Observations of OSIRIS REx Sample Return Capsule with Distributed Acoustic Sensing. Carly Donahue¹, Chris Carr¹, Loïc Viens¹, Luke Beardslee¹², Elisa McGhee¹, Lisa Danielson¹
¹Los Alamos National Laboratory, Earth and Environmental Sciences, P.O. Box 1663 Los Alamos, NM 87545,
²Silixa, 3102 W Broadway St Ste. A, Missoula, MT 59808,
³Colorado State University, Department of Geosciences, 1482 Campus Delivery, Fort Collins, CO 80523-1482

Introduction: On September 24, 2023 the OSIRIS REx space capsule returned through the earth’s atmosphere, crossed over California and Nevada, and landed in Utah. Along its path, the capsule generated infrasonic signals, with the predicted point of highest heating occurring above Eureka, Nevada. A number of sensors were deployed around Eureka to characterize the return, including infrasound sensors and seismometers [1]. For the first time, fiber-optic Distributed Acoustic Sensing (DAS) was utilized to record a space capsule return [2]. We deployed approximately 12 km of optical fiber in two locations, namely, the Eureka Airport and Newark Valley, by unspooling directly to the ground with no trenching. Signals from the return can be distinguished in both locations on thousands of sensors, therefore, a clear moveout is observed that is not possible with traditional sensors. Given its relative ease of deployment for a significantly large number of sensors, this work demonstrates that DAS can be a practical sensor in a large range of applications.

Fig 1. OSIRIS REx sample return capsule shortly after its landing. Credit: NASA/Keegan Barber

Distributed Acoustic Sensing: DAS interrogators emit a laser pulse into an optical fiber that is backscattered from material heterogeneities. The deformation of those heterogeneities in the fiber changes the phase of the backscattered light into a measurable signal. The captured light is processed as a dense array of seismoacoustic sensors that can extend 10’s of kilometers to produce a spatially dense real-time network.

Experimental Setup: We deployed 12 km of fiber at two locations in Nevada, chosen for their proximity to the portion of the trajectory with anticipated maximum infrasound generation. At each fiber location, we deployed three co-located seismometers and infrasound sensors to inform interpretation of DAS data. For nearly the entire fiber length, we placed the fiber directly on the ground without any trenching or weights to increase ground coupling. We used three different interrogators to sample the fibers at the two locations: an AP Sensing interrogator sampled 4.5 km of fiber at the Eureka Airport and Silixa and Alcatel interrogators sampled 7.5 km of fiber in nearby Newark Valley.

Fig 2. Deployment of optical fiber at the Eureka Airport Newark Valley, NV.

Results: The signal from the space capsule was apparent at both locations, but appeared more clearly on the fiber at Newark Valley since this location was closer to the point of maximum heating. At Newark valley, the signal was apparent on a majority of the channels, and the moveout was clear. Since the fiber was only laying on the ground, it is coupled to both the air and the ground – the comparisons to infrasound sensors and seismometers have been used to aid in qualifying the relative contributions to the DAS acquired data. At the Eureka airport, a small section of the optical fiber was buried, significantly reducing the air coupling. Conversely, the very end of the fiber remained wrapped around the spool, which most likely improved the air coupling and amplified the signal. Consequently, on the spool, the characteristic N-wave of a sonic boom was most clearly observed.

Fiber construction also played a significant role; the fiber in Newark valley was composed of 3 km of armored fiber, and 4.5 km of tight buffered fiber with a polyurethane jacket. The armored fiber was not as sensitive to the signal from the capsule, whereas, it was more sensitive to noise from wind.
Acknowledgments: This research was supported by Los Alamos National Laboratory (LANL) through the Laboratory Directed Research and Development (LDRD) program, under project number 20220188DR and under the LANL Center for Space and Earth Science (CSES) LDRD project number 20240477CR-SES. We also thank the Eureka County Commission and Eureka Airport for access at the airport site, and the Bristlecone BLM Field Office for guidance in complying with casual use requirements at the Newark Valley site. We are grateful for the loan of a field truck by the MPA-Q Division at LANL. Funding for Elisa A. McGhee was provided by the Pat Tillman Foundation Scholarship and the Colorado State University Vice President for Research Graduate Fellowship Program.

References: