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Spectroscopic study of neutron-rich Ru isotopes

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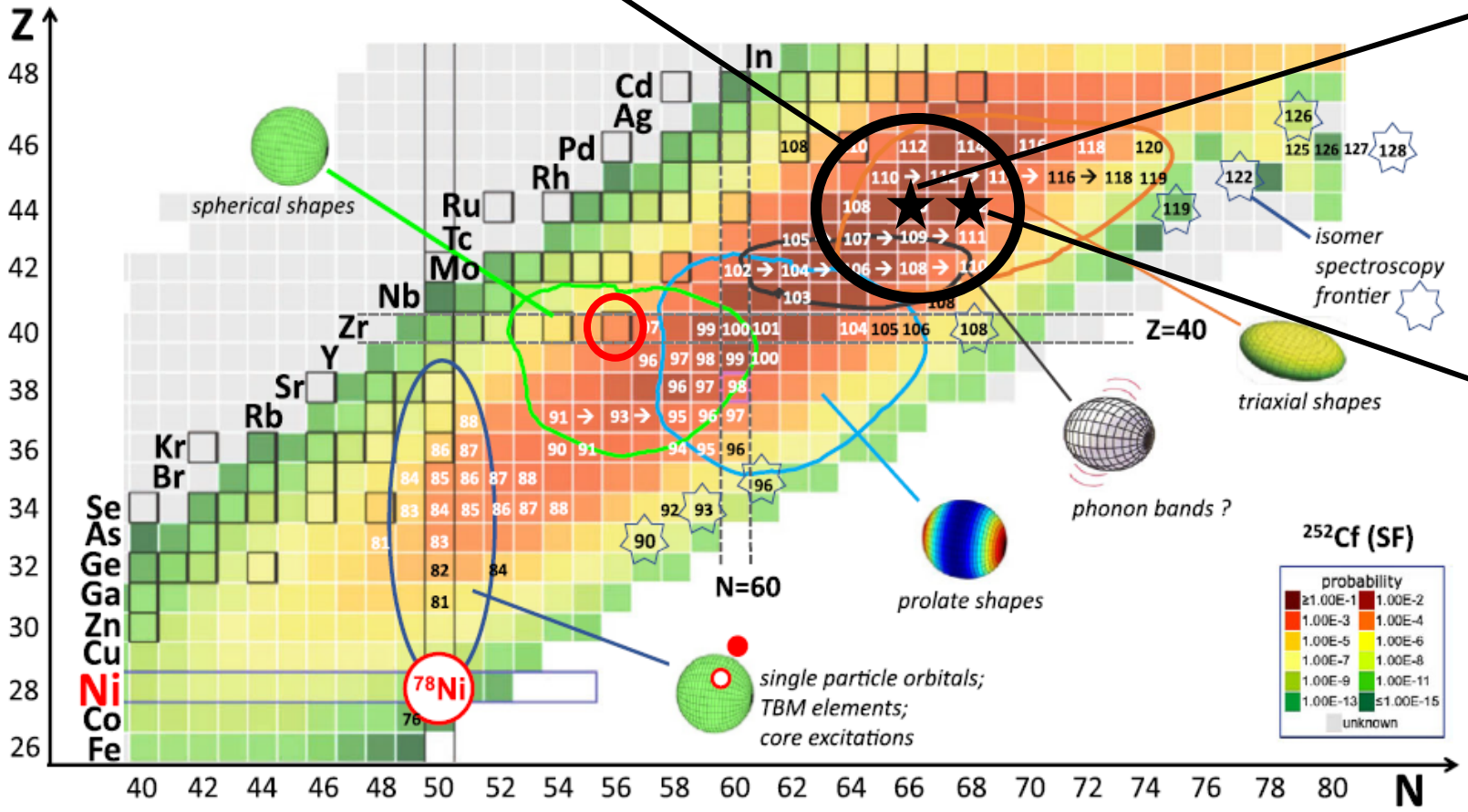
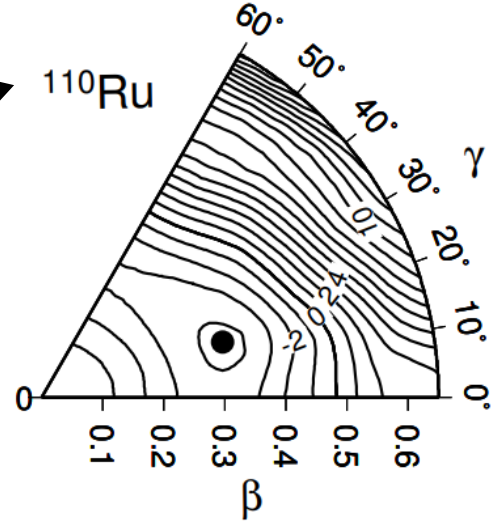
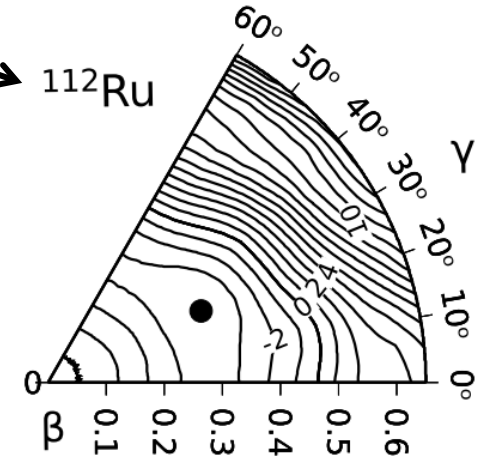
Introduction

