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TriTel 3 dimensional space dosimetric telescope in the European Student Earth Orbiter project of ESA ☆

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ABSTRACT

The development of the European Student Earth Orbiter (ESEO) was announced in the year of 2008 by the European Space Agency for students interested in the space exploration. The Budapest University of Technology and Economics joined this international cooperation with three student groups among other participating European universities. One of them is the ESEO-TriTel team. The development of the TriTel 3D silicon detector telescope began in the KFKI Atomic Energy Research Institute several years ago in order to determine the average radiation quality factor of the space radiation field for dosimetric purposes. In the year 2011—before the start of the ESEO mission—it will be operated on board the European Columbus module of the International Space Station (ISS) and will be installed in the Russian segment of the ISS as well. The ESEO version of TriTel will fly higher than the ISS version, at an altitude of 520 km. At this altitude the Earth's geomagnetic field is much lower and the spectrum of the radiation field is also different. In the ESEO-TriTel experiment the anisotropies in the radiation field, the effects of the Earth shadow and the South Atlantic Anomaly (SAA) will be analysed and the results will be compared with the fluxes calculated with the standard AP-8 and AE-8 trapped proton and electron models. In the near future the frequency of manned space flights will probably increase, we can think of the continuous human presence in the near-Earth region (low Earth orbits) or the proposed human Mars expedition. That is why the cosmic radiation field is interesting not only in the near-Earth region but at higher altitudes or in the interplanetary field as well. The present paper addresses the optimal shielding of the dosimetric telescopes of TriTel in order to avoid the saturation of the electronics. The amount of optimal shielding is equivalent to the effective thickness of astronaut's space suit, which means that the same dose will be measured as what the astronauts might experience in the interplanetary field. The thermal requirements, both the general and TriTel specific ones, are discussed as well.

1. Introduction

The development of the European Student Earth Orbiter (ESEO) was announced by the European Space Agency for students who are interested in space exploration. Originally this project is Europe's first student made space mission with ambitious objectives, though Student Space Exploration and Technology Initiative (SSETI) Express as a technological test-bed and a logistical precursor for the ESEO mission was launched and operated for 12.5 h in

Abbreviations: ESEO, European Student Earth Orbiter; ESA, European Space Agency; ISS, International Space Station; SAA, South Atlantic Anomaly; SSETI, Student Space Exploration & Technology Initiative; LET, Linear Energy Transfer; SPENVIS, Space Environment Information System; MULASSIS, Multi-Layered Shielding Simulation; AU, Astronomical Unit; MLI, Multi Layer Insulation; SRIM, The Stopping and Range of Ion in Matter

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2005 [1]. The most important parameters of the orbit of the ESEO satellite can be found in the Table 1. The planned mission time will be six months. However, if the satellite is working well, it can be extended for two years. On board the ESEO satellite two scientific experiments will be carried out, which are developed by two Hungarian research groups supported by the Budapest University of Technology and Economics. The experiments will focus on the cosmic radiation and plasma processes in the near Earth region, especially in the South Atlantic Anomaly (SAA), on the variations in space weather and the effects of solar activity on the Earth's magnetic field.

The ESEO-TriTel student team is responsible for designing and building an instrument for cosmic radiation experiments. The development of the TriTel 3D silicon detector telescope began in the Hungarian Academy of Sciences KFKI Atomic Energy Research Institute several years ago. By evaluating the deposited energy spectra recorded by the instrument the absorbed dose, the LET spectra in three directions, the average quality factor of the cosmic radiation and the dose equivalent can be determined for different segments of the orbit [2]. The ESEO-TriTel Team is working on a specific, satellite version of the instrument, called TriTel-S (Fig. 1).

Table 1
Main orbital parameters of the ESEO satellite.

Type of the orbit	Sun synchronous circular
Expected launch date	End of 2012
Altitude	520 km
Inclination	97.48°
Orbital period	95 min
Average eclipse	35 min
Average sunlight	60 min

This instrument was originally developed in order to determine the absorbed dose and the dose equivalent. After evaluating the results of the measurements it will be possible to make an assessment of the anisotropies in the radiation field as well as the effects of the Earth shadow and the SAA on the measured deposited energy spectra. The contribution of the galactic cosmic rays, the solar cosmic rays and the particle flux of high energy particles precipitating from the radiation belts will also be analysed and the results will be compared with the fluxes calculated with the standard AP-8 and AE-8 trapped proton and electron models [3].

Before the start of the ESEO mission, different versions of the instrument will be operated on board the European Columbus module of the ISS and will be installed in the Russian segment of the ISS as well. These measurements will provide for the first time data and experiences from this new Hungarian instrument. The ESEO version of TriTel will fly at an altitude higher than the ISS version. At this altitude the Earth's geomagnetic field is much lower and the spectrum of the radiation field is also

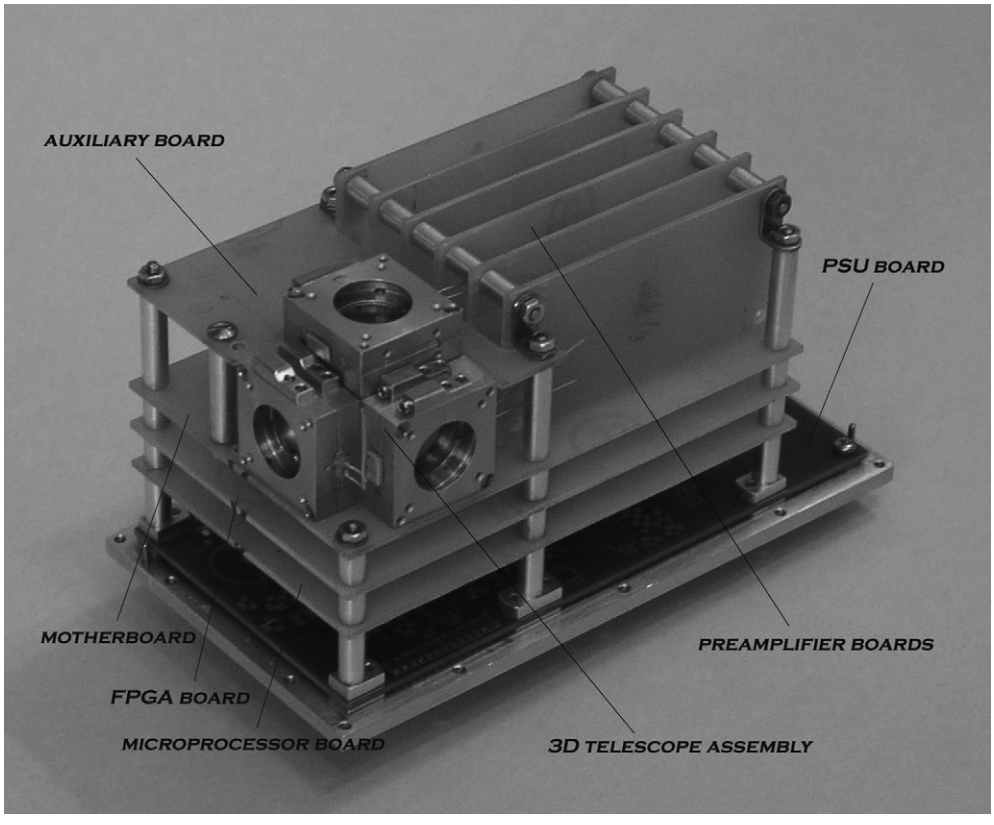

Fig. 1. Internal structure of TriTel-S.