Gamma-ray Detection Array with SuperClover Detector

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Motivation

Gamma-ray Detection Array with High-Purity Germanium Detector

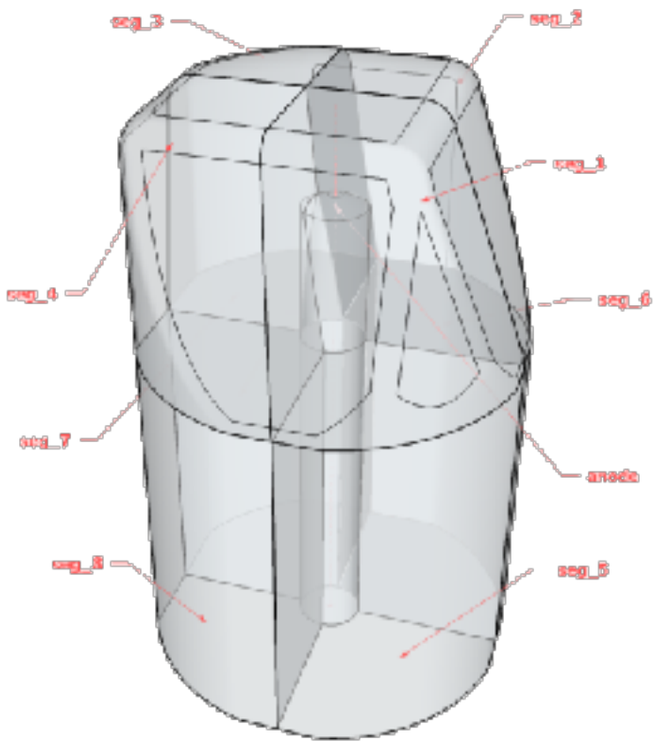
- Gamma-ray are important probes for the detailed structure of nuclei.

- Their energies can be measured in high precision by using a high-purity germanium detector (HPGe detector).

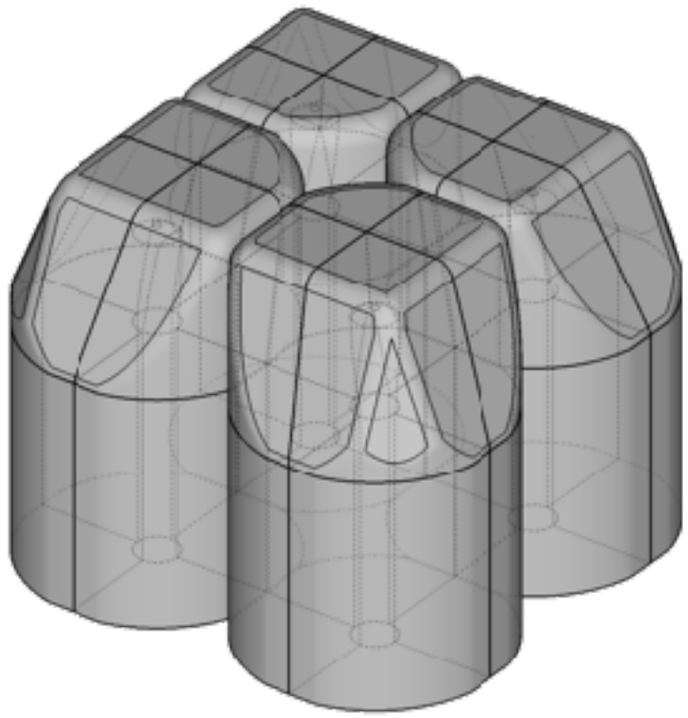
- There are Six Super Clover detector (SC detector) on RISP.

SC detector

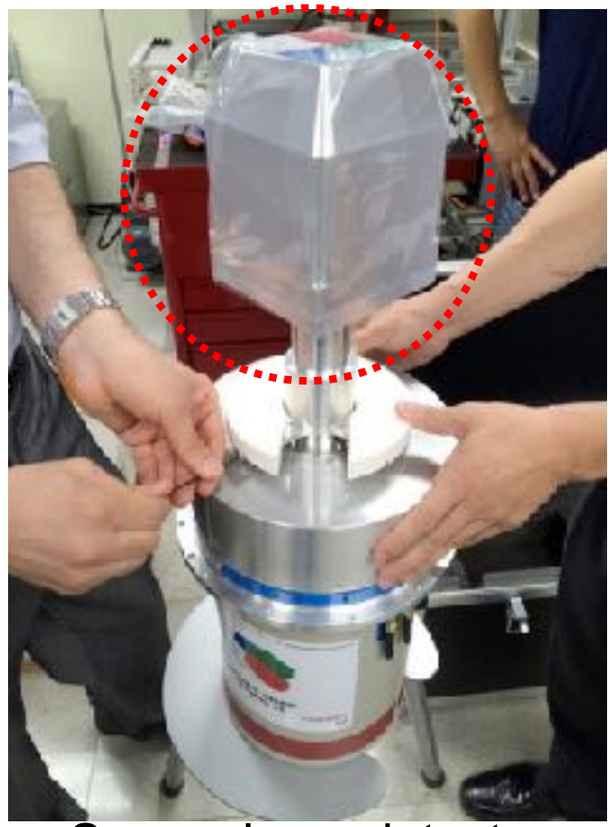
- 4-fold 32 segmented super clover detectors.
- Size: 90 mm (height) × 60 mm (diameter) × 4,
  22.5˚ tapered at 36.2 mm from the top
- Performance: Energy resolution of 0.15%@1332 keV
  Relative efficiency of > 160%@1332 keV



