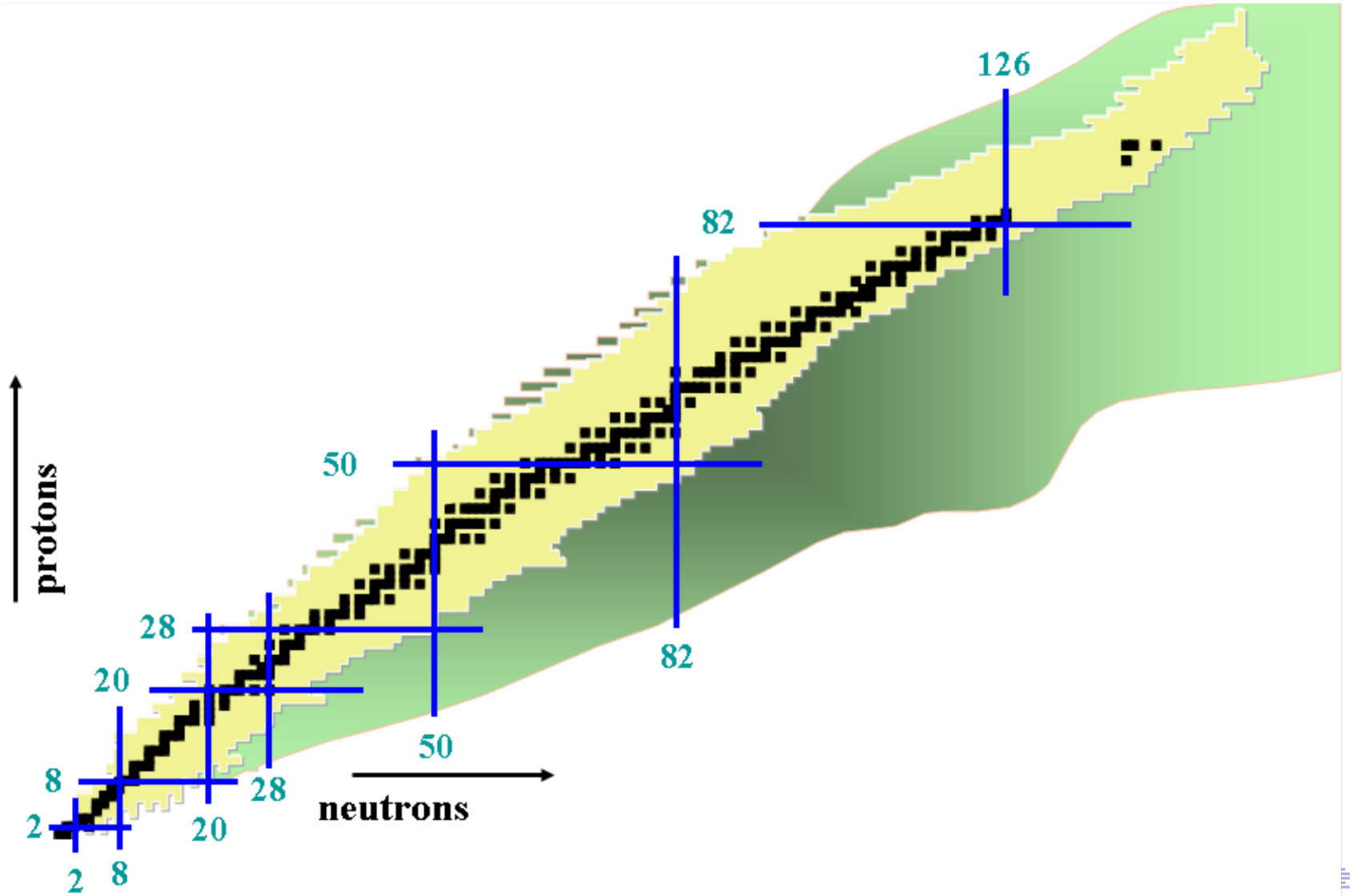
AGATA@GSI: Status report

Damian Ralet

Centre de Sciences Nucléaires et de Sciences de la Matière

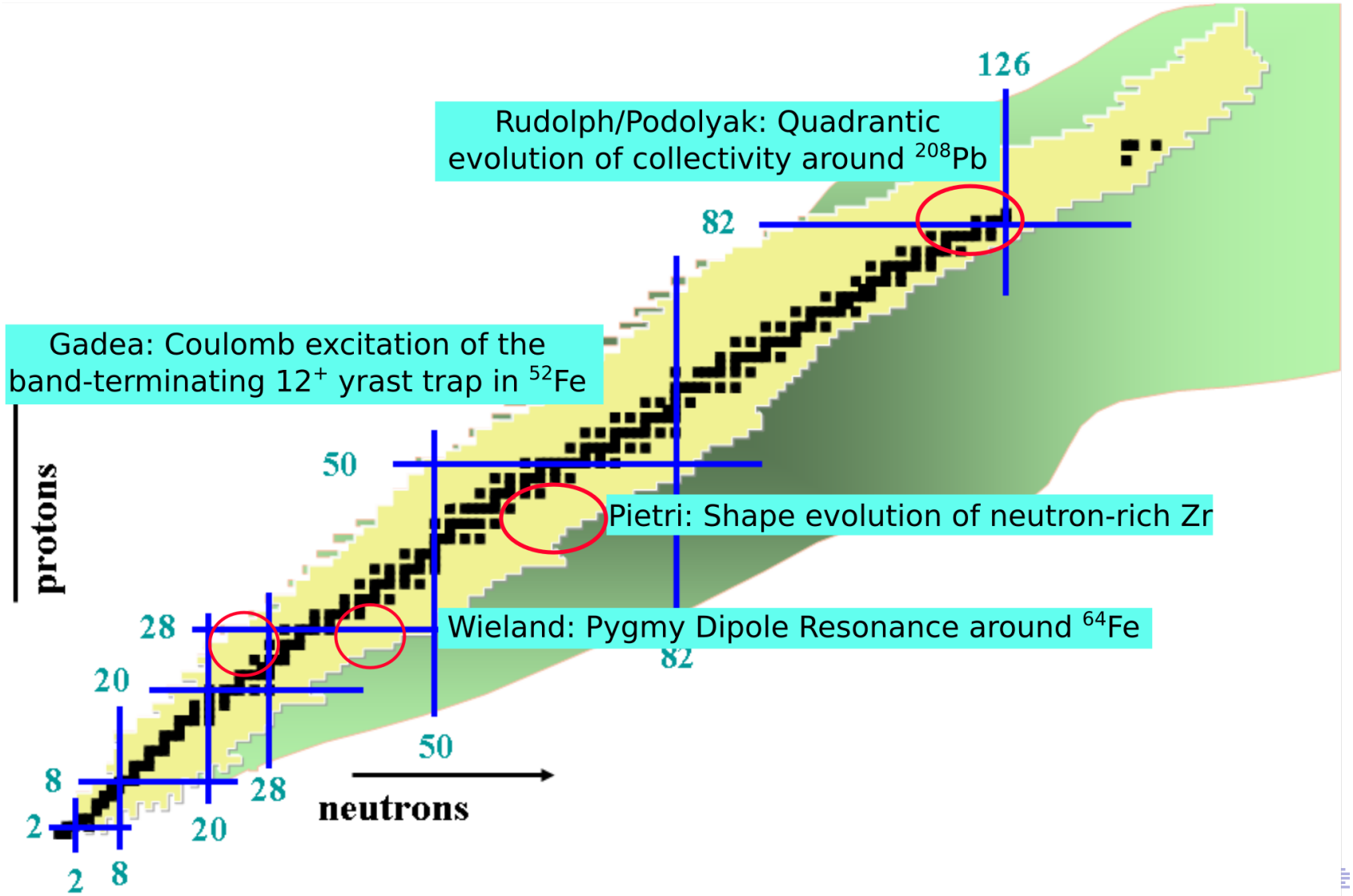
- Introduction
- Standard setup
- AGATA advantages
- Status of the data analysis
  - Stopped beam spectroscopy
  - In flight spectroscopy
- Conclusion

Overview of the experiments



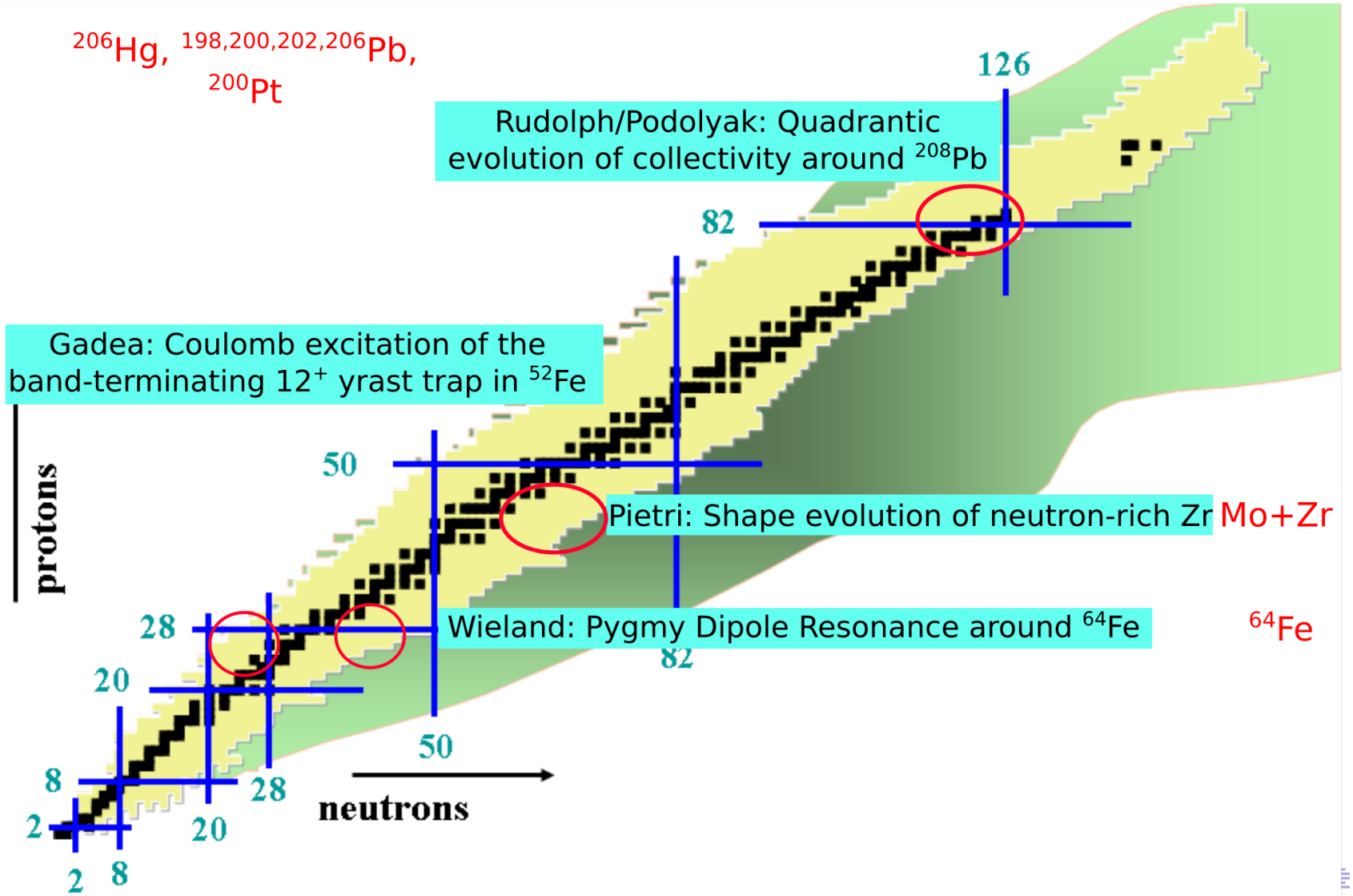
Overview of the experiments

2012: 4 experiments



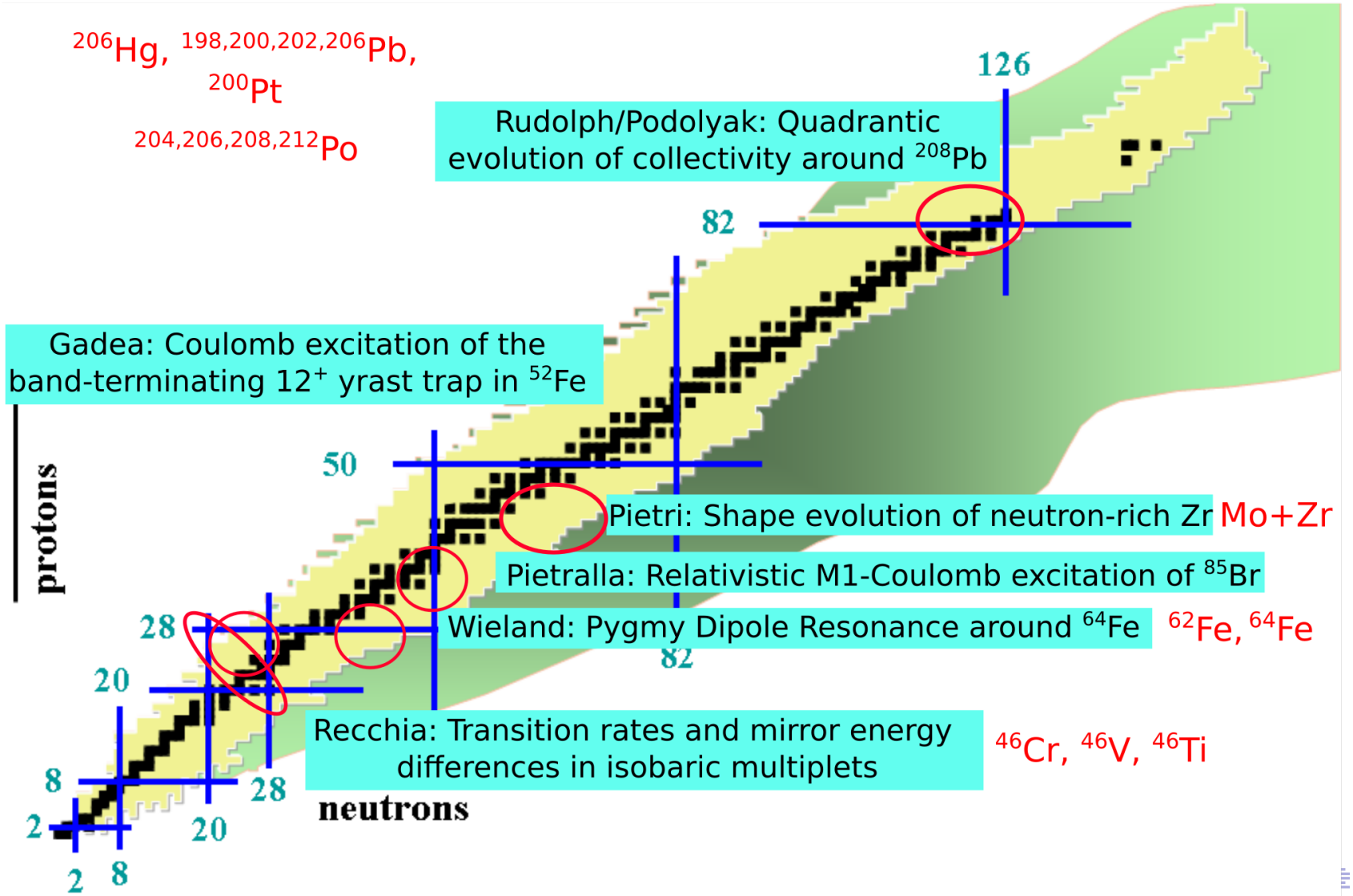
Overview of the experiments

2012: few nuclei investigated



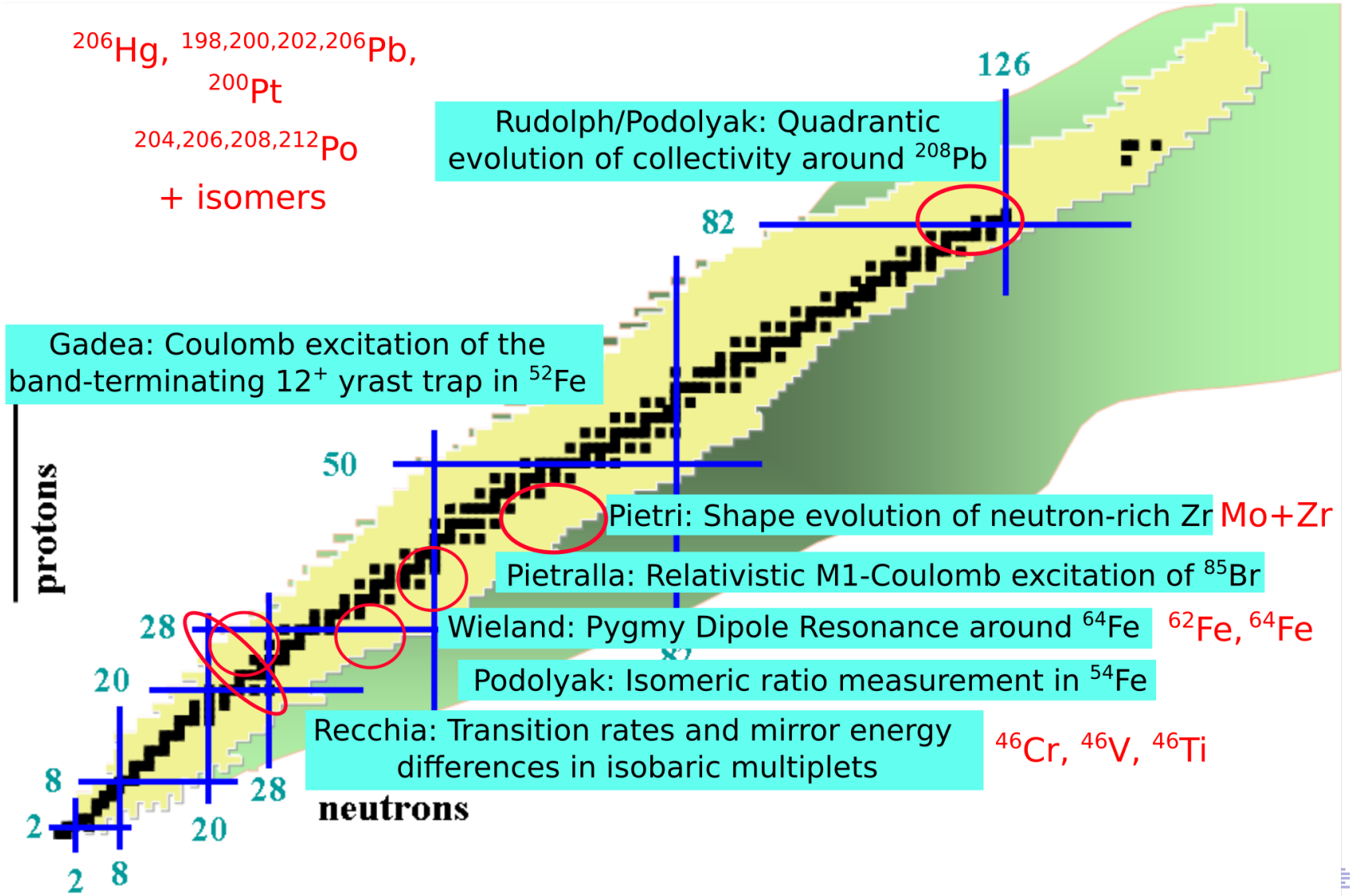
Overview of the experiments

2014: completed 2 experiments, 2 experiments performed



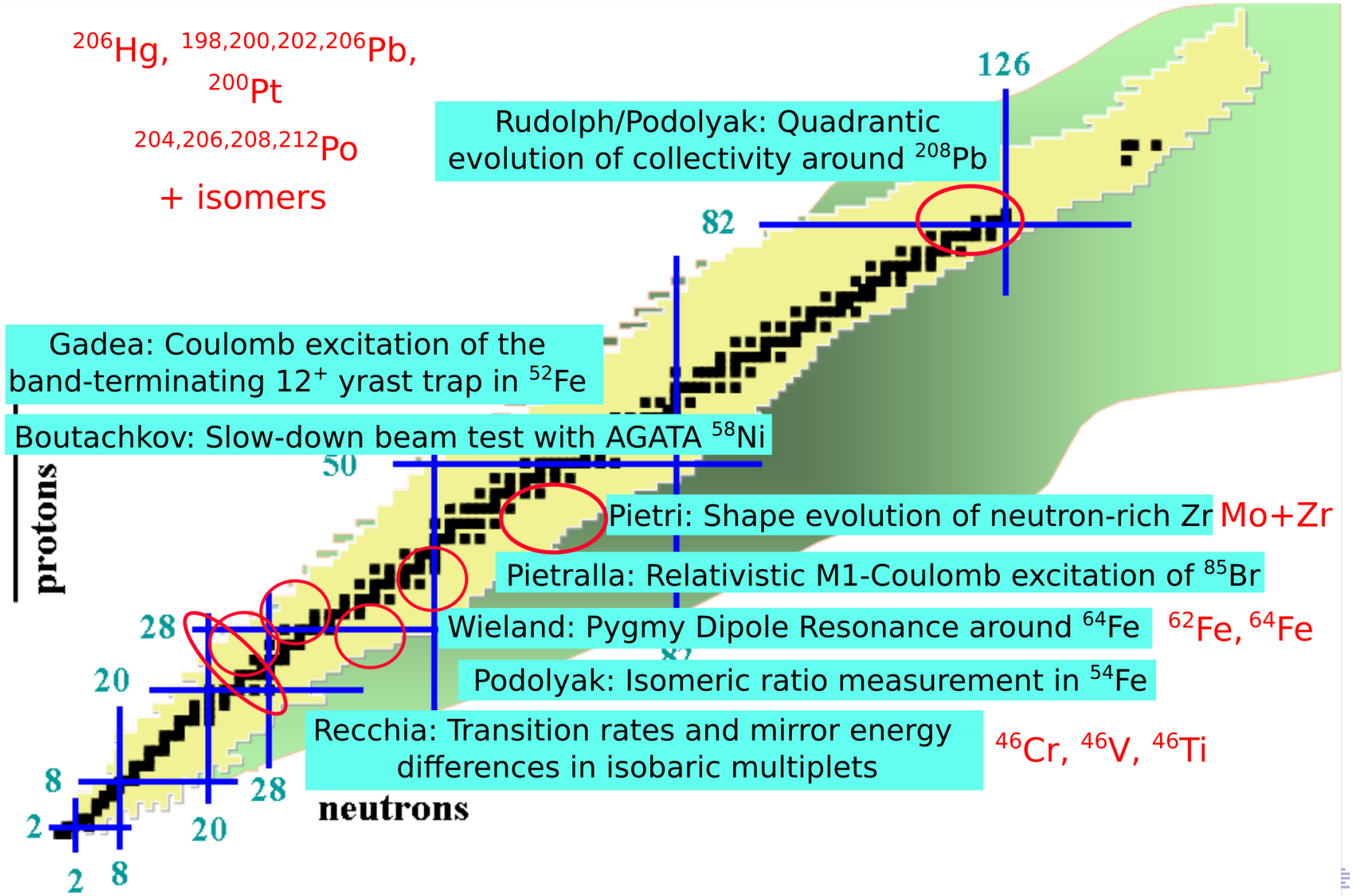
Overview of the experiments

Isomer data: Pb region, and one dedicated beam time



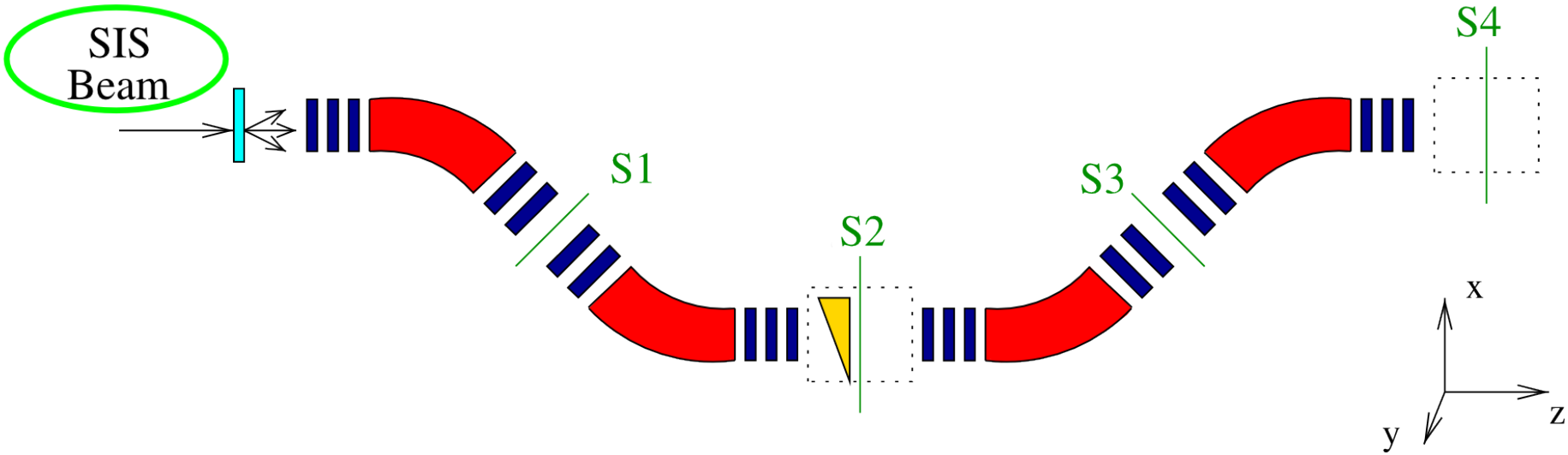
Overview of the experiments

A test for DeSPEC experiments



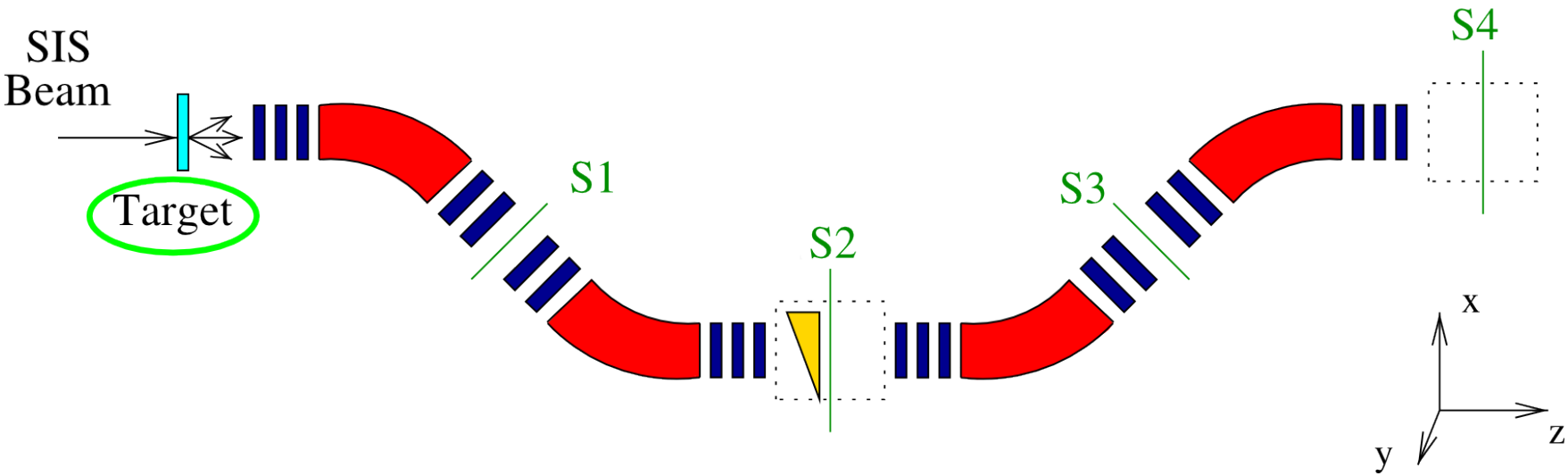
Production of relativistic beam

Primary beam from SIS-18, 600 MeV/A to 1 GeV/A



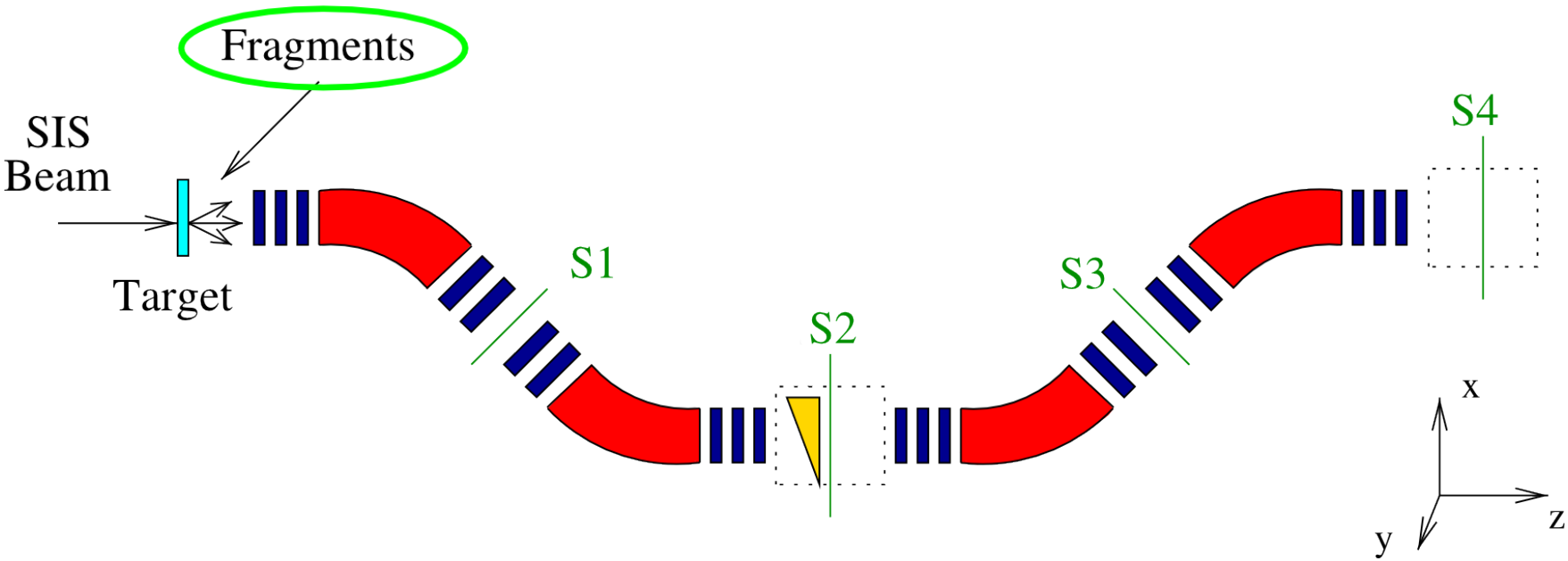
Production of relativistic beam

Relativistic fission or fragmentation



Production of relativistic beam

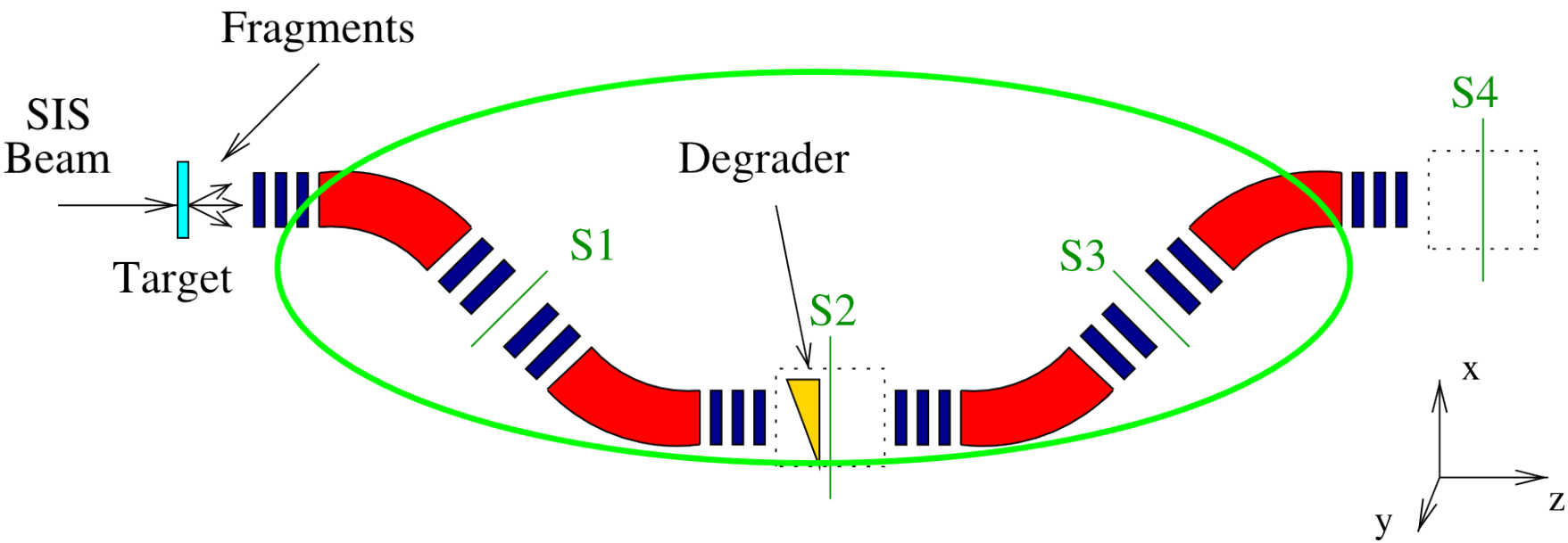
Reaction products



Production of relativistic beam

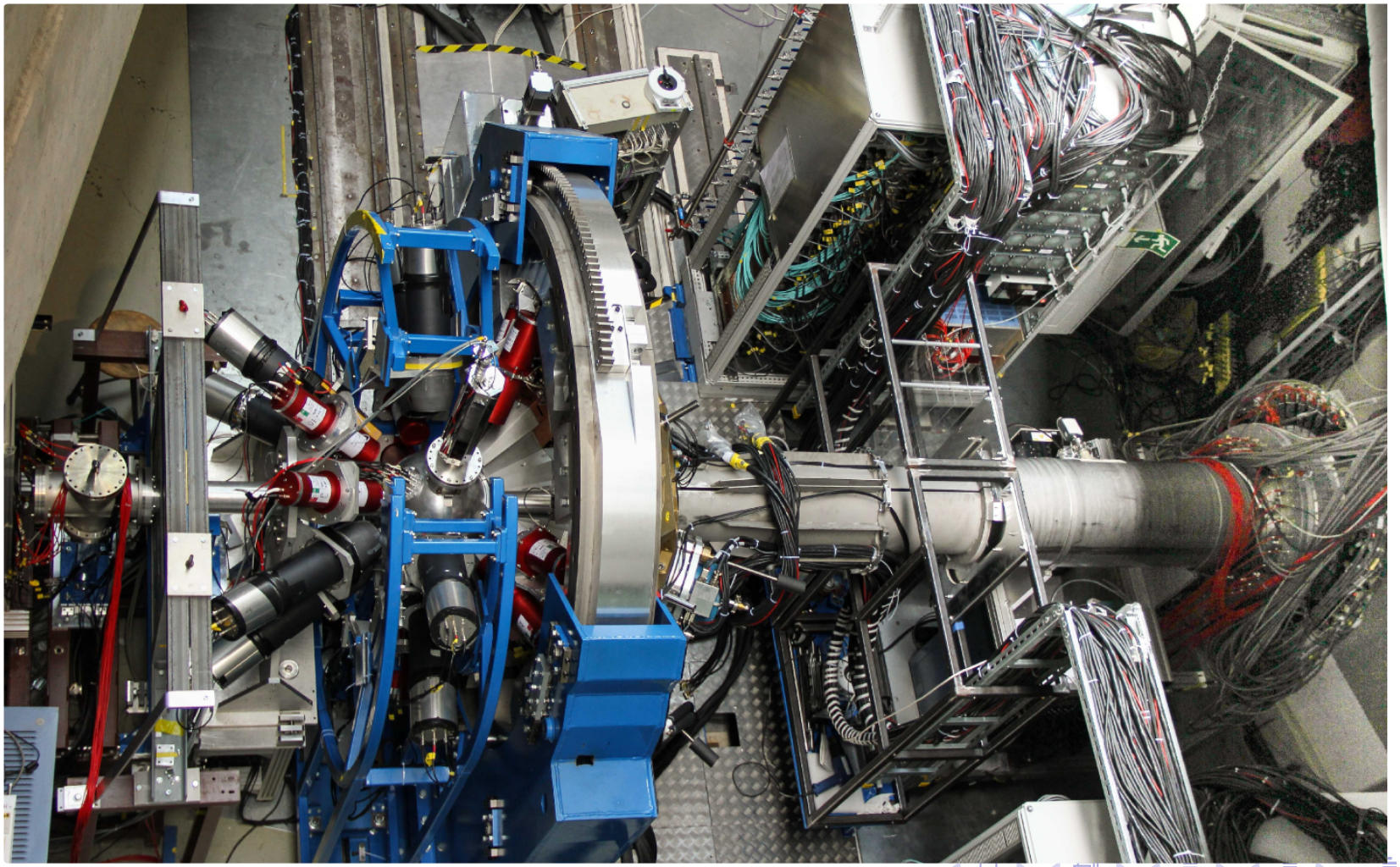
Selection and identification of the fragments:

