

Status report of the ongoing analysis of the pygmy AGATA experiment at GSI

Riccardo Avigo^{1,2}

1 Università degli Studi di Milano

2 Istituto Nazionale di Fisica Nucleare



UNIVERSITÀ
DEGLI STUDI
DI MILANO

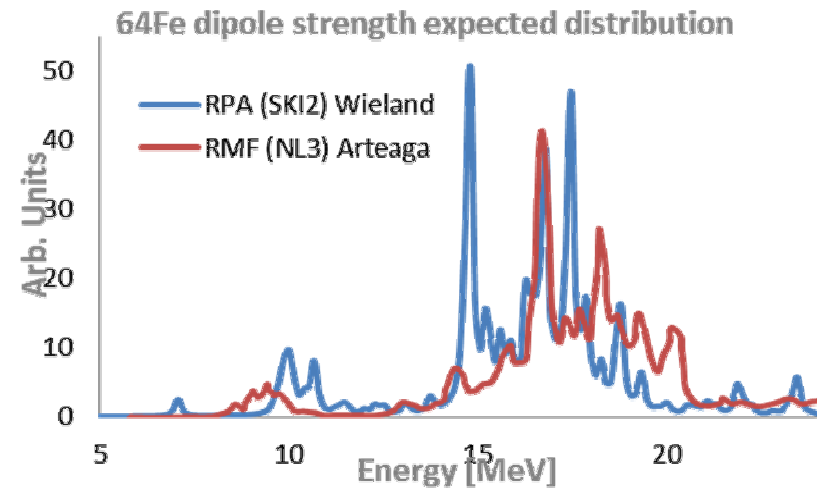
67As	68As	69As	70As	71As	72As	73As	74As	75As	76As	77As	78As	79As	80As	81As	82As	83As	84As
68Ge	69Ge	70Ge	71Ge	72Ge	73Ge	74Ge	75Ge	76Ge	77Ge	78Ge	79Ge	80Ge	81Ge	82Ge	83Ge	84Ge	85Ge
69Ga	70Ga	71Ga	72Ga	73Ga	74Ga	75Ga	76Ga	77Ga	78Ga	79Ga	80Ga	81Ga	82Ga	83Ga	84Ga	85Ga	86Ga
70Zn	71Zn	72Zn	73Zn	74Zn	75Zn	76Zn	77Zn	78Zn	79Zn	80Zn	81Zn	82Zn	83Zn	84Zn	85Zn	86Zn	87Zn
71Cu	72Cu	73Cu	74Cu	75Cu	76Cu	77Cu	78Cu	79Cu	80Cu	81Cu	82Cu	83Cu	84Cu	85Cu	86Cu	87Cu	88Cu
72Ni	73Ni	74Ni	75Ni	76Ni	77Ni	78Ni	79Ni	80Ni	81Ni	82Ni	83Ni	84Ni	85Ni	86Ni	87Ni	88Ni	89Ni
73Co	74Co	75Co	76Co	77Co	78Co	79Co	80Co	81Co	82Co	83Co	84Co	85Co	86Co	87Co	88Co	89Co	90Co
74Fe	75Fe	76Fe	77Fe	78Fe	79Fe	80Fe	81Fe	82Fe	83Fe	84Fe	85Fe	86Fe	87Fe	88Fe	89Fe	90Fe	91Fe
75Mn	76Mn	77Mn	78Mn	79Mn	80Mn	81Mn	82Mn	83Mn	84Mn	85Mn	86Mn	87Mn	88Mn	89Mn	90Mn	91Mn	92Mn
76Cr	77Cr	78Cr	79Cr	80Cr	81Cr	82Cr	83Cr	84Cr	85Cr	86Cr	87Cr	88Cr	89Cr	90Cr	91Cr	92Cr	93Cr
77V	78V	79V	80V	81V	82V	83V	84V	85V	86V	87V	88V	89V	90V	91V	92V	93V	94V
78Ti	79Ti	80Ti	81Ti	82Ti	83Ti	84Ti	85Ti	86Ti	87Ti	88Ti	89Ti	90Ti	91Ti	92Ti	93Ti	94Ti	95Ti
79Sc	80Sc	81Sc	82Sc	83Sc	84Sc	85Sc	86Sc	87Sc	88Sc	89Sc	90Sc	91Sc	92Sc	93Sc	94Sc	95Sc	96Sc

