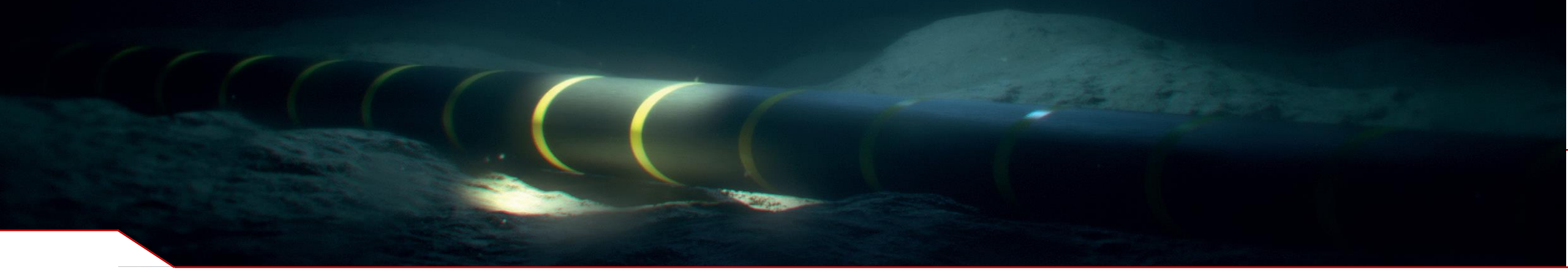

Offshore Power Cable Mapping and Exposure Identification based on the DTS and DAS Technologies

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Tony Lucignano, Statnett
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Tekna Seabed Mapping and Inspection, 09.03.2023

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Company Introduction

- Leading distributed optical sensing solution provider (DTS, DAS)
- Over 35 years of optical measurement expertise based on HP/Agilent heritage
- Approved manufacturer by UL, FM, VdS, IECEx, ATEX
- ISO 9001, 14001, 45001 and 27001 certified
- Experienced and certified project managers and engineers, 365 days support, proven training programs

HEWLETT PACKARD

1939

Hewlett-Packard (HP) started as a test and measurement company.

1959

HP establishes its first production site outside of the US in Böblingen, Germany.

Agilent Technologies

1999

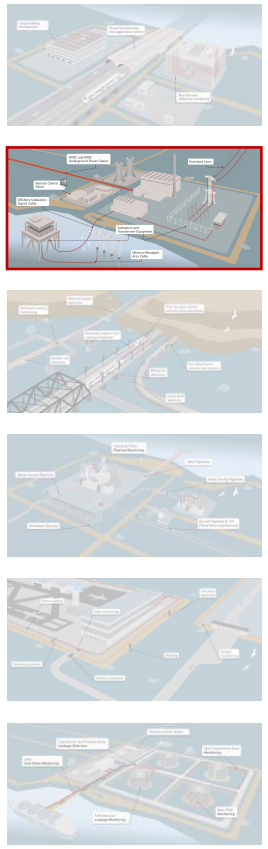
Measurement business from HP is spun off into Agilent Technologies.

2007

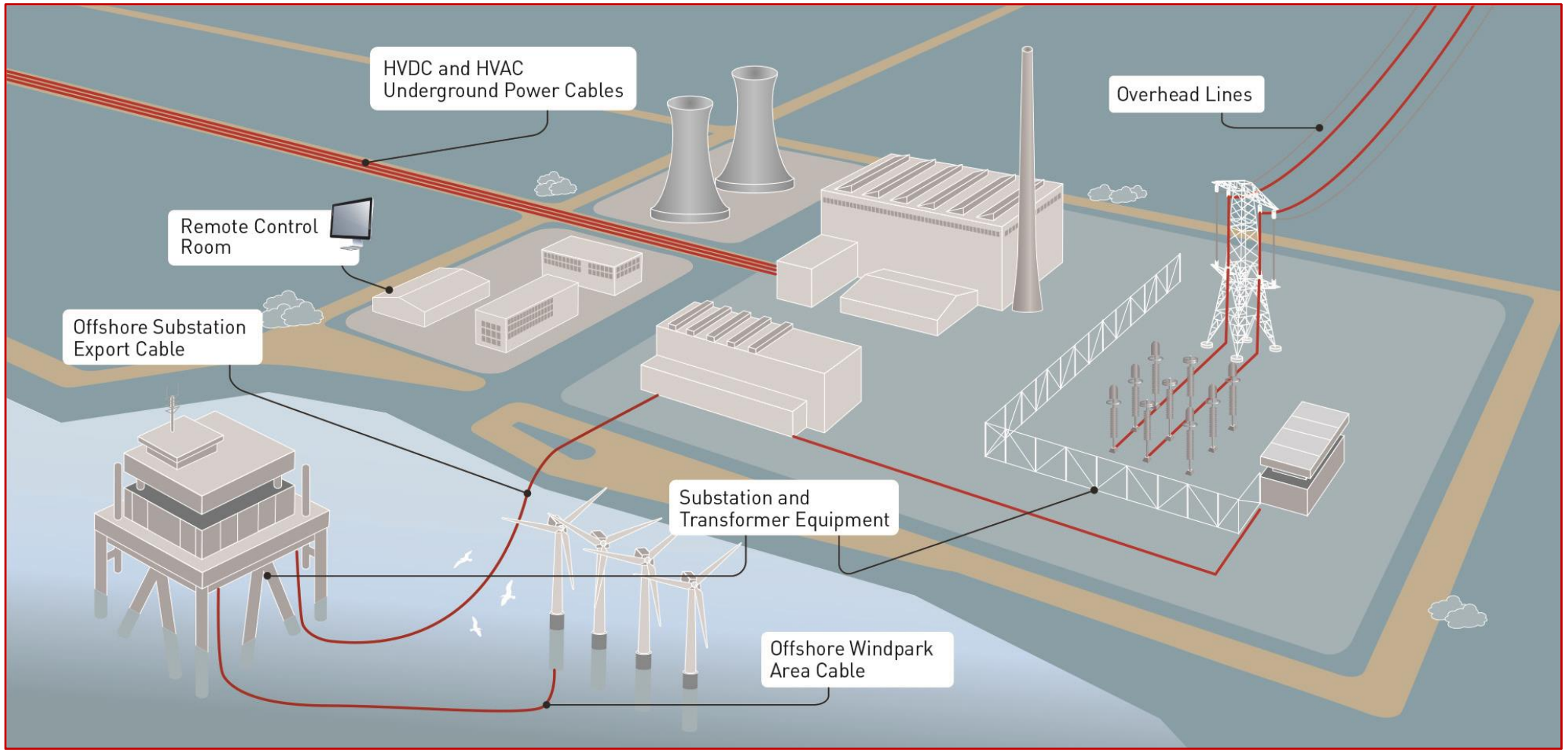
Fiber optic sensing business is spun off into AP Sensing.

