Fitting the Data from Boulby Mine

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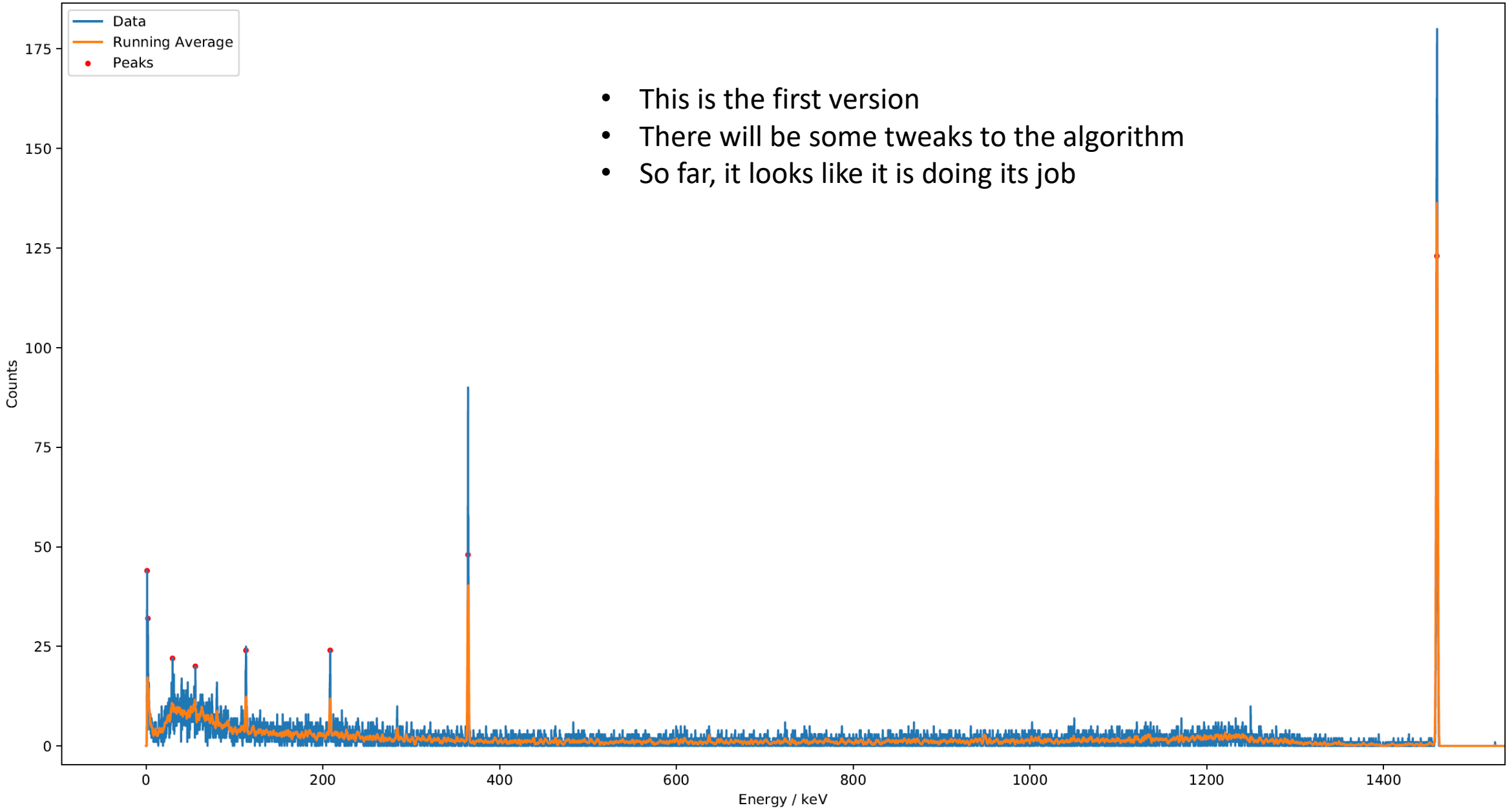
Peak Finding

- We want the framework to be able to identify the peaks automatically
- For this reason, I have been trying to develop a peak finding algorithm
- I will show you a version of this that will be modified
- Also, after the fitting is performed for each peak, we want to be able to compare them
- However, there are some things I need to change to make it more general for different data files from different detectors
- What you will see is the first version of this algorithm

