Response of AGATA detectors to gamma-rays in the energy range up to 15 MeV

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Outline

- “Measurement of 15 MeV γ-rays with the AGATA cluster detectors‟ and Am-Be-Fe Source Data

- Energy Resolution and Linearity

- Multiplicity Distributions(Clusters, Crystals, Segments)

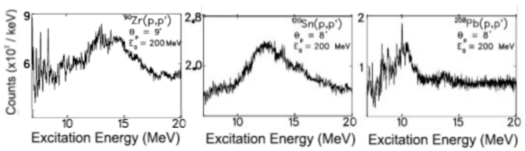
- Doppler Correction and Tracking

Response of AGATA detectors to high-energy gamma rays

In many in-beam gamma spectroscopy experiments the detection of high-energy gamma rays in the range up to 10-20 MeV is of primary importance, e.g.:

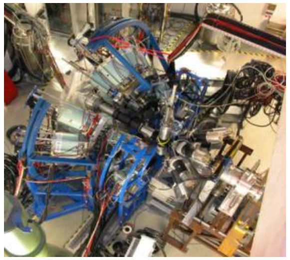
Giant Quadrupole Resonance investigation by inelastic scattering

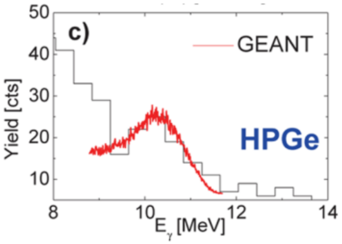
R. Nicolini 2010 AGATA Experiment



Shevchenko et al.,
PRL 93, 122501 (2004)

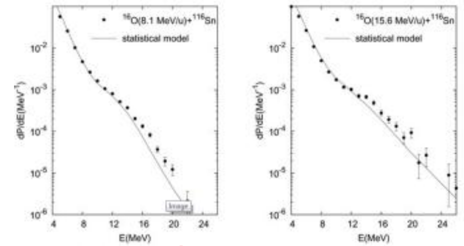
Search for the Pygmy Dipole Resonance in ^{68}Ni





O. Wieland *et al.*,
PRL 102, 092502 (2009)

Measurement of Dynamical Dipole γ decay in N/Z asymmetric reactions

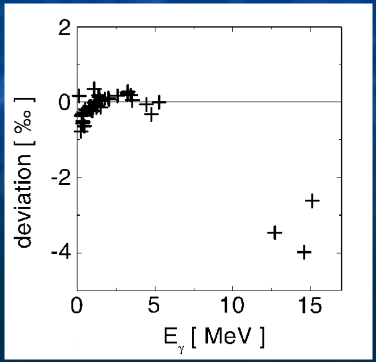


A.Corsi *et al.*,
PLB 679, 197 (2009)

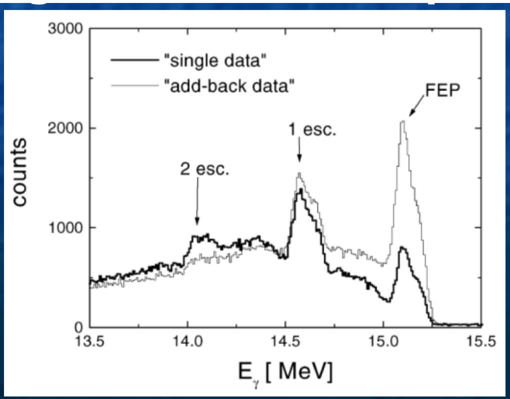
"…experiments requiring the detection of γ-rays in the 10-20 MeV interval with good energy resolution, can benefit from the use of these germanium detectors…" B. Million et al., NIMA 452 (2000) 442

