## Effect of Flux Conservers on Inductive Pulsed Plasmoid Thrusters \* Christopher L. Sercel, Joshua M. Woods, Tate M. Gill and Benjamin A. Jorns Department of Aerospace Engineering, University of Michigan (csercel@umich.edu)

Inductively driven pulsed plasmoid thrusters are propulsion devices which function by inducing strong currents in plasmas using electromagnetic fields to form plasmoids, coherent plasma structures which can then be ejected at high speed to produce thrust. These devices have several potential advantages over state-of-the-art steady-state propulsion schemes [1]. Recently, both the Department of Defense and NASA have expressed interest in the Field-Reversed Configuration thruster, a design which borrows heritage from the fusion community [2].

A common feature of the FRC confinement device used in fusion research is the inclusion of flux-conserving rings. These are conductive metal bands surrounding the plasma which serve

to increase the magnetic pressure outside the plasmoid separatrix [3]. Flux-conserving rings, or flux conservers, are often included in FRC thrusters as well, with the argument the increased magnetic pressure will help to accelerate the plasmoid [4]. However, quantitative evidence of the benefits of flux conservers is lacking.

To analyze the effect of these flux conservers, we present a circuit analysis of the FRC thruster. The device is abstracted into several current loops which couple to each other inductively. After establishing this model, two primary assumptions are made: elimination of loss terms and the limiting case of instant current spin-up, in which the driver coil couples all its energy into the plasma instantaneously. By making these assumptions we arrive at a closed

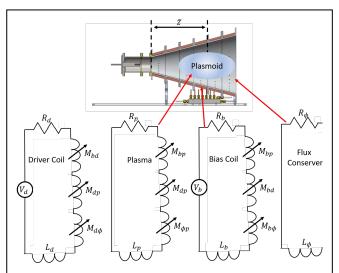


Figure 1 - A general thruster design is broken up into several component circuits, each of which couple into the others via mutual inductance.

form expression for thruster efficiency as a function of initial conditions.

It is found that in the limit of instant current spin-up, in which the driver coil couples all its energy into the plasma instantaneously, flux conservers represent an efficiency loss to the thruster. This result suggests that conductive structure elements should be minimized in the designs of future thrusters to reduce losses unless confinement is an important goal.

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## References

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