Proton range calibration for the R³B-CALIFA calorimeter

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DPG Spring Meeting, Köln
HK 55.2
13.3.2025

Overview of R³B and CALIFA
Structure of calibration algorithm
Calibration in the gamma range
Extrapolation to proton range
QC plots

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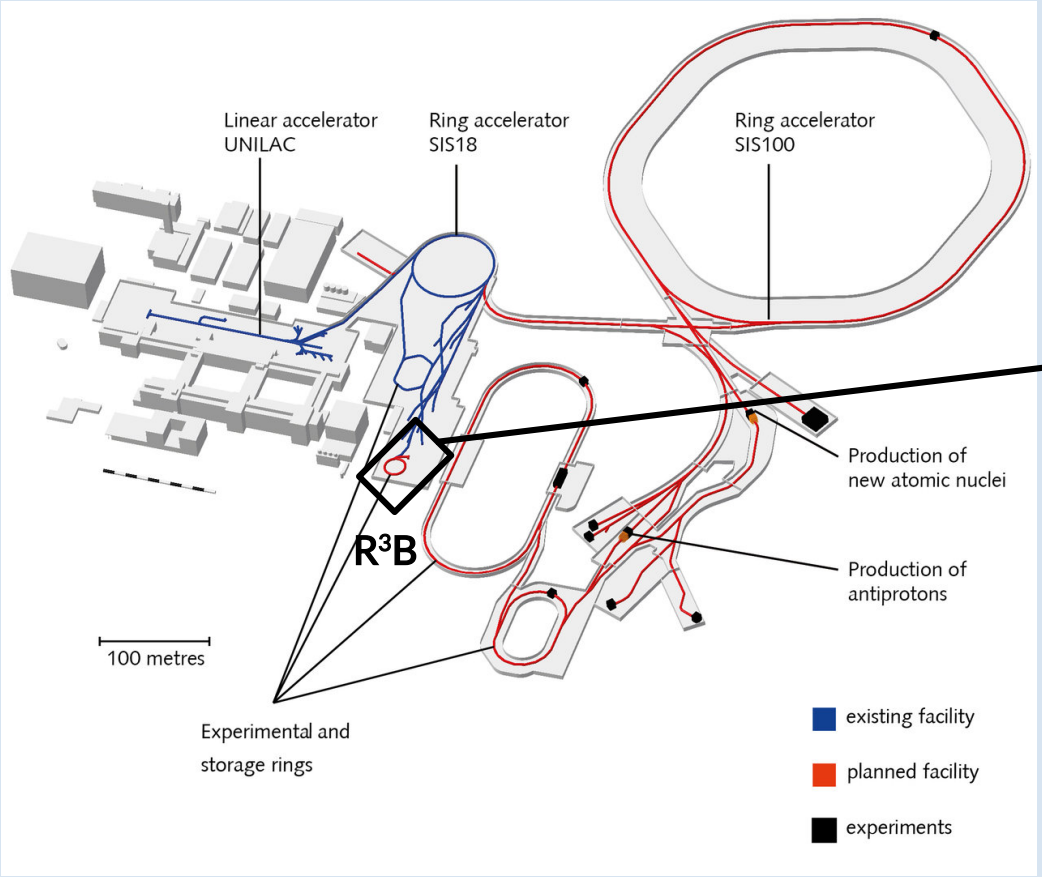
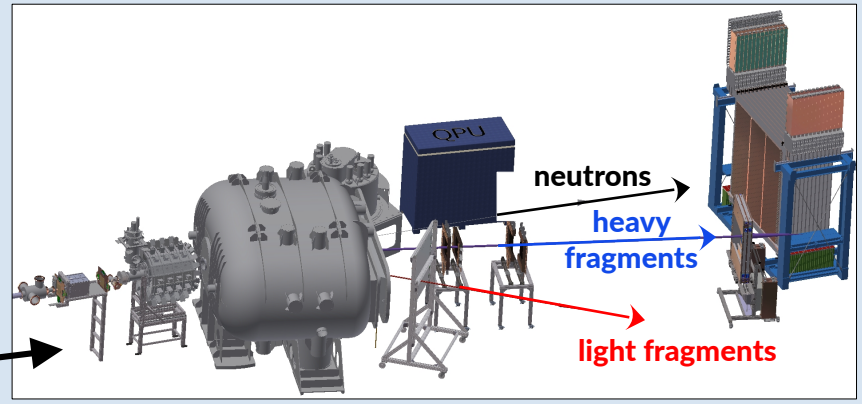
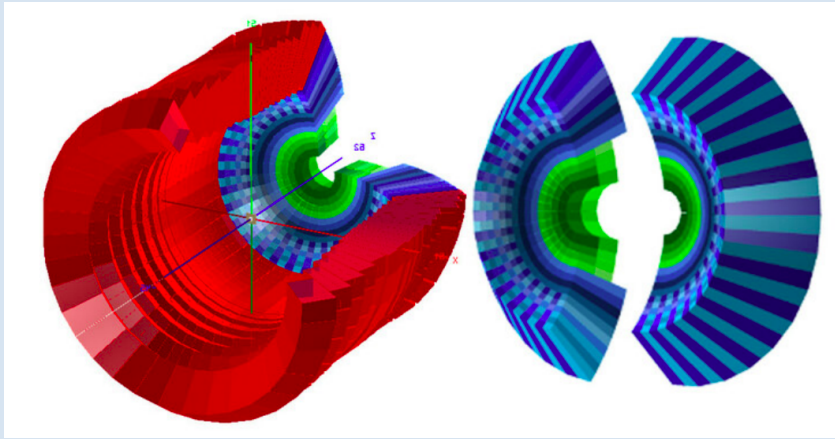
TUM Members:
Mrunmoy Jena, Tobias Jenegger, Roman Gernhäuser

Overview : R³B and CALIFA

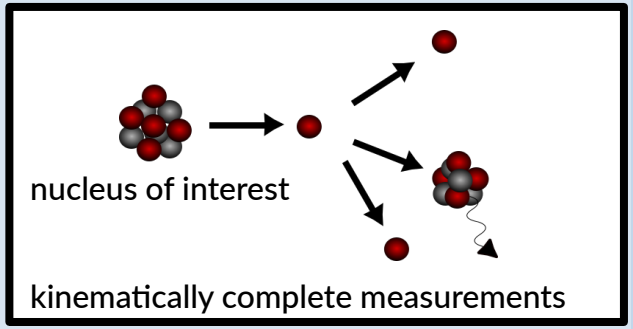


R³B: Reactions with Radioactive Beams





CALorimeter for the **I**n **F**light detection
of γ rays and light charged p**A**rticles



Barrel: $43^\circ < \theta < 140^\circ$

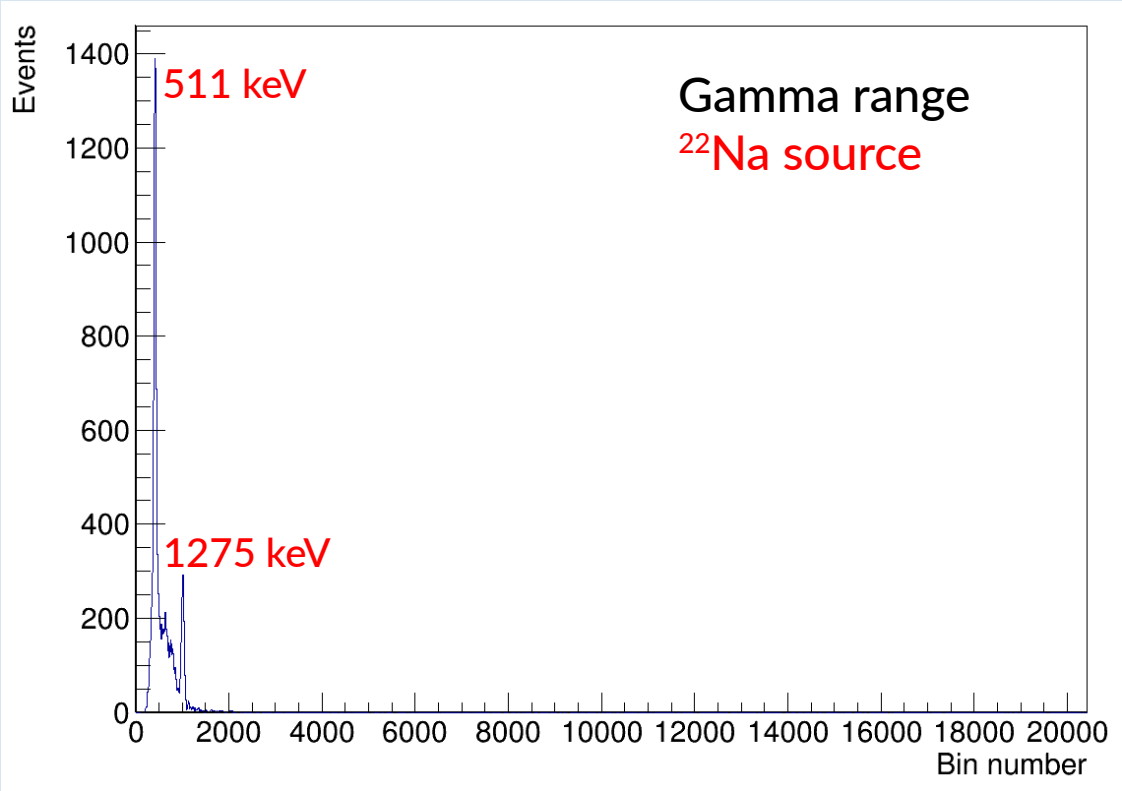
iPhos: $19^\circ < \theta < 43^\circ$

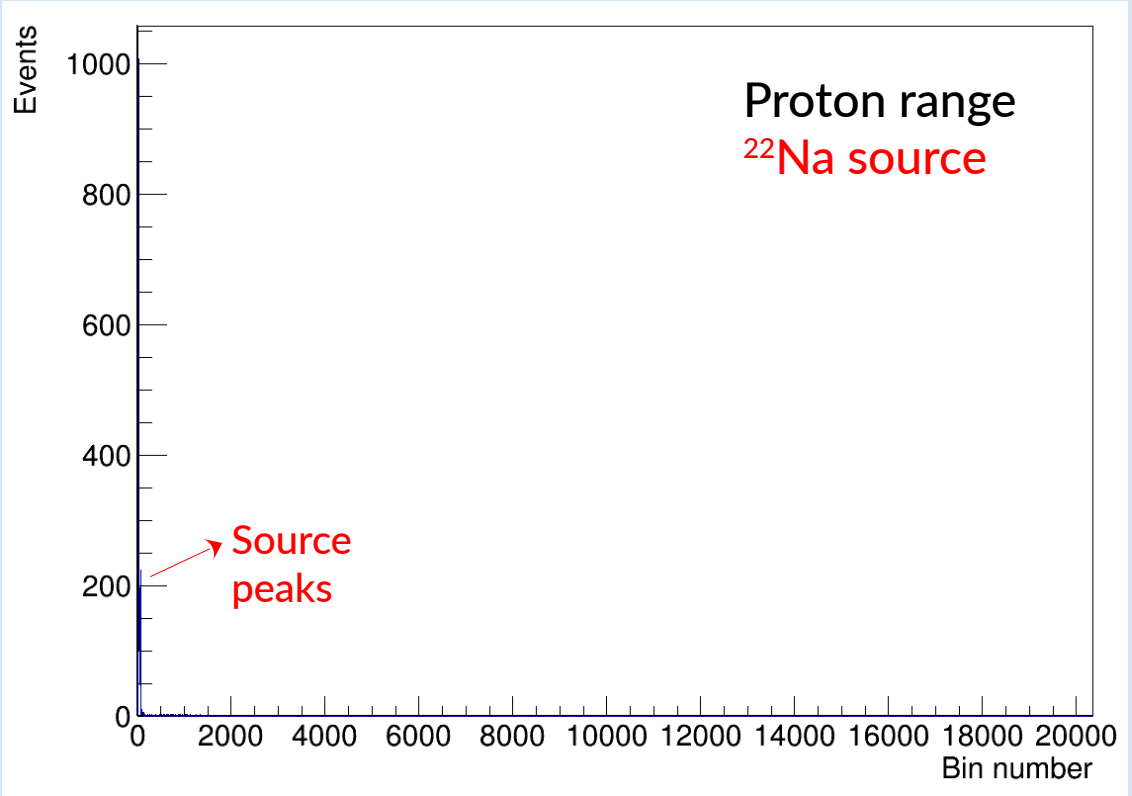
CEPA: $7^\circ < \theta < 19^\circ$

Group report:

HK 33.1, Tobias Jenegger (Wed.,17:30)

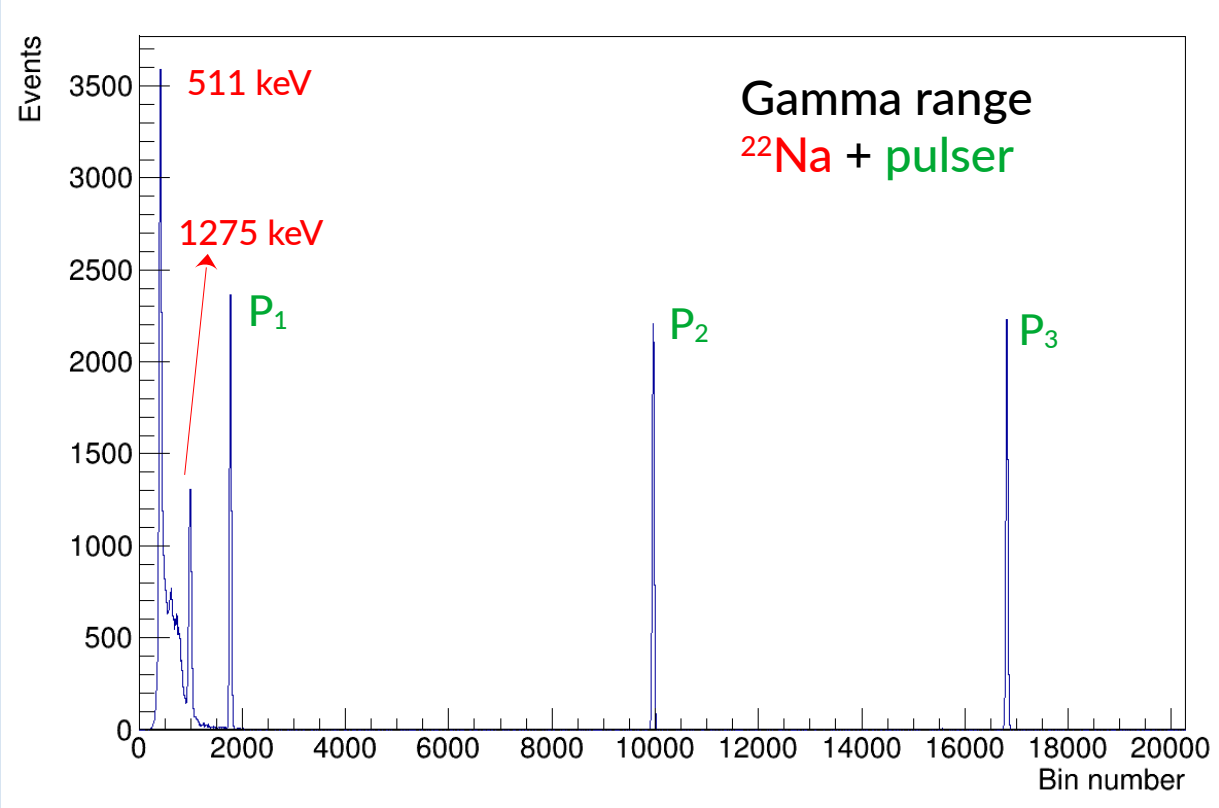
Introduction

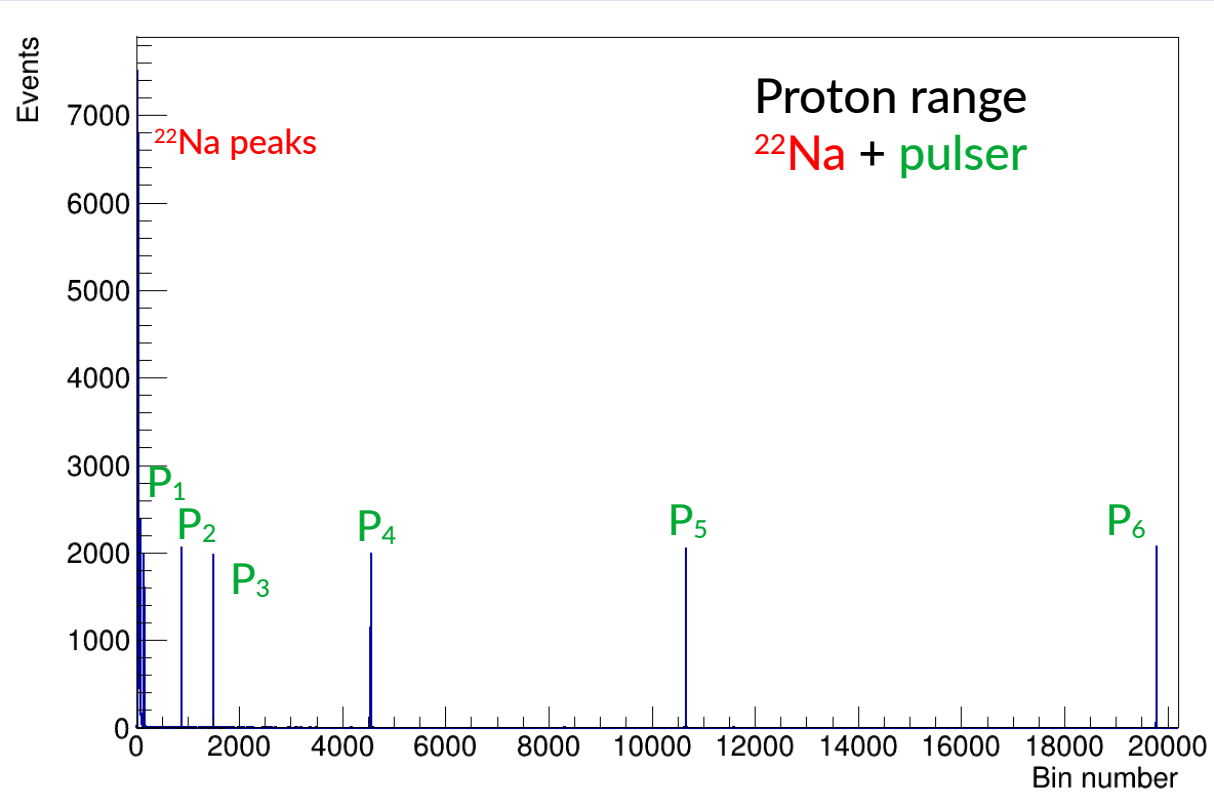




^{22}Na source hardly useful for performing calibration in the proton range !

