



In-Beam Gamma-Ray Spectroscopy of Neutron-Rich Actinides after Multi-Nucleon Transfer Reactions

EGAN Workshop 2014

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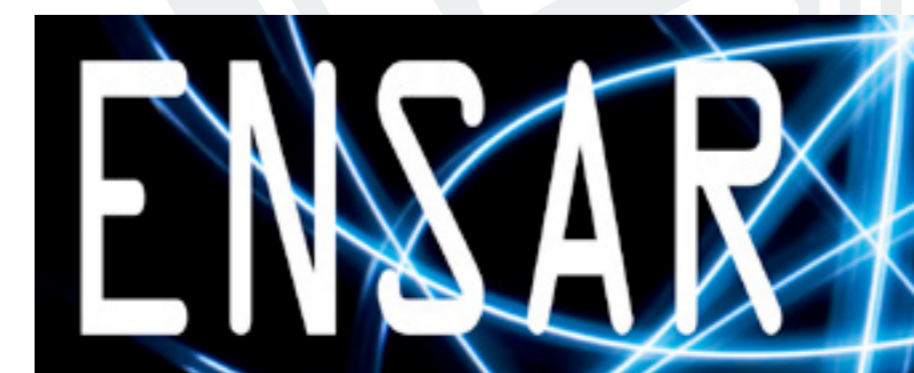
24 June 2014



Bonn-Cologne Graduate School
of Physics and Astronomy



Bundesministerium
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Motivation: Spectroscopy of neutron-rich Z=90-92 actinides

Recent theoretical investigations of neutron-rich actinide nuclei

Shell Correction Energy

A. SOBICZEWSKI, I. MUNTIAN,
Z. PATYK, PHYS. REV. C, 63
(2001) 034306

Alternative Parity States

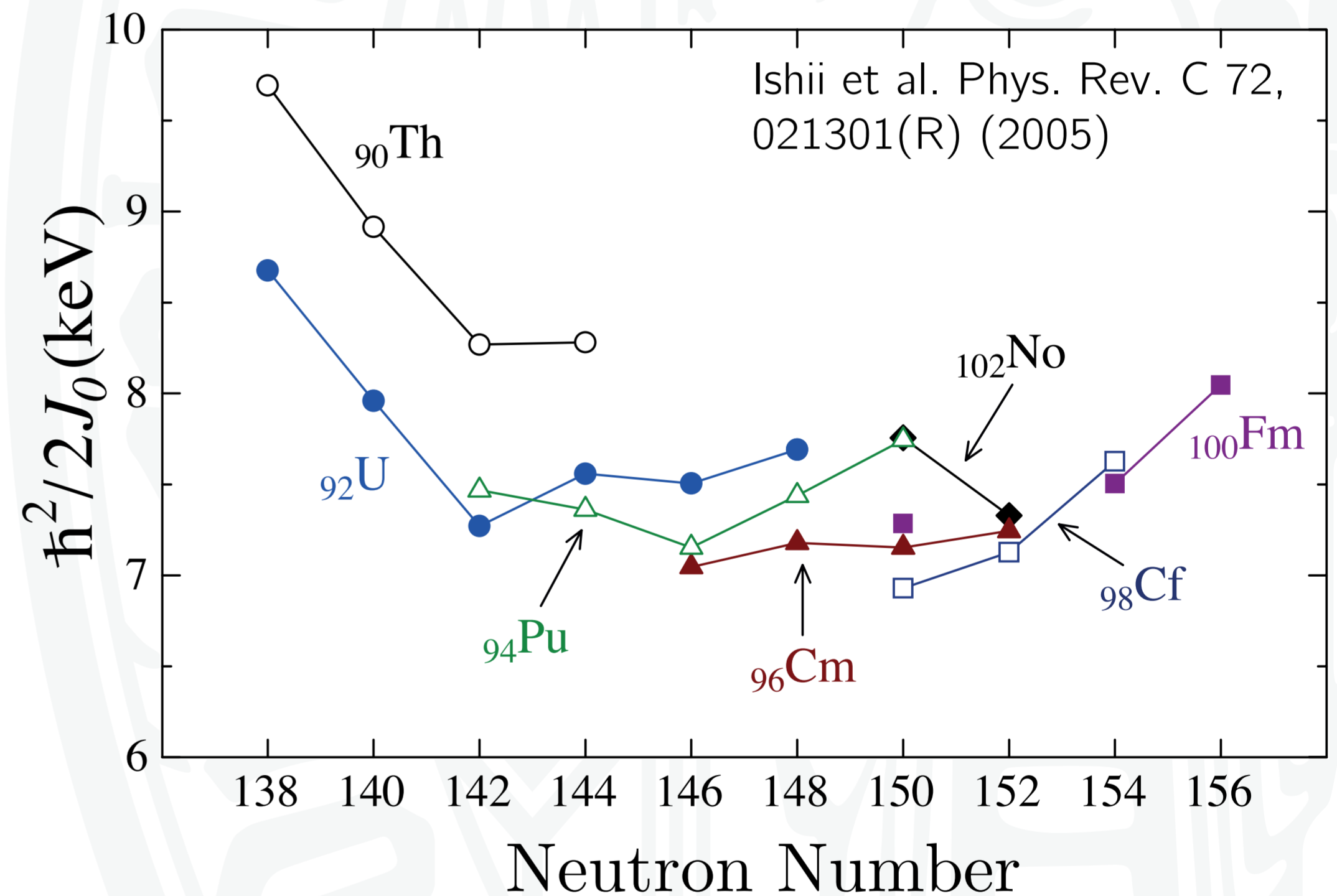
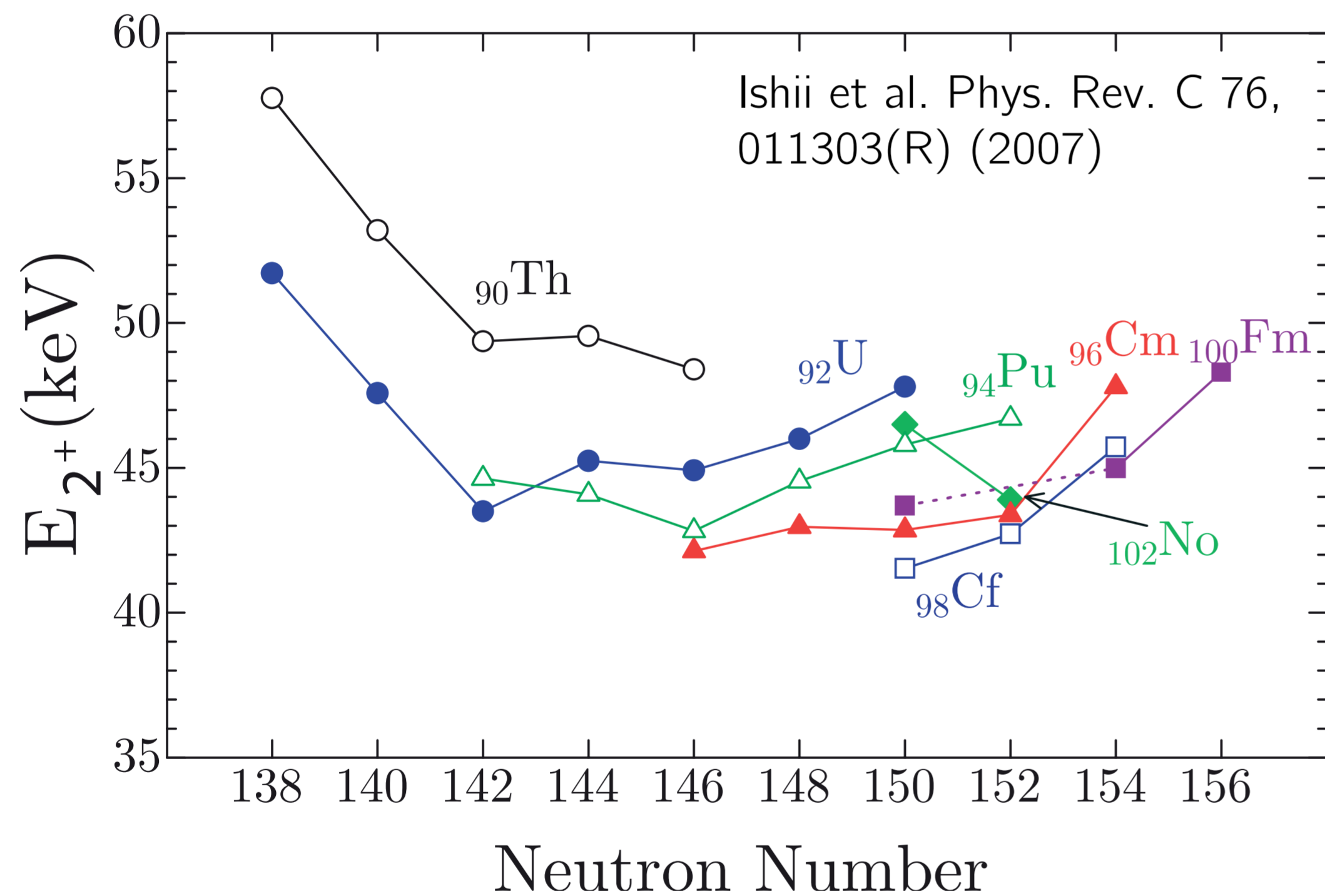
SHNEIDMAN, ET AL.
PHYS. REV. C 74,
034316 (2006)

MF and beyond-MF methods, Gogny force

J.-P. DELAROCHE ET AL.
NUCLEAR PHYSICS A 771
(2006) 103–168

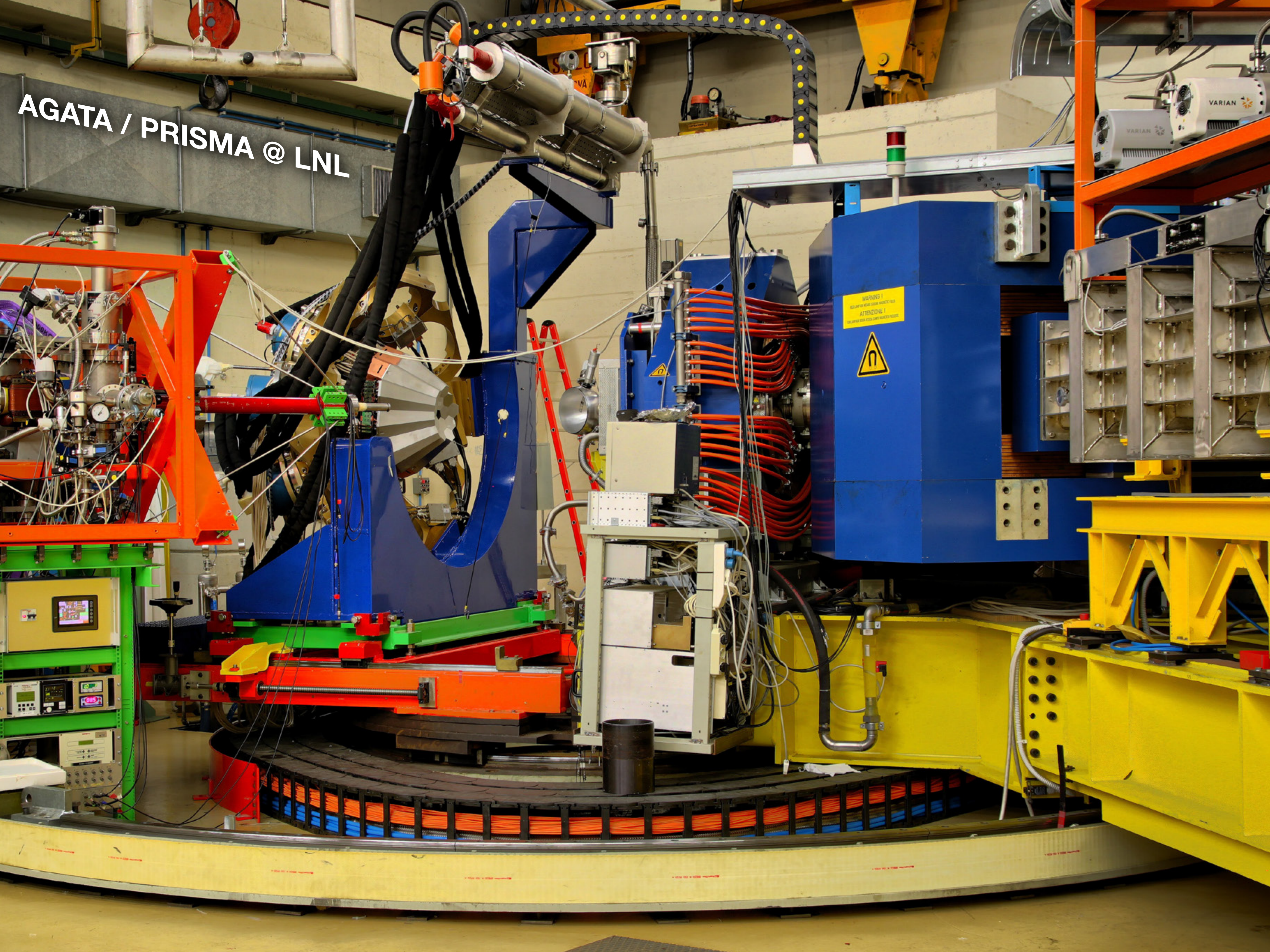
Relativistic nuclear energy density functionals

