SEASON update
Tests and mounting

Mathilde Ragot

Supervisors : Damien Thisse
Marine Vandebrouck
Iain Moore

ISOL-France workshop - 03/04/2025

SEASON development team :

Project Managers :
O. Cloué (technic)
M. Vandebrouck (scientific)

Mechanical conception :
S. Cazaux, P. Daniel-Thomas

Detection/Acquisition :
F. Bouyjou, T. Chaminade, D. Thisse

Control & Command :
A. Gaget, J. Relland, A. Roger

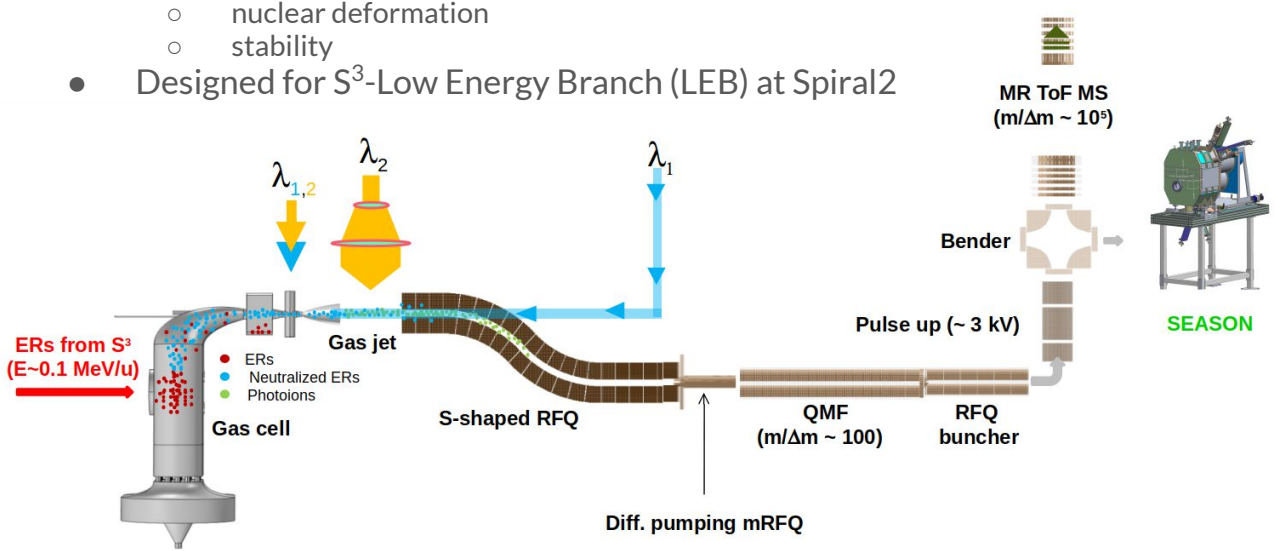
Electrical engineering :
J. Noury, Y. Reinert

Simulations :
E. Rey-herme

1. SEASON decay station and context

SEASON's environment

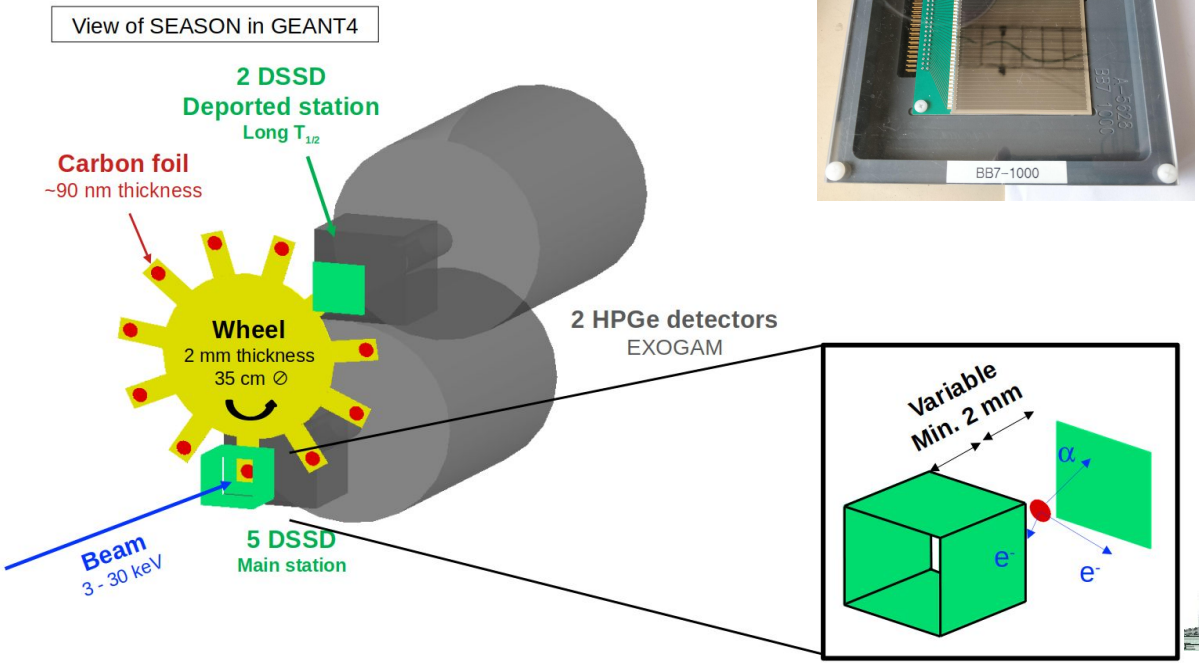
- Study of heavy and super heavy nuclei
  - single particle structure
  - nuclear deformation
  - stability
- Designed for S^3-Low Energy Branch (LEB) at Spiral2