Pygmy Dipole Resonance in Fe isotopes

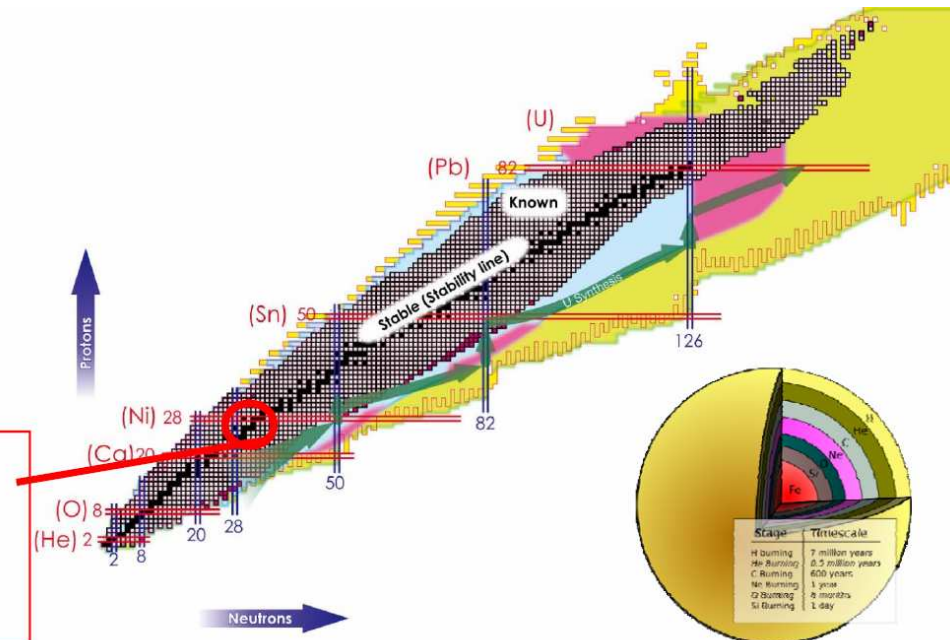
E1 strength distribution in exotic nuclei is a part of a study over decades of Collective excitations

Neutron rich iron isotopes show an expected E1 strength accumulation around one particle separation energy (Pygmy Dipole Resonance)

Measuring E1 strength above and below one particle separation energy is the key point



Supernova-Explosion
Starting in Ni and Fe region
going towards exotic
r-process starting points



