Investigation of the octupole correlation of neutron-rich $Z \sim 56$ isotopes by β-γ spectroscopy.

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COMEX 5

17 Sep. 2015 @Kraków, Poland

Collaborators

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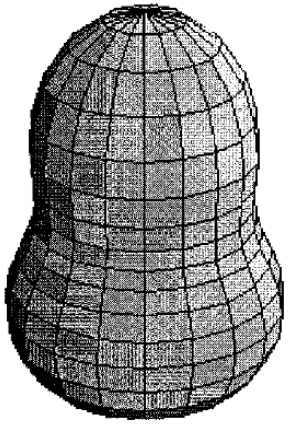
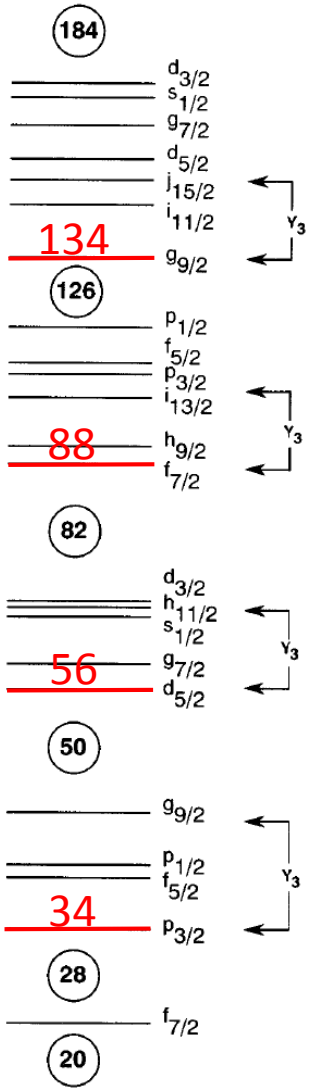
Octupole deformation

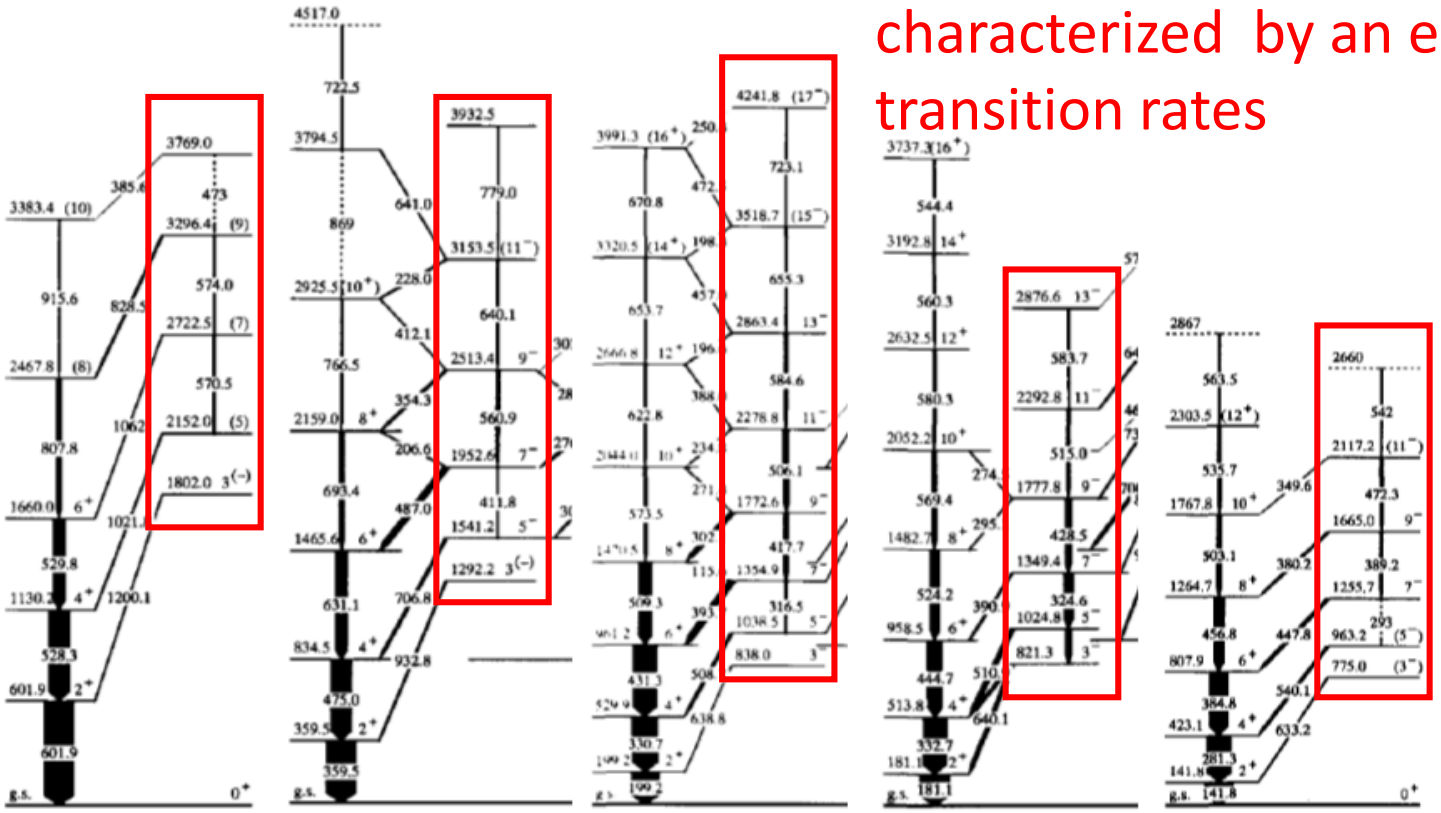


- Interaction between orbits with $\Delta J = \Delta I = 3$ are responsible
- N or $Z = 34, 56, 88, 134$ expected to have large octupole correlation
- Octupole deformation in ^{224}Ra discovered (L. P. Gaffney et. al. 2013)
- Neutron-rich Ba region?



P. A. Butler and W. Nazarewicz (2008)

Octupole bands in Ba isotopes

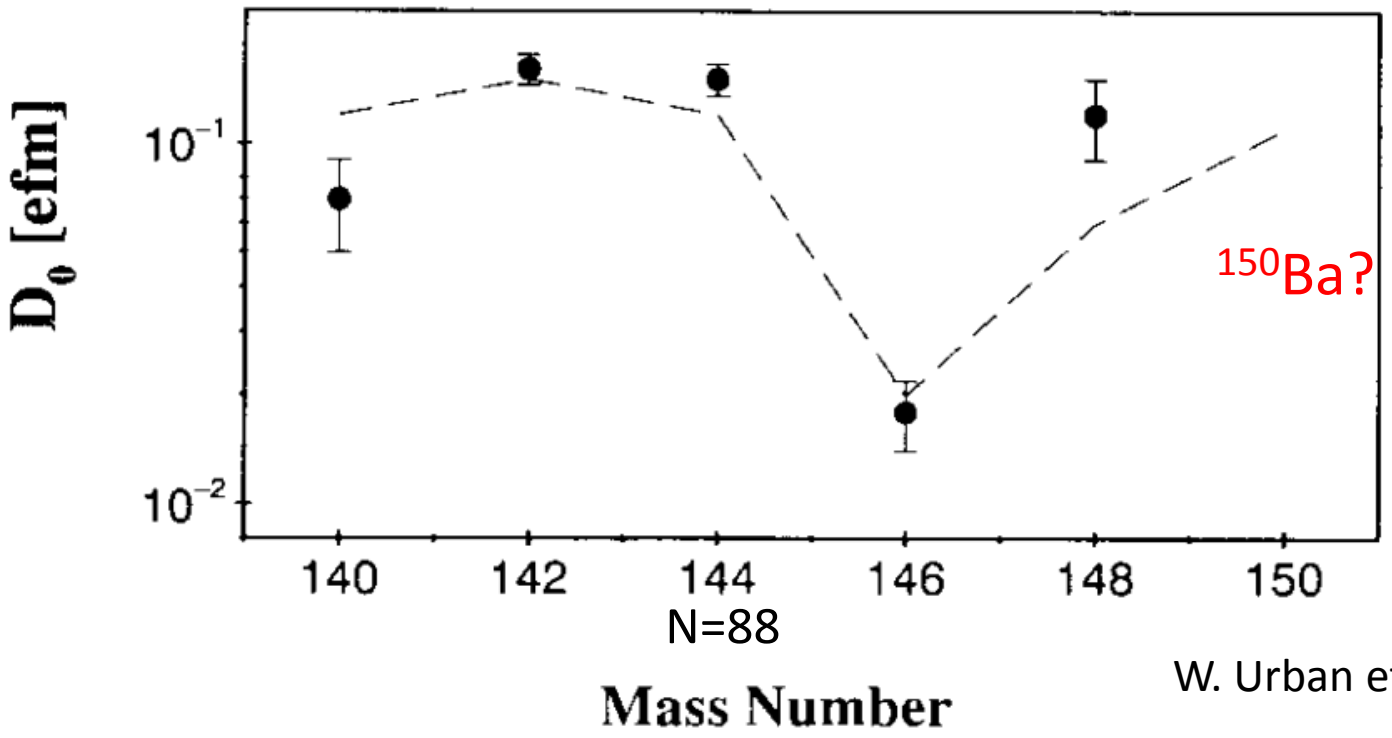


characterized by an enhanced E1 transition rates

^{150}Ba?