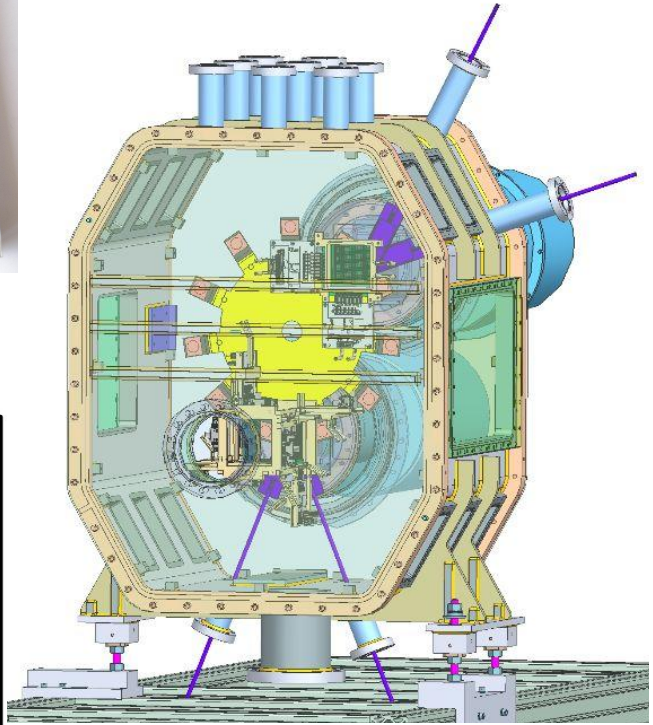


- Counter for laser spectroscopy
- Detailed α, e-, γ decay spectroscopy

Coupling of atomic and nuclear approaches

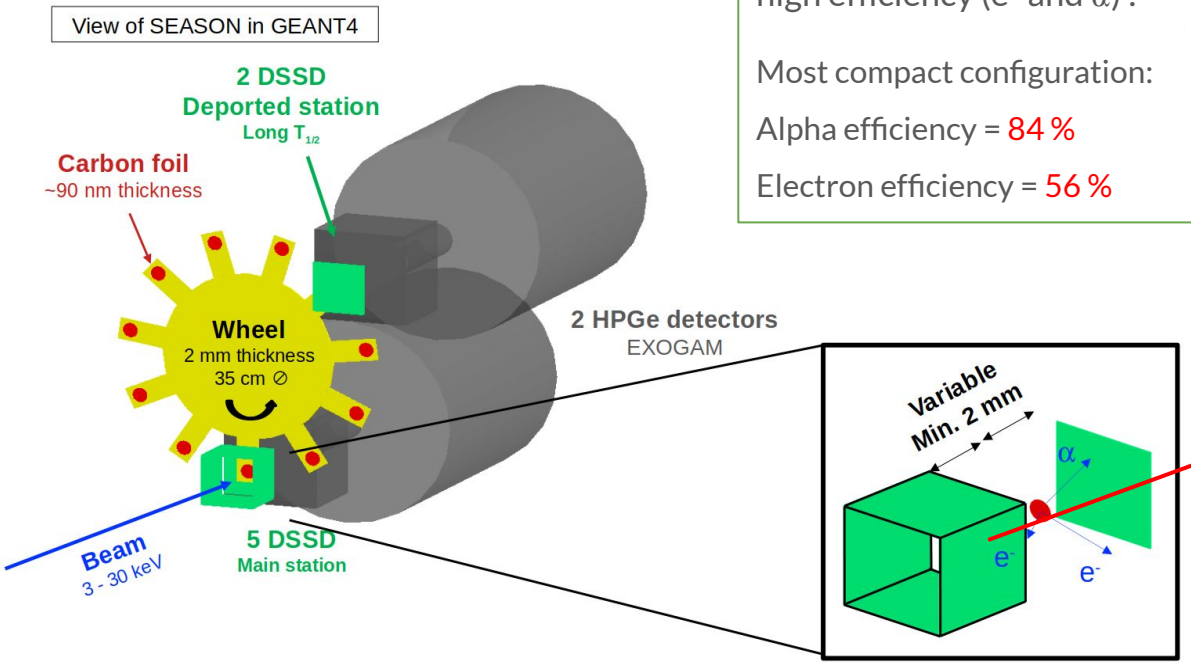
SEASON scheme





simulation done by Emmanuel Rey-herme

SEASON scheme

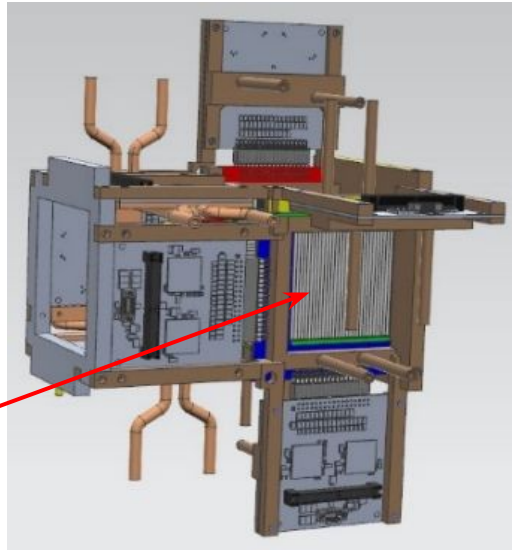


Compact configuration for high efficiency (e- and α) :

Most compact configuration:

Alpha efficiency = 84 %

Electron efficiency = 56 %

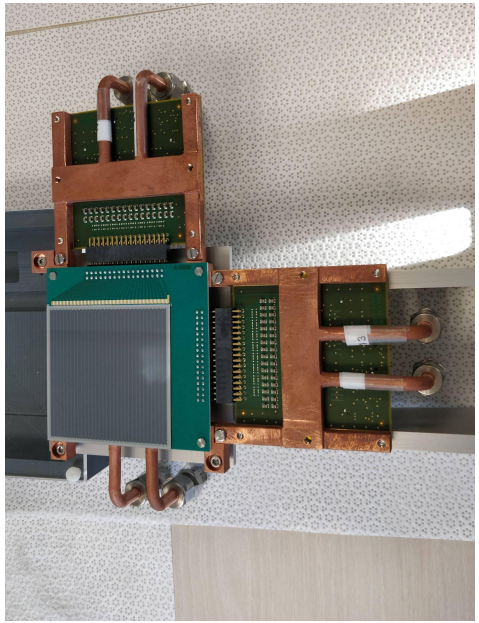


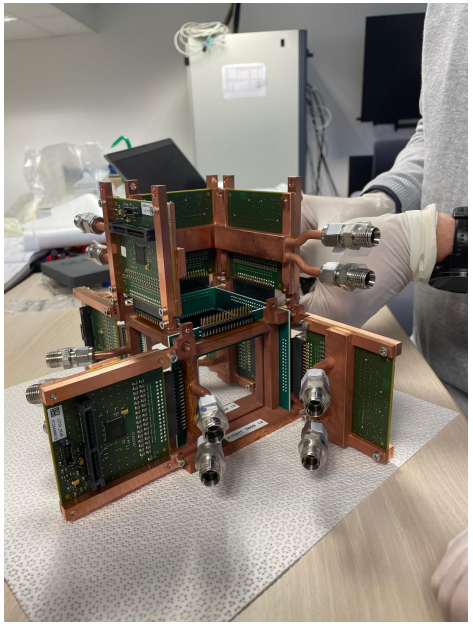
simulation done by Emmanuel Rey-herme

2 Mounting at GANIL

February : delivery and mounting

- 1st week: mounting of the tunnel and the rest of the detectors on their copper frames.





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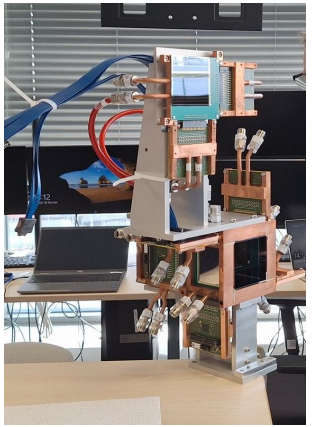
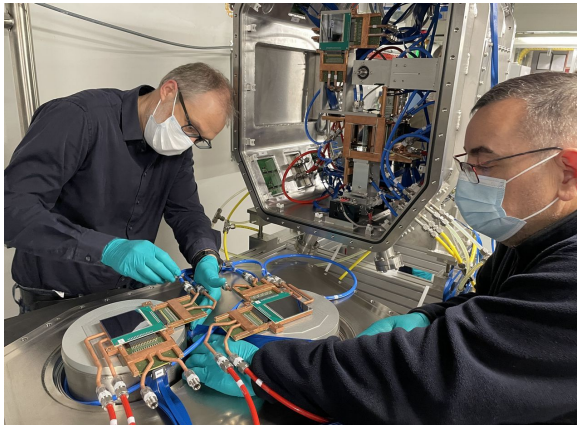
- 3rd week:
  - vacuum tests and installation of detectors, cables and cooling circuit.
  - first polarization.





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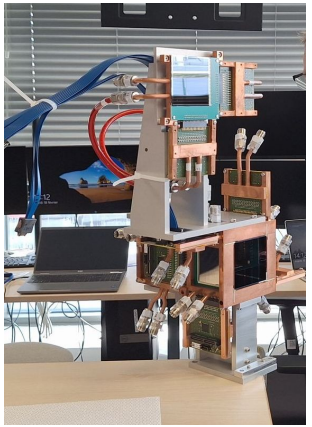
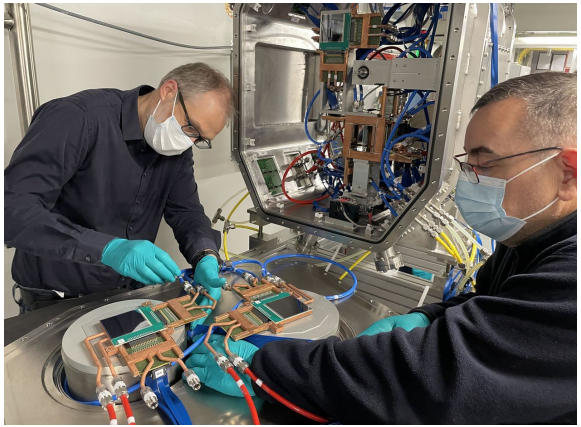
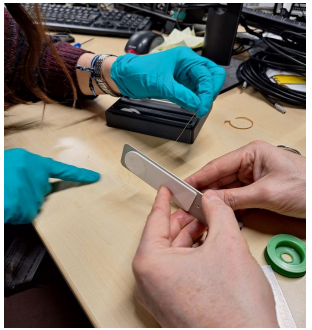
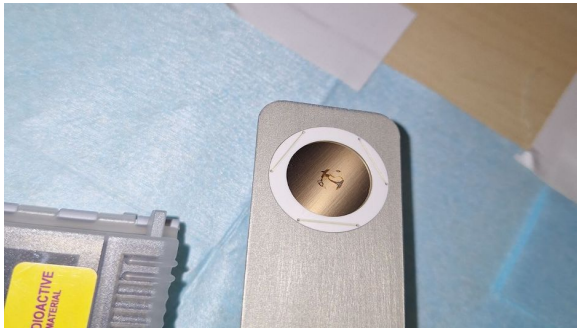

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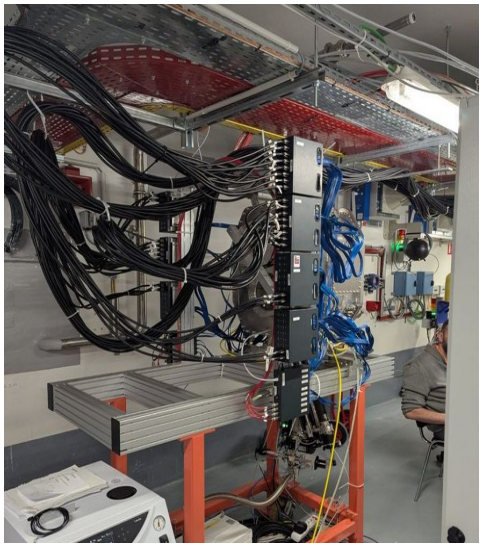
  - connecting to the acquisition (NUMEXO2)



