



Passive Acoustic Monitoring with Gliders

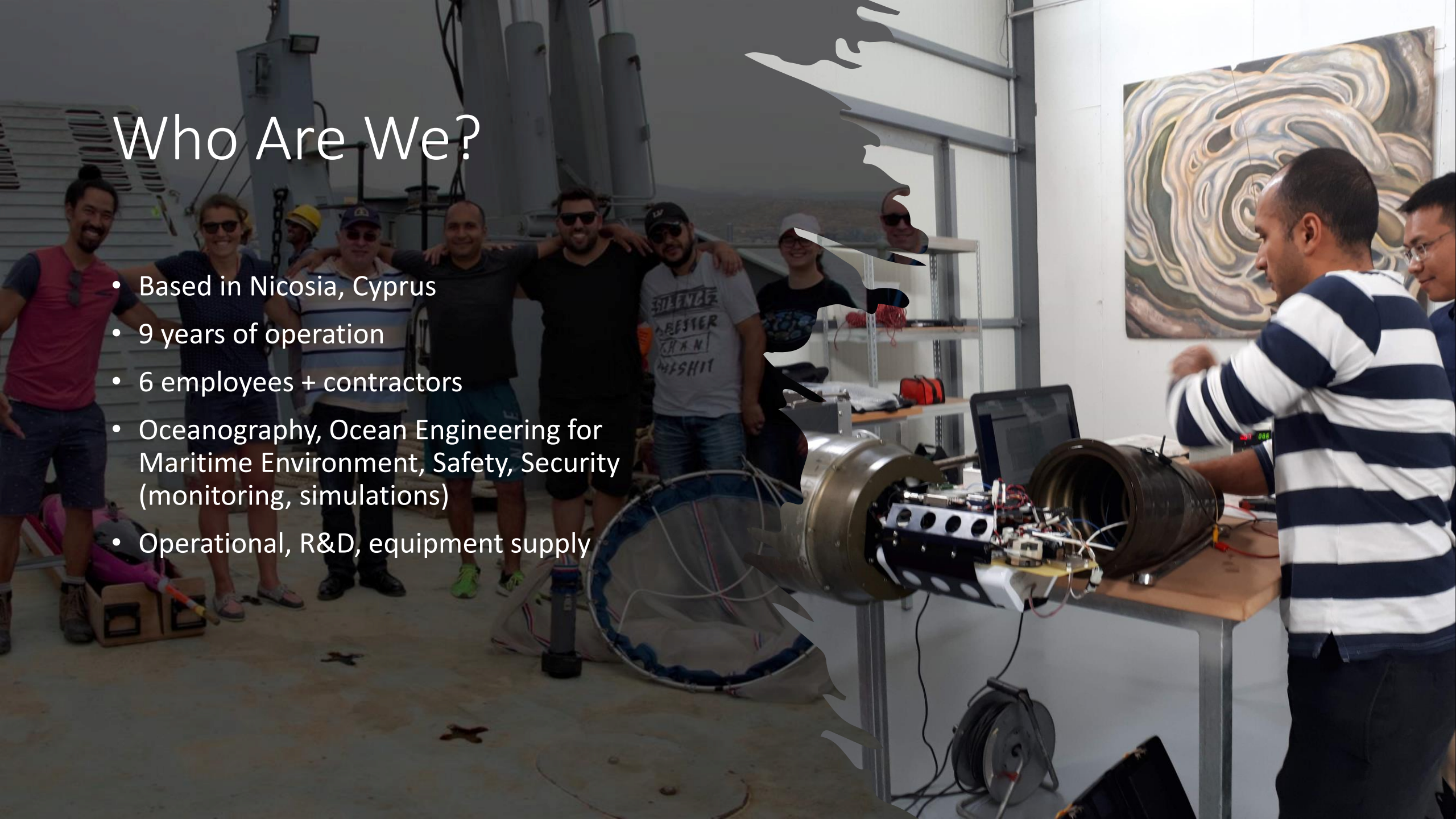
Daniel Hayes

Ehsan Abdi

European Data Management Workshop-2022

Who Are We?

- Based in Nicosia, Cyprus
- 9 years of operation
- 6 employees + contractors
- Oceanography, Ocean Engineering for Maritime Environment, Safety, Security (monitoring, simulations)
- Operational, R&D, equipment supply





EUMarineRobots
Marine robotics research infrastructure network

Research Projects

Gliders and advanced observing methods

H2020

- **GROOM2 (Gliders for Research, Ocean Observation and Management II)**
- **TechOceanS (Technologies for Ocean Sensing)**
- EU Marine Robots Transnational Access Grant, "Ecosystem profiling with ocean gliders"
- **BRIDGES (Bringing together Research and Industry for the Development of Glider Environmental Services)**



NSF

- **Development of a Carbon Dioxide Seaglider (University of Alaska Fairbanks)**



RIF Cyprus

- **OS Aqua (Open Sea Aquaculture in the Eastern Mediterranean)**
- **STEAM (Sea Traffic Management in the Eastern Mediterranean)**
- **SMART CABLES (Smart Standardized Marine Sensor Cable Interface)**



