UKSWSE III
Sheffield
2025

POSTER 23

UK-ODESSI: A Low-Cost, Low-Earth Orbit, In-Orbit Pathfinder for UK Space Weather Instrumentation

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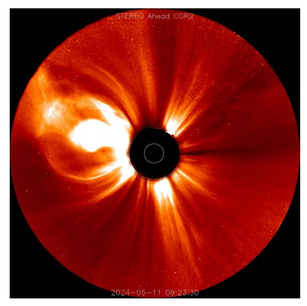
1 INTRODUCTION

- Recent years have seen increased awareness of the increasing risks of space weather - the changing environmental conditions in near-Earth space caused by arrival of radiation, particles and magnetic fields originating from the Sun - on human infrastructure and potentially health.
- For this reason, the UK Government has listed severe space weather as one of the highest priority natural hazards in the UK National Risk Register, with Met Office being delegated risk owner.
- As part of Space Domain Awareness in the National Space Strategy and its annex, the Severe Space Weather Preparedness Strategy, space weather is one of the five National Space Capability Goals of the Space Industrial Plan prioritised for implementation.

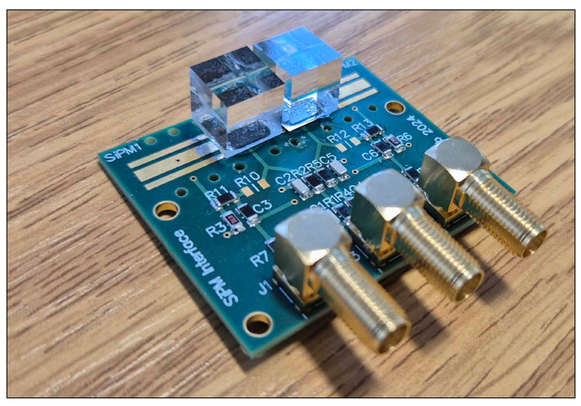


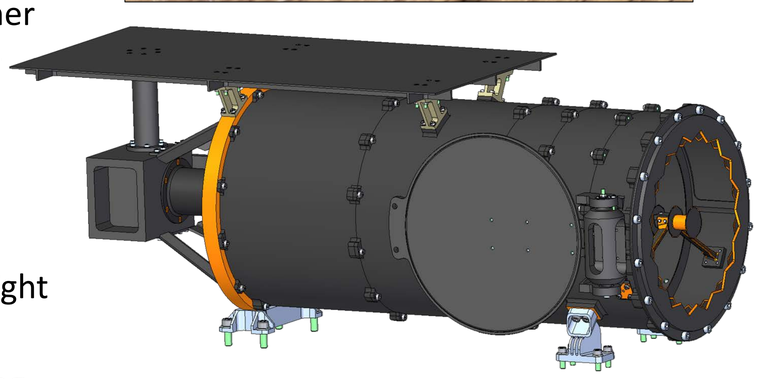
2 MISSION OVERVIEW

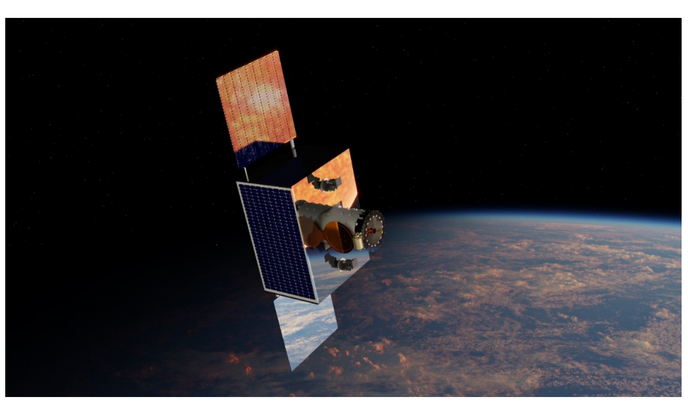
- UK-ODESSI (UK-Orbital pathfinDEr for Space-borne, Space-weather Instrumentation), is a low-cost national Low-Earth Orbit (LEO) SmallSat mission concept.
- UK-ODESSI would provide UK sovereign capability, and enhance European capability, by:
  - Enabling near-continuous operational space weather forecasting of the Earth arrival of Coronal Mass Ejections (CMEs);
  - Providing continuous space weather data of solar High-Energy Protons (HEPs) in LEO;
  - Providing data from potential additional payloads.
- UK-ODESSI would also act as a test bed for UK space weather instrumentation and any potential satellite/ground-segment sub-systems/ technologies being developed in parallel in the UK.

