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GEANT SIMULATION OF THE AGILE GAMMA-RAY IMAGING DETECTOR

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ABSTRACT

Using a GEANT-based Simulator of the Gamma-Ray Imaging Detector (GRID) developed for the AGILE space astrophysics mission, we optimized the event trigger processing. In this paper, we describe the AGILE instrument geometry and the model assumed for the charged particle and the albedo-photon backgrounds. We present the main results on different levels of data processing and obtain the background rejection efficiency of the GRID detector.

1 Introduction

AGILE is an ASI Small Scientific Mission dedicated to high energy astrophysics [1]. The AGILE instrument is designed to detect and image photons in the 30 MeV - 50 GeV and 10 - 40 keV energy bands, with excellent spatial resolution and timing capability and an unprecedently large field of view covering $\sim 1/5$ of the entire sky at energies above 30 MeV. The AGILE gamma-ray mission requires a low-background orbit to maximize its scientific output.

The optimization of the AGILE design was obtained through a Montecarlo study of the detector performance, using the GEANT 3.21 code [2]. In this paper, we describe the AGILE instrument and the particle/albedo-photon background models assumed for the optimization of the on-board data processing. We outline the adopted trigger strategies and present the main results about the on-board background rejection.

2 The AGILE instrument model

The AGILE scientific instrument is made of three integrated detectors with broad-band detection and imaging capabilities [1, 3]. The AGILE Gamma-Ray Imaging Detector (GRID) consists of a Silicon-Tungsten Tracker, a Cesium Iodide Mini-Calorimeter, an Anticoincidence system made of segmented plastic scintillators, fast readout electronics and processing units. The Super-AGILE detector will provide detection and imaging capabilities in the hard X-ray range. The CsI Mini-Calorimeter will also detect and collect events independently from the GRID in case of impulsive transients.

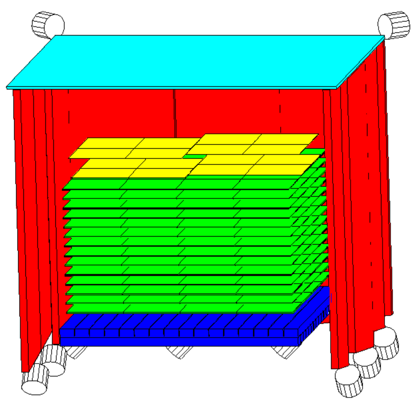

Figure 1: *A simplified view of the AGILE instrument model.*

In the simulation code we modelled the GRID detector according to the AGILE design [3]. Fig. 1 shows a simplified view of the AGILE instrument model used in our simulations.

3 Background assumptions

A quasi-equatorial orbit is preferred for the AGILE mission and will provide a relatively low-background environment. Taking into account data from SAS-2 and Beppo-SAX missions, we expect an average rate of charged particle background above ~ 1 MeV of ~ 0.3 particles cm^{-2} s^{-1} for a quasi-equatorial orbit near 550 km. The charged particle energy spectra assumed in our simulations are shown in Fig. 2. They are based on data from the 1998 AMS Shuttle flight [4, 5], and from the MARYA experiment on board of the MIR space station [6]. The interaction of the charged cosmic-rays with the upper atmosphere

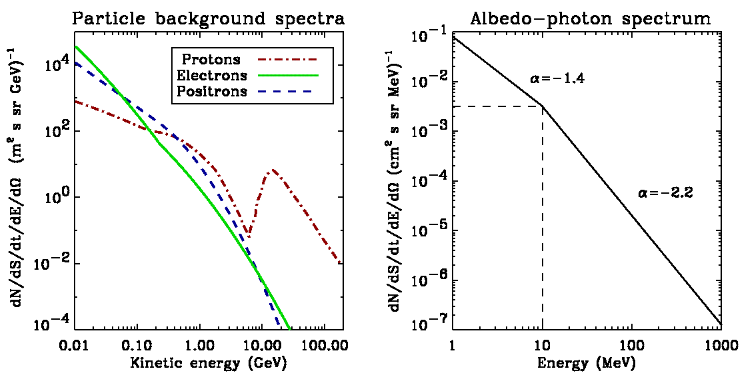

Figure 2: *Left Panel: Charged particle background energetic spectra assumed in our simulations. Right Panel: Average albedo-photon energy spectrum.*

induces a relatively strong gamma-ray background peaking at the Earth horizon. This effect involves a localized increase of the gamma-ray emission that we properly took into account on the basis of SAS-2 [7] and balloon data [8]. Fig. 2 shows the average flux of albedo photons over the solid angle of the subtended Earth surface at the height of 550 km.

4 Trigger Strategies and Background Rejection

We studied different GRID trigger configurations, and optimized their performance. The baseline GRID trigger logic consists of two different levels. A (hardware) Level-1 trigger logic uses the information from the Silicon detectors and AC panels and considers also a simplified view of the event topology obtained by the front-end chips. Level-1 trigger reduces the charged-particle background from a rate of ~ 2000 Hz to a rate of ~ 60 Hz. A (software) Level-2 on-board data processing makes a crucial use of the analog (charge) information in the Si-microstrips for a refined view of the event topology at the "cluster" level. Level-2 on-board processing also selects events based on a simplified photon direction reconstruction (necessary to reject Earth albedo photons). After the on-board Level-2 processing, we can reduce the total (charged particle and albedo-photon) background rate to $\sim 20-30$ Hz, without affecting significantly the cosmic gamma-ray detection.

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