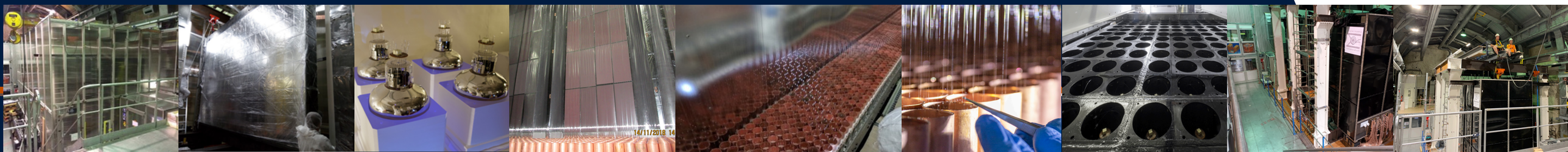
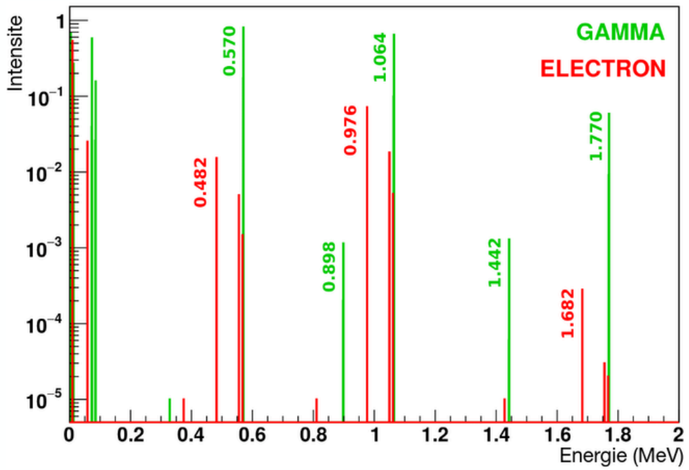
Energy calibration using ^{207}Bi source

