RADIATION DOSIMETRY MEASUREMENTS IN HEO ORBIT

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ABSTRACT

Observations are presented of radiation dose measurements made in HEO (Molniya) orbit since the Spring of 1994. It is found that the dose measurements are in good agreement with the predictions of AP-8, but not with AE-8. AE-8 predictions are several times larger than the observations, and the disagreement gets worse with decreasing shield thickness.

INTRODUCTION

We have been making continuous radiation dose measurements in HEO (Molniya) orbit since the Spring of 1994. The nominal shielding thicknesses of the current suite of sensors range from 12 mil (0.3 mm) of aluminum to ~500 mil (~13 mm) of aluminum in nine channels. The observations to date are summarized, and compared to the predictions of the AE-8 and AP-8 models. The HEO data also are organized in terms of the probability that a given dose rate is exceeded per orbit for use in the analysis of bulk charging and sensor background effects.

SENSORS AND OBSERVATIONS

The data were acquired by a set of sensors aboard two HEO satellites: 1994-026 and 1997-068. The detector element of each sensor consists of a small cylinder of silicon (2 mm diam by 2 mm high) under a hemispherical shield. The rear 2p is heavily shielded. The shielding thicknesses were different for the two flights; depth-dose profiles are available for seven shielding thicknesses since the launch of 1997-068 and four prior to that time. Each sensor makes a direct measurement of dose and the electron and proton countrate.

Figure 1 shows the time history of the dose/orbit from Day 128, 1994 to Day 250, 1998 from 1994-026. For the first year, during the descent to solar minimum, the 76-mil data clearly show the synodic period of the Sun. This periodicity is due to the fact that high-speed solar wind from coronal holes energizes the outer zone as the outflowing wind sweeps over the Earth. Because the coronal holes can persist for several solar rotations, the radiation dose increases in phase with the synodic period of the Sun. Recently, as solar activity increased, the dose enhancements occurred more irregularly, and there are longer time periods when the radiation intensity steadily decreases. The thicker shields show less variability, largely due to the fact that energetic protons become the dominant dose source, and the intensity of these protons is much more temporally stable.

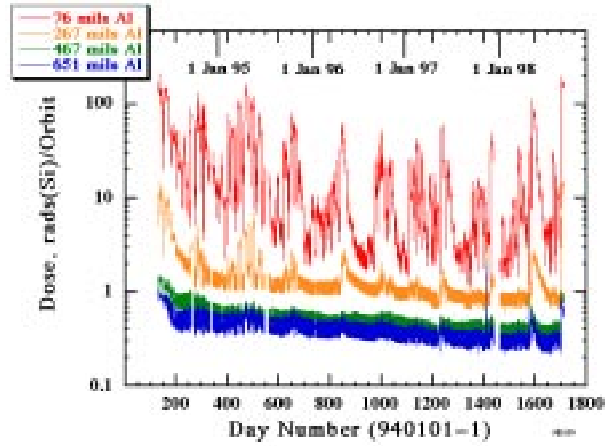

Figure 1. The history of the total dose integrated over each orbit is shown as a function of time for 1994-026.

With the launch of 1997-068, the depth dose profile has been measured over a larger range of shielding thicknesses. Figure 2 shows the dose history from Day 314, 1997 until Day 250, 1998. The sawtooth variability, most obvious for the thicker shielding, arises for two reasons. The apogee of a HEO spacecraft occurs at two fixed geographic longitudes. Because of the tilt of the geomagnetic dipole, the magnetic latitude of the satellite changes back and forth from an Atlantic traverse of the radiation belts to a Pacific traverse. Thus, mirroring particles have consistently dif-

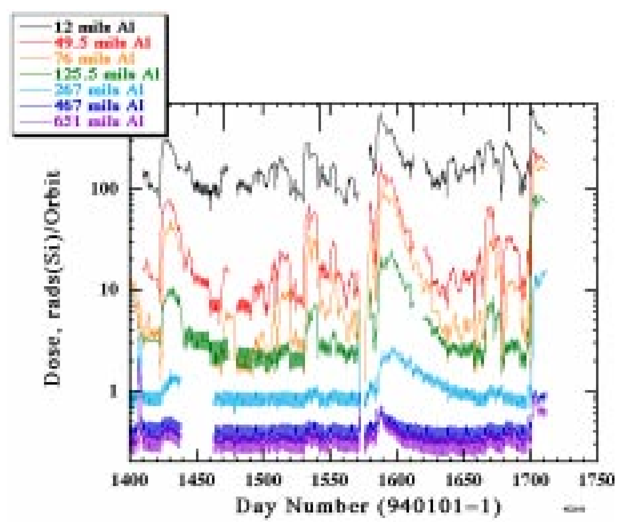

Figure 2. *The history of the total dose integrated over each orbit is shown as a function of time for 1997-068 and for 1994-026 for the time period since the launch of 1997-068.*