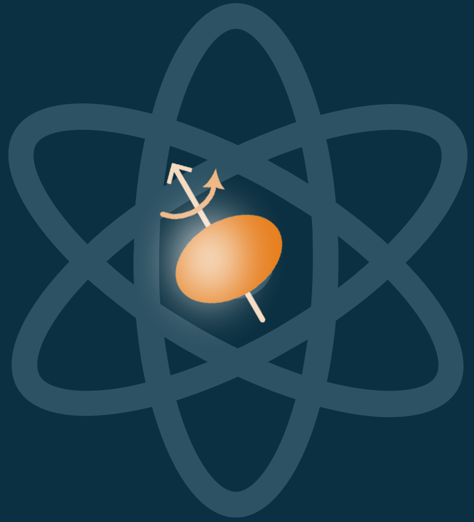
KTH
VETENSKAP
OCH KONST

UPPSALA
UNIVERSITET

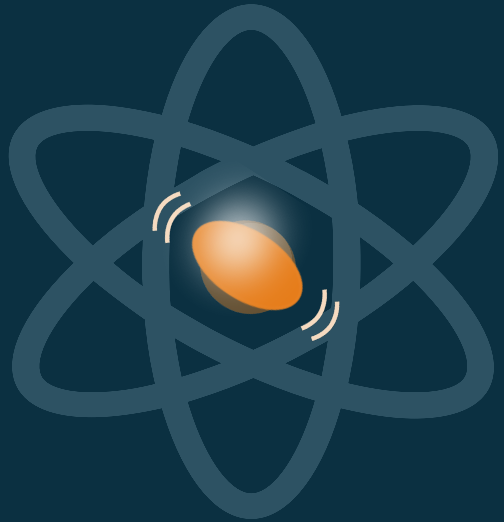
That's odd...

Anomalous lifetimes in odd-mass Te

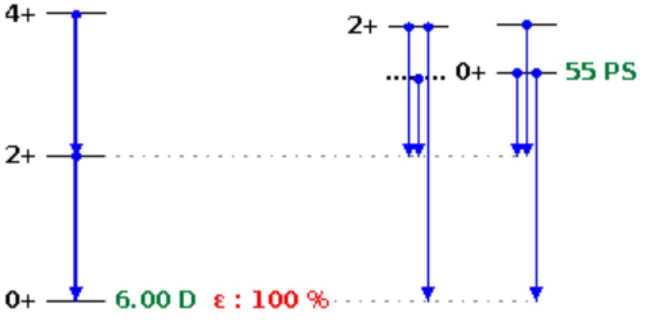


Ebba Ahlgren Cederlöf

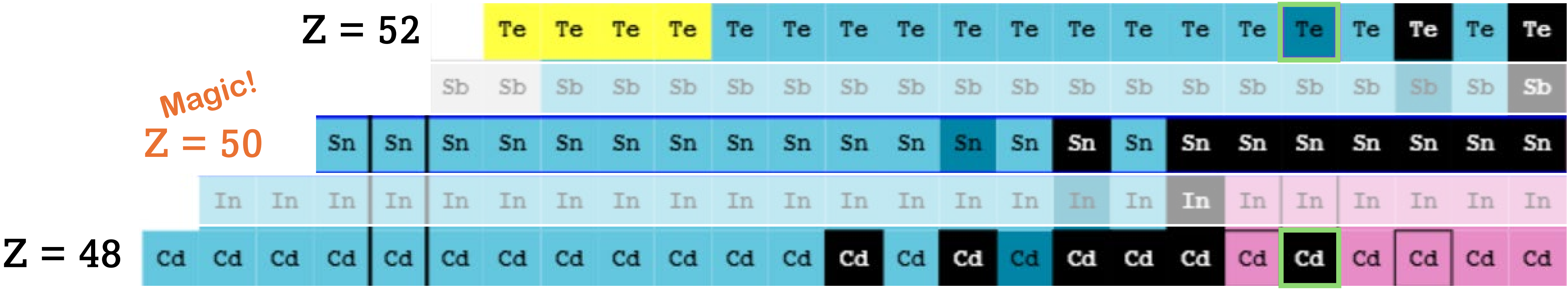
Annual Swedish Nuclear Physics Meeting
2024.01.11



