Multi−Coincidence Spectroscopy of SHE using the TASISpec Setup

* The **TASISpec** Setup
* The GEANT4 Code
* First Experimental Results
* Next Approved Experiment
* TRAPSpec

Lise−Lotte Andersson Helmholtz−Institute Mainz

Helmholtz Institute Mainz

The TASISpec Detector Set−up

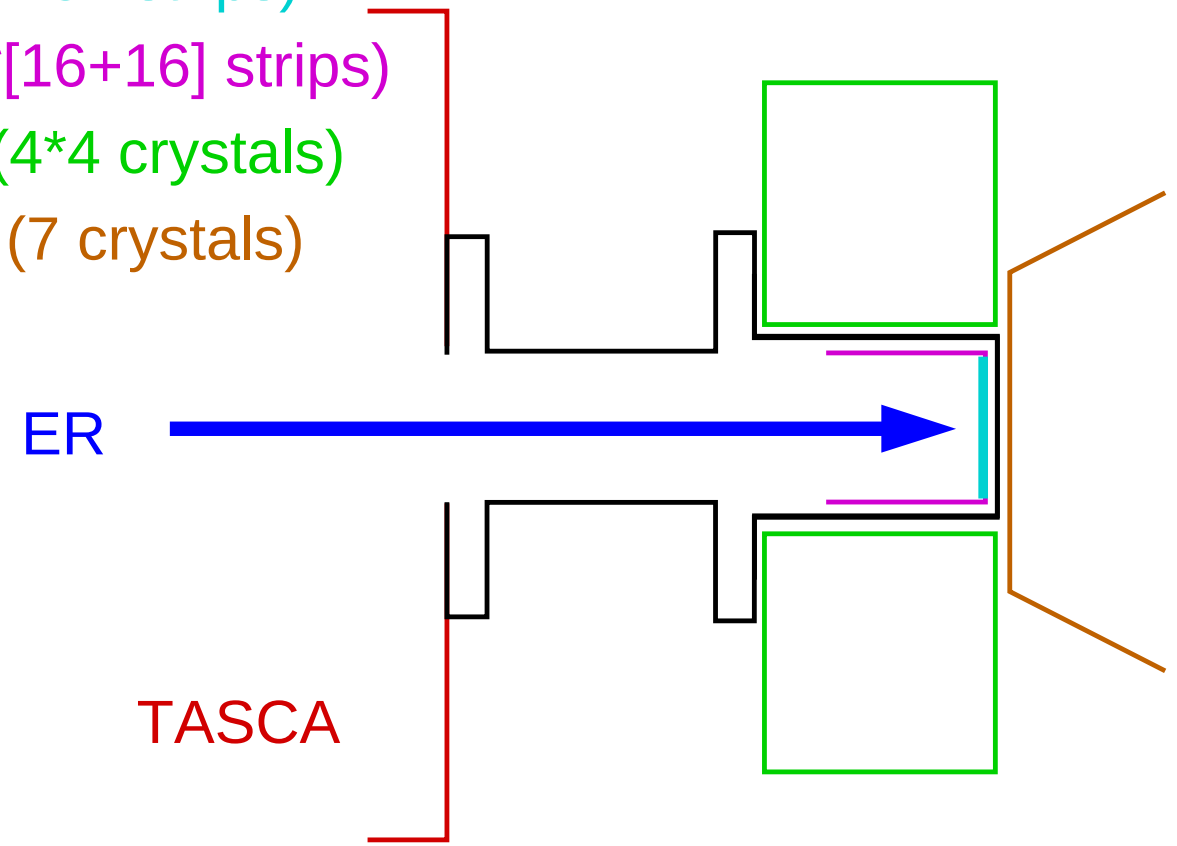
TASCA in Small Image Mode Spectroscopy

1 DSSSD (32+32 strips)

4 DSSSD (4*[16+16] strips)

4 Ge Clover (4*4 crystals)

1 Ge Cluster (7 crystals)



L−L Andersson et al., NIM A 622, 164 (2010)

LUND UNIVERSITY

UNIVERSITY OF LIVERPOOL

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GSI

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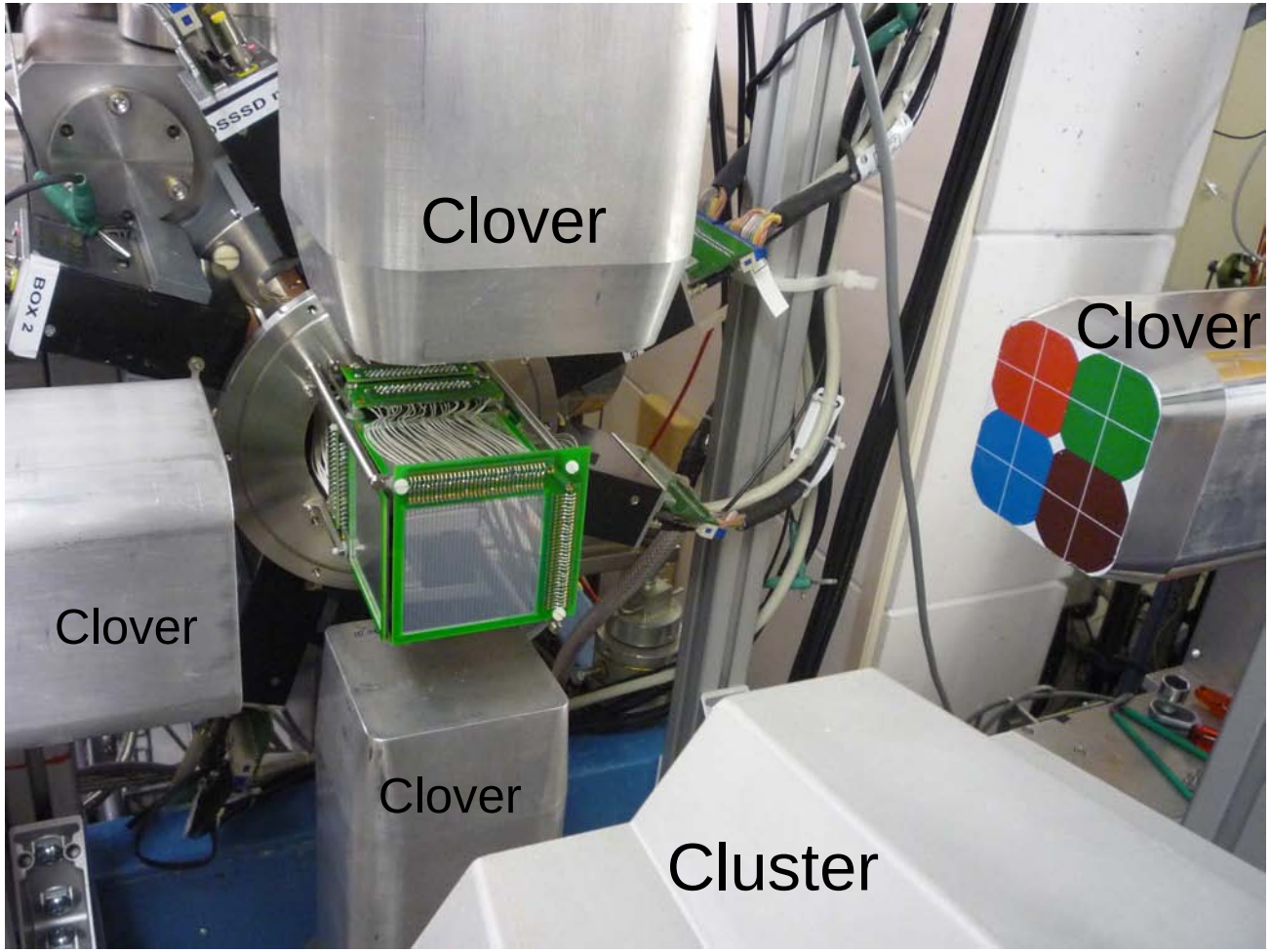
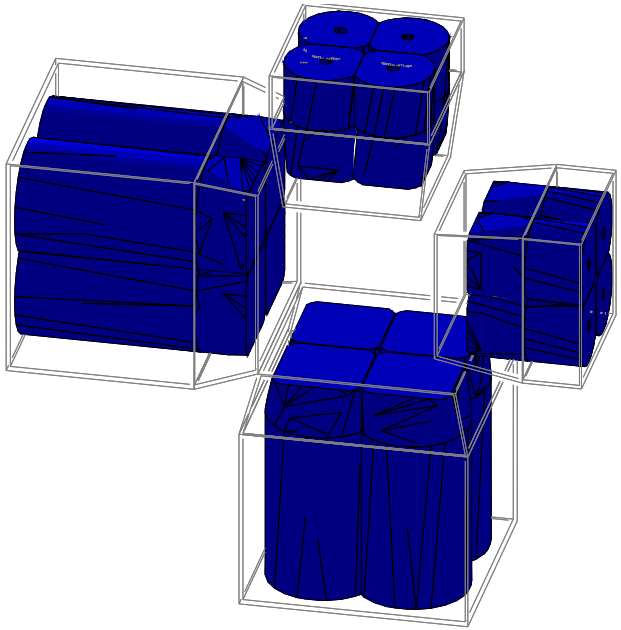
The TASISpec Detector Set−up