EUROBALL Clusters

Linearity



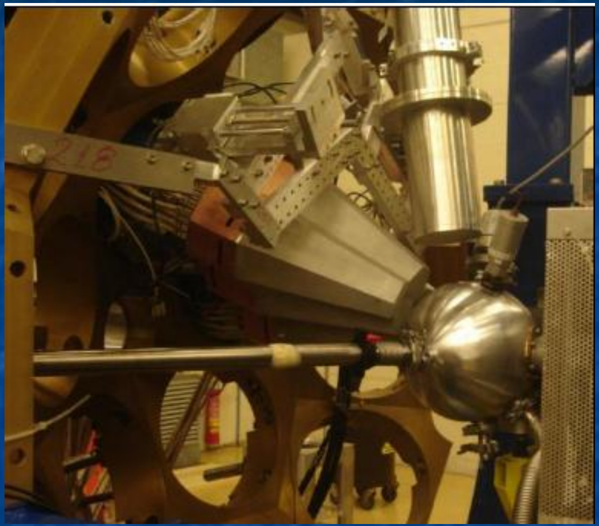
Single and Add-back spectra



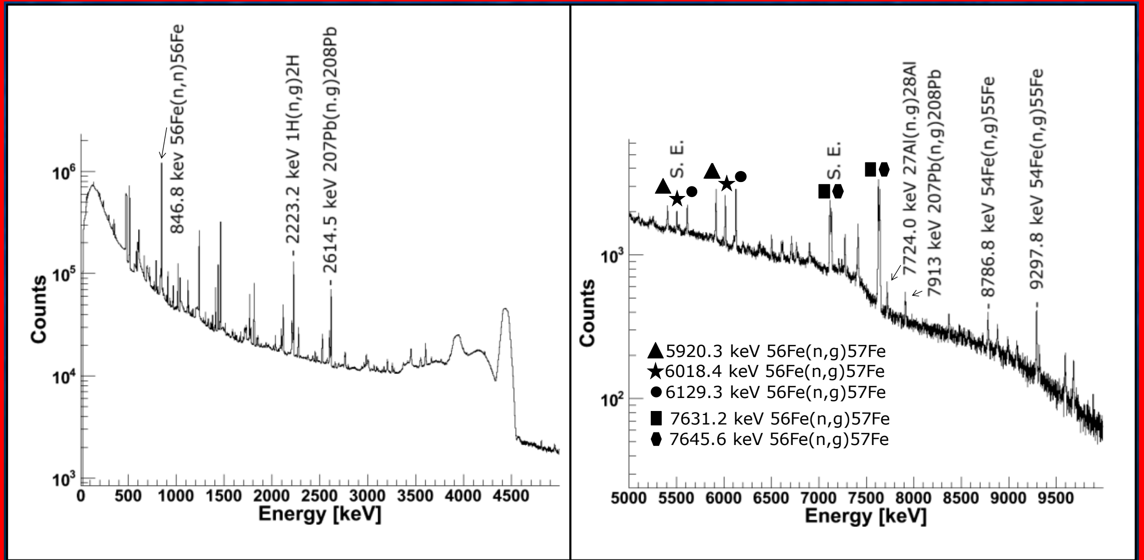
Response of AGATA detectors to high-energy gamma rays

A measurement of the response to 15.1 MeV gamma rays has been performed using two HPGe triple clusters of the AGATA Demonstrator array, operating at LNL. **15.1 MeV gamma rays are emitted by the $1^+ \rightarrow 0^+$ M1 transition in $^{12}C^*$ produced in the reaction:**

