Charge reconstruction with AMS-02 L0

November Test Beam Data @ SPS

AMS-02 Perugia Group

Overview

1. Test beam and ladder introduction

2. Analysis and signal corrections
   - Eta correction
   - VA equalization

3. Comparison between the corrections

4. Charge resolution

The Beam

- Primary beam of 379 GV/c Pb hitting a 40 mm Be target

- Ions produced by fragmentation

- Selection by rigidity: around 300 GV/c (MIPs)

- The setup used corresponds approximately to A/Z = 2

The Ladder

- Composed by 10 silicon sensors and 16 VA (64 channels each)

- Silicon thickness = 320 ± 20 μm

- Number of total strips/readout = 4096/1024

- Strip pitch = 27.25 μm
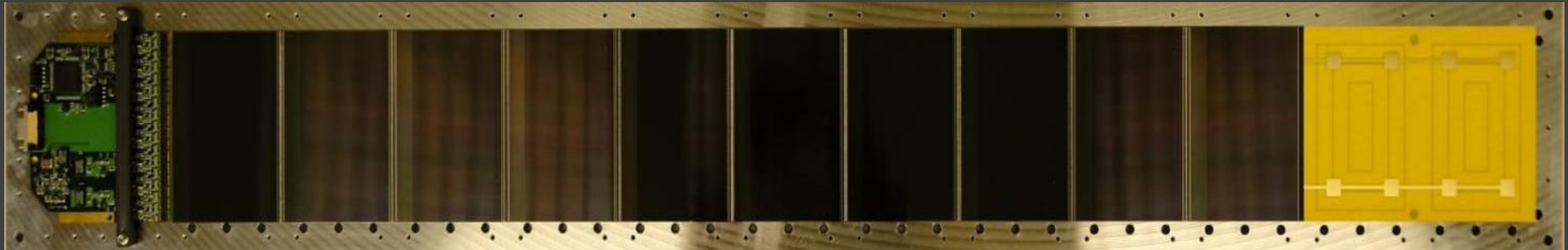
The Dataset

- ~ 12.6 hours between November 25th/26th
- Data Blocks: 6/061– 6/826 with Cal: 6/052
- Trigger-to-hold time: 6.5 µs

# The Custerization

- First strip found with S/N ≥ 5.5 is the seed
- Adjacents are added if S/N ≥ 2.0

Eta Definition

- $\eta = S_R / (S_R + S_L)$ where S_R and S_L can represent the seed signal and the secondary strip signal, based on the position of the secondary (with respect to the seed)

- The charge is shared between the closest readout strips

- It represents the enegy loss between two readout strips

a) $\eta \sim 0$
b) $\eta \sim 0.375$
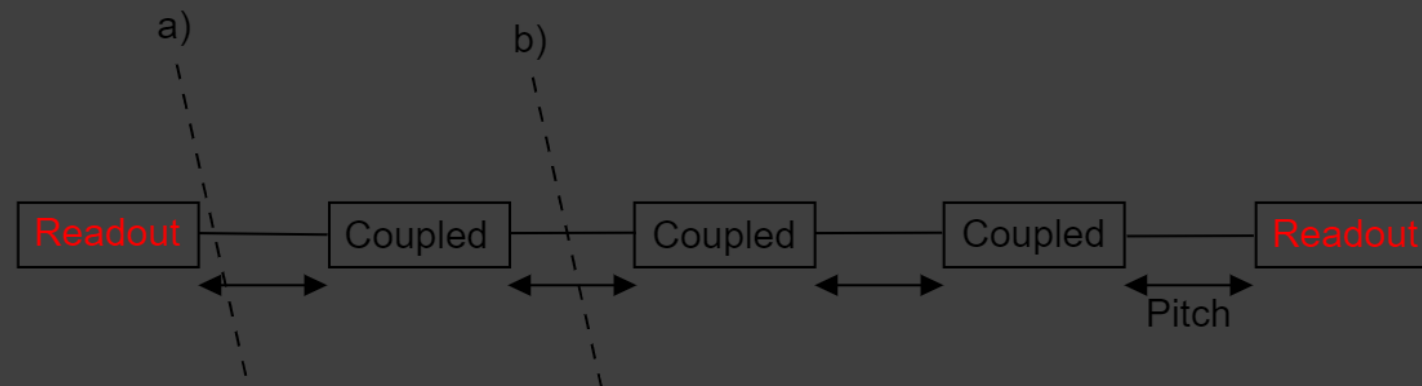
The Analysis