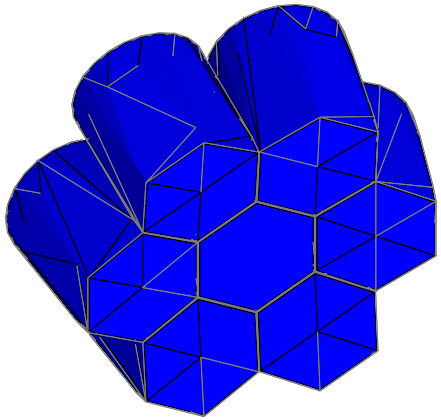
Details of the construction

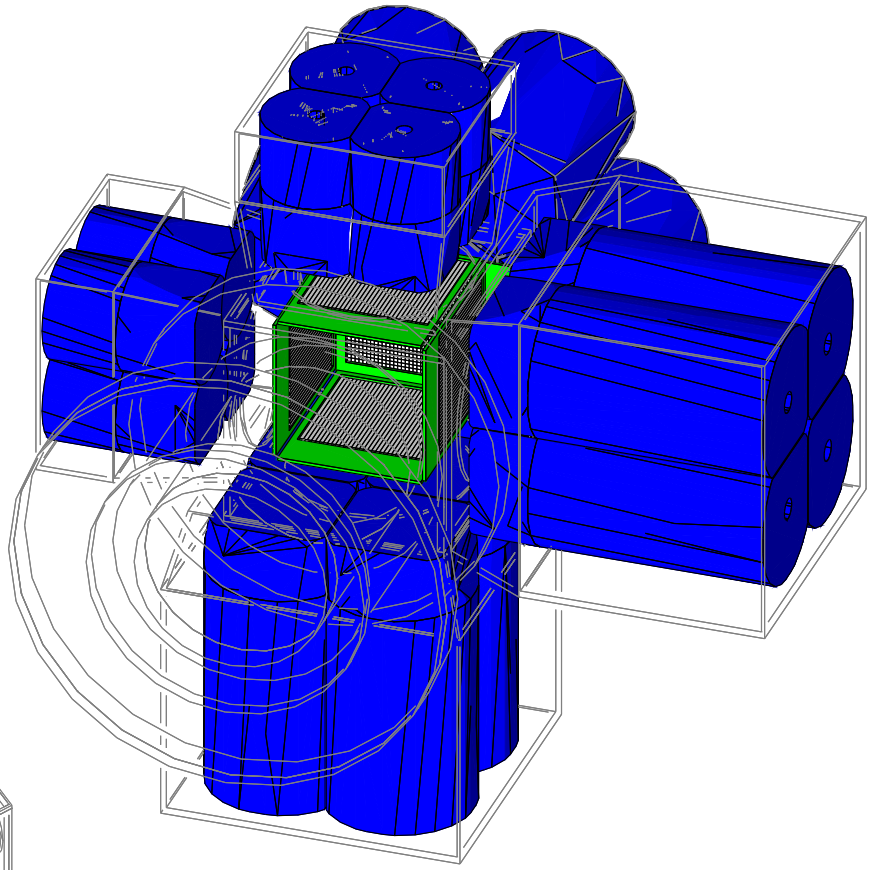


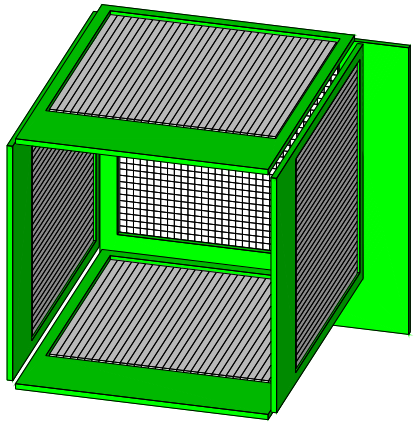
The Full TASISpec Setup in Geant4

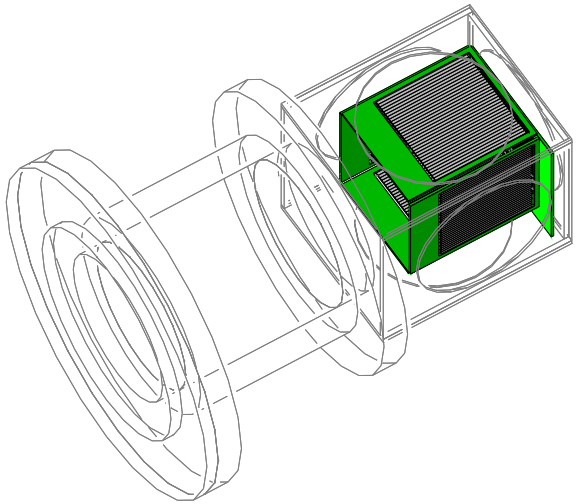
Programmed (in great detail) by: L. G. Sarmiento











