Initial Study of Novel Quantum Diamond-based Sensor aboard the ISS for Future Earth Observation Missions

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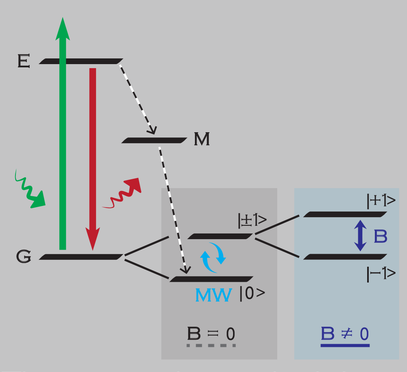
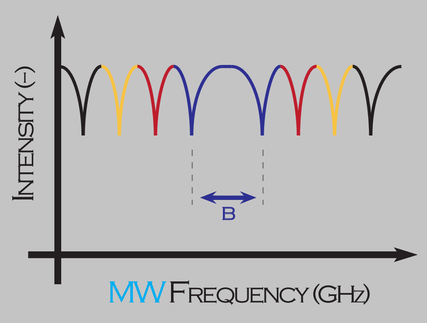
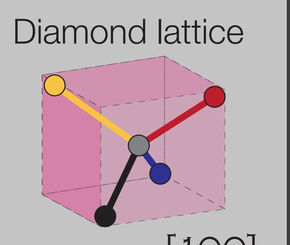
MISSION STATEMENT

Developing and improving magnetic field sensing as a tool for future Earth observation. By bringing quantum technology from the lab to harsh environments, particularly Low Earth Orbit onboard the International Space Station, while empowering students to step into the field of space research and beyond.

PHYSICS BACKGROUND - WHY DIAMOND?

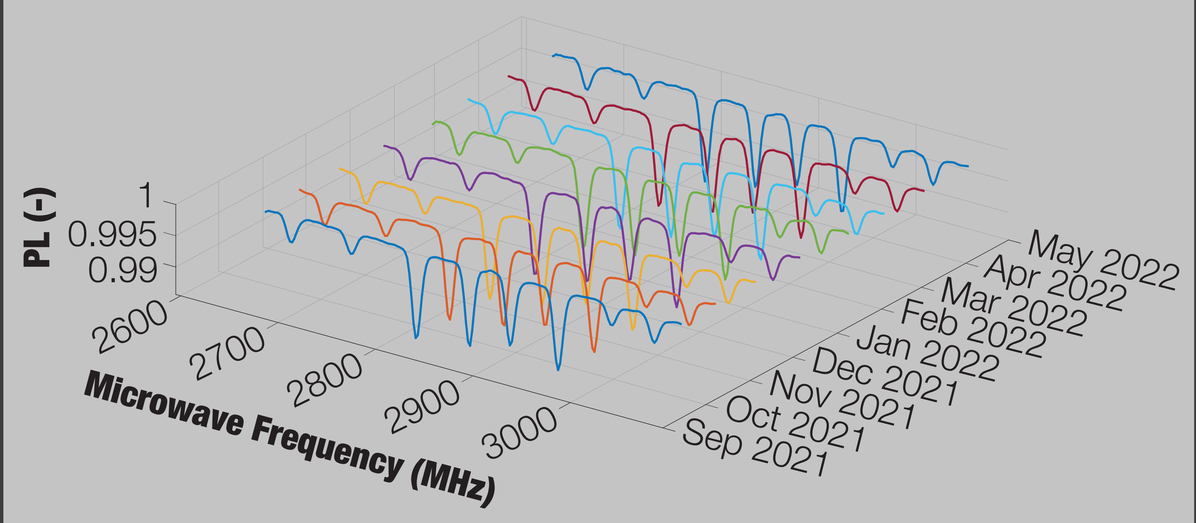






The operating principle of diamond-based magnetometers relies on NV (nitrogen-vacancy) defects in the diamond lattice. A method called Optical Detection of Magnetic Resonance (ODMR) is used to perform these spin state measurements. The NV center is photoluminescent upon green laser excitation with spin-dependent photon emission. Application of MW frequency which is resonant with the NV spin transition, thus results in decreased photoluminescence intensity and can be used for direct readout of the vector magnetic field based on the Zeeman splitting of the resonances.