- Distribution of the cluster total signal vs eta

- Took only the most energetic cluster per event

- The horizontal bands correspond to different nuclei species
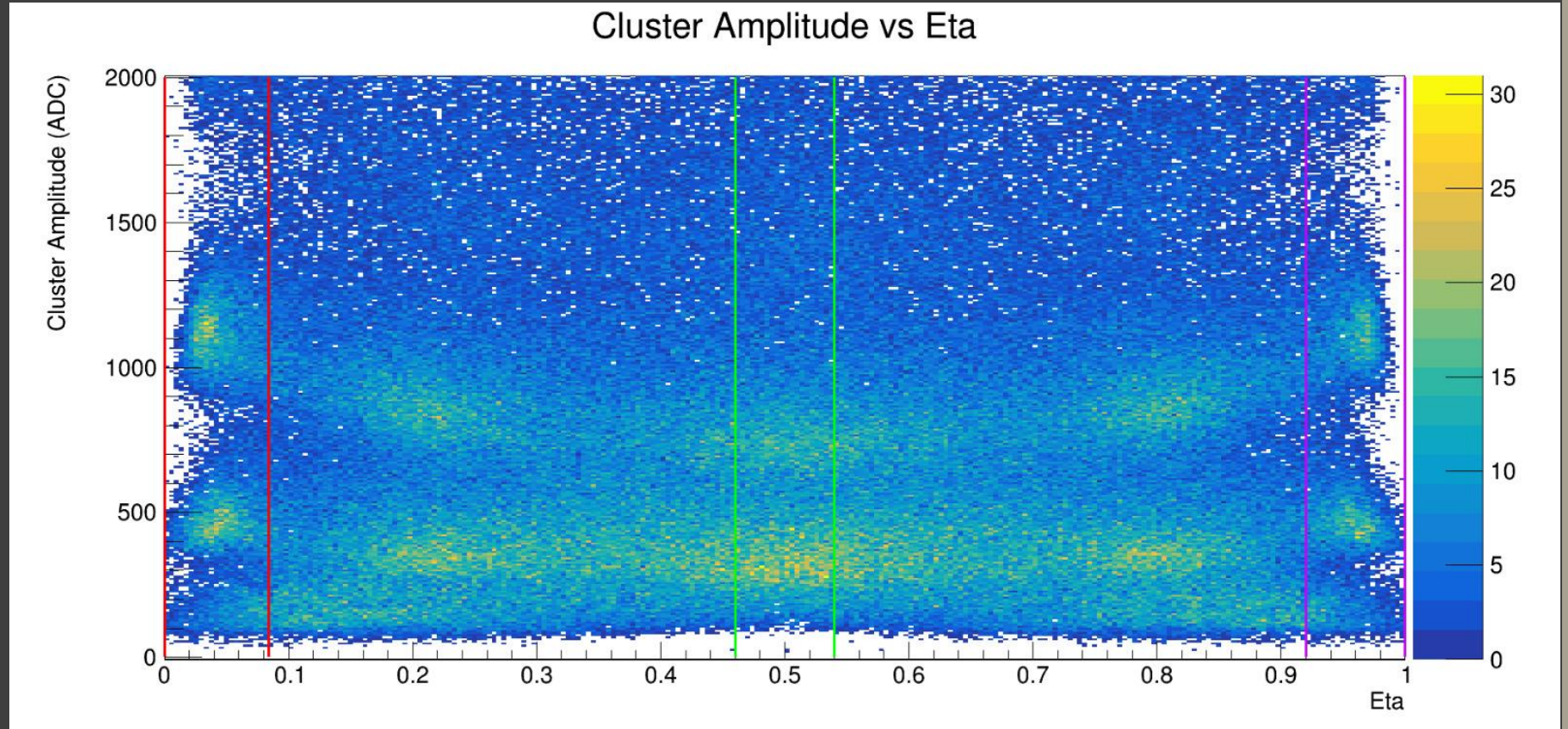
- Saturation of the VA around 9000-10000 ADC

Cluster Amplitude vs Eta
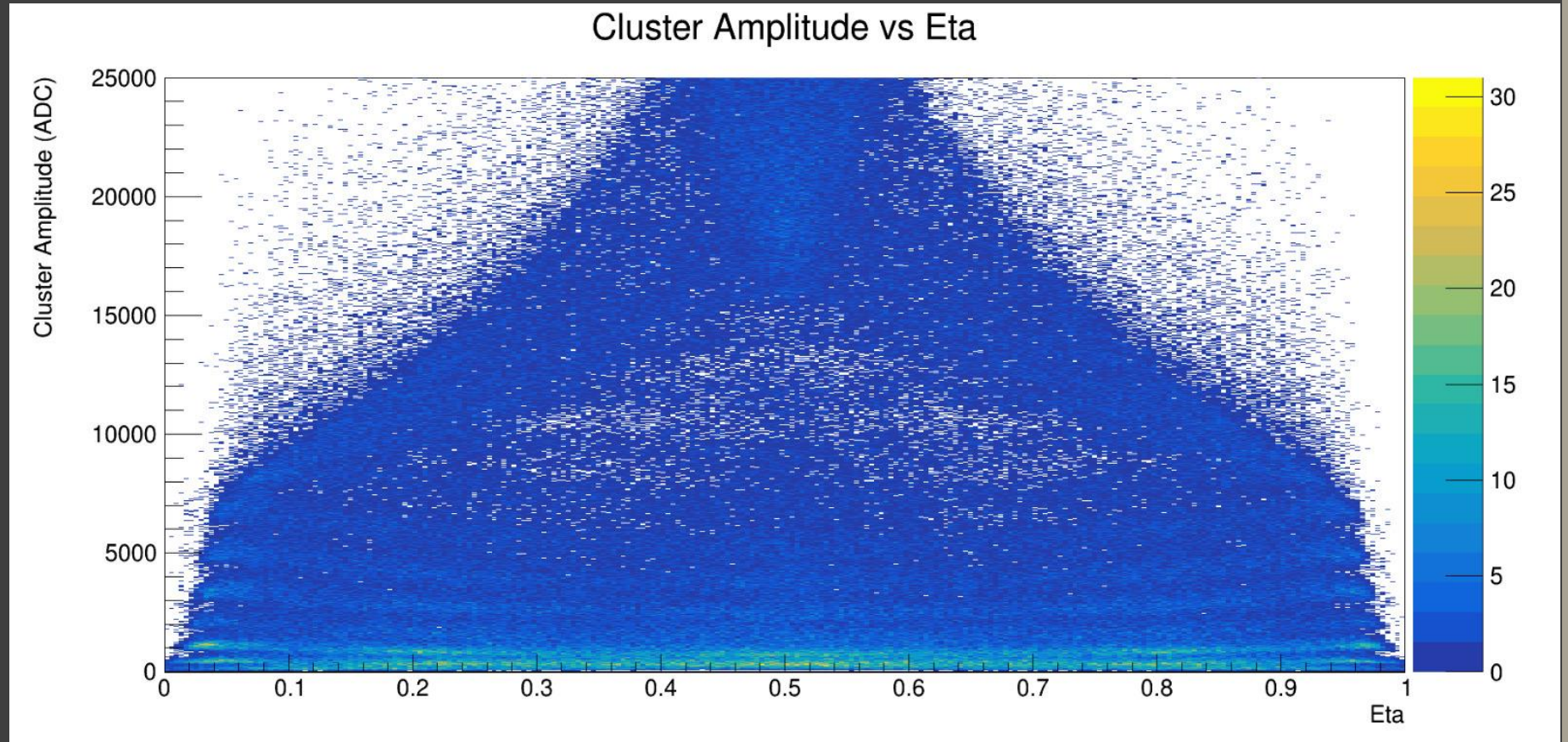
The Analysis
Eta correction

- Inter-strip energy loss is assumed to have a parabolic dependence:

  f (η) = aη² + bη + c

- Using the Z=2 sample to evaluate the correction by fitting the *y* projections one finds:

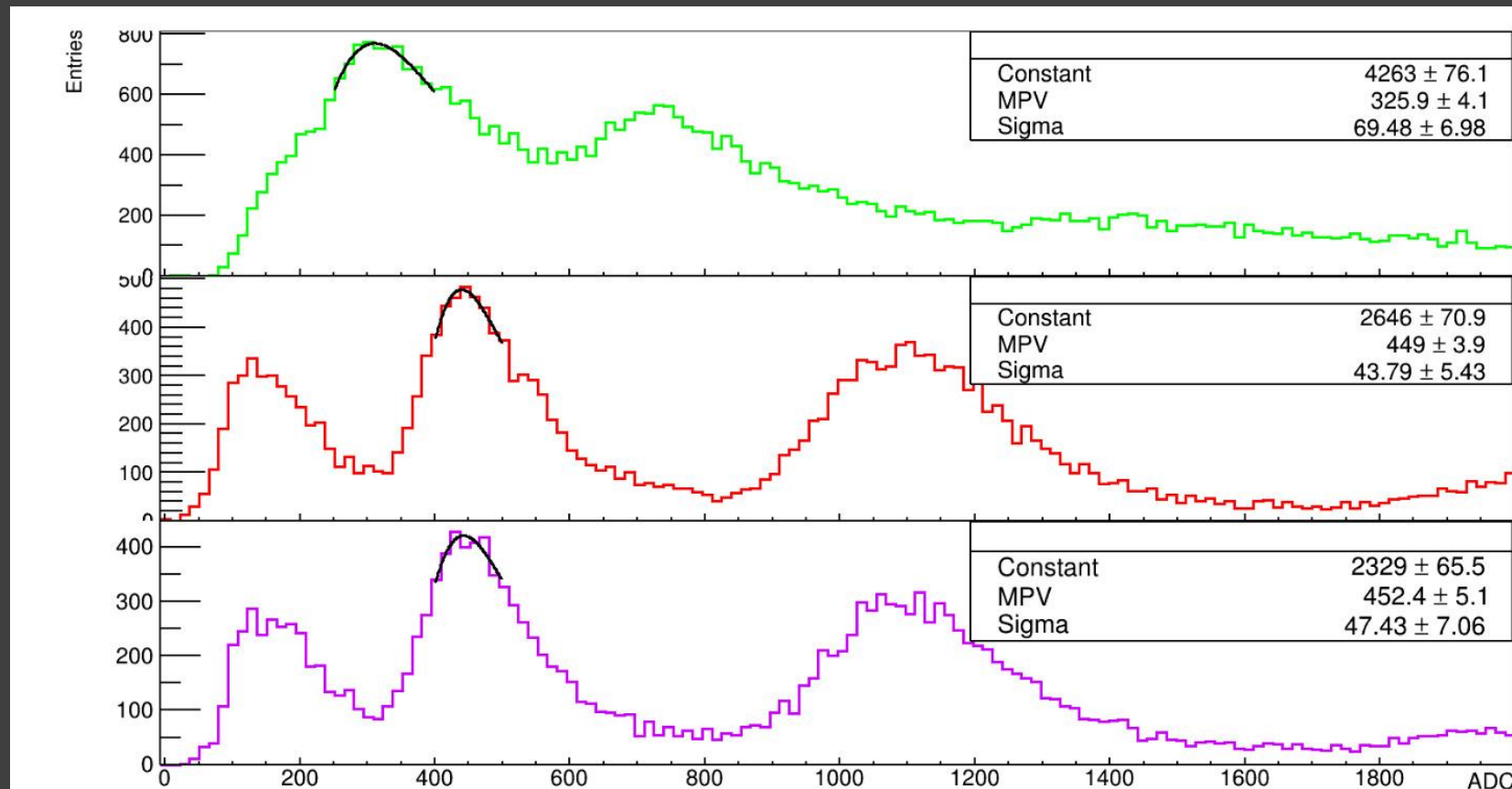Cluster Amplitude vs Eta

f (η) = 498η² − 495η + 449

The Analysis
Eta correction

- The three points founded in the (η-ADC) plane are:
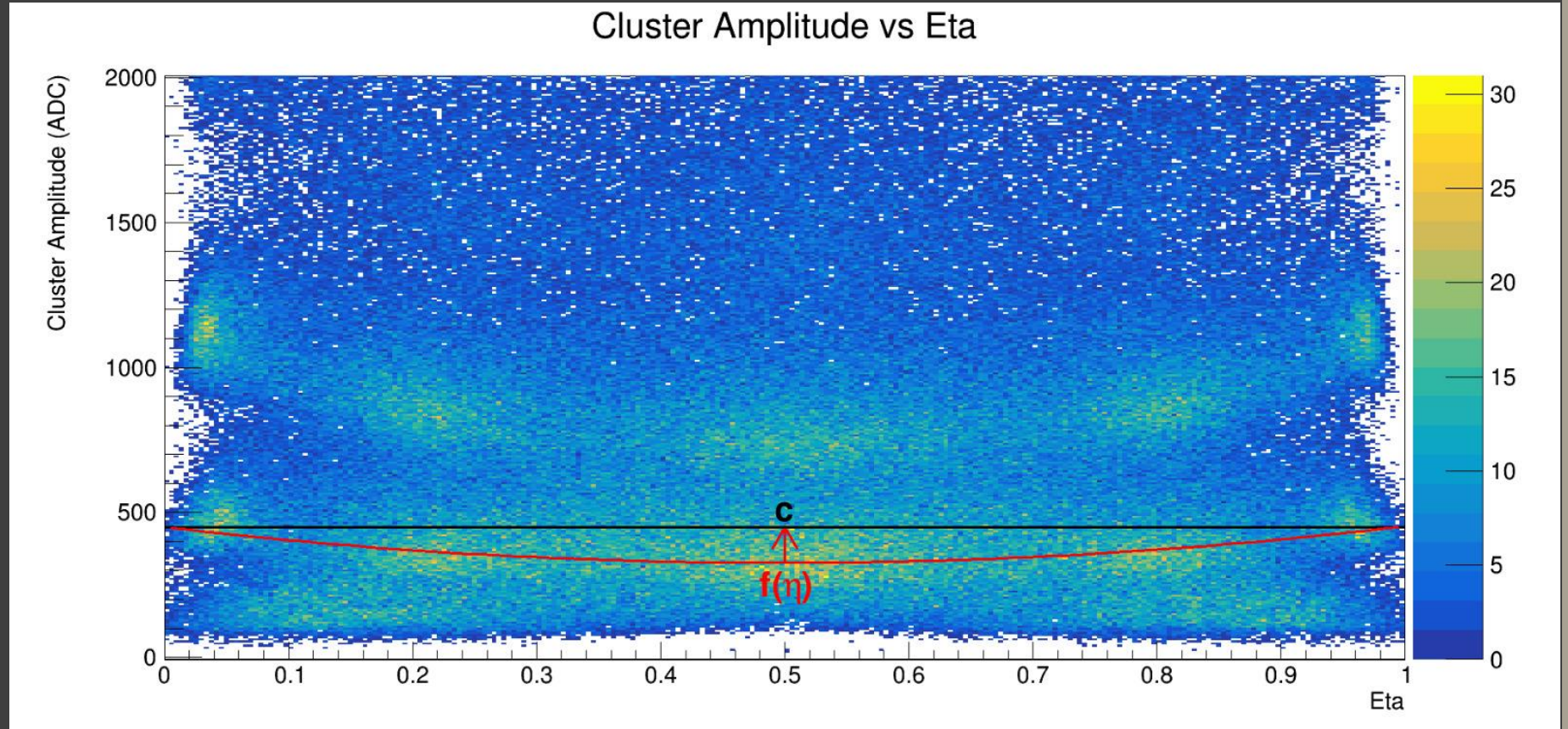
- (0,449)

