

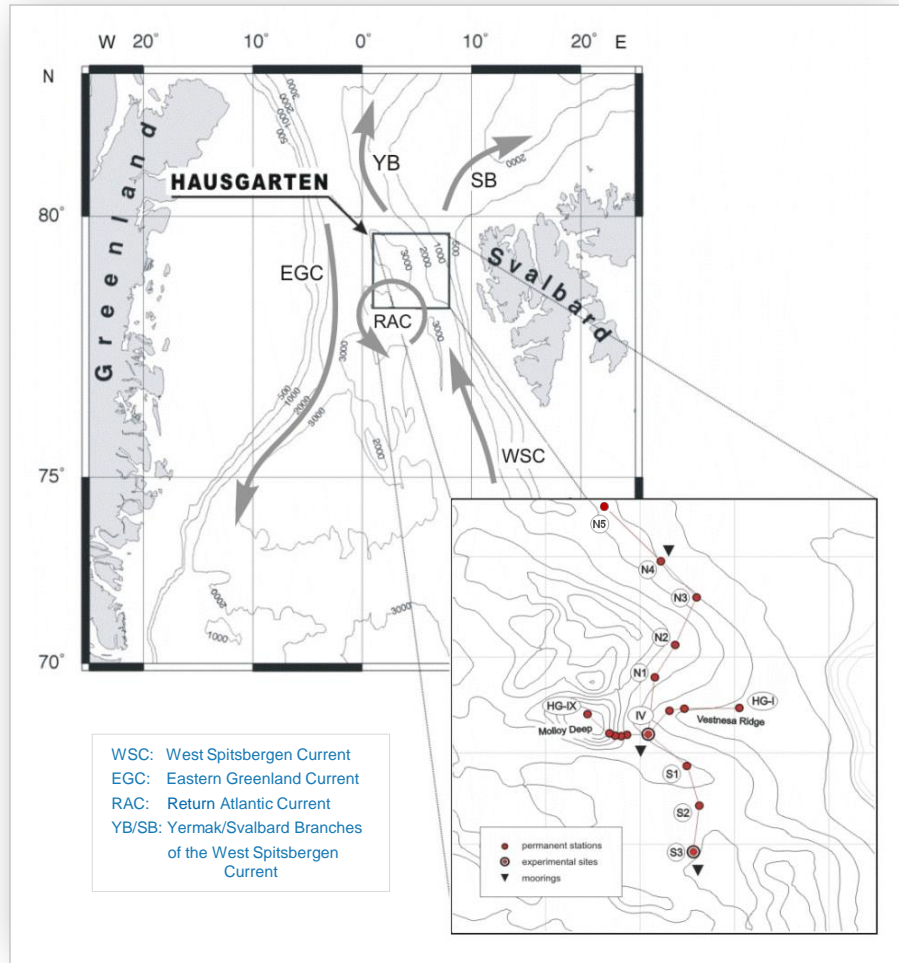
AUV- Team: Engineering at Alfred-Wegener-Institute

Michael Busack, Jonas Hagemann, Sascha Lehmenhecker, Autun Purser



Deep-Sea Group

■ AWI Long-Term Ecological Research site HAUSGARTEN

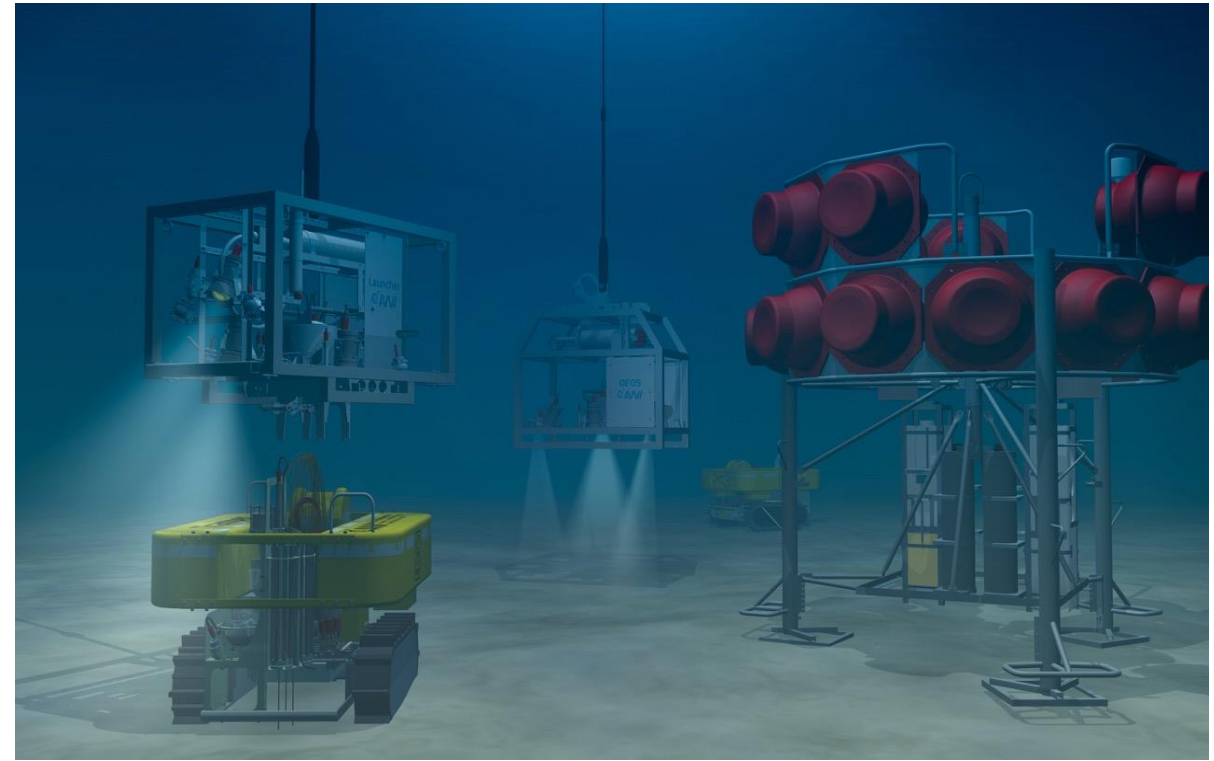


T. Soltwedel

- since 1999
- 17 stations
- 1000 - 5500 m
- bathymetric and latitudinal transect
- repeated sampling
- continuous sampling and measurements
- visual observations
- experimental work

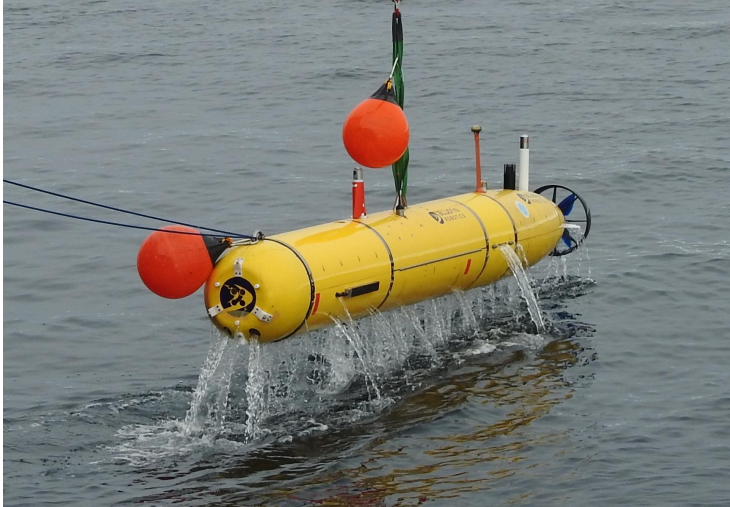
Deep-Sea Group

- Instruments used at LTER HAUSGARTEN



(KDM & Medieningenieure Bremen)

Vehicles



AUV PAUL

- Model: BF-21
- Purposes: Research, pelagic and benthic
- Maximum Depth: 2444 / 3000 m
- Length: 4 – 6 m depending on payload
- Weight in air: 500 / 600 kg
- Endurance: 8:26 h / 47.7 km
- Speed: Up to 4.5 kts



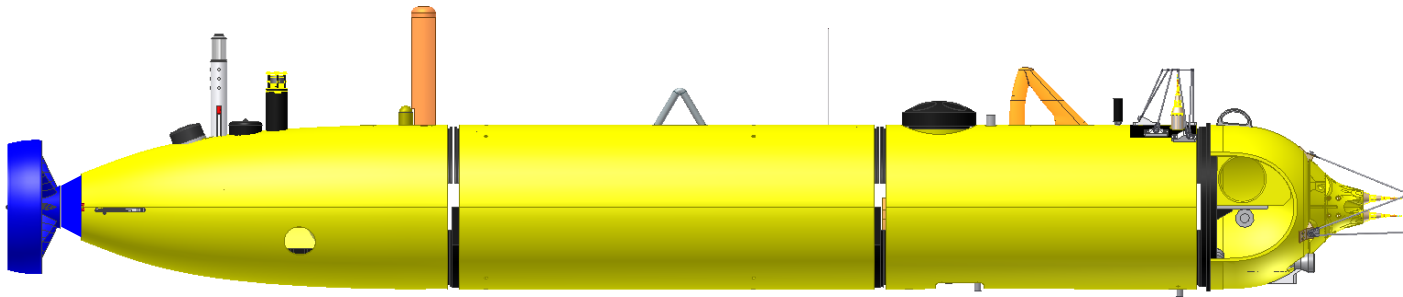
AUV SARI

- Model: BF-SandShark
- Purposes: Training, Education, Development
- Maximum Depth: 200 m
- Length: 51 – 120 cm depending on payload
- Weight in air: 5 – 15 kg / Man-Portable
- Endurance: 4 h / 10 km
- Speed: Up to 2 – 4 kts