- Octupole bands are known in Ba isotopes(Z=56,N∼88)
- No excited states known in ^{150}Ba

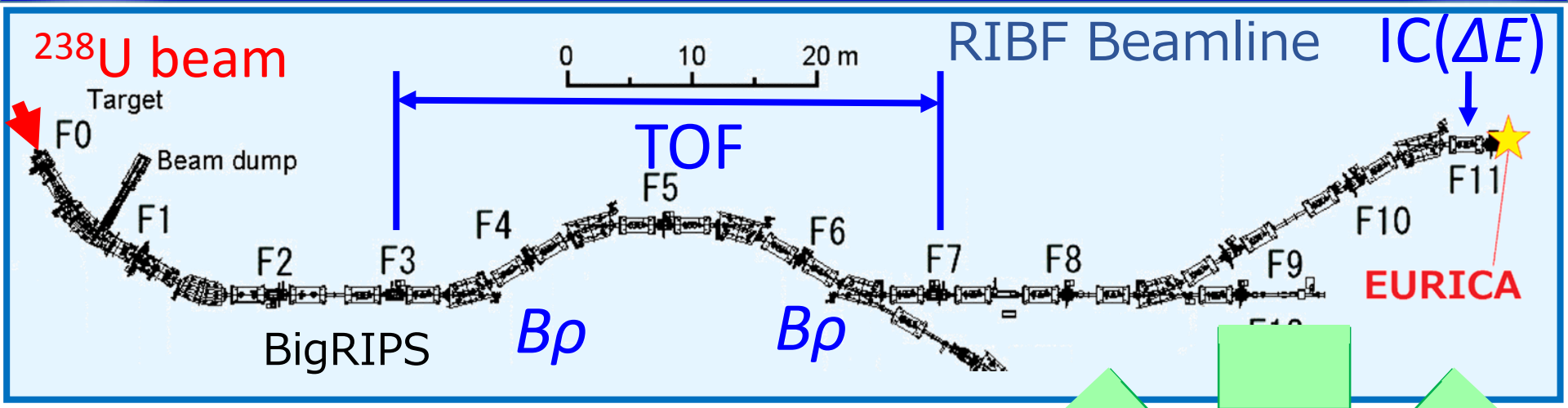
Octupole bands in Ba isotopes



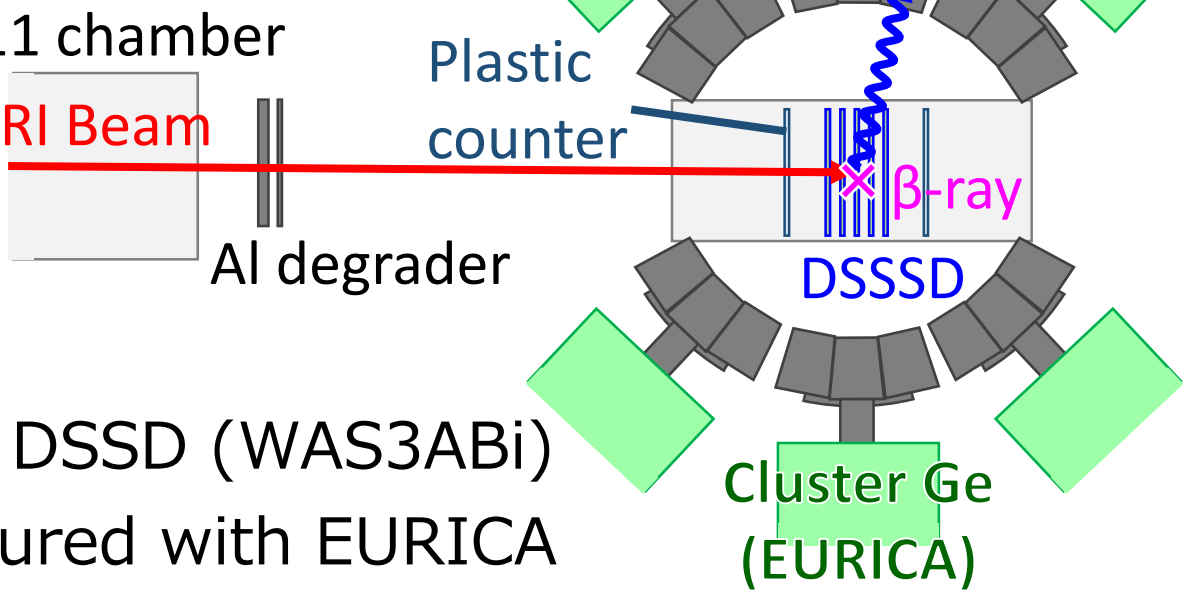
W. Urban et al. (1997)

- D_0 value gets smaller at A=146 but gets larger again at A=148
- Predictions are differ in theory
  - P. A. Butler and W. Nazarewicz (1991): large β_3
  - J. L. Egido and L. M. Robledo (1992): no β_3

