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STARGATE: AN UNDERGRADUATE EXPERIMENTAL ELECTRIC PROPULSION STUDENT RESEARCH PROJECT

Abstract

STARGATE is an experimental electric propulsion undergraduate student research project at the University of Alabama in Huntsville, whose primary mission is to investigate the feasibility of utilizing the Corona Discharge Reaction (CDR) as an alternative method of plasma production in an electron bombardment Kaufman-type derived gridded ion thruster for applications in small satellite propulsion.

Feasibility of the STARGATE system will be proven through the fulfillment of the project's goal-based requirements; which are to create a sub-hectowatt (lower than 100W) ion thruster, utilizing CDR to initiate plasma production, capable of specific impulse >1500 seconds, total thrust >1 mN, and a fully integrated total system size <6U, additional requirements pertaining to factors such as efficiency and lifespan are currently to be determined pending experimental data from testing of future prototypes.

In a Kaufman-type thruster, the Plasma Production and Ion Extraction processes are physically separated. While the STARGATE system utilizes a largely previously untested method to initiate the plasma production process, its Ion Extraction system, as well as it's Electron Confinement and Ion Neutralization systems, will remain conventional as similar on conventional Kaufman-type thrusters.

Phase I of the STARGATE project concluded in August 2023 with the successful hot-firing of an initial concept feasibility prototype. The project is currently in Phase II, which seeks to assess and observe the technology's capabilities and performance characteristics in a relevant operating environment (simulated space vacuum). The first Phase II prototype "SG-2_1" is currently in its preliminary design phase, and is due to be hot-fired at NASA Marshall Space Flight Center in July 2024. The conclusion of Phase II will allow the technology to reach TRL-4.

The STARGATE system, should it demonstrate feasibility, will have the potential of offering a lower cost, drastically simpler, and downscaleable alternative to current smallsat EP systems; however, the biggest value of the STARGATE project is as an educational tool.

The STARGATE project is a predominantly undergraduate student research project, which in addition to fulfilling its project requirements, also seeks to lower the "bar of entry" for students to participate in electric propulsion research. The STARGATE project's secondary mission is to provide a platform which allows for undergraduate students to work on experimental EP systems, where they can learn practical knowledge, develop useful skills, and gain hands-on experience in the field of electric propulsion, as well as in adjacent fields such as electrical engineering, plasma physics, rapid prototyping, systems engineering, and science communication.