Anomalous $B_{4/2}$ in the Osmium isotopic chain

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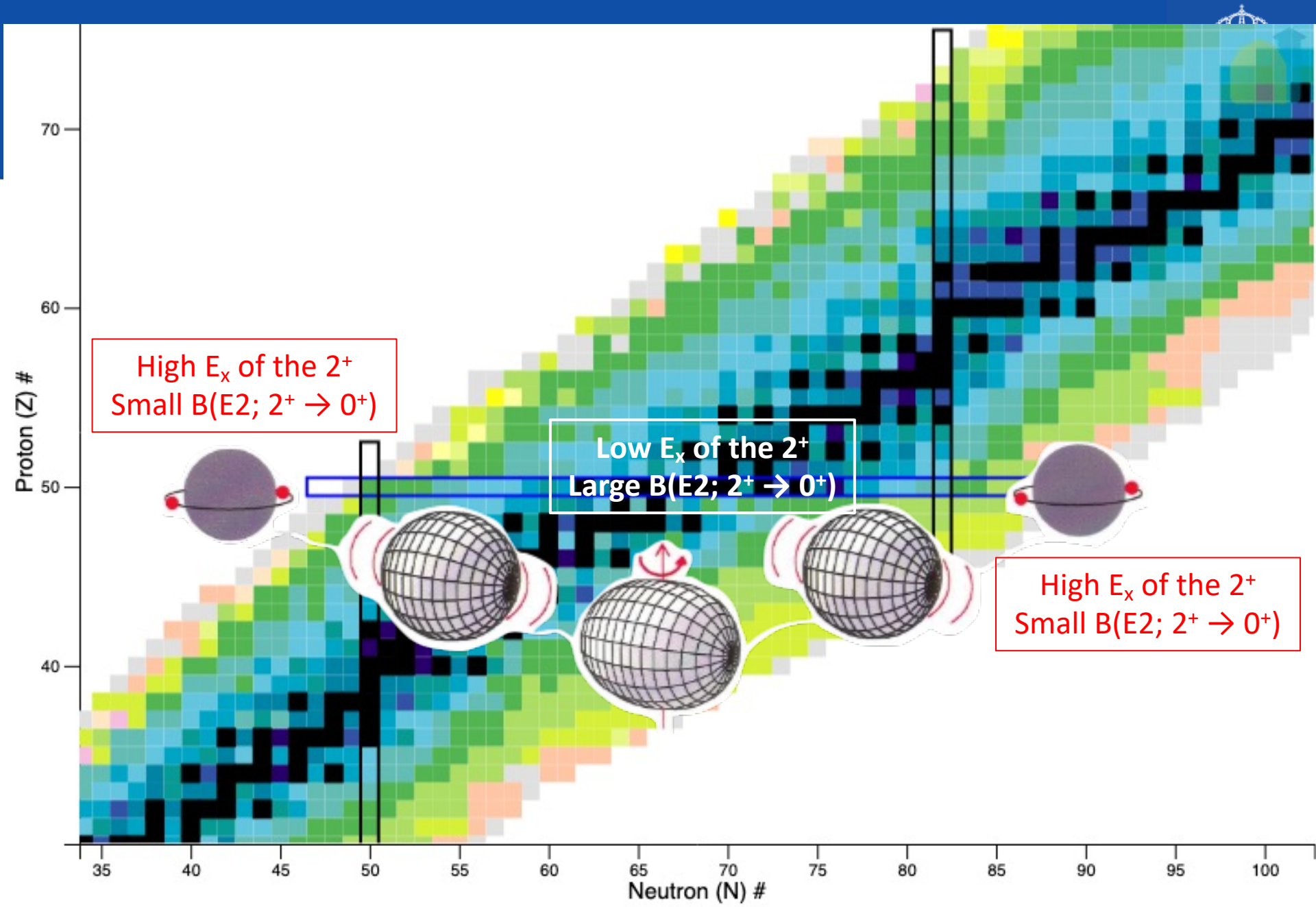
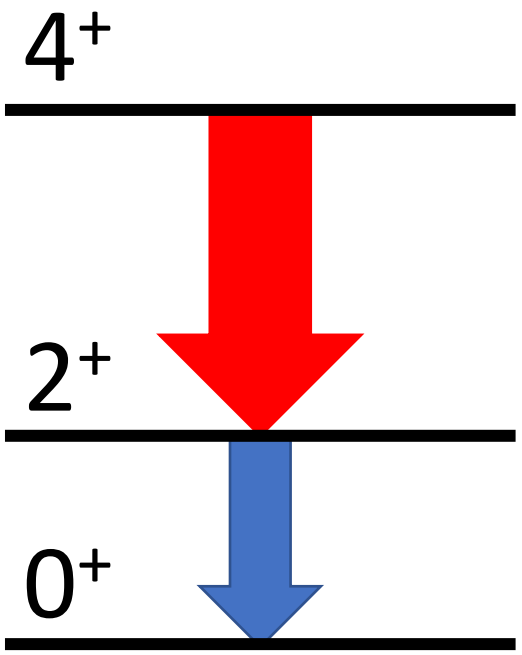

High E_x of the 2^+
Small B(E2; $2^+ \rightarrow 0^+$)
Low E_x of the 2^+
Large B(E2; $2^+ \rightarrow 0^+$)
High E_x of the 2^+
Small B(E2; $2^+ \rightarrow 0^+$)
Proton (Z) #
Neutron (N) #
70
60
50
40
35
40
45
50
55
60
65
70
75
80
85
90
95
100

The $B_{4/2}$ anomaly

$$R_{4/2} = \frac{E_X(4^+)}{E_X(2^+)} > 2$$

$$B_{4/2} = \frac{B(E2;\ 4^+ \rightarrow 2^+)}{B(E2; 2^+ \rightarrow 0^+)} > 1$$

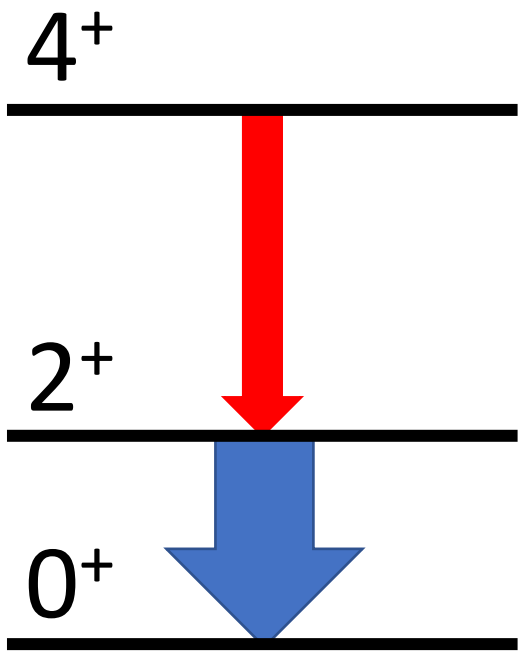
$R_{4/2} > 2$ & $B_{4/2} > 1$
for collective nuclei



