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From the Sea

to Space

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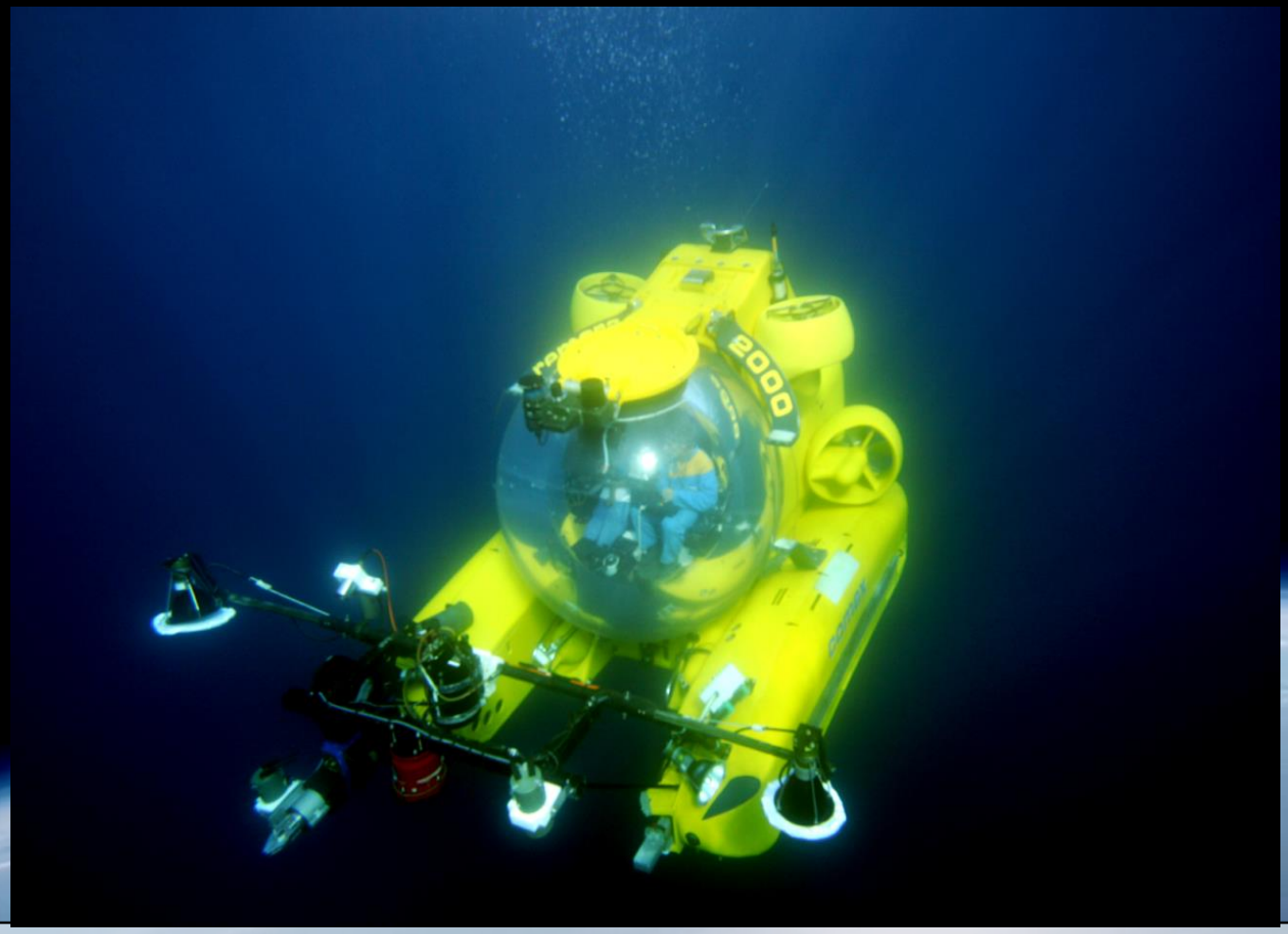
COMEX from Sea to Space



