Investigation of Pygmy Dipole Resonance in Iron neutron rich exotic isotopes

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on behalf of the AGATA collaborations

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The 5th international conference on
"COLLECTIVE MOTION IN NUCLEI UNDER EXTREME CONDITIONS"

COMEX5

Outlines

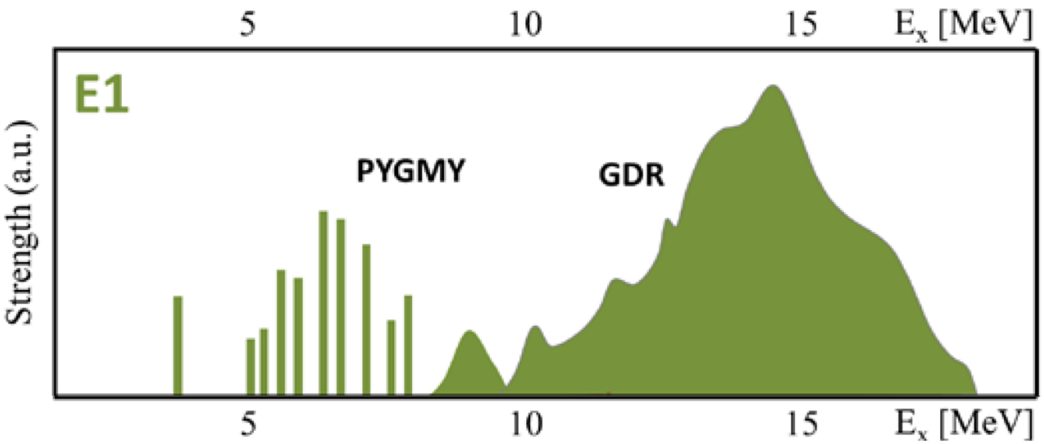
- Pygmy Dipole Resonance in neutron rich nuclei
- E1 strength investigation of $^{62,64}Fe$ nuclei with relativistic coulomb excitation
- PreSPEC-AGATA setup at GSI
- Experimental gamma ray spectra from $^{62,64}Fe$
- Preliminary results
- Conclusions

Pygmy Dipole Resonance in neutron rich nuclei

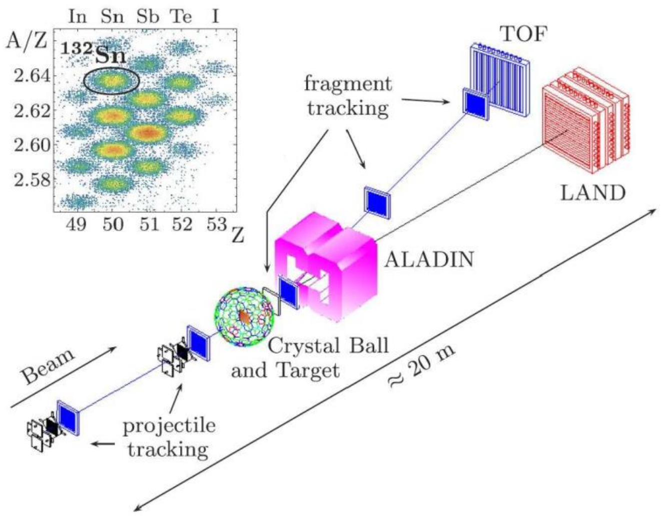
E1 strength response measured in neutron rich stable nuclei

Accumulation of strength around and above neutron separation energy interpret as a collective motion called Pygmy Dipole Resonance (PDR)

Experimental effort over 40 years to investigate this strength accumulation in different mass region towards exotic nuclei



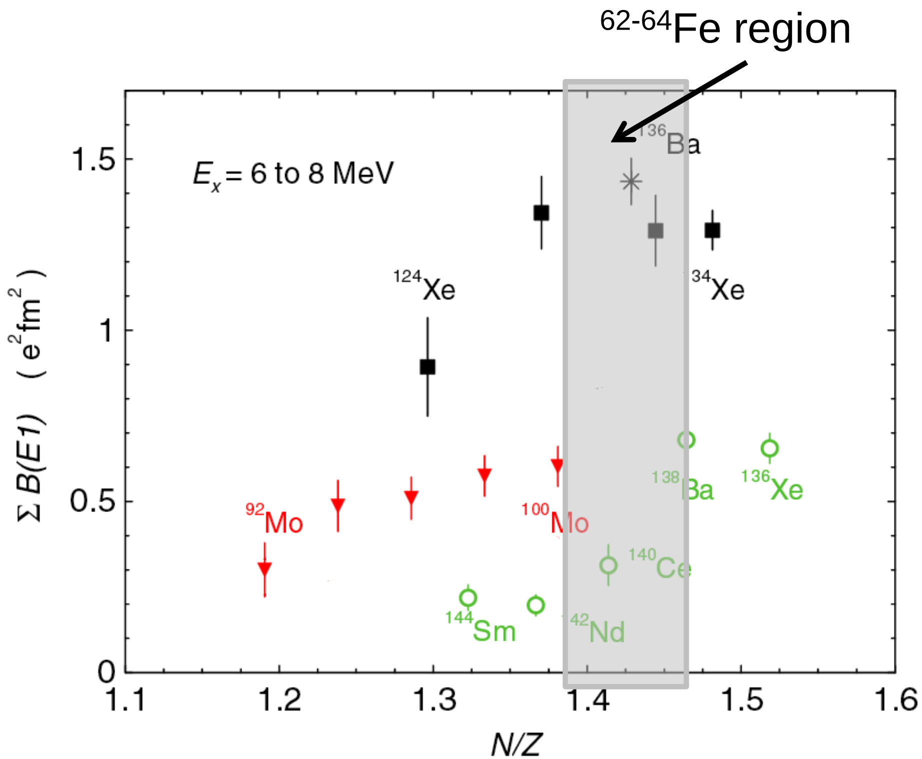
A. Zigles et al. Journ. of Phys. 580 (2015) 012052