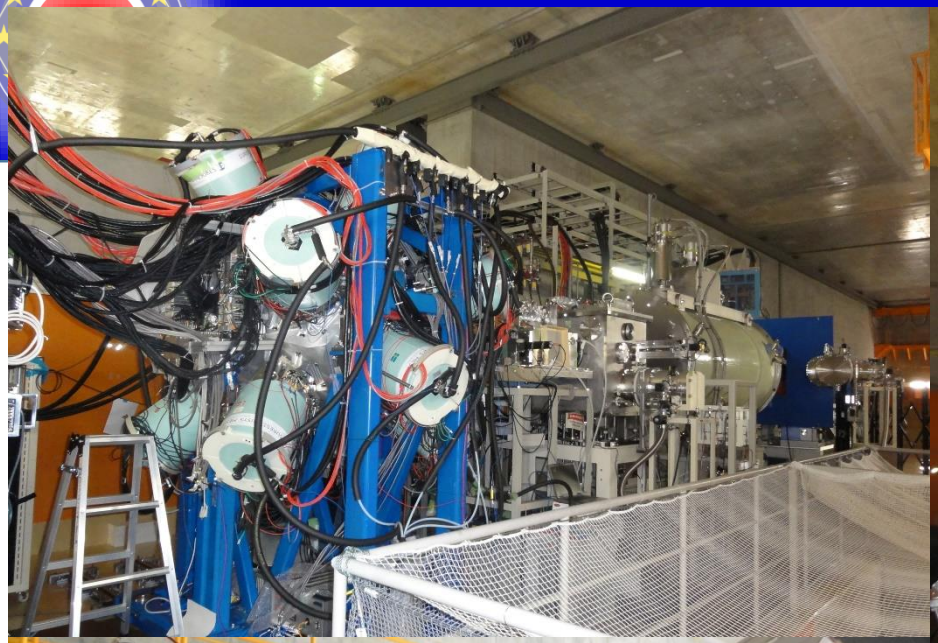
Experimental Setup

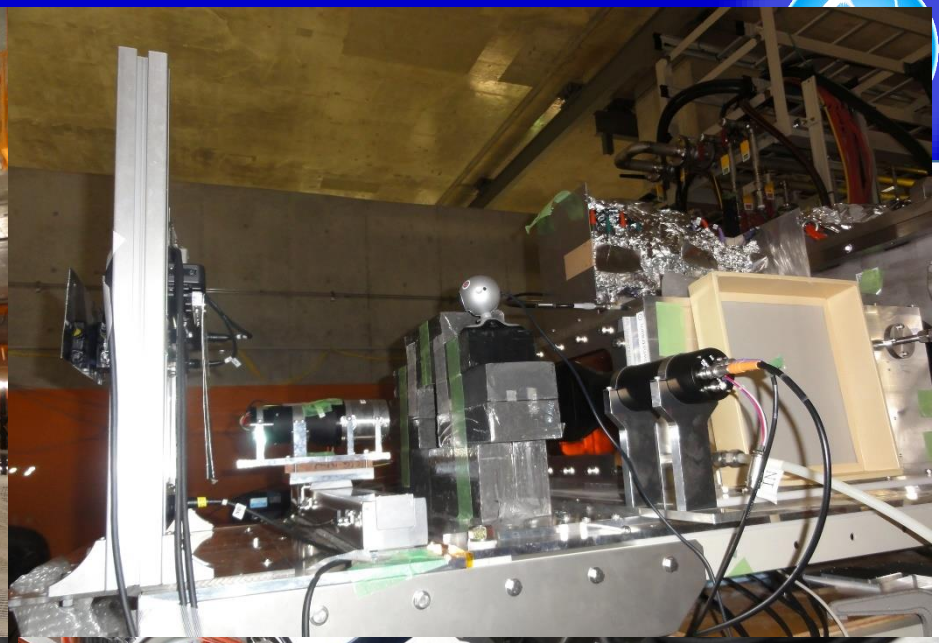


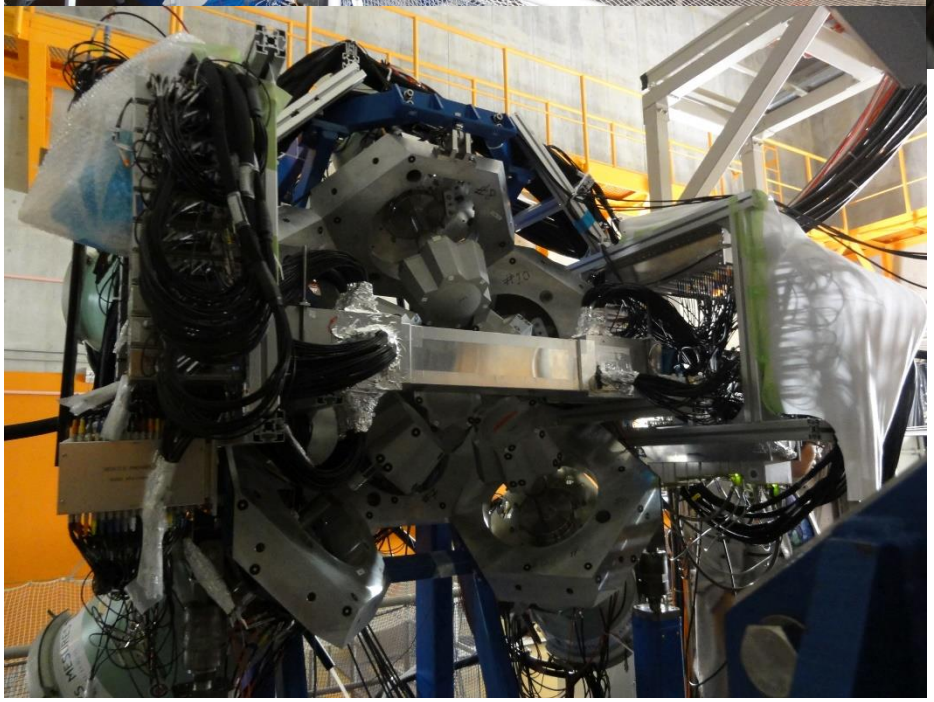
Detector setup @F11→

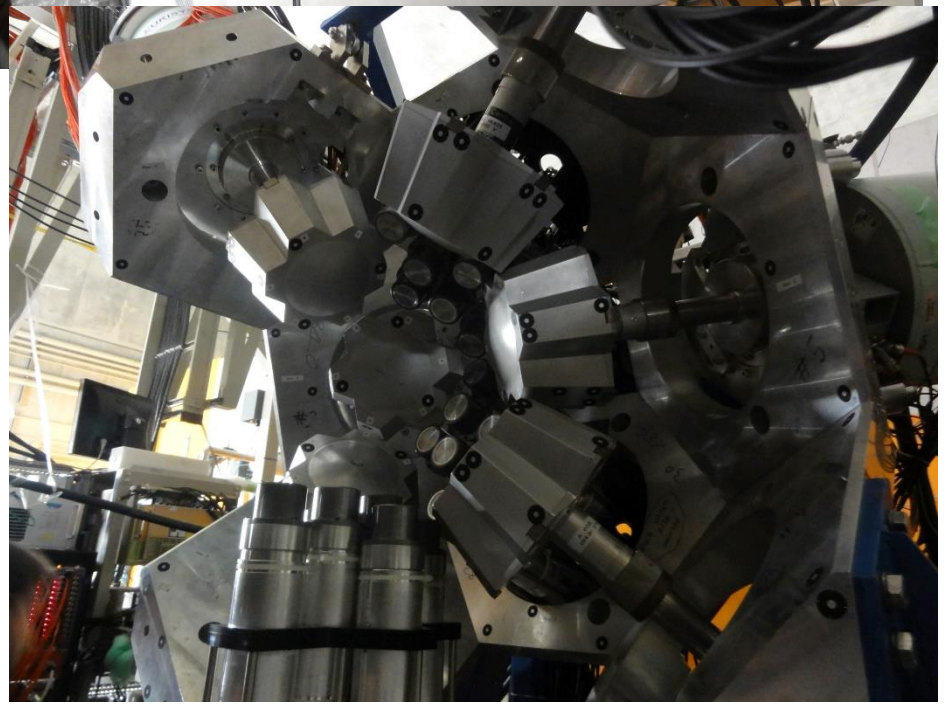


- In-flight fission
- 345MeV/u ^{238}U
- PI with BigRIPS
- Stopped at stripped DSSD (WAS3ABi)
- β-decay γ-ray measured with EURICA

