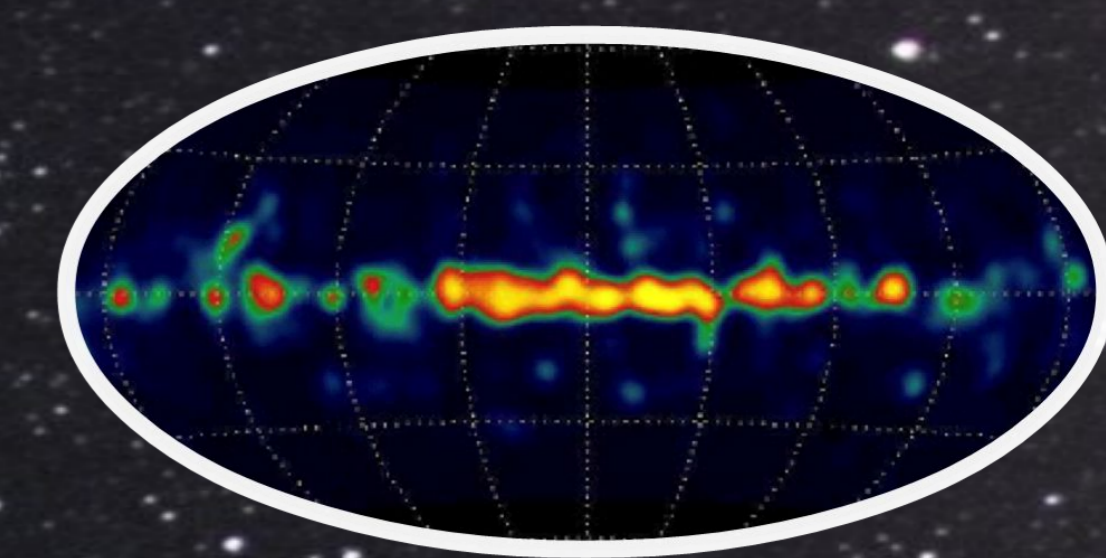
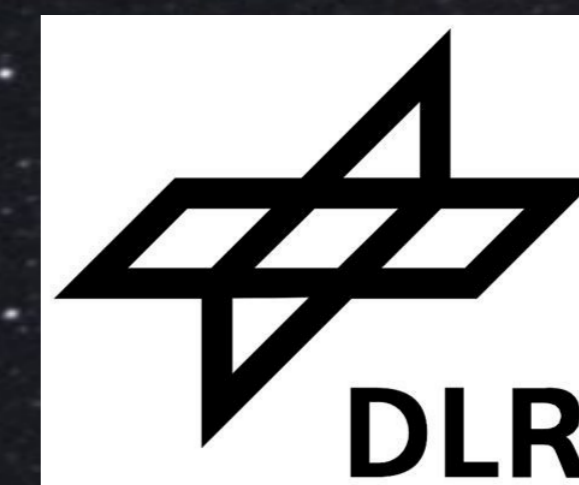




