

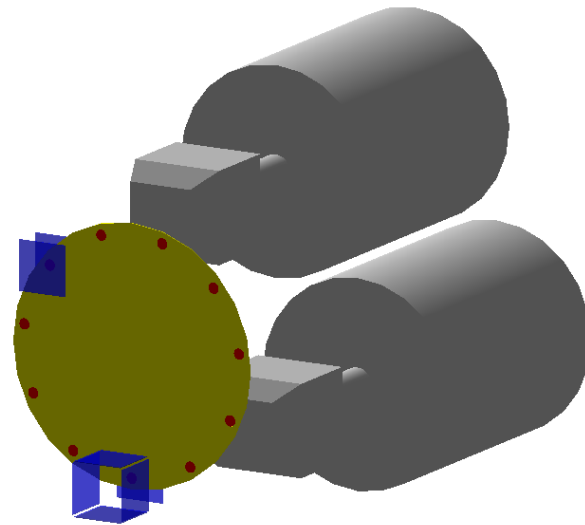
DE LA RECHERCHE À L'INDUSTRIE

cea



SEASON :

**Development of a new
detector for S3-LEB**



Emmanuel Rey-herme CEA/Irfu/DPhN

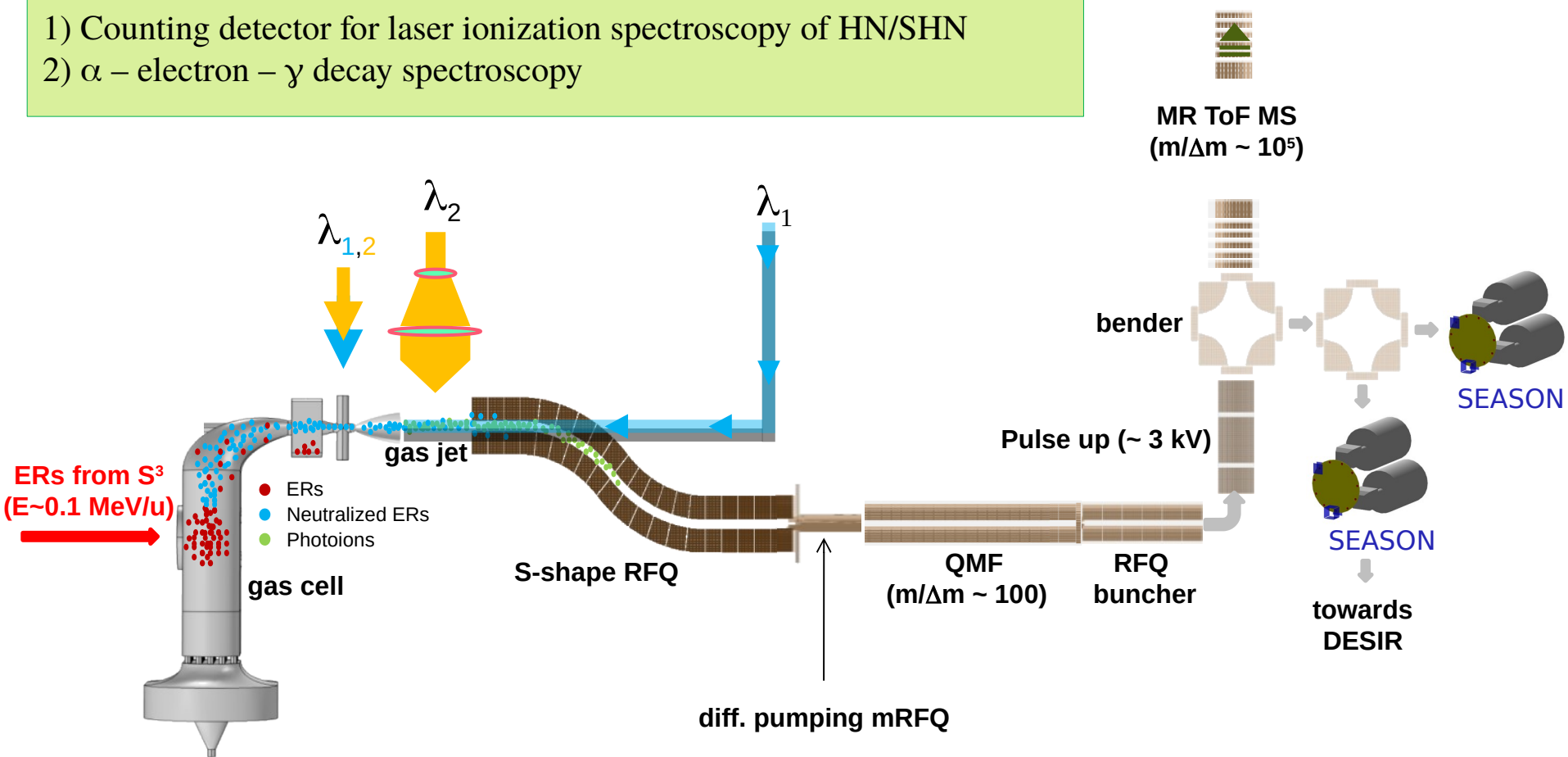
ISOL-France Meeting
March 2021

ANR
AGENCE
NATIONALE
DE LA
RECHERCHE

SEASON

(Spectroscopy Electron Alpha in Silicon bOx couNter)

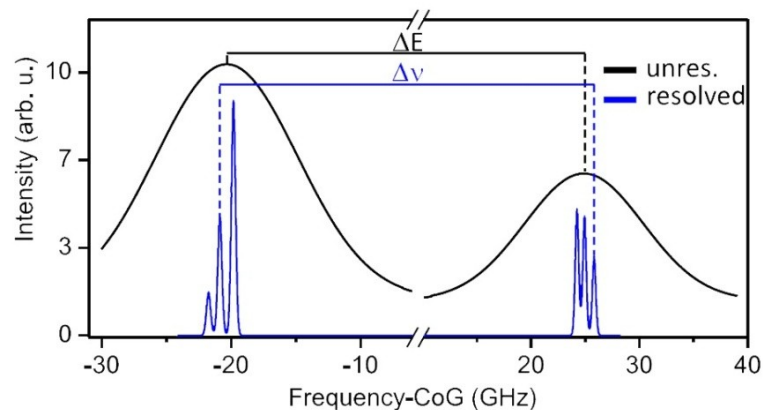
- 1) Counting detector for laser ionization spectroscopy of HN/SHN
- 2) α – electron – γ decay spectroscopy



