The First Main Beam Experiment of TASISpec

(The Good, The Bad and The Ugly)

* The **TASISpec** setup
* Details of first experiment
* Data Analysis
* Problems

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The TASISpec Detector Set-up

TASCA in Small Image Mode Spectroscopy

4 SSSSD (4*32 strips)

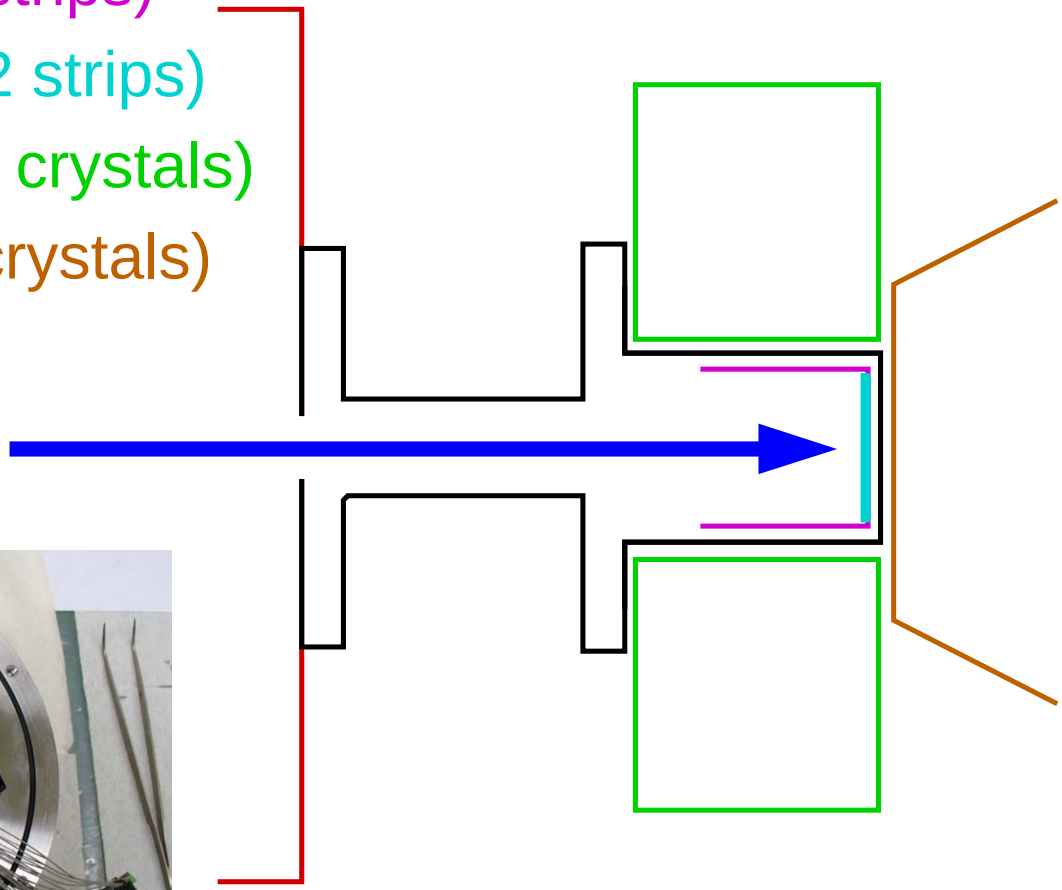
1 DSSSD (32+32 strips)

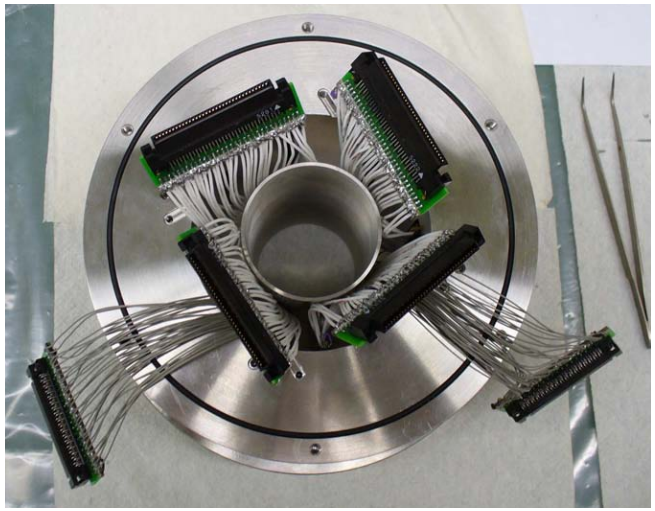
4 Ge Clover (4*4 crystals)

1 Ge Cluster (7 crystals)

TASCA

ER





L-L Andersson et al., Nucl. Instr. and Meth. A 622, 164 (2010

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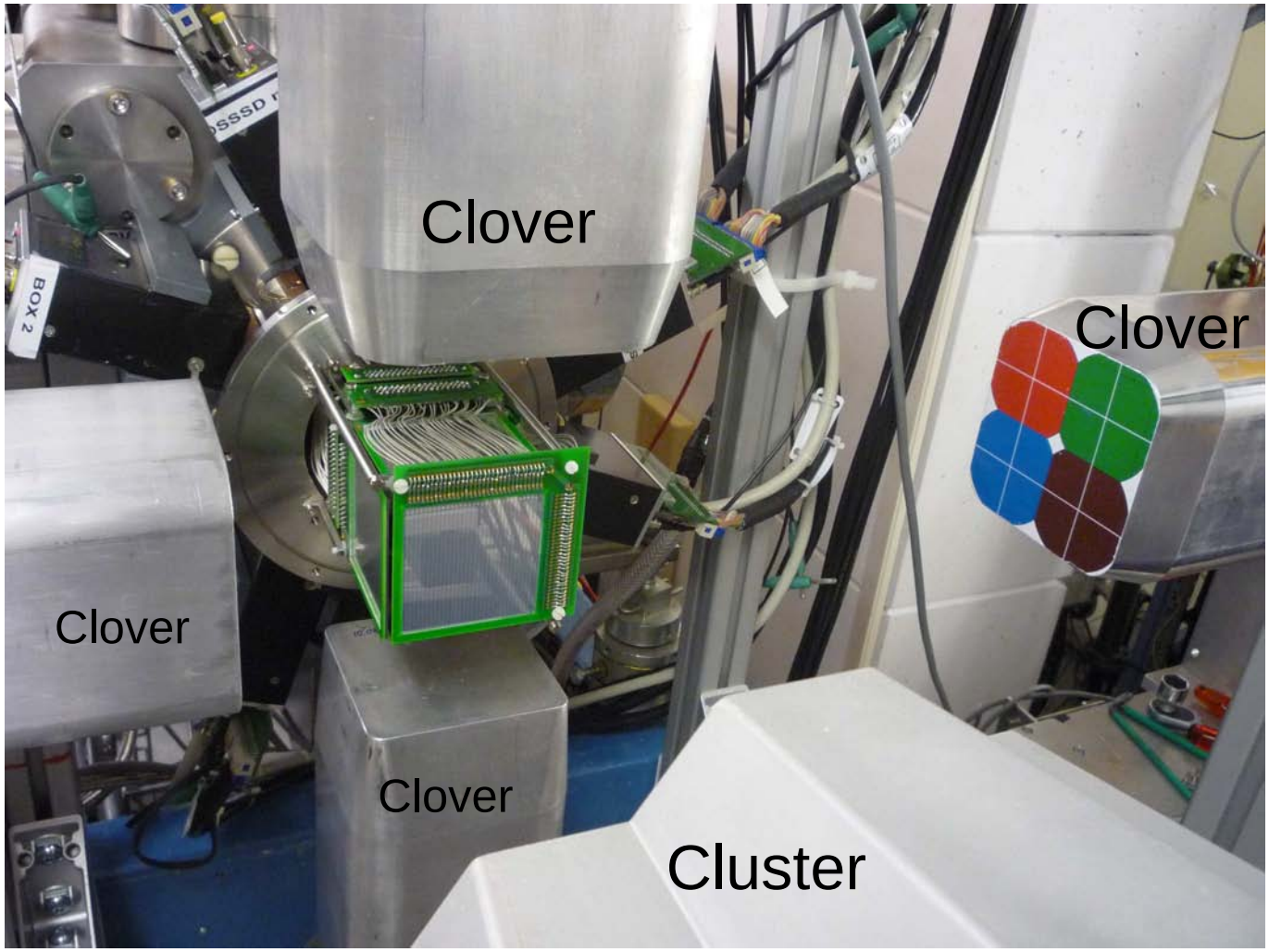
The TASiSpec Detector Set−up

Details of the construction



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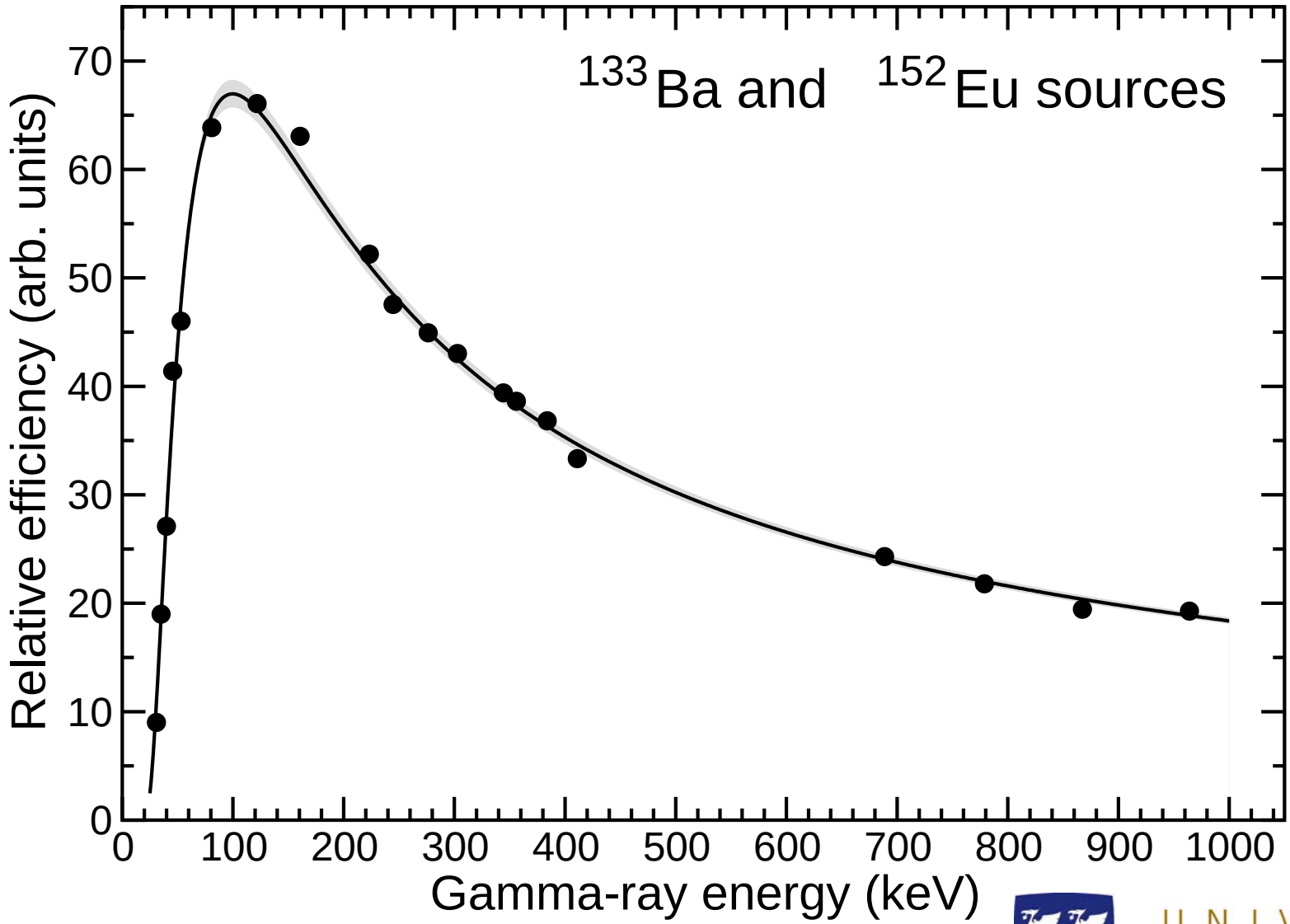
Relative Gamma−ray Efficiencies

Obtained using radioactive sources placed inside TASISpec



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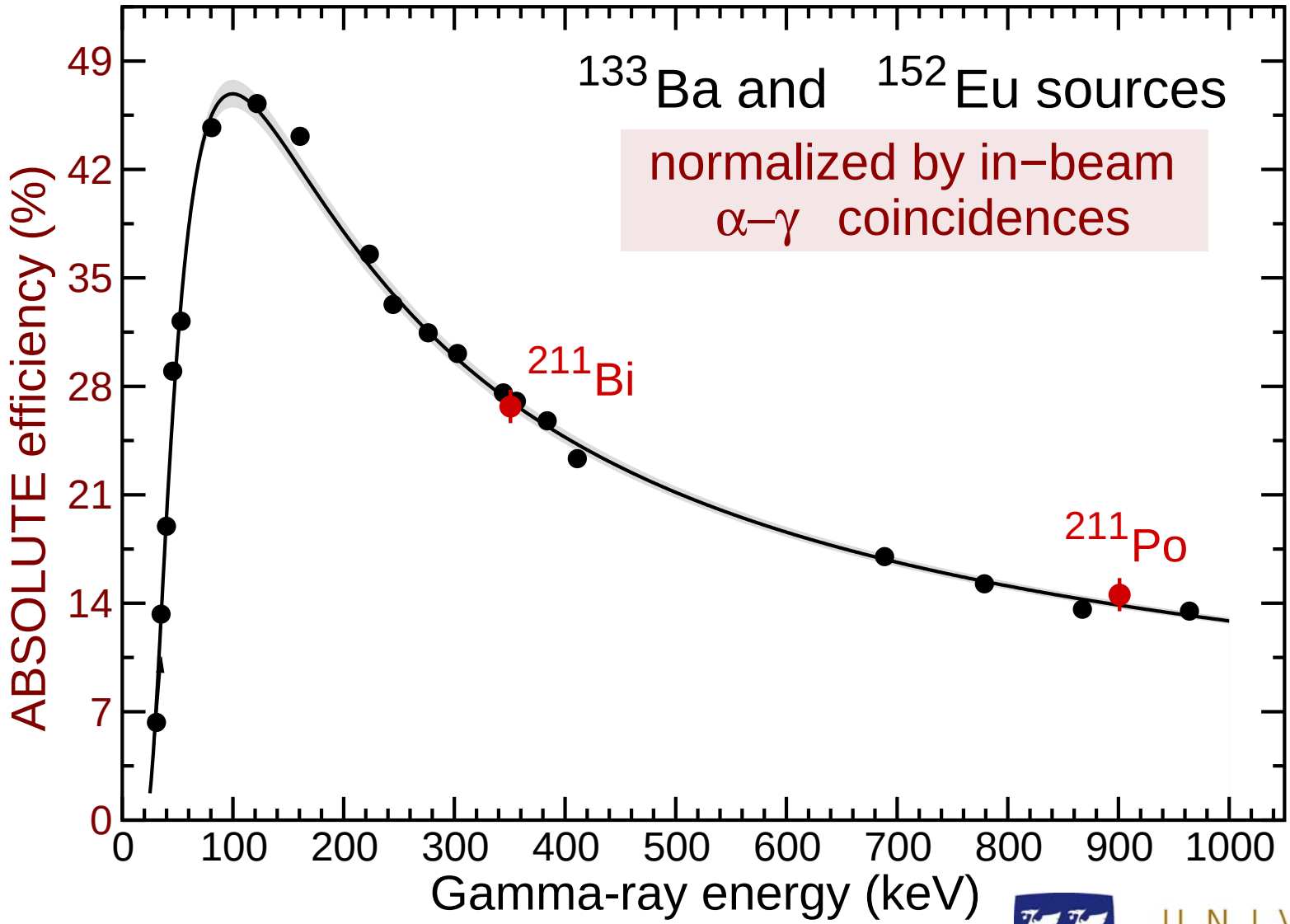
Absolute Gamma−ray Efficiencies

