Light and Heavy Transfer Products in the $^{136}Xe + ^{238}U$ multinucleon transfer reaction

14th Exotic Beams Summer School, FSU 2015

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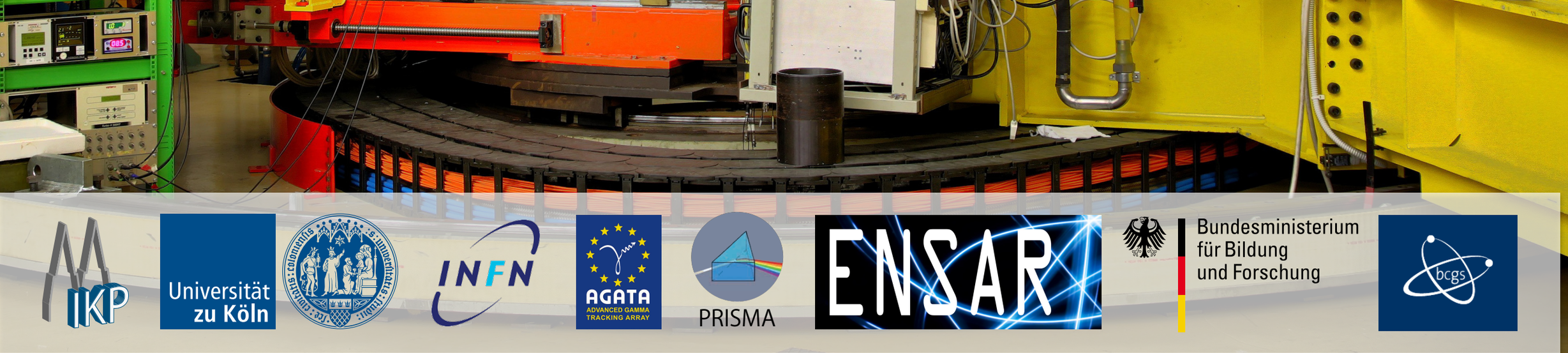
Institute for Nuclear Physics
University of Cologne



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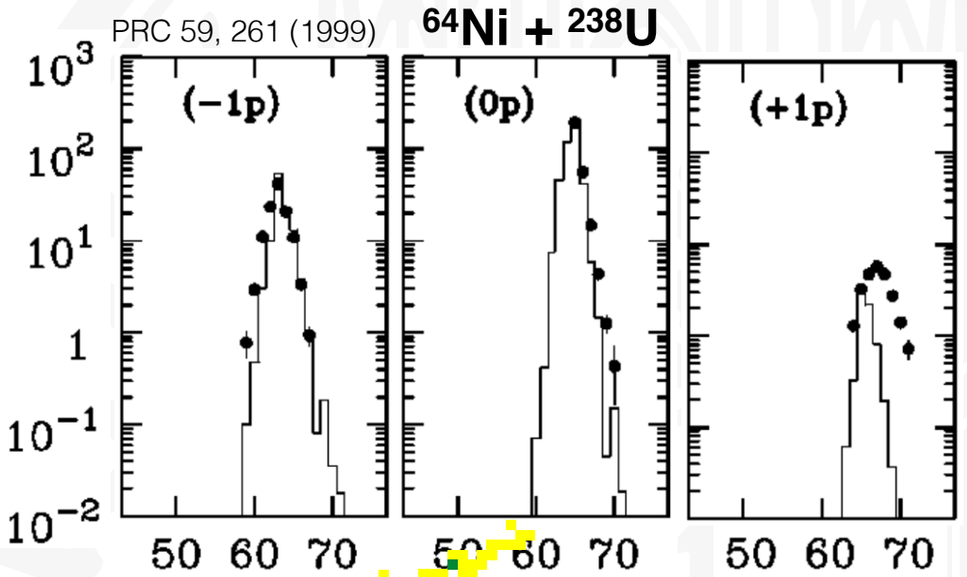
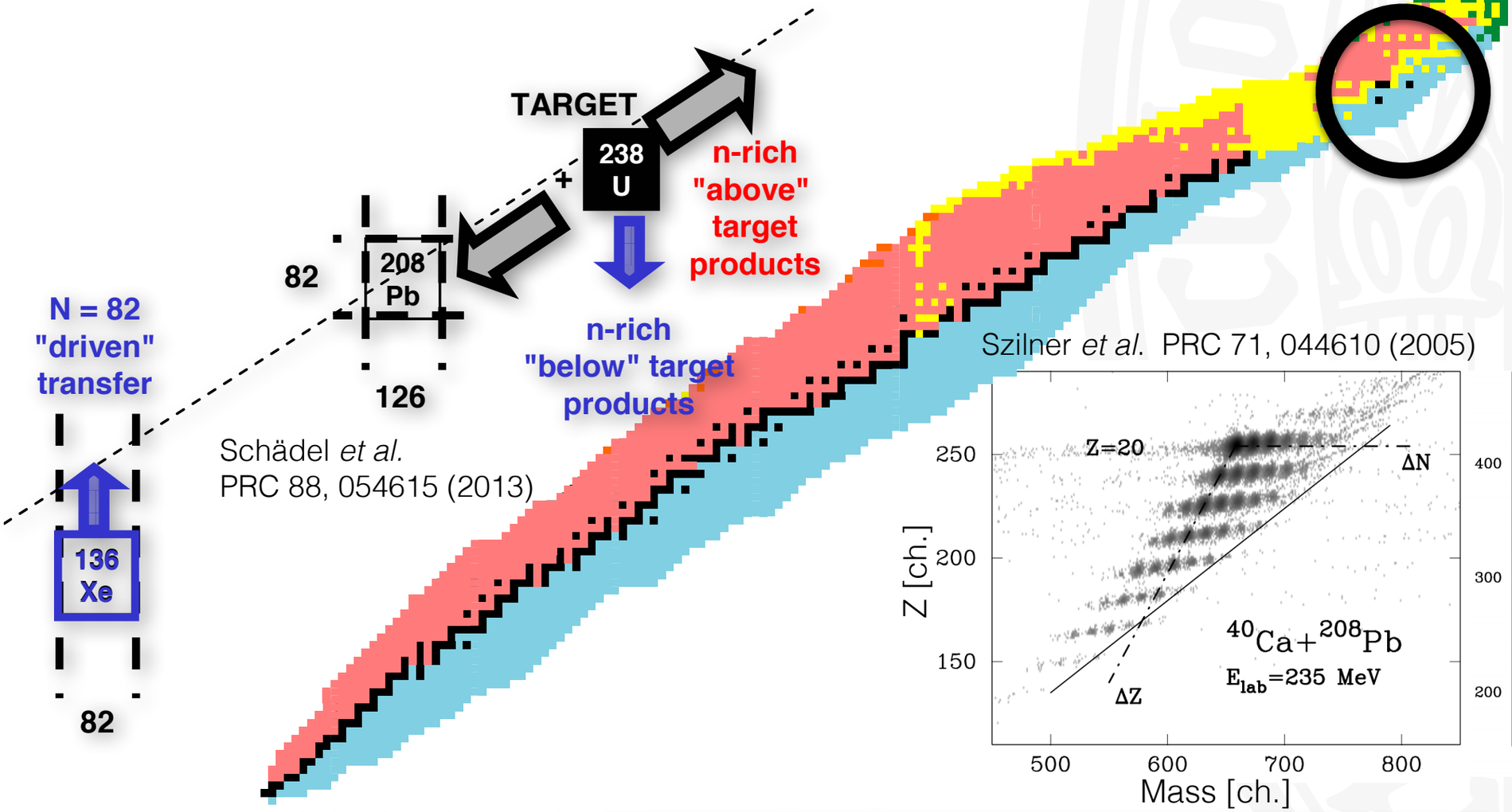
Multinucleon Transfer (MNT) in the Actinide Region

- MNT reactions are a competitive tool to populate **exotic neutron-rich nuclei**
- For each transferred neutron, cross section drops by a constant factor, ***μ*b to mb cross sections**
- **Evaporation** may strongly influence the isotopic distribution of the final fragments
- Main restriction is presently missing **identification** techniques for heavy transfer products

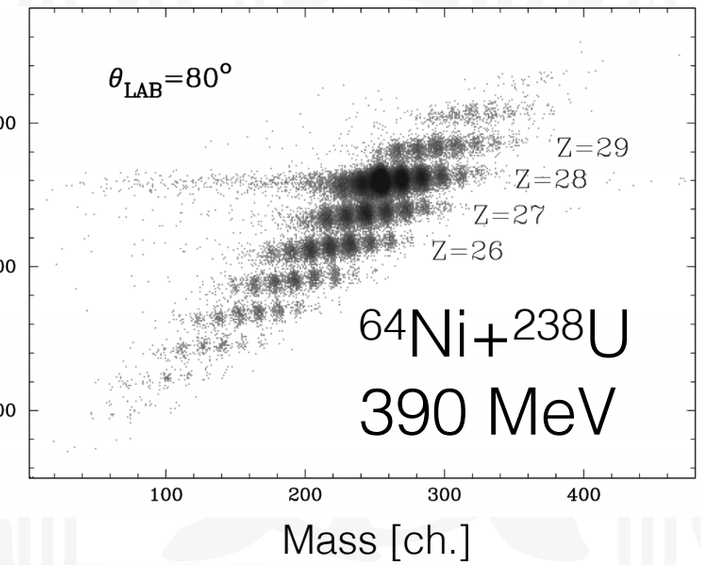


MNT system does not reach charge equilibration, population in the (N,Z) plane is dictated by the Q_{opt}



Szilner *et al.* PRC 71, 044610 (2005)

Corradi *et al.* PRC 59, 261 (1999)



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- **Evapora**
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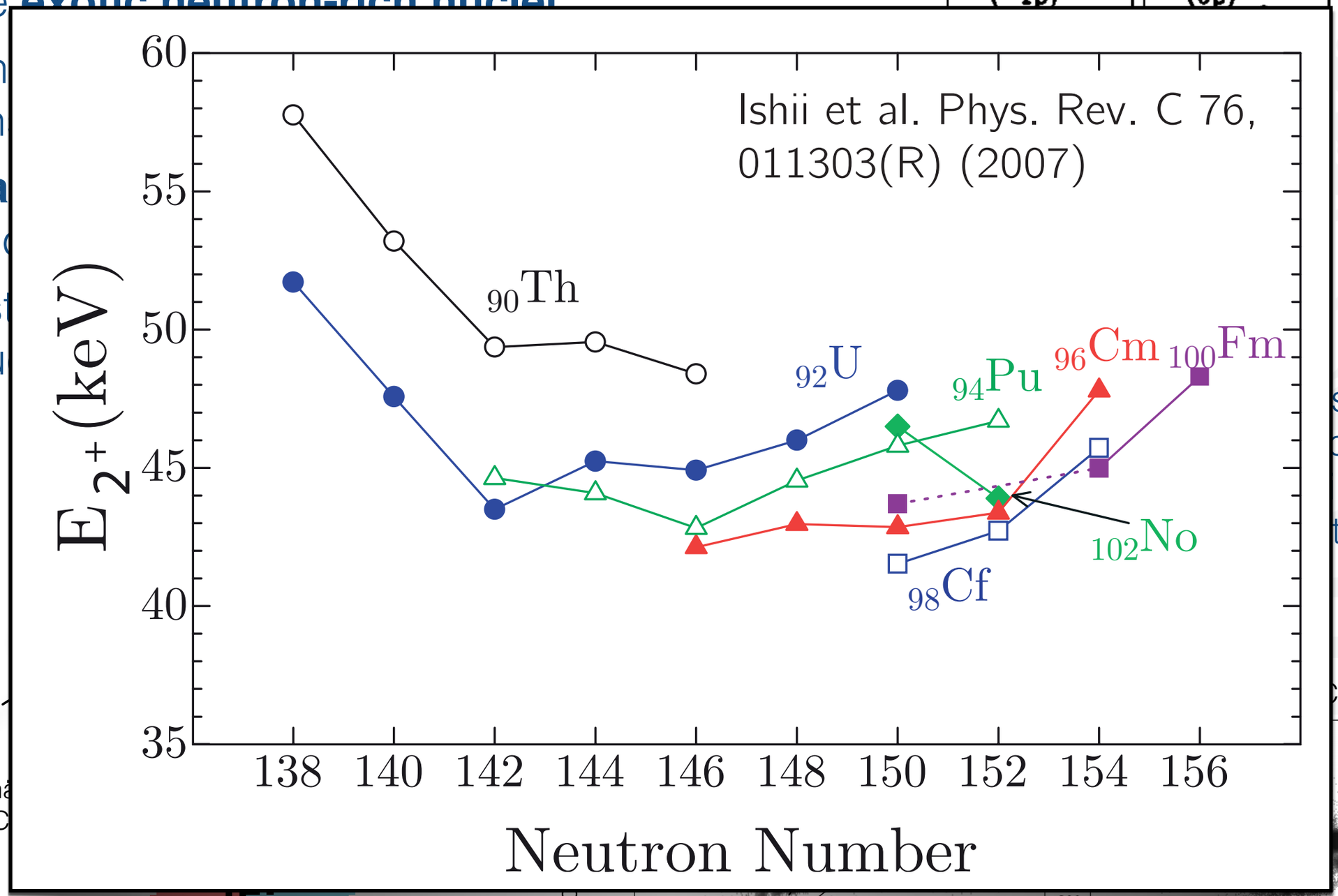

