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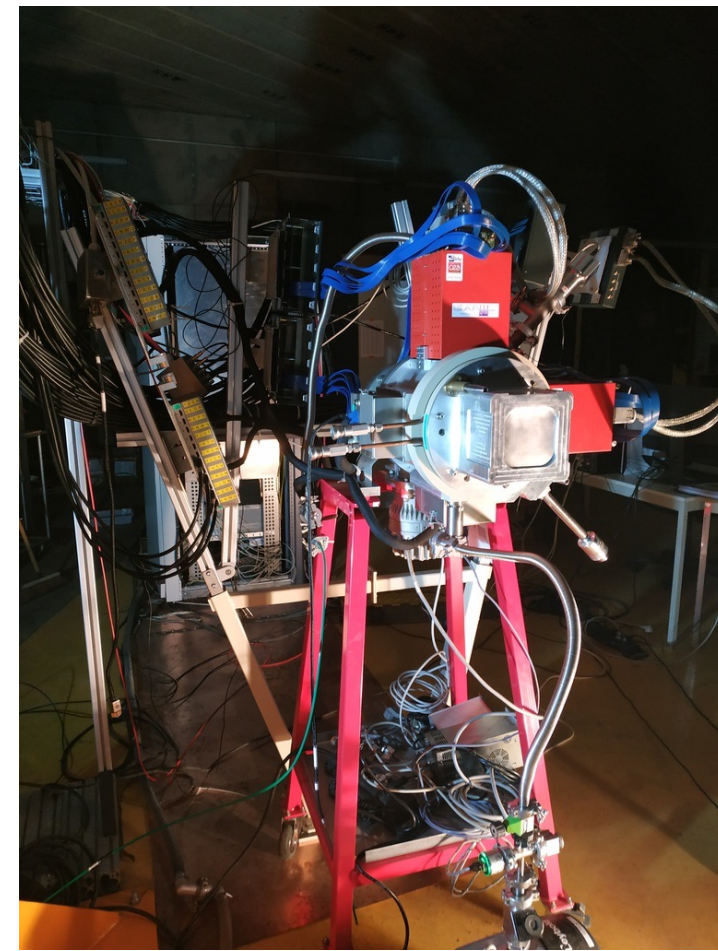
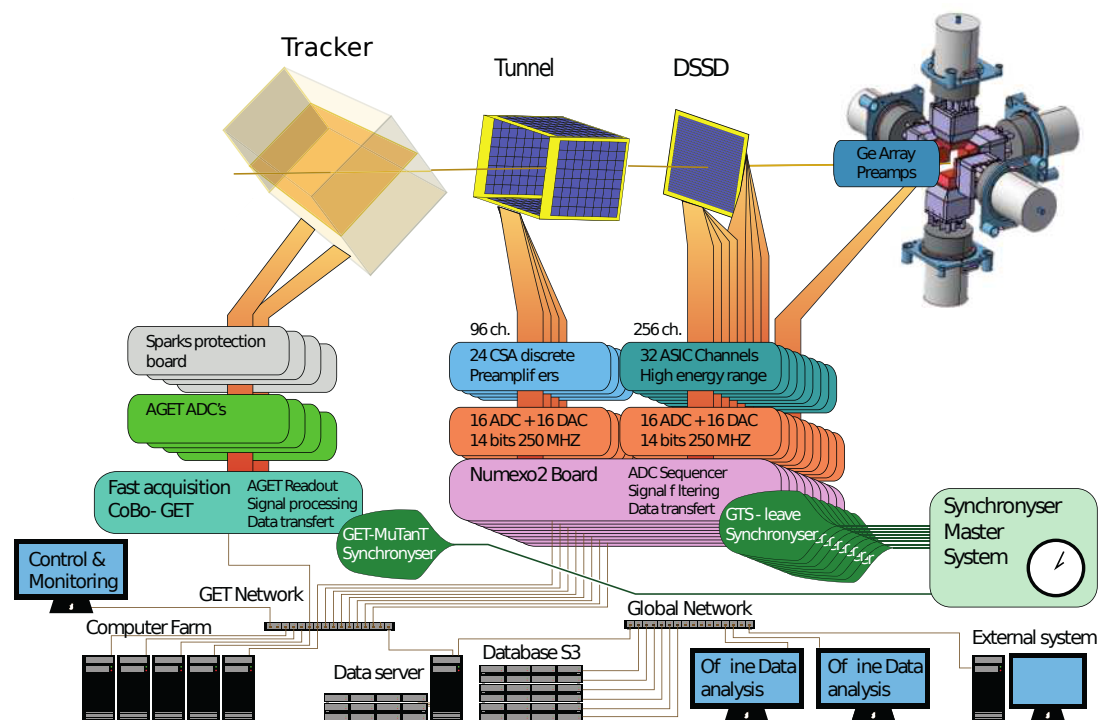
SIRIUS

**Spectroscopy and Identification of
Rare Ions Using S^3**

GANIL Community Meeting 2024

J. PIOT

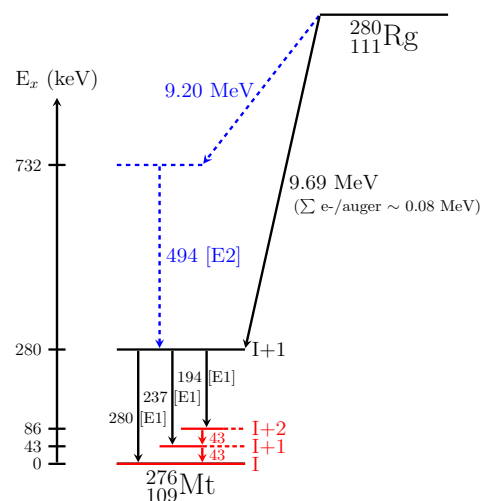
Spectroscopy and Identification of Rare Ions Using S³



