DiaQNOS

Compact Laser Technology for Diamond-Based Quantum Sensing in Neurosurgery

When surgically removing brain tumours, distinguishing between tumour tissue, healthy tissue and functionally important brain regions is crucial. The DiaQNOS collaborative research project is developing a Quantum Neuro-Analyser intended to provide additional information on tissue boundaries and brain function during surgery. The approach is based on highly sensitive diamond-based quantum sensors. Project information in the official project atlas

Sacher Lasertechnik is developing a compact, low-noise laser source and integrating key components into a shared base station.

Project at a glance

- **Collaborative project:** DIAmond-based Quantum sensing for NeurOSurgery
- **Acronym:** DiaQNOS
- **Project duration:** 1 October 2022 to 30 September 2027
- **Consortium coordinator:** Johannes Gutenberg University Mainz
- **Funding:** German Federal Ministry of Research, Technology and Space (BMFTR), under the initiative “Lighthouse Projects in Quantum-Based Metrology to Address Societal Challenges”
- **Sacher Lasertechnik subproject:** Laser Implementation and Pixel Addressing

Project duration, coordination and funding details are provided in the official project atlas.

Objectives and Approach

DiaQNOS uses nitrogen-vacancy centres, known as NV centres, in diamonds as sensitive magnetic field sensors. These defect centres can be excited with green laser light and read out optically. Their magnetic-field-dependent properties enable the investigation of weak biological signals.

The consortium is investigating magnetically detectable properties of living human brain tissue in preclinical studies. Building on this work, the project aims to develop an imaging, magnetically sensitive quantum endoscope at the end of a multimodal optical waveguide. In the longer term, it is intended to support intraoperative functional diagnostics and tumour detection. DiaQNOS objectives and approach

Sacher Lasertechnik’s Contribution

Sacher Lasertechnik is developing a miniaturised laser system at 532 nanometres for optical excitation of the NV centres. A low-noise semiconductor laser source initially generates light at 1064 nanometres. Frequency doubling in a periodically poled lithium niobate waveguide is intended to produce green laser light with an output power exceeding 100 milliwatts. Compact optical assemblies and automated alignment procedures are intended to support high stability and reproducible manufacturing.

Sacher Lasertechnik is also integrating the consortium’s laser, control and readout components into a compact base station. The assemblies will be characterised together and further developed based on feedback from the project partners.

Expected Results and Outlook

By the end of the subproject, a compact laser source with associated drive electronics is expected to be available for optical excitation of the diamond-based sensor system. Together with the base station, it is intended to enable testing of the Quantum Neuro-Analyser in a medical setting.

Beyond the project application, the planned compact, low-noise laser source offers potential for spectroscopy, material analysis and industrial quality control. The assembly and control methods developed are also intended to pave the way for reproducibly manufactured systems.