Gamma spectroscopy of radioactive nuclei

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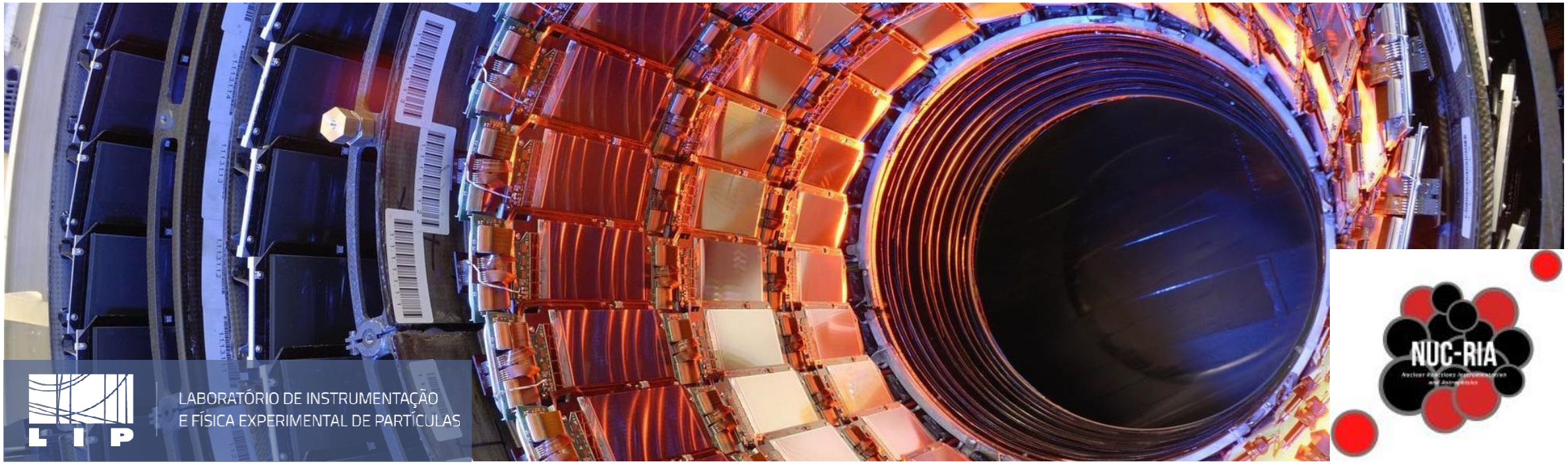


Topics of the presentation

- Contextualization of the experiment and its motivation;
- Experimental setup;
- Challenges of dealing with old data;
- Calibration of the detectors;
- Next steps in the analysis;

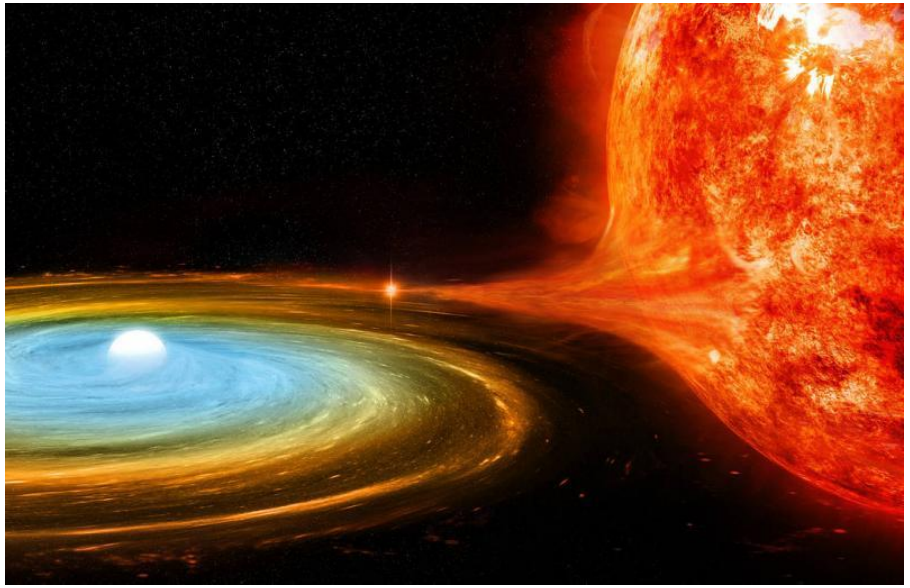
Contextualization of the experiment

- This experiment was performed in NSCL, part of Michigan State University, with the objective to better understand the properties of excited states of ^{30}S and to decrease the uncertainty of the reaction rate in the context of the astrophysical rapid-proton capture process (rp-process).