Granjon Mathis

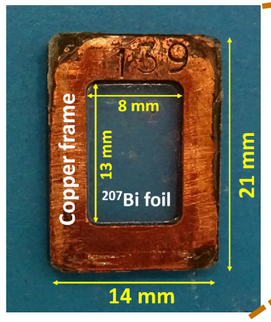


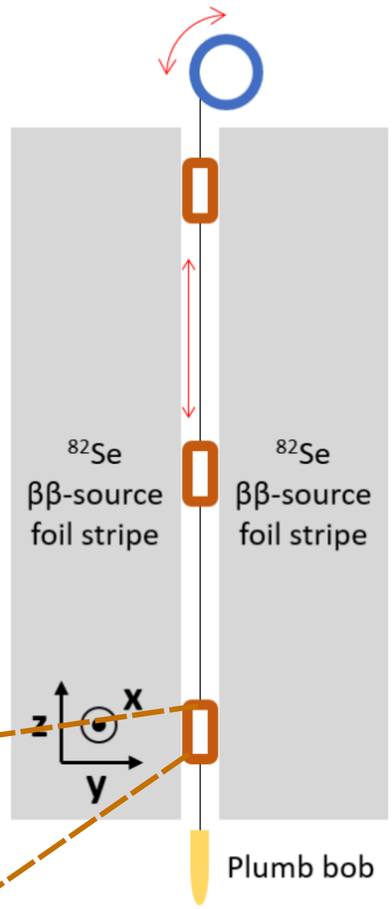
^{207}Bi absolute calibration system

Theoretical spectra of ^{207}Bi sources

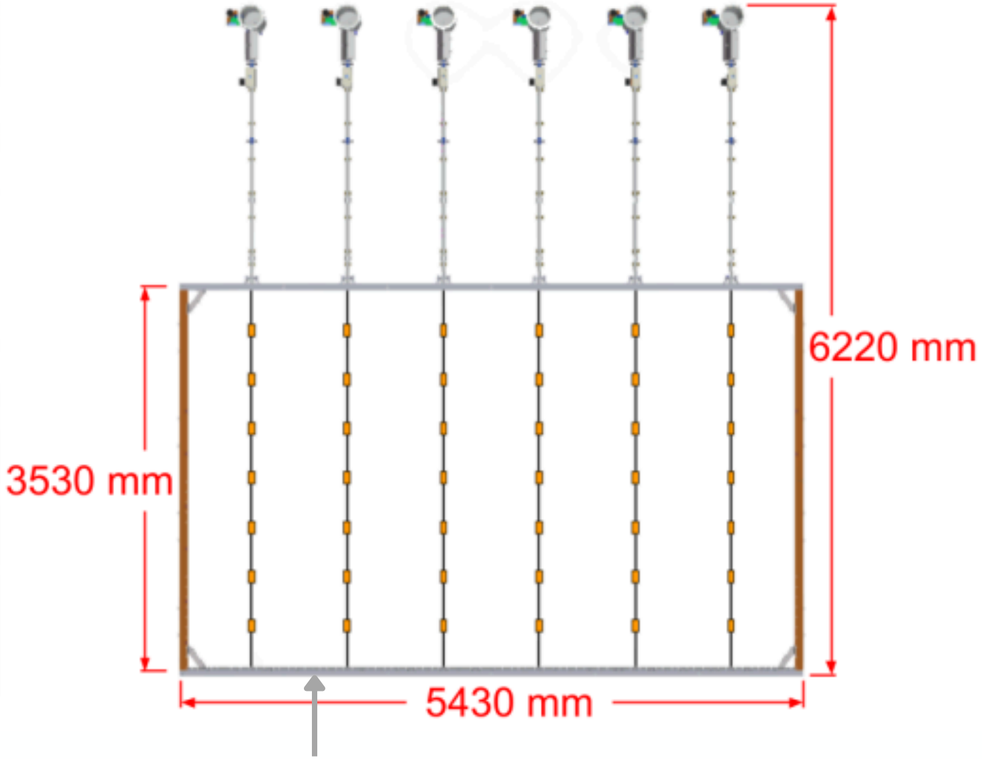


Automatic deployment of 42 ^{207}Bi sources





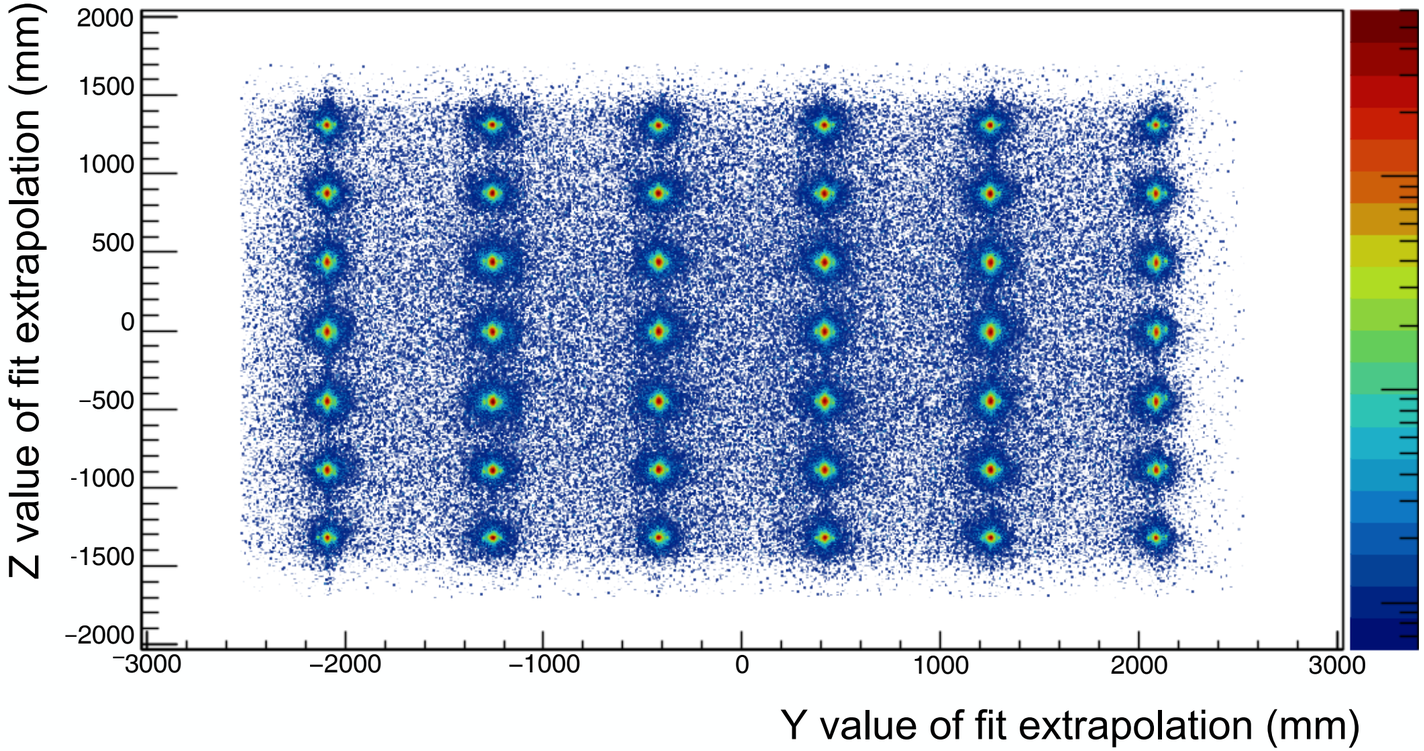
Bismuth deployment system



Side view of the ^{82}Se foil

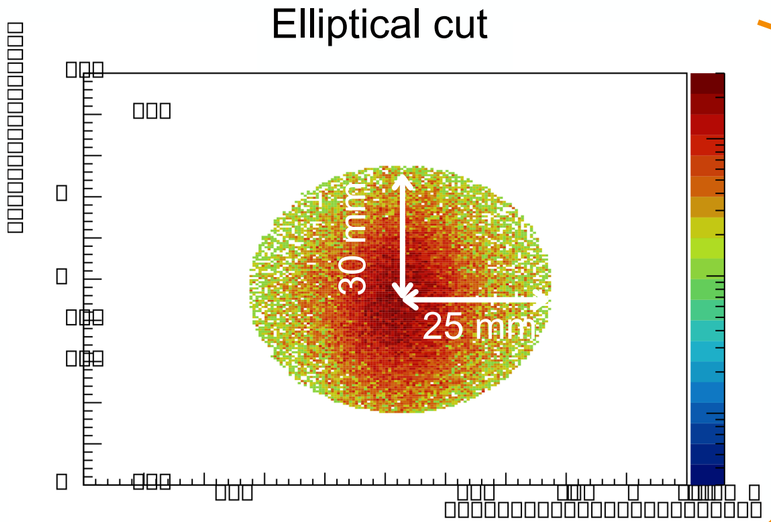
^{207}Bi absolute calibration system

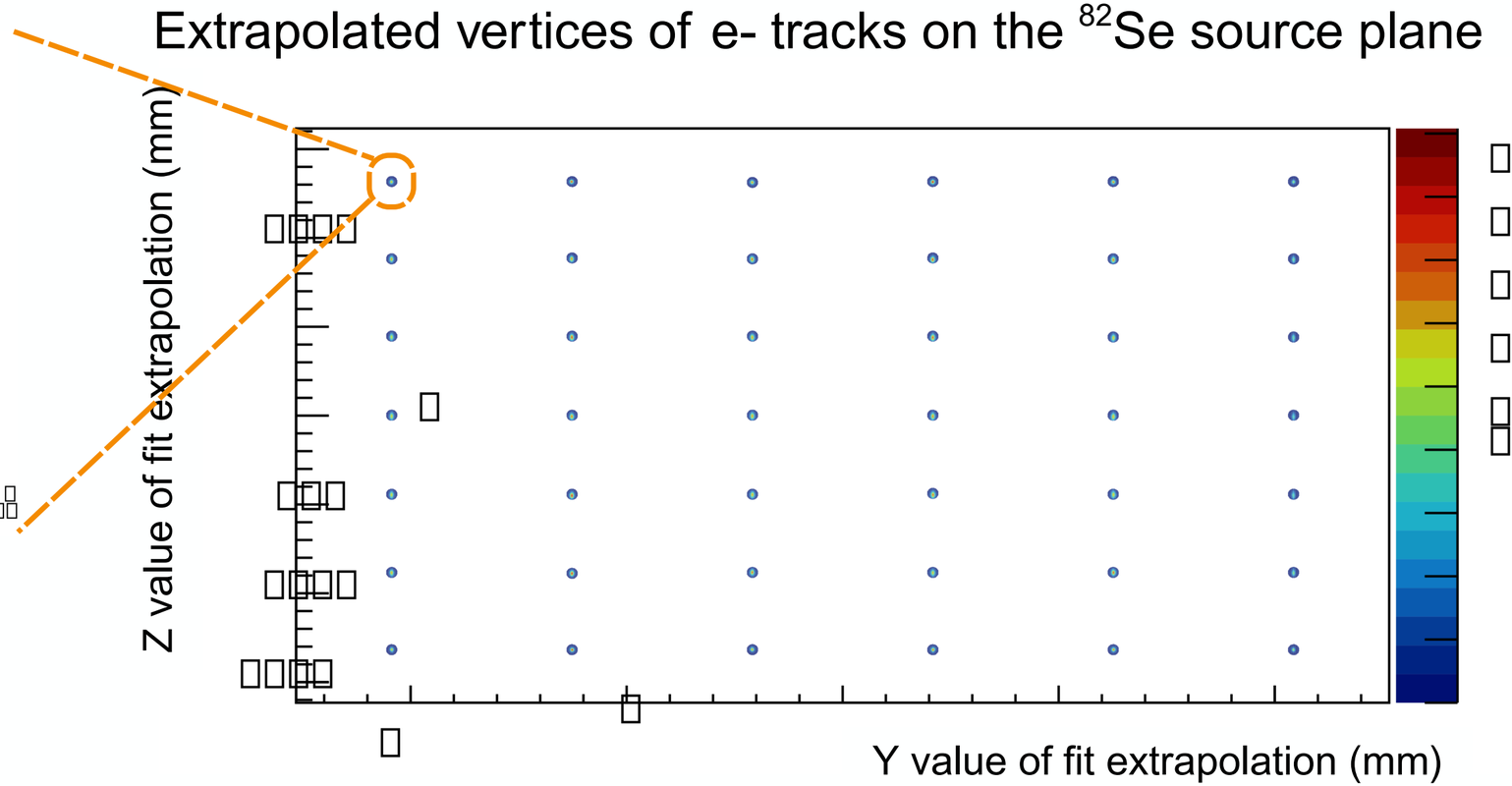
Extrapolated vertices of e- tracks on the ^{82}Se source plane



- Applied an e- selection
- Automate the fit based on theoretical branching ratio of ^{207}Bi e-
- Compute calibration parameters for each OMs

^{207}Bi absolute calibration system

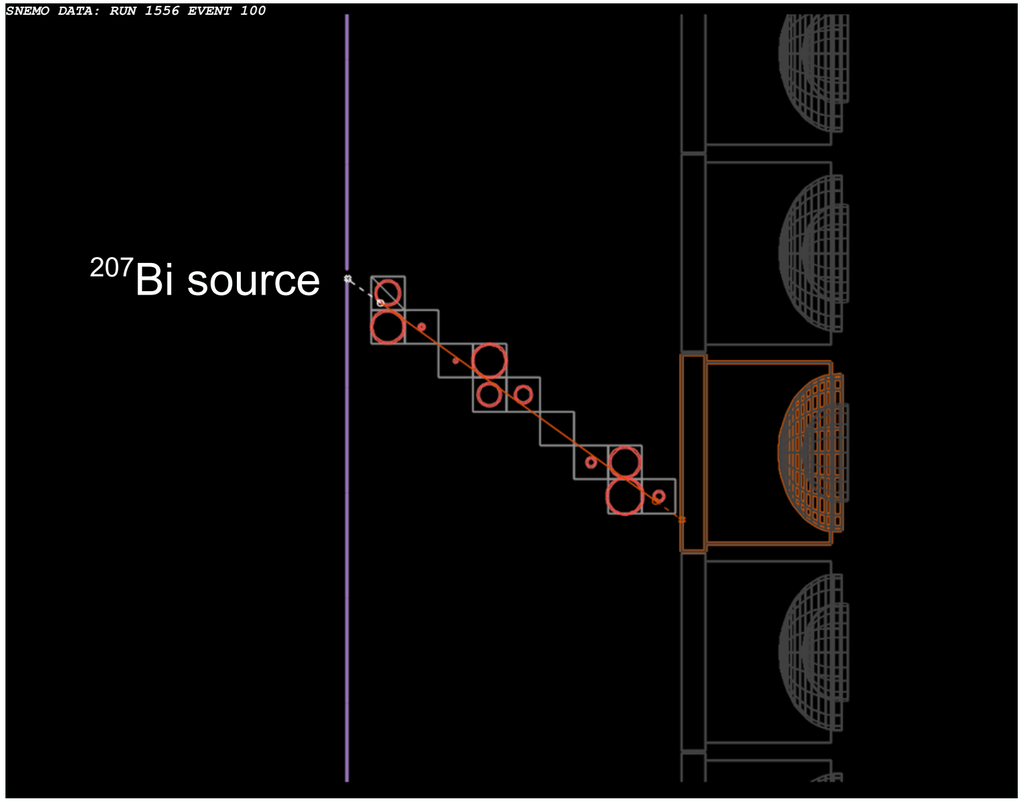




- Applied an e- selection
- Automate the fit based on theoretical branching ratio of ^{207}Bi e-
- Compute calibration parameters for each OMs

^{207}Bi absolute calibration system

Example of selected event



- Applied an e- selection
- Automate the fit based on theoretical branching ratio of ^{207}Bi e-
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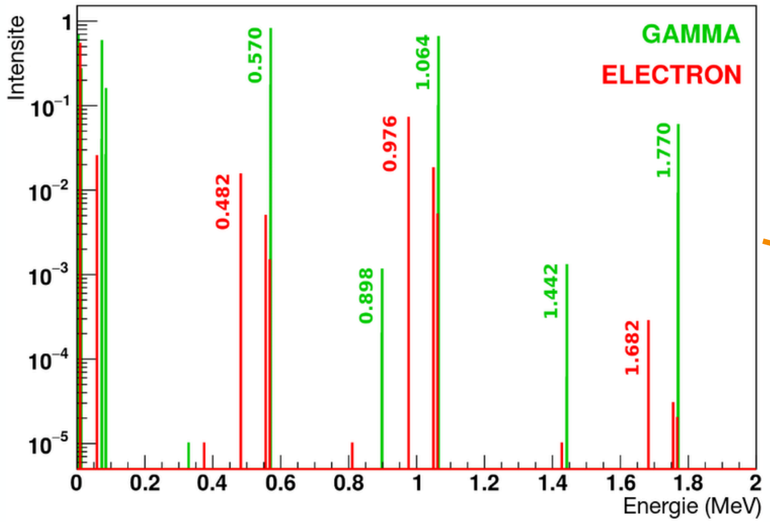
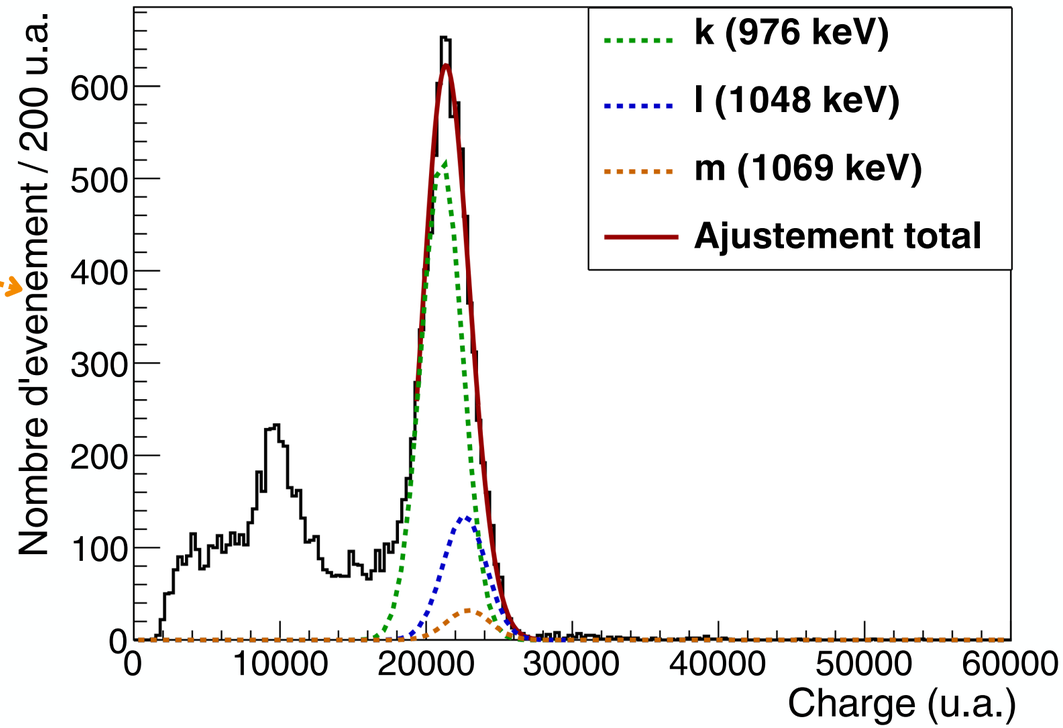
^{207}Bi absolute calibration system

