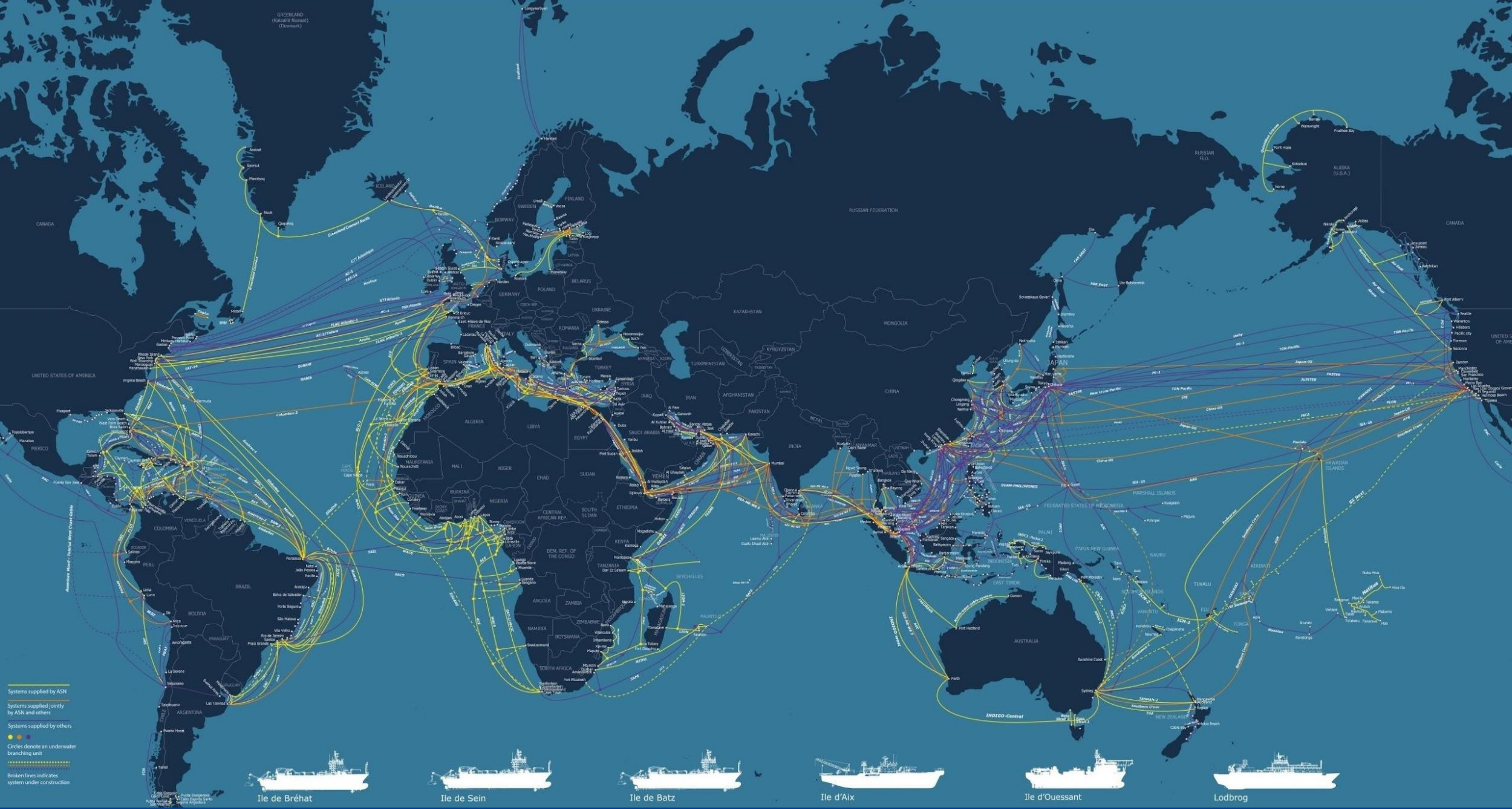
ASN

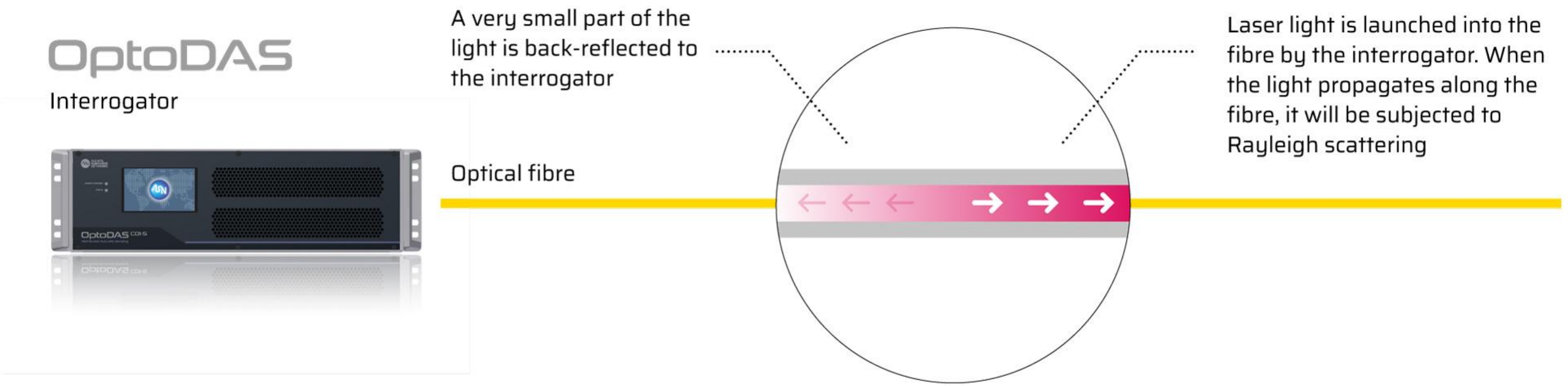
Fra fibernett til sensornett

Hilde Nakstad

FIberMagi – Mars - 2023


Systems supplied by ASN
Systems supplied jointly by ASN and others
Systems supplied by others
Circles denote an underwater branching unit
Broken lines indicates system under construction
Ile de Bréhat
Ile de Sein
Ile de Batz
Ile d'Aix
Ile d'Ouessant
Lodbrog

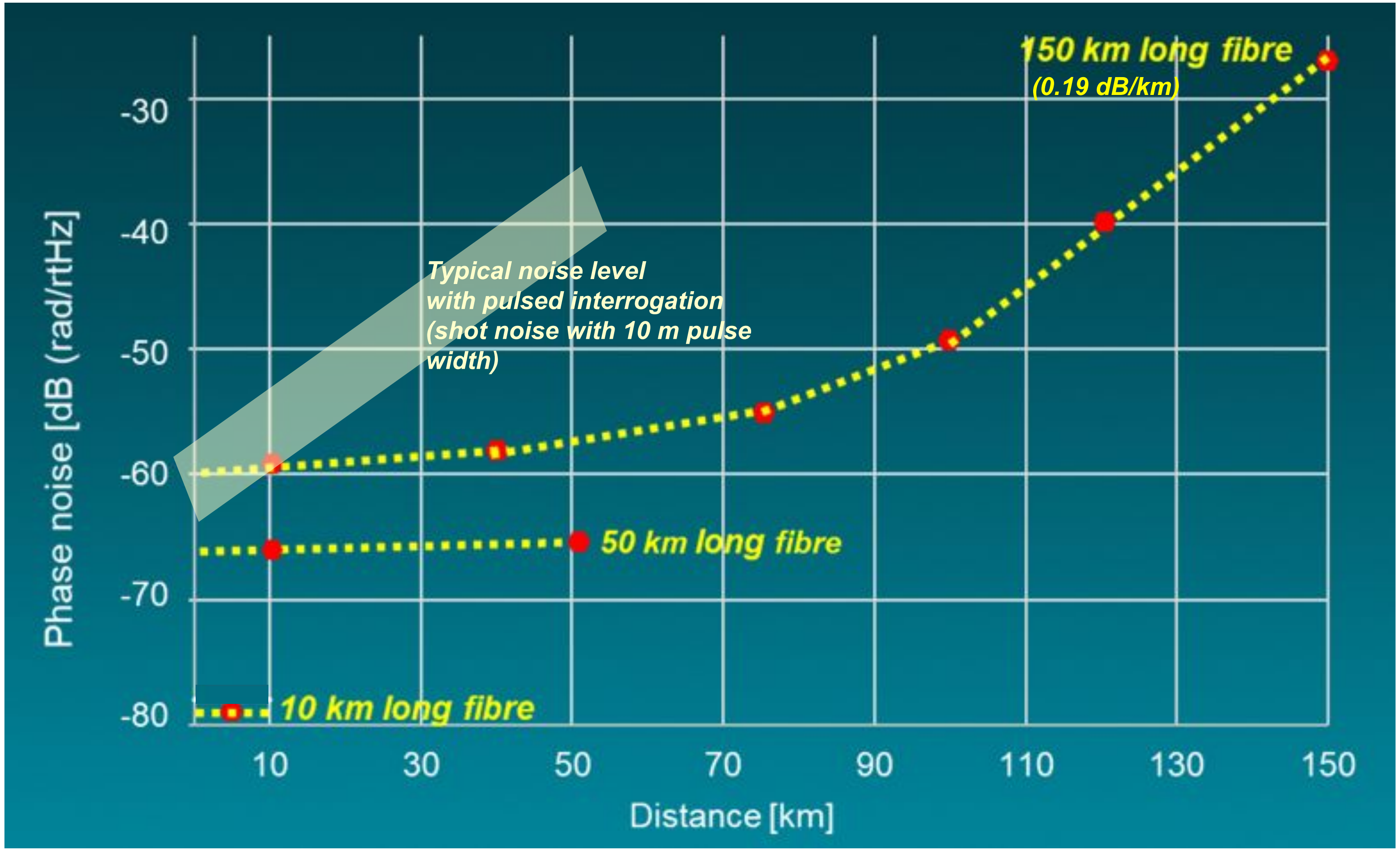
DAS – A Technique for Dynamic Monitoring of Strain Distribution along an Optical Fibre



- ❑ If a section of the optical fibre is subjected to strain, the propagating light will experience an optical phase delay.
- ❑ By analyzing the back-reflected signal one can extract the optical phase modulations induced along the optical fibre. This is done with a coherent OTDR technique where the phase between two adjacent scattering regions is taken to be proportional to strain. The distance between the centers of the two scattering regions is known as the gauge length.
- ❑ Any measurand impacting the cable strain condition can, in principle, be recorded.

