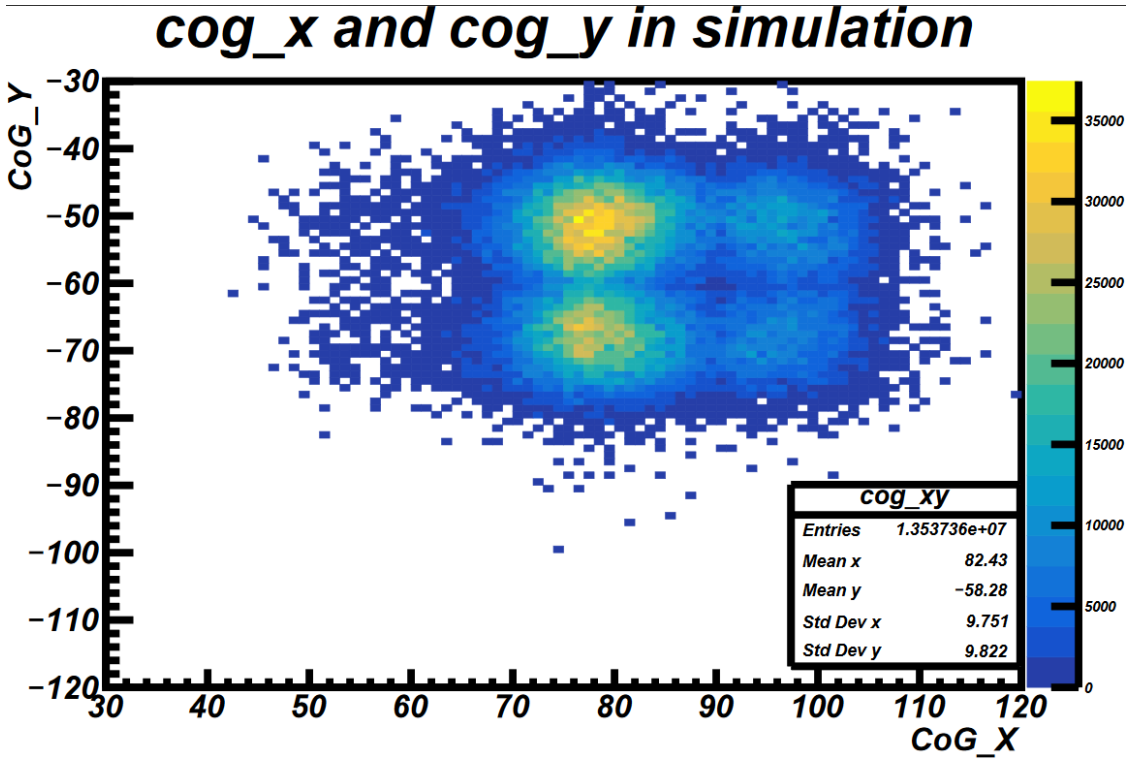
## Run number: 61156

Centre of gravity X: Between 70 mm to 80 mm

Centre of gravity Y: Between -50 mm to -40 mm

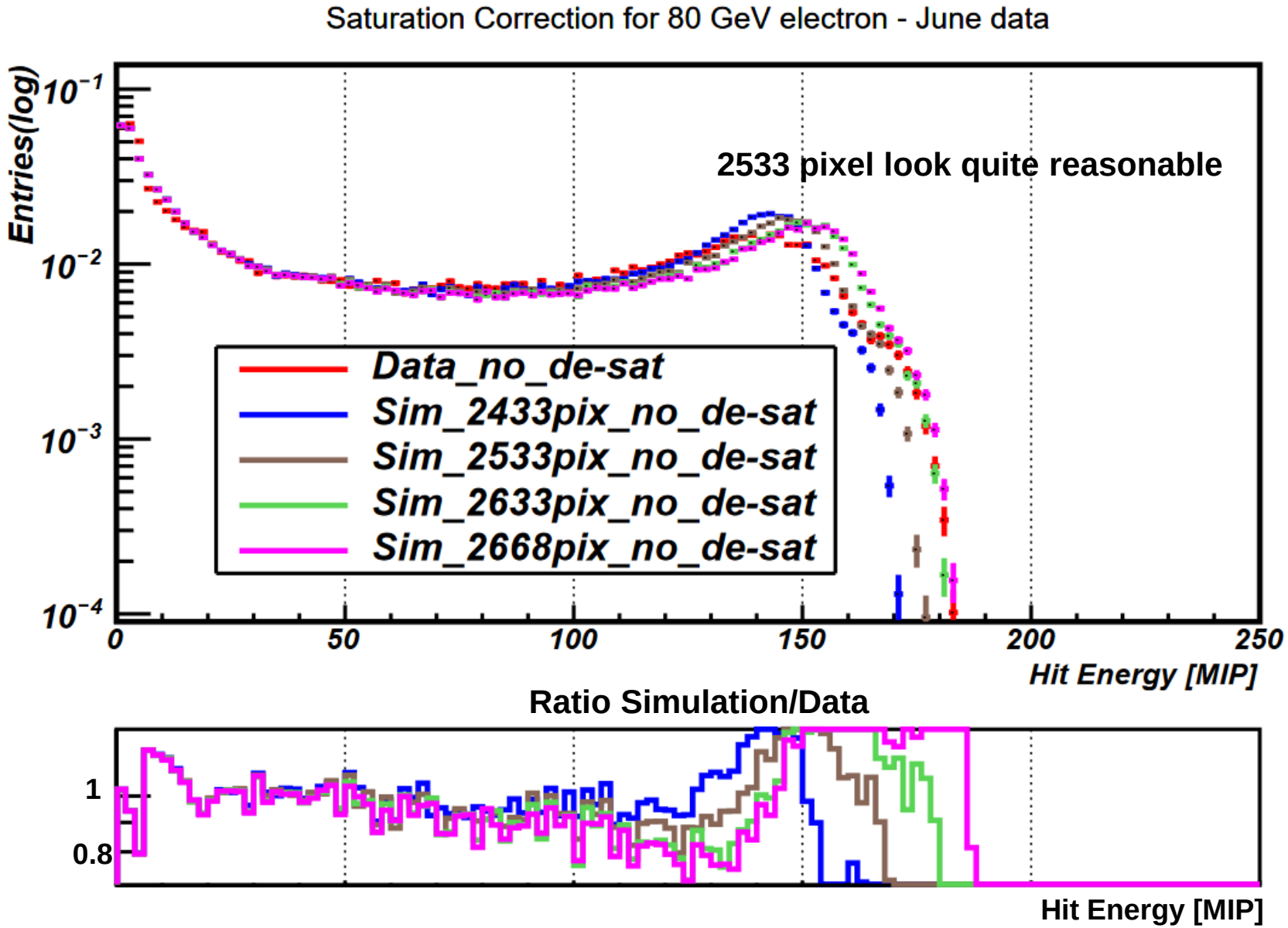
**Choosing 1cm in centre of a tile: Pick events with maximum amplitude**



# Saturation Correction

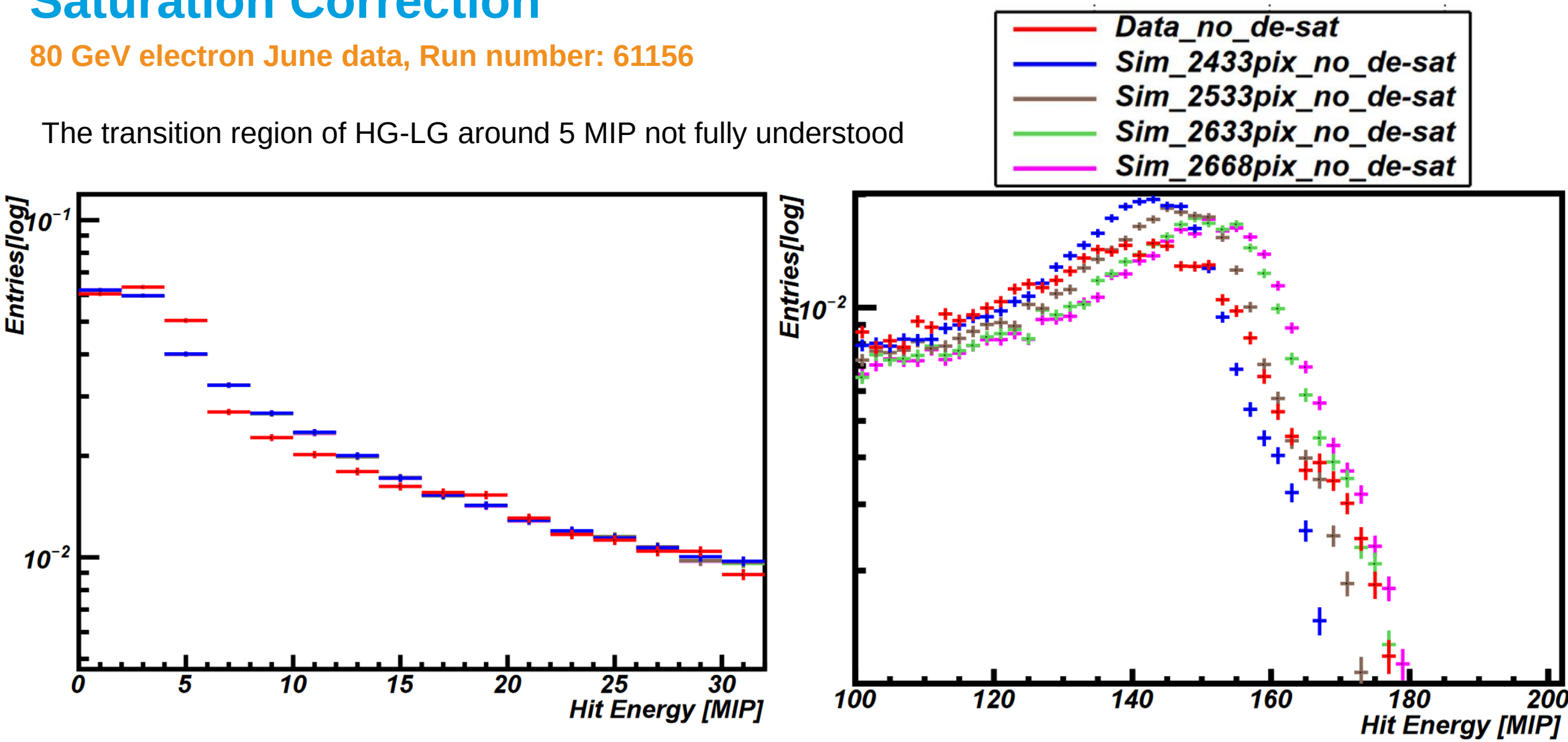
## 80 GeV electron June data, Run number: 61156