Electrically 8-segmented
single HPGe crystal



4-fold HPGes inside of cryostat



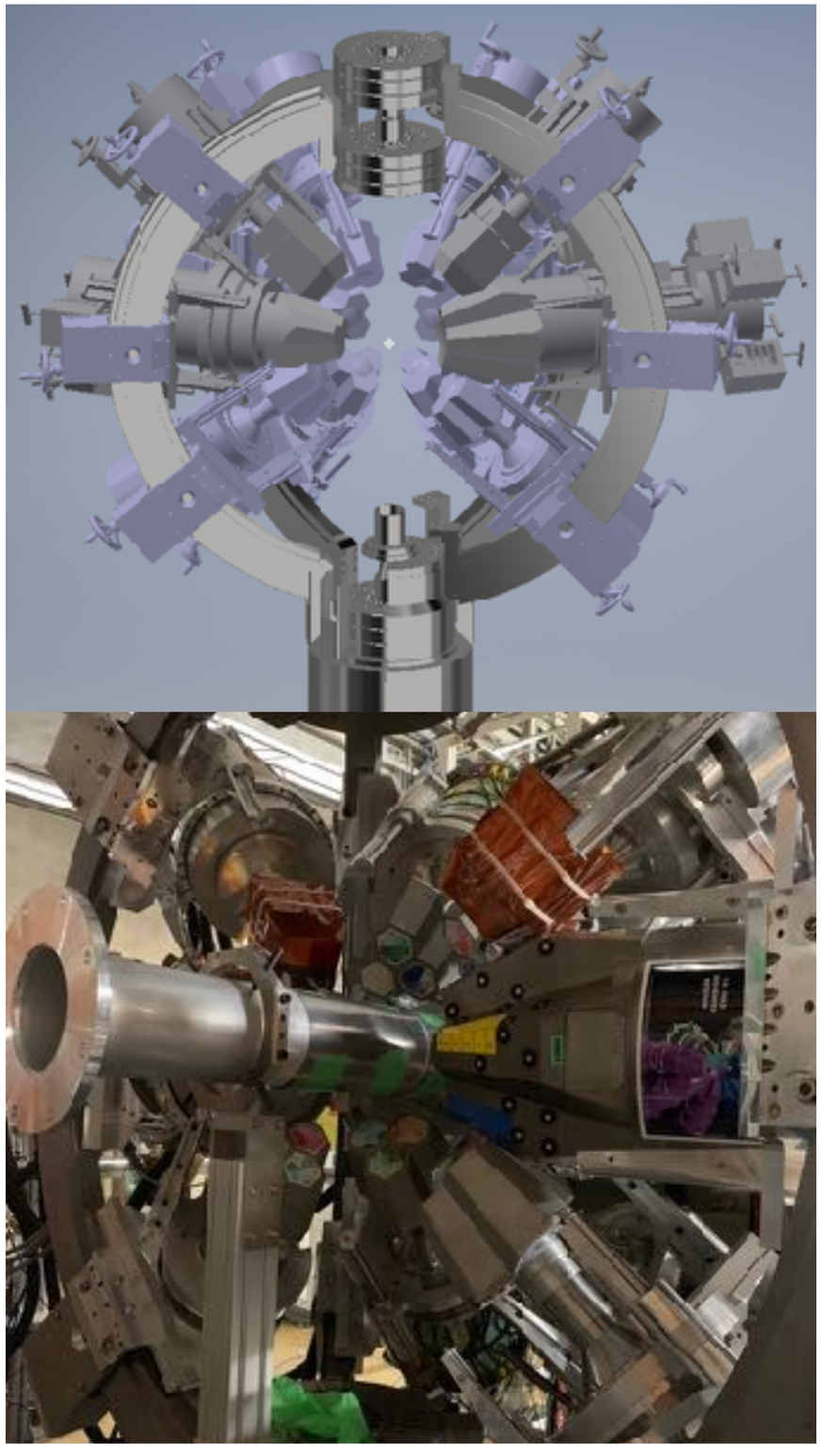
Super clover detector

HiCARI in RIBF

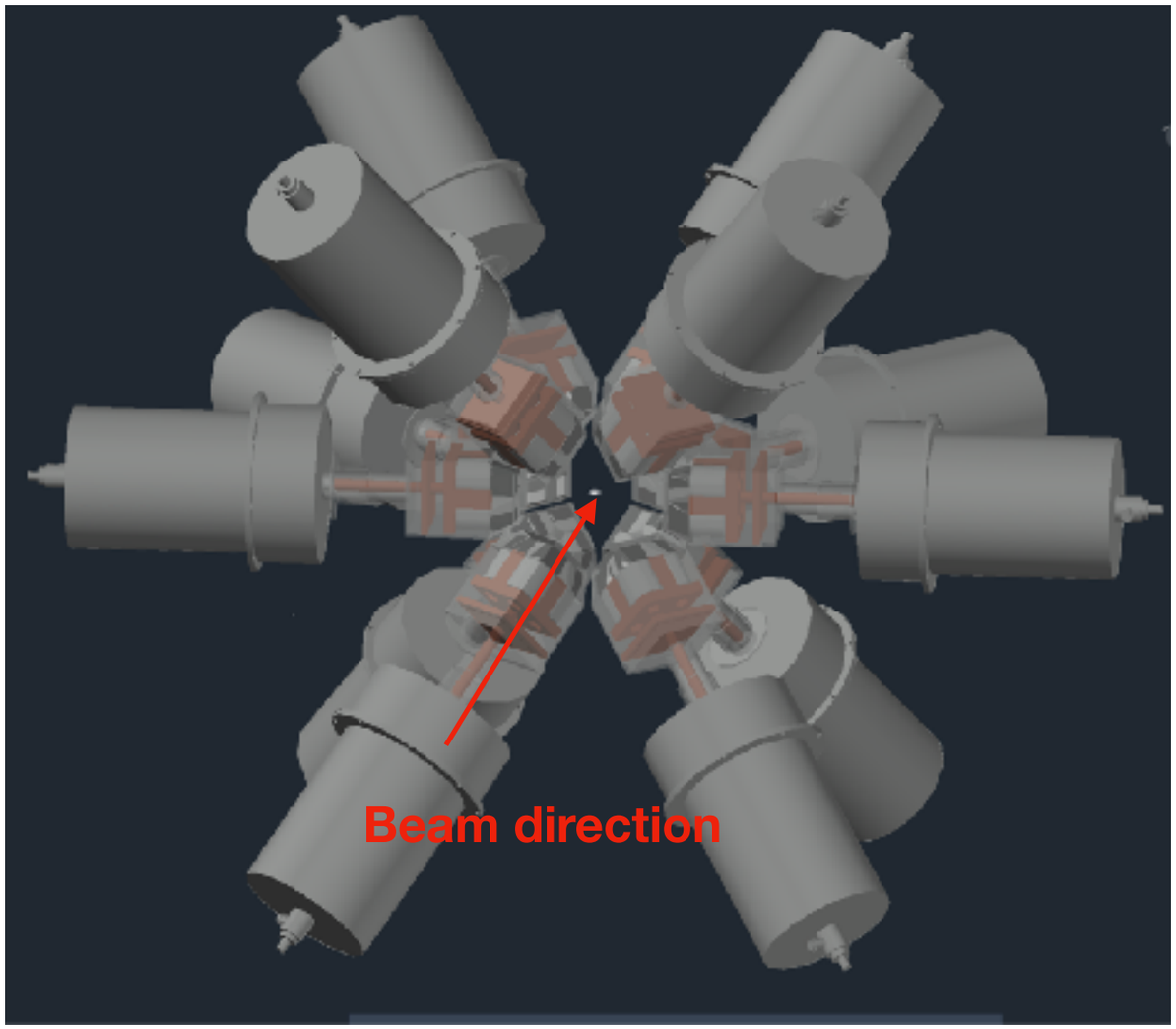
- High-resolution Cluster Array at RIBF (HiCARI)

- A germanium-based gamma-ray spectrometer composed of MINIBALL (ISOLDE), Super Clover detectors (IBS), and Ge tracking detectors (LBNL & RCNP)

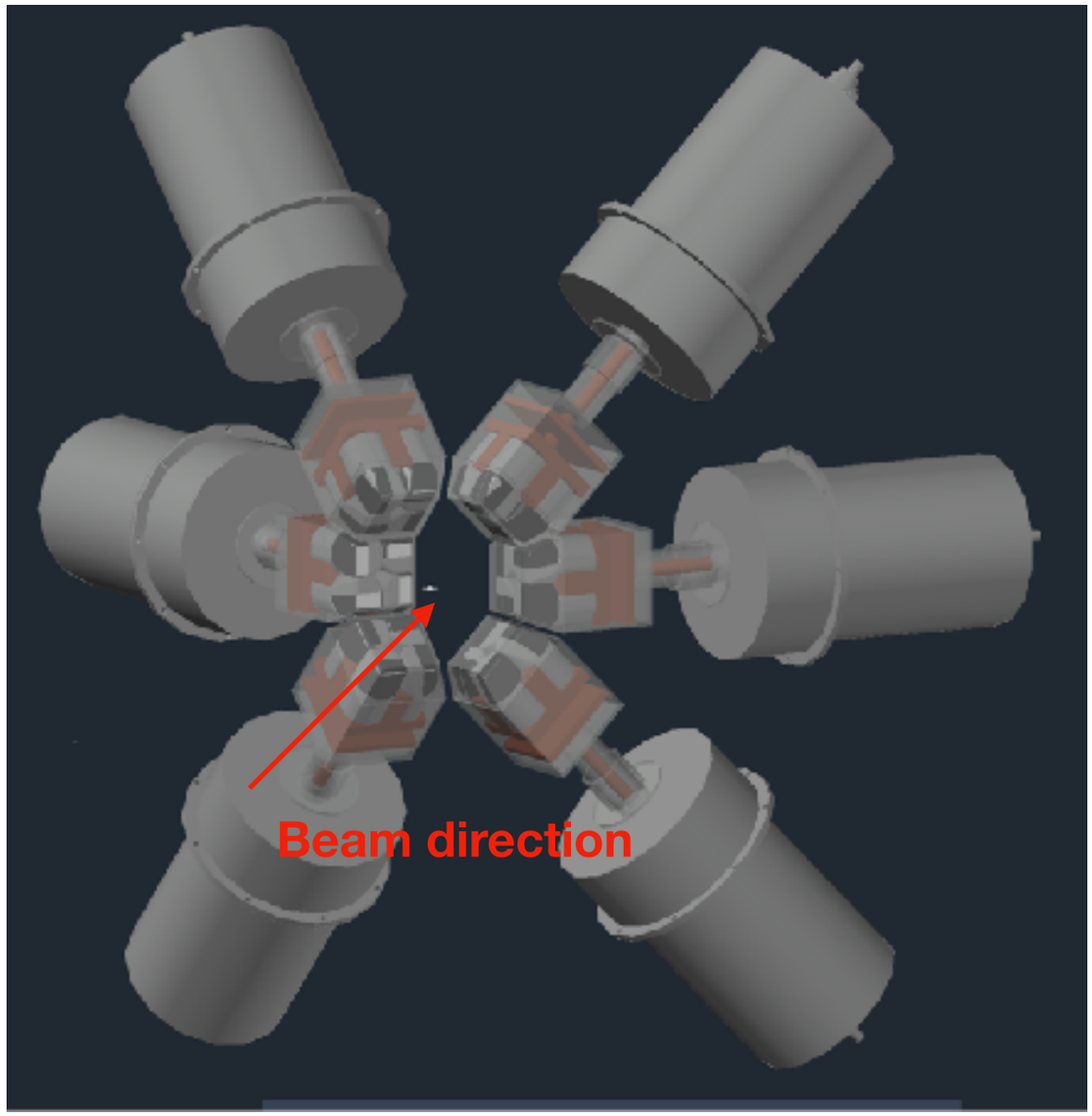
- For In-Beam Gamma ray spectroscopy experiments