Obtained by comparing to values from our experiment



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TASISpec

The Next Step in Superheavy Element Spectroscopy

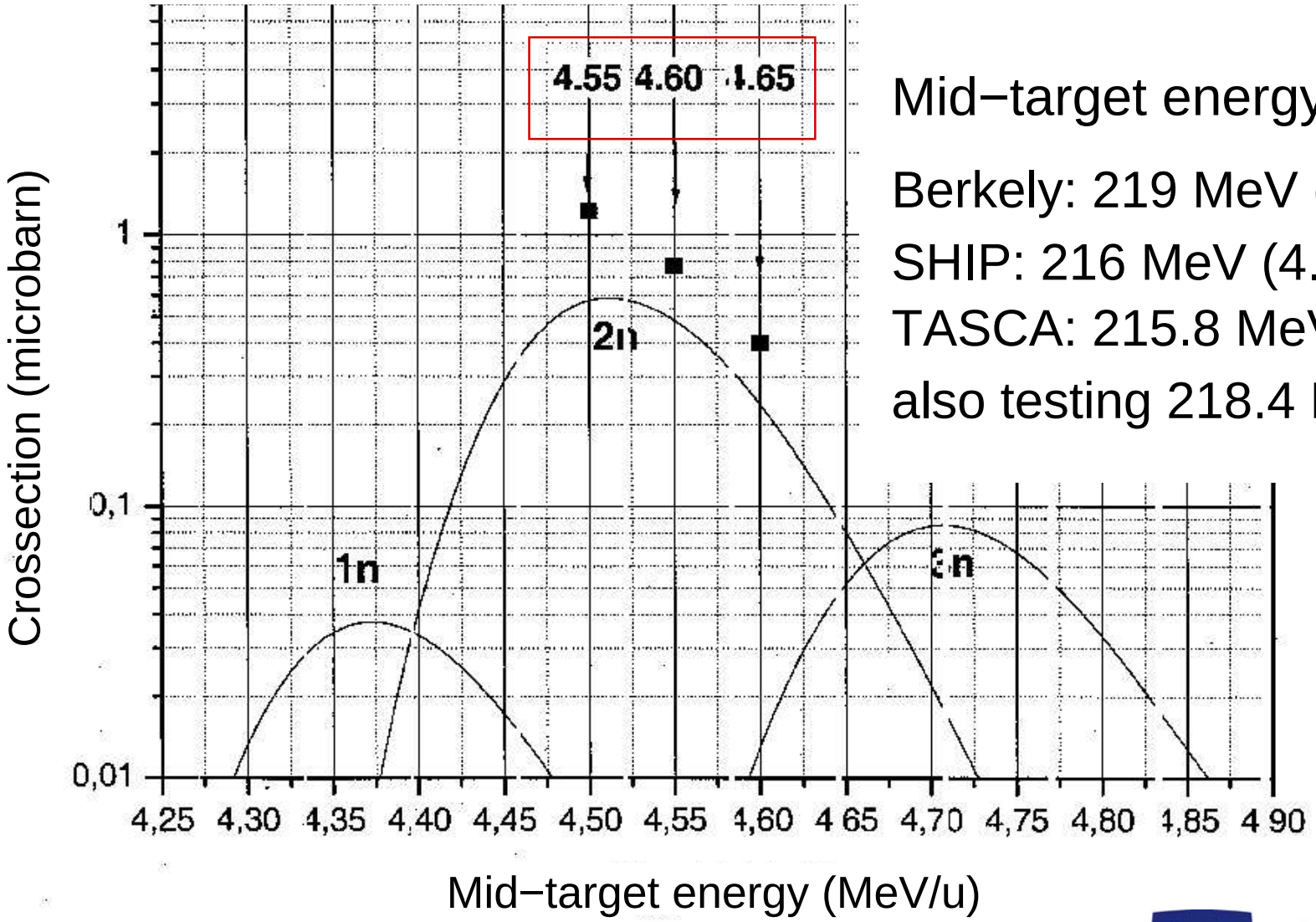
- First main beam experiment run in May

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

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

Crossections for ^{253}No

SHIP Aug 2007 (beginning of target energy)



Mid−target energy for 48Ca + 207Pb

Berkely: 219 MeV (4.56 MeV/u)

SHIP: 216 MeV (4.50 MeV/u)

TASCA: 215.8 MeV (4.50 MeV/u)

also testing 218.4 MeV (4.55 MeV/u)

HIVAP plot made by F. Hessberger (thanks!)

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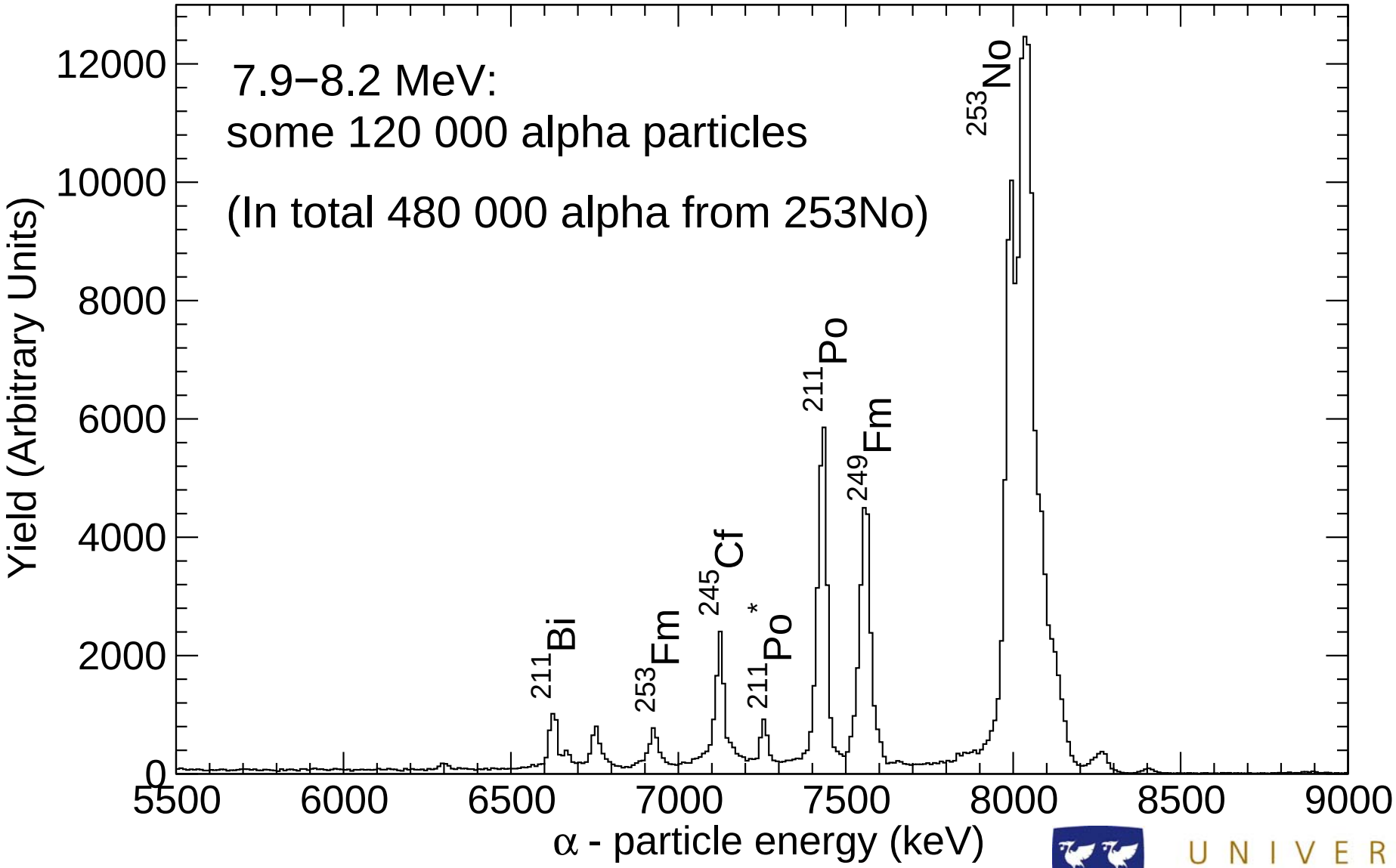
Alpha Particles Detected in the DSSSD

DSSSD p−side Beam off alpha spectrum



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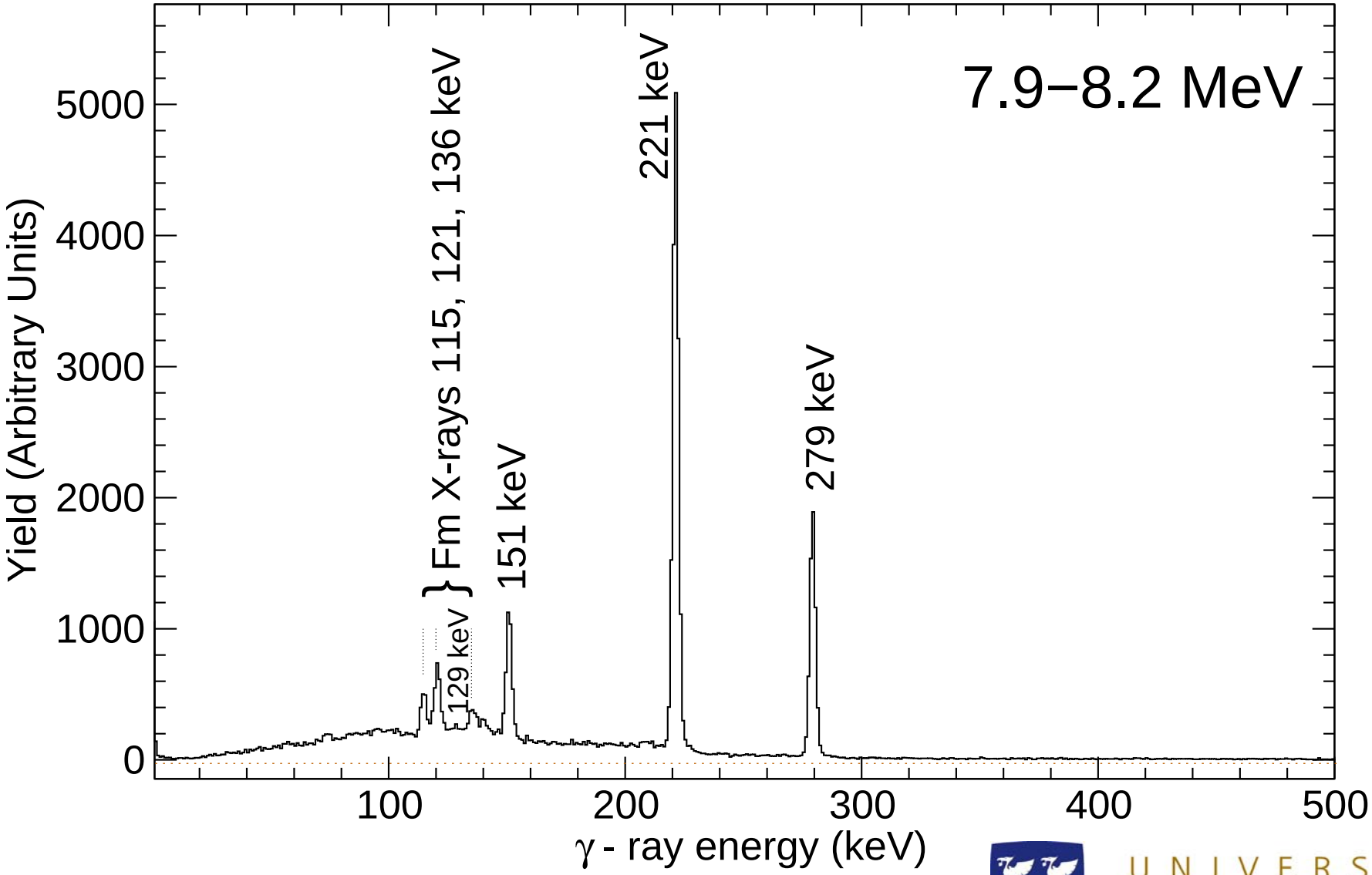
Alpha−Gamma Correlations

