SEASON commissioning
in Jyväskylä

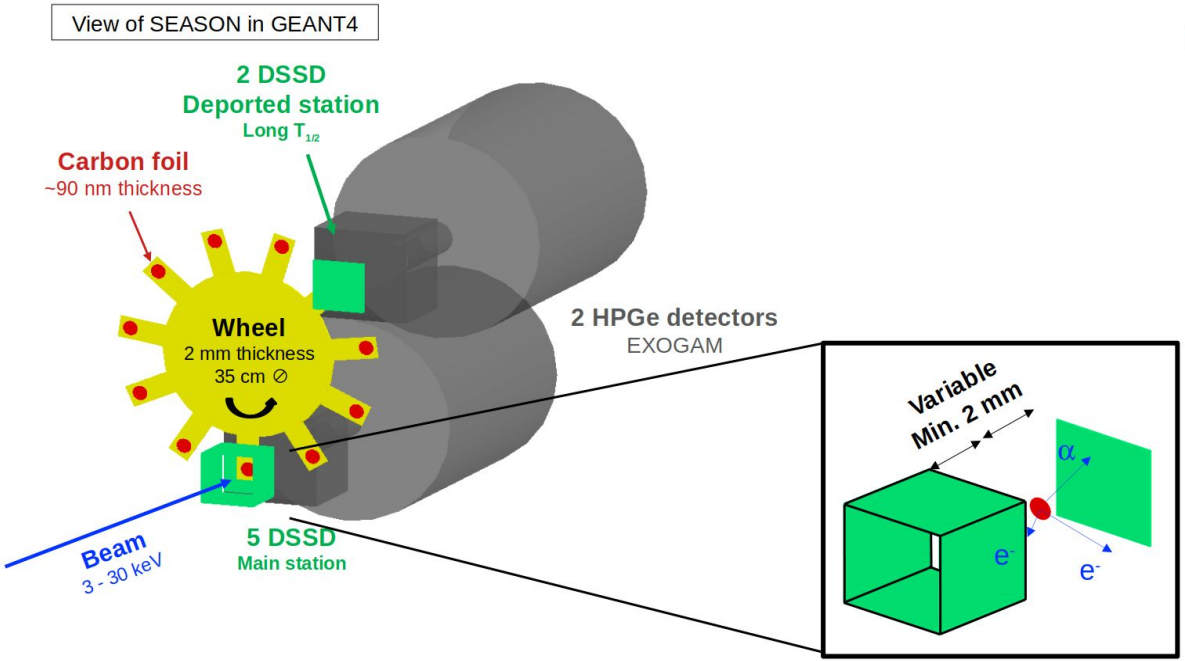
Mathilde Ragot

Supervisors : Damien Thisse
Marine Vandebrouck
Iain Moore

ISOL-France workshop - 17/03/2026

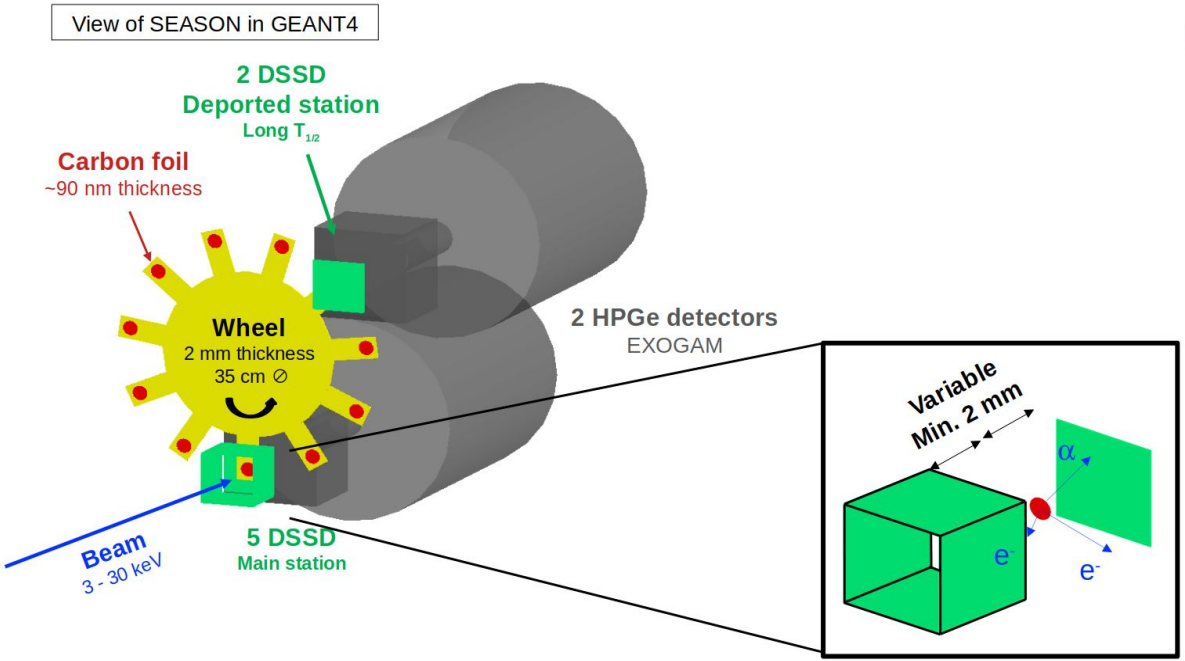
1 . SEASON introduction

SEASON scheme



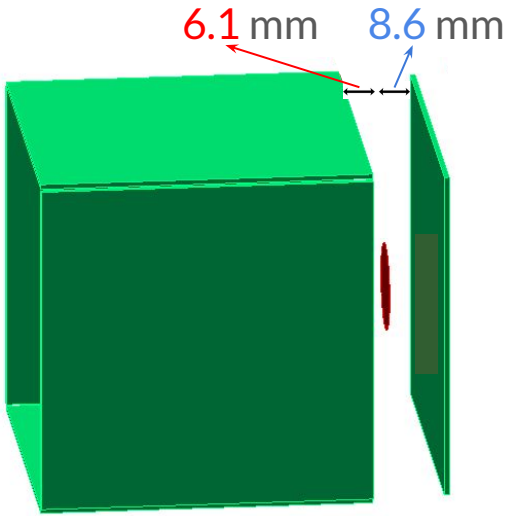
simulation done by Emmanuel Rey-herme

SEASON scheme

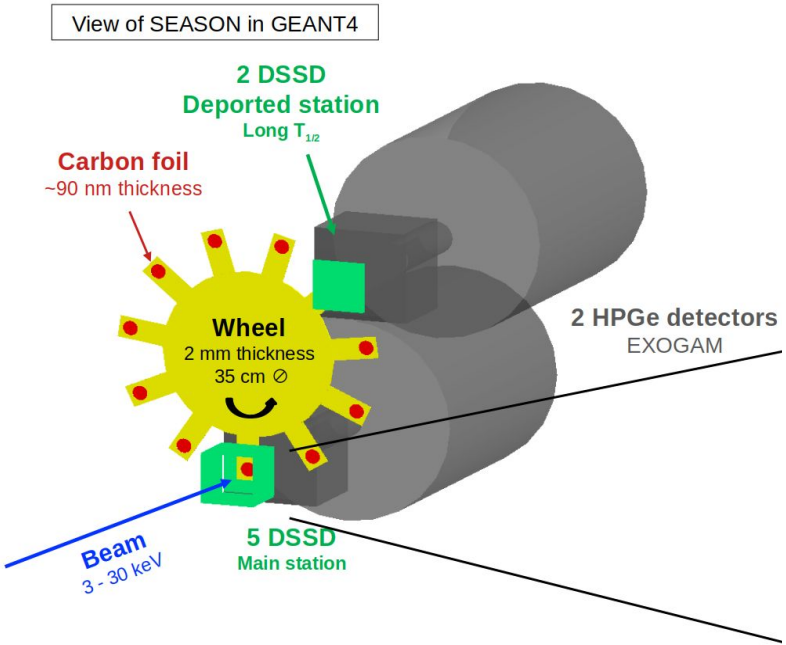


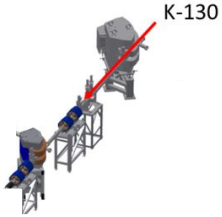
simulation done by Emmanuel Rey-herme

For now minimum distances reached :



SEASON at Jyväskylä

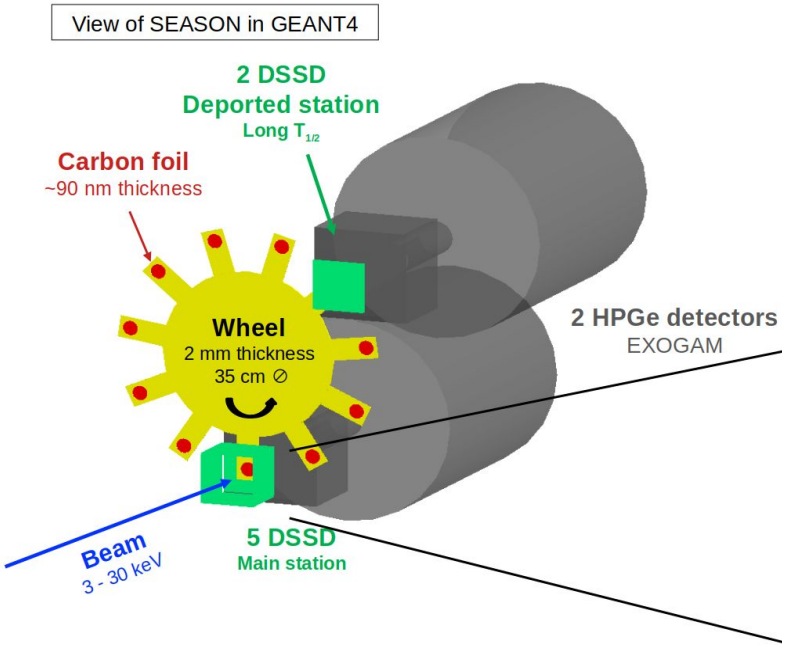




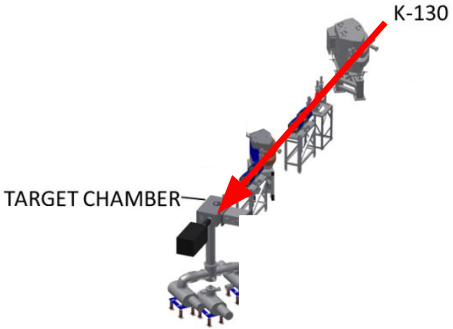
Layout of the IGISOL facility in Jyväskylä, Finland

