UPISC UNIVERSITY OF PITTSBURGH INFRASTRUCTURE SENSING COLLABORATION WORKSHOP

NATIONAL ENERGY TECHNOLOGY LABORATORY

Fusion of Distributed Fiber Optics, Acoustic NDE and Physics-Based AI for Spent Fuel Monitoring

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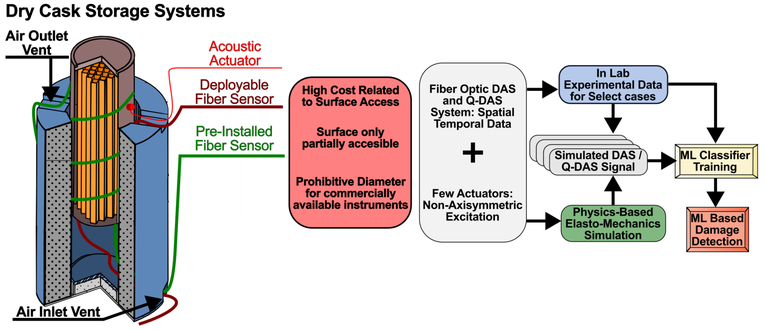
Project Outline:

Motivation:

Current status: *Dry Casks Storage Systems (DCSS) for nuclear waste storage poses challenges for traditional structural health monitoring methods due to hard and limited access, creating a demand for less intrusive techniques of easy installation.*

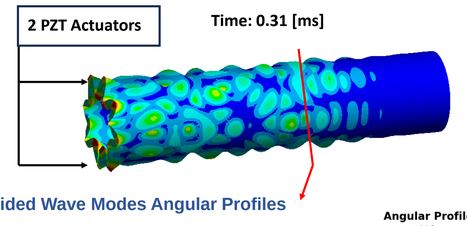
Improvement: *Combine Acoustic nondestructive evaluation (NDE) based on ultrasonic guided waves will be combined with distributed fiber optic sensing enhanced by artificial intelligence (AI) frameworks to quantitatively characterize the internal state of dry cask storage systems (DCSS). Physics-based simulations and reduced order modeling will be coupled with targeted experiments to train and apply AI-classification to distributed acoustic data acquired with fiber optics*

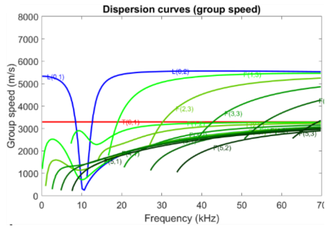
Structural Health Evaluation and Monitoring Enabled by Distributed and Quasi Distributed Optical Fiber Sensor Configuration



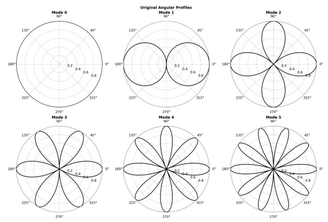
Non-Destructive Evaluation Method Principle

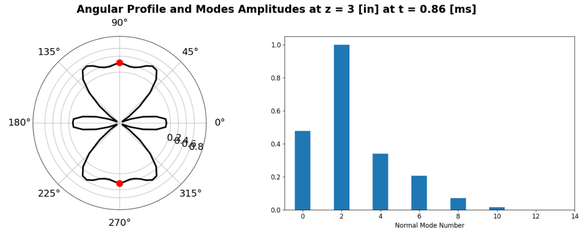
Non-Axisymmetric Guided Wave Excitation



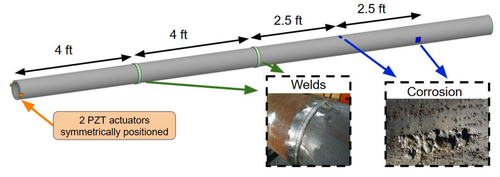


Guided Wave Modes Angular Profiles

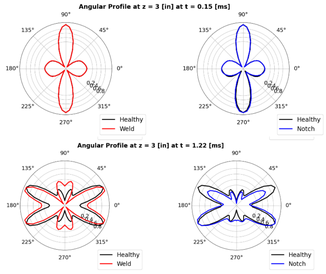




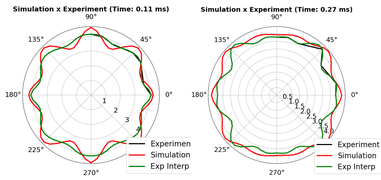
In lab experimental setup for non-axisymmetric guided wave Investigation

