

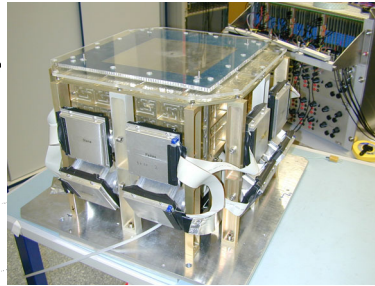
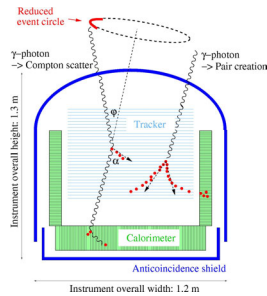
# Calibration of the MEGA Prototype

R. Andritschke<sup>1</sup>, A. Zoglauer<sup>1</sup>, G. Kanbach<sup>1</sup>, V. Schönfelder<sup>1</sup>,

F. Schopper<sup>2</sup>, P. F. Bloser<sup>3</sup>, S. Hunter<sup>3</sup>, J. Macri<sup>4</sup>, R. Miller<sup>5</sup>, V. N. Litvinenko<sup>6</sup>, I. V. Pinayev<sup>6</sup>

<sup>1</sup>MPE, Garching, Germany <sup>2</sup>MPI HLL, Munich, Germany <sup>3</sup>GSFC, Greenbelt, MD, USA  
<sup>4</sup>UNH, Durham, NH, USA <sup>5</sup>UAH, Huntsville, AL, USA <sup>6</sup>FELL, Durham, NC, USA

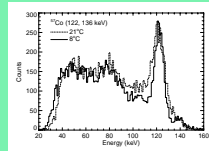
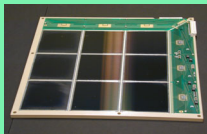
MEGA (Medium Energy Gamma-ray Astronomy) is a concept for a combined Compton scattering and pair creation telescope. It features a tracker for measuring the primary interaction and a calorimeter for detecting secondaries. The surrounding anticoincidence inhibits readout of charged particles passing the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



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

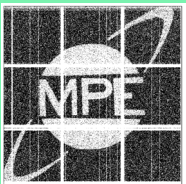
## Double-sided Si strip detectors

3×3 wafers, each 6×6 cm<sup>2</sup> area, 500 μm thick, strip pitch 470 μm

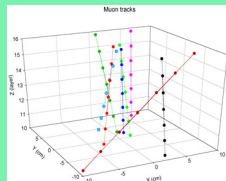


Best energy resolution achieved in lab measurements for <sup>57</sup>Co (122 keV): 15-20 keV(FWHM)@21°C

Shadow of a lead mask (6 mm thick) illuminated with <sup>57</sup>Co



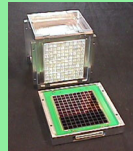
Position resolution: 290 μm determined with muon tracks, sample of muon tracks shown above



## Calorimeter modules

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

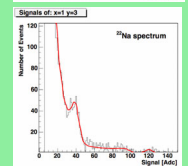
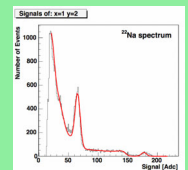
8 cm long version has readout on both crystal ends which allows to determine the position of interaction along the crystal at a FWHM resolution (prelim.) of 3 cm (average), 1.5 cm (best).



Energy resolution (FWHM) of 2 cm and 4 cm versions at average 90 keV, best 67 keV@662 keV  
 Calibration sources are <sup>137</sup>Cs (662 keV) and <sup>22</sup>Na (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:

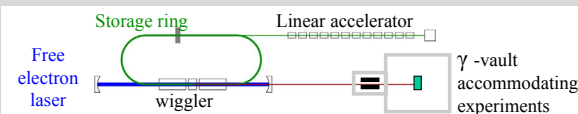
- Photo peak
- Compton edge
- Compton scattered photons, absorbed in the crystal
- Compton scattered photons, scattered out of the crystal

Right: Two <sup>22</sup>Na 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)

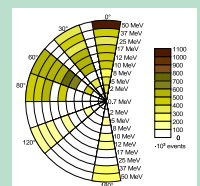
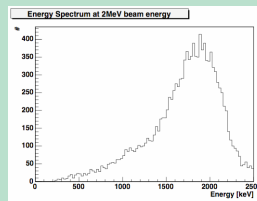
γ-rays are produced at HIGS in an inverse-Compton process. Therefore a free electron laser is driven by an electron storage ring. The laser photons have tunable energies between IR and UV and are fully polarized. The storage ring also provides the electrons for the head on collision with the laser photons.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



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

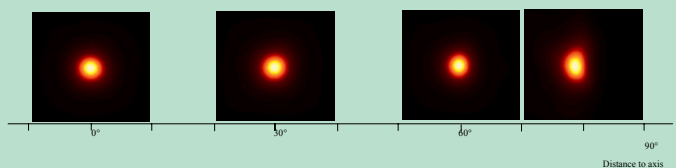
## Measurements at HIGS

Right: Measurements for several energies and incidence angles were performed. A total of 15.5 Mio. events have been recorded.



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):



References:

- G. Kanbach et al., *The MEGA project*, NewAR 48 (2004) 275-280
- P. F. Bloser et al., *Development of silicon strip detectors for a medium energy gamma-ray telescope*, NIM A 512 (2003) 220-228
- F. Schopper et al., *CsI calorimeter with 3-D position resolution*, NIM A 442, 394-399 (2000)
- R. Andritschke et al., *The calibration setup of the MEGA prototype at the high intensity γ-ray source*, NewAR 48 (2004) 281-285
- A. Zoglauer et al., *Data analysis for the MEGA prototype*, NewAR 48 (2004) 231-235
- V. N. Litvinenko et al., *High power inverse Compton γ-ray source at Duke storage ring*, SPIE 2521, 55-77