Abstract *(paper not available)*

‘Real-time’ Modelling of Electrostatic Fields within Dielectrics to Provide a Space Weather Risk Index for Internal Charging

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Spacecraft operators increasingly keep an eye on space weather to in order help them understand and anticipate spacecraft behaviour. Anomalies due to deep dielectric discharge remain a key element of space weather risk for satellites and are strongly associated with periods of elevated energetic electron fluxes [1]. In geostationary orbit energetic electron flux measurements are available from GOES satellites (>2MeV and >0.8MeV) and alerts are sent out by NOAA when certain threshold fluxes and one-day fluences are exceeded, these levels being set according to previous anomaly/environment correlation studies e.g. [1]. Ultimately the physical quantity determining the ESD risk is the electric field within the dielectric and so better on-orbit modelling of this parameter should provide a more accurate risk indicator. Such modelling is a major challenge as it requires good information on the varying electron spectrum in order to perform the radiation transport analysis and determine the charging currents, couple with a good understanding the dielectric material properties. Bodeau [2] has performed such modelling for dielectrics in geostationary orbit but he clearly noted the limitations of his method, especially the use of a single GOES flux channel (>2MeV) and a fixed spectral shape for the radiation transport. Bodeau also pointed out the high dependence of his results on the dielectric charge storage properties i.e. the bulk conductivity. In this paper we take an alternative approach to the electric field modelling by obtaining the charging currents from direct measurements rather than by calculation. Such measurements are increasingly available on satellites as the sensors involved are relatively simple. Thus our approach circumvents the problems of limited spectral information and of how to handle the radiation transport for continuously variable spectra. In this work we use data from a current sensor installed on the Giove-A spacecraft which has been operating in medium Earth orbit since 2005. Using the current sensor data as the input to our model we explore the effects on materials properties such as dielectric conductivity and also look at how radiation induced conductivity can be modelled and how it affects the electric field. We present a history of the modelled electric field over almost a whole solar cycle up to the present day and we conclude that such modelling could also be carried out real-time to provide a more accurate risk indicator for spacecraft operators. 1. G. Wrenn, D. Rodgers and K. Ryden, "A Solar Cycle of Spacecraft Anomalies due to Internal Charging," Annales Geophysicae , vol. 20, pp. 953-956, 2002. 2. M. Bodeau, "High Energy Electron Climatology that Supports Deep Charging Risk Assessment in GEO," in AIAA Aerospace Sciences Meeting, Orlando, 2010. 3. K. A. Ryden, A. D. P. Hands, C.I. Underwood, D.J. Rodgers , Internal Charging Measurements in Medium Earth Orbit Using the SURF Sensor: 2005–2014, IEEE Transactions on Plasma Science, Digital Object Identifier 10.1109/TPS.2015.2416436, July 2015.

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