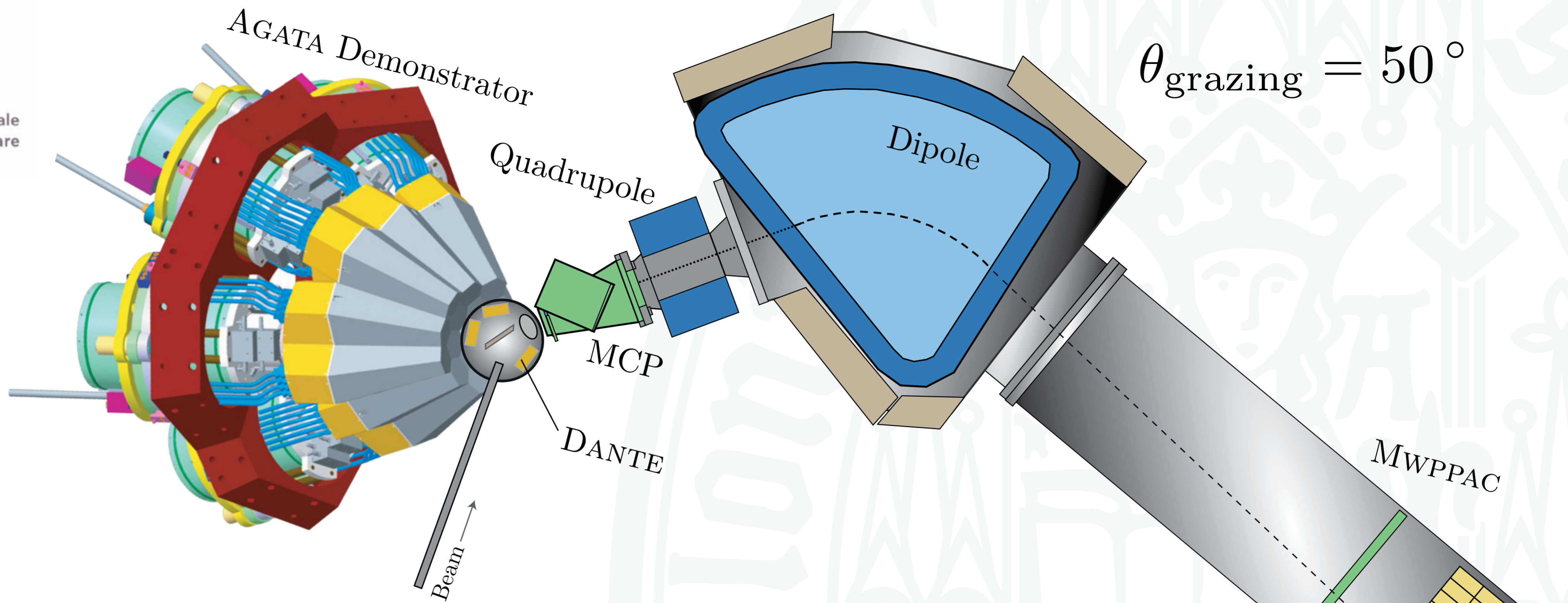
D. VRETENAR, ET AL.,
INT. JOURNAL OF MODERN
PHYSICS E (2010)



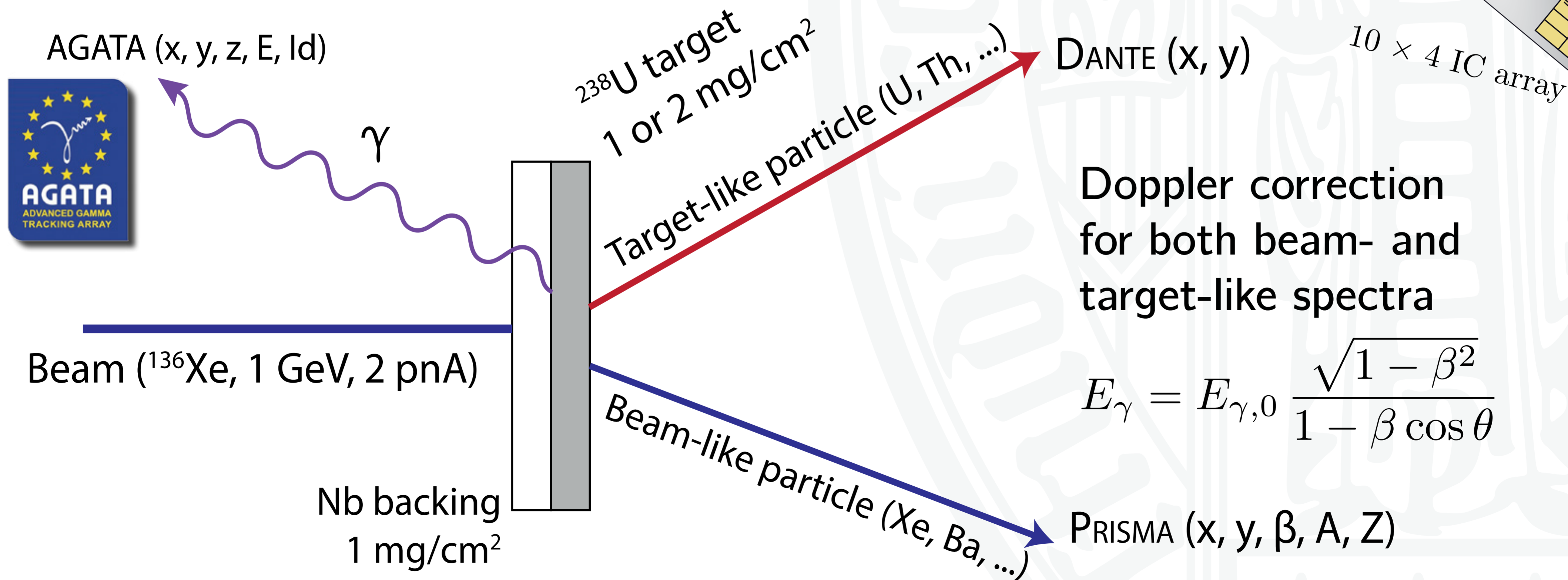
- Explore hardly accessible neutron-rich actinide region
 - » Lack of target and beam combinations
 - » Cross sections of the reactions compared to fission background are very small