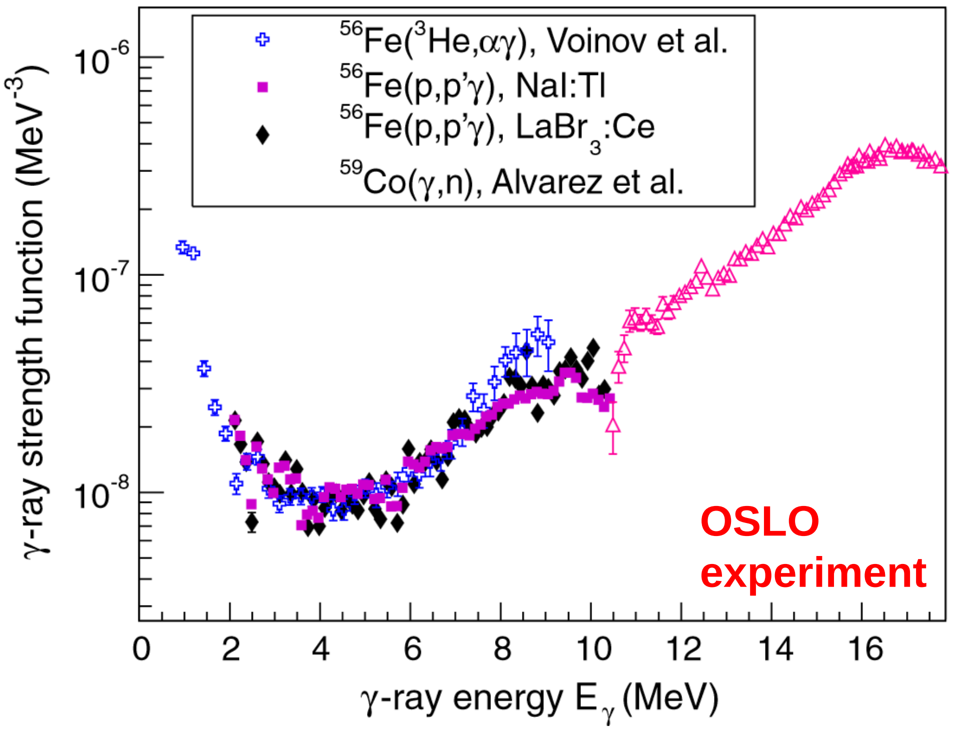
P. Aldrich et al. PRL 95 (2005) 132501

Pygmy Dipole Resonance in Iron

This low energy region contribution of PDR has attracted interest and it was measured in different region of mass



R. Massarczyk et al.,PRL 112, 072501



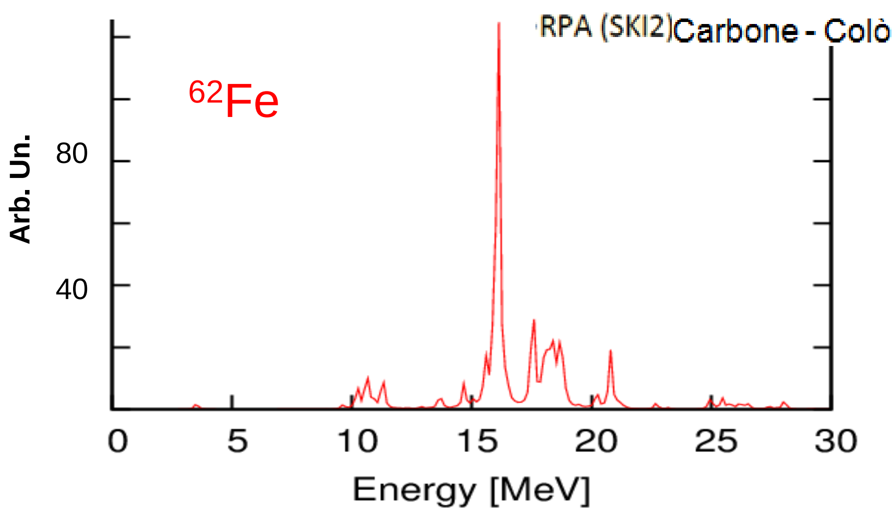
A. C. Larsen et al.,PRL 111,242504 (2013)

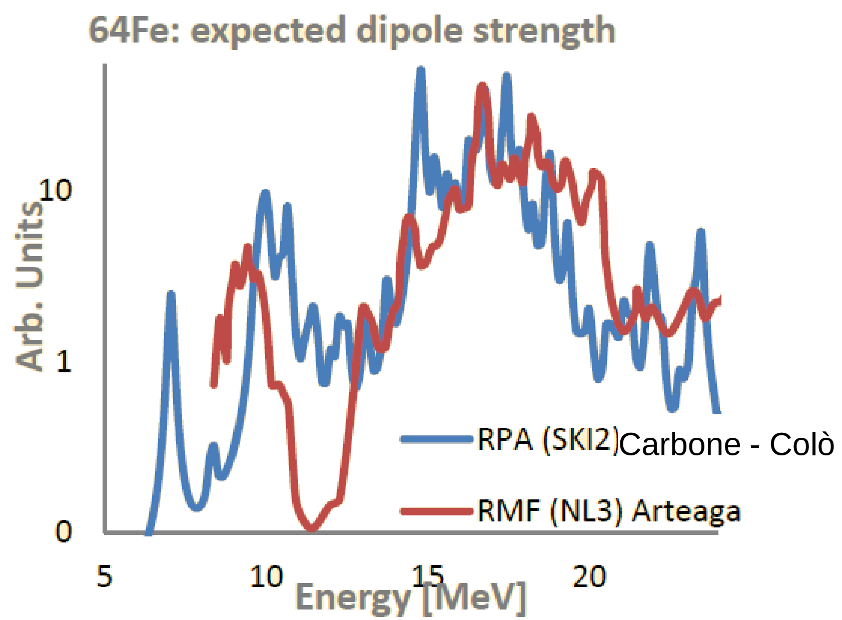
Iron isotopes

Theoretical predictions show dipole strenght around 10 MeV and also below the threshold for $^{62,64}Fe$

For the first time E1 strength distribution below the threshold will be studied for exotic isotopes at varying of the neutron number

