β-delayed beyond-threshold spectroscopy program at ALTO using the MONSTER and PARIS spectrometers

Mathieu Babo, Institut de Physique Nucléaire d'Orsay

PARIS Workshop - Warsaw - 24-5-6/12/2108

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1) Introduction to the physics case
   - Structure above S_n
   - Pygmy resonances in n-rich

2) Experimental Set-up
   - ALTO and the room 110
   - PARIS and MONSTER @ ALTO

3) Prospectives
   - Future campaign
   - Timeline

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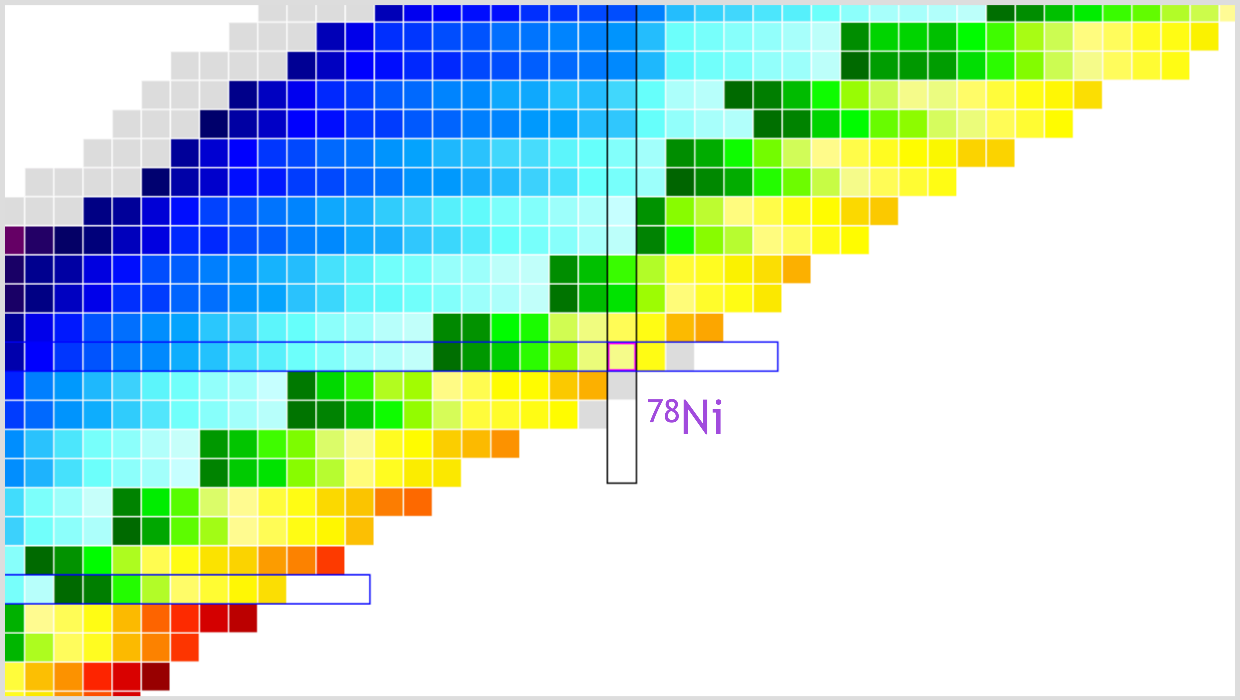

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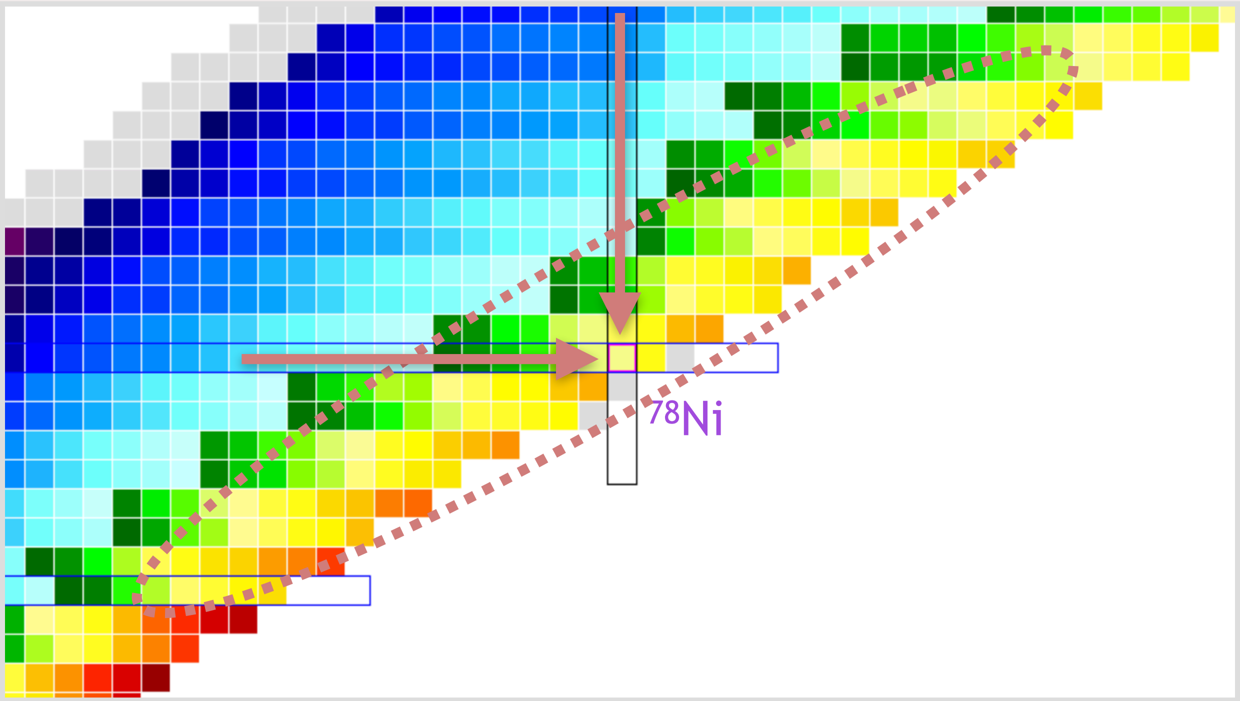
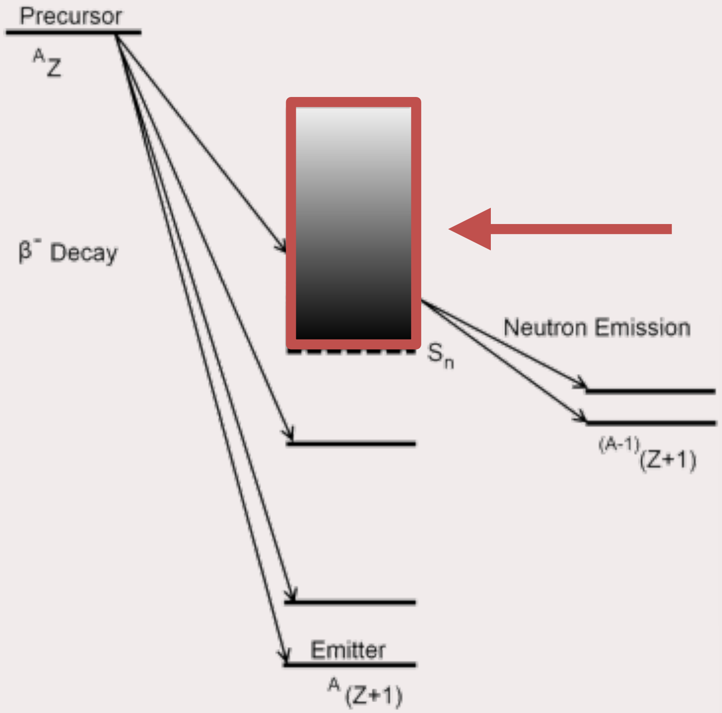


