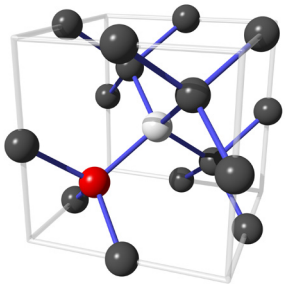
Quantum Sensing & Quantum Computing Education Kits

Your hands-on experience in Quantum Technology

Nitrogen-Vacancy Center

Diamond became a major host material for studying quantum effects. Artificial defects in the crystal lattice, known as nitrogen-vacancy (NV) center, allow the study of the quantum nature of magnetic moments. Thanks to the underlying physics, these studies can be conducted at room temperature.
The localised electronic state behaves similar to molecular systems and is optically addressable by means of green light excitation. The system responds with a fluorescence in the red. The collected fluorescence intensity is dependent on the state of the electron spin.
The state can be manipulated with microwave radiation, which enables scientists to detect the magnetic resonance and address even single defects under ambient conditions. This makes the NV center a perfect studying and learning platform to educate on spin-physics, EPR, NMR, properties of single photon emitters, confocal microscopy and quantum applications such as quantum sensing.



Your Advantage

- Small footprint spin-physics experiments.
- Low-cost and low-maintenance room-temperature operation.
- Broad variety of experiments adapted from real-world application scenarios within and outside the lab.
- Easy to use browser-based experiment control software.
- Suitable for lab courses and live-demonstrations in lectures.
- Sophisticated teaching concept developed in close collaboration with didactics experts.

Available Experiments

Our product range provides experience and knowledge in the increasingly important fields of quantum sensing and quantum computing. Adapted to your needs they provide hands-on teaching in spin defect based magnetometry as well as magnetic resonance pulse sequences and basic quantum computing operations.
We offer the following three kits with different experiments included in them:

	Quantum Sensing Basic	Quantum Sensing Advanced	Quantum Computing
CW ODMR	●	●	●
Fluorescence Quenching	●	●	●
Scalar Magnetometry	●	●	●
Hyperfine Detection	●	●	●
Hyperfine Driving	○	○	
Vector Magnetometry	○	○	
Temperature Sensing	○	○	
Pulsed ODMR		●	●
Rabi		●	●
Ramsey		●	●
Hahn Echo		●	●
Single Spin Detection			●
g(2) Correlation Function			●
Hadamard Gate			●
CNOT-Gate			●
Deutsch–Jozsa Algorithm			●

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Quantum Sensing Basic

The Quantum Sensing Basic kit is the entry level product in our educational series. It comes with a sensor head containing the diamond and all optical elements as well as a control unit housing the required electronics, including laser control, data acquisition system and RF generators.
The kit combines theoretical insights with practical hands-on experience by providing course materials for basics in spin-physics and the corresponding experiments based on NV centers. The electron paramagnetic resonance (EPR) experiments include the observation of optically detected magnetic resonance (ODMR) of NV centers under ambient conditions. The hyperfine interaction with the nitrogen nuclear spin introduces students to the interplay of electron and nuclear spin. Additionally students can learn about the practical application as a quantum magnetic field sensor, both based on quantum state mixing and EPR.

Quantum Sensing Advanced

The Quantum Sensing Advanced kit extends the functionality of the Quantum Sensing Basic by an additional fast pulse sequence generator. This allows pulsed measurement schemes to be performed and therefore introduces students to the concepts of controlled spin manipulation in pulsed EPR. The available pulse sequences well known from EPR and nuclear magnetic resonance (NMR) include pulsed ODMR, Rabi, Ramsey and Hahn echo.

Quantum Sensing Options

The Quantum Sensing Basic and Advanced Kits can be extended with the following courses:

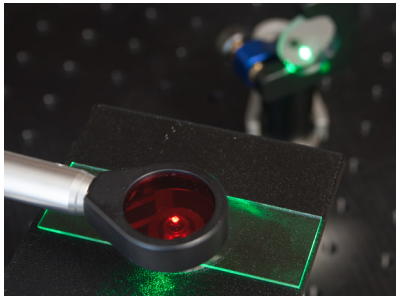
Vector Magnetometry An additional lecture on vector magnetometry using the NV center is provided. For precise magnetic field application, a 3-axis Helmholtz coil and coil driver is added to the Quantum Sensing Basic or Advanced kit. The helmholtz coil accessory allows very easy control over the magnetic field applied to the diamond via the graphical user interface of the experiment software.

Temperature Sensing With this option, the shift of the magnetic resonances due to temperature variations can be observed. The additional lecture explains the underlying physical effects while the included hardware kit provides temperature control of the diamond.

Hyperfine Driving This option adds a course on the interplay between the Nitrogen nuclear spin and NV-Electron spin and its use in quantum sensing. By simultaneous excitation of the hyperfine transitions, the detected signal is enhanced. It demonstrates how a deep understanding of quantum physics of the system can improve practical sensors for applications.

Breadboard Kit The kit provides a set of loose components, which replicate the optical functionality of the integreated sensor head. In this way, students can assemble the optical system on an optical breadboard. This involves the students in the quantum sensor design process and provides hands-on experience in alignment of optical elements.

Quantum Computing



Quantum Computing is a key future technology, underlining the difference between the classical and quantum world. The course allows students to learn about the basics of quantum computing using single spin qubits and properties of single photon emitters, a key component of quantum cryptography and quantum networks. The kit operates at room-temperature and consists of a confocal microscope, a diamond sample and all required optics and electronics in a compact table-top format. The system especially teaches the full process, starting from characterising a single spin-qubit, over obtaining the correct experimental parameters to constructing and applying the pulse sequences to perform e.g. Hadamard, CNOT gate and the Deutsch-Jozsa algorithm.

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Company Portrait

Advanced Quantum is your partner for spin-defect based quantum technologies.

As a spin-off from the well-known 3rd Institute of Physics at the University of Stuttgart, the team of Advanced Quantum allows you to benefit from the ground breaking research and development on the nitrogen-vacancy center in diamond.

With decades of personal experience in science, instrumentation, precision measurements and engineering, Advanced Quantum adapts advanced measurement technology based on quantum effects to enhance your application. The offered products and solutions address a broad variety of challenges in research and industry.

Additionally, Advanced Quantum aims to pass on the accumulated decades of experiences to a new generation of students. Next to the theoretical background, the available educational courses focus on teaching practical aspects of quantum technology. As former students and long-time educators, the team believes that sharing experiences is key to flattening the steep learning curve involved with quantum technology. The practical approach close to real-world applications motivates and inspires students to advance quantum technology in the future.

Other Products and Services

Advanced Quantum developed the first commercial high-precision vector magnetometer based on NV centers in diamond. This sensor is suitable for various applications, ranging from non-destructive material testing and building inspection, over archeology and geology to aerial magnetic surveys.

Besides the educational products and specialised sensors, Advanced Quantum offers customised solutions.
Our team will tackle projects of any complexity, from simple instrumentation to complex measurement systems. Examples include low-temperature microscopes, spin-defect characterization systems, custom RF generators and qubit control units.

Reach out now – our experts are eager to learn about your challenges.

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