SEASON : a powerful decay-station for the study of (super)-heavy nuclei

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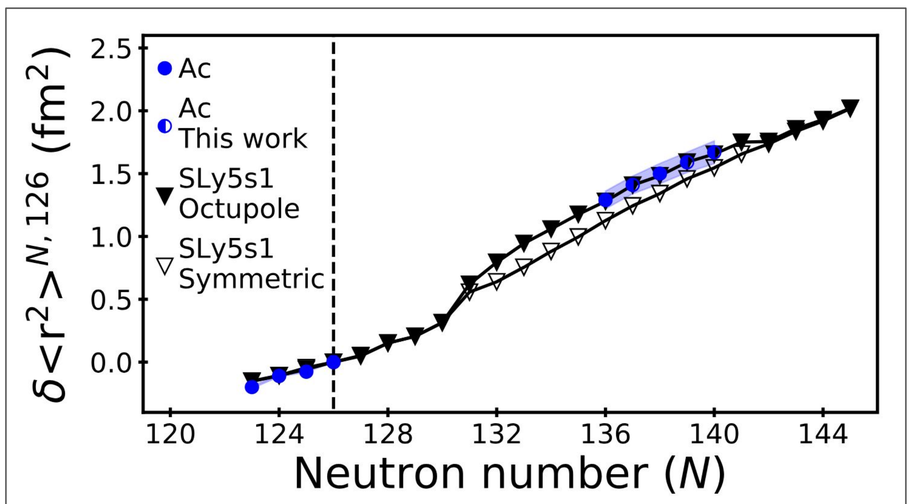
Physical context :

➪ Octupole deformations [1] play a crucial role in understanding :

- Fission dynamics
- Cluster radioactivity
- Physics beyond the standard model

➪ Experimental results in agreement with theoretical predictions of strong octupole deformations in the **actinide** region.

➪ More experimental data needed to precise the **extent and the magnitude** of this phenomenon.



Comparison of the experimental $\delta\langle r^2\rangle^{N,126}$ values with calculations using the SLy5s1 interaction [2]

Experimental technique : SEASON decay station

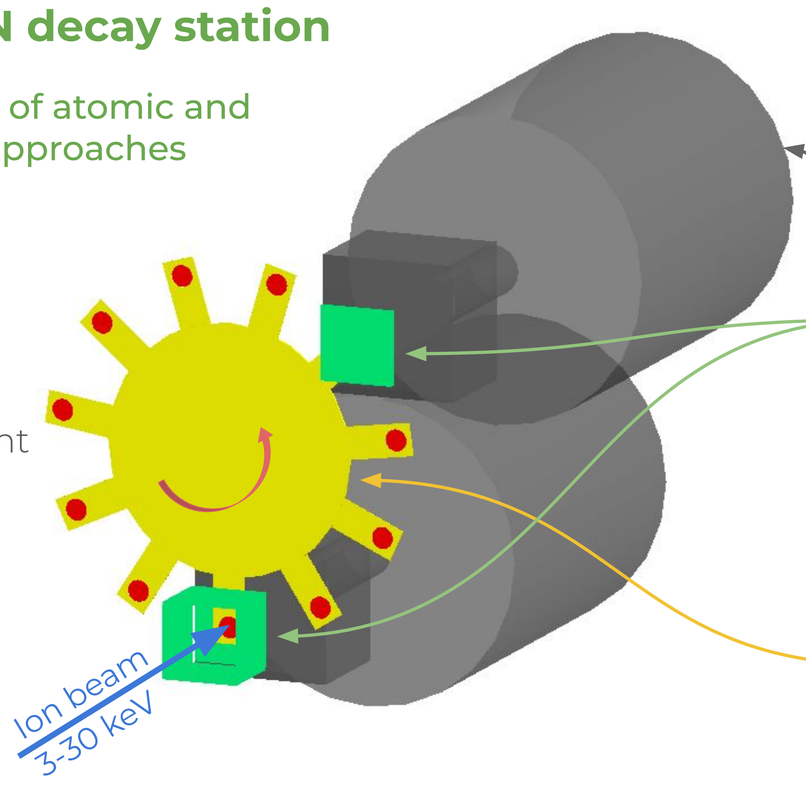
- counter for laser spectroscopy
- detailed α, e^-, γ spectroscopy

} Coupling of atomic and nuclear approaches

Heavy ion beam :

➪ Production of the beam through the process of **fusion evaporation**

➪ Actinides produced are carefully selected in the beam line with separators or by laser ionization and then sent to the decay station