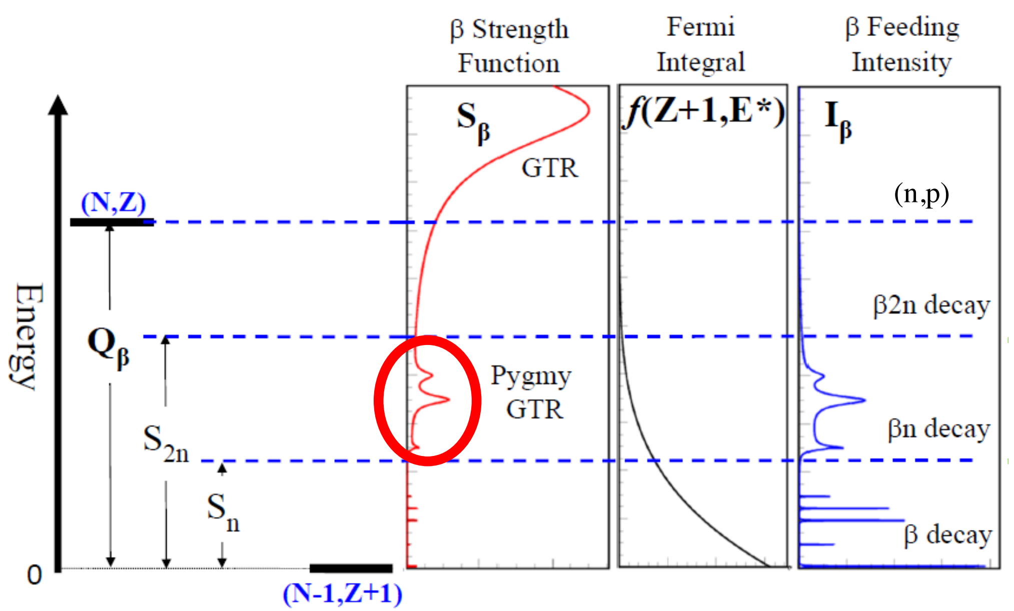
1) Introduction to the physics case

- Large Q_β and decrease of S_{n-2n}
- β-delayed (one- and two-) neutron decay channels are open
- Powerful tool to perform spectroscopy of unbound excited states !



1) Introduction to the physics case

- Discrete states but also collective GT resonances
- B(GT) not negligible … but “killed” by *f*



Courtesy of D. Verney

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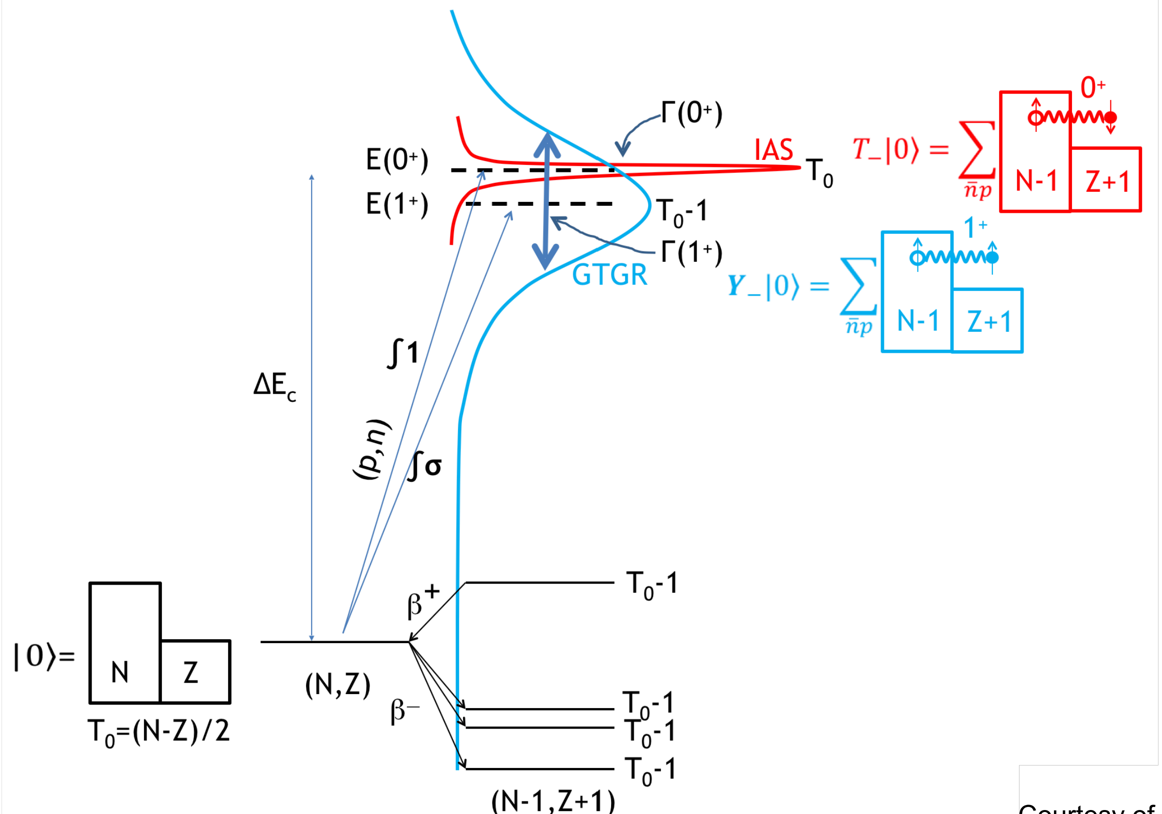

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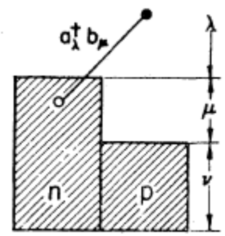
1) Introduction to the physics case

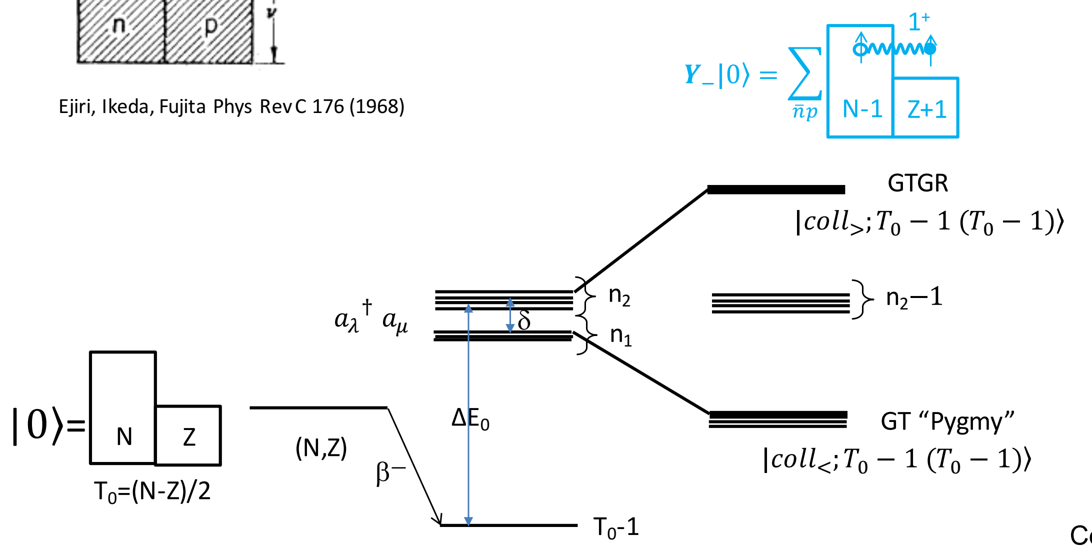
- On a nuclear-structure point of view

Ikeda, Fujita, Ejiri et *al.*
Phys Lett 2 169 (1962)
Phys Lett 3 271 (1963)
Nuc Phys 67 145 (1965)
Phys Rev 133 B549 (1964)
Prog Theor Phys 38 107 (1967)
Phys Rep 38 85 (1978)

Gaponow and Lyutostanskii
Sov J Part Nucl 12 528 (1981)



Ejiri, Ikeda, Fujita Phys Rev C 176 (1968)