3 PAYLOAD: SCOPE

- A wide-angle, broad-band visible-light, space-based solar coronagraph is key for timely forecasting of the Earth arrival of CMEs.
- Such coronagraphs image the solar atmosphere, and CMEs therein, via Thomson scattering of photospheric light.
- Having identified the need to develop a space weather coronagraph in Europe, STFC-RAL Space led the ESA-funded Solar Coronagraph for OPErations (SCOPE) Phase A/B1 study - as part of which, a stray-light breadboard was built and tested.
- The SCOPE design was refined as part of ESA's Vigil Phase A/B1 study, and a more representative stray-light breadboard built and tested.
- Within a current UKSA-funded activity, an engineering-qualification model (EQM) breadboard is being built and subjected to vibration/shock testing to verify stability of its critical components.
- The current version of the SCOPE instrument has a field-of-view extending from 3 to 25 Rs.







4 PAYLOAD: HEPI

- >300 MeV solar protons are highly penetrating and produce copious secondaries, resulting in sudden radiation increases even for well-shielding systems e.g. aircraft, ground infrastructure, space stations.
- Very few such measurements are currently available (e.g. EPHIN, GOES); the UK real-time atmospheric radiation nowcast model (MAIRE+) uses ground neutron monitors to estimate the space spectrum.
- The compact High-Energy Proton Instrument (HEPI; *O'Neill et al. 2025*), being developed at the University of Surrey, directly measures >300 MeV protons.
- The novel HEPI design consists of multiple Cherenkov telescopes, each comprising a 10x10x10mm radiator coupled to a 6x6 mm silicon photomultiplier; 3 telescopes, or more, provide directionality.
- Initial HEPI development was supported by ESA and UKSA; current activity is ESA/EU Horizon-funded.
- Deployment in multiple locations, from LEO to the L-points, will yield better nowcasts by improved modelling of particle flux, spectrum and transport.

5 MISSION CONFIGURATION

- The UK-ODESSI mission concept baselines a low-cost SSTL SmallSat platform, based on existing heritage, in a LEO Sun-synchronous terminator (dawn-dusk) orbit, at an altitude of some 500-600 km above the Earth's surface.
- Such an orbit provides a near-continuous view of the Sun, except for a small period of eclipses around one of the solstices.
- Attaining such an orbit could be achieved by, for example, either a low-cost rideshare via Space-X or potentially even a dedicated UK launch.
- We are currently at a highly conceptual phase with UK-ODESSI and are just starting to seek funding for an initial design study. Should we secure funding for the mission to go ahead, we would target UK-ODESSI launch within 5 years.

6 CONCLUSIONS

- The proposed UK-ODESSI mission concept, in dawn-dusk terminator LEO, would deliver UK sovereign capability via a low cost SSTL SmallSat to provide the following within 5 years:
  - Near-continuous operational monitoring of CMEs;
  - Continuous operational monitoring of HEPs;
  - A test bed for emerging space weather instrument/satellite/ground-segment sub-systems/technologies being developed in UK.
- Although the baseline payload currently consists of SCOPE and HEPI, further instruments could be hosted on UK-ODESSI or a follow-on mission.
- UK-ODESSI would also be designed to assess the capability of a UK SmallSat to operate beyond Earth-orbit, potentially at the Lagrange L1, L4 or L5 points, or indeed closer to the Sun.

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