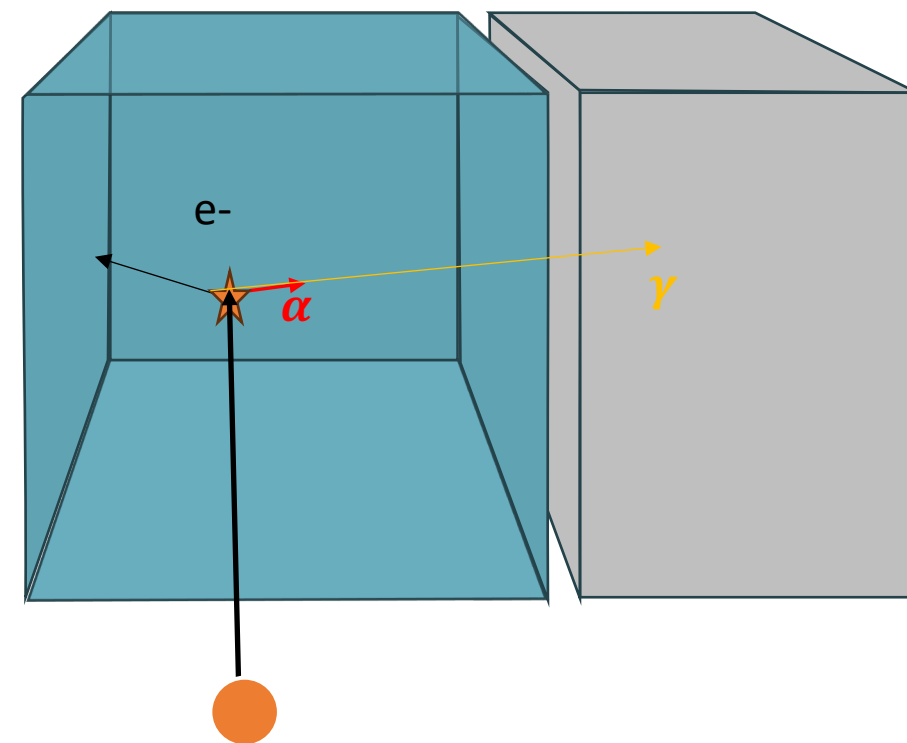
- **Tracker** : Temps de vol ($\sigma(t) < 1ns$), Position ($\sigma(x) < 0.5mm$)
- **DSSD-Tunnel** : Corrélation implantation décroissance (10x10cm², 128x128ch DSSD)
- **FEE** : Commutation bas gain/haut gain pour grande dynamique $\sigma(E_{\alpha}) < 20keV$
- **BEE** : Electronique digitale (NUMEXO2)

Decay Spectroscopy

- α -decay measurement for identification and spectroscopy
- Conversion electron spectroscopy
- γ -ray and X-ray spectroscopy
- TKE for fission fragments



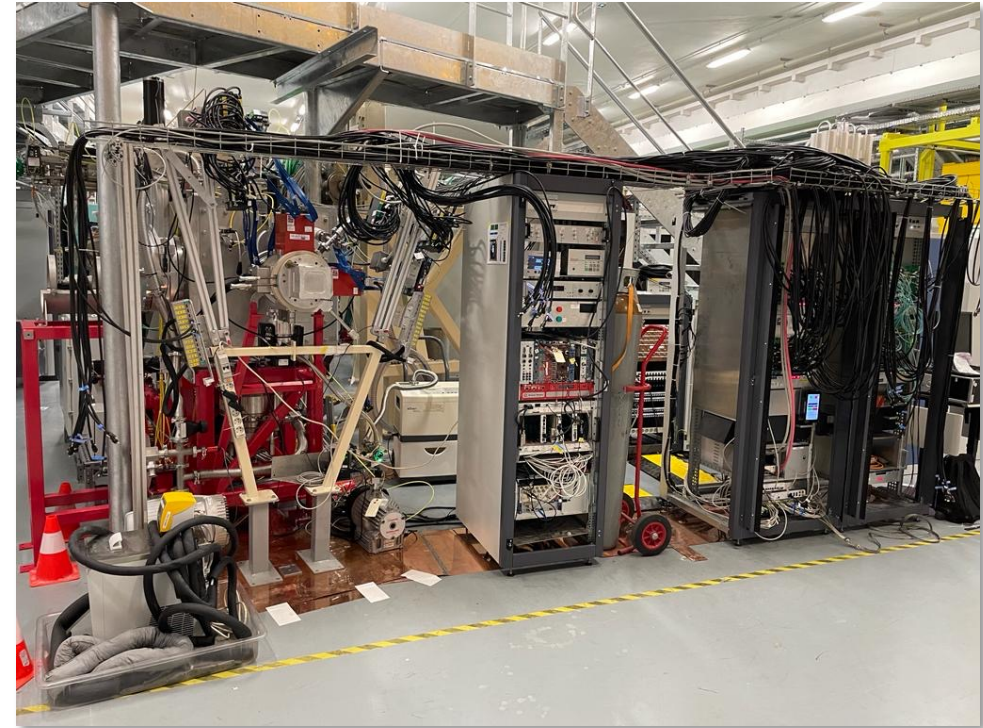
D. Rudolph et al.,
Phys. Rev. Lett. **111** (2013) 112502



Improved energy resolution
 Large range detection : from conversion electrons to Fission fragments
 Optimized Efficiency

What happened in 2023-2024?