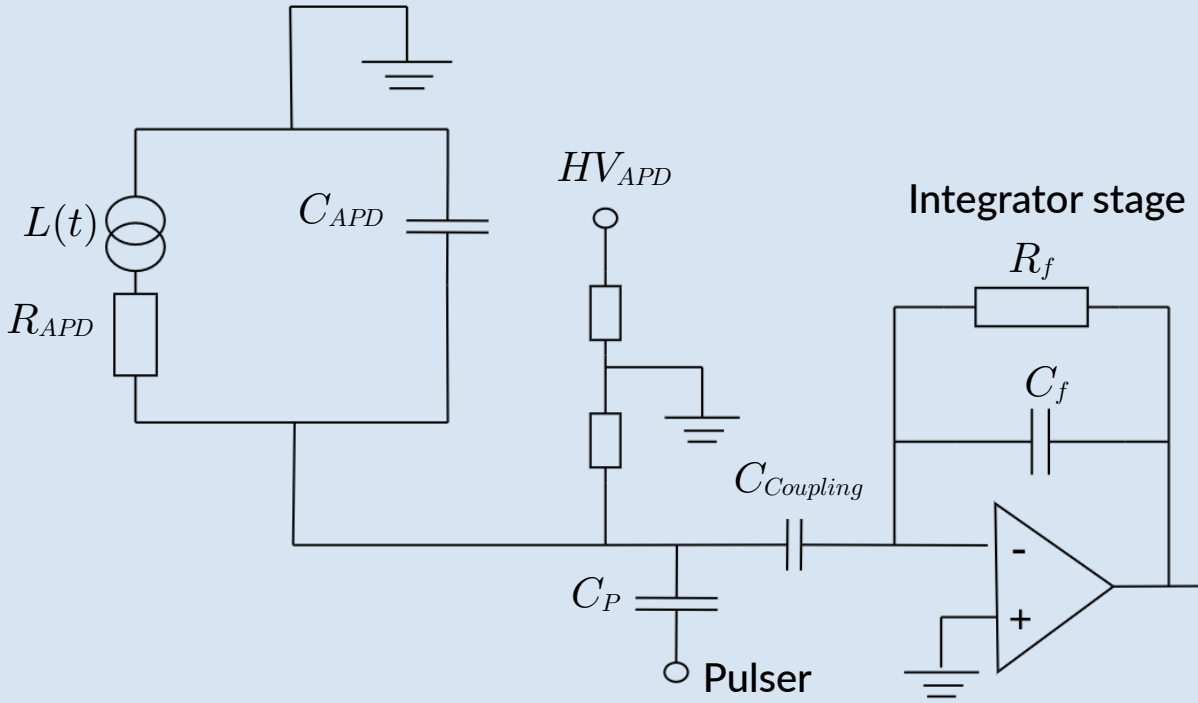
Introduction

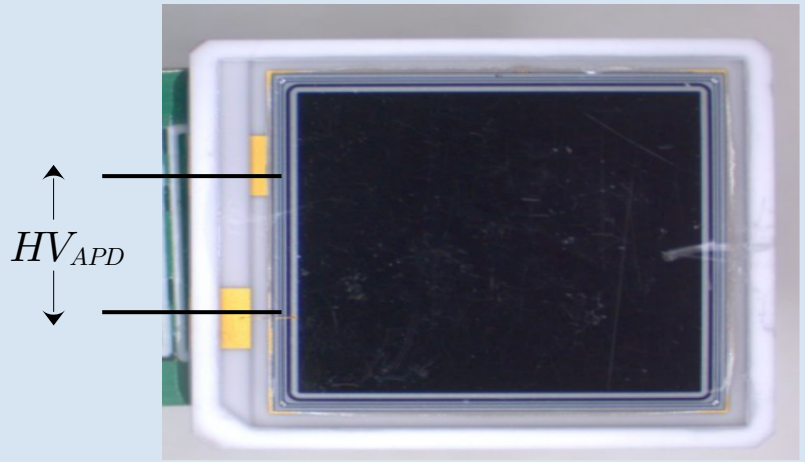


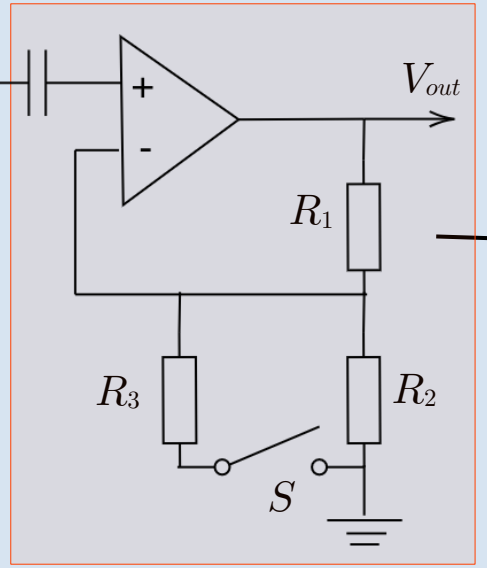


Using pulsers is essential for calibration in proton range

Introduction







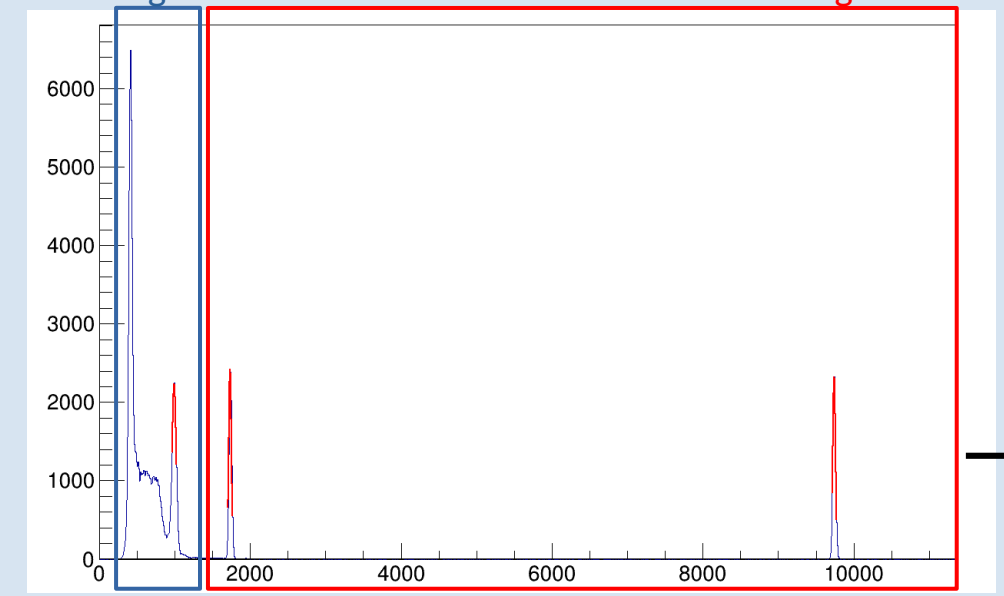
$$L(t) \equiv f(N_\gamma \cdot c_{Transp.} \cdot c_{Absorp.} \cdot \epsilon_{APD} \cdot g_{APD})$$

Need to calibrate: $\frac{\int L(t)dt}{V_{out}}$

Calibration algorithm

Unpacking

data.lmd → Unpacker → unpacked_gamma.root, unpacked_proton.root



Calibration program

Run bash script (bash_pulser_calibration.sh)

read all events and fill

spectra_gamma.root
spectra_proton.root
(5088 1D histograms)

