

Plasma sail propulsion based on the plasma magnet is a unique system that taps the ambient energy of the solar wind with minimal energy and mass requirements. The coupling to the solar wind is made through the generation of a large-scale (~ 30 km) dipolar magnetic field. Unlike the original magnetic sail concept, the coil currents are conducted in a plasma rather than a superconducting coil. In this way the mass of the sail is reduced by orders of magnitude for the same thrust power. The plasma magnet consists of a pair of polyphase coils that produce a rotating magnetic field (RMF) that drives the necessary currents in the plasma to inflate and maintain the large-scale magnetic structure. The plasma magnet is deployed by the Lorentz self-force on the plasma currents, expanding outward in a disk-like shape until the expansion is halted by the solar wind pressure. It is virtually propellantless as the intercepted solar wind replenishes the small amount of plasma required to carry the magnet currents. Unlike a solid magnet or sail, the plasma magnet expands with falling solar wind pressure to provide constant thrust.

In phase I a small prototype plasma magnet was built and tested. The RMF coils generated over 10 kA of plasma currents with a radial expansion pressure sufficient to expand the dipole field to well over the 30 km scale that would supply as much as 5 MW of thrust power. The antenna and driver need weigh no more than 10 kg, and can operate from a 300 V supply. With the predicted scaling with size, it is possible to test the concept in the laboratory with a greatly enhanced laboratory solar wind source. Under phase II, a laboratory scaled experiment with an intensified solar wind source will assess the power gain predicted. With the successful demonstration of thrust power at the several hundred kW level, a final large tank test would be undertaken in phase III, and provide the final confirmation of the scaling for a space-based demonstration.

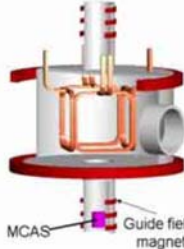
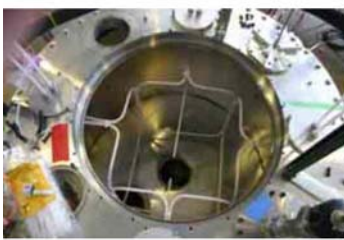


Figure 4. Metal vacuum chamber with two pair of RMF coil sets for producing the B_x and B_y component of the rotating field.

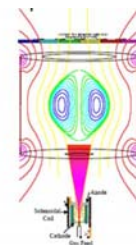
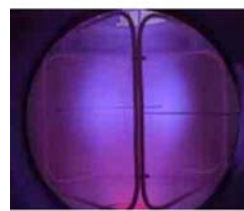


Figure 8. At left is a time integrated image of the plasma emission during an Argon RMF discharge. The center picture provides the perspective for the image. The figure at right is the 2D MHD equilibrium flux contours corresponding to the discharge conditions determined by the magnetic probe array and Langmuir probe profiles, as well as external magnetic measurements.