- Test DSSD + Tracker june 2023 in IRRSUD
- Installation on S3 focal plane end june 2023
- Installation of 4 tunnels detectors january 2024
- Arrival of Armand Bahini for 2 years Post-doc on SIRIUS april 2024
- Moved SIRIUS to room 51 in may 2024
- Tunnel detectors test
- Improvement of Electromagnetic Compatibility (EMC) in room 51



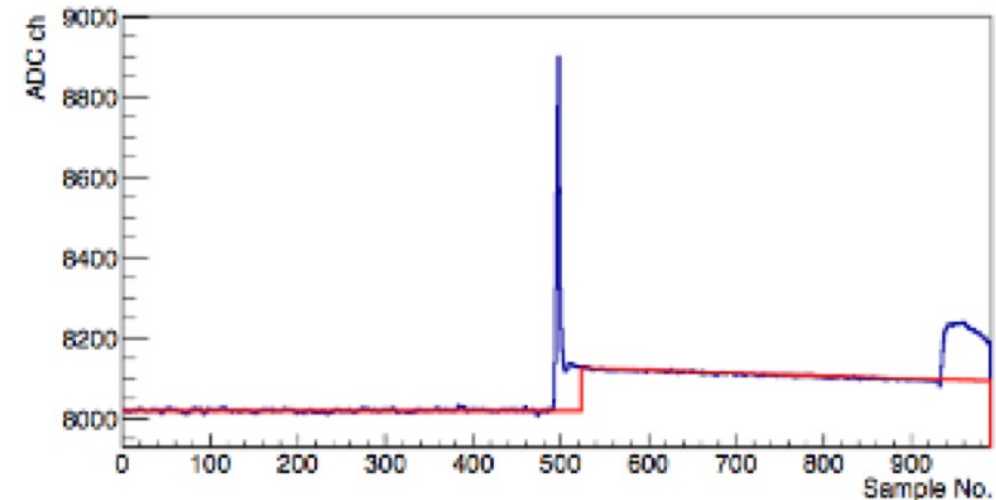
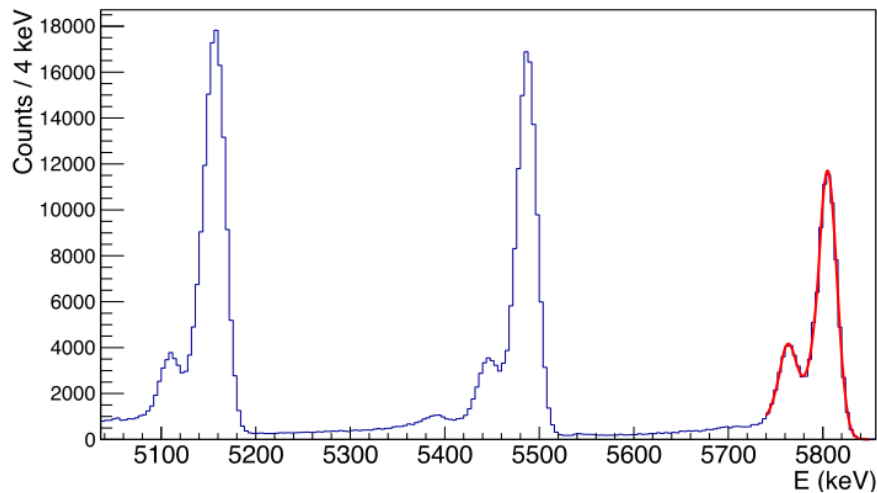
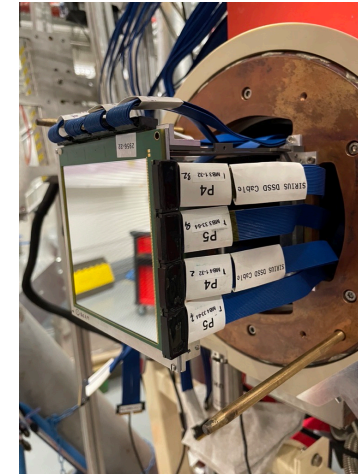


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Double Sided Silicon strip Detector

DSSD

128x128 strips – 10x10 cm² active area
Full pulse digitization
Large energy range with gain switching capability



High gain (alpha, electrons): 20,9 keV FWHM

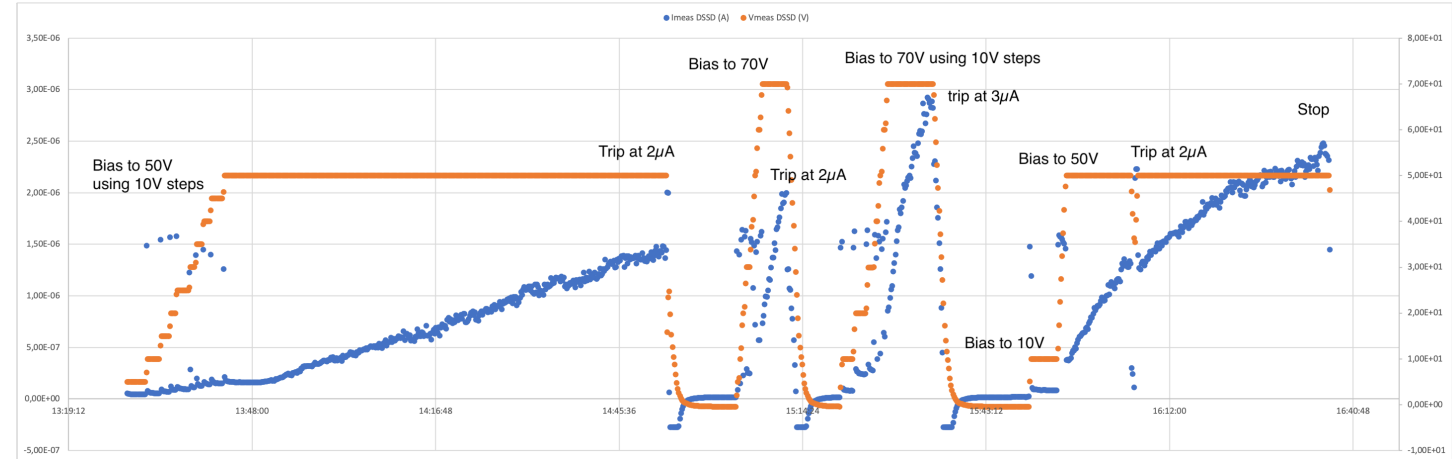
Automatic gain switch - Low gain (implantation, fission) :
1 % FWHM