A~110 region: Well-known shape transition area

- Few stable oblate shapes in chart of nuclides



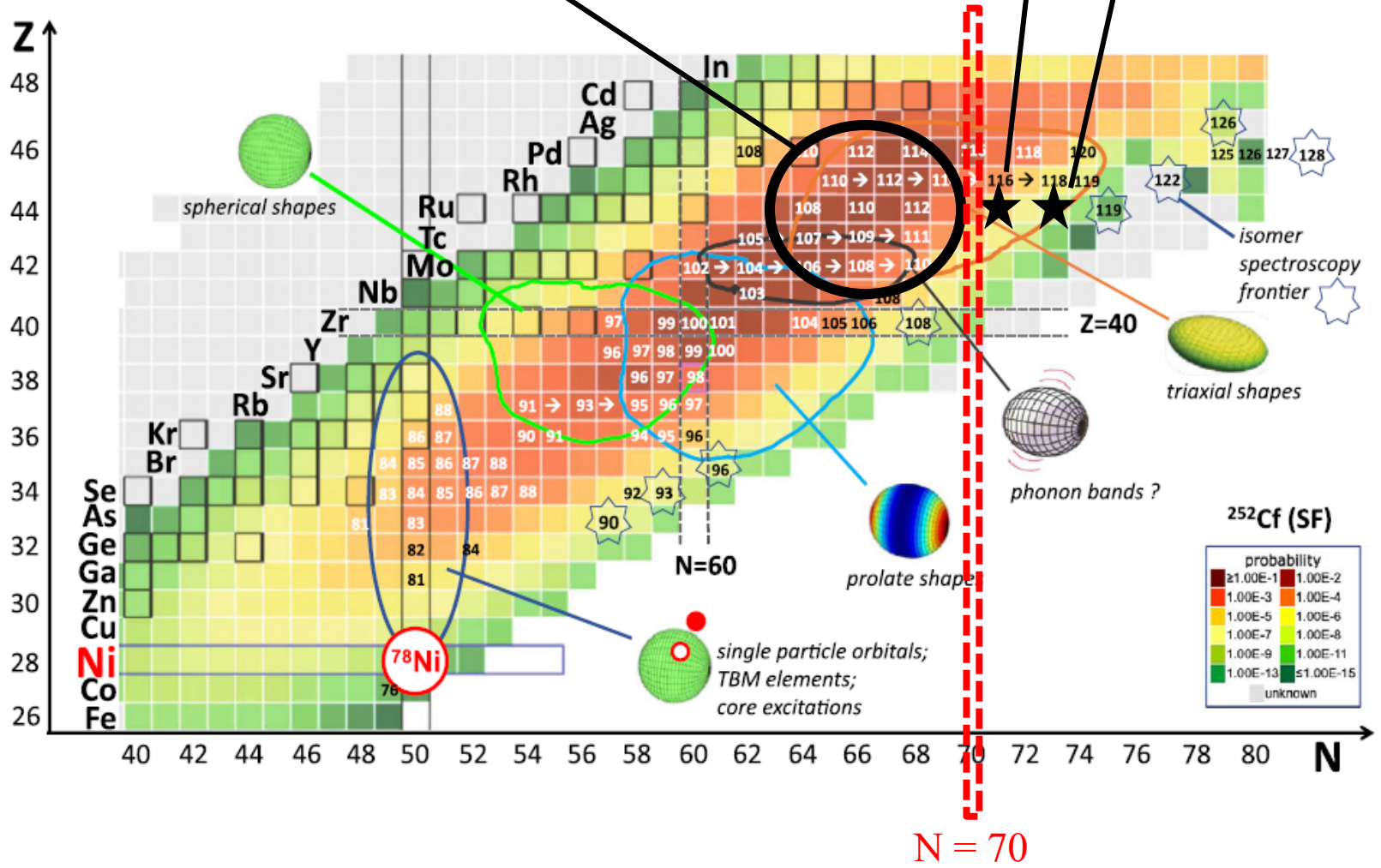




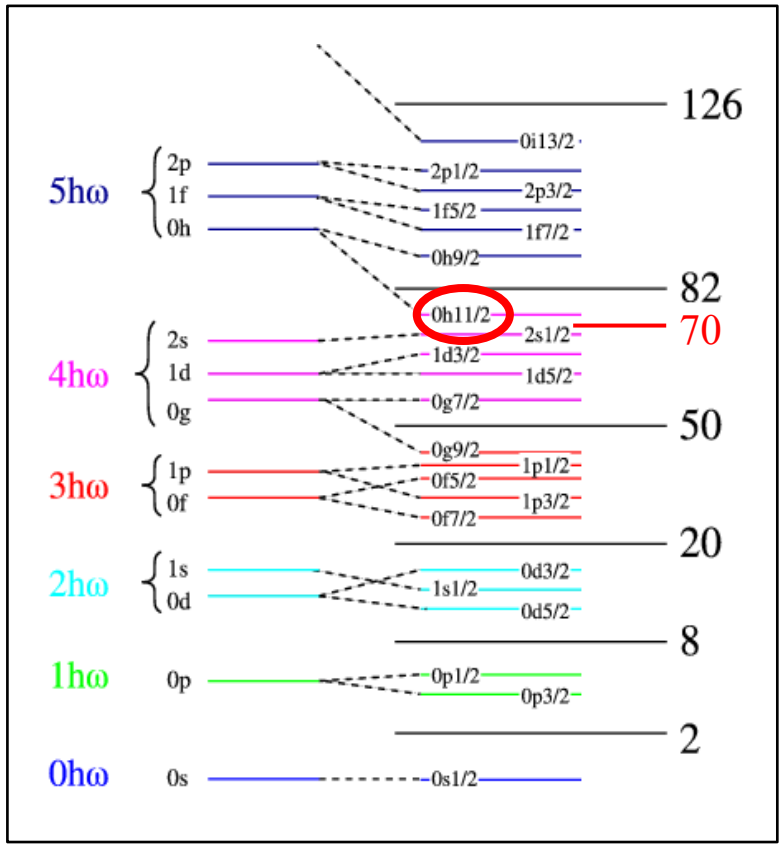
- Leoni et al., Riv. Nuovo Cim. 45, 461 (2022)
- Ch. Droste et al., Eur. Phys. J. A. 22, 179 (2002)

A~110 region: Well-known shape transition area

Target: ^{115}Ru ^{117}Ru (N = 71, 73)



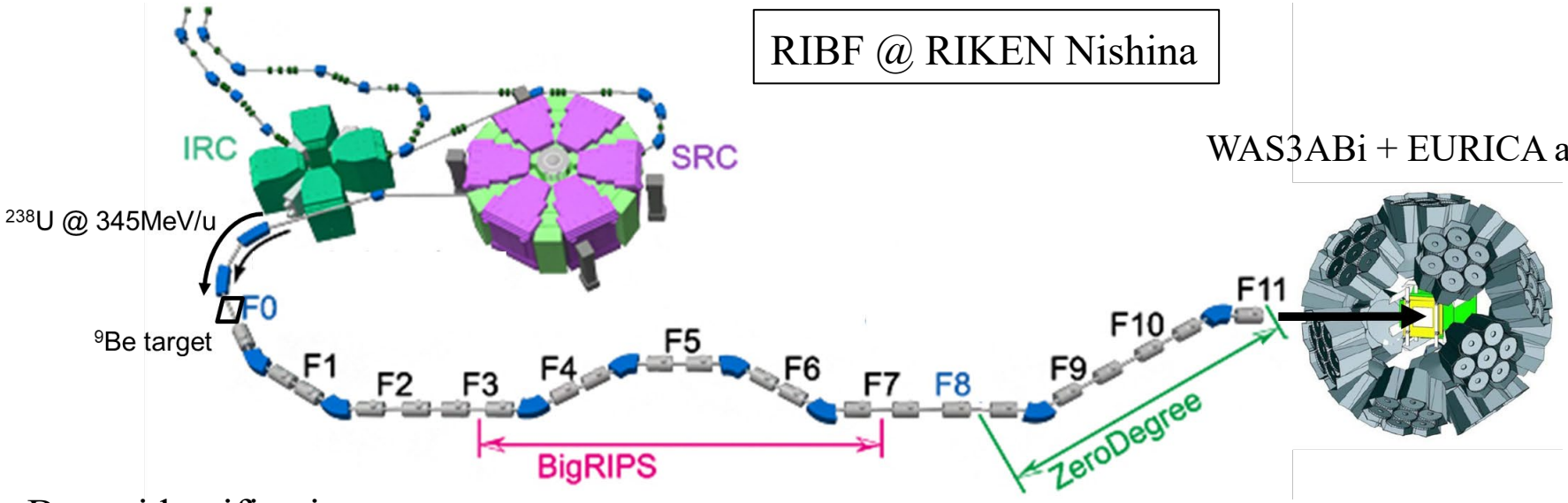
- The stability of oblate shapes will be strengthened when N > 70 (theory)



