

Calibration of the TimePix3 detector for Radiation to Electronics (R2E) using the FLUKA Monte Carlo code

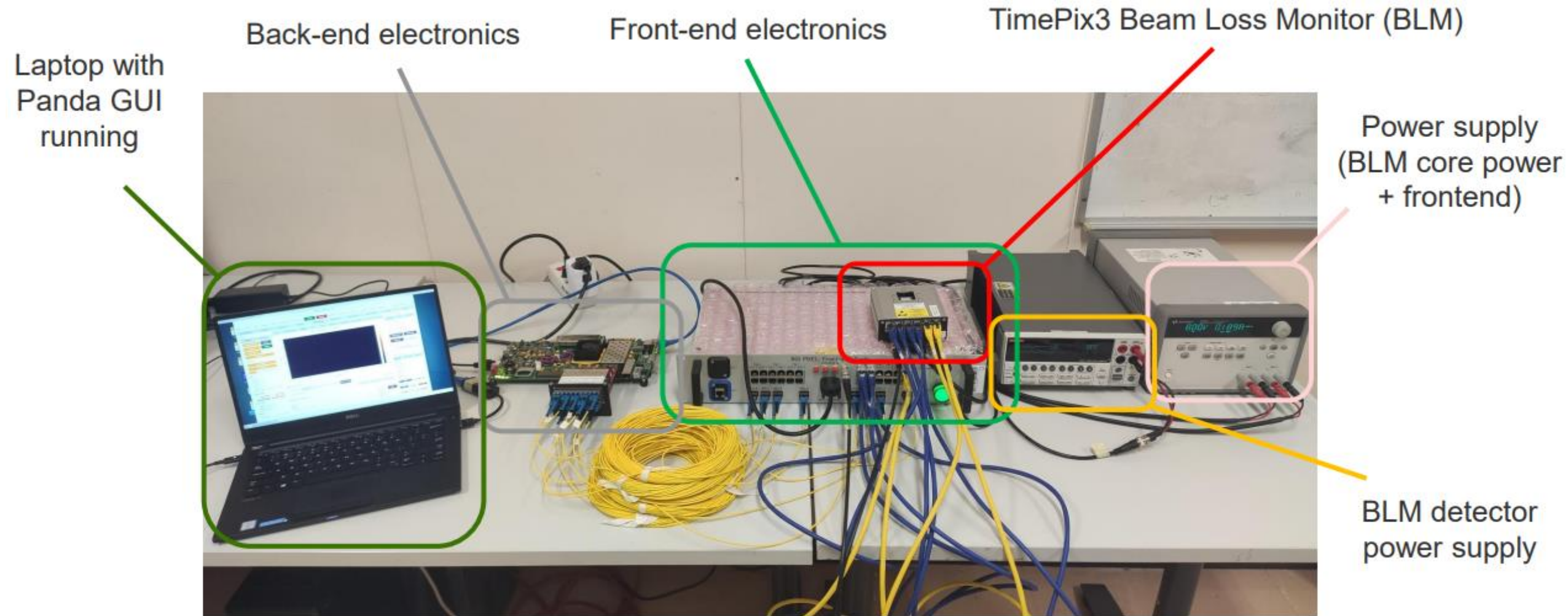
Andrei-Valentin Ştirbu & Victor-Ştefan Fortiş

Supervised by Daniel Prelipcean

Romanian High-School Students Internship Programme 2021 - Friday, 19th November
<https://indico.cern.ch/event/856138/>