DSSD

March 2024 : Failure of the DSSD – the leakage current rises steadily over time until the power supply trips

Two detectors with the same issue
Many hypothesis explored
Complete electronics chain tested

Detector sent to Irfu for independent testing :
Same issue observed



Two months of thermal cycling for annealing
Detector is back in order
Installation back on SIRIUS planned next week.

Hypothesis : The frequent opening of the vacuum chamber led to moisture trapping in the detector.
Confirmed by experience from the manufacturer



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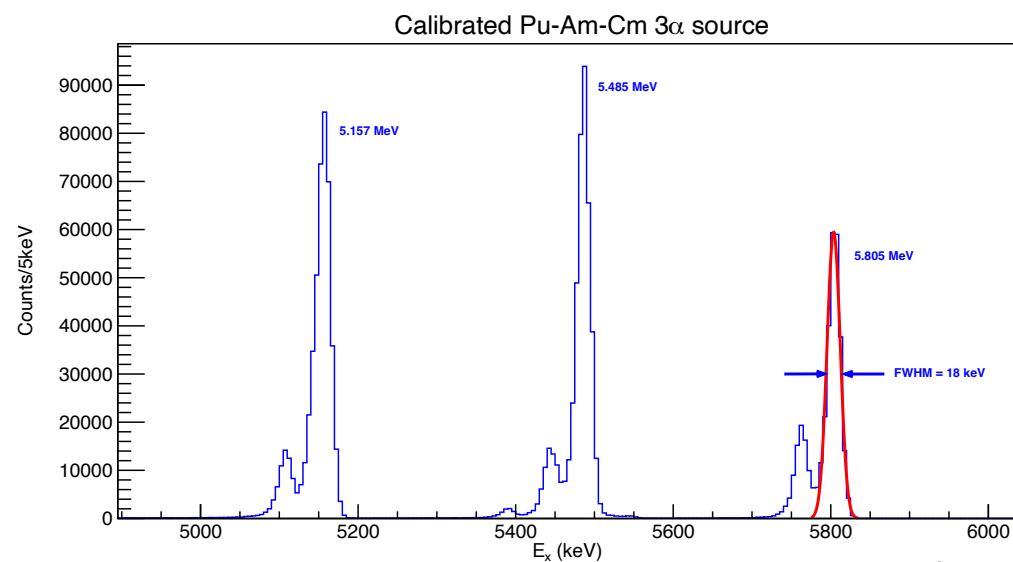
Tunnel detectors

Tunnel detectors

Detectors for alpha and conversion electron spectroscopy

Measurement of particles escaping the DSSD.

Average Energy resolution
21.2 to 18 keV FWHM

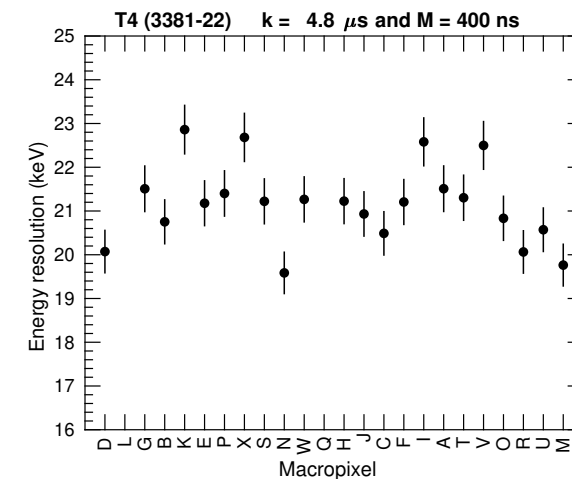
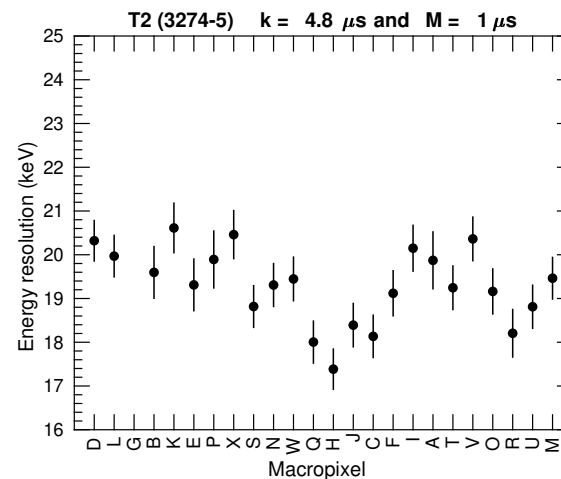
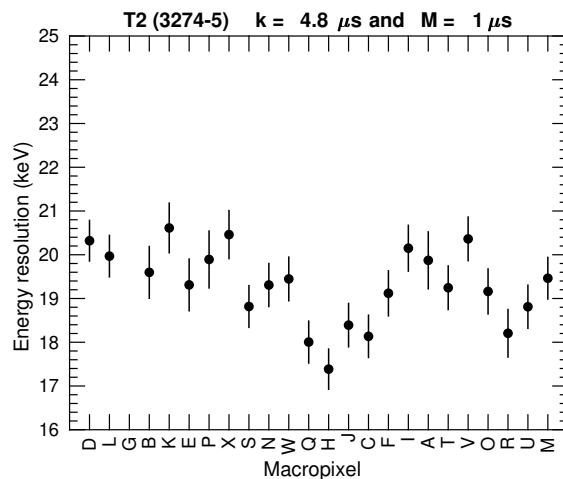
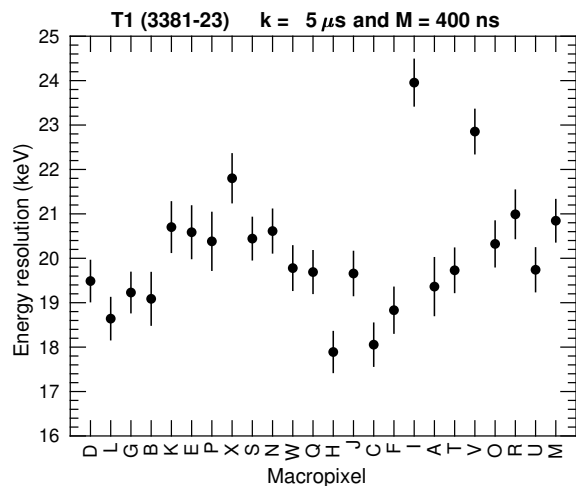