- (0.5,326)

- (1,452)

The Analysis
Eta correction

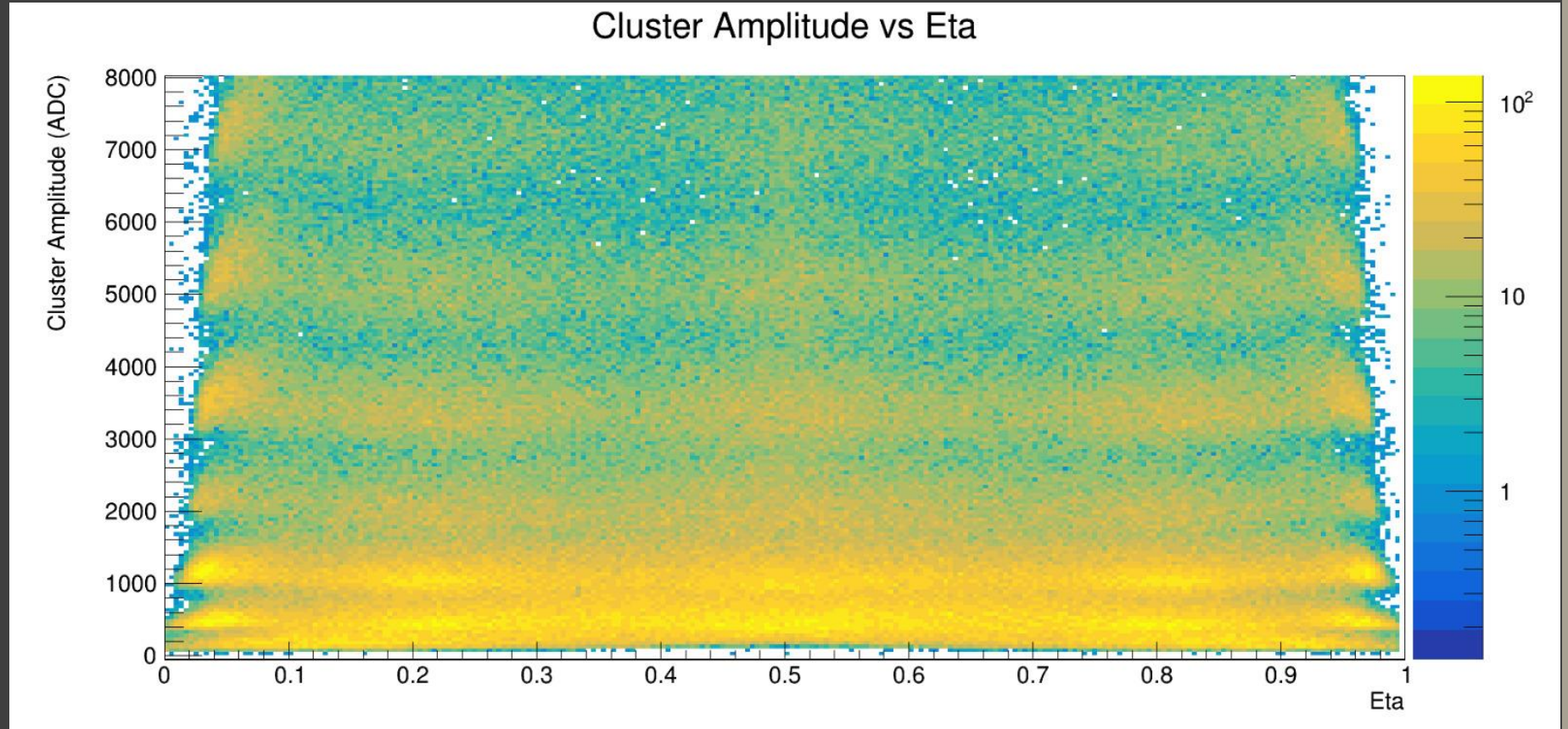- The correction consists to multiply each ADC value by:

$$w = c / f(\eta)$$

- $f(\eta)$ will be the function value at the eta point corresponding to the ADC value being considered

