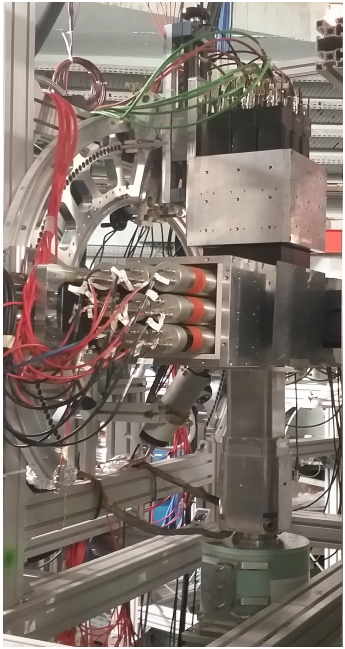


JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

IJCLab Irène Joliot-Curie
Laboratoire de Physique des 2 Infinis

# Pygmy dipole resonance studies of $^{82}Ga$ via $\beta$-decay spectroscopy using PARIS array

## Les lundis du CAT

Lama Al Ayoubi

May 3, 2021

# Physics Motivation

# PDR studies in neutron-rich nuclei

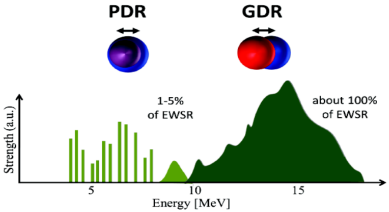
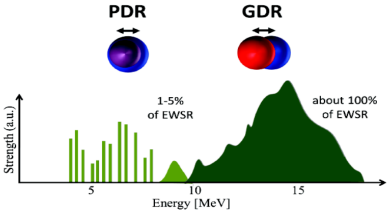



Figure by A. Zilges

# PDR studies in neutron-rich nuclei

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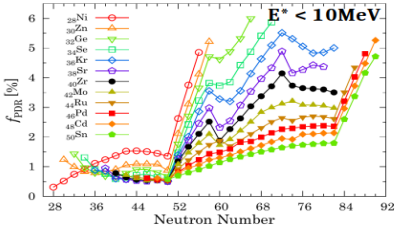
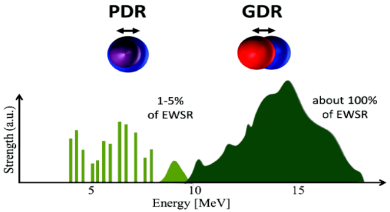



Ebata et al., PRC90, 024303 (2014)

- Predicted enhancement after crossing N=50

# PDR studies in neutron-rich nuclei

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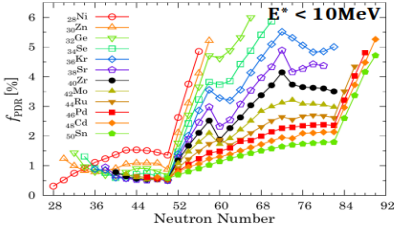


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- Predicted enhancement after crossing N=50
- Enhancement with exoticity (further from stability, better it is ...)

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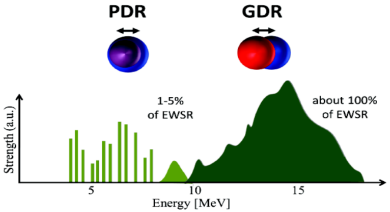


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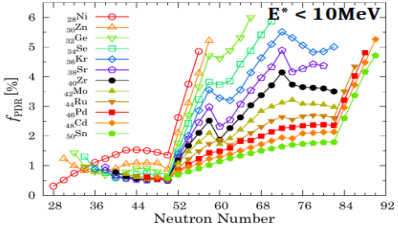
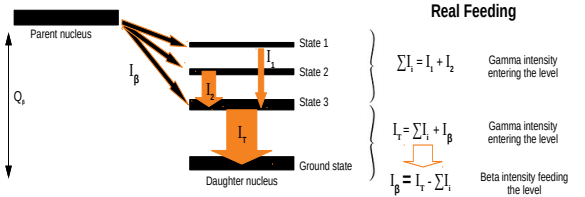


