SiPM Readout with VMM3 at FoCal testbeam
Data Analysis

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РЕПУБЛИКА БЪЛГАРИЯ
МИНИСТЕРСТВО НА ОБРАЗОВАНИЕТО
И НАУКАТА

* *partially supported by*
National Roadmap for Research Infrastructures – CERN
D01-374/18.12.2020 г.

RD51 WG5 Meeting
05.12.2023

Data Reconstruction

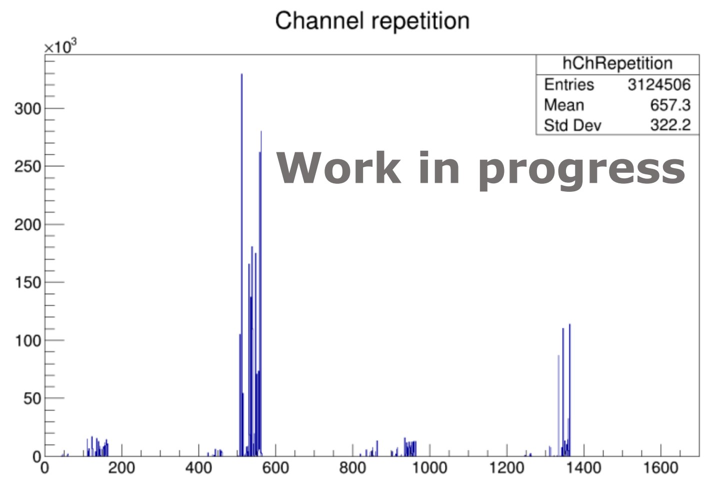
- Data is sent in packets consisting of “hits” – 38 bit strings, holding information about a single channel activation (shown in table to the right);
- The VMM is self-triggering and data is sent in a stream, resulting in no clear distinction of events;
- Events are defined based on time windows. Current method counts out 8 us from the first hit in a potential event;
- There is also filtration by number of hits in an event, meaning that after the time window passes, events with too few hits are considered fake/noise;
- After reconstruction, in order to deal with saturation effects, a calibration of the charges recorded is performed, allowing for the low gain channels to be used instead of saturated high-gain ones.

Name	Length (bit)	Values
Data flag	1	always 1
Over-threshold flag	1	Over threshold: 1
		Below threshold (requires NL on): 0
Channel number	6	0 to 63
ADC (PDO)	10	0 to 1023
TDC (TDO)	8	0 to 255
BCID (clock counter)	12	0 to 4095

https://doi.org/10.1016/j.nima.2022.166548

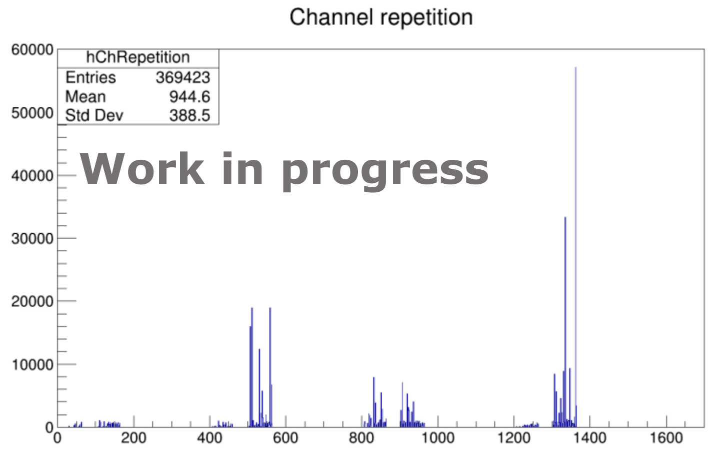
Noise estimation

- Mainly, noise reduction is done by cutting out events with hit numbers beneath a threshold;
- Reading through the events, there are cases of “activation repetition” - one channel activating multiple times in the scope of a single event;
- Repetitions have been attributed to noise attached to the events and as of now are simply being removed;
- Worth noting that the “repetition” is affected by change of power supply and some fiddling with the cables/connections.
- Note: Conditions are different between runs – comparison can hardly be considered proper.



