Why Fraunhofer IAF?

In our application laboratory partners from science and industry have the opportunity to evaluate the innovative potential of quantum sensors for their specific requirements.

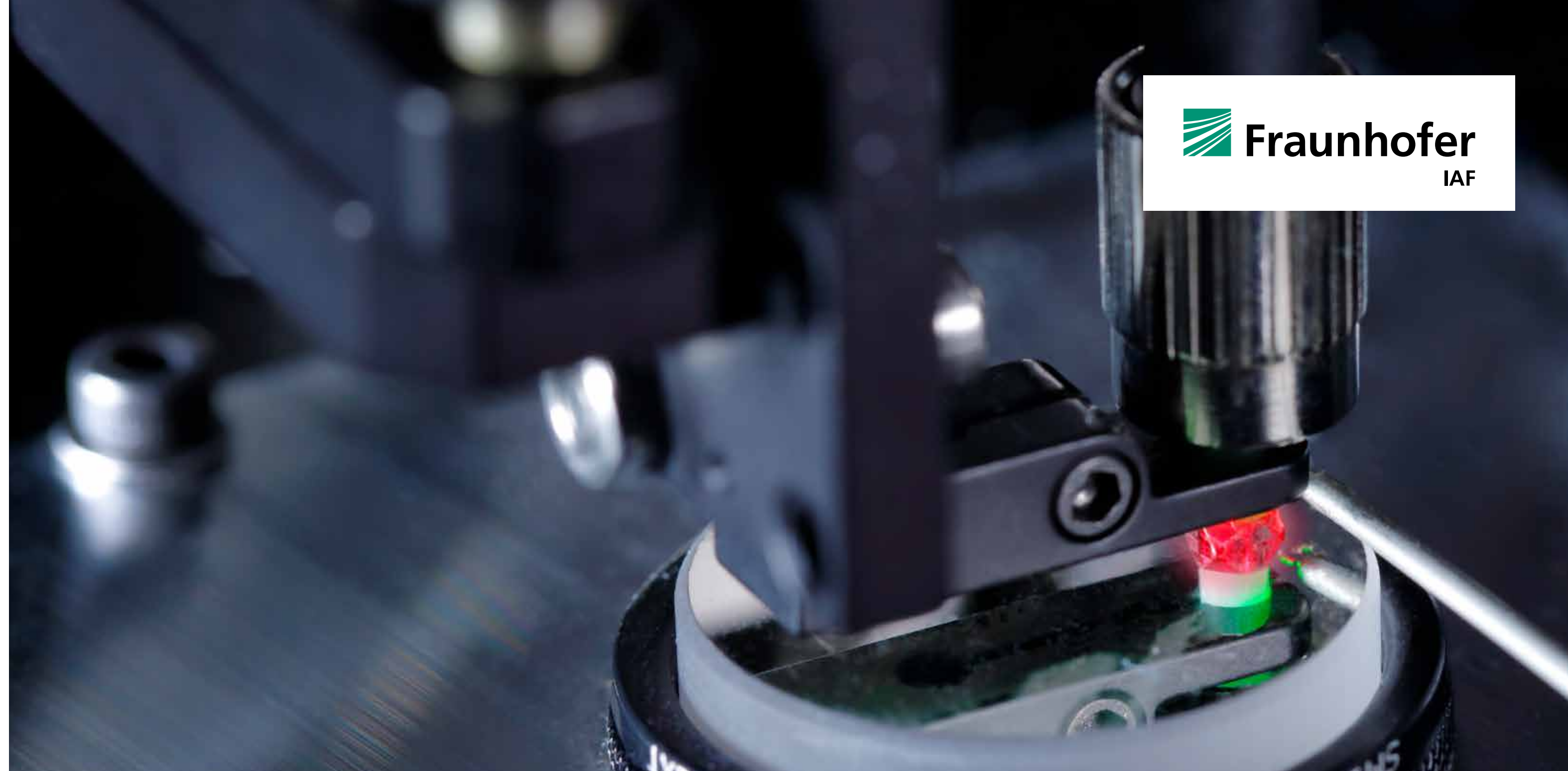
Several quantum magnetometers are available — all based on diamond tips with NV centers:

- The **Qnami ProteusQ** is an adapted atomic force microscope and a plug and play device. The system measures small DC magnetic fields with atomic spatial resolution and is well suited to investigate materials science issues.
- **Attocube CSFM** is an atomic force microscope (AFM) combined with a confocal microscope, which offers extreme stability. The system is modified to a quantum magnetometer for measurements of DC and AC currents.
- **QZabre QSM** is a plug and play AFM with two additional features: AC magnetometry and the magneto-optical Kerr effect. The first allows measurements that require high sensitivity, the second measures the magnetization of samples.

What we offer:

- Exploring novel use-cases of quantum sensing and magnetic field sensing
- Validation of samples and measurements
- Test and verification of components
- State-of-the-art benchmark sensors and full imaging instruments

If you are interested in testing quantum magnetometers for your specific applications, please contact us. We look forward to learning about new use cases and supporting the journey of quantum sensors into industry!



