In-beam background tests at GSI-FRS with an AGATA capsule

GSI-Gamma-Ray Spectroscopy Group, Prespec- & AGATA-Collaborations

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In-beam test of an AGATA symmetric detector at FRS

Outline

- Aim of the test
- Beam and experimental setup
- Segment hit multiplicity distribution
- Segment counting rate distribution
- High-energy spectrum (time-over-threshold)
- UMBRELLA proposal (2011) for a new background test

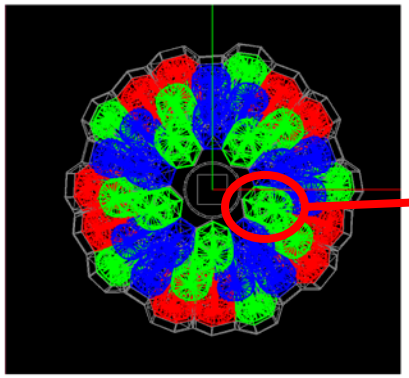
In-beam test of an AGATA symmetric detector at FRS

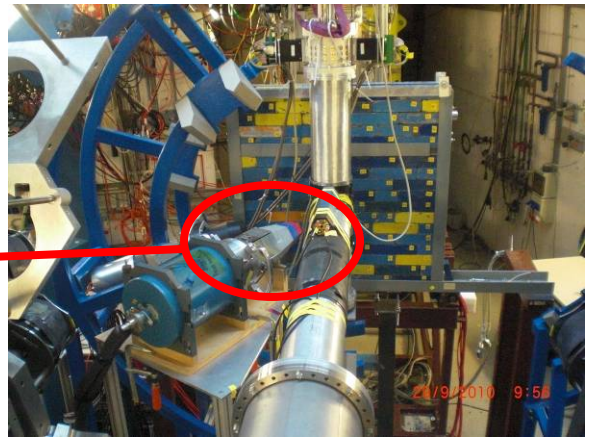
Aim:

- **Study the AGATA response to in-beam gamma- and particle-background at S4**
- Preliminary test of the time-over-threshold method

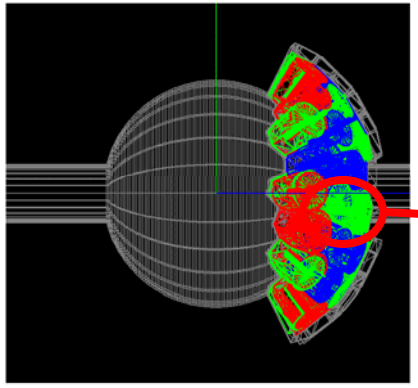
Setup: mimic the capsule closest to the beam-pipe in the AGATA S2' configuration (5 doubles + 10 triples)

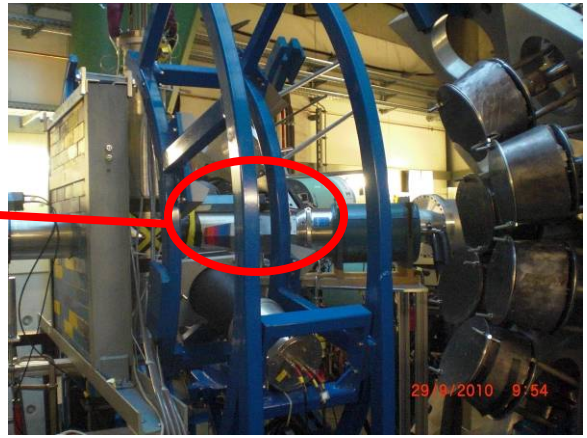
- S2' Geometry

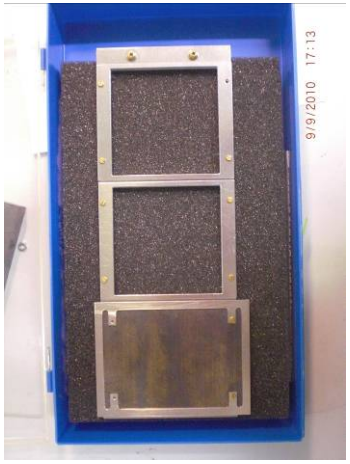




21 cm from target







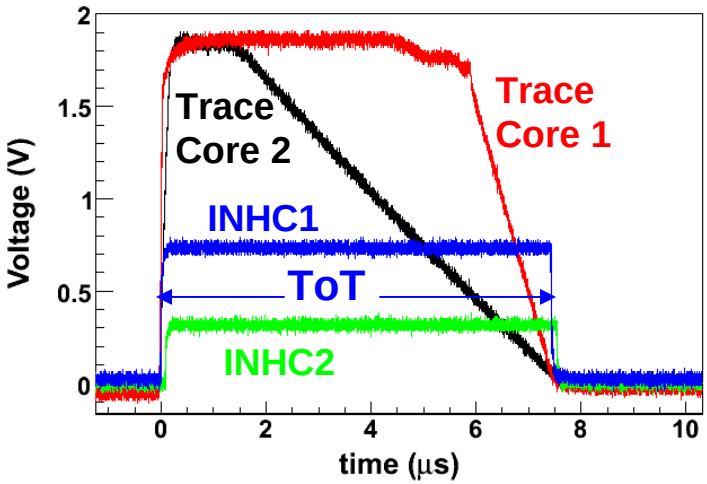
Extended Pb target 500mg/cm2 (not used).

In-beam test of an AGATA symmetric detector at FRS

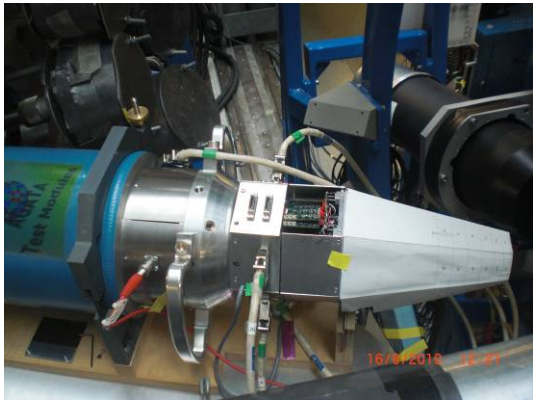
Aim:

- Study the AGATA response to in-beam gamma- and particle-background at S4
- **Preliminary test of the time-over-threshold method (in-beam)**

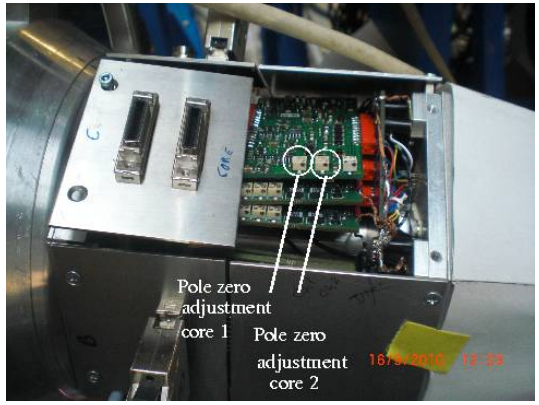
Example of high-energy event:



Energy = a x ToT + b x (V1-V2)



Time-over-threshold: the inhibit LVDS signal from the core has a time-width (quasi) proportional to the energy of the high-energy event.

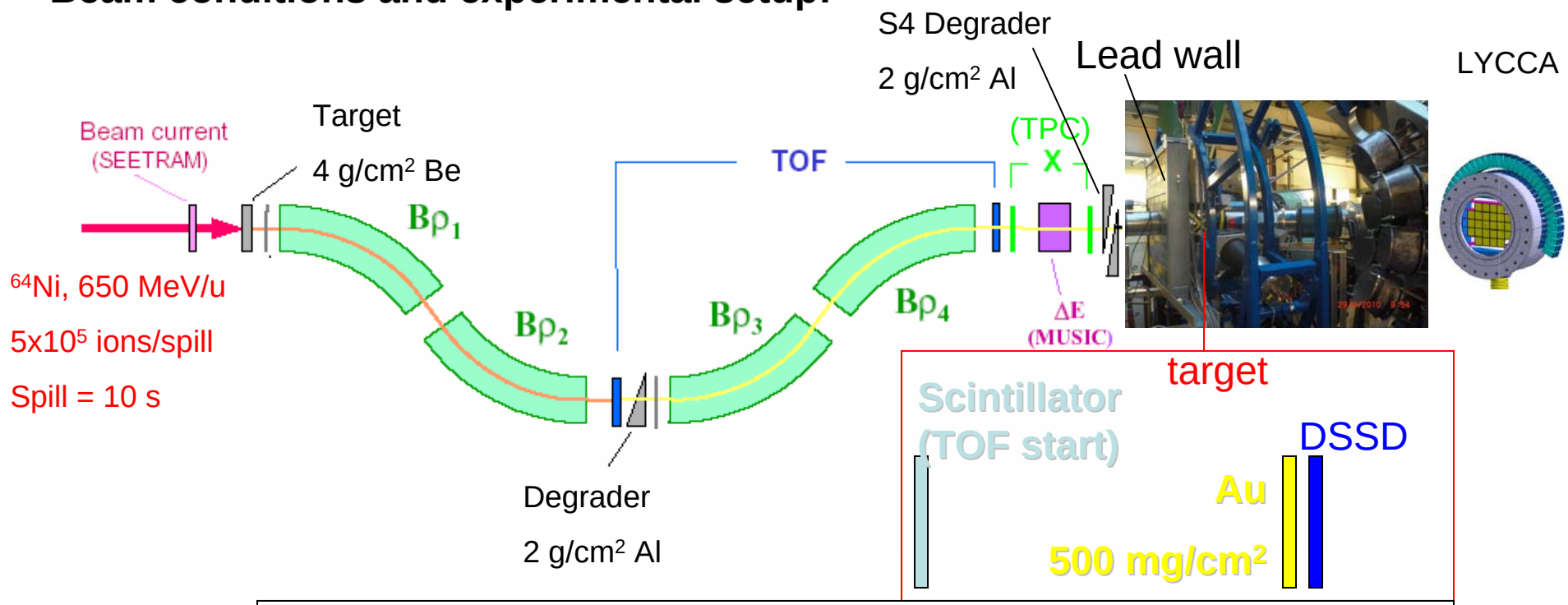


The detector is equipped with a dual core preamplifier, which provides two energy signals, Core1 and Core2. The gain of the second one is four times smaller (4x larger energy range).

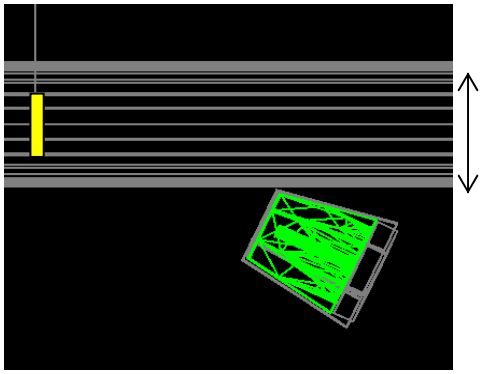
F.Zocca et al. IEEE-TNS 56-4 (2009)

In-beam test of an AGATA symmetric detector at FRS

Beam conditions and experimental setup:

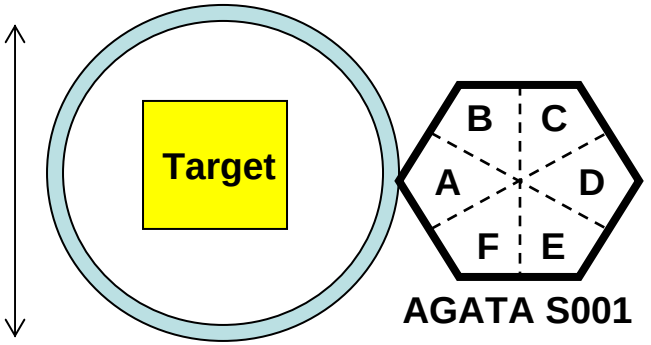


- **Top-view of the setup:**



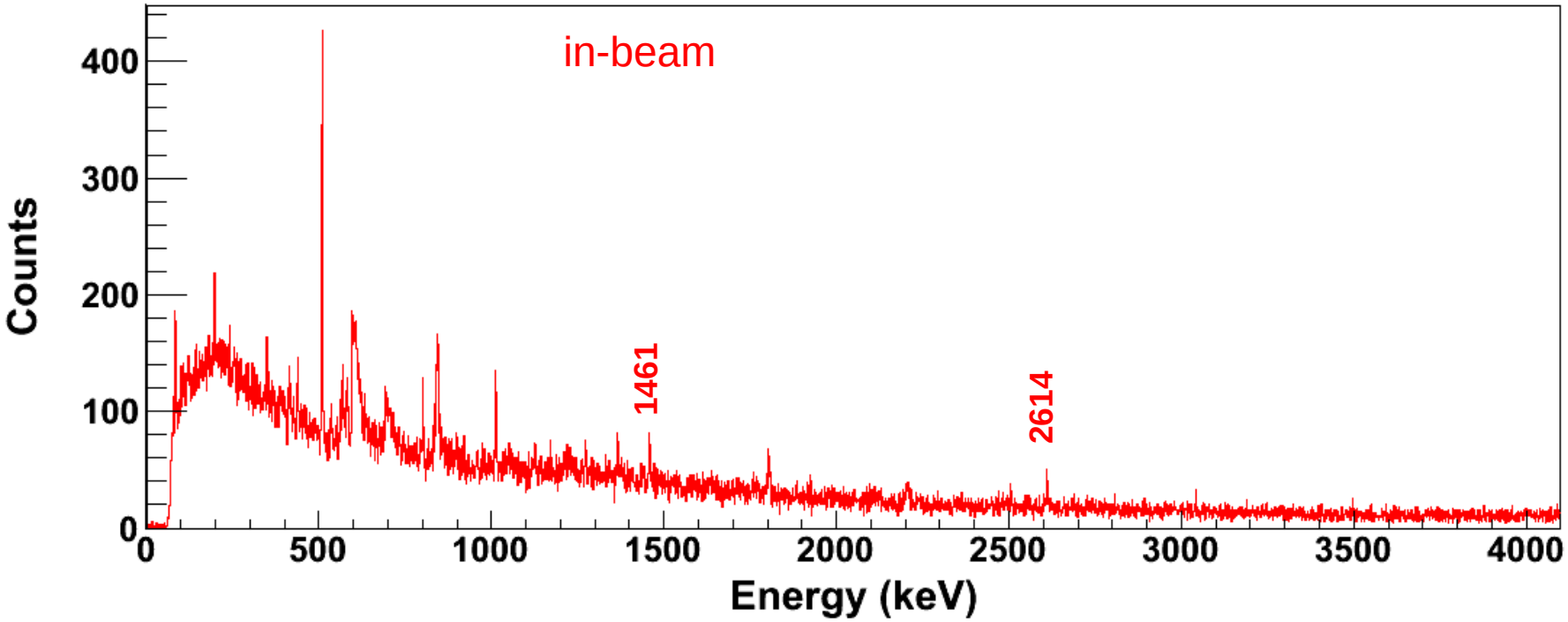
Beam pipe
160 mm

- **Front-view of the setup:**



In-beam test of an AGATA symmetric detector at FRS

Gamma-ray energy spectrum (core1):