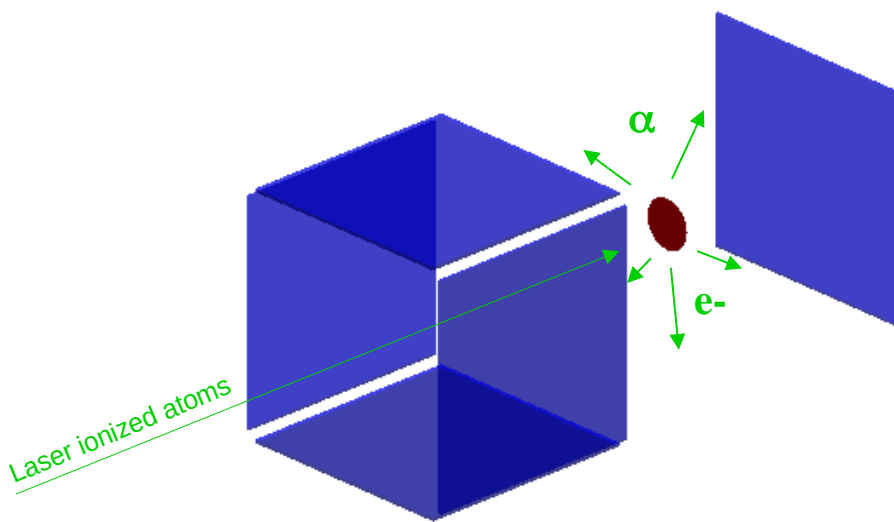
Goal 1: counting the laser ionized atoms with the best efficiency for each laser frequency

Technical constraints: ions energy (3 – 30 keV)

⇒ Implantation in C/Si₃N₄ foil + detection of particle decay
(α or electrons) in Si



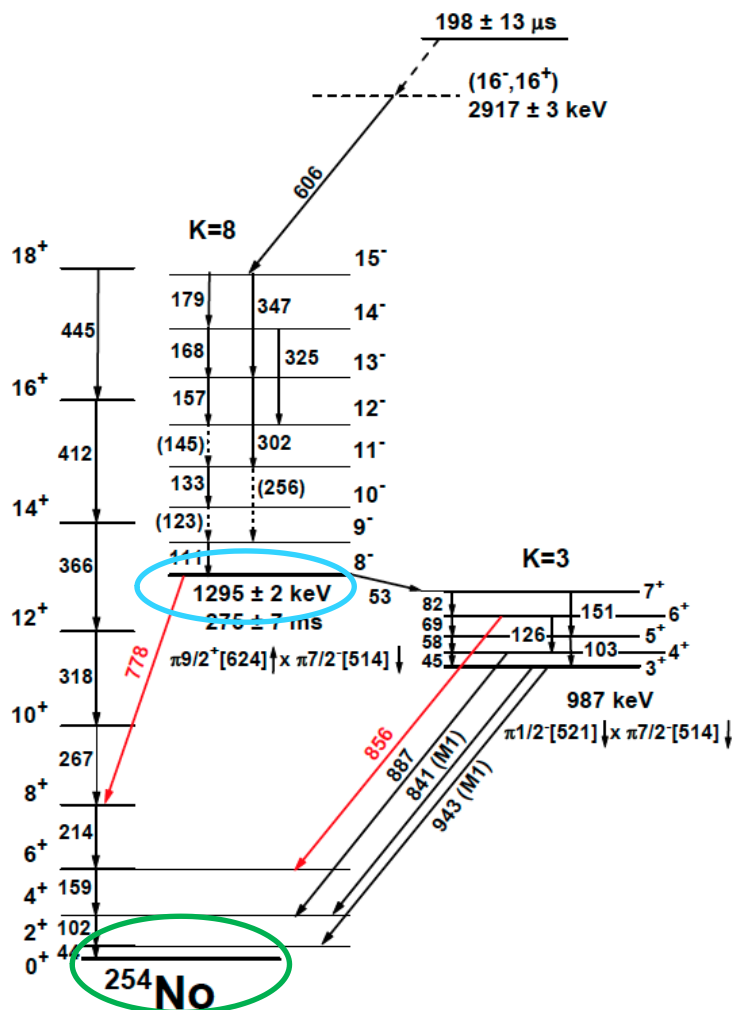
R. Ferrer *et al.*, PLB 728(2014)



5 Si detectors (BB7 from Micron)

- ✓ Thickness: 1 mm
- ✓ Active area: 64 x 64 mm²

Goal 2: perform α – electron – γ decay spectroscopy

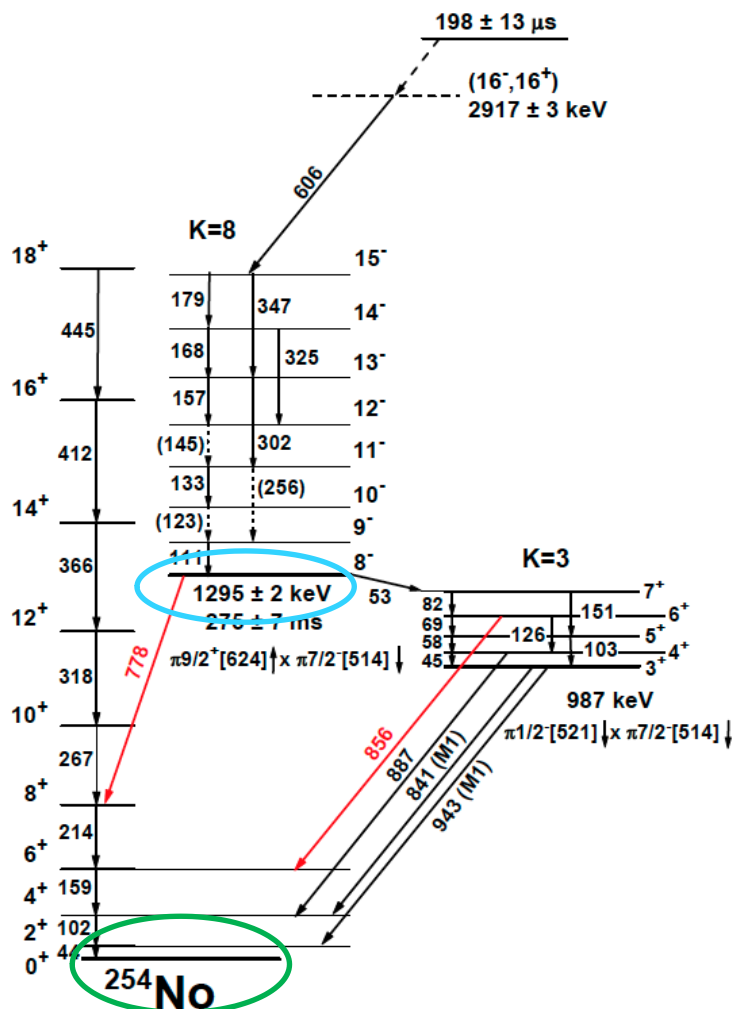


F. P. Heberger *et al.*, EPJA **43**(2010)

Laser ionization spectroscopy of the isomeric state ($T_{1/2} = 275$ ms)
 Counting of conversion e-
 Range $E_e = 20 - 600$ keV