# Saturation Correction

## 80 GeV electron June data, Run number: 61156

The transition region of HG-LG around 5 MIP not fully understood



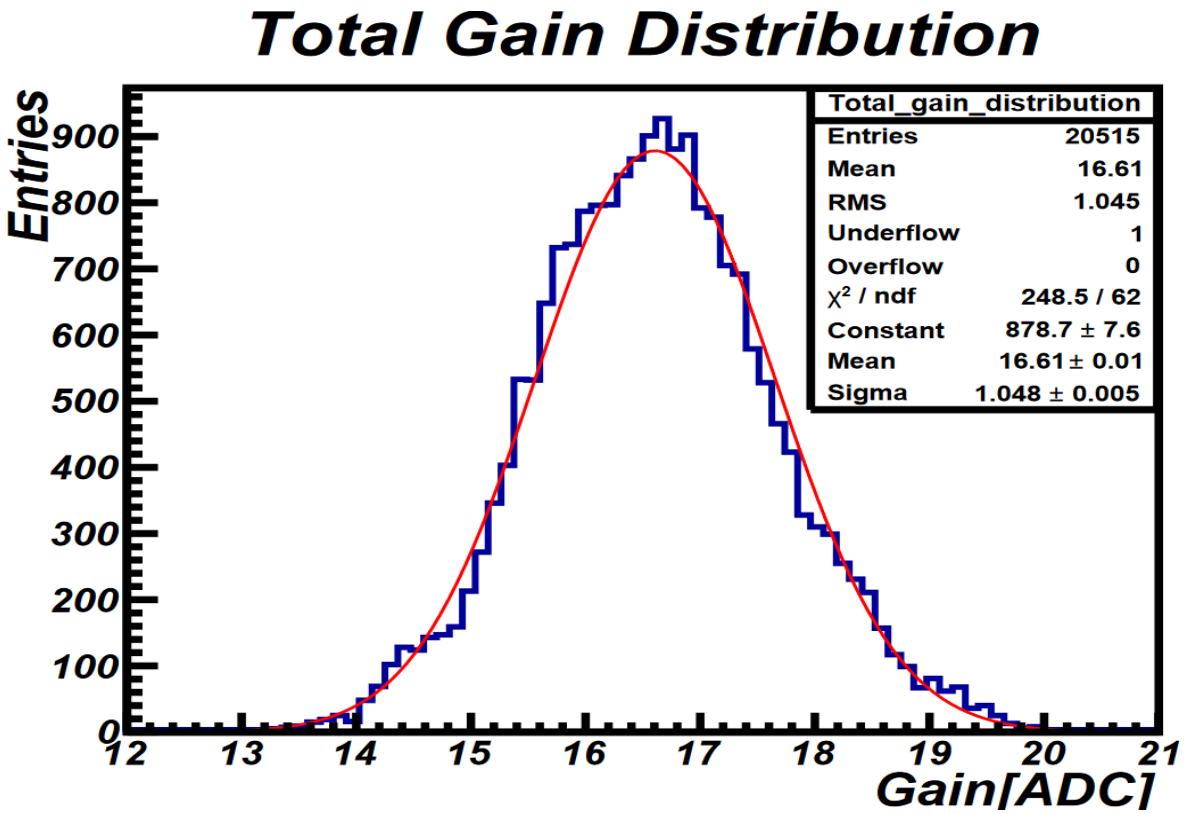
# Gain Calibration

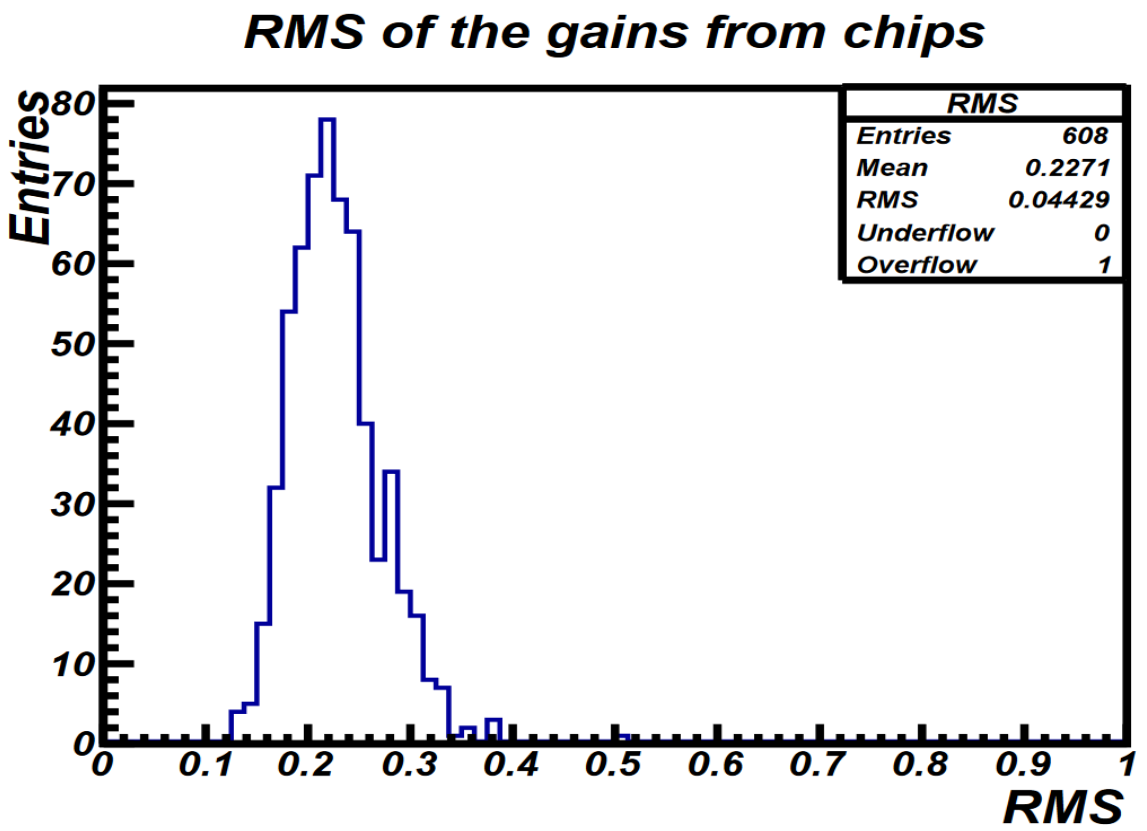
## May 2018

- Fitted channels from each LED voltages are combined.

May: Short LED - no power pulsing run.

- Gain distribution for May which consists only AHCAL(21, 888 channels). **94% channels fitted**
- Remaining 1373 channels - acquire gain value from the mean of the corresponding chip.



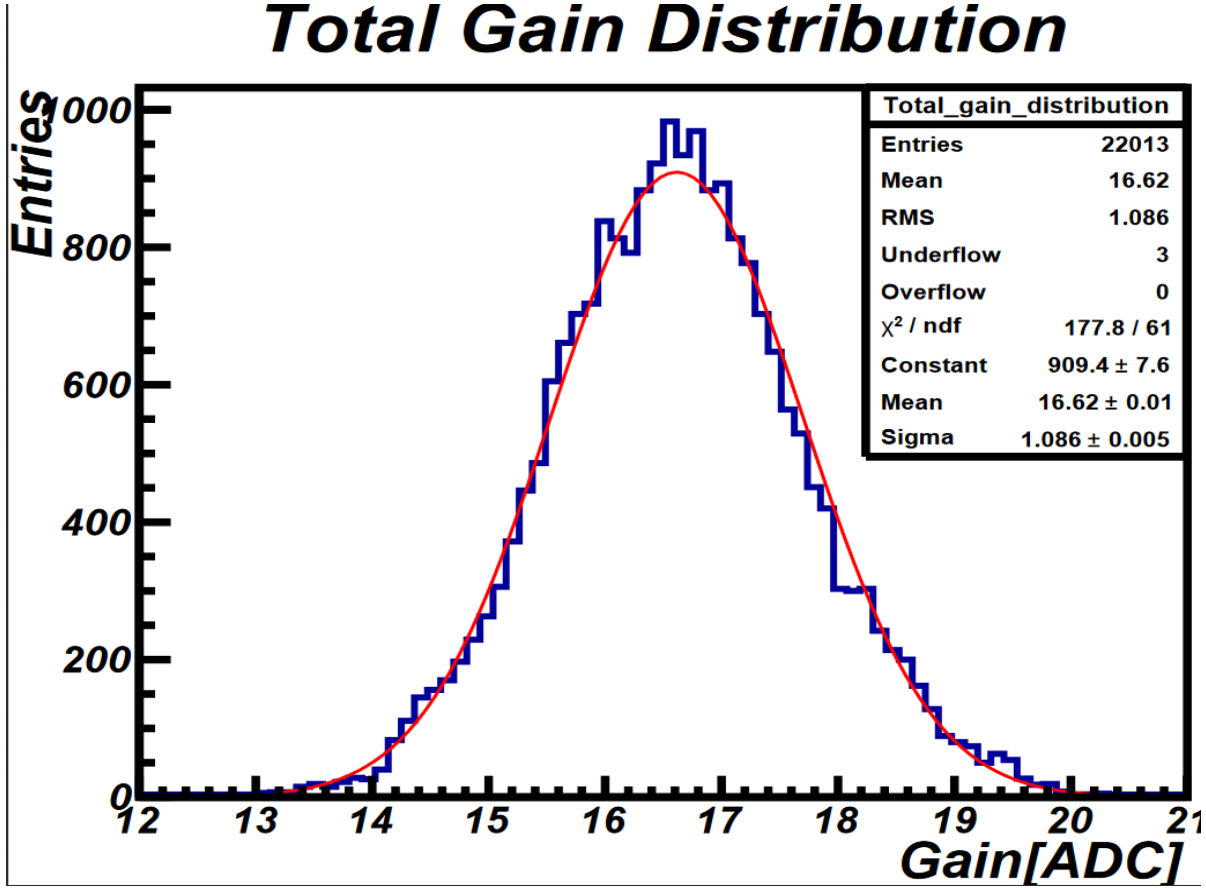



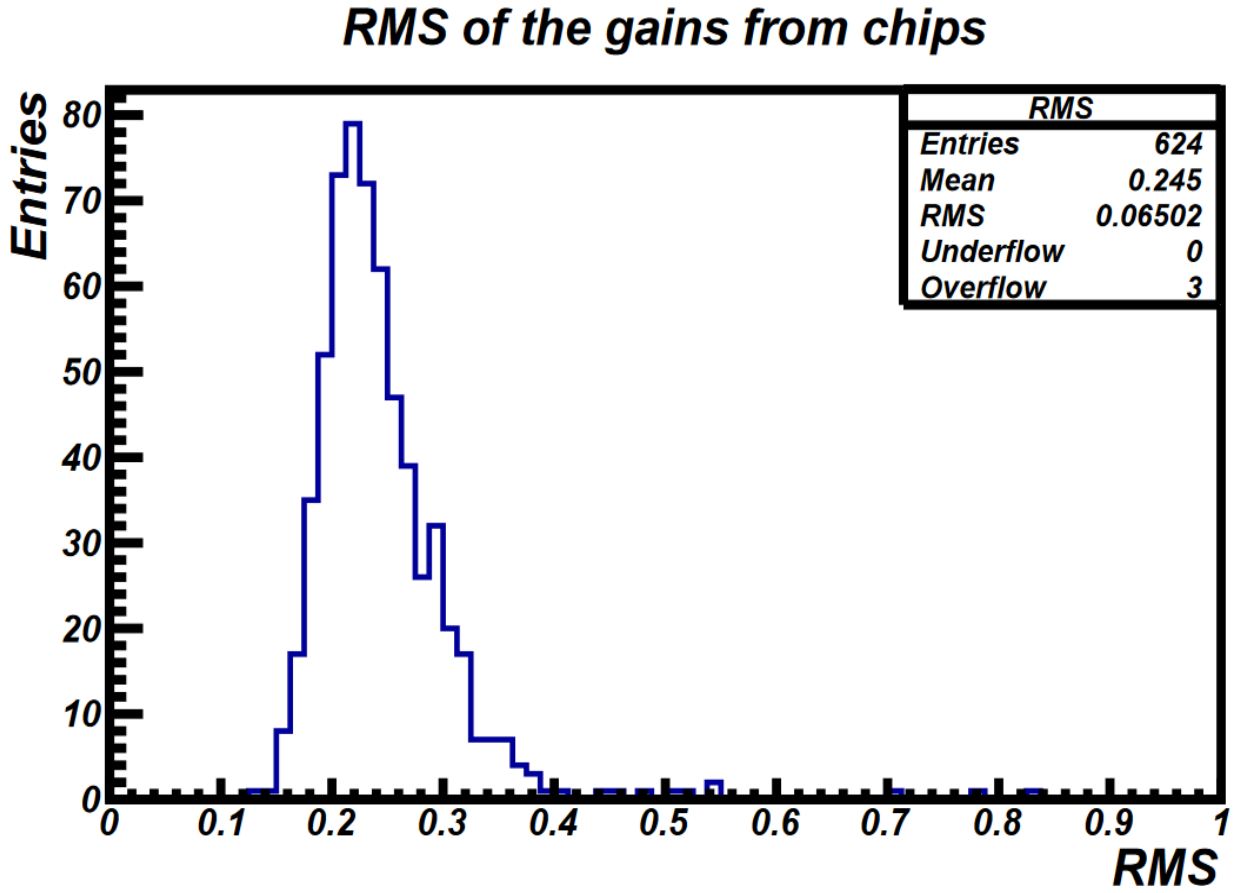
# Gain Calibration

## June 2018

- Gain distribution from June, includes the Tokyo  layer (22464 channels).
- Long LED no power pulsing run on 25.06.2018