OptoDAS Instrument - Self-Noise

- OptoDAS instrument noise curves compared to typical instrument noise with pulsed interrogation – all curves with a spatial resolution of 10 m
- Key parameters impacting the noise level are
  - Spatial resolution/gauge length
  - Sampling frequency (limited by the fibre length – 1 kHz with 100 km)
  - Total fibre loss
  - Bandwidth
- The unit provides nearly constant instrument noise along fibre lengths up to 90-100 km (instrument noise is here limited by the laser frequency noise and <u>not</u> shot noise)



The fibre laser frequency noise limits the OptoDAS instrument noise for distances up to about 100 km. Beyond 100 km, the instrument noise is determined by shot noise. Noise curves are for a spatial resolution of 10 m (GL=10m) and with a fibre loss of 0.19 dB/km

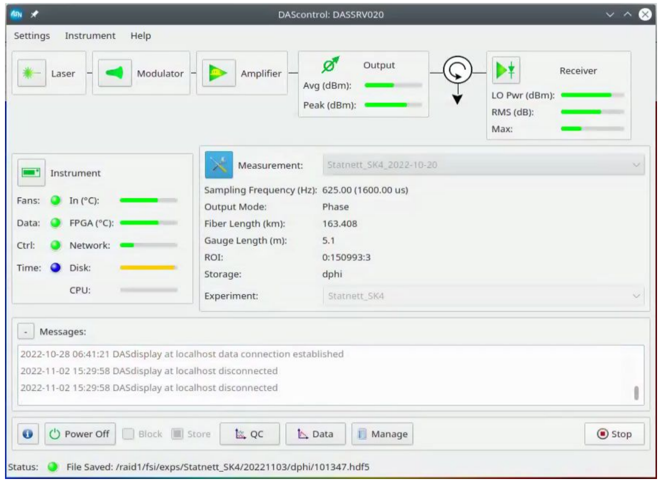
OptoDAS components

Field rack

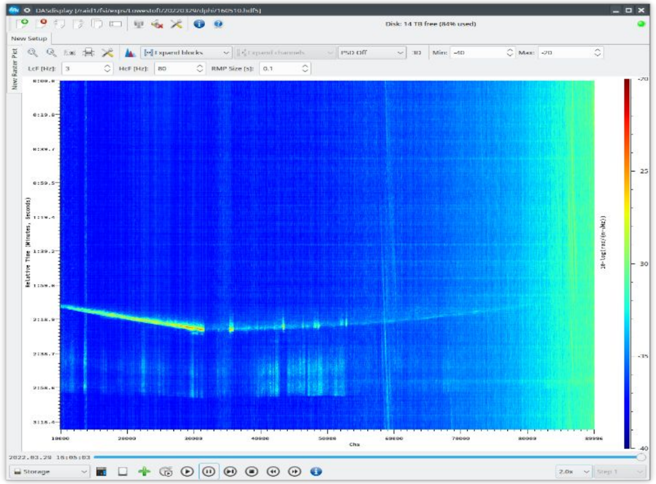
DAS instrument

Instrument
server

DAScontrol



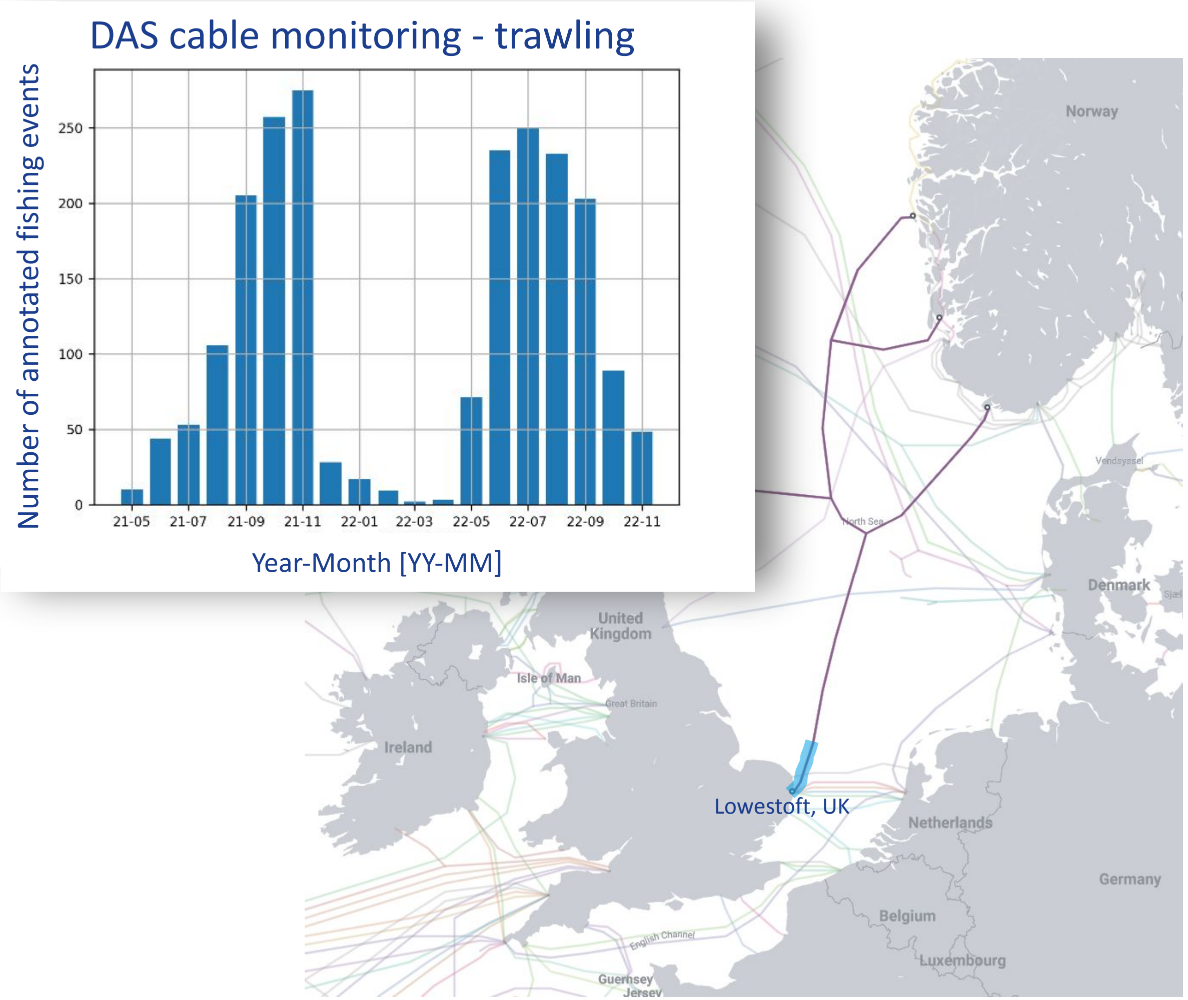
DASdisplay



Cable threat monitoring – Seabed fishing

- Cable failures typically caused by damage from seabed activity
  - Fishing gear on seabed
  - Vessel anchors

- Prevalence of bottom-trawl fishing
  - Study area: Southern North Sea
  - Strong seasonal-activity variation
  - 2/3 of detected fishing without associated AIS records

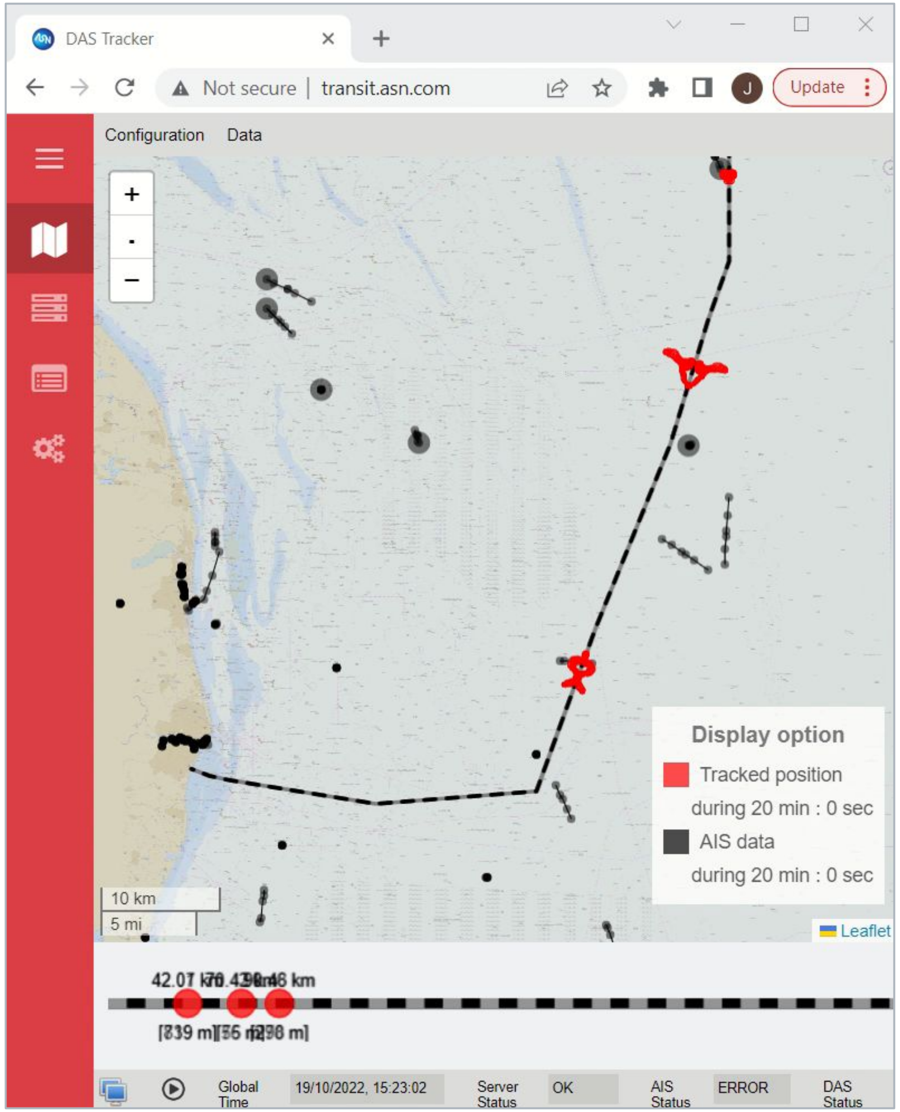


http://submarinecablemap.com courtesy of TeleGeography

Cable threat monitoring – Seabed fishing

- Integration of DAS and AIS for asset protection
- Real-time surface and sub-surface information as web service