Run021,
350 GeV,
Hadrons,

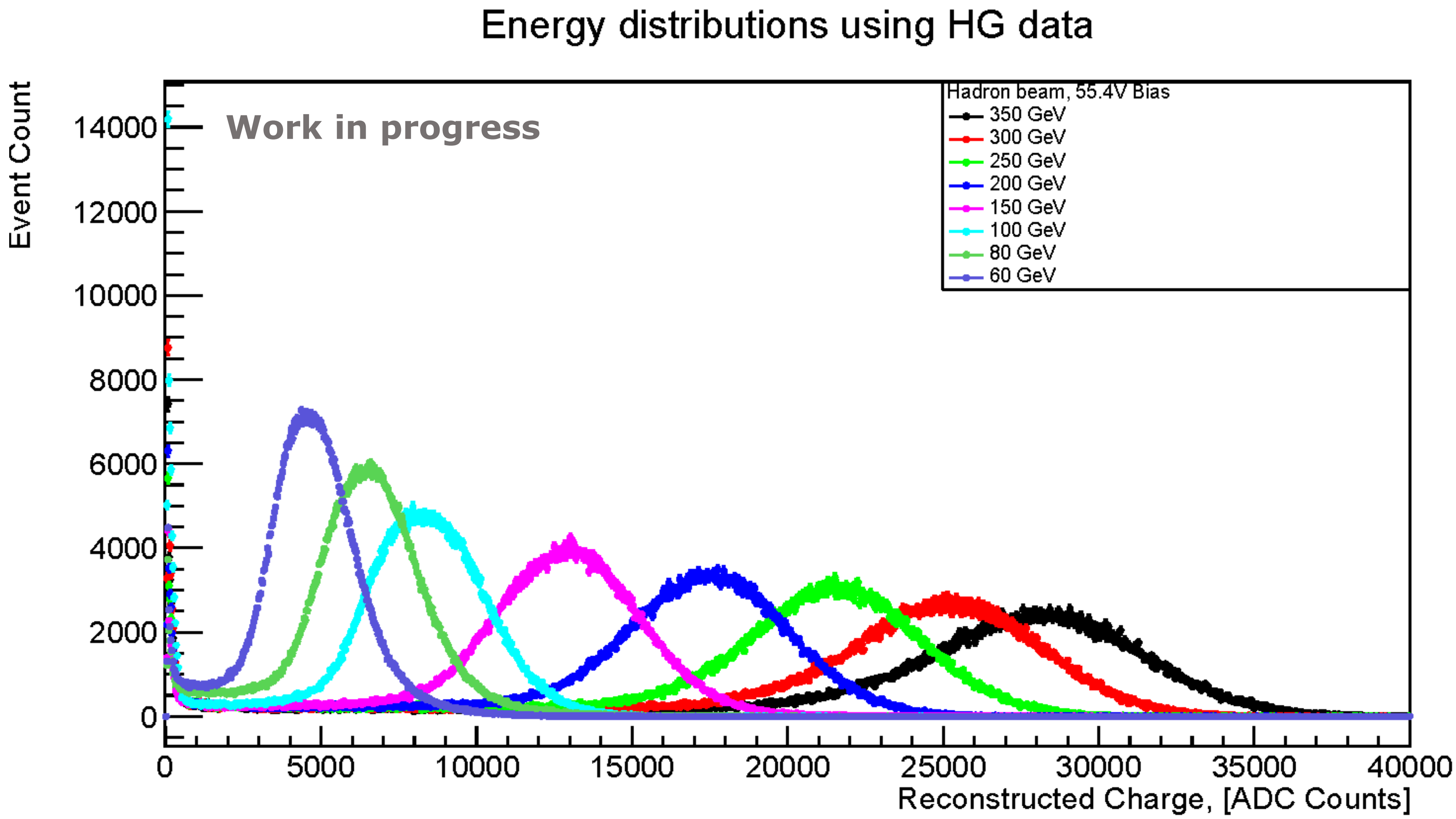
56.5V Bias
0 degrees



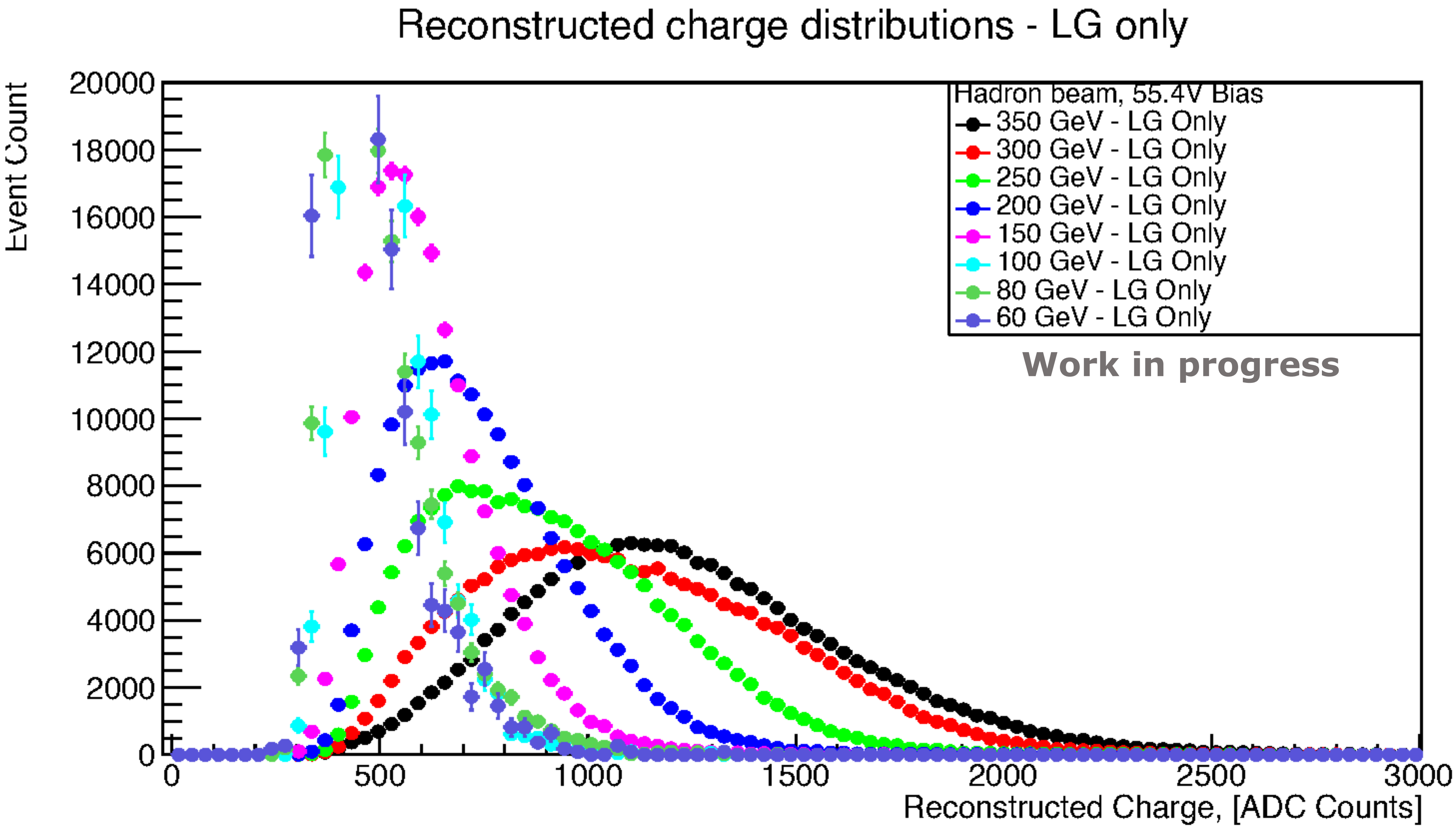
Run050,
350 GeV,
Hadrons,

55.4V Bias
2 degrees

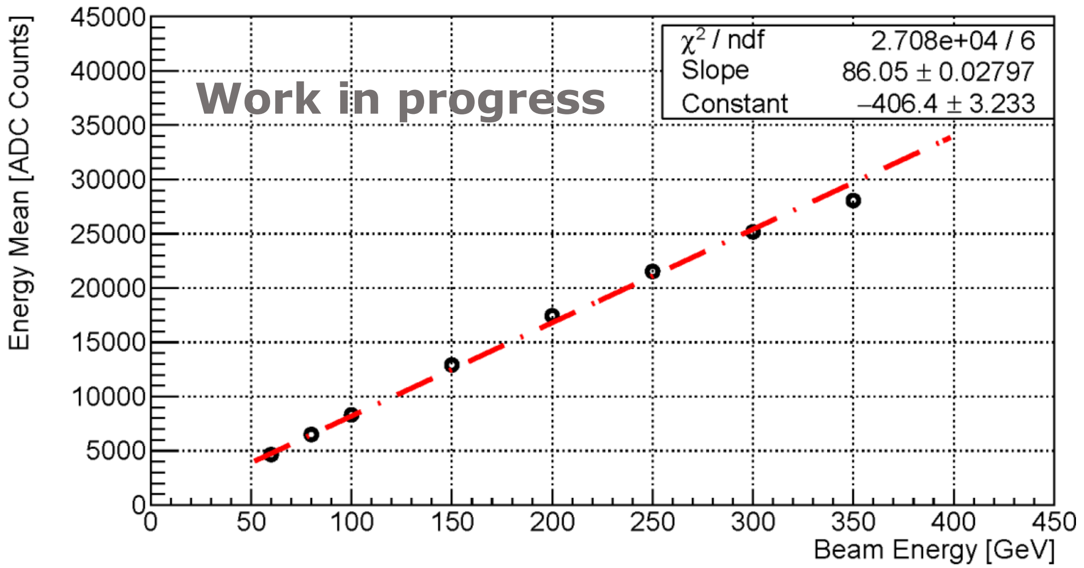