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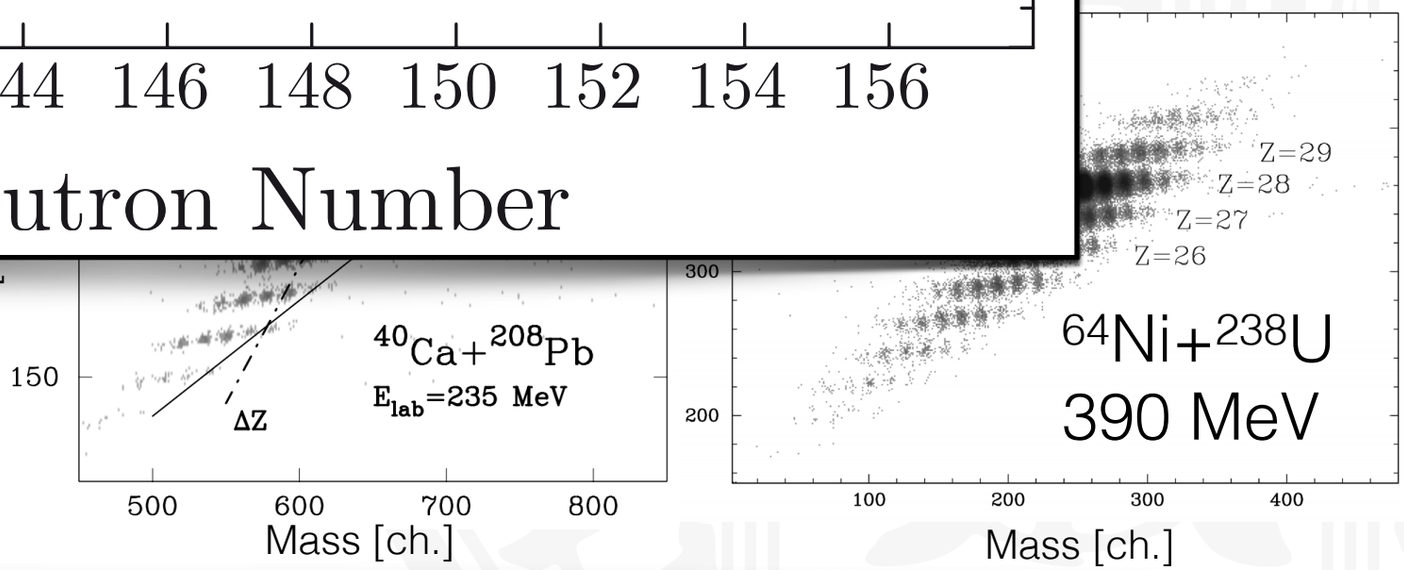
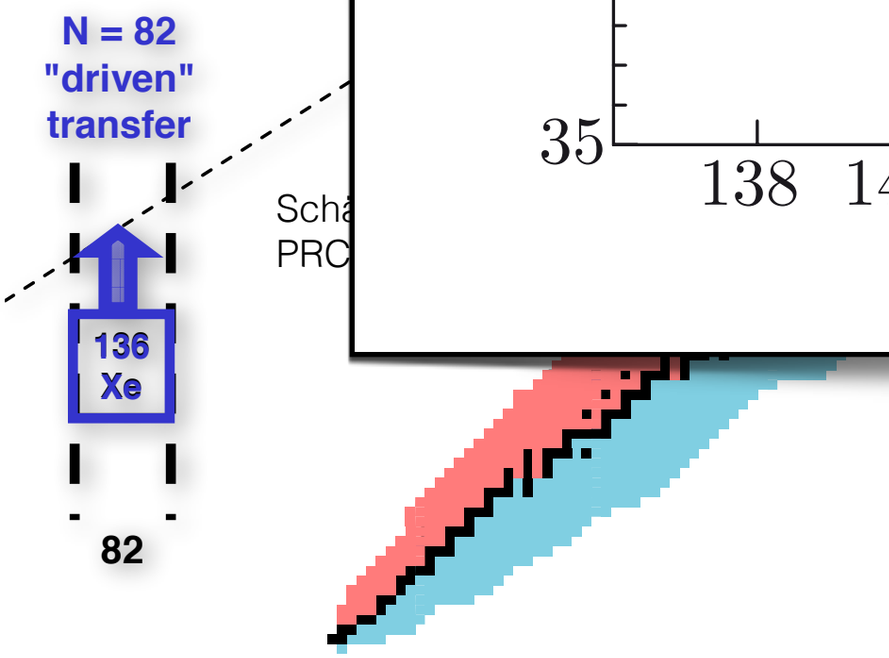
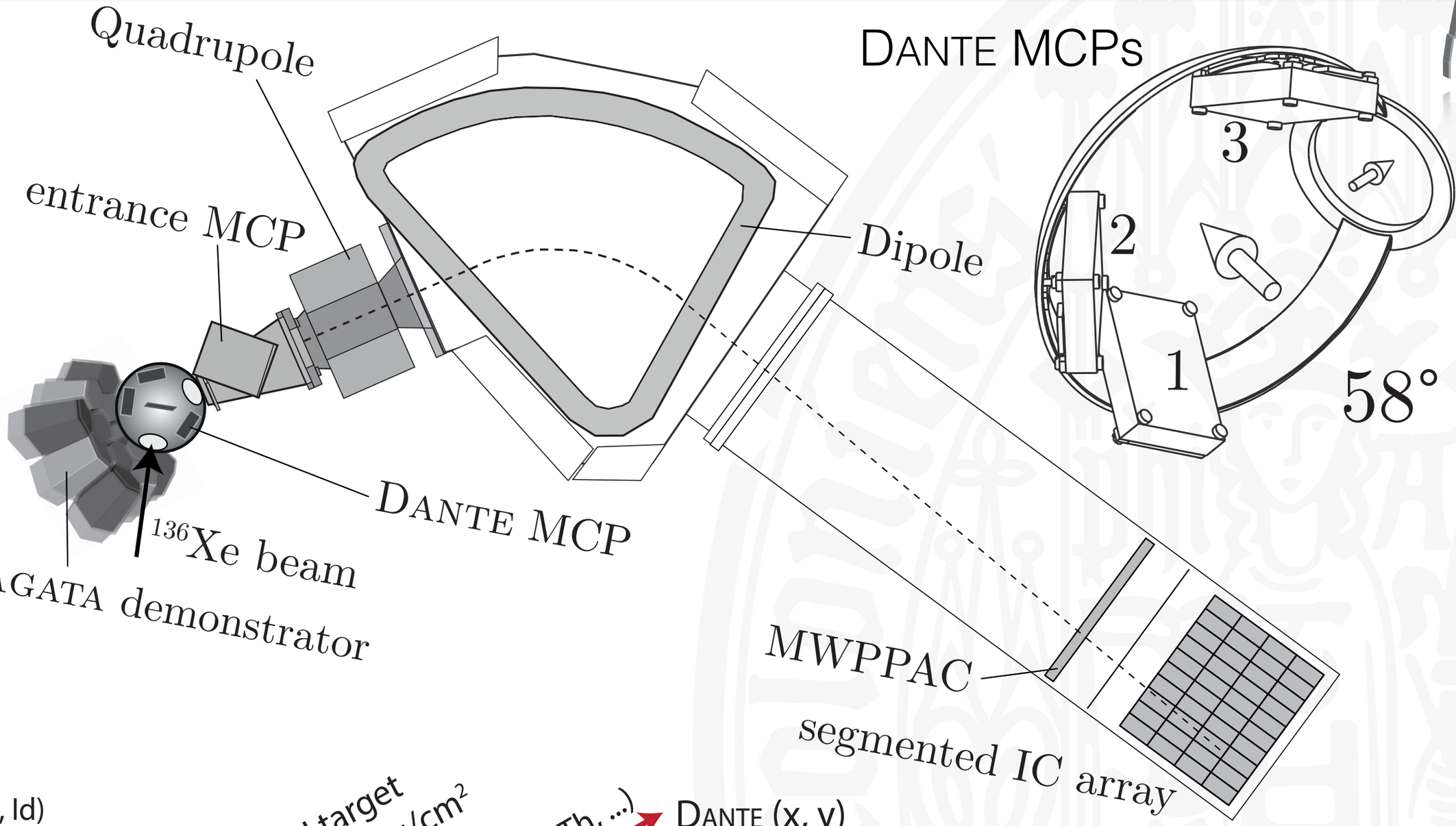