Web service snapshot: Real-time monitoring AIS and DAS



Tidal power cable monitoring

Image courtesy of SIMEC Atlantis

- Tidal current turbines on seabed
- Currently producing 28 MW, potential 398 MW

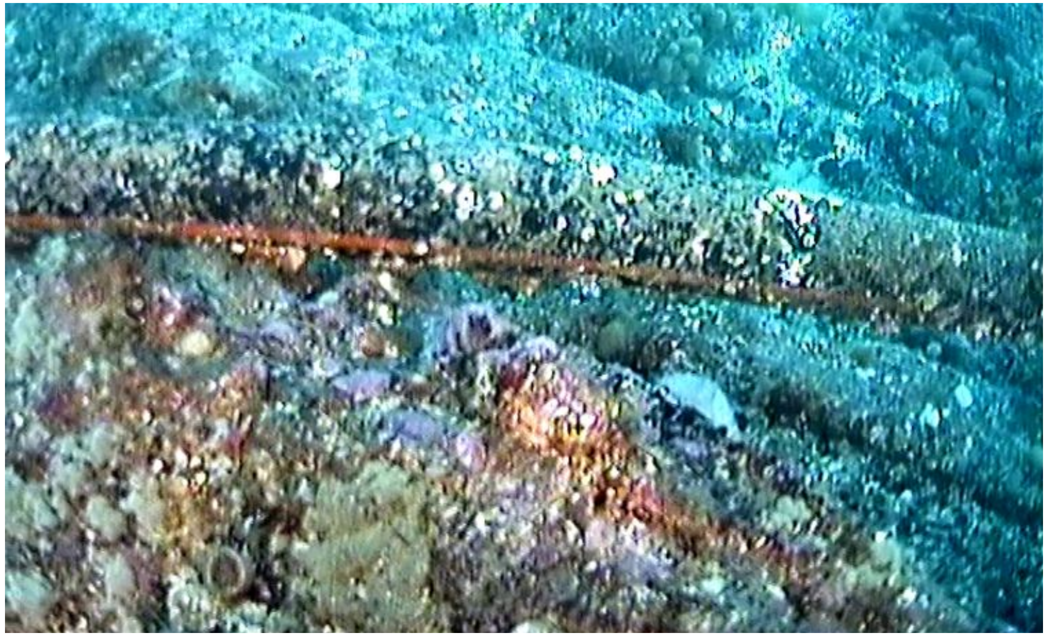
- Cables carry electric power to onshore substation
- Hard seabed prevents cable burial
- Armoured cables - withstand tidal/wave loading
- Experience shows substantial cable movement
- ROV visual inspections costly

- Challenge: Use FO sensing to monitor cable stability, impacts/abrasion, strumming

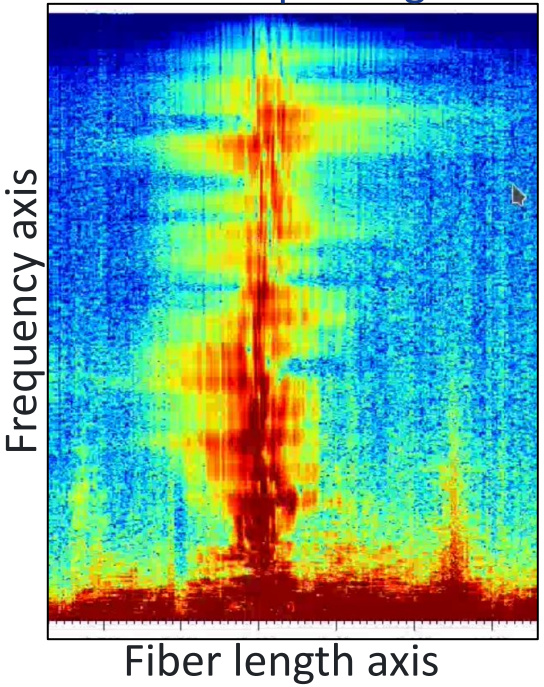
Diagram from https://www.offshore-energy.biz/subseaworldnews/

