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#2-197 Overview of the GlowRIA radiation monitor: a miniaturized fiber optic dosimeter compatible with Cubesat missions

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Abstract - Optical fiber based dosimetry is a fast growing research topic, that in most of the cases exploits either Radiation Induced Attenuation (RIA) or Radiation Induced Luminescence (RIL) processes in silica or plastic based fibers. The RIA based optical fiber dosimetry was developed and greatly improved in the particle accelerator domain, and was later on extended to space applications during the ALPHA mission that launched the first optical fiber based dosimeter (the LUMINA experiment) to the International Space Station (ISS). This experiment is based on the use of two several kms long spools of fiber that have been specifically developed and selected for its dosimetric properties. More specifically, it is able to detect radiation without dependence to the dose rate, temperature, or type of particles which are important aspects for space applications. LUMINA was installed in August 2021 by ESA astronaut Thomas Pesquet and has shown great performances in orbit at monitoring the radiation levels inside ISS, detecting for instance each pass inside the most intense region of the 400 km orbit called the South Atlantic Anomaly. This experiment is well suited for the ISS missions associated with very low dose rates, low doses thanks to its very long spool of fiber. In order to target other missions in satellites and cubesats, characterized by higher radiation constraints, we decided to adapt the existing architecture of the experiment and create a miniaturized space version named GlowRIA. One important difference to mention is that the LUMINA experiment was developed to be used in ISS environment inside COLUMBUS module for which it was not mandatory to use radiation hardened electronics for the acquisition chain as the radiation levels is low (about 300 uGy/h) whereas in the case of GlowRIA, the targeted environment requires the use of radiation tolerant or hardened electronics. GlowRIA is using the same optical fiber as LUMINA with a shorter length of several hundreds of meters, that can be adjusted to the expected dose for the mission. New optoelectronics (laser and photodiodes) components have been selected to reduce their electrical consumption and form factor. Concerning the electronic readout, a radiation tolerant microcontroller has been implemented to replace the raspberry board that was used in the LUMINA experiment. With this architecture, the dosimeter could resist to both cumulated dose effects and single event effects.
This paper intends to present the architecture of the GlowRIA dosimeter, including the results of the characterization tests that were performed during its development to evaluate the performance of the equipment. More specifically, we tested the ability of the dosimeter to resist under harsh conditions in orbit such as vacuum, large temperature variations, electromagnetic perturbations and total ionizing dose. We also plan to present the different approaches we could use to adapt such dosimeter to different space missions and their related radiation environment.
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