Laser ionization spectroscopy of the ground state ($T_{1/2} = 55$ s)
 Counting of α particles
 Range $E_\alpha = 5 - 12$ MeV

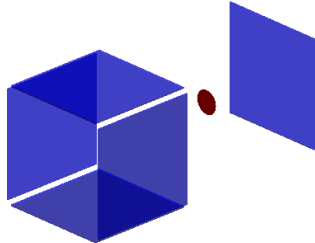
Goal 2: perform α – electron – γ decay spectroscopy



Laser ionization spectroscopy of the isomeric state ($T_{1/2} = 275$ ms)
Counting of conversion e-
Range $E_c = 20 - 600$ keV

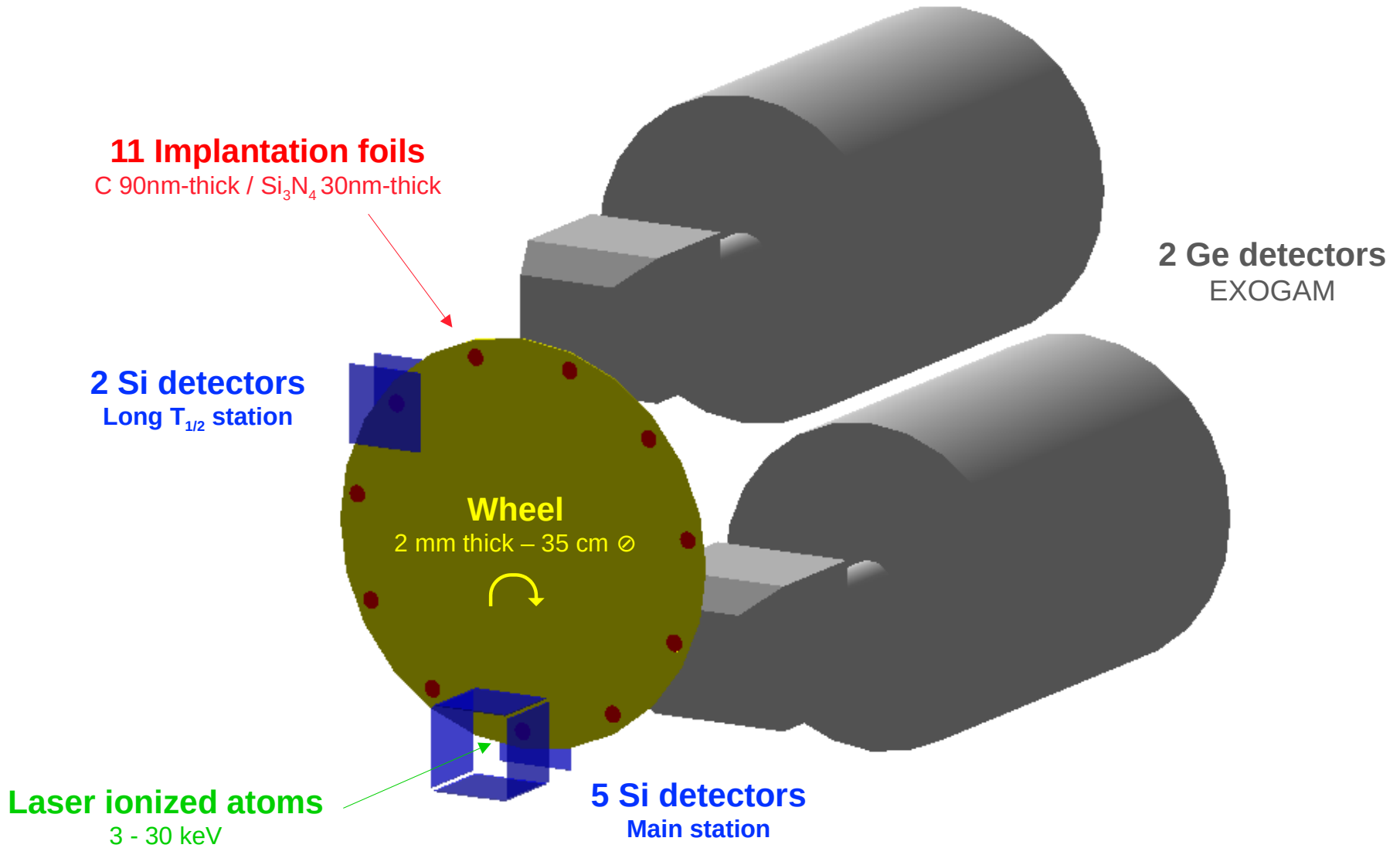
Laser ionization spectroscopy of the ground state ($T_{1/2} = 55$ s)
Counting of α particles
Range $E_\alpha = 5 - 12$ MeV

Energy resolution (FWHM)	15 keV (α from 5 MeV to 12 MeV) 7 keV (electron from 20 keV to 600 keV)
Energy threshold	20 keV
Time resolution (FWHM)	20 ns



