

DE LA RECHERCHE À L'INDUSTRIE



The SEASON decay station

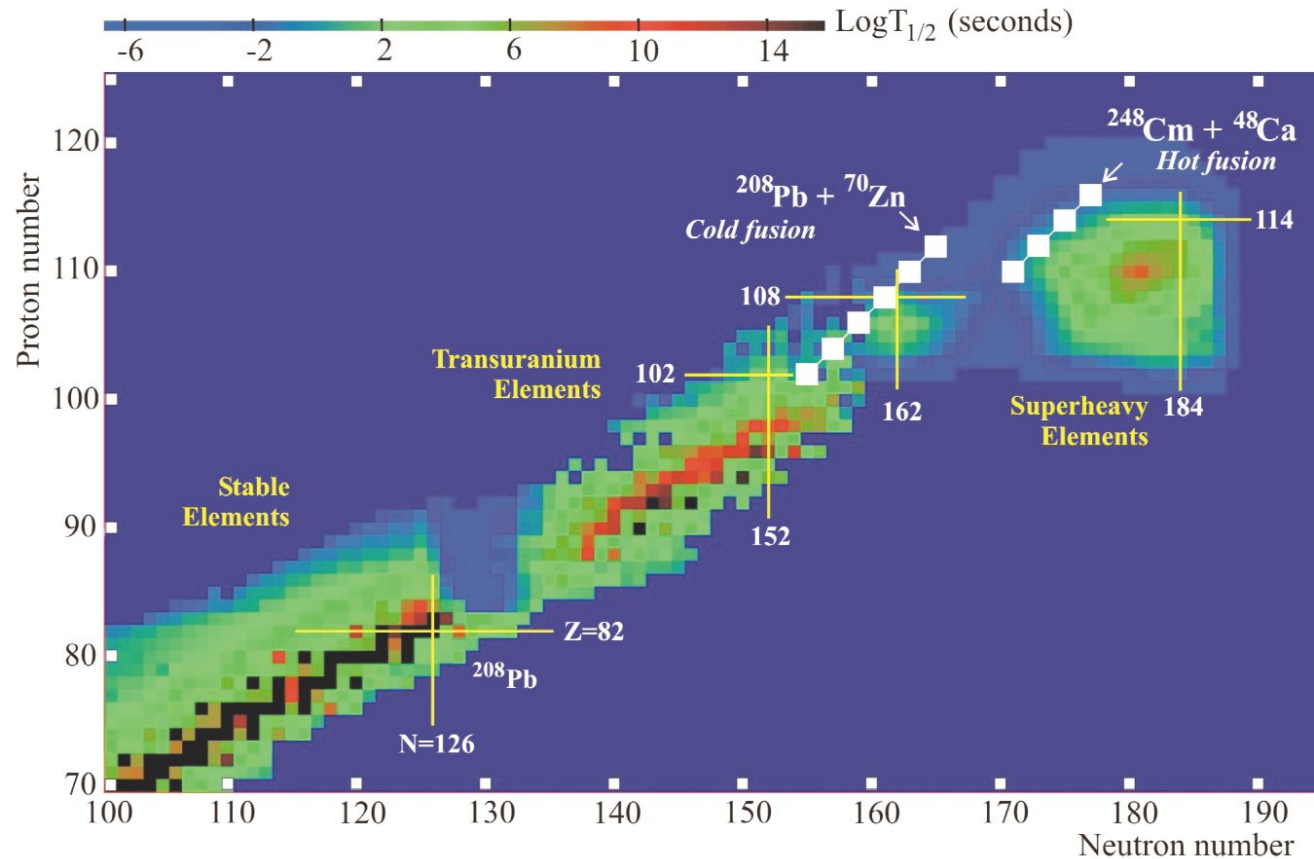
Spectroscopy Electron Alpha in Silicon bOx couNter

Damien THISSE
CEA IRFU (Saclay)