$B\rho - \Delta E - B\rho$ method



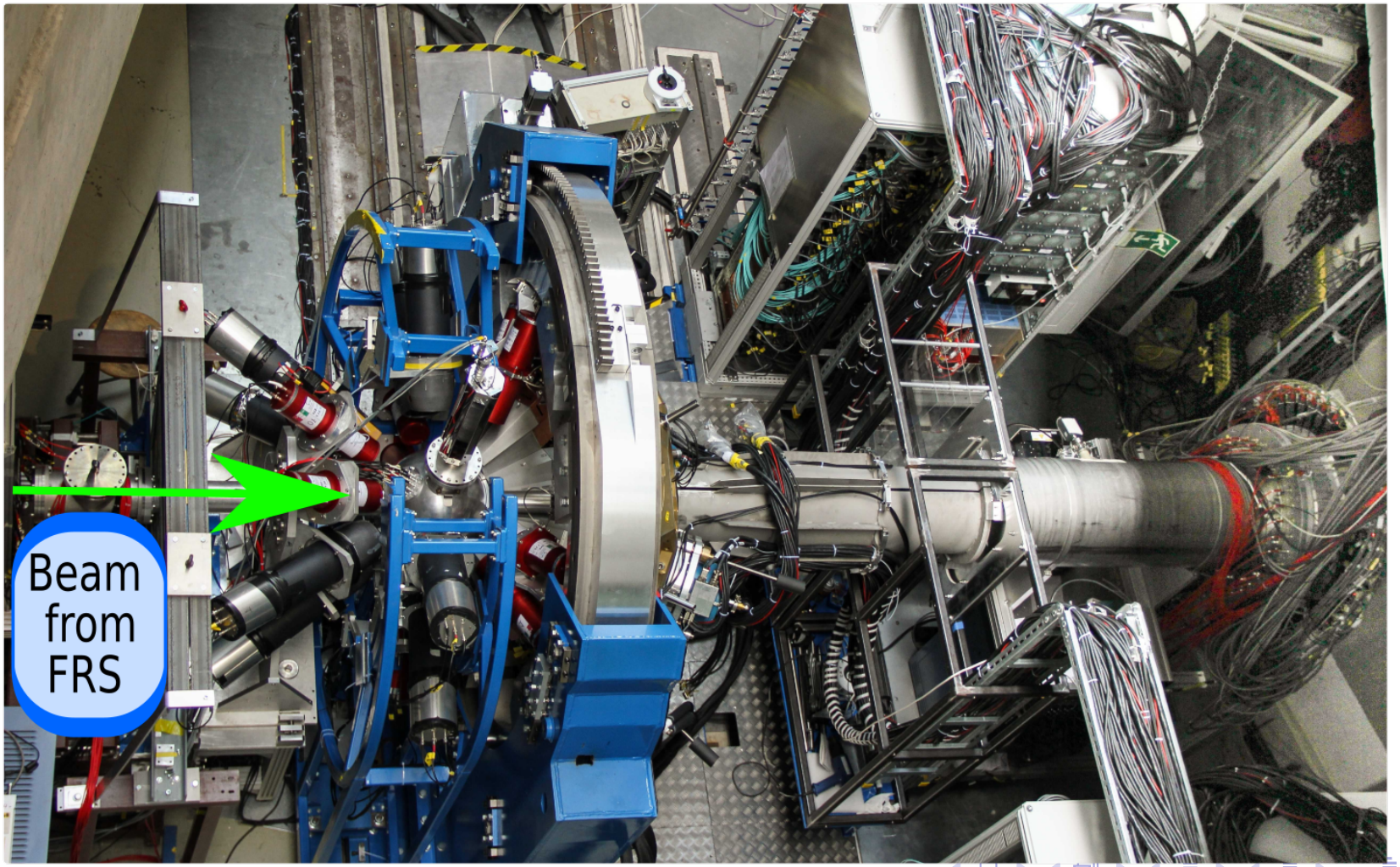
PreSPEC-AGATA setup

Picture of the experimental area



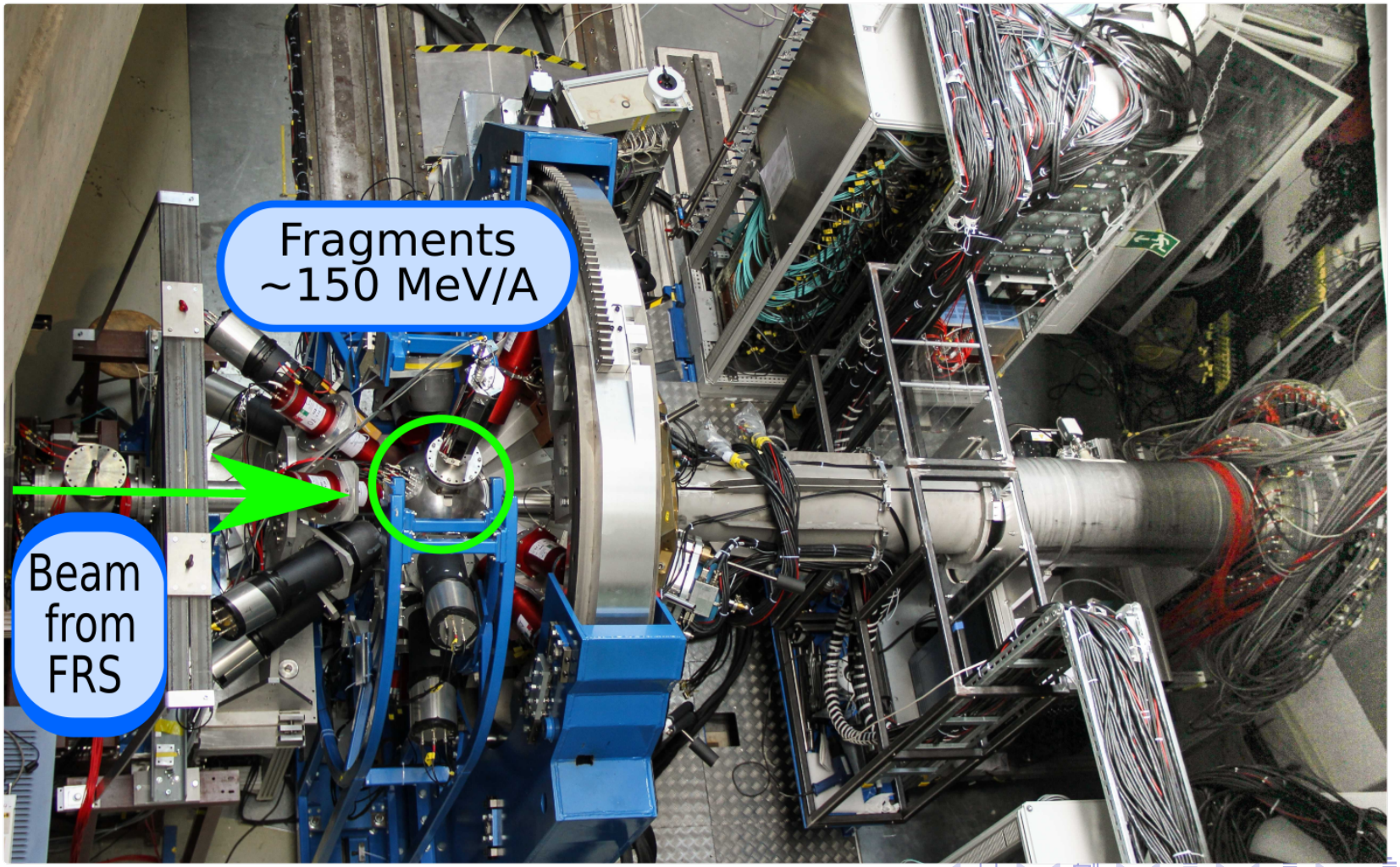
PreSPEC-AGATA setup

Exotic beam from the FRagment Separator (FRS)



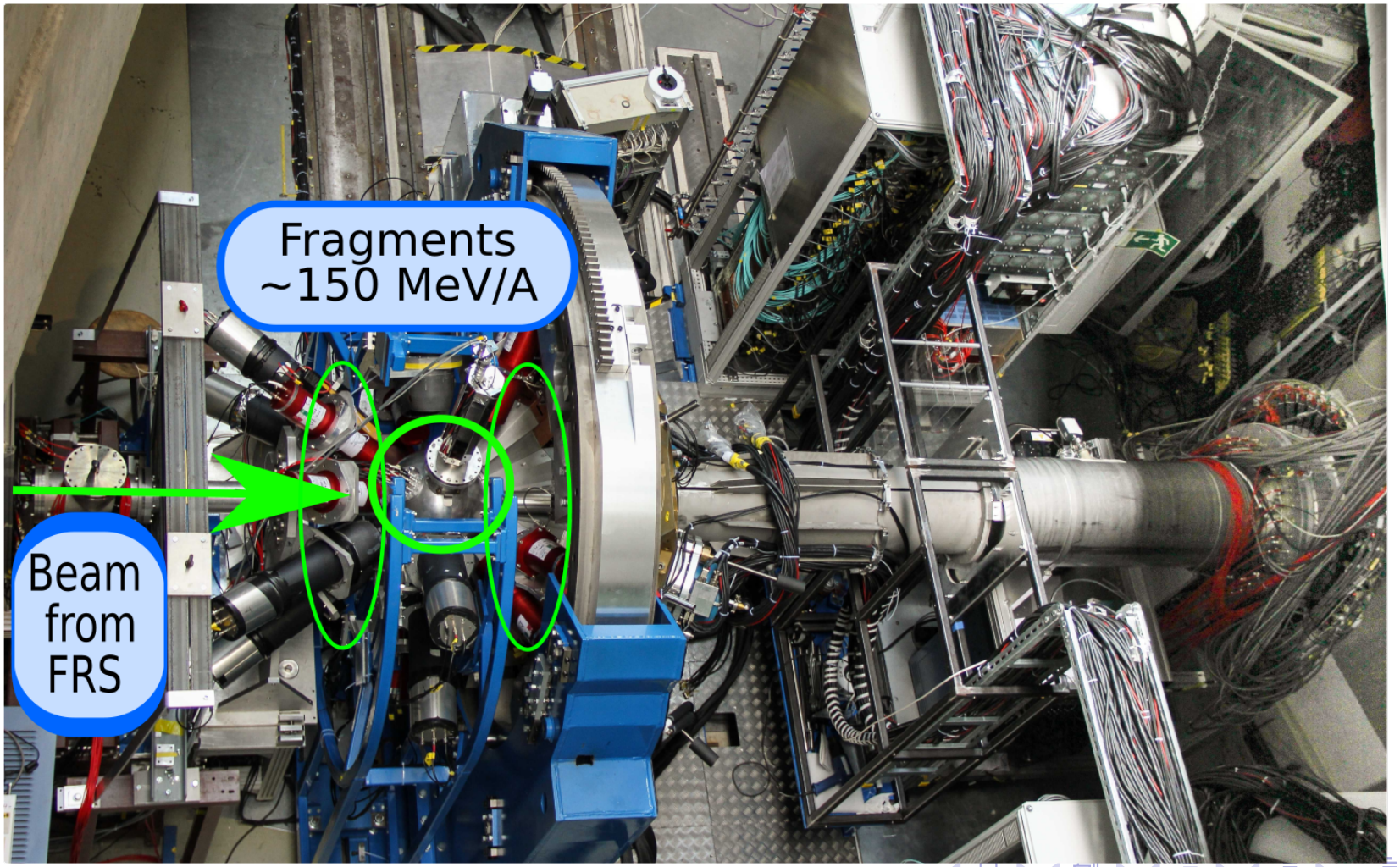
PreSPEC-AGATA setup

Fragmentation or relativistic coulomb-excitation



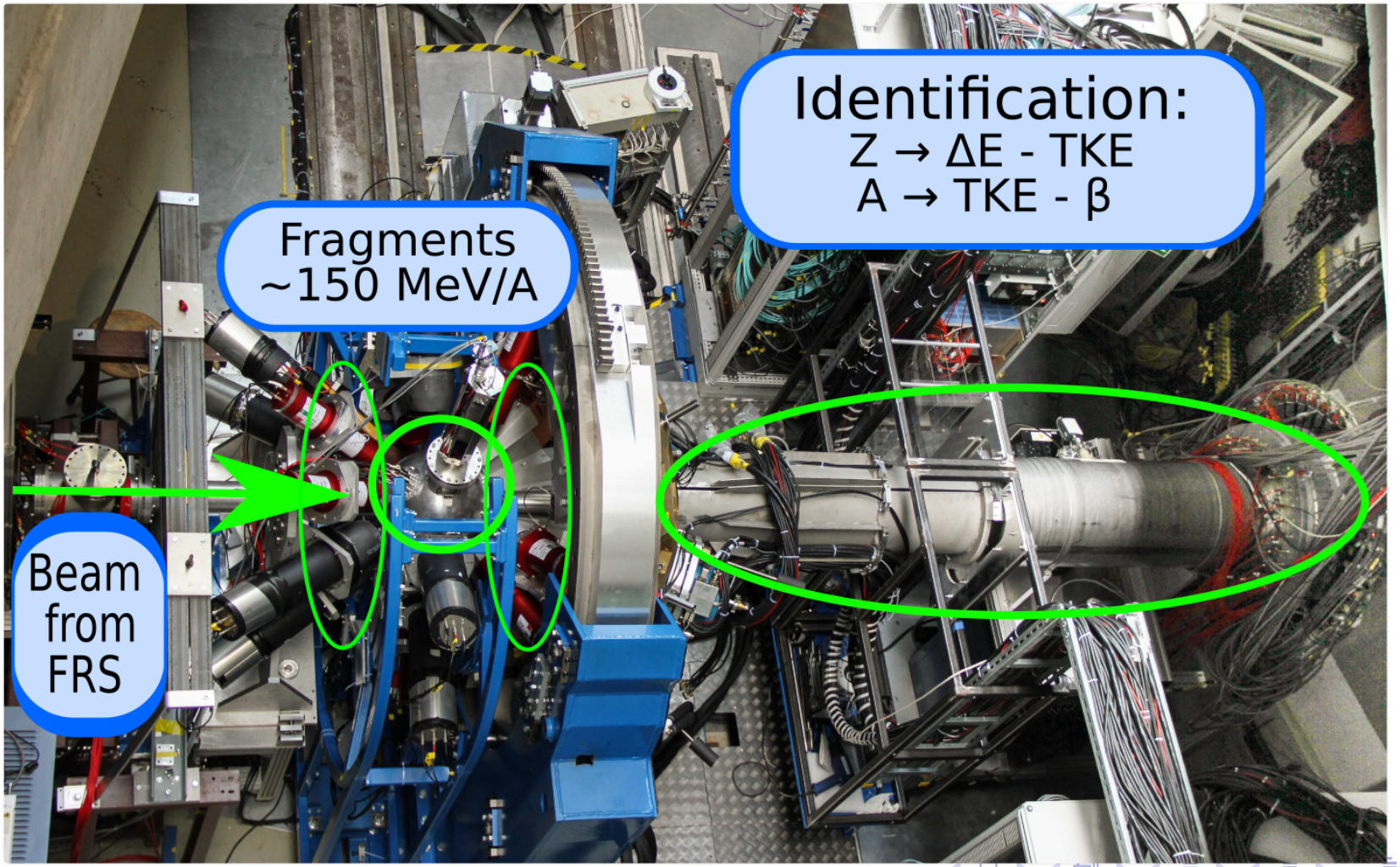
PreSPEC-AGATA setup

γ rays detected with the AGATA and HECTOR+ detectors



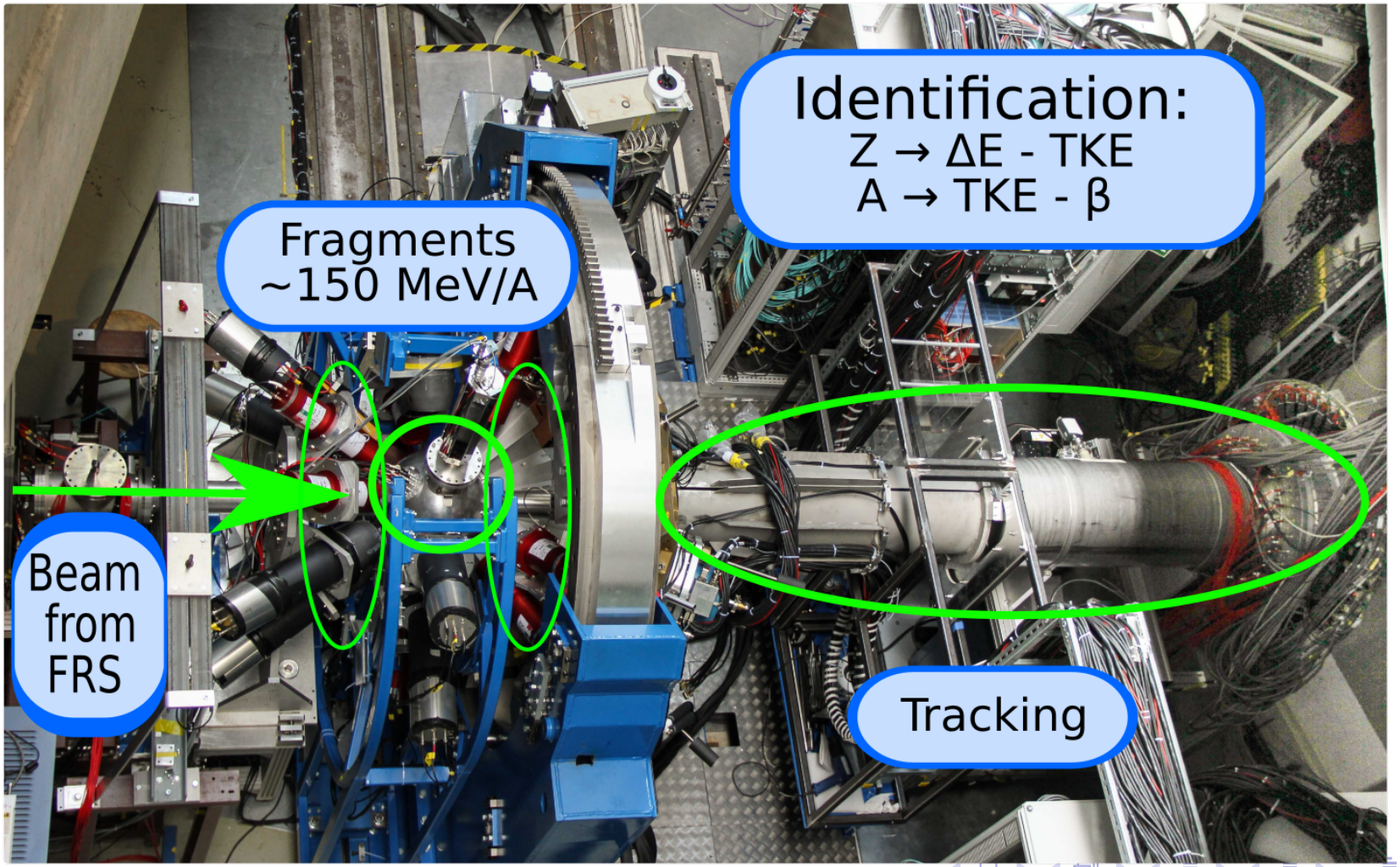
PreSPEC-AGATA setup

Reaction products detected in LYCCA



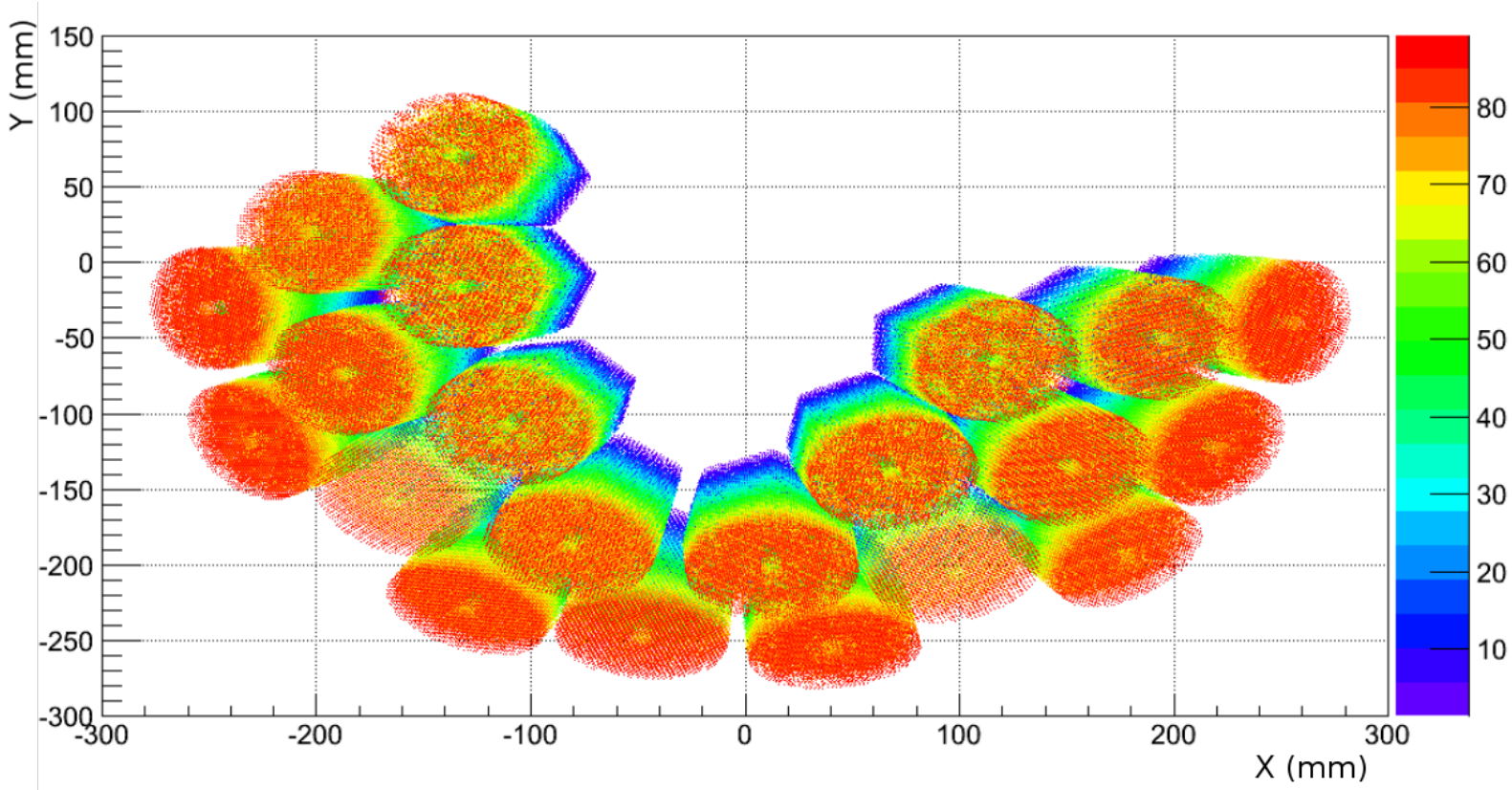
PreSPEC-AGATA setup

Reaction products detected in LYCCA



Measured efficiencies

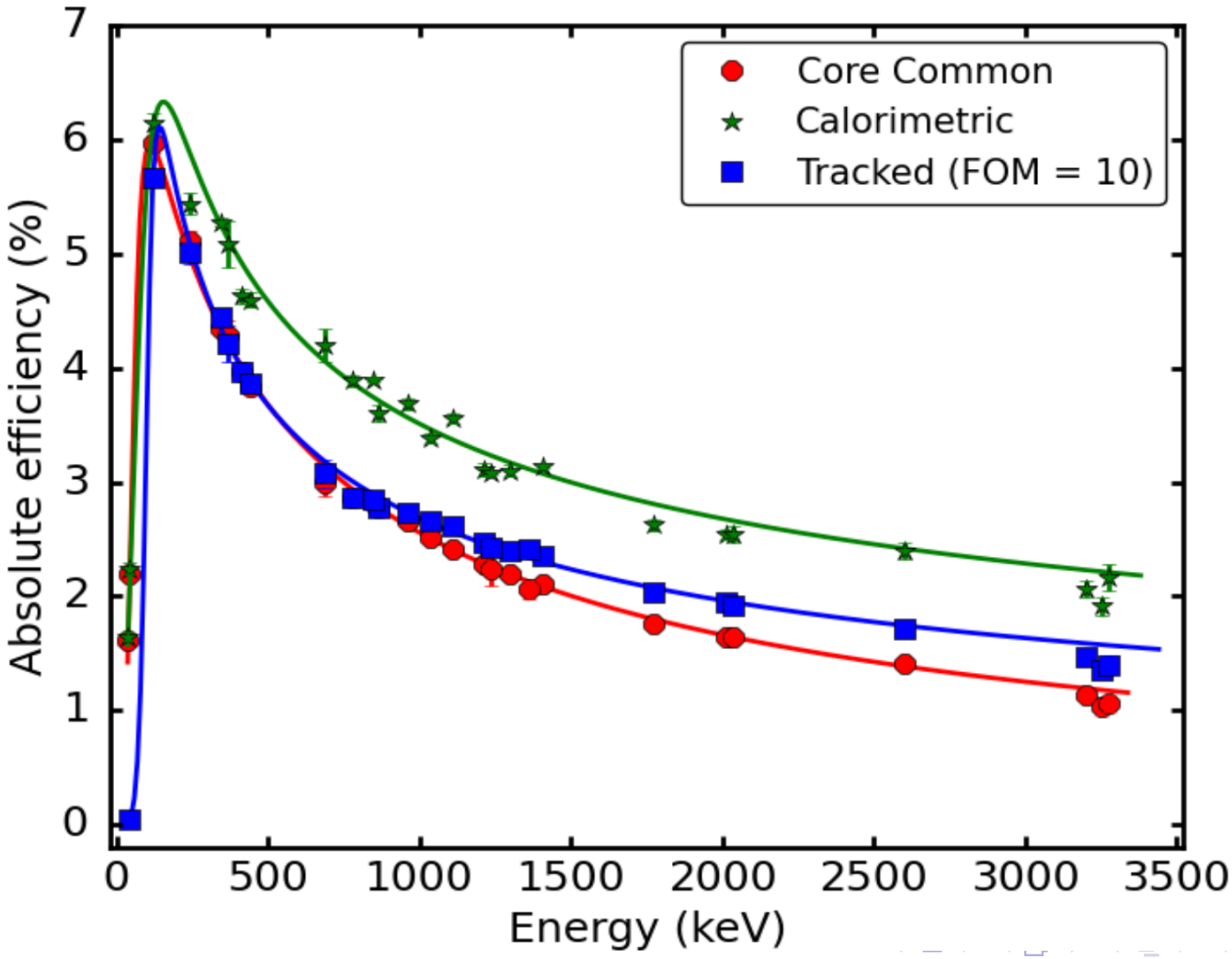
Up to 21 AGATA crystals (2014)



Measured efficiencies

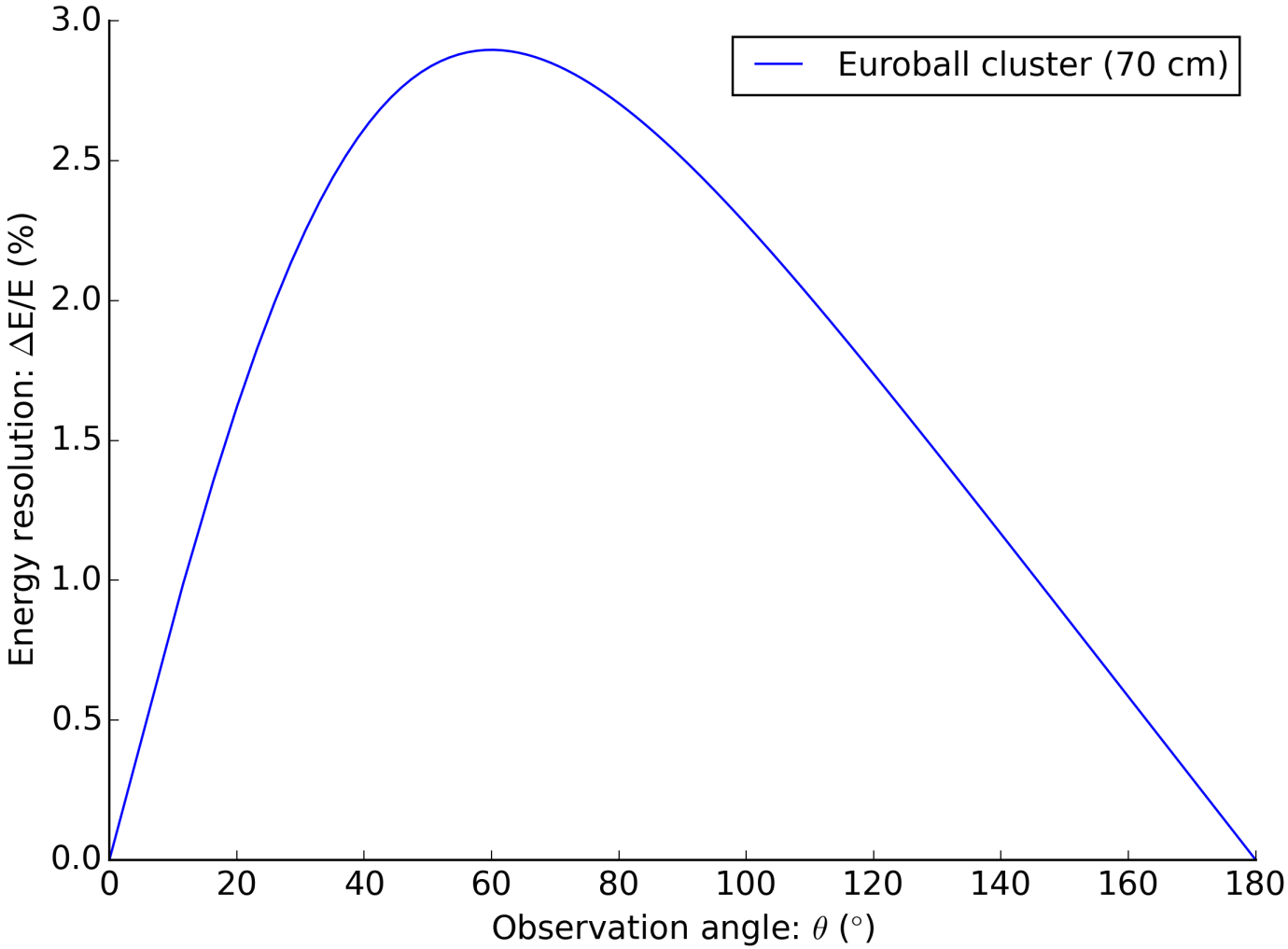
N. Lalović, NIMA 806, 258-266 (2016)

For 21 AGATA detectors



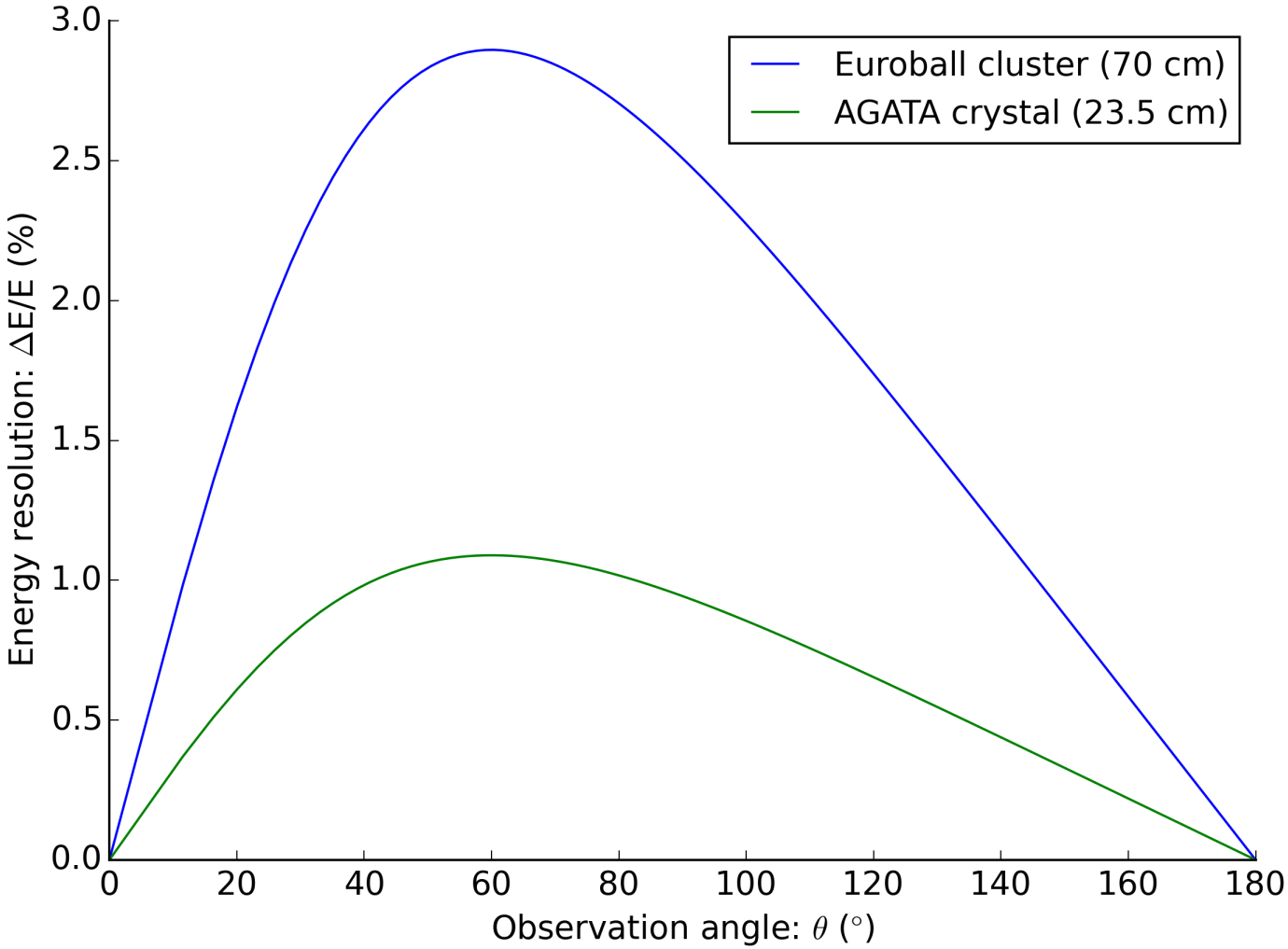
PSA advantage

Opening angle: Euroball cluster detector



PSA advantage

Opening angle: AGATA segmented detector



Stopped beam spectroscopy

Slow down beam: ^{58}Ni on ^{197}Au

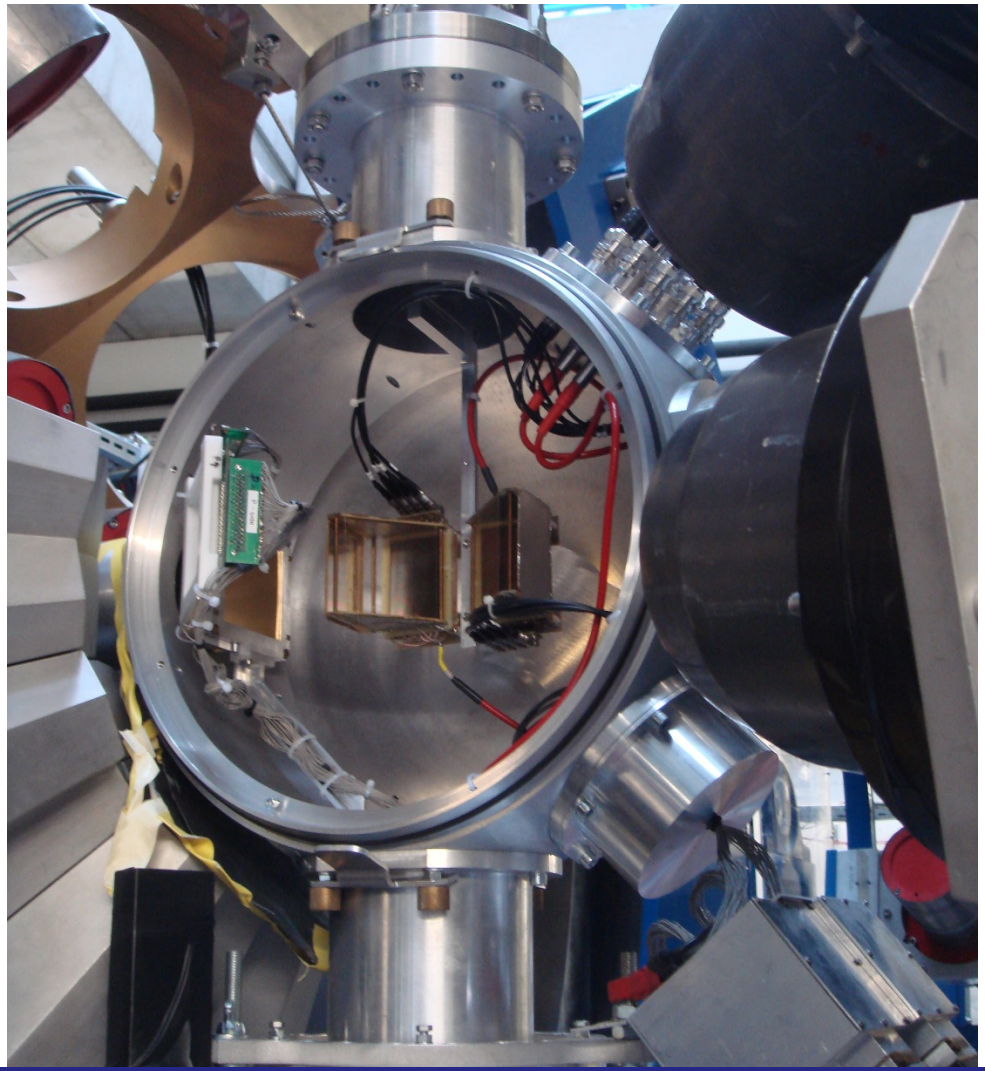
Courtesy: M. Cappellazzo

- 2 shift of ^{58}Ni beam at 250 MeV/A
- Slowed down to 7 MeV/A in Al degrader
- Trigger: SC41 (last FRS plastic scintillator)
- Thick ^{197}Au target
- AGATA for γ ray

