STATUS REPORT on the AGATA - experiment

"Order-to-chaos transition in warm rotating ^{174}W nuclei"

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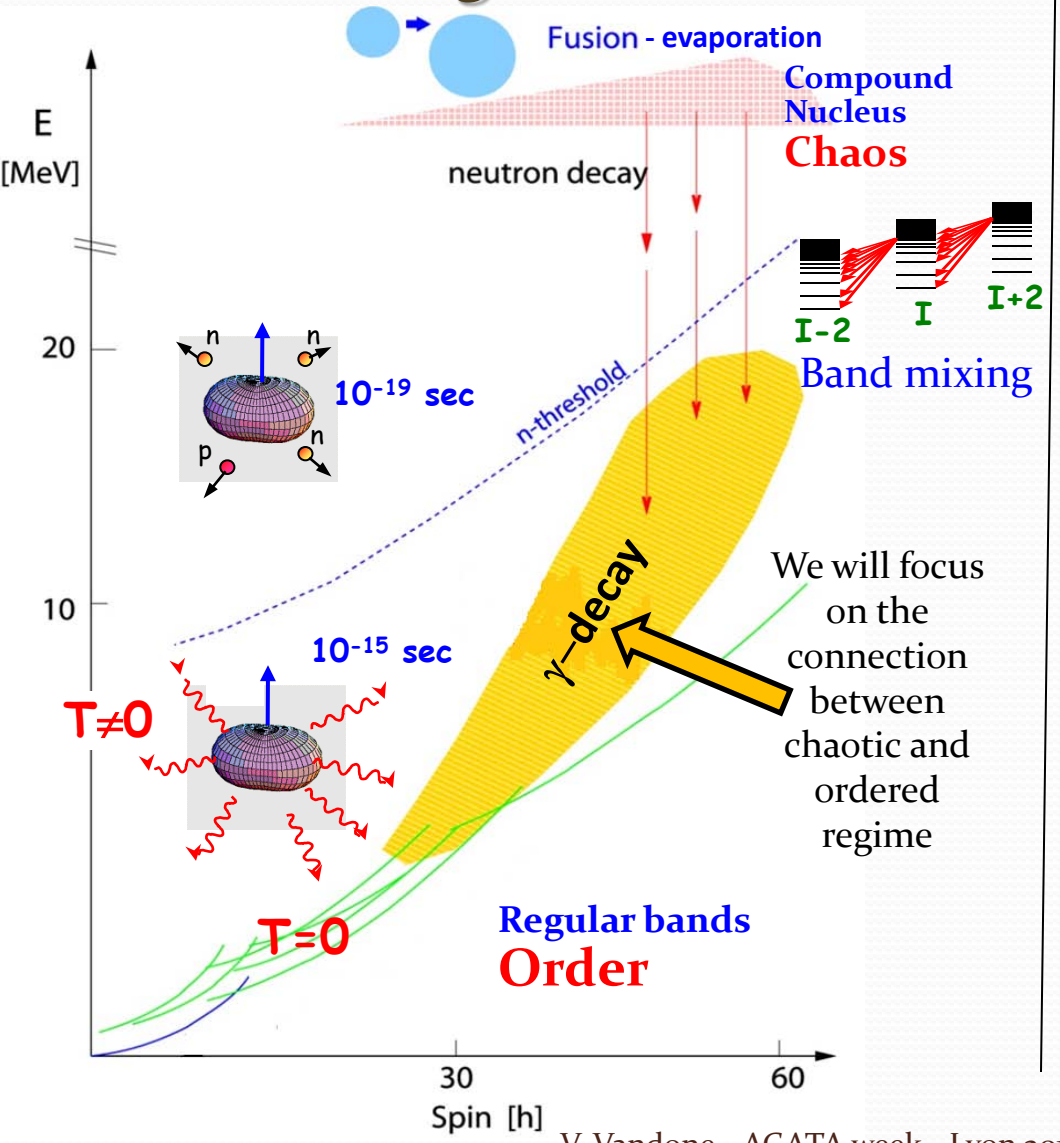
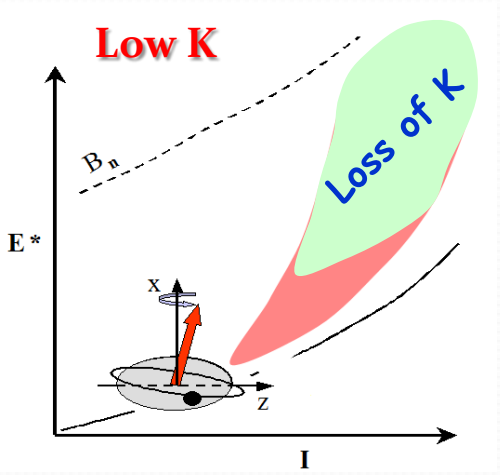
T ~ 0.5 MeV
I ≥ 20 ħ

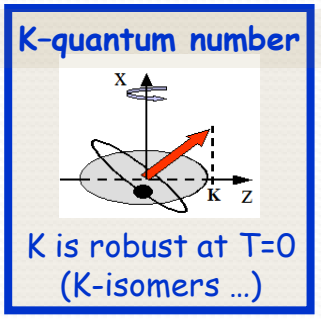
Physics Motivation

Warm rotating nuclei

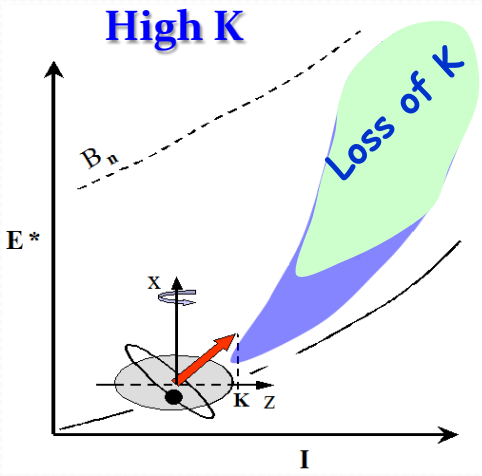


Loss of selection rules on K with temperature





Comparative study of γ-decay flow gated by **Low-K** and **High-K** bands



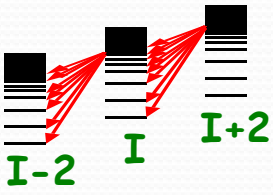
Experimental analysis

T. Døssing, S. Leoni et al., Physics Report 268 (1996)1

Quasi-Continuum γ-γ coincidence spectra

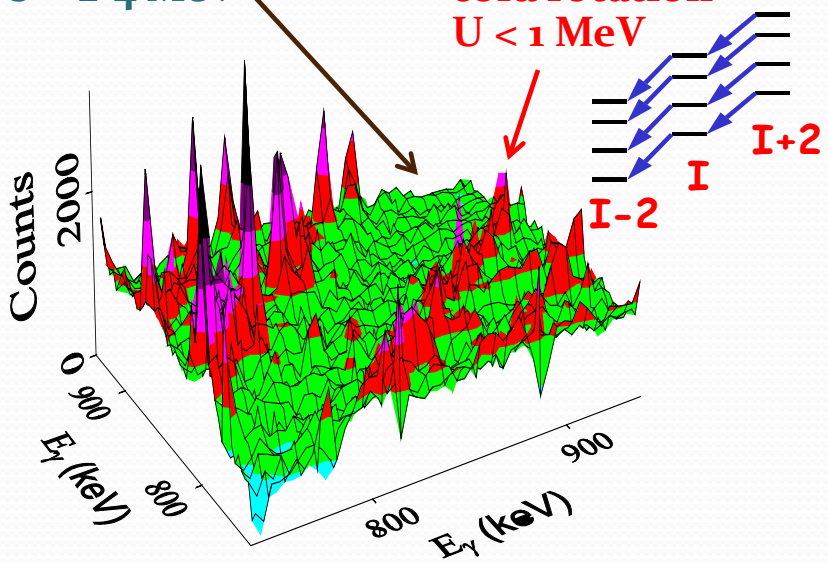
possibility to separate contributions from:

- Cold Rotation
- Warm Rotation

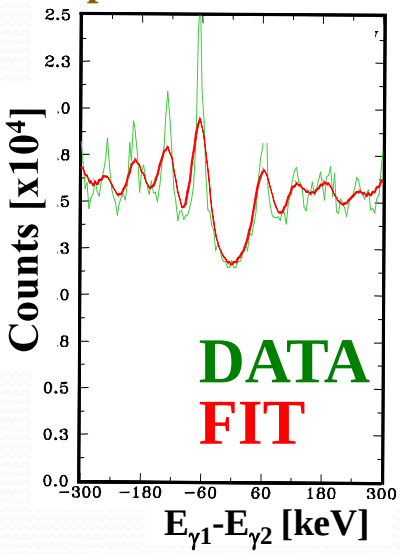


VALLEY
warm rotation
U ~ 2-4 MeV

RIDGE
cold rotation
U < 1 MeV

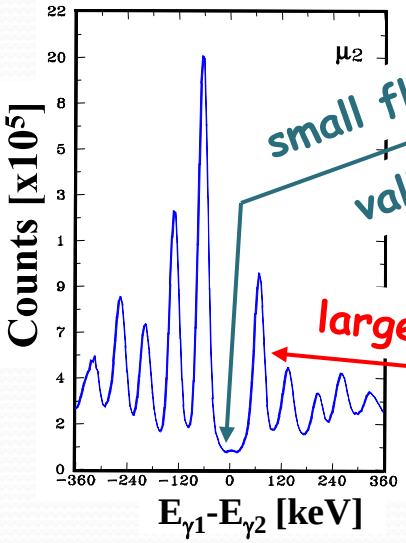


Perpendicular Cuts



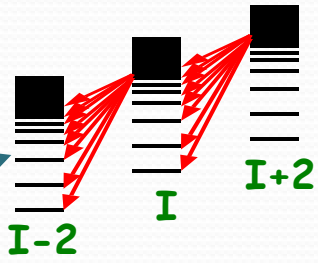
$\mu_2/\mu_1 = N_{eve}/N_{band} + 1$

quantitative information:
# of rotational bands

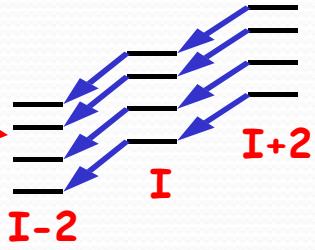


small fluct.
valley

large fluct.
ridge



many bands

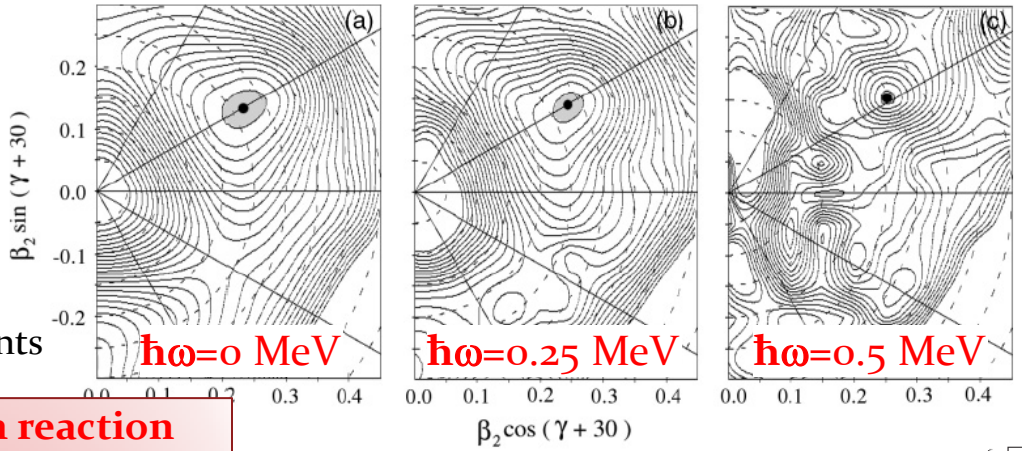


Few bands

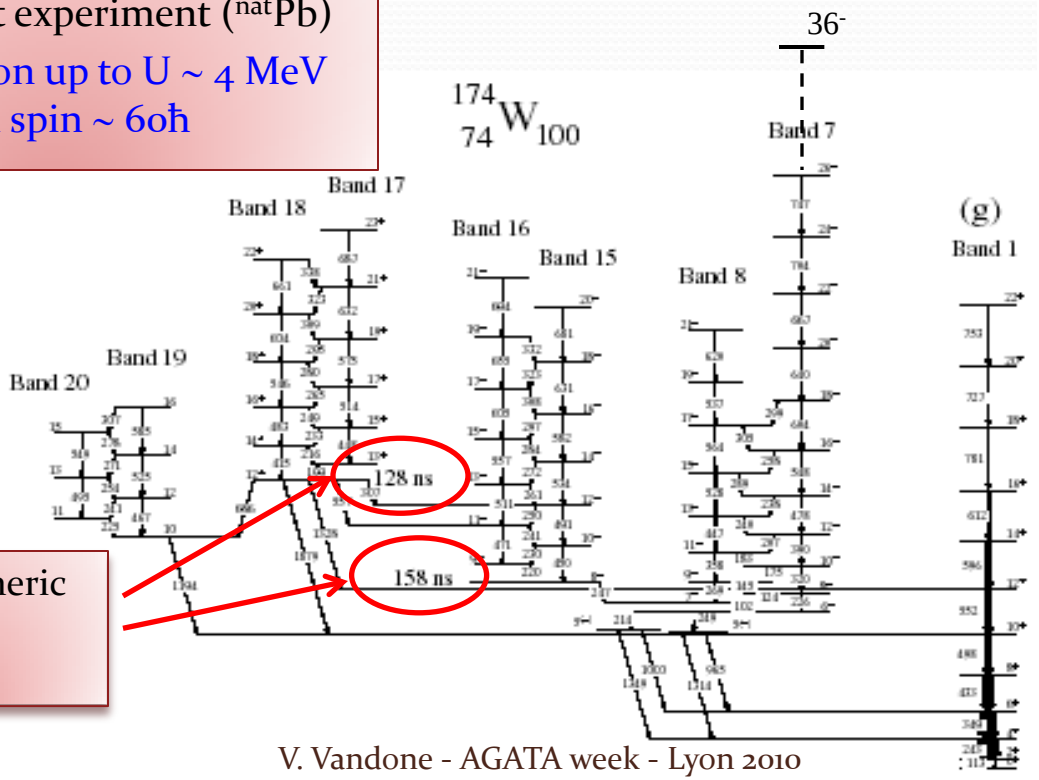
Physics case: ^{174}W

^{174}W

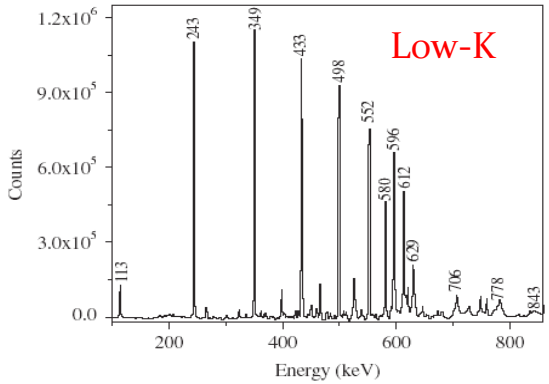
TRS Calculations:
Stable prolate rotor
up to high frequency
confirmed by experiments