SC Array

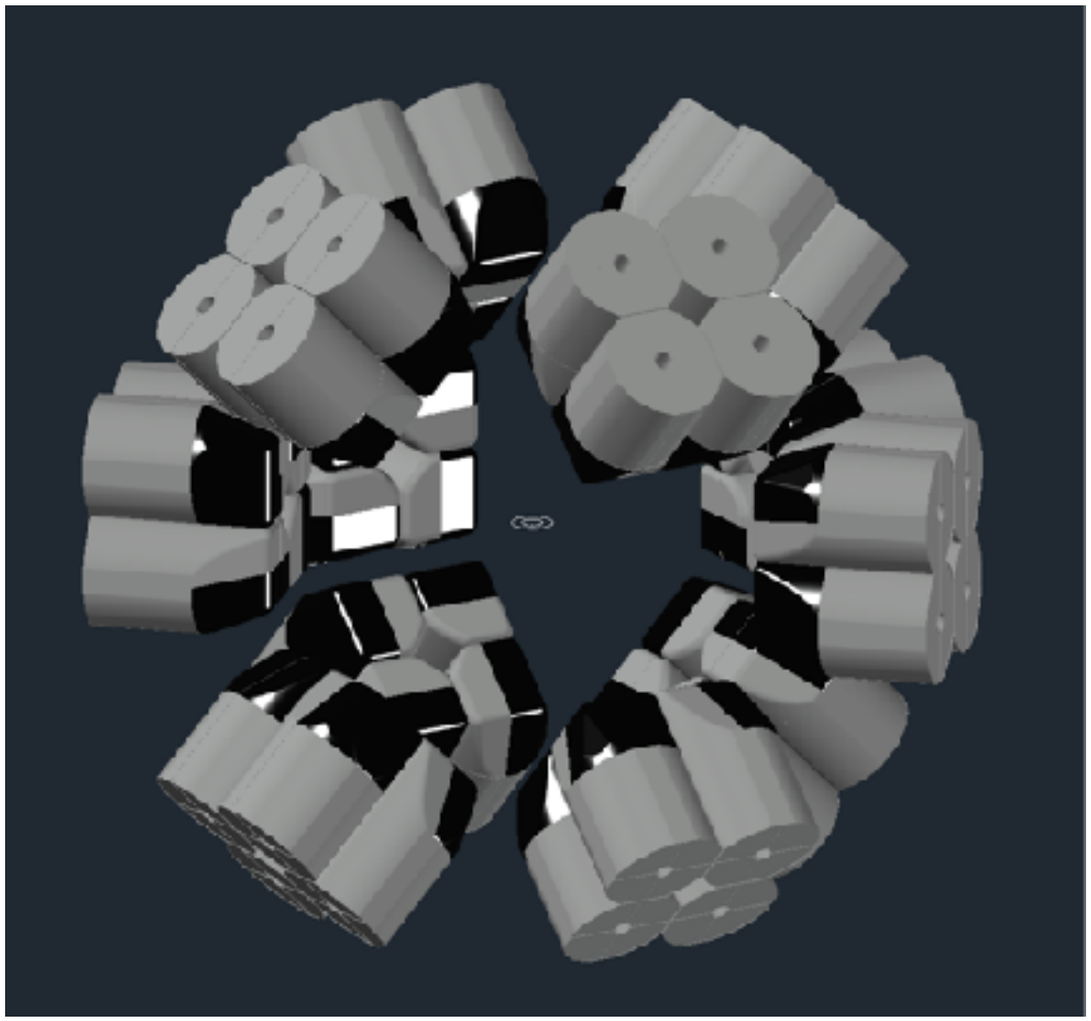


12 SC Configuration

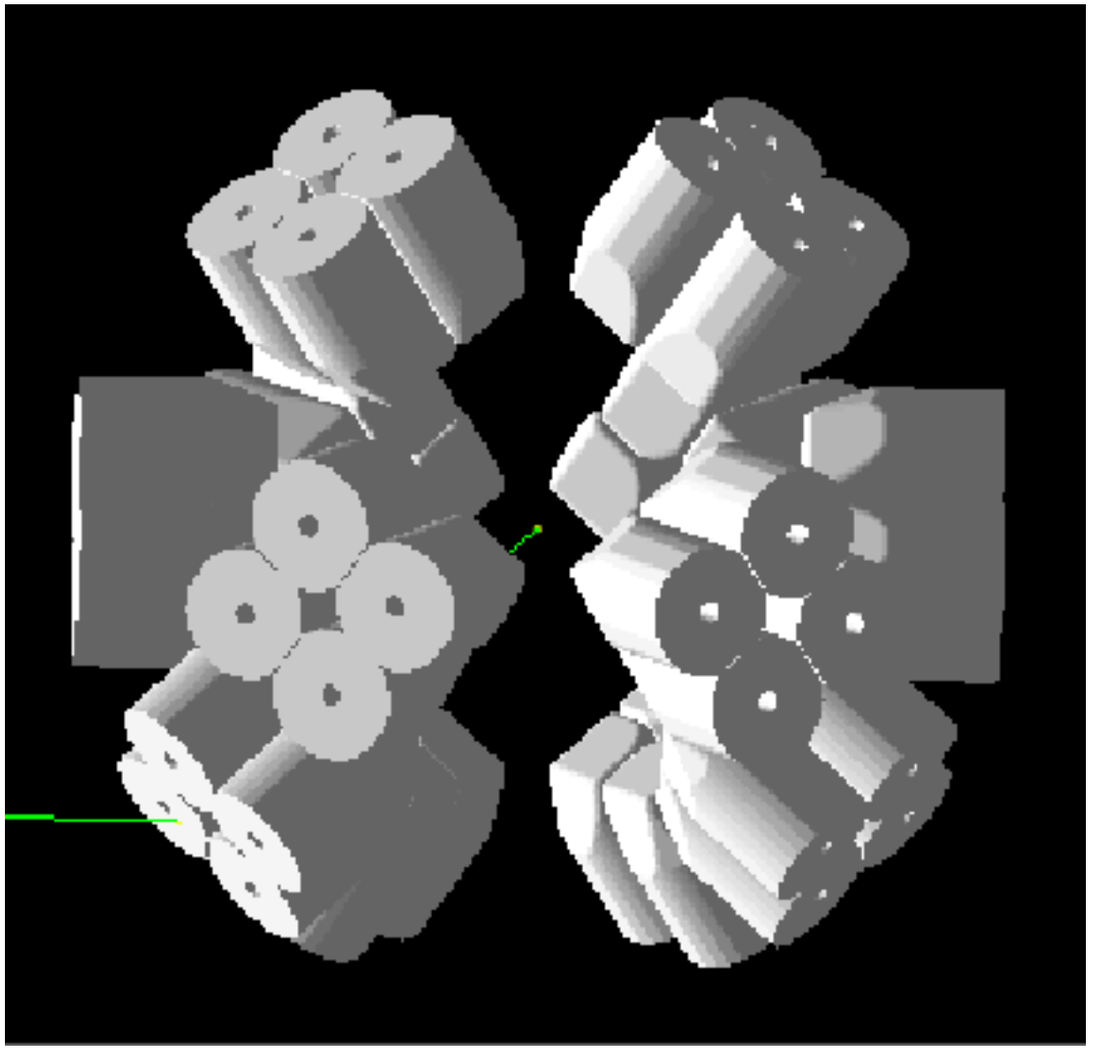


6 SC Configuration

Simulation - 12 SC Configuration

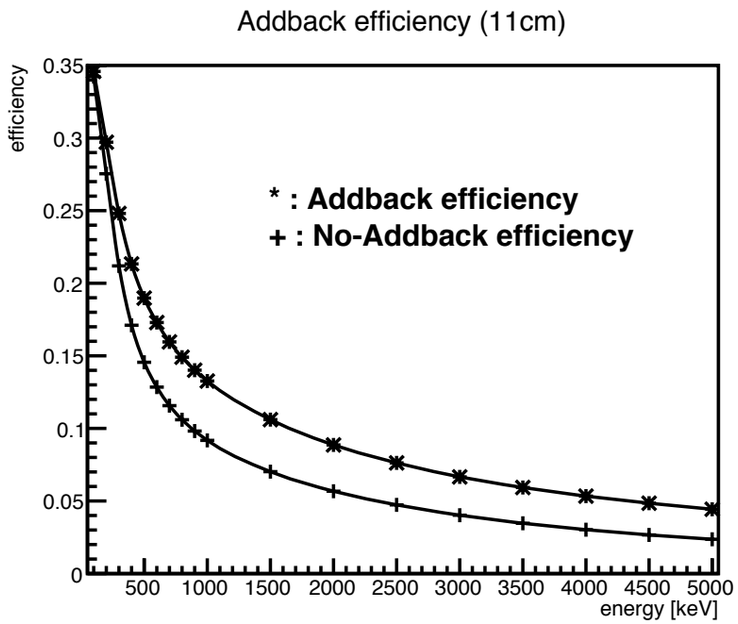


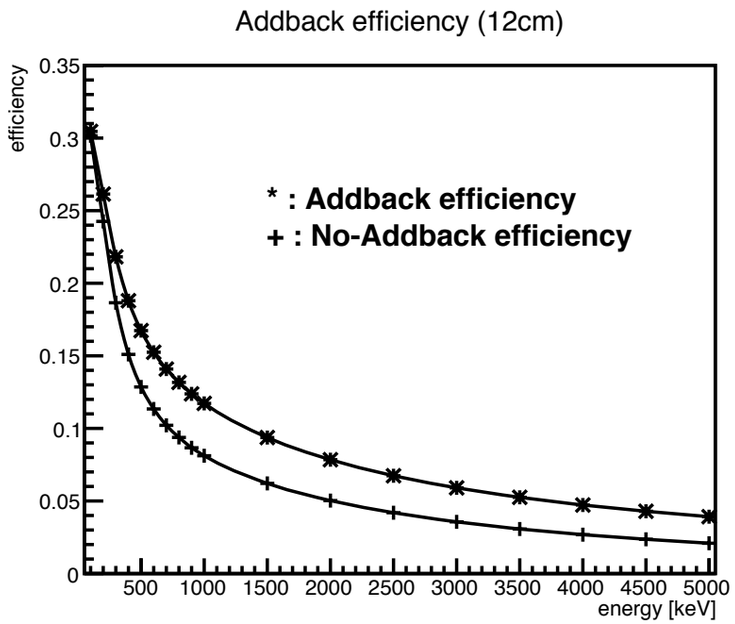
Ge crystal only - AutoCad

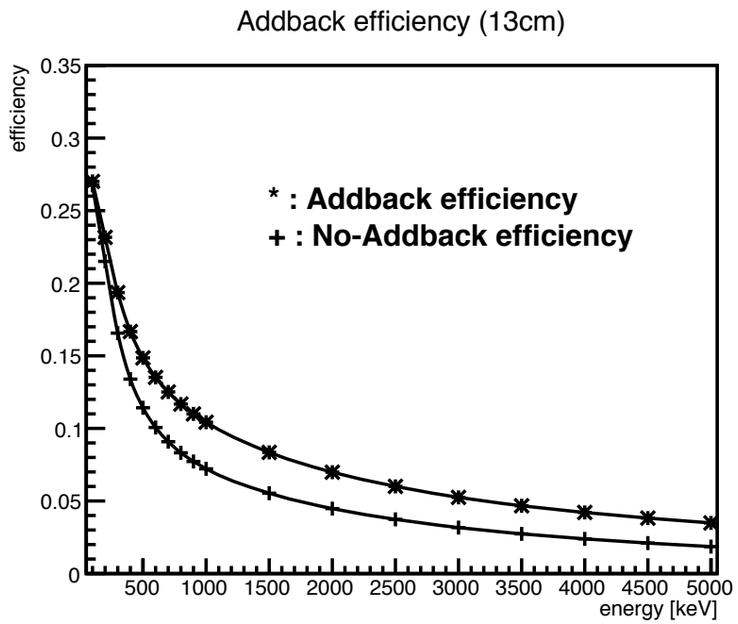


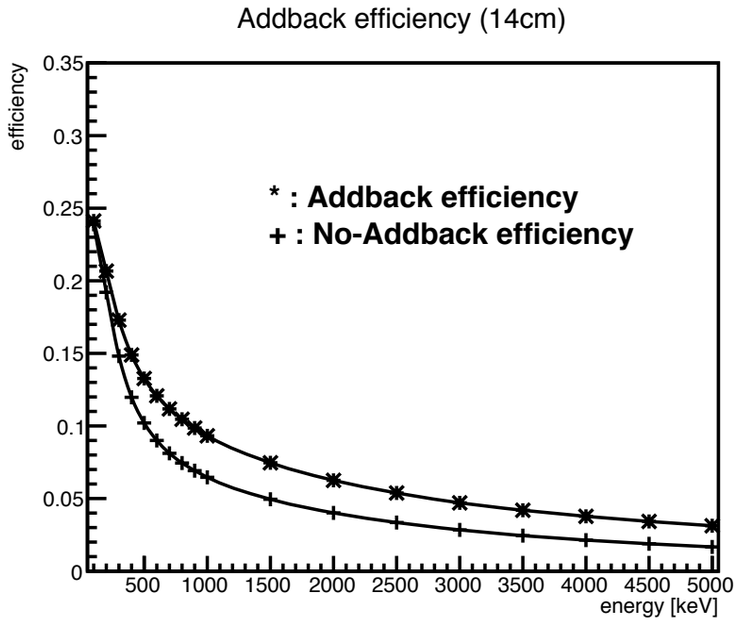
