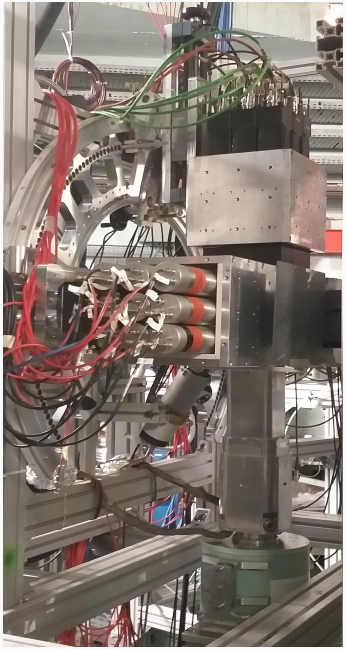

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UNIVERSITY OF JYVÄSKYLÄ

IJCLab
Irène Joliot-Curie
Laboratoire de Physique des 2 Infinis

Pygmy dipole resonance studies of ^{82}Ga via β-decay spectroscopy using PARIS array

Isol-France meeting

Lama Al Ayoubi

March 17, 2021

Outline

Physics Motivation

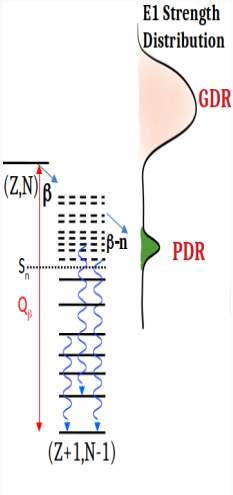
Experimental Setup

Data Analysis

Preliminary Results

Physics Motivation

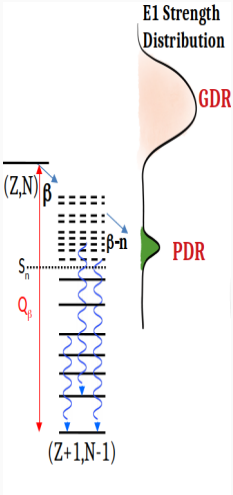
PDR studies in neutron-rich nuclei



Pygmy Dipole Resonance:

Oscillation of a neutron skin against a symmetric core of proton/neutron

PDR studies in neutron-rich nuclei



- < 10% of the total B(E1)

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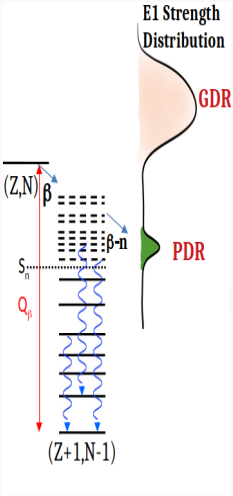

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- Predicted enhancement after crossing N=50

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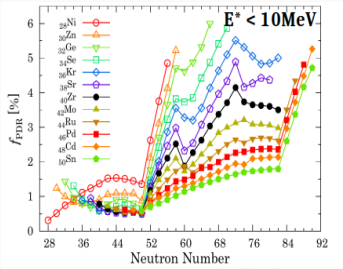
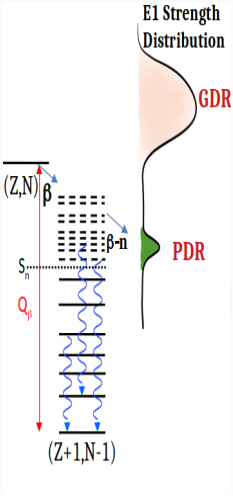


Ebata et al., PRC90, 024303 (2014)

PDR studies in neutron-rich nuclei



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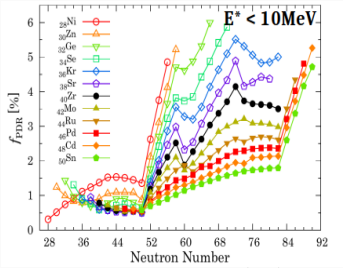

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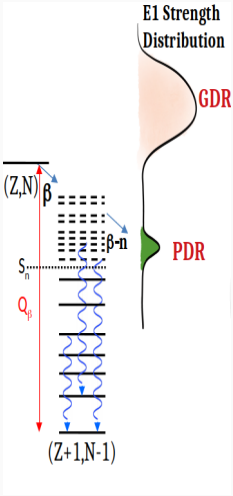

- < 10% of the total B(E1)
- Predicted enhancement after crossing N=50
- Enhancement with exoticity (further from stability, better it is …)
- Enhancement of Γγ→ consequence on (n,γ) cross sections which in turn has impact on the r-process calculations.

