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Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: PROPHY, CFDMPS *(3 maximum from the list of topics)*

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Title
Numerical modelling of supersonic magnetic nozzles

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Abstract
New, out of low-earth orbit missions' concepts, accentuates the role of electric propulsion in space exploration. This drives the demand for innovative thruster architectures to provide new capability in terms of thrust control and vectorisation. Possible technical realisation of such demand comes with an application of strong external magnetic field [1]. These so-called magnetic nozzles bring the possibility of contactless acceleration and vectorisation of plasma plumes [2]. Acceleration mechanism in magnetic nozzles is often compared to the one observed in deLavale nozzles where thermal energy is converted to axial acceleration due in transonic conditions [3]. However due to the presence of electric currents, detachment and collision with neutral particles magnetic fields magnetic nozzles are considerably different and their understanding requires application of specific numerical techniques[1].

In this work we present our results on application of steady state magnetohydrodynamic (MHD) model to simulate magnetic nozzle condition. Our one-fluid approach in-coded in the OpenFOAM framework explores capability of Finite Volume Method for simulating magnetic nozzle scenarios. Presented results include the discussion on its capability to resolve neutral and magnetohydrodynamic shockwaves using pressure-based algorithm with modified advection upstream splitting method. Model verification is done by comparison with the results of established tow-fluid codes [1]. As a result, this work explores a niche area, on the nexus of numerical plasma physics and engineering application. Parametric studies show the role of different magnetic field configurations and derive conclusions on possible coil architectures that could develop unique magnetic field scenarios and their related problems.

This work shows the capability of universal numerical frameworks to simulate plasma behaviour of low-temperature quasi-neutral plasmas. Application of open-source framework demonstrates potential of direct code utilisation in engineering and academic environment. Additionally, the work contributes to the development the next generation thruster derived from applied field magnetoplasmadynamic, helicon, electron cyclotron resonance thrusters.

References
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