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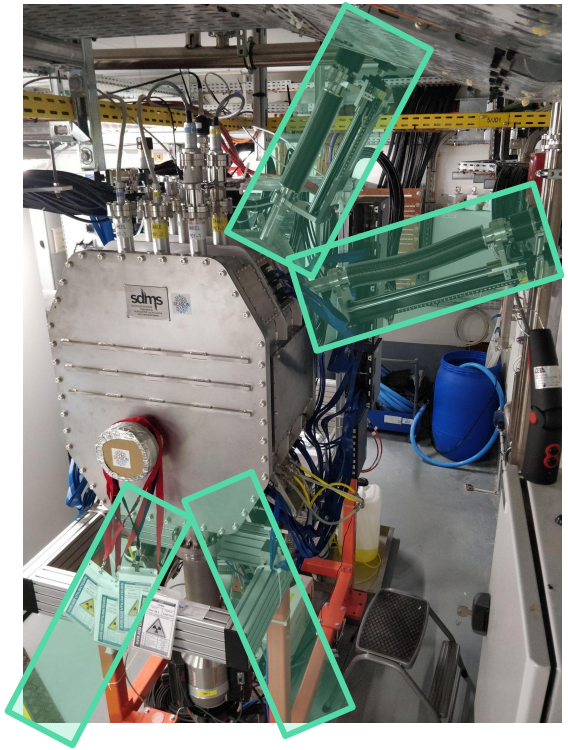
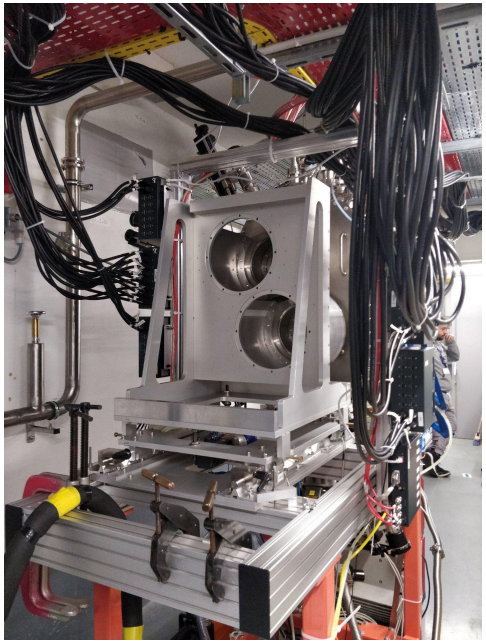
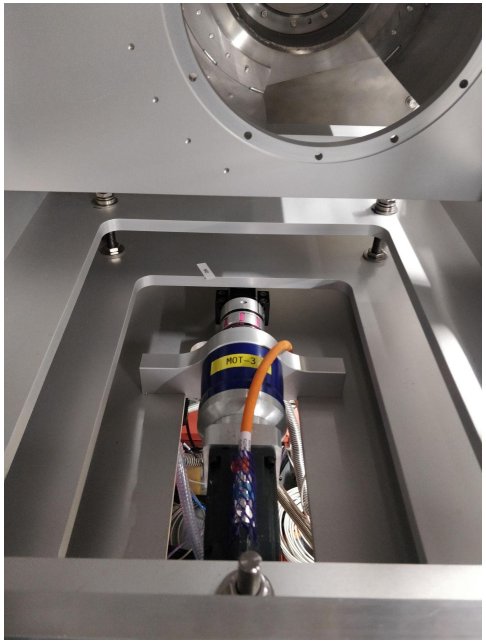


March : finishing the mounting and starting the acquisitions

- 5th week:
  - installation of the back table for HPGe, with translation motor (but mechanical problems).
  - leakage issues (partly solved - now $2*10^{-5}$ mbar).





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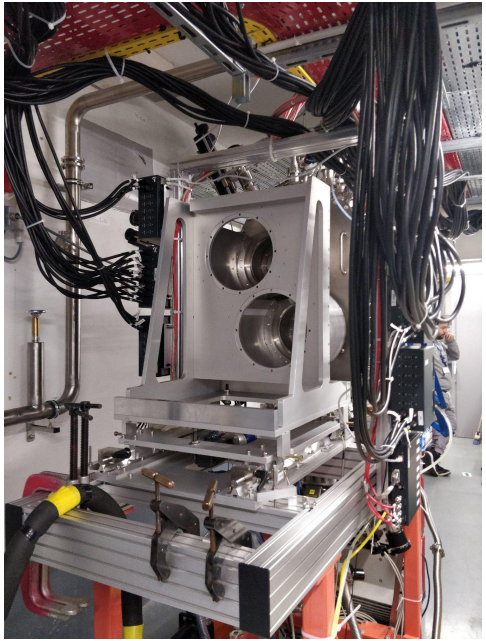
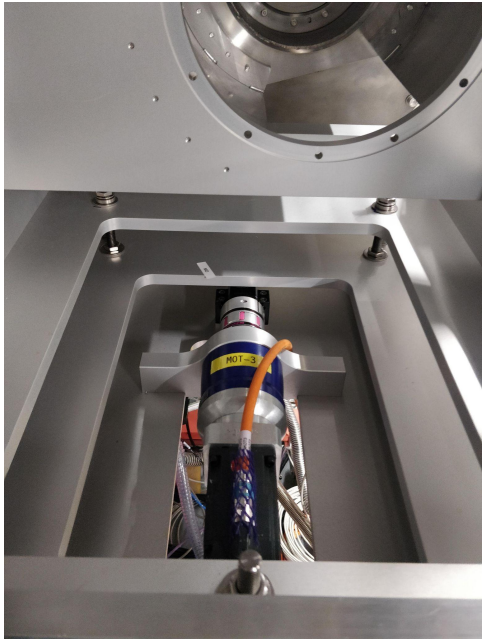
- 6th week: First acquisitions with sources !
- 7th week: First acquisitions with sources and with timestamps (issues with GTS cards fixed).

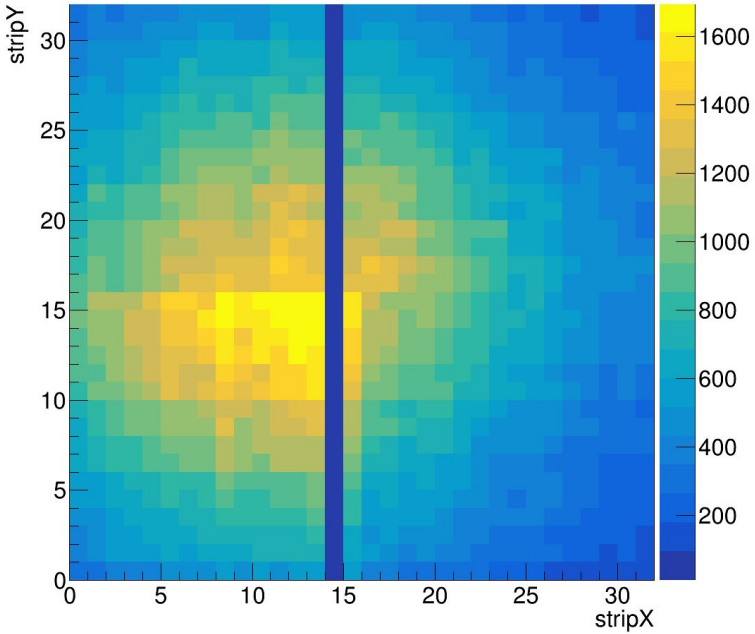




3 First results of the source commissioning

First acquisitions:

- No time alignment : issues with the injection (now solved)
- Missing strips : possibly due to issues in the “éclateurs”



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- Detector DU at 30 mm from the source:
  - 1 ASIC with higher count rate
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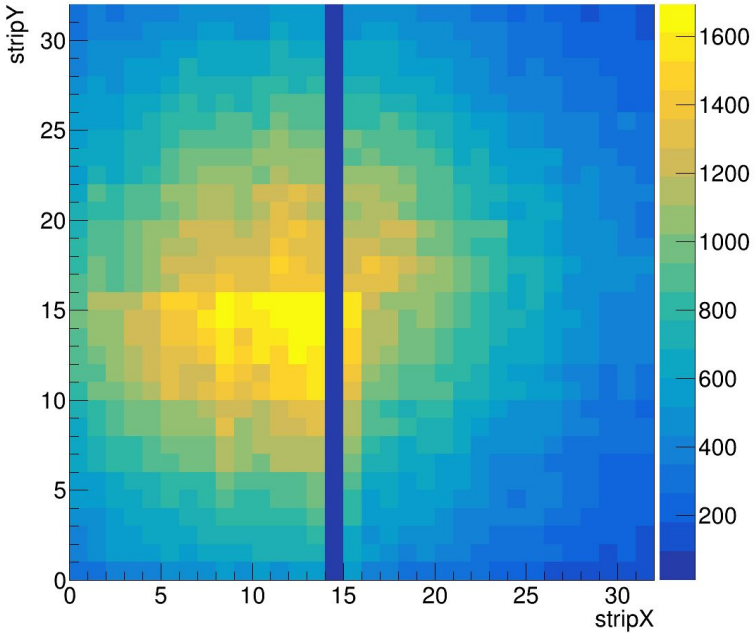