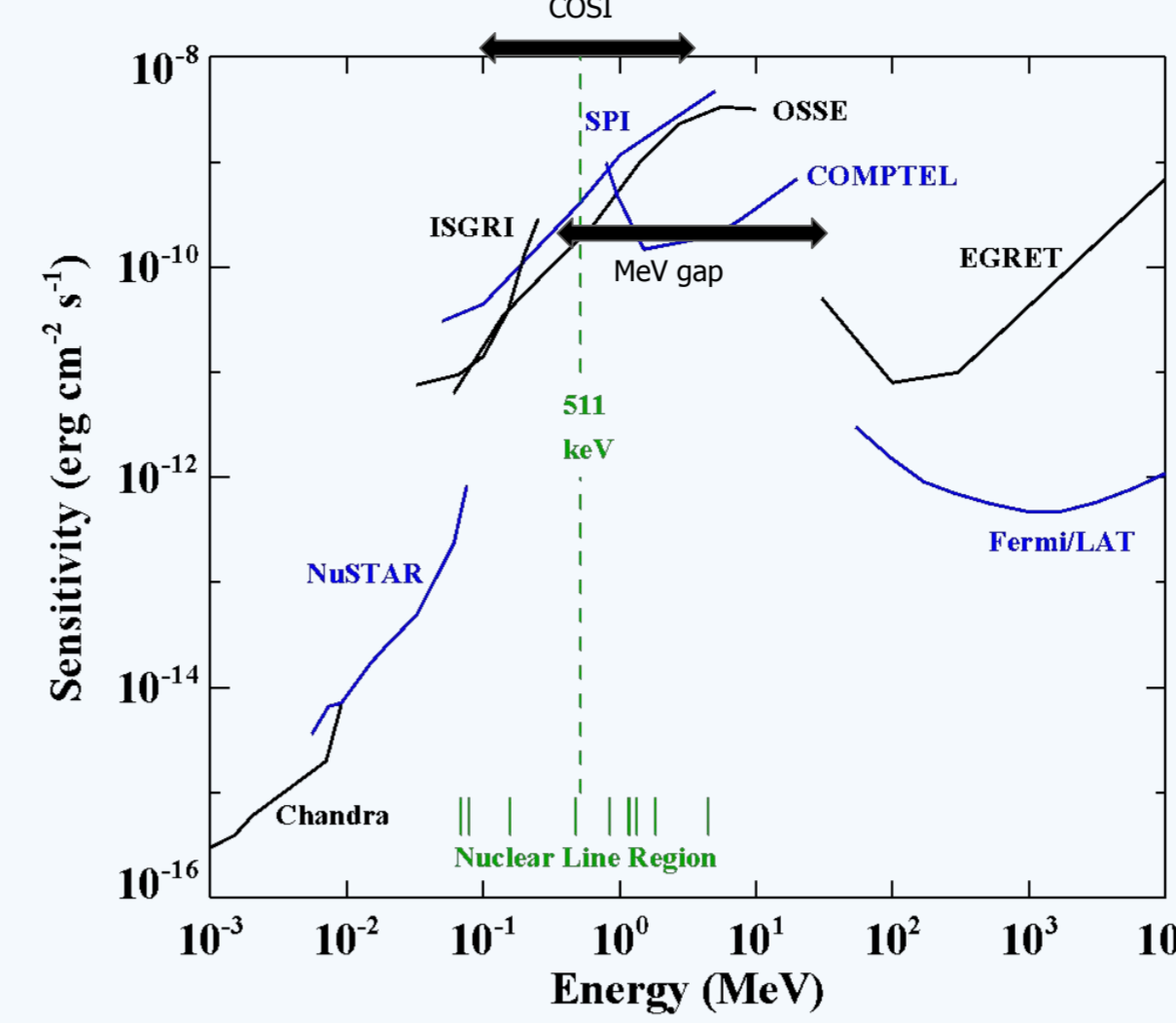
Pre-flight Background Estimates for COSI

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 on behalf of the COSI collaboration



Summary

- The Compton Spectrometer and Imager (COSI) [1] is a compact Compton telescope designed to survey the 0.2–5 MeV sky, consisting of a compact array of cross-strip germanium detectors. COSI's main science goals are to:
 - Uncover the origin of Galactic positrons
 - Reveal Galactic element formation
 - Gain insight into extreme environments with polarization
 - Probe the physics of Multimessenger events
- The MeV gamma-ray regime is dominated by the background, especially due to the activation of the detector materials induced by cosmic ray interaction. Thus, background identification and simulation is crucial for analysis.
- In this poster we present the background simulation done for the pre-flight estimation of COSI [2]



COSI

- COSI will launch in 2027 into an equatorial low Earth (530 km) orbit
 - North-South repointing ($\pm 22^\circ$) every 12 hours to cover the whole sky every day
- The simulation, detector effect engine and event reconstruction is done with MEGALib [3]
- The simulations account for time-dependent variations due to the geomagnetic cut-off, South Atlantic Anomaly (SAA) passages, and they include detailed modeling of delayed activation from short/long-lived isotopes

