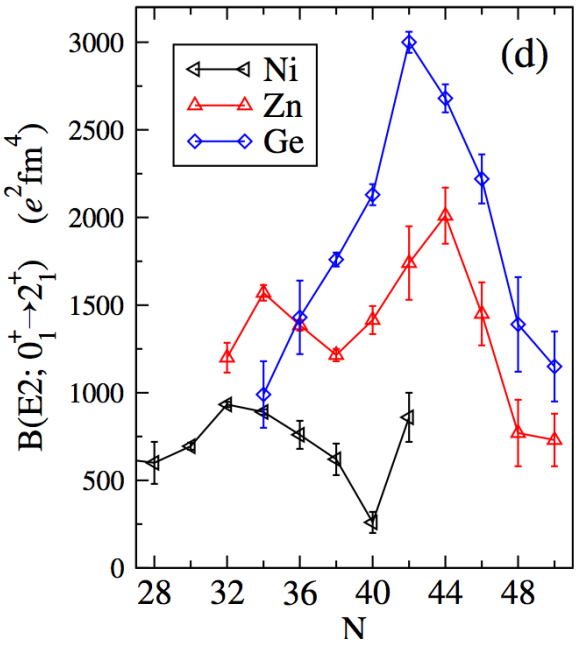
Lifetime of first excited states In ^{72}Zn and ^{74}Zn

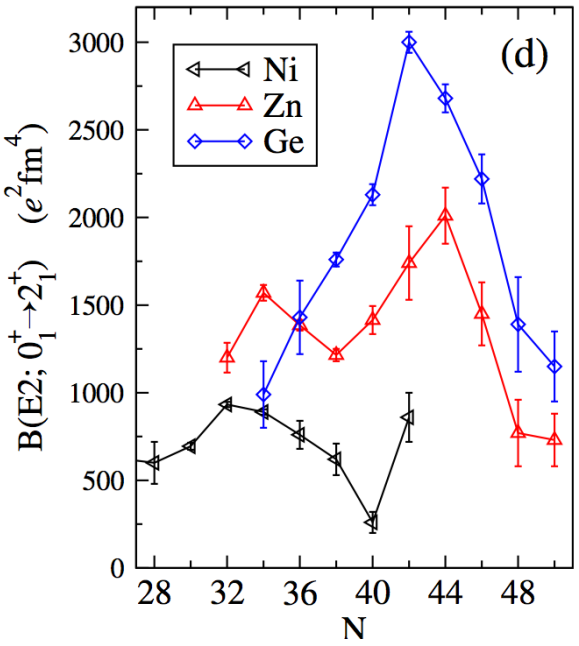
Corinne Louchart, CEA Saclay

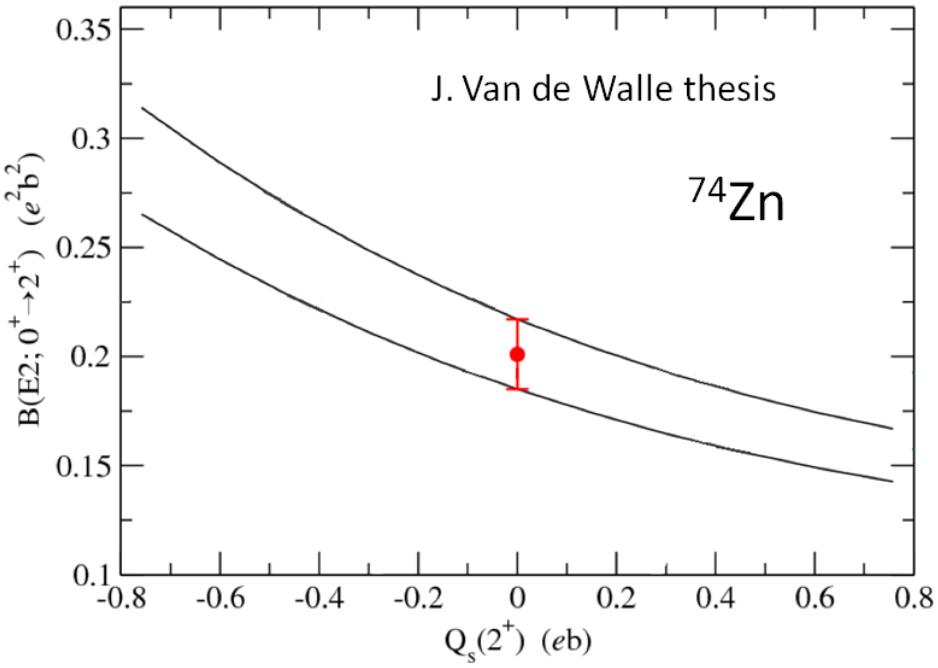
AGATA week, Lyon, November 24th, 2010

Onset of collectivity near N=40



Onset of collectivity near N=40

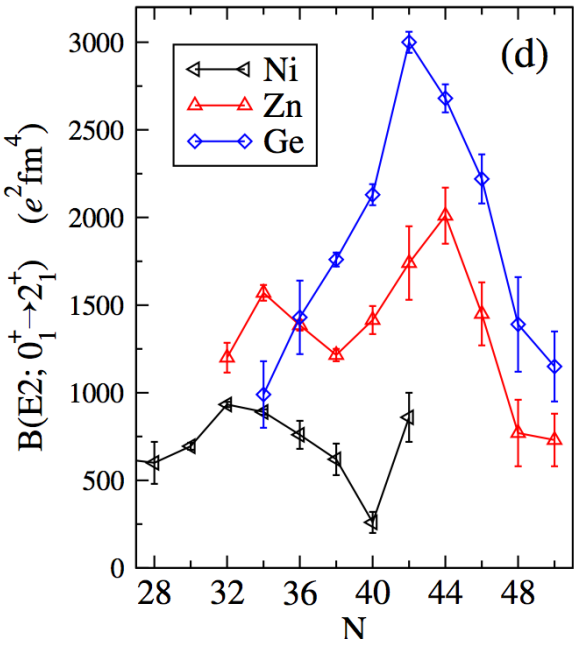


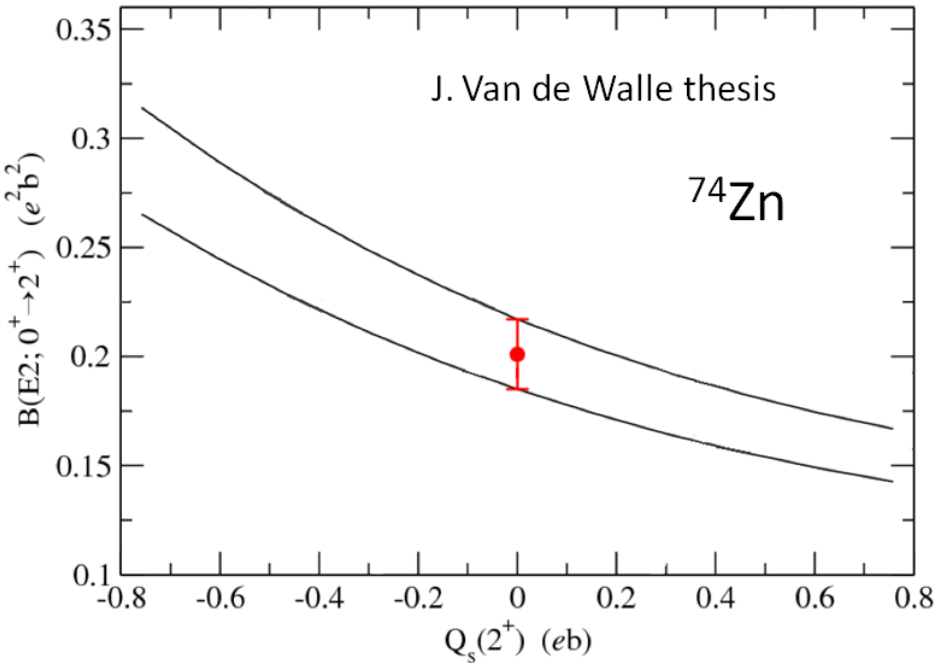


Coulomb excitation of $^{74\text{-}80}$Zn at CERN
(J. Van de Walle et al., PRL 99, 142501 (2007))

$$\sigma = \sigma_{transition} + \sigma_{reorientation}$$

Onset of collectivity near N=40





Coulomb excitation of $^{74\text{-}80}$Zn at CERN
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$$\sigma = \sigma_{transition} + \sigma_{reorientation}$$