AP SENSING advanced photonic

Distributed Sensing Applications



Power Cable Monitoring



Fiber Optic Cable Advantages

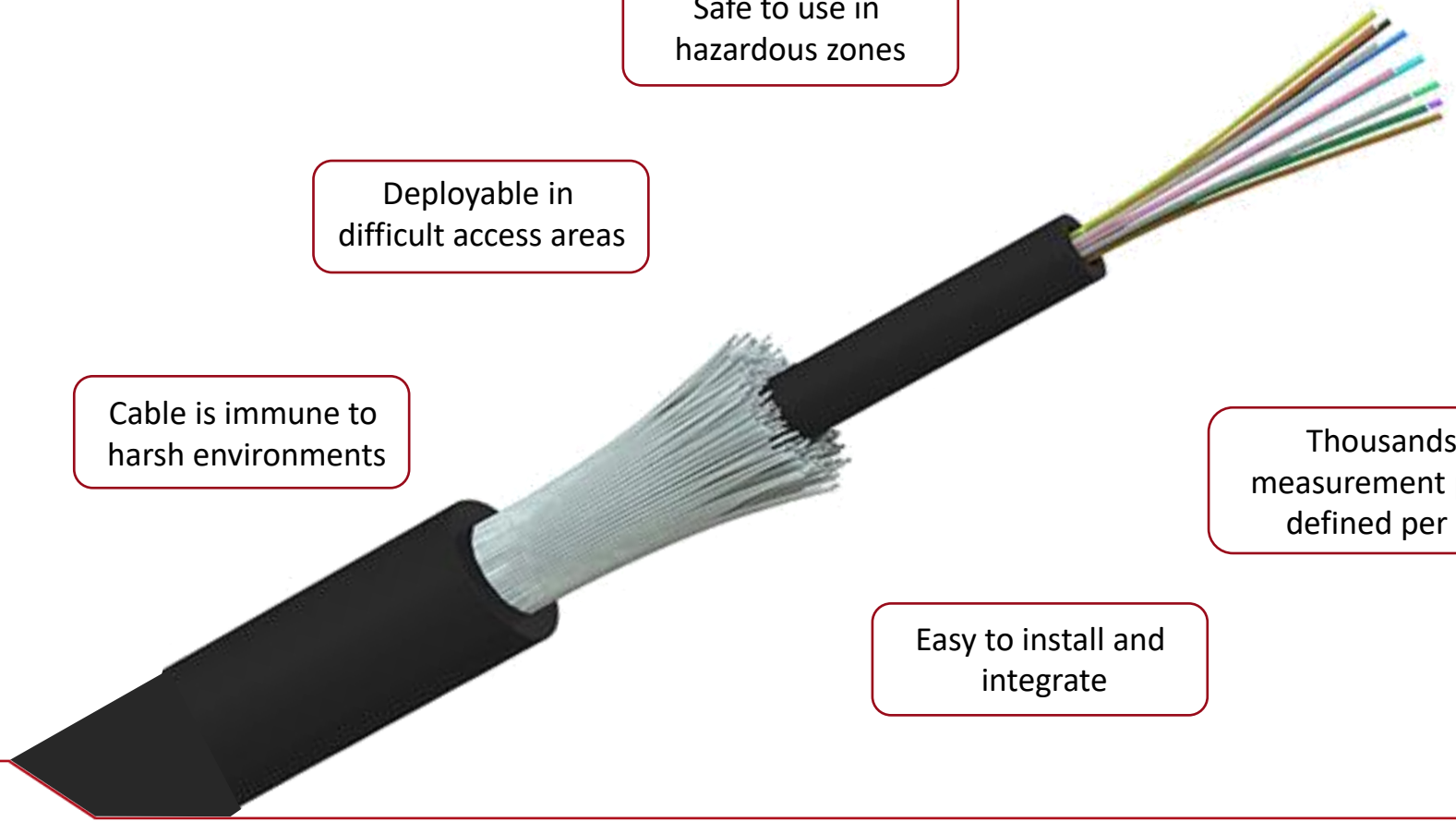
Immune to EMI

Maintenance free for decades

Safe to use in hazardous zones

Deployable in difficult access areas

Entire cable length monitored in real time



Cable is immune to harsh environments

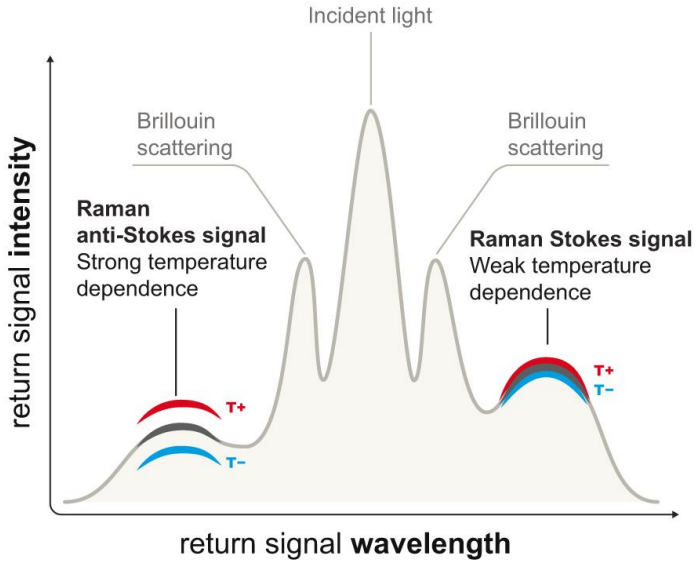
Thousands of measurement points, defined per zone

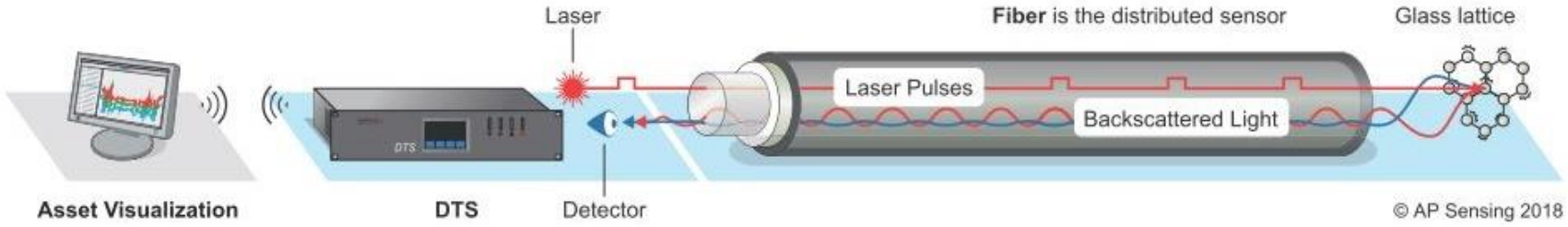
Easy to install and integrate

DTS Measurement Principle

The Distributed Temperature Sensing (DTS) utilizes the **Raman effect** to measure the temperature. An optical **laser pulse** sent through the fiber results in some scattered light reflecting back to the transmitting end, where it is analyzed. The intensity of the Raman scattering is a measure of the **temperature** along the fiber.