- Natural environment radioactivity: ^{40}K, ^{208}Pb, etc

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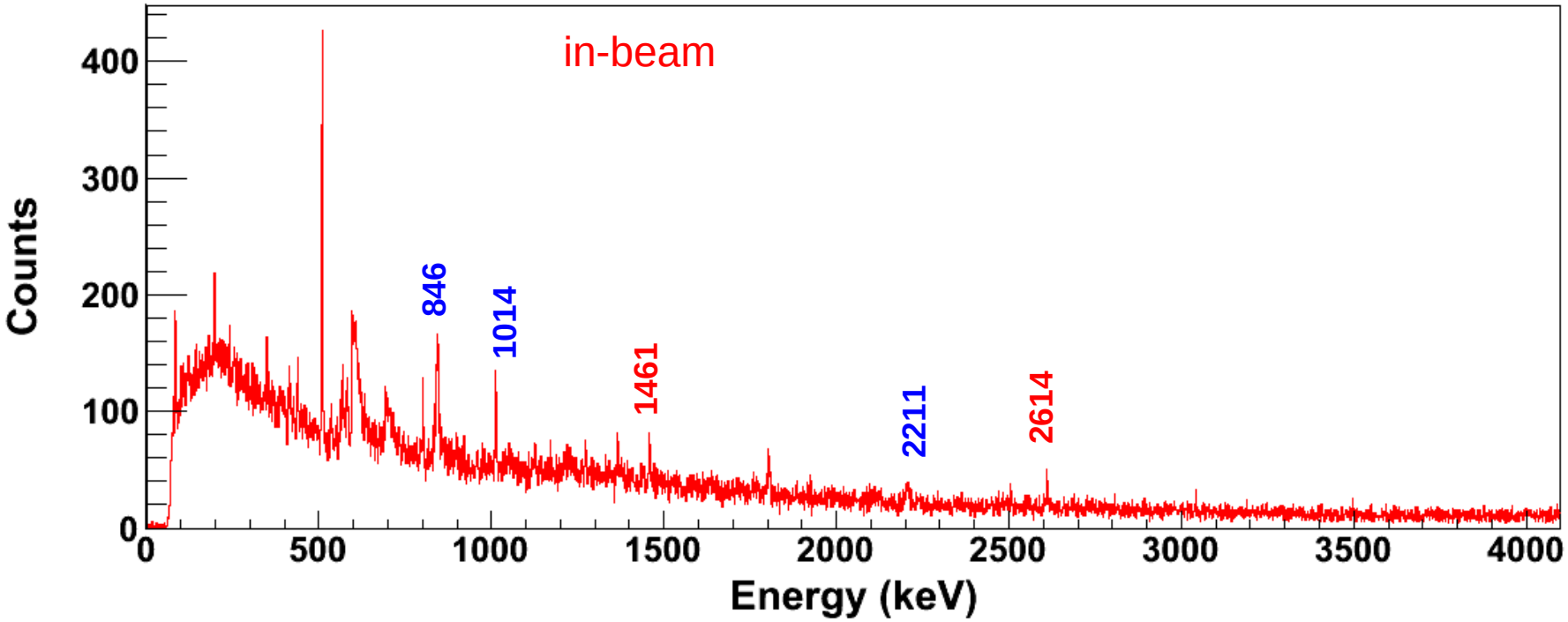

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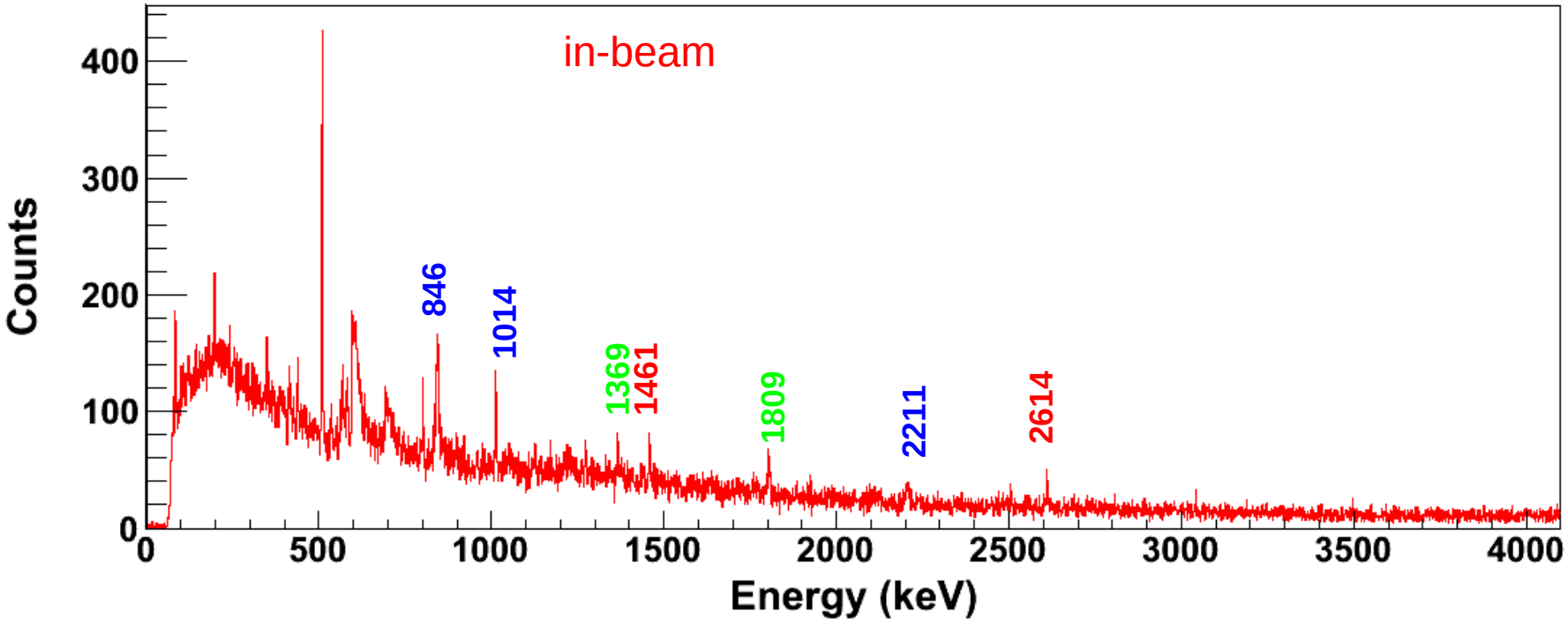

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- ^{27}Al(p,2p)^{26}Mg; with Ep ~ Ebeam/u

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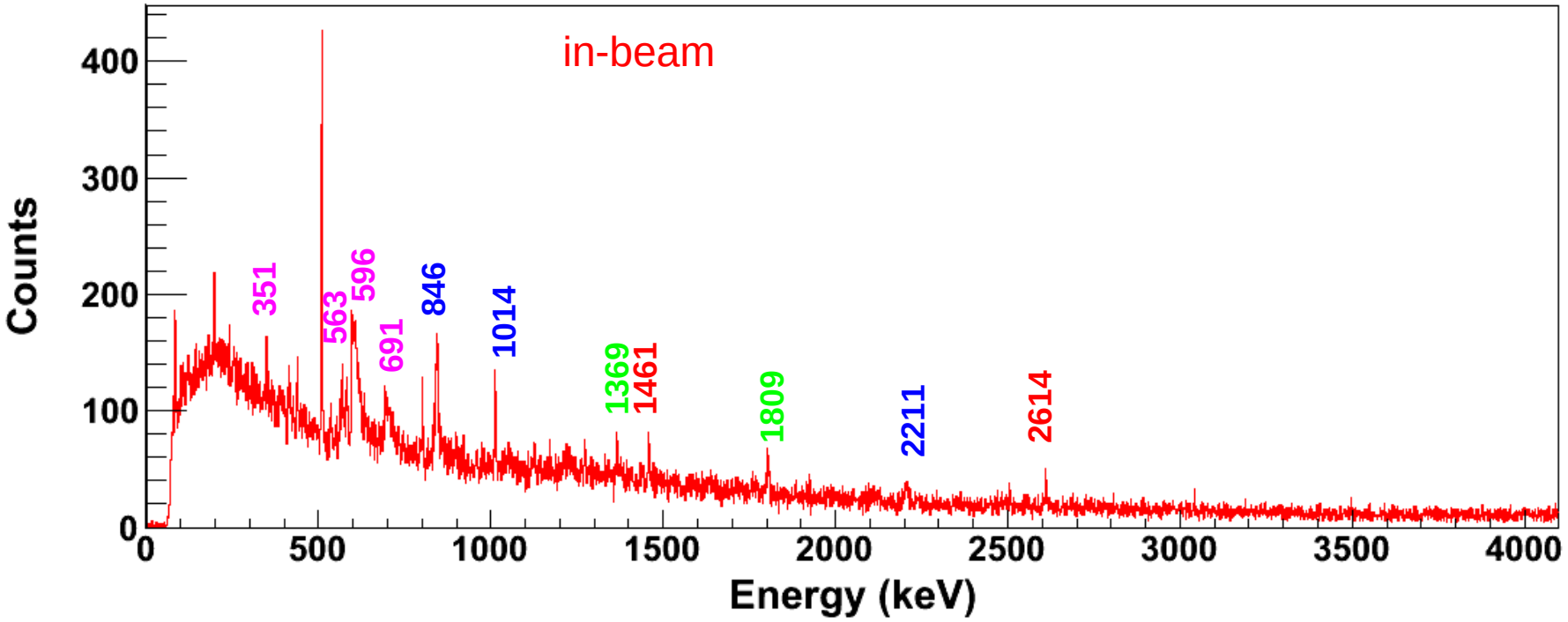

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- ^{27}Al, ^{56}Fe(n,n') with fast neutrons
- ^{27}Al(p,2p)^{26}Mg; with Ep ~ Ebeam/u
- (n,n') in ^{72}Ge (691 keV), ^{73}Ge (351 keV), ^{74}Ge(596 keV), ^{76}Ge(563keV)

In-beam test of an AGATA symmetric detector at FRS

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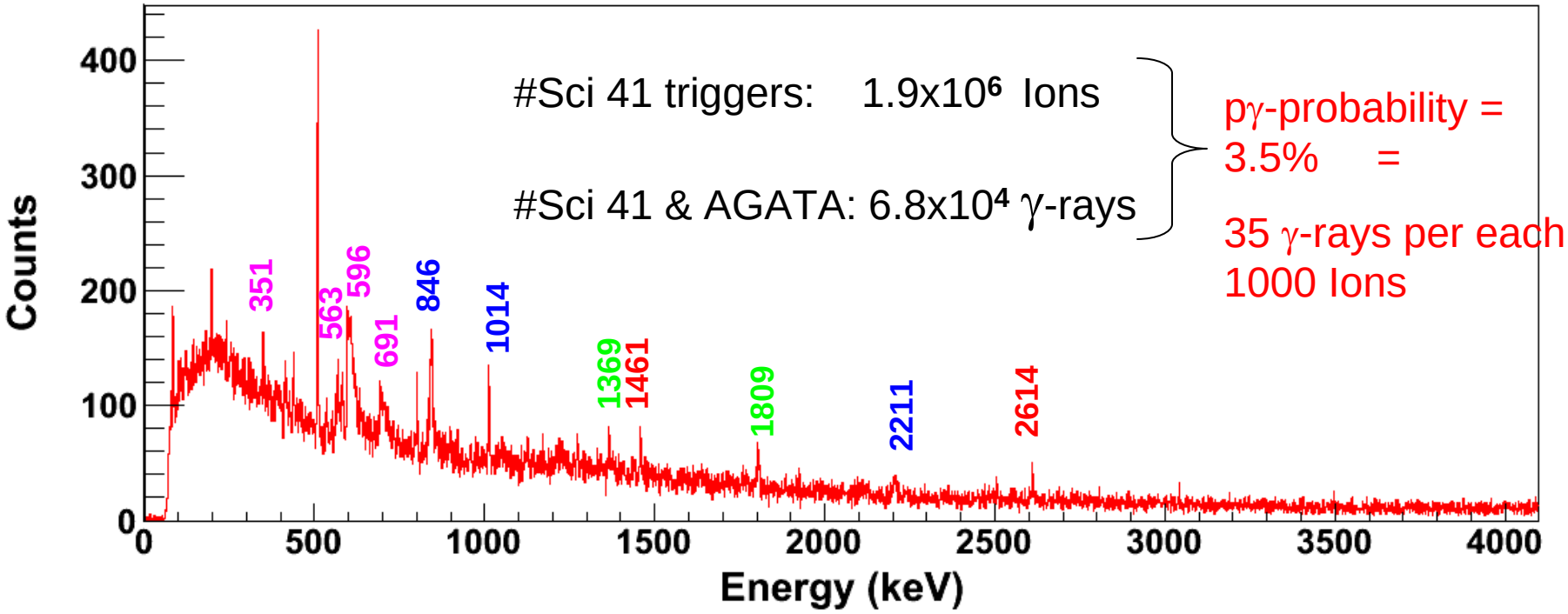

