KU LEUVEN

Update muX meeting 12/07

Michael Heines

Rerunning for gain drift

- Anticoincidence window adjusted to 1μs before the muon and 3μs after

→Factor 2-2.5 increase in statistics for calibration lines for stable isotopes!

- Reran analyzer with [-3; +1]μs anticoincidence window

- Gaindrifting: divide in 2 hour batches → Use moving average of 3 blocks

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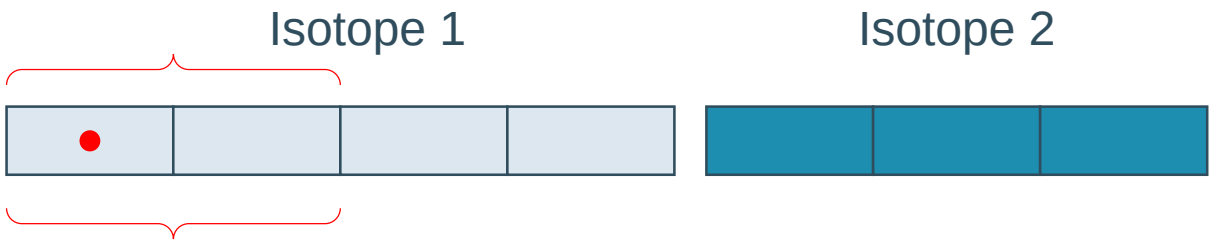

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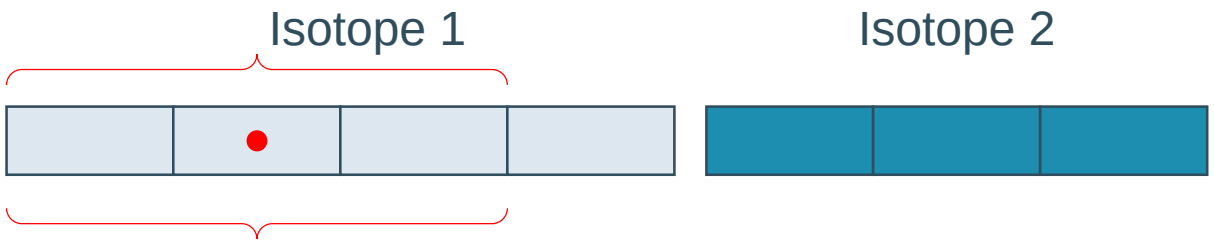

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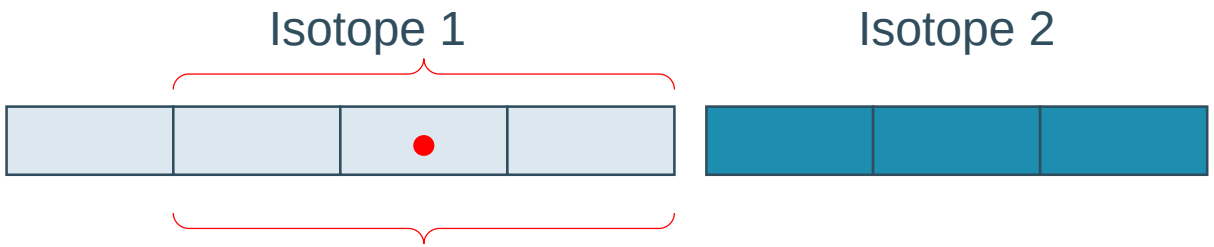

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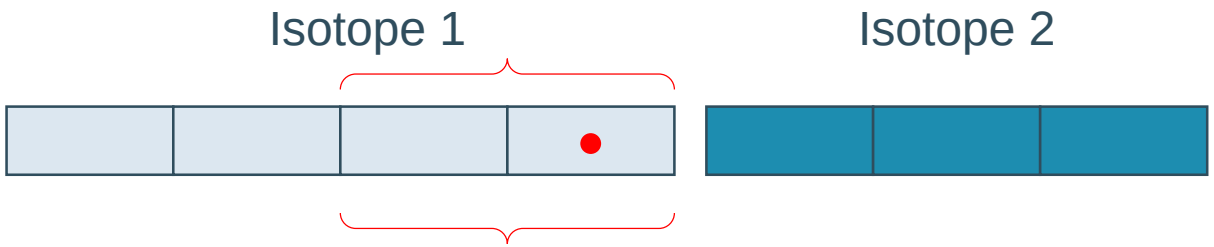
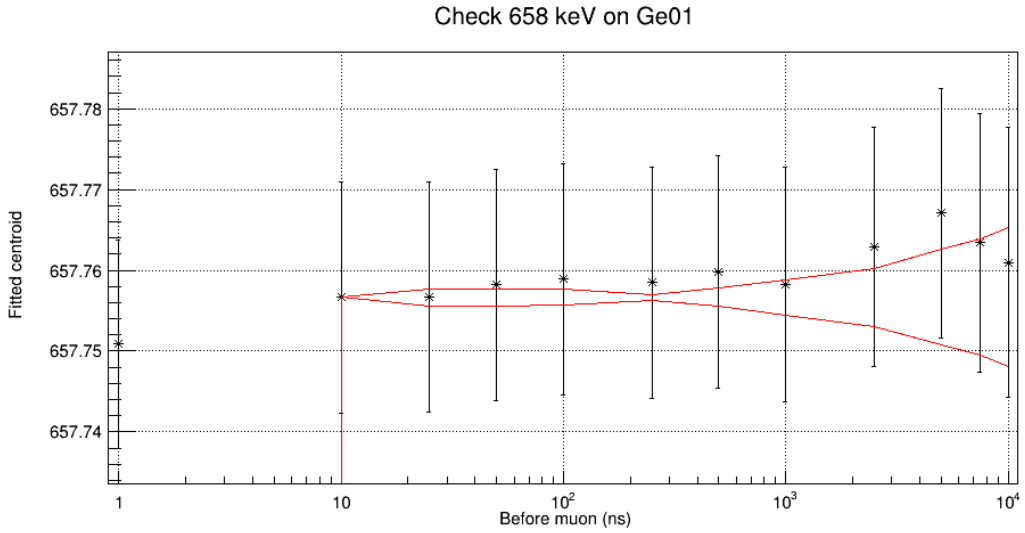
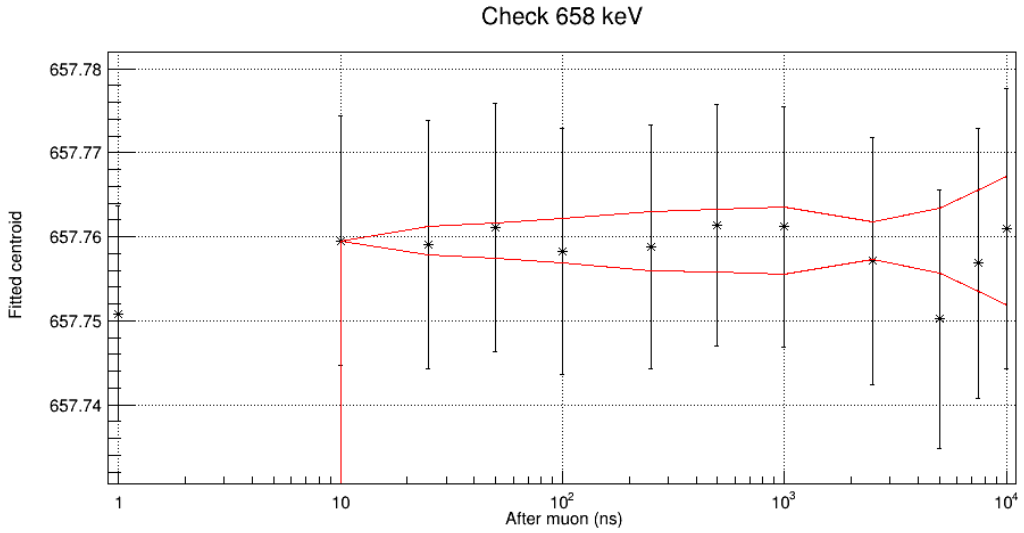