Peak Finder

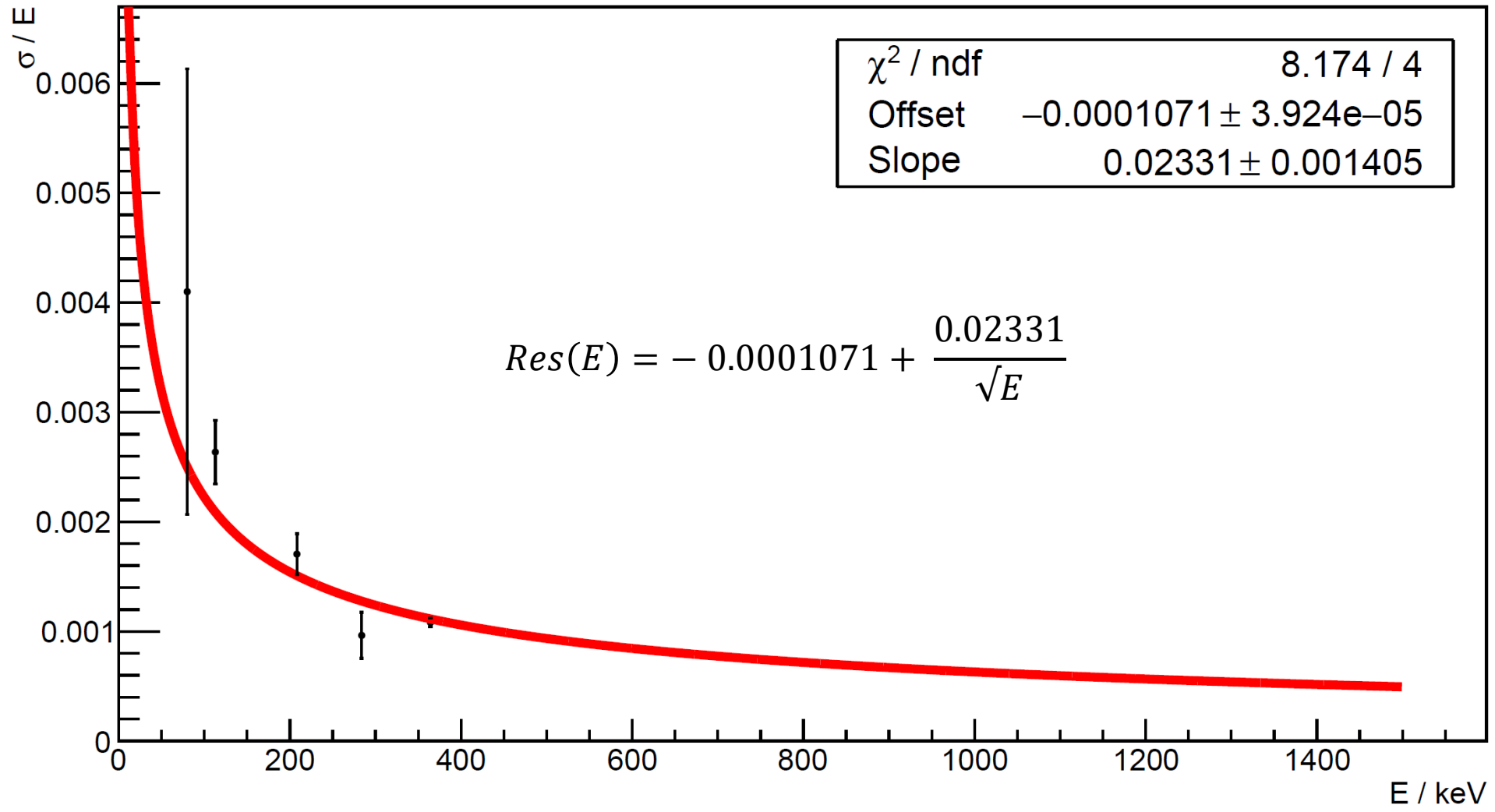


- This is the first version
- There will be some tweaks to the algorithm
- So far, it looks like it is doing its job