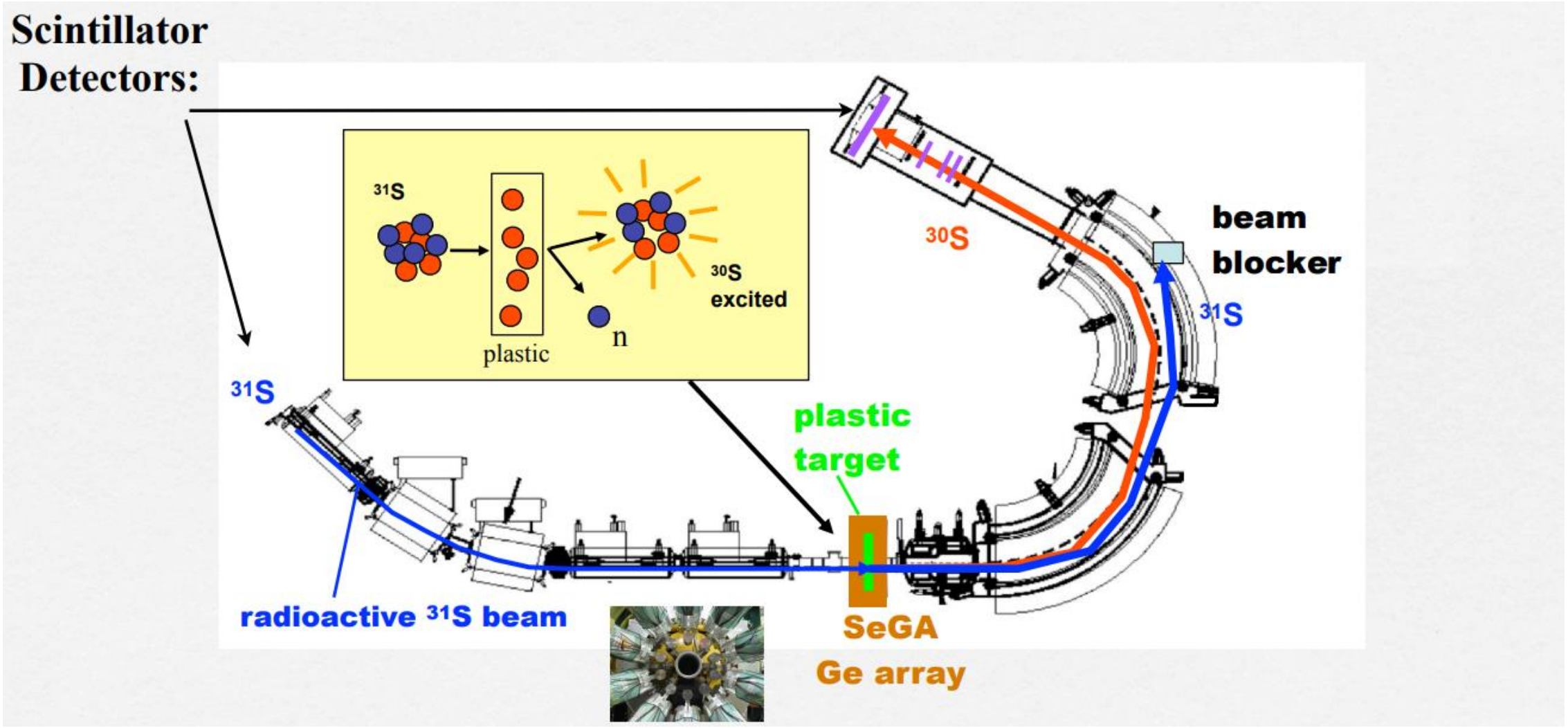
- The rp-process is characteristic of type 1 x-ray bursts that happen in neutron stars.