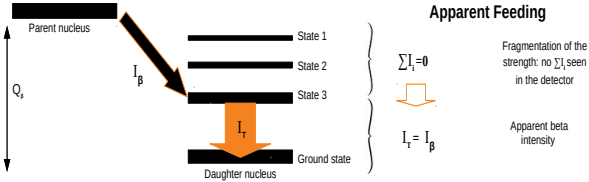

Ebata et al., PRC90, 024303 (2014)

- Predicted enhancement after crossing N=50
- Enhancement with exoticity (further from stability, better it is ...)
- The Low production rate of very neutron-rich systems makes investigating the PDR via the standard charge-exchange or Coulomb-excitation reactions difficult → $\beta$-decay

# Pandemonium effect

## What happens if we miss some $\beta$-intensity?



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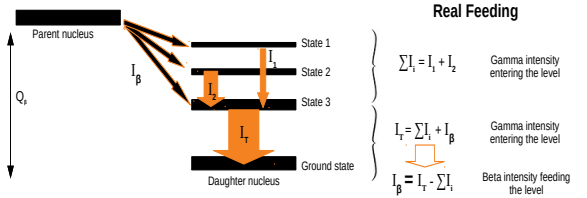


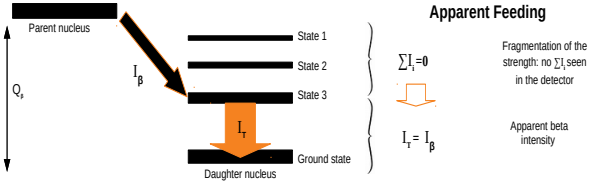


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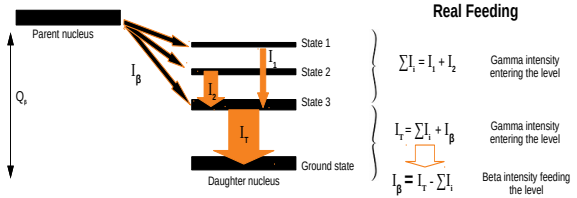


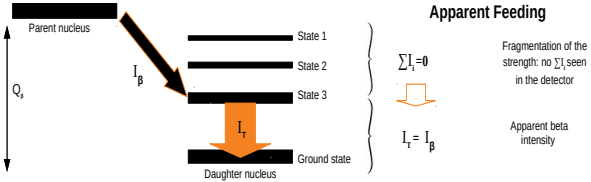


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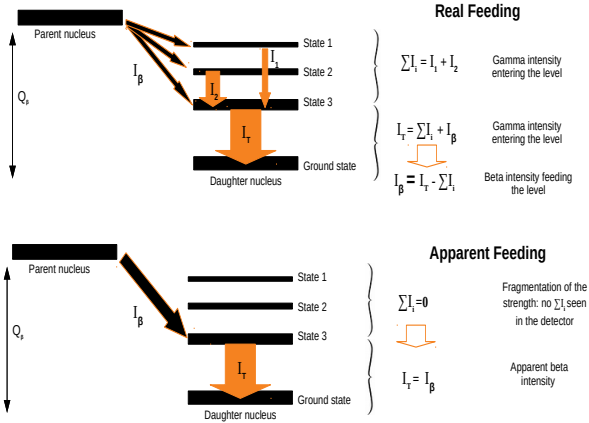


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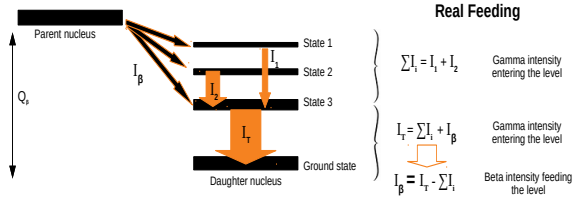


