IDEAS³ decay station

Identification and DEcay Assisted by S³

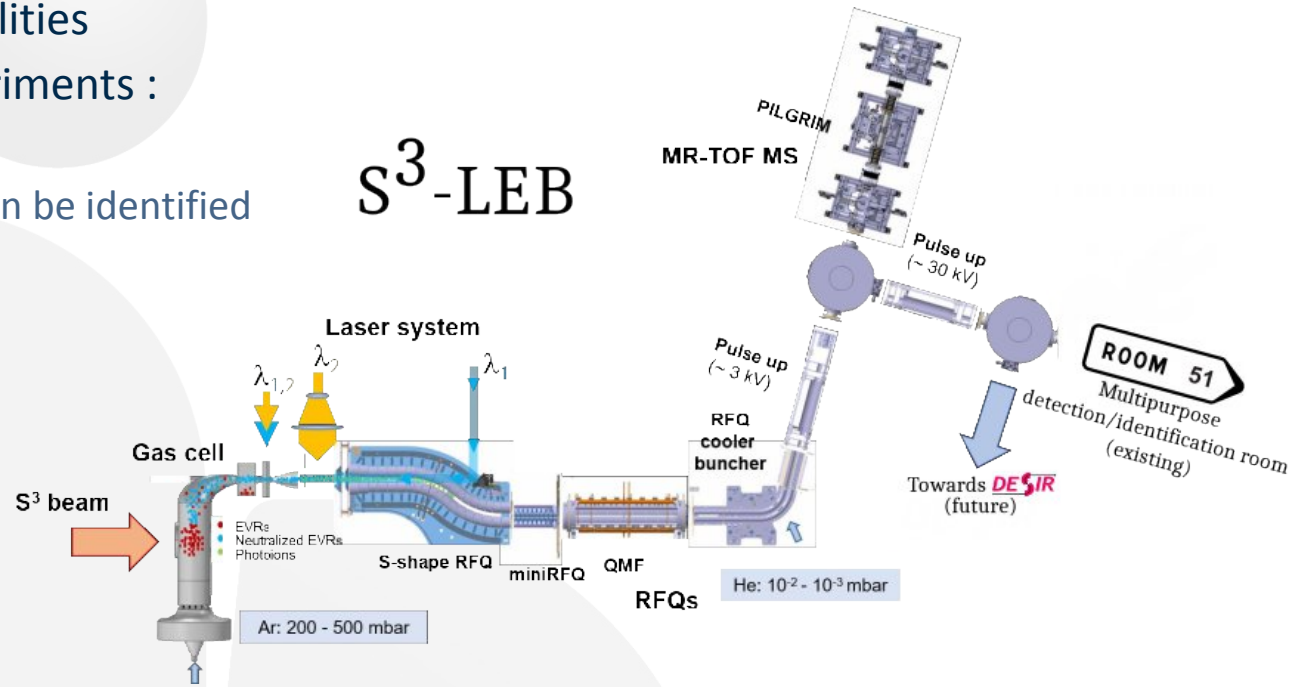
Project context and current design

Léo Plagnol

Context : S³-LEB@GANIL

ID station @ S³-LEB :

- Enhance isotope identification capabilities
- Benefits for other spectroscopy experiments :
  - Production measurement
  - Contaminants with similar masses can be identified



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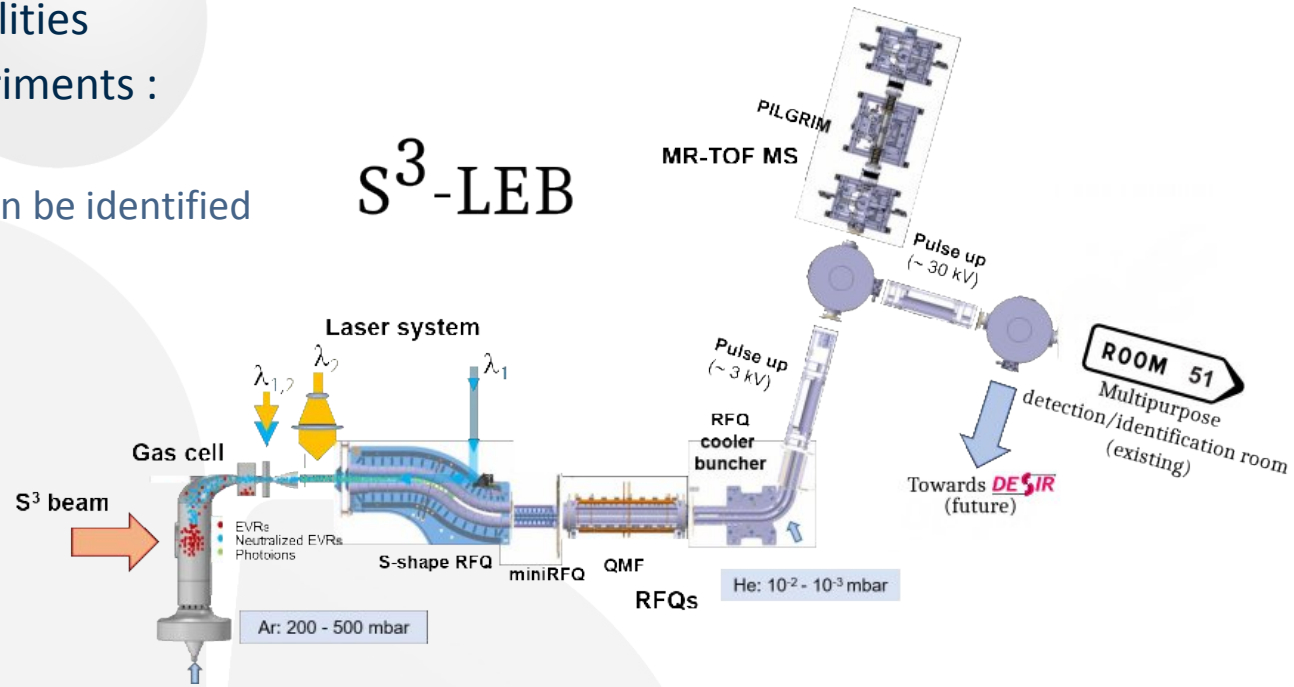
Detailed β-decay spectroscopy

- Powerful technique (narrow lines)
- Benefits from :
  - Beam purification
  - Isomer selection
- Complementarity with SEASON :