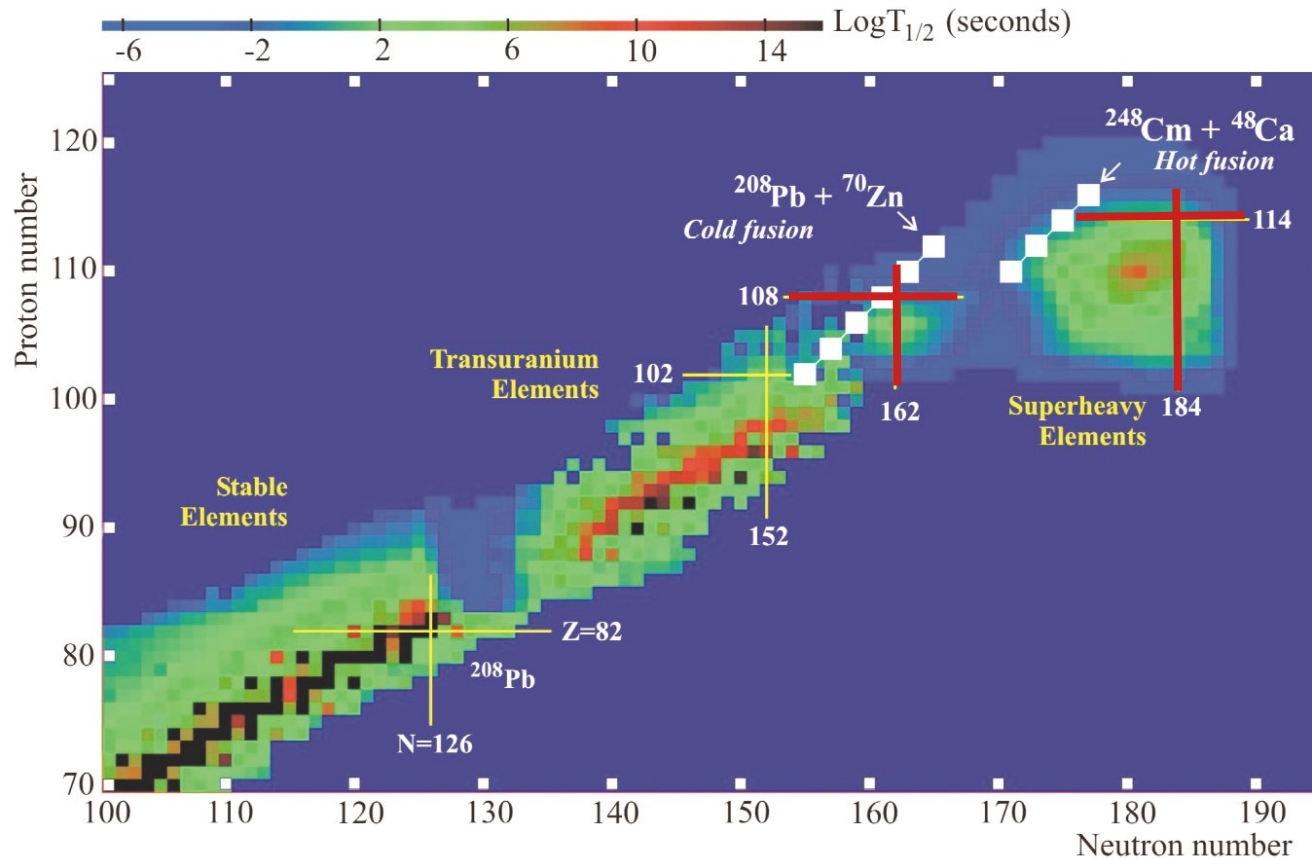
On behalf of the SEASON collaboration



Workshop ISOL-France
22-03-2023

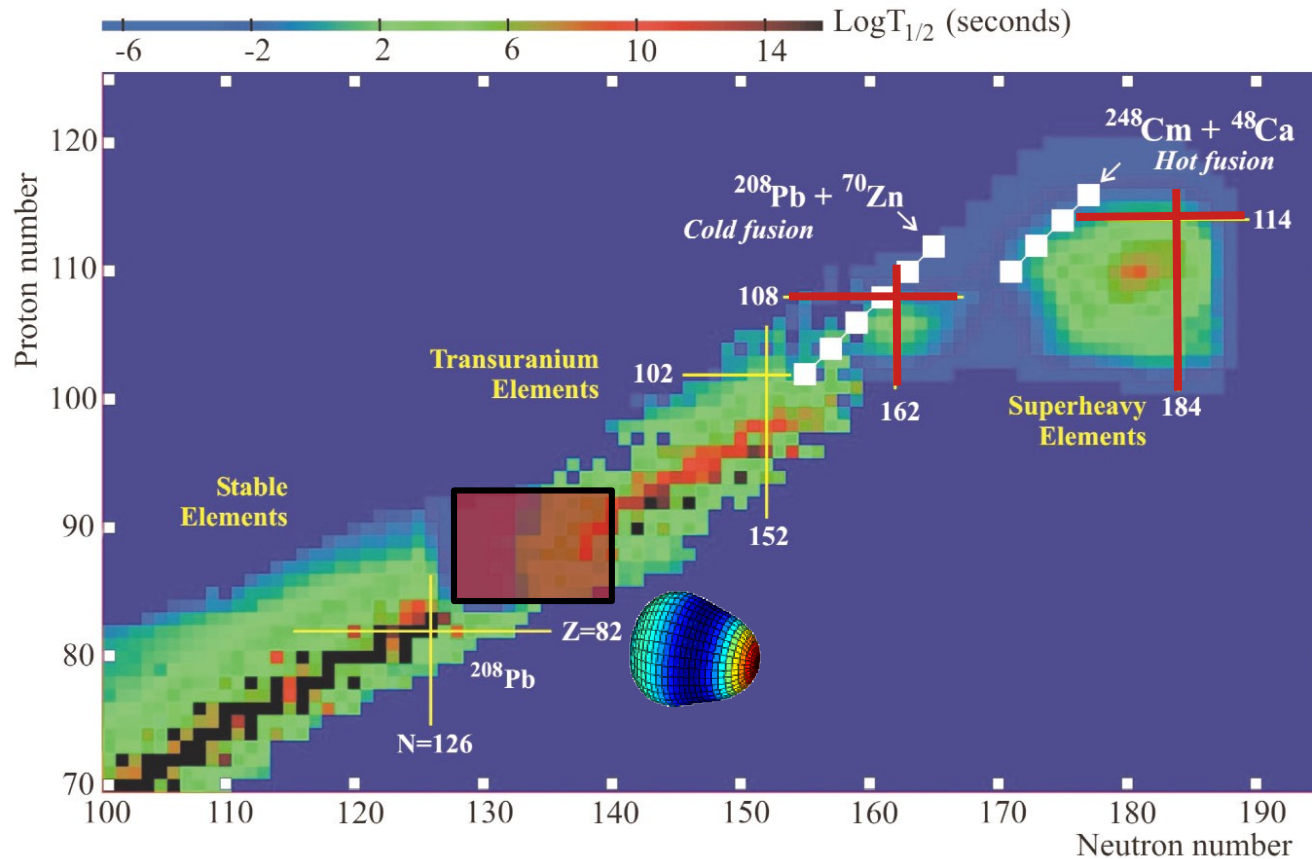


Laboratory to probe the limit of nuclear stability



Laboratory to probe the limit of nuclear stability

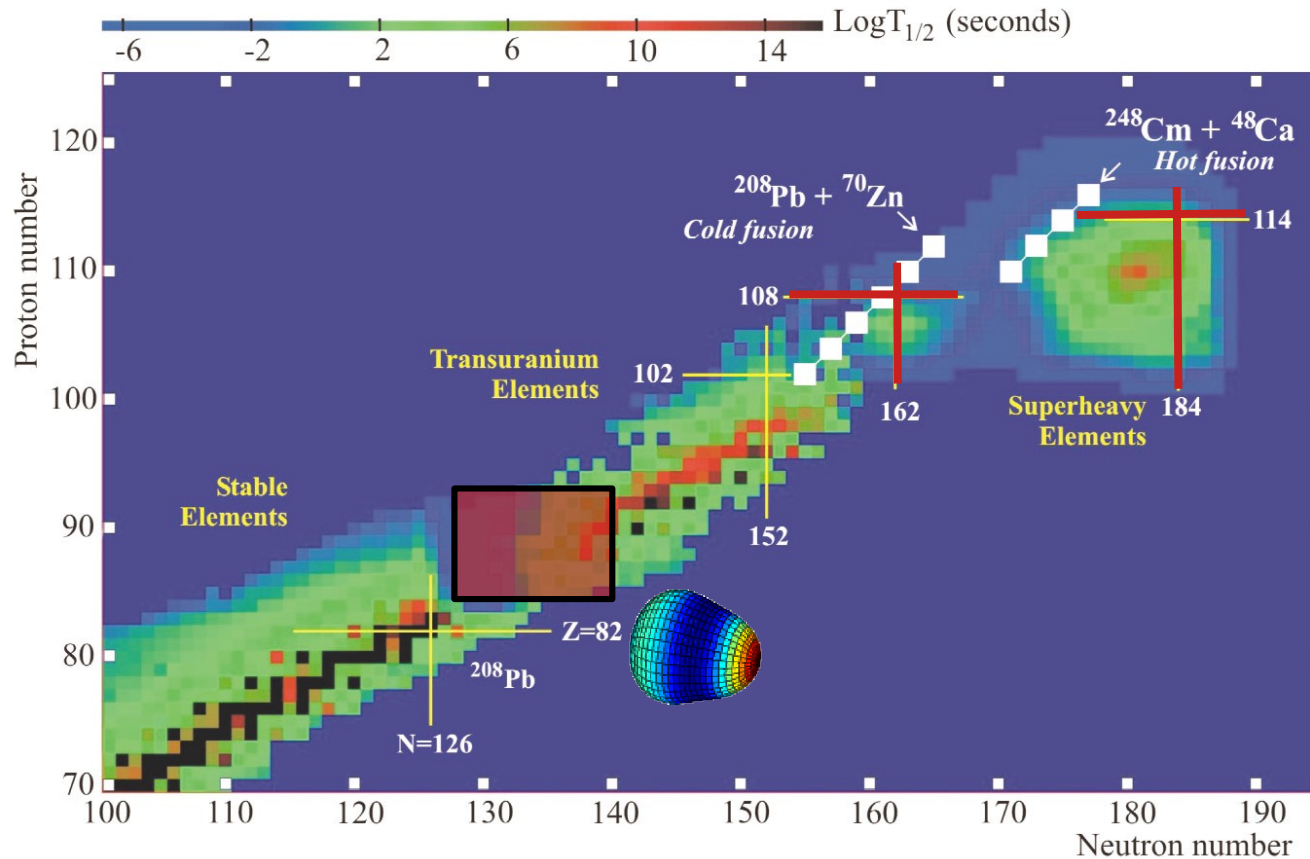
Unstability increased by the growing Coulombian repulsion
But shell effects play a stabilizing role



