COMCUBE Instrument Performance

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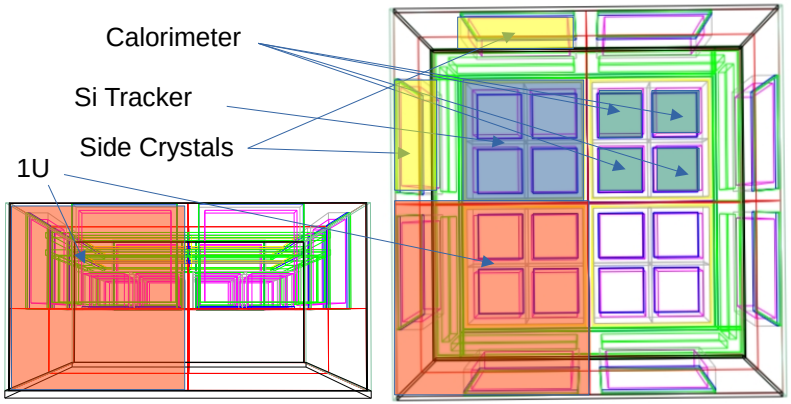
AHEAD 2020 Progress Meeting Coimbra

Overview

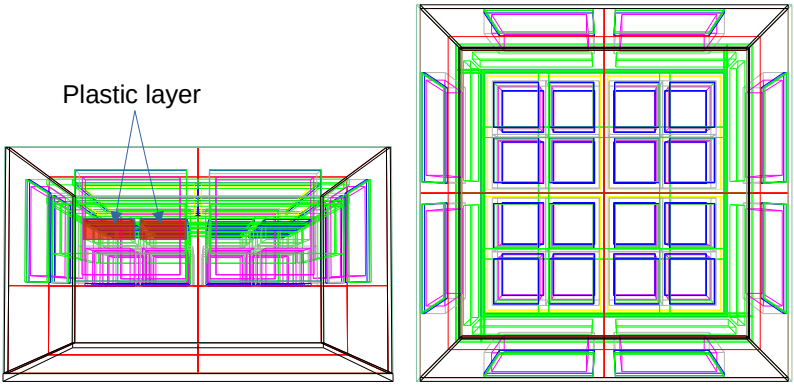
Geometries: 4U Baseline



Each detector unit consists of:

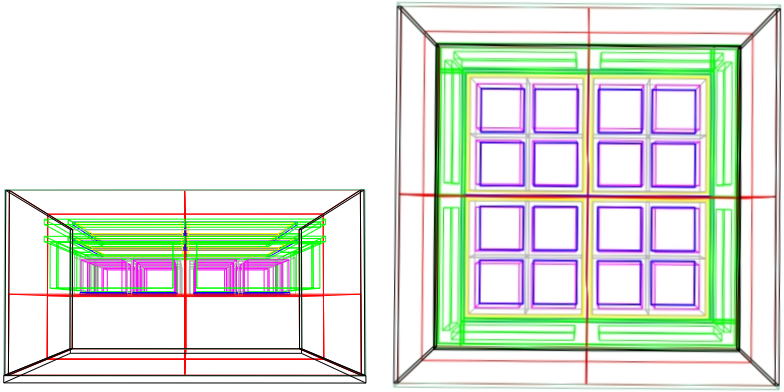
Detector	Size	Type
Tracker(Si)	$2 \cdot 68 \cdot 68 \cdot 15$ mm^3	32 by 32 2D Strips
Calo ($CeBr_3$)	$4 \cdot 25 \cdot 25 \cdot 20$ mm^3	Anger Camera
Side ($CeBr_3$)	$2 \cdot 51 \cdot 51 \cdot 10$ mm^3	Anger Camera

Geometries: 4U Baseline with Plastic layer



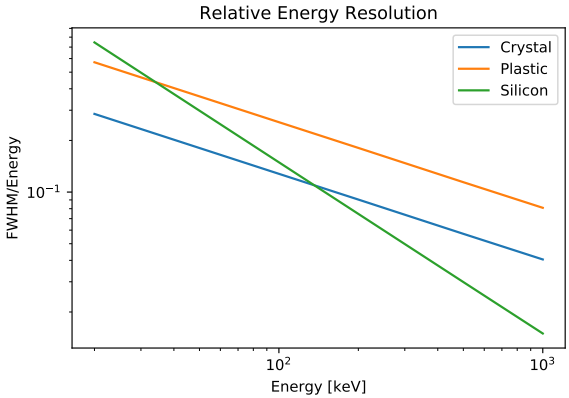
- Baseline model with added layer of p-Terphenyl plastic scintillator between Si-tracker and CeBr3 crystals($4 \cdot 25.6 \cdot 25.6 \cdot 10$ mm^3 for each unit)
- Idea of increasing effective area at low energies with less electronic overhead

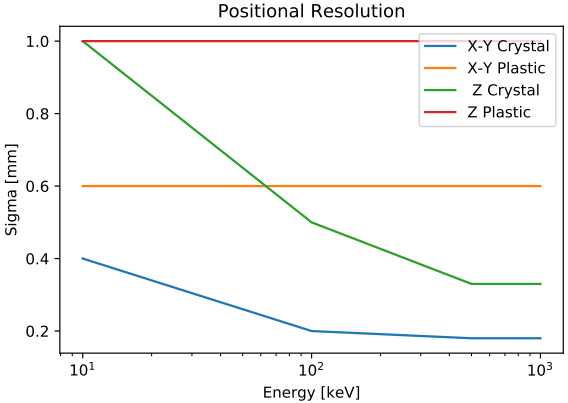
Geometries: 4U Baseline without Side detectors



