Report of Transnational Access Projects

Project ID: C4_TA3-83-5_1

Principal investigator: Angeliki Xenaki, PhD

Foundation for Research and Technology–Hellas (FORTH), Greece

ORCID: orcid.org/0000-0003-0930-4011

Homepage: https://www.iacm.forth.gr/index.php/cb-profile/angelx

LinkedIn: https://www.linkedin.com/in/angelikixenaki/

Project team: George S. Piperakis, MSc, FORTH, Greece

Project title: Inquiring the Frequency REsponse of Distributed Acoustic Sensing in monitoring the underwater soundscape

Project acronym: FREDAS

Hosting installation: Eastern Sicily – INFN-LNS submarine FO cable (TA3-83-5)

National Institute for Nuclear Physics (INFN) – National Laboratories of the South (LNS)

Hosting team: Giorgio Riccobene, PhD, INFN-LNS, Italy

Salvatore Viola, PhD, INFN-LNS, Italy

Period of access: 5-20 March 2026

Report of activities:

Project FREDAS took place at the facilities of INFN-LNS in Eastern Sicily, Italy, during March 2026 supported by the Geo-INQUIRE Transnational Access to research infrastructures. The project was carried out in collaboration between FORTH, Greece, as the visiting institution and INFN-LNS, Italy, as the host institution.

FREDAS aims to showcase the utility of DAS on submarine fiber-optic cables for passive acoustic monitoring of the underwater soundscape and to demonstrate experimentally the effect of the acquisition parameters on the frequency response of DAS. To achieve these objectives, FREDAS utilized:

- the submarine fiber-optic cable of the INFN-LNS research infrastructure at Portopalo di Capo Passero, Italy, interrogated with a commercial OptoDAS (https://www.asn.com/fiber-sensing/) interrogator for DAS measurements

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- two commercial piezoelectric hydrophones for baseline passive acoustic measurements (icListen RB9-ETH https://oceansonics.com/documents/icListen_FULL_specsheet.pdf)
- a commercial vessel as a controlled sound source

Figure 1 illustrates the basic components for FREDAS project.

Figure 1: (a) Double-armoured and single-armoured structure of the submarine fiber-optic cable, (b) deployment structure for the piezoelectric hydrophones, and (c) FREDAS team onboard a commercial vessel at the port of Portopalo di Capo Passero, Italy.

During the experiment, the vessel followed a predefined trajectory along the coordinates of the submarine cable as documented during the cable's deployment in 2006. The battery-powered, self-recording hydrophones were deployed along the trajectory at approximately 30 m and 50 m depth and collected passive acoustic measurements throughout the experiment. An OptoDAS interrogator was connected to a dark fiber within the submarine cable and collected DAS measurements with different acquisition parameters. Figure 2 maps the location of the submarine fiber-optic cable, the trajectory of the vessel (from AIS measurements), and the location of the hydrophone deployments. The coating of the fiber-optic cable is double-armoured (DA) for reinforced protection close to the shore and switches to single-armoured (SA) at around 9.5 km from shore; see Fig.1 (a) and legend in Fig.2.

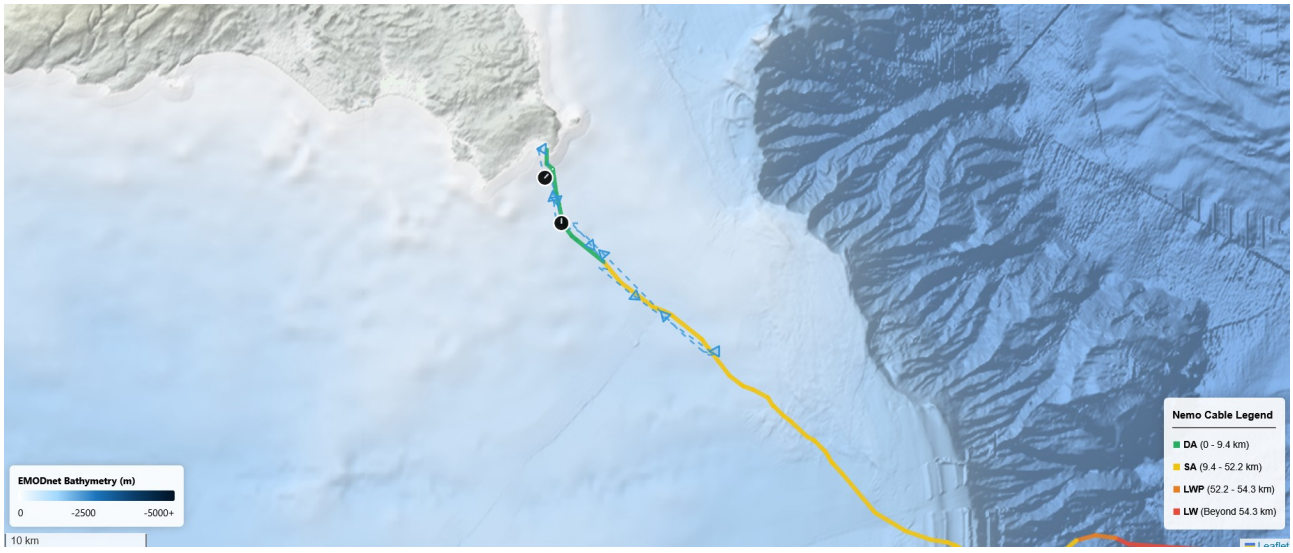

Figure 2: Bathymetric map of the INFN-LNS installation site indicating the location of the submarine cable, the trajectory of the vessel and the location of the hydrophone deployments.