Gamma rays in prompt coincidence with 253No alpha



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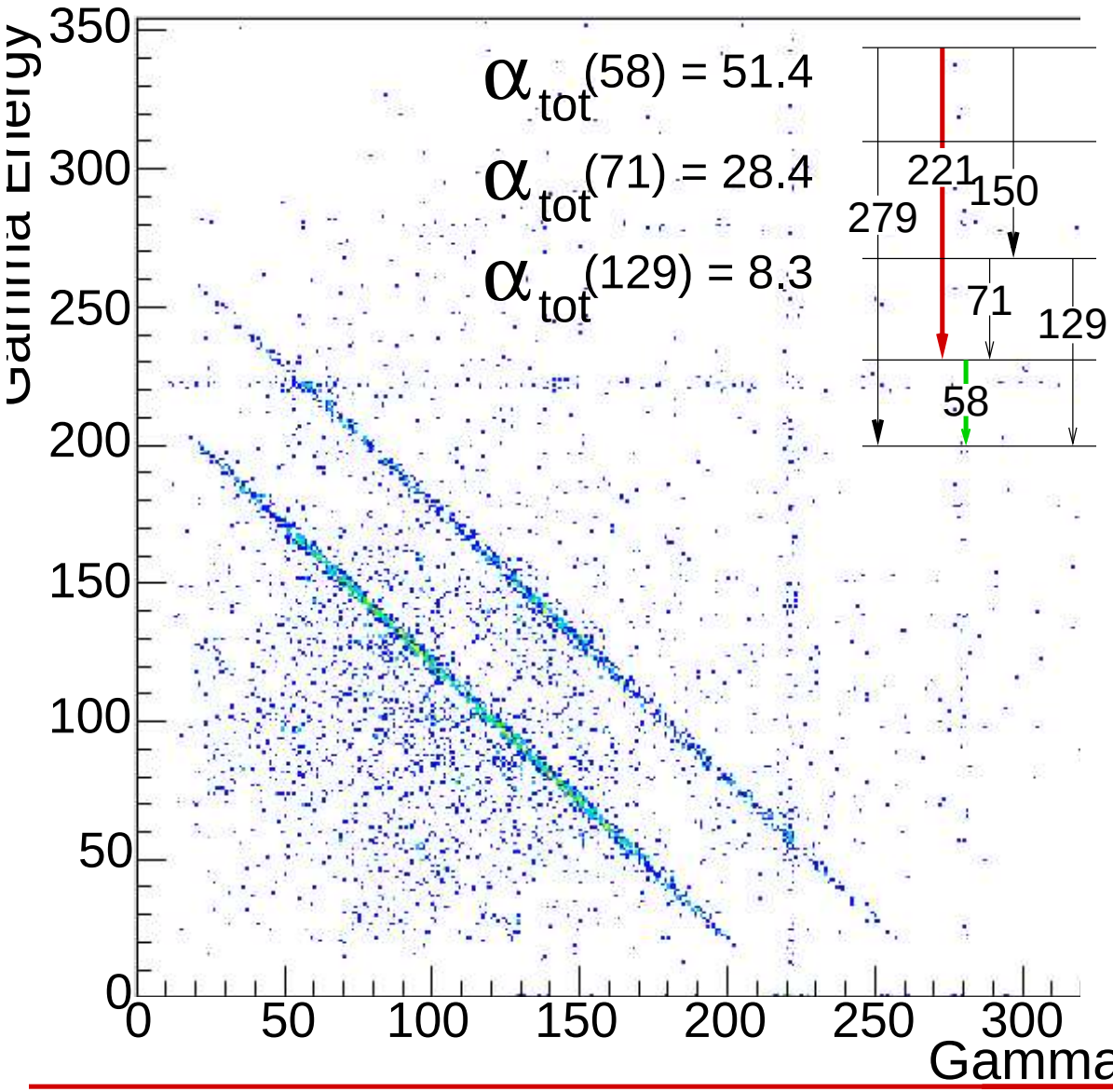
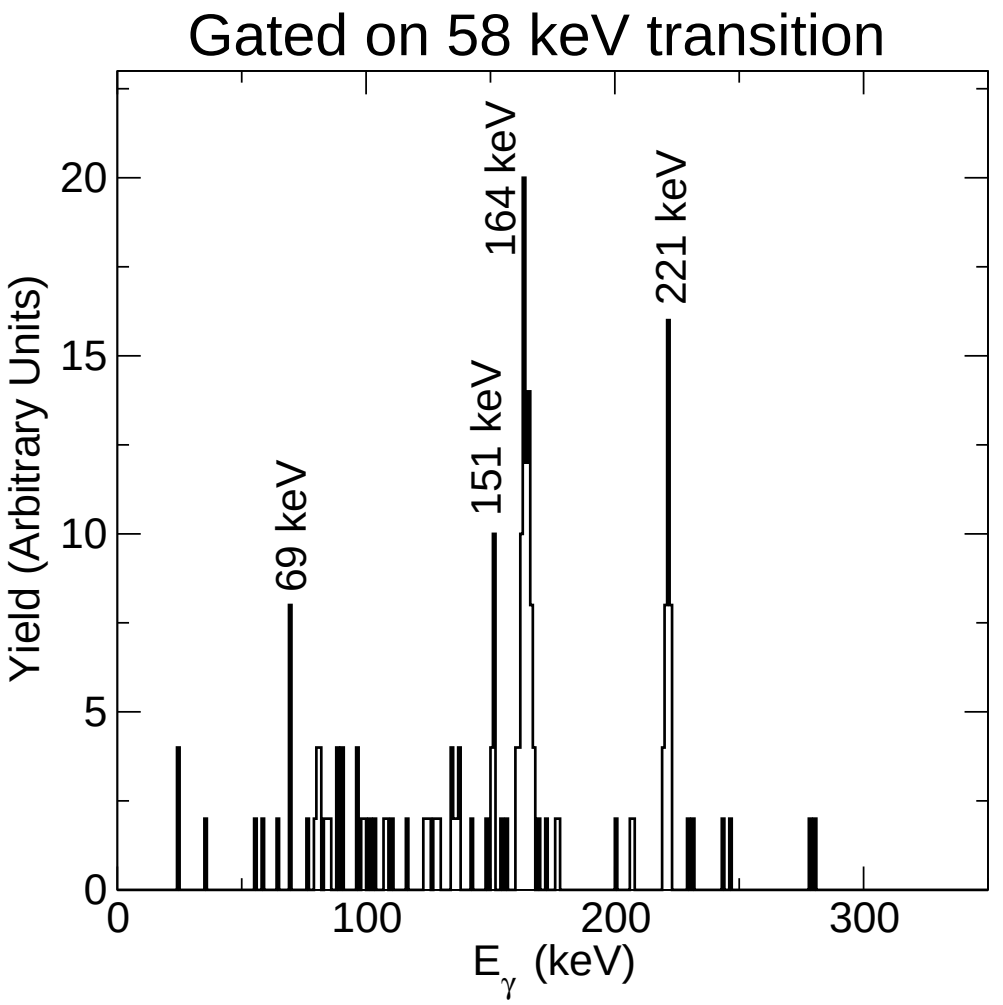
Alpha−Gamma−Gamma Coincidences

Addback + time gate





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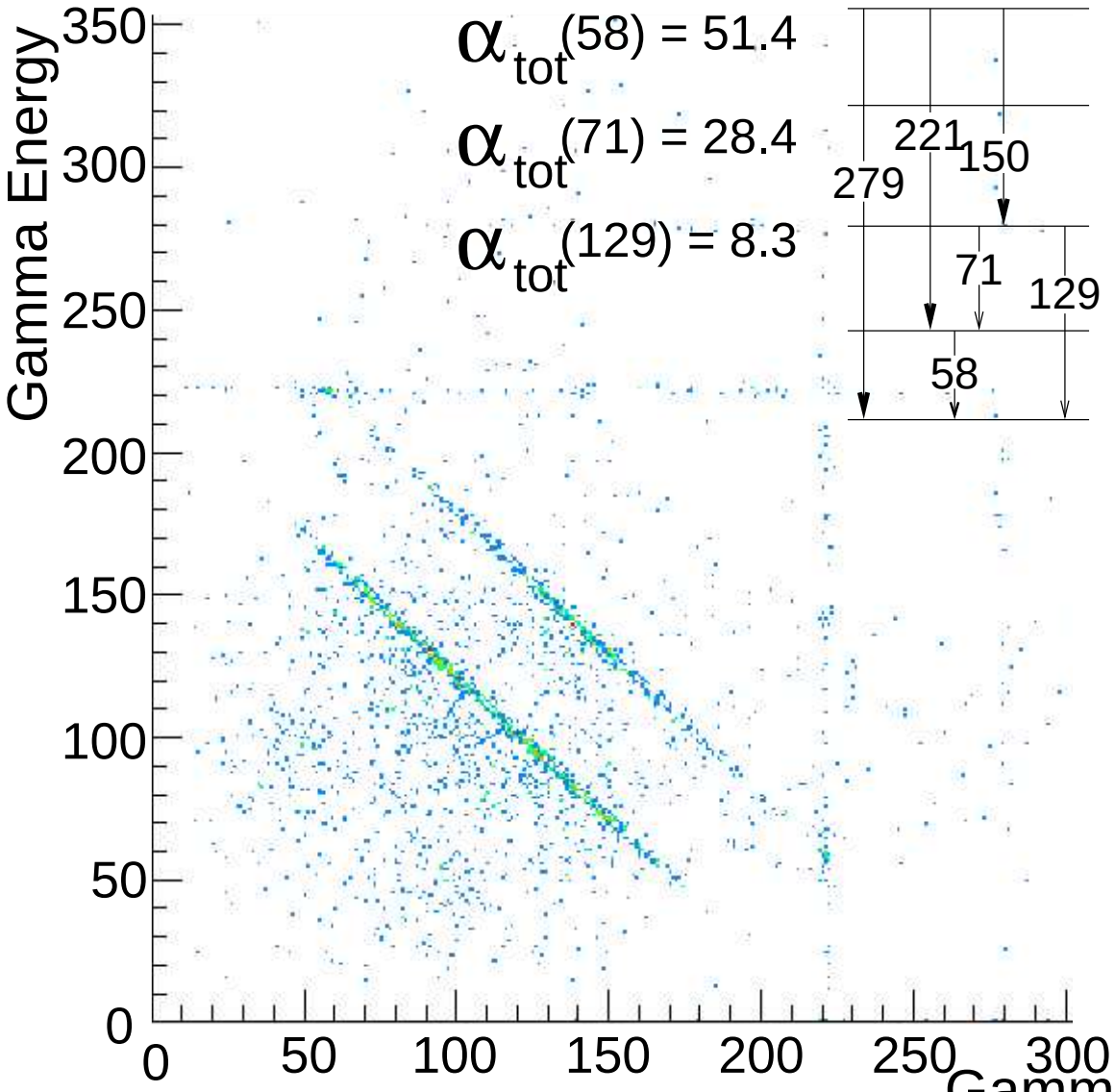
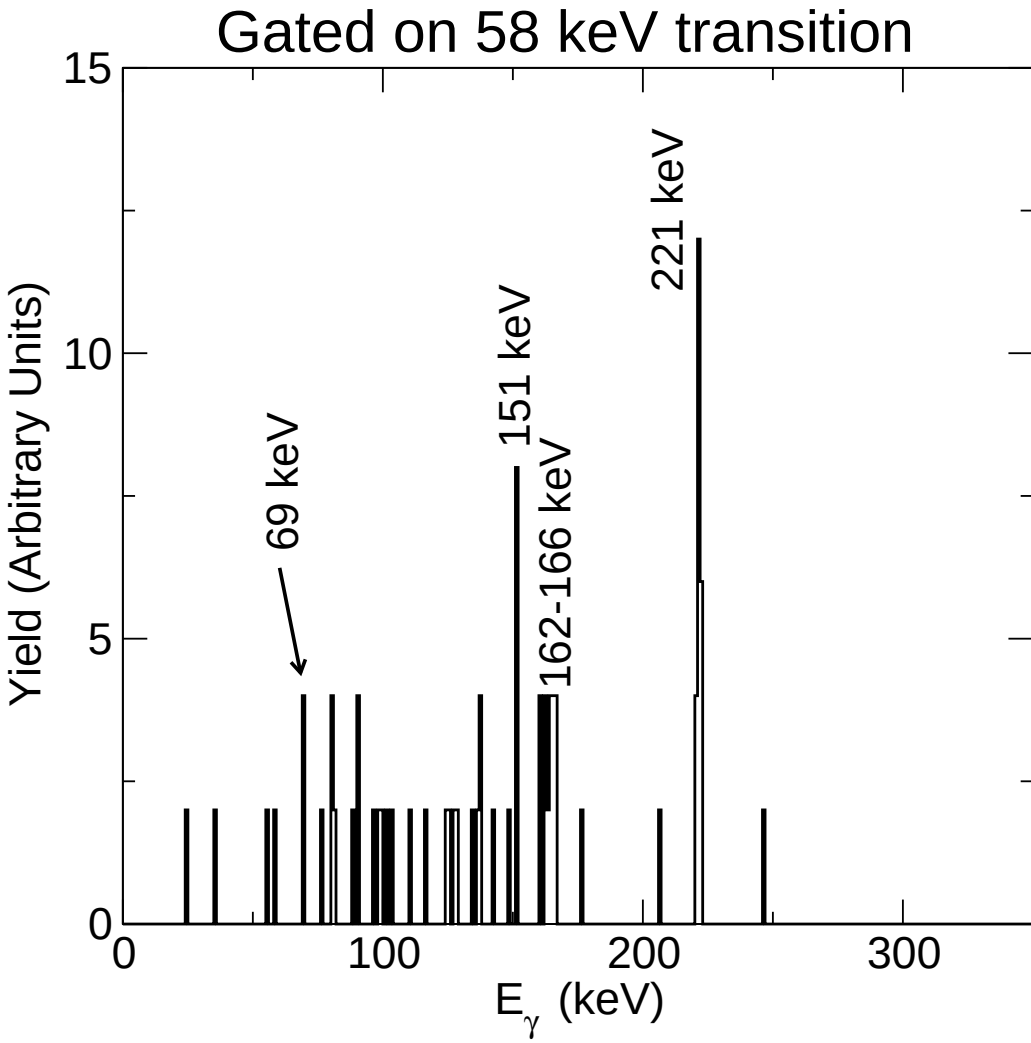
Alpha−Gamma−Gamma Coincidences

Addback + time gate + ONE crystal in each detector fireing





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Looking at K−isomers

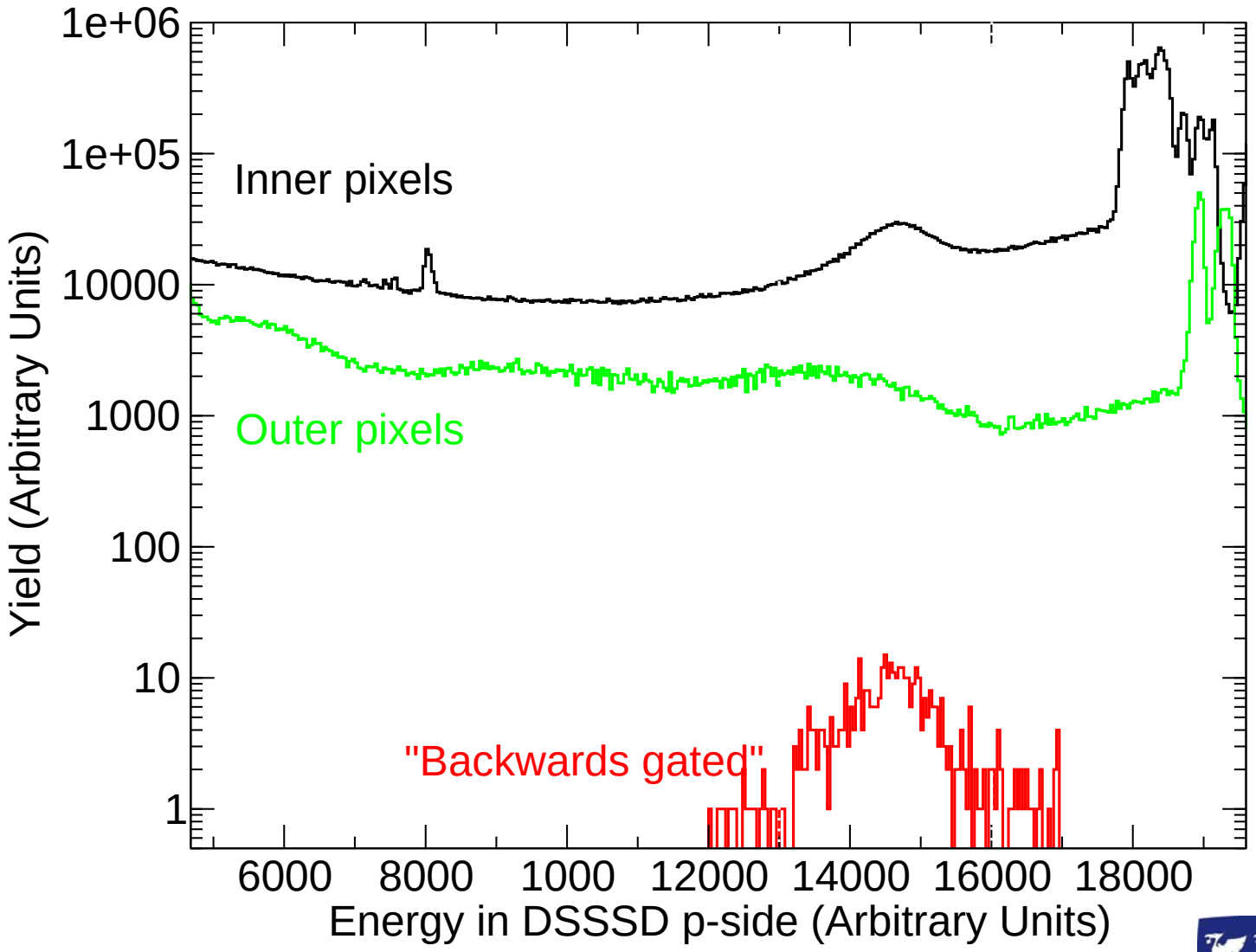
To create an implant−electron−gamma spectrum

* Implant energy
* Electron energy
* Chose a time gate between implant and electron
* Chose a time between electron and gamma

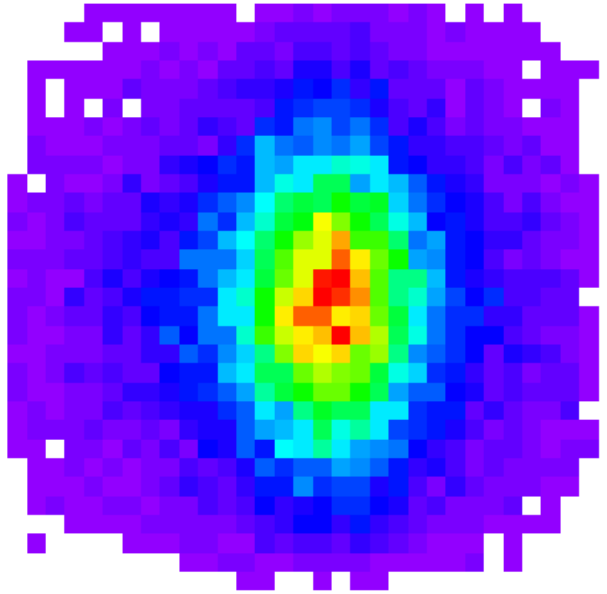
...et Voilà...?!

