APECS-ARICE Online Technical Training

Moderation: Boris Radosavljevic and colleaugues (APECS/ARICE)






Arctic Research Icebreaker Cons.
ARICE

APECS
Association of Polar Early Career Scientists

How to Build a Deep Sea Robot

FRAM

Speaker:

Elena Schiller

Alfred Wegener Institute

Helmholtz-Centre

for Polar and Marine Research, Bremerhaven

Graphic: Alfred-Wegener-Institute/FRAM/Sabine Lüdeling

ARICE

Hi ☺ I‘m Elena

And this is what I do.

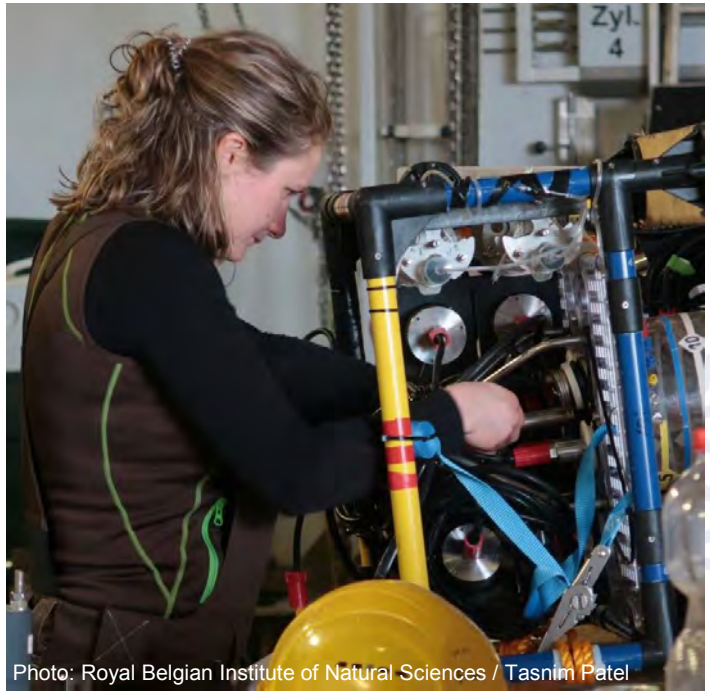
Photo: Royal Belgian Institute of Natural Sciences / Tasnim Patel


Photo: Alfred-Wegener-Insitut/Julia Otte

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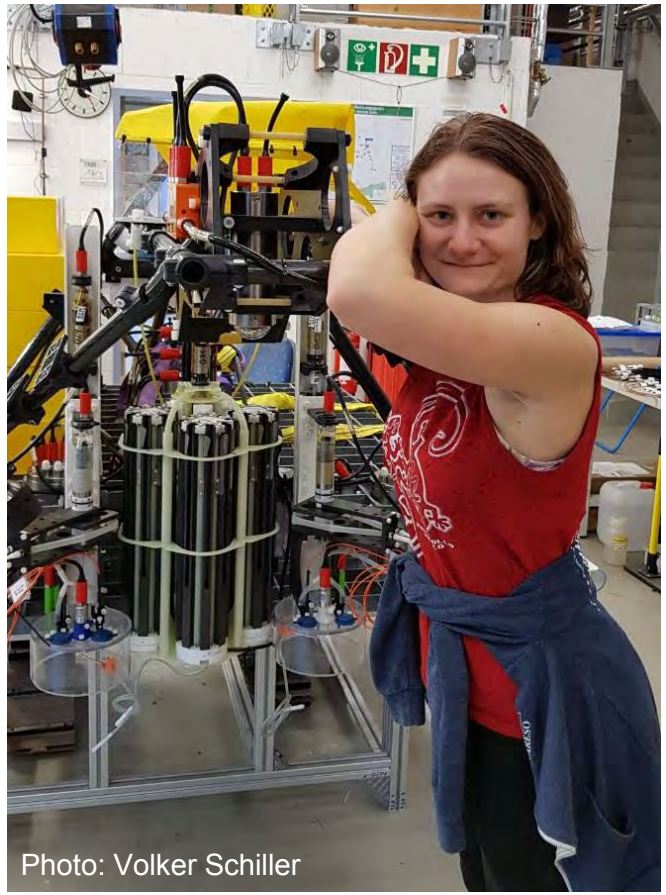


Photo: Volker Schiller

Nice to meet you. Who are you?

Schedule

I. Introduction
– Who even builds deep sea robots and why?

Q&A → WonderMe break → switch to Zoom Meeting

II. The steps of doing magic
– From a scientist‘s demand to a diving science mashine

Q&A → WonderMe break → go into Zoom break-out rooms

III. Practical part
– Design your own deep sea robot

Who even builds deep sea robots and why?