- B(E2) α $1/\tau_{2+}$

<u>goal</u> : Measurement of τ_{2+}, τ_{4+} in ^{72,74}Zn

Proposal

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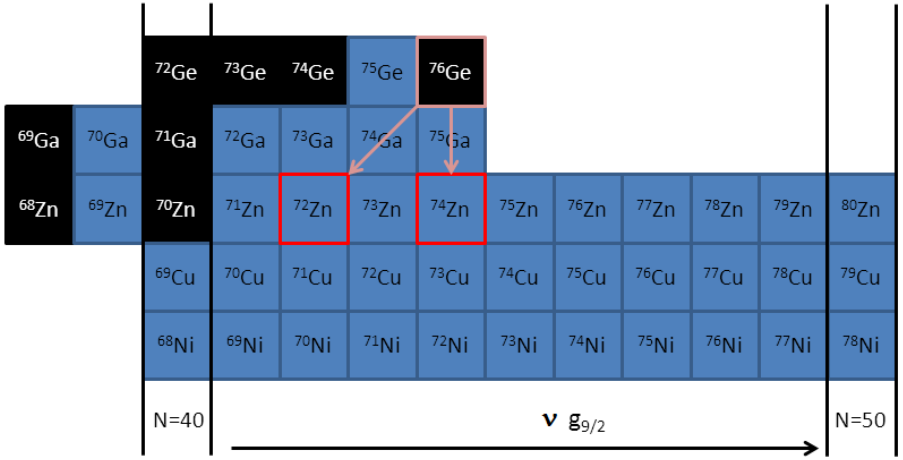
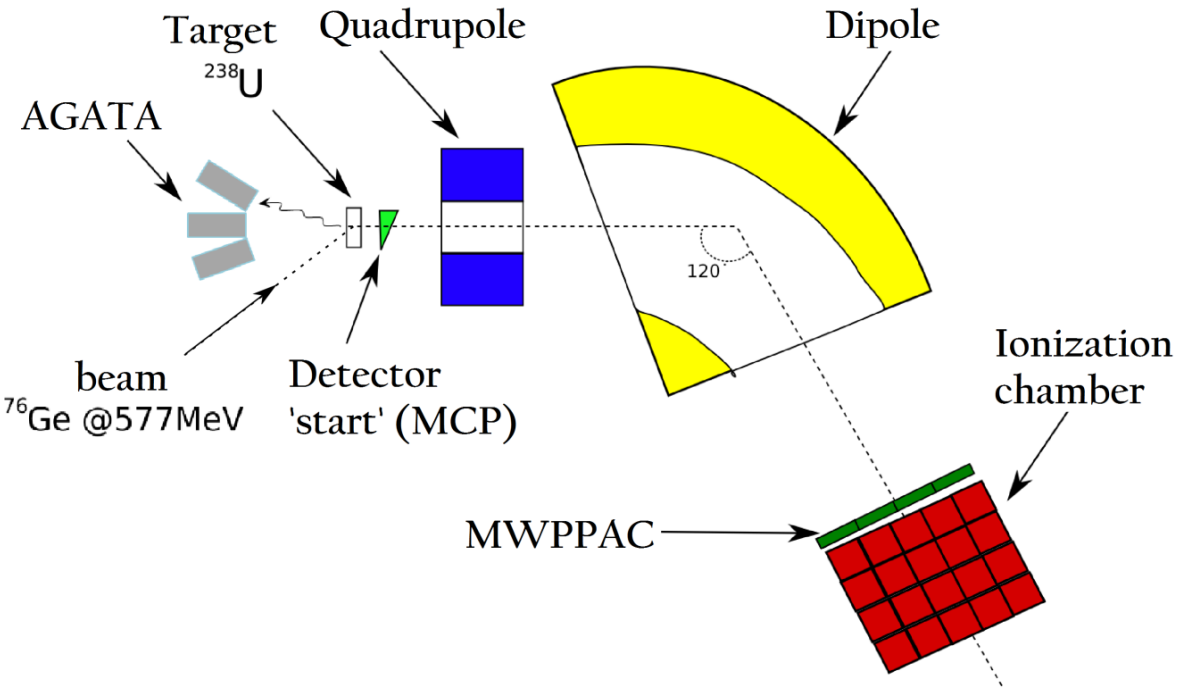
[m] *University of the West of Scotland, Scotland*
[n] *Dipartimento di Fisica Teoria, Universitá di Torino, Italy*
[o] *Inter-University Accelerator Centre, New Delhi, India*
[p] *Ruder Boskovic Institute, Zagreb, Croatia*
[q] *ISOLDE, CERN, Geneva, Switzerland*

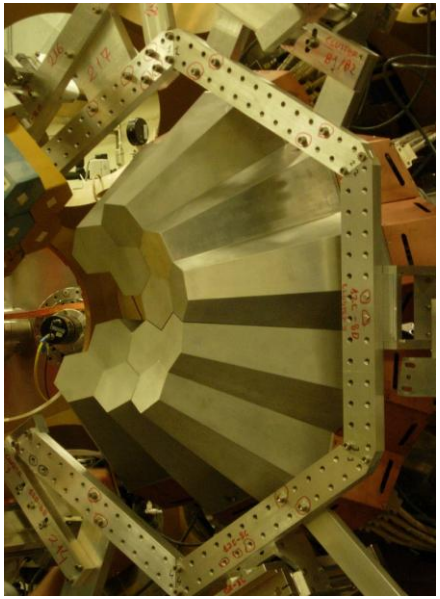


- Study of ^{72}Ni
- Study of ^{71}Cu and ^{73}Cu
- Study of ^{72}Zn, ^{74}Zn and ^{76}Zn