**98% channels fitted**



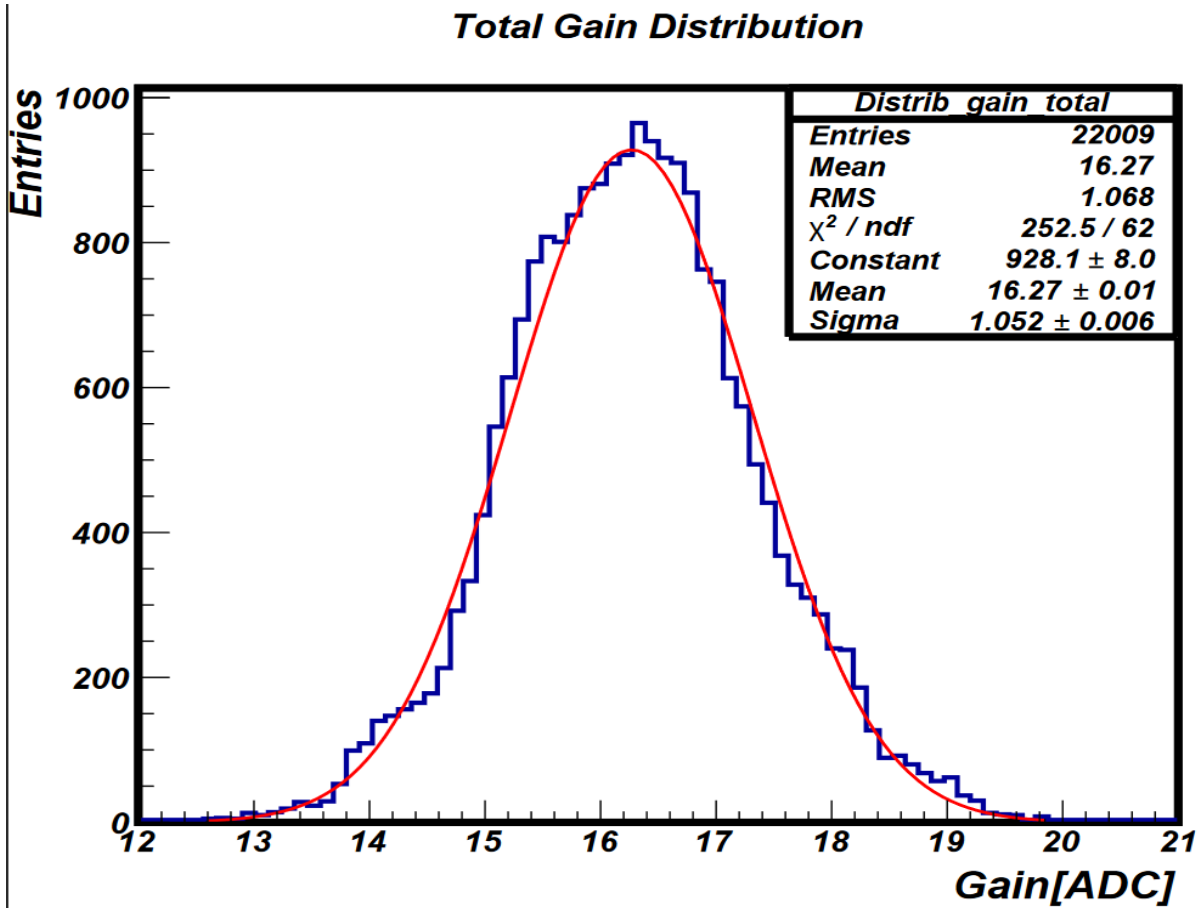



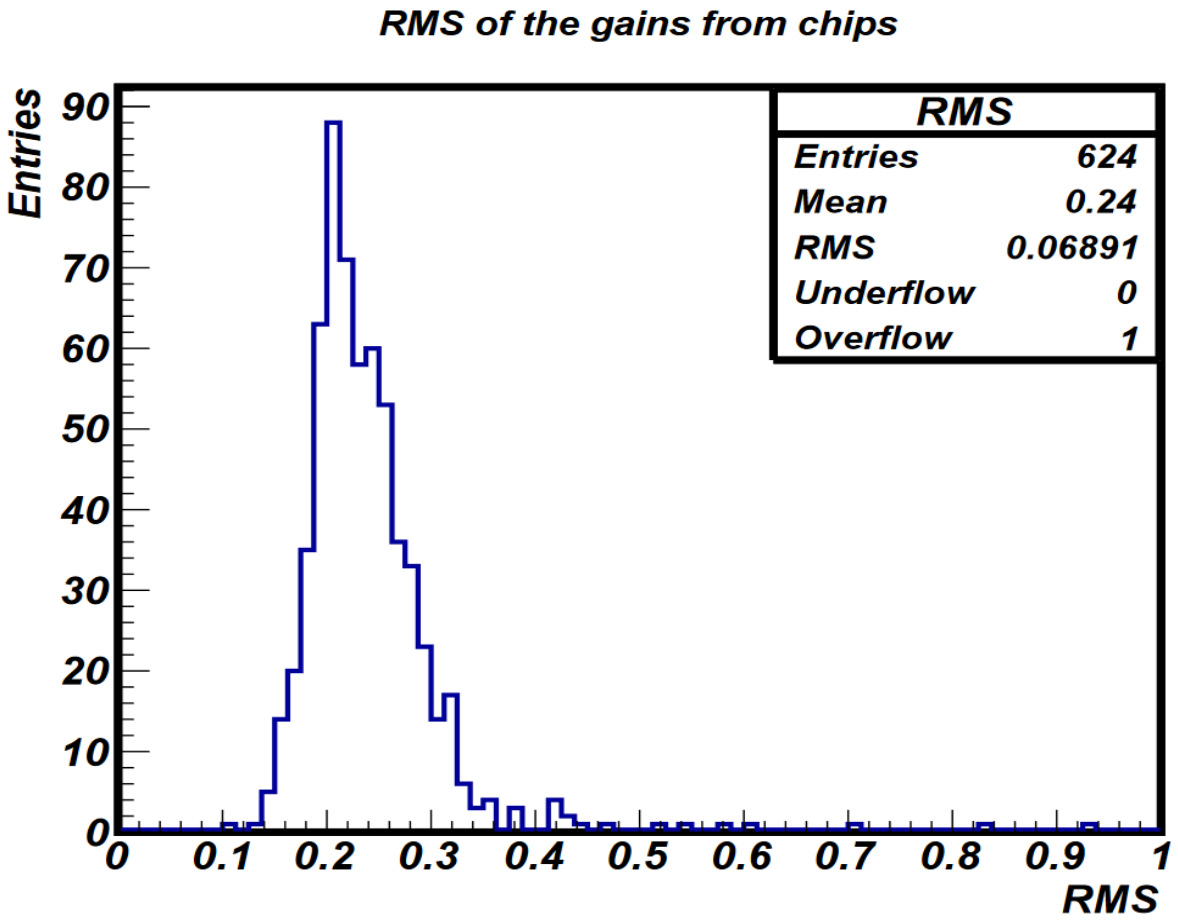
# Gain Calibration

## October 2018

- AHCAL + Tokyo layer.
- Long LED - power pulsing run on 17.10.2018
- 20 mV steps with 2000 cycles each run.

