AGATA

Advanced GAmma Tracking Array

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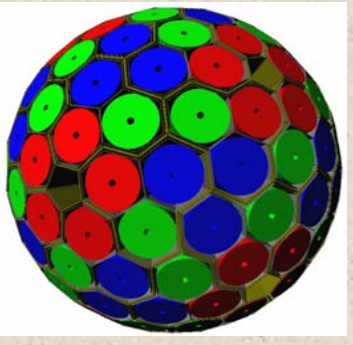
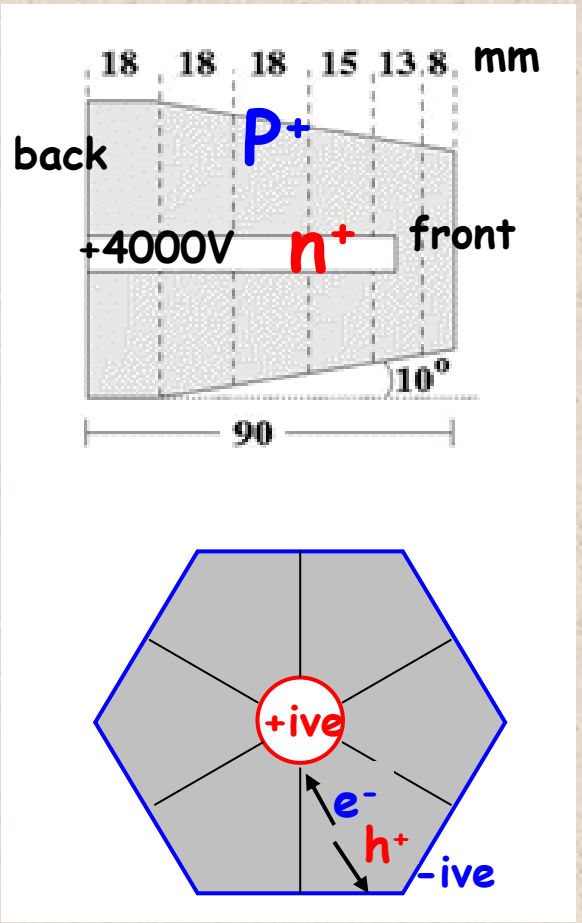
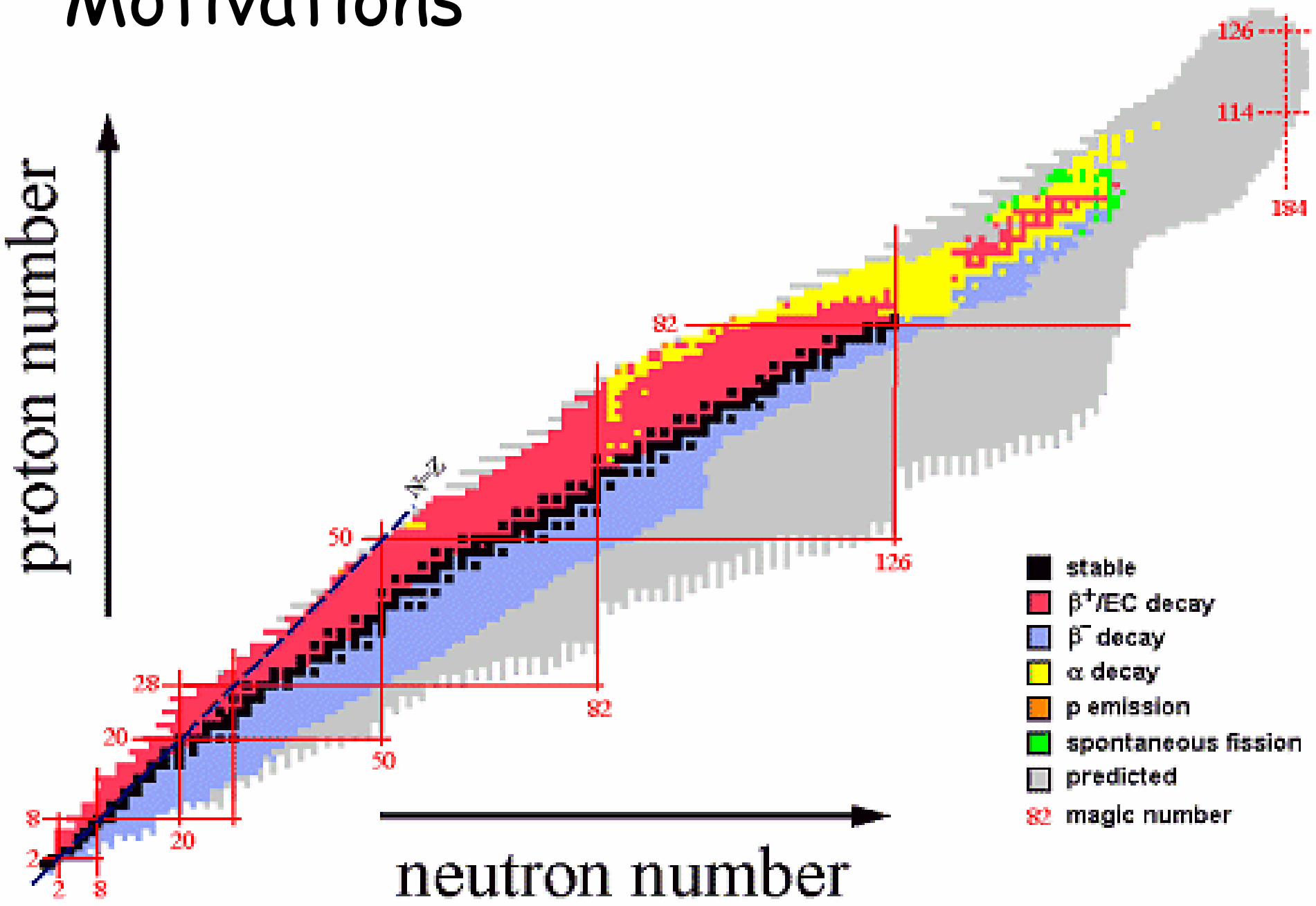