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- Detector DU at 30 mm from the source:
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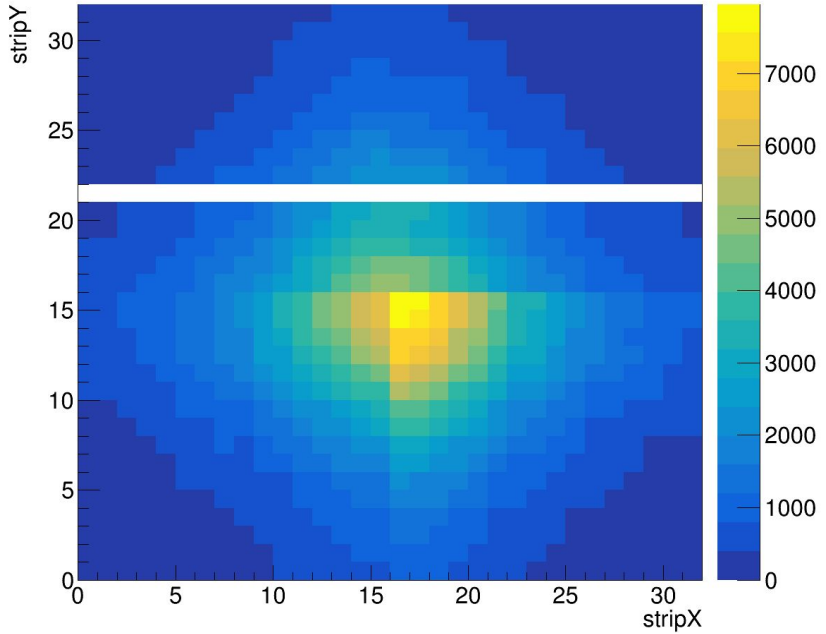
  - 1 missing strip
- Detector MD at 9.5 mm from the source:
  - 1 ASIC with higher count rate
  - 1 missing strip

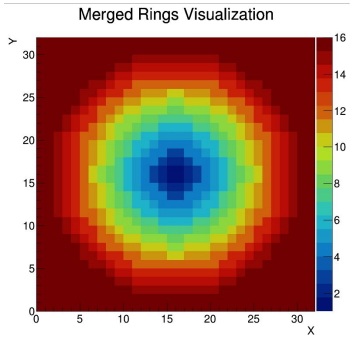


Calibration per ring

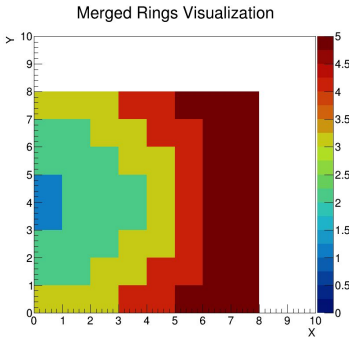
simulations

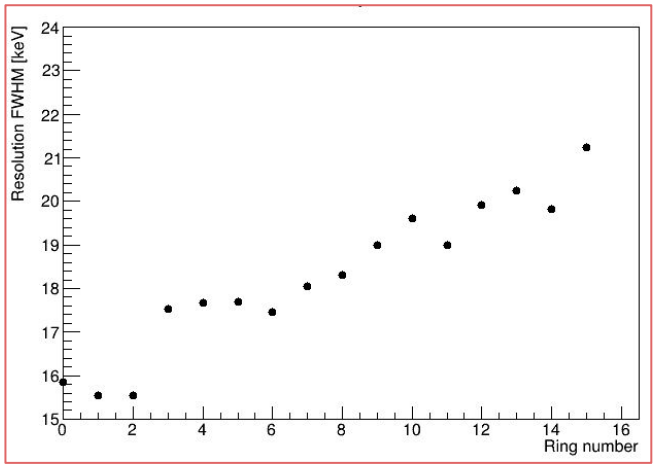
- First: calibration per strip
- Due to straggling: calibration per pixel
- Due to low statistics on the sides: calibration per ring

full DSSD



coupled DSSD



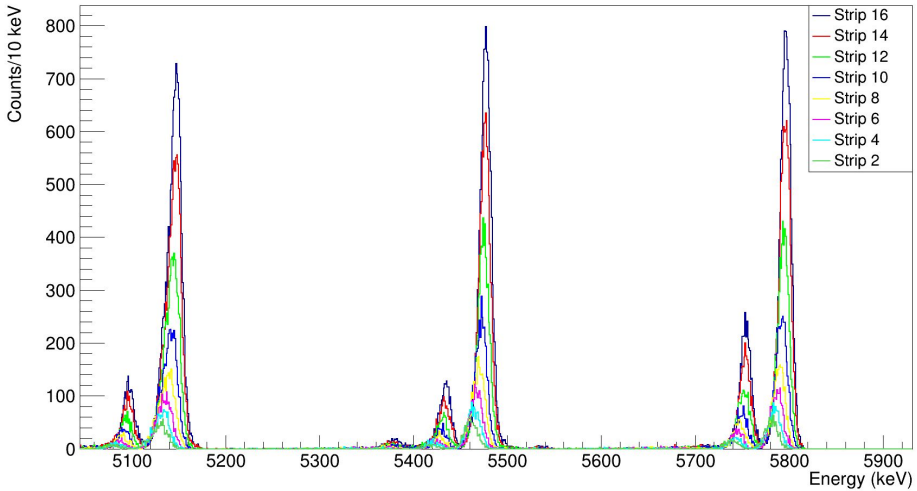


Example:
Resolution vs ring number for MD

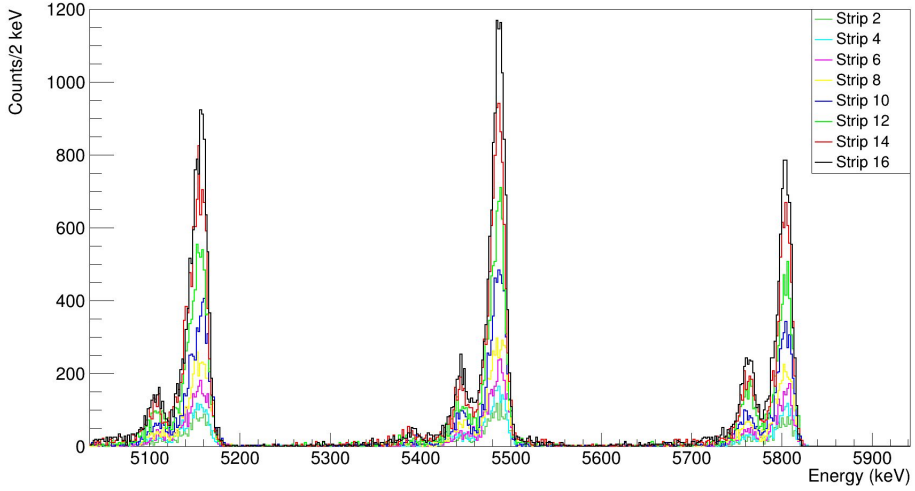
Comparison per strip with simulation

MD- 9.5 mm from source

Spectrum from simulation

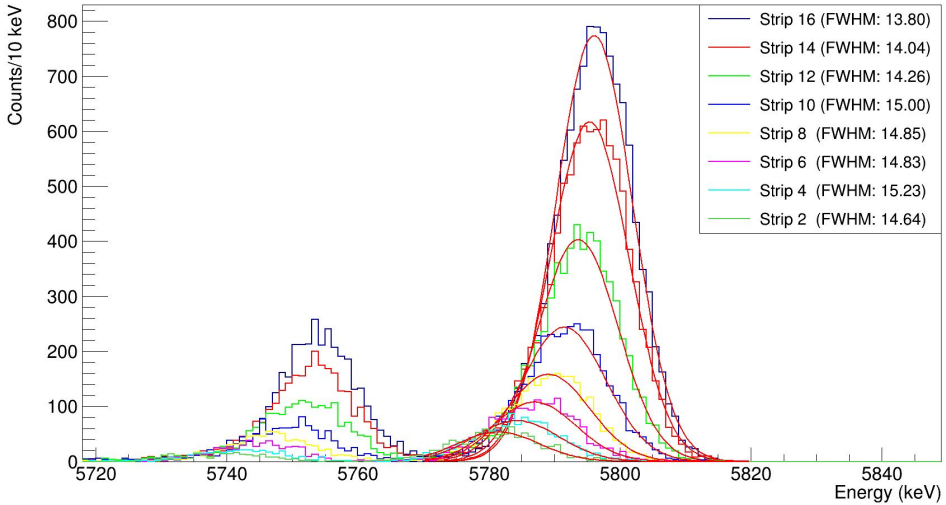


Spectrum from acquisition



Comparison per strip with simulation

Spectrum from simulation (strip per strip)