- Removed side detectors to check necessity
- Sanity check

Simulation Input





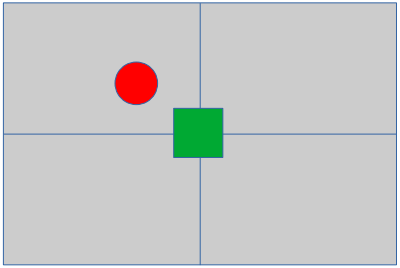
Trigger thresholds:

- Silicon: 30 keV
- Crystal and Plastic: 15 keV

Detector Simulation in MEGAlib v3.01

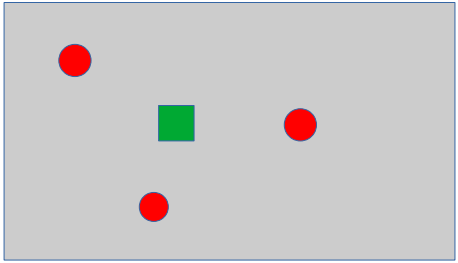
2D Strip

- reported (x,y) are the x and y coordinate of the closest strip crossing for each hit



Anger Camera

- reported (x,y,z) are the AVERAGE x,y and z coordinate of ALL hits in the volume



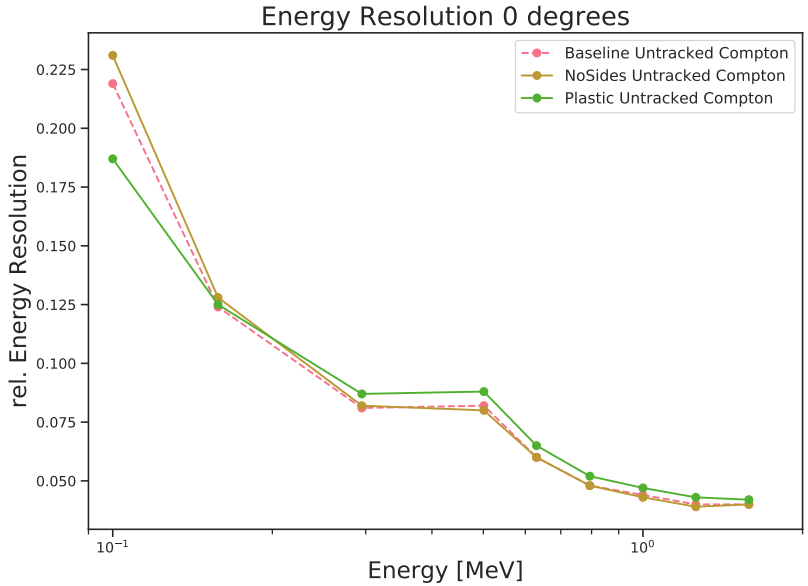
Simulation Procedure

- Used MEGAlib v3.01
- Mono energetic far field point source with random polarization
- Simulated 10^6 events
- Energies: 0.1 to 1.5 MeV
- Incident angles Θ: $0. - 90.$ degrees
- $\Phi = 0$ degrees

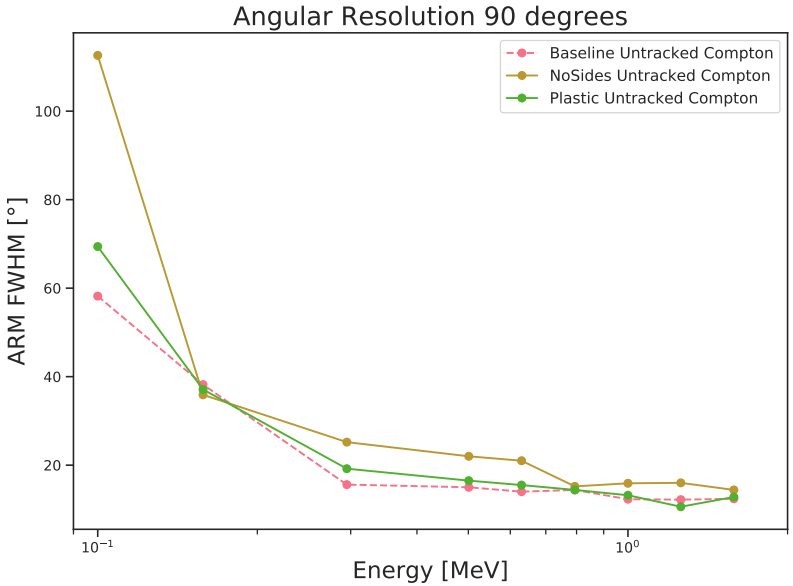
Analysis Procedure

- Select all Compton events
- Fit the photo peak with a Gaussian and use 1 FWHM to determine an energy cut
- Generate an ARM histogram with the surviving events and fit them with a double Lorentzian + asymmetric Gaussian. If the fit fails, determine the FWHM of the distribution by looking for the maximum and then move bins to the left and to the right until under 1/2 max. Use the determined FWHM as a directional cut.
- Calculate the effective area with the energy and directional cuts derived above

