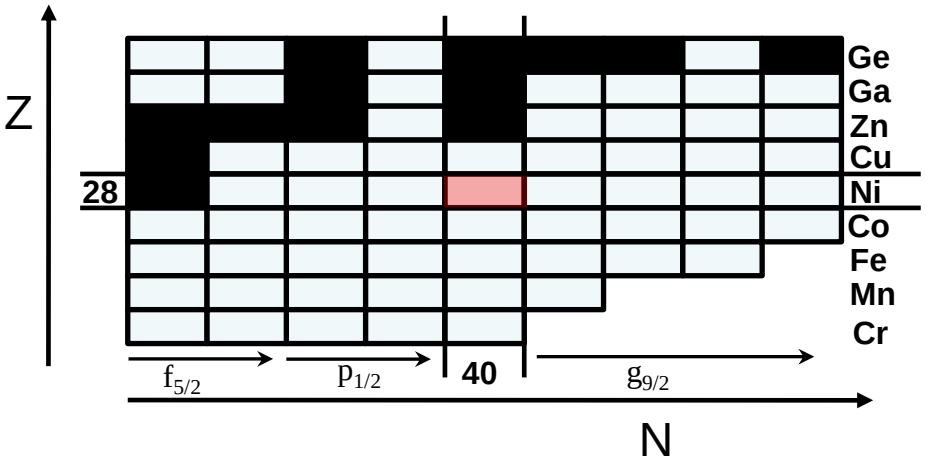
# Lifetimes of excited states in neutron-rich Zn isotopes using the AGATA demonstrator


Corinne Louchart, CEA Saclay

EURORIB, 2012

# Onset of collectivity near N=40



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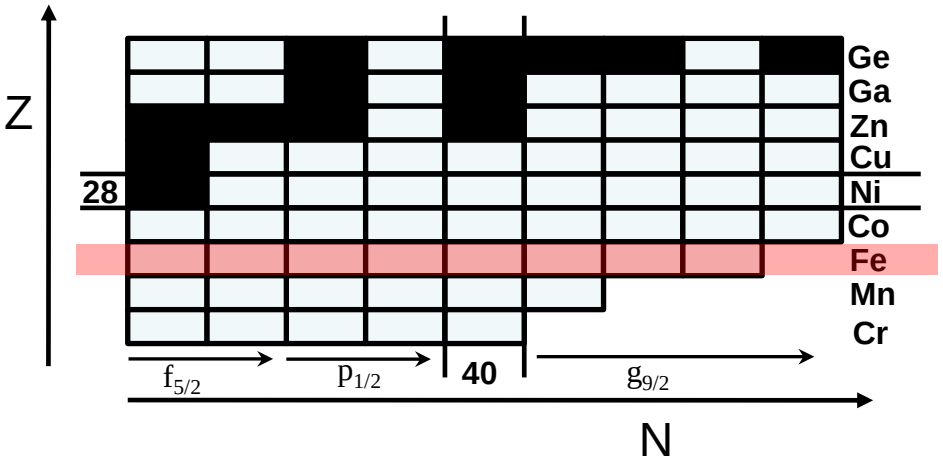


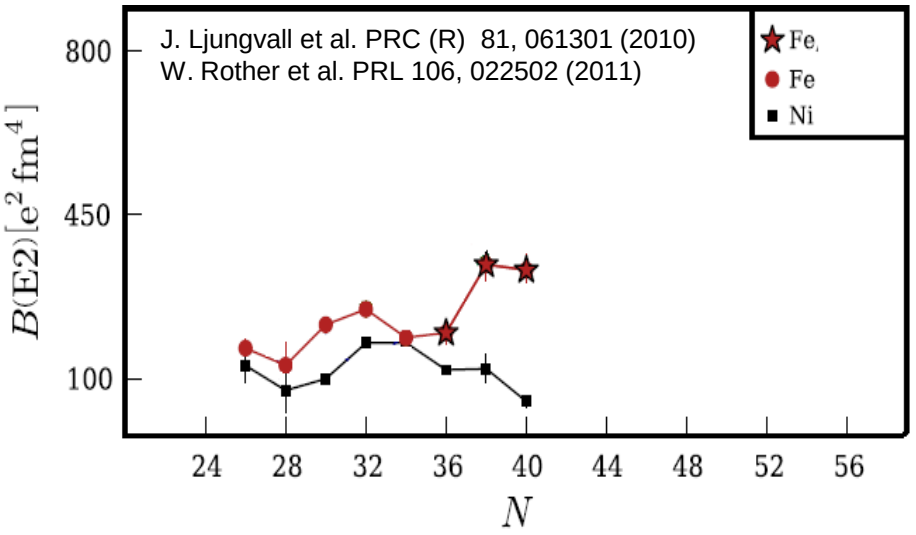


➢Rapid increase of collectivity

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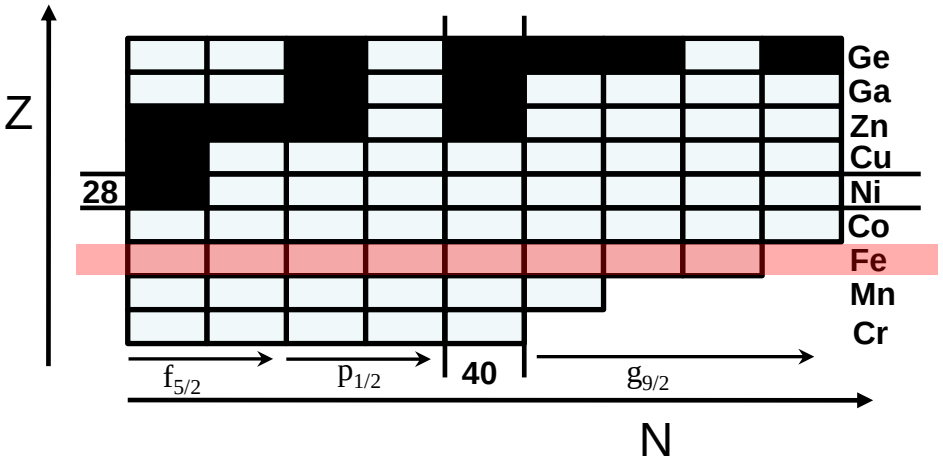


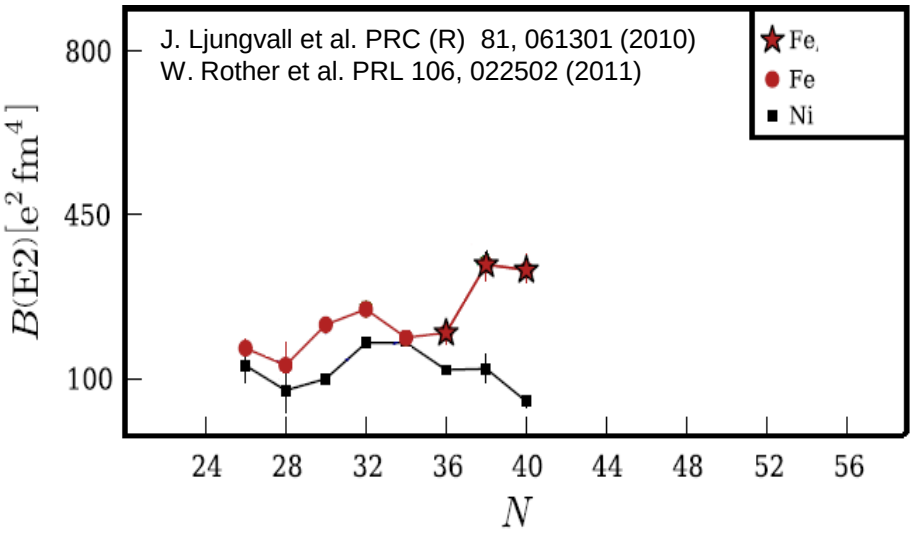


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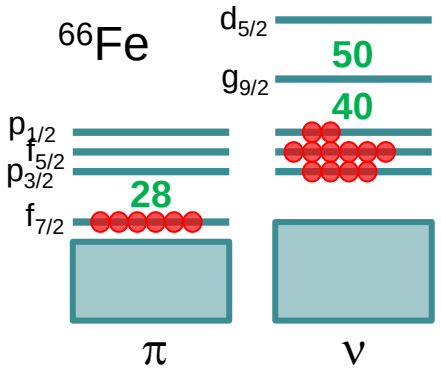
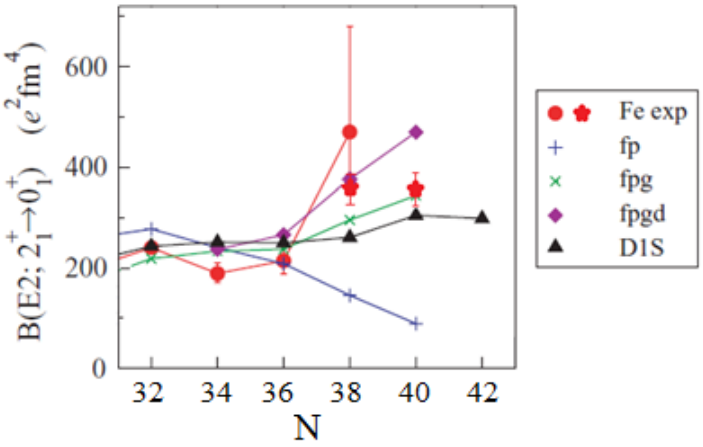