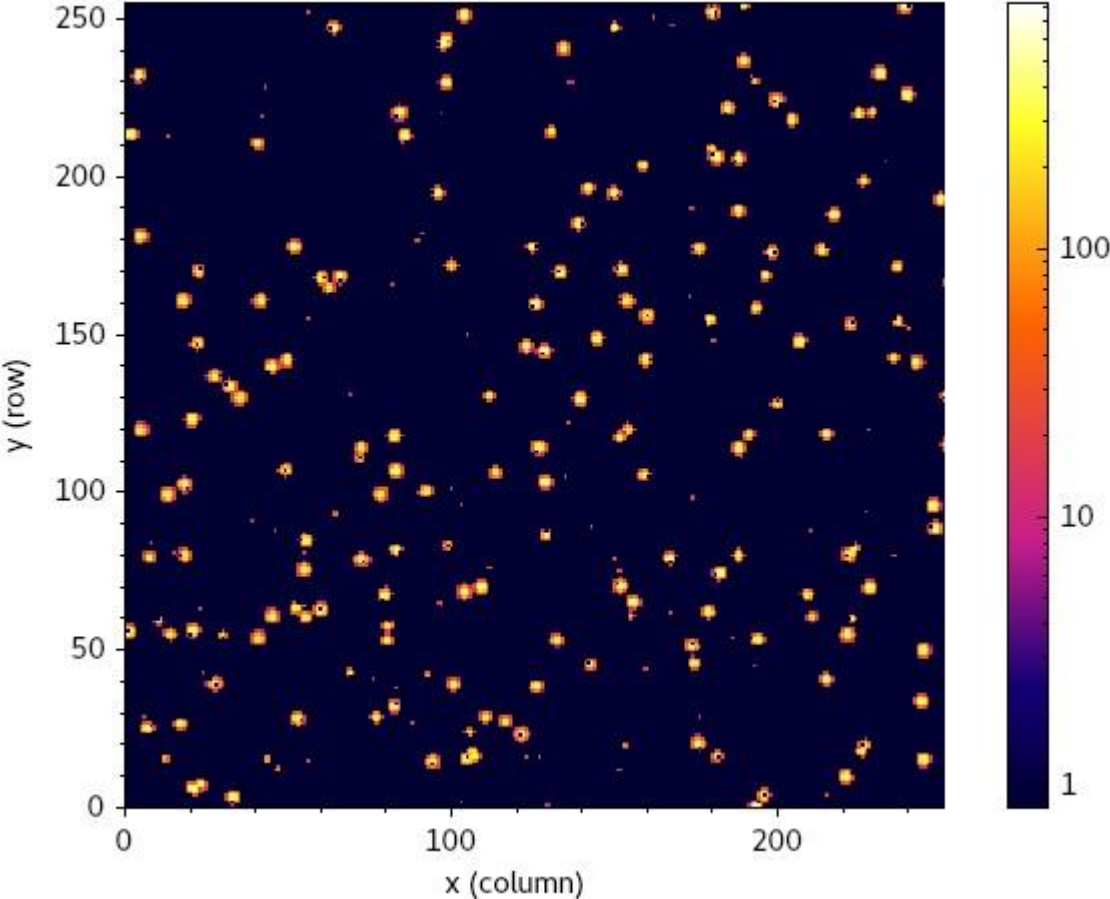
TimePix3 Detector Setup in R2E



Credits to the R2E team, Ivan Slipukhin and David Lucsanyi

Measured pixels

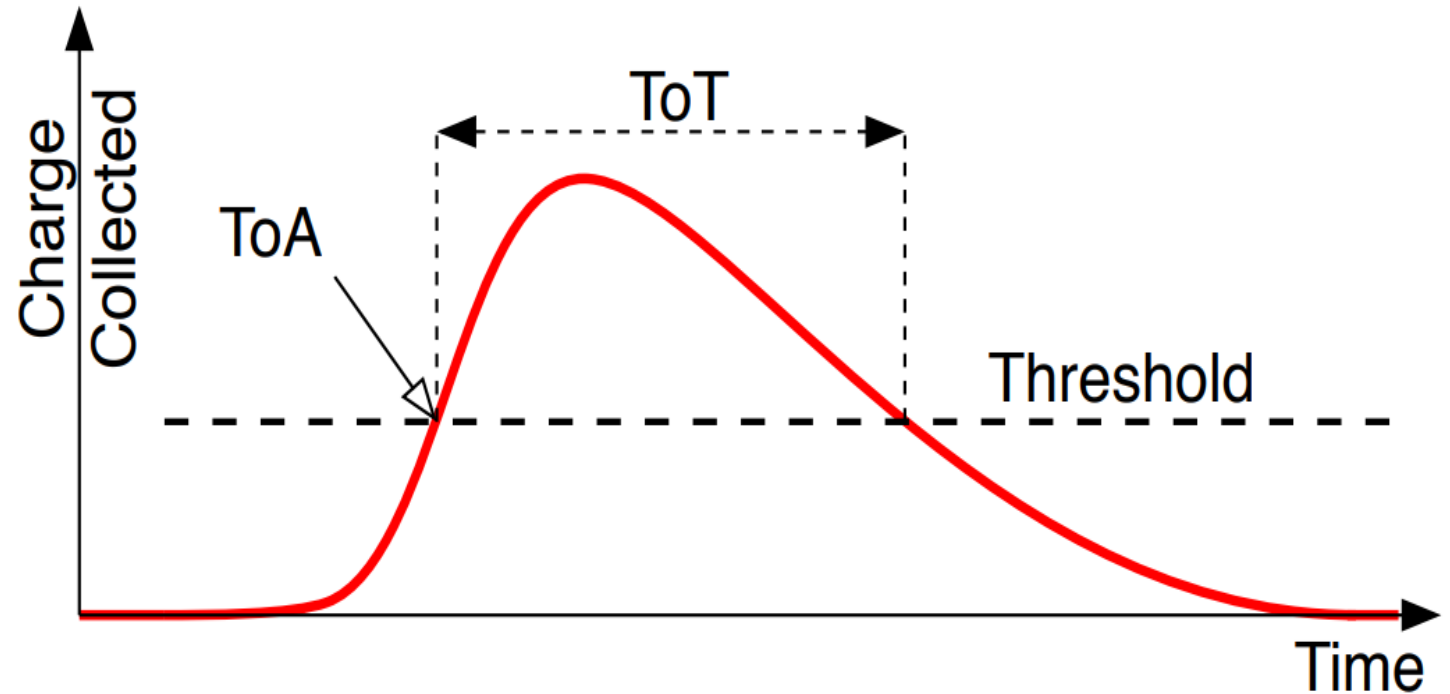
Integrated ToT - Last Aquisition UTC Time: 2021-02-19 15:59:27.380368



Time over Threshold (ToT)

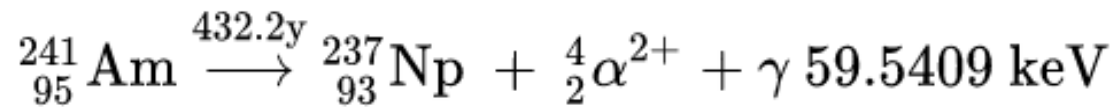
Represents the time spent by a particle at a voltage level above a set threshold.

In this situation, the threshold is set in such manner that most of the background noise is removed.

