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LUMINA, A FIBER-OPTIC DOSIMETER ABOARD THE ISS

Abstract

Monitoring of ionizing radiation is a major topic for future space exploration, on top of being of real interest on earth in the medical and nuclear domains. A robust dosimeter that provides a real time measurement of the fluctuation levels of the dose rate could allow anticipating radiation flares, for example, and thus reacting properly to these dangerous events.

Optical fiber dosimetry is a promising technology to address these needs. Lumina dosimeter, first active fiber-optic dosimeter now in space, allows testing this concept in low earth orbit. It was developed by CNES, installed on board the ISS in the frame of the French contribution to Thomas Pesquet's ESA Alpha mission, and is still performing measurements up there.

The main objective of Lumina is to demonstrate the ability of a fiber-based dosimeter to measure, in real-time, the radiation dose on the ISS, under realistic space conditions. The second objective is to increase scientific knowledge regarding the fiber behavior in the visible and infrared domains when exposed at a low radiation dose rate for extended periods in space.

This paper proposes to explain the work that was performed to design a dosimeter able to fulfill these objectives, and where we are now with respect to these objectives.

The capacity of silica-based optical fibers to darken, due to damages caused by ionizing radiations, constitutes the operation principle of Lumina. An optical signal measurement at the extremity of the several kilometer-long coils enclosed in the black box allows evaluating the attenuation due to the radiation-induced defects, and then the total ionizing dose received can be deduced. Regarding the results obtained during these first months on board, Lumina has shown its ability to measure radiations, detecting the South Atlantic Anomaly singularity peak of dose rate. The performances and limitations of this current generation of Lumina dosimeter will be discussed at the conference.

Lumina was built thanks to the successful cooperation between the expertise of Laboratoire Hubert Curien of University Jean Monnet with iXblue unique know-how in optical fibers field. Characterization tests in radiation environment were performed at CERN. CNES coordinates the development and operations of Lumina.