Experiment S430 - PDR in $^{64,62}\text{Fe}$

2012

primary beam : ^{86}Kr @ 730 MeV/nucleon

relativistic coulomb excitation: ^{64}Fe @ 400 MeV/u on ^{208}Pb target

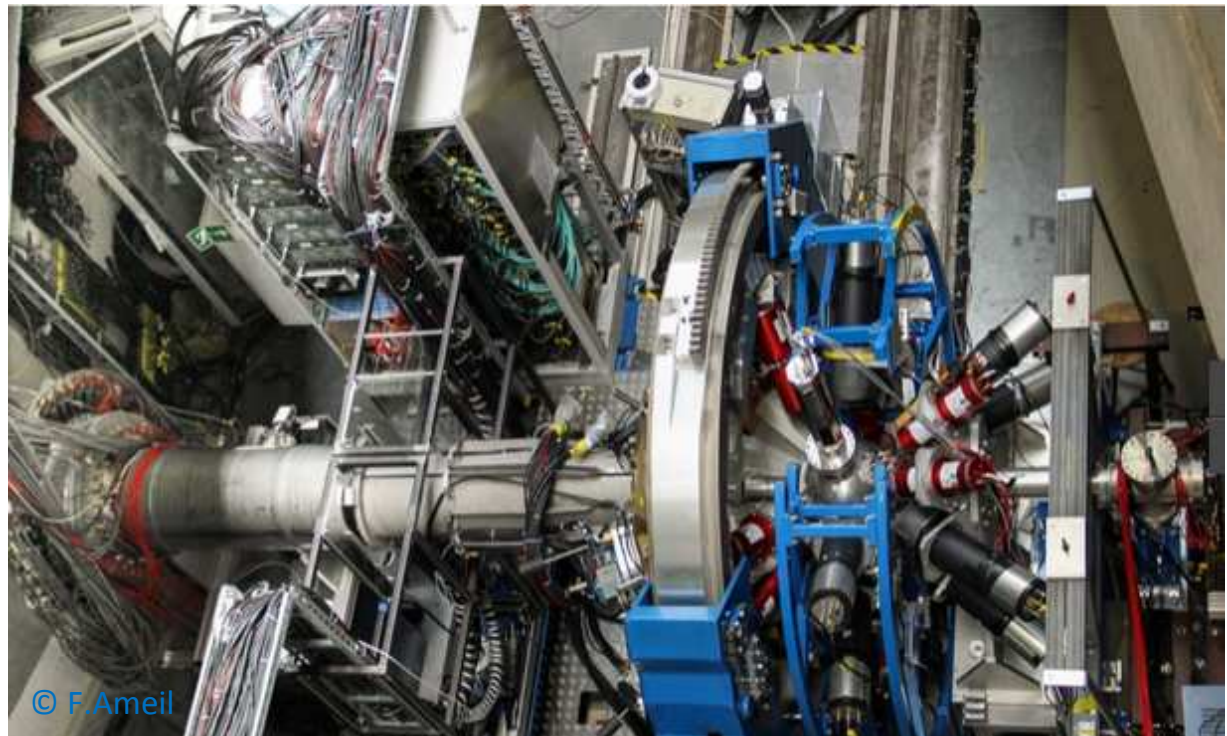
2014

primary beam : ^{86}Kr @ 700 MeV/nucleon

relativistic coulomb excitation: $^{62,64}\text{Fe}$ @ 400 - 440 MeV/u on ^{192}Au target

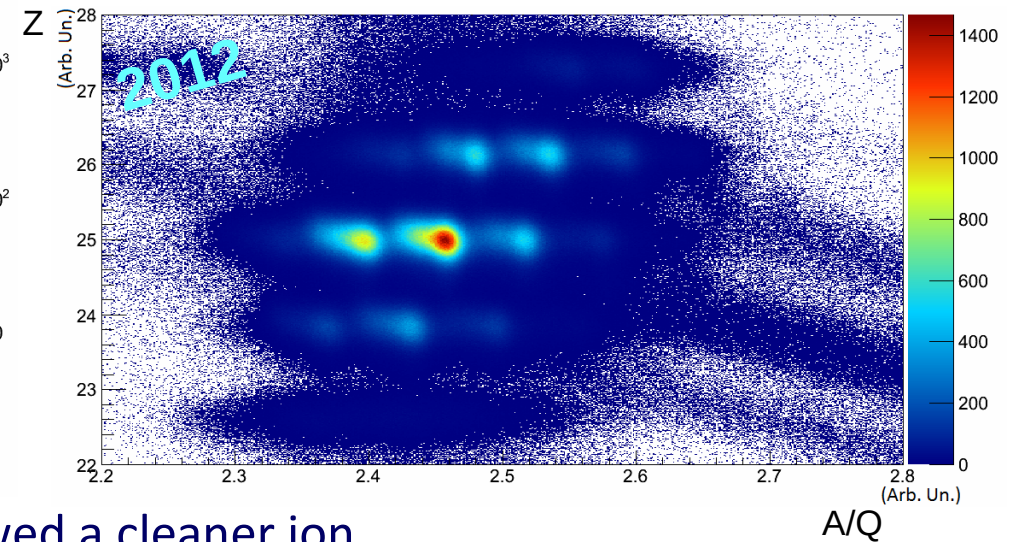
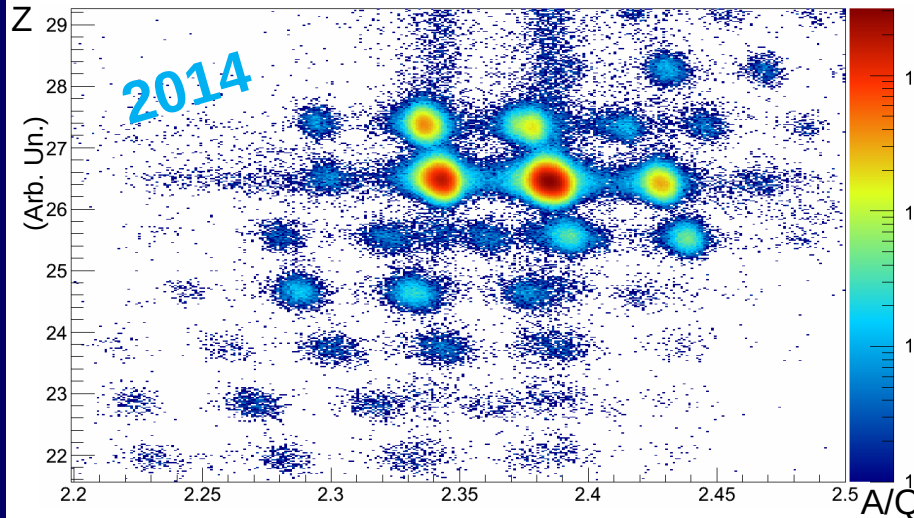
PDR gamma decay : expected gammas energy range 9-10 MeV in CM frame (low multiplicity). Expected Energies in Lab frame ~15-20 MeV

