LYCCA-0 simulations

EGAN Ancillary simulations working group meeting

Daniel Bloor & the AGATA collaboration

The University of York

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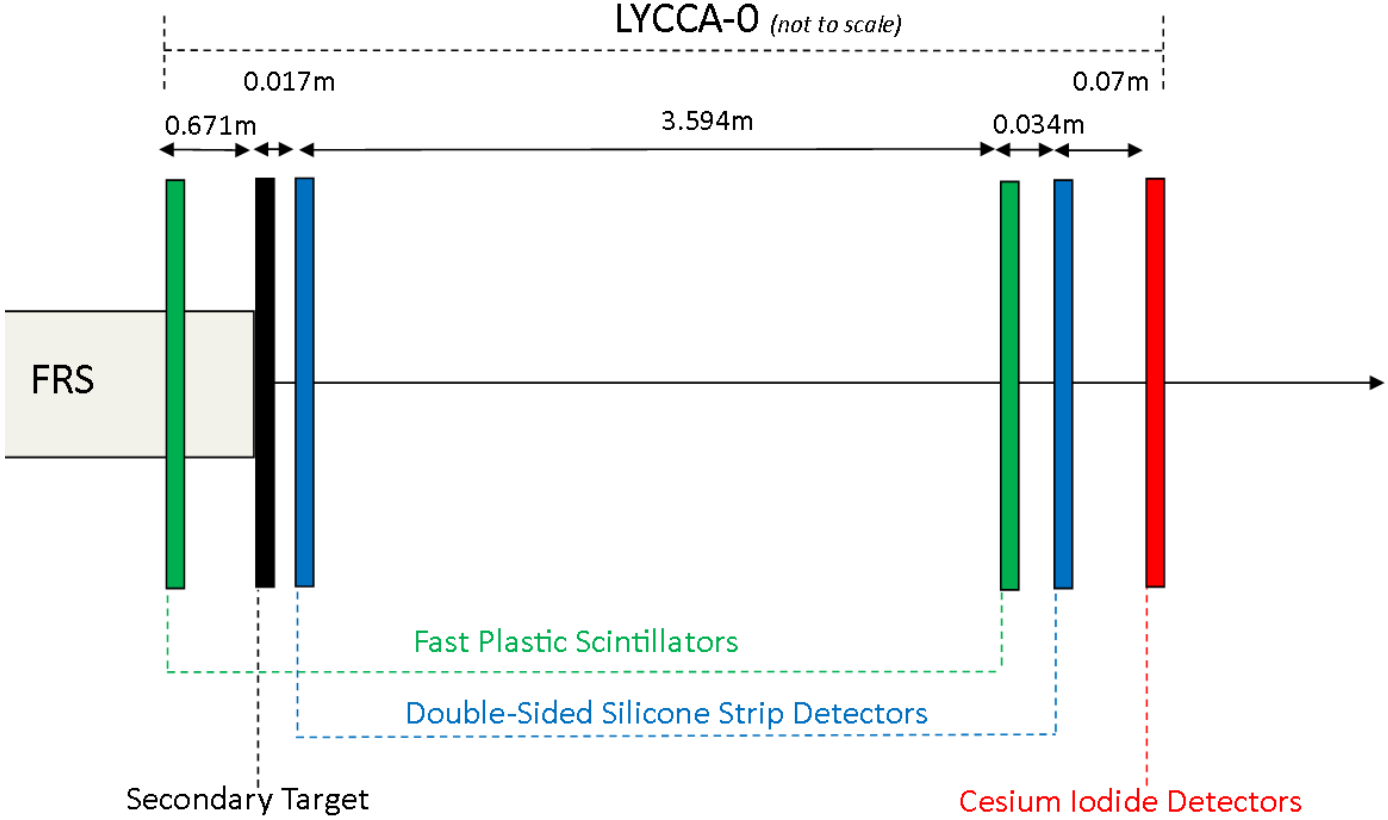
Science & Technology Facilities Council

Outline

- LYCCA used to track and identify exotic nuclei by their mass, A, and charge, Z
- Precisely measure the recoil direction and velocity event by event which are then used to correct for Doppler effects
- Show the effect that tracking using LYCCA has on the γ-spectra

LYCCA Overview



Existing LYCCA Simulations

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A new simulation package to model detector systems with fragmentation reactions and ion separators: Application to the LYCCA-0 system

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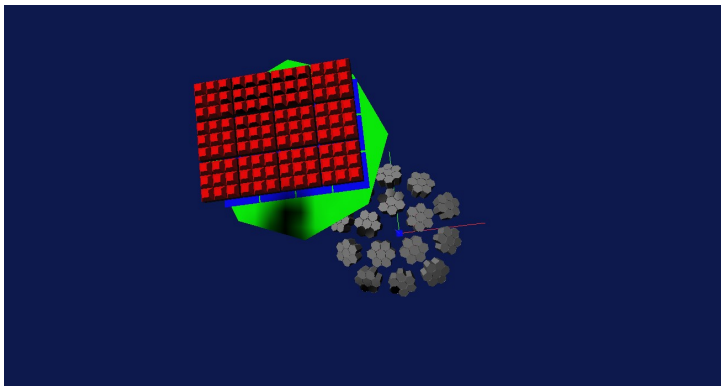
ABSTRACT

A Monte-Carlo simulation package has been developed to model the response of a detector system for ion identification used in conjunction with ion separators following nuclear reactions. The simulation is written predominantly using the GEANT4 framework but utilises the ion transport code MOCADI for accurate separator and reaction modelling. A novel MOCADI–GEANT4 interface has been developed to utilise the parameter file output option of MOCADI as an event generator for the GEANT4 detector simulation. Test simulation results have been compared with experimental data and excellent agreement was observed. The simulation has successfully been used to model a new particle detection system prototype (Lund-York-Cologne CAlorimeter (LYCCA)-0) and validate a method of ion identification using energy and time-of-flight with this system.