2 HPGe detectors : to measure γ-rays emitted in coincidence with α

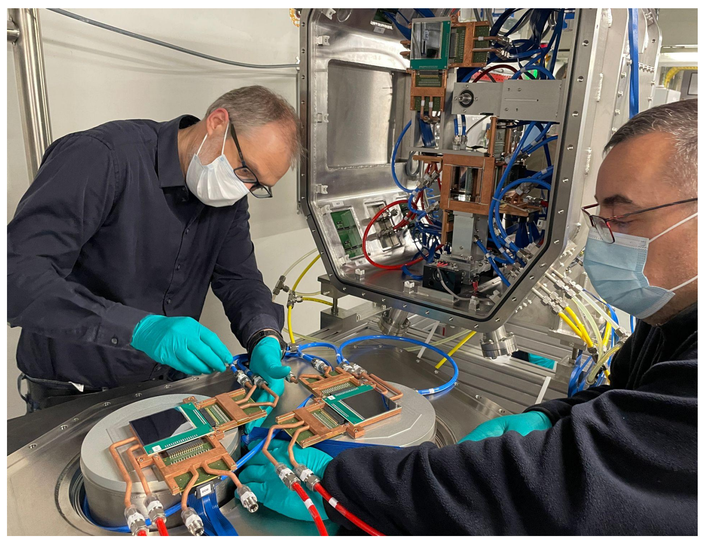
7 DSSDs : Double-sided Silicon Stripped Detectors to detect α and conversion e^-.

➪ **Energy resolutions** of about **12 keV** (FWHM) for α and about **9 keV** for the e^-.

➪ Main station with compact adjustable geometry **for high α and e^- efficiency**

Wheel :

➪ **90 nm carbon foils** to stop the heavy ions.

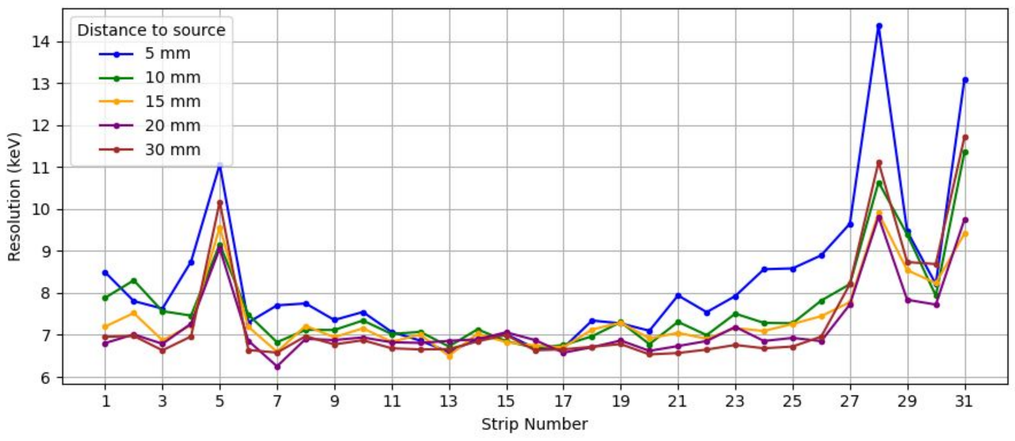


➞ Source commissioning at GANIL from February to July 2025. Full mounting of the station and test of the SEASON integration at S^3.
Detector tests and characterization done in full setup conditions.

Source commissioning results at GANIL :

- **Electron** energy resolutions :

At different source - detector distances in the deported station



- **Electron** detection efficiency :

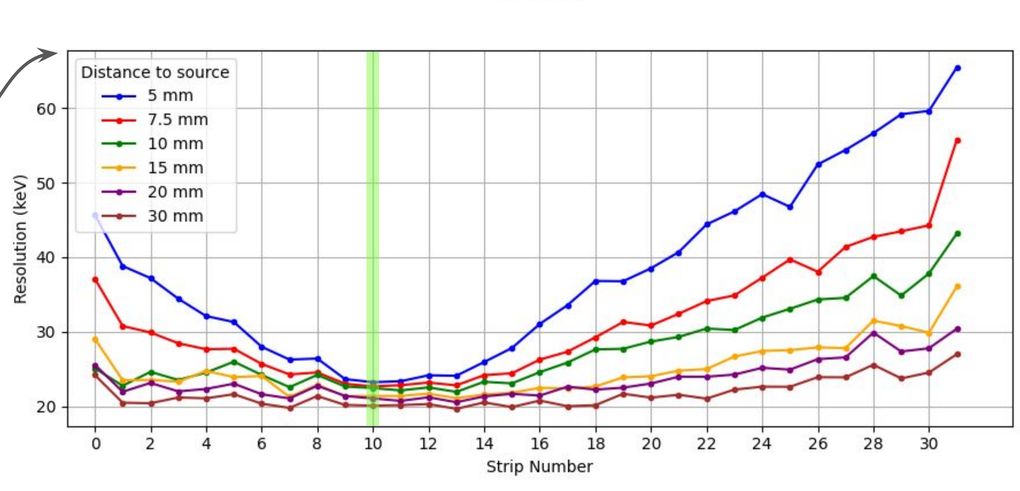
about 20 % at 5 mm and 15 % at 20 mm

- **Alpha** energy resolutions :