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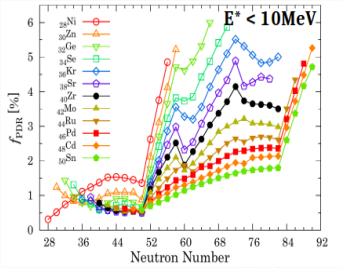
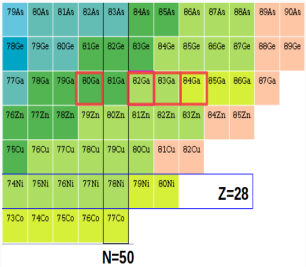


Ebata et al., PRC90, 024303 (2014)

β-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



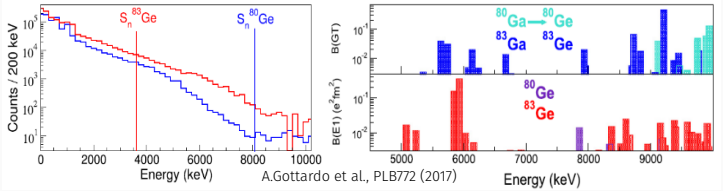
$^{80}Ga \rightarrow {}^{80}Ge$

$^{82}Ga \rightarrow {}^{82}Ge$

$^{83}Ga \rightarrow {}^{83}Ge$

$^{84}Ga \rightarrow {}^{84}Ge$

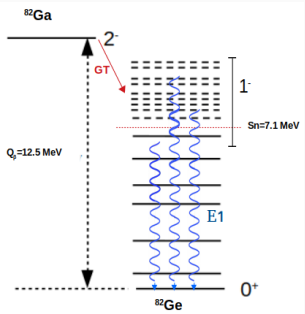
ALTO-RIB experiment: Measurement (1 single LaBr3): $^{80}Ga \rightarrow {}^{80}Ge$ and $^{83}Ga \rightarrow {}^{83}Ge$



- Gamow-Teller (GT) beta decay creates a depletion of n-density in the core.
- The excited ^{83}Ge states can then decay via E1 γ-emission with a «PDR-like» transition densities.
- The Low production rate of very neutron-rich systems makes investigating the PDR via the standard charge-exchange or Coulomb-excitation reactions difficult → β-decay

β-decay of ^{82}Ga

- High Q_β +Low neutron separation energy S_n
- J^π selection rules compatible between GT transitions and E1 decays to the ground state
  $\rightarrow$so likely to populate 1^- states



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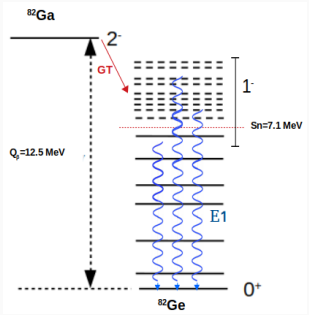
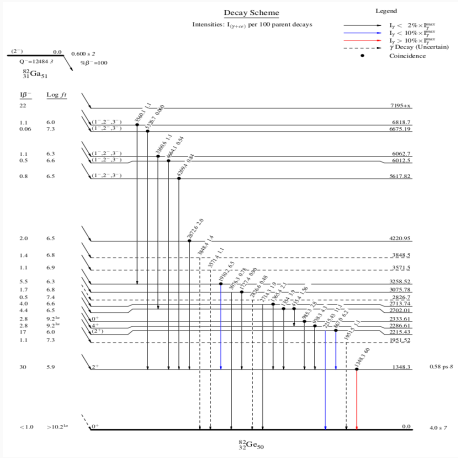
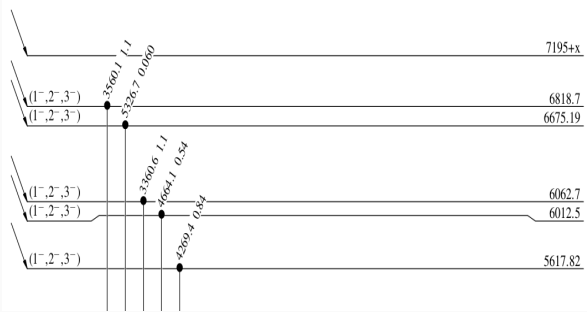


