

Gamma-ray spectroscopy of actinide nuclei after multinucleon transfer reaction

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Spectroscopy of neutron-rich $Z=90-92$ actinides



Shell Correction Energy

A.Sobiczewski, I. Muntian,
Z. Patyk,
PRC, 63 (2001) 034306

Alternative Parity States

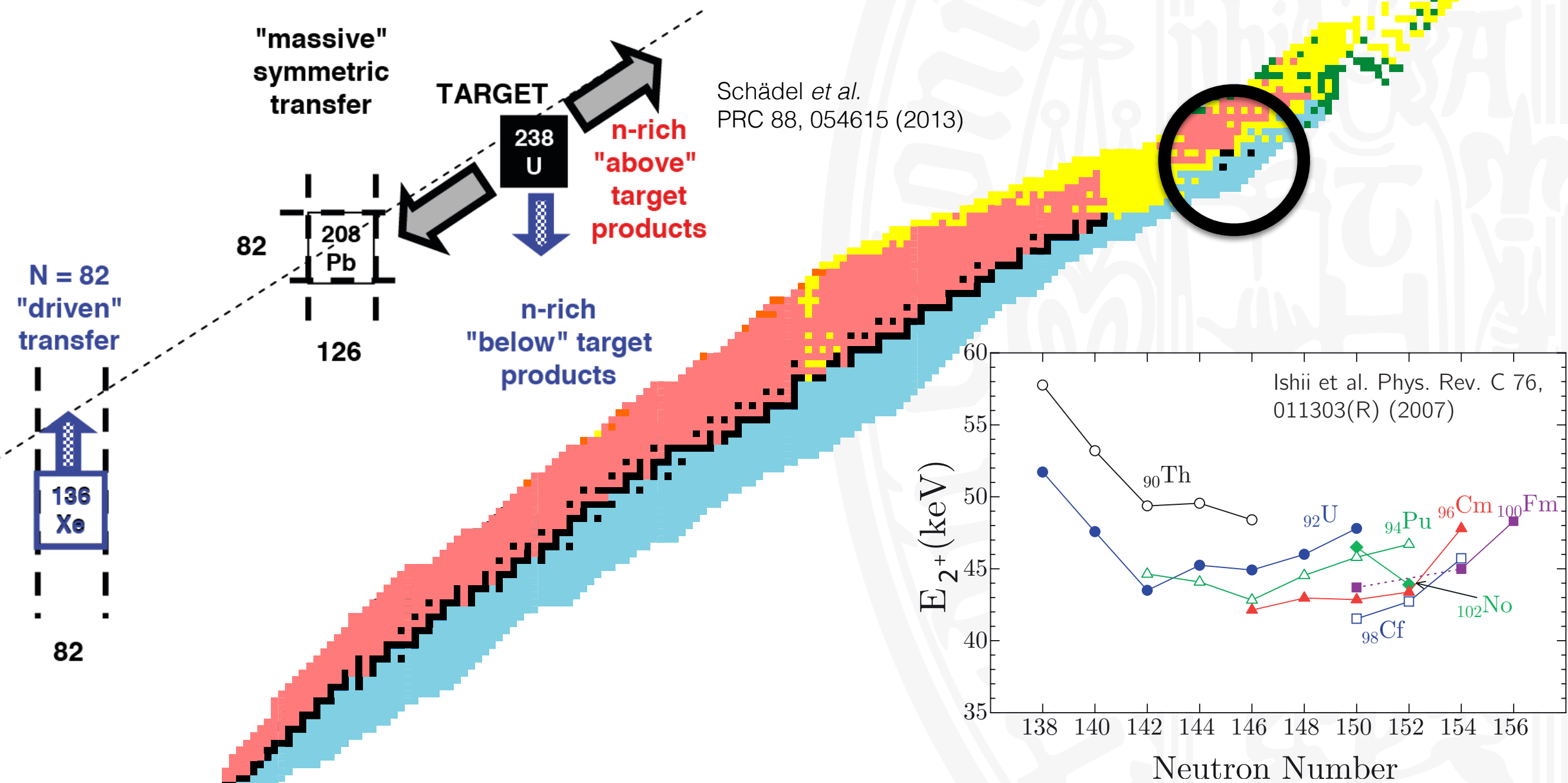
Shneidman, et al.
PRC 74,
034316 (2006)

MF and beyond-MF methods, Gogny Force

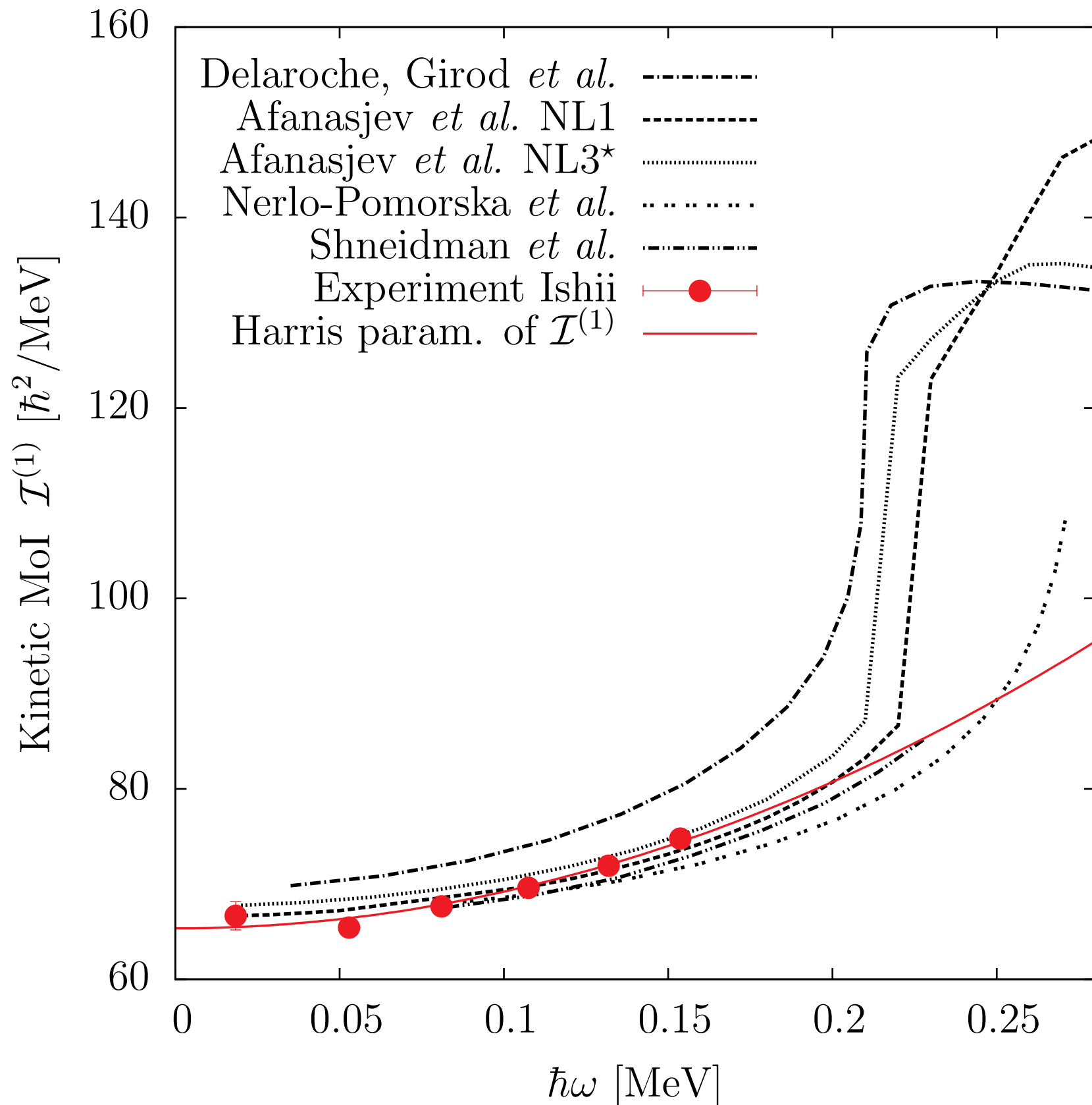
J.-P. Delaroche, M. Girod.
Nucl. Phys. A 771 (2006) 103–168

Relativistic Nuclear Energy Density Functionals

D. Vretenar, *et al.*,
Int. J. Mod. Phys. E (2010)



Example: Predictions for ^{240}U



$$\mathcal{J}^{(1)} = \frac{\hbar^2 (2I - 1)}{E_\gamma (I \rightarrow I - 2)}$$

Mean Field Calculations

Delaroche *et al.*
Nucl. Phys. A 771 (2006)
Afanasjev *et al.*
Phys. Rev. C 88, 014320 (2013)

Macroscopic Microscopic

Nerlo-Pomorska *et al.*
Phys. Rev. C 84, 044310 (2011)

