



Advancing Fisheries Acoustics: The Role of CRIMAC in Expanding Applications through Innovative Technologies

Oceanology International 2024

Ocean Observation & Measurement: Observing Systems

South Gallery Room 7 & 8, 10:00-11:40, 12.03.2024

Geir Pedersen, Marine Ecosystem Acoustics, Institute of Marine Research

CRIMAC – Centre for Research based Innovation in Marine Acoustic abundance estimation and backscatter Classification

The Institute of Marine Research

IMR is one of the largest research institutes of its kind in Europe.
Our main activities are **monitoring, research and advisory** work.



Employees: About 1050

Funding: 1.8 billion NOK – 40 % from the Ministry of Trade, Industry and Fisheries



Our vessels



Kronprins Haakon



Dr. Fridtjof Nansen



G.O. Sars



Johan Hjort



Prinsesse Ingrid Alexandra



G.M. Dannevig



Hans Brattström

Our vessels are at sea
approx. 1600 cruise days
per year.

Argo floats



Buoyancy gliders



LoVe Ocean Observatory ++



AUV (Hugin, Munin+)



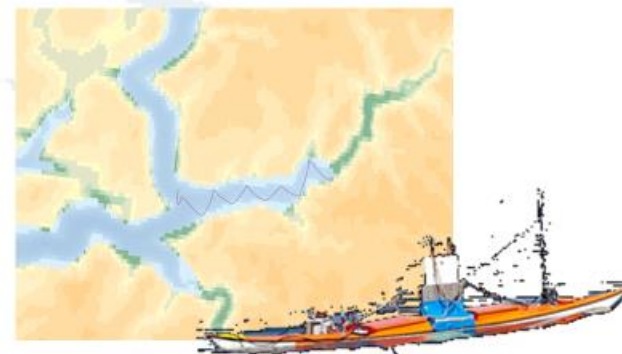
Sailbuoy (USV)



Saildrone (USV)



HI Echodrone (USV - electric)



KM Sounder (USV)





CRIMAC

Centre for research-based innovation in marine acoustic abundance estimation and backscatter classification(2021-2028)



[Hjem](#) [Nyheter](#) [Prosjektpartnere](#) [Om CRIMAC](#) [Publikasjoner](#) [Bildearkiv](#) [Kontakt oss](#) [Ressurser](#)

Om CRIMAC

CRIMAC er et senter for forskningsdrevet innovasjon der målet er å forbedre og automatisere tolkningen av bilder fra bredbåndsakustikken på forskningsfartøy og fiskebåter. Dette vil vi oppnå ved hjelp av tokt og feltforskning, kunstig intelligens, droner og annen teknologi.

[Les mer](#)

Nyheter



Publisert 09.01.2024
Studying the Twilight Zone of a Norwegian Fjord

Norway's fjords are ideal for studying the ocean. They're calm, deep, have consistent populations of interesting marine creatures, and there's still a lot to learn about them. Every



Publisert 08.01.2024
Testet selvgående fartøy i nordlige strøk

Da silden inntok fjordene i nord – ga det perfekte forhold for å teste HI sin nye Sounder.

[Les mer](#)

Finansiert av

Forskningsrådet, industripartnere og Havforskningsinstituttet

Ledet av

Havforskningsinstituttet

Periode

01. oktober 2020 - 30. september 2028

Industripartnere

Kongsberg Maritime, Scantrol, Scantrol Deep Vision, CodeLab Bergen, Norway Royal Salmon, Liegruppen fiskeri og Eros.

Forskningspartnere

NORCE, Norsk Regnesentral og UIB



Stand: N200



KONGSBERG

Stand: D600



Eros AS



<https://crimac.no>



The primary objective of CRIMAC is to **advance the frontiers in fisheries acoustic methodology and associated optical methods**, and to apply such methods to

1) surveys for marine organisms, 2) fisheries, 3) aquaculture and 4) the energy sector

Marine science



Fisheries



Aquaculture



Offshore energy





- Improve automatic interpretation of (broadband) fisheries acoustics, including sizing of targets (fish, zooplankton and bubbles) and target identification
- Develop better verification methods using optical systems
- Develop data processing pipelines for automated processing and analysis applicable for cloud and edge
- Implement uncrewed surveys and monitoring