for each histogram

find peaks

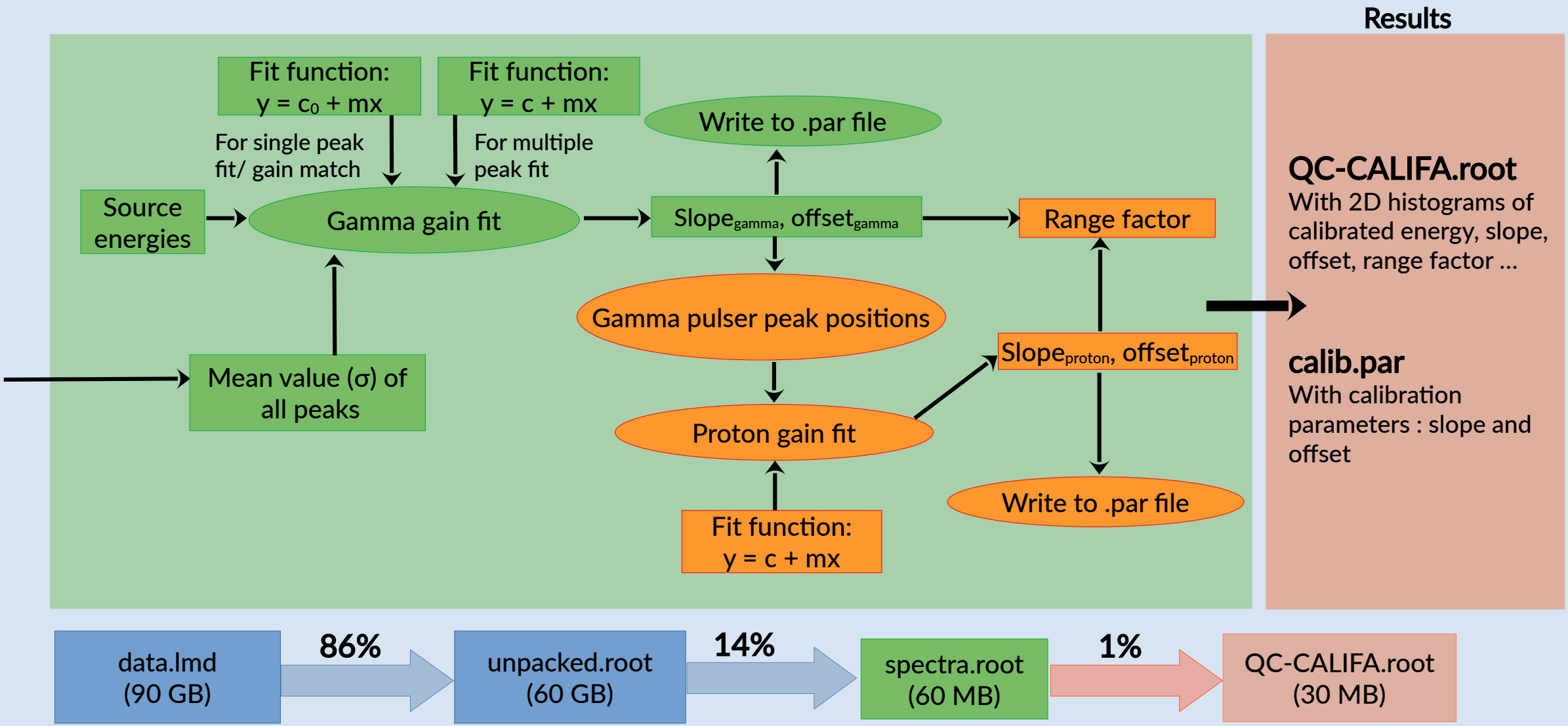
Gauss fit each peak

Mean, Sigma, Events

Peak parameters:
number and region for source and pulser peaks

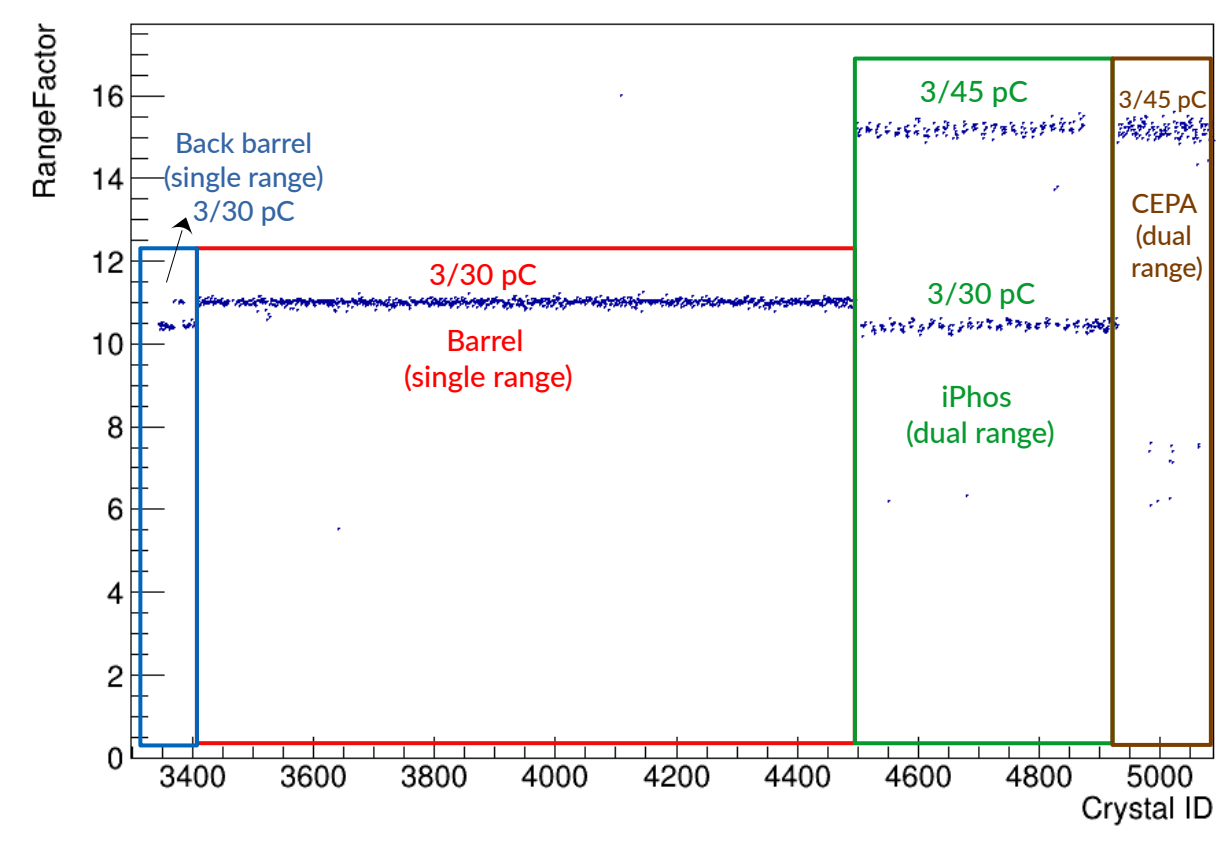
Fit parameters:
Expected width

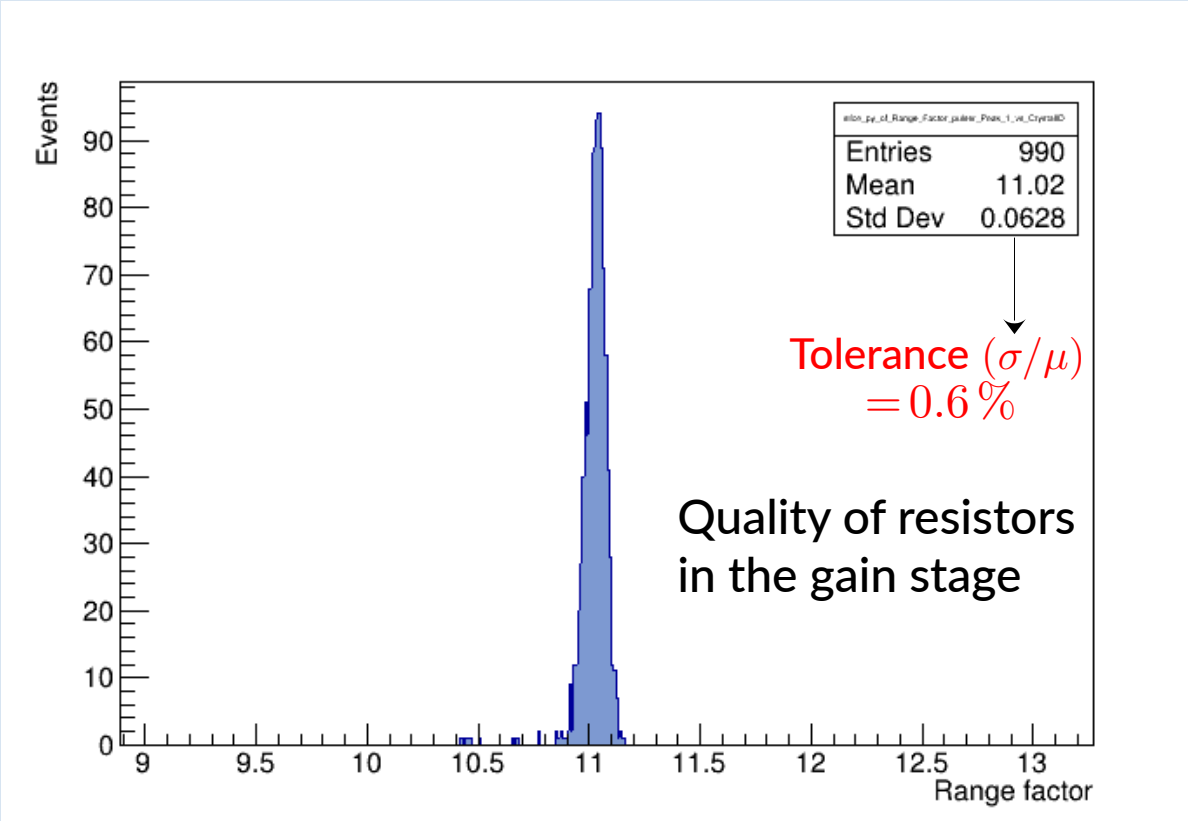
Calibration algorithm



* % in terms of time taken on an 12th Gen Intel Core i5-12500, 12 cores

Range factor

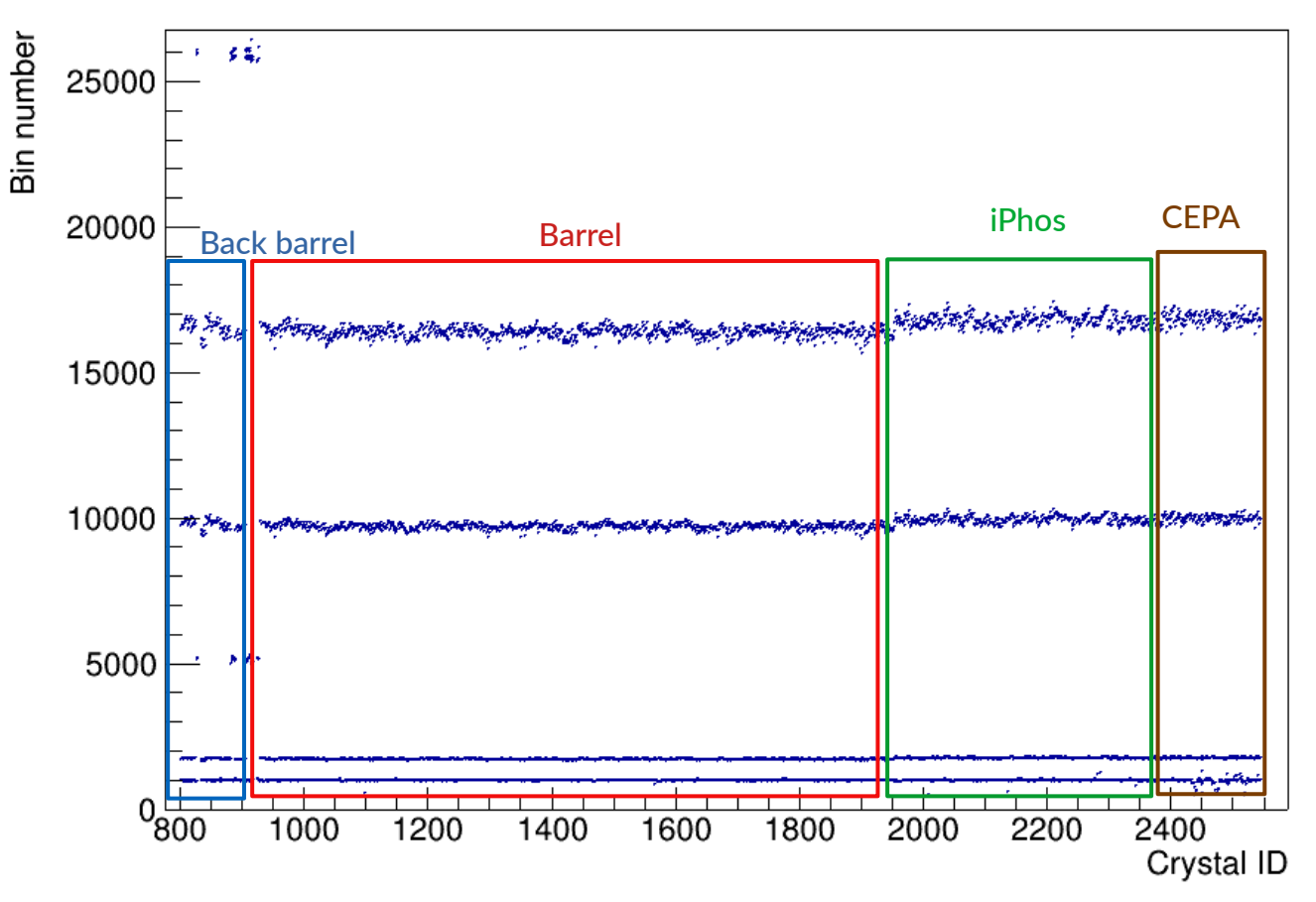


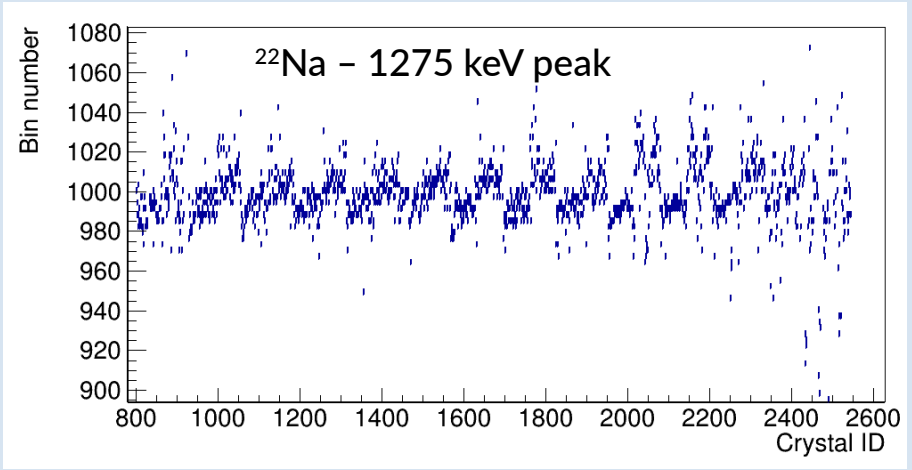


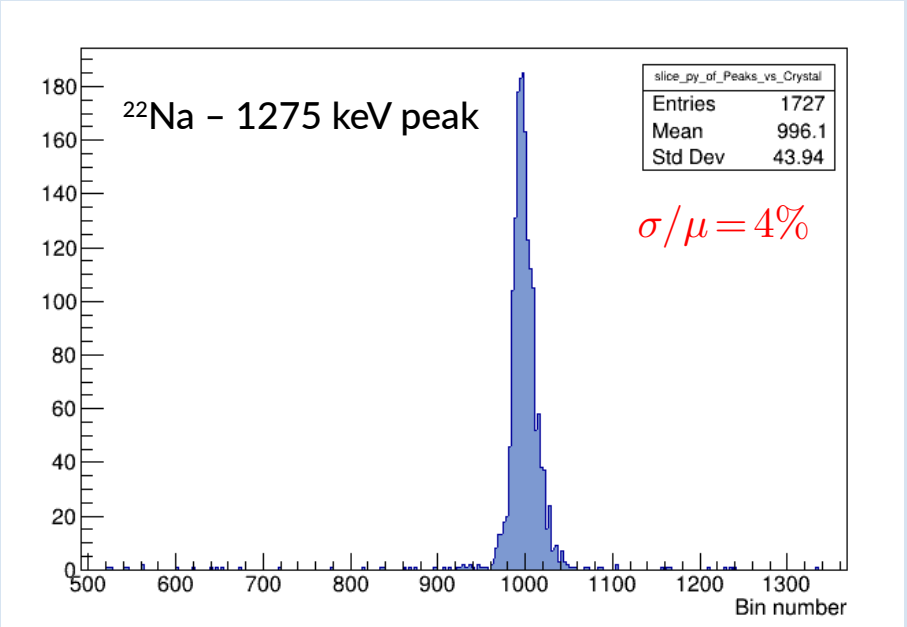
$$R = E_{\gamma\,(uncalib.)} / E_{p\,(uncalib.)} \approx 11$$

Serves as a translation factor between gamma range and proton range

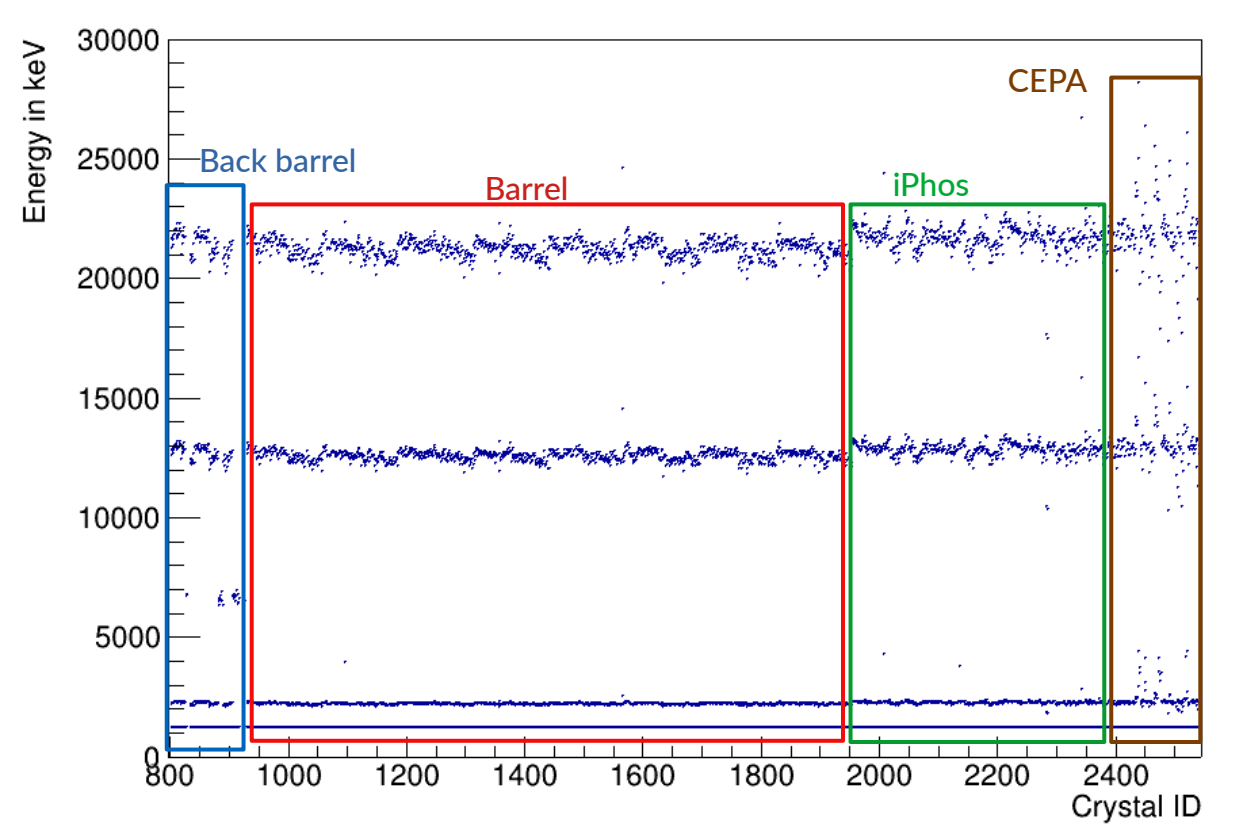
Gamma range: uncalibrated spectra

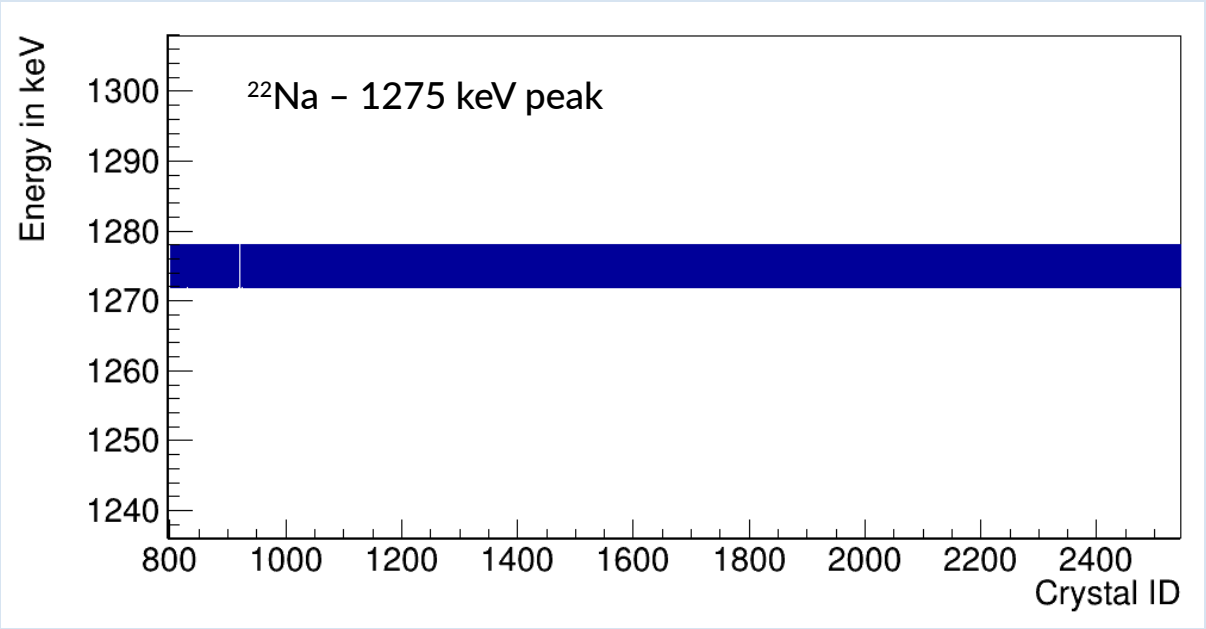






Gamma range: calibrated spectra



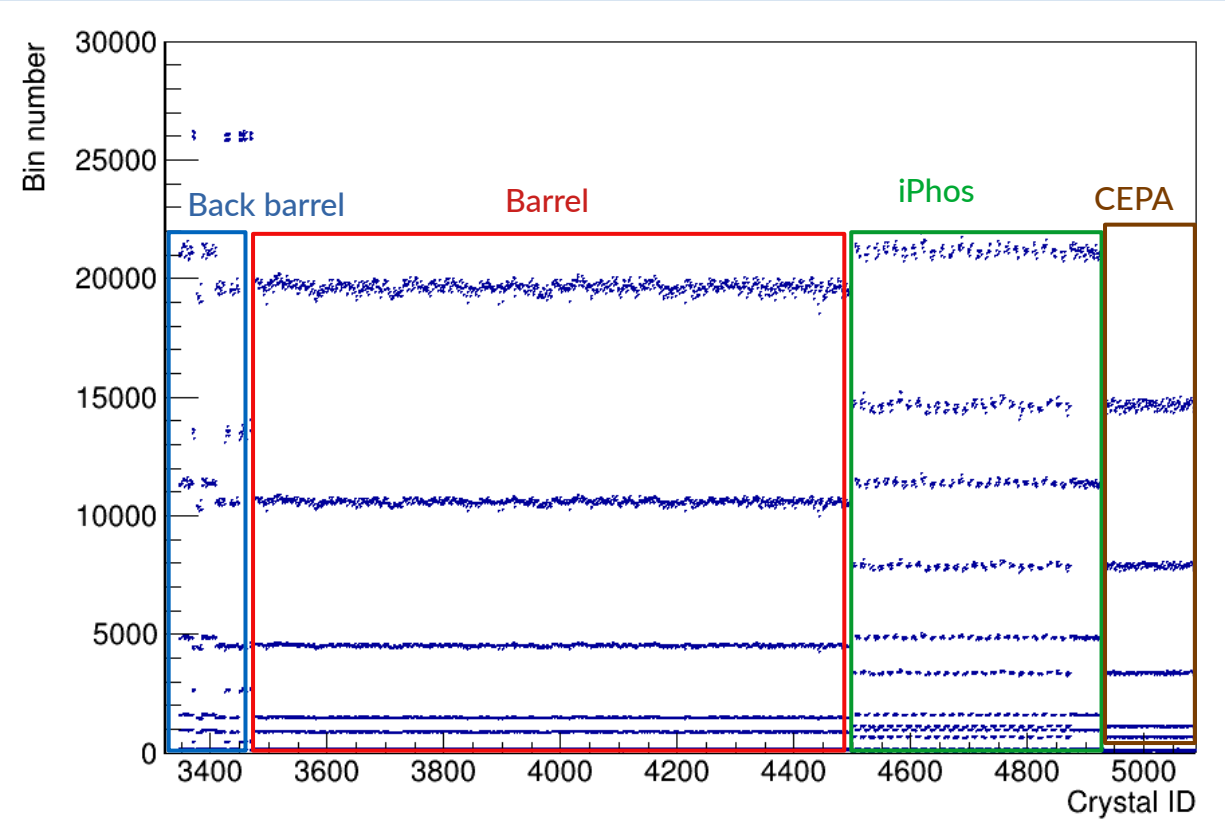


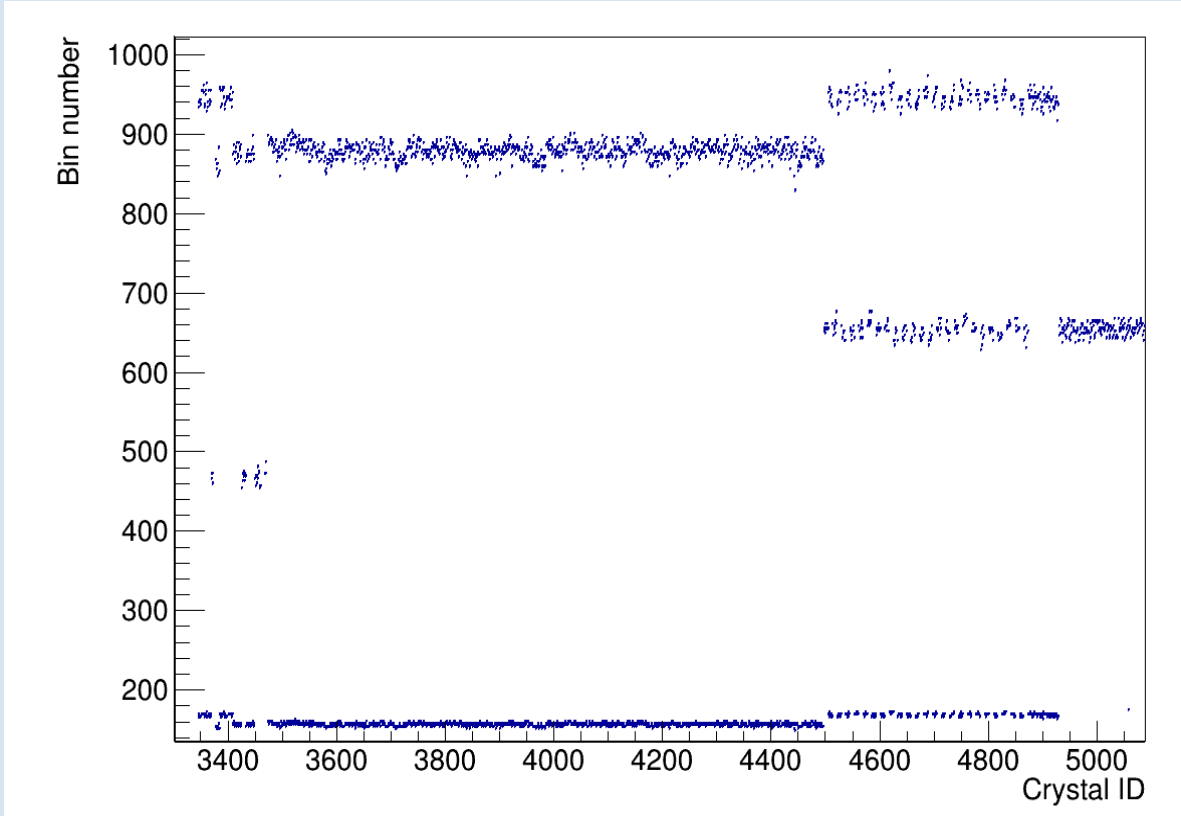
Applying a linear fit: $y = m_\gamma x + c_\gamma$

Software works !