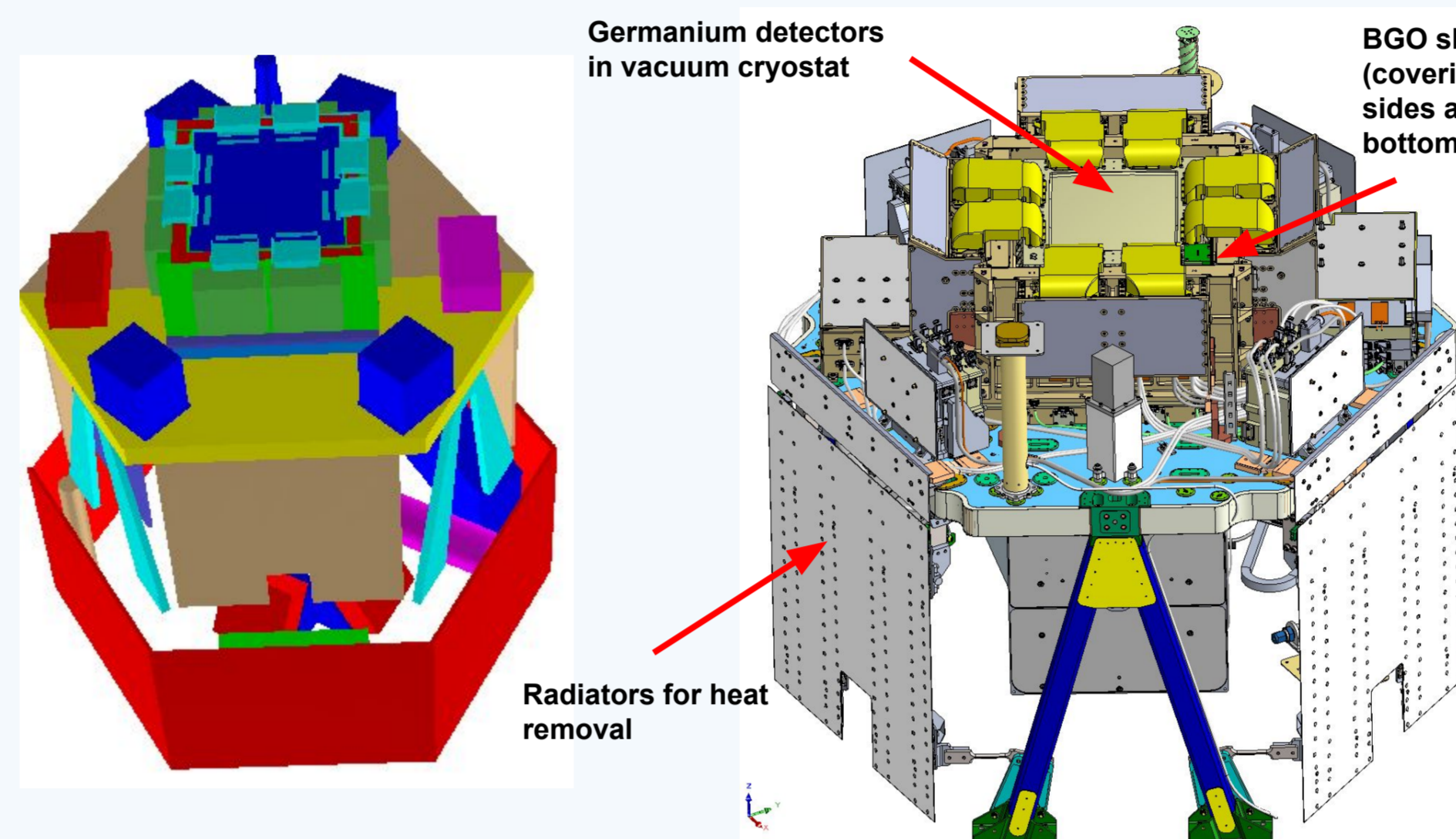


Figure 1: Left: Screen-shot of the MEGALib's mass-model used for the simulation. Right: Schematic of the current Computer-Aided Design (CAD) mass model for comparison.