NSCL

MICHIGAN STATE UNIVERSITY

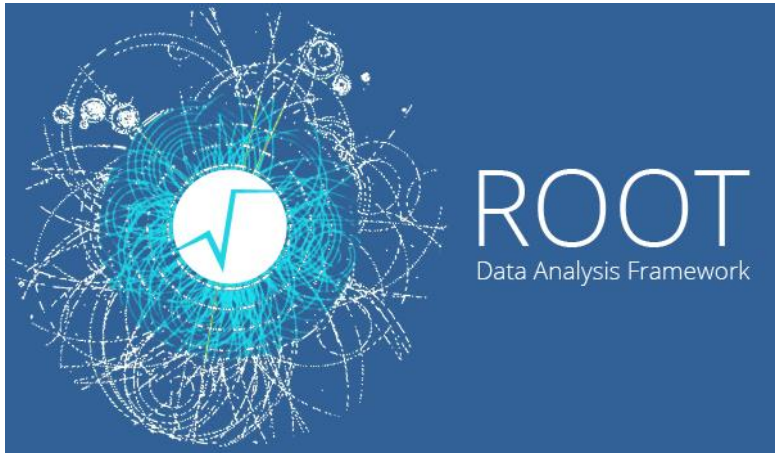


Experimental Setup



Data retrieval

- The experiment was performed at NSCL in 2005;
- The data was “stuck” in an old computer with no possibility of doing any analysis;
- A virtual machine was created with the same operating system and software as the old computer;
- The data was successfully transferred to the virtual machine;



Calibration of the SeGA detectors

Types of runs:

	^{31}S Primary beam	Plastic target	Radioactive sources
Reacted setting	✓	✓	✗
Unreacted setting	✓	✗	✗
Calibration	✗	✗	✓

- Reacted setting corresponds to runs where the primary beam of ^{31}S interacted with the target;
- Unreacted setting corresponds to runs where there was beam but no target, therefore no interaction;
- Calibration corresponds to runs where there was no target and where, instead of using the primary beam, radioactive sources with a well known gamma emission spectrum were used;
- There were also background runs made with no beam with the purpose of measuring the background spectrum for later confirmation of the calibration done.