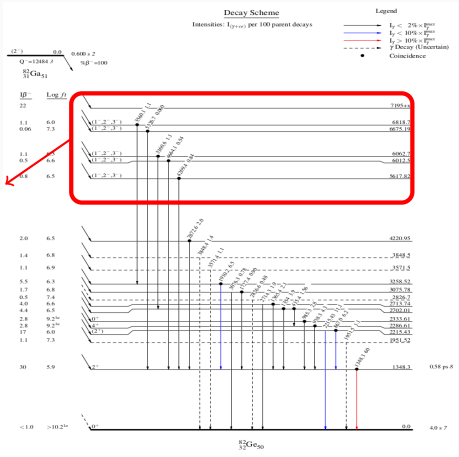


M. F. Alshudifat et al. Phys. Rev. C 93, 044325 (2016)
D. Testov et al. Nuclear Inst. and Methods in Physics Research, A (2016)

β-decay of ^{82}Ga

- High Q_β +Low neutron separation energy S_n
  → no reported states above Sn
- J^π 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 γ-ray detected is 2 MeV below Sn





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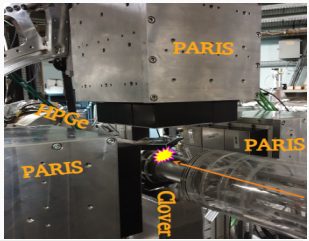
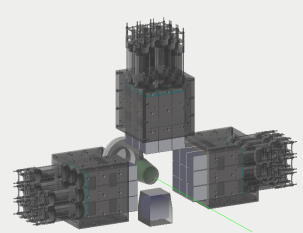
Experimental Setup

Experimental Setup

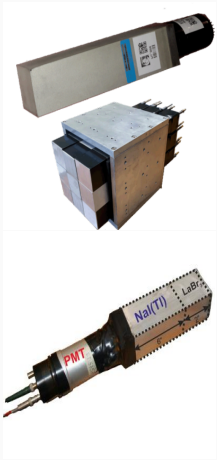




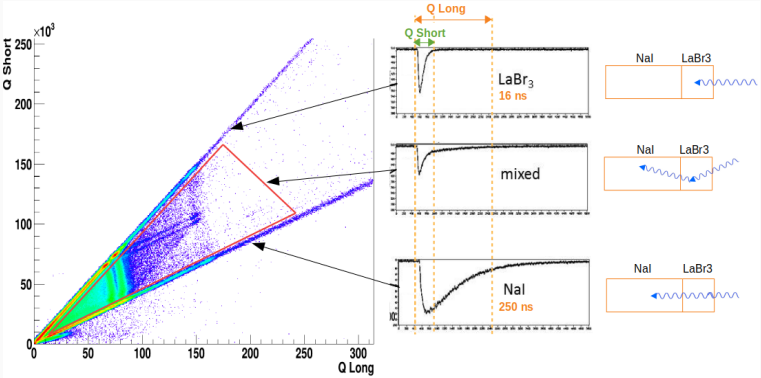
(SToGS : https://github.com/stezow/stogs)

- ALTO facility: Use of laser resonance ionisation
  to select only Ga element
- BEDO tape station
- Plastic detector for β-particles detection
- A Segmented clover detector
- A HPGe detector
- 3 PARIS clusters for efficient high-energy γ-ray detection.

