The International Space Station Floating Potential Measurement Unit and Instrumentation Validation in Laboratory Plasma

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Space vehicles charge relative to the ambient environment by collecting electrons from the space plasma through which they pass. Vehicle charging, a function of the local electron density and temperature, involves a complex interaction of exposed potentials on solar panels, photoelectrons, surface properties, vehicle wake effects, and secondary electron emission. Considerable work has gone into developing charging models for the International Space Station (ISS). The excessive vehicle charging these models predict is a risk to astronauts working outside of the station and accelerates degradation of space station surface properties. A redundant set of plasma contactors have been installed on the space station to control vehicle charging. A Floating Potential Measurement Unit (FPMU) is being developed to assess how well this control system works. It will be placed on orbit January 2003 and will be operational for three years. Built by the Space Dynamics Lab at Utah State University, FPMU consists of a narrow sweeping Langmuir probe, a wide sweeping Langmuir probe, a floating potential probe, and a combination impedance / plasma frequency probe. Figure 1 depicts the Floating Potential Measurement Unit. These instruments will directly measure the floating potential of the space station over a +20 to -80 volt range. Local electron density will be measured at 520 Hz over the range of 103 to 107 per cm3 using plasma frequency probe measurements. Electron temperature will be determined from Langmuir sweeps at a 1 Hz rate and will provide temperature in the range of 500 to 4800 K. FPMU will be mounted remotely on the S1 truss of the space station out of the wake of ISS components. FPMU must make data and power connections through one of the external ISS camera sites. The video downlink provides 80 kbits/s for data, providing an unprecedented opportunity to transmit all raw Langmuir data to the ground for analysis. A drawback of video interface is that data collection is only possible when Ka-band contact is established with the ISS, or for approximately one half of an orbit.

FPMU will undergo testing in plasma chambers as part of NASA's development and acceptance requirements. This testing will occur at NASA Marshall and the Naval Research Laboratory. Both facilities have large plasma chambers that can accommodate the entire FPMU. Testing will be carried out using a range of densities and temperatures. FPMU will be compared with the standard instrumentation at each of the laboratory sites. The FPMU provides an interesting and rare opportunity to correlate Langmuir and impedance probe techniques for plasma diagnostics in both space and laboratory conditions. It also provides a unique opportunity to cross correlate plasma chamber measurements

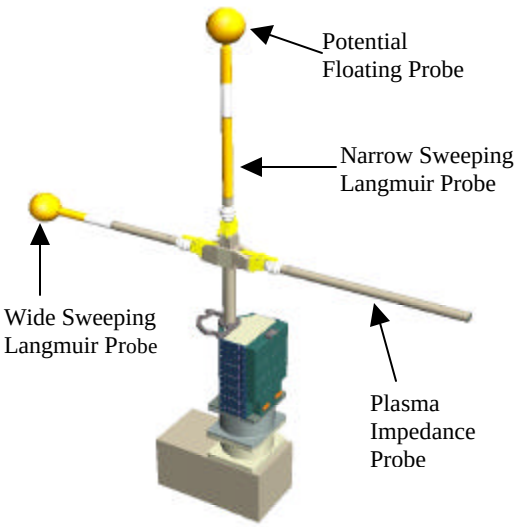

Fig. 1. The Floating Potential Measurement Unit