simulation done by Emmanuel Rey-herme

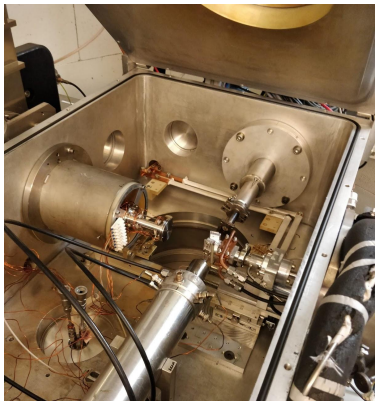
SEASON at Jyväskylä



simulation done by Emmanuel Rey-herme

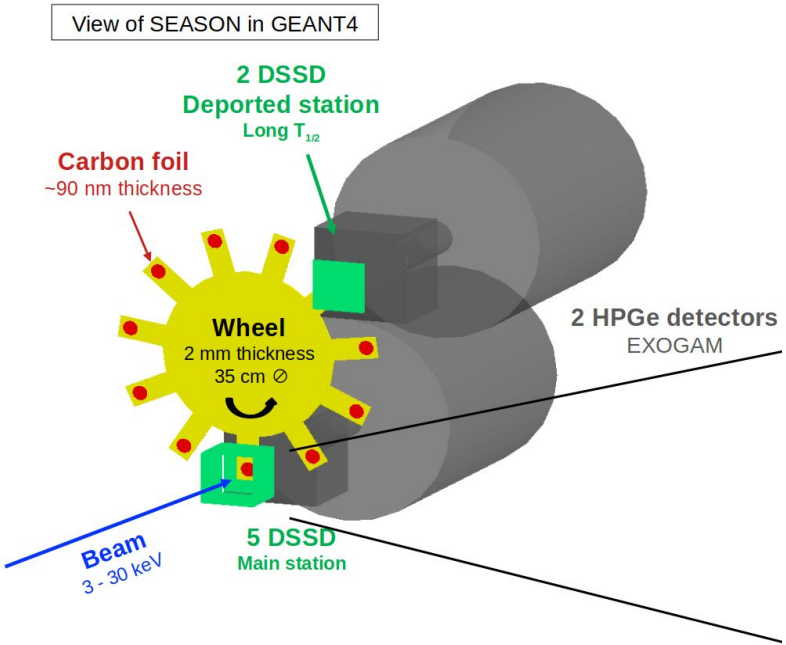


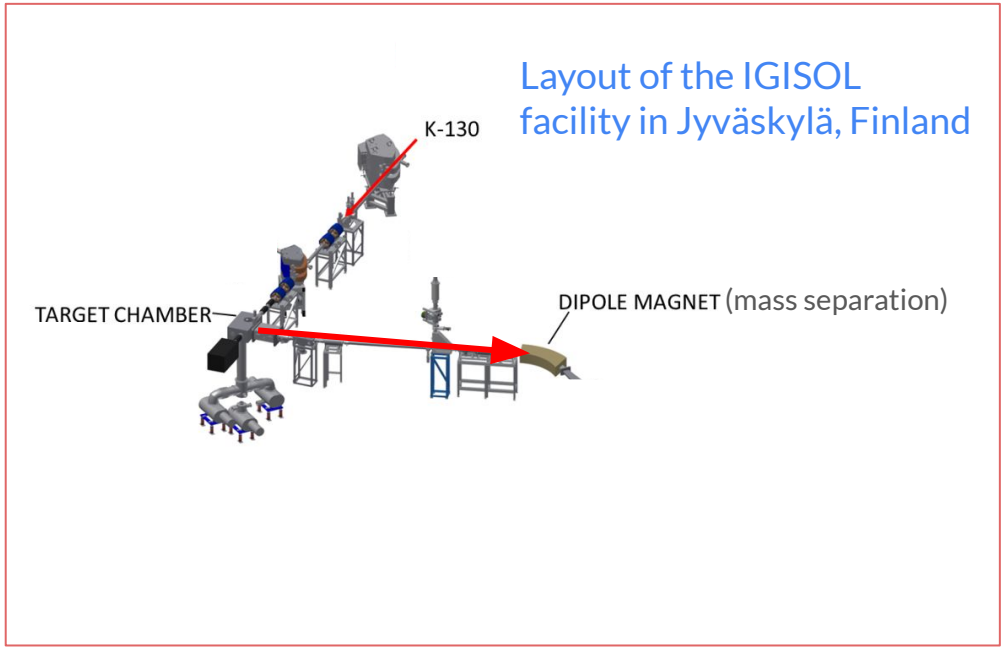
Layout of the IGISOL facility in Jyväskylä, Finland