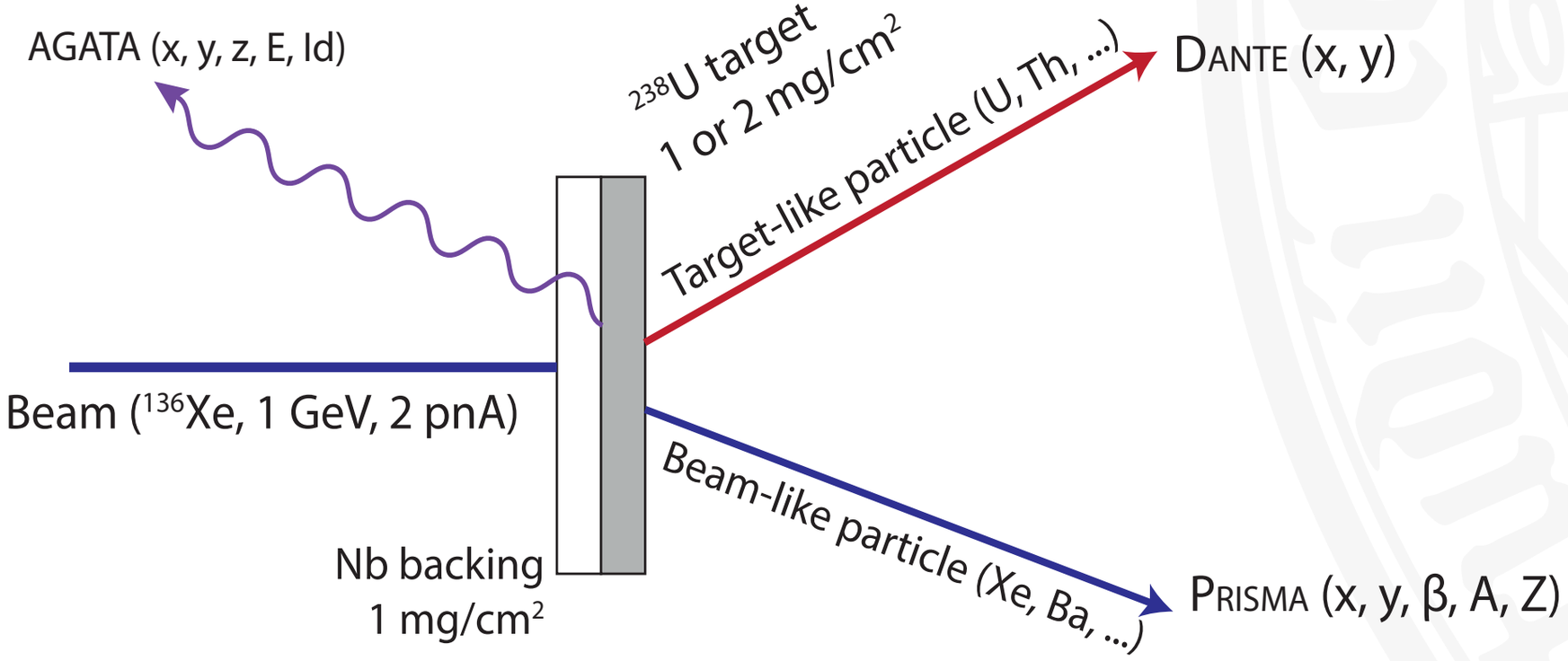


Istituto Nazionale di Fisica Nucleare

AGATA ADVANCED GAMMA TRACKING ARRAY

PRISMA

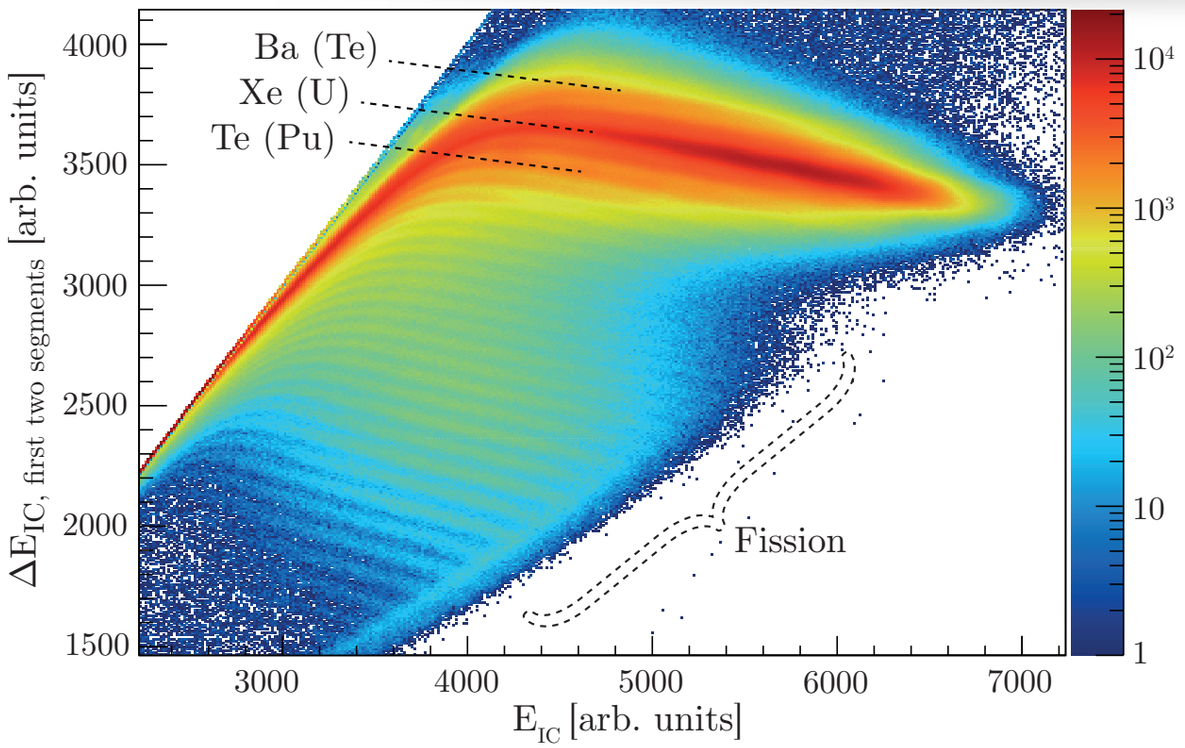


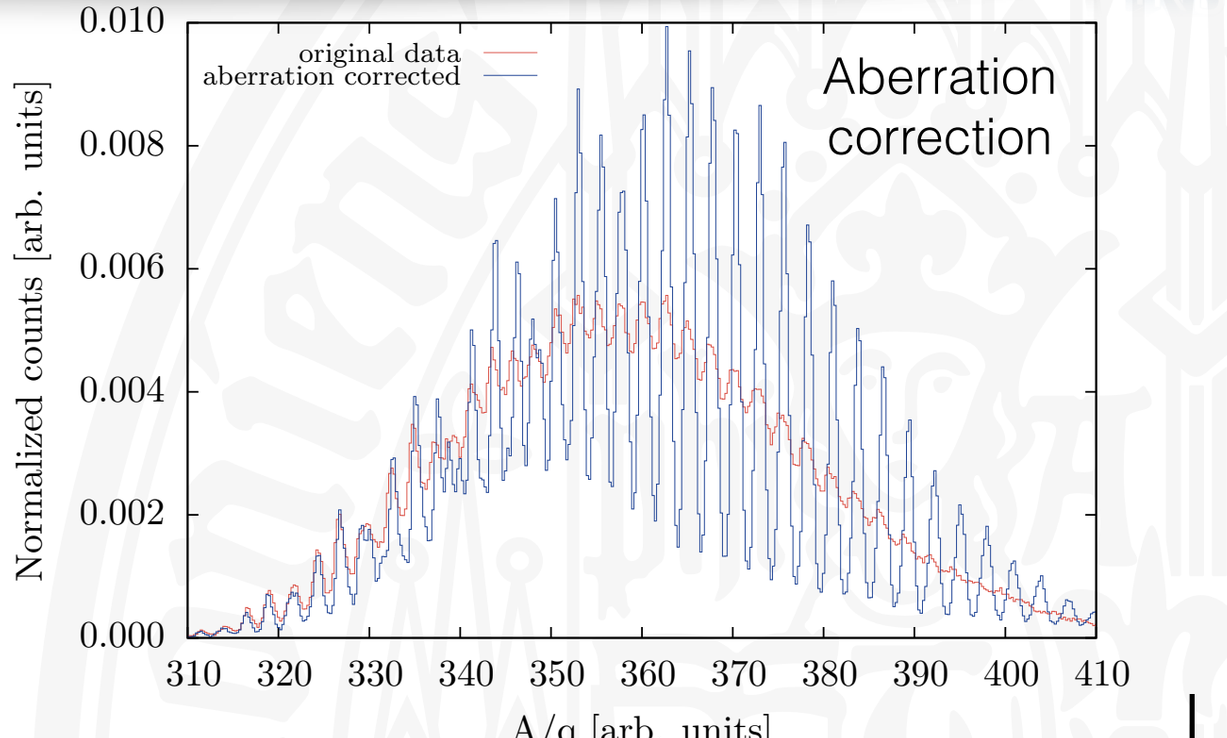


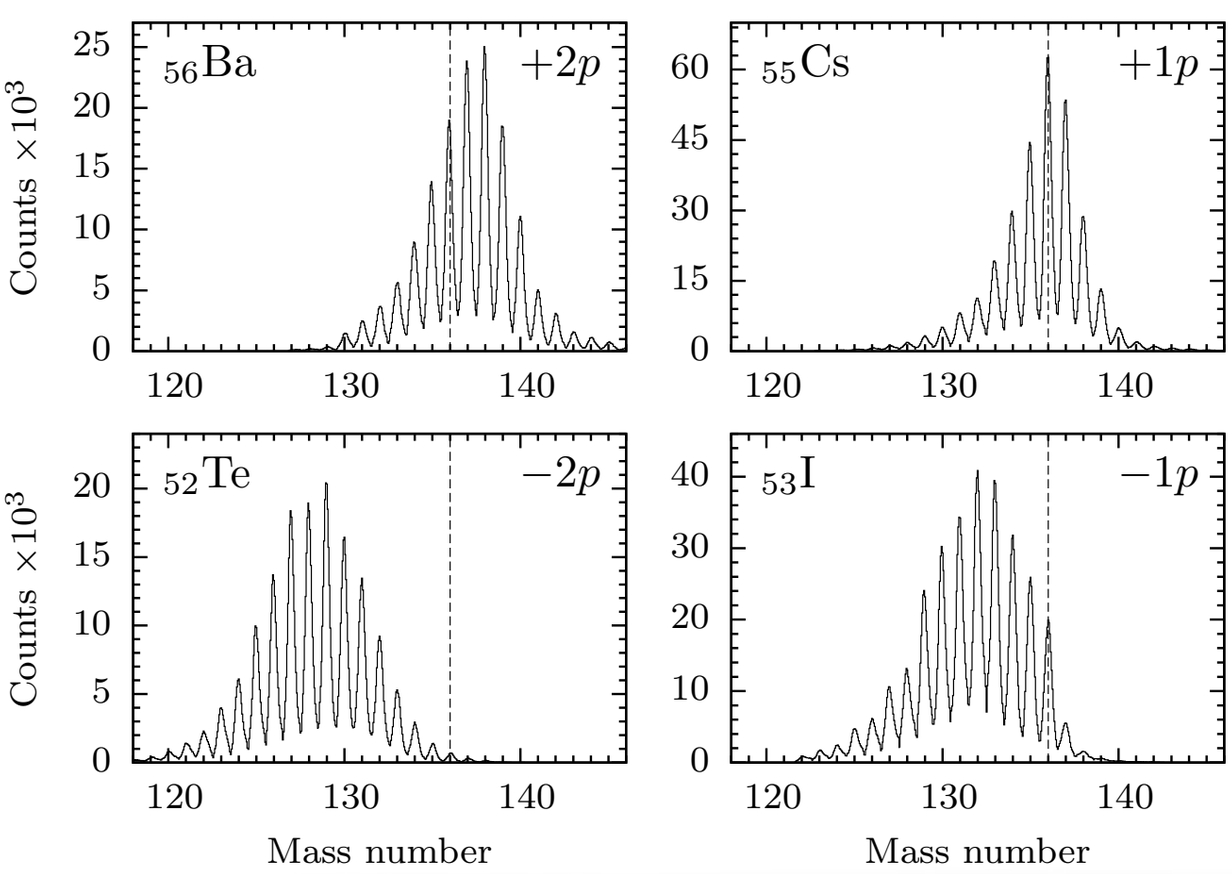
Doppler correction for both beam- and target-like spectra

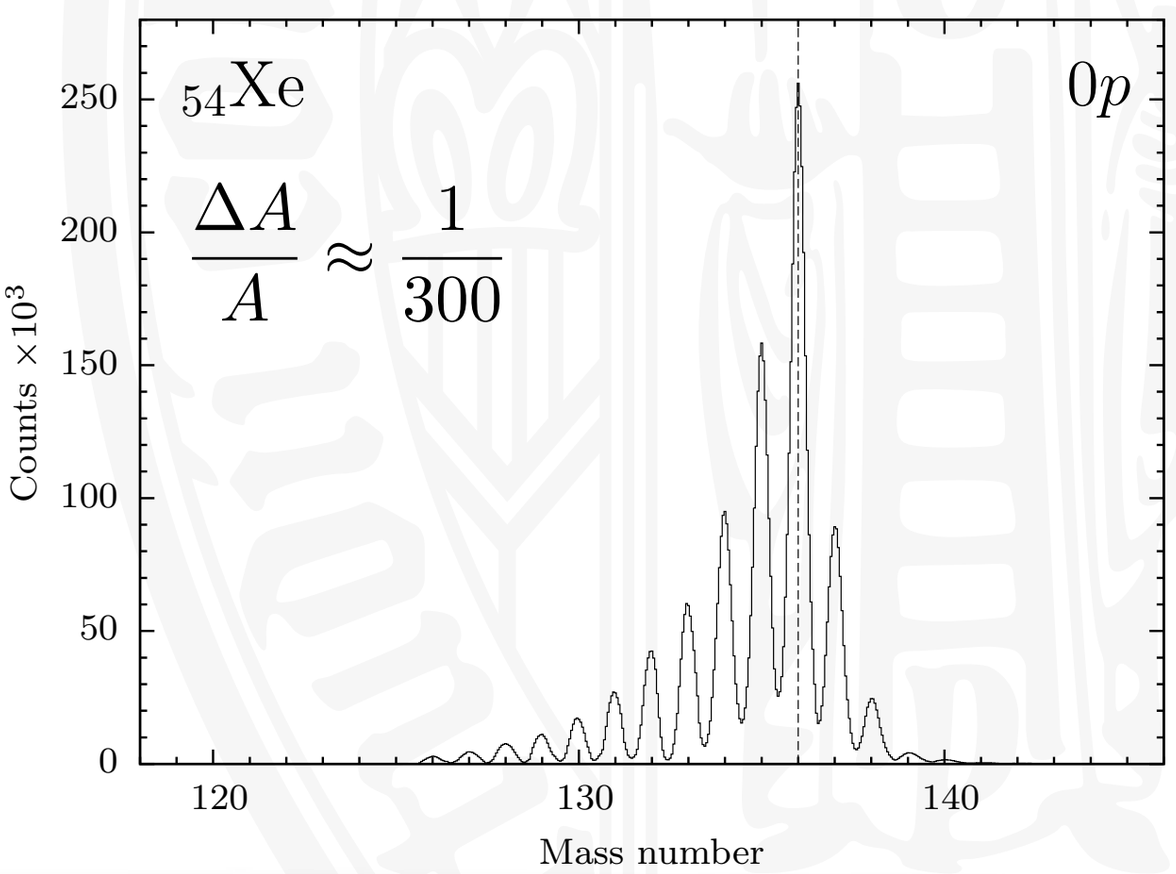
$$E_\gamma = E_{\gamma,0}\,\frac{\sqrt{1-\beta^2}}{1-\beta\cos\theta}$$

PRISMA Analysis Procedure









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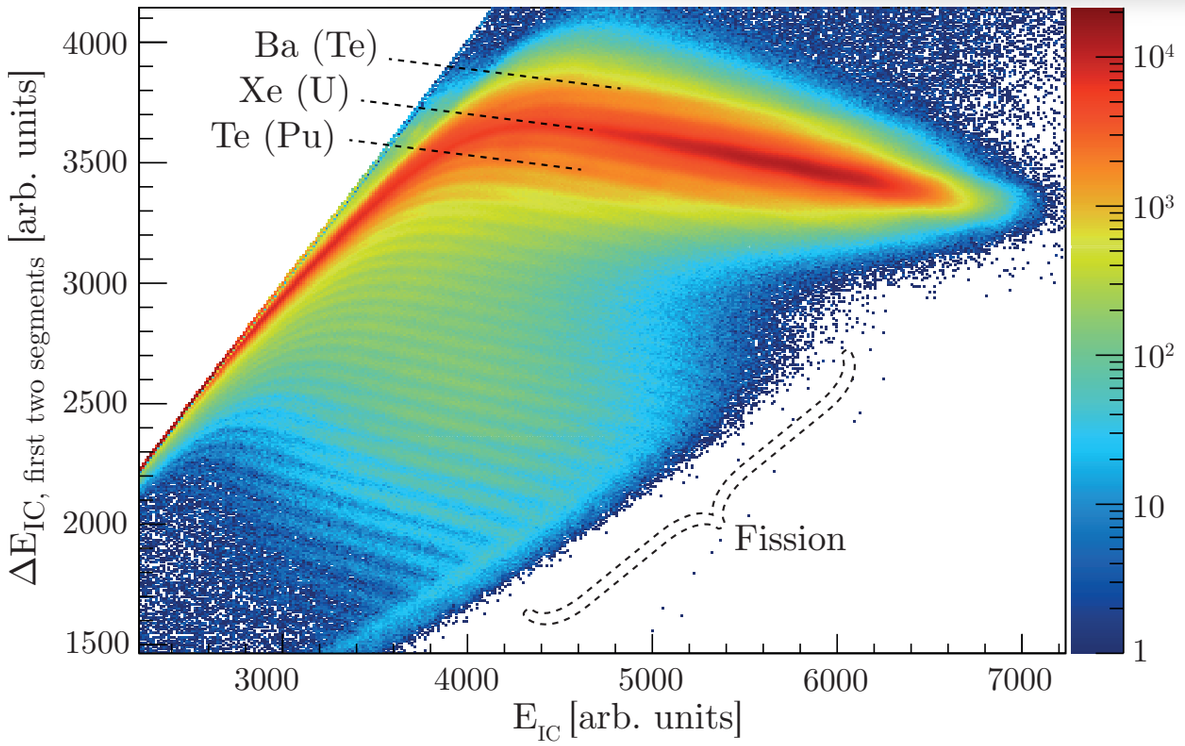
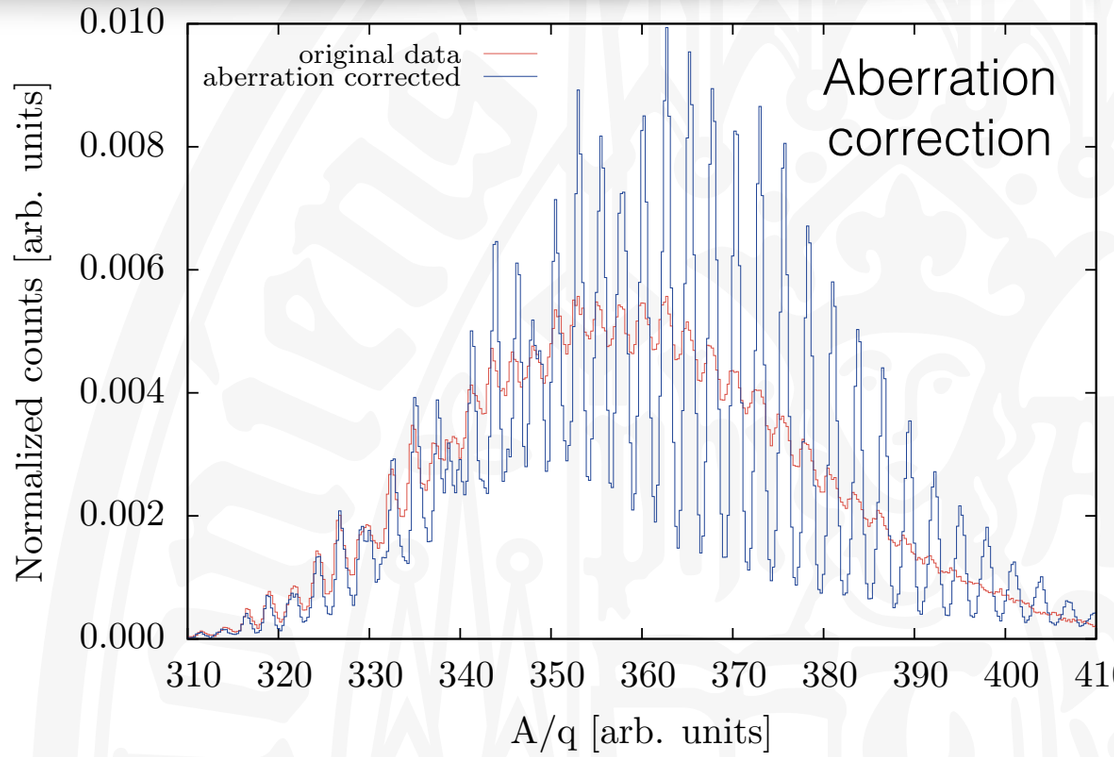
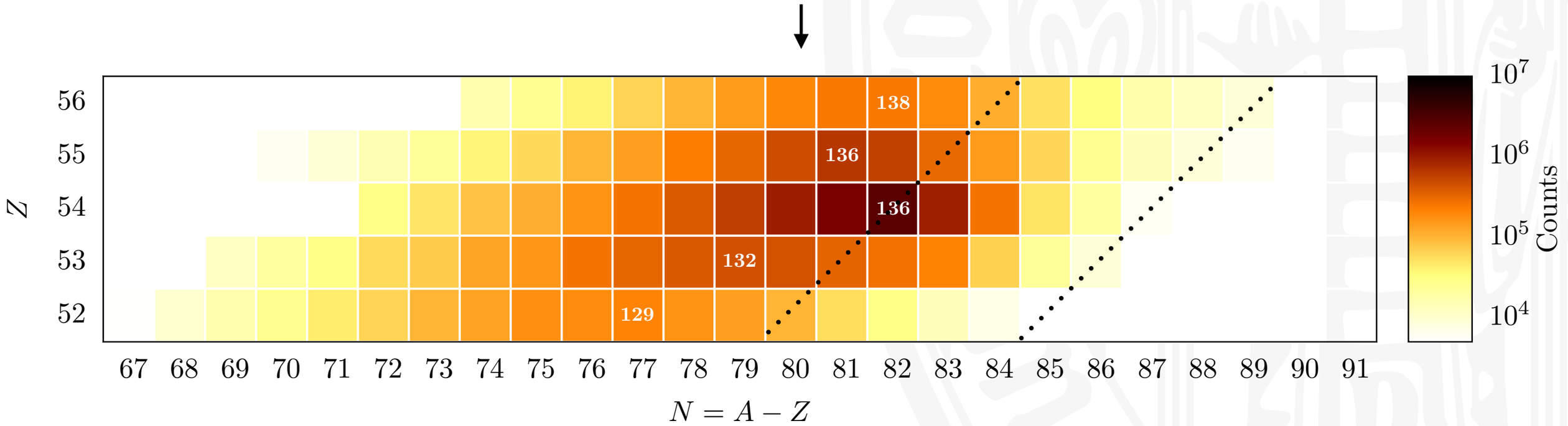