Martera ERANET-cofund

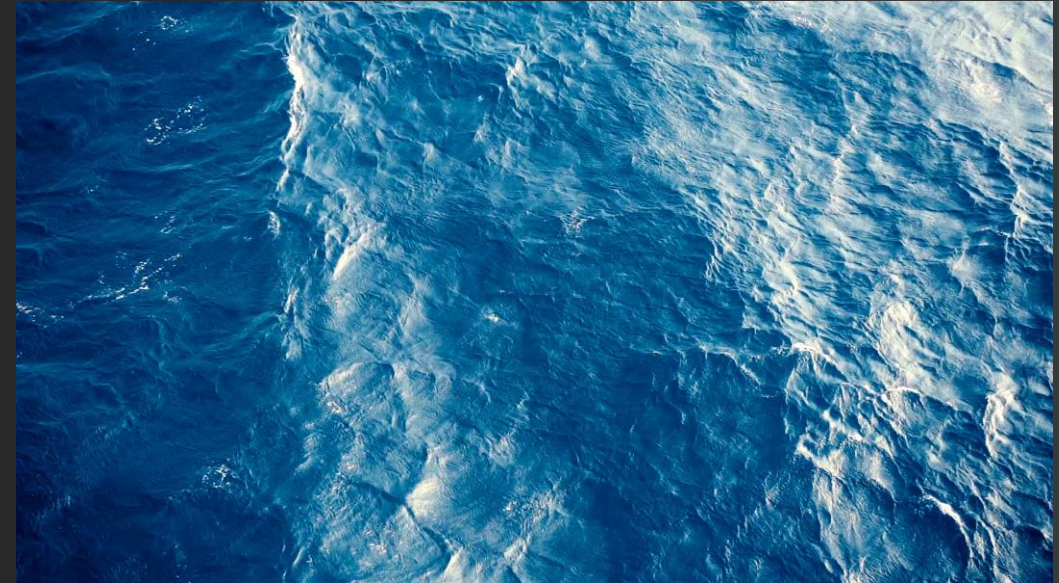
- **PIMEO-AI (Pollution Identification, Mapping, and Ecosystem Observation with AI-powered water quality USV)**
- **BioGlider: Autonomous Exploration and Monitoring of Marine Ecosystems**



Areas of Expertise

Operations, maintenance, support, development, analysis

- **Autonomous Vehicles:** for ocean conditions, acoustic monitoring.
- **Fixed Buoys:** for ocean conditions and acoustic monitoring.
- **HF Radar (over the horizon):** for ship tracking, currents, waves.
- **Drifting and/or profiling buoys:** for search and rescue, currents.
- **Operational Oceanography:** for search and rescue, current prediction for pollution. Monitoring and forecasting of ocean in real time.
- **Ocean acoustics:** for quantifying noise levels, marine mammal presence and identification, ship detection, fish and bubble detection.
- **Remotely-Operated Vehicle (ROV):** for inspection, search and recovery.



Passive acoustic monitoring with gliders

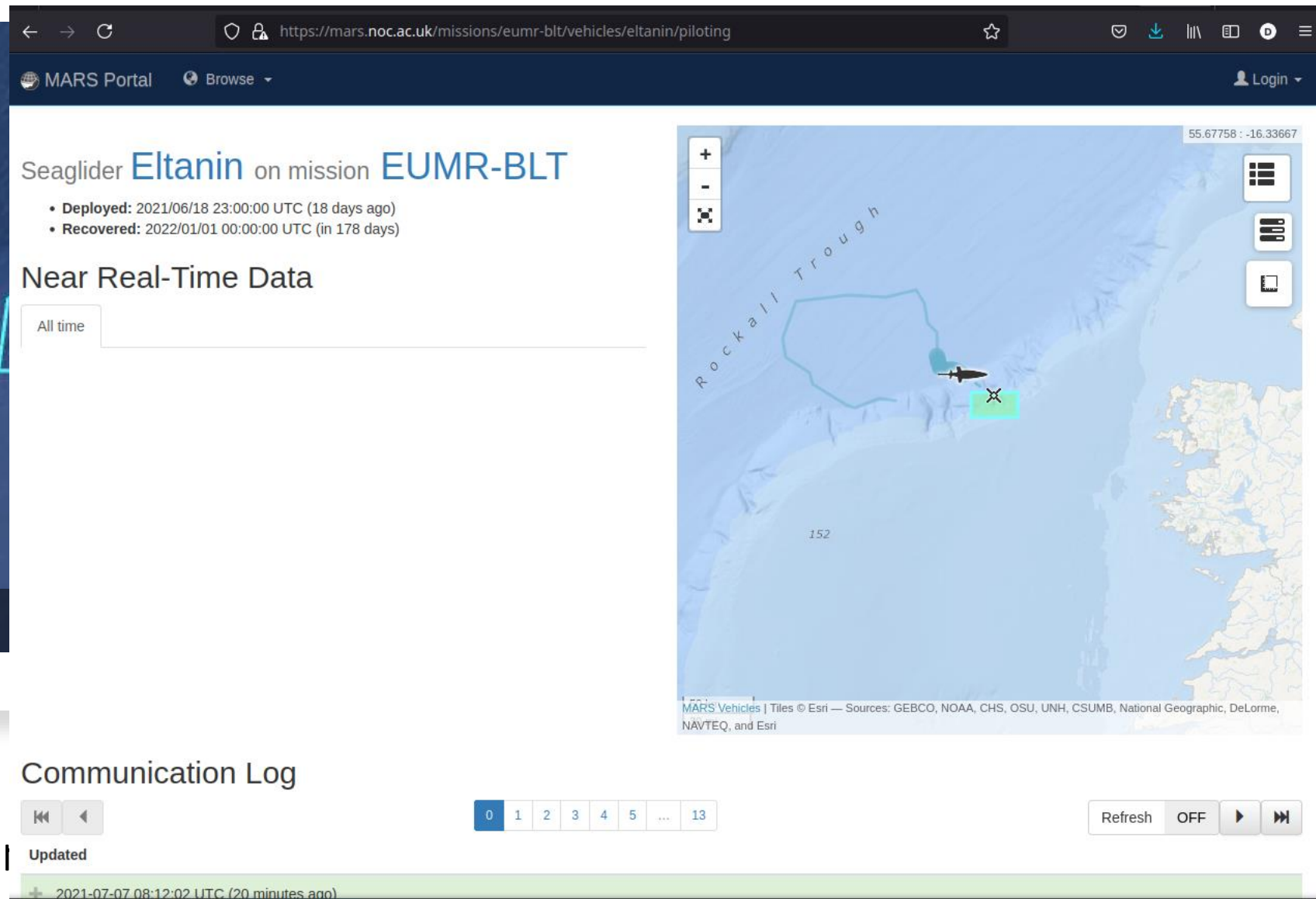


- Pros
 - High persistence
 - Less cost for long-term data
 - Higher spatial coverage
 - Nonintrusive
 - Low self-noise
 - 1000 m depth range
 - Environmental parameter profiles
- Cons
 - Can only determine presence
 - Limited transmission to user
 - Limited processing real time
 - Unknown sources;
 - Slow speeds
 - Low precision navigation/localization



The system consists of four small hydrophone elements integrated on a Seaglider along with a four channel recorder in a pressure housing.