Now we also have pulser peaks in keV

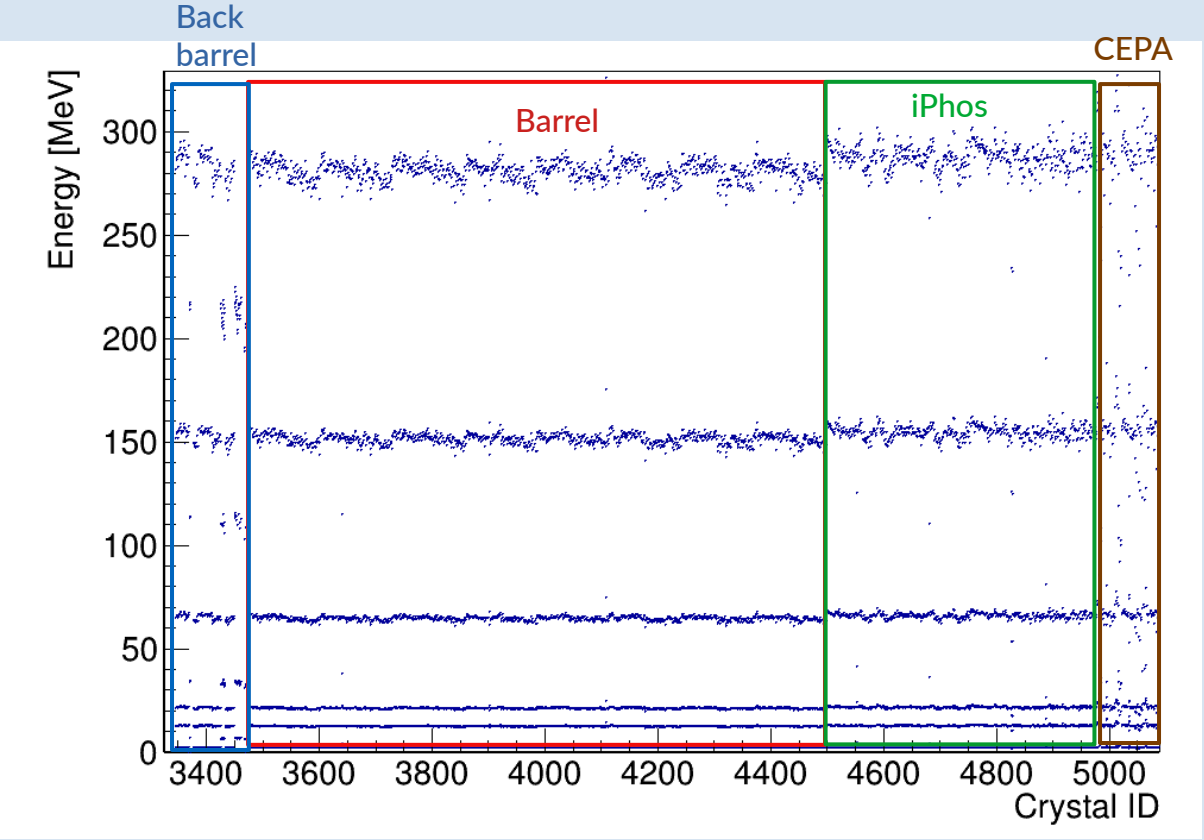
Proton range: uncalibrated spectra

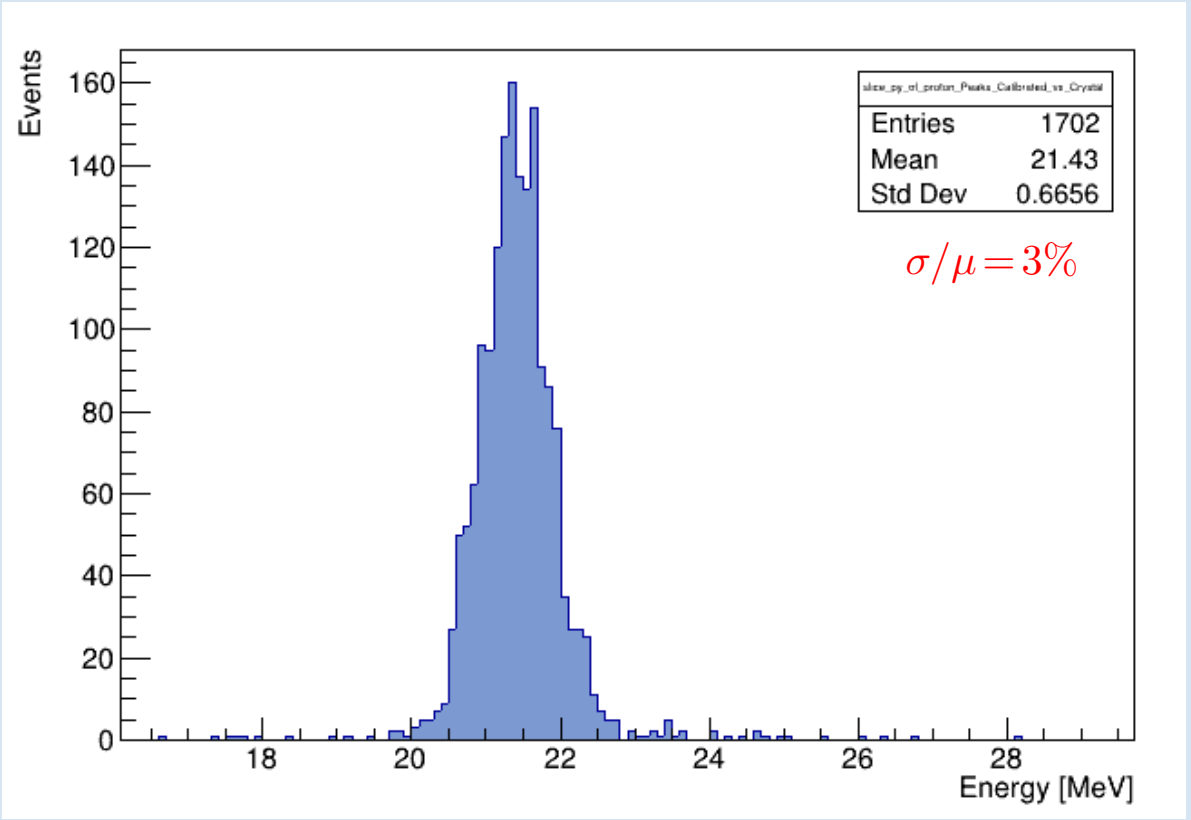




There are (channel to channel) variations in the electronics

Calibration in proton range

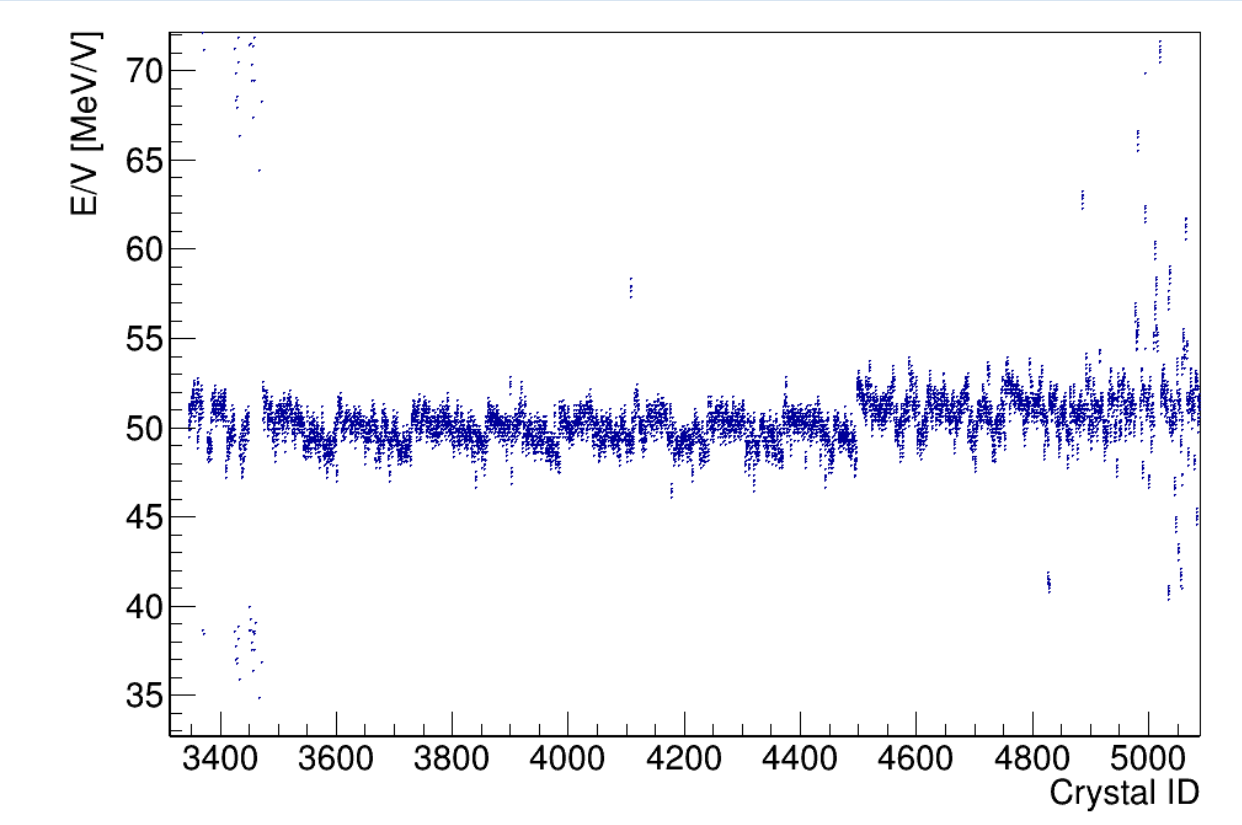


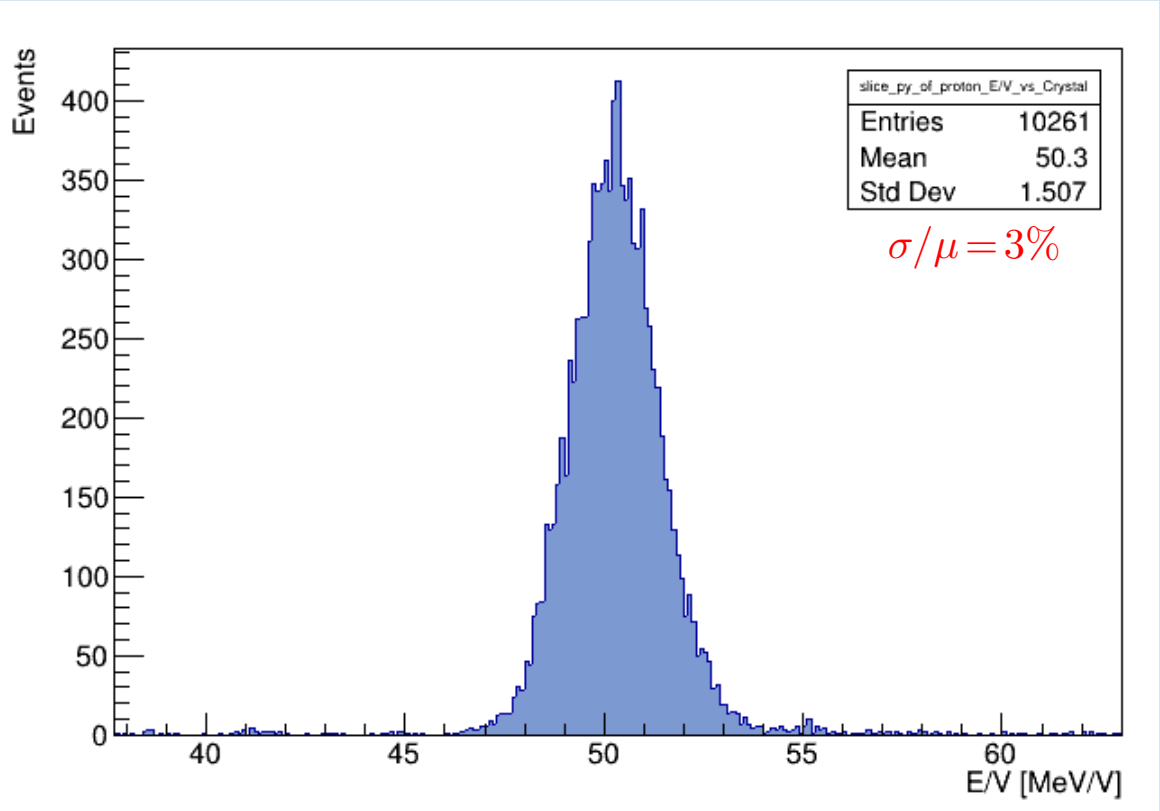


Energies for first 3 pulsers obtained from gamma calibration
Then doing a linear fit : $y = m_p x + c_p$ ⇒ All pulser energies in keV

Variation in pulsers include all uncertainities (depending on $L(t)$, R and C_{pulser})