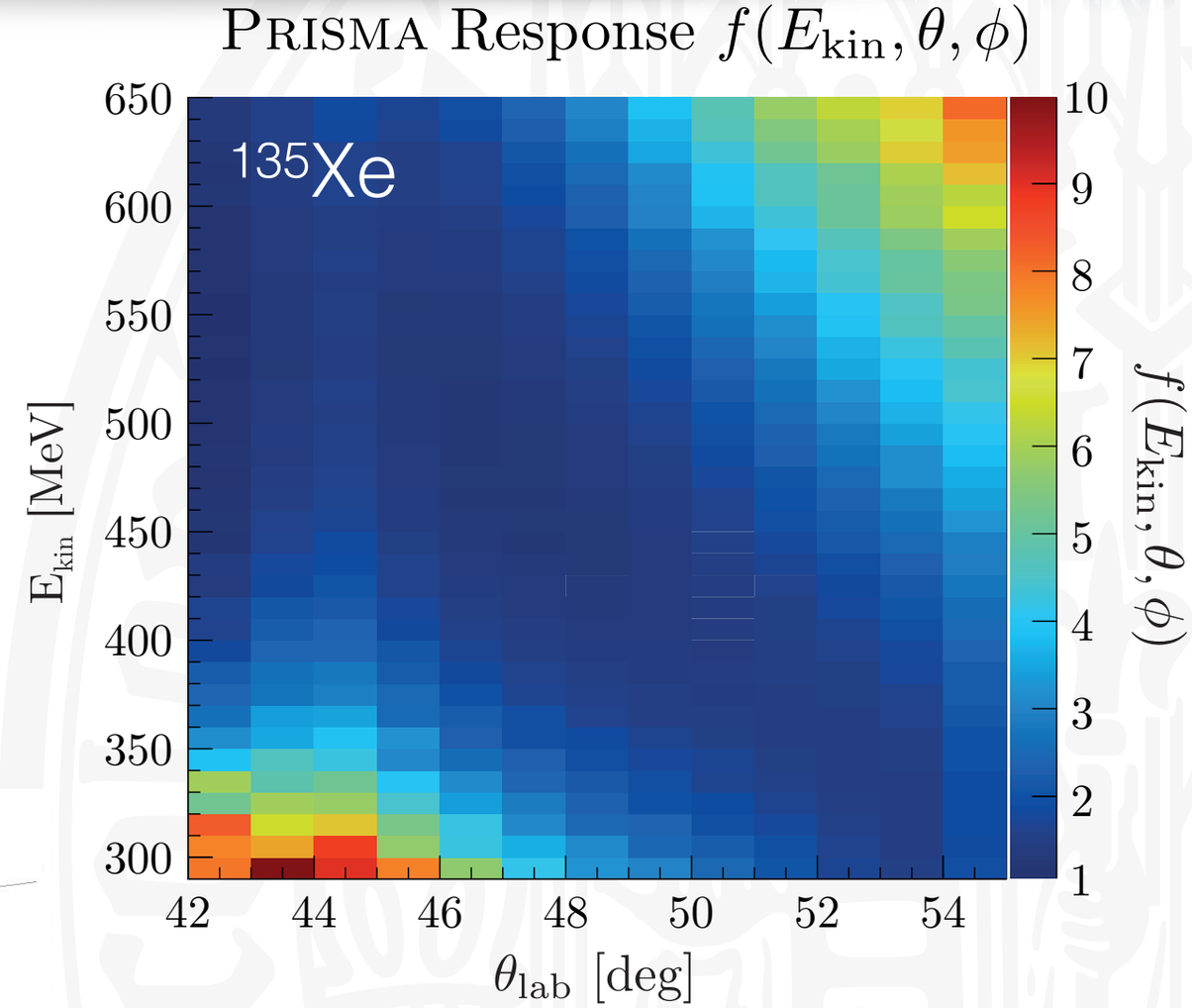


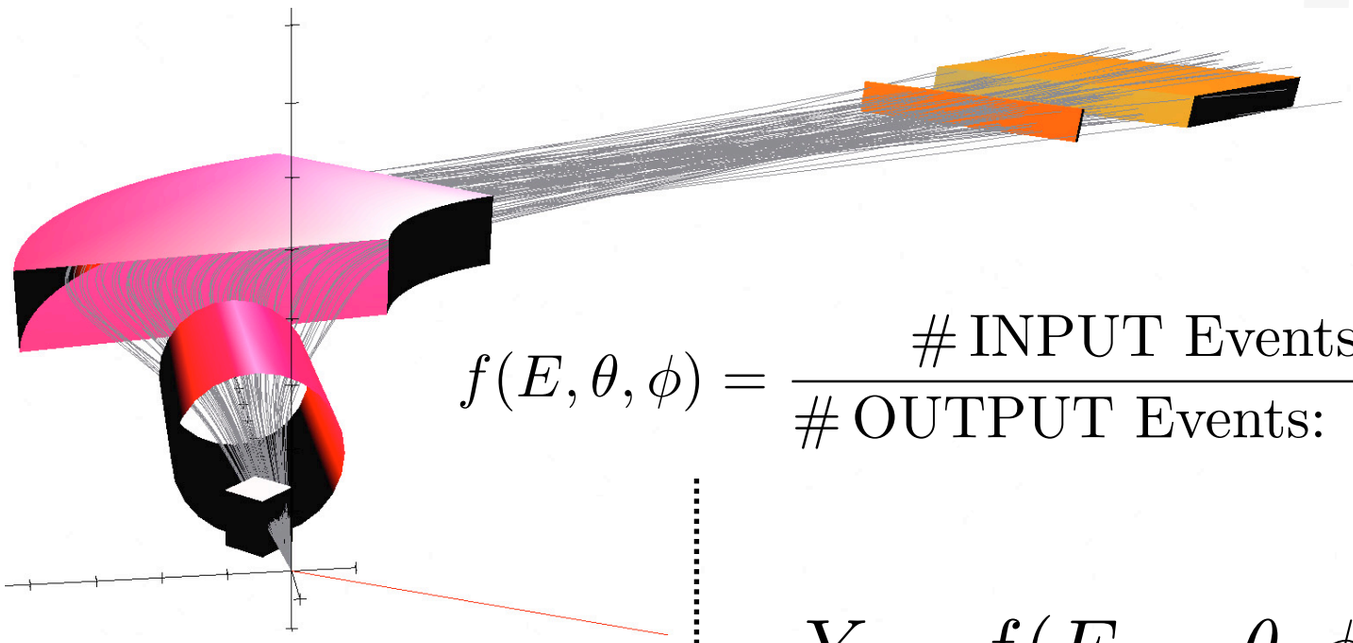


PRISMA Response Function

Transport uniform event distribution in [E,ϑ,ϕ] with Monte Carlo simulation

- ray-tracing code of PrismaLibrary
- adjust dipole and quadrupole fields to align experimental event distribution with simulation





$$f(E,\theta,\phi) = \frac{\#\,\mathrm{INPUT\ Events:\ at\ MCP}(E,\theta,\phi)}{\#\,\mathrm{OUTPUT\ Events:\ at\ Focal\ Plane}(E,\theta,\phi)}$$

MCP input

transported to PPAC, signal in IC, no IC veto

$$Y = f(E_{\mathrm{kin}},\theta,\phi) \times Y_{\mathrm{measured}}$$

D. Montanari *et al.* Eur. Phys. J. A 47, 11004-9, 2011

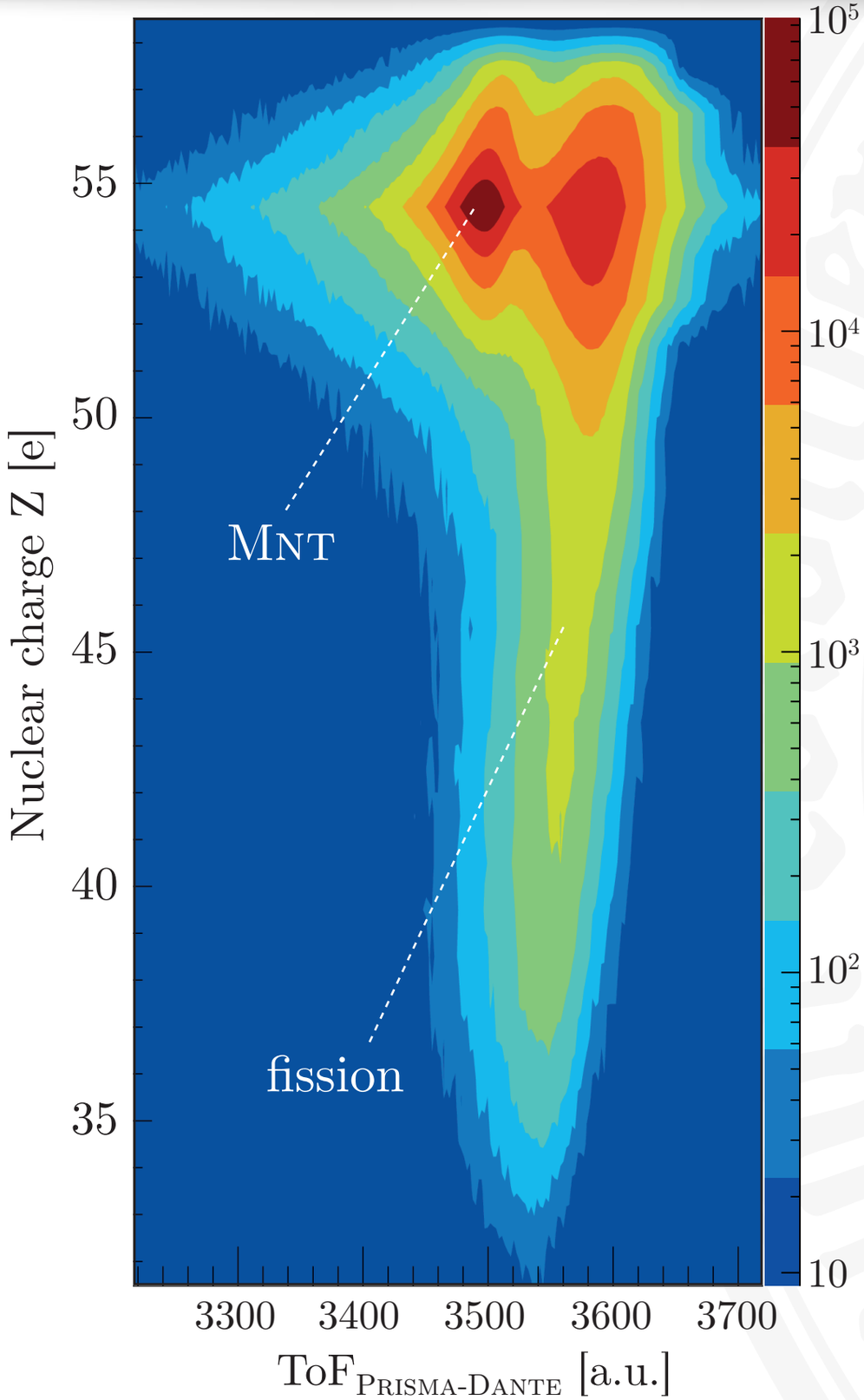
Discriminating Fission & Transfer

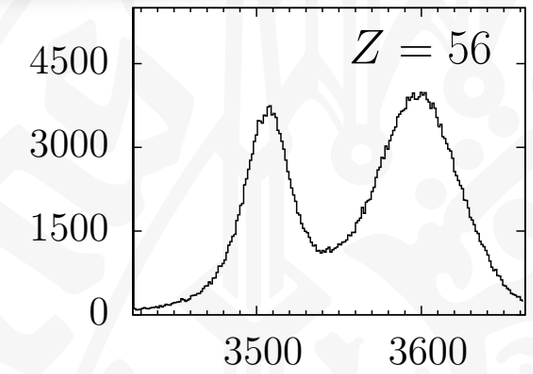
PRISMA

ejectile

recoil/fragment

DANTE





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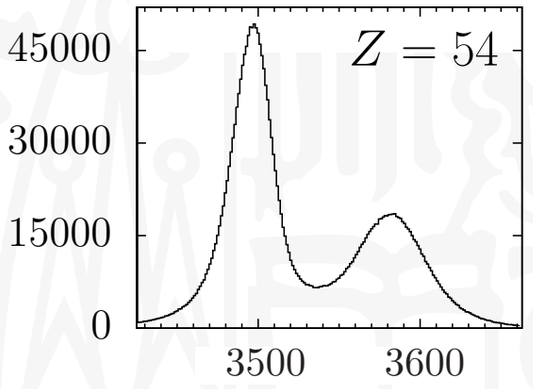