- c is the known term of the parabola

Cluster Amplitude vs Eta

The Analysis
Eta correction

- Corrected cluster amplitude by eta vs eta

- Improved charge separation

Cluster Amplitude vs Eta
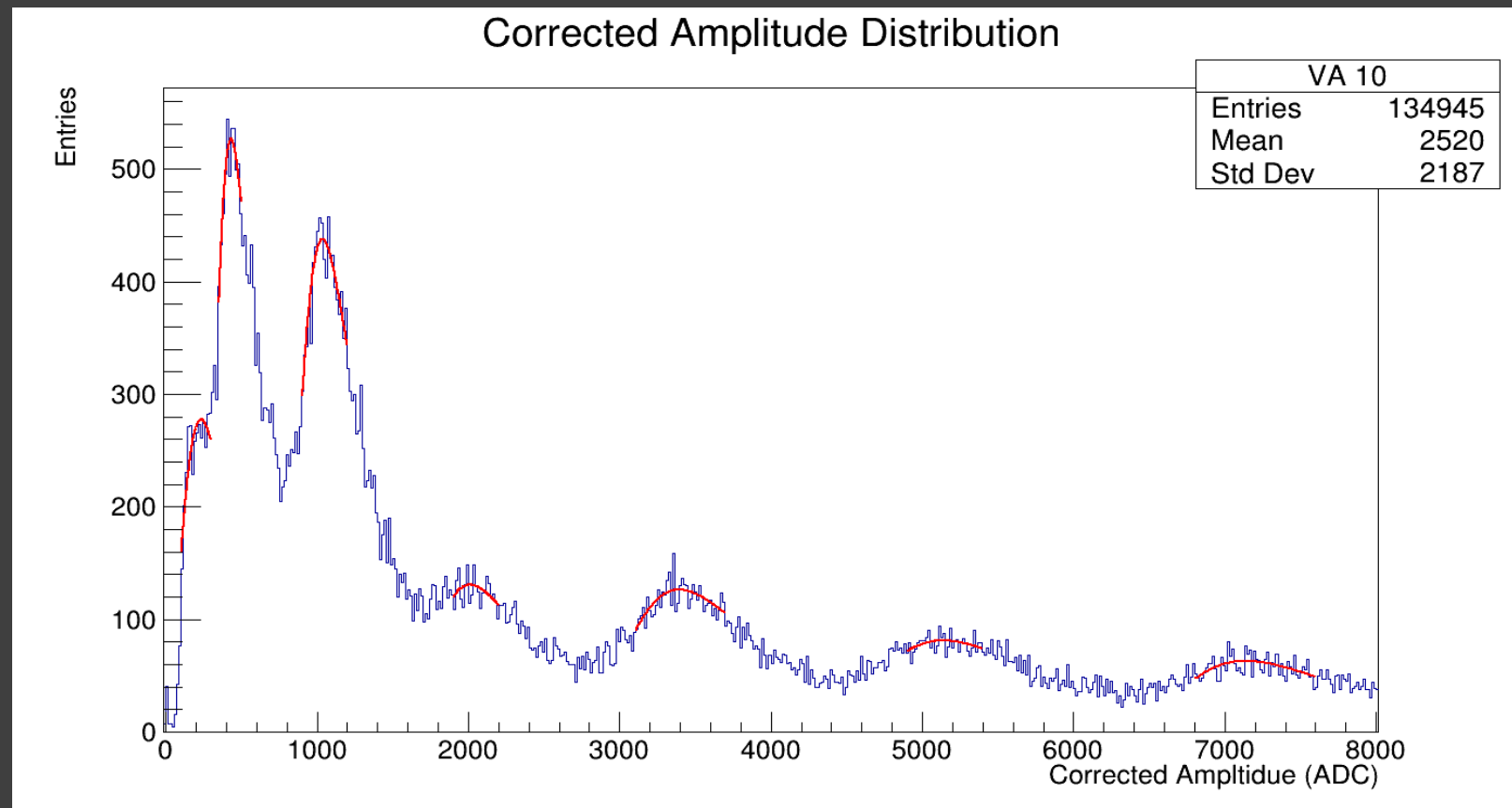
The Analysis
VA Equalization

- Corrected cluster amplitude by eta vs Cog

- The center of gravity (Cog) is an estimate of the impact position of the particle