I do ☺

means I invent things

Elena Schiller

Construction Engineer

HGF-MPG Joint Research Group for **Deep-Sea** Ecology and Technology

Alfred Wegener Institute for Polar and Marine Research (**AWI**) Bremerhaven, Germany

means I kinda do heavy metal

means I don't do electricity

Background:

B.Sc. Mechanical Engineer

Thesis: Design of a buoyancy system for a manned submersible for 1000 m depth

Scientific Diver

Some semesters of Biochemistry

Currently studying M.Sc. Marine Sensoring at Uni Oldenburg

Who even builds deep sea robots and why?

1. Scientific Institutions
2. Military
3. Industry
4. Crazy people with expensive hobbies
5. Daydream-Me …

1. Scientific Institutions

… what does „build“ even mean?

- from scratch?
- buy basic system somewhere and customize it?
- motivate industry partners to build customized version of what they usually build?
- co-production with industry partners?
- co-production with other institutes?
- Re-assemble elements you already have as spares to build a completely new system?

… We do all of the above!

1. Scientific Institutions

- **AWI** (Alfred-Wegener-Institute Helmholtz-Centre for Polar and Marine Research Bremerhaven, Germany)
- **GEOMAR** (Helmholtz Centre for Ocean Research Kiel, Germany)
- **MPI** (Max Planck Institute for Marine Microbiology Bremen, Germany)
- **marum** (Center for Marine Environmental Sciences Bremen, Germany)
- **DFKI** (German Research Centre for Artificial Intelligence Kaiserslautern, Germany)
- **WHOI** (Woods Hole Oceanographic Insitution, Massachusetts, USA)
- P.P. Shirshov Institute of Oceanology of the Russian Academy of Sciences, Russia
- **Ifremer** (Institut français de recherche pour l'exploitation de la mer, France)

… and more

1. Scientific Institutions

What do they do? → Science!

What kinds of science?
→ biology
→ (bio-)(geo-)chemistry
→ geology
→ climatology
→ ocean physics
→ mapping
→ anything …

Are the robots all alone?
→ autonomous systems
→ remotely operated systems
→ crewed systems

Do they move?
→ stationary systems
→ mobile systems
→ towed systems

today's focus

How long are they down there for?
→ short-term (minutes – hours – days)
→ mid-term (days – weeks)
→ long-term (weeks – years)

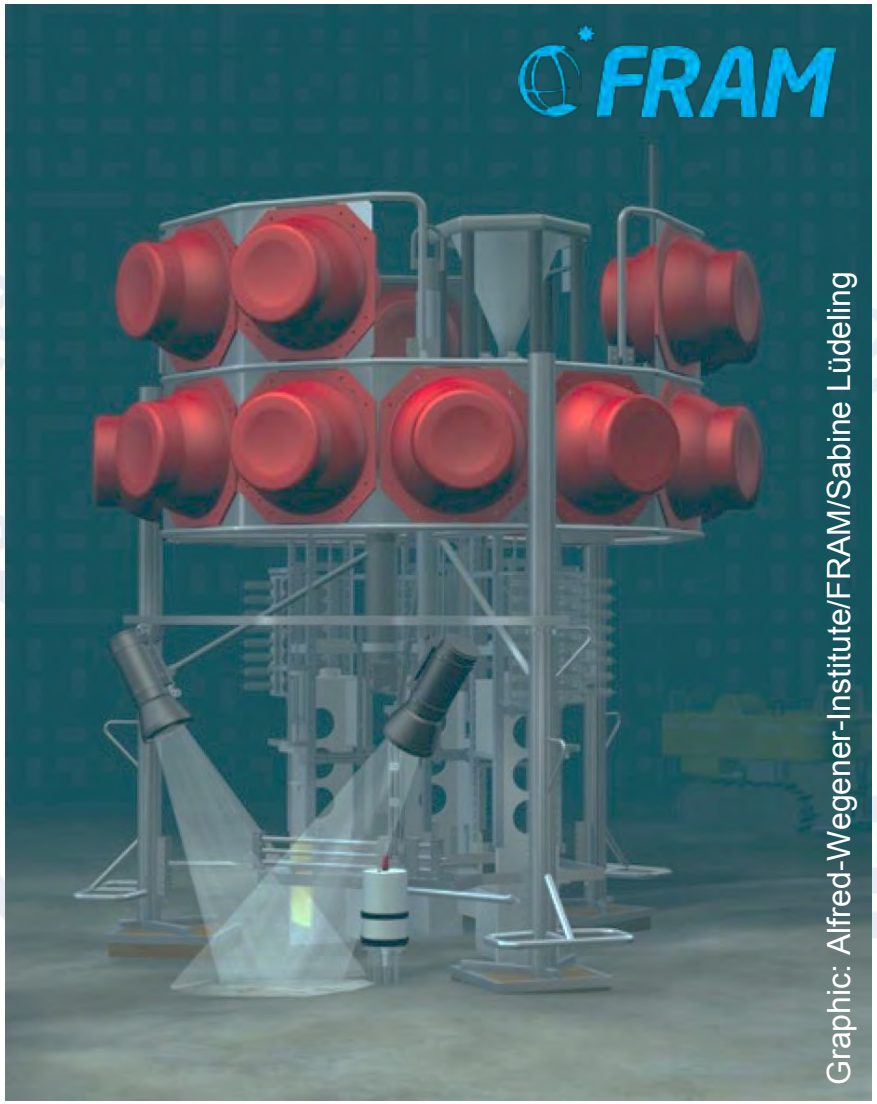
By what kinds of methods?
→ photo and video footage
→ measurements
→ sample taking
→ experiments