A. Bahini



Tunnel detectors

Pictures courtesy of A. Bahini

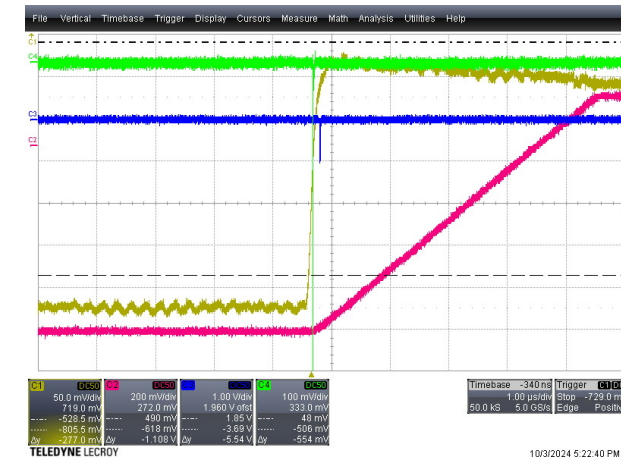
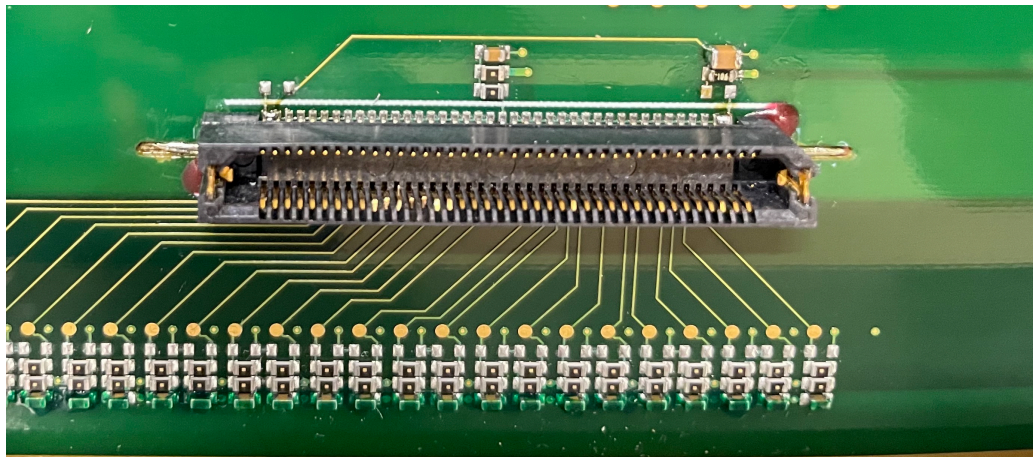
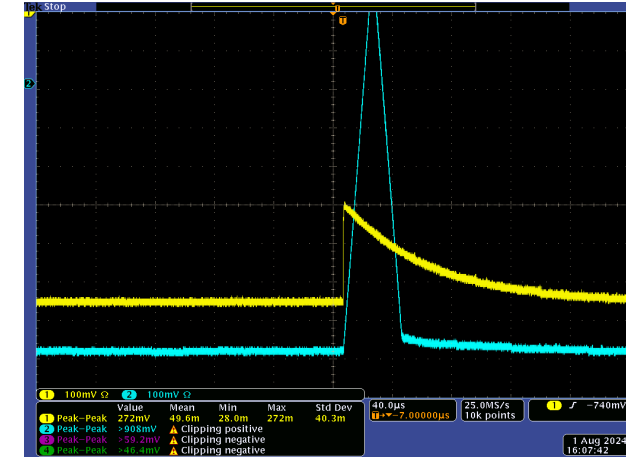
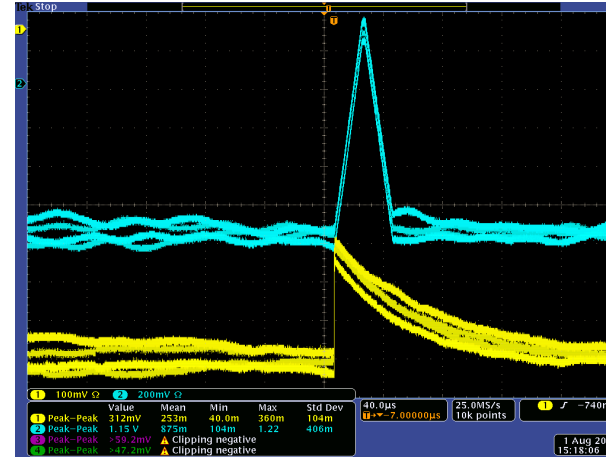


