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CNR polar marine robotics

Under ice robotics: the origin

- Problem: topography of the packed-ice underwater profile
- Solution: using underwater vehicles equipped with acoustic sensors
- Interesting natural test site
  - Fletcher's Ice Island (T-3)
- UARS Unmanned Arctic Research Submersible
  - University of Washington's Applied Physics Laboratory
- Spring 1972
  - UARS explores the keel of Fletcher's Ice Island

Figure 2 Unmanned Arctic Research Submersible System (UARS) - University of Washington, Seattle

UARS: technology challenge

- AUV deployed from a hole in the packed-ice
- Challenge: to find the **launch&recovery** hole after having traveled a 17 mile transect!
- Solution:
  - an acoustic transponder deployed in water through the hole
  - two directional acoustic receivers mounted on the vehicle bow and one omnidirectional acoustic receiver mounted on the vehicle stern
  - recovery via a net in which the tip of the vehicle got caught

Mid Nineties: Odyssey AUV in the Arctic

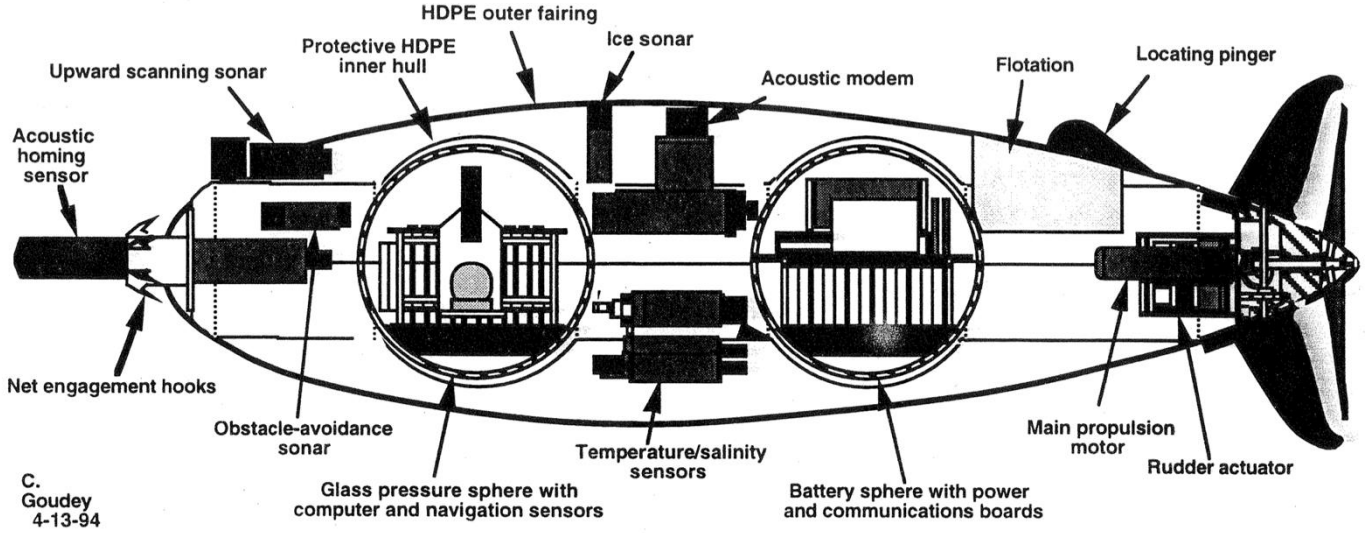
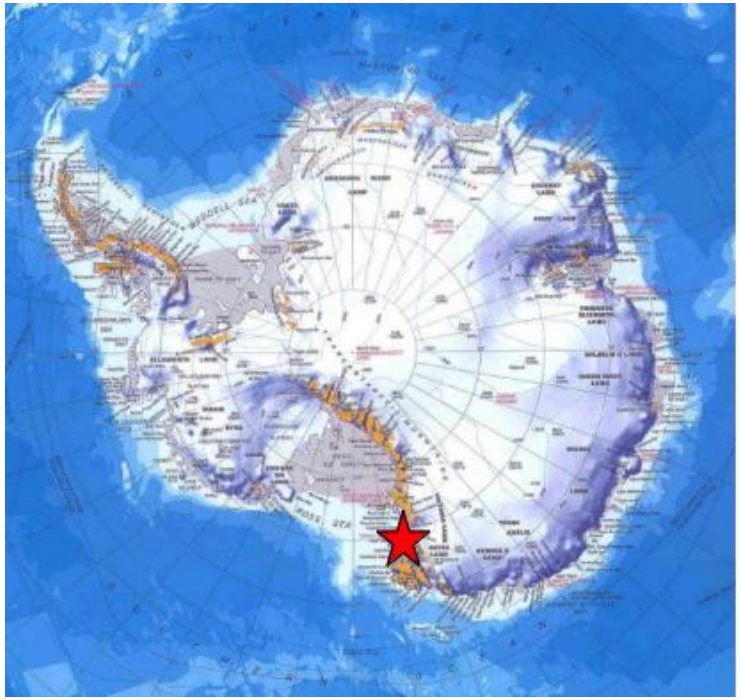