Ge crystal only - Geant4

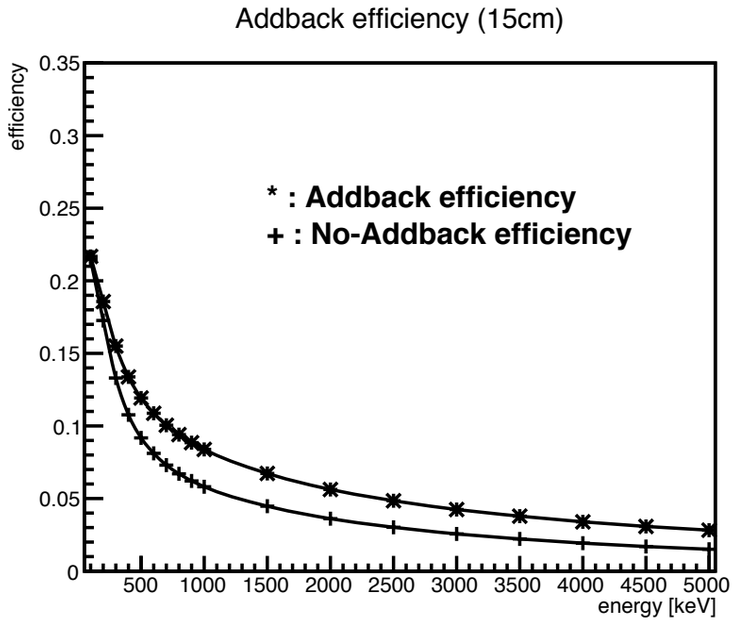
Efficiency - 12 SC Array



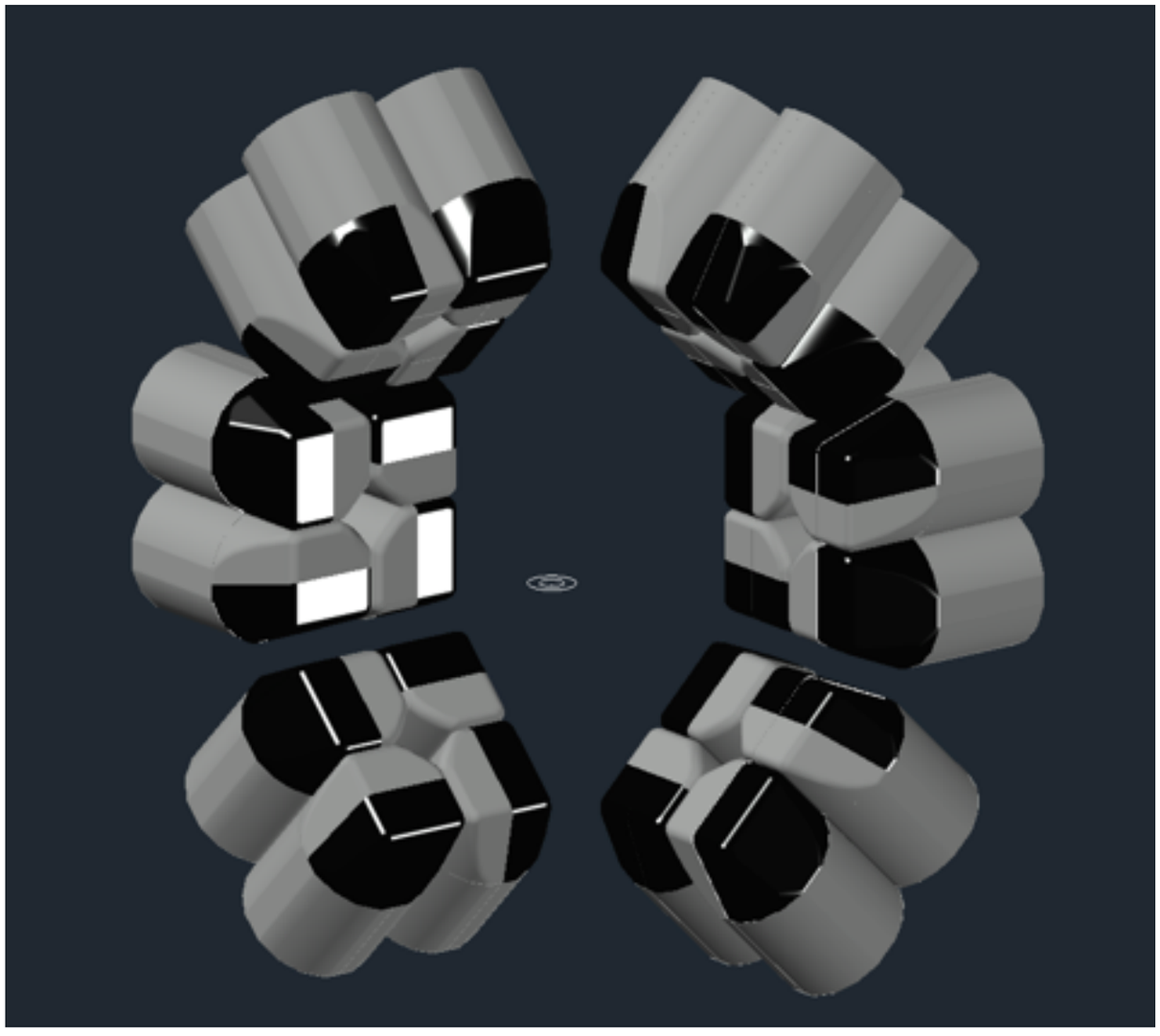




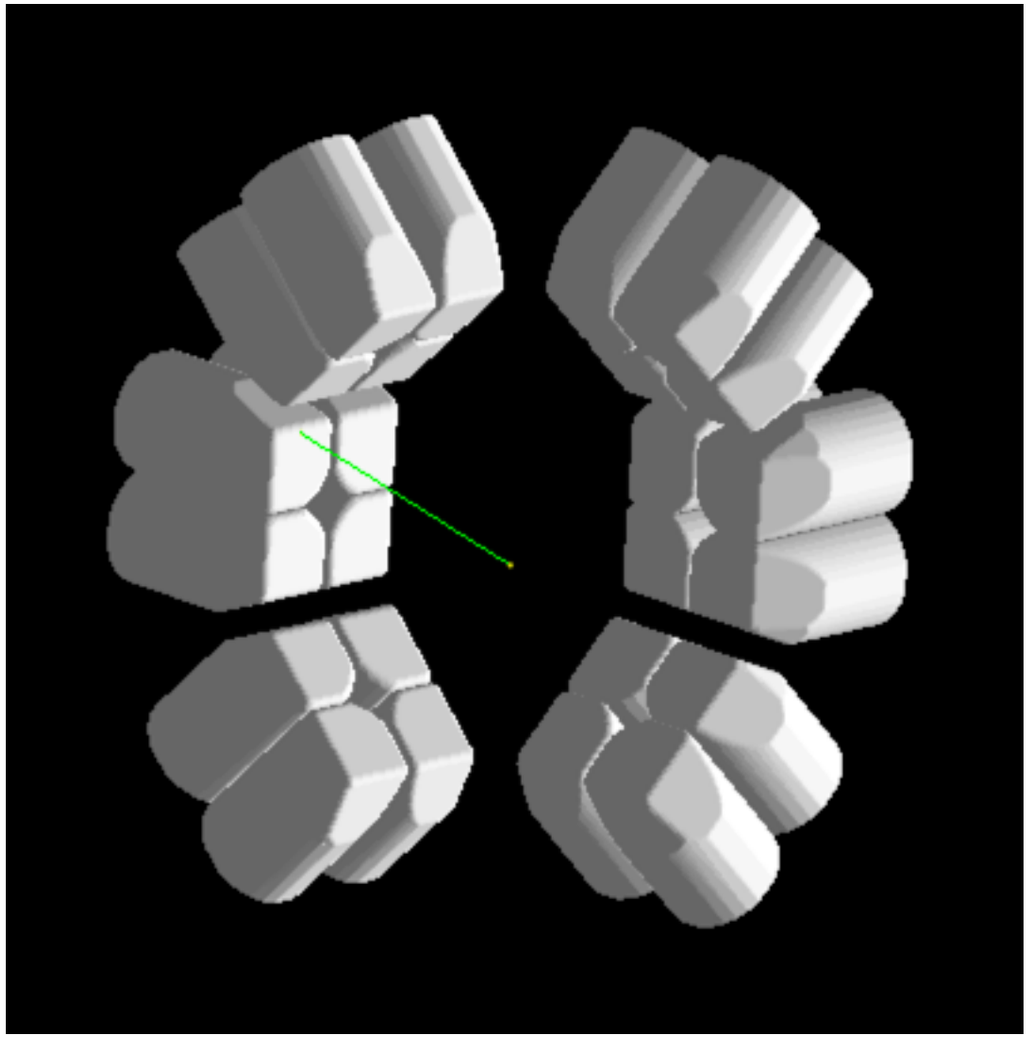




Simulation - 6 SC Configuration

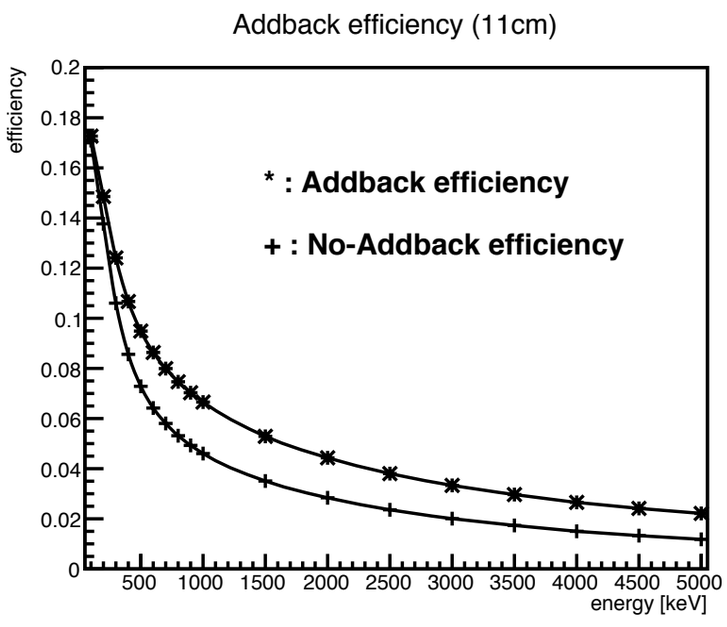


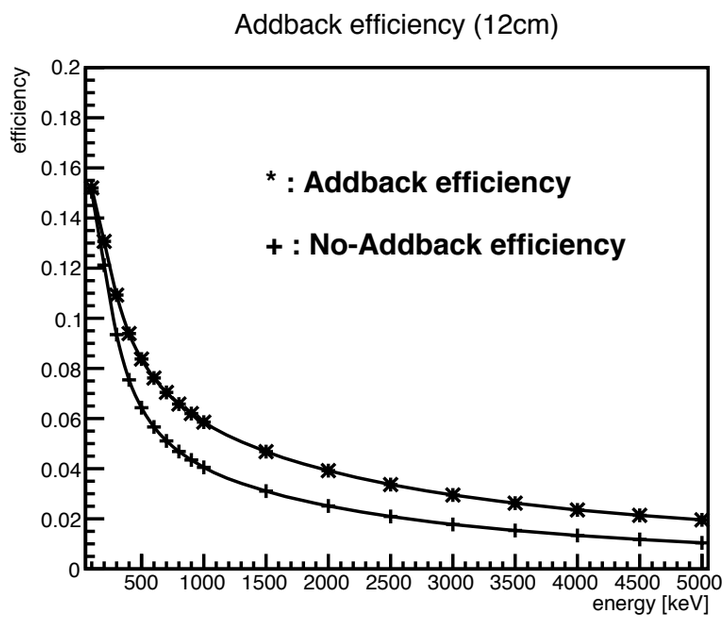
Ge crystal only - AutoCad