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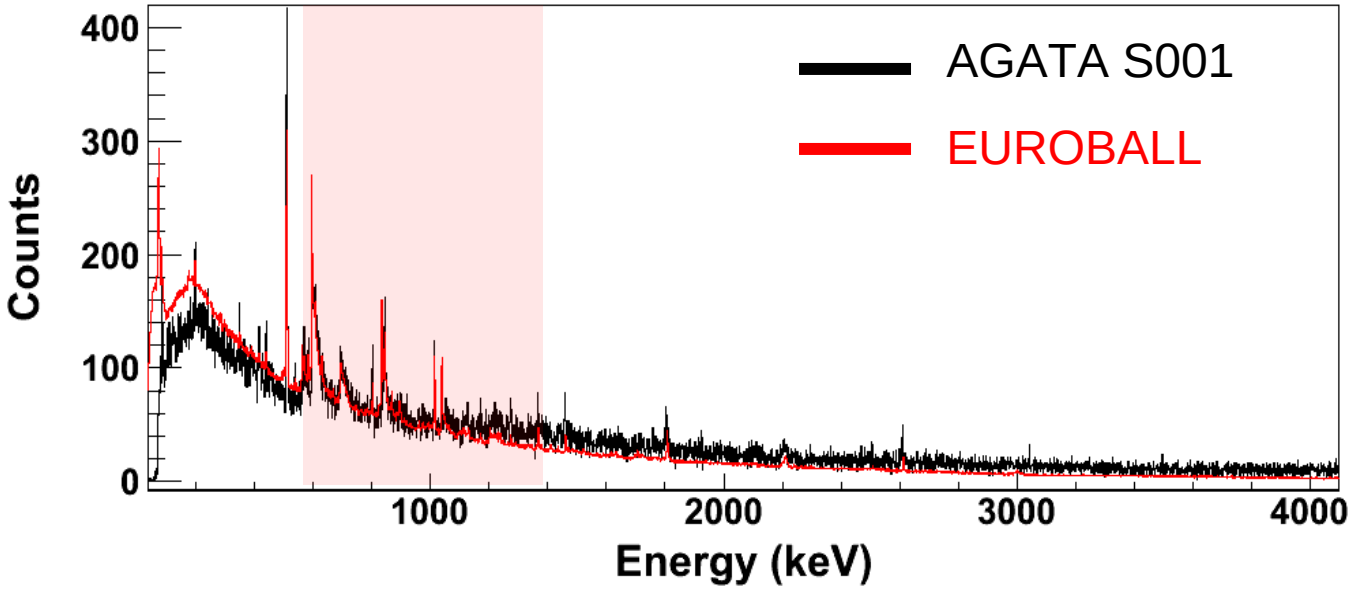
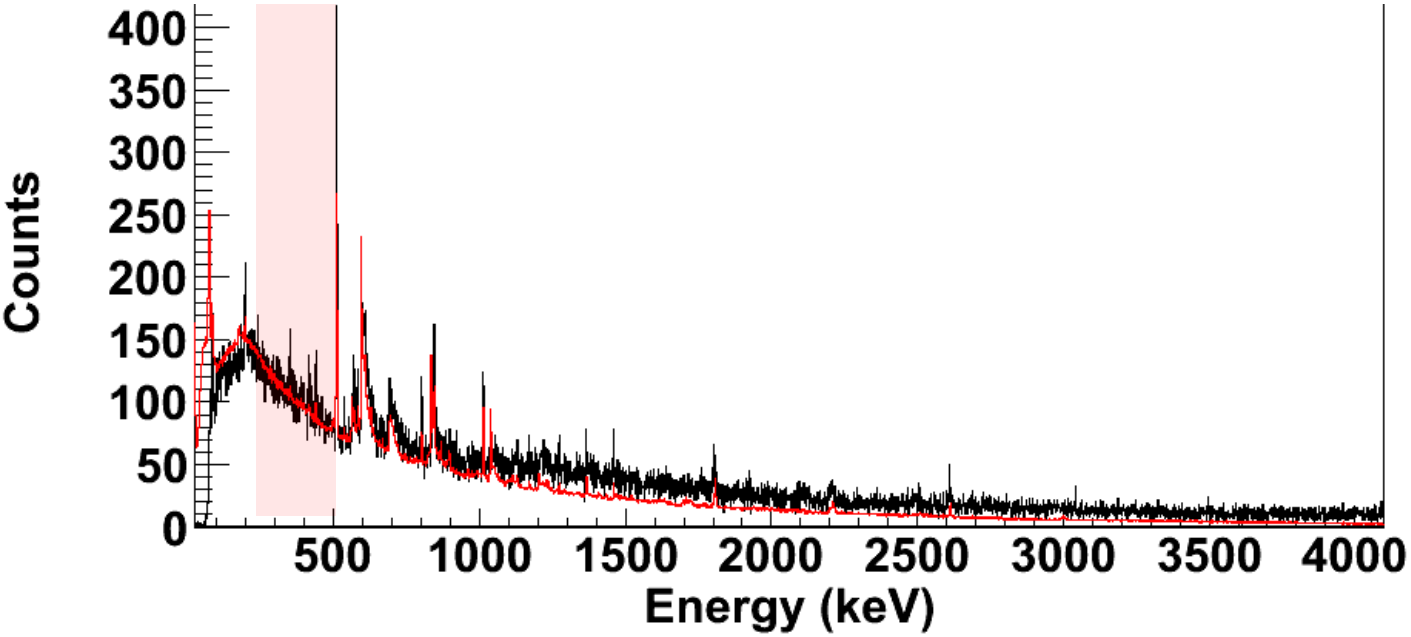
In-beam test of an AGATA symmetric detector at FRS

Gamma-ray energy spectrum (core1) vs. 5 EUROBALL Clusters (1/2 RISING)





Relative background comparison

AGATA

vs.

RISING

In-beam test of an AGATA symmetric detector at FRS

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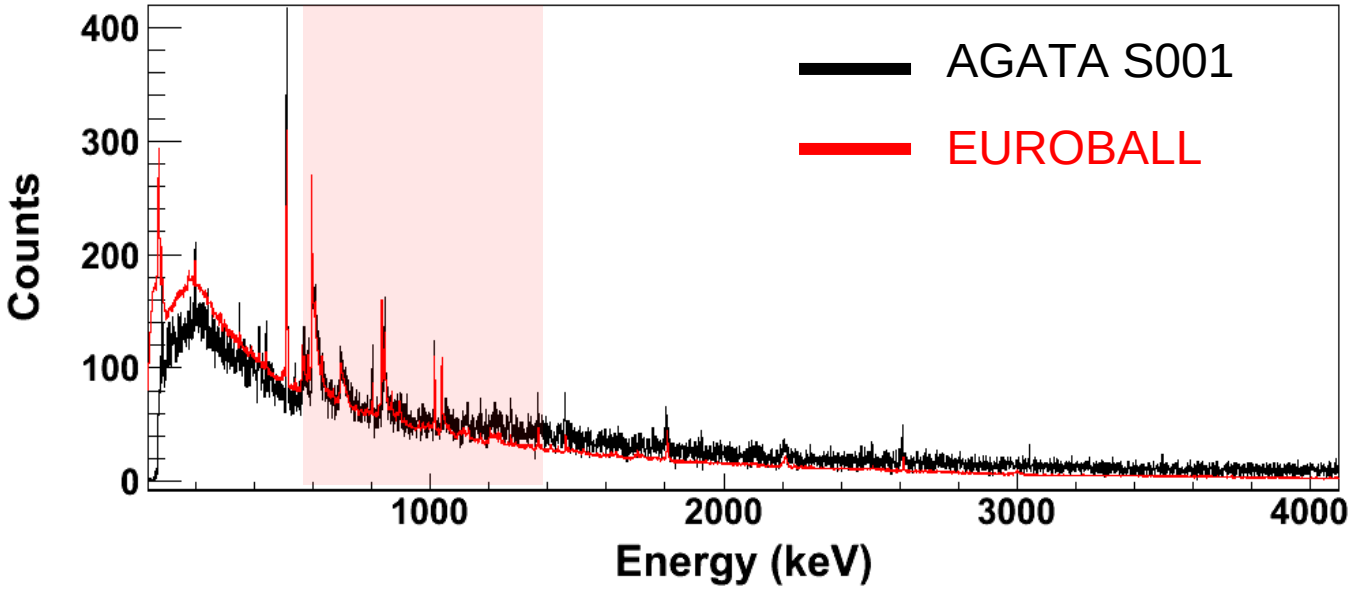
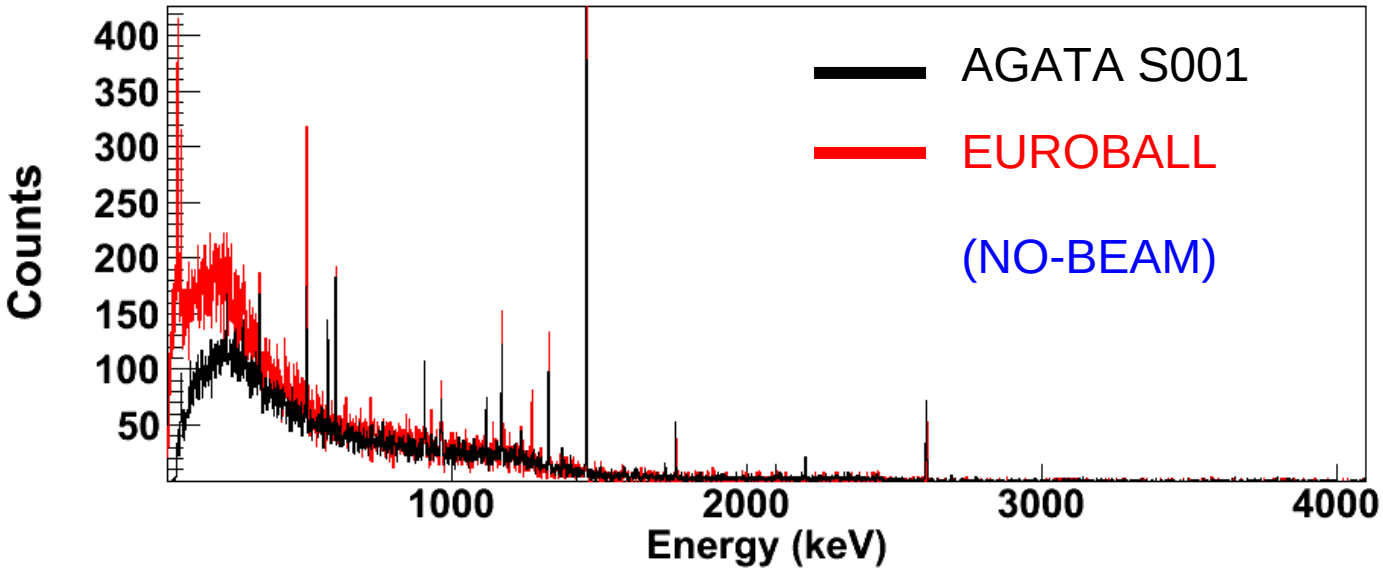
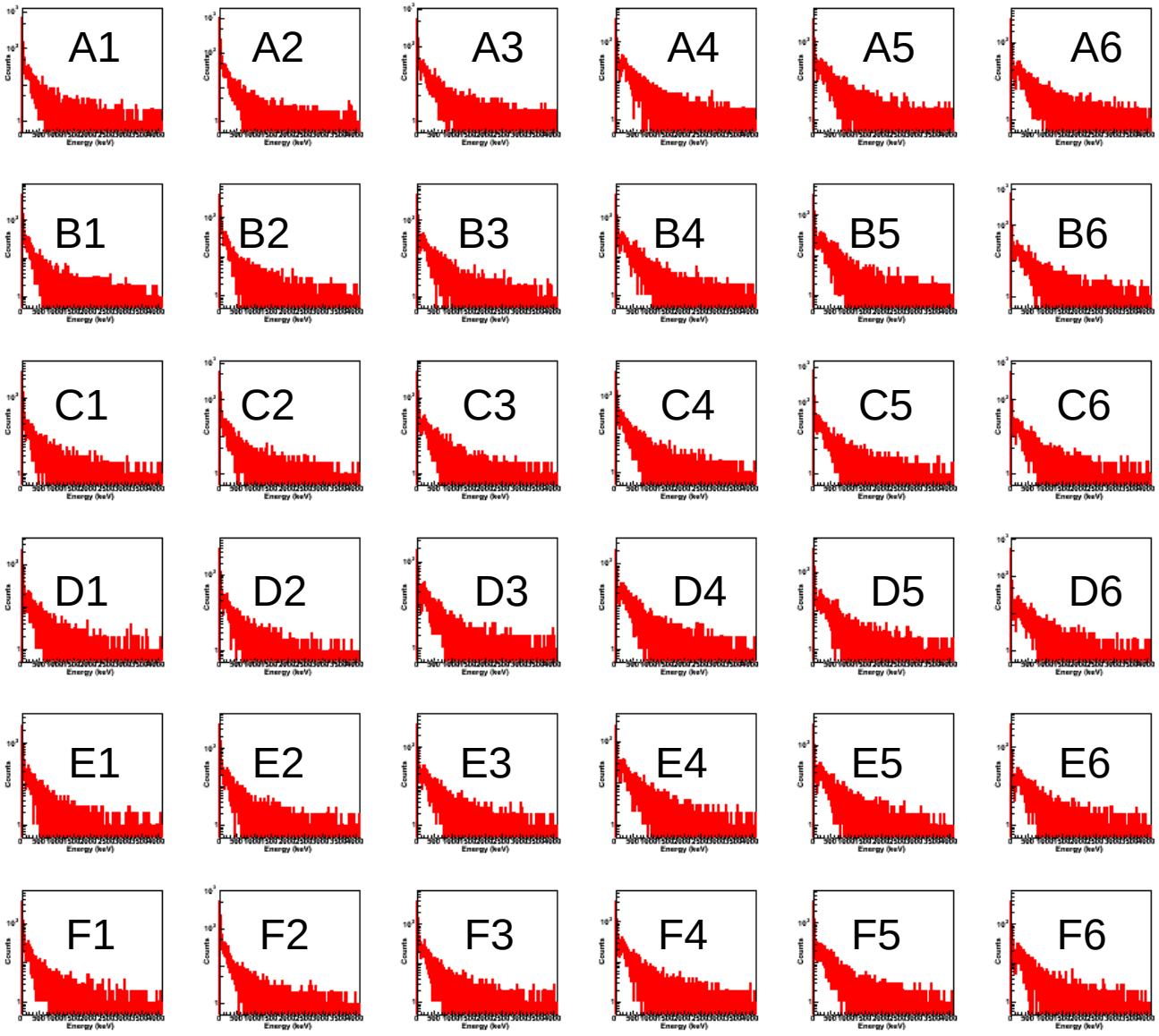


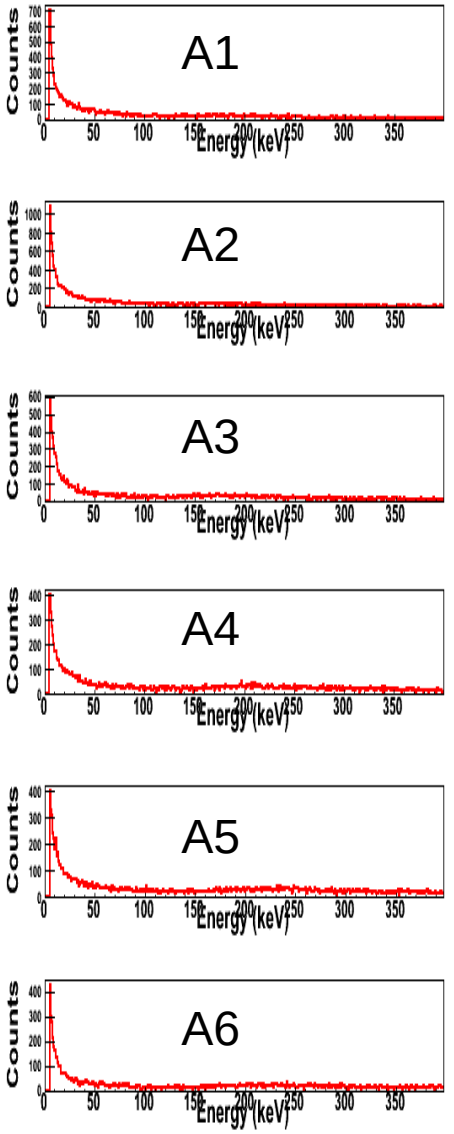


Both with beam and without beam the background distribution seems very similar in RISING and in AGATA, which means that it should be easy to “model” in a MC simulation.

