2014 ISS Proposal Abstracts

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DE 14ISS-EPSCoR-0009

Improved EVA Suit MMOD Protection using STF-Armor TM and self-healing polymers

EVA Suit Self-healing polymers

We propose to evaluate the stability and efficacy of advanced extra-vehicular activity (EVA) suit lay-ups containing advanced nanocomposite textiles and self-healing materials (being developed under a NASA EPSCoR award) in the extreme thermal, vacuum, atomic oxygen and radiation environment of low-earth orbit (LEO). The proposed material testing in the Materials on the International Space Station Experiment (MISSE) is aimed at advancing the technology readiness level (TRL) of MMOD-resistant and self-healing materials that have been developed and tested on Earth. Proof-of-concept and prototype testing (TRL 3 to 4) has been performed on MMOD-resistant STF-textiles in the full EVA suit lay-ups using hypervelocity testing at NASA Marshall Space Flight Center and most currently, at White Sands Test Facility with the assistance of the NASA Johnson Space Flight Center's Hypervelocity Impact Technology (HVIT) Group (Lead Dr. Eric Christiansen). *Our goals it to achieve TRL 6 by the end of the three years of proposed effort.*

KY 14ISS-EPSCoR-0012

Validation of a CubeSat stellar gyroscope system

CubeSat Gyroscope Validation

KySat-2 is a 1U CubeSat develop by Kentucky Space through collaboration between the University of Kentucky (UK), Morehead State University (MSU) (NNX10AN01A). In this work, we propose to upgrade the second Flight Model of KySat-2 for launch from the International Space Station from the NanoRacks External Deployment system into low-Earth orbit. The primary mission of KySat-2 is to test a novel new method of attitude determination for small spacecraft called the stellar gyroscope directly addressing one of the major technological challenges limiting the utility of small spacecraft for a variety of missions. The stellar gyroscope estimates attitude changes by analyzing the relative motion of stars between successive image frames, lowering the computational and power requirements necessary to propagate attitude changes. Launch from the ISS will allow characterization the stellar gyroscope hardware, verification of the sensitivity of the sensor for star imaging as well as the image processing required on-orbit. Additionally, ejection from the ISS altitude will allow analysis of the ejection dynamics of the spacecraft using the Smart Nanosatellite Attitude Propagator (SNAP) tool developed by the UK Space Systems Laboratory to characterize atmospheric drag for Low Earth-Orbit (LEO) CubeSats.

ME 14ISS-EPSCoR-0003

Joint leak detection and localization based on fast Bayesian inference from network of ultrasonic sensors arrays in microgravity environment

Ultrasonic Leak Sensors Arrays

Leaks causing air and heat loss are major source of concern in mission safety. This project involves development of a flight ready wireless sensor system based on recent NASA EPSCoR funded structural health monitoring R&D activities at UMaine. The proposed system will be able to detect and localize leaks based on ultrasonic sensor array signals using a novel fast Bayesian inference technique. The proposed system test and verification in a microgravity environment is expected to expand knowledge of sensor system operations and performance degradations in outer space. Partners include the University of Maine (UMaine) Electrical and Computer Engineering (ECE) and Mechanical Engineering (MEE) departments and NASA Johnson Space Center SC ISS Technology demonstration branch.

MT 14ISS-EPSCoR-0013

Space flight demonstration of a radiation tolerant, FPGA-based computer system on the ISS

Radiation Tolerant Computer Tech Demo

The overall goal of this project is to test a novel radiation tolerant computer system on the International Space Station (ISS) in order to demonstrate its proper functionality in an operational environment. The computer system achieves radiation tolerance through a new architecture that can detect, avoid, and repair faults caused by high energy ionizing radiation by exploiting the re-programmability of commercial off-the-shelf (COTS) Field Programmable Gate Arrays (FPGA). This fault mitigation approach has been shown to deliver higher reliability, increased computation and power efficiency, and an order of magnitude cost reduction compared to existing radiation-hardened computer systems. The computer technology to be demonstrated has been matured to TRL-5 through existing NASA EPSCoR funding (2010-present). The success of our team's EPSCoR project has led to three competitively awarded follow-on projects from NASA that has allowed this computer technology to be matured to the point where a demonstration on the ISS requires minimal effort and budget. Testing of this technology on the ISS will expose the system to a high energy radiation environment that cannot be duplicated on earth (>GeV/amu). An ISS demonstration will also provide prolonged exposure to the infrequent high energy radiation strikes (2-3 faults per day) in order to provide a comprehensive evaluation of the reliability of the computer system. The ISS provides an ideal platform to mature this technology to TRL-9 without building the required avionics for a stand-alone satellite mission.

In this project, our team will implement our computer in a 1U form factor (100mm3) for deployment on the ISS using the *CubeLab* experiment system from *NanoRacks LLC* [1-4]. The CubeLab system provides the necessary power for our experiment (2W). The NanoRacks platforms are already deployed on the ISS in the EXPRESS 4 racks in the Japanese Experiment Module (JEM) [5-7]. Our computer logs its state-of-health information to an internal non-volatile memory system so no ISS crew time is required beyond installation and removal. The effort to implement our system into a 1U, CubeLab format is minimal since our existing NASA projects are already developing the hardware in a CubeSat form factor for a potential demonstration through the NASA CubeSat Launch Initiative. Our existing projects are focusing on the development of the CubeSat avionics in order to mature the computer technology to TRL-8 through flight qualification (ground) in a full satellite form factor. A demonstration of just the computer technology (no avionics) on the ISS will achieve TRL-9 with minimal effort and in less time (<1 year) than a stand-alone, low-earth-orbit mission and will greatly increase the possibility of adoption of this technology into future NASA programs. Figure 1 shows the mission concept for this flight demonstration.

NE 14ISS-EPSCoR-0006

Investigation of fatigue due to solar neutron and other radiation absorption in new materials for neutron voltaic devices

Radiation Absorption in New Materials

The PIs of this proposal seek to install an experiment on the International Space Station, ISS, to investigate the neutron absorbers Lithium tetraborate and boron carbide, and specifically radiation damage and materials fatigue as the result of the absorption of solar neutrons and exposure to other solar radiation. The PIs currently receive funding from the NASA EPSCoR program to study those materials as neutron absorbers in neutron voltaic devices, which would be useful to NASA to generate electricity to power deep space satellites. The development of neutron voltaics is currently subject of a NASA EPSCoR grant at UNL, titled "**Neutron voltaics for deep space missions**", where Enders is PI, and Dowben and Ianno are Co-PIs. This present application would expand the scope of this current grant, by allowing the PIs to study materials developed in the space environment. Neutron voltaic devices generate electricity from the absorption of neutrons, analog to the photon absorption in a photovoltaic device.