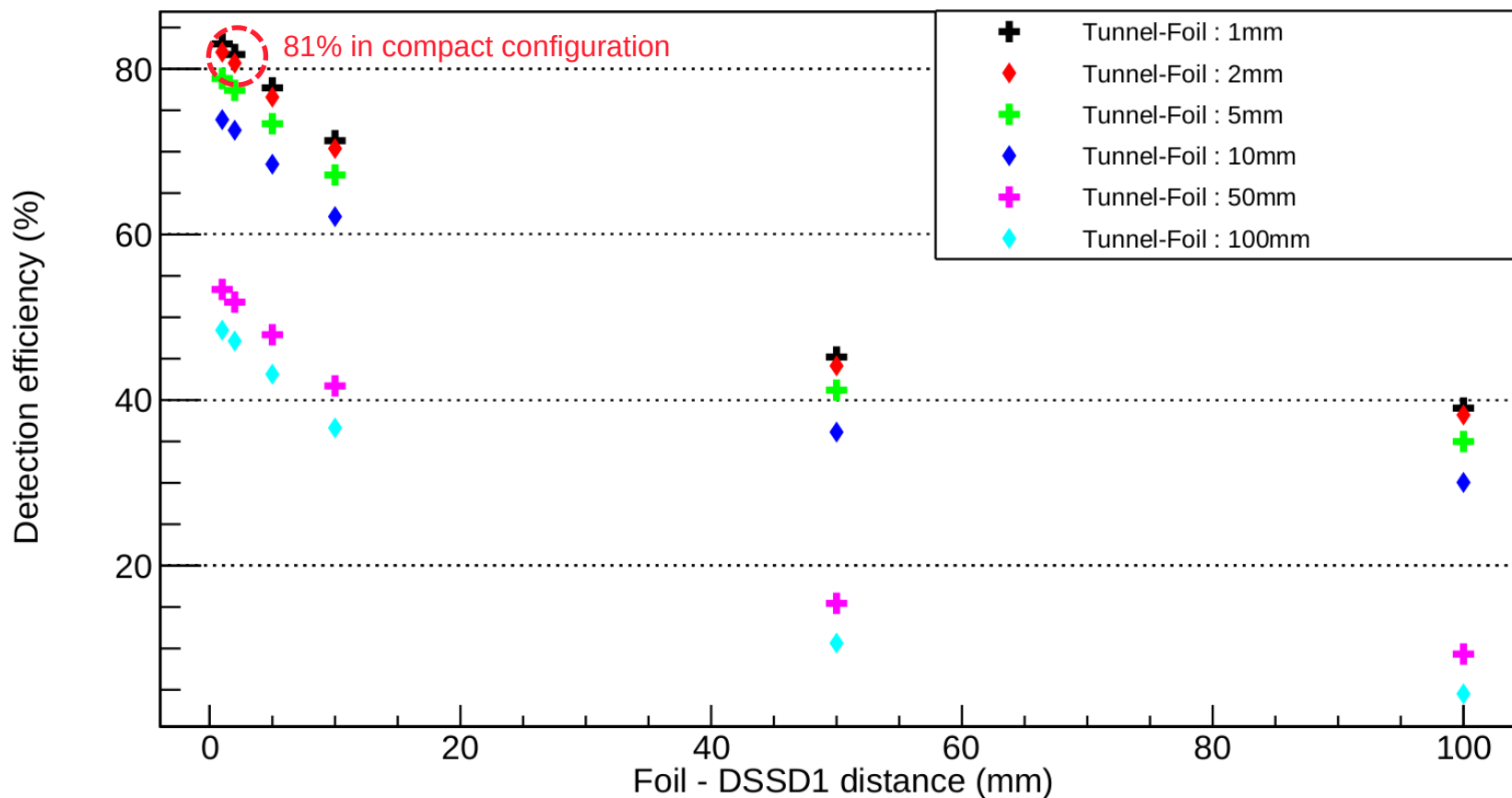
- 5 Si detectors (BB7 from Micron)**
- ✓ Thickness: 1 mm
 - ✓ Active area: 64 x 64 mm²
 - ✓ Number of strips: 32 x 32
 - ✓ Strip pitch: 2 mm

F. P. Heberger *et al.*, EPJA **43**(2010)



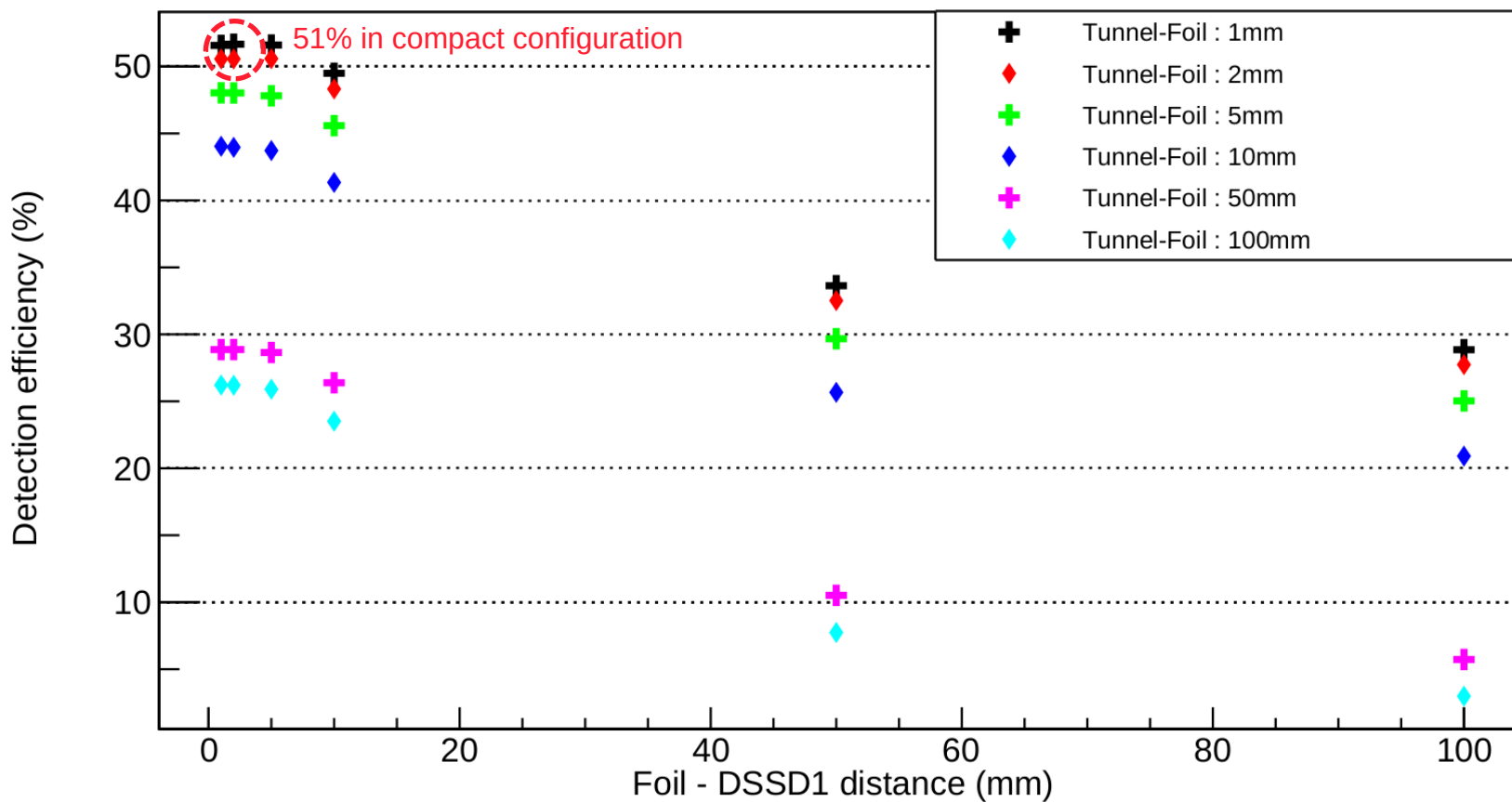
NPTool (A. Matta *et al.* J. Phys. G. Nucl. Part. Phys. 43 045113 (2016))