References

- Tomsick et al. (2023) The Compton Spectrometer and Imager
- Gallego et al. (in prep.) Pre-flight Background Estimates for COSI
- Zoglauer (2006) MEGALib – The Medium Energy Gamma-ray Astronomy Library
- Cumani et al. (2019) Background for a gamma-ray satellite on a low-Earth orbit
- Porter et.. (2022) The GALPROP Cosmic-ray Propagation and Nonthermal Emissions Framework: Release v57
- Ginet et al. (2013) AE9, AP9 and SPM: New Models for Specifying the Trapped Energetic Particle and Space Plasma Environment

Input models

- Primary/secondary particles and extragalactic gamma-ray background (EGB) flux are generated using the model tool from [4]
- Galactic diffuse continuum emission is modeled using GALPROP [5]
- SAA trapped protons spectrum is generated using IRENE AP9 [6]

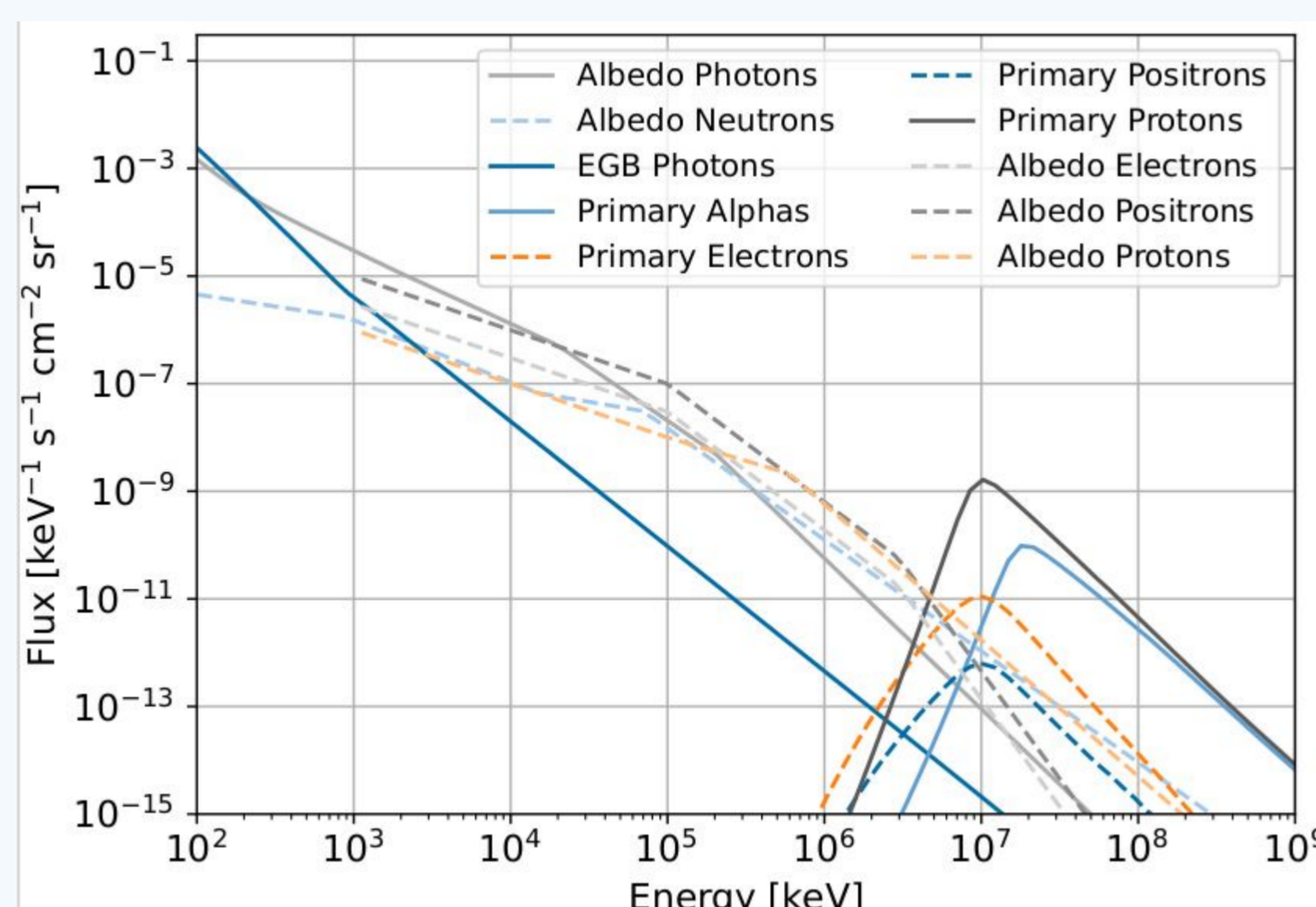


Figure 2: Full on-orbit BG spectra for charged particles, neutrons, and photons. All spectral components are divided by the solid angle of their region of origin.