Figure 1: Arctic configuration of Odyssey II. Mission sensors are the scanning sonar at the nose, and the temperature and conductivity sensors located in the center of the vehicle.

- the MIT Odyssey AUV was launched from a hole in the pack protected by a tent

Nineties: CNR underwater robots in Antarctica

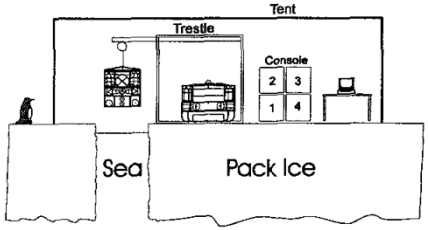
- Mario Zucchelli station, Terra Nova Bay, Ross Sea

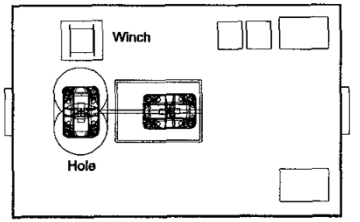


1993: CNR-IAN Roby2, the first Italian ROV in Antarctica

Roby2 ROV deployed from TNB pier

ROV deployment from a tent on the ice pack





to support the proposal of an Antarctic Specially Protected Area No 161 in Terra Nova Bay, Ross Sea

Malippo: 14m support vessel

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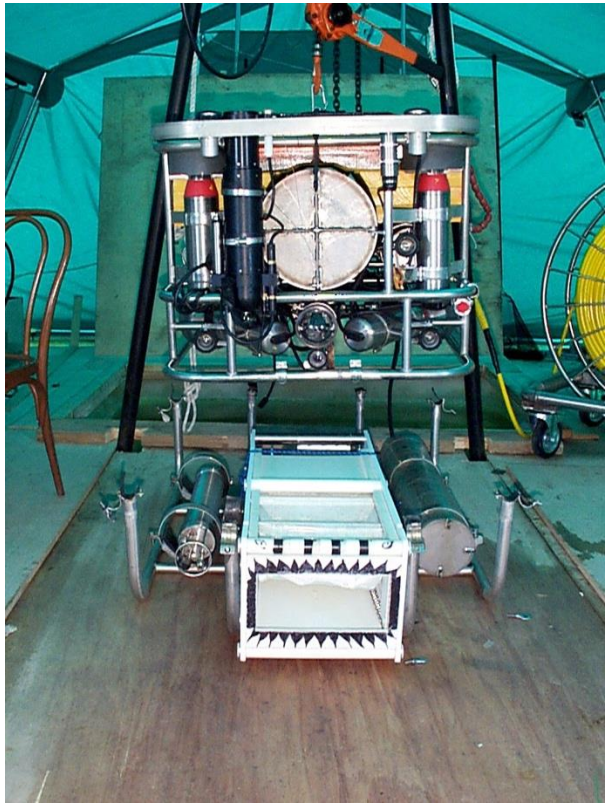
1997: Romeo ROV & PRISMA project



- under packed-ice monitoring
- performance evaluation of acoustic instrumentation of SARA AUV
- underwater monitoring from Malippo support vessel