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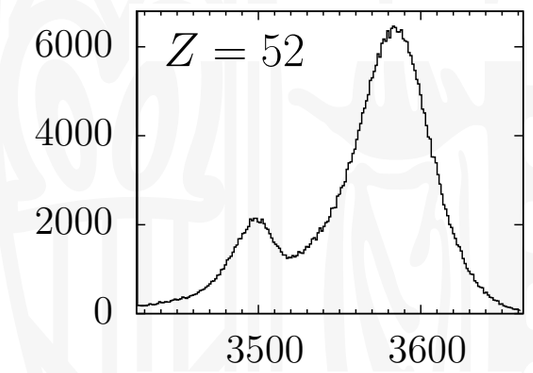

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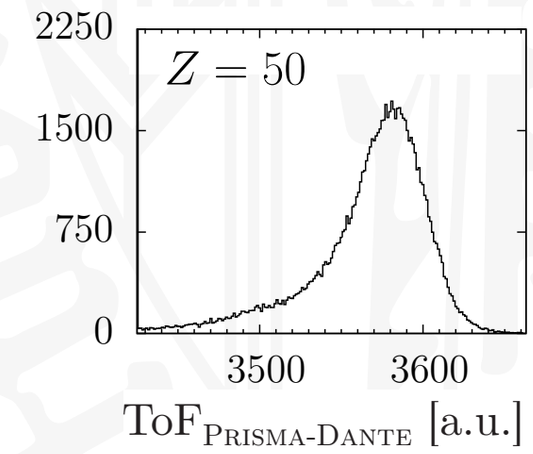

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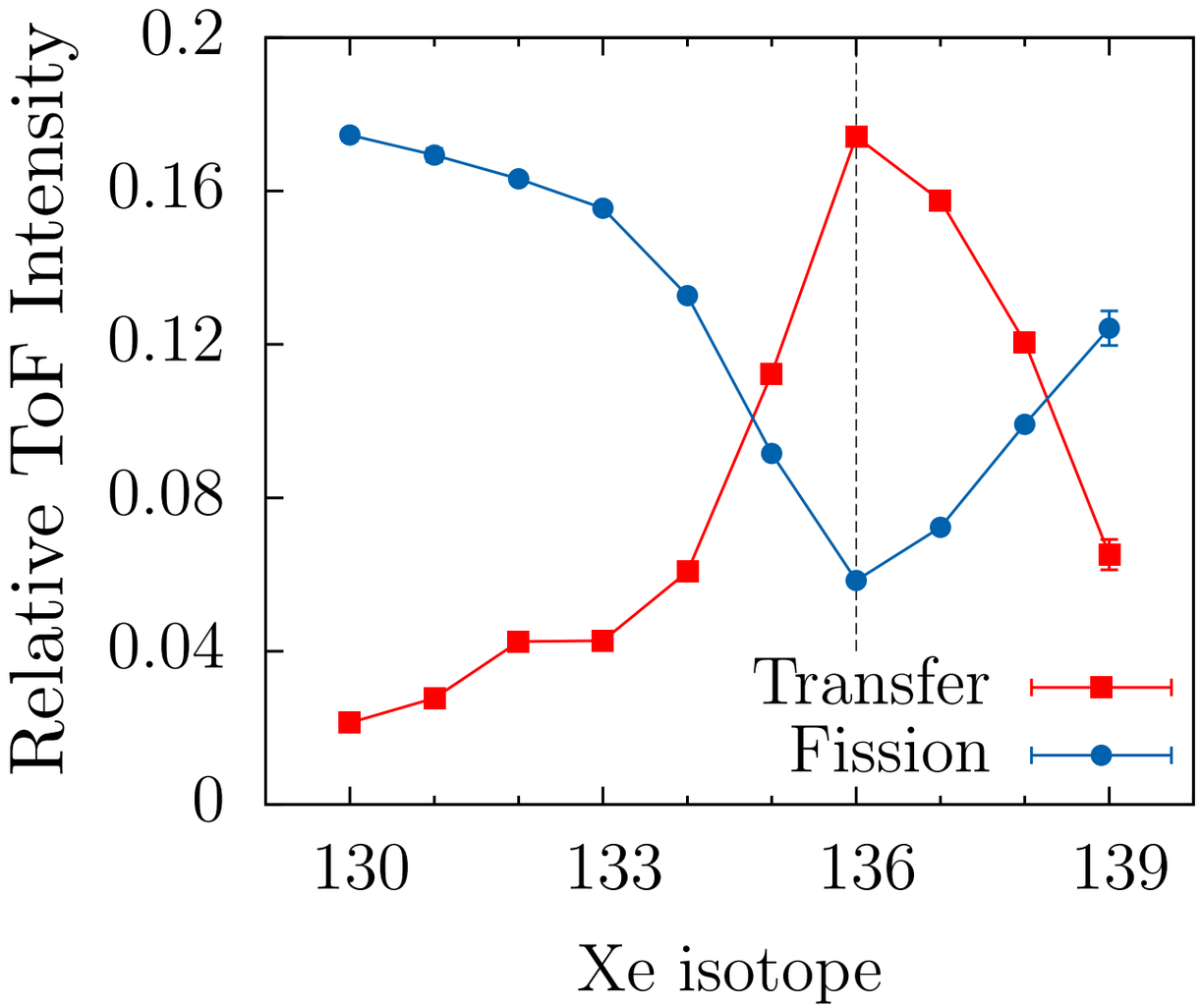
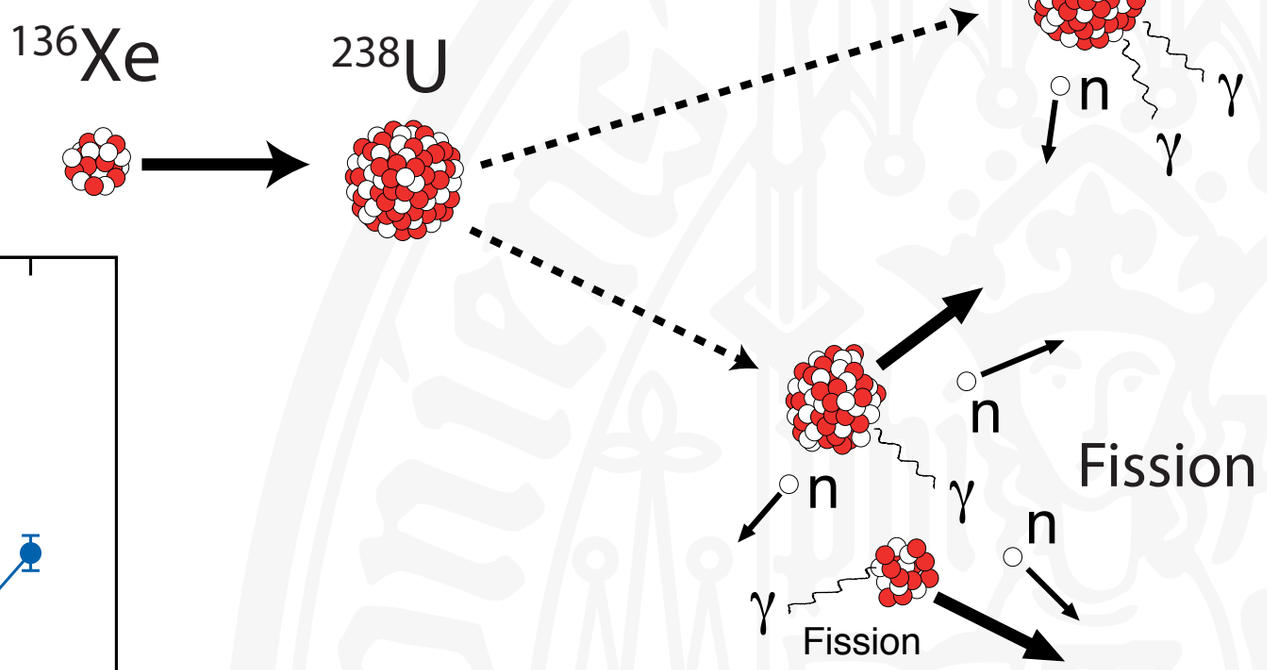
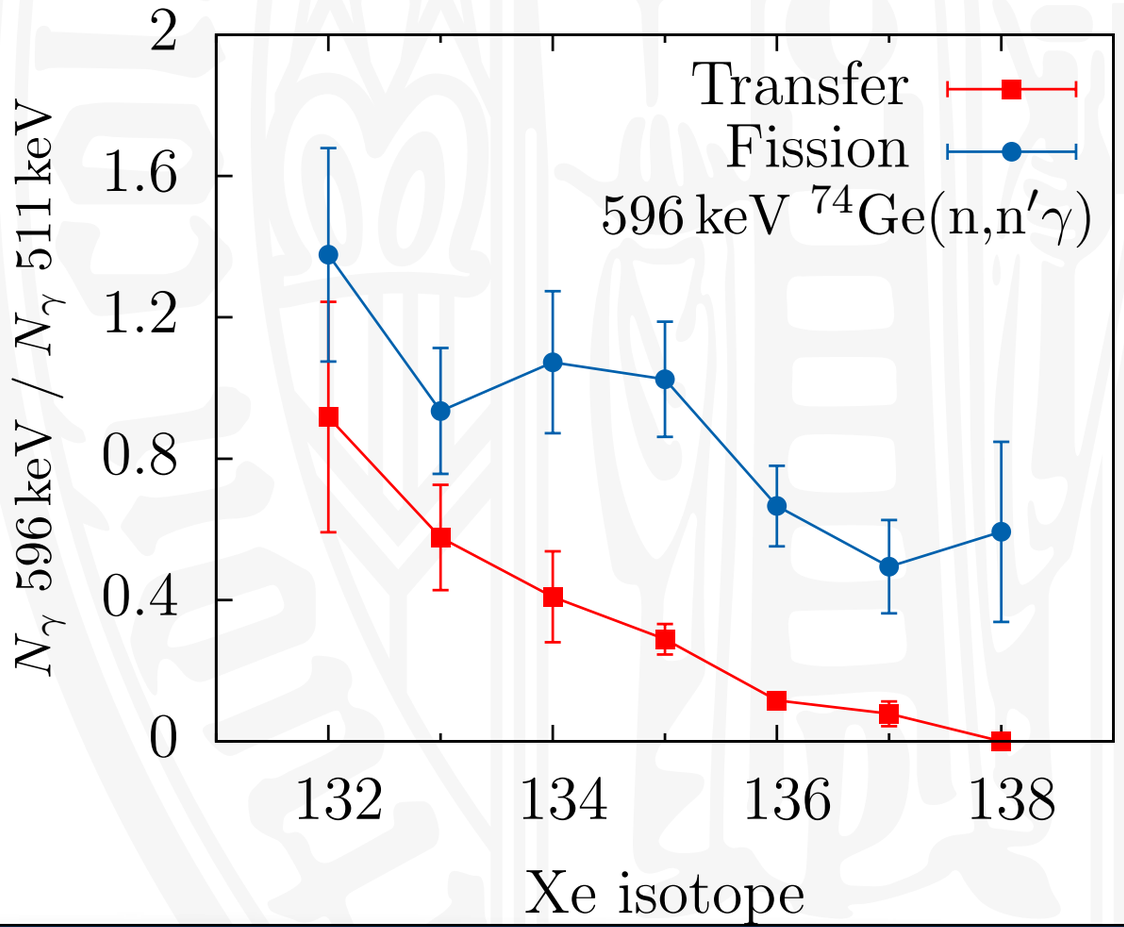
Neutron transfer & evaporation

To what extend can exotic or n-rich nuclei be produced via MNT?