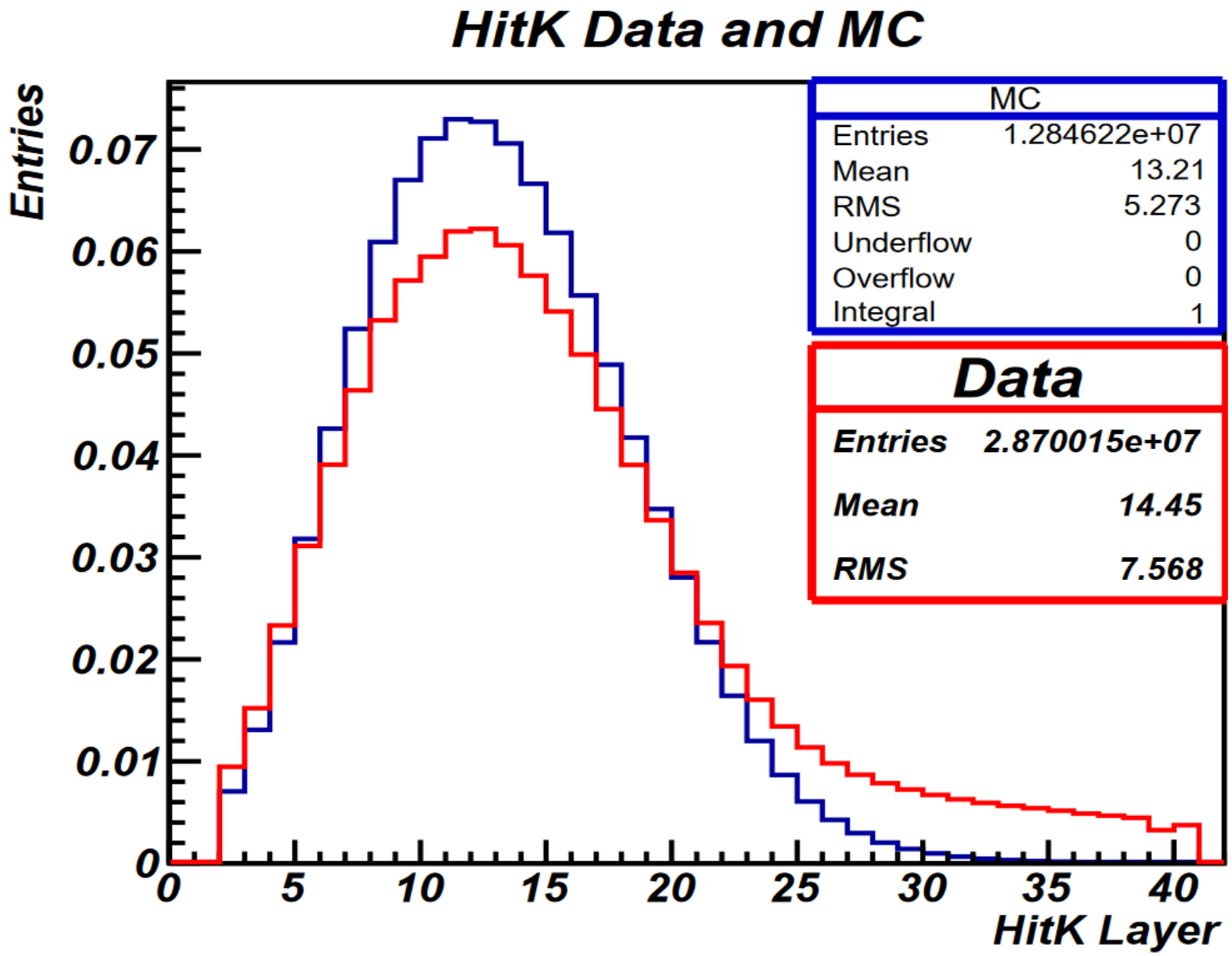
**98% channels fitted**



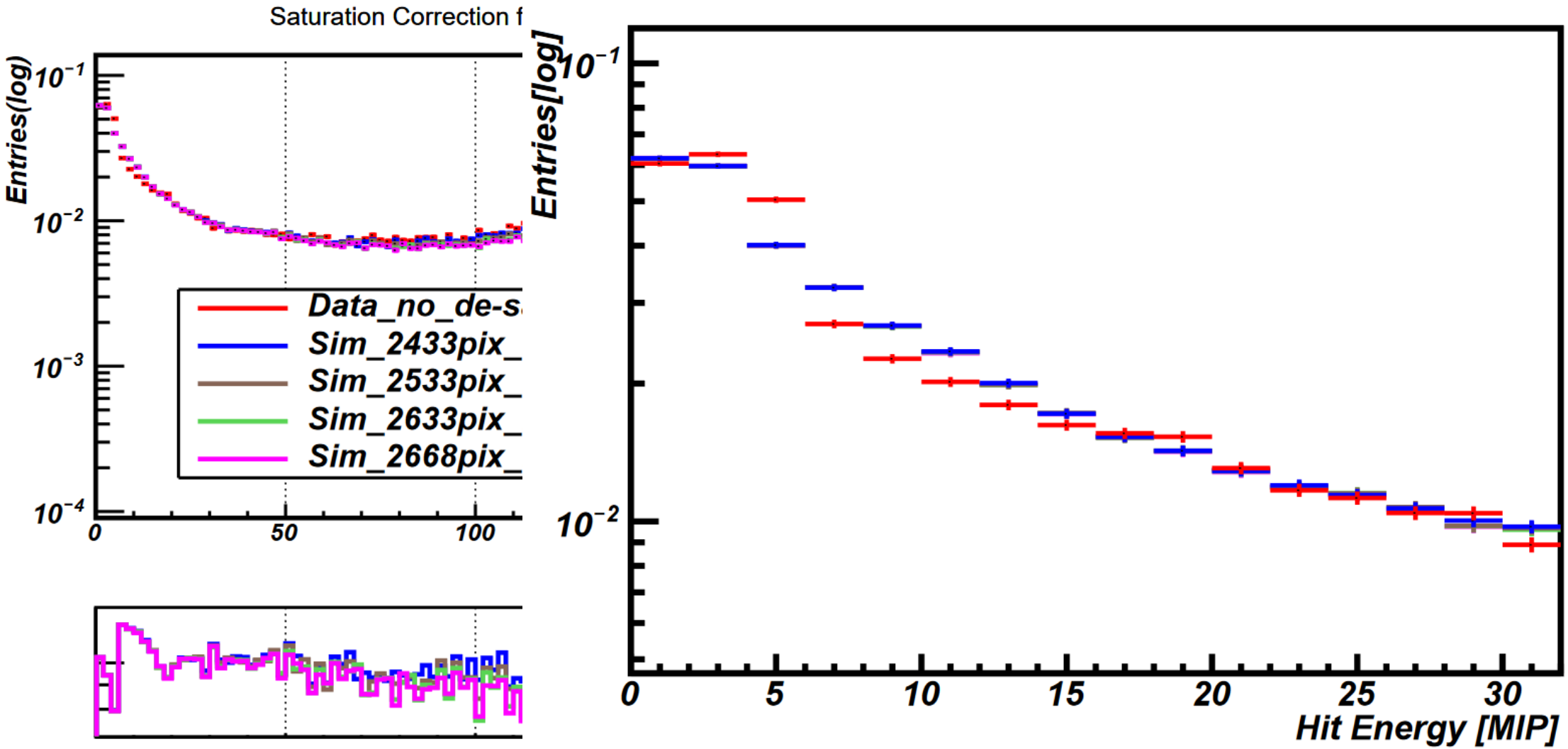
# Hit K

## Data and MC



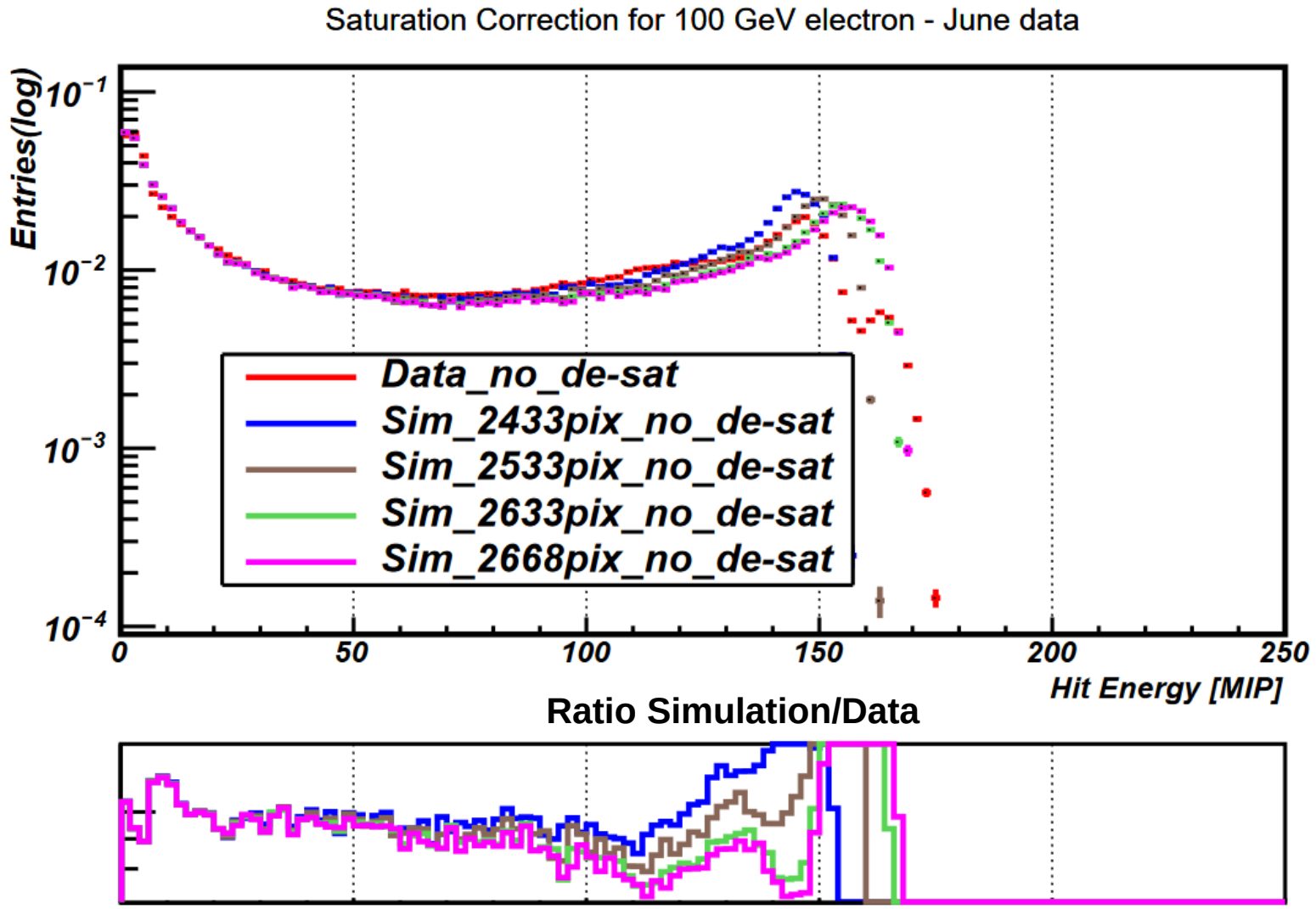
# Hit energy

## At lower MIP values



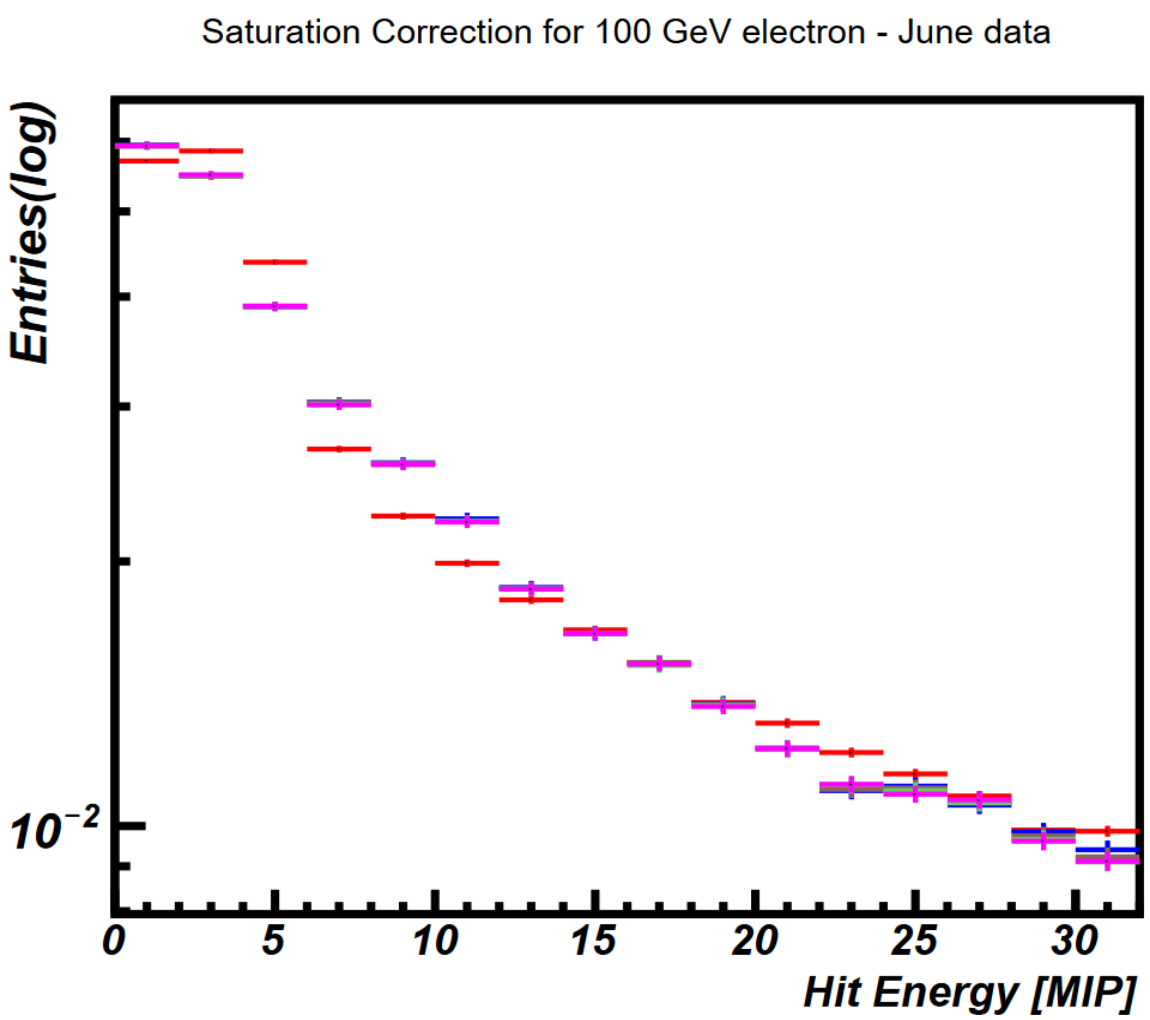
