Simulating the solar wind plasma environment in a vacuum chamber

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Abstract. The Mechanical and Aerospace Engineering Department's Gas and Plasma Dynamics Laboratory's large-scale vacuum chamber has been retrofitted to create an environment that is analogous to that of the lunar surface. The large-scale vacuum chamber in use is 6-ft in diameter and 10-ft in length and is brought down to pressures of 10^{-3} Torr by two roughing pumps before being brought to base pressures of 10^{-6} Torr by four oil diffusion pumps. To reach these low pressures, only one diffusion pump needs to be turned on, but if a higher throughput is needed (i.e., large amounts of external gas is being put into the chamber) multiple diffusion pumps can be used to maintain a low base pressure. This set up has an estimated pumping speed of 200,000 L/s on air. A series of hydraulic valves are used to open and close lines to the pumping system as needed, and pressure and temperature sensors are used to monitor the facility at all times.

A 12-cm radio frequency (RF) plasma source is fitted to the chamber wall and used to simulate the charged lunar environment. This source can generate an ion beam with up to 1.5 keV of kinetic energy with a maximum beam current of 500 mA. A Langmuir probe is used to interrogate this plume for relevant plasma properties. This probe is placed downstream of the source and on a moving platform. This platform is able to move throughout a large region of the source's generated plasma. This plasma source, as well as a map of the probe scan region, can be seen in Fig. 1. The characteristics found from this interrogation (beam potential, electron density, and electron temperature) will be presented and discussed.

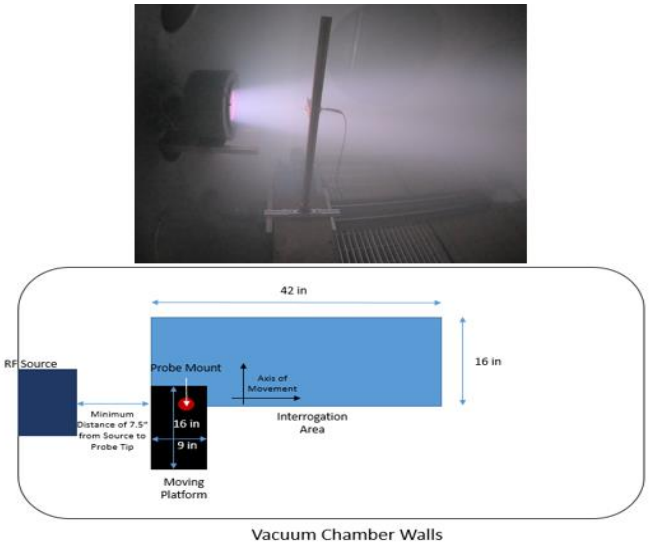

Figure 1: A Langmuir probe positioned within the generated plasma (top) and a map of the scan region this probe can interrogate (bottom).