Laboratory to probe the limit of nuclear stability

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Region of strong deformation (in particular octupole)



Laboratory to probe the limit of nuclear stability

Unstability increased by the growing Coulombian repulsion
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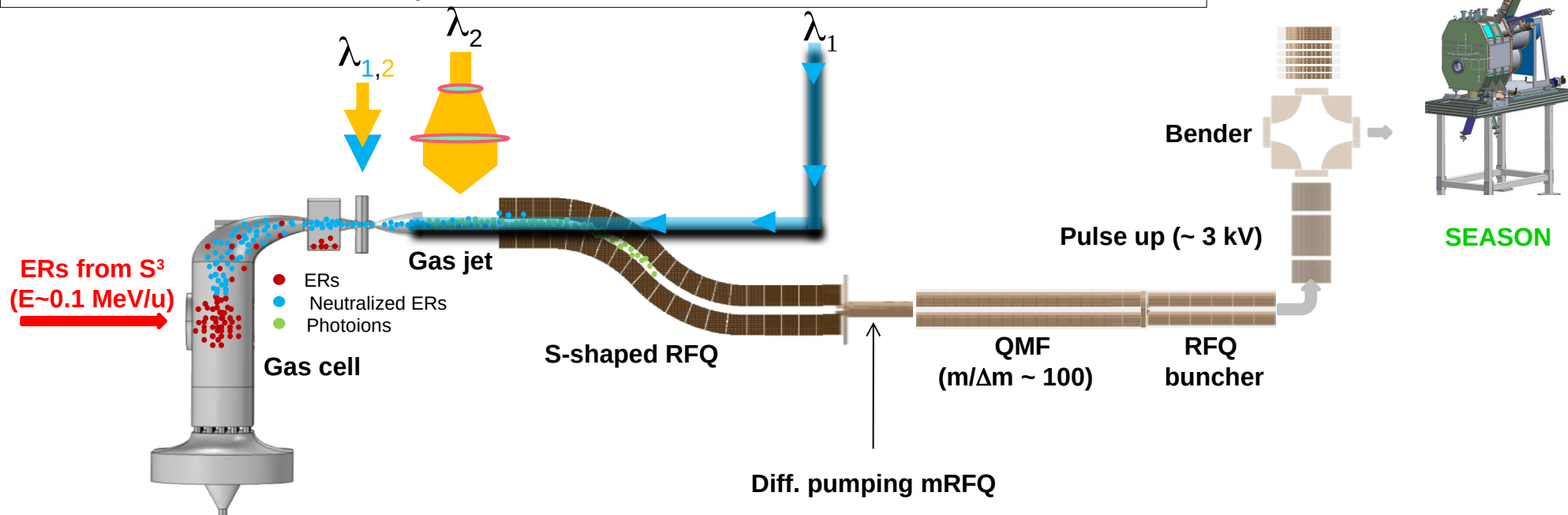
Region of strong deformation (in particular octupole)