Energy of the ^{253}No Implants

Beam On − implanted into the p−side of the DSSSD



DSSSD hit pattern
(gated on 253No alpha)



(beam off)

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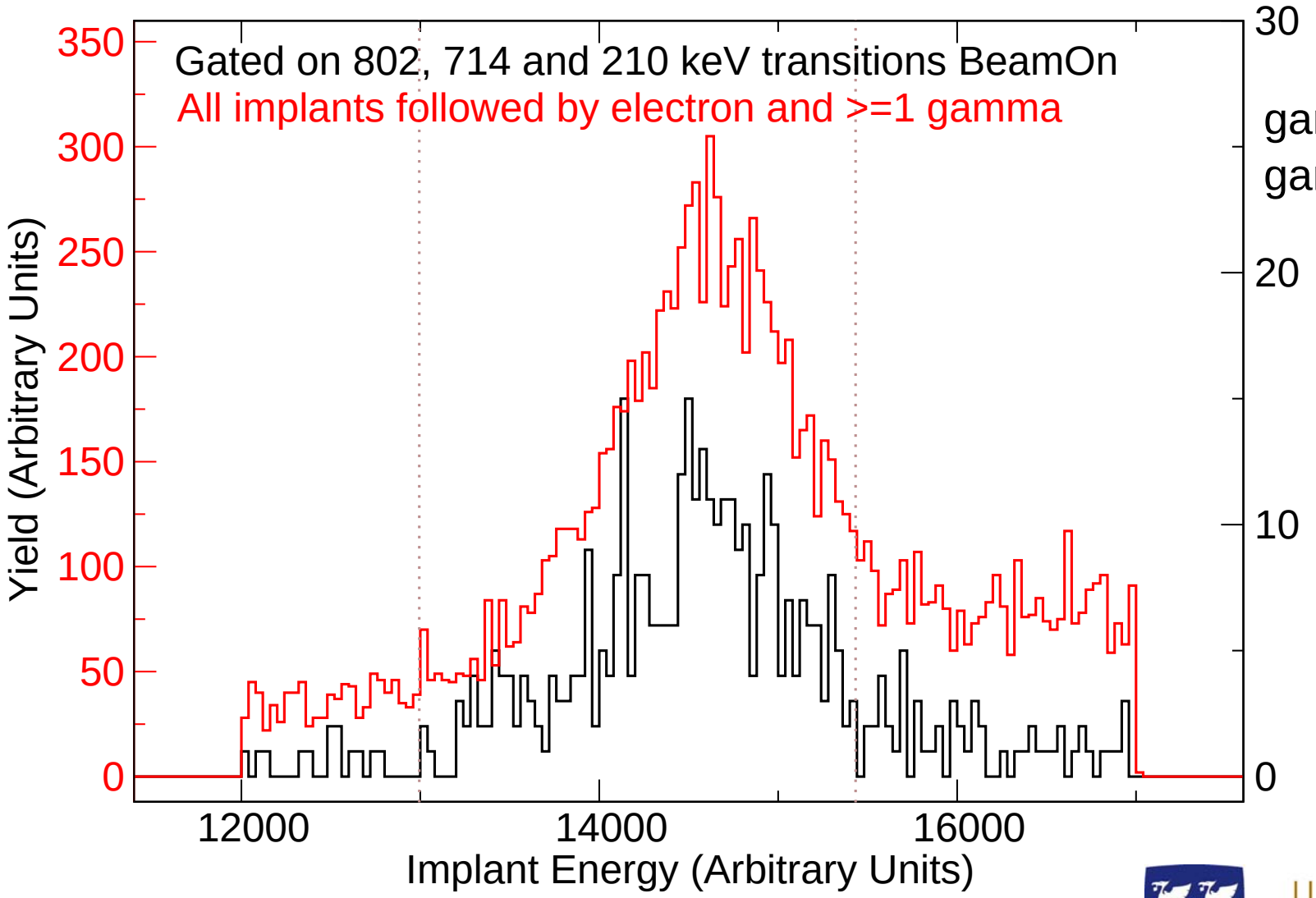
Implant Energy Revisited

Seems possible to narrow gate to improve cleanliness



gamma energy >10 keV
gamma time 44−60 "ticks"

Generous gate:
12−17 "MeV"
Tight gate:
13−15.5 "MeV"

(Thanks Fritz!)

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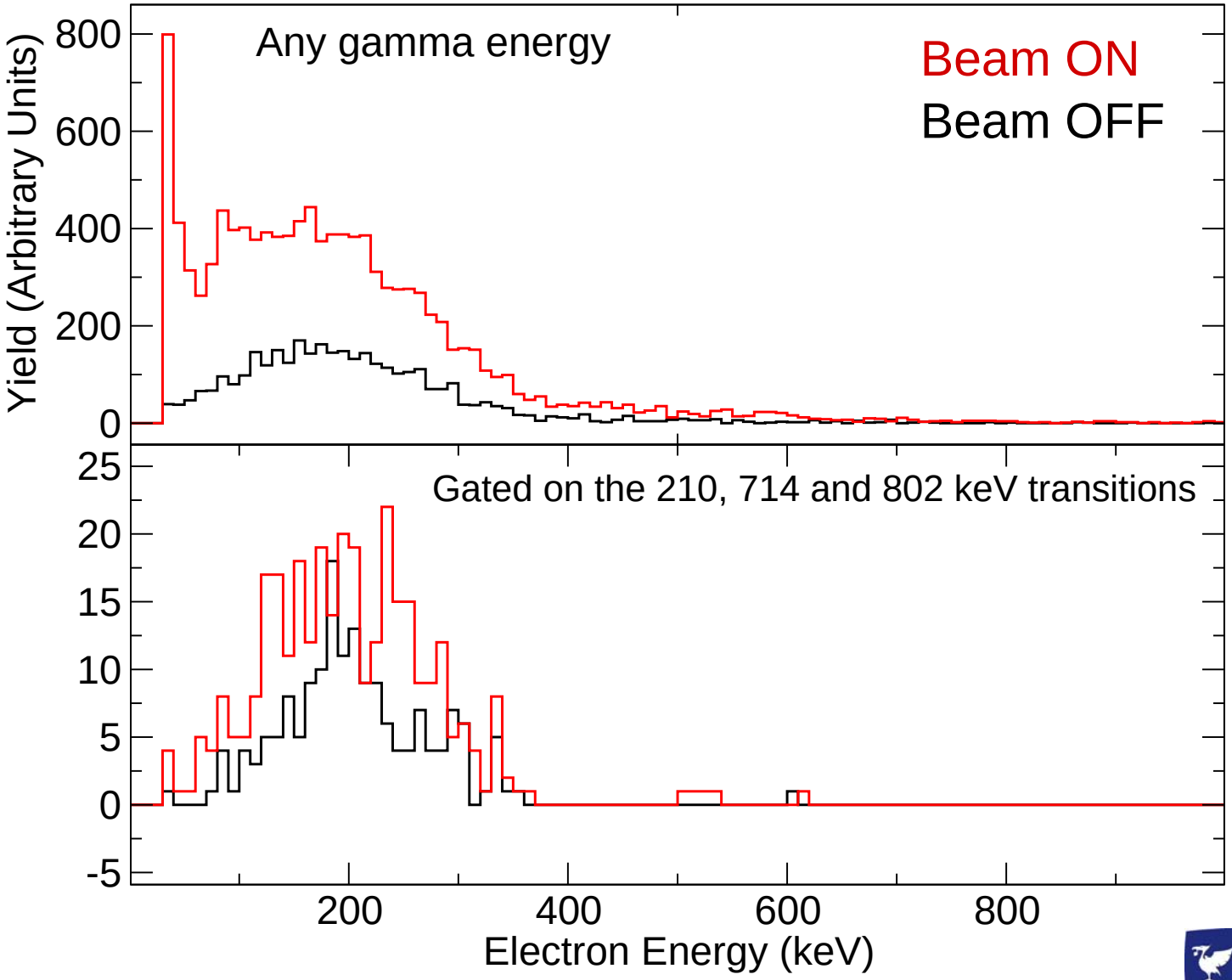
Electron Energy

Implant−electron correlation followed by at least 1 gamma ray



Generous gate:
30−2000 keV
Tight gate:
30−400 keV

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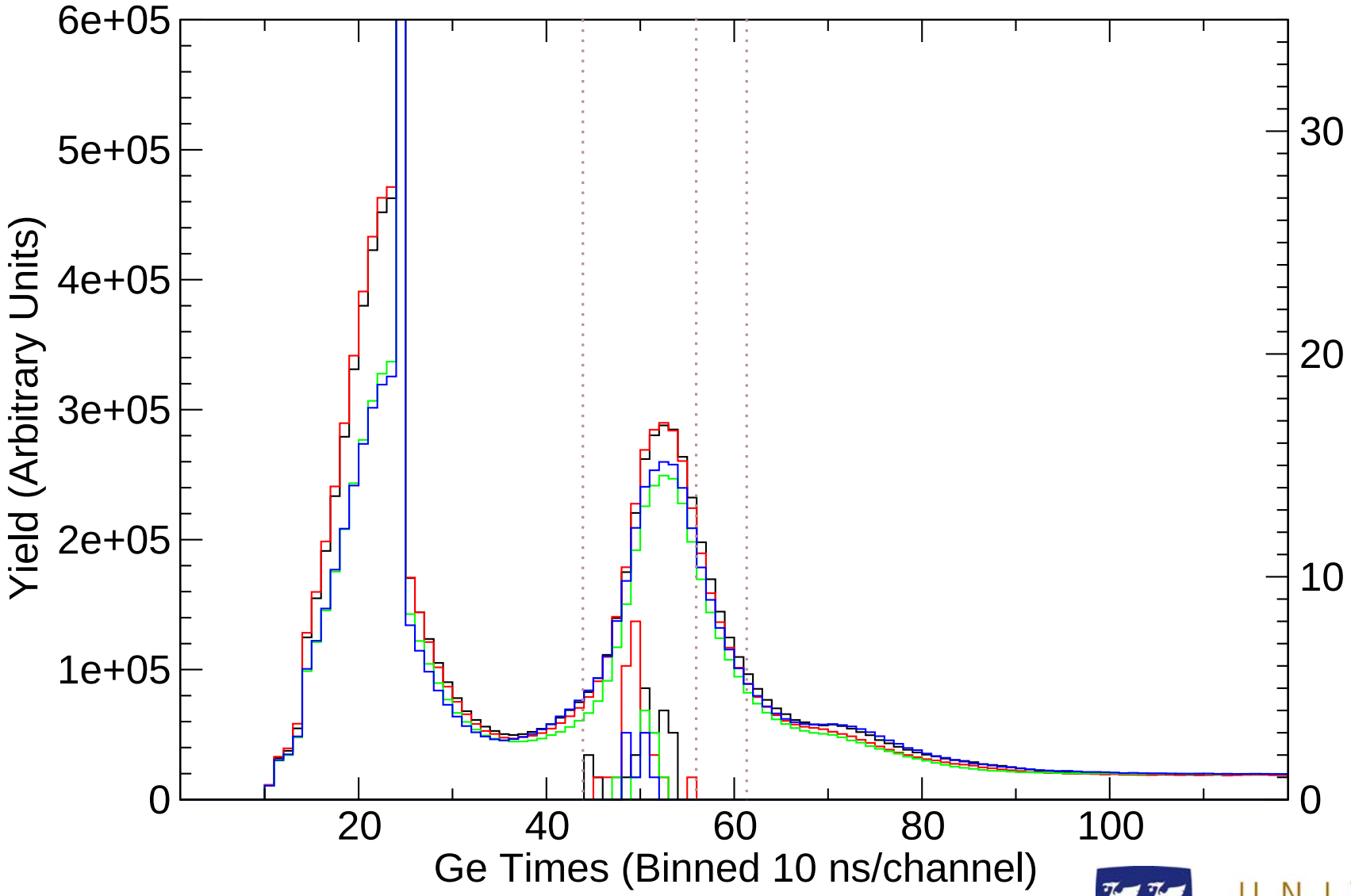
Ge Times

Times shown for 4 VEGA crystals + gated on 802 keV



Generous gate
440−600 ns
Tight gate:
440−550 ns

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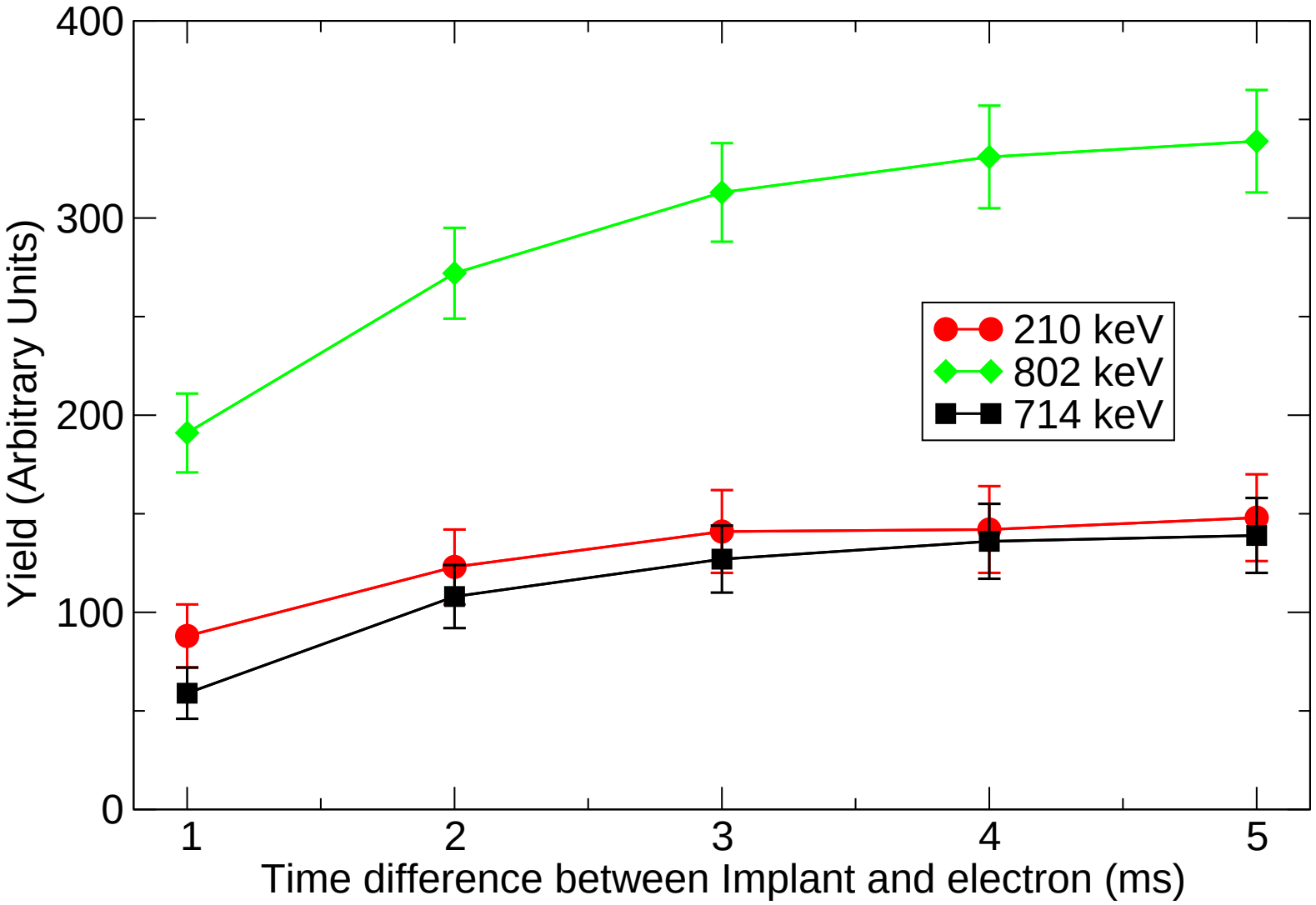
Time Difference Between Implant−Electron

Counts for the three intense peaks from the K−isomer



Previously: 3−5 ms

Seems reasonable also in this case!