Results on a full DSSD

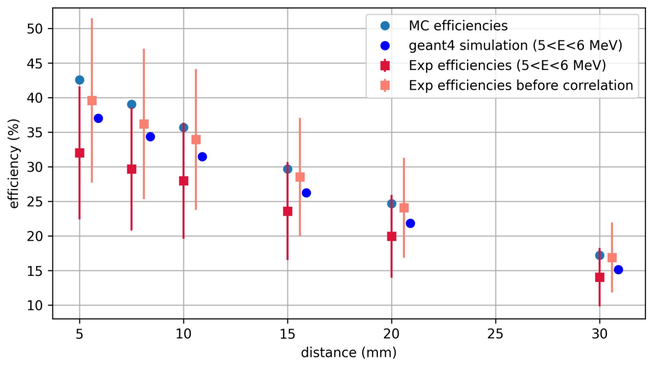
Strip with the most counts ➞ source position in X

For DSSDs in tunnel configuration, resolutions vary between 25 and 45 keV.

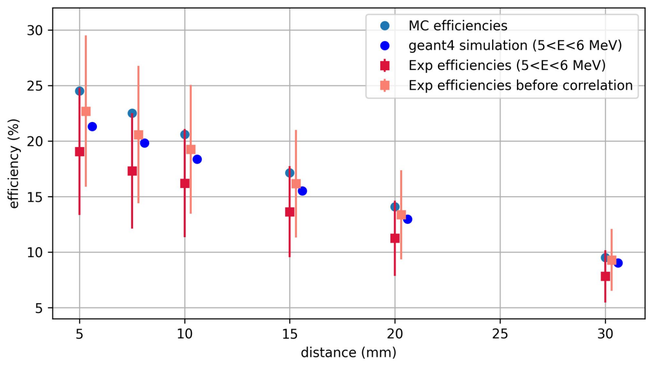


- **Alpha** detection efficiency :

for a detector in the deported station

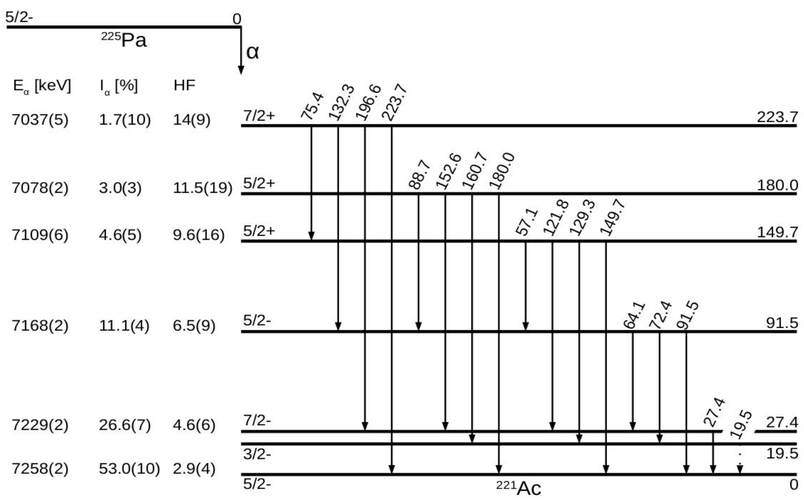


for tunnel detectors



Schedule :

- January/February 2026 : **online commissioning** in Jyväskylä. ^{232}Th(p,xn)$^{233-x}$Pa



^{221}Ac level scheme reconstructed by decay spectroscopy at IGISOL. [3]

- 2026 : following of the **experimental campaign at Jyväskylä**

Considered beam-target combinations :

^{233}U(p, xn)$^{234-x}$Np

To further study the Pa isotopes and the extent of the octupole region.

^{233}U(α, xn)$^{237-x}$Pu

To explore SEASON half life measurement capabilities.

- 2027 : SEASON sent to **GANIL** for experimental campaign at S^3-LEB

References :

[1] P. A. Butler, Octupole collectivity in nuclei J. Phys. G: Nucl. Part. Phys. **43** (2016)

[2] E. Verstraelen *et al*, Search for octupole-deformed actinium isotopes using resonance ionization spectroscopy. Phys. Rev. C **100** (2019)

[3] E. Rey-herme, PhD thesis, Octupole deformation in ^{221}Ac and development of the SEASON detector, Université Paris-Saclay, 2023.