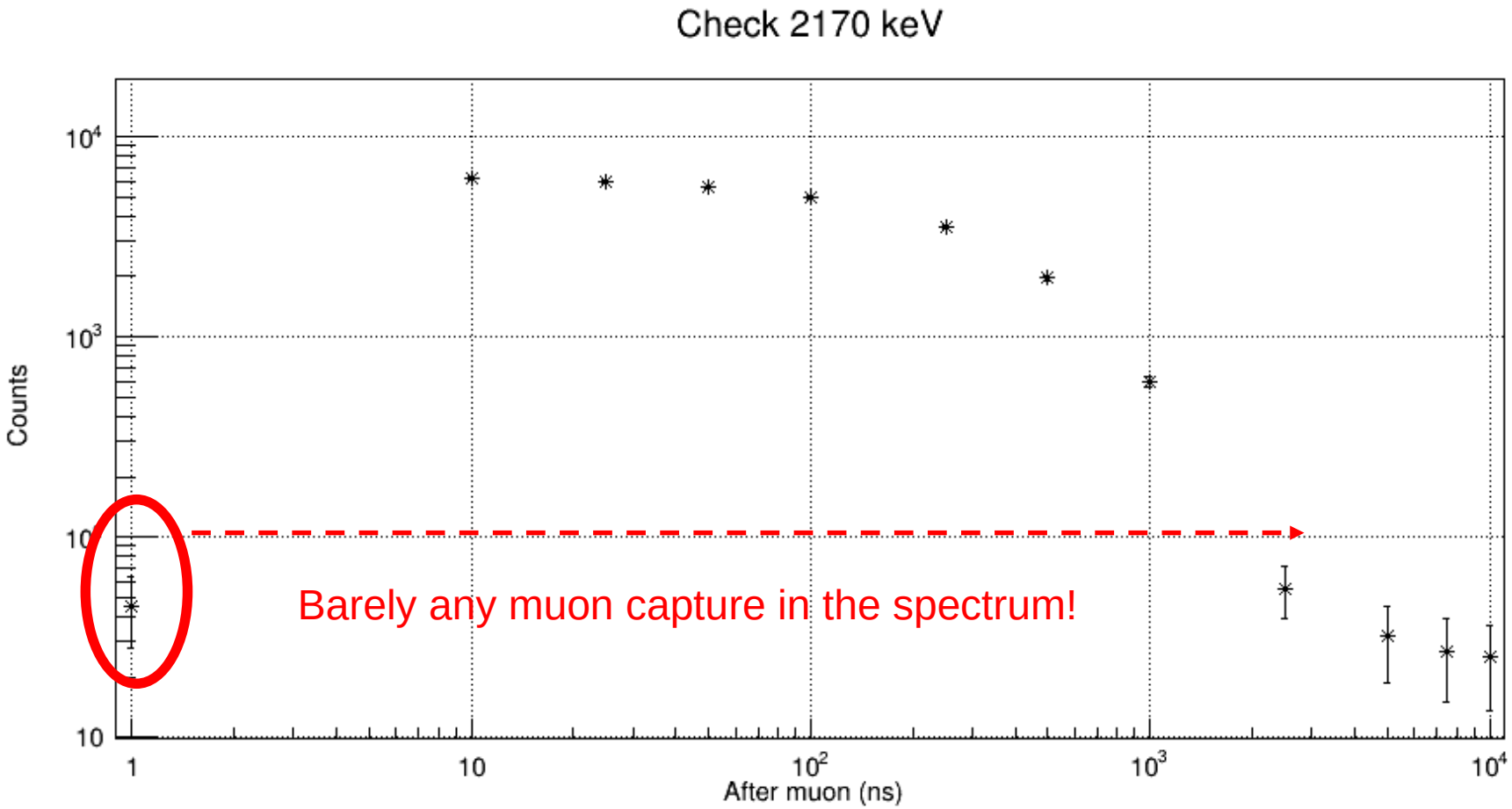
Do we increase bias?

Partially shared statistics → Red line gives “allowed deviation”
Fitting process not exact, so slight deviations are possible

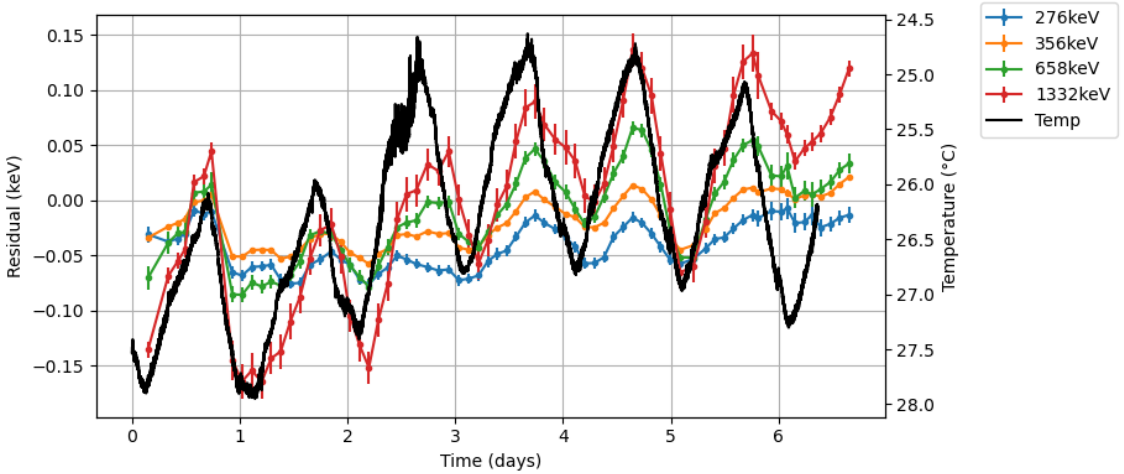


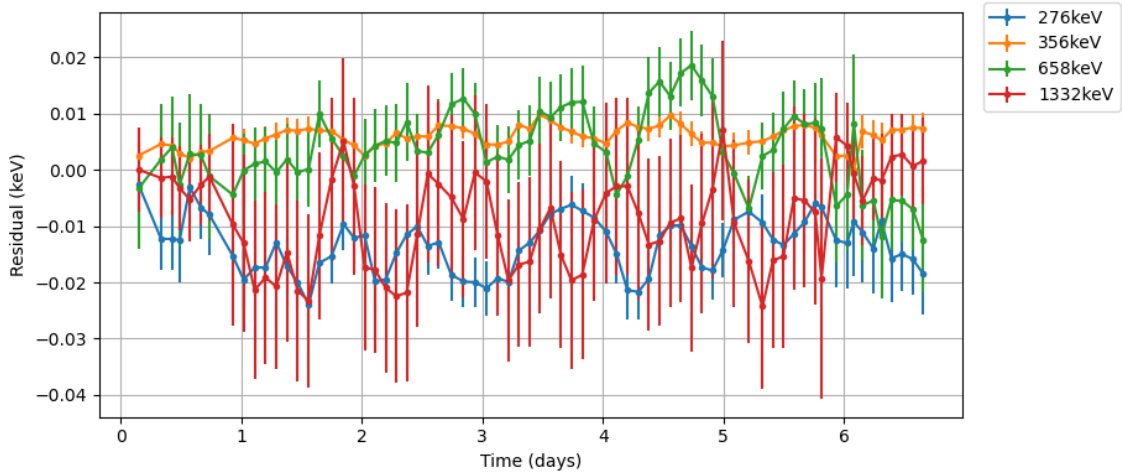


Rate decrease of muon capture lines



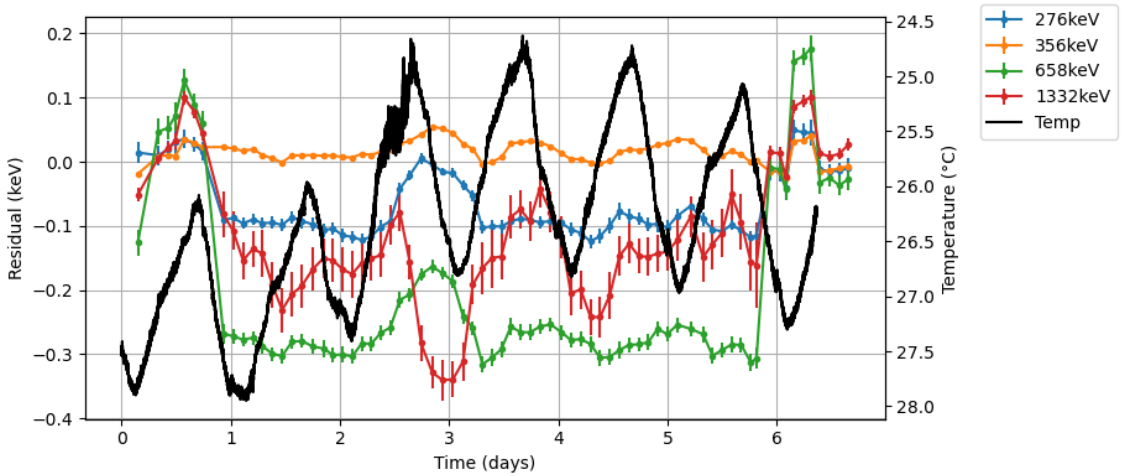
Gaindrift – Same story, just more statistics