Where in the sea do they do it?
→ on the bottom (benthic systems)
→ in the water column (pelagic systems)
→ deep, deep down … ('Full Ocean Depth' ≙ 6000m)

1. Scientific Institutions – AWI and GEOMAR

stationary systems: Landers

- long-term deployment
- free-falling or launched
- autonomous
- water measurements (pH, salinity, temperature, turbidity, …)
- current measurements
- water sampling
- sediment images
- experiments (respiration chambers)
- sediment trap
- …



Graphic: Alfred-Wegener-Institute/FRAM/Sabine Lüdeling

Alfred-Wegener-Institut, author unknown
https://www.awi.de/fileadmin/_processed_/d/0/csm_Lander-2_fd044f69e6.jpg

1. Scientific Institutions – AWI and GEOMAR

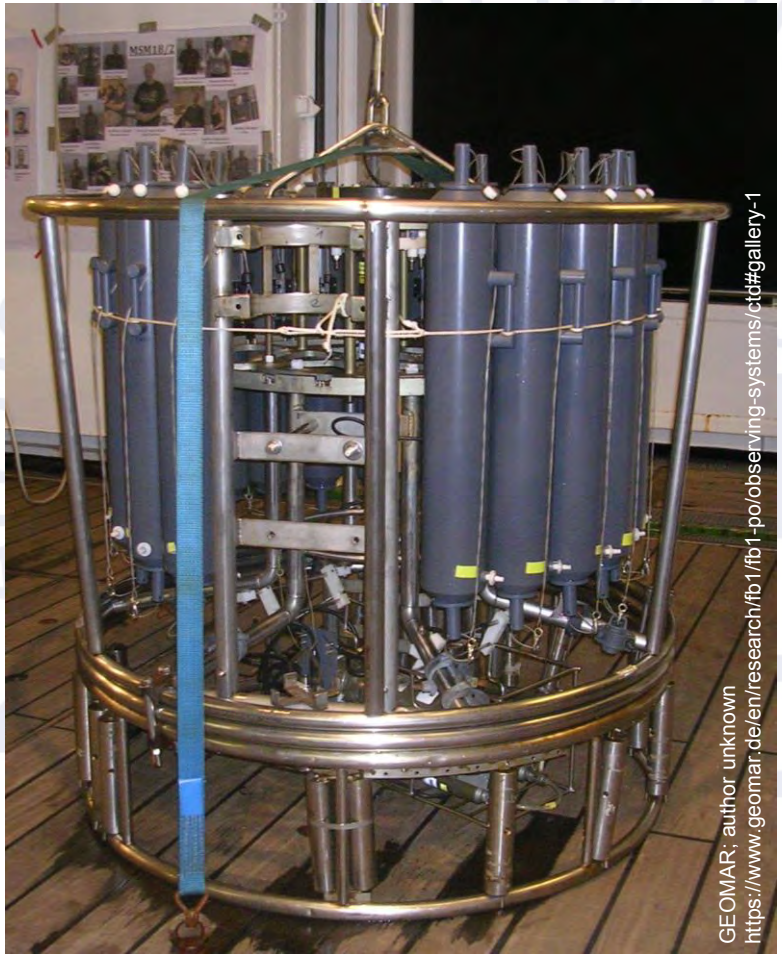
towed system(s): CTD and MUC

Conductivity Temperature Depth (CTD)

- short-term
- dragged by ship
- water measurements
- water sampling

Multi-Corer (MUC)