Charge Reconstruction – HG only

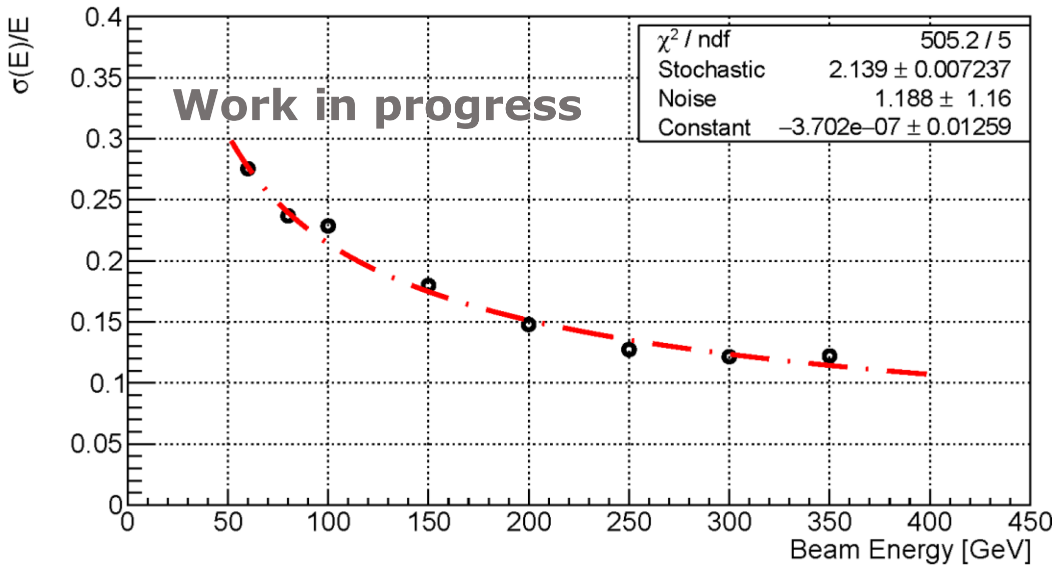


Charge Reconstruction – LG only



Detector properties – HG only





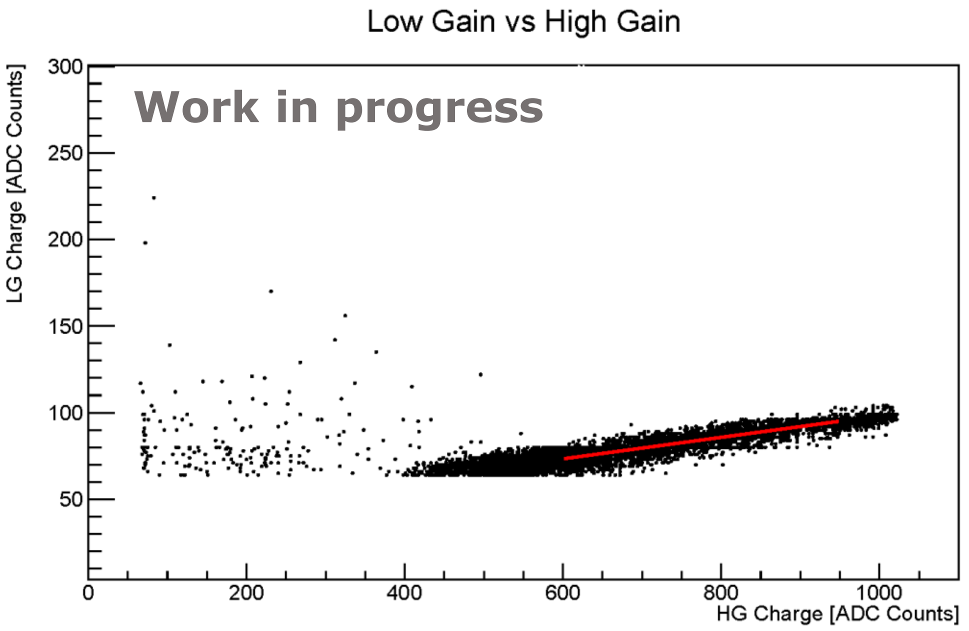
- It is possible to construct and fit