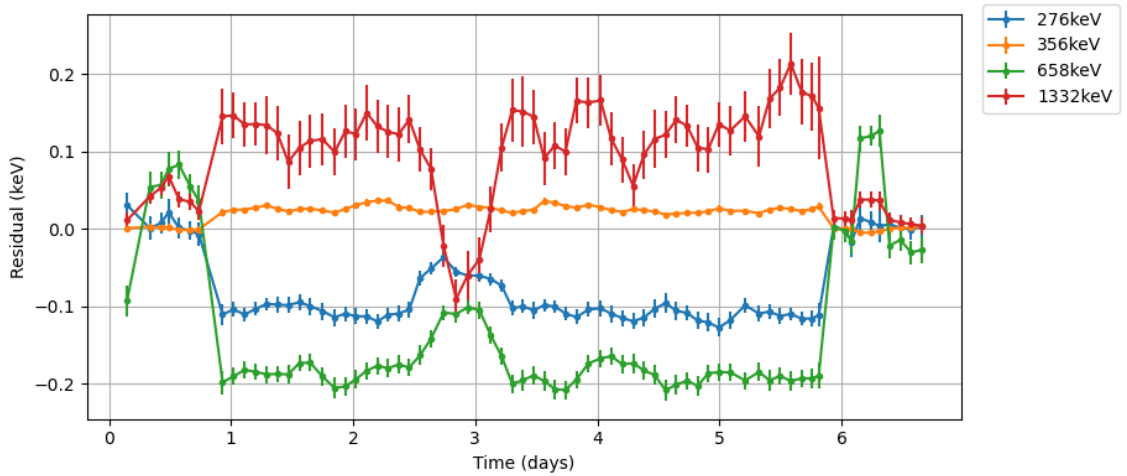




Gaindrift – Same story, just more statistics

Ge06A still wonky during ^{40}K run; other Ge06 detectors quite ok





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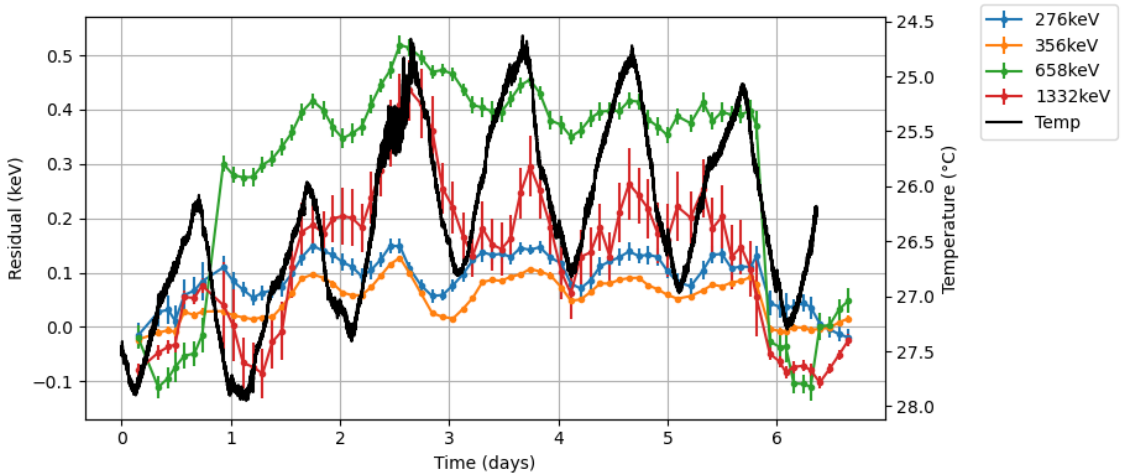
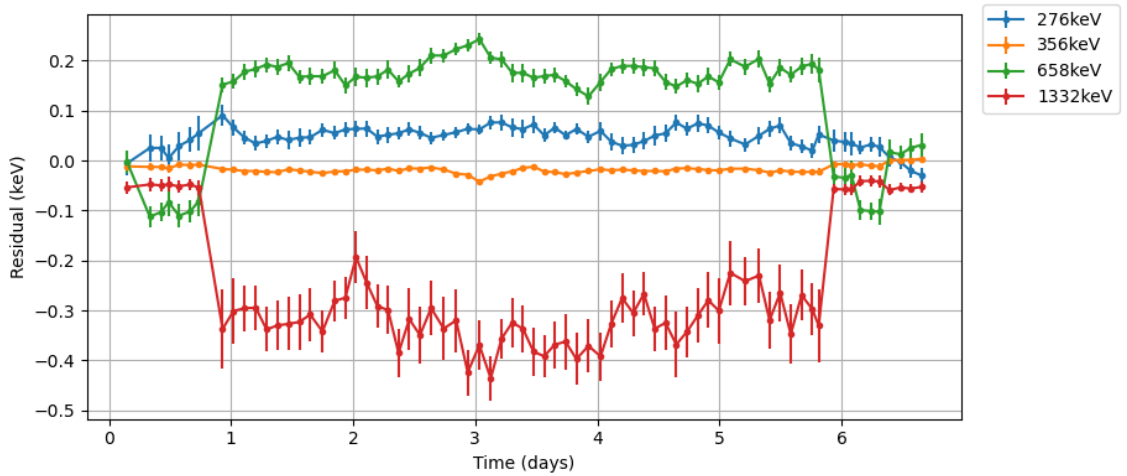
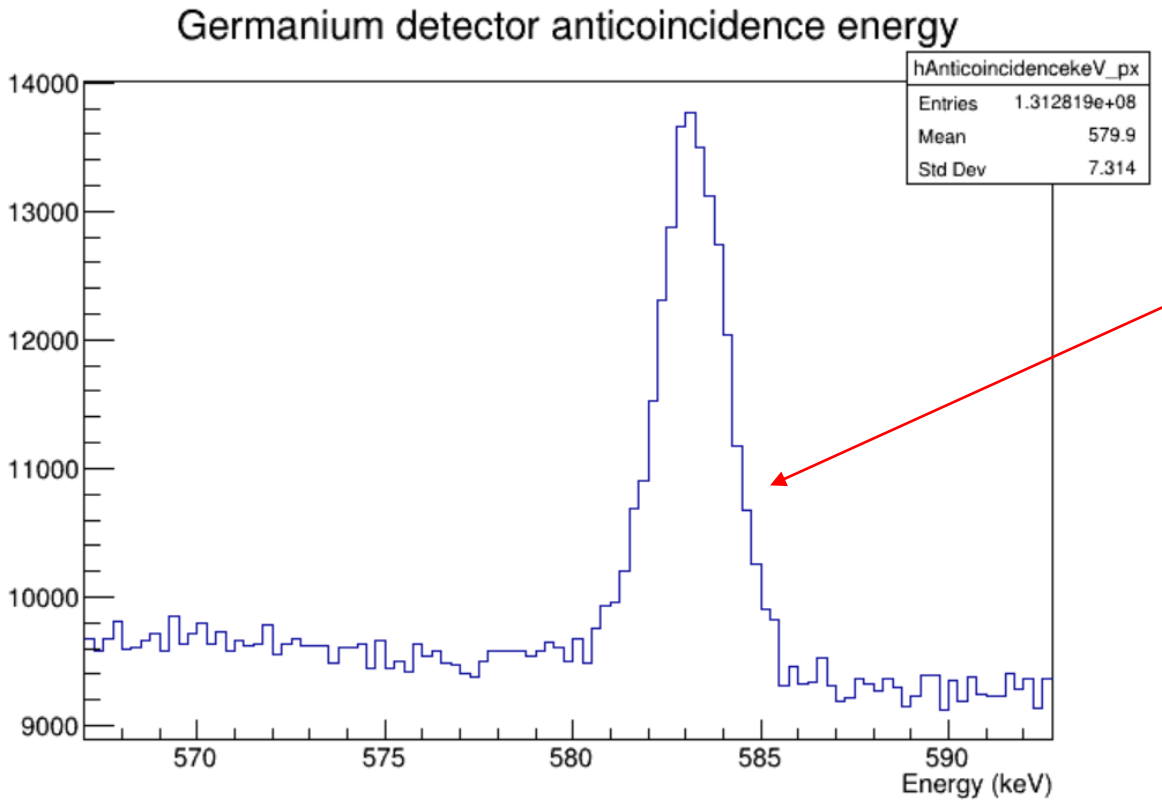