Marine science



Fisheries



Aquaculture



Offshore energy



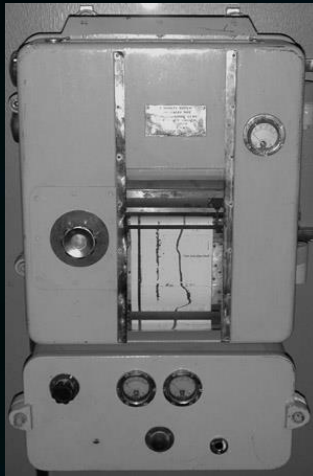


Nature, June 8, 1935

First published acoustic recording of single fish

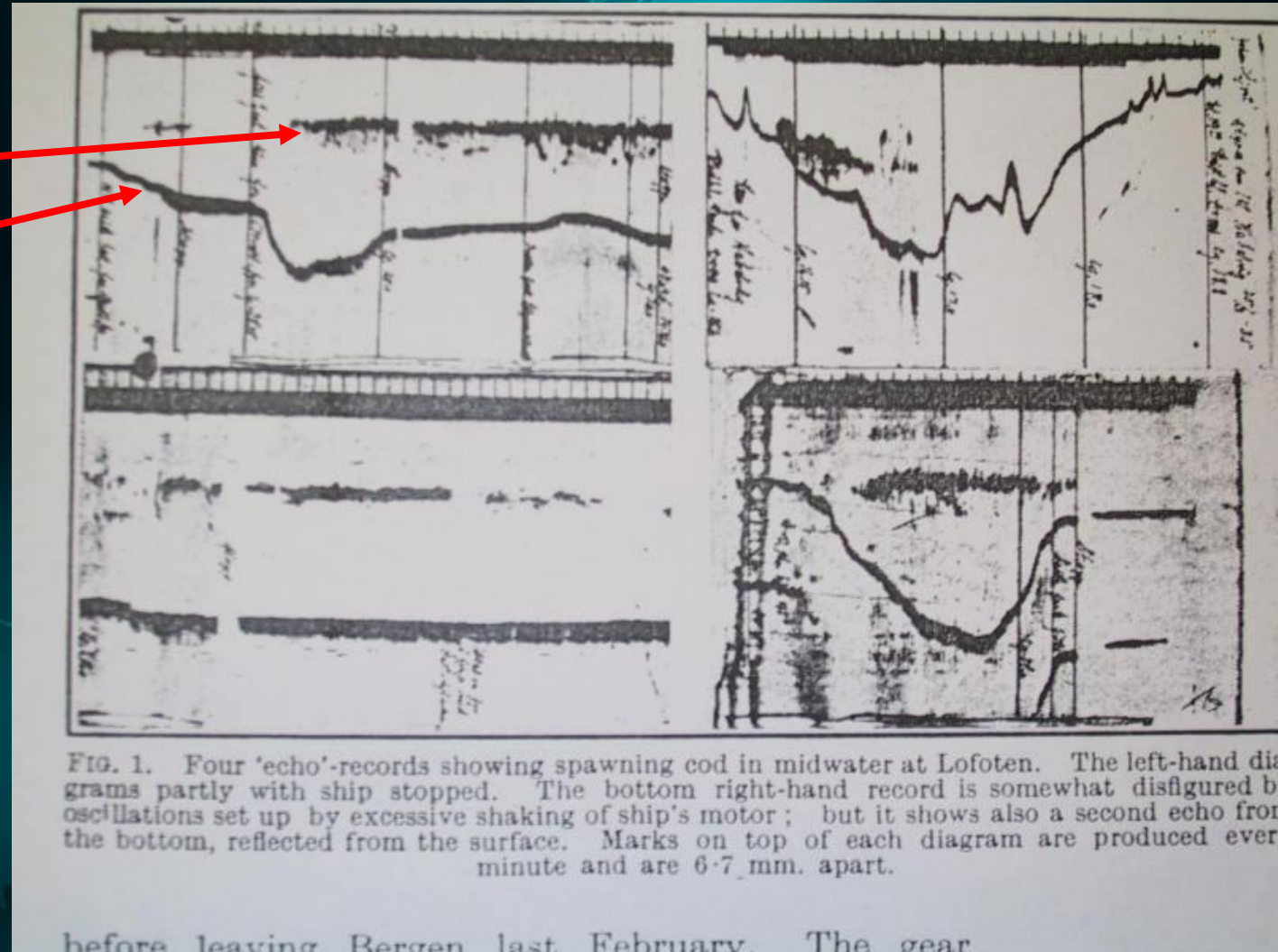


Oscar Sund



RV "Johan Hjort"

Cod
Seafloor



Høla, Norway, 1934. Oscar Sund (RV "Johan Hjort")

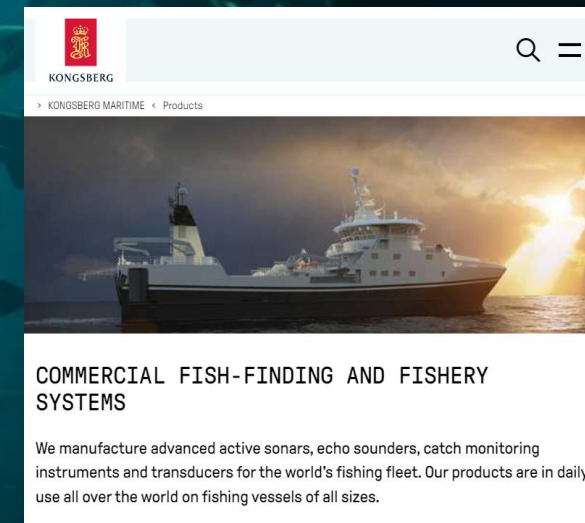
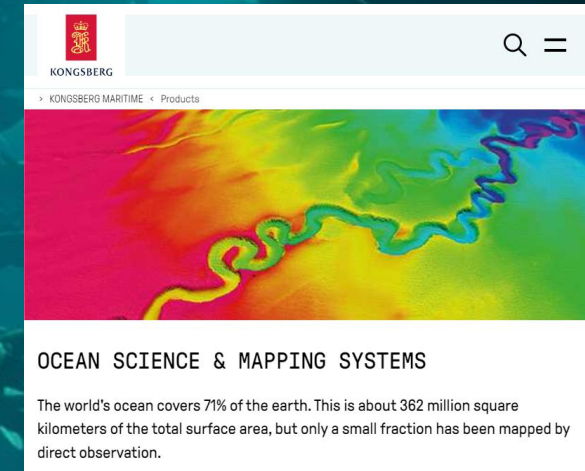
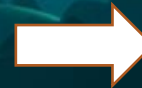
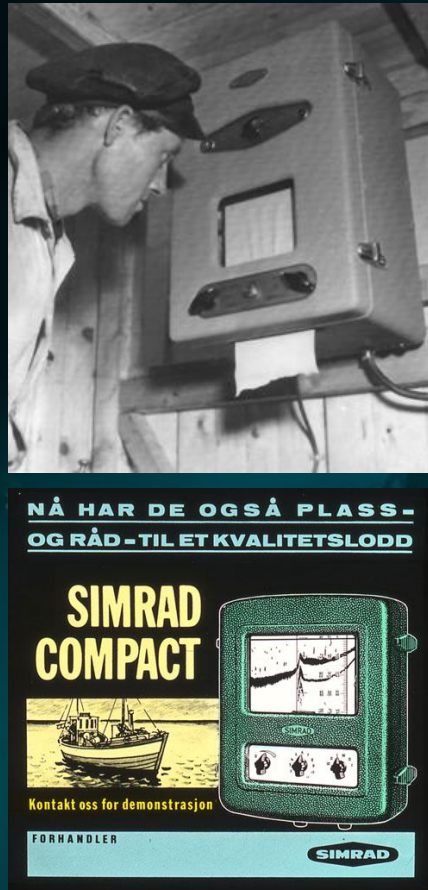
Spawning cod recordings.



Science – industry collaboration (1950s-present)