SEASON

- Alpha-oriented detection
- Windmill system

IDEAS³

- Gamma-oriented detection
- Tape system suitable for more intense beams

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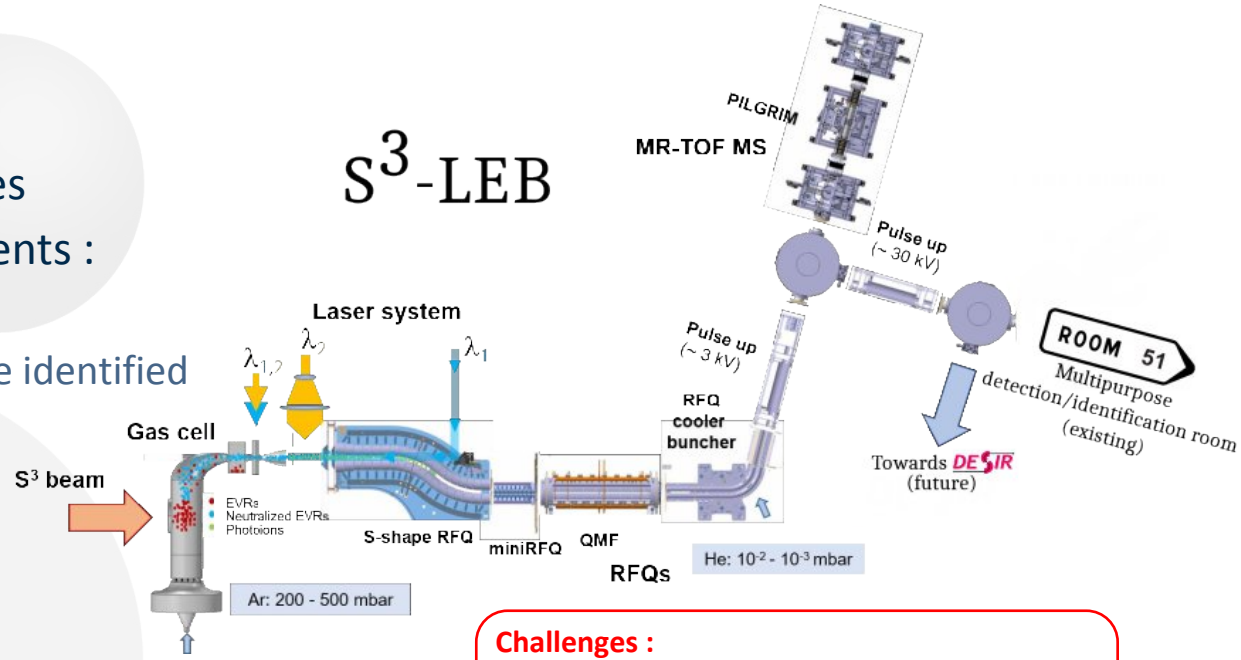


SEASON
- ➢Alpha-oriented detection
- ➢Windmill system

IDEAS³
- ➢Gamma-oriented detection
- ➢Tape system suitable for more intense beams

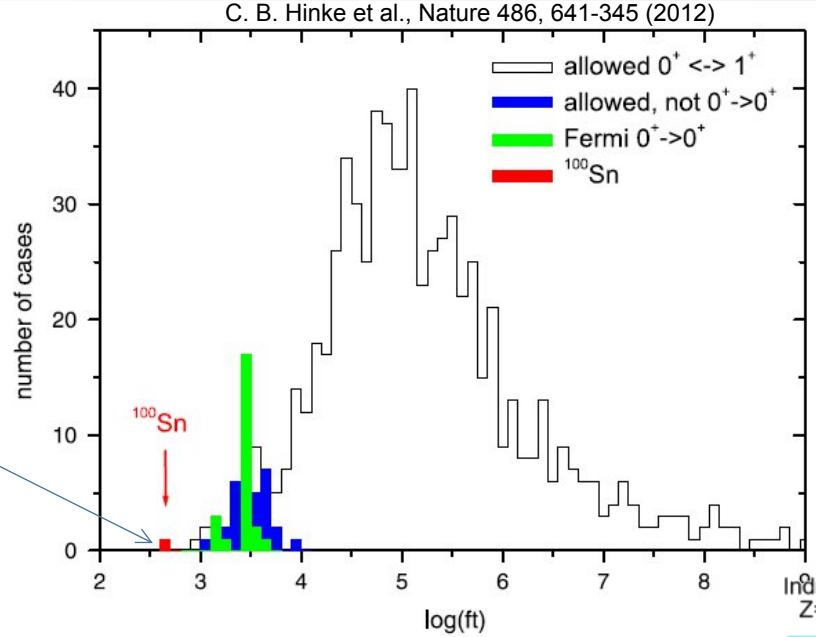
Challenges :

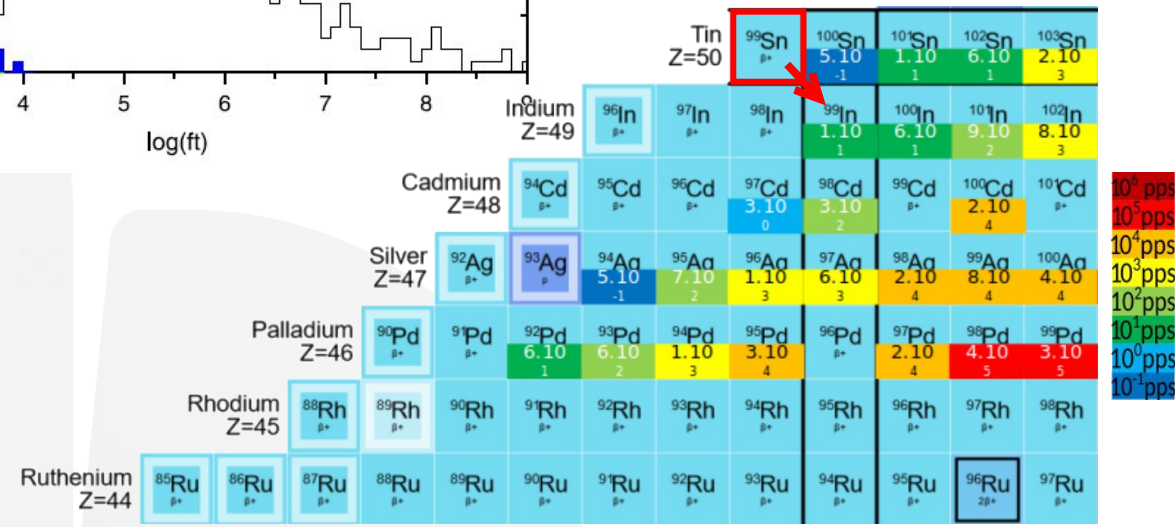
- **Simplicity :**
  - Installation
  - Repairing
  - Use & analysis (plug-and-play)
    - → few electronic channels
- **Modularity**
  - Adaptation to needs

IDEAS³ : scientific goals

- ^{100}Sn :
  - Doubly magic & self-conjugate
  - Lowest log(ft) value
  - ➢ β-decay strength ?