→ Important role of the neutron $g_{9/2}$ and $d_{5/2}$ intruder orbitals



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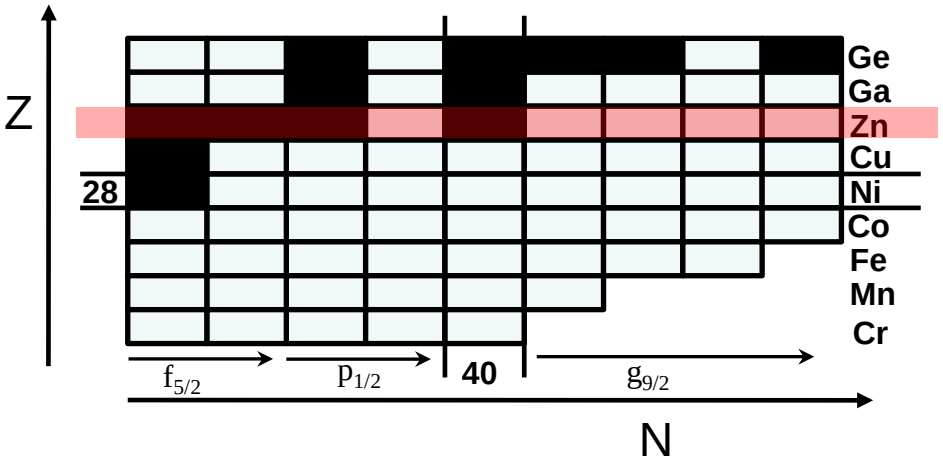


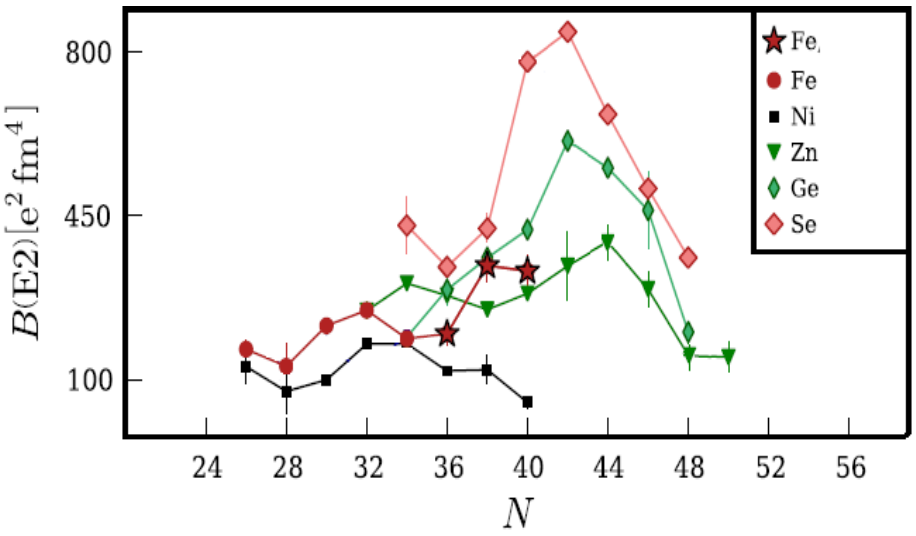

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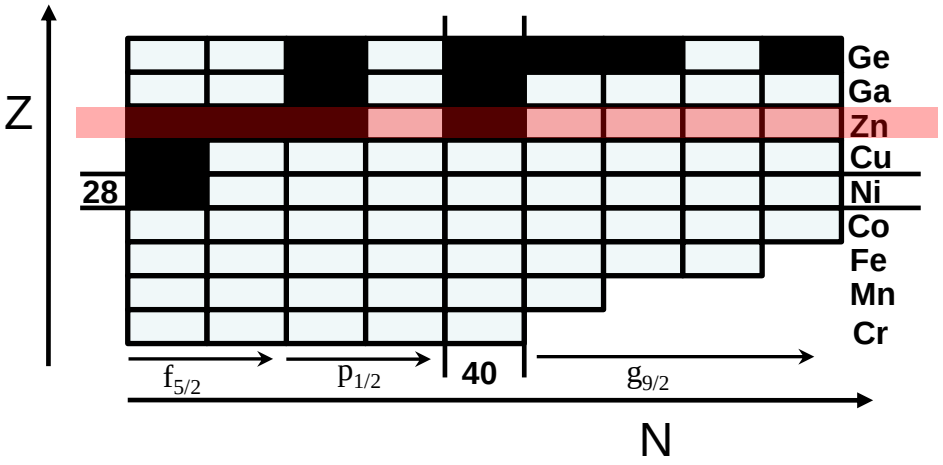


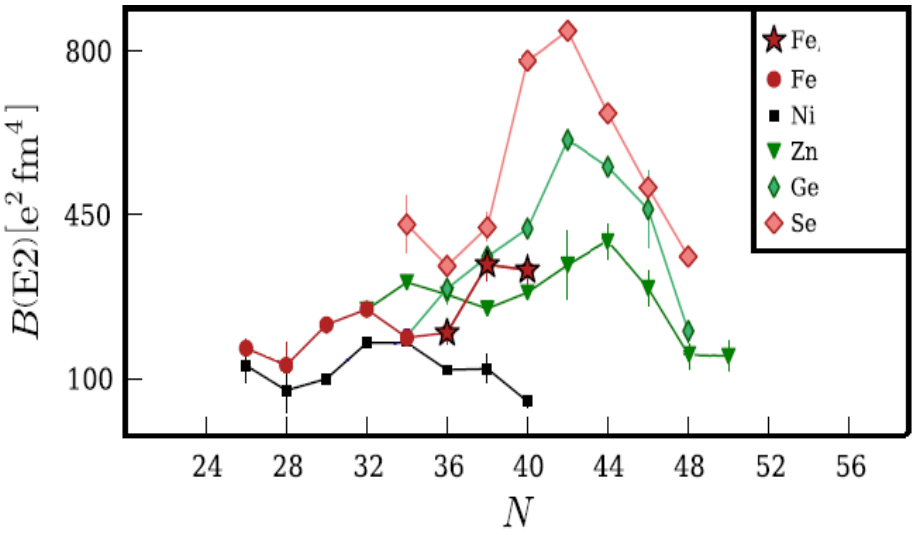


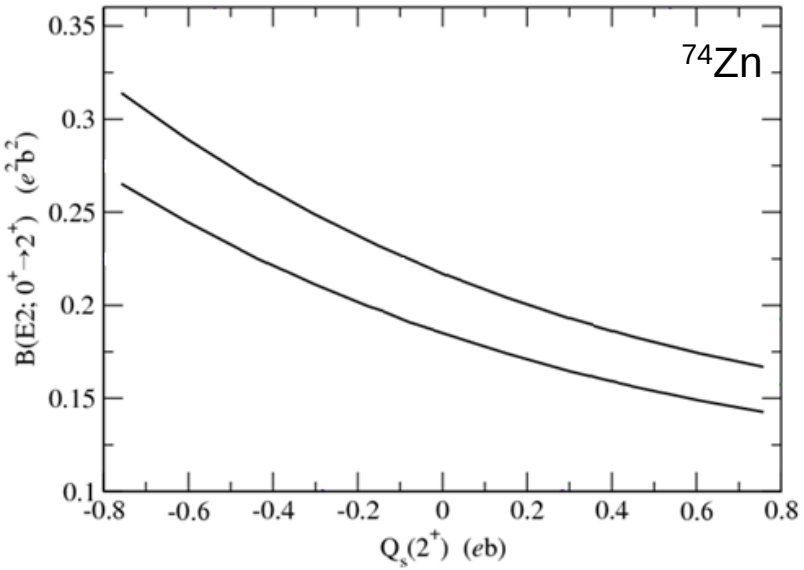


Ref: J. Van de Walle thesis

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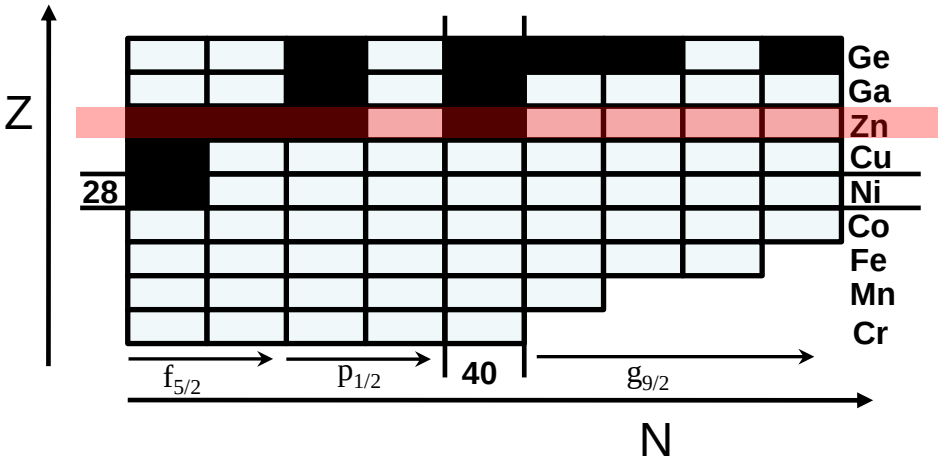


