

# MagiQ Research Labs (MRL) Fiber Sensors

One of the key innovations recently developed at MagiQ Technologies, Inc. for Quantum Key Distribution (QKD) is a pair of stabilized, perfectly length-matched optical interferometers that can be separated by up to 100km of fiber. The interferometer at the receiver side of the system is able to actively track and reject vibrations to keep the phase match between the interferometers extremely precise.

This technology also applies directly to sensing acoustic disturbances under the ocean, in the ground, and in the air. The active tracking allows for high sensitivity links with extreme linearity and high dynamic range. We are able to design the sensor end to be completely passive, with no electronics. Compared to current acoustic sensors fabricated using PZTs, our approach is completely passive at the sensor end, it has higher sensitivity, and wider frequency range. In our approach, we are able to locate all of the tracking and demodulation electronics at a remote site, such as inside a submarine or in a military facility. Phased arrays of the interferometers can be fabricated and arranged to allow for direction finding. Our design allows for low cost mass production of perfectly matched arrays of interferometers.

The phase modulator has an extremely linear, broadband frequency response. The voltage applied to the phase modulator is a linear reproduction of the acoustic disturbances at the sensor head. It is possible to track multiple pi excursions in the fiber length with a frequency response well into the MHz regime. It is also possible to detect very small changes in the interferometer length, limited by the shot noise of the pulsed laser source. Increasing the laser power improves the sensitivity, the dynamic range, and the frequency response.

The advantages of this acoustic sensor over PZTs include; completely passive sensor head, very wide bandwidth, high dynamic range, and high sensitivity. All of the electronics are able to be located at a remote site many kilometers away, in an electronics bay for example. Our approach is also compatible with mass production techniques, and scalable to arrays of sensors for direction finding and enhanced performance.

Our ability to produce and match optical interferometers allows us to have better sensor performance in terms of sensitivity, linearity, speed and dynamic range. These parameters are applicable to the oil and gas industry for sensing locations of oil under the ocean floor and underground with higher speed and precision than previously possible. In addition, the sensors have applications down-hole when drilling and pumping for oil. Our technology can withstand higher pressures and temperatures compared with electronic techniques. This allows for more precise monitoring of the conditions down-hole, and allows for more efficient pumping. MagiQ intends to commercialize this technology and is looking to partner with an entity that can benefit from increased efficiency in oil and gas exploration and production.

MRL can also produce other types of fiber sensors. Contact us for a needs assessment

#### About MagiQ Research Labs (MRL)

MagiQ Research Labs provides custom products, design engineering, and contract research and development services for optics, quantum information, fiber sensing, aerospace and defense applications. MRL also contracts directly with private firms and government agencies such as the Army, DARPA, and NASA.

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## Key Features

- High-Sensitivity
- High-Dynamic Range
- Active Tracking
- Length-Matched Interferometers

## Applications

- Ocean
- Ground
- Air

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