Calibration of the SeGA detectors

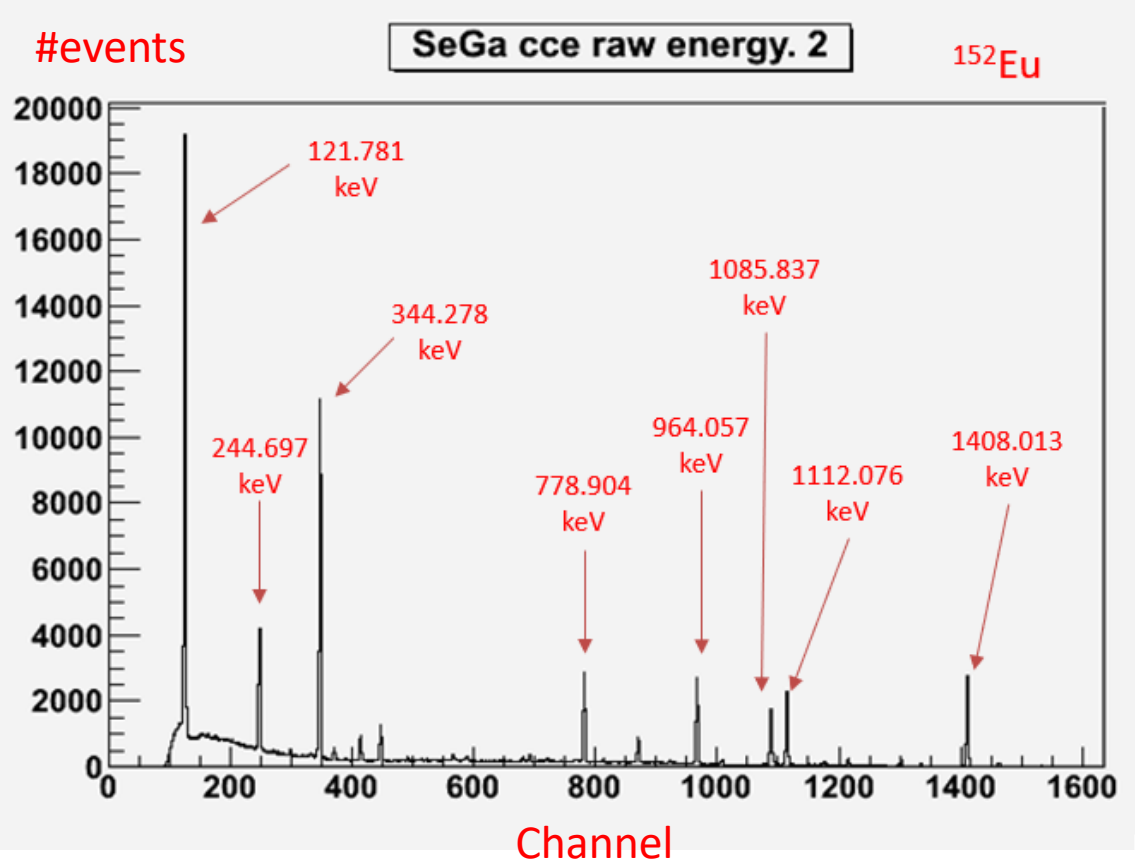


Figure 1: Gamma spectrum of 152Eu measured by the SeGA detector number 2.

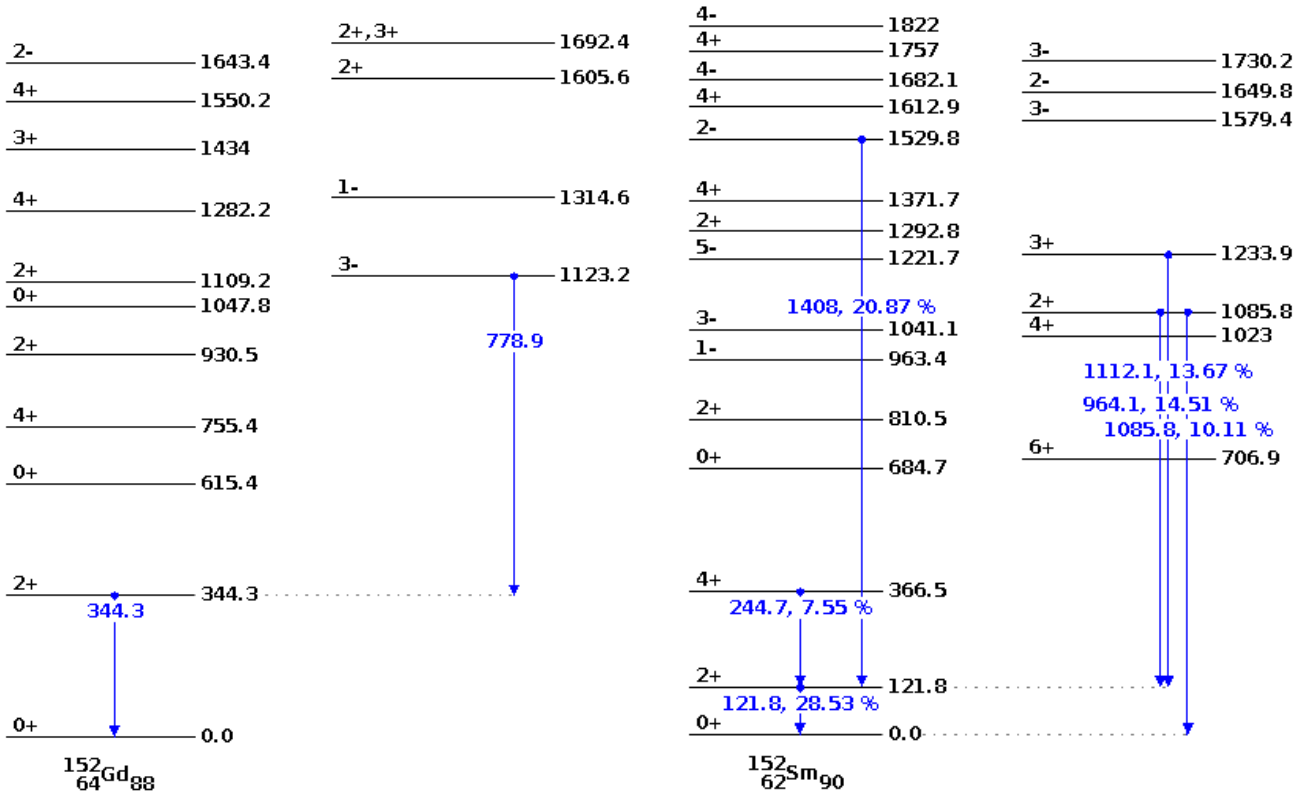


Figure 2: Gammas from the decay of the radioactive source ^{152}Eu. These values were taken from NuDat 3.0.