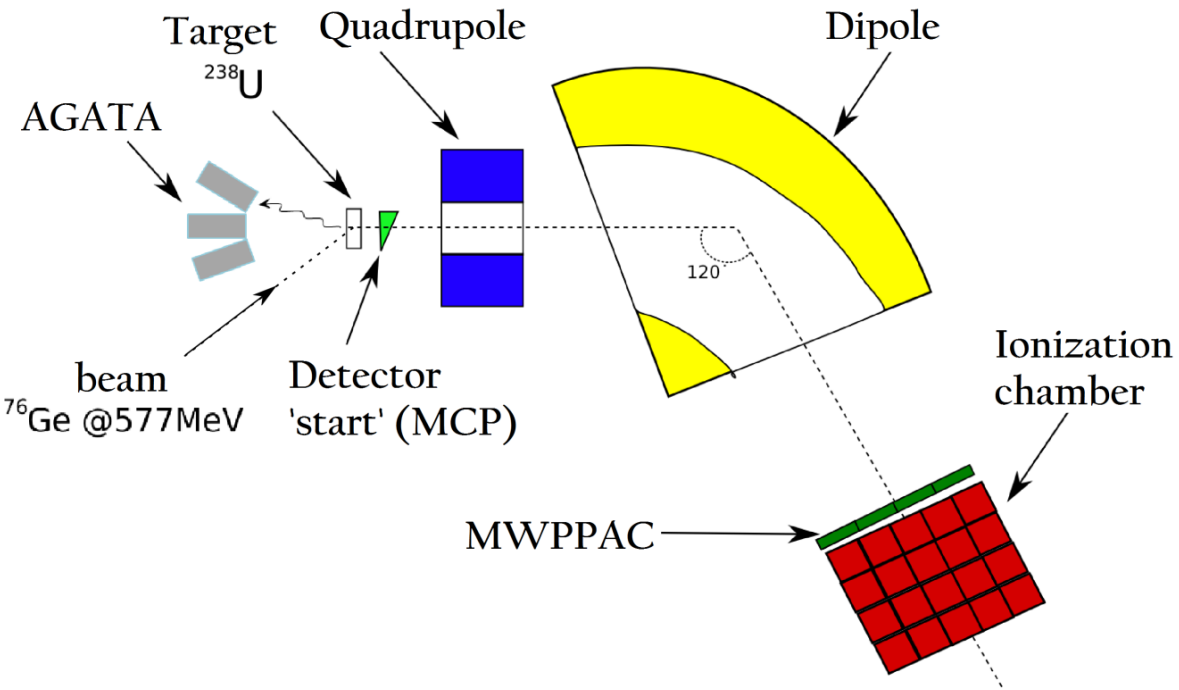
Experimental set-up



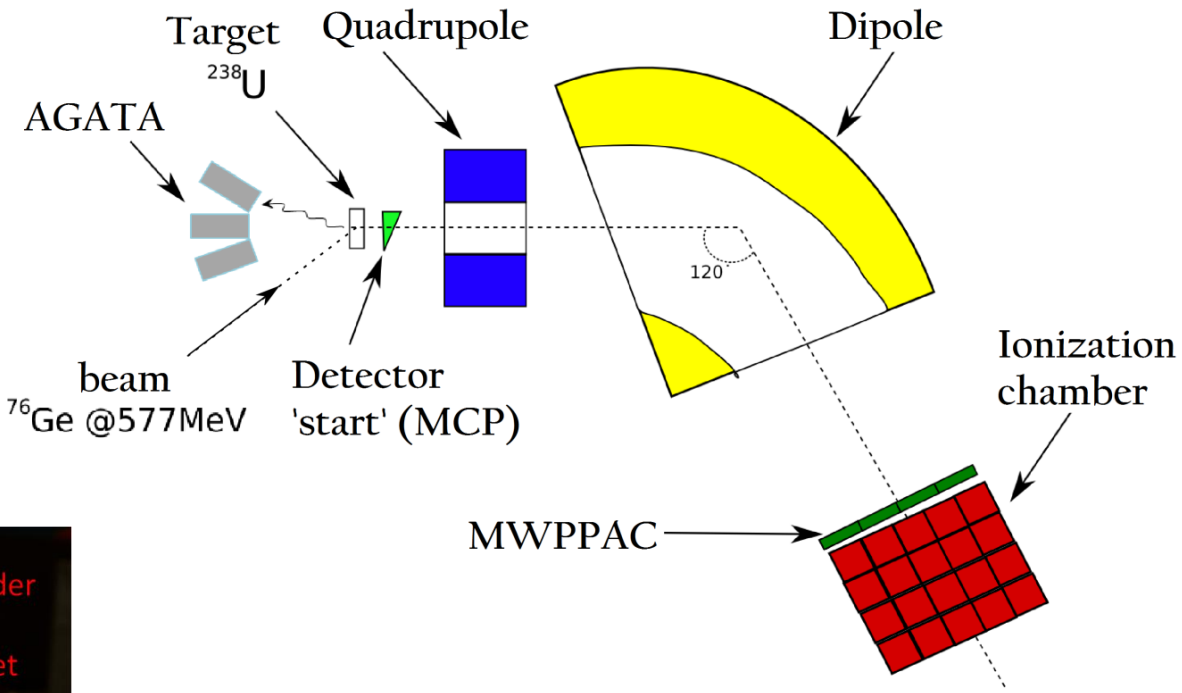
Experimental set-up

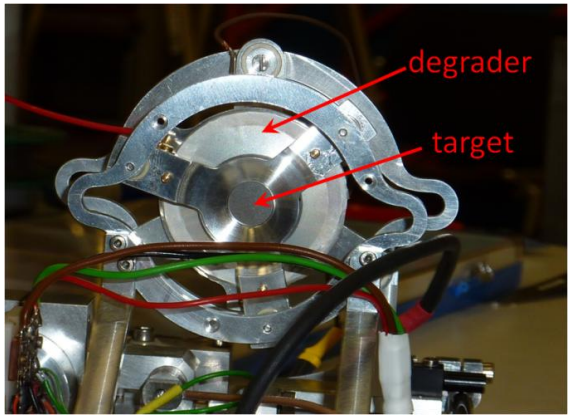


- γ rate : 50 kHz per crystal



Experimental set-up



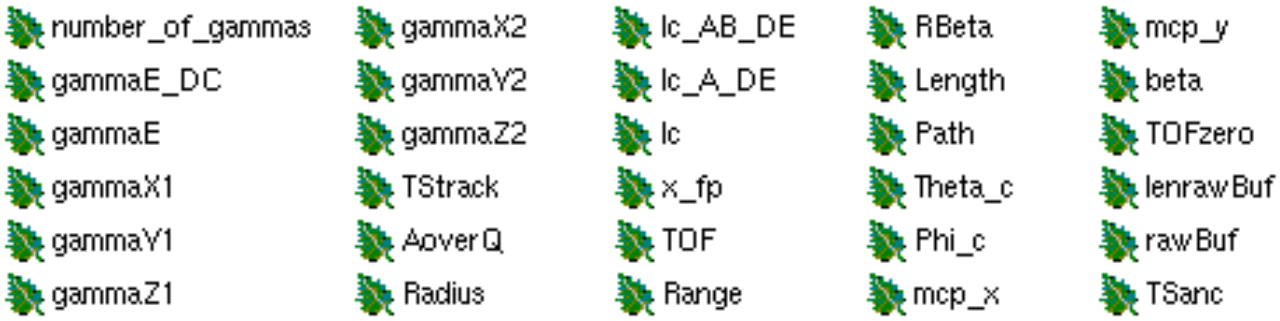


- degrader: ^{91}Nb of 4.2 mg/cm^2 thickness
- target: ^{238}U of 1.4 mg/cm^2 thickness

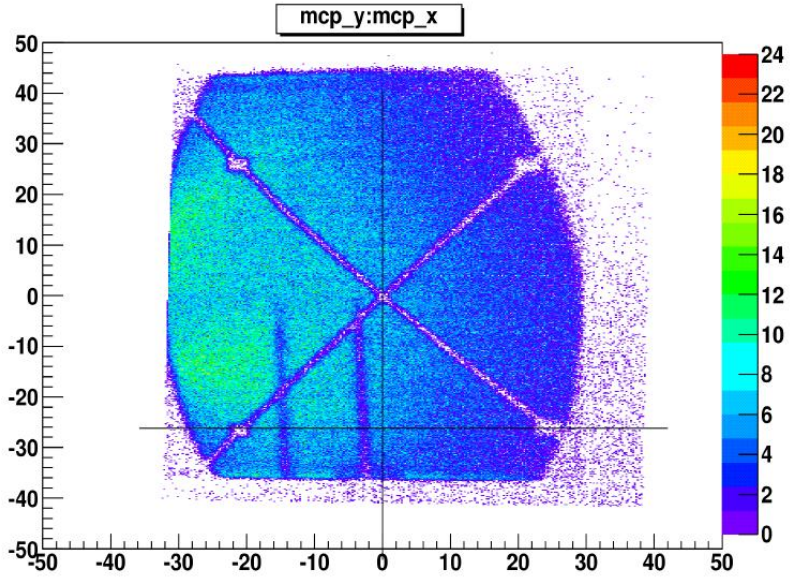
Analysis tools

- ADF files produced during the experiment
- Gamma Ware package (developed by Olivier Stezowski) and Prisma library
- Offline Watchers to produce a calibrated TTree in root file

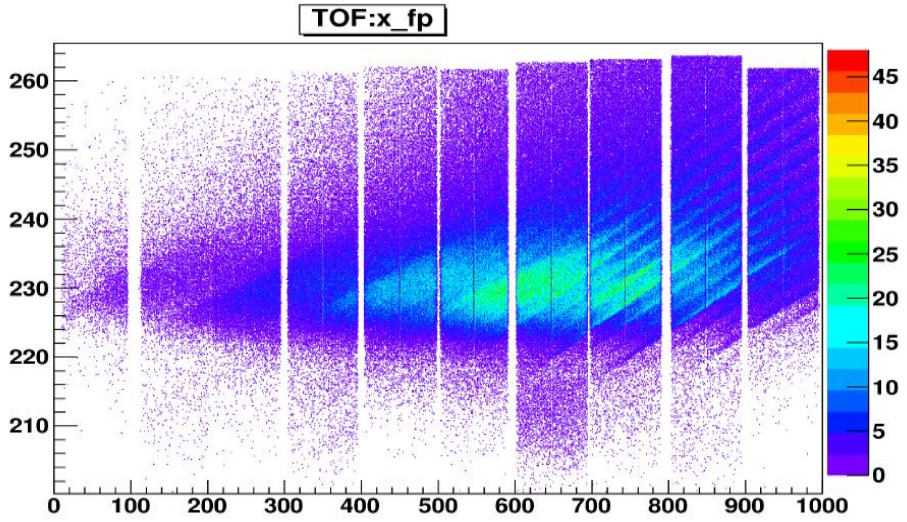
Branches :