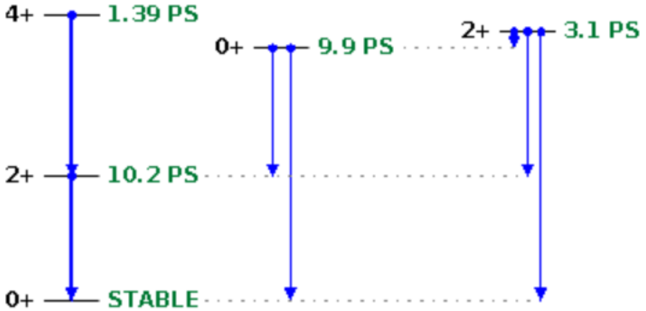
Collectivity in Cd and Te

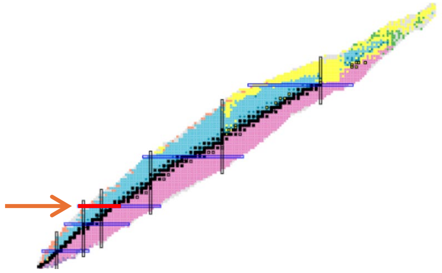


^{118}Te

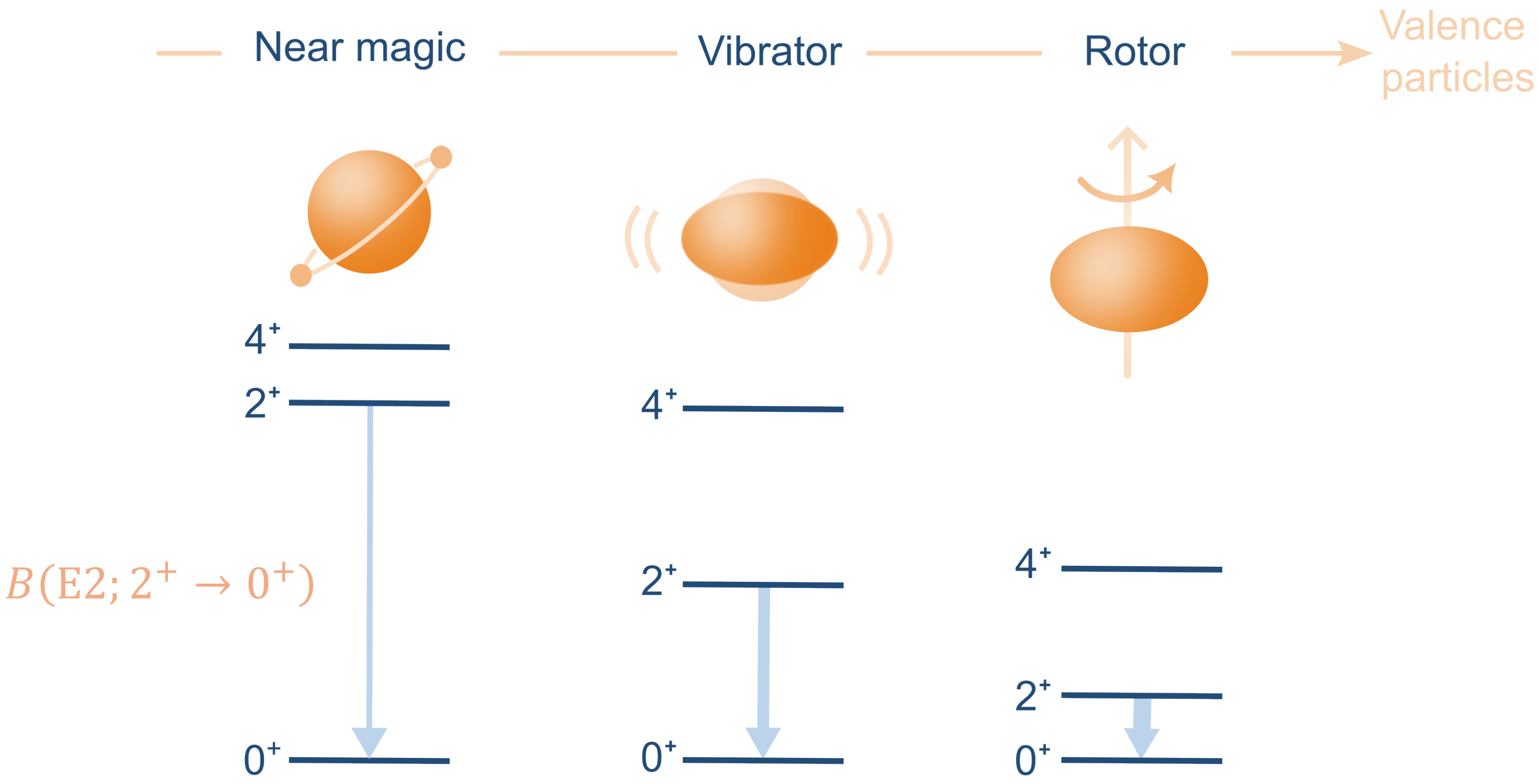


^{114}Cd





B(E2) and collectivity

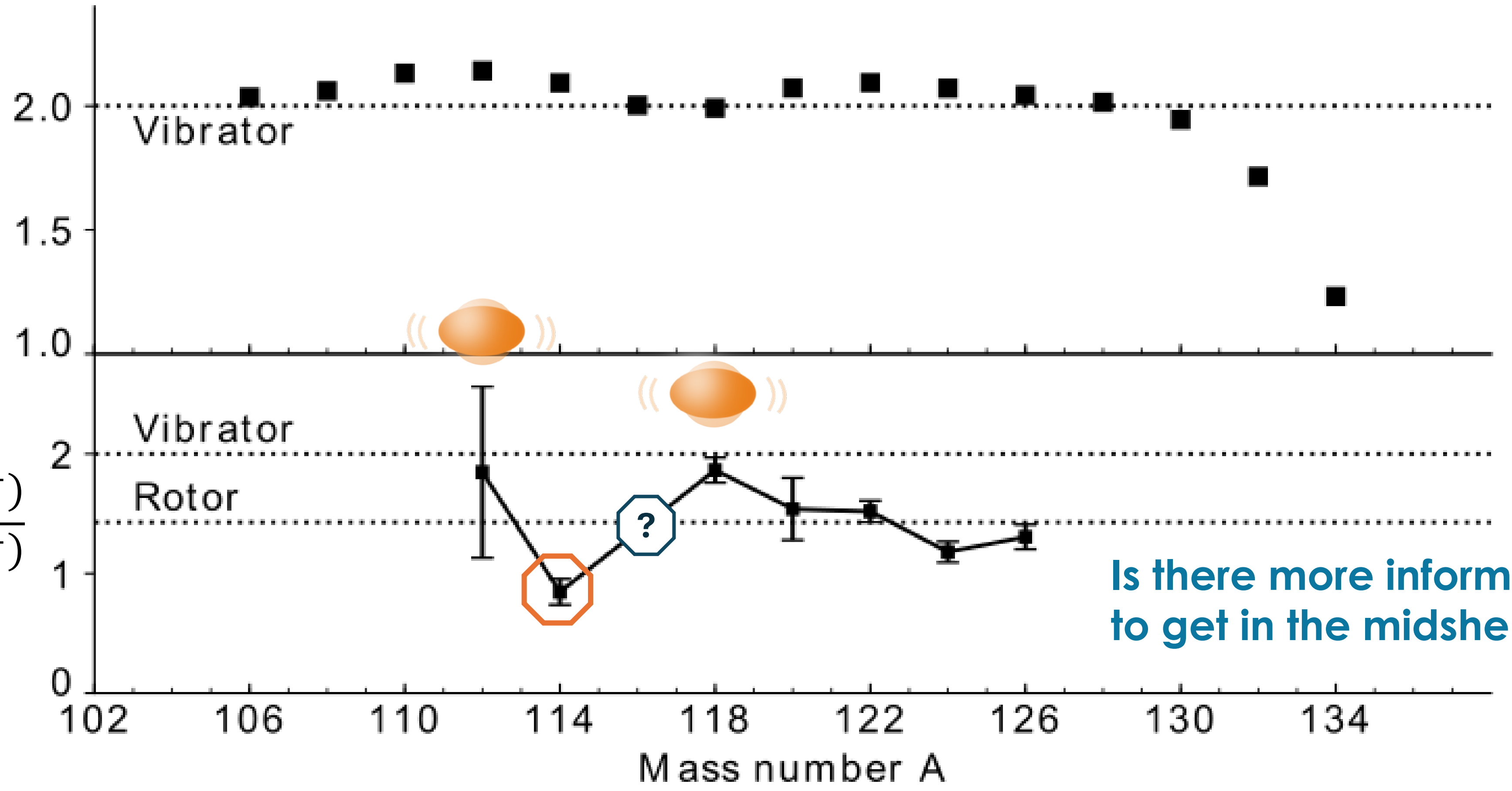


$B(\mathrm{E2}; 2^+ \rightarrow 0^+)$