- European project involving at least 10 countries
- Conceptual array consisting of 180 High-Purity Germanium (HPGe) detectors arranged in a 4π geometry
- Detectors are of closed-ended coaxial configuration
- Large volume: approx 9cm long with a 4cm radius
- Each detector segmented 36-fold
  => 6660 channels of data !
- Total cost of project ~50 M € !



Motivations



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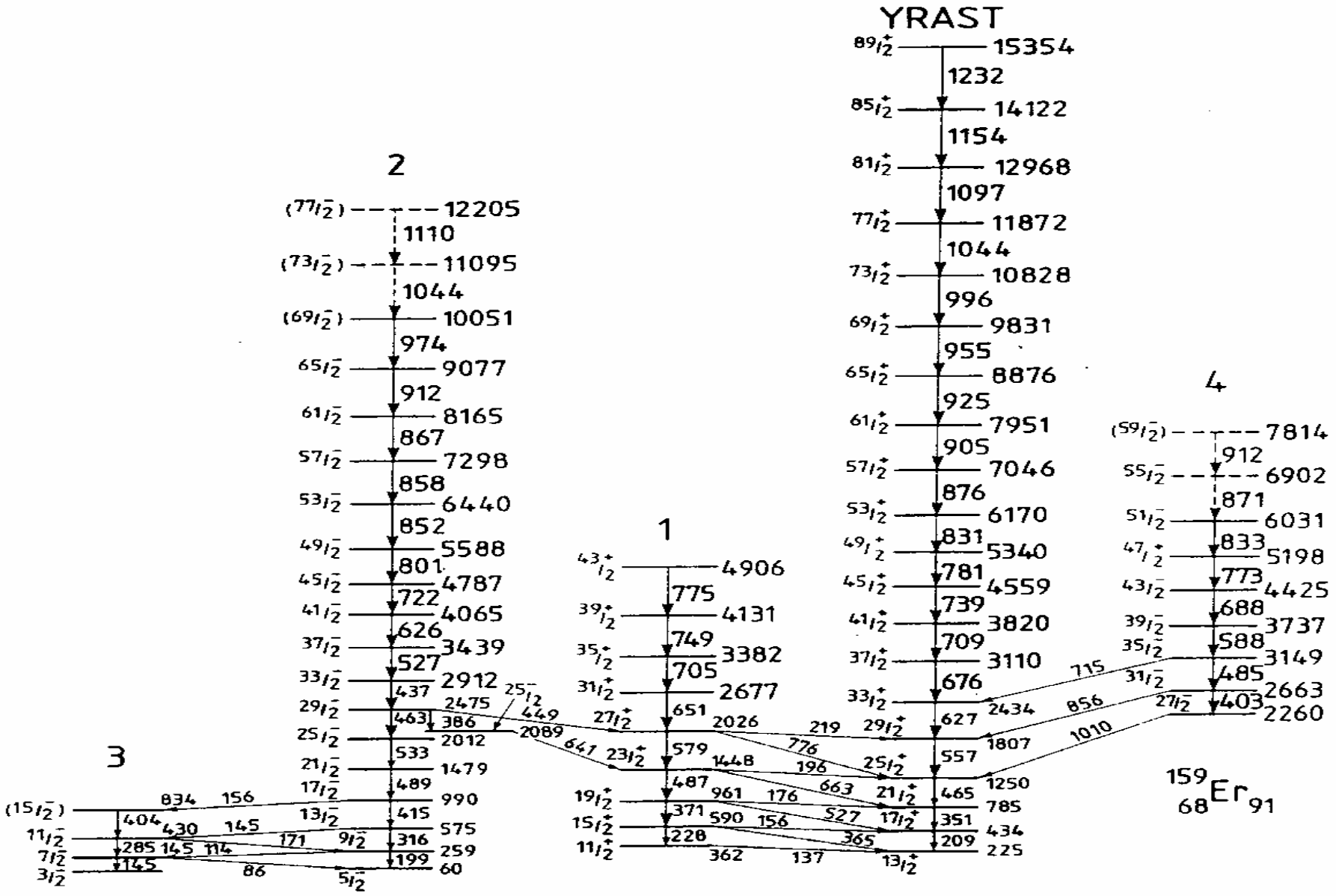