- Equalization of VA # **5** to **13** (red labels)
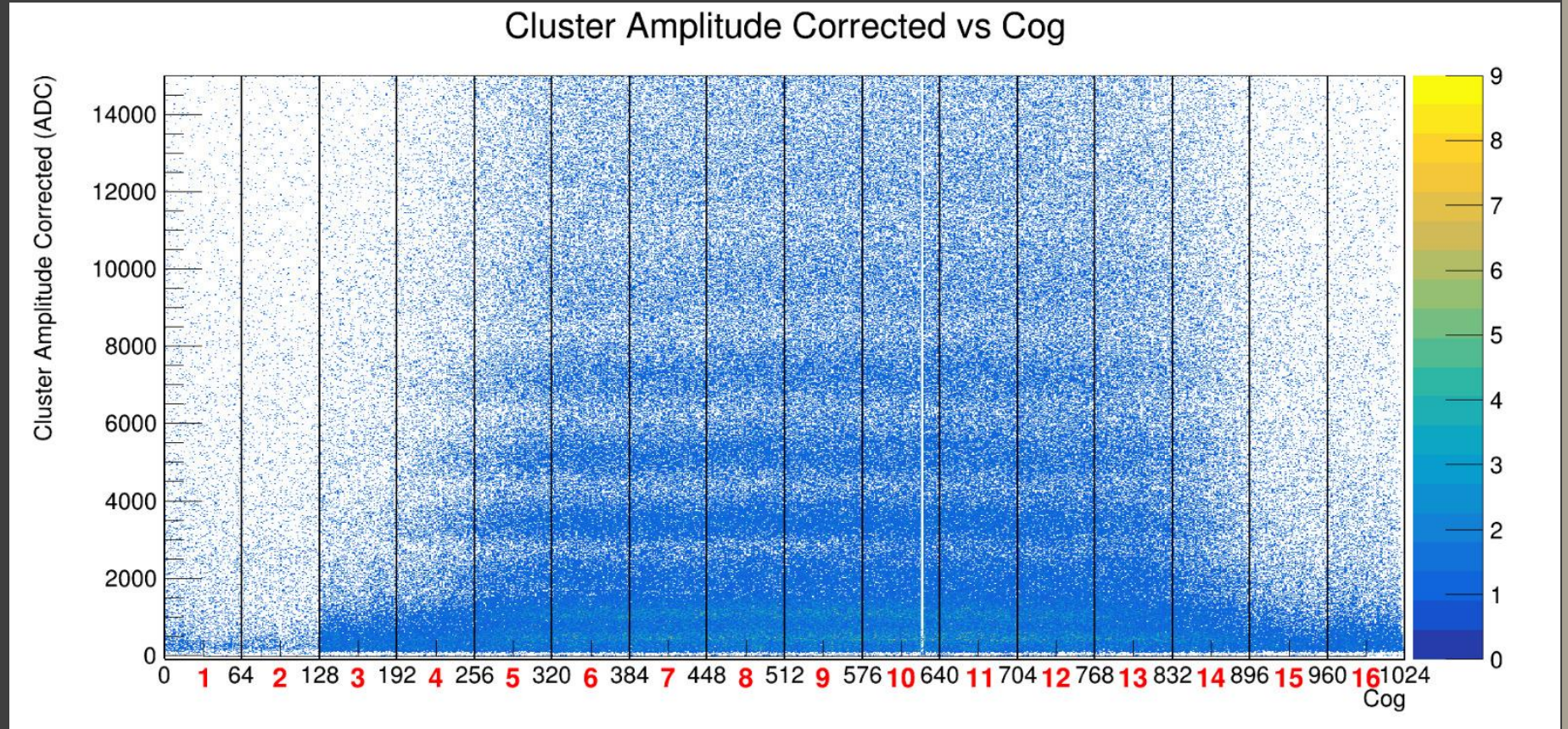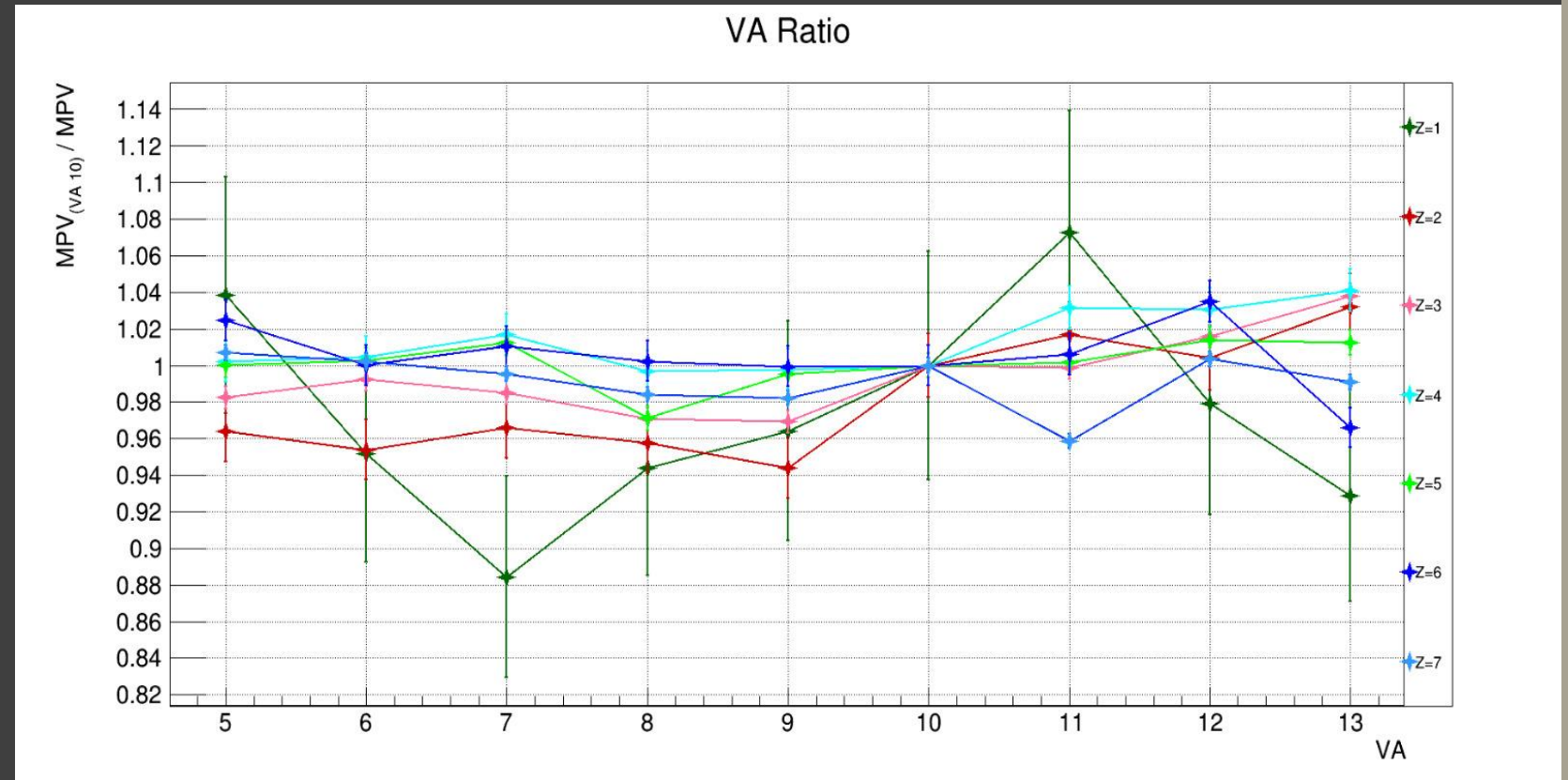
The Analysis
VA Equalization