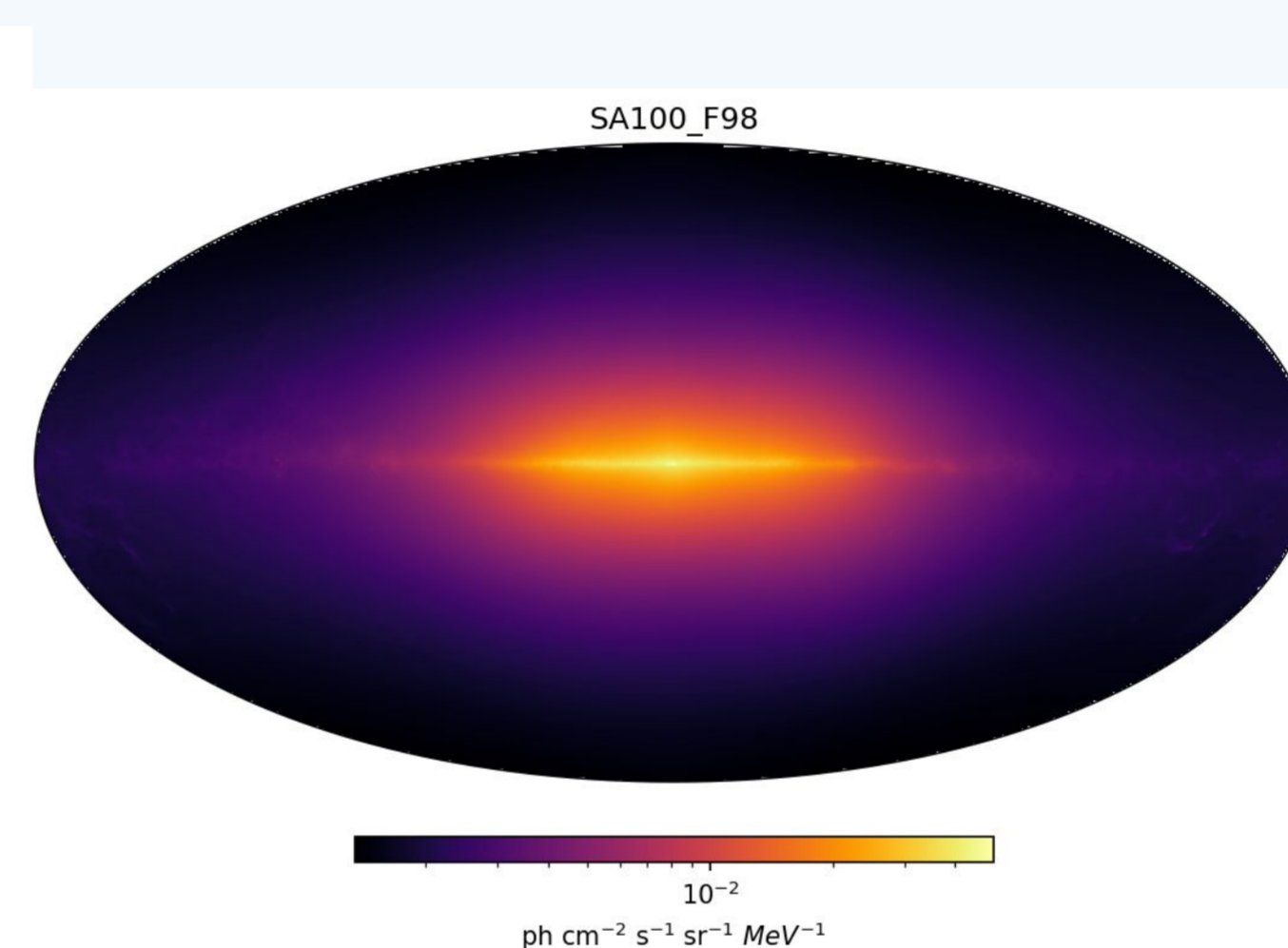


Figure 3: All-sky map of the SA100-F98 model for the Galactic diffuse emission