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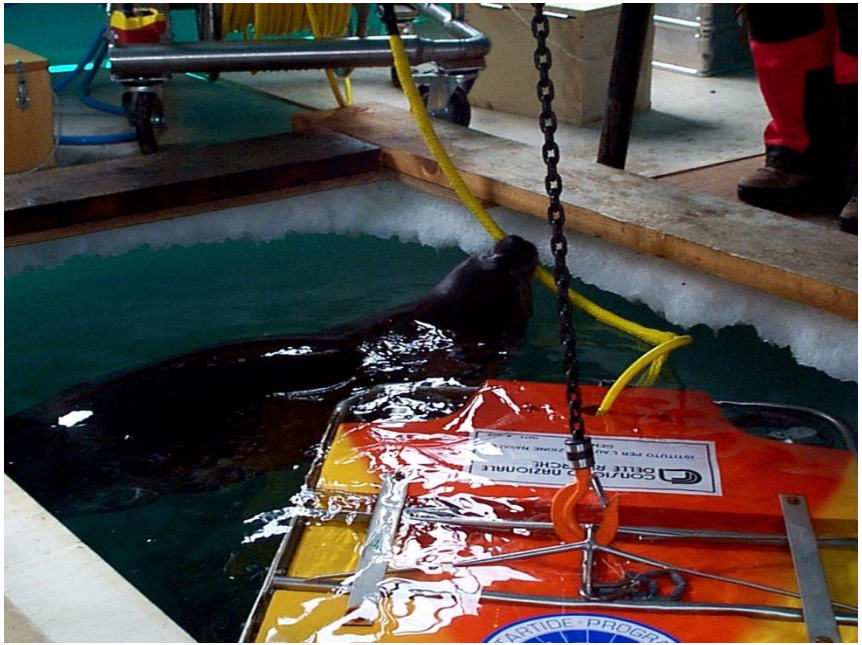
1997: Romeo ROV & PRISMA project

Romeo ROV: robot-seal interactions



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Tele-operation of underwater robot in Antarctica

- Satellite-based tele-operation of a ROV into McMurdo Sound in Antarctica from NASA AMES Research Center in USA
  - preliminary trials towards Mars missions

Antarctica used as a space robotics training ground

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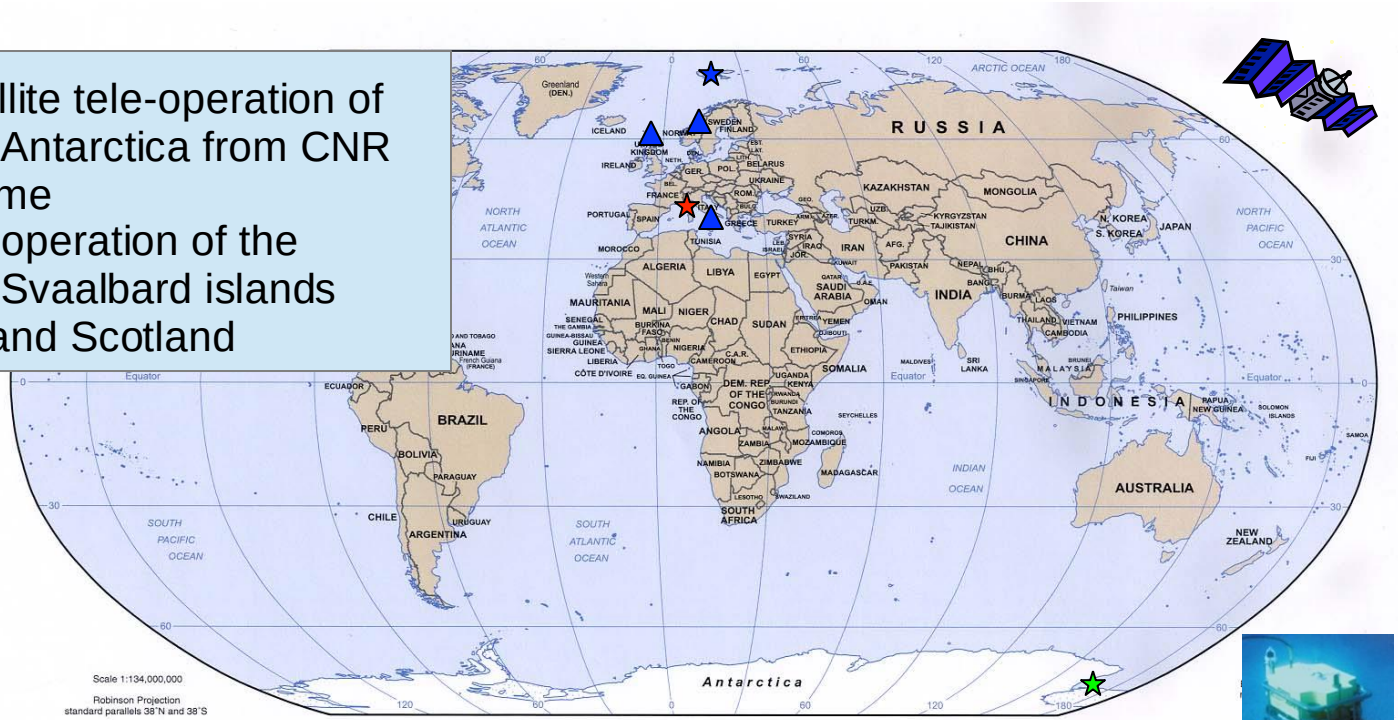
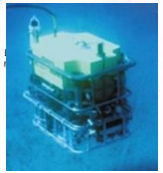
New Millennium: polar Internet-based tele-operation

