Department of Applied Physics

Michel Digonnet

Professor (Research) of Applied Physics

Directory Link

Research areas:
Control and Estimation, Electrical Engineering, Information Sci/Tech, Laser Physics, Materials Science, Nano Sci/Eng, Photonics, Precision Measurement

Description

Nanoscience and Quantum Engineering

My research activities center mostly on advanced fiber-based sensors, in particular fiber optic gyroscopes, fiber hydrophones and microphones, and strain sensors. The primary aim in the area of gyroscopes is to develop radically new approaches to improve their rotation sensitivity and long-term stability to the point where they can be used for the enormous market of inertial navigation of aircrafts. This work involves in particular interrogating the sensor with a laser instead of a traditional broadband source to reduce the noise, and using a hollow-core photonic-bandgap fiber instead of a conventional fiber to eliminate residual sources of output drift. This concept has recently led to the first laser-driven fiber optic gyroscope with tactical-grade performance. A portion of this activity involves experimental and theoretical studies of the fundamental properties, in particular birefringence, loss, and backscattering, of photonic-bandgap fibers. In the area of acoustic-wave detection, we are spearheading a new class of miniature sensors utilizing a MEMS nano-membrane placed at the tip of a fiber to form extremely sensitive interferometers. This technology has produced the world's most sensitive optical microphone. Our ultimate objective is to develop a suitable process to fabricate on a single silicon wafer hundreds of identical sensors that can be multiplexed together on a single fiber to assemble large-scale sensor arrays for the oil extraction industry and surveillance applications. Another important aspect of this research is the implementation of slow and fast light in practical optical structures to produce sensors with unprecedented sensitivity. In one particular implementation, we have used a fiber Bragg grating to generate the world's slowest light in an optical fiber, and utilized it to make a breakthrough sensor capable of detecting dynamic strains at the femtostrain level.

Selected Publications

- Photonic-crystal-diaphragm-based fiber-tip hydrophone optimized for ocean acoustics
- Optomechanical fiber gyroscope
- Miniature photonic-crystal hydrophone optimized for ocean acoustics
- Birefringence analysis of photonic-bandgap fiber using the hexagonal Yee's cell
- Classification of the core modes of hollow-core photonic-bandgap fibers
- Rare Earth Doped Fiber Lasers and Amplifiers
- Coherent Backscattering Noise in Photonic-Bandgap Fiber Optic Gyroscope
- Performance comparison of slow-light coupled-resonator optical gyroscopes
- Power Scaling Fiber Amplifiers: Challenges and Opportunities

Lasers and Accelerators

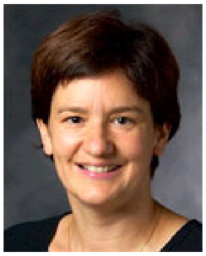
I am working in collaboration with Bob Byer on the development of Tm-doped mode-locked fiber lasers operating around 2 μm for possible implementation in table-top particle accelerators. The mid-range objective is to demonstrate frequency-stable pulse trains with 10-fs pulse width and average powers in the range of hundreds of watts.

More Faculty in This Theme

See all >>

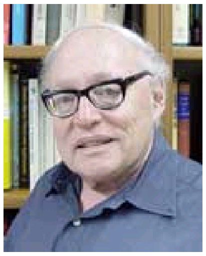
Hideo Mabuchi

Mark A. Kasevich

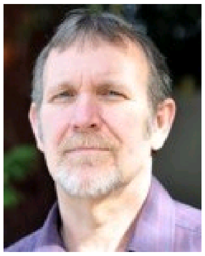


Kathryn A. Moler

Yoshihisa Yamamoto



Stephen E. Harris



Raymond G. Beausoleil