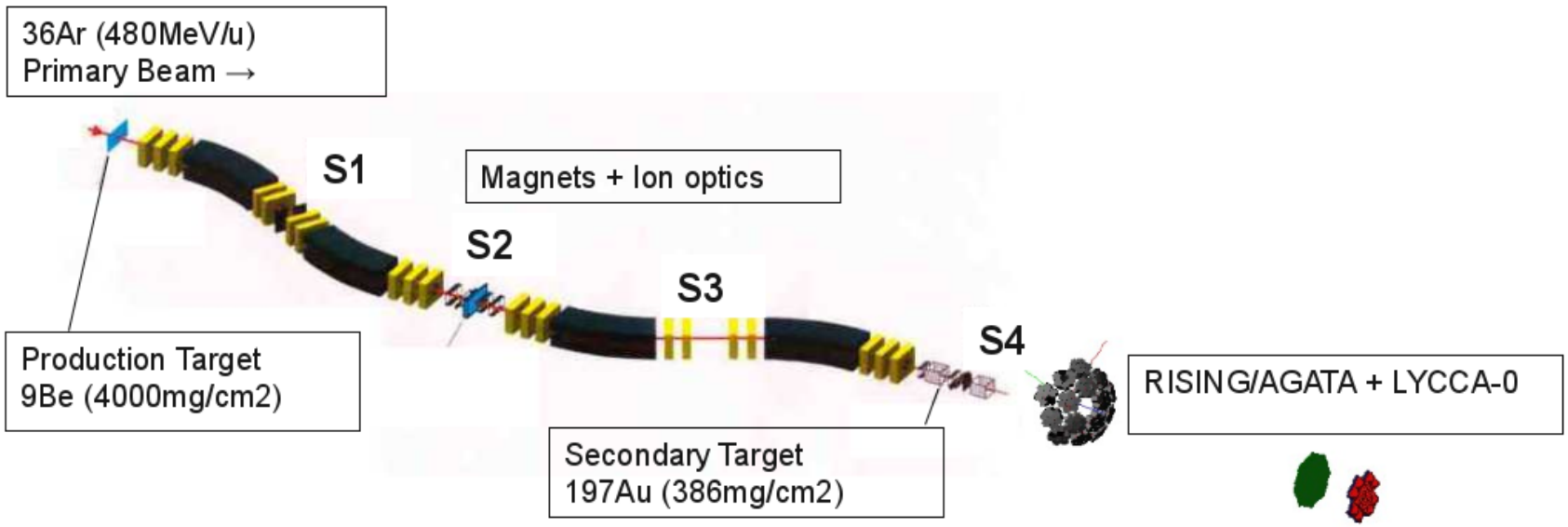
AGATA code

- Geant4 application used to test the response of AGATA + ancillary detectors to an internal or external events file
- LYCCA geometry imported into AGATA code from Mike Taylor's LYCCA simulation package
- MOCADI used to simulate outgoing fragments

