Dr. John Slough
University of Washington
The Plasma Magnet

By intercepting the solar wind on a large enough scale, it is possible for a spacecraft to attain unprecedented speeds. The plasma magnet provides for a novel way by which this ambient energy of the solar wind can be captured with minimal energy and mass requirements. The coupling to the solar wind is made through the generation of a large-scale (~ 30 km) dipole-magnetic field. Unlike the original magnetic sail concept [1], 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 small-scale, low power plasma source and a pair of meter size polyphase coils. These coils produce a rotating magnetic field that drives the necessary currents to maintain the large-scale magnetic dipole structure. These coils act much in the same way that the stator does in an induction motor where the plasma electron fluid acts as the rotor. The plasma electrons rotate synchronously with the rotating field and produce a large dipole field in which the plasma remains magnetically confined. The plasma magnet is deployed by the Lorentz self-force on the plasma current, which causes it to expand 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 can replenish and sustain 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 as it moves regardless of the distance from the sun.

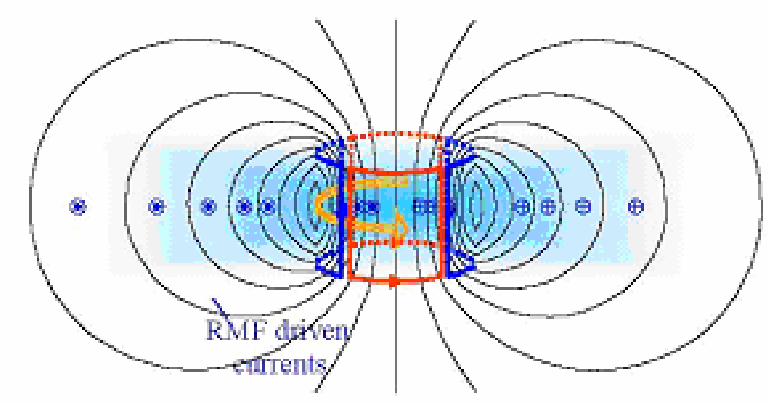

Figure 1. Plasma magnet configuration. The steady confining dipole field shown is produced by azimuthal currents driven in the plasma. The two pair of saddle coils (red and blue) carry RF currents that are phased to produce a magnetic dipole field that rotates in the equatorial plane (field not shown for clarity – see fig. 2).