- Internet-based satellite tele-operation of the Romeo ROV in Antarctica from CNR headquarters in Rome
- Internet-based tele-operation of the Romeo ROV in the Svaalbard islands from Italy, Norway and Scotland





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2002: Internet-based tele-operation of Romeo ROV in the Arctic

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Harsh environment

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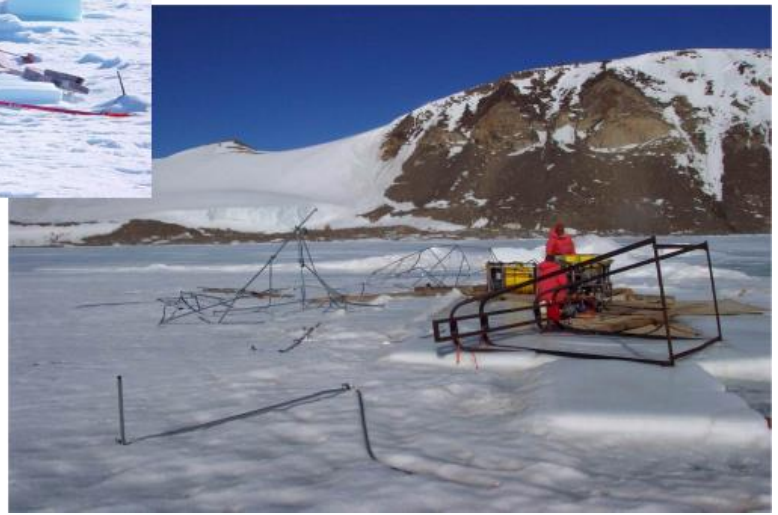
Wind effects

It was the day before the Internet-based tele-operation from CNR headquarters...

... the camp was mounted again in one day



Heavier logistics

from tent...

to containers...

2003: Romeo ROV as Antarctic Benthic Shuttle

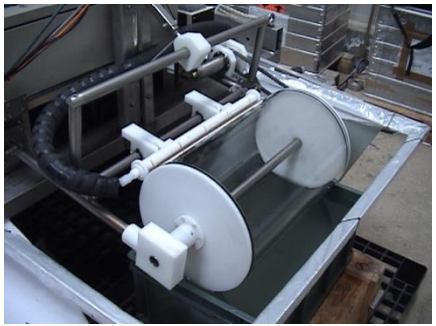
ABS project

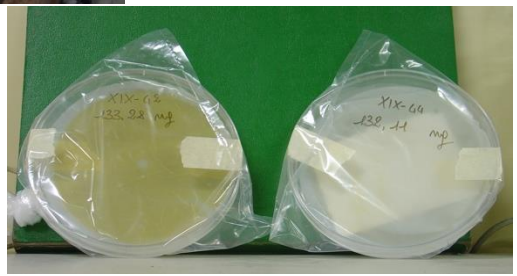
Goal: persistent monitoring of seafloor-water interactions below the packed-ice in Antarctica

- accurate positioning of a benthic chamber over the seabed below the packed ice and recovery after 24 hours

2004: CNR Charlie, the first USV in Antarctica

- **SESAMO project**
  - study of the sea-air interface
    - integral sampling of the sea surface microlayer and immediate sub-surface water with a Harvey-like cylinder





