Investigating the deformation of the intruder isomeric 1/2$^+$ state in ^{79}Zn (N=49) via Coulomb excitation

Report on IS646

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INFN - LNL

ISOLDE Workshop and Users meeting

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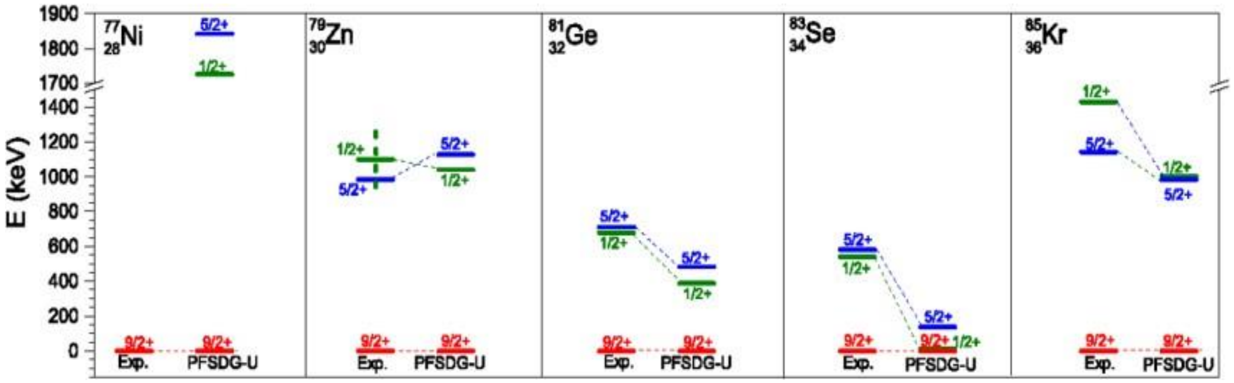
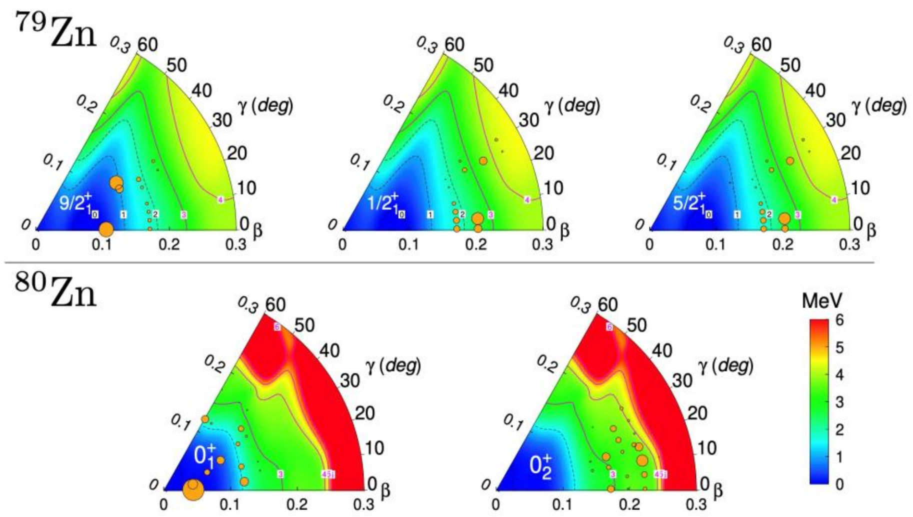
^{79}Zn shape coexistence

- Intruder states along the N=49 isotone chain

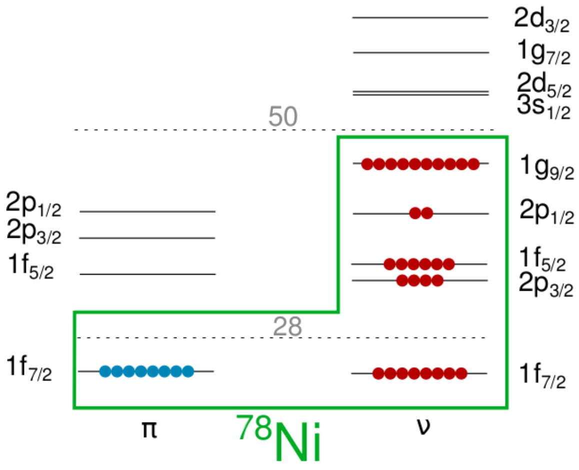
- $1/2^+$ and $5/2^+$ from neutron two-hole-one-particle excitations to the $s_{1/2}$, $d_{5/2}$ shells beyond N=50



C. Wraith et al., Phys. Lett. B 771 (2017) 385391



L. Nies et al., Phys. Rev. Lett. 131, 222503, 2023



- Shell-model calculations predict a **shape coexistence** among a spherical ground state and well-deformed intruder states

- In ^{79}Zn, the long-lived $1/2^+$ intruder isomer provides the unique possibility of probing its deformation by performing a **Coulomb excitation** on it

- Intruder $1/2^+$ 7% isomeric ratio in ^{79}Zn ISOLDE beam (from mass spectroscopy)

^{79}Zn coulex at HIE-ISOLDE

Miniball with 8 clusters

CD detector 25-55 deg, S2 Micron

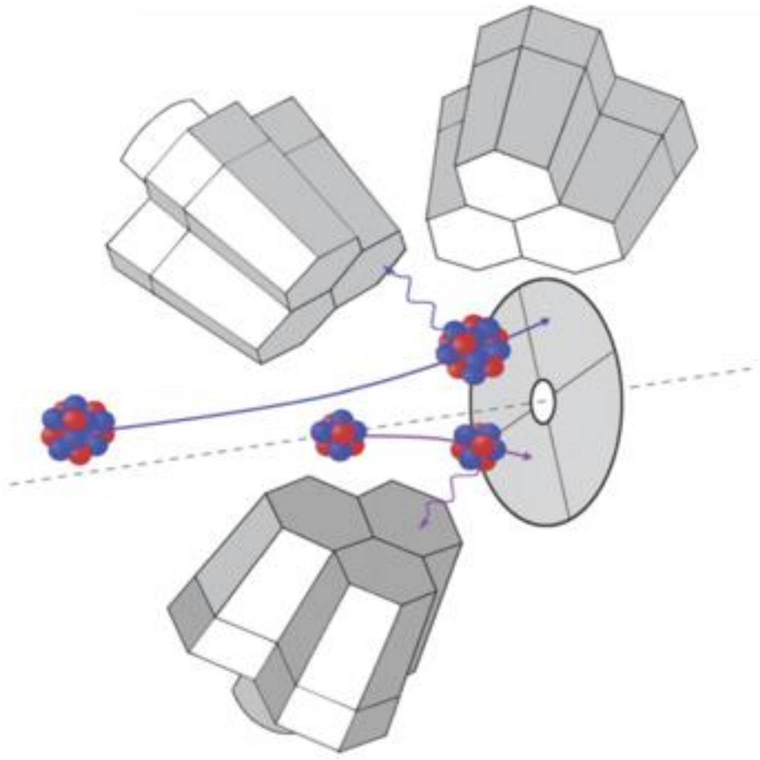
Targets ^{208}Pb 4 mg/cm^2, ^{196}Pt 3 mg/cm^2