Production of these nuclei is complicated

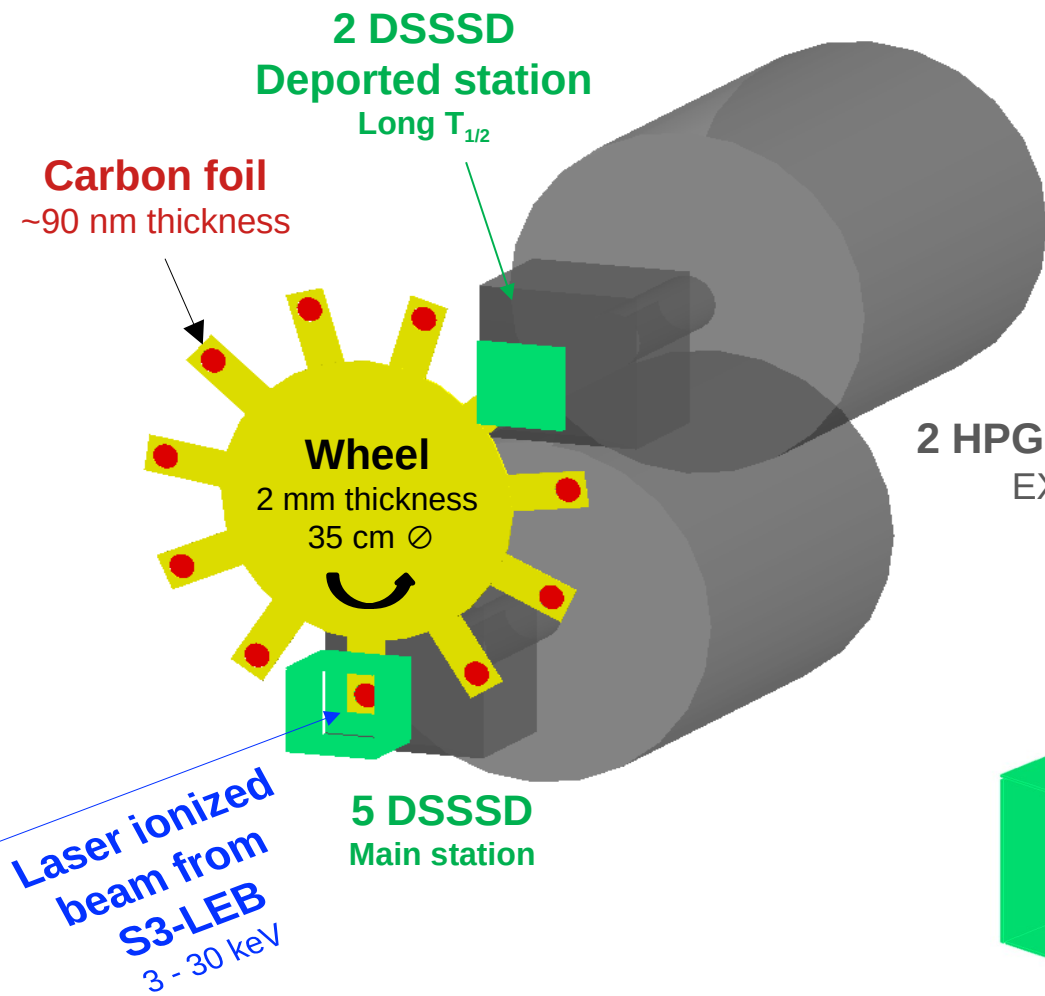
- **SEASON** will be mounted at the end of the S³-LEB for the study of HN/SHN

- It will be dedicated to :
 1. Counting laser ionized atoms (laser ionization spectroscopy)
 2. α , electron and γ decay spectroscopy

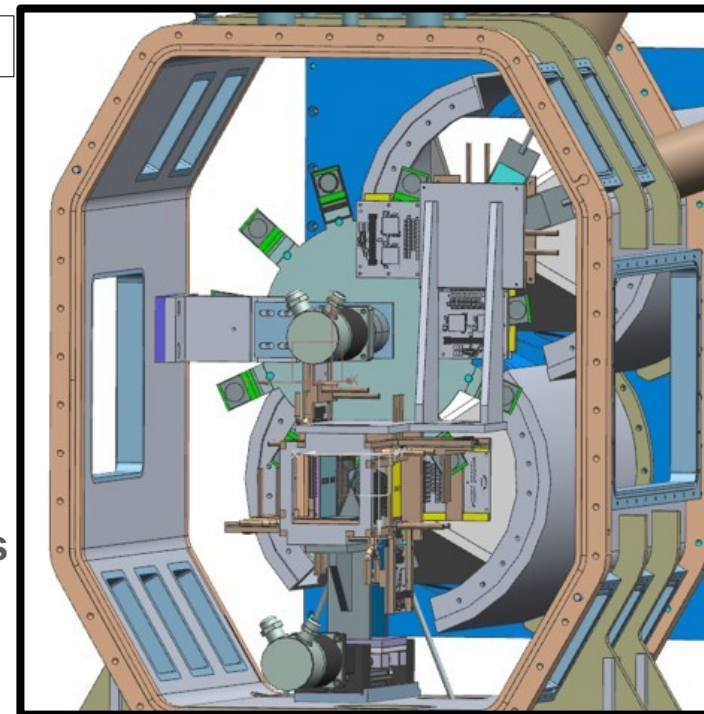
⇒ **Coupling atomic and nuclear approaches to study HN/SHN produced at S³**
 Octupolar deformation (see talk of E. Rey-herme)
 SHN structure study