target chamber

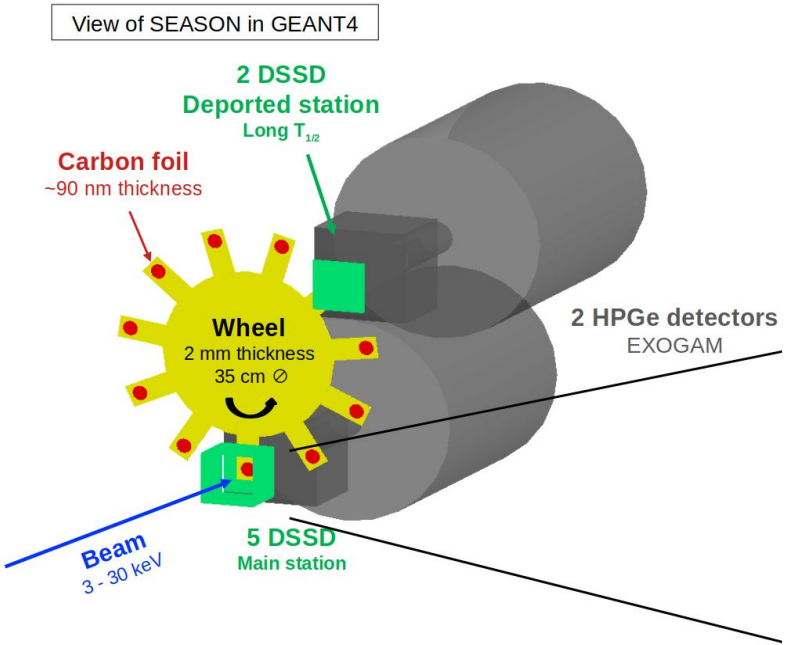
SEASON at Jyväskylä

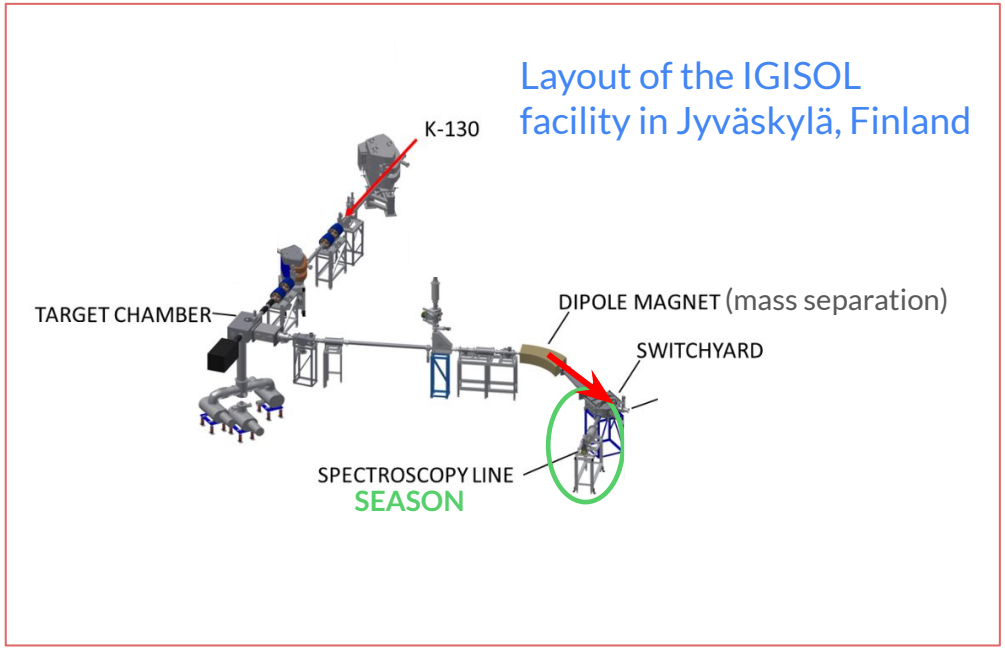




simulation done by Emmanuel Rey-herme

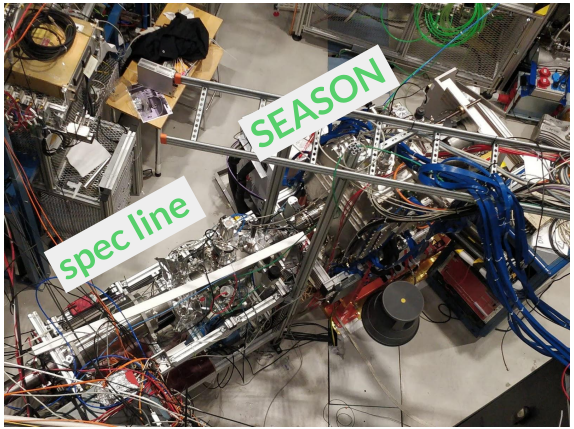
SEASON at Jyväskylä

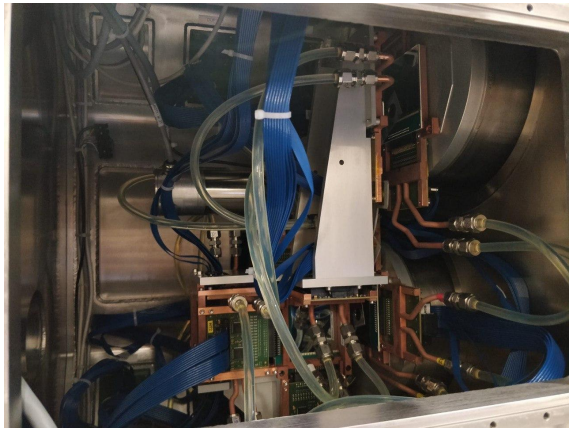


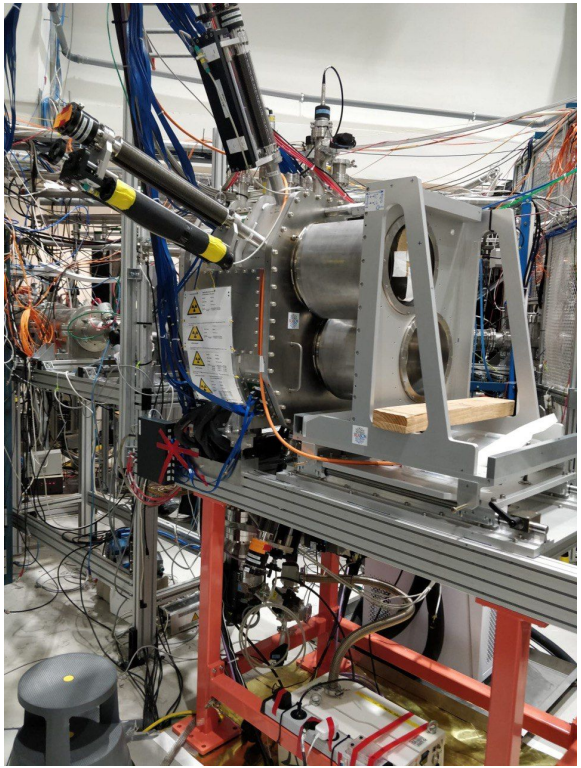


simulation done by Emmanuel Rey-herme

Mounting in Jyväskylä







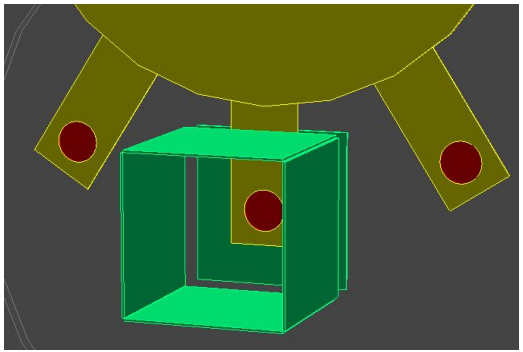
2. Commissioning in Jyväskylä

→ february 20th – february 27th

SEASON's commissioning experiment

Test of two FEANICS modes :

All detectors : automatic gain switch between α and e^-



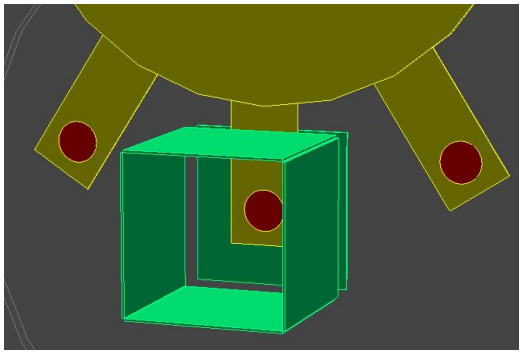
+ high efficiency

− noise level higher → resolution slightly degraded → higher energy threshold

SEASON's commissioning experiment

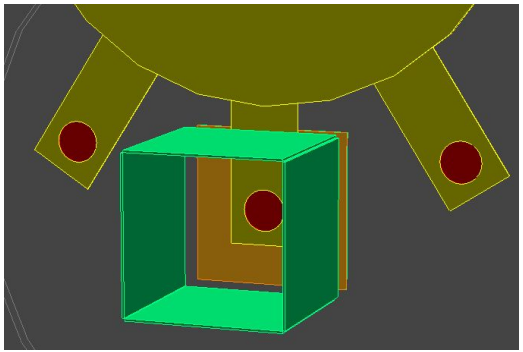
Test of two FEANICS modes :

All detectors : automatic gain switch between α and e^-



- ✚ high efficiency
- ▬ noise level higher → resolution slightly degraded → higher energy threshold

Fixed gain :
Main detector in a high gain mode,
Tunnel detectors in a low gain mode



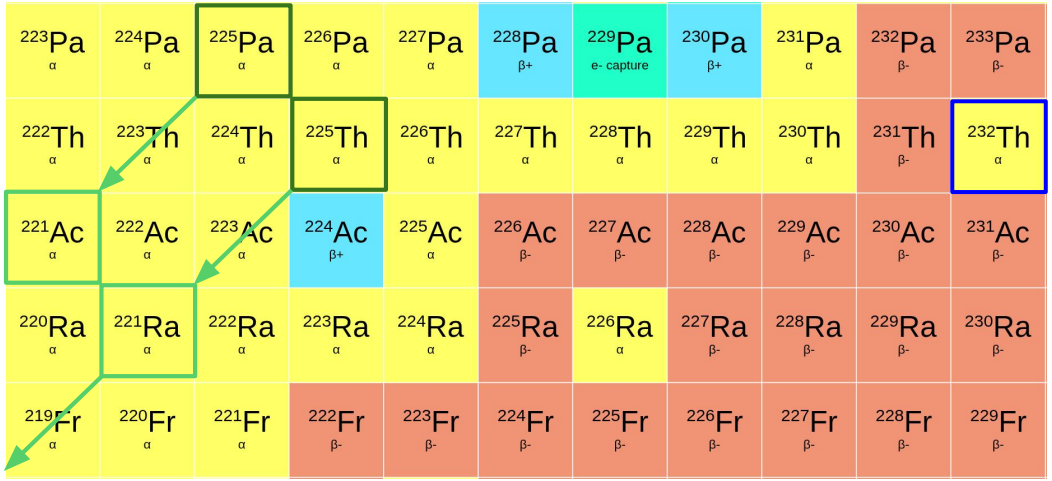
- ✚ less noisy → better resolution → lower energy threshold
- ▬ lower efficiency

SEASON's commissioning experiment

Reaction used : $^{232}Th(p,xn)^{233-x}Pa$

Beam time use :

- mass 225 : 40 hours

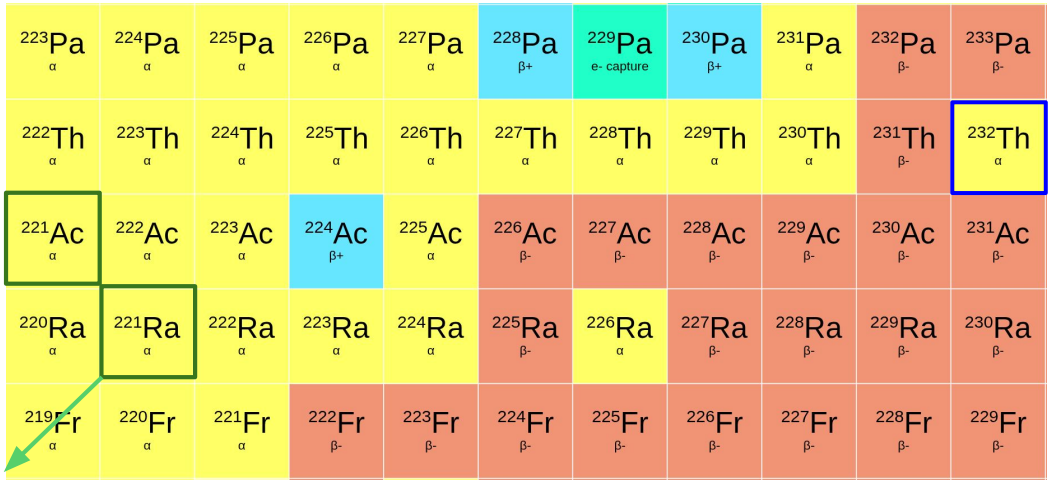


SEASON's commissioning experiment

Reaction used : $^{232}Th(p,xn)^{233-x}Pa$

Beam time use :

- mass 225 : 40 hours
- mass 221 : 32 hours

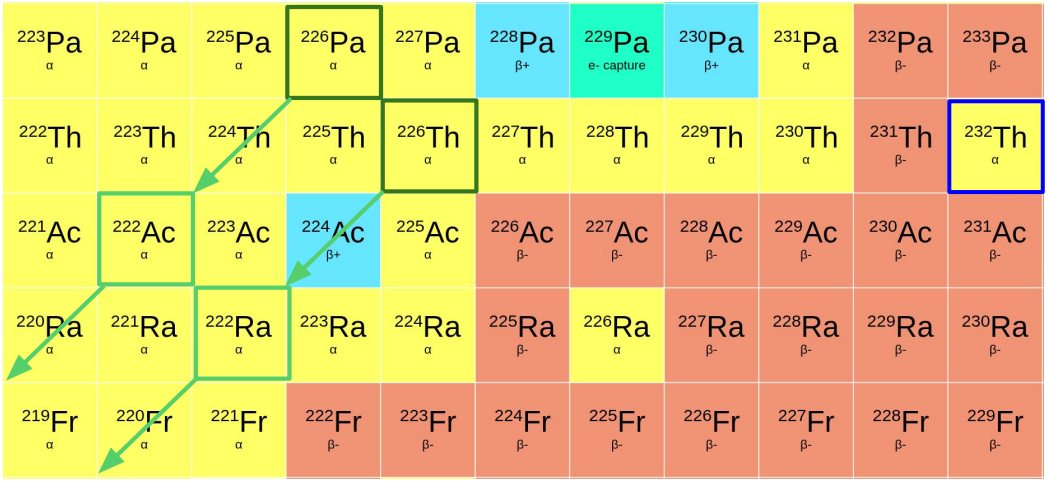


SEASON's commissioning experiment

Reaction used : $^{232}Th(p,xn)^{233-x}Pa$

Beam time use :

