



Radiation resistance monitor on VZLUSAT-1: preliminary results



Veronika Stehlikova^a, Ondrej Nentvich^a, Martin Urban^a, Ladislav Sieger^a
Faculty of Electrical Engineering, Czech Technical University in Prague

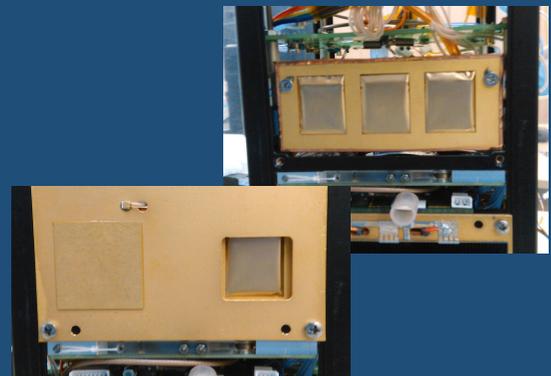
Introduction

The first Czech CubeSat, a technological satellite VZLUSAT-1, was launched in June, 2017 with PSLV-XL carrier from Shriharikota Range in India. The satellite hosts a number of scientific and commercial experiments aboard. Several of them are focused on in-orbit investigation of a novel carbon-fibre composite developed by 5M company; examination of residual liquids evaporation, change of eigenfrequencies of the material according to the ageing of it, and shielding abilities against cosmic radiation. The quality of shielding is evaluated as a comparative measurement between three channels with different shielding. Each channel contains a calibrated biased PIN diode as a radiation sensor, which is sensitive to radiation in 6 keV to 20 keV energetic range.

Radiation monitor

The radiation monitor at the VZLUSAT-1 consists of three independent measuring channels. Each of them begins with a PIN diode with bias voltage 60 V, which is able to catch radiation in energetic range from 6 keV – this is the limitation given by the noise of supportive electronic – to 20 keV – this is the practical limitation given by the material the diodes are produced from. The sensors have different shielding – a tungsten sheet, studied composite layer, and thin golden foil, serving as a protection against light only. The foil and the tungsten covered diodes serve as a zero and hundred percent reference for the composite-shielded one.

In the pictures to the right is the situation during the final assemble of the satellite. One picture shows the three-diodes monitor with light protection as it is mounted inside a tungsten housing, which is designed to protect the monitor against the radiation coming from undesired directions. The lower photograph shows the different shielding of channels.



Shielding material

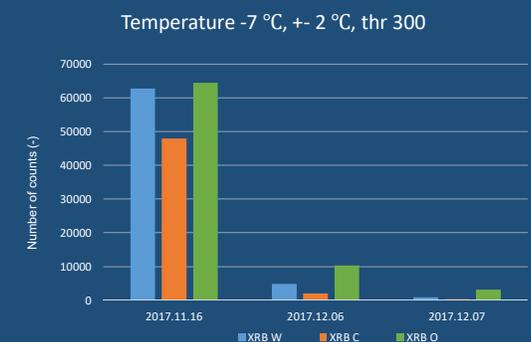
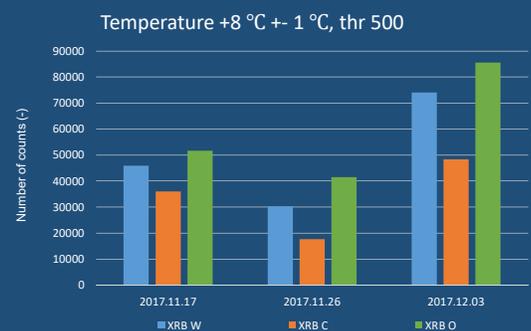
The composite material was developed by Czech company 5M s.r.o. and the detailed composition of materials is a matter of industrial protection. It is possible to say that the new material is a combination of carbon fibres and resin with improved protecting abilities mainly against protons. The shielding level of the material was raised using the incorporation of light elements into the resin of 7-layers carbon composite. Layers of carbon fibres are mutually rotated for 45 deg to provide high toughness and all-directions stability when cutting and shaping.

The development aimed on producing material which would have similar shielding properties as nowadays used shielding materials (mainly aluminium), but was lightweight, more sturdy and had wide options of shaping.

In orbit measurement

The diodes are marked as W (covered by tungsten), C (covered by carbon composite) and O (open into free space). Threshold serves as a cut off of the noise caused by electronic. The threshold depends on the temperature of the monitor, showed are several measurements from different days, when the temperature was similar with maximal deviation 1 °C.

The preliminary results show, at the satellite orbit at about 520 km altitude, the shielding effectivity of composite is higher even in comparison with the tungsten shield. This fact is probably caused by the type of radiation in orbit, and also originally unexpected possibility of secondary radiation of tungsten.



This research was done as a part of cooperation of several subjects, namely Czech Aerospace Research Centrea.s., TTS,s.r.o. - Thin-film Technology Services, Rigaku Innovative Technologies Europe, s.r.o., 5M s.r.o., as well as the Czech Technical University in Prague and the University of West Bohemia. The project was supported by the Czech Republic grants TA03011329, TA04011295, and partly by SGS18/186/OHK3/3T/13