Ill.: Unknown/NTB Scanpix

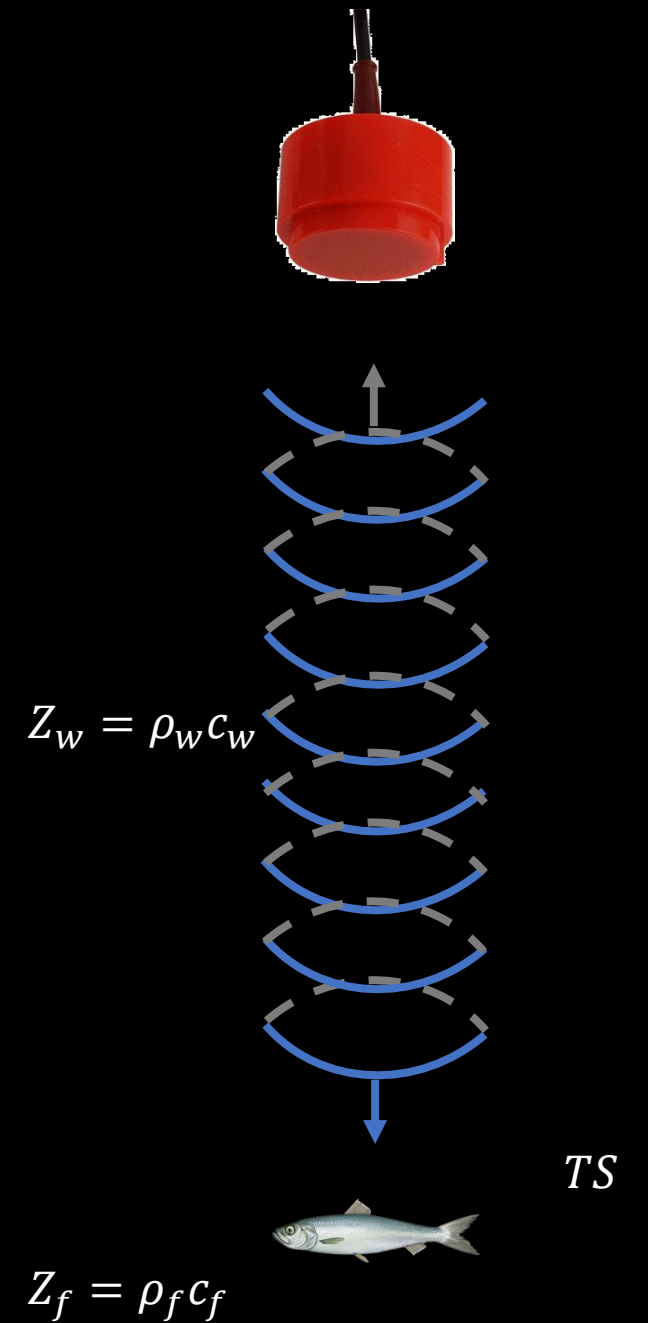
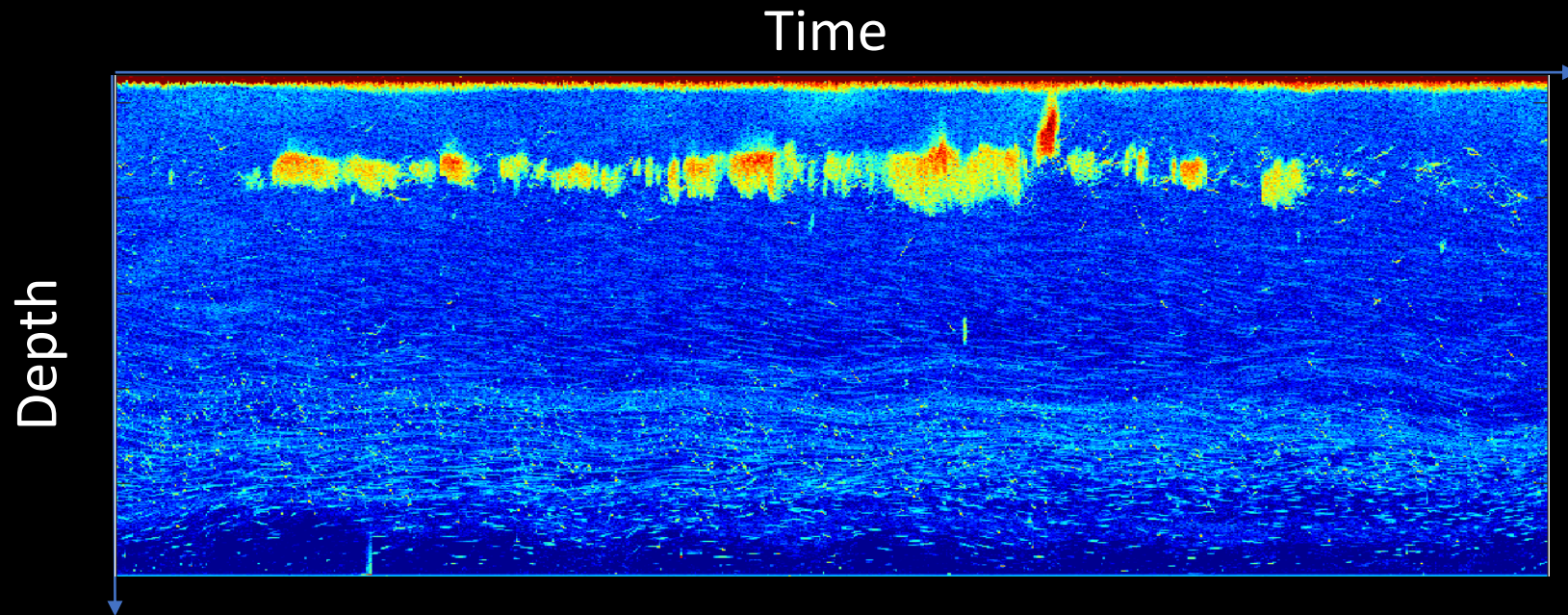


Ill.: <http://www.kongsberg.com/discovery/>



Fisheries acoustics

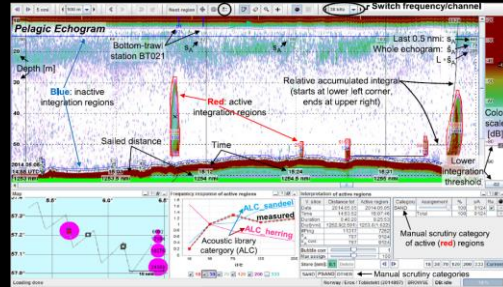
Fisheries Acoustics i



Fisheries acoustics ii



Sensors



Scrutiny and integration



Survey estimation



Assessments and harvest control rules



Catch statistics
Fiskeridirektoratet



Estimating Catch at Age
IMR & International partners



Fisheries acoustics iii (broadband)

Advantages:

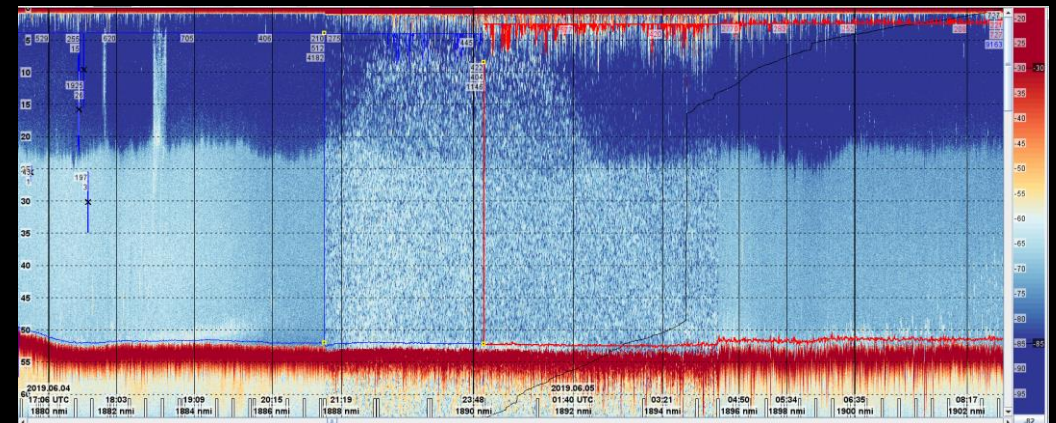
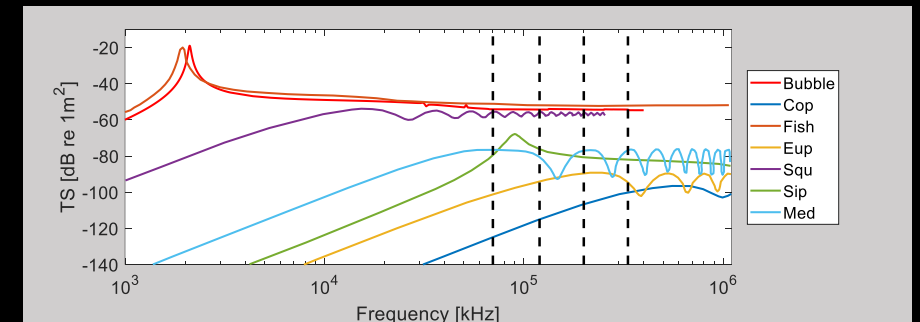
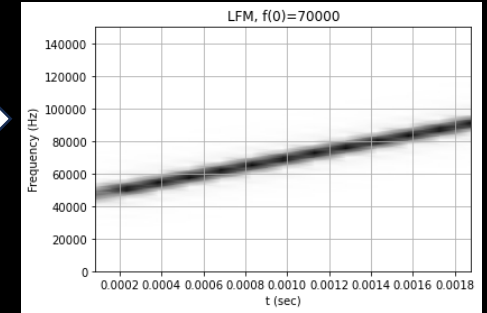
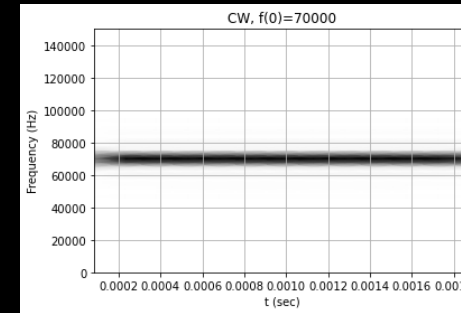
- Continuous frequency response
 - Potentially better target classification
 - Higher Signal-to-Noise Ratio (SNR) (2BWT)
 - Greater detection range
 - Higher quality data
 - Better temporal resolution (Δr) ($\frac{1}{BW}$)
 - Better target characterization (individual and in aggregation)
-
- **Challenges:**
 - Large datasets
 - Potentially more noise/interference
 - Data processing is still in a relatively early fase / potential not fully utilized



Simrad (Kongsberg) EK60



Kongsberg Discovery EK80



Broadband

Narrowband

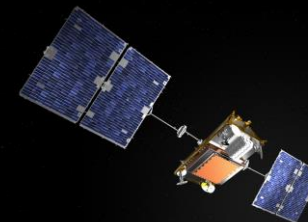
Broadband



Platforms



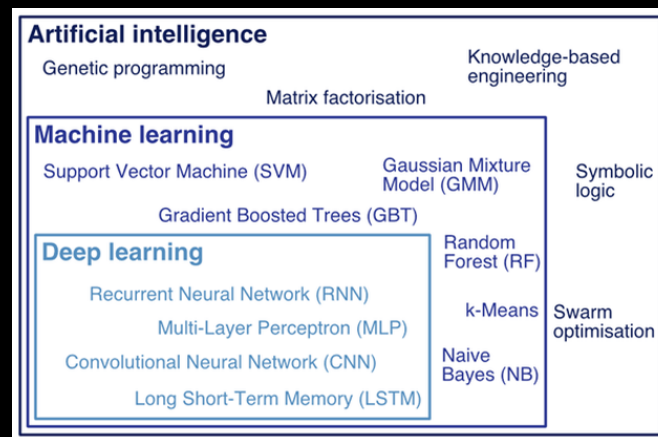
(Acoustic) sensors



Communication technology



Increased need for marine monitoring



Data processing methods



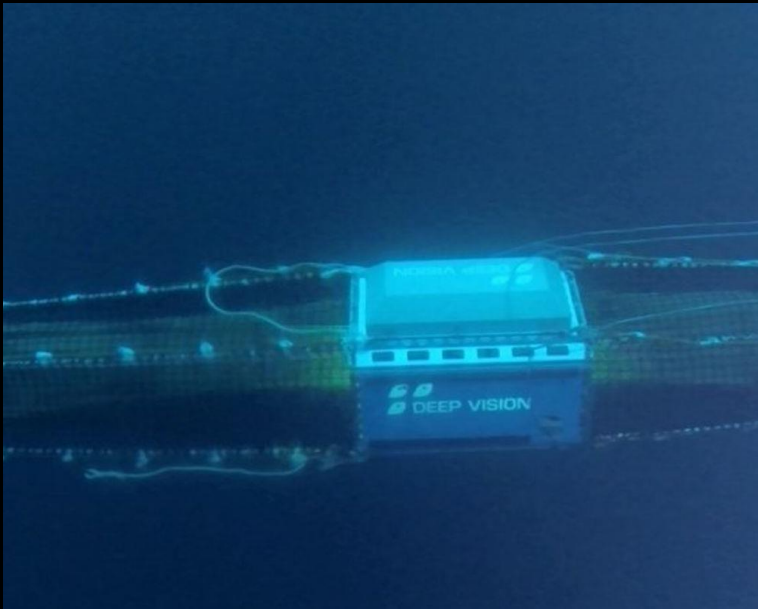


- i) Verification of acoustic recordings
- ii) CRIMAC data processing pipeline
- iii) USVs for marine monitoring and fisheries assesment

In-trawl camera system

Scientific surveys

- *Provide better temporal and spatial resolution*
- *Maintain small and sensitive organisms*
- *Remove the need to bring catches on deck*



Commercial fisheries

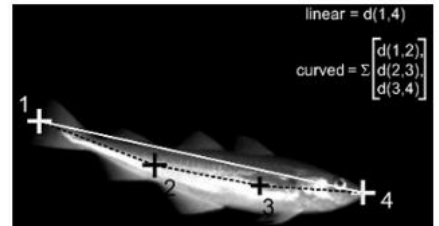
*Better catch control =
less by-catches and discards and better catch efficiency*

Automatic species identification and count



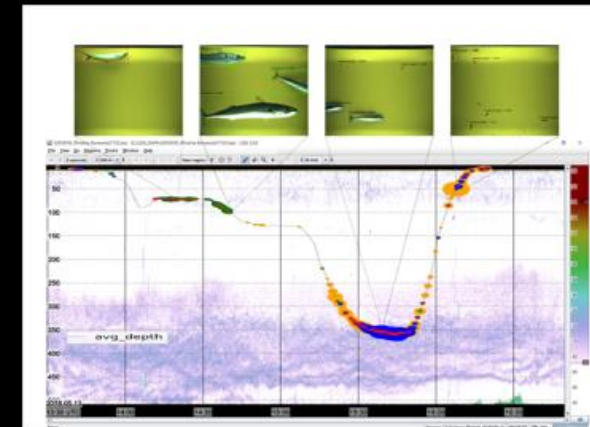
Allken et al., 2021

Automatic length estimation



Williams et al., 2016

Integration with acoustic analysis systems (LSSS, Echoview,...)