Marine Mami



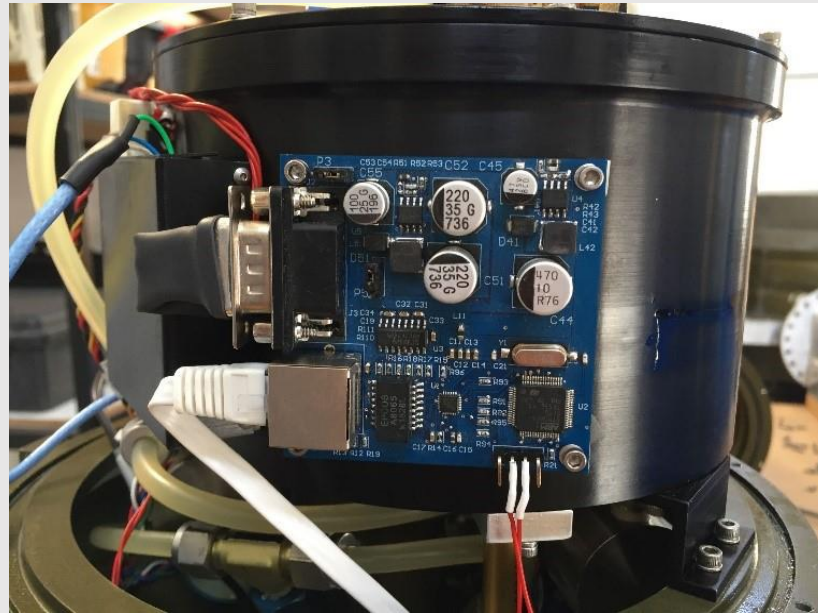
icListen hydrophone

- TNA: Ocean Sonics' icListen HF integrated with Seaglider
- High sensitivity
- Built-in processing
- Streamlined data processing and display
- Kayak new architecture is more compact, energy efficient and scalable



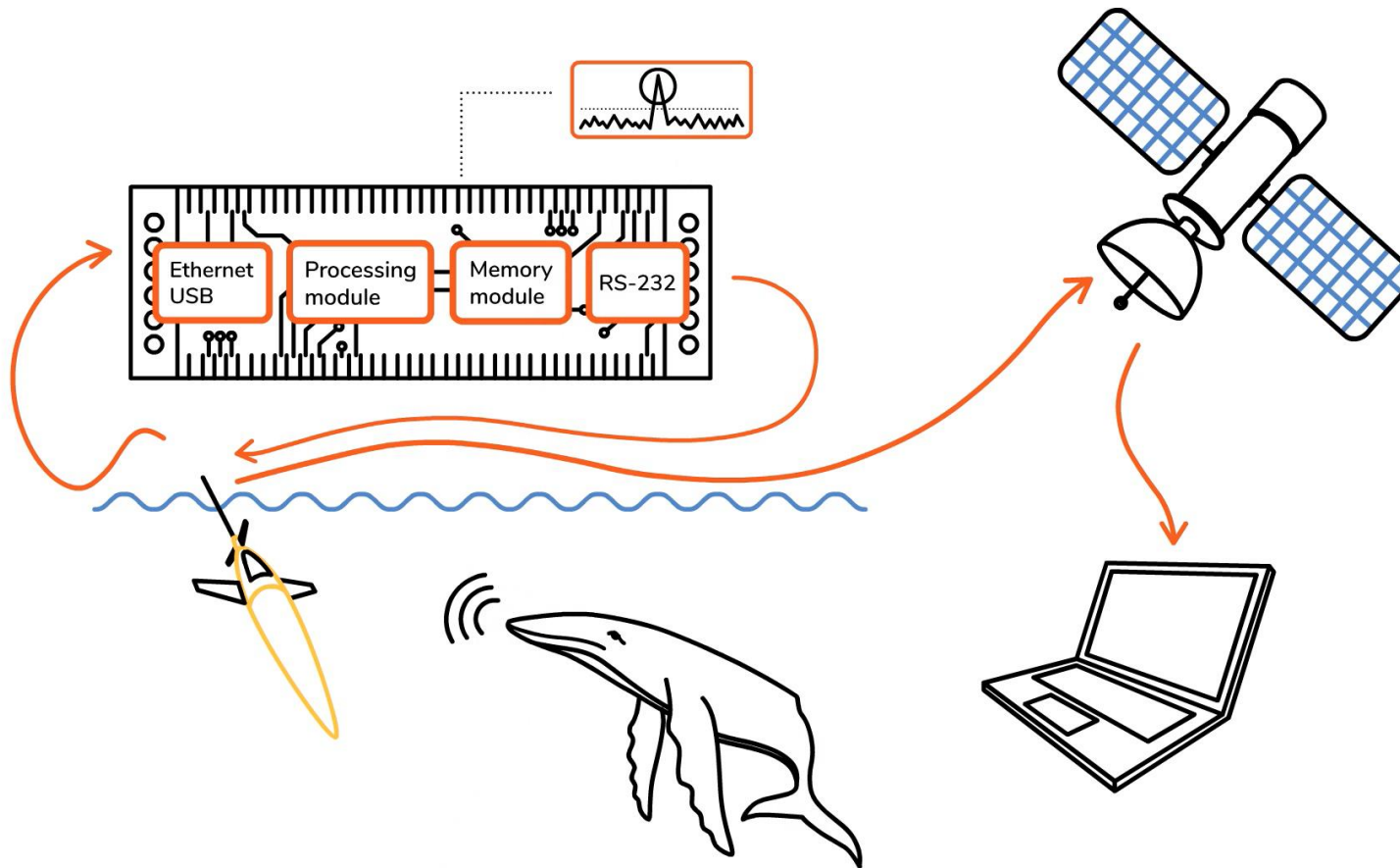
Technical integration of icListen HF

- gListen board integrated inside glider translates Ethernet to Serial
- Analyzes and transmits acoustic spectra
- Near-real-time event detection



Technical integration and data flow

SIRMA™ or gListen makes the integration of sensors to platforms possible and facilitates the real-time transfer of data