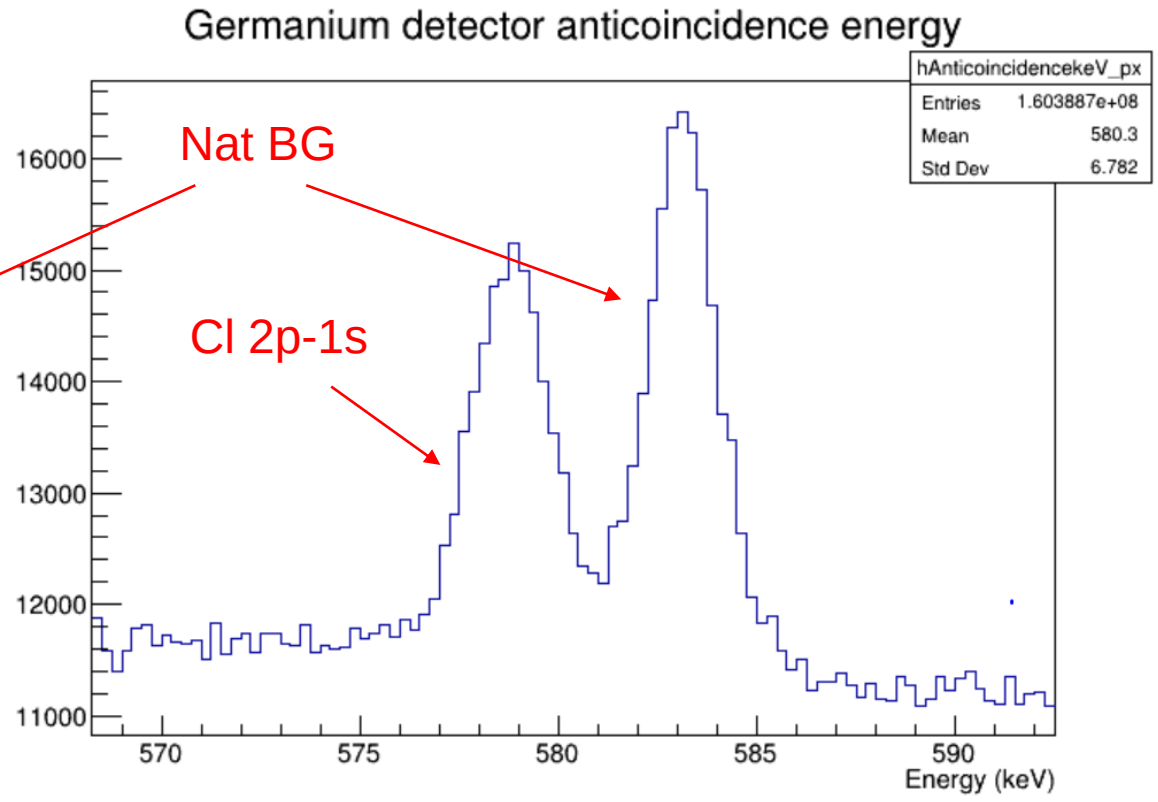
Nonlinearity seems to change, but at least it is consistent within an isotope!