- Leoni et al., Riv. Nuovo Cim. 45, 461 (2022)
- F. R. Xu et al., Phys. Rev. C 65, 021303 (2002)

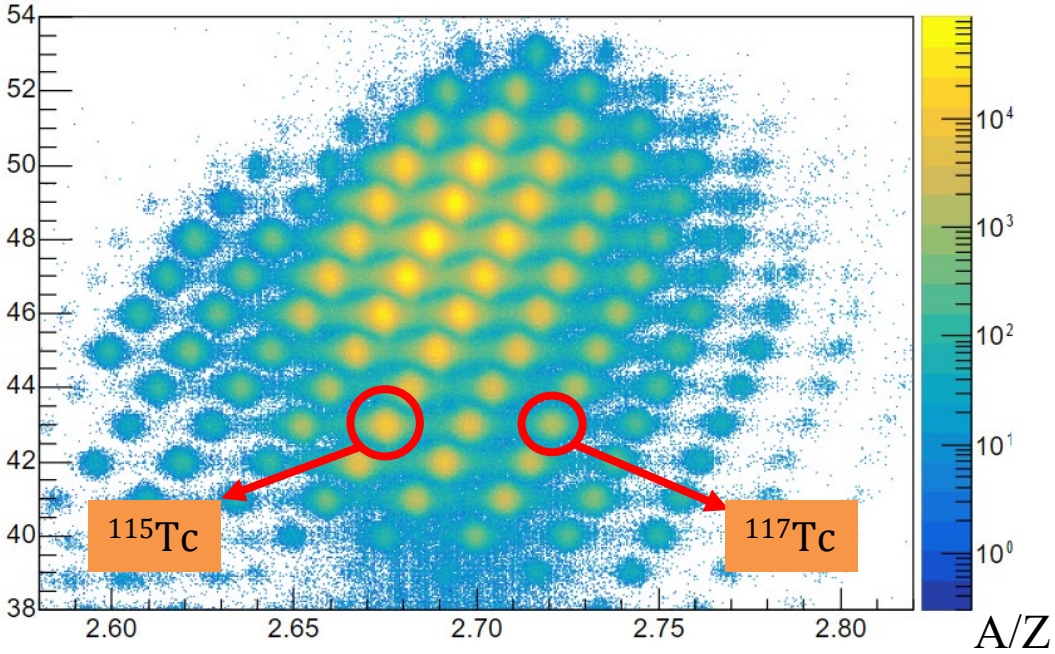
Experimental setup

RIBF @ RIKEN Nishina



WAS3ABi + EURICA array

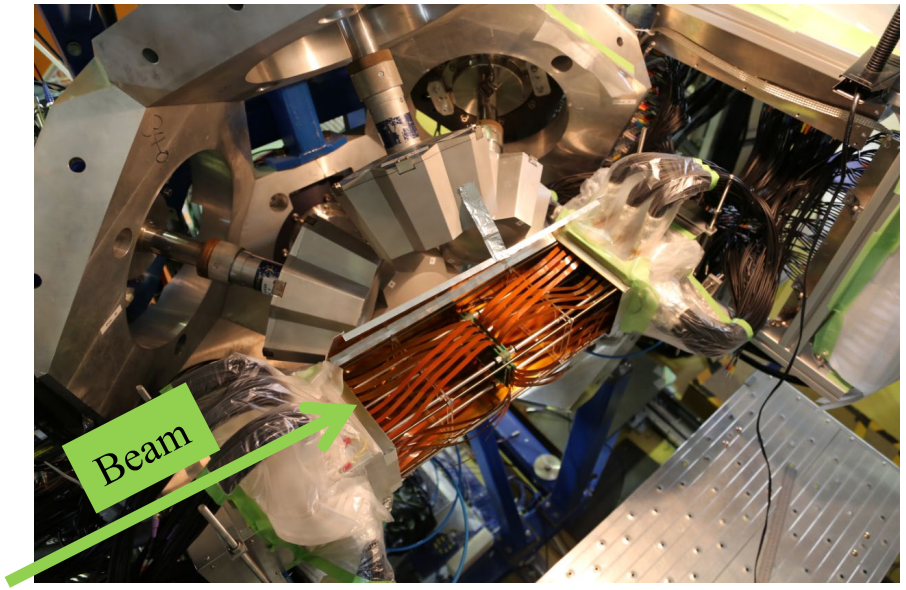
Beam identification

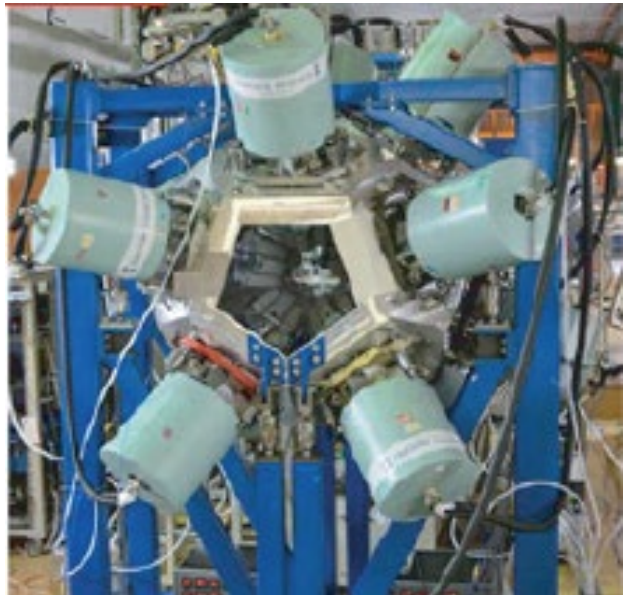


- Neutron-rich radioactive beam was produced by induced fission of ^{238}U
- ΔE-Bρ-TOF method (for beam identification)
  - 6.0×10^6 $^{115}\mathrm{Tc} \xrightarrow{\beta^-} {}^{115}\mathrm{Ru}$
  - 0.8×10^6 $^{117}\mathrm{Tc} \xrightarrow{\beta^-} {}^{117}\mathrm{Ru}$
- The beam finally implanted into WAS3ABi array and went through β-decay