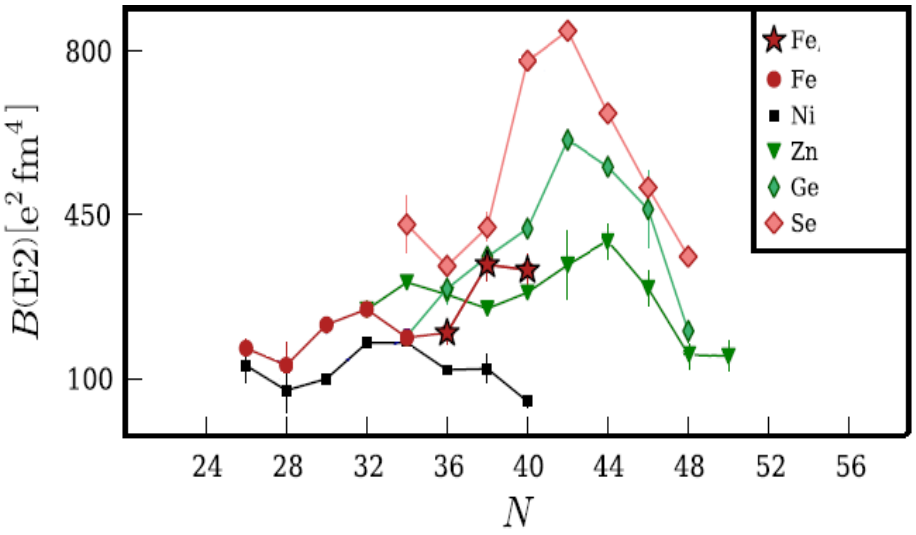


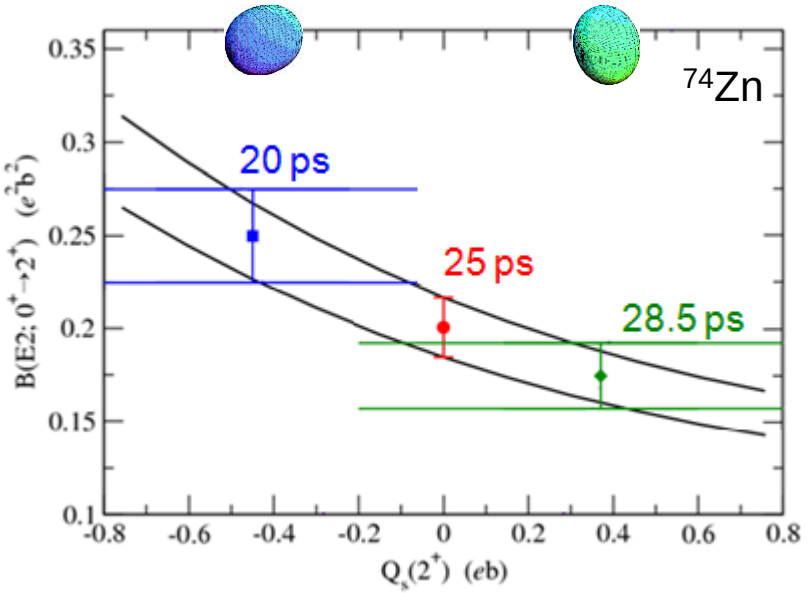


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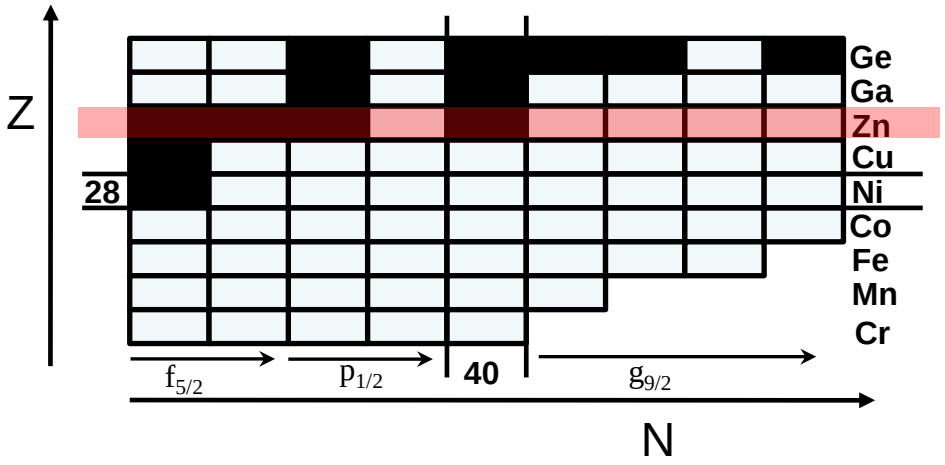


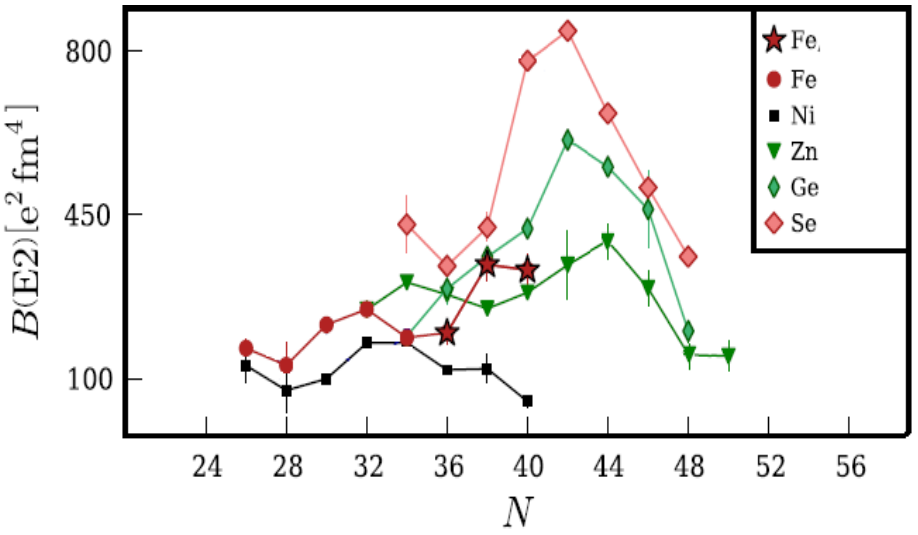


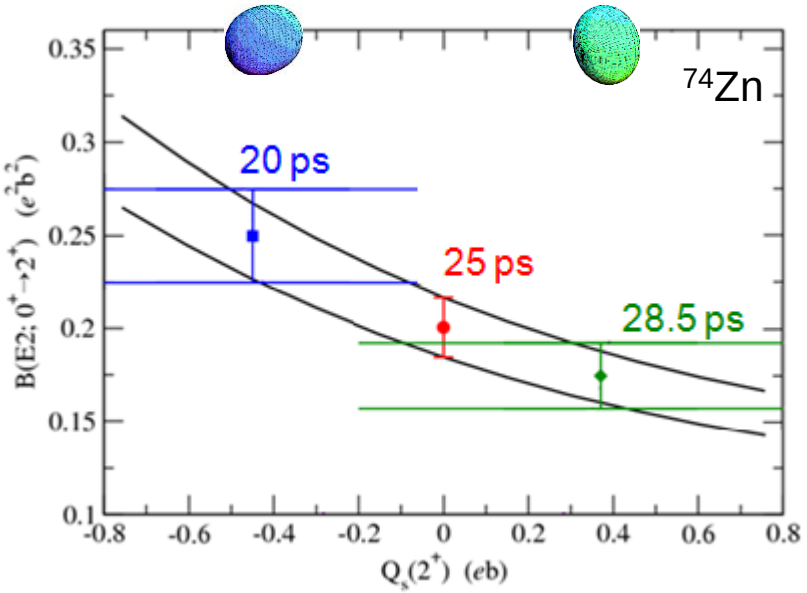


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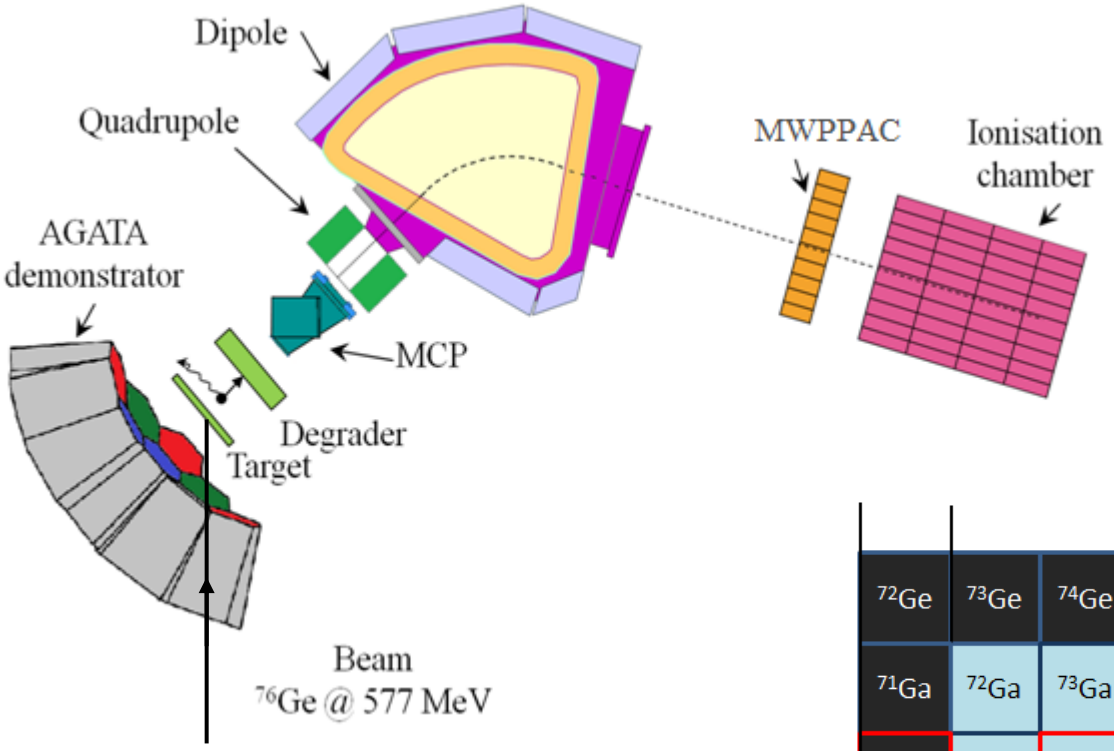
- Lifetime measurement to determine accurate B(E2) value for $2^+/4^+$ states
- Comparison with theory