Calibration with PRISMA

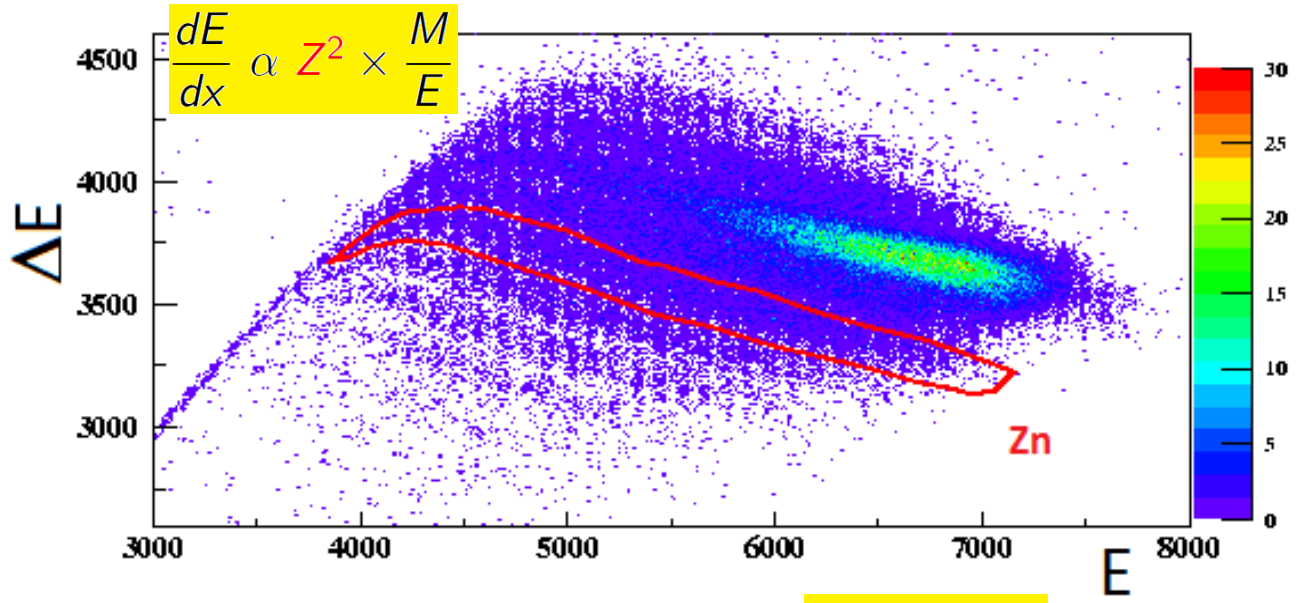


- absolute position for the four “points”
- alignment

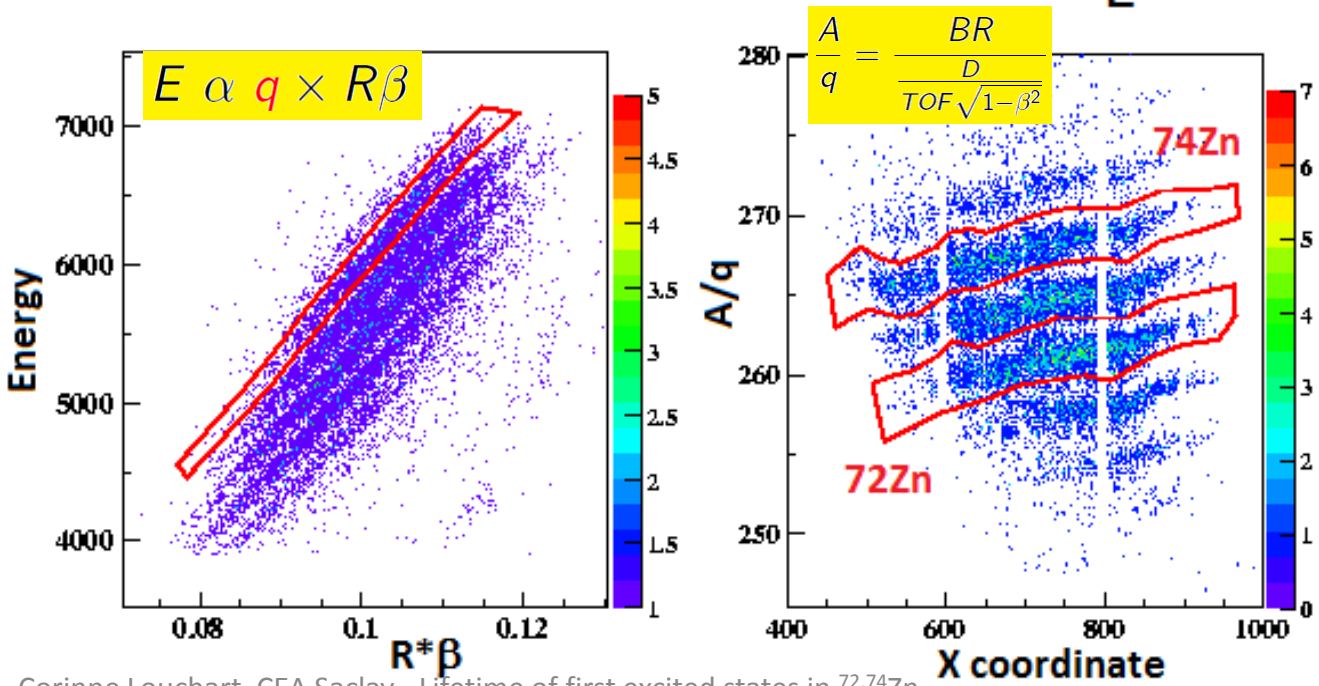


- TOF offset alignment of every MWPPAC sections
- Global TOF offset : set the $2^+ \rightarrow 0^+$ of ^{76}Ge at the known energy (563 keV)