Tidal power cable monitoring

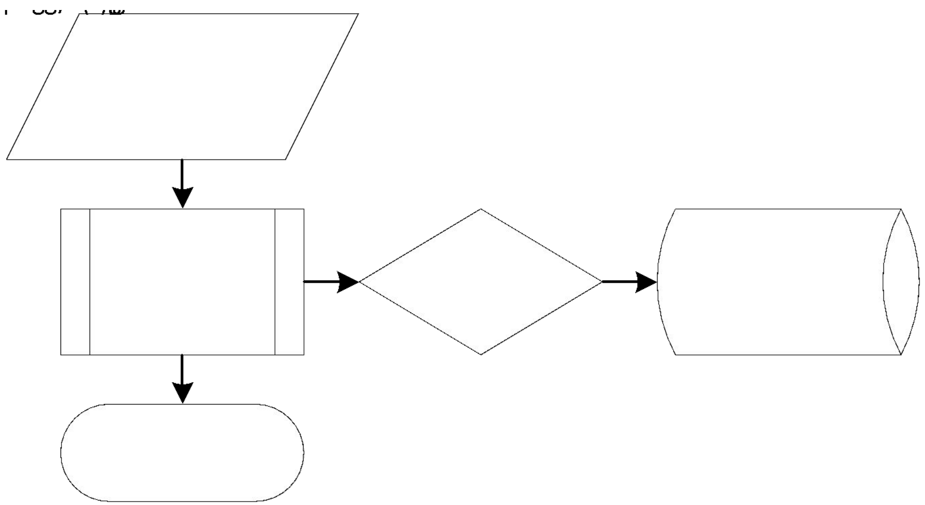
Scour marks from cable movement



Cable movement
DAS data spectrogram



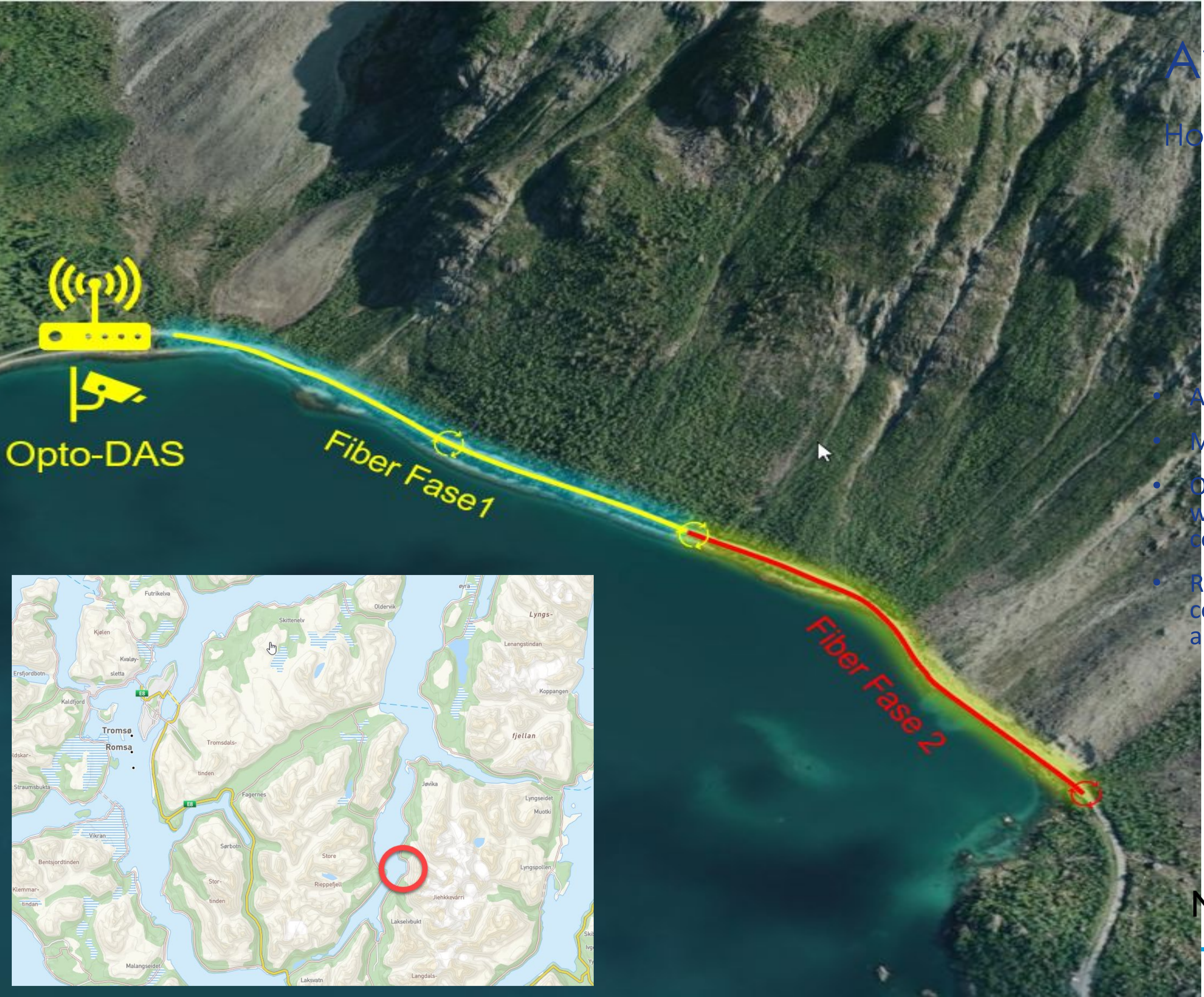
Processing workflow



- Database for statistical analysis
- Event data for long time periods (months/years)
- Detect hotspots - frequent cable movement
- Stabilize using rock bags