Theoretical spectra of ^{207}Bi sources



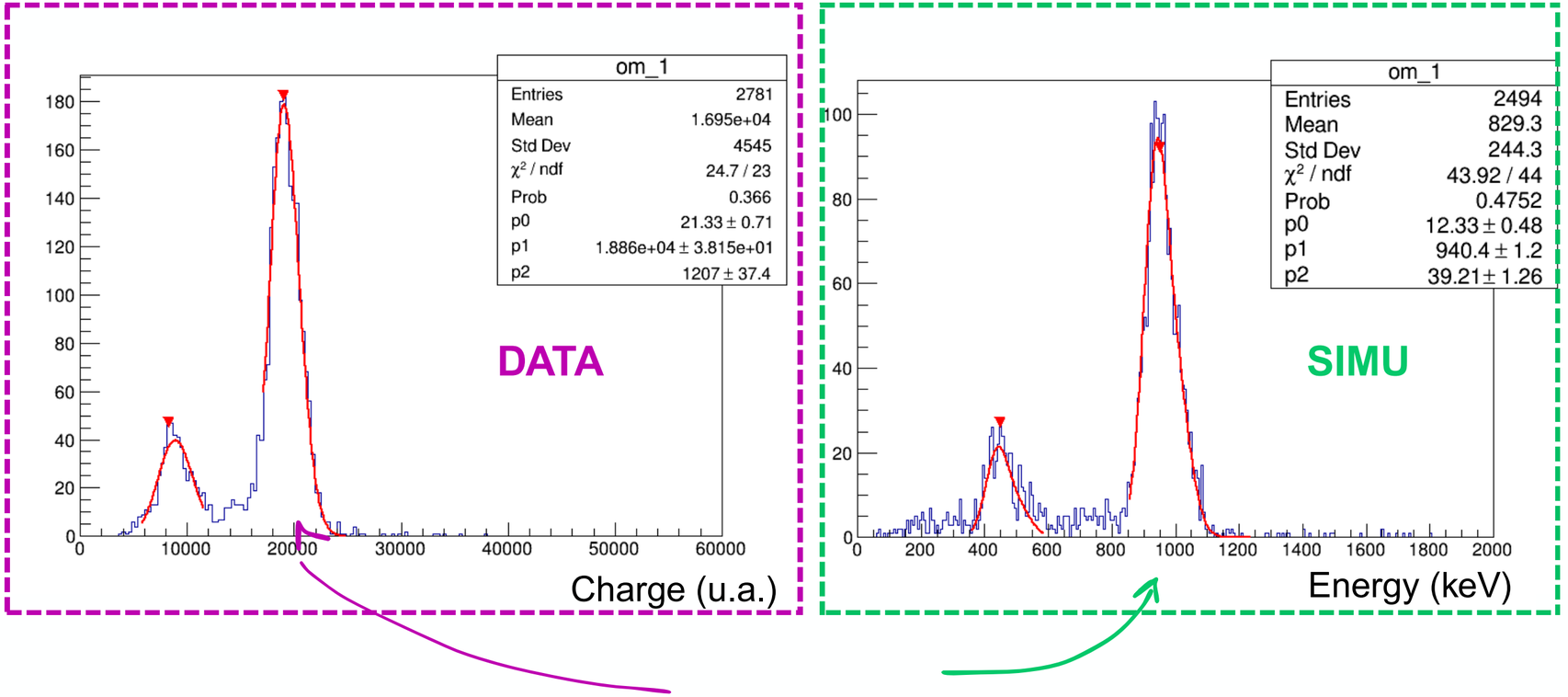
Charge e- spectra with ^{207}Bi deployed



- Applied an e- selection
- Automate the fit based on theoretical branching ratio of ^{207}Bi e-
- Compute calibration parameters for each OMs

Extract values after an e^- selection based on theoretical branching ratio

^{207}Bi absolute calibration system



Parameters are based on both: **DATA** and **SIMULATION**

- Applied an e- selection
- Automate the fit based on theoretical branching ratio of ^{207}Bi e-
- Compute calibration parameters for each OMs

Current calibration to apply

MC and data **must be** calibrated independently

MC calibration

Use the path

/sps/nemo/scratch/granjon/simu_pipeline

To apply the

$$E_{dep} = a \times E_{bcu} + b$$

calibration per simu

Data calibration

Use the path

/sps/nemo/scratch/granjon/full_gain_analysis/Bi/root/compute_a/data_calibration_pol2