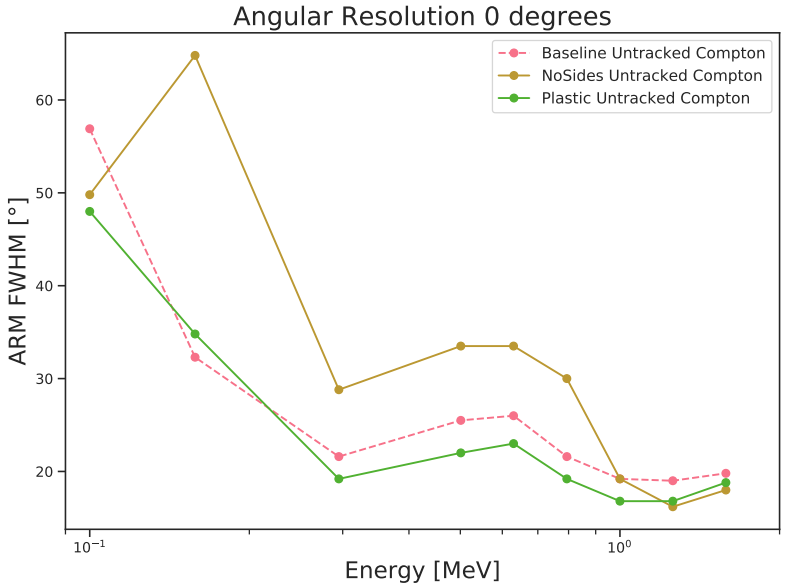
Energy Resolution 0 degrees



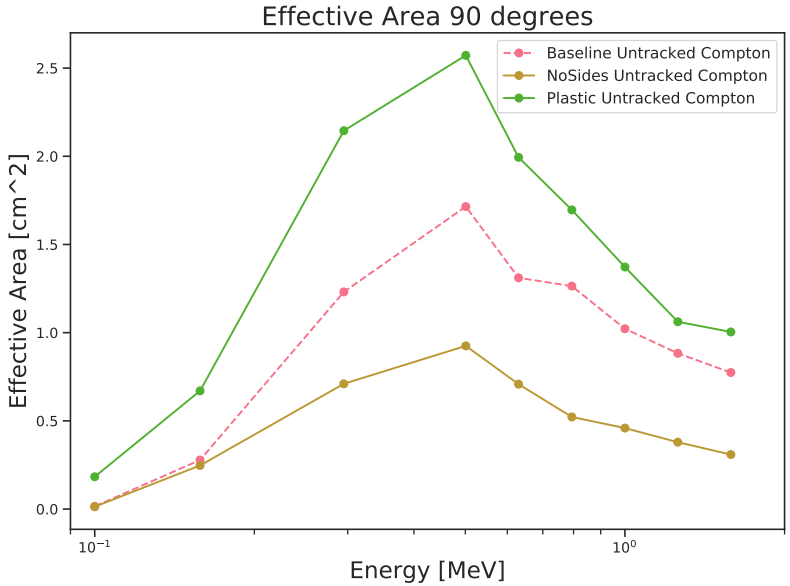
Angular Resolution 90 degrees



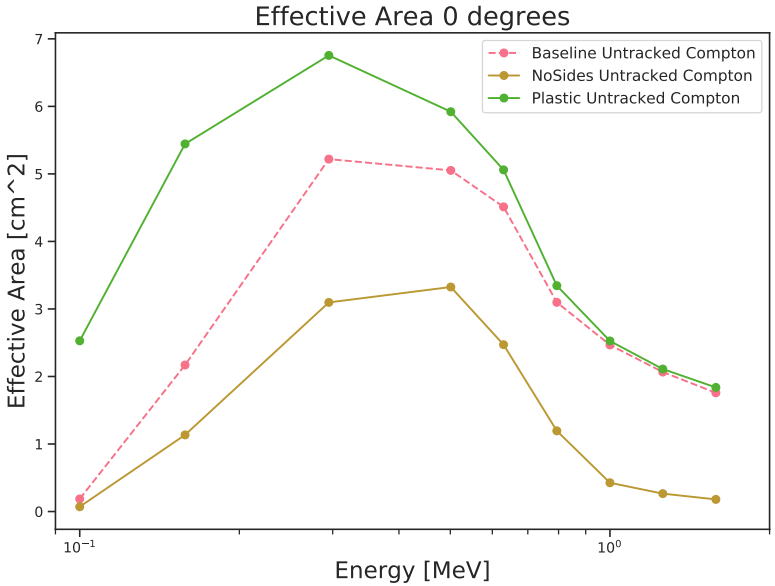
Angular Resolution 0 degrees



Effective Area 90 degrees



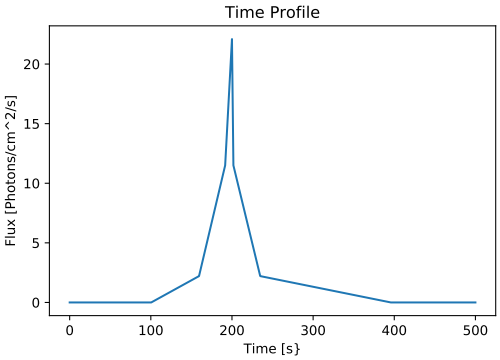
Effective Area 0 degrees



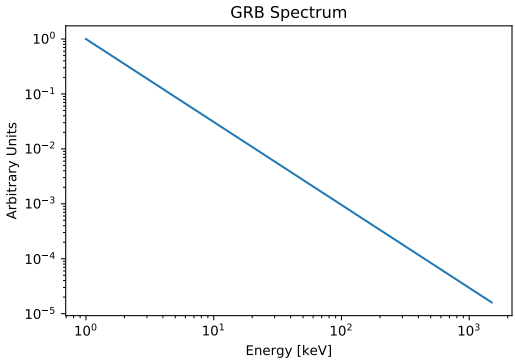
Basic GRB Simulations: Setup

- Generated background for an ISS orbit with geomagnetic cutoff at 5GV with the built-in background generator of MEGAlib
- Not included: Trapped radiation from SAA
- Simulated GRB14026A with spectrum, flux and light curve taken from the SWIFT catalogue at $\Theta = 45$ degrees
- Energy cut at 1 MeV, no directional cut
- Plot light curve for single site events only and Compton events only

Basic GRB Simulations: Input Spectrum

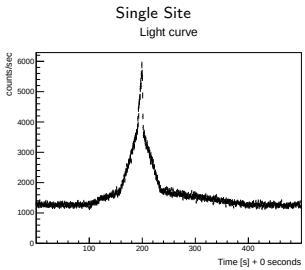


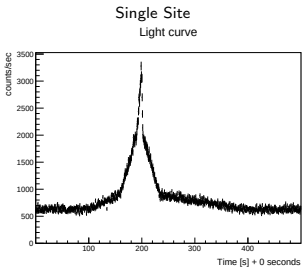