^{62}Fe:expected dipole strength

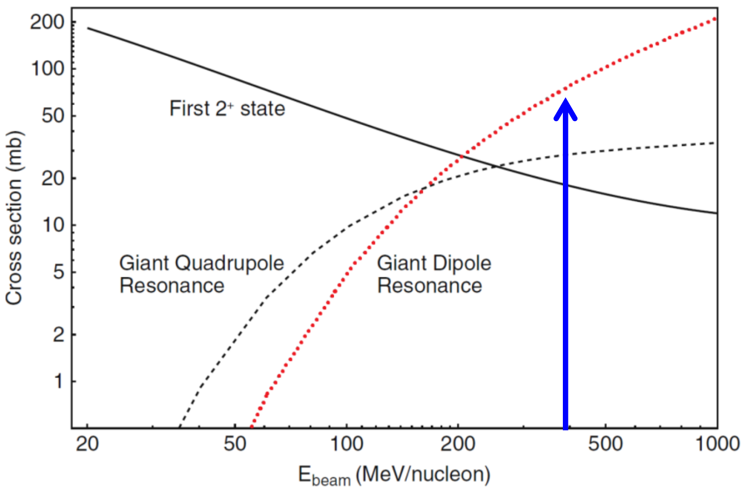




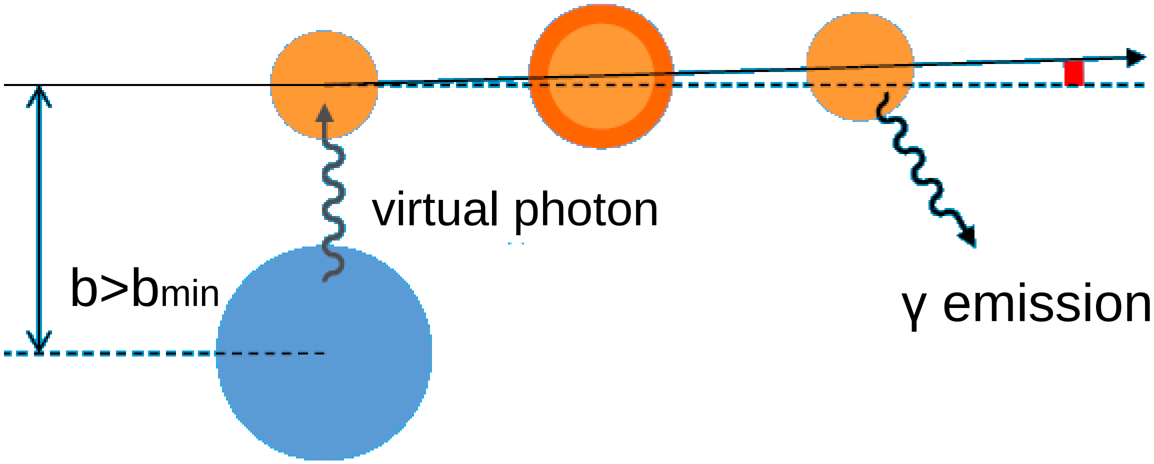
Relativistic coulomb excitation

Relativistic coulomb excitation of Pygmy Dipole Strength

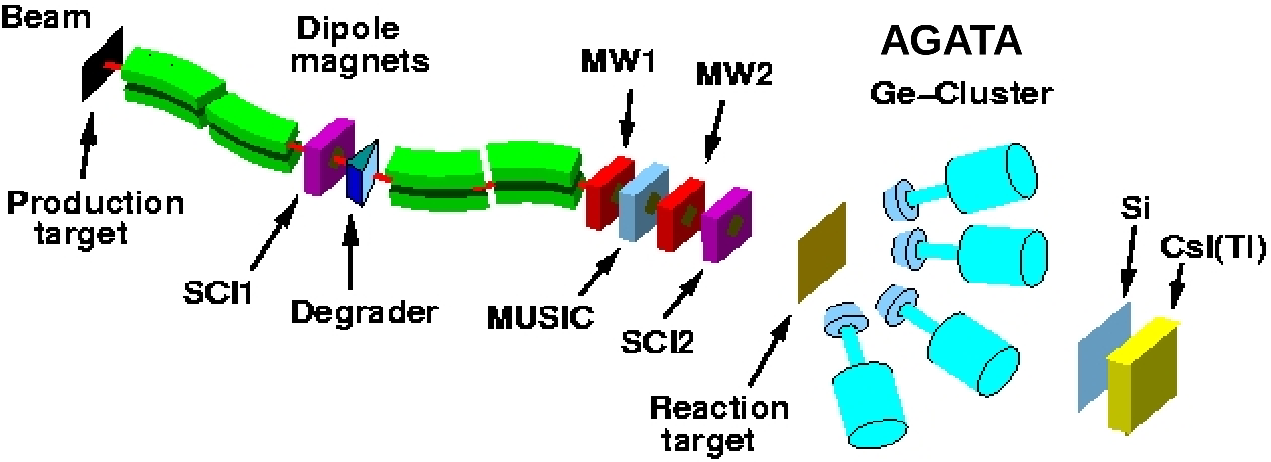
- High selectivity
- No neutron-threshold effect



Pygmy Dipole Strength measured for the first time in exotic nuclei:
$^{62,64}Fe$ coulomb excitation experiment in GSI



PreSPEC-AGATA setup to investigate exotic nuclei



EPJ Web of Conferences 66, 02083 (2014)

