A full range calibration for CALIFA

Mrunmoy Jena

R3B Week
12.11.2024

Overview and structure of macro

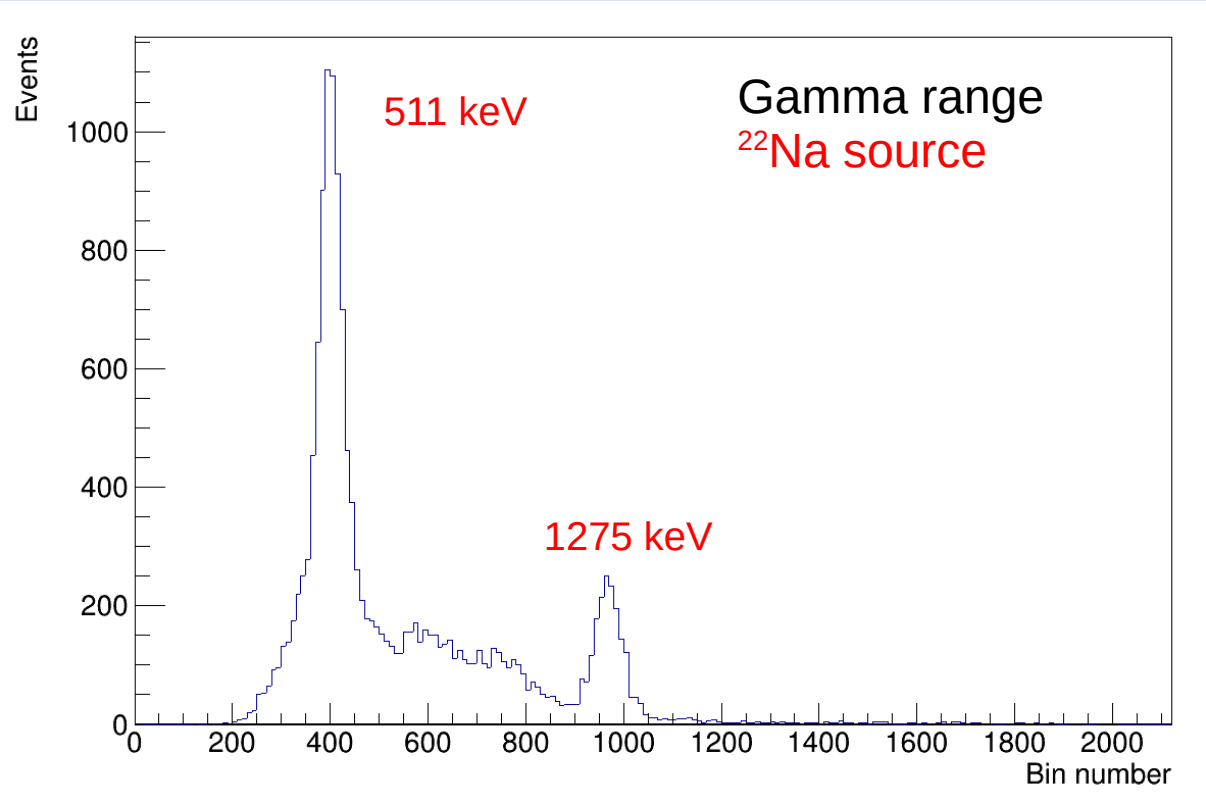
Calibration in the gamma range

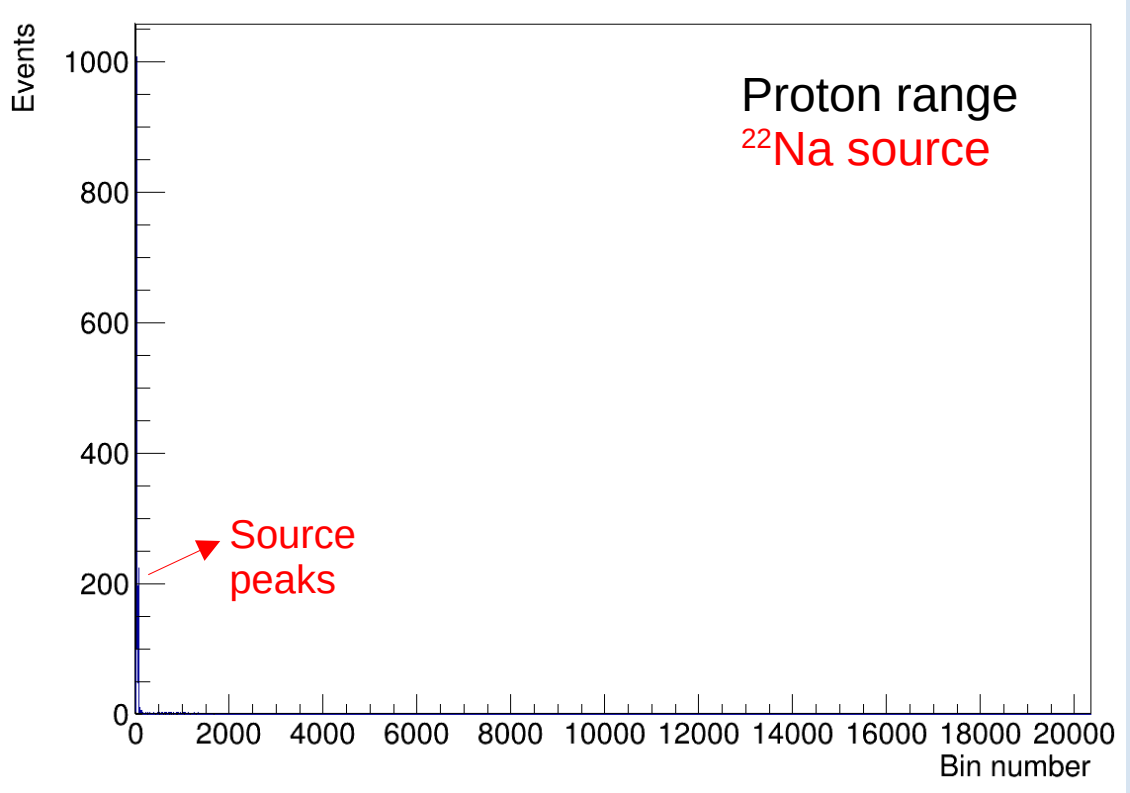
Extrapolation to proton range

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

TUM Members:
Roman Gernhäuser,Philipp Klenze,Tobias Jenegger, Mrunmoy Jena

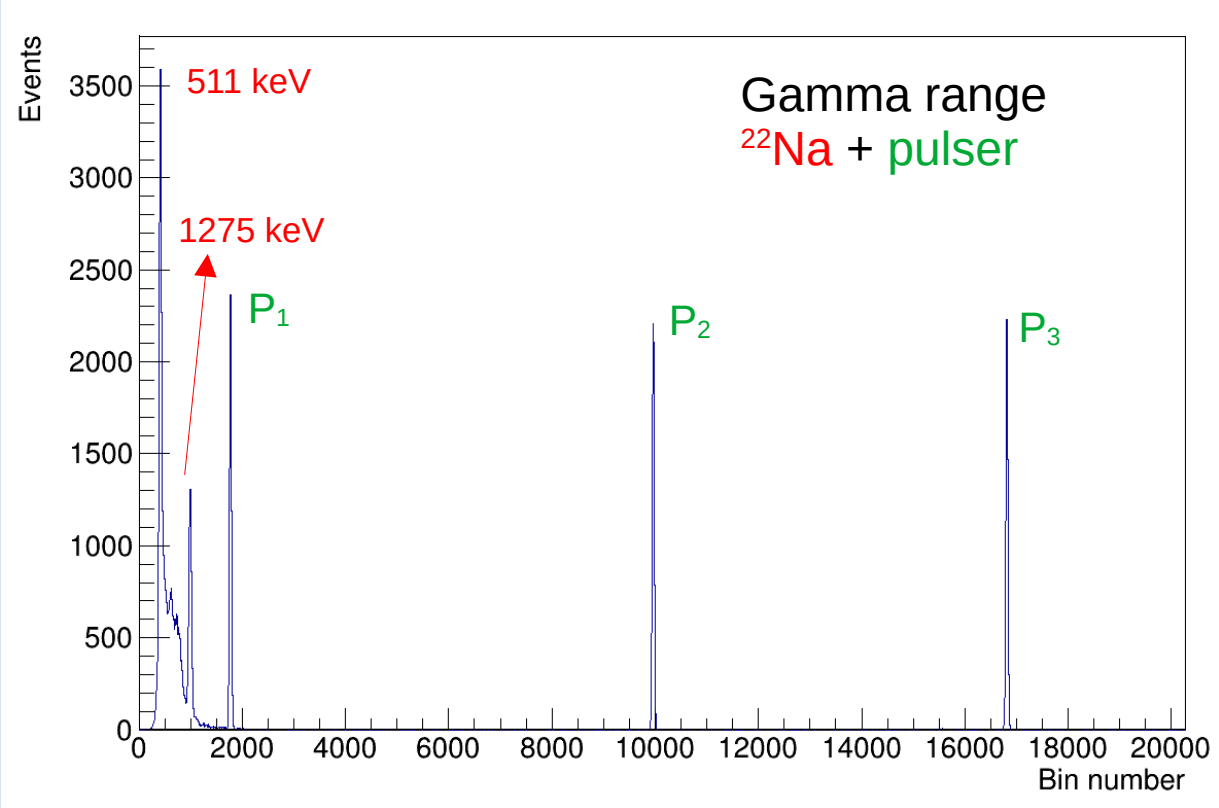
Introduction

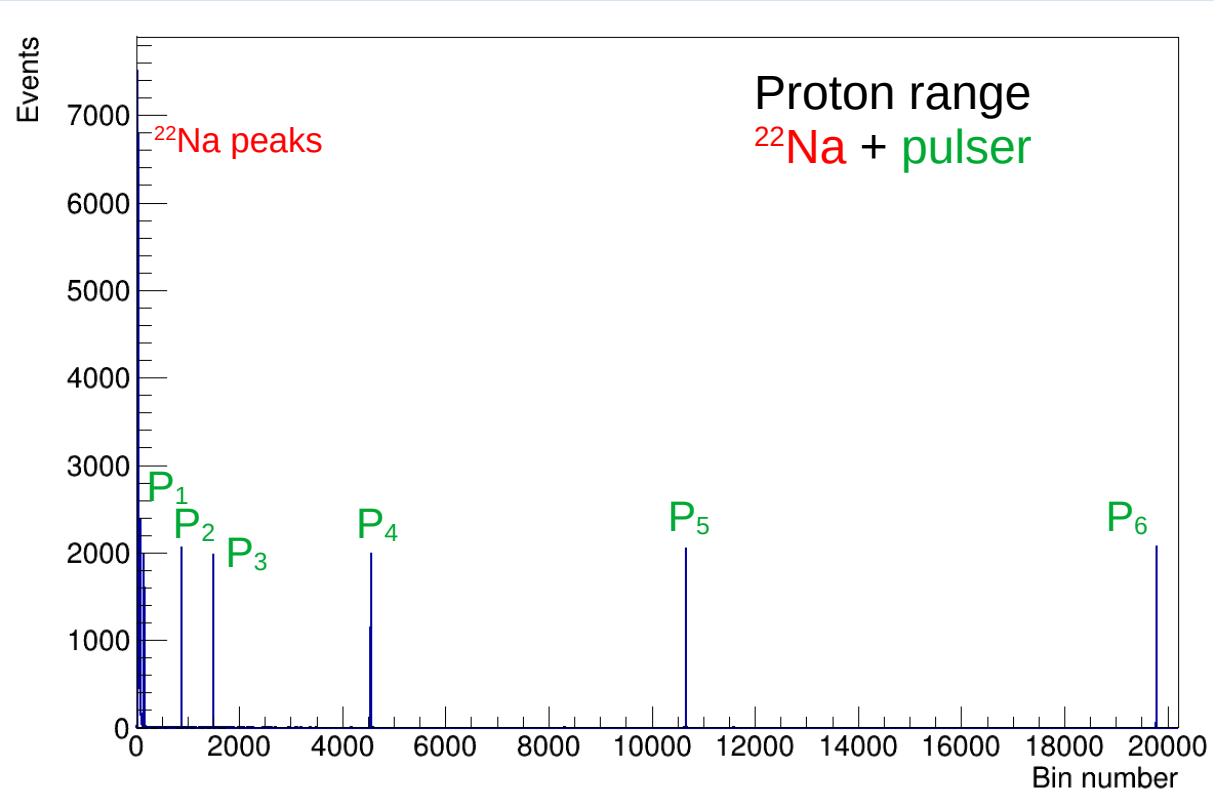




^{22}Na source hardly useful for performing calibration in the proton range !