AGATA / PRISMA @ LNL





$\theta_{\text{grazing}} = 50^\circ$

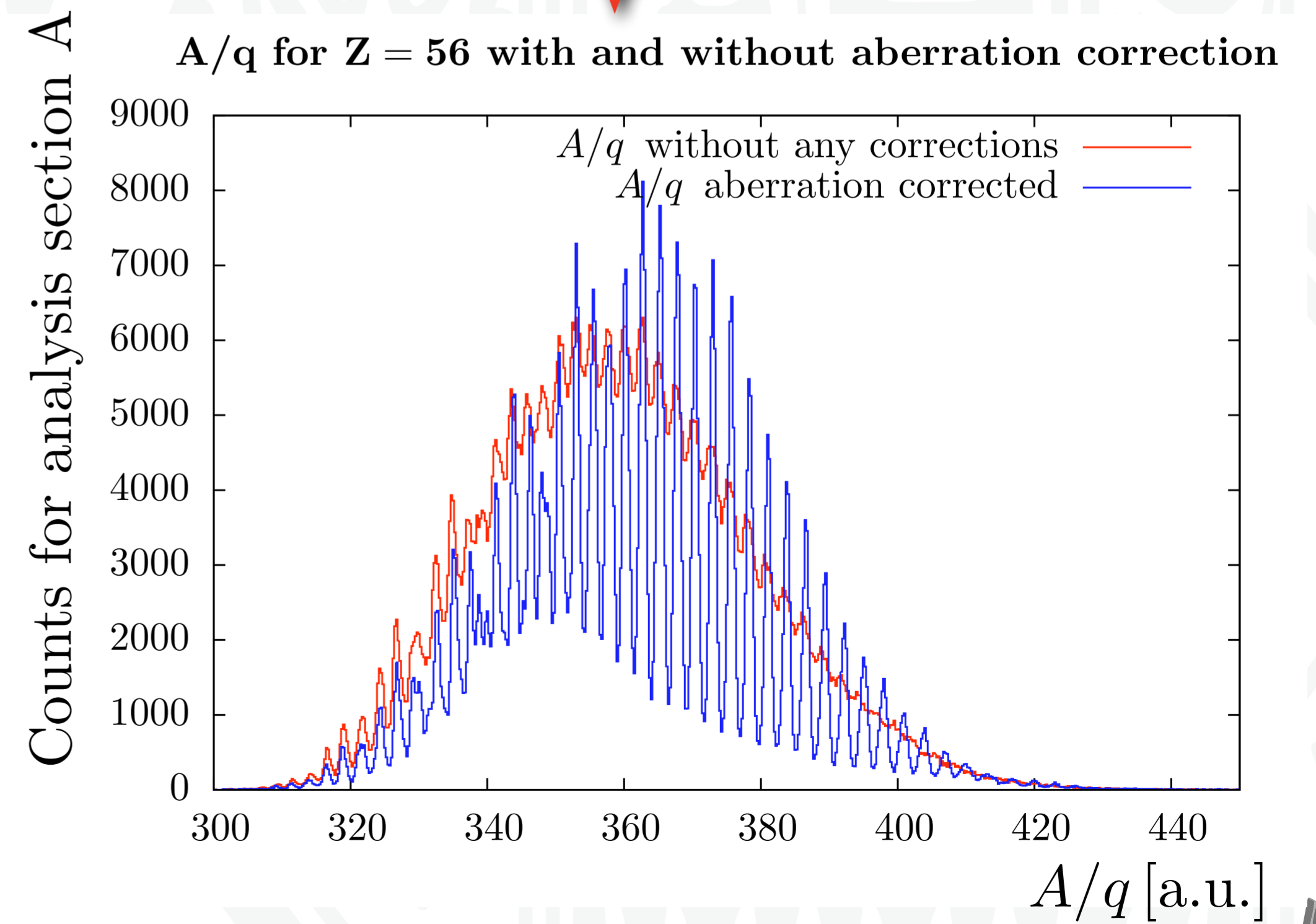
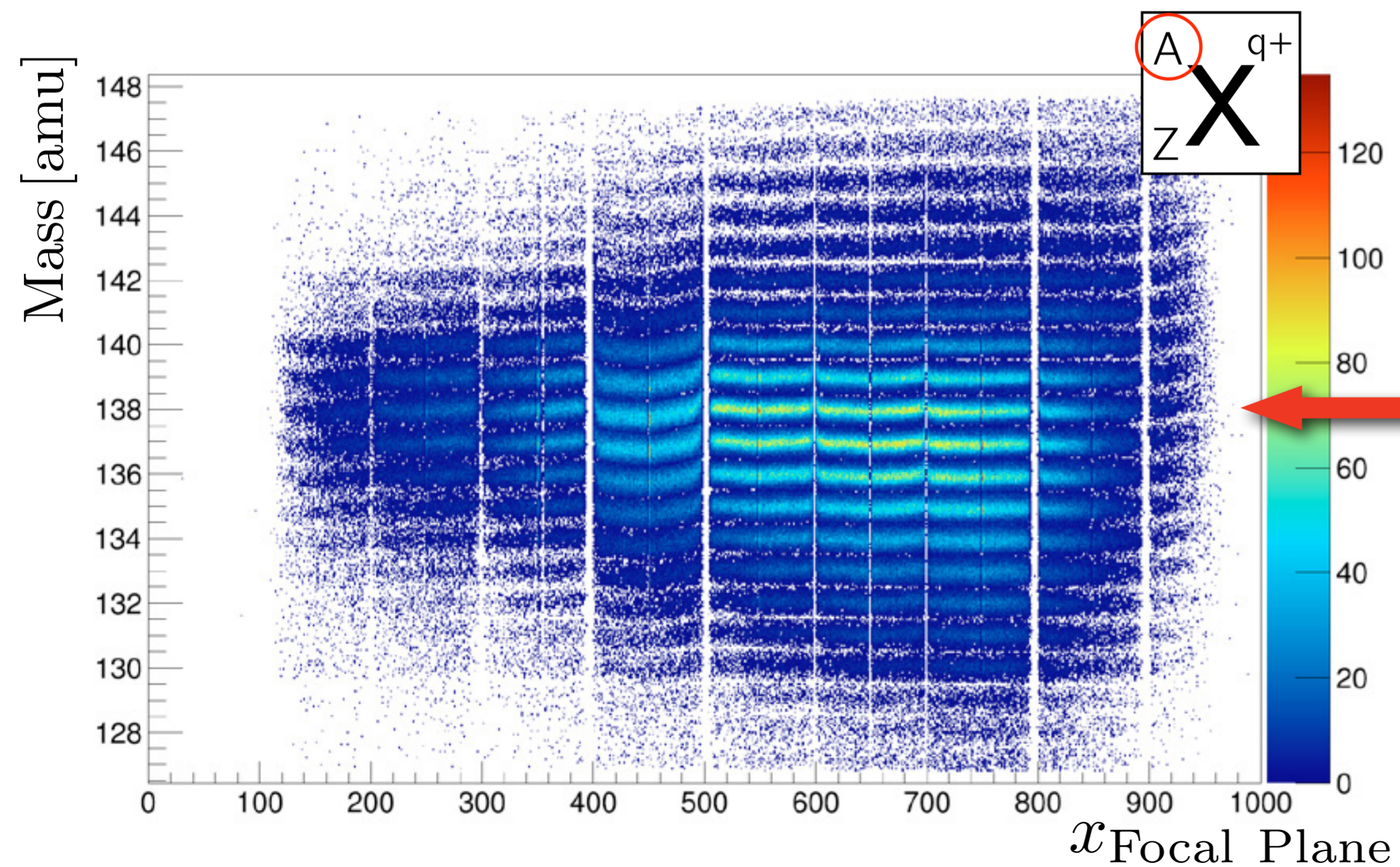
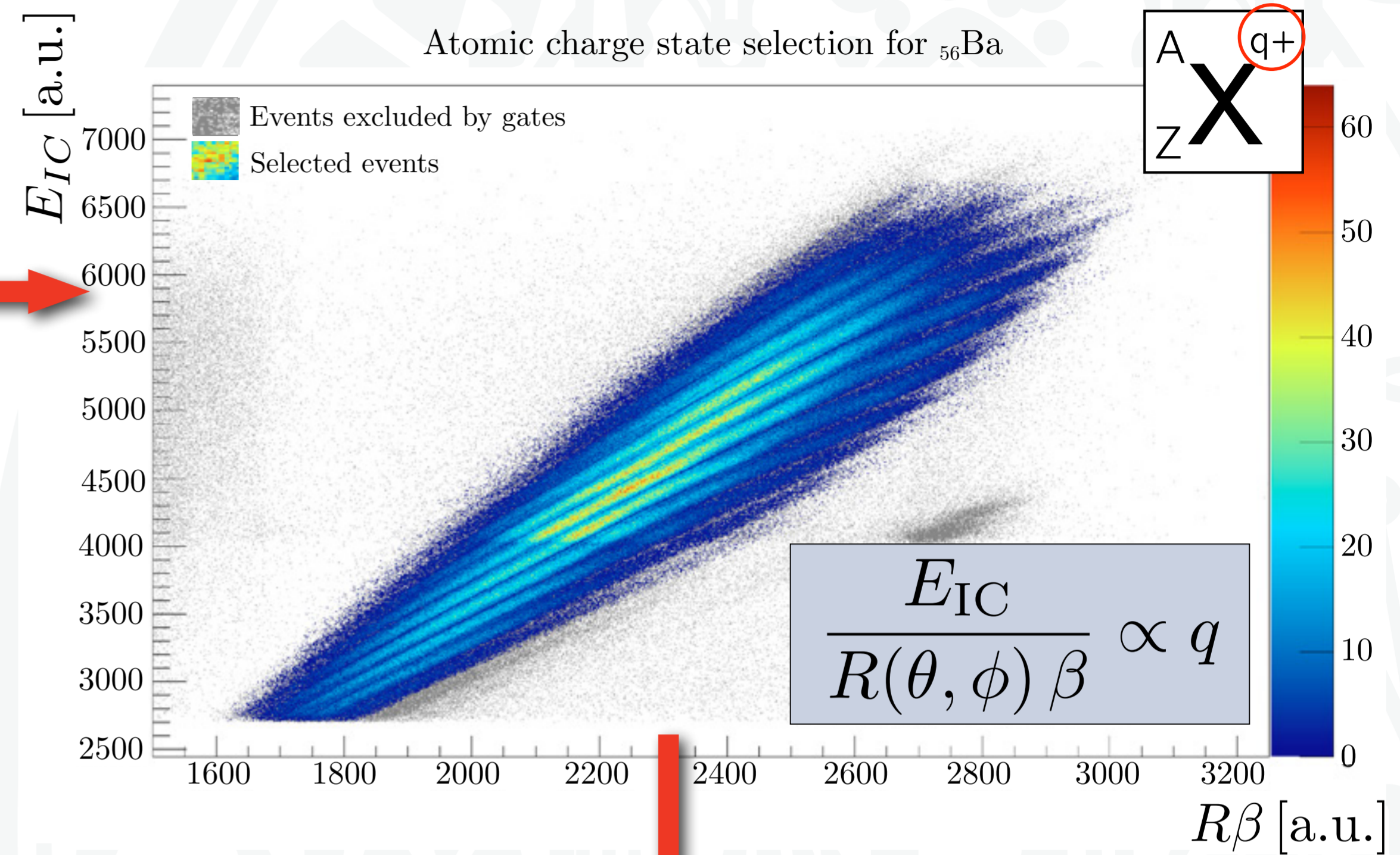
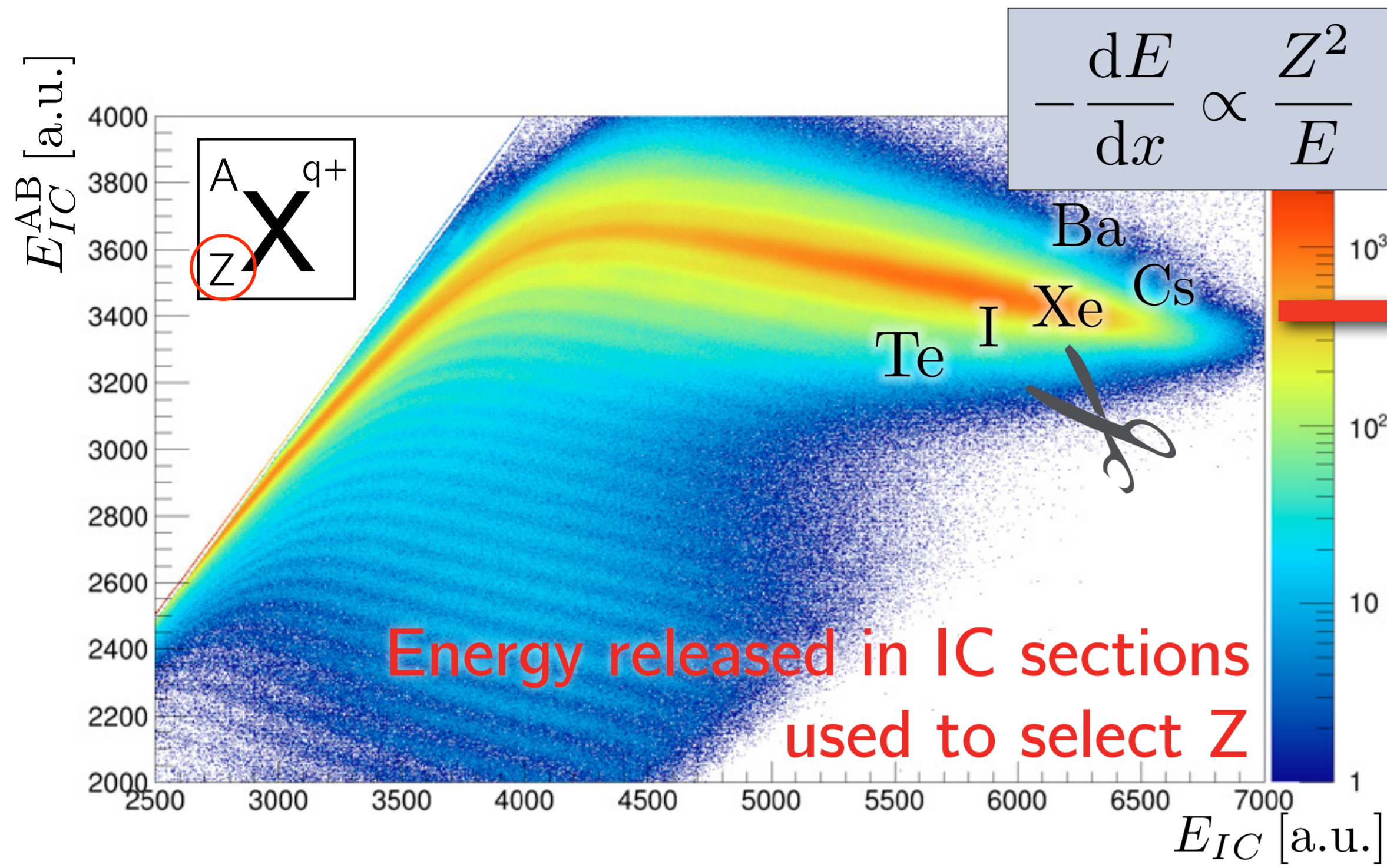


Doppler correction
for both beam- and
target-like spectra

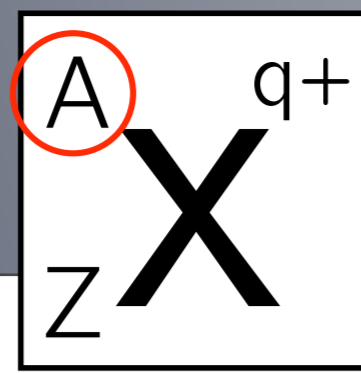
$$E_\gamma = E_{\gamma,0} \frac{\sqrt{1 - \beta^2}}{1 - \beta \cos \theta}$$



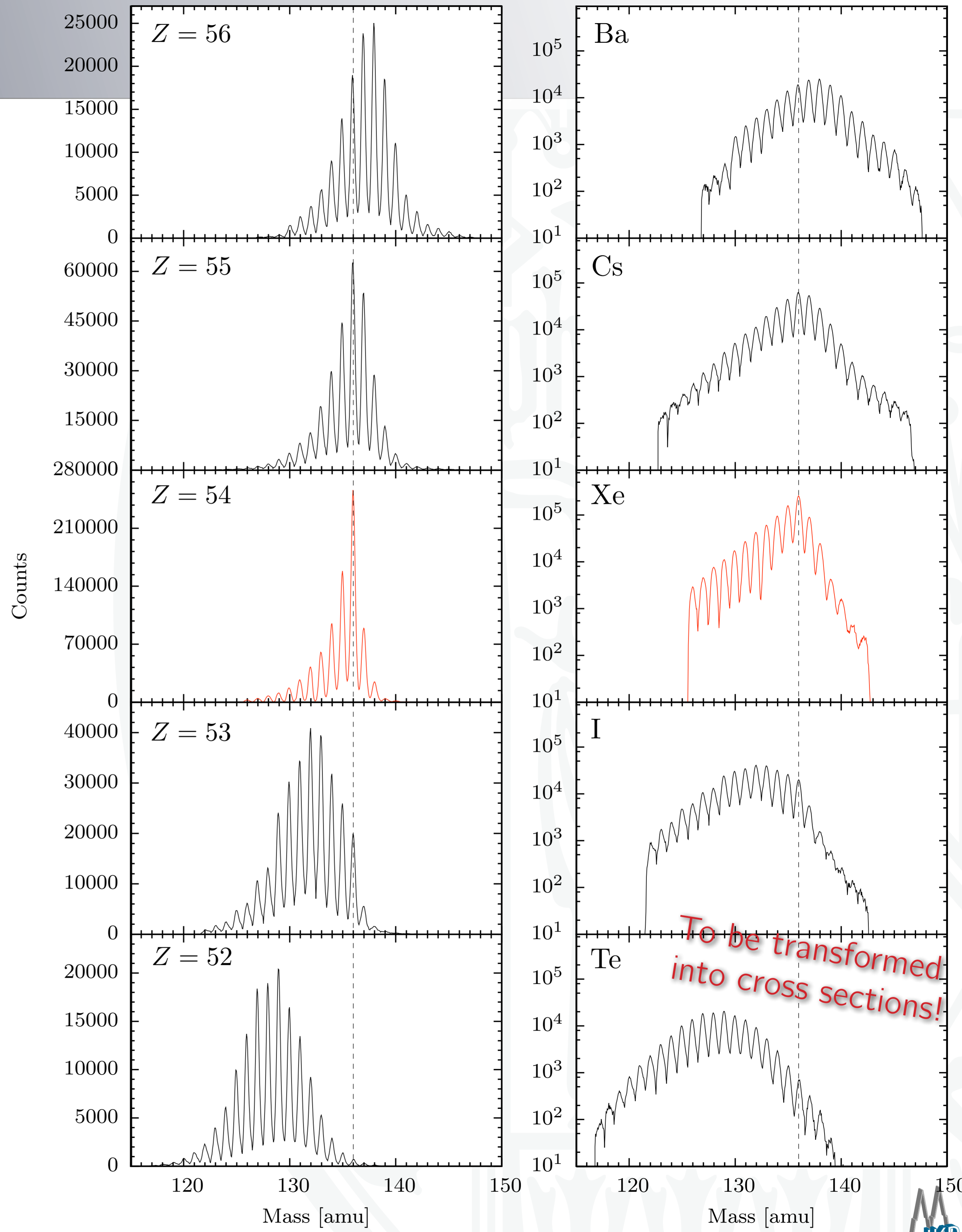
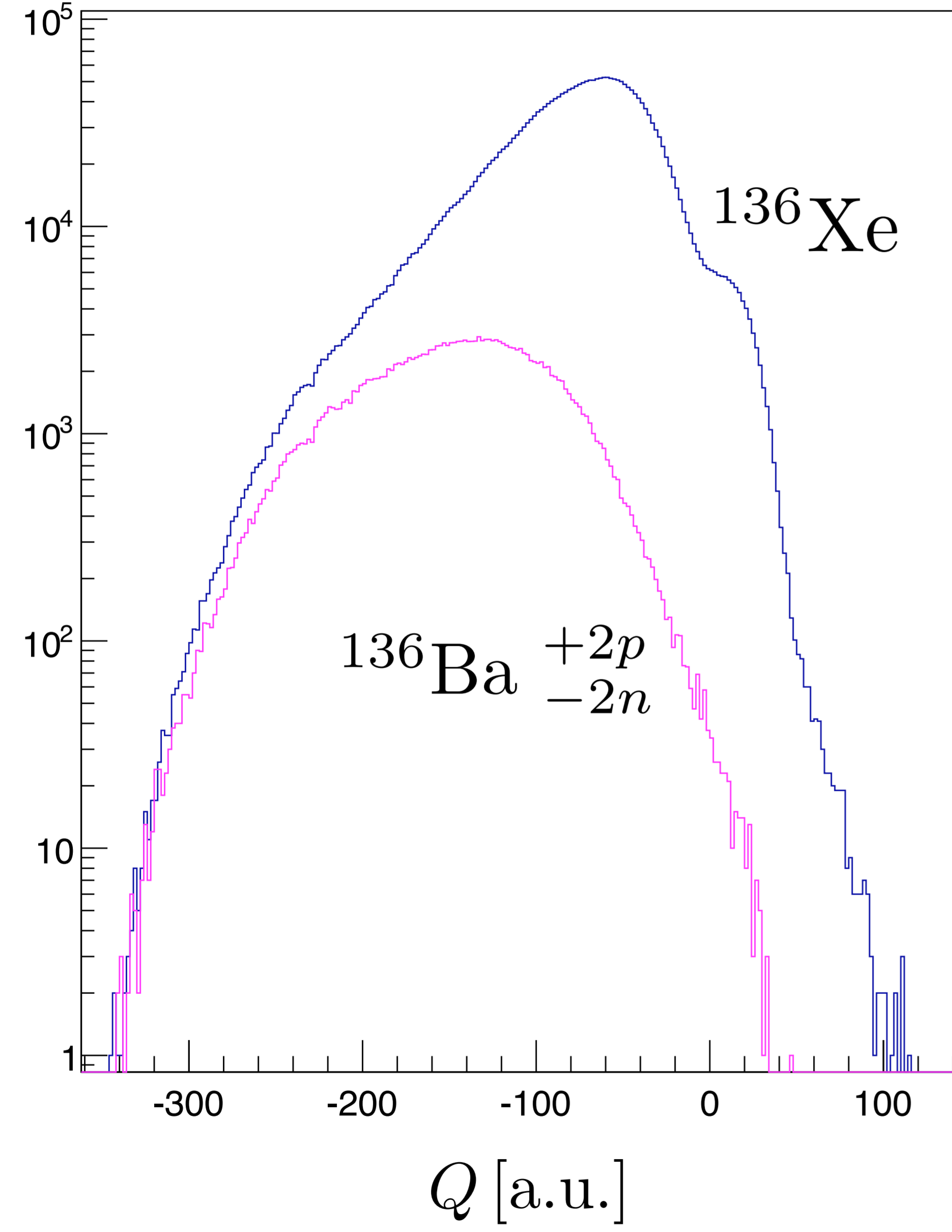
PRISMA Analysis