PARIS performance



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



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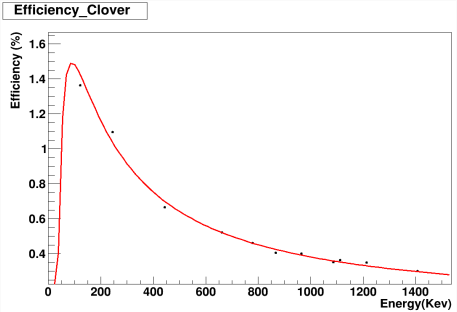
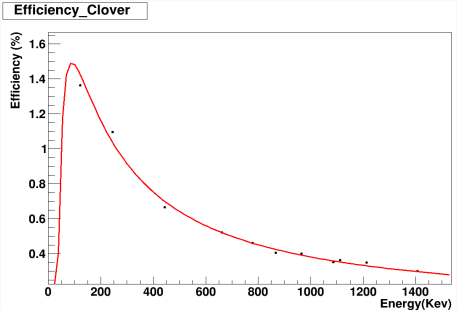
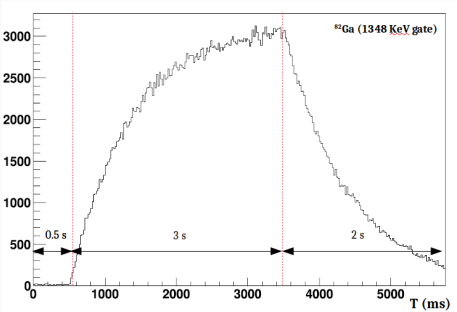


- HPGe efficiency : $\sim$ 0.4 % @ 1-MeV
- PARIS efficiency : $\sim$ 5 % @ 8-MeV
- $\sim$ 60 % efficiency for beta detection

Experimental Setup





- HPGe efficiency : $\sim$ 0.4 % @ 1-MeV
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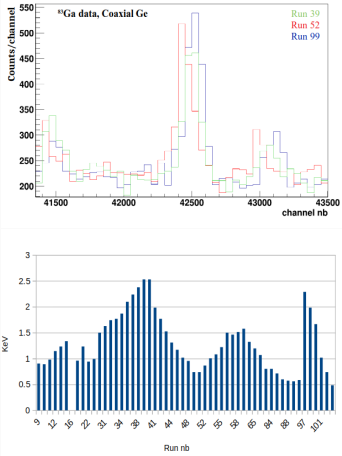
- 3 sec : Beam collection
- 2 sec : Decay time
- 0.5 sec : Background

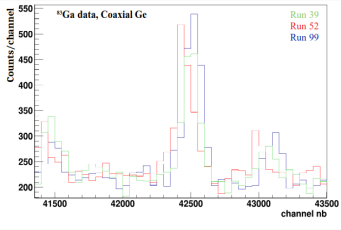
Data Analysis

Energy calibration



- Gain drift observed in all detector types
- Example: The positions of the internal radioactivity of PARIS peak have been tracked in the coax and compared to run number 8
- Solution: calibrate the group of files that have similar gain

Energy calibration



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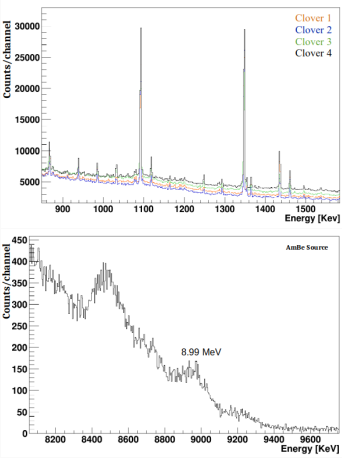
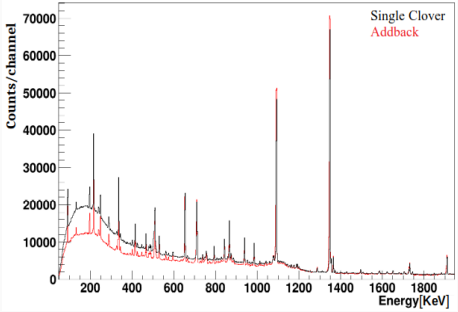
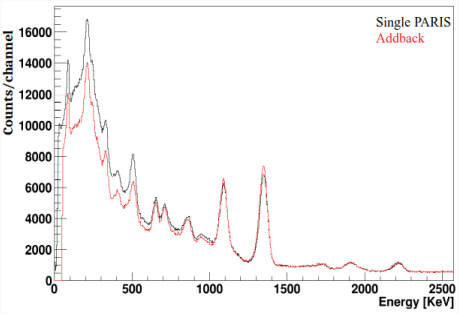