<u>Run in 2023</u>

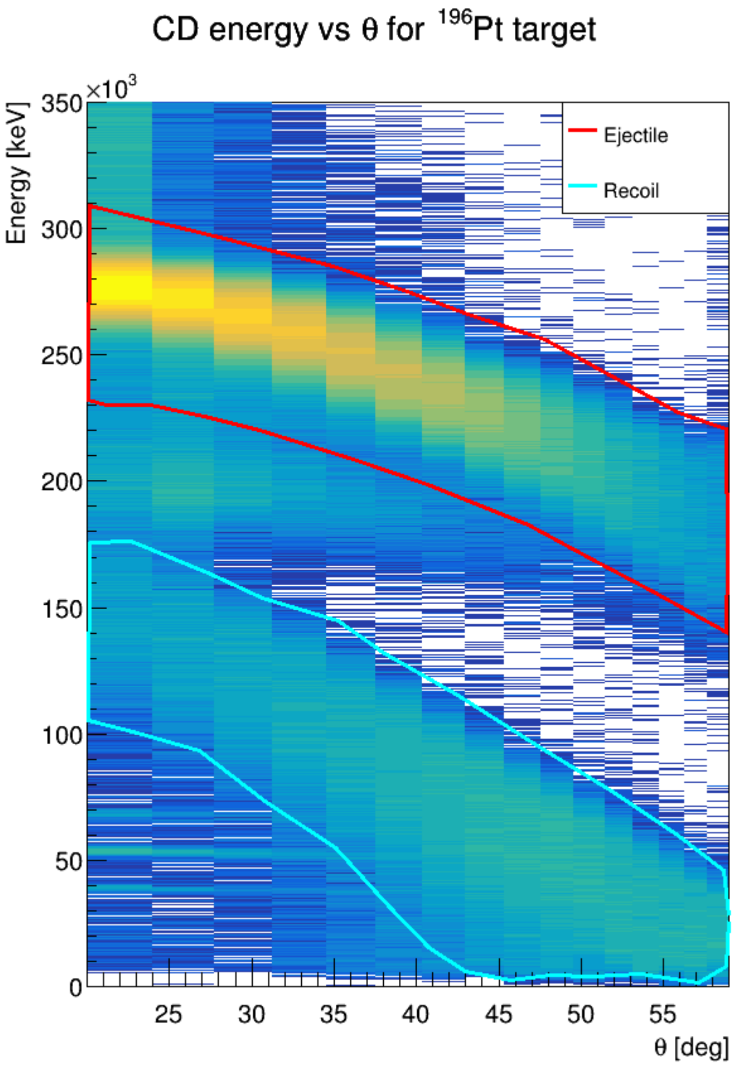
Beam intensity ~10^4 pps, ^{79}Zn @ 4.07 MeV/u
Problems with beam (target issues)