Existing Configurations

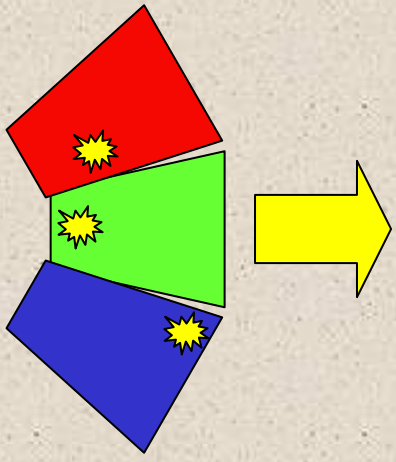
EUROGAM at IReS
MINIBALL at CERN
EXOGAM at GANIL

GAMMASPHERE at Argonne National Laboratory, USA

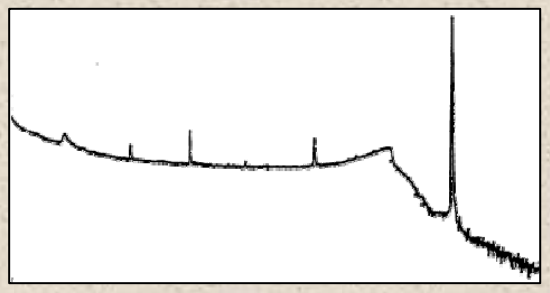
- 110 High-Purity Germanium detectors
- Stable and radioactive beams used to create excited nuclei
- Photopeak efficiency for 1.3 MeV γ-rays of 10%
- Each detector enclosed in a Bismuth-Germanate (BGO) Compton-suppression shield

Compton Suppression Shielding

Without Compton suppression shields

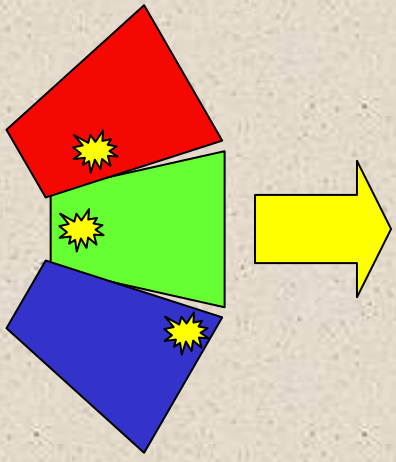


Compton continuum. => Large peak to total ratio



Compton Suppression Shielding

Without Compton suppression shields



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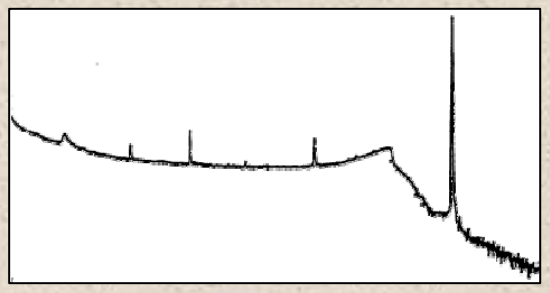
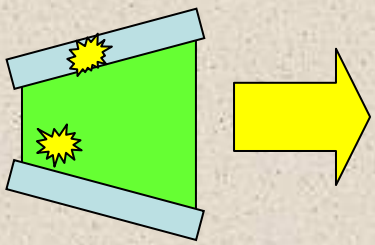
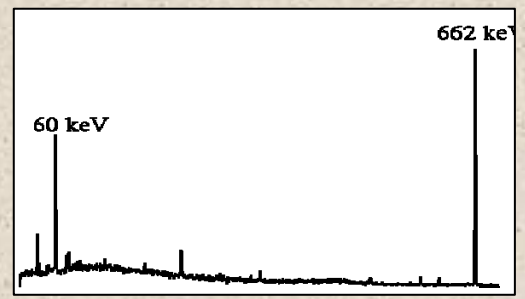