Interpolated light curve

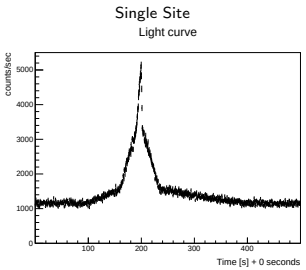


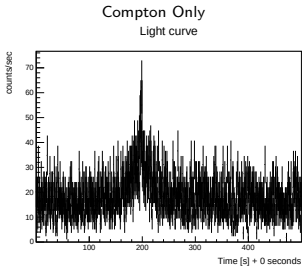
Power-law with $\gamma = -1.51$

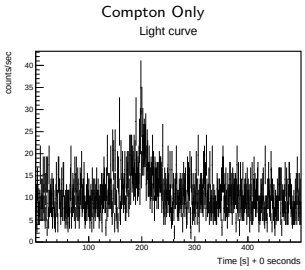
Basic GRB Simulations: Reconstructed Light Curves

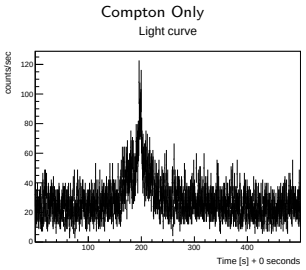












Baseline

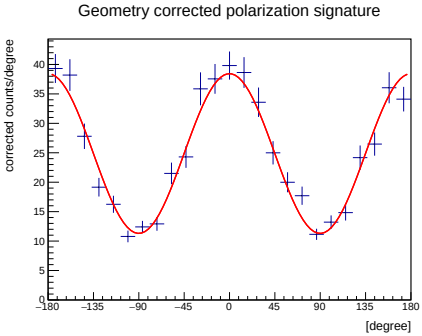
No Side Detectors

With Plastic

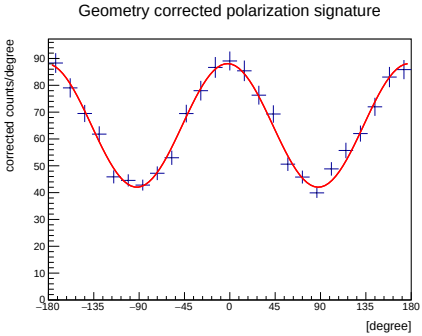
Response to linear polarization

- Used MEGAlib v3.01
- Simulated 10^6 (10^7 for 100 keV) events with 100 percent linear polarized mono energetic source
- Polarization vector perpendicular to the plane spanned by the direction vector of the photon and the x-axis of the detector
- Energies ranging from 100 to 1000 keV
- Incident angles Θ: $0. - 90.$ degrees
- $\Phi = 0$ degrees
- ARM-cut for polarization is the angular resolution at the given energy

