Data-Driven Predictive Modeling of Electrospray Thruster Arrays

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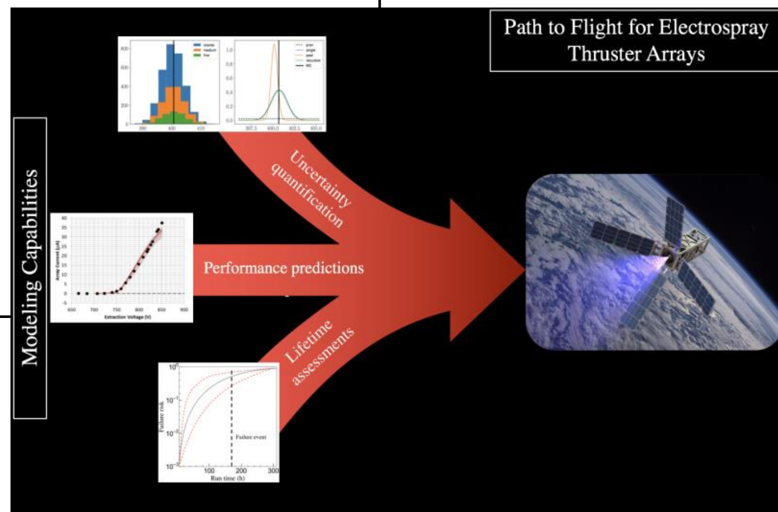

Approach

- Use existing numerical framework of the Electrospray Propulsion Engineering Toolkit (ESPET)
- Introduce new modules to ESPET for key physical processes such as life-limiting erosion and efficiency losses
- Apply novel algorithms for optimal experimental design (OED) that combine direct numerical simulations with targeted experiments and machine learning to populate ESPET modules
- Apply rigorous uncertainty quantification (UQ) methods to evaluate confidence in predictions from expanded version of ESPET
- Validate predictions compared to known electrospray thruster array concepts

Research Objectives

Goal: Develop a modeling and simulation capability to address key challenges with the path to flight for electrospray thruster arrays

Key innovations

- Predictions of performance and efficiency
- Assessment of thruster plume/spacecraft interactions
- Lifetime assessment and predictions of off nominal operation
- Predictions of differences between ground and on orbit perform.

Comparison to SOA: Current capabilities for predicting listed aspects of operation are non-existent.

Start TRL 2: Numerical framework and concepts exist
End TRL 3-4: Validation of critical properties and predictions

Potential Impacts

Electrospray thruster arrays are a potential **game-changing propulsion technology** for **small spacecraft mission architectures**. Although the TRL of these thrusters is 6, the modeling and simulation capability lags behind at TRL 2.

If successful, result will yield a powerful tool for **building confidence in flight readiness of technology**. May also provide **key insight for designing concepts** that enable new paradigm of space exploration

Additional benefits: Effort will introduce for the first time rigorous SOA techniques for model uncertainty quantification to the field of electric propulsion (EP). Successful demonstration of techniques here could have immediate and far sweeping implications for improving how UQ is performed for NASA proposed missions flying EP.