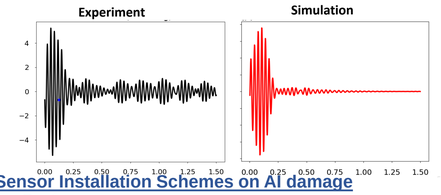


Angular Profile for Different Structural Features

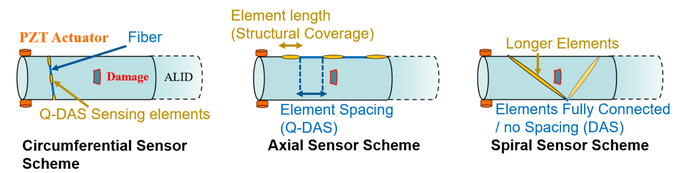


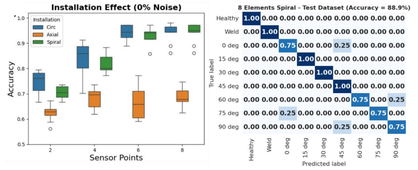
Simulation x Experiment angular profile

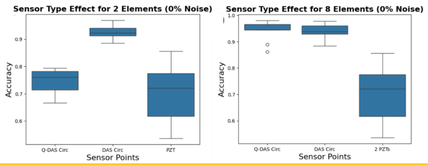




Investigation of Different Fiber Optic Sensor Installation Schemes on AI damage Identification Performance

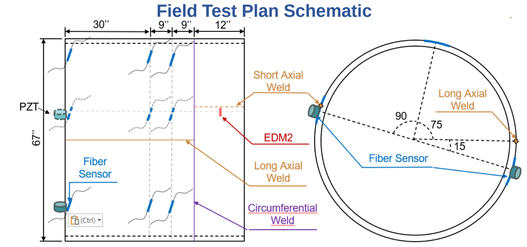




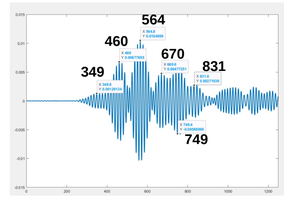


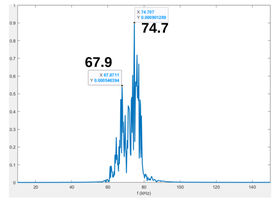
Future Field at PNNL Facility

Field Test Plan Schematic

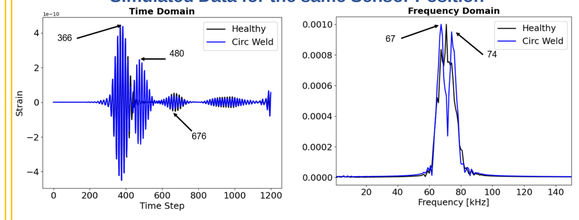


Field Test Data from Sensor at 48” from left end





Simulated Data for the same Sensor Position



Future Objectives: 1) Field testing for demonstration of sensor deployment on real dry cask storage structure at Hanford Waste Facility. 2) Complete analysis of field test on real size structure in comparison with physics-based simulations.

Publications:

[1] Zhang, P., Venketeswaran, A., Wright, R. F., Lalam, N., Sarcinelli, E., and Ohodnicki, P. R., 2023, “Quasi-Distributed Fiber Sensor-Based Approach for Pipeline Health Monitoring: Generating and Analyzing Physics-Based Simulation Datasets for Classification,” Sensors, **23**(12), p. 5410.

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