With BGO shielding

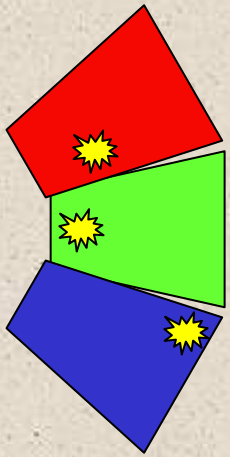




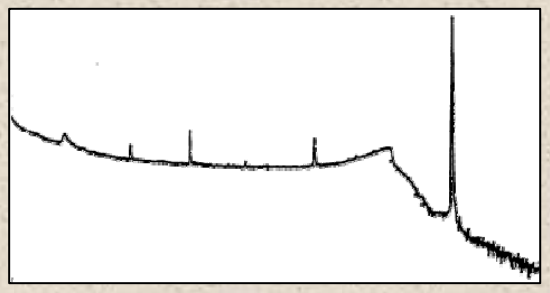
Less solid angle coverage => Big drop in efficiency

Compton Suppression Shielding

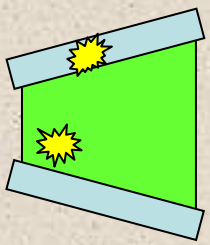
Without Compton suppression shields

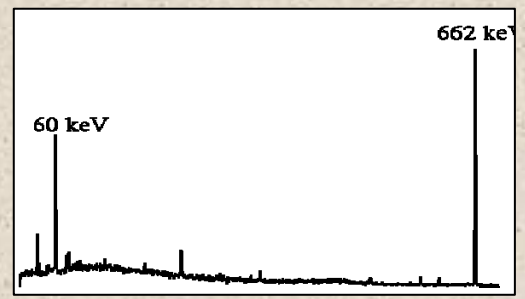


Compton continuum.
=> Large peak to total ratio



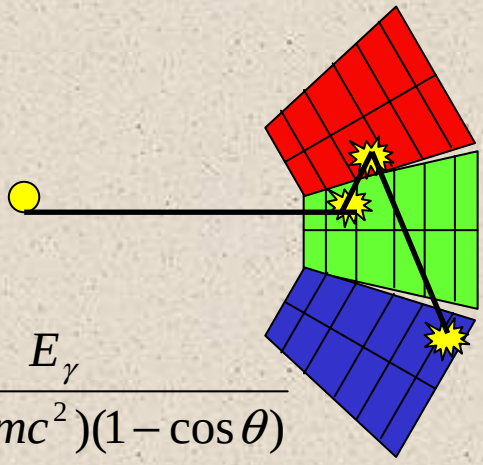
With BGO shielding





Less solid angle coverage
=> Big drop in efficiency

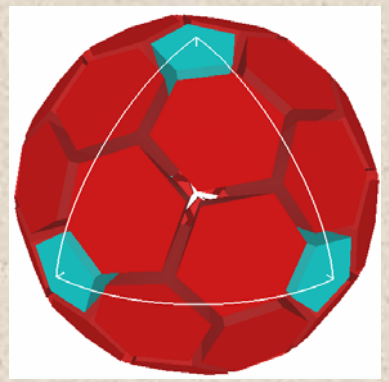
With highly segmented detectors



$$E_{\gamma}^{'} = \frac{E_{\gamma}}{1+(E_{\gamma}/mc^{2})(1-\cos\theta)}$$

Path of γ-ray reconstructed to form full energy event
=> Compton continuum greatly reduced
=> As well as excellent efficiency
~50% for 1MeV γ-rays!
=> Greatly improved angular resolution (~1^0) to reduce Doppler effects

AGATA Design



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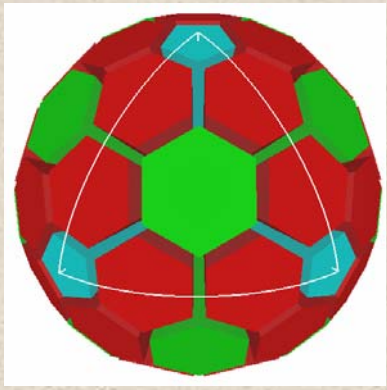

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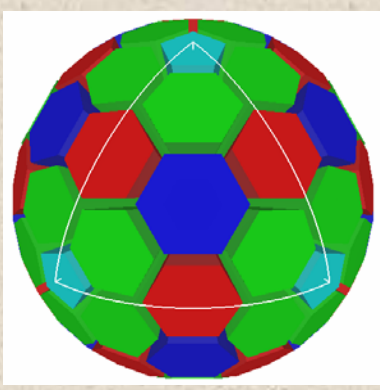

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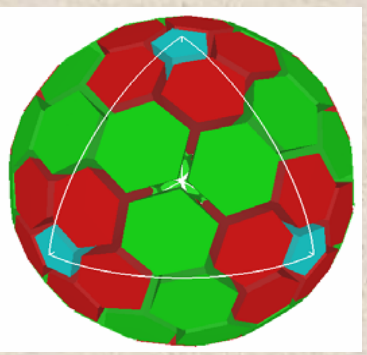

