Abstract Submitted
for the GEC10 Meeting of
The American Physical Society

Detachment mechanisms in a magnetic nozzle MARIO MERINO, EDUARDO AHEDO, Universidad Politécnica de Madrid — A 2D model of the supersonic plasma expansion in a divergent magnetic nozzle generated by an external coil is considered. The plasma is assumed collisionless, low-beta, and constituted of fully-magnetized electrons and cold, partially-magnetized ions. Thus, electrons are attached to the magnetic streamtubes by the gyro-force, whereas ions are attached electrostatically to electrons, i.e. by quasineutrality. The gain in plasma kinetic energy is driven mainly by electrothermal acceleration. Hall current runs opposite to the coil current, as it is mandatory to provide confinement and thrust. For a non-rotating jet, a modest (ion) swirl current develops, cancelling partially the Hall current. Three feasible detachment mechanisms have been proposed in the literature, based (1) in the plasma induced field, (2) electron inertia, and (3) collisions. The relevance of each one depends on the plasma collisionality and beta, and the upstream conditions, but they all rely on the plasma azimuthal (i.e. Hall plus swirl) current. A critical assessment of detachment theories for a propulsion device will be carried out. Inertial and resistive detachment mechanisms are found to be divergent (i.e. the radial detachment of electron streamtubes is outwards), in contrast to the prevailing theory. Magnetically-induced detachment depends on the direction of the Hall current. Established theory, which postulates a stretching of the magnetic field, does not hold for thrusting plasmas.

Mario Merino
Universidad Politécnica de Madrid

Date submitted: 12 Jun 2010 Electronic form version 1.4