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Title

The Hēki Mission: Testing Superconducting Magnet Technology for Space Propulsion on the International Space Station.

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Abstract

Applied-field magnetoplasmadynamic (AF-MPD) thrusters are a form of high-power, high efficiency and high specific impulse in-space electric propulsion for satellites and spacecraft, utilising strong external magnetic fields to accelerate plasma to high velocities [1-4]. A New Zealand consortium led by Paihau-Robinson Research Institute is currently developing an AF-MPD thruster that will be significantly enhanced by the use of high-temperature superconducting (HTS) electromagnets [5]. The use of such HTS applied field modules will substantially reduce the mass, power and volume required for AF-MPD thrusters, paving the way for their use in space [6-8].

To date there have been no public examples of HTS electromagnets operating in space. It is therefore vital to demonstrate the superconducting components for an AF-MPD thruster in a relevant space environment to assess their suitability for long-duration use and relevant operational constraints. A team led by Paihau-Robinson Research Institute has partnered with Nanoracks LLC to to demonstrate the successful operation of an AF-MPD compatible HTS magnet on the Nanoracks External Platform (NREP). This demonstration will bean important step toward the validation and commercialization of this key enabling technology.

The HTS magnet thruster under development has been dubbed ‘Kōkako, after a native New Zealand bird with a blue wattle reminiscent of the blue glow emitted by the operating plasma thruster. As the ISS technology demonstration to the ISS is an important preliminary step to the creation of the Kōkako thruster, it has been dubbed the ‘Hēki mission’, hēki being the New Zealand Māori word for egg.

This paper will provide an overview of the Hēki mission to the space community, including the mission's goals and technical challenges. The HTS magnet has a 50 mm diameter warm bore to accommodate the future integration with a thruster. It comprises four double-pancake HTS coils and targets a 0.3-0.5 T central field. It will be conduction-cooled using a space-rated miniaturised cryocooler, targeting a 70 K operating temperature. The total payload power budget to cool and energise the HTS magnet is only 100 W, a feat possible thanks to advances in efficient miniaturised cryocoolers and the use of an HTS flux pump.

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