Energy Resolutions close to specifications for alpha particles (< 20 keV FWHM)

	K	L	W	X
	I	J	U	V
	E	F	G	H
	A	B	C	D
	M	N	O	P

Tunnel detectors

- Some pixel have a very bad resolution or missing
- Connectors are very fragile and some are damaged
- EMC still needs some work



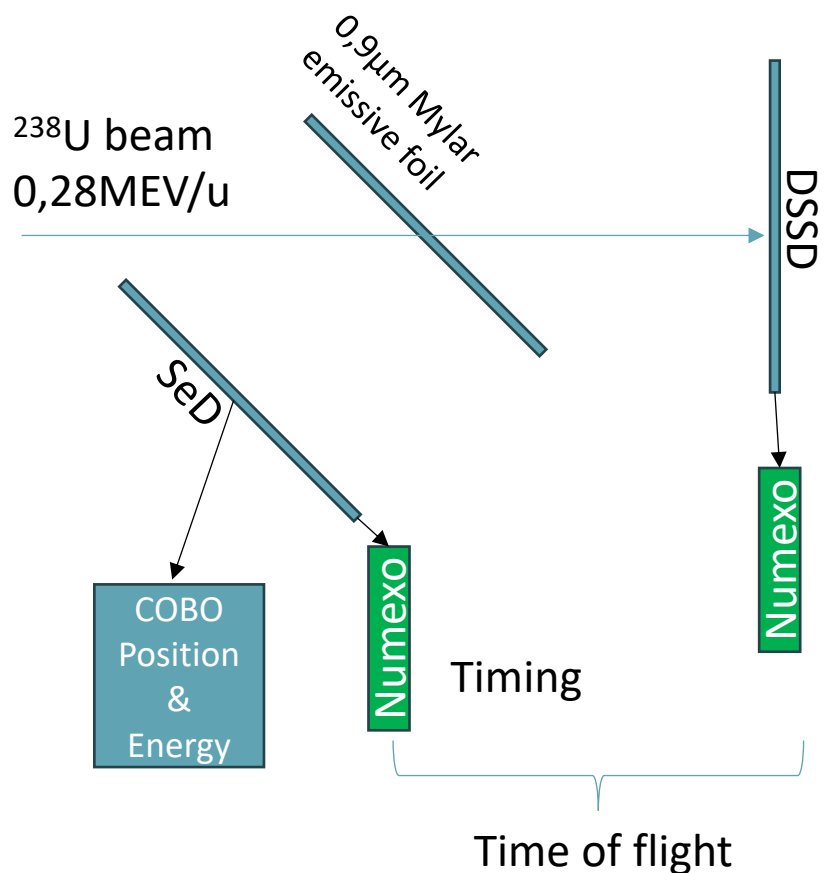


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Tracker

Time of Flight & tracking