Gamma detector arrays:
AGATA [forward angles]
HECTOR+ [$\text{LaBr}_3\text{:Ce}$ + BaF_2
at different angles]



Ion Identification

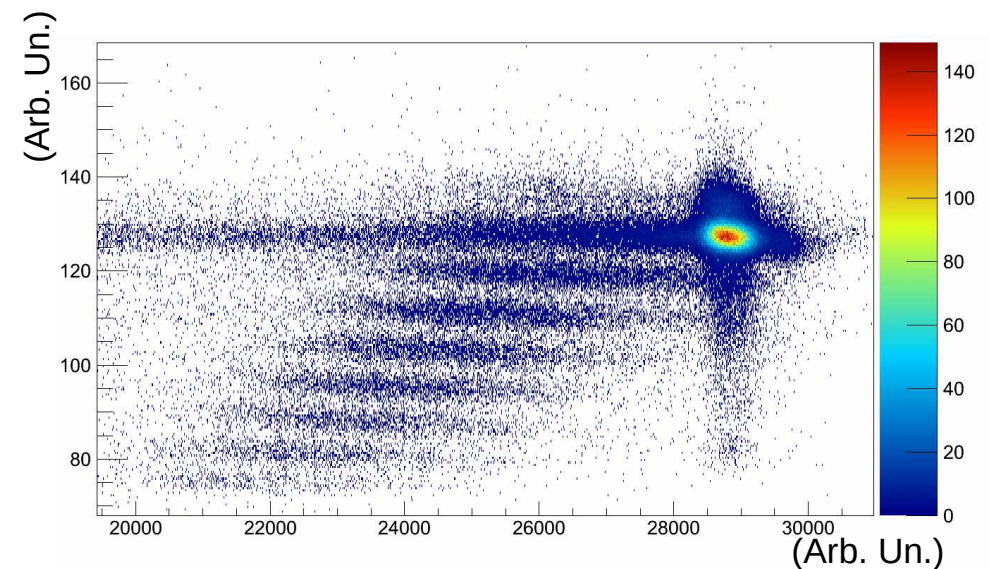
FRS identification



2014 run - Lower rate at S2 stage allowed a cleaner ion identification. Higher identification efficiency with TPCs $\rightarrow$ 75% .