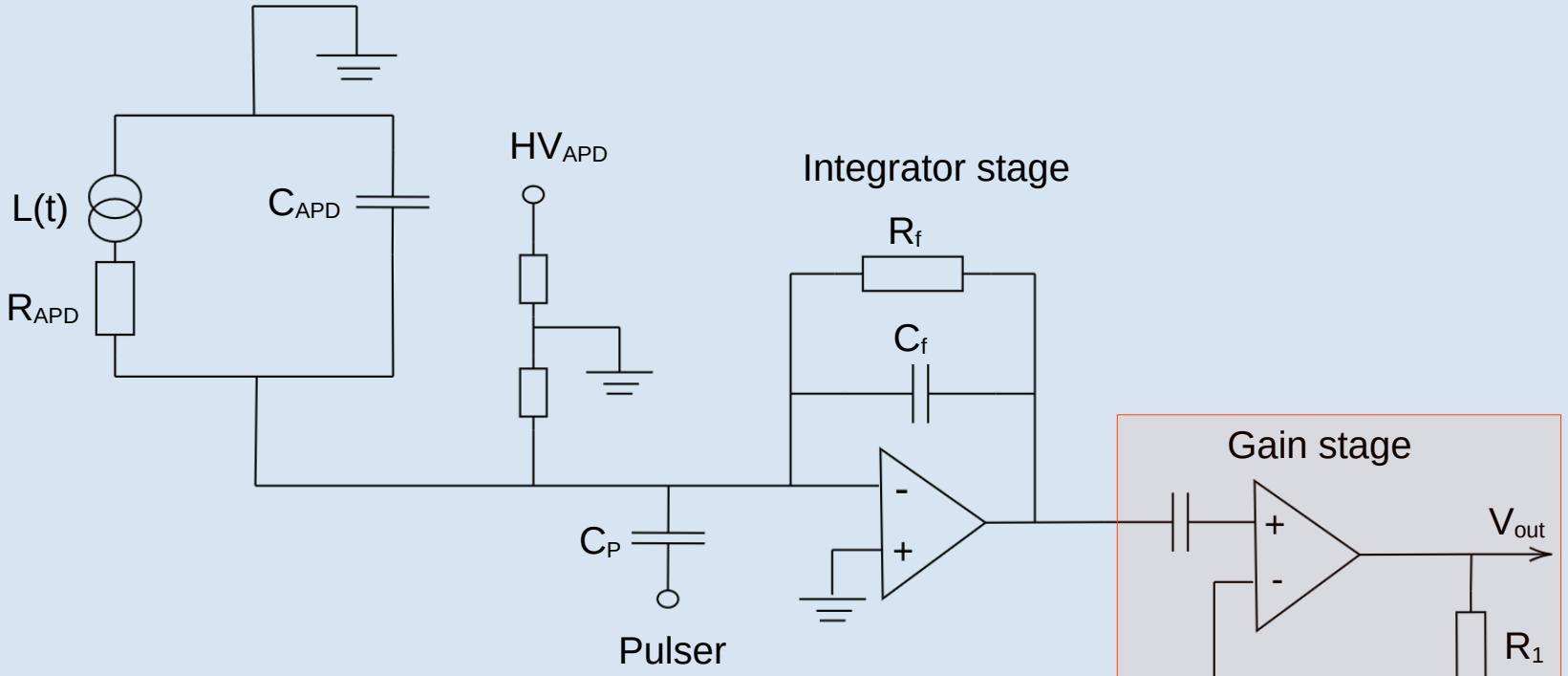
Introduction

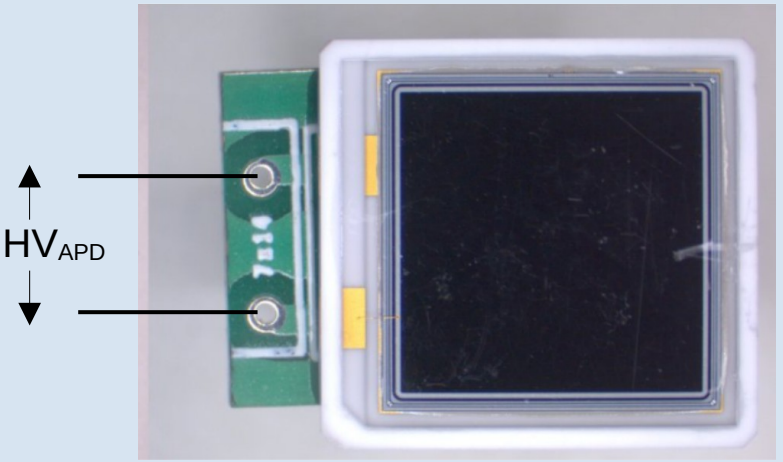




Using pulsers is essential for calibration in proton range

Introduction

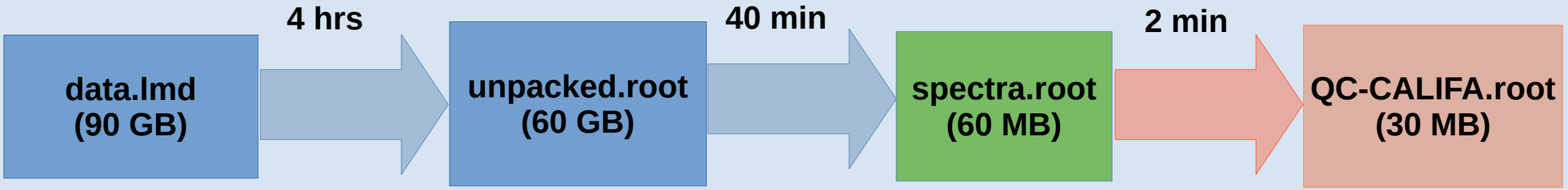




$$L(t) \equiv f(N_\gamma \cdot c_{Transp.} \cdot c_{Absorp.} \cdot \epsilon_{APD} \cdot g_{APD})$$

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

Calibration overview



Key advantages:

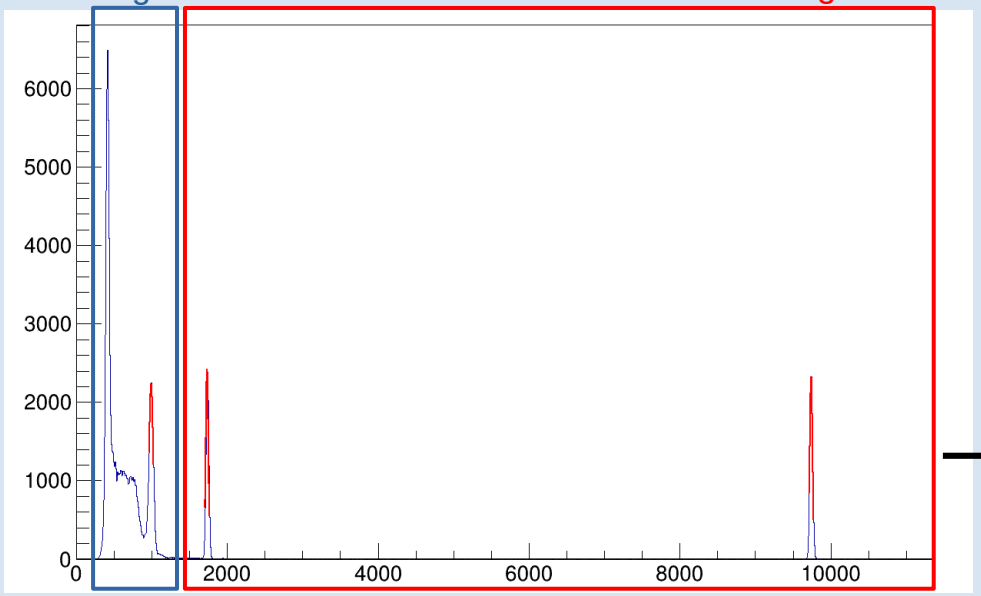
- Unpacking, writing spectra done only once !
- Calibration takes just **2 min.**

Calibration overview

Unpacking

data.lmd → Unpack using UCESB reader → unpacked_gamma.root, unpacked_proton.root

Source region / Pulser region



Calibration macro

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

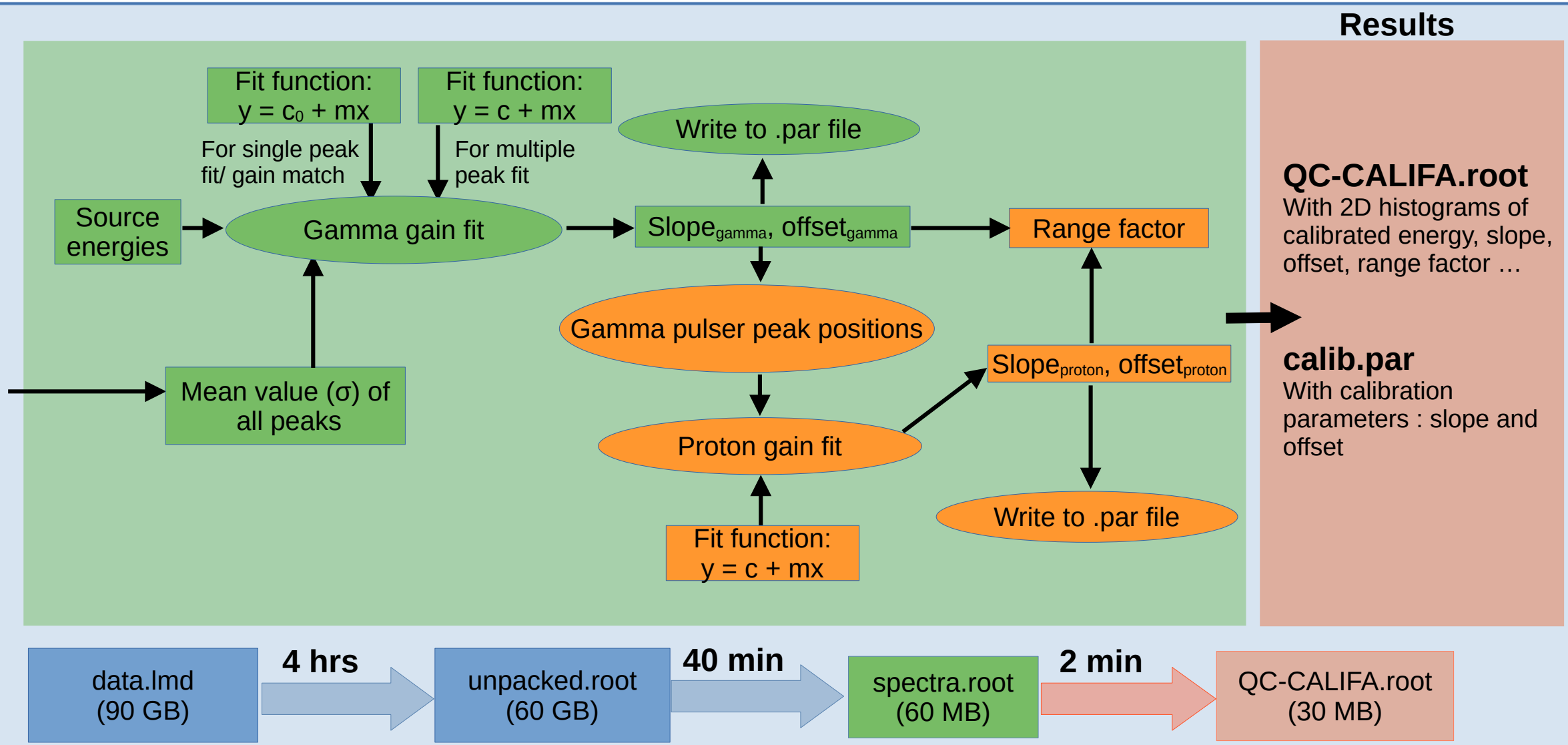
Gauss fit each peak

Mean, Sigma, Events

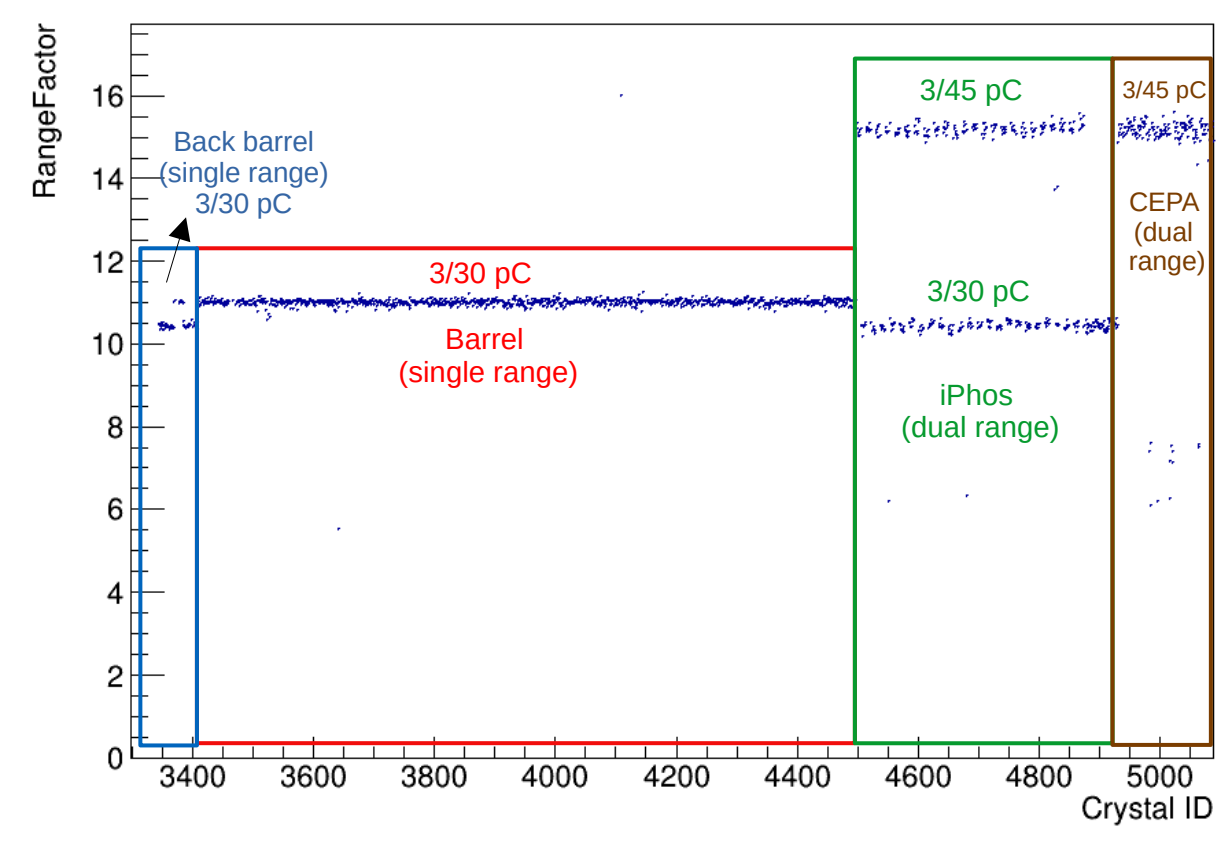
Peak parameters:
number and region for source and pulser peaks

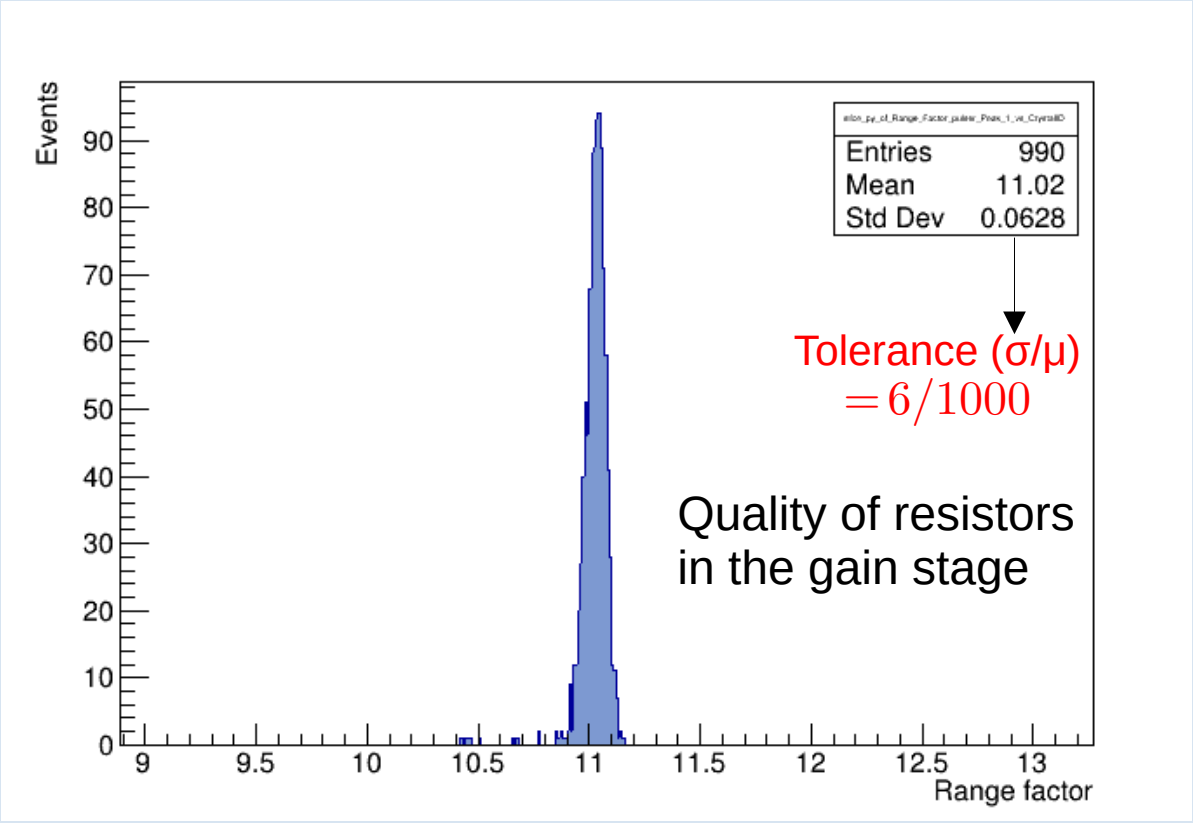
Fit parameters:
Expected width

Calibration macro



Range factor

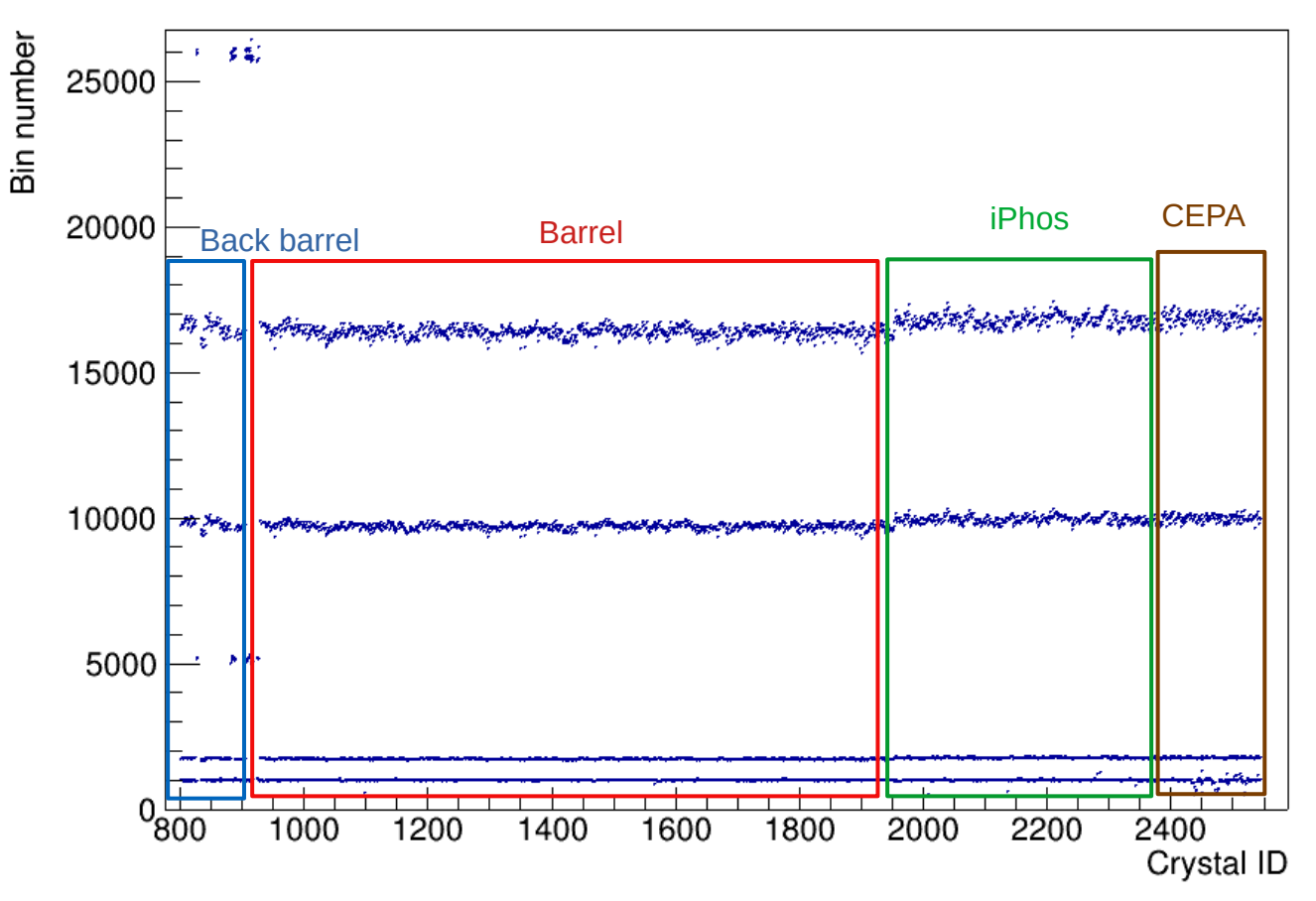


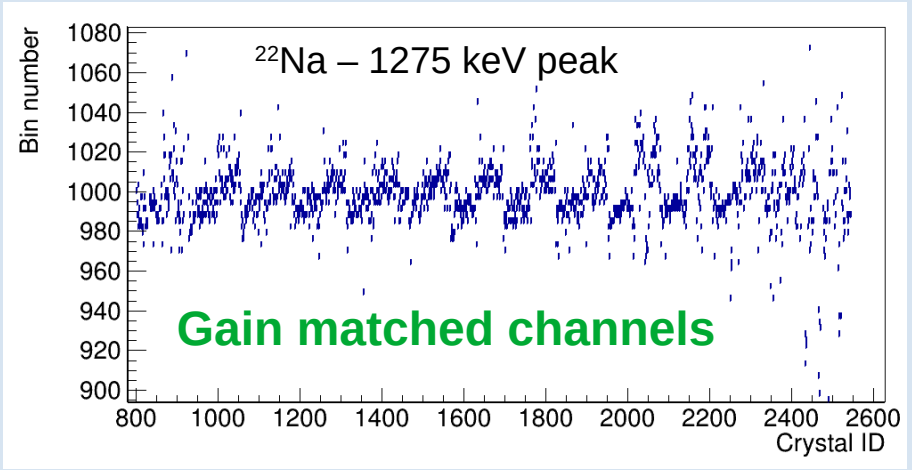


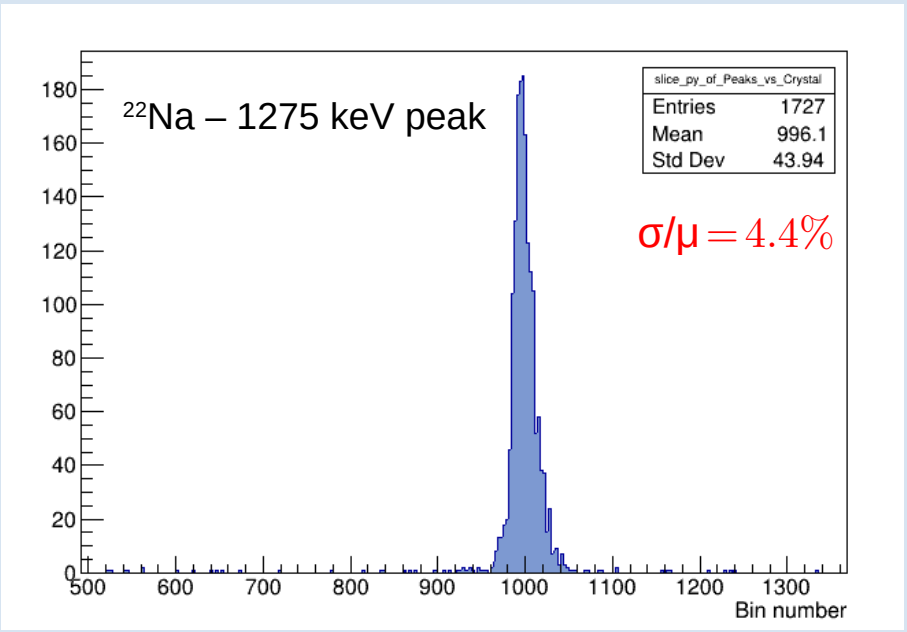
$$R = E_{\gamma\,(uncalib.)} / E_{p\,(uncalib.)} \approx 11$$

Serves as a translation factor between gamma range and proton range

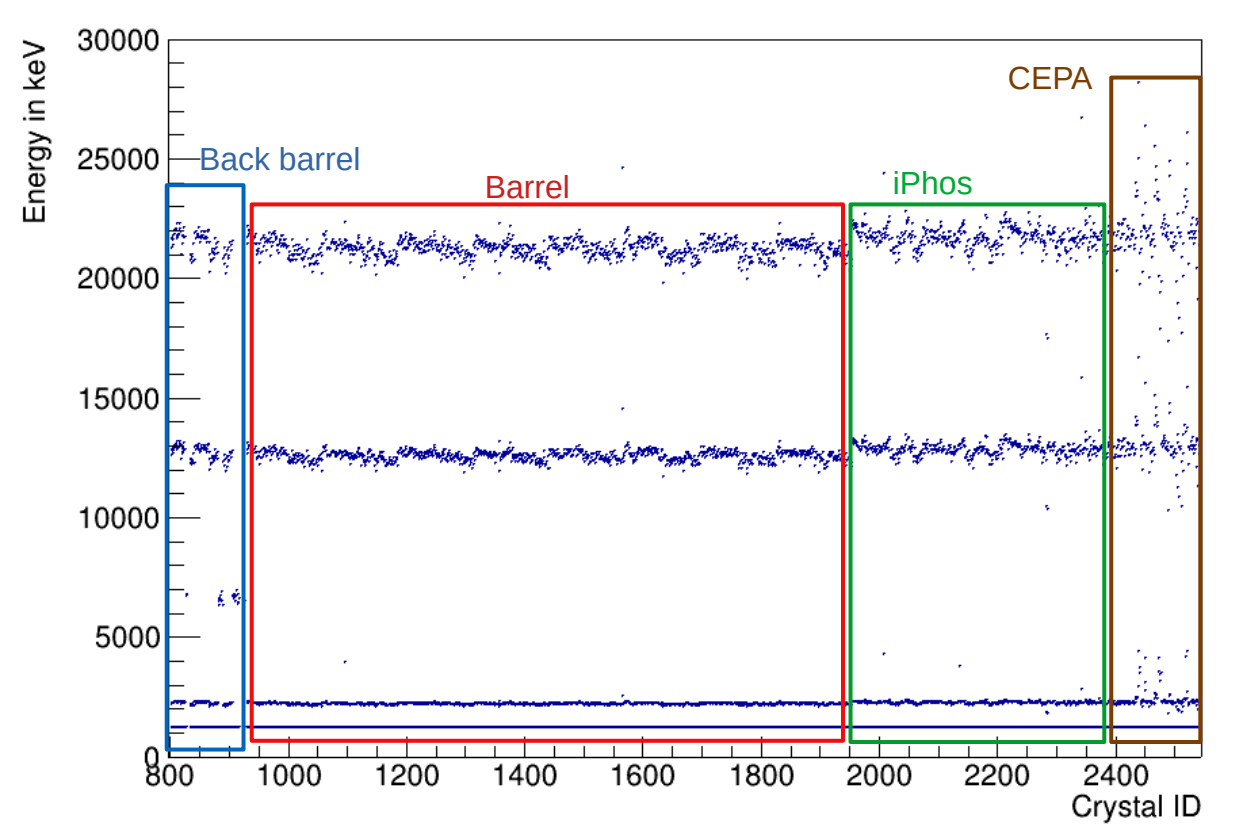
Gamma range: uncalibrated spectra

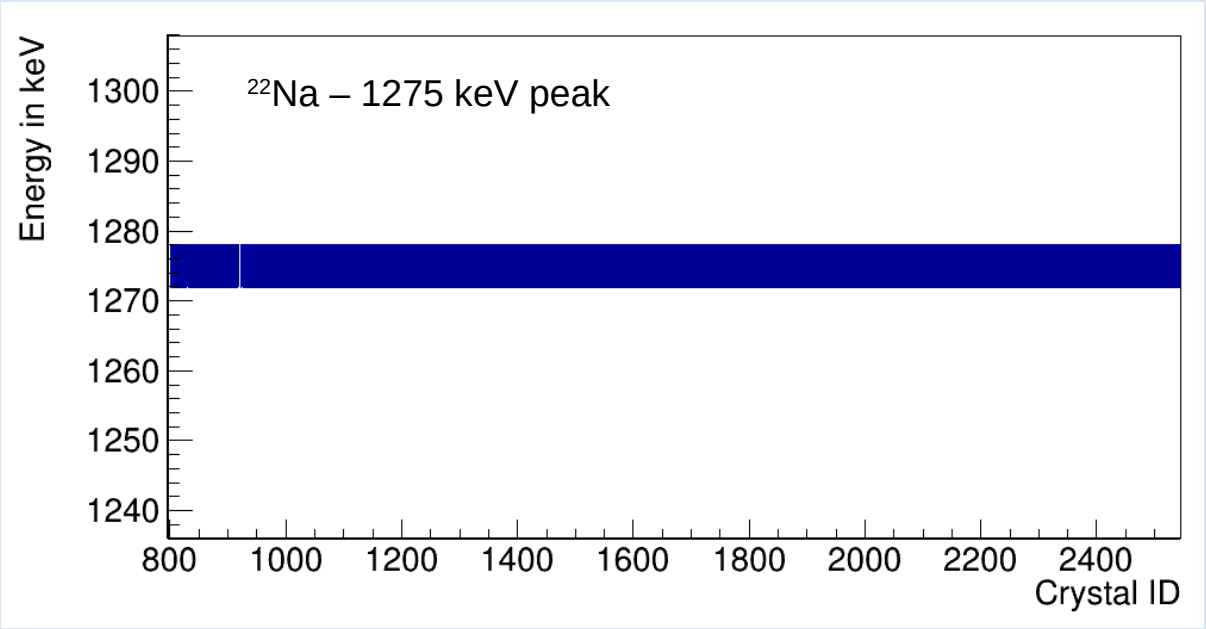






Gamma range: calibrated spectra



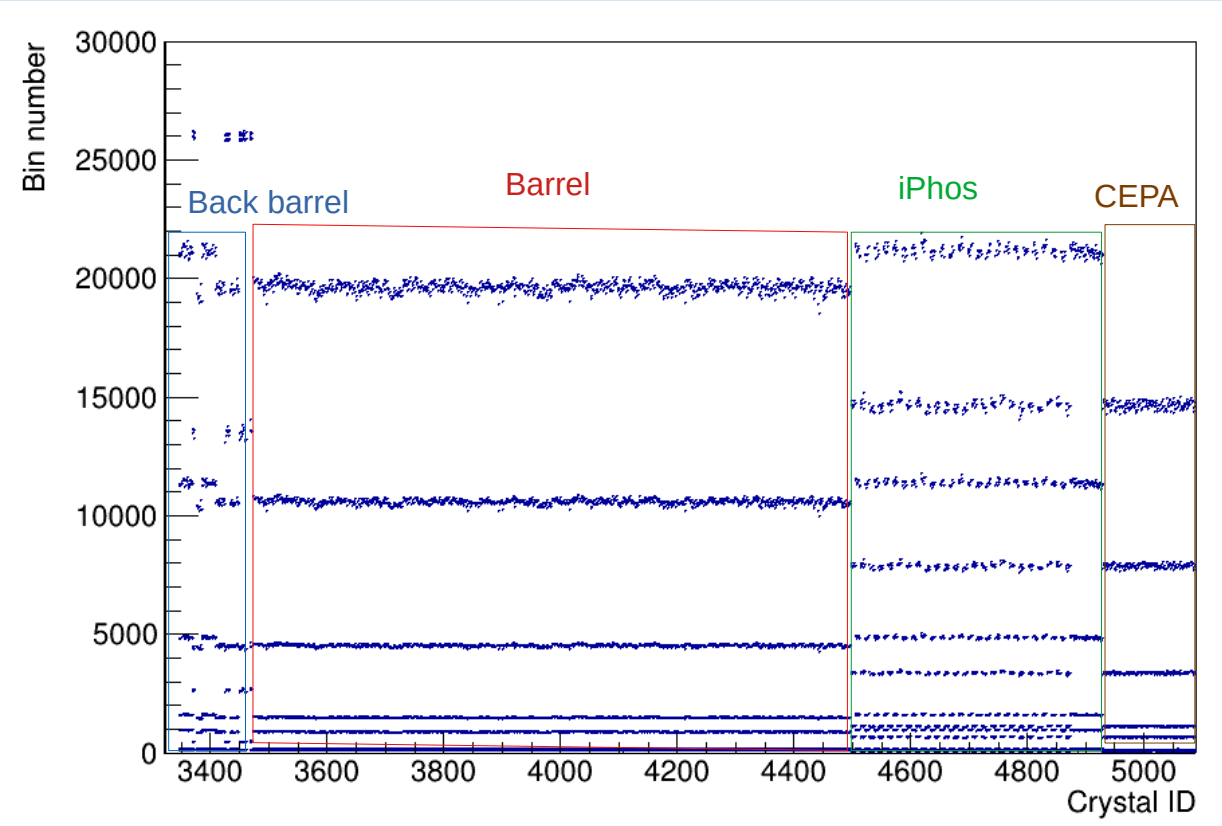


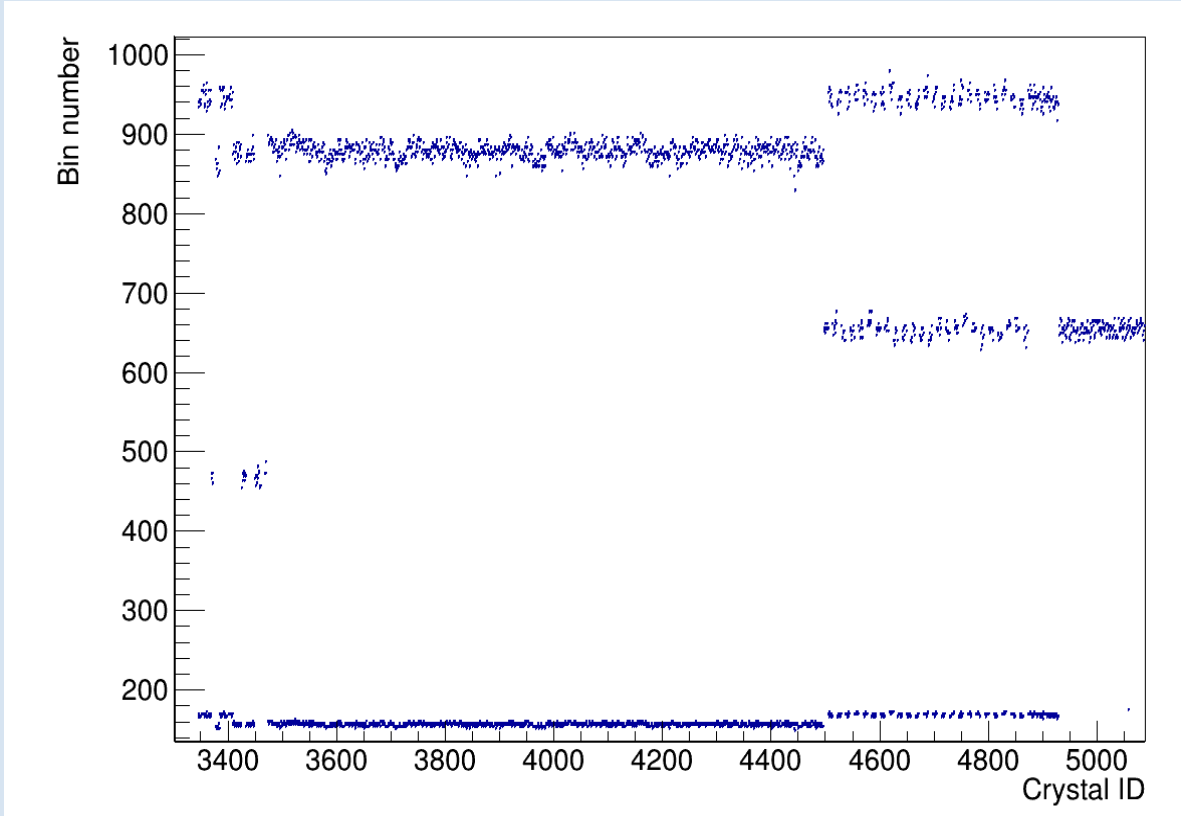
Applying a linear fit: $y = m_\gamma x + c_\gamma$

Software works !

Now we also have pulser peaks in keV

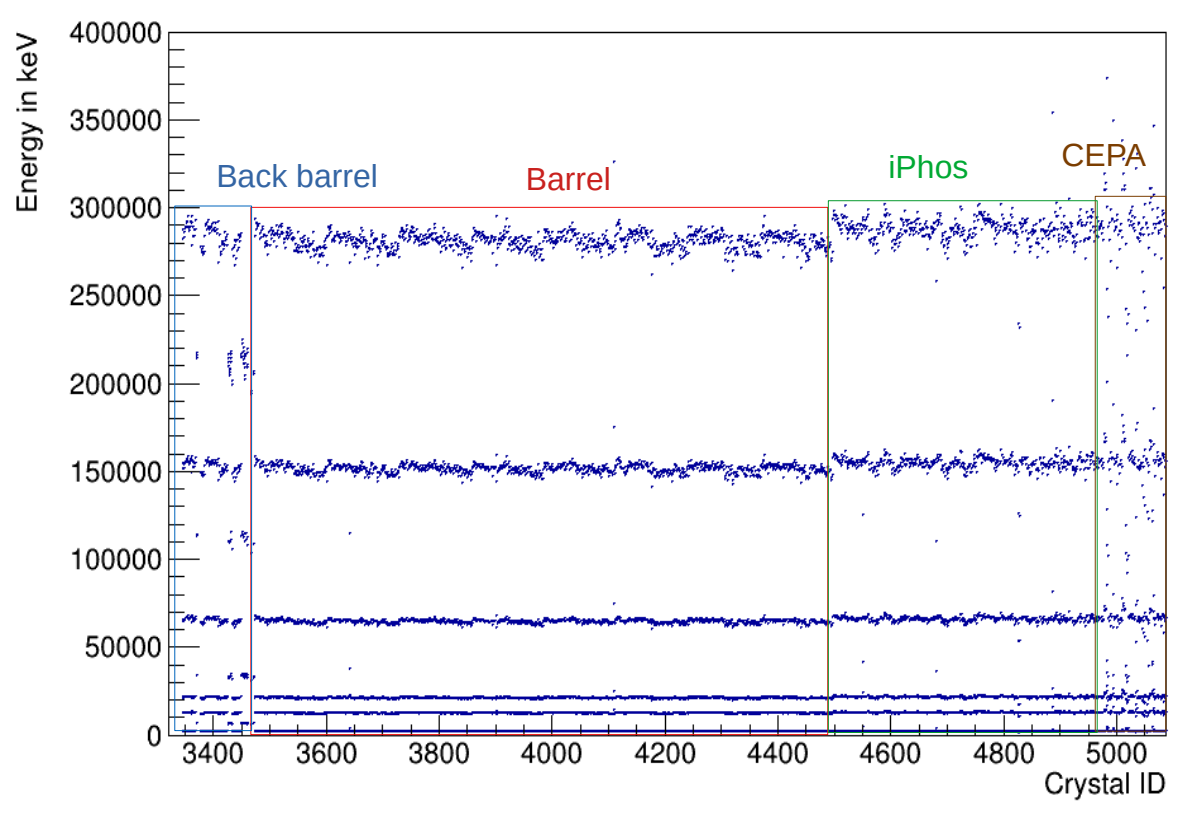
Proton range: uncalibrated spectra

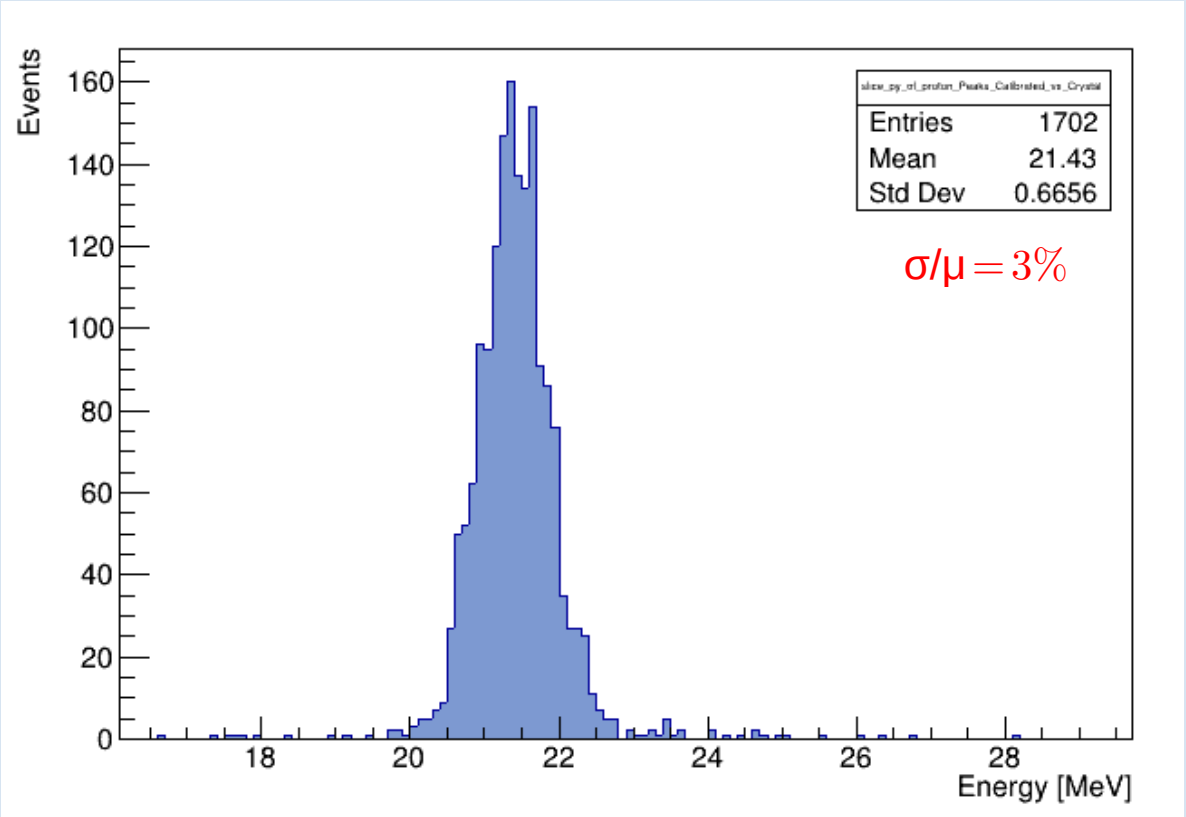




There are (channel to channel) variations in the electronics

Calibration in proton range

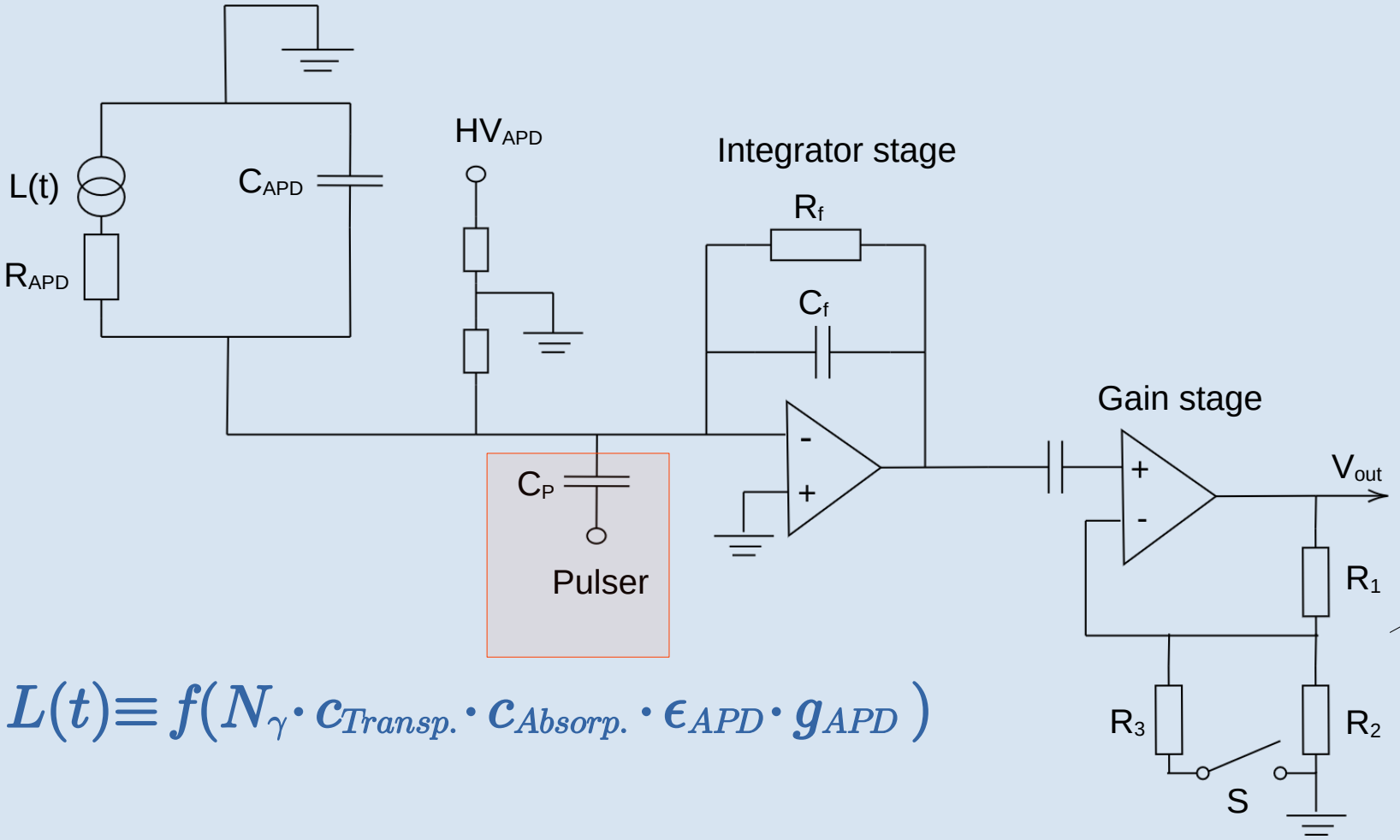


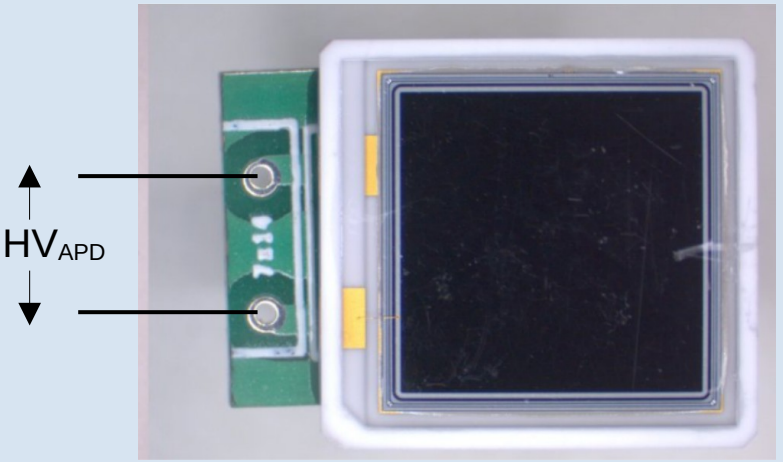


Energies for first 3 pulsers obtained from gamma calibration
Then doing a linear fit : $y = m_p x + c_p \Rightarrow$ All pulser energies in keV

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

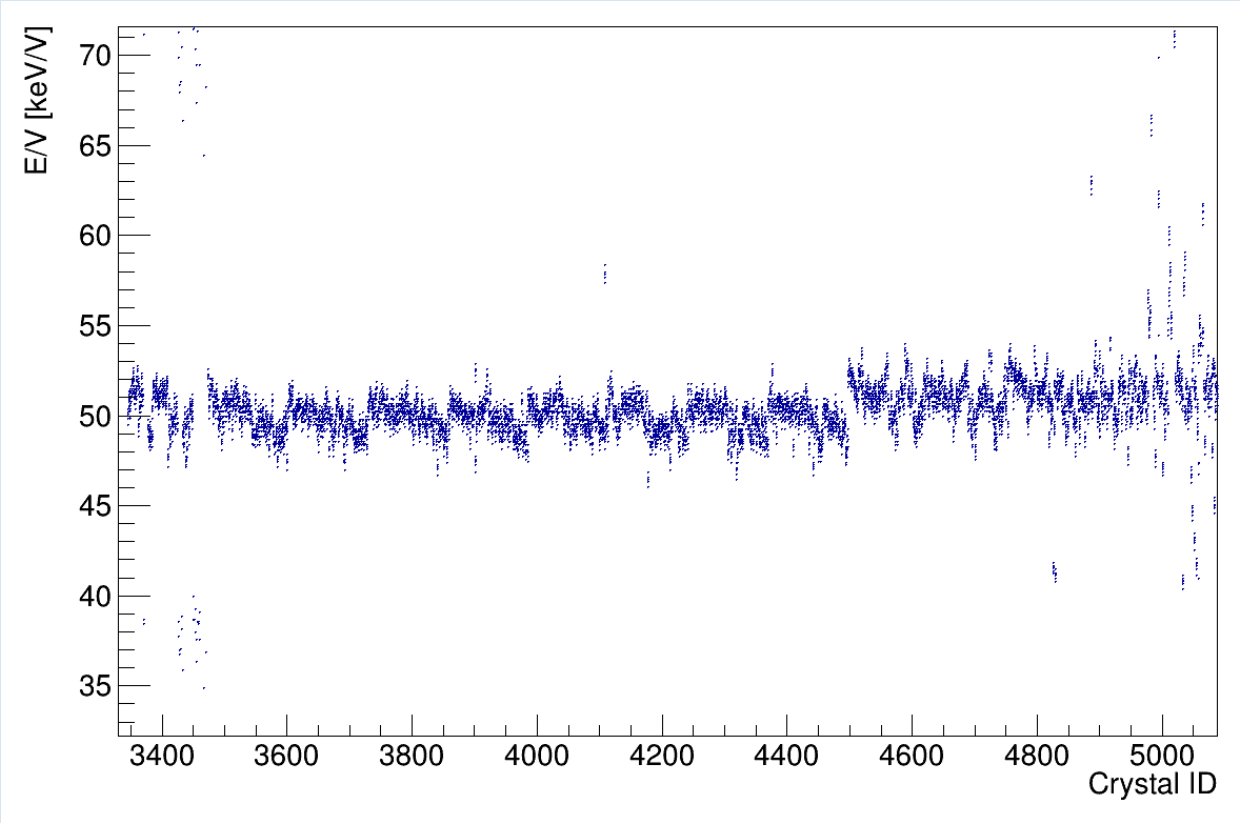
Circuit diagram

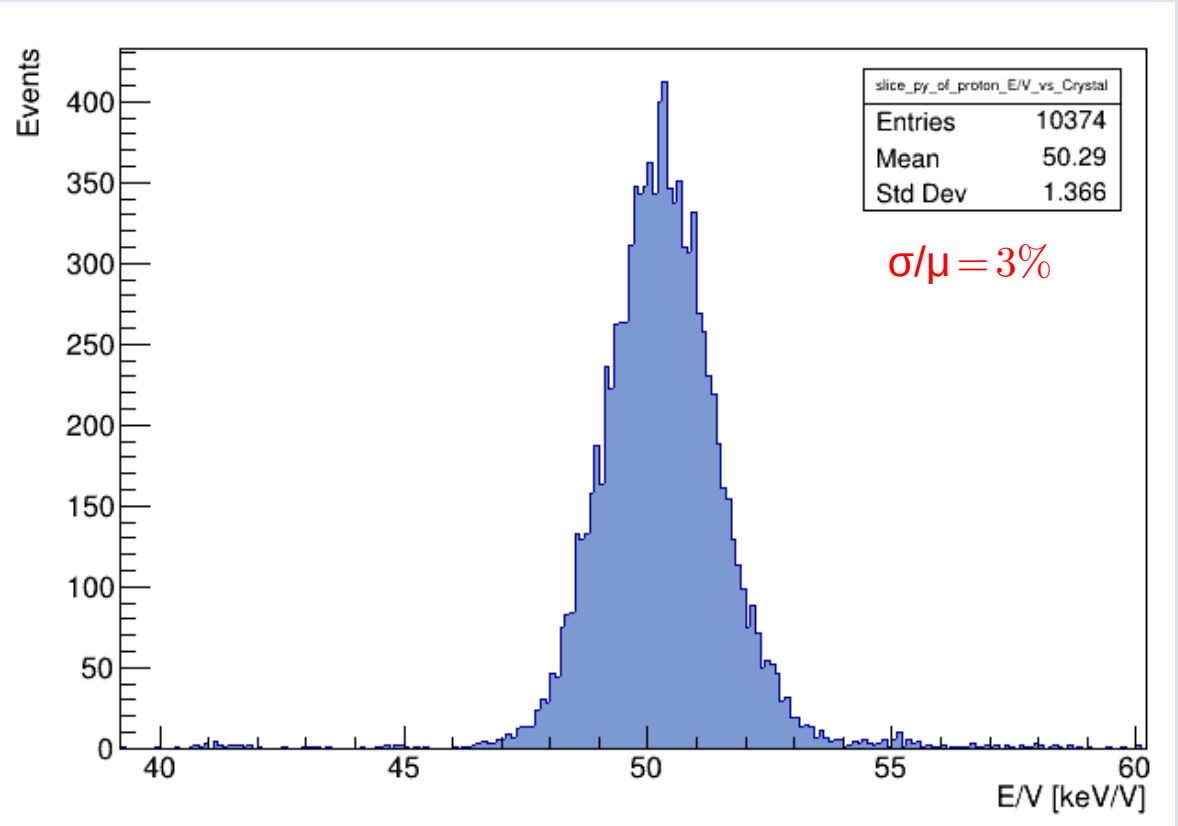




$$L(t) \equiv f(N_\gamma \cdot c_{Transp.} \cdot c_{Absorp.} \cdot \epsilon_{APD} \cdot g_{APD})$$

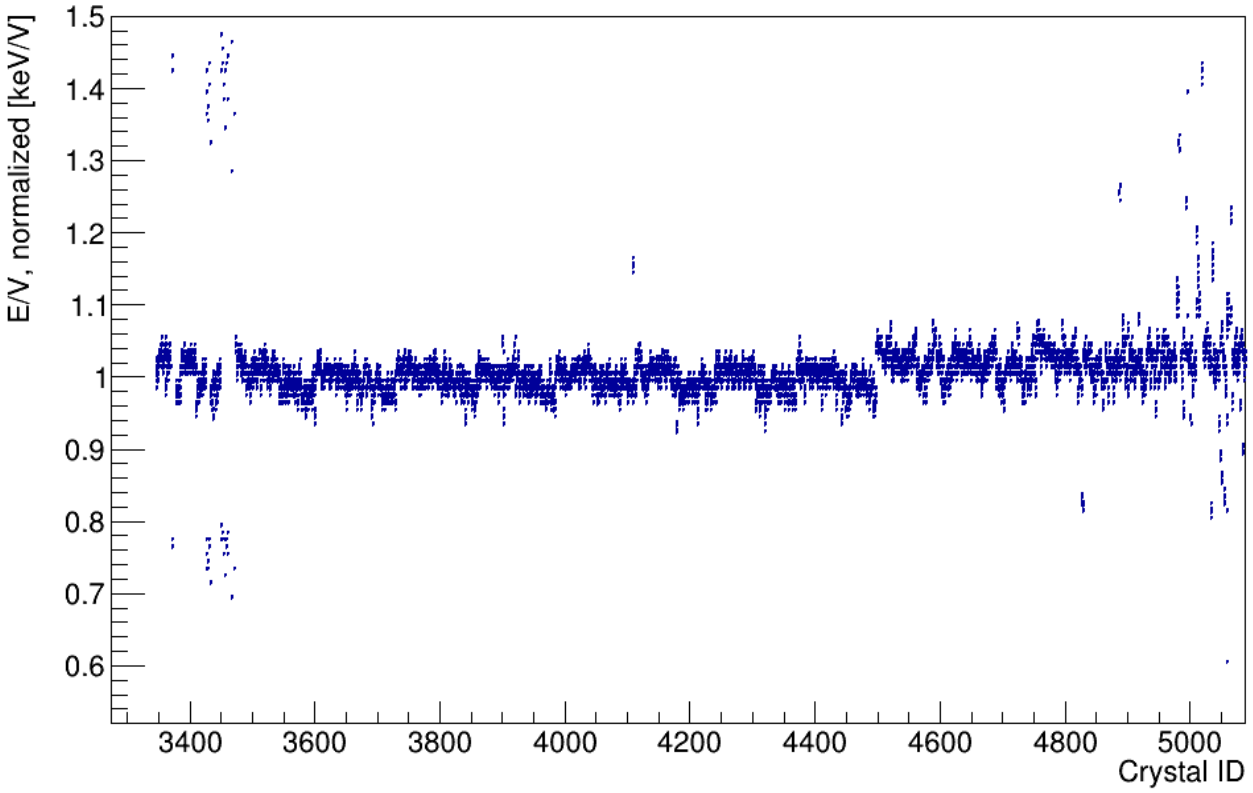
Pulser capacitance

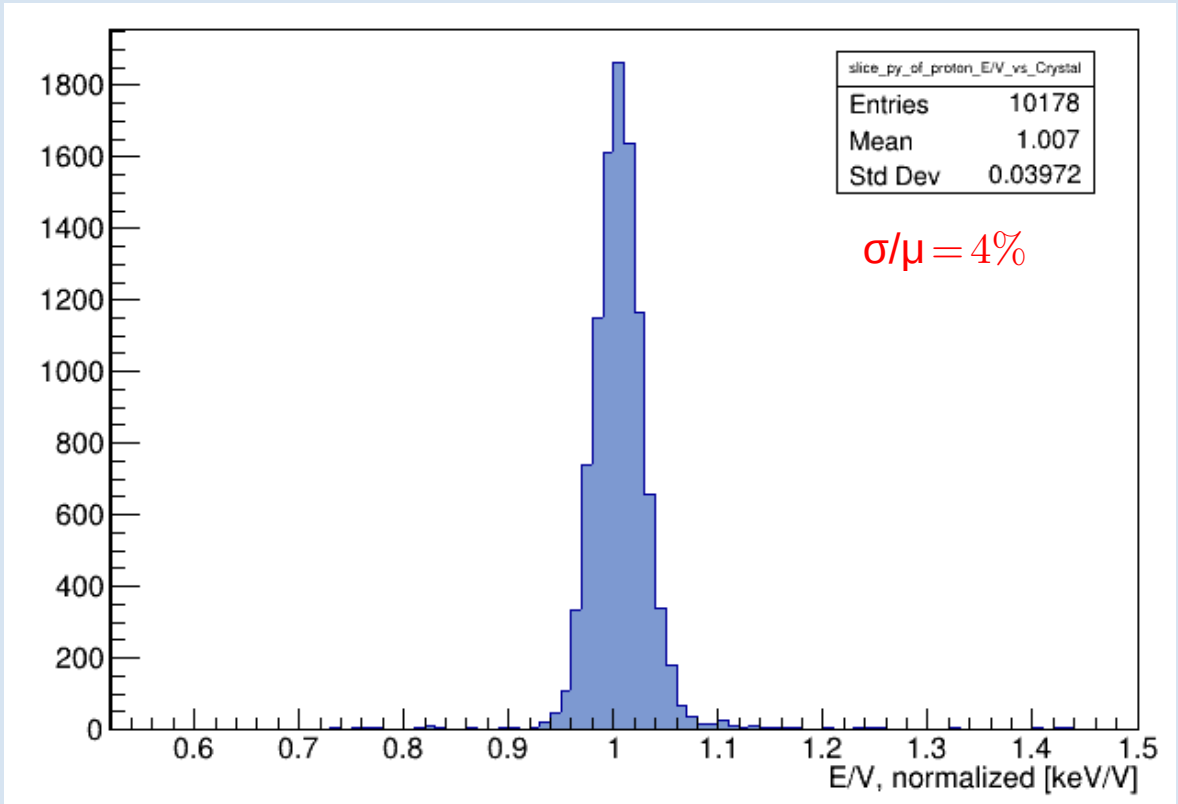




Variation in E/V for the pulsers again include all uncertainities (L(t), R and C_{pulser})

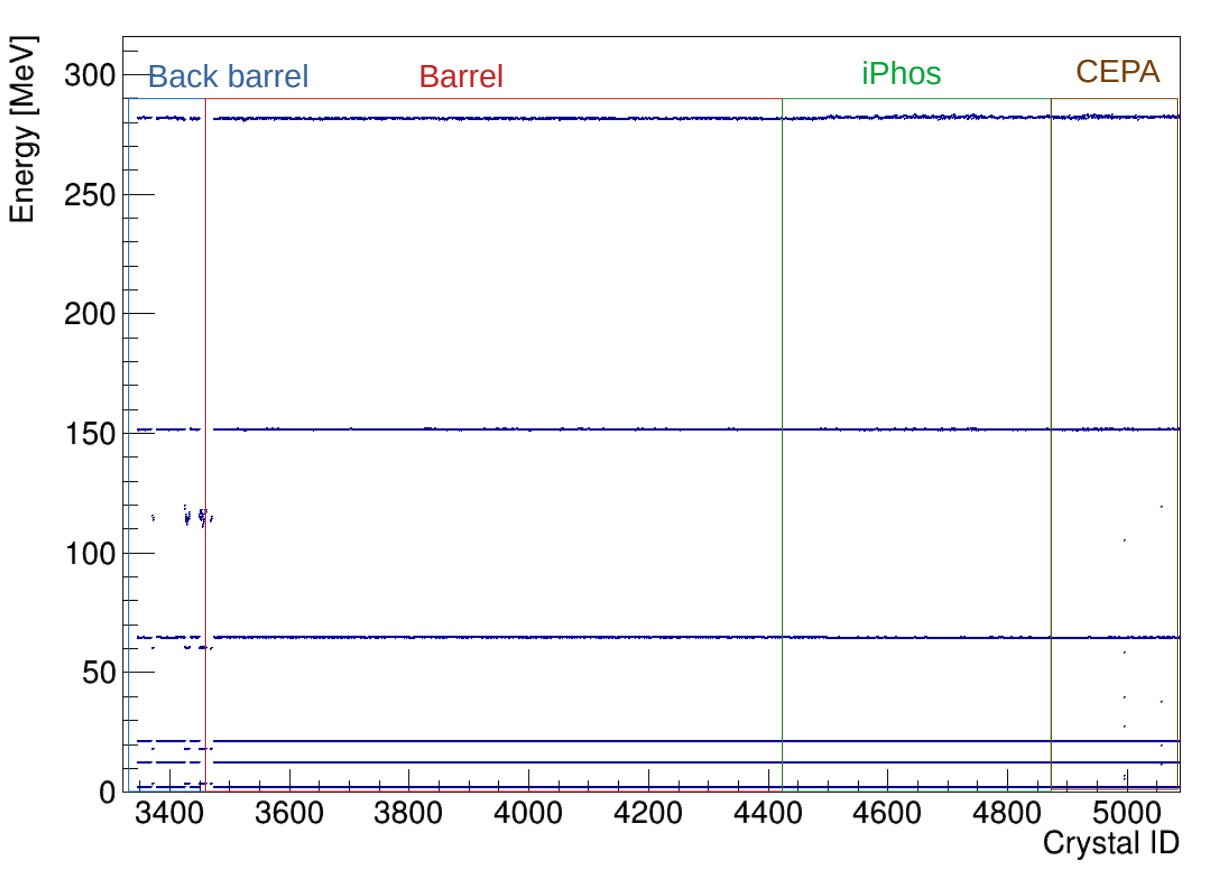
Pulser capacitance

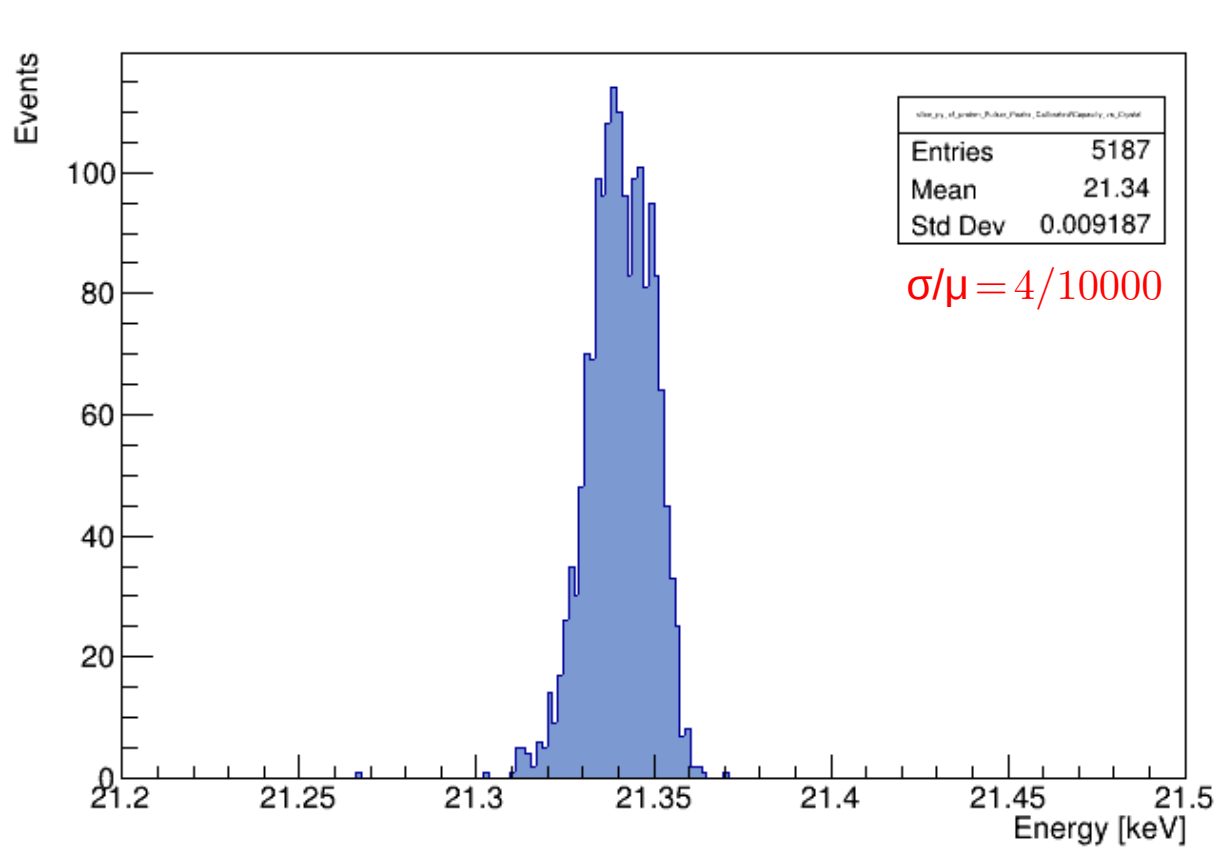




Pulser capacitance (E/V) now normalized with the mean value (50)

