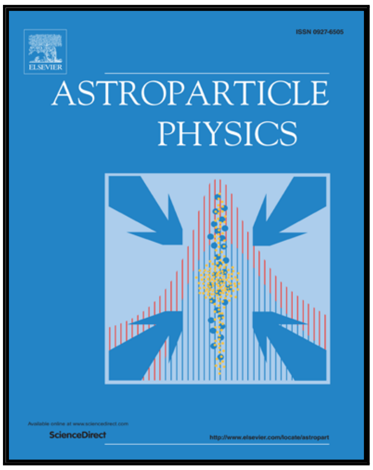

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The orbital TUS detector simulation

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Abstract

The TUS space experiment is aimed at studying energy spectrum and arrival distribution of UHECR at energies $E > 7 \cdot 10^{19}$ eV by using the data of EAS fluorescent radiation in atmosphere. The TUS mission was launched at the end of April 2016 on board the dedicated "Lomonosov" satellite. The TUSSIM software package has been developed to simulate performance of the TUS detector for the Fresnel mirror optical parameters, the light concentrator of the photo detector, the front end and trigger electronics. Trigger efficiency crucially depends on the background level which varies in a wide range: from $0.2 \cdot 10^6$ to $15 \cdot 10^6$ ph/($m^2 \cdot \mu$s$\cdot$ sr) at moonless and full moon nights respectively. The TUSSIM algorithms are described and the expected TUS statistics is presented for 5 years of data collection from the 500 km solar-synchronized orbit with allowance for the variability of the background light intensity during the space flight.

Keywords: TUS, UHECR, UHECR space detector

1. Introduction

The TUS project's goal is the experimental study of Ultra High Energy Cosmic Rays (UHECR). The fluorescent and Cherenkov radiation of the Extensive Air Showers (EAS) generated by UHECR particles is supposed to be detected in the Earth's atmosphere on the night side of the space orbit at altitudes 400–500 km. It will be possible to evaluate the EAS primary energy, position of Xmax and arrival directions at energies $E > 7 \cdot 10^{19}$ eV beyond the GZK limit[1]. The SINP MSU, JINR and Space Regatta Consortium together with several Korean and Mexican Universities collaborate in the TUS detector preparation.

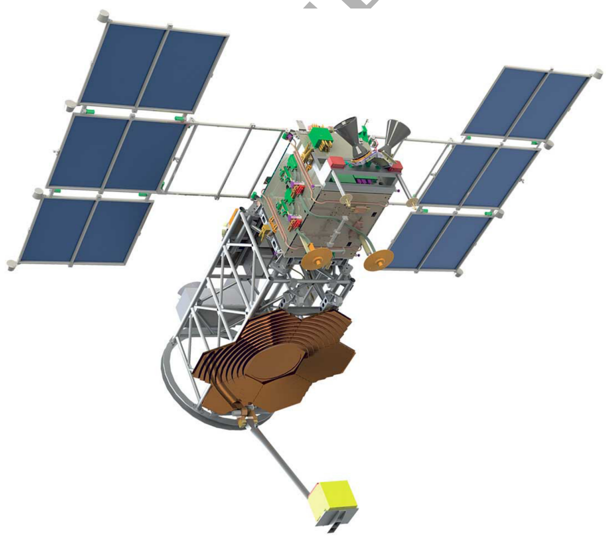

Figure 1: TUS Detector on-board the Lomonosov satellite.

An important advantage of space detector is the possibility of taking data from different arrival directions of the sky with the same apparatus and with the same systematics. In addition, the atmospheric conditions are more stable for the EAS measurements from a space orbit in comparison with the ground-based study. EAS photons move to detector through the atmosphere that is more transparent in the way to space-based detector in comparison with the EAS photons going down to the ground-based detectors. Naturally atmospheric conditions are very unstable during the flight over the different geographical locations. This leads to a change of background atmospheric radiation and an automatic system of HV regulation is used to react. With such data the existent difference between the results of the Auger detector in the south hemisphere and the TA detector in the north hemisphere may be understood [2] including obtaining definite conclusions concerning anisotropy and mass composition of UHECRs. However, the EAS signal in the space orbit is ~100 times weaker in comparison with the ground-based detectors, which leads to a difficult problem due to background albedo radiation of the Earth's atmosphere. The permanent monitoring and calibration of the apparatus with different ground-based calibration sources is supposed to be carried out during all the TUS data-taking in the orbit [3] to get more reliable data and interpret them adequately.

"The TUS detector was launched to the orbit with altitude 500 km on April 28, 2016. Being the first orbital detector of EAS fluorescence in the atmosphere it is a pathfinder for the next, larger UHECR fluorescence detectors KLYPVE [4] and JEM-EUSO [5].