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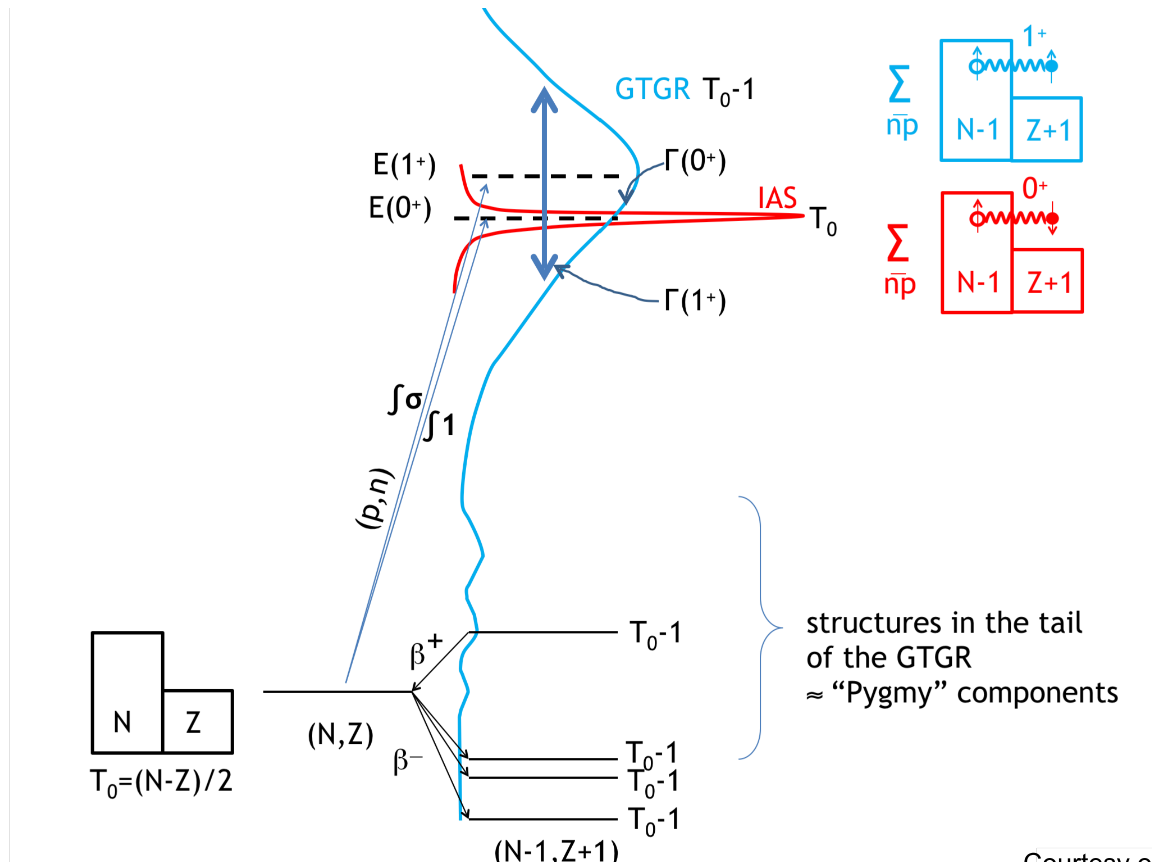

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1) Introduction to the physics case

- Case of N=52 nucleus: ^{87}Br

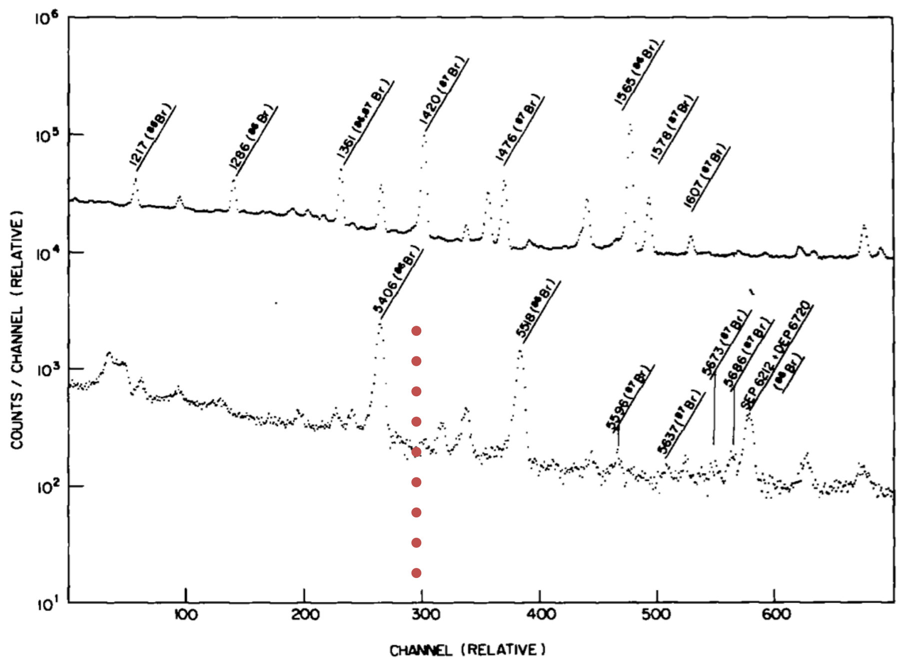

Fig. 3. Partial γ-ray spectrum from ^{86,87}Br sources in the energy range 1180–1740 keV (upper) and 5150–5820 keV (lower) (see subsect. 3.1).

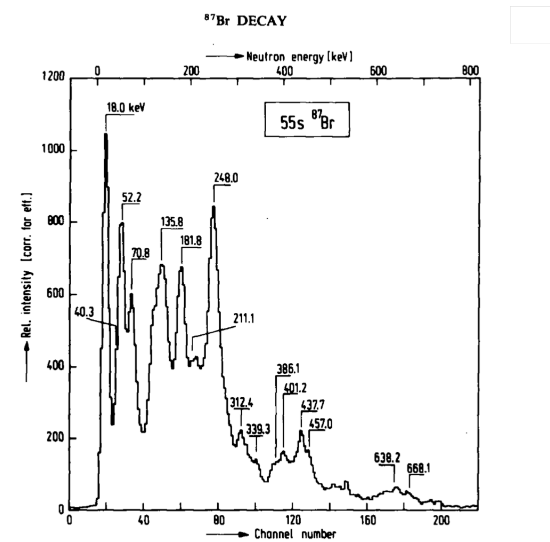

Fig. 2. Neutron spectrum from ^{87}Br decay after correction for detector efficiency and thermal neutrons.

F. M. Nuh *et al.*, NPA 293 (1977)
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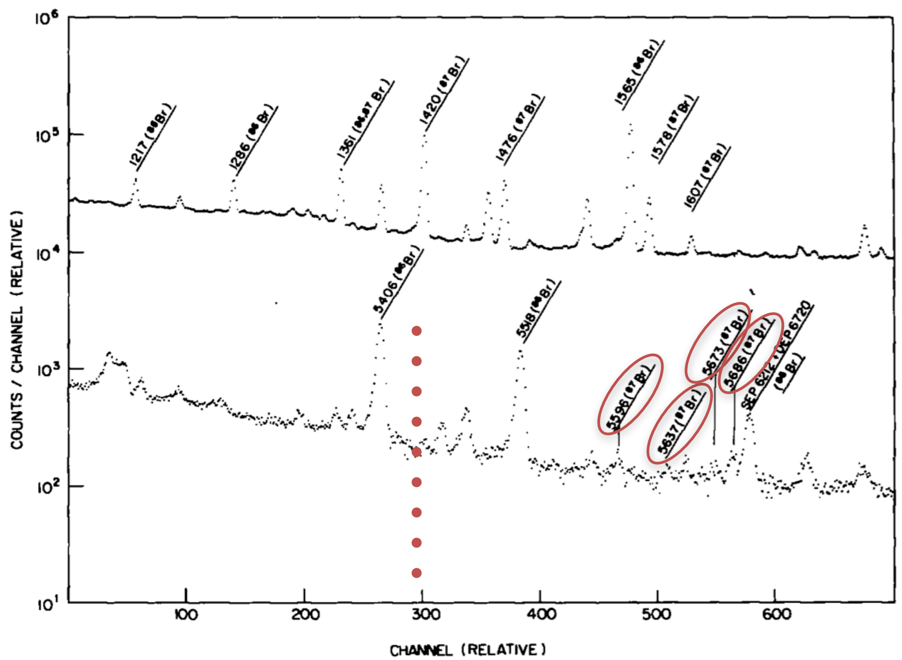