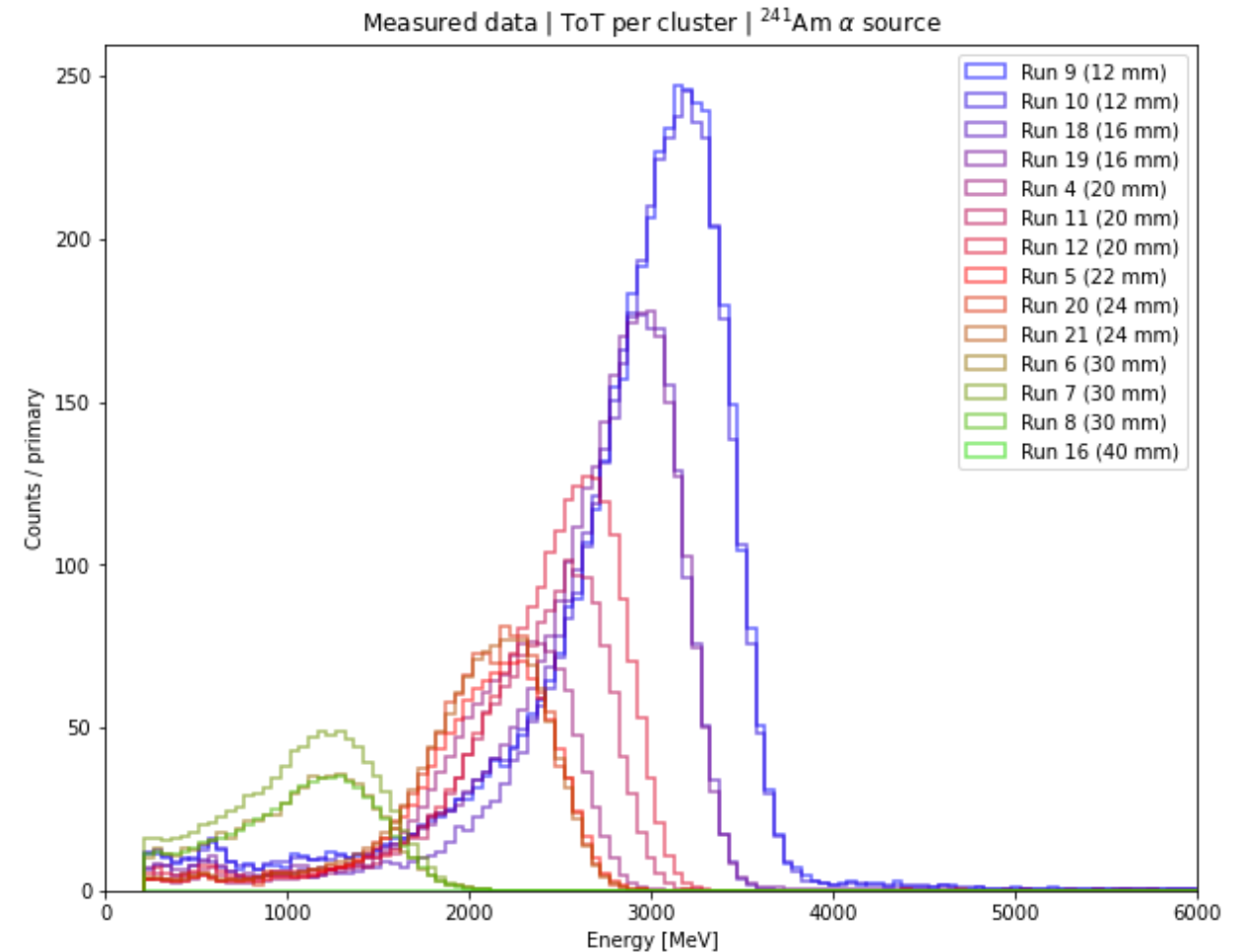


Measured Data

- We used Americium 241 for this experiment.



- The α -decay energies are 5.486 MeV 85% of the time
- By identifying the maximum in each run, we obtain data required to fit a gaussian distribution to a run.



Gaussian Distribution

$$f(x) = a \cdot \exp\left(-\frac{(x - b)^2}{2c^2}\right)$$

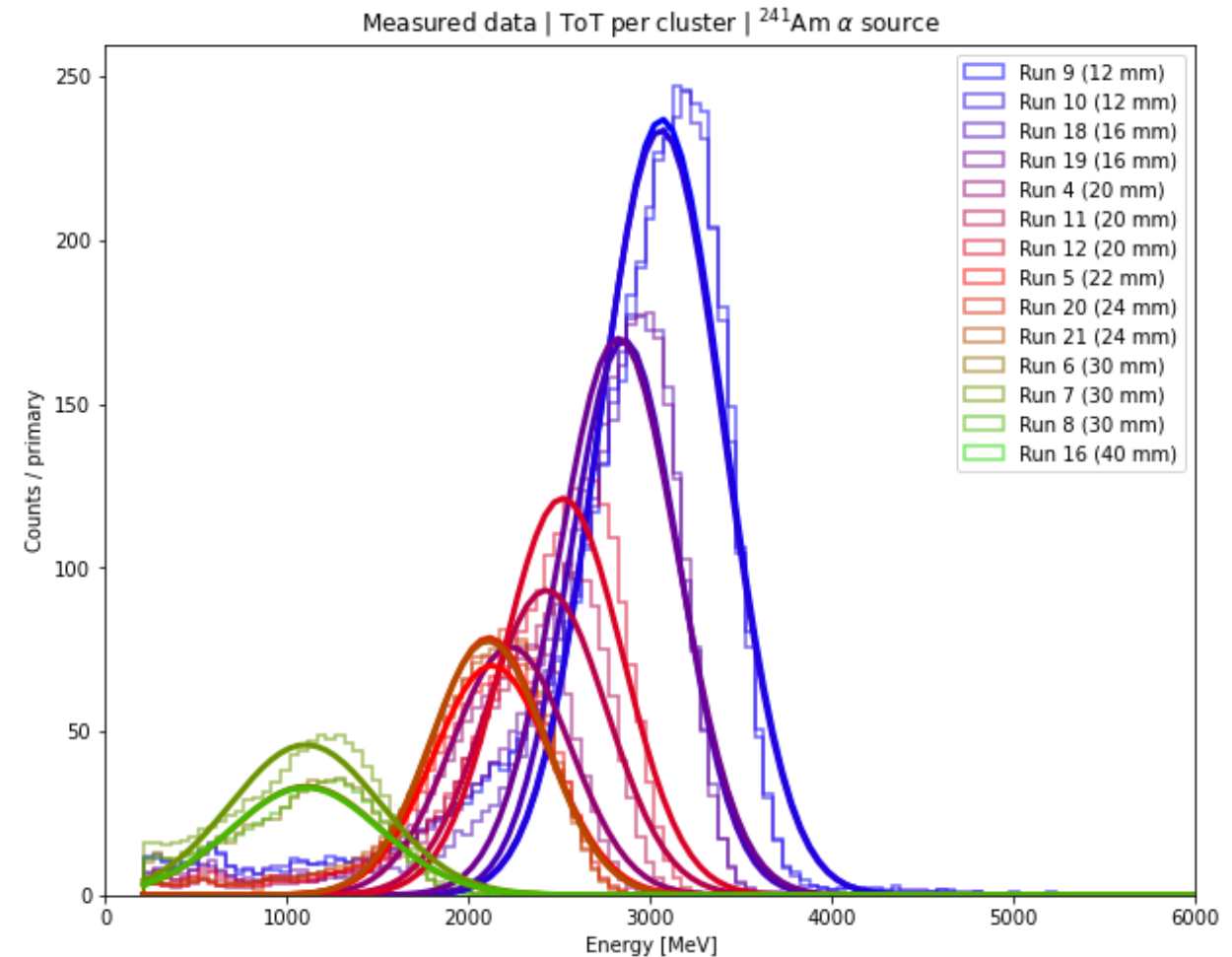
The graph of the Normal Distribution is a characteristic symmetrical “bell curve” shape, defined by:

a: height

b: distance from origin

c: the standard deviation, describing the width of the gaussian

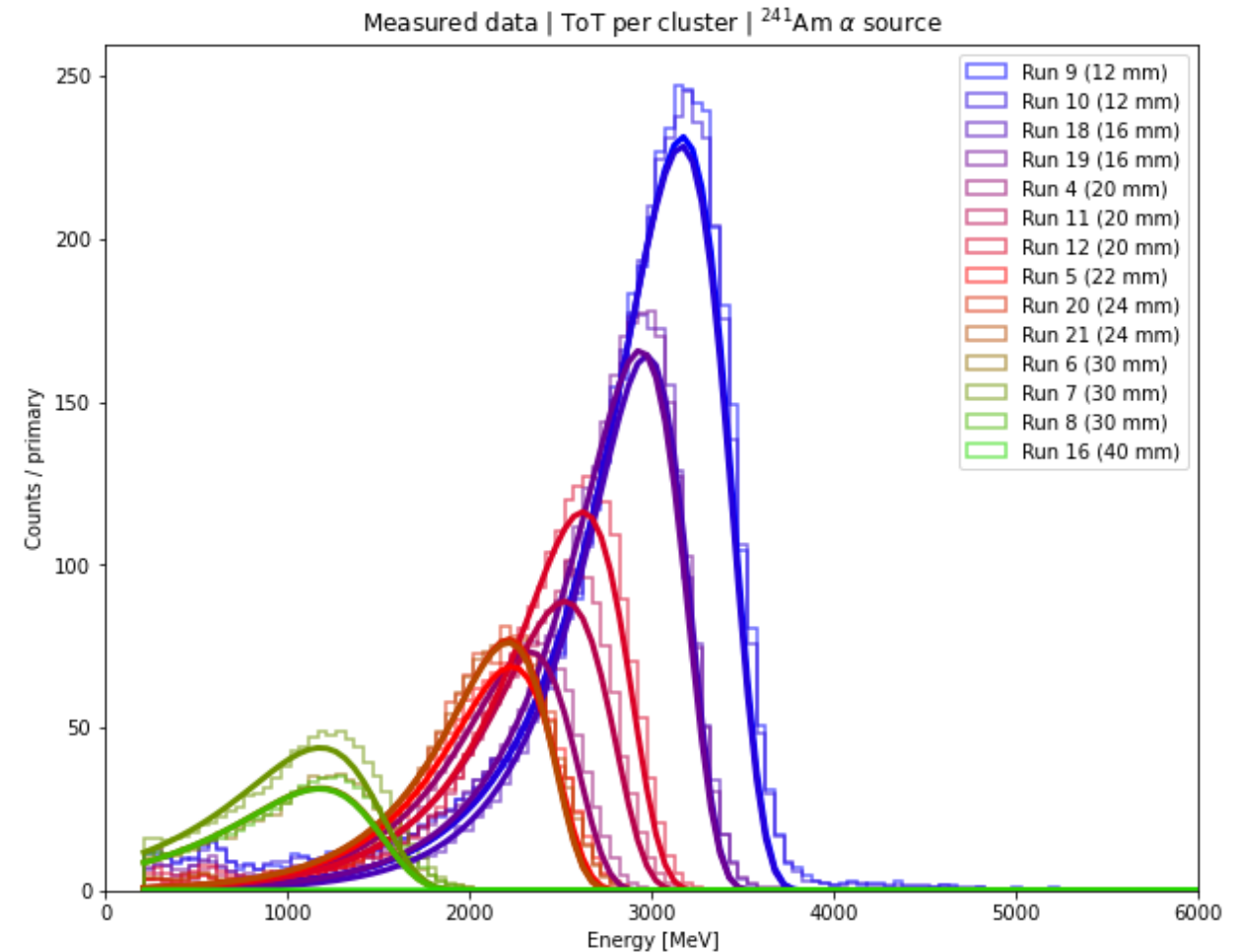
Width is shared with the more physically accurate Landau distribution.



Landau Distribution

We fit a Landau distribution to the measured data in order to accurately determine energy losses of charged particles.

We use the mean energy and standard deviation of the gaussian fit as first guess for the Landau fit.



