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Characterisation of the first prototype of the LISA Radiation Monitor

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LISA will be the first space-based gravitational wave observatory sensitive to the unexplored frequency band of 0.1 mHz –1 Hz. It will consist of three identical spacecraft (SC) 2.5 million km away from each other. Each SC will be equipped with lasers and free-falling Au/Pt solid cubes (known as Test Masses, TMs). Gravitational waves will be detected by measuring small variations in the distance between TMs of different SC. Background radiation interacting with the SC may charge the TMs, limiting LISA sensitivity, especially < 1mHz. Therefore, monitoring the background radiation flux is essential to understand the charging nature of the TMs and evaluate its associated systematic uncertainties.

For this purpose we have designed a low-power Radiation Monitor (RM) capable of detecting protons and alpha particles above ˜70 and ˜600 MeV, respectively. The RM consists of a telescopic arrangement of four plastic scintillators and three W absorbers. The scintillators are coupled to silicon photomultipliers and their readout is performed by the BETA ASIC, which can amplify, shape and digitize the signals of up to 64 channels with a power consumption of ˜1mW/ch. An FPGA controls the trigger and reduces the data digitised by BETA. The RM will be capable of monitoring the cosmic-ray flux integral with ˜1% statistical uncertainty in ˜1 hour. It will have at least four energy channels for reconstructing the spectrum between ˜100 MeV and ˜1 TeV. During quiet solar activity, the RM has an expected trigger rate of a few tens of Hz. However, it was designed to handle up to a few kHz to be able to detect the high-energy tail of solar-energetic particle events.

We built a prototype of the RM suitable for a CubeSat, in the frame of the ILIADA experiment. ILIADA aims at demonstrating the technology developed for LISA and at characterizing the Birkland's currents near the Earth poles, through the data collected by the RM and high-precision magnetometers. We characterized our prototype with a proton beam and through dedicated MonteCarlo simulations. It will undergo vibration, vacuum and thermal tests during the first half of 2025 and its flight in a Small Satellite is scheduled for the beginning of 2026.

In this contribution I will discuss the design of the RM, the evaluation of the performance of its CubeSat prototype and the expectations for its on-flight operation.

Eligibility for ”Best presentation for young researcher” or ”Best poster for young researcher” prize

Yes

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