background component.

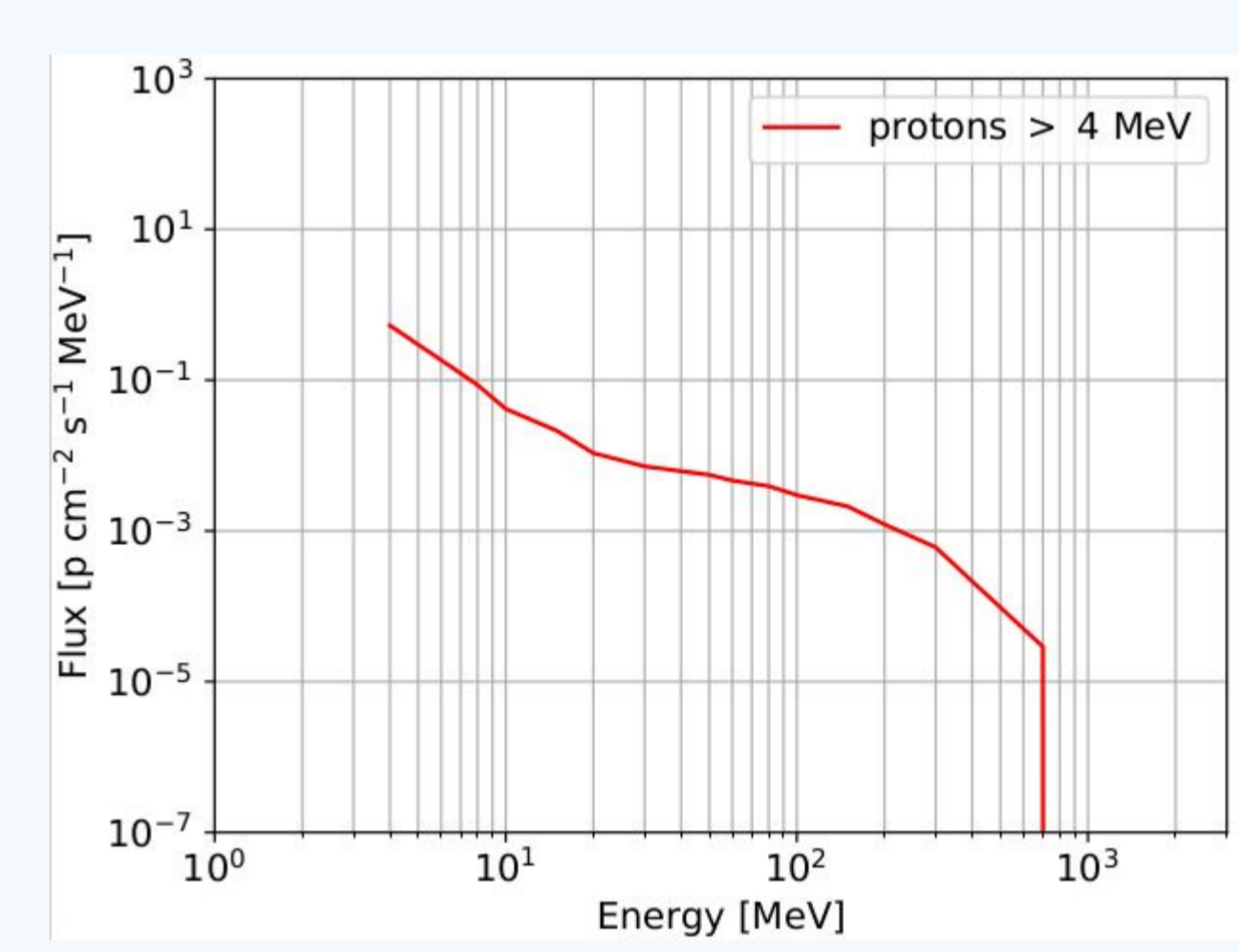


Figure 4: AP9 trapped proton spectrum during SAA passage.