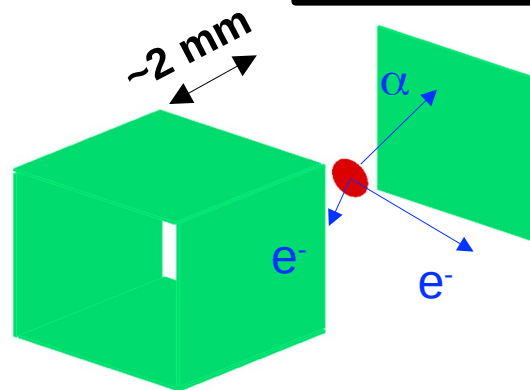
View of SEASON in GEANT4



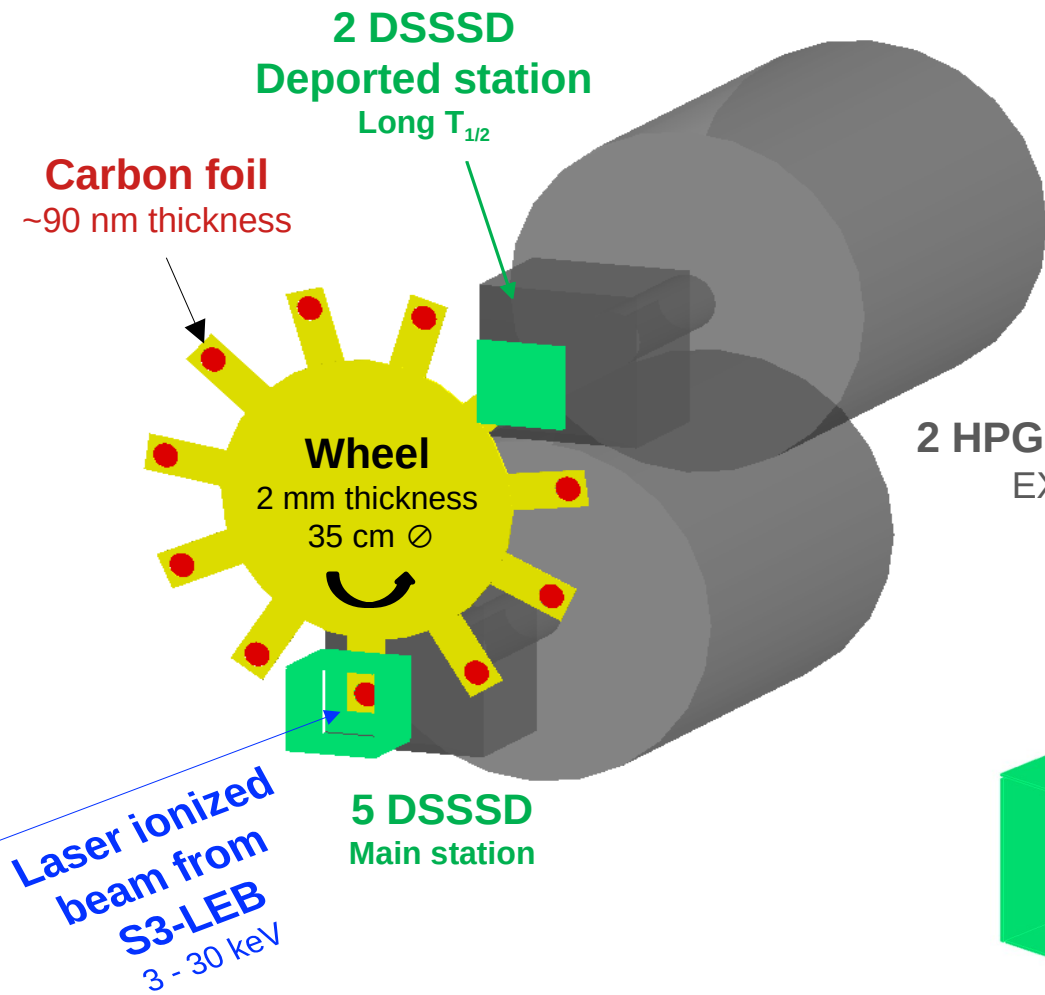
CAD of SEASON



2 HPGe detectors
EXOGRAM

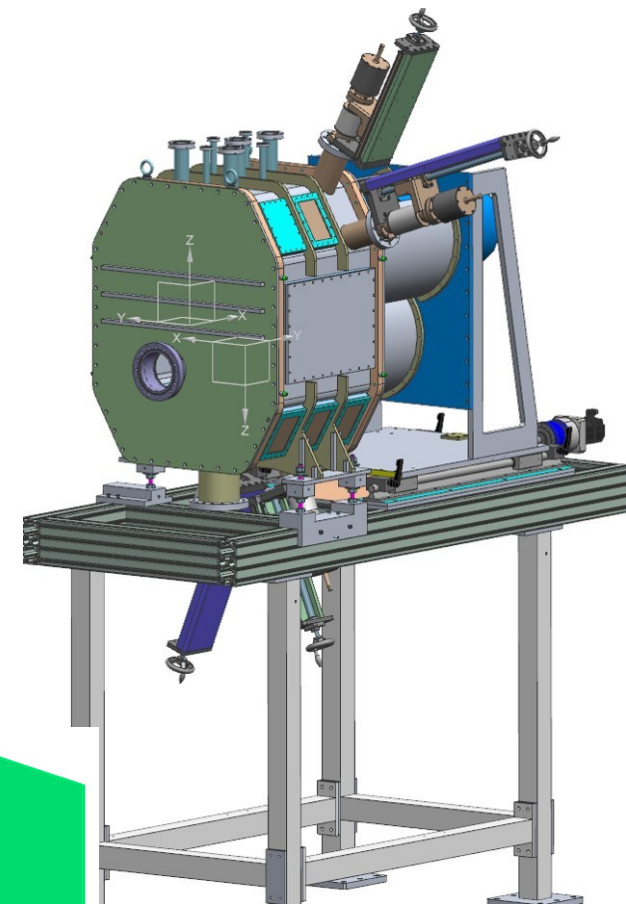
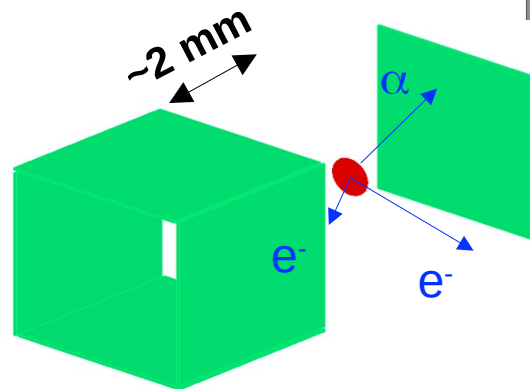