One oddity…

- K-39[KCl] first part



- K-39[KCl] second part



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- K-39[KCl] first part
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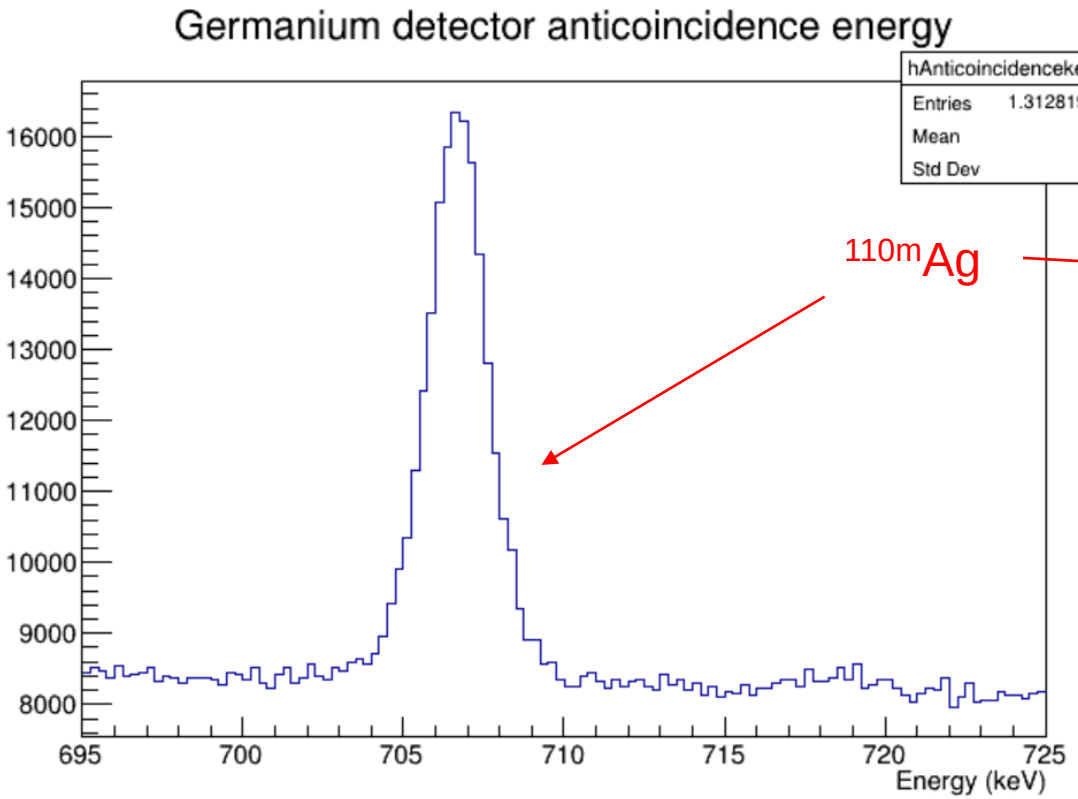
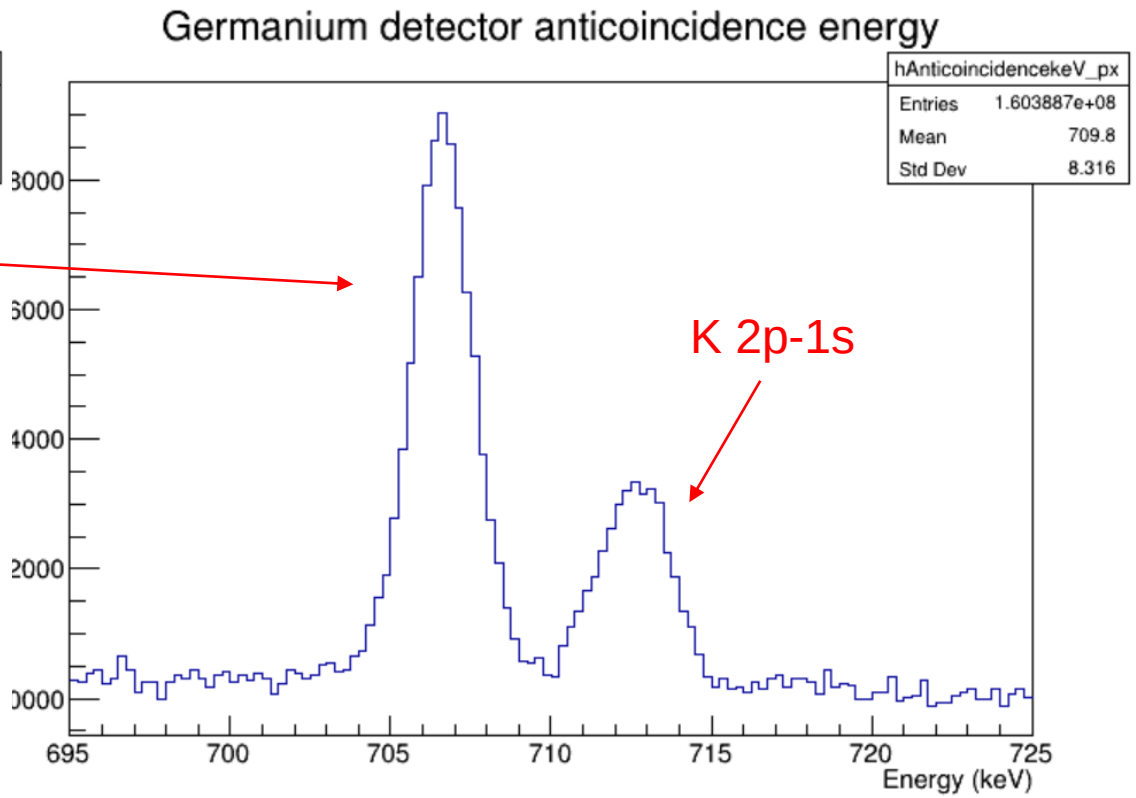
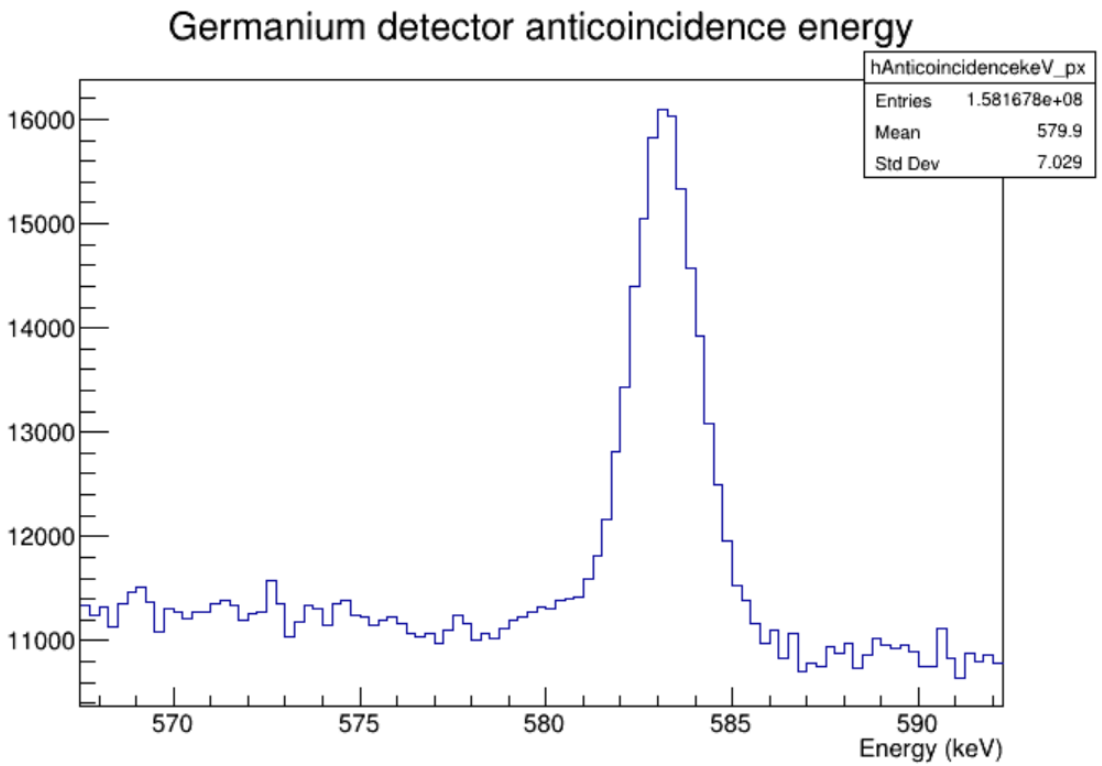
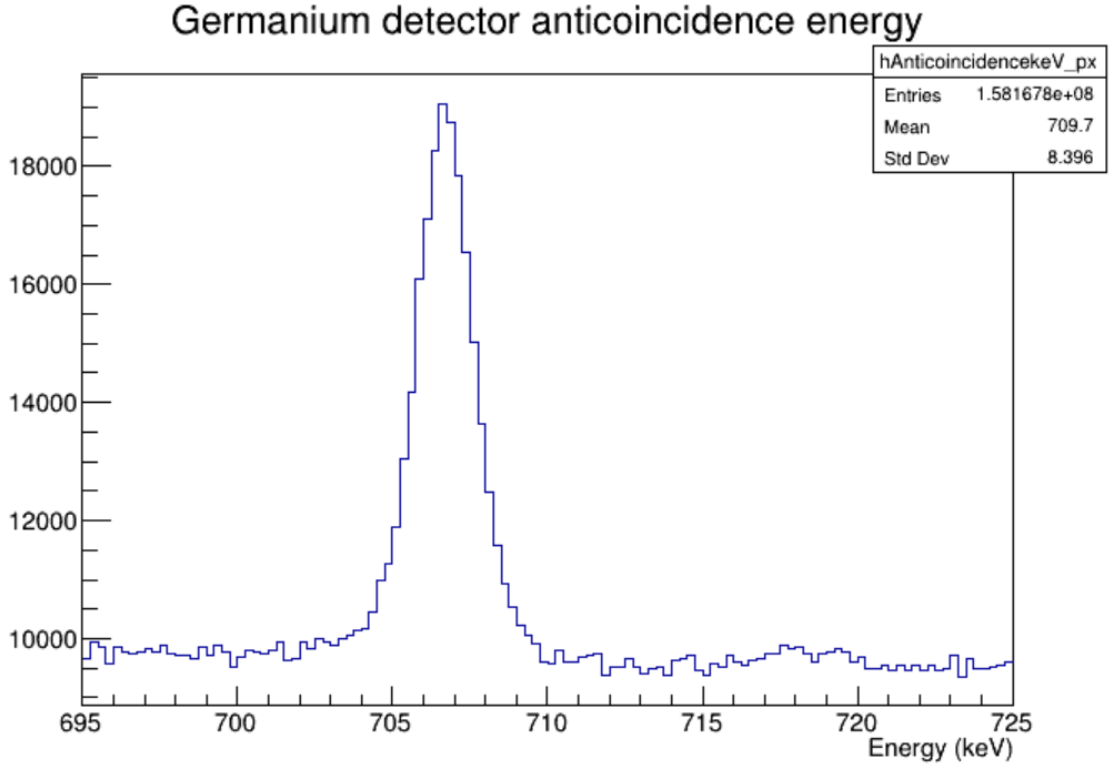




Run right after K-41[KCl]