Background simulation result

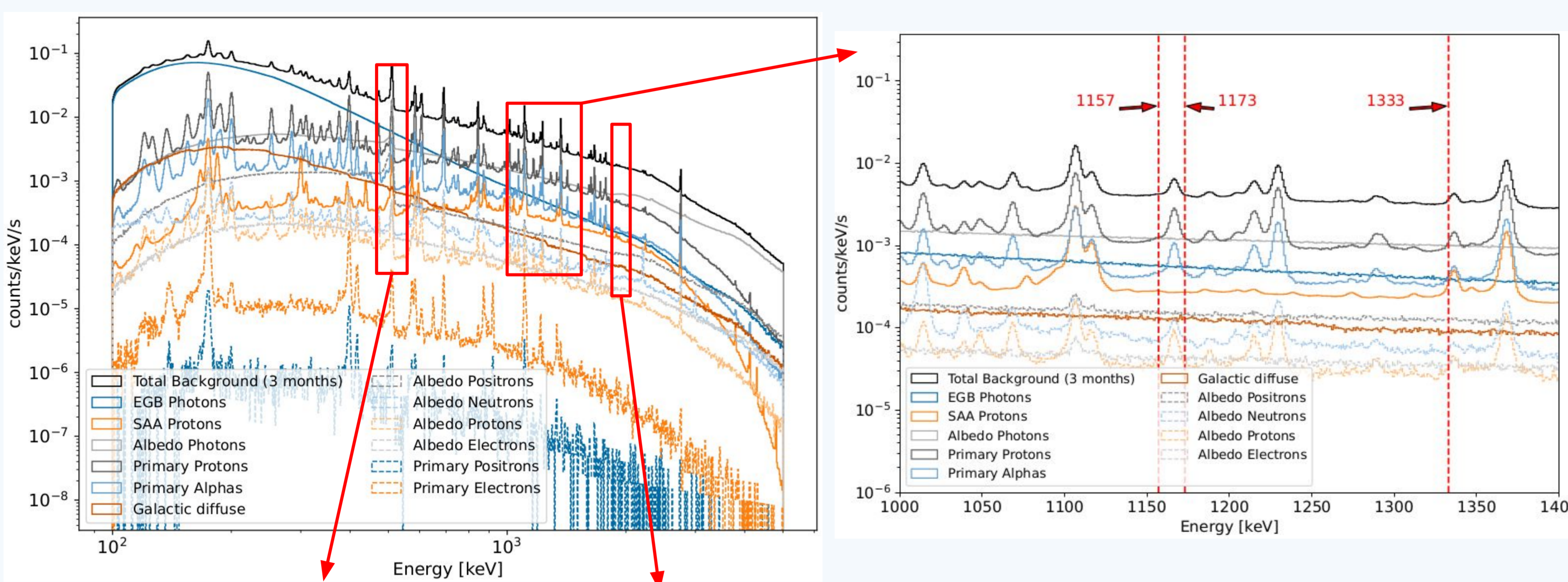


Figure 5: Spectra of the reconstructed Compton events after 3 months of orbit for each background component.