Identification

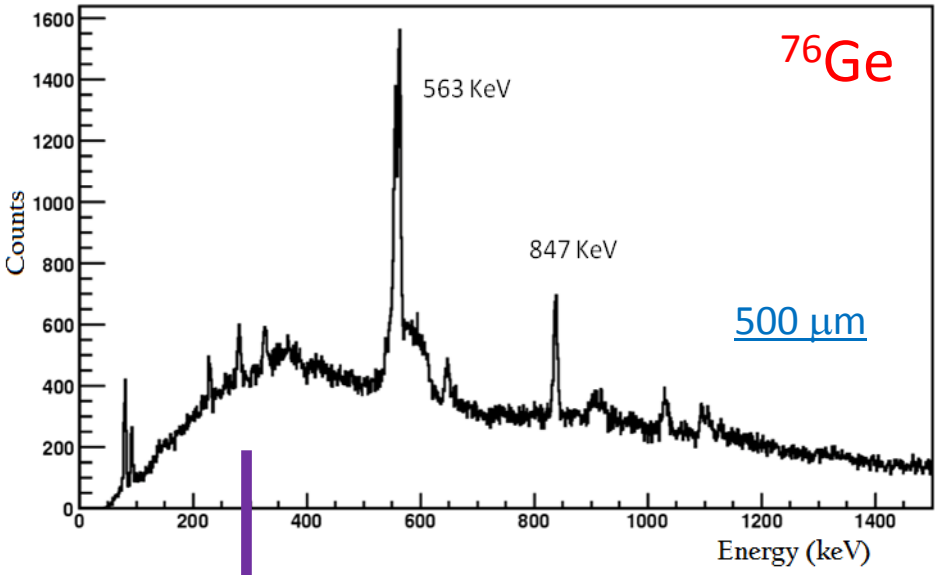


- ΔE in the two first ionization chamber sections
- total energy lost

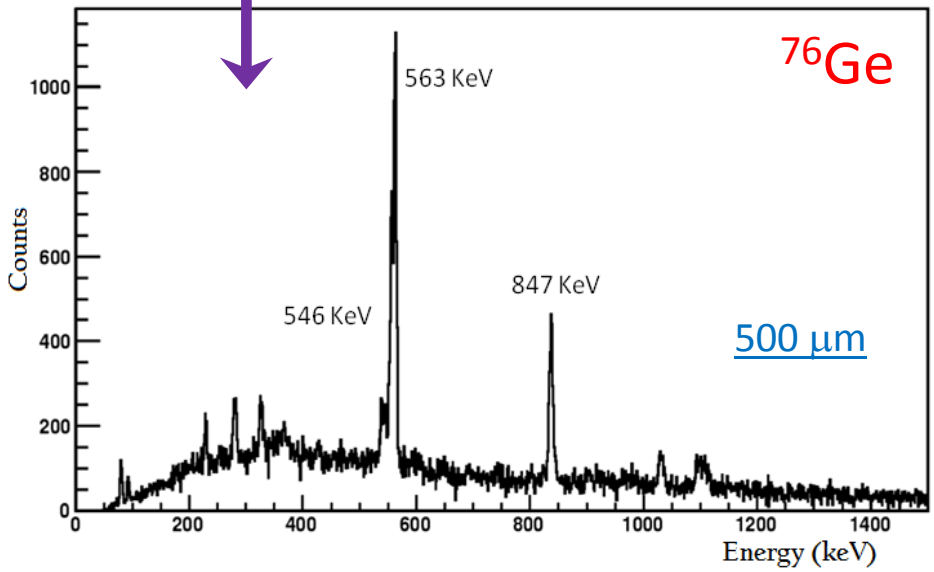


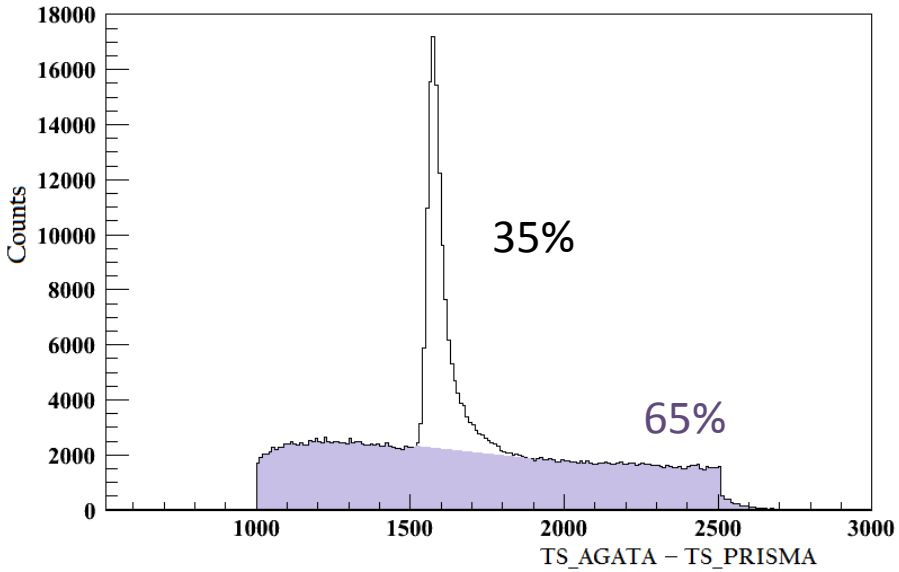
- β = Path/(TOF*c)
- x in focal plane by PPAC

Selected spectra



Background subtracted





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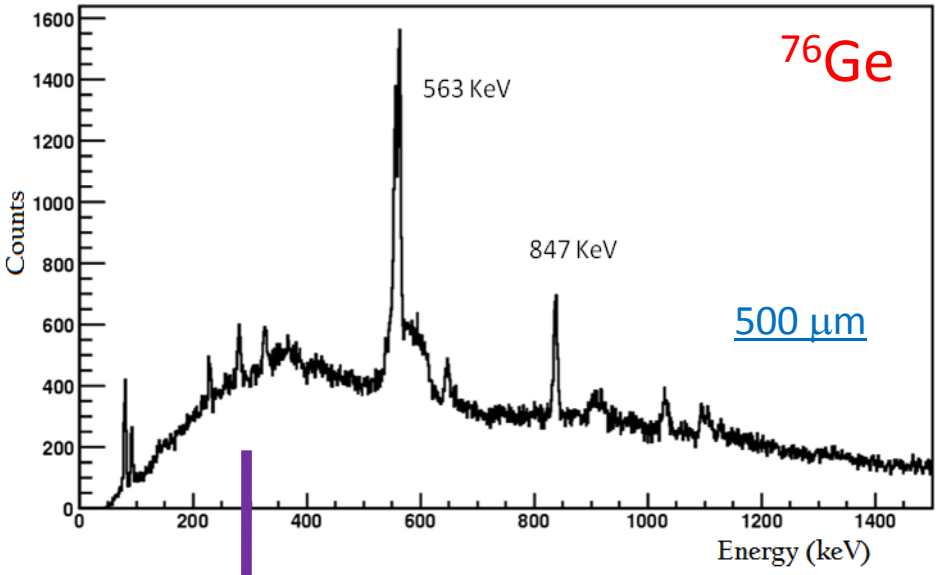

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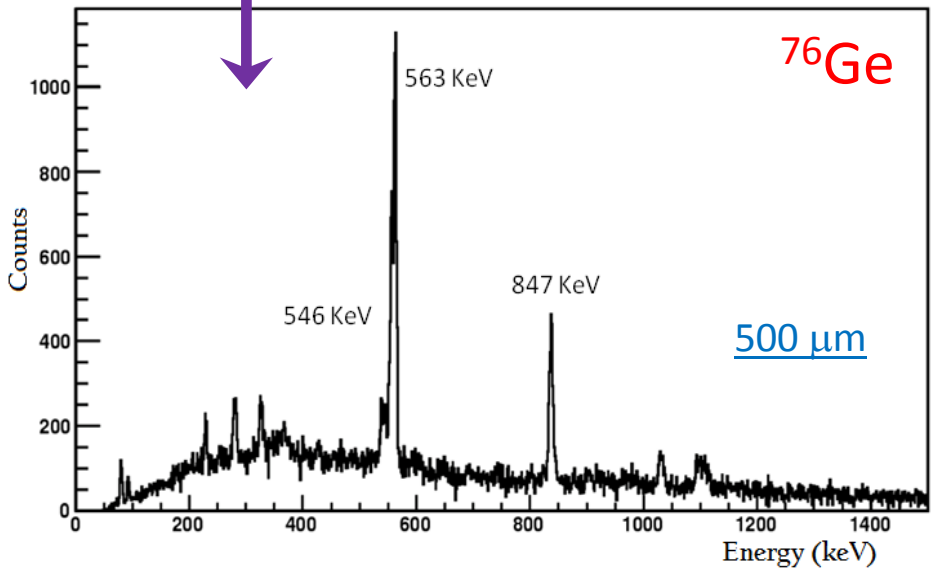
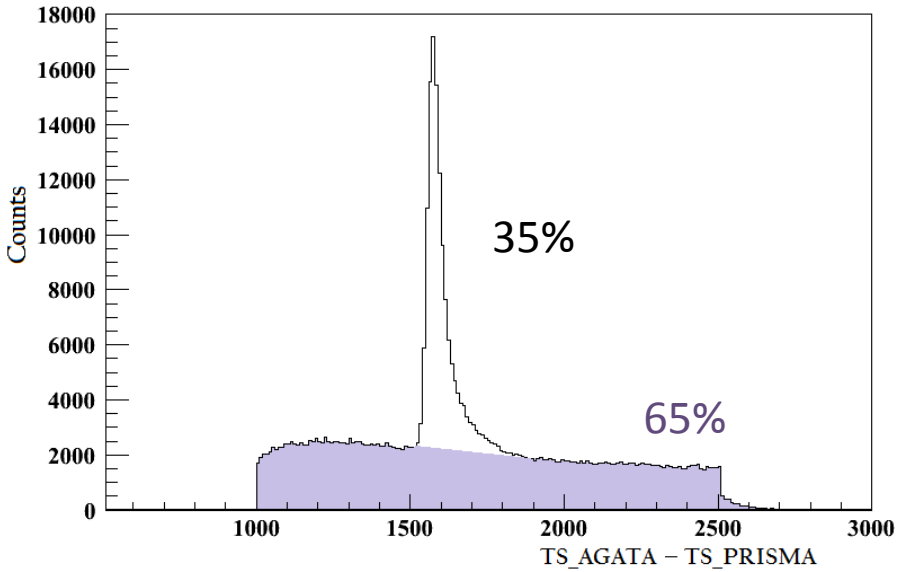
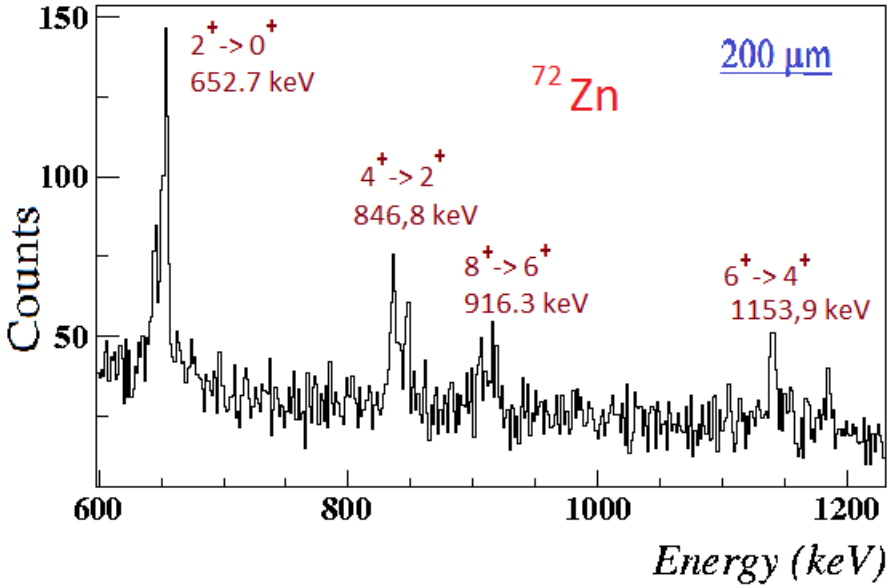
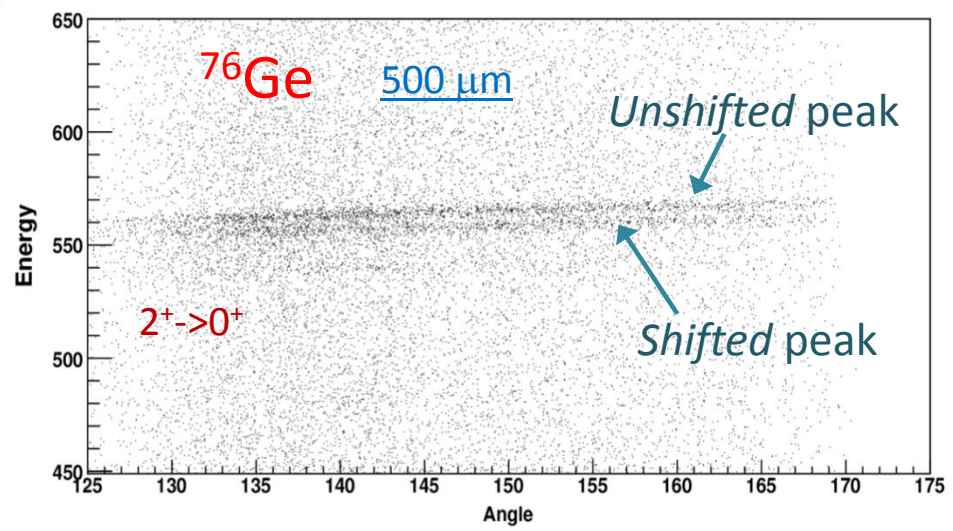