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COMEX and its expertise

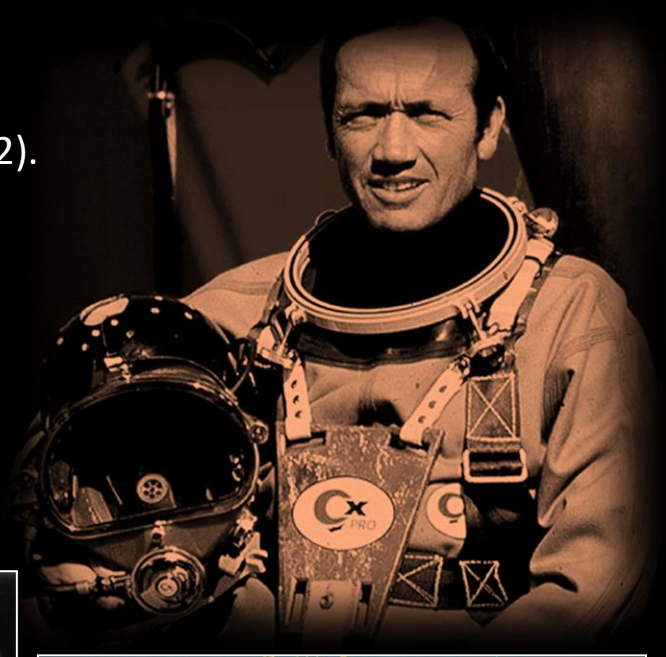
The *Compagnie Maritime d'Expertise* (COMEX) was founded in 1961 by Henri Germain Delauze (1929-2012).

It became a worldwide pioneer in the development of technologies for human and robotic intervention in extreme environments.

Saturation dive 180m under ice (1969)

SEACOM dive support vessel (1983)

HYDRA-10 deep-diving record (1992)



FONASURF subsea mining (2017)

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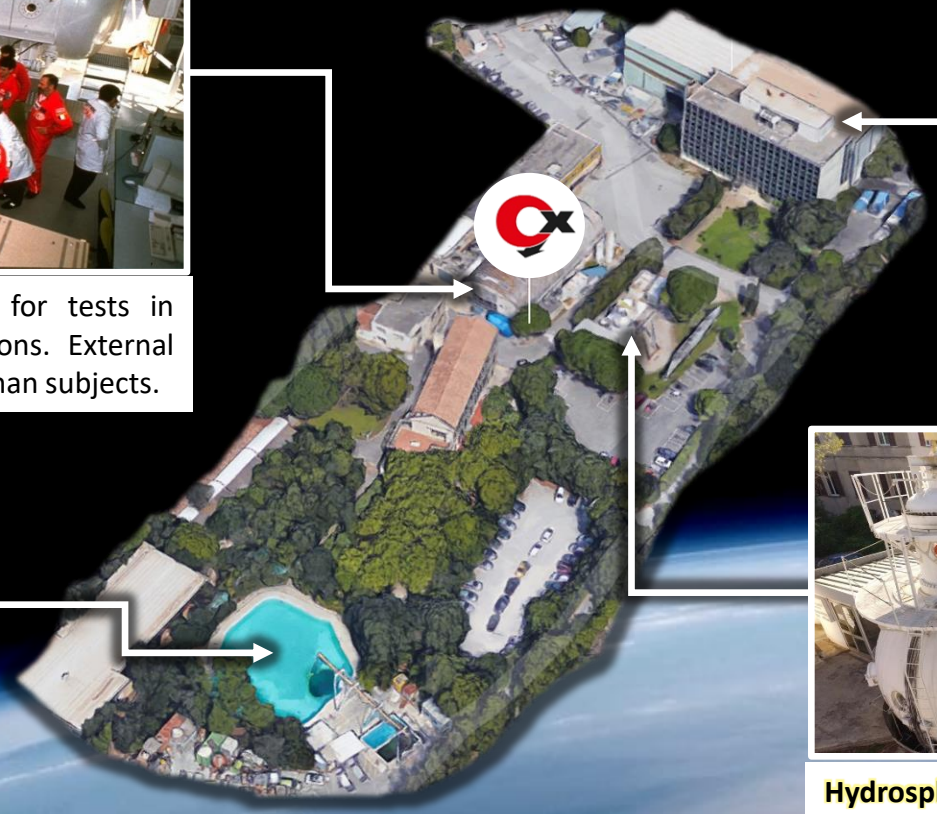
A variety of testing facilities in one single place

Hyperbaric Experimental Centre for tests in hyperbaric and hypobaric conditions. External medical platform for tests with human subjects.

The COMEX Hyperbaric Experimental Centre is classified ESA Ground Based Facility.