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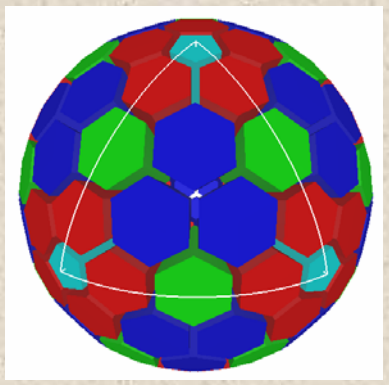

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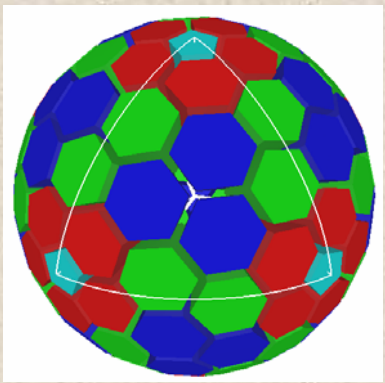

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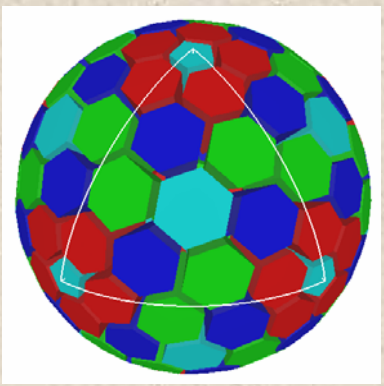

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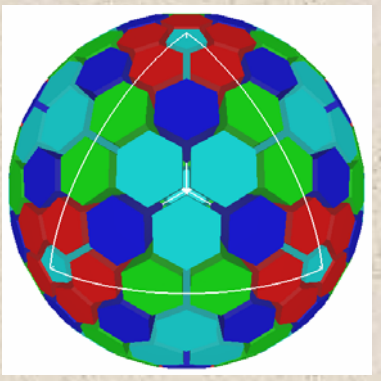
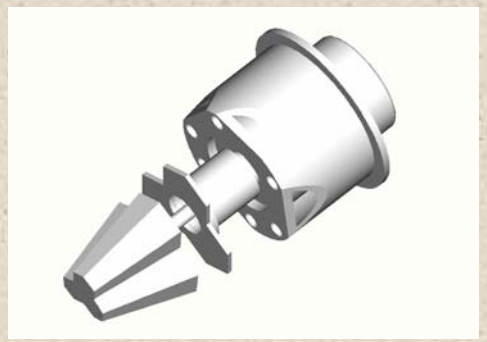


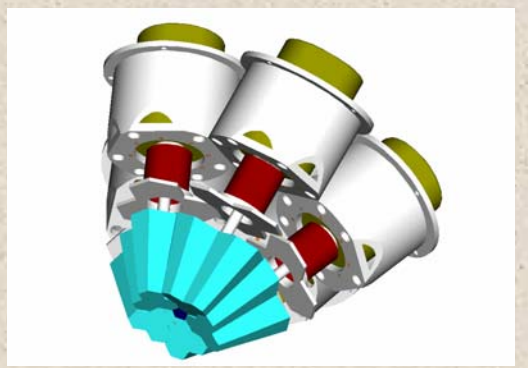
240

AGATA Design

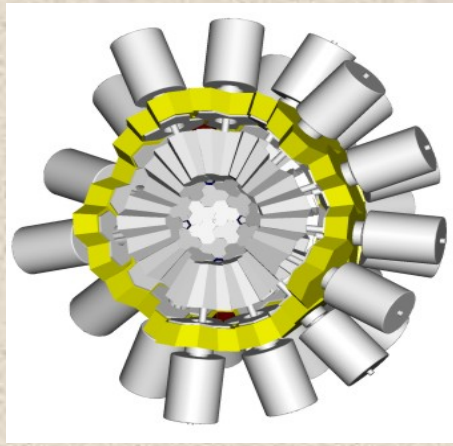
3 different asymmetric hexagonal shapes are used



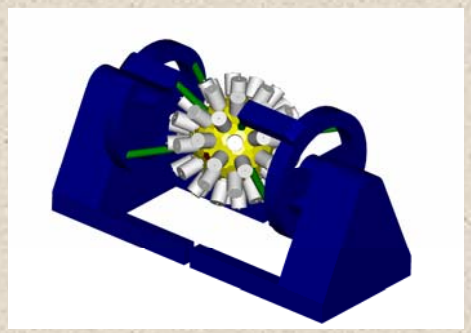
Triple cluster modular units in a single cryostat



The AGATA demonstrator: 5 triple clusters, 540 segments. Scheduled for completion 2008