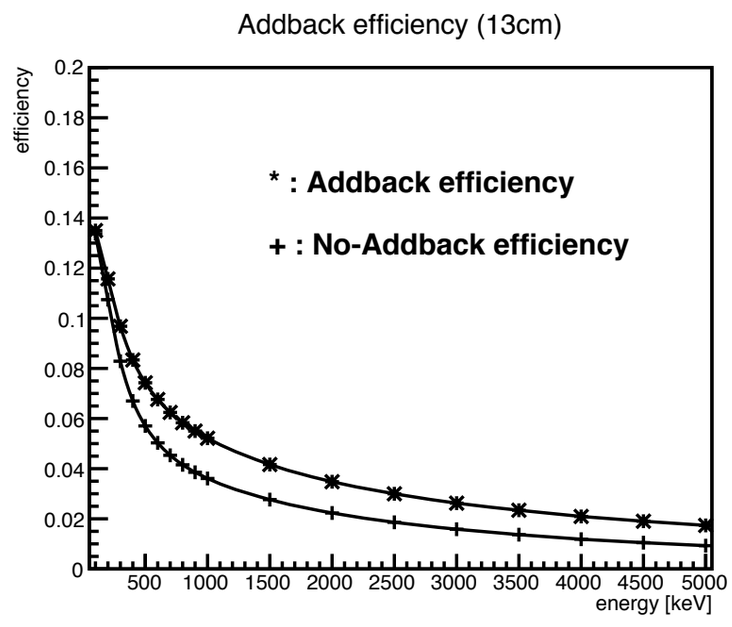


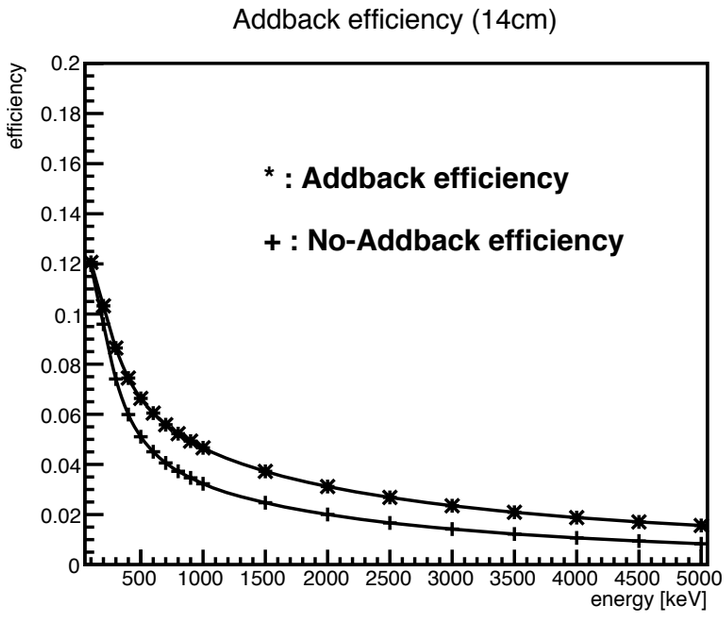
Ge crystal only - Geant4

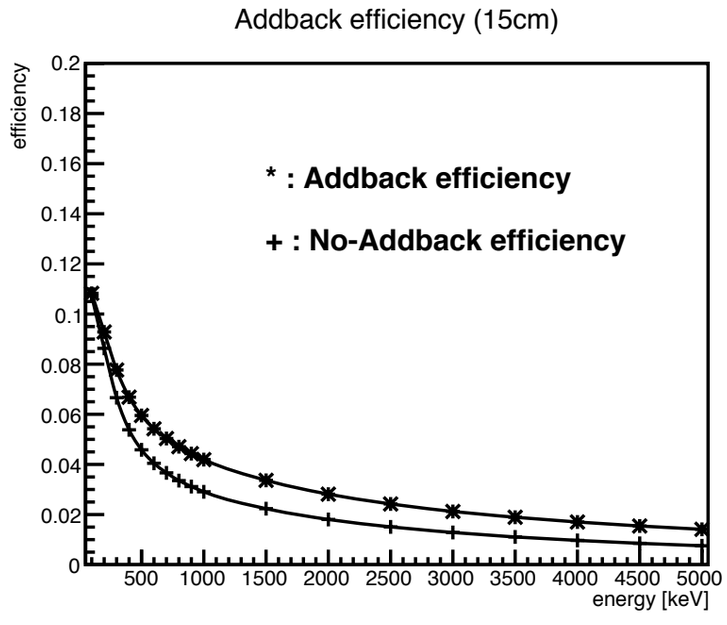
Efficiency - 6 SC Array



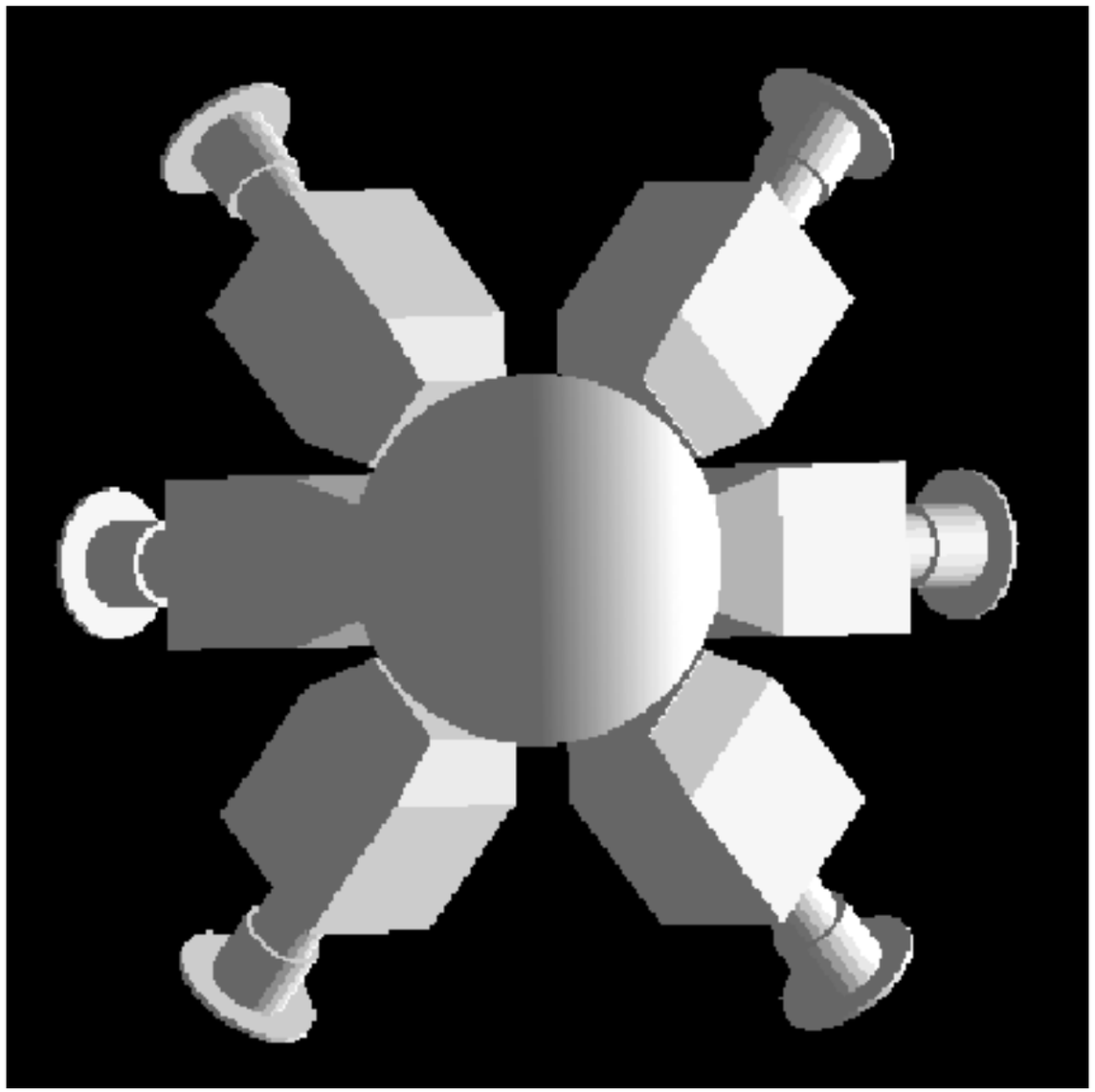






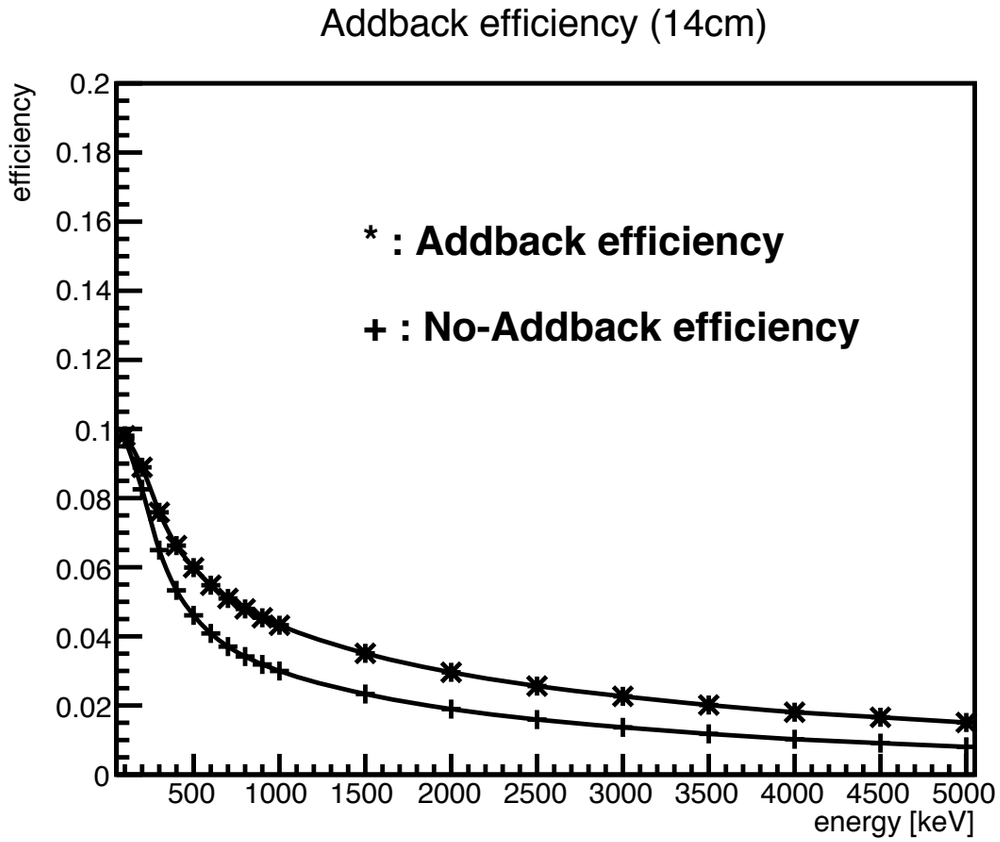


Simulation
6SC + Spherical Chamber

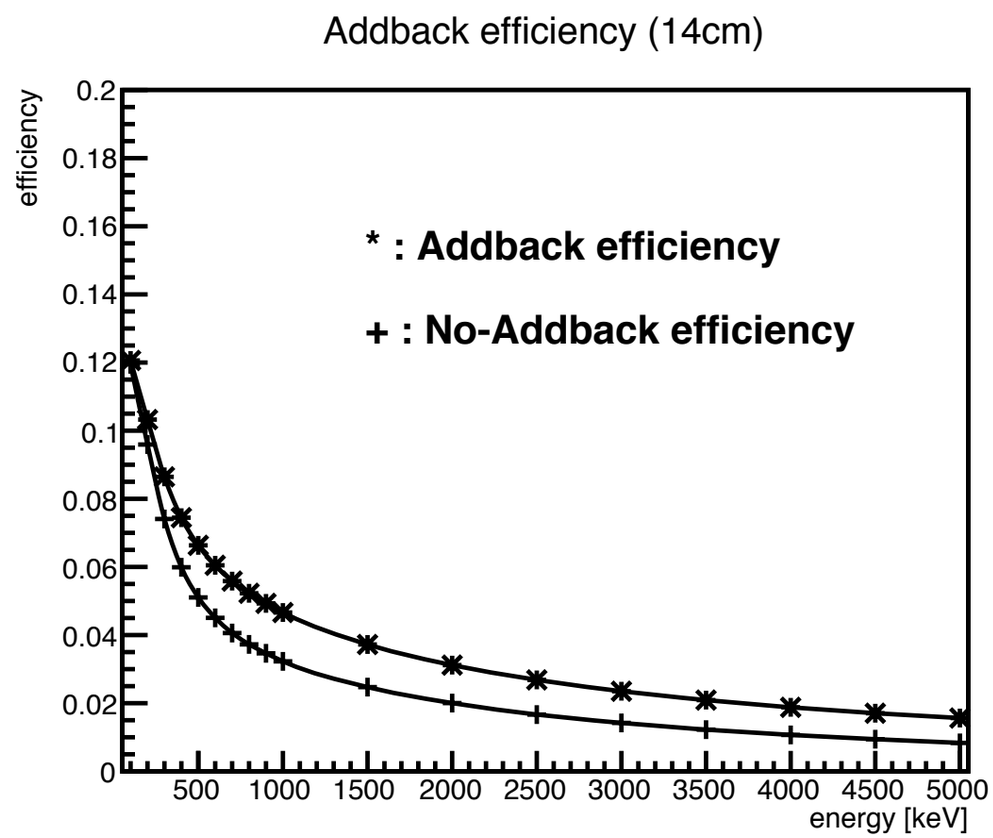


