Paper ID: 8354
student

SPACE PROPULSION SYMPOSIUM (C4)
Nuclear Propulsion and Power (7.-C3.5)

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SCALING LAWS FOR PLASMA JET MAGNETO-INERTIAL FUSION

Abstract

Plasma jet magneto-inertial fusion (PJMIF) is a prospective fusion energy concept which consists of an imploding liner which shock heats and compresses a magnetized target. The liner is formed by the merging of a cylindrical or spherical distribution of plasma jets, which are launched by a salvo of plasma rail-guns. Simulations as well as analytical analysis show that PJMIF concept is capable of achieving conditions for reaching fusion break-even. PJMIF potentially has many advantages over the conventional pure magnetic or pure inertial approaches for both space propulsion and terrestrial power applications. United States Department of Energy has recently approved funding for a mid-scale Plasma Liner Experiment (PLX), which will be carried out at Los Alamos National Laboratory. University of Alabama in Huntsville is developing the theoretical model for the experiment, which will help identify possible deleterious effects due to instabilities or asymmetries, identify departures from ideal behavior due to thermal and radiative transport, and help determine scaling laws for possible follow-on applications. This paper is a result of analysis of simulation series which were carried out by a smooth particle hydrodynamics (SPH) code. In particular we present results from a series of cylindrical and spherical implosion models with the purpose of understanding fundamental scaling laws of PJMIF. Variables which have been observed are: jet species, number of plasma jets, specific heat ratio, initial jet velocity, initial Mach number, initial number density, jet diameter, jet length, and initial jet configuration. Preliminary results indicate a strong correlation between the peak pressure and the initial jet Mach number. The presence of an adiabatic target greatly enhances the peak conditions reached. The dwell time at these conditions is also linear with the plasma liner thickness. Future work will include developing of more complex physical model simulations for 1D, 2D and 3D geometries, model validation and benchmarking by experimental data.