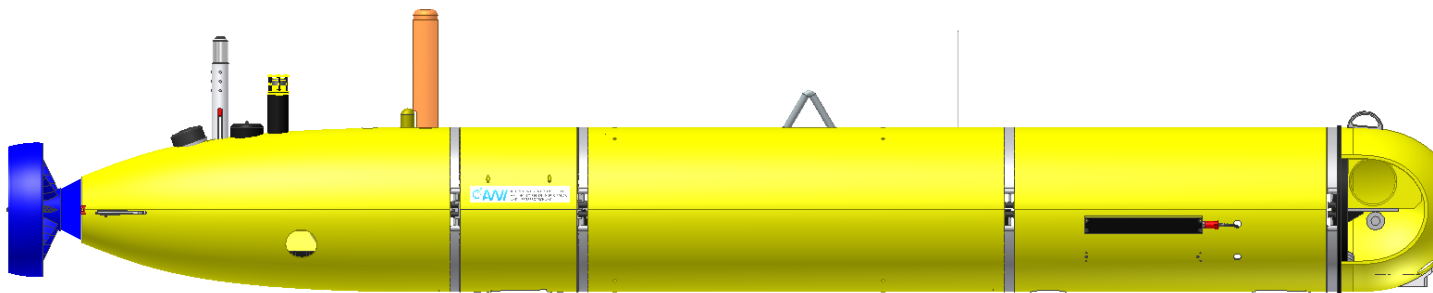
FRAM

Vehicles

- PAUL



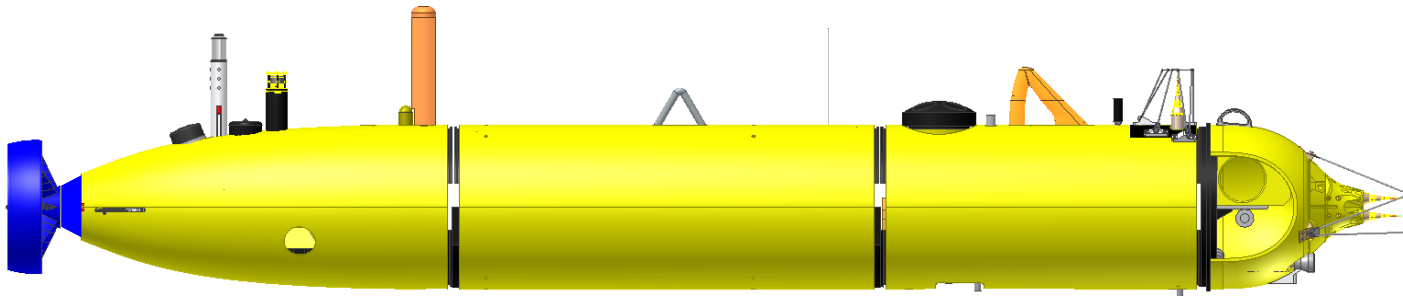
Pelagic



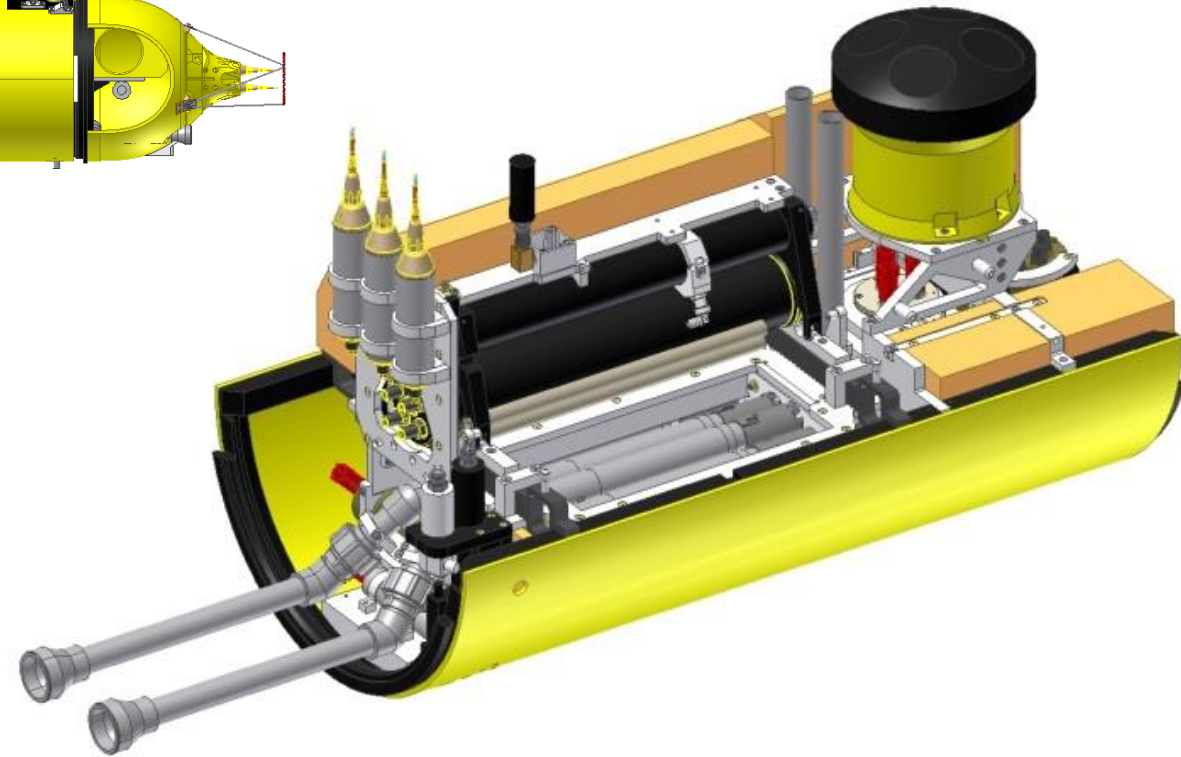
Benthic

Vehicles

- PAUL
 - Pelagic

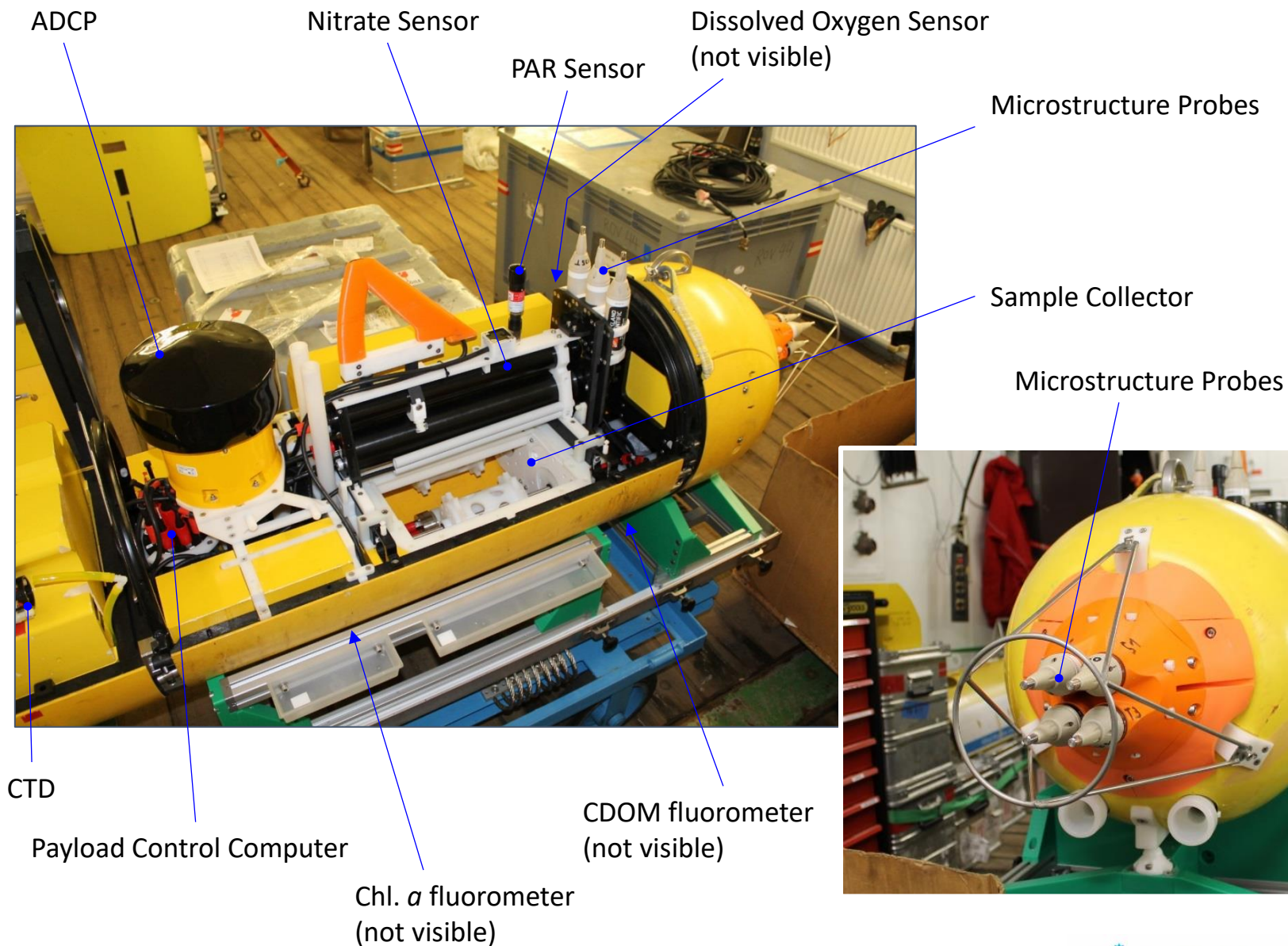


Pelagic



Vehicles

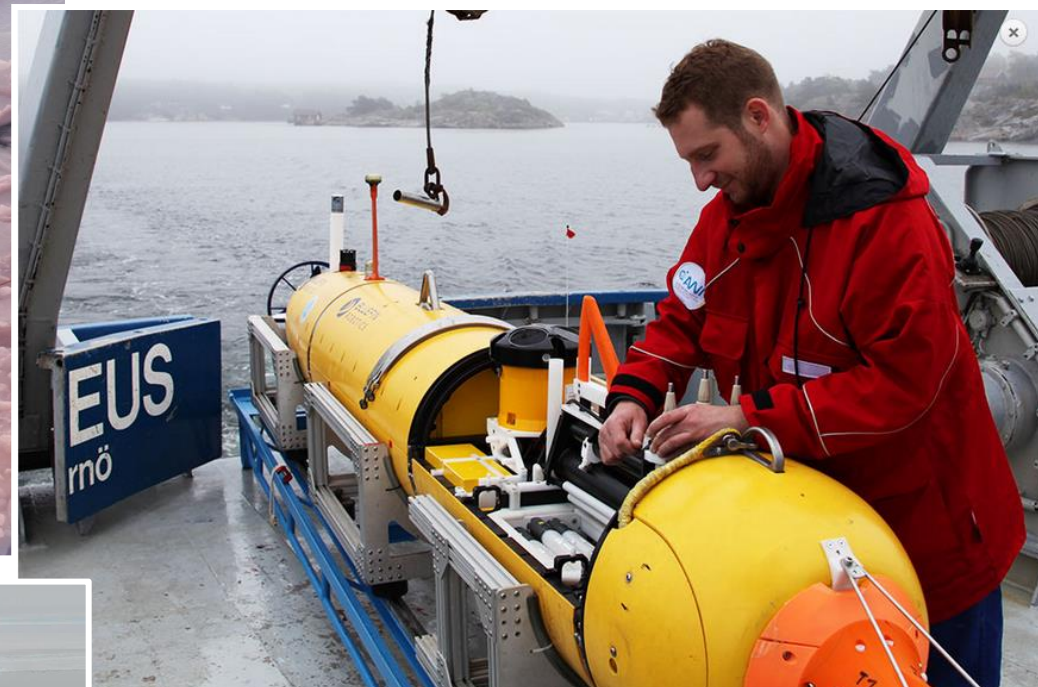
- PAUL
 - Pelagic



FRAM

Vehicles

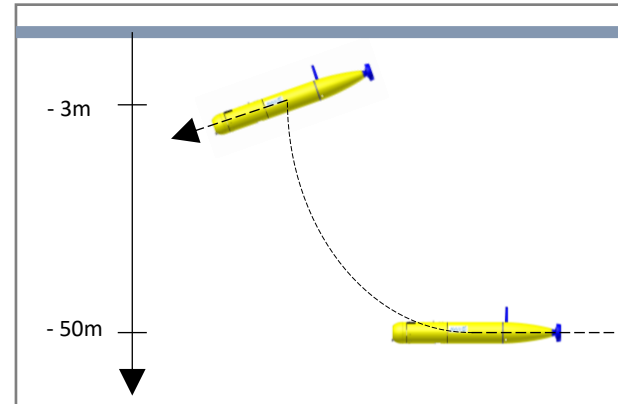
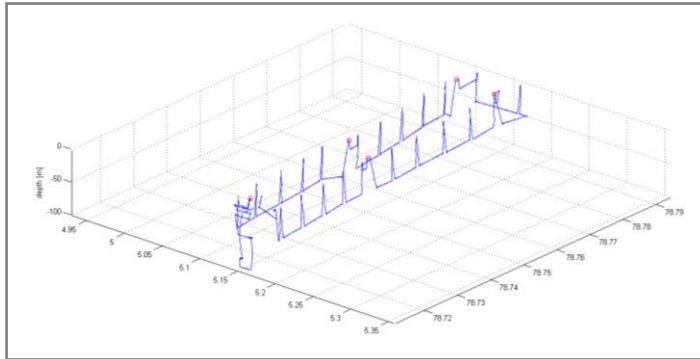
- PAUL
 - Pelagic



Vehicles

PAUL

Pelagic



Float Maneuver:

Thruster deactivated

-> Vehicle ascends slowly

-> Little disturbance of surface water stratification

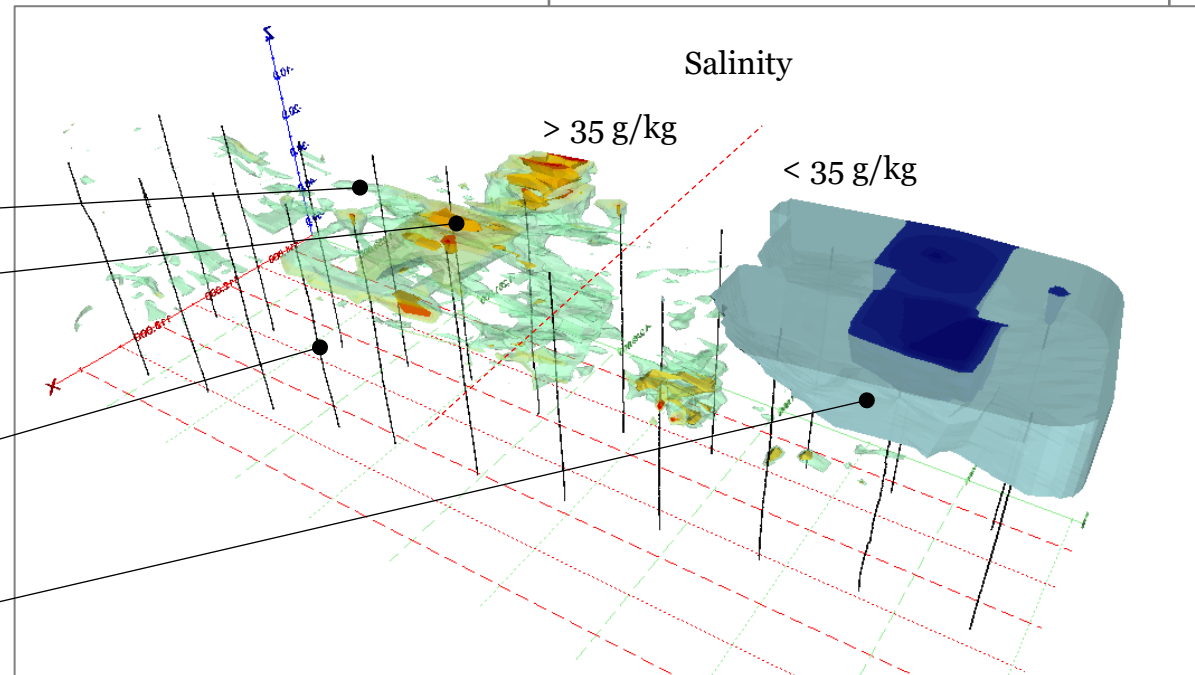
-> High resolution vertical profile

Repeated Floats for 3D investigation

Chlorophyll a concentration:

> 2.5 $\mu\text{g/l}$

> 4.0 $\mu\text{g/l}$



Ascend path during Float maneuver

10 m thick melt water layer
(salinity < 34.5 g/kg)

Dive in Arctic Marginal Ice Zone:

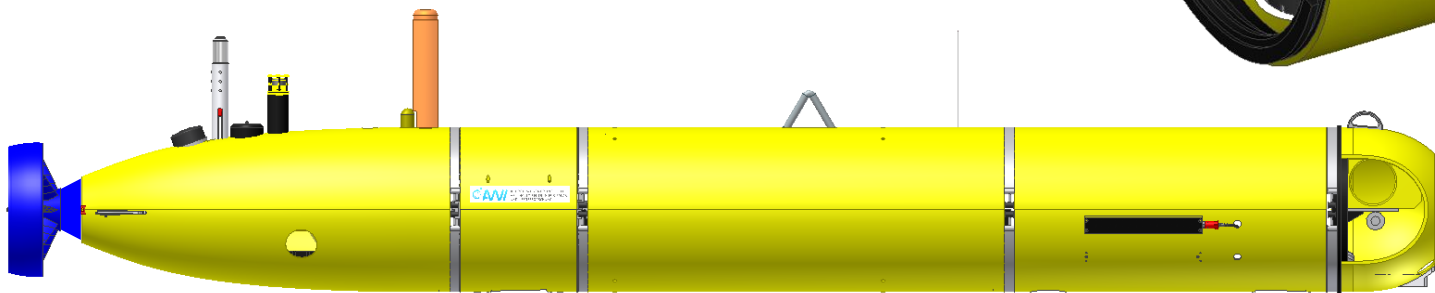
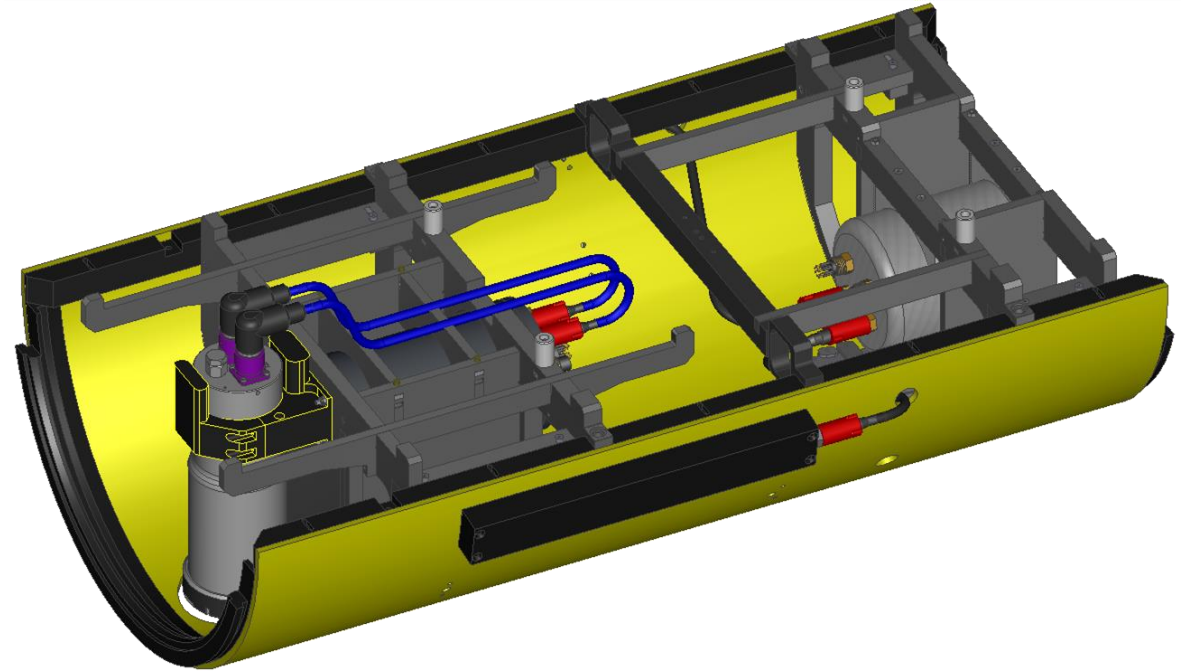
-> Chlorophyll a as tracer for phytoplankton and marine primary production