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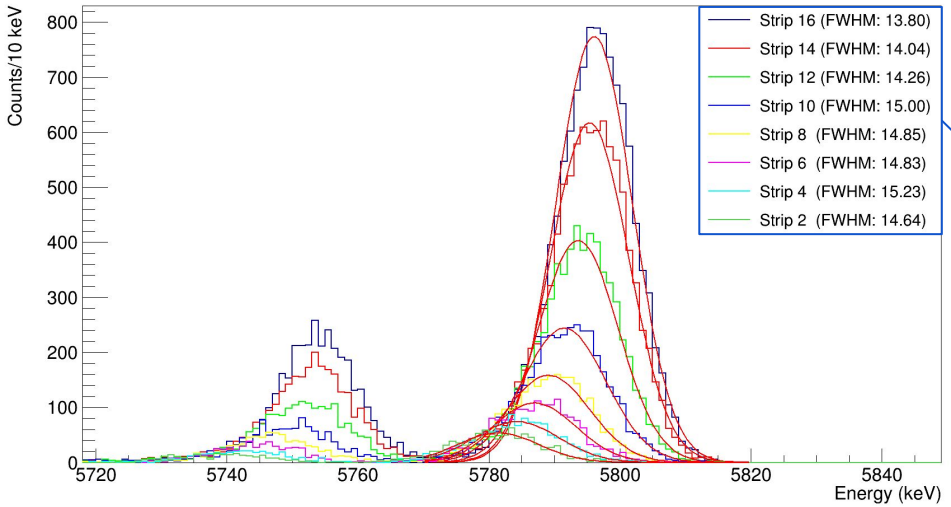
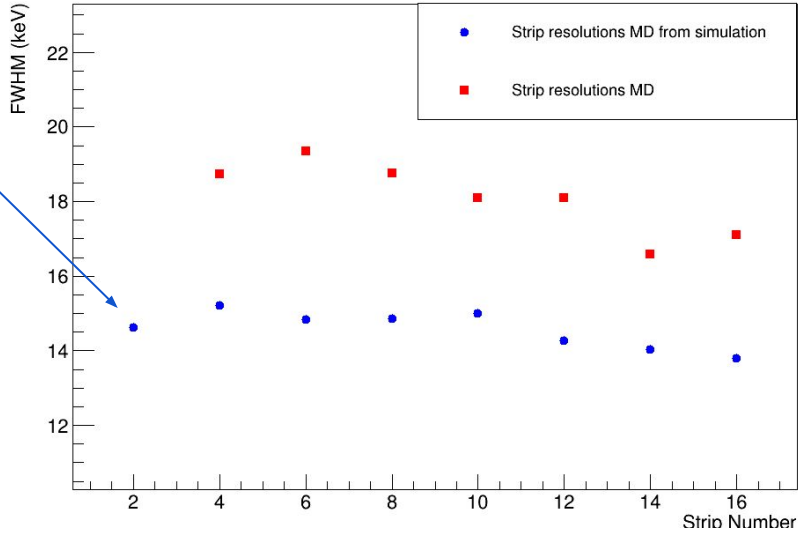




4. Schedule

SEASON's schedule in 2025

Source commissioning at GANIL

DIS intervention to solve mechanical and vacuum issues

Moving to Finland

Online commissioning at Jyväskylä

Commissioning experiment : ^{232}Th(p, xn)$^{233-x}$Pa (accepted)
Spokesperson : D. Thisse

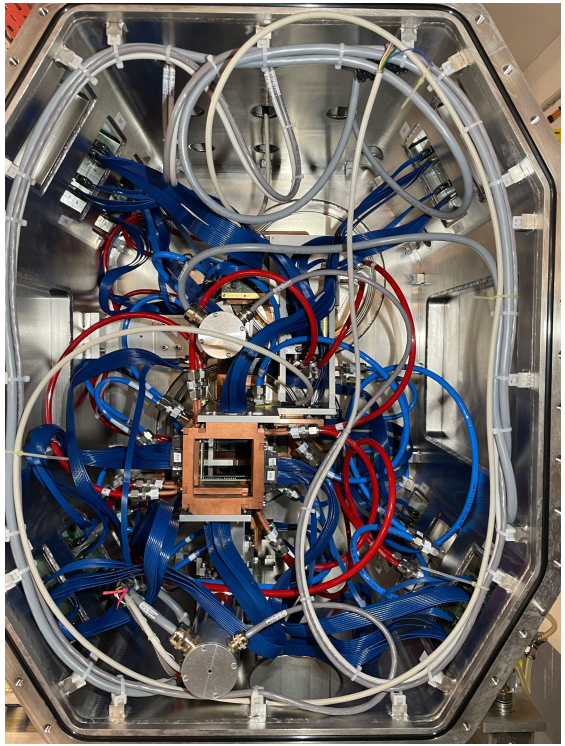
Experimental campaign at Jyväskylä and then moving to S^3-LEB

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

GANIL

Conclusions

- Mechanical mounting is almost over.
- All DSSDs are functioning, although more acquisitions and analysis are needed.
- What is next:
  - Mechanical and vacuum issues should be fixed soon
  - During the summer, sent to Jyväskylä for the commissioning experiment and the experimental campaign, before being sent back to GANIL



Thank you !

SEASON development team :

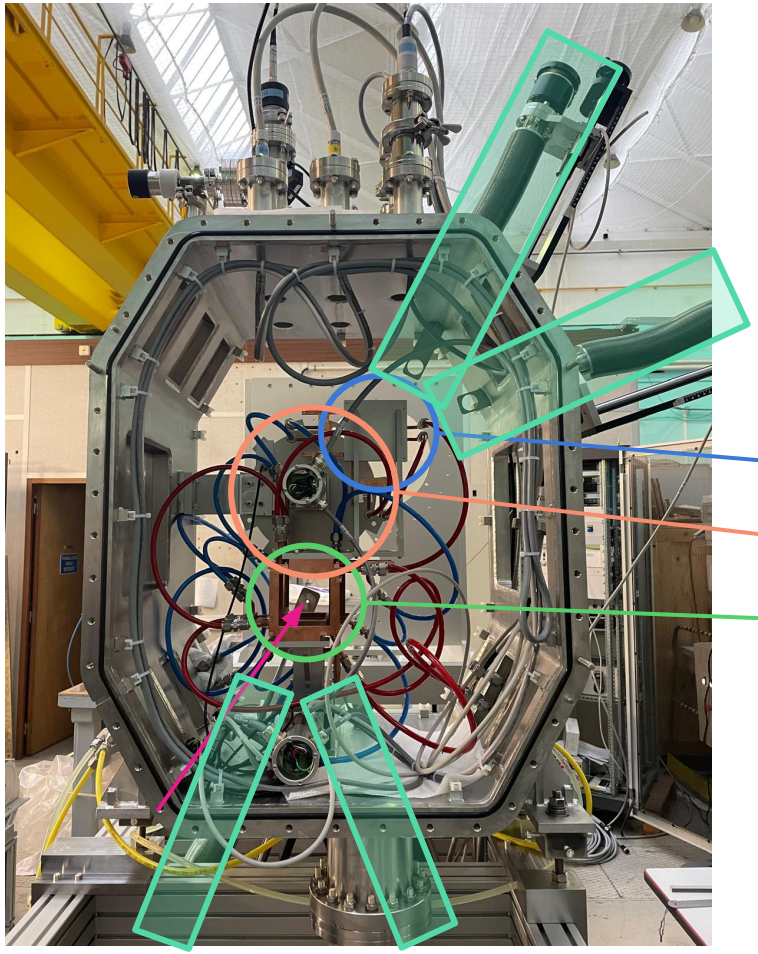
Thomas Bey[1], Florent Bouyjou[1] , Sandrine Cazaux[2] , Thomas Chaminade[1] , Olivier Cloué[2] (technical project manager), Olivier Corpace[2], Philippe Daniel-Thomas[2], Jules Dartois[1] , Antoine Drouart[3] , Alexis Gaget[2] , Olivier Gevin[1] , Thomas Goigoux[3] (postdoc), Jean-Christophe Guillard[2], Mariam Kebbiri[1], Fabien Prunes[1] , Jorge Mendes-Ribeiro[2] , Julien Noury[2], Mathilde Ragot[3] (PhD student), Yann Reinert[2] , Johan Relland[2], Emmanuel Rey-herme[3] (PhD student), Arnaud Roger[2] , Barbara Sulignano[3] , Christophe Theisen[3], Damien Thisse[3] , Marine Vandebrouck[3] (scientific project manager).

1. Irfu/DEDIP (Département d'Électronique des Détecteurs et d'Informatique pour la Physique)

2. Irfu/DIS (Département d'Ingénierie des Systèmes)

3. Irfu/DPhN (Département de Physique Nucléaire)

Back-up



beam direction

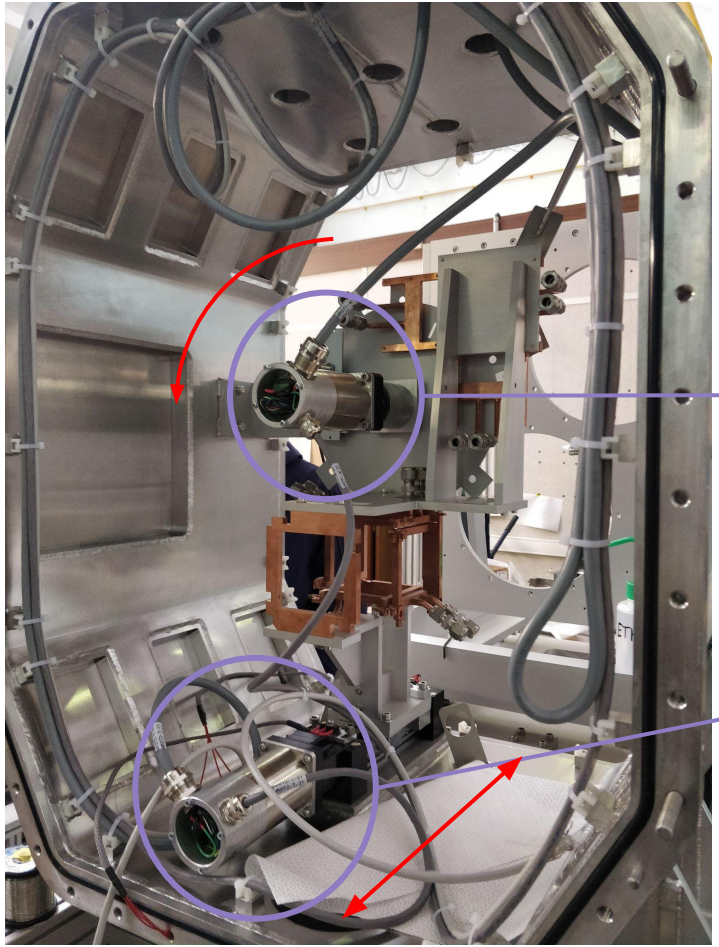
deported station

wheel

main station

calibration arms and its HMI that manages:
- the control of the sources storage
- the different calibration step