Slow down beam: ^{58}Ni on ^{197}Au

Courtesy: M. Cappellazzo

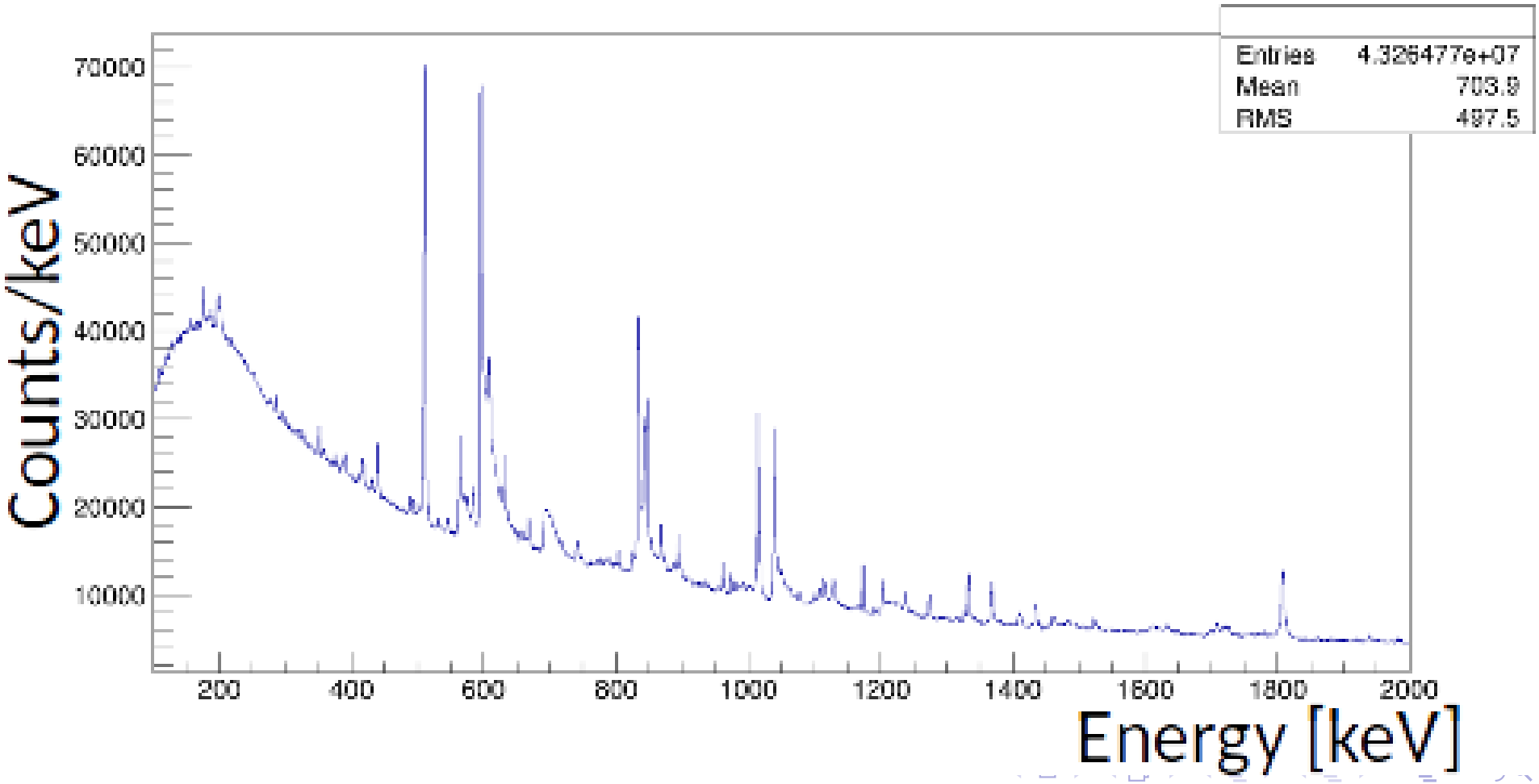
Picture of the reaction chamber



Slow down beam: ^{58}Ni on ^{197}Au

Courtesy: M. Cappellazzo

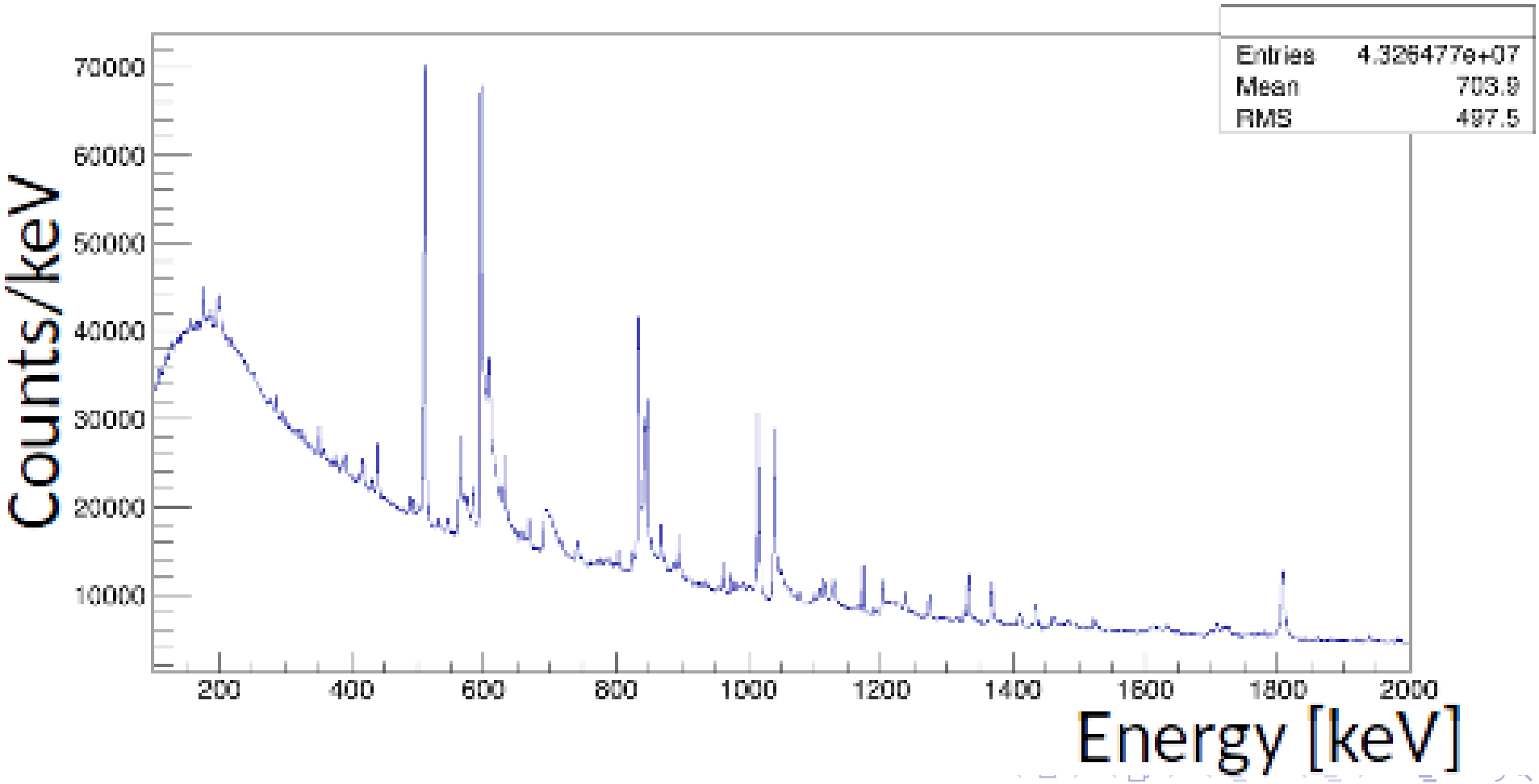
γ-ray spectra without any selections



Slow down beam: ^{58}Ni on ^{197}Au

Courtesy: M. Cappellazzo

High neutron background: time selection tracking imaging capacities



Isomeric ratio in ^{54}Fe

PODOLYÁK: ISOMERIC RATIO MEASUREMENT IN ^{54}FE

Isomeric ratio in ^{54}Fe

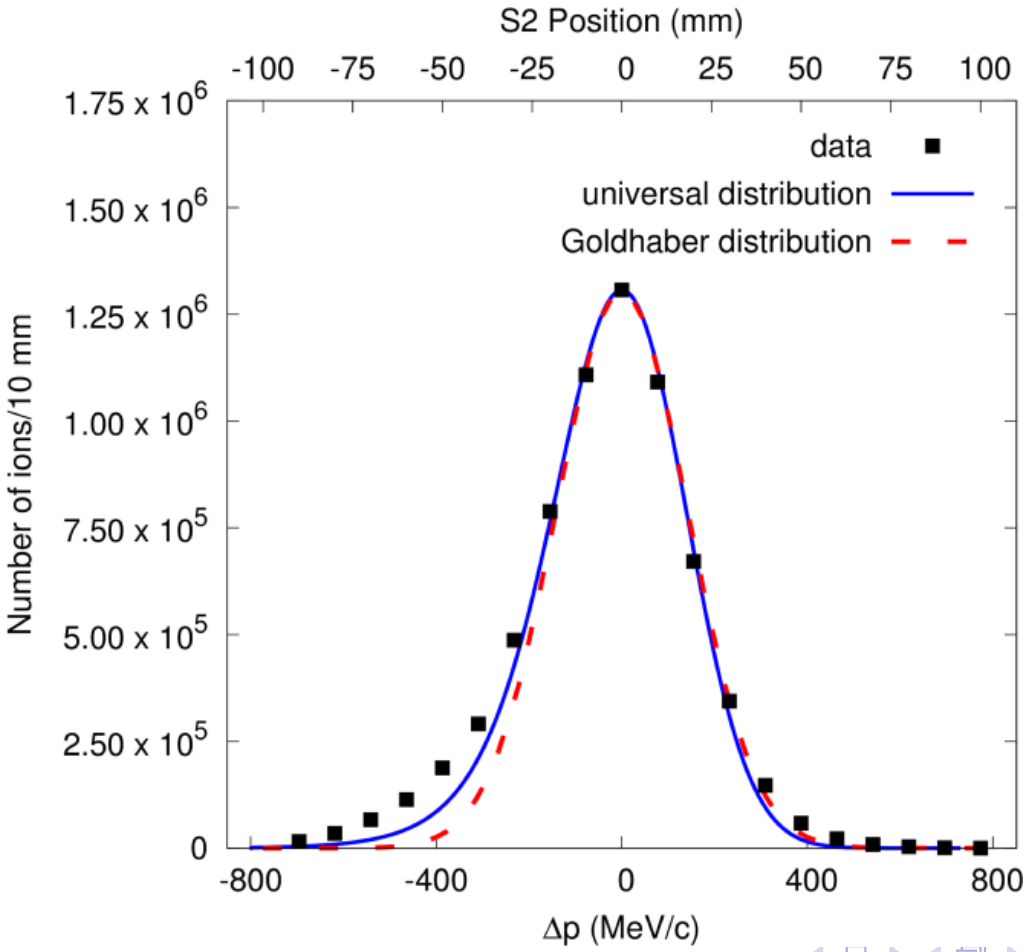
Zs. Podolyák, submitted to PRL (2016)

^{56}Fe beam at 500 Mev/A fragmented on a beryllium target

Isomeric ratio in ^{54}Fe

Zs. Podolyák, submitted to PRL (2016)

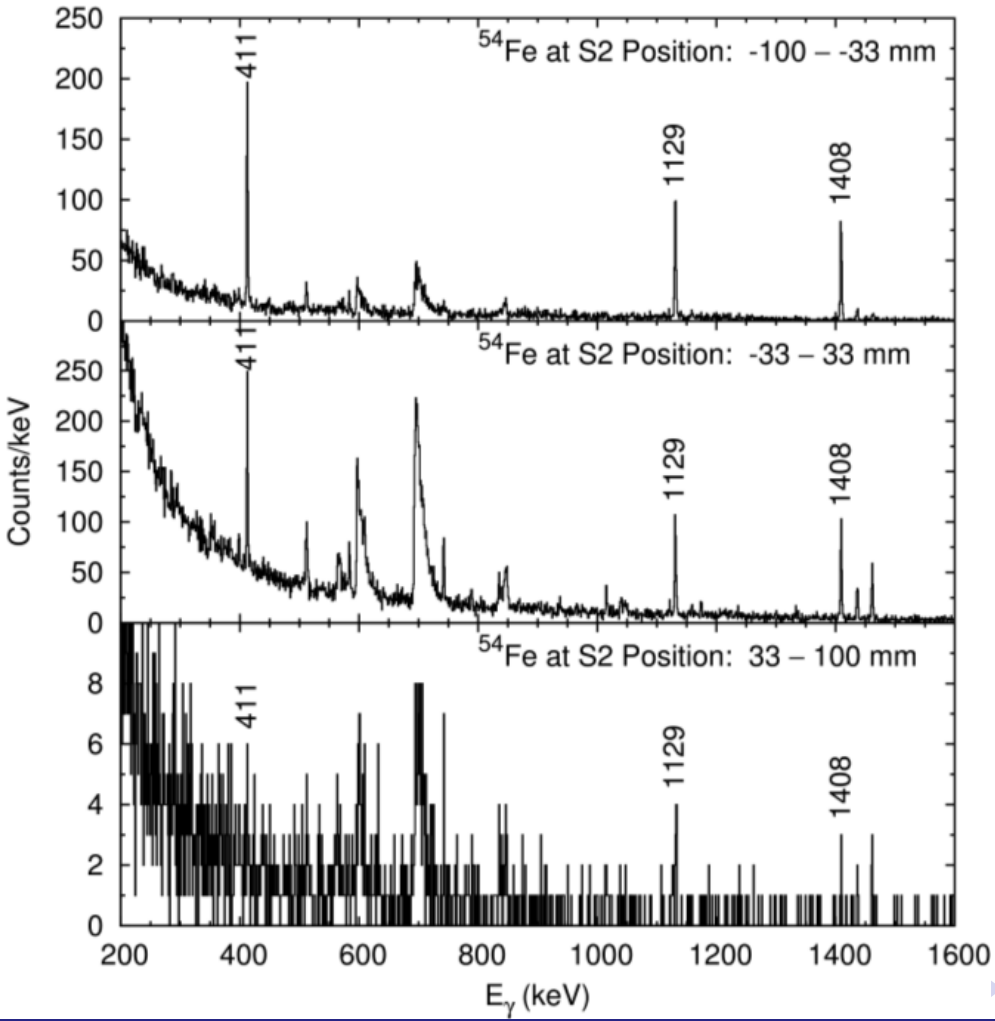
Intermediate focal plane positions



Isomeric ratio in ^{54}Fe

Zs. Podolyák, submitted to PRL (2016)

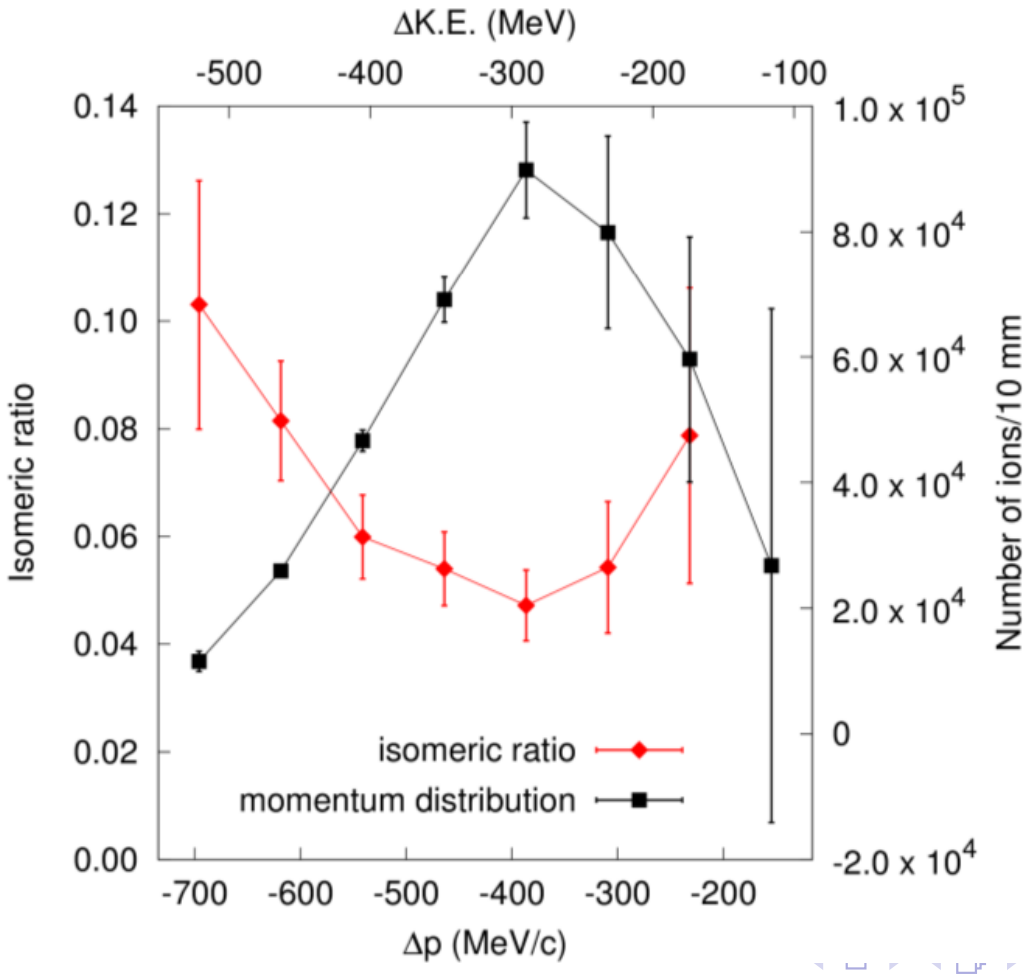
γ-ray spectra for three momentum selection



Isomeric ratio in ^{54}Fe

Zs. Podolyák, submitted to PRL (2016)

Isomer production influenced by the momentum transfered



Isomeric ratio around ^{208}Pb

Courtesy: N.Lalović

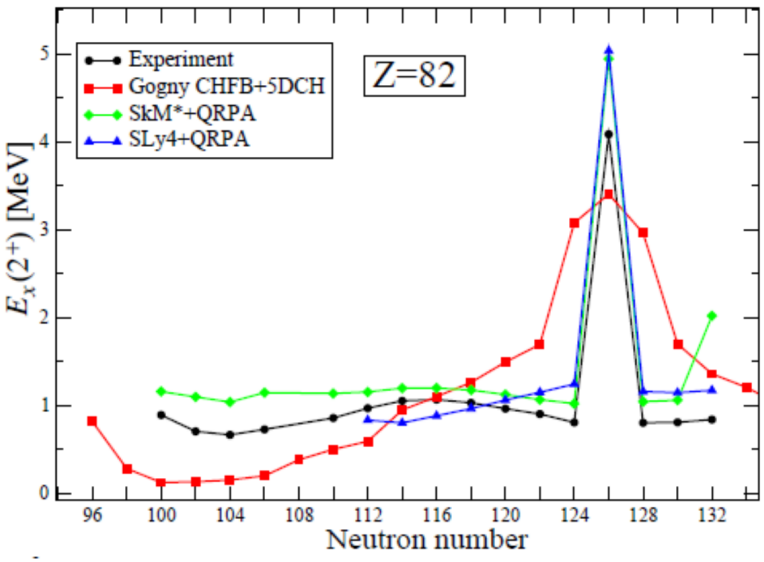
Rudolph/Podolák: Quadrantic evolution of collectivity around ^{208}Pb

Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Constrains on shell-model parametrizations
Anchor point for beyond-mean field calculations

Quadrantic Evolution of Collectivity Around ^{208}Pb



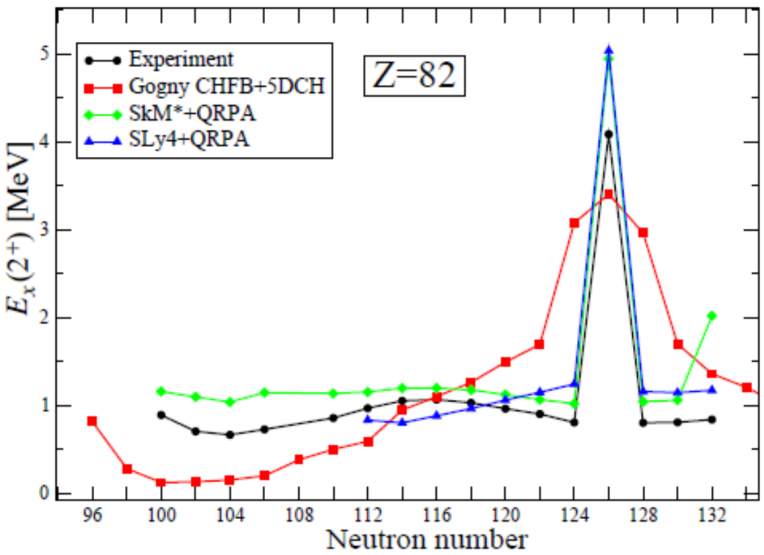
[1] J. –P. Delaroche et al., Phys. Rev. C **81**, 014303 (2010).
[2] B. Sabbey et al. Phys. Rev. C **75** 044305 (2007).
[3] J. Terasaki and J. Engel, Phys. Rev. C **82**, 034326 (2010).

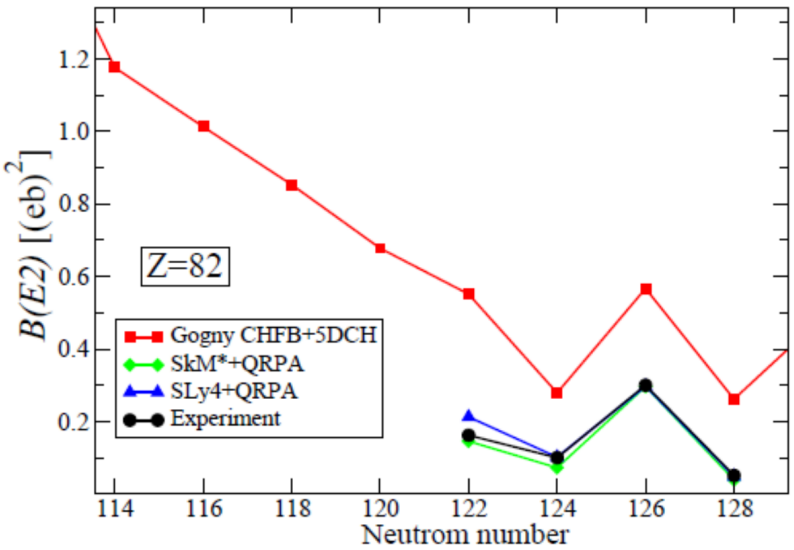
Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Constrains on shell-model parametrizations
Anchor point for beyond-mean field calculations

Quadrantic Evolution of Collectivity Around ^{208}Pb



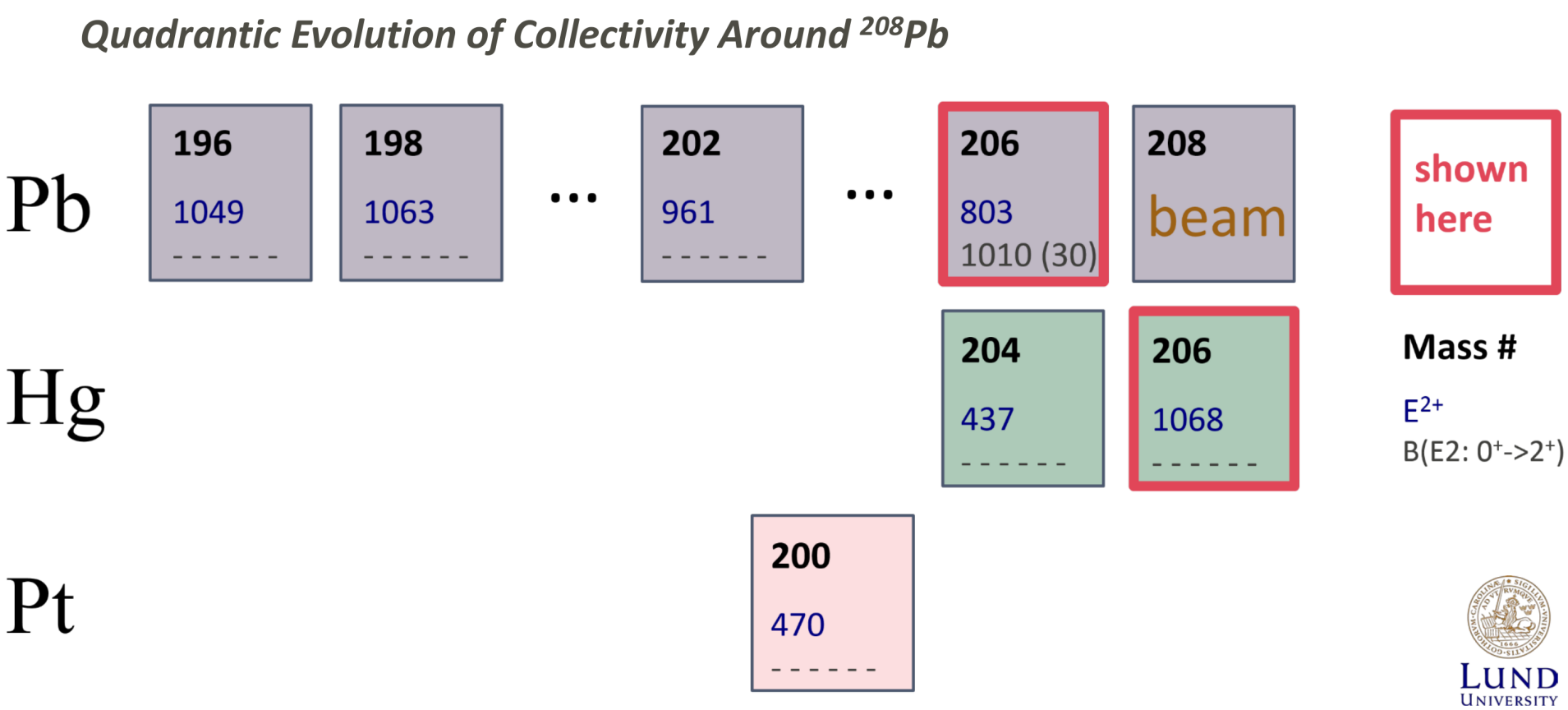


[1] J. –P. Delaroche et al., Phys. Rev. C **81**, 014303 (2010).
[2] B. Sabbey et al. Phys. Rev. C **75** 044305 (2007).
[3] J. Terasaki and J. Engel, Phys. Rev. C **82**, 034326 (2010).

Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Measured $B(E2; 2^+ \rightarrow 0^+)$ in the region

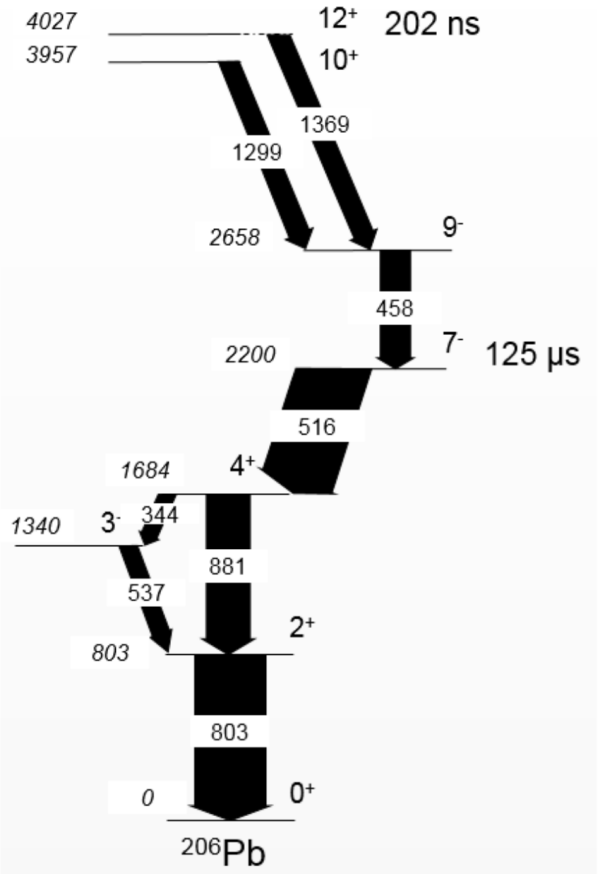


Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Measurement of lifetime of isomeric state

Isomeric decay studies ^{206}Pb

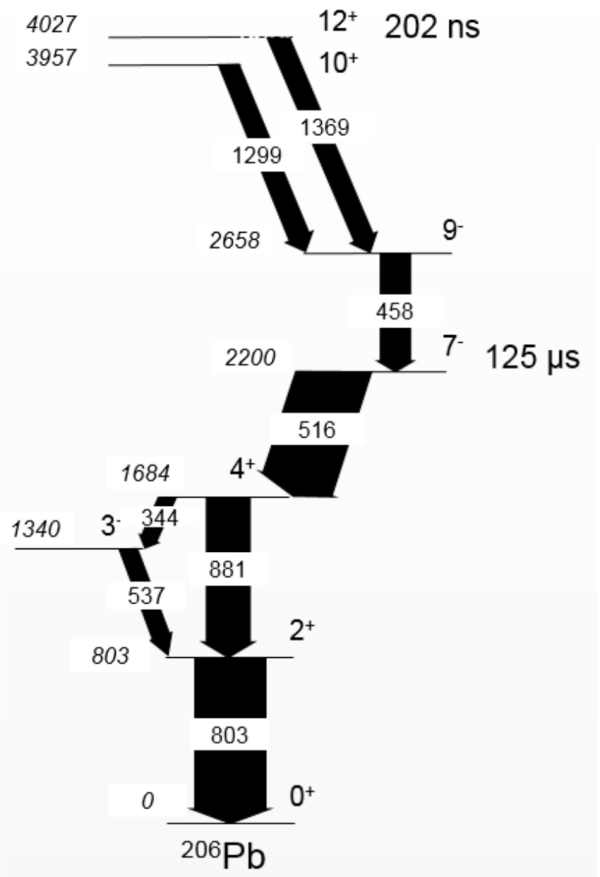


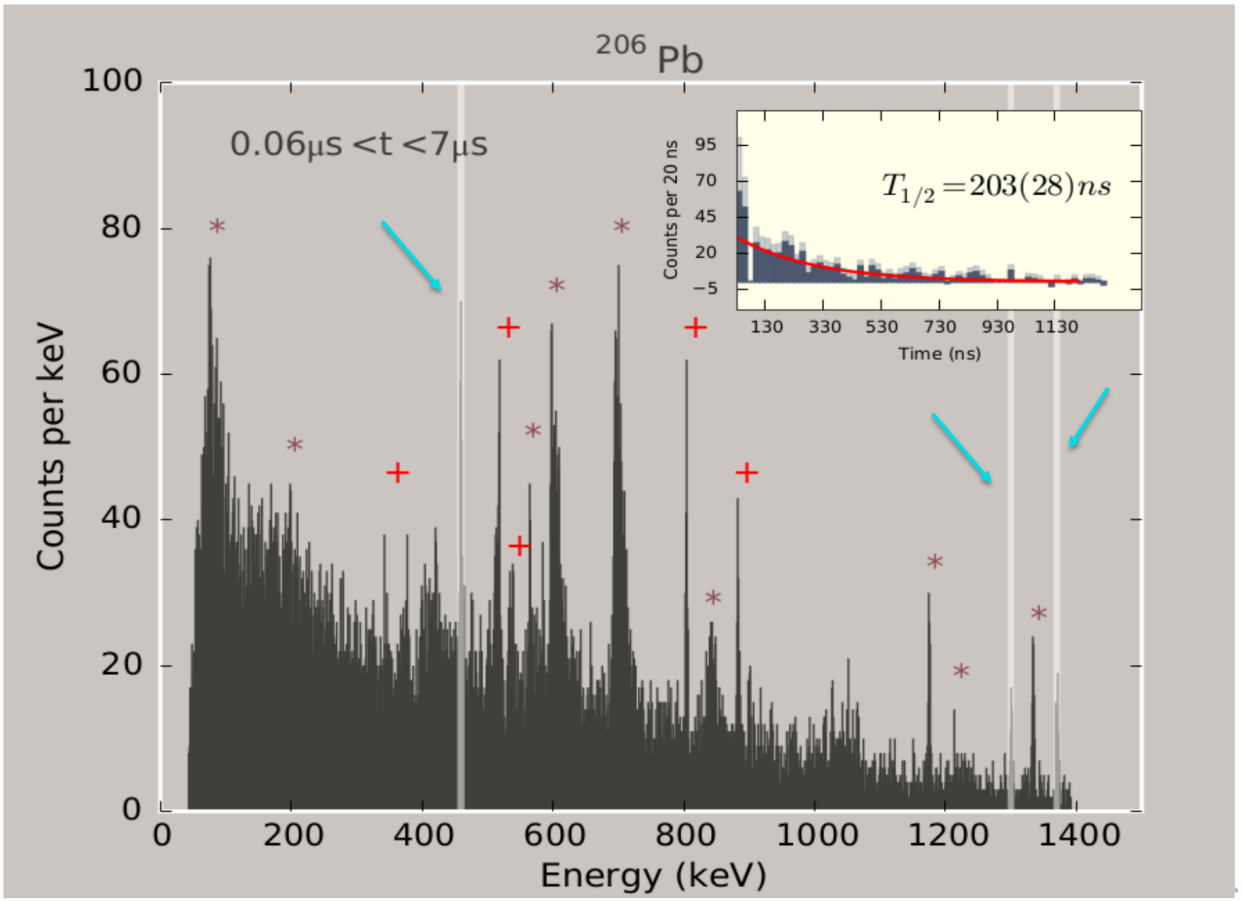
Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Measurement of lifetime of isomeric state