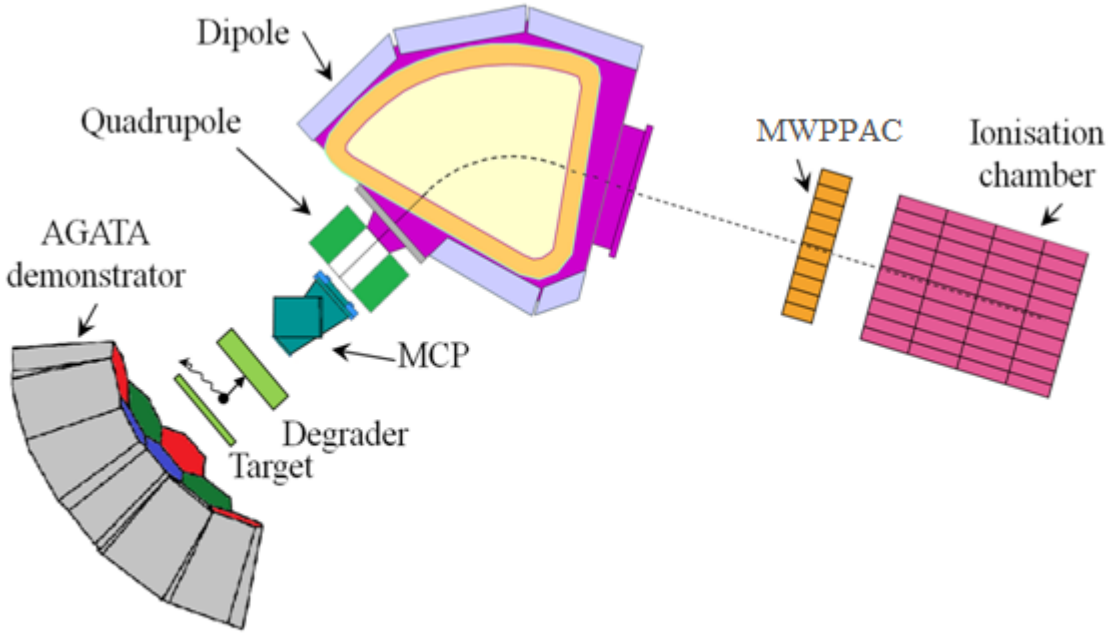
# Experiment



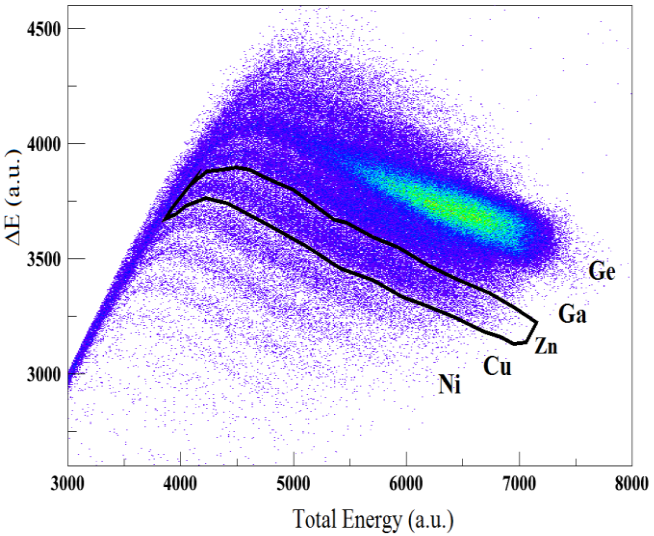

❖ multi-nucleon transfer reaction :
$^{76}$Ge on $^{238}$U @ 577MeV, 0.3 pnA

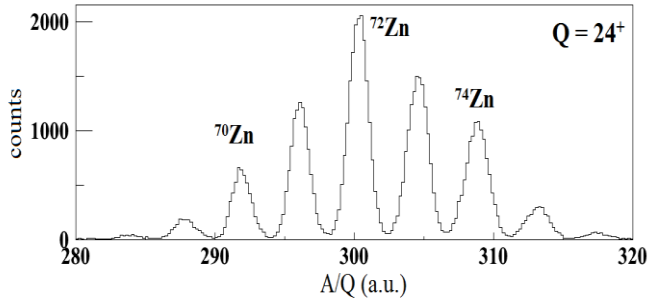
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $^{72}$Ge | $^{73}$Ge | $^{74}$Ge | $^{75}$Ge | $^{76}$Ge | $^{77}$Ge | $^{78}$Ge | $^{79}$Ge | $^{80}$Ge | $^{81}$Ge | $^{82}$Ge |
| $^{71}$Ga | $^{72}$Ga | $^{73}$Ga | $^{74}$Ga | $^{75}$Ga | $^{76}$Ga | $^{77}$Ga | $^{78}$Ga | $^{79}$Ga | $^{80}$Ga | $^{81}$Ga |
| $^{70}$Zn | $^{71}$Zn | $^{72}$Zn | $^{73}$Zn | $^{74}$Zn | $^{75}$Zn | $^{76}$Zn | $^{77}$Zn | $^{78}$Zn | $^{79}$Zn | $^{80}$Zn |
| $^{69}$Cu | $^{70}$Cu | $^{71}$Cu | $^{72}$Cu | $^{73}$Cu | $^{74}$Cu | $^{75}$Cu | $^{76}$Cu | $^{77}$Cu | $^{78}$Cu | $^{79}$Cu |
| $^{68}$Ni | $^{69}$Ni | $^{70}$Ni | $^{71}$Ni | $^{72}$Ni | $^{73}$Ni | $^{74}$Ni | $^{75}$Ni | $^{76}$Ni | $^{77}$Ni | $^{78}$Ni |
| N=40 | | | | | $\nu g_{9/2}$ | | | | | N=50 |

