Monitoring of the Earth and Moon Radiation Environment with RADOM Experiment On-board Chandrayaan-1

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Introduction

The Radiation Monitor (RADOM) is a spectrometer-dosimeter designed to measure the total absorbed dose and spectrum of the deposited energy from high energy particles on board the Chandrayaan-1 mission. The basic objective of the RADOM experiment is to monitor the radiation environment, both en-route and in lunar orbit.

Instrument Configuration

The RADOM is a very low-weight (~100 gm) low-power (~100 mW) instrument. It consists of a single 0.3 mm thick semiconductor detector with 2 cm^2 area, one low noise hybrid charge-sensitive preamplifier (A225F from Amptek Inc.); a fast 12 bit ADC; 2 microcontrollers and buffer memory. Pulse analysis technique is used for the obtaining the deposited energy spectrum, which can be used to estimate the deposited dose and flux in the silicon detector. The unit is managed by the microcontrollers through specially developed firmware. RS232 interface facilitate transmission of the data stored in the buffer memory to the Chandrayaan-1 telemetry. After switching on, the RADOM starts to measure the spectrum of the deposited energy in 256 channels with a pre-defined exposure time of 30s for a given spectrum. The exposure time can be changed by ground command if necessary. After finishing the first measurement cycle the data are stored in the buffer memory and the accumulated data are transmitted through RS232 interface for telemetry. RADOM is a very similar to some of the earlier instruments such as 1) The Liulin-E094 4 Mobile dosimetry units and R3DE/R3DR dosimeters flown onboard the International Space Station (ISS).

Results

RADOM was the first scientific payload to be switched on after the launch of the Chandrayaan-1. It started measurements on 22nd October 2008 two hours after the launch, which the space craft was still orbiting earth in a low elliptical orbit with apogee of about 23000 km and perigee of about 250 km. Here we present the results of the radiation measurement by RADOM during earth orbiting period, lunar transfer trajectory as well as during the lunar orbiting period. During earth orbiting period, Chandrayaan-1 spacecraft passed through earth's radiation belts – lower belt consisting primarily of energetic protons and upper belt consisting primarily of energetic electrons. The particle

flux and total dose in the outer electron belt are found to be ~1.5×10^4 particle cm^{-2} s^{-1} and ~40 mGy respectively, whereas the in the inner proton belt, the same are found to be ~8×10^3 particle cm^{-2} s^{-1} and ~150 mGy respectively. The higher dose in the proton belt despite slightly low flux is due to the fact that absorbed dose per proton is much higher then that for electron. Comparison of these results with other similar instruments on board ISS shows that the RADOM performance is as expected. Outside the radiation belts, en-route to the Moon the particle flux (~4 particle cm^{-2} s^{-1}) and corresponding dose were very small (~12 μGy) which further decreased slightly in the lunar orbit because of the shielding effect of the Moon. Due to the lack of significant solar activity only minor variations in the particle flux and dose were observed in the lunar orbit.