SINTEF NTNU

Institutt for marin teknikk

The journey:

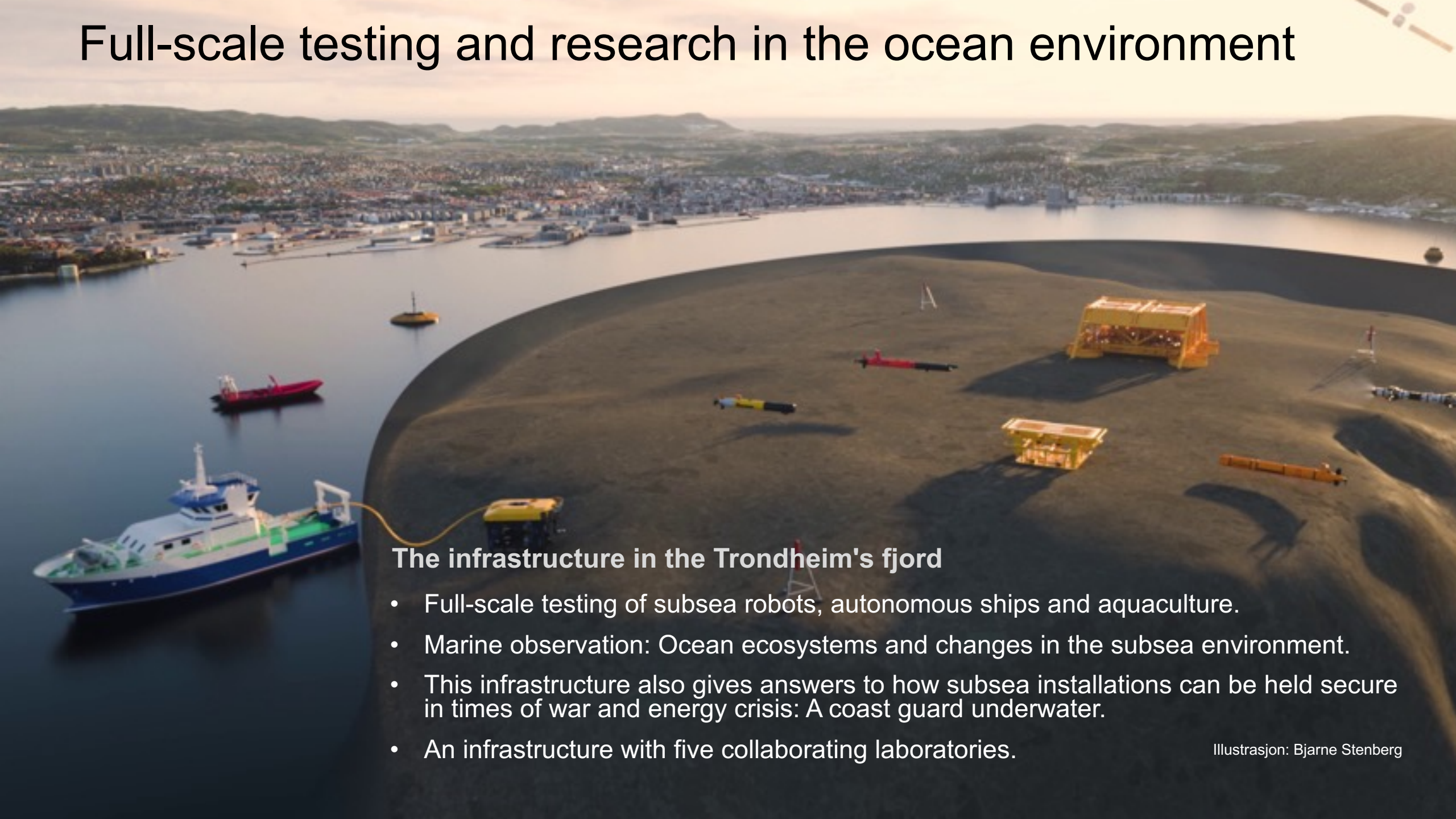
From OceanLab to Fjordlab

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

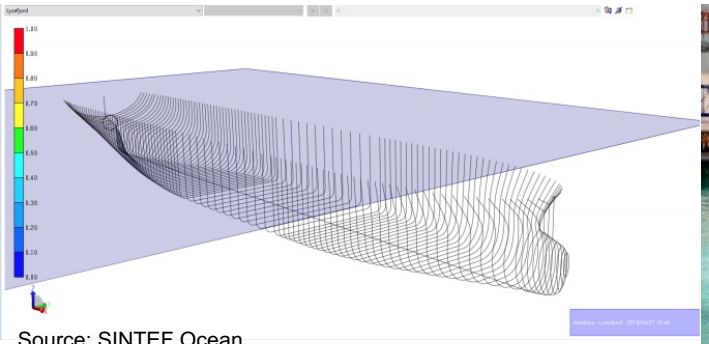
What is OceanLab and Fjordlab?

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).

From simulation to full-scale testing and verification



Source: SINTEF Ocean

Ship design

Source SINTEF Ocean

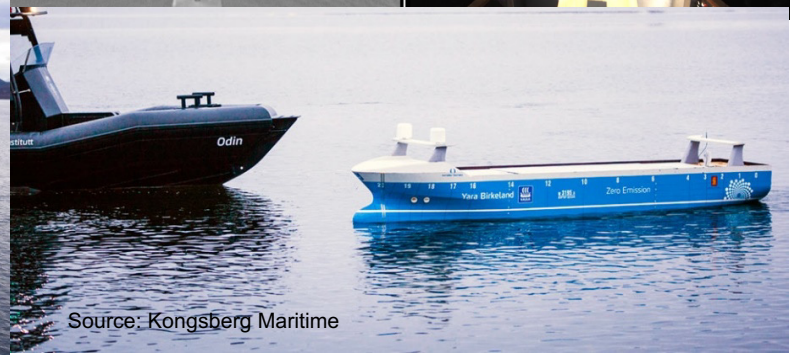
Verification of ship design

Source: VARD

Sea trials

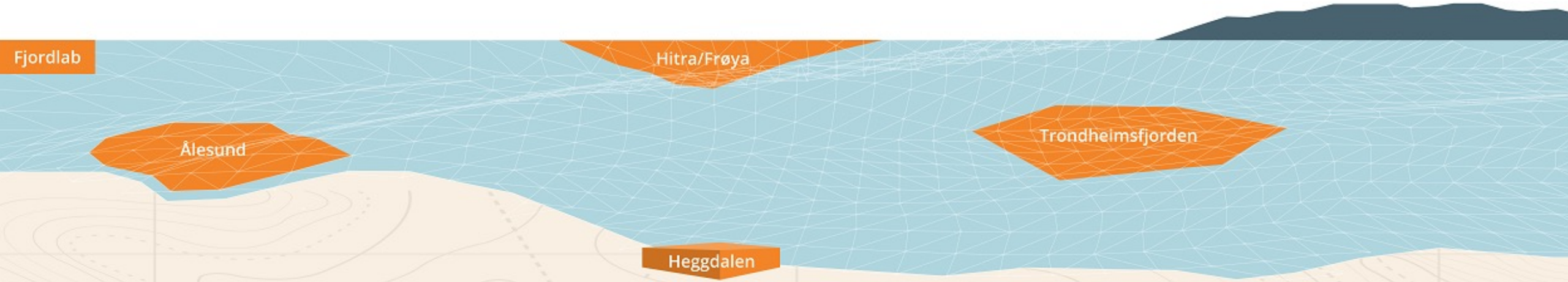
Source: Kongsberg Seatex

Source: NTNU

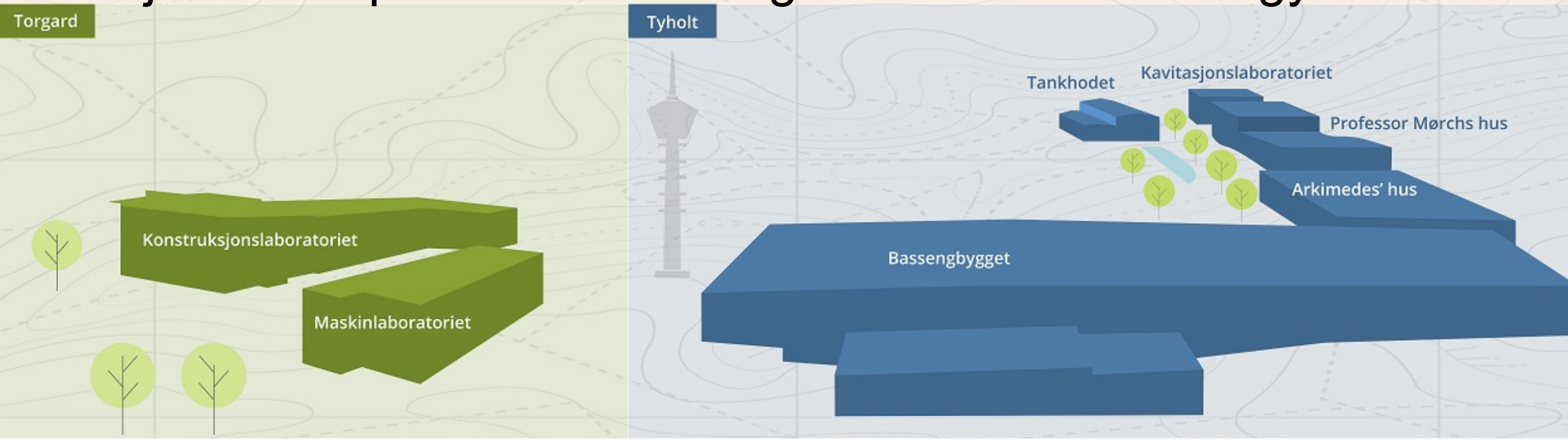


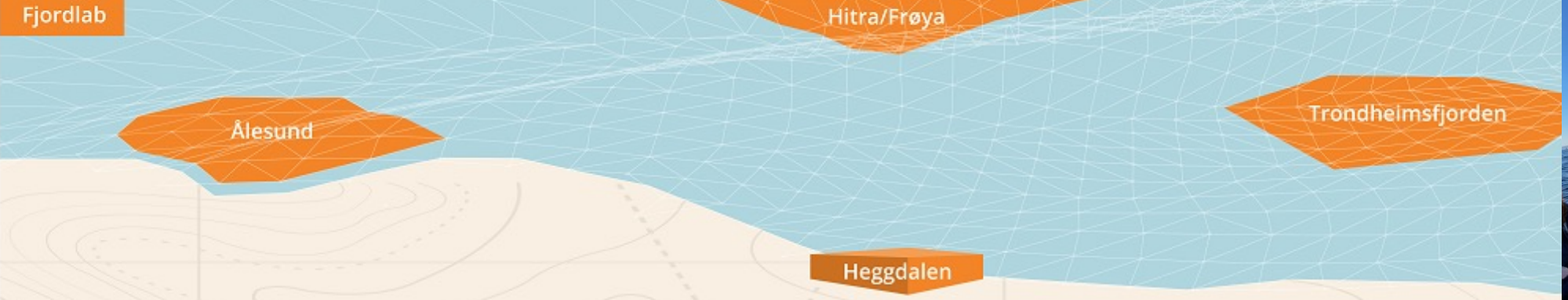
Source: Kongsberg Maritime

Advanced technology and system development

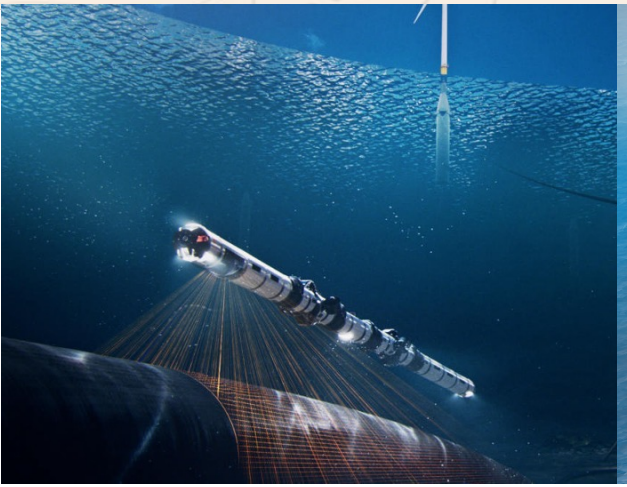


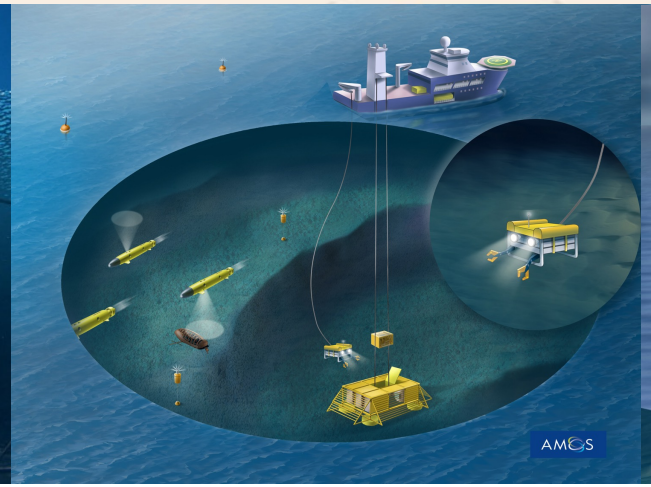
Fjordlab is part of the Norwegian Ocean Technology Centre

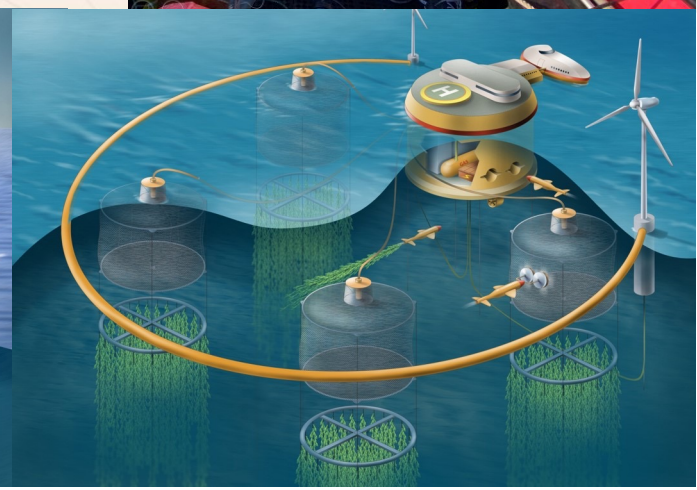




OceanLab: Four laboratories

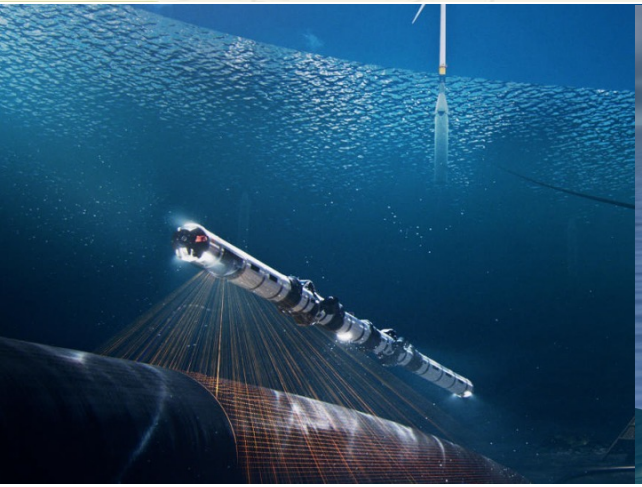


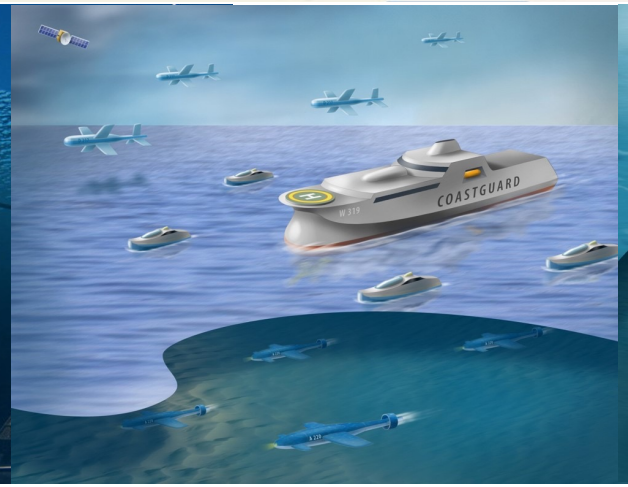


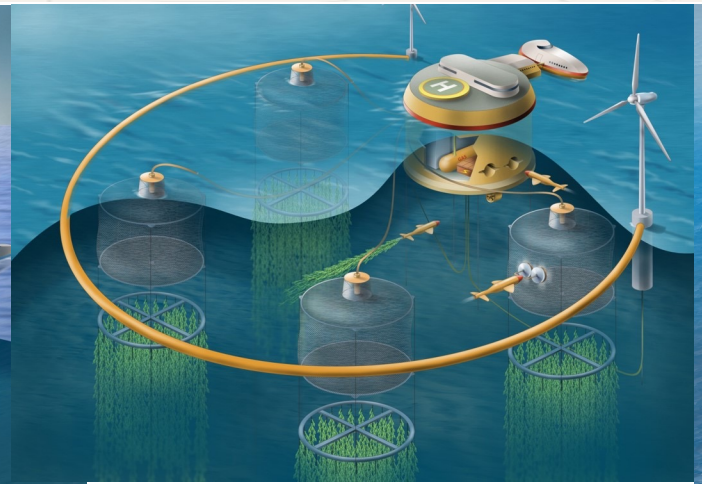


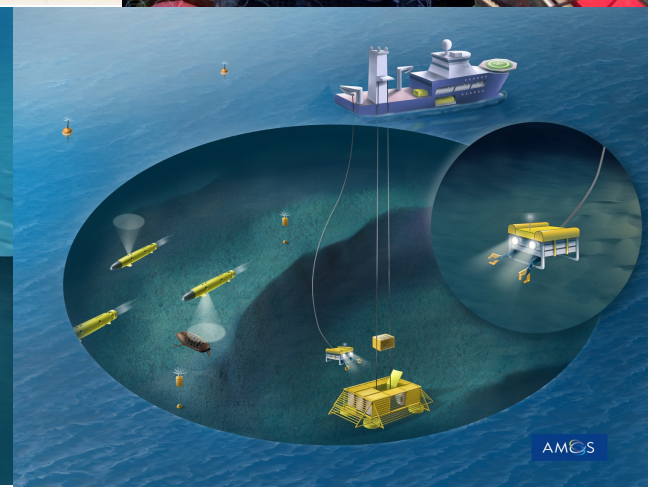
- Subsea robots and subsea infrastructure
- Autonomous ships and ship operations
- Aquaculture
- Marine observatory
- + Communication & e-infrastructure

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

Fish farms

Test area for autonomous ships

e-infrastructure

Underwater robotics and subsea facilities

Marine observatory

Marine observatory

Phase 1 (OceanLab project)

Phase 2 (Fjordlab project)

Sea trials (ship) Simulation and visualization

Fjordlab will be critical infrastructure for

World leading ocean research
enabling technology development, and education for students to the maritime industry.

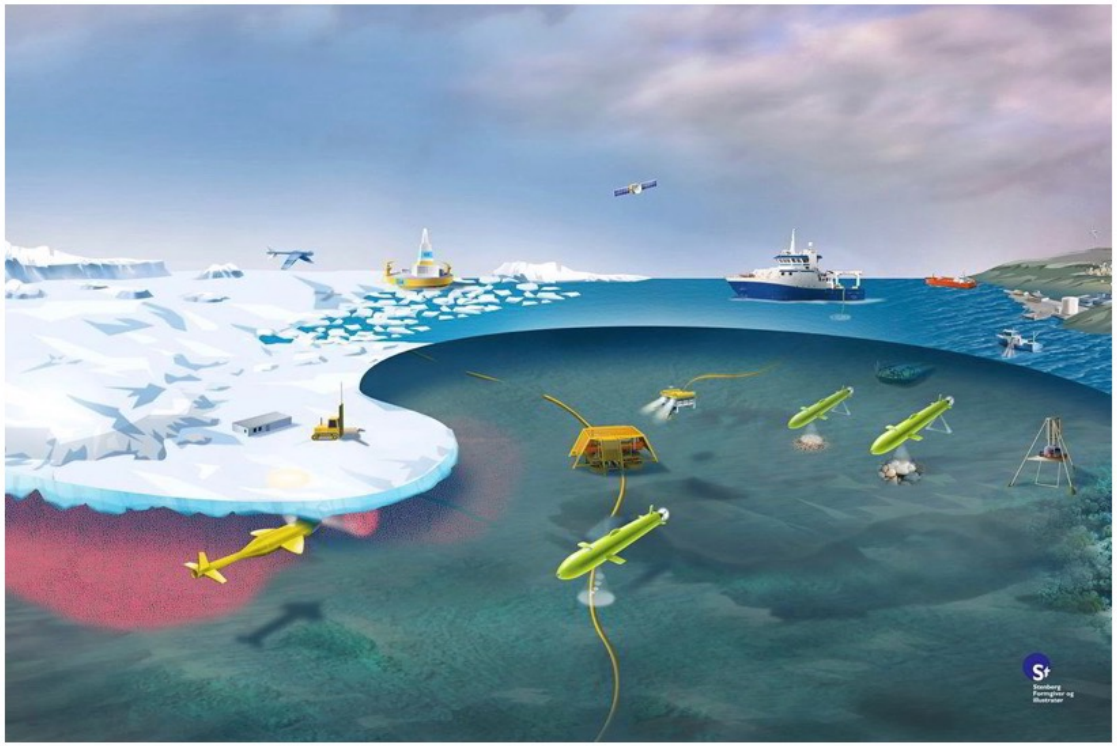
The green shift in the blue economy
- Climate crisis and energy crisis: Transition to zero-emission shipping and autonomous shipping.
- Nature crisis: ocean observation is needed.

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



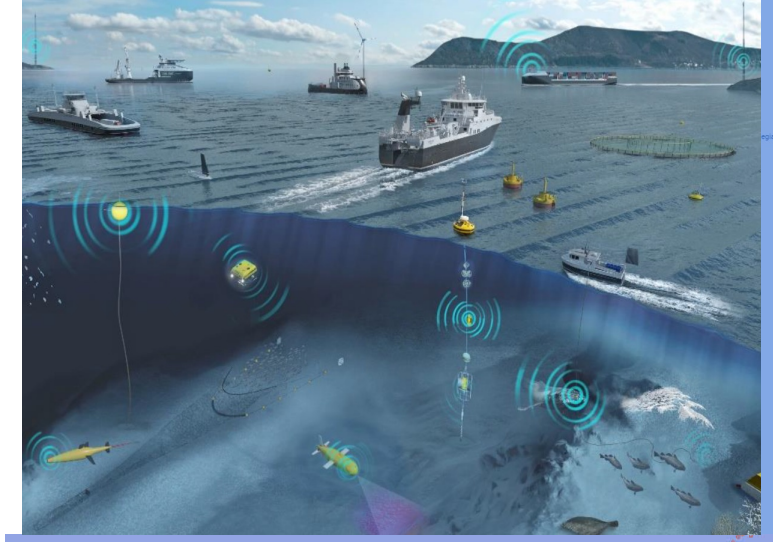
Vi mener at Norge bør bygge ut en undervannskystvakt basert på de nye mulighetene som teknologien gir, skriver artikkelforfatterne. (Foto: Illustrasjon: NTNU Amos/Stenberg)

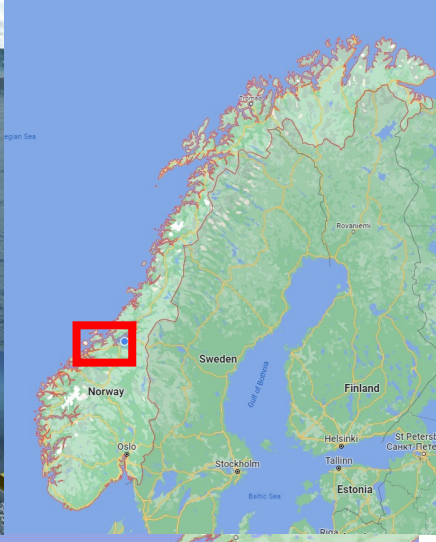
Development of existing infrastructure

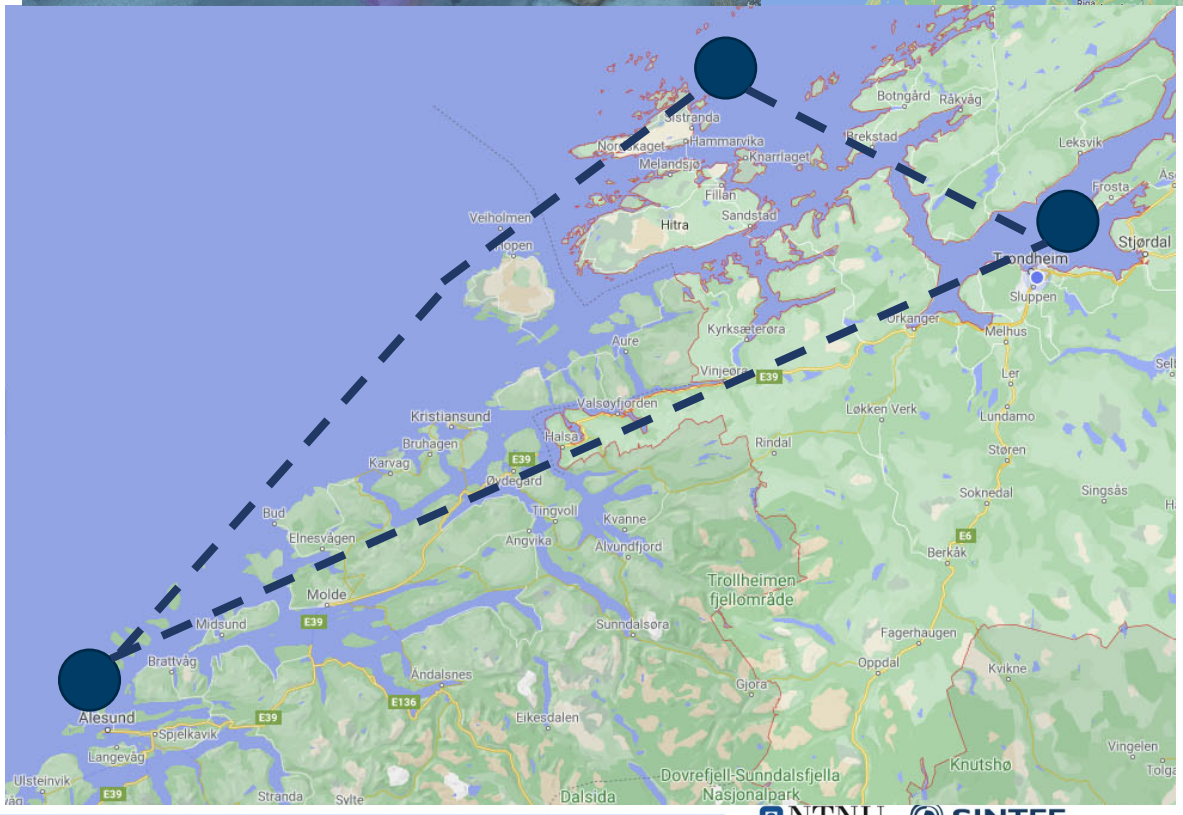
- NTNU AUR-Lab (underwater robotics lab, Trondheim)
- SINTEF ACE (aquaculture, Frøya)
- OceanLab Observatory (Trondheim-Frøya-Ålesund)
- National test area for autonomous vessels (Trondheim)
- Ship Operation Research Lab (simulators, Ålesund)
- OceanLab infrastructure project (2020-2023)

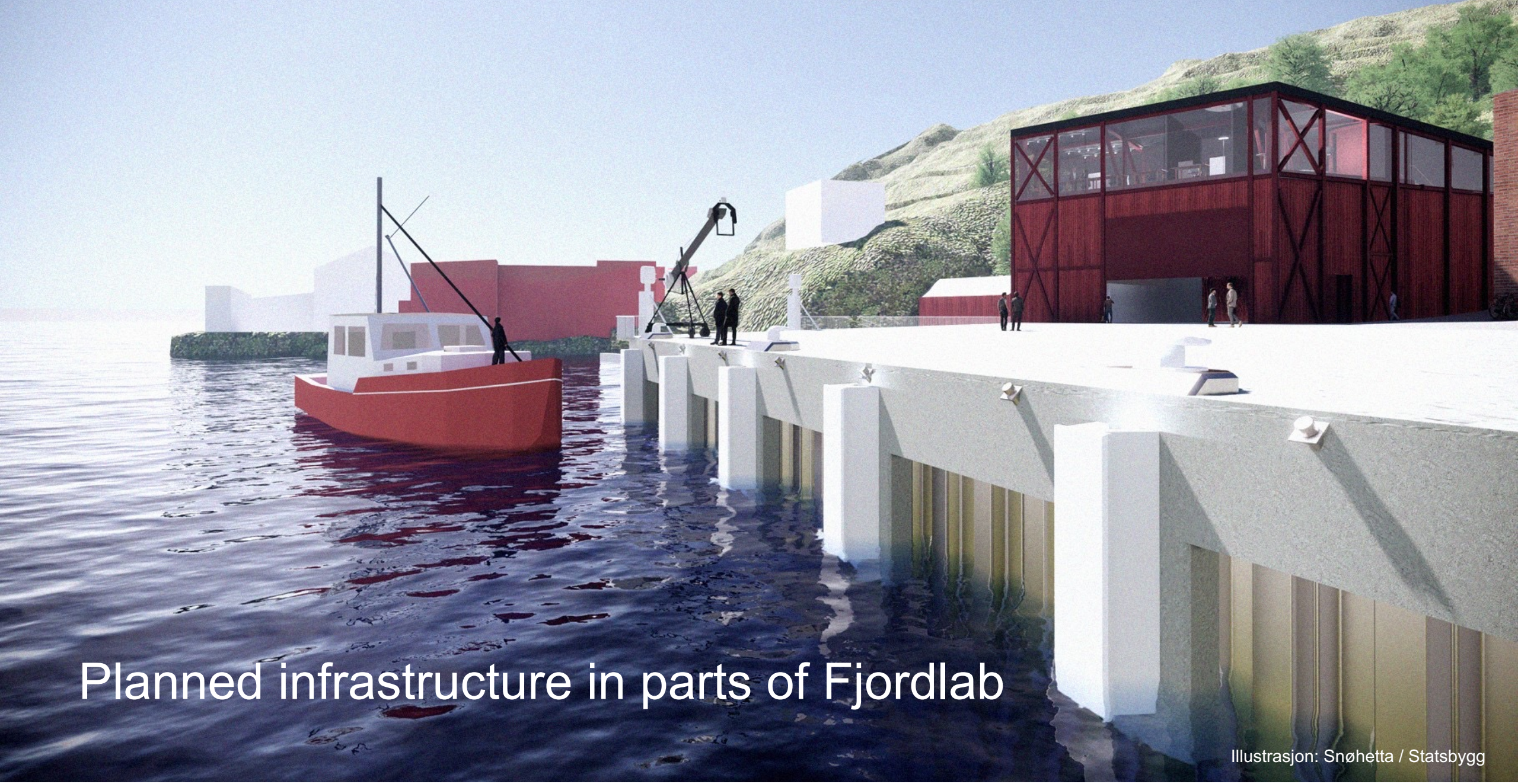
The new infrastructure will provide new and improved facilities for eduction and research within

- 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







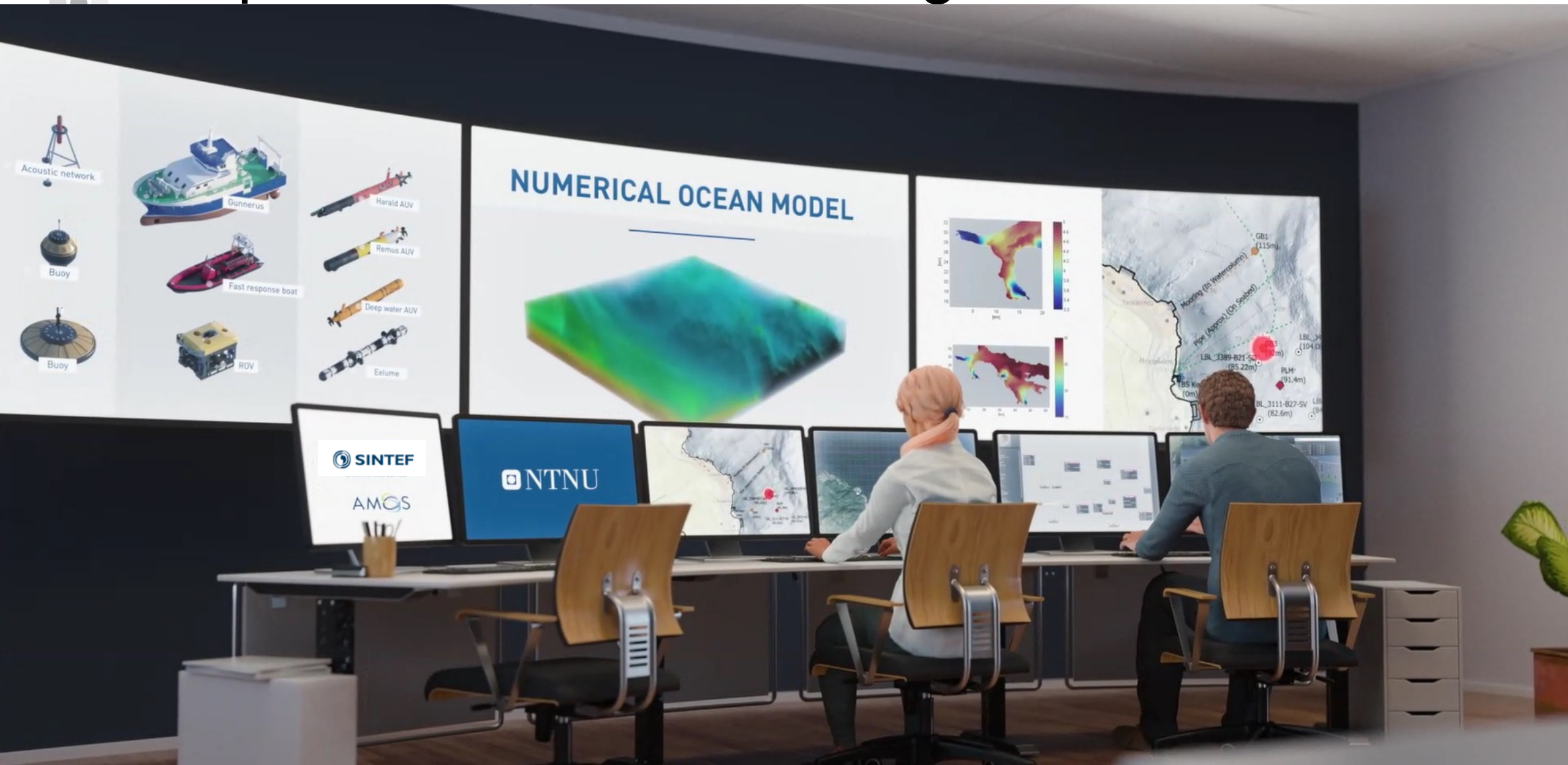


Planned infrastructure in parts of Fjordlab

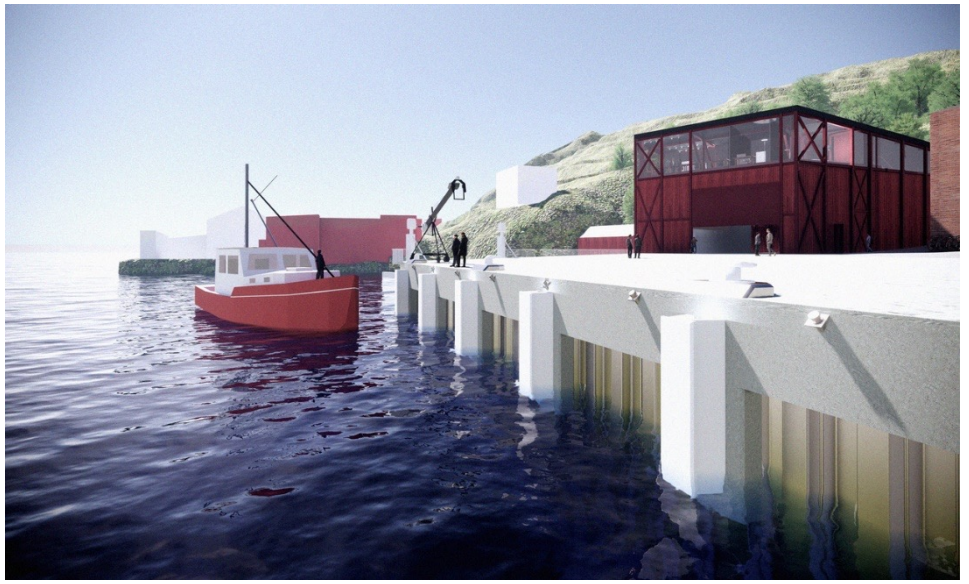
Illustrasjon: Snøhetta / Statsbygg

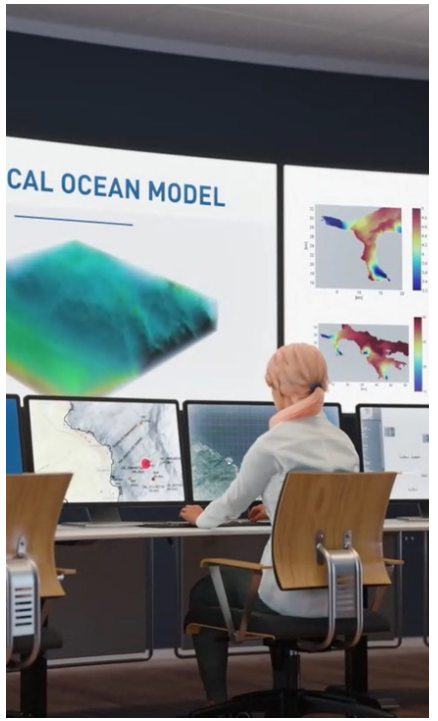
Illustrasjon: Snøhetta / Statsbygg

Operations, data and integration centre



Timeline



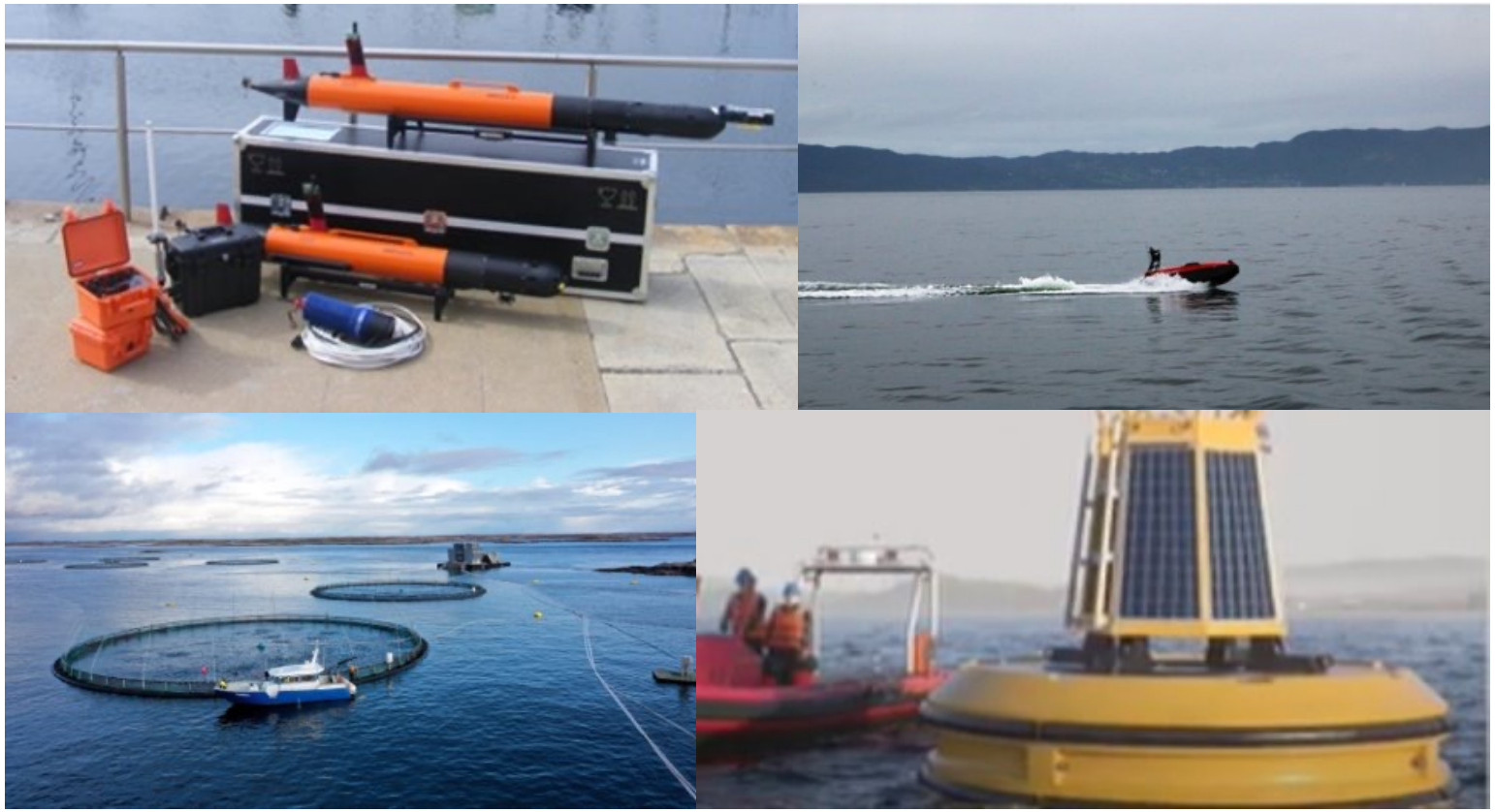


OceanLab **Fjordlab**

Phase 0 - 2021	Phase 1: 2020-2024	Phase 2: 2024-2027	Phase 3: 2027-
AurLab, SINTEF ACE, Ship Operation Research Lab	**OceanLab** **Møre Ocean Lab** Establish test facilities (4 nodes)	**Fjordlab** earliest start	Operation and further extension

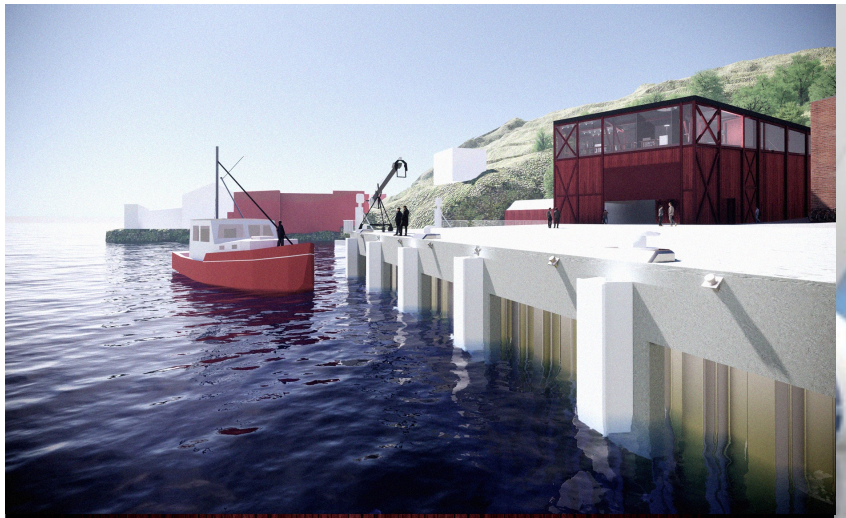
OceanLab – investments 2020-2023 (97 MNOK)

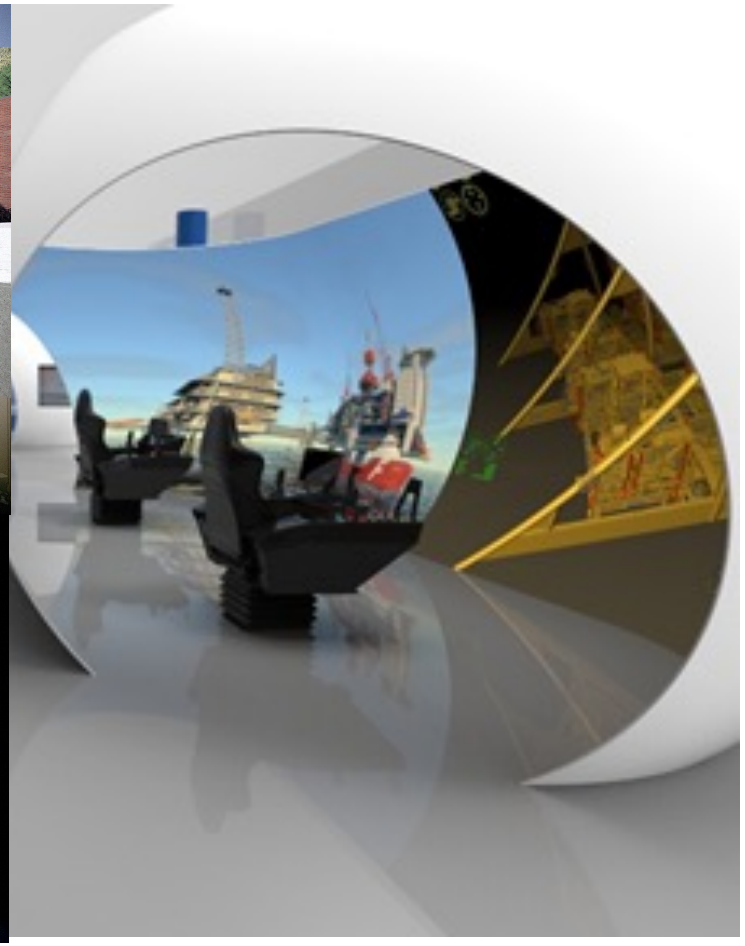
- Subsea robots and subsea facilities
- Test area for autonomous ships
- Aquaculture research and development
- NEW — Marine observatory
- NEW — Communication & e-infrastructure



Fjordlab – planned investments 2024-2026 (400 MNOK)

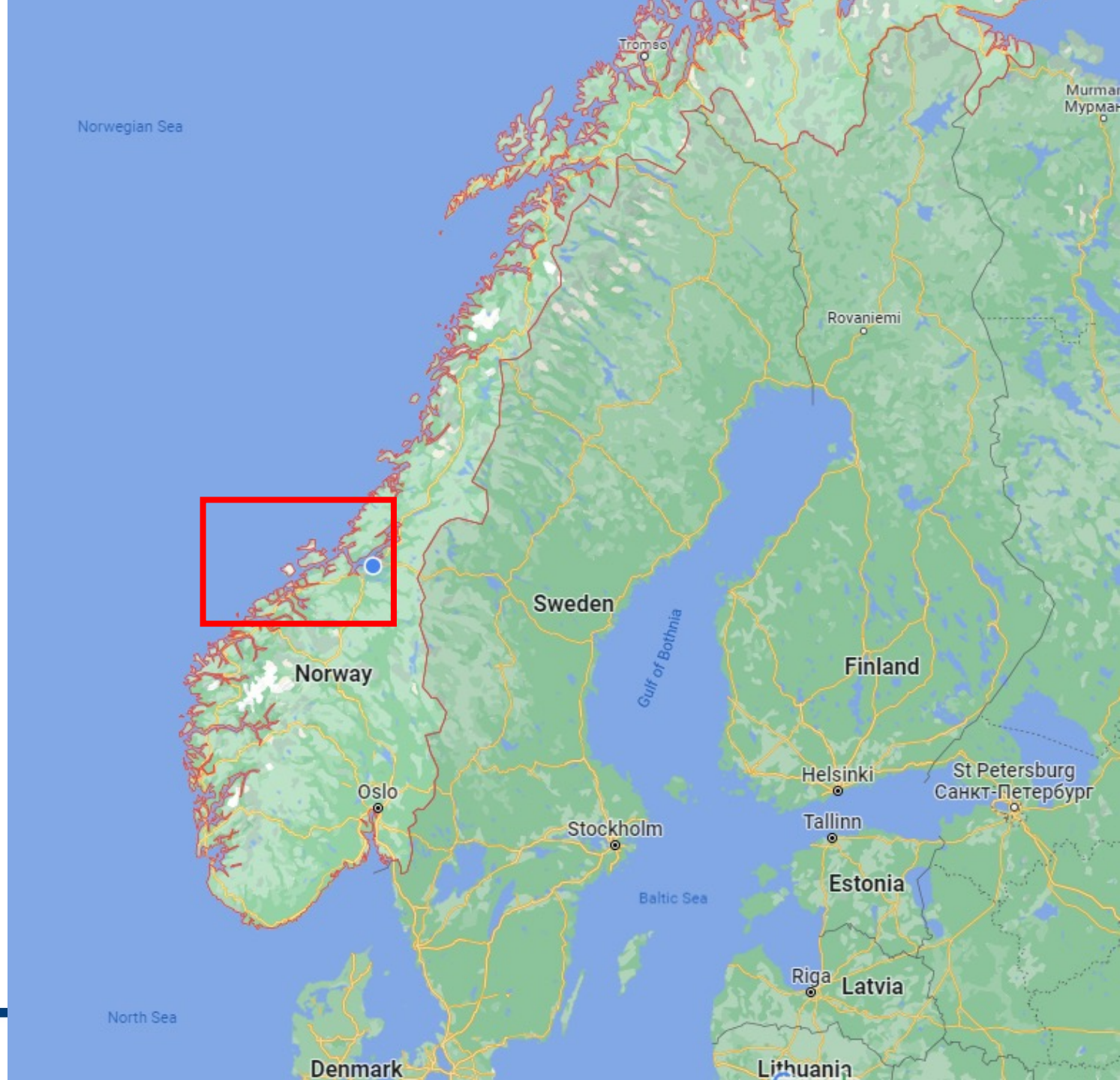
- Subsea robots and subsea facilities
- Test area for autonomous ships
- Aquaculture research and development
- Marine observatory
- NEW — Digital twin and visualisation
- NEW — Digital Fjord
- NEW — Full scale maritime testing
- Communication & E-infrastructure
- NEW — Land infrastructure (Trondheim & 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

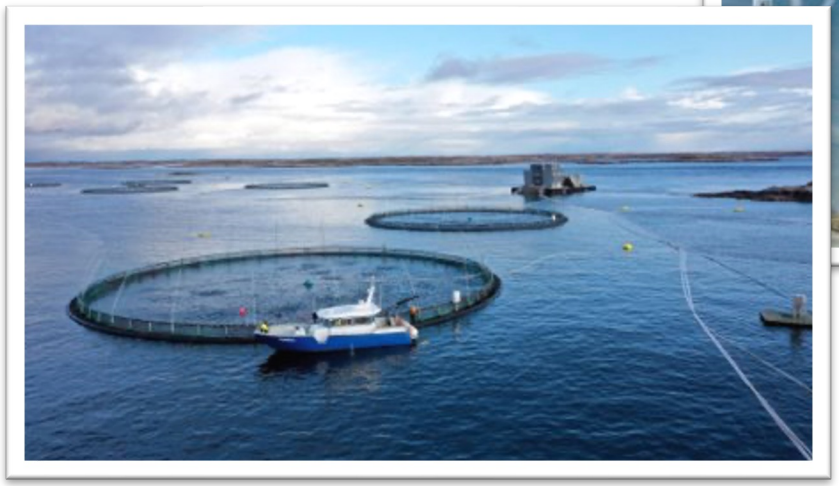


The OceanLab nodes

Node 1: Subsea robots and subsea facilities

Communication & e-infrastructure

Node 2: Test area for autonomous ships



Node 3: Aquaculture

Node 4: Marine observatory

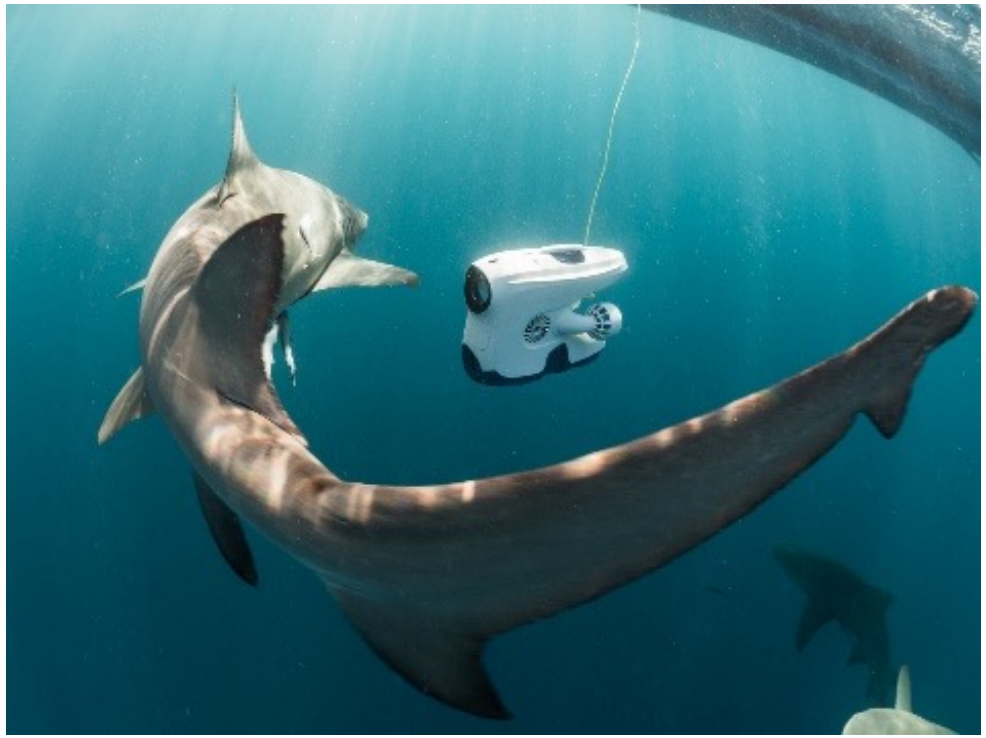
Node 1 – TBS/ Trondheim fjord

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)

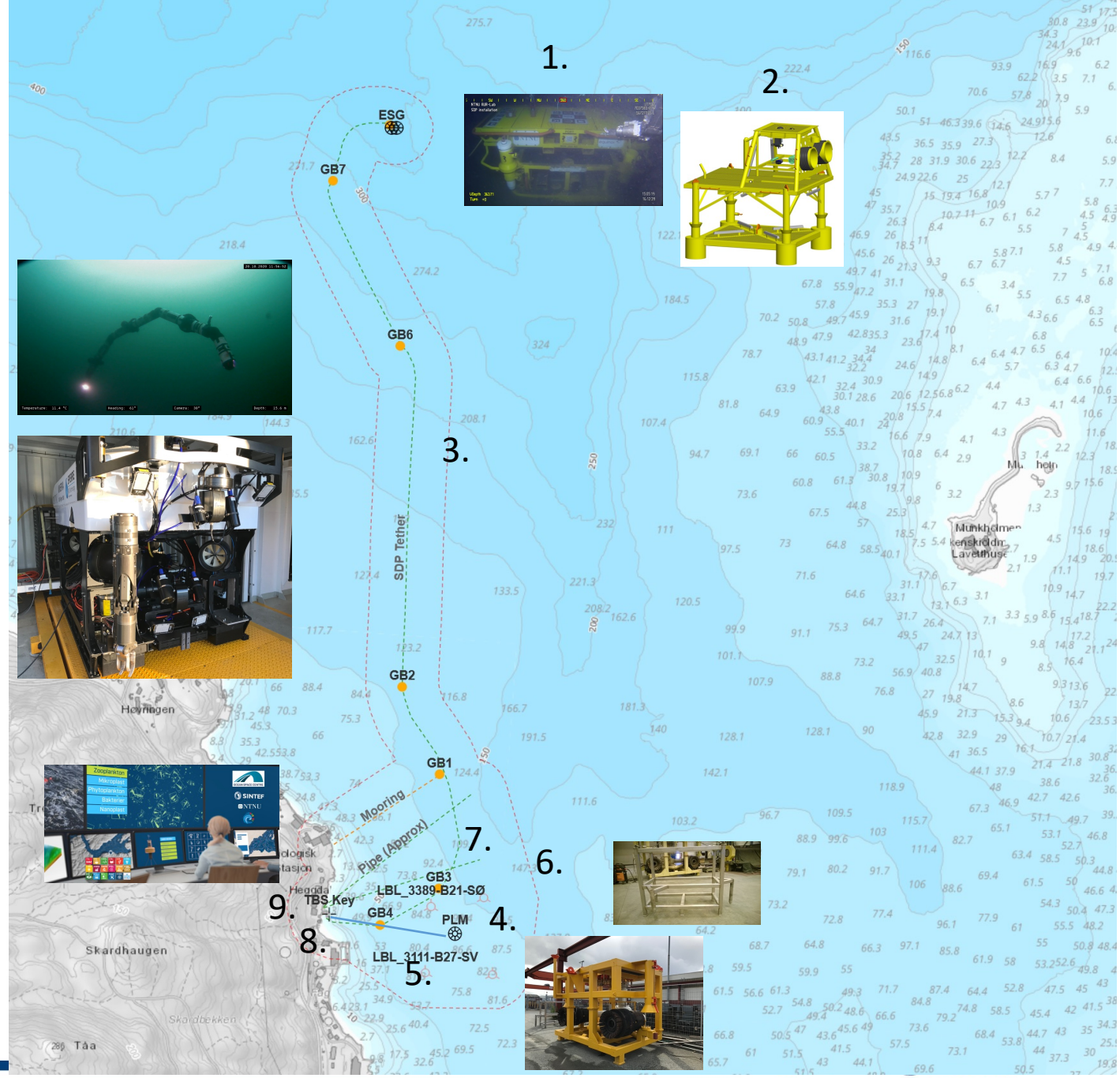
See more at
https://www.ntnu.edu/aur-lab

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



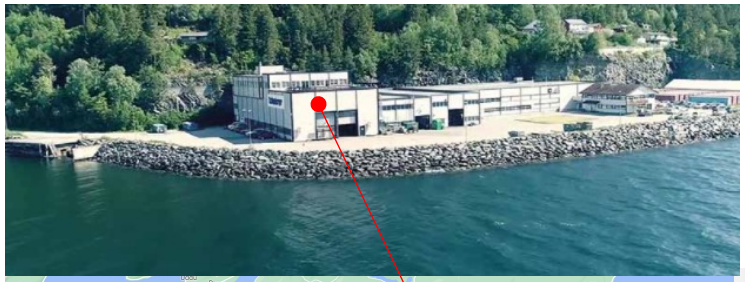
Node 1

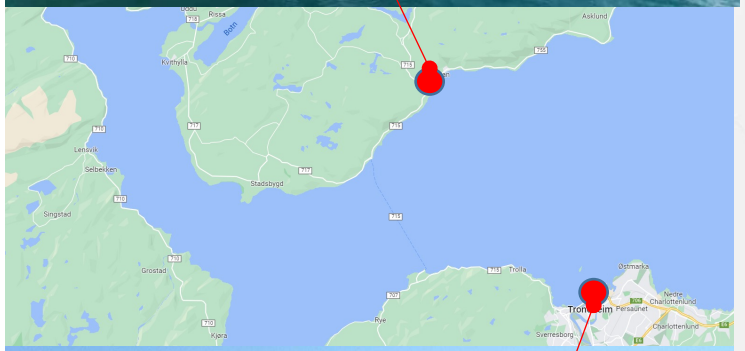
Subsea robots and subsea facilities

- 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.

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

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/

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

Node 3 – Hitra/Frøya - coastal areas

Finn Olav Bjørnson
Research Scientist, SINTEF Ocean
Node 3 manager

Equipment

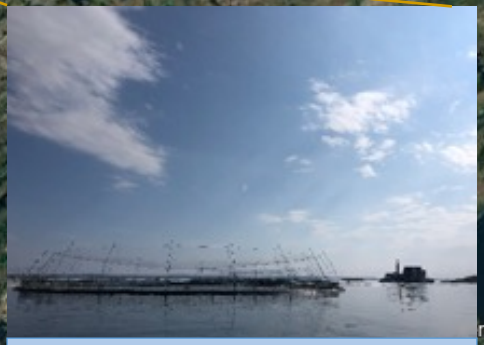
- Aquaculture sites with biomass.
- Instrumentation for digitalized and autonomous operations.
- Underwater cameras and split beam sonars.
- Automated crane, RPAS and ROVs.
- Load shackles and accelerometer.
- GPS/motion reference unit.
- Sensors for measurement of oxygen, temperature, salinity, turbidity,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

See more at
https://www.sintef.no/en/all-laboratories/ace/

Workboat Torra

Rataren

Buholmen



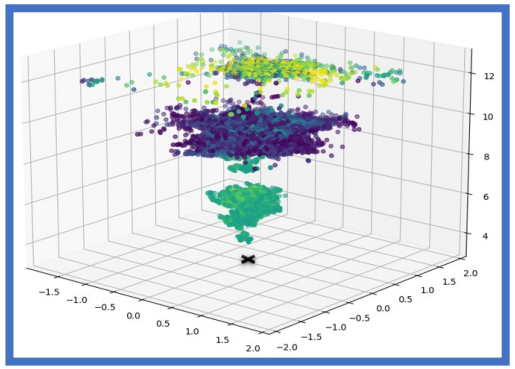
Tristeinen

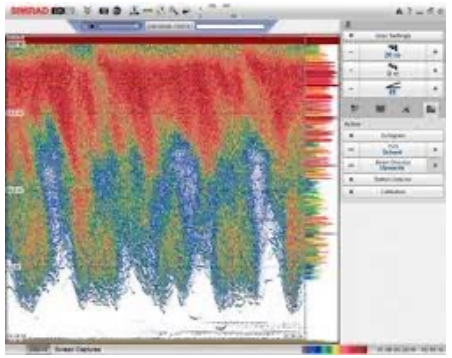
Korsneset

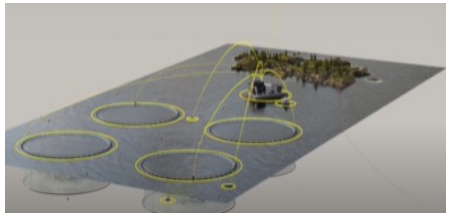
Node 3

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

Node 3







Aquaculture

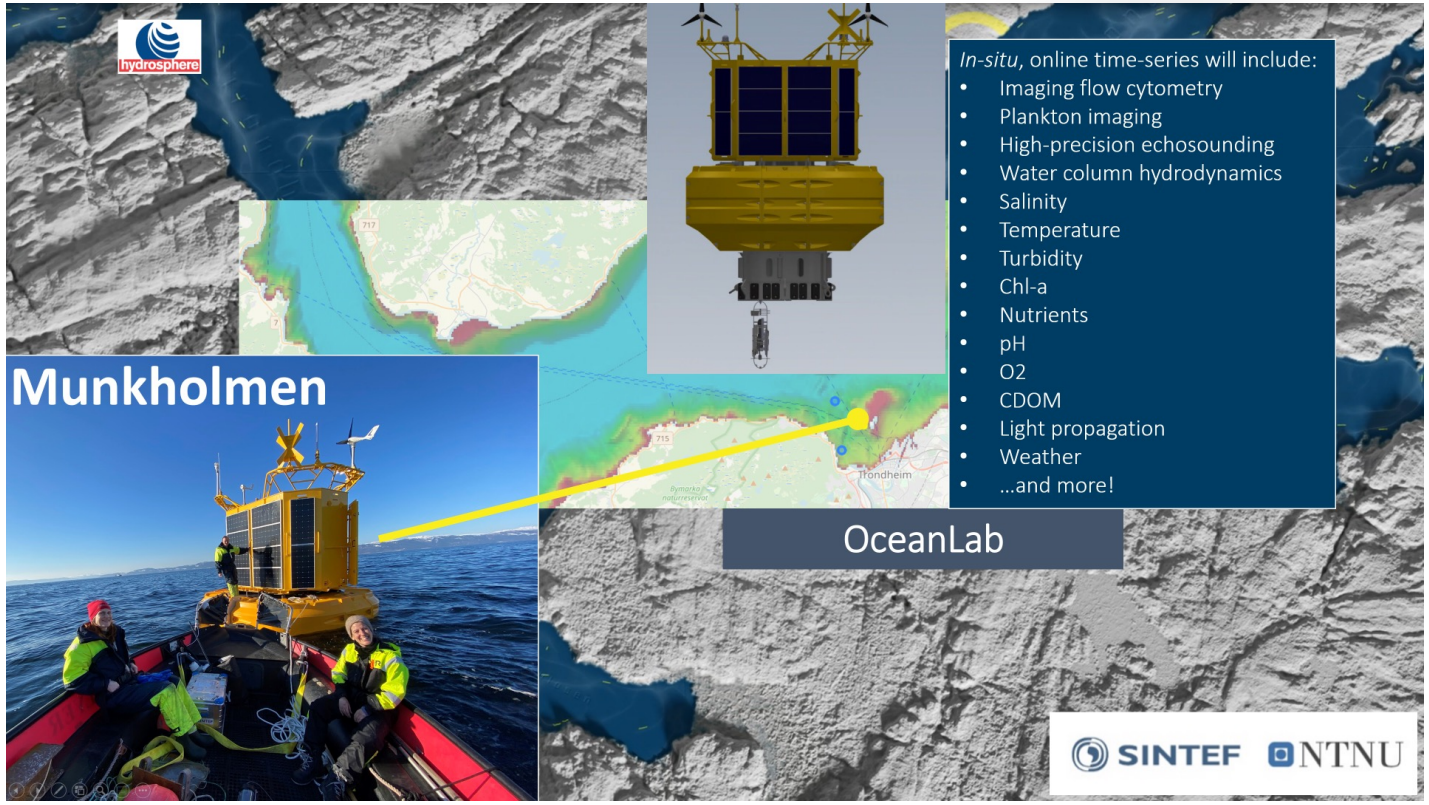
- Bio marine production
- Fish farming on four locations
- Fish well-fare
- Monitoring
- Remote operation
- Safety

Node 4

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

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



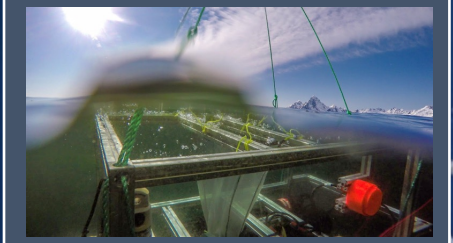
See more at
https://oceanlabobservatory.no/

OceanLabObservatory.no

Ecosystems

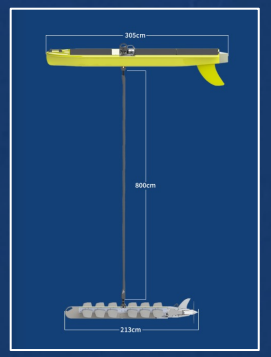
Pollution / Litter

Technology

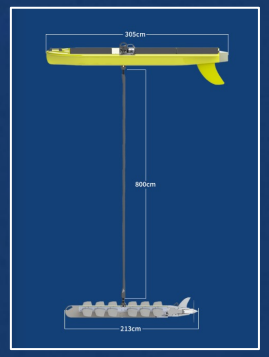


FjordLab
2023-2026

Glider 2



Glider 1

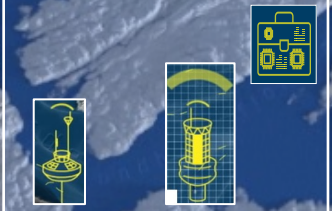


Instruments

Long-range AUVs

Buoy

OceanLab Phase 1
2020-2024



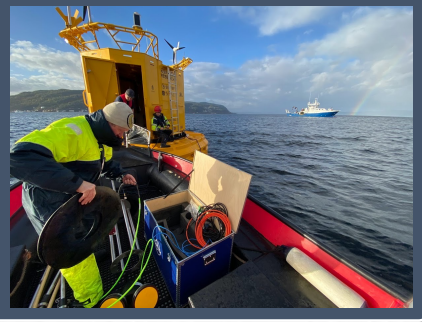
Trondheim

Buoy

USVs

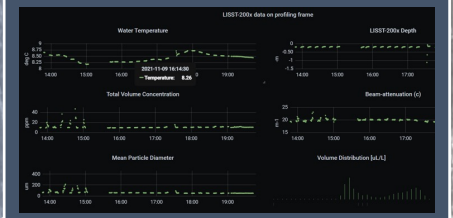
Ålesund

Trondheim's floating lab



Technology innovation platform

Data for fundamental research & model development

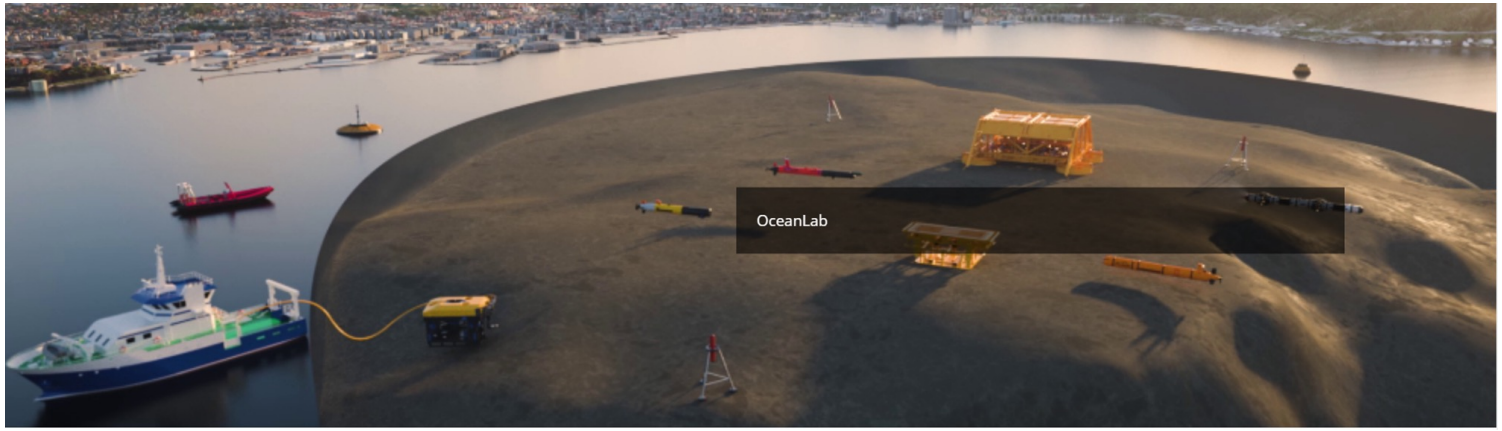


Communication & e-infrastructure

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

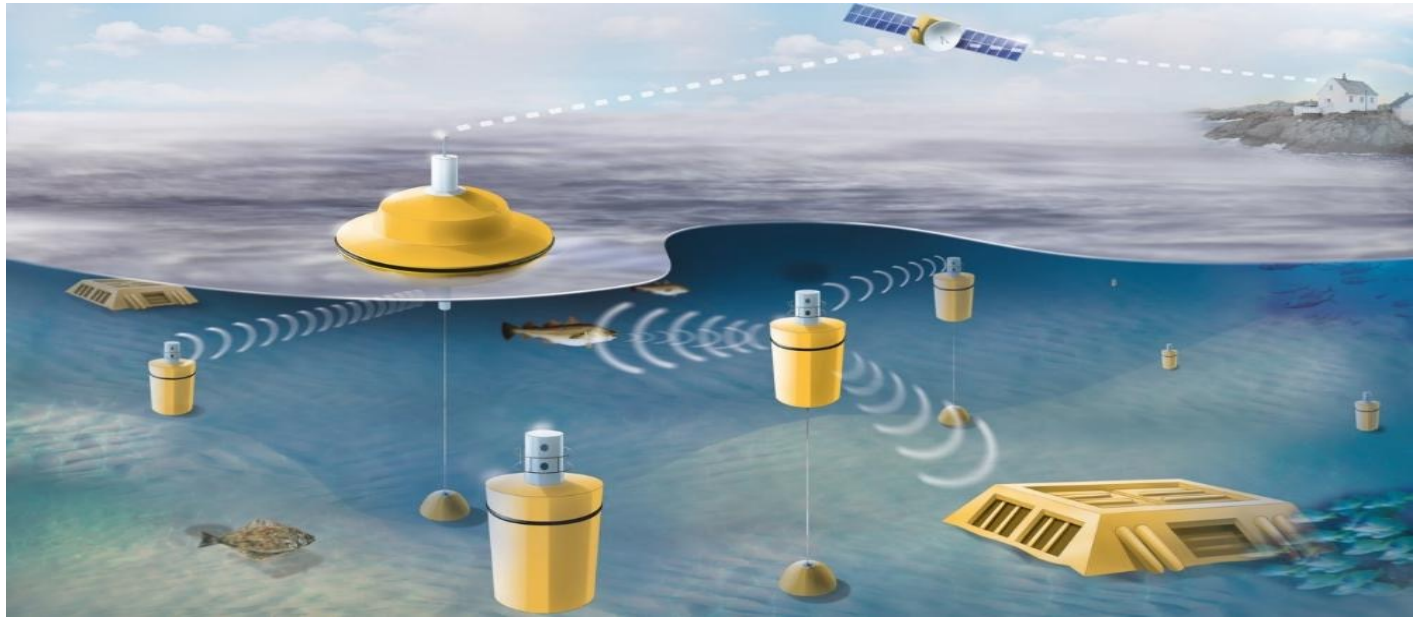
Equipment

- 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



OceanLab and Fjordlab

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