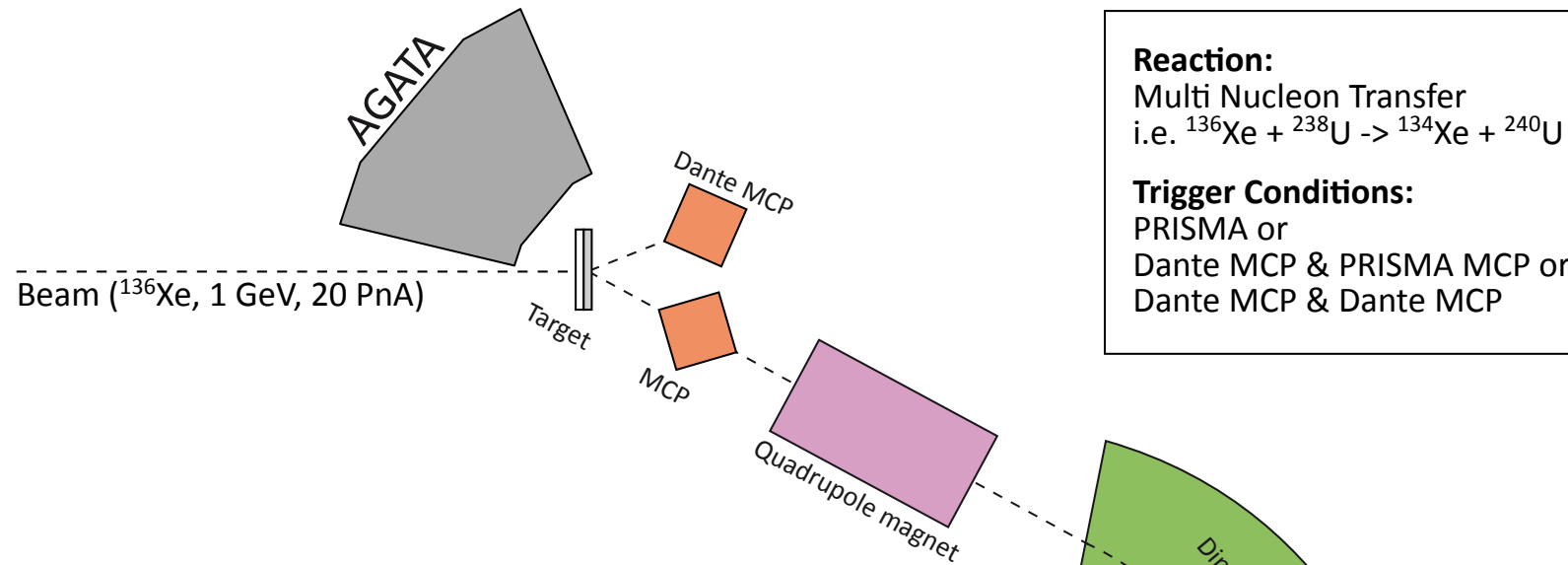
Cluster Model

Shneidman *et al.*
Phys. Rev. C 74, 034316 (2006)

Experiment

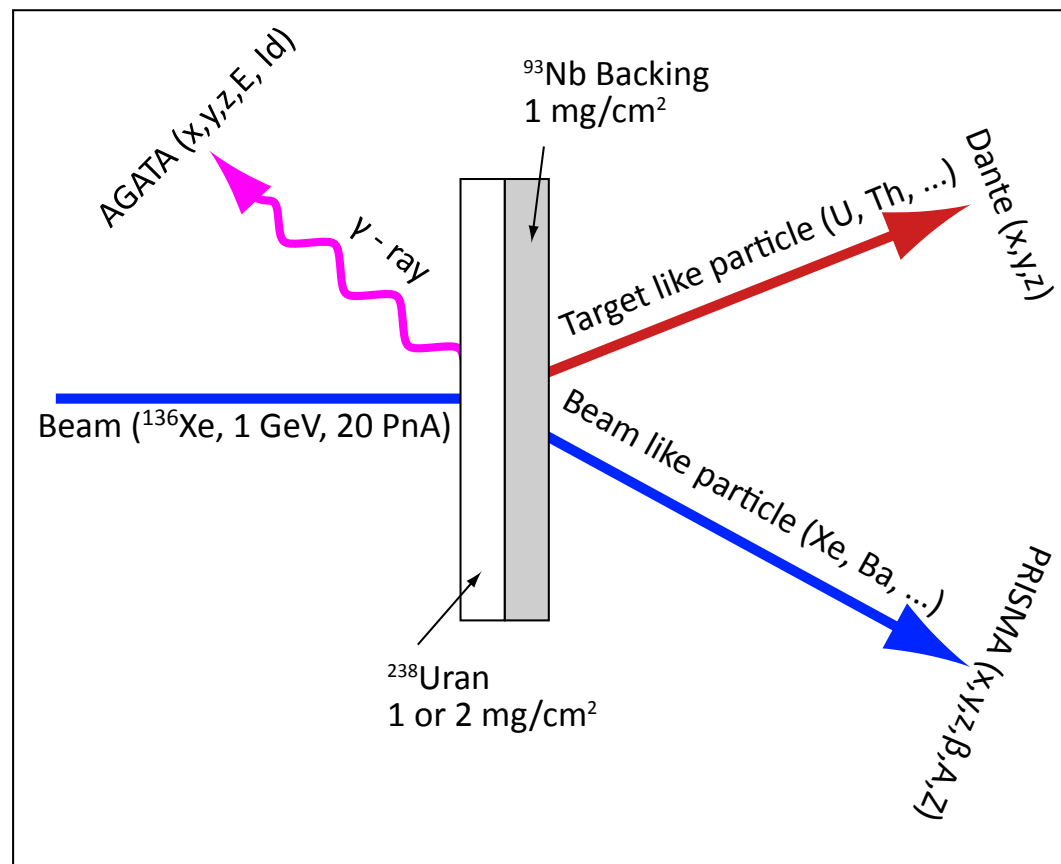
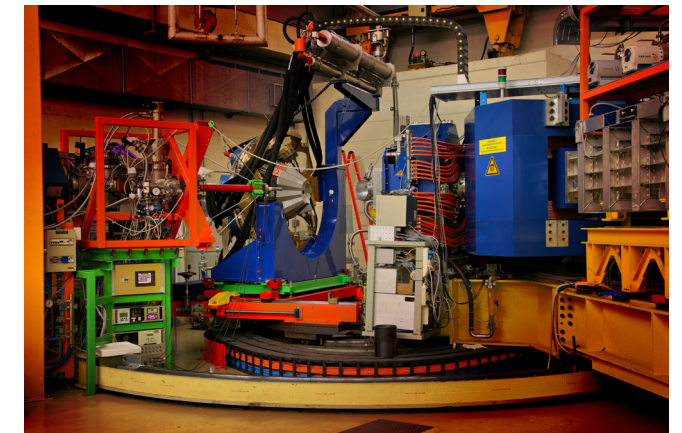
Phys. Rev. C 72, 021301(R)
(2005)

Actinides production by a multinucleon transfer reaction (MNT) - 11.22

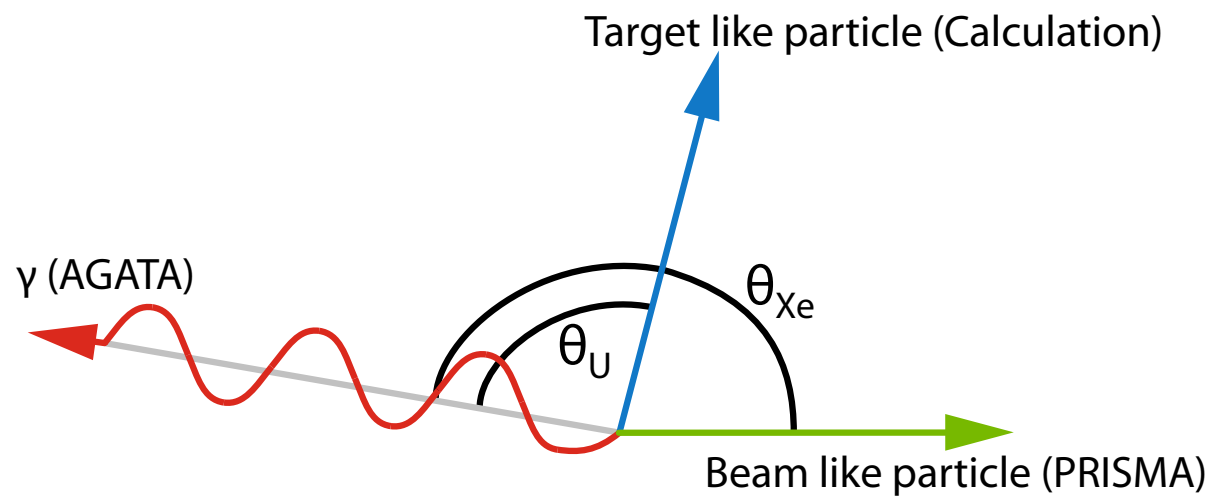


Reaction:
Multi Nucleon Transfer
i.e. $^{136}\text{Xe} + ^{238}\text{U} \rightarrow ^{134}\text{Xe} + ^{240}\text{U}$