-> Almost synoptic, volumetric investigation of phytoplankton standing stock

-> "Patchy" distribution of phytoplankton along ice edge

Vehicles

- PAUL
 - Benthic

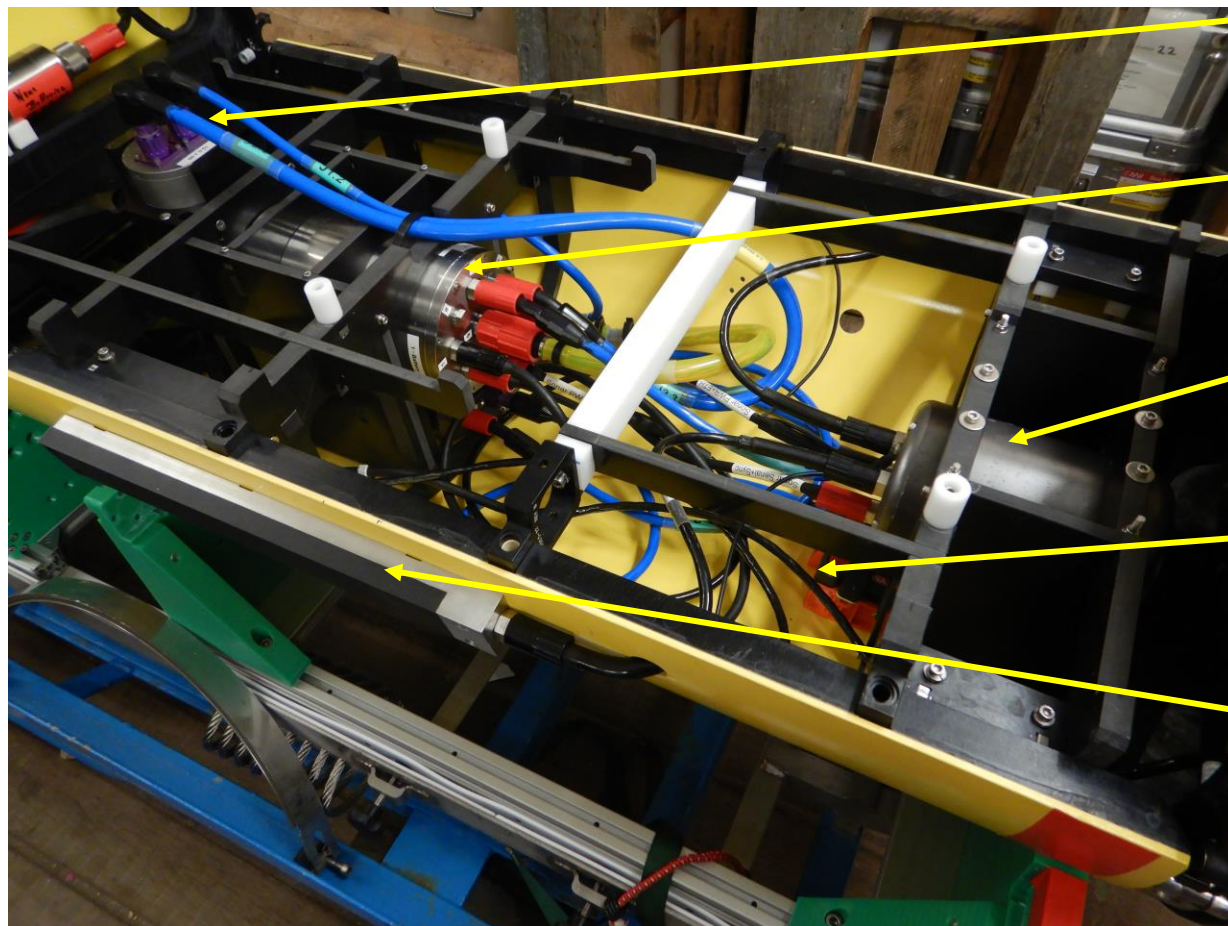


Benthic

Vehicles

- PAUL

- Benthic



Camera

Payload Control Computer

Sonar Electronics

Fwd. Strobe

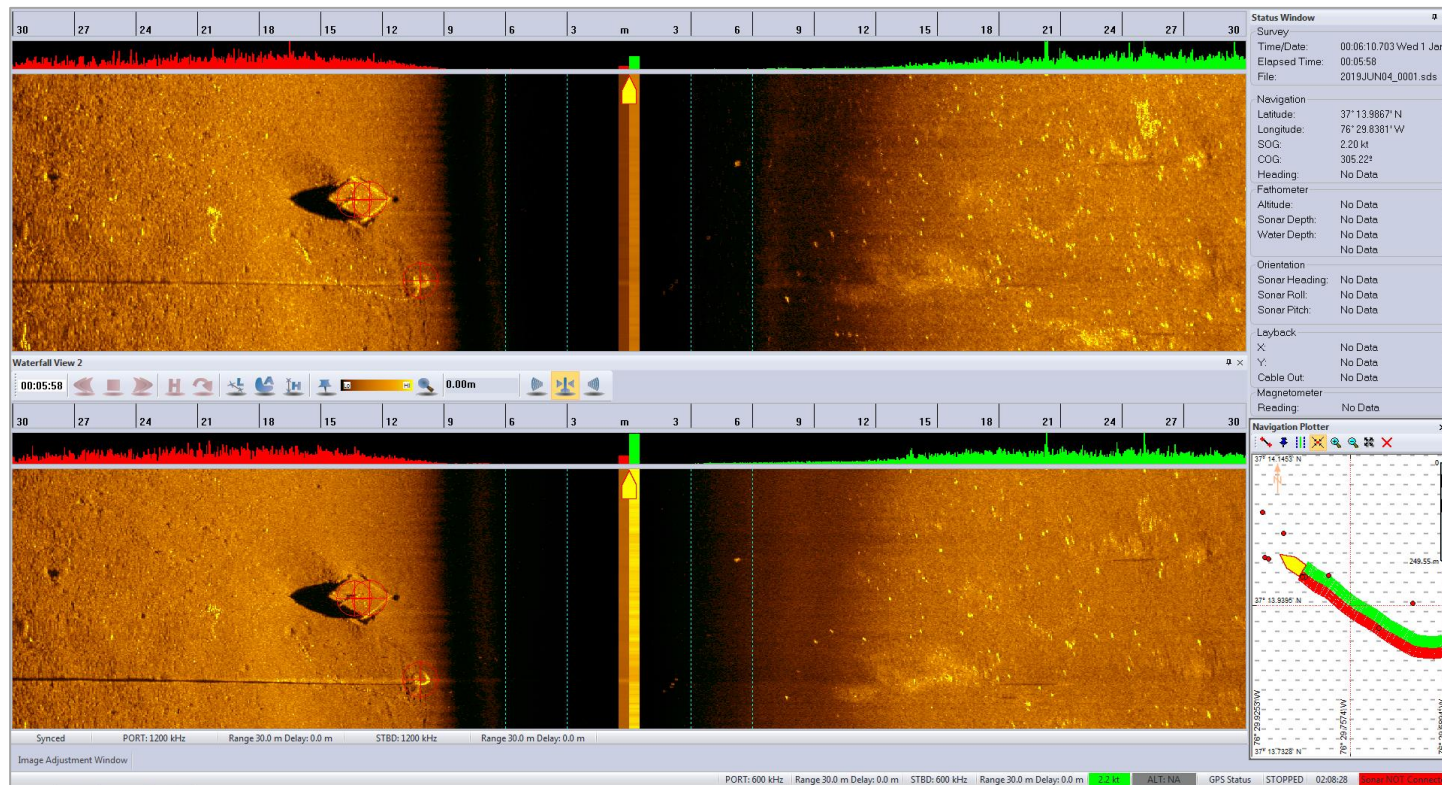
Sonar Transducer

Vehicles

- PAUL

- Benthic

- Side-Scan-Sonar



Vehicles

- PAUL
 - Benthic
 - Stills-Camera

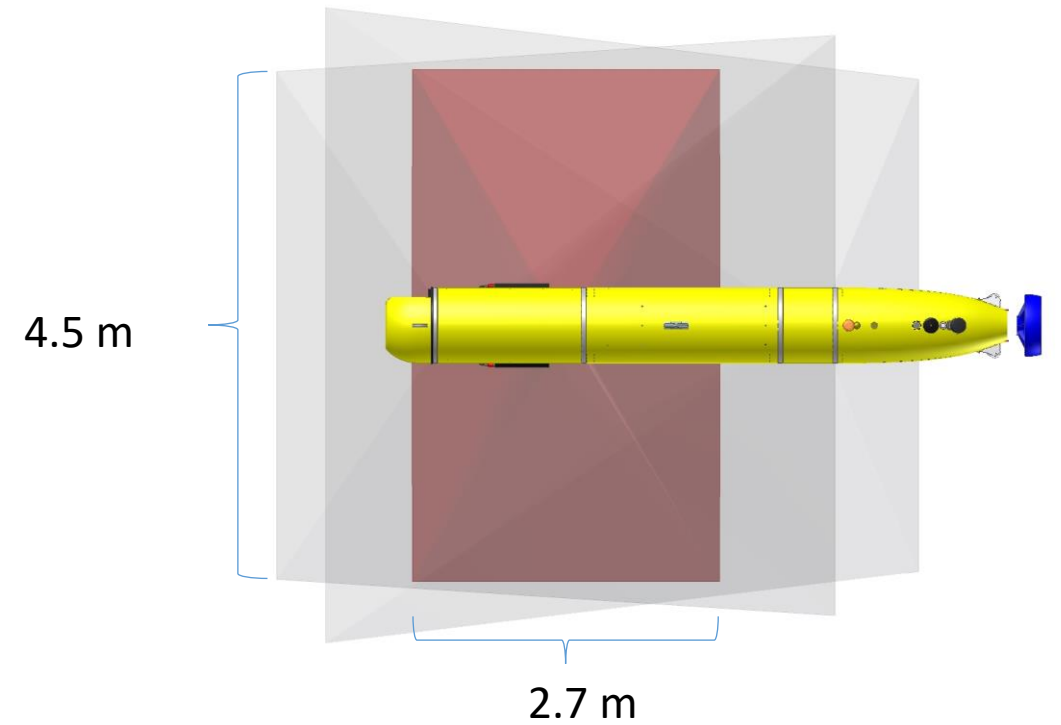
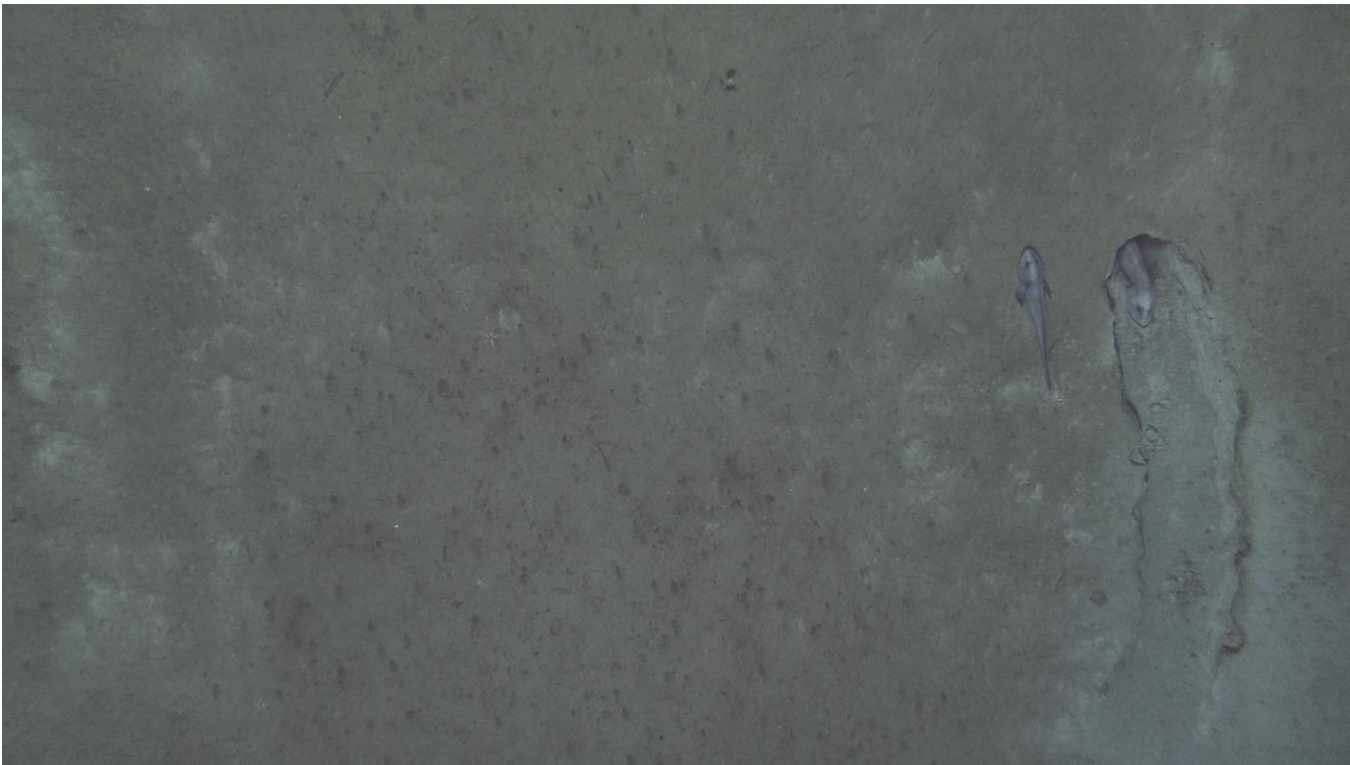
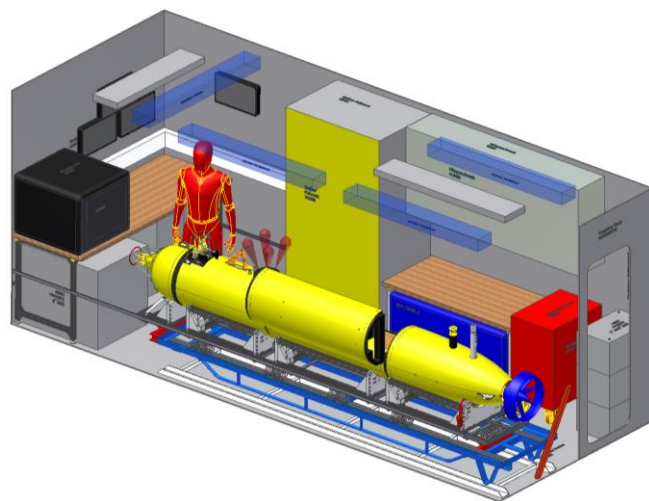


Image Area: 12.15 m² || Pixel Resolution (mm/pixel): 1.1

Infrastructure



FRAM

What's my job?