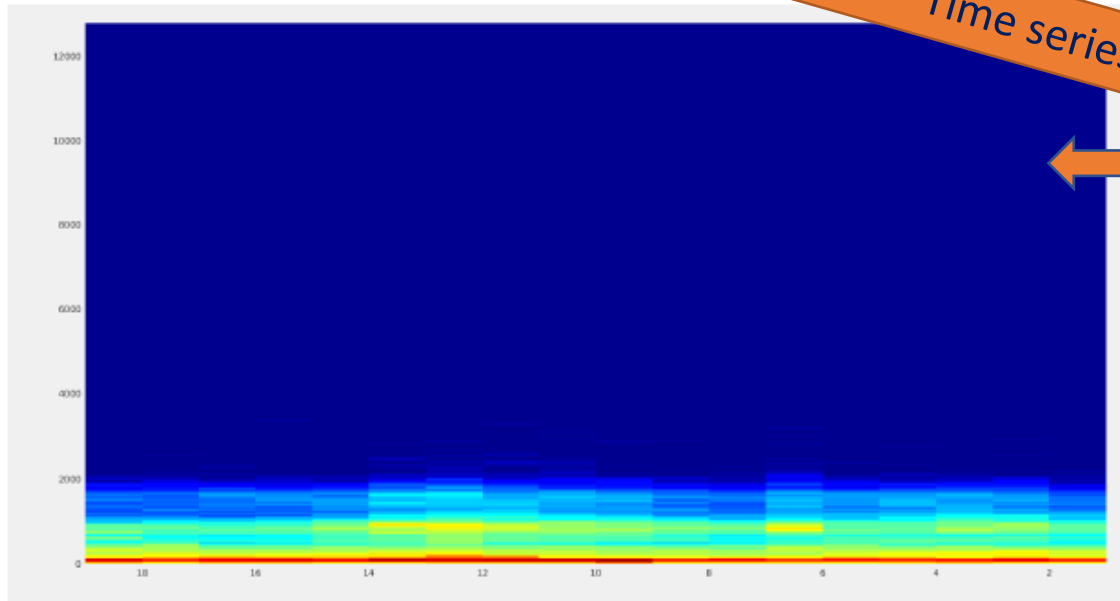


- What's saved on glider?
- What's sent via Iridium?
- How is it shared/used?

Near Real Time Data (Iridium)

■ icListen HF Hydrophone

- Near-real-time event detection capability
- Ethernet to RS-232 interface integrated inside glider hull
- Analyzes and transmit acoustic spectra



```
$INTERNAL_PRESSURE,13.3388
$TCM_TEMP,25.00
$XPDR_PINGS,0
$HP_EVENTS,epoch_stat:3,4,0,0,0
$24V_AH,22.98,63.856
$10V_AH,10.02,46.898
$FG_AHR_24Vo,0.000
$FG_AHR_10Vo,0.000
```

Event detection counter

Time series of Spectra

```
1 File Details:
2 File Type Spectrum
3 File Version 5
4 Start Date 2019-08-09
5 Start Time 07:12:43
6 Time Zone UTC
7 Author icListen HF #1722
8 Starting Sample 12107776
9
10 Device Details:
11 Device icListen HF
12 Model SB35-ETH-12V
13 S/N 1722
14 FW Release 36.1
15 Firmware v2.2.08
16 Release 6
```

```
29 Data:
30 Time Comment Temperature [C] Humidity [%] Sequence # Data Points 0 31.25 62.5 93.75 125 156.25
31 07:12:43 22.1 25.3 739 410 7 8 12 15 17 19 18 16 14 15 21 21 14 12 9 15 16 12
32 07:12:43 22.1 25.3 740 410 15 13 12 13 15 18 18 15 15 14 20 21 14 9 9 13 17 13
33 07:12:44 22.1 25.3 741 410 14 22 27 30 31 30 26 24 22 23 27 26 21 21 19 27 30 23
34 07:12:44 22.1 25.3 742 410 11 18 21 23 24 23 20 17 19 18 22 22 20 19 18 19 17 13
35 07:12:45 22.1 25.3 743 410 35 37 44 50 53 58 58 56 57 63 66 63 64 64 61 63 59 59
36 07:12:45 22.1 25.3 744 410 12 26 34 40 48 53 51 44 42 47 50 46 47 52 51 51 46 44
37 07:12:46 22.1 25.3 745 410 19 26 31 35 38 41 41 41 40 42 41 43 46 42 43 41 40 40
38 07:12:46 22.1 25.3 746 410 30 39 44 47 52 56 55 53 54 56 60 59 56 56 54 53 53 52
39 07:12:47 22.1 25.3 747 410 10 13 21 27 32 37 37 33 31 30 31 30 26 28 27 22 22 21
40 07:12:47 22.1 25.3 748 410 9 17 27 33 38 41 38 35 37 39 38 37 33 32 32 32 32 30
41 07:12:48 22.1 25.3 749 410 41 46 48 50 56 57 56 56 55 55 55 53 51 51 49 48 50 48
42 07:12:49 22.1 25.3 750 410 33 38 43 46 54 57 55 52 51 51 49 47 47 47 46 45 46 46
43 07:12:49 22.1 25.3 751 410 18 20 25 27 25 25 24 23 25 24 21 19 20 20 16 19 18 12
44 07:12:50 22.1 25.3 752 410 24 28 35 41 49 53 54 53 50 46 44 45 46 45 45 43 41 39
45 07:12:50 22.1 25.3 752 410 24 28 35 41 49 53 54 53 50 46 44 45 46 45 45 43 41 39
```

Recovery Data (raw or “waveform”)

BODC’s first passive acoustic data in a publicly accessible archive [HERE](#).