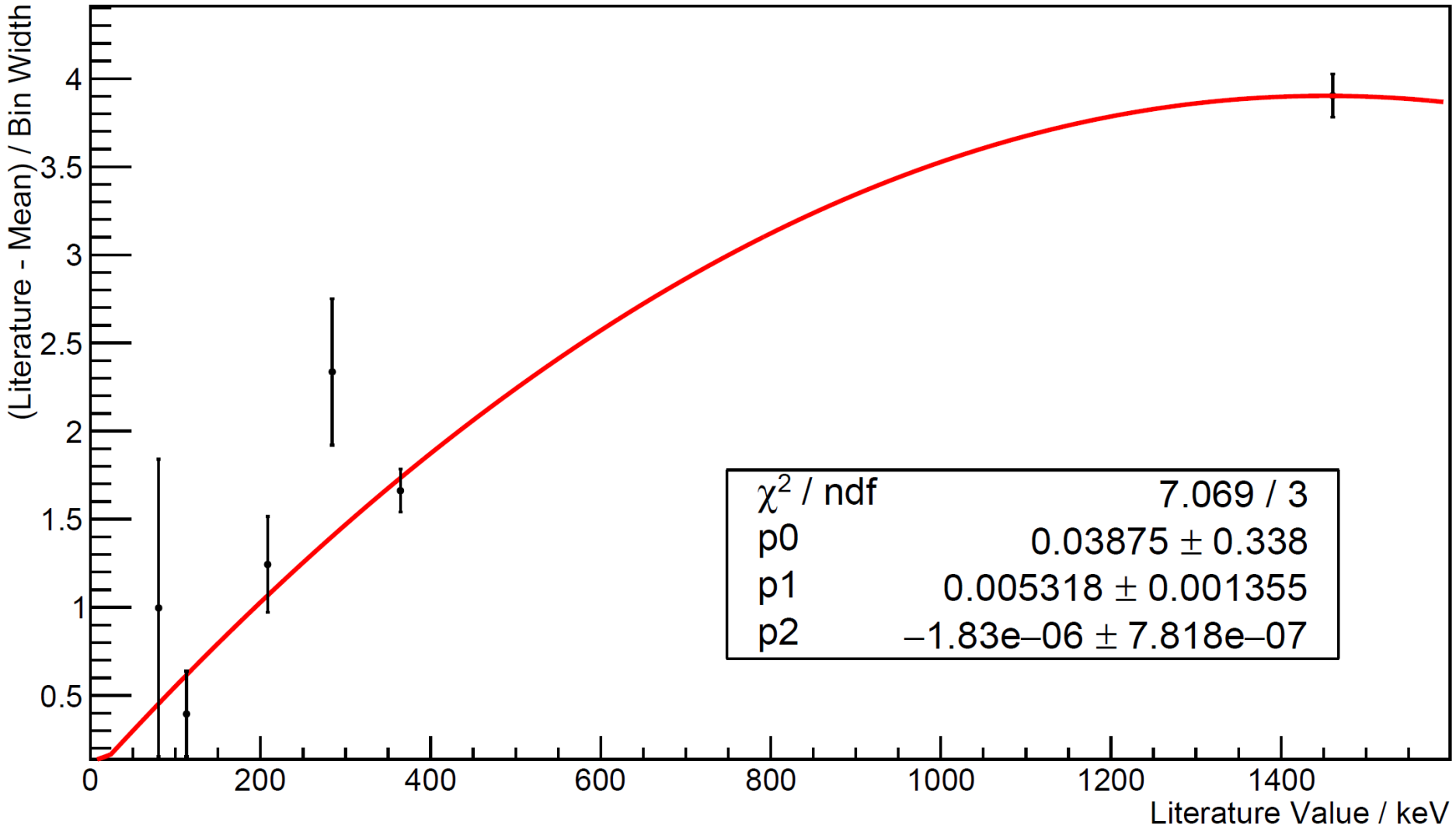
Specifics

- Data set used with peak finder
  - Place of measurement: Boulby Mine
  - Used detector: HPGe
  - Date of measurement: 26.03.2019
  - Exposure: 79178 s
- More data sets will be tested once it is optimised using this data set
- Peak finder
  - A running average was used to get the baseline
  - A constant was used on top of this to decide whether it is a peak or not
  - If data > (running average + constant) -> peak
  - I would like to replace this “constant” with a variable which will adapt to the data at hand – we are thinking something like n x σ where σ is sqrt(σ), n to be determined

Energy Resolution



Shift of Energies



- From this shift in energies, it seems that the calibration used may not be fully accurate.
- Which data was used to make the calibration and how was it performed?

