Project Introduction

We propose a 4-year 6-U CubeSat mission with the primary science goal of advancing our quantitative understanding of acceleration and loss of relativistic electrons in the Earth’s outer radiation belt. From a low inclination geosynchronous transfer orbit (GTO), GTOSat will measure electron spectra and pitch angles of both the seed and the energized electron populations simultaneously, using a compact, high-heritage Relativistic Electron Magnetic Spectrometer (REMS), a customized version of the MagEIS-Medium instruments from NASA's Van Allen Probes mission. A boom-mounted fluxgate magnetometer will provide 3-axis knowledge of the ambient local magnetic field. These high quality particle and field measurements enable direct measurement of spectral and pitch angle evolution of the outer radiation belt and calculation of physically significant quantities, such as phase space density (PSD) and its radial gradients, which are necessary to discriminate between radial transport and in-situ modes of electron energization. GTOSat will fly in a highly elliptical GTO, with nominal apogee near 6.6 Earth Radii (RE). A likely off-equatorial inclination means GTOSat will sample the particle dynamics of the outer radiation belt beyond 6.6 RE, well beyond the Van Allen Probes, providing two radial profiles of the radiation belts every orbit (~11 hours). The GTOSat bus consists of a 6U structure designed for Planetary System Corporation's (PSC) 6U deployer. It is spin-stabilized with a Sun-pointing spin-axis and deployable solar arrays. Mitigation of radiation effects is accomplished through a multi-pronged systems approach consisting of spot shielding, parts selection, and a "vault" that reduces the total dose for 1 year on orbit to less than 10 krad. The attitude determination and control system (ADCS) consists of a reaction wheel system with magneto-torquers for stability and momentum dumping, multiple fine and coarse sun sensors for pointing, and an inertial measurement unit. Communication is achieved via an S-band transceiver, enabling high data throughput through the Near-Earth Network (NEN) and real-time radiation belt monitoring via the Tracking and Data Relay Satellite System (TDRSS).

Significant systems engineering analyses have been performed already, including "Day in the Life" studies for thermal, communications, ACS, and power. In addition to the compelling science objective, which has never been attempted on a CubeSat, GTOSat will fly a new scalable radiation tolerant command and data handling (C&DH) and electrical power system (EPS) systems that could be used for future SmallSat missions, and pave the way for highly reliable, capable cubesat constellations and missions beyond low earth orbit (LEO). The NASA 2014 Science Plan notes that Heliophysics science relies on maintaining the Heliophysics System Observatory (HSO), and that this is difficult in the current constrained fiscal environment. By demonstrating that a cubesat can reliably obtain high quality scientific measurements in the Van Allen radiation belts, at a time after the Van Allen Probes will end, GTOSat serves as a timely HSO replacement spacecraft for the radiation belts, and also as a pathfinder for other reliable, low-cost, small inner magnetospheric spacecraft, in line with the NASA Science Plan and the Heliophysics Roadmap. GTOSat directly addresses the objectives of the Low-Cost Access to Space Program.
(LCAS) program by providing scientifically valuable measurements to the radiation belt community while advancing technologies to support future missions and scientific investigations and training early career scientists in instrument and mission development.

Primary U.S. Work Locations and Key Partners

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<tr>
<th>Organizations Performing Work</th>
<th>Role</th>
<th>Type</th>
<th>Location</th>
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<tr>
<td>★ Goddard Space Flight Center(GSFC)</td>
<td>Lead Organization</td>
<td>NASA Center</td>
<td>Greenbelt, MD</td>
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<tr>
<td>Aerospace Corporation</td>
<td>Supporting Organization</td>
<td>Industry</td>
<td>El Segundo, CA</td>
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<tr>
<td>University of Iowa</td>
<td>Supporting Organization</td>
<td>Academic</td>
<td>Iowa City, IA</td>
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Organizational Responsibility

Responsible Mission Directorate: Science Mission Directorate (SMD)

Lead Center / Facility: Goddard Space Flight Center (GSFC)

 Responsible Program: Heliophysics Technology and Instrument Development for Science

Project Management

Program Director: Steven Clarke
Program Manager: John Moses
Principal Investigator: Lauren Blum

Primary U.S. Work Locations

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Heliophysics Technology And Instrument Development For Science

GTOSat: A 6U CubeSat in Geosynchronous Transfer Orbit to Study Radiation Belt Dynamics
Active Technology Project (2018 - 2022)

Technology Maturity (TRL)

- Start: 4
- Current: 4
- Estimated End: 7

Technology Areas

Primary:
- TA8 Science Instruments, Observatories, and Sensor Systems

Target Destination

The Sun

For more information and an accessible alternative, please visit: https://techport.nasa.gov/view/94406