Calibration of the SeGA detectors

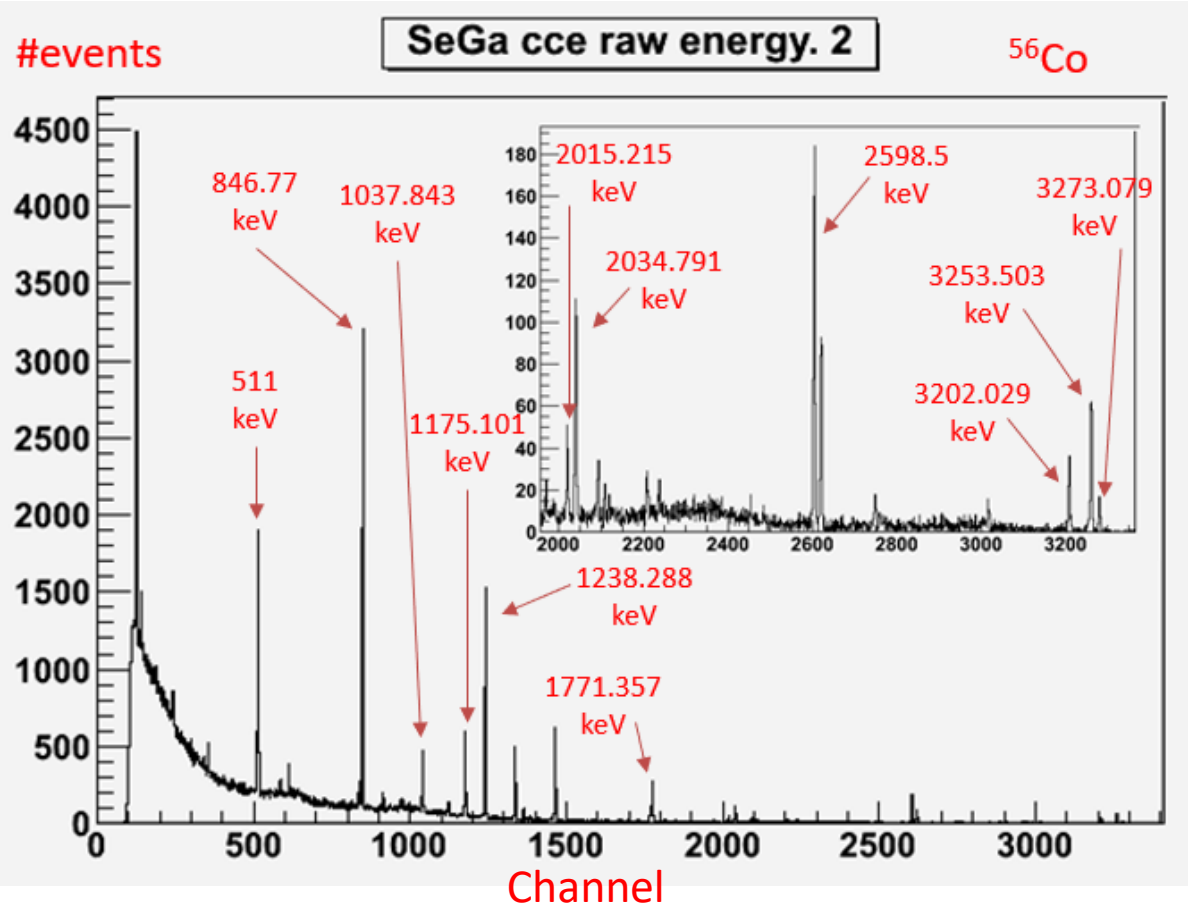


Figure 3: Gamma spectrum of ^{56}Co measured by the SeGA detector number 2.