View of SEASON in GEANT4

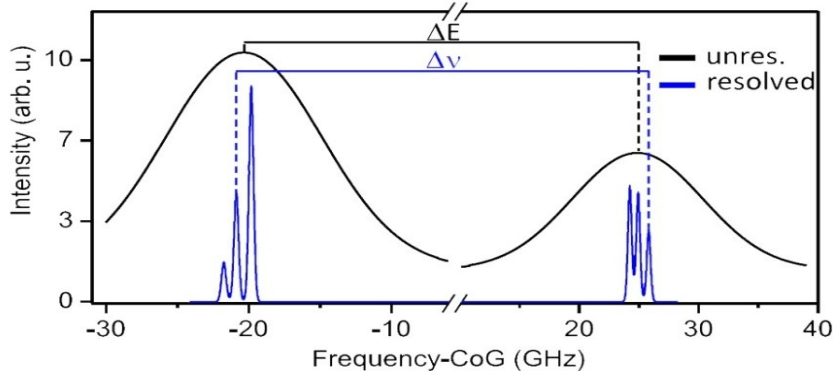


CAD of SEASON

2 HPGe detectors
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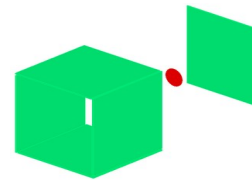


Goal 1: counting the laser ionized atoms to perform laser ionization spectroscopy



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

- Need good detection efficiency for α (5 – 12 MeV) and electrons (20 – 600 keV)



Compact configuration

Si detectors (BB7 from Micron)

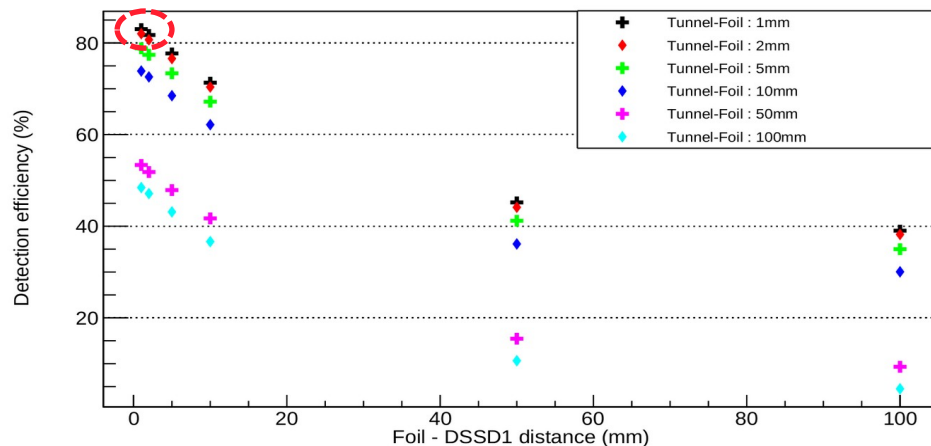
✓ Thickness 1 mm

✓ Active area 64 x 64 mm²

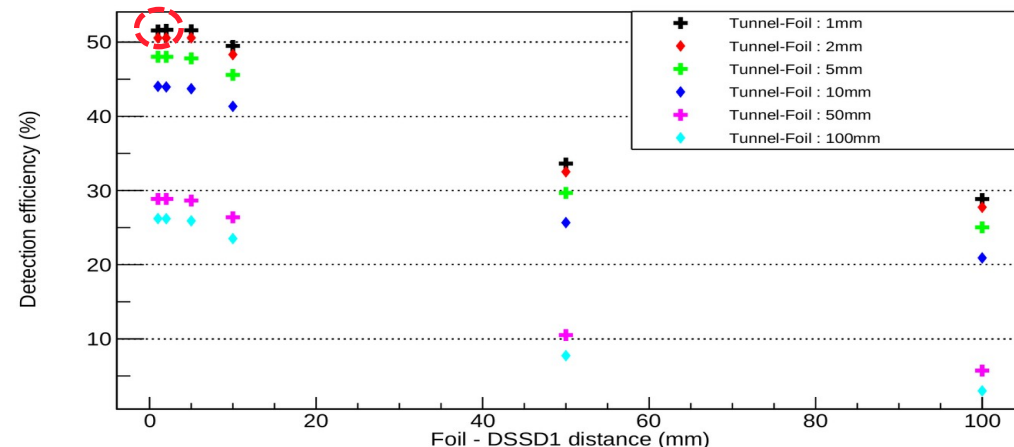
α detection efficiency **80%**
electron detection efficiency **50%**

From Geant4 simulation
(work of T. Goigoux
and E. Rey-herme)

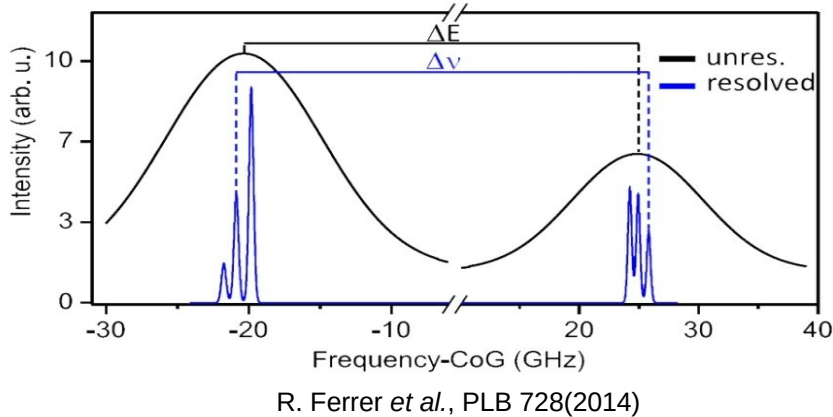
Alpha detection efficiency (simulated)



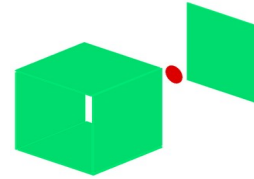
Electron detection efficiency (simulated)



Goal 1: counting the laser ionized atoms to perform laser ionization spectroscopy



- Need good detection efficiency for α (5 – 12 MeV) and electrons (20 – 600 keV)



Compact configuration

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

α detection efficiency **80%**
electron detection efficiency **50%**

From Geant4 simulation
(work of T. Goigoux
and E. Rey-herme)

Goal 2: perform α , electron, γ decay spectroscopy

- Need good energy resolution and avoid summing effects

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

Si detectors (BB7 from Micron)