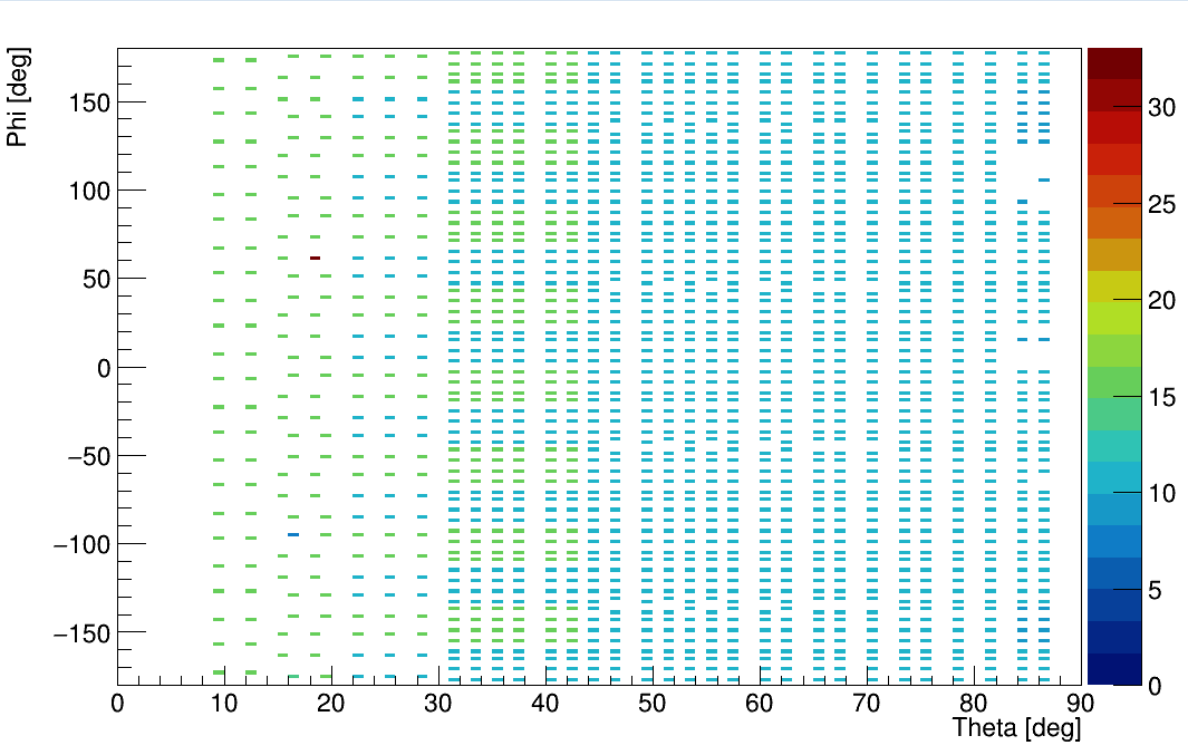
Proton range: calibrated spectra



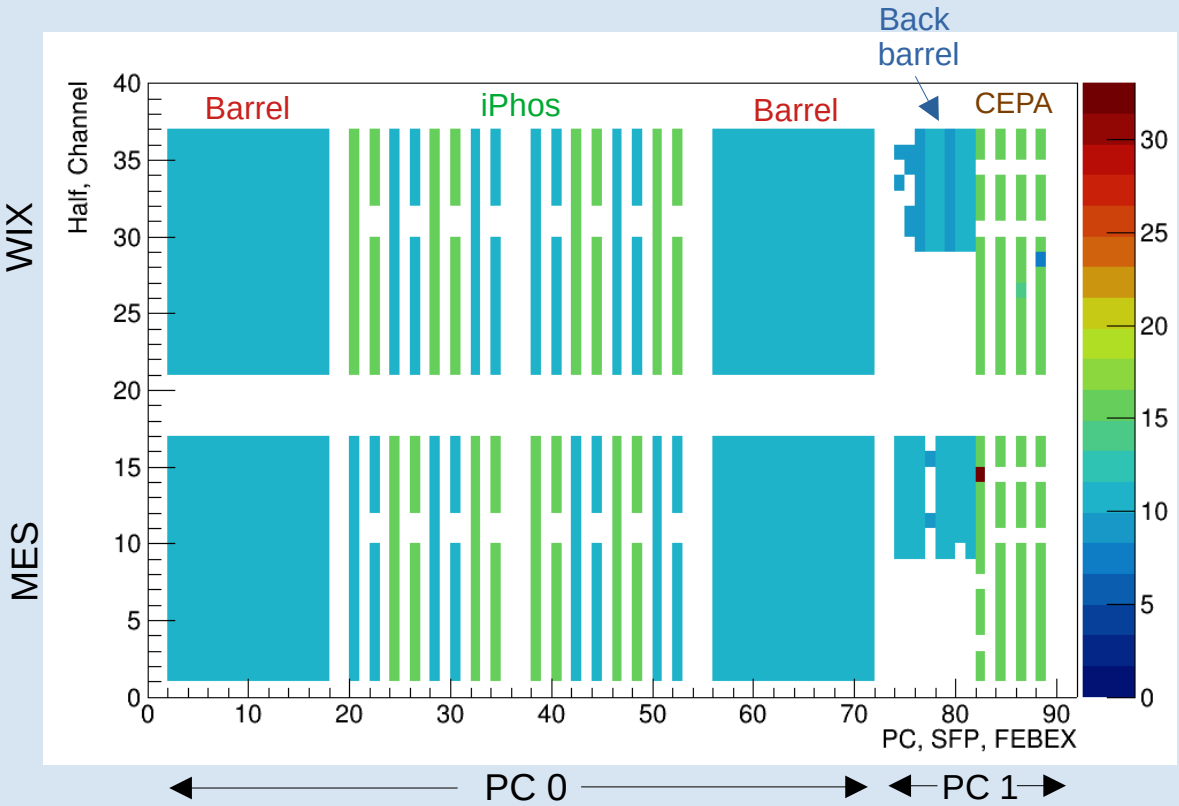


After dividing pulser energies with the normalized capacitances, variations cancel out

QC Plots

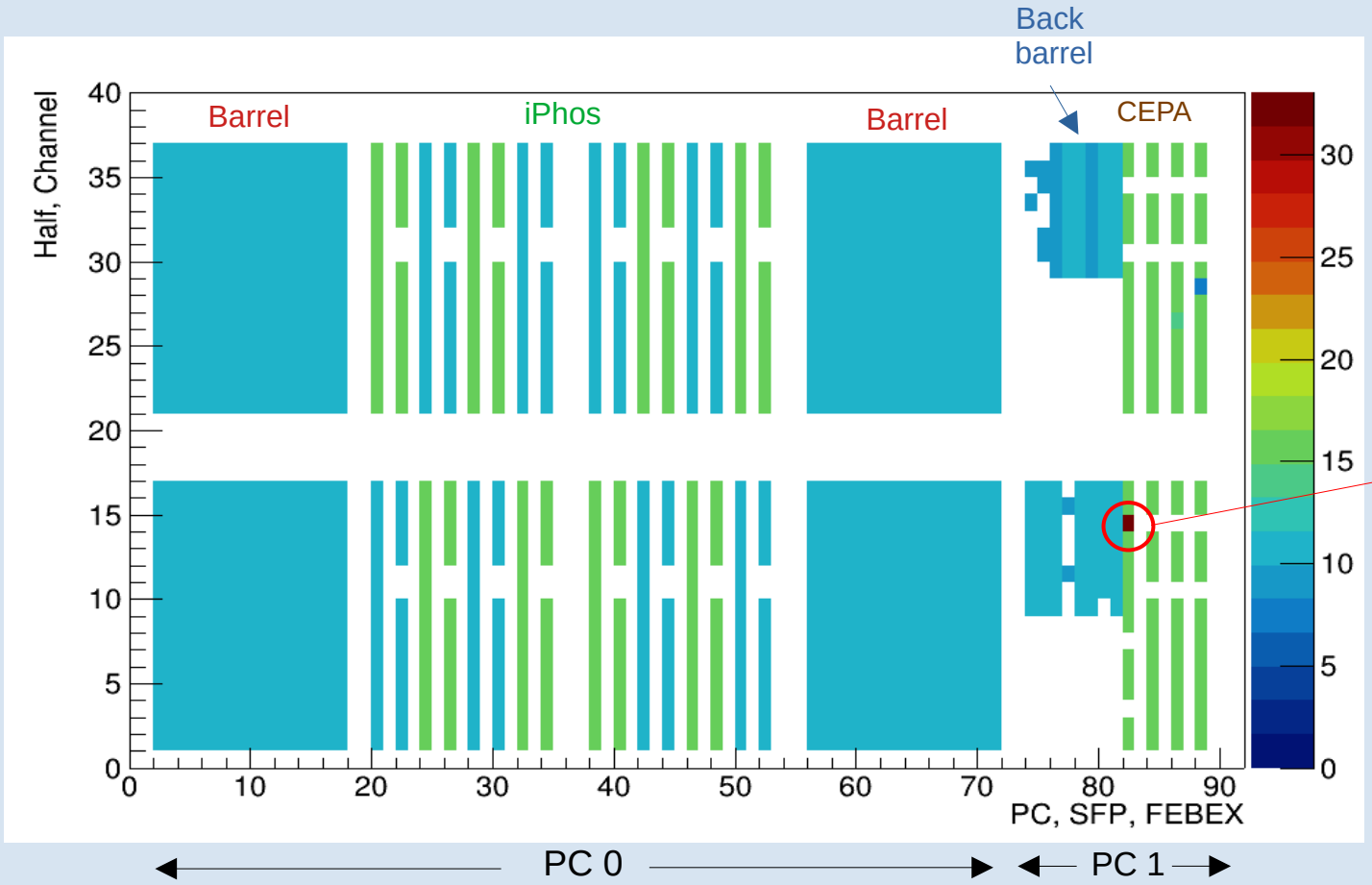


Quality Assessment Plot

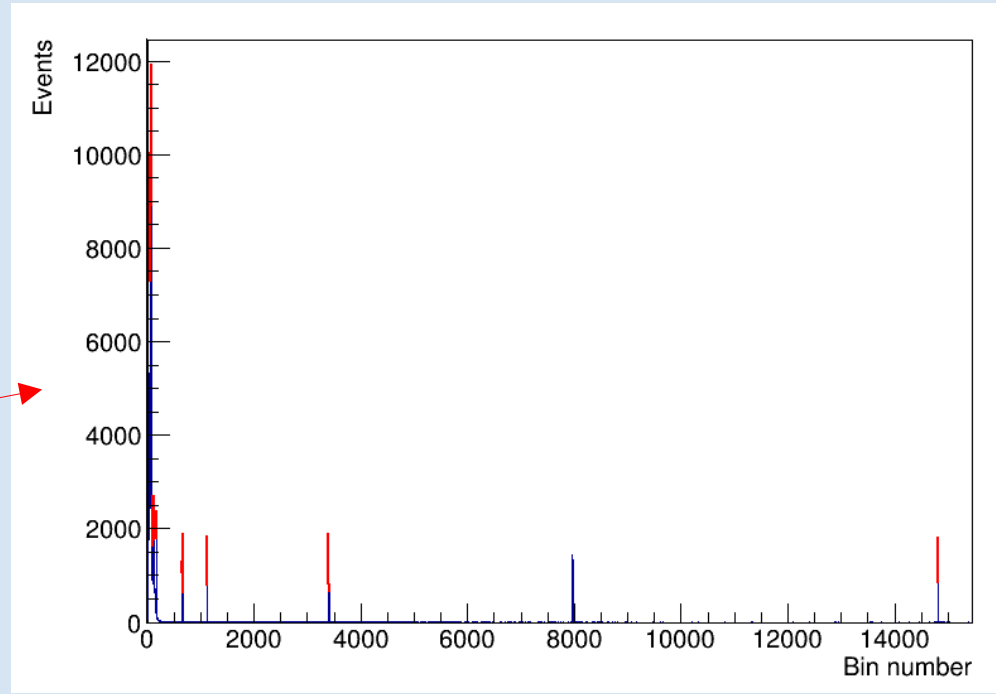


DAQ Plot (Hardware level)

QC Plots



DAQ Plot



Spectrum for incorrectly calibrated channel (one pulser peak not detected)

Thank You !

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

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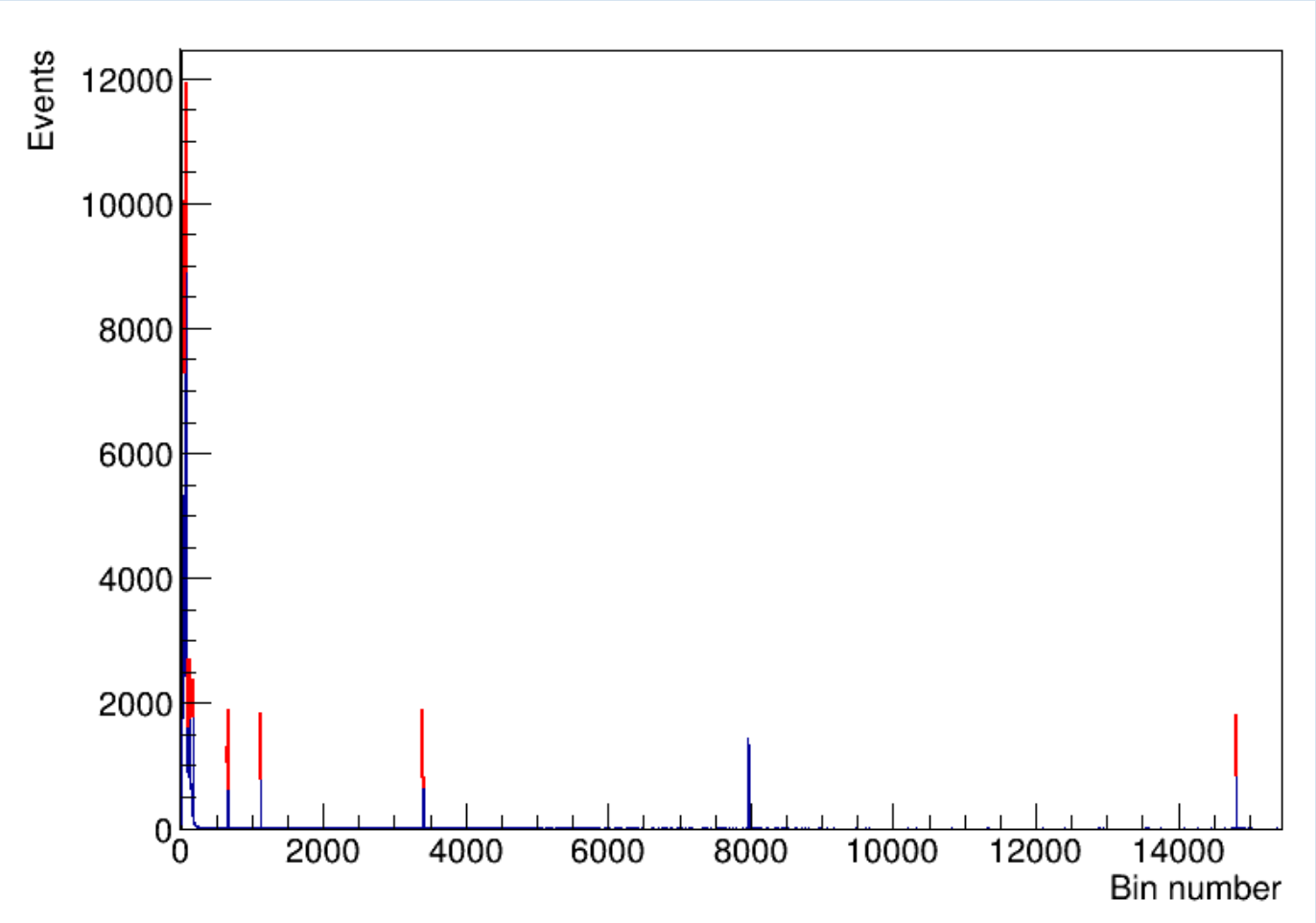
GSI
FAIR Phase 0 Research Program

Extras: Irregular channel



Crystal ID: 5057, in CEPA

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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
```