- mass 225 : 40 hours
- mass 221 : 32 hours
- mass 226 : 29 hours

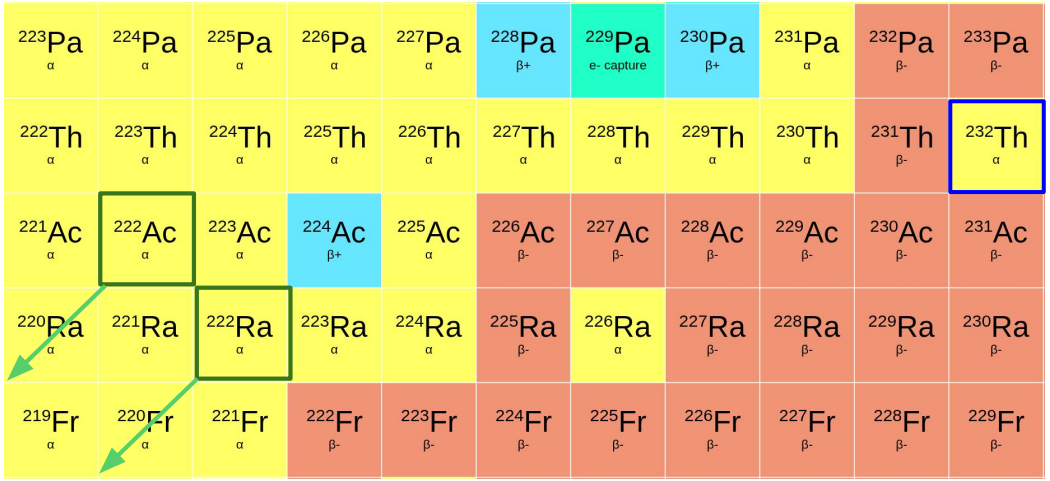


SEASON's commissioning experiment

Reaction used : $^{232}Th(p,xn)^{233-x}Pa$

Beam time use :

- mass 225 : 40 hours
- mass 221 : 32 hours
- mass 226 : 29 hours
- mass 222 : 12 hours

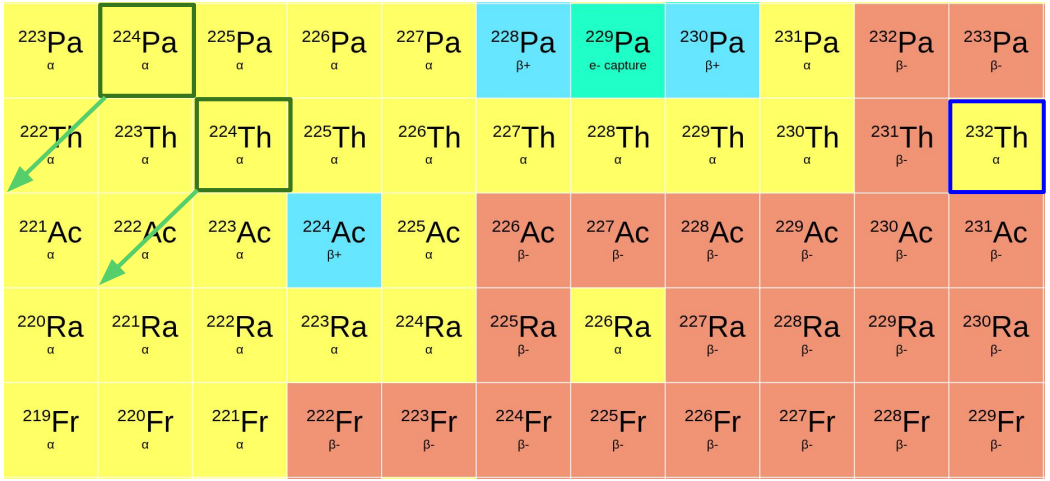


SEASON's commissioning experiment

Reaction used : $^{232}Th(p,xn)^{233-x}Pa$

Beam time use :

- mass 225 : 40 hours
- mass 221 : 32 hours
- mass 226 : 29 hours
- mass 222 : 12 hours
- mass 224 : 4.5 hours



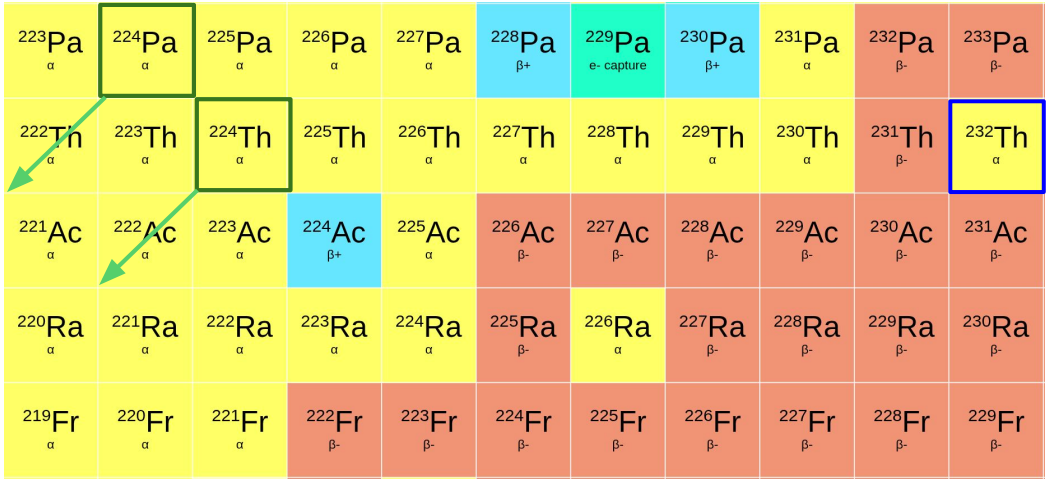
SEASON's commissioning experiment

Reaction used : $^{232}Th(p,xn)^{233-x}Pa$

Beam time use :

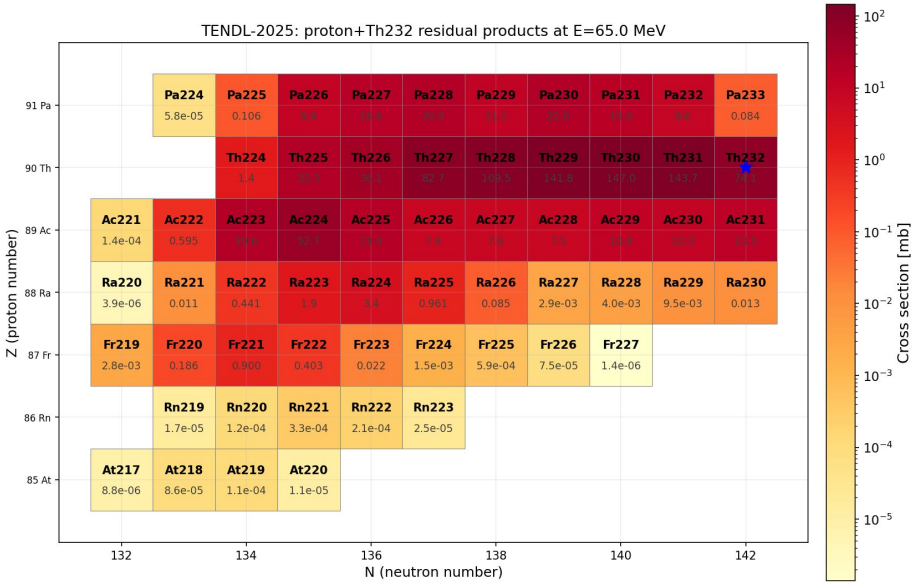
- mass 225 : 40 hours
- mass 221 : 32 hours
- mass 226 : 29 hours
- mass 222 : 12 hours
- mass 224 : 4.5 hours

Also tried ^{4}He beam



Test of the ^{4}He beam

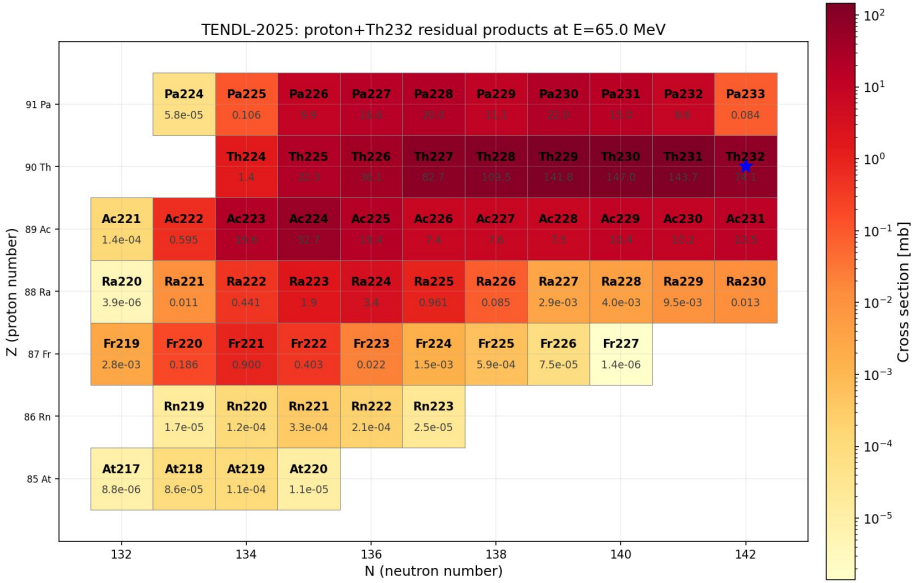
In principle :