The **position** of the temperature reading is determined by measuring the arrival timing of the returning light pulse similar to a radar echo.

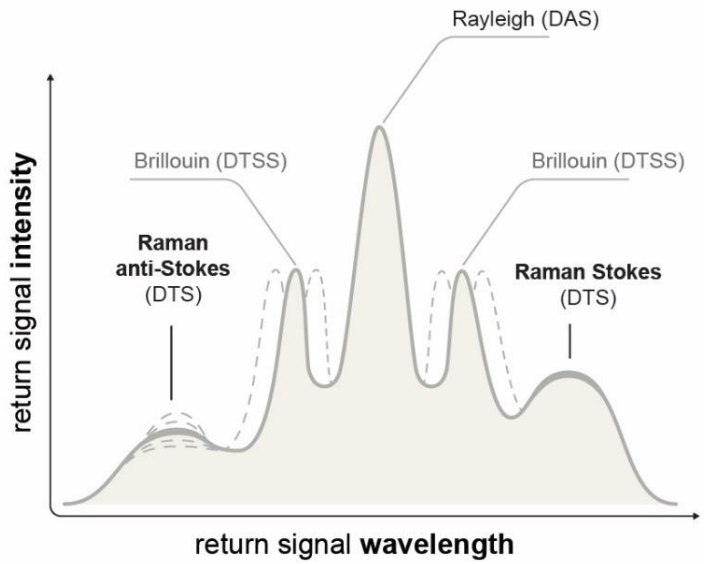


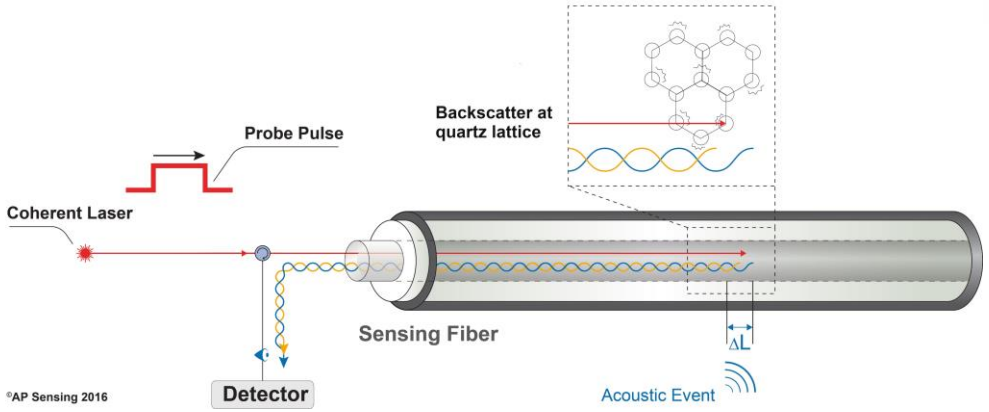


DAS Measurement Principle

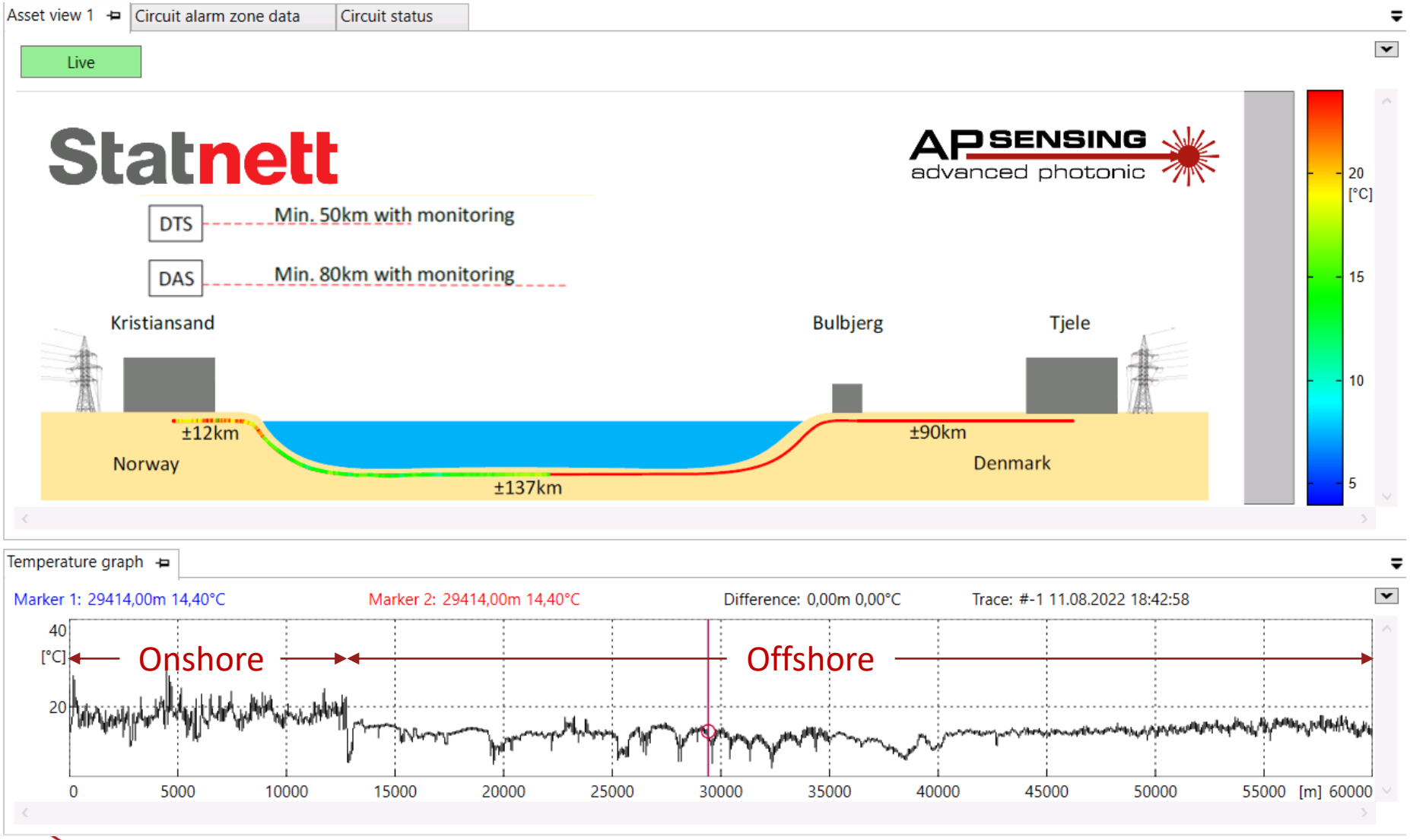
The Distributed Acoustic Sensing (DAS) is based on the **Coherent Rayleigh effect**, which is stimulated by minute strain changes in the fiber as a consequence of an **acoustic or vibration activity**. The returned signals are analyzed and presented in the form **of frequency and amplitude of disturbance**.