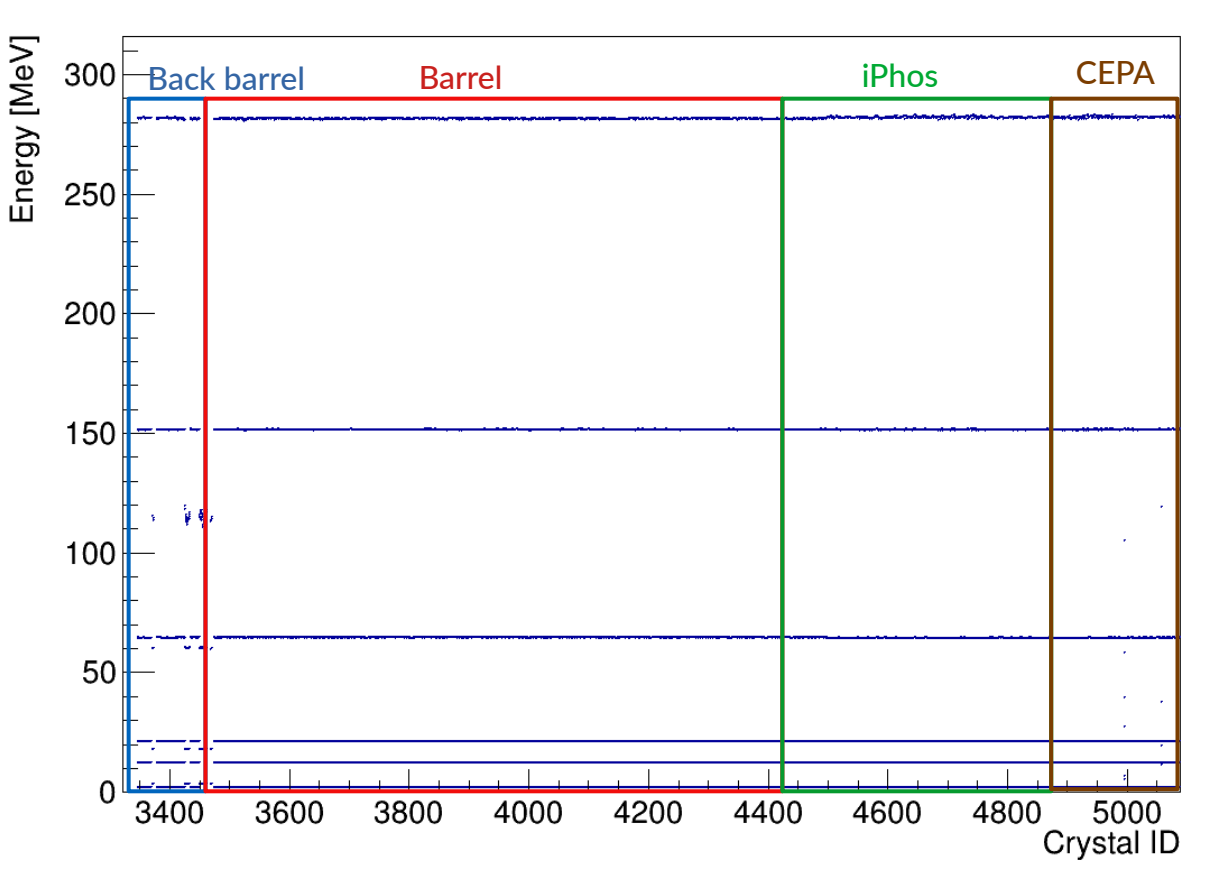
Pulser E/V ratio

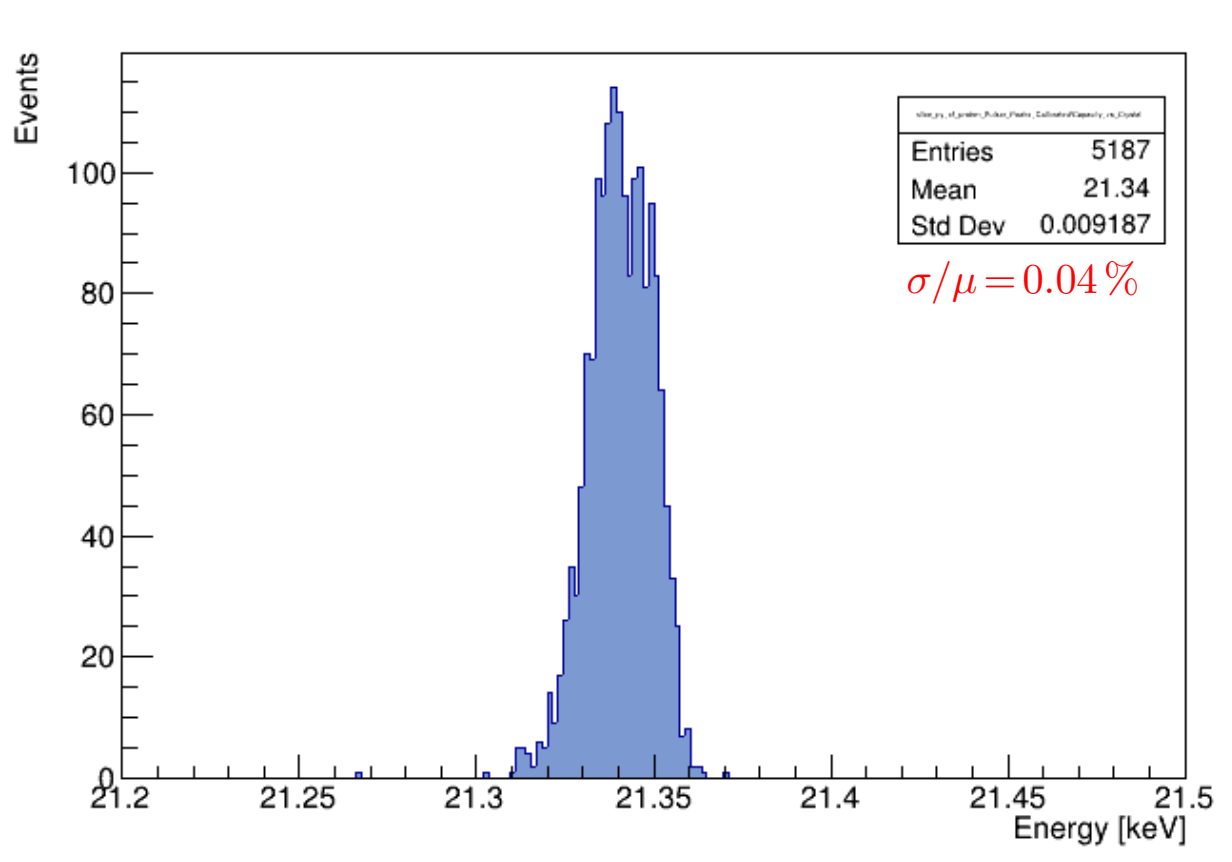




Variation in E/V for the pulsers again include all uncertainities ($L(t)$, R and C_{pulser})

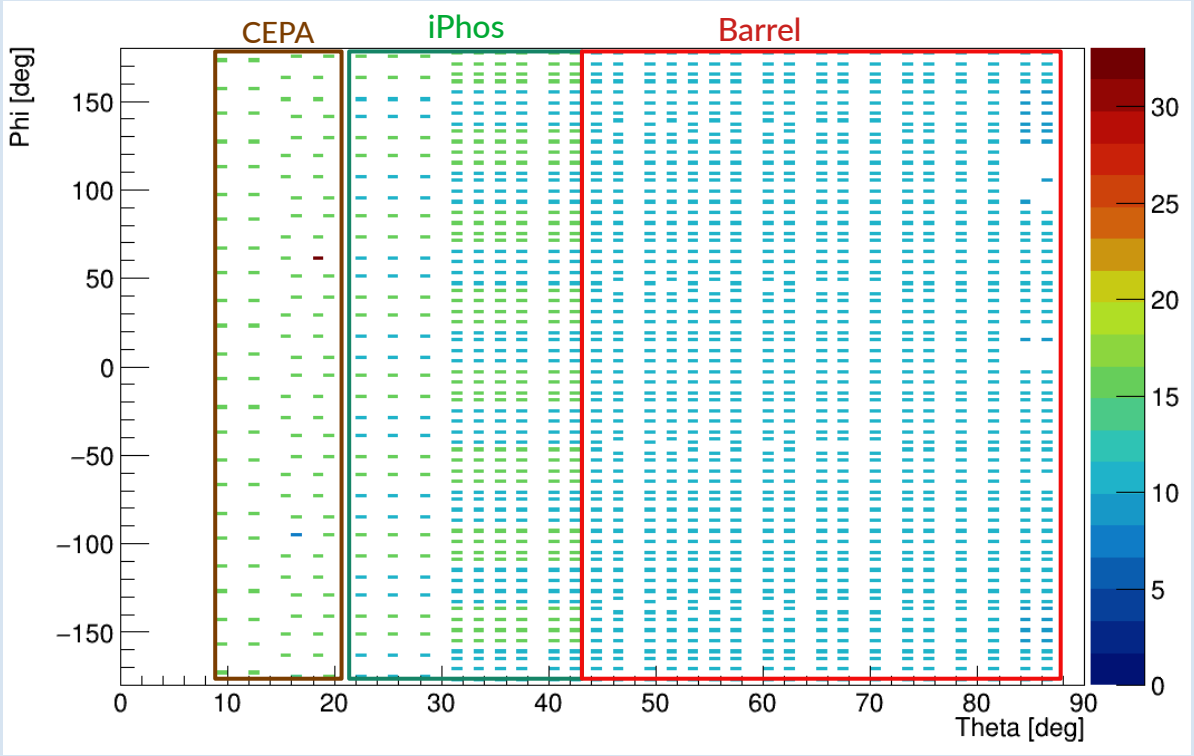
Proton range: calibrated spectra



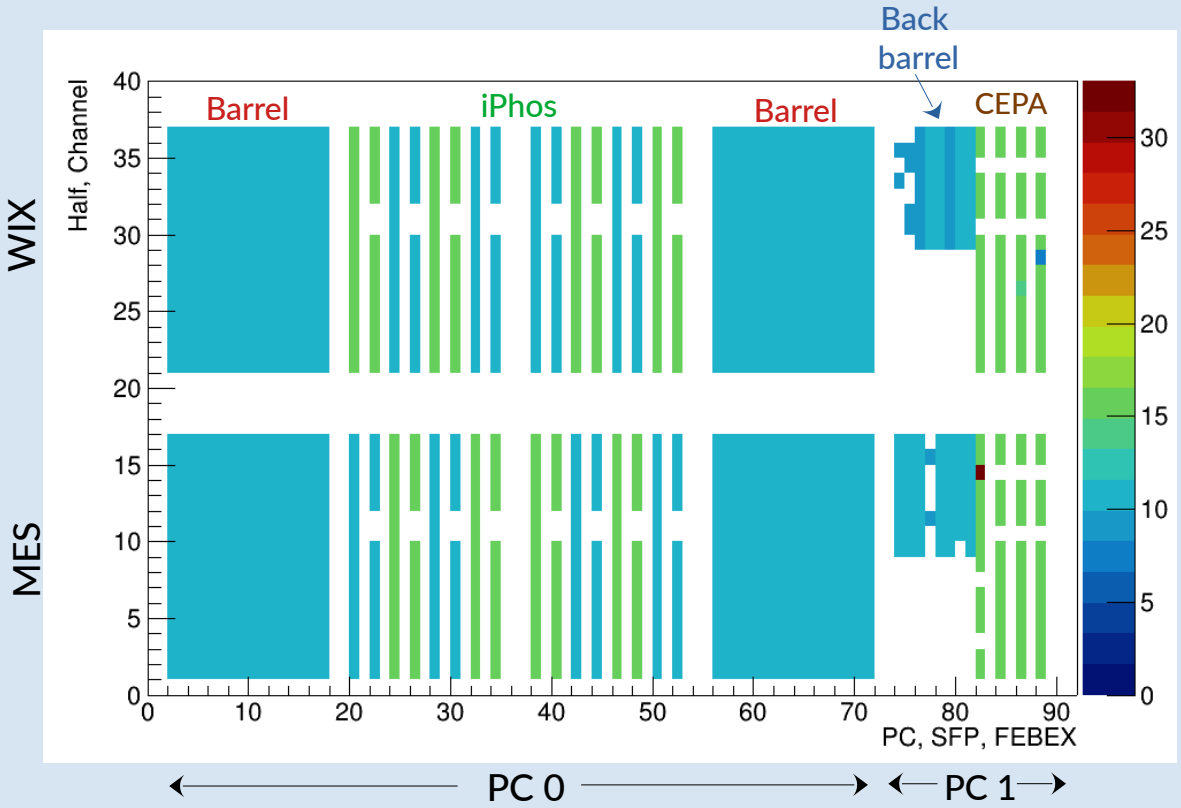


Software works !