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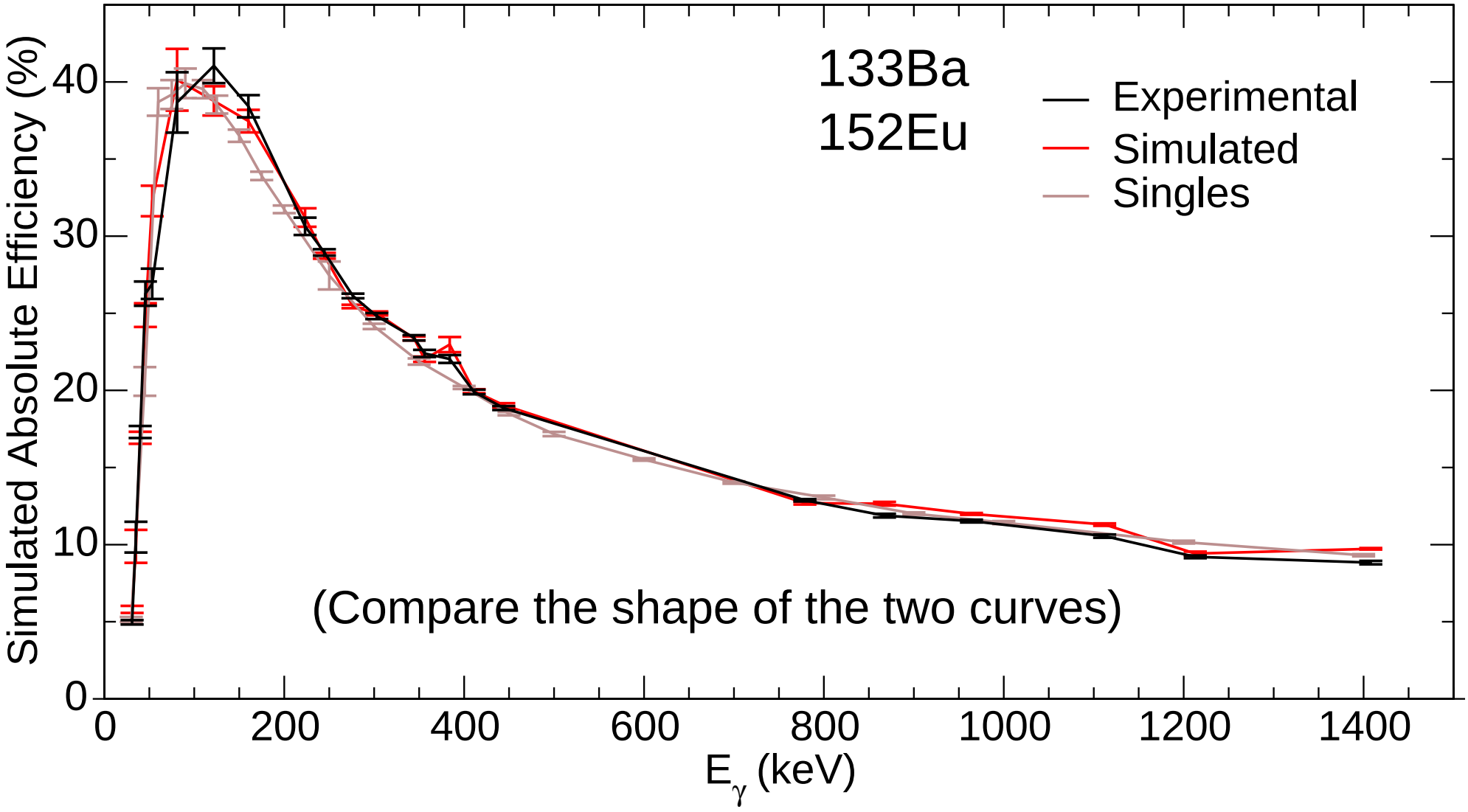
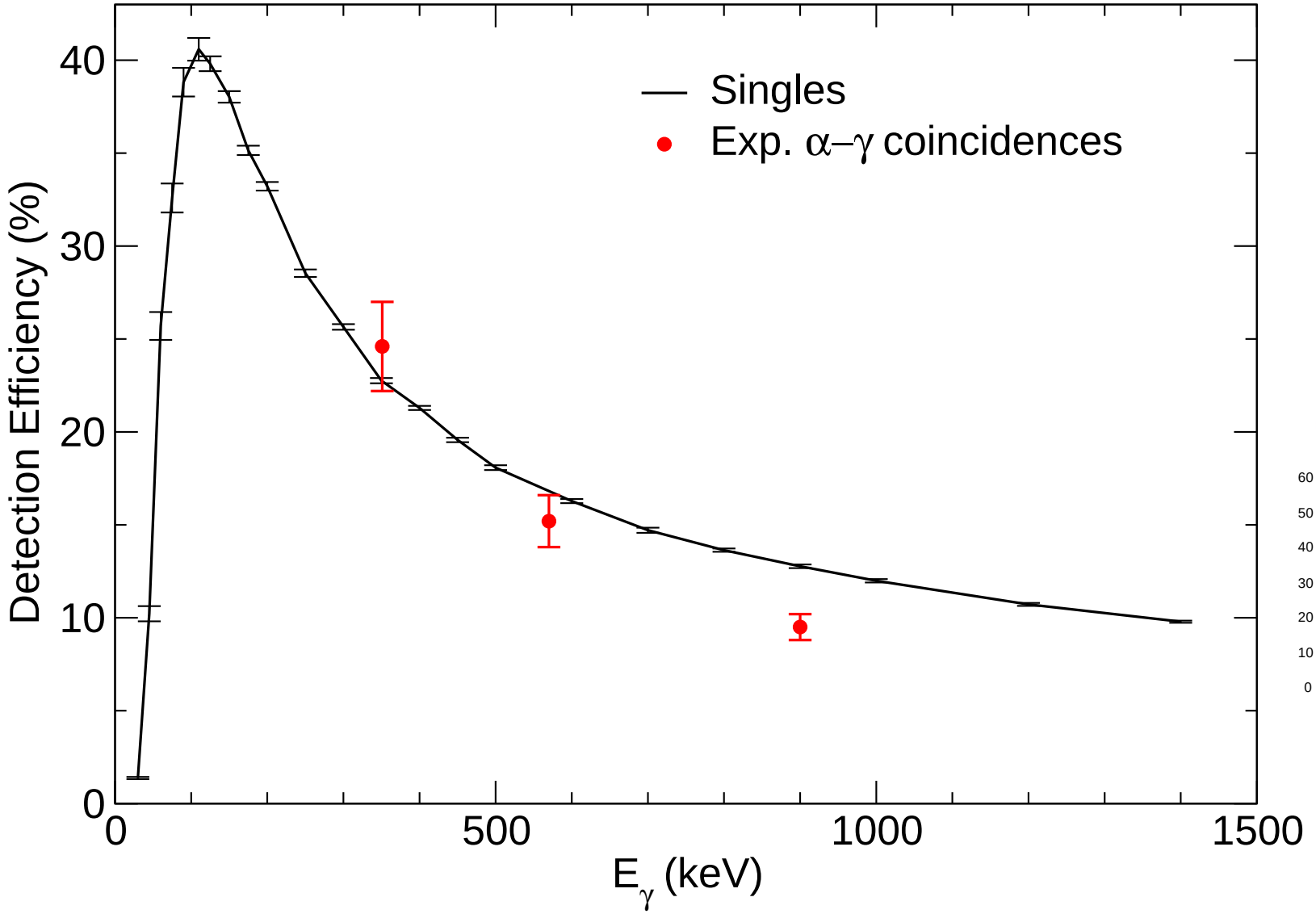
Comparing Experiment With Simulations

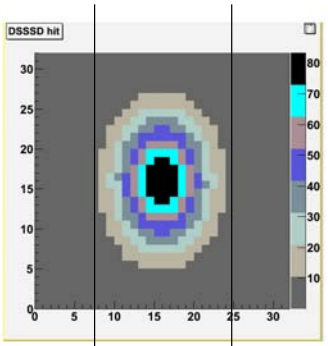
Relative gamma−ray efficiency with source on holder

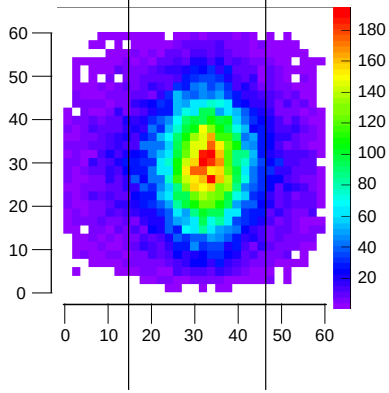


Comparing Simulations With Experiment

Gamma−ray efficiency obtained via alpha−gamma coincidences







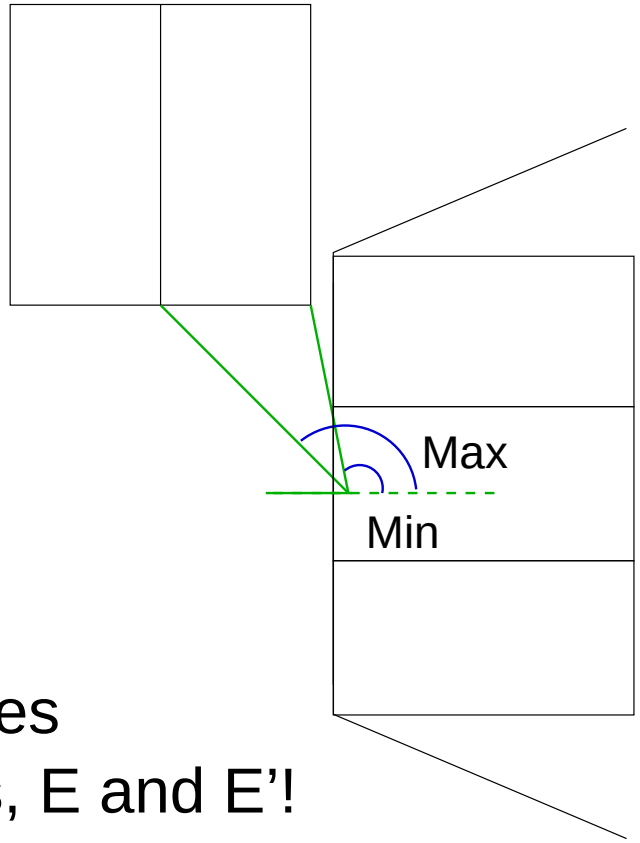
Limiting Background and "False" Coincidences

There are no Compton shields in the setup

1) Internal Add−back (between crystals in same detector)
2) Cross detector add−back (some combinations are more likely)

Compton Scattering:

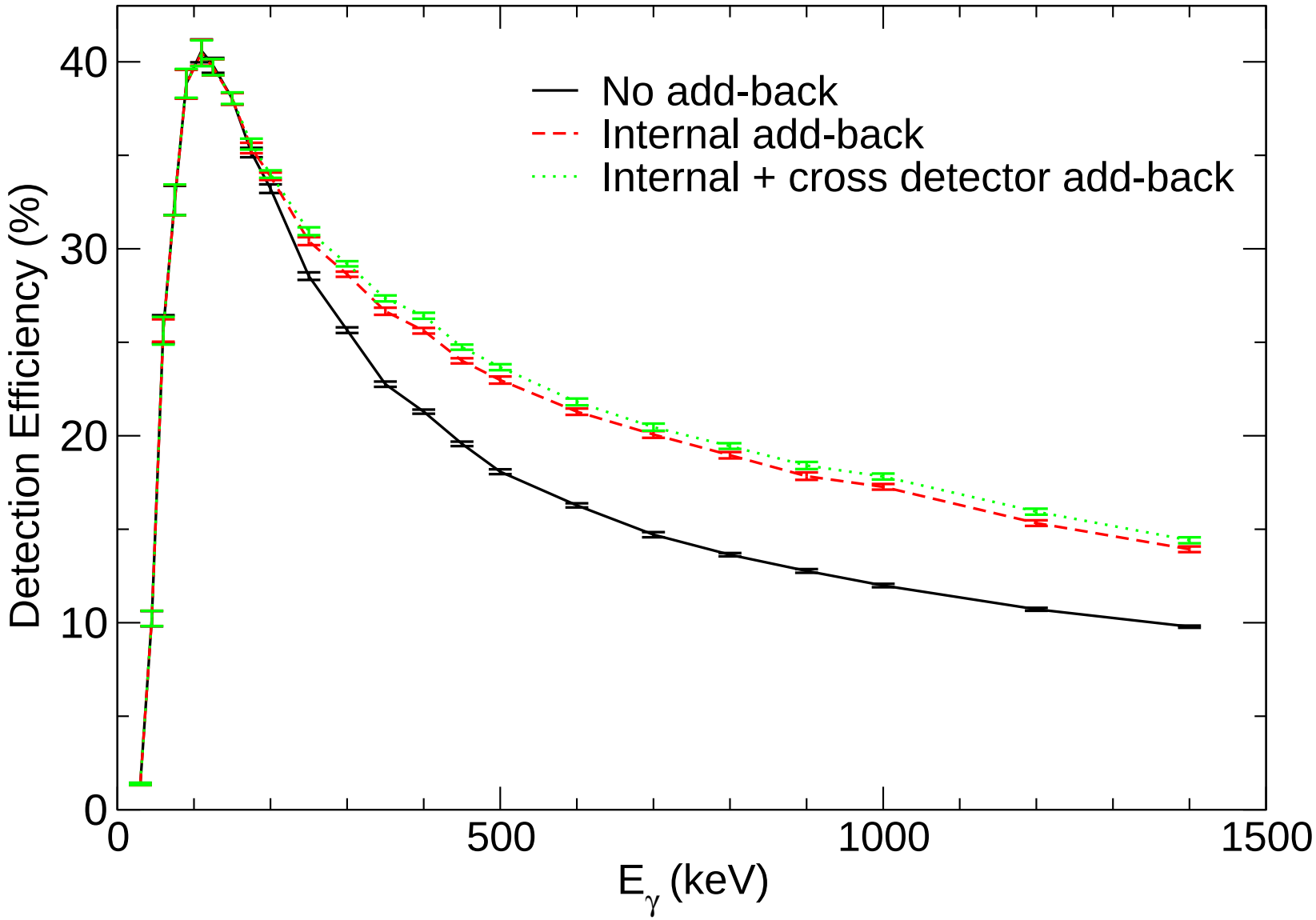
$$\frac{E' - E}{E * E'} = \frac{(1 - \cos\theta)}{m_e c^2}$$



Geometric limits of possible scattering angles
lead to restricted ratios for the two energies, E and E'!

Simulating Addback Efficiencies

Implanted nuclei decaying with a single gamma−ray



TASISpec

The Next Step in Superheavy Element Spectroscopy

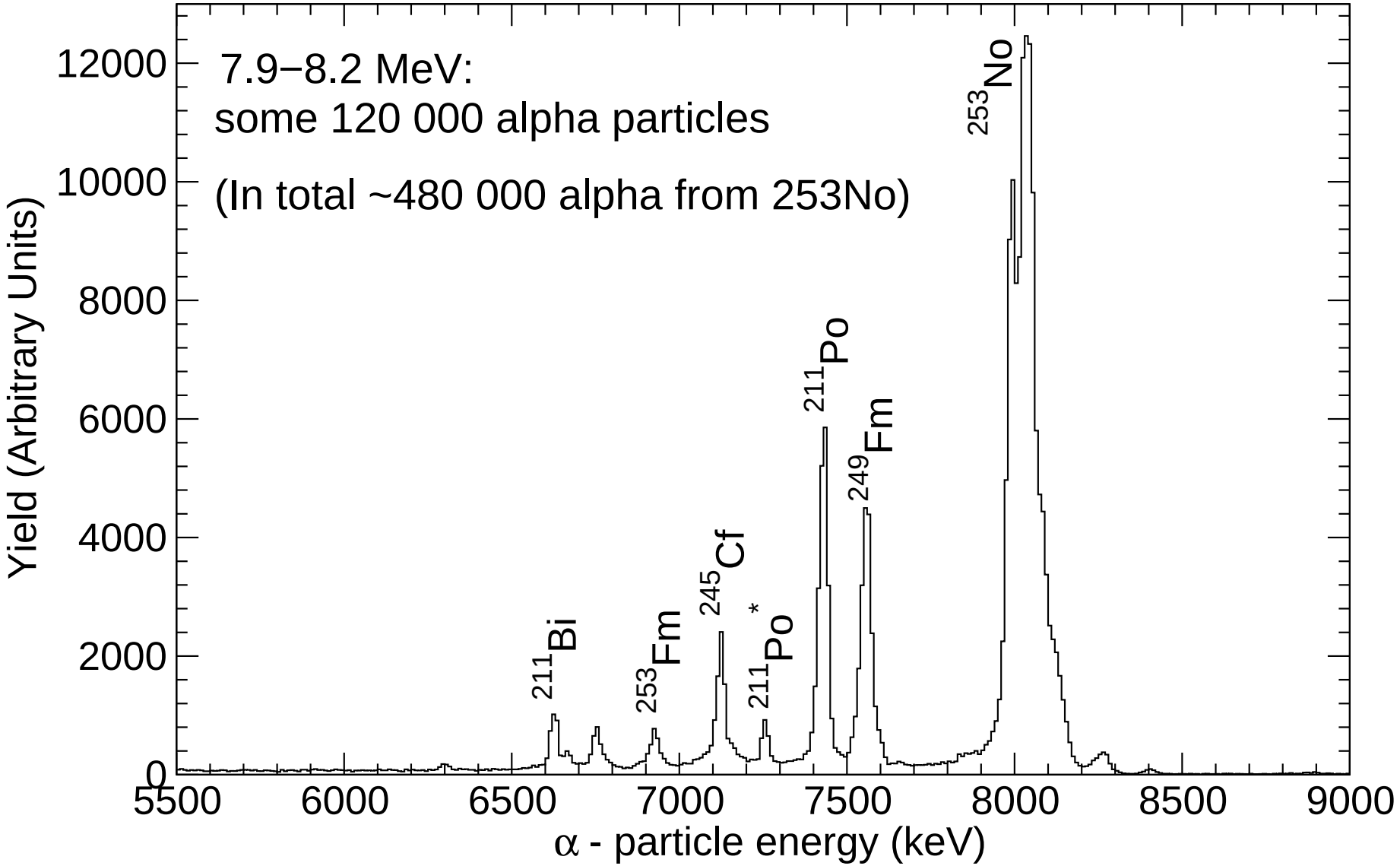
* First main beam experiment run in May

$$^{207}Pb(^{48}Ca, 2n)\,^{253}No$$

* Total beam integral 2.4E18
* Results from a subset of runs, corresponding to some 25% of the collected data