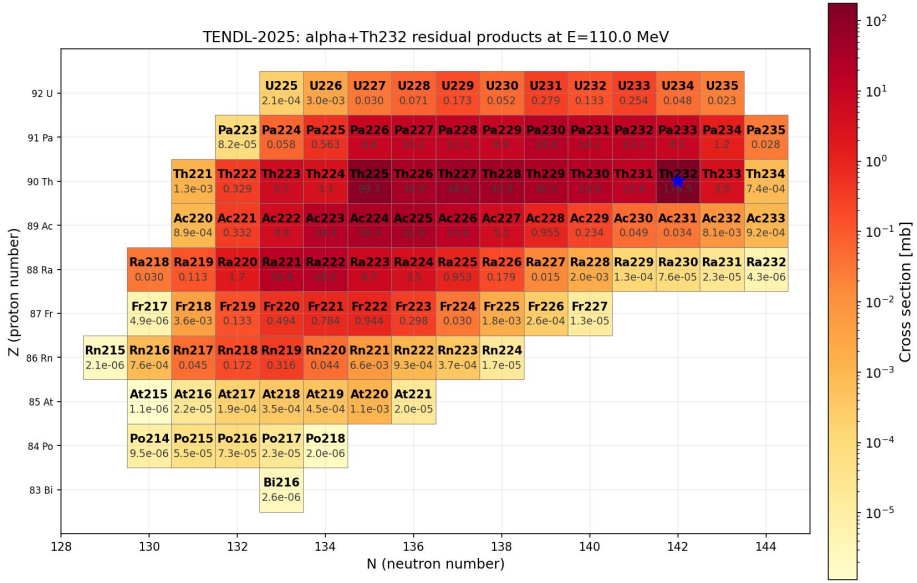


Figures by Emmanuel Rey-herme

Test of the ^{4}He beam

In principle :



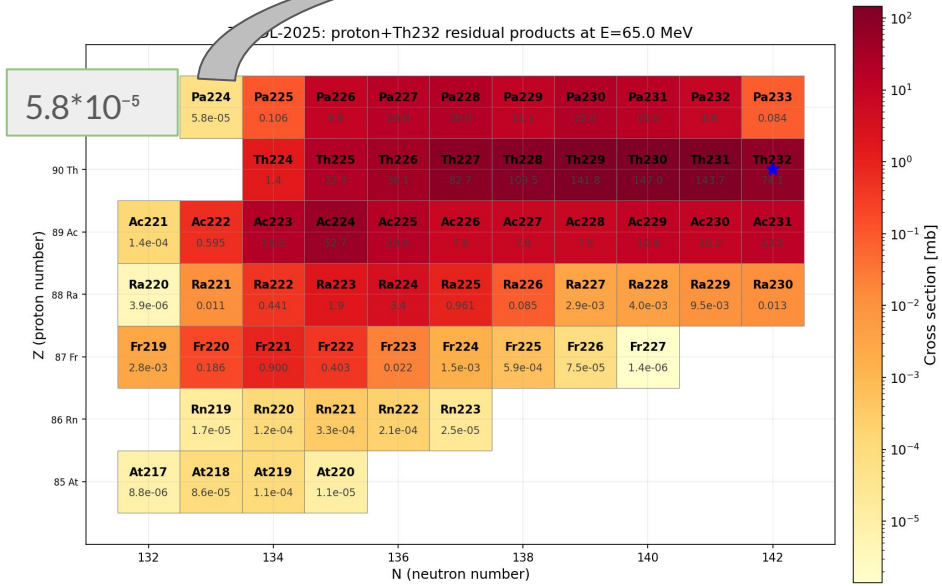


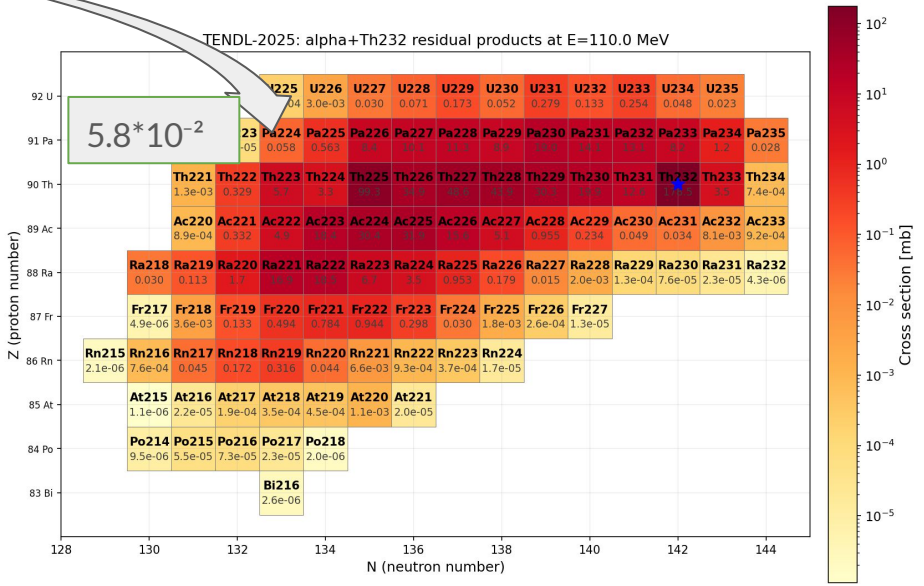
Figures by Emmanuel Rey-herme

Test of the ^{4}He beam

In principle :

x10^3



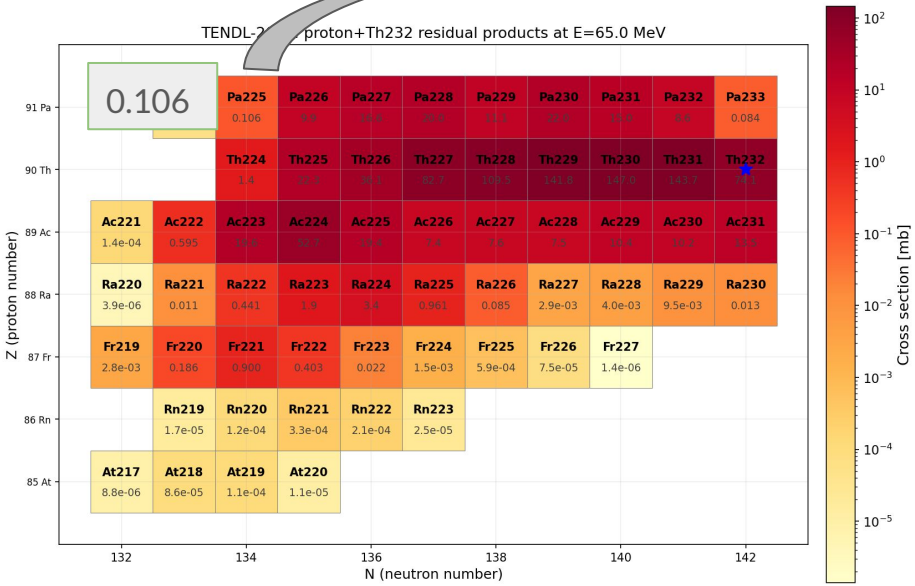


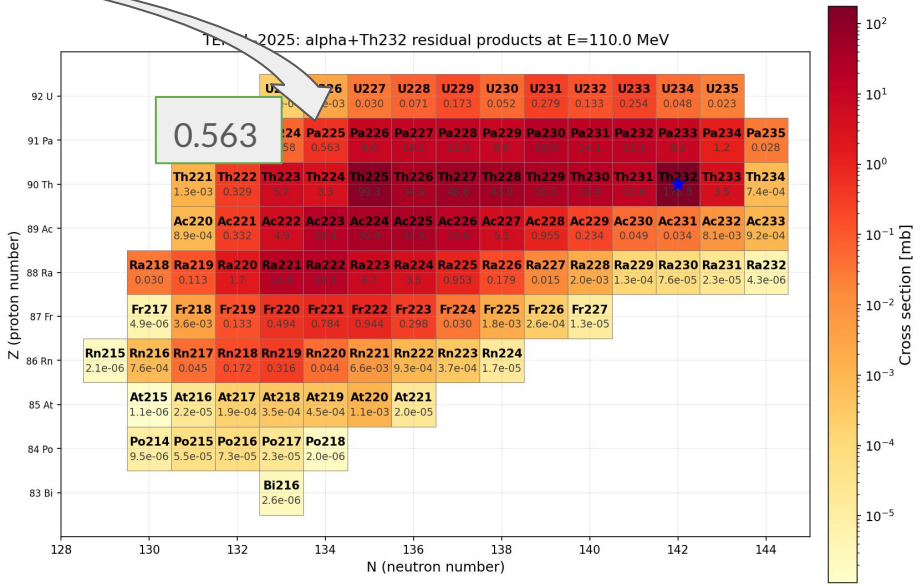
Figures by Emmanuel Rey-herme

Test of the ^{4}He beam

In principle :

x5





Figures by Emmanuel Rey-herme

3 Preliminary results of the online commissioning

Technical SEASON properties

In automatic gain switch mode :