Isotope Database

- Also, after the fitting is performed for each peak, we want to be able to compare them with the gamma energies of the known isotopes
- For this goal, we need a isotope database which has the name of the isotope, the energy of the gamma ray and the intensity of the said peak
- I made the first version of this database based on a template sent from Francisco and Mauricio

Isotope Database

- As there are so many isotopes and I needed to start somewhere with the list, I started to look at which elements can be found in water
- I found an article from a nutrition perspective: “Major inorganic elements in tap water samples in Peninsular Malaysia” (https://www.researchgate.net/publication/221804247_Major_inorganic_elements_in_tap_water_samples_in_Peninsular_Malaysia)
- It showed the following elements:

sodium, magnesium, potassium, calcium, chromium, manganese, iron, nickel, copper, zinc, arsenic, cadmium and lead

- So I added the unstable isotopes of these elements containing gamma rays with intensity of 1 % or higher
- I will update this database in time with more isotopes
- I have a screenshot of the print-out of the database script

Isotope Database

```
(keras) [Fri Jul 26 13:00:38 ct417@feynman:gcrf ] $ python isotope.py
Mean energy of the gamma ray observed in the data =  93
Energy resolution at this energy =  0.302
Matching isotopes:
Isotopes        Energy[keV]     Intensity[%]
¹⁰⁷Cd            93.12 +- 0.02   4.80 +- 0.30
(keras) [Fri Jul 26 13:00:38 ct417@feynman:gcrf ] $ vi isotope.py
(keras) [Fri Jul 26 13:01:34 ct417@feynman:gcrf ] $ python isotope.py
Mean energy of the gamma ray observed in the data =  112.7
Energy resolution at this energy =  0.308
Matching isotopes:
Isotopes        Energy[keV]     Intensity[%]
¹⁷⁷Lu  -> ¹⁷⁷Hf          112.95 +- 0.00  6.17 +- 0.07
¹⁷⁷mLu -> ¹⁷⁷Hf          112.95 +- 0.00  21.90 +- 0.90
(keras) [Fri Jul 26 13:01:36 ct417@feynman:gcrf ] $ vi isotope.py
(keras) [Fri Jul 26 13:02:18 ct417@feynman:gcrf ] $ python isotope.py
Mean energy of the gamma ray observed in the data =  283
Energy resolution at this energy =  0.362
Matching isotopes:
Isotopes        Energy[keV]     Intensity[%]
⁶¹Cu            282.96 +- 0.00  12.20 +- 0.30
(keras) [Fri Jul 26 13:02:19 ct417@feynman:gcrf ] $ vi isotope.py
(keras) [Fri Jul 26 13:02:31 ct417@feynman:gcrf ] $ python isotope.py
Mean energy of the gamma ray observed in the data =  344
Energy resolution at this energy =  0.382
Matching isotopes:
Isotopes        Energy[keV]     Intensity[%]
(keras) [Fri Jul 26 13:02:32 ct417@feynman:gcrf ] $ vi isotope.py
(keras) [Fri Jul 26 13:02:40 ct417@feynman:gcrf ] $ python isotope.py
Mean energy of the gamma ray observed in the data =  345
Energy resolution at this energy =  0.382
Matching isotopes:
Isotopes        Energy[keV]     Intensity[%]
(keras) [Fri Jul 26 13:02:45 ct417@feynman:gcrf ] $ vi isotope.py
(keras) [Fri Jul 26 13:03:15 ct417@feynman:gcrf ] $ python isotope.py
Mean energy of the gamma ray observed in the data =  327
Energy resolution at this energy =  0.376
Matching isotopes:
Isotopes        Energy[keV]     Intensity[%]
⁷¹As            326.79 +- 0.01  3.03 +- 0.03
(keras) [Fri Jul 26 13:03:16 ct417@feynman:gcrf ] $ vi isotope.py
(keras) [Fri Jul 26 13:03:28 ct417@feynman:gcrf ] $
```

Future Work

- Optimise the peak finding algorithm by
  - basing the peak on n x sigma instead of constant
  - use resolution function to determine the number of bins used in the running average
- Add more isotopes to the database as we go along
- Test software on more samples
  - Can I get Boulby data sets, with calibration data / resolution function information?