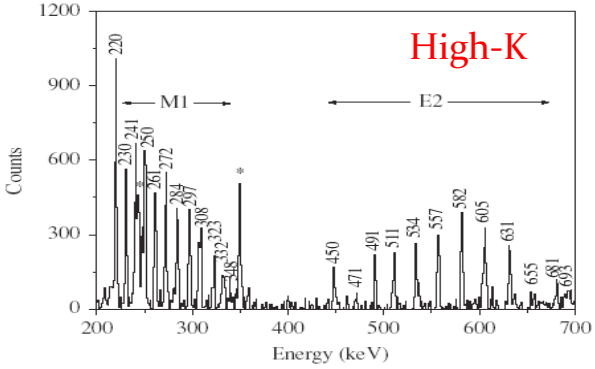


Fusion-evaporation reaction
^{50}Ti (@217MeV) + ^{128}Te → ^{174}W + 4n
Backed target experiment (^{nat}Pb)
Warm rotation up to U ~ 4 MeV
High spin ~ 60ħ



2 high-K isomeric states:
K=8 & K=12





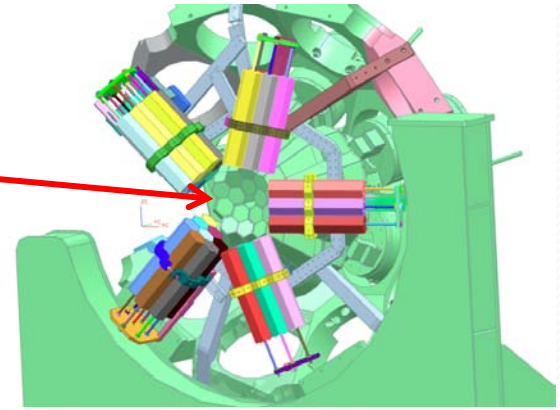
S.K. Tandel, Phys. Rev. C73 (2006) 044306
S.K. Tandel, Phys. Rev. C77 (2008) 024313

Experimental setup : AGATA + Helena

Experiment performed last July at Laboratori Nazionali di Legnaro of INFN

AGATA Demonstrator:
Distance from target = 14cm

2 and 3 folds: $\varepsilon_{2\gamma}$=30%, $\varepsilon_{3\gamma}$=10%
(M_γ = 30)



HELENA:
27 detectors – 5 clusters of BaF_2 (3"×3", exagonal)
Distance from target = 15cm
Total solid angle: 25% of 4π
Total efficiency: 16% @ 500keV

Focus on high-spin, high-excitation energy

Goals of the experiment

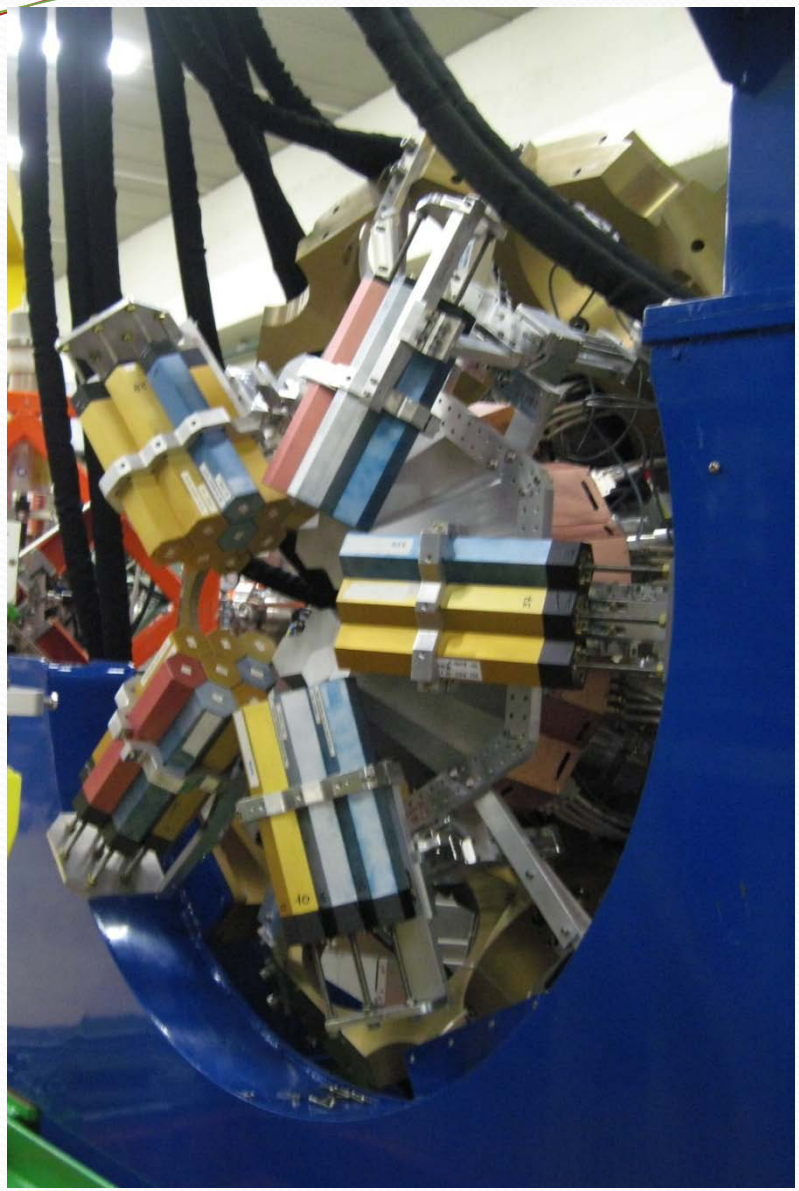
Populate ^{174}W at the **highest possible spins** (≥60ħ), in order to make:

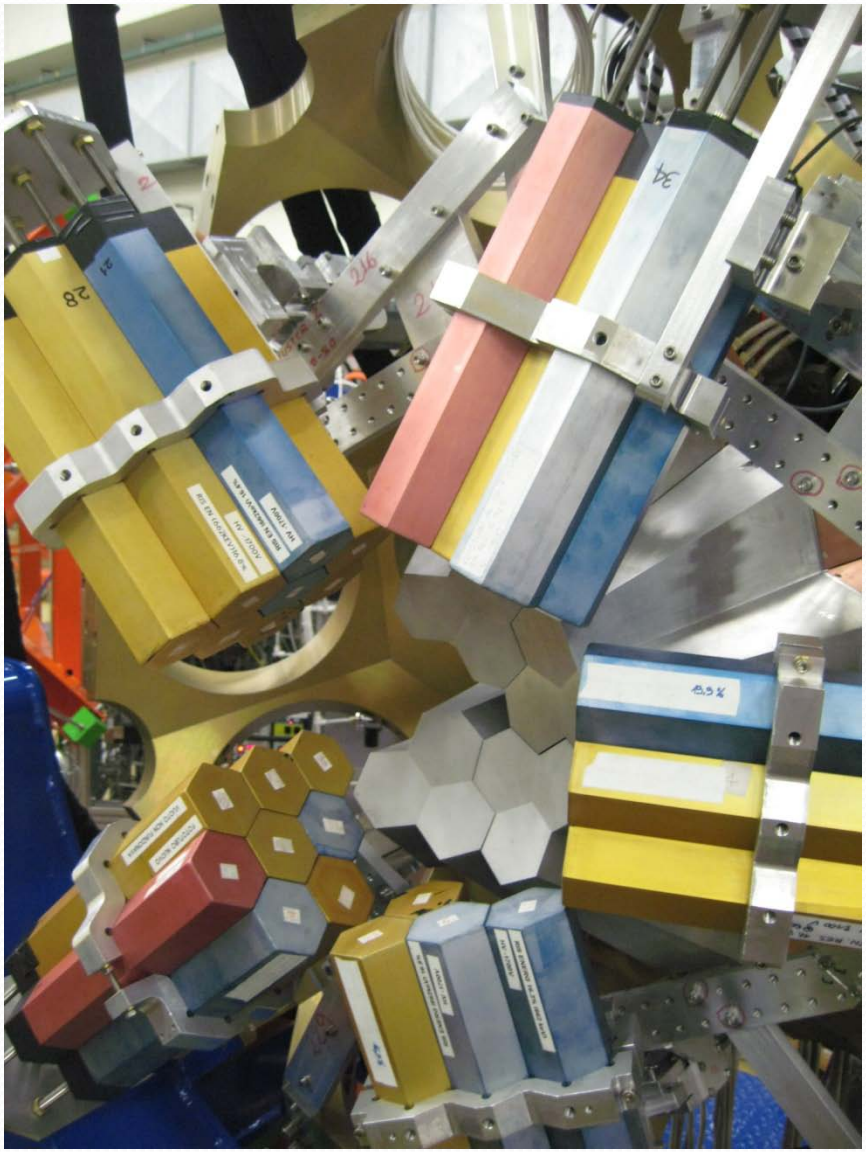
- **Statistical analysis of the ridge-valley structures in the γ–γ matrices**, to estimate the number of low-K and high-K bands and their correlation;
- **Lifetime analysis of the excited rotational bands** (measure of the quadrupole moment of the quasi-continuum structures);