Generous gate:
5 ms
Tight gate:
4 ms

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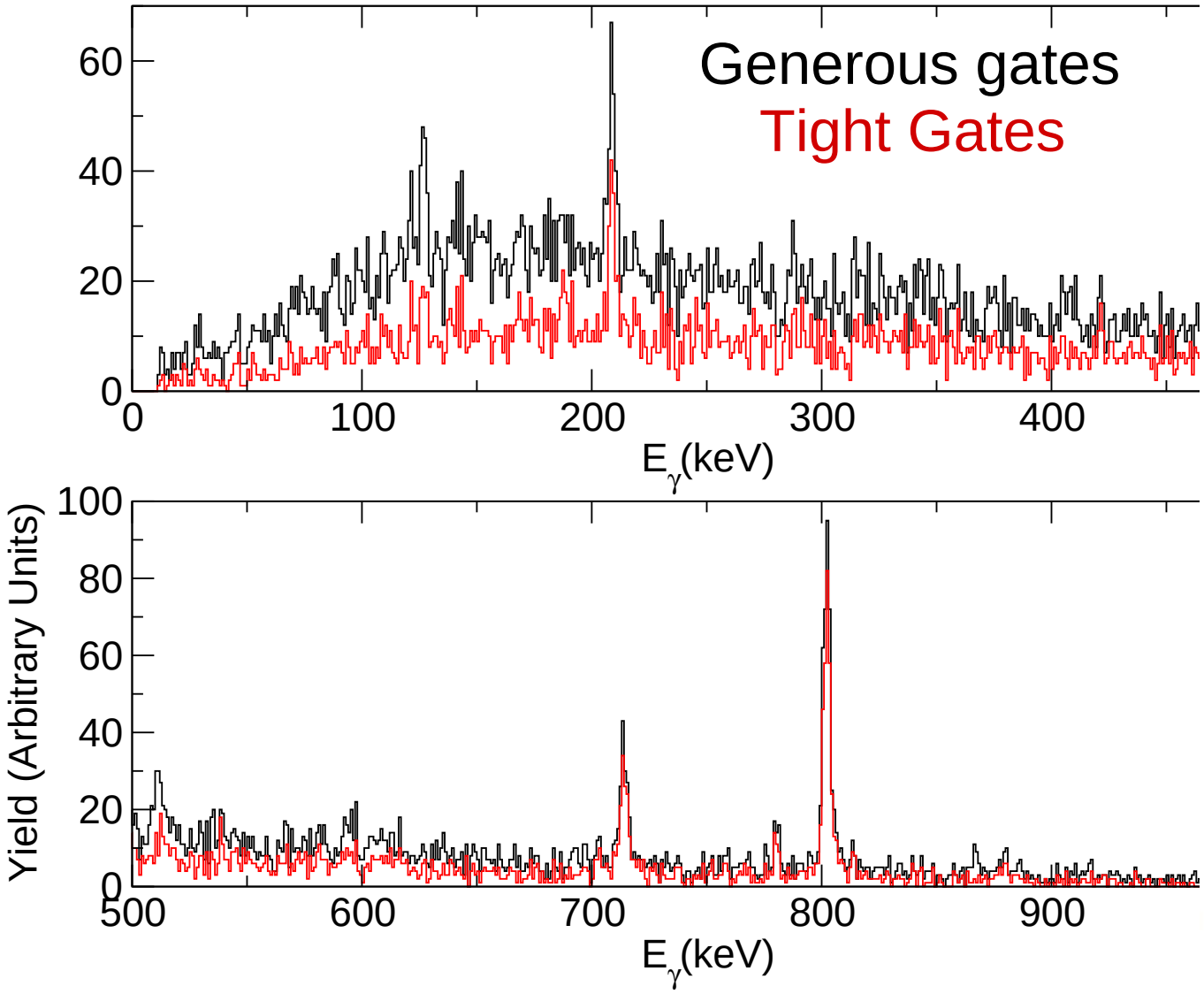
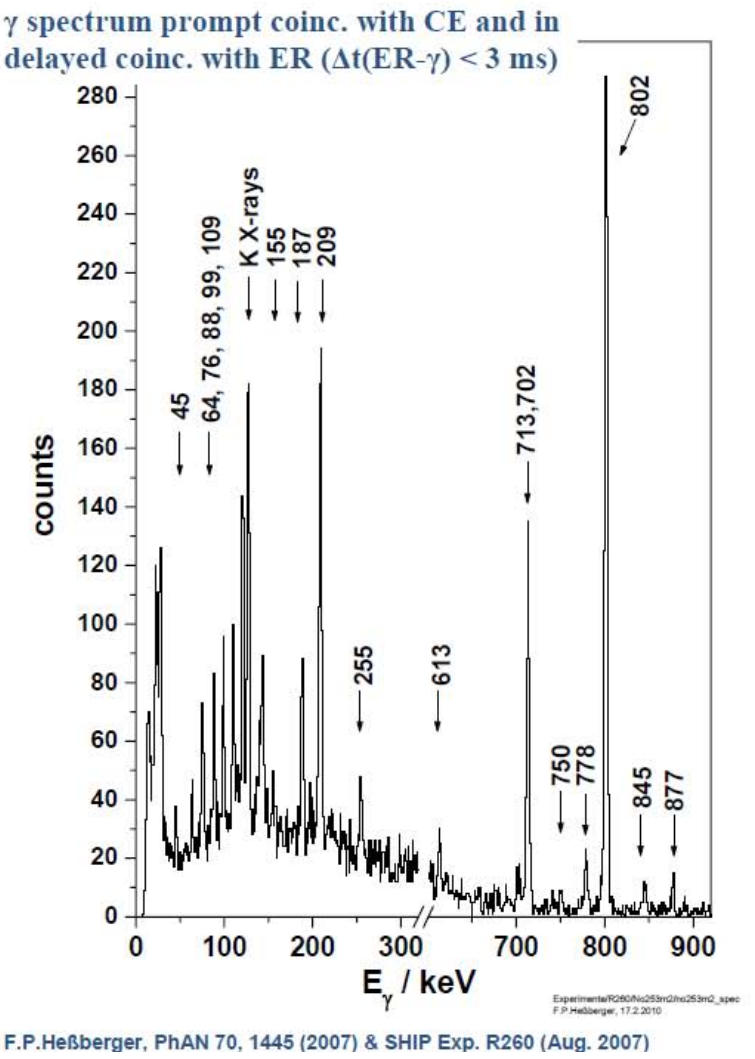
The Final K−isomer Spectra

...and a comparison with Fritz spectrum from SHIP





F.P.Heßberger, PhAN 70, 1445 (2007) & SHIP Exp. R260 (Aug. 2007)

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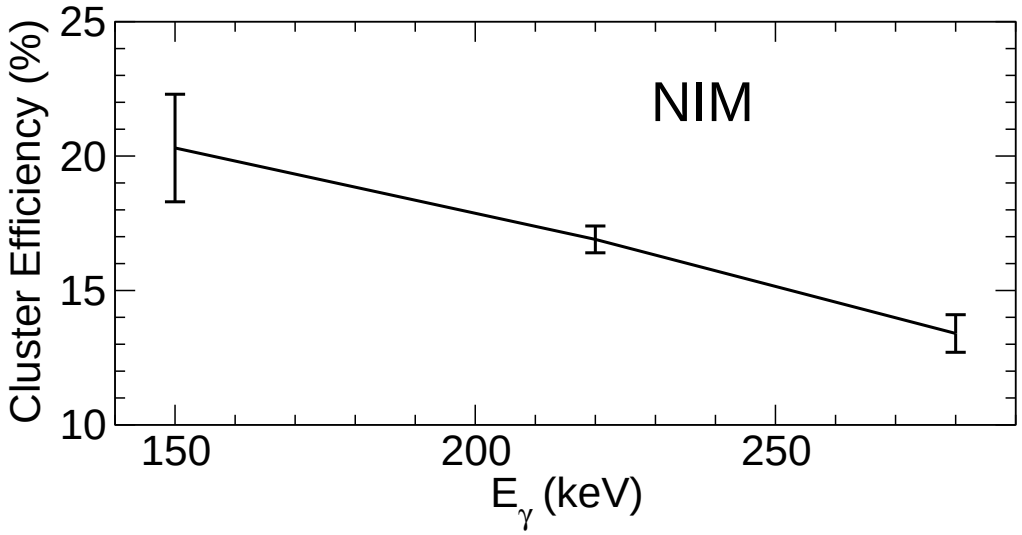
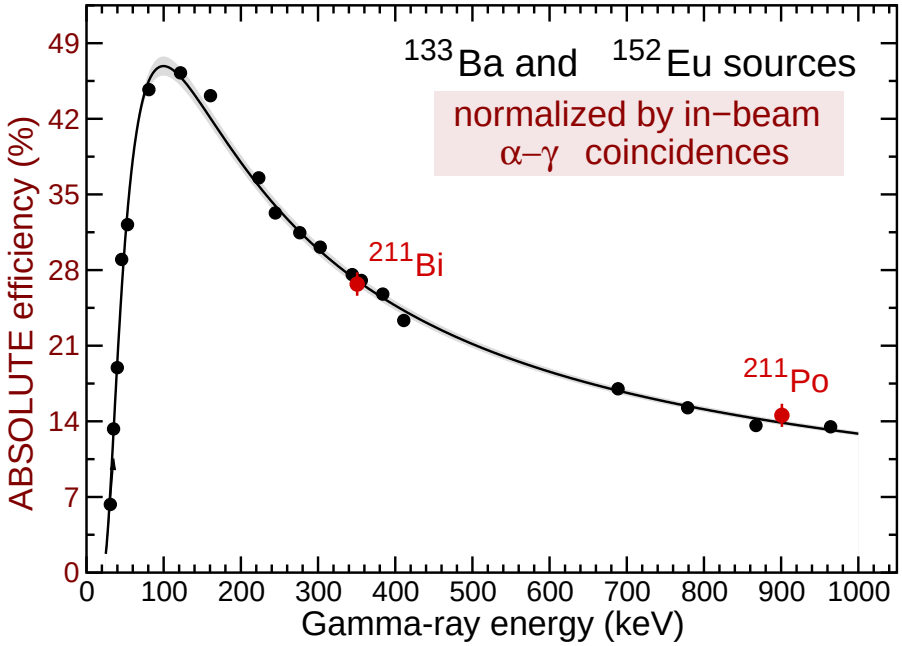
Comparing Efficiencies

My efficiencies does not add up. Why??



Run with 4.50 MeV/u beam energy



Alpha paticles: 104700 (7.96−8.1 MeV && n−side)

Clover: 4.1(3)%, 4.3(1)%, 3.2(2)%

Cluster: 10.1(7)%, 11.2(3)%, 8.2(4)%

Cluster: 20.3(20)%, 16.9(5)%, 13.4(7)% (NIM)

50(6)% 66(3)% 61(4)%

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Comparing Efficiencies

Where do the data go? (Beam OFF only)

Looking at Cluster data to compare the numbers.

Good event requires:
Fast Trigger Count==1
No pileup flag
No re−trigger flag

From the events in the read−in structure:
100% comes trough to good/bad event sort
77% have fast trigger counter ==1 (the rest varies between 2−15)
77% have NO pileup flag (can only be YES or NO)
91 % have NO retrigger (can only be YES or NO)

Related

In total 70% are good events by these standards. Reasonable?

Henning says YES!

The numbers persist through the program!

Comparing the results from the two beam energies

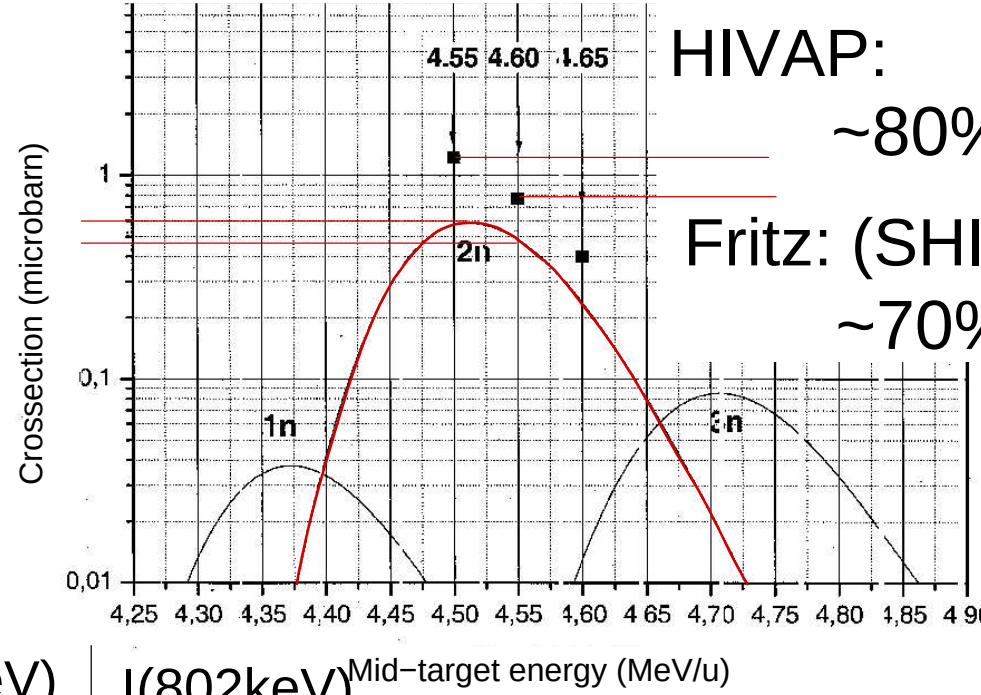
Comparing mid target energy of 4.50 with 4.55 MeV/u

Alpha particles: (7.9–8.2 MeV)

(beam integral accounted for)

124 000
43 500

=> 70%



HIVAP: ~80%

Fritz: (SHIP) ~70%

Gates used: implant 12−17 MeV & electron 30−2000 keV
5 ms imp−electron, 440−660ns ge−time

B Energy	B Integral	I(210 keV)	I(714keV)	I(802keV)
4.50	6.02 E 17	142(18)	146 (19)	334(26)
4.55	2.95 E 17	66(10)	82(13)	229(22)
Ratio:	50%	46(9)%	56(11)%	69(9)%

142/334=0.43(6)

146/334=0.44(7)

66/229=0.29(5)

82/221=0.36(7)

Fritz:

0.50

0.43

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A Summary of Difficulties

* Efficiency for the Ge not agreeing with previous measurements
  - Germanium?
  - Si−Ge correlations?
  - In the data or in the code?
  - Why are not all energies affected equally?
* Implant energy unknown. Can be bypassed!
* Scattering between the crystals??
  - Implement some kind of shielding in the future?

ALL INPUT IS GREATLY APPRECIATED!