CE4000 for tests from vacuum to 400bar, temperature regulated. Test diameter 2,4m.

Test Pools (-10m) for tests of systems and robots, including teams of **professional divers**.

Hydrosphere hyperbaric and hypobaric tests. The facility includes a habitat for tests with humans.

Image courtesy: GOOGLE Maps

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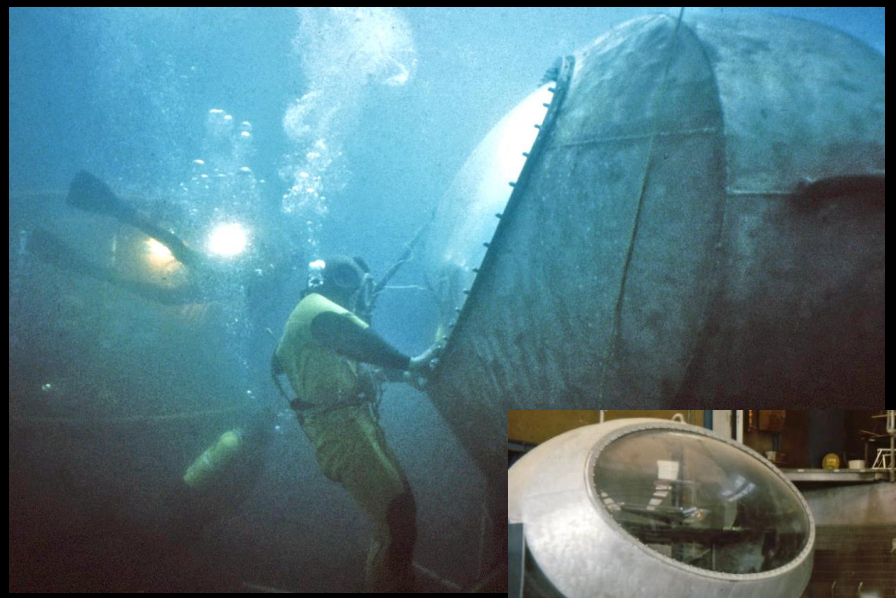
Expertise in pressure chambers and habitats

Development and on-site installation of a test facility for ROLEX watches (600bar) including control by camera.
(image courtesy: ROLEX)