Collectivity in Te

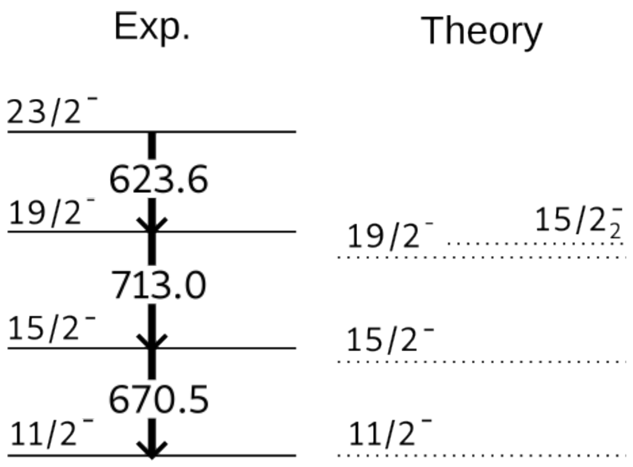
$$E_{4/2} = \frac{E(4^+)}{E(2^+)}$$

$$B_{4/2} = \frac{B(\mathrm{E2}; 4^+ \to 2^+)}{B(\mathrm{E2}; 2^+ \to 0^+)}$$

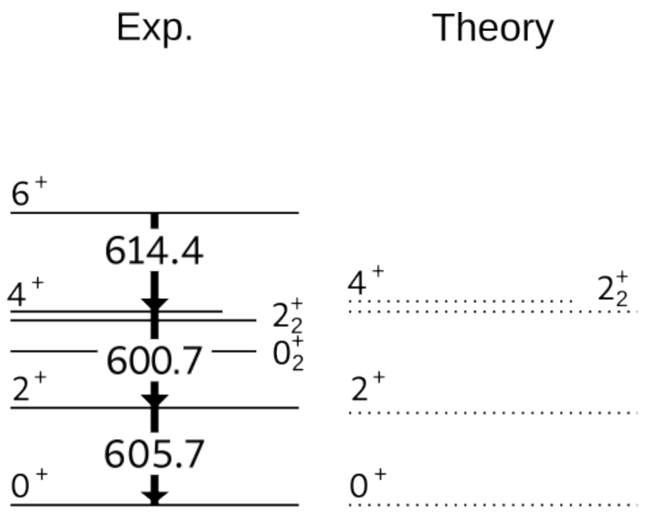


Is there more information to get in the midshell?