Payload development

- Light modelling

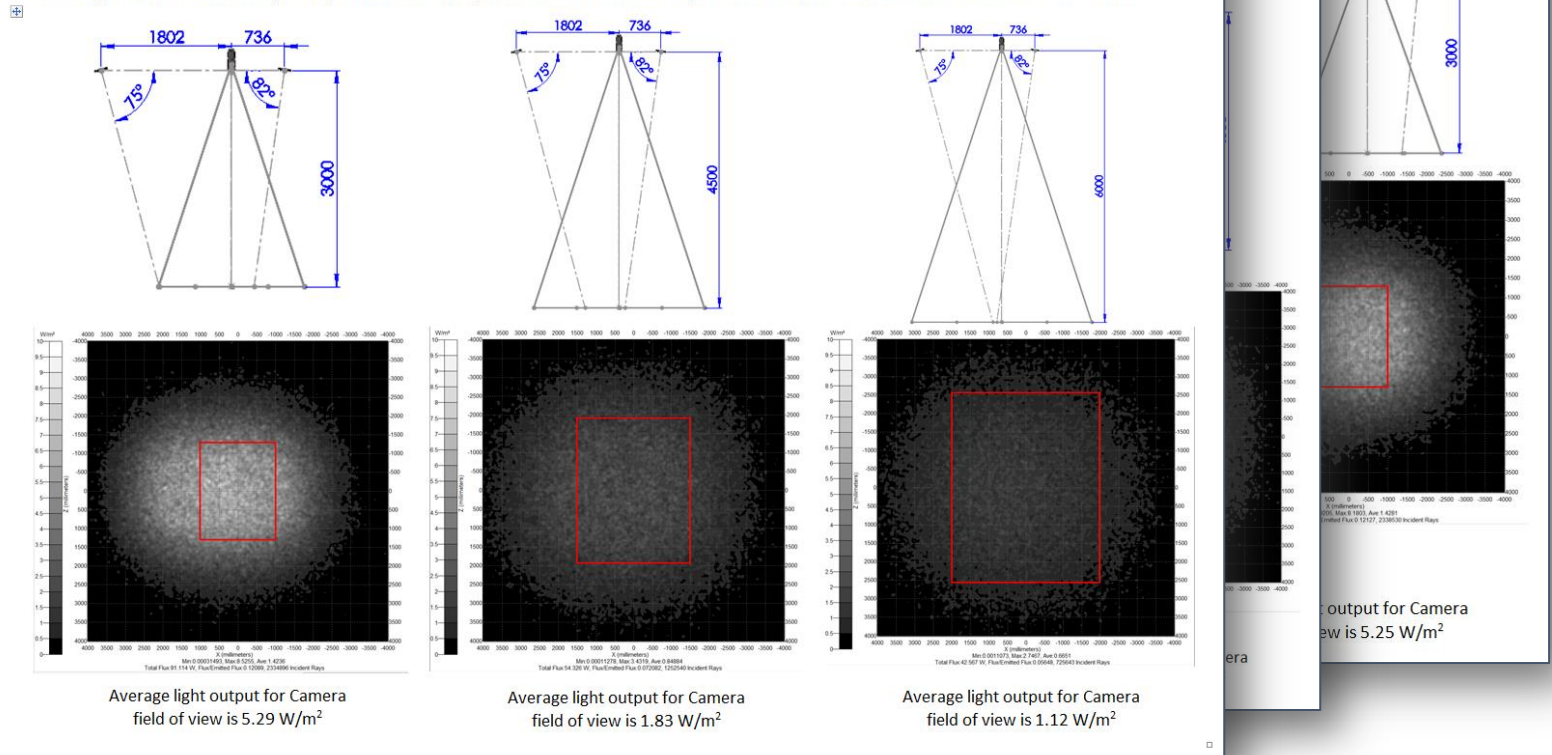


1. 3m Altitude

2. 4.5m Altitude

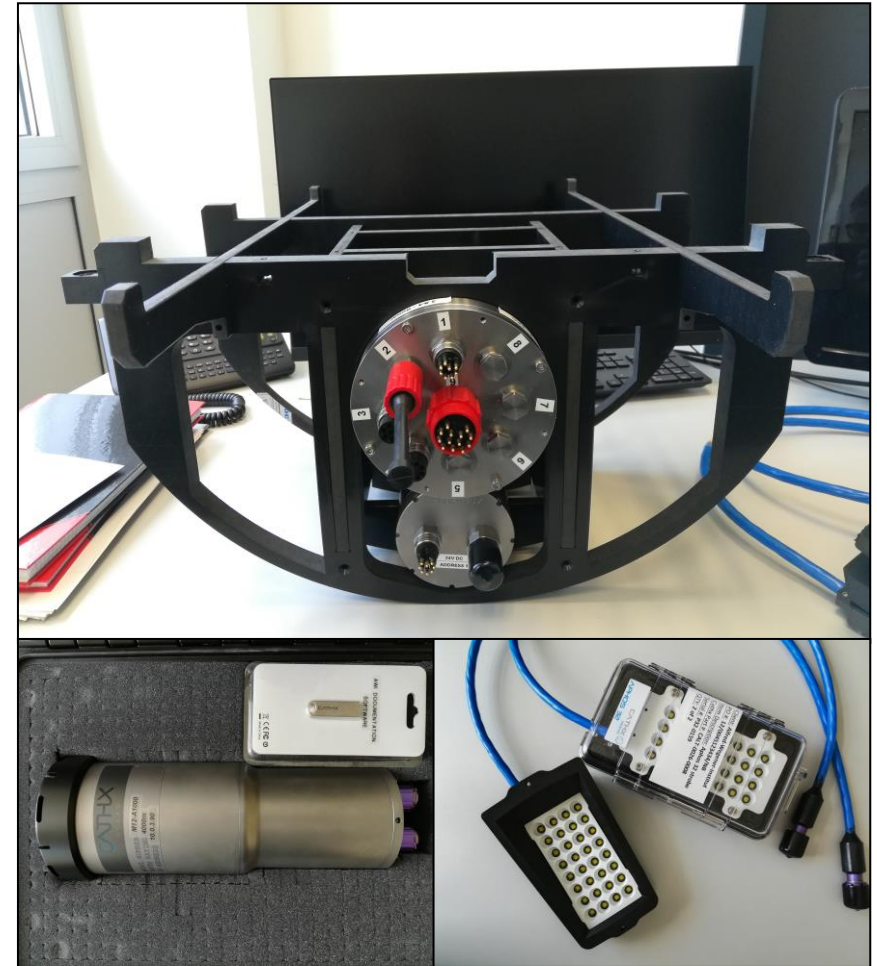
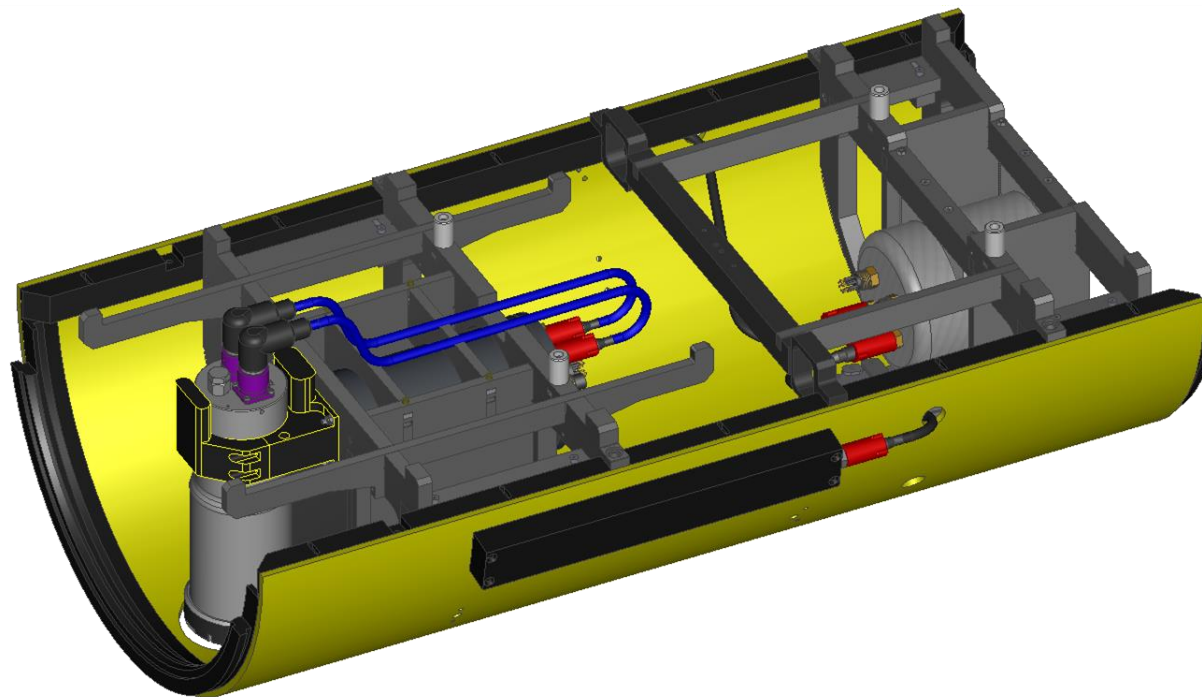
4. LED Panels at 75° and 82°

The images below show the light output when the LED panels are at 75 and 82 degrees at distances of 3m, 4.5m and 6m from the seabed.



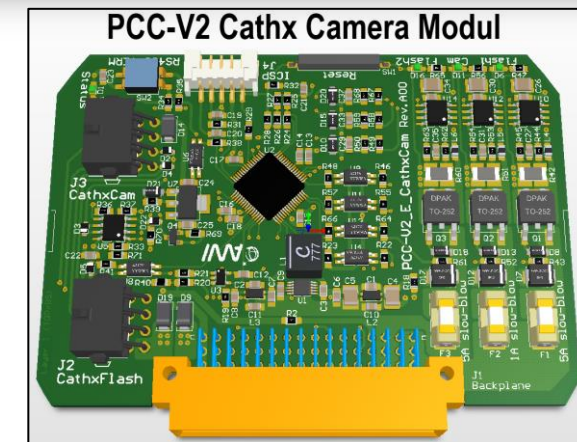
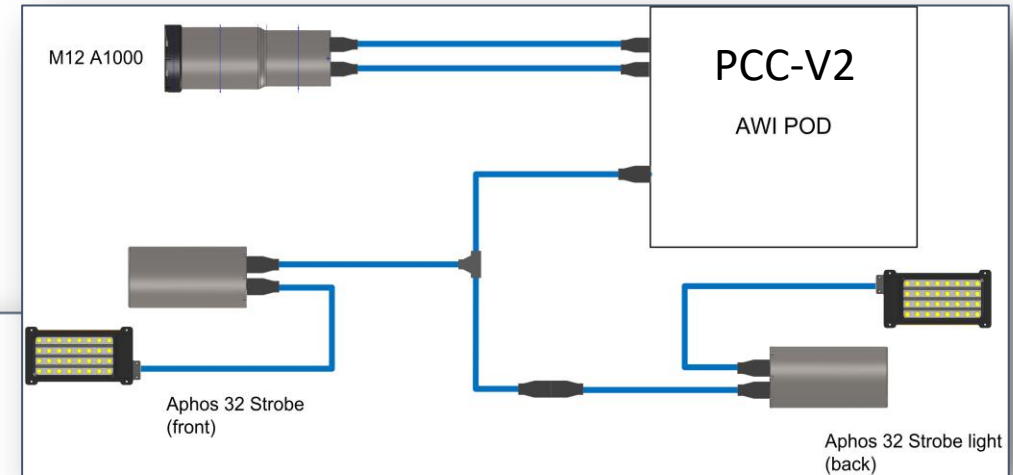
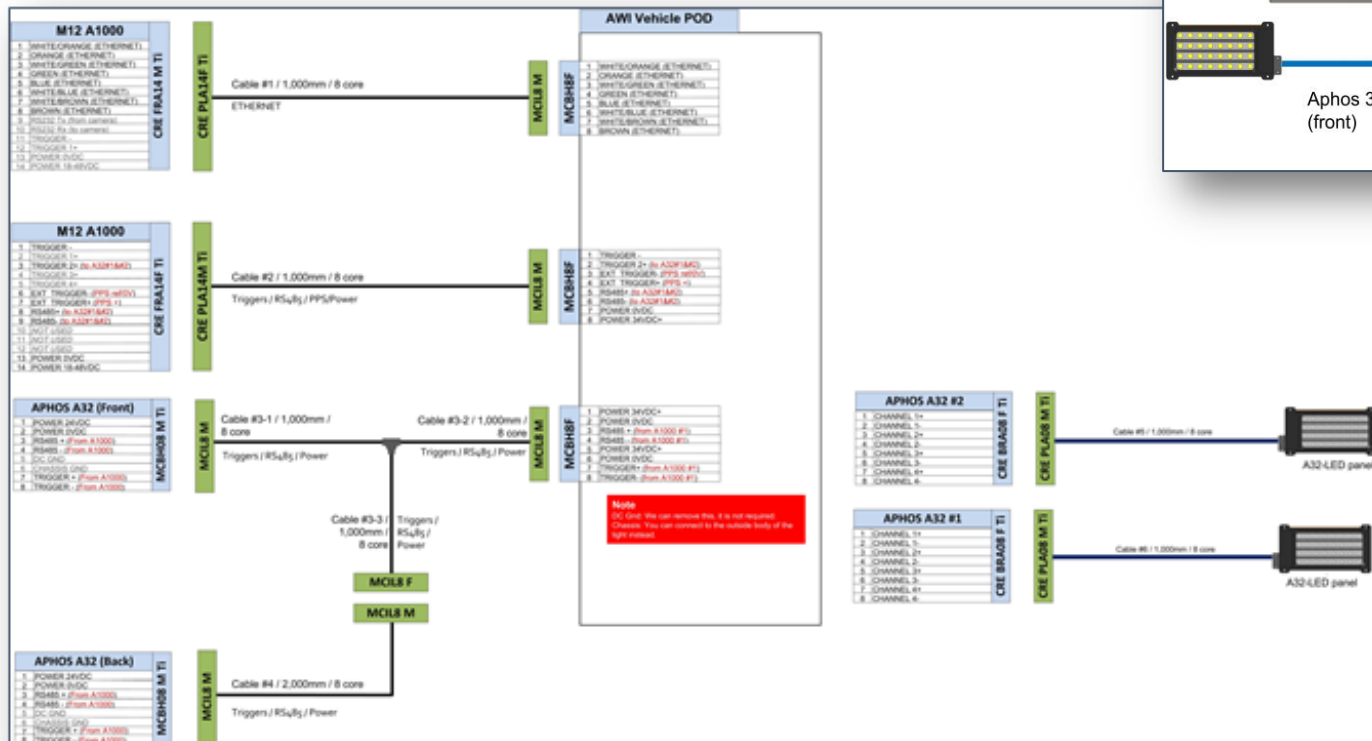
Payload development