Capabilities

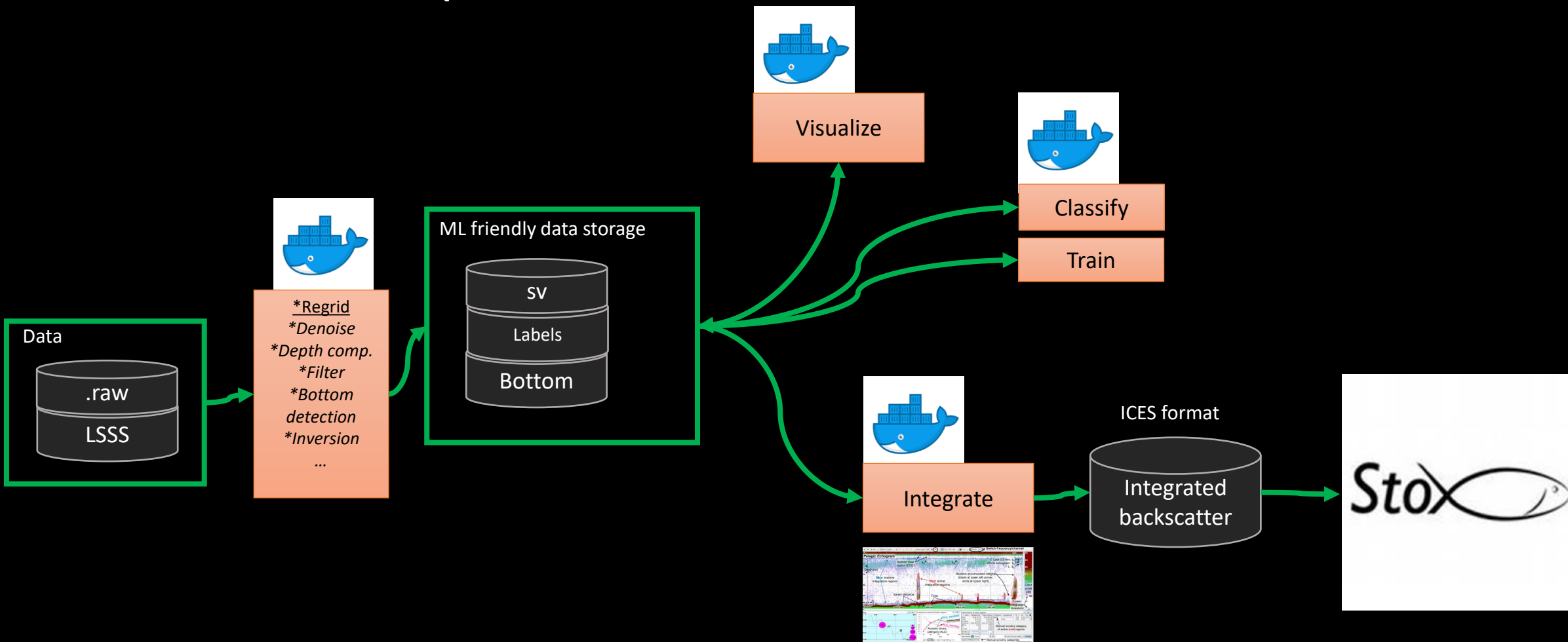
	Deep Vision 2018	Deep Vision CamSounder
Camera	Stereo Cam 1.4 MP resolution 5 Hz sampling rate	Stereo Cam 5.1 MP resolution 10 Hz sampling rate
Light	2 x 30 000 lumen	15 500 lumen
Connection	Ethernet	Ethernet WiFi Bluetooth
Battery	20 Ah 24 V NiMH 8 hours operation	99 Wh Li-ion 8 hours + operation
Depth	2000 m	1000 m
Weight in air	395 kg	15 kg
Weight in water	Neutral	2 – 5 kg
Dimensions	1.4 x 1.2 x 0.9 m	0.5x0.3x0.15 m
Echo sounder	No	200 kHz Transducer Kongsberg composite 12.5 m range 12 mm resolution





- i) Verification of acoustic recordings
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CRIMAC Pipeline