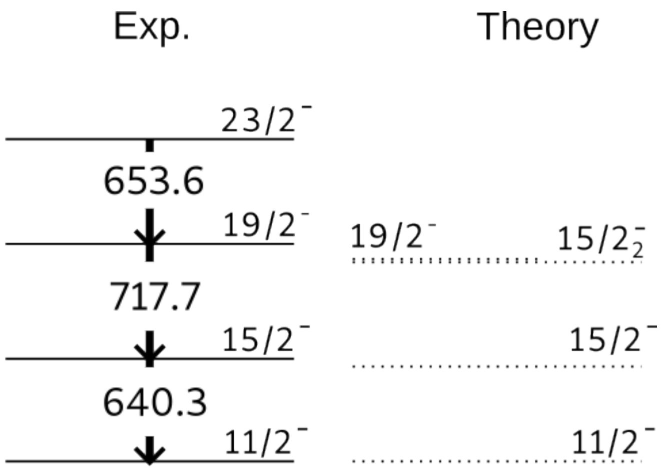
Odd mass isotopes



^{117}Te



^{118}Te



^{119}Te

Aim

Objective

- Measure lifetimes of 15/2- and 19/2- states in ^{117}Te and ^{119}Te

- Calculate $B_{4/2}$

$$B(\mathrm{E2}) \propto \frac{1}{\tau}$$

Method

- Plunger experiment
  - RDDS
  - DDCM

Goal

- Investigate vibrational nature of midshell Te

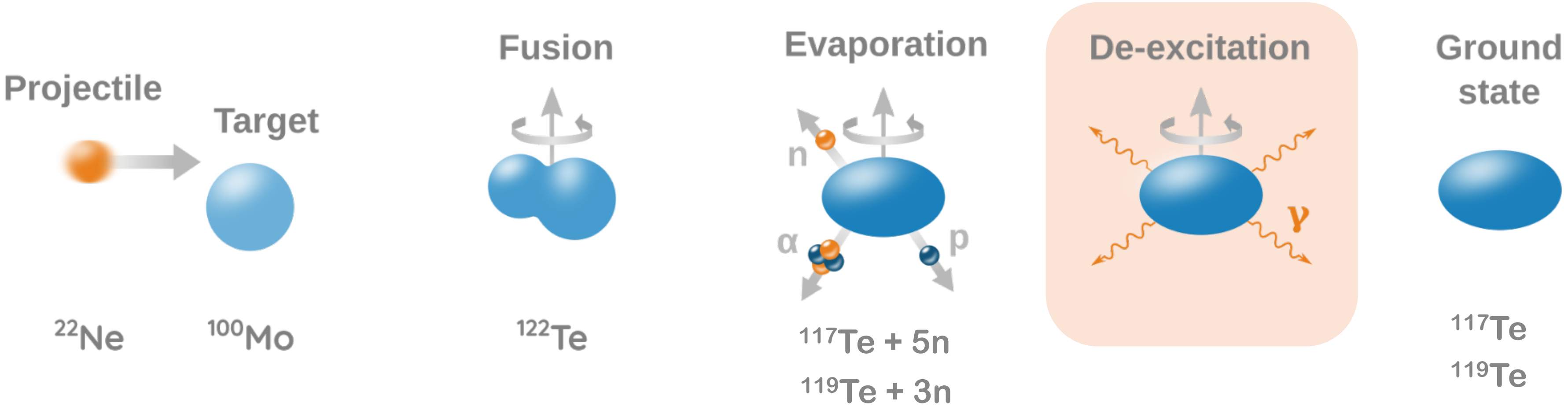
Recoil production

- Optimized for ^{118}Te [1]

[1] Cederlöf, E.A. *et al.*, *Eur. Phys. J. A* **59**, 300 (2023)