the detector linearity and resolution plots;

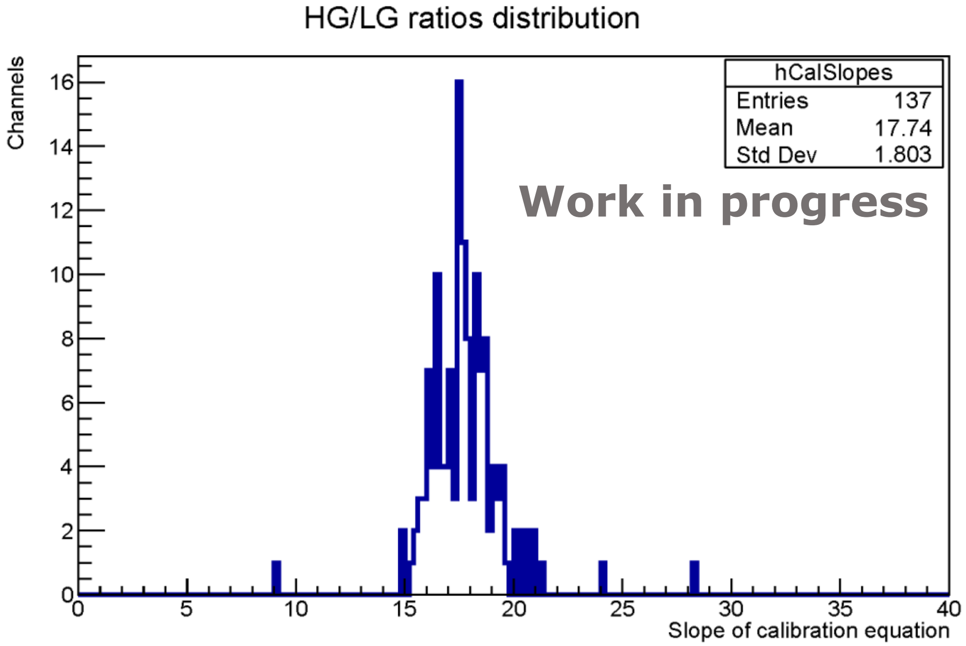
- Loss of linearity is visible
  - Most probably due to **saturation**;
  - Maybe also affected by some **lost charge** (dead channels);