Trigger Conditions:
PRISMA or
Dante MCP & PRISMA MCP or
Dante MCP & Dante MCP

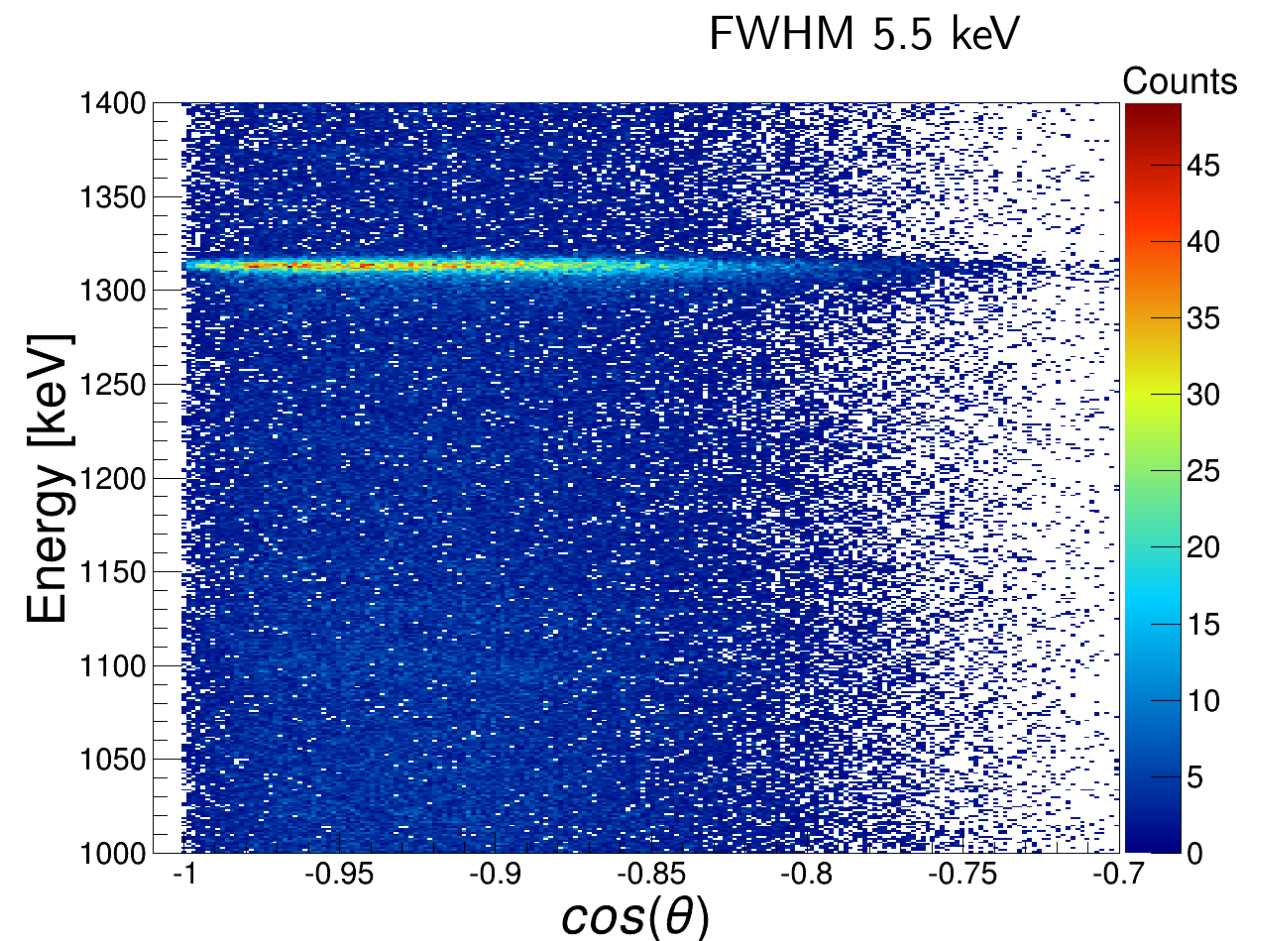
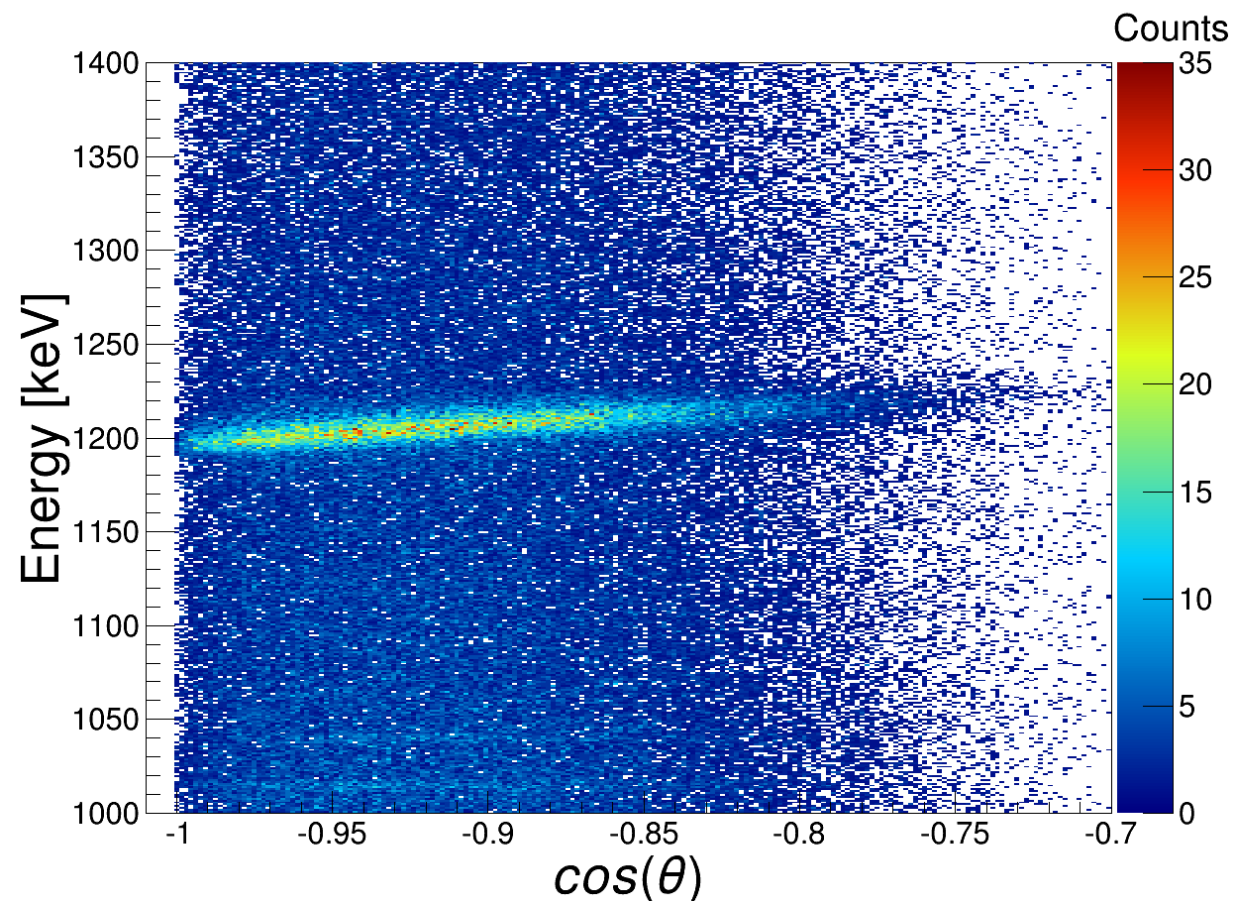