FRS
production and selection of exotic nuclei

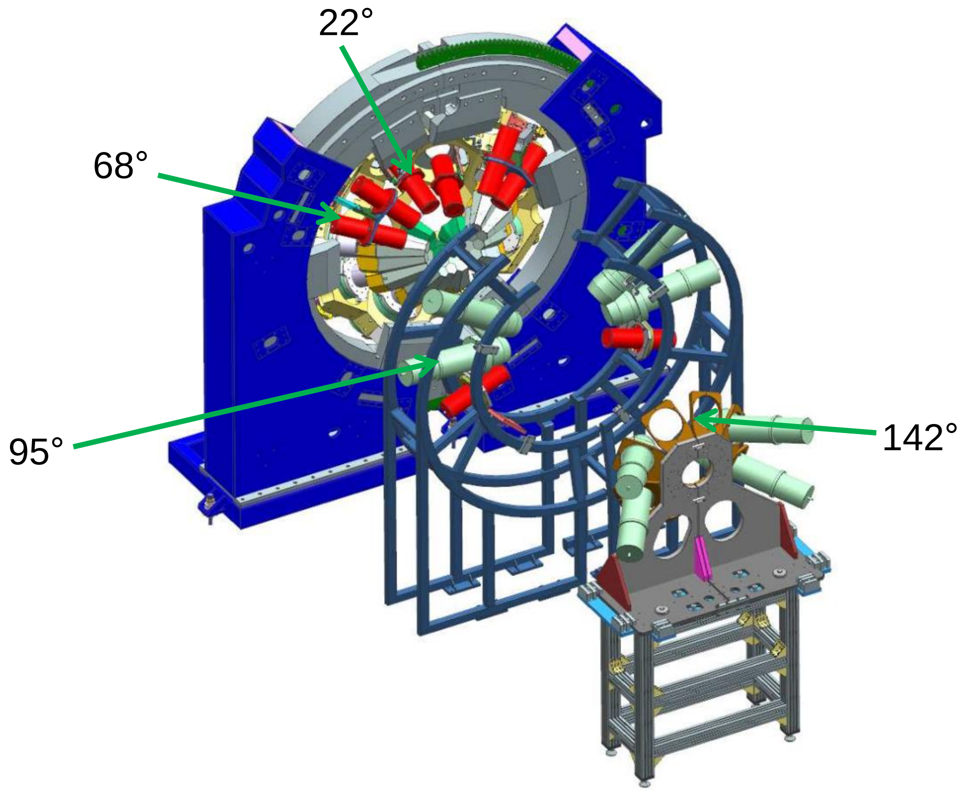
LYCCA
selection of coulomb excitation events on secondary target

AGATA – HECTOR
Measurement of gamma decay of:

first 2^+ state
High energy levels

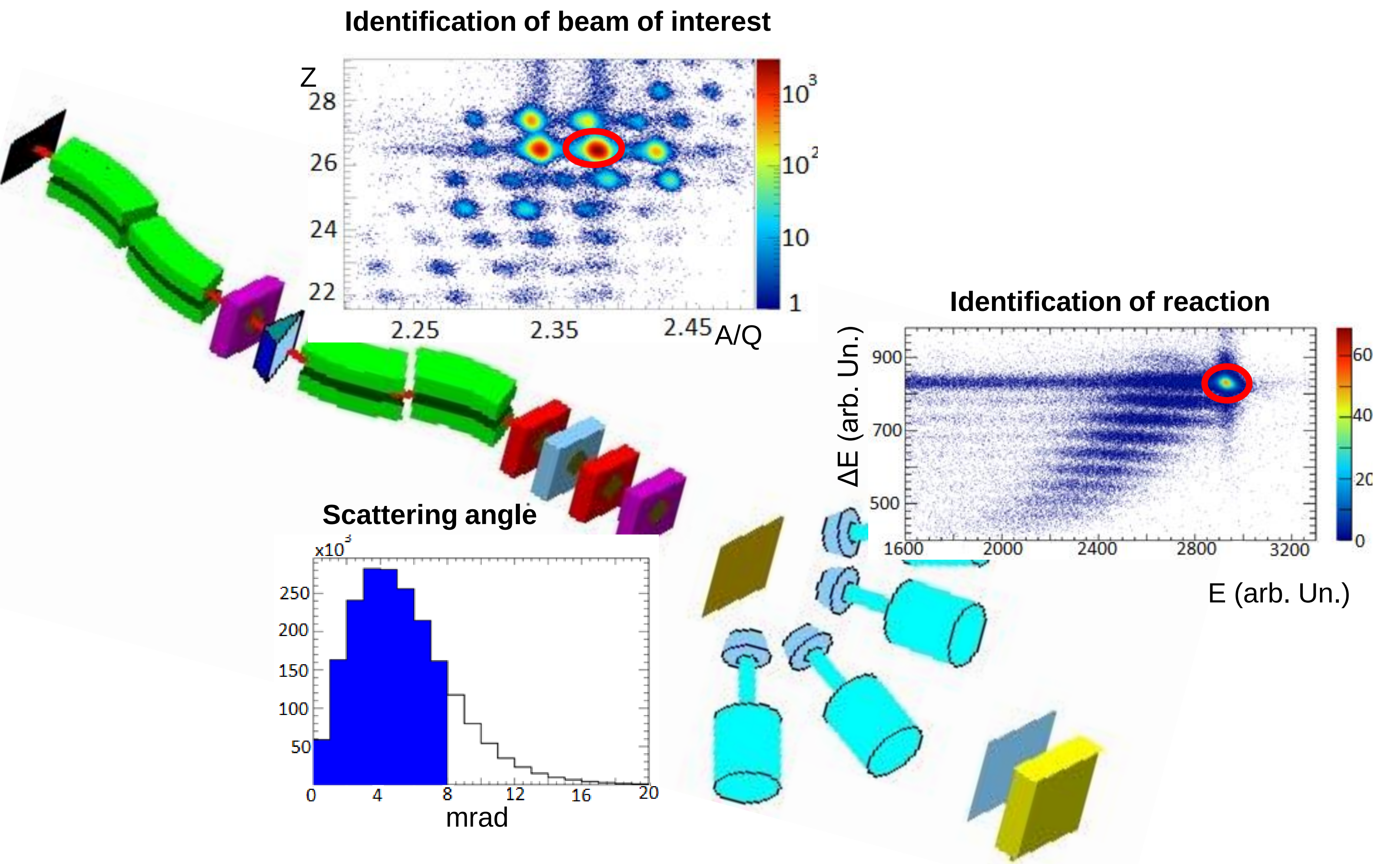
PreSPEC-AGATA setup

AGATA coupled with HECTOR allows to cover a wide angular range.
This can be used to get informations on the multipolarity of gamma rays detected
In addition backward scintillators can be used for the estimation of background