- Resolution coefficients make little sense unless we zero the Noise component forcefully.

Saturation handling

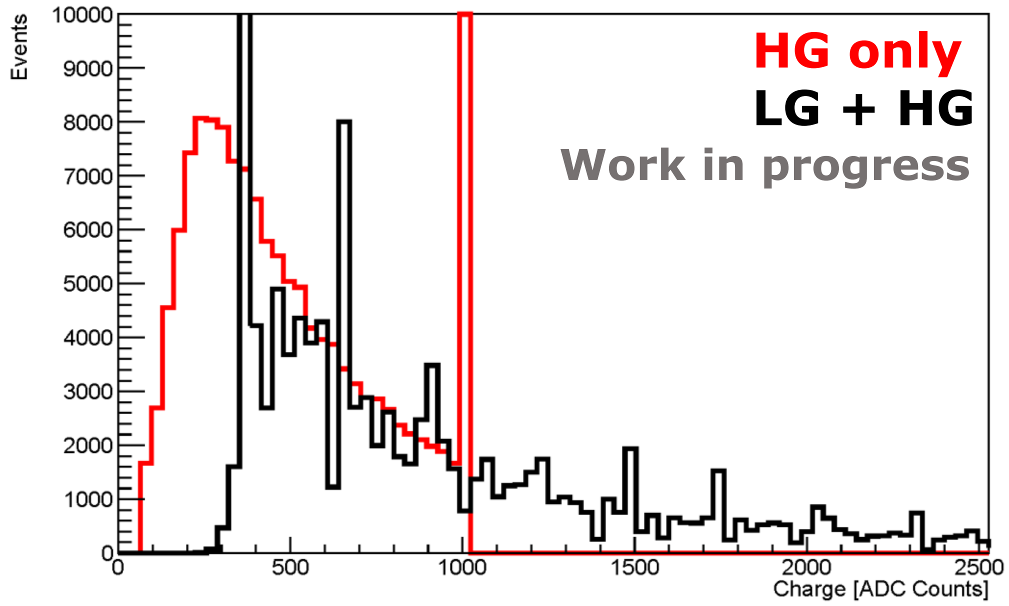
- In order to deal with saturation, we utilize the LG channels and reconstruct the charge using a combination of LG and HG data;
- A type of “calibration” is made through fitting a “versus” graph, in order to find the matching between LG and HG data
  - It would be better to calibrate both independently and then equalize – not possible in the present case;
- The slopes of the fits should correspond to the ratio of the input capacitors $C_{HG}/C_{LG} \sim 18$;
- The calibration is performed separately for each channel and fitting is only done for graphs with sufficient statistics
  - Else, an average is used.