Alpha detection efficiency

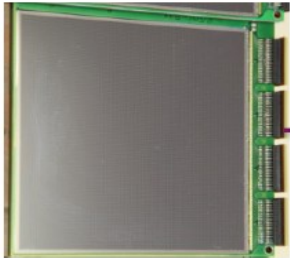


NPTool (A. Matta *et al.* J. Phys. G. Nucl. Part. Phys. 43 045113 (2016))

Electron detection efficiency



Si detector



FRONT- END



FEANICS

BACK- END



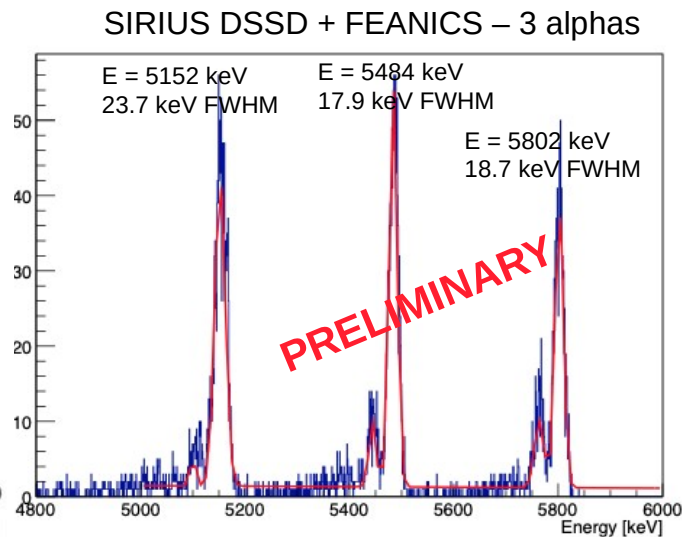
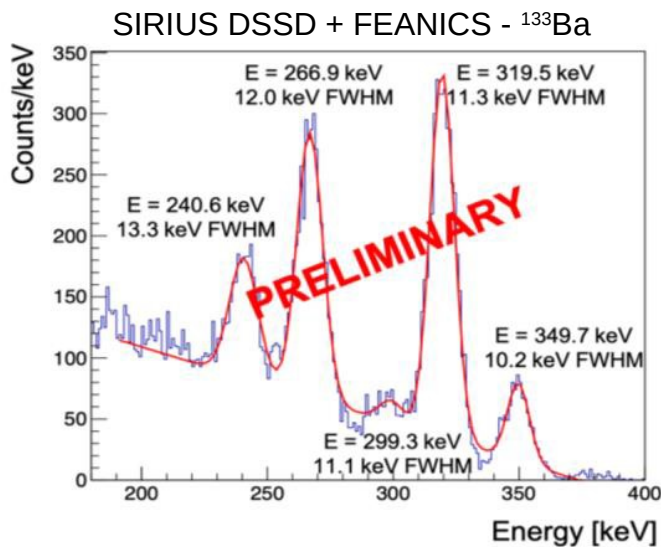
NUMEXO2

Front-End Adaptive gain Integrated Circuits
is a novel multi-channel ASIC in development at
CEA/IRFU

FEANICS tests at CEA

T. Chaminade, F. Bouyjou, O. Gevin, M. Vandebrouck

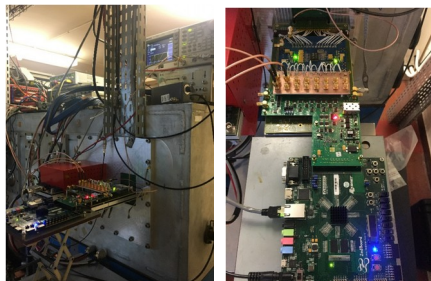
- ✓ 2 gains (2 energy ranges) depending of the signal height
 - High gain 50 fF ↔ electron
 - Low gain 550 fF ↔ alpha
- ✓ Injection tests with gain 50 fF
- ✓ Source tests with FEANICS coupled to SIRIUS DSSD



	2019	2020				2021				2022			
	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
T0 : Kickoff meeting	25-nov												
FRONTEND electronics		Pre study		Detailed study				Call, Cde and Recept.					
BACKEND electronics								Firmware dvt					
Mecanics		Pre study		Detailed study				Call, Cde et Implem.					
Control command						Study	Dvt, Test and Tuning						
Assembling, integration, tests									AIT - Saday				
Commissioning										Offline Saday	Online GANIL +Jyväskylä		