- Light modelling
- Mechanical payload design

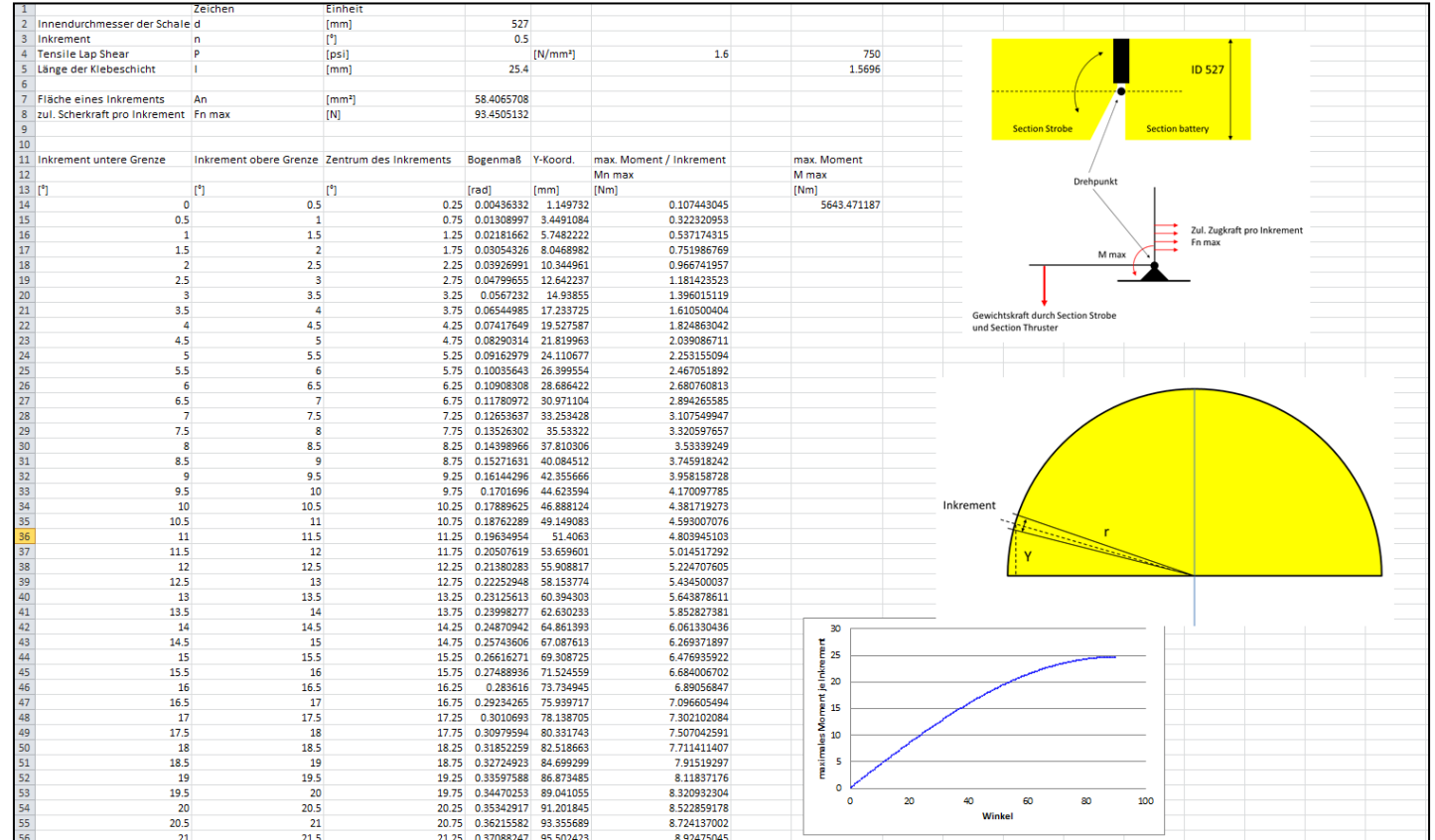
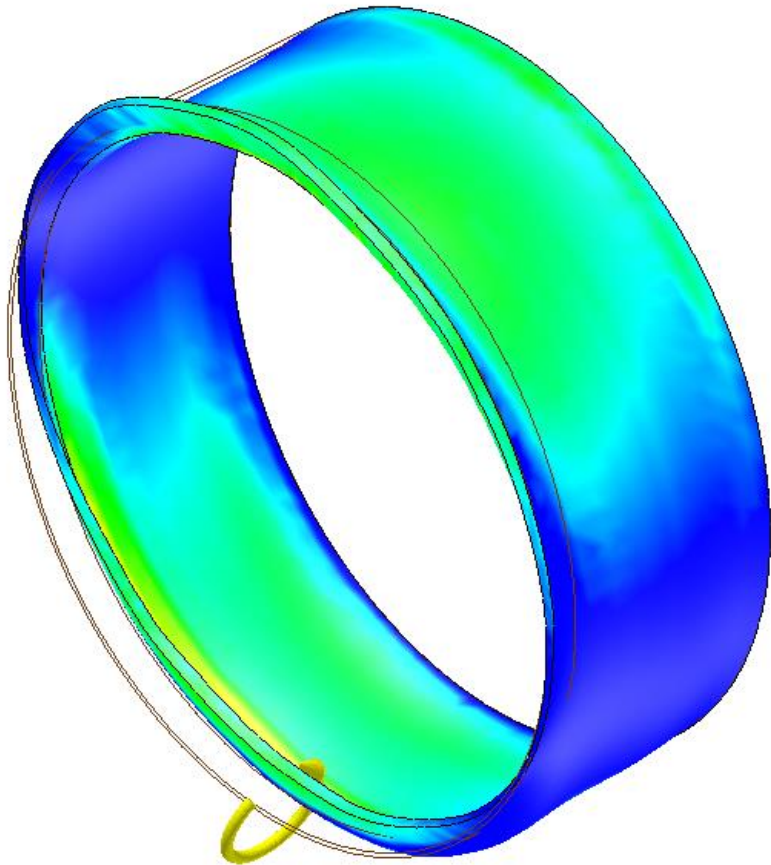


Payload development

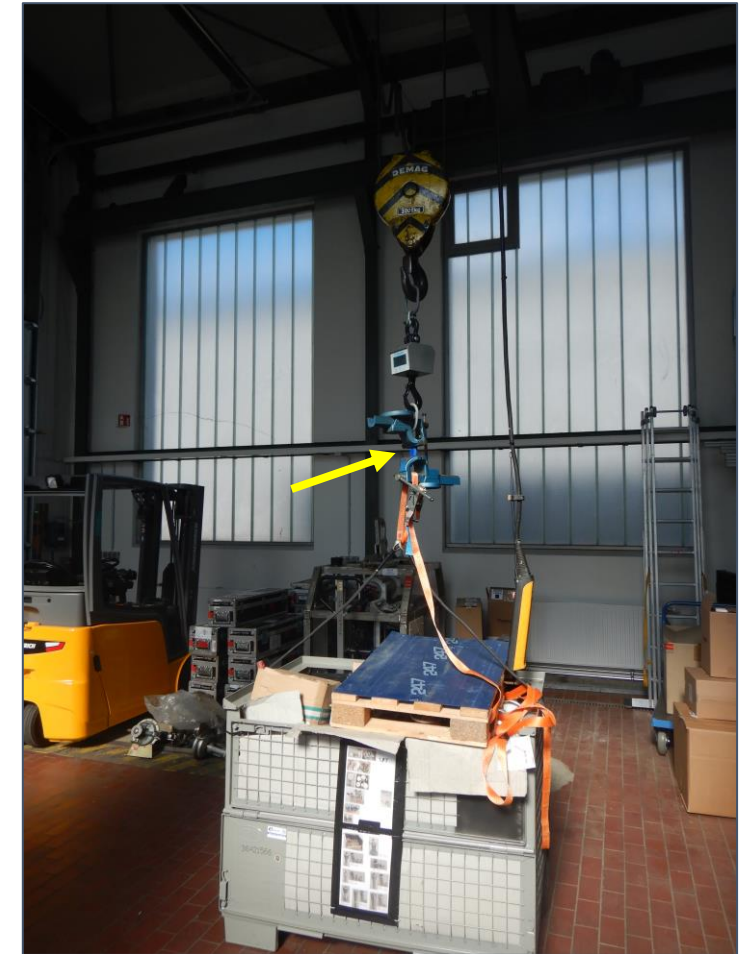
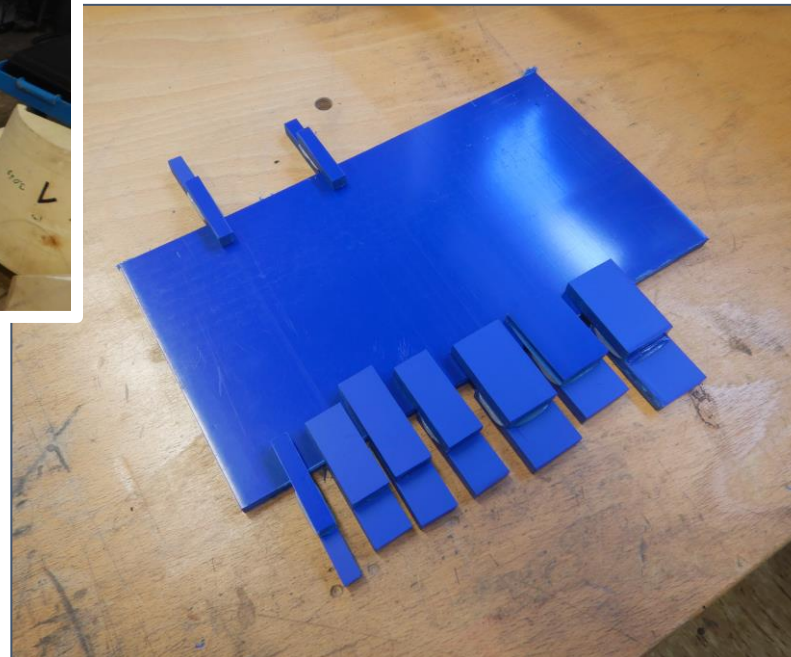
- Light modelling
- Mechanical payload design
- Electrical payload design



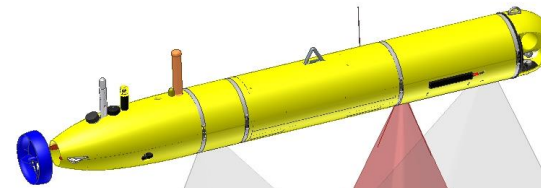
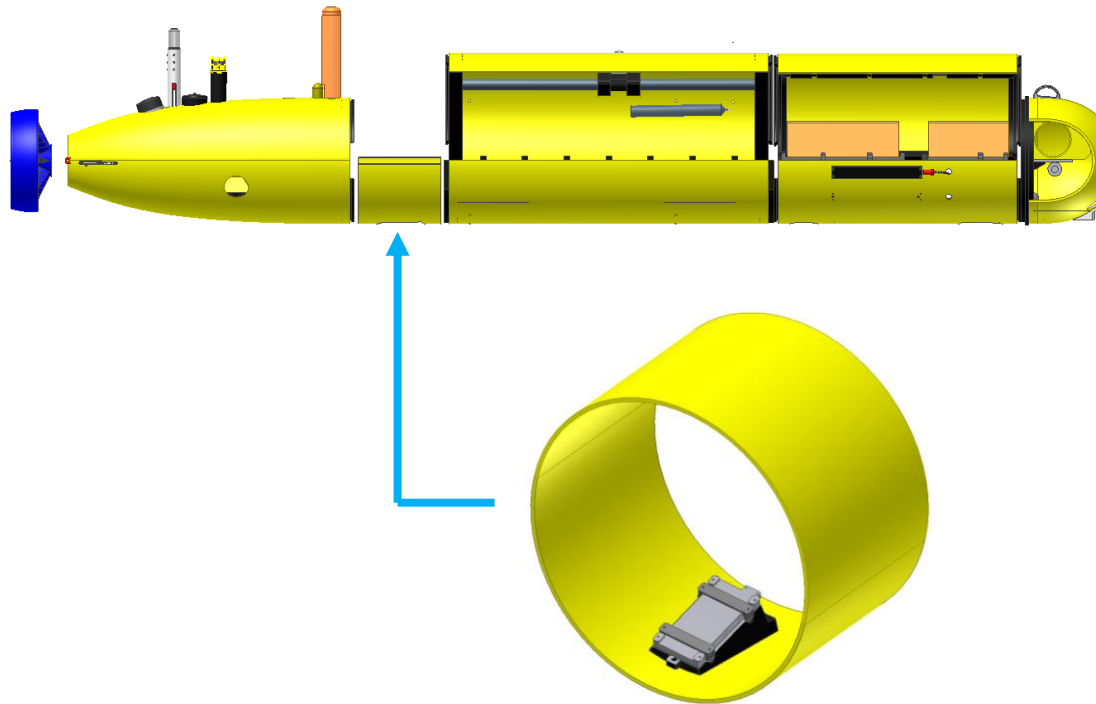
Payload development



Payload development



Payload development

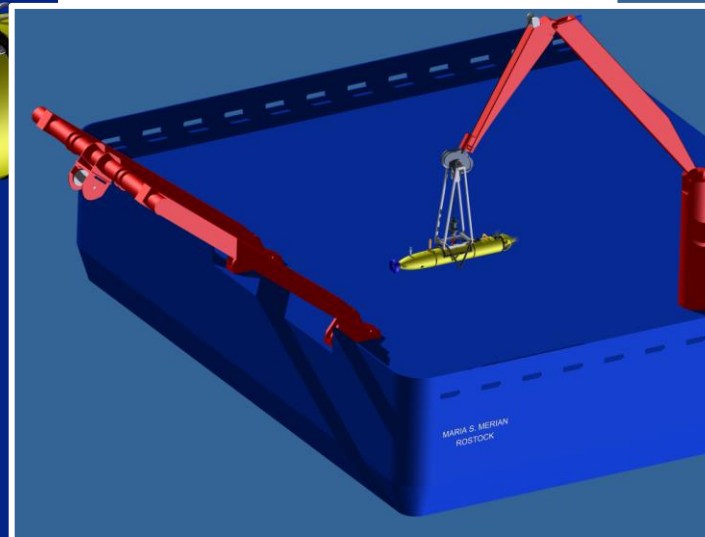
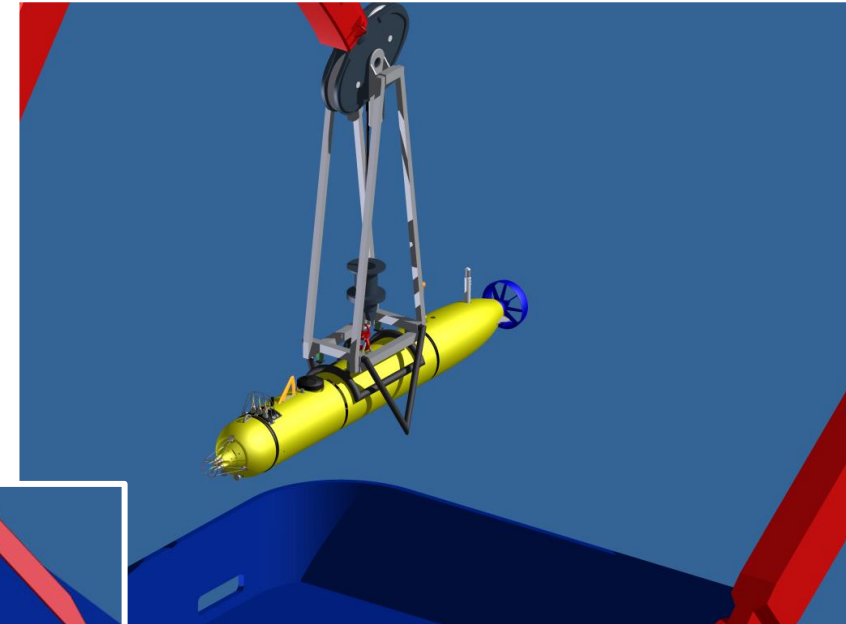
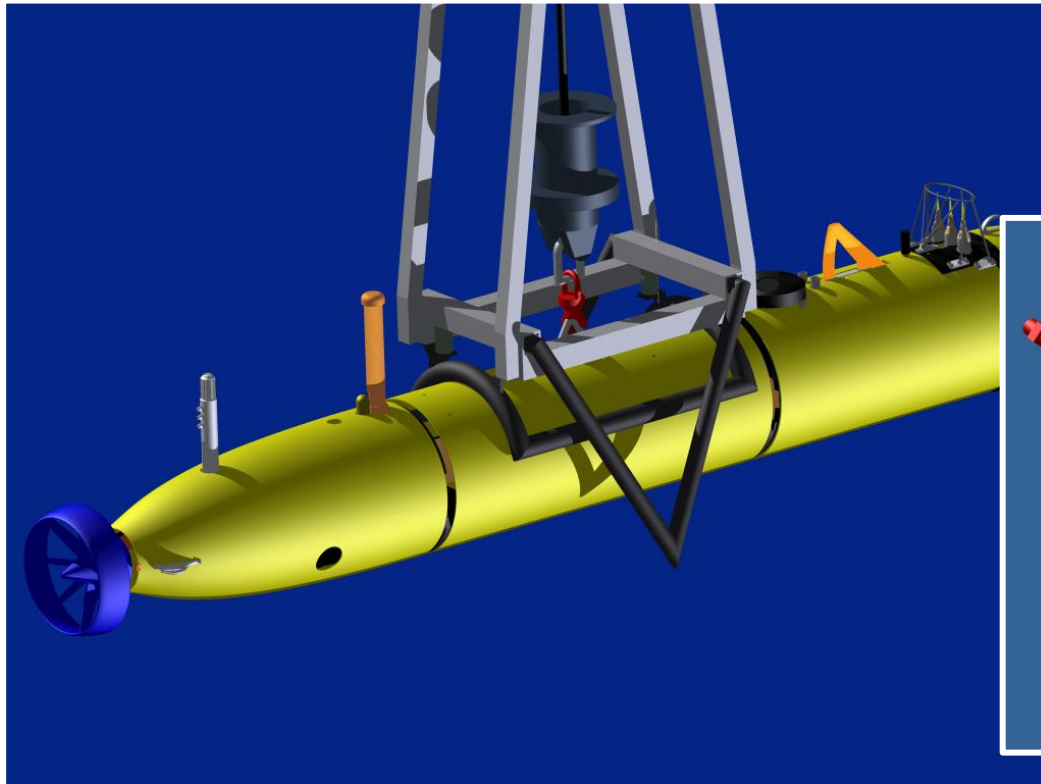