C. B. Hinke et al., Nature 486, 641-345 (2012)





From **https://u.ganil-spiral2.eu/chartbeams/**

IDEAS³ : scientific goals

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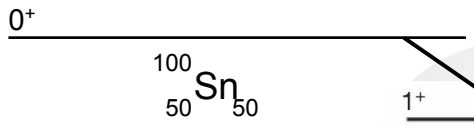
  - ➢ β-decay strength ?
  - ➢ States in odd-odd ^{100}In



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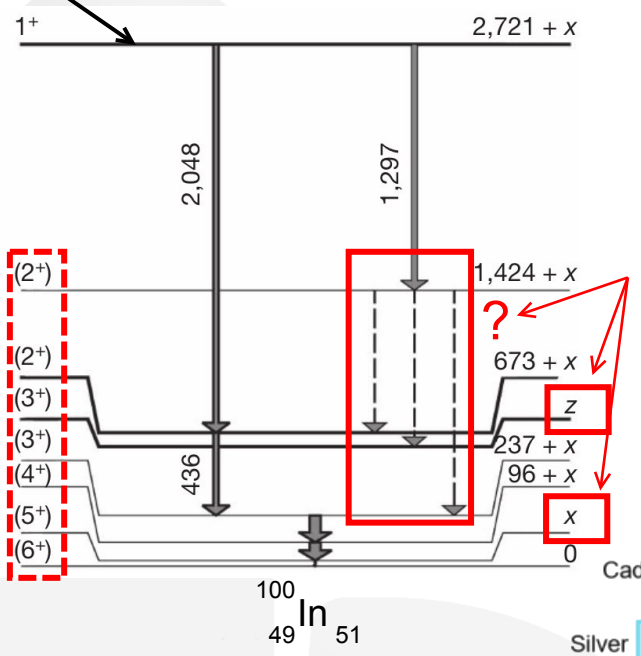
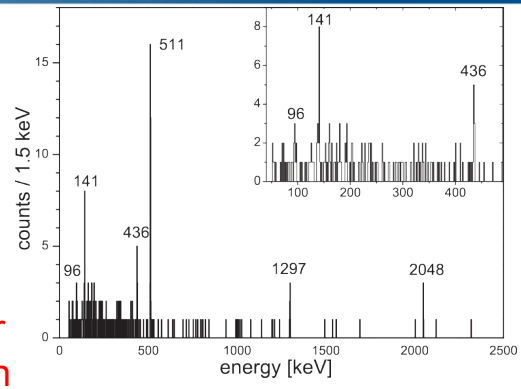
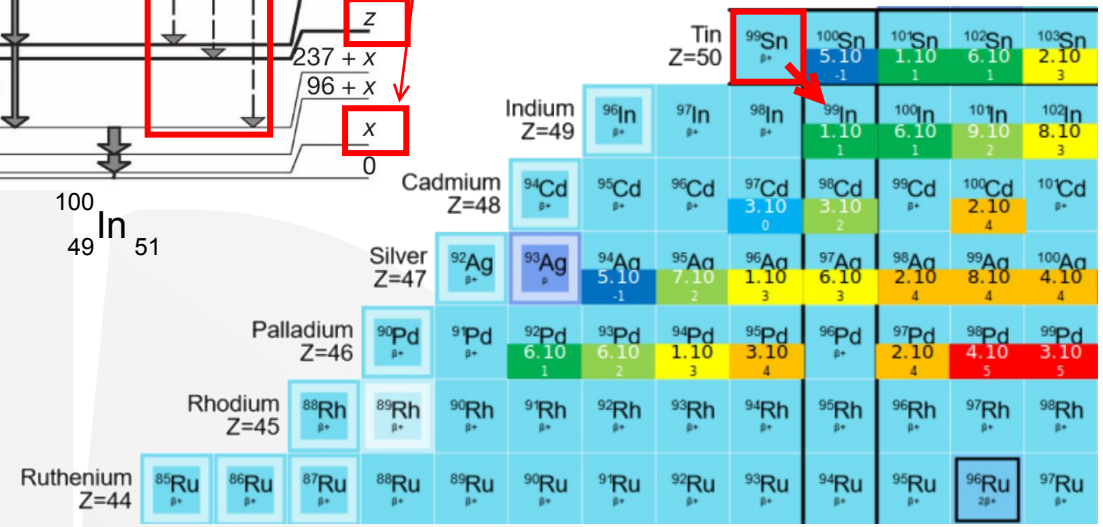




Need for precision spectroscopy !



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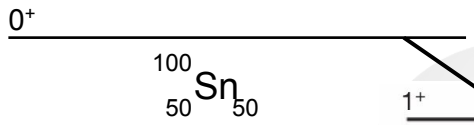
IDEAS³ : scientific goals

- ^{100}Sn :
  - Doubly magic & self-conjugate
  - Lowest log(ft) value
  - ➢ β-decay strength ?
  - ➢ States in odd-odd ^{100}In
  - Longest chain of semi-magic nuclei
- Region N=Z :
  - p-n pairing
  - Seniority isomers
  - Shape coexistence (Z<50)
  - Low-energy intruders
  - rp-process