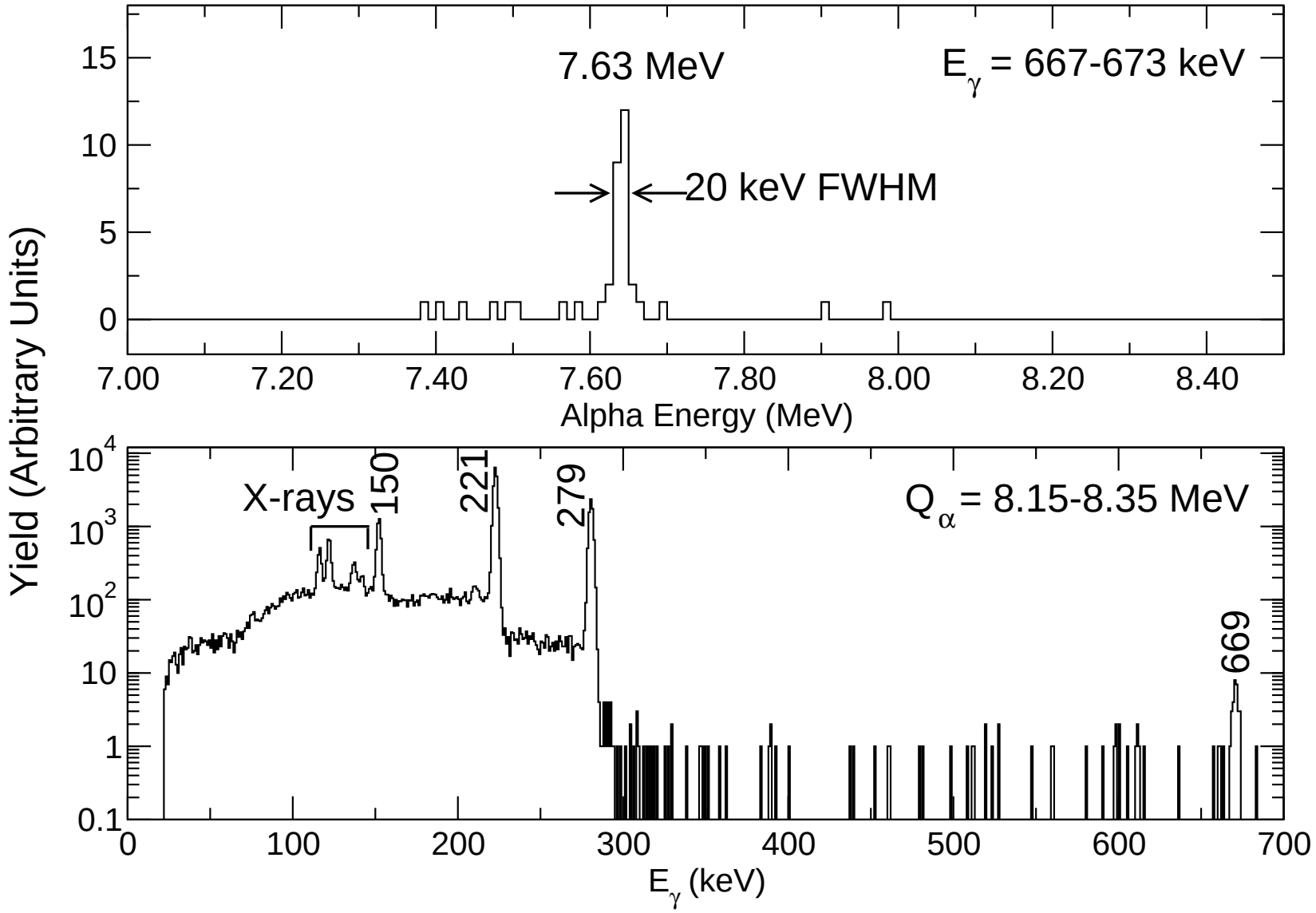
Alpha Particles Detected in the DSSSD

DSSSD p−side beam−off alpha spectrum



Alpha Decaying 253No

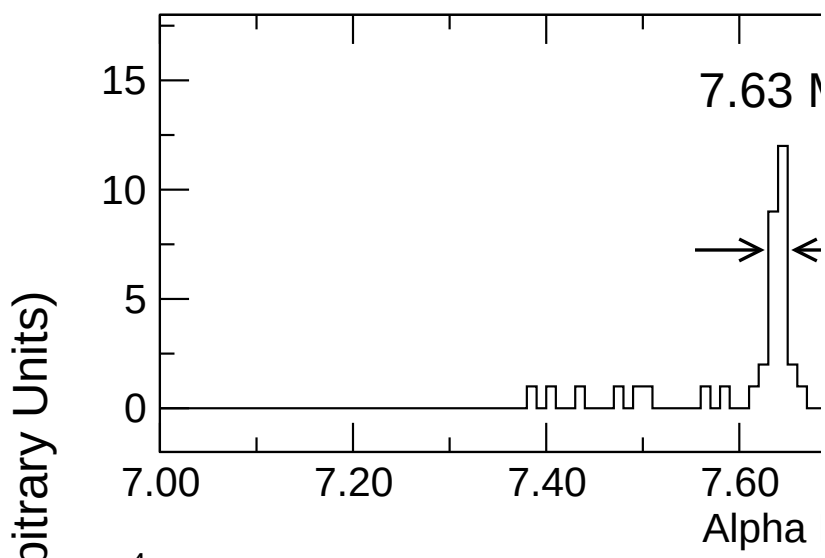
Gates clearly show new(ish) gamma−ray transition at 669 keV