The **position** of the acoustic / vibration event is determined by measuring the arrival time of the returning light pulse, similar to a radar echo.

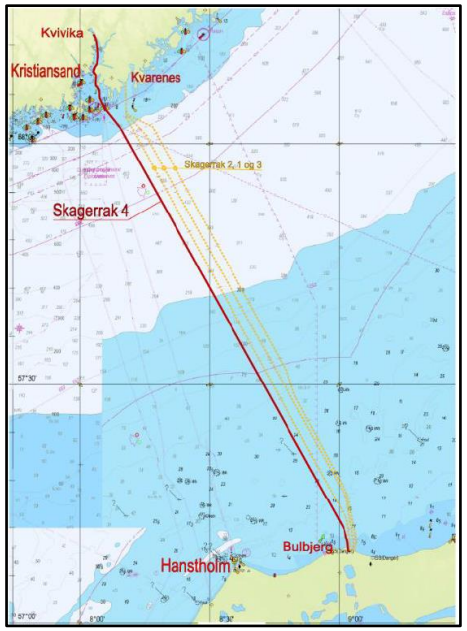




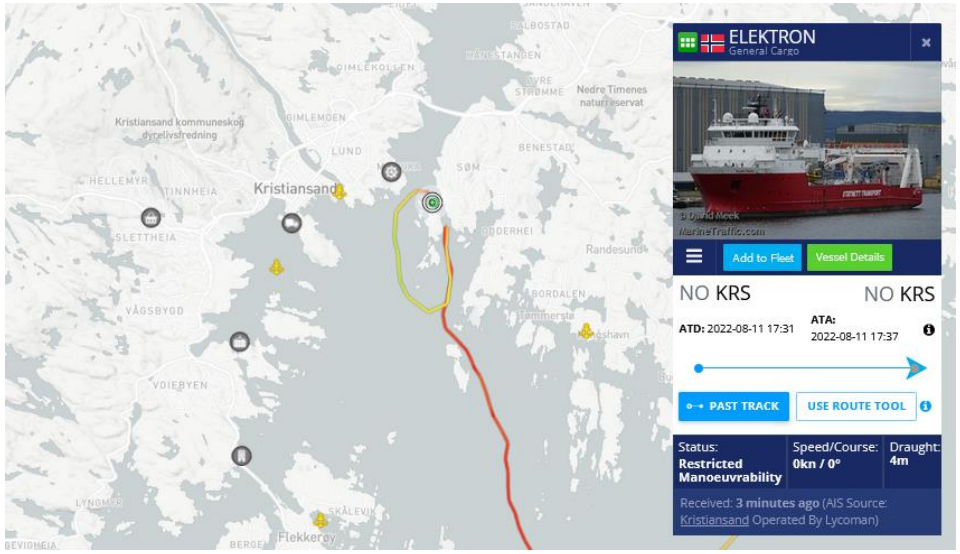
Skagerrak4 Monitoring Overview

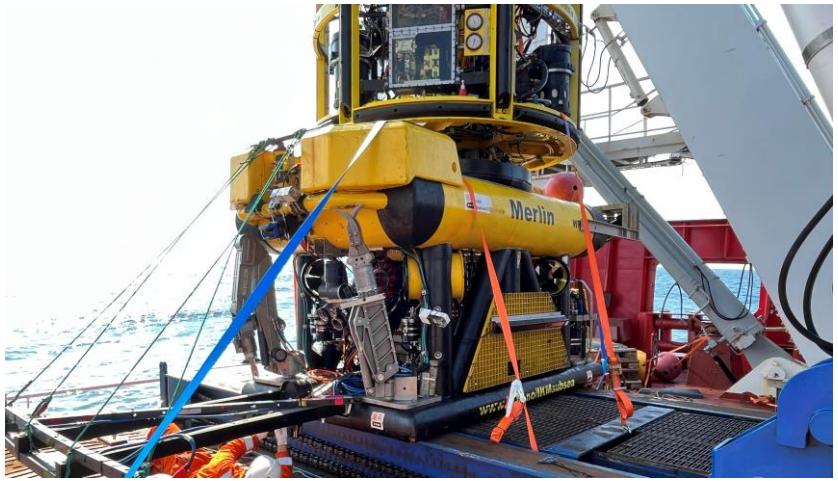


- Skagerrak4 HVDC Interconnector:
  - 700 MW
  - 500 kV HVDC
- Monitoring scope:
  - Hotspot detection
  - Cable-fault localization
  - Depth of Burial Status