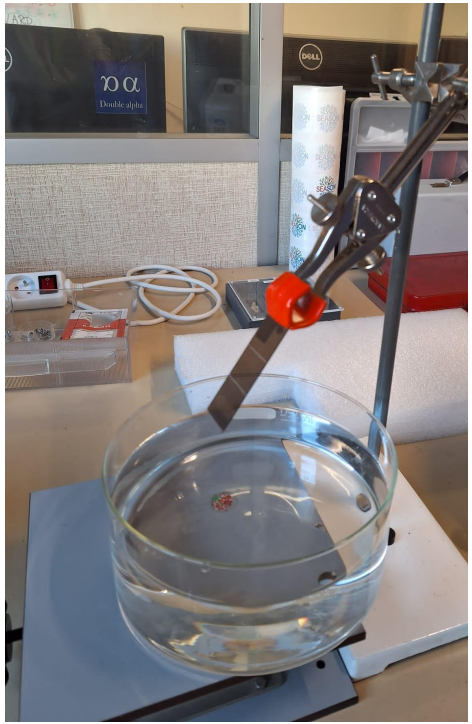
& provides safety features to avoid detector damage.

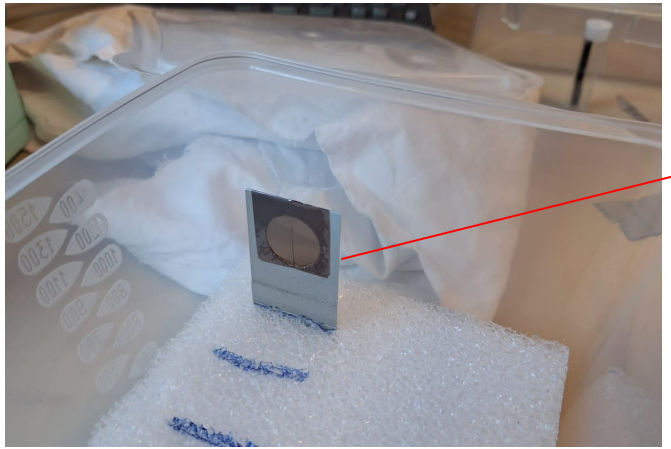


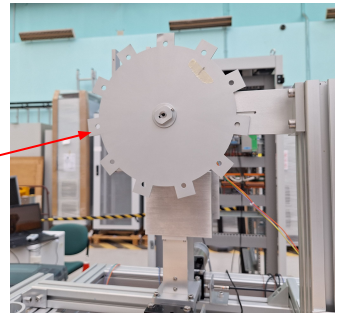
motor to rotate the wheel

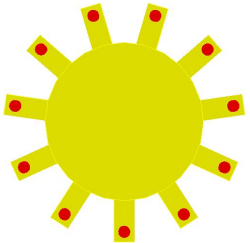
Upstream system: motorised to slide the tunnel part of the main station and one of the two detectors in the deported station

Deposing carbon foils onto the metal holders





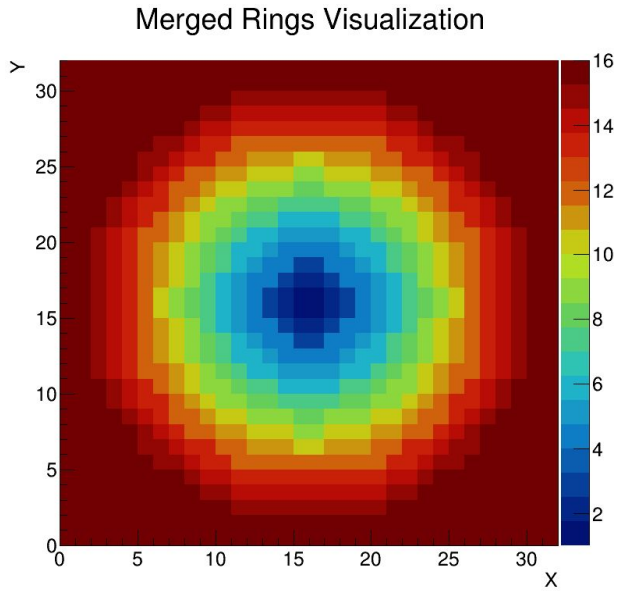


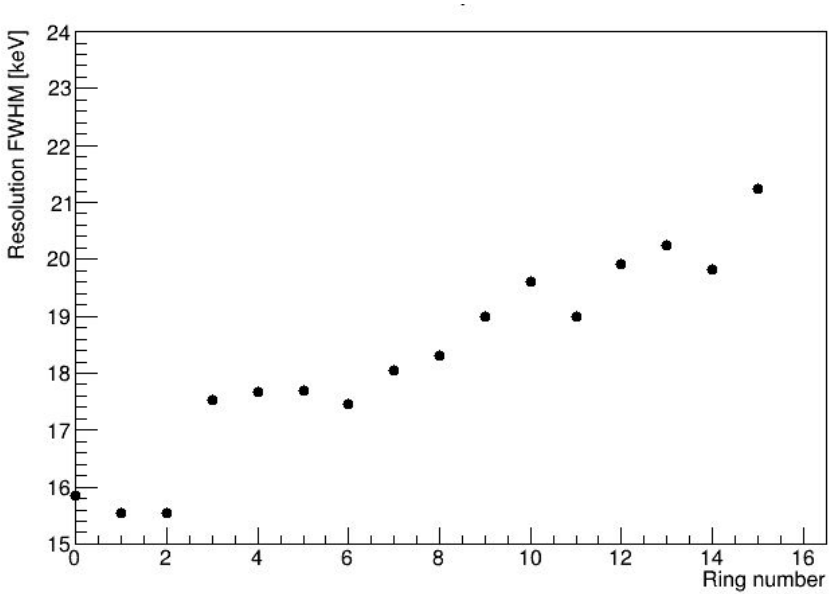


Already tested twice in experiment & survived the vacuum test in SEASON's chamber

Example for the MD at 9.5 mm (30 min acquisition)

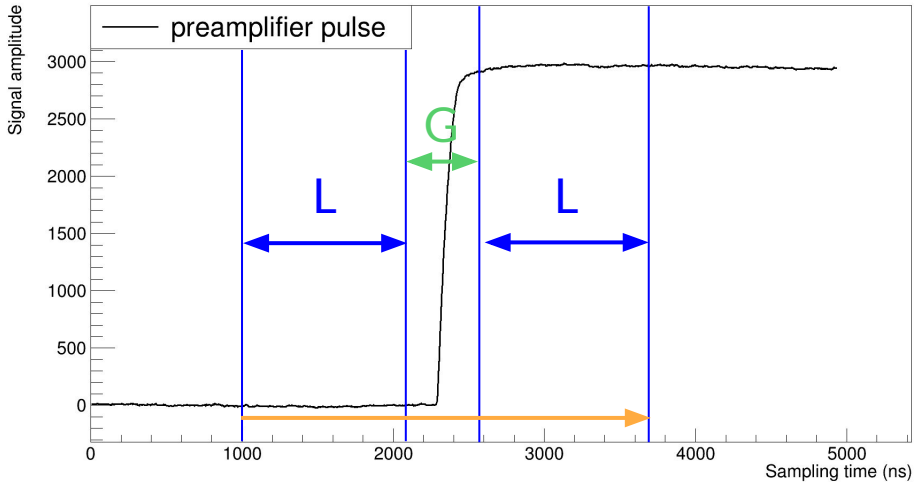
Low coincidence rate since no time alignment

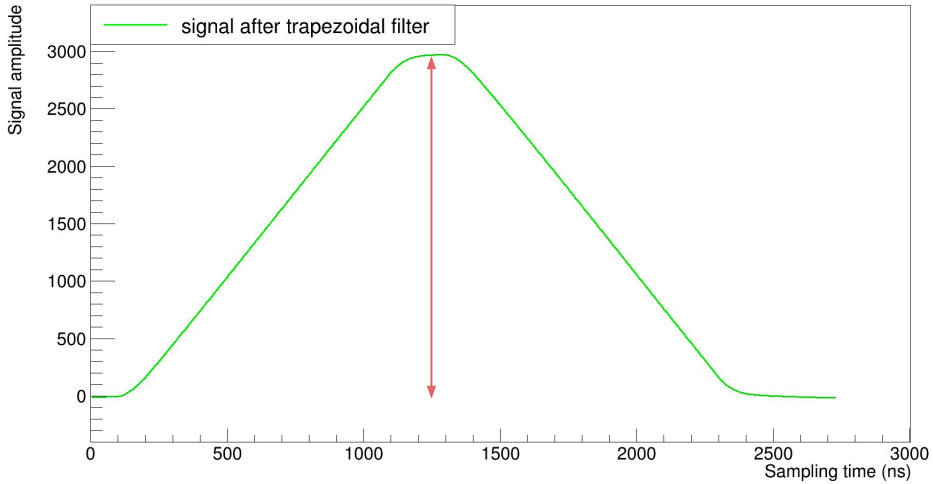




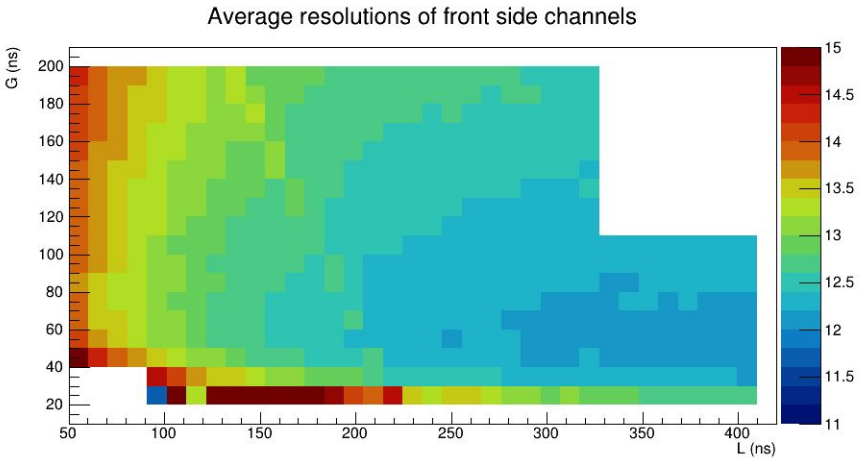
Analysis method for fixed gain acquisitions