By-products:

- **Study of the dependence of the GDR-width on the angular momentum**;
- **Study of AGATA response to high energy γ–rays:**
  - **Tests on n-γ discrimination methods** developed by Monte Carlo calculations
  - Investigations on the **possibility of improving HPGe detectors time resolution** through Pulse Shape Analysis techniques

Helena in AGATA





Experimental conditions

Reaction

^{50}Ti (@217MeV) + ^{128}Te
TANDEM+ALPI beam

Main evaporation residua:

- ^{174}W (~40%)
- ^{173}W (~50%)

Little known

^{50}Ti beam has been developed for this purpose by the LNL accelerator group

- 7 days of beam time
- Beam intensity = 1 pnA limited to prevent target damage
- Target thickness = 1 mg/cm^2
  backed by 50mg/cm^2 of ^{nat} Pb
- σ_{TOT} ^{174}W production = 210mb

Trigger request:

- 4-fold events in AGATA

OR

- 3-fold events in AGATA in coincidence with an event in Helena

40 TB of collected data stored on GRID and in Milan

Count-rates:

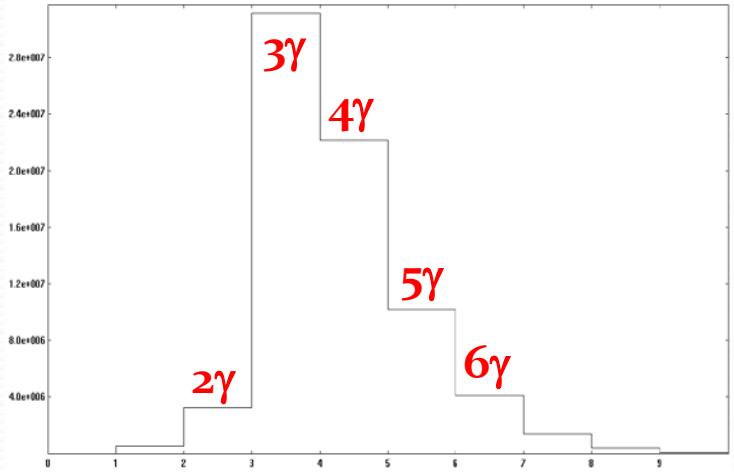
Single AGATA → ~ 13kHz
AGATA → ~ 1.5 kHz
Helena → ~ 1 kHz

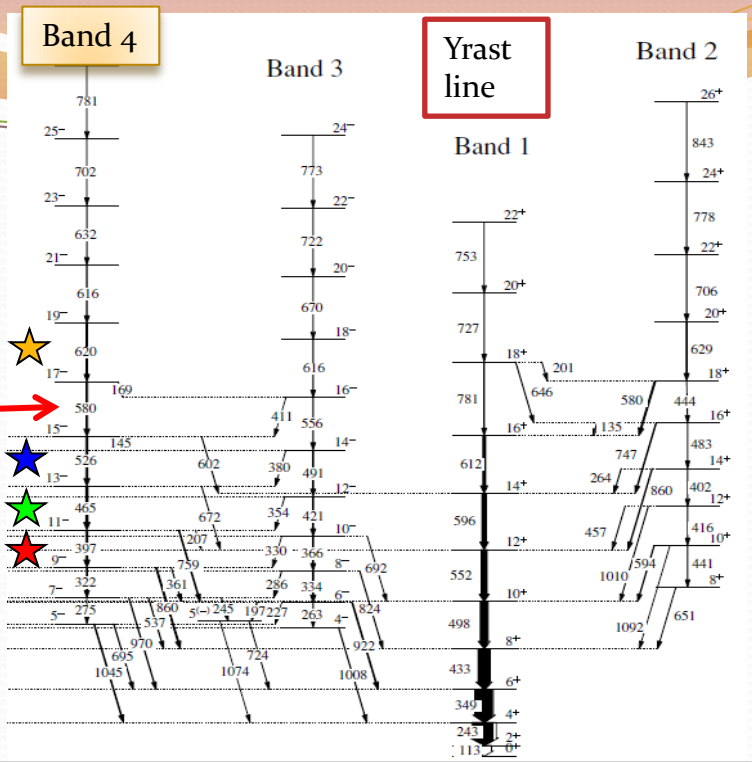
high rate →

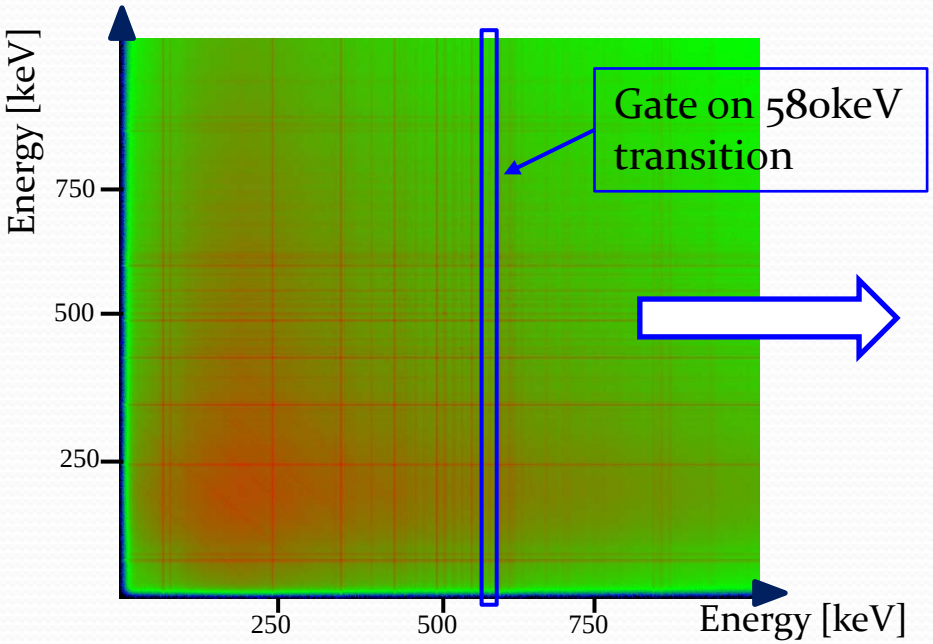
Reduced shaping time = 2μs
No energy resolution degradation
FWHM @ 1.112MeV = 2.5 keV (^{152}Eu)