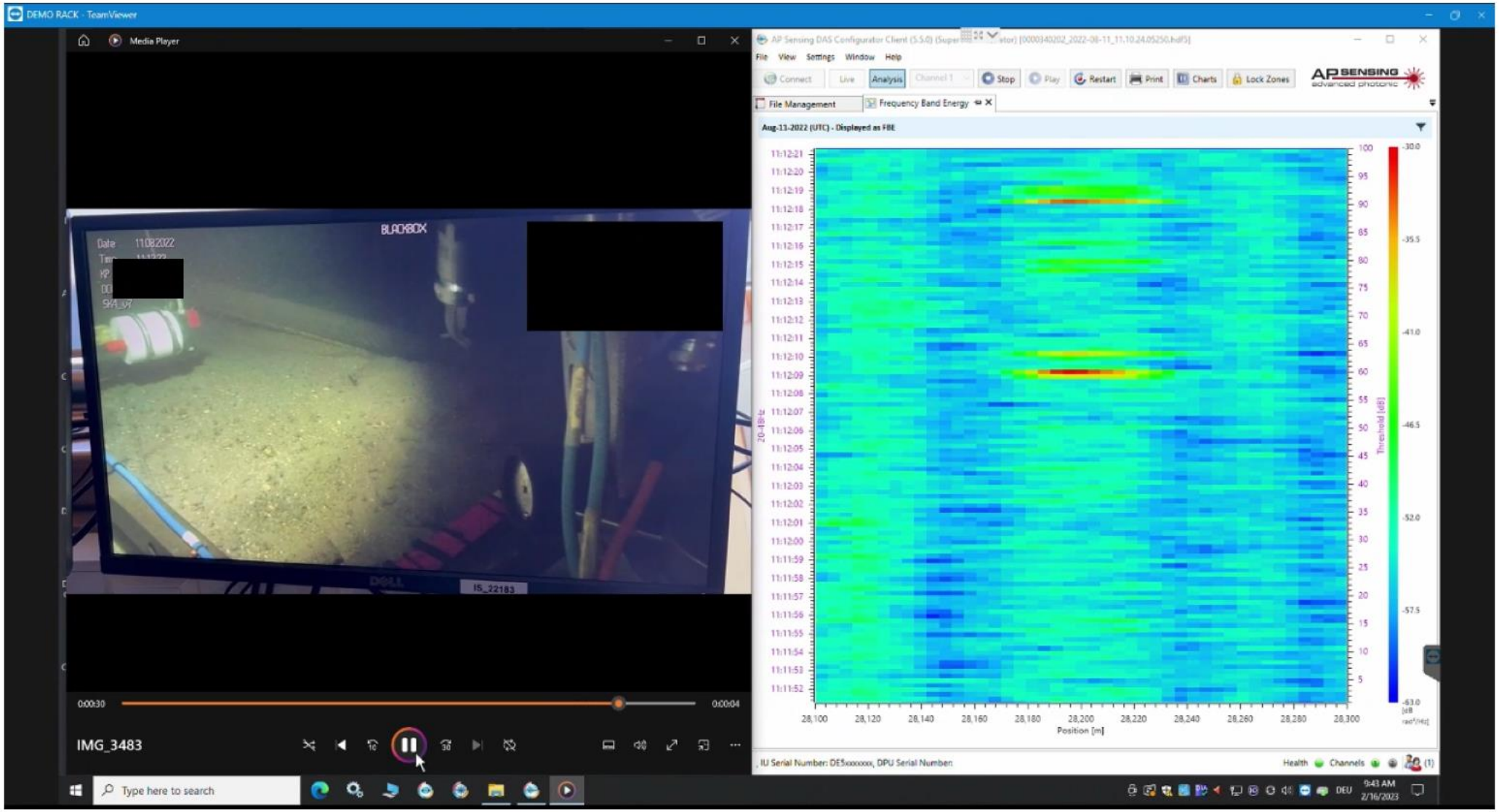
Skagerrak4 ROV Survey



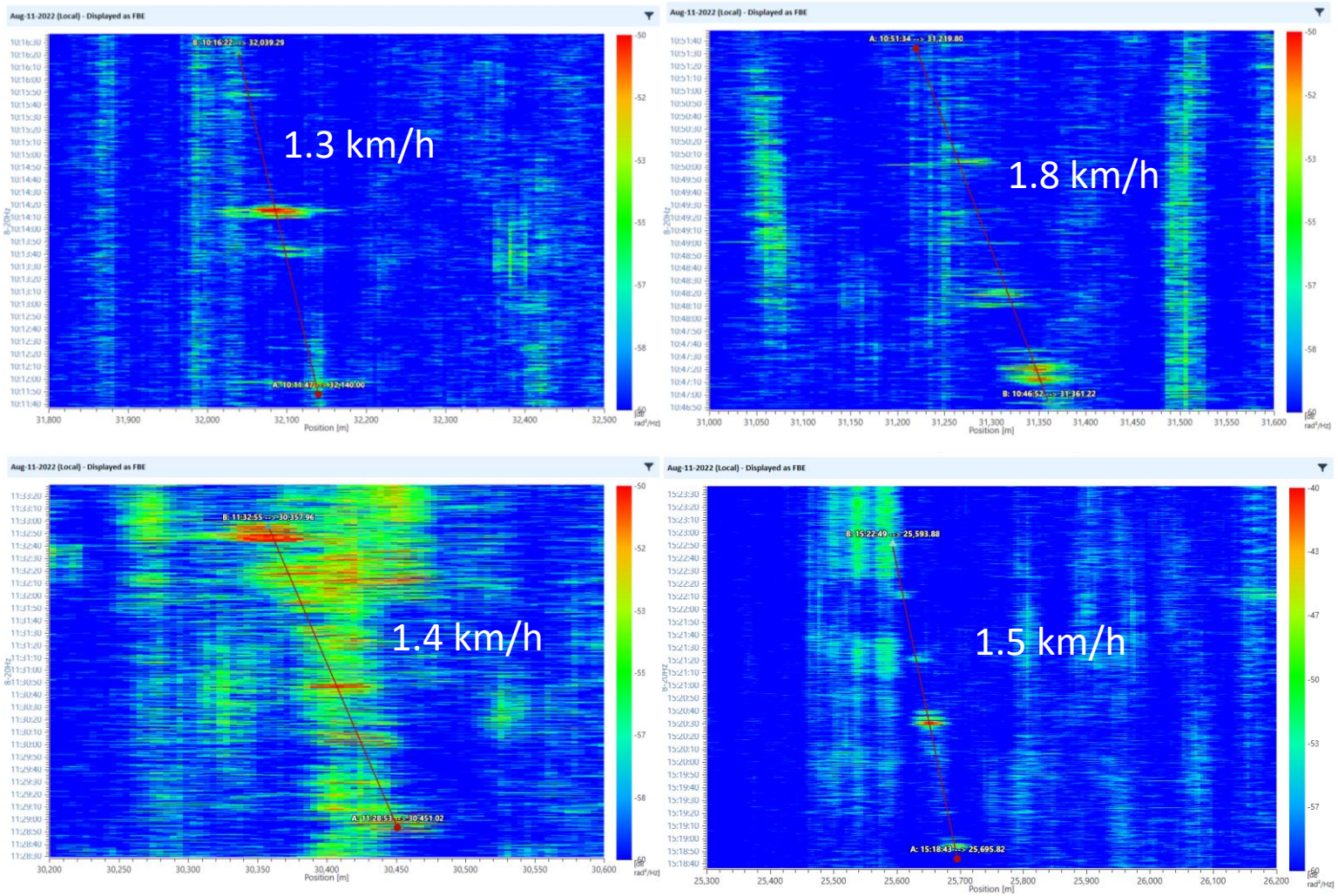


- Subsea power cable inspection along a 22 km section by means of video and multibeam tools on a Remotely Operated Vehicle (ROV) during summer 2022
- Documentation of the burial state
- Determination of the exposed sections
- Verification of the DoBS engine output
- Fiber-to-asset mapping based on the ROV signals captured by the DAS system

