

Protection of Space Assets

- N.01 Space Radiation Mitigation for Satellite Operations
- N.02 Compact Environmental Anomaly Sensor II ACTD
- N.03 Space Environments and Hazards
- N.04 Satellite Passive Protection

N.01 Space Radiation Mitigation for Satellite Operations

Objectives. Establish the relationship between the space radiation environment, satellite anomalies, and satellite systems degradation/failures; and develop techniques/instrumentation to mitigate these adverse effects and to provide alerts for hazardous space environments. DoD dependency on space-based assets makes it imperative that space systems provide uninterrupted support to military operations. Satellite operations are adversely affected by space radiation causing transients, failure of electronic and optical components, and degradation of power systems.

Payoffs. Major benefits are increased understanding of the complex interactions of spacecraft systems, subsystems, and components with the space radiation environment and the implications of those interactions for both systems design and operations. The operational benefits include improved spacecraft reliability and availability, extended mission durations, and increased autonomy, which will reduce spacecraft development, operations, and maintenance costs.

Challenges. The technology challenges are to demonstrate in space highly miniaturized operational sensors systems for real-time alerts of space environmental hazards; develop and fly a compact system that can routinely determine the space environmental hazards to new and emerging space technologies; and develop models needed for radiation specification and forecasting. Specific demonstrations are the Compact Environmental Anomaly Sensor (CEASE) to provide real-time alerts; Relativistic Electron and Energetic Proton Experiment (REEPER) to provide in situ monitoring of the space radiation environment; and the AF-GEOSpace suite of space radiation models.

Milestones/Metrics.

FY2000: Integrate REEPER onto radiations effects test flight; continue analysis of CEASE flight data to assess operational effectiveness: goal of 90% local specification of hazardous space conditions for satellites flying CEASE. Begin radiation model development with CEASE data.

FY2001: Begin design of high-voltage interactions experiments; first test flight of REEPER; first test flight of CEASE II; develop transition plan for CEASE and REEPER to operational systems to include space weather forecasting.

FY2003: Begin fabrication of high-voltage interactions experiments and component testing of radiation effects experiment. Integrate new CEASE and REEPER models into AF-GEOSpace.

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N.01 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602601F	1010	0.4	0.4	0.4	0.4	0.0	0.0
0603410F	2822	3.2	3.3	3.6	4.0	0.0	0.0
	DTO Total	3.6	3.7	4.0	4.4	0.0	0.0

N.02 Compact Environmental Anomaly Sensor II ACTD

Objectives. Develop a miniaturized environmental sensor, weighing approximately 3 lb and having a size of less than 4 in³, for integration on a critical satellite system for launch into geosynchronous orbit prior to Solar Max (this will maximize the availability of the space system to the warfighter); provide warnings of dangerous space environment conditions to allow for safe spacecraft operations; and provide environmental data to speed anomaly resolution.

Payoffs. Specific payoffs include reduced satellite downtime, reduced user impact from satellite malfunctions, and improved ability to rule out hostile actions. The information from the Compact Environmental Anomaly Sensor (CEASE) should (1) permit the satellite operator to safe the satellite during solar storms and quickly identify space environmental sources for spacecraft anomaly resolutions, and (2) reduce downtime.

Challenges. The challenge is to develop a concept of operations (CONOPS) that utilizes data provided by the Compact Environmental Anomaly Sensor and other sources to improve the availability of military satellites for mission tasks.

Milestones/Metrics.

FY2000: Integrate into a defense support program satellite and launch.

FY2001: Demonstrate CONOPS and mission support.

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N.02 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603410F	2822	0.3	0.0	0.0	0.0	0.0	0.0
0603750D	P523	0.0	0.1	0.0	0.0	0.0	0.0
	DTO Total	0.3	0.1	0.0	0.0	0.0	0.0

N.02 Non-S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0305911	None	0.4	0.0	0.0	0.0	0.0	0.0
	DTO Total	0.4	0.0	0.0	0.0	0.0	0.0

N.03 Space Environments and Hazards

Objectives. Develop and distribute the technology and technical understanding needed to predict natural and weapon-induced hazards to space systems, and provide protection against these hazards. This encompasses both the physical threats to space systems and to their missions (e.g., propagation of RF signals through disturbed environments).

