ISS Local Environment Spectrometers (ISLES)

In order to study the complex interactions between the space environment surrounding the ISS and the ISS surface materials, we propose to use low-cost, high-TRL plasma sensors on the ISS robotic arm to probe the ISS space environment. During many years of ISS operation, we have been able to condut effective (but not perfect) extravehicular activities (both human and robotic) within the perturbed local ISS space environment. Because of the complexity of the interaction between the ISS and the LEO space environment, there remain important questions, such as differential charging at solar panel junctions (the so-called â€œtriple pointâ€ between conductor, dielectric, and space plasma), increased chemical contamination due to ISS surface charging and/or thruster activation, water dumps, etc, and â€œbootstrapâ€ charging of insulating surfaces. Some compelling questions could synergistically draw upon a common sensor suite, which also leverages previous and current MSFC investments. Specific questions address ISS surface charging, plasma contactor plume expansion in a magnetized drifting plasma, and possible localized contamination effects across the ISS.

Question 1: How does the ISS potential and surface charging vary across the ISS as a function of location, external perturbations, and ISS states? The ISS Floating Potential Monitoring Unit (FPMU) instrument has provided invaluable information regarding the average ISS frame-to-ambient plasma potential, but little is known about potential variation across the ISS due to the complexity of the station surface materials, solar array interactions with the ionosphere, and external perturbations such as in the auroral zones. A portable instrument suite that could be scanned by the Space Station Remote Manipulator System (SSRMS) would be capable of addressing such a question.

Question 2: How do emitted plasma plumes moving in a mesosonic, magnetoplasma ambient expand as well as emit and collect current? The ISS Xe plasma plume drifts through the ionosphere and across the Earthâ€™s magnetic field, resulting in complex dynamics. This is of practical and theoretical interest pertaining to contamination concerns (e.g. energetic ion scattering) and the ability to collect and emit current between the spacecraft and the ambient plasma ionosphere. This impacts, for example, decisions about placing high energy electric propulsion thrusters in on ISS. Plasma emissions from ISS Plasma Contactor Unit (PCU) using a portable instrument suite on the SSRMS is uniquely capable of addressing this question.

The instrument suite for this mission concept study consists of the Thermal Ion Capped Hemispherical Spectrometer (TICHS), Thermal Electron Capped Hemispherical Spectrometer (TECHS), Charge Analyzer Responsive to Local Oscillations (CARLO), the Collimated PhotoElectron Gun (CPEG), the University of Michigan Langmuir Probe (UMLP), and four optical/UV narrow-band photometers. A quantitative analysis of the performance of these instruments acting in concert to answer the investigation's questions will be presented.