Response to linear polarization: Sample output for baseline model

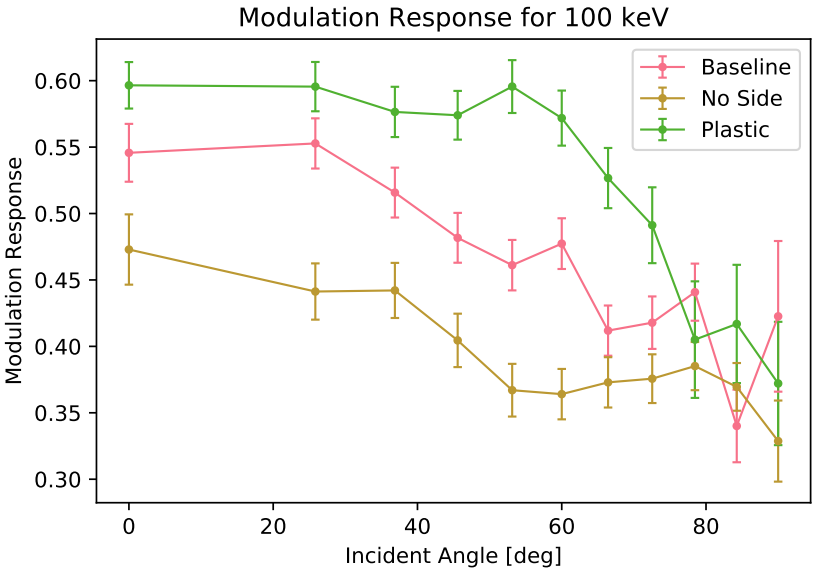


Polarization response at 100 keV for on-axis source: 0.55 ± 0.02

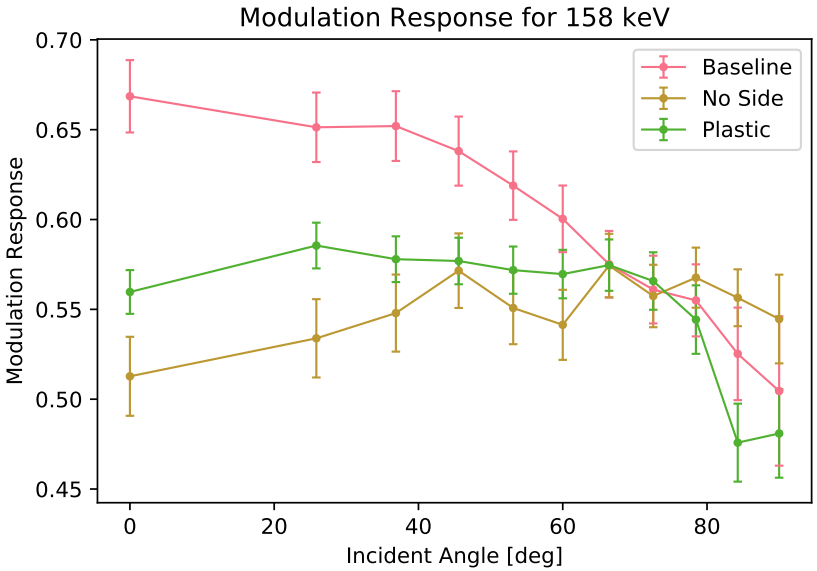


Polarization response at 1000 keV for on-axis source: 0.35 ± 0.01

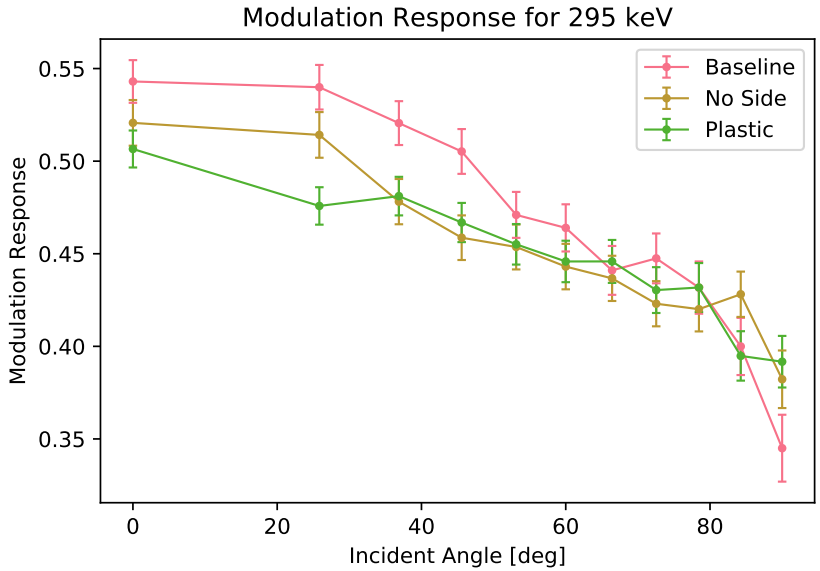
Polarization Response against incident angle: 100 keV