Development of a temperature controlled testing chamber for 3000bar



Underwater habitat HIPPOCAMP and AQUABULLE with Jacques ROUGERIE

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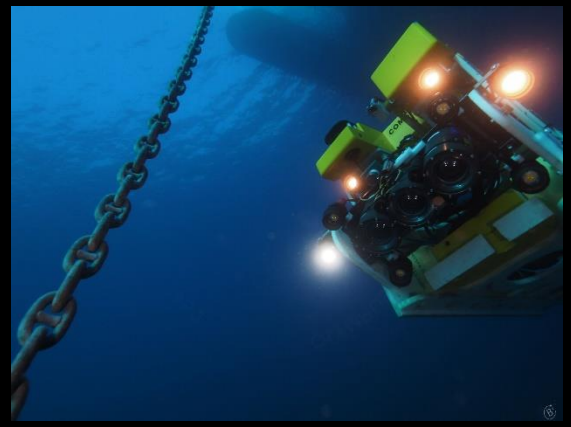
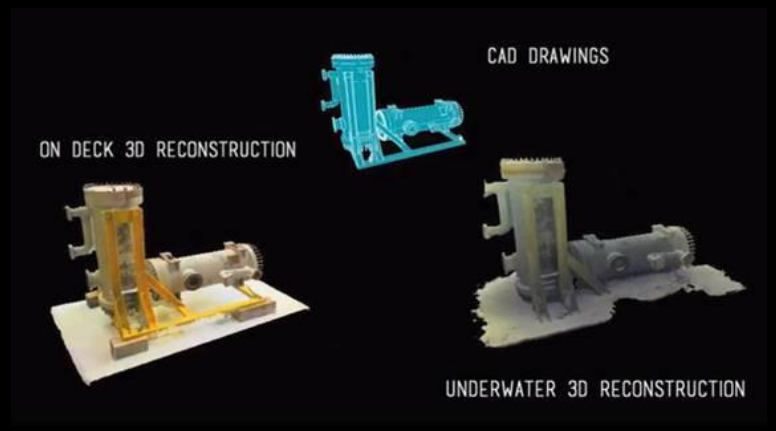
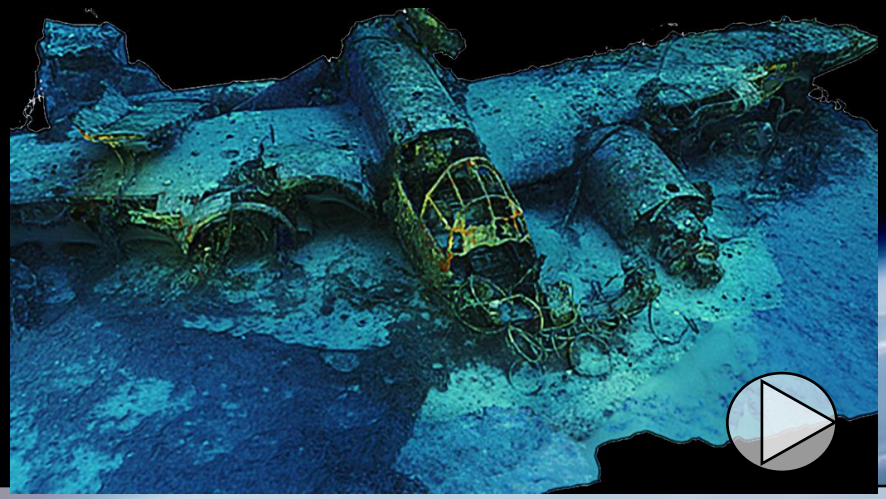
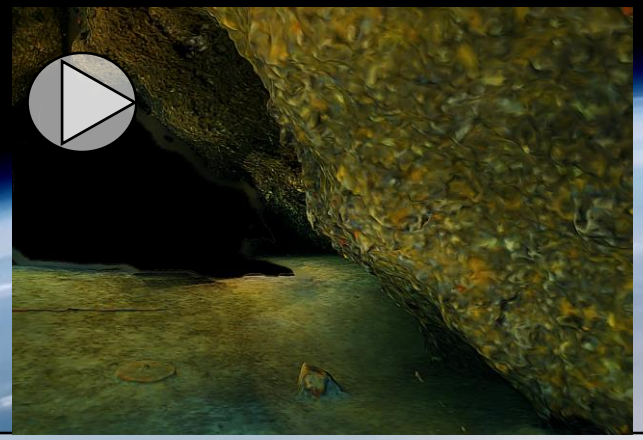
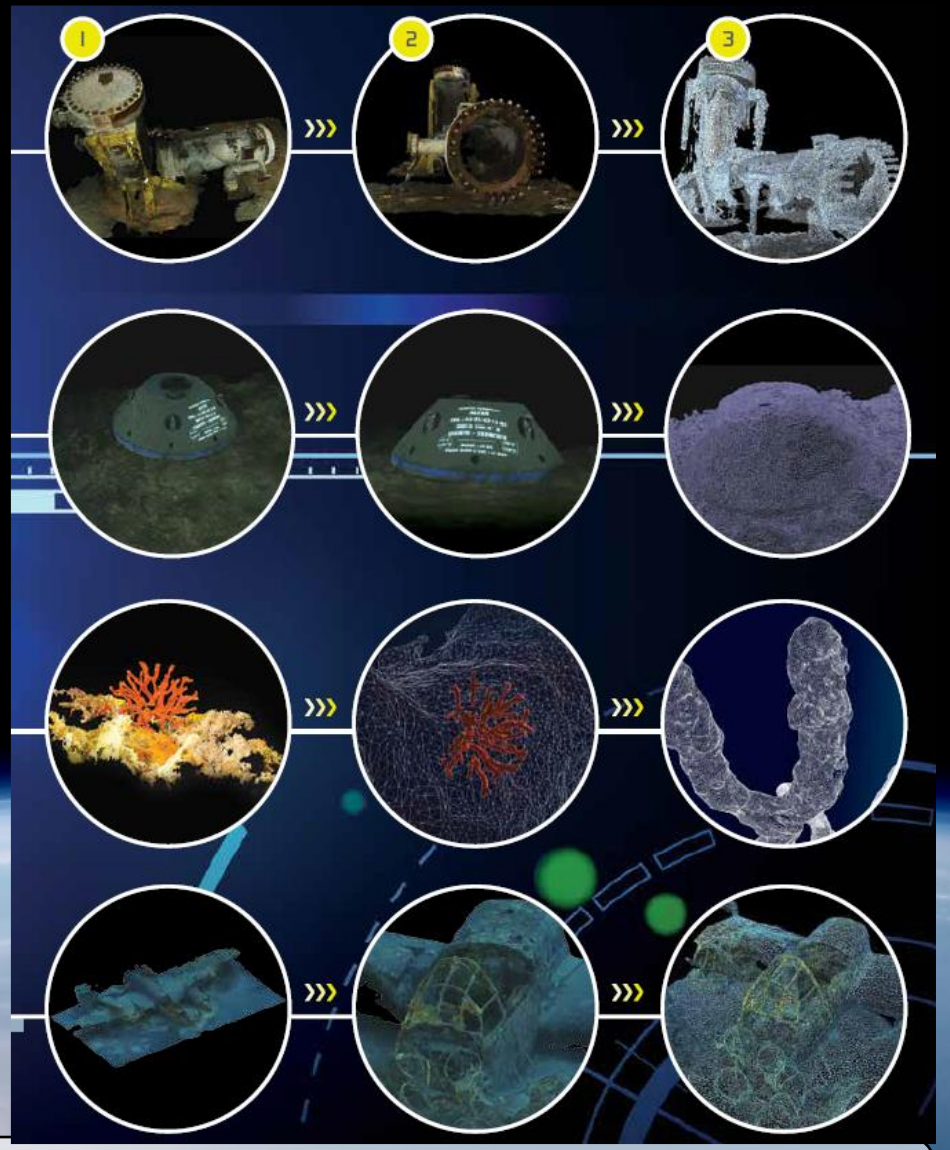
ORUS3D underwater 3D photogrammetry system with real-time coverage and data quality control











