20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Post Mission Disposal and Space Debris Removal 2 - SEM (6)

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FACILITATING ACTIVE DEBRIS REMOVAL WITH HIGH TEMPERATURE SUPERCONDUCTING MAGNETS.

Abstract

High temperature superconductors enable compact, ultra-high magnetic field strength electromagnets with reduced cooling requirements. Benefits can be broadly classified into two areas. First, sustained control of high density plasma which is an obvious spinout from fusion energy technology allows the potential for high thrust and high Isp propulsion, in a selectable mode. This is the operational principle of the Magdrive, which is being studied under UK government funding for its ability to enhance active debris removal missions. Missions such as Astroscale's ELSA-M currently require an complex combination of separate high thrust (but low Isp) chemical, and low thrust (but high Isp) electric propulsion.

Second, controllable high field electromagnet technology has potential usage in various other proximity operations required during active debris removal. Magnetic flux pinned non contact connections may allow formation flying between chaser and cooperative client spacecraft. Non contact detumbling through induction of eddy currents in metallic parts of client spacecraft is possible in principal but has not yet been demonstrated at scale. Rapid magnetic attitude control or even translation relative to Earth magnetic field lines may benefit from high magnetic field strengths achievable with superconducting coils. The final stage of active debris capture is docking and or grappling, which may be enhanced through use of magnetic capture especially if a dedicated attach or grapple point such as a number of in-orbit servicing companies are developing, exists on the client spacecraft.

Rocket Engineering has been funded by the UK government to conduct knowledge transfer from high temperature superconductor manufacturers in the fusion energy sector, to the space sector, with a particular emphasis on active debris removal applications. We discuss in this paper engineering test and system study results focused on the thermal management and power supply challenge faced when integrating a superconducting coil, power supply and coolers into a spacecraft. We are working closely with one supplier of high temperature superconducting magnets, one electric propulsion system manufacturer, and a company already demonstrating active debris removal technologies in orbit. The near term objective for the consortium is to demonstrate sustained operations of a small high temperature superconducting magnet in orbit on a leading UK technology demonstration platform provider. A space experiment roadmap, and recent tests which will provide essential superconductor test data for a number of the applications highlighted above is described in this paper.