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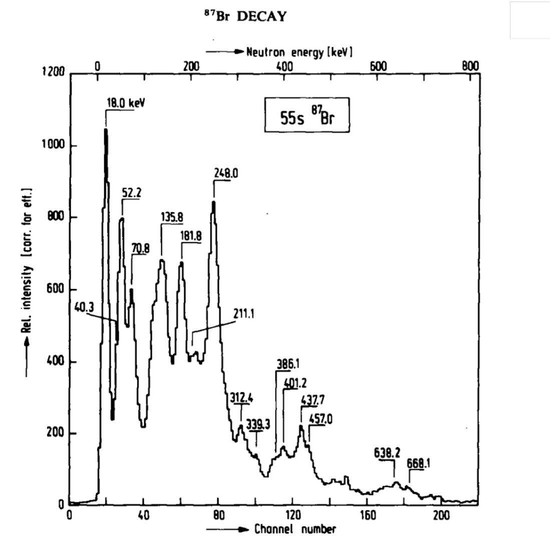

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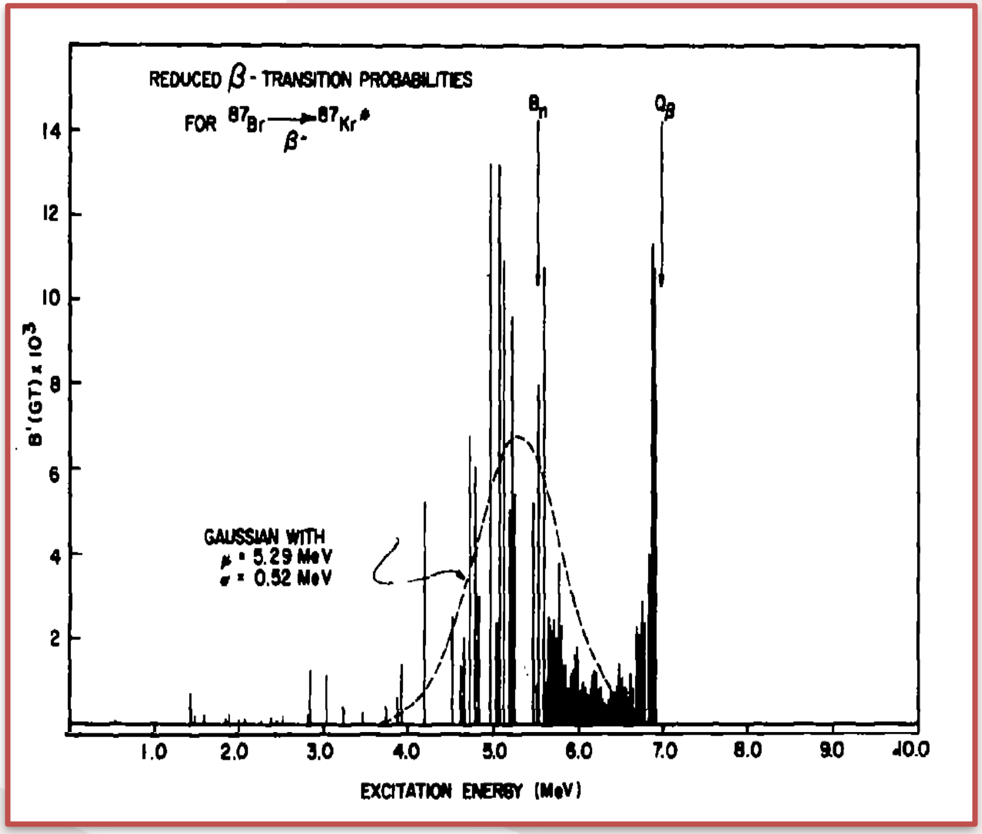

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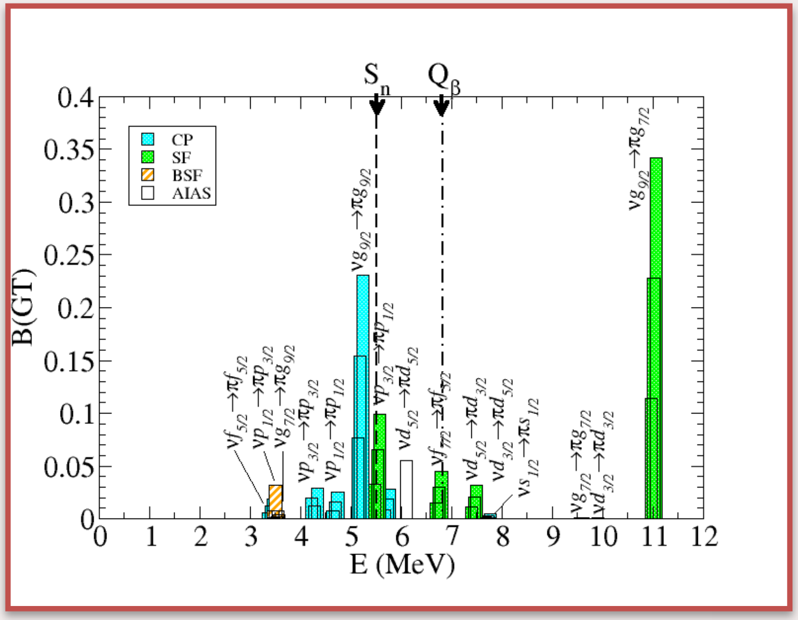

- Phenomenological approach at low energy

D. Verney *et al.*, PRC 95 (2017)

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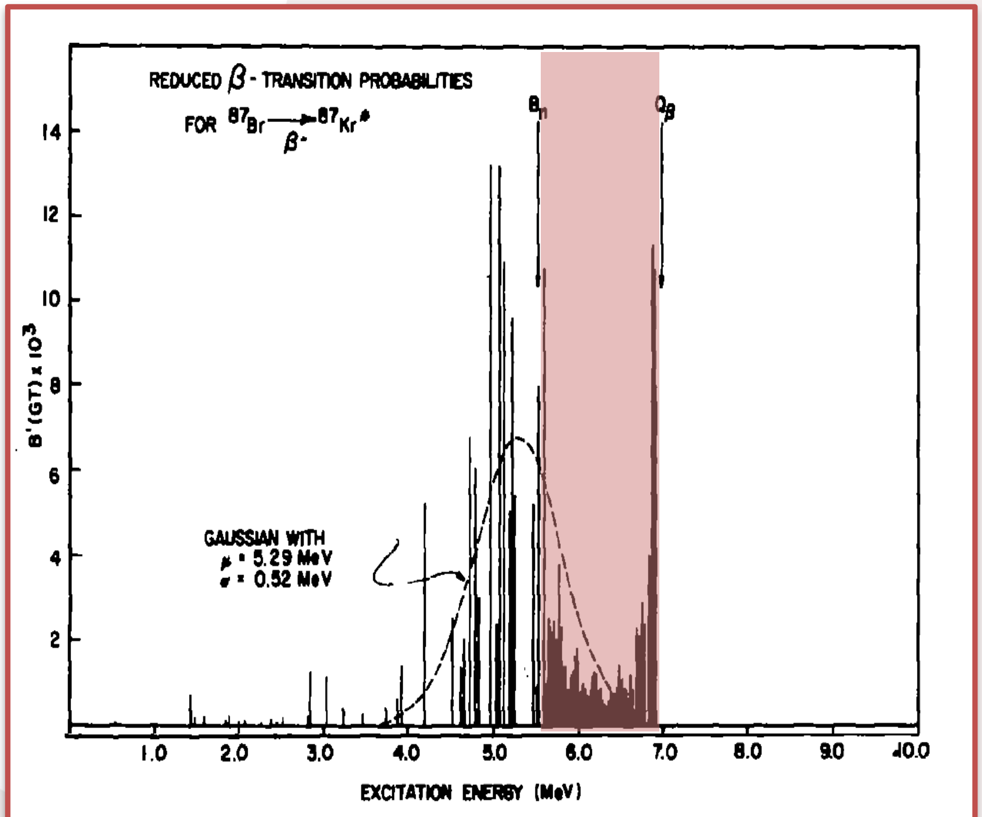