# Saturation Correction

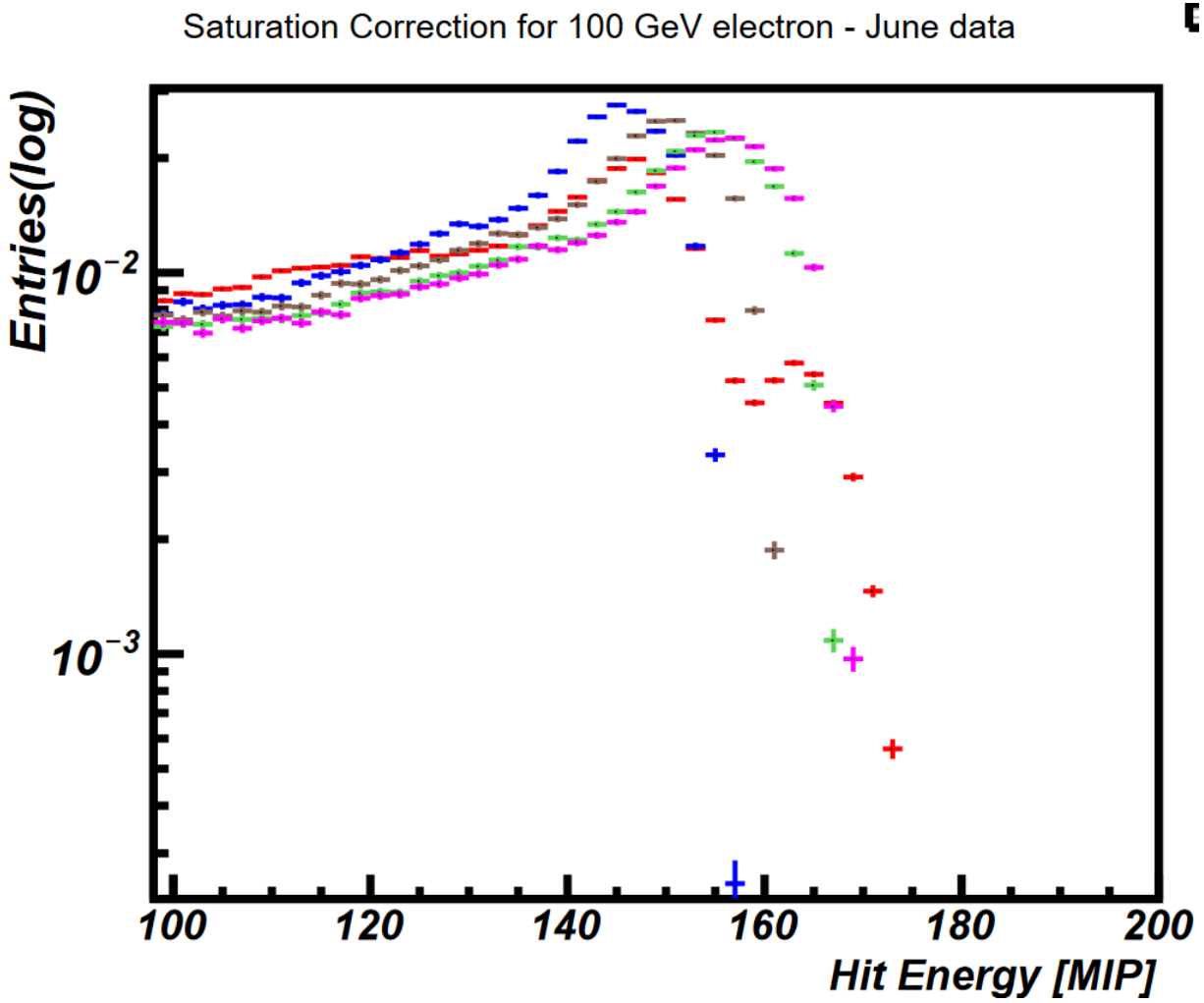
## 100 GeV electron June data, Run number: 61217



# Saturation Correction

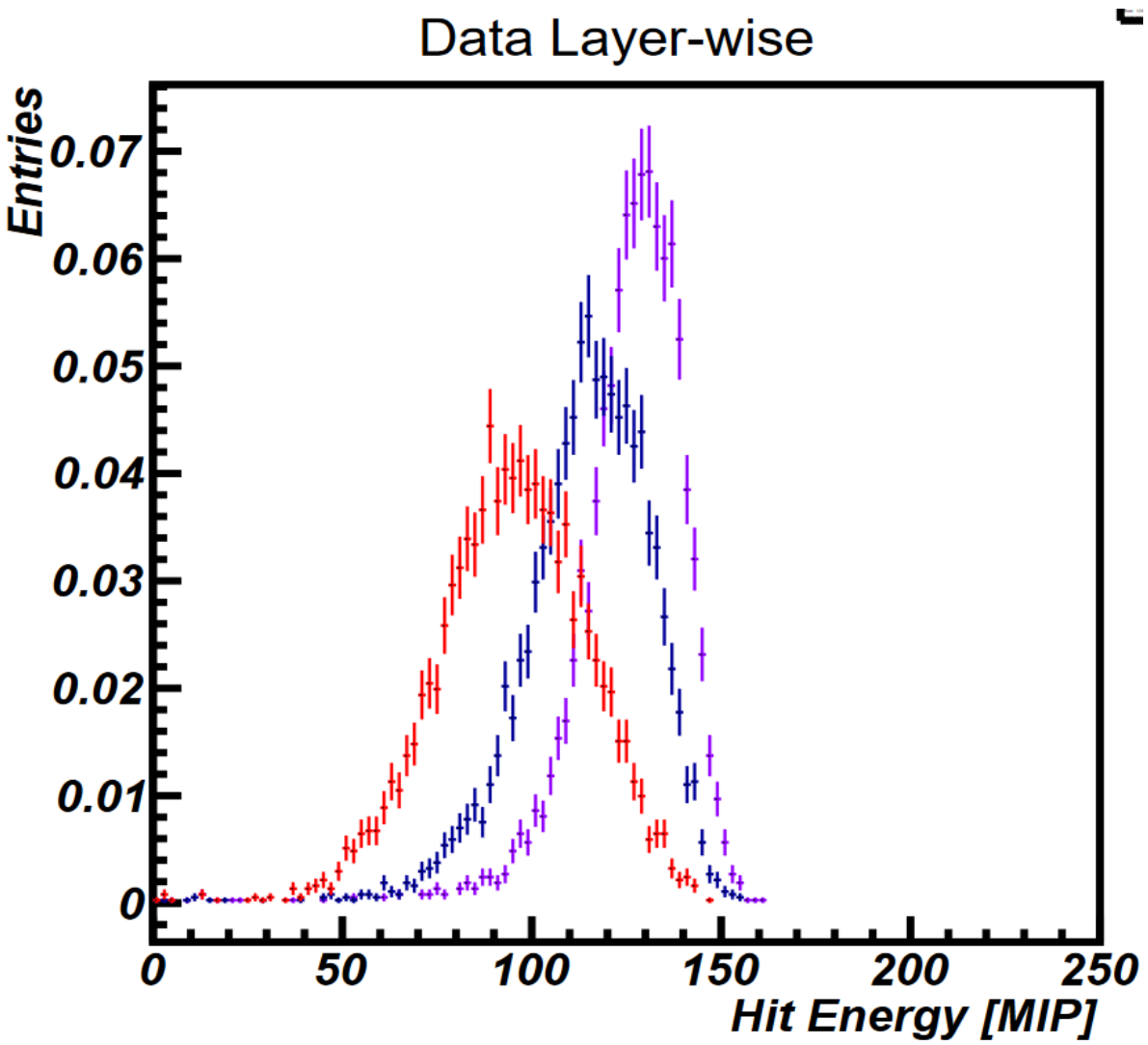
## 100 GeV electron June data, Run number: 61217