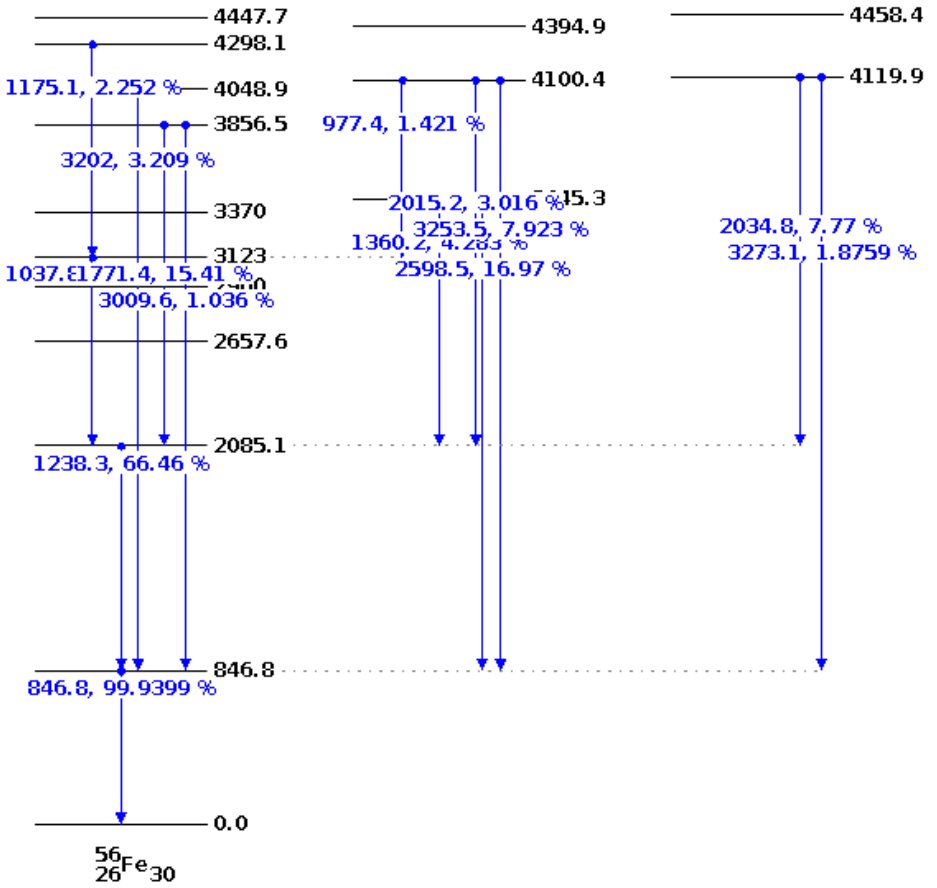


Figure 4: Gammas from the decay of the radioactive source ^{56}Co. These values were taken from NuDat 3.0.

