

**Fiber Optic Sensing at the Edge: From Cryogenic
Performance to Infrastructure Deformation
Monitoring**

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325 McCone Hall

UC Berkeley Campus

Abstract: Distributed fiber-optic strain sensing is transforming how we observe and understand complex systems—from superconducting magnets at 4 K to multimillion-dollar pipelines crossing active faults. In this presentation, I will first introduce our in-house BOTDR and OFDR platforms, highlighting key performance metrics: kilometer-scale reach with meter-level resolution (BOTDR) and sub-millimeter precision over hundreds of meters (OFDR). We then showcase how OFDR has enabled real-time monitoring of mechanical strain in cryogenic superconducting magnet coils, revealing magnet fabrication quality control, magnetic force loads, and quench precursors under extreme conditions.

Building on the distributed strain measurements, a shape-sensing framework—based on Cosserat rod theory—was used to reconstruct full 3D shape. Lab demonstrations on a smart mooring line illustrate bending, shear, and twist capture, while field data from the Hayward Fault crossing reveal pipeline axial elongation and lateral deflection over seasonal and seismic cycles. Finally, we'll discuss an innovative application at a nuclear-waste analog site, where fiber-optic shape

sensing detected salt-rock deformation induced by controlled heater operations.



Linqing Luo is a Research Scientist in the Energy Geosciences Division at Lawrence Berkeley National Laboratory. He received a B.ENG. in Electrical Engineering from the University of Liverpool, a M.Res of Photonics Systems Development and a PH.D. from University of Cambridge in 2018. He specializes in the development of advanced sensing

technologies, especially within the domain of distributed fiber optic sensing. His research centers on distributed measurements of strain, temperature, acoustics, and chemical changes. This work has significant applications in various energy-related projects: from monitoring underground gas storage and detecting gas leakages, to assessing the structural health of infrastructures, examining offshore wind turbines, overseeing superconducting magnets, and evaluating battery health. Luo's contributions cover sensor design, deployment methods, optimization, and enhancing data acquisition and processing workflows.

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