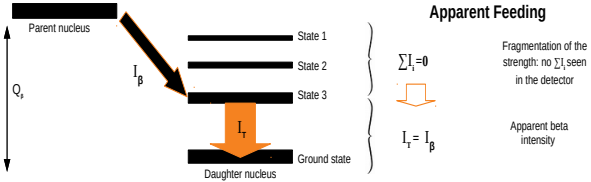


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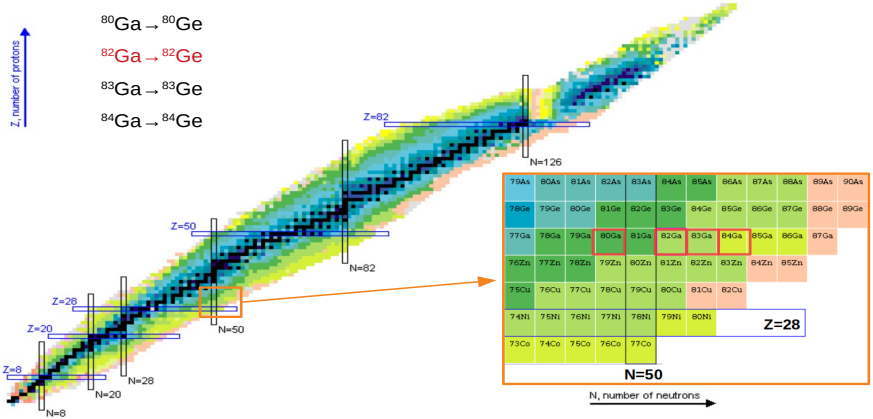
- It was introduced by the work of Hardy *et al.* (Phys.Lett 71B (1977) 307).
- Their study questions the possibility of building correctly a level scheme from a $\beta$-decay experiment using conventional techniques.
- Solution: The use of high energy $\gamma$-rays detectors.

# $\beta$-decay of $^{82}Ga$

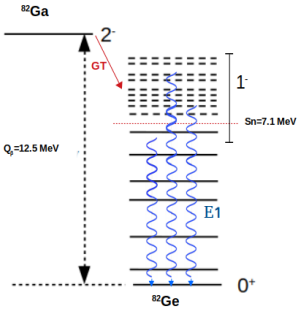
The start of a program to investigate the population of PDR states through β-decay in $N \geq 50$ isotonic chains at ALTO



# $\beta$-decay of $^{82}Ga$

- High $Q_\beta$ +Low neutron separation energy $S_n$
- $J^\pi$ selection rules compatible between GT transitions and E1 decays to the ground state

  $\rightarrow$so likely to populate $1^-$ states



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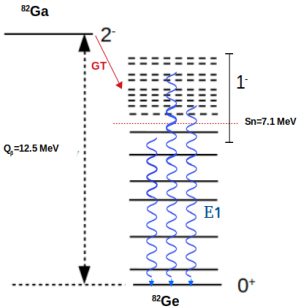
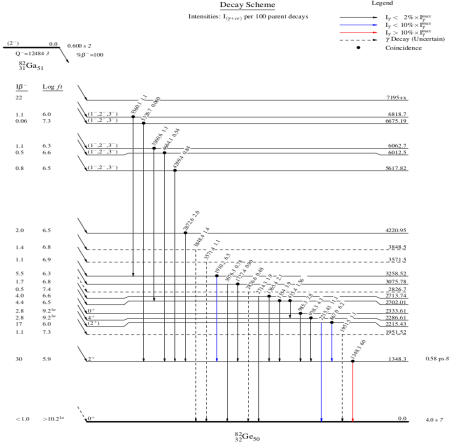
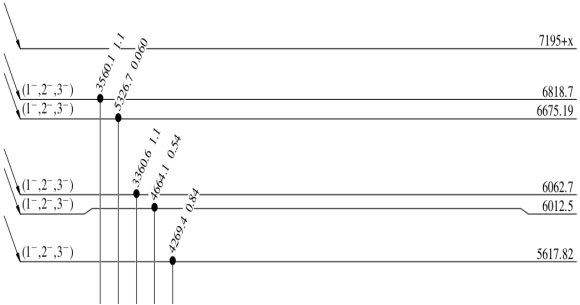


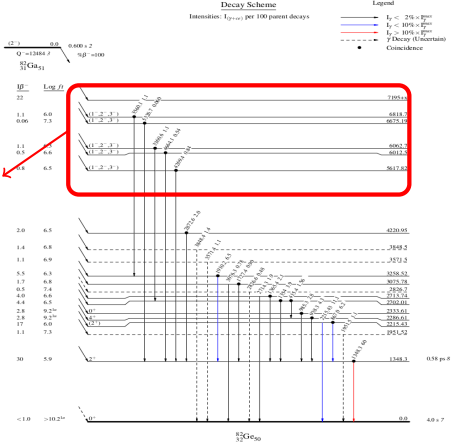




M. F. Alshudifat et al. Phys. Rev. C 93, 044325 (2016)
D. Testov et al. Nuclear Inst. and Methods in Physics Research, A (2016)