Mass Yields

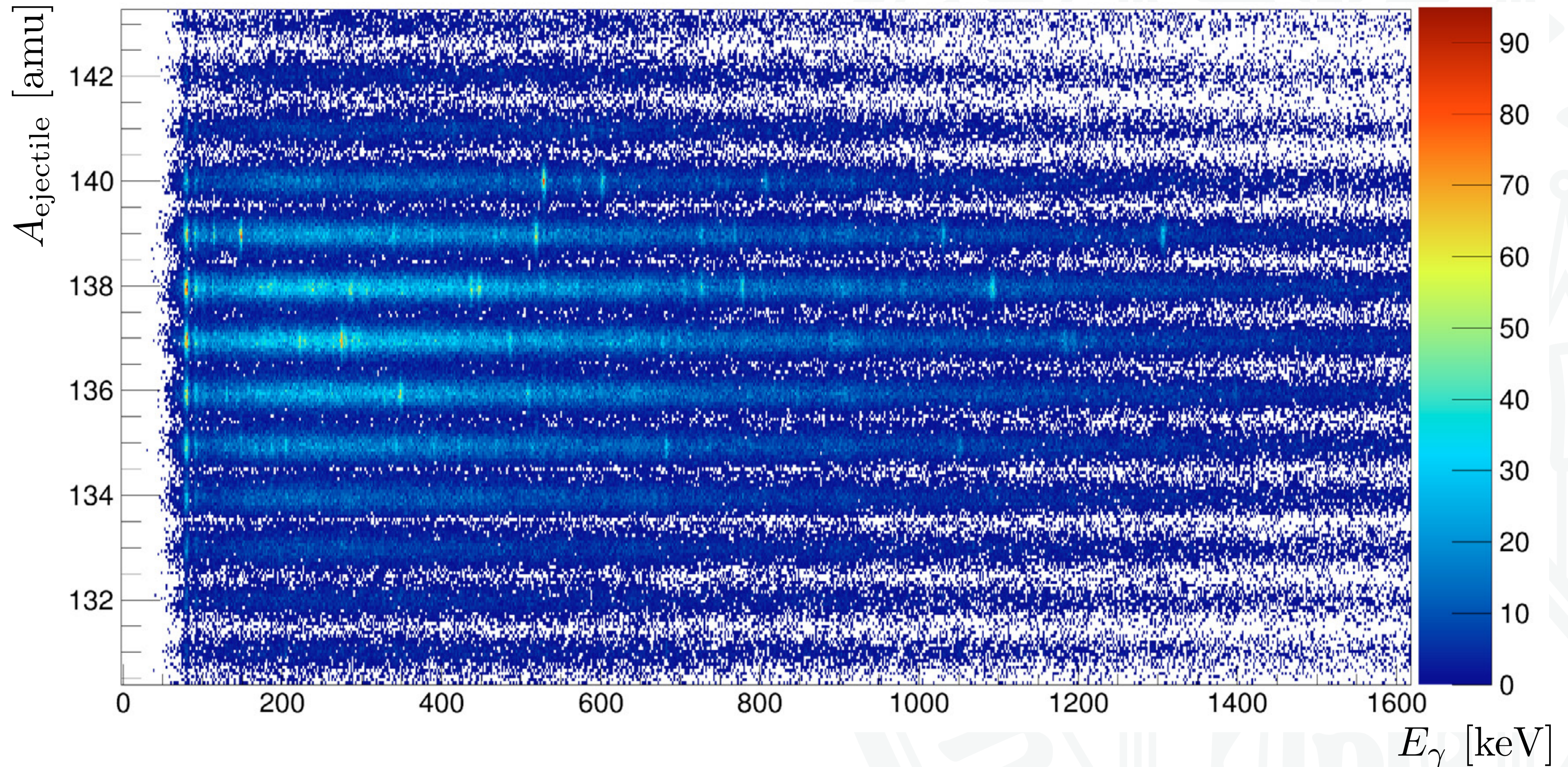


Q-value distribution

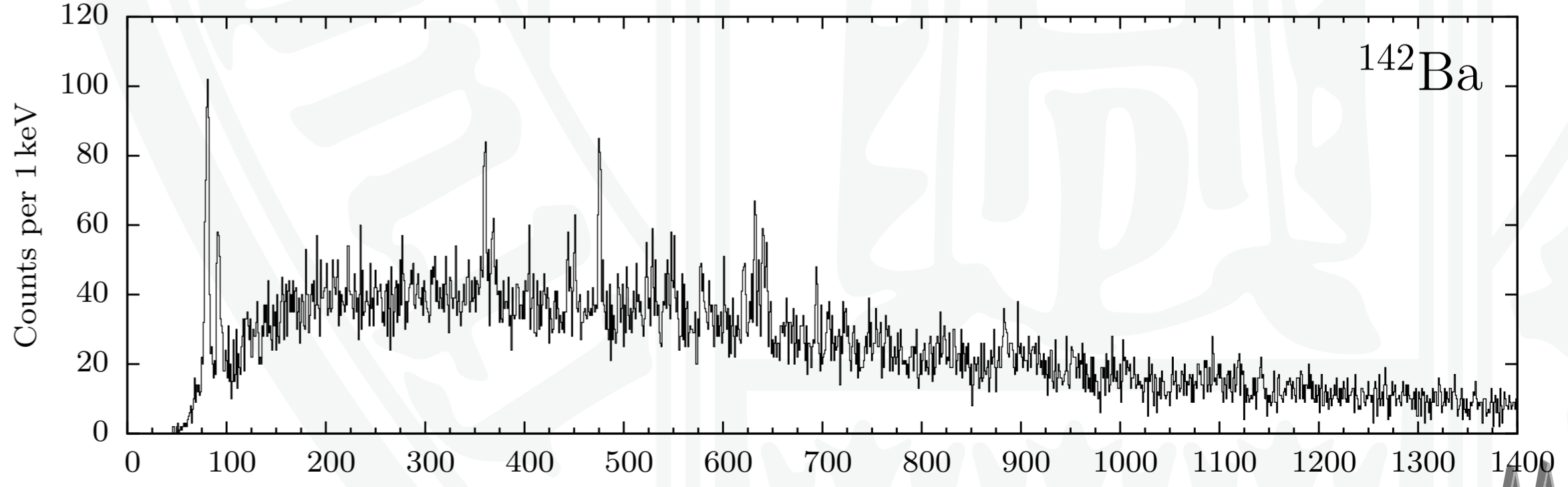
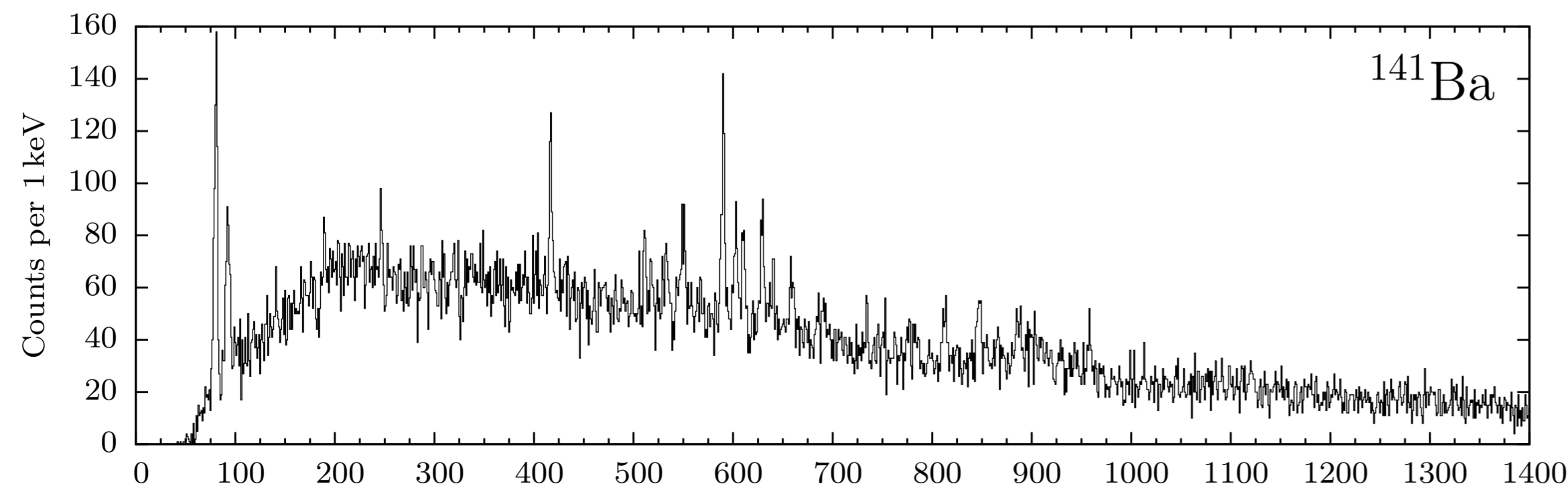
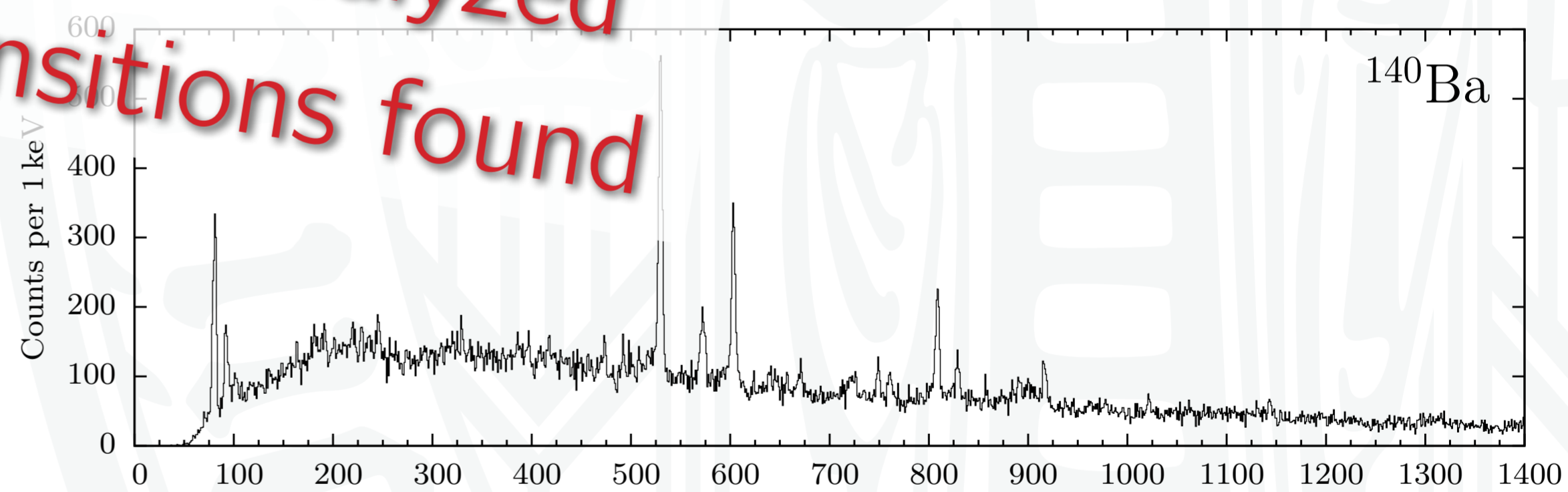