- By doing the *y* projection of every VA we obtain this type of plot

- The equalization procedure consists of comparing how the MPV values given by the Landau fit, for a given Z, change with the VA.
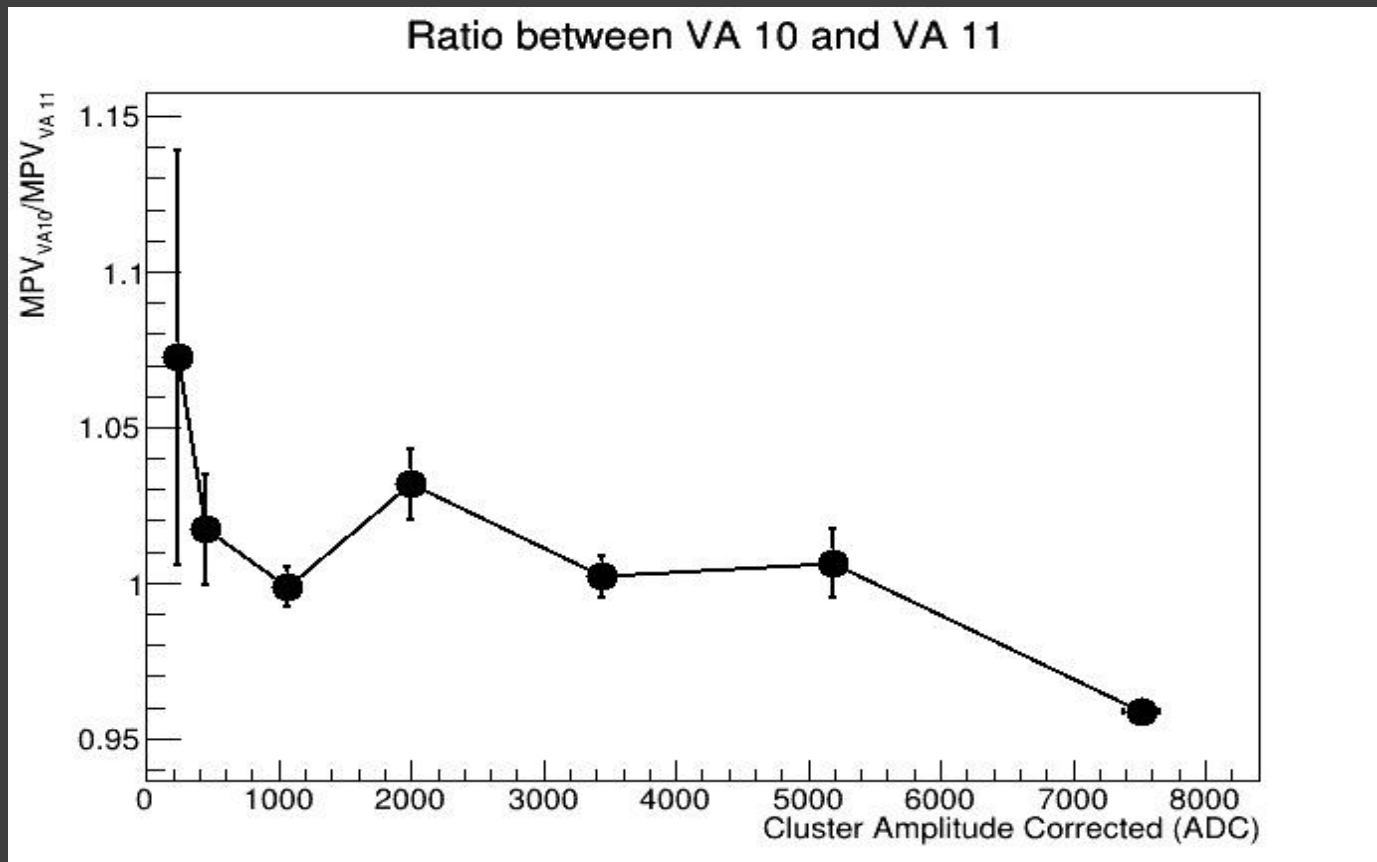
The Analysis
VA Equalization

- VA #10 chosen as a reference

- Ratio, in each VA, between the MPV value, for each peak, of the VA 10 and the corresponding VA

- Represents the percent change between peaks from VA 10

The Analysis
VA Equalization

- This graph represents the *ratio function for the VA 11, $f_{11}(ADC)$*

- The x coordinate corresponds to the MPV given by the fit for the peaks of the VA number eleven.

- On the y coordinate there is the ratio between the MPV of VA 10 and VA 11


Ratio between VA 10 and VA 11

- The graph is used as a function to equalize the VA 11 with respect to the VA 10:

1. Take the eta corrected ADC_{11} value on VA 11

2. Evaluate $f_{11}(ADC_{11})$

3. Multiply ADC_{11} by $f_{11}(ADC_{11})$

The Analysis
All together on √ADC

- √ADC ∝ Z

- Biggest improvements given by the eta correction

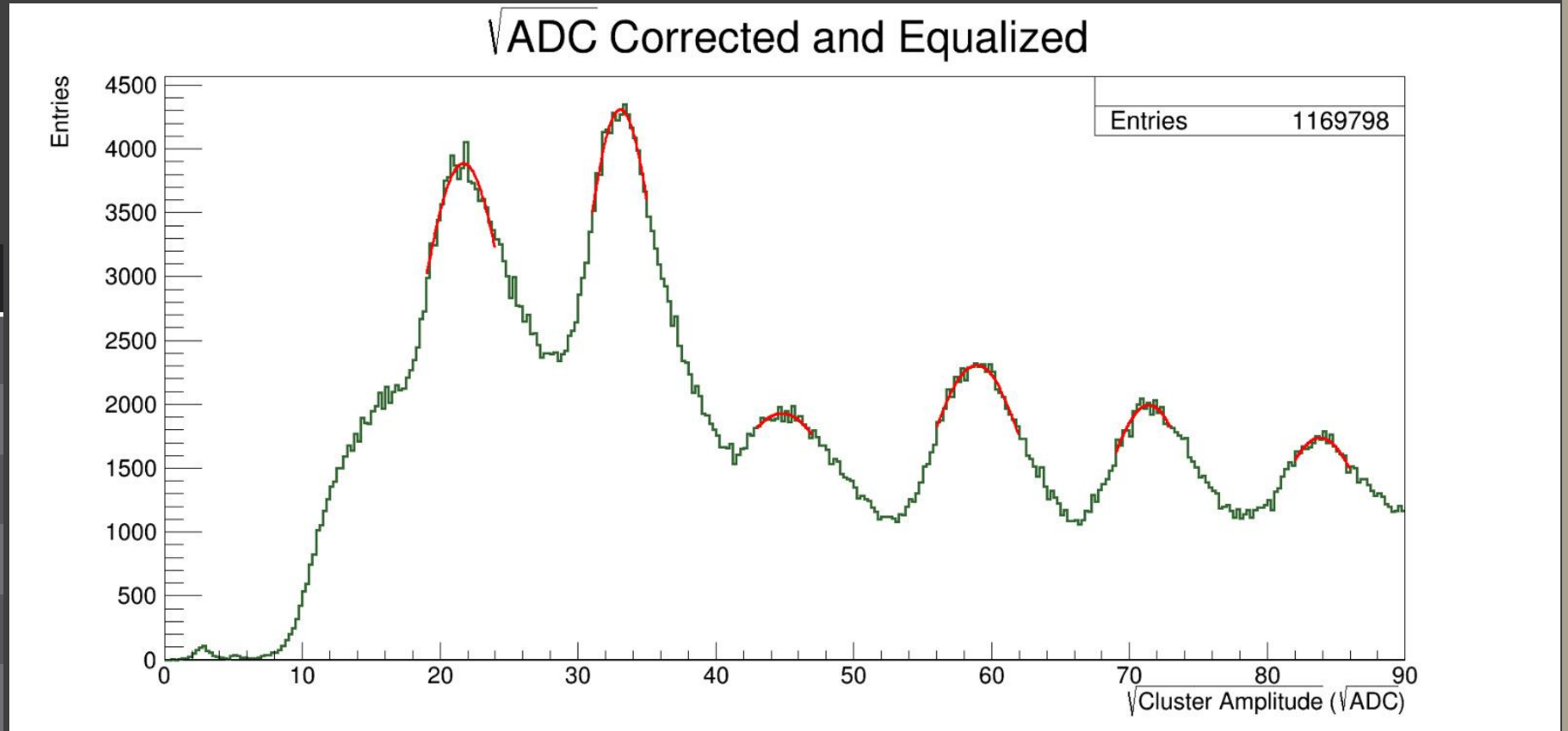- Z=1 is suppressed by the triggers and the clusterization thresholds