QC Plots

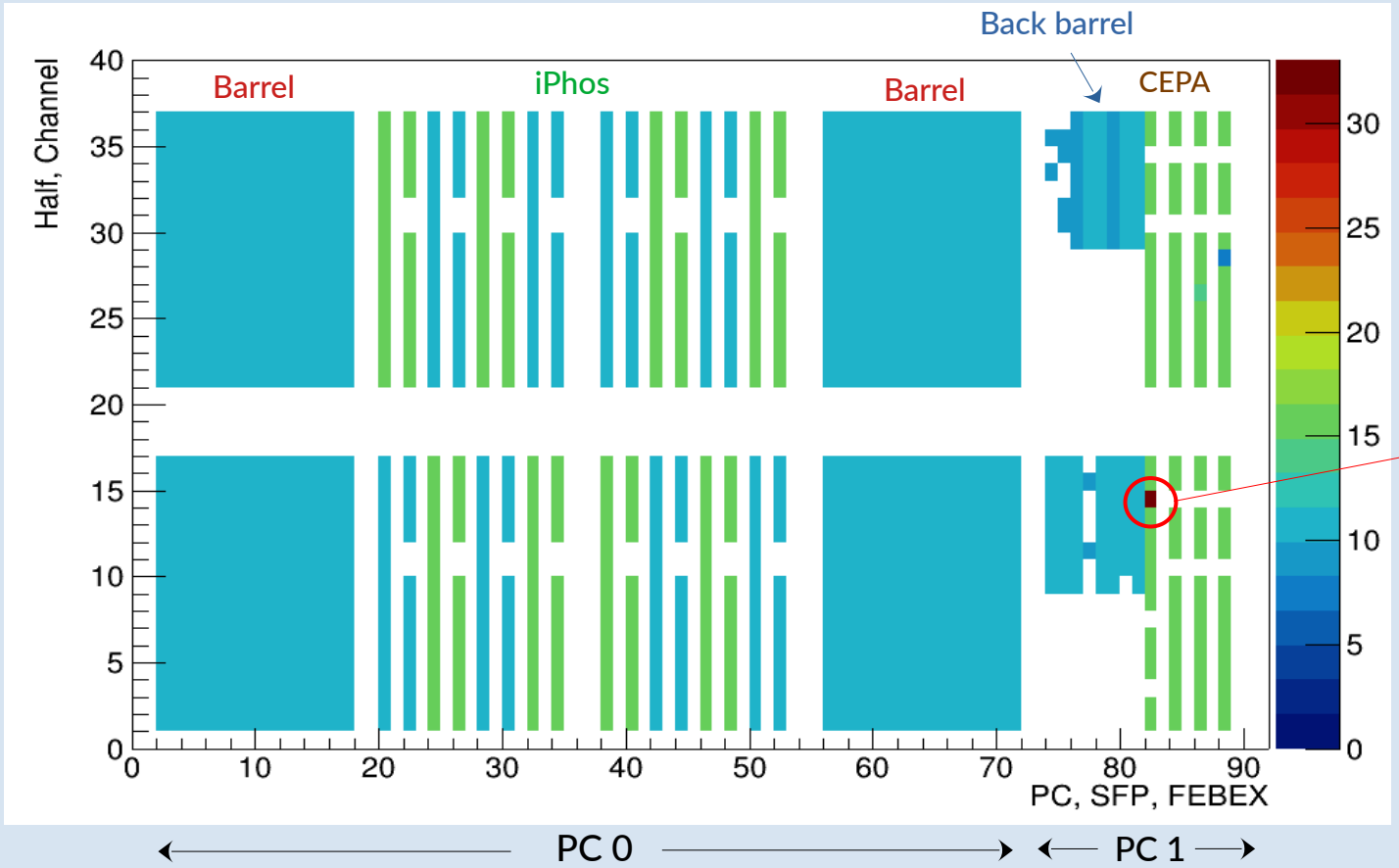


Quality Assessment Plot

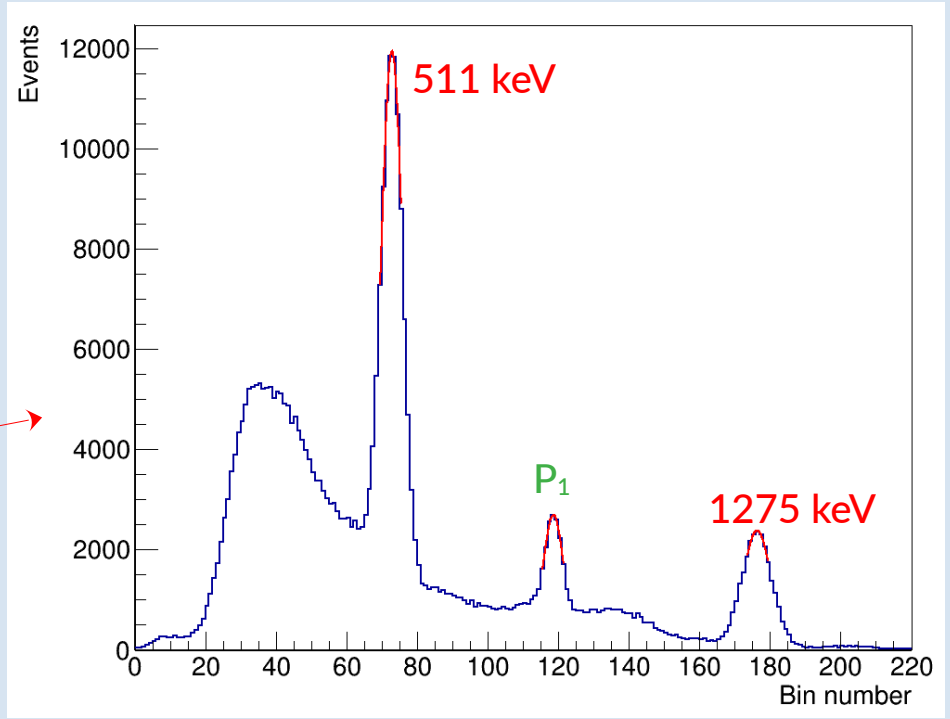


DAQ Plot (Hardware level)

QC Plots



DAQ Plot



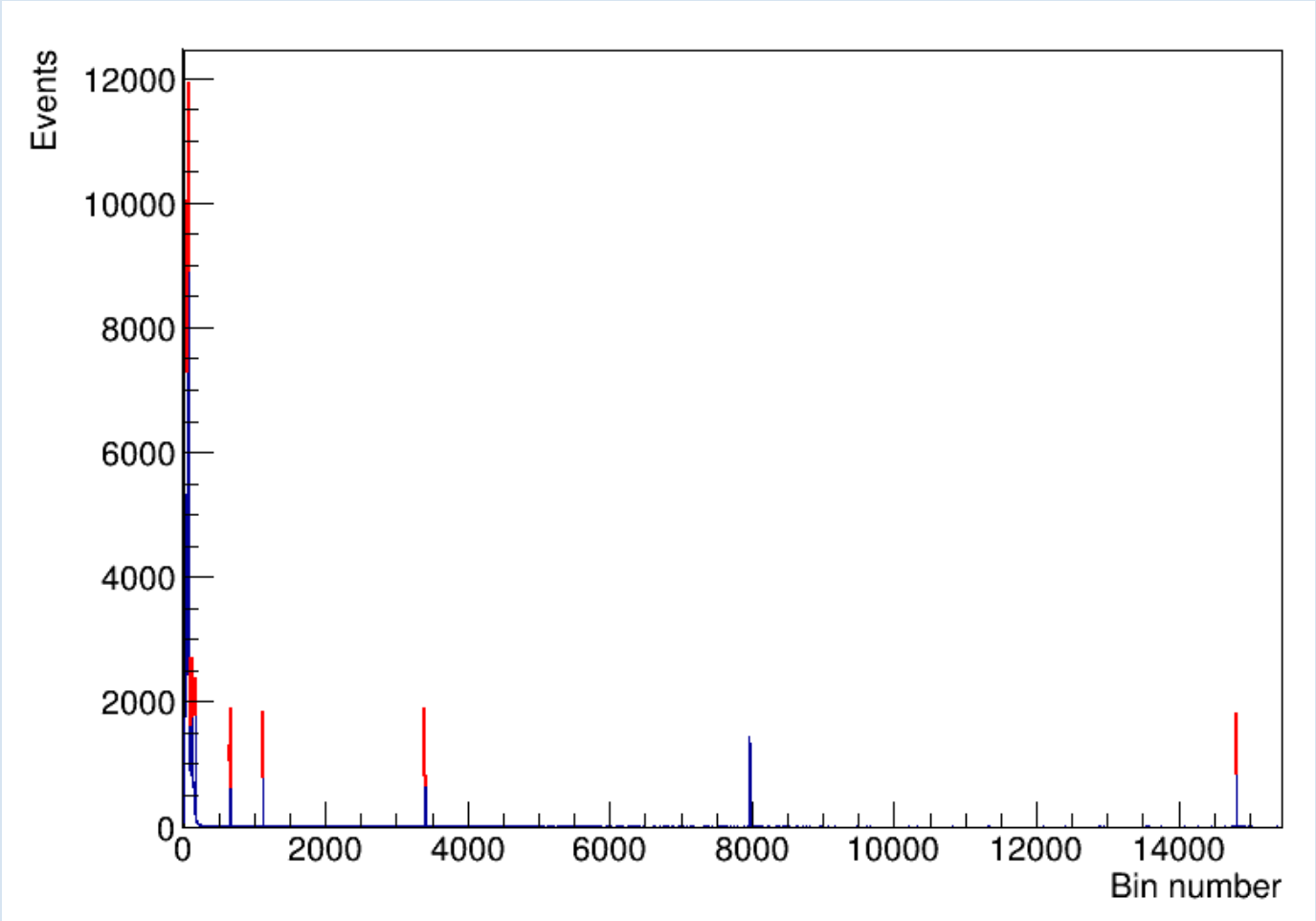
Spectrum for bad channel
(incorrect gain matching)

Thank You !

CALIFA @ Technical University of Munich
Mrunmoy Jena, Tobias Jenegger, Roman Gernhäuser

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

Extras: Bad channel



Crystal ID: 5057, in CEPA

```
Crystal 5057
Source Peak 1, Bin number: 72.8852
Pulser Peak 1, Bin number: 118.622
Pulser Peak 2, Bin number: 176.335
Pulser Peak 3, Bin number: 664.026
Pulser Peak 4, Bin number: 1121.33
Pulser Peak 5, Bin number: 3402.16
Pulser Peak 6, Bin number: 14819.5
Range factor Pulser Peak 1: 15.2875
Range factor Pulser Peak 2: 57.8574
Range factor Pulser Peak 3: 25.9151
Range factor: 33.02
Pulser Offset: -2053.82
Pulser Slope: 36.794
```