The screenshot shows the CEDA Archive website interface. At the top is a navigation bar with the CEDA Archive logo, a search bar, and links for Search Catalogue, Get Data, Help, Tools, Deposit, News, and a Sign in button. Below the navigation bar is a 'Dataset' section. The dataset title is 'Acoustic data collected from a glider deployment in the North Sea in June-July 2021 as part of the EU Marine Robots (EUMR) project.' To the right of the title is a table with metadata: Update Frequency: Not Planned, Status: Ongoing, Online Status: ONLINE, Publication State: Citable. Below the title is a 'ViewXML' button and a 'Download' button. An orange arrow points to the 'Download' button with the text 'Download link'. Below the dataset title is an 'Abstract' section. The abstract text describes the data collection process and mentions an error in the instrument system. At the bottom of the abstract is a 'Citable as' section with the citation: 'Hayes, D.; Abdi, E. (2021): Acoustic data collected from a glider deployment in the North Sea in June-July 2021 as part of the EU Marine Robots (EUMR) project.. NERC EDS British Oceanographic Data Centre NOC, 16 December 2021. doi:10.5285/096690aba290452d9b7208133274b69b. <http://dx.doi.org/10.5285/096690aba290452d9b7208133274b69b>'. An orange arrow points to the citation with the text 'Citation'. To the right of the abstract is a 'Coverage' section with a map of the United Kingdom and a table with temporal range information: Start time: 2021-06-22T06:53:40, End time: 2021-07-25T08:59:05.

https://catalogue.ceda.ac.uk/uuid/096690aba290452d9b7208133274b69b

CEDA Archive Search Catalogue Get Data Help Tools Deposit News Sign in

Dataset

Acoustic data collected from a glider deployment in the North Sea in June-July 2021 as part of the EU Marine Robots (EUMR) project.

Update Frequency: Not Planned
Status: Ongoing
Online Status: ONLINE
Publication State: Citable

ViewXML

Open Access Download See Related

Download link

Abstract

This dataset consists of acoustic data collected using an icListen Smart Hydrophone (model SC35-ETH) integrated into an iRobot M1 Seaglider during a campaign in the North Sea, west of Ireland. The glider was deployed from 22nd June to 25th July 2021 as the sole glider in the campaign on behalf of the EU Marine Robots (EUMR) project. The acoustics data are provided as both raw acoustic waveform (.WAV format) files, and spectral analyses of the data (as ascii .txt files). Once the glider was recovered, the acoustics data were transferred directly from the glider and so no post processing has been completed.

An error in the instrument system led to an error in the timestamps on the data files. The first waveform was started at 2021-06-27 12:29:42, and this was recorded as 2010-01-01 00:02:30. The timestamps for all filenames and the timestamps of all records in the spectral files have been corrected for this time offset. All the filename name changes are provided in the timestamp_logs directory. In addition, some spectral files were not closed correctly and held multiple records. These files have been split into new files and timestamps corrected

Citable as: Hayes, D.; Abdi, E. (2021): Acoustic data collected from a glider deployment in the North Sea in June-July 2021 as part of the EU Marine Robots (EUMR) project.. NERC EDS British Oceanographic Data Centre NOC, 16 December 2021. doi:10.5285/096690aba290452d9b7208133274b69b. <http://dx.doi.org/10.5285/096690aba290452d9b7208133274b69b>