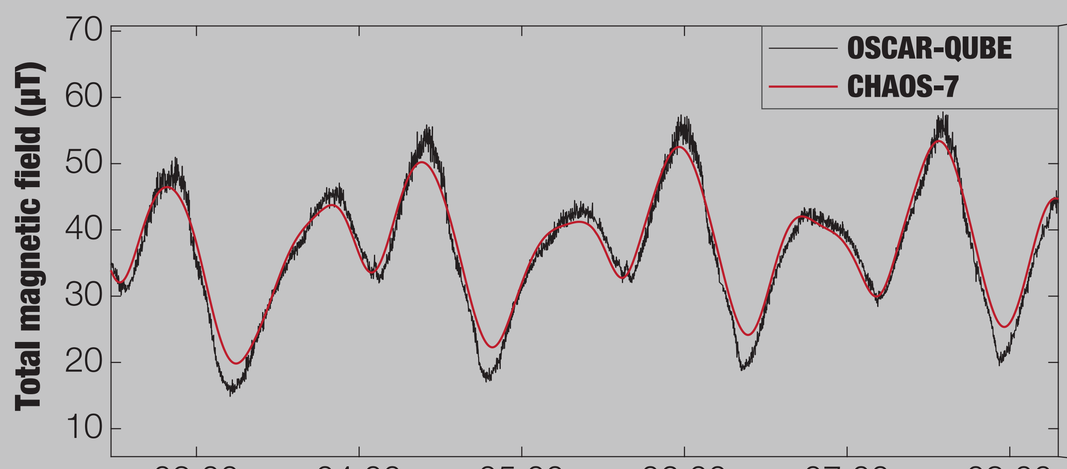
TECHNICAL RESULTS - LONG TERM STABILITY



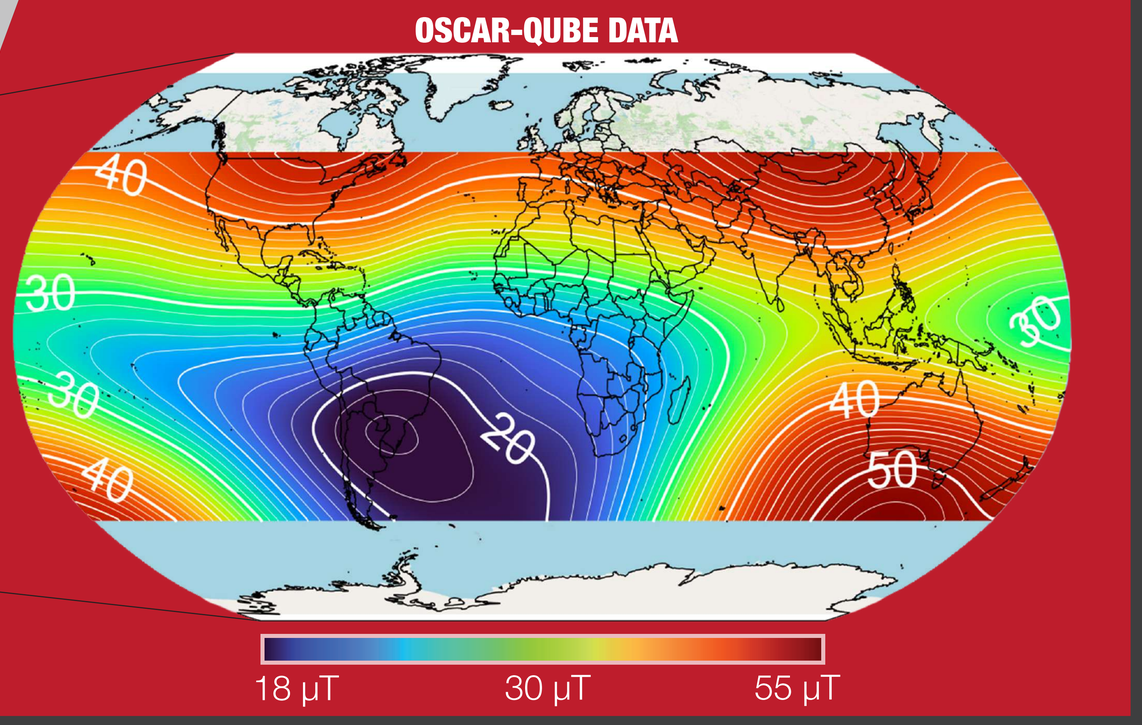
To assess the degradation of the OSCAR-QUBE sensor, measurements over a span of nine months were acquired. Normalized photoluminescence ODMR spectra with the eight peaks for comparison show no degradation, proving the feasibility of this technology in long-duration missions in space environment.