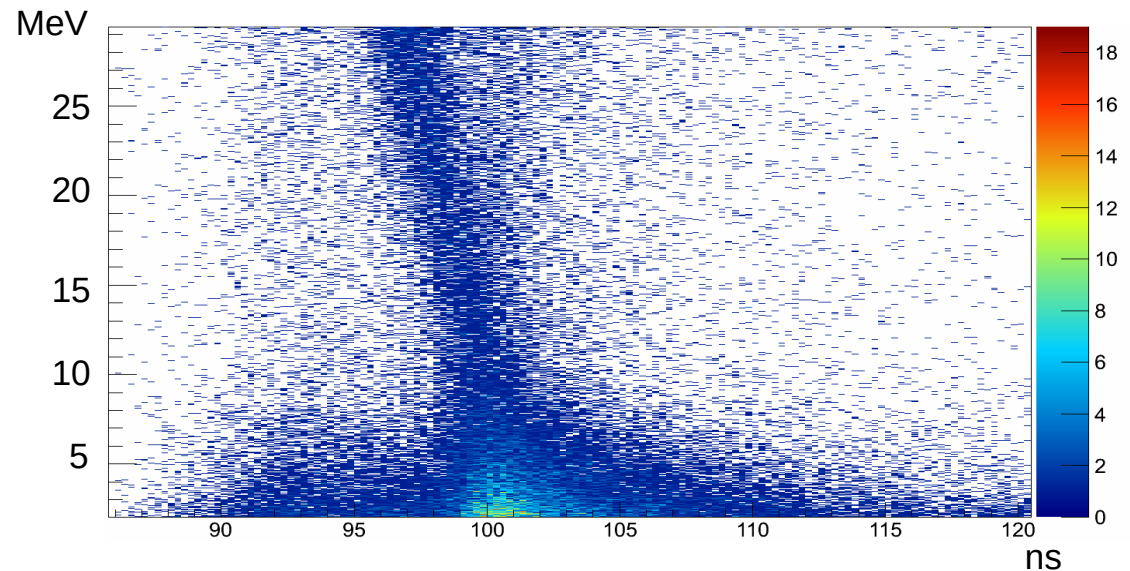
LYCCA identification

Nice identification in LYCCA E- ΔE plot

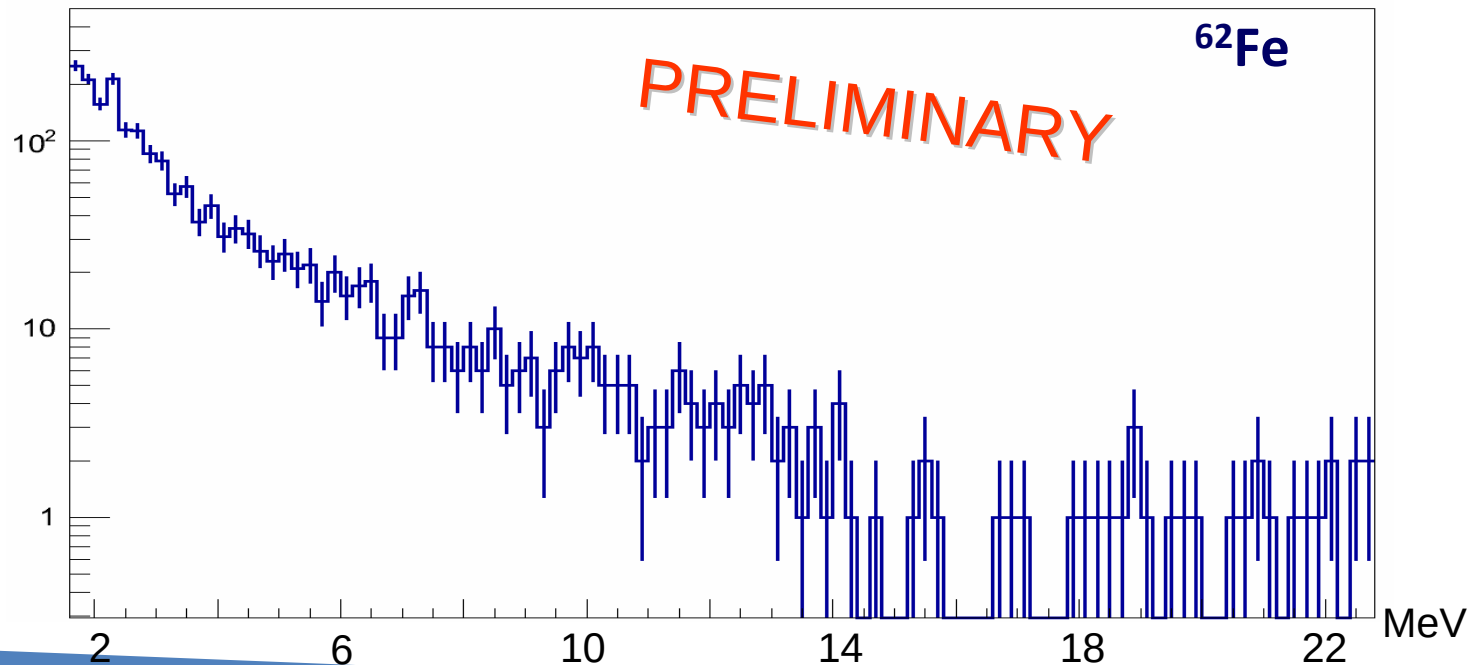


HECTOR+ spectra

LaBr₃:Ce Energy-Time matrix show typical pattern with a drift in time at high energies