L. Frommhold

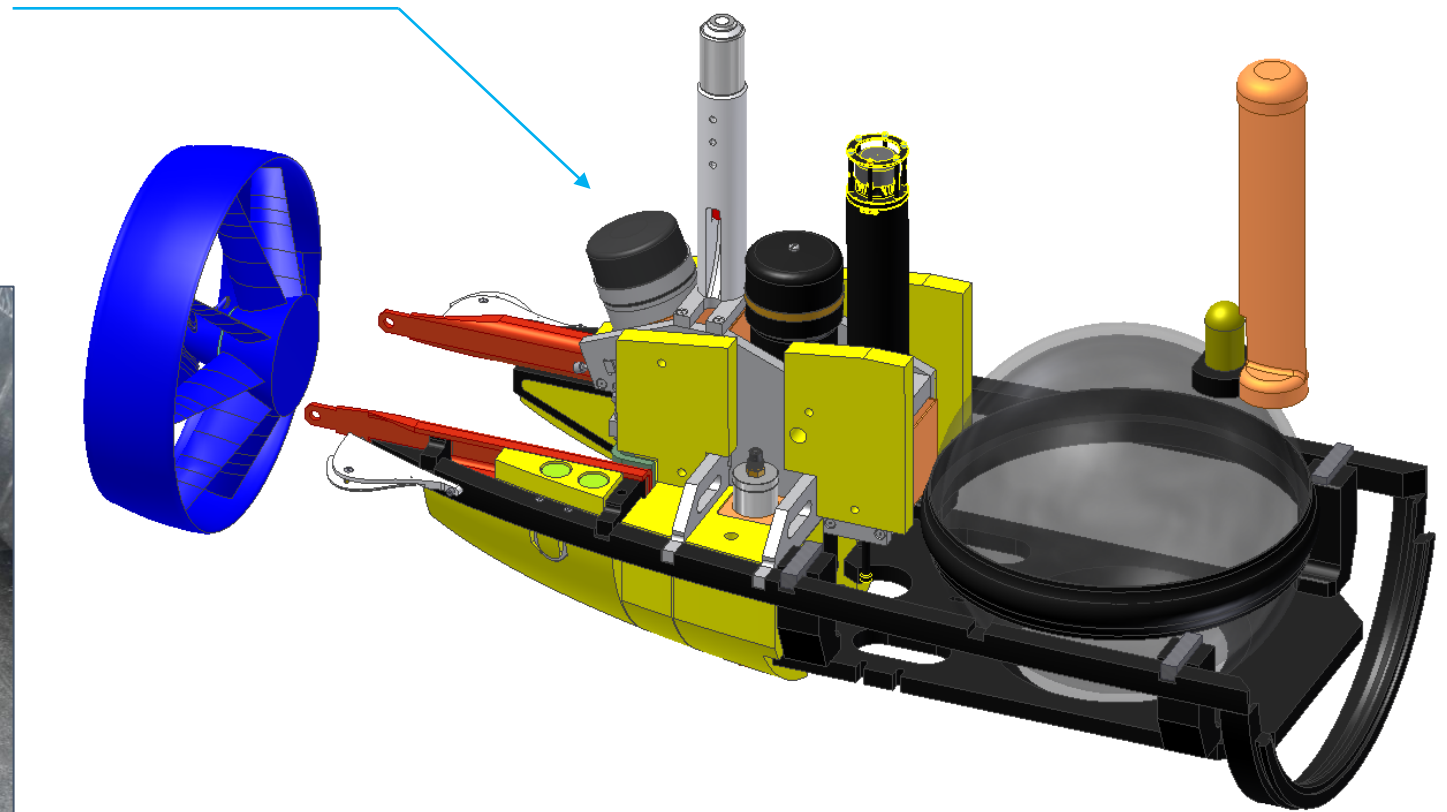
Launch and Recovery Design



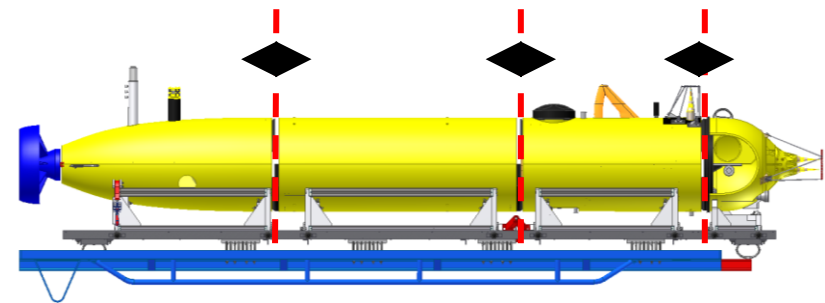
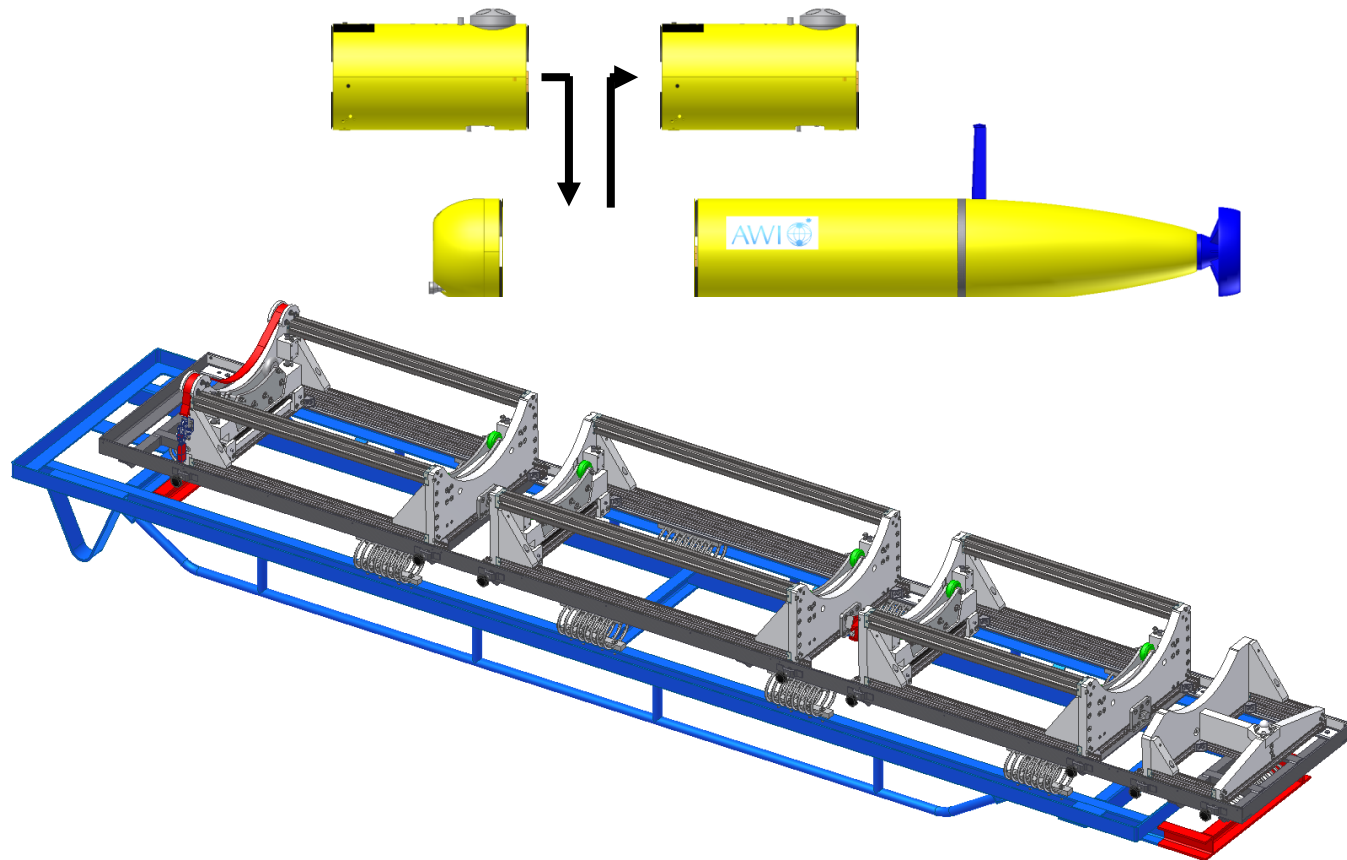
Launch and Recovery Design



Sensor implementation



Infrastructure development



Expeditions

Topics which benefit from the use of AUVs

Deep-Sea Ecology and Technology:

- Physical-biological coupling at the Ice edge
- Ecology at frontal systems
- Sub-mesoscale processes in and below the euphotic zone
- Stratification near the surface
- Foto-mosaicing (distribution of species, garbage, etc.)

Physical Oceanography:

- Mixing processes in the marginal Ice zone
- Mixing processes in the Denmark Strait
- Processes under shelf ice of Filchner-Ronne ice shelf
- Physics at frontal systems
- Polar front in the Fram -Strait

Sea Ice-physics:

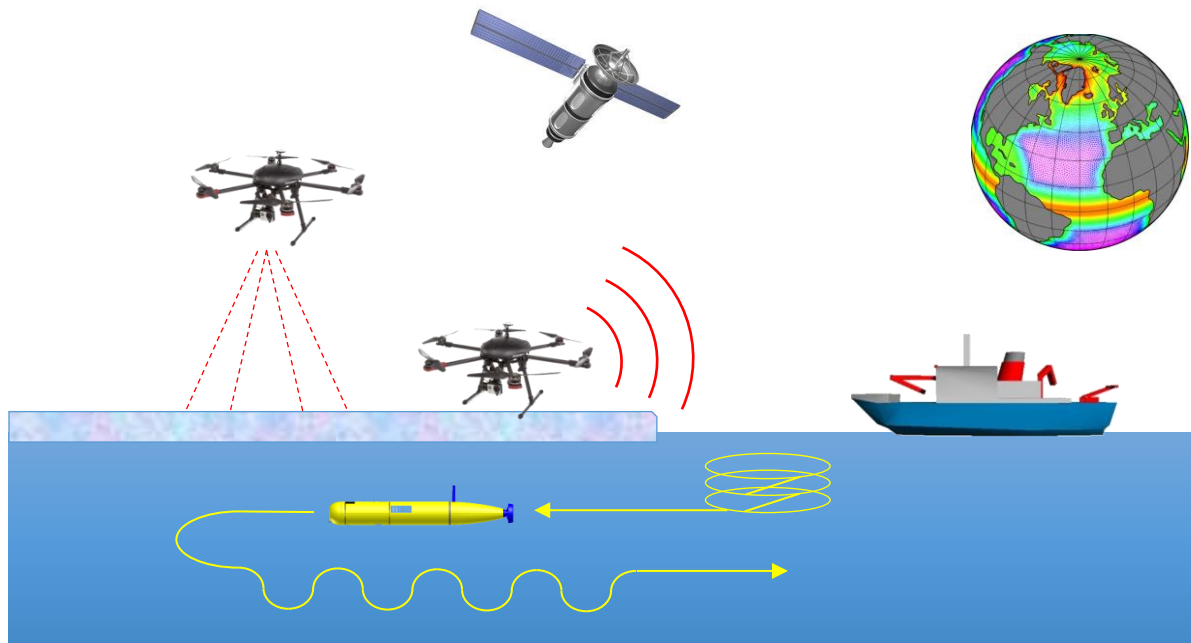
- Ice thickness observations
- Light observations under the Ice
- Under Ice topography
- Ice formation processes

Marine Geochemistry:

- Methane and CO₂ seeps (off Svalbard, in the North and Baltic Sea)