- T. Kubo et al., Nucl. Instr. and Meth. B 204, 97 (2003)

Experimental setup





➢ β detection array

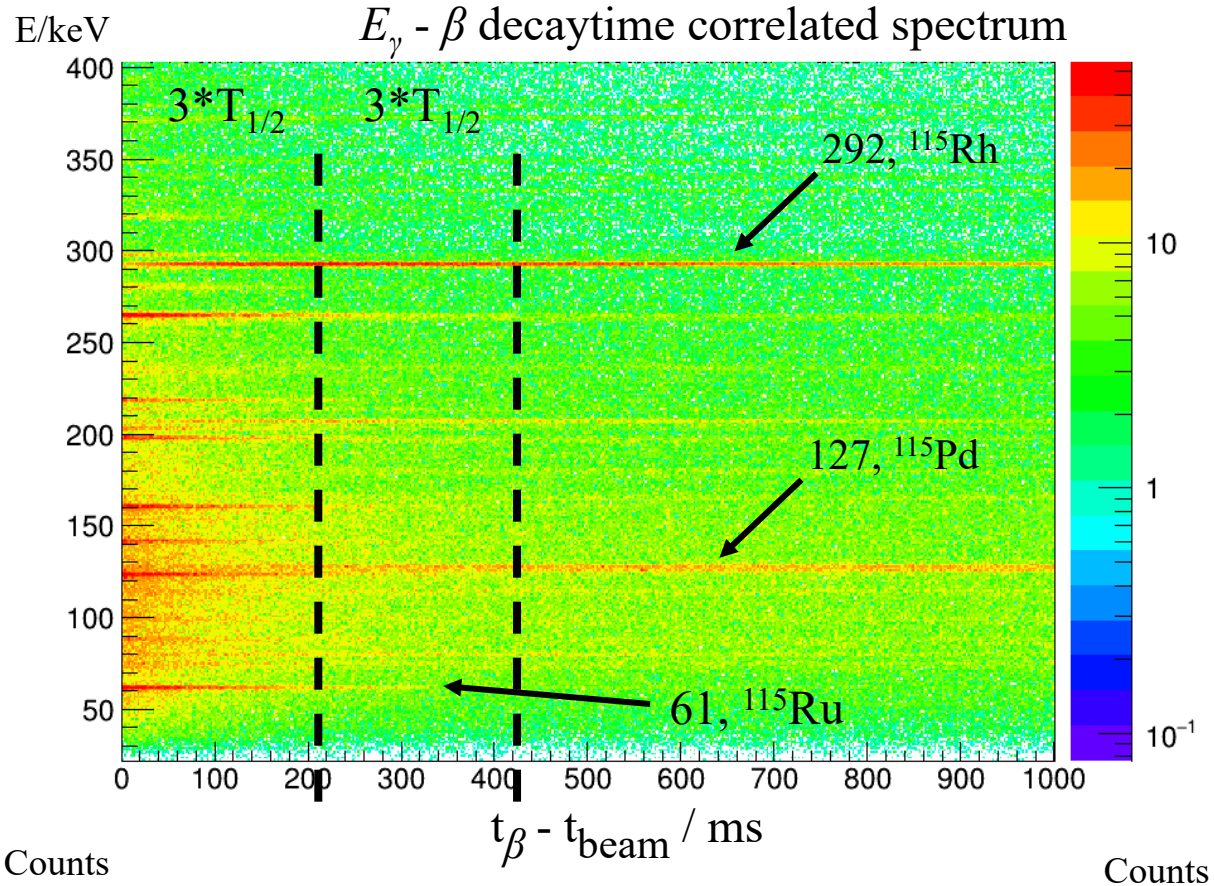
- 8 pieces of DSSD with 60×40 pixels (segmented)
- The heavy-ion beam implant and stop in DSSD, followed by β decay
- The time and positions of the implantation of heavy-ion and β-particle are used to reconstruct decay events

