Parameterization of the Laboratory Performance of the Mini-Magnetospheric Plasma Propulsion (M2P2) Prototype*†

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The Mini-Magnetospheric Plasma Propulsion (M2P2) Prototype seeks the creation of a magnetic wall or bubble (i.e. a magnetosphere) attached to a spacecraft that will intercept the solar wind and thereby provide a high-speed propulsion system with little expenditure and efficient use of propellant. To accomplish this task, plasma is injected onto the field lines of a dipole magnet and when the plasma pressure becomes greater than the magnetic energy density of the dipole an outward expansion or inflation of the mini-magnetosphere will occur. A prototype for testing the magnetic inflation and necessary plasma parameters has been built and tested at the University of Washington. For M2P2 to work it will require a plasma source capable or producing moderate plasma density (10^{18} m^{-3}) with electron temperatures on the order of a few electron volts. A helicon plasma source was chosen because in other laboratory applications it appears sufficient to generate the necessary plasma parameters and is capable of continuous or pulsed operation with 1-2 kilowatts of power consumption. Characterization of plasma parameters in the dipole geometry, where the plasma is injected along the field lines, while maintaining a low neutral gas pressure outside the dipole has been conducted. Plasma densities are found to be similar to other helicon sources with a possible increase in electron temperature at the source region. The helicon source is able to produce a high beta plasma in the dipole equator, expanding the dipole magnetic field. The magnetic field perturbation from this expansion has been measured with magnetic field probes. The amplitude of the perturbation continues to grow even on long time scales as compared to the relevant plasma equilibration times.

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