In-beam test of an AGATA symmetric detector at FRS

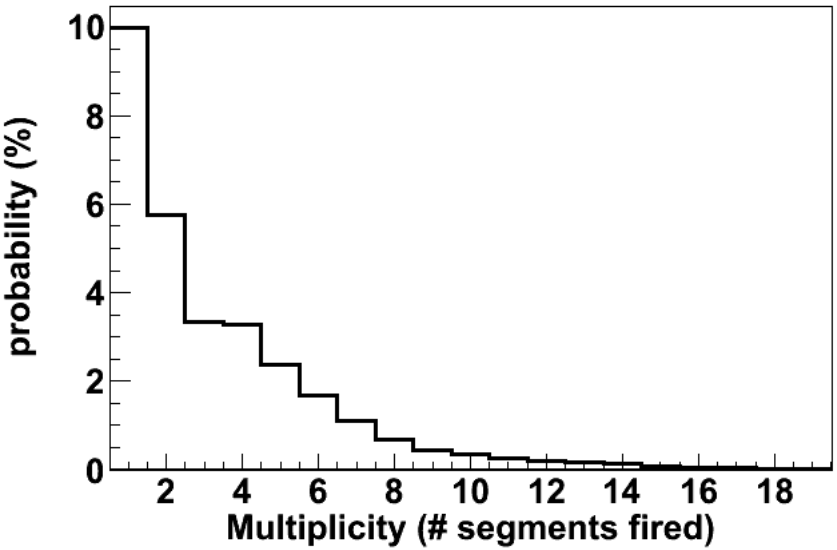
Gamma-ray energy spectra (segments):



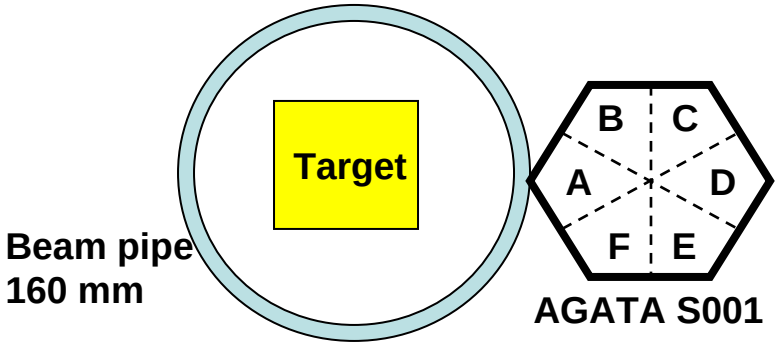


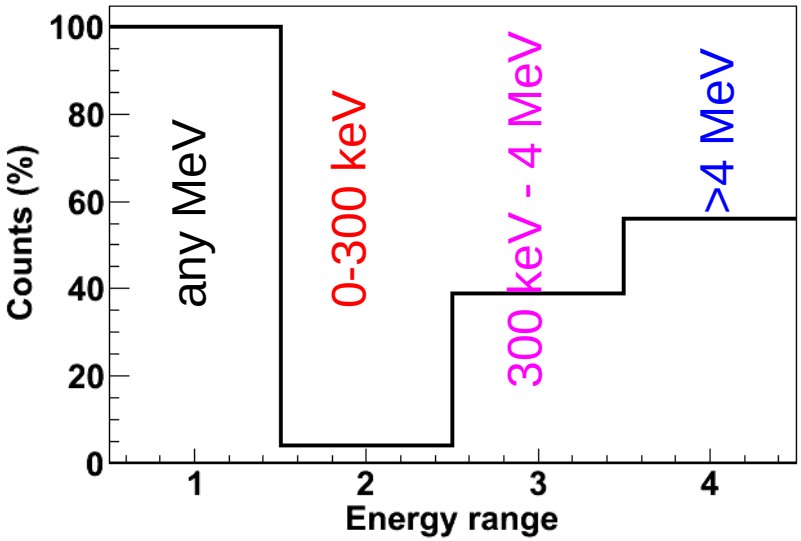
In-beam test of an AGATA symmetric detector at FRS

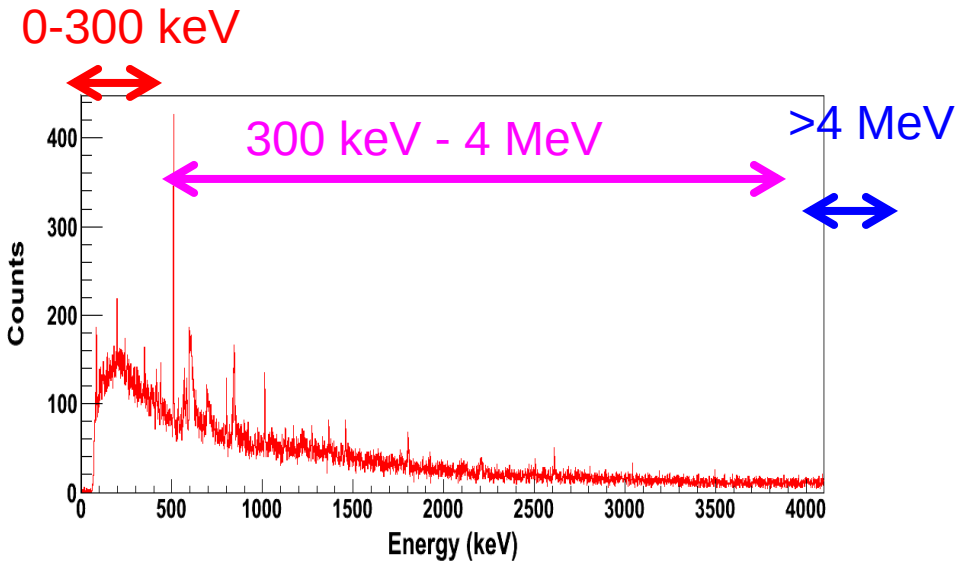
Relative segment multiplicity distribution as a function of the core energy



- Cross-section view of the setup:







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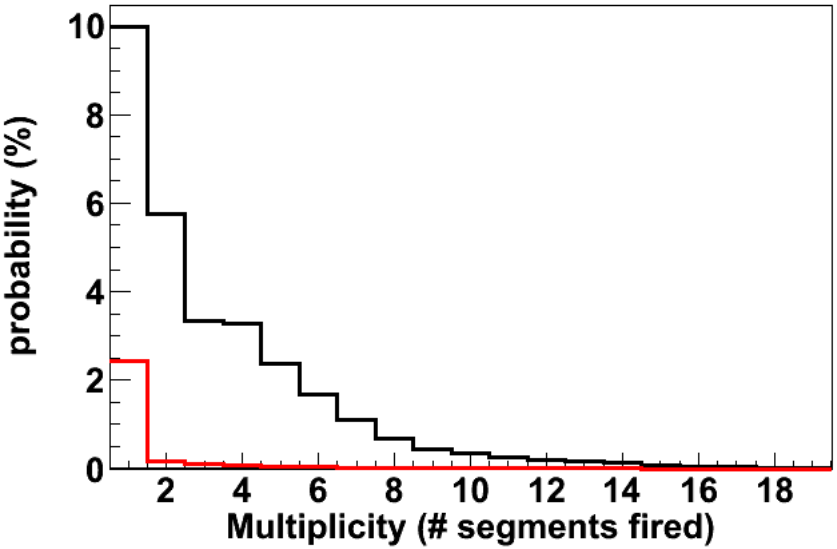

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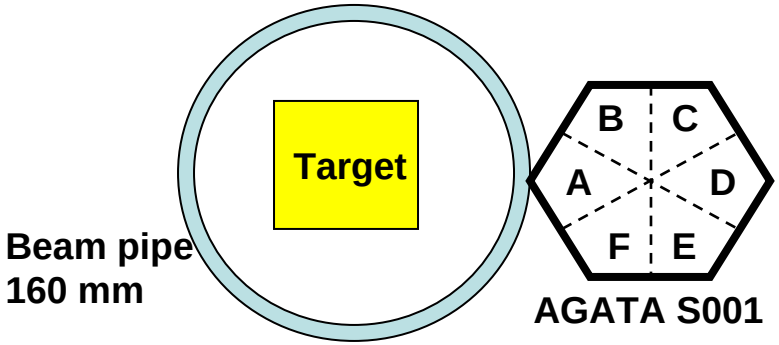

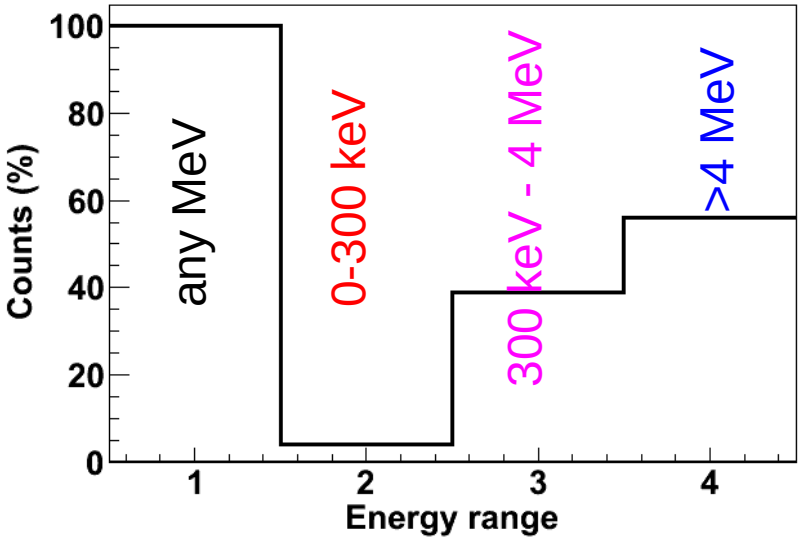

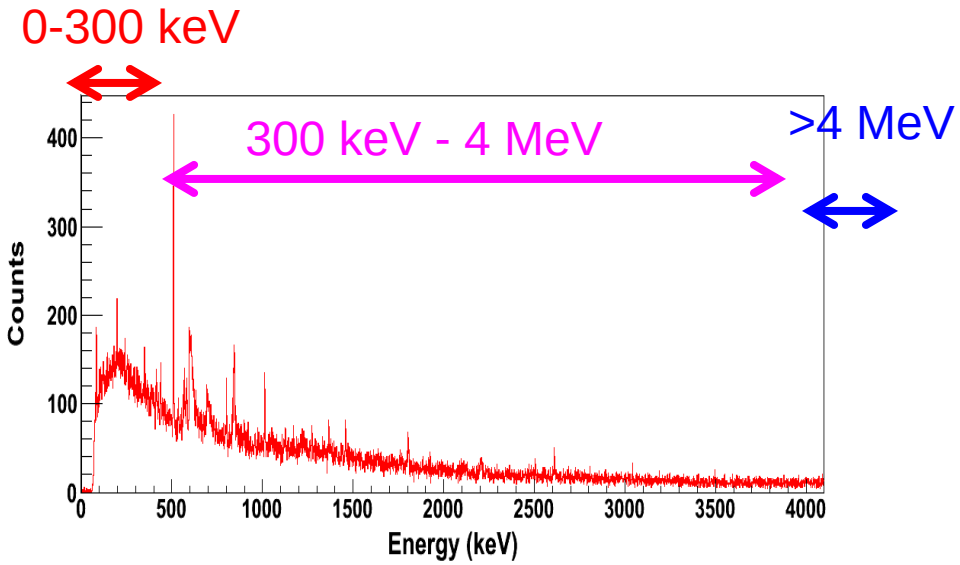

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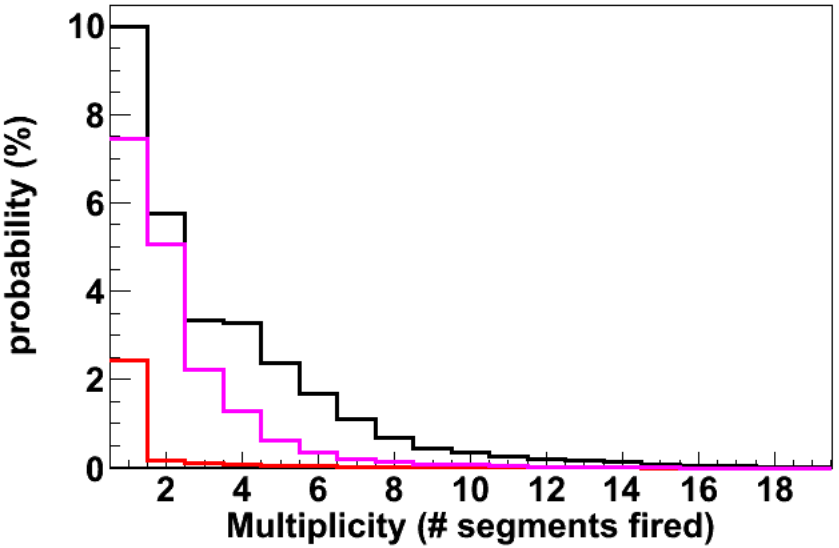

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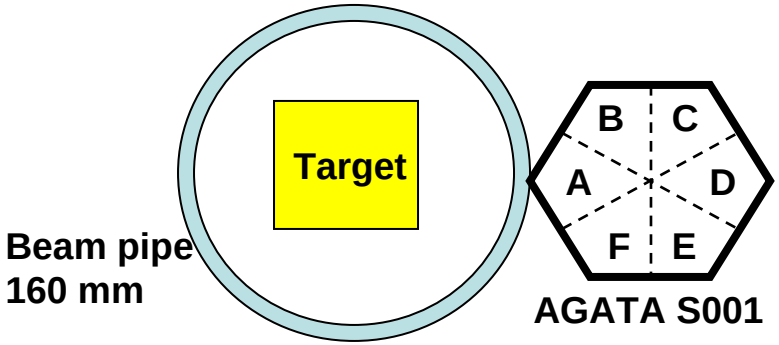