Doppler Correction (DC) with information of AGATA and PRISMA

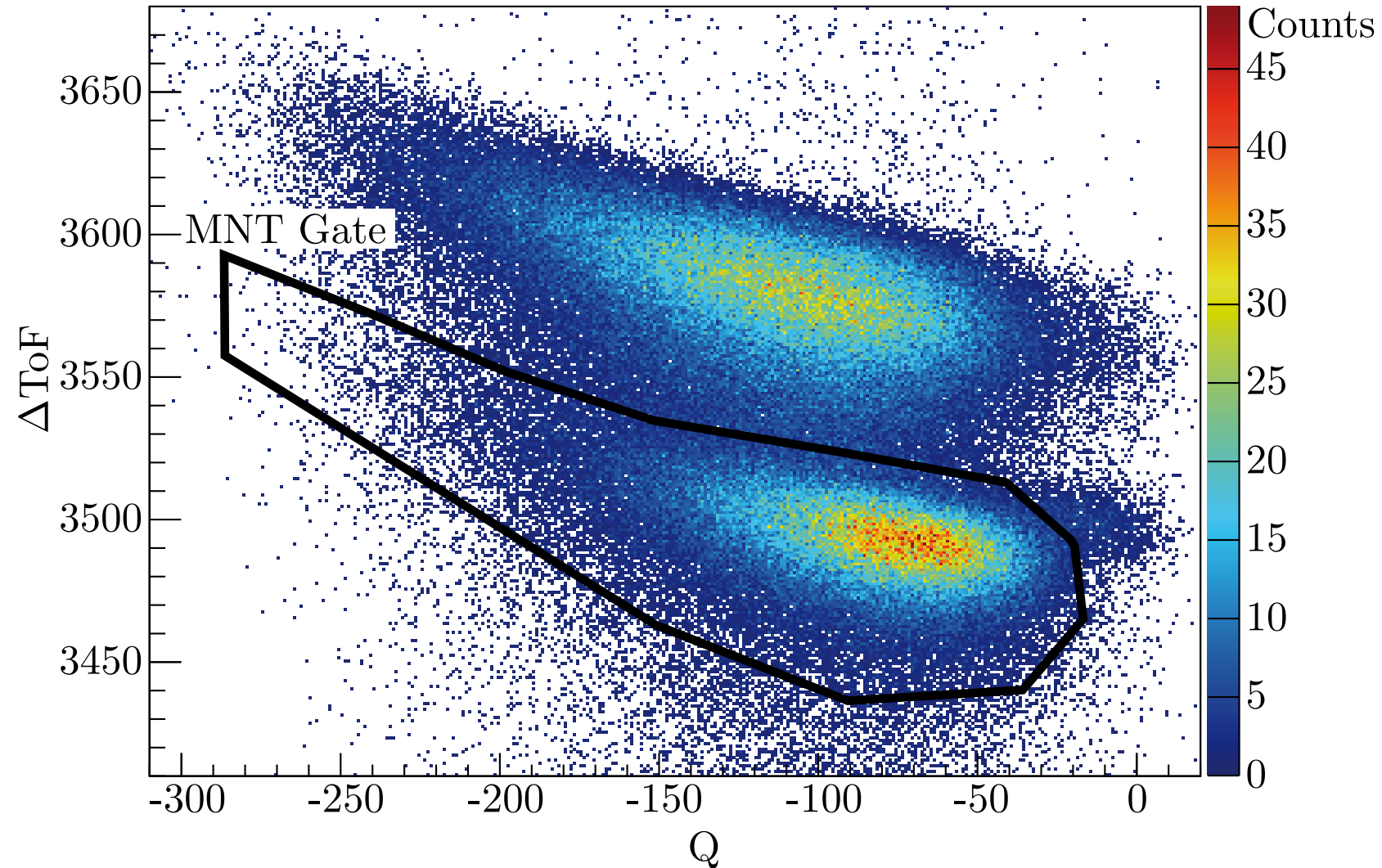
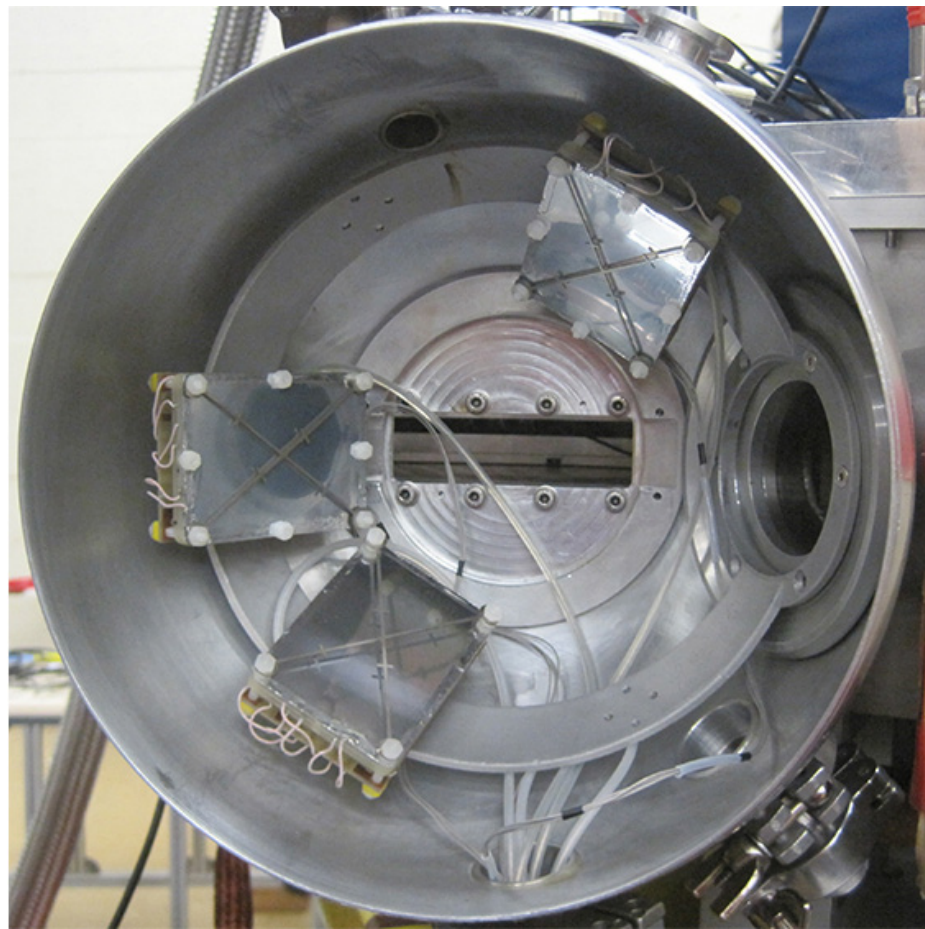
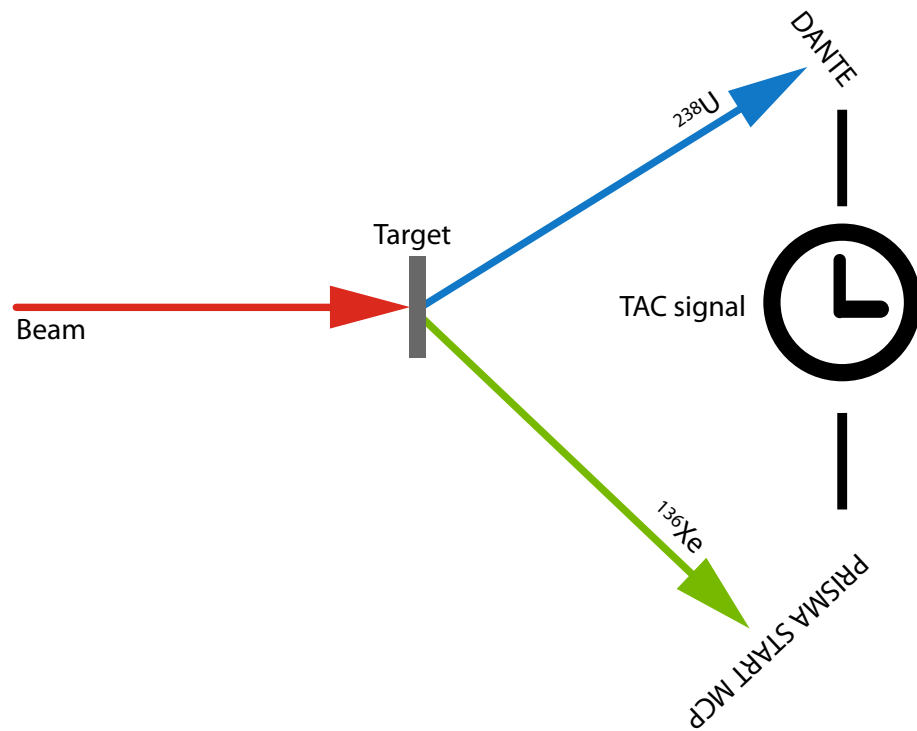


Optimization with four parameters:

- Beta
- Prisma X Position on the entrance detector
- Prisma Y Position on the entrance detector
- AGATA distance