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2013-2014: RAISE project

- Integrate Research on AntarctIc Silverfish Ecology in the Ross sea
  (coordinator: Prof. Marino Vacchi, ISPRA / CNR-ISMAR)
  - observing and understanding the Antarctic silverfish reproduction in the platelet ice
    - adaptation of a COTS mini-ROV

from Divers to Robots

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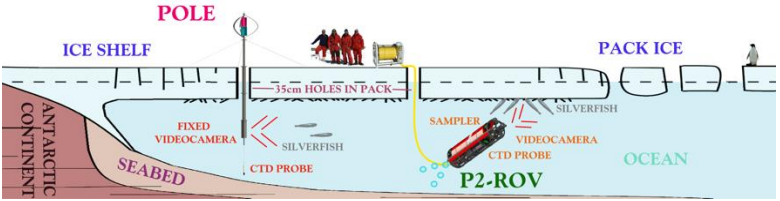
2013-2015: POLE project

- POLE - towards Persistent and autonomous mOnitoring and sampLing of undErsea ice (coordinator Gabriele Bruzzone, CNR-ISSIA)



observing and understanding the Antarctic silverfish reproduction in the platelet ice

2017: ICECLIMALIZERS project

- Scientific goal: to collect bryozoans at 60 m depth and re-implant them in shallow water cages (coordinator Chiara Lombardi, ENEA)
  - Proteus ROV equipped with an innovative underwater electrical arm

CNR in the Arctic

- Dirigibile Italia Station, Ny Alesund, Svalbard Islands

Study of the ice-water-air interface in the Arctic

Operational

Scientific dissemination & cooperations

2018
International training & vertically extended surface robotics

2017
Cooperative marine and air robotics

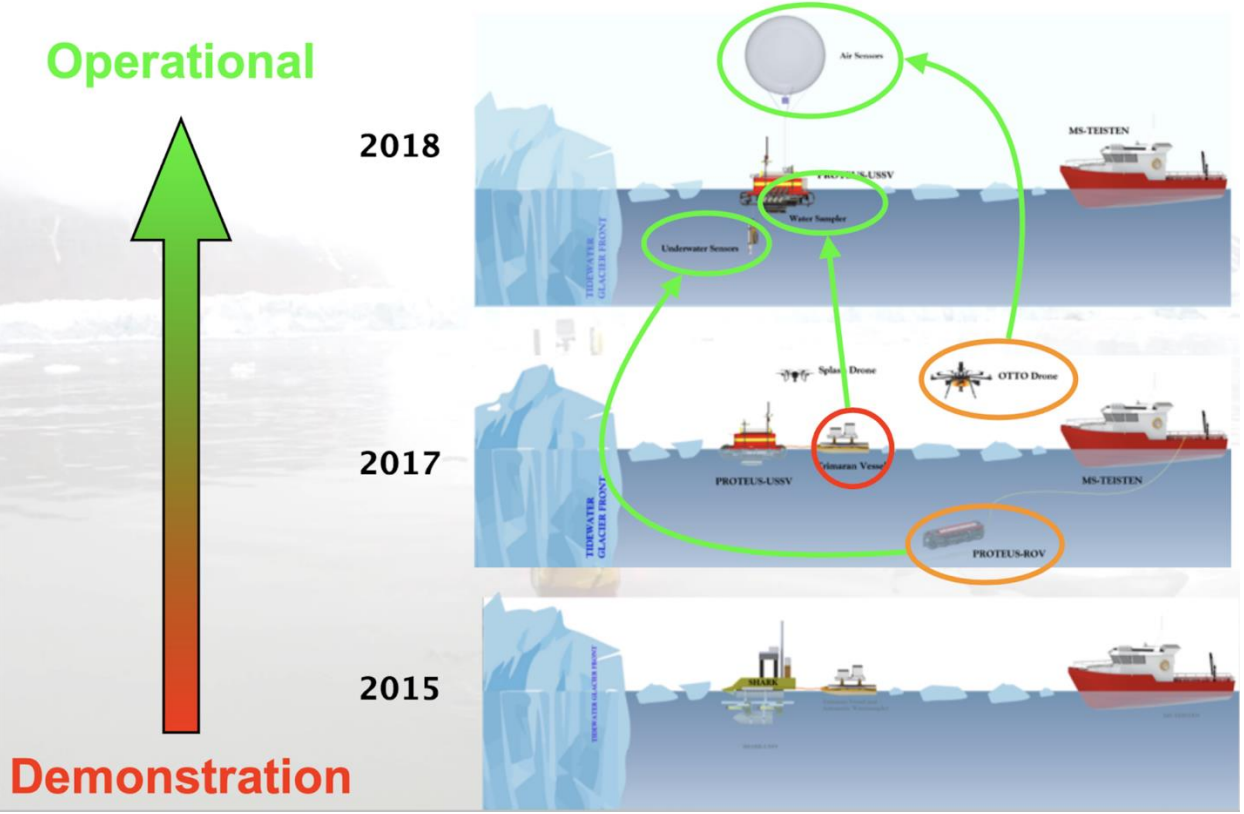
2015
Preliminary demonstration of technology