The $B_{4/2}$ anomaly

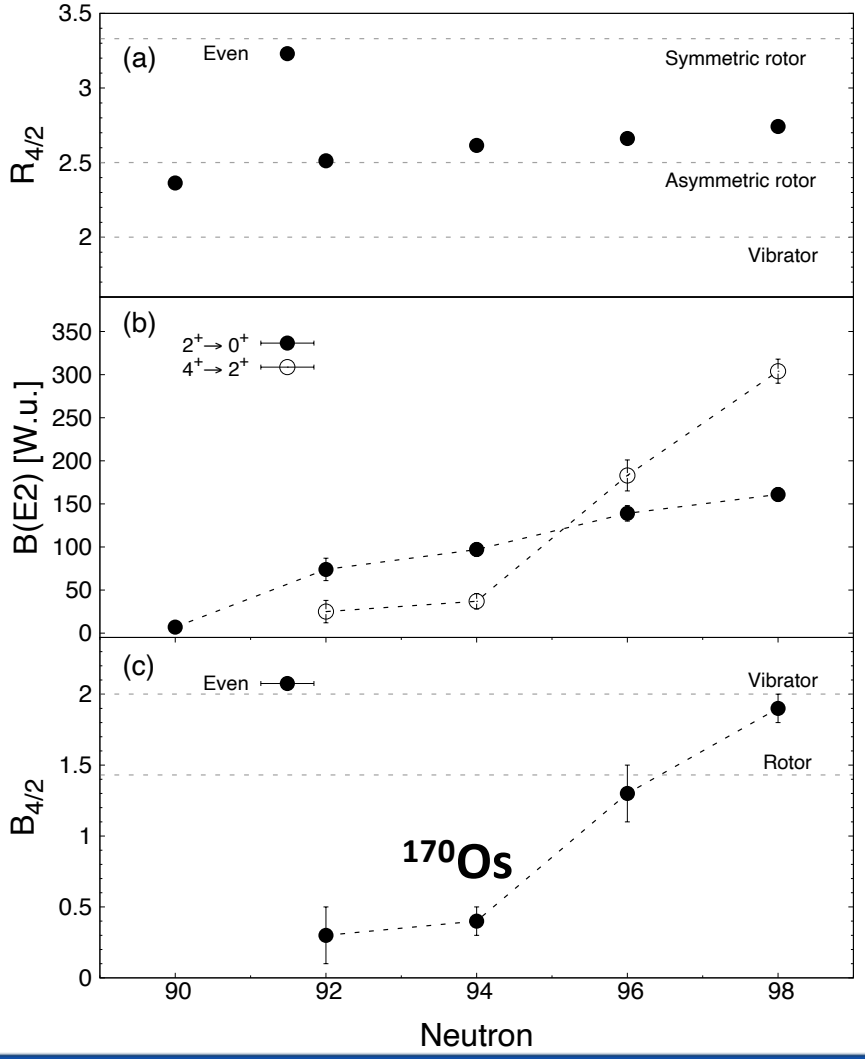
$B_{4/2} < 1$ in mid-shell nuclei!

Observed in: ^{114}Te, ^{166}W, ^{172}Pt, ^{168,170}Os…



$B_{4/2}$ anomaly in Os

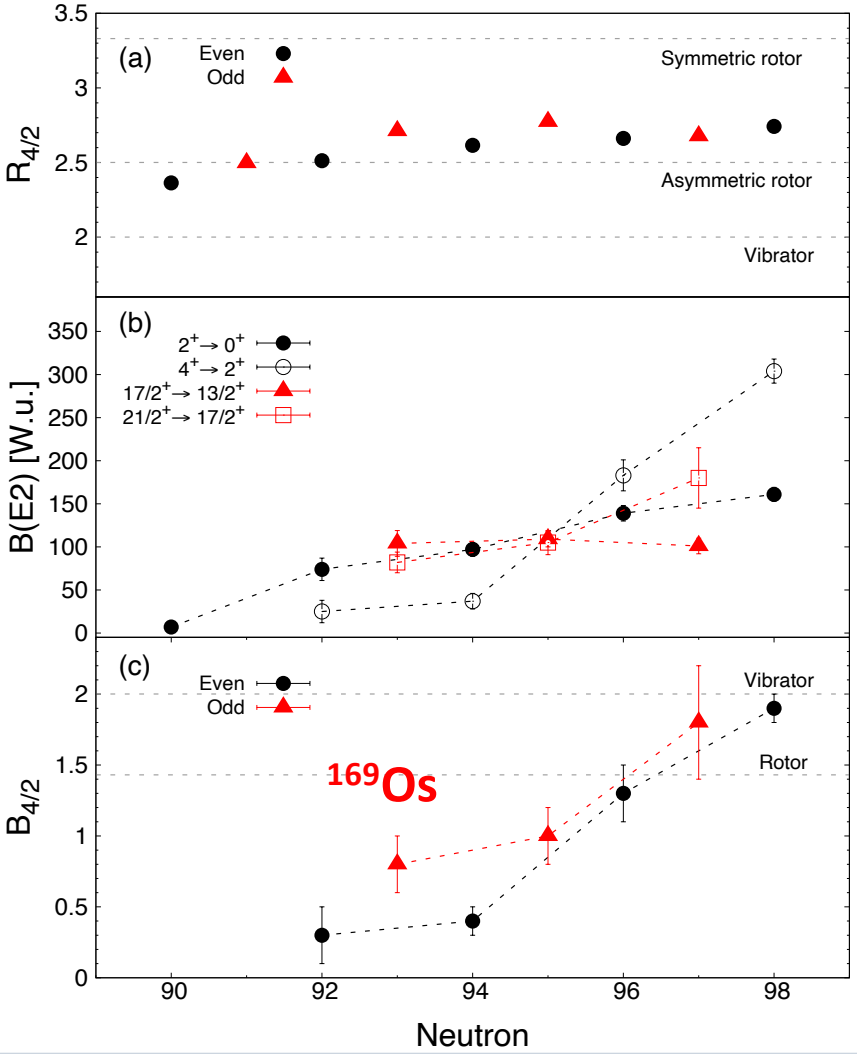
- **Seniority-like scenario;**
  [B. Cederwall et al., PRL 121 (2018)]
- **IBM calculation: triaxial rotor;**
  [Y. Zhang et al., PLB 834 (2022)]
- **No shape change;**
  [T. Grahn et al., PRC 94 (2016),
  A. Goasduff et al., PRC 100 (2019)]



$B_{4/2}$ anomaly in Os

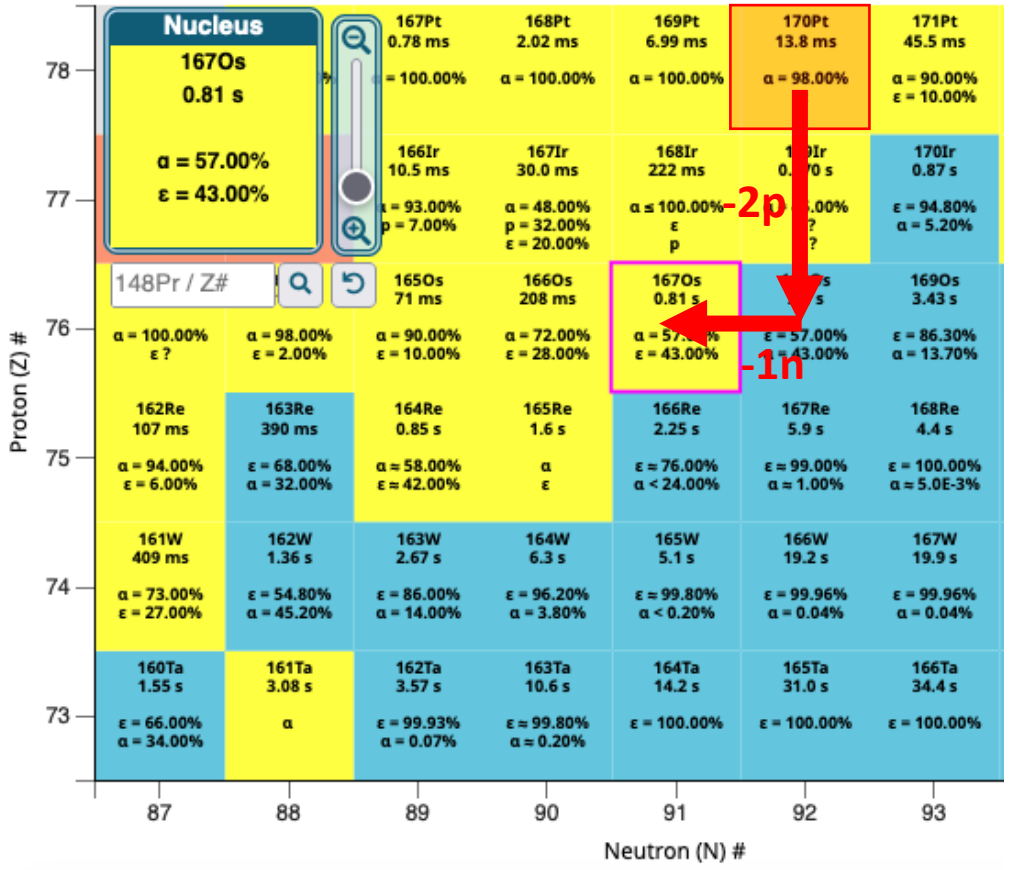
$$B_{4/2} = \frac{B(E2;\ 21/2^+ \rightarrow 17/2^+)}{B(E2; 17/2^+ \rightarrow 13/2^+)}$$