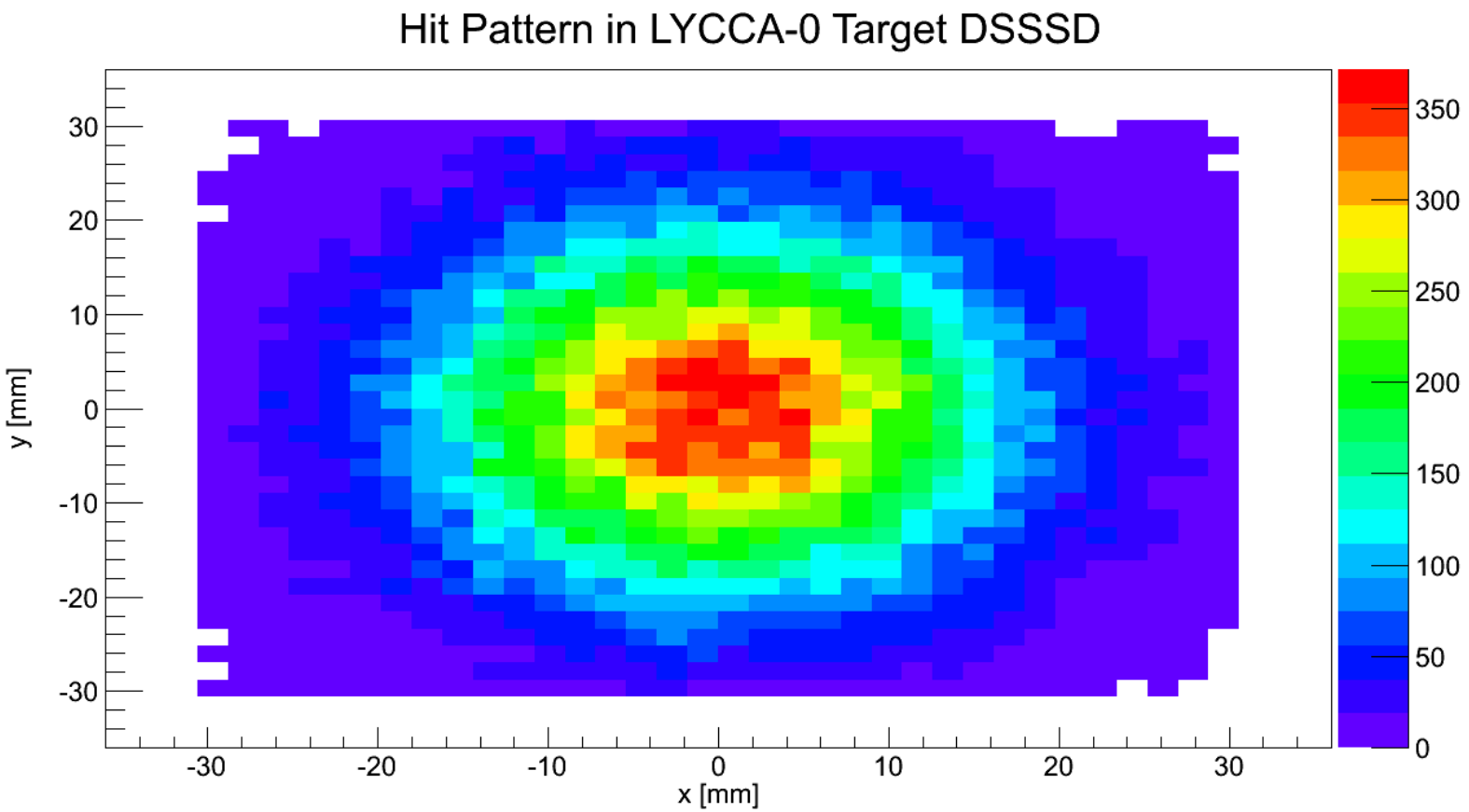


Experimental Details

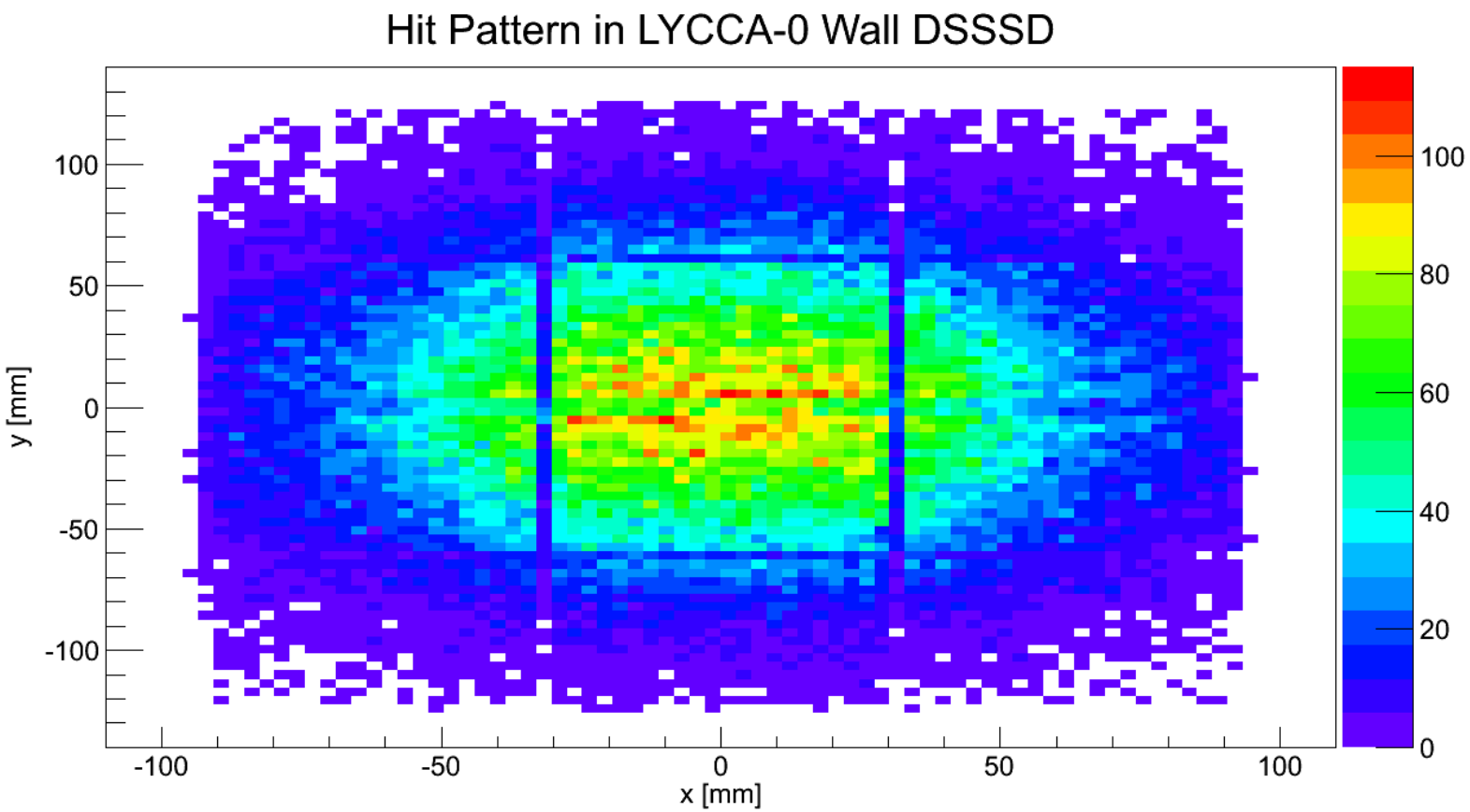
- Relativistic Coulomb excitation of ^{33}Ar