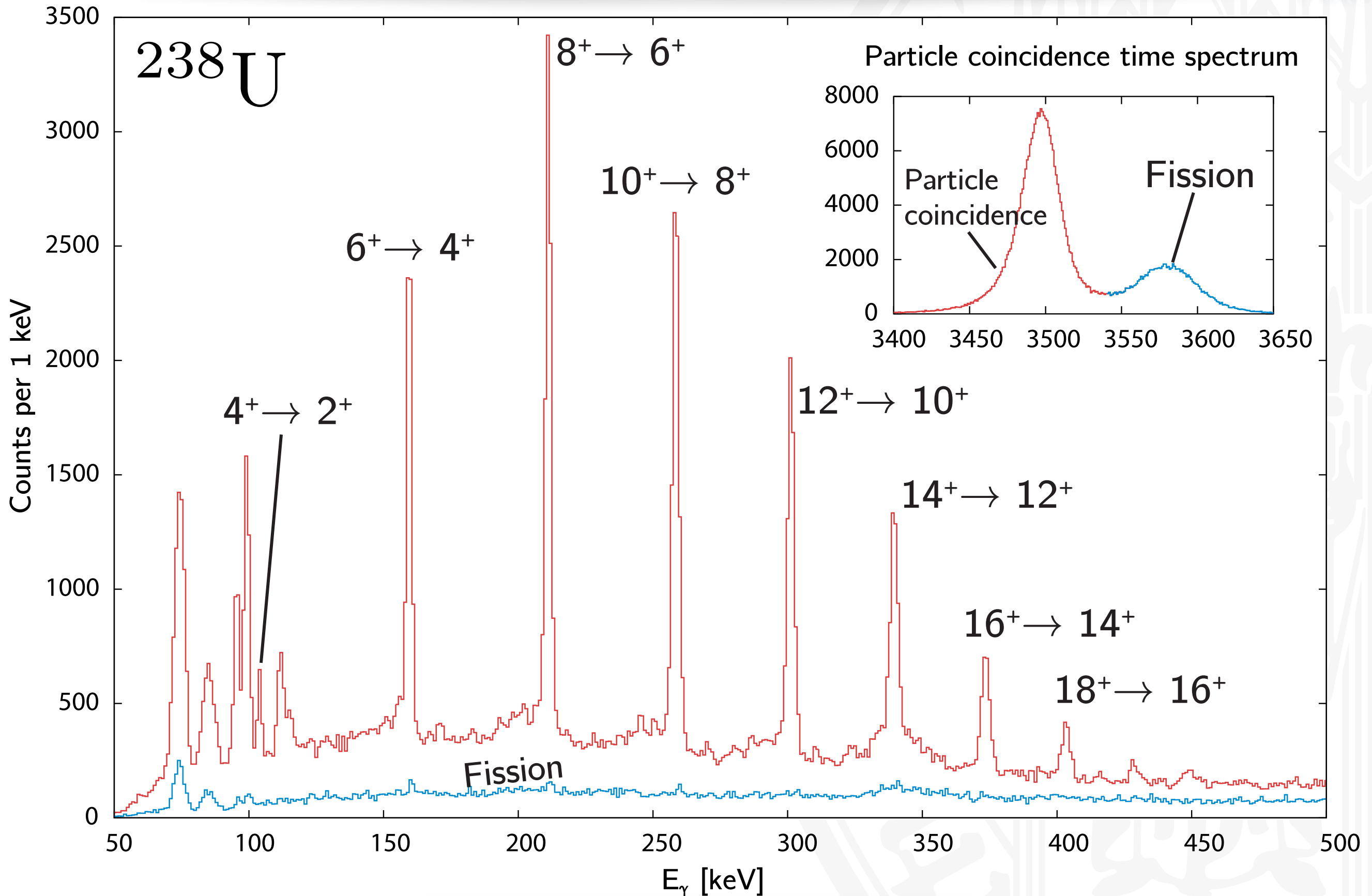


Select only multinucleon transfer events

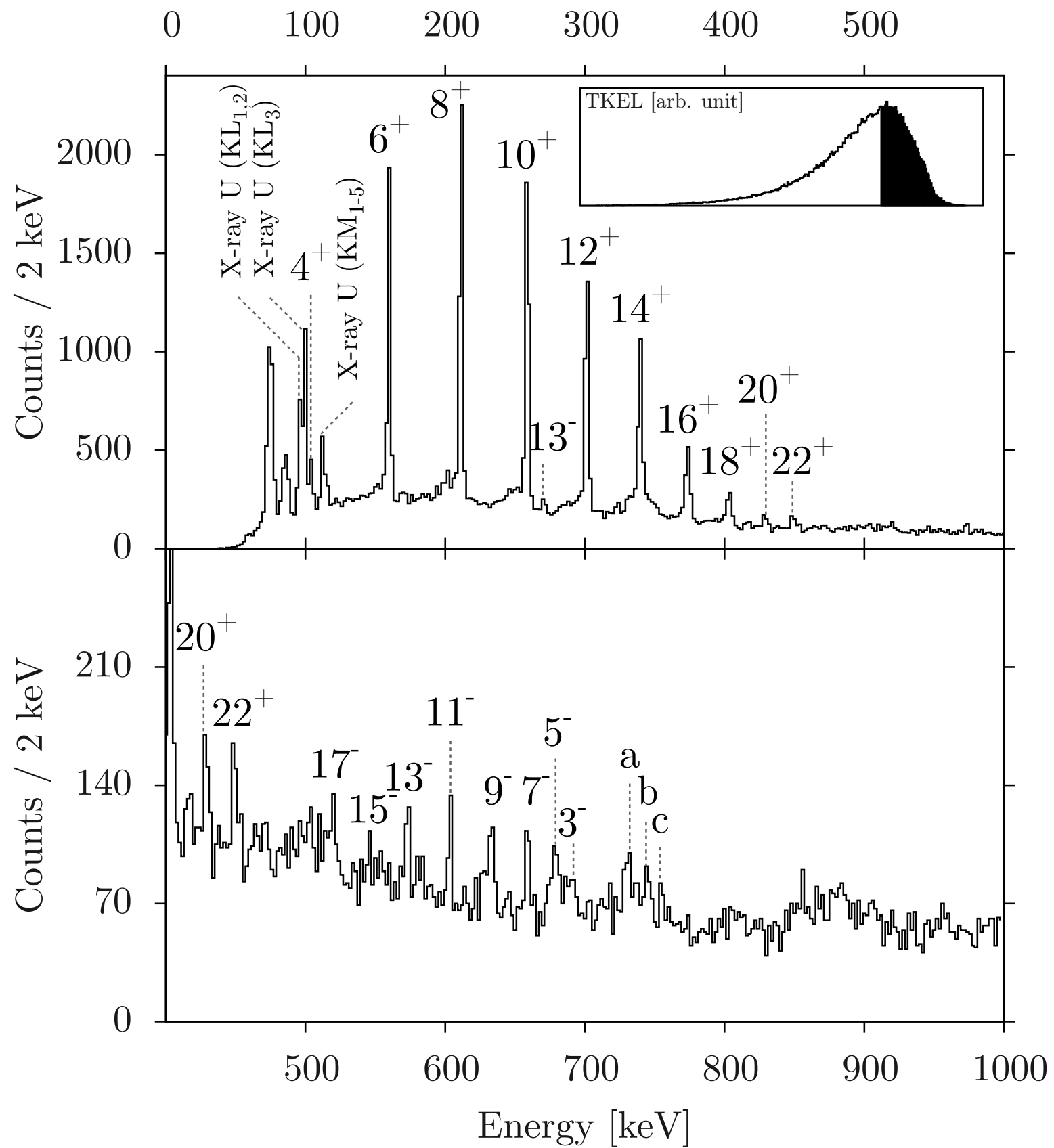


Additional time cut on the time of flight corrected prompt
AGATA / PRISMA timing

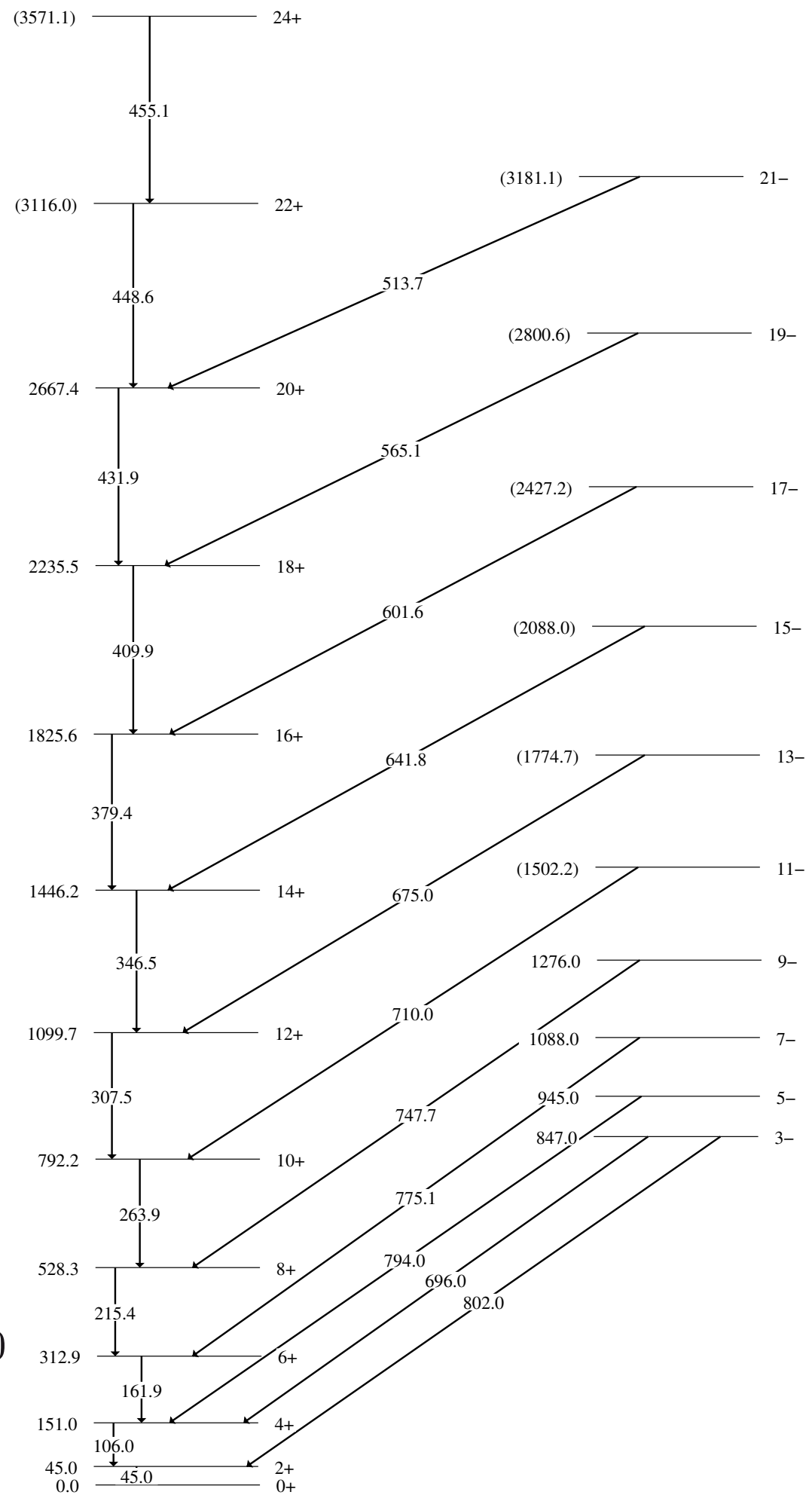
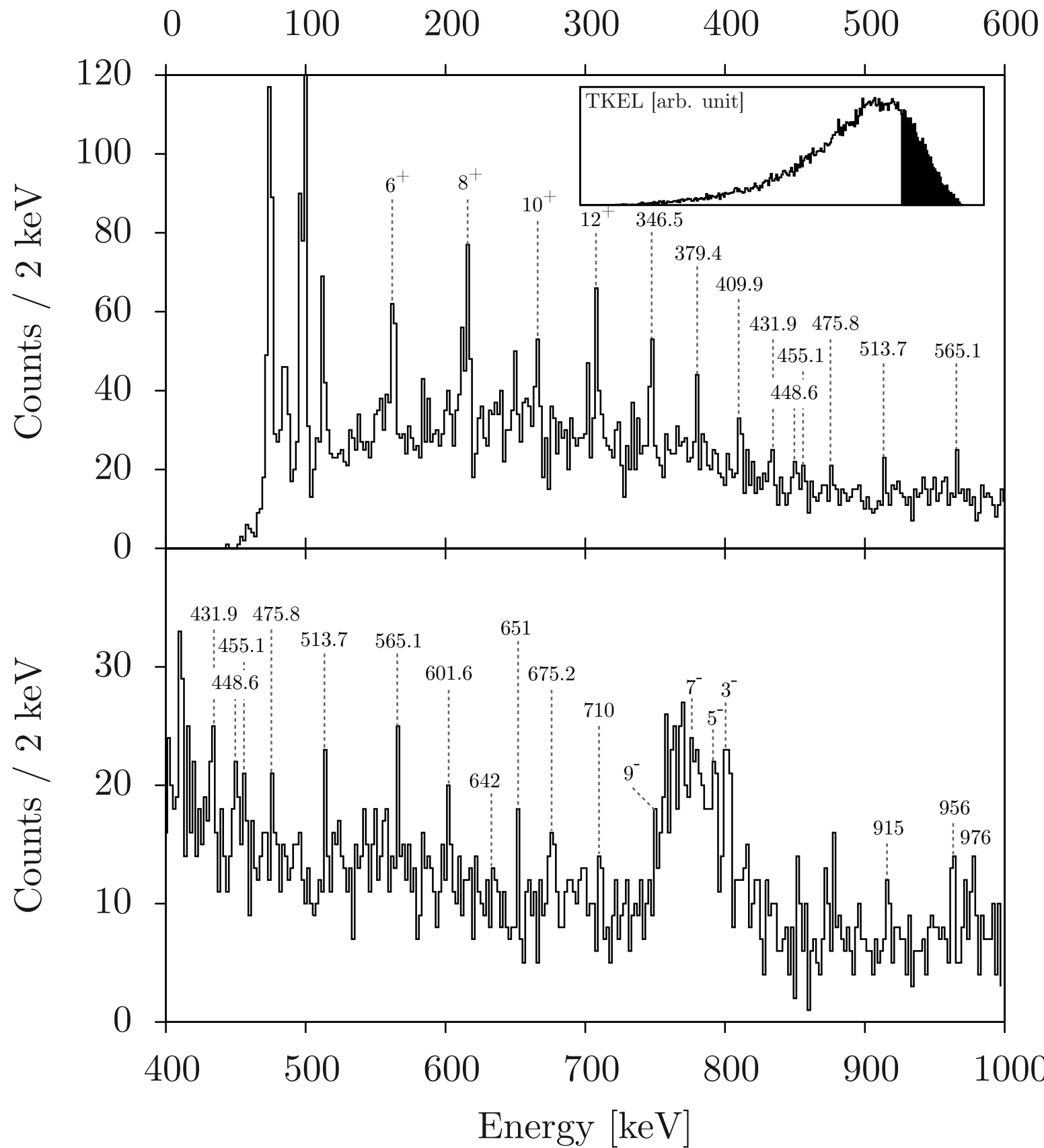
Discriminating Fission & Transfer