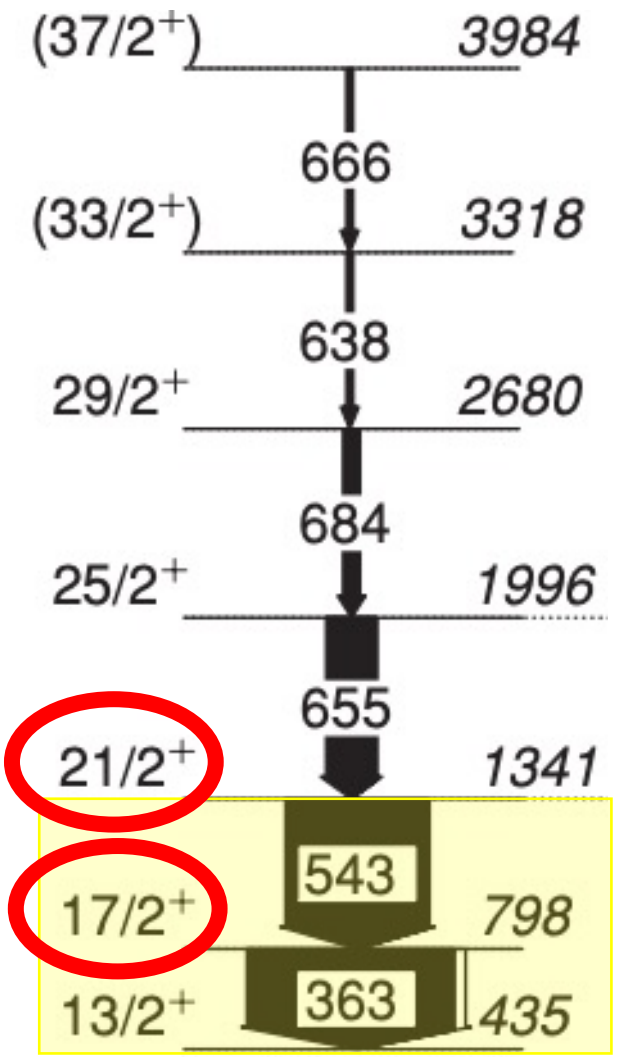
- **$B_{4/2}$ = 0.79(16) in ^{169}Os**
  [W. Zhang et al., PLB 820 (2022)]
- **Same trend of the even isotopes**
- **Role of unpaired neutron?**



