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# STARGATE: AN EXPERIMENTAL CORONA DISCHARGE GRIDDED ION THRUSTER UNDERGRADUATE STUDENT RESEARCH PROJECT

**Abstract**

Electric Propulsion (EP) systems for small-satellite propulsion applications are becoming increasingly prevalent with the widespread deployment of small-sat systems. EP systems could drastically enhance the mission capabilities and flexibility of small-sat payloads and significantly increase the sustainability of future spaceflight by enabling satellites to self-deorbit upon mission completion. Gridded Ion Thrusters (GIT) are among the most capable EP systems, offering the highest specific impulse capabilities of current in-space propulsion technologies.

The STARGATE system is a proprietary Gridded Ion Thruster (GIT) configuration developed by an independent undergraduate student research team at the University of Alabama in Huntsville. The mission of the STARGATE project is to assess the feasibility of utilizing the Corona Discharge Reaction (CDR) as an alternative mode of plasma production in an experimental GIT platform for small-sat propulsion applications. A patent application is currently being pursued for the STARGATE system.

The feasibility of the STARGATE system will be demonstrated by fulfilling its project goal-based requirements, including developing a sub 100W GIT using CDR to initiate plasma production, with a specific impulse of 2000 seconds and total thrust of 1 mN. Additional performance requirements relating to efficiency and lifespan will be determined after further experimental testing.

The STARGATE system replaces the hollow cathode in Kaufman-type thrusters or the radio frequency (RF) antenna in RF ion thrusters with a direct current high-voltage corona discharge system optimized for plasma production in rarefied gas conditions. This system offers several theoretical advantages over other sub-100W gridded ion thrusters, including lower communication interference, a simplified power processing unit, and relative ease of fabrication.

Ongoing experiments with the STARGATE system aim to characterize the behavior of the CDR in low-pressure to rarefied gas discharge conditions using experimental rapid prototypes. A series of prototypes have been fabricated and are scheduled to be tested in simulated space vacuum environments. Experiments will assess the prototype's performance at various propellant volume flow rates and different applied voltages between the discharge electrodes. Plume plasma properties will be measured using a Langmuir probe, and beam current density will be measured with a Faraday cup assembly.

Data from these initial tests will provide valuable insights into the behavior of the CDR and the suitability of this system for a GIT. The plasma and performance data will help validate or improve existing models and simulations. Should testing prove successful, the technology will undergo further development and testing, with the goal of eventual spaceflight demonstration.