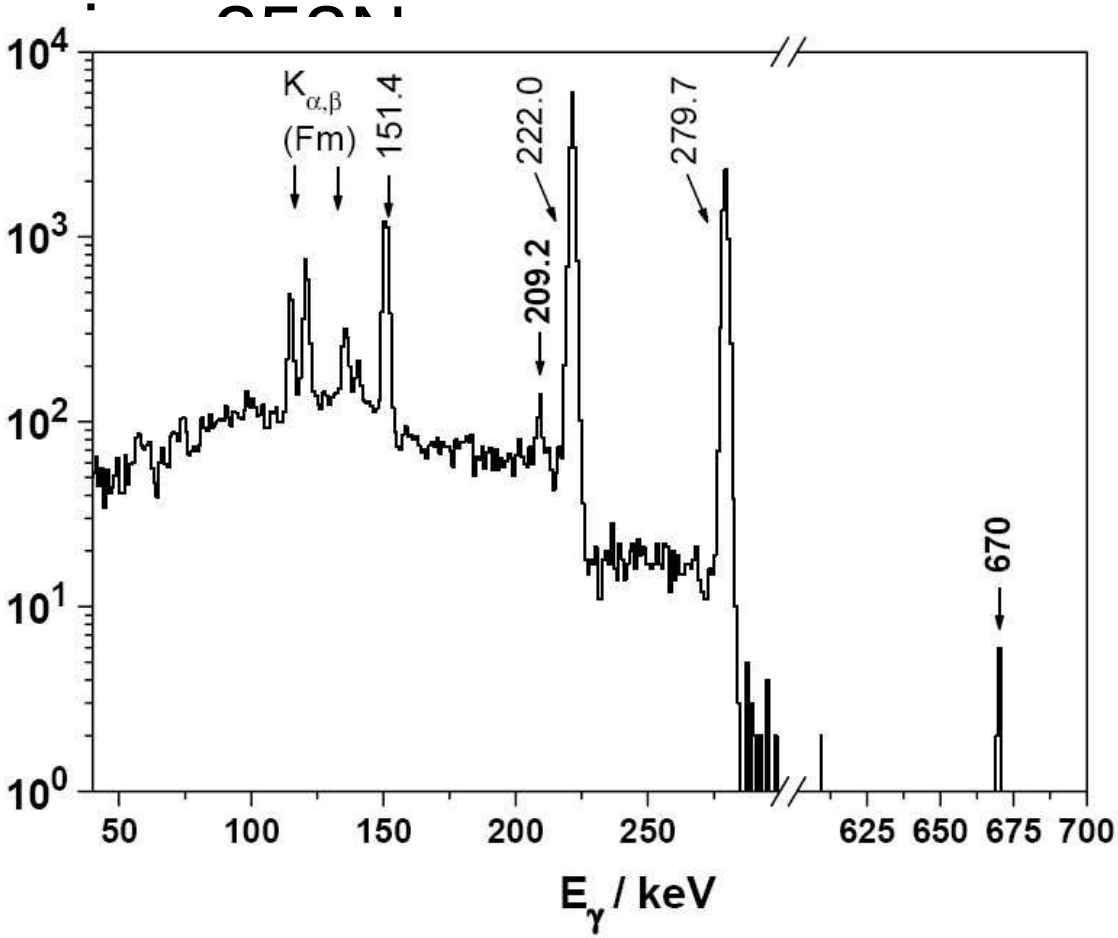


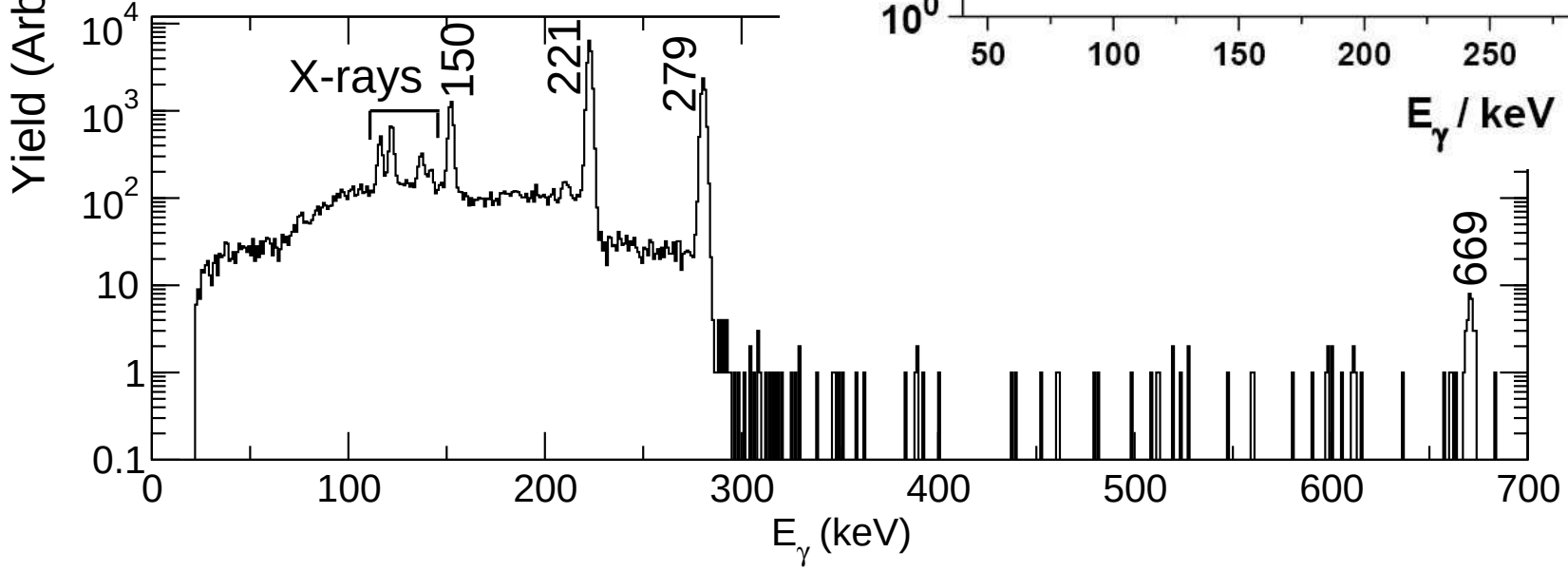
A. Lopez−Martens et al. Nuclear Physics A 852, 15 (2011).

Alpha d

Gates clearly show new(i





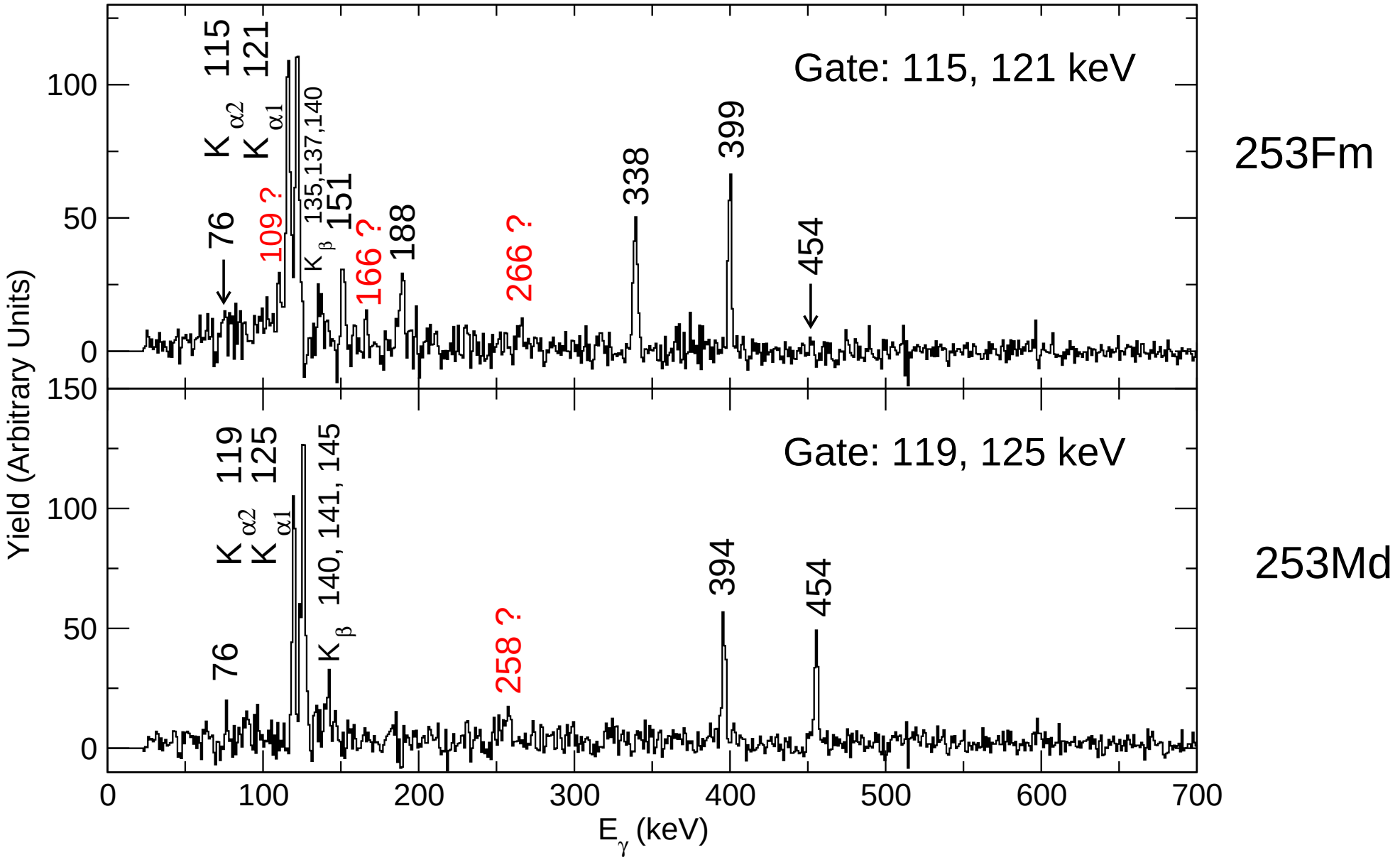


A. Lopez−Martens et al. Nuclear Physics A 852, 15 (2011).

F.P. Hessberger et al. Eur. Phys. J. D 45, 33 (2007).