- Beam energy: 75 MeV
- Beam current: 4 pnA

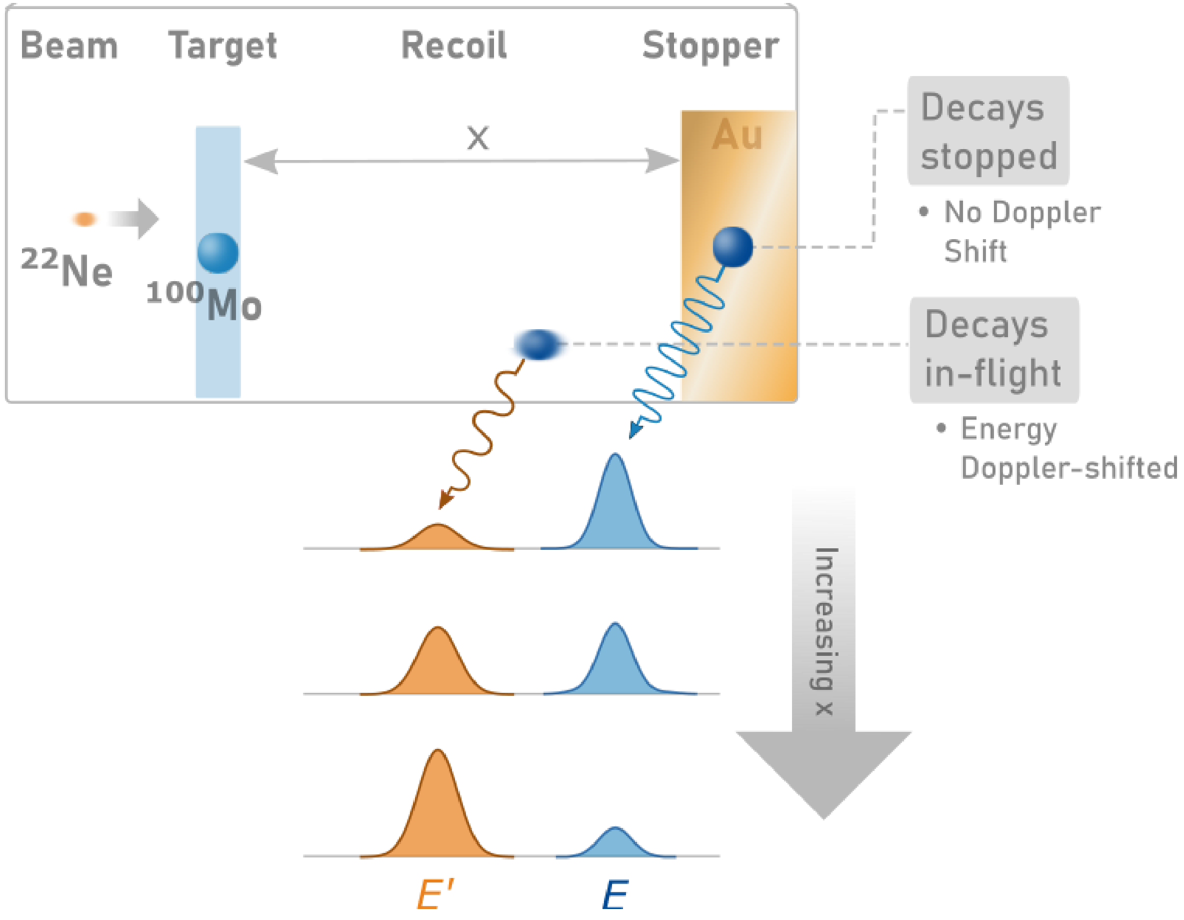
Fusion-evaporation reaction



Time scale: 10^{-22} s 10^{-19} s $10^{-17} - 10^{-10}$ s 10^{-9} s

Lifetime measurement

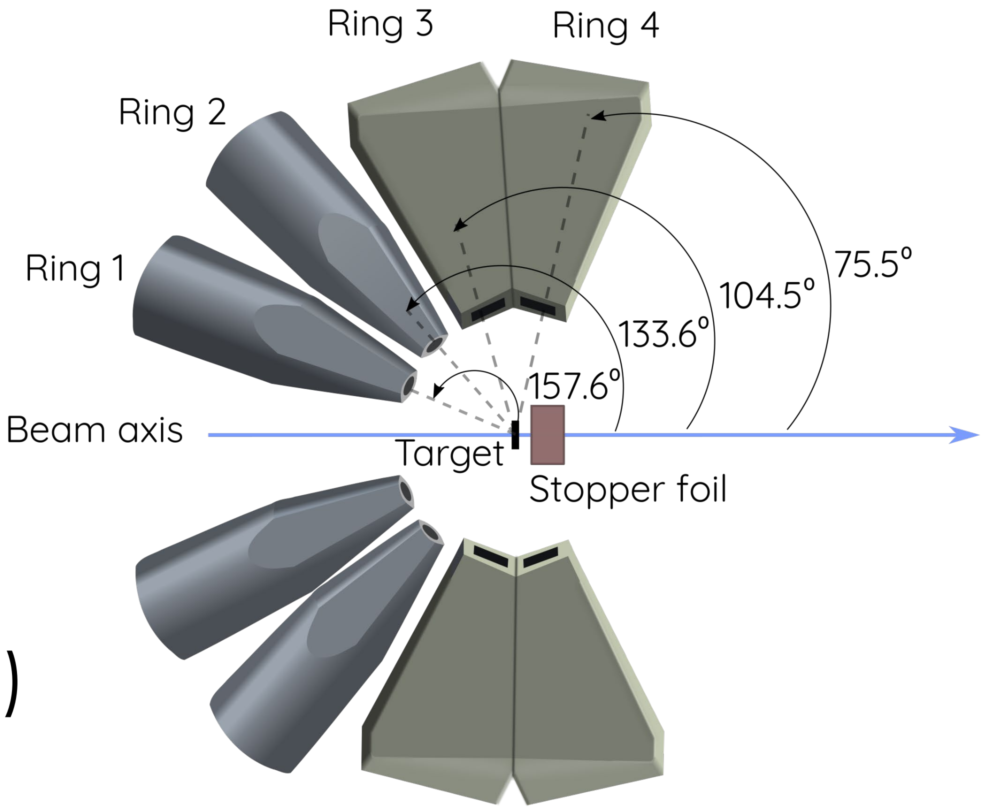
- RDDS technique
- DPUNS plunger
- 8 distances
    - x: 25 - 215 μm
    - ToF: 6 – 54 ps



Gamma-ray detection

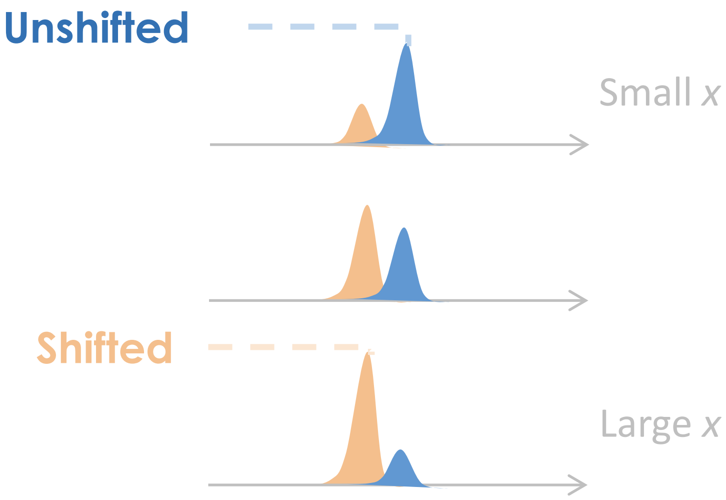
Jurogam II

- 4 rings of HPGe detectors
  - **Ring 1:** 5 detectors
  - **Ring 2:** 10 detectors
  - **Ring 3 and 4:** not used
    - angles ~ 90° (small Doppler shifts)
- Efficiency @ 1.3 MeV: ~ 2 % (Ring 1 + 2)



Differential Decay Curve Method

RDDS data



DDCM analysis

For each x:

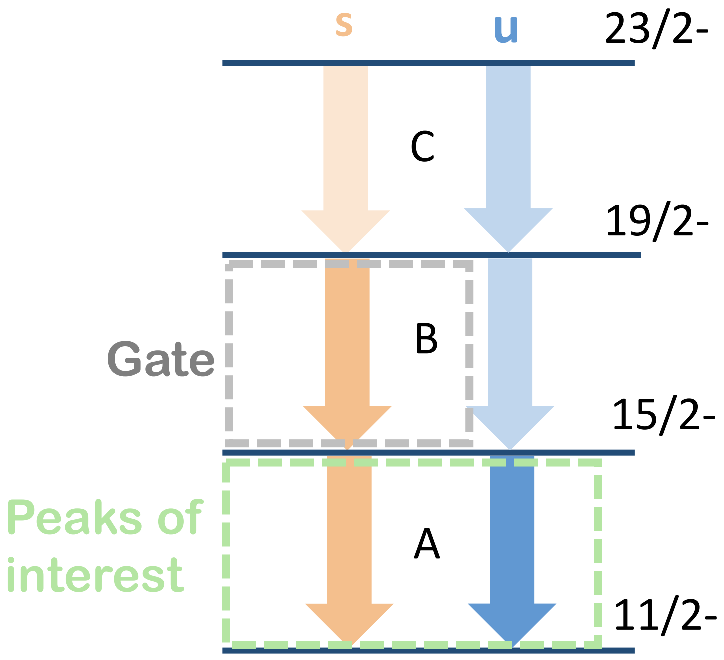
$$\tau(x) = \frac{\{B_s, A_u\}(x)}{\frac{d}{dx}\{B_s, A_s\}(x)} \cdot \frac{1}{v}$$

Where:

$$\{Y, X\}$$

Gate

Intensity



Direct gate not always possible

Problem:

- 19/2- doublet in ^{119}Te
- Direct gate not possible

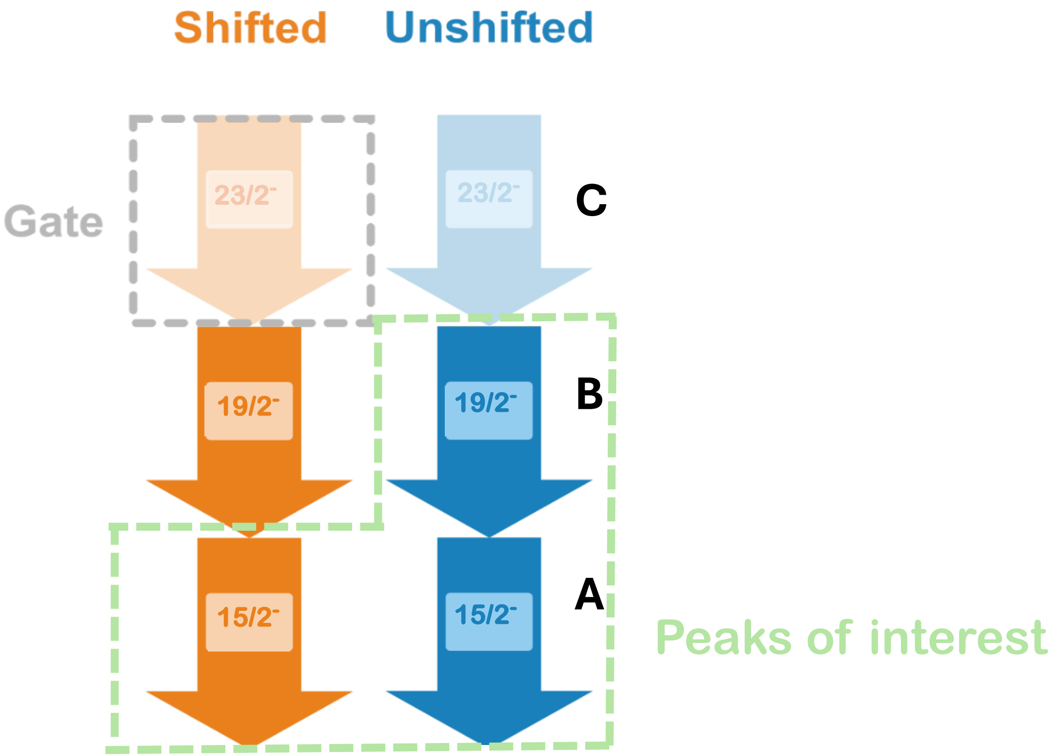
Solution:

- ”Indirect gate” on 23/2$^-$

DDCM with indirect gate:

$$\tau(x) = \frac{\{C_\mathrm{s}, A_\mathrm{u}\}(x) - \overline{\delta} \cdot \{C_s, B_u\}(x)}{\frac{d}{dx}\{C_\mathrm{s}, A_\mathrm{s}\}(x)} \cdot \frac{1}{v},$$