To apply the

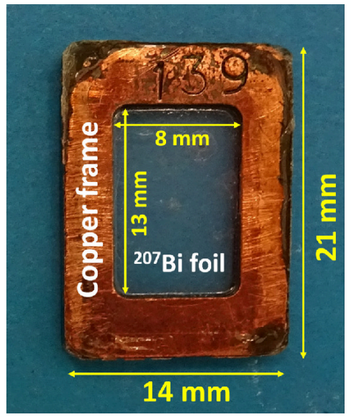
$$E_{dep} = a \times Q + b$$

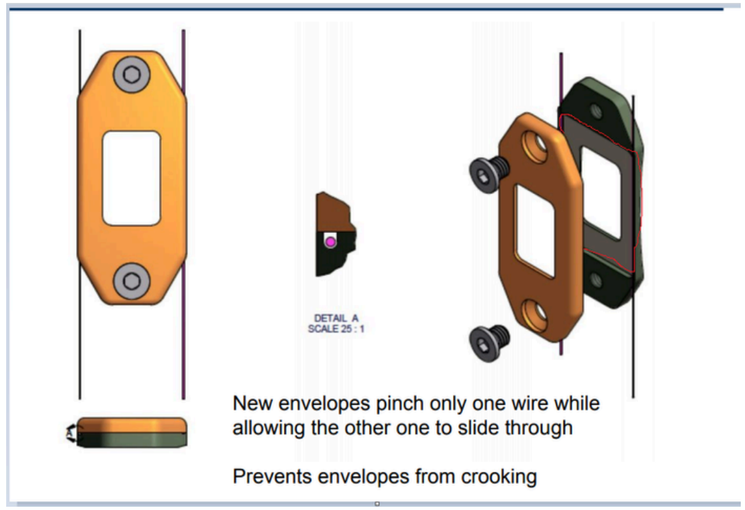
calibration per run

Then you can compare the energy from MC and data

Copper frame

Little introduction on copper frame problem

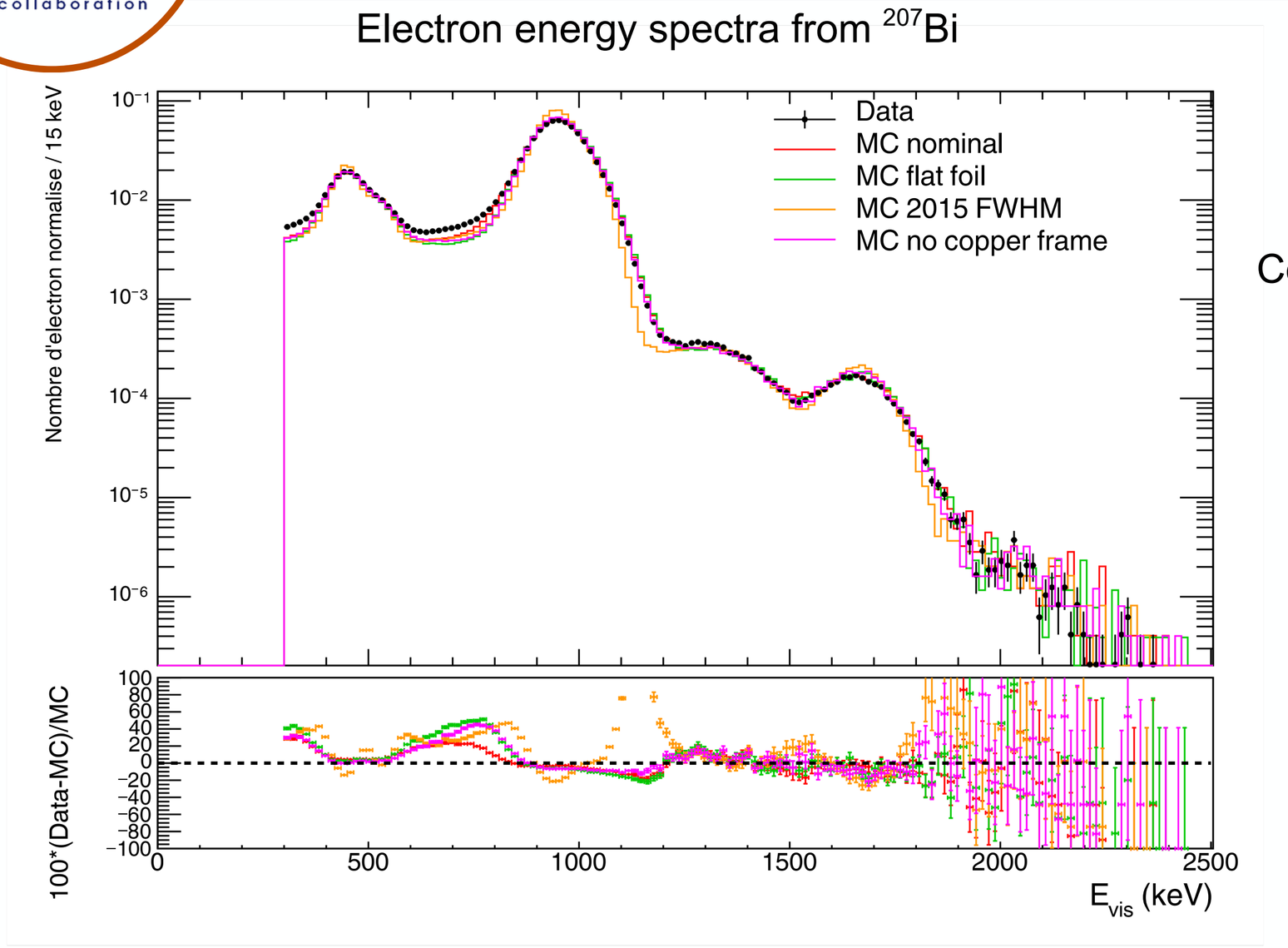




Picture of ^{207}Bi source with copper frame

Simulation = one big rectangle of copper → supress to test the effect

Electron energy spectra



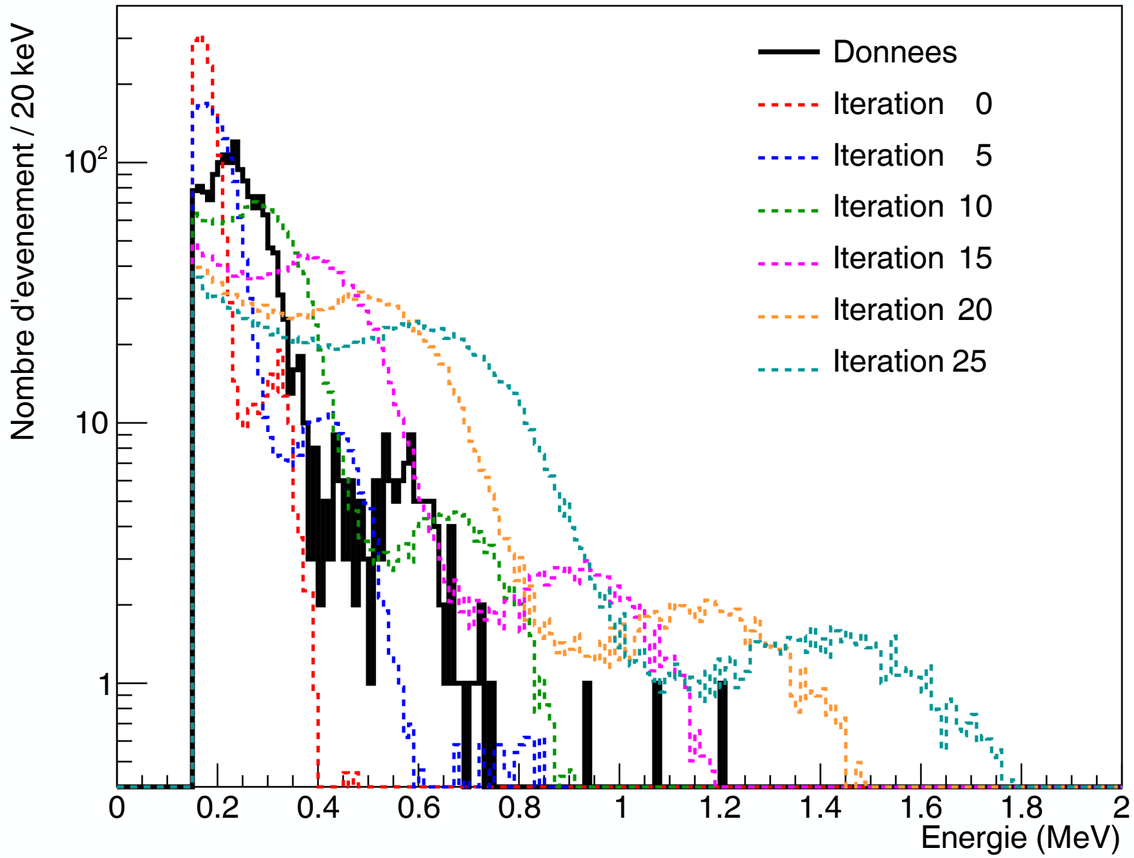
Each simulation is (nominal - effect)

Copper frame impact energy distribution a lot !

Flat or curve foil impact energy distribution **even with copper frame**

The ^{207}Bi energy spectra could not be in MC/data agreement since we haven't **perfect foil geometry**

Gamma calibration



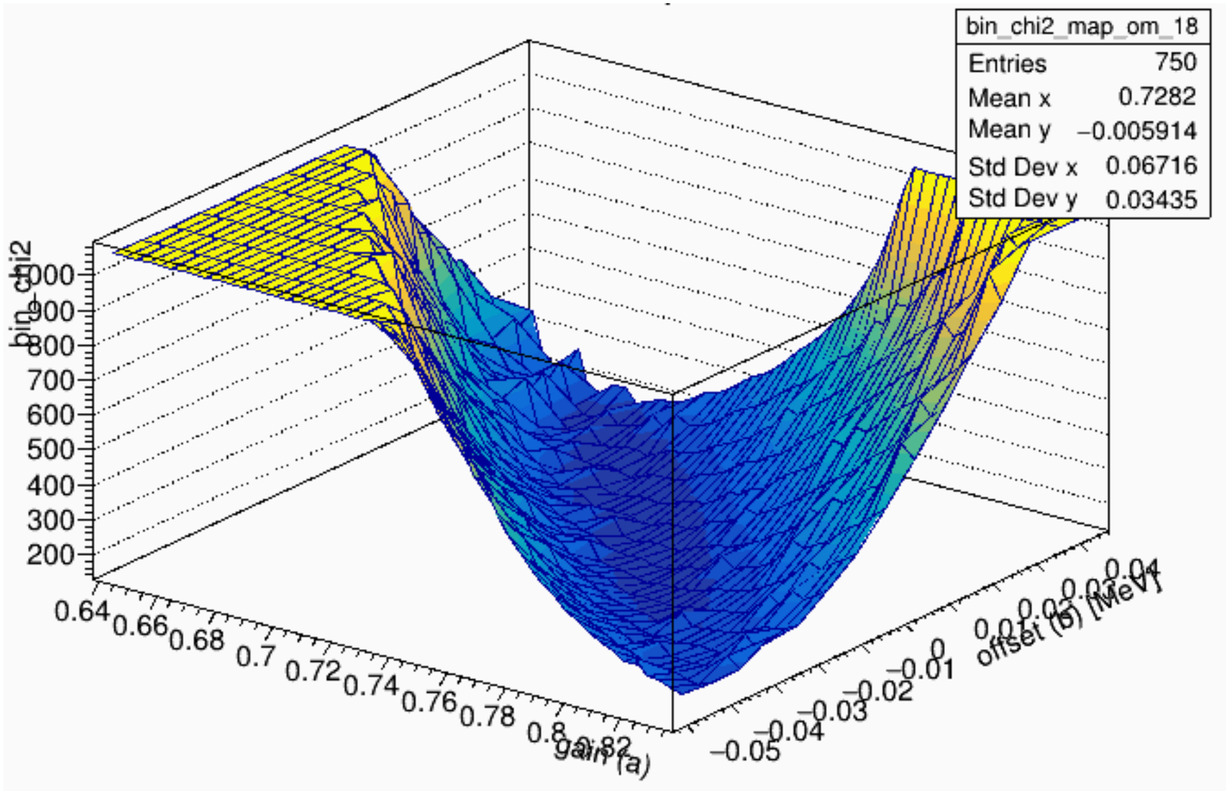
Gamma selection and calibration docDB #6133

E = aQ energy calibration

Bin chisquare between MC and data

Can we try to upgrade to E = aQ+b
to get same energy reconstruction as electrons

Gamma calibration



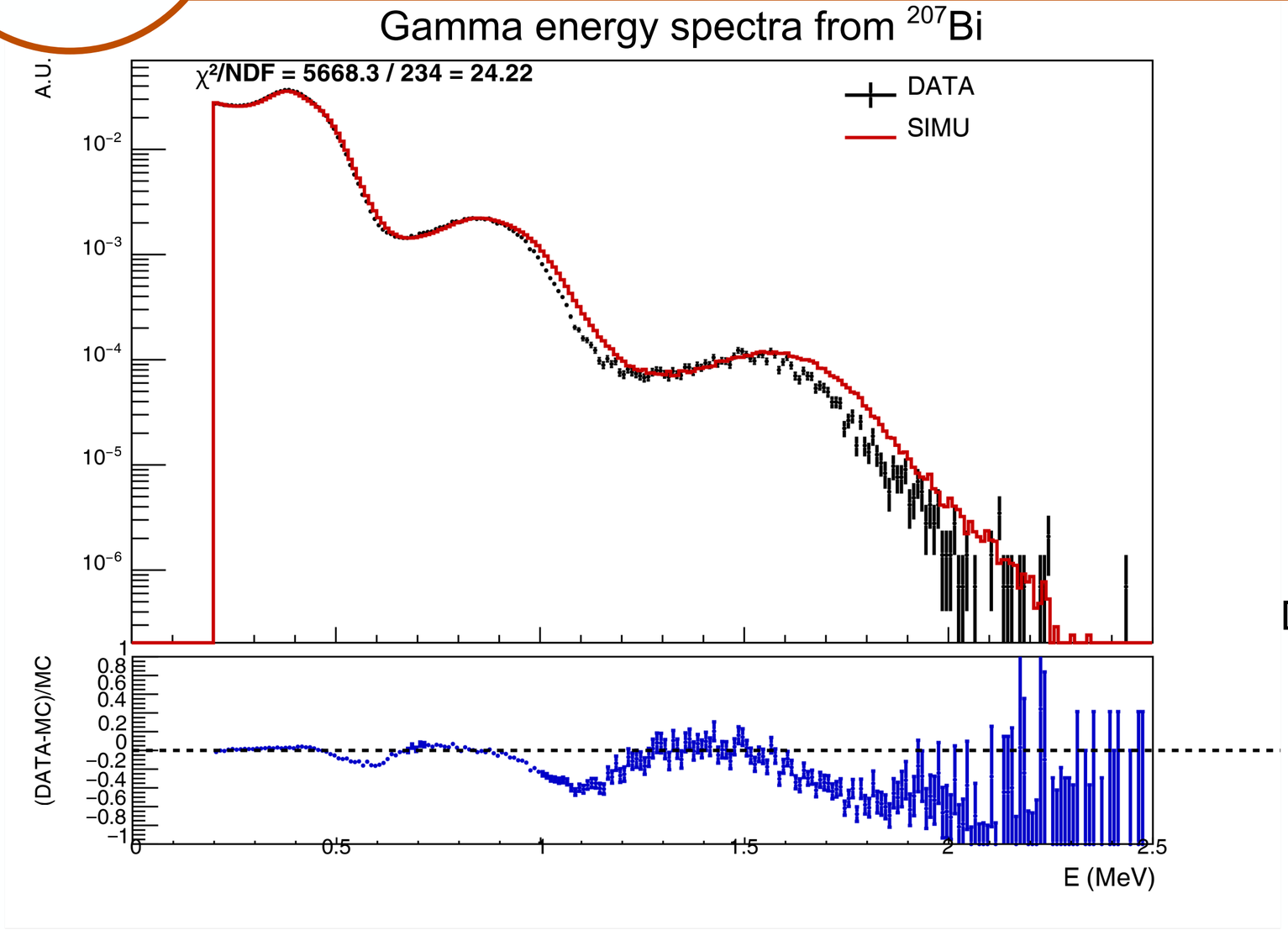
Estimate gamma parameters a and b using bin chisquare analysis