Ge crystal + Endcap + Spherical chamber(Al) - Geant4

Efficiency - 6 SC with chamber

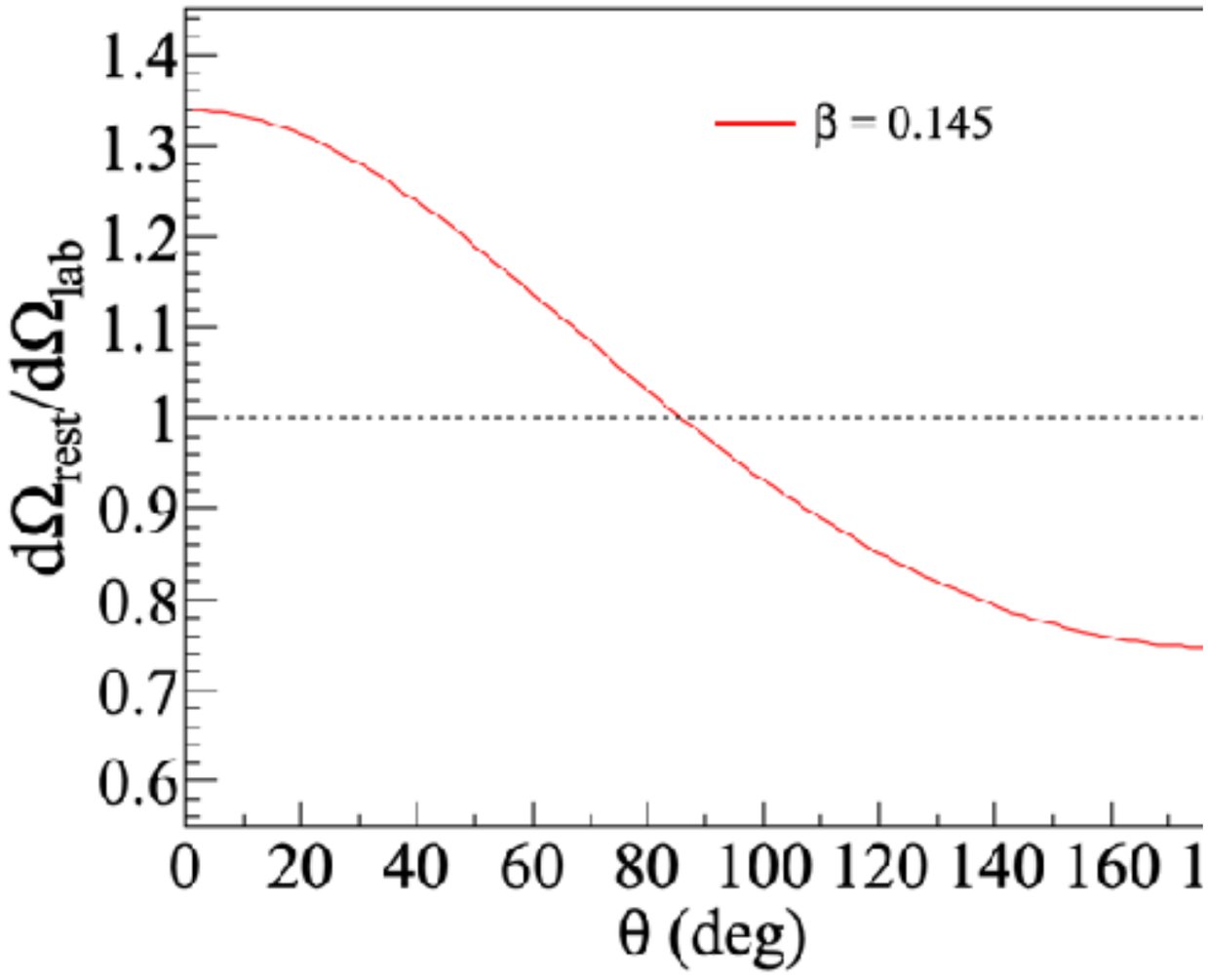


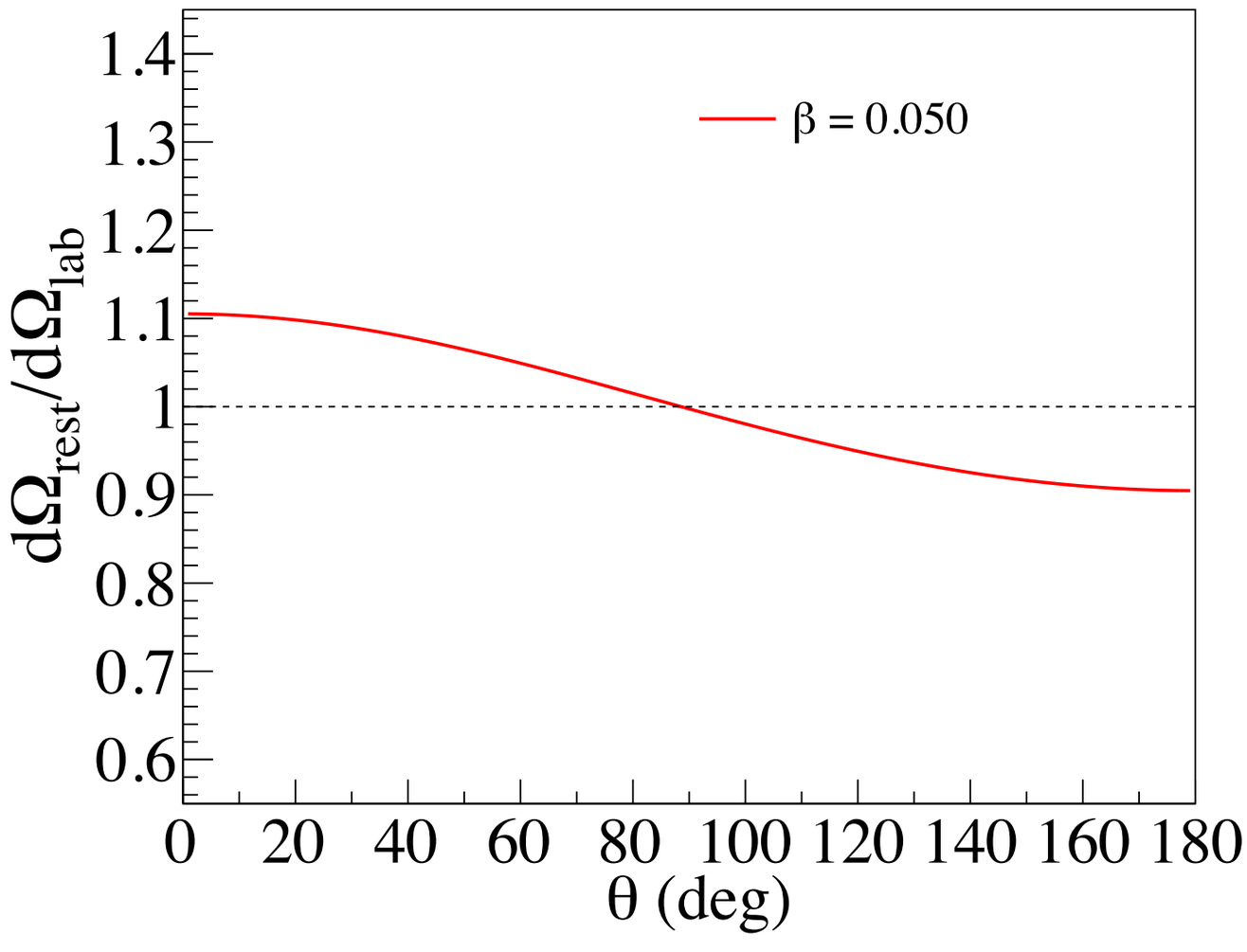
With chamber and endcap



Without chamber

Lorentz Boost

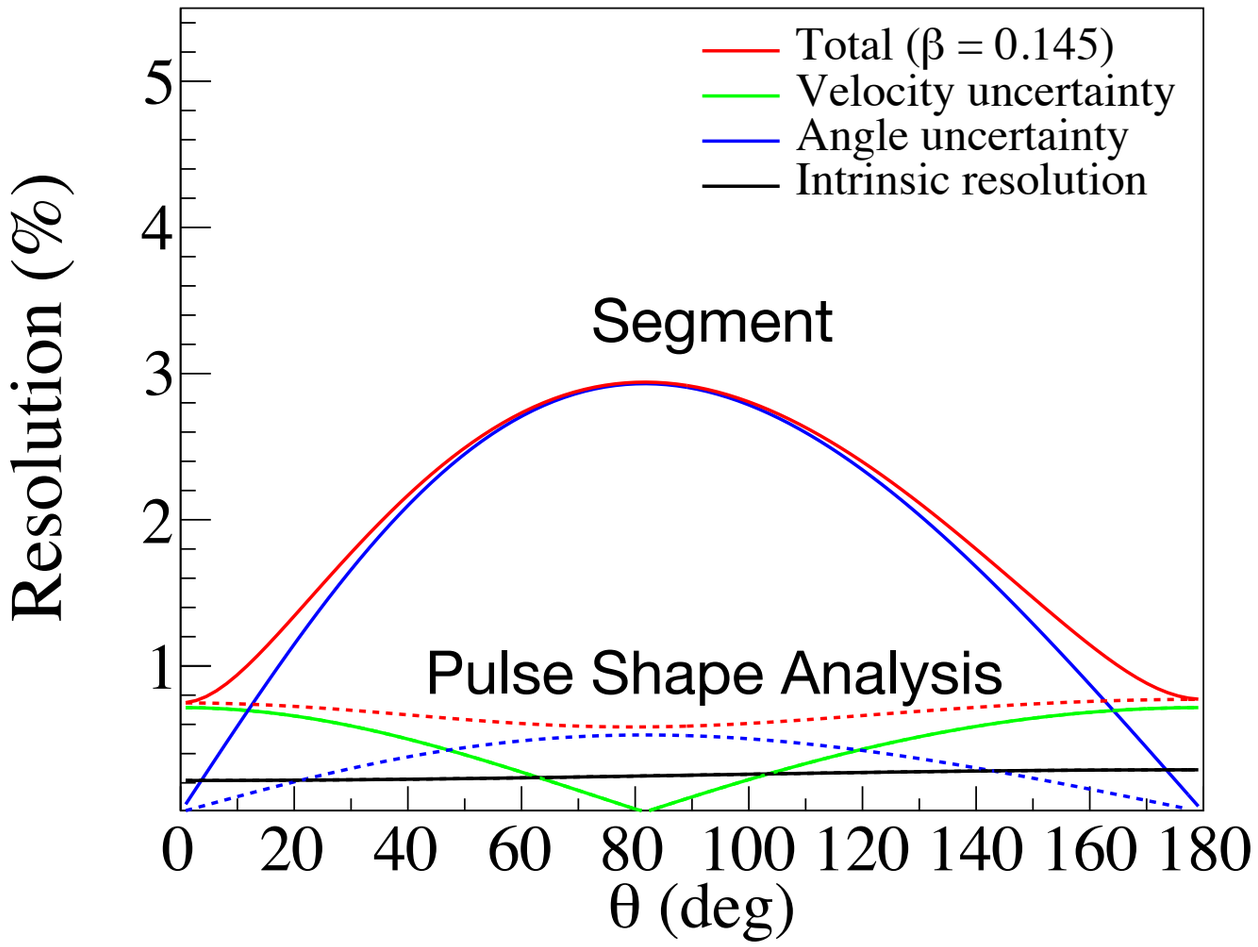


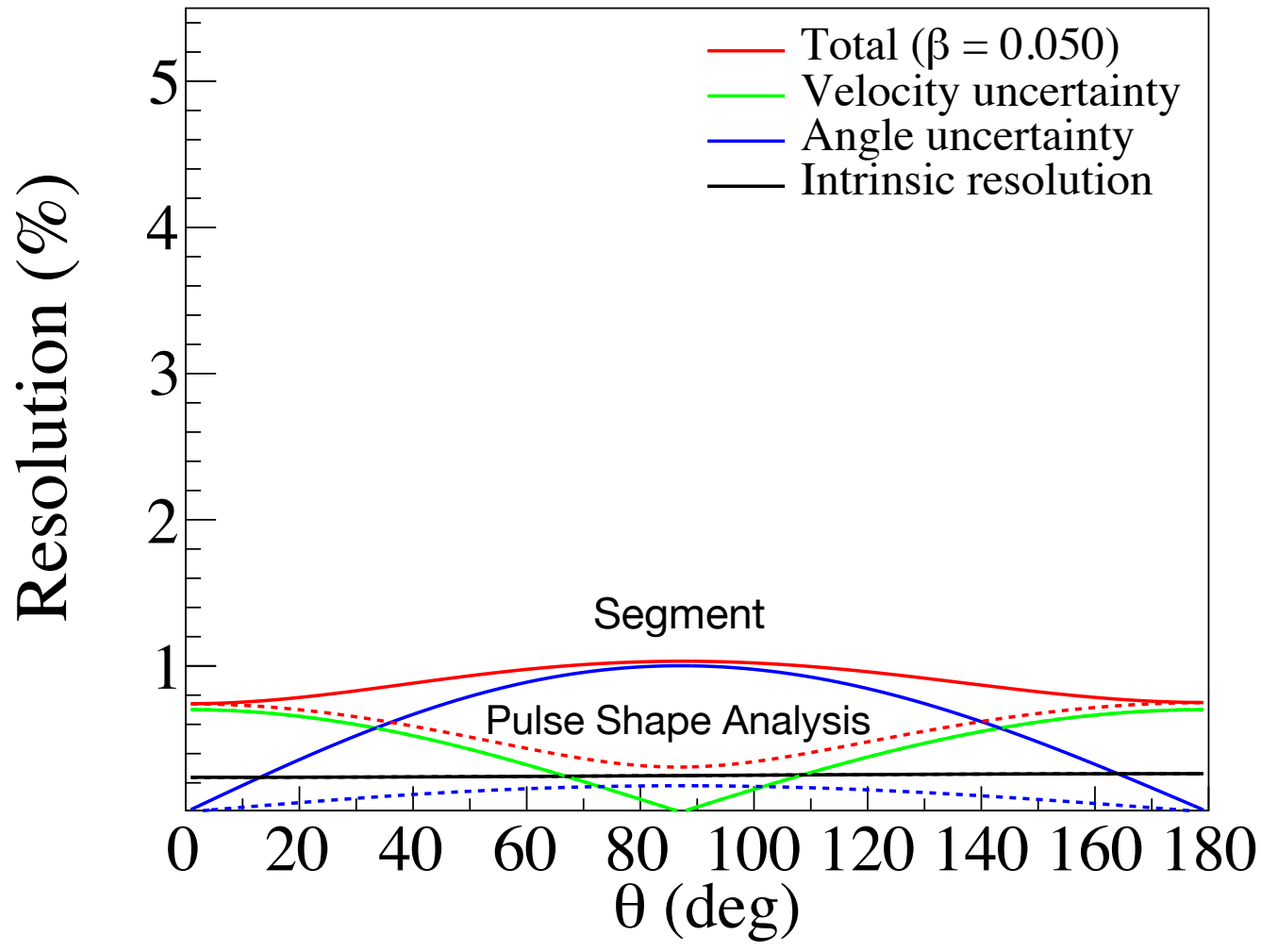


Doppler Broadening

1MeV - γ ray energy