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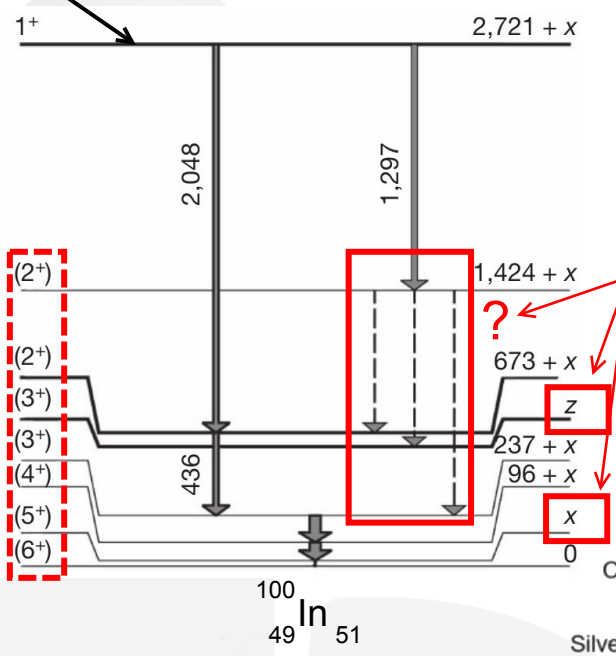
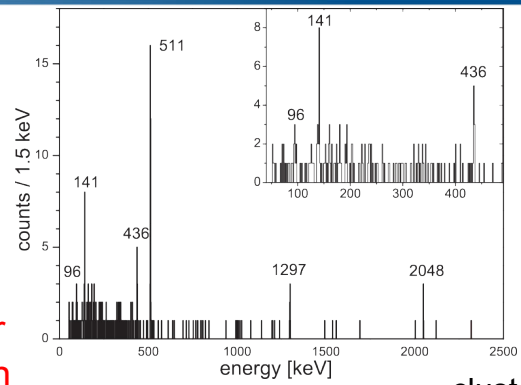
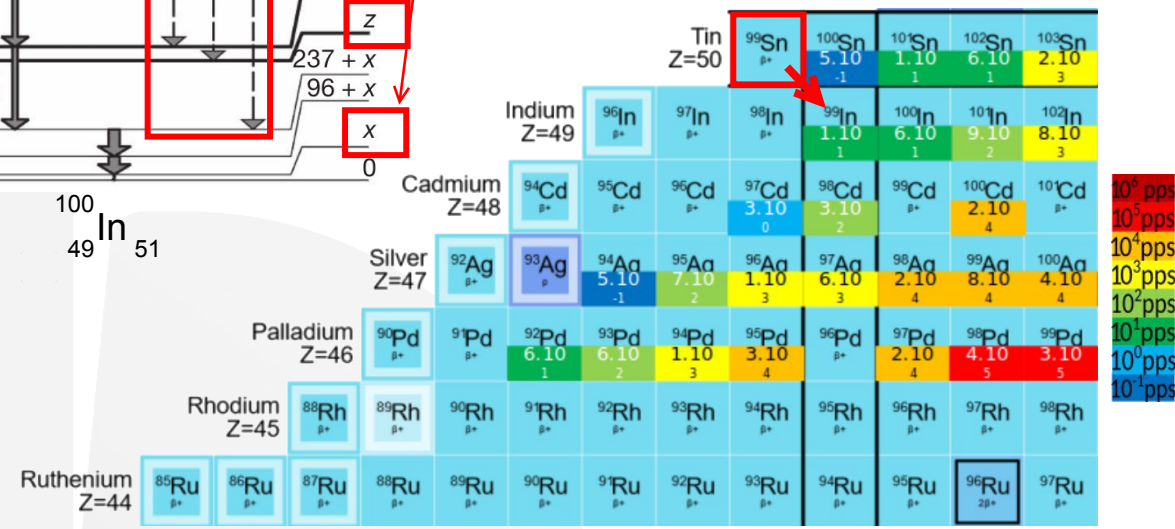




Need for precision spectroscopy !

α-clusters ?



➡ **S³-LEB : a unique place for studying the ^{100}Sn region !**

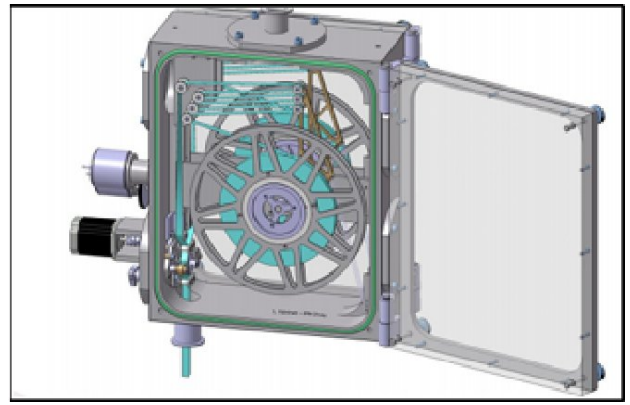
From **https://u.ganil-spiral2.eu/chartbeams/**

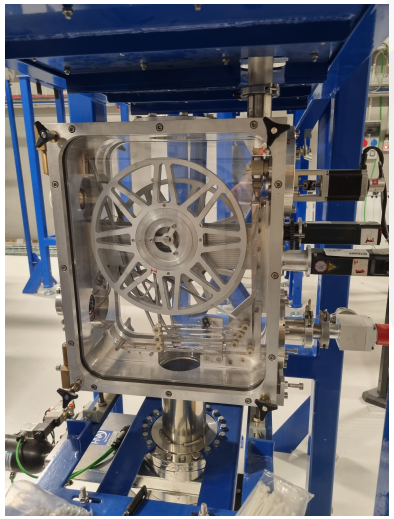
Design run-through

Instrumentation IDEAS³ : tape transport system

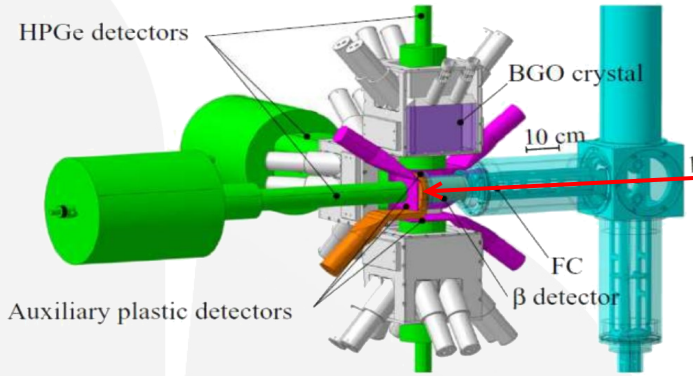
- Design based on BEDO@ALTO
- Beam collected on a tape

- Tape system below the beam line
- Based on latest design

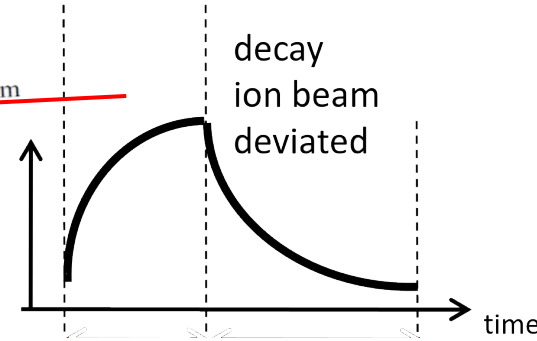




Tape transport system @ SPES (same design)

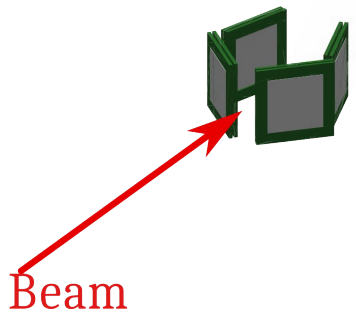


BEDO decay station @ ALTO



Instrumentation IDEAS³ : detection

- Design based on BEDO@ALTO
- Beam collected on a tape
- Multiple observables :
  - β^+ & particle tagging :
    - ➢ 4 Silicon telescopes



Silicon geometry :

- Maximise the efficiency (here ~28% total)
- Not in front of X-ray detectors
- Thickness ↔ sensitivity