√Cluster amplitude distribution
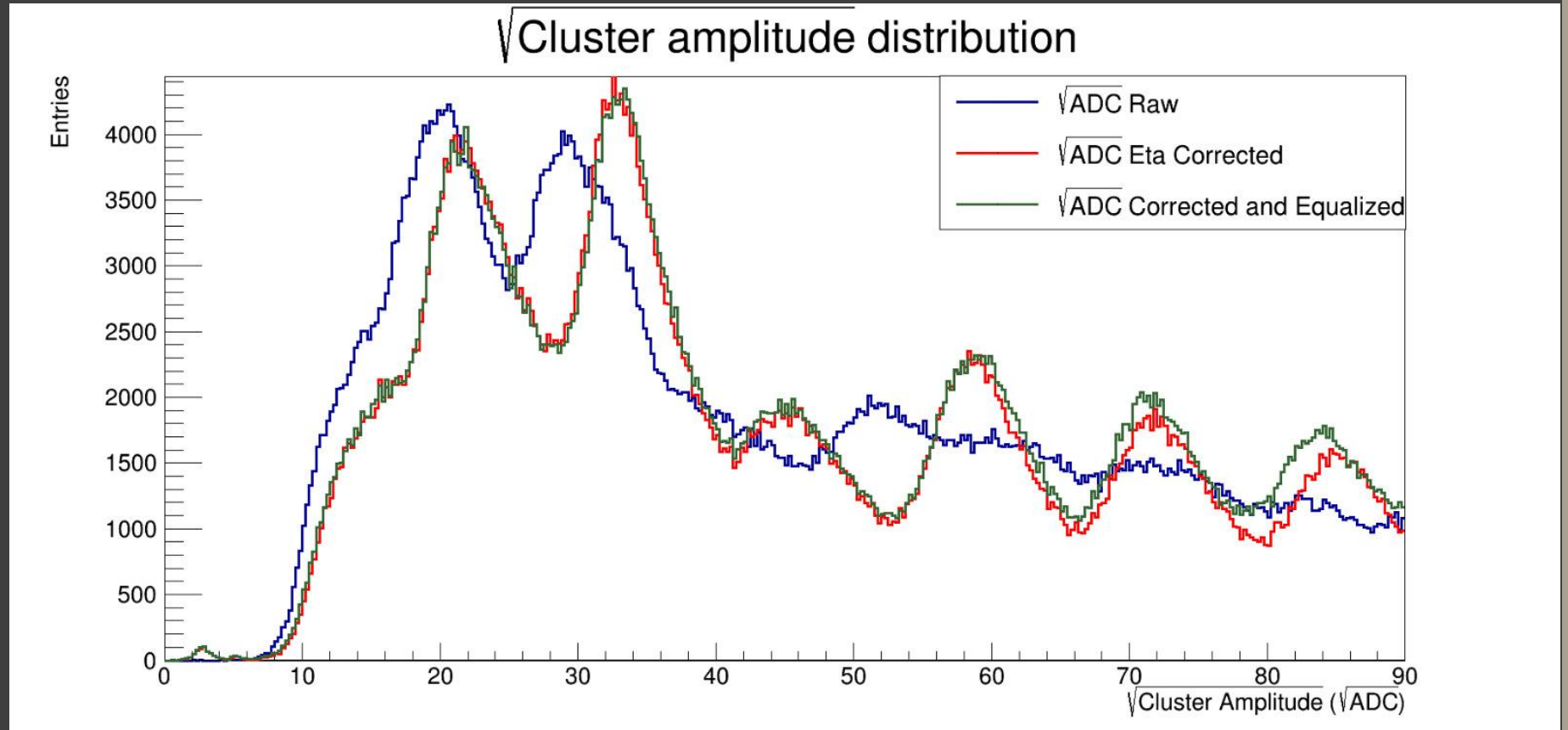
The Analysis
All together on √ADC

- The binned likelihood gaussian fits give

Z	μ(√ADC)	σ(√ADC)
2	21.69 ± 0.04	3.7 ± 0.1
3	33.07 ± 0.03	3.2 ± 0.1
4	44.8 ± 0.1	5.1 ± 0.7
5	58.9 ± 0.05	4.2 ± 0.1
6	71.39 ± 0.08	3.7 ± 0.2
7	83.81 ± 0.09	3.9 ± 0.3

√ADC Corrected and Equalized

Entries — 1169798

Charge resolution

- The √ADC value is proportional to Z: to bring the peaks back to the correct charge number, a multiplicative factor (or, better, a function) is missing

- The resolution is expressed as the relative error

Z	σ/μ
2	0.17
3	0.10
4	0.11
5	0.07
6	0.05
7	0.04