$$D(^{11}B,\gamma)^{12}C + n \ @ \ E_{beam} = 19.1 \text{ MeV}$$



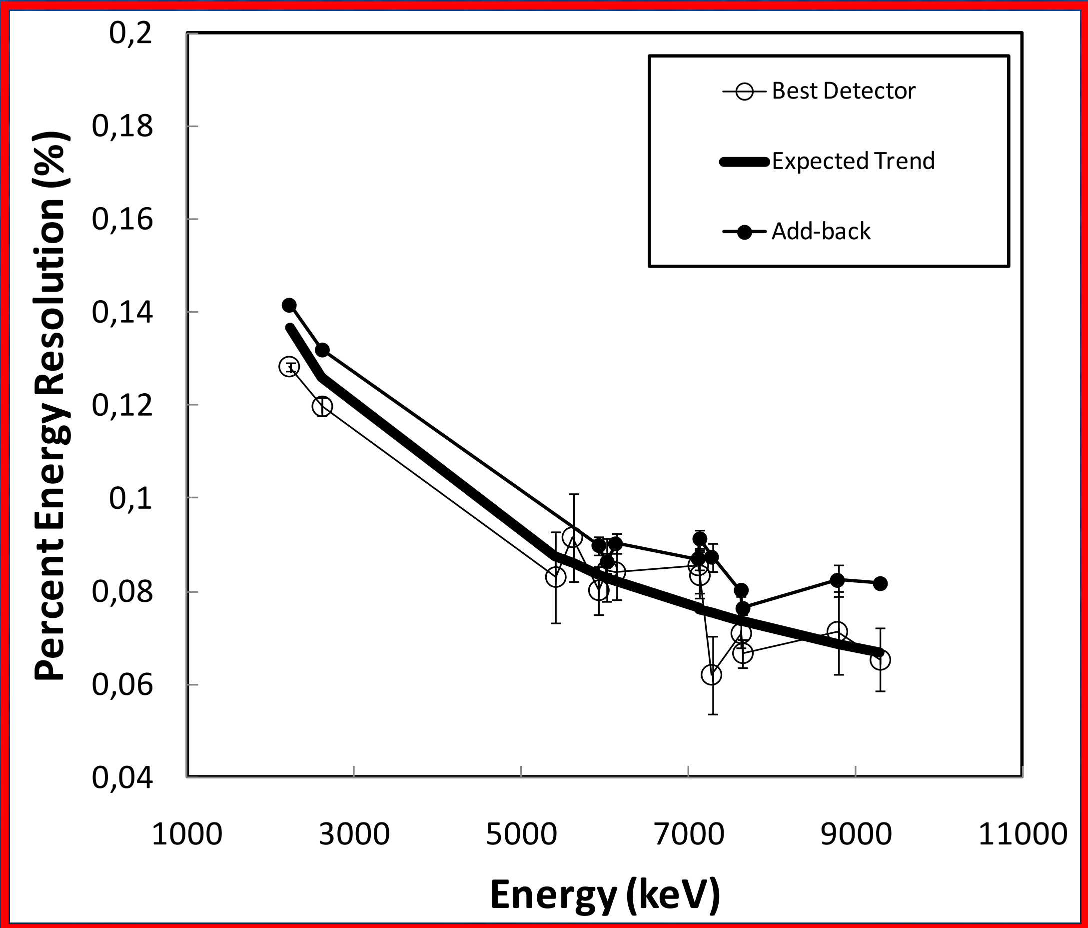
About 23 hours of calibration measurements with an Am-Be-Fe source were carried out. These data allowed a high-energy calibration of the detectors to be made and to check the linearity and the energy resolution of the AGATA detectors up to 9 MeV.



Energy Resolution

Percent Energy resolution is consistent with expected trend up to 9 MeV (15 MeV gamma cannot be used at this purpose, it is emitted in-flight)

Segments Gain matching is important (for sufficient statistics most energetic hit in one segment spectra are used)