Avalanche monitoring

Holmbuktura, Troms and Finnmark



- Avalanche exposed road (1.4 km)
- Multiple locations exposed to avalanches
- OptoDAS interrogator located in weatherproof box with power – 4G communication to road surveillance centre
- Results from DAS monitoring can be compared with existing radar surveillance and reporting system

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Avalanche monitoring

Holmbuktura

- Avalanche detection verified – able to separate between avalanche in terrain and avalanche hitting road
- Traffic recording verified
- Weather independent, continuous
- Local data processing and interpretation
- Alarms sent to Central Road Monitoring system

Grasdalen, Strynefjellet

- Data collection
- Evaluation of methods

Project performed in cooperation with
NTNU SFI Centre for Geophysical Forecasting and SVV.

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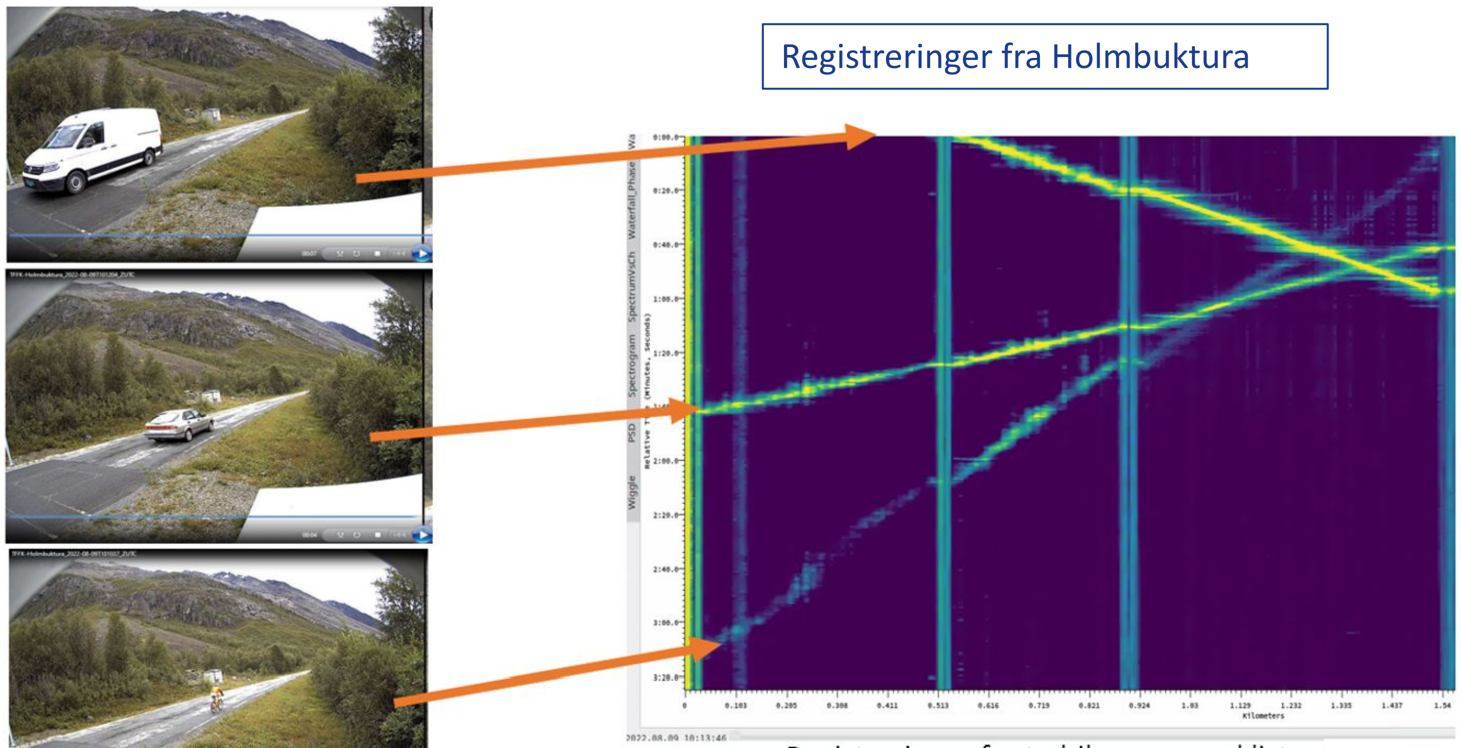
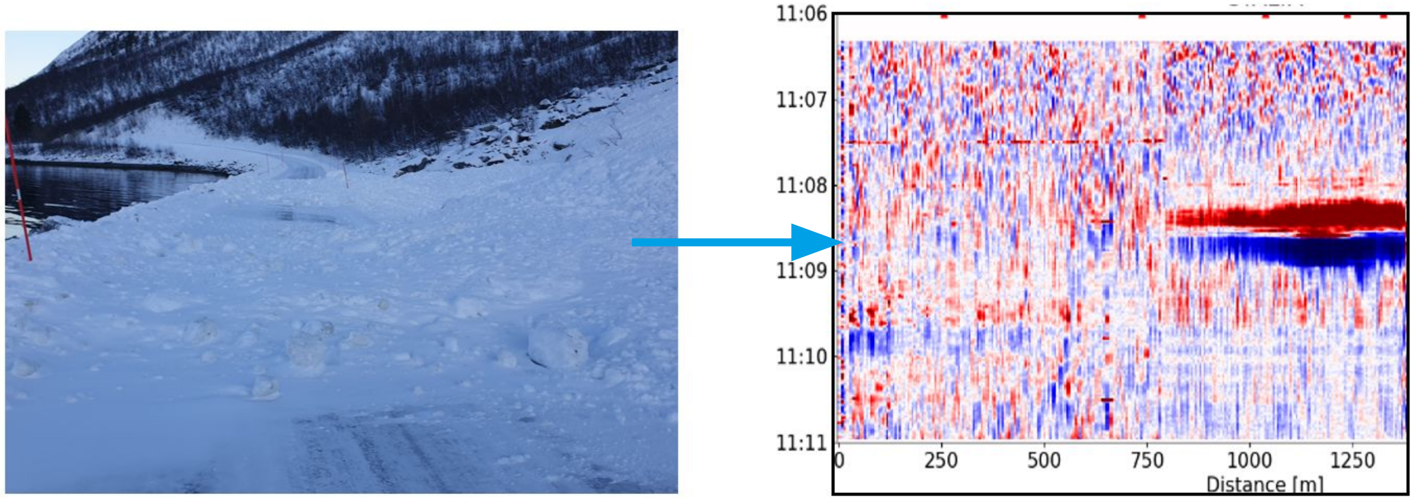