Coverage

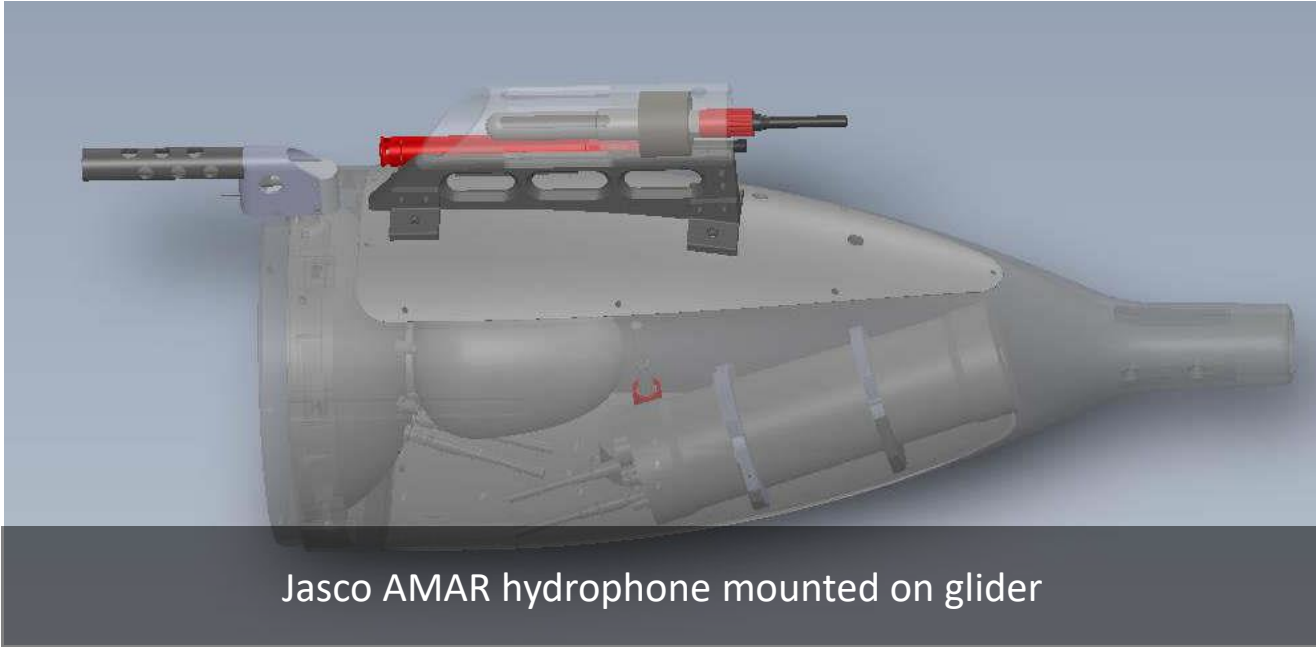
Temporal Range

Start time: 2021-06-22T06:53:40
End time: 2021-07-25T08:59:05

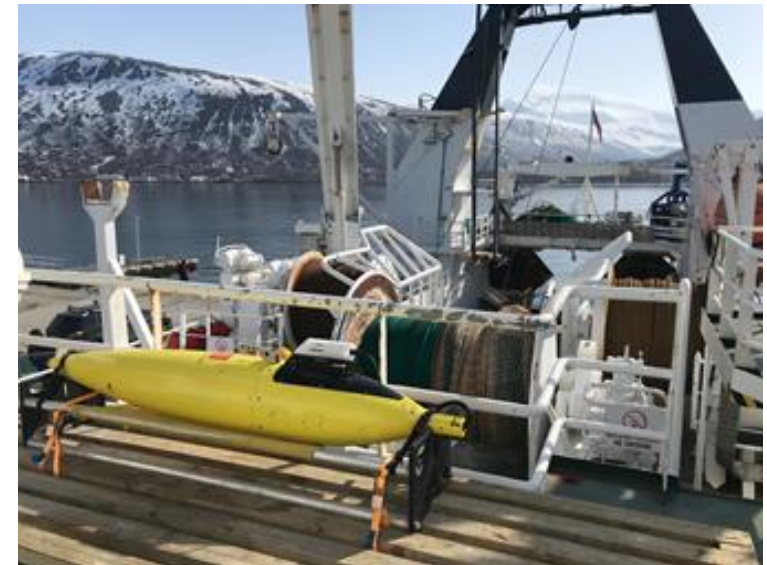
Geographic Extent

United Kingdom

- NOC/BODC manages and assigns **doi**, [link](#) for download of all
- Data infrastructure differs: TB per deployment
- CEDA Archive of NERC's Environmental Data Service (EDS)
- Atmospheric and earth observation research: climate models, satellites, aircraft, met observations, etc.



Jasco AMAR hydrophone mounted on glider



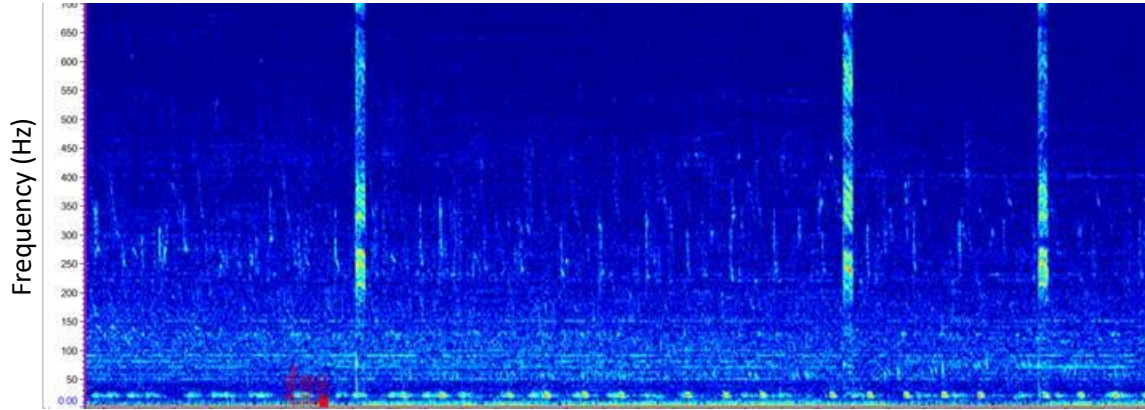
Jasco AMAR
hydrophone
mounted on
seaglider

- Collected over 350GB of acoustic data
- Combined with visual (UVP6) physical and biological data collected on cruise
- Manual upload to private cloud

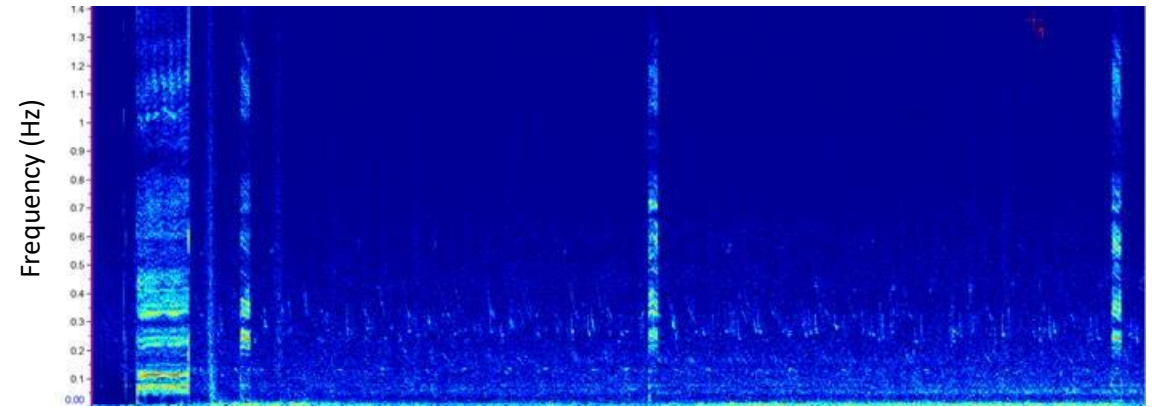
Norway 2017-2019 expedition

Ballen Whales

fin whales

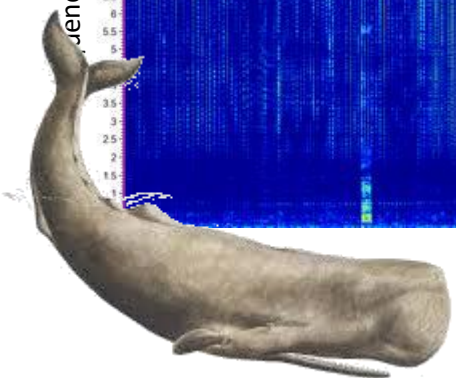
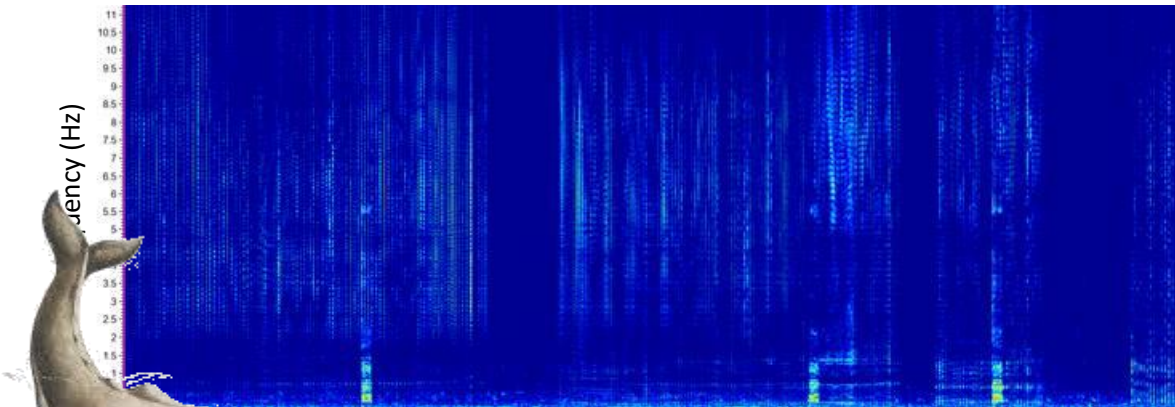