- (extremely) short-term
- tethered to ship
- (blind) sediment sampling



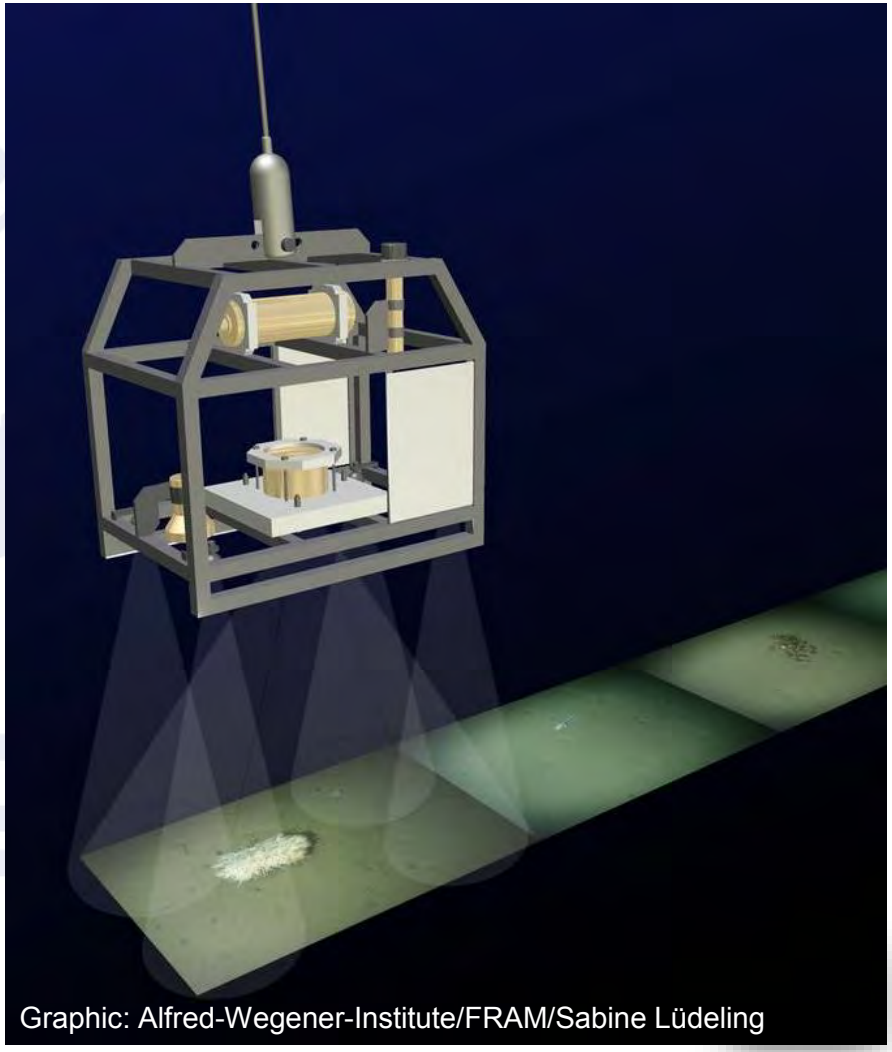
1. Scientific Institutions – AWI and GEOMAR

towed system(s): OFO(B)S

Ocean Floor Obervatory (and Bathymetry) System

- short-term
- dragged by ship
- sediment imagery: HD / hyperspectral / 3D camera systems
- sea floor transect mapping
- (bathymetry)
- can be used as launcher

Alfred-Wegener-Institut, unknown
https://www.awi.de/fileadmin/_processed_/2/d/csm_DSCN3323_381a38b44c.jpg



Graphic: Alfred-Wegener-Institute/FRAM/Sabine Lüdeling

1. Scientific Institutions – AWI and GEOMAR

crewed system: submersible JAGO

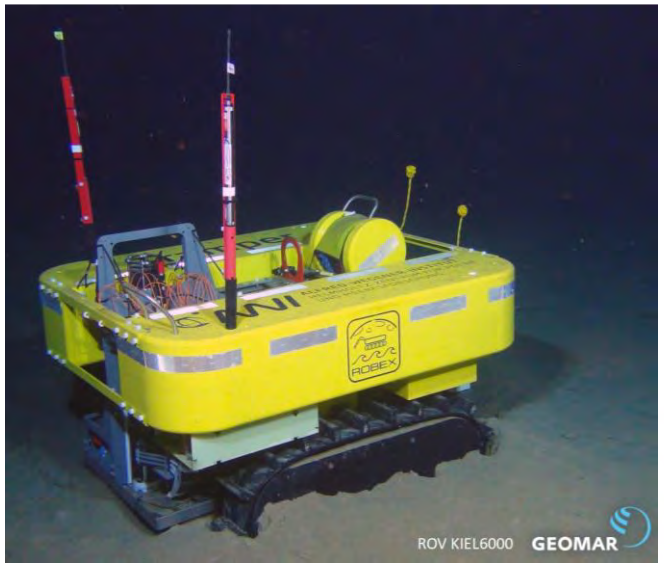
- technically not deep sea (400m)
- technically not a robot (crewed)
- autonomous
- maneuvers by thrusters and buoyancy chamber
- 2 passengers
- manipulator arm and storage board/tray
- modular payload