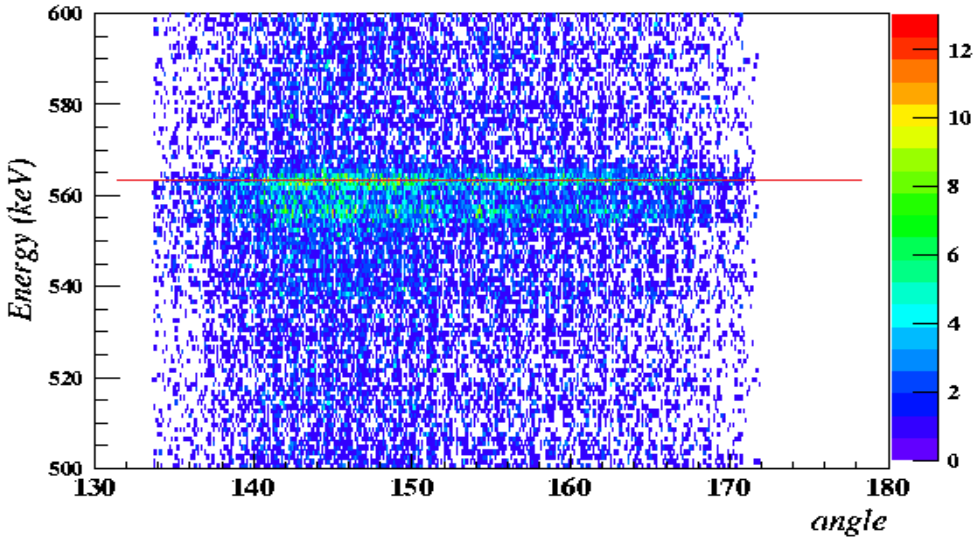


AGATA – Target distance



AGATA-Target ≈ 14 cm

Adopted position for tracking

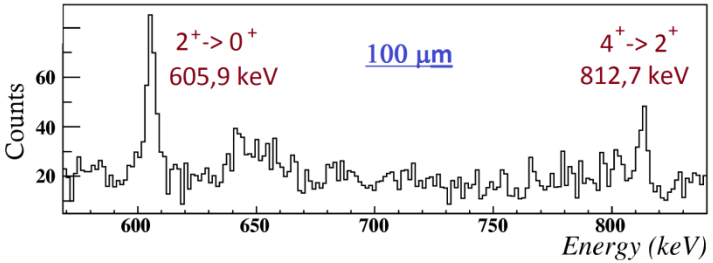


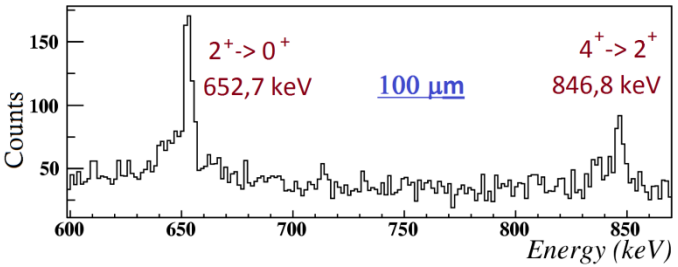
AGATA-Target ≈ 18 cm

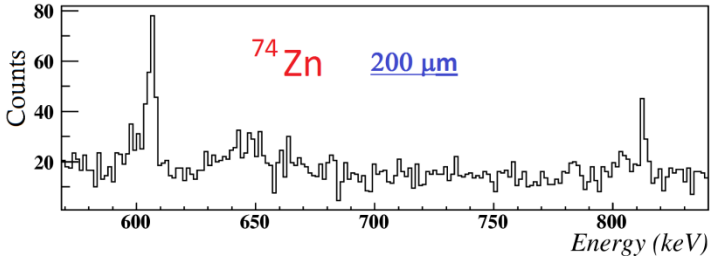
Adopted position for the Doppler correction (analysis)