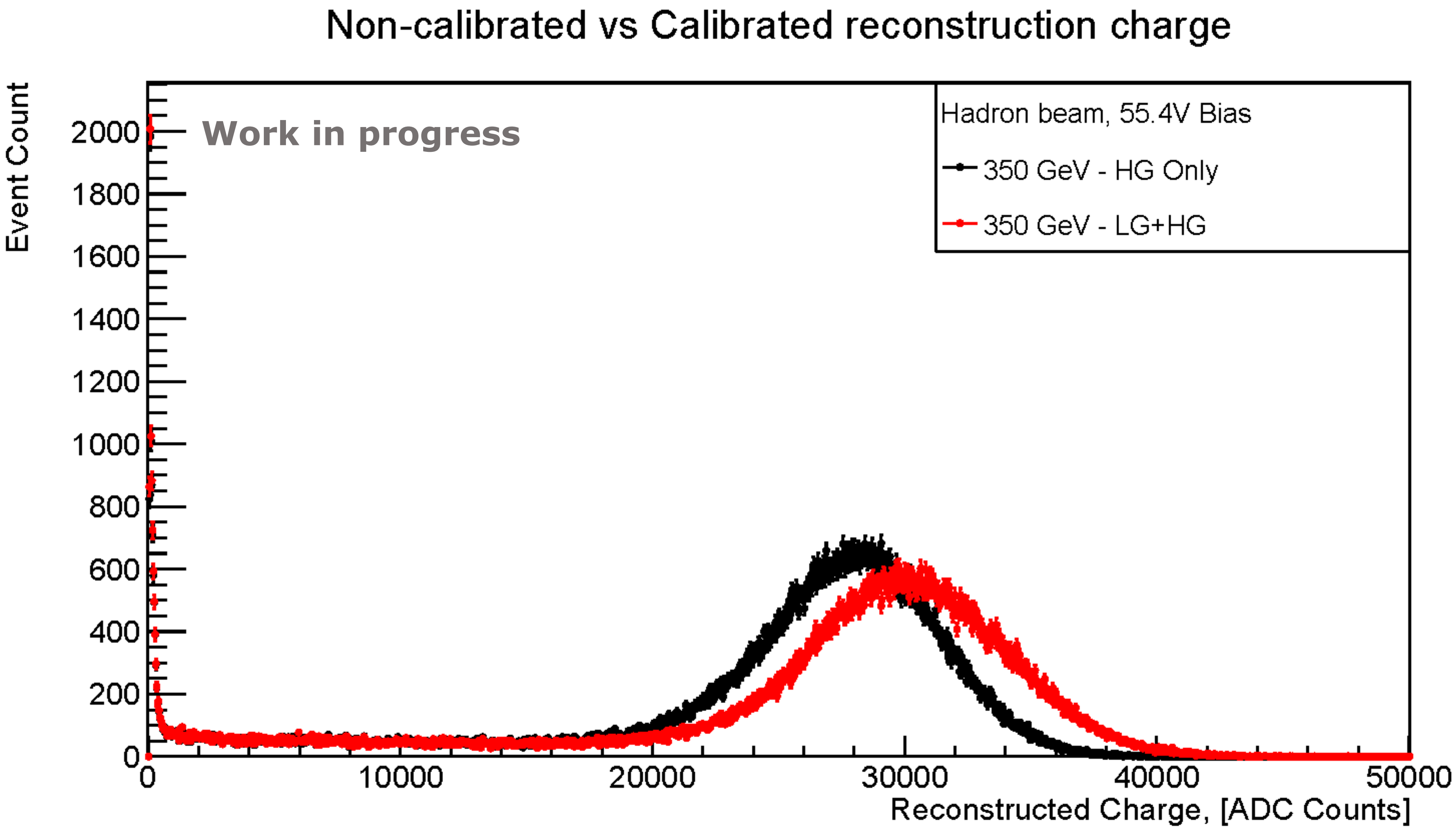


Single channel charge comparison

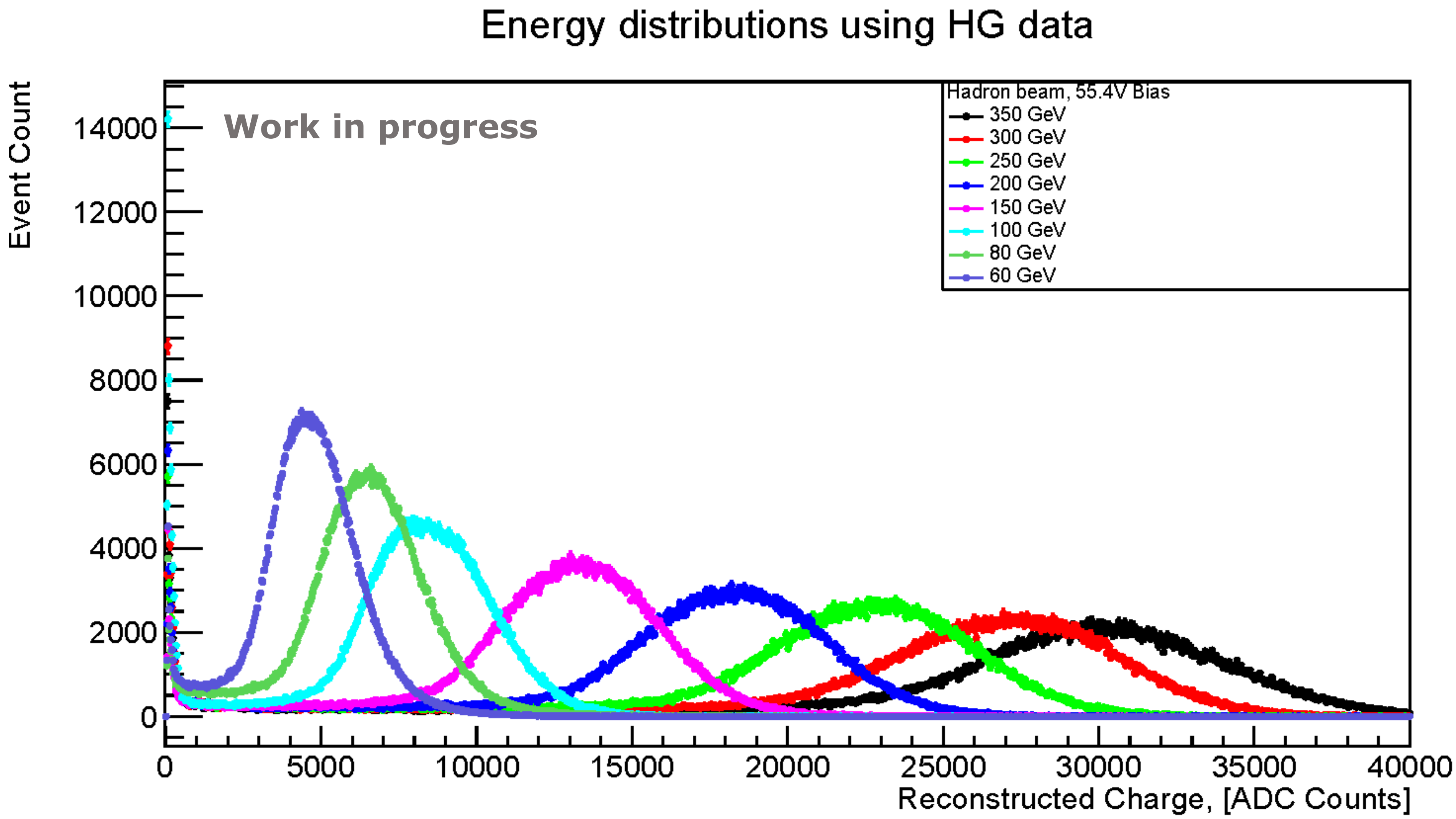
- Using a single channel’s charge distribution, we can see the calibration’s workings;
- The scaled (calibrated) LG distribution starts to follow the trend of the HG one after 600 ADC Counts;
- After saturation at 1023 ADC Counts, the calibrated distribution follows the trend of the HG;
- There are some peaks in the calibrated distribution;
- The calibration (HG-LG matching) is performing acceptably;