Estimate errors with 2 methods: elliptical fit and grid method

Both methods give high errors on b ~ 20 %

We **cannot** extract aQ+b parameters with this analysis

Gamma energy spectra



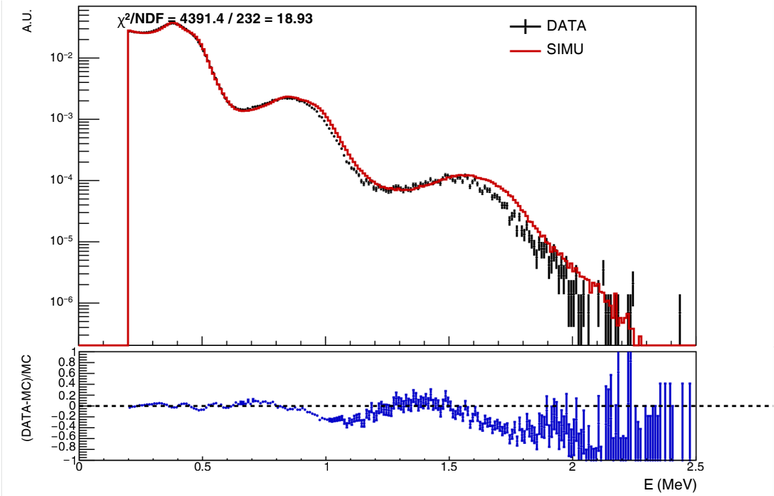
Same a, b compute on electron
→ applied on gamma spectra

Gamma selection docDB #6133

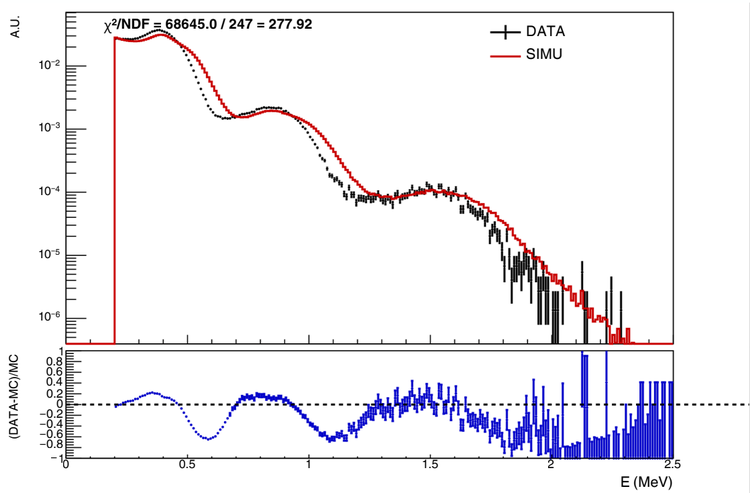
Discrepancies at high energy → 2 factors possibles = **birks** or **non-uniformity**

Gamma energy spectra

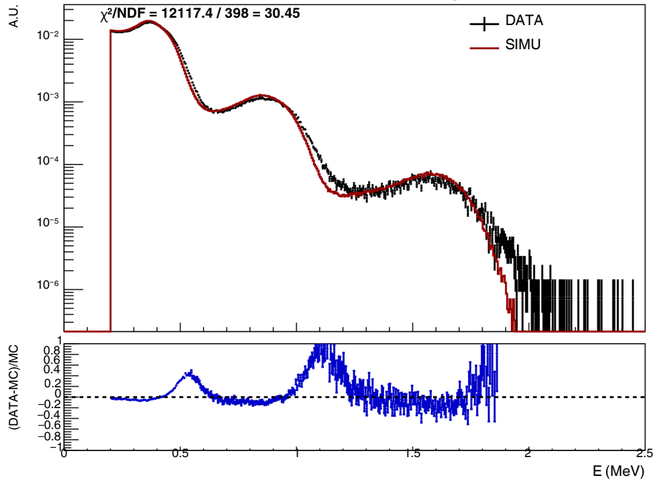
With 2015-2016 measured FWHM



Without Birks-Cerencov corrections



Without non-uniformity corrections



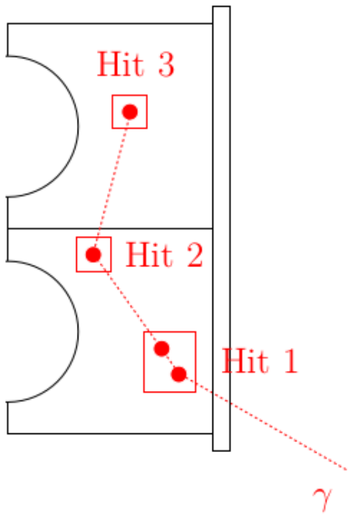
Discrepancies are not coming from FWHM

Birks-Cerenkov corrections needs to be tuned ?

Or non-uniformity correction too strong?

Birks-Cerenkov tuning

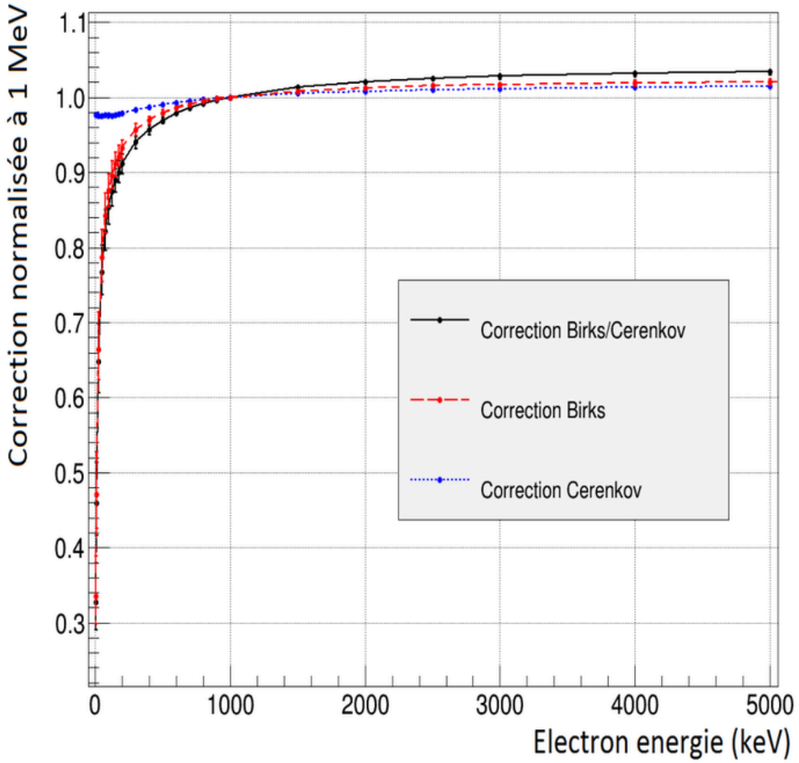
Birks-Cerenkov is corrected this way in simulation



Group energy deposits when time (< 1 ns) and space (< 1 cm) correlations are satisfied

Applied energy correction and non-uniformity correction for **each** energy deposit

Sum energy per OM



Birks-Cerenkov tuning

Birks-Cerenkov is corrected this way in simulation

The correction takes the following form:

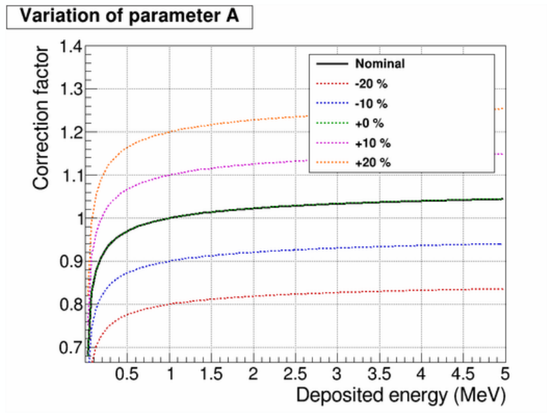
$$f_{\text{Birks-Cerenkov}}(E) = A * (B - \frac{C}{E^D})$$

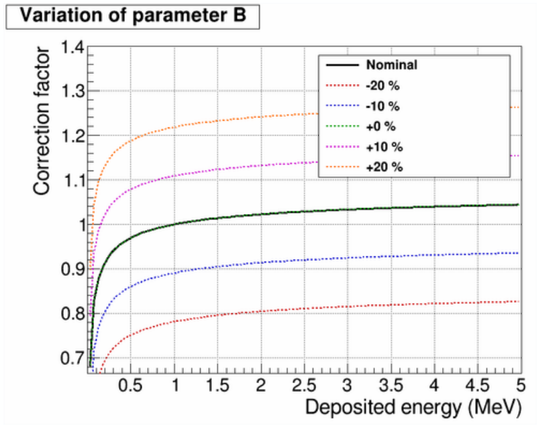
Parameters values fitted from old ^{207}Bi measurement

