Recent Progress Towards a Radiation Belt Remediation Strategy Based on Artificial Injection of Plasma Waves

Gian Luca Delzanno[(1)], Quinn Marksteiner[(1)], Geoffrey Reeves[(1)], Bruce Carlsten[(1)], Patrick Colestock[(2)], Misa Cowee[(1)], Gregory Cunningham[(1)], Seth Dorfman[(3)], Leanne Duffy[(1)], Christopher Jeffery[(1)], Oleksandr Koshkarov[(1)], Vadim Roytershteyn[(4)], Kateryna Yakymenko[(1)] and Nikolai Yampolsky[(1)]

(1) Los Alamos National Laboratory, Los Alamos, NM, 87545, http://www.lanl.gov

(2) Retired

(3) University of California Los Angeles, Los Angeles, CA, USA

(4) Space Science Institute, Boulder, CO, USA

A high-altitude nuclear explosion (HANE) at low latitudes creates an artificial radiation belt of Mev electrons by beta decay of radioactive fission fragments. The HANE belt can be much more intense than the natural radiation belts and, depending on the L drift shell where HANE electrons are created, could last for very long times. Within weeks a HANE belt could damage all Low-Earth-Orbit (LEO) satellites not specifically hardened against a nuclear event, complicating and possibly strongly delaying the replacement of damaged satellites. A radiation belt remediation strategy that returns the environment to safe levels as soon as possible (ideally within less than a month) is the most viable option to mitigate the consequences of HANE and protect our critical space infrastructure.

In this talk, we will present an overview of a broad effort at Los Alamos to develop a radiation belt remediation strategy based on the artificial injection of plasma waves to enhance losses of HANE electrons via wave-particle interaction physics. This effort includes (1) the development of compact electron accelerators for space applications, which could be employed as wave source; (2) the development of modeling tools that can describe the chain of physical processes from wave generation to wave propagation in the near-Earth environment to the effect of the waves on HANE electrons; and (3) laboratory and space-based experiments that are necessary to validate the modeling framework. These include electron-beam experiments at UCLA, the Beam-PIE electron-beam rocket experiment planned for spring 2020 and the AFRL DSX mission.