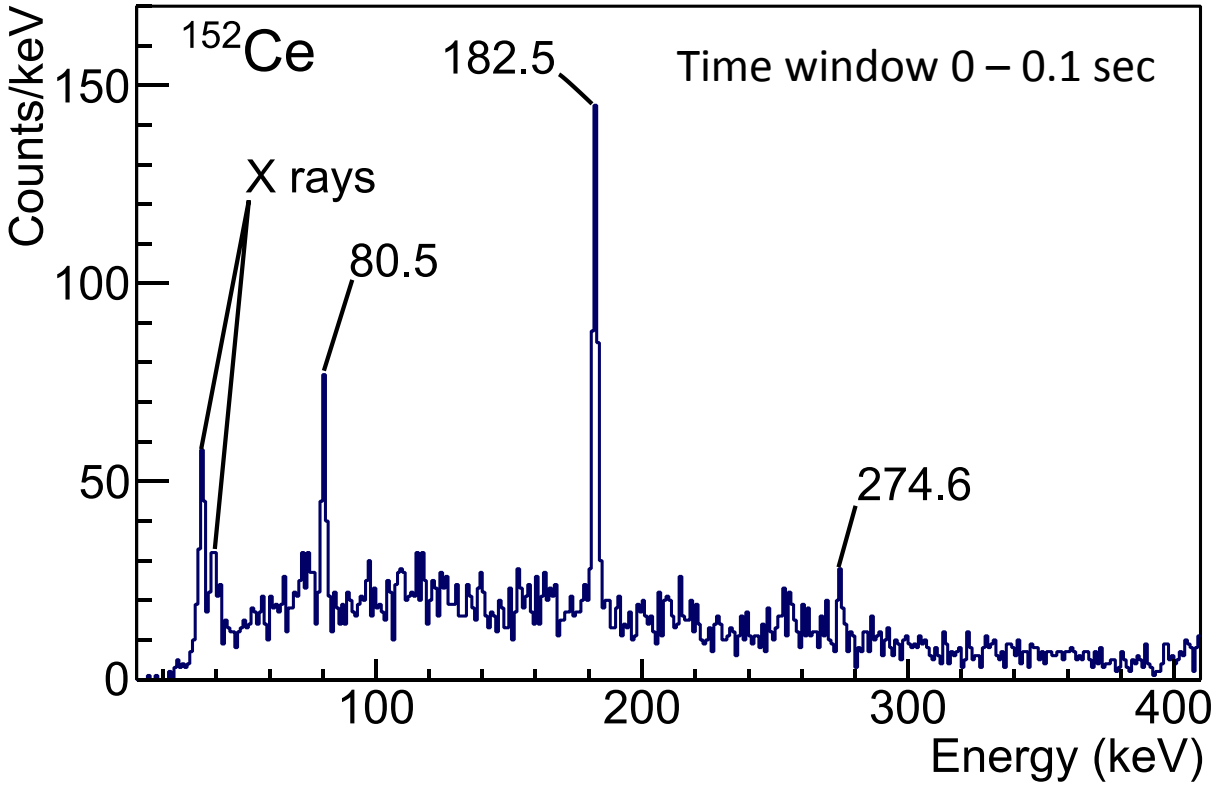




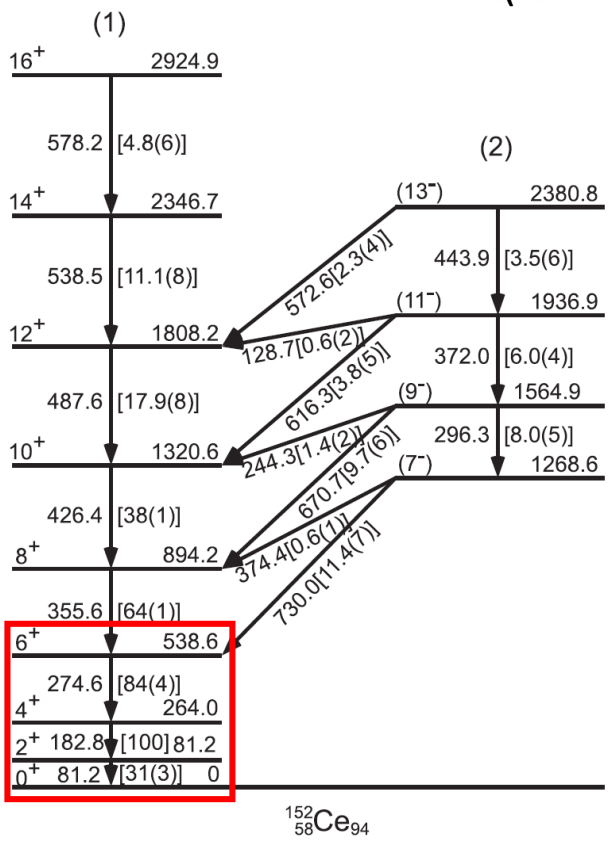




Known γ-rays in ^{152}Ce

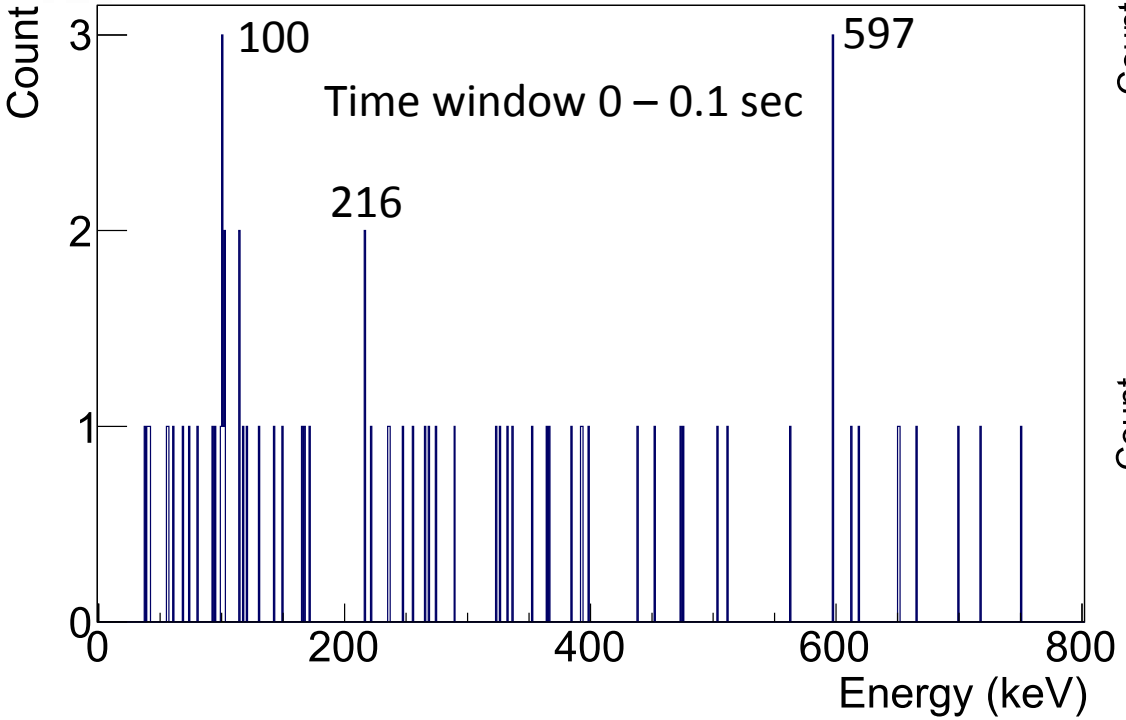


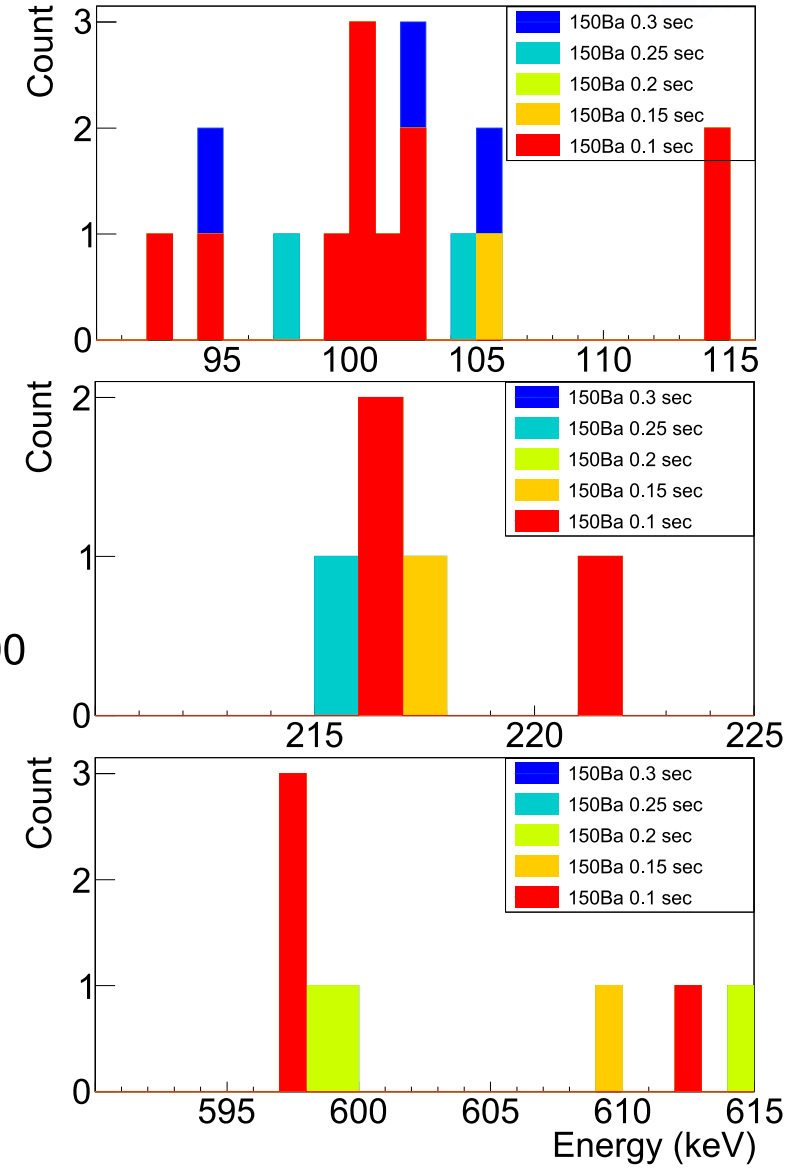
H. J. Li et al. PRC 86 067302 (2012)



- Known γ-rays of ^{152}Ce are observed.
- β-decay from ^{152}La to Ce measured for the first time.