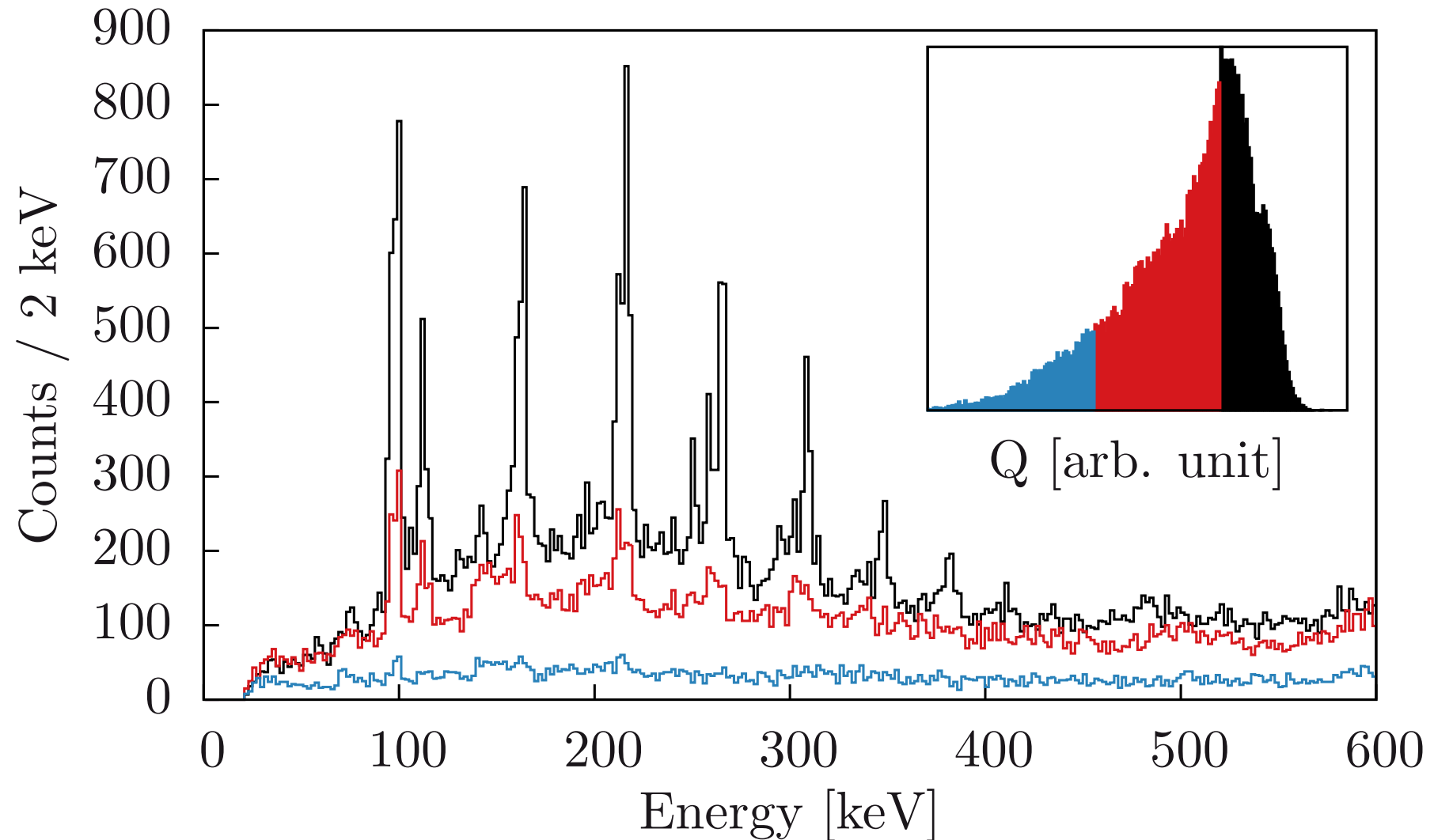
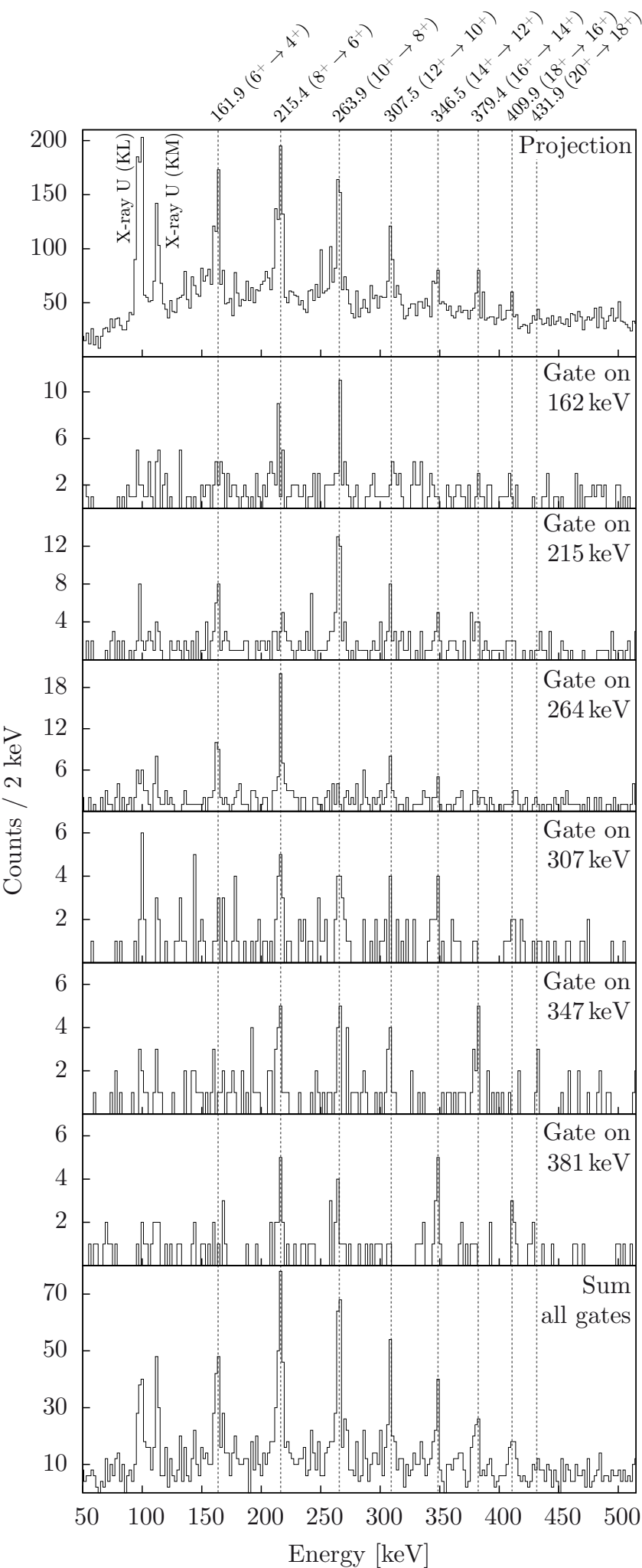
Spectrum of ^{238}U