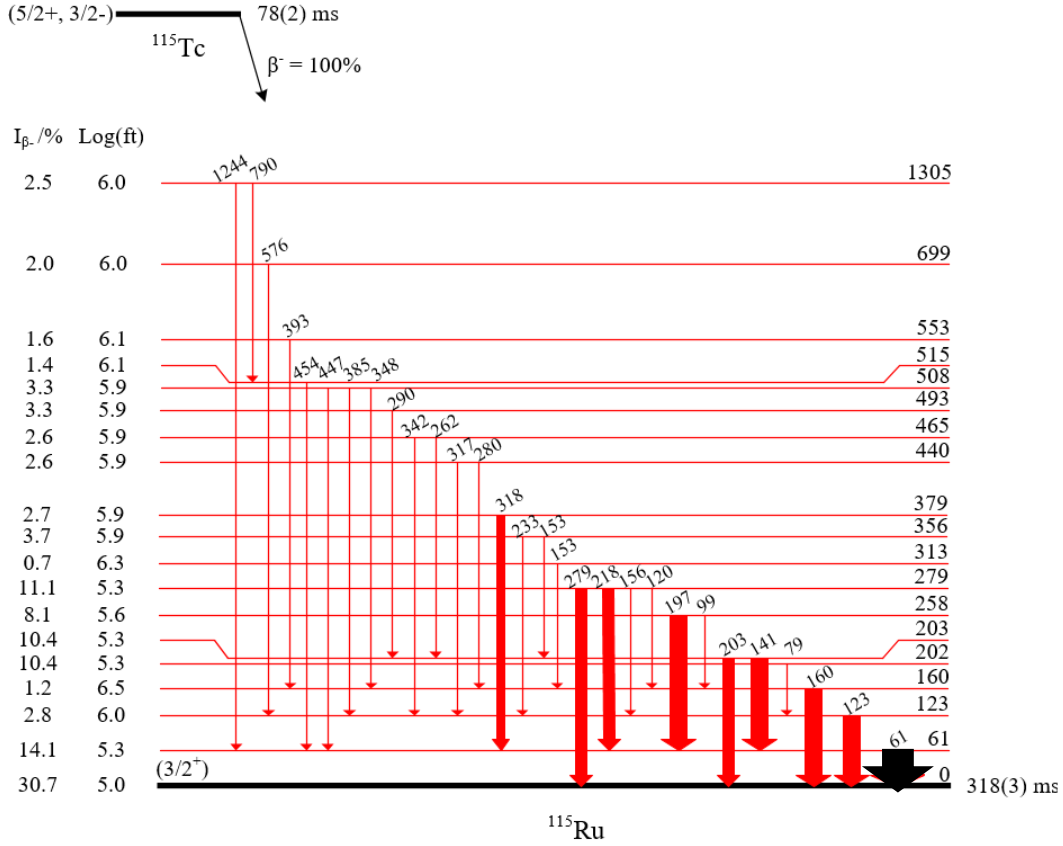
➢ γ detection array

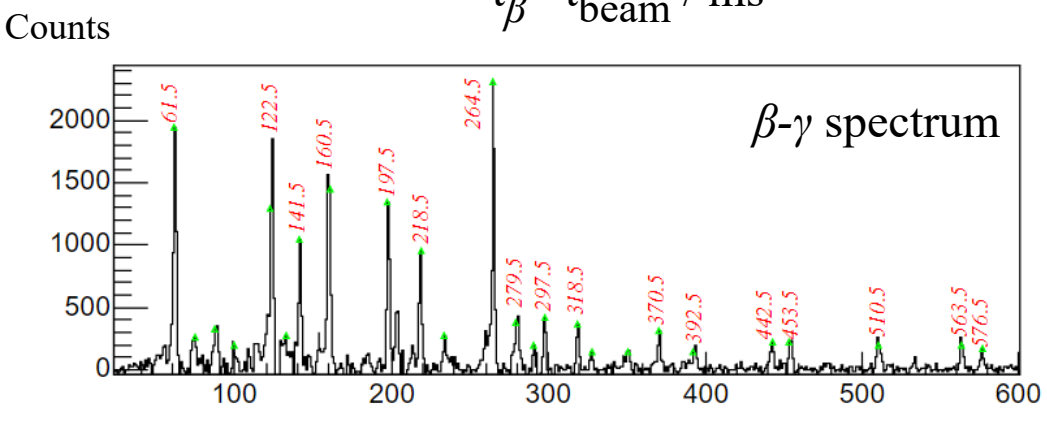
- EURICA，12 cluster detectors
- Detect γ-rays following β-decay
- Addback for higher efficiency

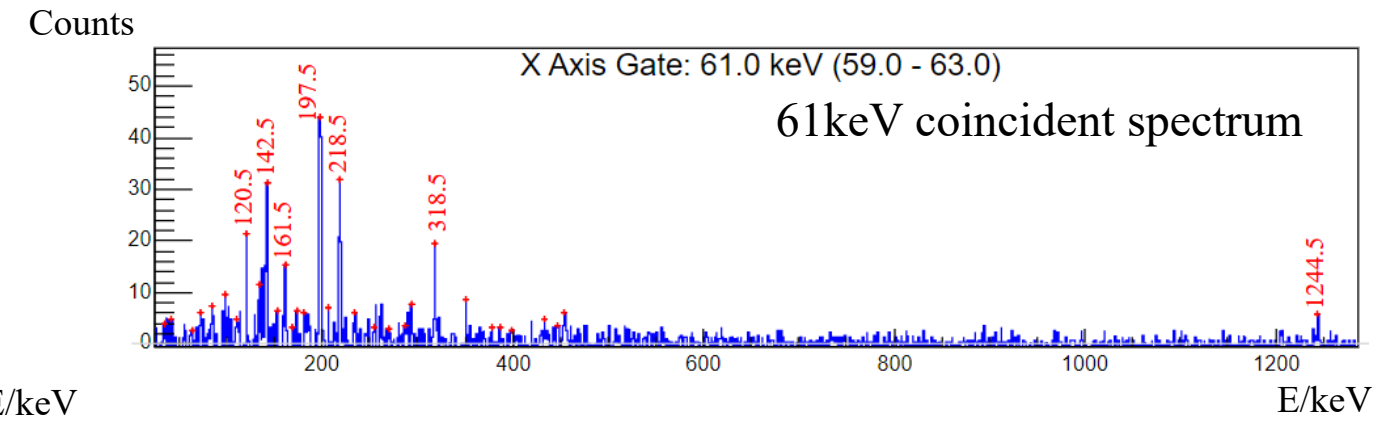
- S. Nishimura et al., Prog. Theo. Exp. Phys. 03C006 (2012)