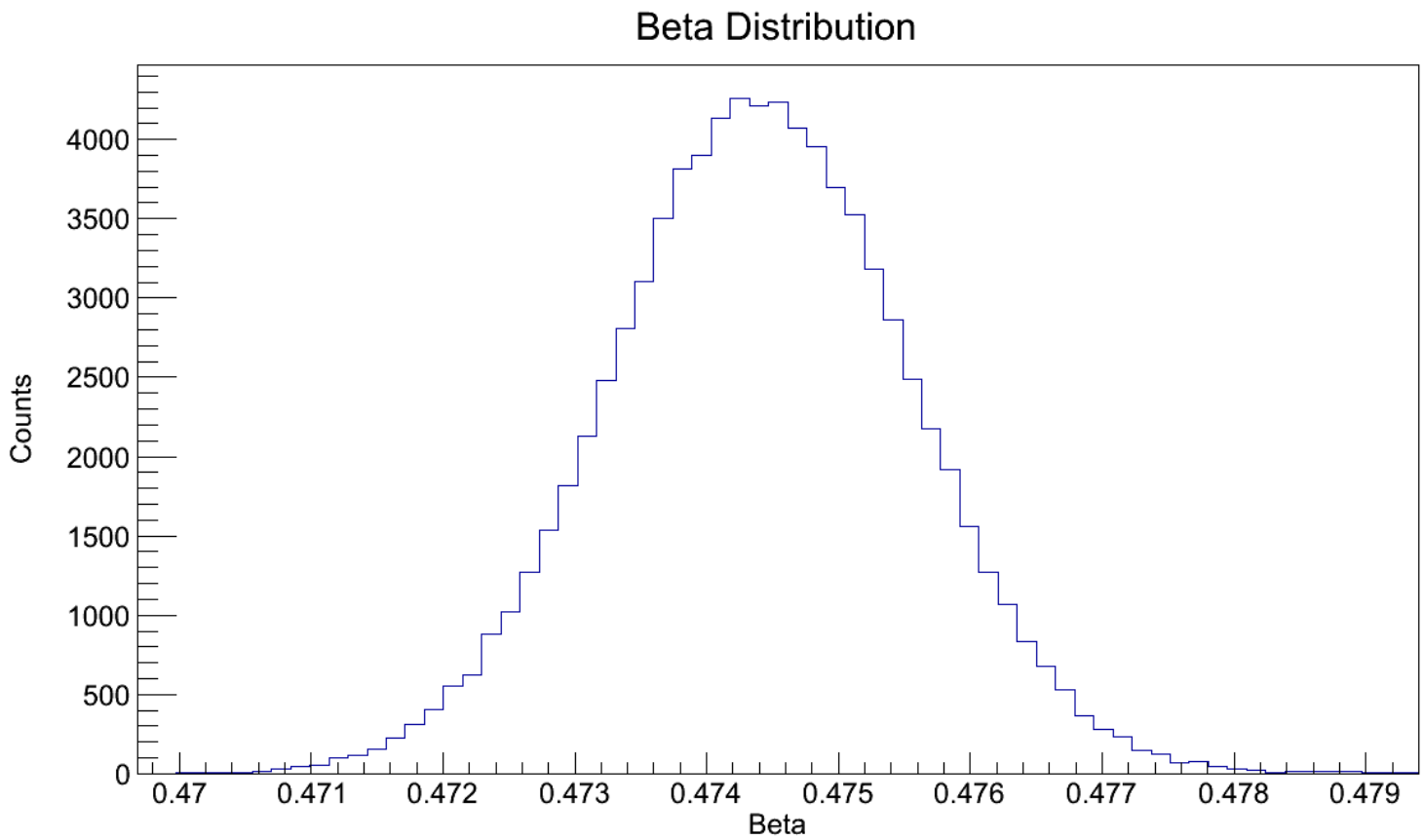
LYCCA-0 Target DSSSD



LYCCA-0 Wall DSSSD



Beta


Beta Distribution
Counts
4000
3500
3000
2500
2000
1500
1000
500
0