Registreringer fra to biler og en syklist

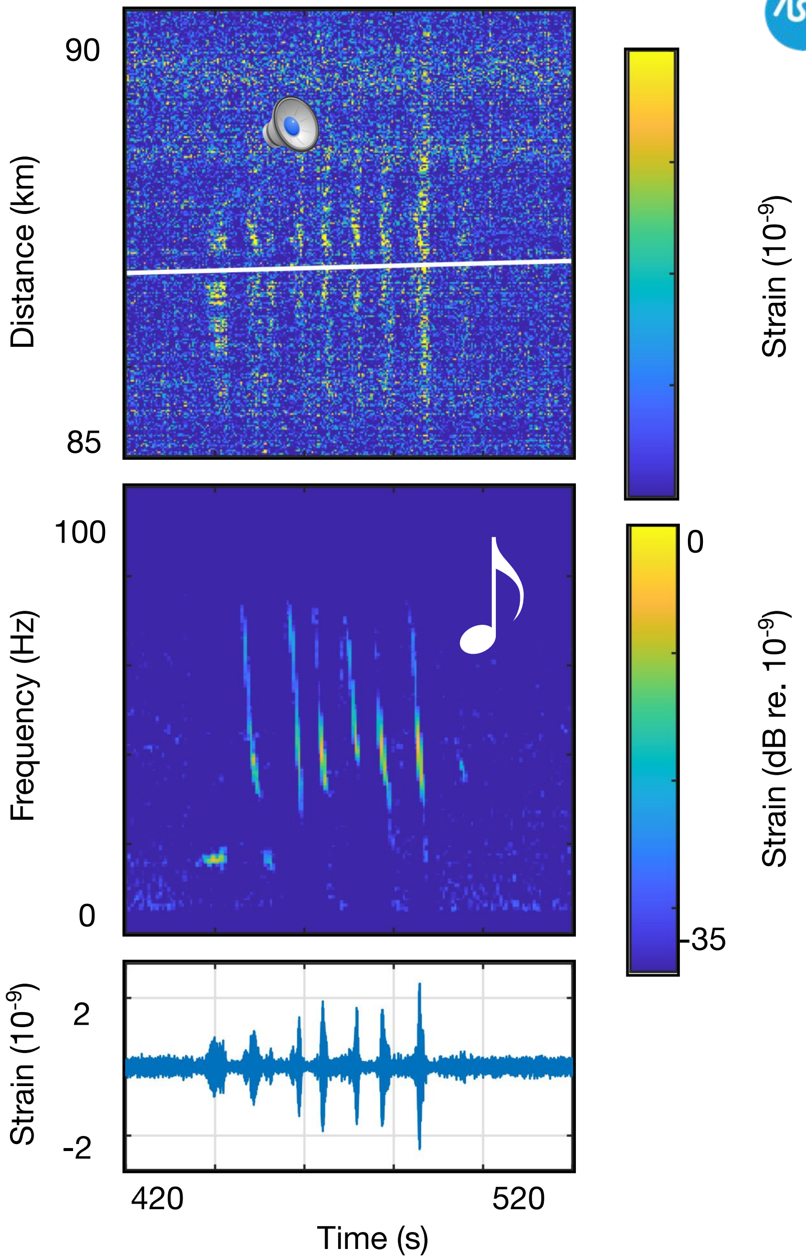


Registreringer av snøskred 30. januar 11.14

Listening to whales

Léa Bouffaut, et. al. “Eavesdropping at the speed of light: distributed acoustic sensing of baleen whales in the Arctic” (2022).

832 whale calls annotated for 44 days (from 23rd June to 5th August 2020).



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