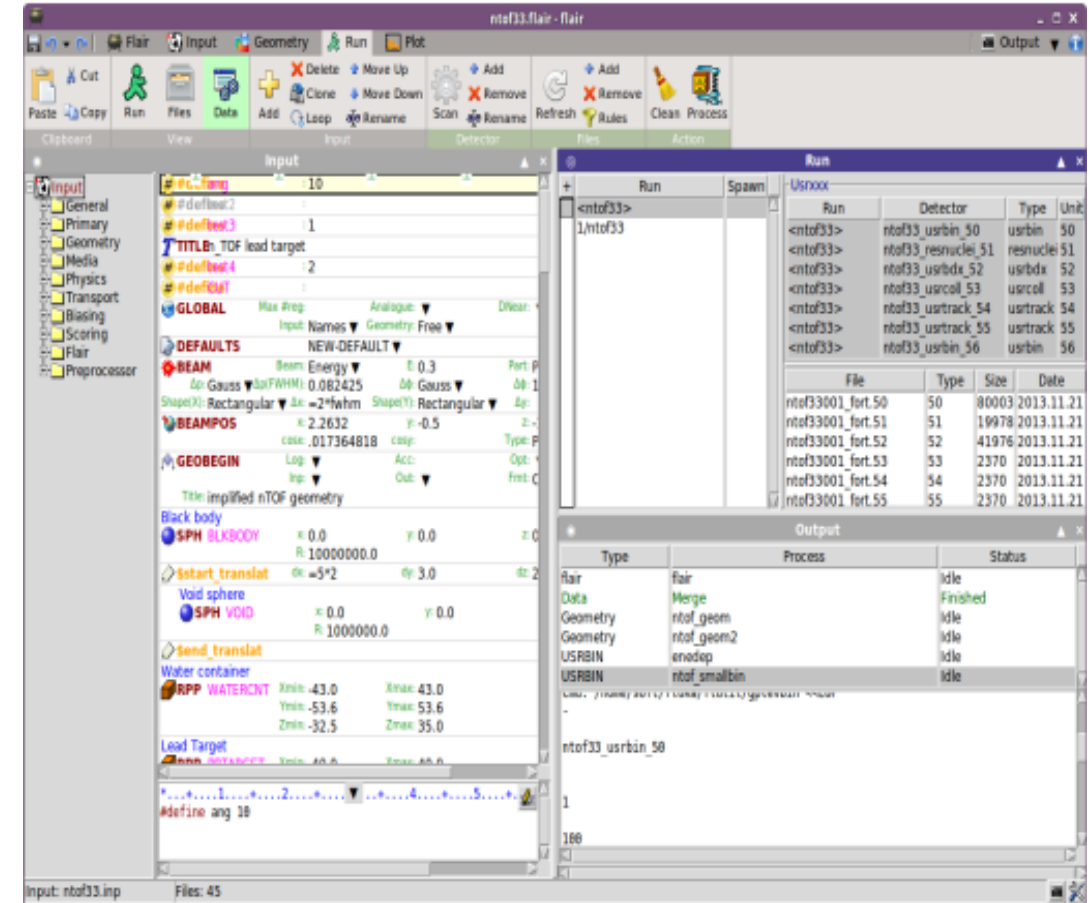
FLUKA and Flair

Stands for **FLU**ktuierende **K**askade.

Is a fully integrated Monte Carlo simulation package for the interaction and transport of particles and nuclei in matter.

Has applications in high energy experimental physics and engineering, shielding, detector and telescope design, cosmic ray studies, dosimetry, medical physics and radiobiology.

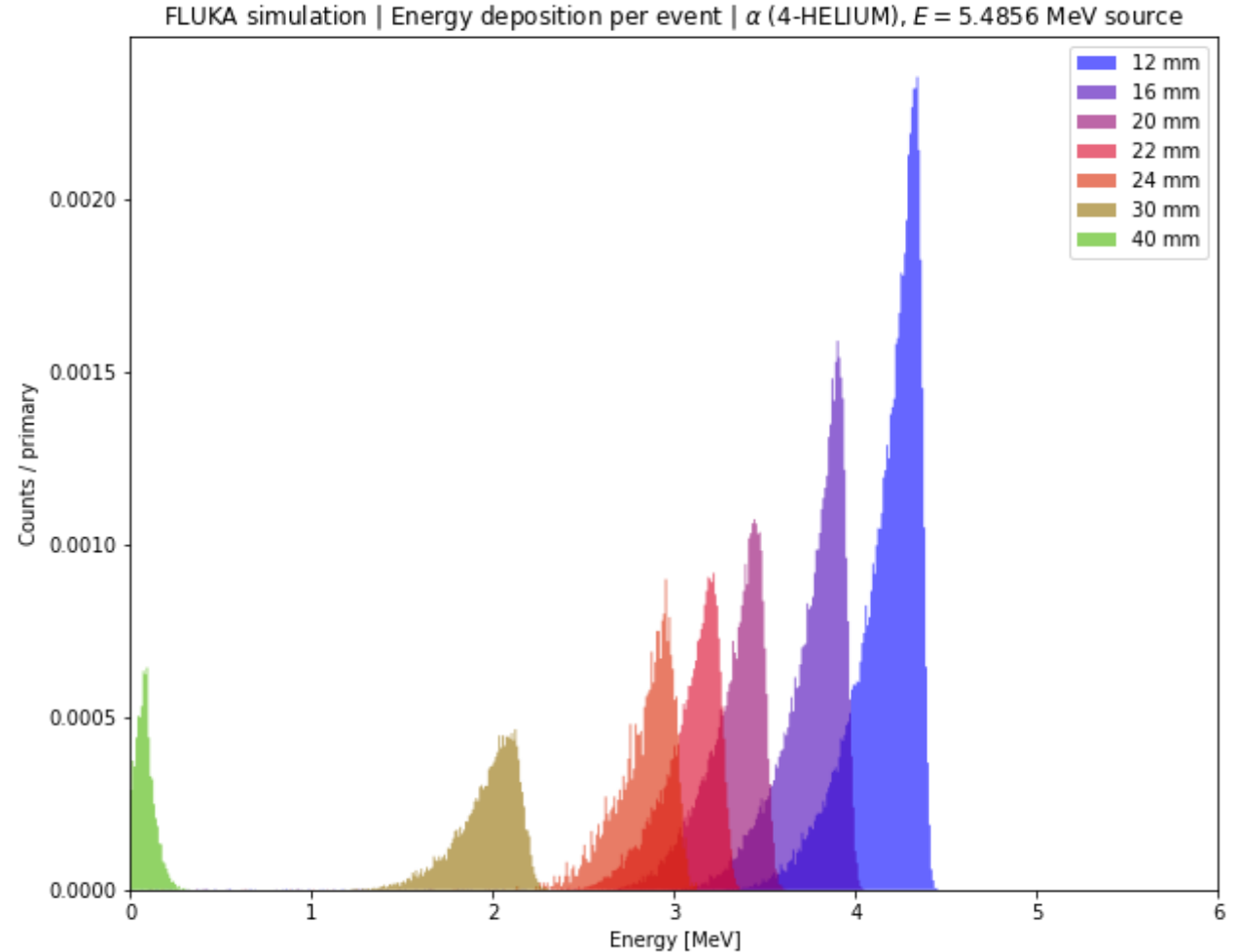
FLUKA Advanced InteRface is an user interface utilized by FLUKA.