Isomeric decay studies ^{206}Pb



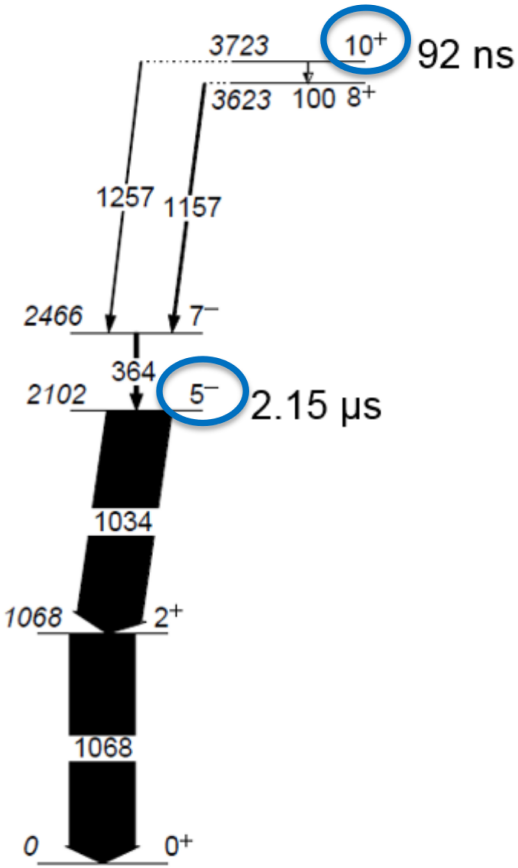


Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Measurement of lifetime of isomeric state

Isomeric decay studies ^{206}Hg

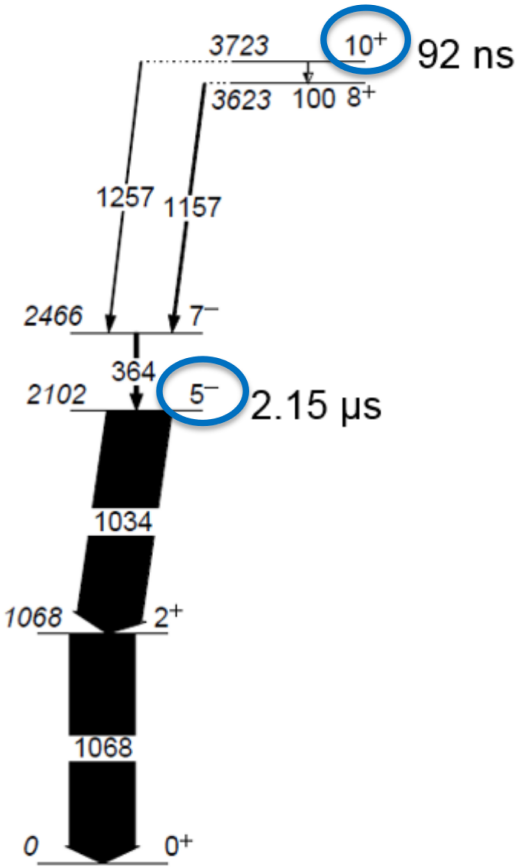


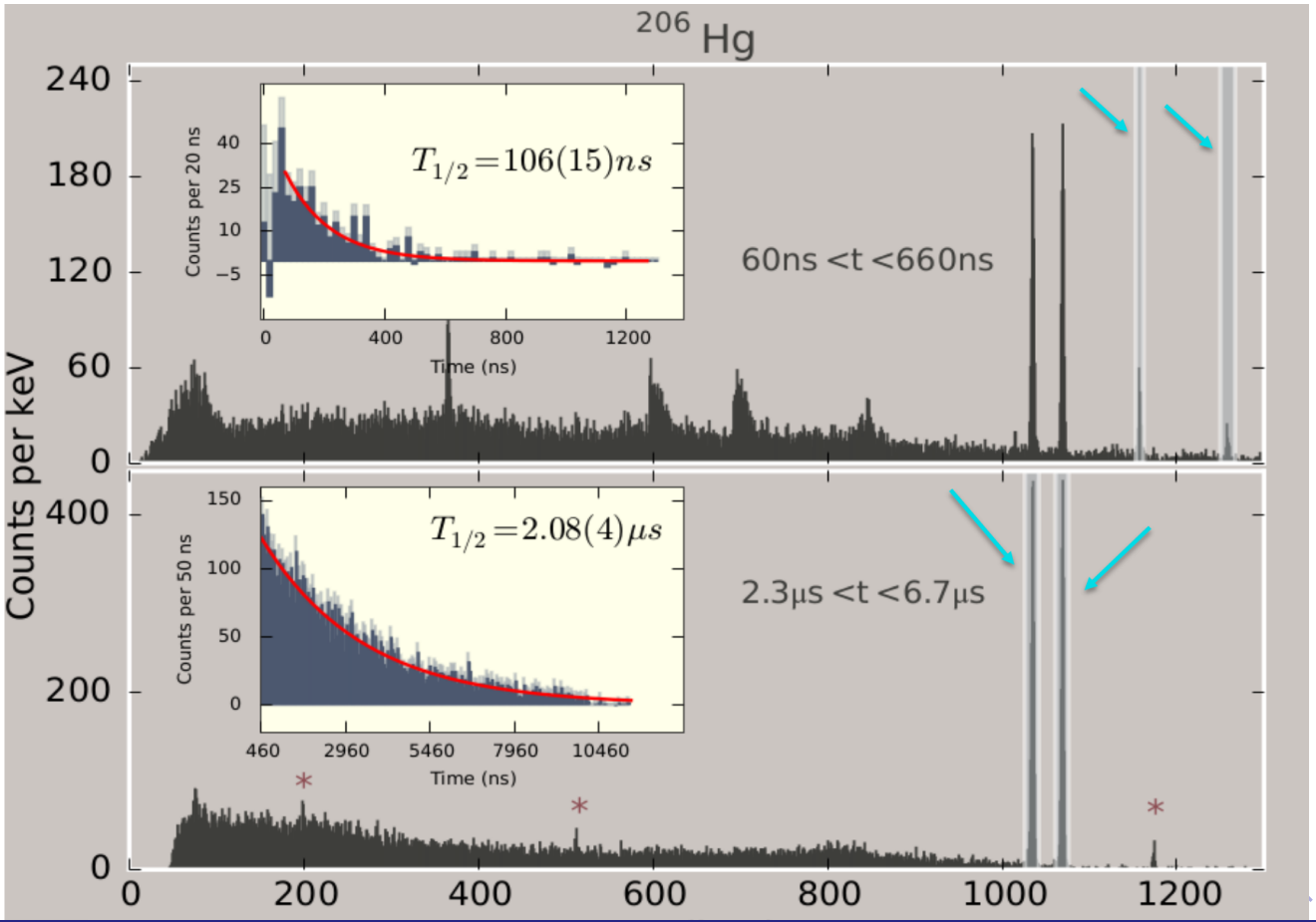
Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Measurement of lifetime of isomeric state

Isomeric decay studies ^{206}Hg



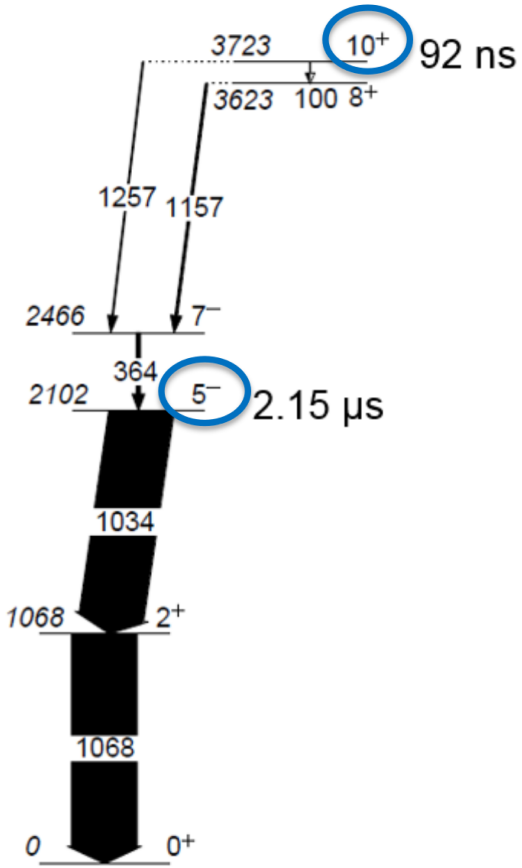


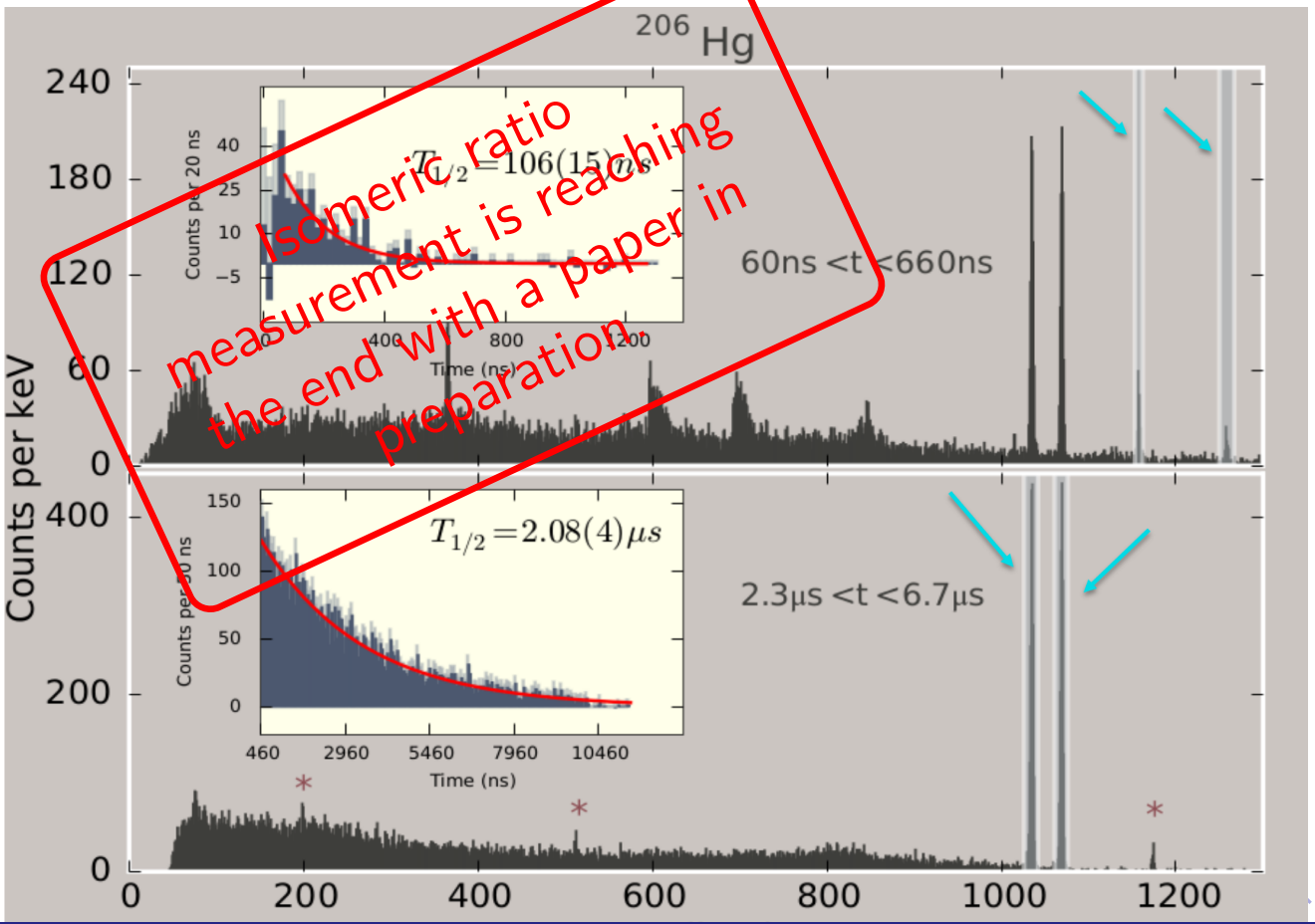
Isomeric ratio around ^{208}Pb

Courtesy: N. Lalović

Isomeric ratio estimations

Isomeric decay studies ^{206}Hg



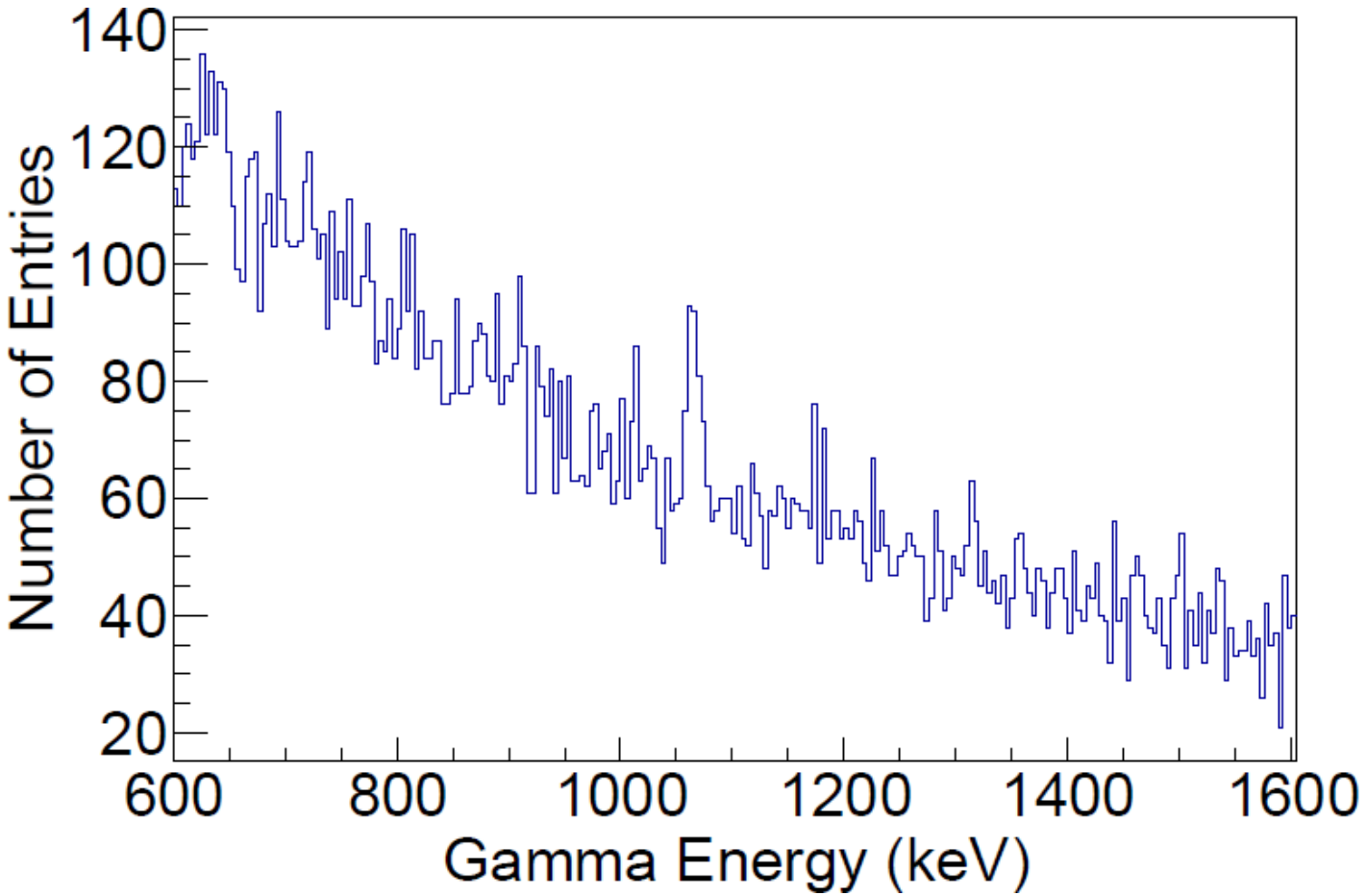


In flight data

Collectivity around ^{208}Pb

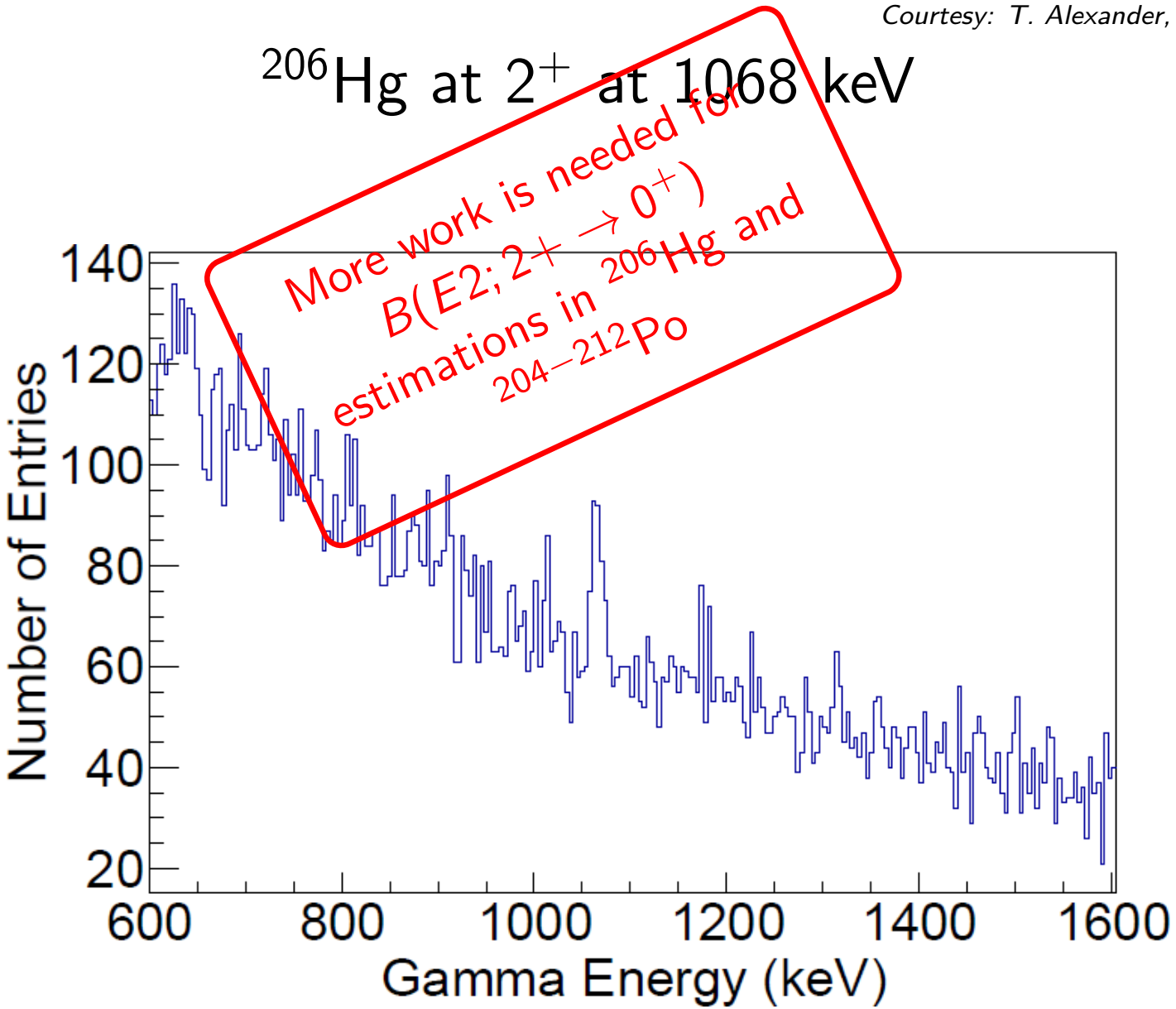
Courtesy: T. Alexander, Zs. Podolyák

^{206}Hg at 2^+ at 1068 keV



Collectivity around ^{208}Pb

Courtesy: T. Alexander, Zs. Podolyák

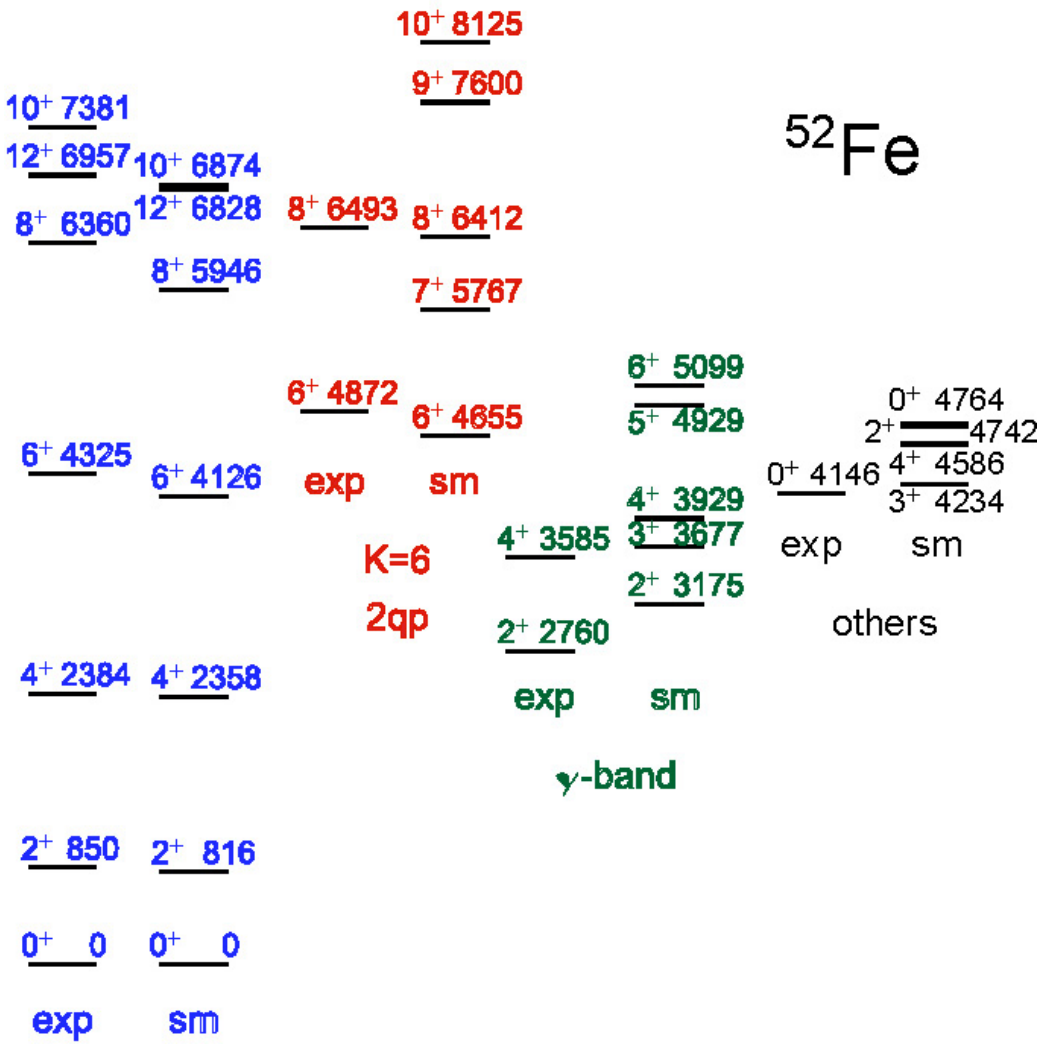


Courtesy: T. Hüyük

Gadea: Coulomb excitation of the band-terminating 12^+ yrast trap in ^{52}Fe

Courtesy: T. Hüyük

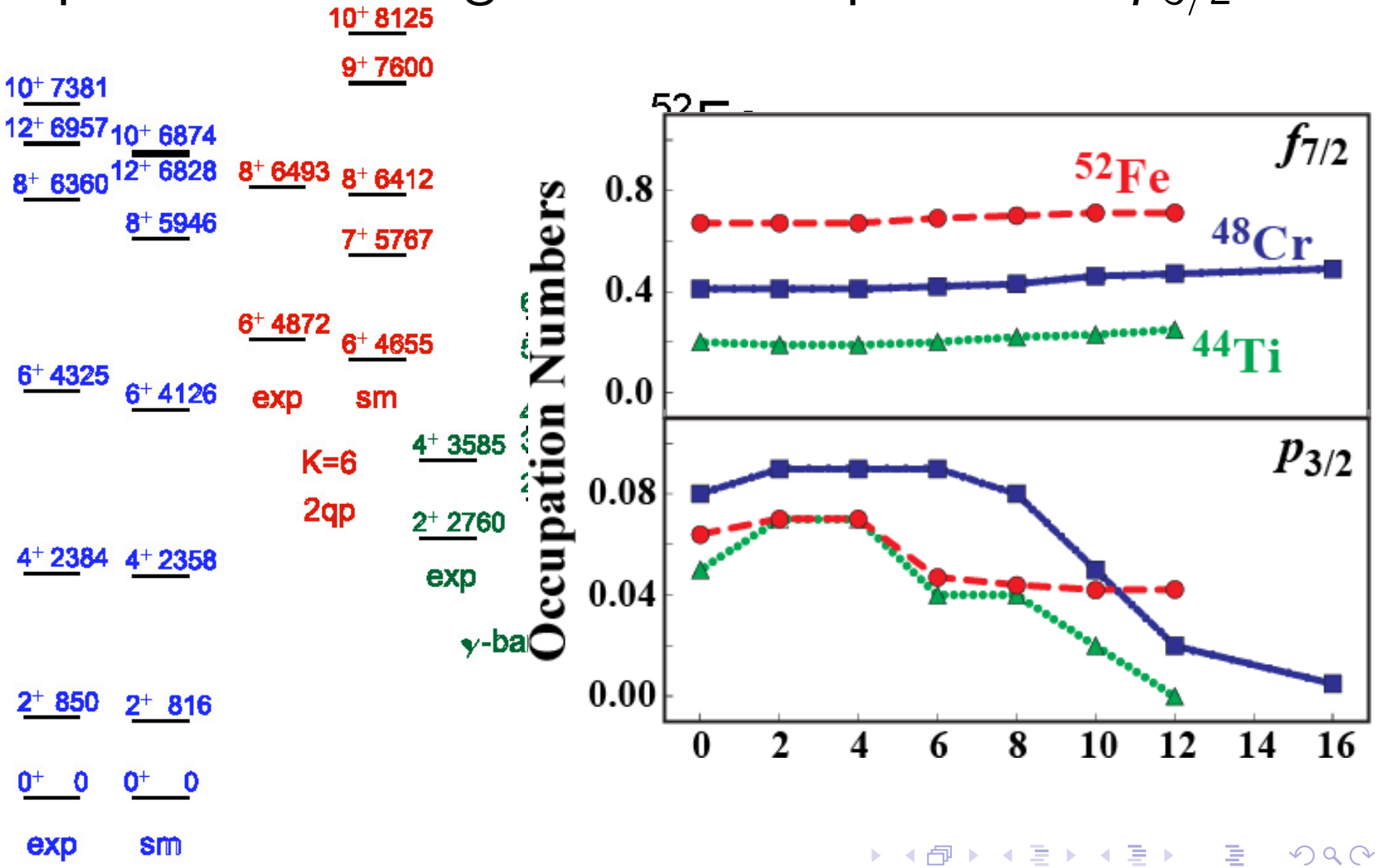
^{52}Fe studies



^{52}Fe

Courtesy: T. Hüyük

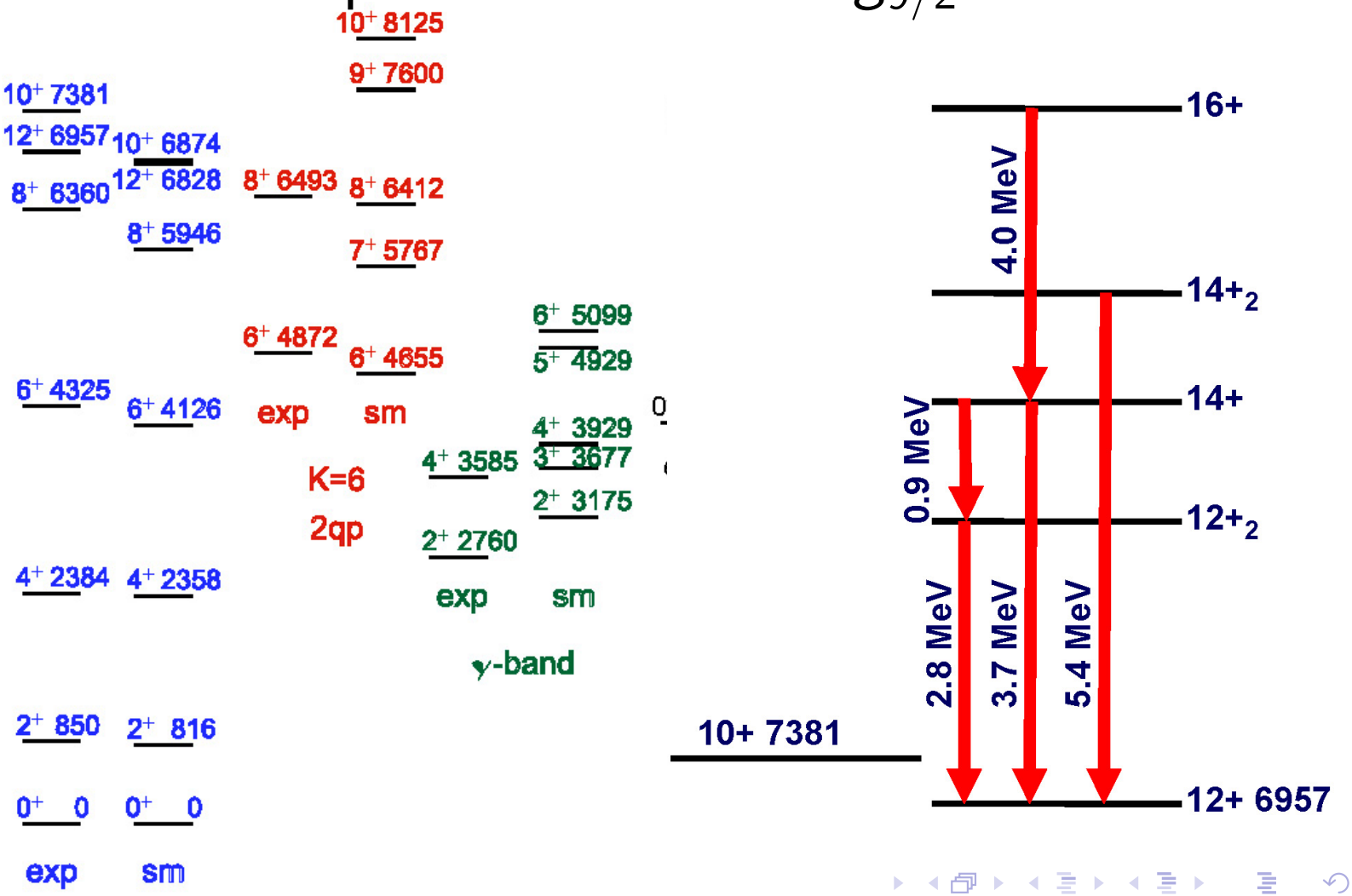
Rotor like structure till 6^+ but change at higher spin
Correspond to a change in the occupancies in $p_{3/2}$



^{52}Fe

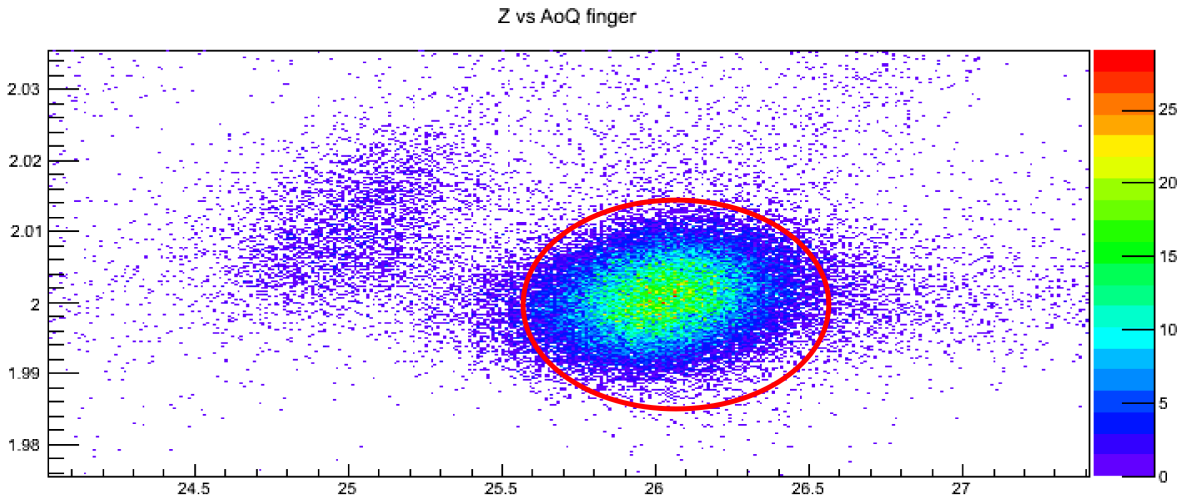
Courtesy: T. Hüyük

Predictions from *fp*-shell LSSM with GXPF1 interaction
Collective structure expected due to the $g_{9/2}$ intruder orbitals