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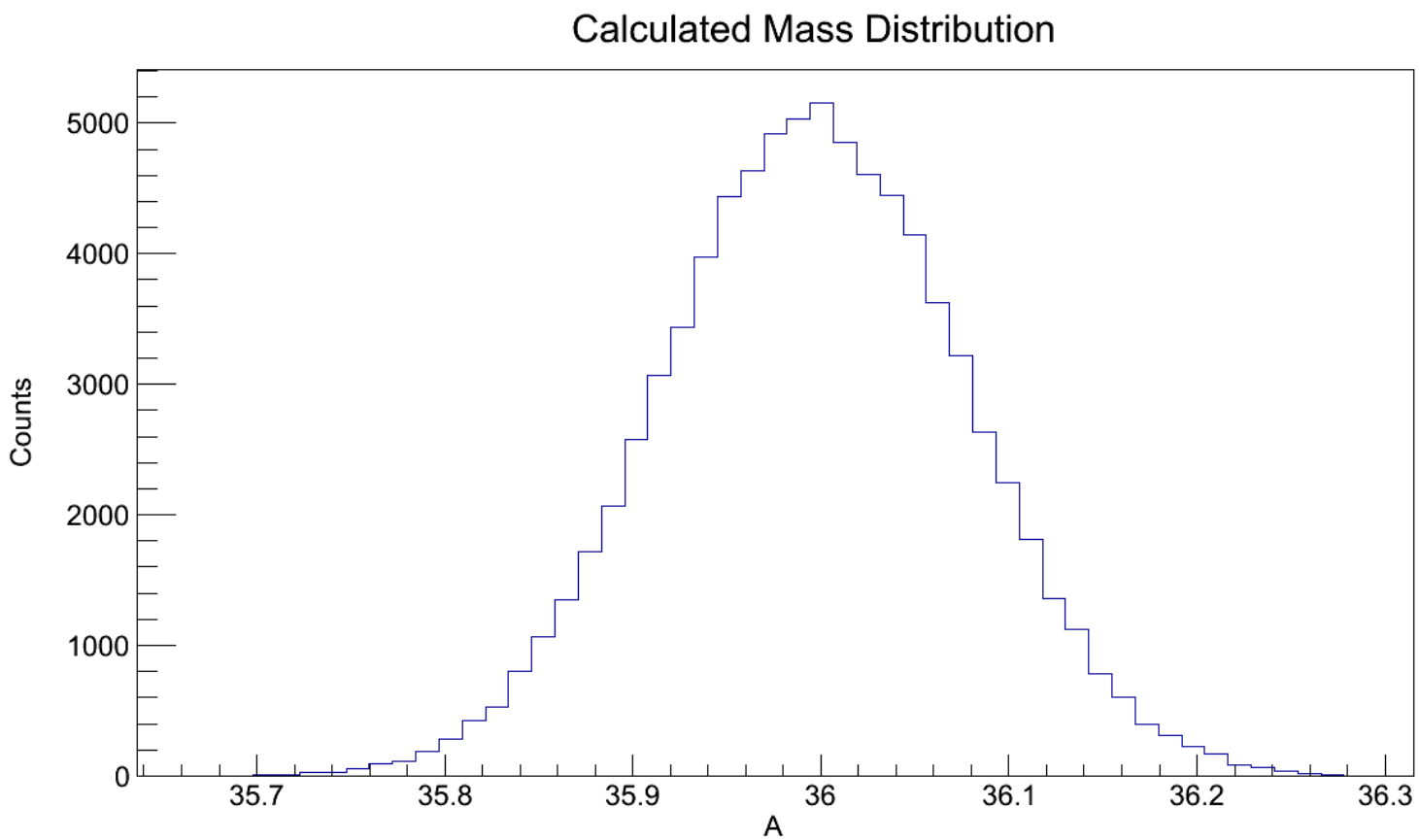
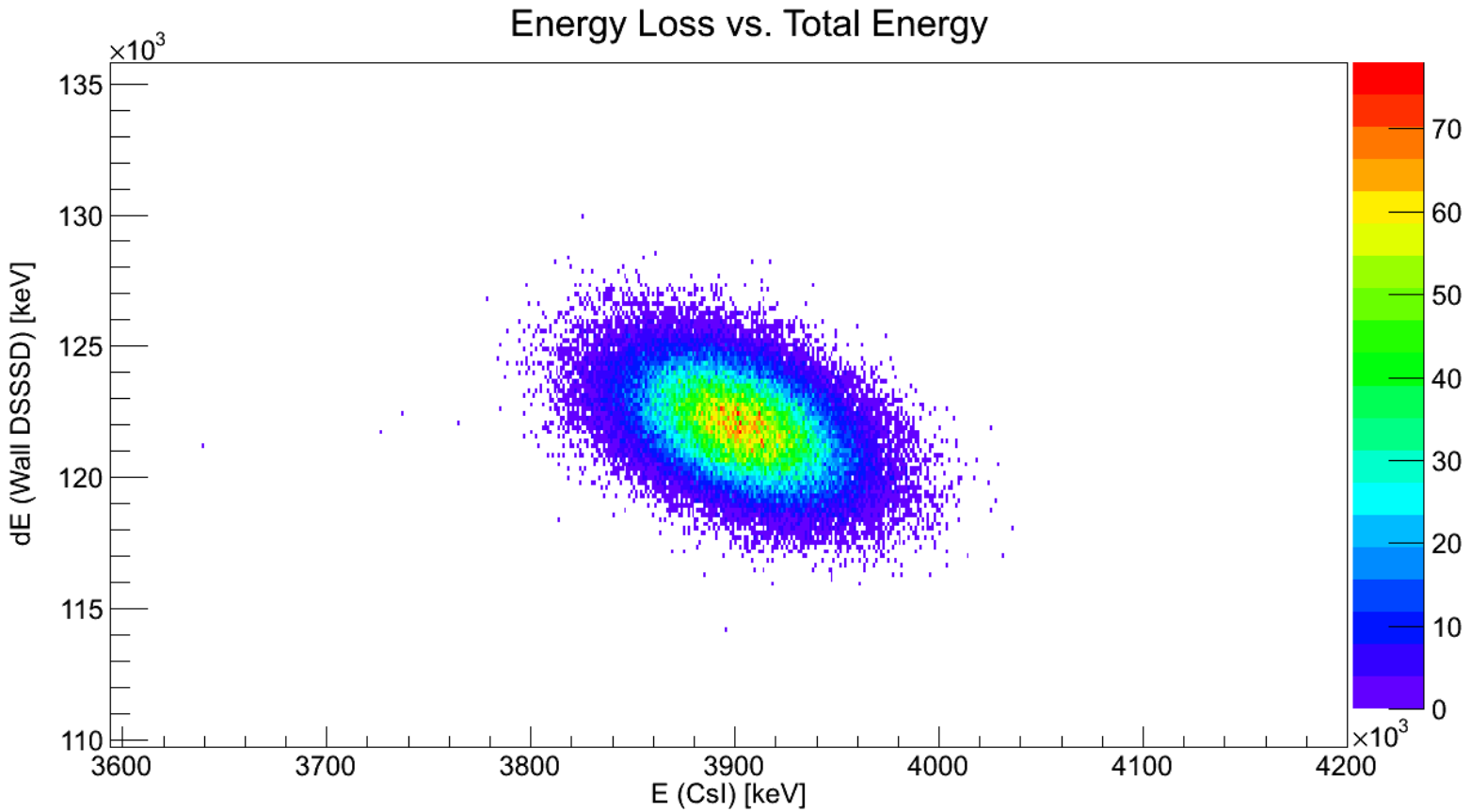
0.471
0.472
0.473
0.474
0.475
0.476
0.477
0.478
0.479
Beta