TASISpec

The Next Step for Superheavy Element Spectroscopy

University of Liverpool, UK

TASCA @ GSI, DE

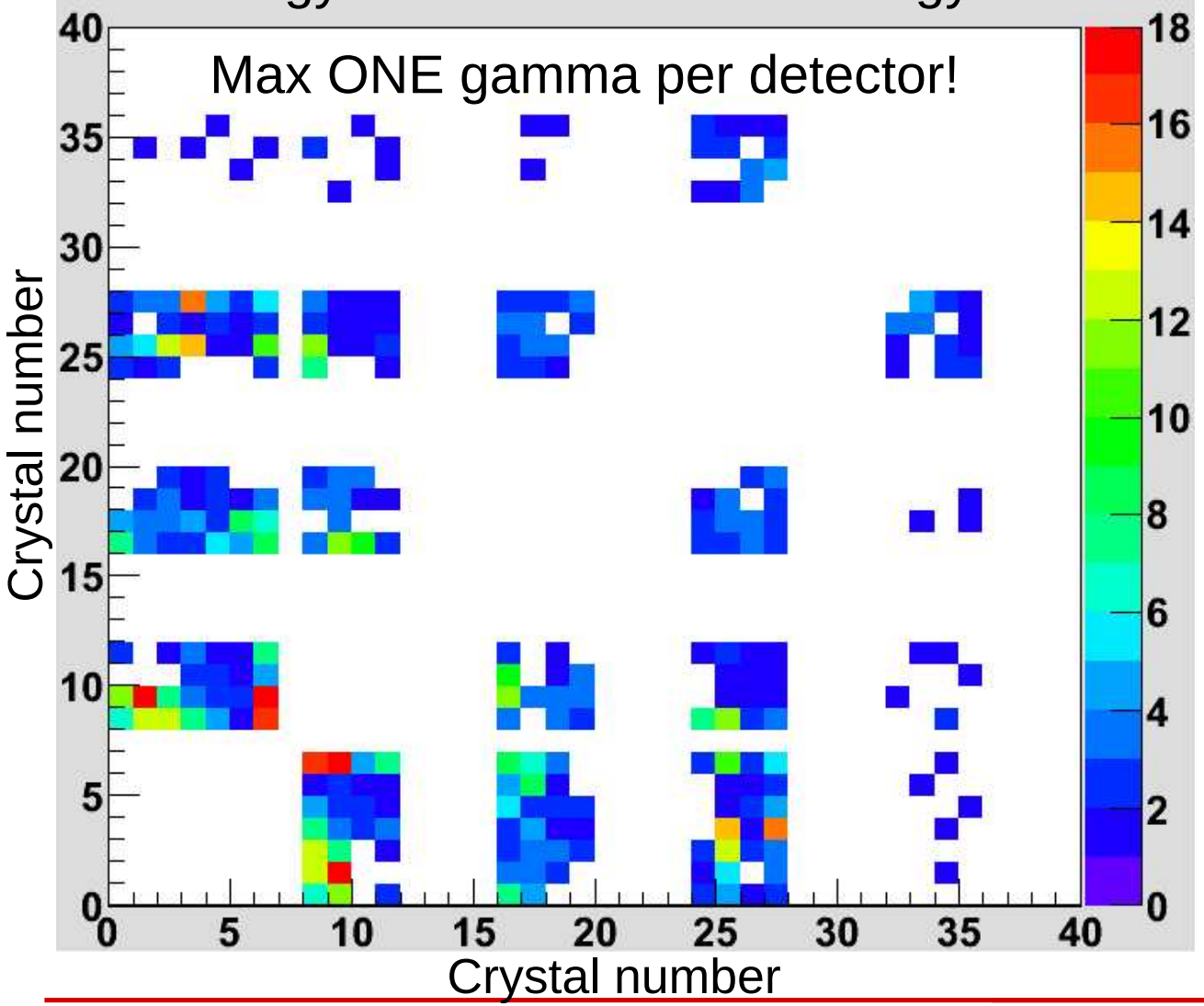
Lund University, SWE

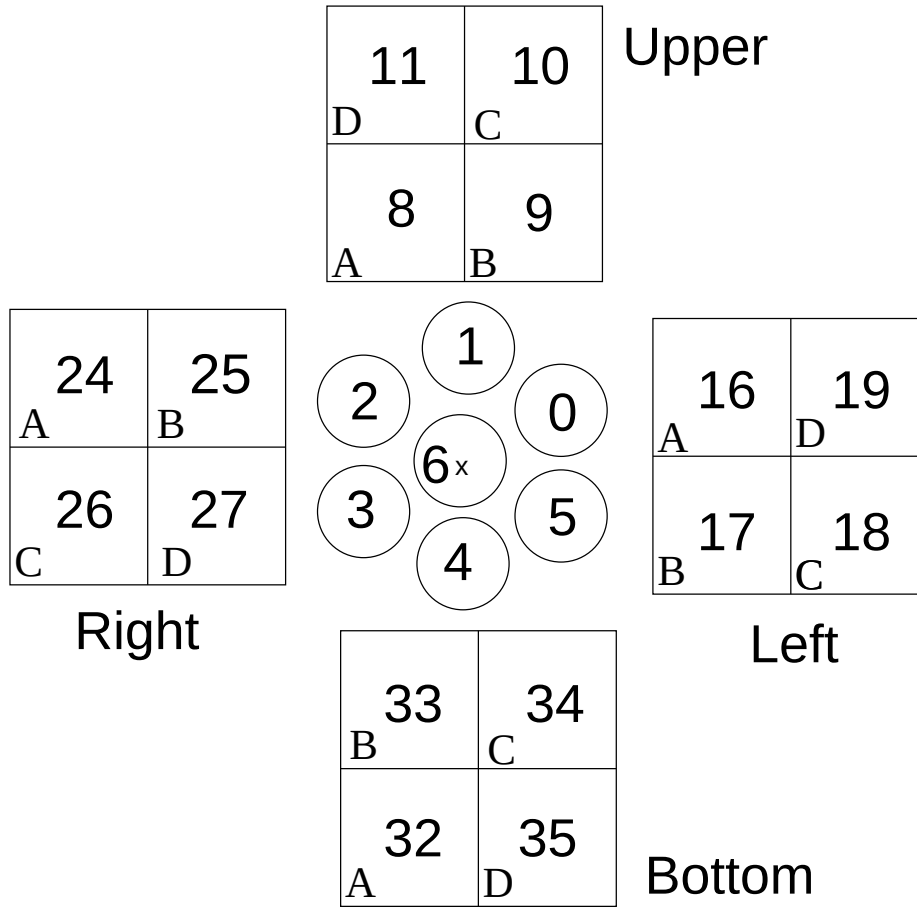
Technische Universität München, DE

Universität Mainz, DE

Scattering of Gamma Rays Between Crystals

Gates on 253No alpha on both p and n−side, Time gate of gamma
Single energy <200
Sum energy 218−225 OR Sum energy 276−282 keV





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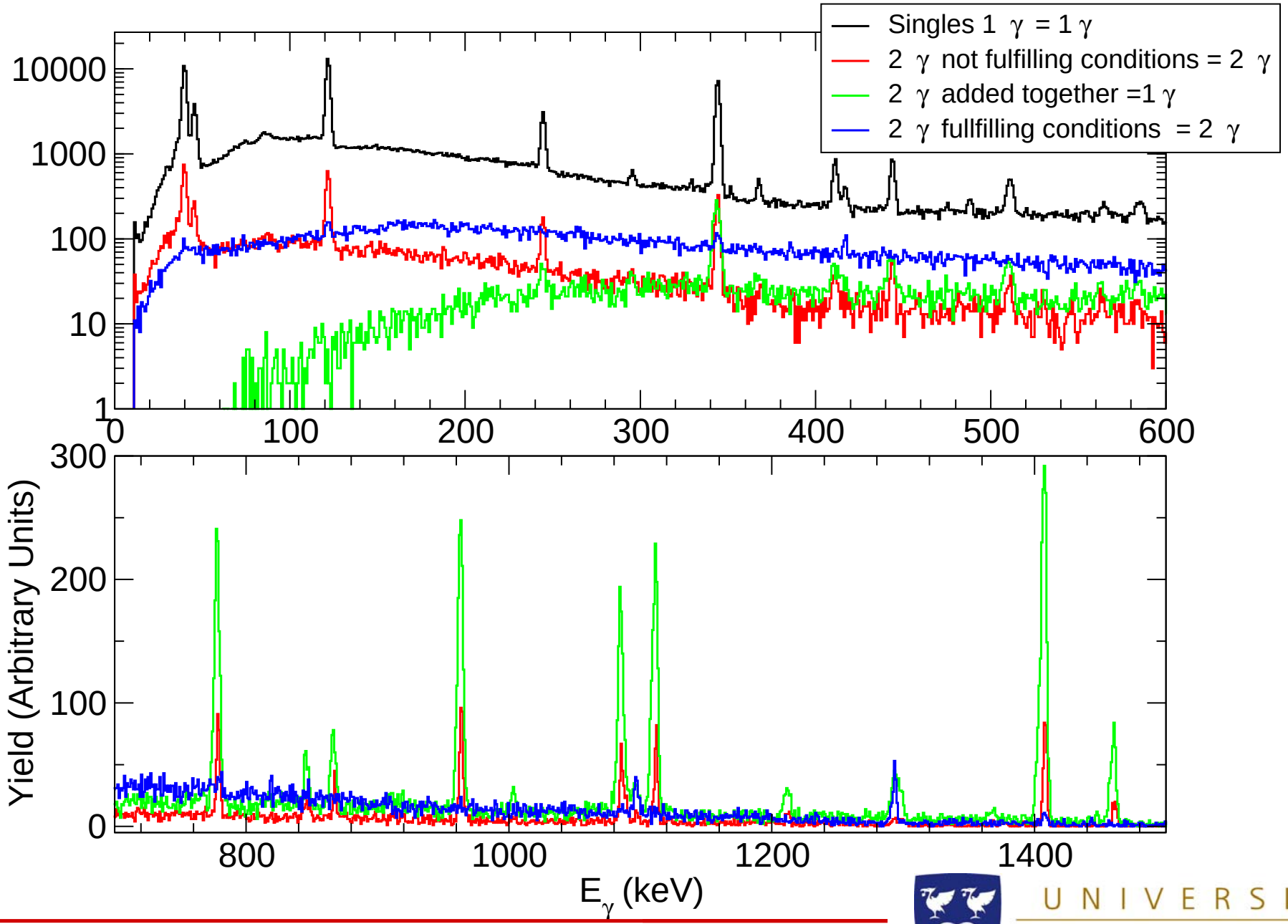
Yes, the addback is working!



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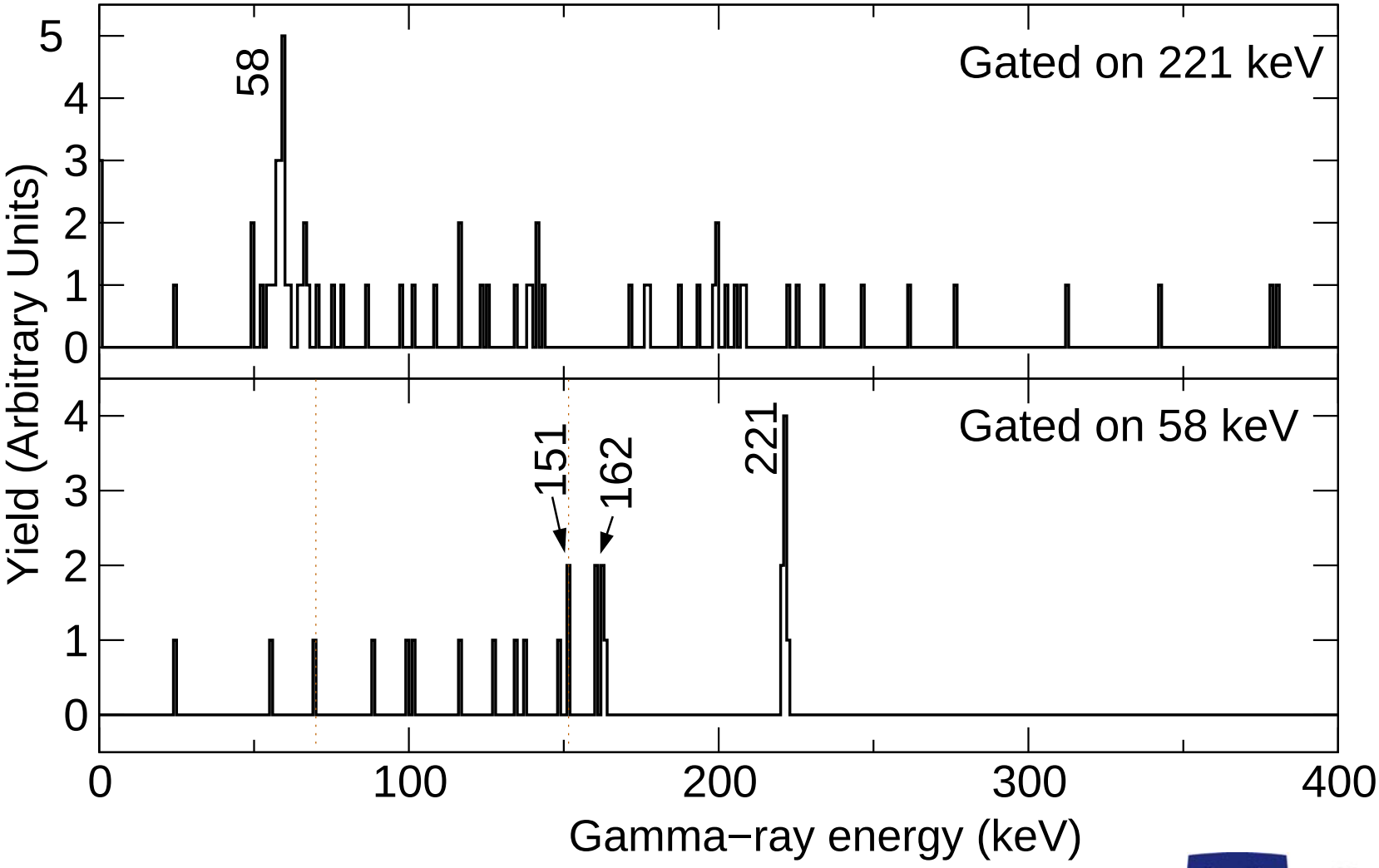
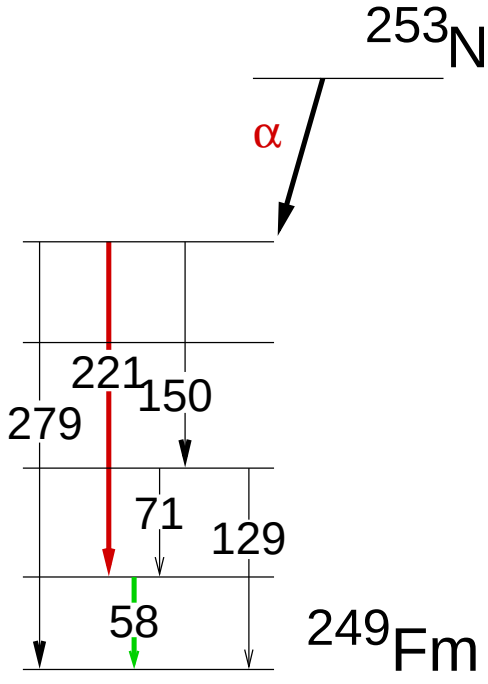
Alpha−gamma−gamma Correlation