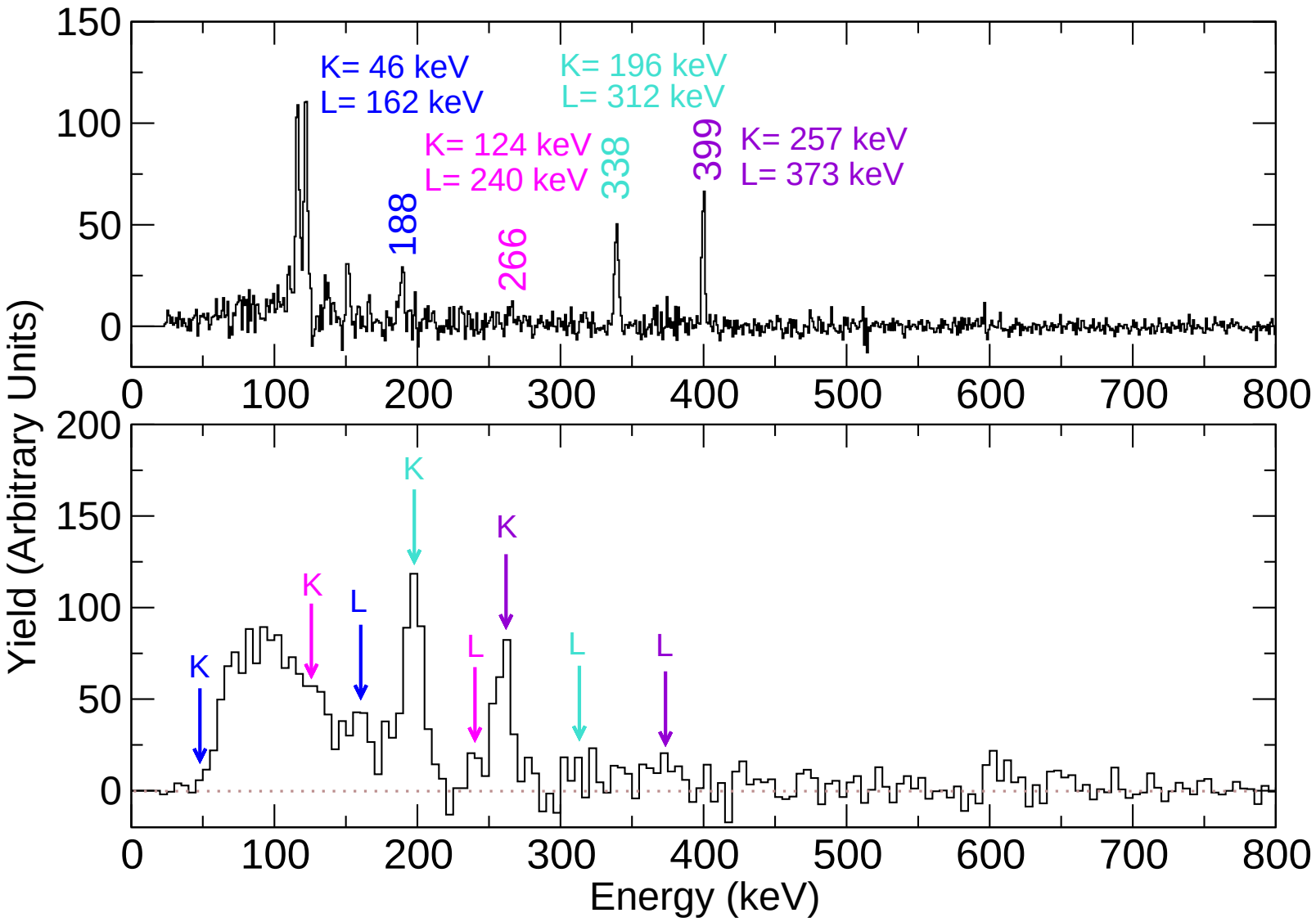
Gamma−Gamma Coincidences

Gated prompt on p−side DSSSD <600 keV + X−rays



Conversion Electrons and Gamma Rays

253Fm comparison: All Ge detectors vs Si box detectors



Predicted by
BrIcc v2.2b

TASISpec Flagship Experiment

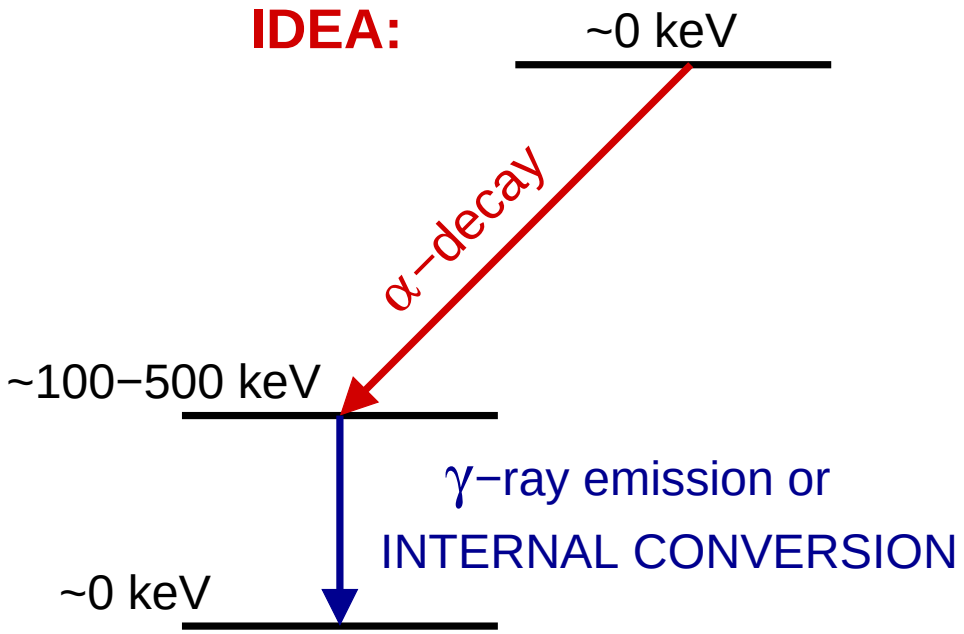
Fingerprinting E115 decay chains via X−rays
Direct measurement of proton number of the new SHE island!

8 weeks of beamtime approved at GSI.

1 α − X−ray coincidence detection per week expected.

Set−up and settings are prepared and **ready to run** at any time!

IDEA:



=> K X−rays

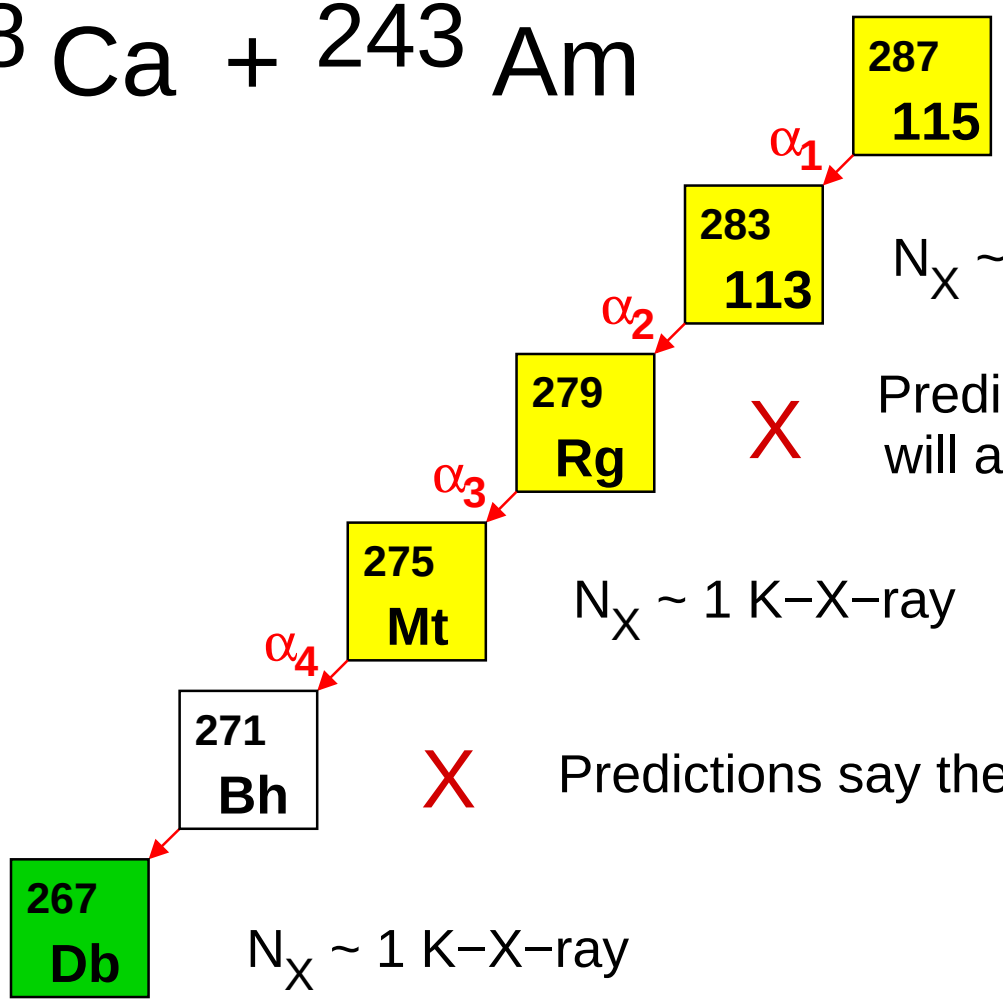
Long decay chains of odd−A nuclei!