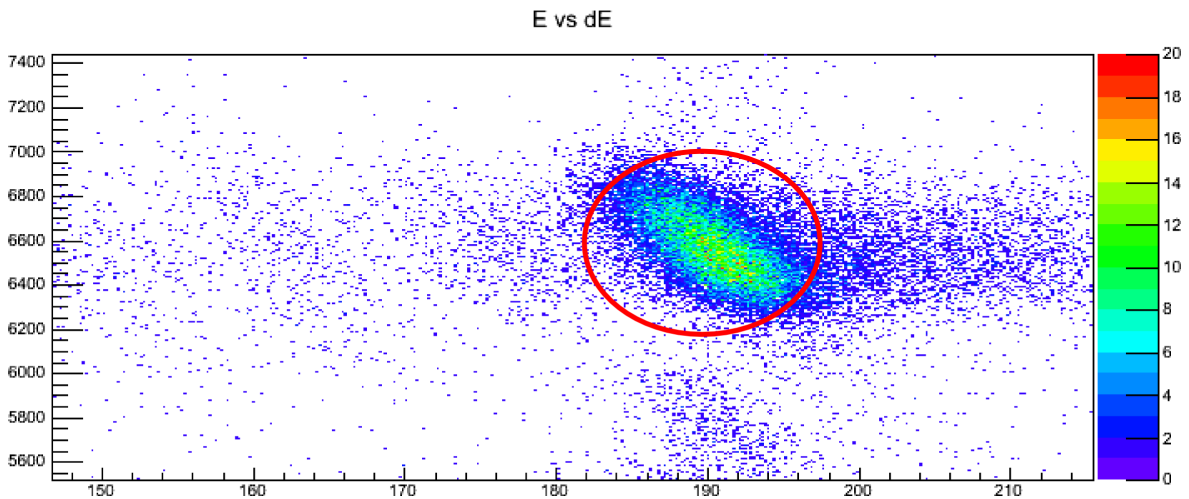
Courtesy: T. Hüyük

Production of ^{52}Fe isomer by fragmentation for isomer population



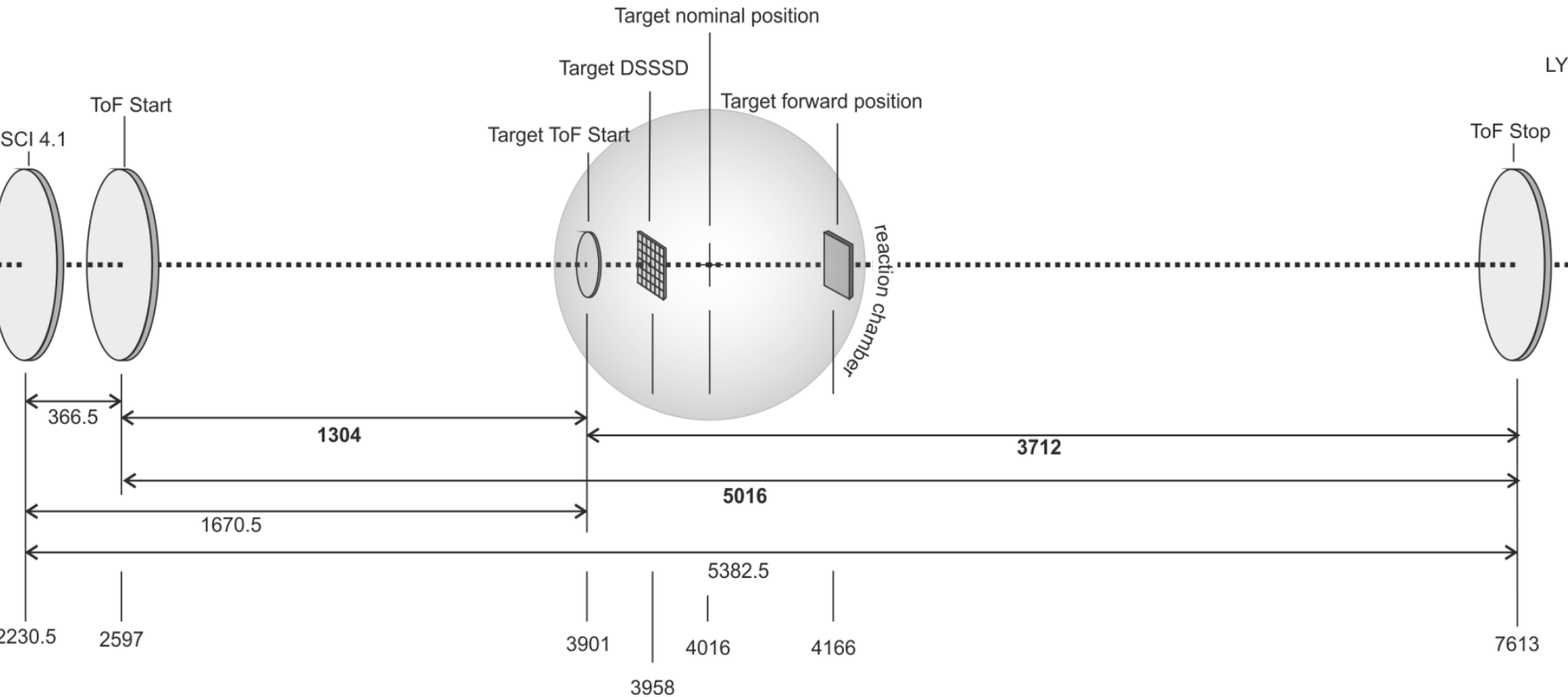
^{52}Fe

Courtesy: T. Hüyük



Courtesy: T. Hüyük

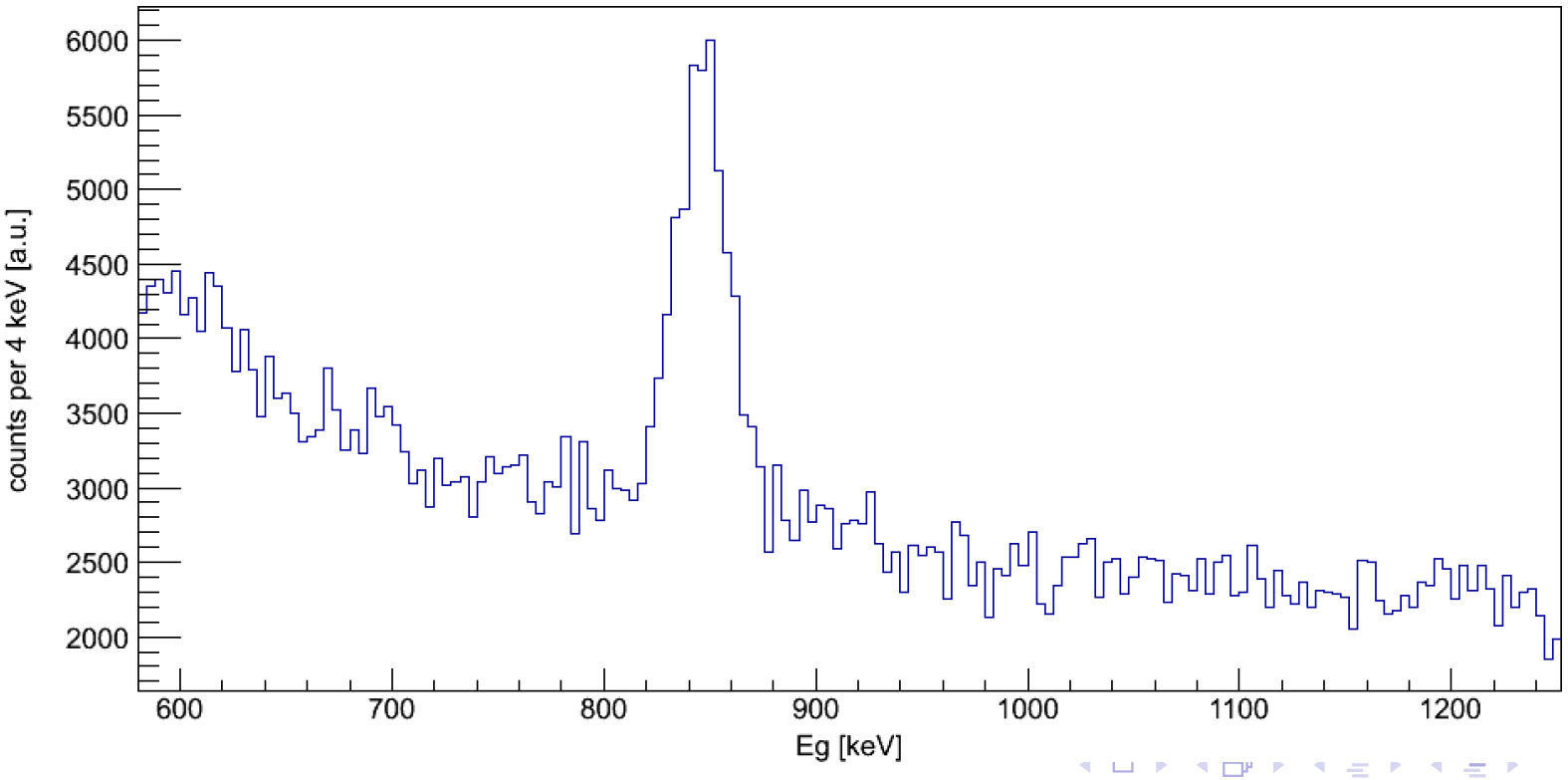
AGATA in close configuration: increase efficiency
Coulomb excitation of ^{52}Fe on ^{197}Au target



Courtesy: T. Hüyük

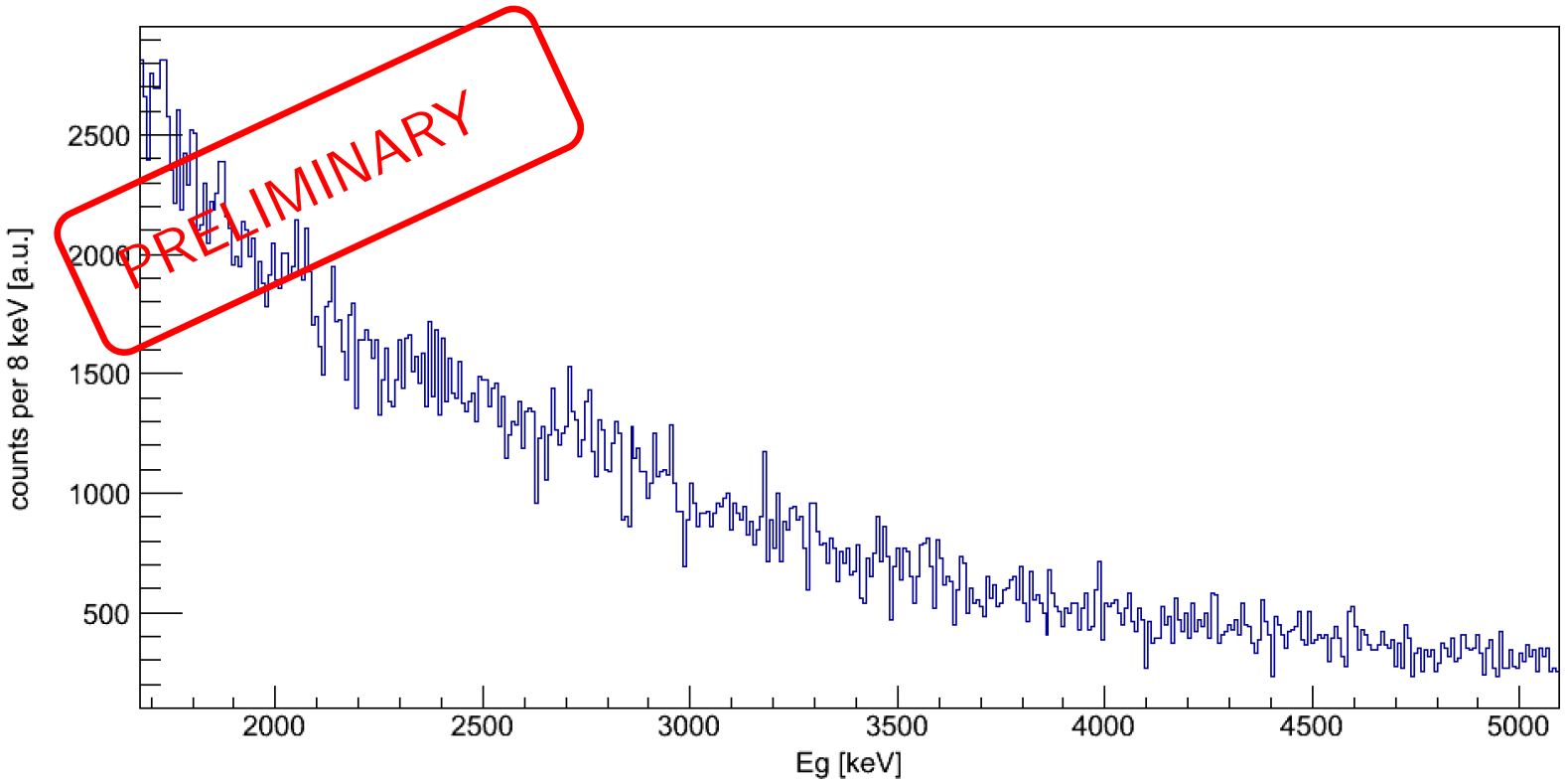
Tracked spectra of the first 2^+ of ^{52}Fe, 849.5 keV, 27keV at FWHM

20 ns particle-γ time selection, criteria for safe coulomb excitation



Courtesy: T. Hüyük

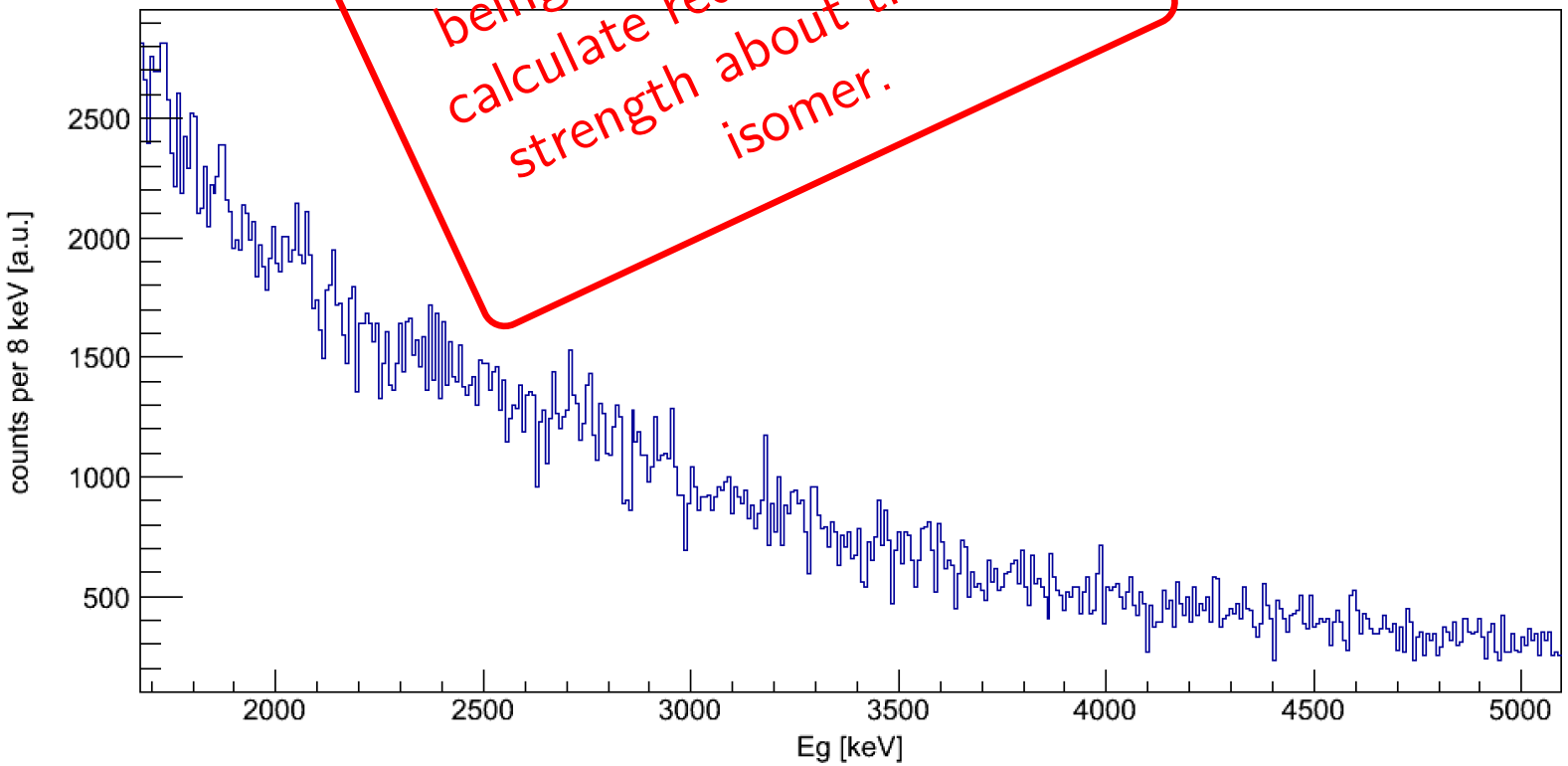
Hint of coulomb excitation above the 12^+ isomer



Courtesy: T. Hüyük

Hint of coulomb excitation above the 12^+ isomer

$B(E2; 2+ \rightarrow 0^+)$ are being calculated to later calculate reduce transition strength about the 12^+ isomer.

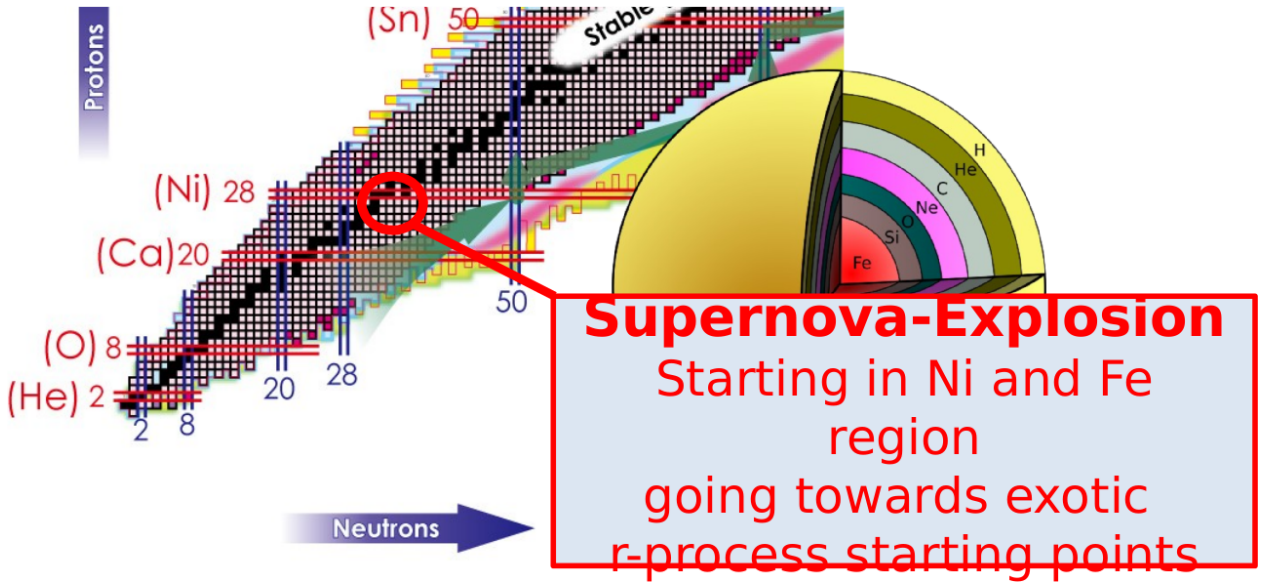


Courtesy: O. Wieland, R. Avigo

Wieland: Pygmy Dipole Resonance in ^{64}Fe and the properties of neutron skin

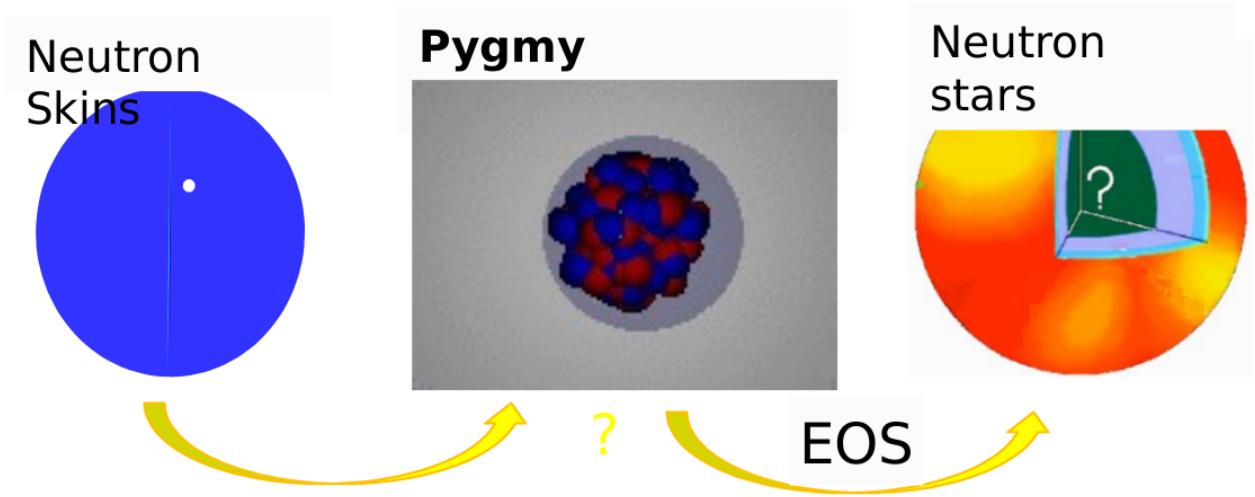
Courtesy: O. Wieland, R. Avigo

Study of nuclei toward the r-process



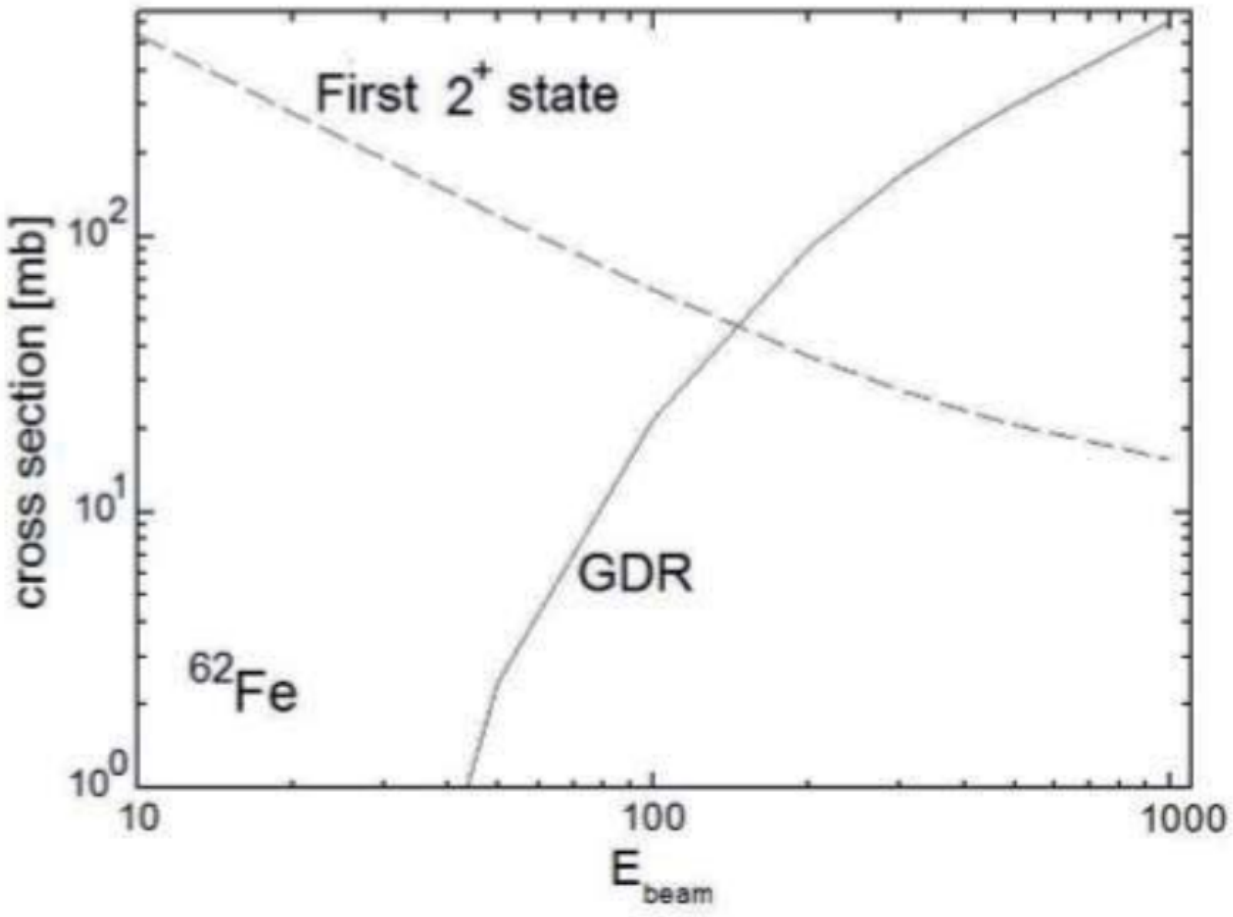
Courtesy: O. Wieland, R. Avigo

Study of the dipole strength



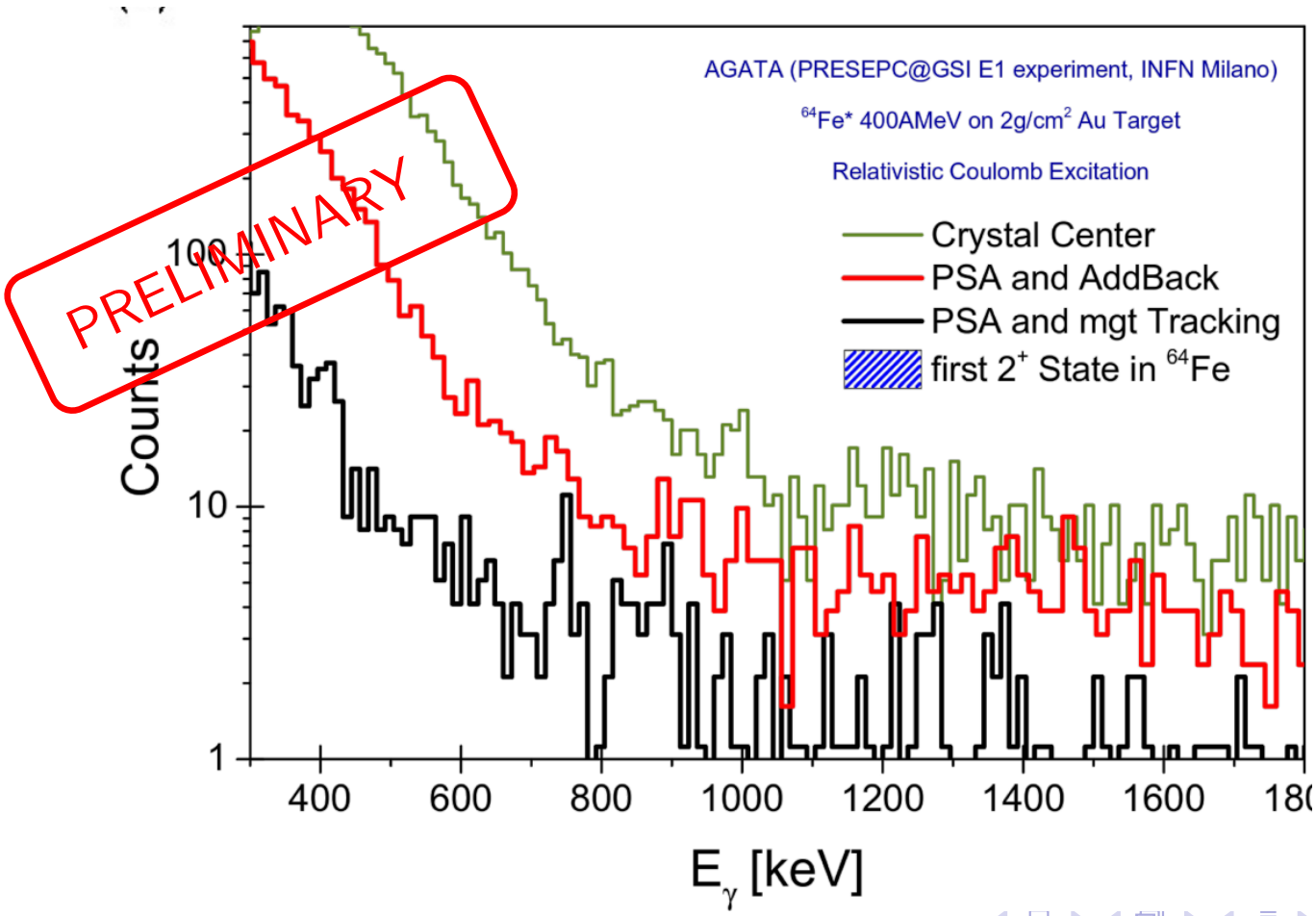
Courtesy: O. Wieland, R. Avigo

Access the dipole strength via relativistic coulomb excitation ($\beta \sim 0.7$)



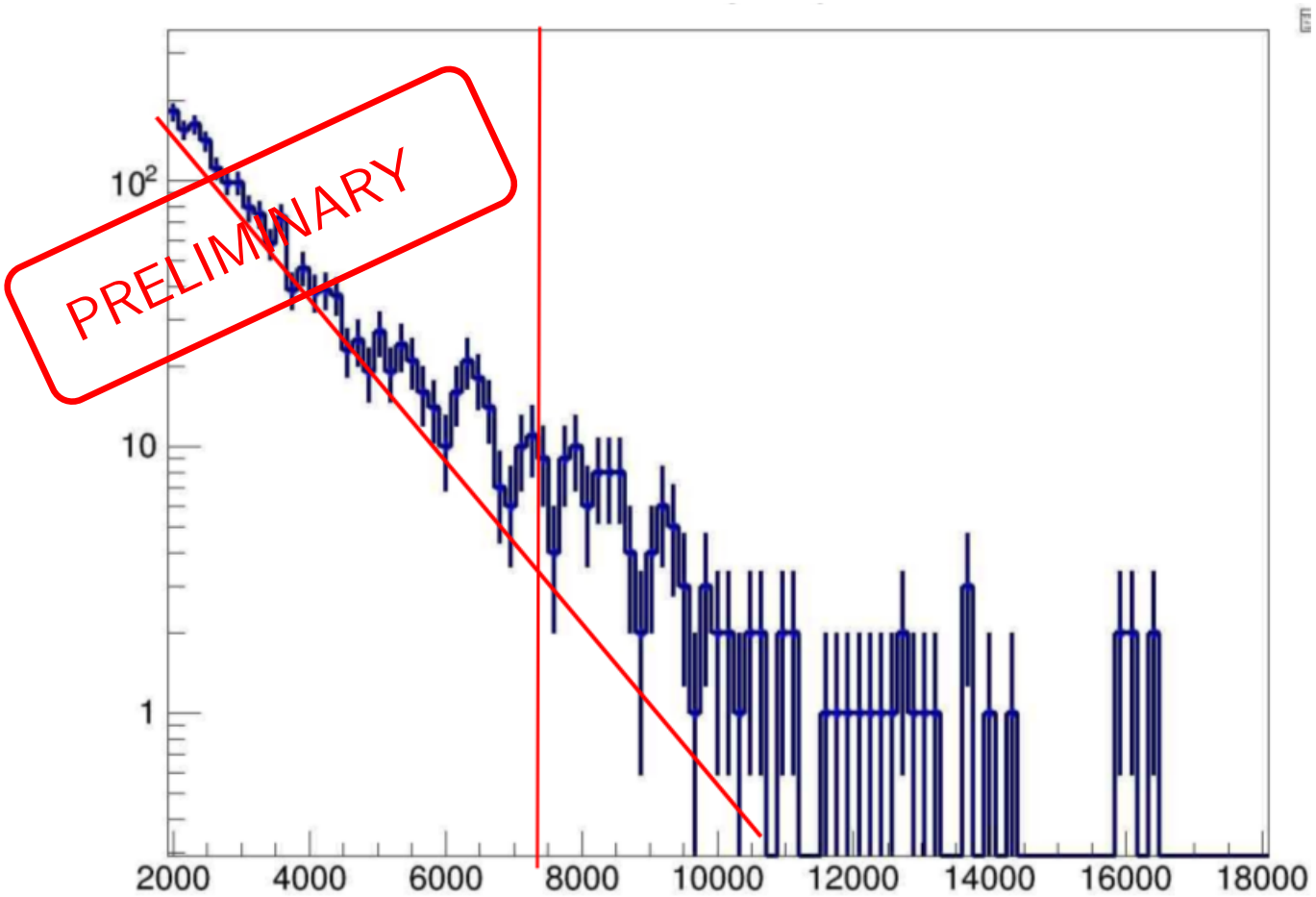
Courtesy: O. Wieland, R. Avigo

Observation of the 2^+ of ^{64}Fe: Essential for normalisation



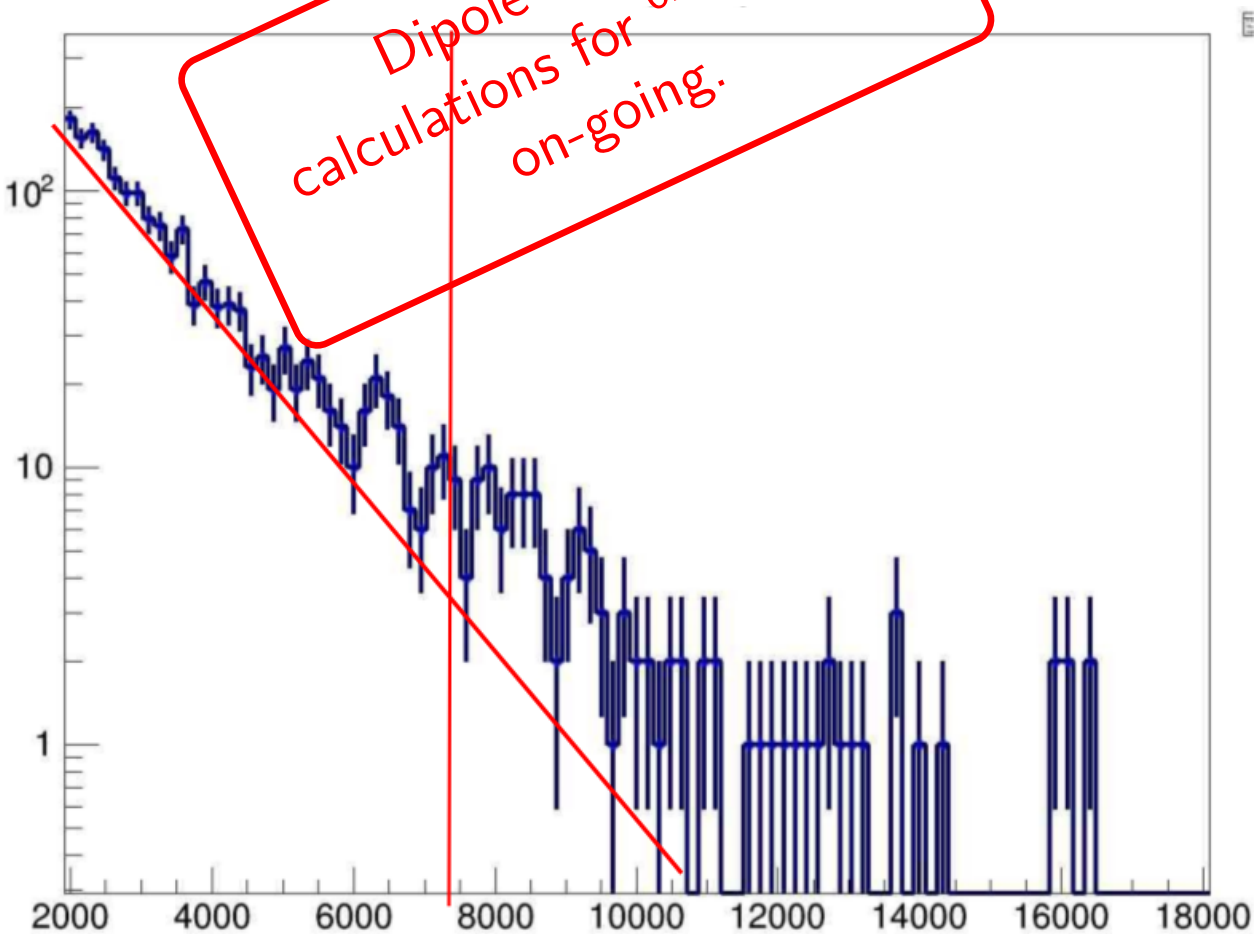
Courtesy: O. Wieland, R. Avigo

High energy structure observed with AGATA



Courtesy: O. Wieland, R. Avigo

High energy structure observed with AGATA

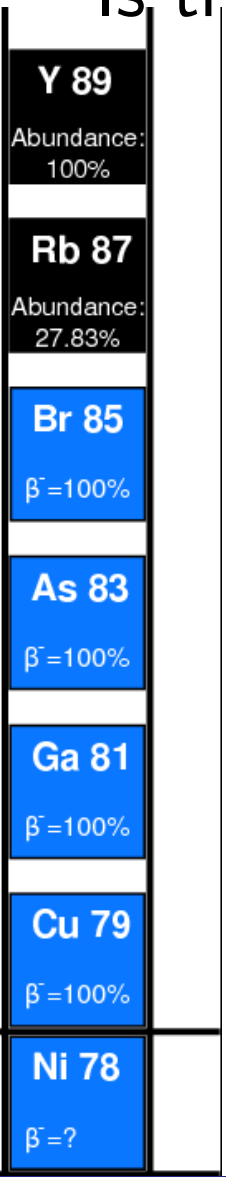


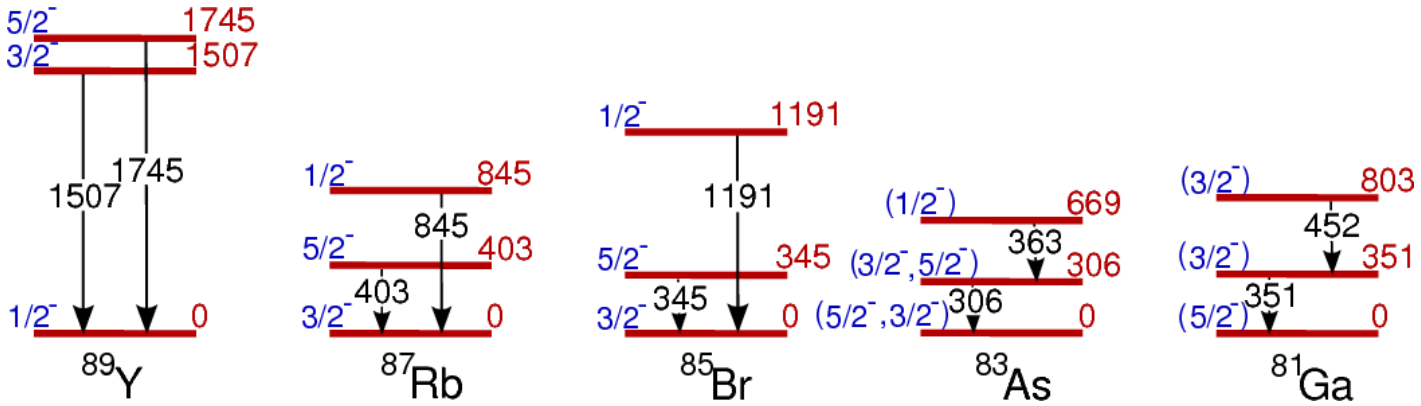
Courtesy: M. Lettmann

Pietralla: Relativistic M1 excitation of ^{85}Br

Courtesy: M. Lettmann

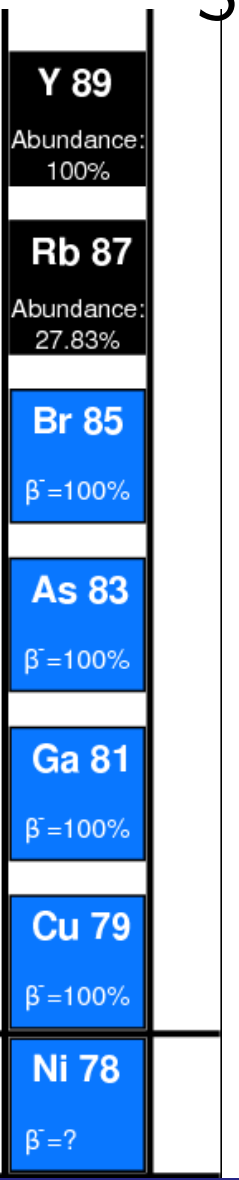
Is the $1/2^-$ state in ^{85}Br a $\pi p_{3/2}$ single particle state?