12/2019

SIRIUS DSSD + FEANICS tests



12/2020

Reception FEANICS v2

04/2021 Test bench
SEASON DSSD + FEANICS tests



Validation SEASON DSSD + FEANICS v2 electronics

25/11/2019

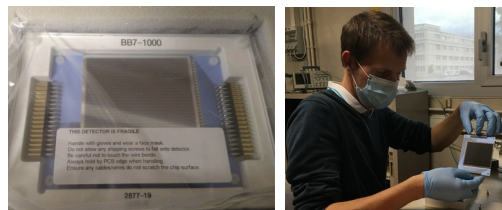
Kickoff meeting @Irfu

09/2020

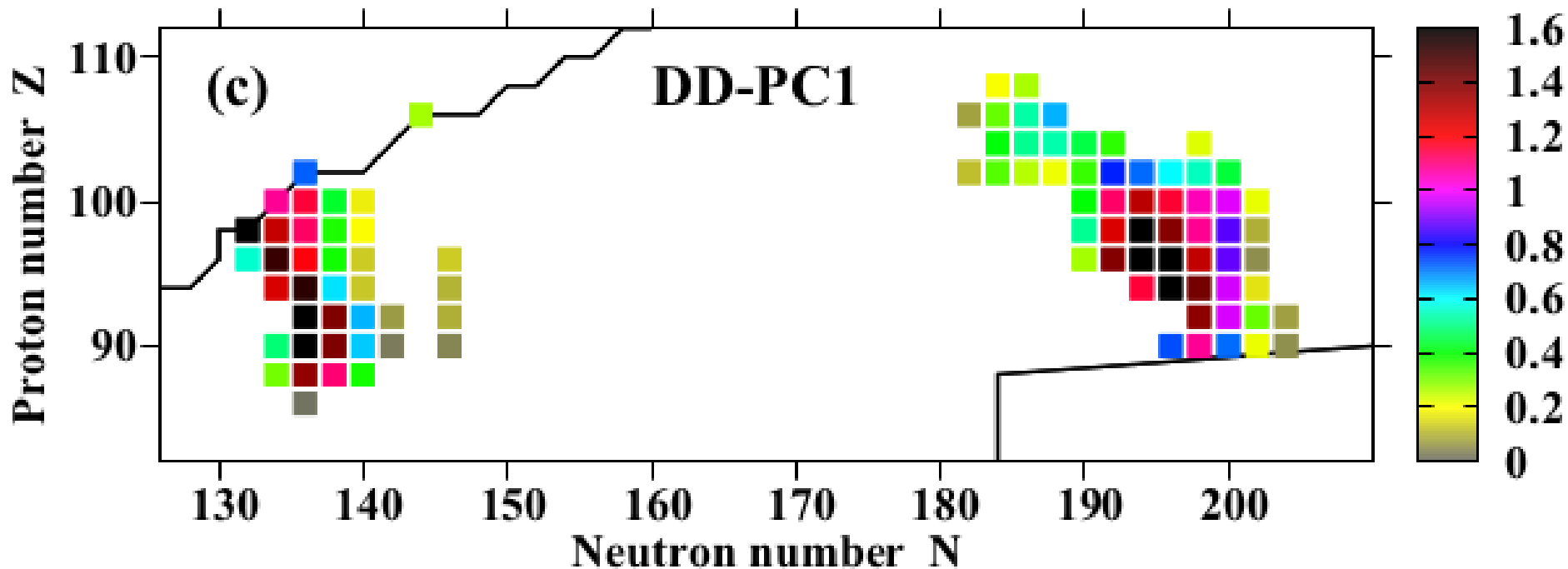
ANR JCJC funding

05/2020

1st SEASON detector

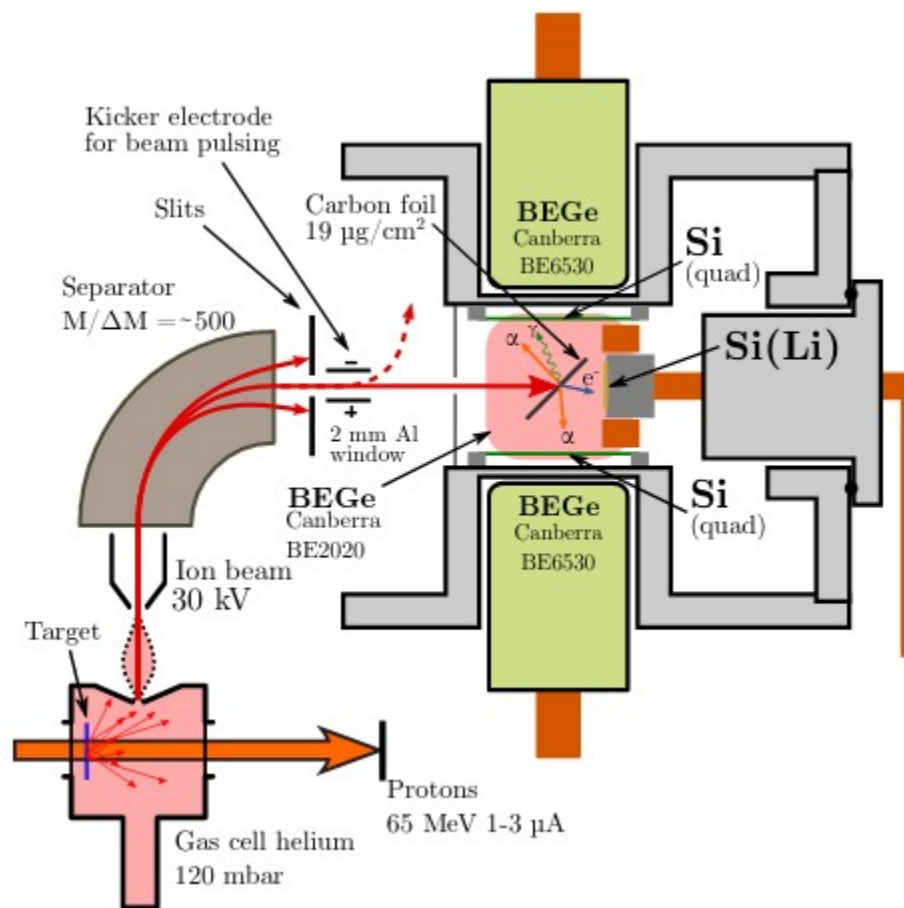


Search for pear shaped nuclei in the actinides:

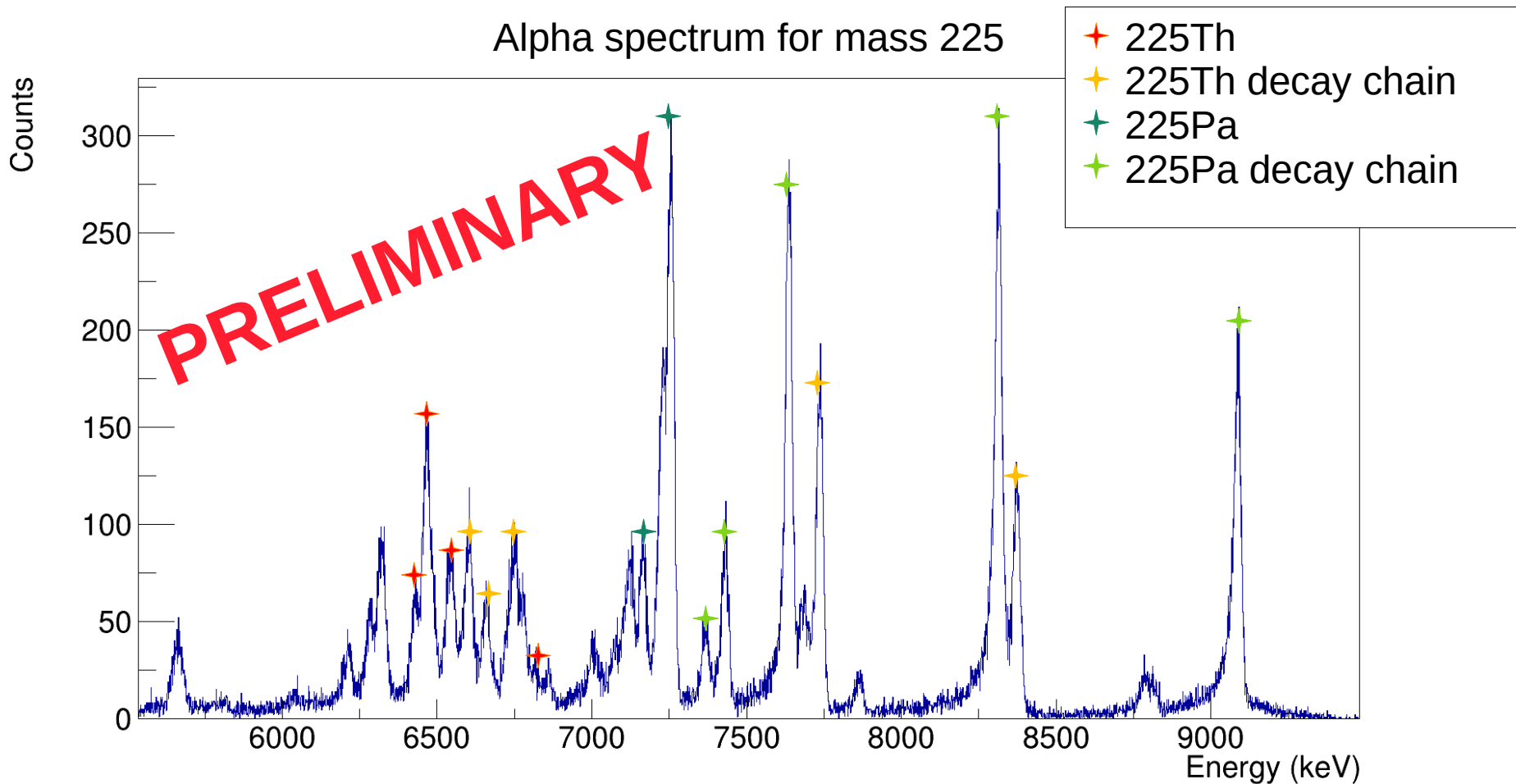


From : S. E. Agbemava *et al.* PRC 96 (2017)

Study of the production of neutron deficient actinides through proton induced fusion evaporation : $^{232}\text{Th}(p, x)\text{Y}$ at IGISOL (Jyväskylä, Finland)