# $\beta$-decay of $^{82}Ga$

- High $Q_\beta$ +Low neutron separation energy $S_n$
  → **no reported states above $S_n$**
- $J^\pi$ selection rules compatible between GT transitions and E1 decays to to the ground state
  → **no E1 transitions to the ground state are seen**
- **The highest $\gamma$-ray detected is 2 MeV below $S_n$**

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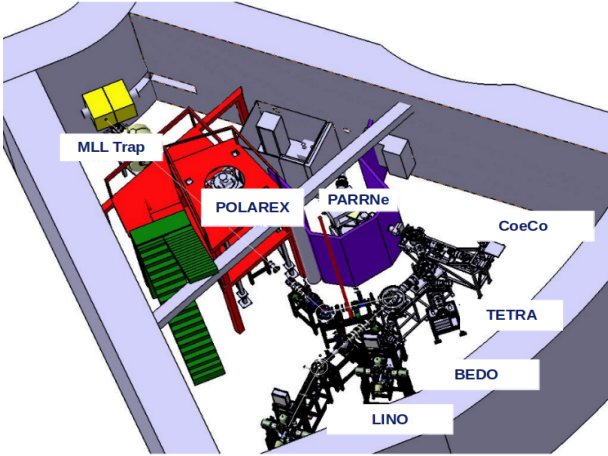
# Experimental Setup

# ALTO facilty

## Accélérateur Linéaire et Tandem d'Orsay

- Electron beam accelerated at 50 MeV on a target of 70g of $UC_x$ to produce radioactive nuclei by photofission of uranium.



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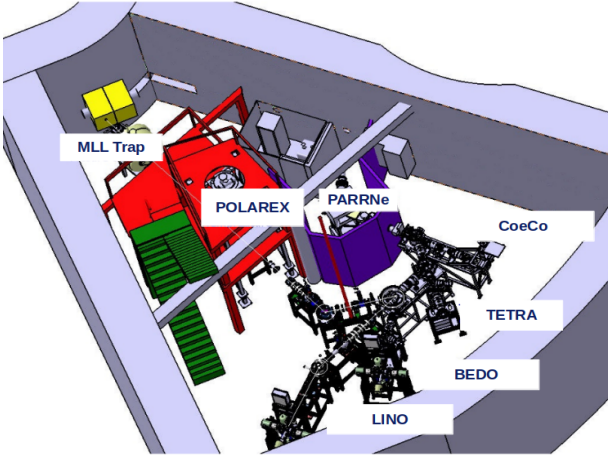

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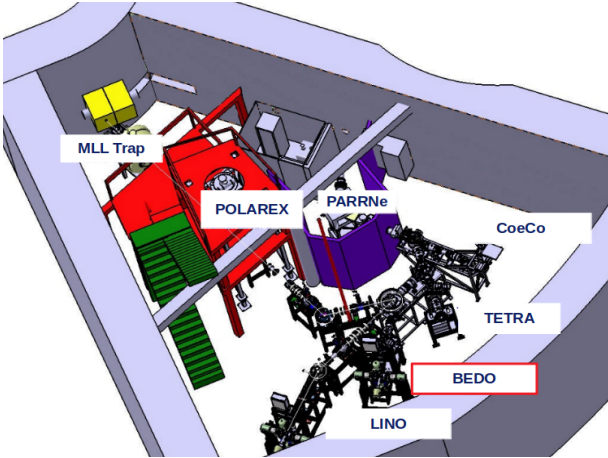
- BEDO: BEta Decay studies at Orsay



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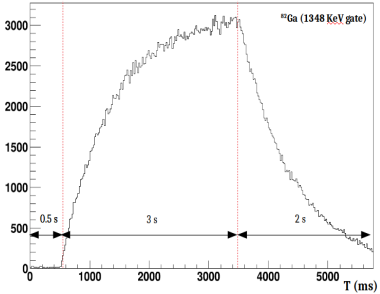


