Simulations of the Instrument Performance

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Energy range: 200 keV to >10 GeV
good energy and angular resolution
sensitivity 20-50x better than previous instruments

Measures both
Compton-scattering events and
pair-production events

This is an overview of the AMEGO simulation campaign:
initial results for effective area, angular resolution, polarization and sensitivity projections.
**INTRODUCTION TO AMEGO**

- **Probe Concept:** 2020 NASA Astrophysics Decadal Review

- Observing strategy: survey
  - 80% sky/orbit, ~2.5 sr FoV

- Well *understood, tested* technologies with *space heritage*

- Science: pulsars/magnetars, gamma-ray bursts and multimessenger astrophysics, active galaxies, dark matter

**SIMULATION OVERVIEW**

- Performed using the MEGAlib toolkit [4]
  - ROOT (v6), Geant4 (v10)

- Event classes
  - Current: tracked Compton scattered, pair production
  - Future: untracked Compton scattered (low energies)

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3-year mission (20% efficiency for FOV/SAA) assuming the background shown (bottom left). In the compton regime, the backgrounds are scaled up by x10, which we found to be conservative. Fermi-LAT (5-year mission), COMPTEL and EGRET (2 week pointing), and NuSTAR and SPI (10^5 s live time) are also shown for comparison. These choices reflect the observing strategy and preliminary approximated mission duration. In the energy band ~1 to ~100 MeV AMEGO is at least an order of magnitude more sensitive, due mainly to the increased effective area and angular resolution. Comparing a 2 week AMEGO exposure, AMEGO is ~10x more sensitive than COMPTEL.
**Effective area**: ratio of the reconstructed ($N_R$) and generated ($N_T$) events times the total area ($A_{sphere}$) vs. energy. Relatively constant vs. incidence angle.

**Angular resolution**: angular distance from true direction to outer edge of Compton cone (Compton events), bisect angle of the electron/positron vectors weighted by energy (pair events) vs. energy. Also relatively constant vs. incidence angle.

**Polarization**: simulated polarized source is fit to a sin function. Determine amplitude of azimuthal modulation ($\mu_{100}$) (top left) vs. energy. Calculate minimal detectable polarization (MDP) for the signal ($R_S$), background ($R_{BG}$) and observation time ($T_{obs}$) (see equation inset and table on the left).

<table>
<thead>
<tr>
<th>MDP</th>
<th>Energy (MeV)</th>
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</thead>
<tbody>
<tr>
<td>5%</td>
<td>0.5-1</td>
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<tr>
<td>12%</td>
<td>1-2</td>
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</tbody>
</table>

**MDP** = $\frac{4.29}{\mu_{100} R_S} \sqrt{\frac{R_S + R_{BG}}{T_{obs}}}$
Sources of Backgrounds: cosmic photon sources (Galactic and Isotropic), charged particles from cosmic sources and the Earth’s Albedo, atmospheric secondary gamma rays, internal instrument backgrounds and from SAA.

Backgrounds in analysis: Gruber et al. (1999) in blue x10, and Acero et al. (2016) in pink

REFERENCES