Payoffs. Both military and civilian space systems provide mission-critical support to military operations. These space systems are needed for achieving and maintaining information dominance and accomplishing the Revolution in Military Affairs. Operational planning envisions use of both dedicated military and commercial space systems. Civilian space systems are also of strategic importance as critical infrastructure, damage to which would affect the society and economy.

Challenges. The space environment is complex. There are shortfalls in understanding, modeling, and predicting the disturbed and hazardous environments, even where our knowledge is robust. Multiple hazards must be predicted and countered. There are shortfalls in the available experimental data and in the understanding of many important potentially hazardous effects. Models of the space environment and space system–environment interactions do not have the required fidelity.

Milestones/Metrics.

FY2000: Initial multifluid MEGS computation to follow debris expansion at very high burst altitudes.

FY2001: SHYPS and CIVIC codes transferred to and running on the DoD high-performance computer; COMLINK version including a full GPS constellation.

FY2002: Simulation of high-altitude bursts to provide improved debris and shock expansion data. Complete natural environment in ISM.

FY2003: Inclusion of new debris and shock expansion data into prediction tools; inclusion of NWE in ISM.

FY2005: Dynamic trapped radiation model integrated into national/theater missile defense engagement modeling.

Customer POC

Service/Agency POC

USD(A&T) POC

N.03 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602715BR	AF	3.8	0.0	0.0	0.0	0.0	0.0
0602715BR	BD	0.0	2.8	3.0	1.9	1.4	1.5
	DTO Total	3.8	2.8	3.0	1.9	1.4	1.5

N.04 Satellite Passive Protection

Objectives. Develop and demonstrate, by 2005, passive technologies for satellite onboard laser protection (e.g., IR surveillance and launch detection systems) against ground-based laser threats (dazzle and damage). Concepts include antijam and damage protection materials/devices. Analysis tools to demonstrate the impact of ground-based lasers on surveillance systems will be developed. Computer animation techniques will provide these tools with a graphical user interface. Hardware and software will be developed to trigger dazzle protection devices with prior knowledge of ground-based laser wavelengths. Where possible, agile laser filters will be developed and used. Laser damage protection devices will be demonstrated using ground simulations.

Payoffs. The technologies being developed will provide cost-effective, performance-compatible protection techniques to withstand man-made hostile environments and preclude unacceptable mission or lifetime degradation. Reliance on military space assets is constantly growing, but at the same time, so are the sophistication, power, and availability of low-cost directed-energy weapons as hostile threats to those space assets. The technologies being developed will help ensure the availability of friendly space assets in the face of these growing threats.

Challenges. The major technical challenge is to develop and demonstrate passive laser protection techniques for multiple-wavelength, multiple-pulsewidth lasers with minimal cost and performance impact to the systems being protected. Products include laser filter and limiter technologies and analysis tools, and nominal interface electronics for conducting experiments/demonstrations. Tunable filters must be developed for true agile jamming protection. Analysis tools must be developed that demonstrate to space system users the value added by passive protection techniques.

Milestones/Metrics.

FY2001: Demonstrate IR Rugate filters for jamming protection.

FY2002: Demonstrate candidate limiter materials for laser damage protection.

FY2003: Deliver PC-based threat assessment tool with animation capability. Integrate experiment hardware and develop software for flight demonstration.

FY2004: Integrate into planned space sensor protection experiment.

FY2005: Fly planned experiment. Complete data reduction and analysis.

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N.04 S&T Funding (\$ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603112F	2100	1.2	1.1	1.2	0.9	1.0	1.0
0603270F	691X	0.5	1.3	1.3	1.1	1.2	1.8
0603401F	4400	0.0	0.2	2.3	2.8	3.1	3.6
	DTO Total	1.7	2.6	4.8	4.8	5.3	6.4