Detector Addback



Time window: 50 ns

Addback factor: 1.4 at 1348 KeV

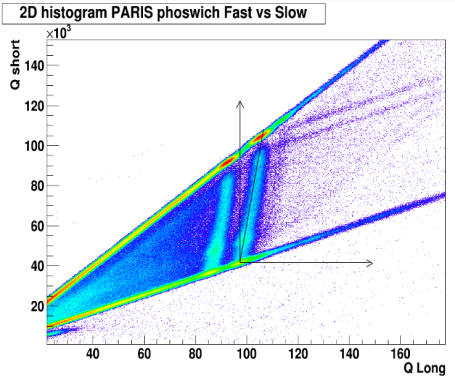


Time window: 30 ns

Addback factor: 1.1 at 1348 KeV

PARIS Internal Addback

More than 10 % of events are recovered from internal addback



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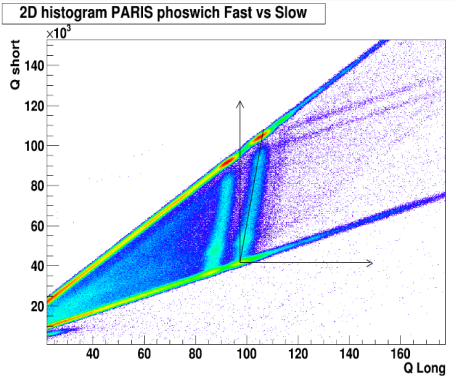
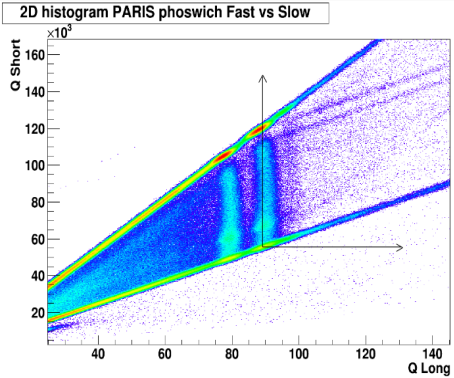
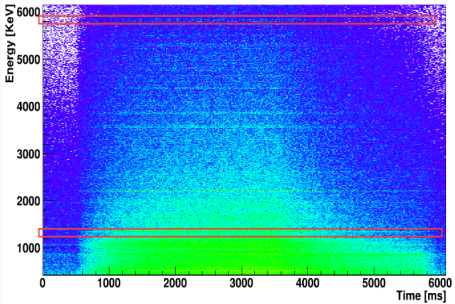


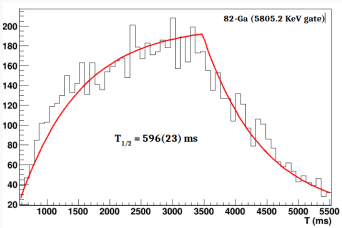


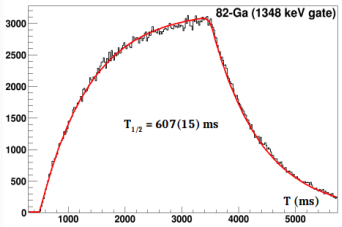
Preliminary Results

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

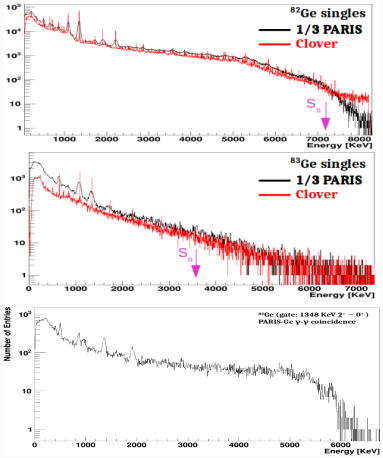
- $T_{1/2}$ = 607 (15) ms (599 (2) ms NNDC) on the most intense ^{82}Ge peak
- $T_{1/2}$ = 596 (23) ms at higher energy => compatible with $T_{1/2}$ of ^{82}Ga







