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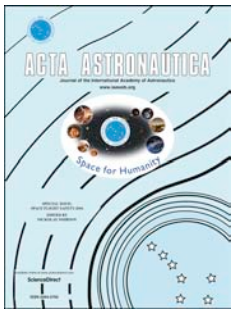


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# Pulsed Fusion Space Propulsion: Computational Magneto-Hydro Dynamics of a Multi-Coil Parabolic Reaction Chamber☆

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**Abstract**

Pulsed fusion propulsion might finally revolutionise manned space exploration by providing an a ordable and relatively fast access to interplanetary destinations. However, such systems are still in an early development phase and one of the key areas requiring further investigations is the operation of the magnetic nozzle, the device meant to exploit the fusion energy and generate thrust. One of the last pulsed fusion magnetic nozzle design is the so called multi-coil parabolic reaction chamber: the reaction is thereby ignited at the focus of an open parabolic chamber, enclosed by a series of coaxial superconducting coils that apply a magnetic field. The field, beside confining the reaction and preventing any contact between hot fusion plasma and chamber structure, is also meant to reflect the explosion and push plasma out of the rocket. Reflection is attained thanks to electric currents induced in conductive skin layers that cover each of the coils, the change of plasma axial momentum generates thrust in reaction. This working principle has yet to be extensively verified and computational Magneto-Hydro Dynamics (MHD) is a viable option to achieve that. This work is one of the first detailed ideal-MHD analysis of a a multi-coil parabolic reaction chamber of this kind and has been completed employing PLUTO, a freely distributed computational code developed at the Physics Department of the University of Turin. The results are thus a preliminary verification of the chamber s performance. Nonetheless, plasma leakage through the chamber structure has been highlighted. Therefore, further investigations are required to validate the chamber design. Implementing a more accurate physical model (e.g. Hall-MHD or relativistic-MHD) is thus mandatory, and PLUTO shows the capabilities to achieve that.

*Keywords:* fusion rocket, computational MHD, magnetic nozzle

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Abbreviations: British Interplanetary Society (BIS), Constrained Transport (CT), Electro-Motive Force (EMF), High Resolution Shock Capturing (HRSC), Human Outer Planet Exploration (HOPE), International Astronautical Congress (IAC), Inertial Confinement Fusion (ICF), Inertial Electrostatic Confinement Fusion (IECF), Magnetic Confinement Fusion (MCF), Initial Mass in Low Earth Orbit (IMLEO), Magneto-Inertial Fusion (MIF), Magnetised Target Fusion (MTF), Magneto-Hydro Dynamics (MHD), Relativistic Magneto-Hydro Dynamics (RMHD), Specific impulse ($I_{sp}$), Total Variation Diminishing (TVD)