Spectrum of ^{240}U



Additional information ^{240}U from a PRISMA / CLARA experiment

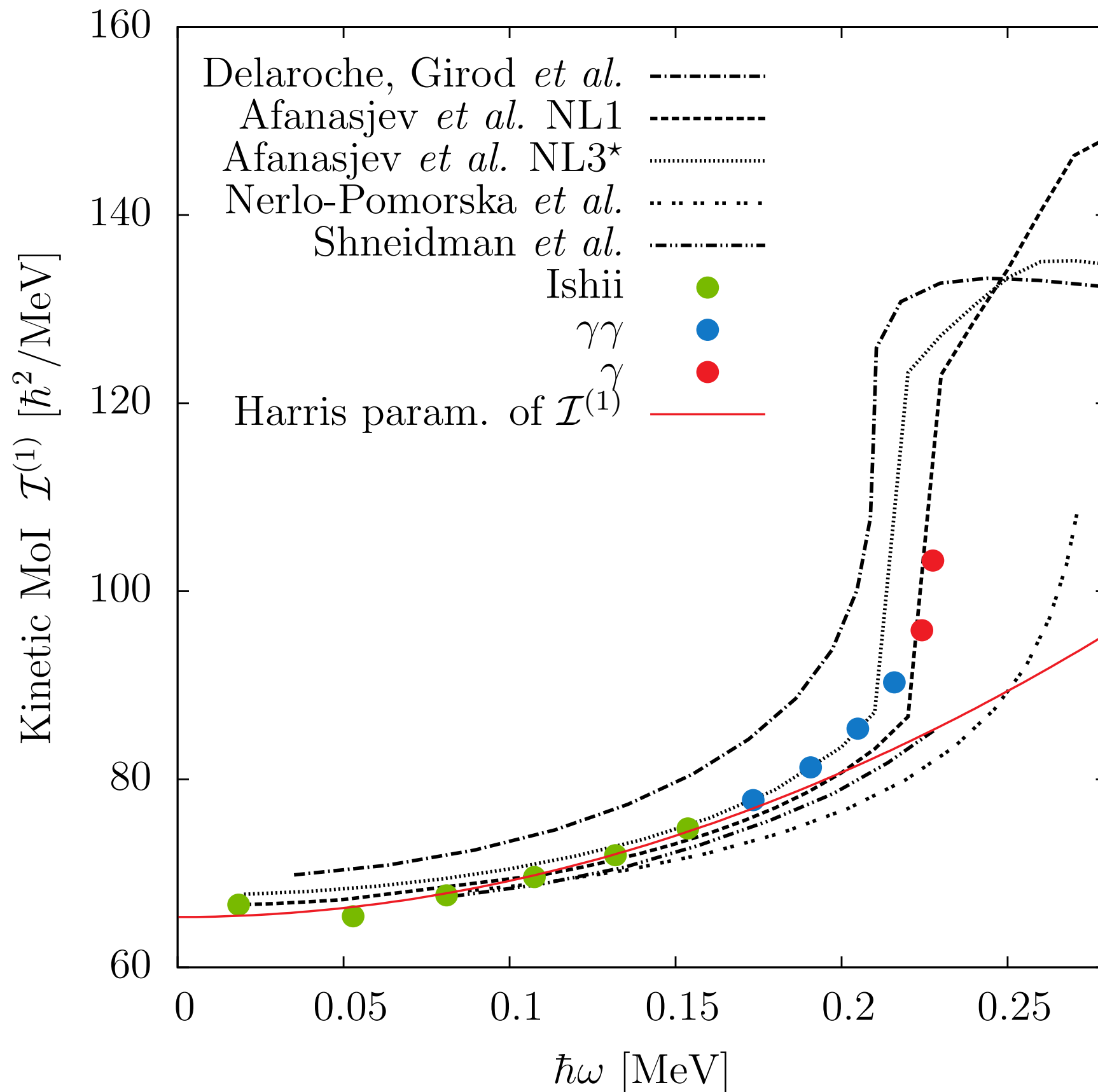


Experiment performed at INFN Legnaro 2007

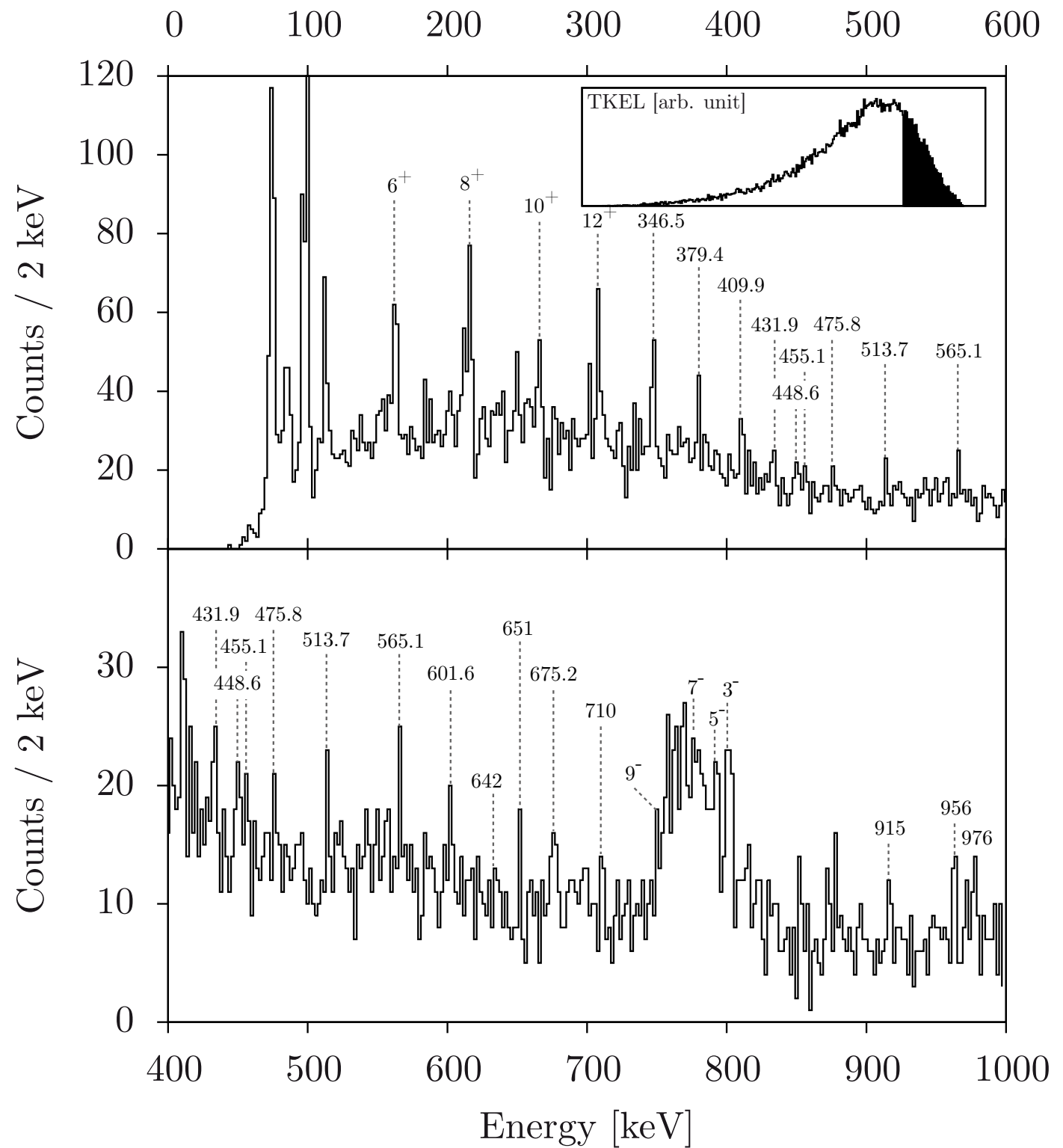
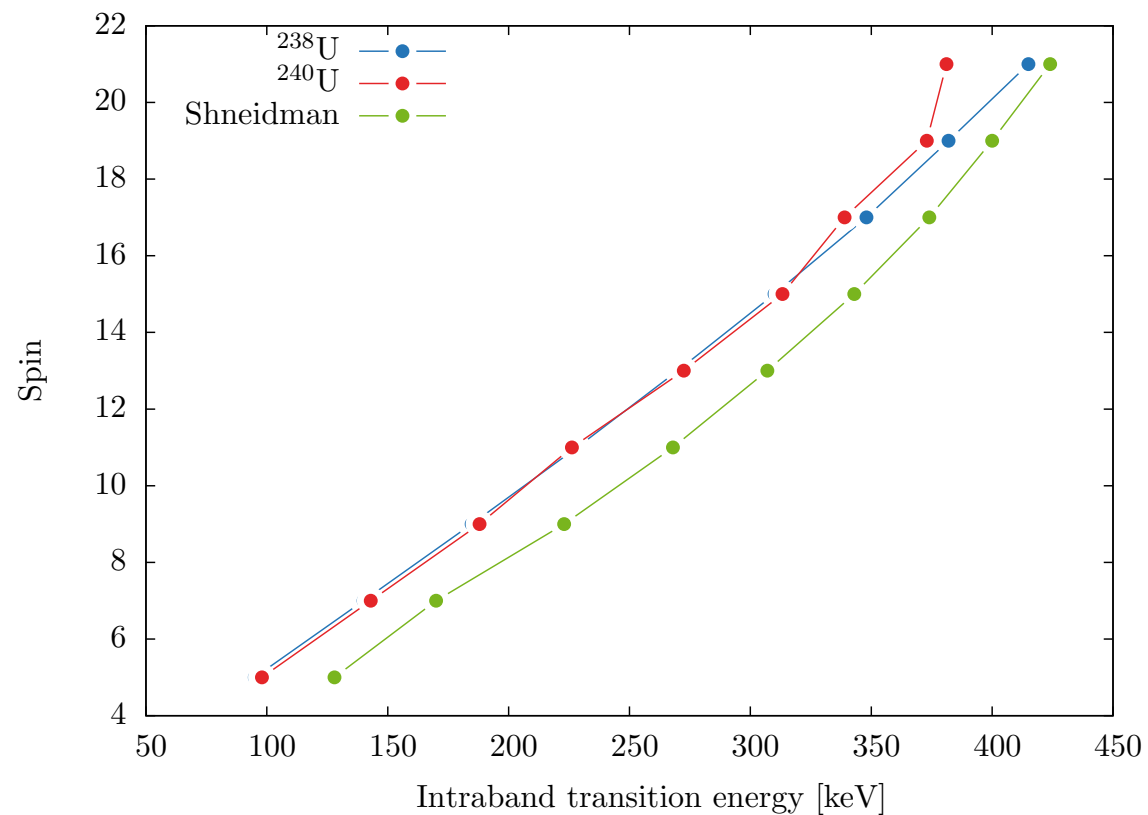
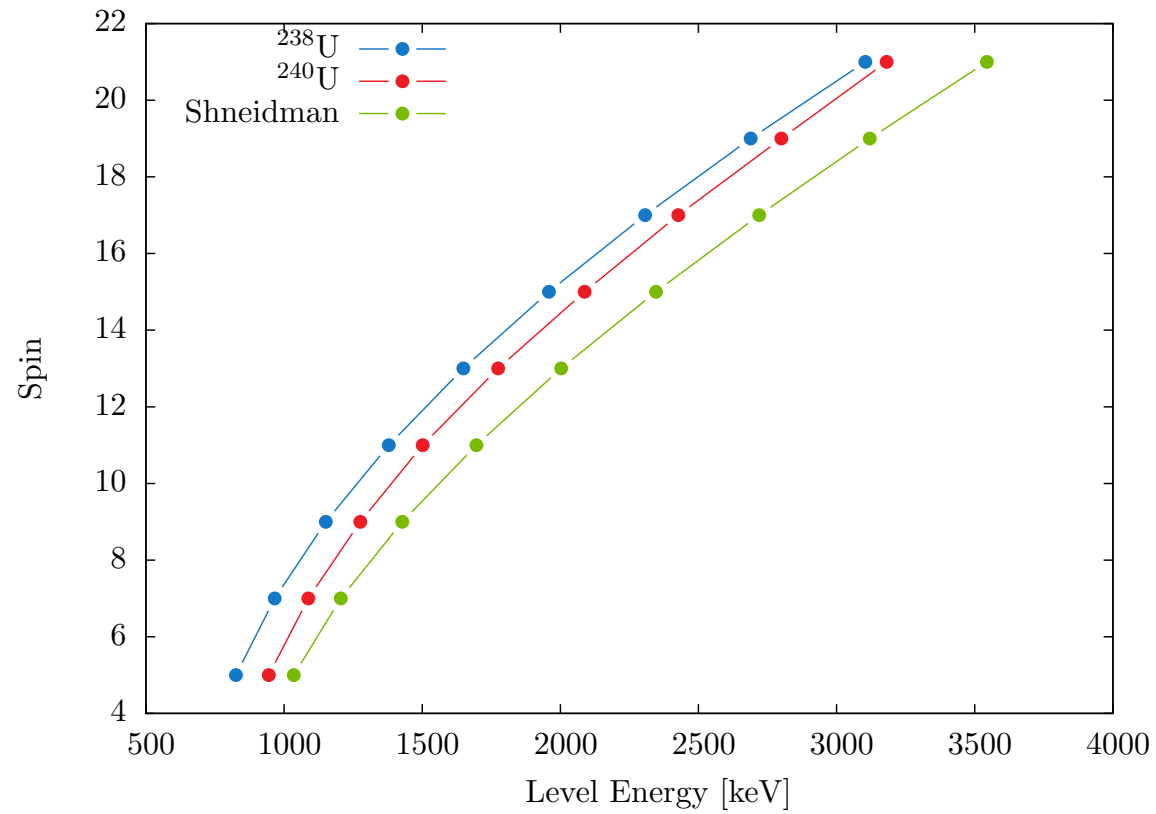
- 70 Zn Beam @ 460 MeV