Website: fluka.cern

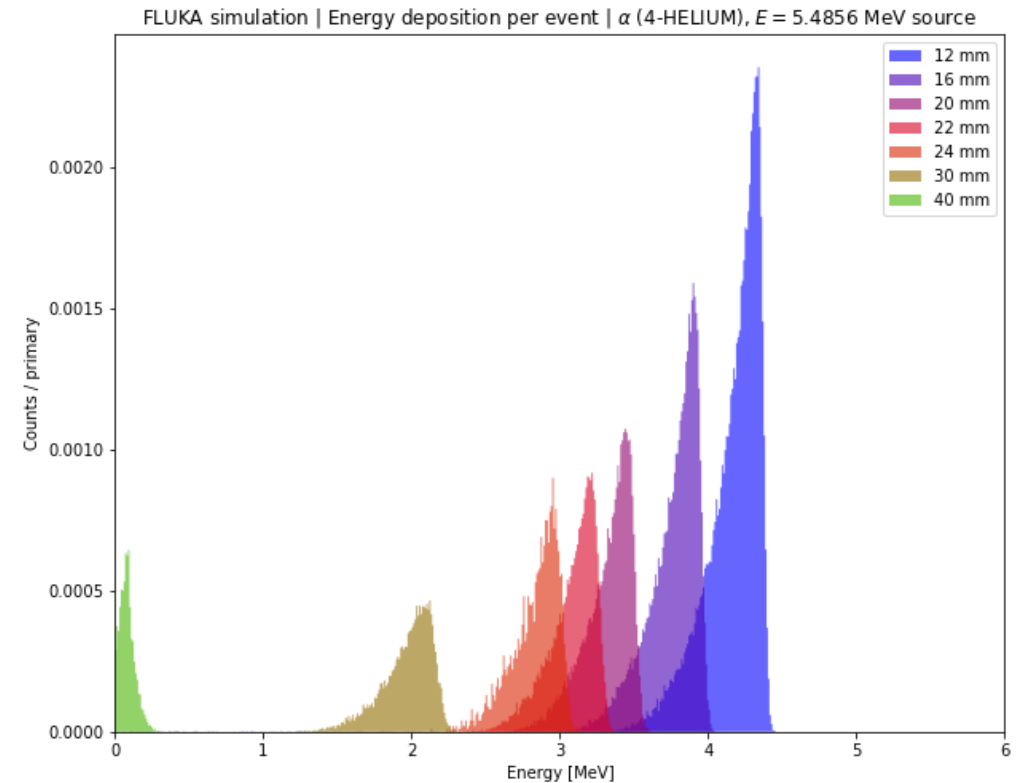
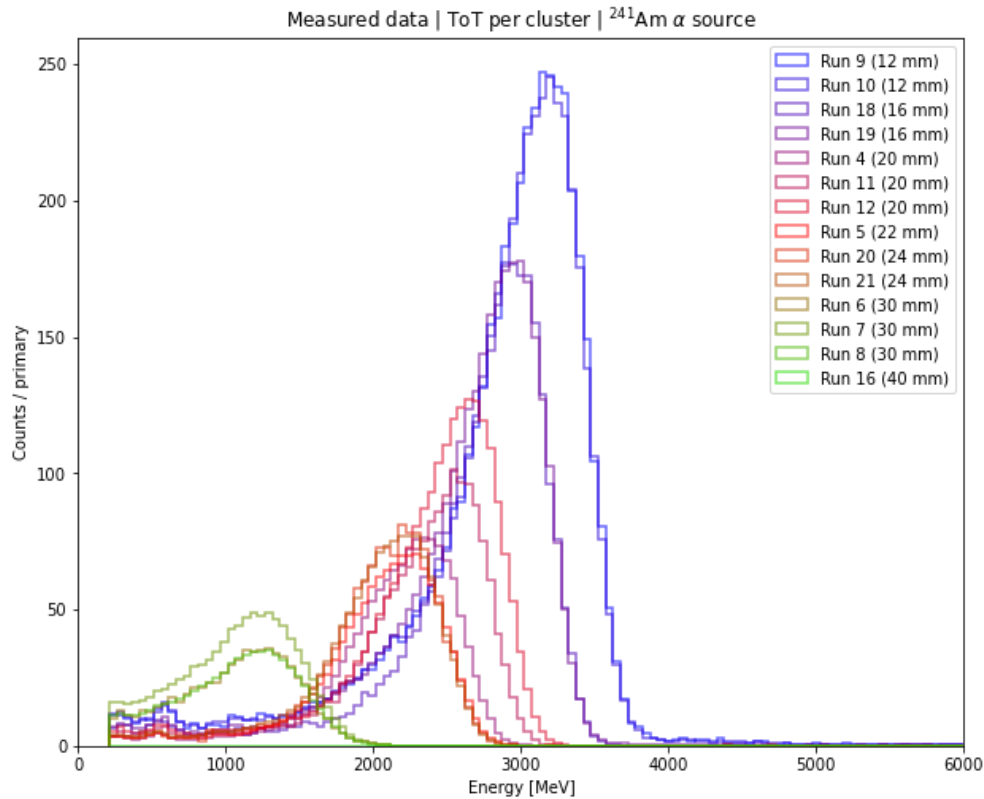
Monte Carlo Simulations

The Monte Carlo Simulation is a mathematical technique that generates random variables in order to predict the probability of different outcomes.