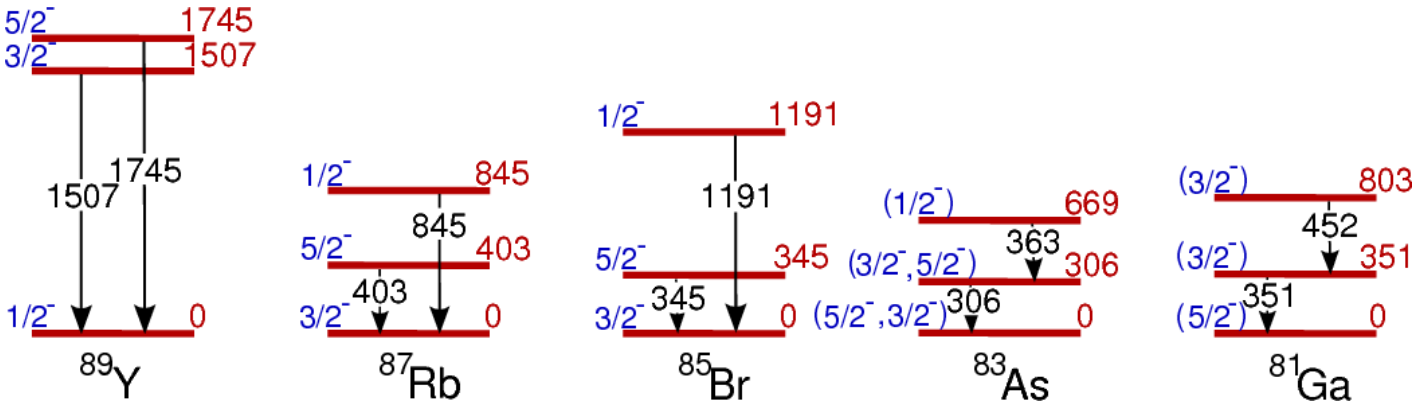


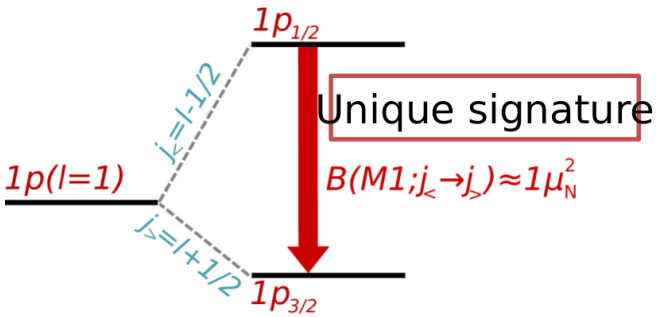


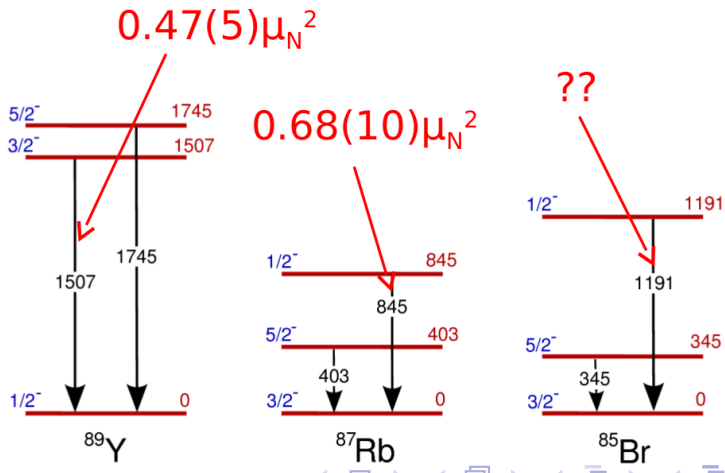
Courtesy: M. Lettmann

Signature of the decay: $B(M1; j_> \rightarrow j_>) \approx 1\mu_N$



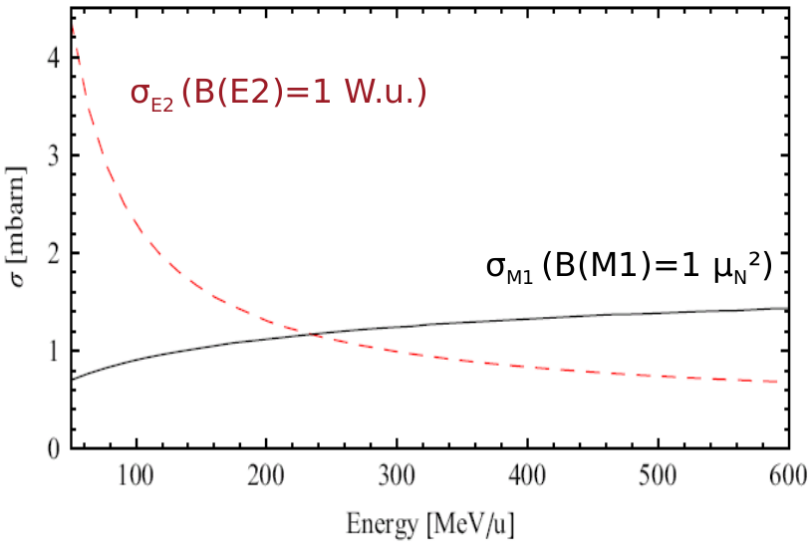


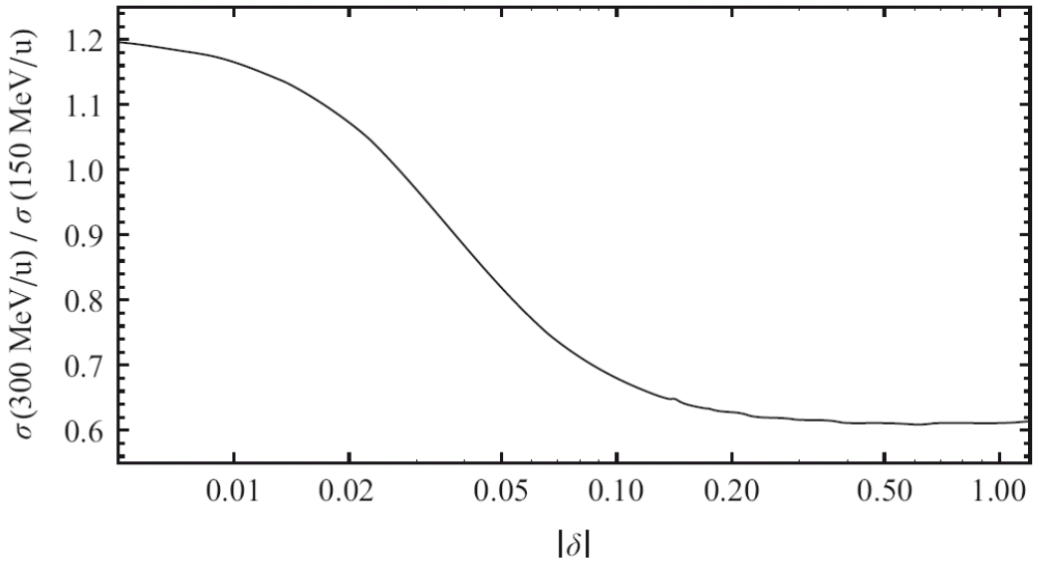




Courtesy: M. Lettmann

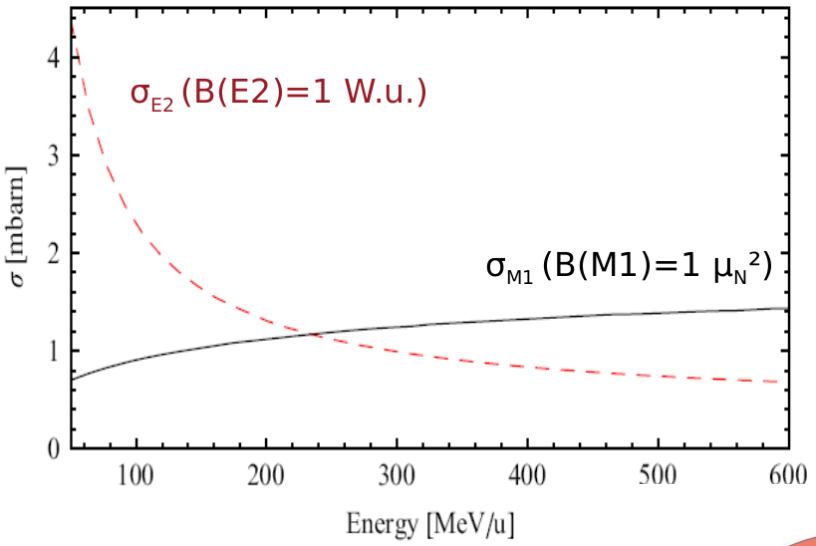
Measure the mixing ratio: coulomb excitation with 2 beam energies

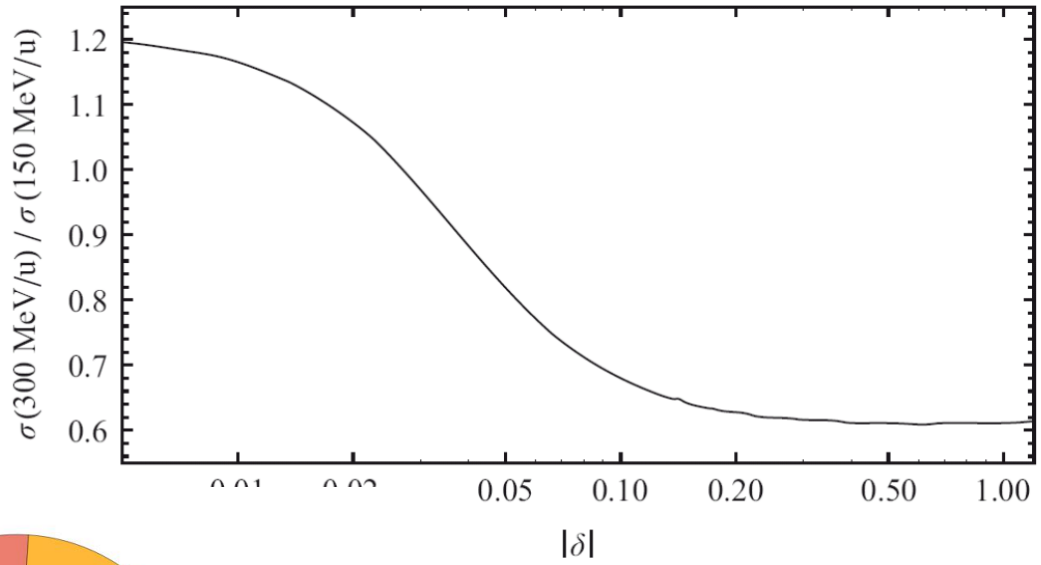


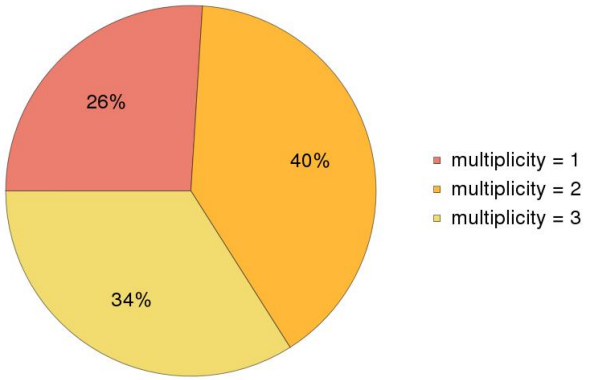


Courtesy: M. Lettmann

Measure the mixing ratio: coulomb excitation with 2 beam energies Need high count rate, but pure beam from FRS

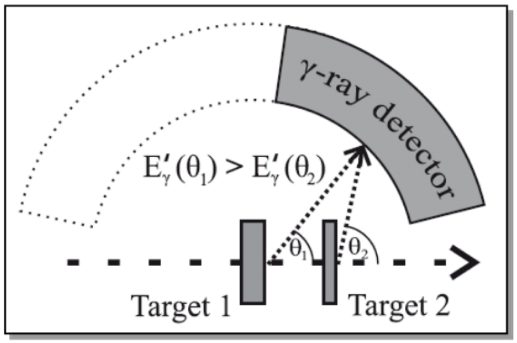


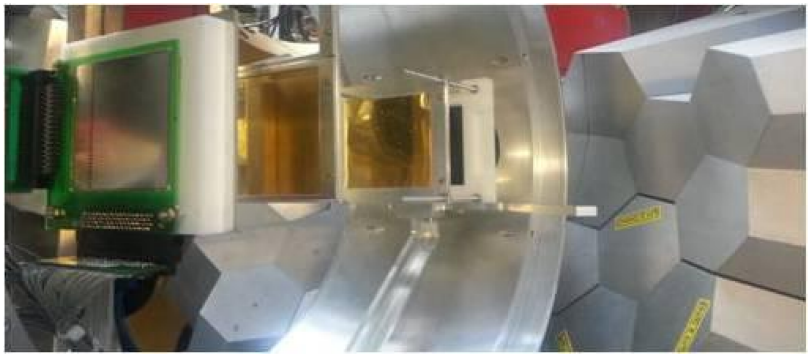




Courtesy: M. Lettmann

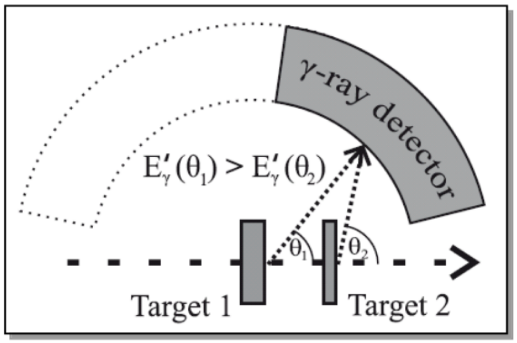
Installation of 2 targets in the reaction chambers

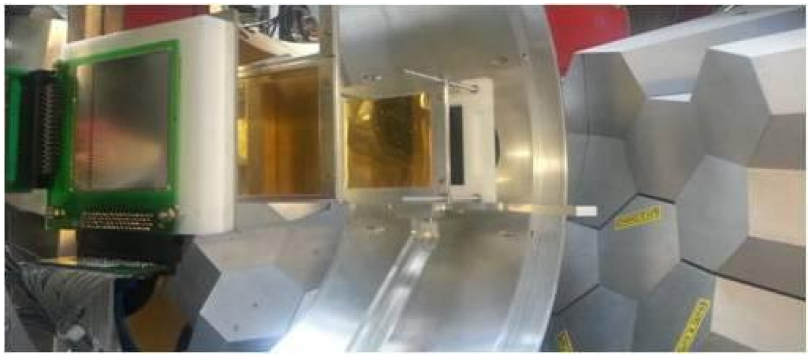


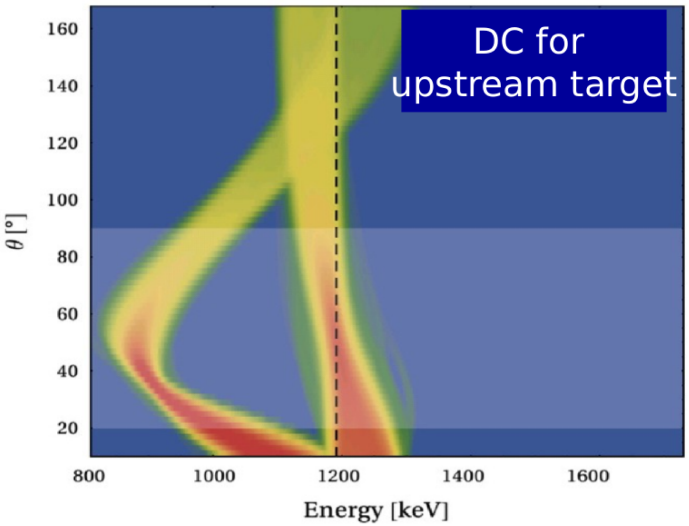


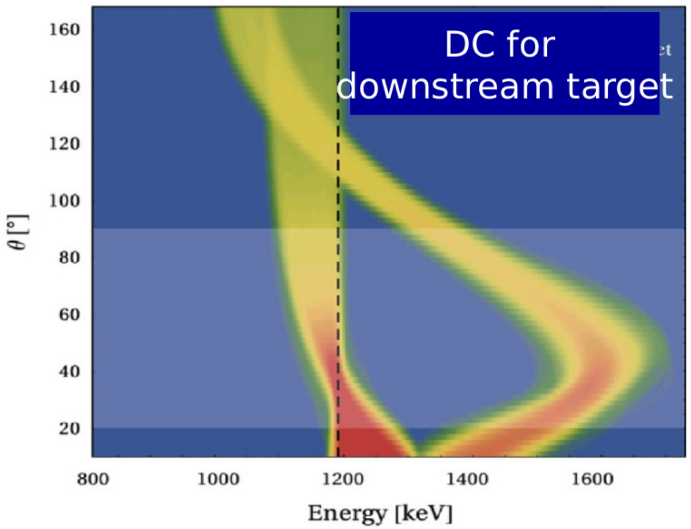
Courtesy: M. Lettmann

AGATA resolution used to disentangle the excitation from two targets



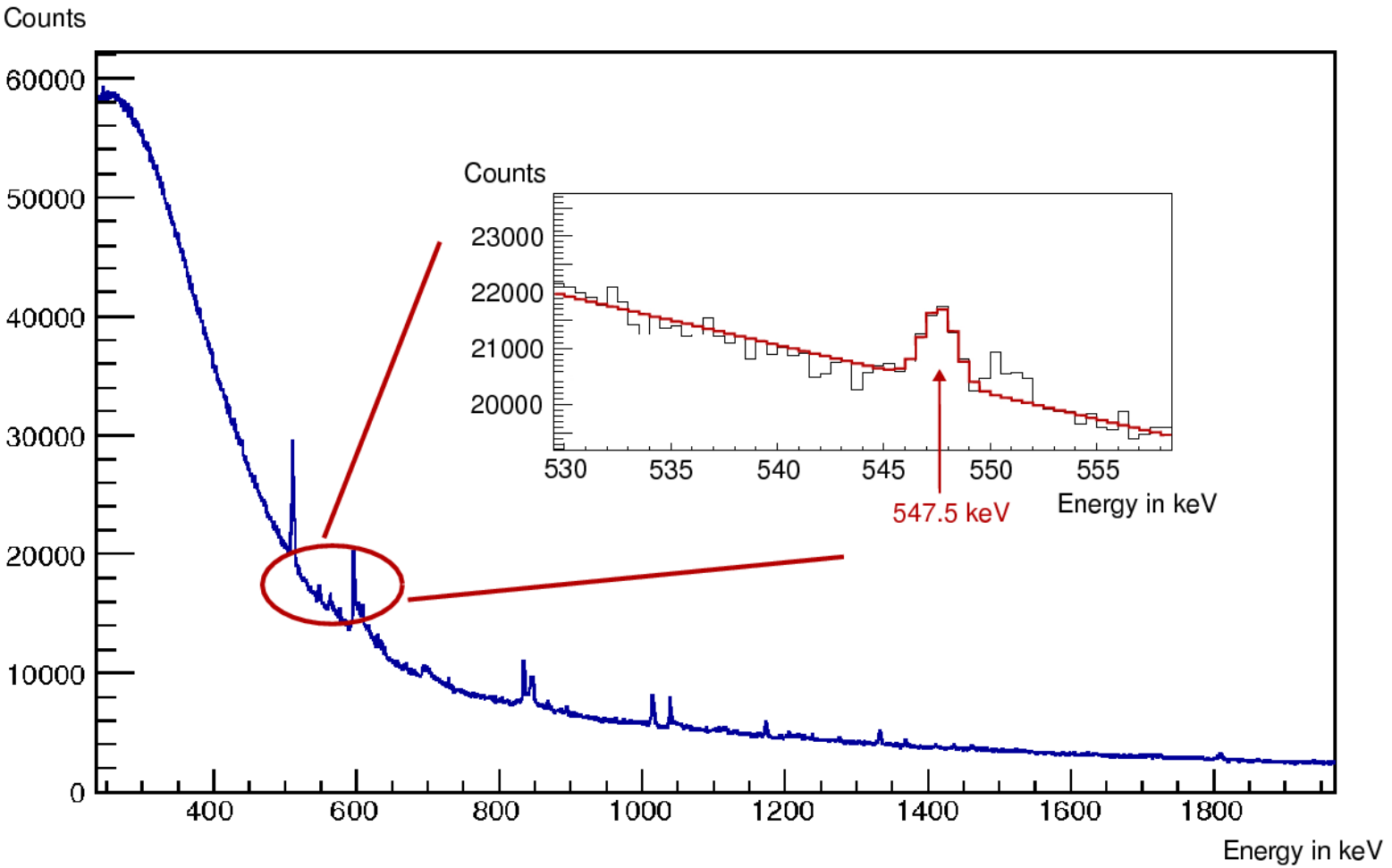






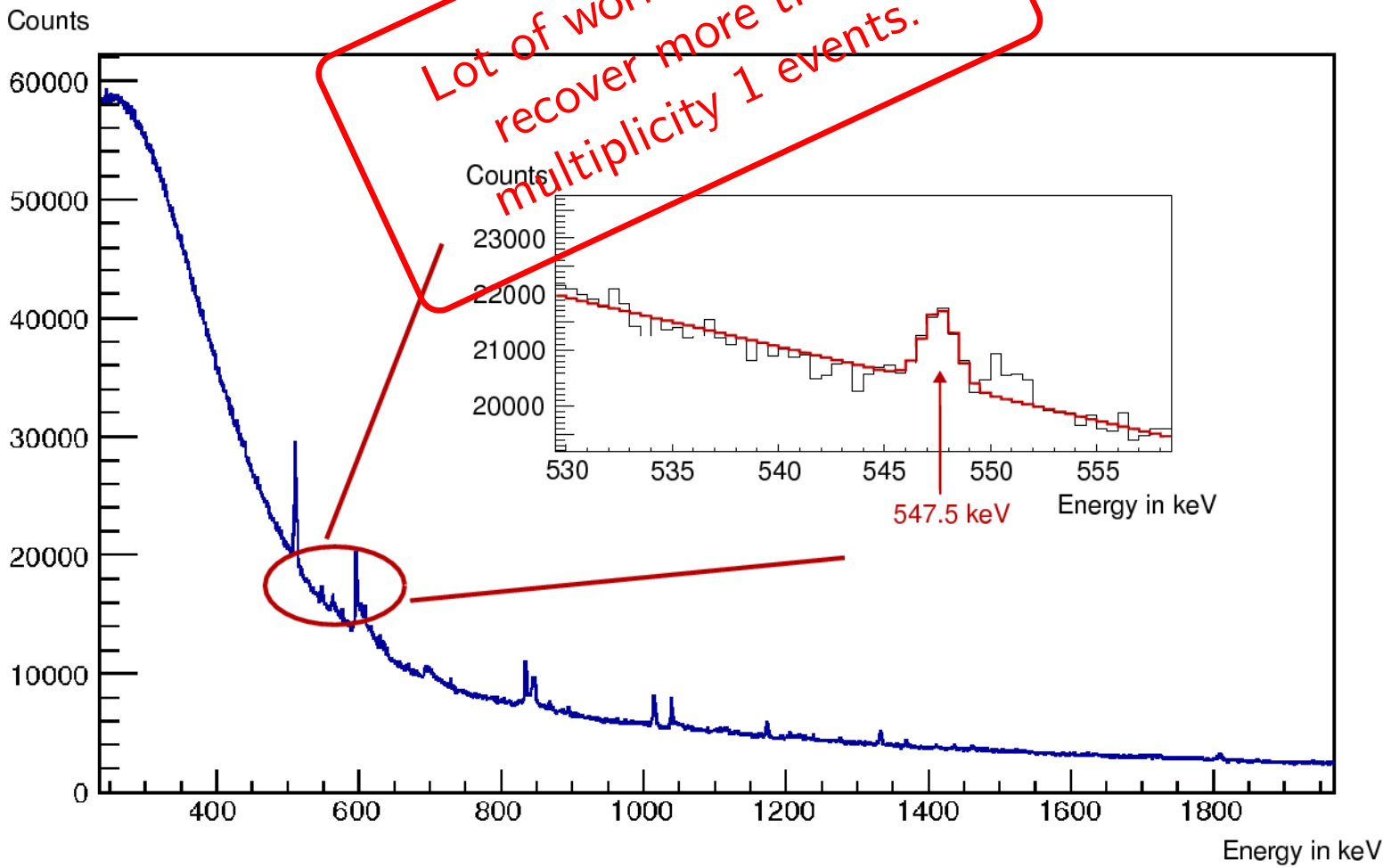
Courtesy: M. Lettmann

See target excitation with multiplicity 1 events



Courtesy: M. Lettmann

See target excitation with multiplicity 1 events

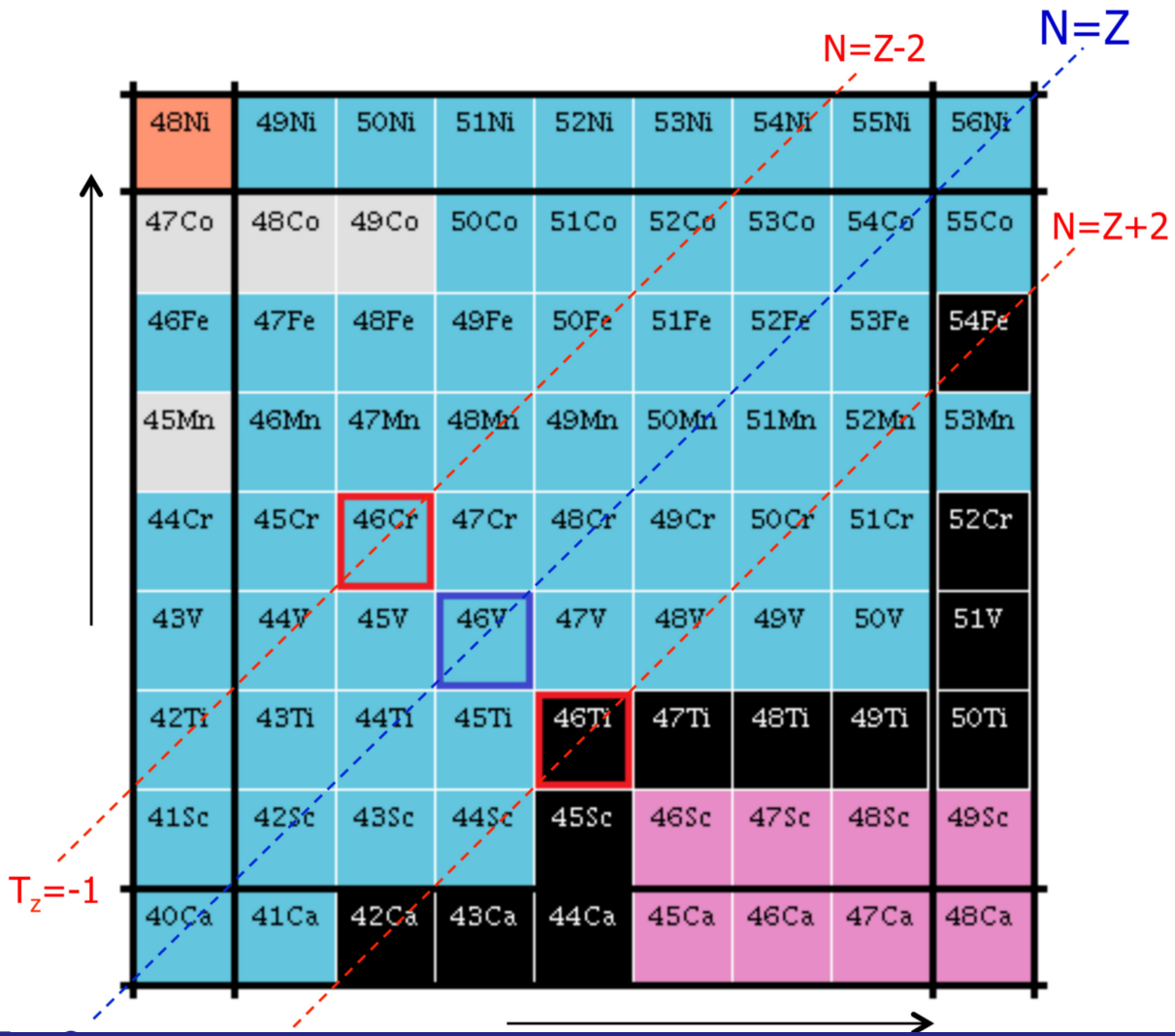


Courtesy: A. Boso, S. Milne, M. Bentley

Recchia/Bentley: Transition rates and mirror energy differences in isobaric multiplets

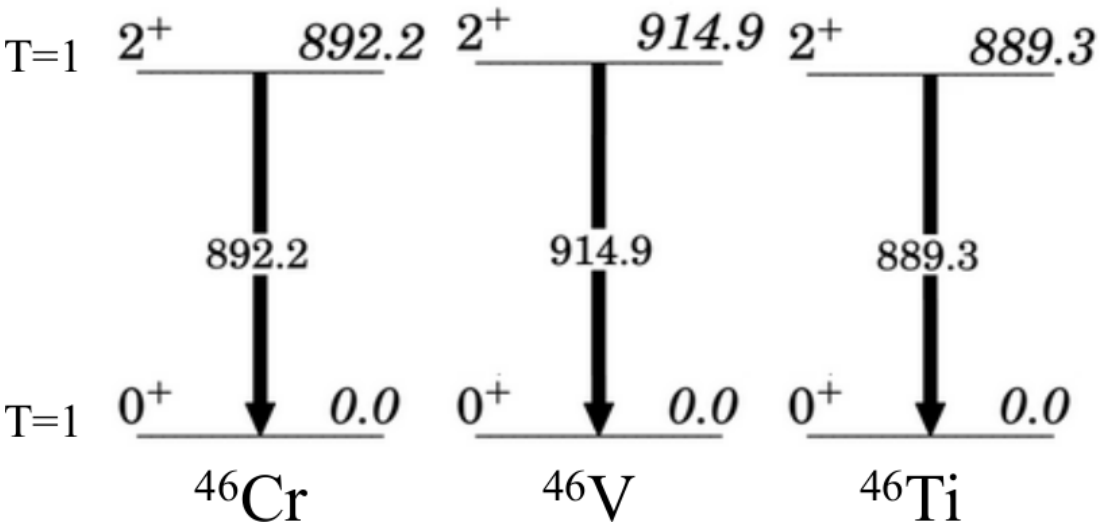
Courtesy: A. Boso, S. Milne, M. Bentley

Isospin triplet $A = 46$



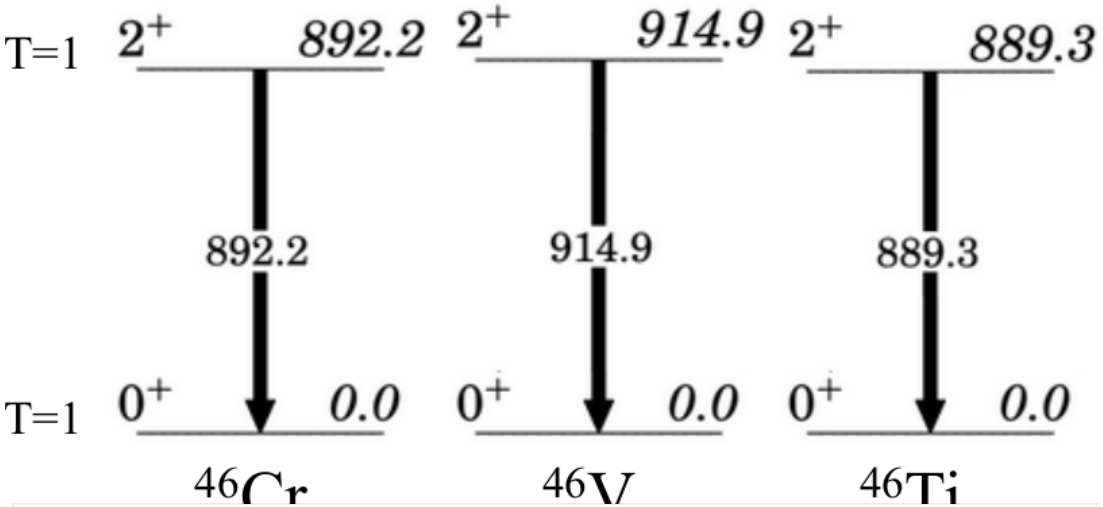
Courtesy: A. Boso, S. Milne, M. Bentley

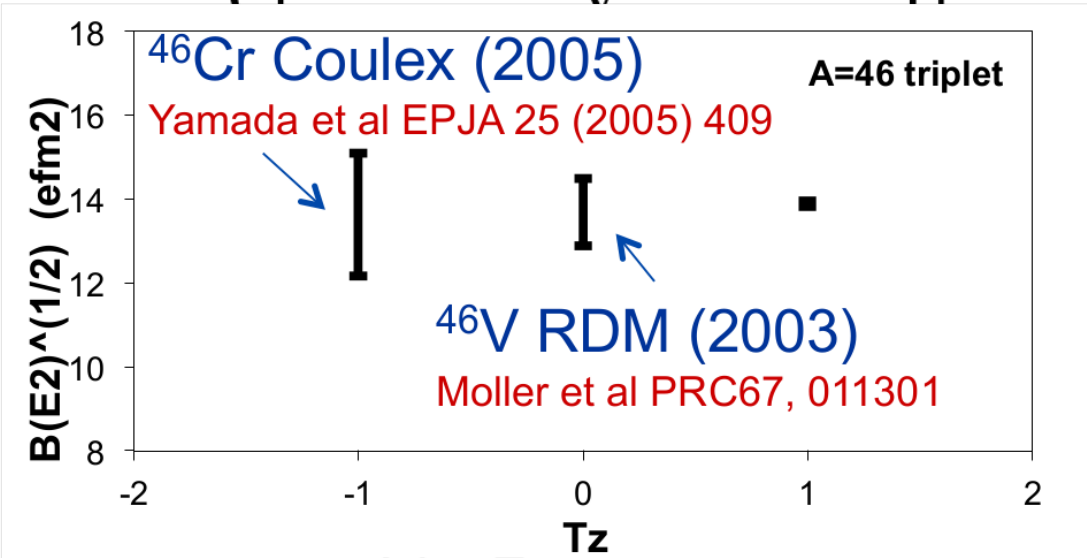
First 2^+ energy are similar in the $A = 46$ isospin triplet



Courtesy: A. Boso, S. Milne, M. Bentley

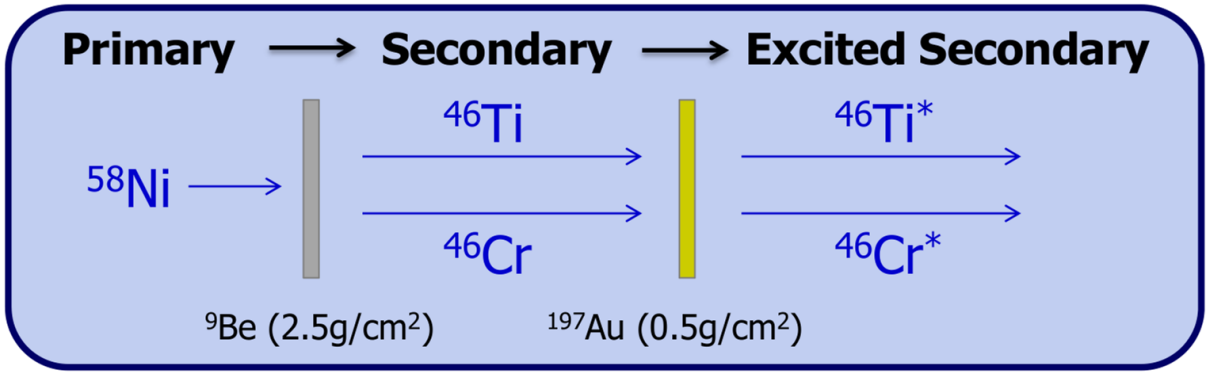
$B(E2; 2^+ \rightarrow 0^+)$ measurement with large error
Not clear if there is a linear dependence