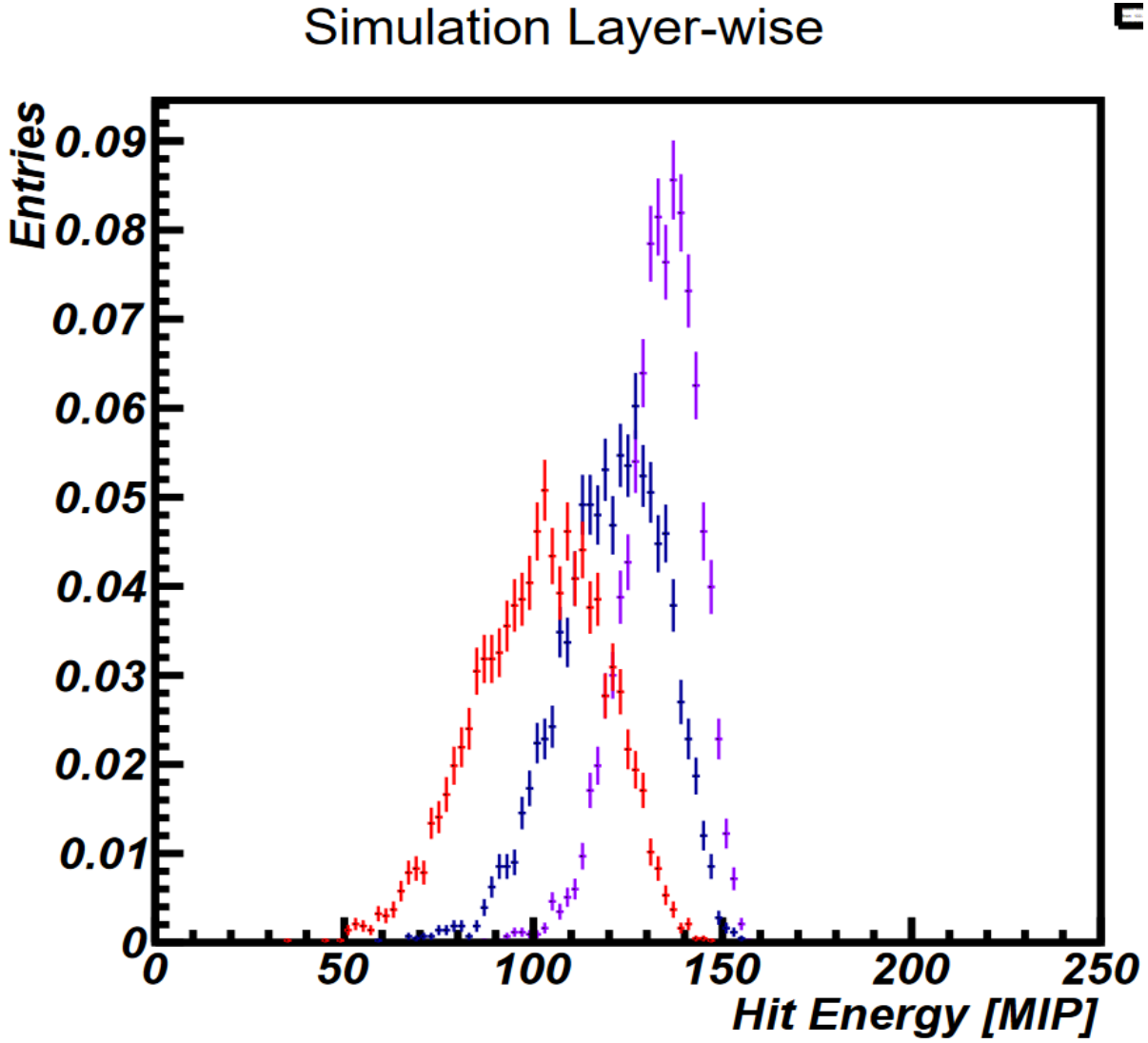



# Hit energy layer wise

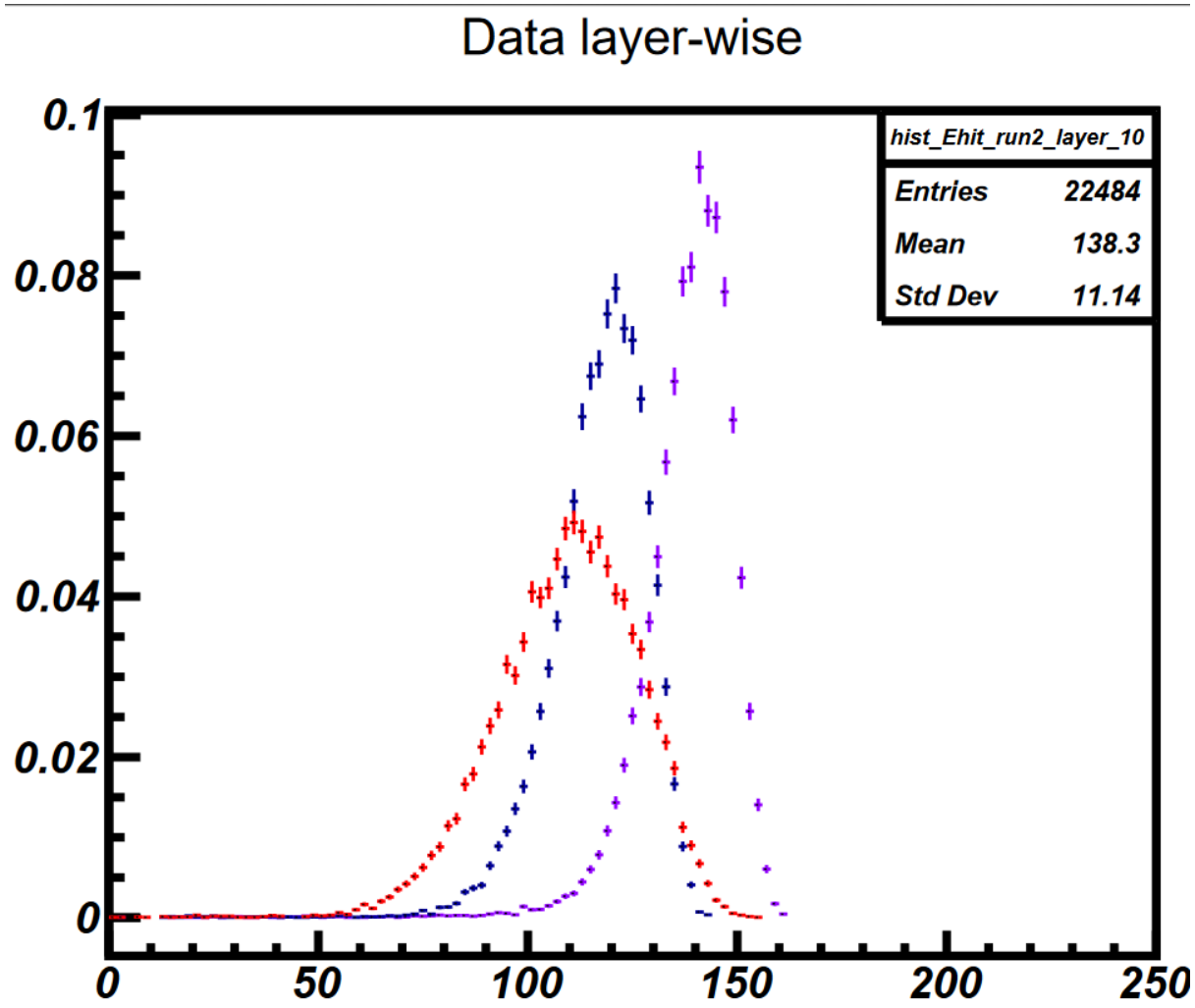
## 80 GeV electron

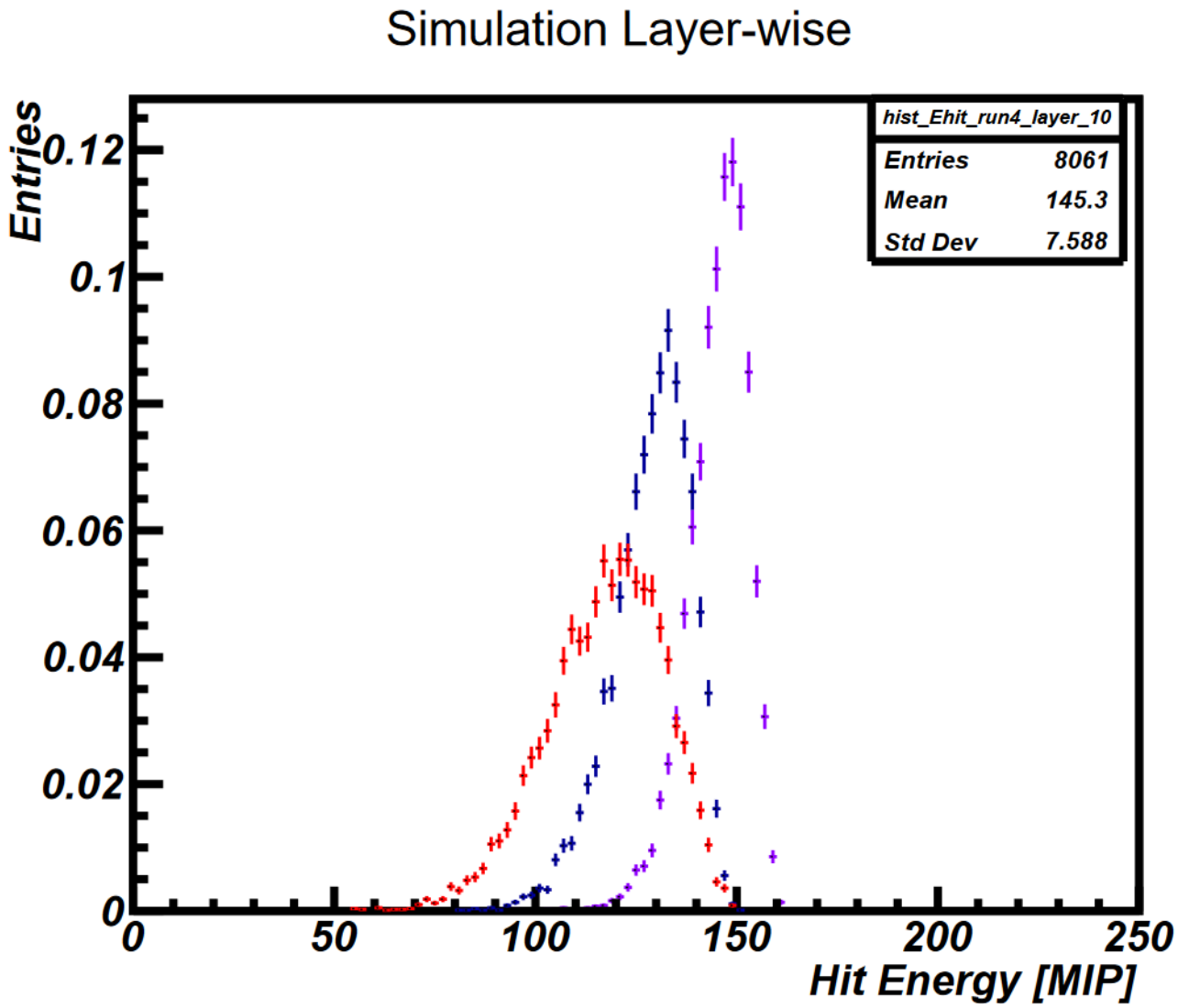


# Hit energy layer wise

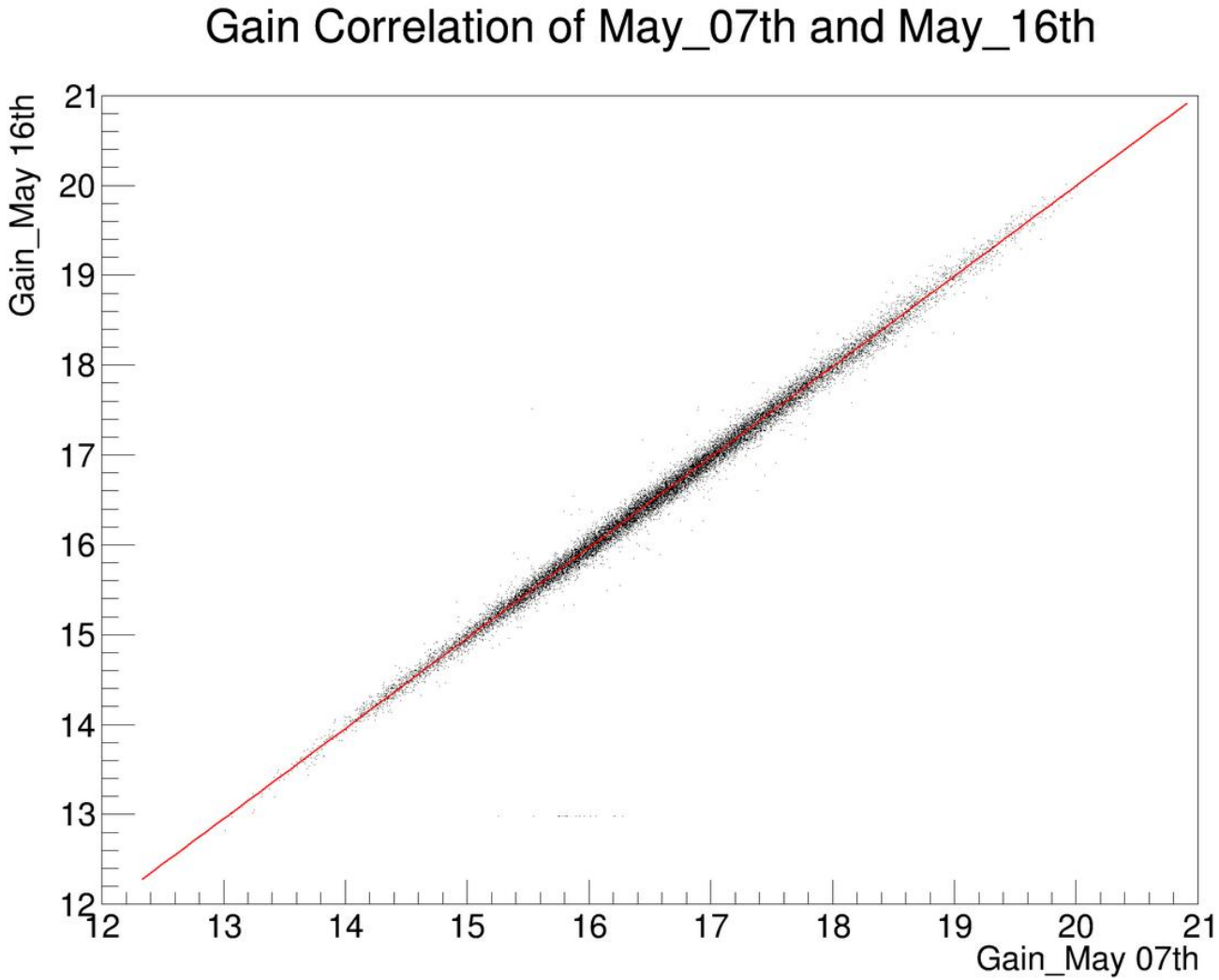
## 100 GeV electron



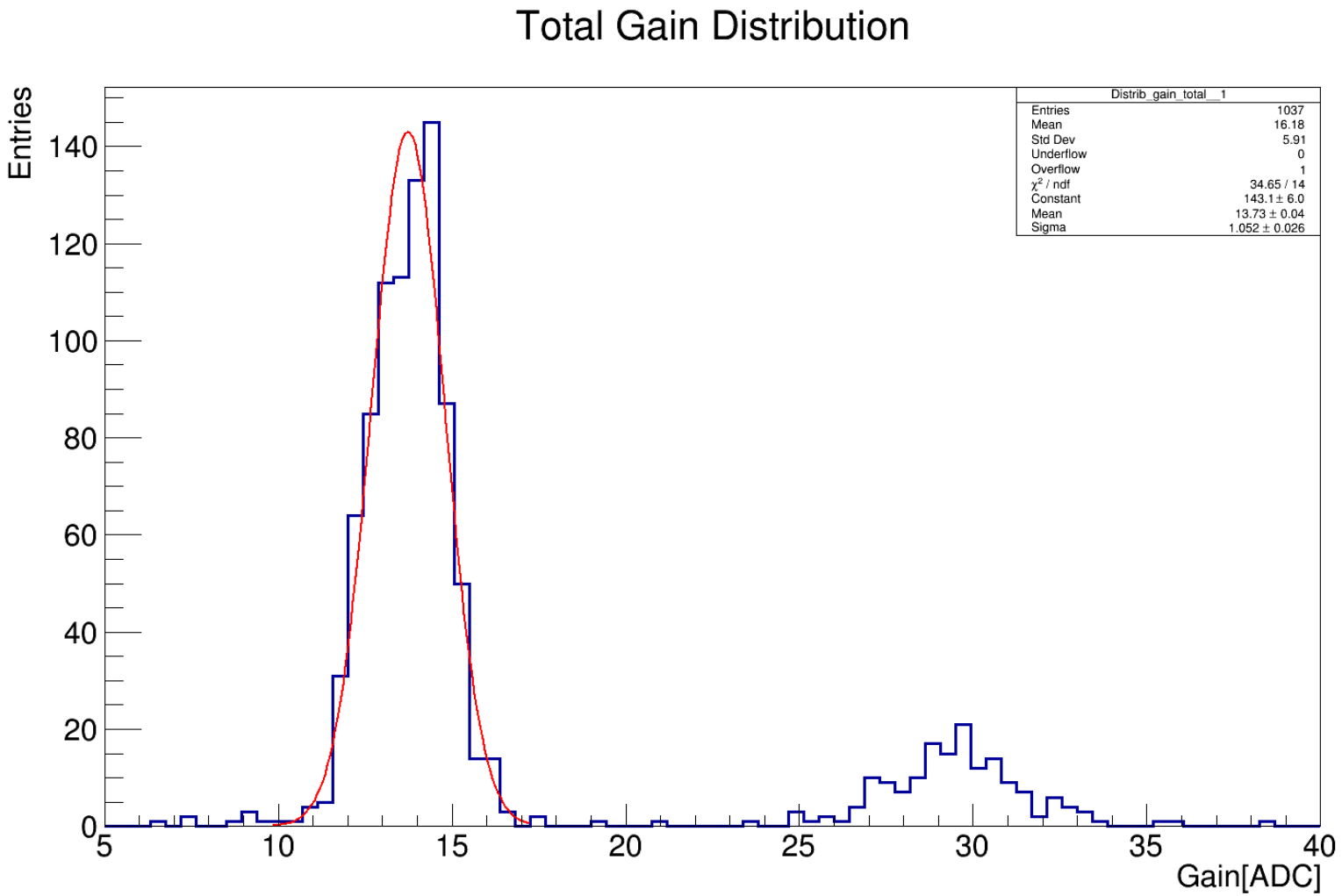
# Gain Correlation

## Between two days



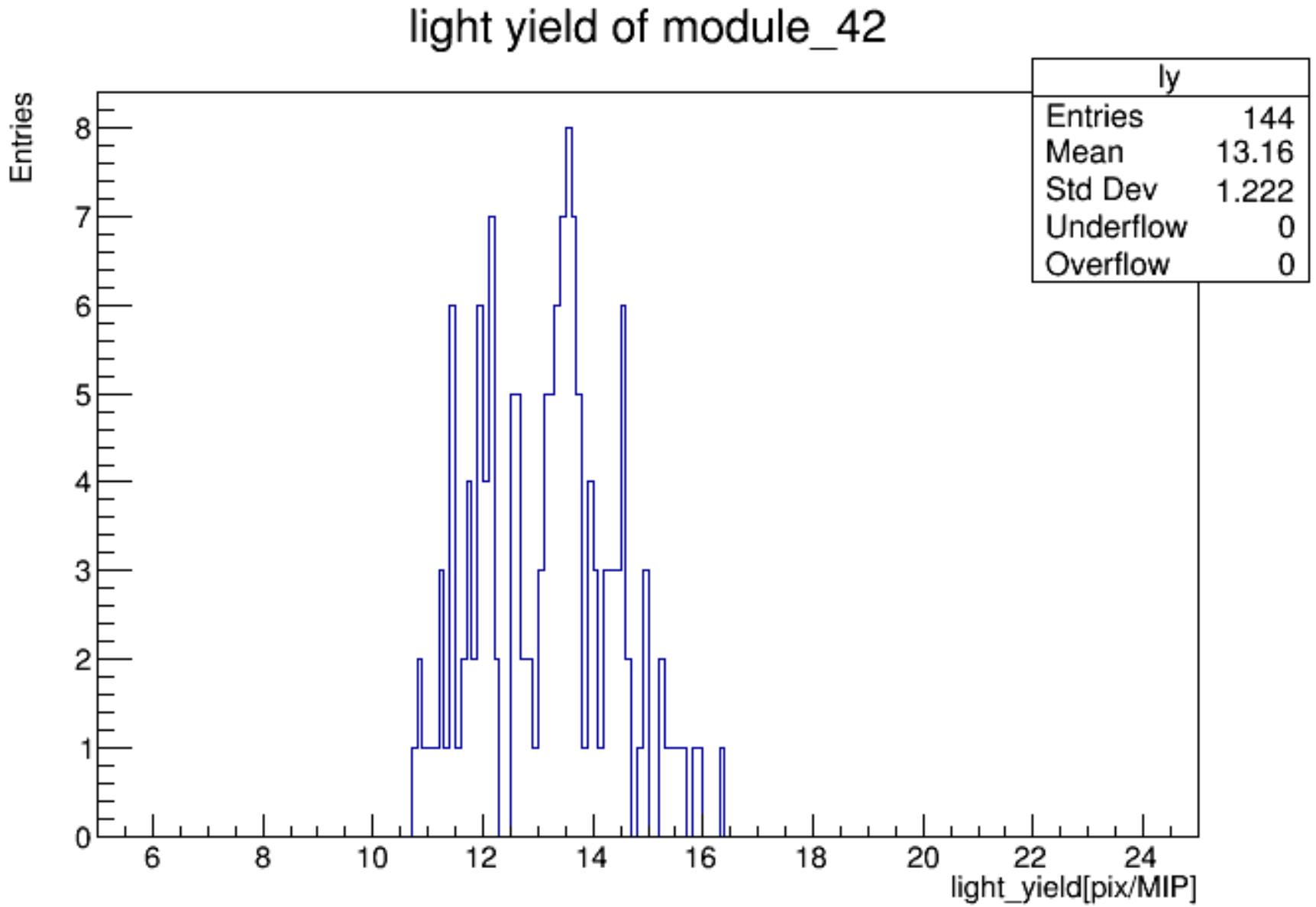