humpbacks

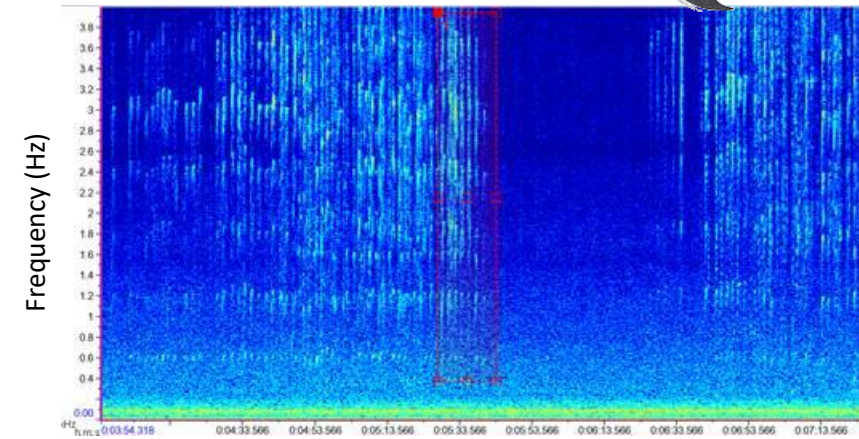


Toothed Whales

sperm whales



Delphinids





Thank you

- Daniel Hayes, Managing Director, hayesdan@cyprus-subsea.com
- Ehsan Abdi, Head Engineer, e.abdi@cyprus-subsea.com
- And the whole team!

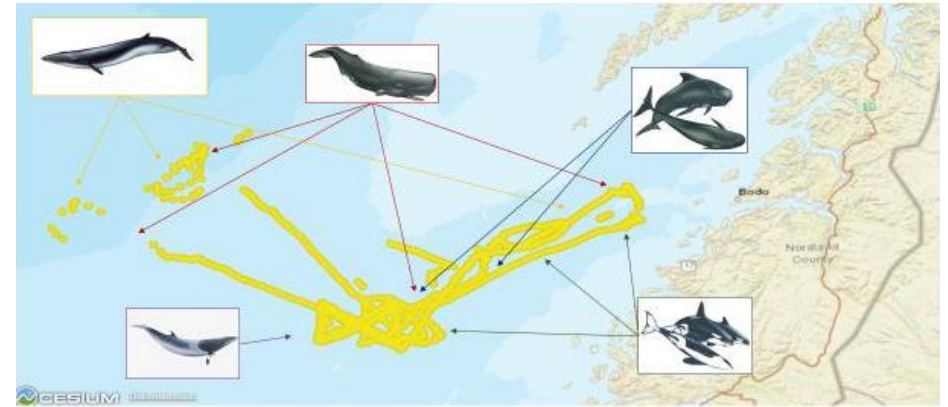
Combining Passive and Active Acoustics

Location of mammals through passive acoustics

Location of food sources (plankton) with echosounder.

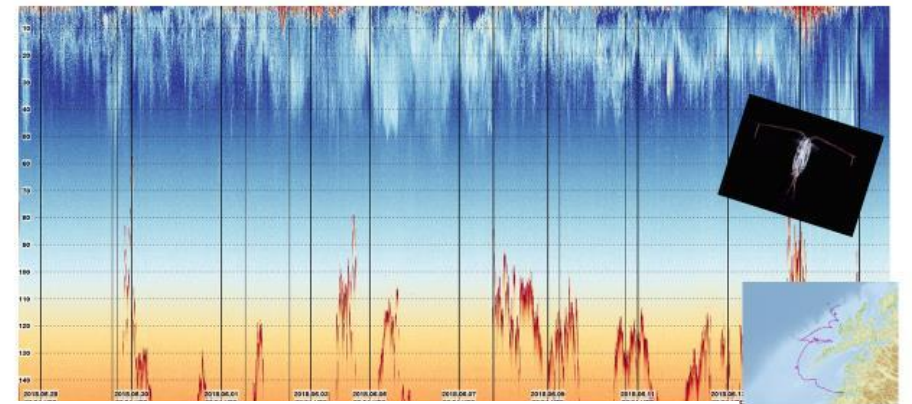
Detected the presence of sperm whales actively feeding in marine areas

Could be done from a single platform (glider)



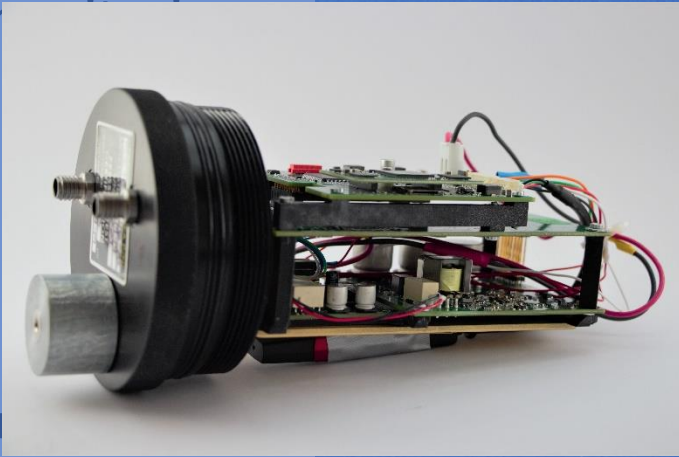
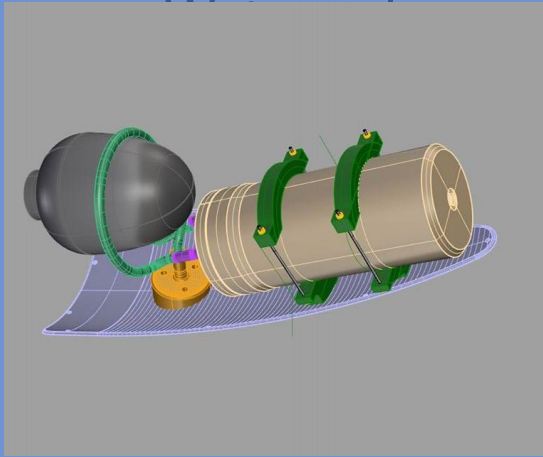
Mammals recorded through hydrophone integrated to a glider