7.9−8.2 MeV Si energy, max 1 crystal in each Ge−detector fireing





$\alpha_{tot}(58) = 51.4$

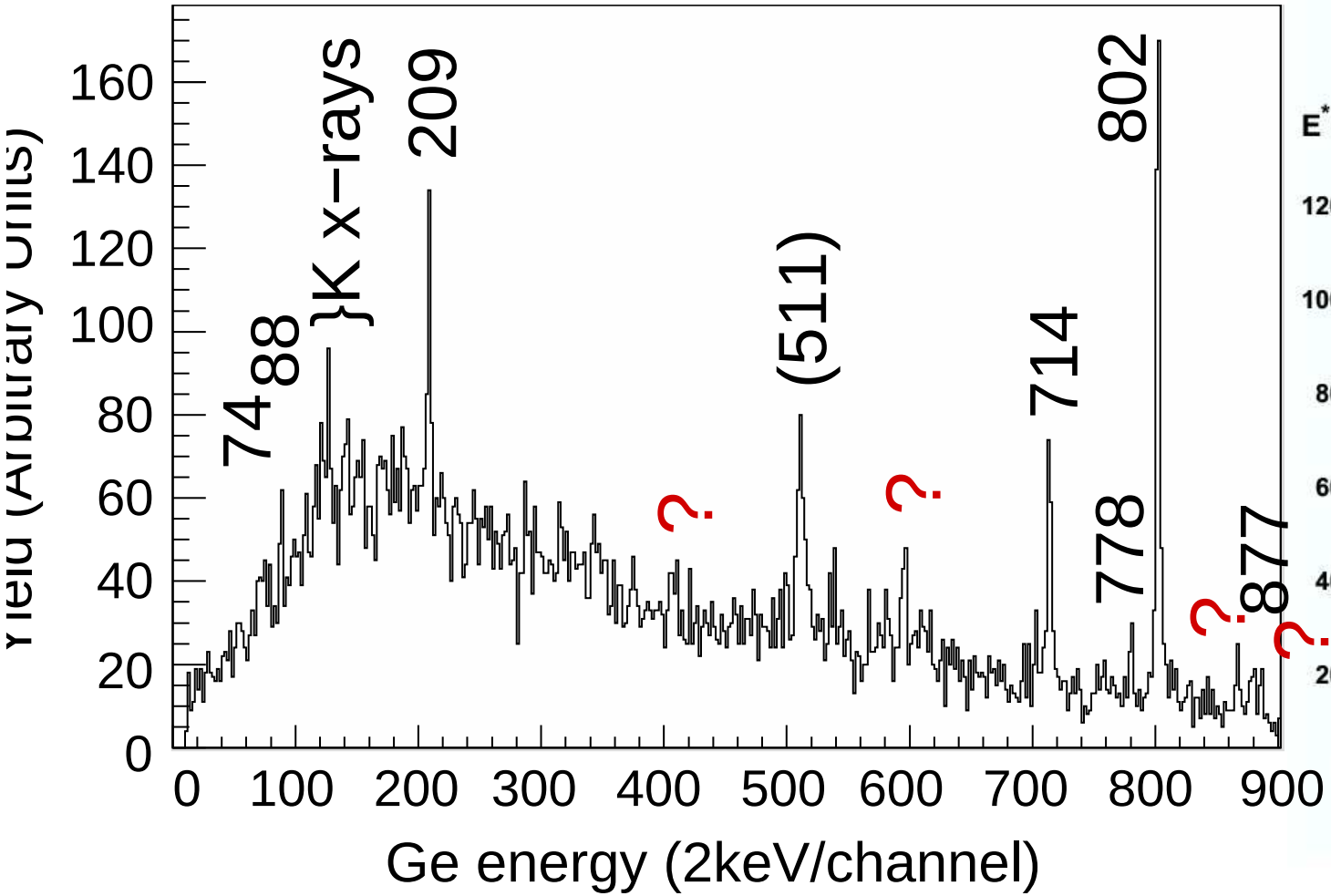
$\alpha_{tot}(71) = 28.4$

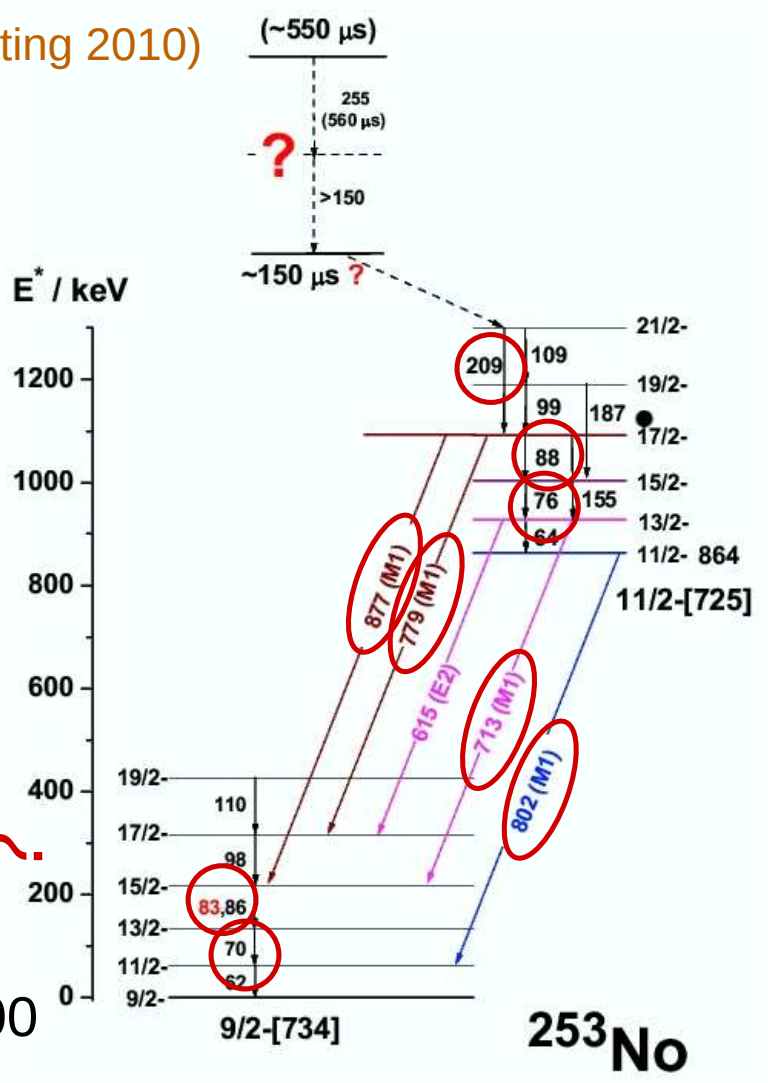
$\alpha_{tot}(129) = 8.3$

Implant−electron−gamma correlations

PRELIMINARY!!! 5ms ER−>electron, electron=40−450 keV

Level scheme borrowed from F. Hessberger (annual NUSTAR meeting 2010)





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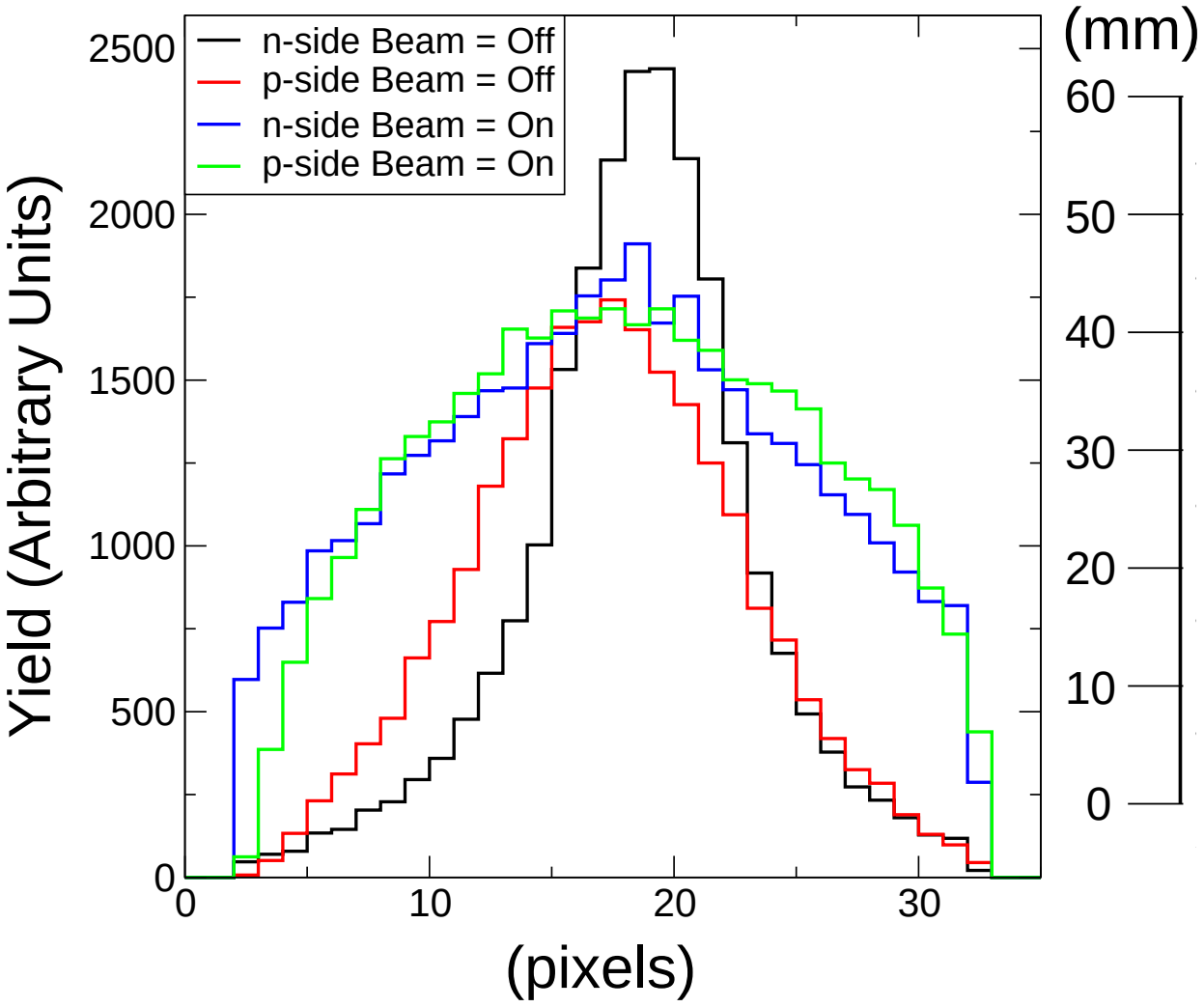
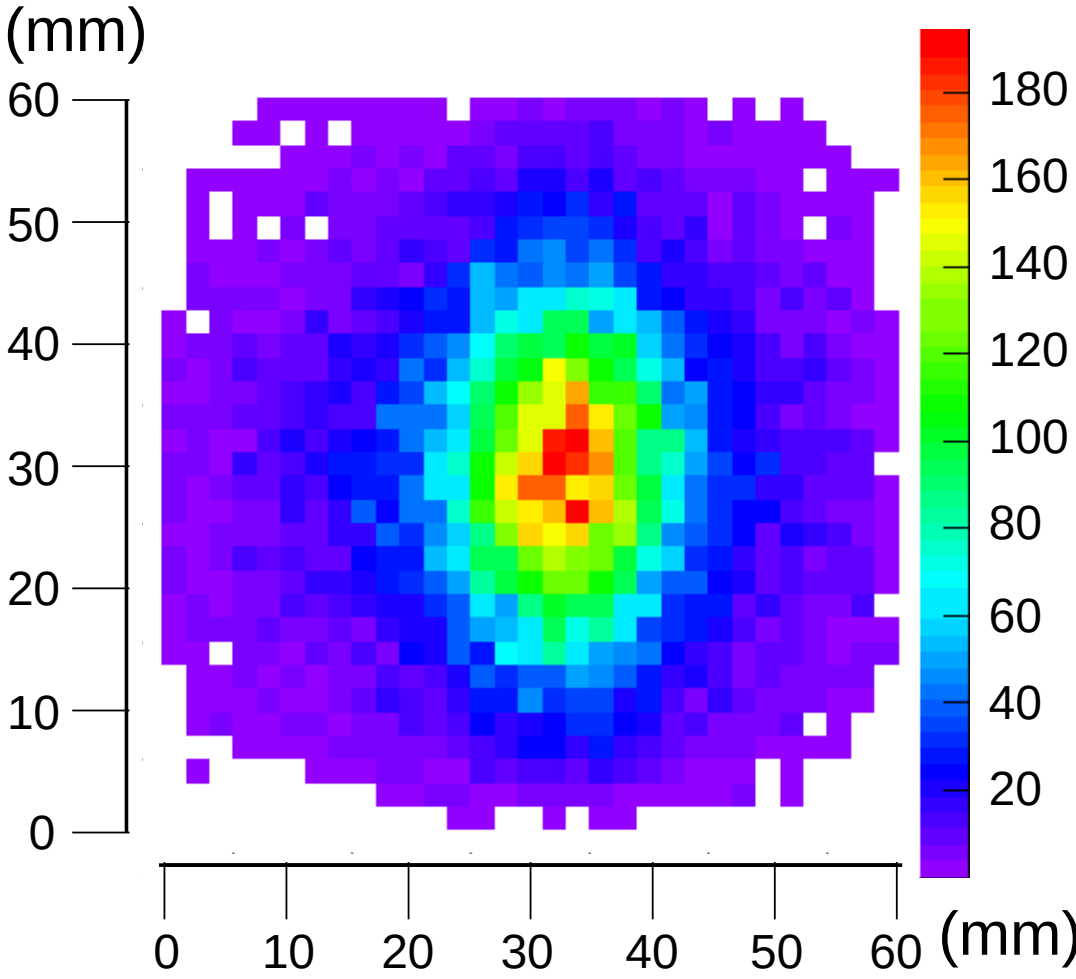
DSSSD Implantation Profile

Hitpattern in 1D and 2D for the DSSSD





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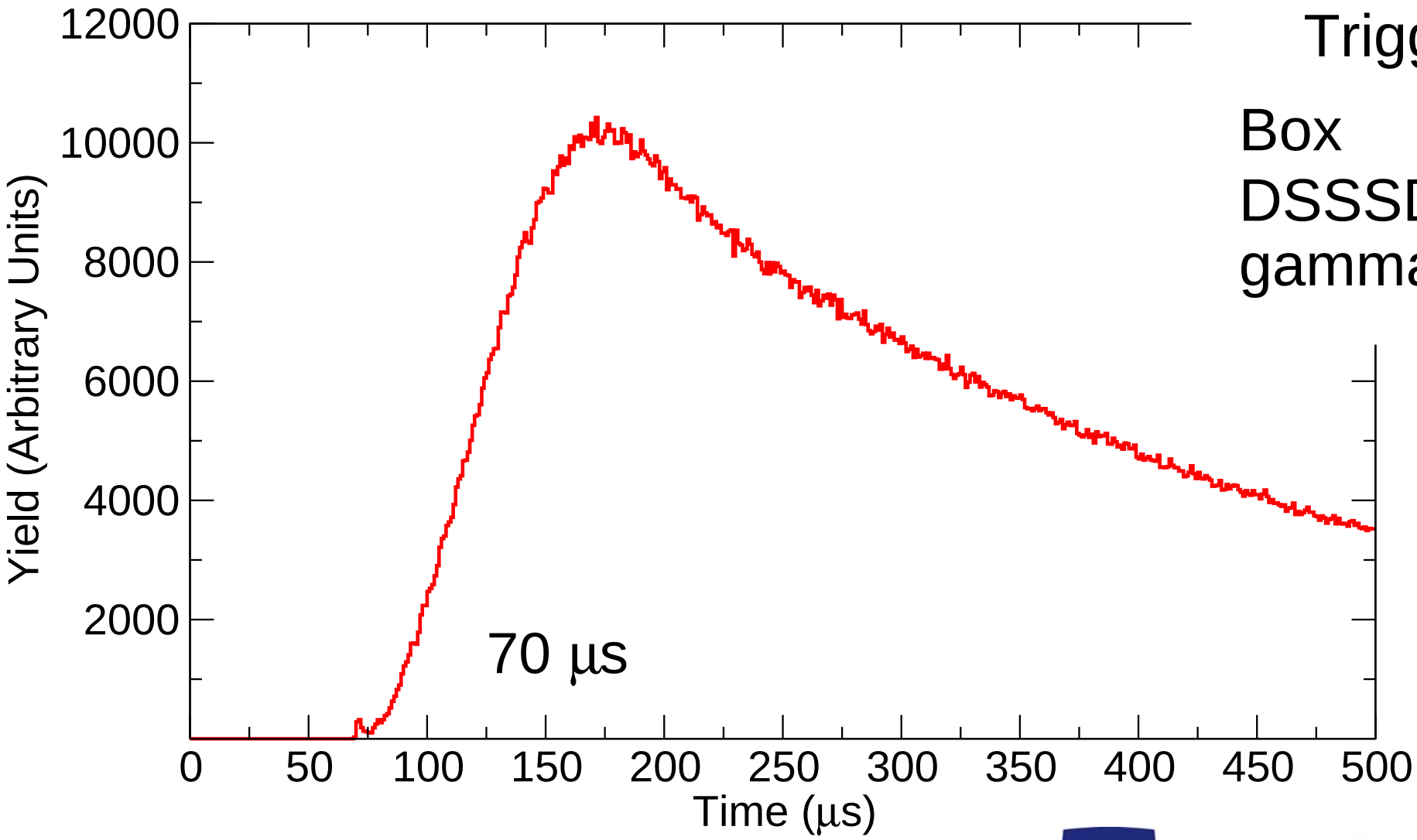
Dead Time Using the Full Set−up

