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MAGIC: a miniaturised magnetometer for space weather monitoring with CubeSats

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In situ space weather measurements are currently sparse; this represents an obstacle to further improving our understanding of the Sun-Earth interaction. Constellation missions are ideal as they enable a comprehensive and broader set of magnetic field data at many points simultaneously. A novel approach is to exploit CubeSat platforms, however, on them, mass and power resources are limited.

MAGIC (MAGnetometer from Imperial College) is a miniaturised magnetometer, which optimises noise performance while minimising power consumption by utilising a hybrid anisotropic magnetoresistive (AMR) sensor triad. This solution is suitable for CubeSats: it has flown on three of them to date (TRIO-CINEMA) and an improved design was developed for the Sunjammer microsatellite. On CINEMA, the instrument was able to detect magnetic field fluctuations associated with field aligned currents over the northern auroral oval.

An evolved version of MAGIC instrument will fly on board RadCube as part of the RadMag payload. RadCube is a 3U CubeSat funded by ESA under the IOD (In-Orbit Demonstrator) GSTP, scheduled for launch in 2020. The aim of the mission is to demonstrate miniaturised instrument technologies in LEO for space weather monitoring purposes.

The primary scientific goal of MAGIC is to improve the understanding of field aligned currents and ring current during geomagnetically disturbed conditions for space weather monitoring.

Consequently, the opportunity to openly share MAGIC data with the scientific community, could improve our capabilities to predict space weather phenomena such as geomagnetic storm, but also understanding of substorms (in terms of occurrence, severity, duration).

MAGIC on RadCube will include 2 AMR three axes DC sensors: one in-board, and one out-board, housed in a mechanical chassis, deployed by means of tape spring motorized boom.

Although the main sensor and control loop is at TRL 9, the proposed magnetometer design on RadCube includes some technical development. For example, a major addition from the CINEMA design is the inclusion of intelligence via the addition of an Atmel microcontroller. This enables use of standard communications protocol to the bus. Furthermore the instrument will be implemented on a PCB compliant with CubeSat form factor, with components optimised for a longer lifetime mission than CINEMA. The target sensitivity is less than 2 nT.

Achieving this improved design will enable an optimised and more resilient magnetometer instrument, implementable as a “plug and play” sensor on CubeSat platforms, to be used either in a constellation configuration or as single hosted payload, for space weather monitoring in the context of ESA Space Situational Awareness’s D3S monitoring concept.

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