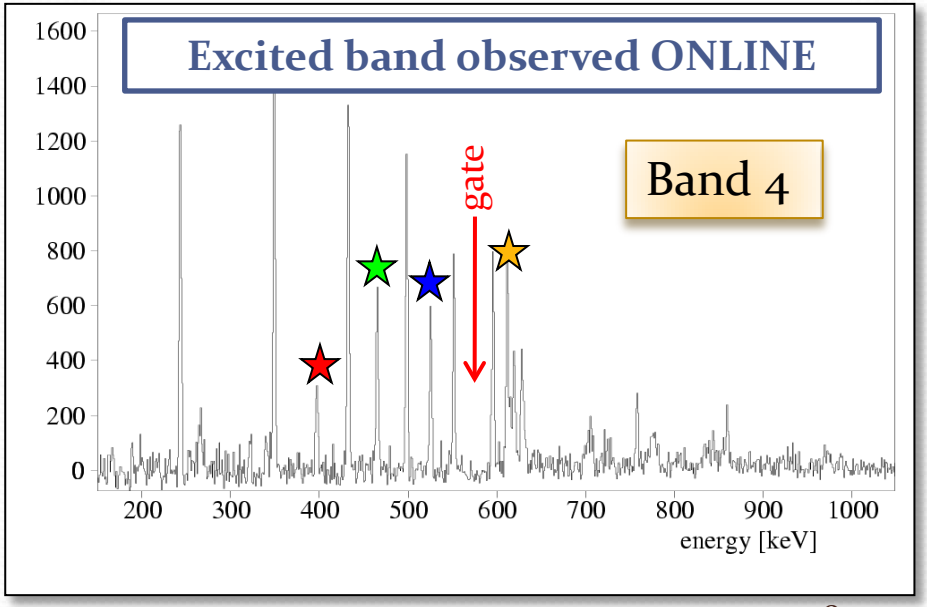
On-line results

AGATA
FOLD Distribution









Data Analysis

1. Presorting

STEP 1

- AGATA calibration
- Pulse Shape Analysis

↓

Performed @ LNL using 10 parallel nodes

Gamma hit position and energy information

STEP 2

- Event correlation
- Fine AGATA Calibration
- Helena calibration
- γ-ray tracking
- Time alignment

↓

Performed in Milan

ROOT Tree generated

2. Extract physical information

↓

Statistical fluctuation analysis

To be done

Now: test of **tracking performances** with simulated and acquired data
Comparison between different tracking algorithms

→

Geant4 simulation:

- **Single gamma-ray**

$M_\gamma = 1$ $E_\gamma = 1 - 3 - 6 - 9$ MeV

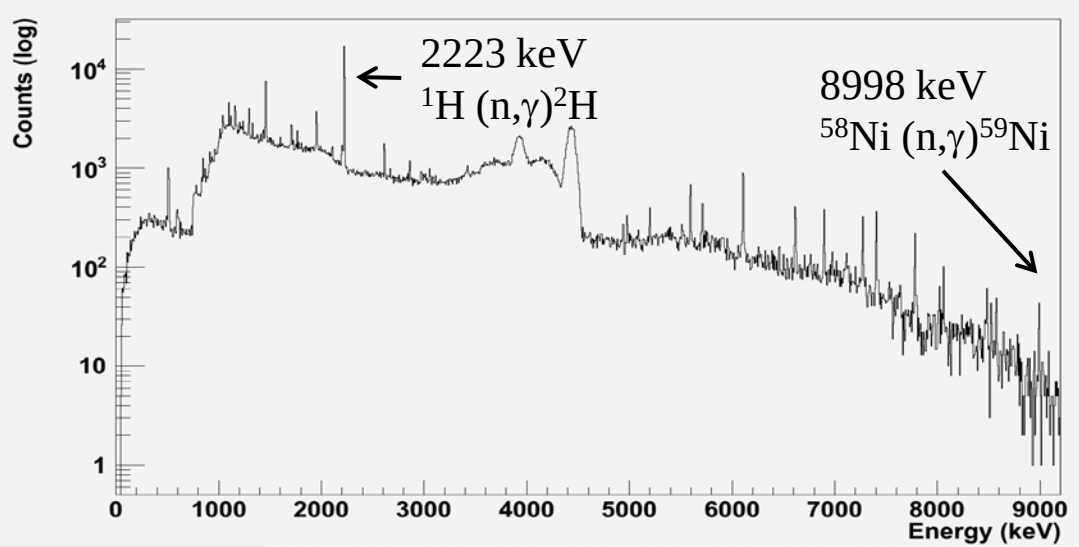
- **Rotational band**

$M_\gamma = 6$ $E_\gamma = 300$ keV $\Delta E_\gamma = 100$keV

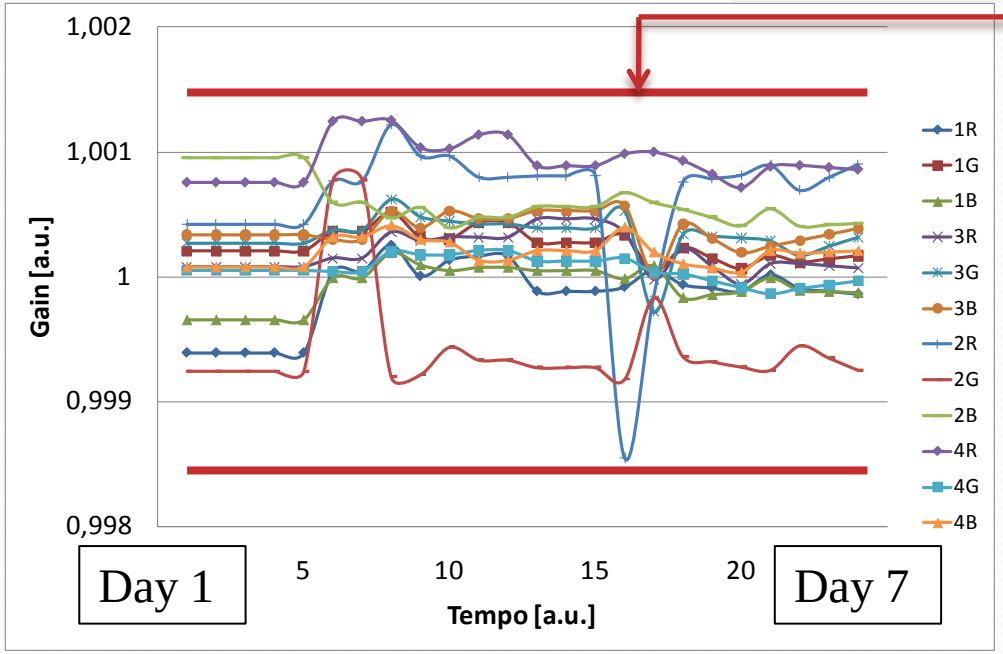
Preliminary analysis

AGATA calibration

AmBe(Ni) source
Energy calibration up to 9MeV
using 20 gamma lines for the core
and 7 for the segments
Test of detector linearity