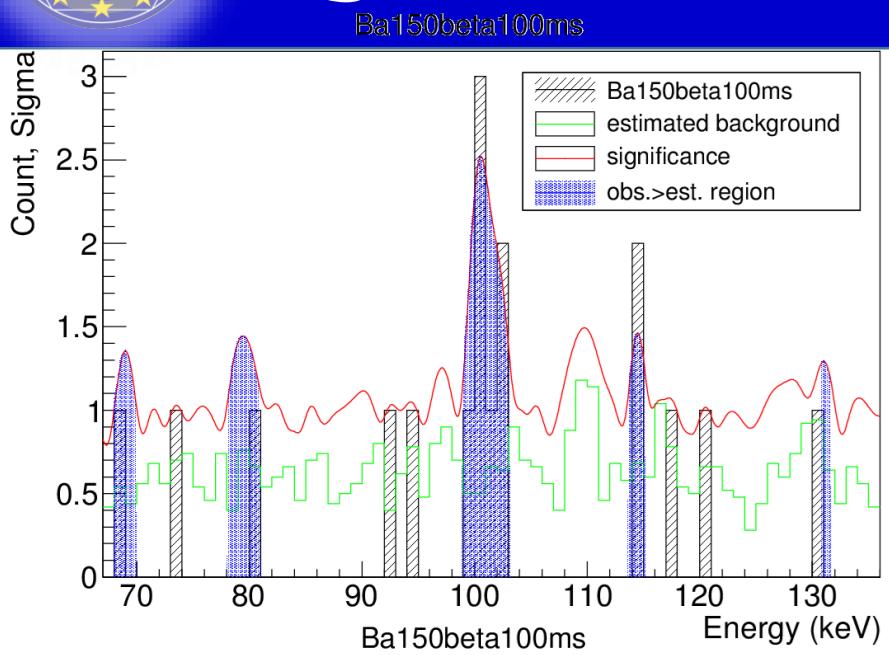
β-decay from ^{150}Cs to ^{150}Ba

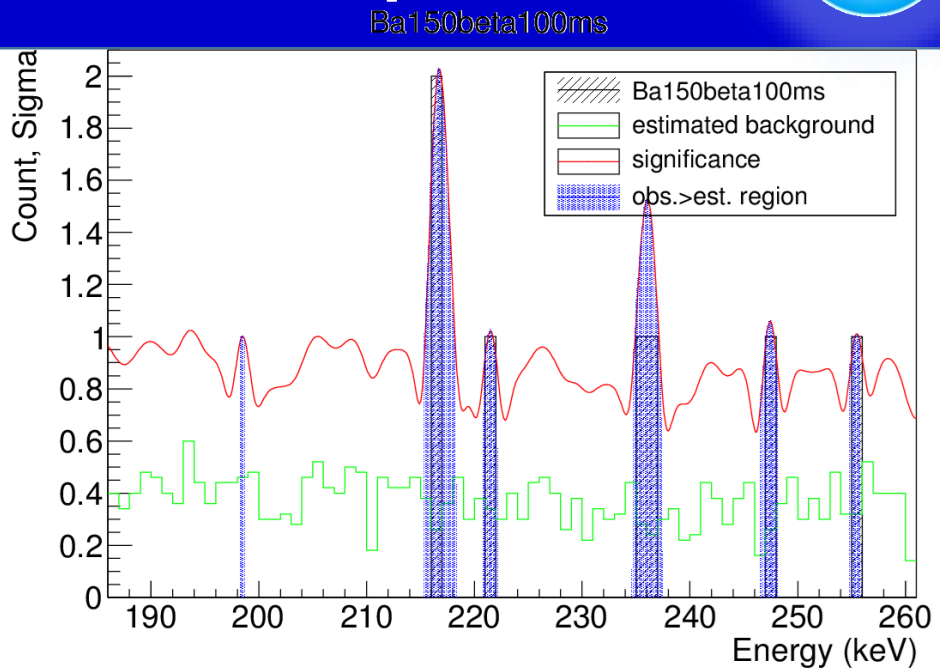


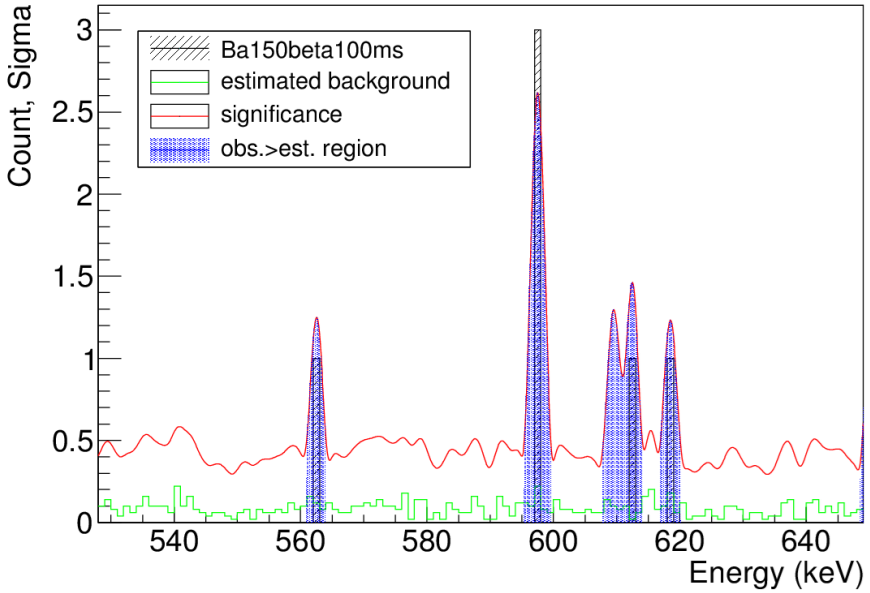


- Candidates for ^{150}Ba γ-rays are observed.
- Half-life with order of 0.1s

Significance of the peaks

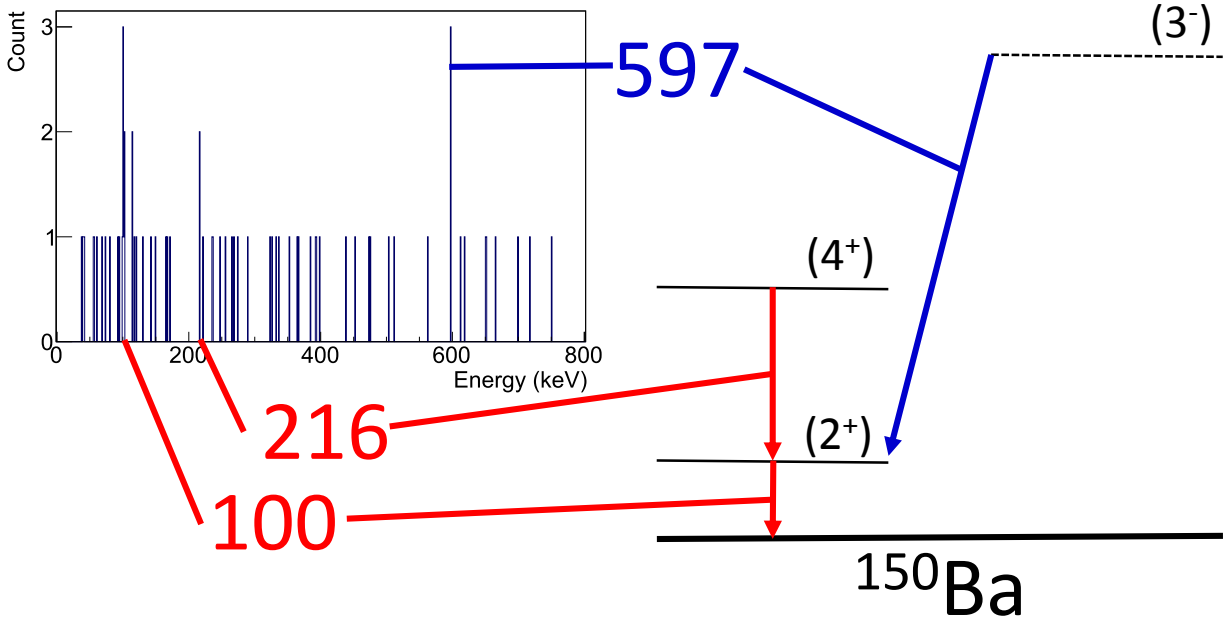


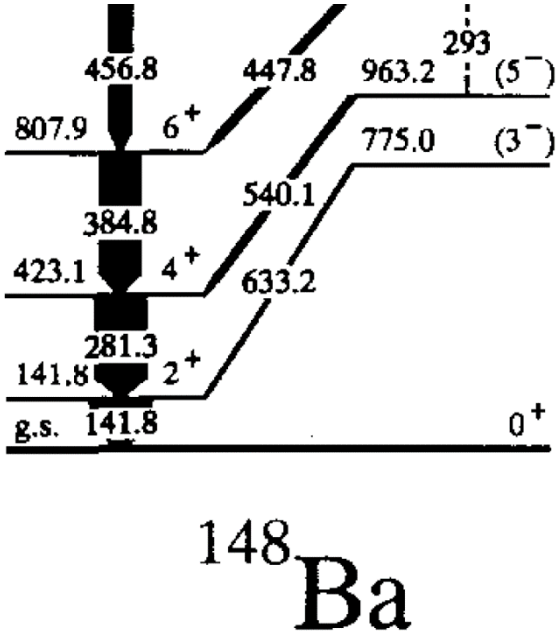




- Significance of the peaks are 2.0-2.5 σ
- Some more runs are in analysis

Assignment of ^{150}Ba γ-rays

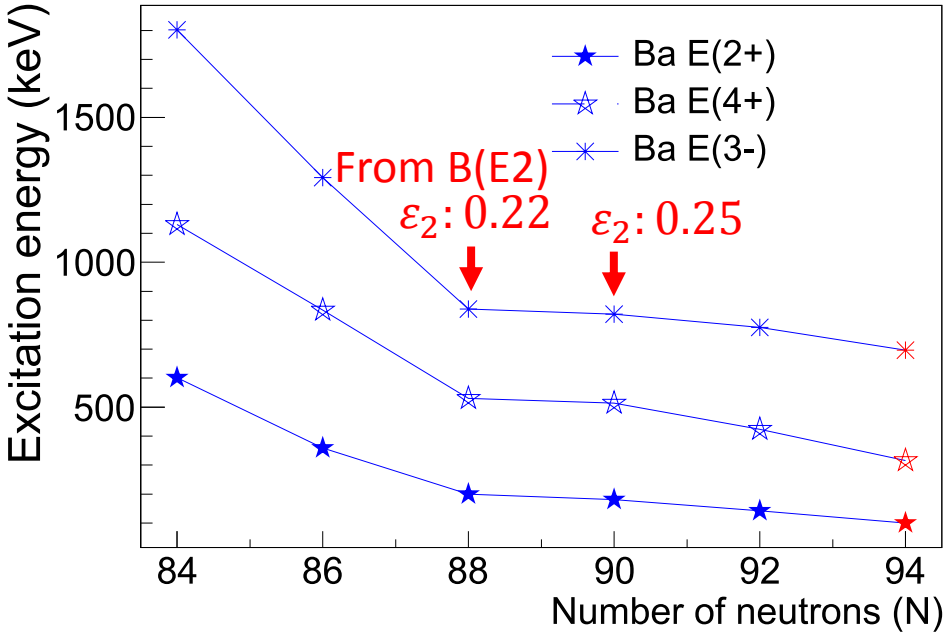


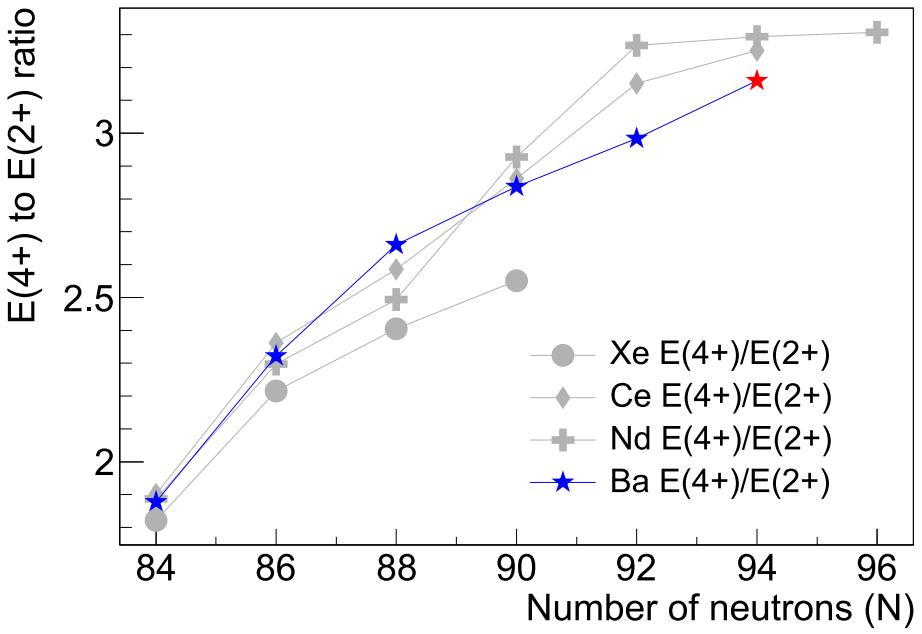


- 100 keV: $2^+ \rightarrow 0^+$, 216 keV: $4^+ \rightarrow 2^+$?
- 597 keV: from negative parity state?