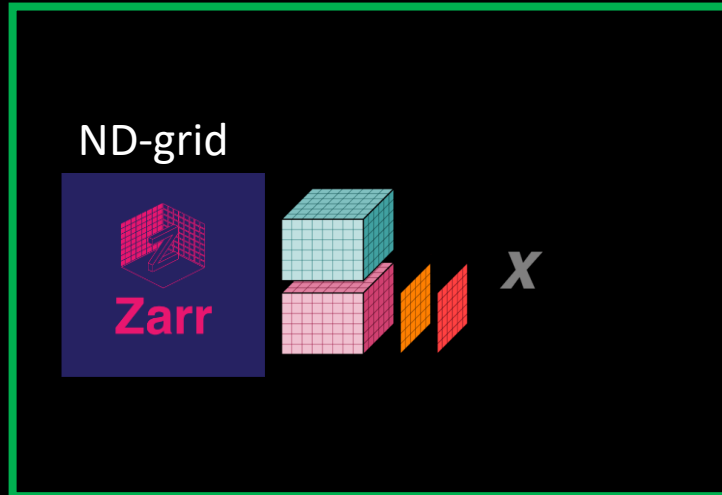


(Python) tech stack

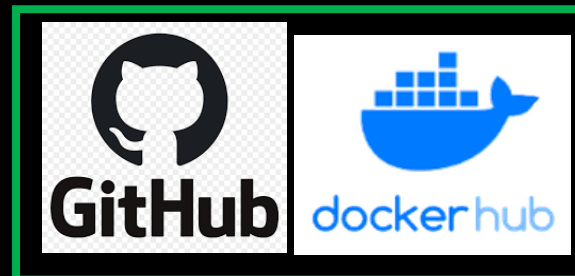
(Pre)processing



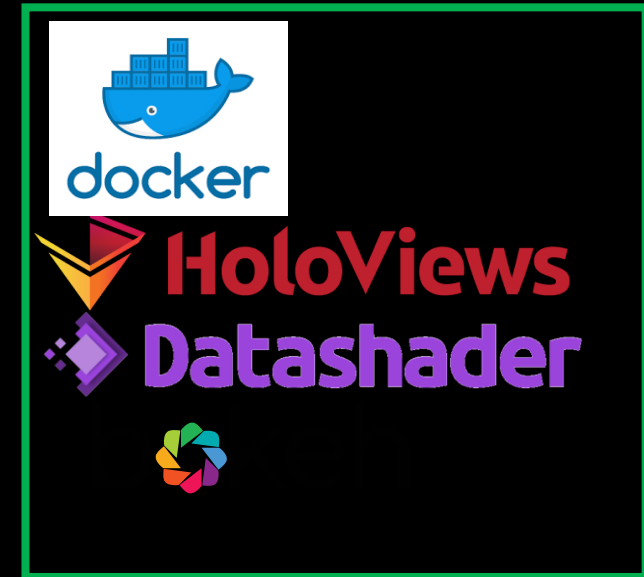
ML friendly data storage



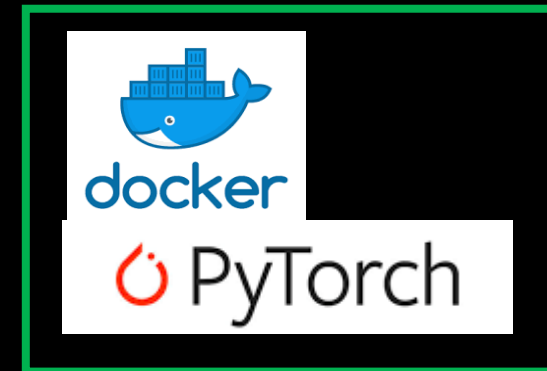
Code Sharing



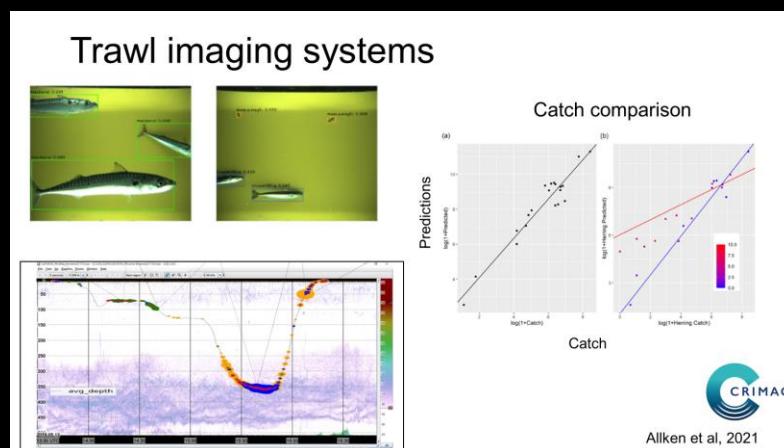
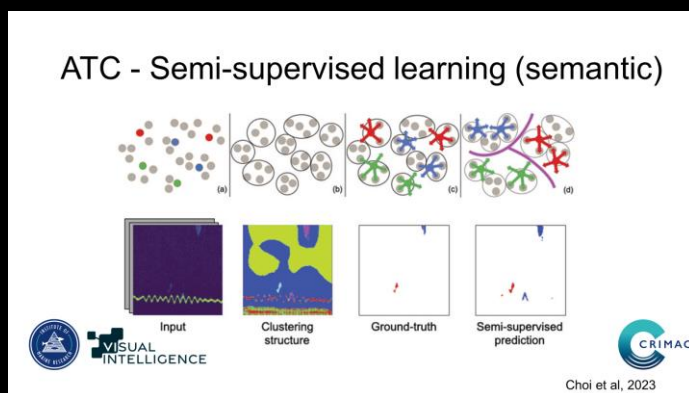
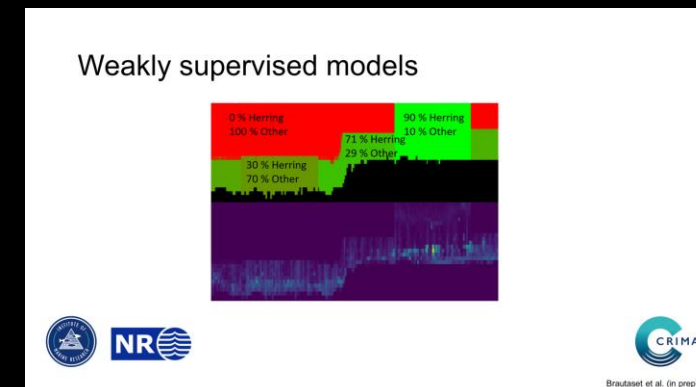
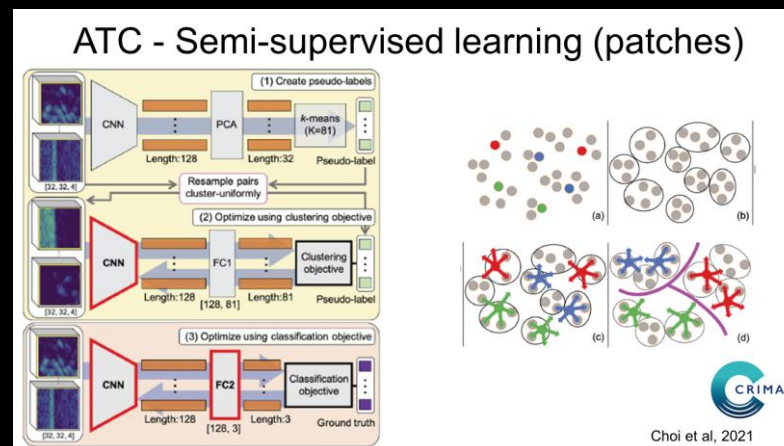
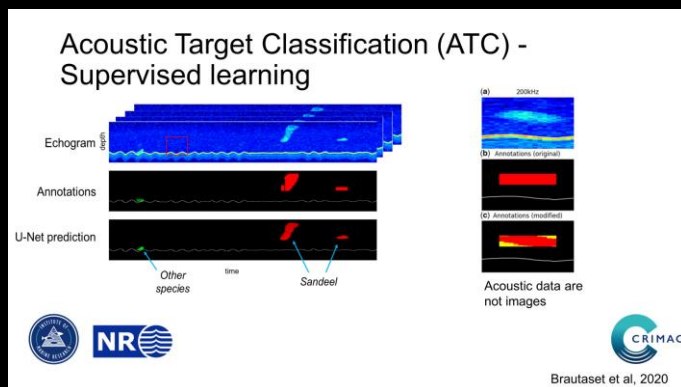
Vizualization



Deep learning



ML for fisheries/zooplankton acoustics



Fish, mesopelagics, large zooplankton



Edge deployment



Model
Training

Blue Insight

Model repo

ICES format

Remote
(EK, EM, ...)