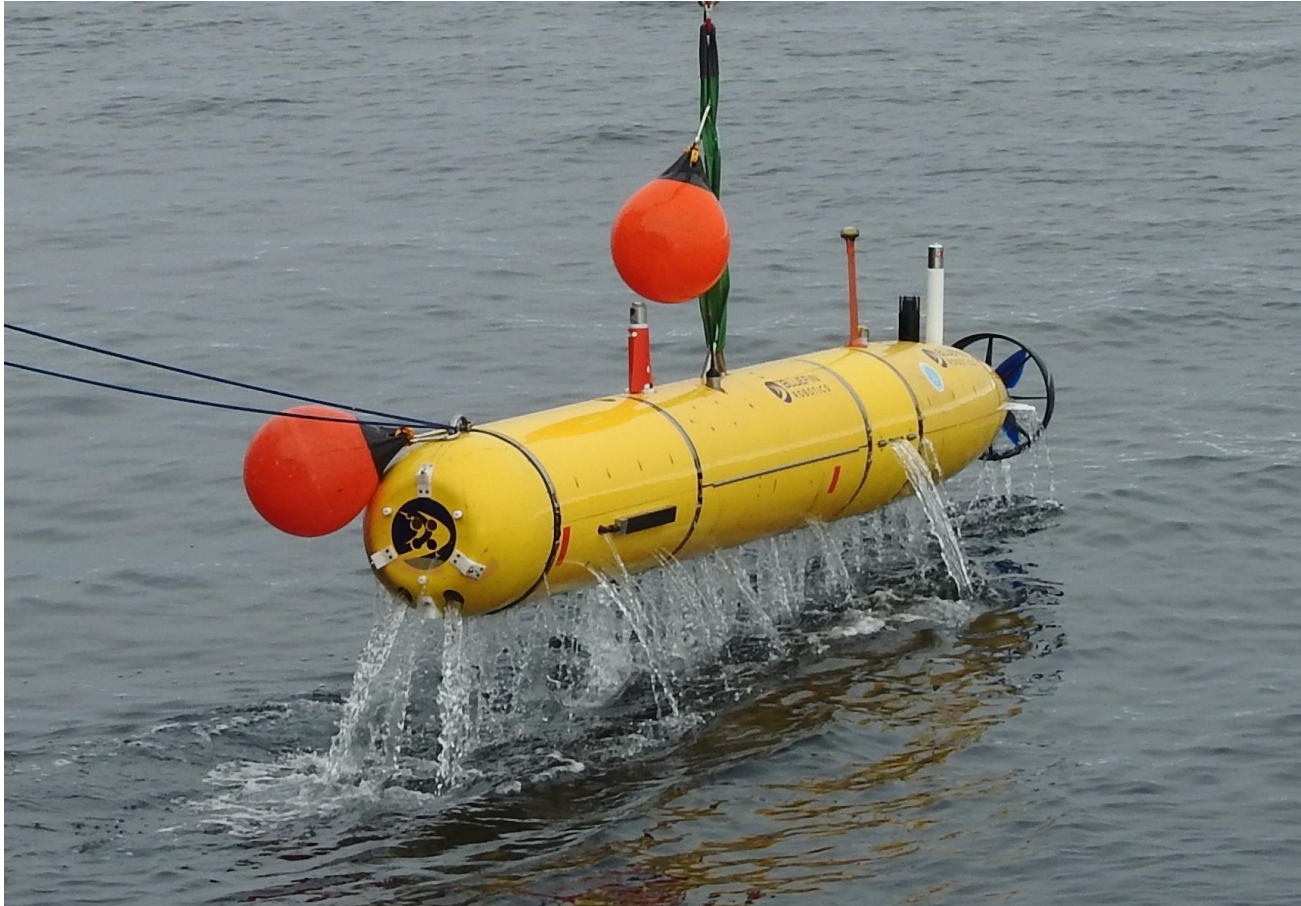
Marine Geology

- Bathymetry below Antarctic shelf Ice
- Assistance during drilling work



T. Wulff

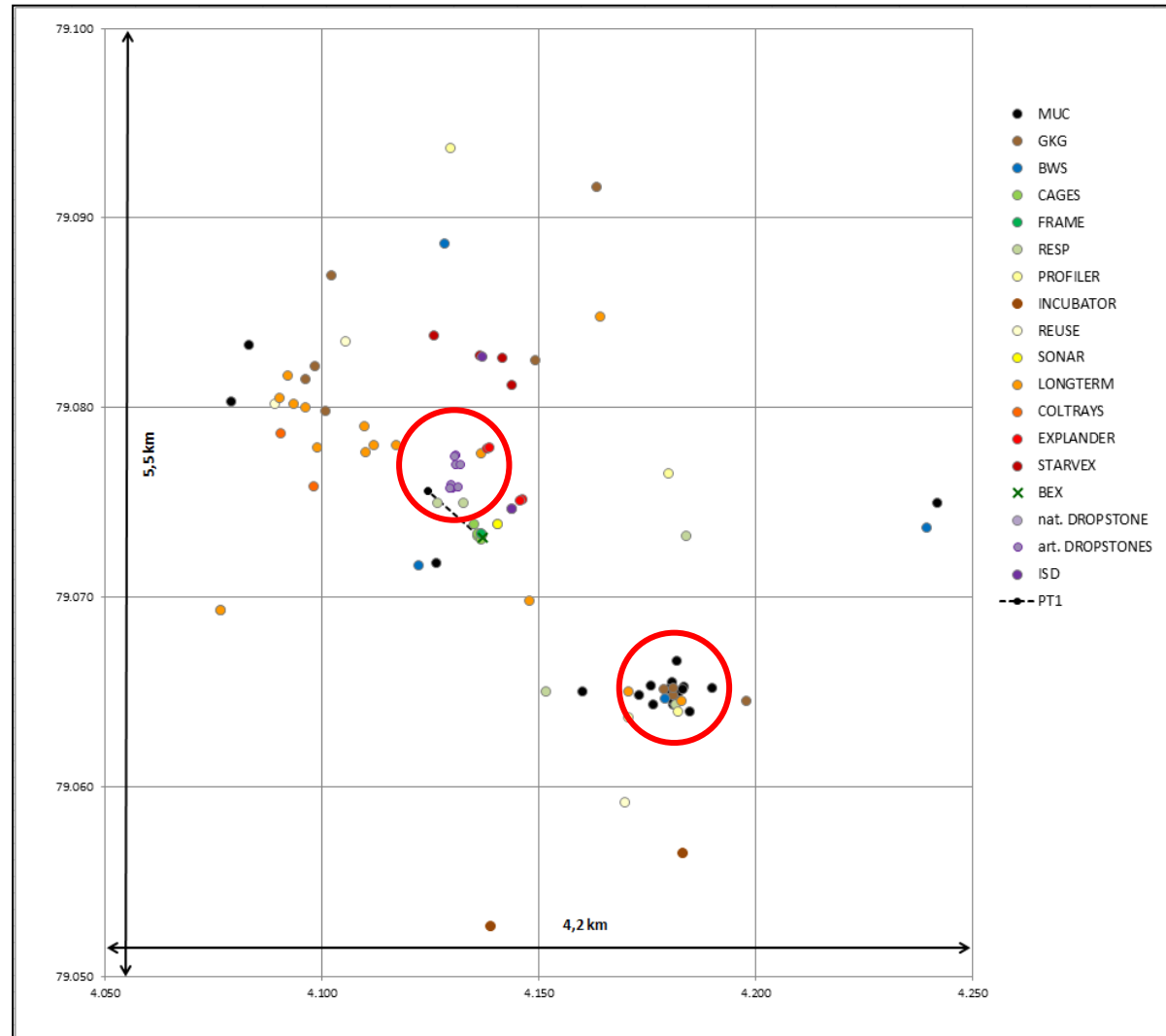
Expeditions



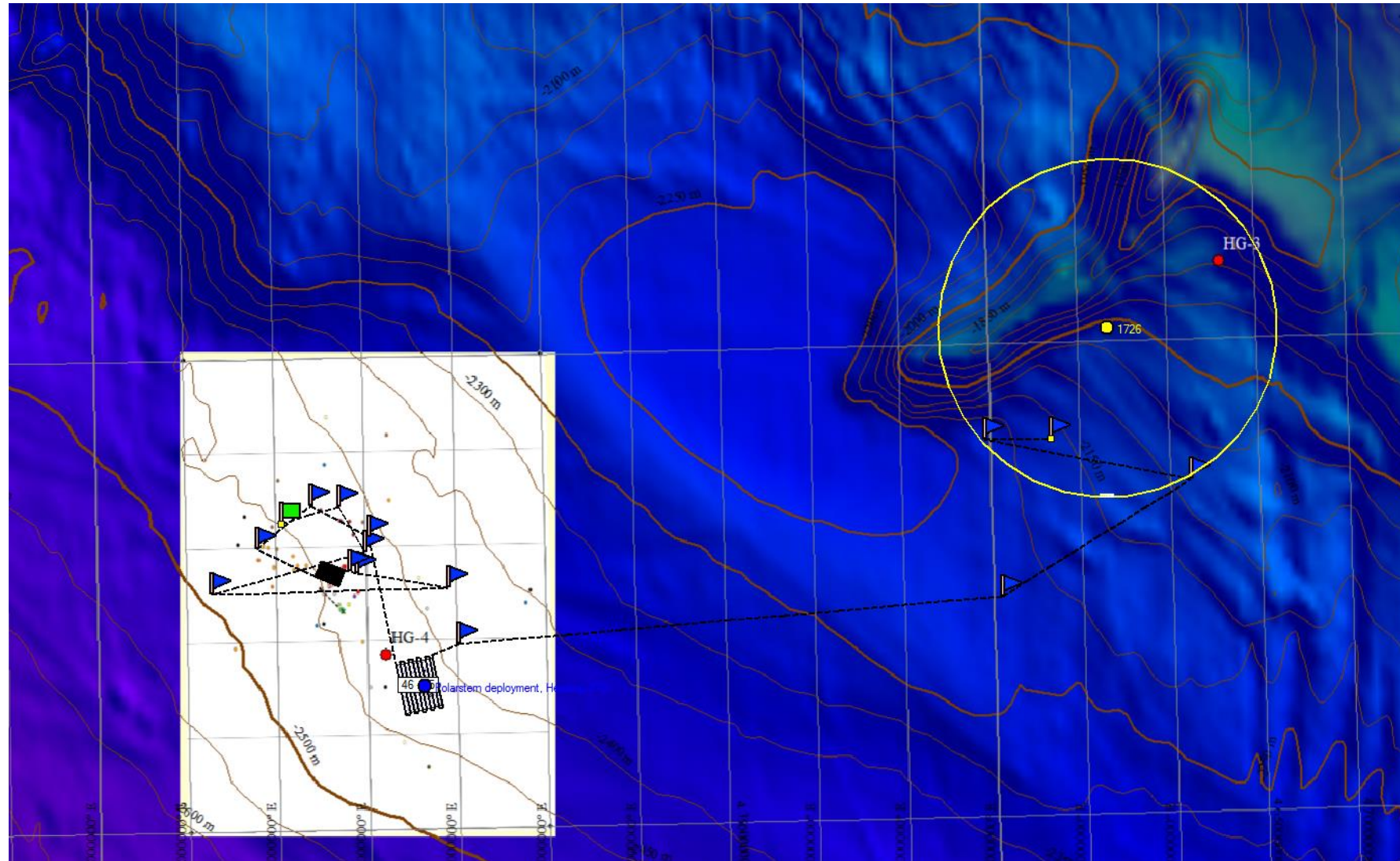
PS 121 (Benthic Payload)

Dives:	5
Distance covered:	116.2 km
Max. depth:	2444 m
Longest unattended dive:	8:26 h / 47.7 km
Photos:	40354
Sonar:	38.9 km
Collisions:	1