High energy γ detected



High energy levels are populated in ^{82}Ge

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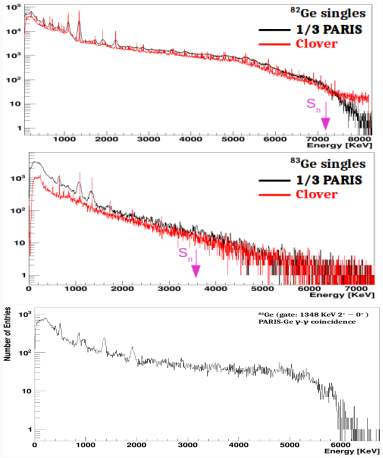

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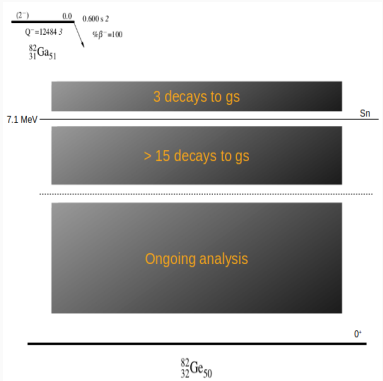

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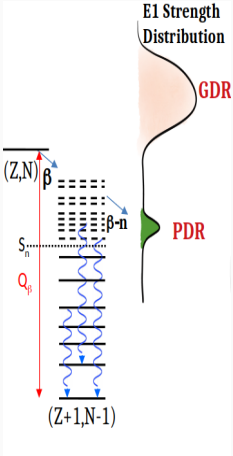

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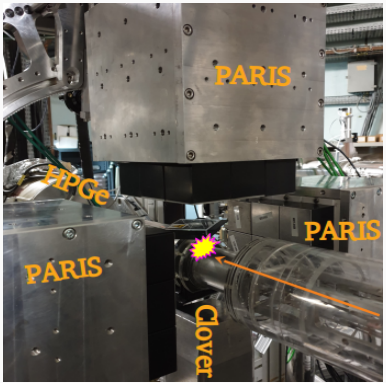

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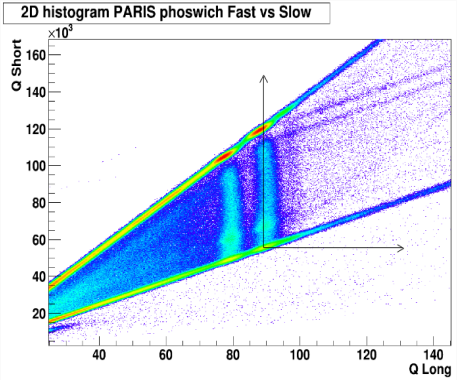

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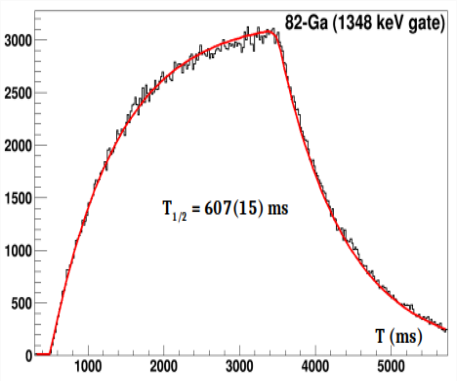

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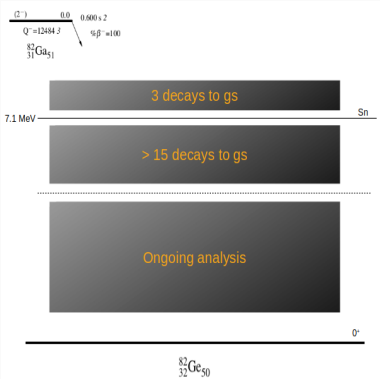
2. The setup used was composed of Ge detectors and the PARIS array.
3. Energy calibration and addback procedure were presented as part of the data analysis.
4. The half life of 82Ga was found to be 607 (15) ms
5. High energy levels around and above Sn are populated in ^{83}Ge and ^{82}Ge , analysis will be finished soon.



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.