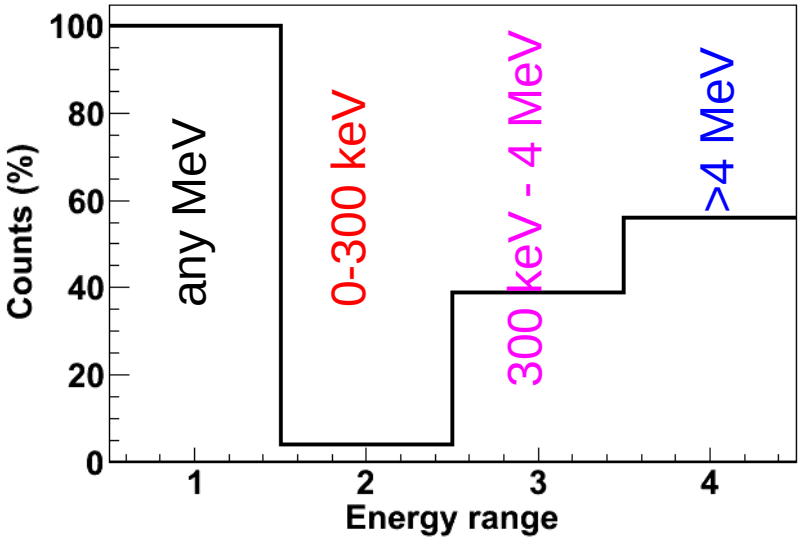

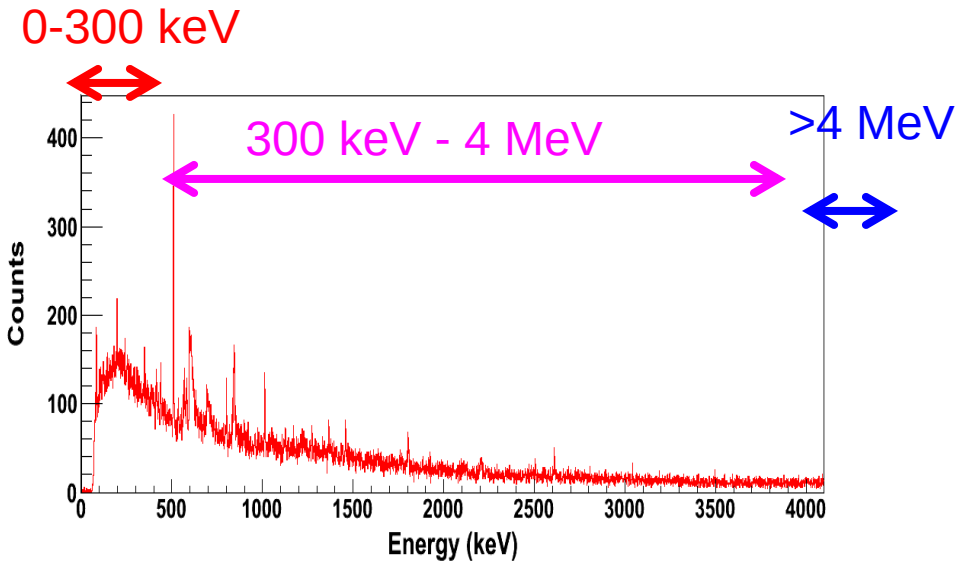

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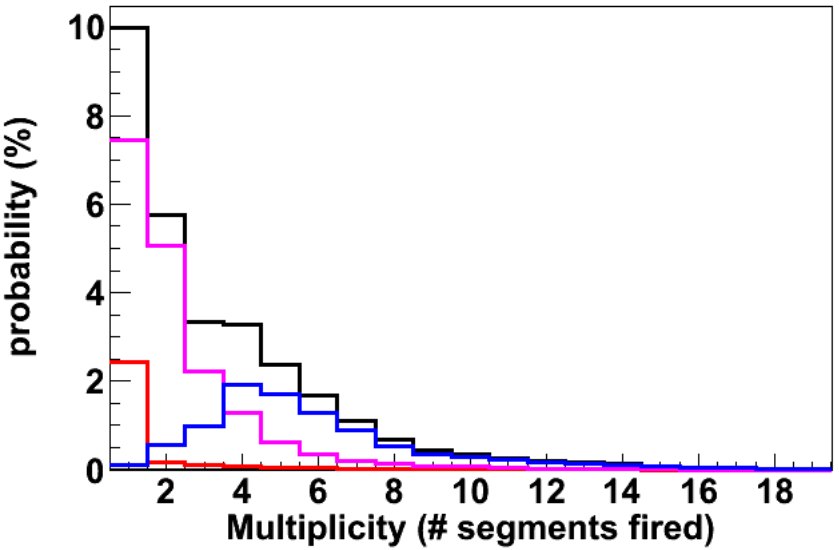

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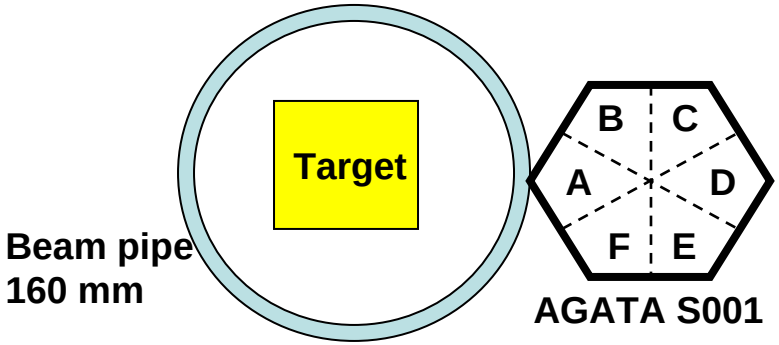
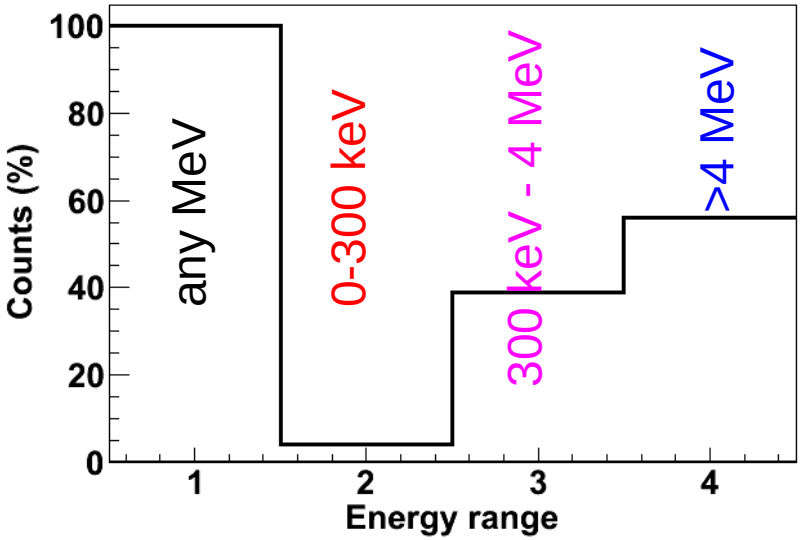
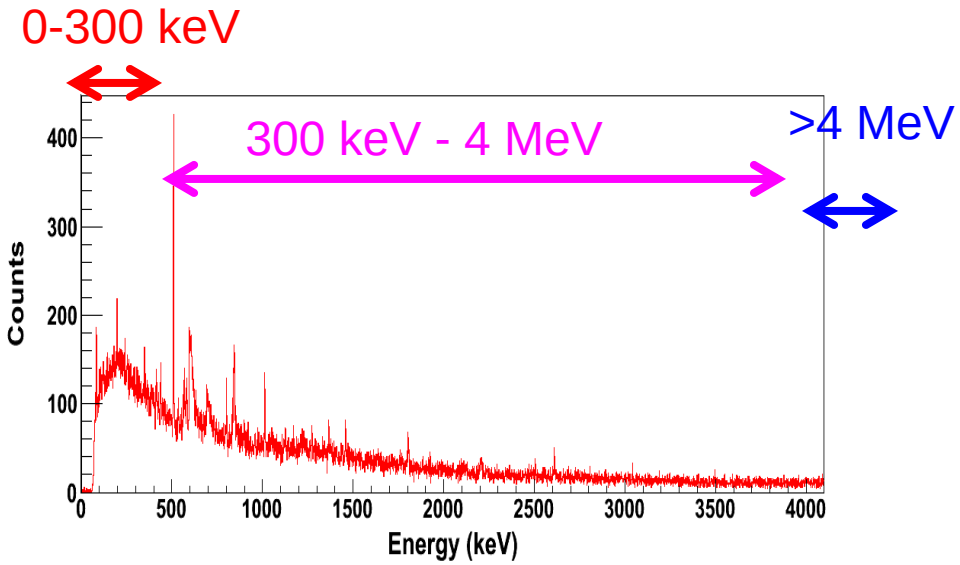
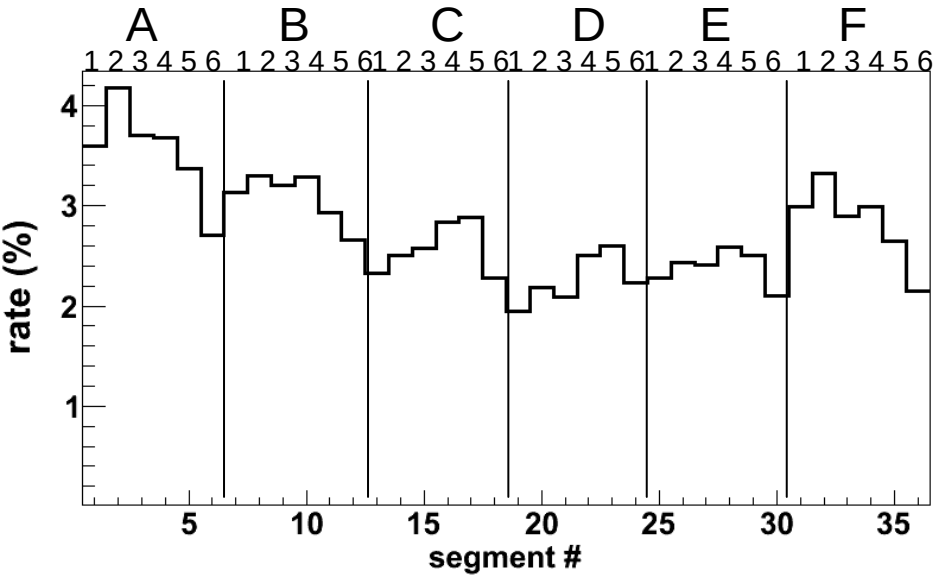






In-beam test of an AGATA symmetric detector at FRS

Relative counting rate as a function of the segment hit energy



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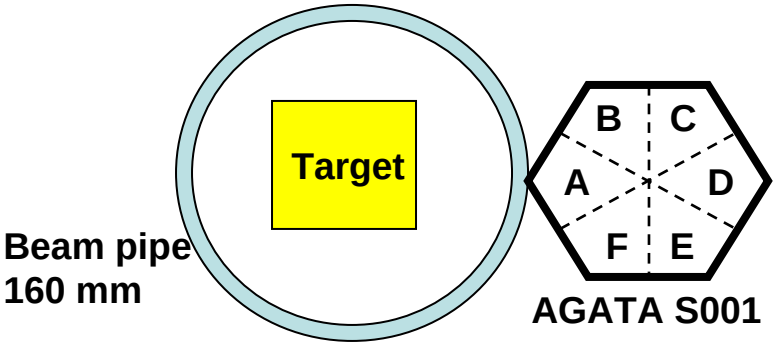

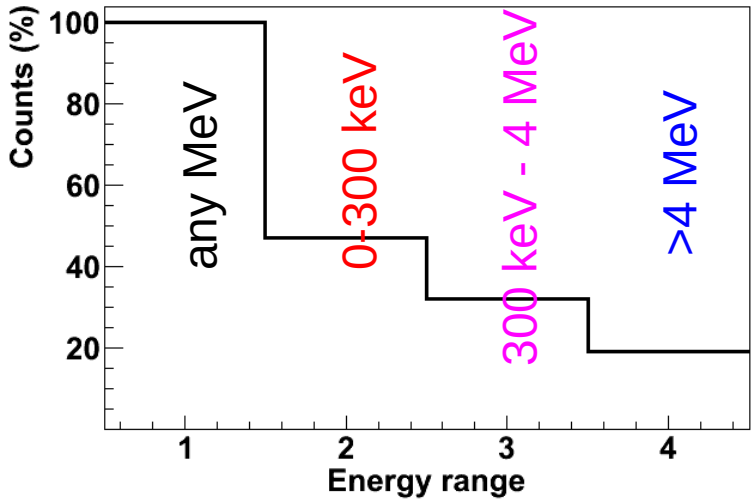

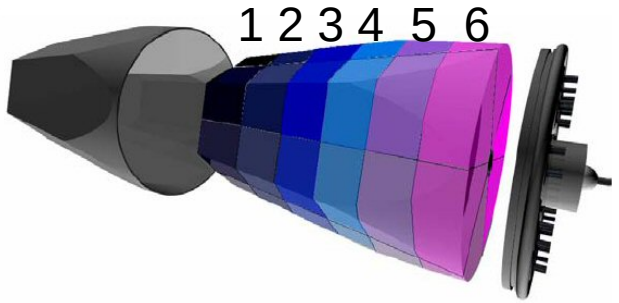

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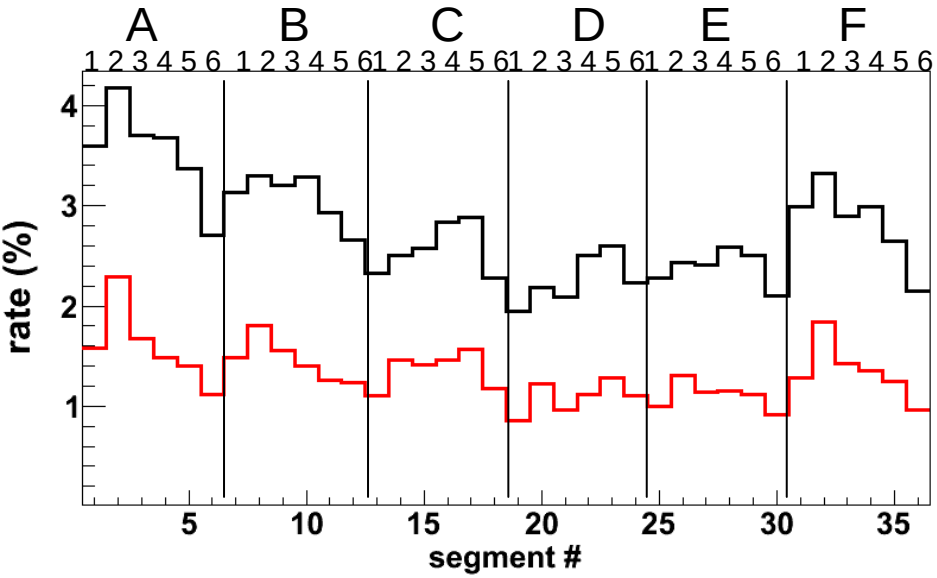

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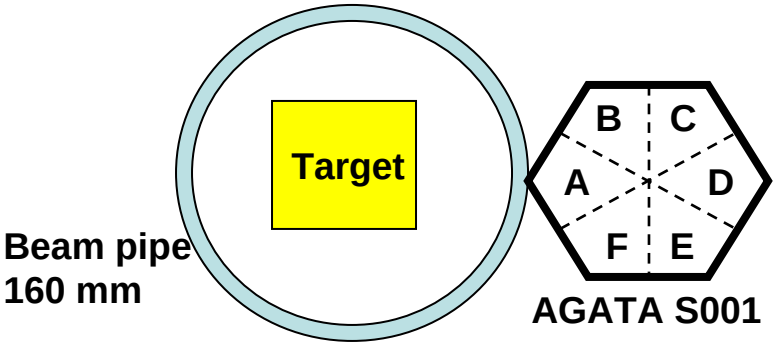