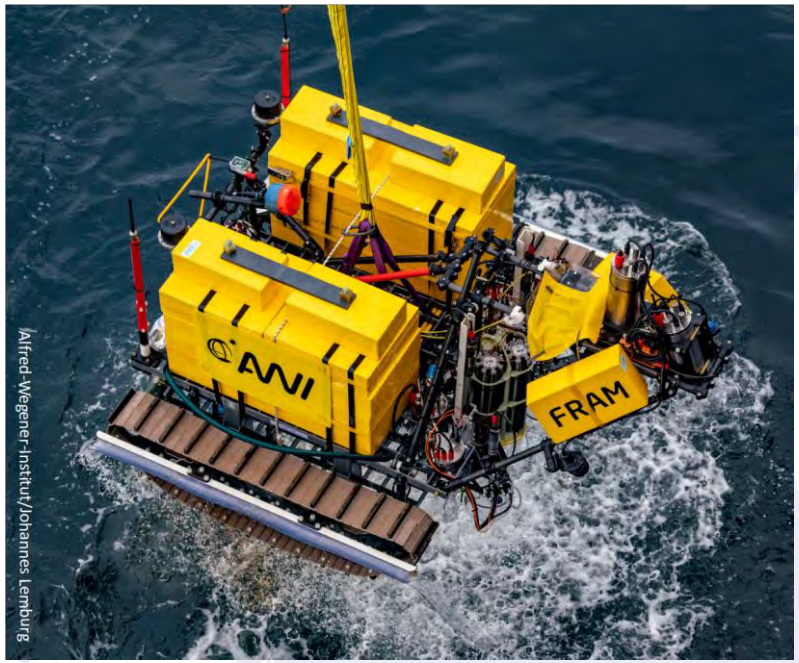
GEOMAR, author unknown
https://www.geomar.de/zentrum/einrichtungen/tlz/jago/spezifikationen-logistik

GEOMAR, author unknown
https://www.geomar.de/zentrum/einrichtungen/tlz/jago/uebersicht

1. Scientific Institutions – AWI and GEOMAR

mobile benthic systems: Crawlers TRAMPER and NOMAD





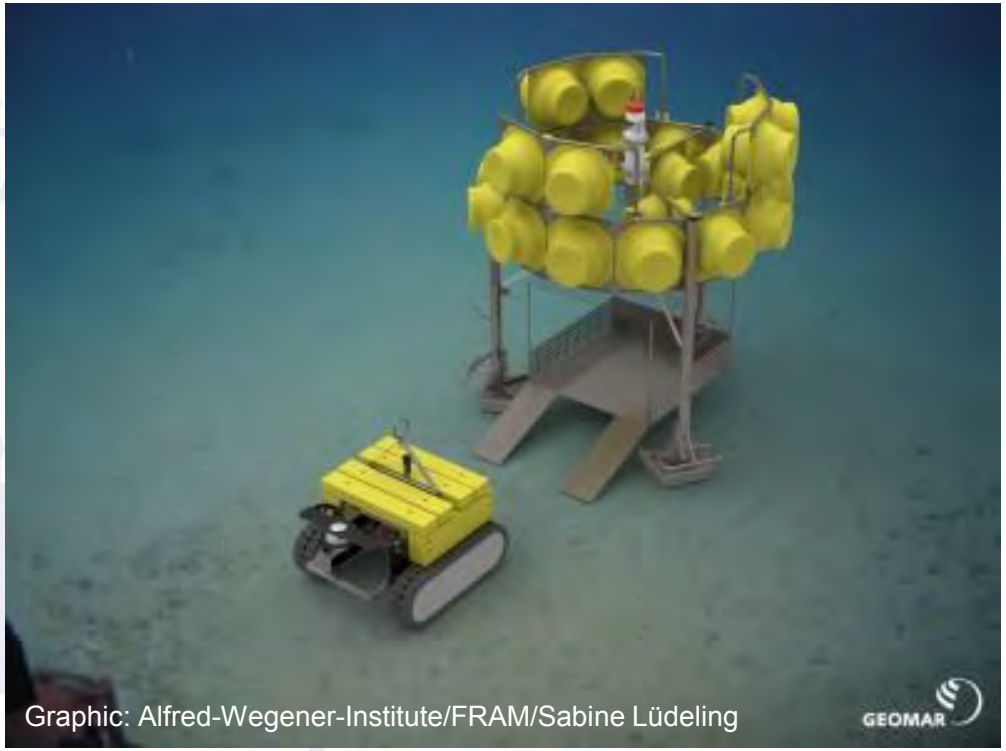
- free-falling or launched, long-term (1-2 years)
- autonomous, maneuvers by chain drive on sediment
- sediment imagery: HD / hyperspectral / 3D camera systems
- sediment O_2 measurements & experiments: concentration depth profiles and respiration chambers