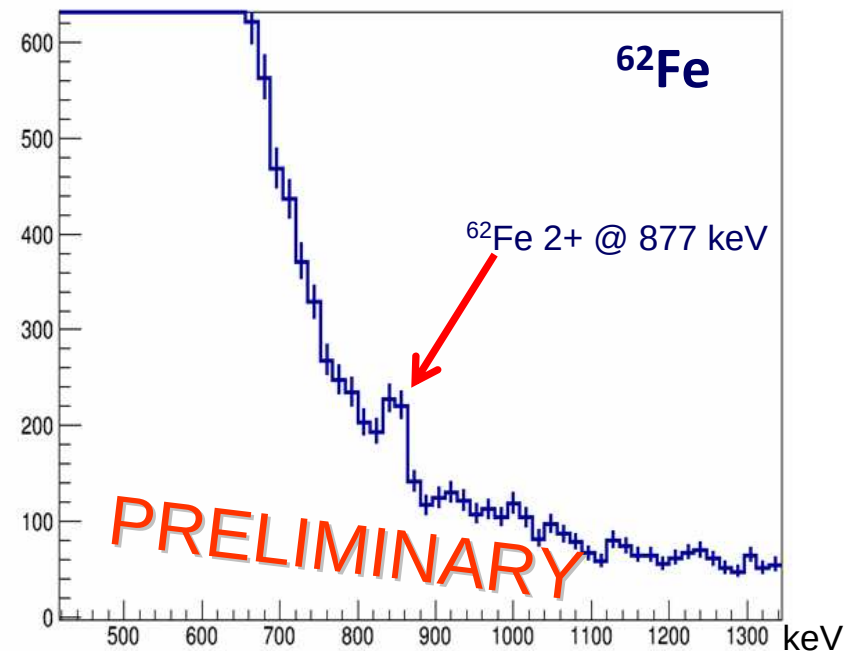
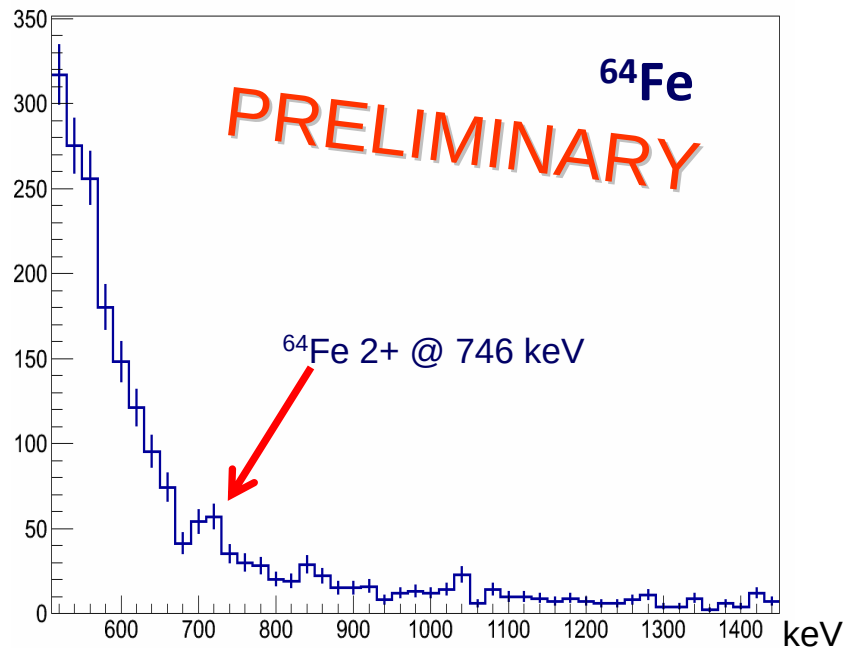


Preliminary LaBr₃:Ce energy spectrum shows some accumulations at high energies



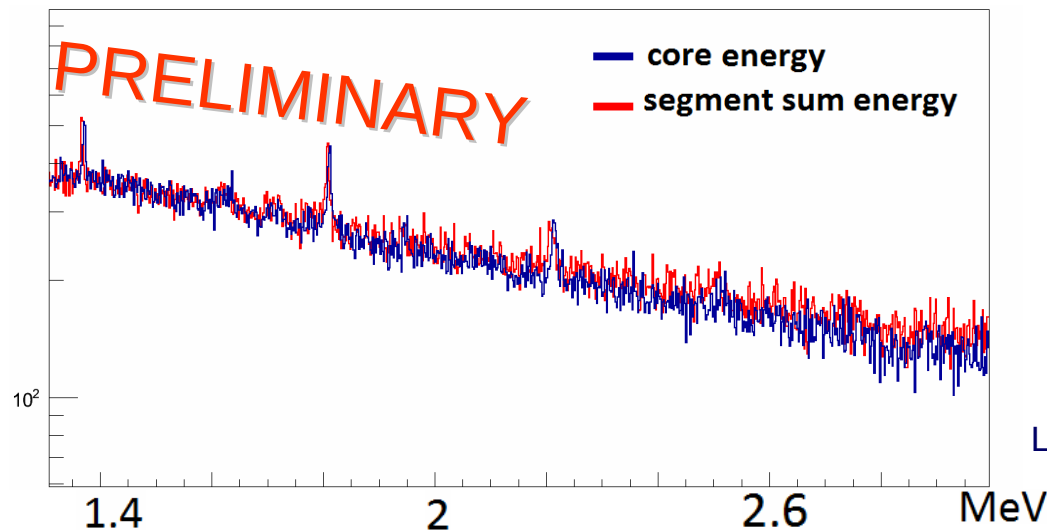
AGATA spectra at low energy

Doppler corrected AGATA spectra requiring coulomb excitation condition on ion tracking