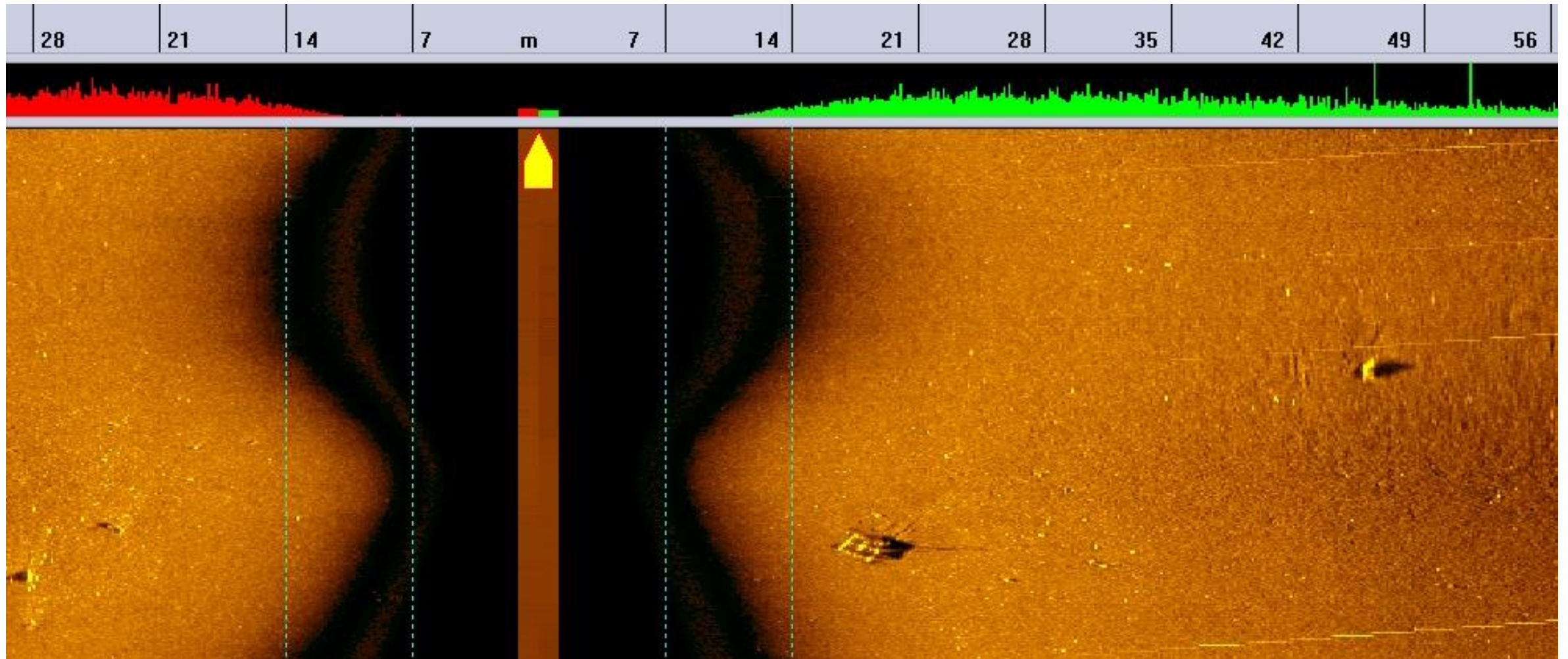
Expeditions



Expeditions



Expeditions



Expeditions

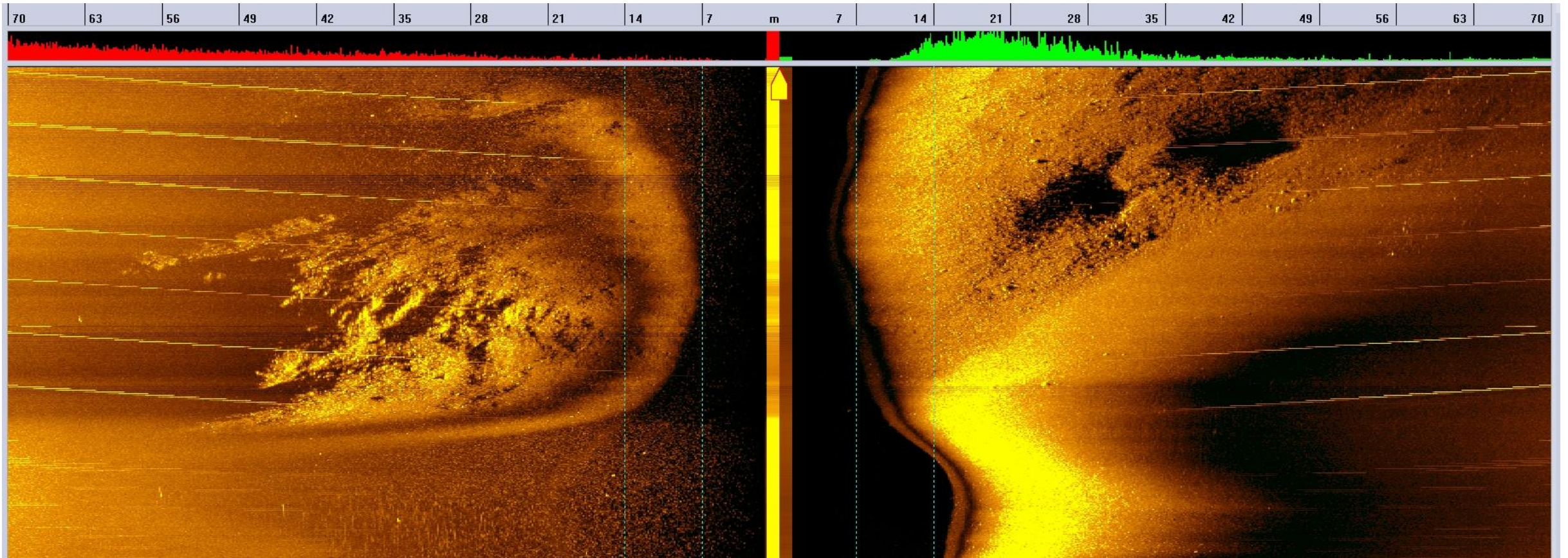


Expeditions



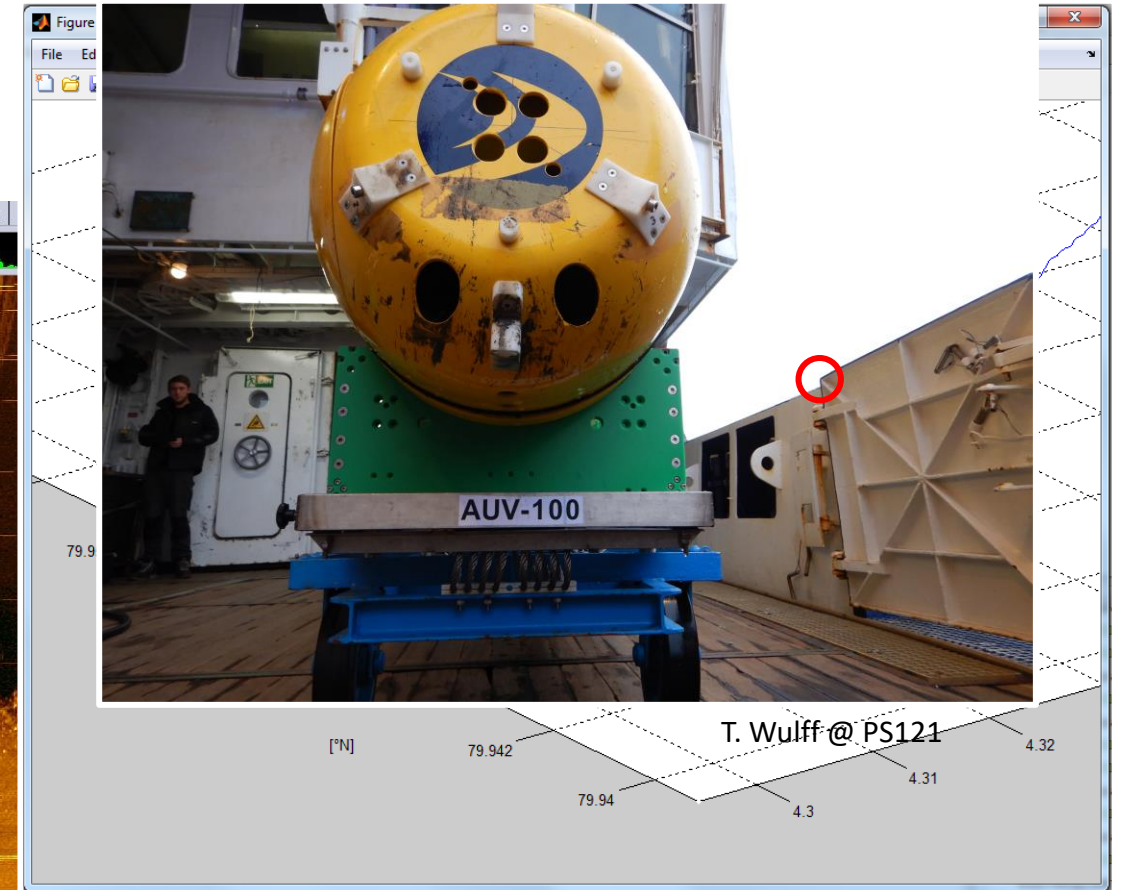
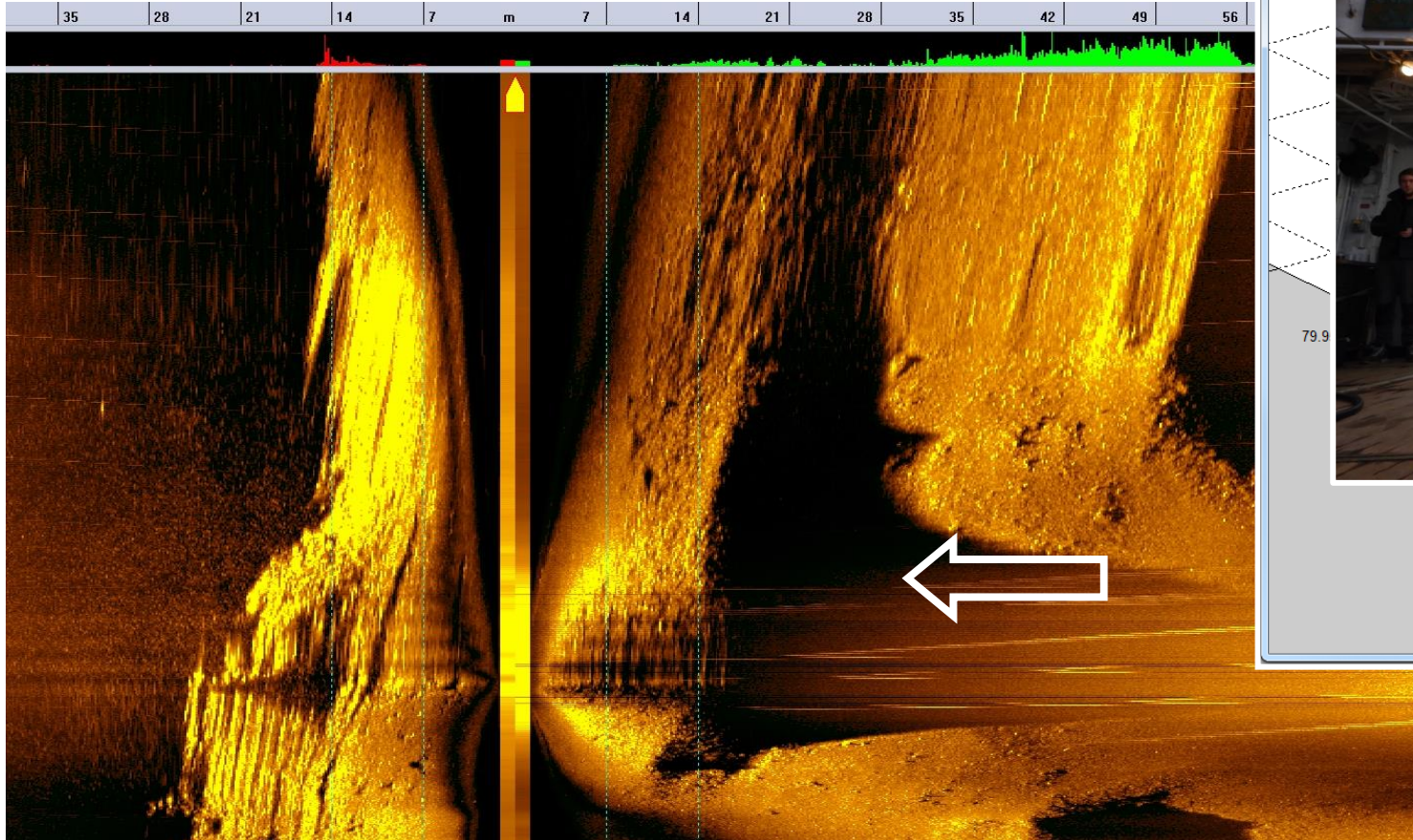
Expeditions

- Challenges



Expeditions

- Challenges



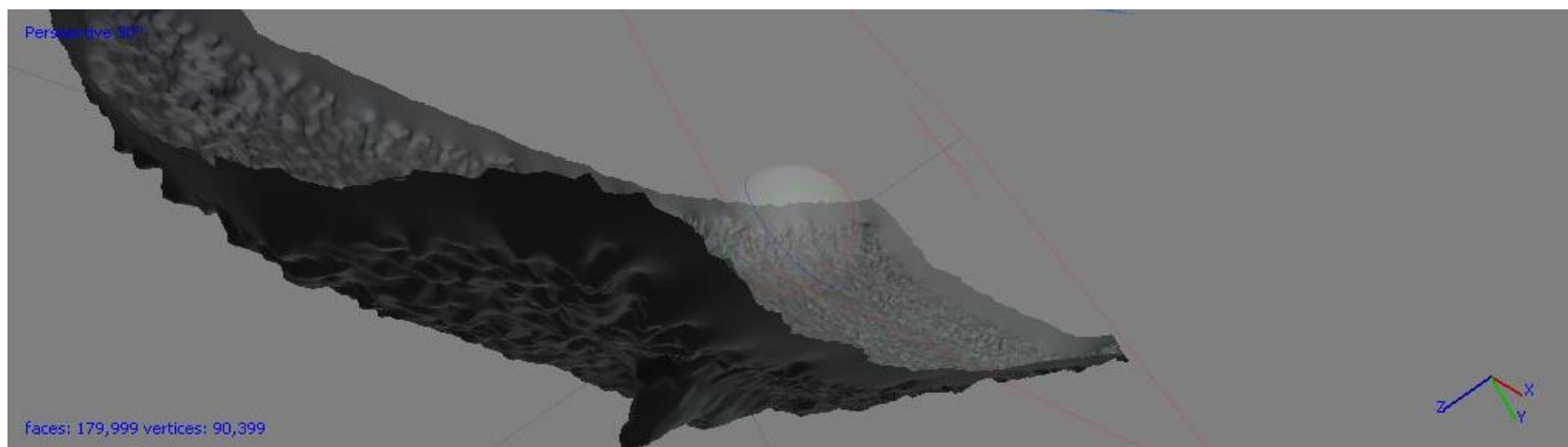
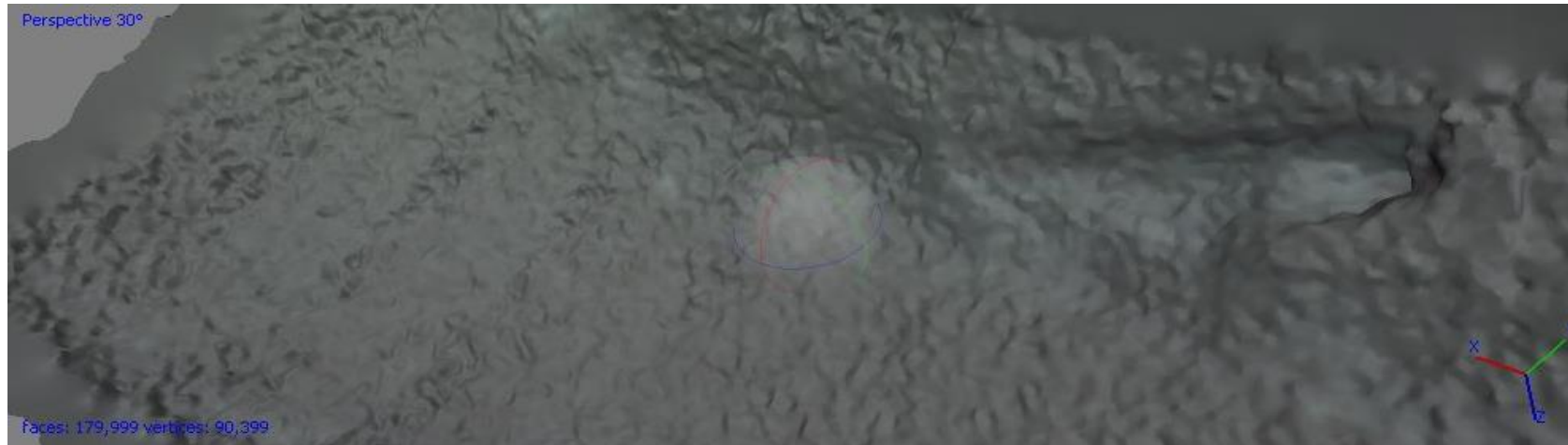
Expeditions

- **Scientific Outcome**



Expeditions

- Scientific Outcome



Achievements / Scientific Highlights



Expeditions

- Scientific Outcome



200 individuals / 8 soccer fields

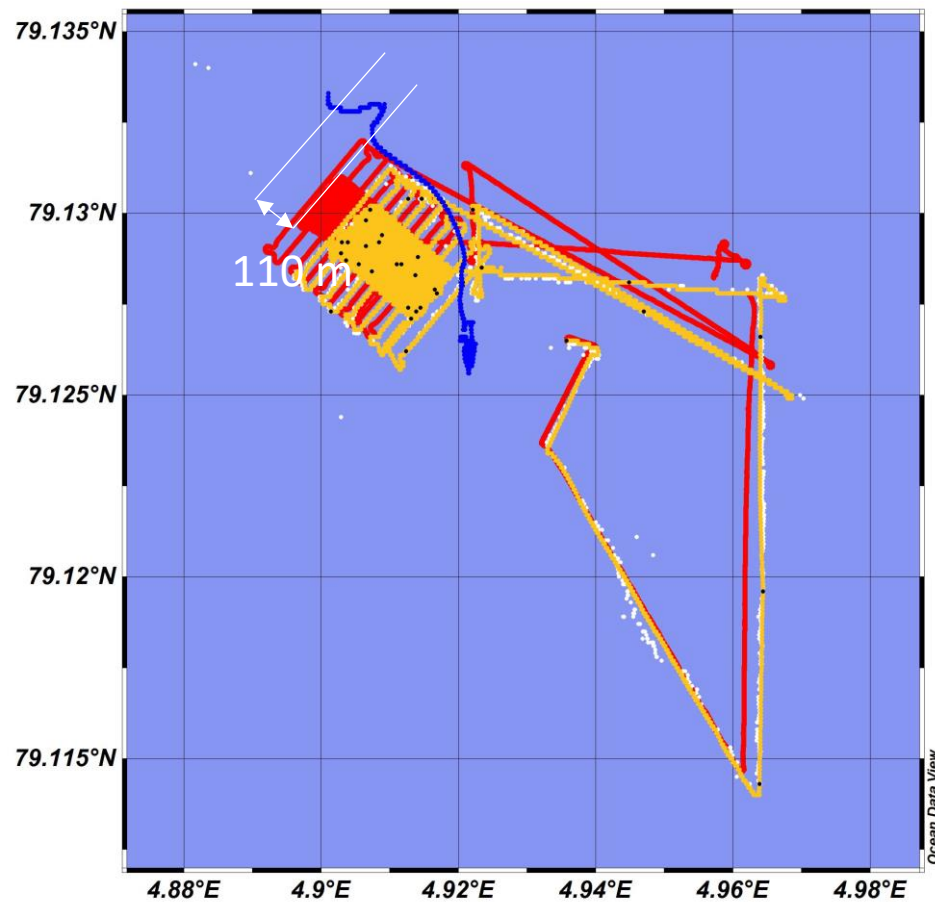
=

3500 individuals / kilometer²

Rang	Name	Fläche in km ²	Einwohner 31. Dez. 2018	Ew./km ²	Kreis
1.	München	310,70	1.471.508	4.736	Kreisfreie Stadt
2.	Ottobrunn*	5,23	21.542	4.119	München
3.	Berlin	891,12	3.644.826	4.090	Kreisfreie Stadt
4.	Gröbenzell*	6,36	19.967	3.139	Fürstentfeldbruck
5.	Stuttgart	207,22	624.820	3.012	Stadtkreis
60.	Bad Soden am Taunus	12,00	22.070	1.839	Main-Taunus-Kreis
61.	Karlsruhe	173,42	313.092	1.805	Stadtkreis
62.	Bremen	317,88	569.352	1.791	Kreisfreie Stadt
63.	Altbach*	3,34	5.967	1.787	Esslingen

Expeditions

- Data correction



Water Depth: 1500 m

Time to descend: 31 min

Error: 110 m



Thank you!