Discussion

Systematics of the ground-state band

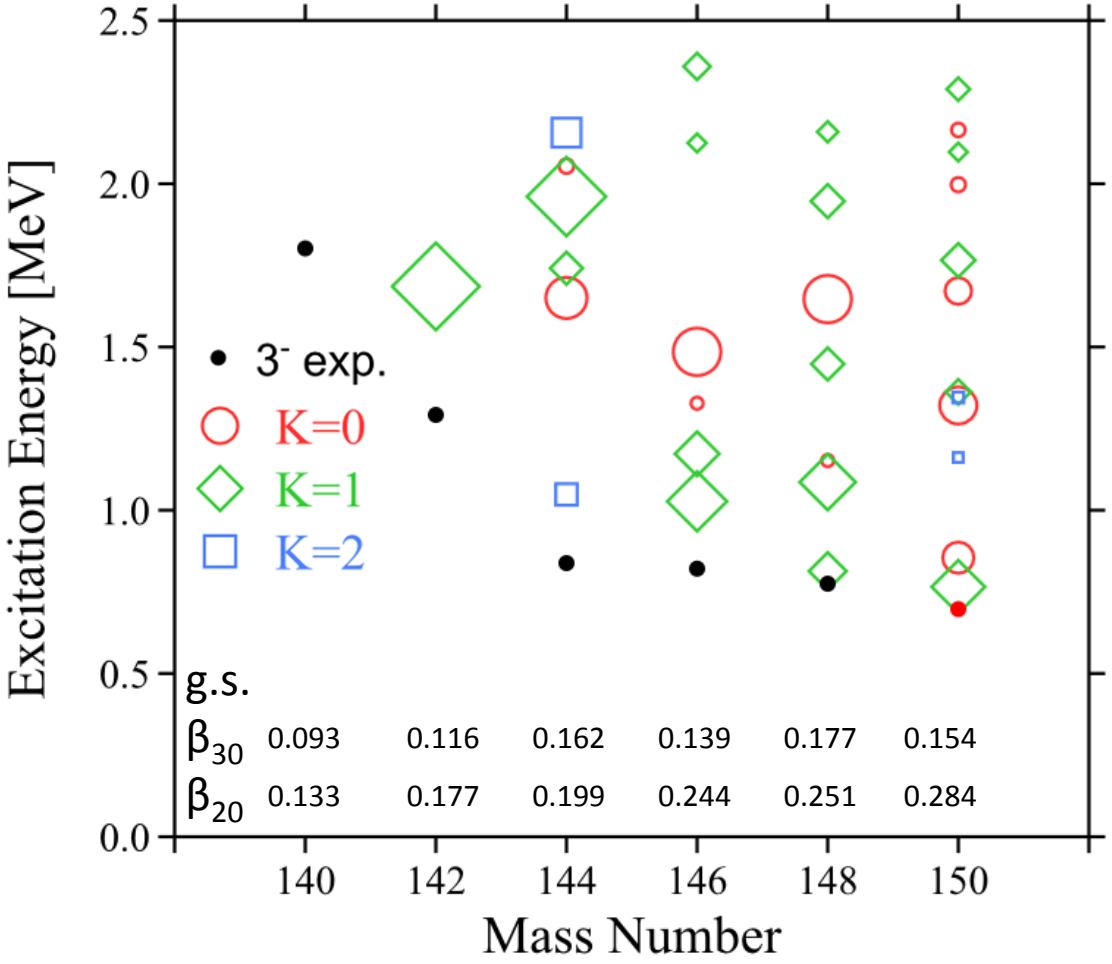




- Assignment of ^{150}Ba γ-rays are consistent with the systematics.
- Ba isotopes (Z=56) get deformed as N increases.

$\varepsilon_2 \sim 0.25$ or larger expected for ^{150}Ba

RPA Calculation



- RPA (SkM*)
- Full 3D (w/o any symmetry)
- Totally self consistent
- LS
- No pairing

T. Inakura, T. Nakatsukasa , K. Yabana,
PRC **80** (2009) 044301
PRC **76** (2007) 024318

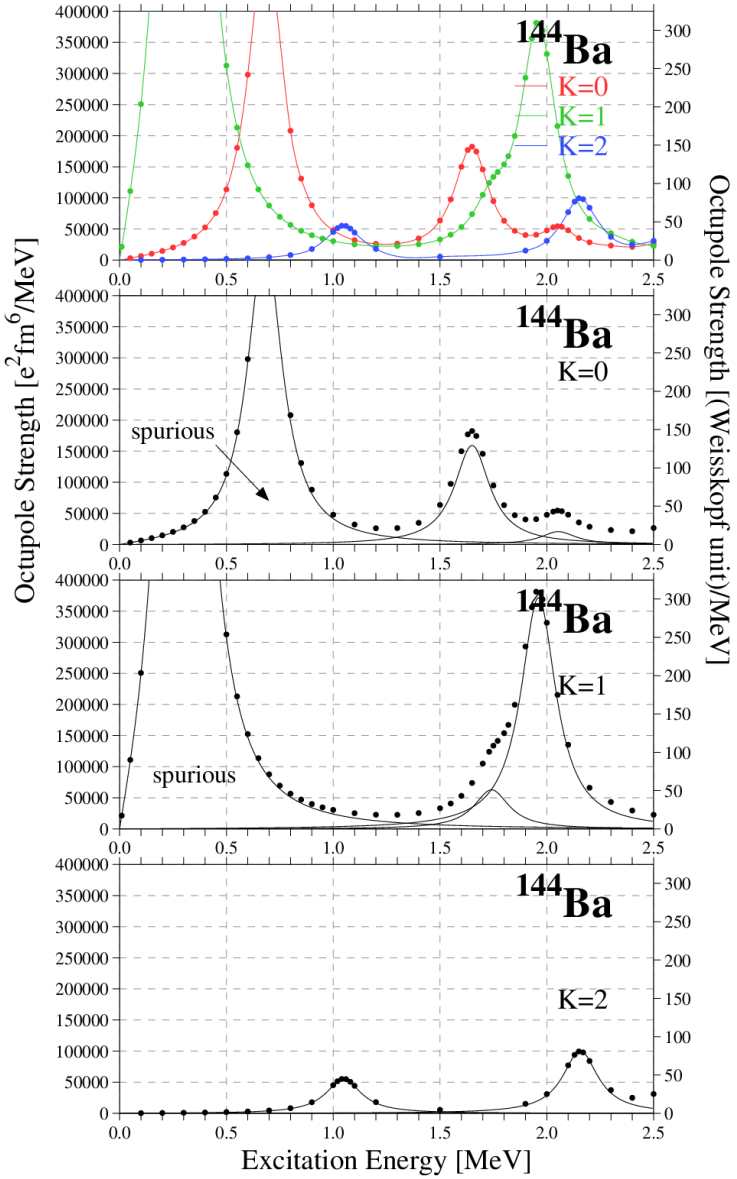
- Octupole deformation on the g.s.
- 3- excitations are reproduced < 1 MeV

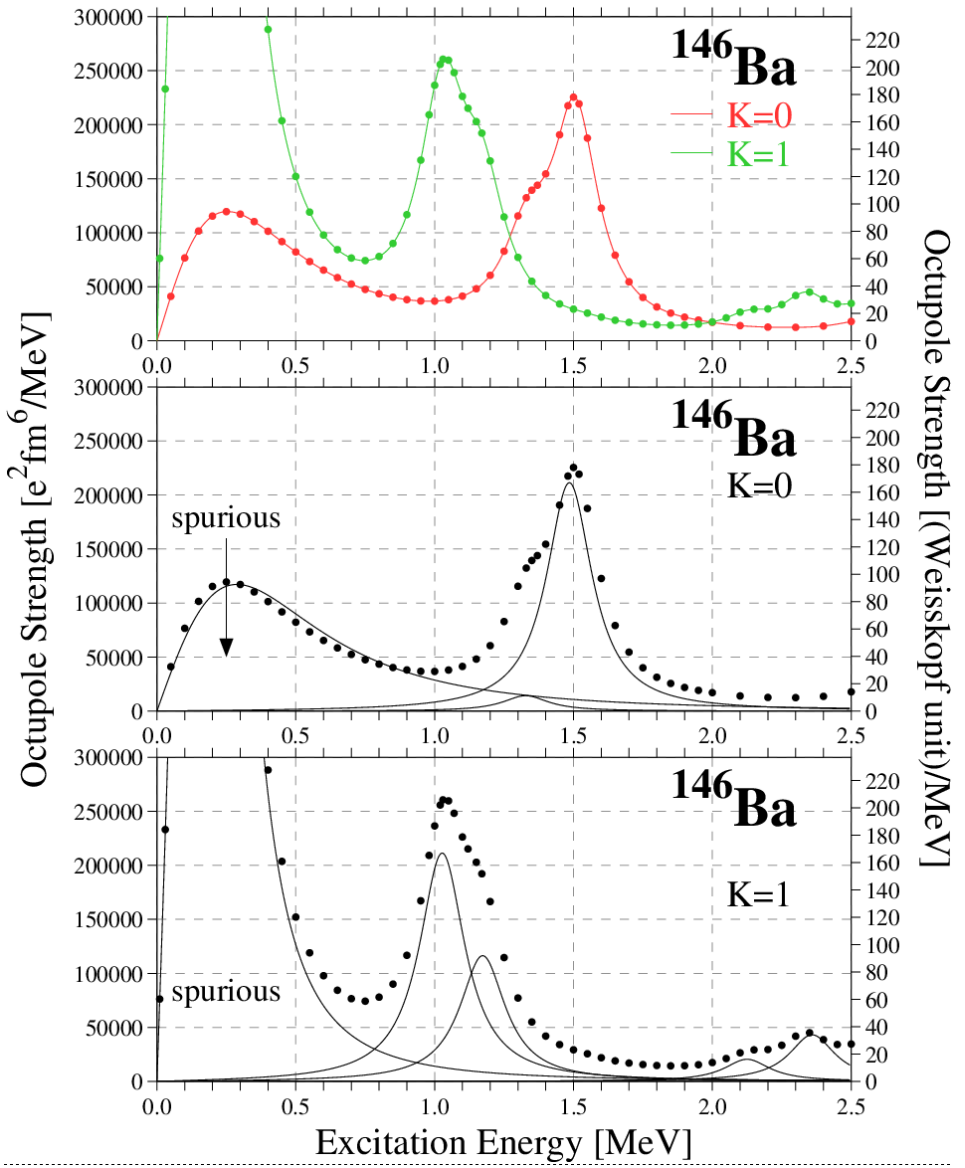
Summary

- β-γ spectroscopy of neutron-rich $Z \sim 56$ nuclei using BigRIPS + WAS3ABi + EURICA
- Known γ-rays of ^{152}Ce are observed
- Candidates of ^{150}Ba peaks found at 100, 216, 597 keV
  - 100 and 216 keV: $2^+ \rightarrow 0^+$ and $4^+ \rightarrow 2^+$
  - 597 keV: from negative parity state? (3^- for example)