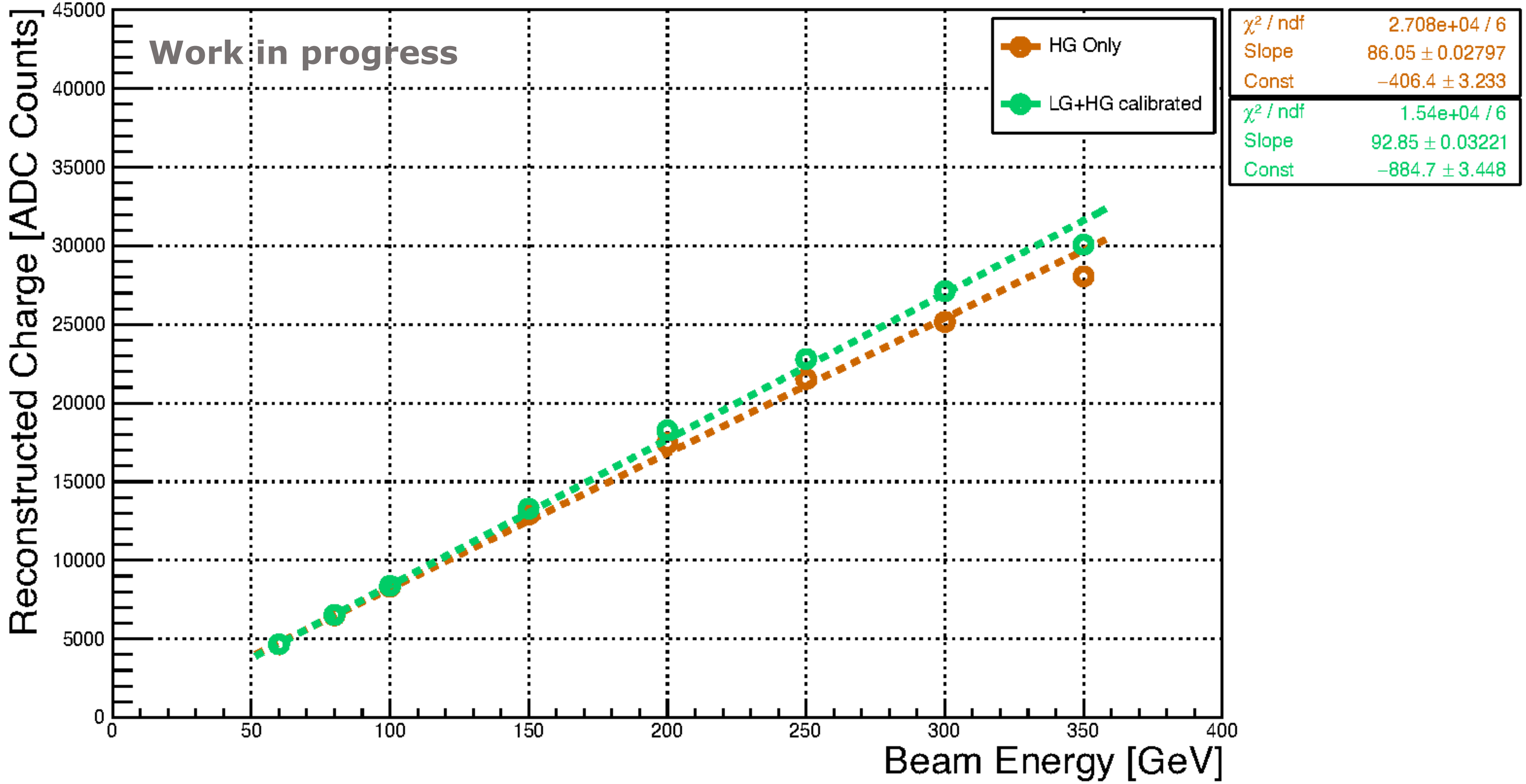
Charge reconstruction comparison



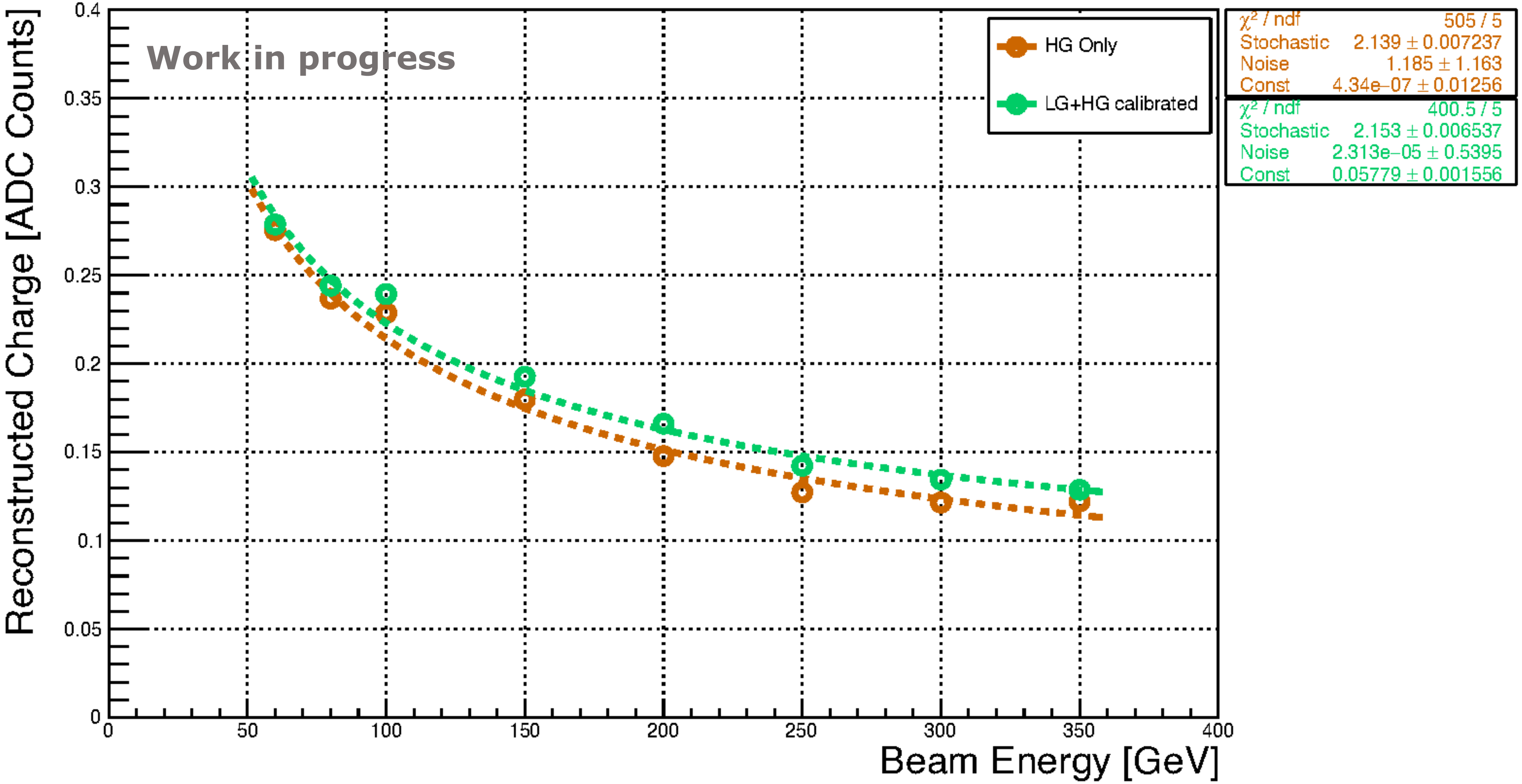
Charge reconstruction comparison



Linearity comparison



Resolution comparison



Conclusions

- While not originally intended for SiPM detector readout, the VMM seems to be mostly successful at the task, at least as far as Hadron data is concerned;

- The attempt at extending the dynamic range of the VMM is successful with the “calibrated” data from the “Low Gain” doing well at extending the saturated signals
  - There are improvements in Resolution and Linearity;
  - There is good agreement between the trend of the calibrated charge distribution and the original HG distribution in single channels;

- Further analysis work is needed in order to solve the current conundrums.

Thank you for your attention ☺