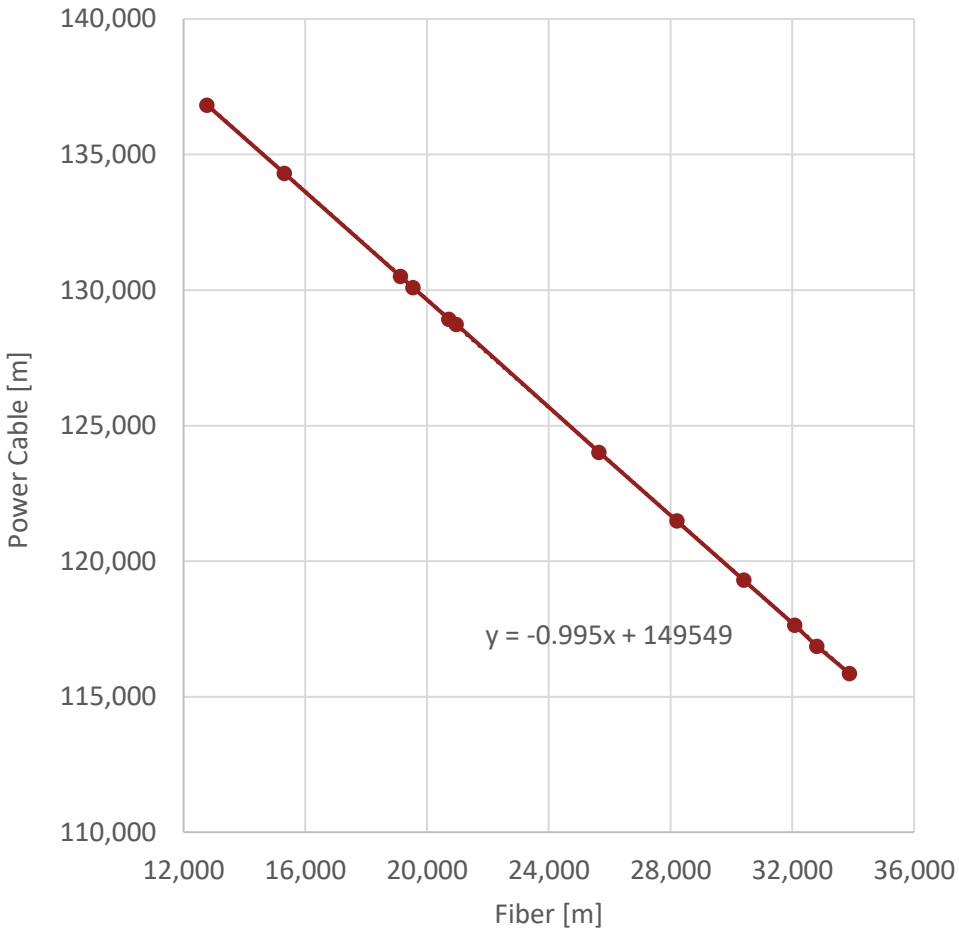
Offshore Fiber-to-Asset Mapping – ROV Vibration Tests