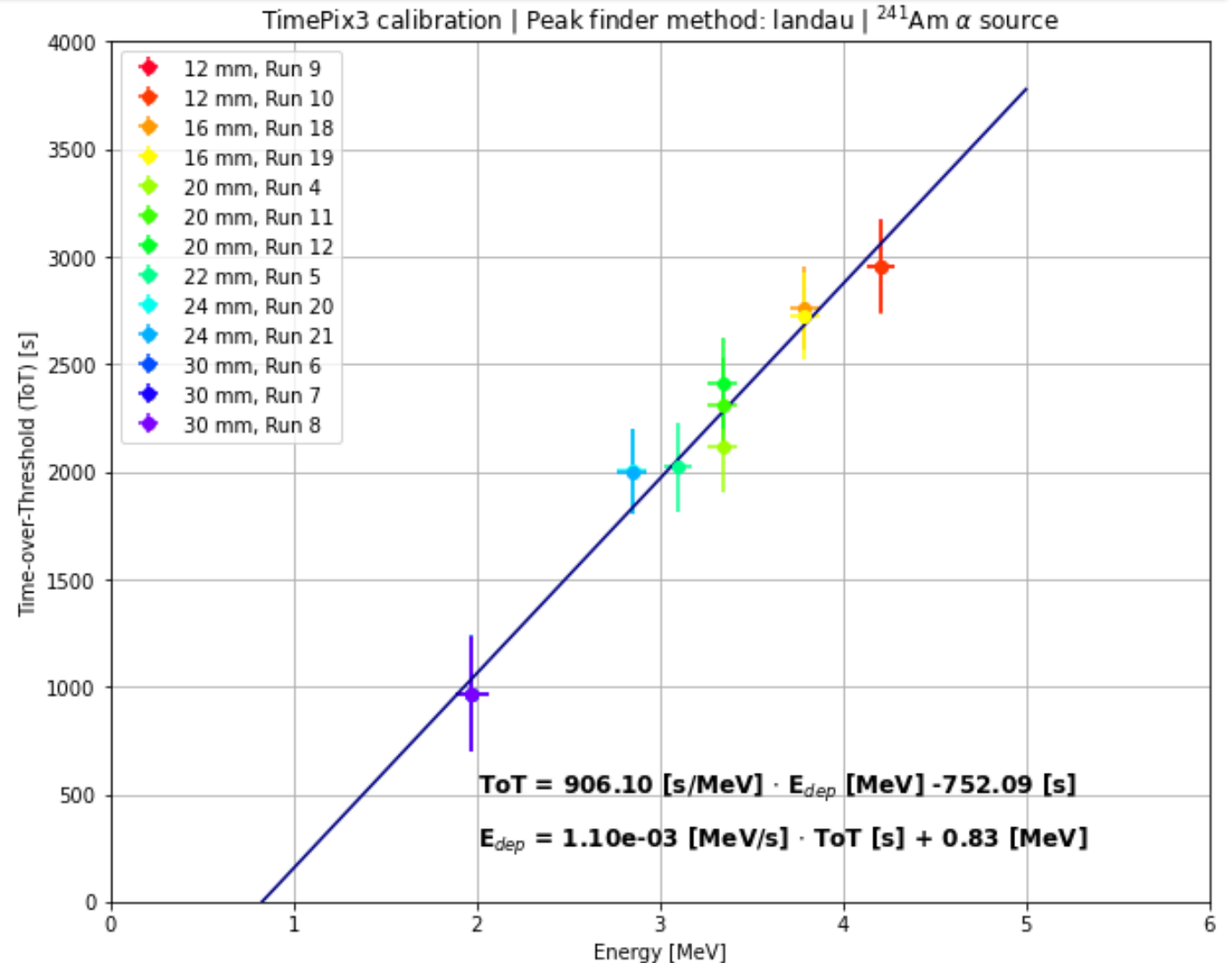
Measured Data vs Simulated Data

We extract the location of the peaks according to the Landau distribution fit, for both the measured and simulated data.



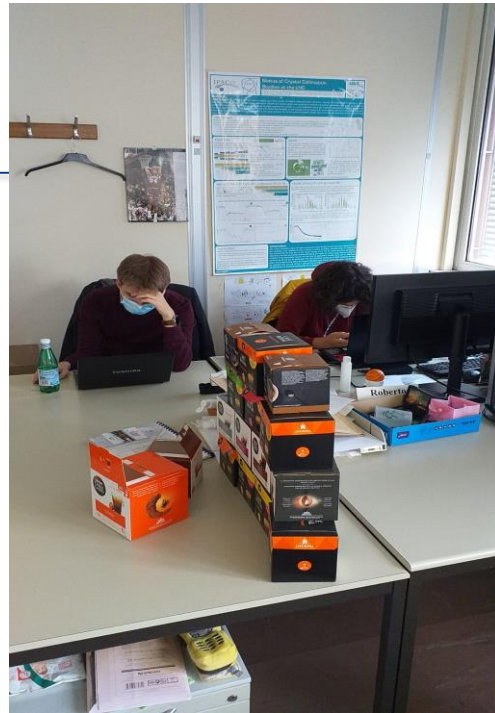
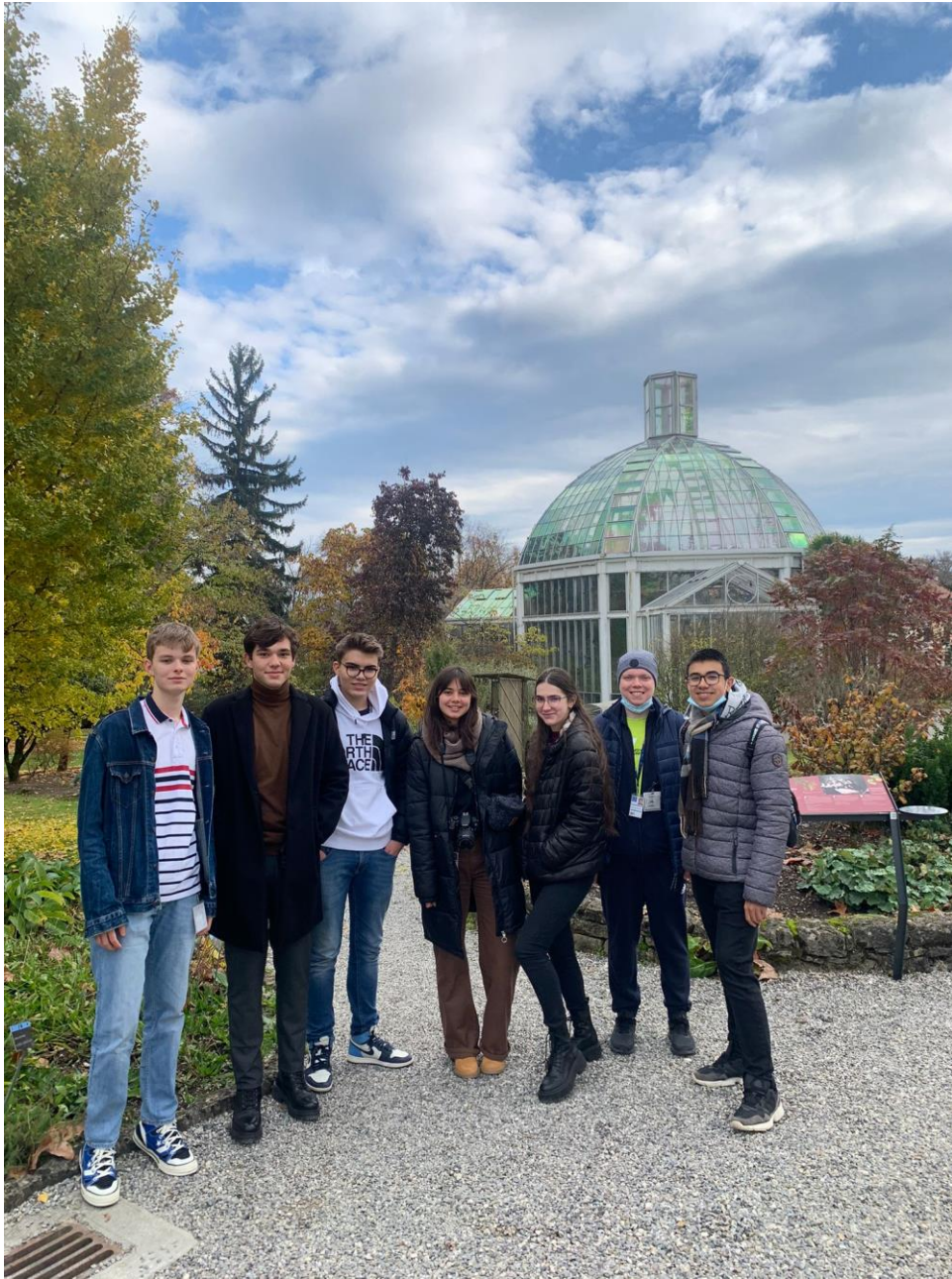
Main Results