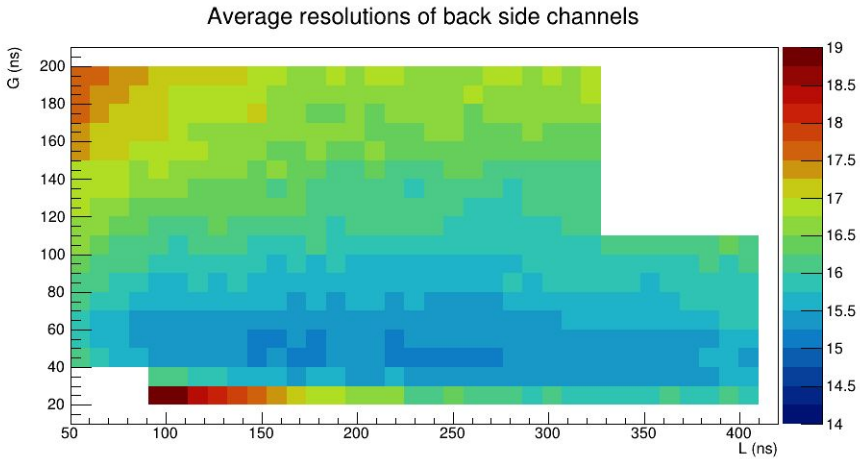
Signal from FEANICS digitized by NUMEXO2





Optimization of the trapeze parameter: for alphas





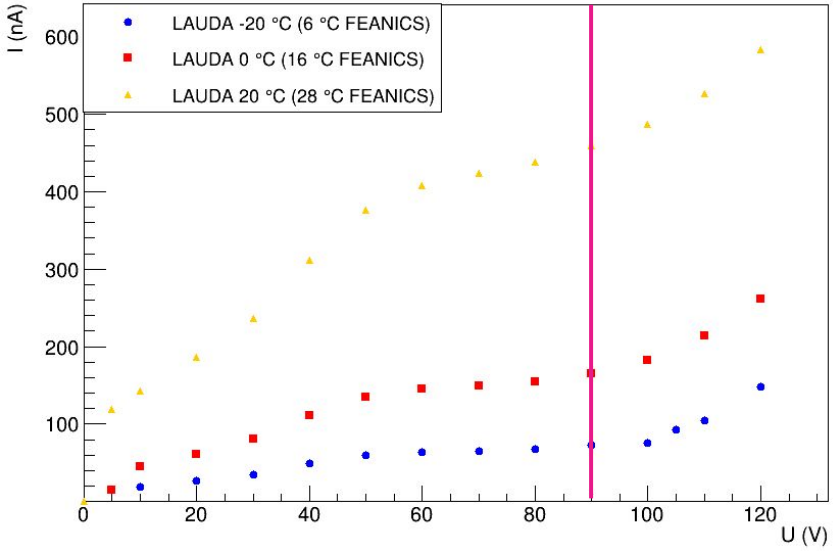
conclusions :

sampling time = 5 ns

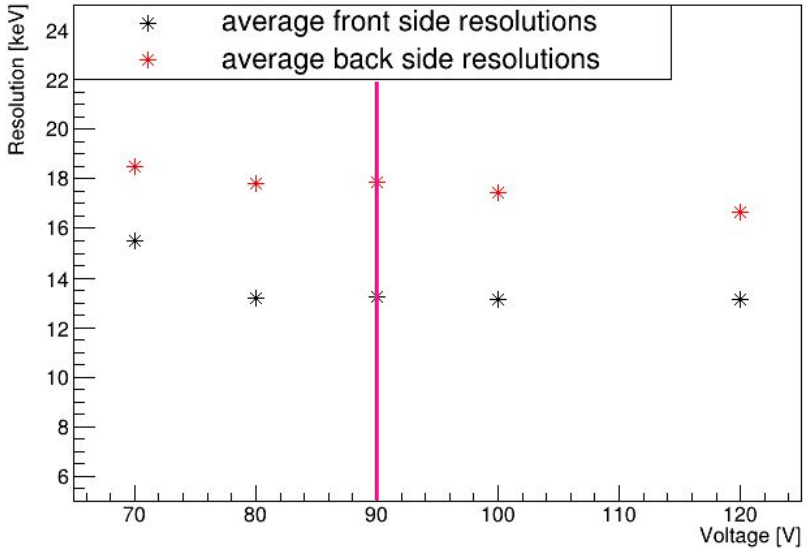
- L should be as large as possible on the front side and around 1250 ns on the back side
- G should be set at about 1/10 of L