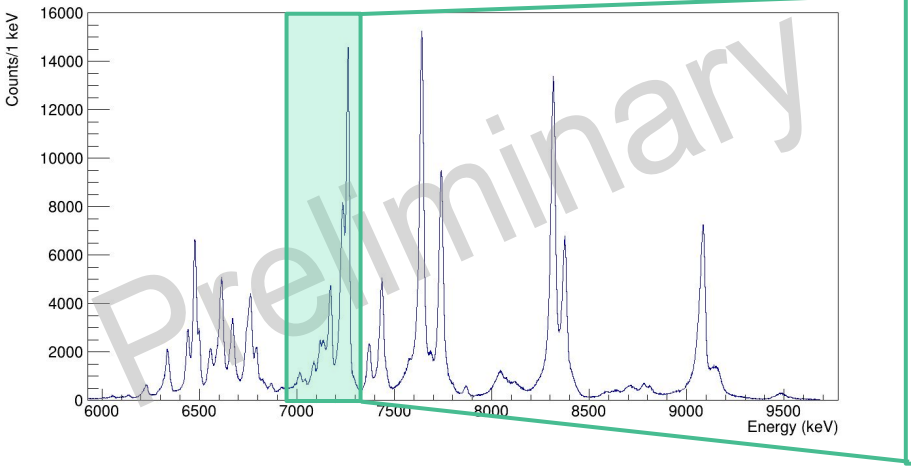
In conditions of the online commissioning experiment

	Energy resolution in main	Energy resolution in tunnels	Efficiency on Main	Efficiency in tunnels	Total efficiency
α-particle	~20 keV	**~18 keV**	~36%	~20%	**~56%**
electron	~14 keV	~14 keV	~23%	~18%	**~41%**

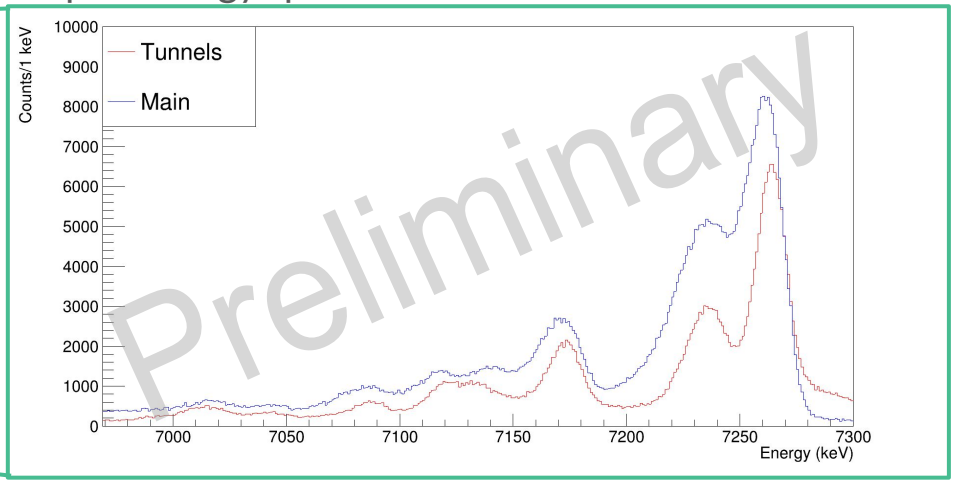
→ from mass 225 energy spectrum
→ from 3 α source measurements
→ from 133 Ba source measurements