Fine AGATA calibration

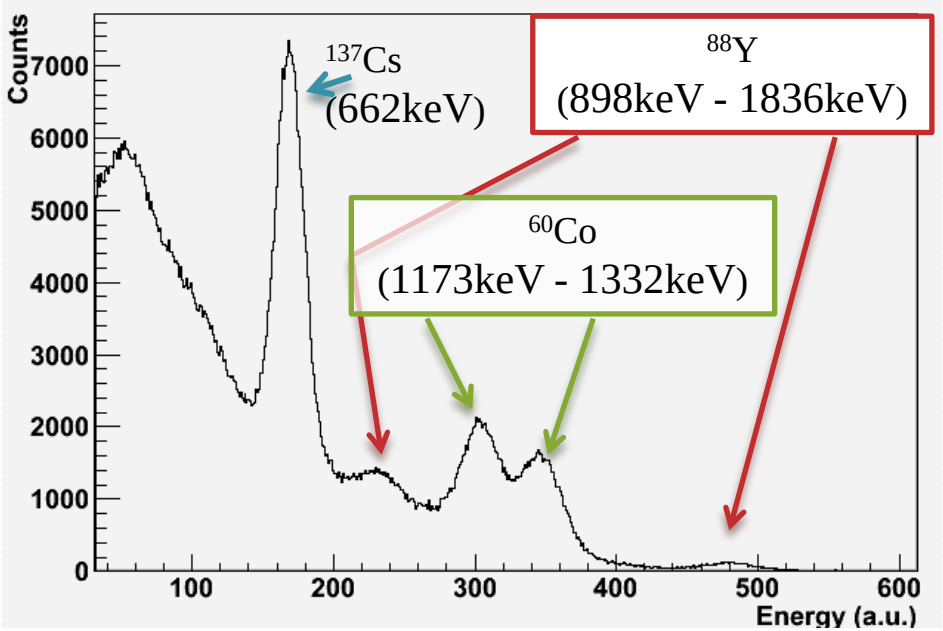


Reference peaks:
- 243keV (^{174}W)
- 1014keV (^{27}Al)

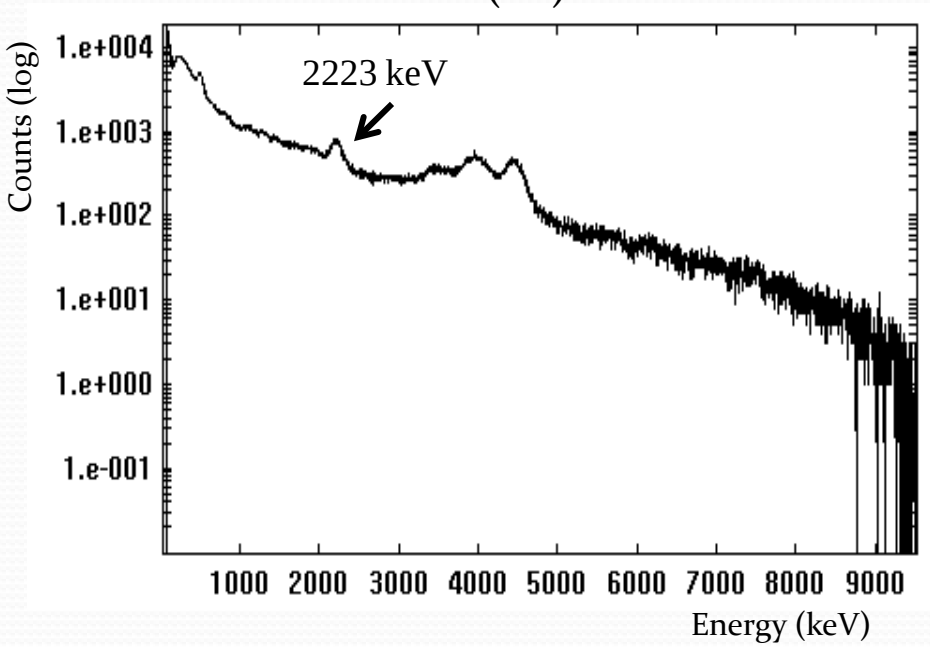
No gain fluctuation
(within 3‰)
Very stable detectors in 7-days measurements

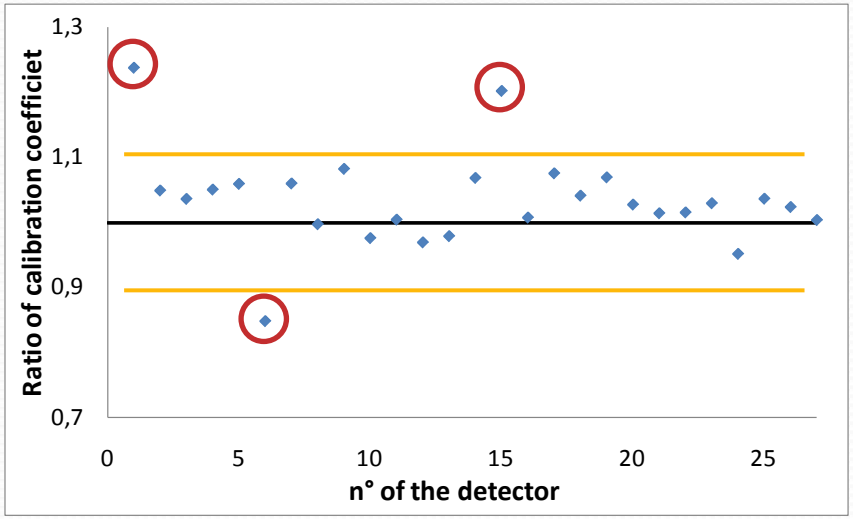
Preliminary analysis

Helena calibration



AmBe(Ni) source





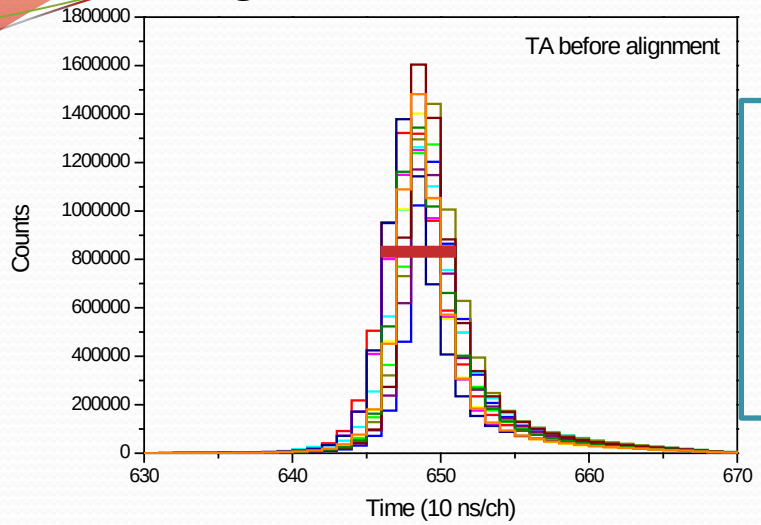
3 scintillators have large gain fluctuations (>10%) due to electronic instability