- ✓ Thickness: 1 mm
- ✓ Active area: 64 x 64 mm²
- ✓ Number of strips: 32 x 32
- ✓ Strip pitch: 2 mm
- ✓ **High resistivity (purer material)**
- ✓ **Dead layer: 50 nm**

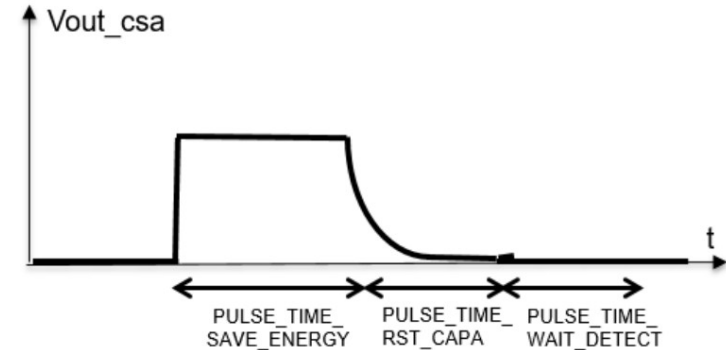
- ✓ R&D on implantation foils

In order to measure both alpha and electrons with the best energy resolution

DSSSD
(BB7 from Micron)



Shaping



FRONT-END



FEANICS

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

Key feature:
Automatic **gain switch** depending on the signal amplitude

High gain (~50 fF) ↔ electron
Low gain (~550 fF) ↔ alpha

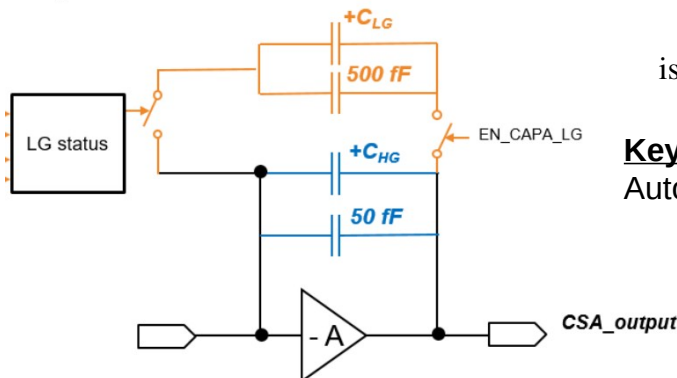
BACK-END

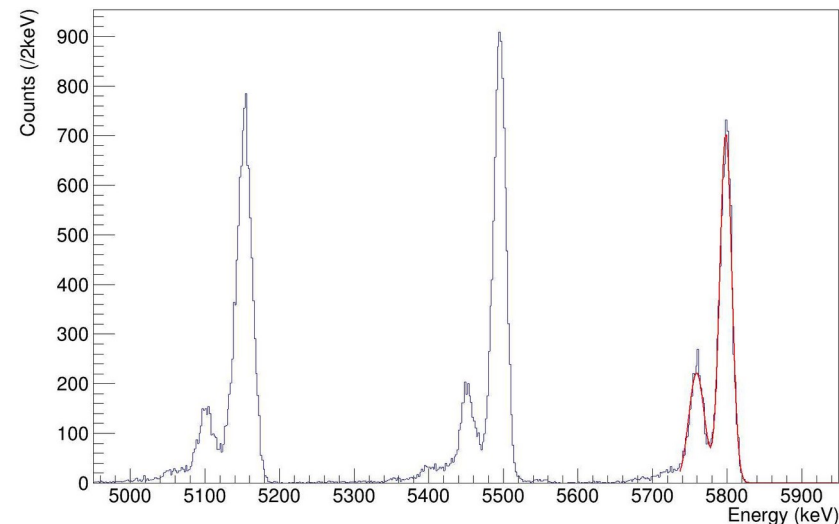


NUMEXO2

Tracks recording for
offline processing

Gain switch

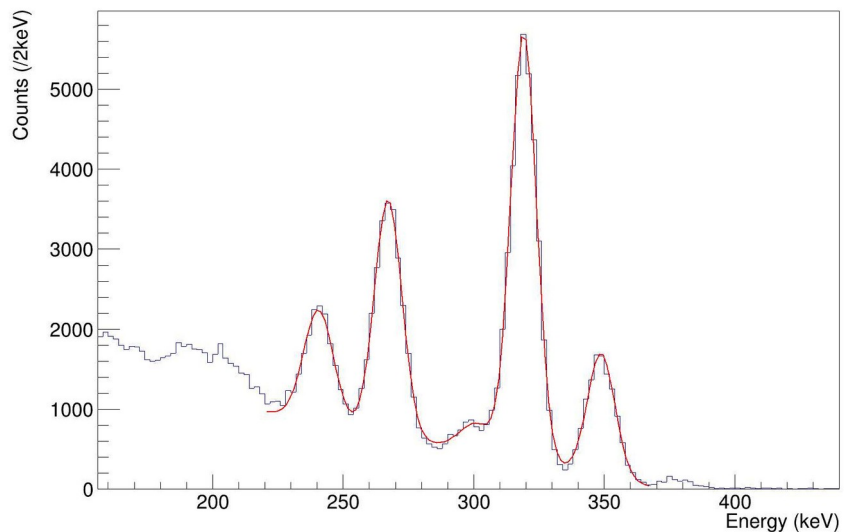




First SEASON's DSSSD has arrived and is being tested !