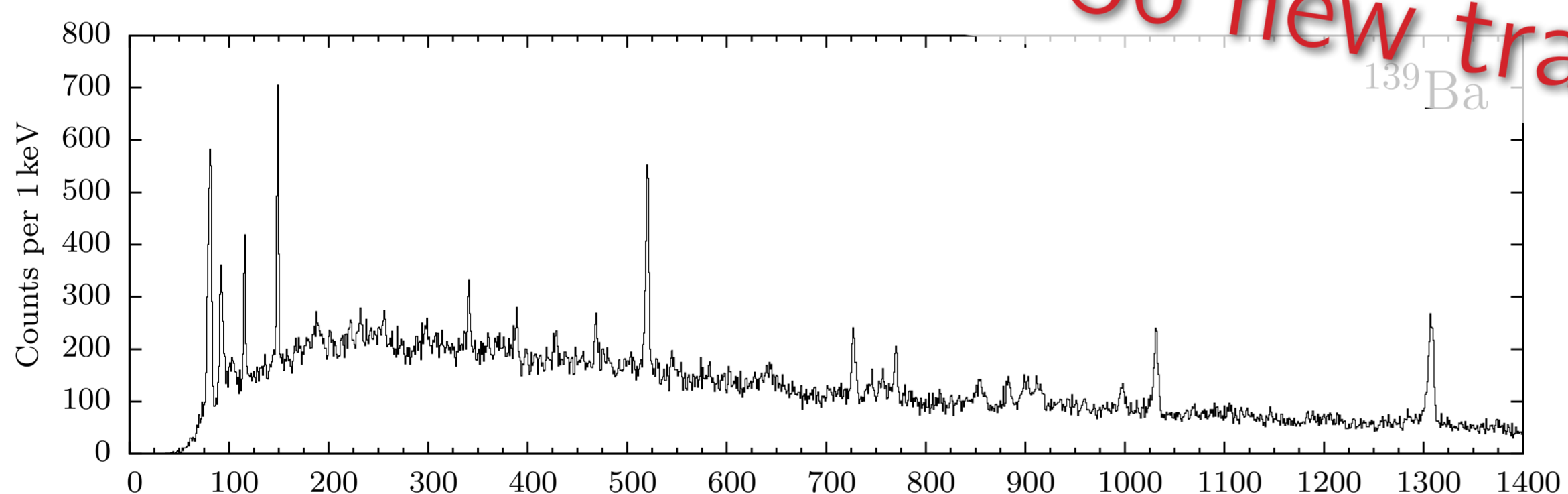
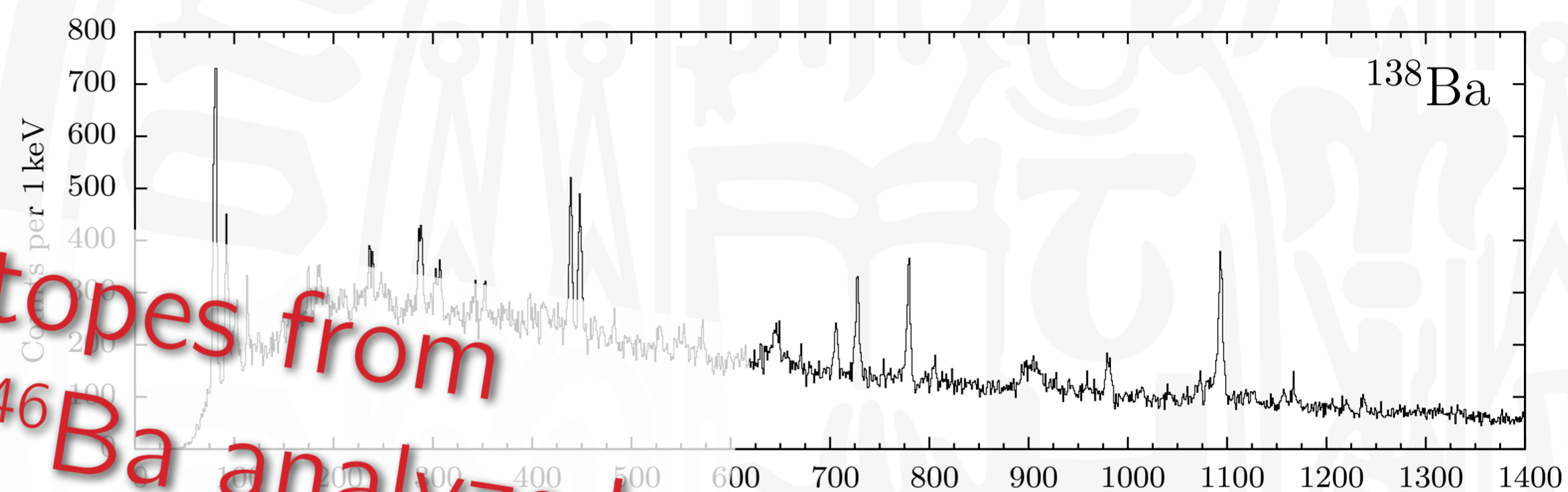
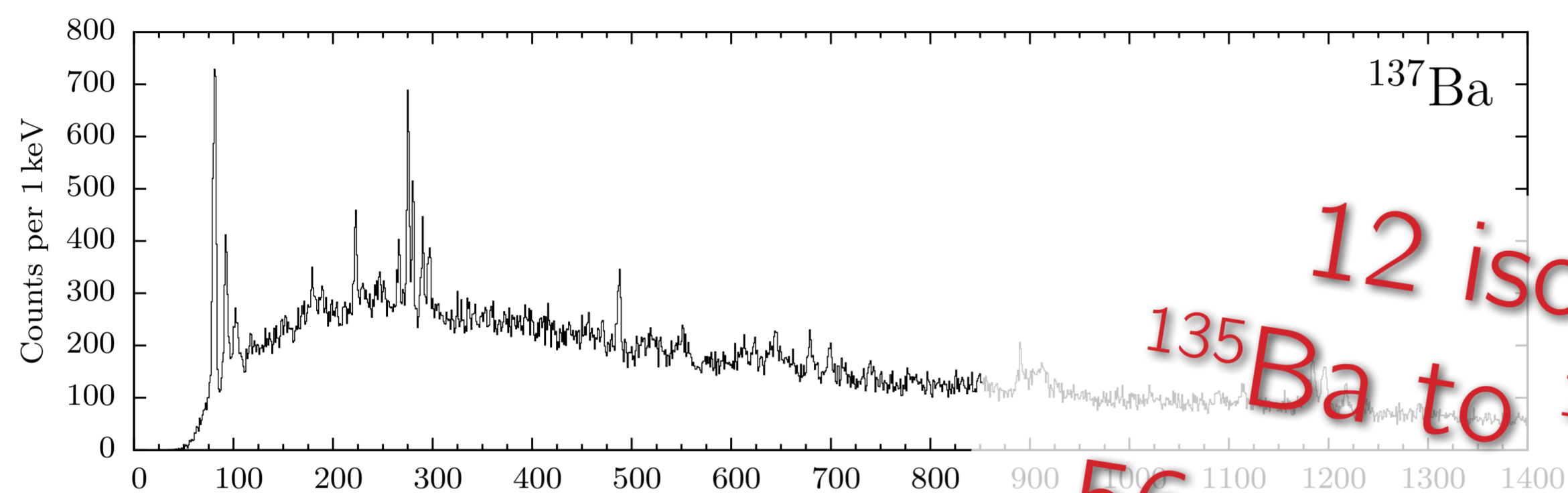
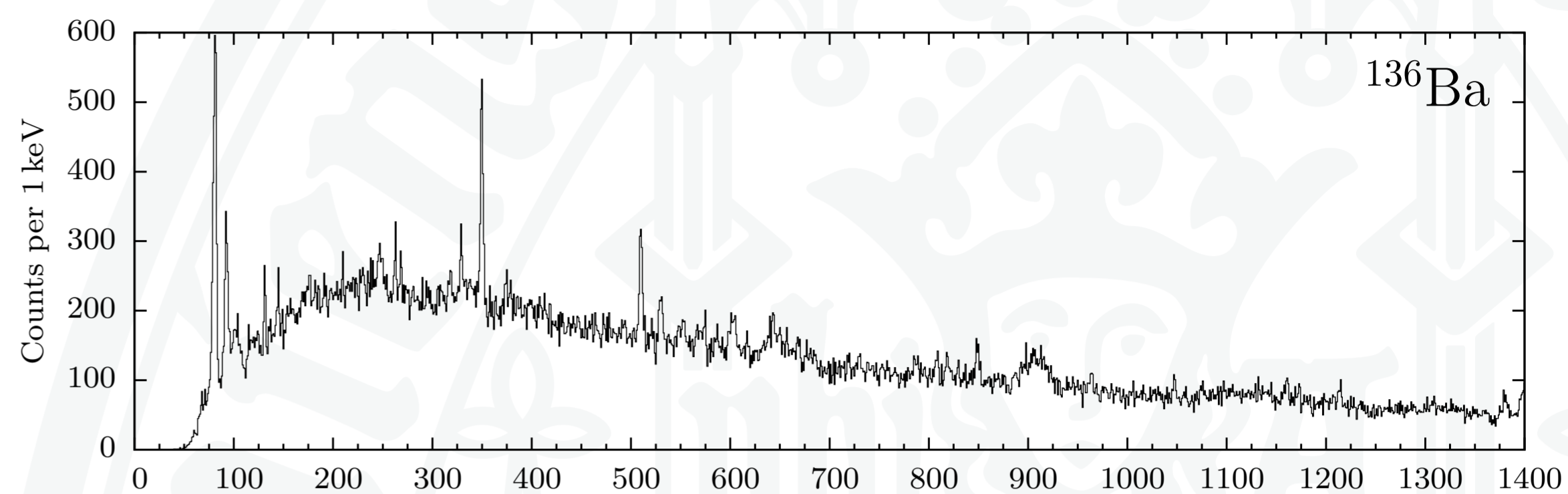
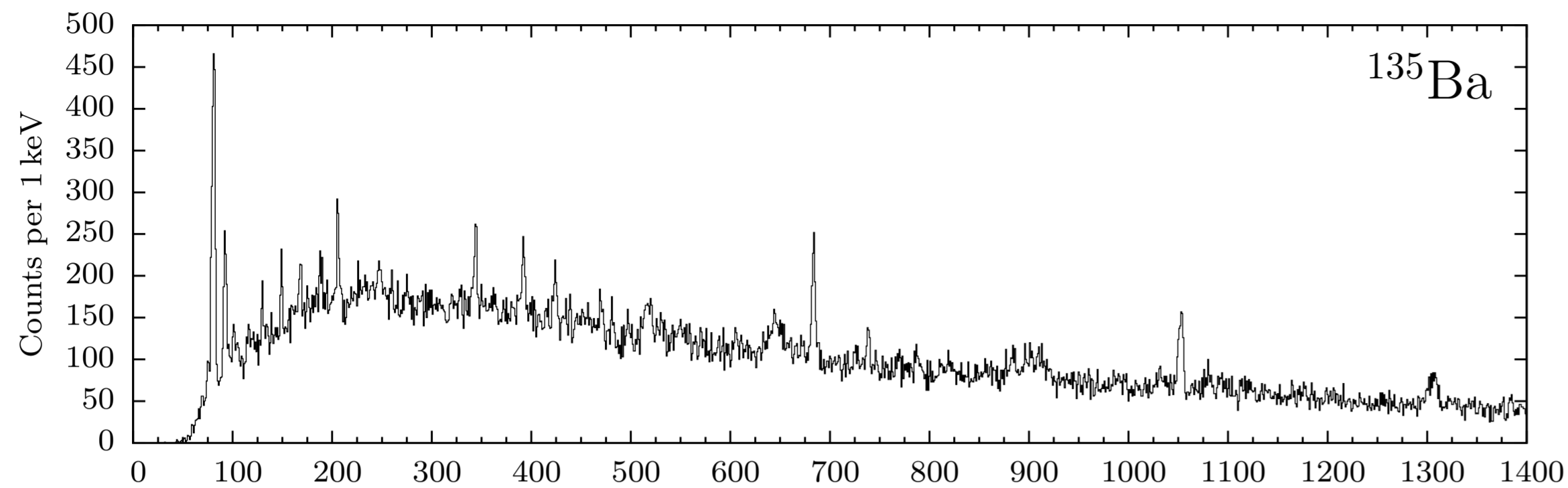