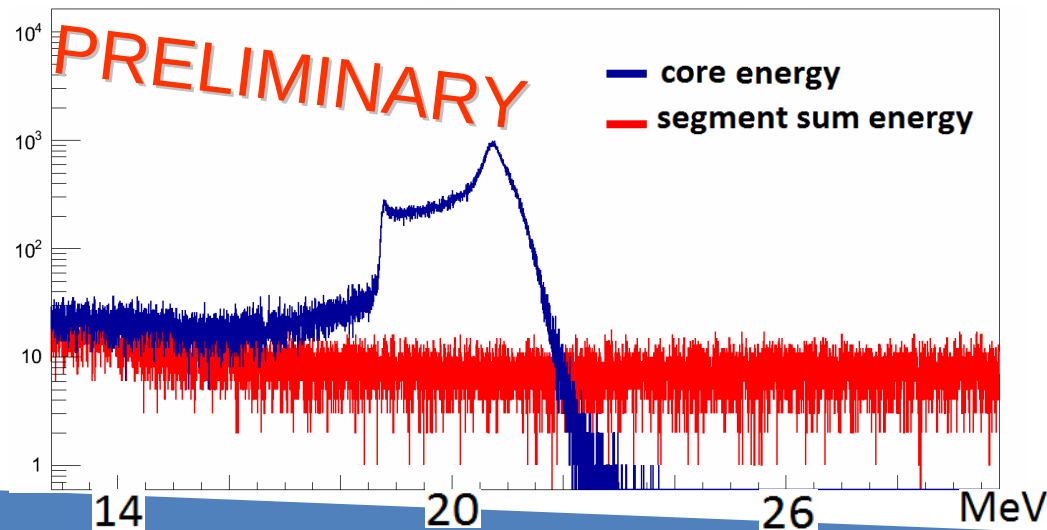


2012 High Energy AGATA data (replay)

2012 runs with long range segments (16 MeV) show that summing energy segments allows to overcome the core saturation energy. Events at so high energies are a good test for MGT libraries and for other possible algorithm used for tracking gammas

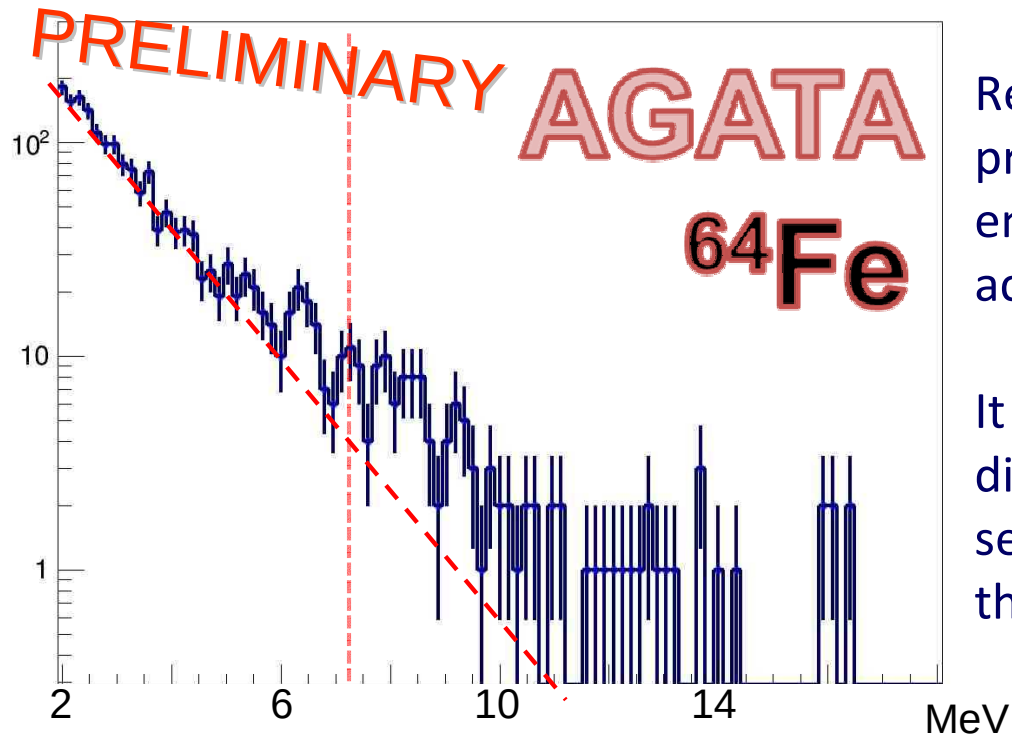


Low Energy spectrum comparison



High Energy spectrum comparison

Physic interpretation of gamma spectra



Requiring coulomb excitation condition, preliminary gamma spectra at high energy from 2012 data show accumulation at high energies