Sekundær produksjon
Dyreplankton, mest *Calanus* (raudåte)
Også torskelarver

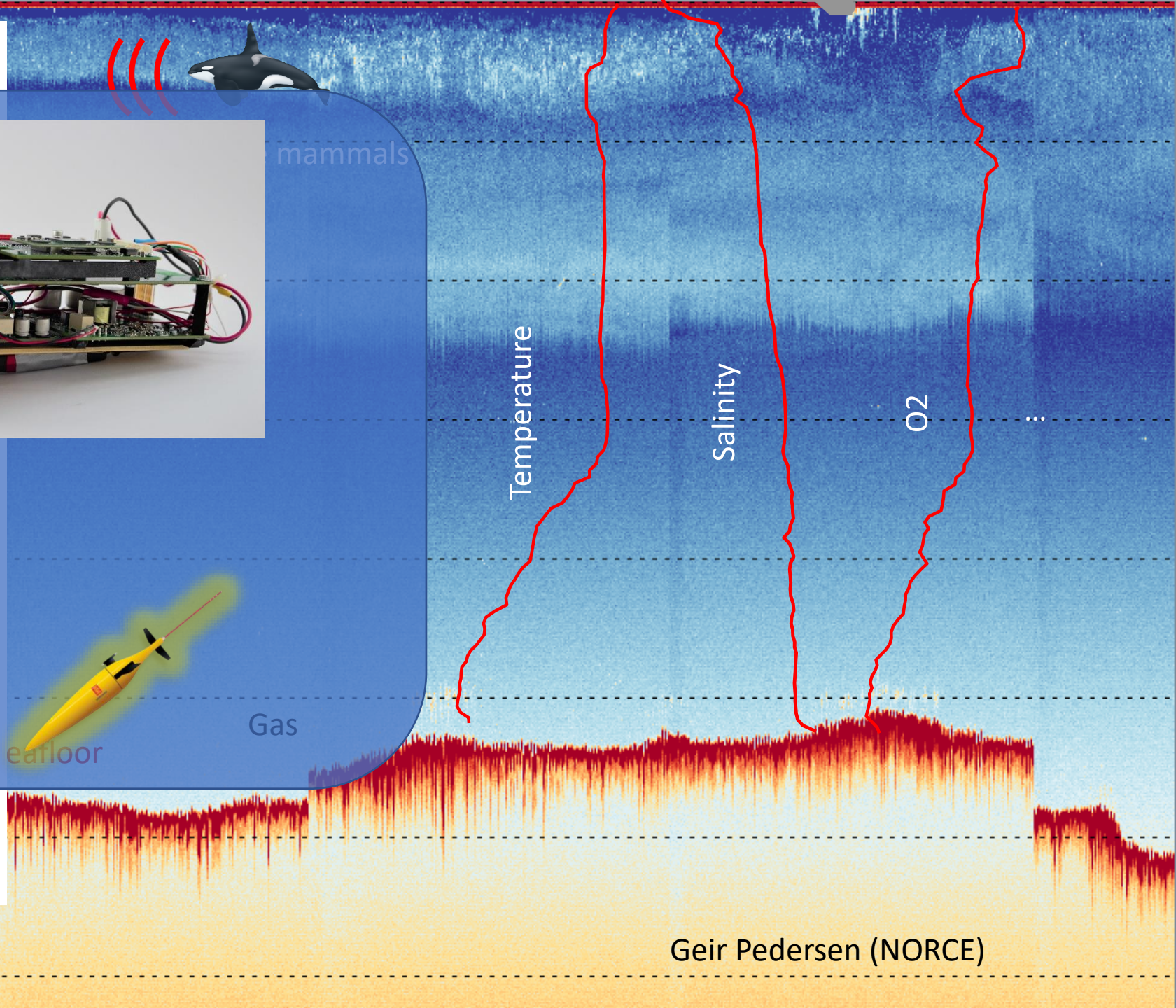


Integration of deep echo echosounder to glider

- Scientific echosounder

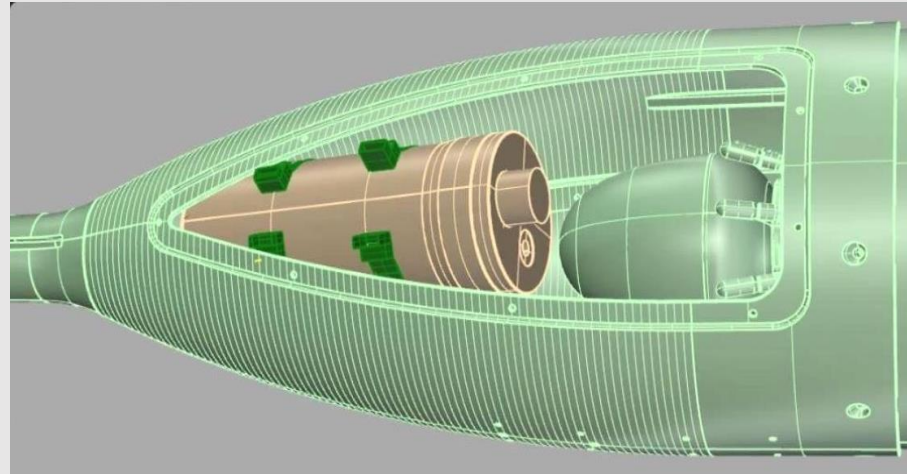


- Oceanographic features
 - Depth / bathymetry
 - Ecosystem, behavioural studies
- Marine mammals and prey



Technical integration of ek80

- Kongsberg Simrad WBAT mini
- First scientific wide-band echosounder on glider
- Modified electronic boards to fit a pressure housing



*This experiment was jointly carried out with UCY