Yields of beam-like particles

Cumulated γ -ray spectra, Doppler corrected for $Z = 56$



New high-spin transitions in barium isotopes



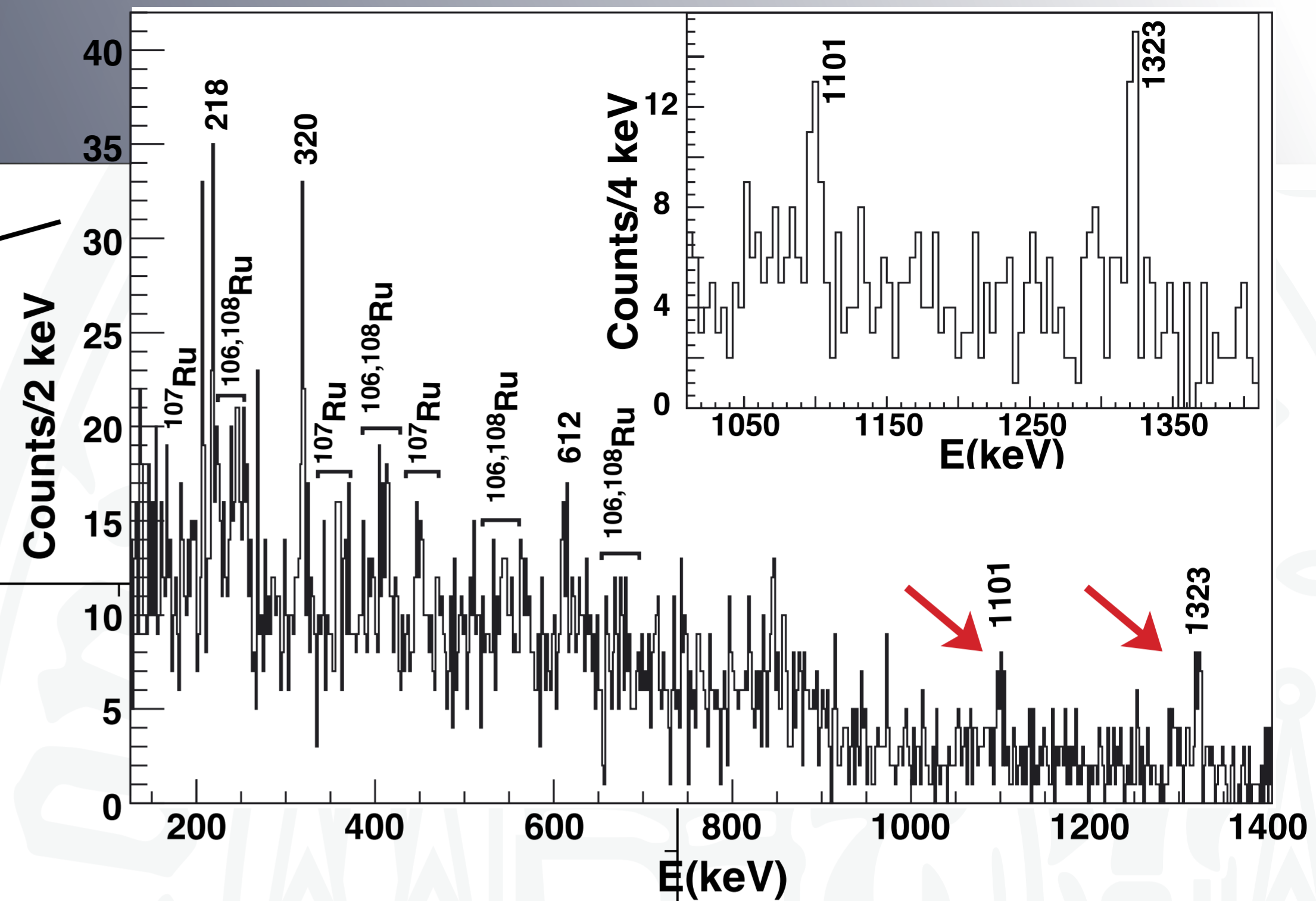
12 isotopes from
 ^{135}Ba to ^{146}Ba analyzed
56 new transitions found

High-spin states in ^{134}Xe

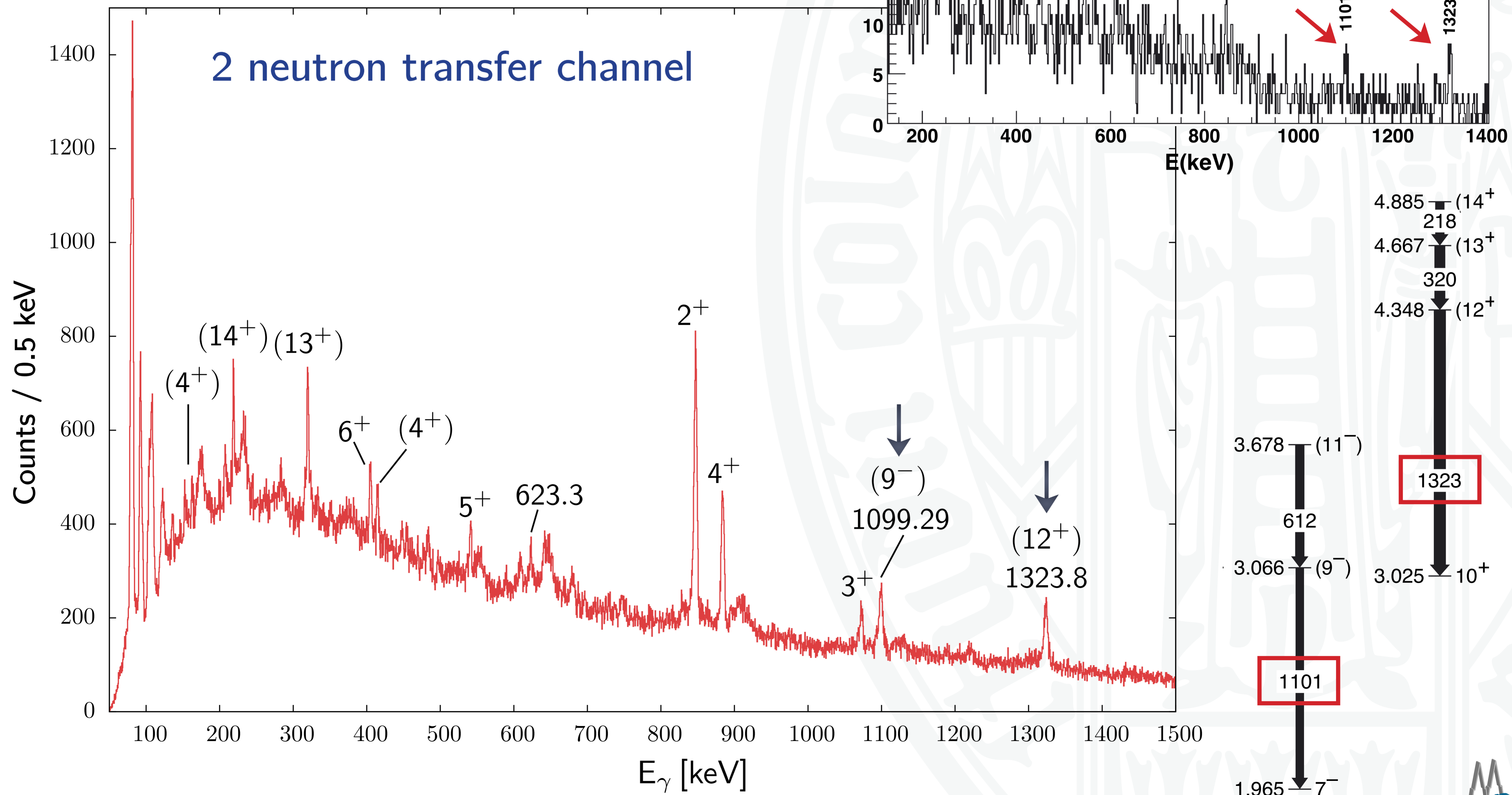
Exogam-Vamos

A. Shrivastava *et al.*

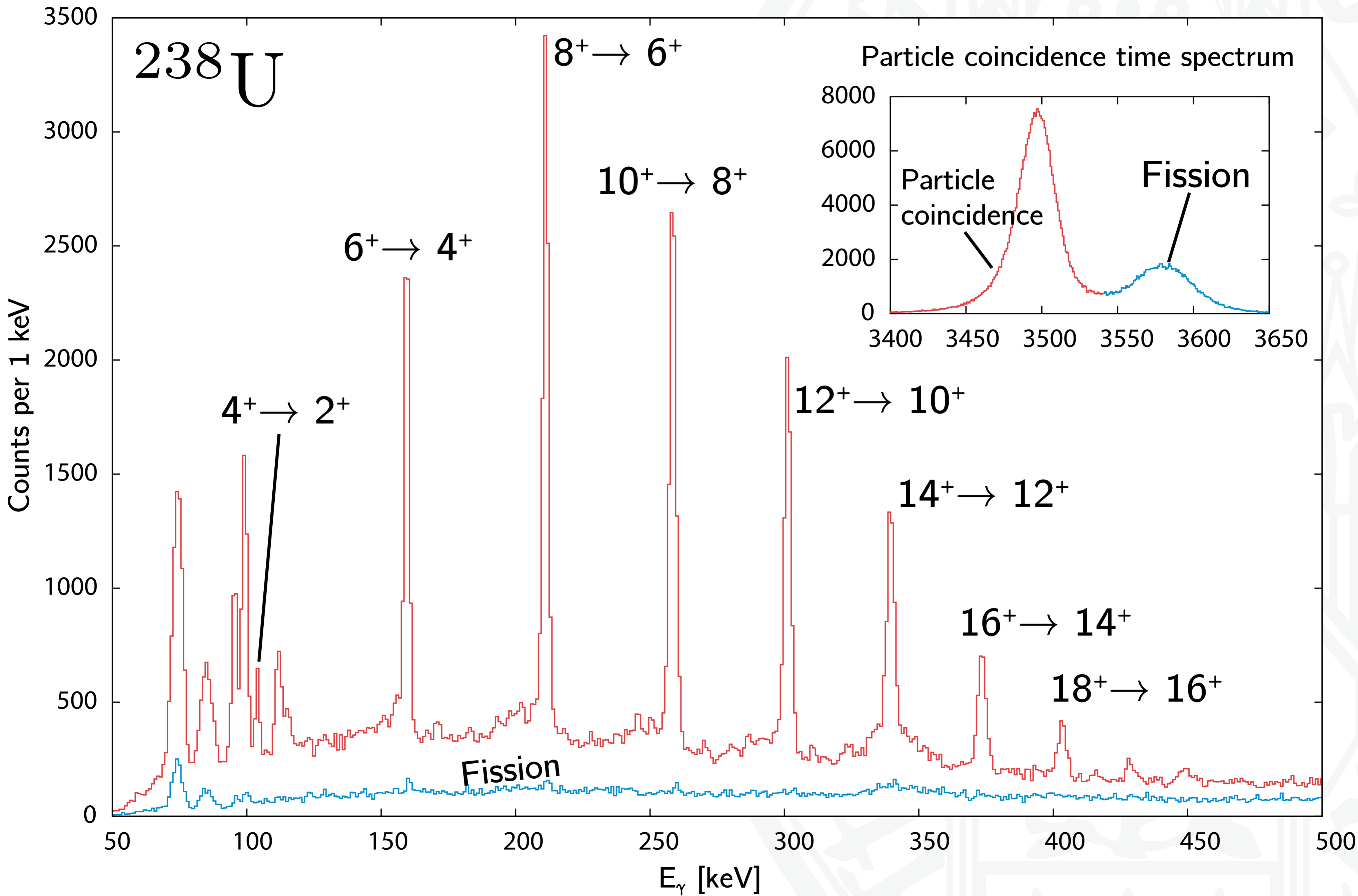
Phys. Rev. C 80, 051305 (2007)