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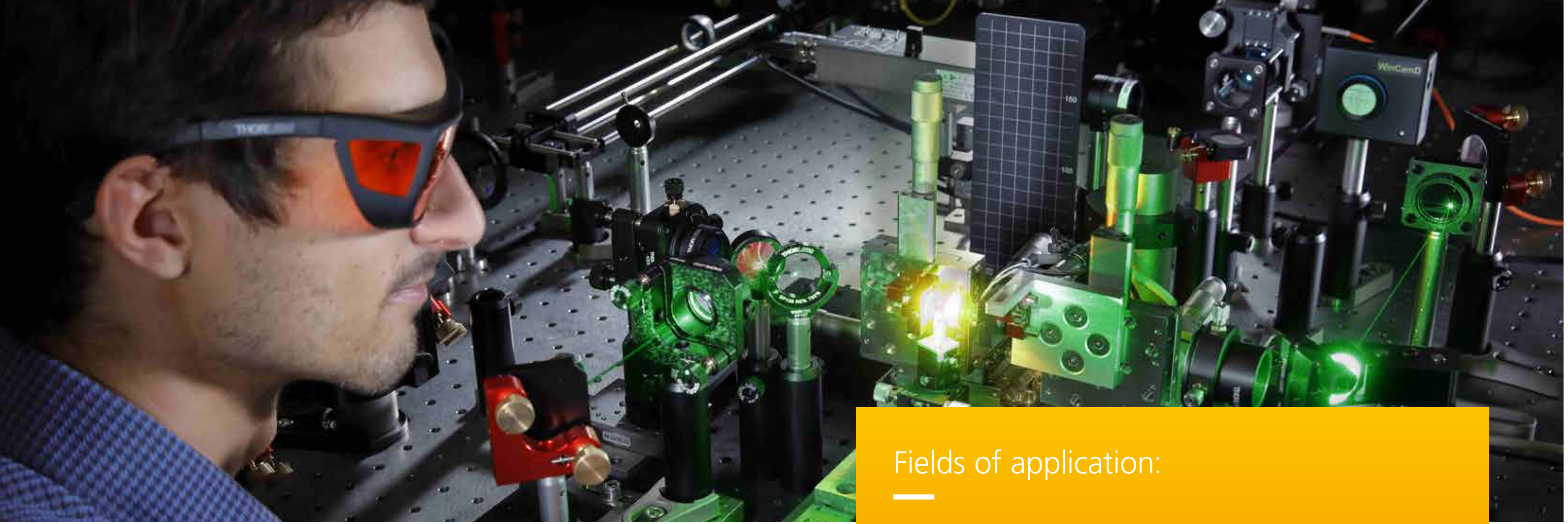
From diamond development all the way to industrial applications

Quantum sensing



Quantum magnetometers for industrial use

At Fraunhofer IAF, we develop diamond-based quantum magnetometers that not only achieve outstanding properties in the combination of spatial resolution and sensitivity, but also operate at room temperature — making them ideal for industrial applications.

Quantum sensing based on NV diamond

Our quantum sensors are based on solid-state spins in the form of nitrogen-vacancy (NV) centers in diamond. They can detect magnetic and electric fields with a spatial resolution of a few nanometers down to single electron and nuclear spins. Measurements with quantum sensors based on NV centers are absolute and do not require calibration. Therefore, the processes are robust and reproducible. Our aim is to transfer our quantum sensing technology from research laboratories to specific industrial applications.

Fields of application:

- Micro- and nanoelectronic industry
- Medical diagnostics
- GPS-independent navigation, E-mobility
- Materials science and chemical industry
- Aviation, broadband communication, radar, telemetry

Multiple sensing technologies

Extensive and long-standing expertise of diamond growth and sensor system implementation enable the construction of various types of quantum sensors. Also, different sensor principles can be combined and allow very compact designs.

We focus our research on the following sensing principles

Sensing principle	Sensitivity	Spatial resolution
Scanning probe magnetometer	< 10 μT	< 30 nm
Laser threshold magnetometer	1 fT / sqrt(Hz)–30 pT / sqrt(Hz)	100 μm–1 mm
Widefield magnetometer	< 10 μT	< 1 μm
RF sensors	0.1–10 GHz	< 1 μm

Scanning probe quantum magnetometer

High-resolution scanning probe quantum magnetometry is based on diamond with a single NV center in the tip. For the first time, it is now possible to measure magnetic field distributions at the atomic level in order to map current flows of micro and nanoelectronic circuits with high resolution.

Laser threshold magnetometer

- This worldwide new research approach using NV diamond as laser medium achieves higher signals and higher contrast leading to much more precise measurement results.
- With the laser threshold magnetometer it is possible to measure the smallest magnetic fields, such as those generated by brain waves, thus opening new doors in medical diagnostics.

Widefield NV magnetometer

Widefield NV magnetometry is a non-scanning technique that provides a unique compromise between spatial resolution and measurement time. This principle can be use in electronics, materials science and bio-imaging.

RF sensors with optical readout

- RF sensors based on diamond arrays with NV centers and "optically detected magnetic resonance spectroscopy" (ODMR) can be used to analyze the time-frequency behavior of complex, agile RF signals in the 0.1–10 GHz range with > 1 GHz bandwidth in real time.
- These signals are widely used in aviation, broadband communication, radar and telemetry.