Results of ^{115}Ru

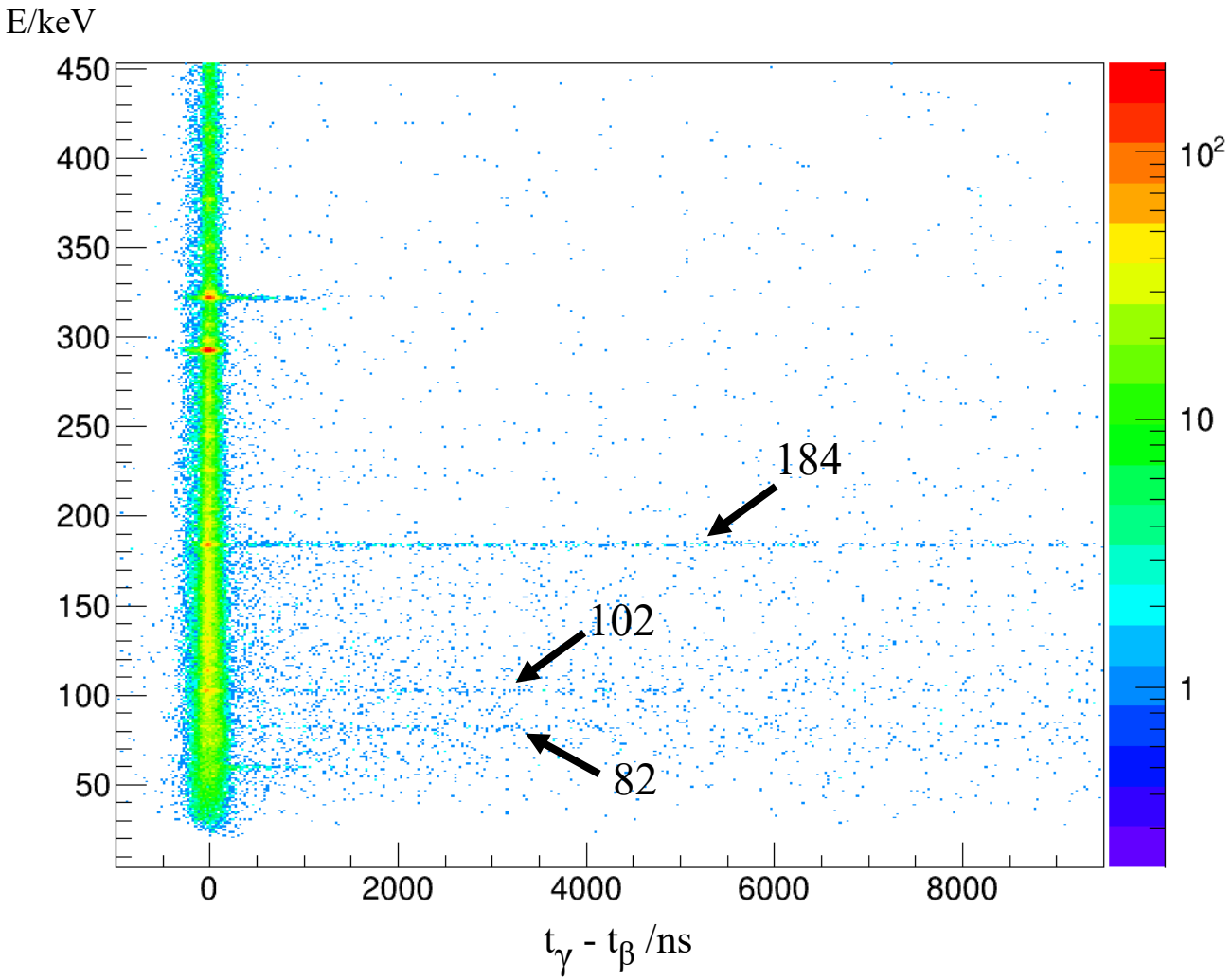


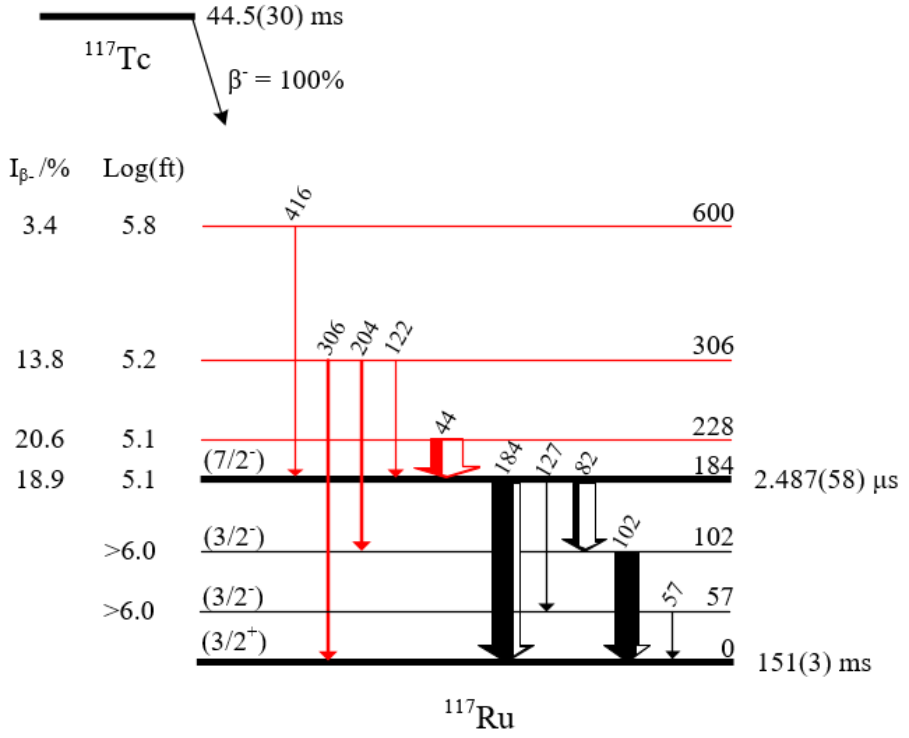


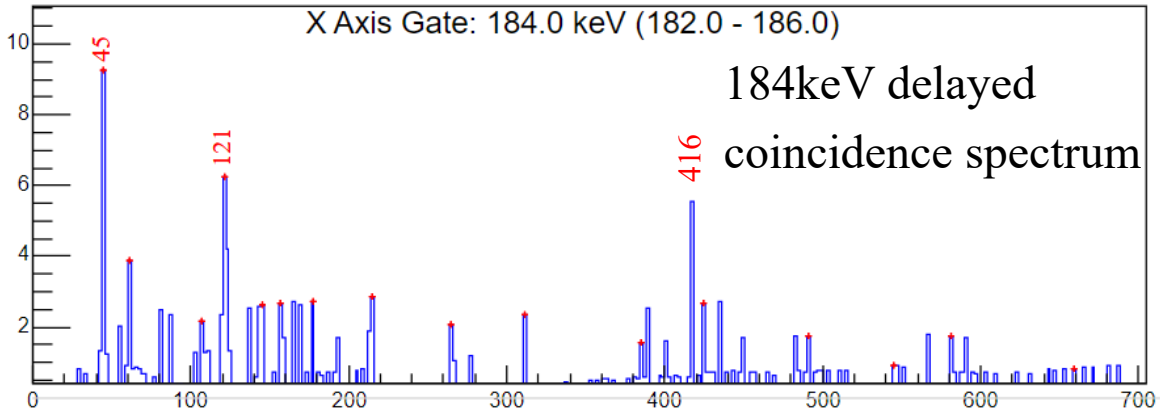




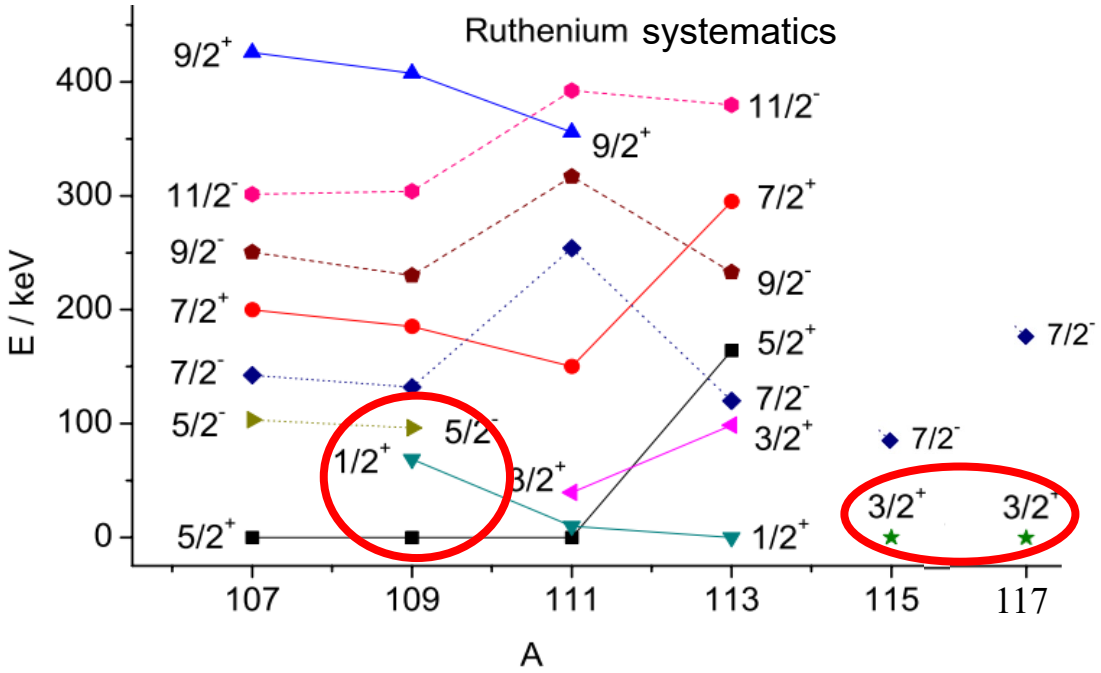
Results of ^{117}Ru

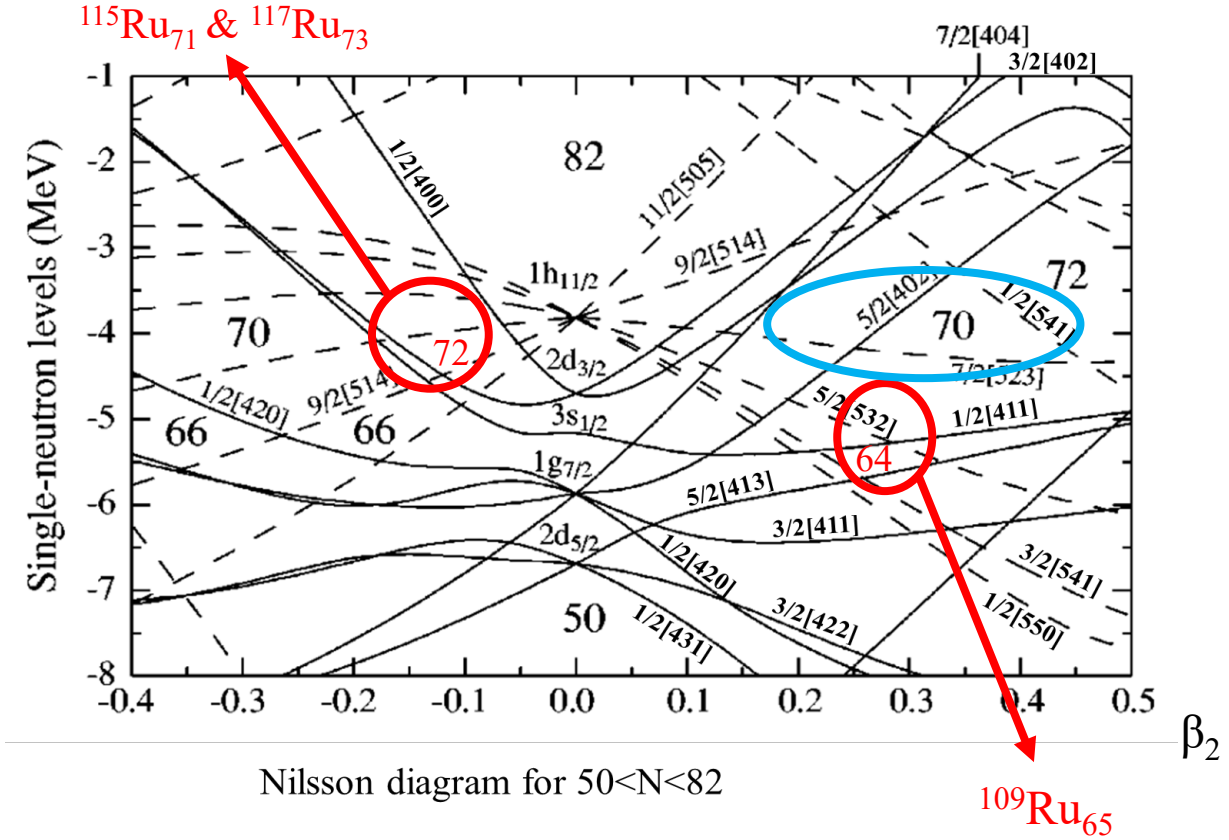






Systematics and Nilsson diagram



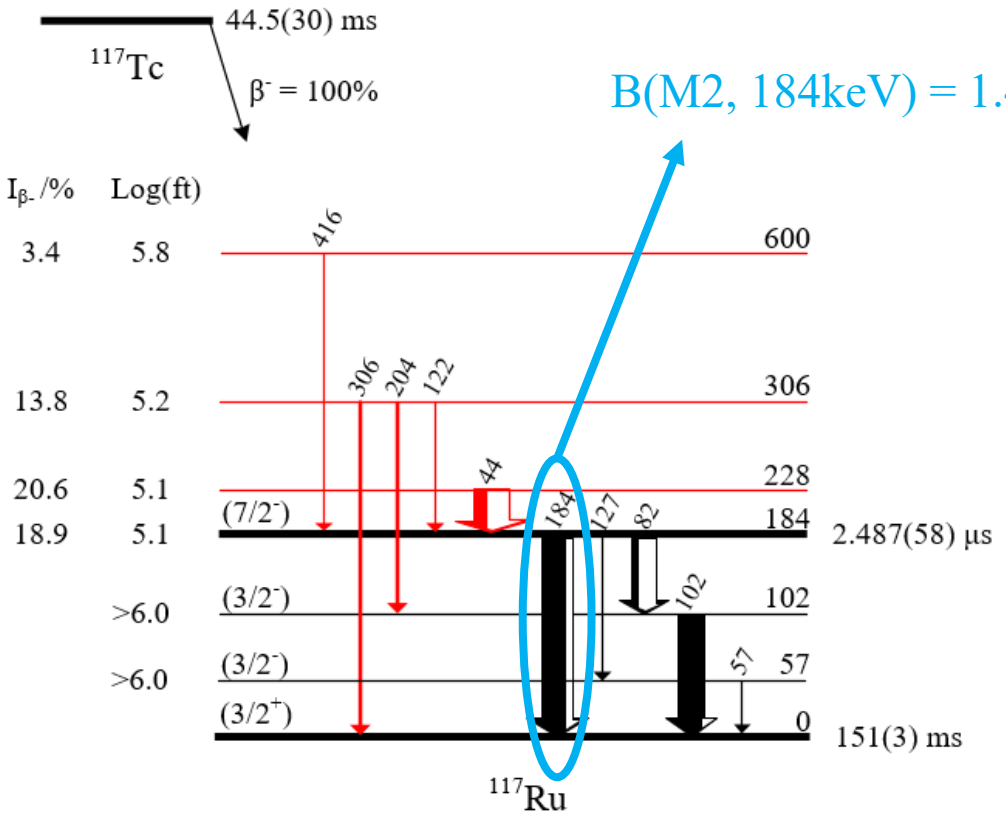


Nilsson diagram for 50<N<82

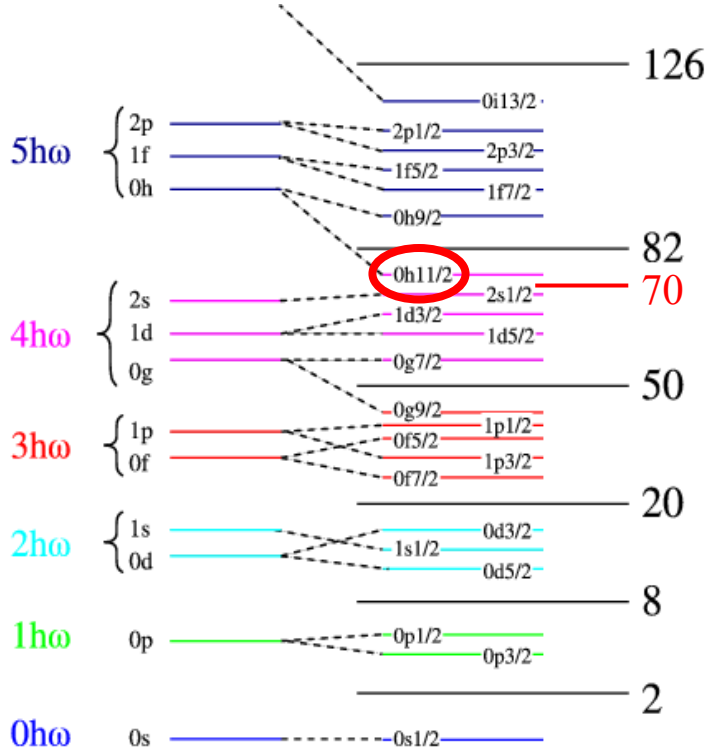
- ^{109}Ru has prolate deformation of $\beta_2 \sim 0.3$ (probably with some triaxial degrees of freedom)
- No $3/2^+$ orbital in the vicinity of N = 72 Fermi surface on the prolate side
- One could find such orbital on the oblate side as the g.s. of ^{115}Ru ^{117}Ru