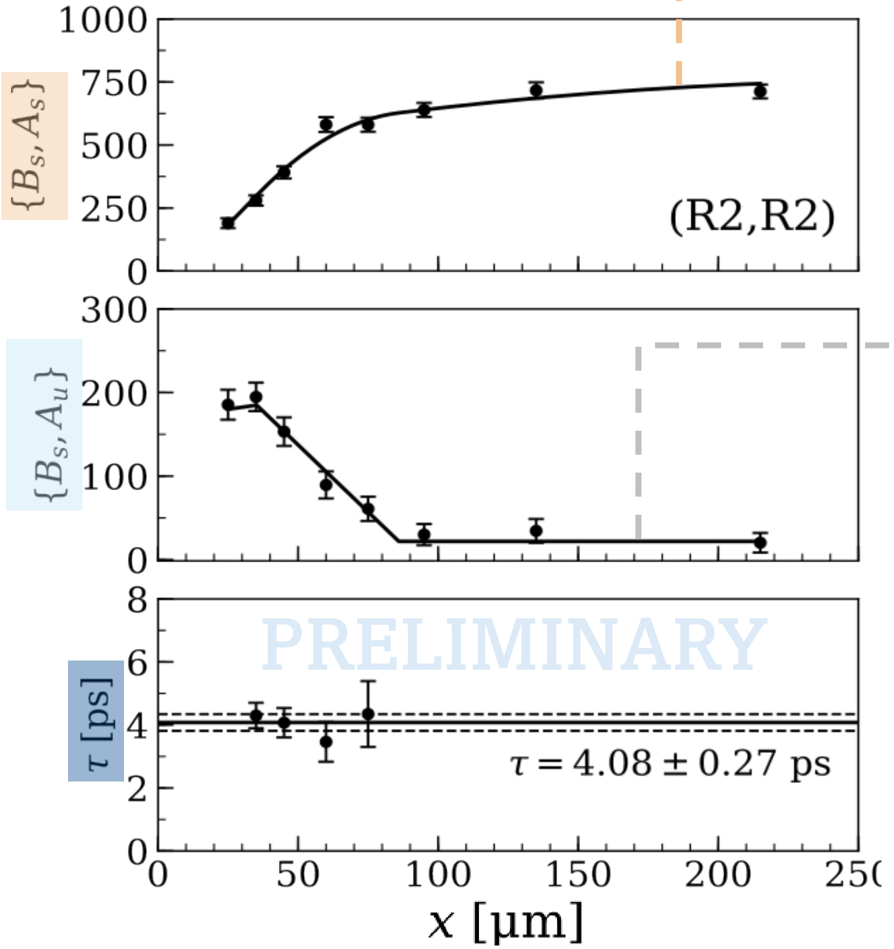
$$\delta(x) = \frac{\{C_\mathrm{s}, A_\mathrm{u}\}(x) + \{C_s, A_s\}(x)}{\{C_\mathrm{s}, B_\mathrm{u}\}(x) + \{C_s, B_\mathrm{s}\}(x)}.$$



Results ^{117}Te: $15/2^- \rightarrow 11/2^-$

Direct gate

$$\tau(x) = \frac{\{B_s, A_u\}(x)}{\frac{d}{dx}\{B_s, A_s\}(x)} \cdot \frac{1}{v}$$



Fitted in Napatau

Control

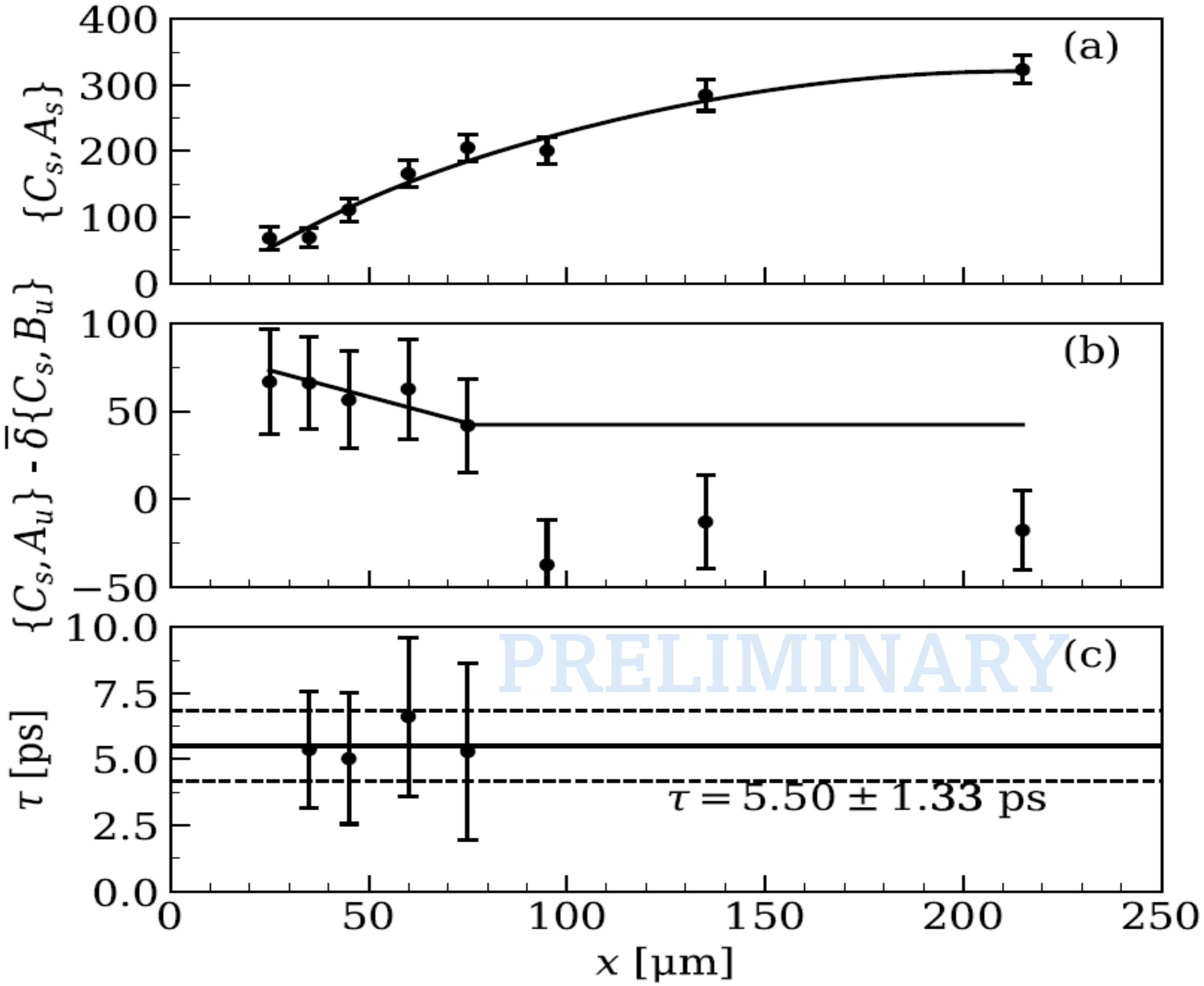
$$\{B_s, A_u\}(x) = v \cdot \bar{\tau} \cdot \frac{d}{dx}\{B_s, A_s\}(x)$$