Work still in progress

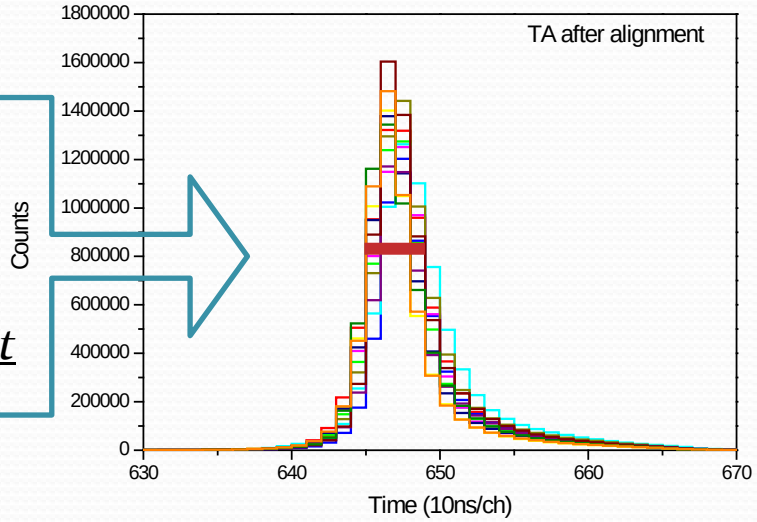
Preliminary analysis

Time alignment of the AGATA detectors

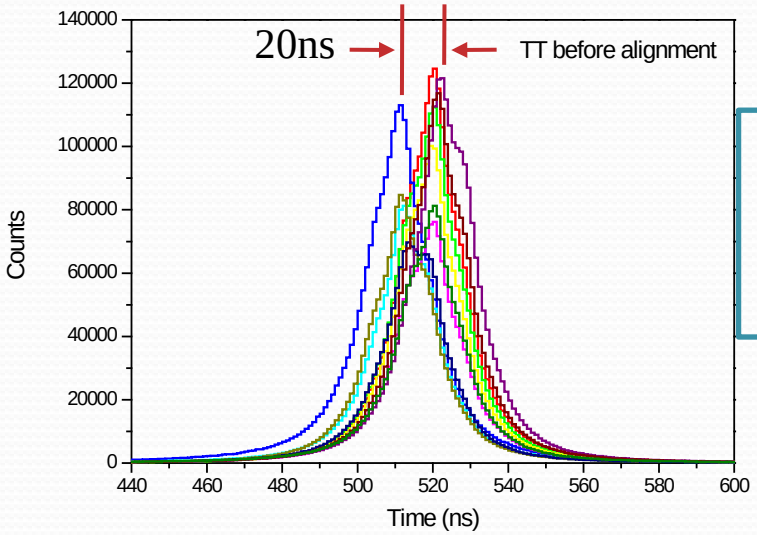
Time difference between the AGATA and Ancillary Timestamp [TA]



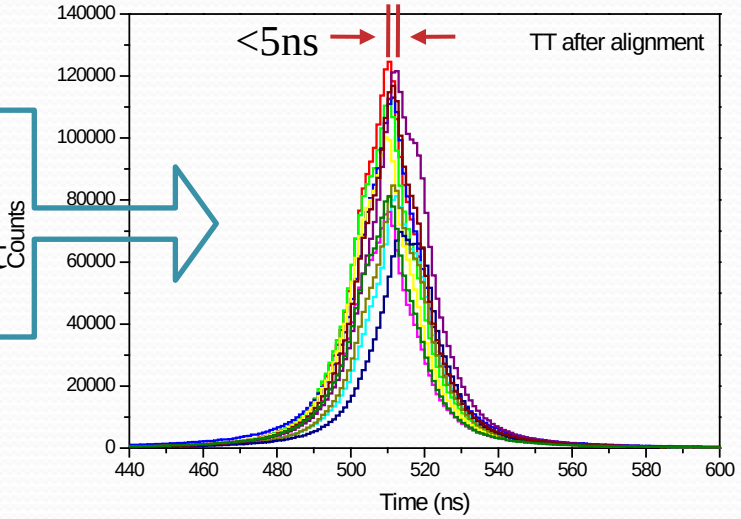
Alignment of TA spectra using the keyword *TimestampCorrect*



Time difference between the 12 AGATA detectors (CFD + Timestamp) [TT]



Improving in TT spectra alignment



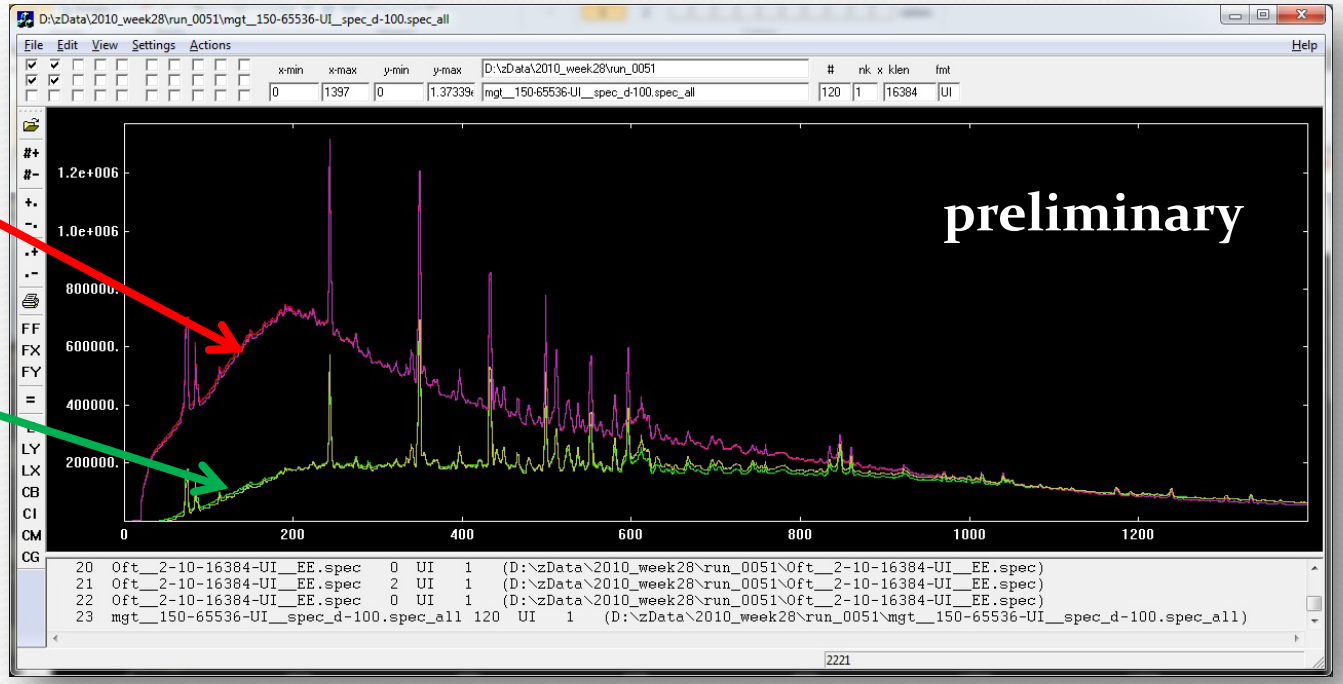
Tracking performances: Data

MGT vs. OFT - Acquired data

Very Similar Performances

Raw

Tracked



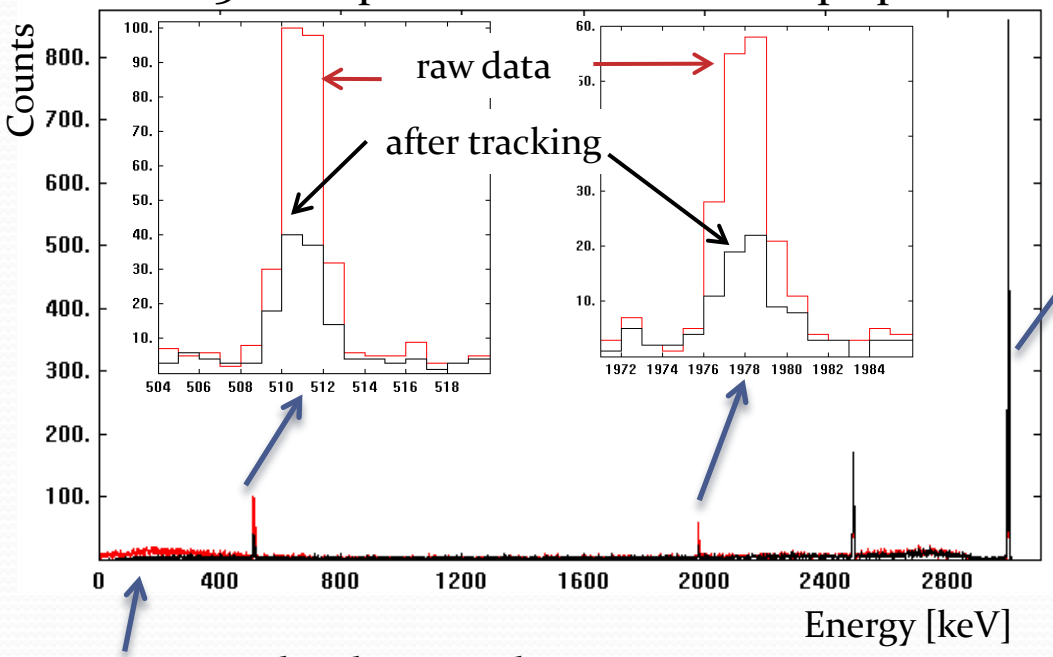
Effect of TRACKING: - **Large Compton reduction**
- **Small Photopeak gain**