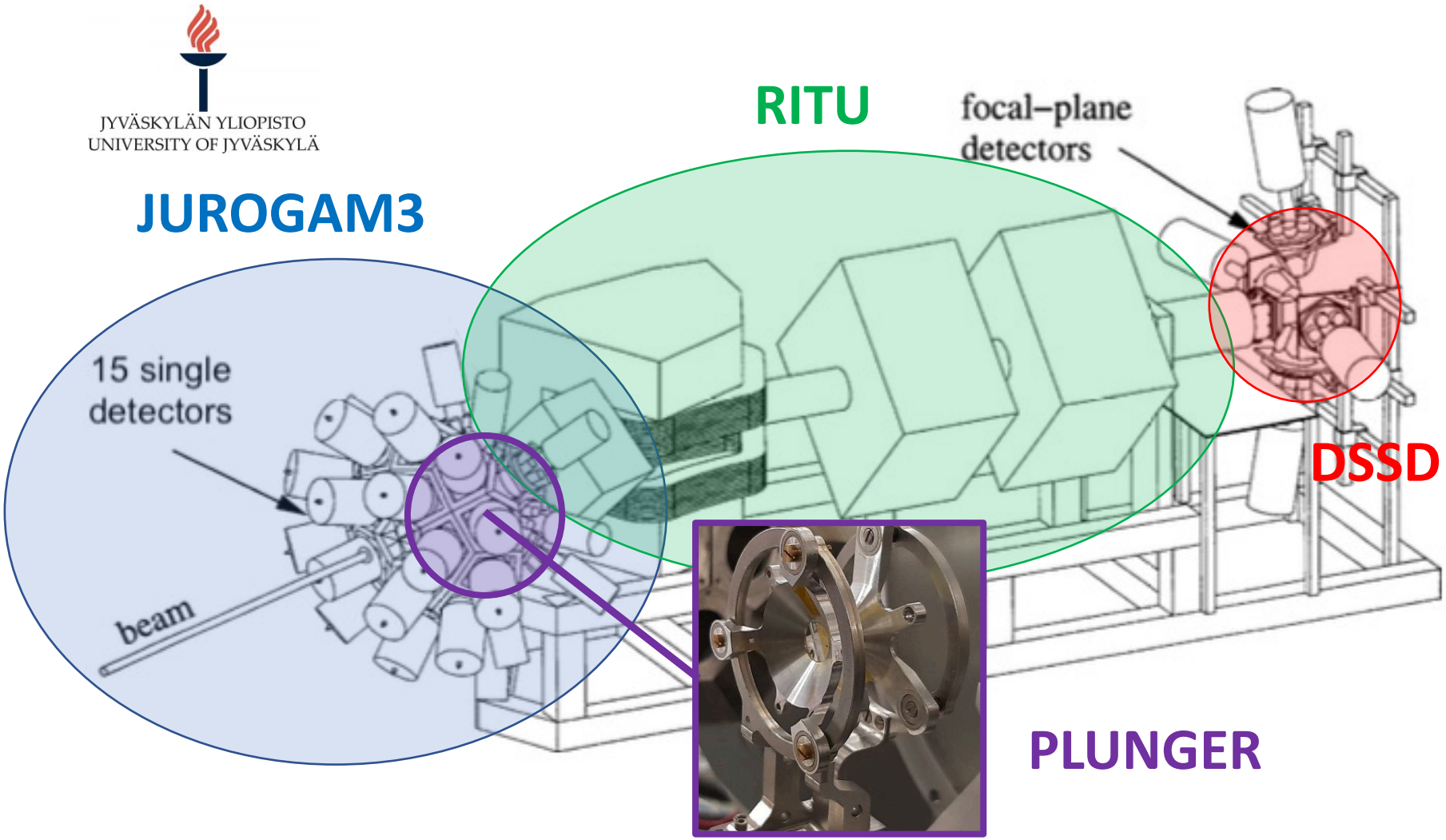
^{167}Os study case

FE Reaction: ^{78}Kr(^{92}Mo,2pn)^{167}Os @ 360 MeV

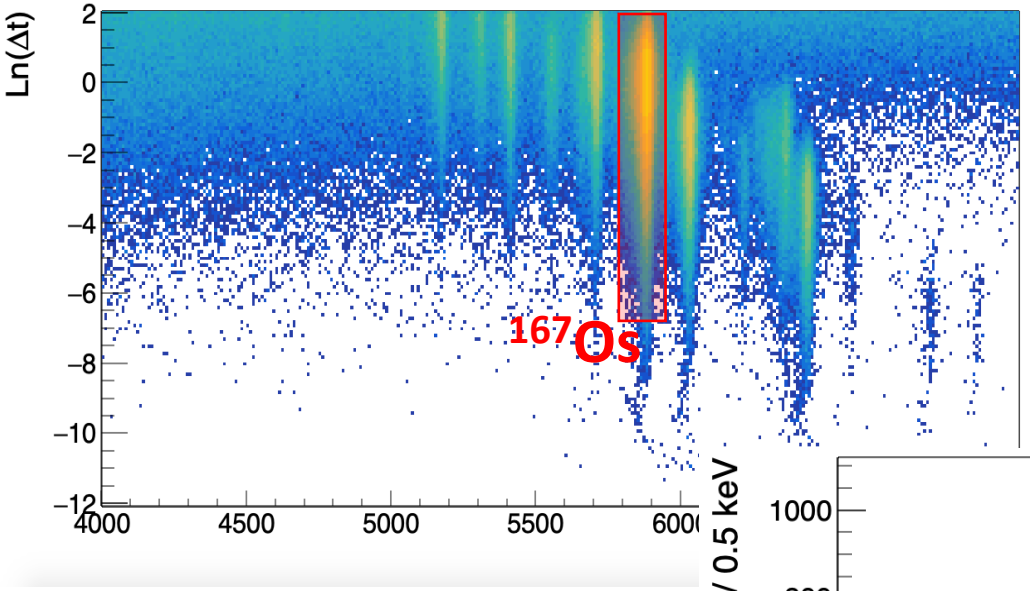




Experimental setup



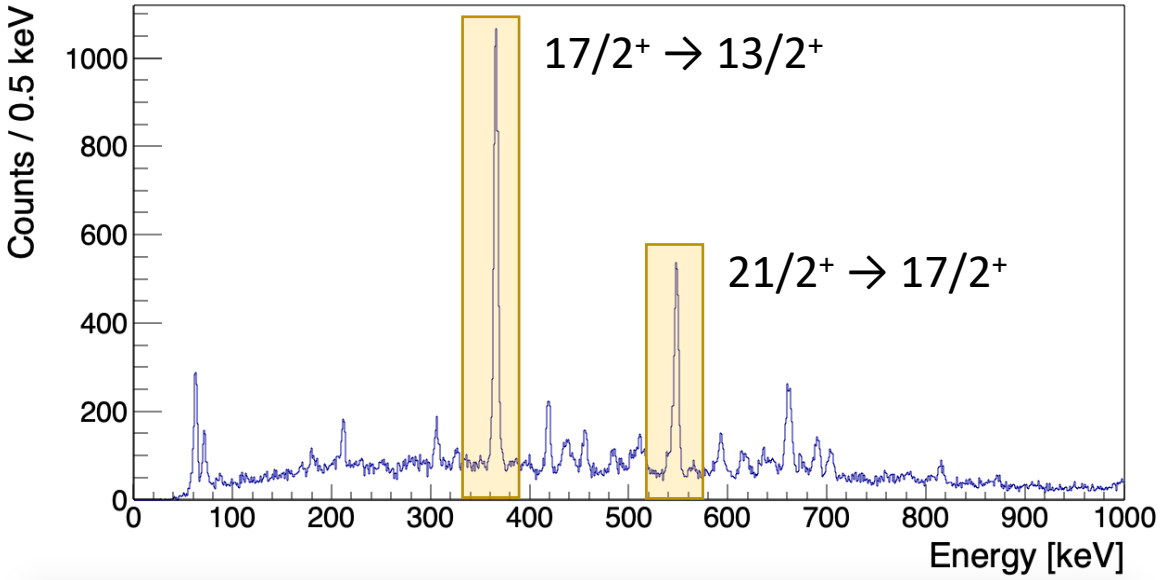
Recoil-alpha tagging



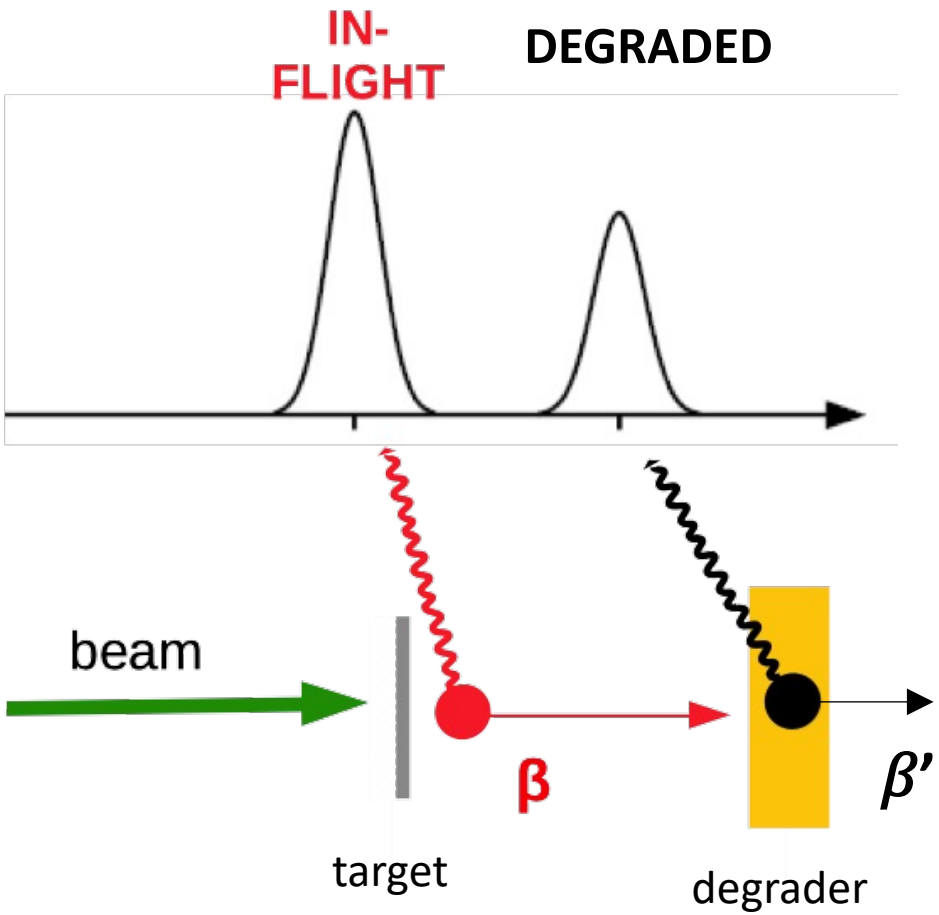
DSSD:

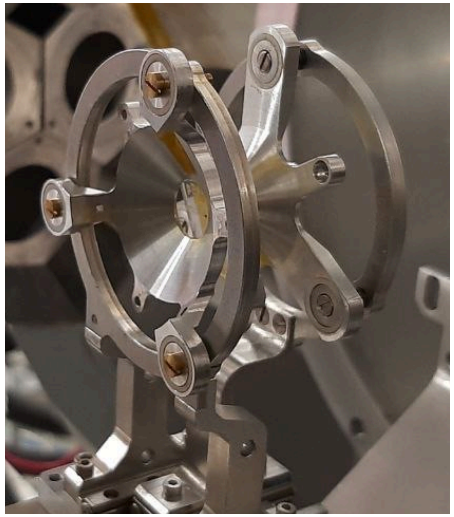
- Detection of reaction product;
- Recoil-alpha tagging

Gamma-ray spectrum obtained in coincidence with the alpha-decay at 5839 keV



RDDS method



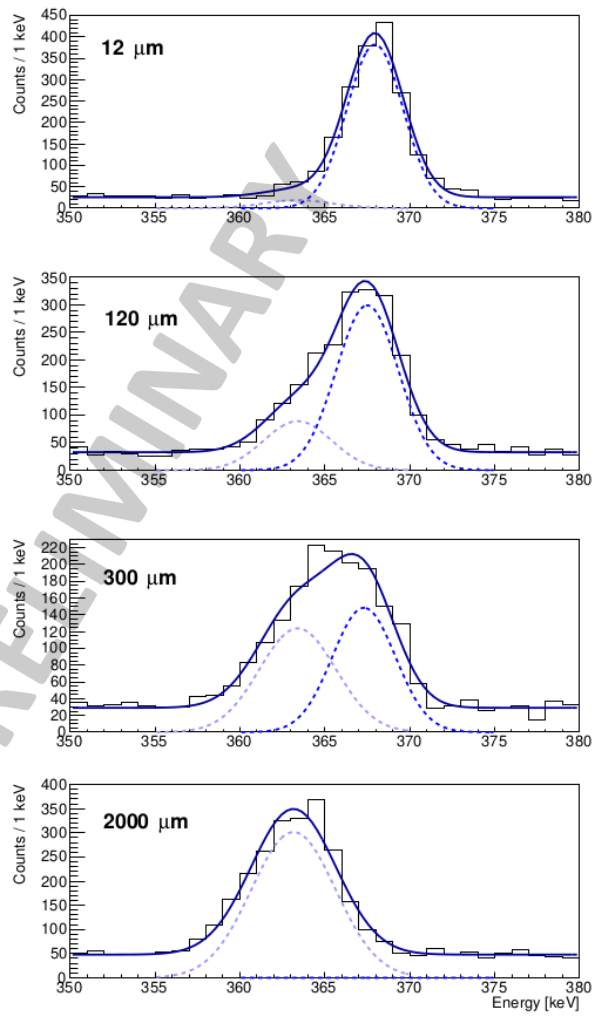


$$Ratio = \frac{D}{(IF + D)}$$

Depends on:

- the speed;
- the distance;
- the lifetime!