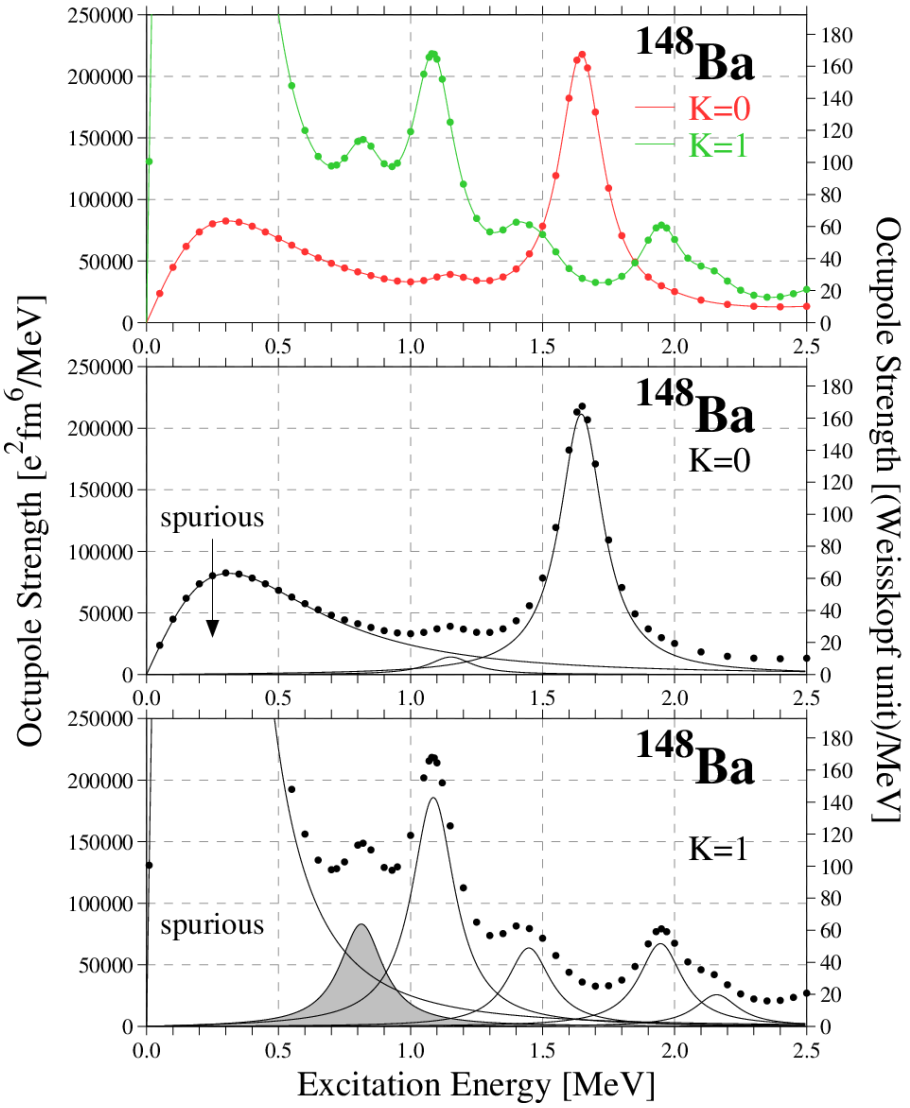
    $\rightarrow ^{150}$Ba may also have some octupole correlation.
- Systematics of g.s. band shows Ba isotopes are more deformed in neutron-rich side. ($\varepsilon_2 \geq 0.25$)
- New RPA calculation → Octupole deformation
  - 3- excitation reproduced around 1 MeV

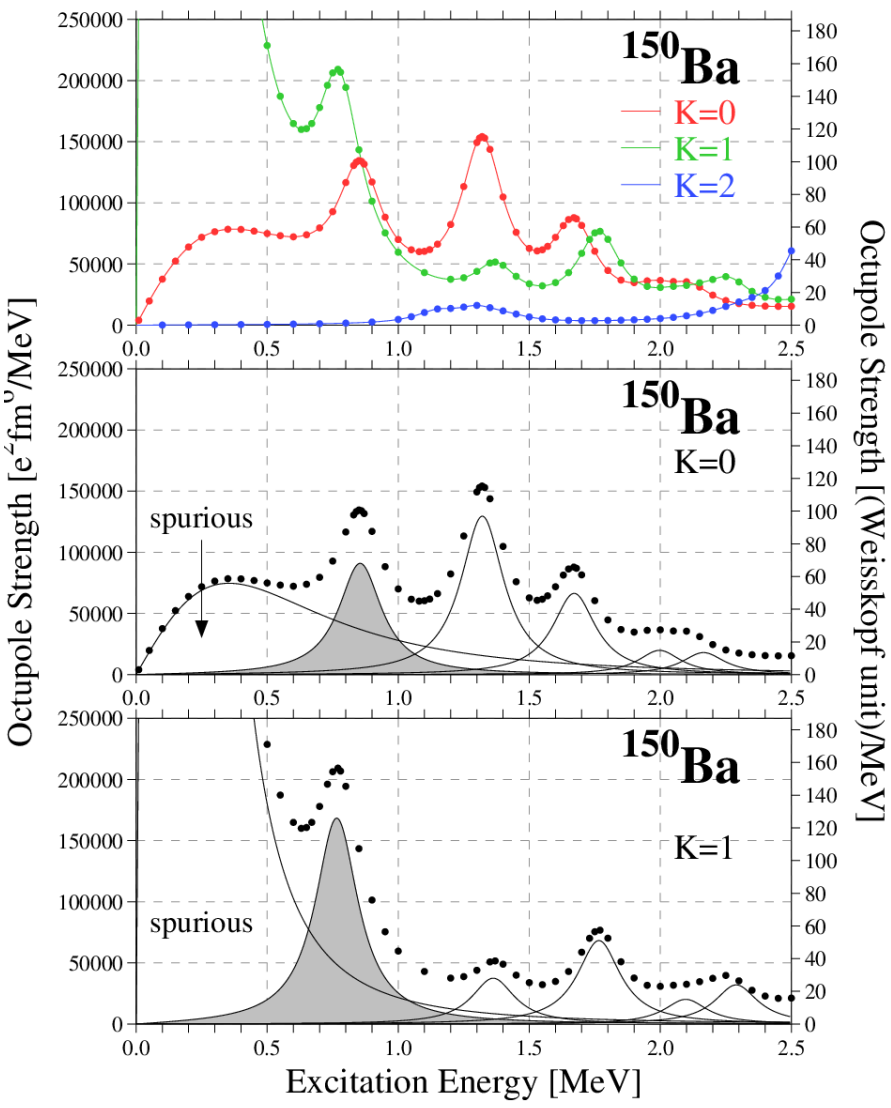
RPA Calculation



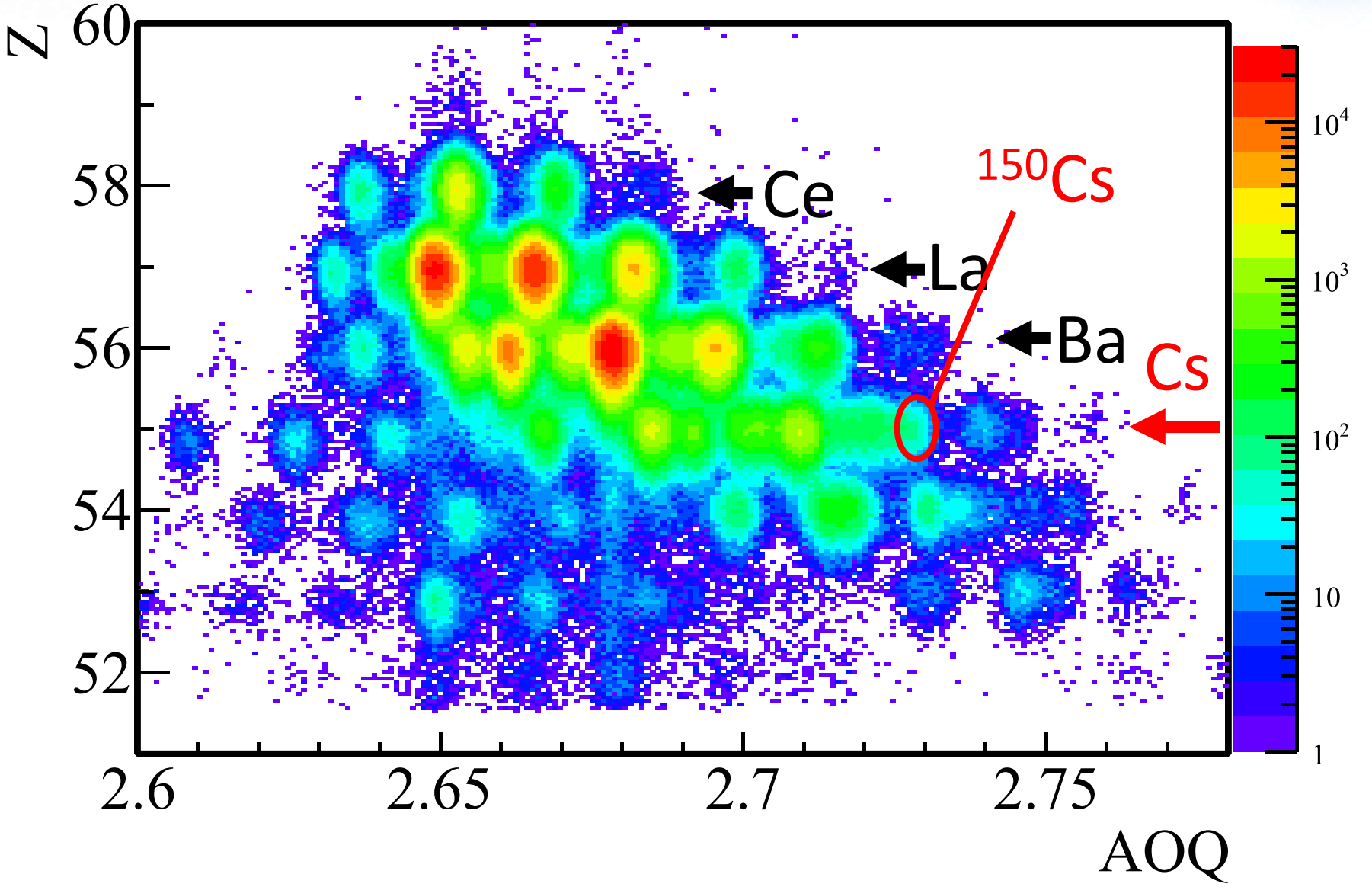


RPA Calculation





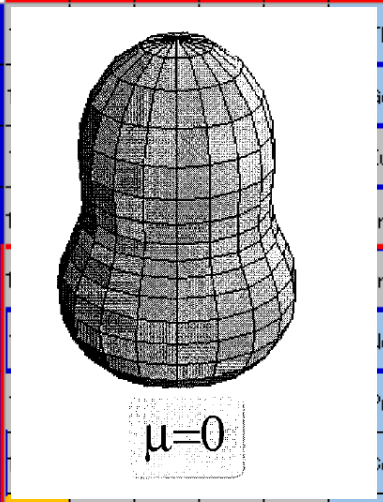
PID



background of the study

Neutron number

Proton number



K-isomers?