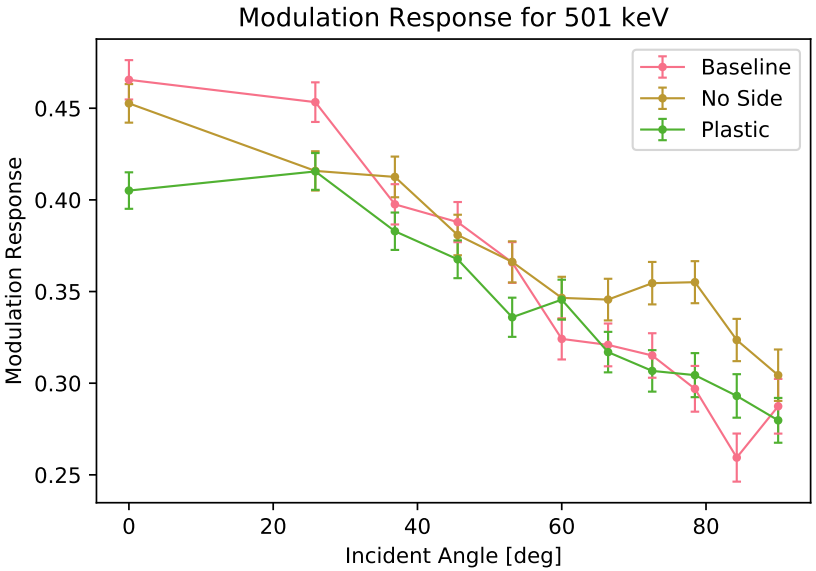
Polarization Response against incident angle: 158 keV



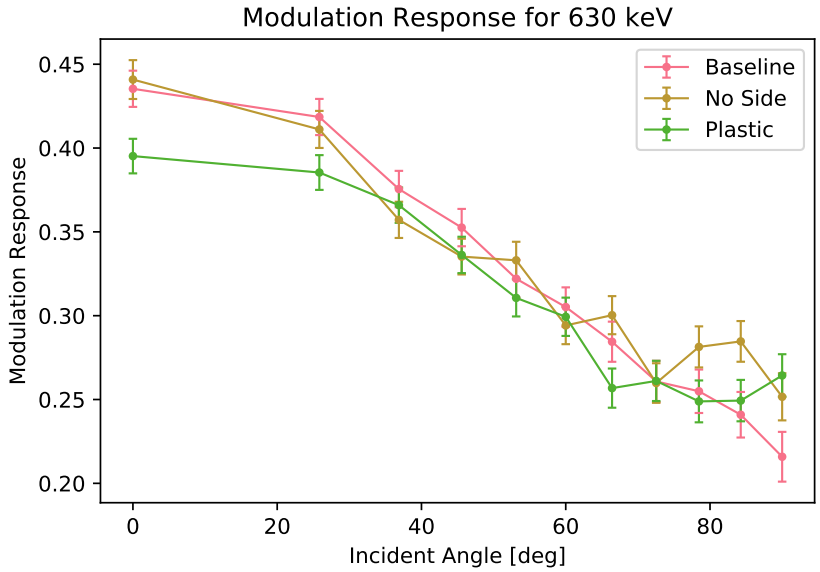
Polarization Response against incident angle: 295 keV



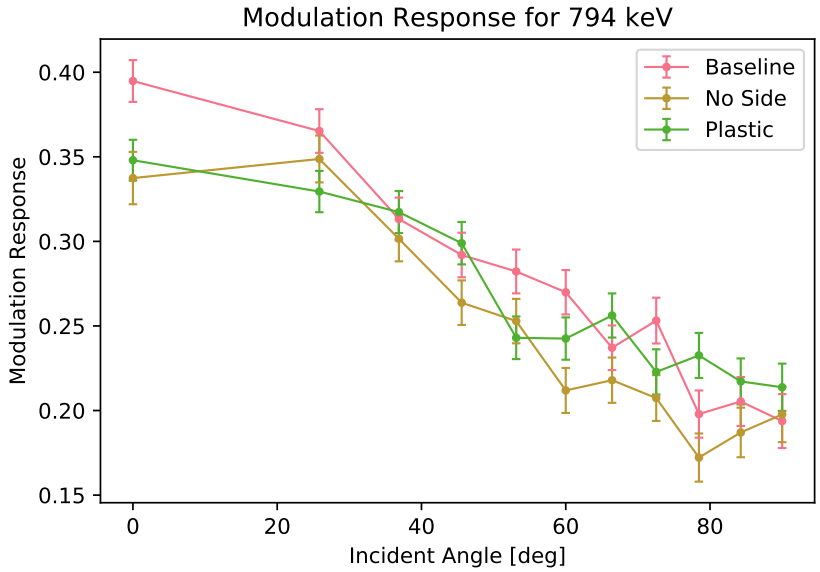
Polarization Response against incident angle: 501 keV



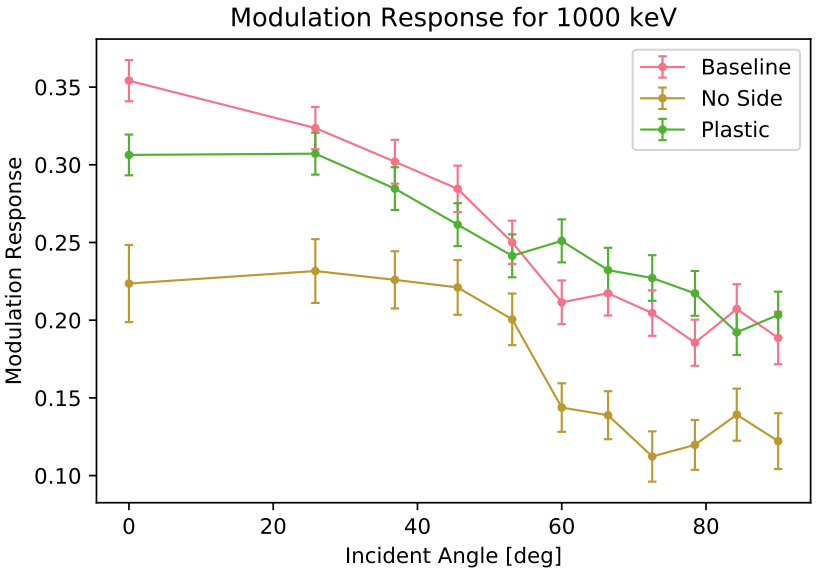
Polarization Response against incident angle: 630 keV