Mass 225

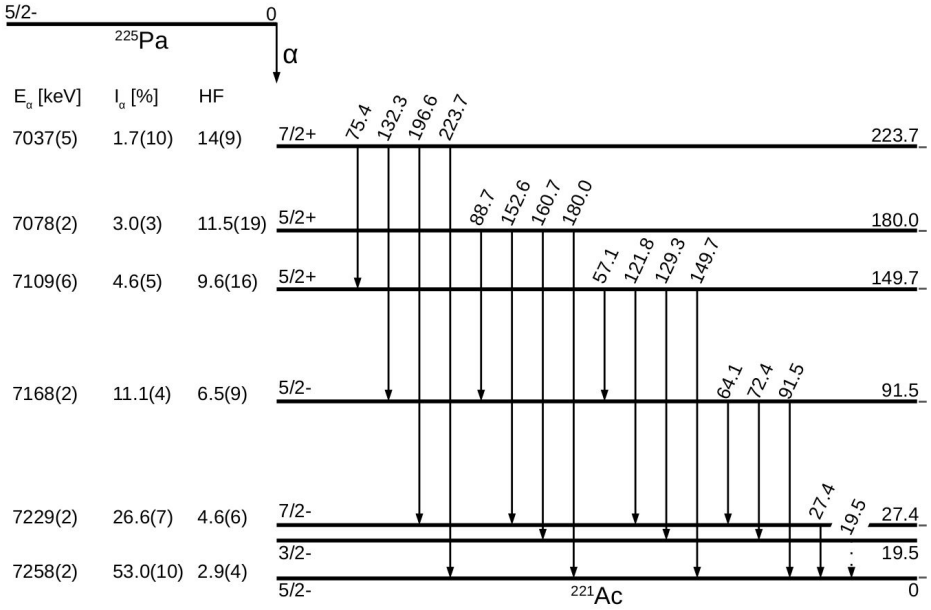
Alpha energy spectrum

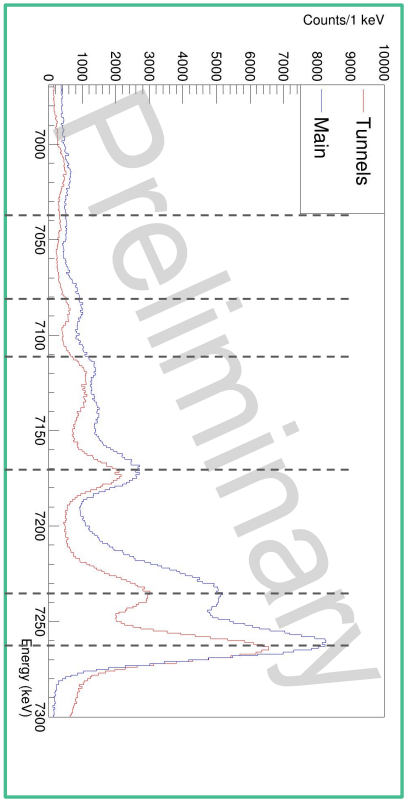


Alpha energy spectrum



Mass 225

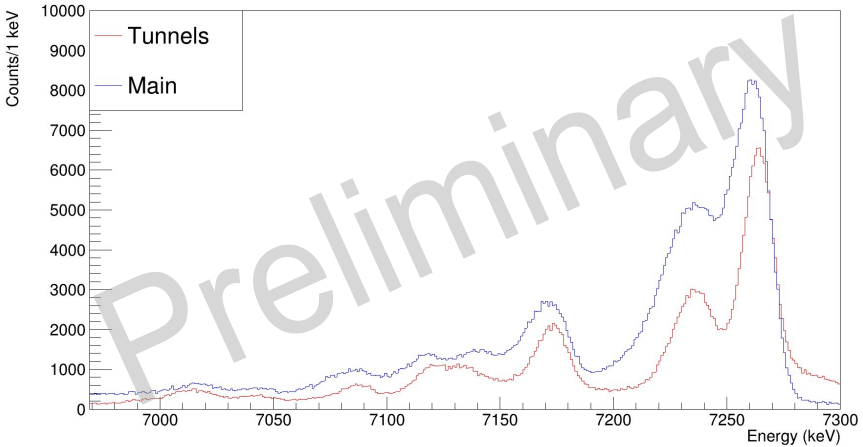




E. Rey-herme PhD thesis (2023)

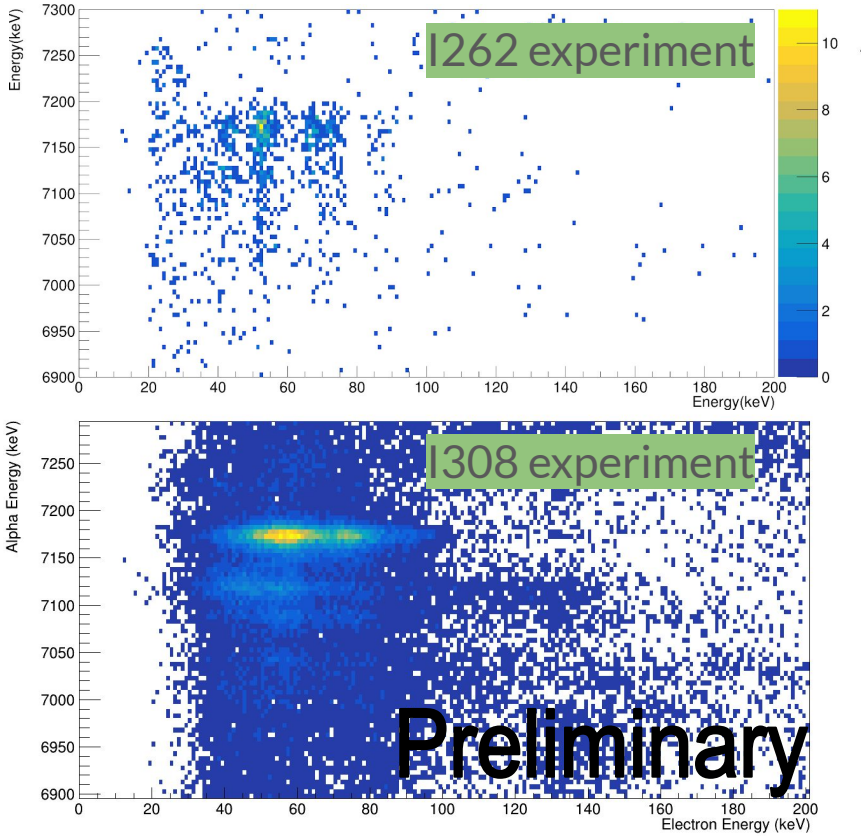
Mass 225 : study of ^{225}Pa

Alpha energy spectrum



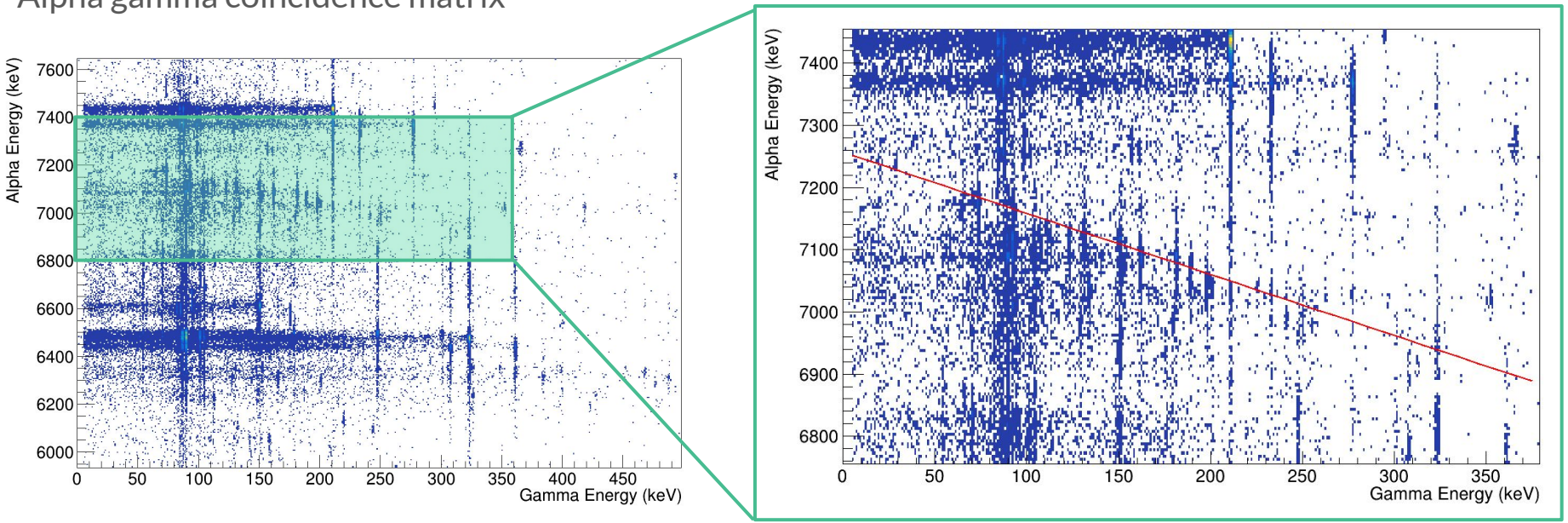
-> few issues of time alignment and energy resolution to be solved

Alpha electron coincidence matrix



Mass 225 : study of ^{225}Pa

Alpha gamma coincidence matrix



$$Q_\alpha + E_\gamma = Q_\alpha(gs\ to\ gs)$$

SEASON's schedule in 2026 - 2027

- 2 proposals have been submitted to the PAC of March at Jyväskylä :

Decay spectroscopy of Neptunium isotopes produced through the fusion-evaporation reaction ^{233}U(p, xn)$^{234-x}$Np with SEASON

D. Thisse[1], E. Rey-herme[1], M. Vandebrouck[1], M. Ragot[1], N. Abrassart[1], B. Sulignano[1], I. Moore[2], J. Sarèn[2], T. Eronen[2], A. Kankainen[2], A. Raggio[3], S. Pineda[4], D. Renisch[5,6], C. Düllmann[5,6,7], S. Lecanuet[8], the IGISOL group[2], and the SEASON collaboration[1]

Decay spectroscopy of ^{223}Pa produced through the fusion-evaporation reaction ^{230}Th(p, xn)$^{231-x}$Pa with SEASON

E. Rey-herme[1], D. Thisse[1], M. Vandebrouck[1], M. Ragot[1], N. Abrassart[1], I. Moore[2], Ch. E. Düllmann[3,4,5], T. Eronen[2], A. Kankainen[2], S. Lecanuet[6], S. Pineda[7], A. Raggio[8], D. Renisch[3,4], J. Sarén[2], B. Sulignano[1], et al.[0], the IGISOL group[2], and the SEASON collaboration[1]

- From september : **SEASON will be available for anybody to propose an experiment at the PAC**

Thank you !

Jyväskylä
Natalia Ambrosio, Theodore Davids, Tommi Eronen, Zhuang Ge, Anu Kankainen, Brian Koote, Iain Moore, Prince Parvez, Simon Rausch, Mikael Reponen, Alexandre Roger, Jan Saren

GSI
Sebastian Raeder

IJCLab
Matthieu Lebois

LP2iB
Samuel Lecanuet

LPC Caen
Skyy Pineda

GANIL
Margarida Paulino

KU Leuven
Andrea Raggio

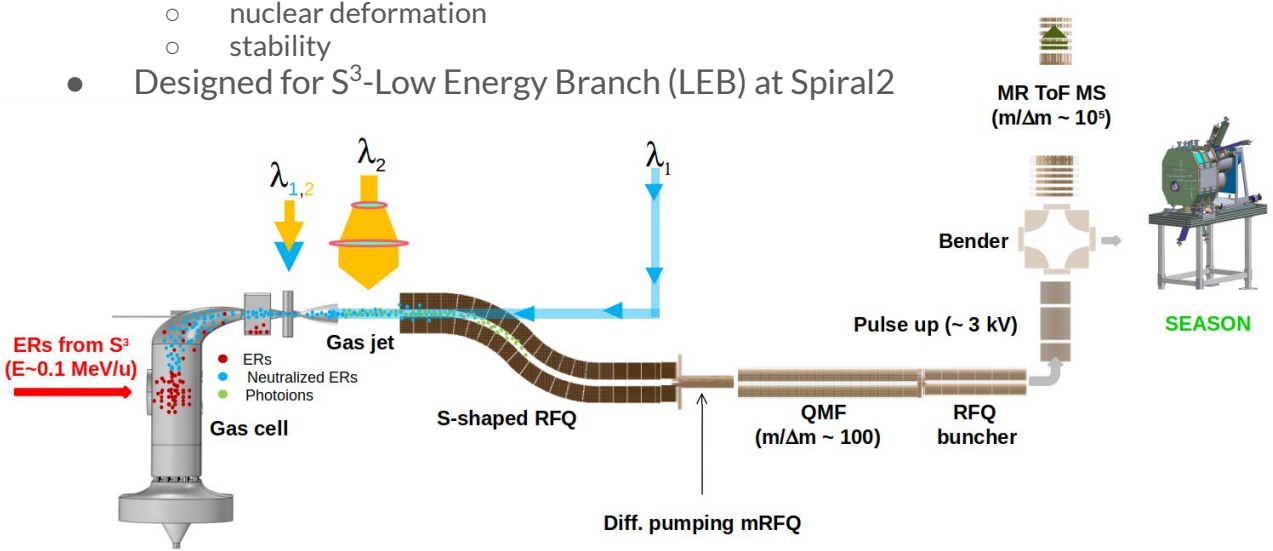
CEA
Damien Thisse, Léonard Jost, Emmanuel Rey-herme, Kilian Ronxin, Barbara Sulignano, Marine Vandebrouck

SEASON development team :
Project Managers :
O. Cloué (technic)
D. Thisse (scientific)
Mechanical conception :
S. Cazaux, P. Daniel-Thomas
Detection/Acquisition :
F. Bouyjou, T. Chaminade, Jules Dartois
Control & Command :
A. Gaget, J. Relland, A. Roger, S. Tzvetkov, T. Joannem
Electrical engineering :
J. Noury, Y. Reinert, J. Mendes Ribeiro

