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The Situational Awareness Sensor Suite for the ISS (SASSI) Mission Concept: Investigating ISS Charging and Wake Effects

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The complex interaction between the International Space Station (ISS) and the surrounding plasma environment often generates unpredictable environmental situations that affect operations. Examples of affected systems include extravehicular activity (EVA) safety, solar panel efficiency, and scientific instrument integrity. Models and heuristically-derived best practices are well-suited for routine operations, but when it comes to unusual or anomalous events or situations, especially those driven by space weather, there is no substitute for real-time monitoring. Space environment data collected in real-time (or near-real time) can be used operationally for both real-time alarms and data sources in assimilative models to predict environmental conditions important for operational planning. Fixed space weather instruments mounted to the ISS can be used for monitoring the ambient space environment, but knowing whether or not (or to what extent) the ISS affects the measurements themselves requires adequate space situational awareness (SSA) local to the ISS. This paper presents a mission concept to use a suite of plasma instruments mounted at the end of the ISS robotic arm to systematically explore the interaction between the Space Station structure and its surrounding environment. The Situational Awareness Sensor Suite for the ISS (SASSI) would be deployed and operated on the ISS Express Logistics Carrier (ELC) for long-term "survey mode" observations and the Space Station Remote Manipulator System (SSRMS) for short-term "campaign mode" observations. Specific areas of investigation relevant to spacecraft charging and wake effects include: 1) ISS frame and surface charging during perturbations of the local ISS space environment, 2) calibration of the ISS Floating Point Measurement Unit (FPMU), 3) long baseline measurements of ambient ionospheric electric potential structures, 4) electromotive force-induced currents within large structures moving through a magnetized plasma, and 5) wake-induced ion waves in both electrostatic (i.e. particles) and electromagnetic modes. SASSI will advance the understanding of plasma-boundary interaction phenomena, demonstrate a suite a sensors acting in concert to provide effective SSA, and validate and/or calibrate existing ISS space environment instruments and models.