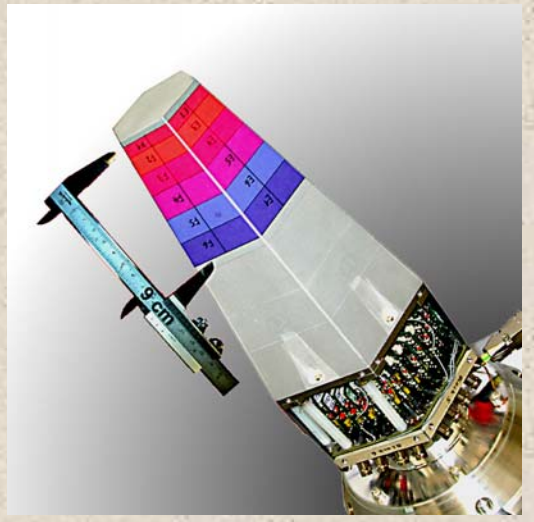
2π of completed array

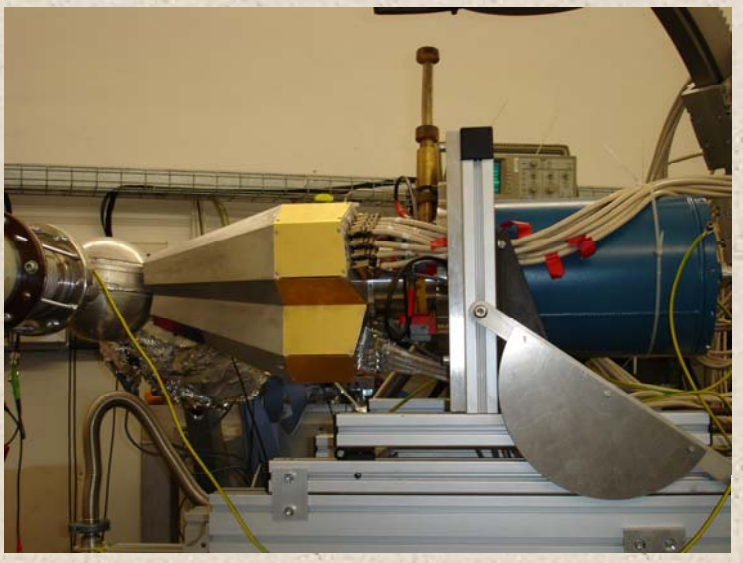


Completed array (6480 segments) with support structure

AGATA Prototypes

- 3 symmetric prototype detectors have been constructed and tested
- All preamps contain cold FETs for minimal noise
- Typical resolutions;
  ~1keV for 60keV γ rays
  ~2keV for 1.3MeV γ rays
- Symmetric triple cluster has been formed and has recently been tested in-beam at Cologne.
  Reaction; d(48Ti, 49Ti)p
- First asymmetric detectors are currently under construction

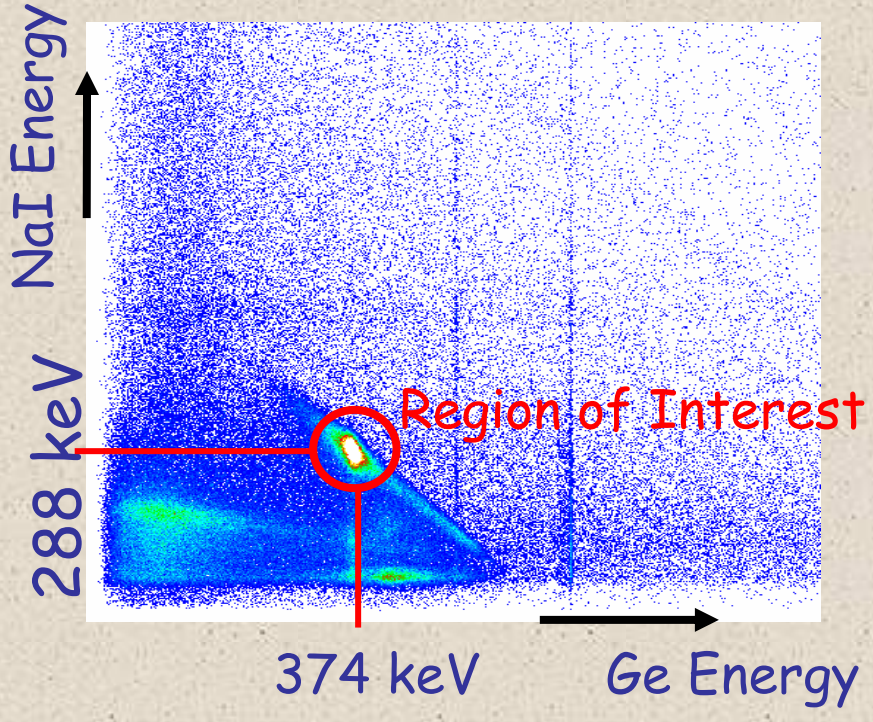




Experimental Set Up at Liverpool

11.1MBq ^{137}Cs (662keV) source scanned across front face of detector through 2mm injection collimator