Experimental conditions : depletion voltage

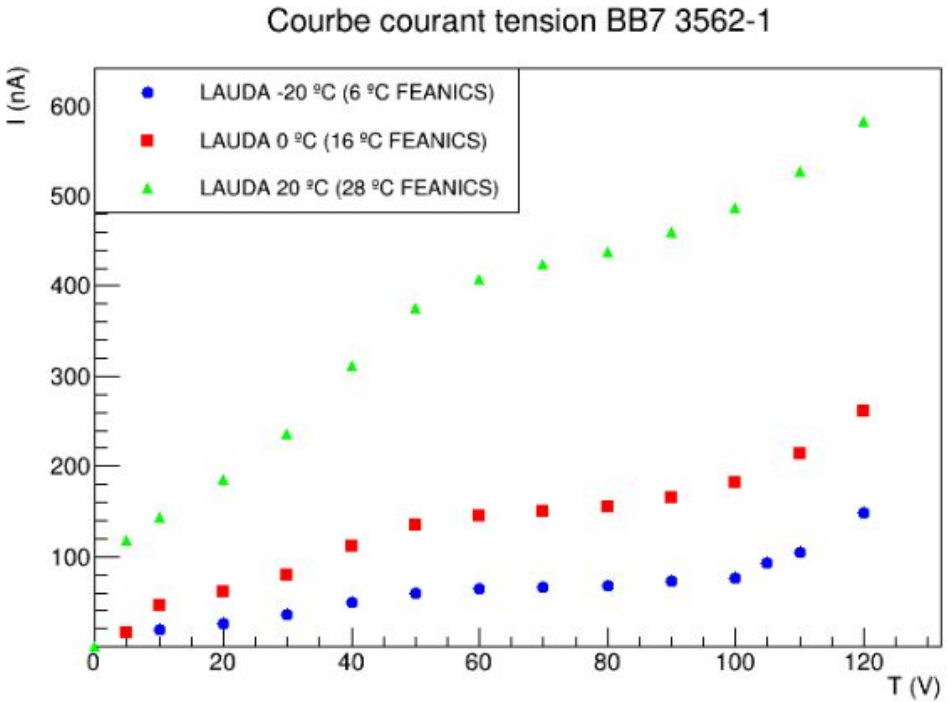
Current vs Voltage



Energy resolution (FWHM) vs voltage

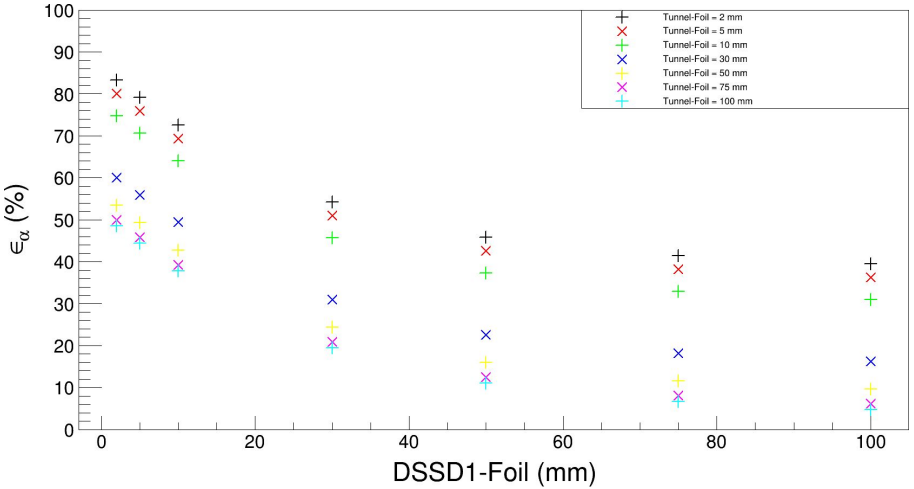


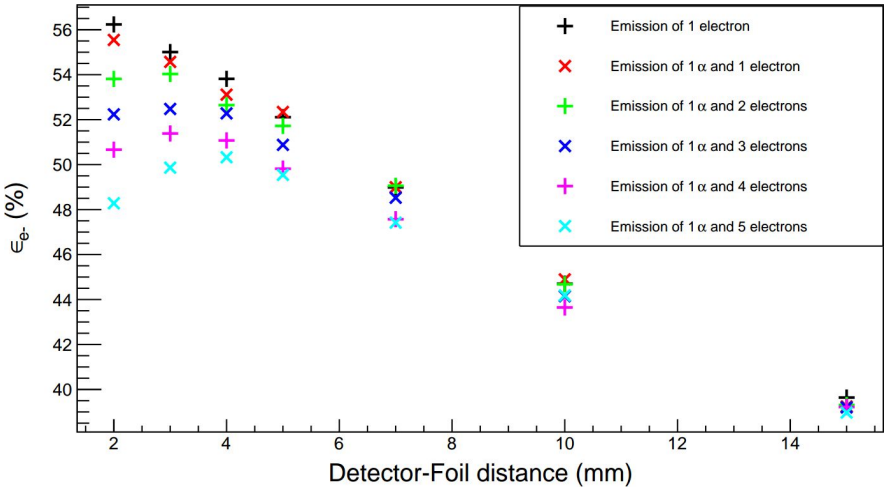
Leakage current comparison



High efficiency for both electron and α-particle

E. Rey-herme, PhD thesis (2023)



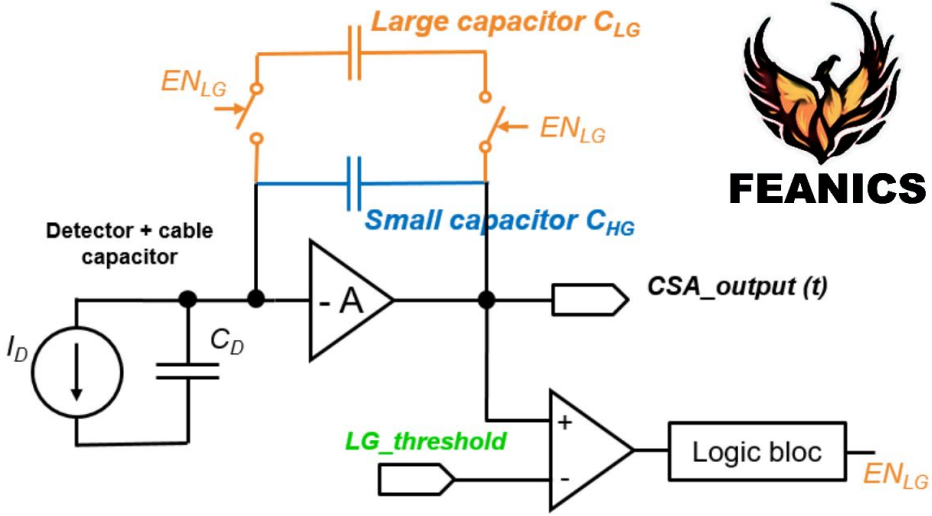


Most compact configuration:

Alpha efficiency = 84 %

Electron efficiency = 56 %

FEANICS



FEANICS

Front **E**nd **A**daptive gai**N** **I**ntegrated **C**ircuit**S**:

- double gain preamplifier with automatic gain switch
- CSA floor noise (no detector): ~2.3 keV variable threshold for gain switch
- can also be set to fixed gain

➔ Directly connected to the detector to limit the noise

➔ Outputs a differential signal to be sent to the digitizer

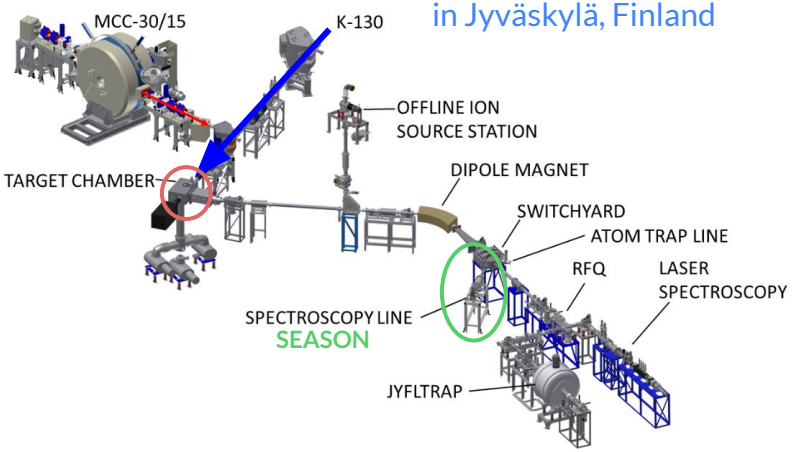
SEASON's commissioning experiment

1. proton beam onto ^{232}Th target
2. reaction of fusion evaporation
3. production of actinides
4. study of ^{225}Pa decay towards ^{221}Ac

$$^{232}\mathrm{Th(p,xn)}^{233\text{-}x}\mathrm{Pa}$$

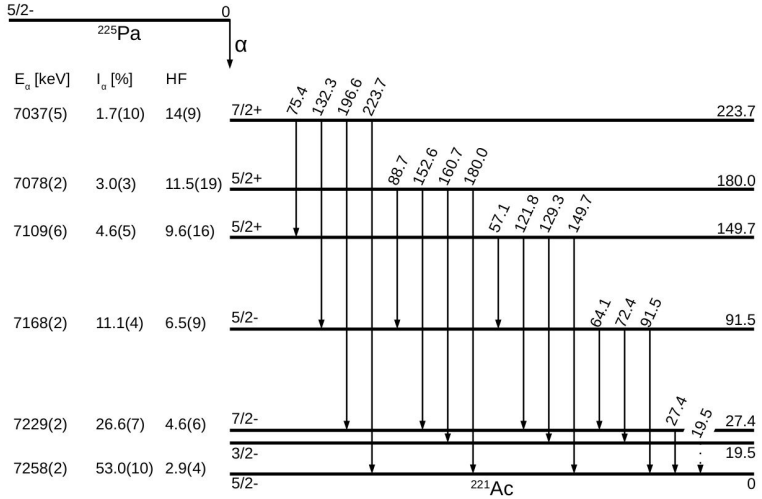
Considered experiments :
^{232}Th(α, xn)$^{236\text{-}x}$U
^{233}U(p, xn)$^{234\text{-}x}$Np
^{233}U(α, xn)$^{237\text{-}x}$Pu
Coupling with mass measurement (trap)

Layout of the IGISOL facility in Jyväskylä, Finland

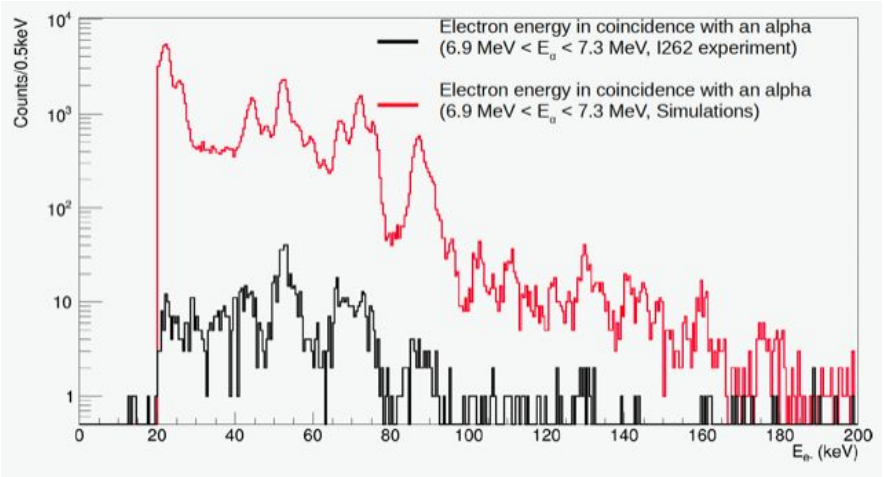


^{223}Pa α	^{224}Pa α	^{225}Pa α	^{226}Pa α	^{227}Pa α	^{228}Pa β+	^{229}Pa e- capture	^{230}Pa β+	^{231}Pa α	^{232}Pa β-	^{233}Pa β-
^{222}Th α	^{223}Th α	^{224}Th α	^{225}Th α	^{226}Th α	^{227}Th α	^{228}Th α	^{229}Th α	^{230}Th α	^{231}Th β-	^{232}Th α
^{221}Ac α	^{222}Ac α	^{223}Ac α	^{224}Ac β+	^{225}Ac α	^{226}Ac β-	^{227}Ac β-	^{228}Ac β-	^{229}Ac β-	^{230}Ac β-	^{231}Ac β-

Why this reaction ? $^{232}Th(p,xn)^{233-x}Pa$



E. Rey-herme, PhD thesis (2023)



- Use previous experimental results as a benchmark to characterize SEASON
- Improved efficiency => look for new transitions that were not visible before