Back-up

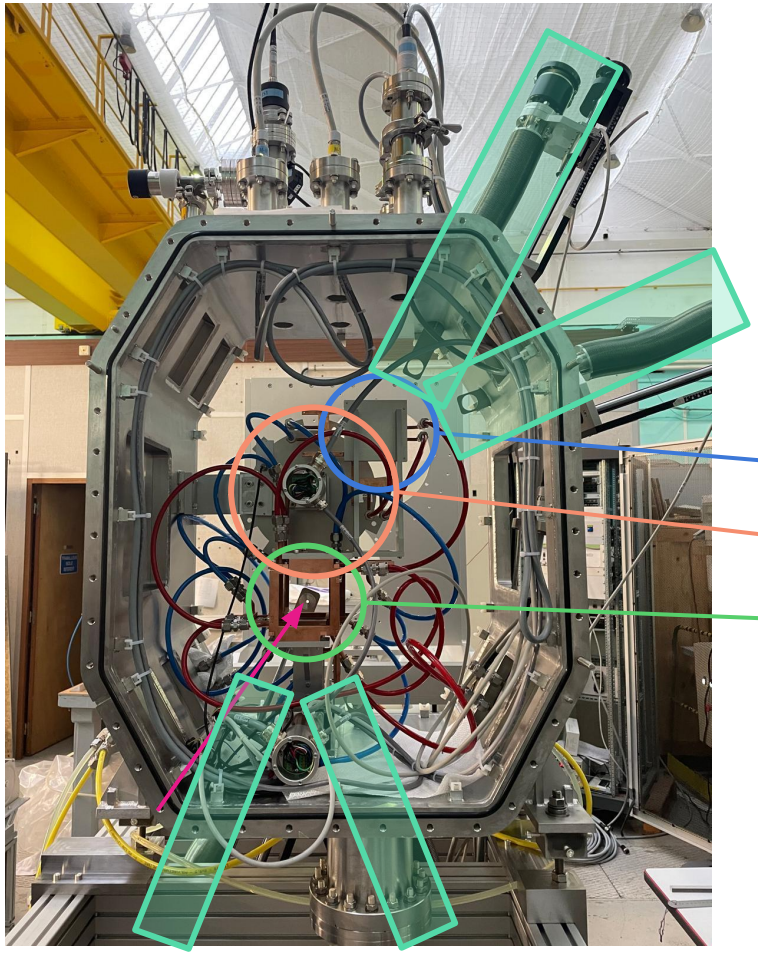
SEASON's at GANIL

- 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



beam direction

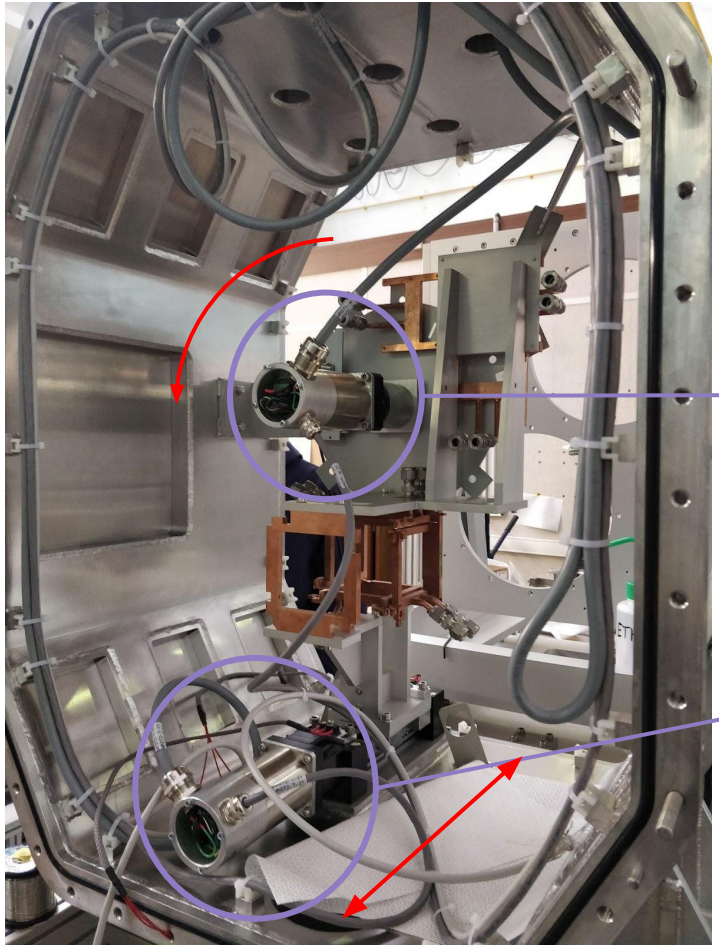
deported station

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.

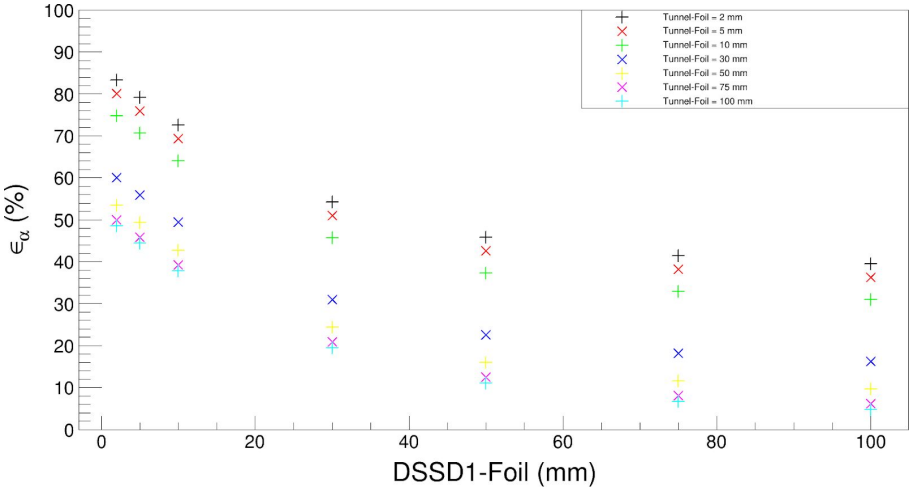


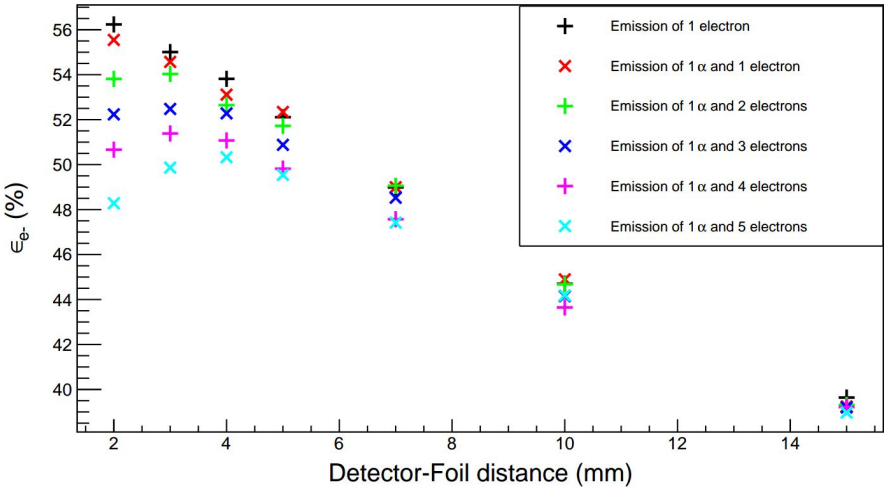
motor to rotate the wheel

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

High efficiency for both electron and α-particle

E. Rey-herme, PhD thesis (2023)



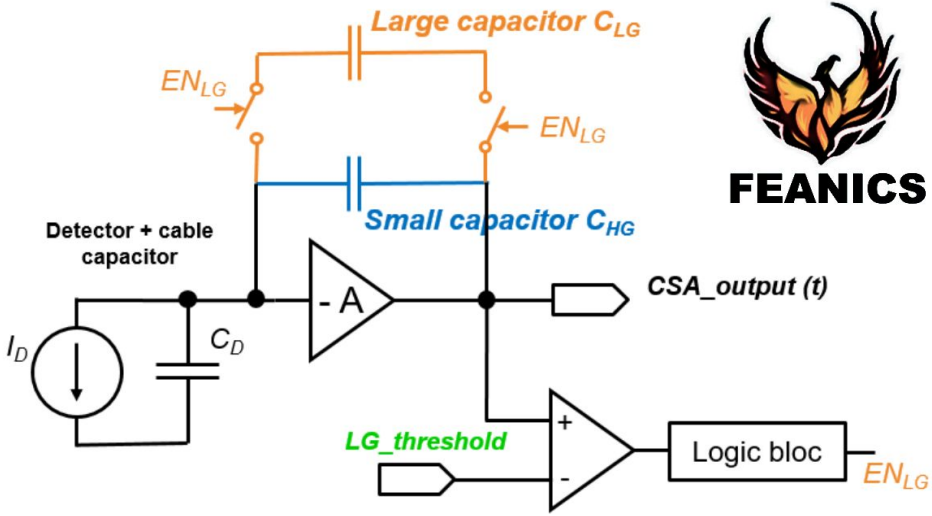


Most compact configuration:

Alpha efficiency = 84 %

Electron efficiency = 56 %

FEANICS



FEANICS

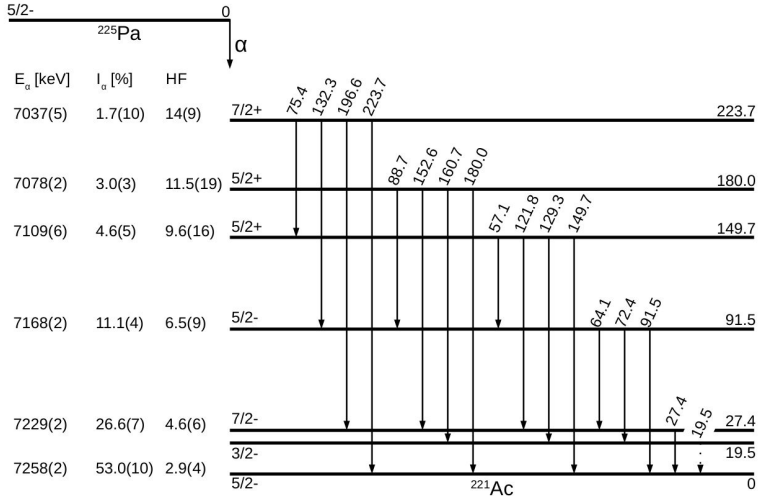
Front **E**nd **A**daptive gai**N** **I**ntegrated **C**ircuit**S**:

- 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

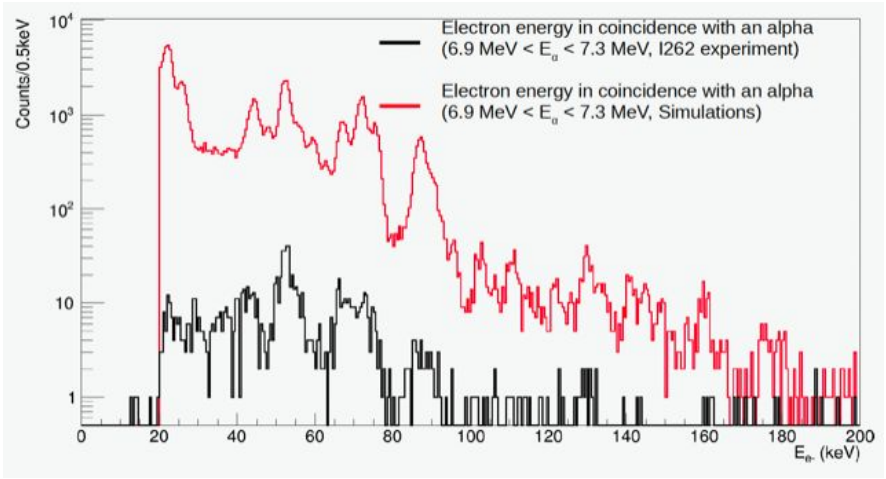
➔ Directly connected to the detector to limit the noise

➔ Outputs a differential signal to be sent to the digitizer

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