In-beam test performed at IRRSUD in june 2023

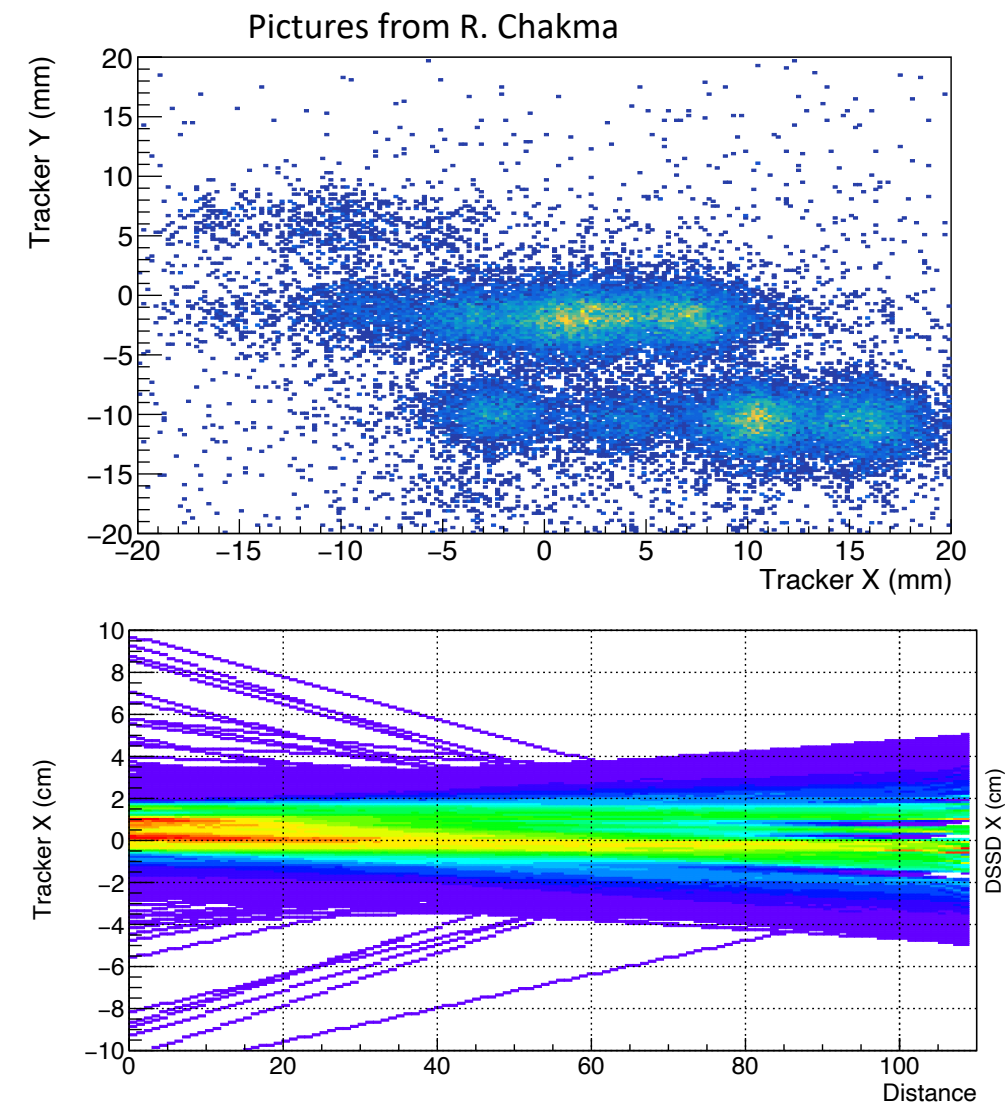


- Tracking between position in SeD and Pixel in DSSD
 → sub millimeter resolution
- ToF between digitized SeD timing signal & DSSD signal

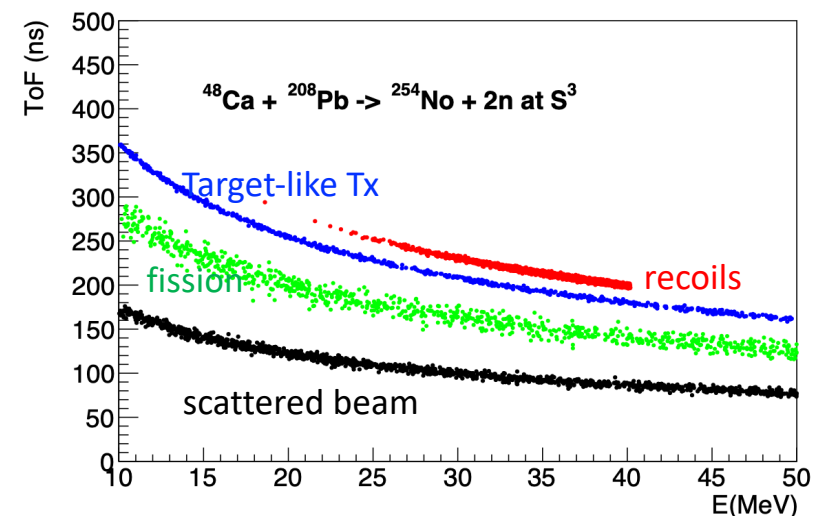
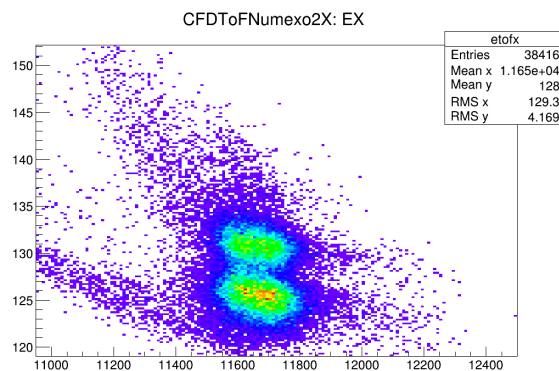
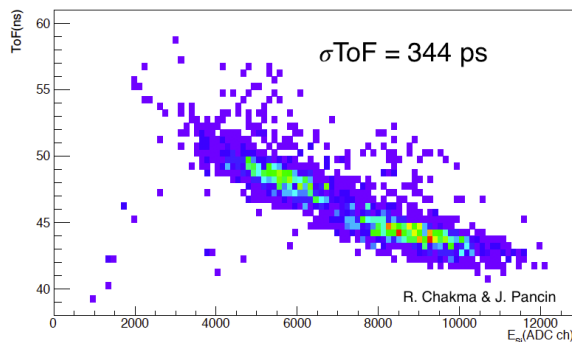
Tracking

- Position in the Tracker with position resolution 1,1 mm FWHM
- DSSD Strip pitch = 700 μm