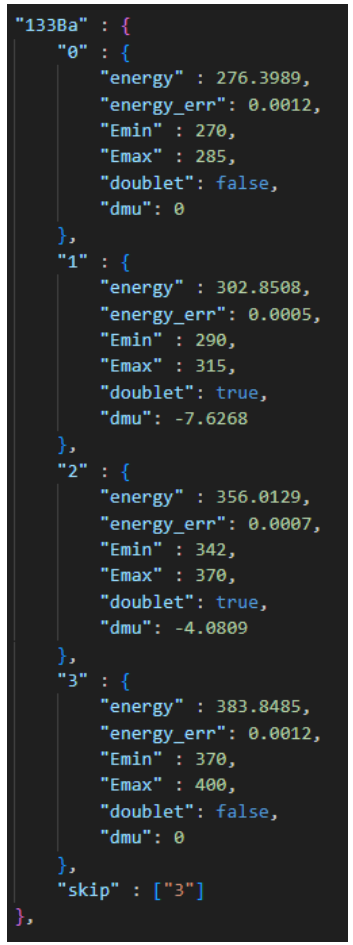
Clean again? Only second K-39[KCl] run has remains of 2p-1s
→ In principle not an issue for calibration, but weird…



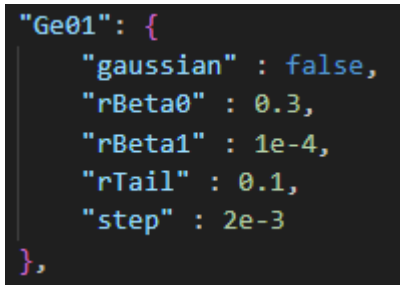


Still need to check if it is in a few runs (remove short bit of data) or in all runs of the second part (need to live with it)

Hypermet fitting - inputs



Literature energy + error
Range to fit
If doublet, relative distance
List of lines to skip (not good to fit)



Hypermet or Gaussian
Initial lineshape parameters

Parameters for $\sigma = aE + b\sqrt{E} + c$
Kept fixed in hypermet fit

Hypermet fitting – ouputs

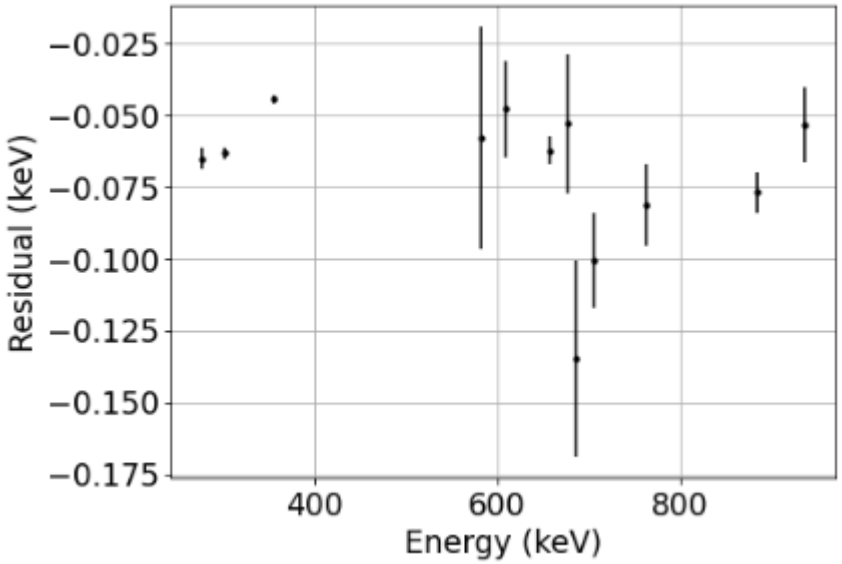
```
Converged!
MB07C
----------------------------------------
Fitted centroids:
276.399:        276.471 0.00214234
302.851:        302.873 0.00444684
356.013:        356.028 0.00232166
657.76: 657.667 0.00861775
677.622:        677.384 0.0390073
687.009:        687.139 0.0817566
706.676:        706.638 0.0370242
763.942:        763.9   0.0335183
884.678:        884.771 0.0135266
937.485:        937.506 0.0281504
583.187:        583.125 0.0561839
609.321:        609.239 0.0263114
----------------------------------------
Line shape parameters:
rBeta0: 0.991189        0.0146337
rBeta1: 0.000697706     0.000150737
rTail0: 0.0500562       0.000208972
aStep:  0.00324952      0.000334138
----------------------------------------
Line shape correlation:
Correlation rBeta0, rBeta1:     0.725913
Correlation rBeta0, rTail0:     0.248423
Correlation rBeta0, aStep:      -0.0694103
Correlation rBeta1, rTail0:     0.220643
Correlation rBeta1, aStep:      0.391931
Correlation rTail0, aStep:      -0.00465907
----------------------------------------
```

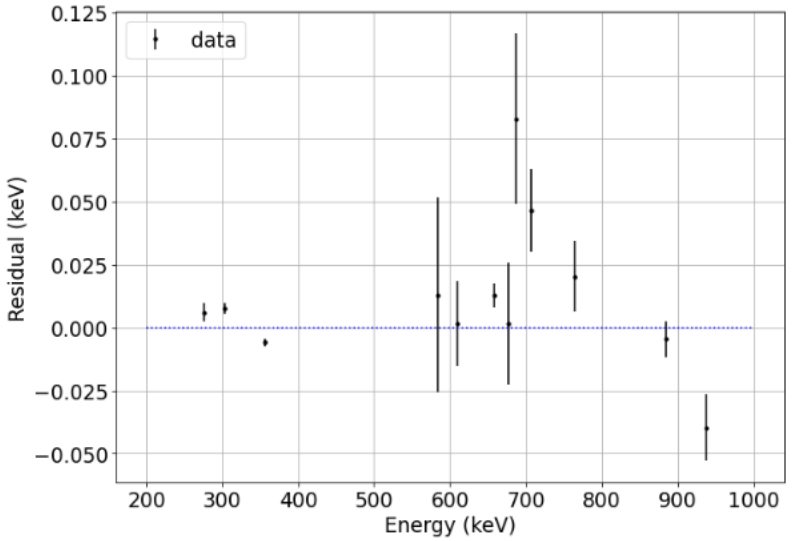
Literature values + errors
Fit centroids + errors
Line shape parameters + errors
Correlation between line shape parameters

→ Written to json for easier processing

Using outputs for recalibration

- Before correction: Offset likely due to change between hypermet and gaussian
- After: No more offset, nice energy precision!





Data for Ge02 (95% REGe) on 1 shift of statistics → Can still benefit from increase in statistics!

How to estimate error on calibration - Bootstrapping

Example of non-parametric resampling: draw randomly with replacement

original dataset = {1.2, 4.8, 2.3, 2.1, 7.9, 10.0, 0.5, 5.6, 9.2, 1.1} N = 10

Resampled dataset $\mathcal{X}_1^*$ = {1.2, 2.1, 9.2, 5.6, 0.5, 2.3, 9.2, 0.5, 1.1, 0.5} N = 10

Resampled dataset $\mathcal{X}_2^*$ = {9.2, 0.5, 10. , 2.3, 2.1, 7.9, 2.1, 4.8, 5.6, 1.2} N = 10

⋮ ⋮

Resampled dataset $\mathcal{X}_M^*$ = {2.1, 10. , 1.2, 0.5, 7.9, 1.1, 7.9, 1.2, 5.6, 10.} N = 10