# Experiment



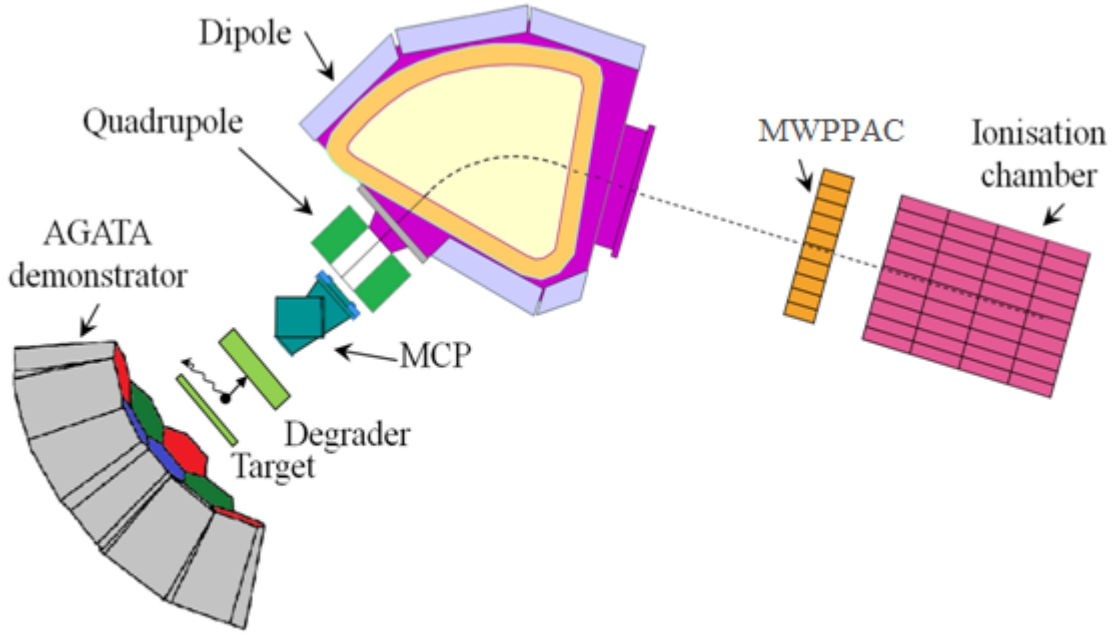

PRISMA



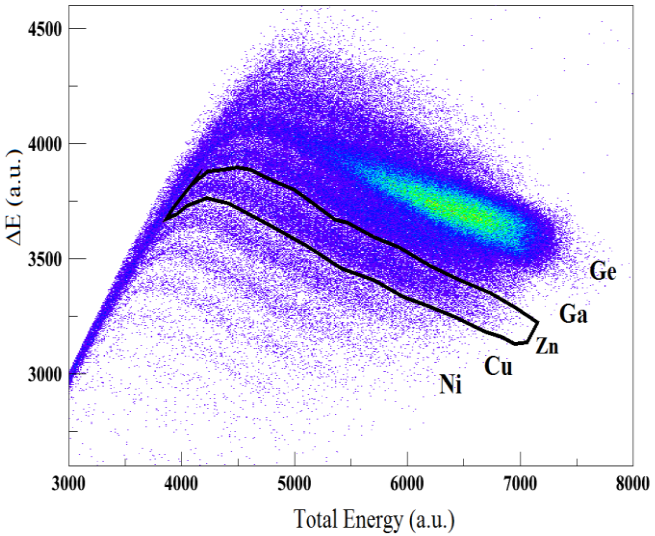



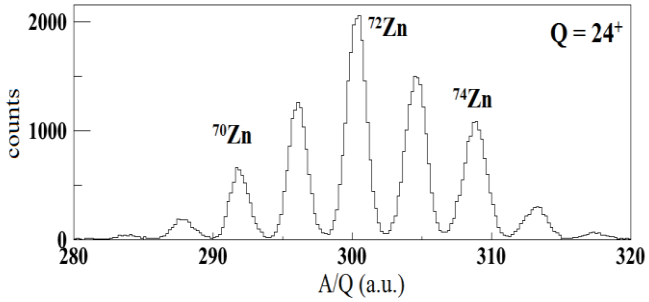

- PRISMA rotated at 55°
- Z, Q, A well separated

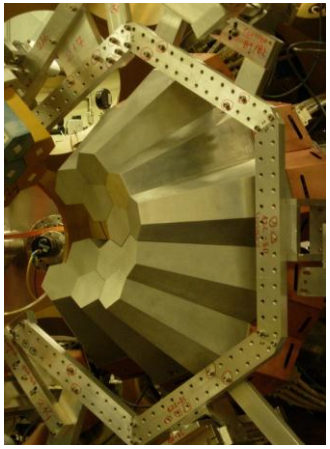
# Experiment




PRISMA



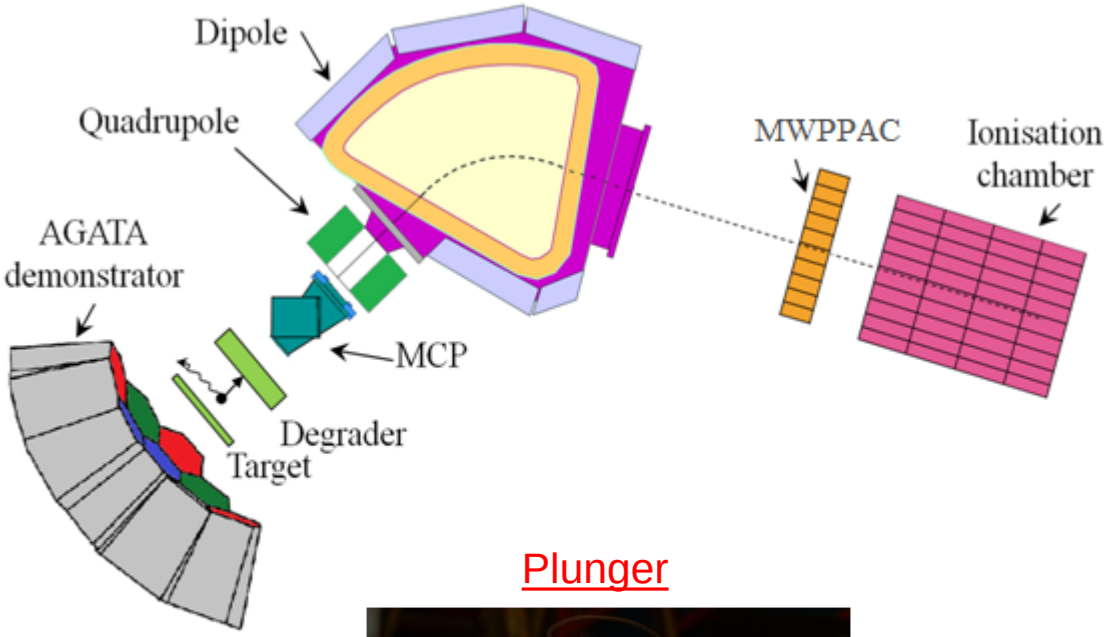



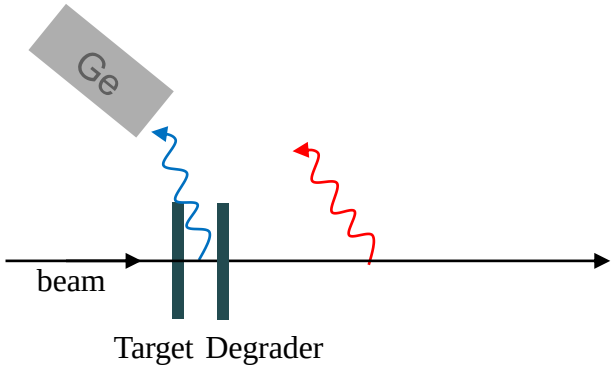
AGATA

- 4 triple clusters
- γ rate : 50 kHz per crystal
- 18 cm from target and [135°/175°] range

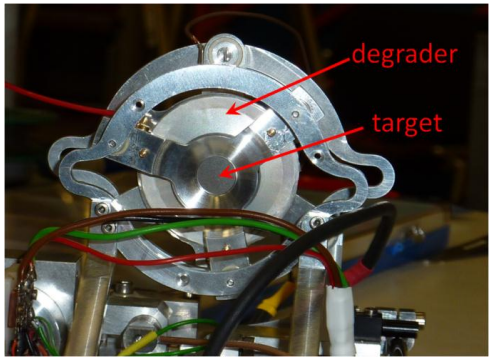
- PRISMA rotated at 55°
- Z, Q, A well separated

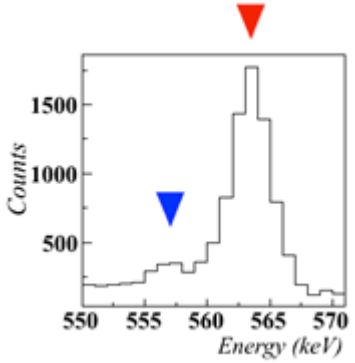
# Experiment



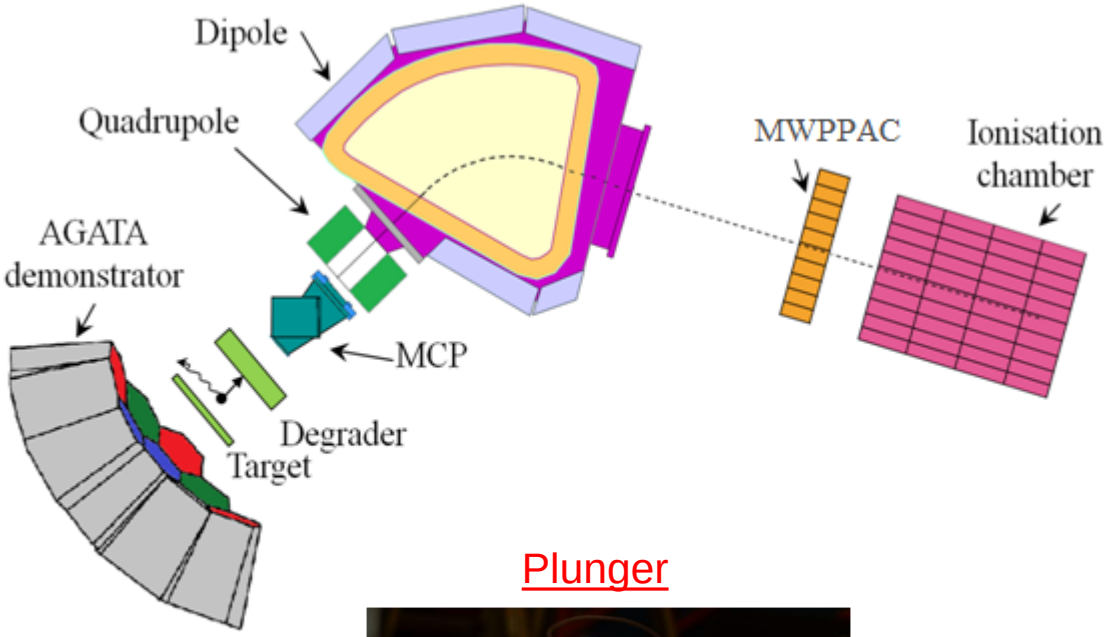

Plunger

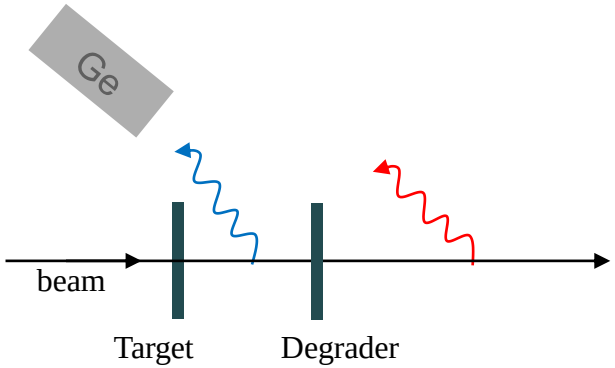


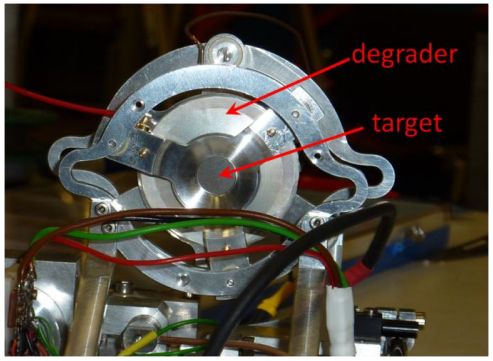

- 1.4 mg/cm$^2$-thick $^{238}$U target
- 4.2 mg/cm$^2$-thick Nb degrader
- 5 distances : 100, 200, 500, 1000, 1900 µm