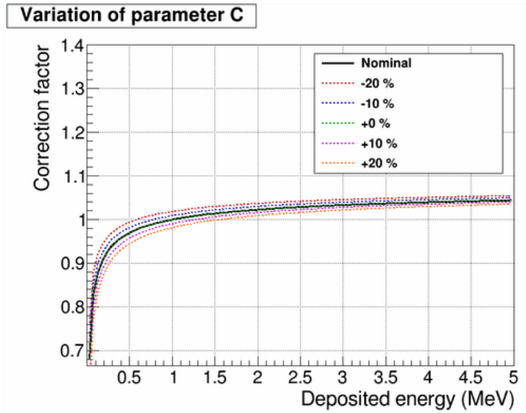
Idea = change them to better gamma/ electron calibration agreement

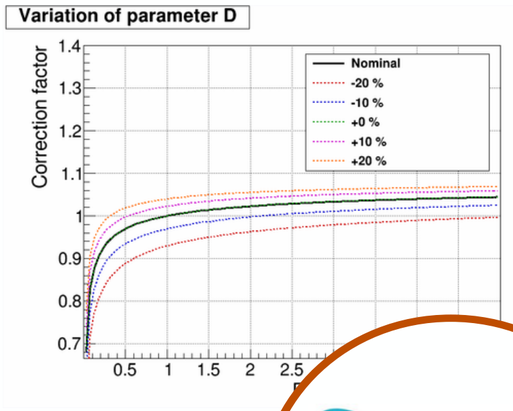
Only two parameters changed: C and D

A adjusted to keep the normalization **f(1) = 1**



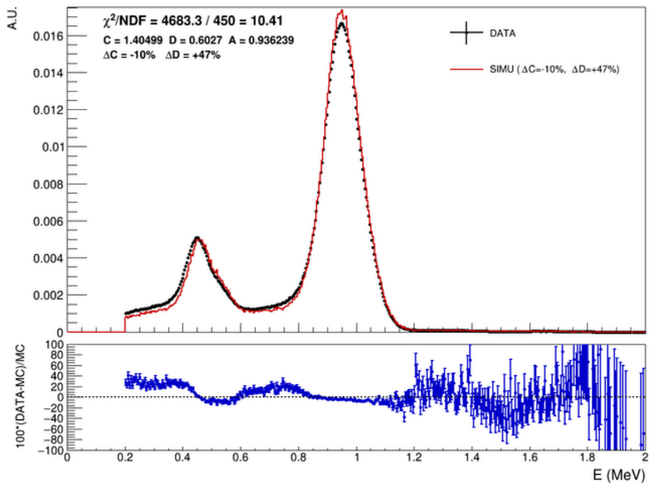


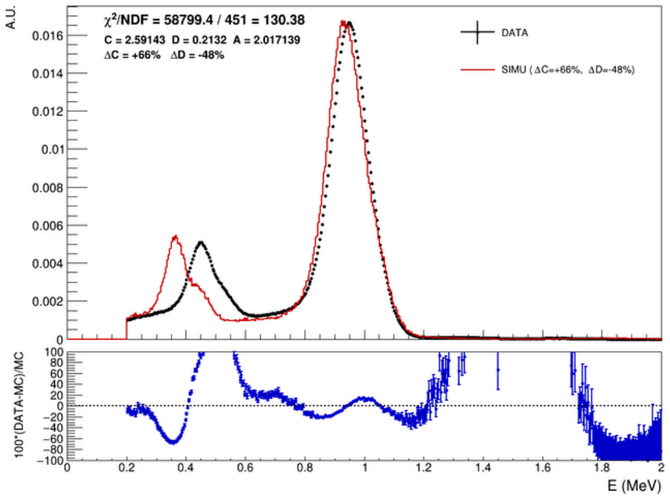




Birks-Cerenkov tuning

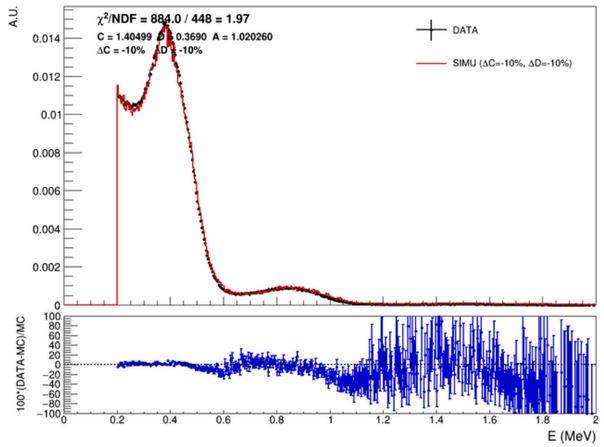
Electron energy spectra ^{207}Bi

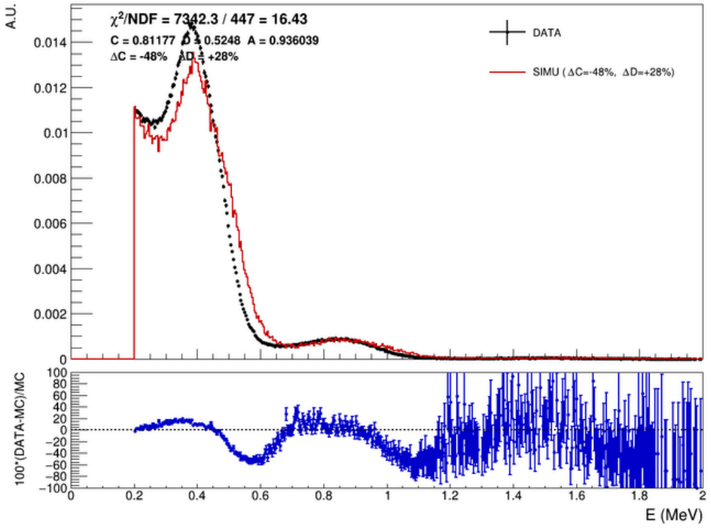




Huge impact on gammas and electrons

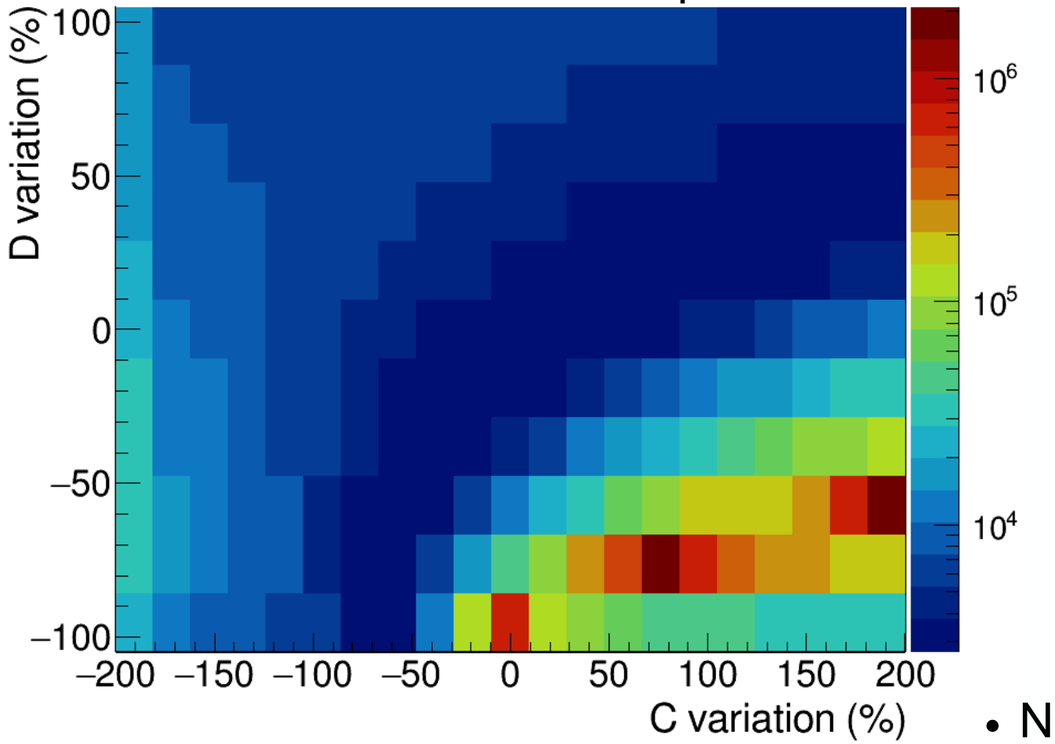
Gamma energy spectra ^{207}Bi



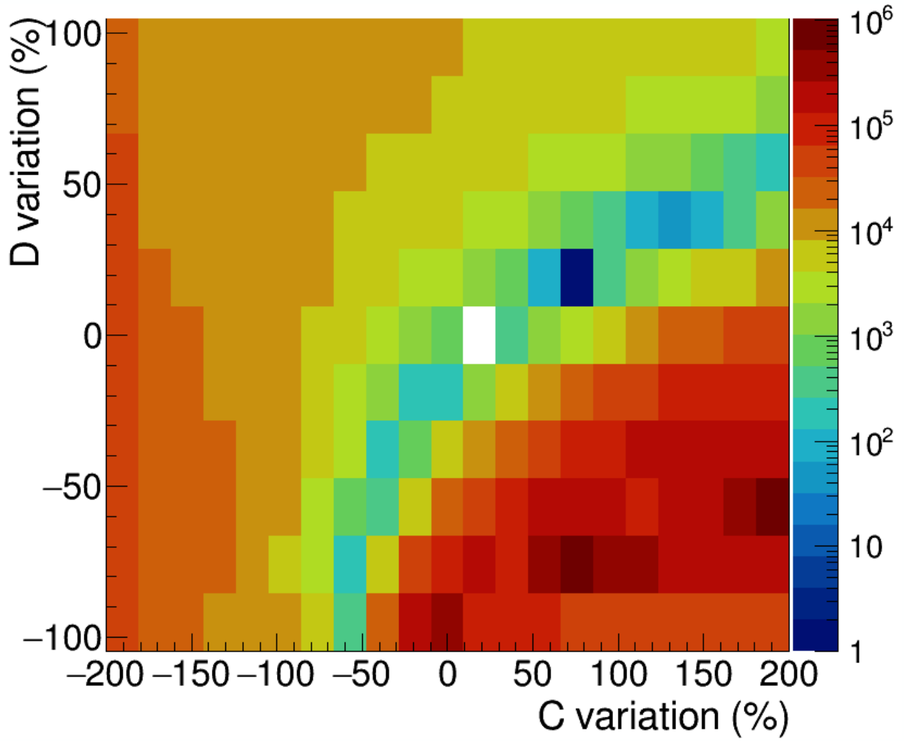


Birks-Cerenkov tuning

Electron chi2 map



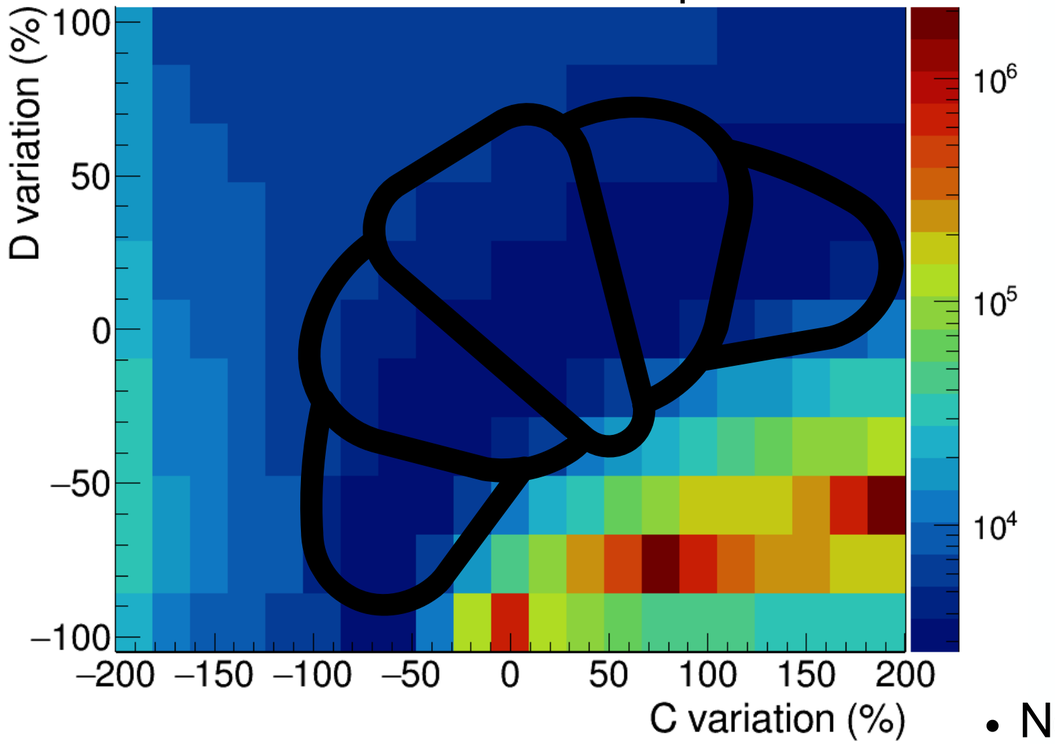
Gamma chi2 map



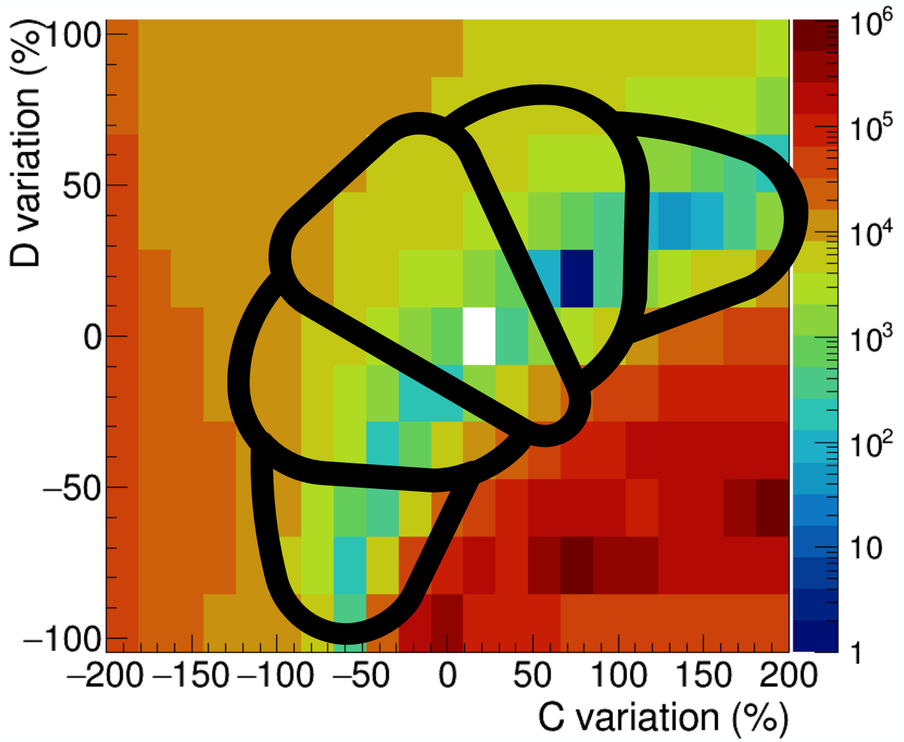