Spokesperson D. Rudolph (Lund University)

Predicted X−rays in the Decay Chain

Numbers include realistic conversion factors

$^{48}Ca + ^{243}Am$



Expected to detect 8 decay chains

N_X ~ 1 K−X−ray

X

Predictions say the populated excited state will alpha decay directly (not via groundstate)

N_X ~ 1 K−X−ray

X

Predictions say the alpha populates the ground state

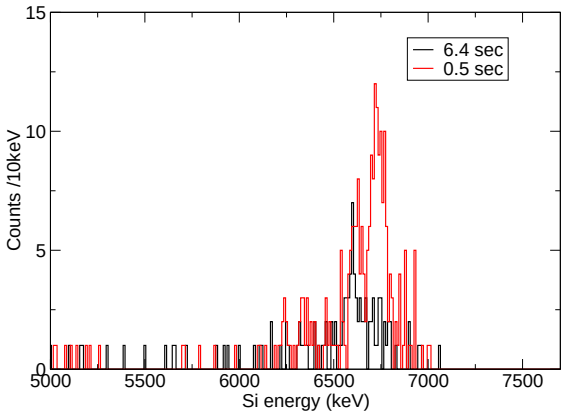
N_X ~ 1 K−X−ray

=> N_X ~ 2−3 K−Xrays/chain!

=> TASISpec efficiencies; detect one alpha−X−ray coincidence/week!

TASISpec + SHIPTRAP = TRAPSpec

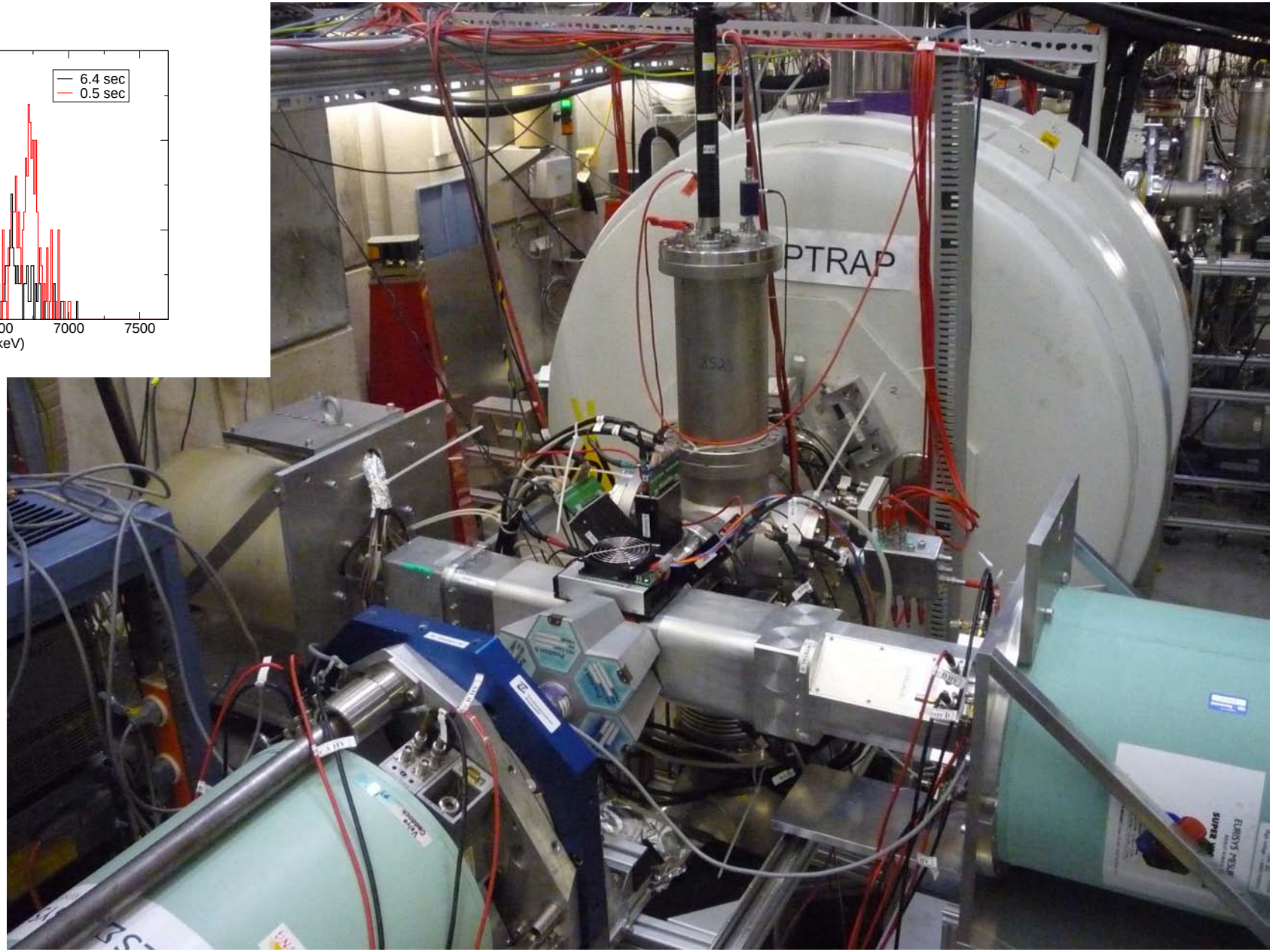
Second test, October 2011



195Po

1.9s 6.7 MeV

4.6s 6.6 MeV



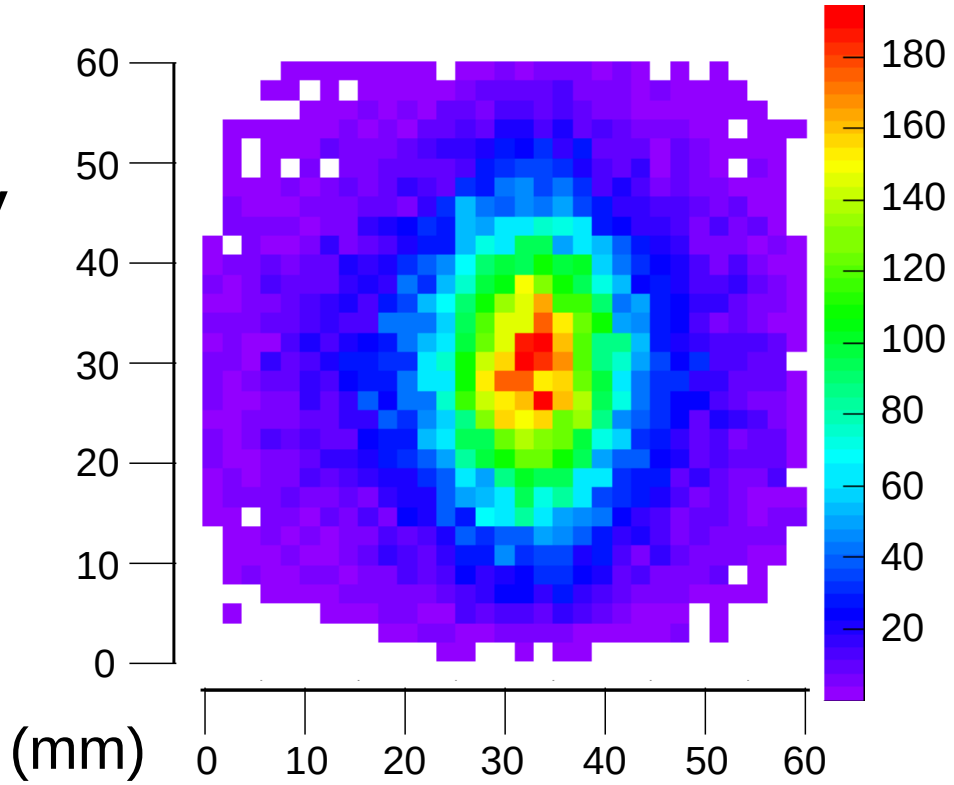
TASISpec

A versatile SHE spectroscopy setup!

- Small−image mode => compact focal plane
- High segmentation => 192 Si strips
  α−efficiency ~80%
- 4+1 segmented Ge detectors
  γ−efficiency ~40% @ 150 keV
- Multi−coincidence capabilities
  => suitable for SHE experiments

Next up: E115!

^{253}No alpha decays



TASISpec

Many thanks to the 'updated' collaboration:

TASCA @ GSI, DE

Helmholtz−Institut Mainz, DE

Lund University, SWE

University of Liverpool, UK

Universidad Nacional de Colombia, CO

Universität Mainz, DE