- J. Rissanen et al., Eur. Phys. J. A 47, 97 (2011)
- F. R. Xu et al., Phys. Rev. C 65, 021303 (2002)

Transition probability



B(M2, 184keV) = 1.4(3) W.u.



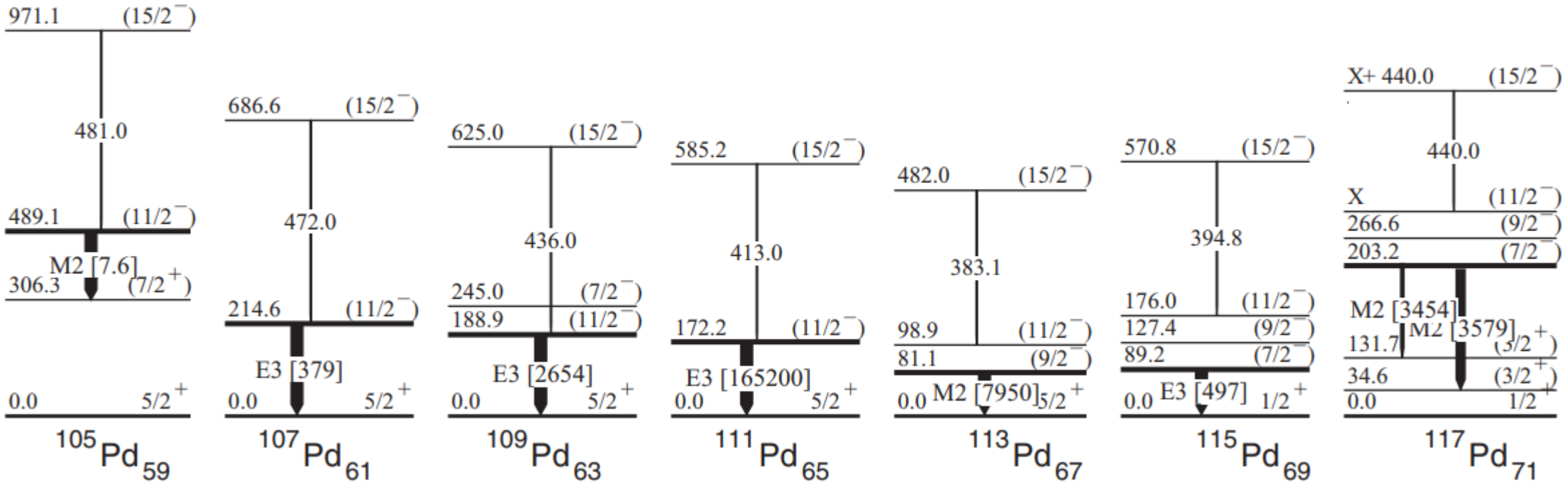
- 7/2- isomer comes from $h_{11/2}$ intruder orbit, with little mixing and (near) sphere shape
- B(M2, 184keV) ~ 1 W.u., indicating a small structural difference between g.s. and isomer
- This is consistent with the slight oblate deformation of ^{117}Ru g.s.

Summary

- The level scheme of ^{115}Ru and ^{117}Ru are established through the spectroscopic study of β-decay.

- Based on the analysis of spin and parity and transition probability, the g.s. of ^{115}Ru and ^{117}Ru are assumed to be slightly oblate deformed, which could be the shape transition point of Ru isotopes.