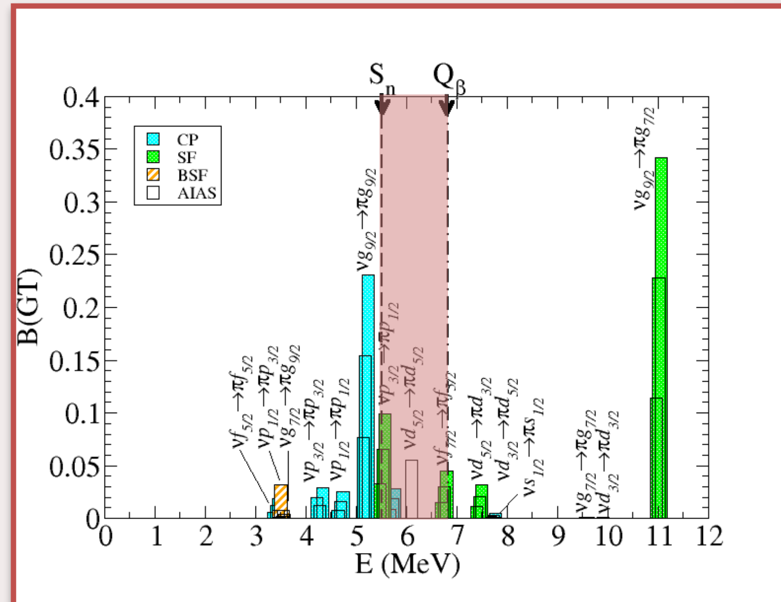

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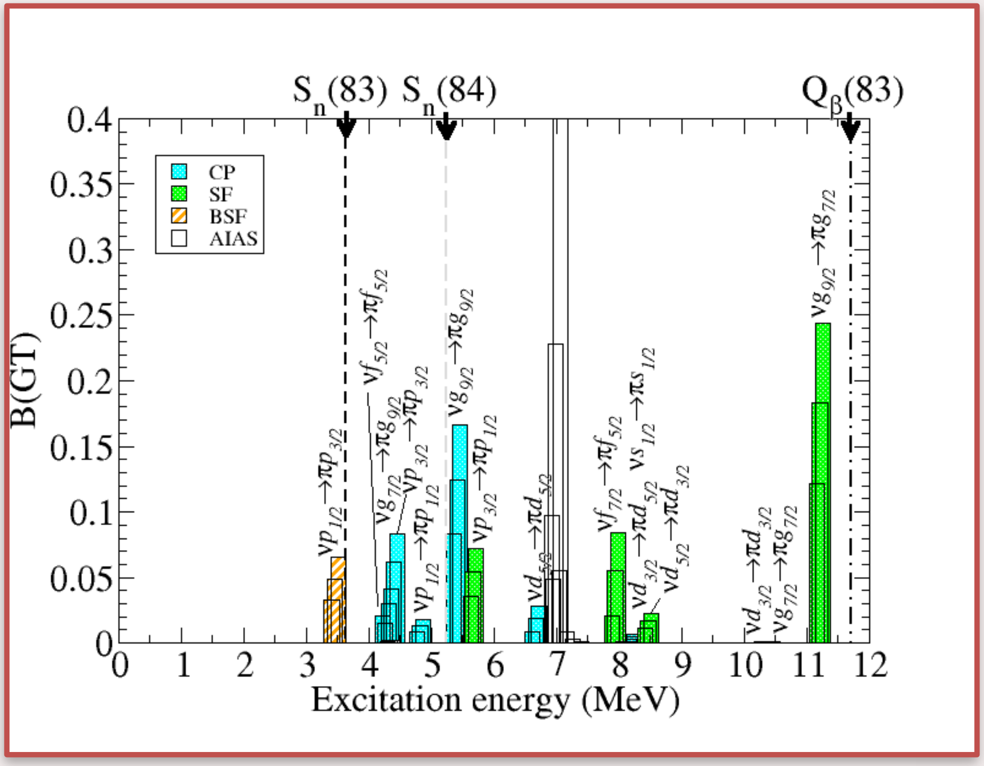
- Case of N=52
  let's go more exotic, ^{83}Ga !

- Big energetic window

- Similar but fragmented
  Pygmy GTR is expected



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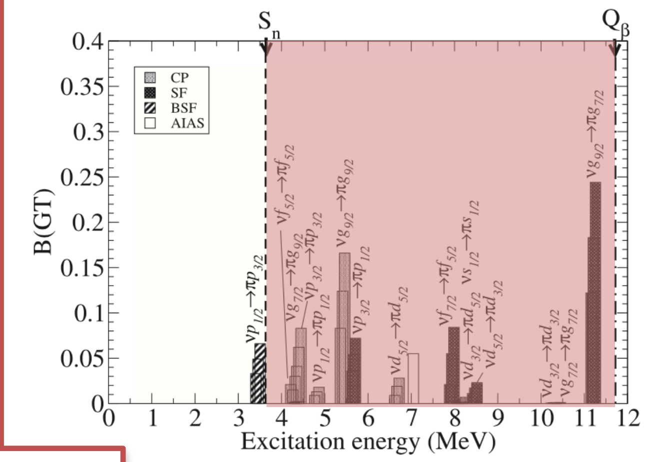
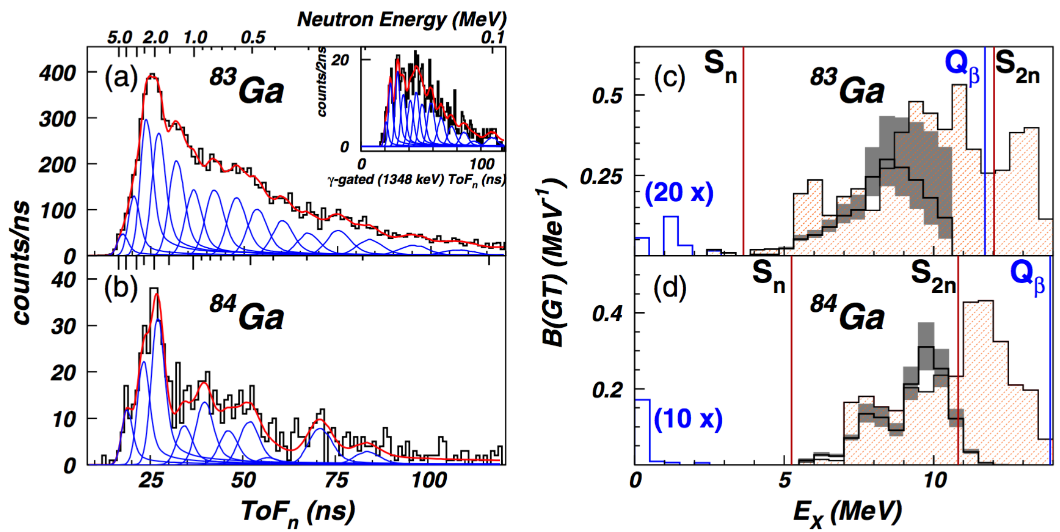
1) Introduction to the physics case

- Structure above the S_n recently observed,
  but low resolution and low statistics,
  resulting in big uncertainties on B(GT)