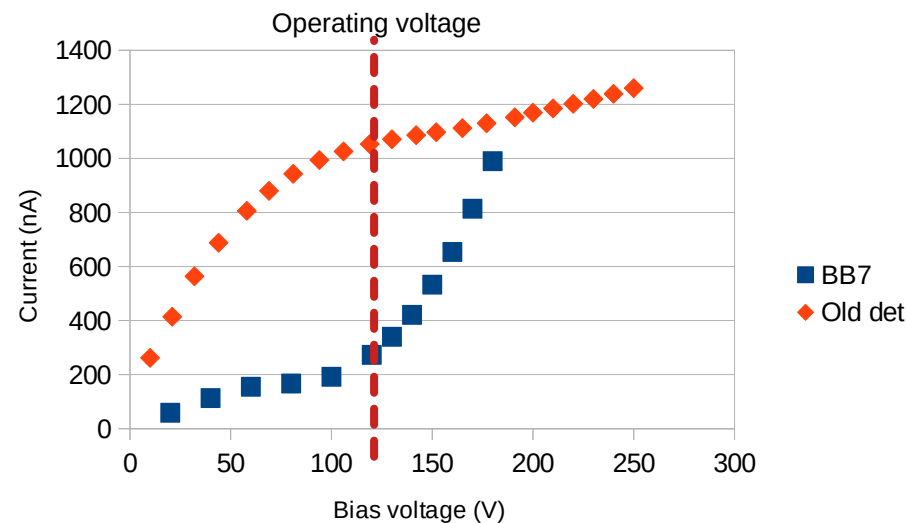
3- α calibration source (^{239}Pu , ^{241}Am , ^{244}Cm)

FWHM @ 5804.77keV : 17.2 keV (was 18.4)



Electron source (^{133}Ba)

FWHM @ 320.3 keV : 10.2 keV (was 11.5)



Will be improved with the latest version of FEANICS cards

**Reception of the mechanics planned
in September-October**

**First mounting will be performed at
CEA-Saclay (end of 2023)**

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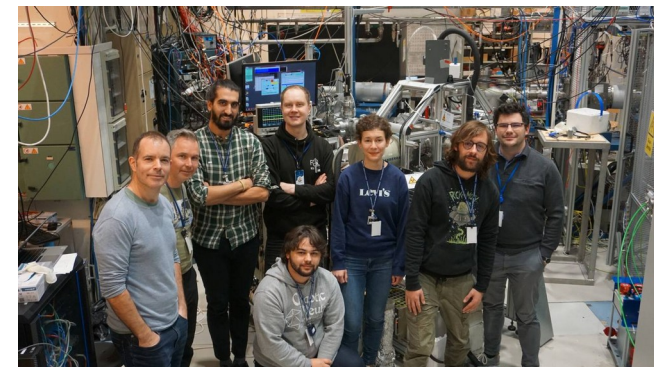
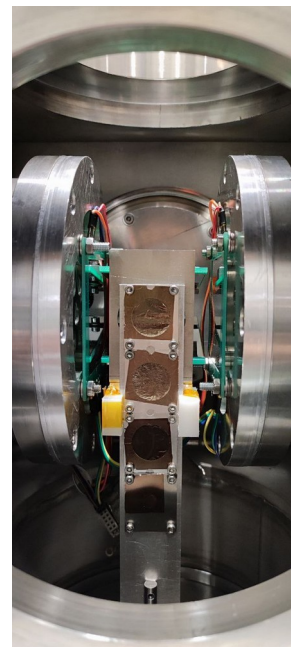
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SEASON@IGISOL : Spring 2024

Online commissioning

Campaign of experiments



Commissioning of VADER setup (Oct. 2022)

Reaction $^{232}\text{Th}(p, xn)$

Study of Pa isotopes decay

Same implantation foils than SEASON

A. Raggio *et al.*, to be published in NIM B

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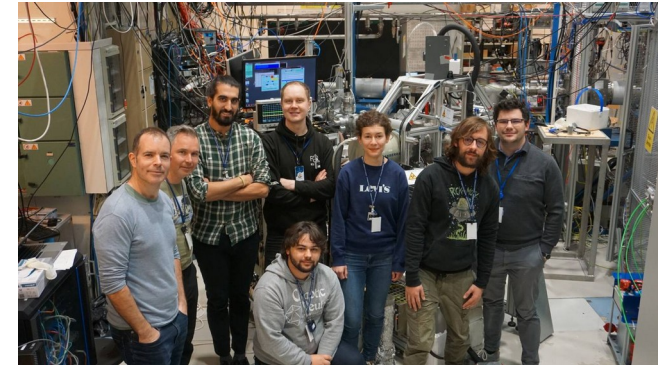
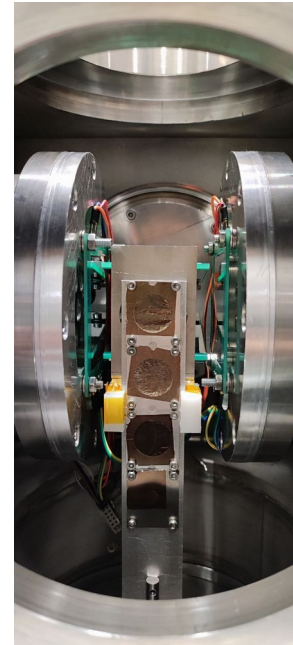
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SEASON will then be placed at S³-LEB



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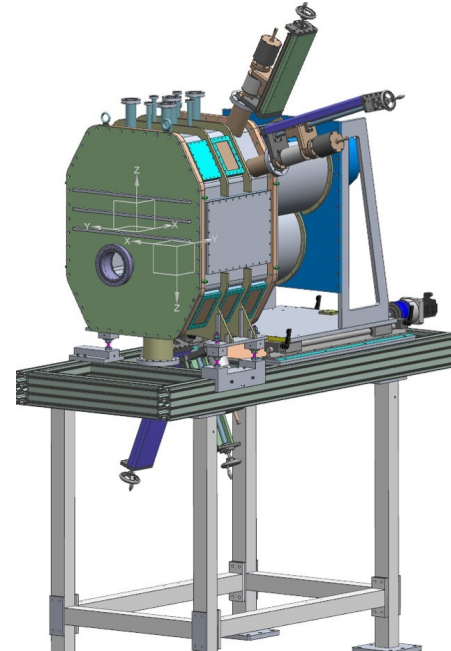


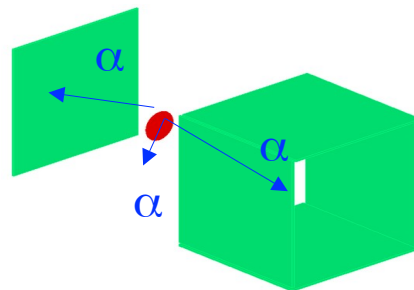
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Thank you for your attention

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





Work of T. Goigoux
+ E. Rey-herme