The 17/2$^+$ state



α-γ concidence spectra

Normalized degraded component

Measured contribution of the feeder

$$\tau_i(x) = -\frac{R_i(x) - \sum_k b_{ki}\alpha_{ki}R_k(x)}{v\frac{d}{dx}R_i(x)}$$

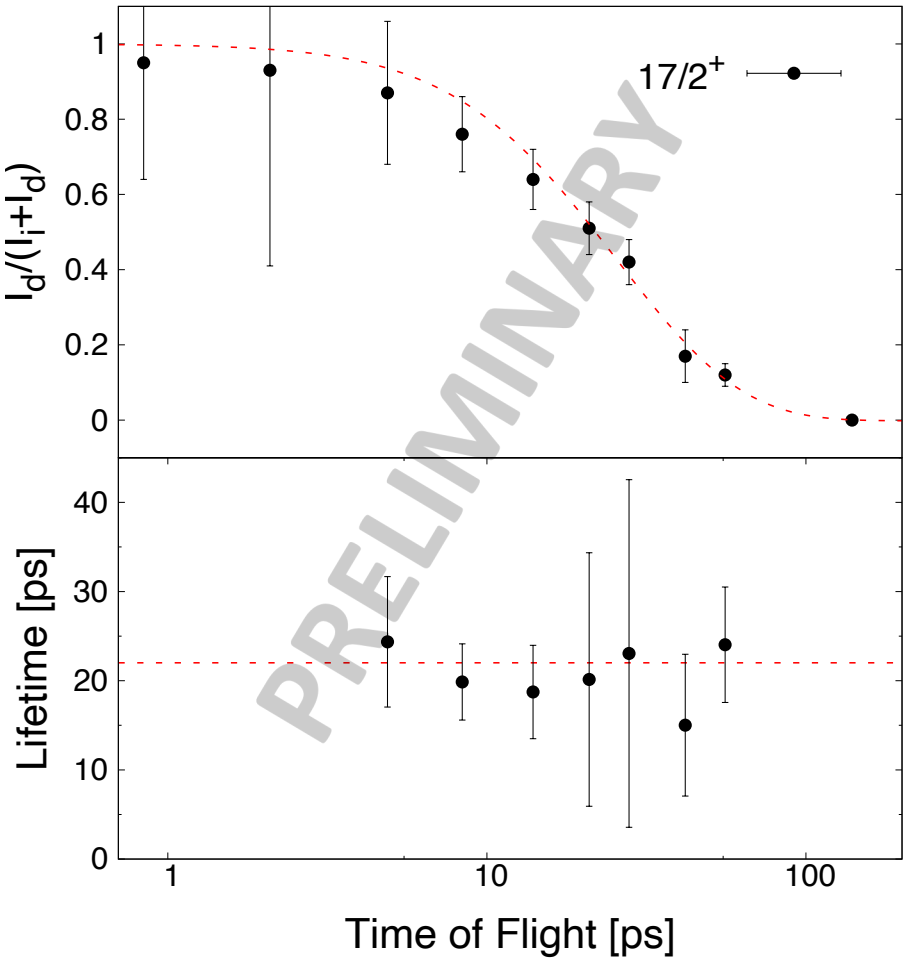
Derivative of the fitting function

Dewald *et al.*, Prog. Part. Nucl. Phys. **63**, (2012)

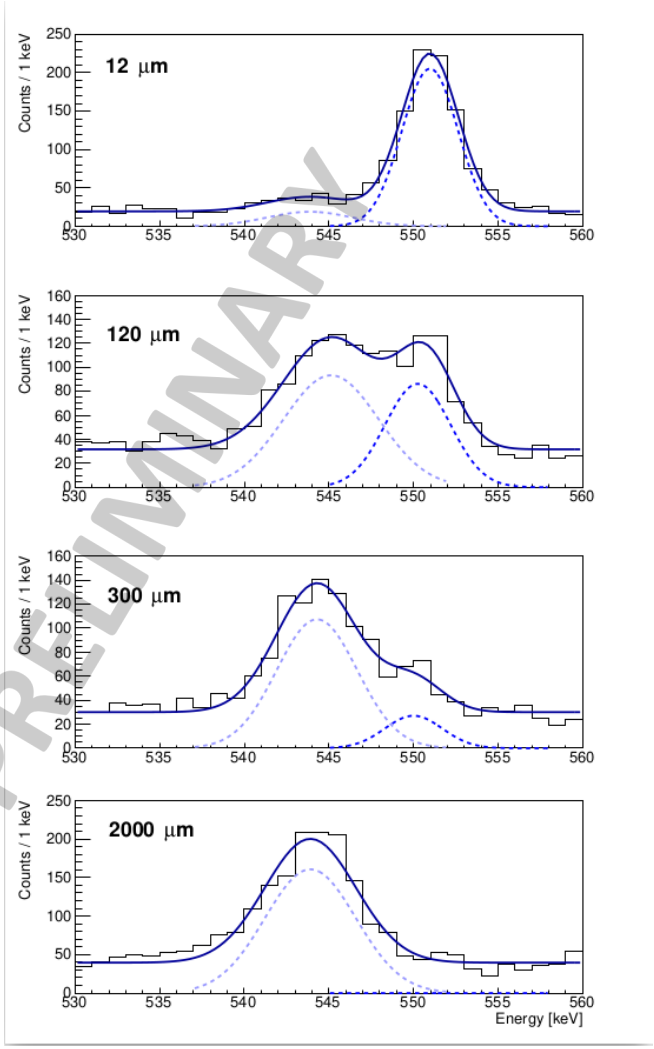
The $17/2^+$ state

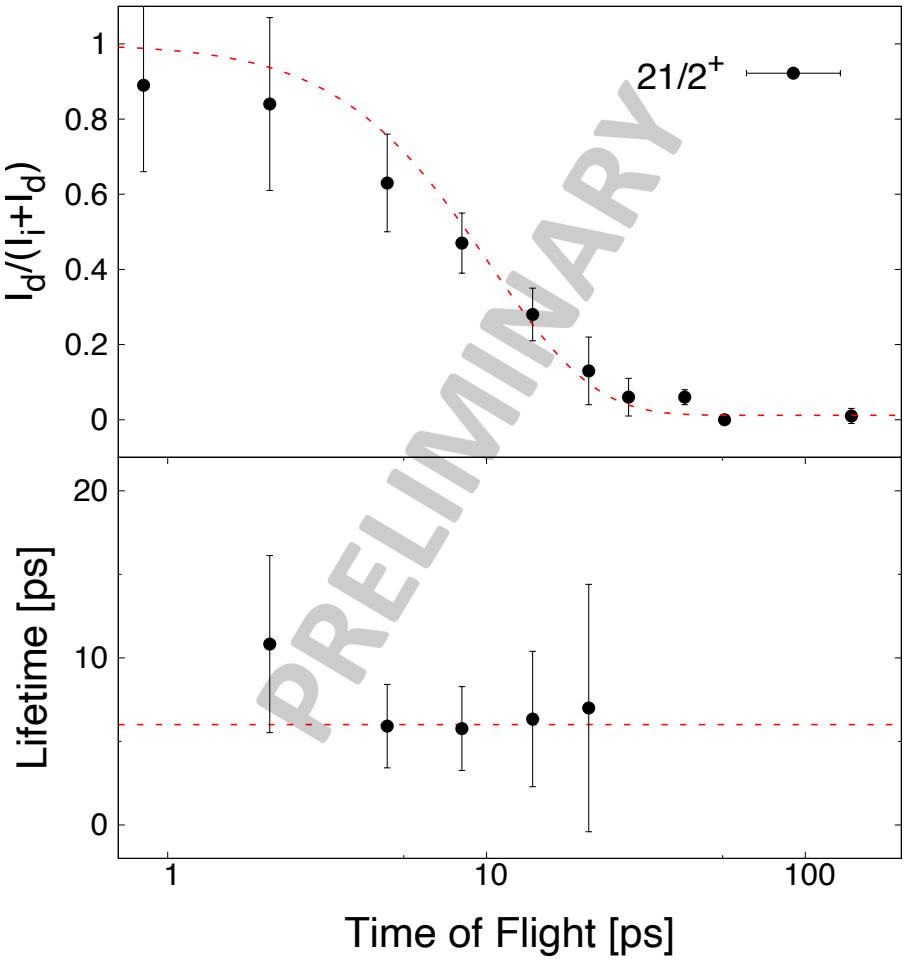
Ring	τ [ps]
Ring 0	20(3)
Ring 1	22(2)

