

Space-Borne Accelerators

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Los Alamos is developing electron-accelerator technology for future space missions, including science missions and a possible future mission to protect low-earth orbit satellites from natural or man-made enhancements of the relativistic electron flux in the radiation belts. The target of the ongoing technology development is to be able to field, in space, an electron accelerator with 1 to 10 mA of average current. The key enabling technology for this accelerator is a new gallium nitride (GaN) high-electron mobility transistor (HEMT) which can produce about 500 W at a frequency of about 5 GHz (C-band). A chain of 50 HEMTs, each individually driving a C-band RF cavity, can accelerate an electron beam from a DC electron gun energy (about 14 keV) to about 1 MeV in about a meter.

The Beam-Plasma Interactions Experiment (Beam-PIE) is a recently selected NASA sounding rocket experiment designed to test new theoretical understandings of beam-based wave generation in the ionosphere. The main objectives of Beam-PIE are to test theories of how energetic electron beams couple to very-low frequency (VLF) waves in plasmas including whistler modes and X-type modes, and measure and quantify the resonant wave-particle scattering of ambient ionospheric electrons by X-type mode electromagnetic waves. Beam-PIE will be the first space experiment to employ the HEMT-driven accelerator technology. The proposed CONNNECTION Explorer (CONNEX) NASA mission will also rely on this technology. In this proposed experiment, a relativistic electron beam will be generated in the transition region of the magnetosphere and aimed to travel down a field line to the Earth. The main CONNEX science objective will be to study the release of energy by magnetic field line reconnections and to understand the origin of auroras and to determine how accurately ionospheric and aurora observations can predict the state of the magnetosphere. Additionally, electron-beam-driven VLF waves in the ionosphere have also been proposed as a mechanism to drain enhanced flux in the radiation belts and to limit satellite damage by allowing trapped electrons to precipitate into the Earth's atmosphere through scattering the electrons off VLF waves.

This talk will provide an overview of the accelerator technology development and experiments to date, the ongoing NASA missions, and a possible future radiation-belt remediation mission.

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