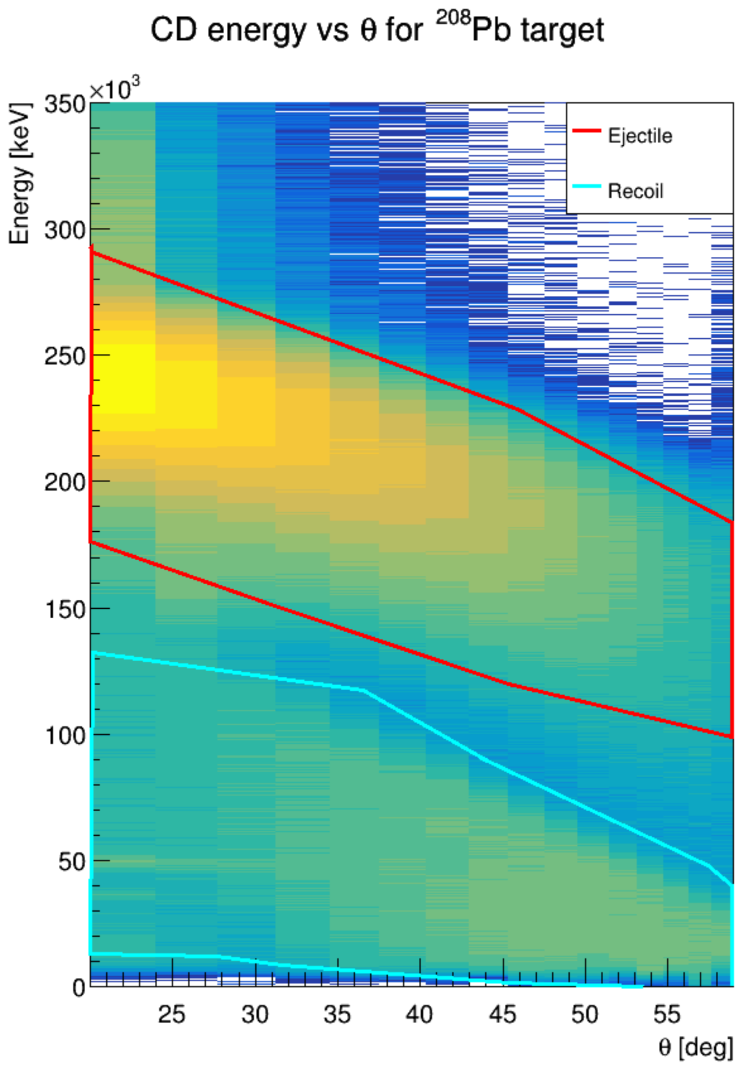
<u>Run in 2024</u>

Beam intensity ~8x10^4 pps, ^{79}Zn @ 4.00 MeV/u



CD detector





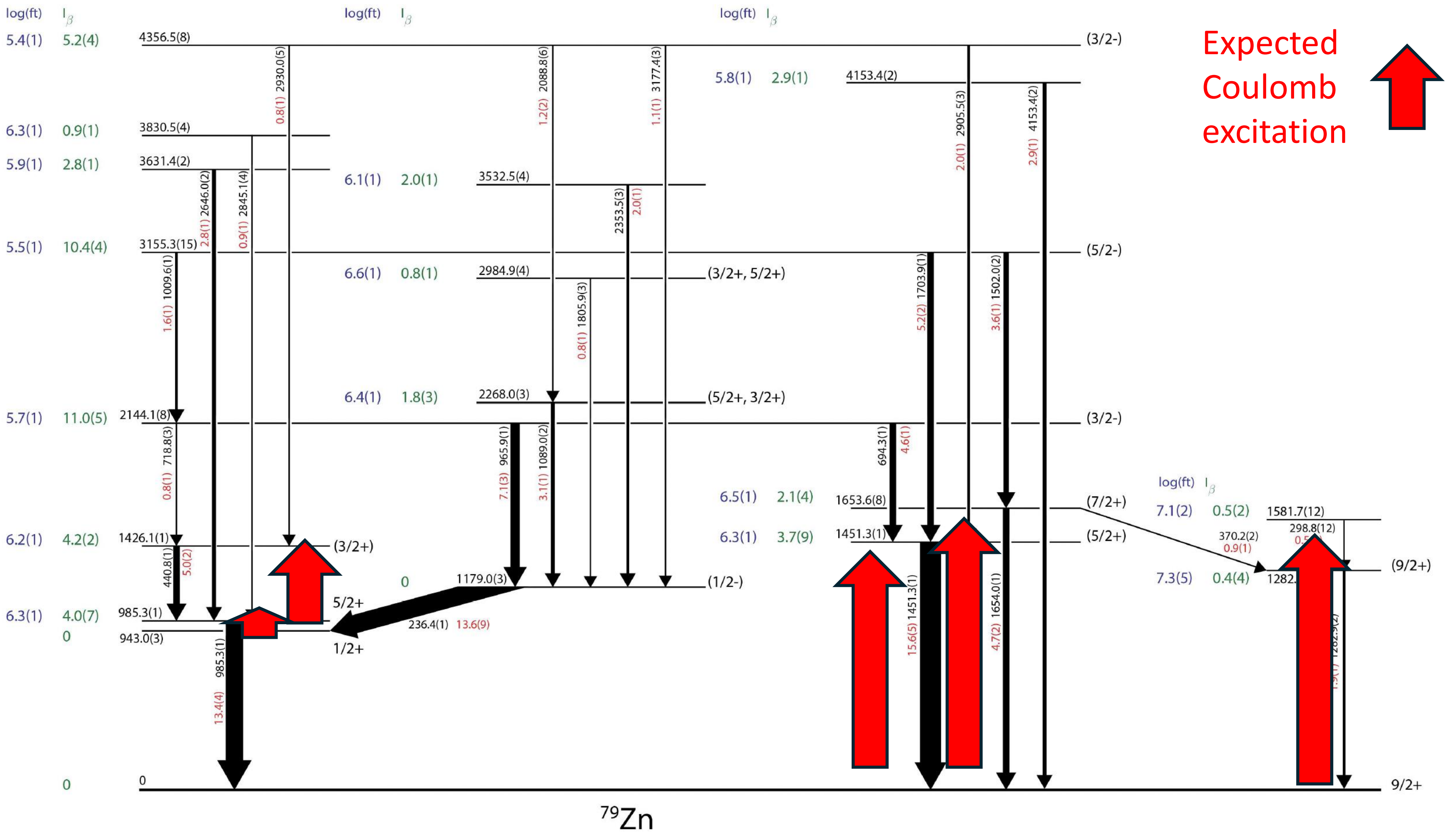
Calibration
A/Q = 4 from EBIS at the beginning of the experiment:
$^{12}C^{3+}$, $^{16}O^{4+}$, $^{20}Ne^{5+}$, $^{40}Ar^{10+}$

Simulation used to estimate energy deposited in each ring for the 4 ions

Alignment of pads

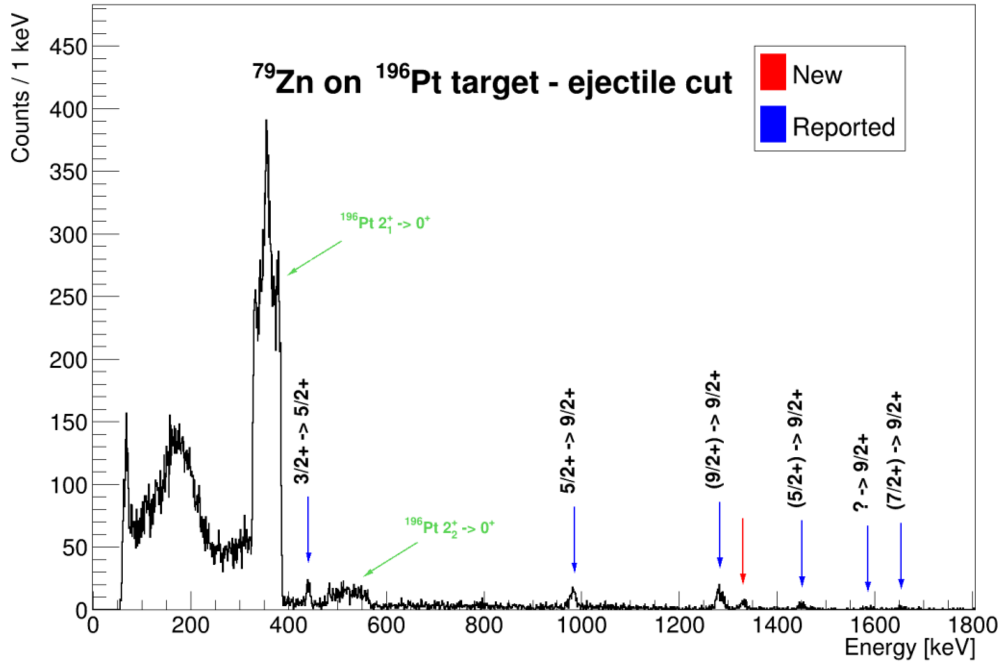
Velocity from kinematics and angle

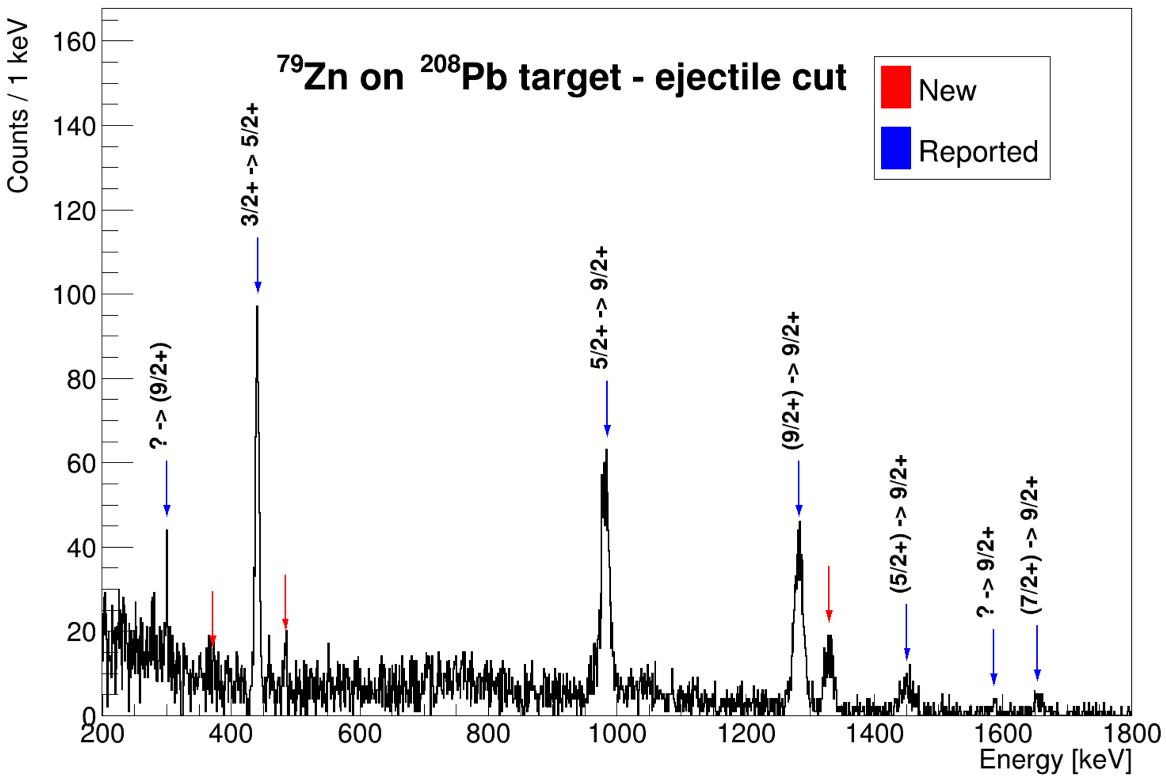
^{79}Zn level scheme from a β decay study