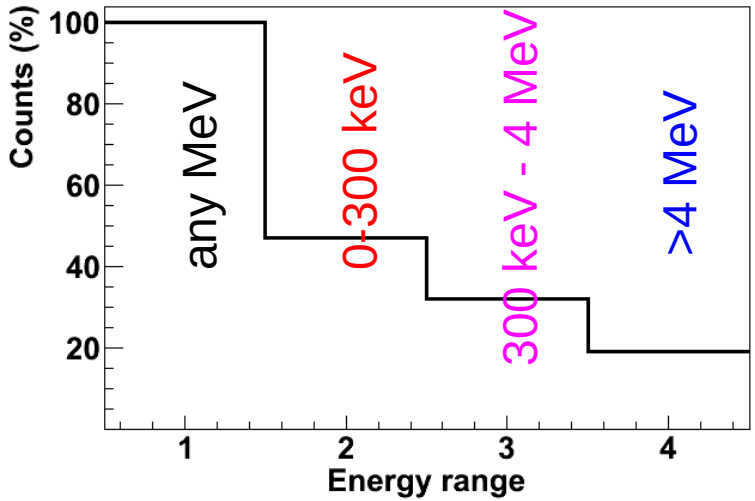

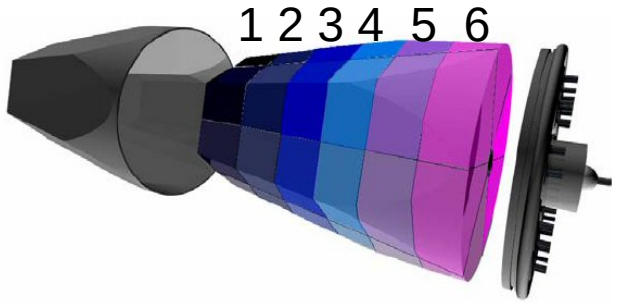

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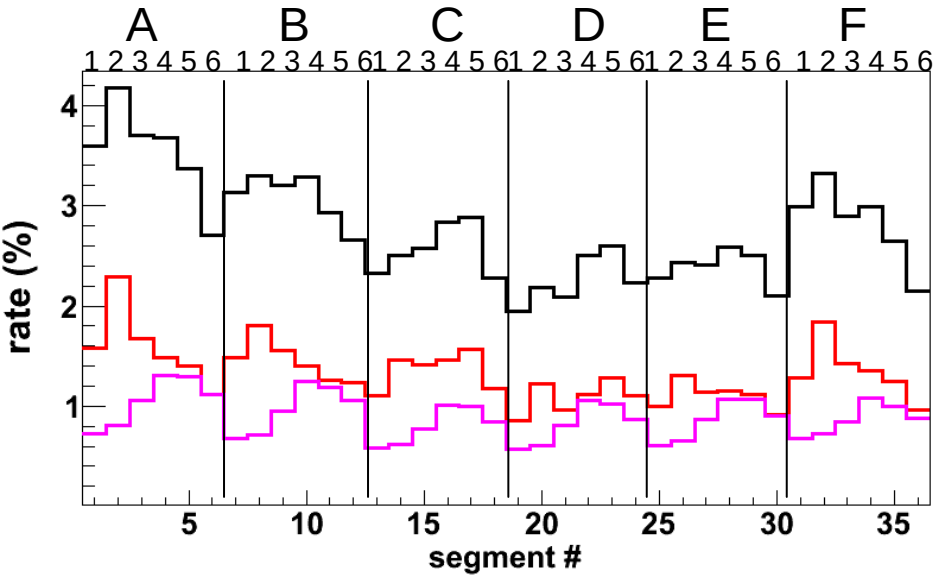

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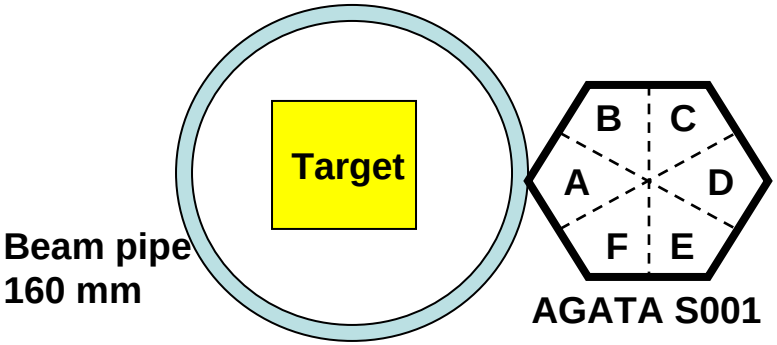

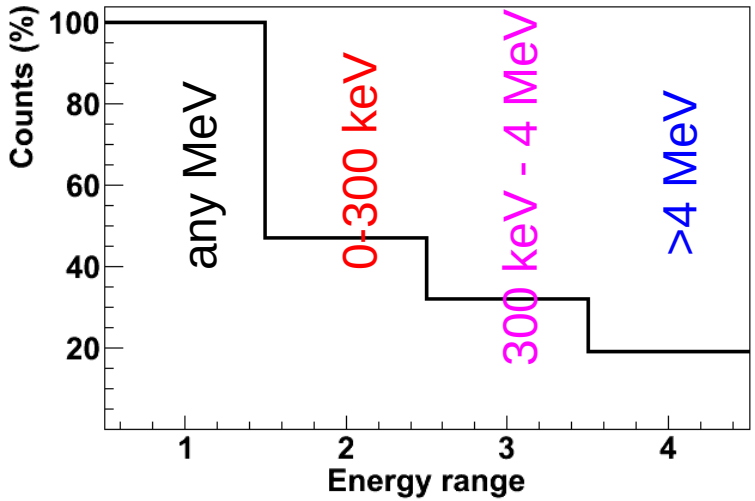

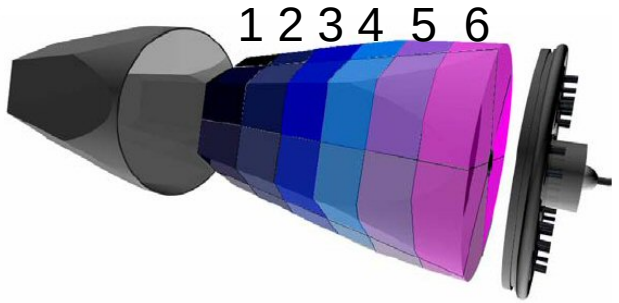

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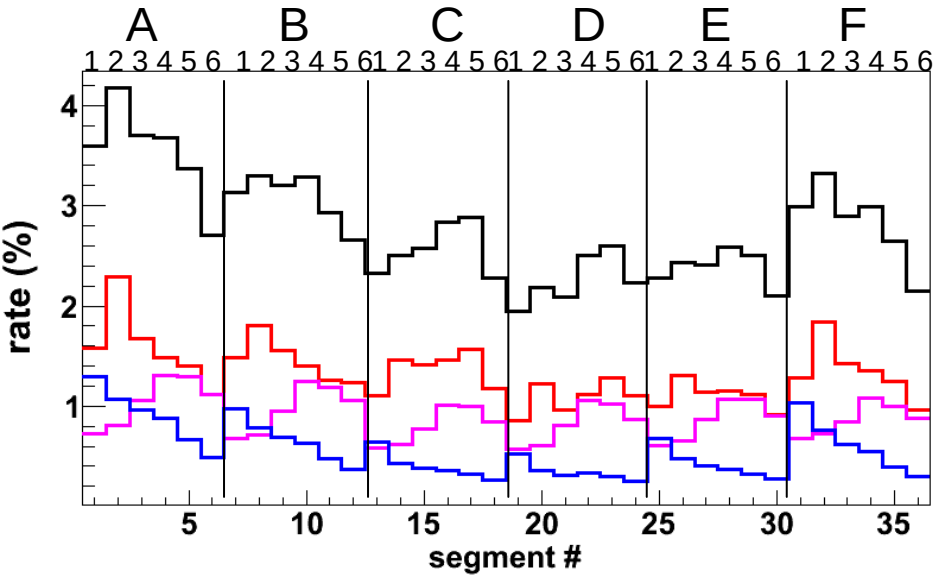
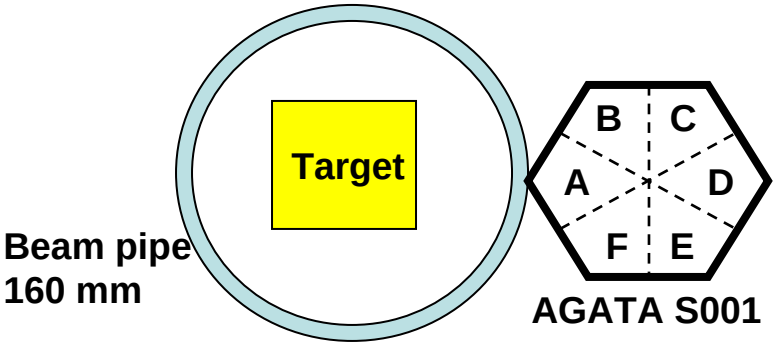
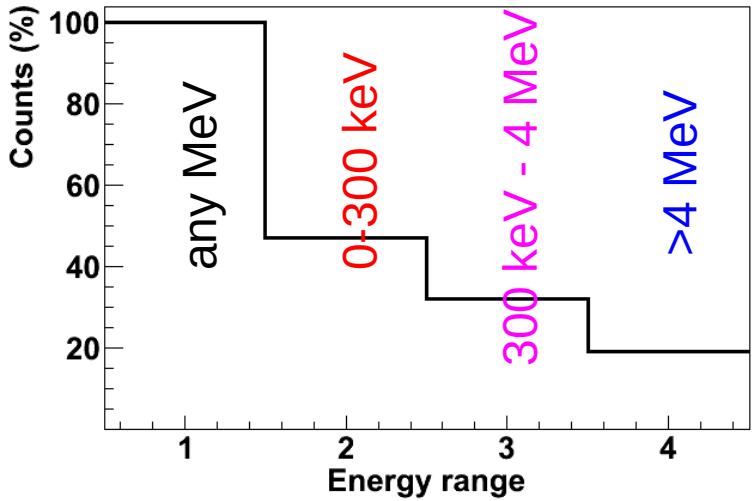
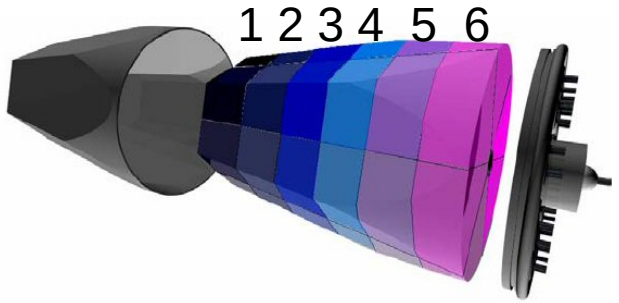


- Cross-section view of the setup:

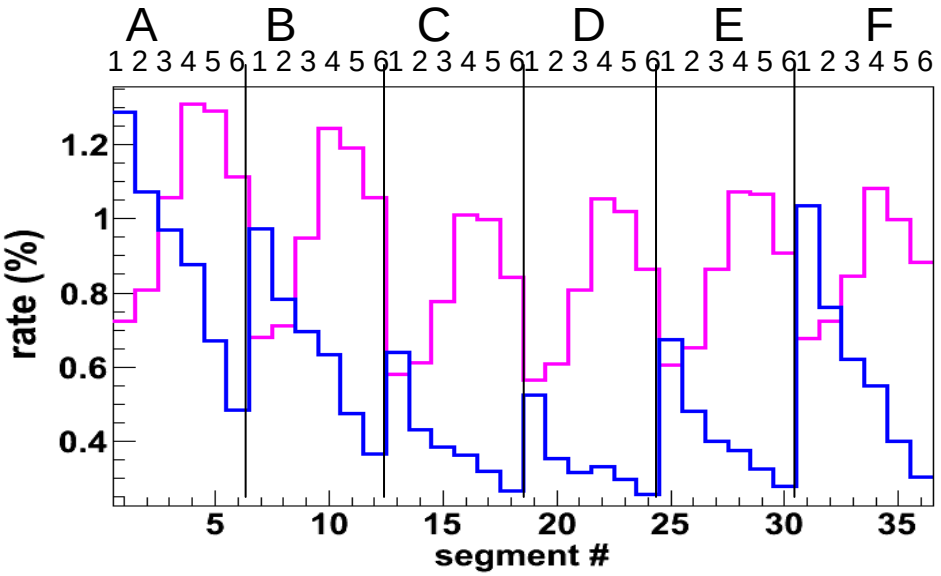


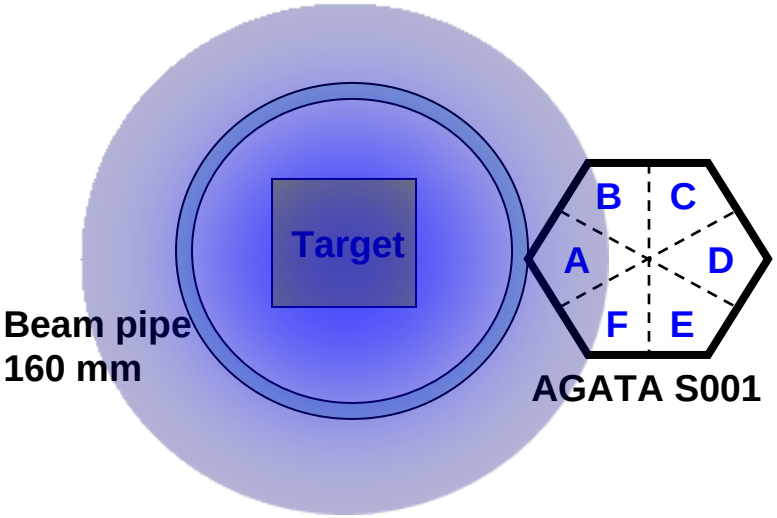


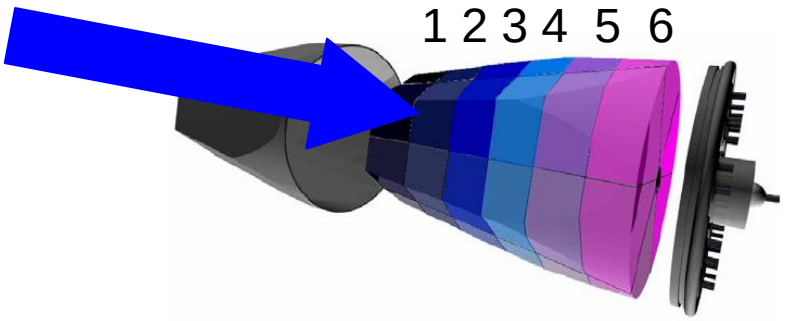


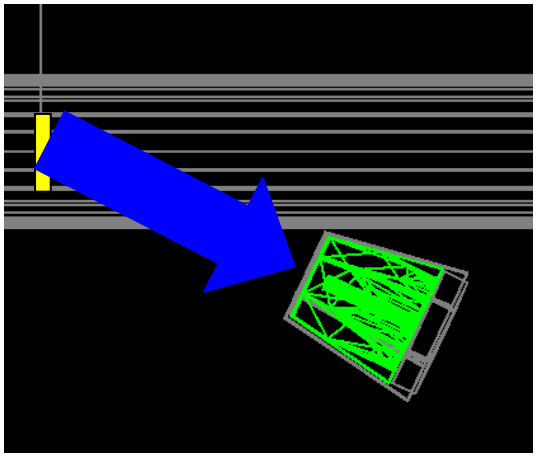
In-beam test of an AGATA symmetric detector at FRS