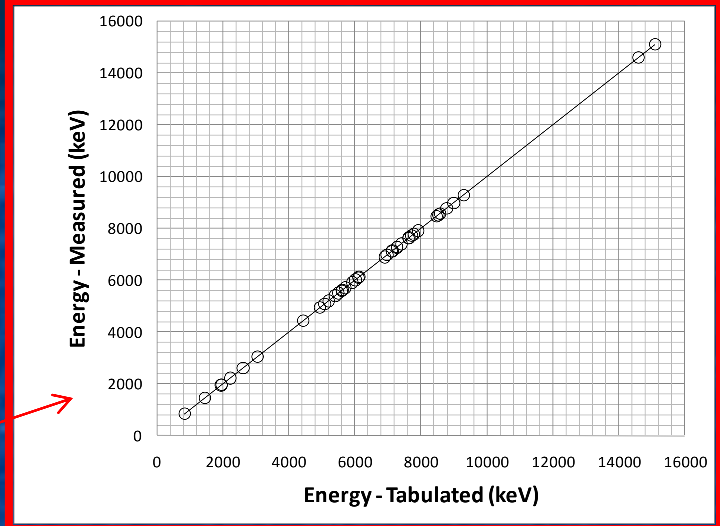


Linearity

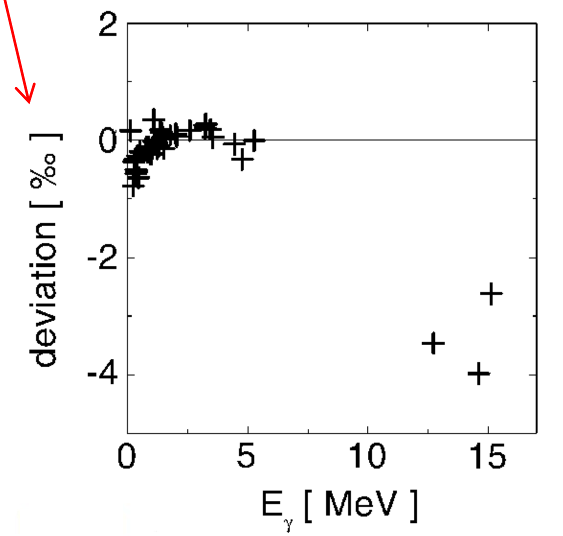
Linearity of AGATA detectors checked up to 15 MeV, using both Am-Be-Fe calibration data and the 15.1 MeV gamma from the in-beam test

EUROBALL Clusters

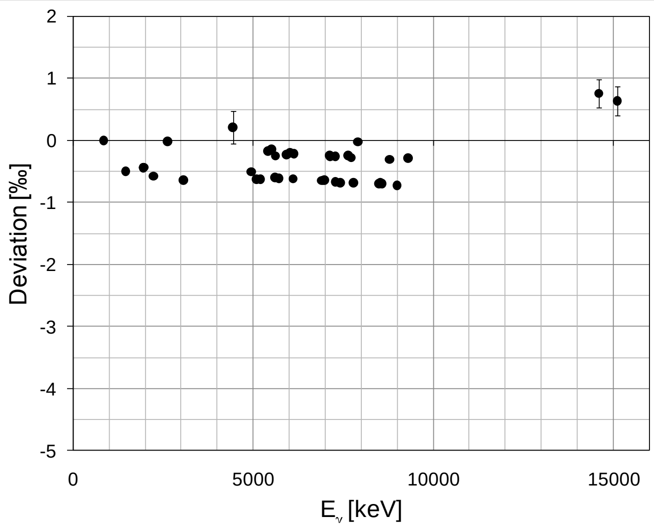
AGATA



B. Million et al., NIMA 452 (2000) 44

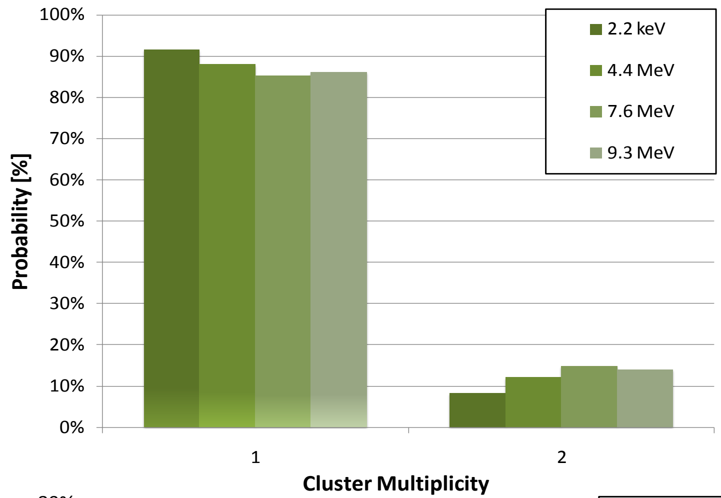


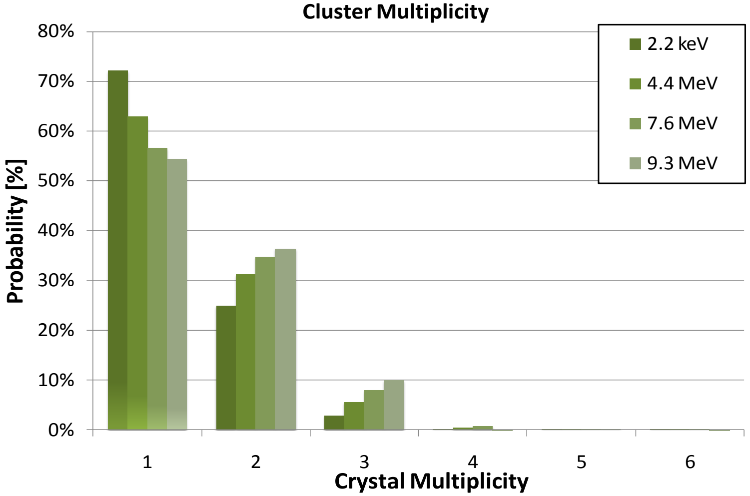
Per mil deviation from ideal linearity:
(E_Tab –E_Meas)/E_Tab