Ion by ion trajectory reconstruction
→ Selection of events



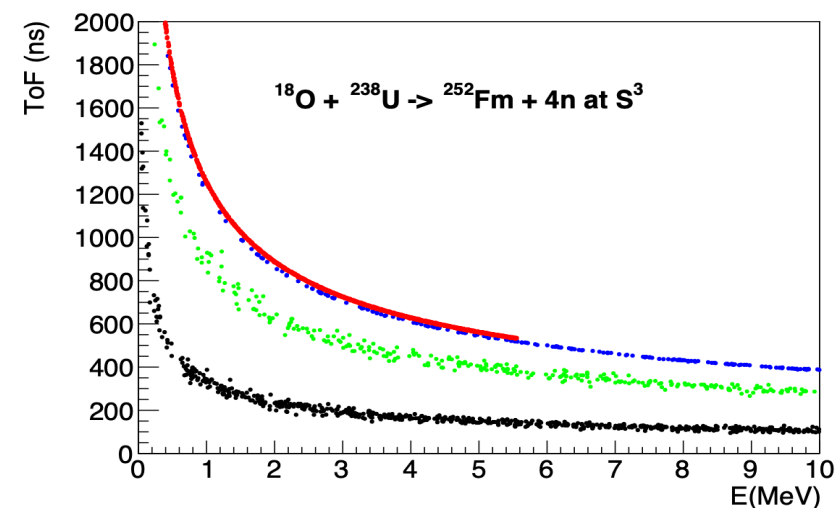
Time of Flight



- 238U beam test :
Time of flight resolution FWHM 2.07 ns

→ 1.2 ns FWHM is needed to separate Evaporation residues
 → 800 ps FWHM would be desirable for Mass Resolution

Work ongoing on the DSSD timing (software) to improve

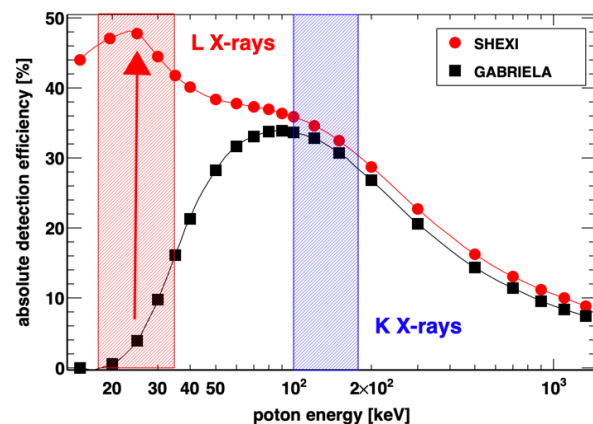
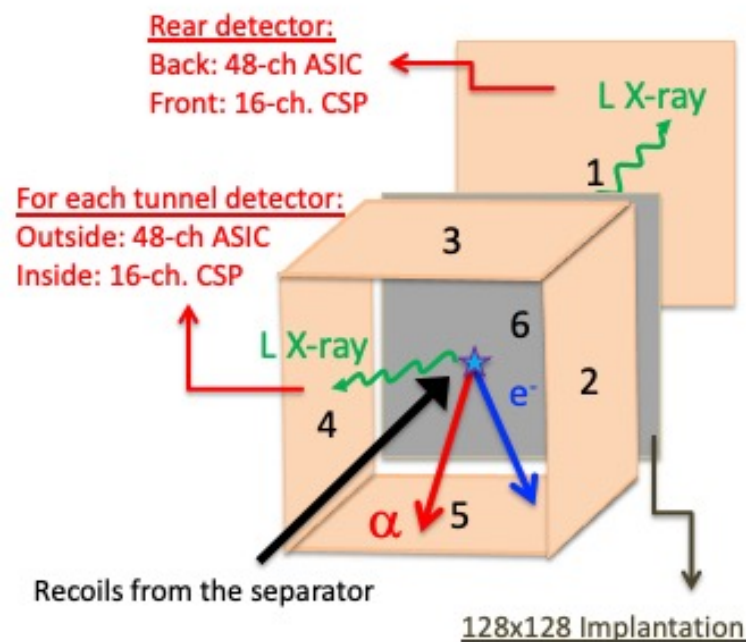


R. Chakma & K. Hauschild

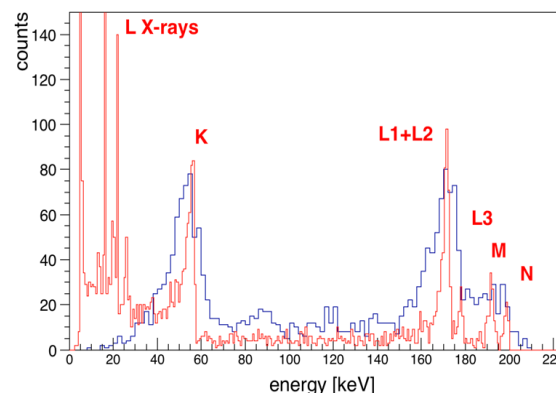
Future

SHEXI (SuperHeavy Elements X-ray Identification)

Upgrade of tunnels & veto detectors + associated electronics

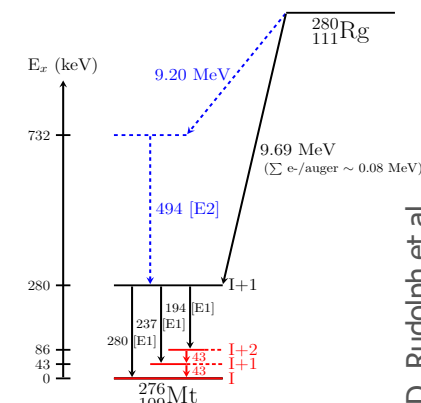


→ L-Xray detection



+ world leading ICE spectroscopy

Z identification of SHE



Detectors & Preamps test starting at IJCLab

Project supported by GANIL Scientific Council

ANR request submitted today by K. Hauschild

D. Rudolph et al., Phys. Rev. Lett. **111** (2013) 112502

Slide courtesy to K. Hauschild

Planning for 2024-2025

- Continue improving EMC in room 51 to decrease thresholds
- Conversion electron source tests (Tunnels et DSSD)
- Alpha-Gamma coincidence tests
- Tests of SEASON with the Numexo digitizers of the DSSD
- Tests for SHEXI at IJClab
- Start the Diagnostic Box in view of the commissioning of S³ end 2025

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Merci pour votre attention