D. Verney *et al.*, PRL 117 (2016)



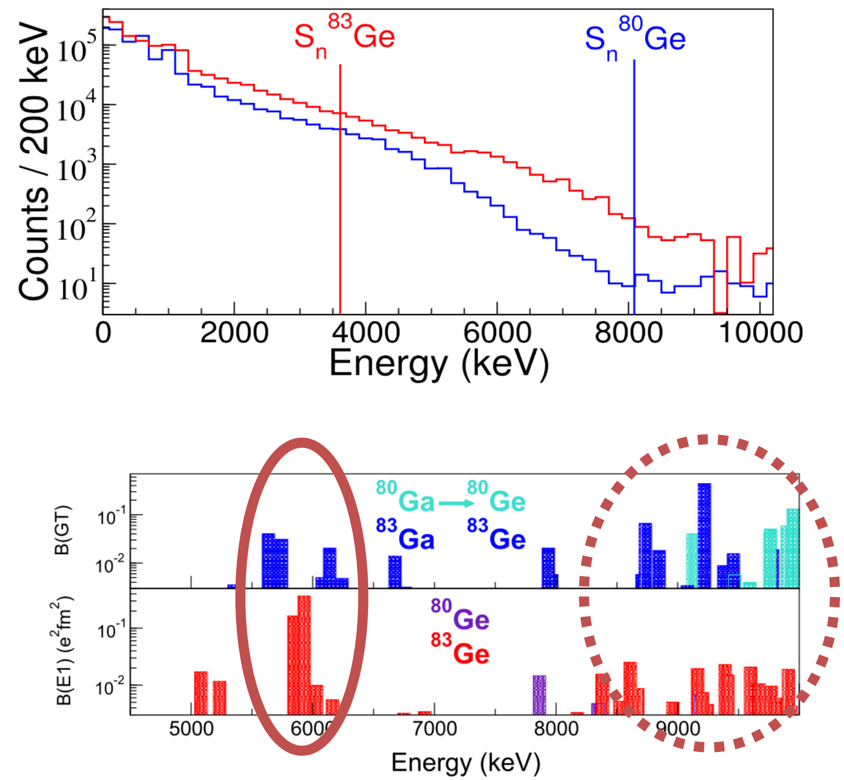
M. Madurga *et al.*, PRC 95 (2017)

- Huge uncertainties on the centroids and GT strength (and above the S_{2n})

1) Introduction to the physics case

- Competition with neutron emission:
  has to be “quick”, thus E1=>PDR

- Pygmy resonances (tail of GR) above S_n
  could decay by γ-rays



A. Gottardo, D. Verney, I. Deloncle, S. Perru, *et al.*, PLB 772 (2017)

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- High-energy γ-rays from fraction of the
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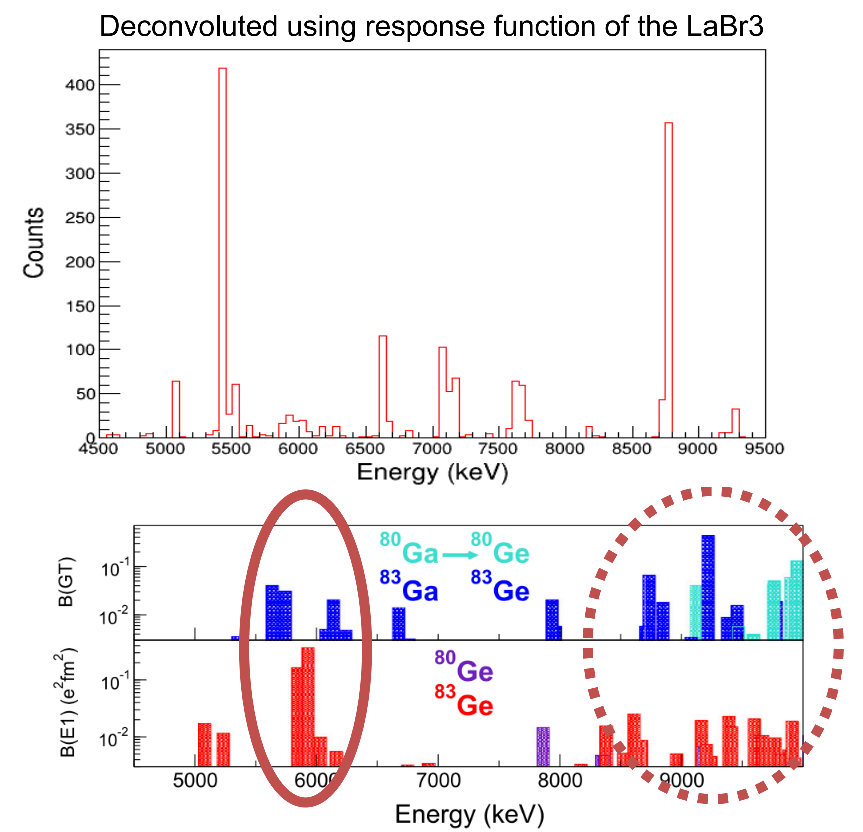

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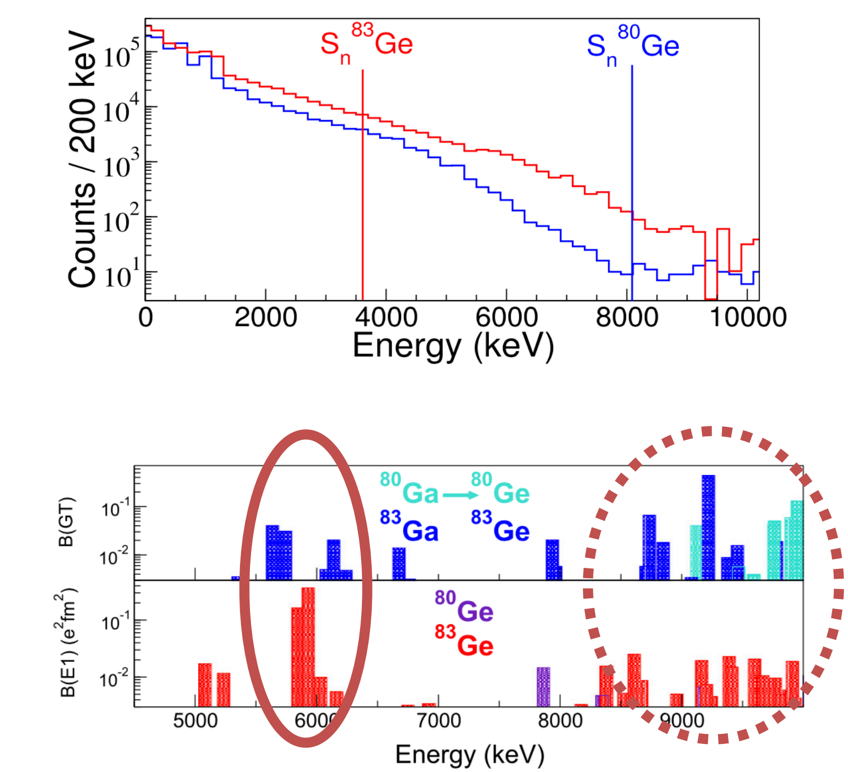
- Need of high detection efficiency !



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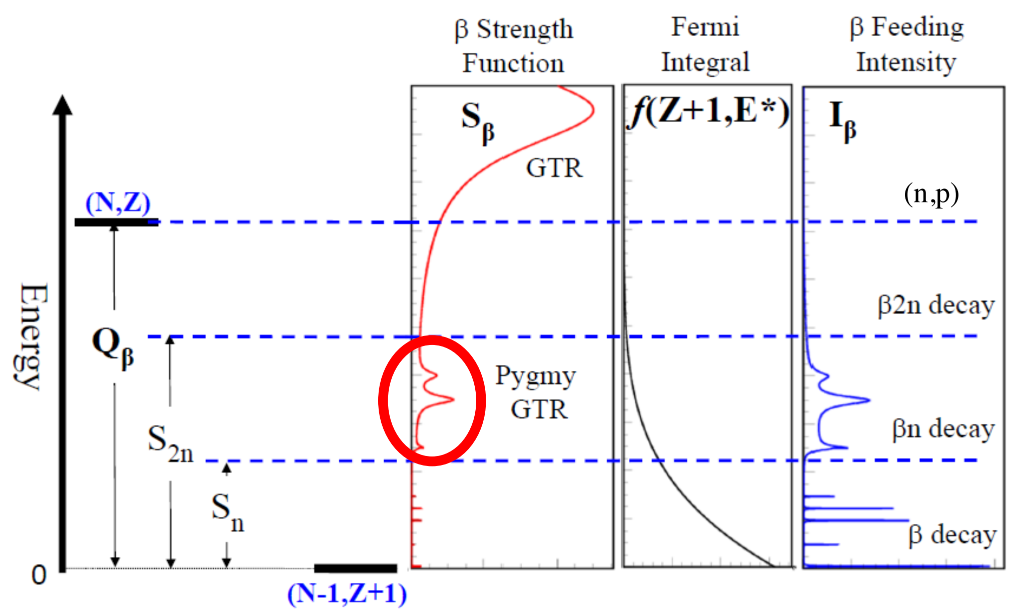
1) Introduction to the physics case