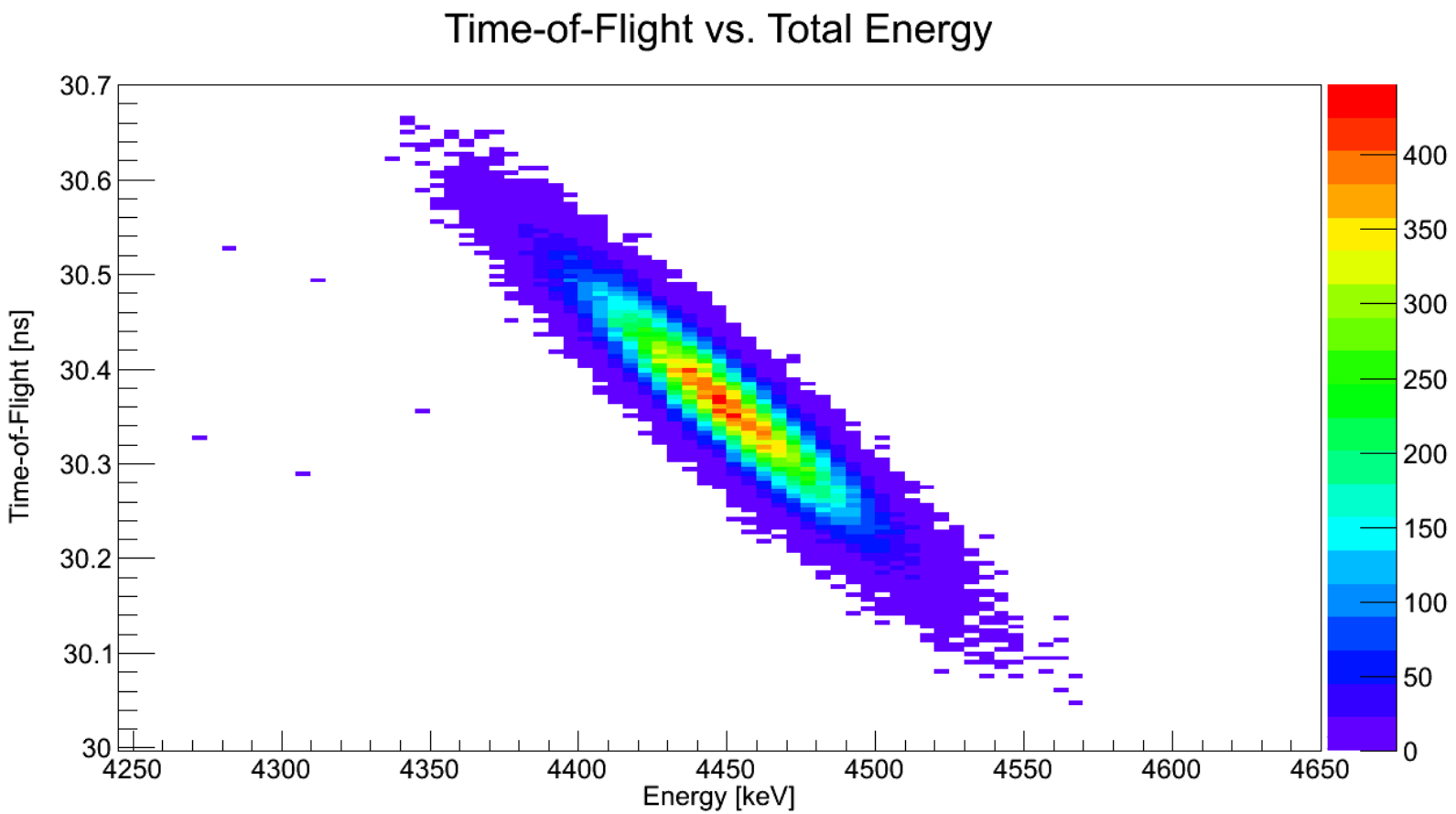
Calculated Mass



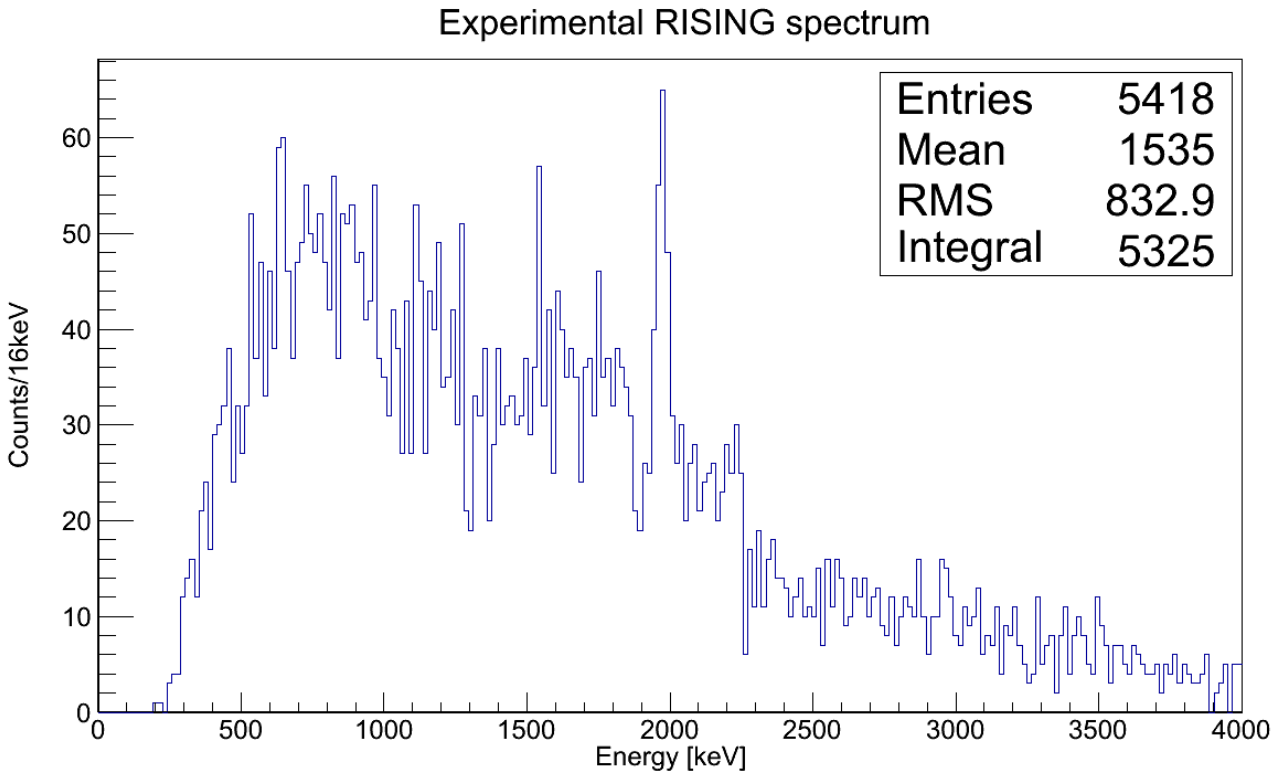
Energy Loss vs. Energy



Time-of-Flight vs. Total Energy

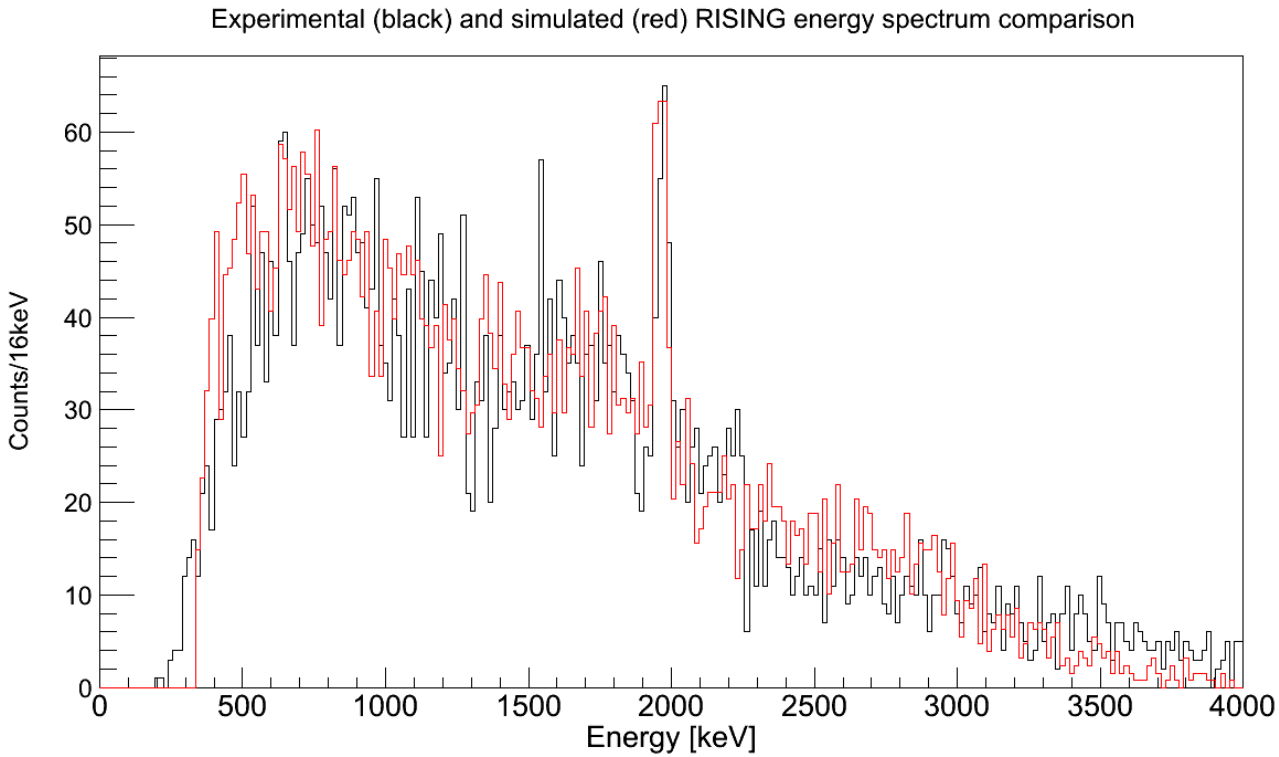


Experimental RISING γ-spectrum

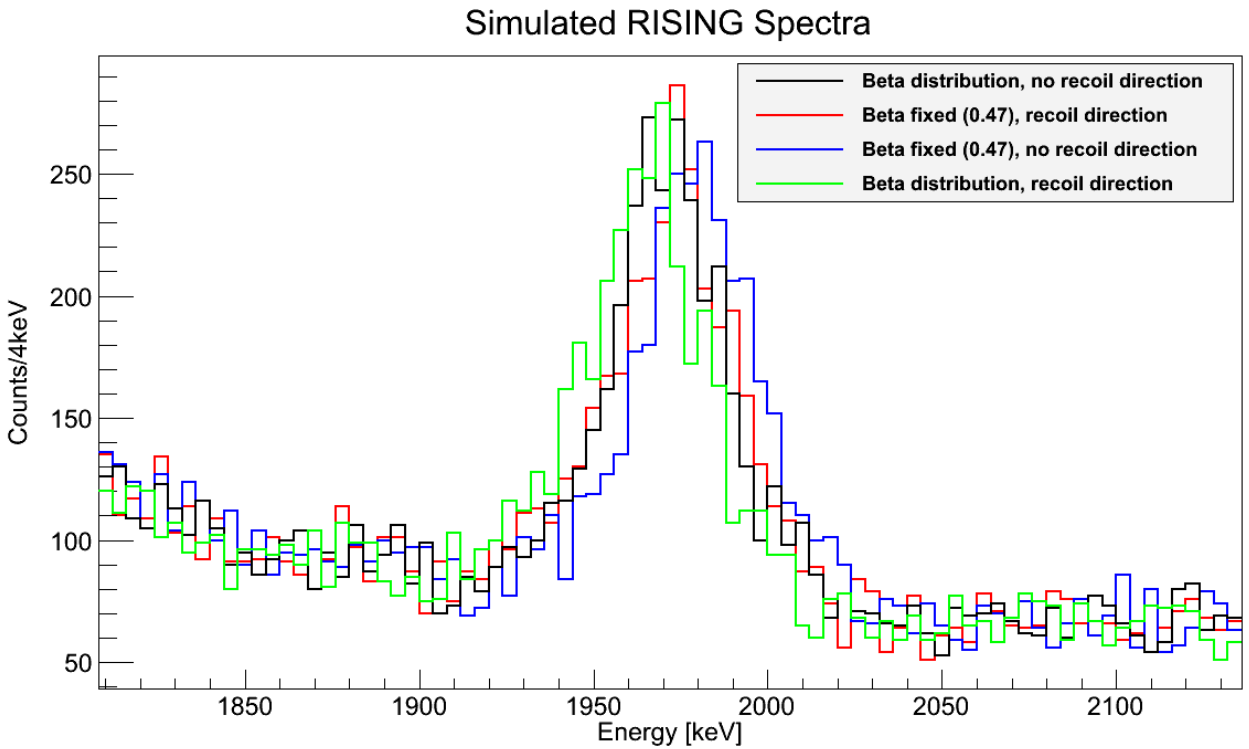


Courtesy of Andreas Wendt, Univ. Cologne

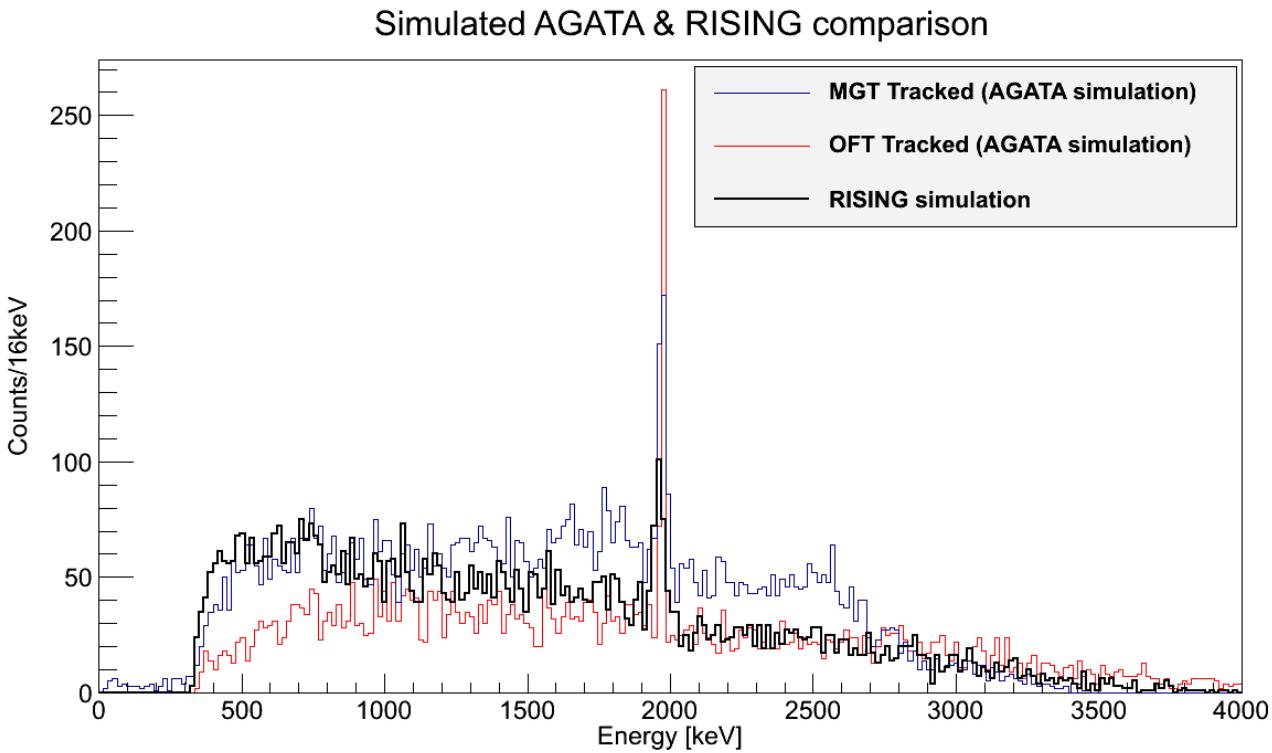
Simulated RISING γ-spectra



Simulated RISING γ-spectra with & w/o LYCCA-0 tracking



Simulated AGATA γ-spectra with LYCCA-0 tracking



Summary

- Relativistic conditions introduce large Doppler shift and Doppler broadening effects
- Doppler broadening resulting from $\Delta\theta$, $\Delta\beta$ & the finite opening angle of the detector
- Important to track and identify the recoiling nuclei to comprehend the origin of the detected γ-rays and for the selection of reaction channels
- AGATA+LYCCA-0 gives better energy resolution in comparison with RISING+LYCCA-0

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IPN Lyon, France
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