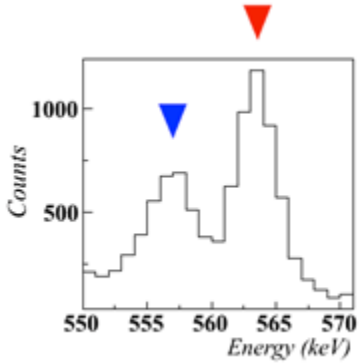
# Experiment




Plunger

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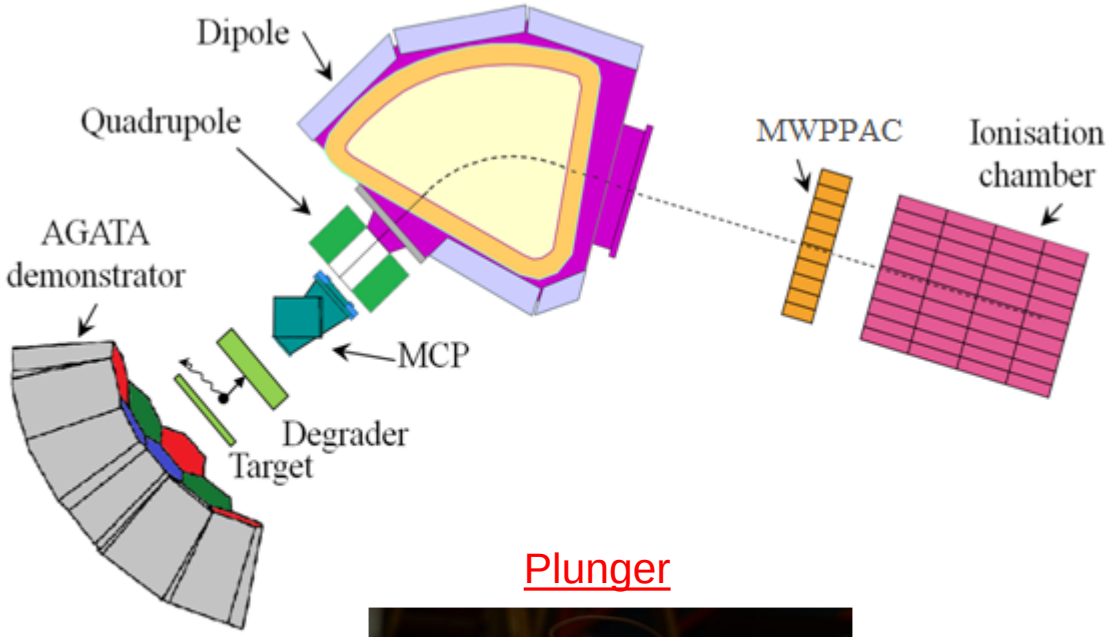
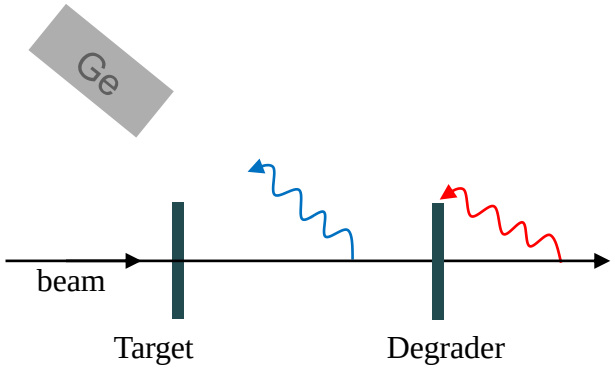
# Plunger device

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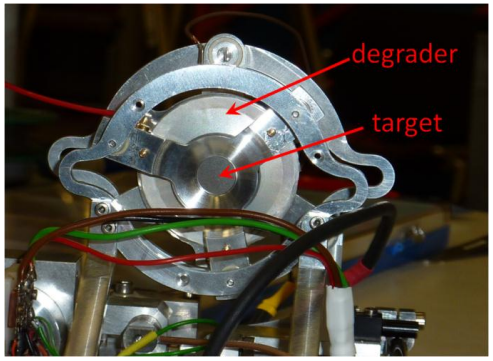


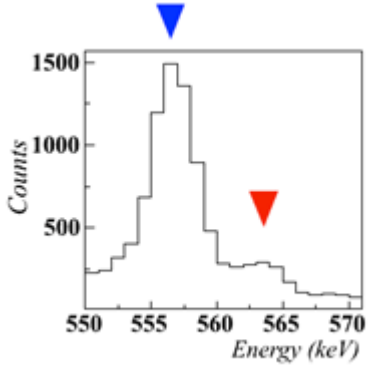


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# Differential Decay Curve method

$$\tau_i(x) = -\frac{Q_i(x) - \sum_k \alpha_k Q_k(x)}{v * \frac{dQ_i}{dx}(x)}$$

- $Q_i = \frac{I_i^u}{I_i}$ and $I_i = I_i^u + I_i^s$
- $v$ = 30 μm/ps

A. Dewald et al. Phys. A 334, 163 (1989)

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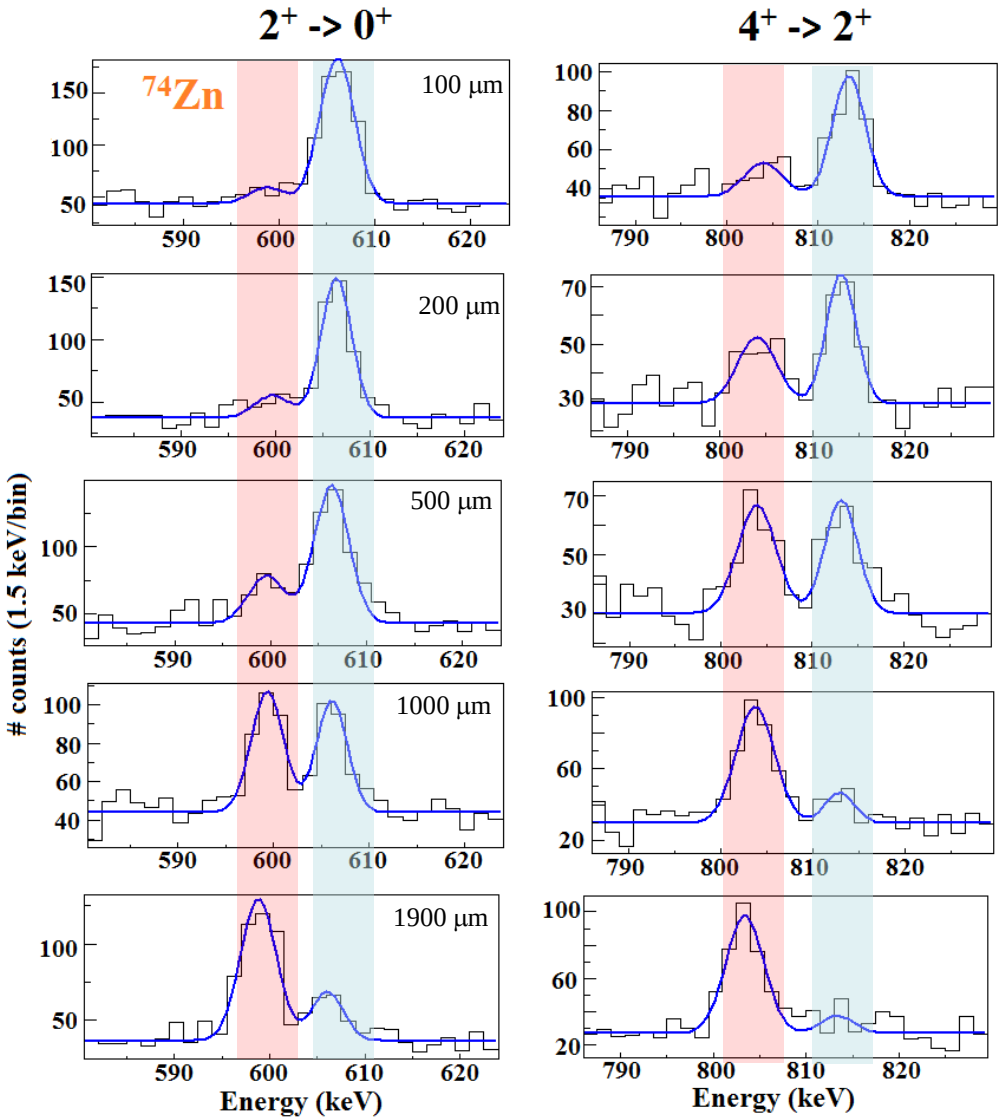