Some values occur multiple times

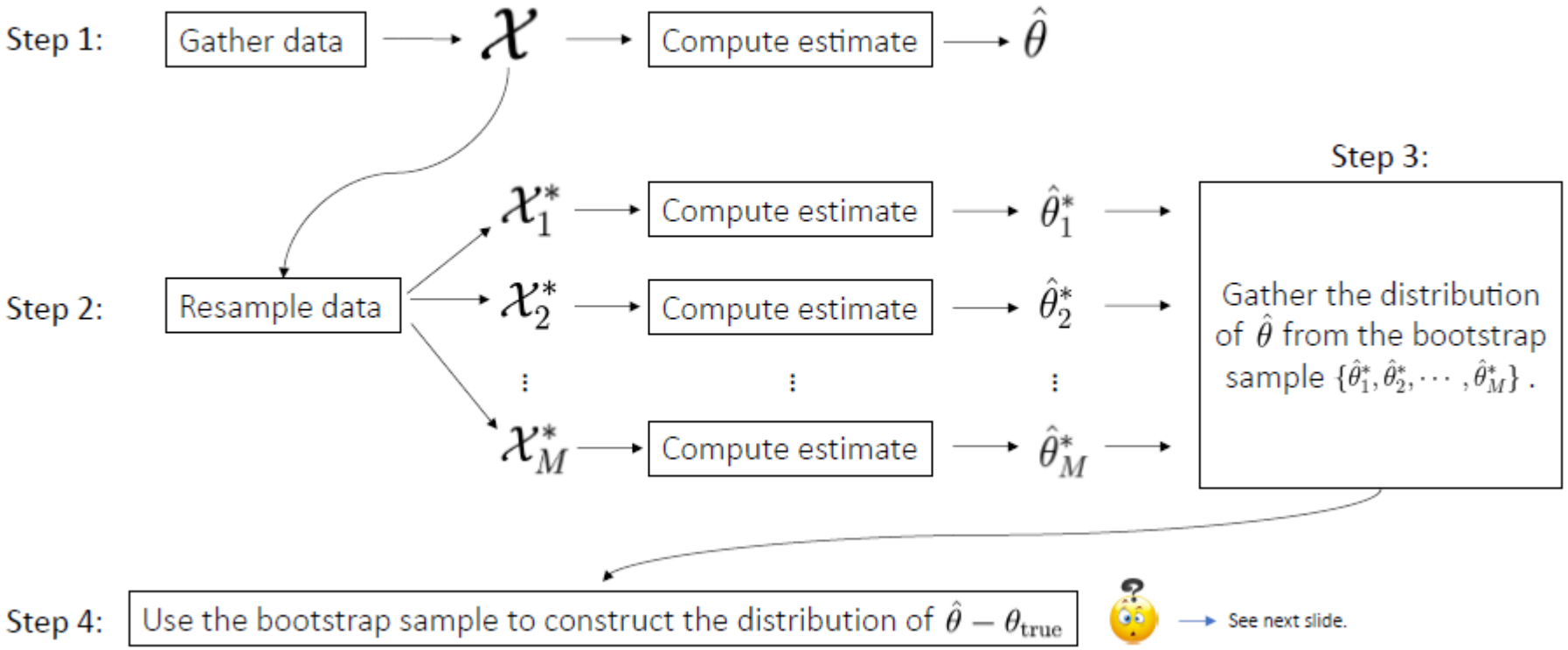
Other values (e.g. 4.8) don't occur at all in dataset #M

The total size of the dataset always stays the same.

Slide courtesy: Joris de Ridder

How to estimate error on calibration - Bootstrapping

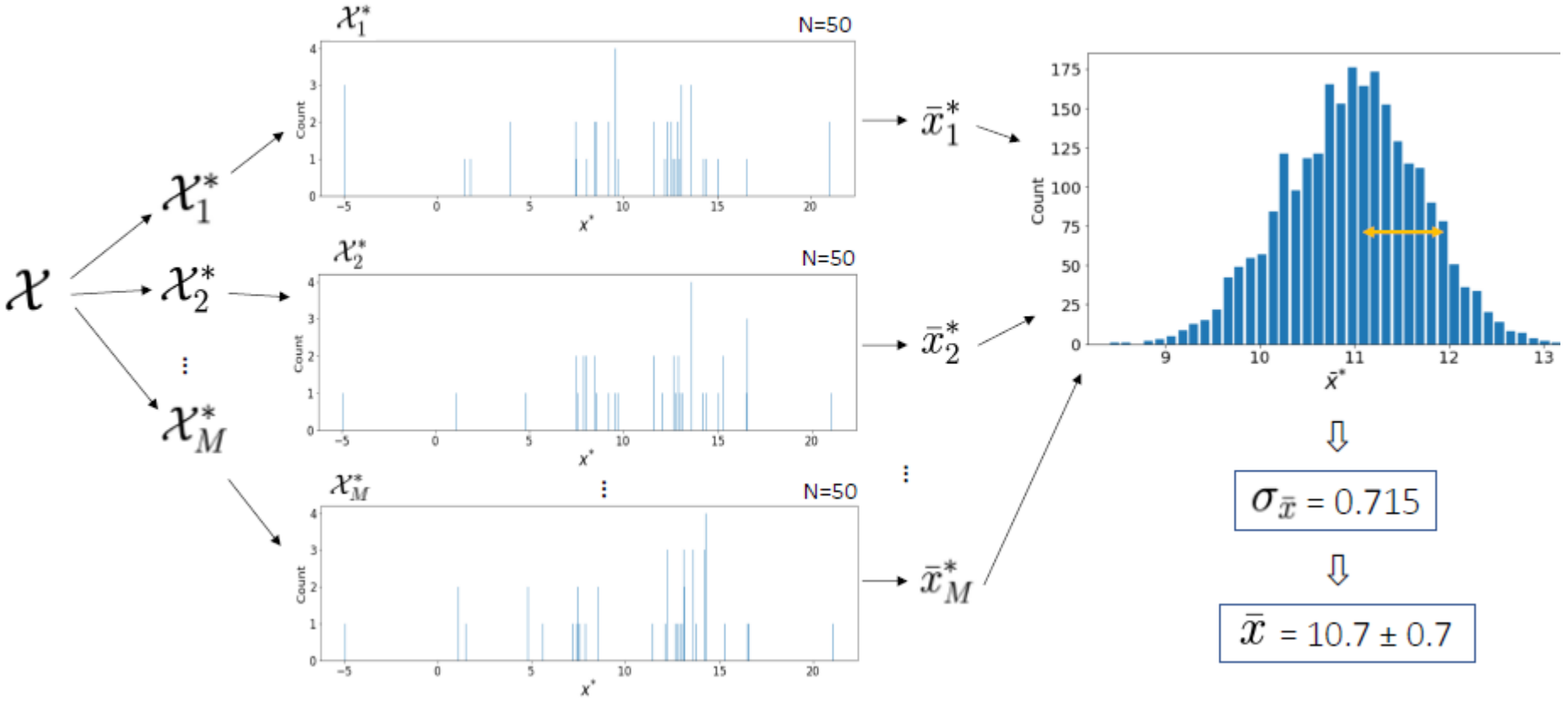
The general principle of non-parametric bootstrapping:



Slide courtesy: Joris de Ridder

How to estimate error on calibration - Bootstrapping

- Resampled datasets (with replacement):