Offshore Fiber-to-Asset Mapping – ROV Tracking Signals

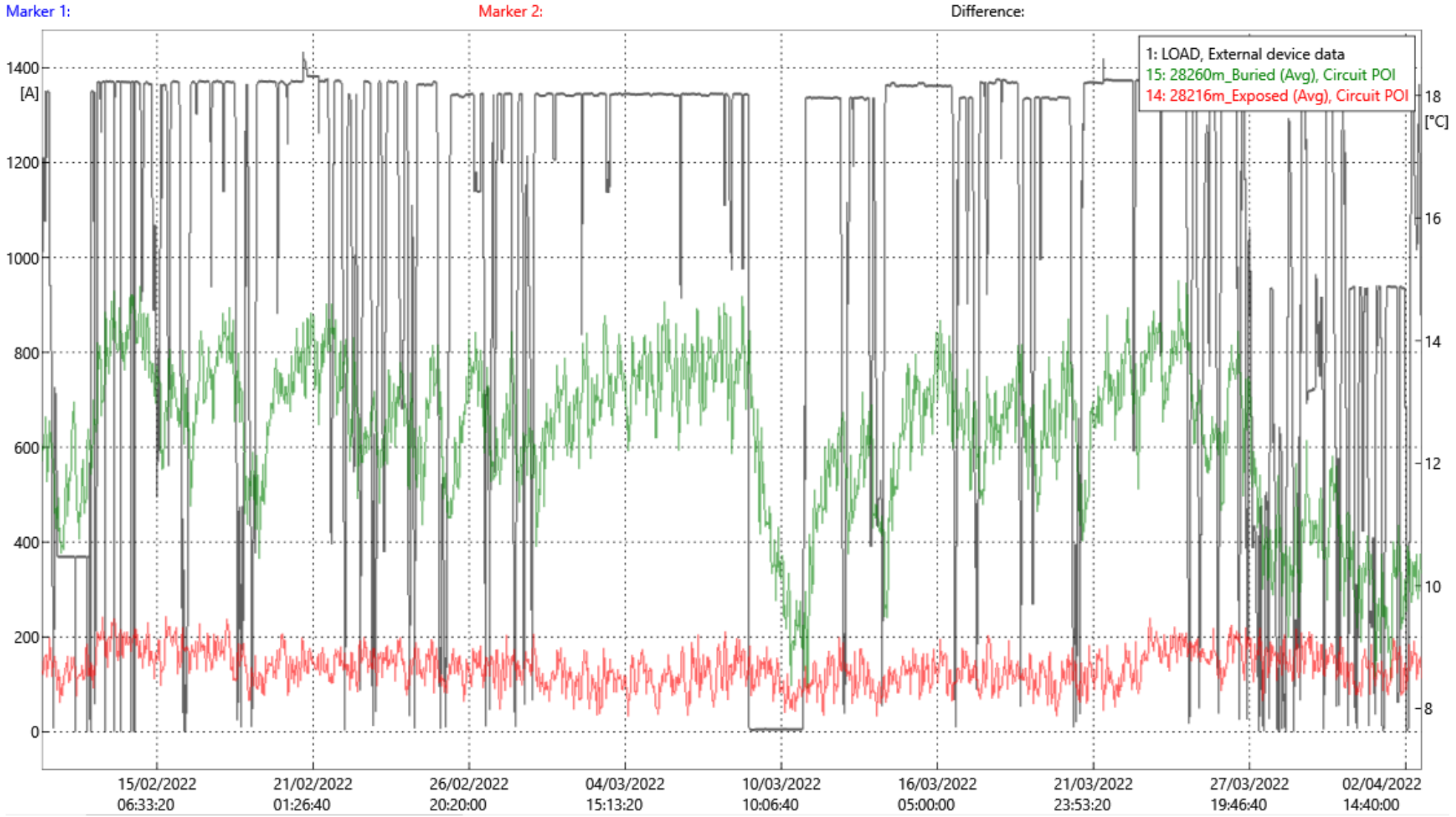


DAS Waterfall Diagrams

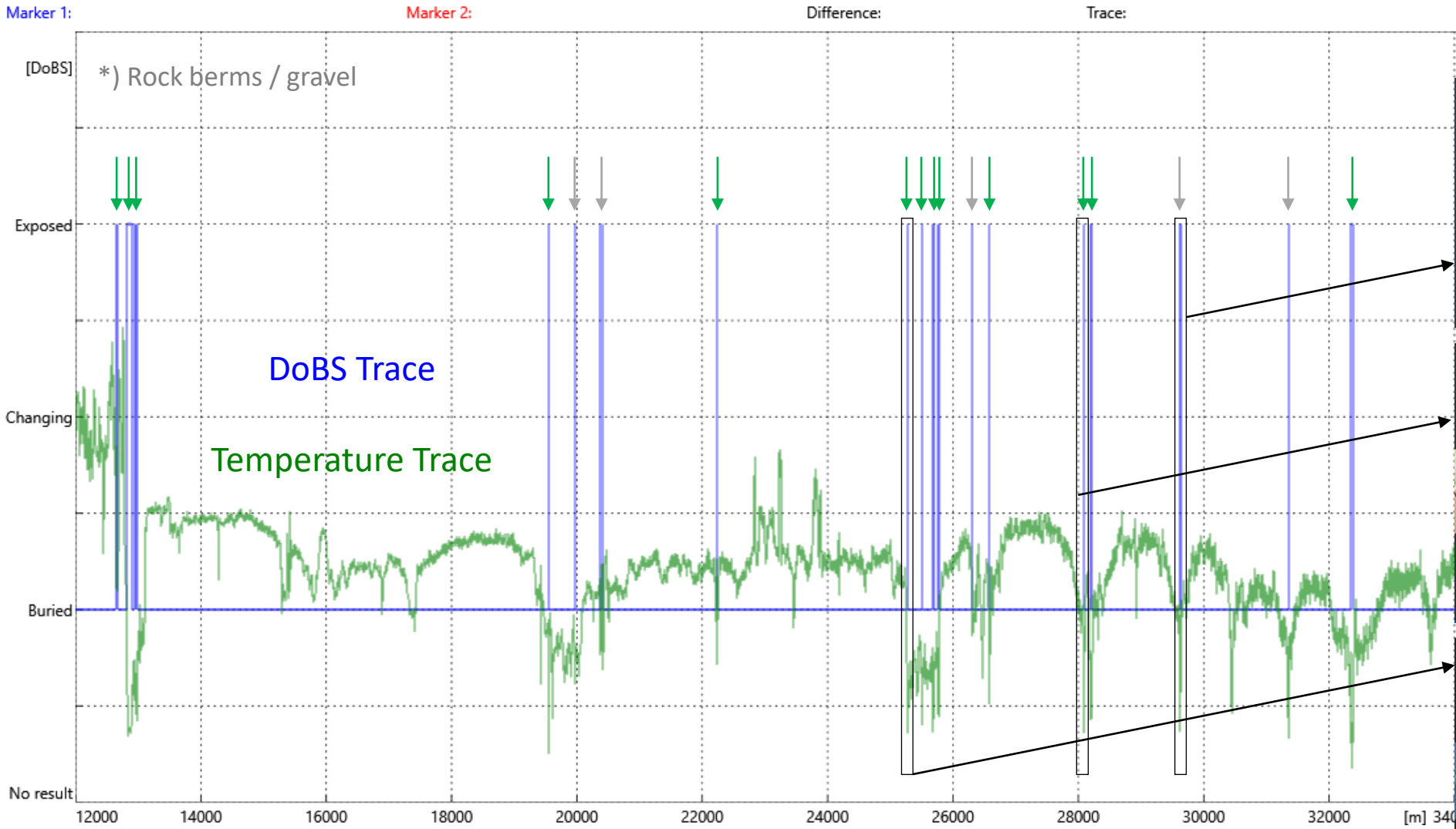


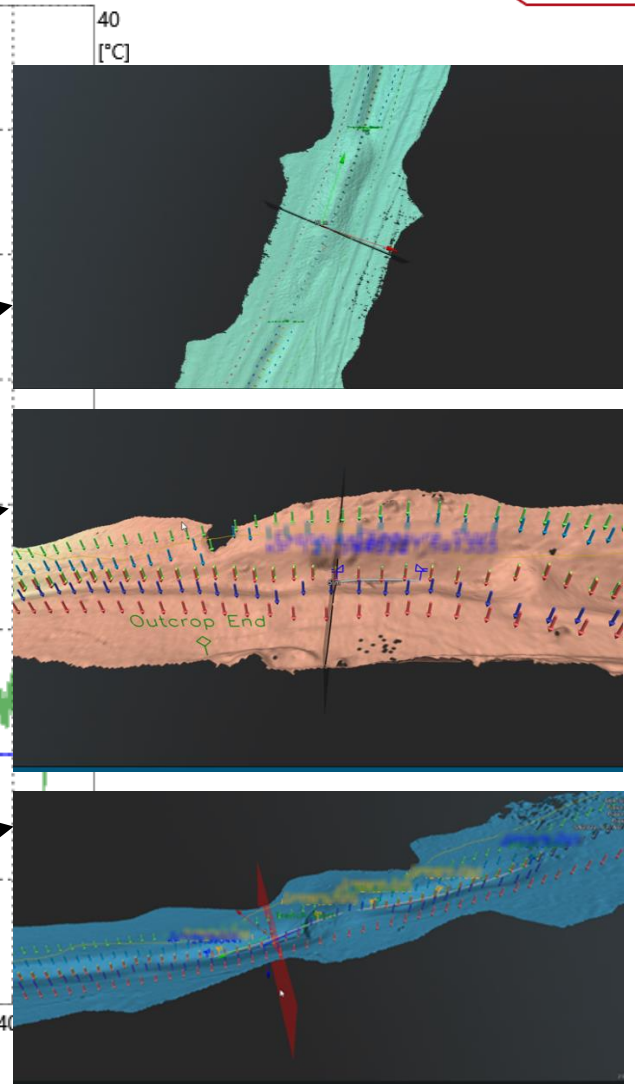
Fiber-to-Asset Mapping

Depth of Burial Status – Working Principle

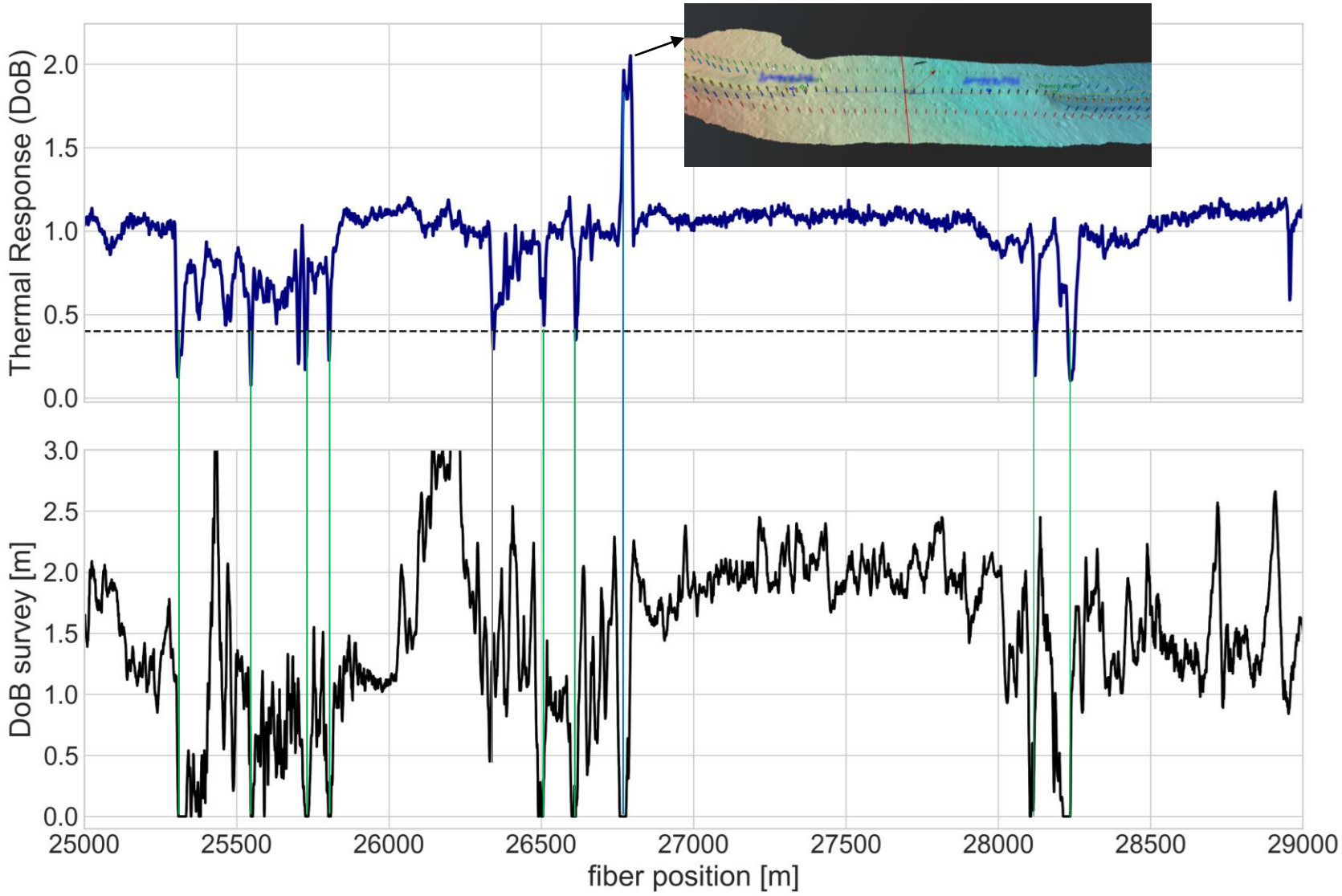


Depth of Burial Status – Measurement Results

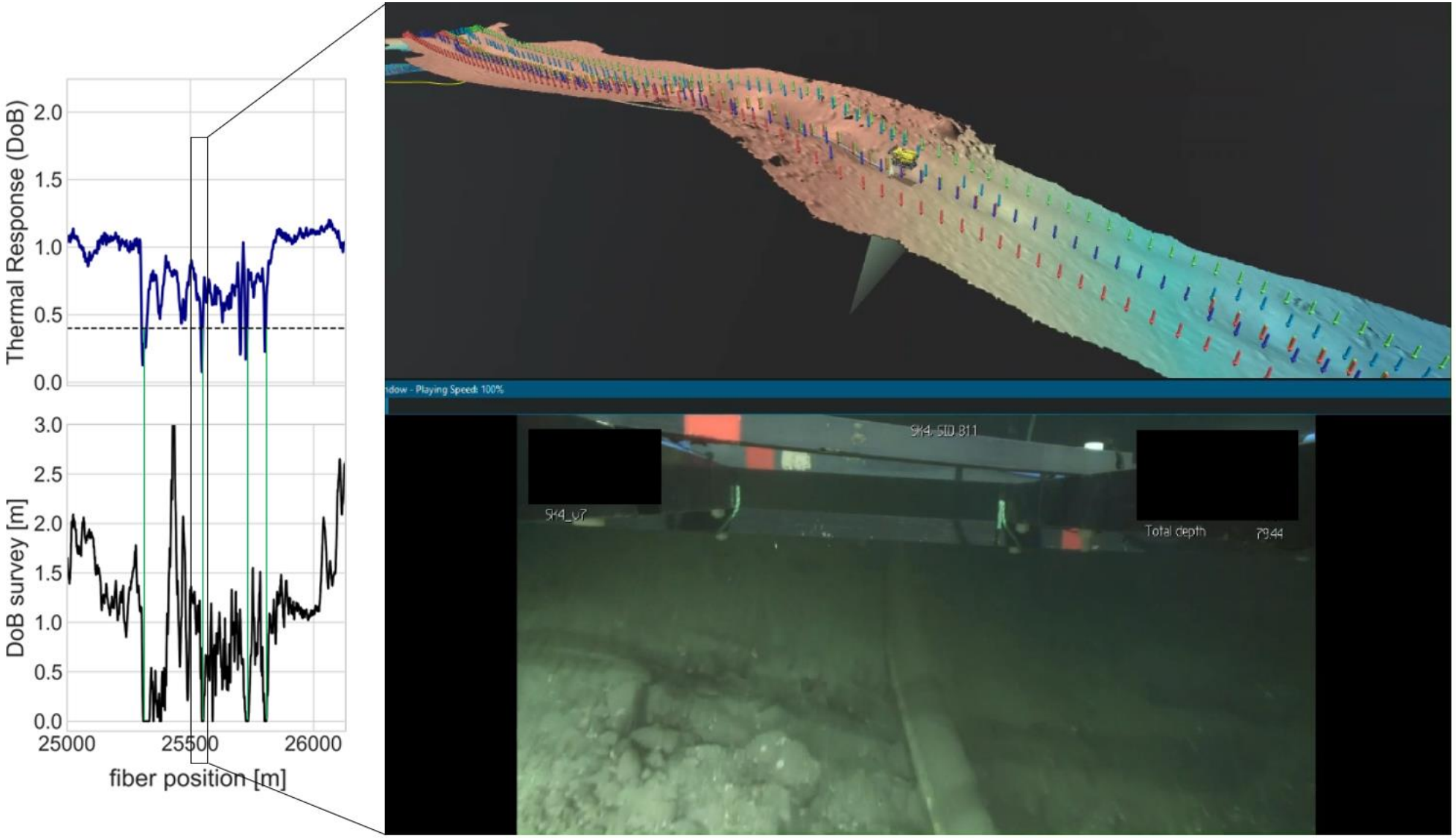




Depth of Burial Status – Thermal Response vs. ROV Survey (1)



Depth of Burial Status – Thermal Response vs. ROV Survey (2)



Summary

- The DTS/DAS technologies have become standard tools for power cable monitoring, offering a variety of different functionalities to the operators, such as:
  - Cable fault localization
  - Hotspot identification
  - Third-Party Intrusion (TPI) detection
  - Real-Time Thermal Rating (RTTR)
- ROVs can be used in combination with the DAS technology for mapping the sensing fibers to the offshore power cable
- The new Depth of Burial Status (DoBS) engine enriches the sensing portfolio for better monitoring of offshore power cables and identification of exposed sections
- Owing to the correlation function between the cable load and temperature traces, the DoBS engine is easy to implement and does not necessitate any thermal modeling or knowledge of the seabed parameters
- The DoBS offers a real-time insight into the burial status and represents an additional tool for better predictive maintenance to reduce the risk of cable faults

Thank you!

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Dr. Wissem Sfar Zaoui

Passion for Plants.