- No obvious minimum
- Need more statistics to conclude
- Lack of granularity
- Lots of values seems correct
- Anyone has idea to fit that?

Birks-Cerenkov tuning

Electron chi2 map



Gamma chi2 map



- No obvious minimum
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Conclusion and next steps

Global comparison of simulated and measured ^{207}Bi energy spectra for electrons and gamma rays

- Investigation of the small MC/data discrepancies using gamma-ray energy spectra
- First tuning of the Birks–Cherenkov model on data

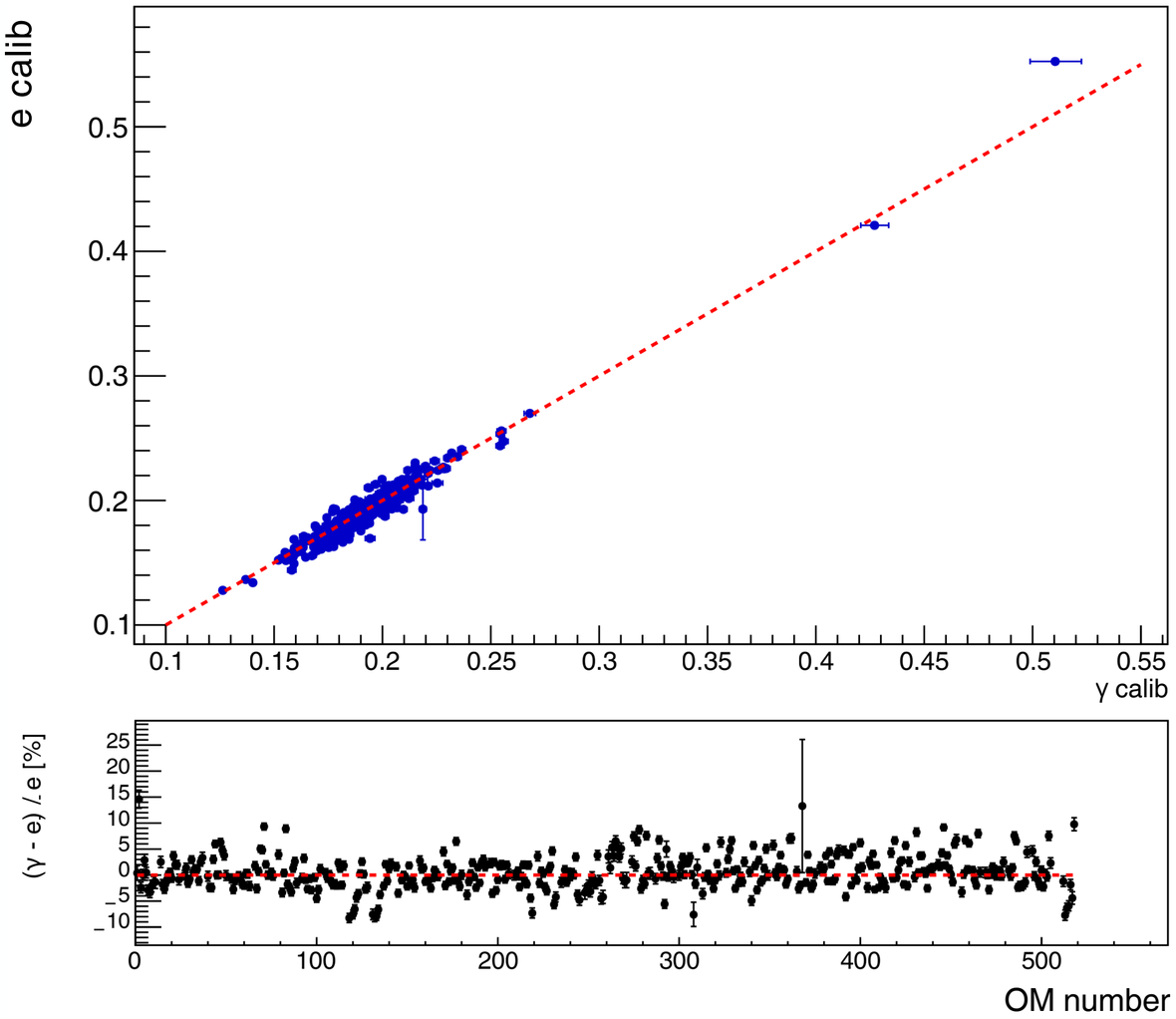
Next steps

- Correct for the measured non-uniformity of the scintillator front face
- Increase statistics and improve the granularity of the Birks–Cherenkov study
- Implement a more realistic foil geometry

