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Author: Mr. Nathan Orr
Space Flight Laboratory, University of Toronto, Canada

Ms. Laura Bradbury
Space Flight Laboratory (SFL), Canada
Dr. Chris Perry
Rutherford Appleton Laboratory, United Kingdom
Mr. Kim Ward
Rutherford Appleton Laboratory, United Kingdom
Dr. Robert Zee
Space Flight Laboratory, University of Toronto, Canada

THE SHIELD MISSION: DEMONSTRATING A MINI-MAGNETOSPHERE SPACECRAFT RADIATION SHIELD

Abstract

Electronic components used for spacecraft avionics are sensitive to ionizing radiation which can lead to component malfunction or failure resulting in reduced mission lifetimes. Radiation protection is traditionally provided by physical (passive) shielding, at the expense of mass and volume, thus either reducing the amount of volume for additional payloads onboard the spacecraft or increasing the cost of the launch. An alternative method proposed by RAL Space would create a mini-magnetosphere to divert the majority of high energy particles around the spacecraft thereby reducing the accumulated Total Ionizing Dose (TID) experienced by the electronic components. Traditional thinking would assume this could only be achieved with a very intense magnetic field. What has now been shown is that there are local charge-separation effects at the boundary of the magnetic field and the surrounding plasma that form an effective shield at a fraction of the power originally envisioned. To demonstrate the viability of this concept RAL Space has partnered with the Space Flight Laboratory (SFL) to develop an on-orbit demonstrator mission called SHIELD (Satellite High-radiation Inhibitor for Extended Liftetime Demonstrator) that will utilize an SFL microsatellite bus with a RAL radiation shield payload called MiniMags. The satellite would be launched into a highly elliptical orbit (HEO) to gather in situ measurements of MiniMags effectiveness in shielding the spacecraft from the harsh radiation environment that includes frequent transits through the Van Allen belts. Validating simulations of the electromagnetic compatibility between MiniMags and other spacecraft subsystems, such as communications and attitude determination and control, would also be a focus of the mission. Initial development of this mission concept was done in collaboration with the Canadian Space Agency and Magellan Aerospace Winnipeg in support of the Polar Communication and Weather (PCW) program which targets a 20 year mission life in a HEO. This shielding technology is also under investigation for its potential to facilitate the use of Commercial Off-The-Shelf (COTS) components in applications beyond low earth orbit.