Society communication

Demonstration

Technological steps

Operational



Demonstration

Proteus ASSV
tele-operated semi-submersible vehicle
+ mini water samplers
+ winch deployed underwater probe
+ winch released balloon with air gauge

Proteus ASSV
tele-operated semi-submersible vehicle
+ towed water sampling system
+ UAV for air column sampling

Proteus ROV
tele-operated underwater vehicle

Shark ASSV
tele-operated semi-submersible vehicle
+ towed water sampling system

Key factor: logistics

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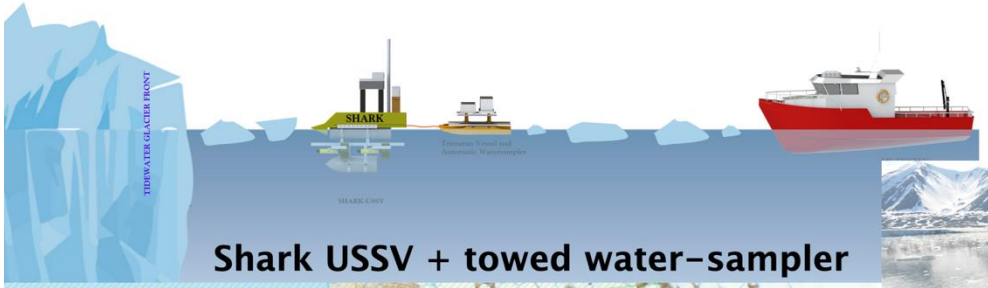
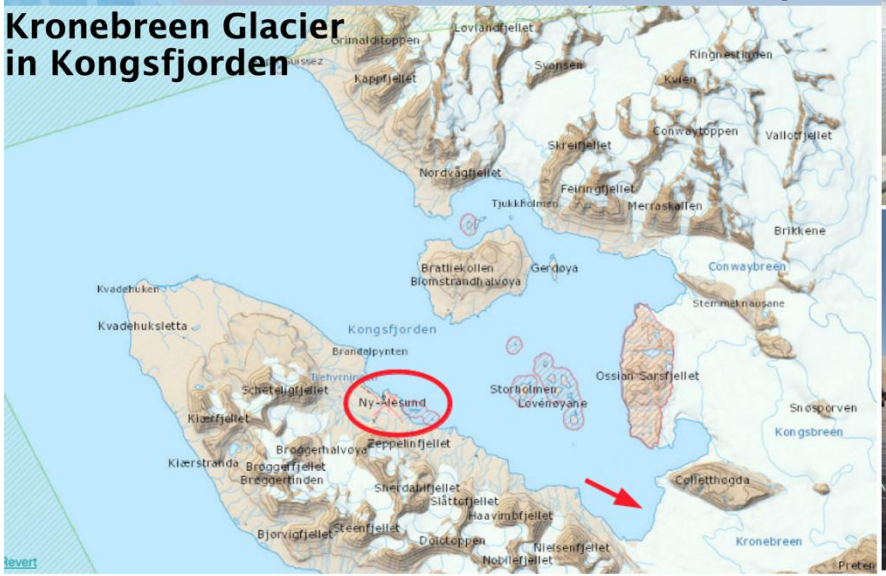
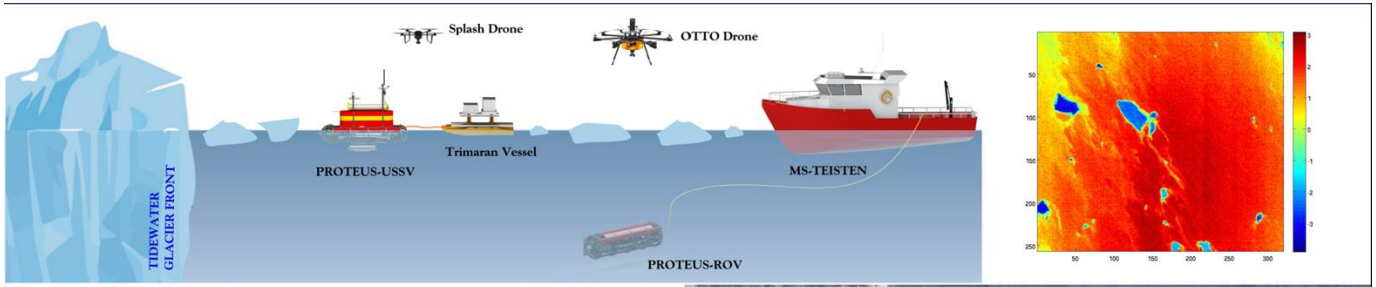
2015: ARCA project