2 neutron transfer channel

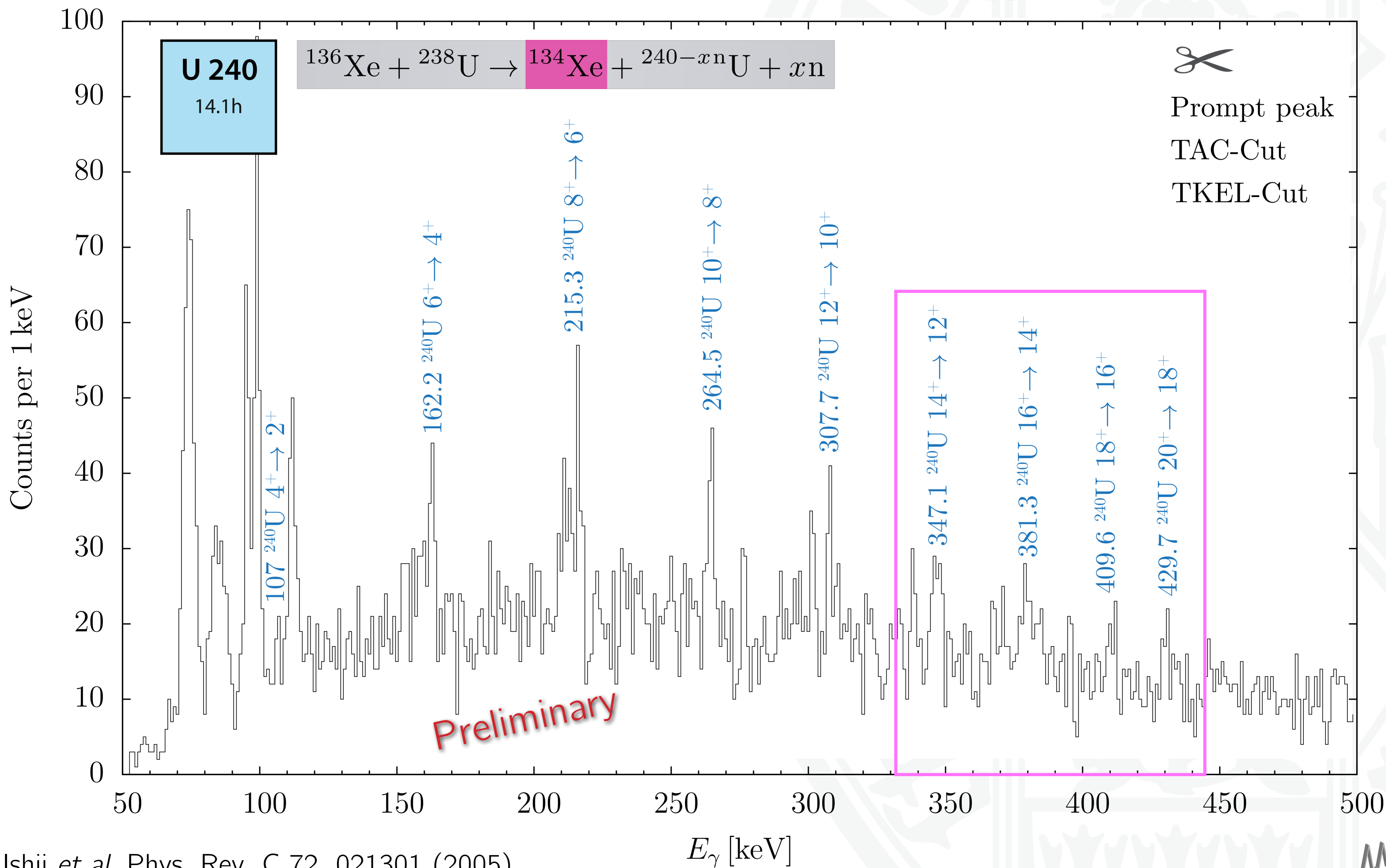


Doppler corrected ^{238}U γ -ray spectra

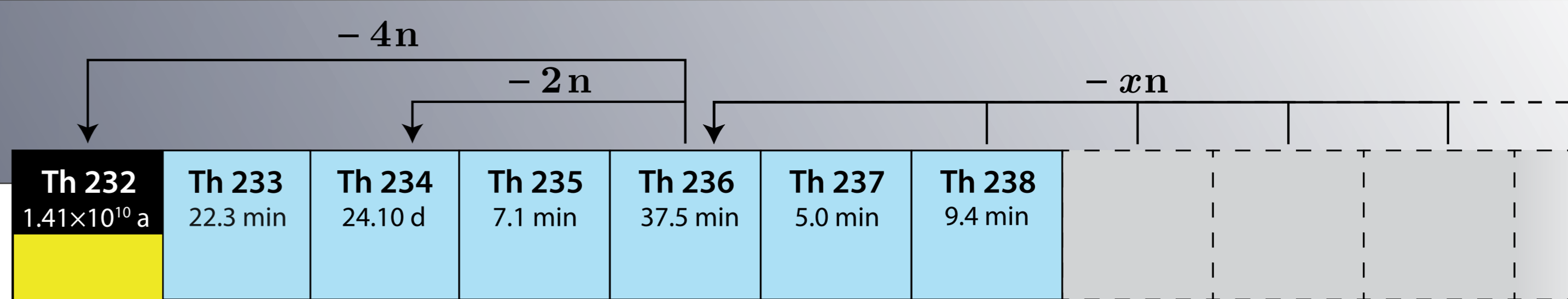


^{240}U ground-state band candidates

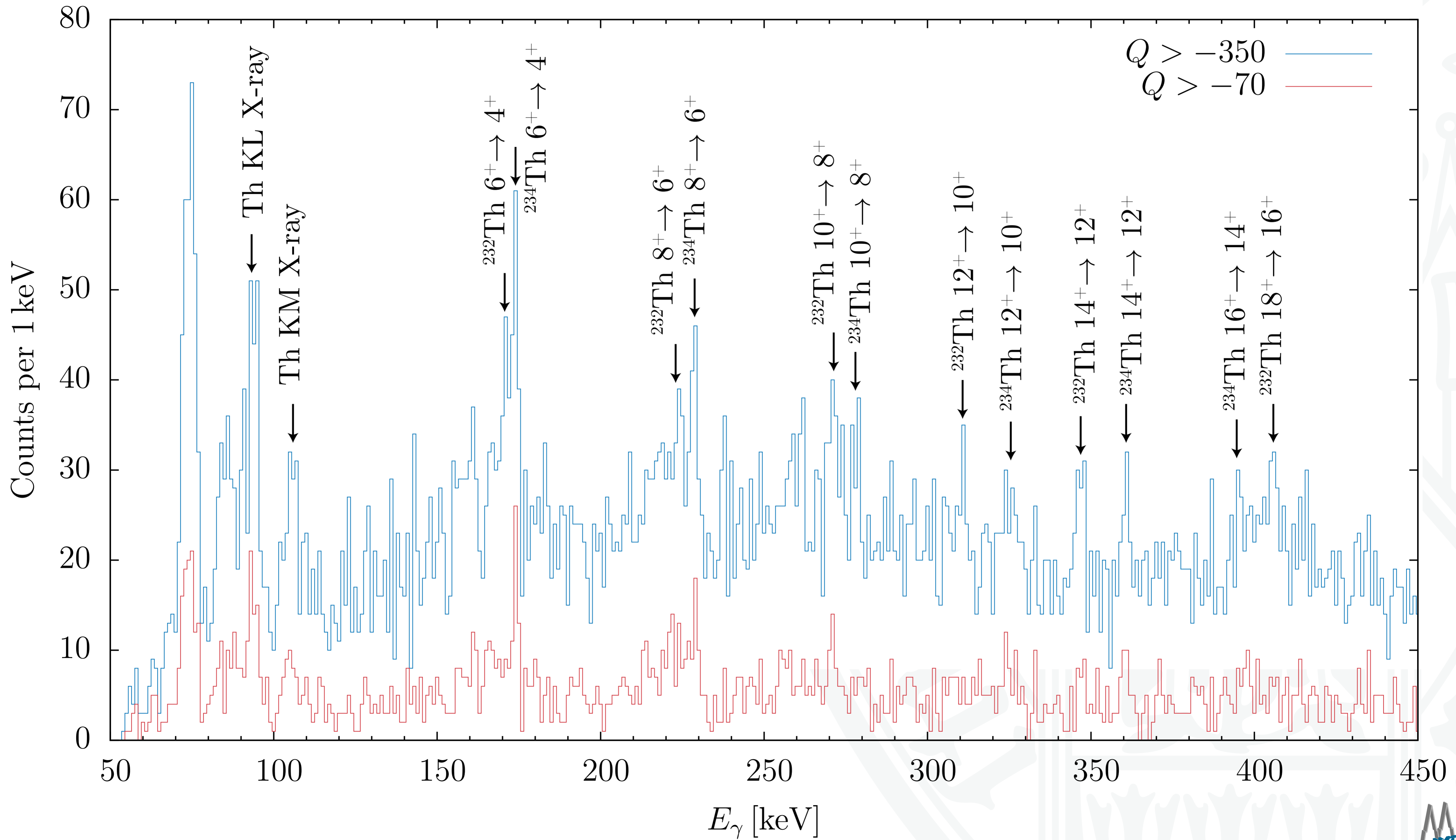
^{240}U transition candidates, cut on ^{134}Xe , recoil Doppler corrected



