Calibration of the MEGA Prototype

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MEGA (Medium Energy Gamma-ray Astronomy) is a concept for a combined Compton scattering and pair creation telescope. It features a tracker for measuring the primary interaction and a calorimeter for detecting secondaries. The surrounding anticoincidence inhibits readout of charged particles passing the instrument.

The prototype consists of
• 11 layers of silicon strip detectors forming the tracker
• 20 calorimeter blocks each enclosing 120 CsI(Tl) crystals
• Anticoincidence shield (not shown here)
• Data acquisition

Double-sided Si strip detectors

3×3 wafers, each 6×6 cm² area, 500 µm thick, strip pitch 470 µm

Best energy resolution achieved in lab measurements for ⁵⁷Co (122 keV): 15-20 keV (FWHM) at 21°C

Shadow of a lead mask (6 mm thick) illuminated with ⁵⁷Co

Position resolution: 290 µm determined with muon tracks, sample of muon tracks shown above

Calorimeter modules

10×12 array of 5×5 mm² area, 2 cm, 4 cm or 8 cm long CsI(Tl) bars, readout by a monolithic Si PIN-diode array.

Energy resolution (FWHM) of 2 cm and 4 cm versions at average 90 keV, best 67 keV at 662 keV Calibration sources are ¹³⁷Cs (662 keV) and ²²Na (511 keV, 1.275 MeV). To determine all three line positions even in data with low statistics, a fit function including four components for each line was used:
• Photo peak
• Compton edge
• Compton scattered photons, absorbed in the crystal
• Compton scattered photons, scattered out of the crystal

Right: Two ²²Na spectra in different detectors of the same measurement. The large variation in gain and statistics is obvious. A full fit of the spectrum helps to find the correct photo peak positions.

The High Intensity Gamma-ray Source (HIGS)

γ-rays are produced at HIGS in an inverse-Compton process. Therefore a free electron laser is driven by an electron storage ring. The laser photons have tunable energies between IR and UV and are fully polarized. The storage ring also provides the electrons for the head on collision with the laser photons. In this collision the laser photons are backscattered to γ-ray energies while preserving their polarization.

Measurments at HIGS

Left: Preliminary spectrum of a 2 MeV beam. It contains only events reconstructed in a 2° radius around the beam direction. Since only the single sided calorimeter blocks are recalibrated yet for the HIGS setup, this spectrum is very preliminary.

Deconvolved beam images at 50MeV for incidence angles of 0°, 30°, 60° and 80° demonstrate a wide field of view up to at least 80° (only pair events used):

Energy range: 0.7 - 50 MeV, ΔE/E = 1 - 2%
100% polarization, beam diameter 1.25 - 2.5 mm

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