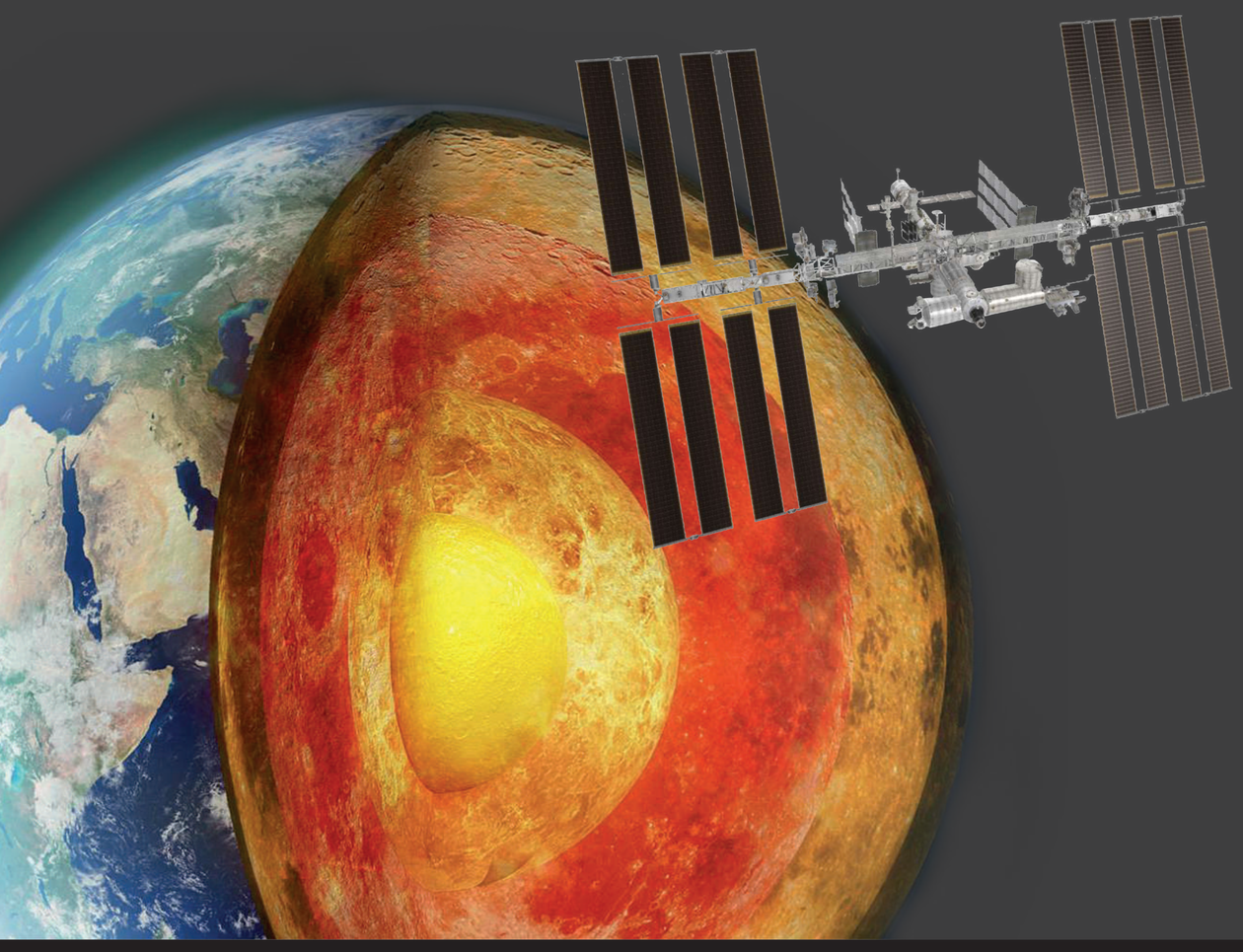
SCIENTIFIC RESULTS - DATA vs MODEL COMPARISON

Map of Earth's total magnetic field strength resulting from two months of data acquired onboard the ISS. The correlation between observed and model magnetic fields demonstrates the functionality of the quantum sensor in the course of the mission.

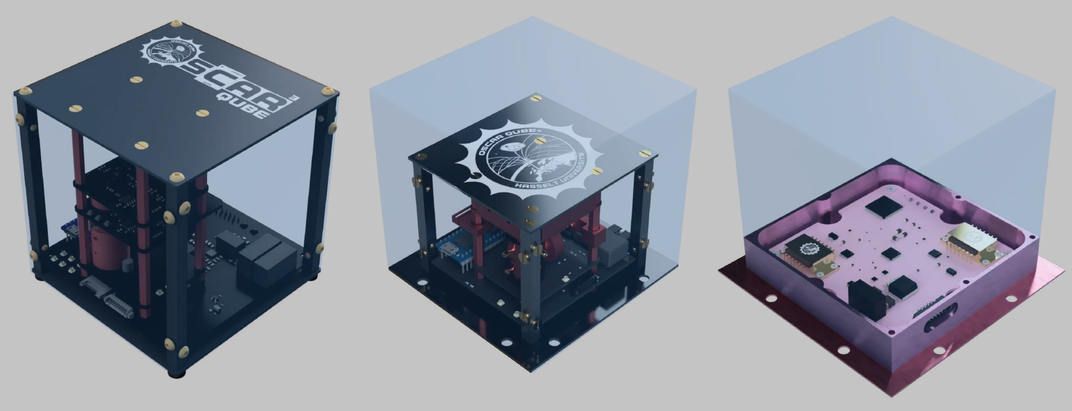


MAGNETIC FIELD MAPPING





GROWTH RESULTS - OSCAR MISSIONS



OSCAR-QUBE	OSCAR-QUBE+	OSCAR-PINQ
1 U (10x10x10 cm³)	0.4 U (8x7x6 cm³)	0.2 U (10x10x2 cm³)
420 g	315 g	150 g
5 W	3.5 W	3.5 W
<300 nT/√Hz	<30 nT/√Hz	<100 pT/√Hz
ISS	Ariane 6 / YPSAT	Space Rider

The OSCAR sensors are developed as part of student project series aiming at validating the viability of diamond-based sensors as a compact and stable sensing solution for future Earth Observation missions.

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ORBIT YOUR THESIS

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