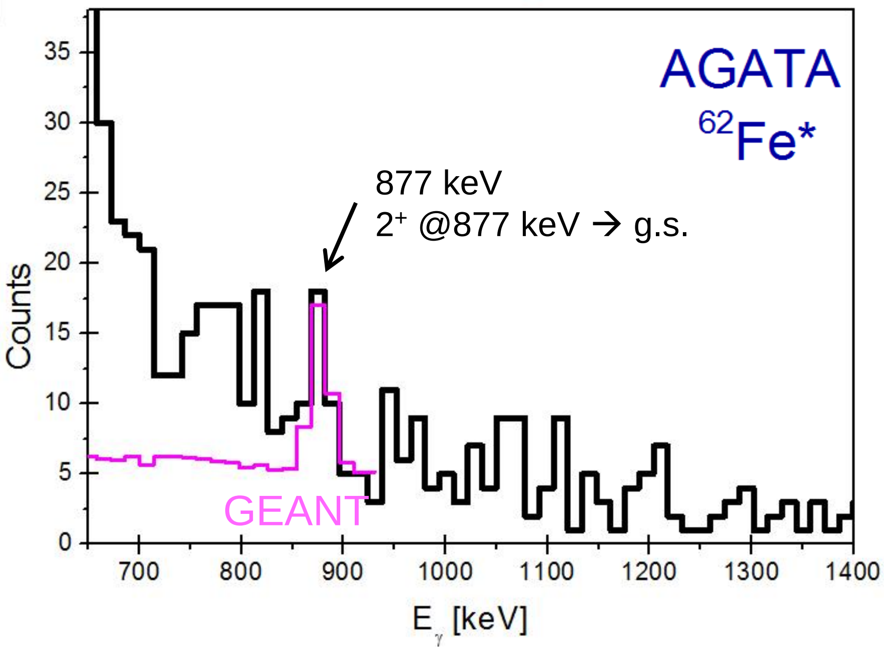


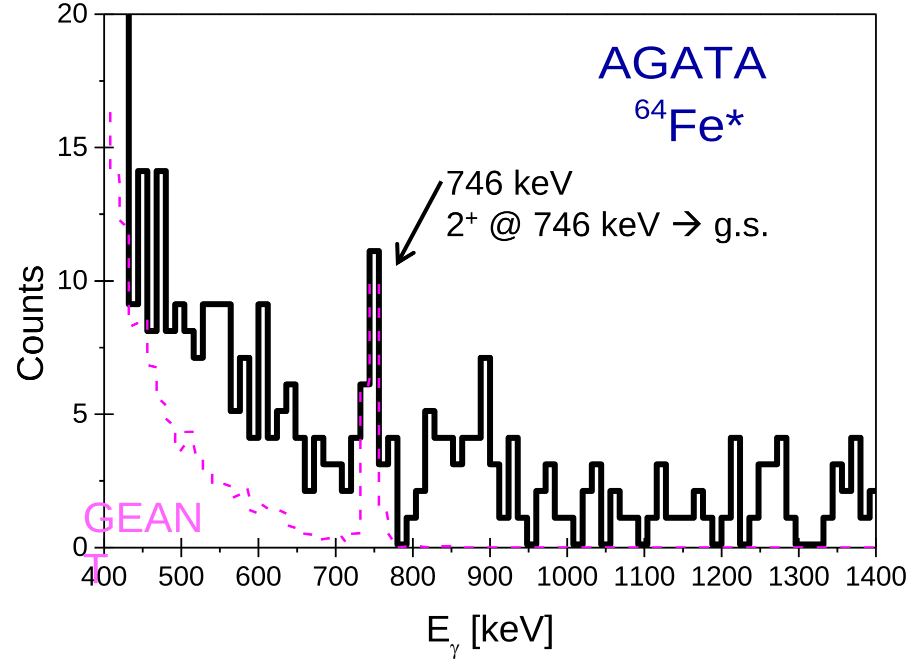
AGATA	From 15° to 60°
HECTOR	22°, 68°, 95°, 142°

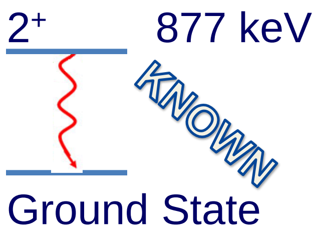
Relativistic coulomb excitation selection @ GSI