Agreement with previous data:
τ = 20(4) ps
O'Donnel et al., PRC 79 (2009)



The 21/2$^+$ state

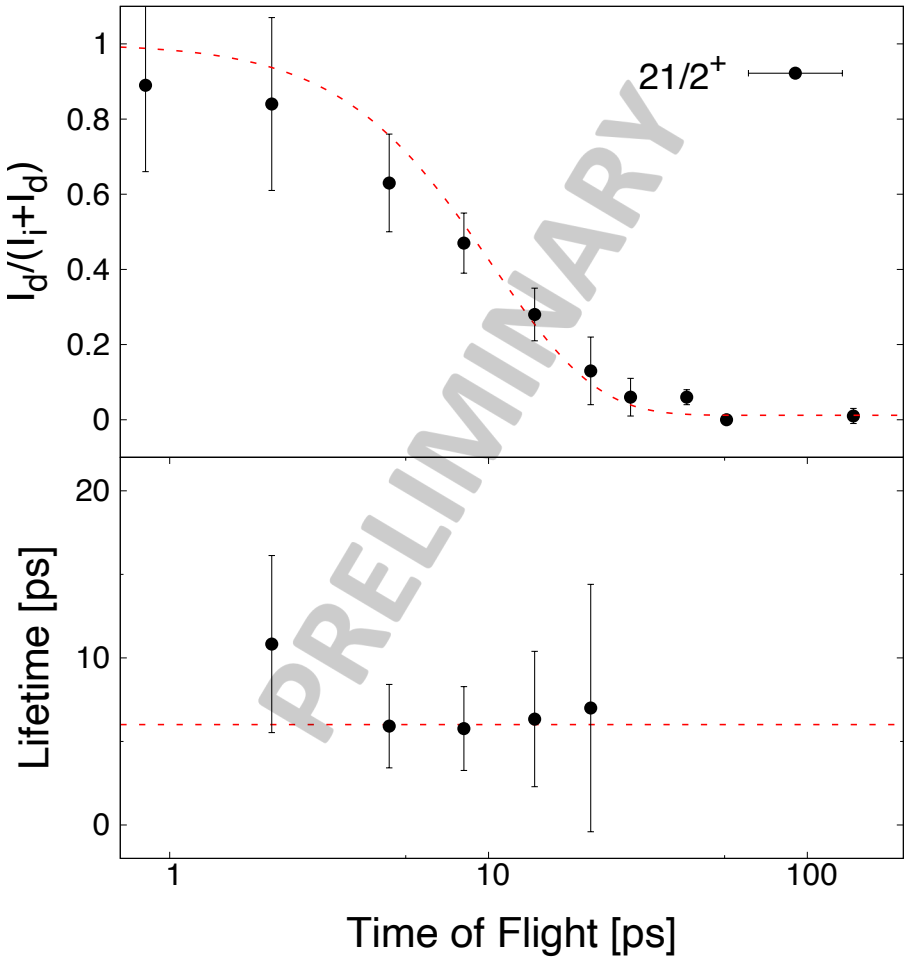




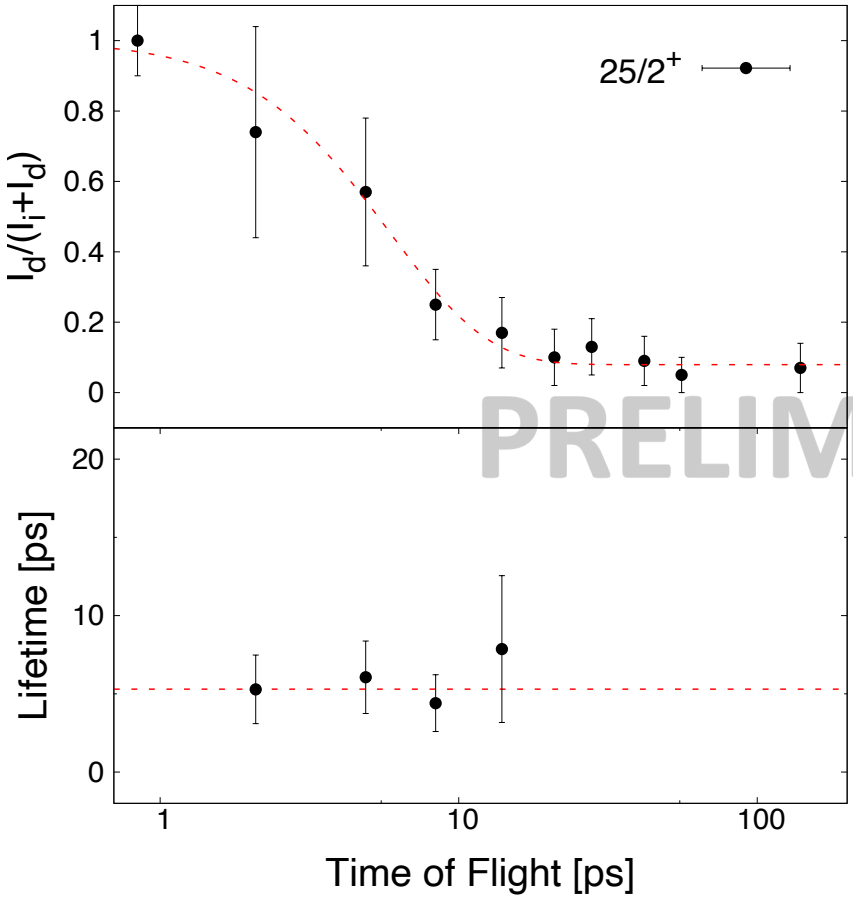
The $21/2^+$ state

Ring	τ [ps]
Ring 0	6.4(1.8)
Ring 1	5.6(1.4)