Relative counting rate as a function of the segment hit energy









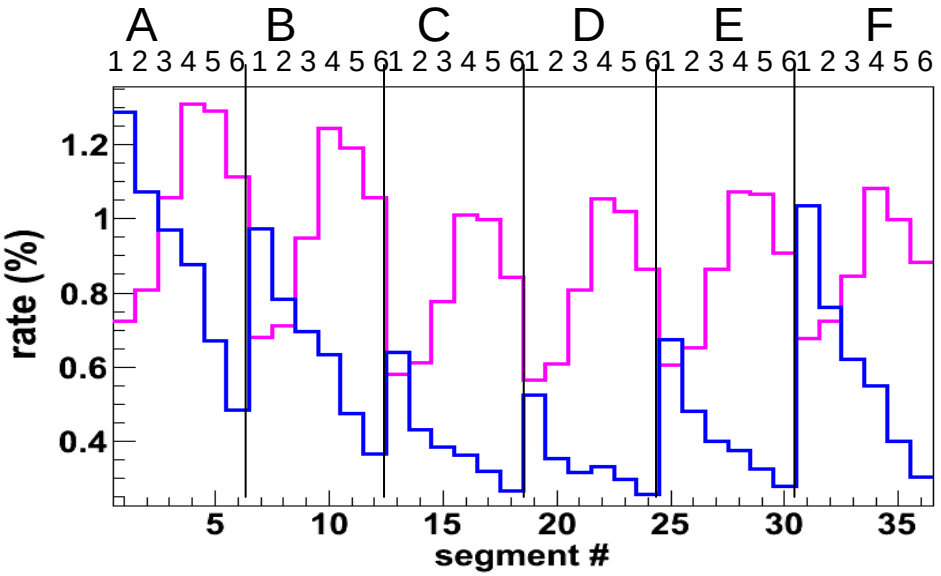
beam – Halo of H.E.

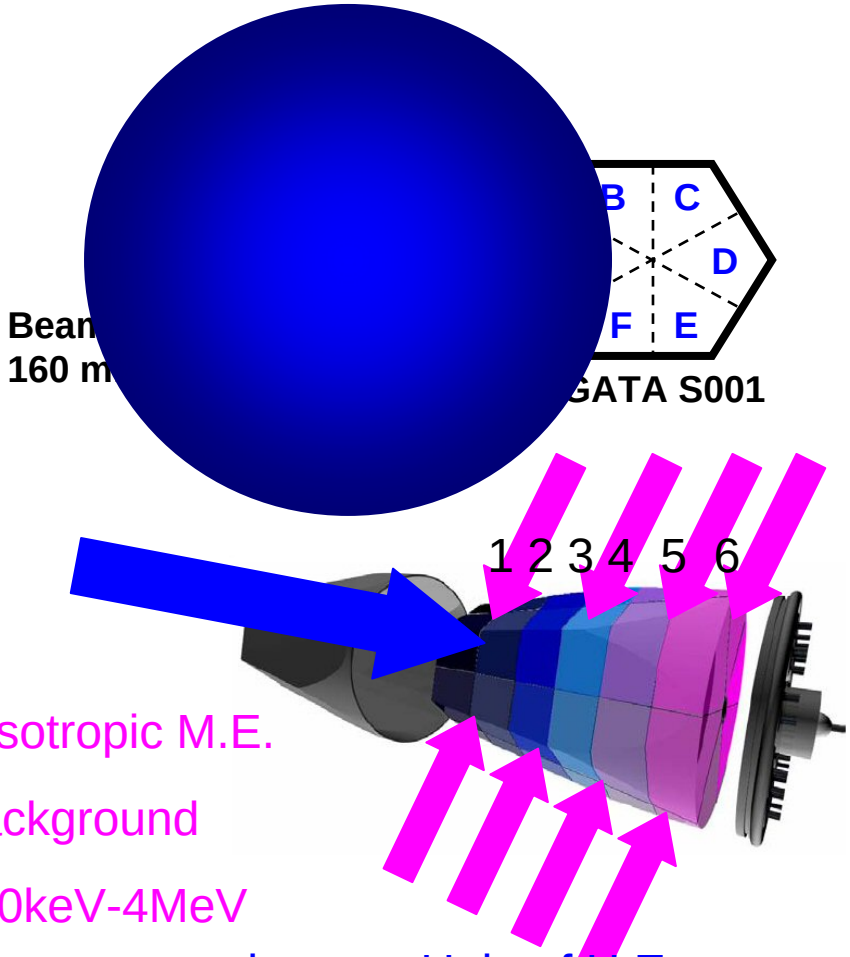
light-charged particles

> 4 MeV

In-beam test of an AGATA symmetric detector at FRS

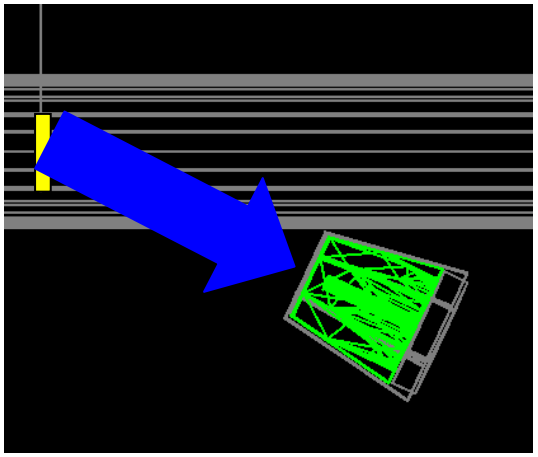
Relative counting rate as a function of the segment hit energy





Bean
160 m

GATA S001



~ isotropic M.E.

Background

300keV-4MeV

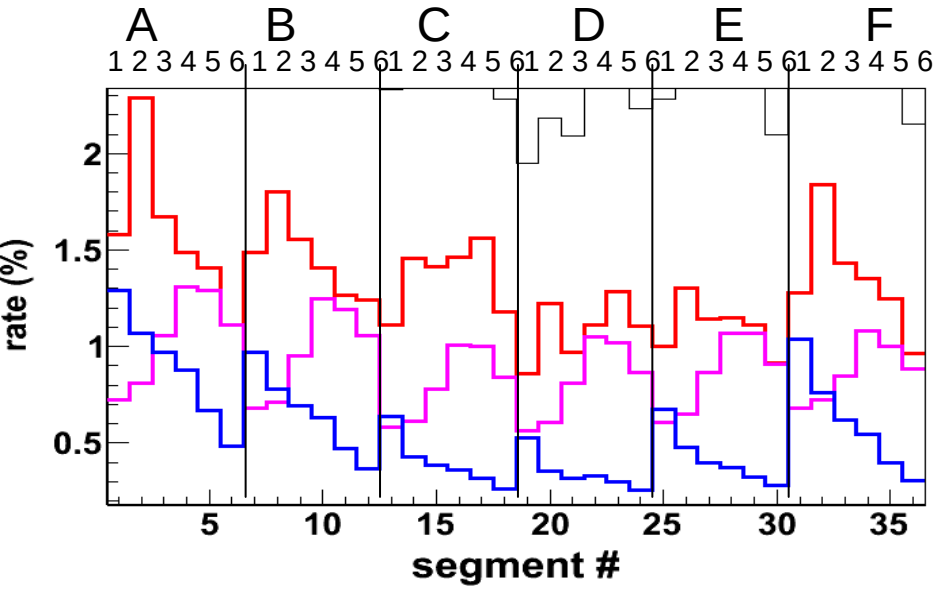
beam – Halo of H.E.

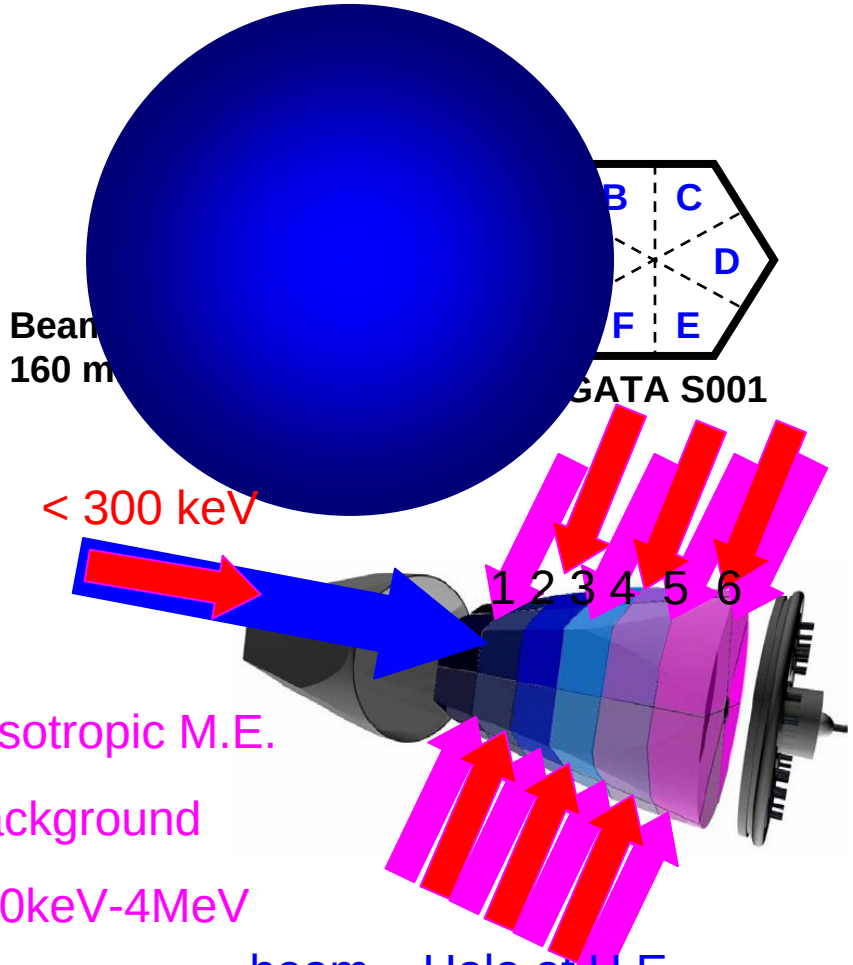
light-charged particles

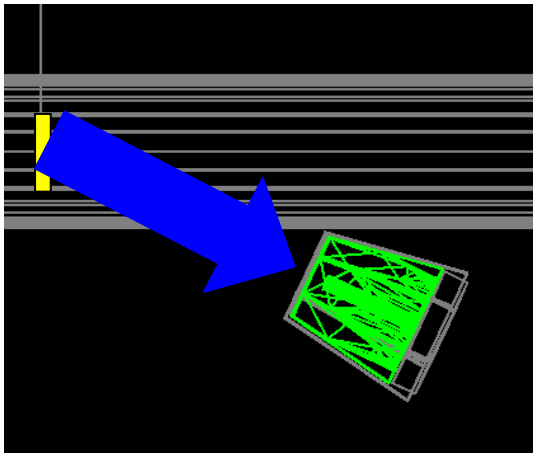
> 4 MeV

In-beam test of an AGATA symmetric detector at FRS

Relative counting rate as a function of the segment hit energy







~ isotropic M.E.

Background

300keV-4MeV

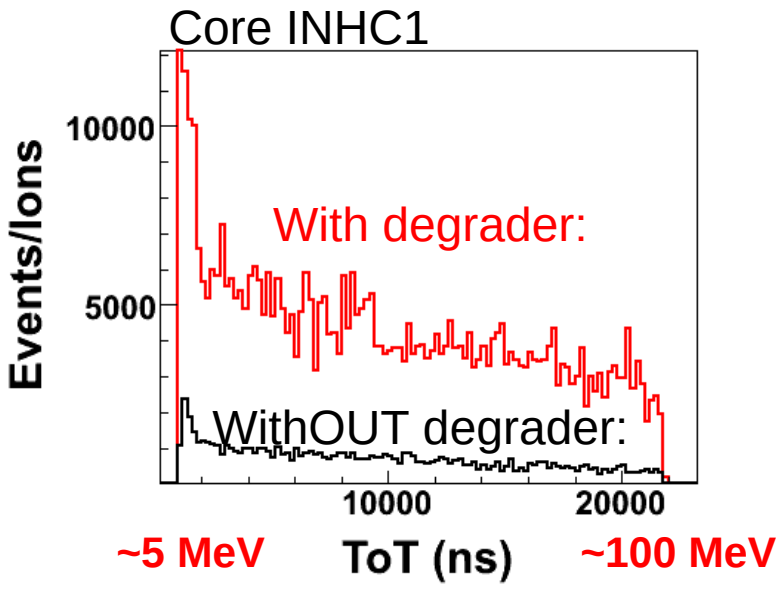
beam – Halo of H.E.