Low energy spectra @ GSI



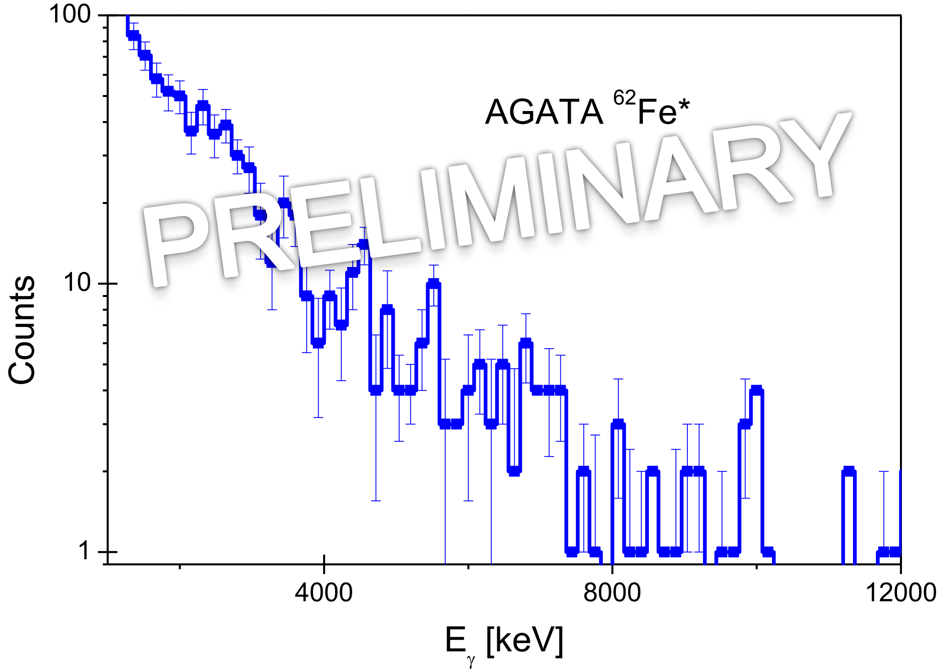


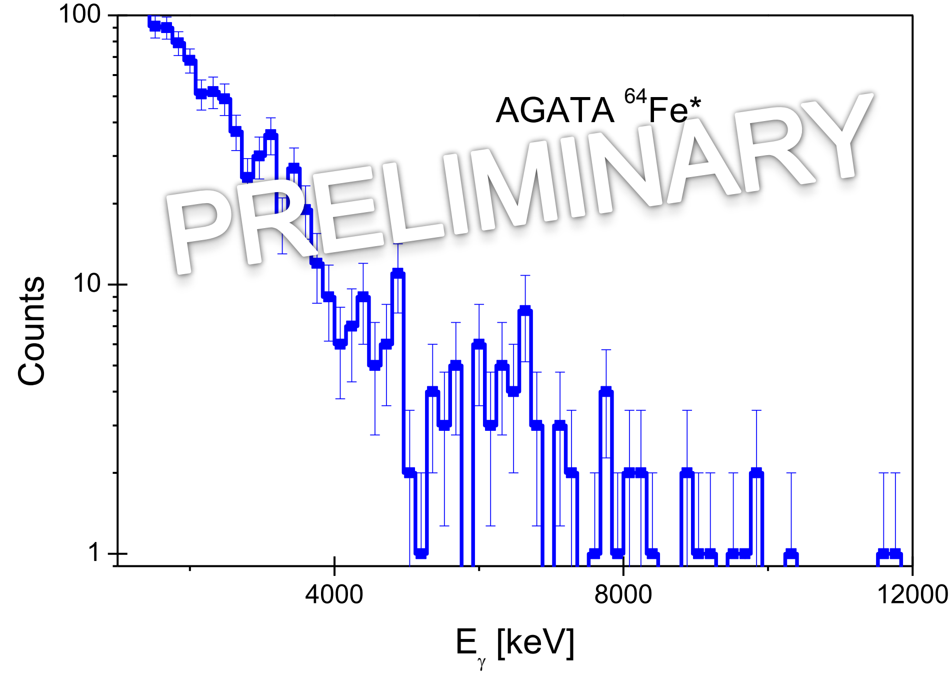


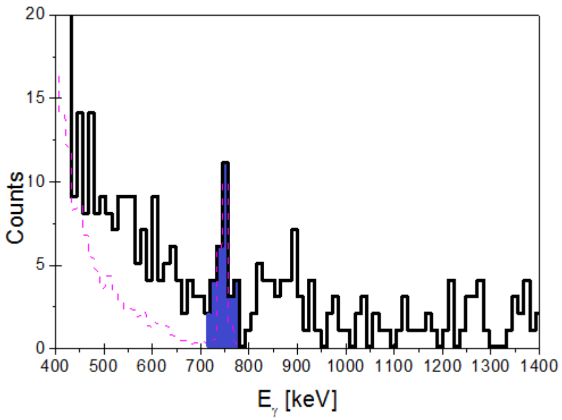
Thick target and relativistic (440 MeV/nucl.) beam required a fine tuning of PreSPEC and AGATA detectors to observe 2^+ state decay for both iron isotopes

B(E2) of 2^+ decay is known and it is used to provide a normalization for the cross section→ essential to deduce **B(E1)** from the high energy γ-transition

High energy spectra

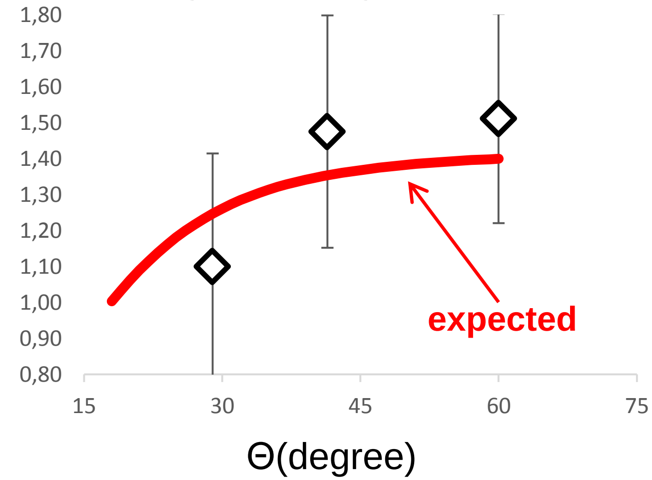






Angular distribution was used to deduce the E1 character of the γ-ray data above 6 MeV.