Remote
Docker repo

Remote
Docker configurator

Start, Stop,
pingrate

Sensor

Pre-
Processing
(copying)

Pre-
Processing
(format
conversion)

Pre-
Processing
(noise
removal)

Classification
(Bottom)

Classification
(unet)

Report
Generation

Configuration

Survey Data

RAW

Metadata

Sv (zarr)

RAW

Metadata

Sv (zarr)

RAW

Metadata

Mask (zarr)

Sv (zarr)

RAW

Metadata

Mask (zarr)

Mask (zarr)

Sv (zarr)

RAW

Metadata

Settings





- i) Verification of acoustic recordings
- ii) CRIMAC data processing pipeline
- iii) USVs for marine monitoring and fisheries assesment

Fotograf: Else Torsten / Havforskningsinstituttet



Sprat

Fotograf: Leif Nøttestad / Havforskningsinstituttet



Lesser sandeel

Thomas de Lange Wenneck / Havforskningsinstituttet



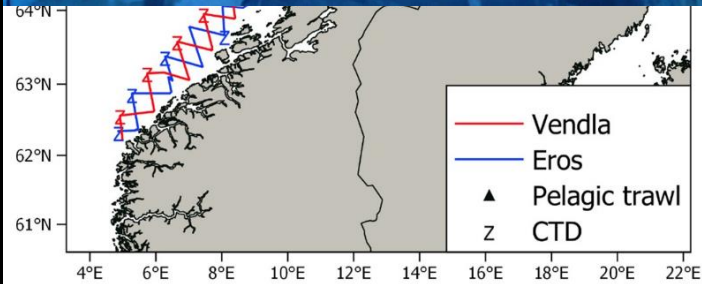
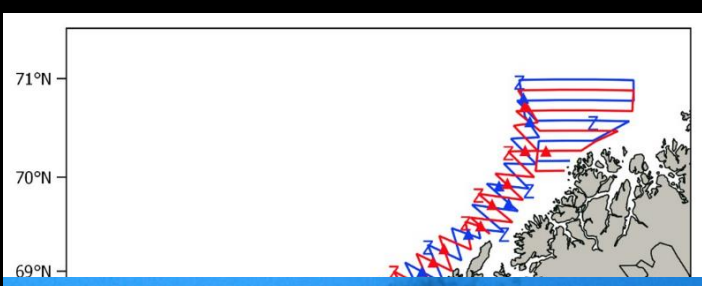
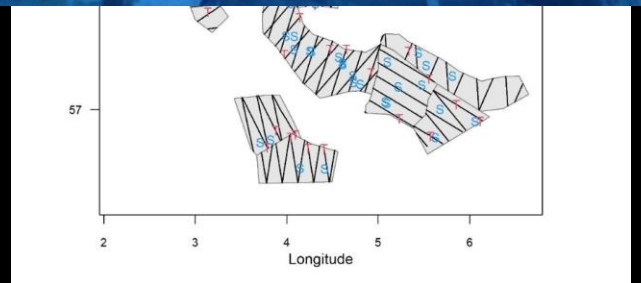
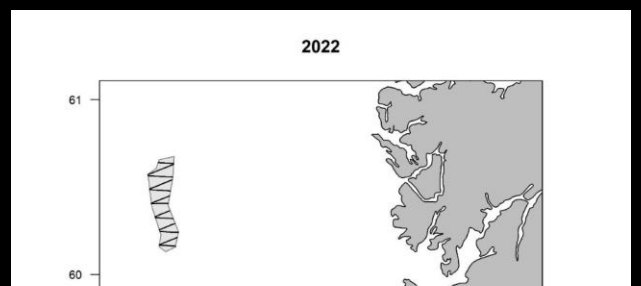
Norwegian Spring Spawning Herring



Trawl st.no 732-764

▲ Pelagic tr.

■ Bottom tr.



Kongsberg Discovery Sounder USV

Stand: D600

Echosounders

- KD EK80 WBT
- Transducers
 - ES18-11 18 kHz
 - ES38-7 38 kHz
 - ES70-7C 70 kHz
 - ES120-7C 120 kHz
 - ES200-7C 200 kHz
 - ES333-7C 333 kHz