- BEDO tape station
- Plastic detector for $\beta$-particles detection (efficiency $\sim$ 60 % )
- A Segmented clover detector (efficiency $\sim$ 0.4 % @ 1-MeV )
- A HPGe detector (efficiency $\sim$ 2.3 % @ 1-MeV )
- 3 PARIS clusters for efficient high-energy $\gamma$-ray detection (efficiency $\sim$ 5 % @ 8-MeV )

**Trigger condition: $\beta$-$\gamma$ coincidence**

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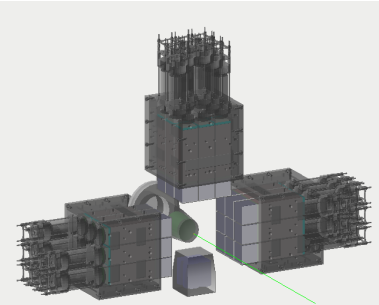

(SToGS : https://github.com/stezow/stogs)

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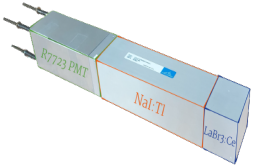
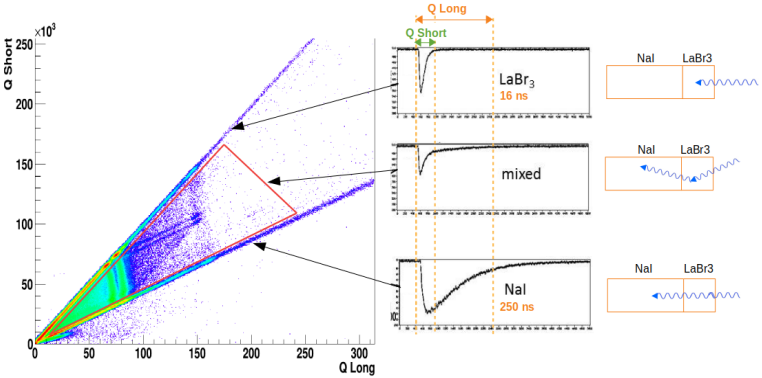
# PARIS particularity



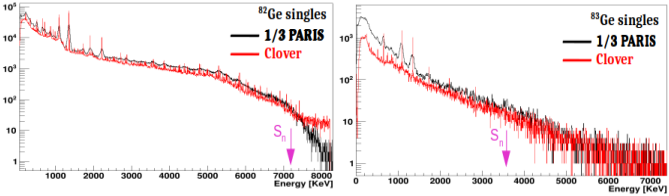

***Phoswich detector:*** LaBr3/CeBr3 crystal (2”x2”x2”) + NaI crystal (2”x2”x6”) + PMT



# Preliminary Results

# High energy $\gamma$ detected

High energy levels are populated in $^{82,83}Ge$



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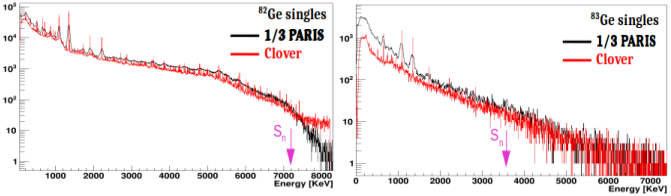
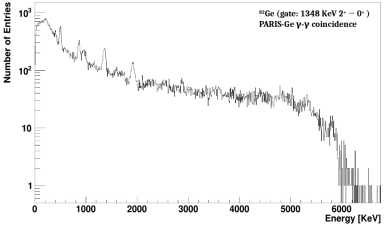
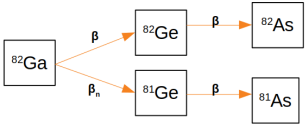
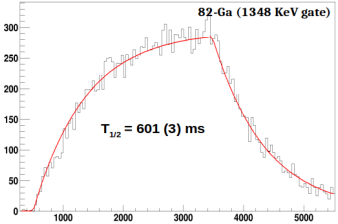