Agreement between the two rings

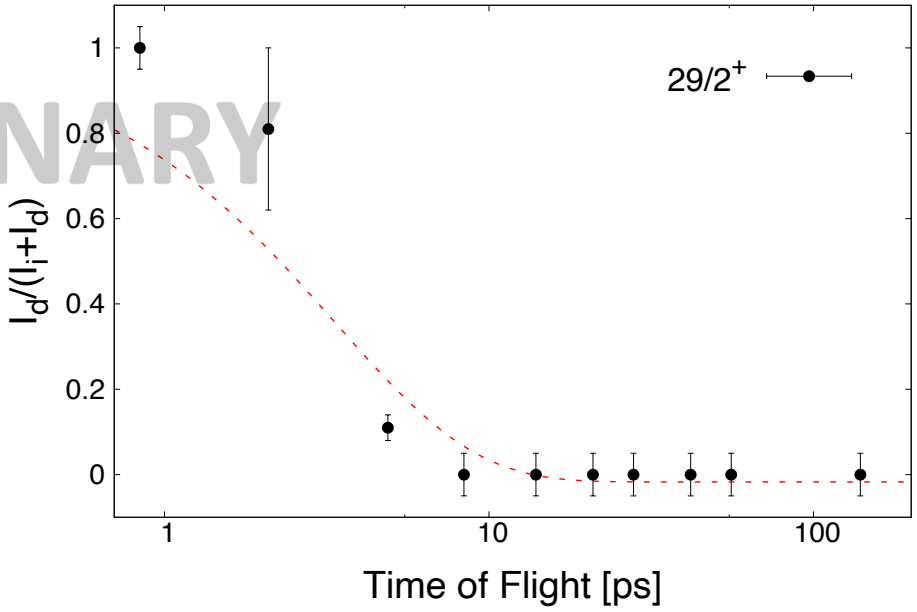


The $25/2^+$ and $29/2^+$ state



$\tau_{25/2+}$ = 5.1(7) ps

$\tau_{29/2+}$ < 3 ps



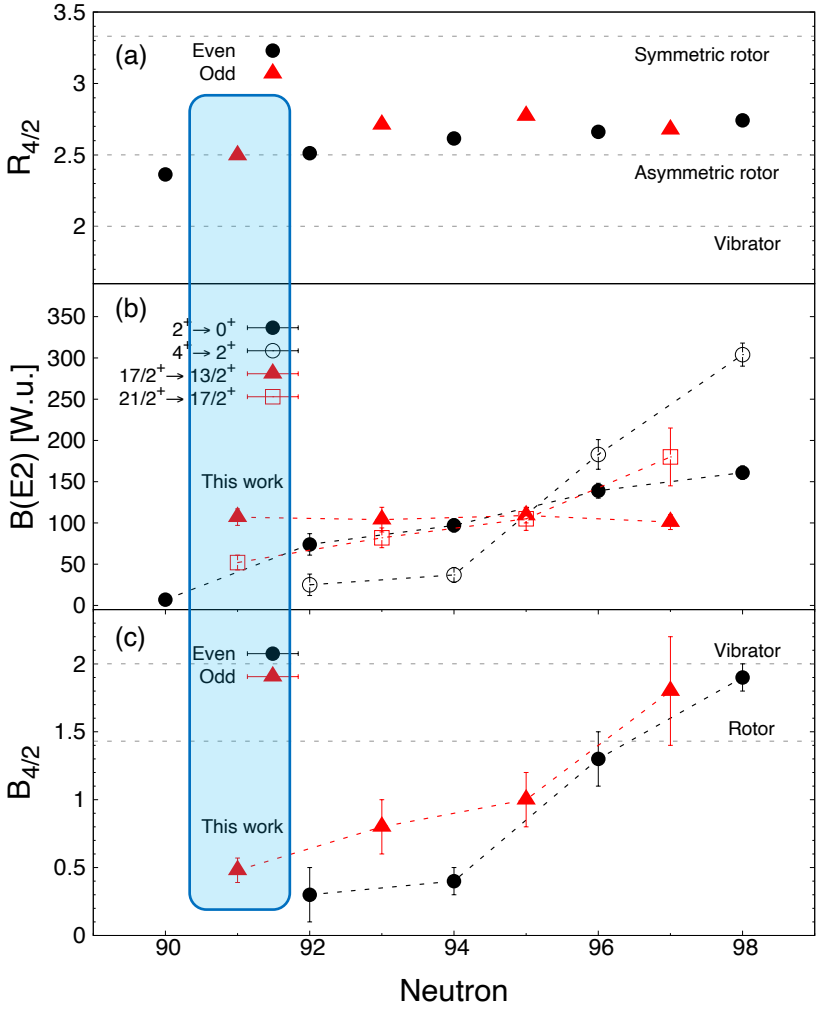
The $B_{4/2}$ ratio

Transition	τ [ps]	B(E2) [W.u.]
$17/2^+ \rightarrow 13/2^+$	22(1)	107(10)
$21/2^+ \rightarrow 17/2^+$	6(1)	52(9)

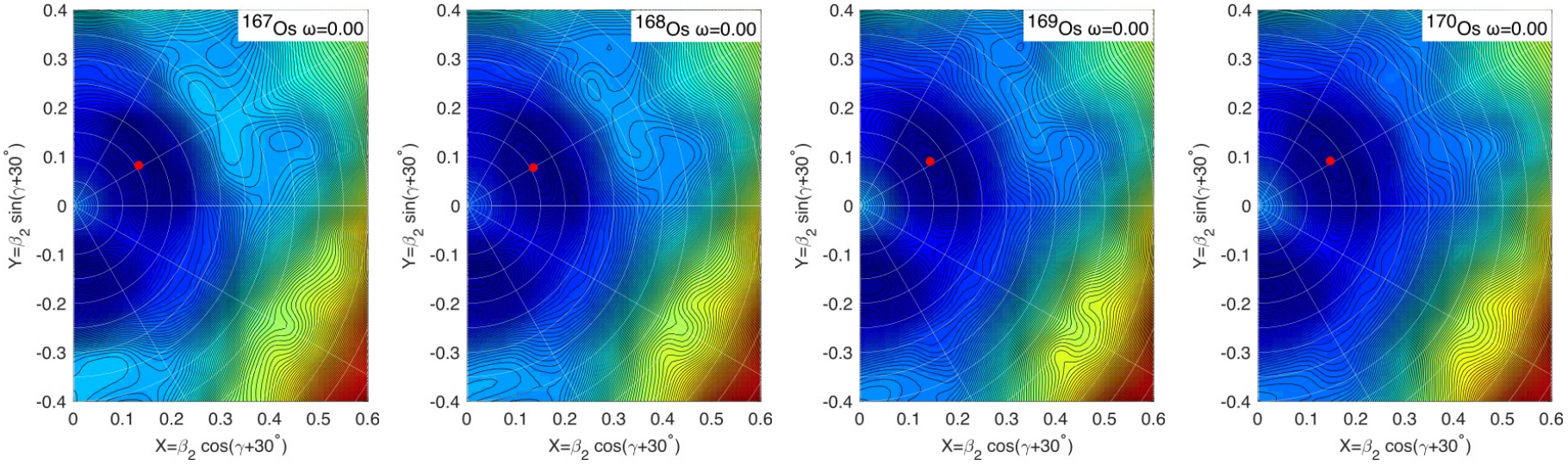
$B_{4/2} \approx 0.49(10)$

The $B_{4/2}$ ratio

- $R_{4/2}$ constant around 2.5, small staggering effect;
- B(E2; $17/2^+ \rightarrow 13/2^+$) constant as a function of neutrons;
- B(E2; $21/2^+ \rightarrow 17/2^+$) decreases with the number of neutrons;
- $B_{4/2}$ ratio follows a similar trend as the even equivalent.