TRAMPER: https://www.youtube.com/watch?v=h9Jh1oEBhAI (AWI)

1. Scientific Institutions – AWI and GEOMAR

combined systems: MANSIO & VIATOR

Photo: Esther Horvath
https://www.oceanblogs.org/eadsm/2015/09/11/toolboxes-at-the-seafloor/


Graphic: Alfred-Wegener-Institute/FRAM/Sabine Lüdeling

- long-term, autonomous, launched together
- Crawler VIATOR with hometown-Lander MANSIO for battery re-charge

1. Scientific Institutions – AWI and GEOMAR

mobile pelagic systems: AUVs PAUL and Glider

Glider: https://www.youtube.com/watch?v=J3ViBke2ZQg (GEOMAR, oceananimation)

- long-term, autonomous
- maneuvers by buoyancy and fins

AUV PAUL: https://www.youtube.com/watch?v=NldvrZXhJcY (AWI)

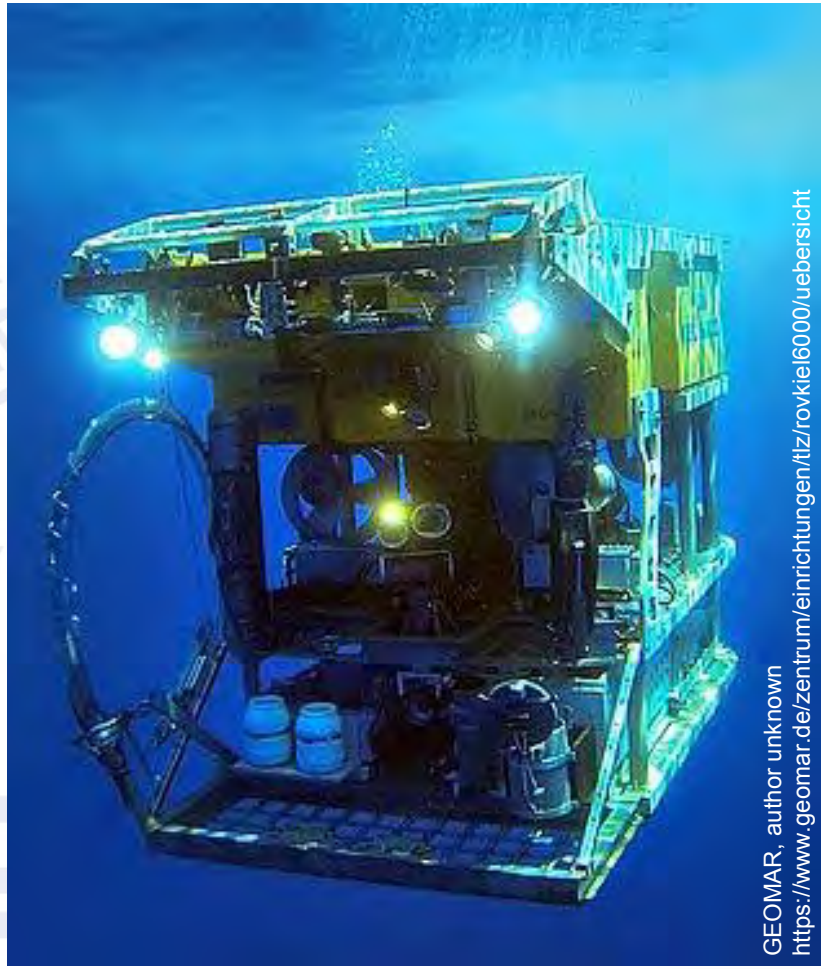
- short-mid-term (hours-days), autonomous
- maneuvers by thruster, fin and buoyancy, navigates by Intertial Navigation
- water measurements: CTD, turbulence, nitrate, fluorometer, light sensor, O_2
- sidescan sonar for sea-floor transect mapping, camera
- water sample collector

1. Scientific Institutions – AWI and GEOMAR

remotely operated system: ROV Kiel6000

- short-term
- bound to ship by umbilical
- maneuvers by thrusters
- requires winch and pilot containers and 4 people
- manipulator arm and storage board/tray
- several cameras
- modular payload
- can install and manipulate ROV modules

GEOMAR, author unknown
https://www.geomar.de/zentrum/einrichtungen/tlz/rovkiel6000/bildergalerie