Results ^{119}Te: $15/2^- \rightarrow 11/2^-$

Indirect gate

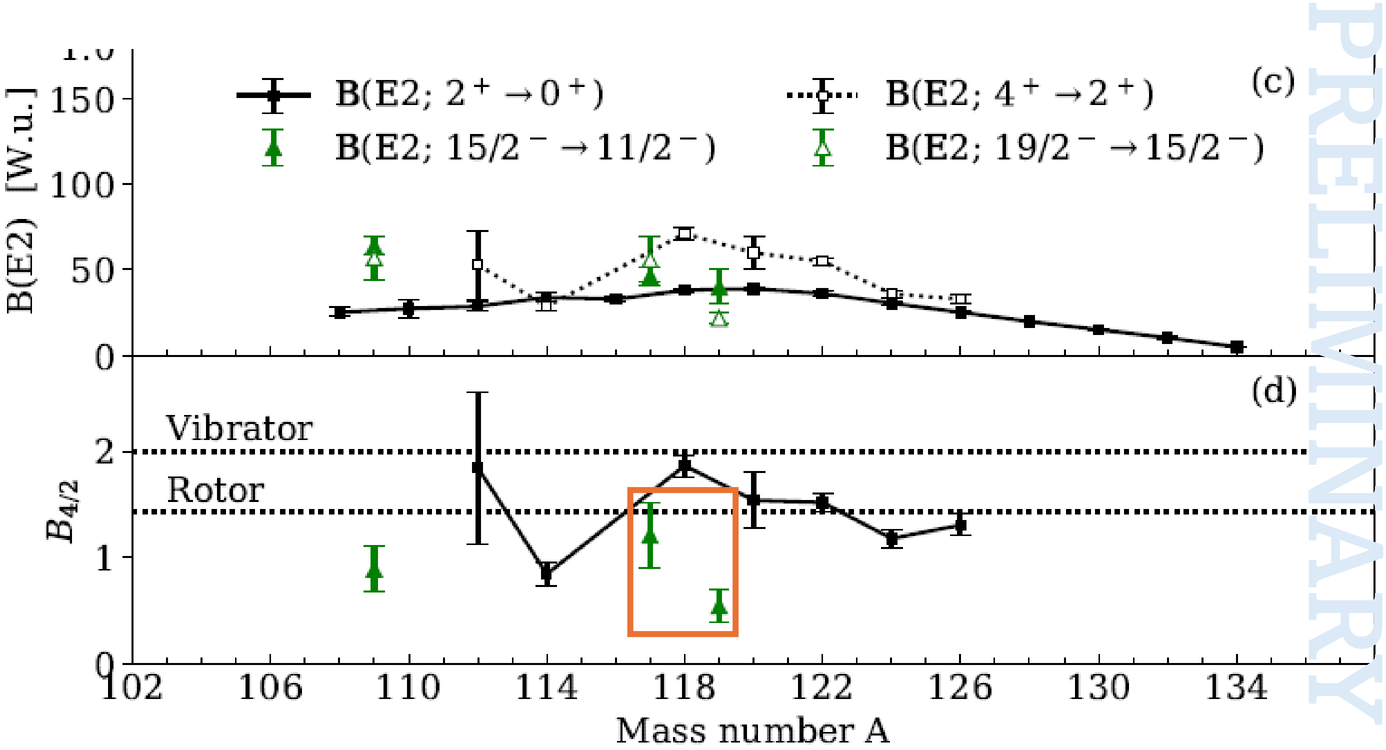
Challenges:

- Lifetime of 15/2- dependent on fit of B_U
- Relatively low statistics
- Sensitive to the background subtraction



Discussion

- ^{118}Te shows excellent agreement with the vibrational limit, while
- Neighbouring odd-mass ^{117}Te and ^{119}Te show surprisingly small $B_{4/2}$ values.

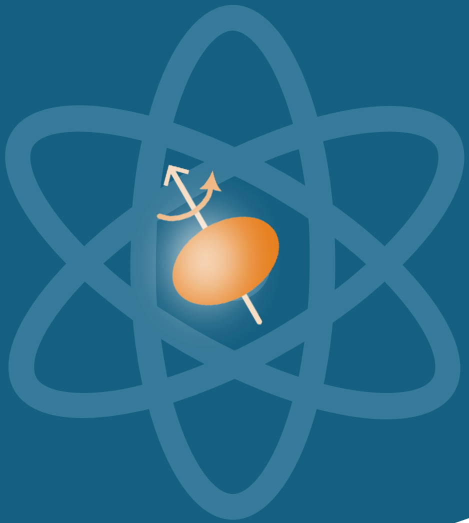


Summary

- Measured lifetimes in the $h_{11/2}$ band of ^{117}Te and ^{119}Te for the first time.

- Analysis is still ongoing.
  - Challenges: Low statistics and sensitivity to background subtraction.

- Results are preliminary pointing towards unusually low $B_{4/2}$ values.



Thank you for listening!