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Validation of equipment for aerospace equipment with humans in the loop

COMEX provides test of equipment with human subjects (including medical monitoring team)

High-altitude tests with a COMEX' subject in the low pressure chamber
(Photo: L. Negrel, COMEX)

Hyperbaric Flight Simulator

Test of a stratospheric suit for the
"Grand Sault" Mission

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Underwater Astronaut Training and NBF Simulations

Photo: A.Rosenfeld

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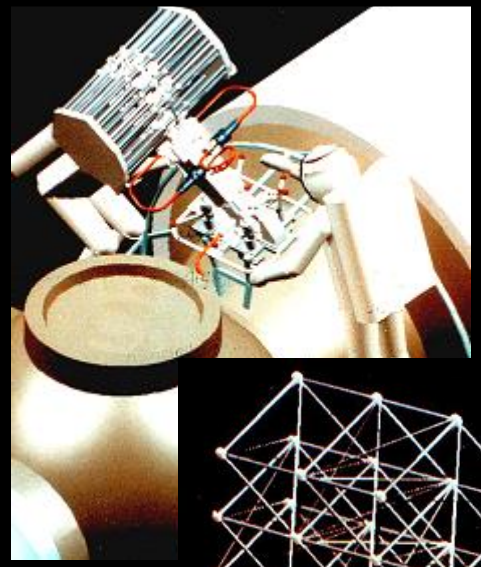
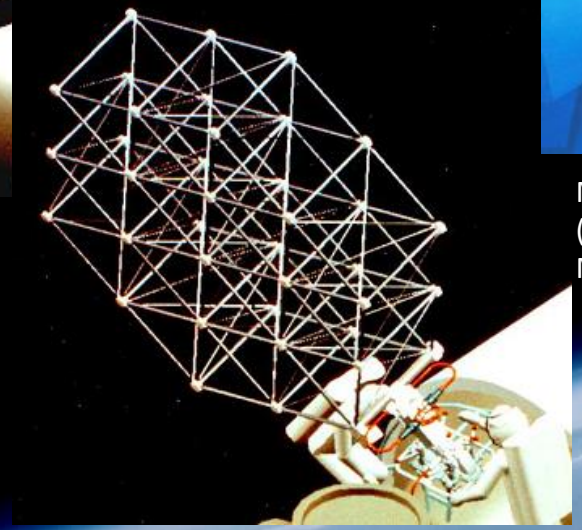
1987 EVA Training of astronauts (CNES / ESA)

Training of Russian and French Astronauts in the COMEX' pools for a mission outside the Russian MIR Station.