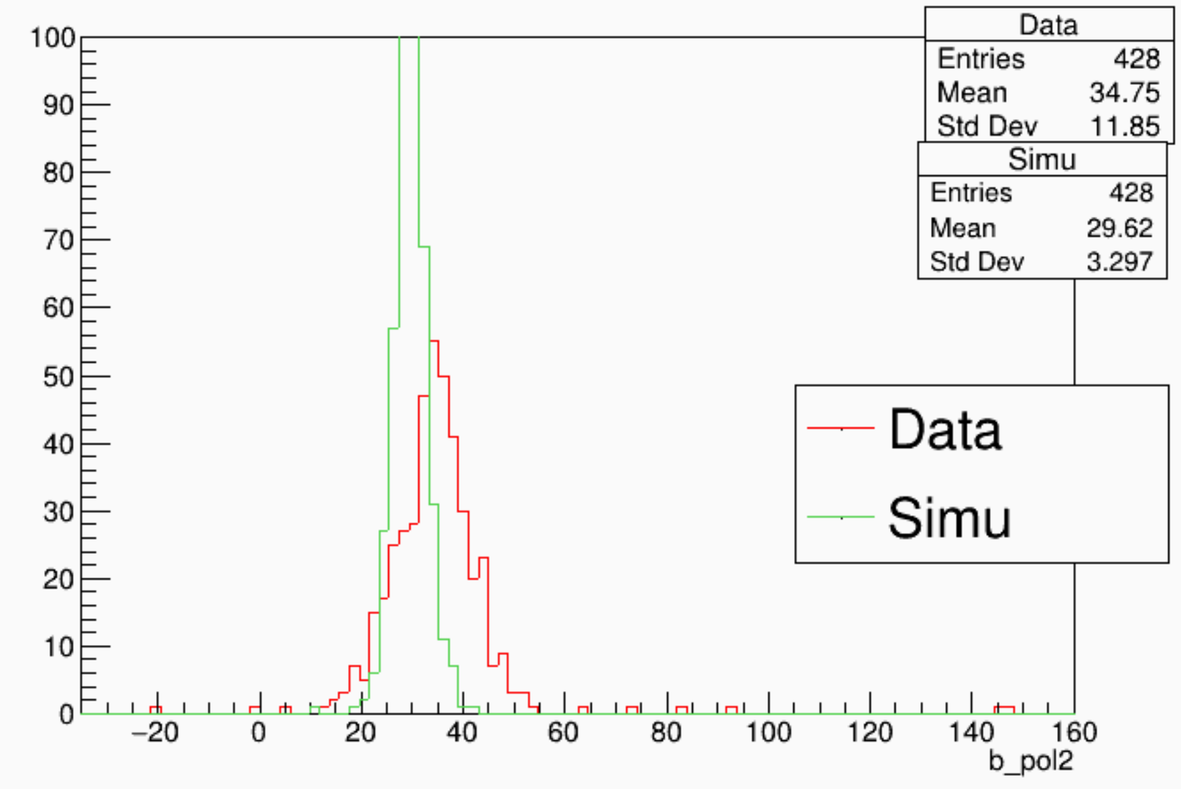
Backup

Thanks for listening

Backup



Backup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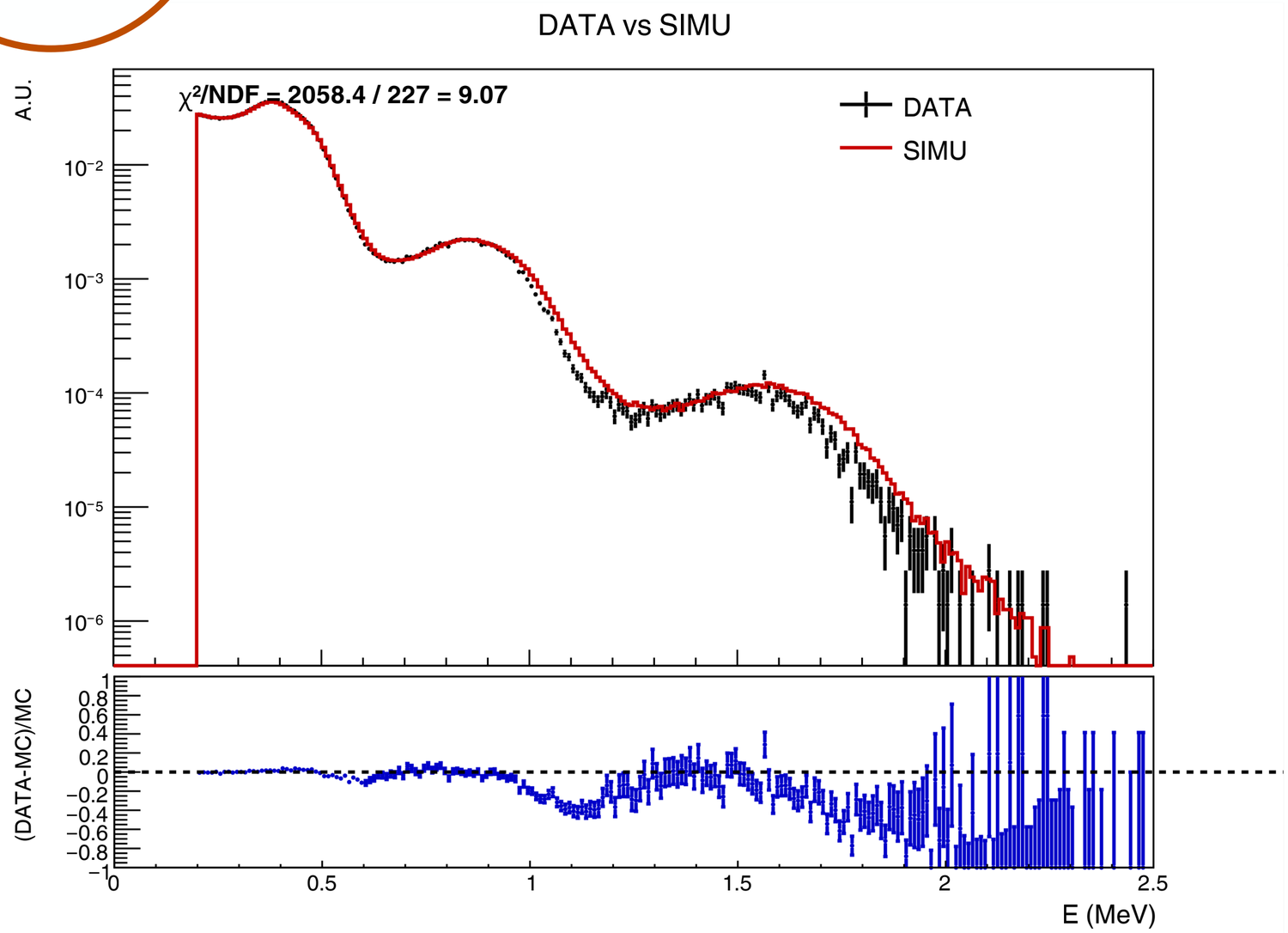
Entries 428
Mean 34.75
Std Dev 11.85
Simu
Entries 428
Mean 29.62
Std Dev 3.297
Data
Simu
100
90
80
70
60
50
40
30
20
10
0
−20
0
20
40
60
80
100
120
140
160
b_pol2

Gamma energy spectra



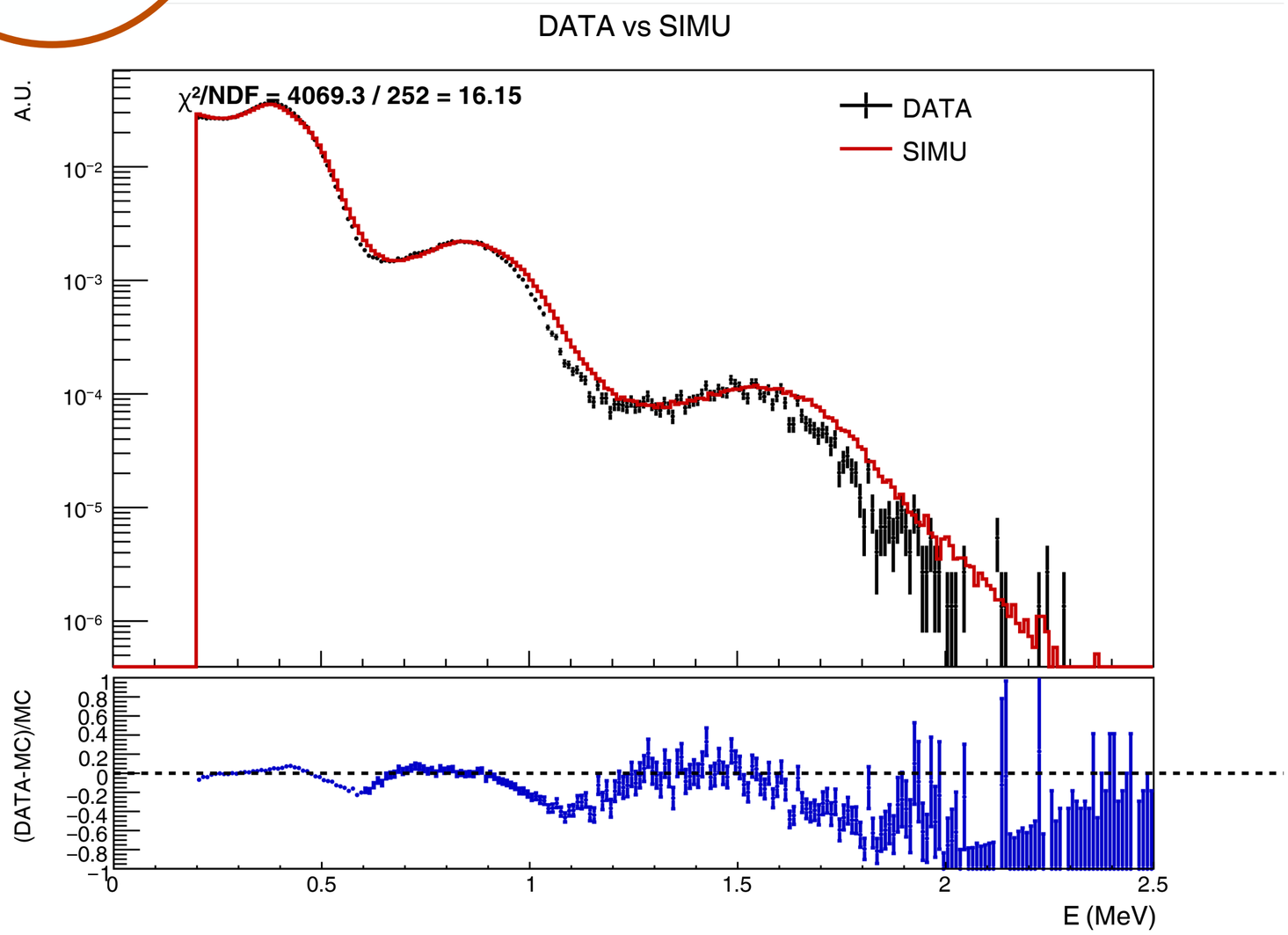
Same a, b compute on electron

→ applied on gamma spectra

per Wall

wall **IT**

Gamma energy spectra



Same a, b compute on electron

→ applied on gamma spectra

per Wall

wall **FR**