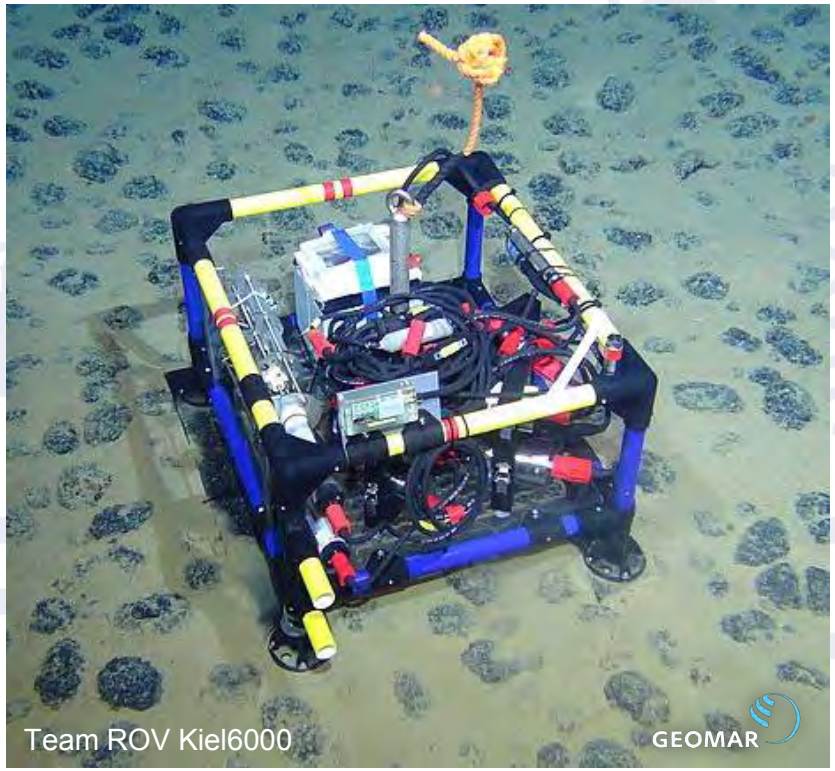


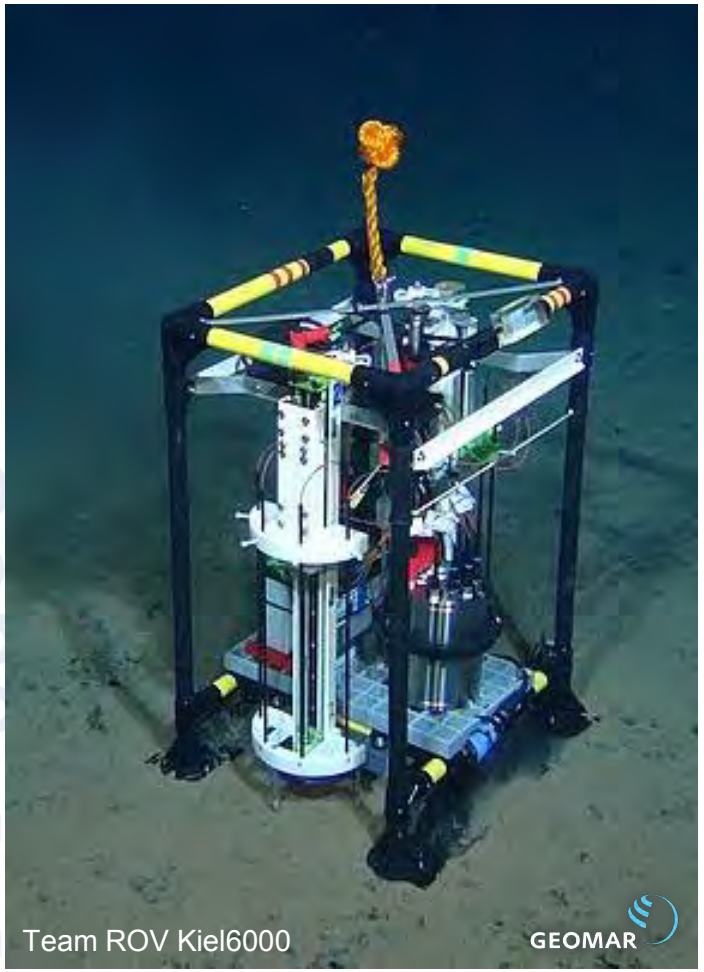
GEOMAR, author unknown
https://www.geomar.de/zentrum/einrichtungen/tlz/rovkiel6000/uebersicht