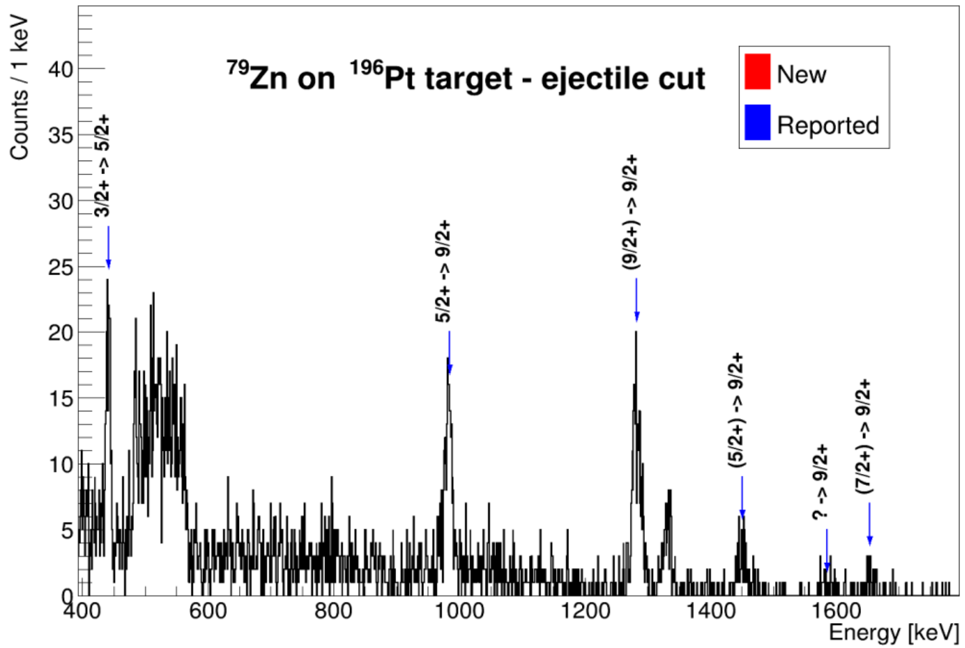


M. C. Delattre, PhD thesis: 2015 experiment with EURICA (RIBF, Riken)

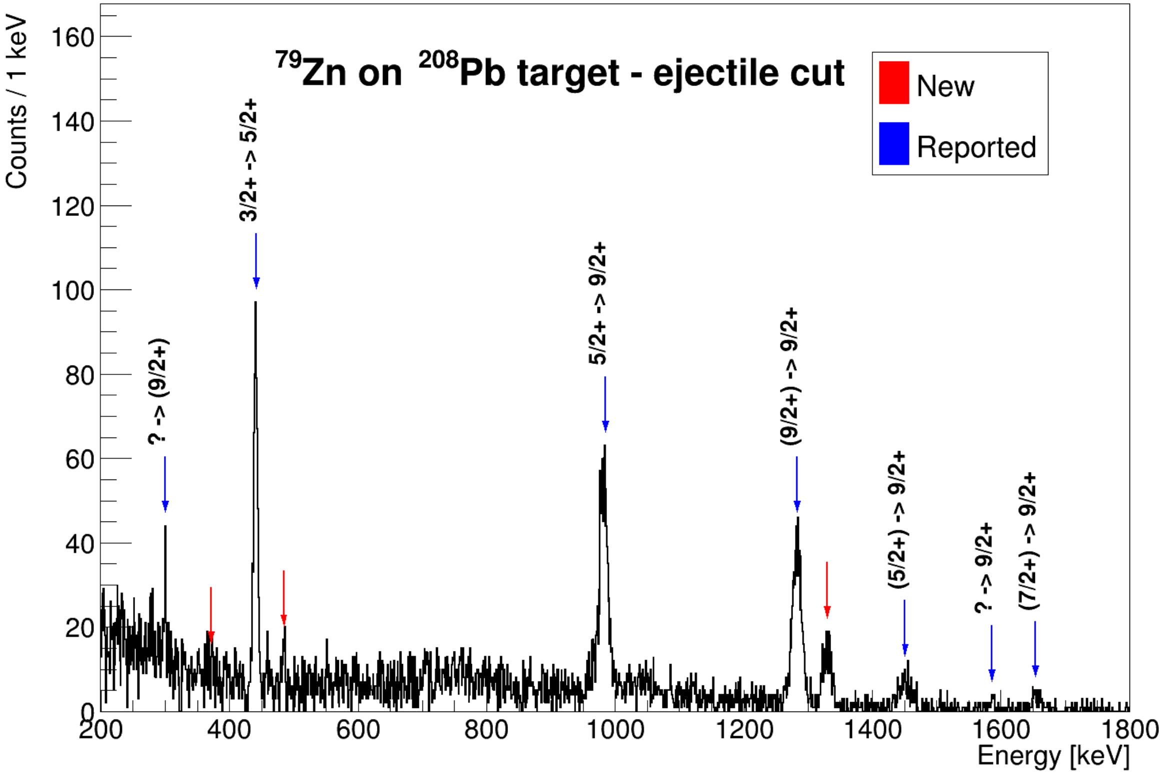
Comparison of Pb and Pt target

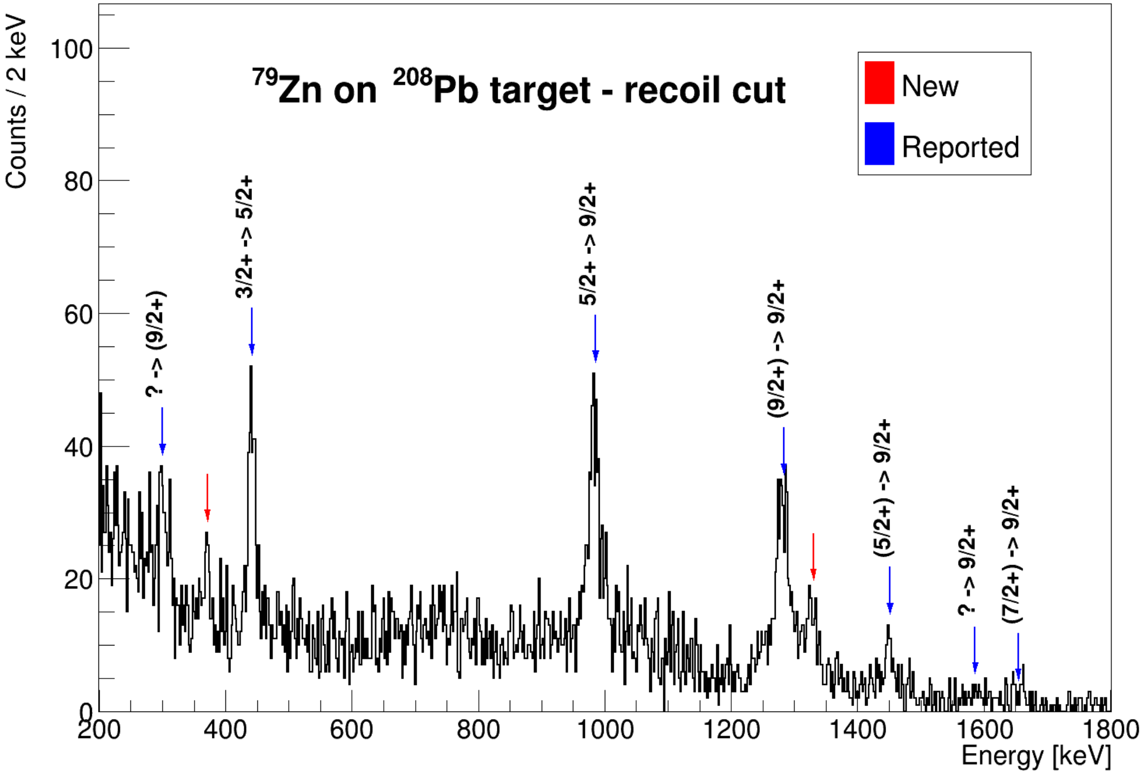




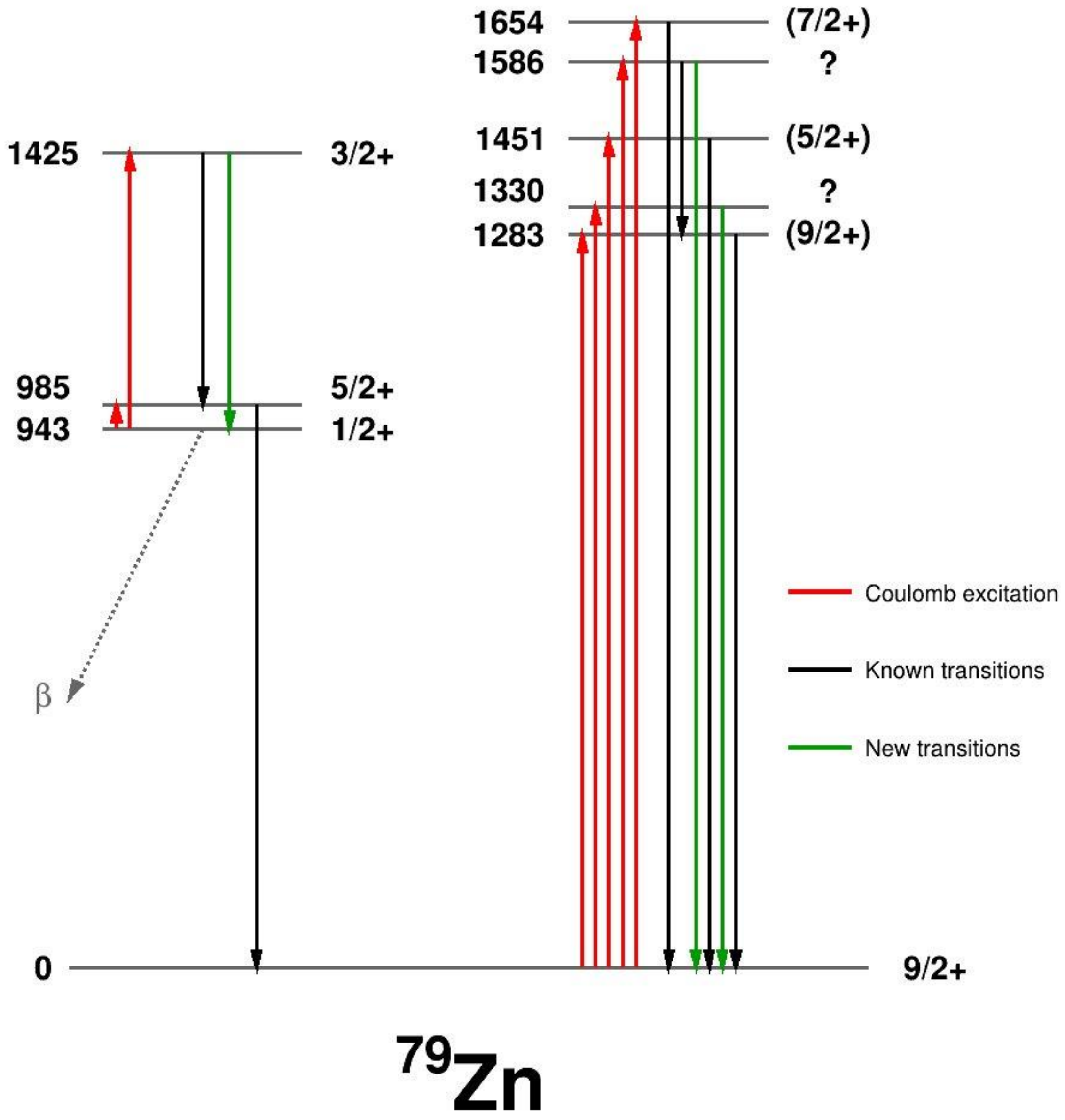


Comparison of ejectile and recoil gate

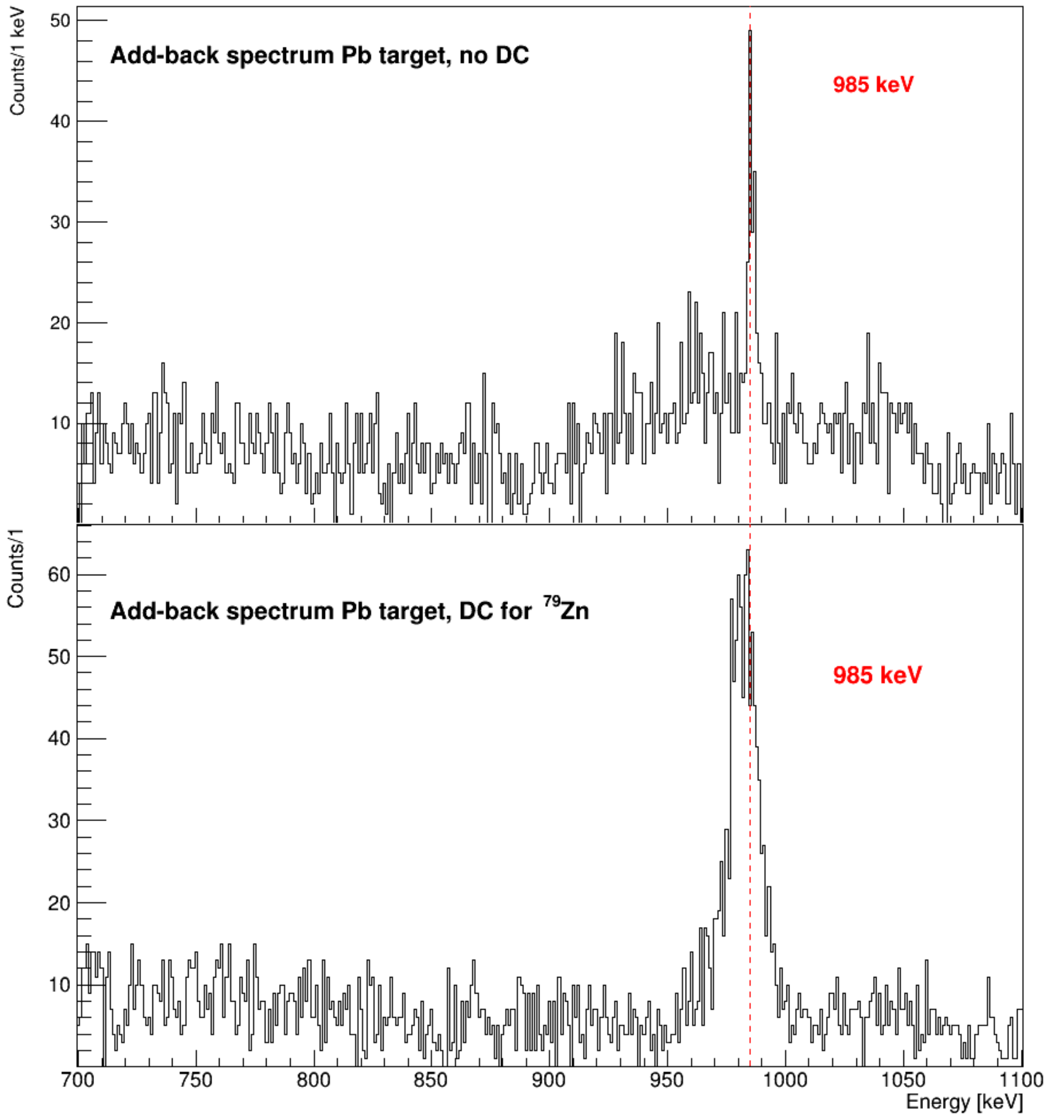