It is possible investigating E1 strength distribution below one neutron separation energies (at energies lower than PDR)

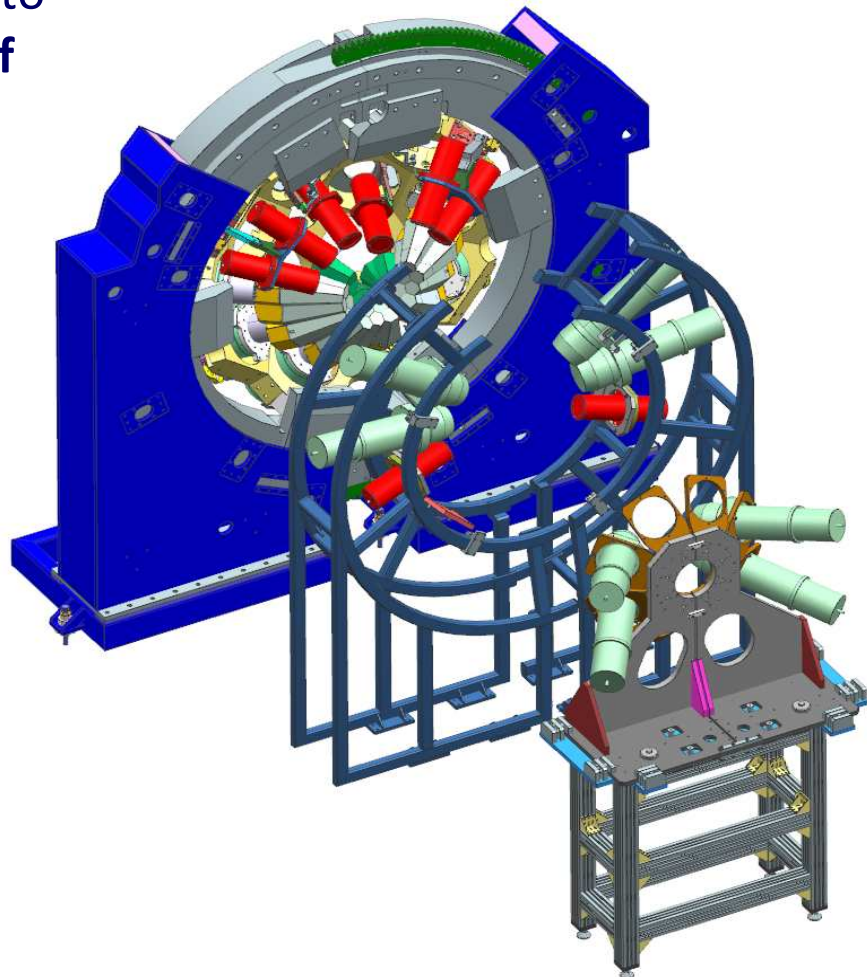
A comparison with theory and simulation is needed

Multipolar character of strength

Dweiko calculations can be exploited to obtain E1 and E2 angular distribution

HECTOR+ array coupled with **AGATA** allow to have angular distribution in a **wide range of angles**

	2012 setup		2014 setup	
	LaBr ₃	BaF	LaBr ₃	BaF
22.5 °	--	--	2	--
68°	4	--	4	--
95°	4	4	2	4
142°	2	4	--	4



Conclusion and perspectives

- 2+ peak identification in AGATA spectra allows to have a fine correction of β value and reference for strength at high energy
- AGATA data replayed without condition on segment energy sum allows to recover statistics at high energy
- Angular distribution for E1 strength is possible thanks to HECTOR detectors angular position

Thanks to: PRESPEC et al : A Great Collaboration

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. Pellegrini, A. Giaz et al.,
Dip. di Fisica and INFN, Sezione di Milano, Italy*
- *A. Maj, M. Kmiecik, P. Bednarczyk, 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, P. Boutachkov,
S. Pietri, M. Reese, D. Ralet, Ch. Stahl et al., GSI, Darmstadt,
Germany*
- *et al. ...*
- *and the AGATA - PRESPEC and FRS collaboration.*

Thank you for your attention!