Instrumentation IDEAS³ : detection

- Design based on BEDO@ALTO
- Beam collected on a tape
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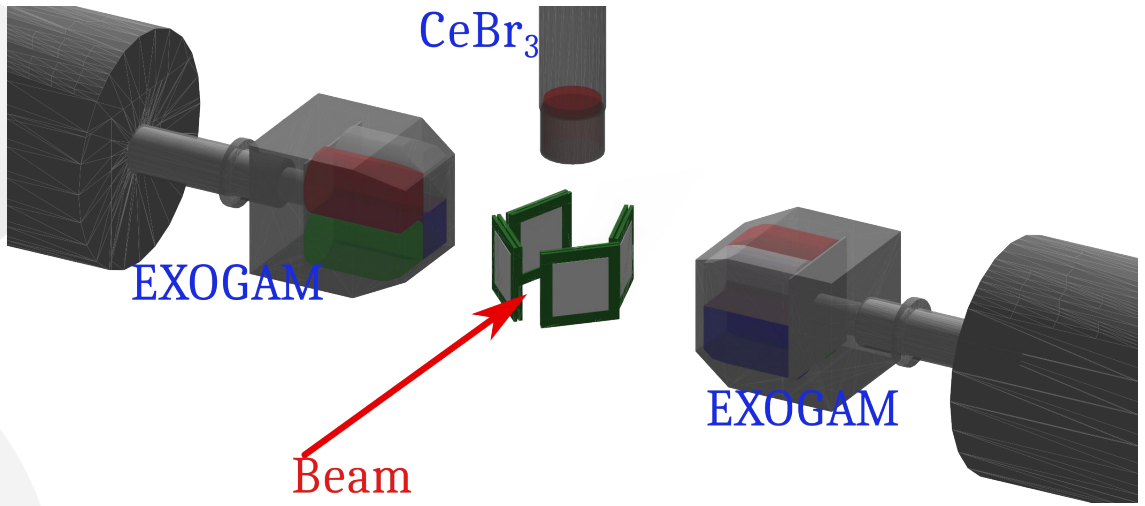
  - Gamma-spectrosopy
    - ➢ HPGe (Exogam)
    - ➢ $CeBr_3$ (HE)



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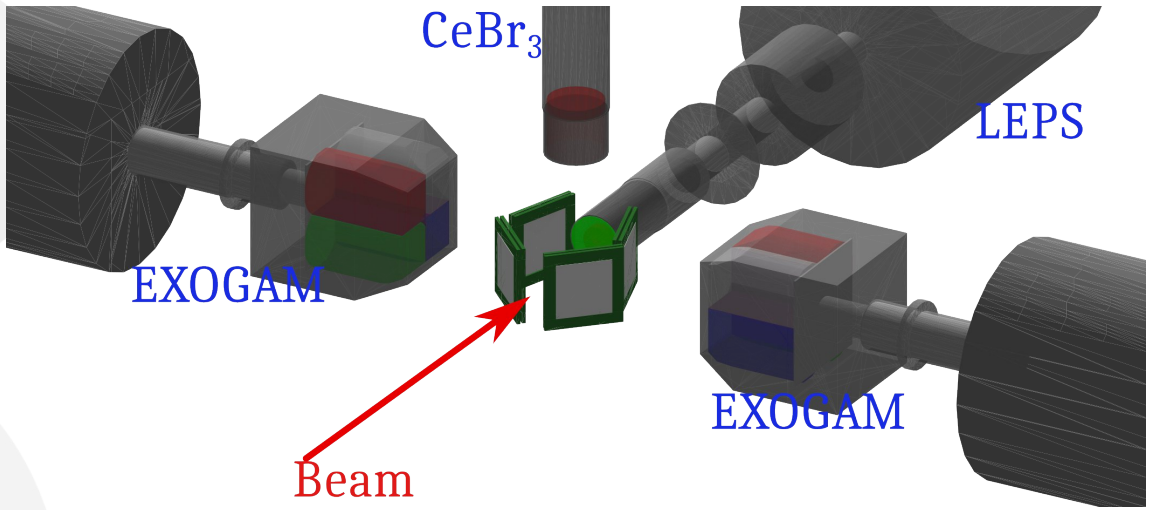
  - X-ray spectroscopy & IC tagging
    - ➢ Planar Germanium detector (LEPS)



(Geometry of the setup being simulated in Geant4)

Instrumentation IDEAS³ : detection

- Design based on BEDO@ALTO
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- Multiple observables :
  - β⁺ & particle tagging :
    - ➢ 4 Silicon telescopes
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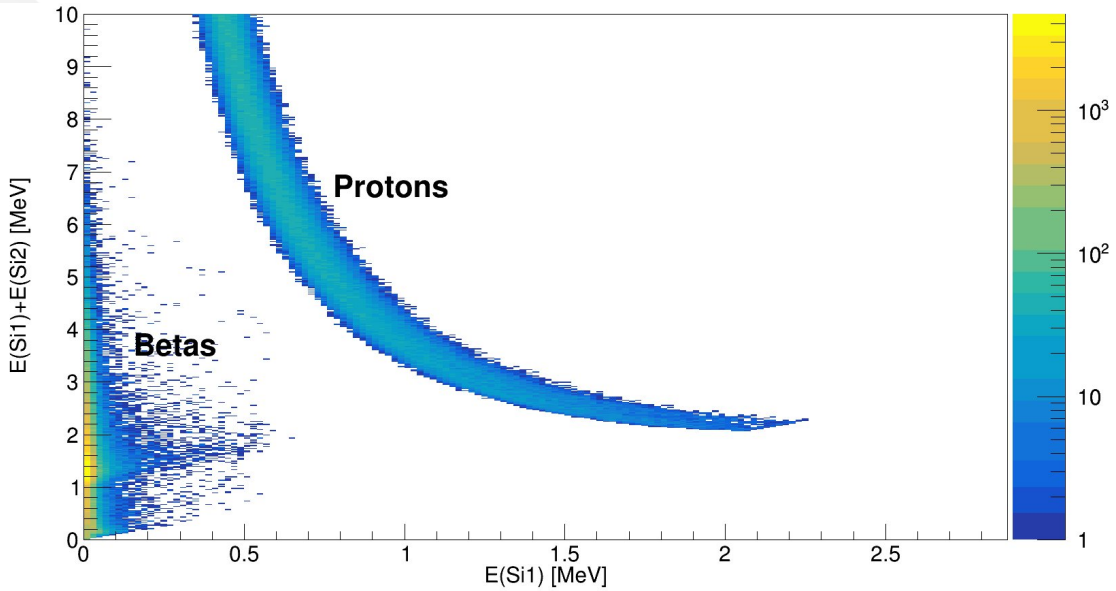
    - ➢ HPGe (Exogam)
    - ➢ $CeBr_3$ (HE)
  - X-ray spectroscopy & IC tagging
    - ➢ Planar Germanium detector (LEPS)
  - β-delayed proton spectroscopy
    - ➢ Silicon detectors