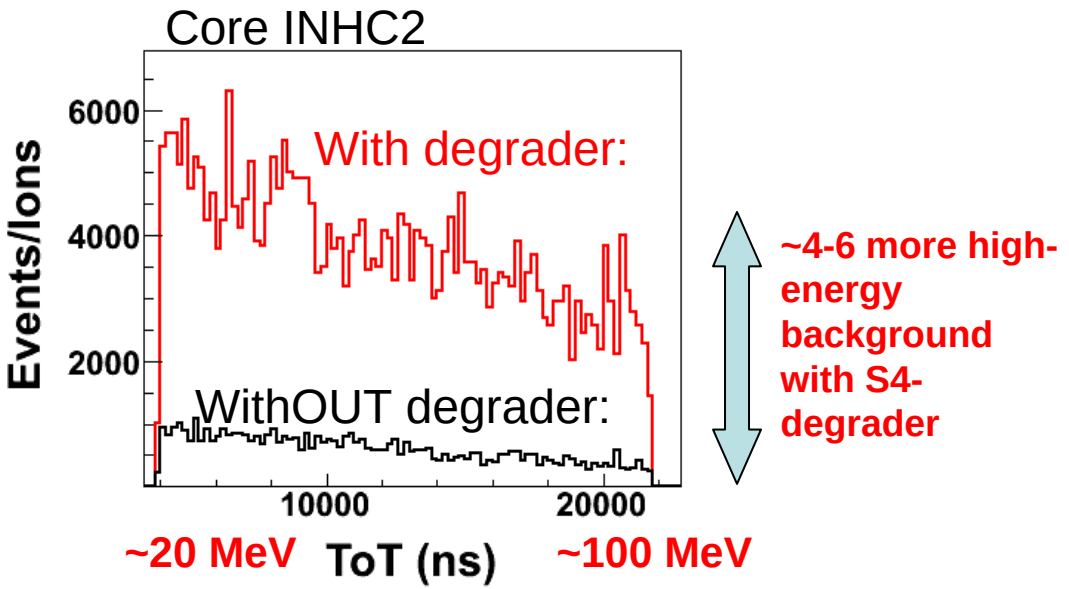
light-charged particles

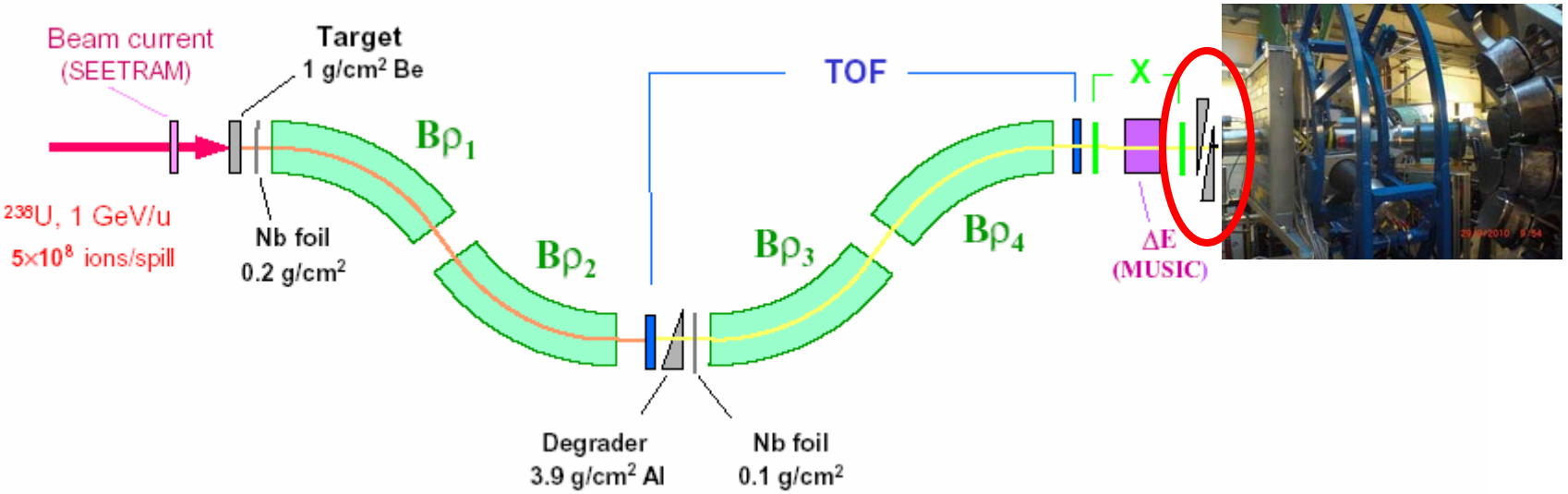
> 4 MeV

In-beam test of an AGATA symmetric detector at FRS

Preliminary results for the high energy range via time-over-threshold:







In-beam test of an AGATA symmetric detector at FRS

Preliminary results:

ToT (High Energy) Spectra

With degrader:

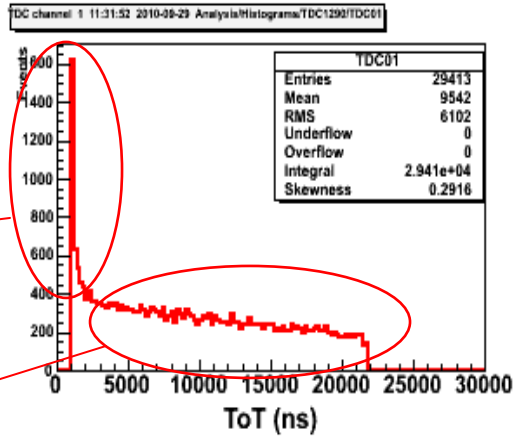
WithOUT degrader:

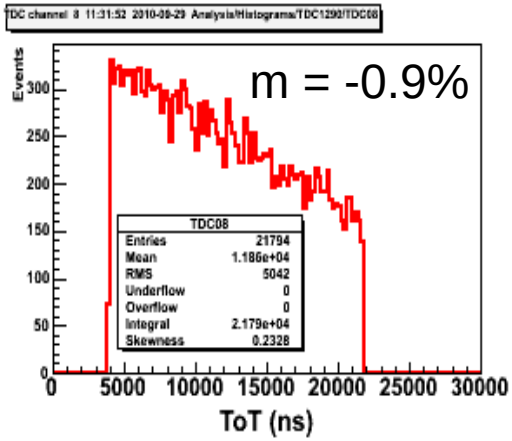
Core 1

Tail of BS

Light charged particles

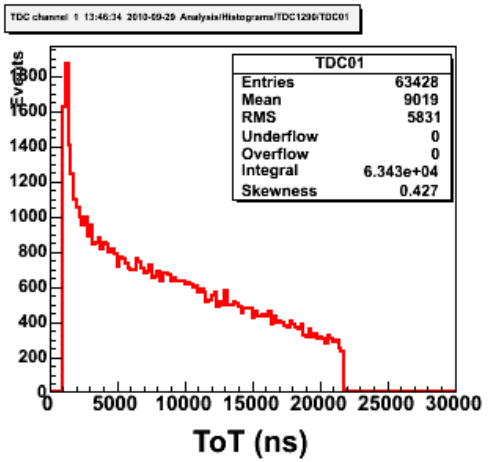
Core 2

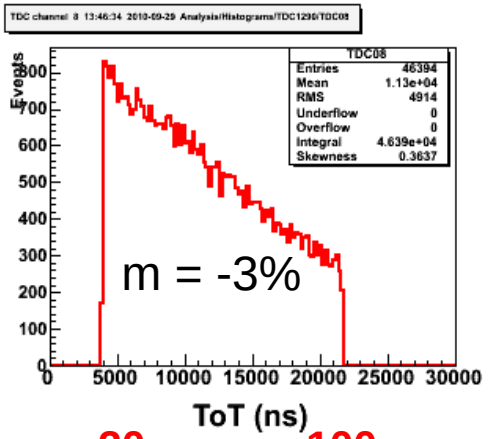




~20 MeV

~100 MeV





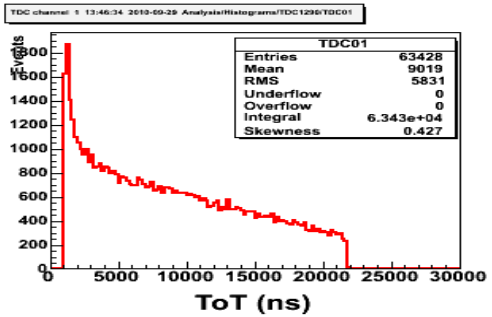
~20 MeV

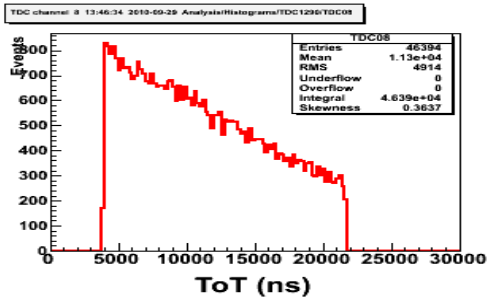
~100 MeV

In-beam test of an AGATA symmetric detector at FRS

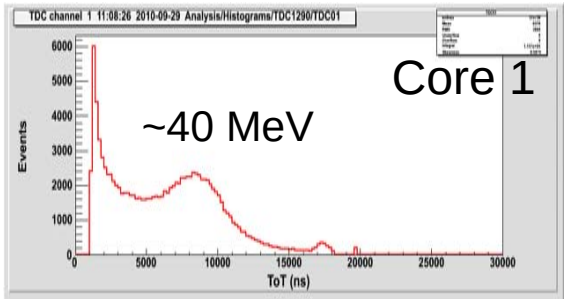
- **Cosmics** run over one night (no beam): shows a peak at around 40 MeV

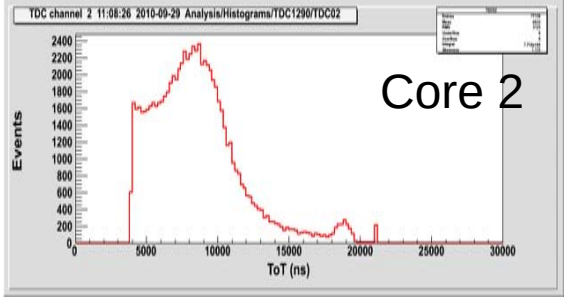
BEAM Induced Bkg:



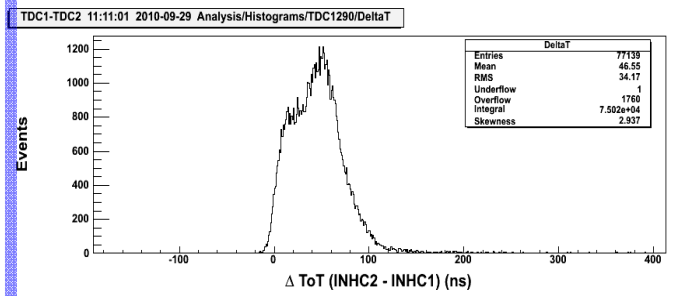


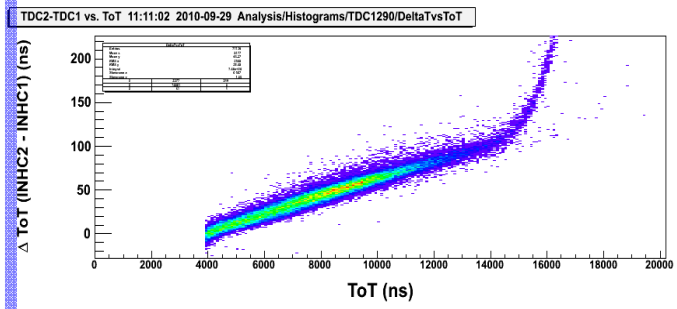
COSMICS:





rms = 34 ns

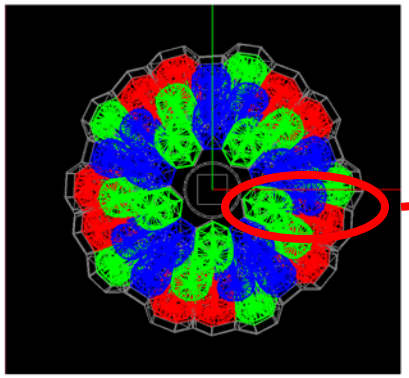


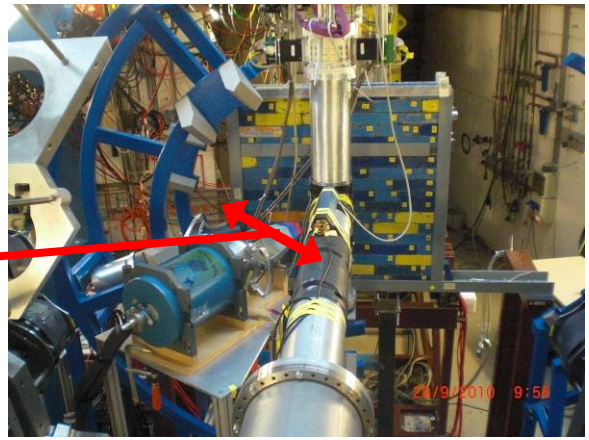


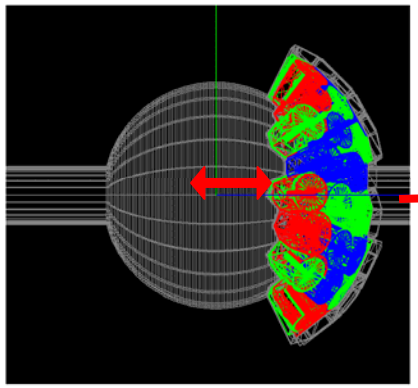
In-beam test of an AGATA symmetric detector at FRS

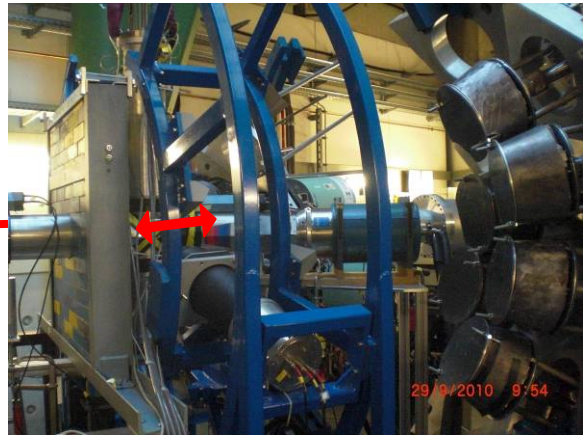
UMBRELLA proposal (parasitic beam time in 2011):

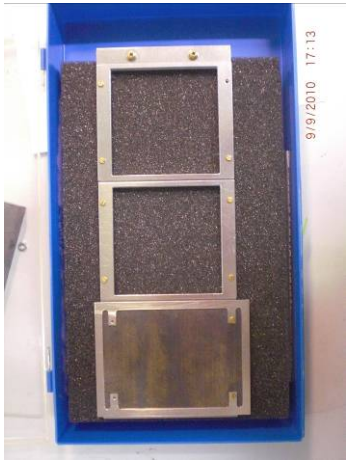
- Cover several angular ranges and distances target-detector with one capsule
- Use an extended target to have more realistic (PRESPEC like) conditions
- Test the effect of the lead abosrber, determine optimum (min.) thickness, how does it affect tracking
- If possible measure a Coulex gamma-line to have an absolute P/N ratio estimate (time information needed)
- Implement the time-over-threhold method with baseline correction, study the high-energy component in the different configurations











Extended Pb target 500mg/cm2

In-beam test of an AGATA symmetric detector at FRS

Summary:

• A preliminary background test has been carried out at GSI-FRS using one AGATA symmetric capsule.

• Both RISING and AGATA backgrounds show a very similar energy distribution.

• In terms of segment-hit multiplicity, the background can be divided in multiplicity one for <300keV events, multiplicity 1-3 for 300keV-4MeV events and multiplicity > 3 for >4MeV events.

• According to the segment counting rates, the energy distribution of the background shows three components, a high-energy (>4MeV) forward-focused light-charged particle halo, a middle energy (300keV-4MeV) rather isotropic contribution and a forward/isotropic low energy (bremsstrahlungs) component.

• The high-energy (>4MeV) component of the background (light-charged particles) increases (approx. x4-6) when 2 g/cm2 Al-degrader is used at S4.

• Further (dedicated) background characterization tests will be performed in the framework of the UMBRELLA proposal (along 2011).