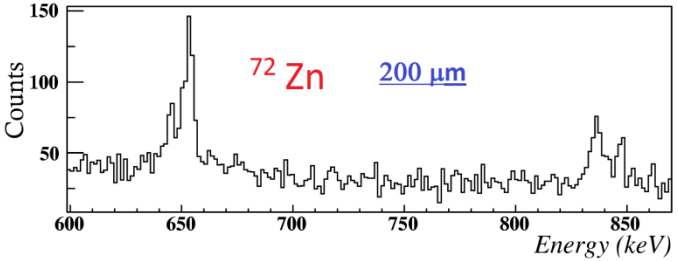
→ **Confirmed by Legnaro**

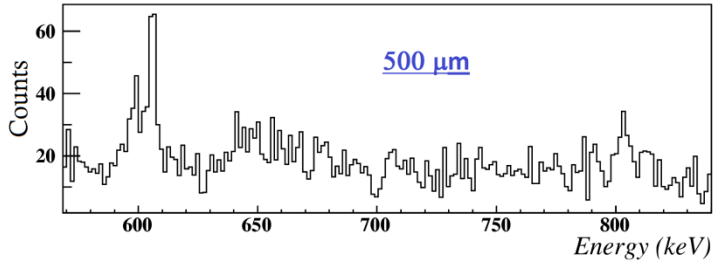
^{72}Zn and ^{74}Zn preliminary spectra

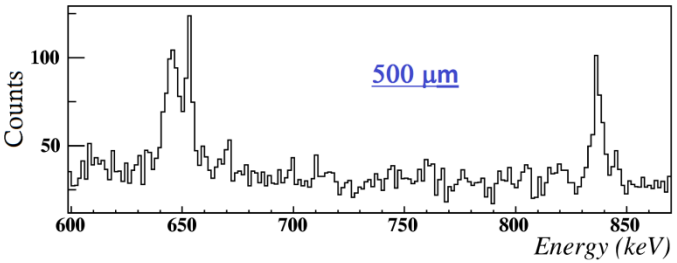


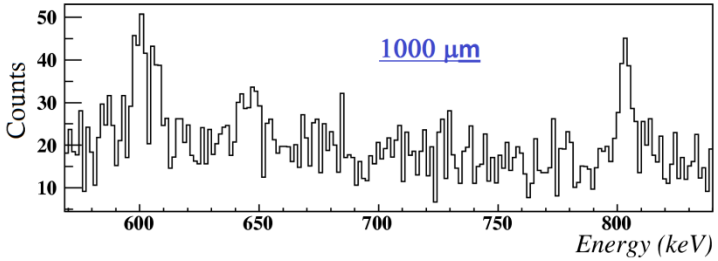


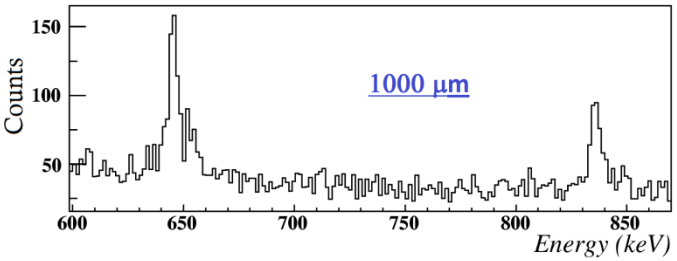


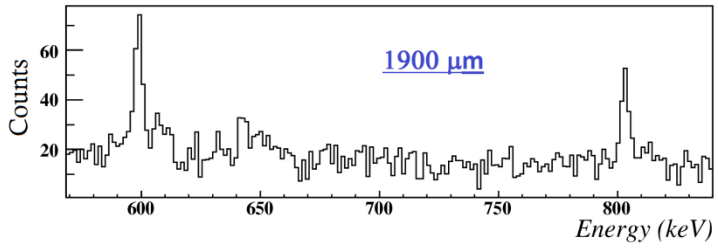


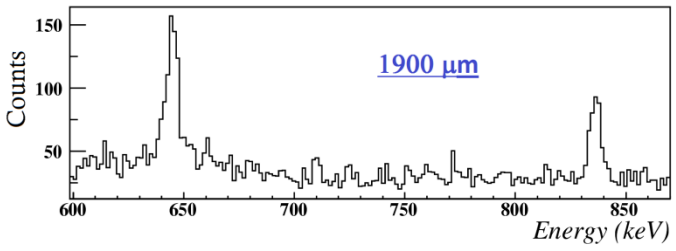












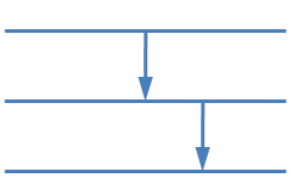
Average Resolution :

Unshifted peak: 3.6 keV

Shifted peak : 5 keV

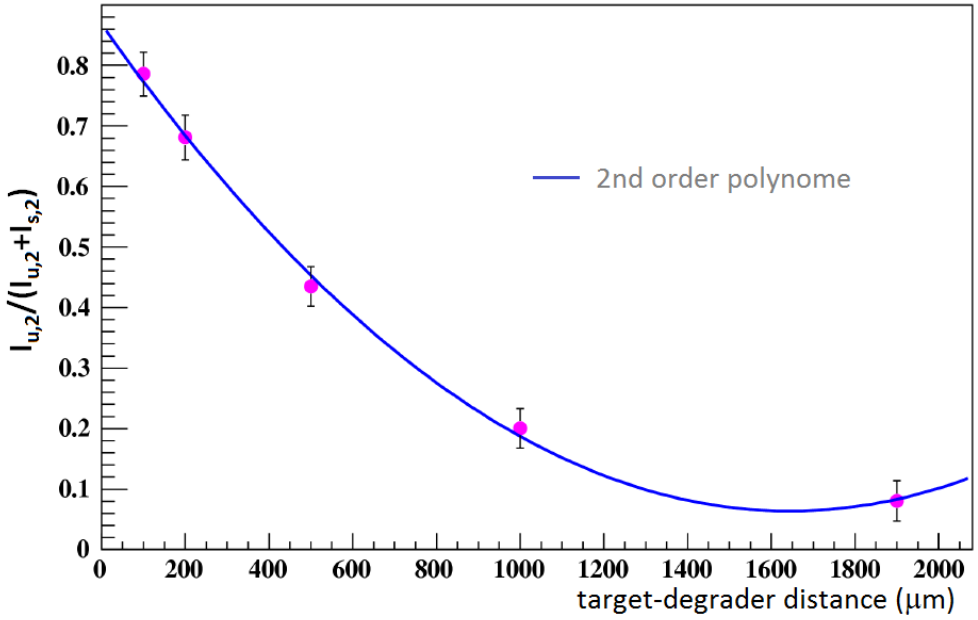
Recoil-Distance Doppler Shift method

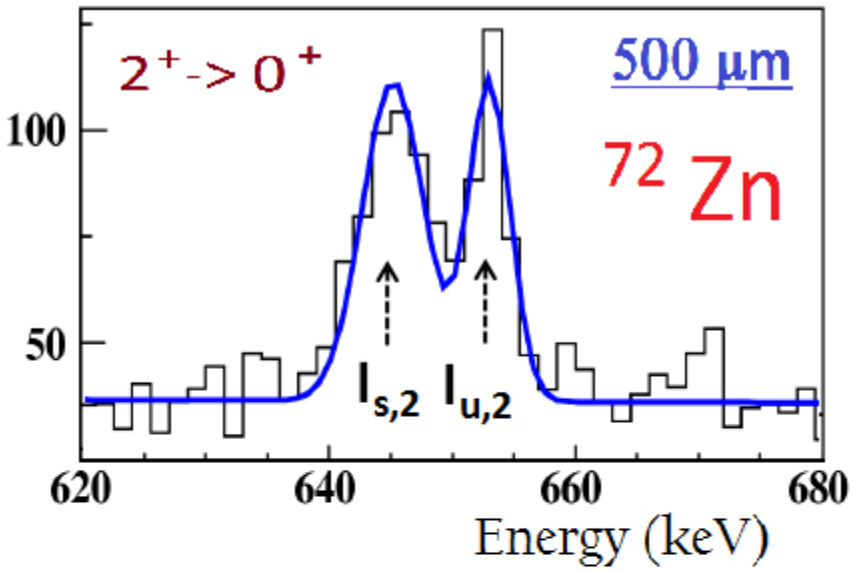
$$\tau_2(x) = \frac{-\left(\frac{I_{u,2}(x)}{I_{u,2}(x)+I_{s,2}(x)} - \frac{\varepsilon_4}{\varepsilon_2}\frac{I_{u,4}(x)}{I_{u,2}(x)+I_{s,2}(x)}\right)}{v * \frac{d}{dx}\left(\frac{I_{u,2}}{I_{u,2}(x)+I_{s,2}(x)}\right)}$$