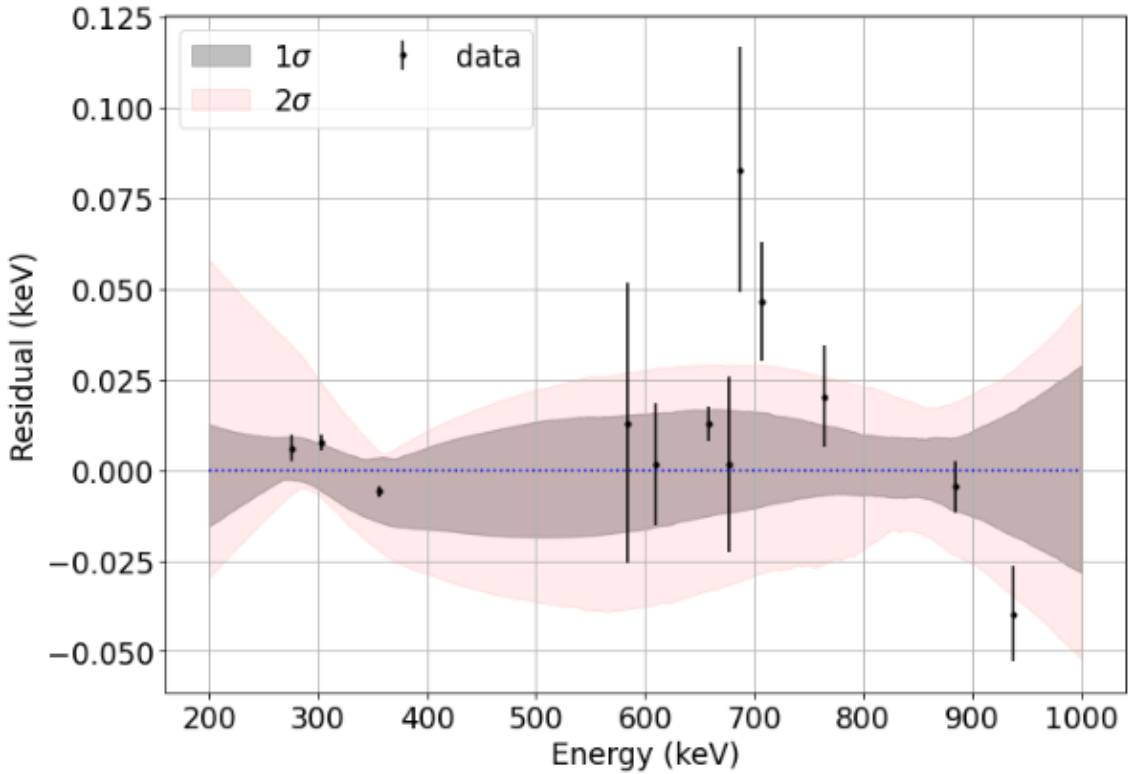
Slide courtesy: Joris de Ridder

How to estimate error on calibration - Bootstrapping

- General idea:
  - Perform many fits
  - Look at distribution of results

- My extra constraints:
  - At least 1/3 points below 400 keV
  - At least 1/2 points above 800 keV

Preliminary on Ge02: Seems to work well



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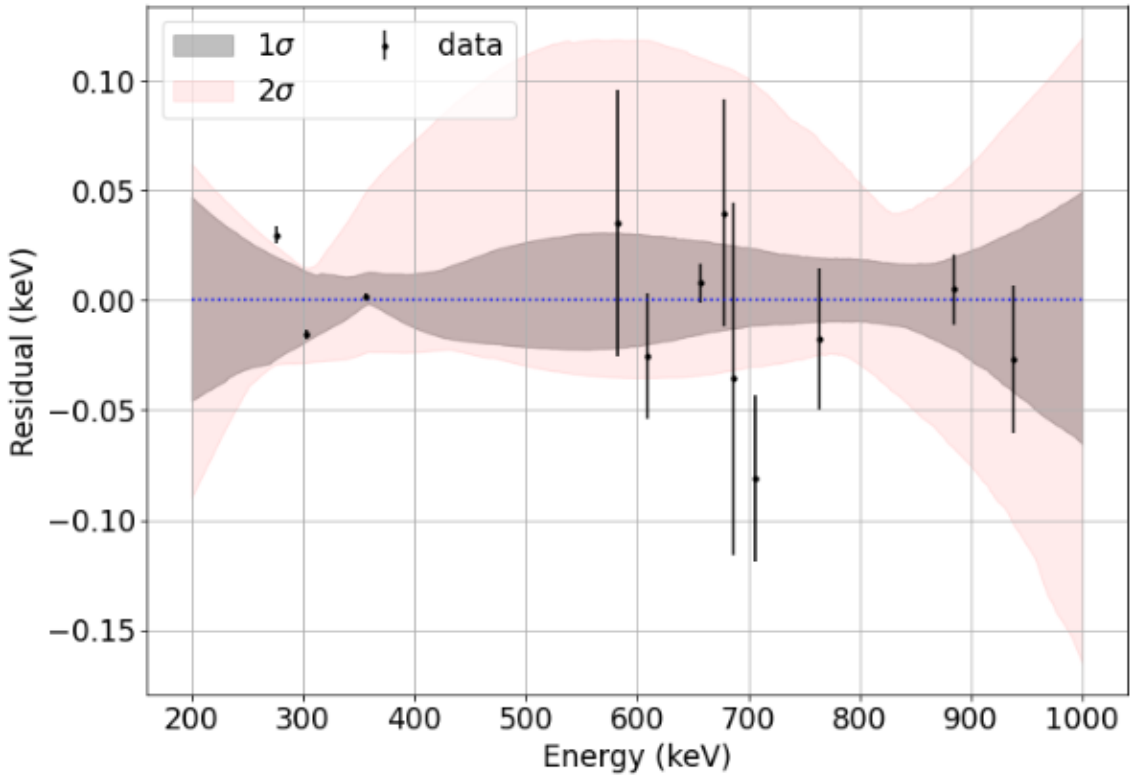
Preliminary on Ge01: 1σ alright, 2σ weird



How to estimate error on calibration - Bootstrapping

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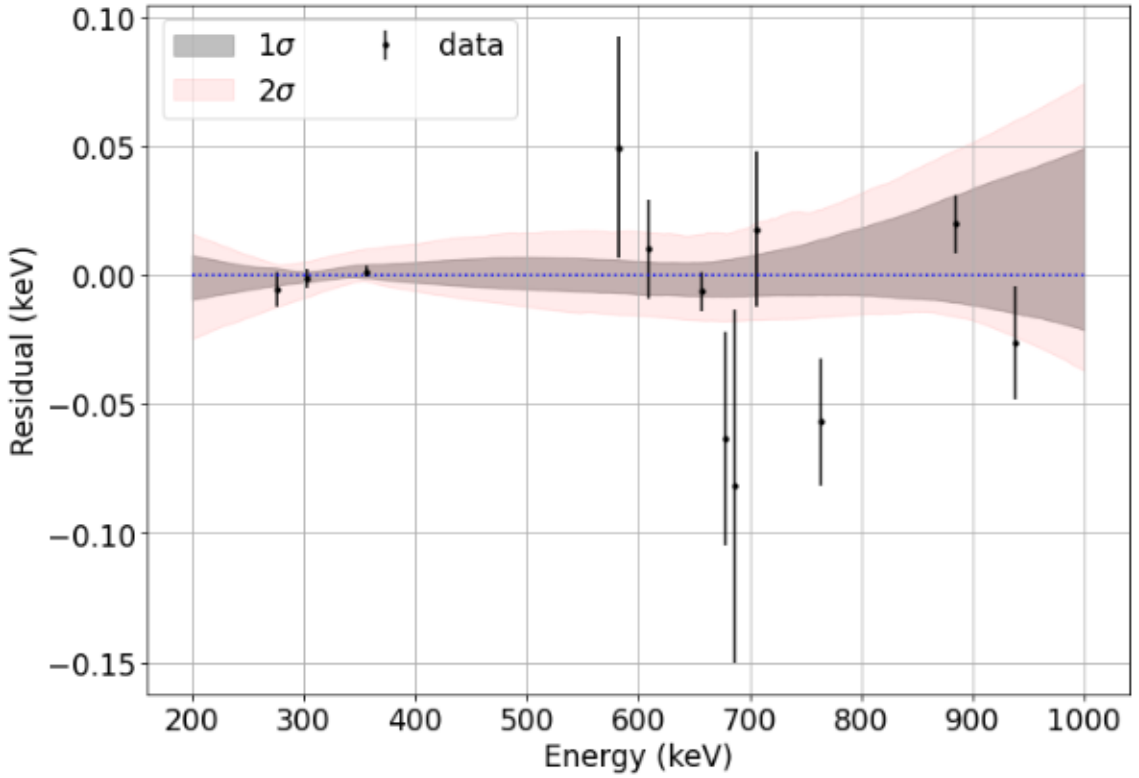
Preliminary on Ge05: Not sure, more stats would be good



What's next

- Rerun analyzer with gaindrift correction
  - Anticoincidence trees → Spectra → Hypermet fitting → Calibration
  - Veto, pile-up, … cuts
- Calibration fit using ODR rather than regular fit with y-error = x-error + y-error to see if anything changes
- Crosscheck calibration without known line (707 keV, 583 keV), check how much a weighted average deviates from literature
- Fit np-1s lines

Update from theory side

- Contacted Paul Indelicato for QED calculations → Awaiting response

- Contacted Karim Bennaceur for charge density calculations (V2 correction)
  - →His methods work best for even-even
  - →K and Cl rather spherical, so he can do mean-field approximation
  - →Still things to implement in his code, but thinks he could get results by end of August!

- Backup/Simple calculation NP? Ben mentioned he knows someone in Mainz who might be able to help

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