At the INFN-LNS facilities the experimental data were preliminary analyzed and further DAS measurements were collected with sources of opportunity. Figure 3 shows an example of a hydrophone recording over 8 min, with the vessel's engine off (first 4 min) and on (last 4 min), providing an estimate of the ambient and the vessel's noise characteristics close to the seafloor (at 30 m depth). Figure 4 shows DAS recordings of the vessel in time-space and in frequency-wavenumber representation. The acoustic signature of the vessel crossing the submarine cable at a length of around 10 km from the shore is clearly visible in the DAS recording.

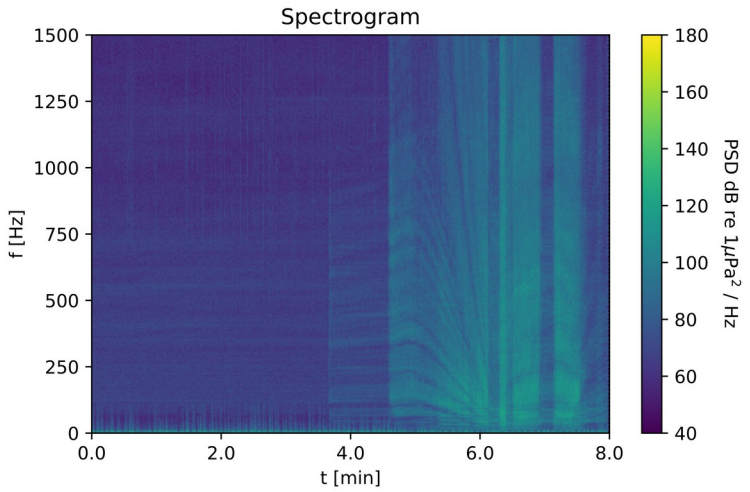

Figure 3: Spectrogram of a hydrophone recording deployed at 30 m depth, featuring ambient noise (first 4 min) and vessel noise (last 4 min). The colormap indicates the power spectral density of the recording over the hydrophone's dynamic range.

Figure 4 shows an instance of DAS recordings in time-space representation. The acoustic signature of the vessel crossing the submarine fiber-optic cable at a distance of around 10 km from the shore is clearly visible in the DAS recording.

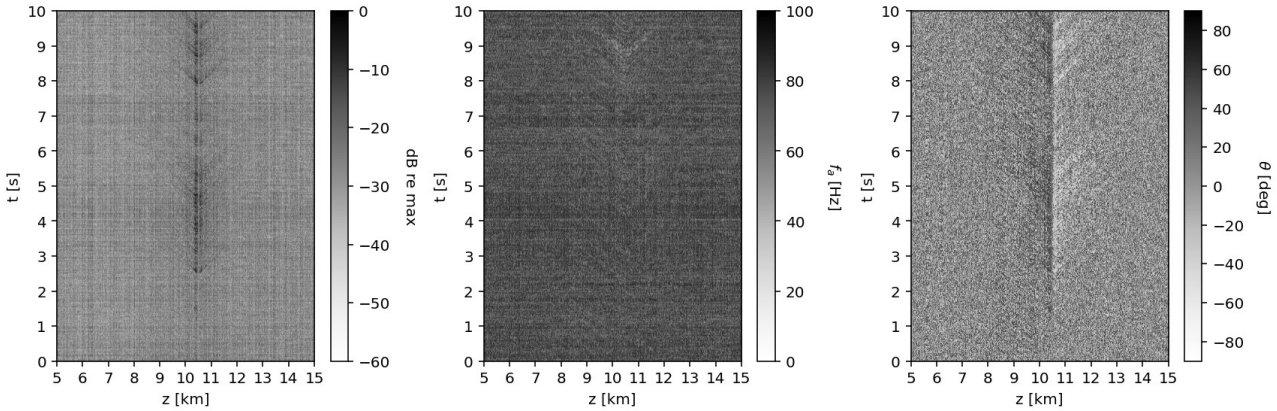

Figure 4: DAS recordings depicted in a two-dimensional format over time and distance along the cable. The data magnitude, acoustic frequency and angle of incidence are indicated seperately at the corresponding subplots.

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Project outcomes:

Data, software and publications related to FREDAS project will become publicly available in due time by the project collaborators, acknowledging Geo-INQUIRE as the funding source.

The stored data can be accessed through the following weblinks:

https://erddap.lns.infn.it/erddap/info/index.html?page=1&itemsPerPage=1000

https://www.eida.ingv.it/it/