



Institutt for marin teknikk

The journey:

From OceanLab to Fjordlab

A national infrastructure for full-scale
ocean space research.

Technology development for protecting
subsea installations

Photo: Adressa Brand Studio

Full-scale testing and research in the ocean environment

The infrastructure in the Trondheim's fjord

- Full-scale testing of subsea robots, autonomous ships and aquaculture.
- Marine observation: Ocean ecosystems and changes in the subsea environment.
- This infrastructure also gives answers to how subsea installations can be held secure in times of war and energy crisis: A coast guard underwater.
- An infrastructure with five collaborating laboratories.

Illustrasjon: Bjarne Stenberg



What is OceanLab and Fjordlab?

OceanLab is an **infrastructure project** funded by the Norwegian Research Council, SINTEF Ocean, NTNU and Equinor.

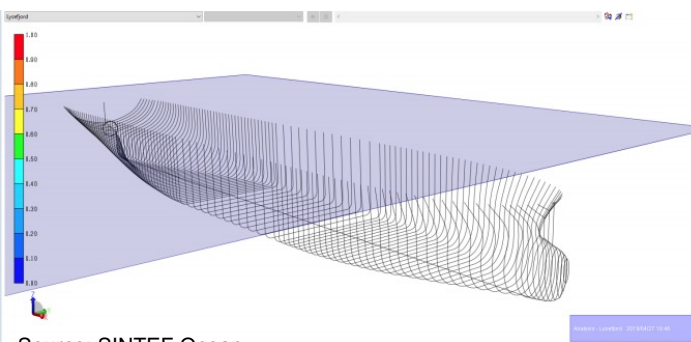
OceanLab is located in Trøndelag.

Fjordlab will be a **continuation and extension** of OceanLab and a part of the Norwegian Ocean Technology Centre ([Norsk havteknologisenter](https://norsk-havteknologisenter.no)).





From simulation to full-scale testing and verification



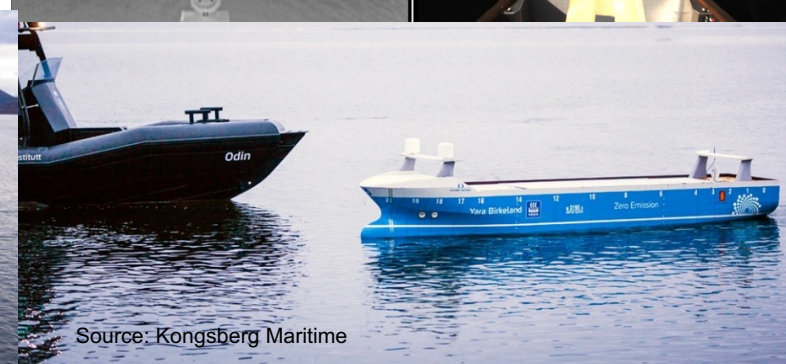
Ship design



Verification of ship design

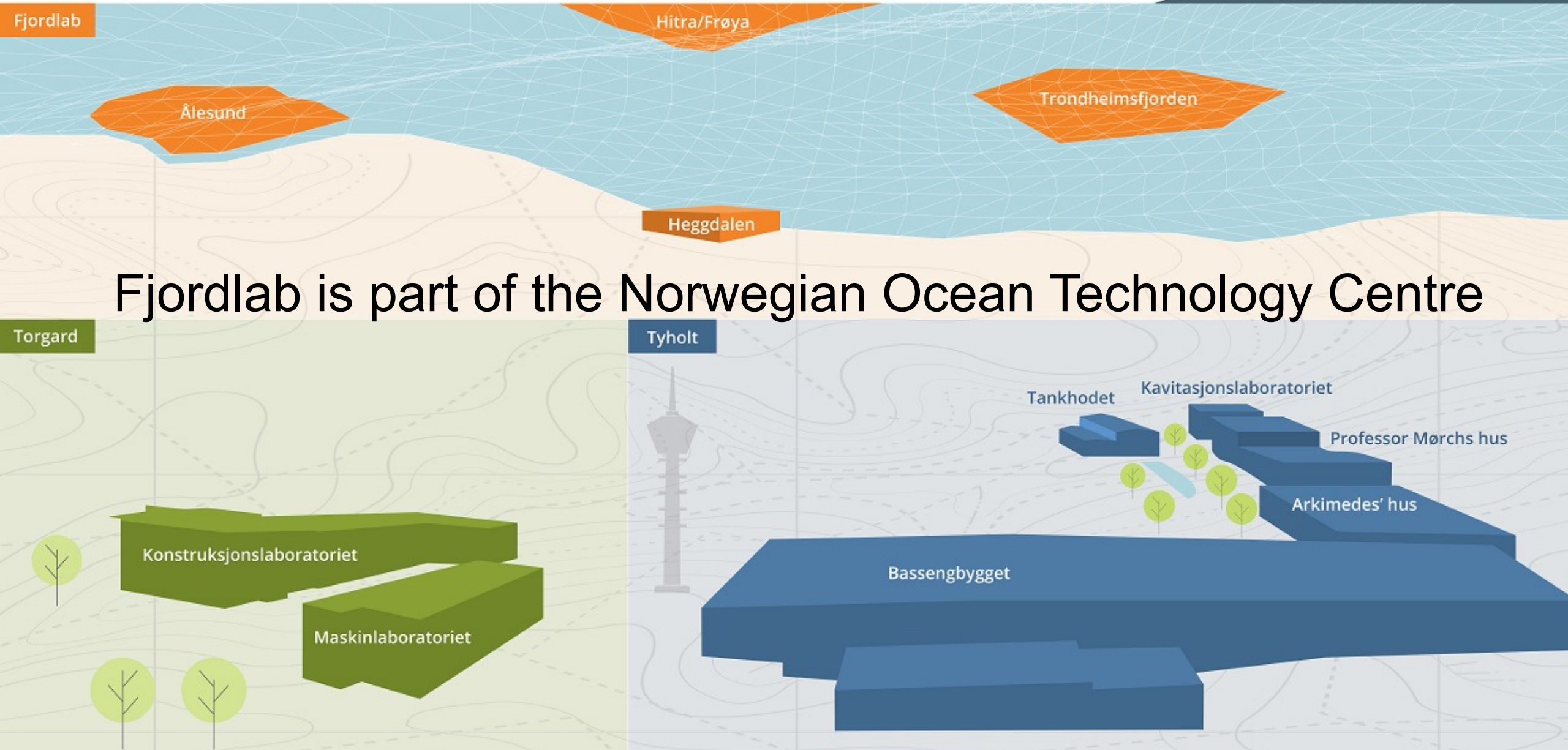


Sea trials

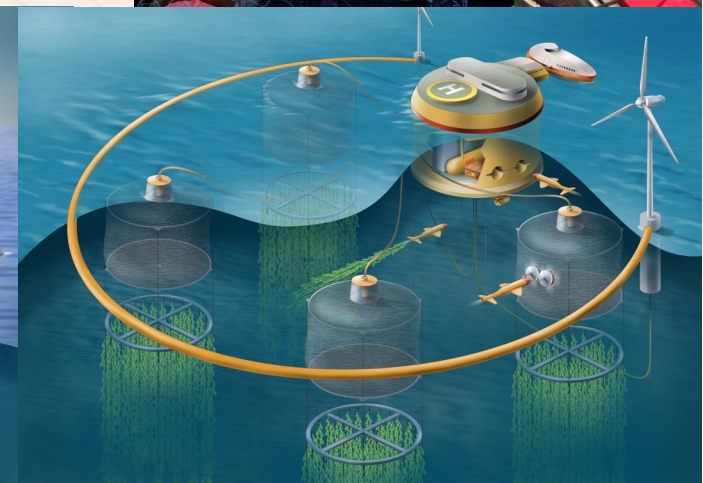
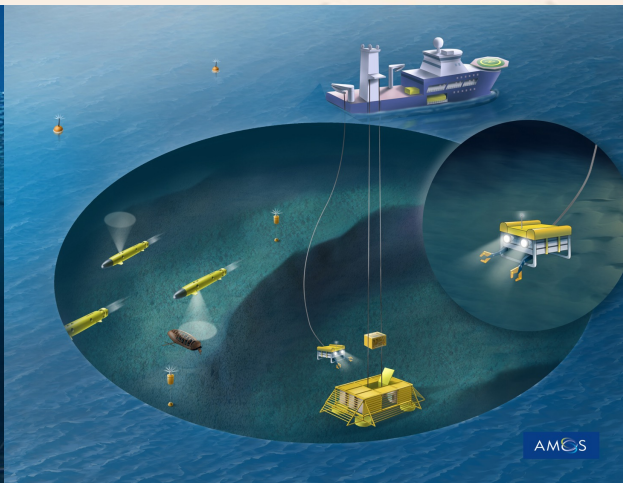
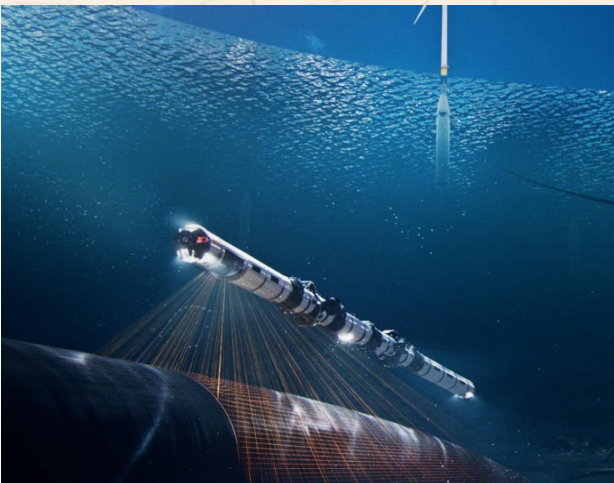


Advanced technology and system development





Fjordlab is part of the Norwegian Ocean Technology Centre



Subsea robots and subsea infrastructure

Autonomous ships and ship operations

Aquaculture

Marine observatory

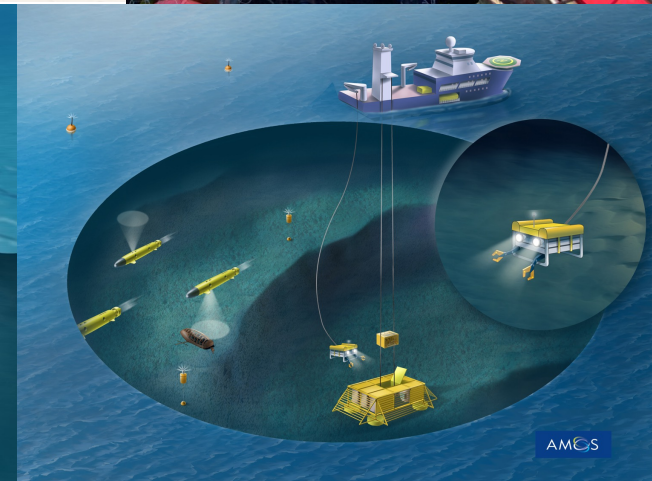
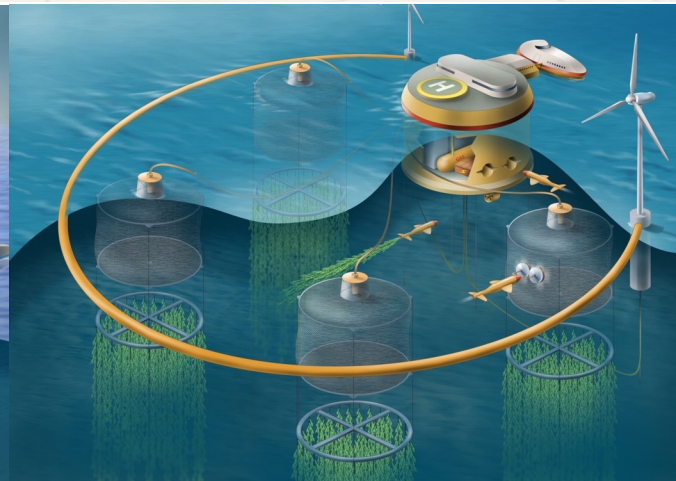
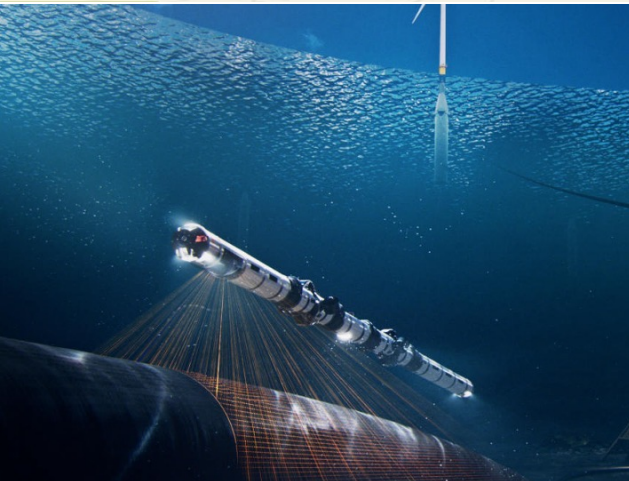
+ Communication & e-infrastructure

Ålesund

Trondheimsfjorden

Heggdalen

Fjordlab: Five laboratories



Subsea robots and subsea infrastructure

Autonomous ships and ship operations

Aquaculture

Marine Observatory

Ship Operation Research

+ Communication & e-infrastructure

OceanLab to Fjordlab

Locations

● Phase 1 (OceanLab project)

● Phase 2 (Fjordlab project)

Sea trials (ship)
Simulation and
visualization

Fish farms

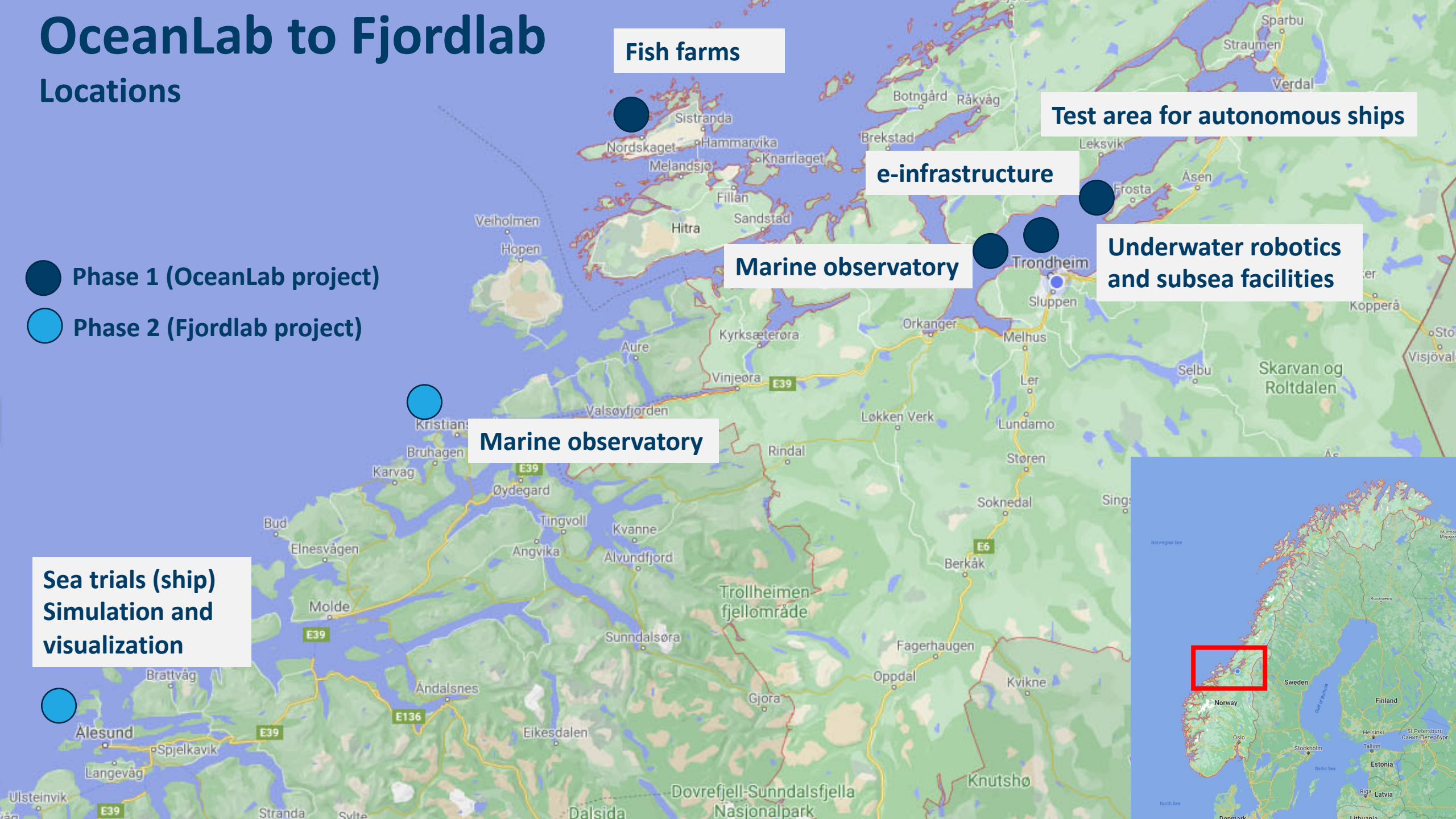
Test area for autonomous ships

e-infrastructure

Marine observatory

Underwater robotics
and subsea facilities

Marine observatory





Fjordlab will be critical infrastructure for

World leading ocean research

enabling technology development, and education for students to the maritime industry.

The green shift in the blue economy

- Climate crisis and energy crisis: Transition to zero-emission shipping and autonomous shipping.
- Nature crisis: ocean observation is needed.

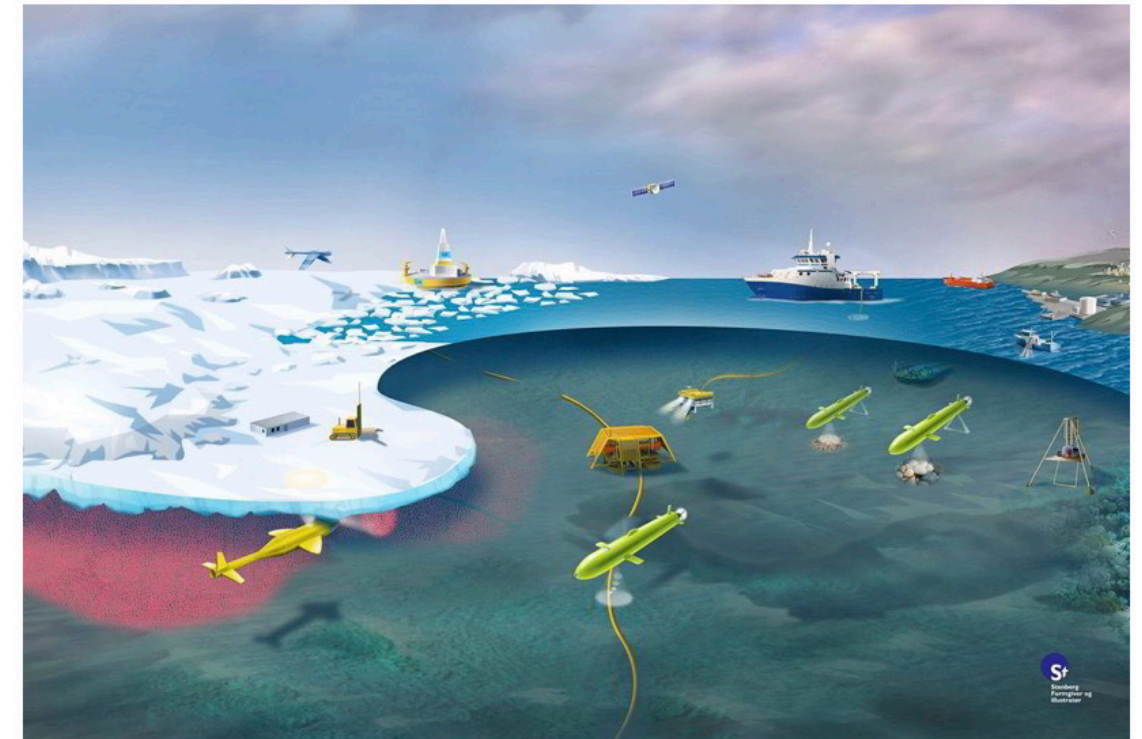
National security and preparedness

Ocean surveillance in a new security situation in Europe – war on energy systems and infrastructure: We need an underwater coastguard.

Vi trenger en kystvakt under vann

Sabotasjen av Nord Stream-rørledningene har vist at undersjøisk infrastruktur er sårbar.

2 MIN | PUBLISERT: 05.10.22 — 13.36 | OPPDATERT: 9 TIMER SIDEN



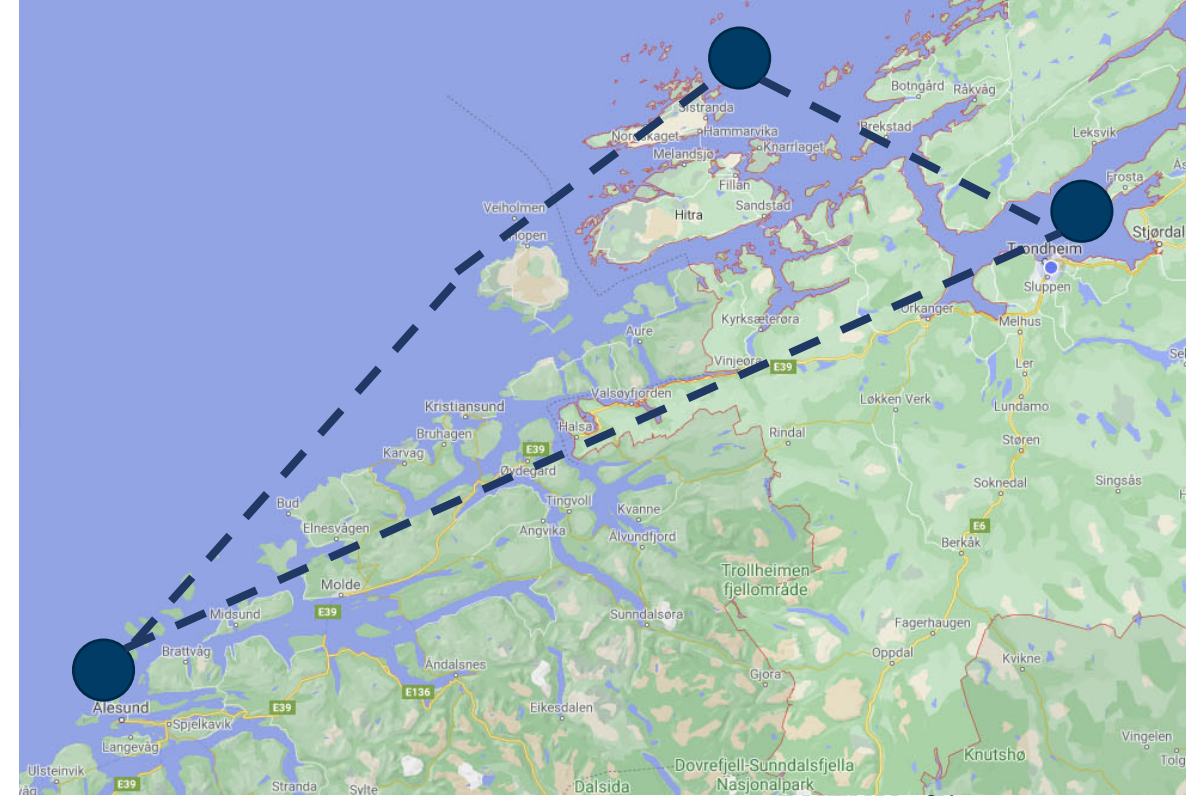
Vi mener at Norge bør bygge ut en undervannskystvakt basert på de nye mulighetene som teknologien gir, skriver artikkelforfatterne. (Foto: Illustrasjon: NTNU Amos/Stenberg)

Development of existing infrastructure

- NTNU AUR-Lab (underwater robotics lab, Trondheim)
- SINTEF ACE (aquaculture, Frøya)
- OceanLab Observatory (Trondheim-Frøya-Ålesund)
- National test area for autonomous vessels (Trondheim)
- Ship Operation Research Lab (simulators, Ålesund)
- OceanLab infrastructure project (2020-2023)

The new infrastructure will provide new and improved facilities for education and research within

- Maritime transport; design, equipment, operation
- Autonomous ships
- Marine environmental research
- Aquaculture; design, operation
- Underwater systems, remote operations, and unmanned
- Technology, sensors and solutions for ocean monitoring
- Digitalisation in the ocean space; models, monitoring, simulations, integration of sensor & communication platforms
- Ocean energy; wind and wave energy



An architectural rendering of a proposed infrastructure project in Fjordlab. The scene features a long, white concrete pier extending from a grassy hillside into a body of water. On the pier, there is a red boat, a crane, and several small figures of people. To the right, a large, modern building with a red facade and large glass windows is visible. The background shows a steep, grassy hill under a clear blue sky.

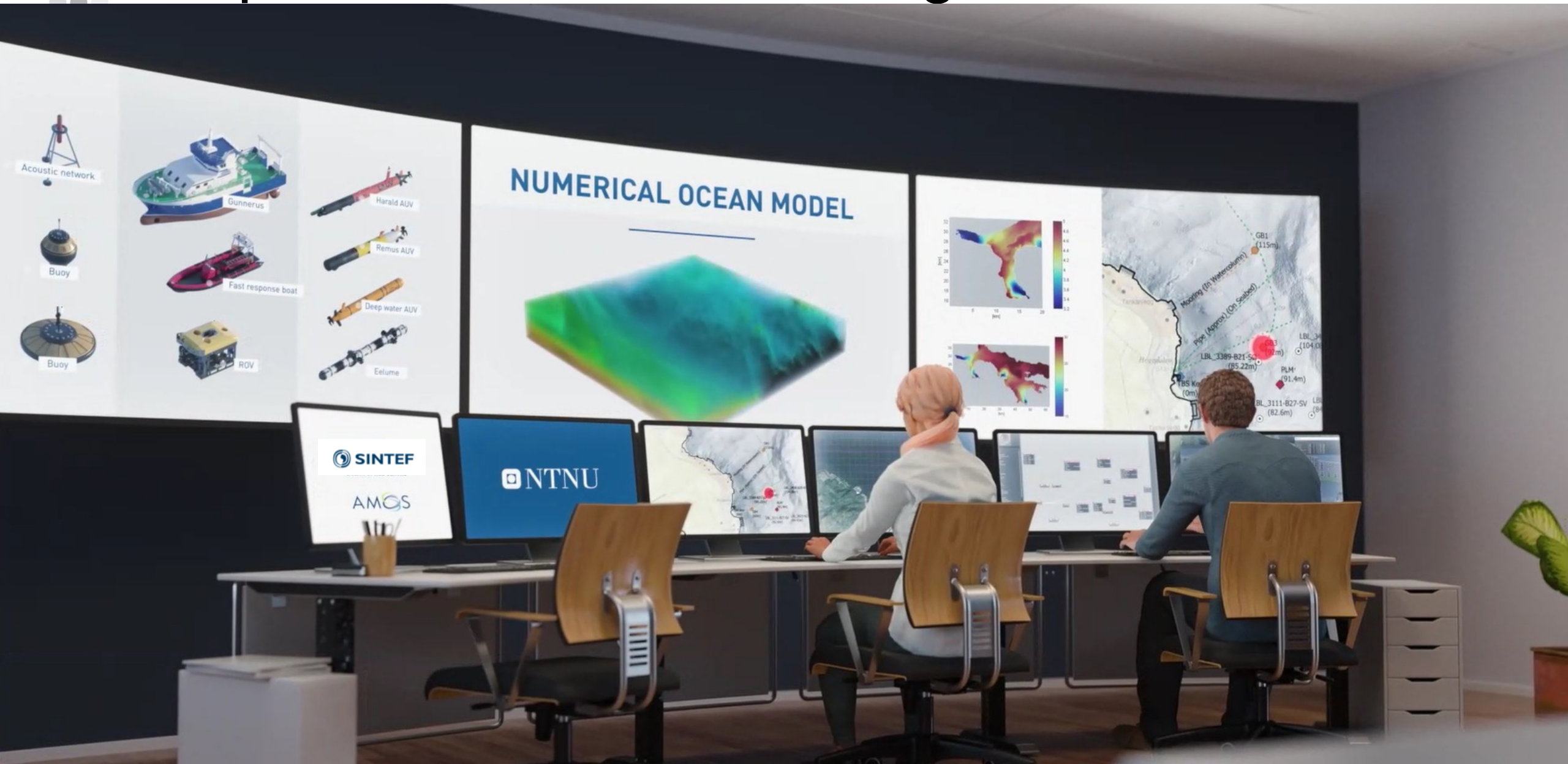
Planned infrastructure in parts of Fjordlab

Illustrasjon: Snøhetta / Statsbygg

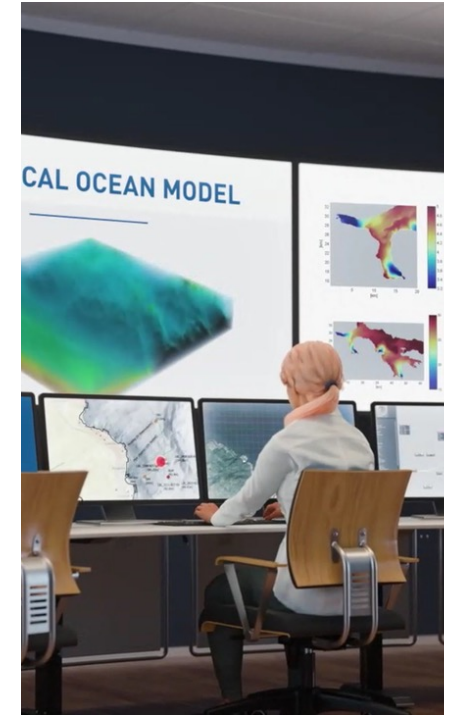
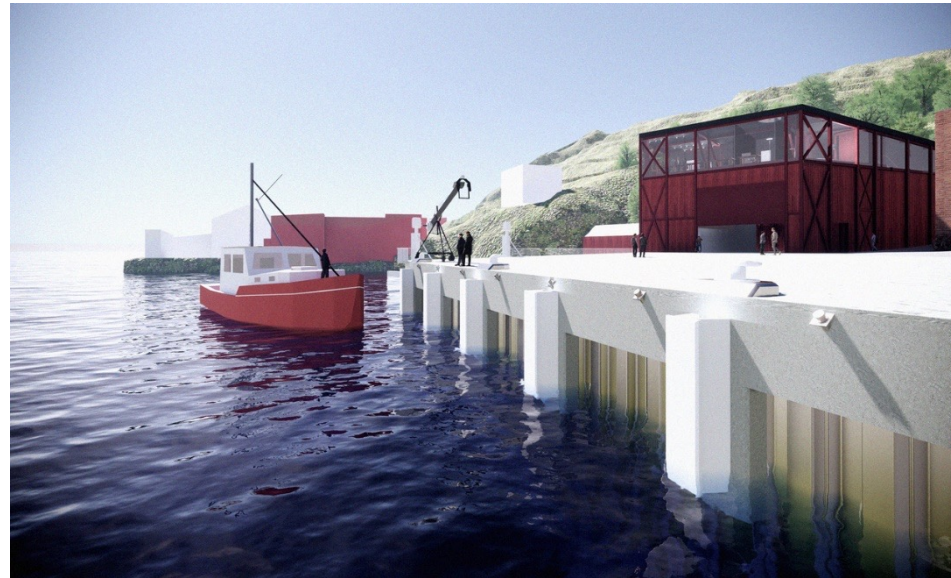
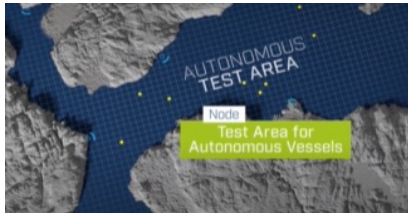


Illustrasjon: Snøhetta / Statsbygg

Operations, data and integration centre



Timeline



OceanLab

Fjordlab



OceanLab – investments 2020-2023 (97 MNOK)

Subsea robots and
subsea facilities

Test area for
autonomous ships

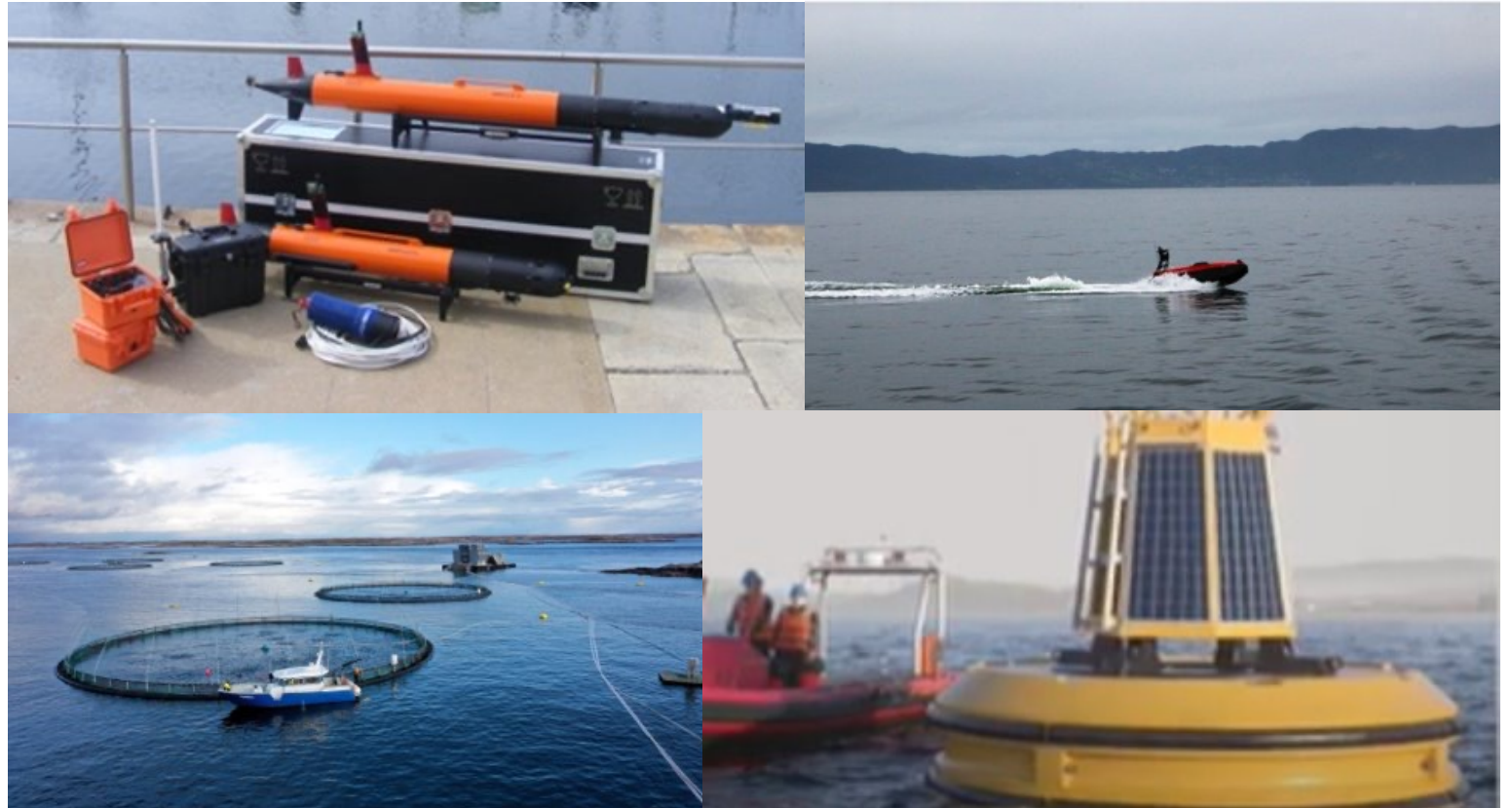
Aquaculture research
and development

NEW

Marine observatory

NEW

Communication &
e-infrastructure





Fjordlab – planned investments 2024-2026 (400 MNOK)

Subsea robots and
subsea facilities

Test area for autonomous
ships

Aquaculture research and
development

Marine observatory

NEW

Digital twin and visualisation

NEW

Digital Fjord

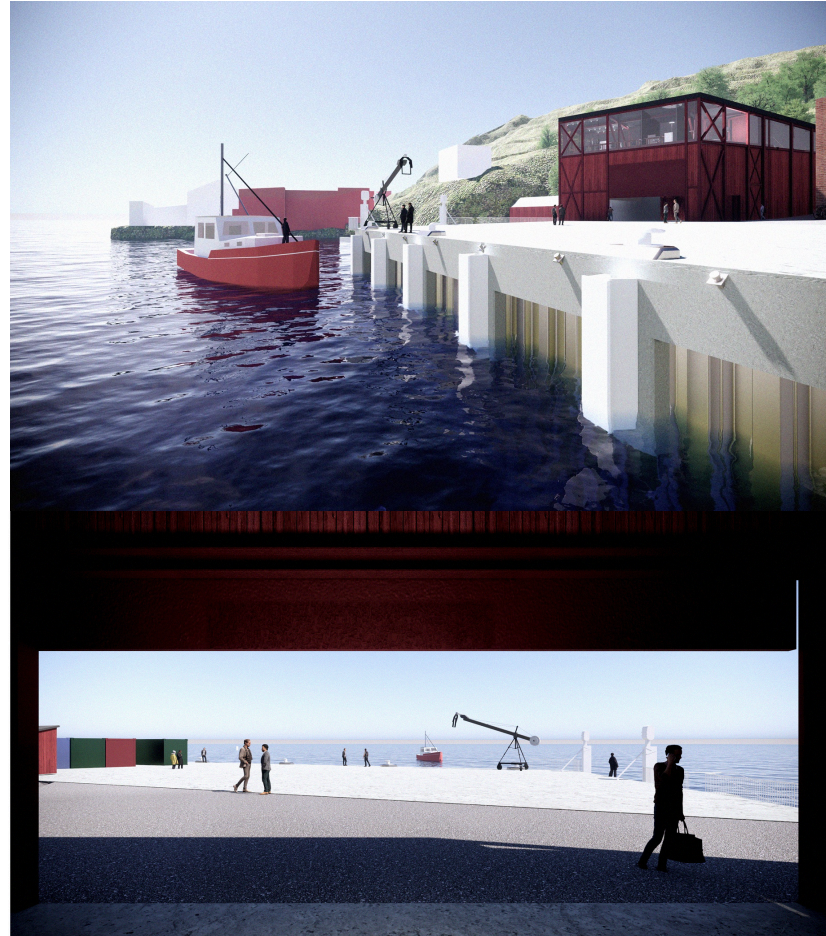
NEW

Full scale maritime testing

Communication &
E-infrastructure

NEW

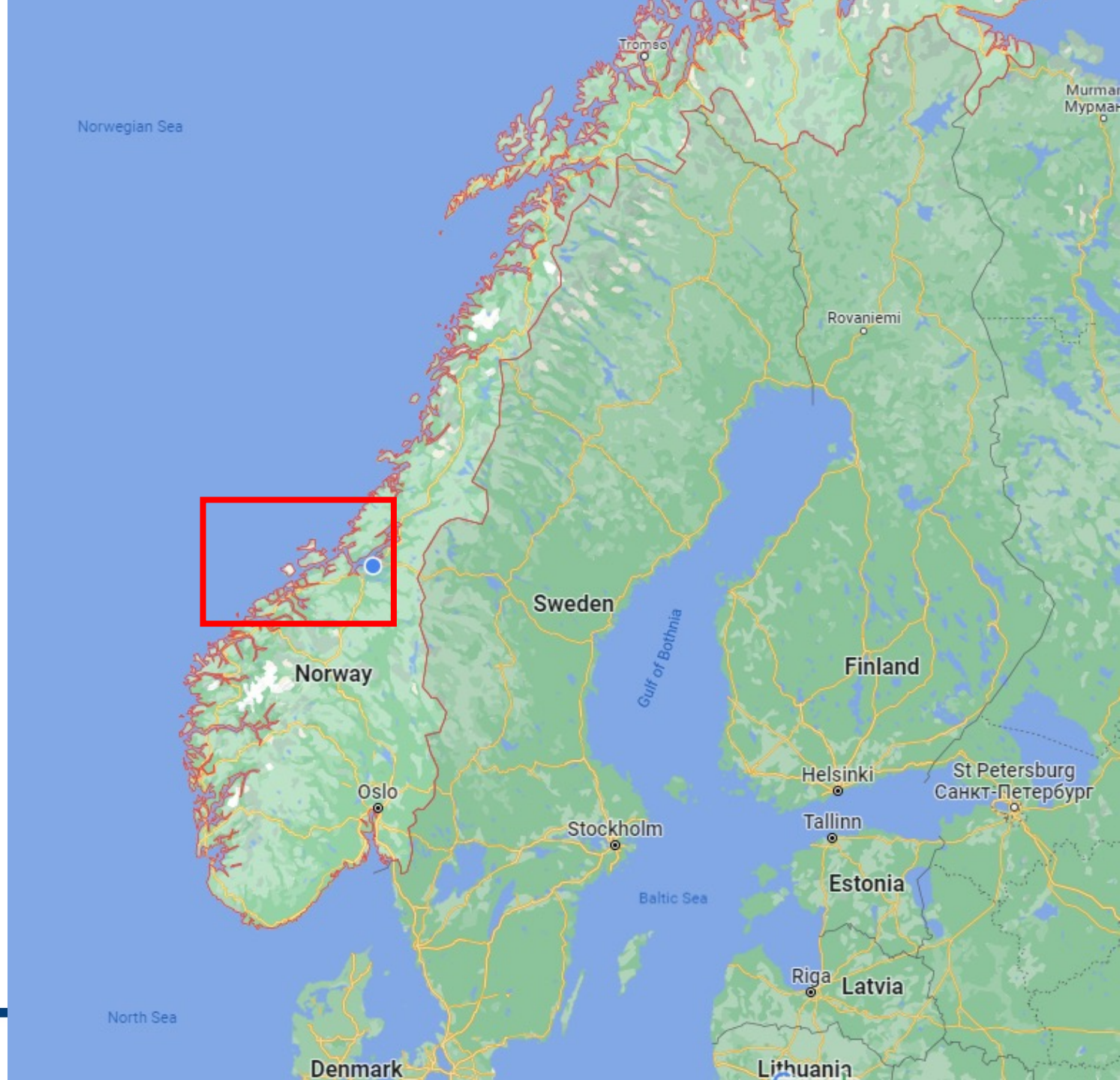
Land infrastructure
(Trondheim & Ålesund)



Who can collaborate in the research and development in OceanLab and Fjordlab?

The OceanLab
infrastructure can be
used both by national
and international
partners, academia and
industry

[https://www.ntnu.edu/
oceanlab](https://www.ntnu.edu/oceanlab)



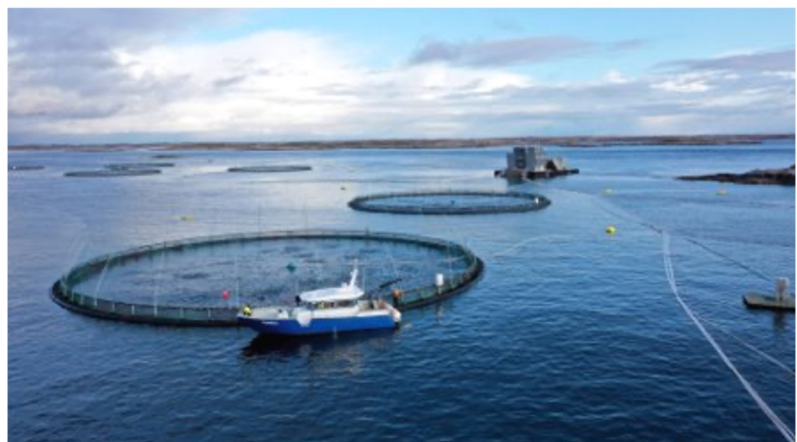
The OceanLab nodes



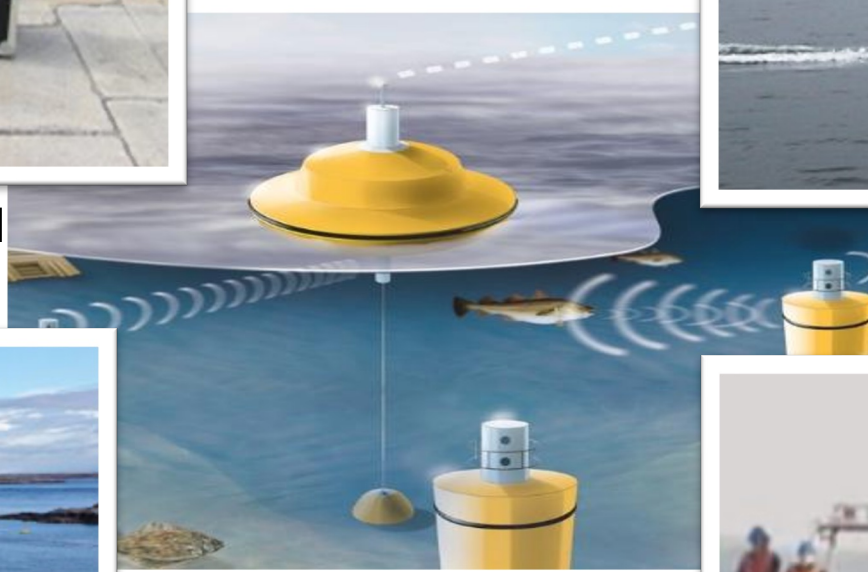
Node 1: Subsea robots and subsea facilities



Node 2: Test area for autonomous ships



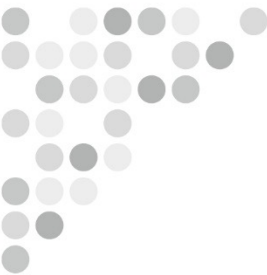
Node 3: Aquaculture



Communication & e-infrastructure



Node 4: Marine observatory



Node 1 – TBS/ Trondheim fjord

Equipment

- Remotely Operated Vehicles (ROVs)
- Autonomous Underwater Vehicles (AUVs)
- Light autonomous Underwater Vehicles (LAUVs)
- Autonomous Surface Vehicles (ASVs)
- Control room
- Docking stations (90 and 365 m depth)

See more at

<https://www.ntnu.edu/aur-lab>

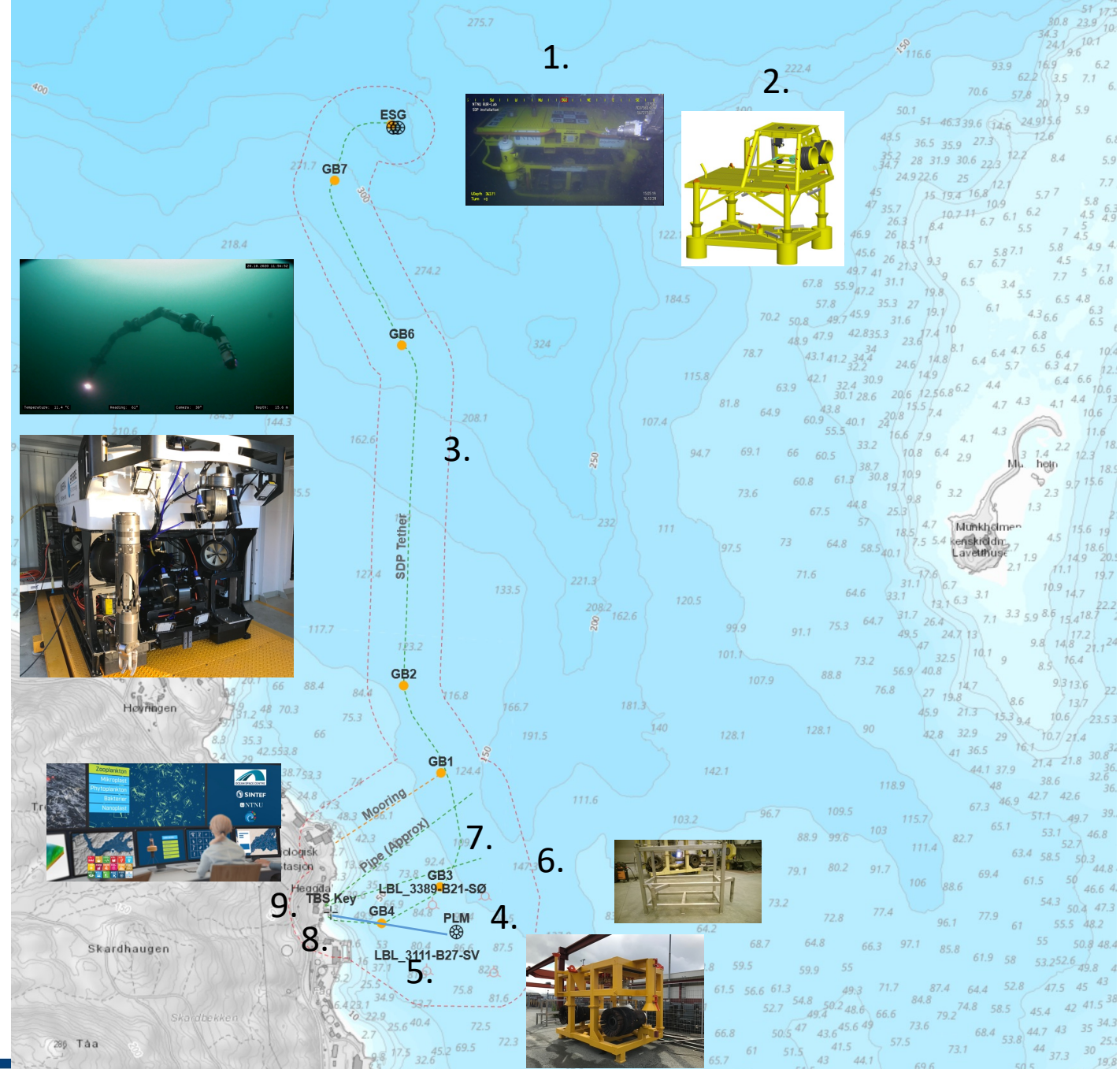
Martin Ludvigsen
Professor NTNU IMT
Node 1 manager





Node 1

1. SDP (Subsea docking plate)
2. Instrument rig SDP
 - CTD
 - ADCP
 - MBE
 - Video
 - Junction box
 - Acoustic modem/USBL
 - Fly out vehicle
3. Main power cable SDP
4. PLM (Pig Loop Module)
5. Power cable PLM
6. Instrument rig PLM
 - CTD
 - ADCP
 - Video
 - Acoustic modem / USBL
 - Junction box
7. LBL navigation
8. Top side communication and power supply
9. Command and control centre
10. Eelume nderwater vehicle
11. ROV Minerva



Node 1

Subsea robots and subsea facilities

- Underwater observations and operations
- Research, education, testing for development, simulations and experiments.
- Subsea interventions
- Marine science
- System approach
- Machine vision
- Underwater navigation and communication
- Autonomy and cyber-physical systems
- Data collection, mapping and monitoring worldwide.





Node 2 – Trondheim fjord

Equipment

- Detection (2 x radars, cameras)
- Positioning (GNSS RTK)
- Communication (VDES, 4G/5G)
- E-Navigation (AIS, 2 x weather stations)
- Electric work boat
- Ocean Info (data portal node 2)

See more at

<https://testsitetrd.no/projects/>

Beate Kvamstad-Lervold
Special Adviser, SINTEF Ocean
Node 2 manager



Node 2

Test area for autonomous and unmanned vessels

- Technology for autonomous ships
- Situational awareness
- Remote control functions and operations
- Resilience in autonomous operations
- Autonomy logistics and transport chains
- Cost-benefit analysis



«MS POLARLYS» har søkt ly i lla i Trondheim.

Node 3 – Hitra/Frøya - coastal areas

Equipment

- Aquaculture sites with biomass.
- Instrumentation for digitalized and autonomous operations.
- Underwater cameras and split beam sonars.
- Automated crane, RPAS and ROVs.
- Load shackles and accelerometer.
- GPS/motion reference unit.
- Sensors for measurement of oxygen, temperature, salinity, turbidity, current, waves and weather conditions.

See more at

<https://www.sintef.no/en/all-laboratories/ace/>

Finn Olav Bjørnson

Research Scientist, SINTEF Ocean
Node 3 manager



Workboat Torra



Rataren



Buholmen



Tristeinen



Korsneset



Node 3

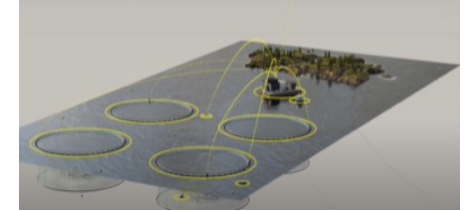
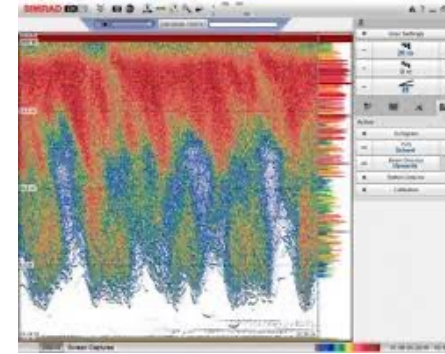
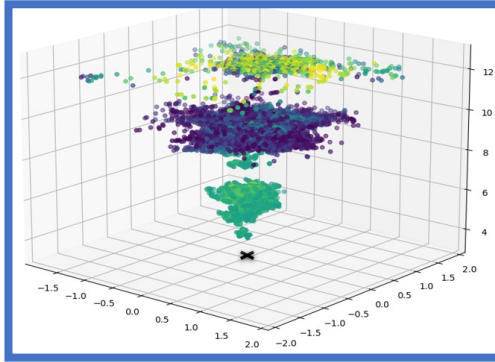
- Production of 2.340 t fish owned by SINTEF Ocean
- 4 locations
- 1 Workboat

OSC

Node 3

Aquaculture

- Bio marine production
- Fish farming on four locations
- Fish well-fare
- Monitoring
- Remote operation
- Safety





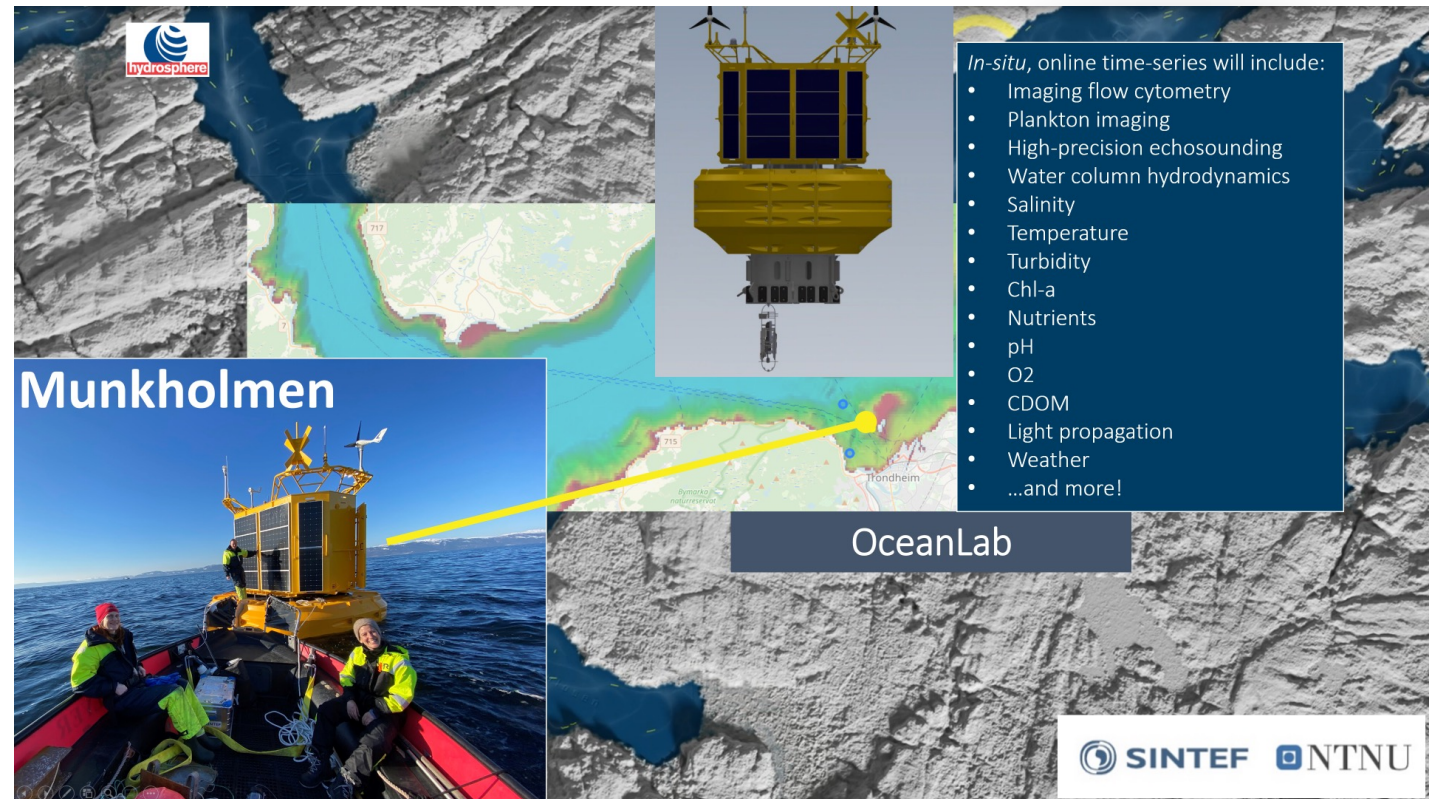
Node 4

Equipment

- Several high-spec environmental data buoys:
 - Covering Trondheim-Frøya-Ålesund
- A suite of mobile oceanographic environmental monitoring.
- Gliders for offshore long-term monitoring
- Long-range AUV for week-long deployments
- USVs for environmental monitoring in Ålesund area

See more at
<https://oceanlabobservatory.no/>

Emlyn Davies
Senior Research Scientist,
SINTEF Ocean, node 4 manager



OceanLabObservatory.no

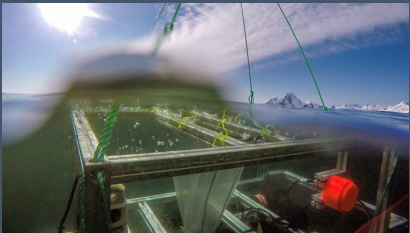
Ecosystems



Pollution / Litter

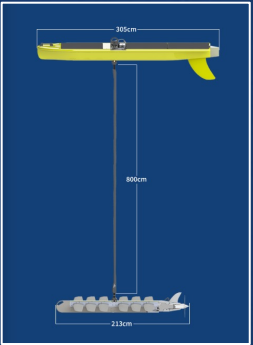


Technology

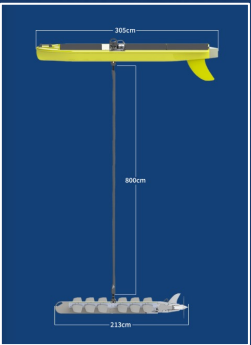


FjordLab
2023-2026

Glider 2



Glider 1



Instruments



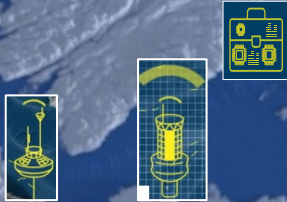
Long-range AUVs



Buoy



OceanLab Phase 1
2020-2024



Trondheim

Buoy



USVs

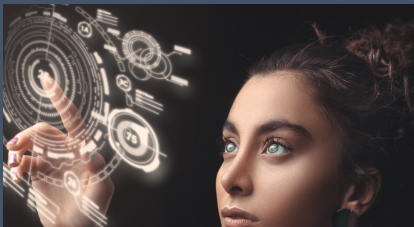


Ålesund

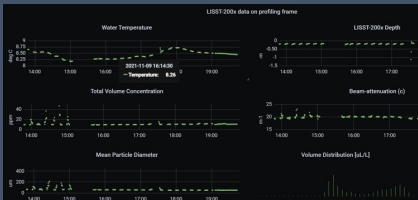
Trondheim's floating lab

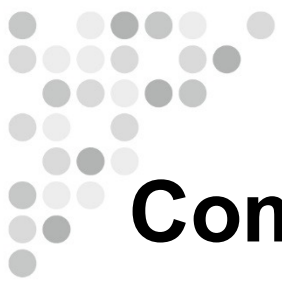


Technology innovation platform



Data for fundamental research & model development





Communication & e-infrastructure

Tor Arne Reinen
Senior Research Scientist,
SINTEF Digital, node 5 manager



Equipment

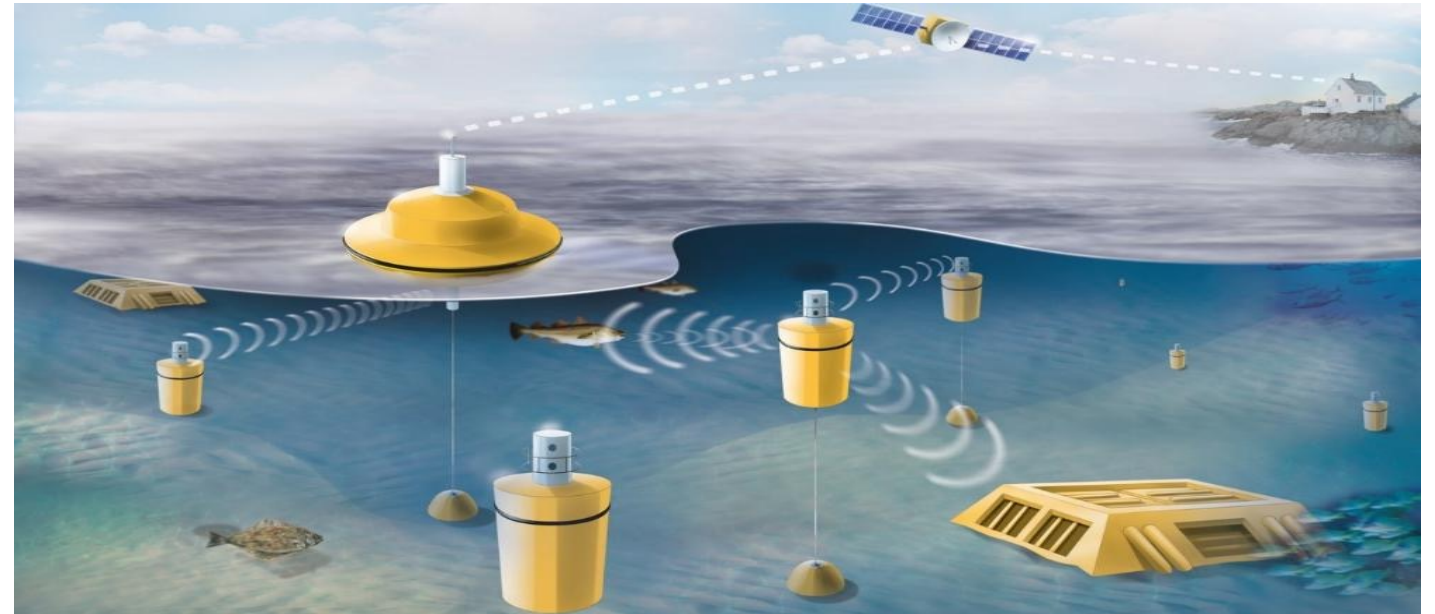
- Communication networks – both surface and subsurface.
- Systems for data storage.
- Management and data integration/interoperability.





Communication & e-infrastructure

- Data management following FAIR principles: Findable, Accessible, Interoperable, Reusable.
 - Restricted access where necessary
- Communication at sea (radio) and under water (acoustics).
- Connecting and secure storing of the data from all the other nodes.
 - Digital twins of the ocean
 - Machine learning and AI



An aerial photograph of a coastal research facility. In the foreground, a red research vessel with a yellow buoy is on the water. To the left, a small stone island with a circular fortification and a few buildings is visible. In the background, a coastal town and mountains are under a blue sky with some clouds.

OceanLab and Fjordlab

The infrastructure can be used
both by national and international
partners, academia and industry