Polarization Response against incident angle: 794 keV



Polarization Response against incident angle: 1000 keV



Summary

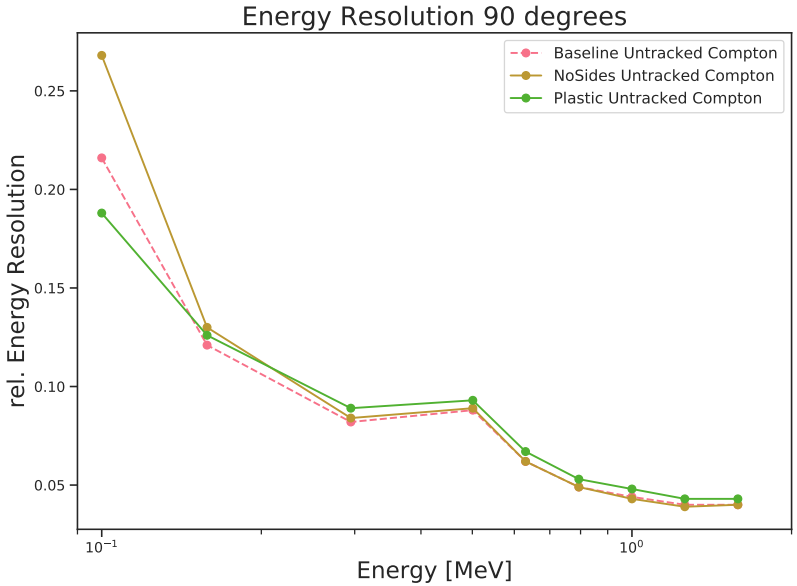
- All inspected models have enough effective area to detect high flux transient sources
- Even without side detectors there is enough effective area left to find the GRB in Compton-only data
- The side detectors have a profound impact on the overall effective area and μ_{100}
- Adding the plastic layers improves effective area at $E < 500$ keV
- Adding plastic improves μ_{100} at $E = 100$ keV
- For all other inspected energies the plastic layers have a non-measurable or even negative effect on μ_{100}

Thank you for your attention!