Calibration of the SeGA detectors

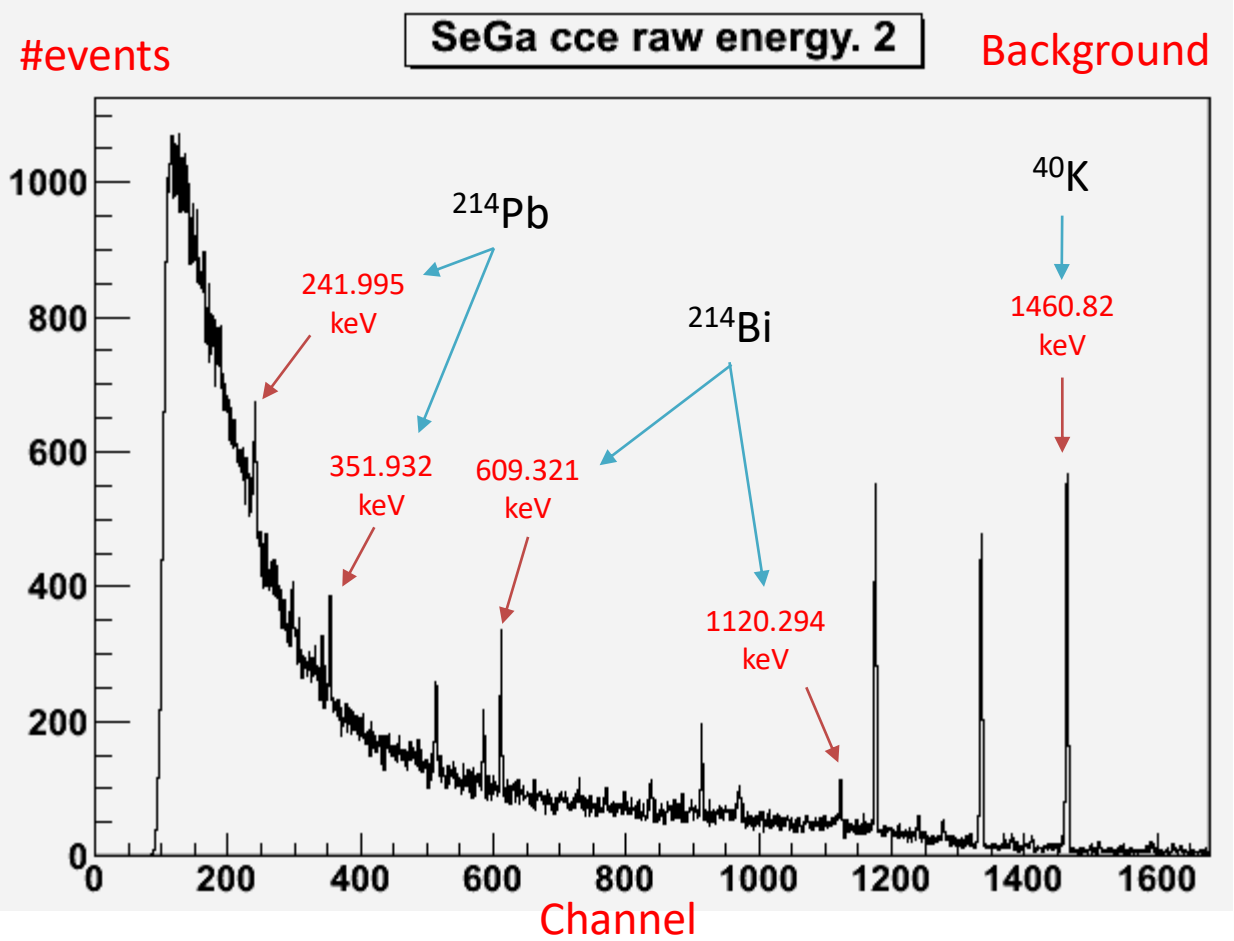


Figure 5: Background spectrum, measured by detector 2, with isotopes like ^{40}K and products from the decay chain of ^{238}U identified.