Mission ARAGATZ to MIR
(Jean-Loup CHRETIEN,
Michel TOGNINI)

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1989 Ergonomic tests for the HERMES SAS (CNES - ESA)

Ergonomic tests for extravehicular activities outside of the HERMES Shuttle. The tests were performed in COMEX' pools.

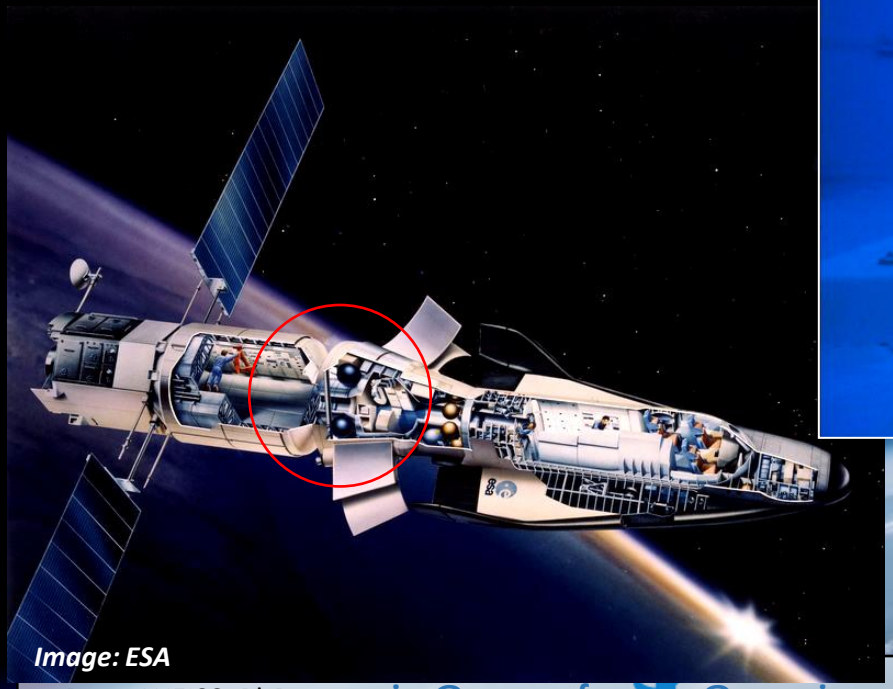
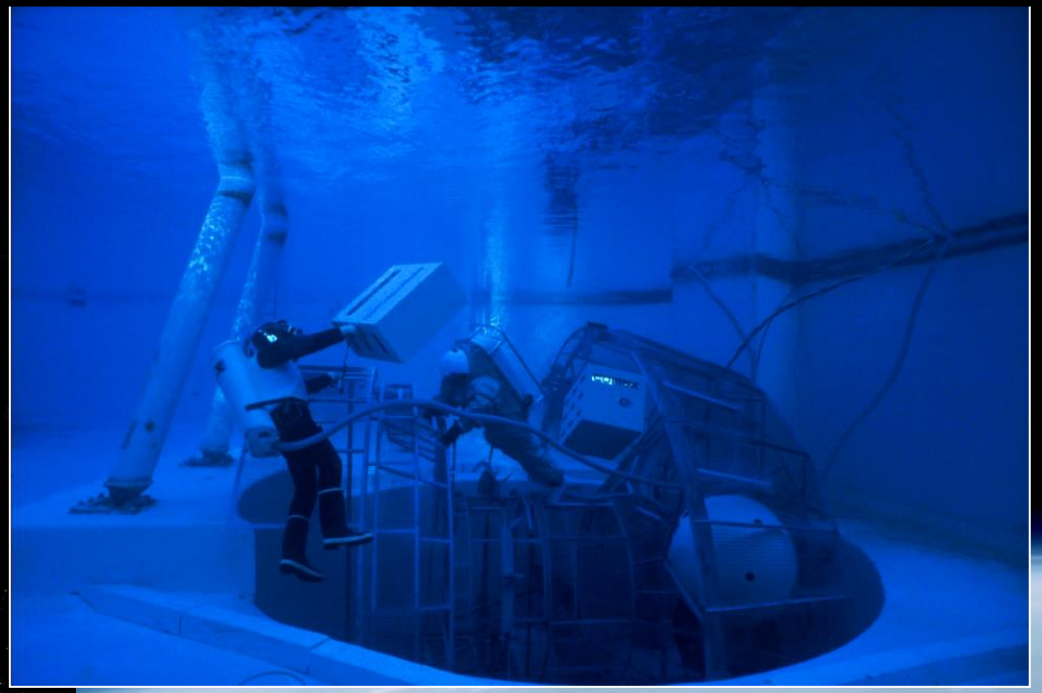