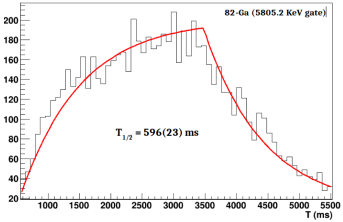



# Bateman fit to extract $T_{1/2}$

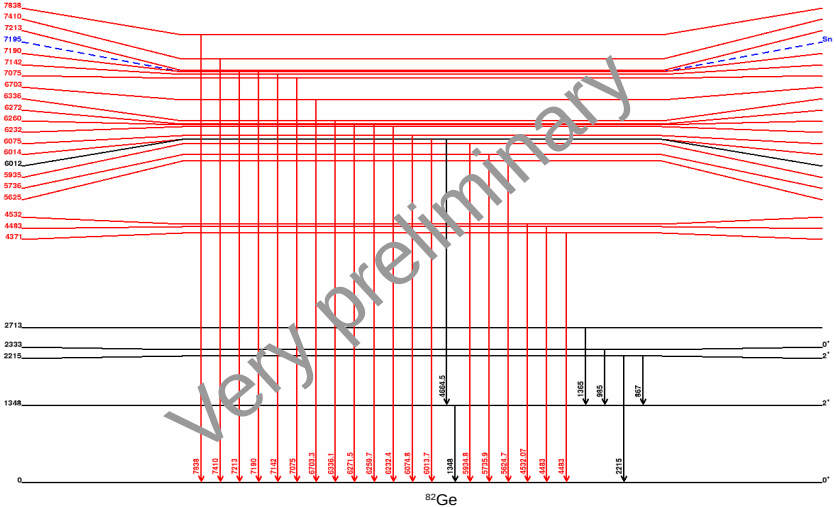



- $T_{1/2}$ = 601 (3) ms (599 (2) ms NNDC) on the most intense $^{82}Ge$ peak
- $T_{1/2}$ = 596 (23) ms at higher energy
  => compatible with $T_{1/2}$ of $^{82}Ga$



# Preliminary level scheme of $^{82}Ge$



# Summary

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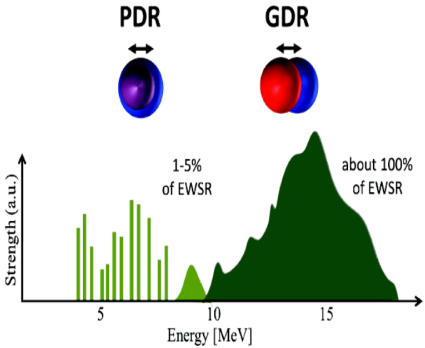

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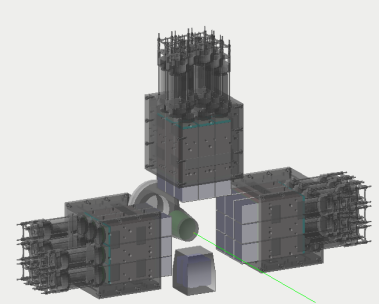

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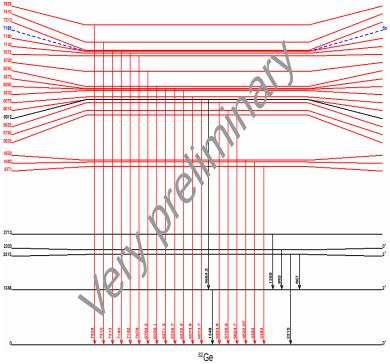
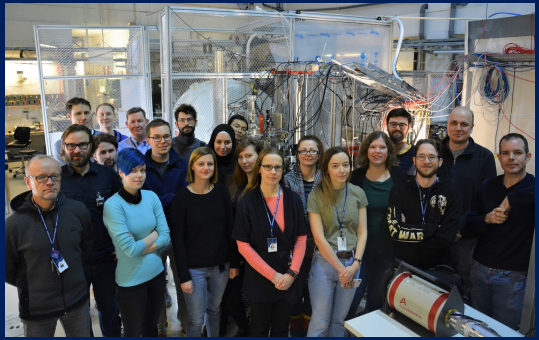
1. An experiment was performed to populate PDR states via beta decay of Ga isotopes at ALTO facilty.
2. The setup used was composed of Ge detectors and the PARIS array.
3. High energy levels around and above $S_n$ are populated in $^{82}Ge$ and $^{83}Ge$ , analysis is ongoing.



# Acknowledgment



This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreements No. 771036 (ERC CoG MAIDEN) and No. 654002 (ENSAR2).
I got ENSAR support for my beamtime participation and therefore it would be good to acknowledge it.