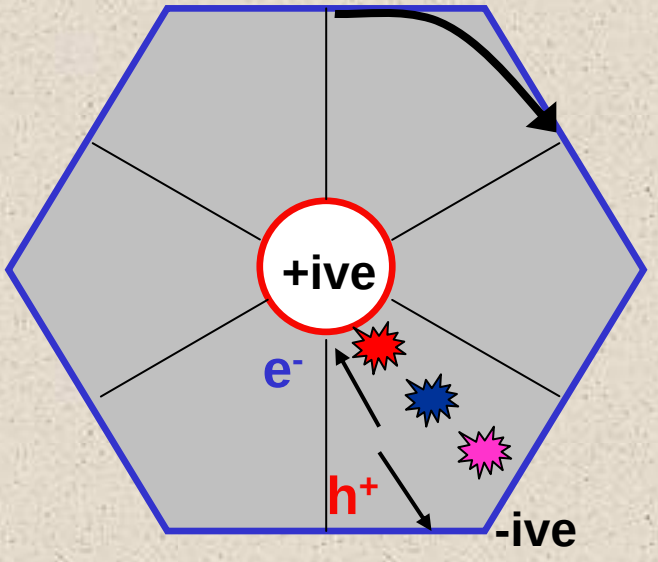
NaI AND Ge detector in coincidence to ascertain 3-D position information
Ensures that only γ-rays scattering through an angle of 90^0 are recorded
=> accurate 3D position



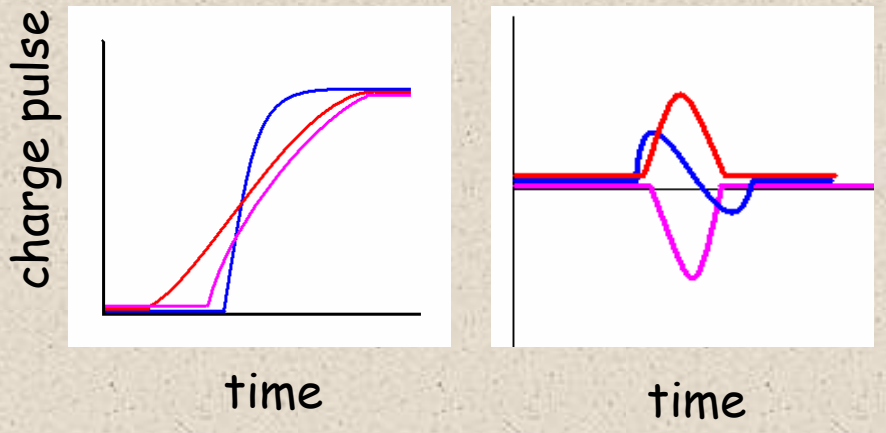
$$E_\gamma' = \frac{E_\gamma}{1+(E_\gamma/mc^2)(1-\cos\theta)}$$

$$= \frac{0.662}{1+(0.662/0.511)(1-0)} = 0.288MeV$$

Pulse Shape Analysis (PSA)



- Granularity achieved by the segmentation is not precise enough for γ-ray tracking algorithms
- PSA performed to achieve greater spatial resolution