Courtesy: A. Boso, S. Milne, M. Bentley

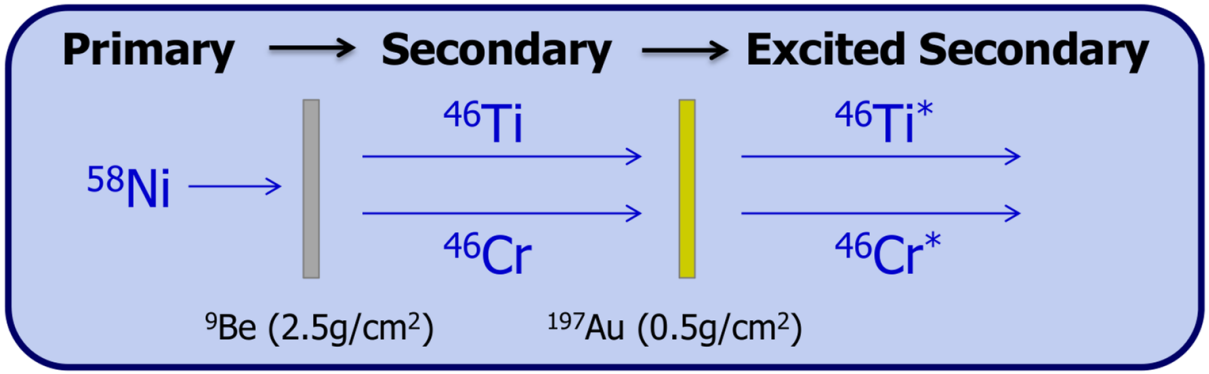
$B(E2; 2^+ \rightarrow 0^+)$ measurement with same conditions



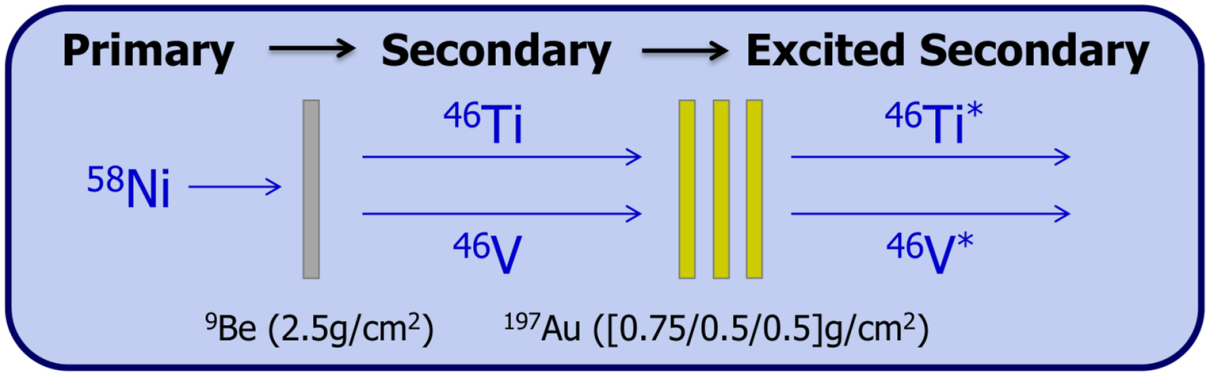
Coulex:
Cross section

Courtesy: A. Boso, S. Milne, M. Bentley

$B(E2; 2^+ \rightarrow 0^+)$ measurement with same conditions



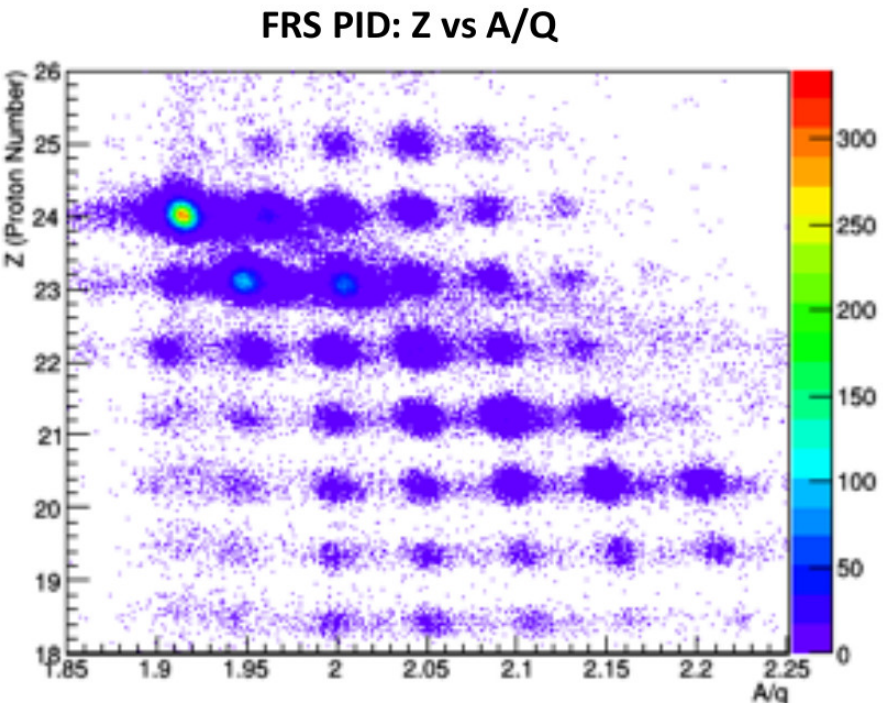
Coulex:
Cross section

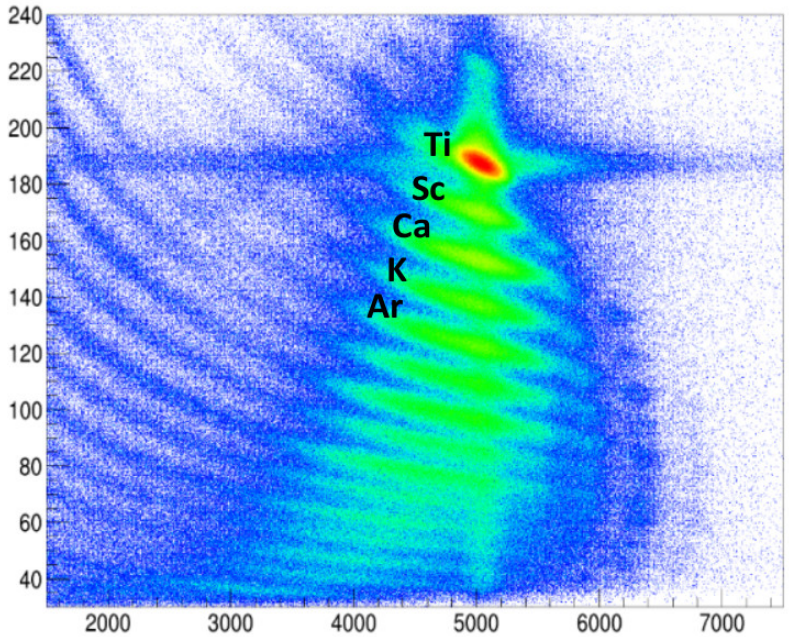


TCP:
Lifetime

Courtesy: A. Boso, S. Milne, M. Bentley

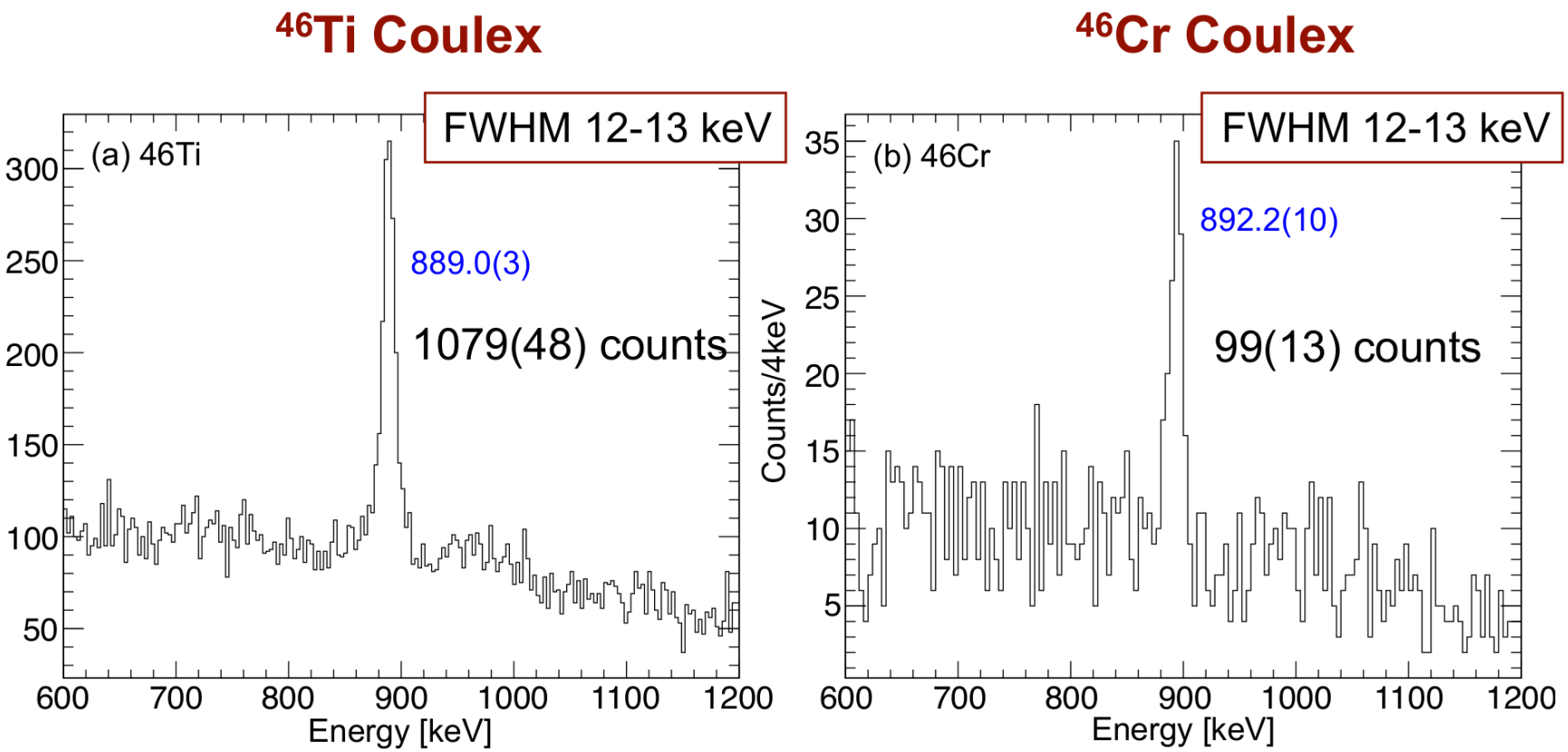
Fragmentation of ^{58}Ni at 600 MeV/A





Courtesy: A. Boso, S. Milne, M. Bentley

γ-ray spectra obtained after safe coulomb excitation criteria

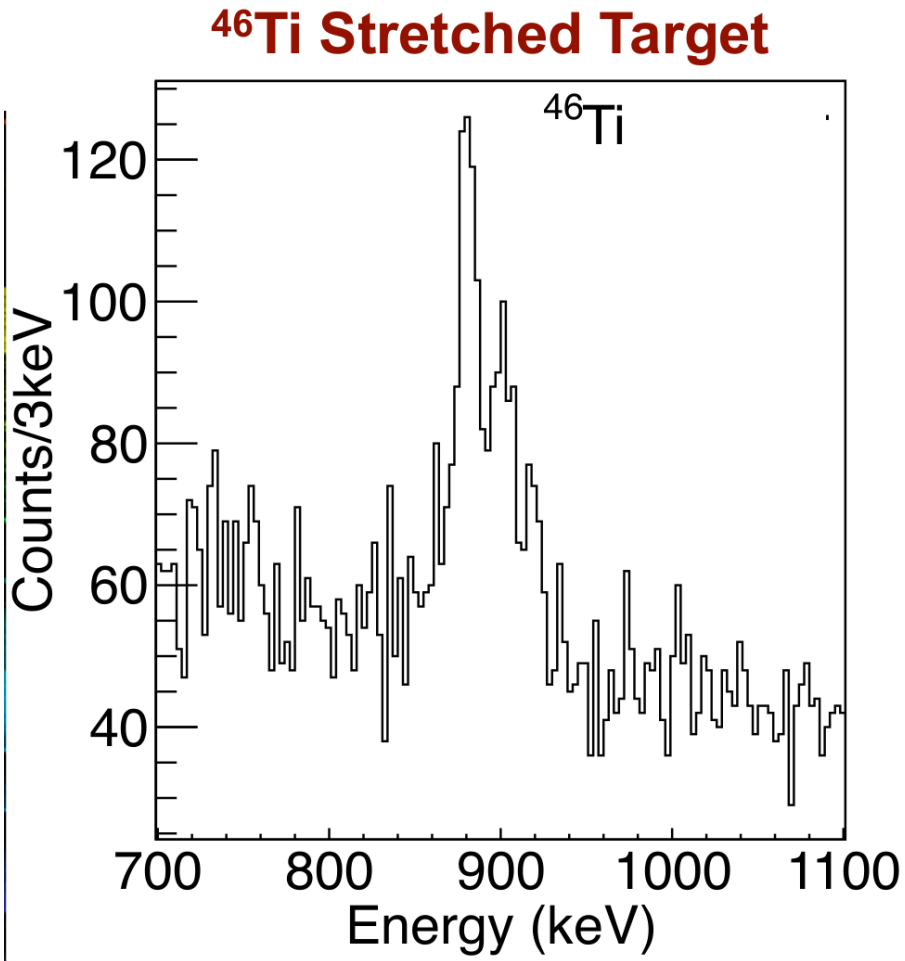


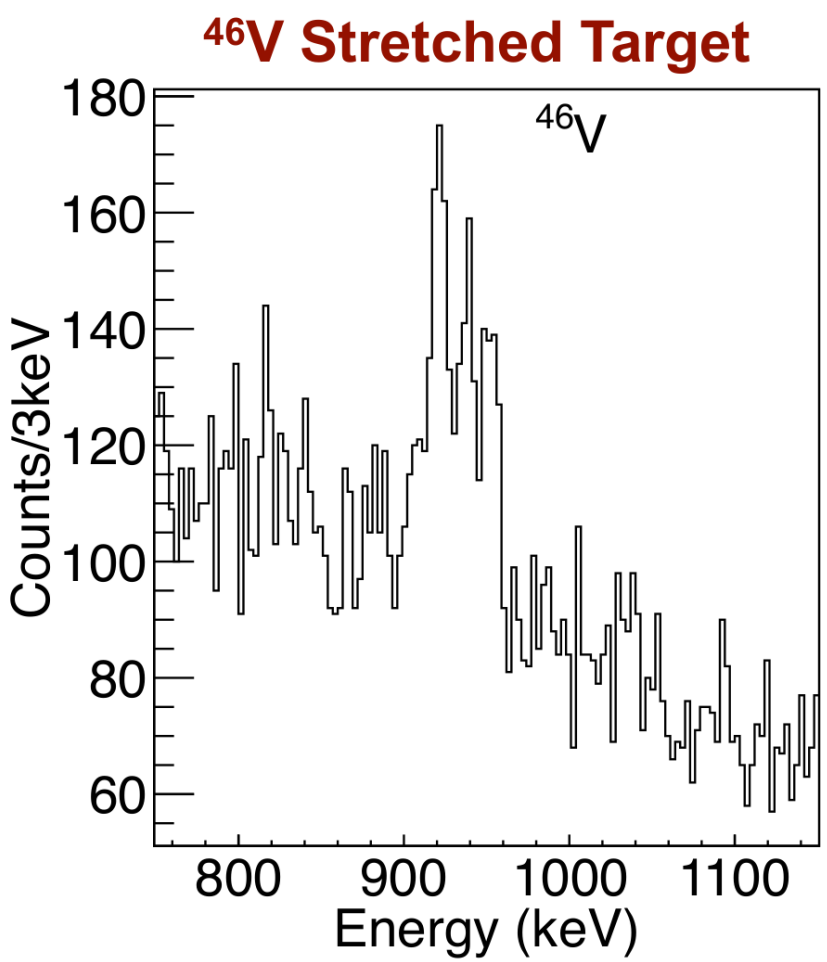
^{46}Cr-^{46}V-^{46}Ti

Courtesy: A. Boso, S. Milne, M. Bentley

γ-ray spectra obtained after safe coulomb excitation criteria

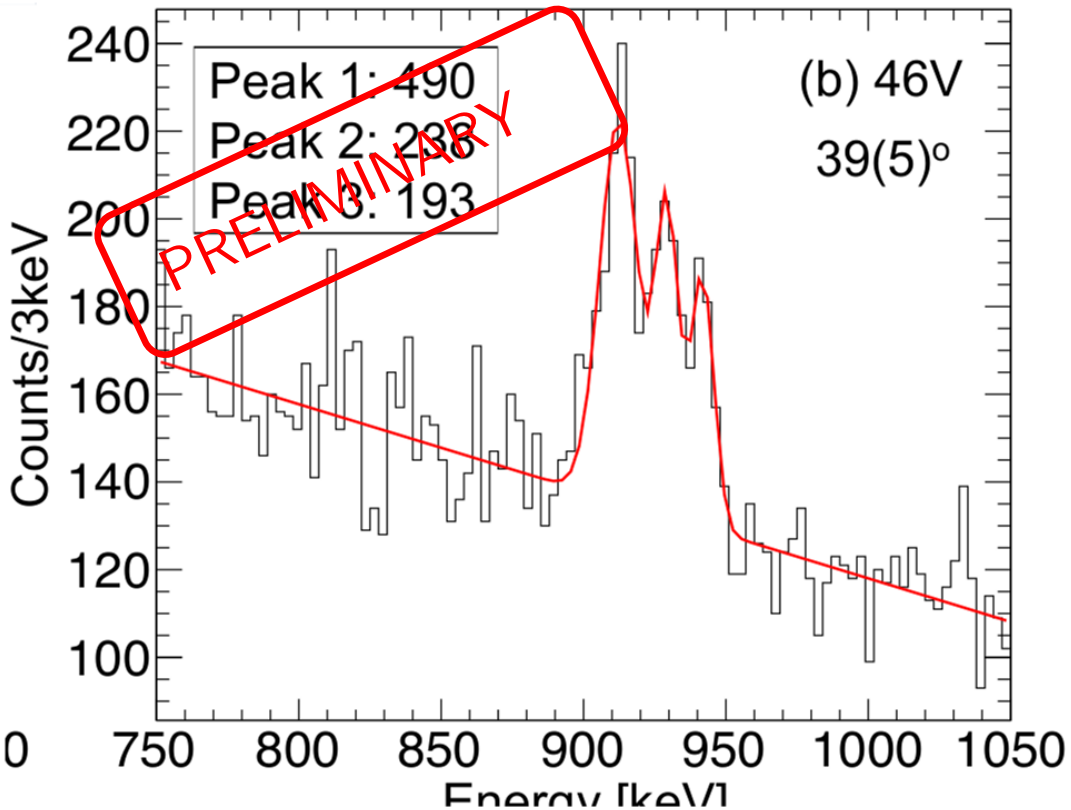
With the triple target stack nice separation between the components





Courtesy: A. Boso, S. Milne, M. Bentley

Estimation with a "plunger" type analysis

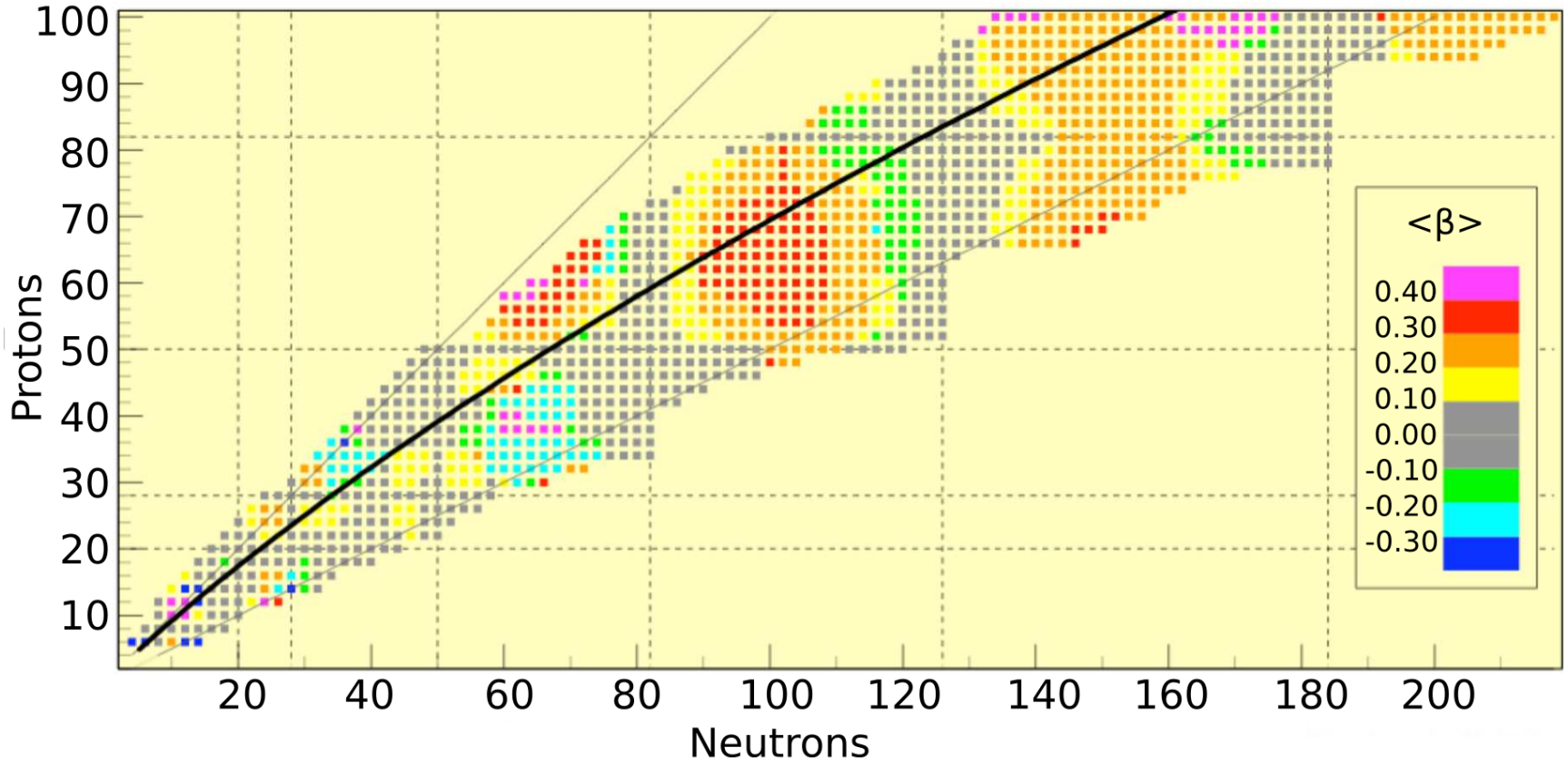


Estimate of half life from basic simulation:
5.3(4) ps
Literature:
4.7(6) ps

Pietri: Shape evolution in neutron-rich Zr

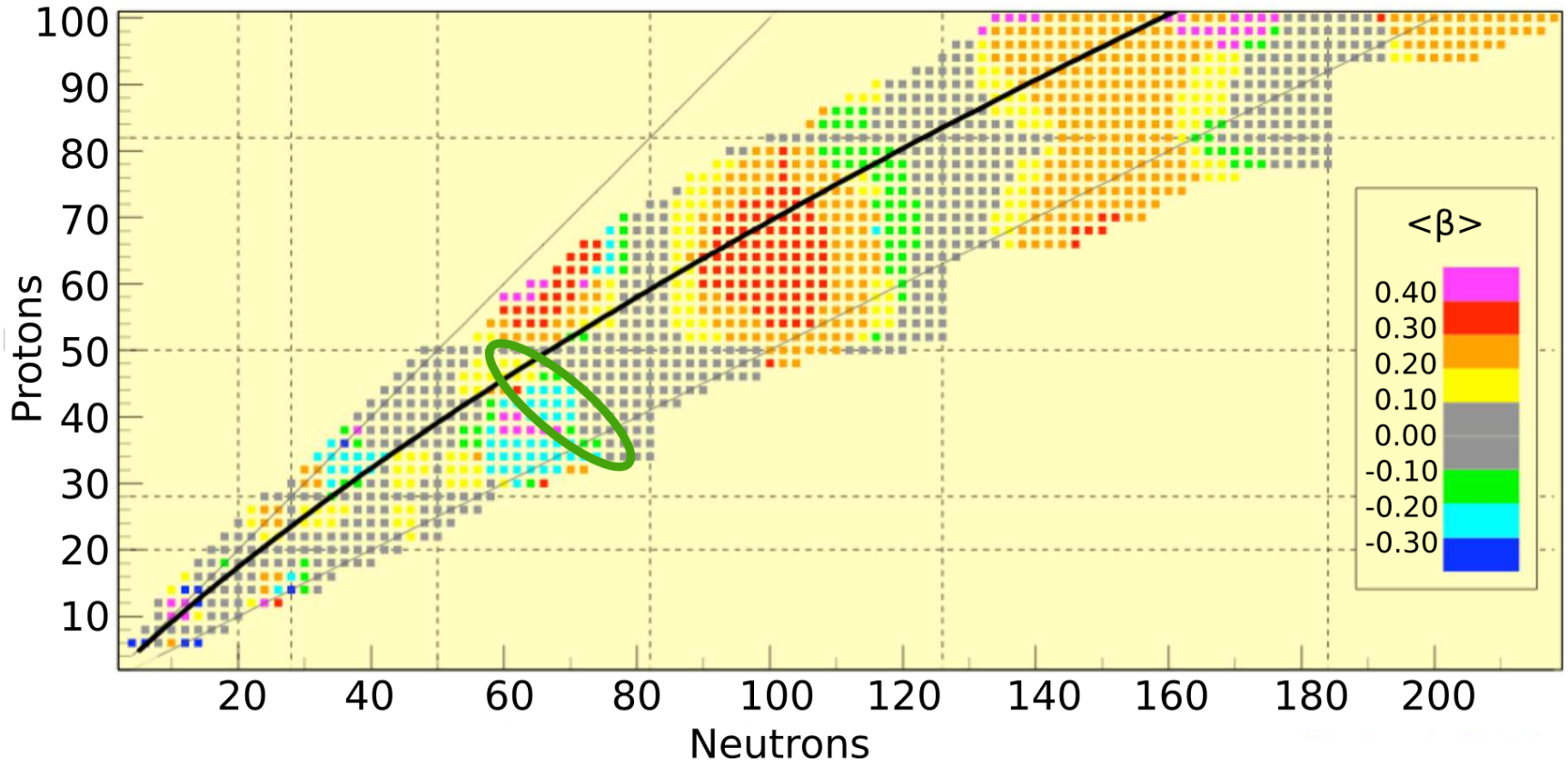
Hartree-Fock-Bogoliubov shape predictions

J.P. Delaroche, Phys. Rev. C 81:014303 (2010)

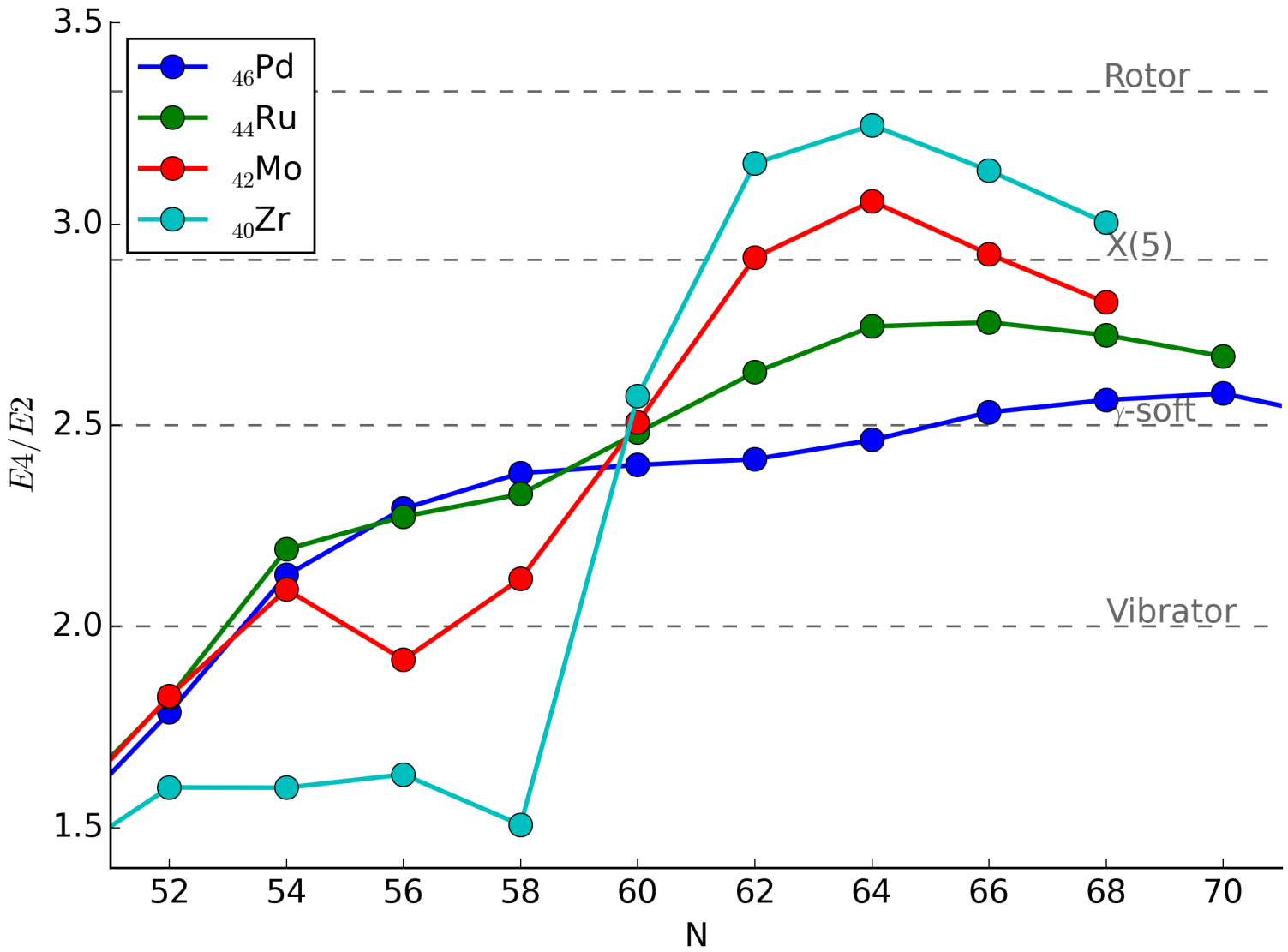


$^{100-108}$Mo, $^{98-106}$Zr

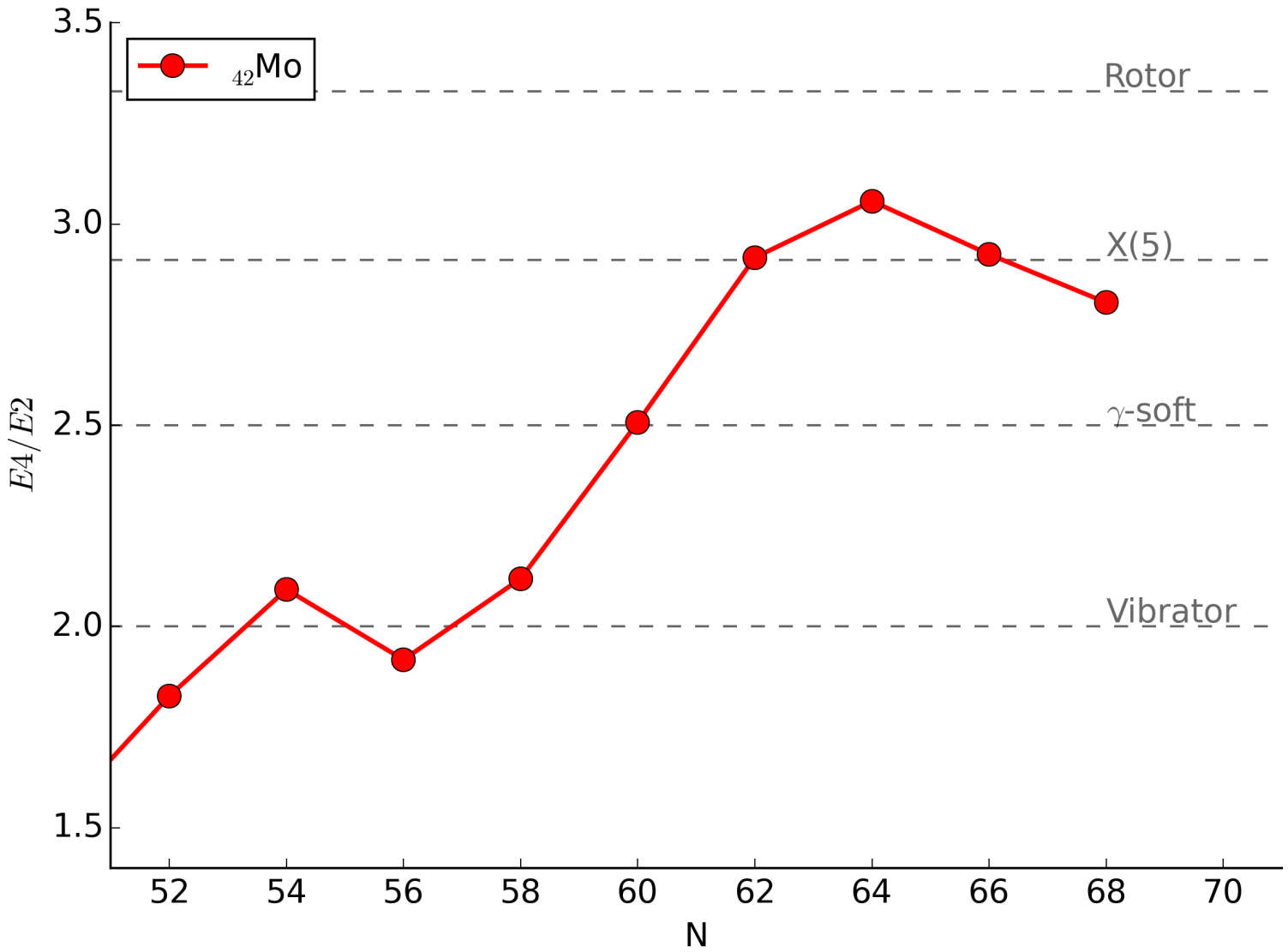
J.P. Delaroche, Phys. Rev. C 81:014303 (2010)