2015: ARCA project

2017: UVASS project



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2017: UVASS project - harsh environment risks

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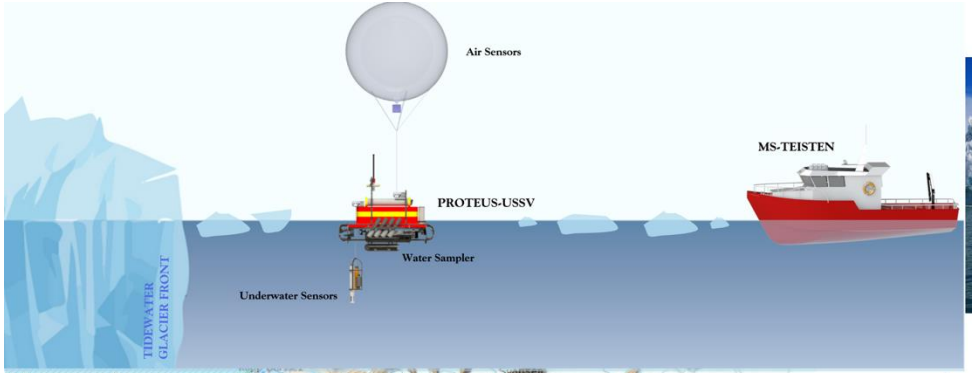
2017: UVASS project

2018: ExcelLABUST project



H2020-TWINN-2015 contract n. 691980 EXCELLABUST Excelling LABUST in marine robotics