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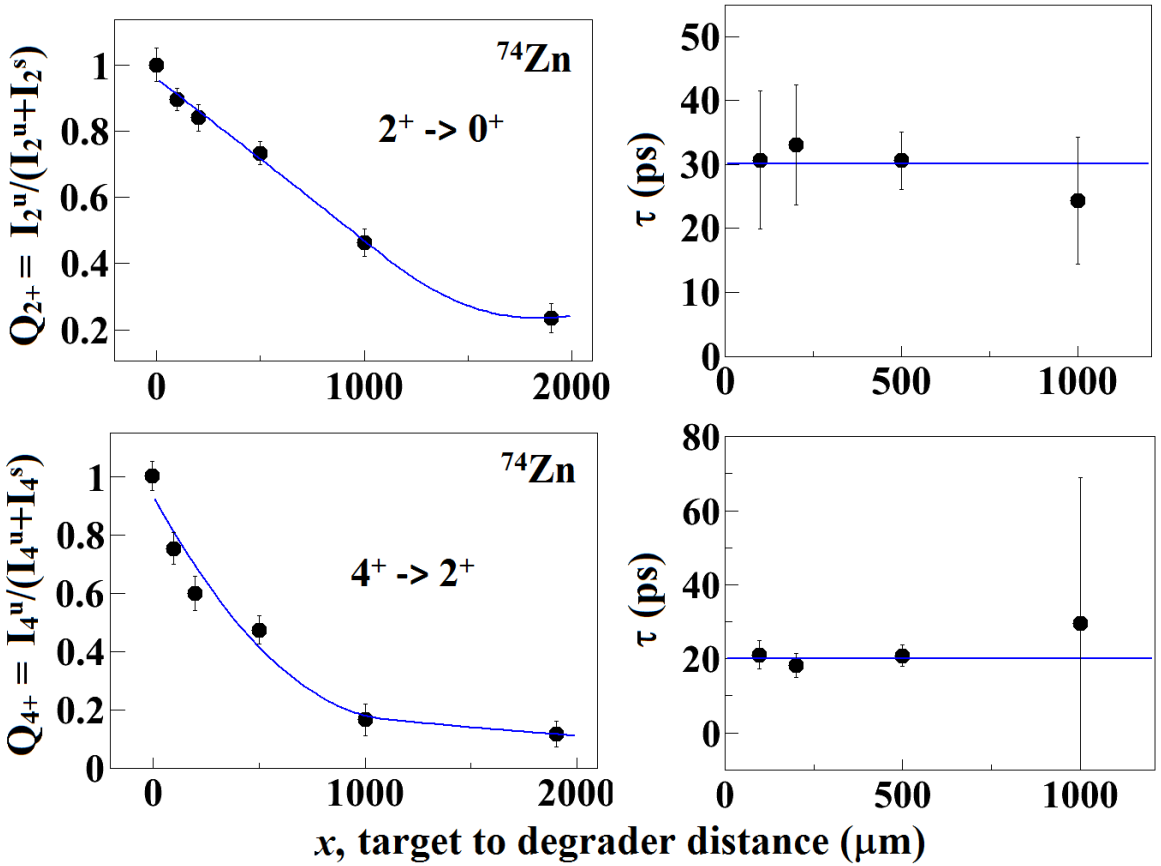
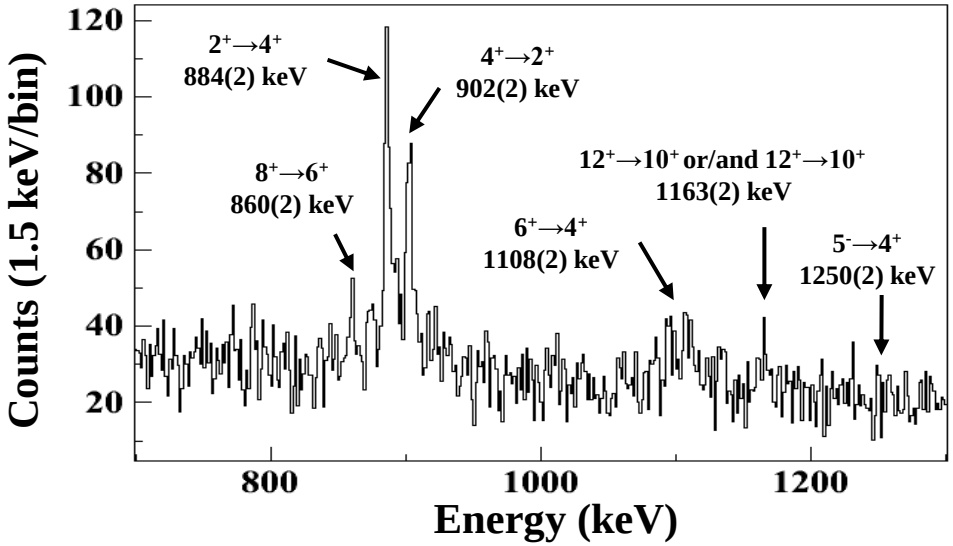
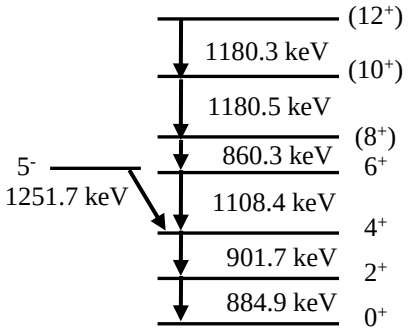
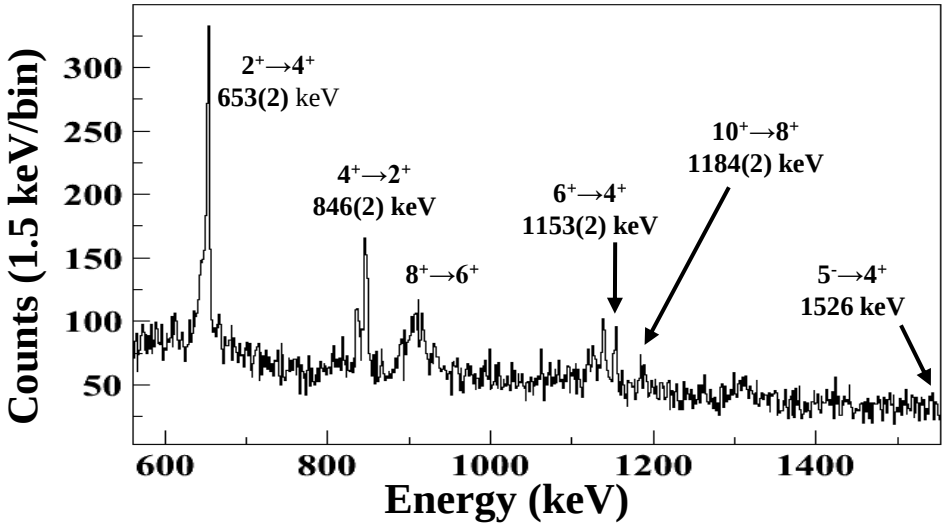


