December 2014

AEROSPACE AMERICA

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A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Expanded power for electric propulsion

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*The **Electric Propulsion Technical Committee** works to advance research, development and application of electric propulsion for satellites and spacecraft.*

This year has seen a renewed push in the operating power of electric propulsion devices, toward both the low and high ends of the scale. A rise in **CubeSat** propulsion demands and funding opportunities, including many from the NASA Small Spacecraft Technology Program, has led to a plethora of new development projects in micro-electric propulsion.

Universities and commercial entities alike are in a race to provide capable, affordable propulsion for small satellites. In particular, Busek Co., the Massachusetts Institute of Technology and NASA's Jet Propulsion Laboratory are developing the next generation of **micro-electrospray thrusters** with operating powers ranging from 2 to 10 watts. Meanwhile, another set of Busek colloid thrusters is expected to fly on the Space Technology 7 Disturbance Reduction System mission in 2015. Michigan Technological University is developing a new electrospray concept based on ferrofluid that can maintain emission tips by a simple application of the magnetic field. The University of Michigan is developing a novel 10-to-50-watt helicon thruster called the CubeSat Ambipolar Thruster and ran a successful Kickstarter campaign to help fund the development.

Busek

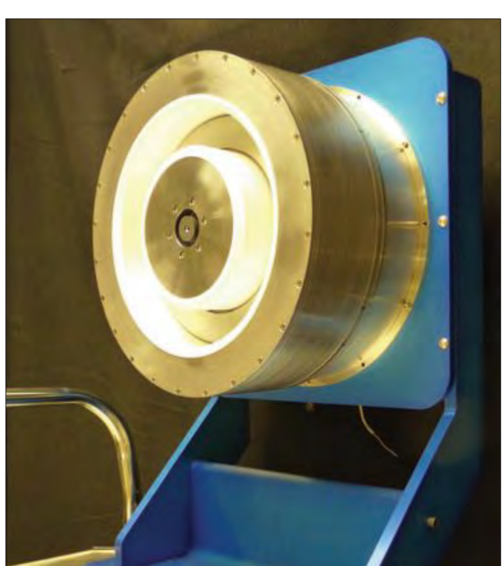
University of Michigan

CU Aerospace

GWU

A collection of micro electric thrusters. Clockwise from upper left: Prototype CubeSat Ambipolar Thruster, Iodine compatible BHT-200 Hall thruster, Propulsion Unit for CubeSat, Micro-cathode arc thruster.

CU Aerospace and VACCO Industries have built and delivered four Propulsion Units for CubeSat systems, which are 15-watt warm gas thrusters, to the Air Force for a 2015 CubeSat launch. George Washington University and NASA Ames Research Center are developing a micro-cathode arc thruster system and plan to deploy it using a PhoneSat bus from the International Space Station in 2015. In addition, Busek is developing two sizes of iodine-compatible micro-RF ion thrusters and **Hall thrusters** for CubeSat and small satellite missions.



NASA Glenn Research Center

A 12.5-kilowat magnetically shielded technology demonstration Hall thruster.

CubeSat and small-satellite mission designers will be glad to hear that there is no shortage of propulsion options in production.

In the development of high-power electric propulsion, a 12.5-kilowatt, 3,000-second, magnetically shielded technology demonstration Hall thruster, jointly developed by NASA's Glenn Research Center and JPL for the Solar Electric Propulsion Technology Demonstration Mission project and the Asteroid Redirect Mission, was operated at Glenn in August. With a predicted throughput of 3,300 kilograms, this thruster is expected to push several boundaries of high-power electric propulsion. At the same time, Glenn and JPL are studying the possibility of a magnetically shielded variant of the 3.9-kilowatt High Voltage Hall Accelerator, or HiVHAc. Glenn has concluded the life test of the 6.9-kilowatt NASA Evolutionary Xenon Thruster at 51,184 hours and 35.5 meganewton-seconds, which are world records for electric propulsion testing. Space Systems/Loral is qualifying the 4.5-kilowatt SPT-140 for use on a new high-power propulsion system with an ongoing life test that has exceeded 6,000 hours. Boeing is on track to produce the 702SP, the world's first **all-electric-propulsion satellite**. Snecma is pushing the operating power of the PPS-1350 Hall thruster from 1.5 kilowatts up to 2.5 kilowatts by performing a new qualification program while developing the 5-kilowatt PPS-5000.

Australian National University developed a new test facility, called the Wombat XL, for helicon thrusters and high-power plasma devices. MSNW of Redmond, Washington, is qualifying 1-to-5-kilowatt power processing modules for rotating magnetic field propulsion systems. Last but not least, the University of Michigan is pushing the Hall thruster power boundary with the 100-kilowatt X3 nested-channel Hall thruster.

The ion-thruster-propelled **Dawn spacecraft** is cruising to the dwarf planet Ceres, with a planned arrival date in March. Hayabusa-2, also propelled by ion thrusters and successor to Hayabusa-1, is slated to launch at the end of 2014 to rendezvous and sample an asteroid.

With each new success, electric propulsion becomes more widely accepted and newer boundary-pushing electric rockets can be developed, paving the way for even greater successes.