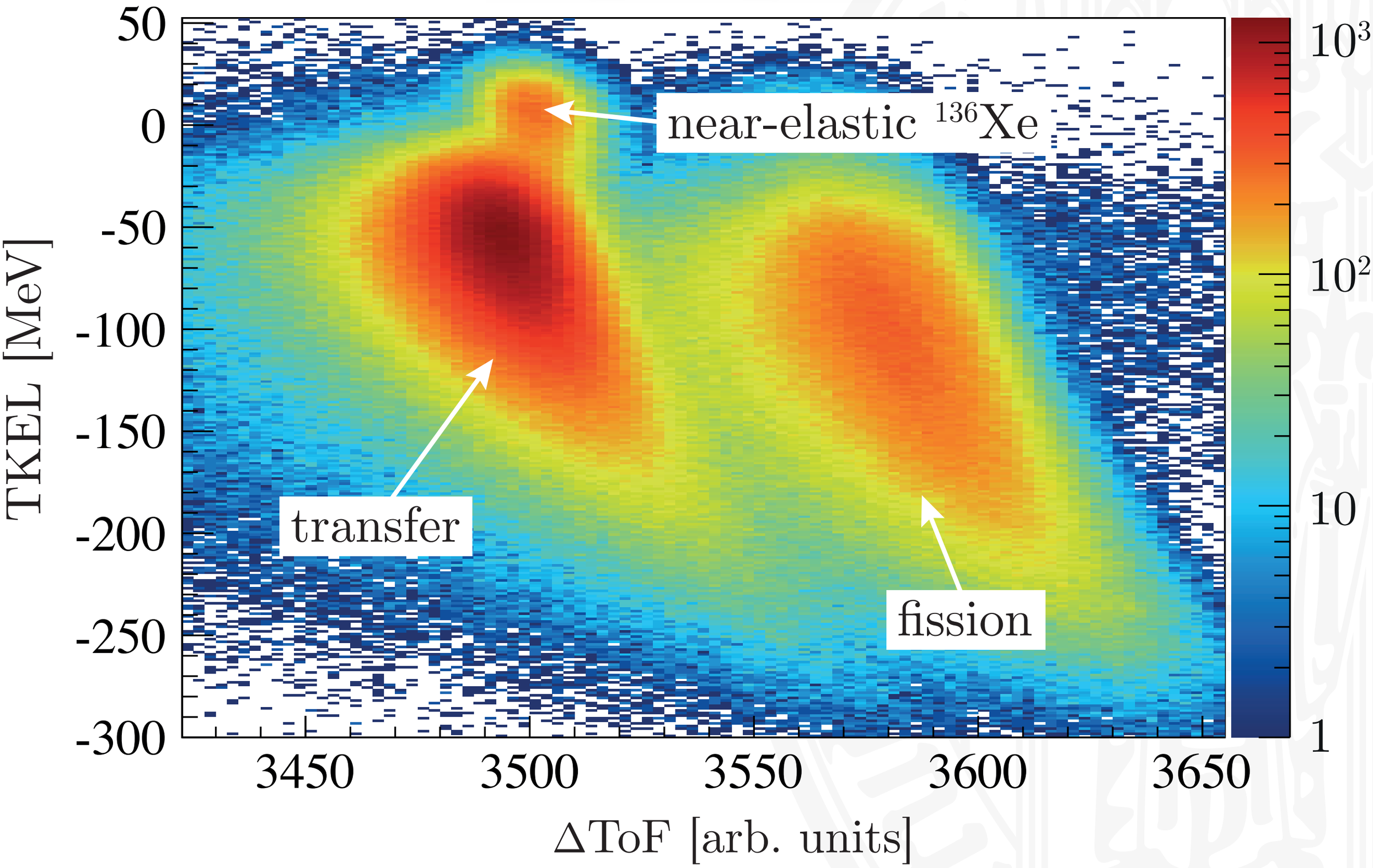


Neutron transfer most probable for up to two neutrons

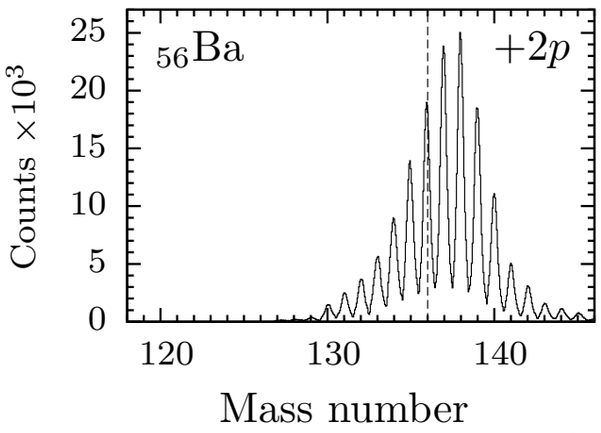




Selecting Transfer Events

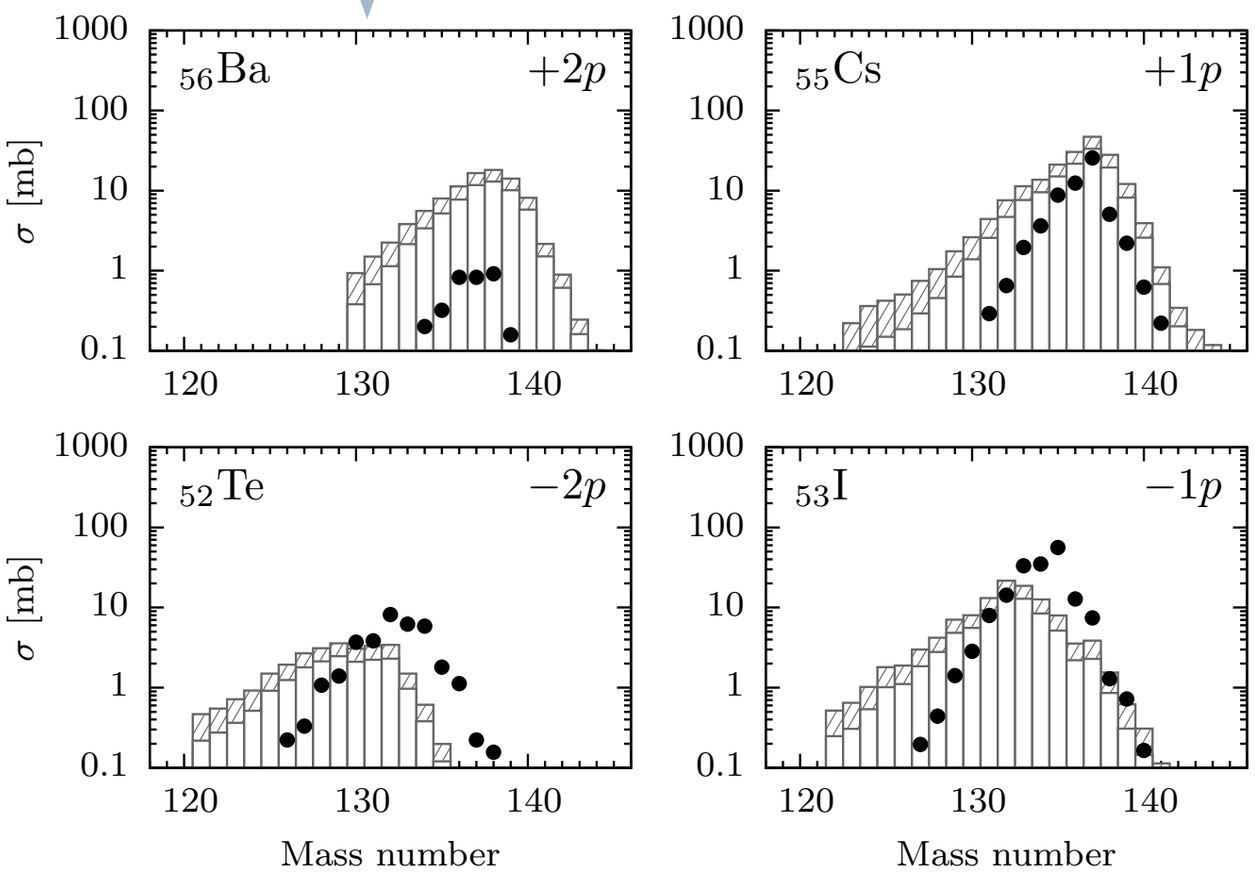


Comparison to GRAZING



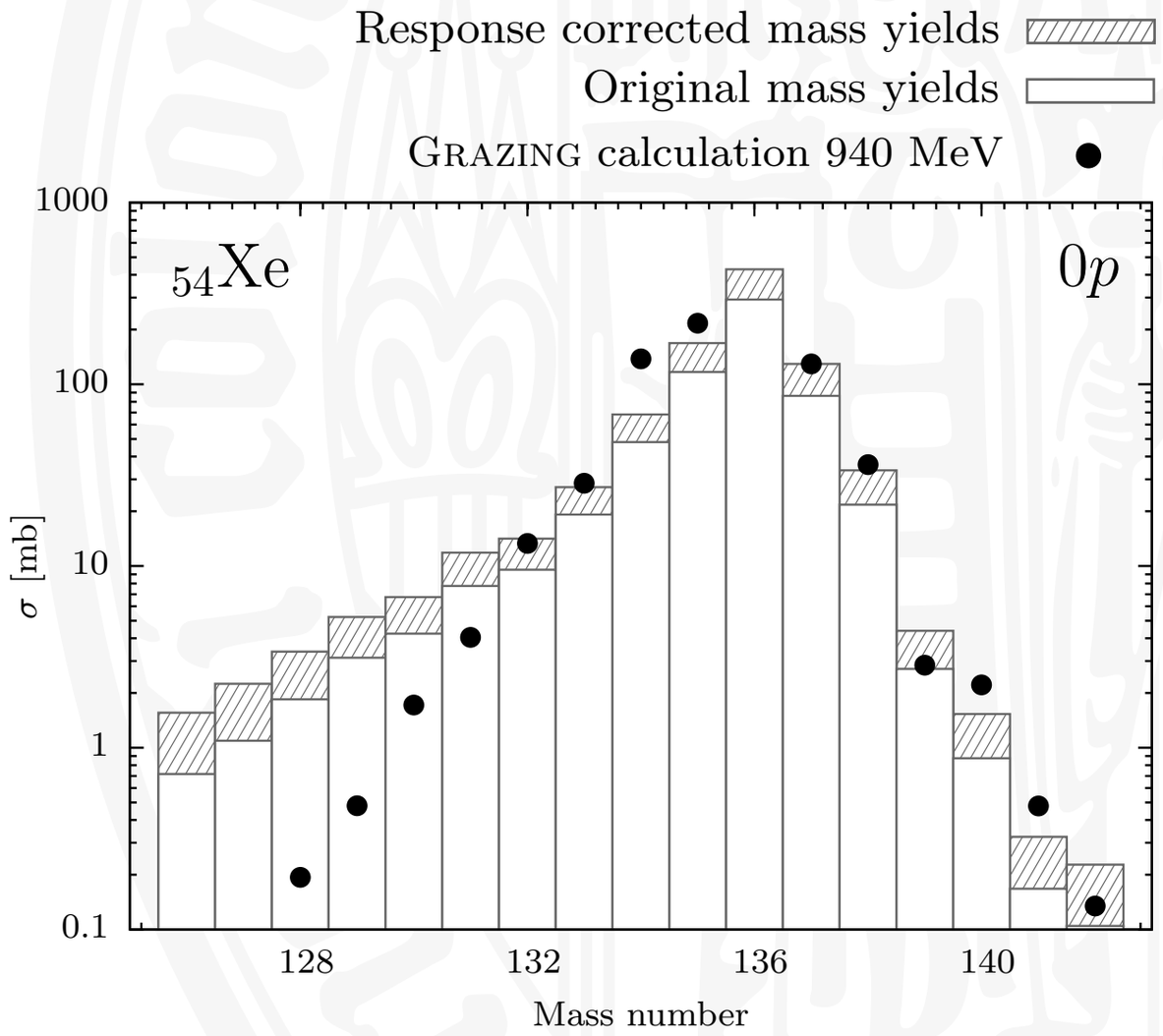
Corrected data normalized to +1n channel calculated by GRAZING model

A. Winther. Nucl. Phys. A 572 (1994) 191-235
A. Winther. Nucl. Phys. A594 (1995) 203-245



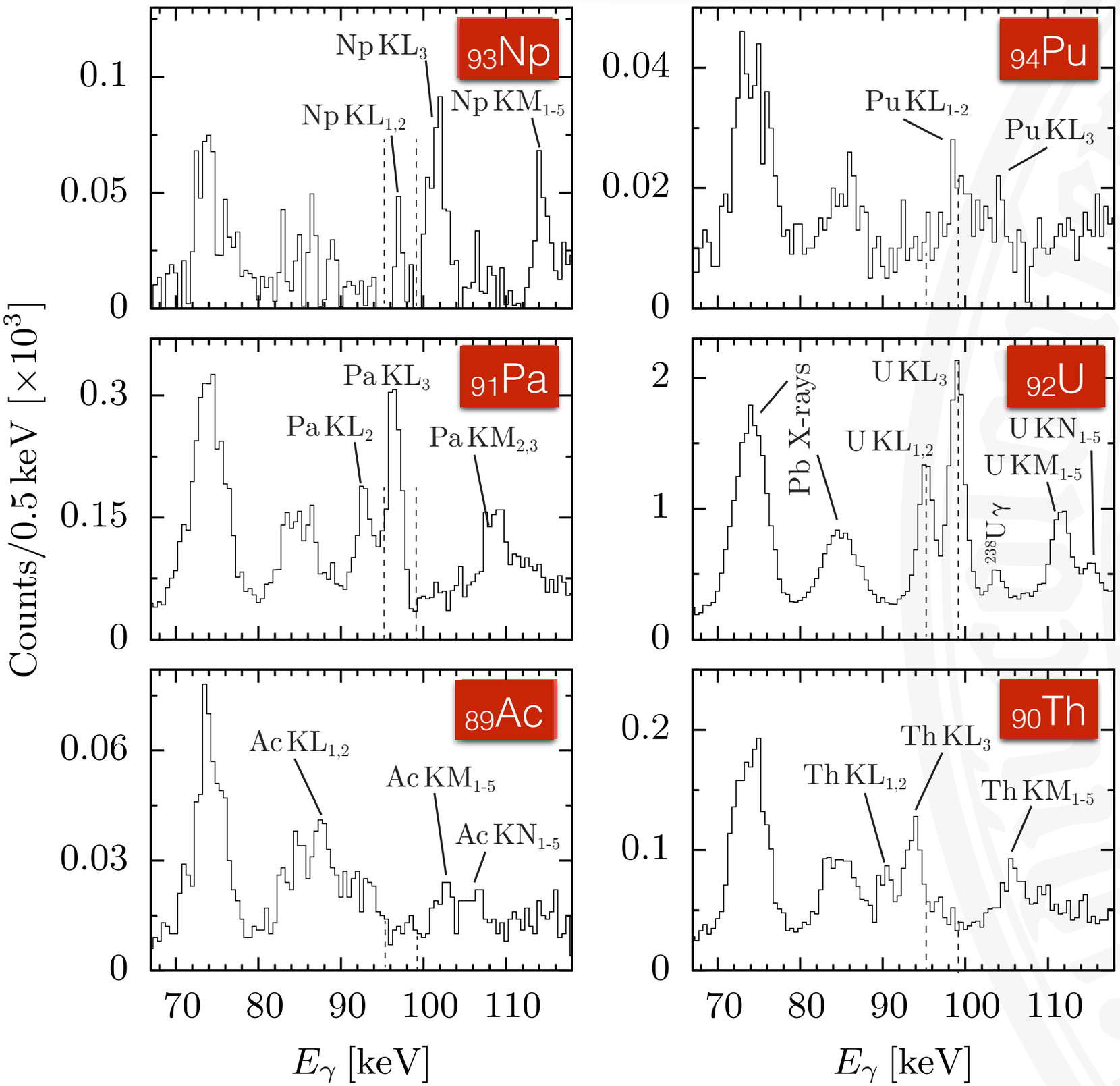
Semiclassical microscopic approach

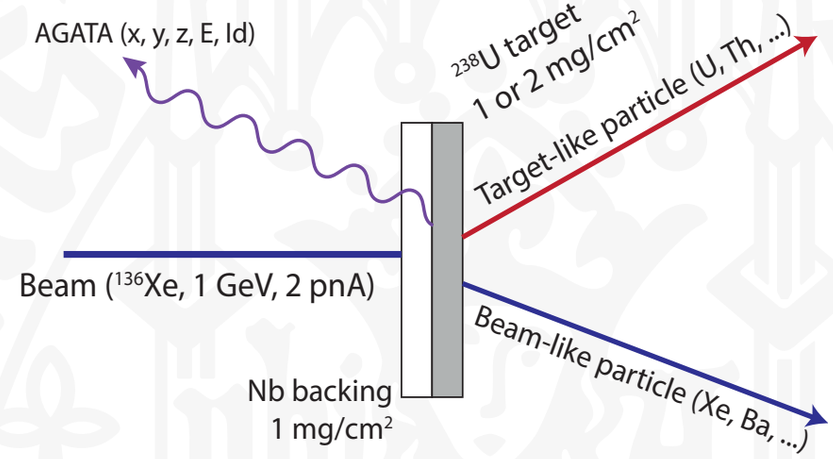
- calculates evolution of reaction by using intrinsic degrees of freedom of two colliding nuclei:
  - surface modes
    low lying modes
    high lying modes
  - microscopic formfactor for transfer
  - transfer described via a multistep mechanism