Identified transitions



- New transition at 480 keV
- Whole multiplet of $g_{9/2}$ hole with 2^+ of ^{80}Zn was observed
- The structure built on the $1/2^+$ resembles a K=1/2 band with a large decoupling coefficient
- We will extract the B(E2) of the band built on the intruder isomer and compare it to theoretical models
- Same structure in ^{83}Se, measured at LNL with GALILEO using $^{82}Se(d,p)^{83}Se$ and DSAM



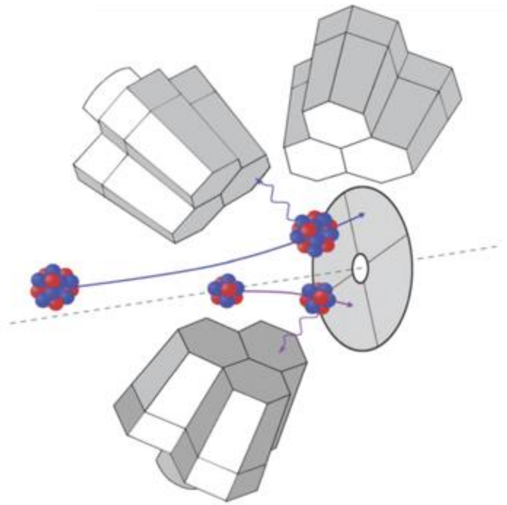
State at 985 keV: lifetime

State at 985 keV:
Components are visible both with and without DC: part of the decays happen at rest

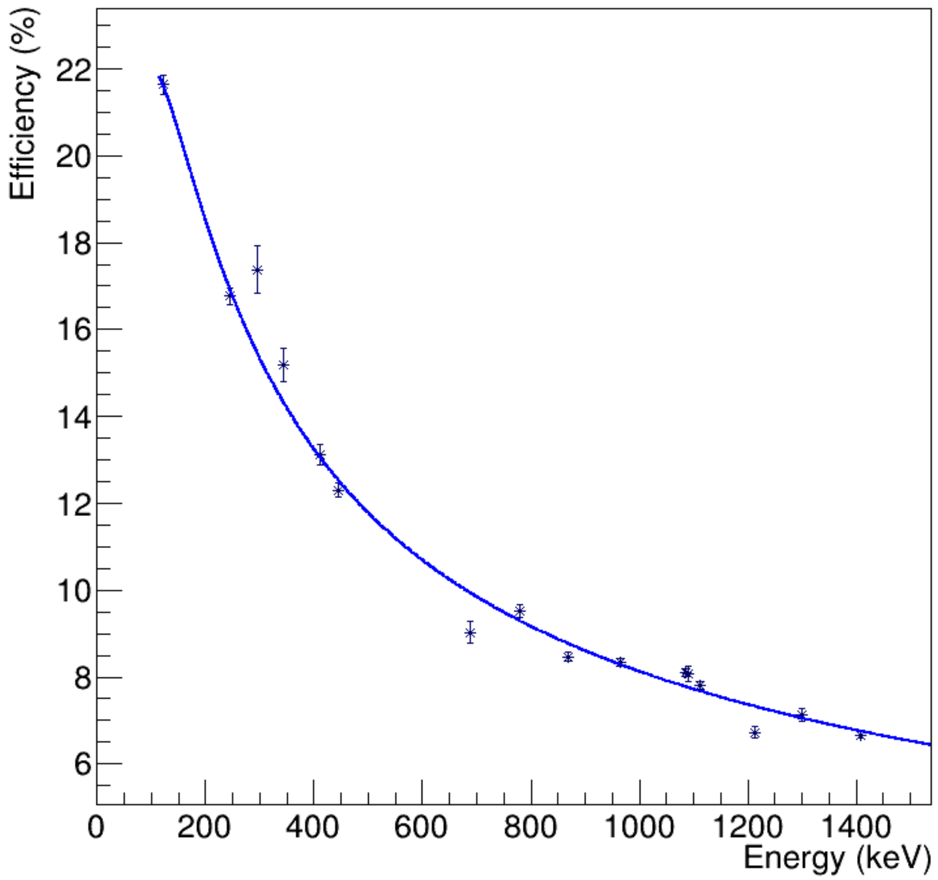
Lifetime might be of the order of the flight time to the CD.