Acoustic Doppler Current Profiler

- KD EC150-3C

Multibeam Sonar

- KD EM2040-04

Sub-bottom Profiler

- KD Topas PS120

Thermosalinograph

- Seabird SBE 45

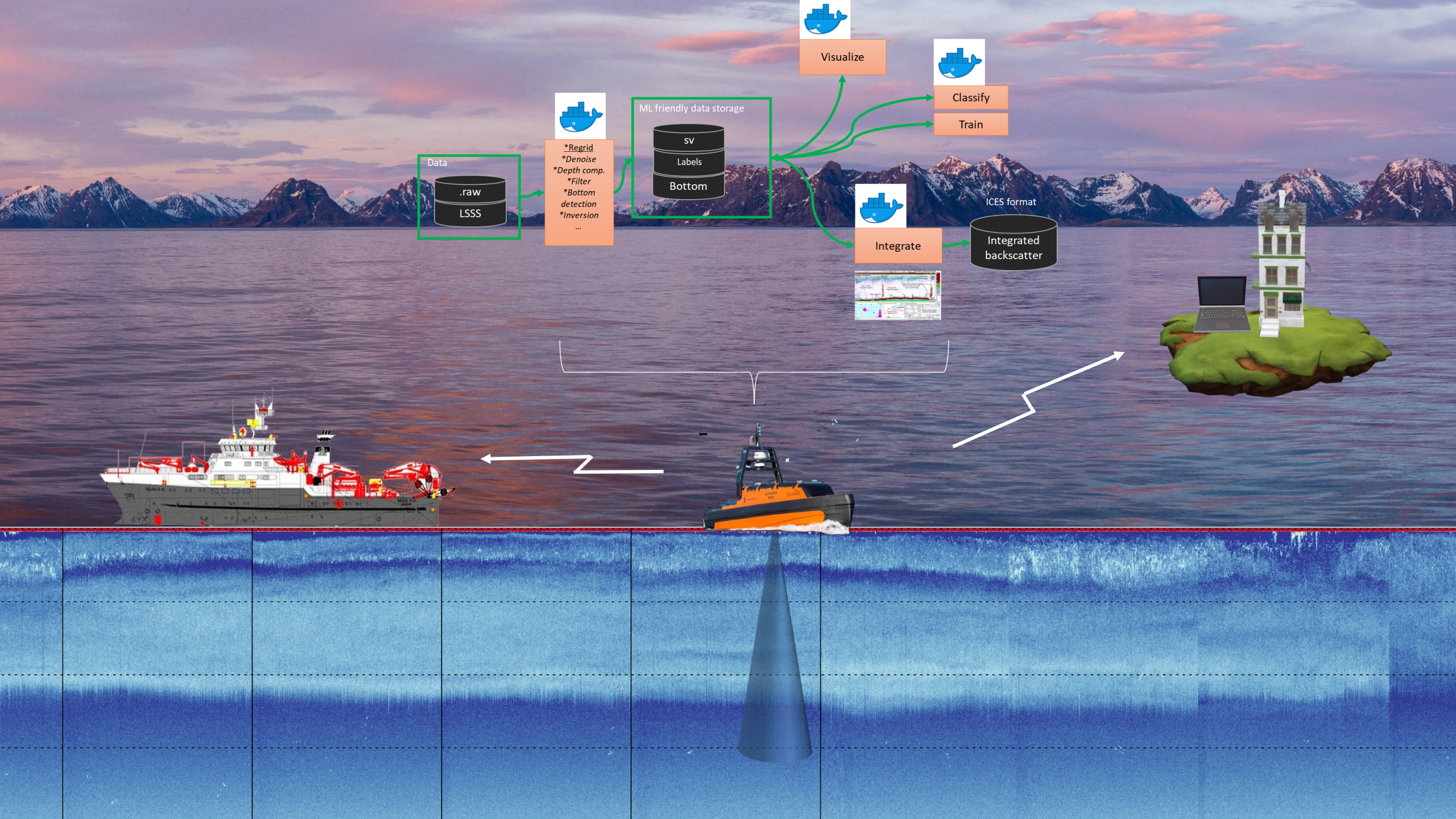
Fluorometer

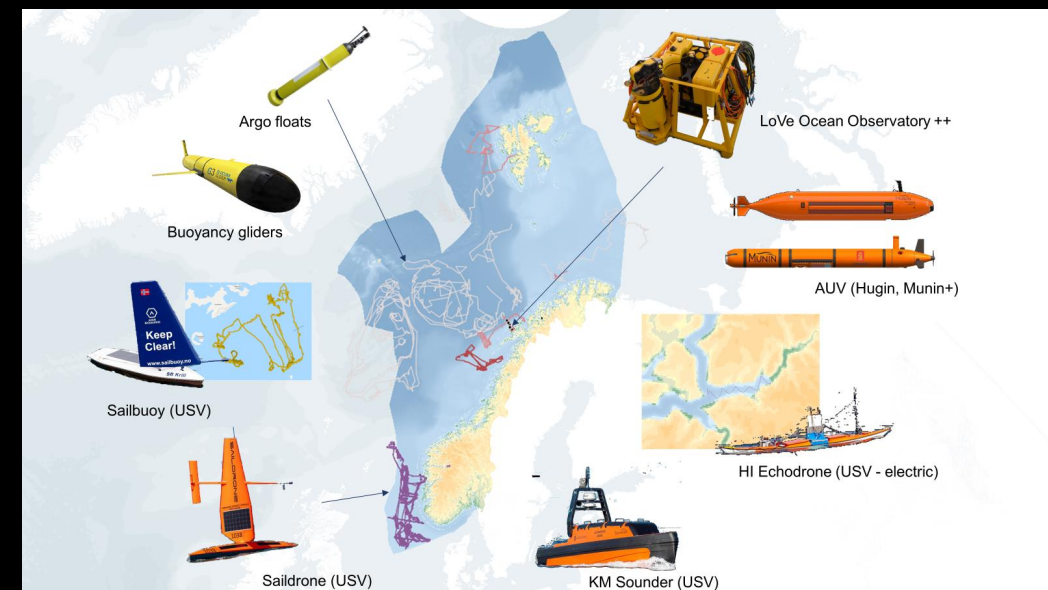
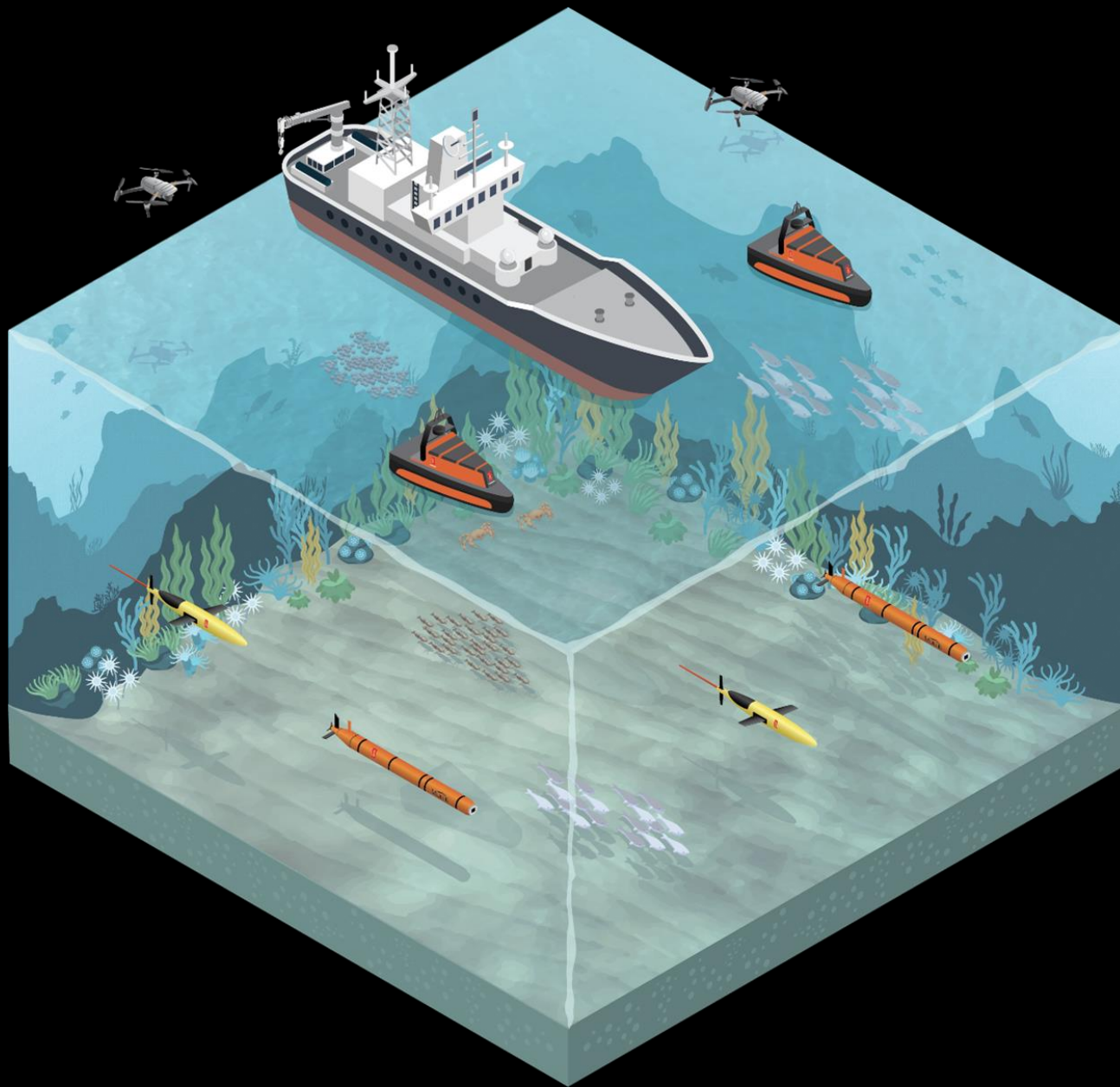
- Seabird WETstar

CTD

- AML 6 CTD









Thank you for your attention!
Questions/comments?

Web page: <https://crimac.no/>

Code library: <https://github.com/CRIMAC-WP4-Machine-learning/>

Scientific library: <https://www.zotero.org/groups/4237816/crimac/library>