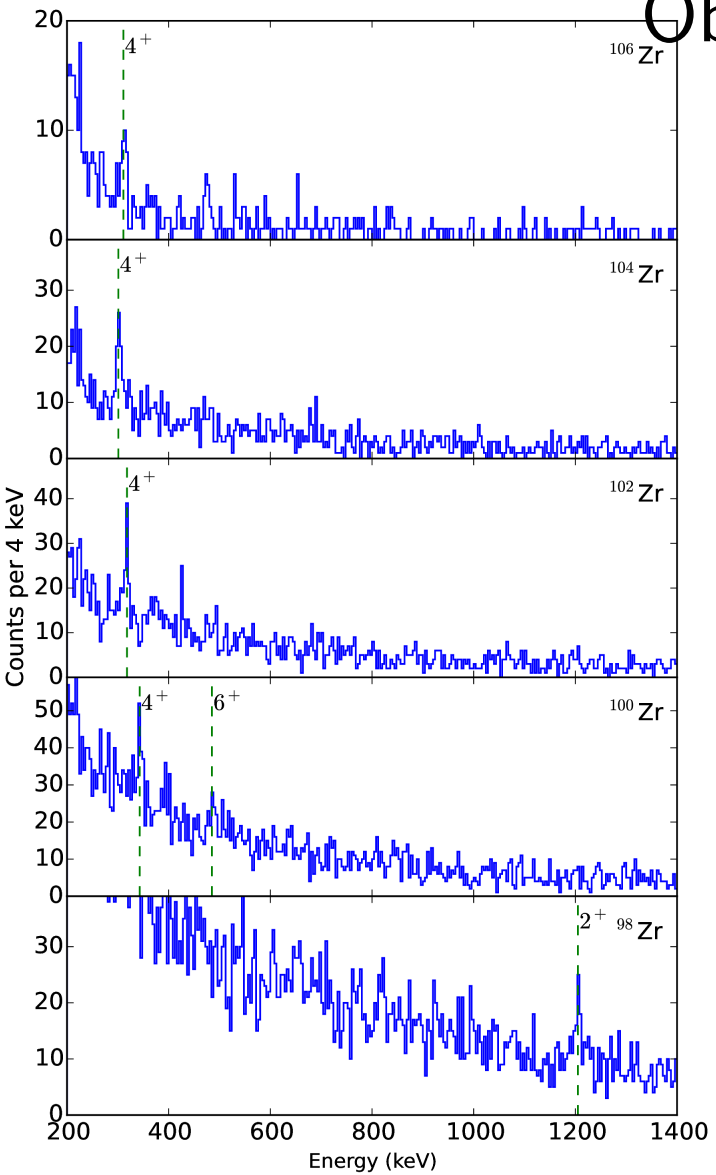
$^{100-108}$Mo, $^{98-106}$Zr



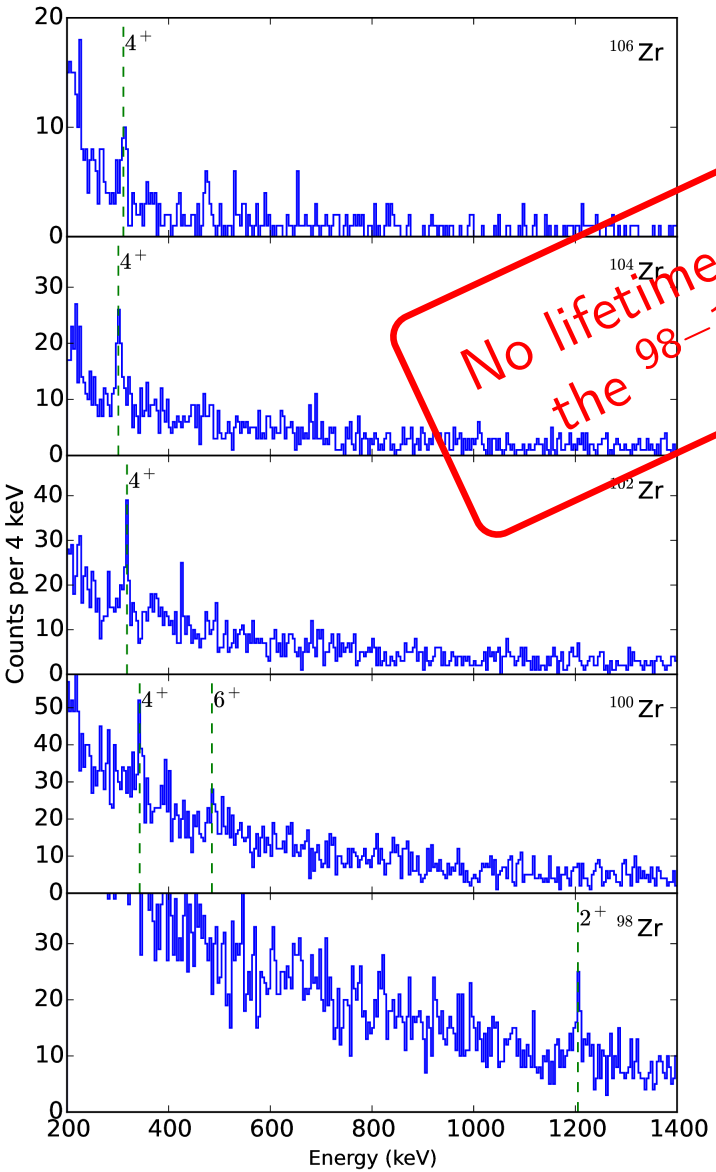
$^{100-108}$Mo, $^{98-106}$Zr



Observed transition in $^{98-106}$Zr



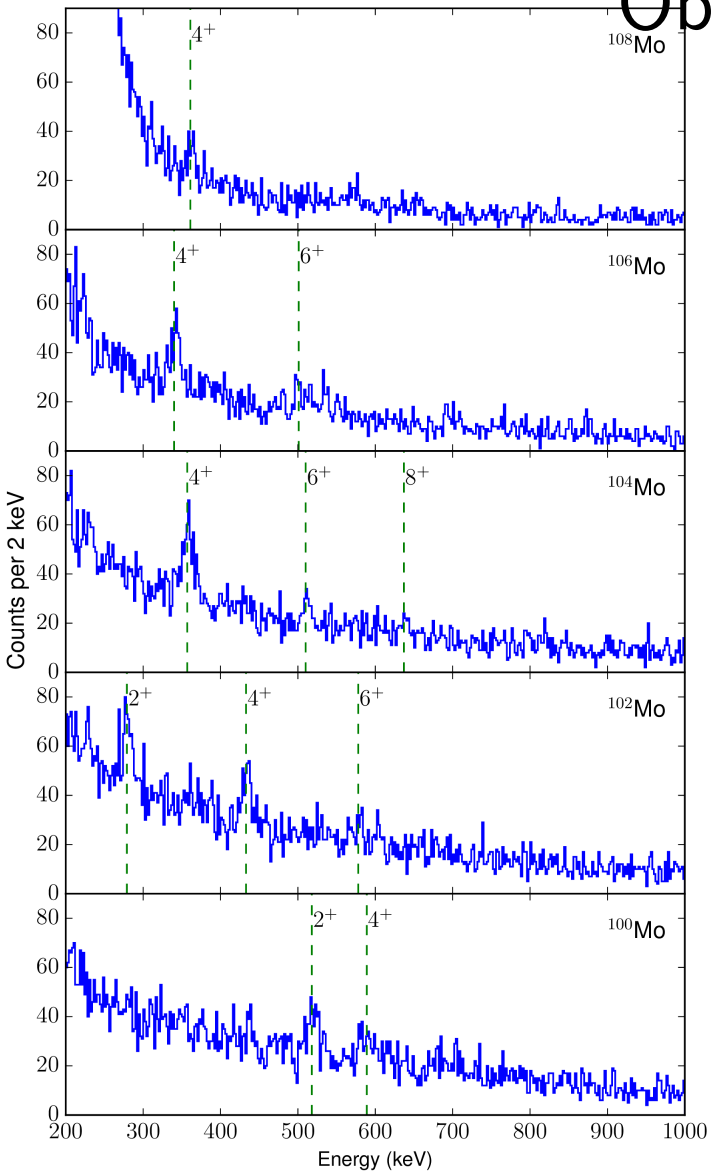
$^{100-108}$Mo, $^{98-106}$Zr



No lifetime determined for the $^{98-106}$Zr isotopes

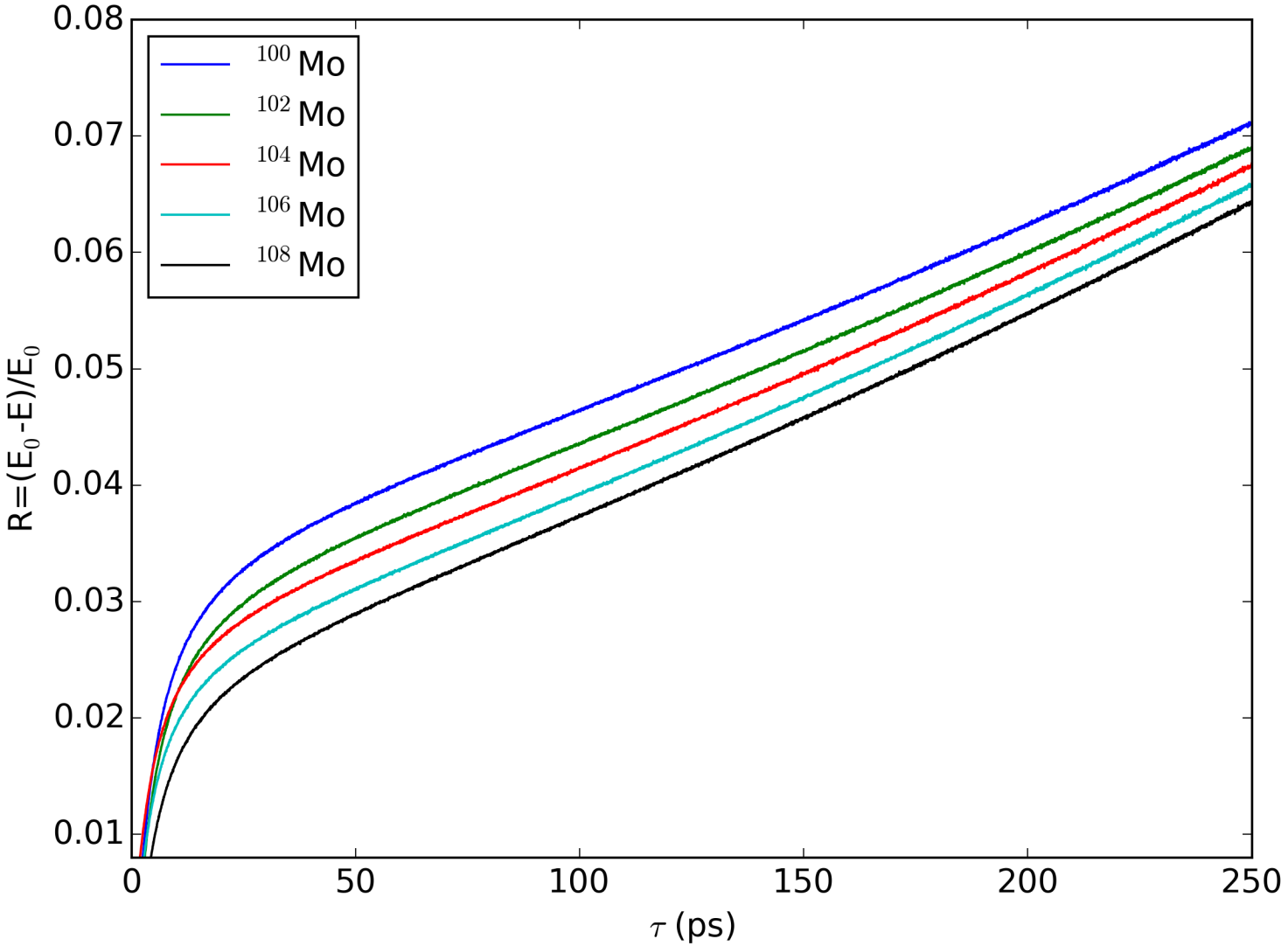
D. Ralet, to be submitted

Observed transition in $^{100-108}$Mo



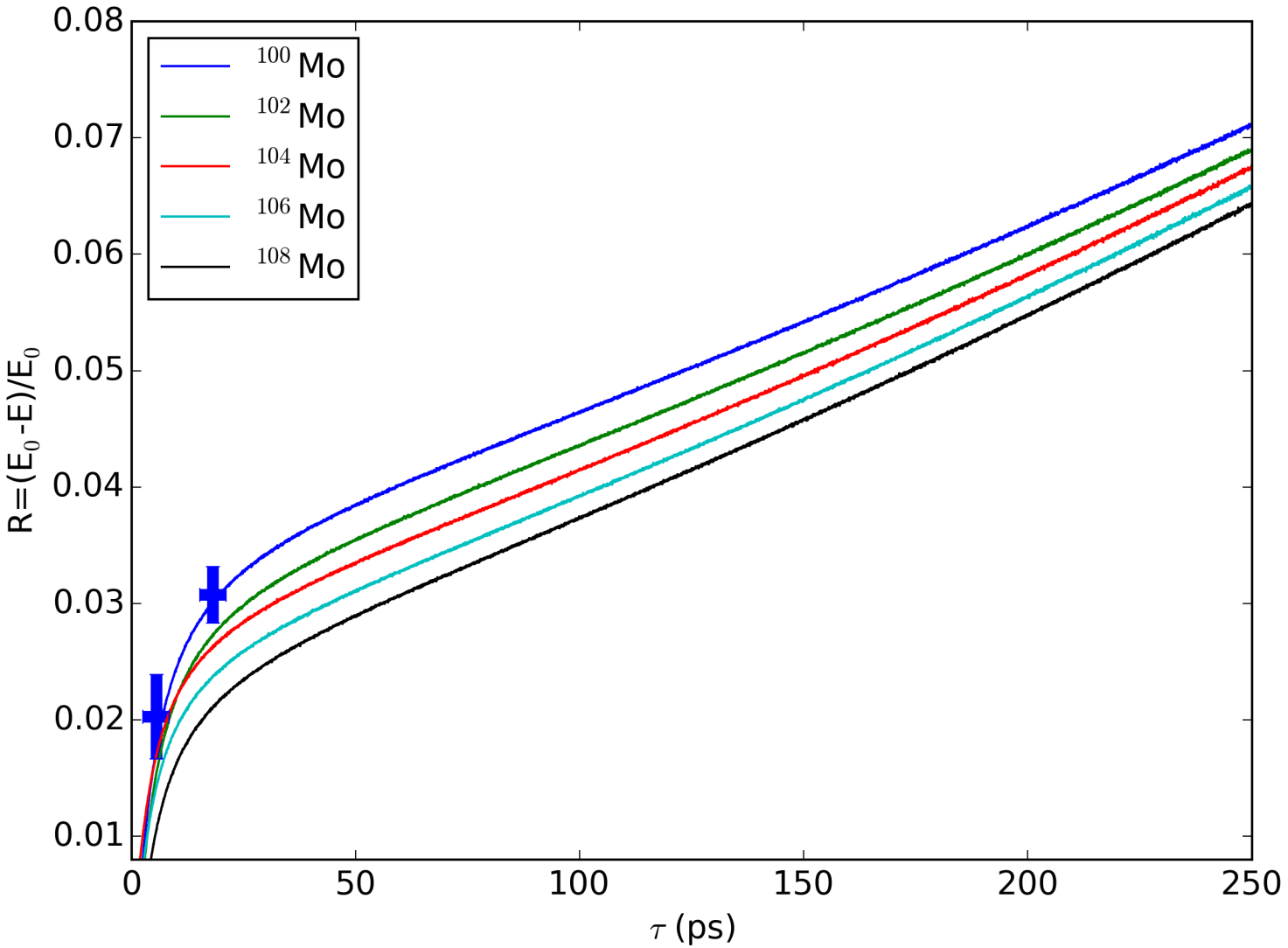
D. Ralet, to be submitted

Simulated centroid shift as a function of the half-life



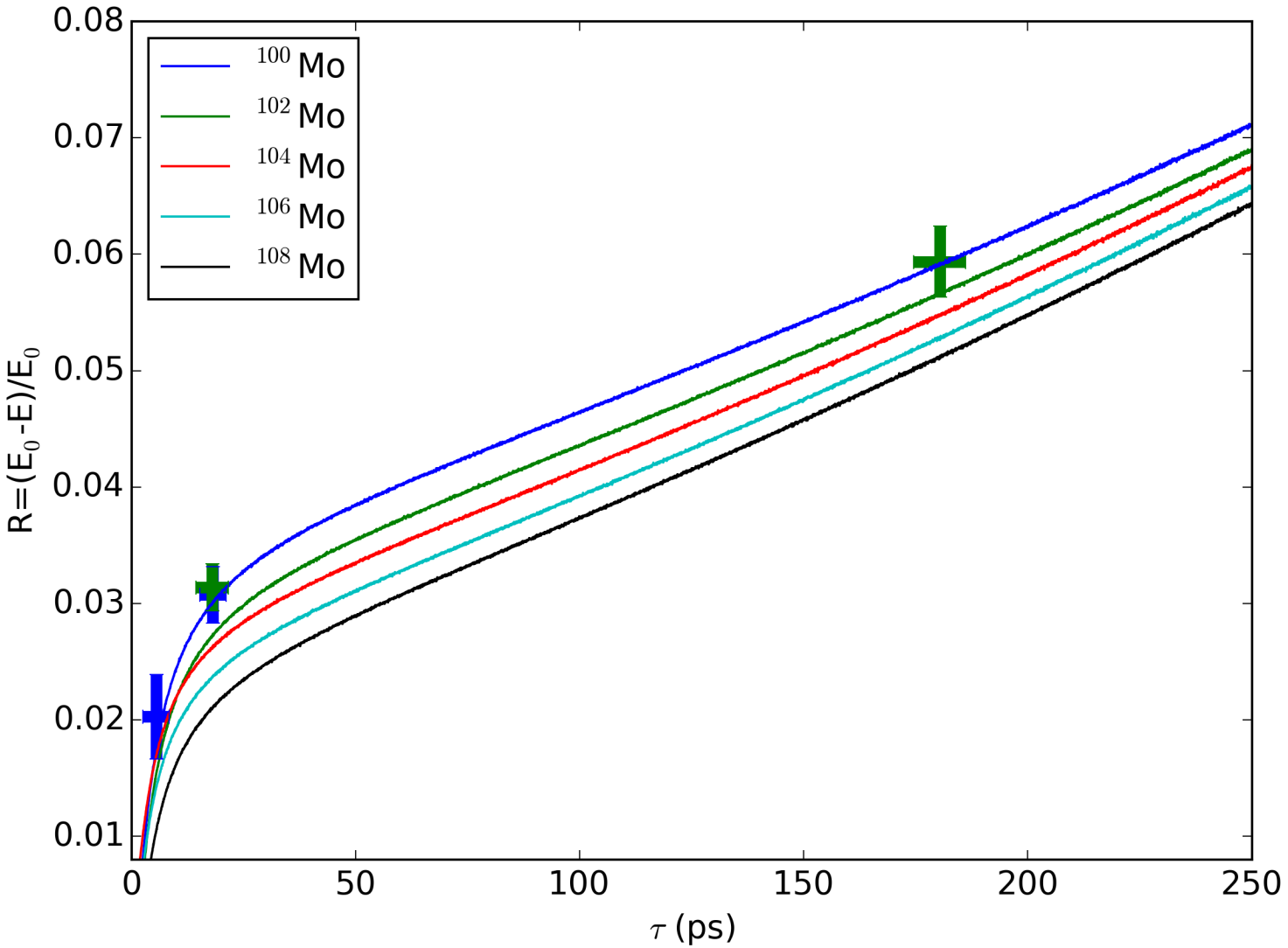
$^{100-108}$Mo, $^{98-106}$Zr

D. Ralet, to be submitted



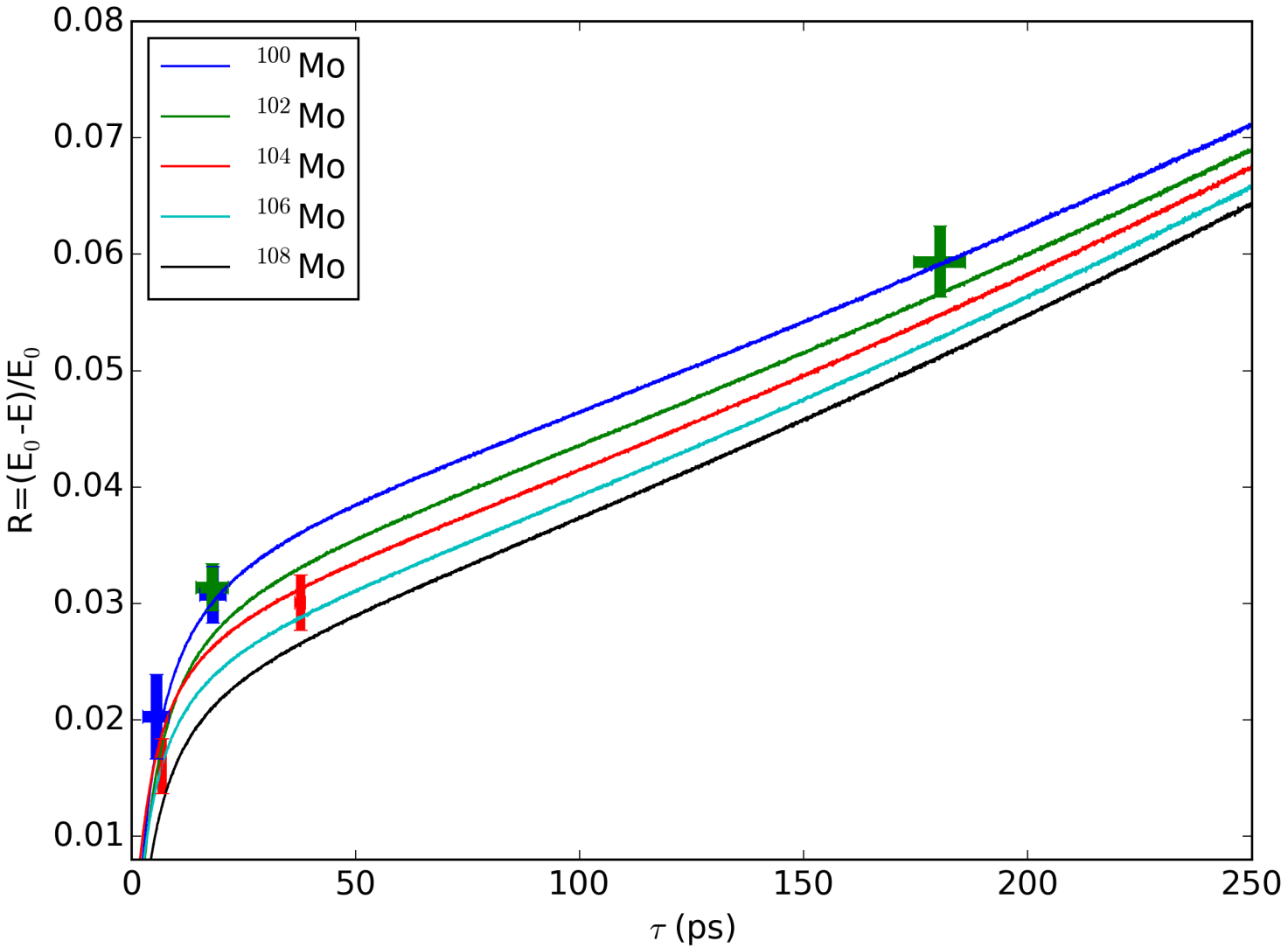
$^{100-108}$Mo, $^{98-106}$Zr

D. Ralet, to be submitted



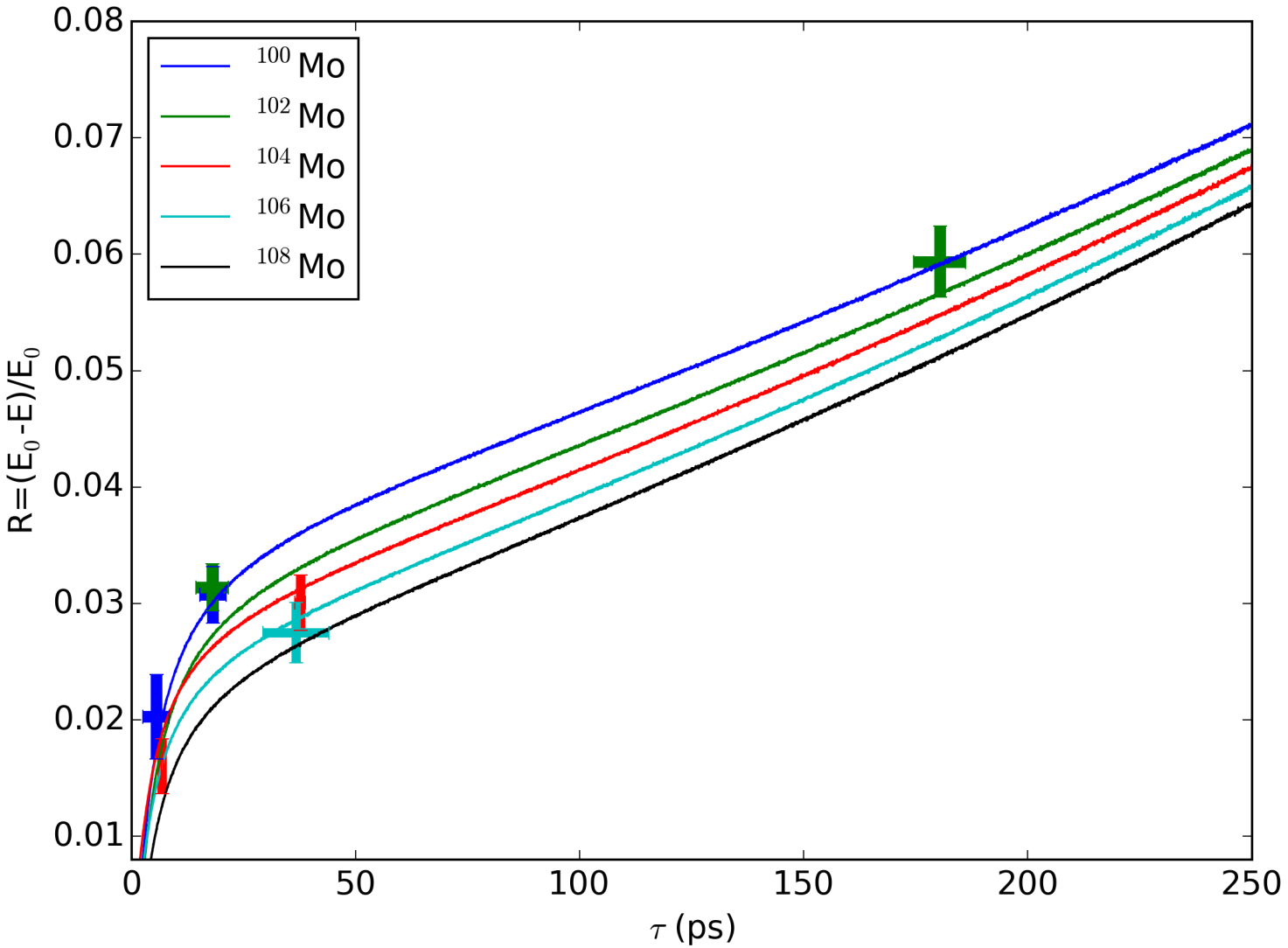
$^{100-108}$Mo, $^{98-106}$Zr

D. Ralet, to be submitted



$^{100-108}$Mo, $^{98-106}$Zr

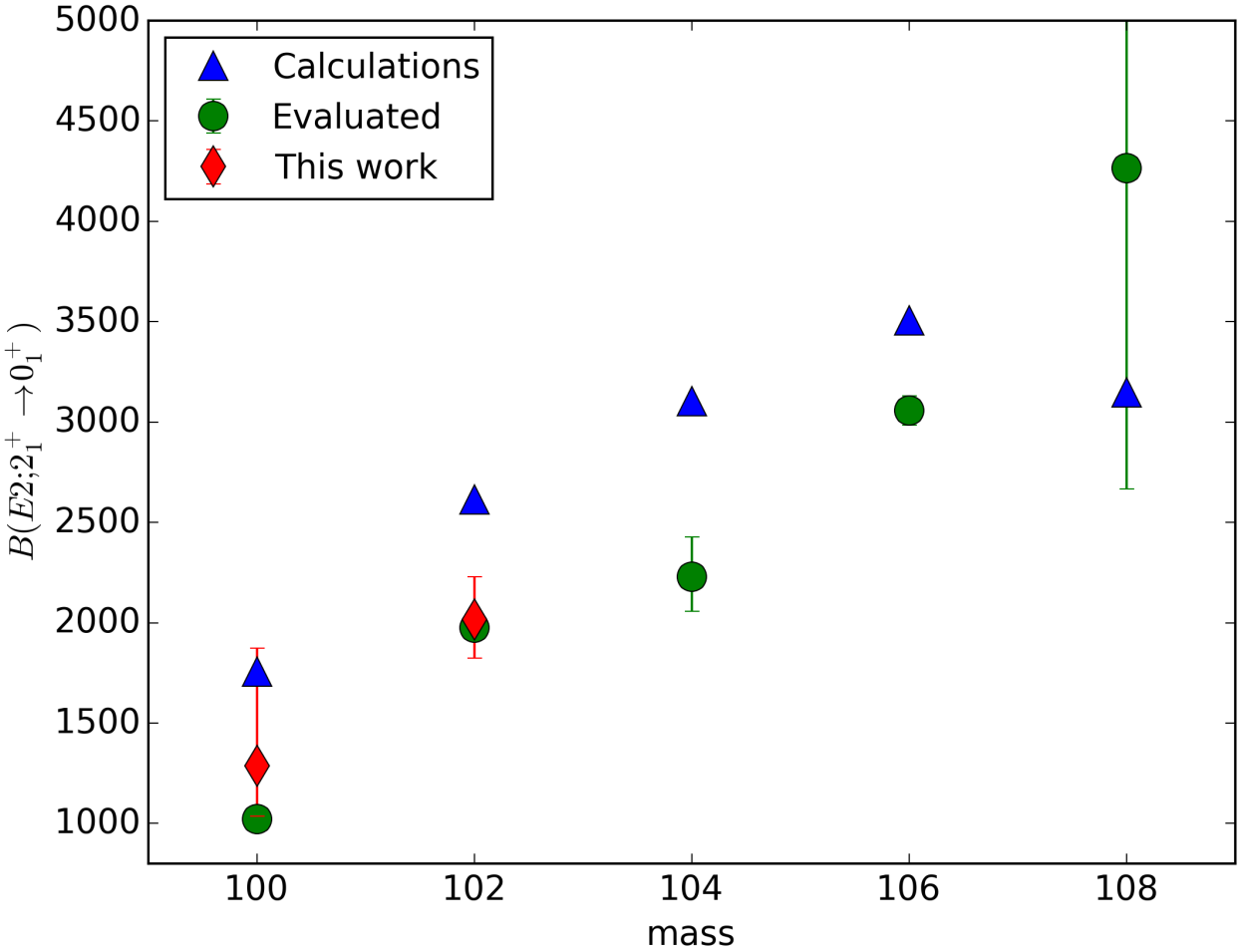
D. Ralet, to be submitted



D. Ralet, to be submitted

Systematics $B(E2; 2^+ \rightarrow 0^+)$

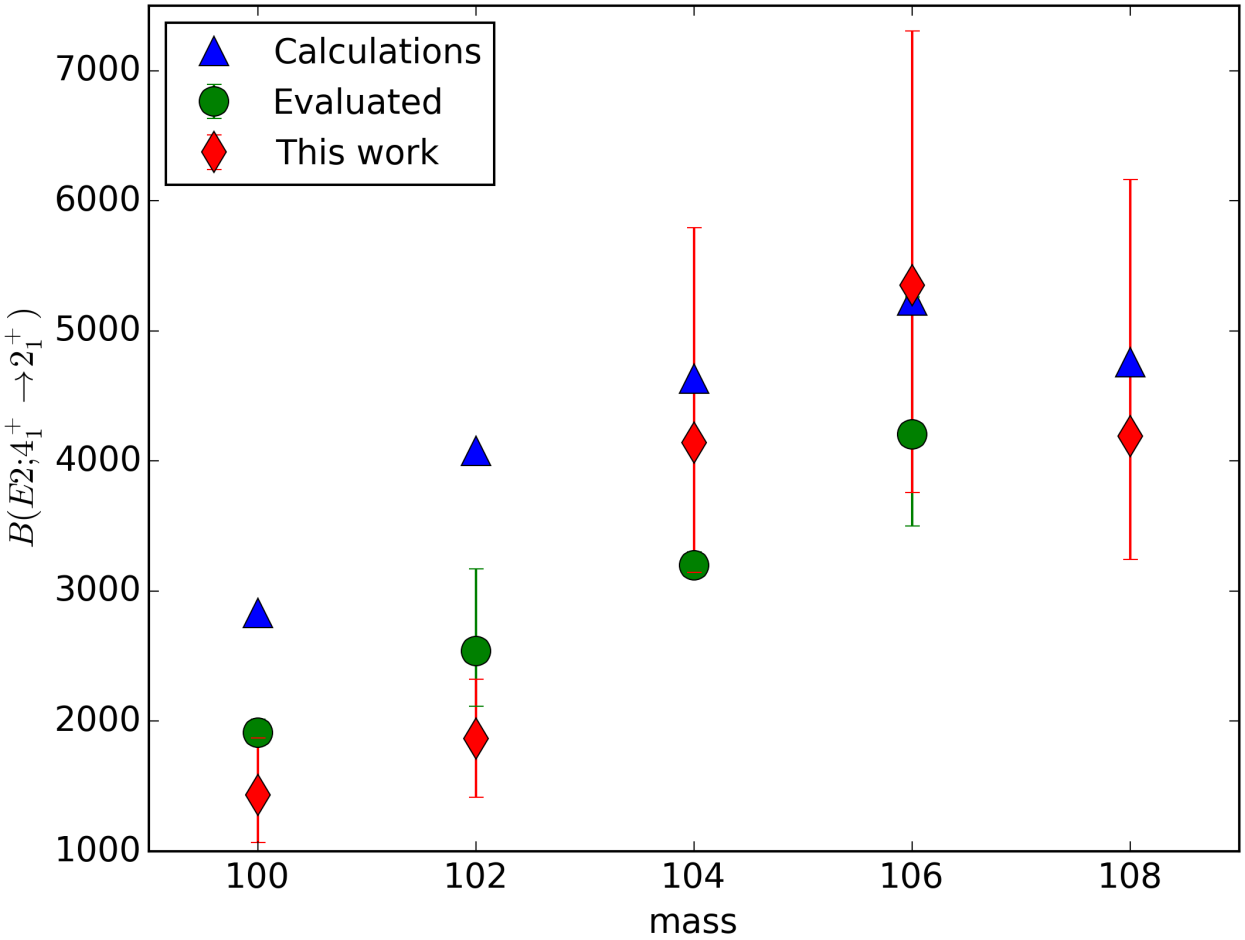
T. R. Rodríguez et al. PRC 81, 064323 (2010)



D. Ralet, to be submitted

Systematics $B(E2; 4^+ \rightarrow 2^+)$

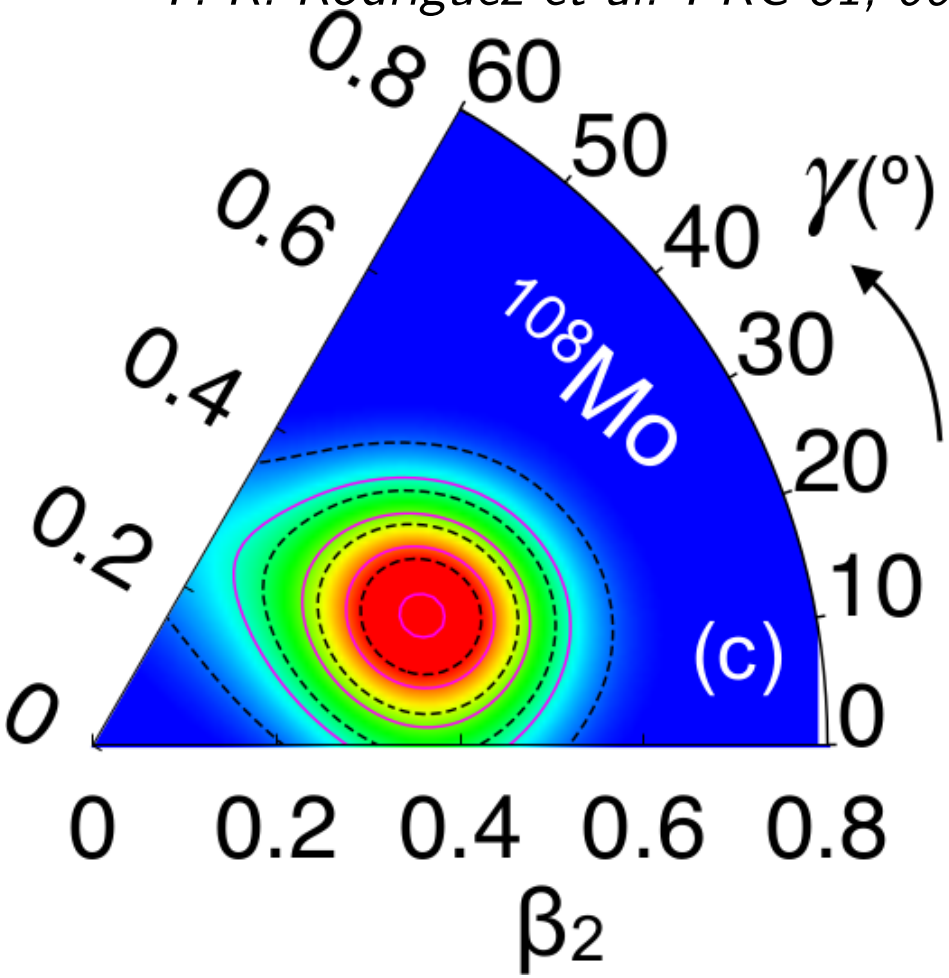
T. R. Rodríguez et al. PRC 81, 064323 (2010)



D. Ralet, to be submitted

^{108}Mo potential energy surface

T. R. Rodríguez et al. PRC 81, 064323 (2010)



- Introduction
- Standard setup
- AGATA advantages
- Status of the data analysis
  - Stopped beam spectroscopy
  - In flight spectroscopy
- Conclusion

Data analysis of GSI data is a long process

4 years after the first part of the AGATA@GSI campaign the first paper are being submitted

Data analysis of GSI data is a long process

4 years after the first part of the AGATA@GSI campaign the first paper are being submitted

over 7 experiments: 4 have finished analysis or will be soon, 1 will have result later

other 2: not yet clear to me what will come out at this point of the analysis

Thank to all the people that send me the material needed for this presentation:

N. Lalović, D. Rudolph, Zs. Podolyák, O. Wieland, M. Lettmand, T. Hüyük, A. Gadea, M. Cappellazzo, A. Boso, S. Milne, M. Bentley, J. Gerl

and the PreSPEC and AGATA collaborations