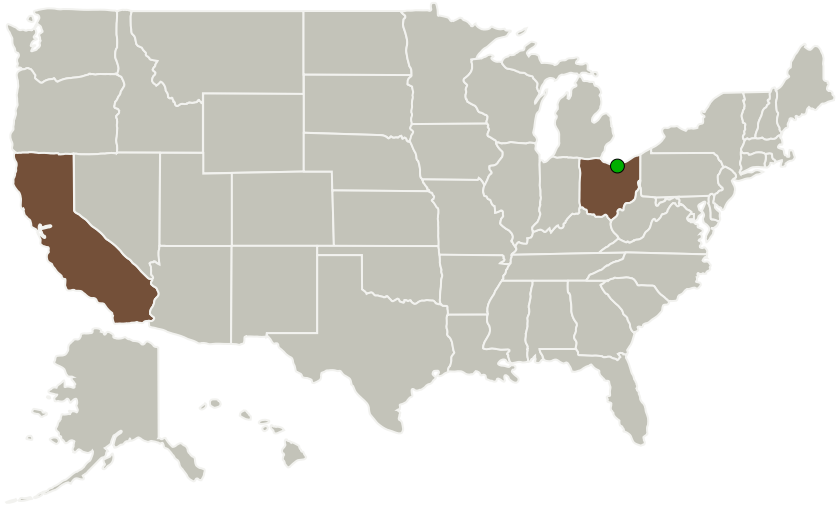
Multiscale Modeling of Hall Thrusters, Phase I

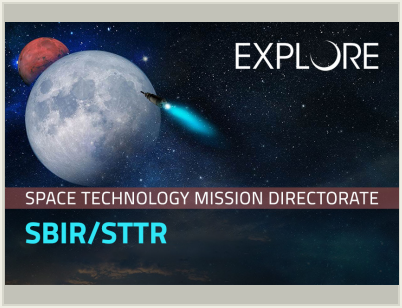
Completed Technology Project (2012 - 2012)

Project Introduction

New multiscale modeling capability for analyzing advanced Hall thrusters is proposed. This technology offers NASA the ability to reduce development effort of new high power Hall thrusters, and reduce system complexity and increase system lifetime and durability. Historically, efforts to model Hall thrusters utilized either hybrid/fluid approach which reduce computational overhead but rely on analytical fits, or required prohibitive computational resources to model thrusters self-consistently. Even with the use of large supercomputers, the self-consistent approach was limited to small, low power thrusters. We propose a new approach in which electron transport along magnetic field lines is computed self-consistently using a kinetic code for electrons, but global cross-field properties are computed using a 2D hybrid code. This approach combines the benefits of fully kinetic self-consistent modeling with the performance gain of hybrid models. The model will be able to analyze Hall thruster discharges without requiring any user-specified mobility fits. The model will also require only computational resources available in a standard desktop workstation. In addition, ions exiting the thruster will be sampled to generate a discretized source model for use with subsequent thruster plume modeling. Plume modeling is necessary to optimize thruster spacecraft coupling, and reduce possible instrument and spacecraft component contamination effects. These three components, magnetic field line, thruster discharge, and the spacecraft environment, form the three scales of our multiscale approach. In this effort we will concentrate on extending the capability of modeling thruster discharges by developing a new light-weight hybrid code with built in support for kinetic mobility modeling.

Primary U.S. Work Locations and Key Partners





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Organizations Performing Work	Role	Type	Location
Particle in Cell Consulting	Lead Organization	Industry	Falls Church, Virginia
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
California	Ohio

Closeout Documentation

Final Summary Chart
(https://techport.nasa.gov/file/82519)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Particle in Cell Consulting

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Lubos Brieda

Co-Investigator:

Lubos Brieda

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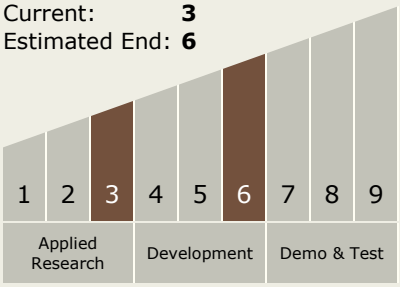
Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **6**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.2 Electrostatic

Target Destinations

The Sun, Earth, The Moon, Others Inside the Solar System, Outside the Solar System, Mars