

SPACE DEBRIS SYMPOSIUM (A6)  
Hypervelocity Impacts and Protection (3)

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## PROTECTING ACTIVE SPACECRAFT WITH A DEBRIS SWEEPER

**Abstract**

At present, remediation research tends to focus on the removal of large, intact objects with the aim of reducing the growth of the debris population in the long-term. However, there is a demand to reduce the debris risk to active satellites in the short-term, by focusing on the removal of small, sub-10 cm debris. In this work, we discuss the use of a debris sweeper system to provide this risk reduction and the constraints and feasibility of such a system.

Our initial study follows the work by Edwardes et al. (2012), whereby the remediation of the LEO region as a whole is considered, with a subsequent focus on the popular 700-900 km and 1350-1550 km altitude regions. By combining the future spatial density growth as projected by the University of Southampton's DAMAGE, and the mean debris flux as calculated by ESA's MASTER 2009, it was possible to calculate the required sweeping area to stabilise the 1 cm and larger debris population. In a best-case scenario for sweeping the 700-900 km altitude region, it was found that a minimum area of 0.2 sq. km would be required to achieve such stability.

An alternative solution is to provide a system to protect specific orbits or spacecraft from impacts with sub-10 cm debris, which was the focus of a second study. Firstly, candidate orbits and spacecraft, including those used in human spaceflight, were identified based on collision risk and the perceived value of the asset. Secondly, the relative trajectory of the sweeper with respect to the protected asset was ascertained; calculated via a trade-off between the mass and size required for the sweeper and the direction of greatest debris flux upon the protected asset. The debris background flux and the flux due to fragmentation events were considered in this process. The outcomes of this study shape the key design requirements for the development of such a protector-sweeper system and these requirements will be discussed.