Target to detector : 14cm

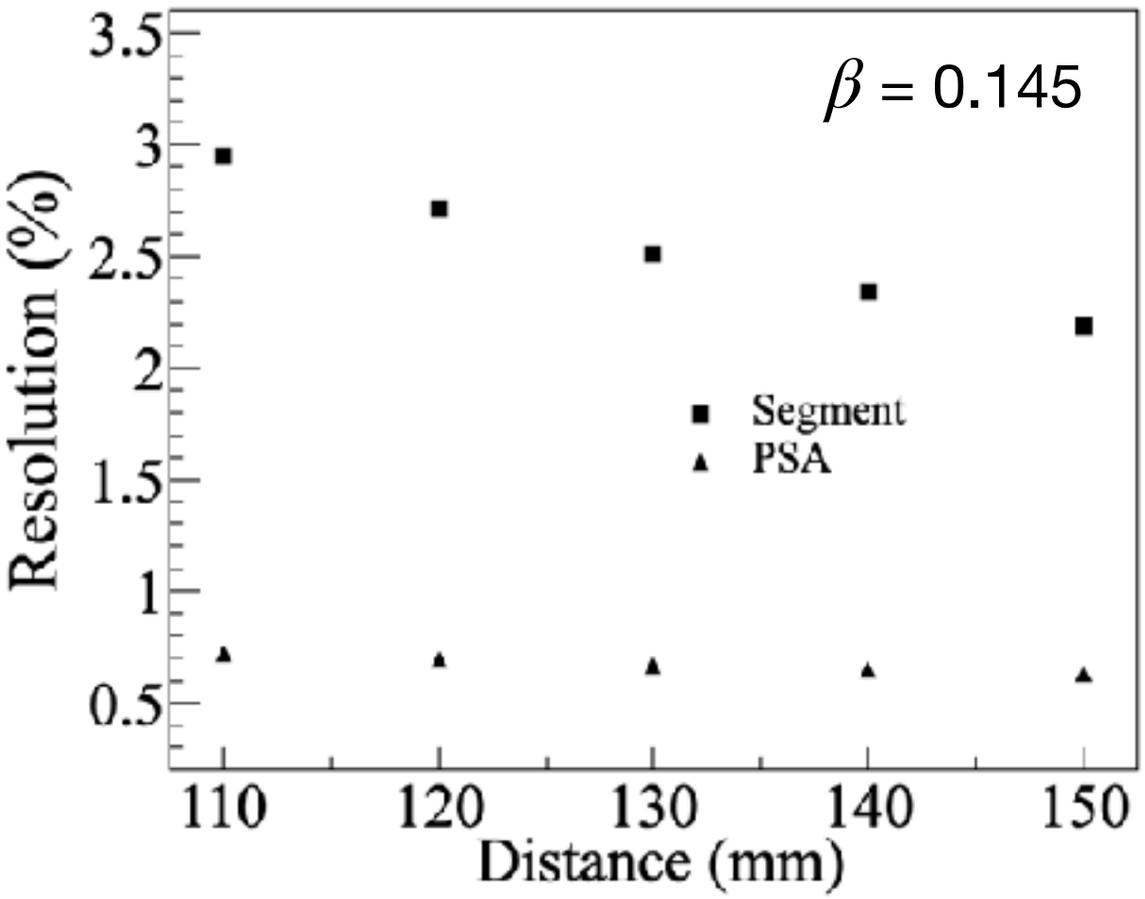


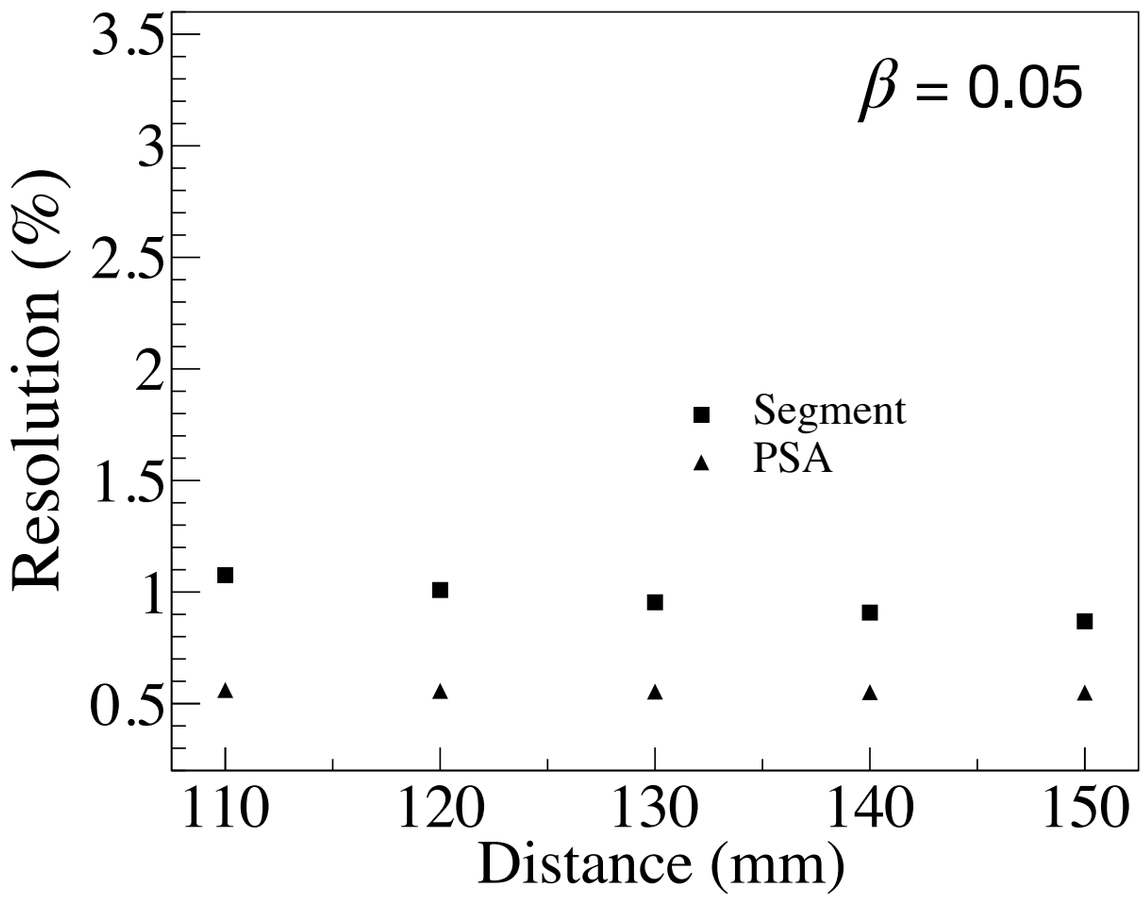


$$\frac{E_\gamma}{E_{\gamma 0}} = \frac{\sqrt{1-\beta^2}}{1-\beta\cos\vartheta_\gamma}$$

$$\left(\frac{\Delta E_{\gamma 0}}{E_{\gamma 0}}\right)^2 = \left(\frac{\beta\sin\vartheta_\gamma}{1-\beta\cos\vartheta_\gamma}\right)^2 \times (\Delta\vartheta_\gamma)^2 + \left(\frac{\beta-\cos\vartheta_\gamma}{(1-\beta^2)(1-\beta\cos\vartheta_\gamma)}\right)^2 \times (\Delta\beta)^2 + \left(\frac{\Delta E_{\mathrm{intr}}}{E_\gamma}\right)^2$$

Energy Resolution According to Distance





Future Plan

- Simulation for In-beam gamma-ray experiment
- Study on Pulse Shape Analysis

Thank you