Tracking performances: Simulations

MGT tracking algorithm – Simulated data

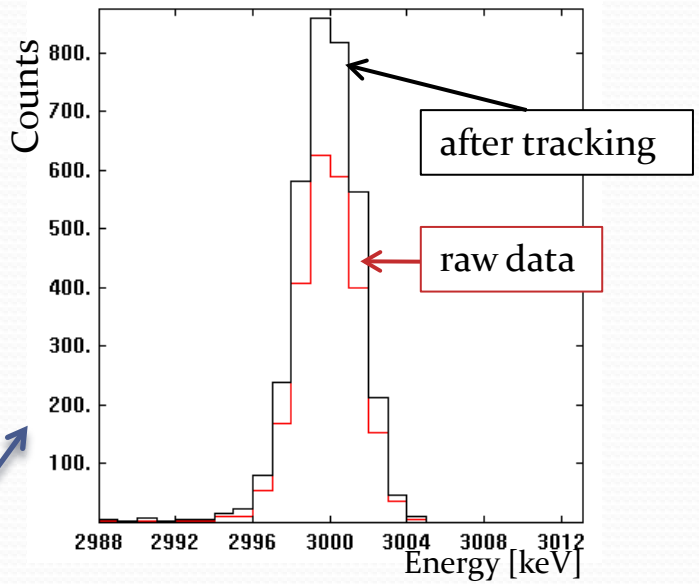
Single gamma-ray – E_γ=3MeV

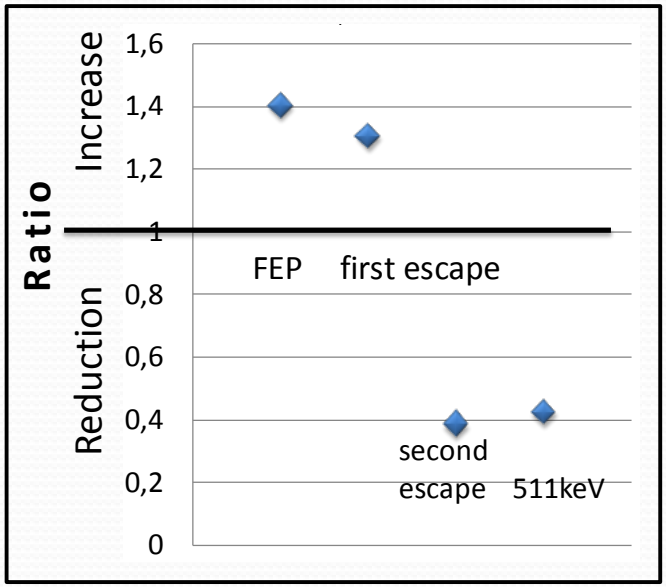
Reduction of
the 511keV peak end the first escape peak



Low-energy background reduction

Increase of the full energy peak



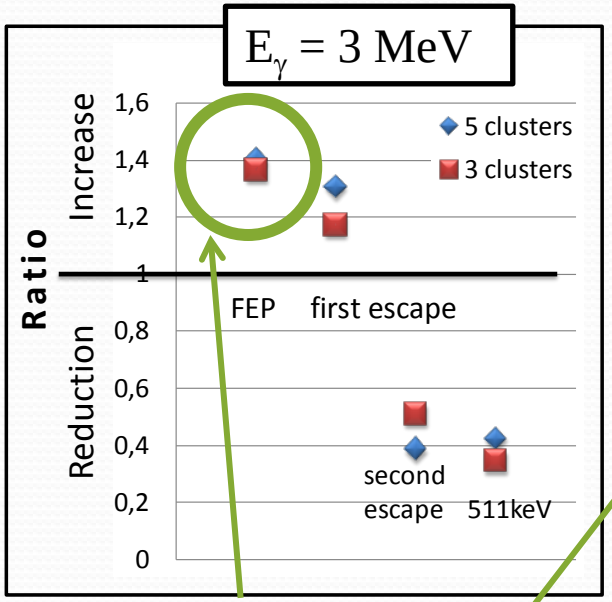


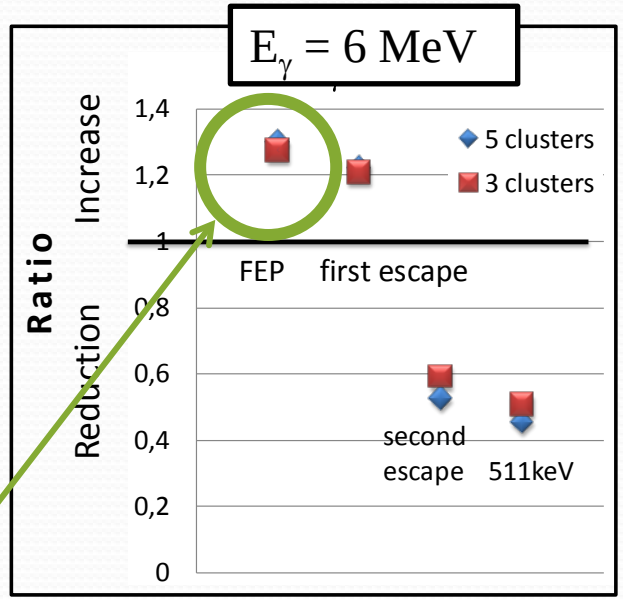
Tracking performances

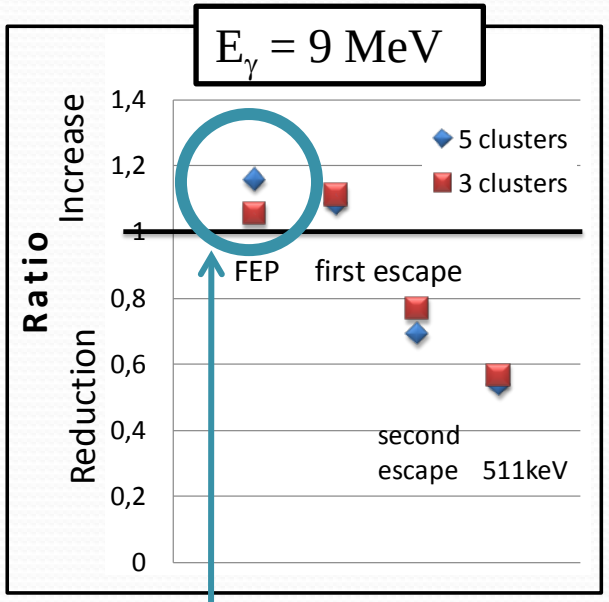
MGT tracking algorithm – Simulated data

Tests with different energies and AGATA configurations

Ratio = Area after tracking / Area before tracking







No difference in Full Energy Peak area improvement @ 3 – 6 MeV with 3 or 5 clusters

Effect due to the number of clusters are visible @ 9 MeV

Conclusion and perspective

- Study of order- to-chaos transition in ^{174}W
- Setup: AGATA Demonstrator + Helena Array
- Fusion-evaporation reaction of ^{50}Ti on ^{128}Te target
- Analysis is at the presorting stage

➢ Tests of the tracking performances:
  - Different algorithms (OFT vs MGT) → changing χ^2
  - Different geometries (3 – 5 – 8 clusters)

➢ Extract physical information from the gated γ-γ matrices

- **Work in progess in Ankara (A. Atac, S. Akkoyun) : n, γ discrimination**
- **Plans for writing up a MANUAL on DATA REPLAY**