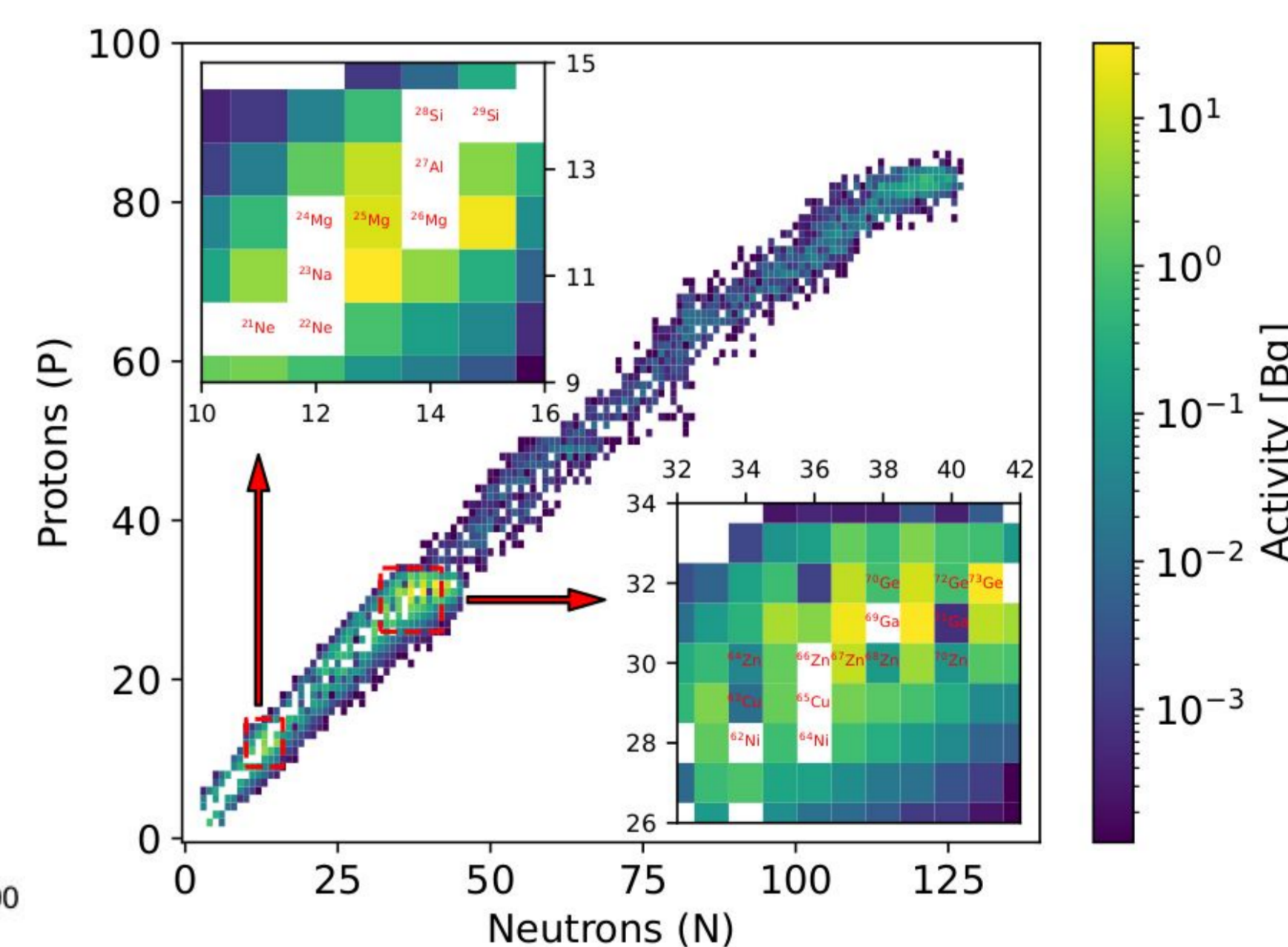


Figure 6: Distribution of isotopes activities produced by the interaction of the primary protons. Some stable elements are written in red.

- The background is dominated by the EGB up to 400-keV and then by the primary protons/alphas and the albedo photons.
- We observe key activation lines, such as from ^{70}Ga , impacting important features like the 511-keV line.
- Short-term activation right after SAA passages seems to be dominated by the isotopes produced in the structure of the spacecraft
- This background modeling and simulations were performed as part of the third Data Challenge of COSI (see QR code)
- This work marks a major step forward in understanding the background rates for the COSI satellite mission

DC3 link