E-ΔE method thanks to Silicon telescopes

Setup components status

Ready components

- HPGe (EXOGAM)
- LEPS

To be acquired/constructed

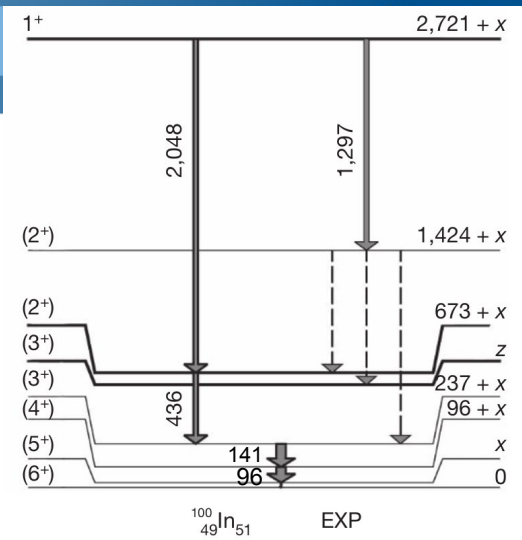
- Tape transport system
  - **Already funded**
  - Constructed @ IJCLab
  - Finalisation stages
- Vacuum chamber
  - Design in progress
- Silicon detectors
- $CeBr_3$ scintillator

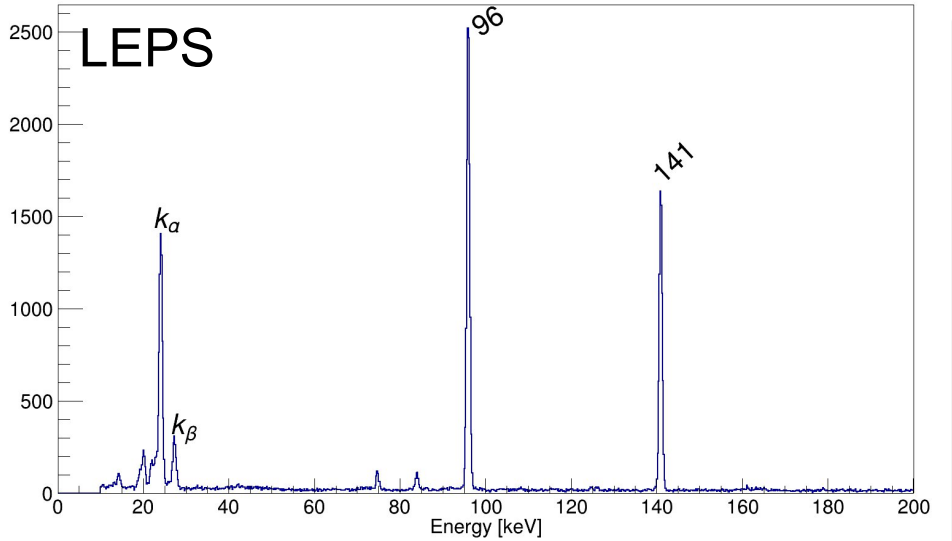
EXOGAM characteristics superior to needs + heavy use of Exogam @ GANIL

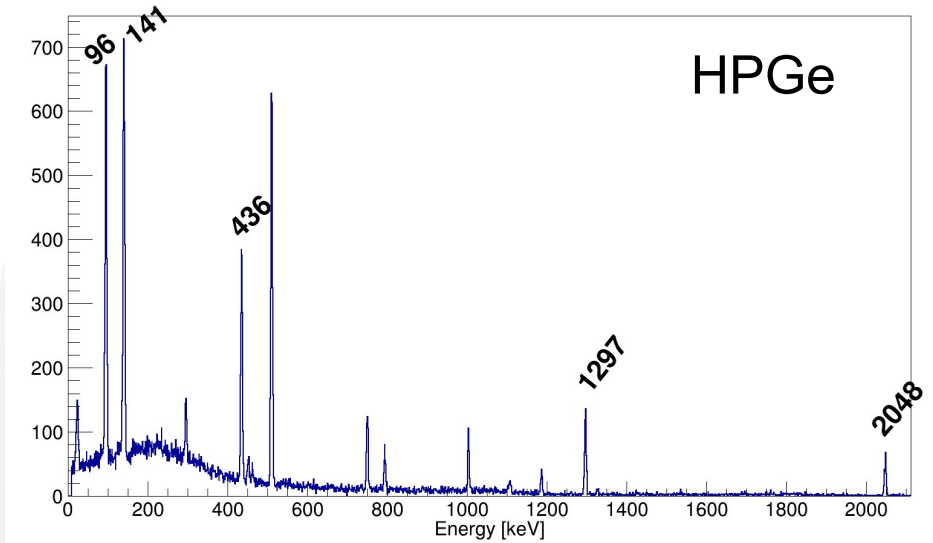
- Gamma detection modularity :
  - Dedicated (or general purpose) simpler HPGe in the future ?
    - In dicussion within ISOL-France community
  - Electrically cooled Germaniums can be used (cf SPIRAL 1)
    - More convenient
    - Always ready identification

Simulation

- NPTool framework :
  - Modular
  - Simulation & analysis framework
- Example of gamma spectroscopy capabilities
  (10^6 events ^{100}Sn beta decay ~ a day @ S³-LEB)