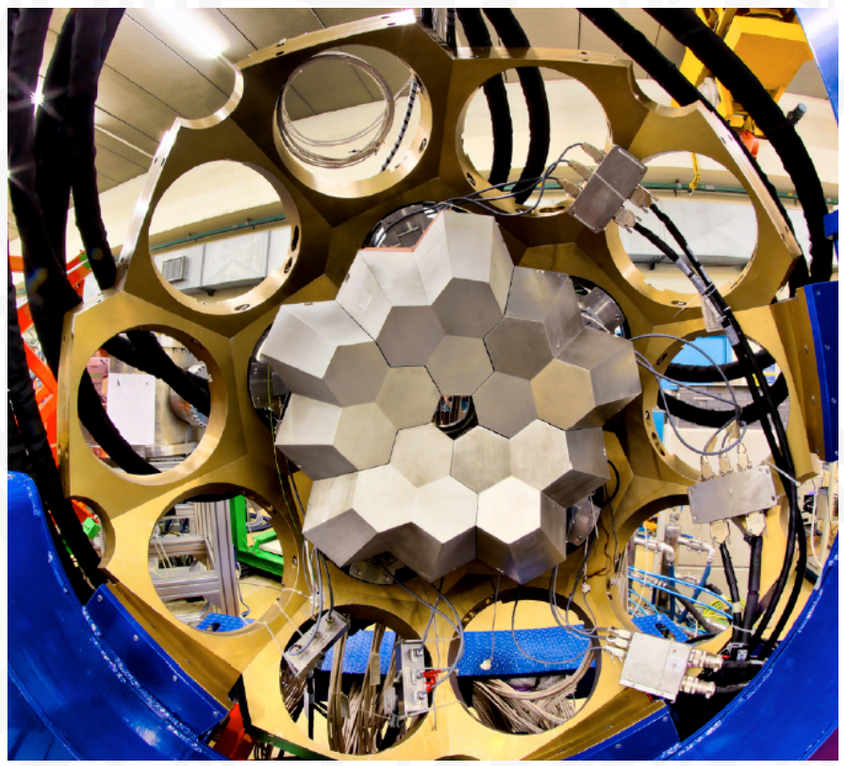


Future: GRAZING-F model: R. Yanez, W. Loveland. Phys. Rev. C 91, 044608

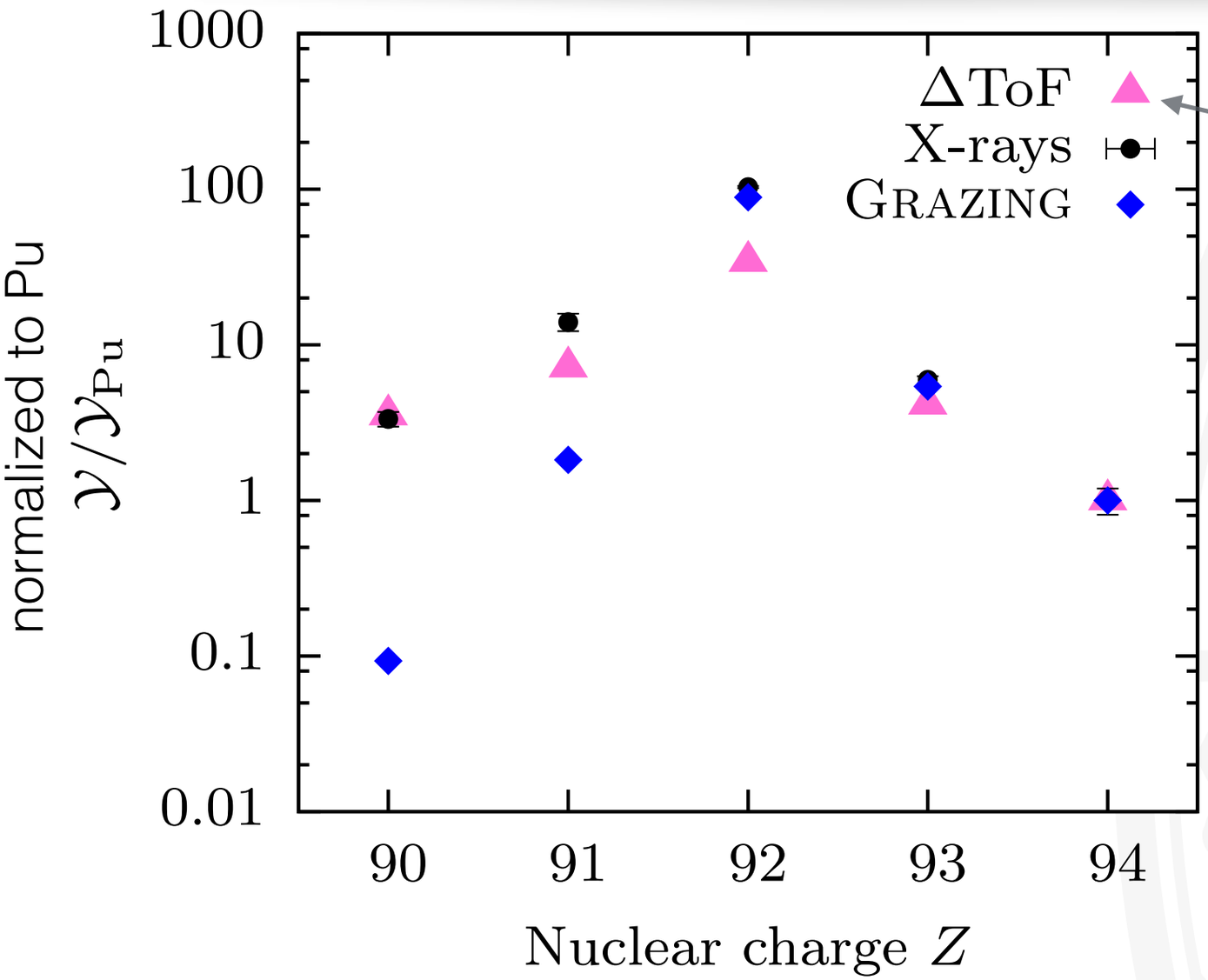
Actinide Yields via X-ray Spectra

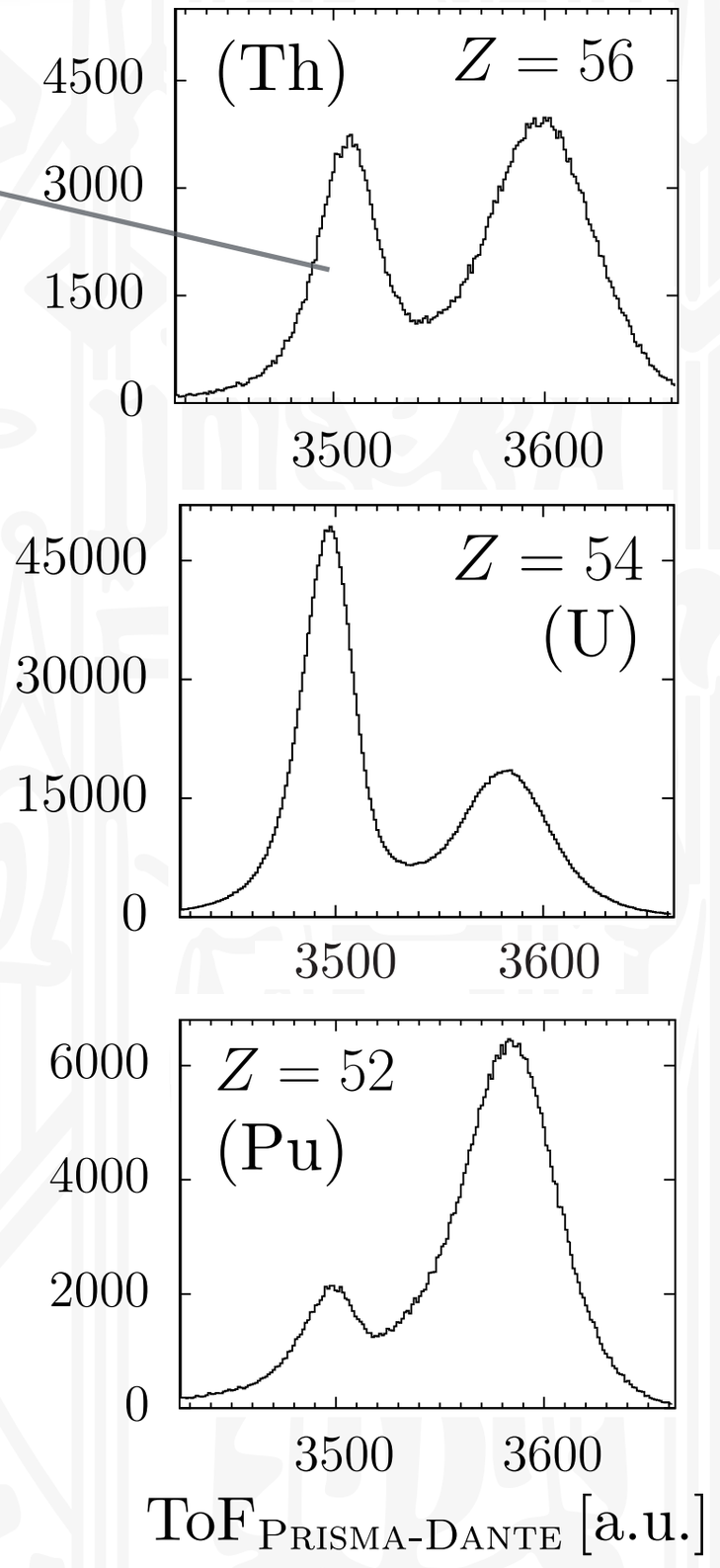






Actinide Yields via X-rays and TAC

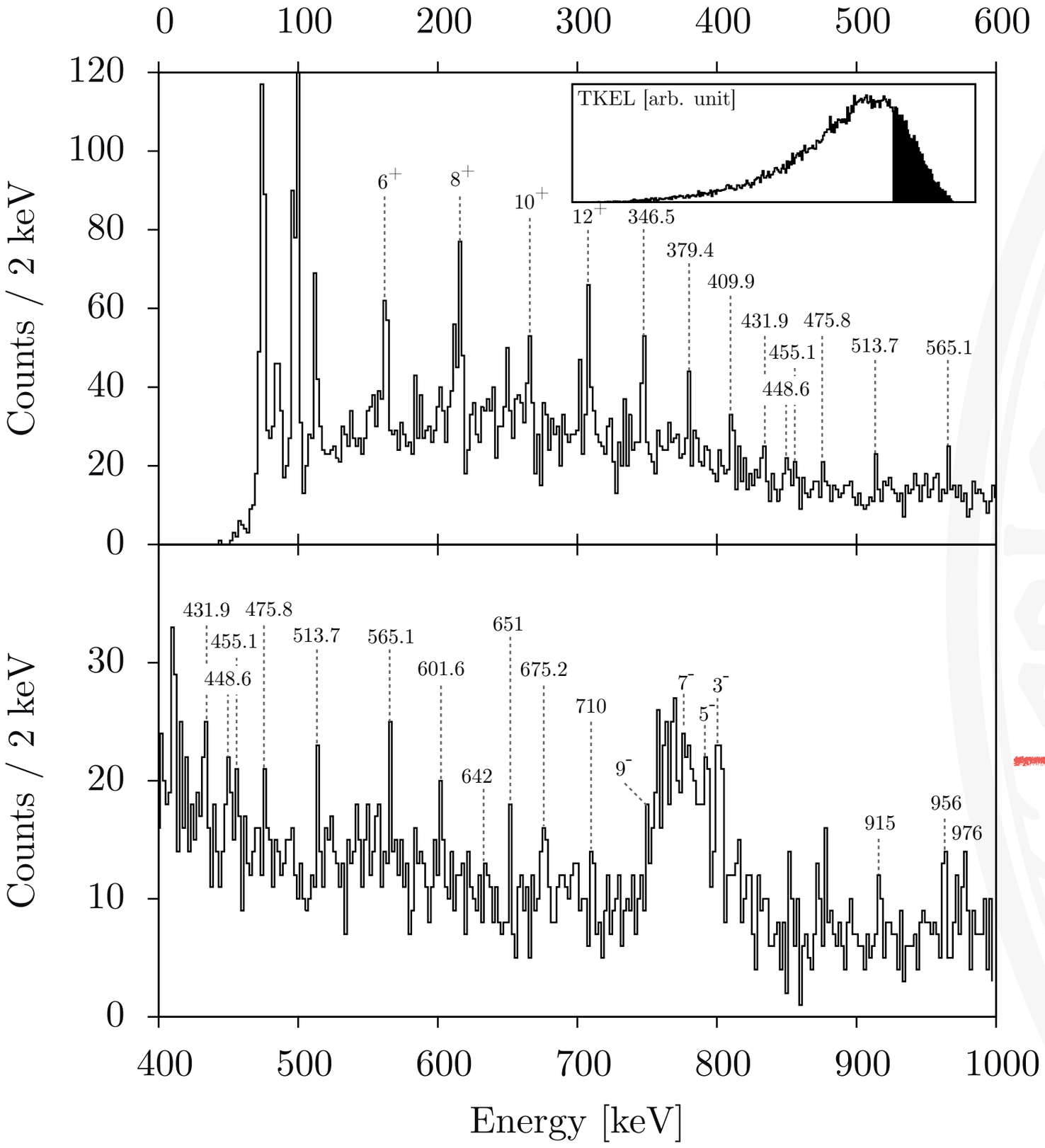


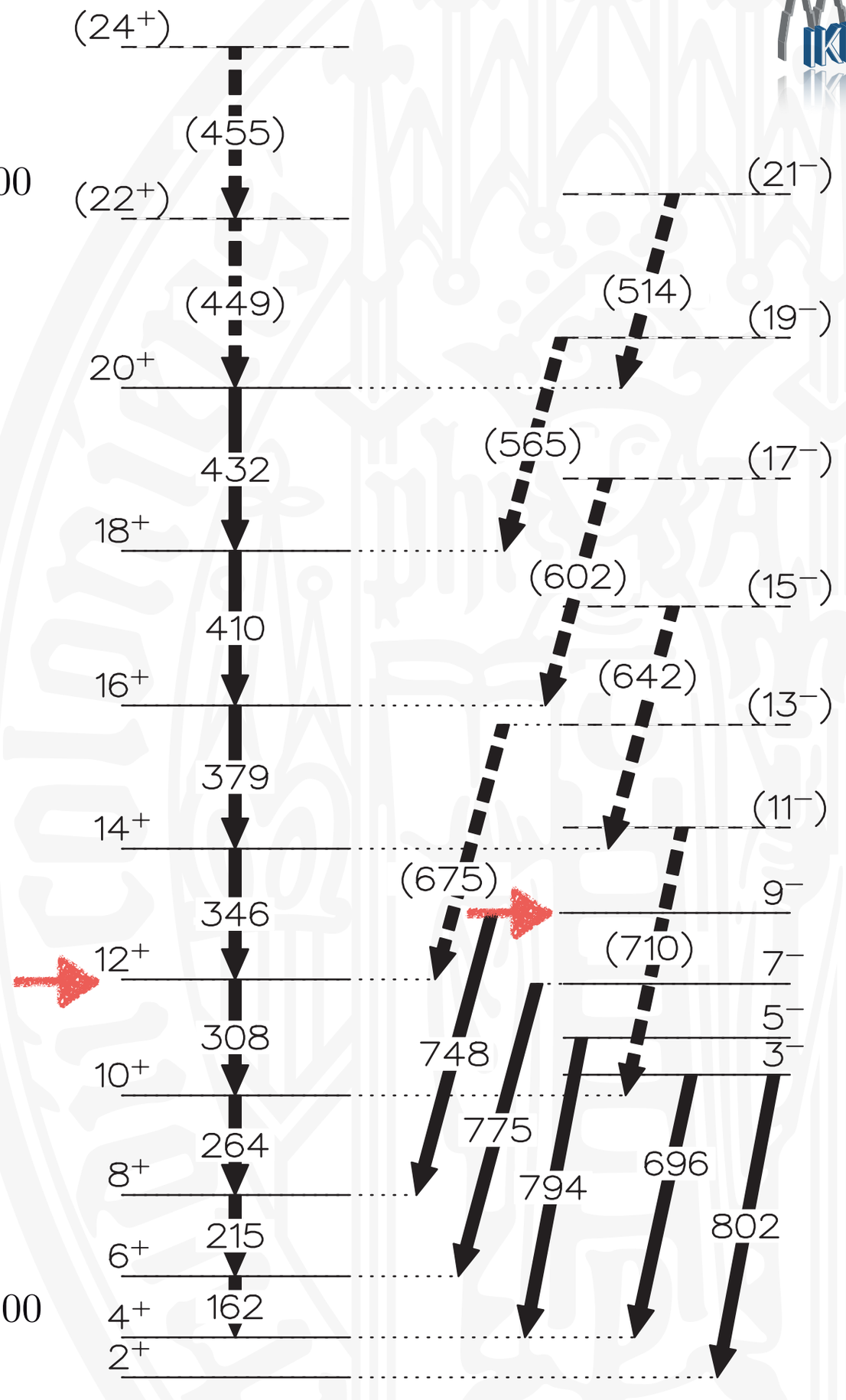


- For actinide binary partners, **proton-stripping reactions are favored** over proton pickup
- **GRAZING underestimates proton-deficient actinides**
- Population of actinide nuclei with **high Z is disfavored**

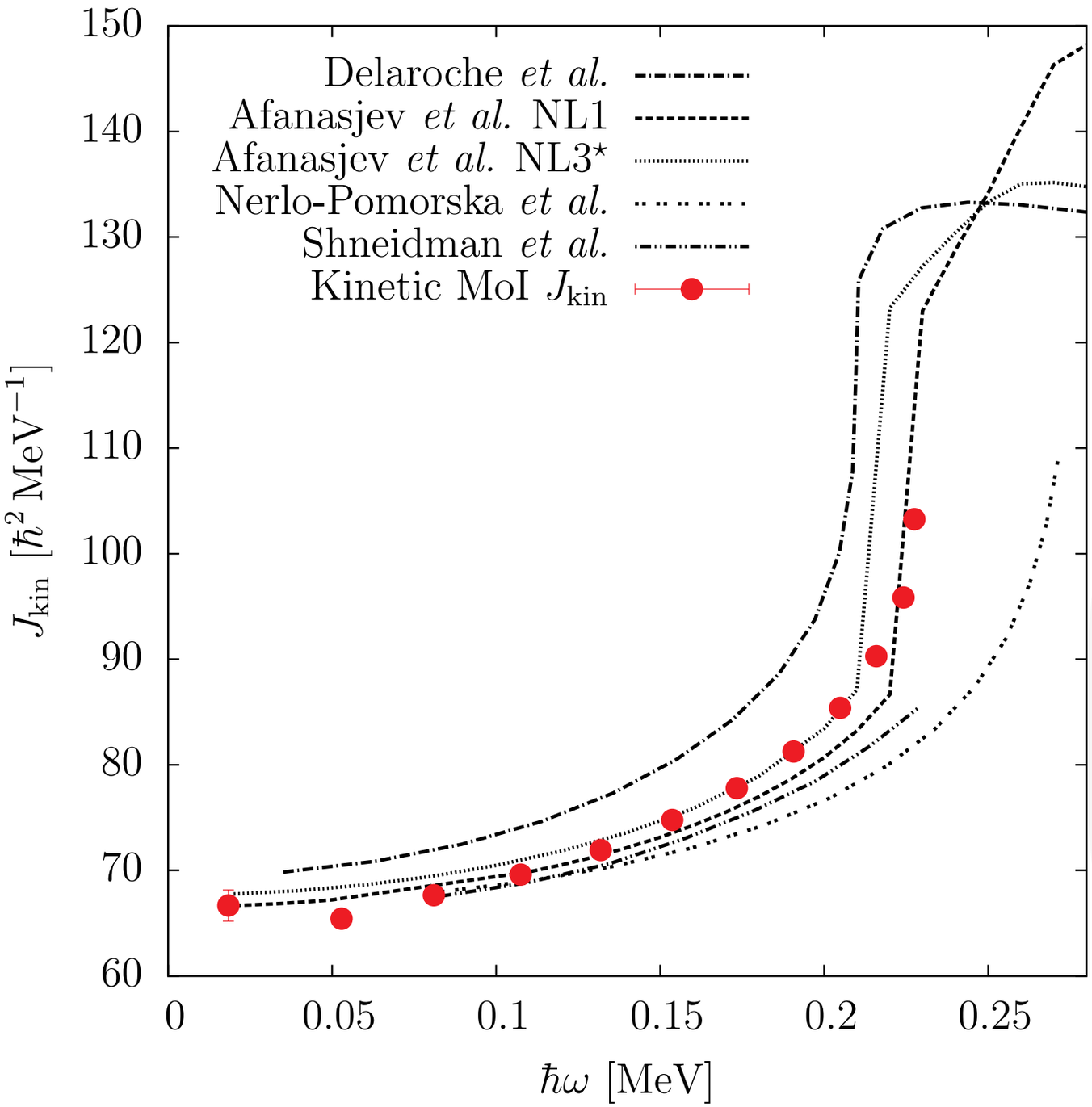
A. Vogt *et al.* (2015). Accepted for publication in PRC

Spectroscopy of ^{240}U

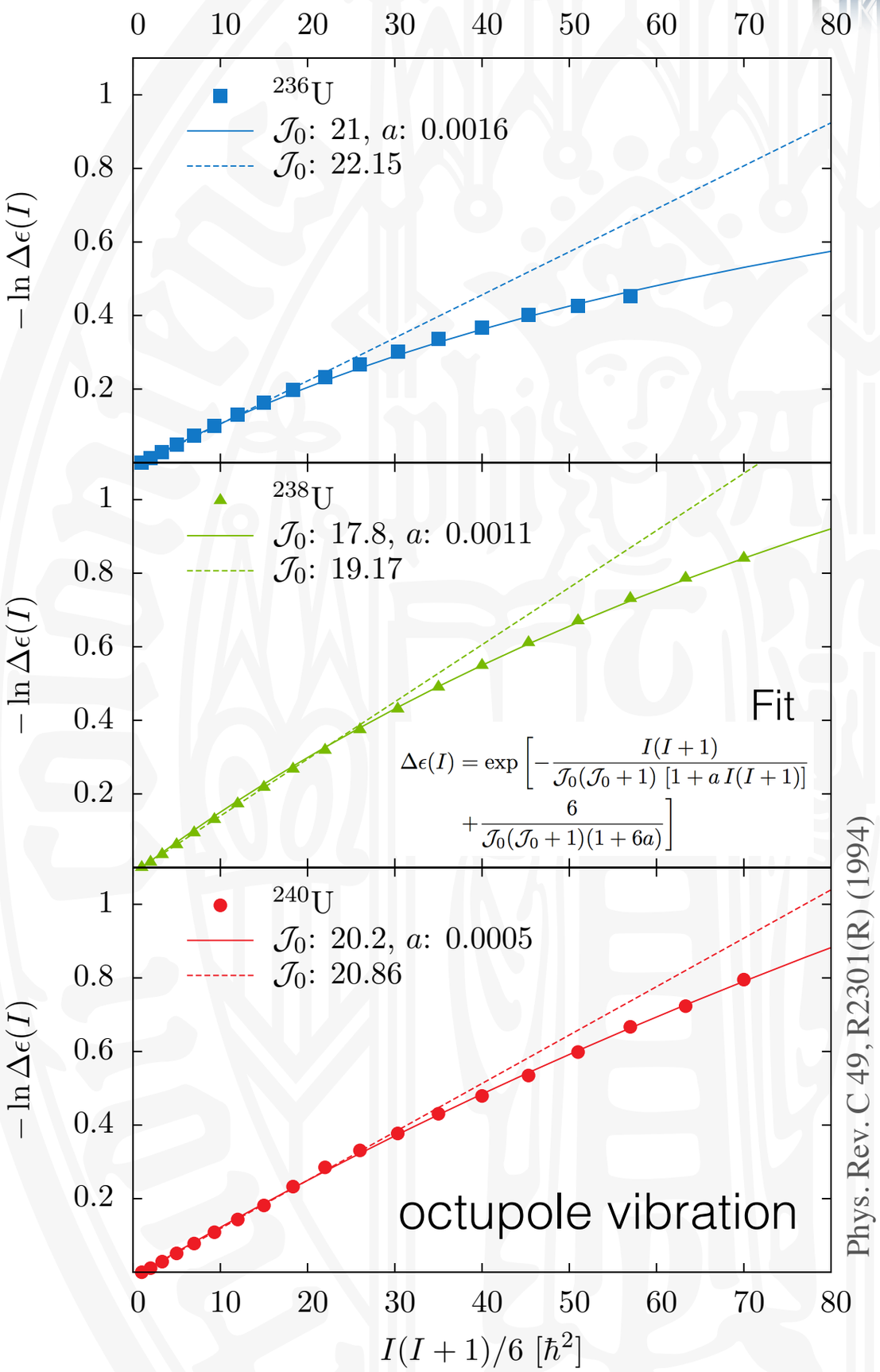




Moment of Inertia



Parity splitting



Phys. Rev. C 49, R2301(R) (1994)

B. Birkenbach, A. Vogt *et al.* (2015). In preparation.

Thank you for your attention!