# Gain of Tail Catcher

## Module 43 to 54



# Light Yield

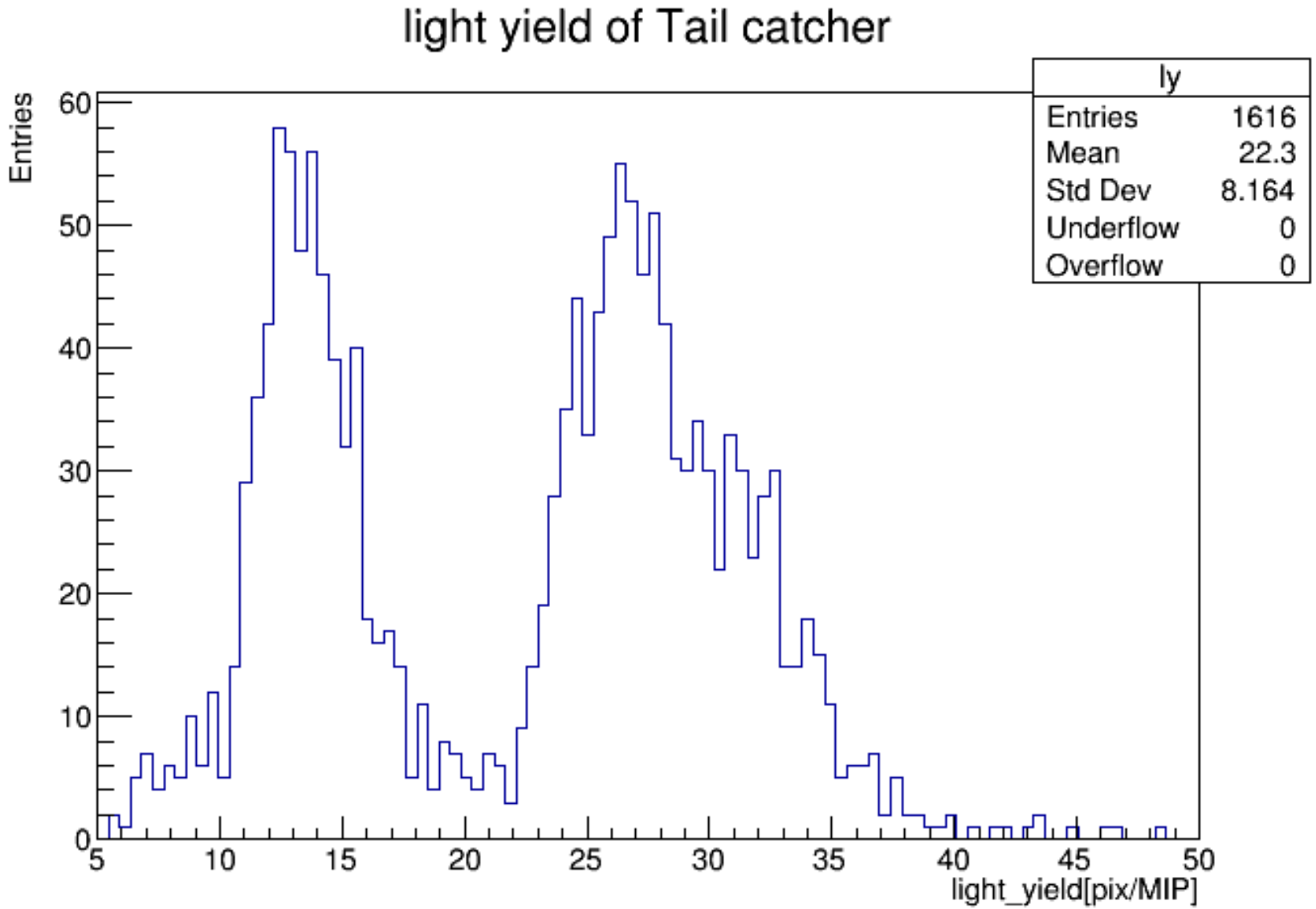
## Pre-shower



# Light Yield

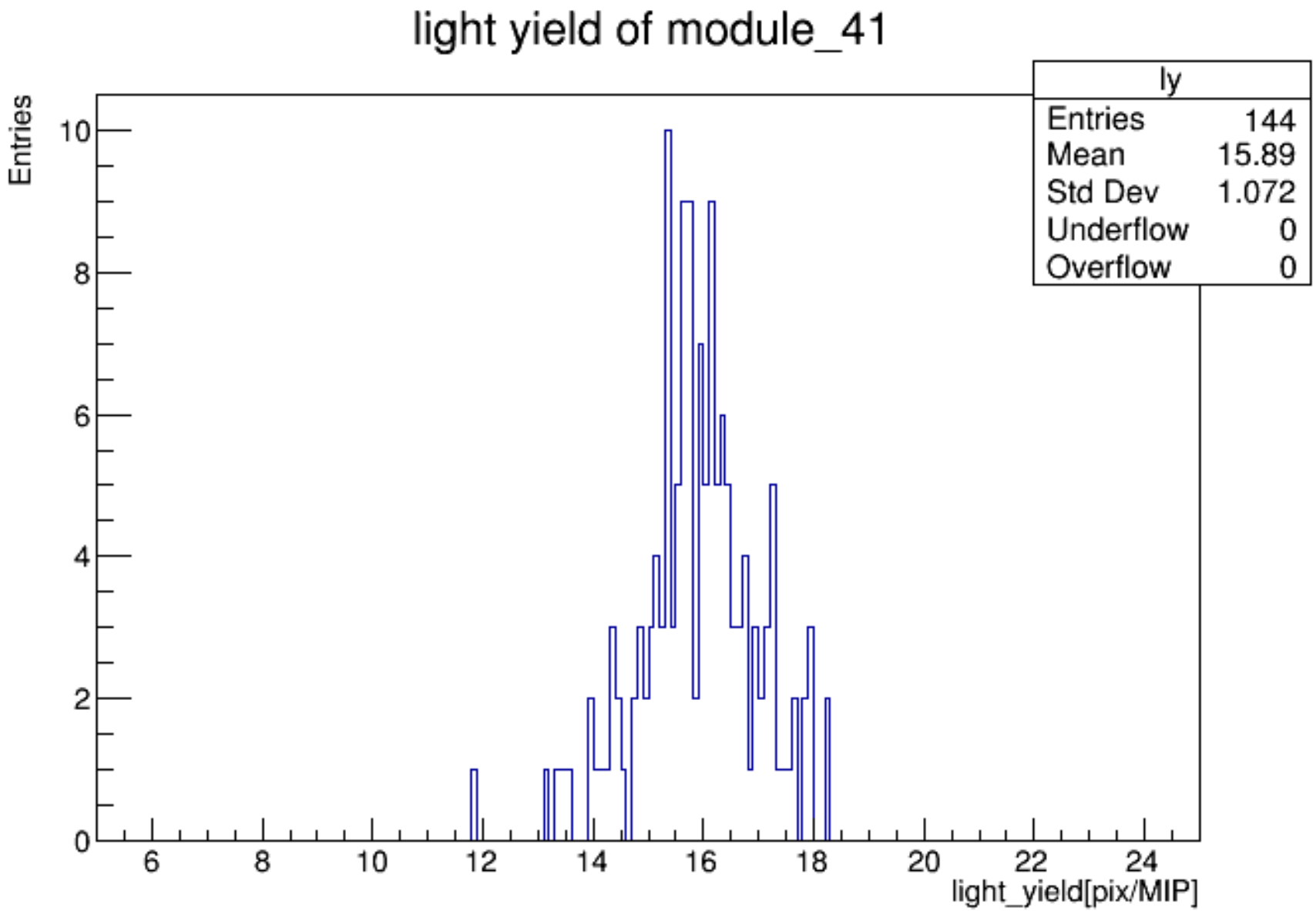
## Tail Catcher

New one here



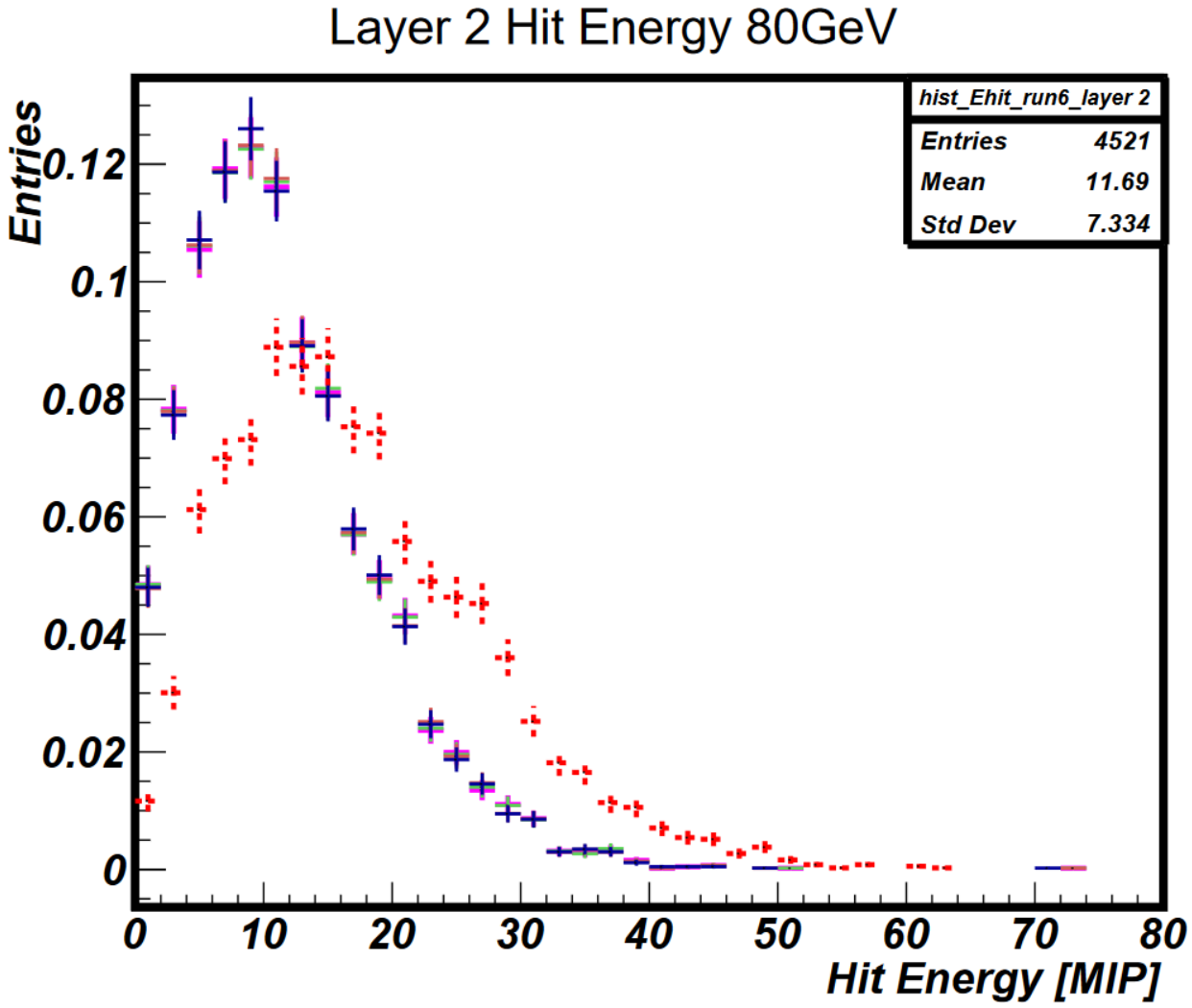
# Light Yield

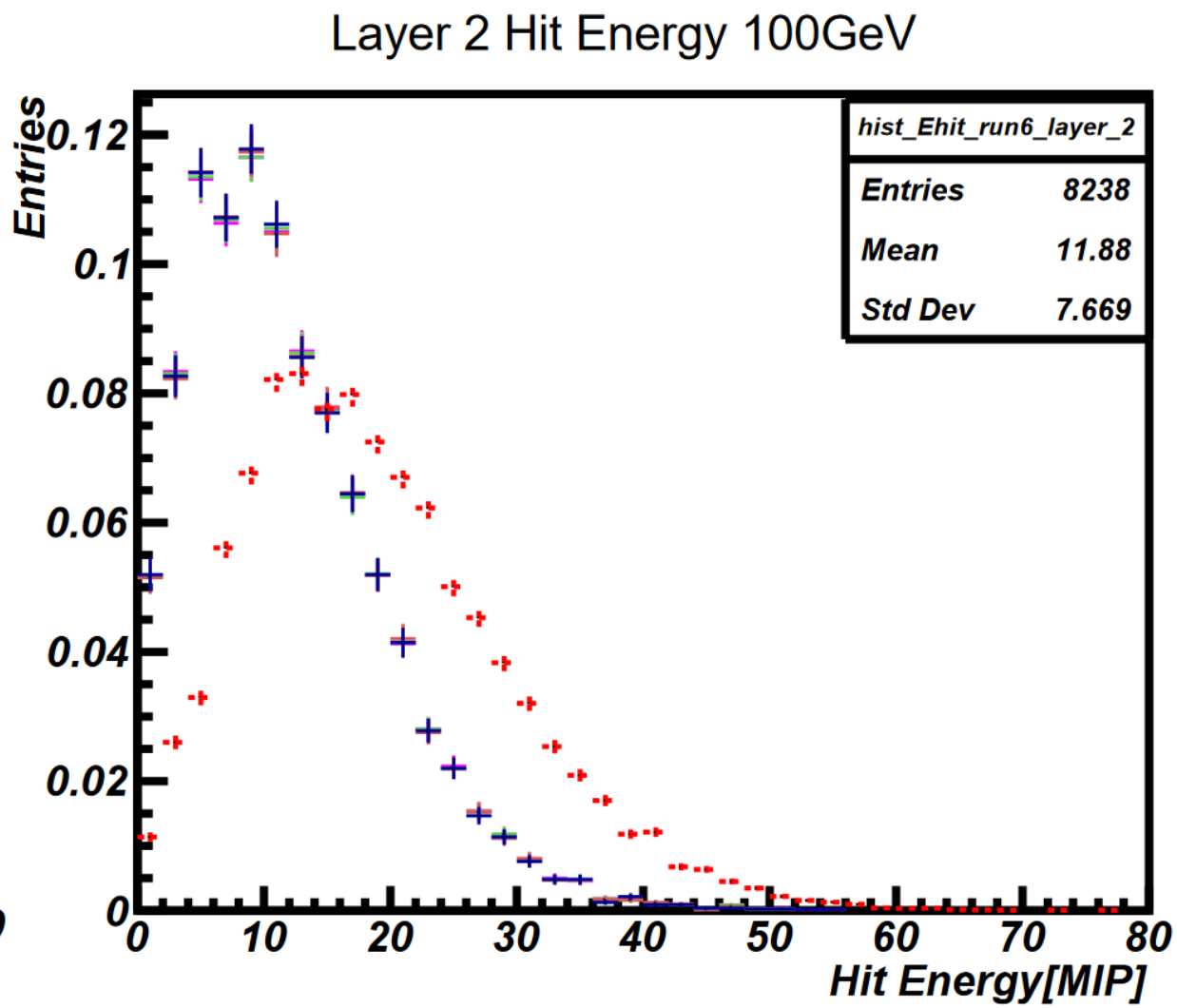
## Tokyo layer



# Hit energy for 80 GeV and 100 GeV electron

## Layer 2



# Conclusion

| | Gain | |
|---|---|---|
| AHCAL | Pre-Shower | Tail Catcher |
| ~16 ADC | Varying from ~15-16 ADC | ~15 and ~30 ADC |
| | **Light Yield** | |
| AHCAL | Pre-Shower | Tail Catcher |
| ~14 pix/MIP | Varying from ~14 pix/MIP | ~13 and ~27 pix/MIP |
| | **Saturation Correction** | |
| 2433 | 2533 and 2668 | 2533 |
| Under-estimates the data | Over-estimates the data | Agrees to certain extent with data |
| | | |