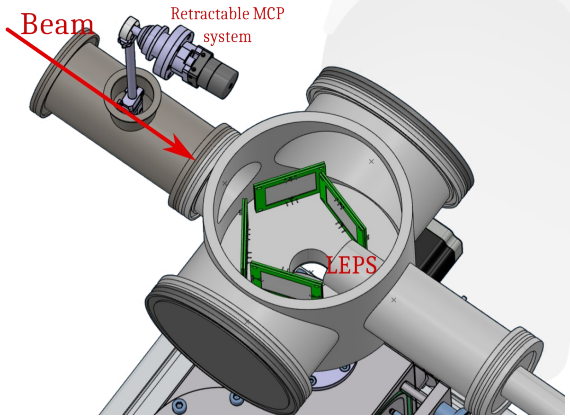




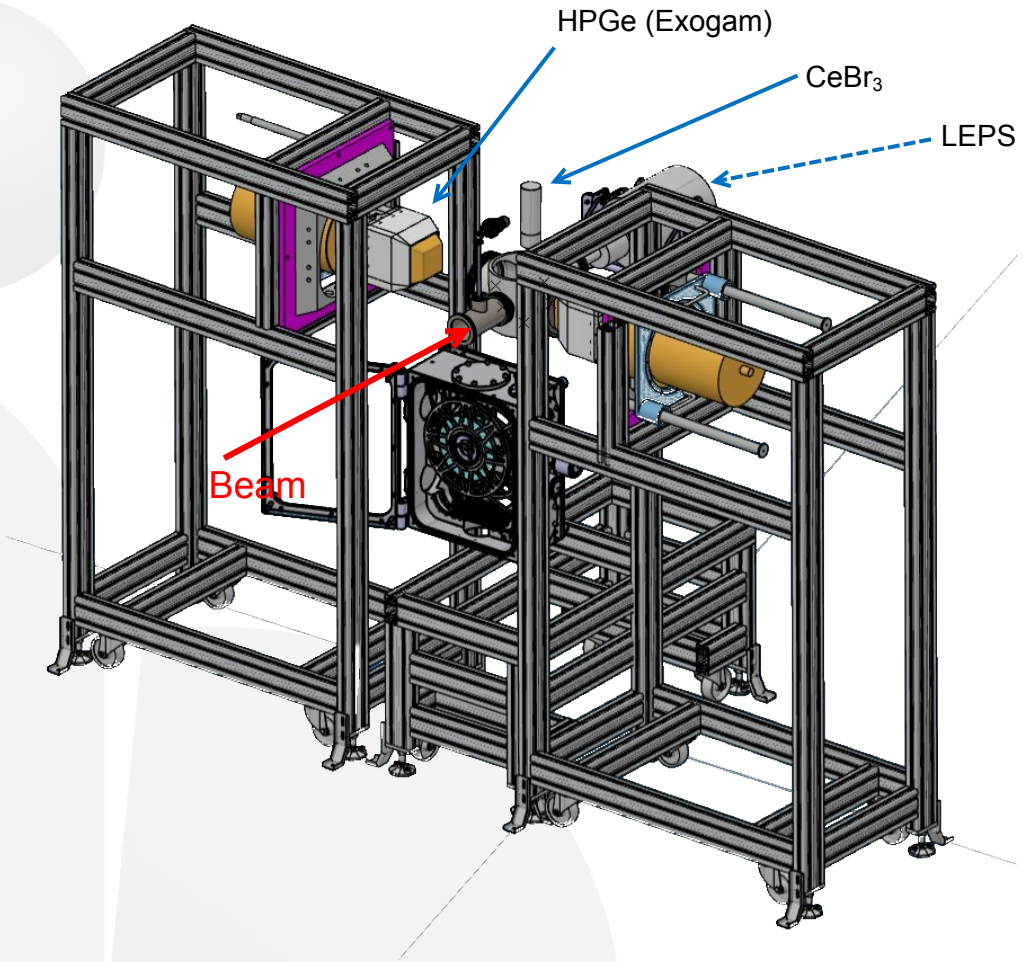


Mechanical design

- Mechanical design in progress
- Focus on :
  - Compactness
  - Accessibility
  - Modularity
- Rely on GANIL only for Ge cooling



Closer view of the vacuum chamber



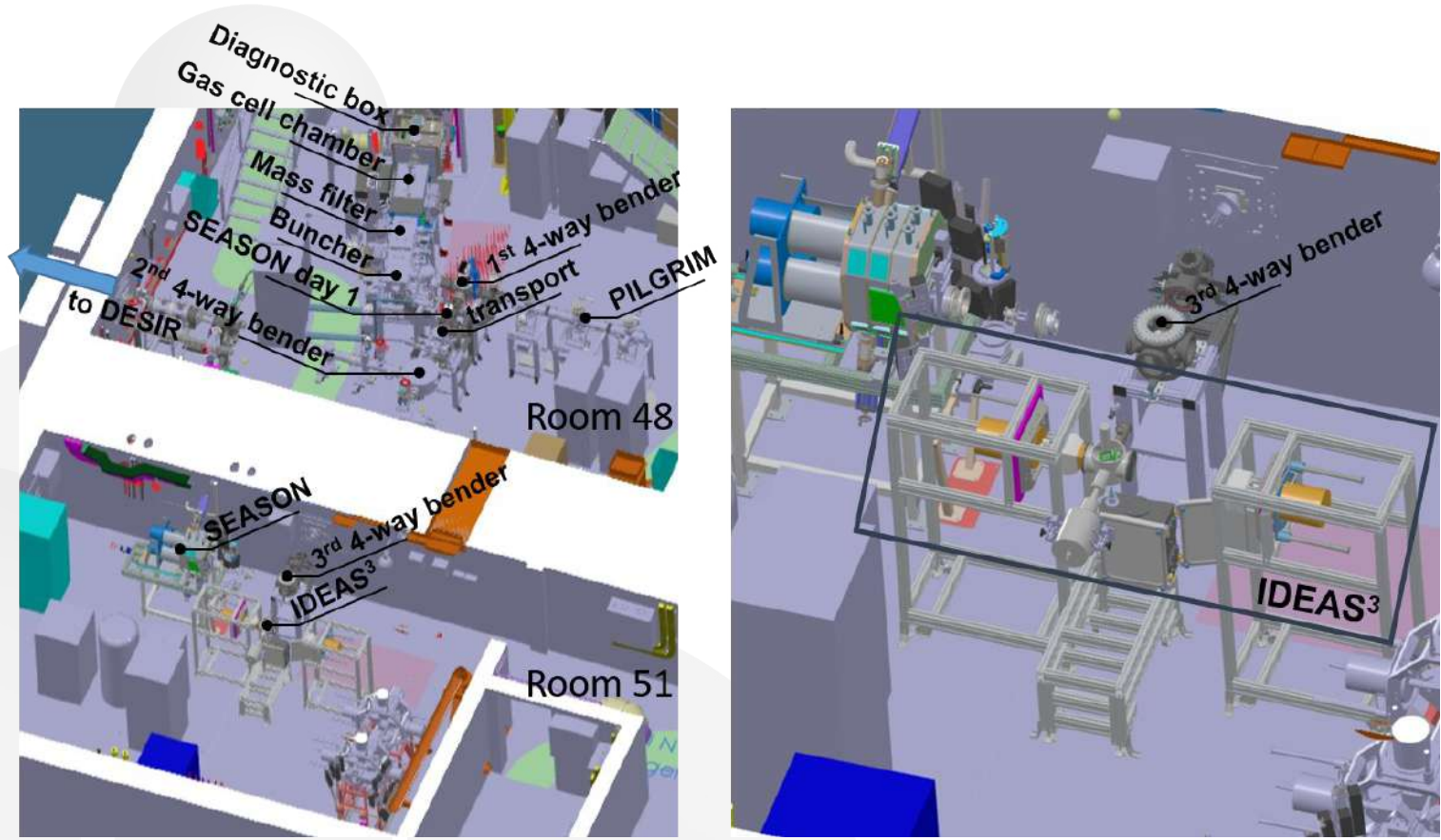
Implementation within S³-LEB

Position :

- Room 51
- 0 deg from 3rd bender

Planning :

- Summer 2025 :
  - Blueprints
  - Tape station ready
- Late 2025 :
  - Testing and mounting
- Early 2026 (S³ commissioning)
  - Mounted @ GANIL