- Structure above S_{n-2n} is expected (and no Pandemonium effect!) such as PDR
- Not only neutron, but also ɣ-ray detection is needed to measure the E1 transitions (~1%)



+ ɣ-ray detection for PDR feeder by fraction of the B(GT)

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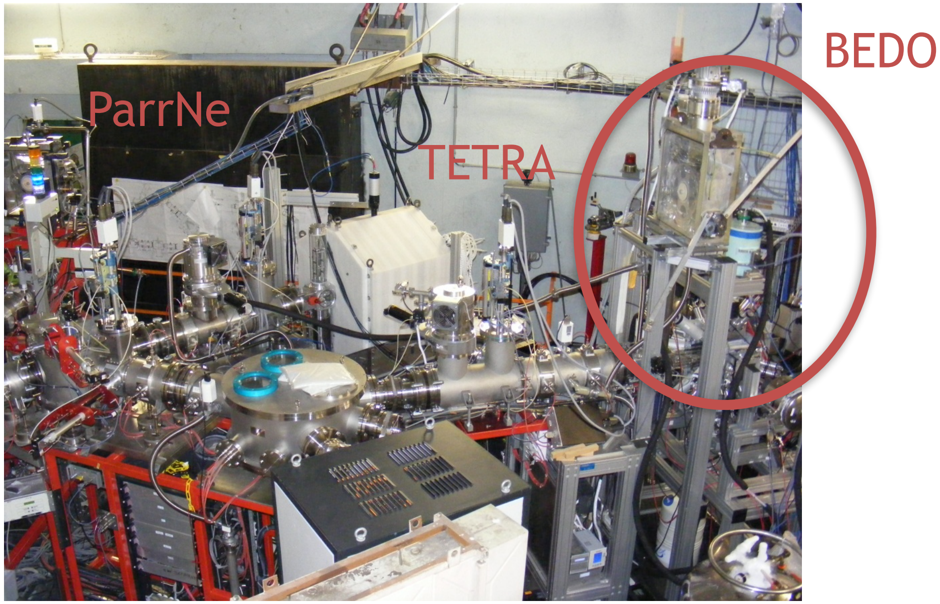
- Neutron-rich beams produced by photo-fission at ALTO facility
- Implanted in a tape station: cycle of implantation and decay



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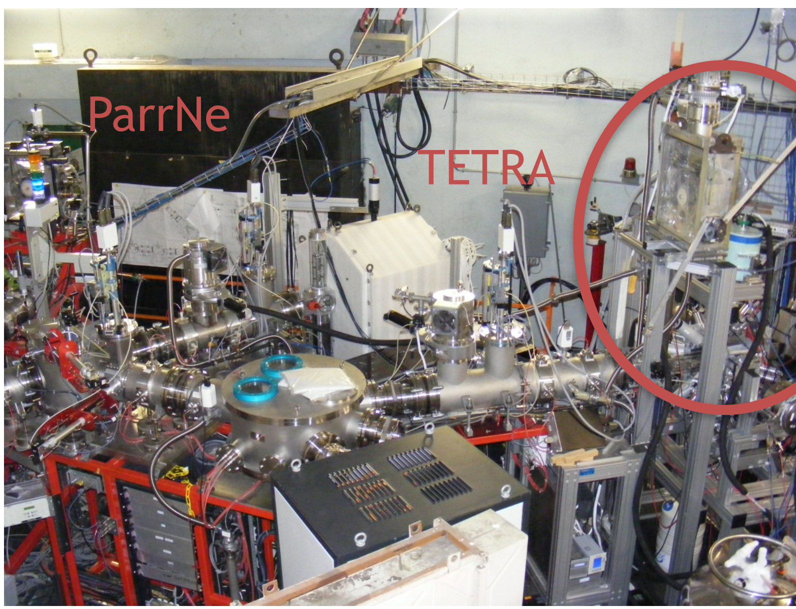

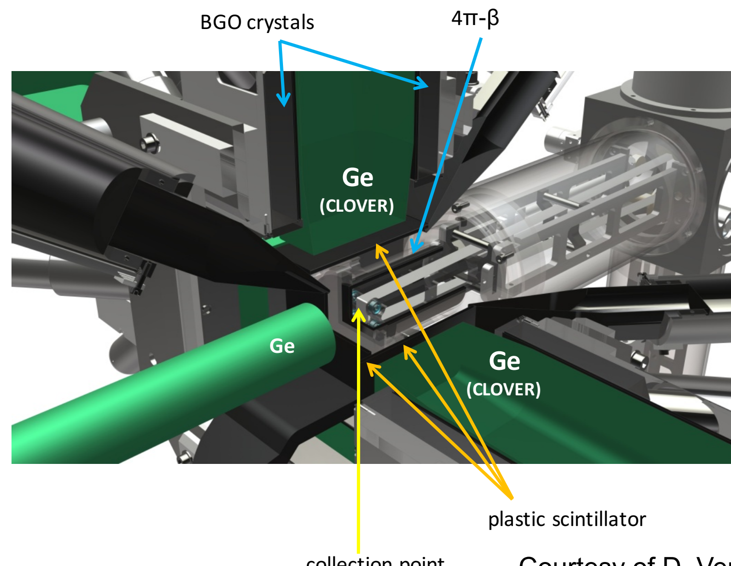

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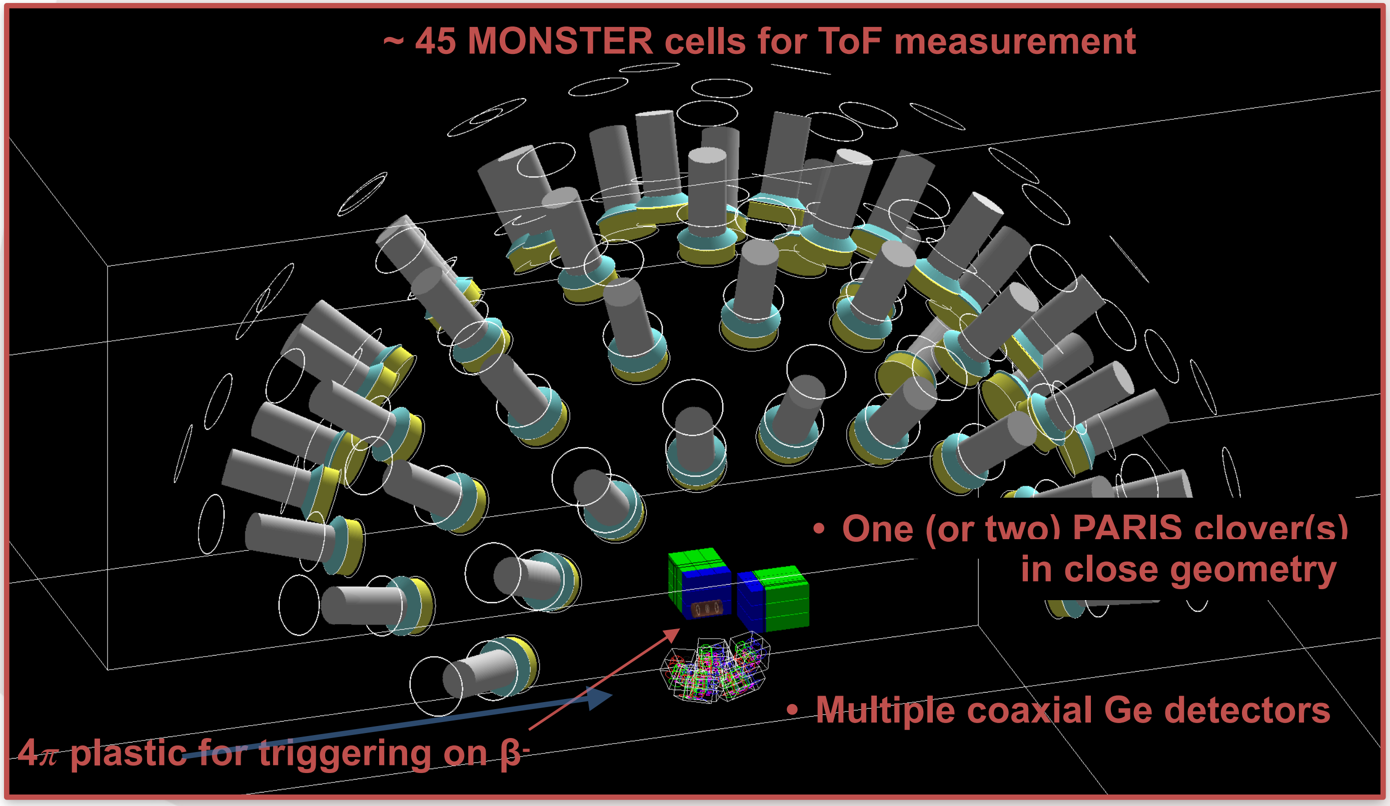
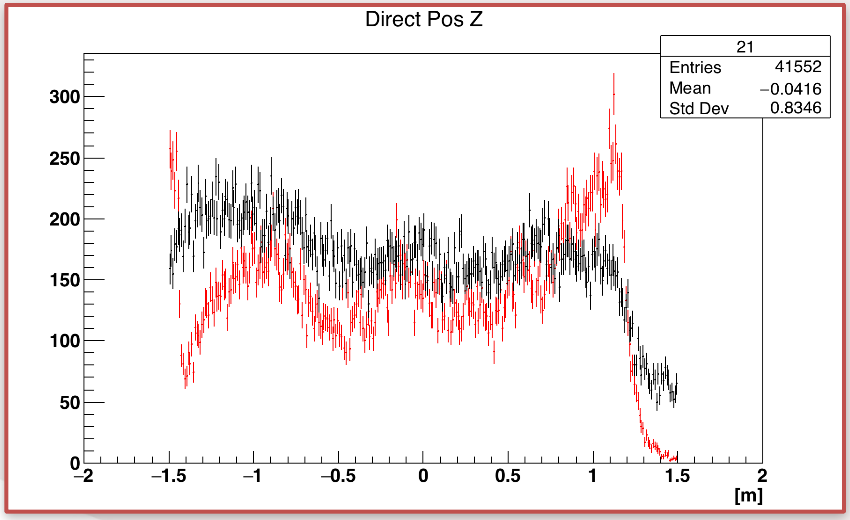