Beta after target ~ 7.3 - 8.5%

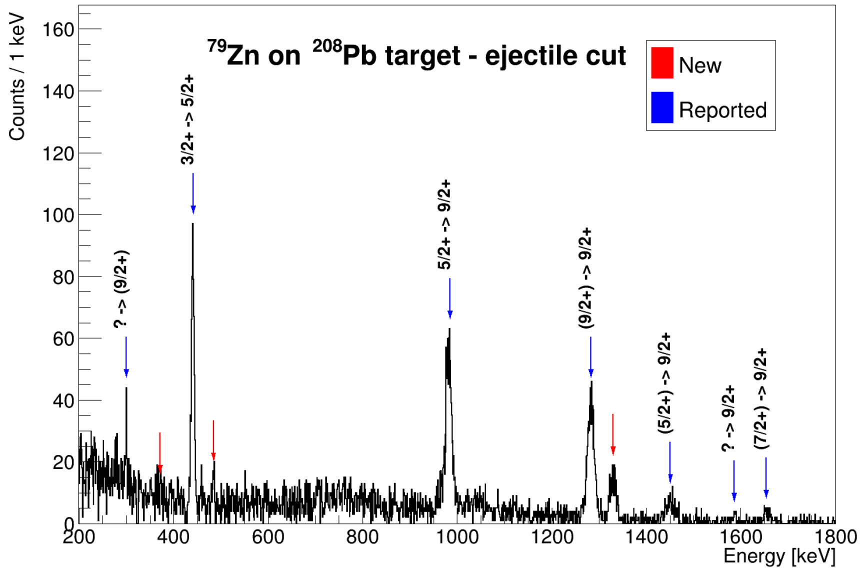
ToF ~ 0.4 - 1.8 ns



Efficiency and intensities



Efficiency curve with 152Eu source

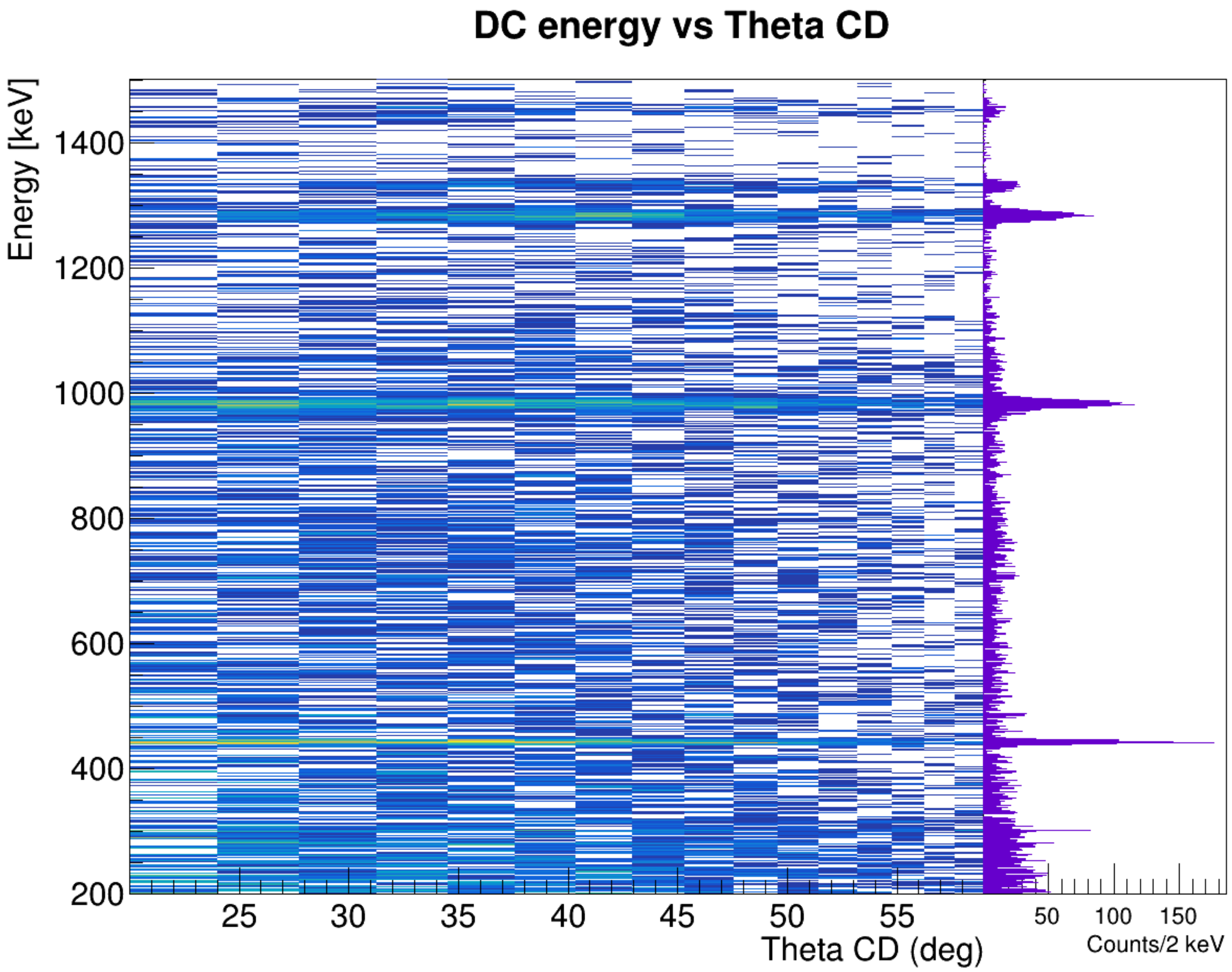


Energy	Efficiency	Eff. corr. counts	Error
300.5	0.153	495	111
441.6	0.126	4562	382
484.8	0.120	468	125
983.5	0.082	9709	683
1283.5	0.071	9439	733
1331.5	0.070	3291	431
1449.7	0.066	2212	376
1582.5	0.063	316	142
1656	0.062	922	243

$1/2^+$ Coulex $\sim 1.0 \cdot 10^4$ (441.6–983.5)

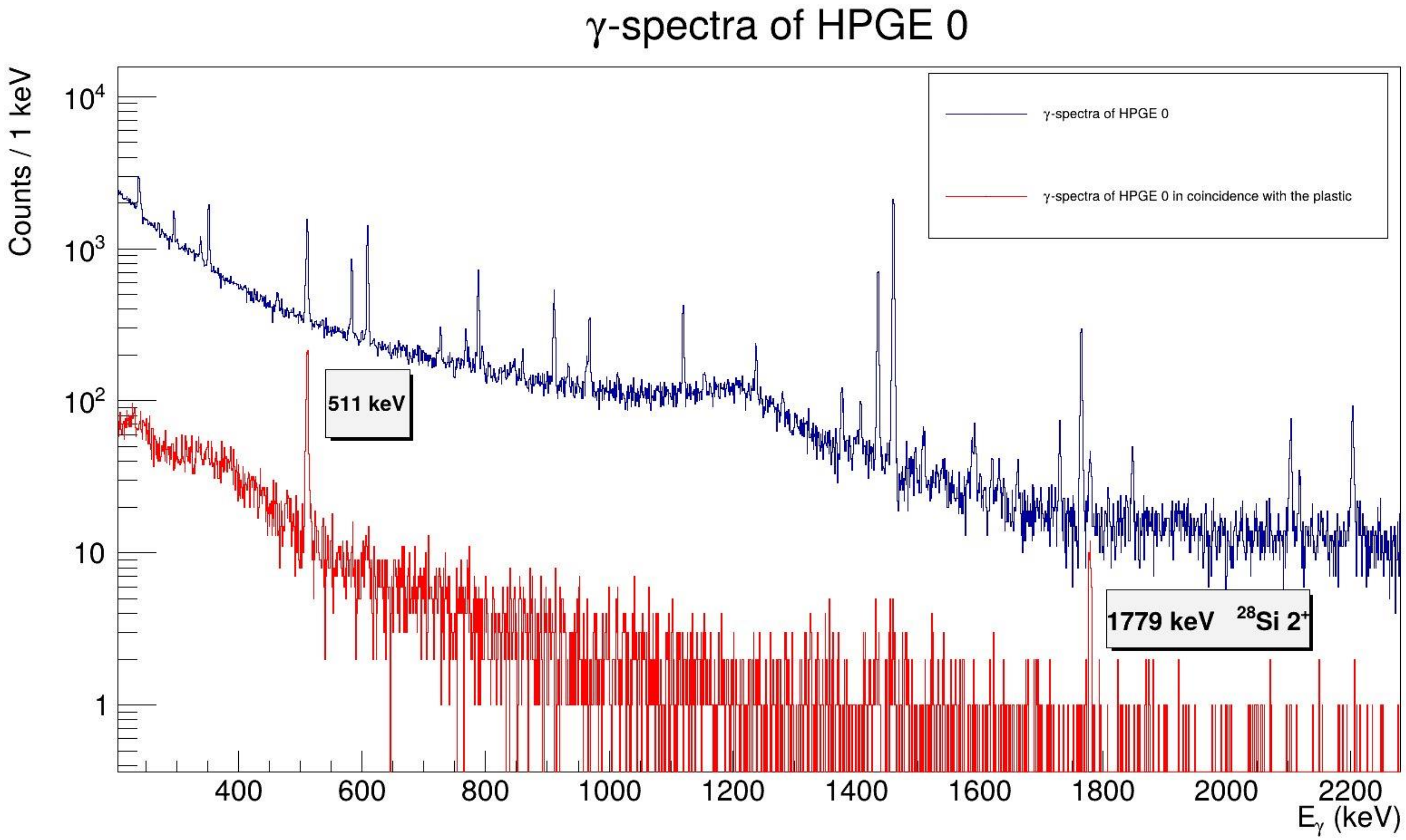
GS Coulex $\sim 1.6 \cdot 10^4$ (1283.5–1656)

Gamma distribution at different scattering angles



<u>First</u> ISOL beam from SPES @ LNL

- Protons on SiC target
- Plasma source
- Mass 28 selected with a Wien filter



Thank you for your attention !