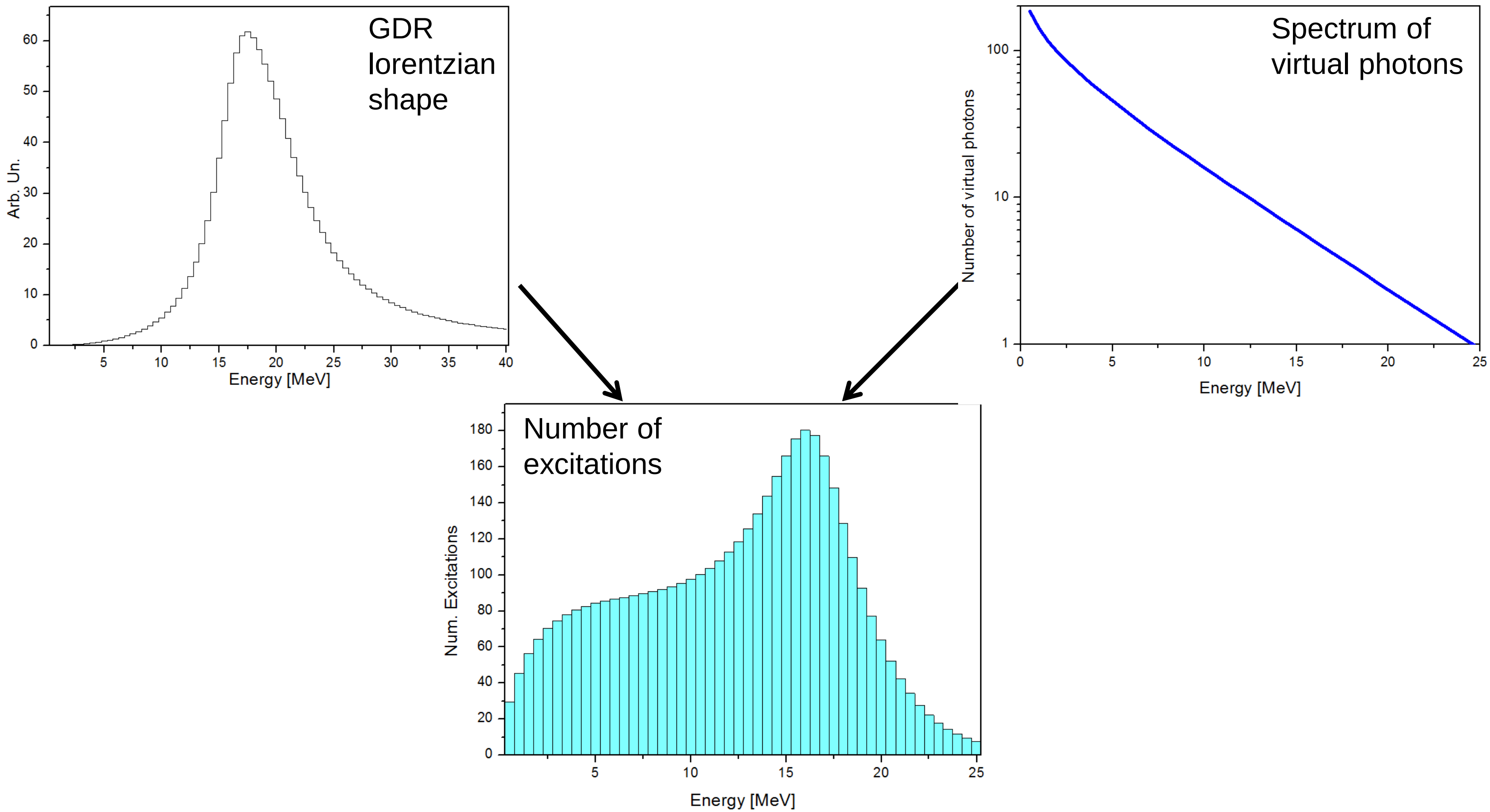
Ratio E2 yield/E1 yield



γ yield in the pygmy region

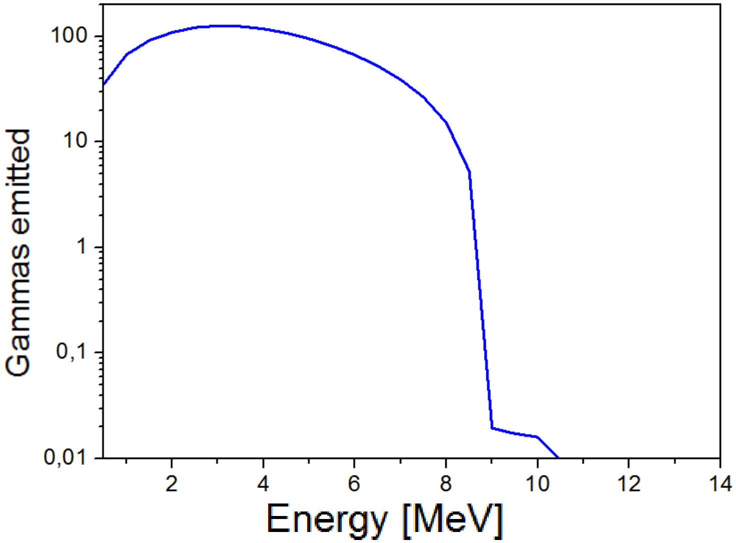
How would be the spectrum if the GDR response is pure lorentzian?

Pure Lorentzian GDR shape and spectrum of virtual photons used to obtain excitation spectrum

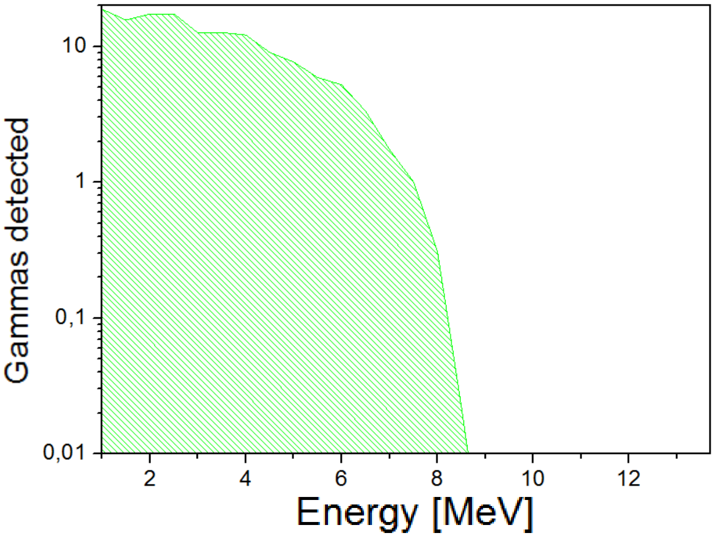


γ yield in the pygmy region

GEMINI code used to deduce de-excitation gamma yield from the excitation spectrum