1) Experimental Set-up

- PARIS: response function and add-back have to be studied.
  $\Omega \sim 20$ %, $\varepsilon_{total} \sim 1\%$ (with add back) per cluster @ d = 20 cm and E ~ 5 MeV.

- Positions of the MONSTER detectors in order to minimize scattered neutrons
  d = 1.5 m, leading to $\Delta E/E \sim 9\%$ and $\varepsilon = 5\%$.



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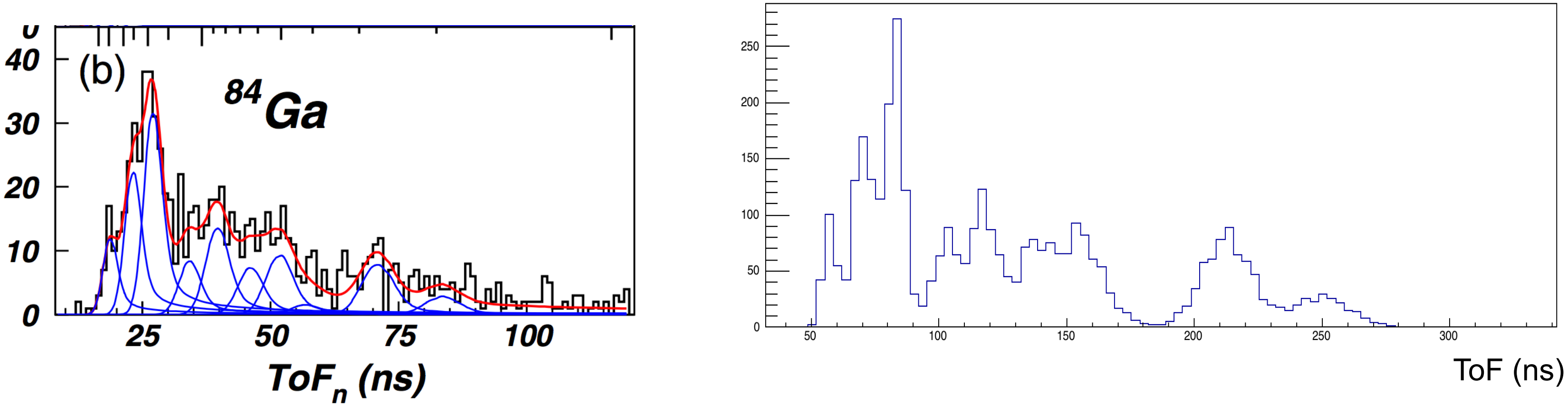
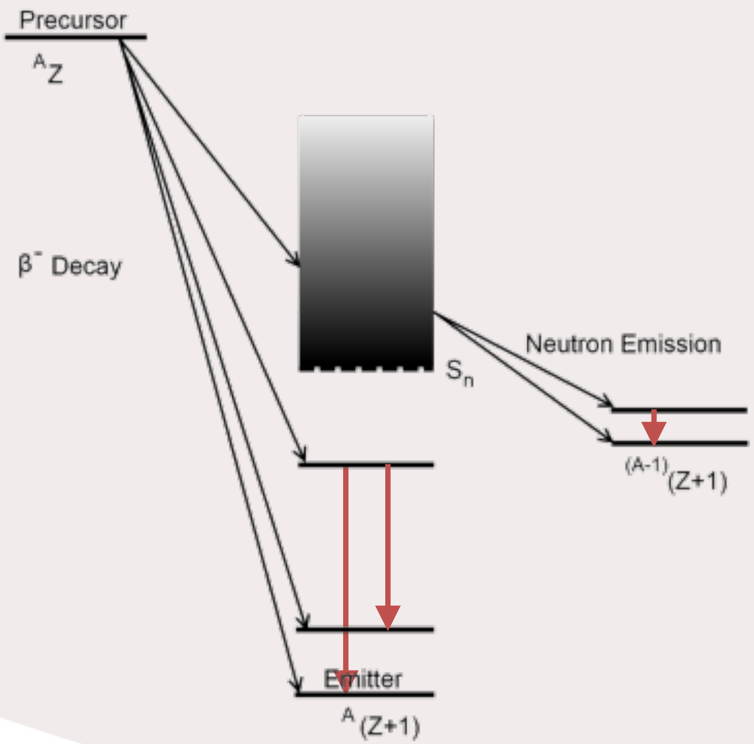


1) Experimental Set-up

- Ge detectors are necessary for the de-excitation of low-lying states
  ΔE/E =0.25%, and at d = 17cm, ε ~ 4%.



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1) Future campaign of measurements

- 1 proposal has been accepted so far : β-decay of $^{83,84}Ga$

• ^{84}Ga P_n ~ 40%, Q Value = 13.9 MeV S_n (^{84}Ge) = 5.2 MeV	• ^{83}Ga P_n ~ 60%, Q Value = 11.7 MeV S_n (^{83}Ge) = 3.6 MeV

- Production rates of $^{133,134}In$ will be investigated (N=82).
- Proposals from I. Matea for systematics on the PDR of N=51 odd-mass nuclei

1) Timeline

<table>
<tr><th></th><th>S1 2018</th><th>S2 2018</th><th>S1 2019</th><th>S2 2019</th></tr>
<tr><td>PARIS clover(s)</td><td>Simulation</td><td>Parisitic beam ?</td><td rowspan="3">1st campaign
(2-4 weeks)</td><td rowspan="3">2nd campaign
(2-4 weeks)</td></tr>
<tr><td>ALTO</td><td>Setting up</td><td>–</td></tr>
<tr><td>MONSTER det.</td><td>Test and characterization</td><td>Calibrations</td></tr>
</table>

- Call of proposals: deadline is 9th of February
- ALTO 2.0 WORKSHOP on ALTO PROSPECTS 5-7 February 2018 - Orsay, France

Thank you for your attention !

Mathieu Babo, on behalf of the BEDO-MONSTER collaboration

ALTO 2.0 WORKSHOP on ALTO PROSPECTS
5-7 February 2018 - Orsay, France

PARIS Photon Array for studies with Radioactive Ion and Stable beams

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Université Paris Sud
université Paris-Saclay
P2IO Physique des 2 Infinis et des Origines
cnrs dépasser les frontières
In2p3

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