M7 simulations in the pair regime

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- Simulation framework: BoGEMMS (Bulgarelli+2012, Fioretti+2014)
- Geant4 version: 10.4 (G4EmLivermorePolarizedPhysics electromagnetic physics list)
- Mass model:





- Main modifications w.r.t. the MEGAlib mass model:
 - No passive material in trays (only Si)
 - single wafer (no guard ring, no towers)

Analysis and reconstruction

Analysis

- No capacitive coupling
- Noise = 1 keV (sigma)
- Energy threshold = 15 keV
- Deposited energy divided 50% X-strip and 50% Y-strip
- Clustering:
 - Cluster = all contiguous strips
 - Cluster energy = sum of all the strips
 - Cluster position = energy barycenter method



Reconstruction:

Kalman filter (A. Aboudan+ 2022 <u>https://iopscience.iop.org/article/10.3847/1538-4357/ac5626</u>)

Scientific performance:

- Effective area
- PSF
- Sensitivity

M7 simulations and results

E (MeV)	ΔE spectrum ^(a) (MeV)	PSF ^(b)	Effective area ^(c) (cm ²)	Inner Galaxy Backgr. rate (count s ⁻¹)	Inner Galaxy Sensitivity (ph cm ⁻² s ⁻¹)	Galactic Center ^(d) Sensitivity (ph cm ⁻² s ⁻¹)	Extragal. Backgr. rate (count s ⁻¹)	Extragal. Sensitivity 3σ (ph cm ⁻² s ⁻¹)
10	7.5 - 15	14.5	128	2.4×10^{-1}	1.1×10^{-5}	2.0×10^{-5}	7.1×10^{-2}	6.2×10^{-6}
30	15 - 40	6.5	347	6.2×10^{-2}	2.1×10^{-6}	3.7×10^{-6}	9.3×10^{-3}	8.3×10^{-7}
50	40 - 60	4.1	519	2.8×10^{-2}	9.6×10^{-7}	1.7×10^{-6}	3.1×10^{-3}	3.2×10^{-7}
70	60 - 80	3.2	568	1.3×10^{-2}	6.0×10^{-7}	1.1×10^{-6}	1.2×10^{-3}	1.8×10^{-7}
100	80 - 150	2.2	616	5.1×10^{-3}	3.5×10^{-7}	6.0×10^{-7}	3.7×10^{-4}	9.4×10^{-8}
300	150 - 400	1.4	708	1.5×10^{-3}	1.6×10^{-7}	2.8×10^{-7}	3.7×10^{-5}	2.6×10^{-8}
500	400 - 600	0.8	700	3.8×10^{-4}	8.3×10^{-8}	1.5×10^{-7}	5.8×10^{-6}	1.0×10^{-8}
700	600 - 800	0.6	698	1.8×10^{-4}	5.7×10^{-8}	9.9×10^{-8}	2.0×10^{-6}	7.2×10^{-9}
1000	800 - 2000	0.4	726	6.2×10^{-5}	3.3×10^{-8}	5.7×10^{-8}	5.6×10^{-7}	6.9×10^{-9}
3000	2000 - 4000	0.25	714	6.9×10^{-6}	1.1×10^{-8}	1.9×10^{-8}	4.6×10^{-8}	7.0×10^{-9}

Table 3: ASTROGAM performance in the pair-production domain simulated with BoGEMMS. All results are for a 30° off-axis source and for $T_{obs} = 10^6$ s.

(a) Source spectrum is an E^{-2} power-law in the range ΔE .

(b) Point Spread Function (68% containment radius) derived from a single King function fit of the angular distribution.

(c) Effective area after event selection.

(d) The background for the Galactic Center is assumed to be 3 times larger than that of the Inner Galaxy.

No instrumental background simulations

Using MEGAlib for the pair production:

• PROS:

- Not doubling the work on different mass models
- Not doubling simulations (at least for the background)
- The raw output (energy deposits in the strip) seems* the same
- BoGEMMS mass models are simplified
- CONS:
 - BoGEMMS pair simulations validated against the AGILE in-flight PSF
 - Additional work required to convert the MEGAlib output to the BoGEMMS output

Our short-term proposal: using MEGAlib for the Geant4 simulation, converting into the BoGEMMS output and using the ASTROGAM pair analysis pipeline

* We just started the first tests with MEGAlib...