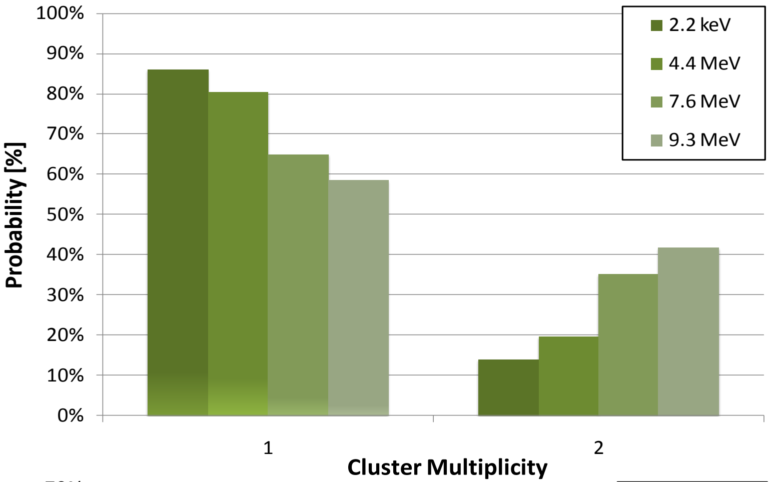
Multiplicity Distributions and Energy Release