Octupole bands?

Region of interest

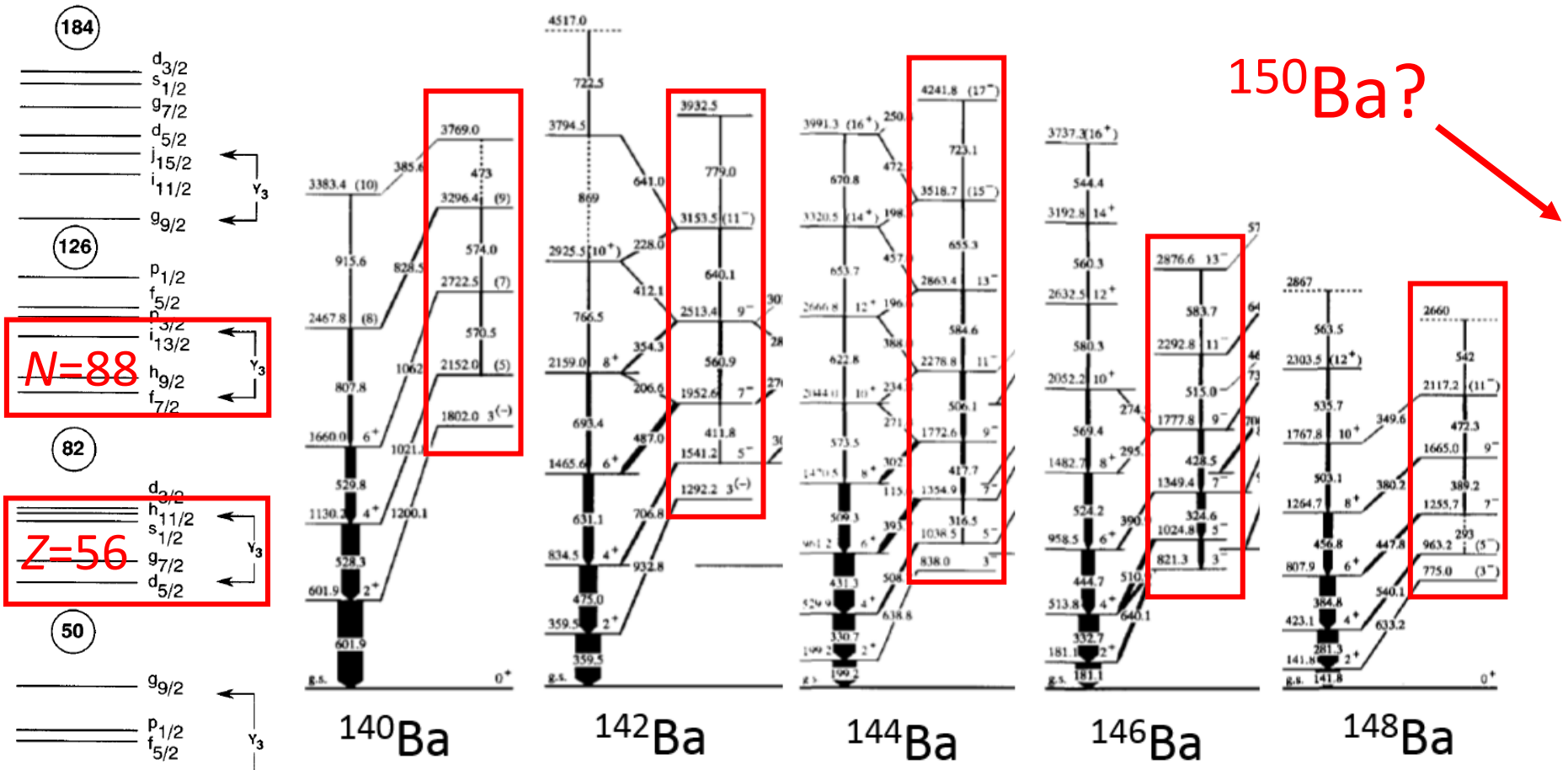
deformed

measurement of the excited states

Octupole band is known

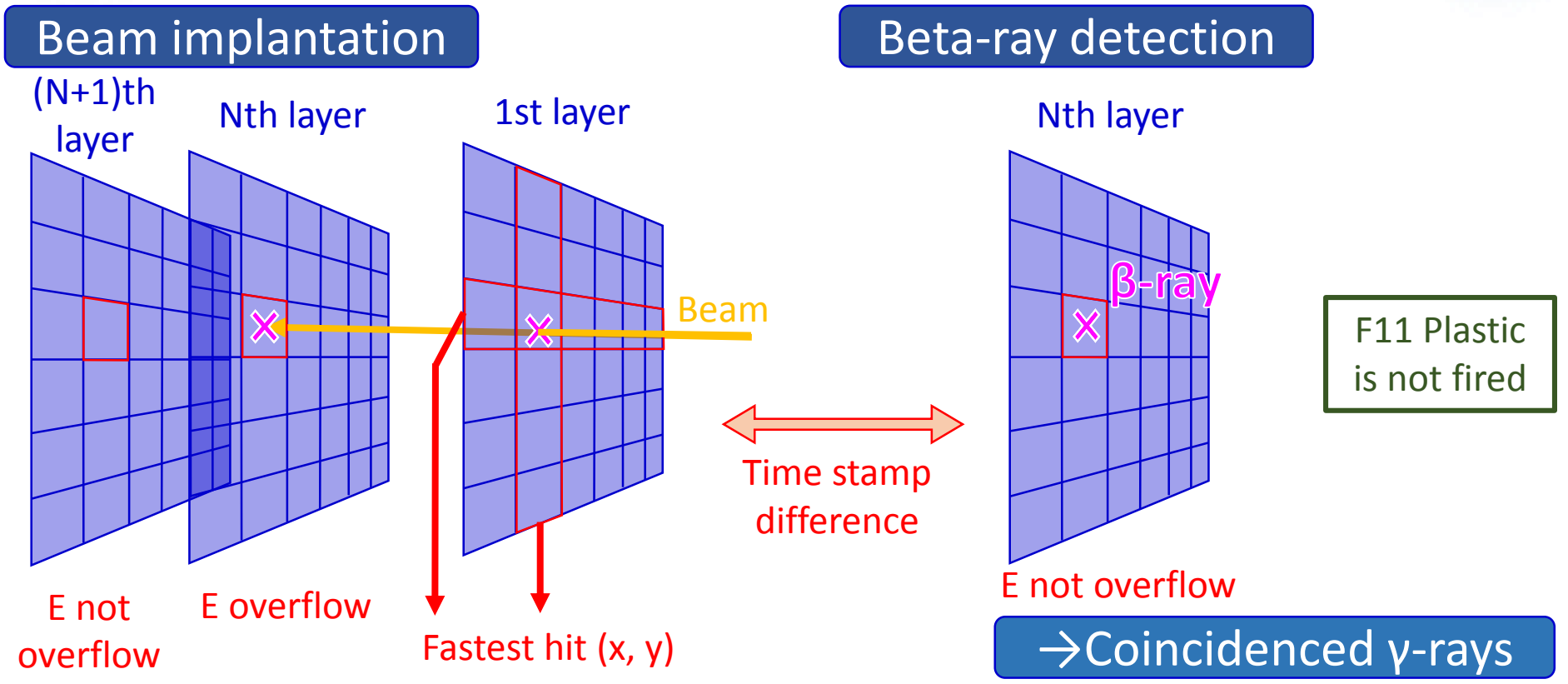
targeted nuclides

Octupole bands in Ba isotopes



- Octupole bands are known in Ba isotopes(Z=56,N～88)
- Theoretical values of β_3 for ^{150}Ba vary in calculations

β-decay measurement by WAS3ABi



- WAS3ABi (Double-Sided Silicon-Strip Detector)
- 60×40 strips (1mm width), 5 layers
- Identifies implant pos. and β-ray emission point.

Discussion on J^{π} of ^{150}Cs

- Proton:$3/2^{+}[422]$?

→from the J^{π} of 145Cs, 147Cs

- Neutron:

→from Nilsson diagram candidates

$$3/2[422] \otimes 5/2[523] \rightarrow 4^{-}$$
$$3/2[422] \otimes 3/2[651] \rightarrow 0^{+}$$
$$3/2[422] \otimes 3/2[521] \rightarrow 0^{-}$$
$$3/2[422] \otimes 5/2[642] \rightarrow 1^{+}$$

4^{-} is a reasonable possibility