Search for ^{236}Th

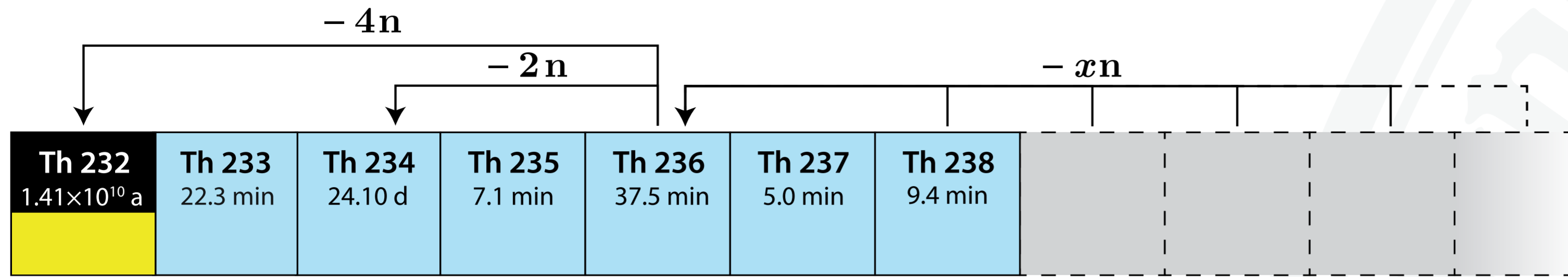


γ -ray spectra of ^{138}Ba , Doppler corrected for Th fragments

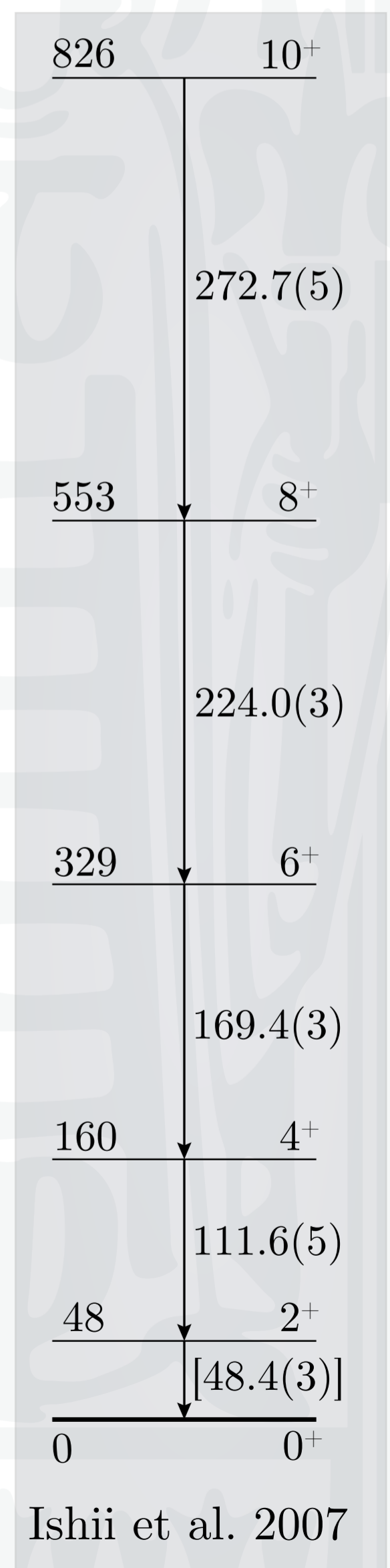
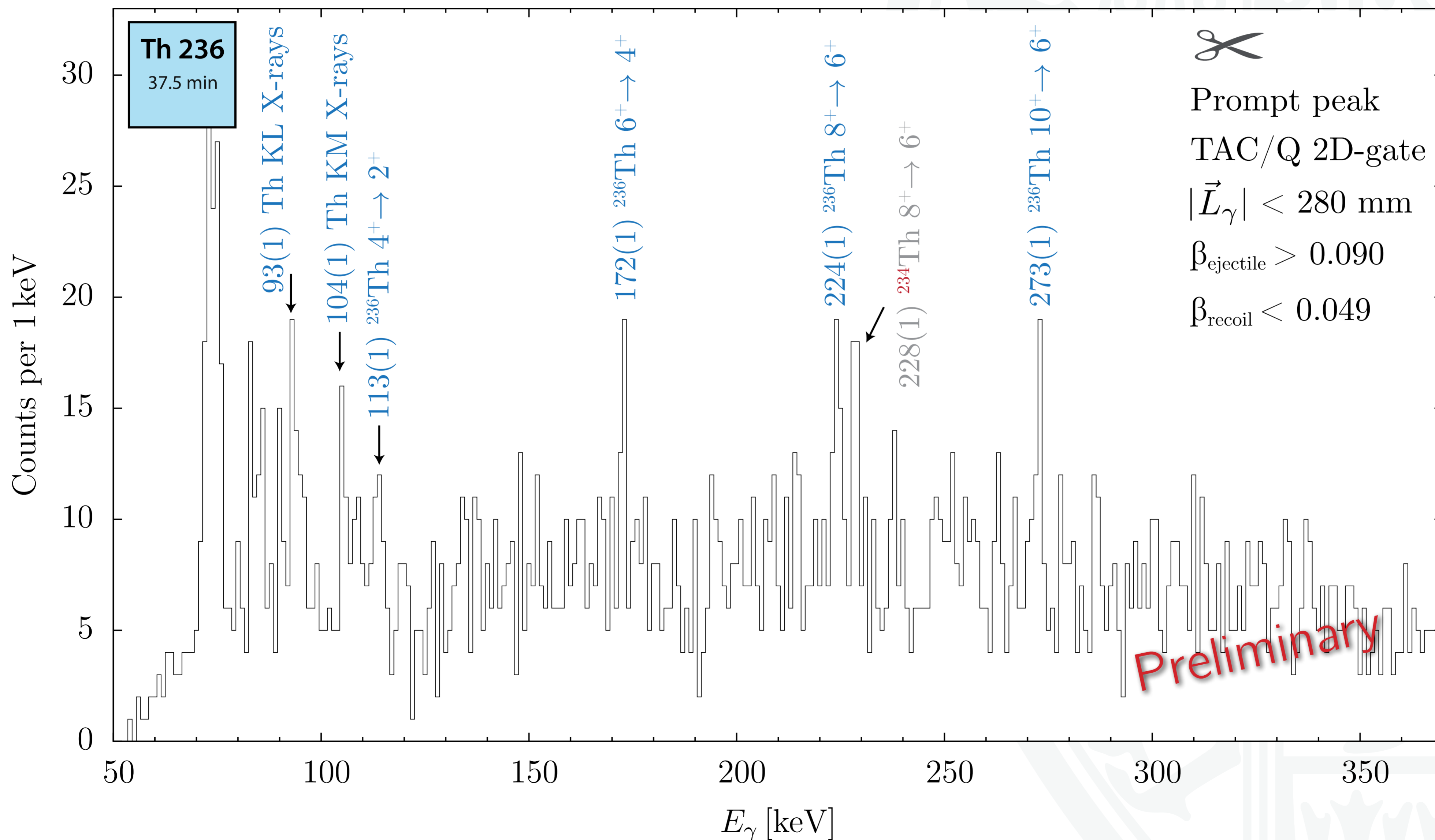


^{236}Th ground-state band candidates

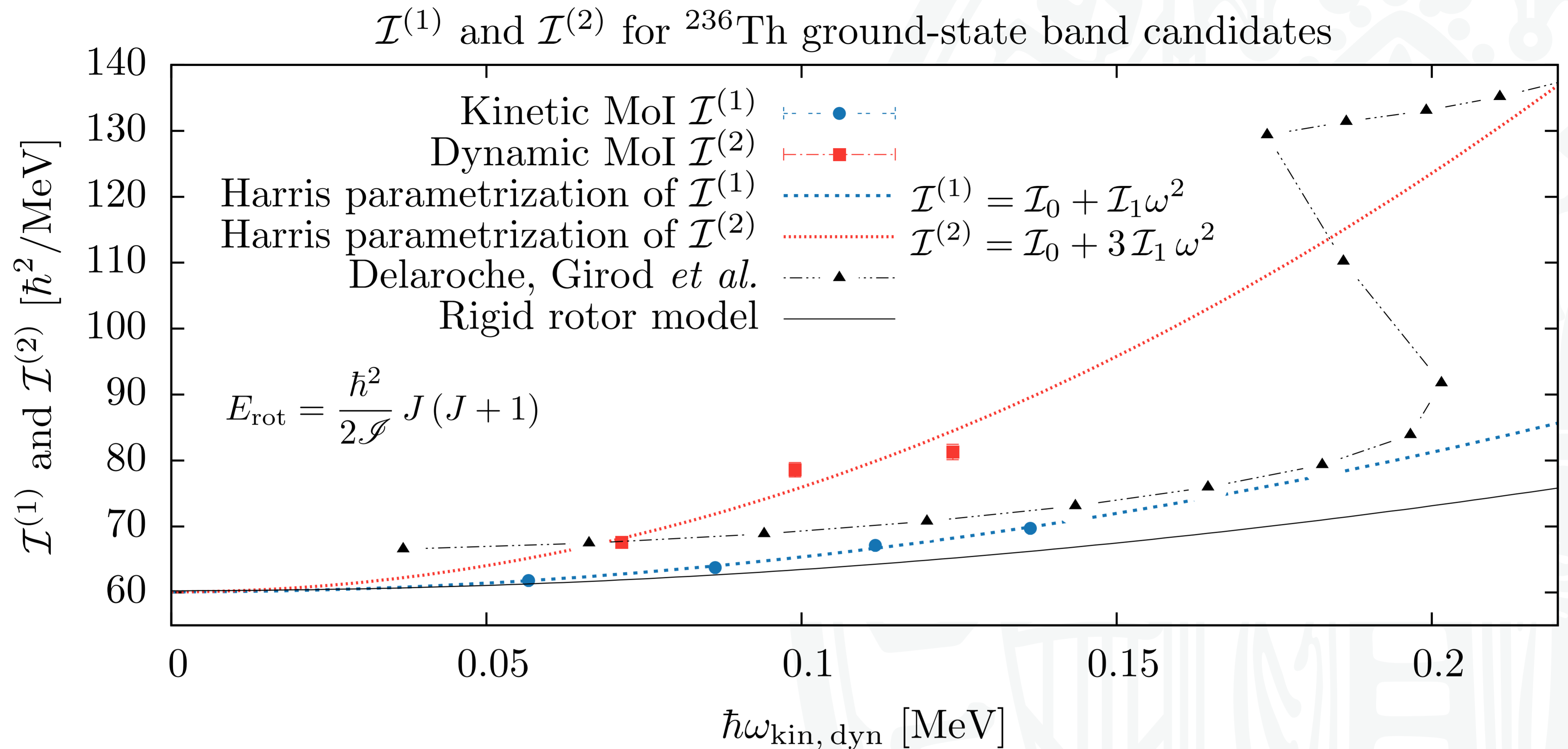
	^{232}Th	^{234}Th
10^+	269.3	277.8
8^+	223.6	228.3
6^+	171.2	173.4
4^+	112.7	113.5
2^+	49.4	49.6



^{236}Th transition candidates in sum spectra of $^{133-136}\text{Ba}$, recoil Doppler corrected



Kinetic and Dynamic Moments of Inertia



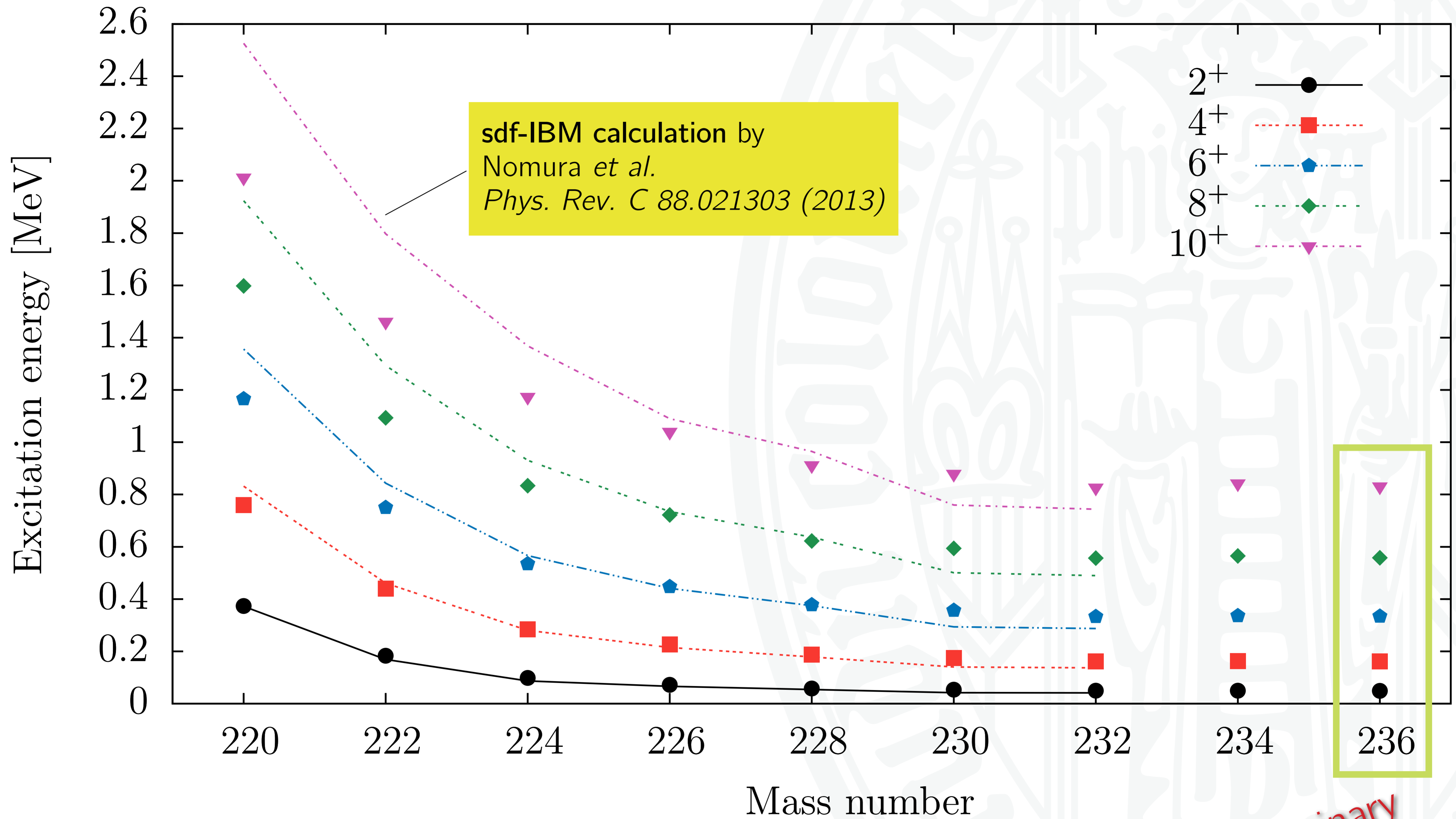
This work: $\mathcal{I}_0 = (60.25 \pm 0.09) \frac{\hbar^2}{\text{MeV}}$ $\mathcal{I}_1 = (322 \pm 8) \frac{\hbar^4}{\text{MeV}^3}$

Ishii et al. 2007 $\mathcal{I}_0 = (62.6 \pm 0.2) \frac{\hbar^2}{\text{MeV}}$ $\mathcal{I}_1 = (334 \pm 23) \frac{\hbar^4}{\text{MeV}^3}$

$\Delta E_{2^+ \rightarrow 0^+} = 2 \hbar\omega_{\text{kin}}^{2^+ \rightarrow 0^+} \simeq (49.7 \pm 0.3) \text{ keV}$

Ishii et al. 2007 $\Delta E_{2^+ \rightarrow 0^+} = (48.4 \pm 0.3) \text{ keV}$

^{236}Th ground-state band along the Th chain



Preliminary
results

Summary



- Isotopic yields for $^{136}\text{Xe} + ^{238}\text{U}$ multi-nucleon transfer reactions
- Spectra for ejectile and recoil particles in kinematic coincidence and various cut conditions
- New high-spin transitions for Xe and Ba nuclei
- Extension of ground-state bands of n-rich U and Th nuclei

Outlook

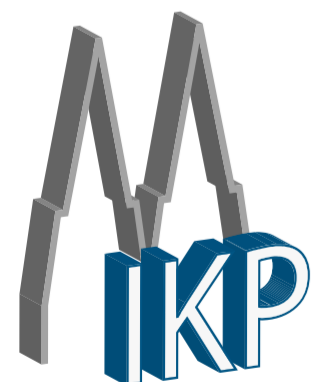


- In-depth analysis of high-spin levels in Xe and Ba
- Analysis of Te and $\pm 1p$ channels
- Mass yields in cross sections
- Features of γ -ray tracking

Personæ

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GEFÖRDERT VOM

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