Collaboration

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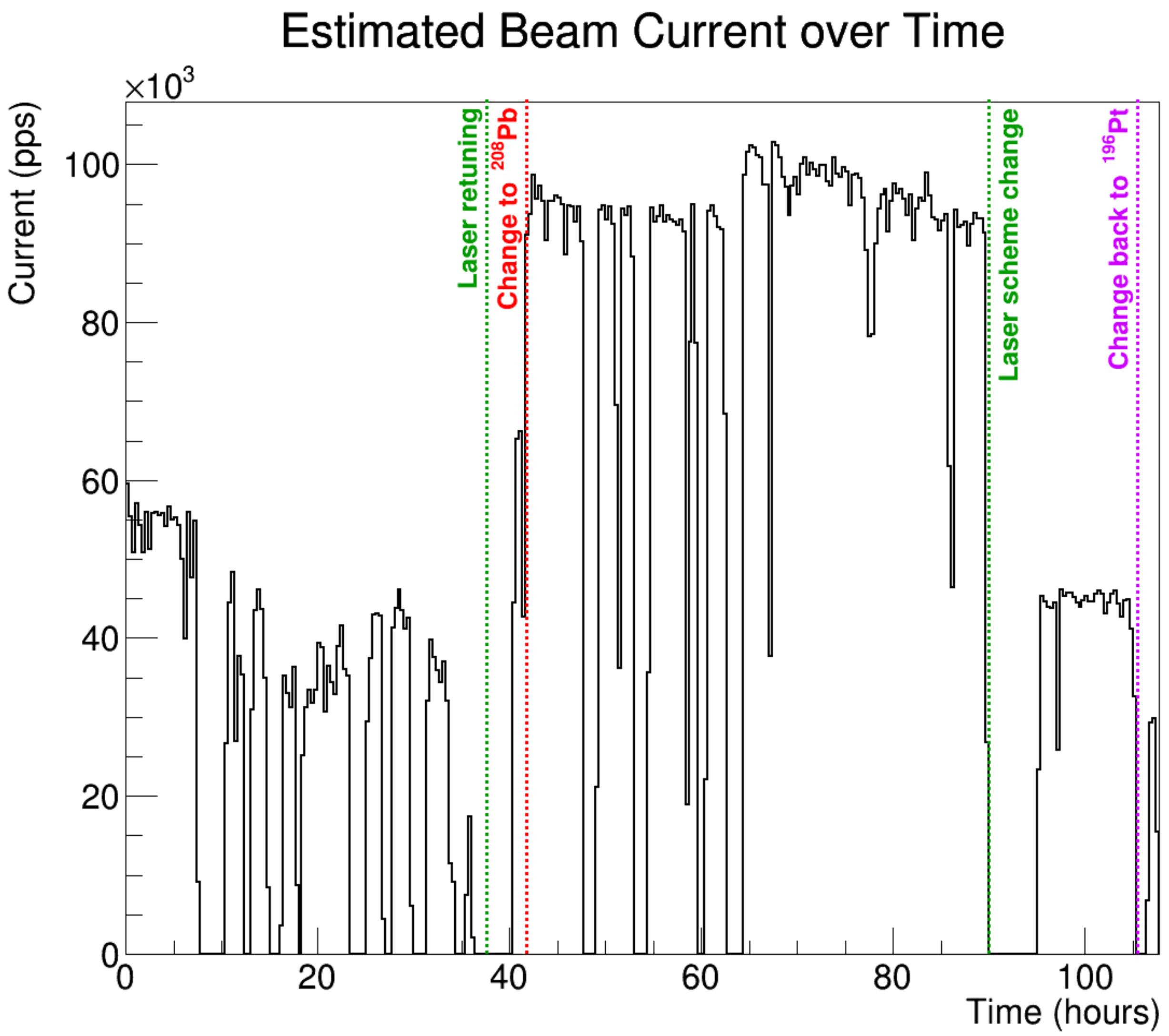
And many thanks to:

- MINIBALL collaboration
- ISOLDE team
- Accelerator team
- RILIS team
- Target team
- EUROLabs funding

Stability during the experiment



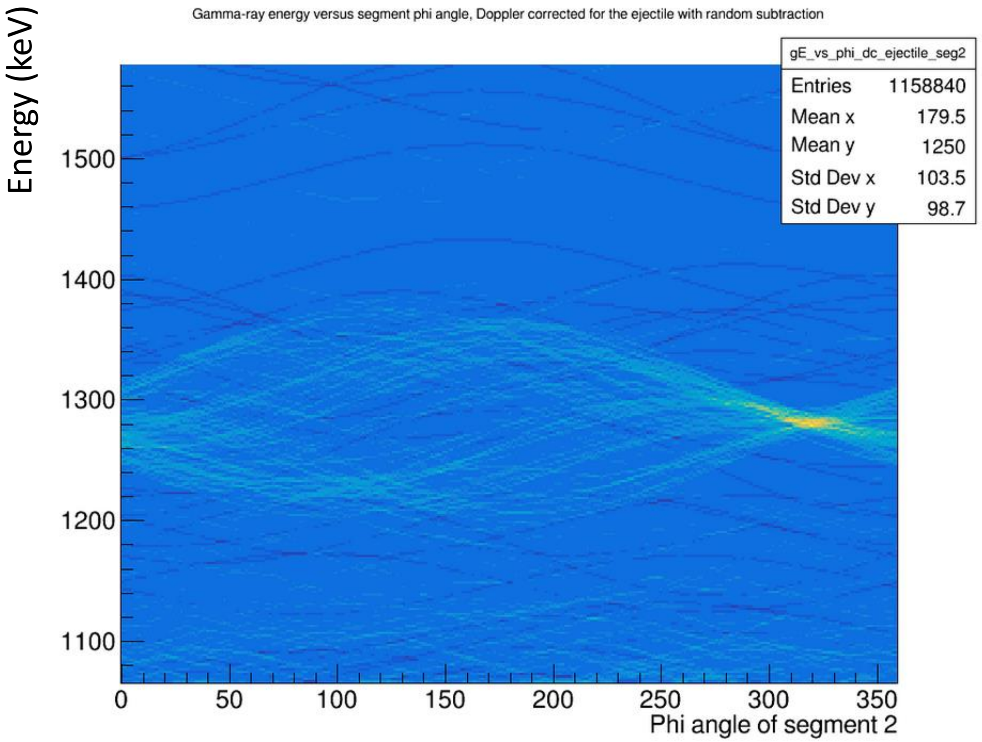
^{79}Zn on target: ~ 81 h

^{79}Zn on 208Pb: ~ 54 h
^{79}Zn on 196Pt: ~ 27 h

Laser retuning (2nd step) at the end of the second day increased intensity

2nd step of the laser tripped the last day
-> Change of scheme (~50% rel. intensity)

Geometry of the setup



Miniball angles
Estimated in July by the IKP group
Intense Sn beam helped optimize Doppler correction

CD distance
Estimated with alpha source ?