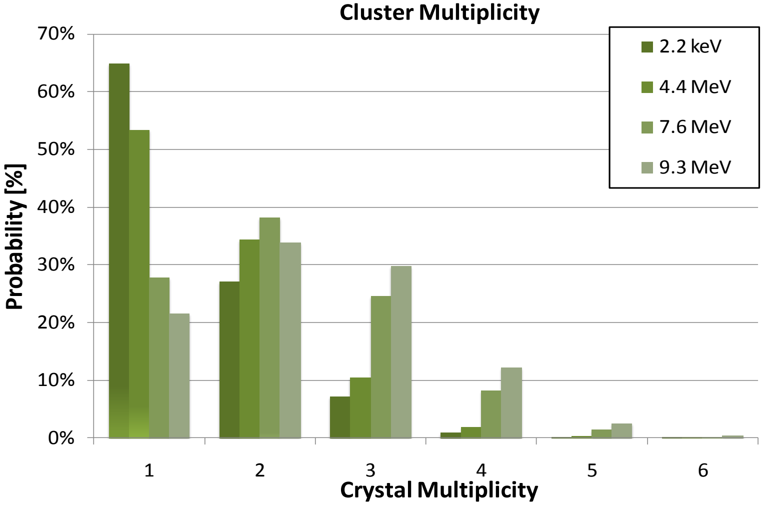
FEP Events





Background



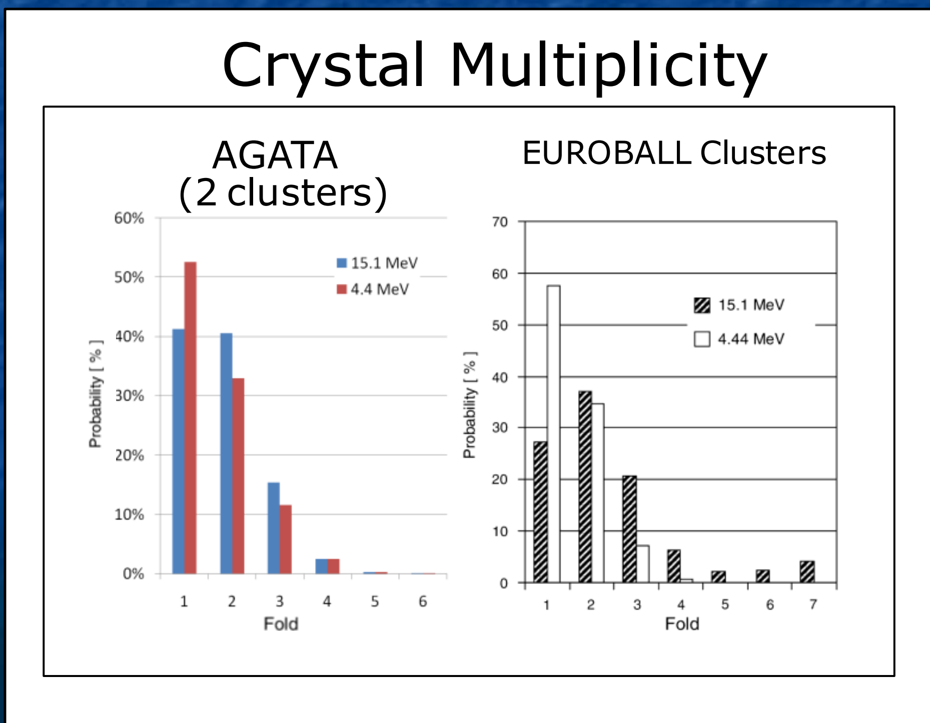


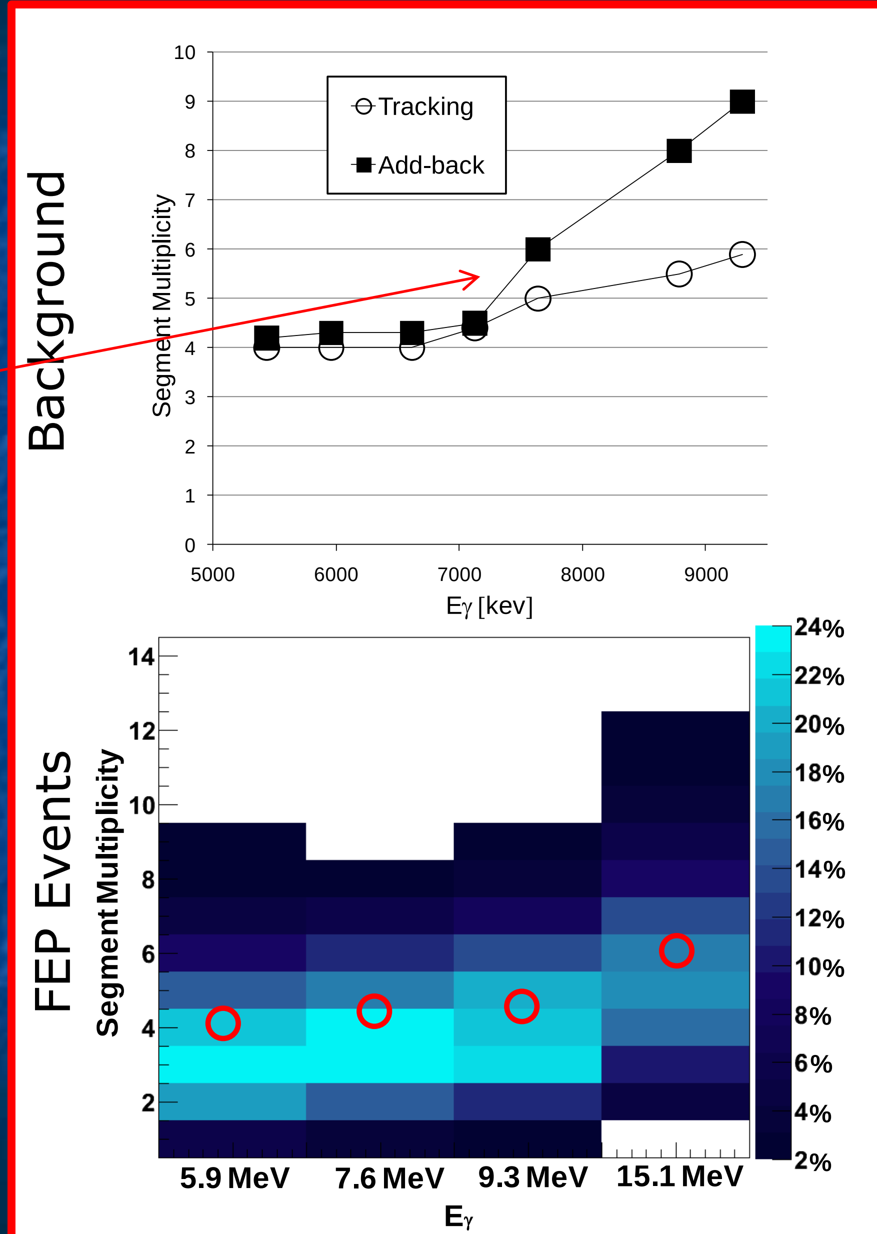
Multiplicity Distributions and Energy Release