Thank you for listening!


971.1 (15/2⁻)
481.0
489.1 (11/2⁻)
M2 [7.6]
306.3 (7/2⁺)
0.0 5/2⁺
105Pd59
686.6 (15/2⁻)
472.0
214.6 (11/2⁻)
E3 [379]
0.0 5/2⁺
107Pd61
625.0 (15/2⁻)
436.0
245.0 (7/2⁻)
188.9 (11/2⁻)
E3 [2654]
0.0 5/2⁺
109Pd63
585.2 (15/2⁻)
413.0
172.2 (11/2⁻)
E3 [165200]
0.0 5/2⁺
111Pd65
482.0 (15/2⁻)
383.1
98.9 (11/2⁻)
81.1 (9/2⁻)
0.0 M2 [7950] 5/2⁺
113Pd67
570.8 (15/2⁻)
394.8
176.0 (11/2⁻)
127.4 (9/2⁻)
89.2 (7/2⁻)
0.0 E3 [497] 1/2⁺
115Pd69
X+ 440.0 (15/2⁻)
440.0
X (11/2⁻)
266.6 (9/2⁻)
203.2 (7/2⁻)
M2 [3454]
M2 [3579]
131.7 (3/2⁺)
34.6 (3/2⁺)
0.0 1/2⁺
117Pd71

Palladium