- ^{238}U Target

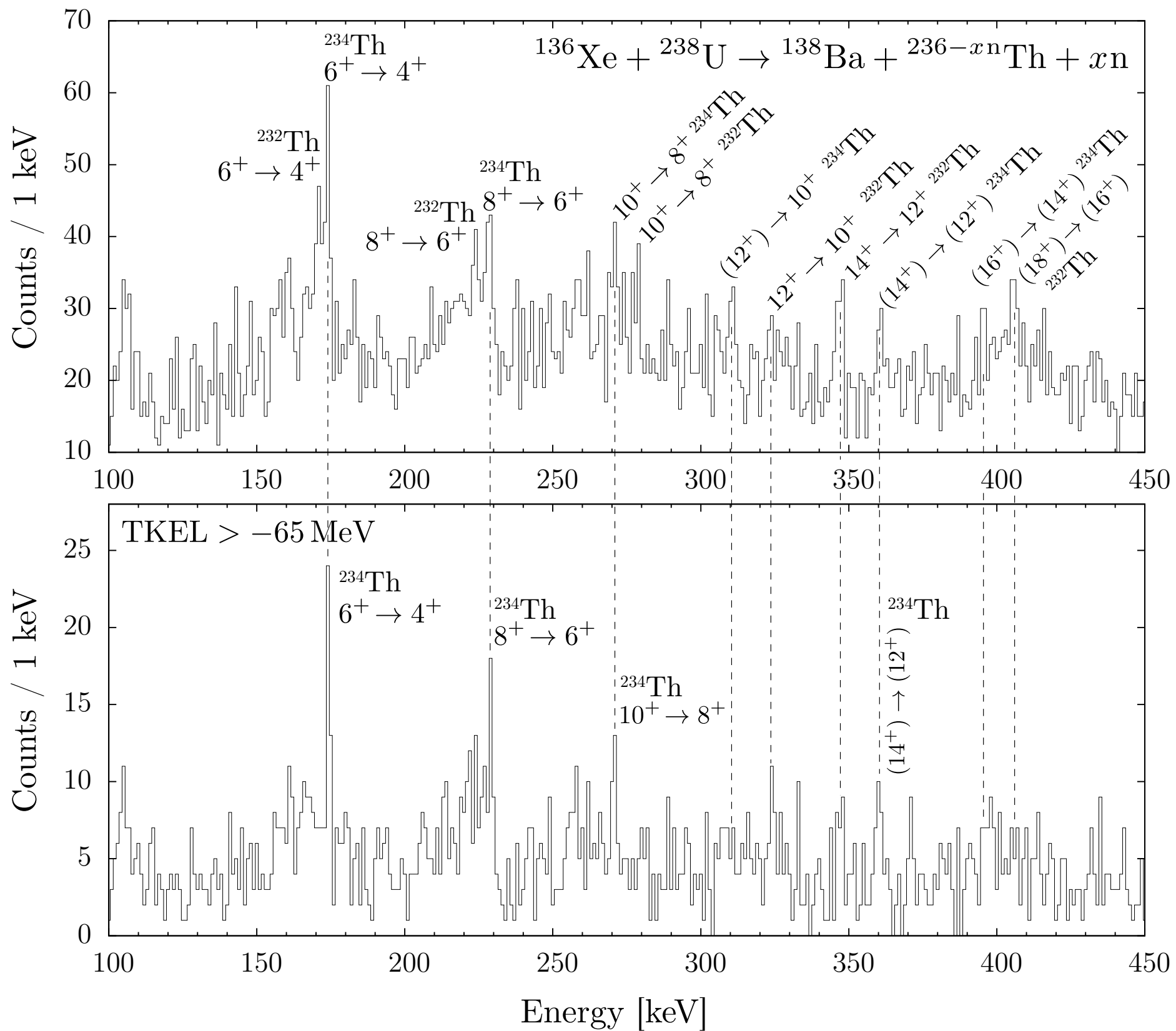
^{240}U Moments of inertia



Candidates for negative parity band in ^{240}U

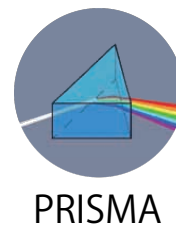


Spectrum of Thorium



Summary

- Actinide spectroscopy after MNT reaction
- Extended ground-state band upbending in ^{240}U
- Candidates for first negative parity band of ^{240}U
- Preliminary Thorium results



Bundesministerium
für Bildung
und Forschung

Gate on: ^{134}Xe
DC for: ^{240}U

$X\text{-ray U (KL)}$
 $X\text{-ray U (KM/N)}$

$^{239}\text{U} ((7/2^-) \rightarrow 7/2^+)$
 $^{238}\text{U} (10^+ \rightarrow 8^+)$
 $^{240}\text{U} (10^+ \rightarrow 8^+)$

