The journey to demonstrate the first iodine electric propulsion system in space

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It is estimated that as many as 24 000 – 100 000 satellites may be launched into space over the next ten years, with most requiring onboard propulsion systems. High-performance electric propulsion often uses rare xenon propellant, but anticipated space industry demand is expected to soon outpace supply and so it is critical that a viable replacement propellant be found. In addition, xenon is relatively expensive, stored under very high pressure and requires special storage and transportation conditions. With growing space industry demand, and the rise of satellite mega-constellations, a viable alternative to conventional xenon propellant is necessary to ensure a sustainable space industry.

Iodine was suggested over sixty years ago as an alternative propellant for electric propulsion systems, but despite being investigated by several organizations around the world, iodine electric propulsion has only recently been demonstrated in space with ThrustMe's successful in-orbit flight 2020. The electric propulsion system developed makes use of solid iodine propellant, which is sublimated to form iodine gas. A plasma is then created using a radio-frequency inductively coupled discharge, and positive iodine ions are extracted and accelerated with a set of high-voltage grids to produce thrust. A filament neutralizer is used to compensate the ion beam space charge, resulting in extreme miniaturization of the system having external dimensions just below 10x10x10 cm.

Development of this system required performing both fundamental and detailed applied studies, since iodine is very poorly studied. To proof critical engineering solutions, a separate cold gas iodine thruster has been developed and tested in space in 2019. A maiden flight of an iodine ion thruster started late 2020, and already resulted in a series of successful satellite manoeuvres in space. Here we review the main challenges of such system development and give an overview of the next steps.