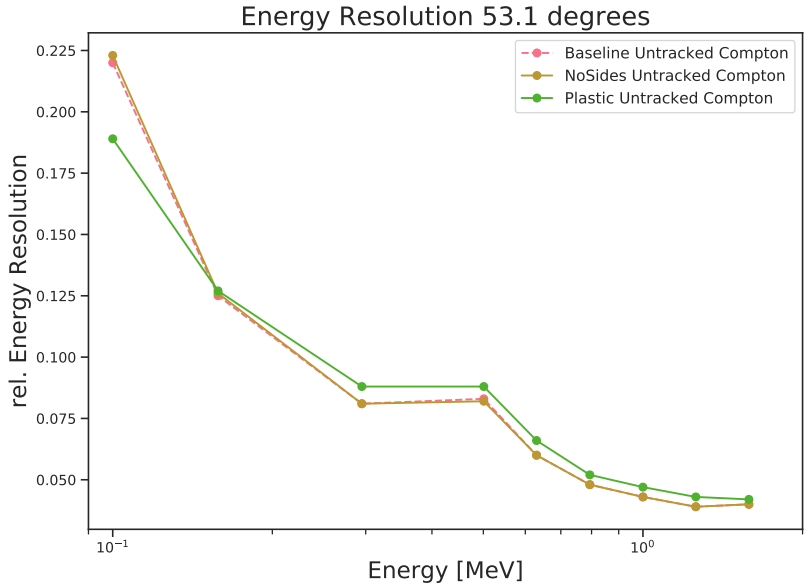
Backup

Backup Slides

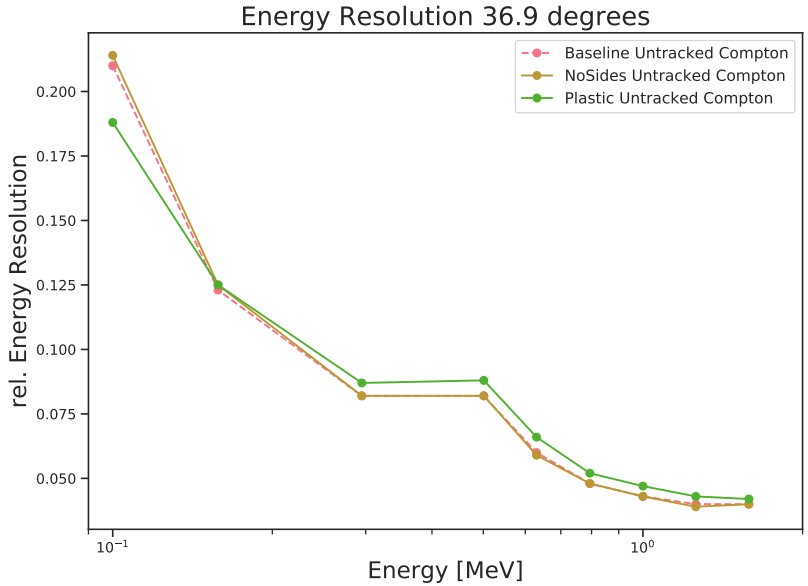
Energy Resolution 90 degrees



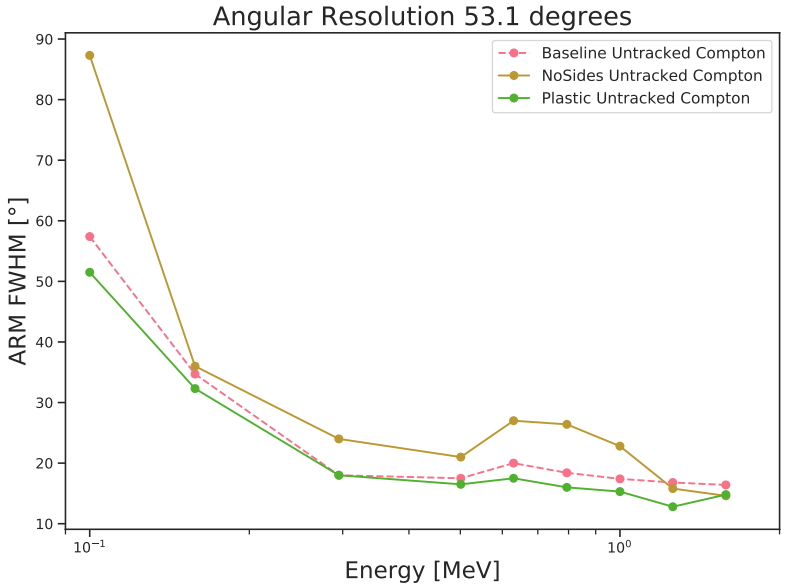
Energy Resolution 53 degrees



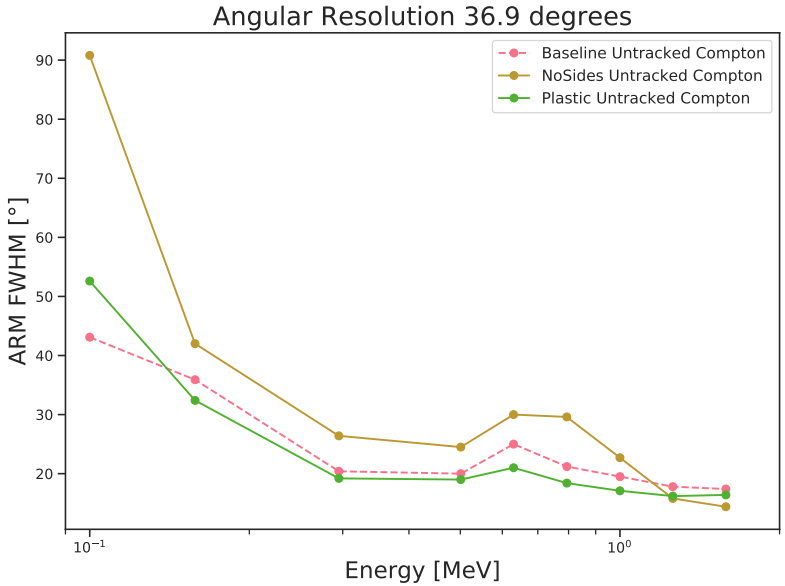
Energy Resolution 37 degrees



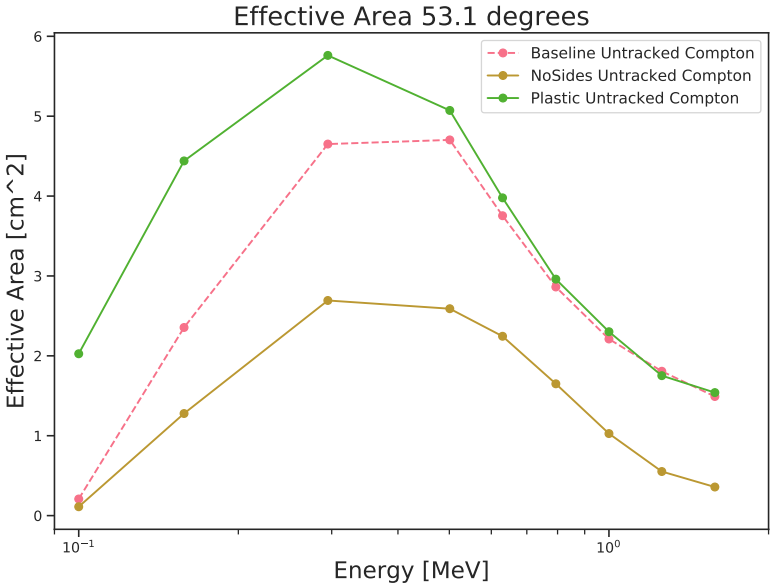
Angular Resolution 53 degrees



Angular Resolution 37 degrees



Effective Area 53 degrees



Effective Area 37 degrees