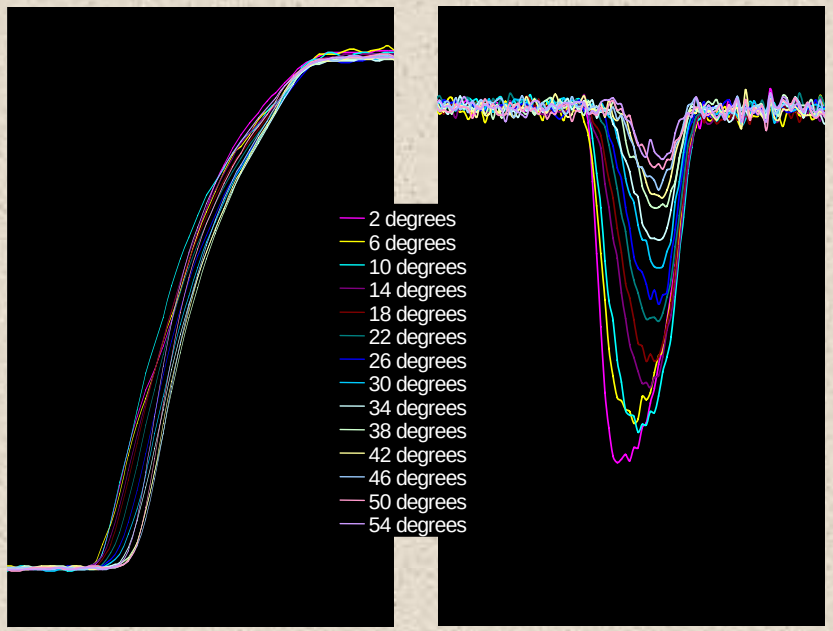


Image Charge Analysis and Comparison to Theoretical Data

Image charge magnitudes

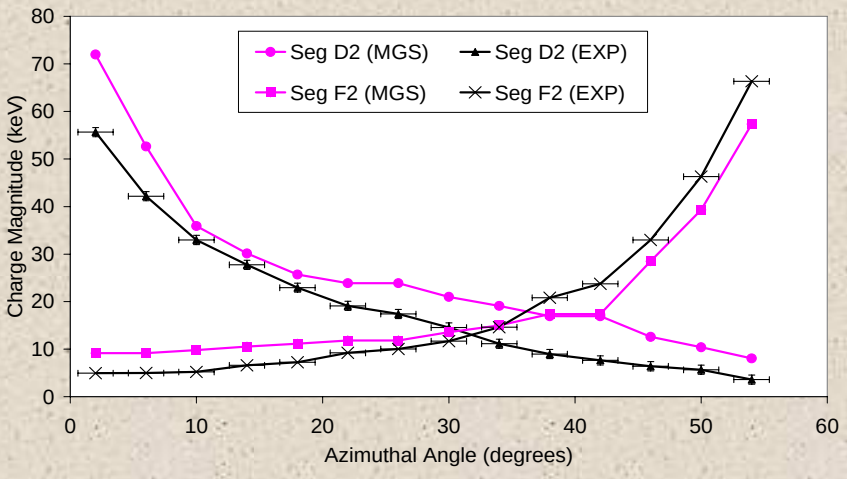
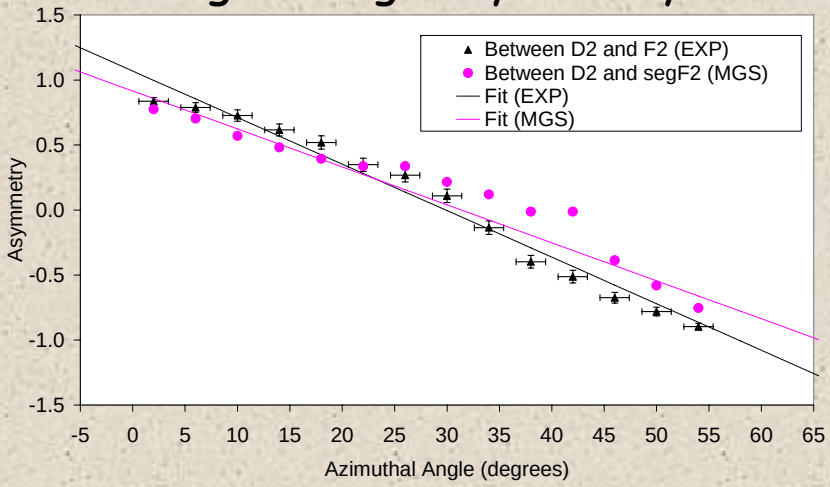


Image charge asymmetry



Theoretical data set produced by MGS Electric Field Simulation software

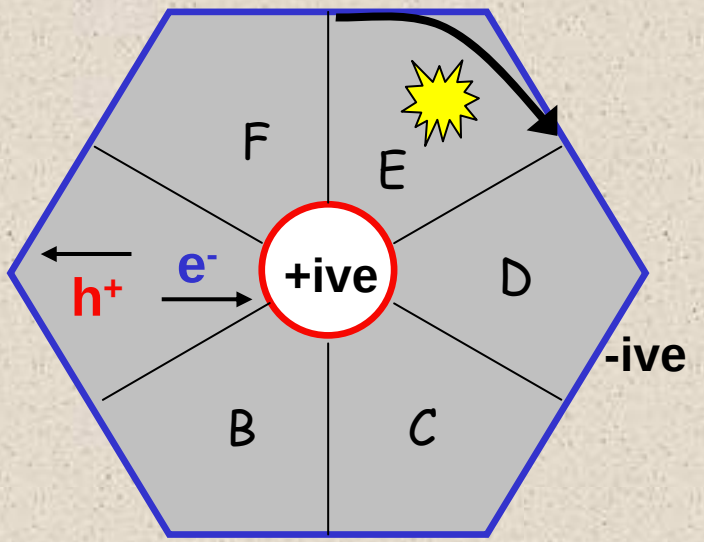


Image charge asymmetry:

$$ICA = \frac{M_1 - M_2}{M_1 + M_2}$$

Summary

- Preliminary analysis shows good agreement between experimental and theoretical results in the truly coaxial regions of the AGATA prototype detector.
- The simulated data fits the experimental least well in the front ring of the detector.
- Confidence gained in the ability of Electric Field Simulation Software to generate a basis data set for GRT
- Analysis is ongoing !

Acknowledgements:

M.R. Dimmock[a], A.J. Boston[a], H.C. Boston[a], J.R. Cresswell[a], P.J. Nolan[a], I. Lazarus[b], J. Simpson[b], P. Medina[c], C. Santos[c], C. Parisel[c].

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