Preliminary room layout

Human resources and budget

- Project endorsed by IJCLab CS
- IJCLab staff implicated

Researchers

Name	Status	2024	2025	Total (FTE)
IJCLab		**70%**	**70%**	**1,40**
L. Plagnol	Post-doc	50%	50%	1,00
D. Verney	Perm.	10%	10%	0,2
V. Manea	Perm.	5%	5%	0,1
I. Matea	Perm.	5%	5%	0,1
TOTAL (FTE)		**0,70**	**0,70**	**1,40**

IT

Name	Status	2024	2025	Total (FTE)
IJCLab		**173%**	**173%**	**346%**
C. Delafosse (Det)	Perm.	40%	40%	0,80
N. Karkour (Electronics)	Perm.	5%	5%	0,10
T. Viaud (Online)	Perm.	50%	50%	1,00
F. Legrand (BE)	Perm.	70%	70%	1,40
S. Olmo (SR2M)	Perm.	4%	4%	0,08
M. Imre (SR2M)	Perm.	4%	4%	0,08
TOTAL (FTE)		**1,73**	**1,73**	**3,46**

Human resources and budget

- Project endorsed by IJCLab CS
- IJCLab staff implicated
- Mechanics budget evaluation
  - Exogam support : 22 k€
  - Vacuum chamber support : 25 k€
  - Vacuum chamber : 27 k€
  - Interfaces (beam, tape system) : 7.2 k€
  - ➢ Total : 81.2 k€

+ Detection ~ 150 k€

Thank you !

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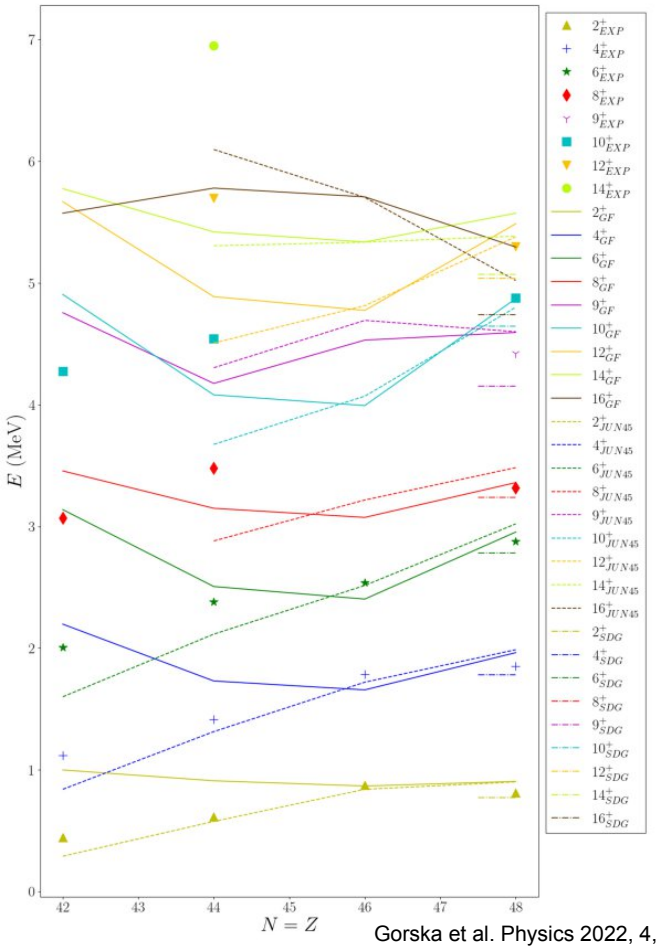
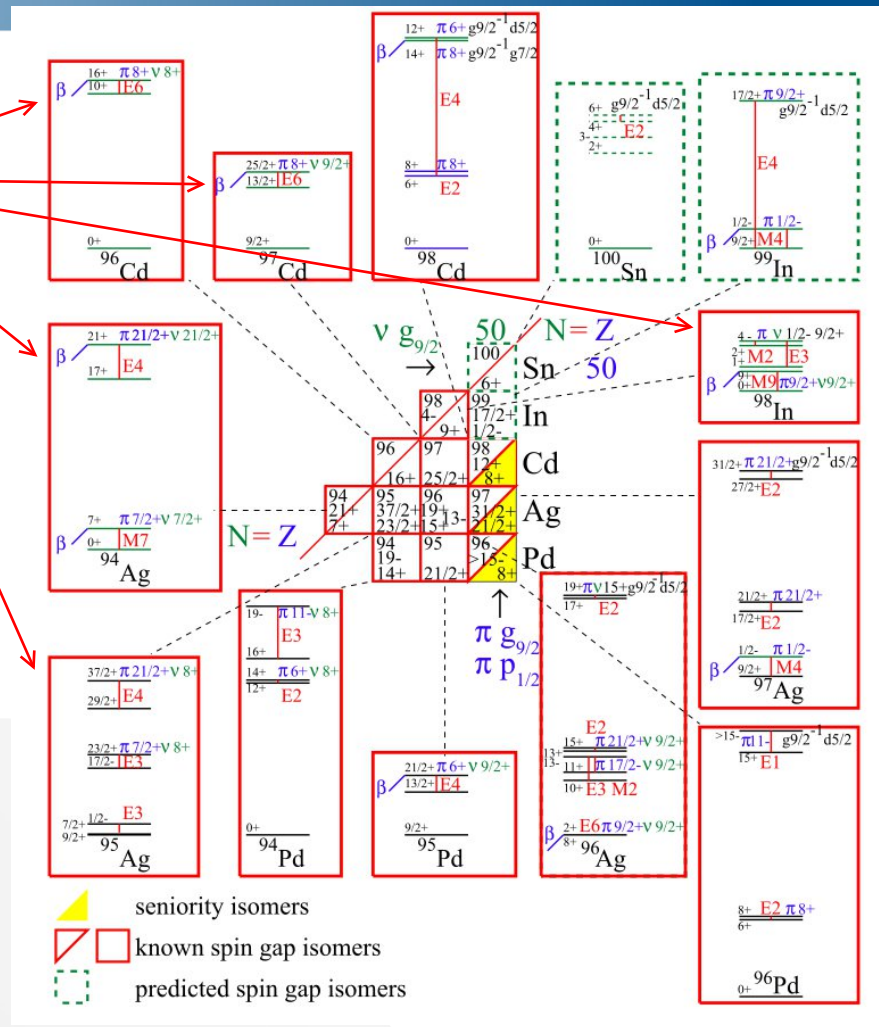
Backup other physics cases

- Isomers @ Z<50, N<50

Unknown excitation energy !



Gorska et al. Physics 2022, 4, 364-382



Faestermann et al. Prog Part Nuc Phys 69 (2013) 85