Multiplicity Distributions :

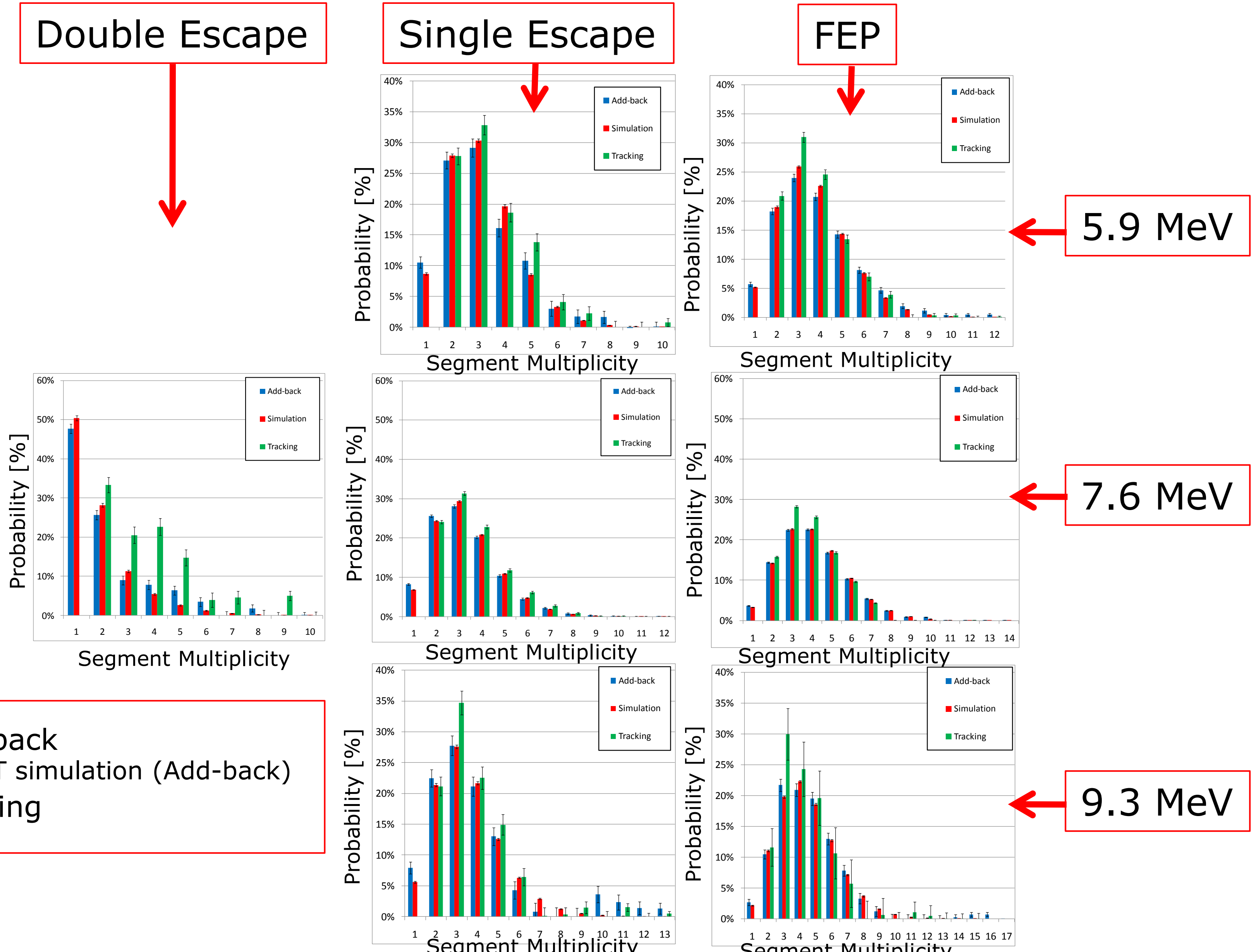
FEP Events VS Background

Background Suppression





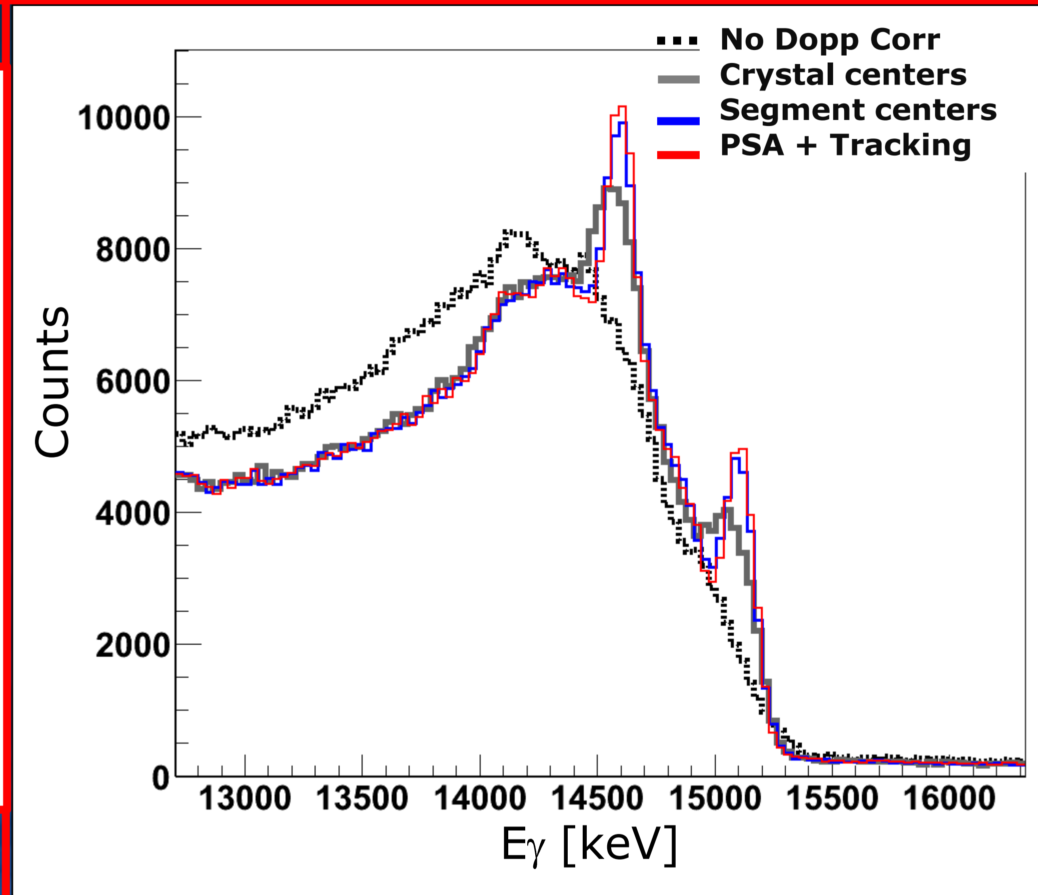
Multiplicity Distributions and Energy Release



- Add-back
- GEANT simulation (Add-back)
- Tracking

Doppler Correction and Tracking

The spectrum obtained **without Doppler correction** (dotted black line) is compared to the one obtained by applying a Doppler correction using only the **central position of the HPGe crystal** with the largest energy deposit (thick gray line), to the one obtained by using the **central position of the HPGe segment** thin blue line)with the largest energy deposit and to the one obtained by using the full information provided by the **PSA and Tracking** (thin red line).



→ Great improvement in Doppler Correction quality using PSA+Tracking (also for high-energy gamma rays)

→ Relatively small improvement between "blue" spectrum and "red" is due to uncertainty in ^{12}C ion velocity (not measured). This is also the limiting factor for Doppler Correction.

Conclusions and Perspectives

- A measurement of the response to 15.1 MeV gamma rays has been performed using the reaction $D(^{11}B,\gamma)^{12}C + n$ @ E_{beam} = 19.1 MeV (+ AmBeFe source measurement)

    - *Energy resolution and Linearity verified up to 9 MeV / 15.1 MeV*
    - *Multiplicity distributions (energy release inside the detector) produced*
    - *Comparison with EUROBALL clusters case*
    - *Doppler correction performed with 15 MeV gammas using PSA+Tracking → Great improvement in Doppler Correction quality*

…still work in progress:

- ***Simulation of the experiment***
- ***Tracking efficiency VS energy***

Collaboration

Measurement of 15 MeV γ rays with the AGATA cluster detectors

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→ ***Riccardo Avigo Master Thesis***