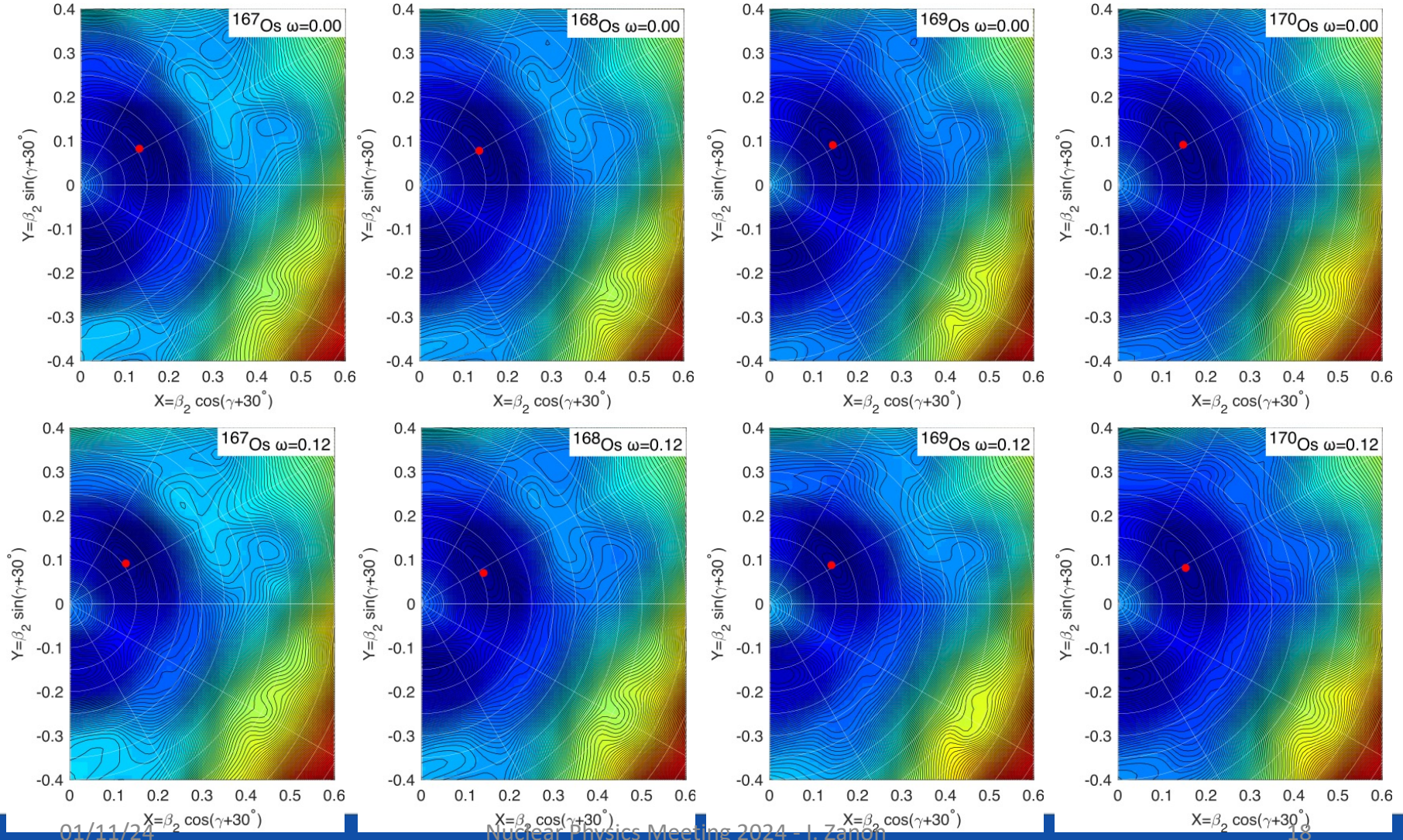


Total Routhian Surface calculations



- For even-N isotopes (π,α)=(+,0) configuration corresponding to g.s.
- For odd-N isotopes (π,α)=(+,1/2) configuration corresponding to $i_{13/2}$ yrast band
- Calculation performed at $\hbar\omega$=0.00 MeV and $\hbar\omega$=0.12 MeV

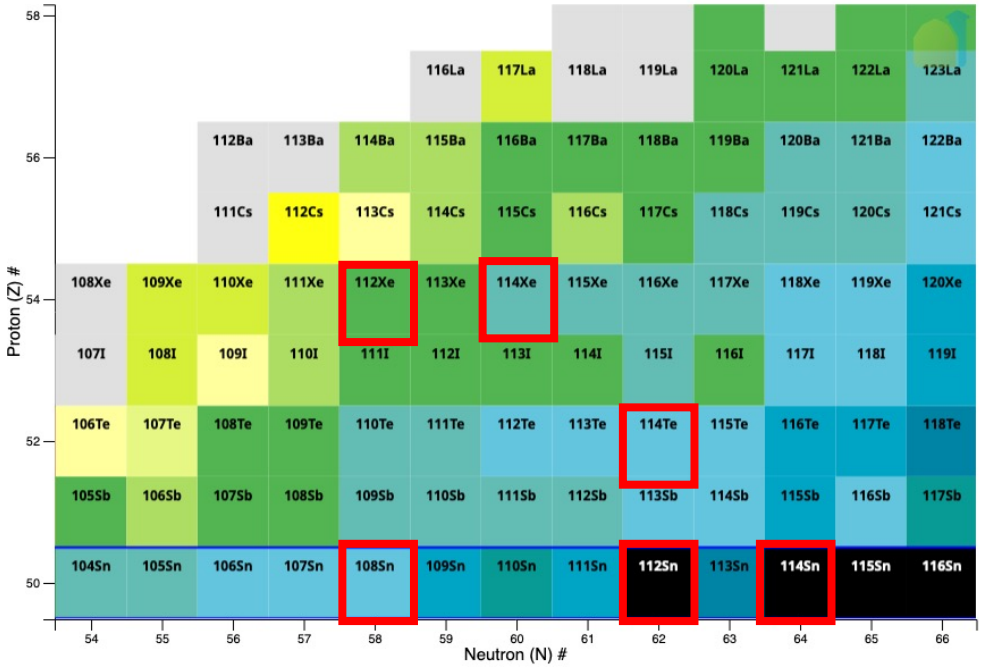
Total Routhian Surface calculations



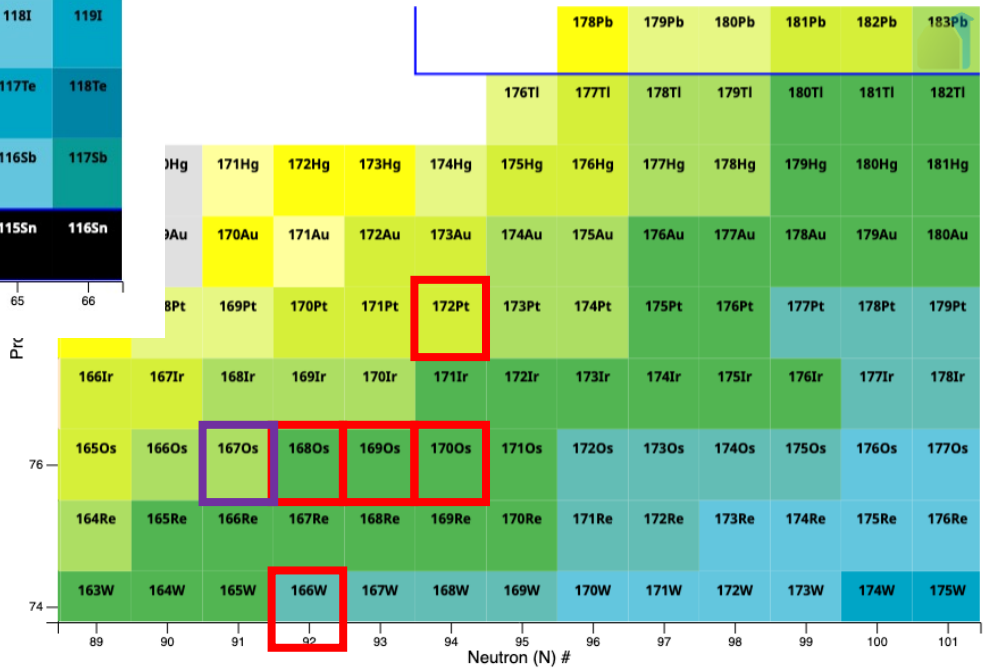
Total Routhian Surface calculations

	$\hbar\omega$ [MeV]	β_2	γ	$B(E2)_{th}$ [W.u.]	$B(E2)_{exp}$ [W.u.]
^{167}Os	0.00	0.155	3.1°	95	107(10)
	0.12	0.155	8.1°	96	52(9)
^{168}Os	0.00	0.157	0.6°	60	74(13)
	0.12	0.158	-3.1°	86	25(13)
^{169}Os	0.00	0.168	2.2°	112	104(15)
	0.12	0.168	2.3°	116	82(12)
^{170}Os	0.00	0.173	0.8°	73	97(9)
	0.12	0.174	-3.6	105	38^{+13}_{-7}

The $B_{4/2}$ ratio anomaly



^{108}Sn: 0.86(10)	^{114}Te: 0.84(12)
^{112}Sn: 0.39(6)	^{112}Xe: 0.35(7)
^{114}Sn: 0.52(7)	^{114}Xe: 0.71(7)



^{166}W: 0.33(5)	^{169}Os: 0.79(16)
^{167}Os: 0.49(10)	^{170}Os: 0.39(10)
^{168}Os: 0.34(19)	^{172}Pt: 0.55(19)

Conclusions

Results:

- ^{167}Os successfully populated in the FE reaction;
- Lifetimes of $17/2^+$, $21/2^+$, $25/2^+$ measured;
- $B_{4/2} < 1$ observed;
- Comparison with TRS calculations.

Future perspective:

- Ground-state band of ^{167}Os
- Lifetime measurements in ^{166}Os

Thank you for your attention

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