National Aeronautics and Space Administration

NASAfacts

Propulsion System and Orbit Maneuver Integration in CubeSats

Trajectory Control Strategies Using Micro Ion Propulsion

The Propulsion System and Orbit Maneuver Integration in CubeSats project aims to solve the challenges of integrating a micro electric propulsion system on a CubeSat in order to perform orbital maneuvers and control attitude.

This represents a fundamentally new capability for CubeSats, which typically do not contain propulsion systems and cannot maneuver far beyond their initial orbits.

Micro RF Ion Thruster in Vacuum Chamber

Thruster Testing

A .4 inch (1 centimeter) micro radio frequency (RF) ion thruster, the BRFIT-1 from Busek Co. Inc., is undergoing laboratory evaluation to measure critical parameters for CubeSat integration. Testing includes:

- Magnetic field measurements to assess interactions between the thruster and the CubeSat attitude control system
- Thrust vectoring measurements to determine the extent to which thrust vectoring is effective and how it may affect the CubeSat

Trajectory Optimization

Simulation and visualization software is also being used to measure the range of feasible CubeSat orbit change maneuvers with <4.4 pounds (2 kilograms) of propellant.

Power limitations are a key design driver. Trajectory control strategies are being developed to maximize orbit changes with 10-20 watts (W) of available power.

Attitude Control Strategy Development

A propulsion-enabled CubeSat requires a sophisticated attitude control strategy. It must satisfy pointing requirements for solar power and communications, and maintain the correct thrust vector alignment during thruster operation. This project is developing active attitude control strategies using electric propulsion, reaction wheels, and magnetic torque systems.

Thrust Vectoring System Design

Laboratory hardware is being developed to modify the direction of the primary thrust vector 5-15° without changing spacecraft attitude. Magnetic thrust vectoring may also be investigated This will allow the spacecraft to perform multiple functions simultaneously, for example, thrusting in the velocity direction without rotating the spacecraft body.

A CubeSat with an integrated electric propulsion system could perform a major orbit maneuver mission, such

as a spiral-out trajectory from Low Earth Orbit to Geostationary Earth Orbit, lunar intercept, or Earth escape. The CubeSat would require an integrated propulsion system, attitude control system, and large solar panels for maximum power generation, as well as an efficient attitude and trajectory control strategy.

This project will result in recommendations for an initial technology demonstration mission, including propulsion system configuration and integration components. The concept will also include a recommended mission design and spacecraft control strategy.

Onboard propulsion would transform CubeSat capabilities. Future nanosatellites could perform orbit-raising maneuvers and potentially escape Earth orbit. Small satellites would become viable platforms for a wide range of missions that require orbital plane changes or altitude variations.

This project is a collaboration between Western Michigan University and the Jet Propulsion Laboratory.

This project is funded through the SmallSat Technology Partnerships, a program within the Small Spacecraft Technology Program (SSTP). The SSTP is chartered to develop and mature technologies to enhance and expand the capabilities of small spacecraft with a particular focus on communications, propulsion, pointing, power, and autonomous operations. The SSTP is one of nine programs within NASA's Space Technology Mission Directorate (STMD).

For more information about the SSTP, visit:
http://www.nasa.gov/smallsats

For more information about this project, please contact:

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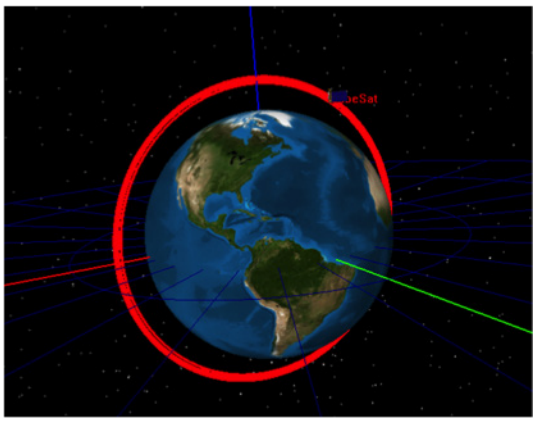
Busek 1 cm Micro Ion Thruster (Source: Busek Co.)



CubeSat Orbit Trajectory with Continuous Propulsion

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