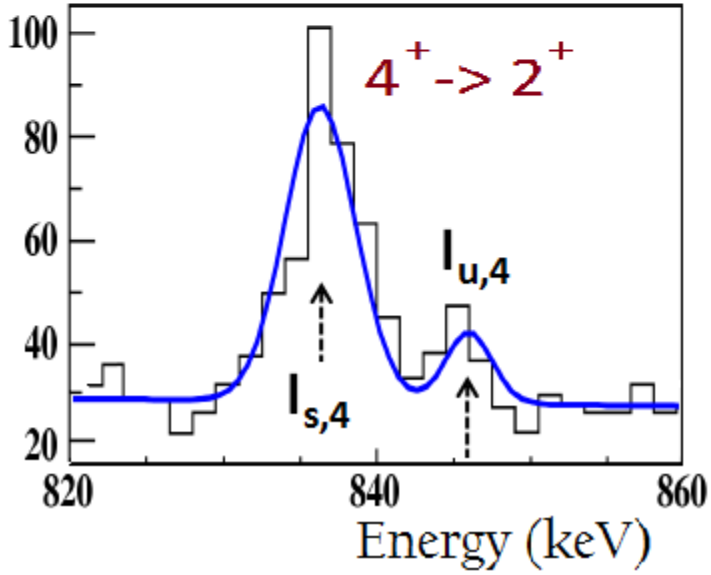


V = 30 µm/ps

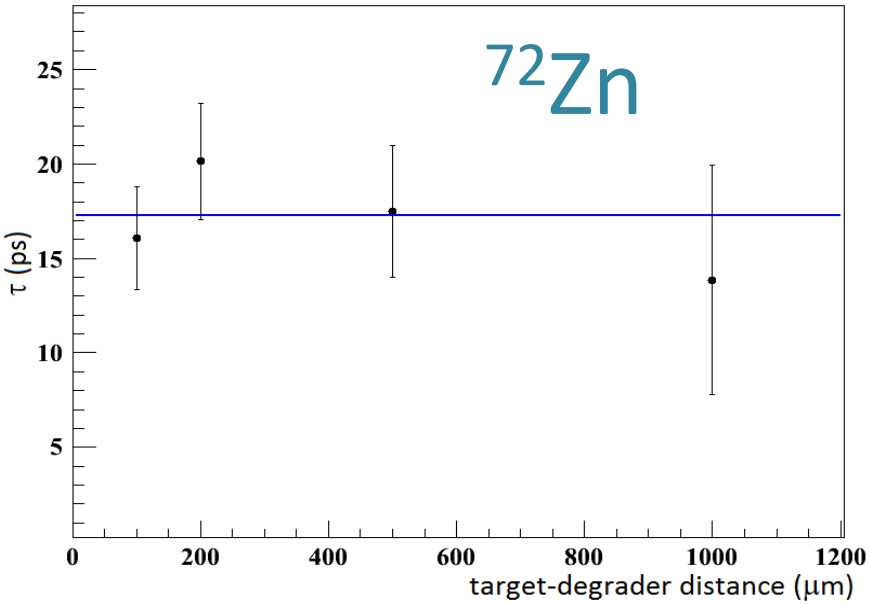
Ref: A. Dewald *et al.*, Z. Phys. A – Atomic Nuclei 334, 163-175 (1989)







Preliminary results

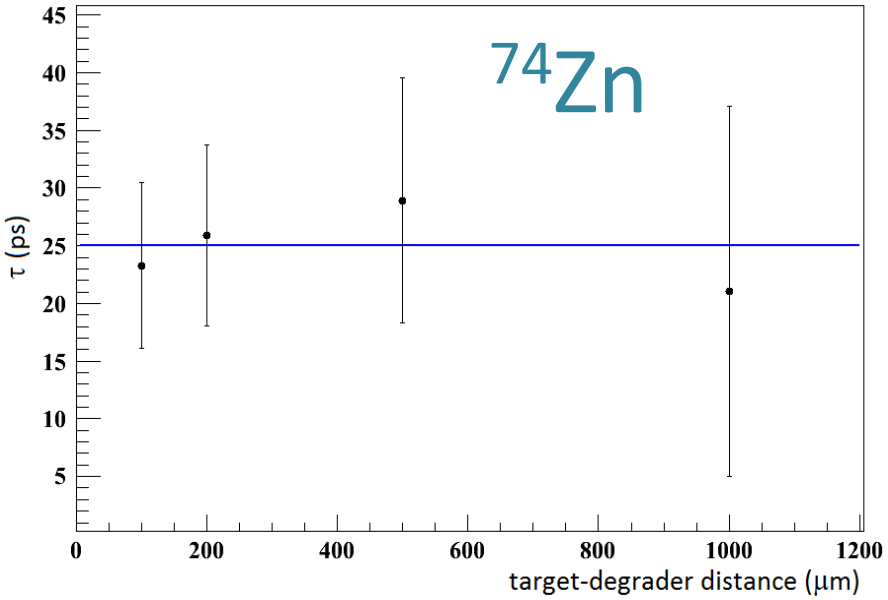


$$\Rightarrow \begin{cases} \tau = 17.3 \pm 1.6 \text{ ps} \\ B(E2; 0^+ \rightarrow 2^+) = 2000\ ^{+220}_{-180}\ \text{e}^2\text{fm}^4 \end{cases}$$

Compared to :

$$B(E2; 0^+ \rightarrow 2^+) = 1740 \pm 210\ \text{e}^2\text{fm}^4$$

ref : S. Leenhardt *et al.*, Eur. Phys. J. A **14**, 1-5 (2002)



$$\Rightarrow \begin{cases} \tau = 25.0 \pm 4.5 \text{ ps} \\ B(E2; 0^+ \rightarrow 2^+) = 2010\ ^{+440}_{-310}\ \text{e}^2\text{fm}^4 \end{cases}$$

Compared to :

$$B(E2; 0^+ \rightarrow 2^+) = 2010 \pm 160\ \text{e}^2\text{fm}^4$$

ref : J. Van de Walle *et al.*, PRL 99, 142501 (2007)

$$B(E2; 0^+ \rightarrow 2^+) = 2040 \pm 150\ \text{e}^2\text{fm}^4$$

ref : O. Perru *et al.*, PRL 96, 232501 (2006)

Summary and Outlook

lifetimes of the first excited states in ^{72,74}Zn with plunger and AGATA at Legnaro

DONE

- Identification in Prisma
- Background subtraction in AGATA spectra
- Preliminary lifetime in agreement with literature

TO BE DONE

- AGATA position: consistent with other analysis
- simulate spectra : expected line shape, resolution,…
- fit with line-shape functions
- error estimate for lifetimes to be finalized

- improve heavy-ion identification
- improve PSA (?)

- Lifetime of 4+, 6+(?) states

Errors

$$\delta\tau = \sqrt{(\frac{d\tau}{dI_{u,2}})^2(\delta I_{u,2})^2 + (\frac{d\tau}{dI_{s,2}})^2(\delta I_{s,2})^2 + (\frac{d\tau}{dI_{u,4}})^2(\delta I_{u,4})^2 + (\frac{d\tau}{df})^2(\delta f)^2}$$

(1) (2) (3) (4)

For ^{74}Zn
- (1) $\simeq 2.1$
- (2) $\simeq 1.3$
- (3) $\simeq 3.1$
- (4) $\simeq 5.7$

For ^{72}Zn
- (1) $\simeq 1.$
- (2) $\simeq 0.8$
- (3) $\simeq 1.4$
- (4) $\simeq 1.7$

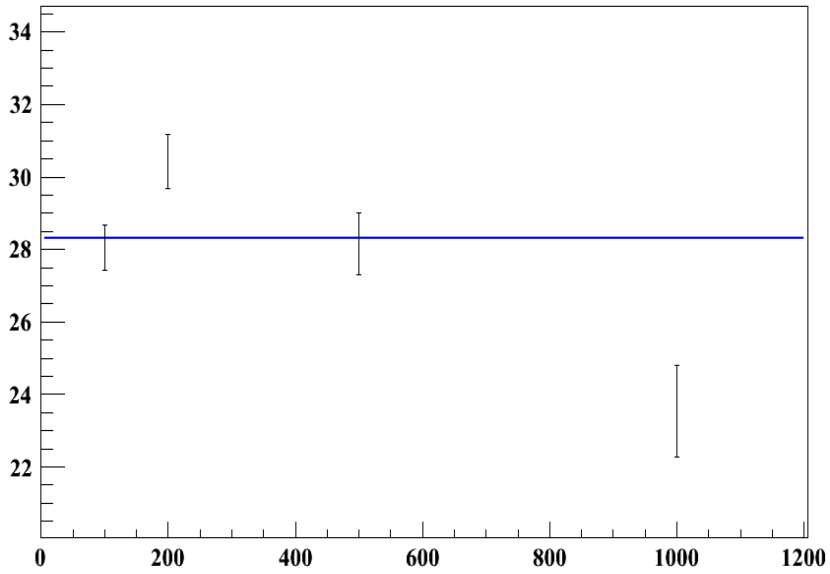
Preliminary results ^{76}Ge

$$B(E2; 0^+ \rightarrow 2^+) = 2562\ ^{+36}_{-35}\ \mathrm{e^2fm^4}$$

Compared to :

$$B(E2; 0^+ \rightarrow 2^+) = 2680 \pm 80\ \mathrm{e^2fm^4}$$

ref : O. Raman *et al.*, Atomic Data and Nuclear Data Tables, 78, 1-128 (2001)



$$\left\{\begin{array}{ll} (1) & \simeq 0.2 \\ (2) & \simeq 0.2 \\ (3) & \simeq 0.2 \\ (3_{bis}) & \simeq 0.2 \\ (3_{ter}) & \simeq 0.2 \\ (4) & \simeq 0 \end{array}\right.$$