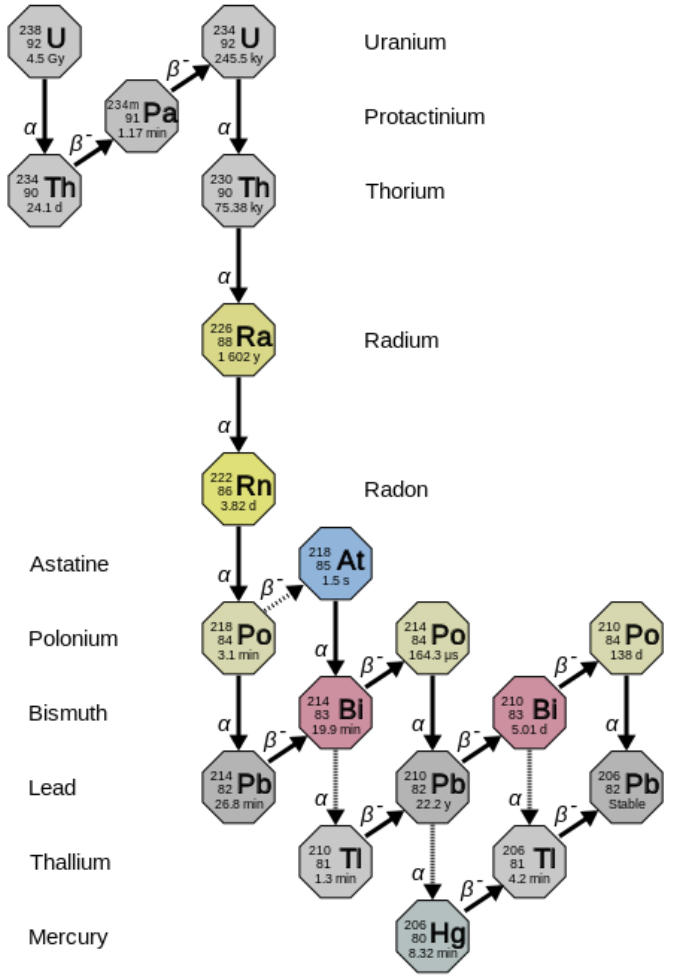
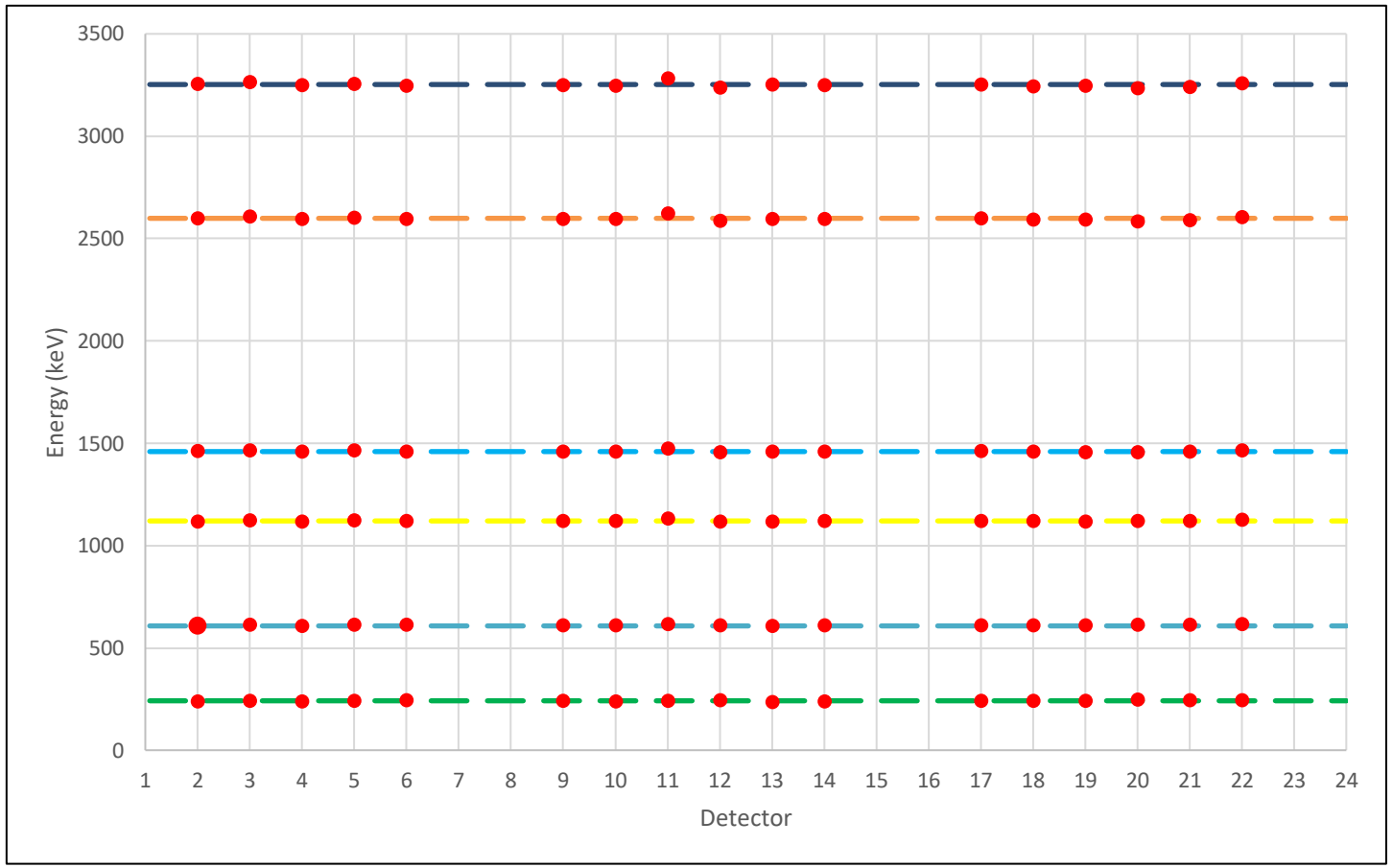


Figure 6: Decay chain of ^{238}U.

Calibration of the SeGA detectors



- ^{56}Co – 3253.503 keV
- ^{56}Co – 2598.5 keV
- ^{40}K – 1460.82 keV
- ^{214}Bi – 1120.294 keV
- ^{214}Bi– 609.321 keV
- ^{214}Pb – 244.995 keV

Figure 7: Verification of the results obtained using the calibration with only ^{56}Co. The horizontal lines represent the energy of the isotopes identified earlier and the dots are the energy obtained after applying the calibration.

The future

- Use the calibration in a reacted setting to obtain the energy of the gammas emitted by the excited nuclei;
- Reconstruct the trajectory of the gammas;
- Calculate the angle of emission;
- Determine the doppler effect;

Thank you for your attention