Time difference between two subsequent incoming triggers



Triggers:

Box

DSSSD p OR n

gamma $\geq$ 3

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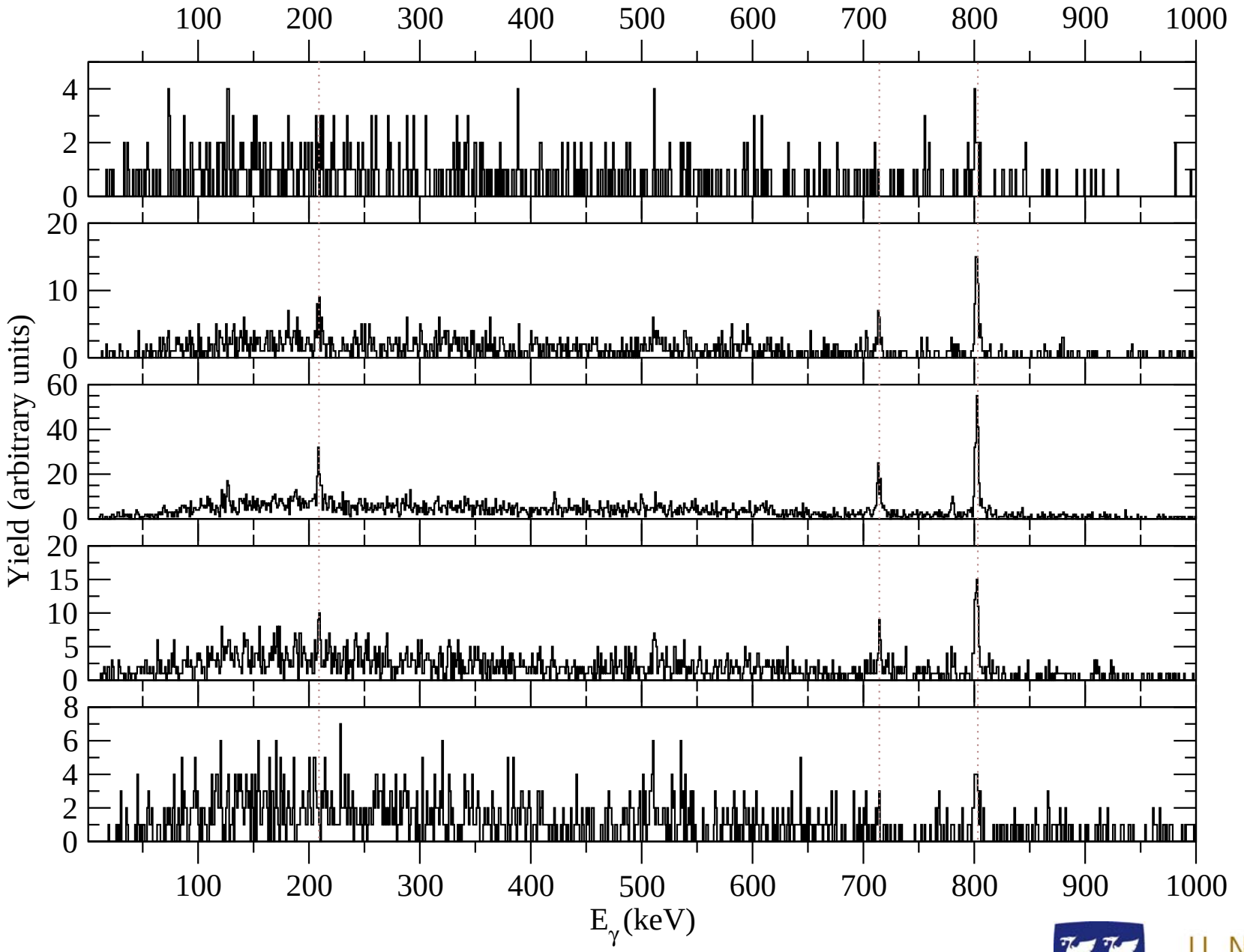
Possible or Desired Improvements

A setup under constant developement

* Thicker implantation detector (0.31 −> 0.52 −> 1.0 mm)
* 32−event block readout mode
* Pulse−shape electronics for DSSSD
* DSSSD for box

Implant Energy Revisited



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TASISpec

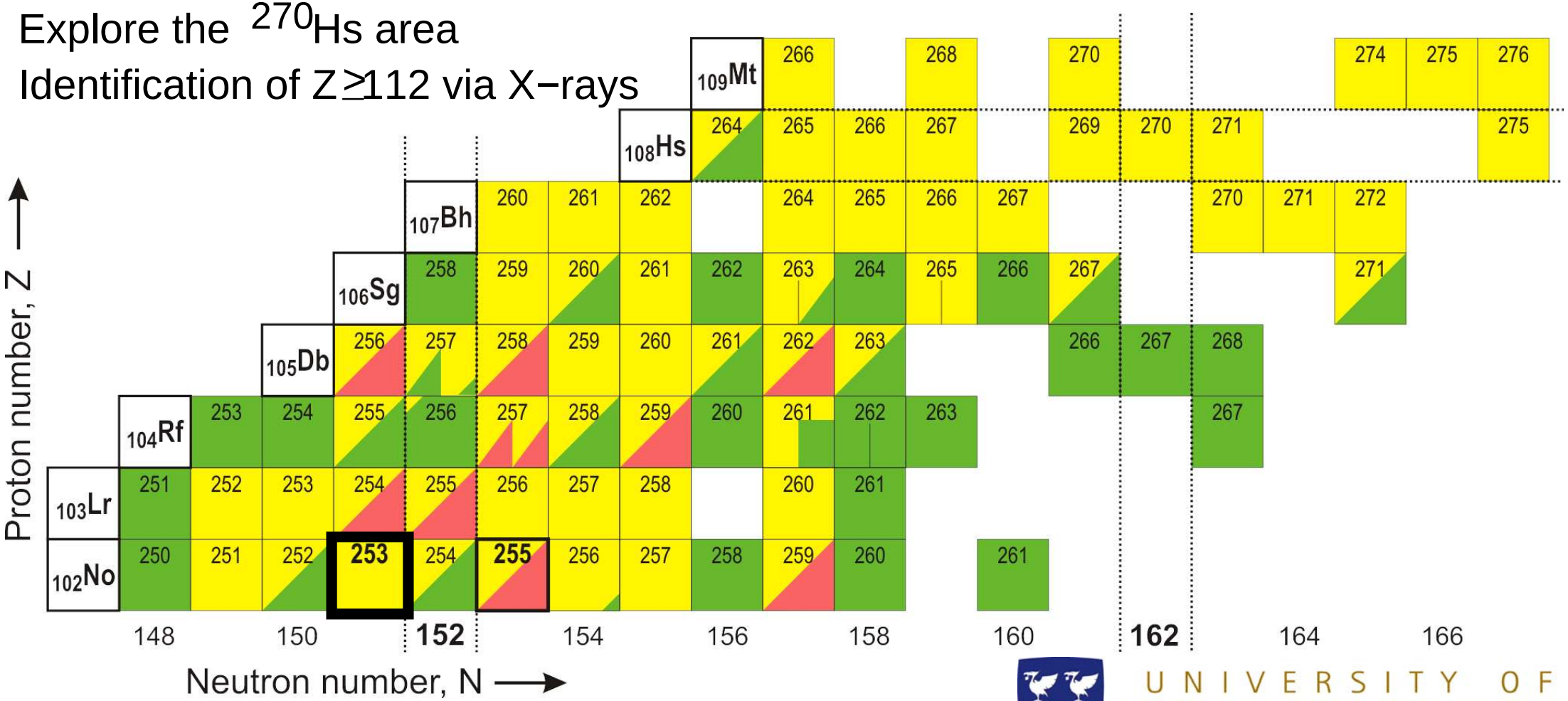
A new tool to explore superheavy elements

Shell structure of the heaviest elements via coincidence spectroscopy

Define the ^{254}No area (^{253}No experiment carried out in May)

Explore the ^{270}Hs area

Identification of Z≥112 via X−rays



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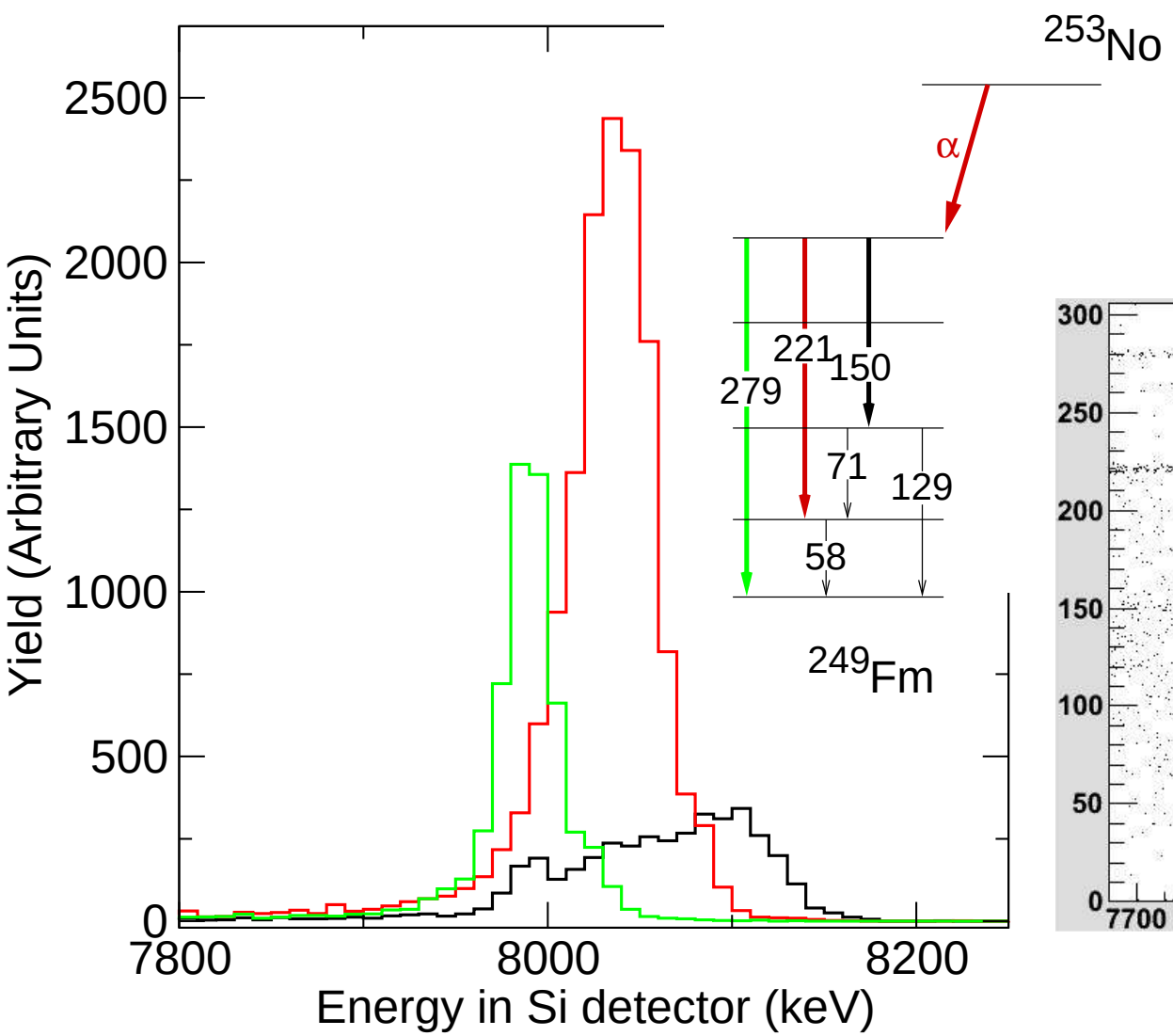
Alpha−gamma Correlation

Gating on gamma rays to see energy in Si detector



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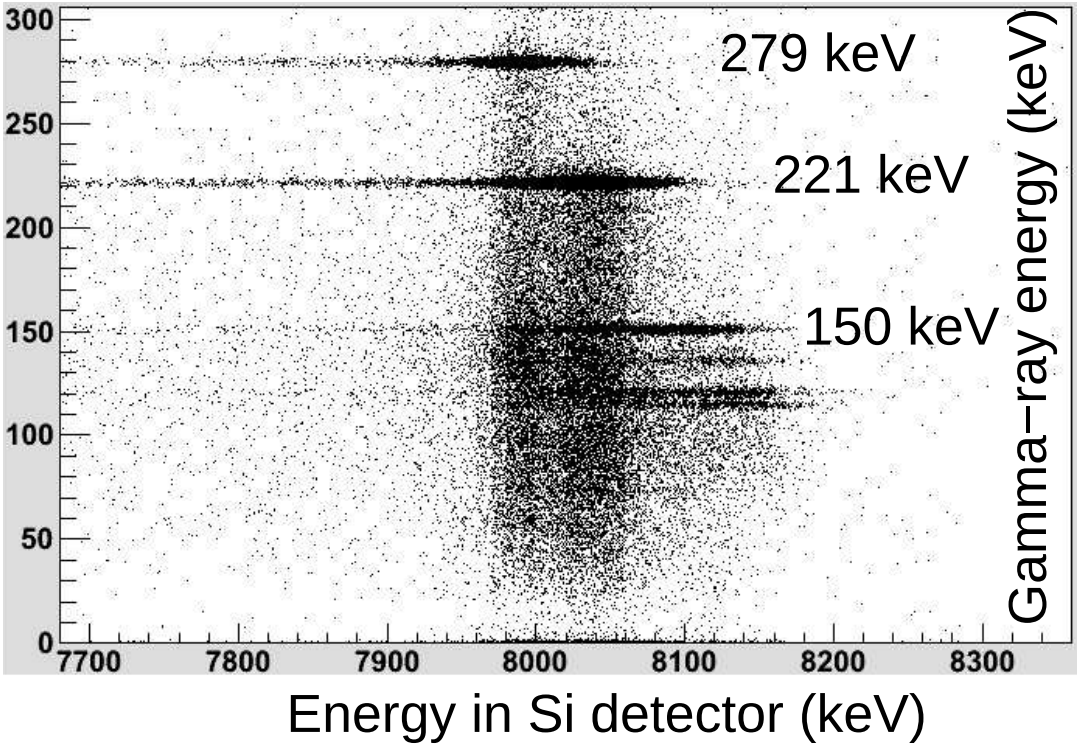

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First Main Beam Experiment

Define K−Isomers in ^{253}No

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

* F.P. Hessberger; α–γ decay studies SHIP 2004
* F. P. Hessberger; isomeric γ and CE decays SHIP 2007
* A. Lopez−Martens; isomeric γ and CE decays Dubna 2007
* R.−D. Herzberg; in−beam studies JYFL 2002
* P. Reiter; in−beam studies ANL 2005