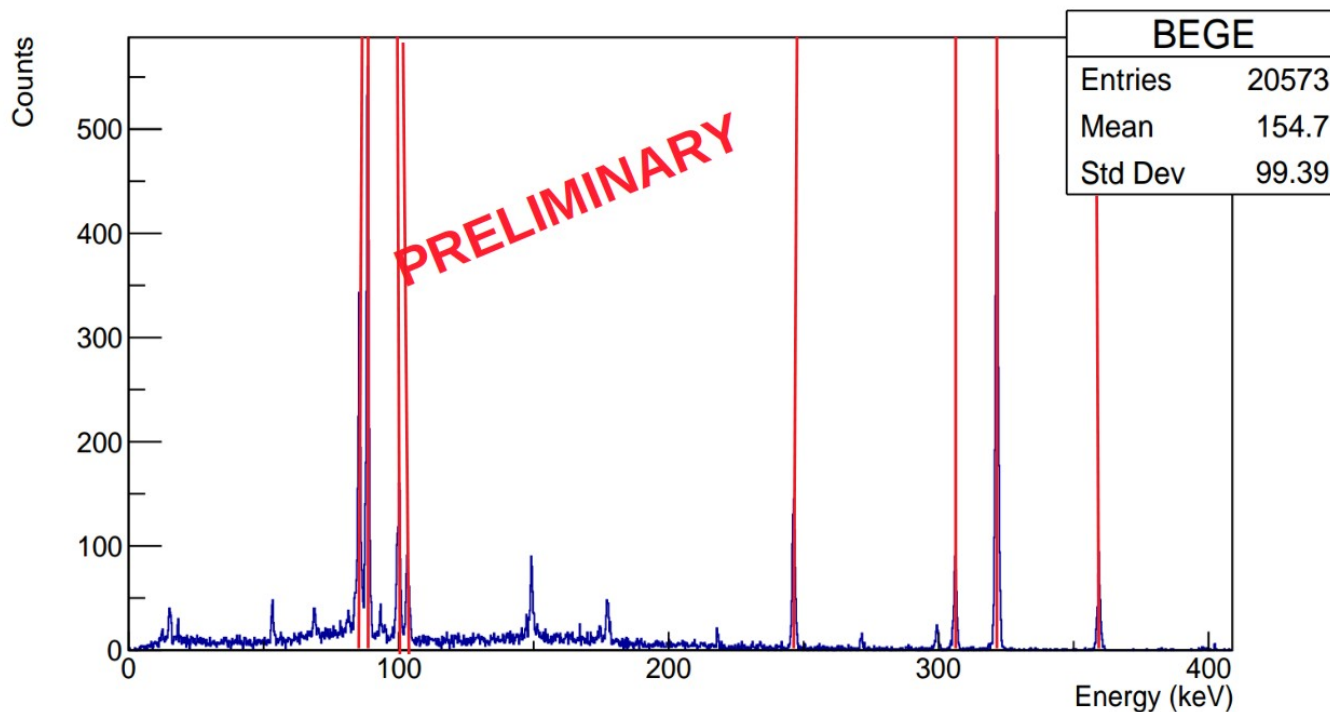


E. RH analysis in collaboration with : I. Moore, I. Pohjalainen, A. Raggio, M. Vandebrouck



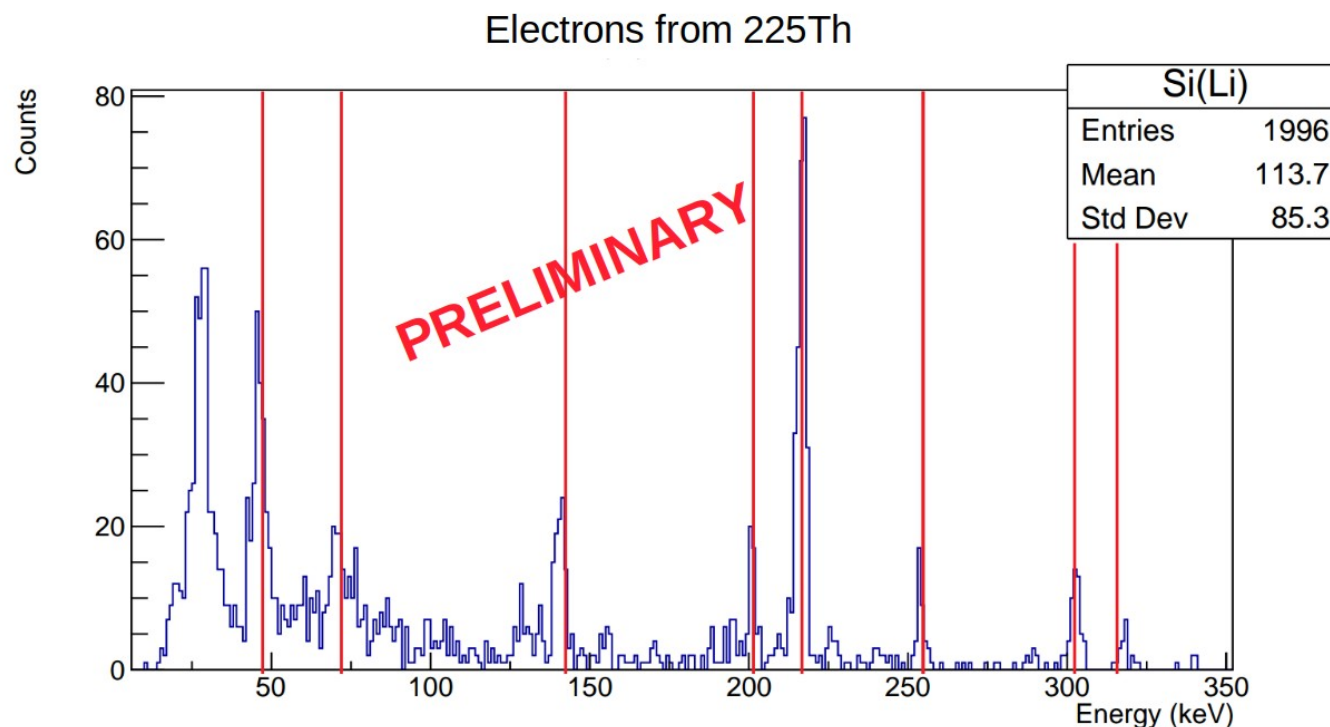
E. RH analysis in collaboration with : I. Moore, I. Pohjalainen, A. Raggio, M. Vandebrouck

Gammas from ^{225}Th



Litterature value (keV)	This work (keV)
85.431 (1)	85.4 (4)
88.471 (1)	88.5 (4)
100.13 (1)	100.0 (4)
103.5 (2)	103.1 (4)
246.0 (1)	246.3 (4)
305.9 (1)	306.2 (4)
321.4 (1)	321.6 (4)
359.0 (1)	359.4 (4)

E. RH analysis in collaboration with : I. Moore, I. Pohjalainen, A. Raggio, M. Vandebrouck



Litterature value (keV)	This work (keV)
48.38 (20)	45.87 (50)
73.28 (10)	69.98 (60)
142.08 (10)	140.70 (80)
201.98 (10)	201.0 (10)
217.48 (10)	216.5 (11)
255.08 (10)	253.9 (13)
302.16 (10)	302.5 (15)
316.58 (10)	318.1 (15)

- Promising simulations and first tests for the SEASON detector
- Lot of data obtained through proton induced fusion evaporation ($^{232}\text{Th}(p, x)\text{Y}$) at Jyväskylä, analysis ongoing

And perspective:

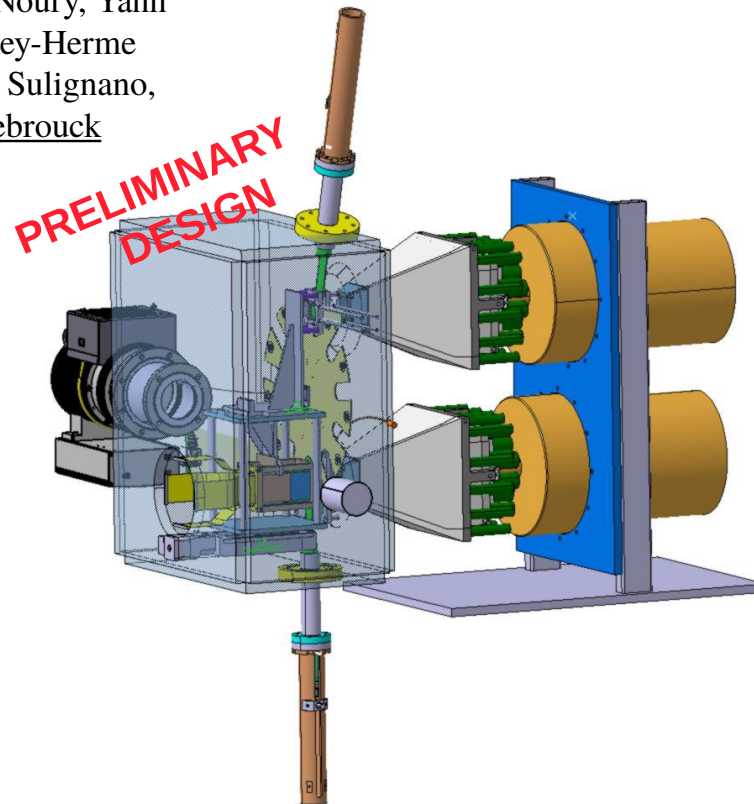
- Middle term: Decay spectroscopy of neutron deficient actinides program at Jyväskylä with SEASON
- Middle/long term : Decay spectroscopy and laser ionisation spectroscopy at S3-LEB with SEASON

SEASON collaboration (CEA/Irfu) :

Florent Bouyjou, Sandrine Cazaux, Thomas Chaminade, Olivier Cloué, Philippe Daniel-Thomas, Antoine Drouart, Alexis Gaget, Olivier Gevin, Thomas Goigoux (postdoc), Jean-Christophe Guillard, Hervé Le Provost, Jorge Mendes-Ribeiro, Gilles Minier, Julien Noury, Yann Reinert, Johan Relland, Emmanuel Rey-Herme (PhD student), Arnaud Roger, Barbara Sulignano, Christophe Theisen, Marine Vandebrouck

I262 Experiment at Jyväskylä :

I. Pohjalainen, I.D. Moore, A. Raggio, T. Eronen, IGISOL group, Ch.E. Düllman, E. Rey-Herme, D. Renisch, J. van de Laar, M.Vandebrouck



Thank you !