Plotting the experimental Time over Threshold (ToT) against the simulated Energy, we can extract a linear calibration fit which will be used to convert from ToT to Energy for future experiments.



Conclusions

- About the project: We successfully used FLUKA to calibrate the TimePix3 detector in Radiation to Electronics(R2E) to convert Time over Threshold (ToT) into Energy.
- About our experience: through this project we got a good view into the day-to day life of an employee here at CERN. We learned more about the accelerators, got to see the evolution of detectors and technology over time and overall we had a fun time visiting Geneva.





Thank you for your attention!

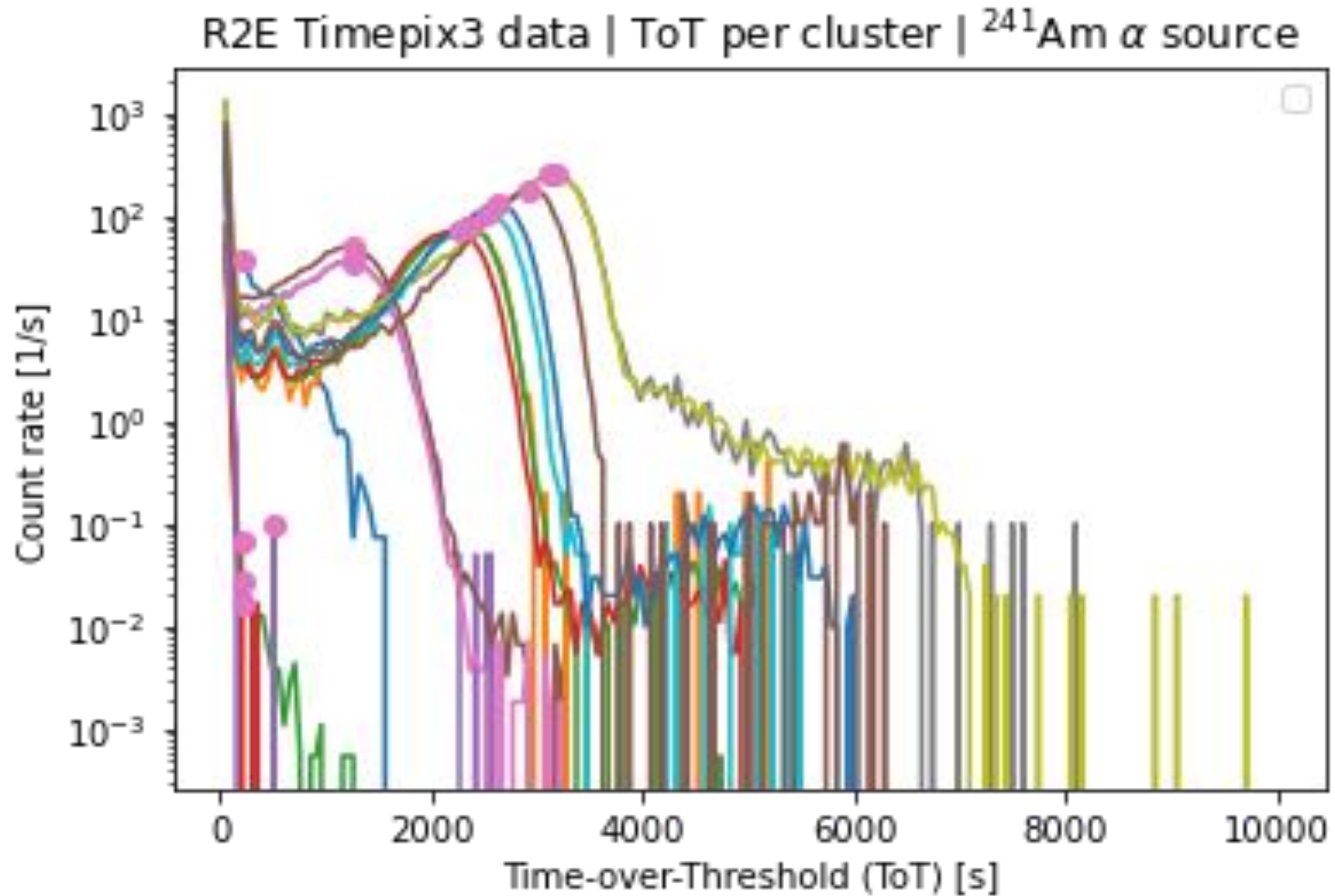
Questions?

andrei-valentin.stirbu@cern.ch

victor-stefan.fortis@cern.ch



Logarithmic Representation of the Measured Data



Thought it looks neat