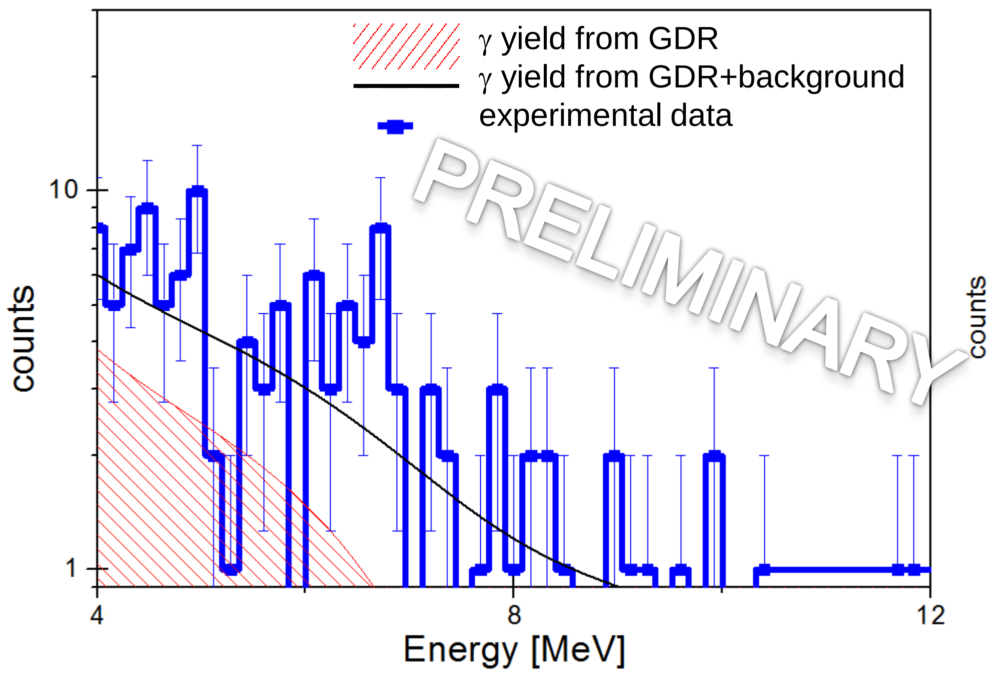
AGATA response function applied to de-excitation gamma yield



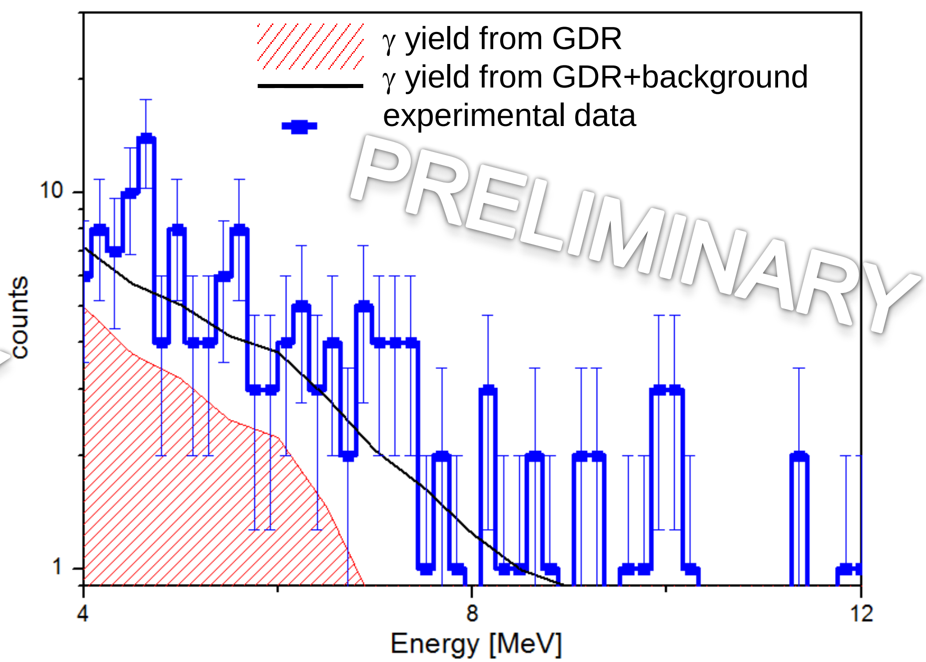
High energy spectra

High energy spectra show statistics accumulations above the background (evaluated with backward angle LaBr) and the GDR tail contribution

^{64}Fe AGATA spectrum



^{62}Fe AGATA spectrum



Conclusions and Perspectives

- E1 strenght accumulation at one particle separation energy has attracted interest because it is relevant for both nuclear structure and astrophysics

  A lot of data available for stable nuclei, data about exotic nuclei very scarce

- E1 response just below the threshold is under investigation

- Measurement of E1 response of ^{64,62}**Fe** by relativistic coulomb scattering at GSI laboratories

- The advanced features of the setup allowed to collect interesting data for both Iron isotopes

- Gamma ray energy spectra show interesting structures over the GDR tail: the analysis showed the possibility to get an estimation of B(E1) value related to high energy γ ray transitions

Special thanks to all AGATA - PreSPEC collaboration:

O. Wieland, R. Avigo, A. Bracco, F. Camera, S. Ceruti, G. Benzoni, N. Blasi, S. Brambilla, F.C.L. Crespi, S. Leoni, B.Million, A. Morales, L. Pellegri, A. Giaz et al.,
Università degli Studi di Milano and INFN, Sezione di Milano, Italy
A. Maj, M. Kmiecik, P. Bednarczyk, J. Grebosz , M. Kmiecik,M. Krzysiek et al.,
The Niewodniczanski Institute of Nuclear Physics, PAN, Krakow, Poland
G. de Angelis, D.R. Napoli, et al.,
INFN, Laboratori Nazionali di Legnaro, Italy
D. Bazzacco, E. Farnea, S.M. Lenzi, S. Lunardi, et al.,
Dip. di Fisica and INFN, Sezione di Padova, Italy
J. Gerl, M. Gorska, H.J. Wollersheim, T. Aumann, N. Pietralla, P. Boutachkov, G. Guastalla, E.Gregor, N. Goel,F. Ameil, P. Singh, A. Ghivechev, M. Reese, D. Ralet, N. Lalovic, S. Pietri, M. Lettman, R. Stegmann, T. Arici, L. Cortes, Ch. Bauer, Th. Moller, A. Ghivechev, C.Sthal, H. Schnaffer, I. Khojouharov et al.,
TU Darmstadt and GSI, Germany
G. Duchene, F. Didierjean
IPHC Strasbourg
K. Moschner, P. Thole
University of Cologne
D. RudolphP. Golubev
University of Lund
Z. Podolyak, T. Alexander
University of Surrey
A. Gadea, T. Huyuk, R. Perez
Universidat de Valencia
G. Rainovsky
University of Sofia
K. Kezzar
King Saud University

Thank you for your kind attention