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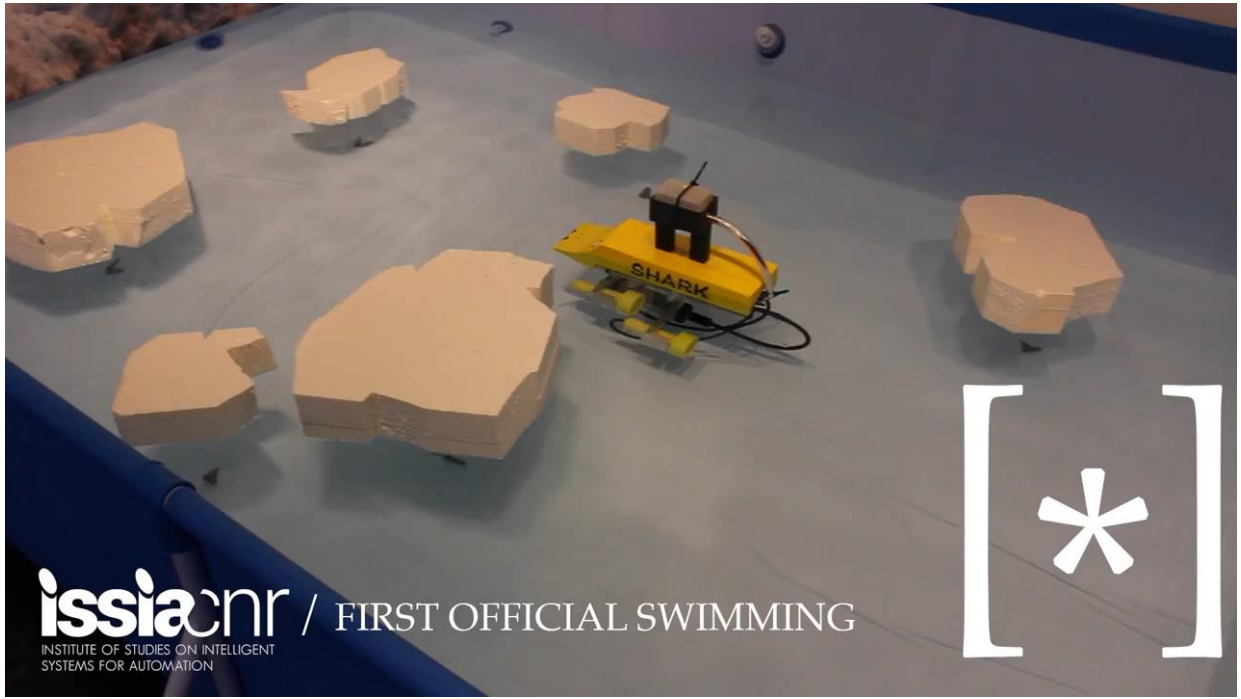
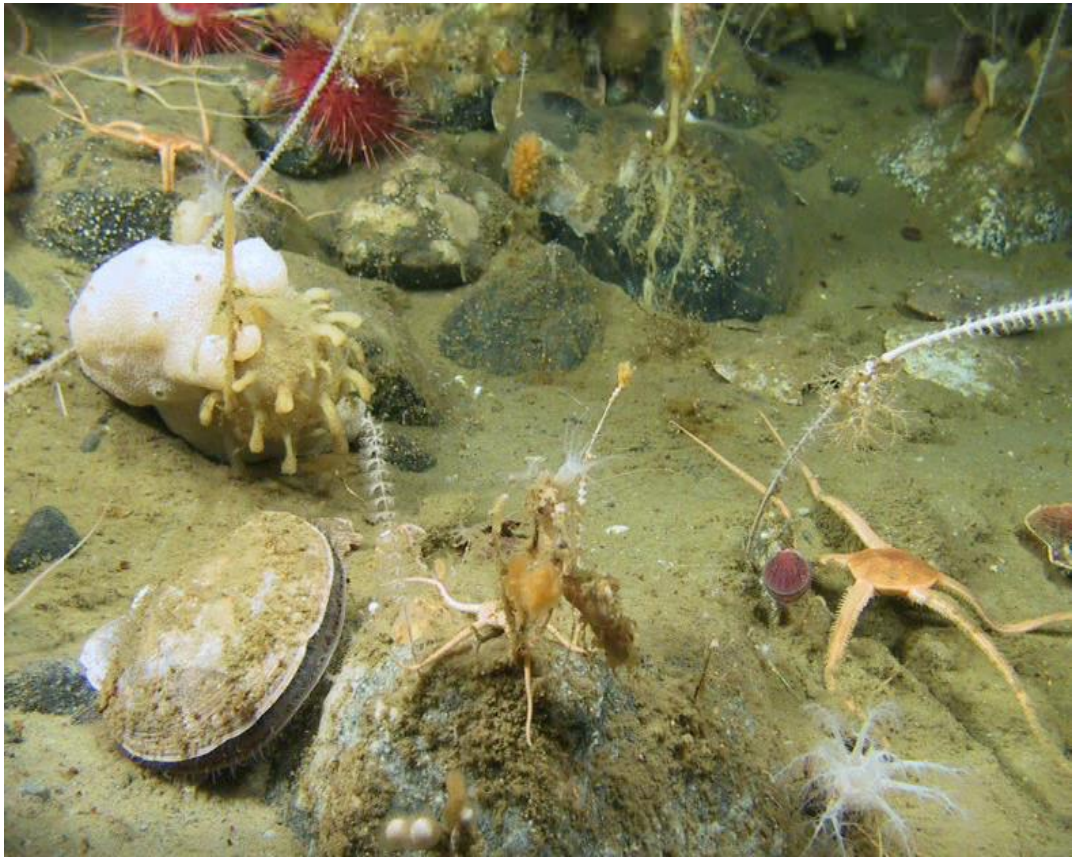
2018: ExcelLABUST project

Society communication

- Festival della Scienza, Genova



Any questions?



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