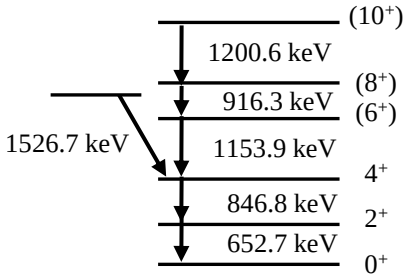
# $^{70,72}$Zn spectra




**$^{70}$Zn**
100 µm

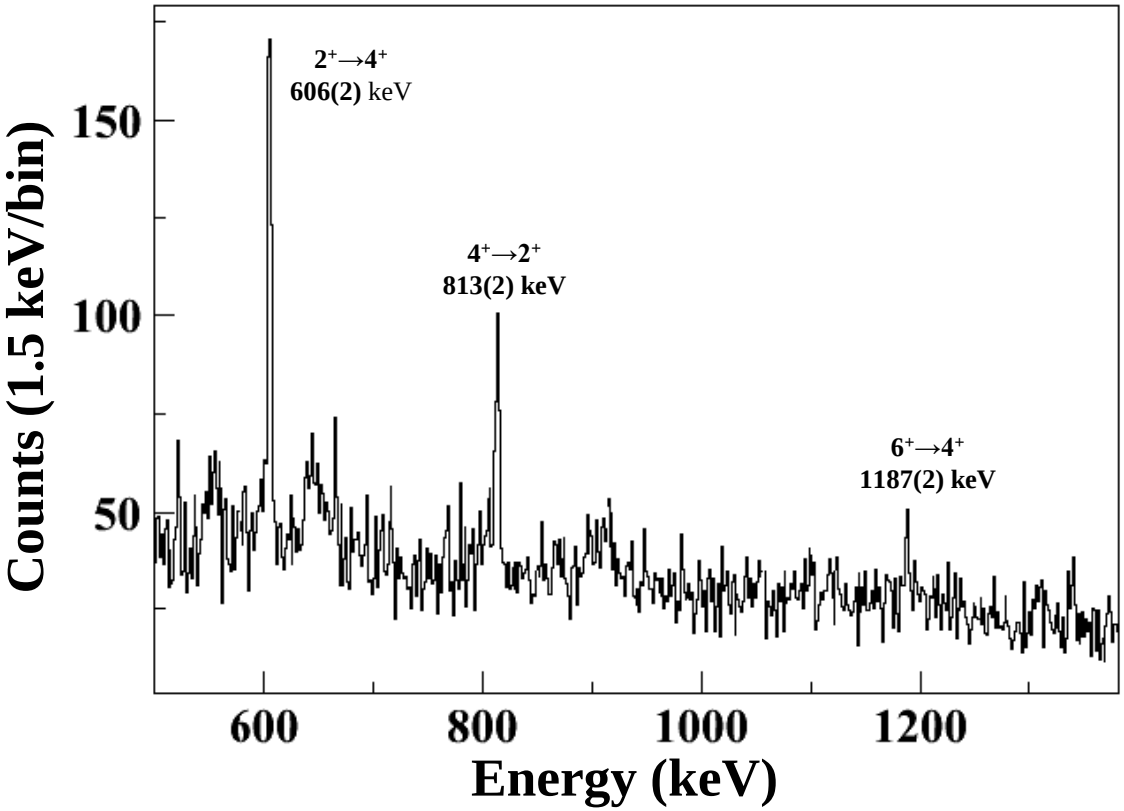


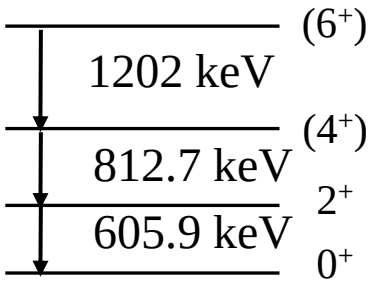

**$^{72}$Zn**
100 µm

From NNDC data base

# $^{74}$Zn spectra

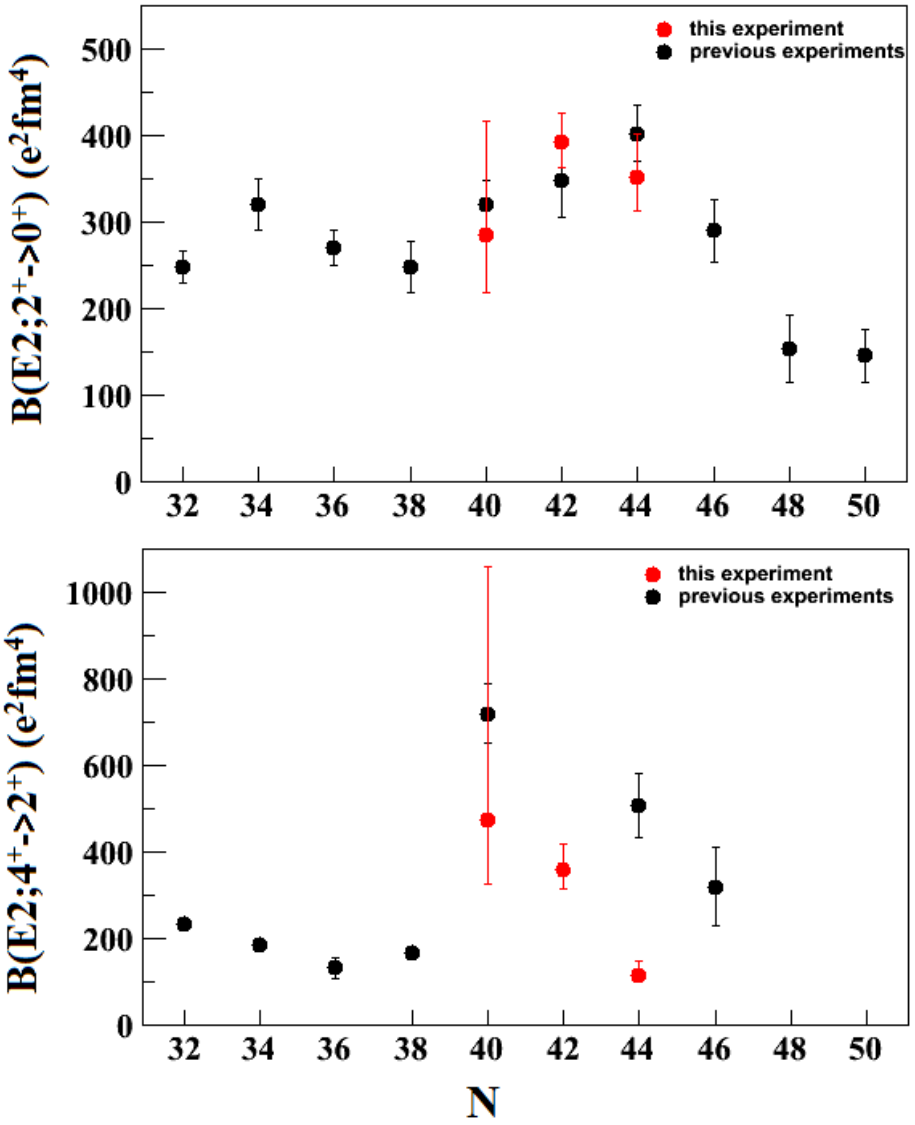



$^{74}$Zn
100 μm




From J. Van Roosbroeck et al. PRC 71, 054307 (2005)
And T. Faul thesis

# Results

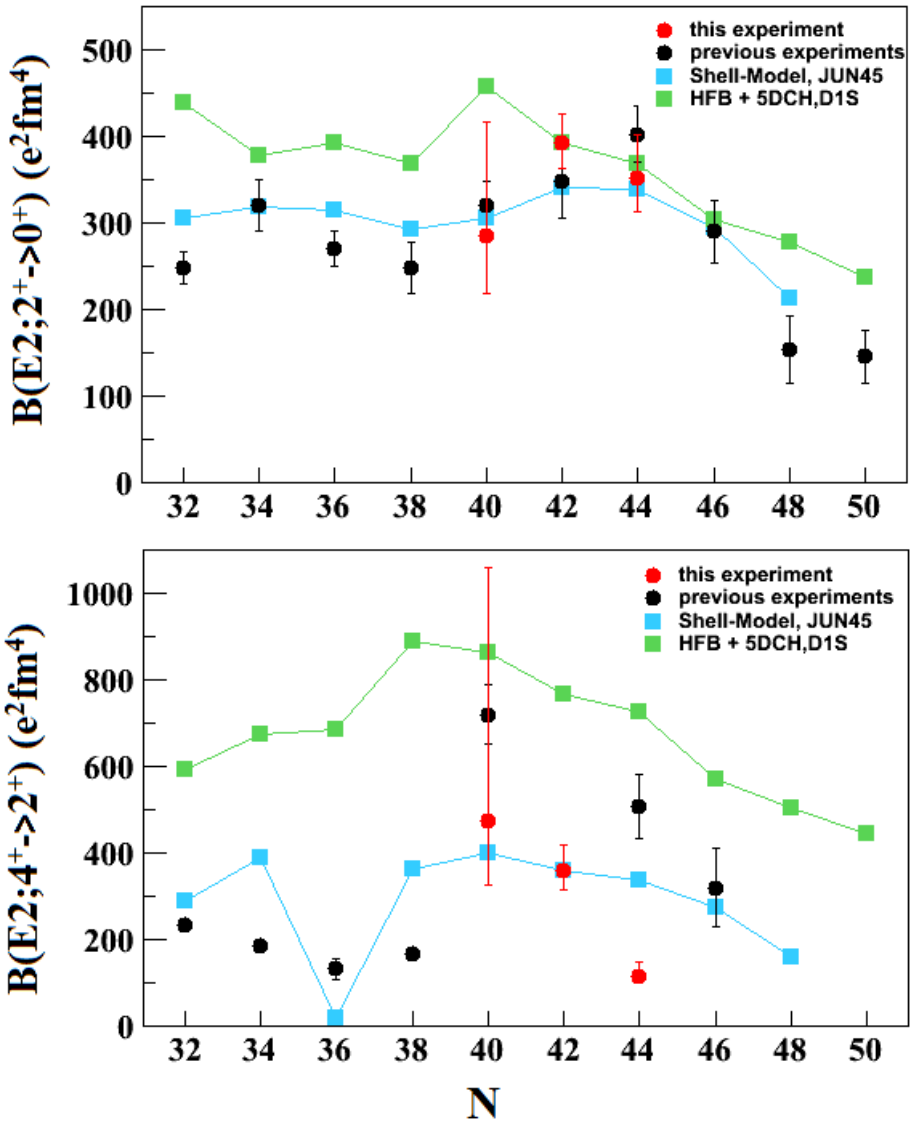



- Maximum of collectivity at N=42
- B(E2; $2^+ \rightarrow 0^+$) values are in agreement with other measurements
- Discrepancy for $\tau_{4^+}$ $^{74}$Zn with previous coulomb excitation measurement



D. Mücher et al. PRC 79 054310 (2009)
J. Van de Walle et al. PRC 79 014309 (2009)

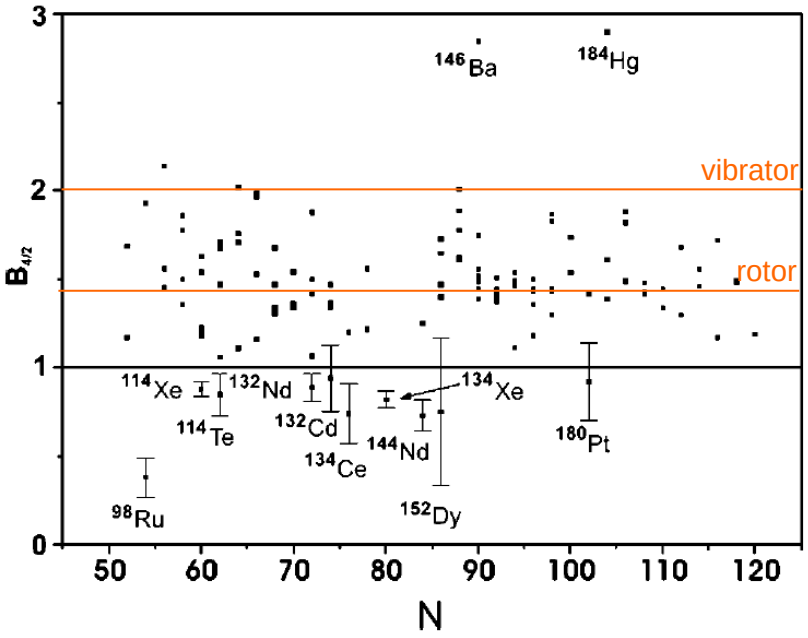
# Results




- B(E2; $2^+ \rightarrow 0^+$) values are in agreement with shell model calculations
- Beyond mean field calculation over estimate the collectivity
- Shell model predictions don't reproduce the trend of the systematics

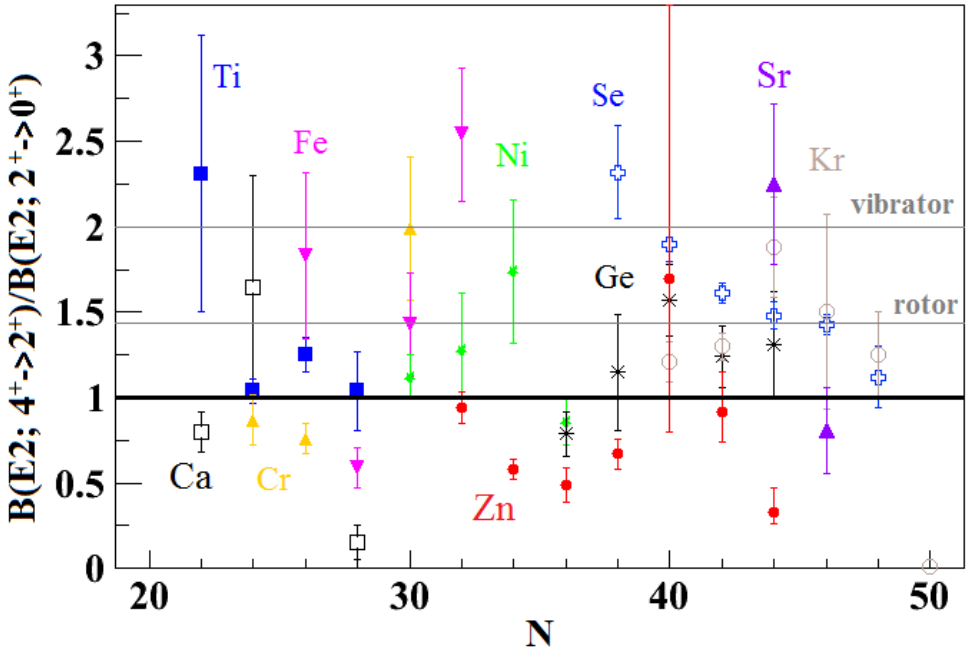
# B(E2) ratio

Nonmagic nuclei 40<Z<80




R.B. Cakirli et al. PRC 70, 047302 (2004)

Nuclei Z<40



# Conclusion

- Measured lifetimes of $2^+$,$4^+$ states in $^{70,72,74}$Zn
- Deduced B(E2) compared with previous data and theory

- B(E2; $2^+ \rightarrow 0^+$) : good agreement with previous measurements
- Maximum of collectivity at N=42

- very low B(E2; $4^+ \rightarrow 2^+$) values
- Inconsistent with previous measurements
- Decrease toward $^{74}$Zn, sign for non collective $4^+$ states?

<u>Perspectives</u> : dedicated coulomb excitation for $^{70}$Zn (accepted experiment)
deep inelastic measurement under analysis for $^{70/72}$Zn (at Ganil)
confirmation needed for the $\tau$(4+) of $^{74}$Zn
extend lifetime measurement to $^{76}$Zn

# Thank you for your attention

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