1. Scientific Institutions – AWI and GEOMAR

dependant systems: ROV modules

- operated by ROV
- short-mid-term
- small, divers payload units



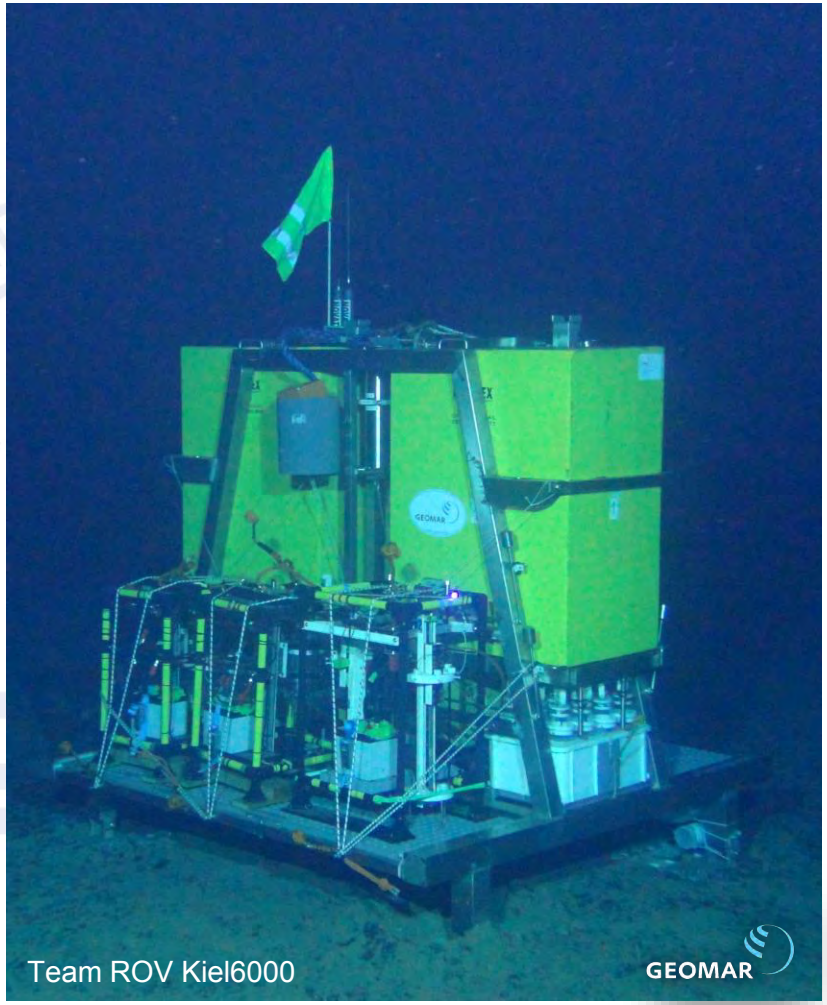


1. Scientific Institutions – AWI and GEOMAR

combined systems: Elevator & ROV & ROV modules

- operated by ROV
- short-mid-term
- vertical transport Lander

Photo: M. Schulz
https://www.oceanblogs.org/eadsm/2015/09/11/toolboxes-at-the-seafloor/



Team ROV Kiel6000

GEOMAR

1. Scientific Institutions – AWI and GEOMAR

https://www.youtube.com/watch?v=RTVzMtuHeoE (GEOMAR Kiel)

„Deep Sea Research as we do it today is technically really challenging,
„It‘s anything but a routine job to deploy this equipment“
„You always have to live with bigger and smaller problems and even failures“

„Most of the technology we are actually deploying is not industry standard yet, so we‘re really at the forefront of developing this deep sea technology and that brings a lot of challenges during such a cruise.“

Matthias Haeckel, GEOMAR

2. Military

Who knows? ….

3. Industry

- For selling them to science, military and industry

  e.g. Bluefin Robotics: https://gdmissionsystems.com/underwater-vehicles/bluefin-robotics

- Deep sea mining
  - report by News Direct on deep sea mining project in Papua New Guinea

    https://www.youtube.com/watch?v=vMs_hoBdGSw
  - report by The Economist: https://www.youtube.com/watch?v=IYKaKeJv2dQ

- Sub-sea cable installation

  e.g. SubCom cable lay: https://www.youtube.com/watch?v=PVgjyUrhTc8

- Installation and maintanance of off-shore wind energy plants (more shallow sea) and oil rig platforms

4. Crazy people with expensive hobbies …

… or maybe they‘re just brilliant and cool?

- Victor Vescovo: The Five Deeps, 2018
- James Cameron: Deepsea Challenger, 2012
- Hans Fricke: Geo and Jago
  ~1990; technically not robots & not deep sea, but German
- Auguste Piccard: Trieste, 1953
- many more …

The New Generation ☺

Design: J. Lenz

5. Daydream-Me …

… ocean bottom cleanup!

- Plastic trash
- World War II naval mines
- Secretly (e.g. political reasons) dumped (bio-)chemical waste or even weapons

Interdiciplinary work (technicians, nautics, ocean scientists, environmental organisations, historians, military experts, diplomats, …) with lots of adventure …

… anyone in!?

APECS-ARICE Webinar
How to Build a Deep Sea Robot
Questions!?



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An international collaboration strategy for meeting the needs of marine based research in the Arctic

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Thank you very much!






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Webinar recording will be available on arice.eu and on the APECS website

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