A. Vogt,[1, a] B. Birkenbach,[1] P. Reiter,[1] L. Corradi,[2] T. Mijatović,[3] D. Montanari,[4,5, b] S. Szilner,[3] D. Bazzacco,[5] M. Bowry,[6] A. Bracco,[7] B. Bruyneel,[8] F.C.L Crespi,[7] G. de Angelis,[2] P. Désesquelles,[9] J. Eberth,[1] E. Farnea,[5] E. Fioretto,[2] A. Gadea,[10] K. Geibel,[1] A. Gengelbach,[11] A. Giaz,[7] A. Görgen,[12,13] A. Gottardo,[2] J. Grebosz,[14] H. Hess,[1] P.R. John,[4,5] J. Jolie,[1] D.S. Judson,[15] A. Jungclaus,[16] W. Korten,[13] S. Leoni,[7] S. Lunardi,[4,5] R. Menegazzo,[5] D. Mengoni,[17,4,5] C. Michelagnoli,[4,5, c] G. Montagnoli,[4,5] D. Napoli,[2] L. Pellegri,[7] G. Pollarolo,[18] A. Pullia,[7] B. Quintana,[19] F. Radeck,[1] F. Recchia,[4,5] D. Rosso,[2] E. Şahin,[2, d] M.D. Salsac,[13] F. Scarlassara,[4,5] P.-A. Söderström,[20, e] A.M. Stefanini,[2] T. Steinbach,[1] O. Stezowski,[21] B. Szpak,[14] Ch. Theisen,[13] C. Ur,[5] J.J. Valiente-Dobón,[2] V. Vandone,[7] and A. Wiens[1]

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