Quantum Sensor Hub（Tokyo Tech）

QIH Quantum Innovation Hubs

1． Mission

At the quantum sensor hub, our goal is to implement societal applications of quantum and quasi-quantum sensors by leveraging solid-state, atomic, ionic, and nano-particle technologies that notably outperform classical sensors.

2． Activities

Quantum Inertial Sensors

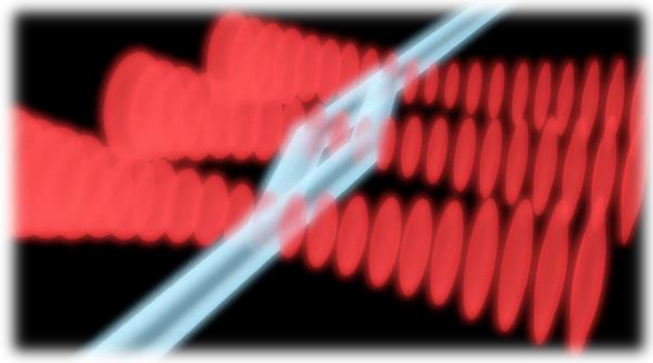
Development of ultra-high-precision inertial navigation devices using quantum and quasi-quantum inertial sensors. Real-time continuous geoid measurement achieved through collaboration with optical lattice clocks and star tracker technology.

Construction of Navigation HILS System

To achieve a precise navigation system, it is essential not only to enhance the performance of inertial sensors but also to employ advanced integration technologies. To facilitate Model Based Systems Engineering (MBSE)-driven integration, we constructed a Hardware In the Loop Simulation (HILS) system for the inertial navigation using an ultra-precision motion simulator.

Implementation of Quantum Inertial Sensors for Field Use

While quantum inertial sensor research has predominantly taken place in static laboratory settings, real-world vehicles undergo movements such as changes in orientation and acceleration. Addressing these dynamics requires new technologies. We propose a quantum gyro with resistance to AUV motion and successfully demonstrated its principles using a device capable of roll, pitch, and yaw rotations.

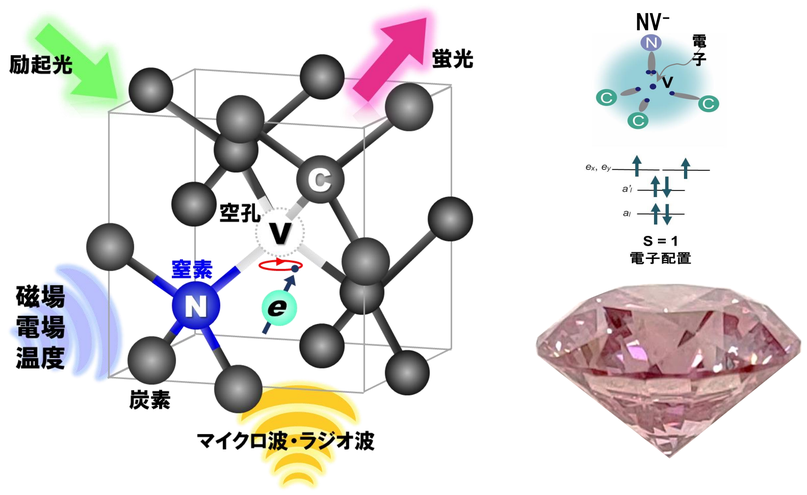


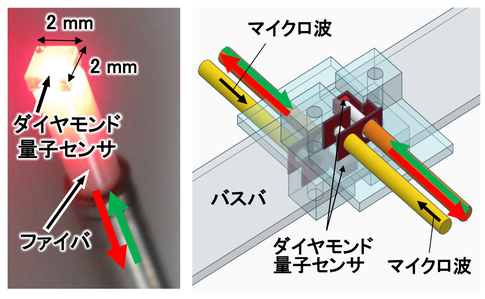
Diamond Quantum Sensors

Innovation creation through the development of ultra-sensitive quantum sensors using nitrogen-vacancy (NV) defects in diamond for detecting magnetic fields, temperature, electric fields, and more.

Measurement applications for batteries and power devices

Developed a diamond quantum sensor with an accuracy of 10 mA within a current range of ±1,000 A to maximize the utilization efficiency of batteries for electric vehicles (EVs). Verified a charging and discharging measurement accuracy of 0.1% in standard driving modes.

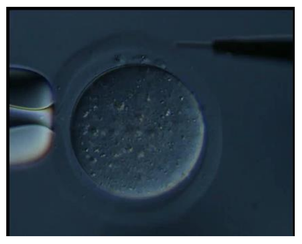




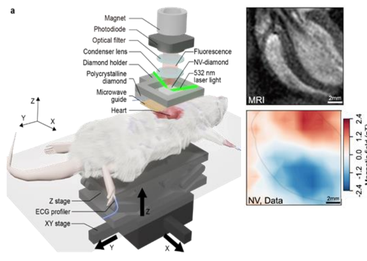
Y. Hatano et al., Sci. Reports (2022)、 Photograph of diamond quantum sensor (left), battery current measurement setup (center), and expected EV driving range extension by improving sensor accuracy (right)

Scalable applications for biometric

Demonstrated temperature measurement at arbitrary locations within cells (sensitivity <0.2° C) and small animal magnetocardiography with millimeter resolution. Currently working on enhancing sensitivity for human brain magnetoencephalography (MEG).



Unfertilized mouse oocyte and probe-type diamond sensor (top right)



K. Arai et al., Comm. Physics(2022) Magnetocardiography and magnetic field/current mapping in rats

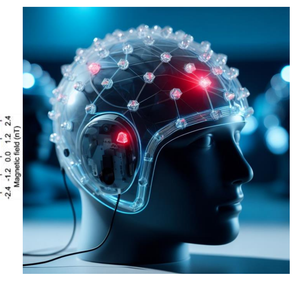


Image of human magnetoencephalography sensor