Image: ESA



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1990 IVA Study for COLUMBUS (ESA)

Tests on the installation of racks inside the ISS-COLUMBUS laboratory in simulated microgravity (underwater)

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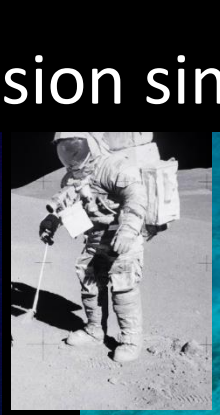
2013 APOLLO XI UNDER THE SEA: Subsea Space mission simulation



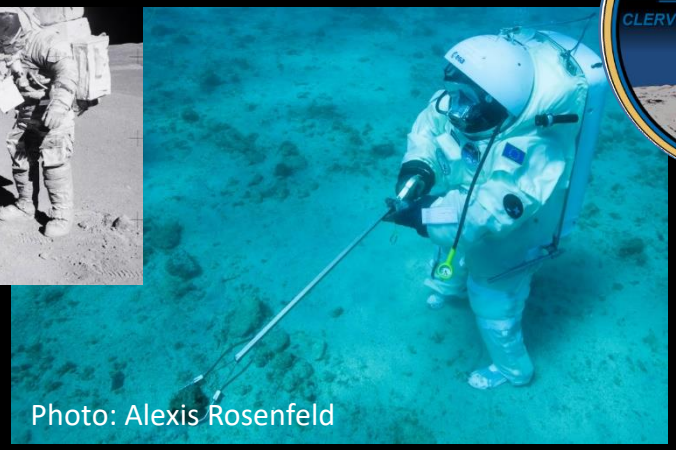


Photo: Alexis Rosenfeld

Underwater lunar mission simulation offshore Marseilles, France

Photo: Alexis Rosenfeld

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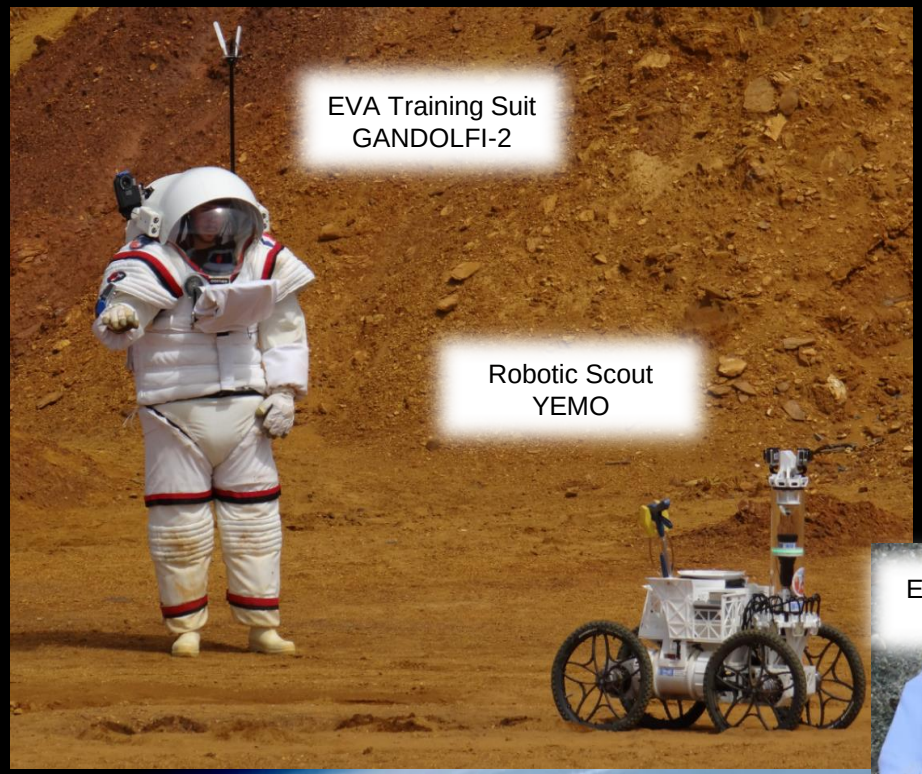
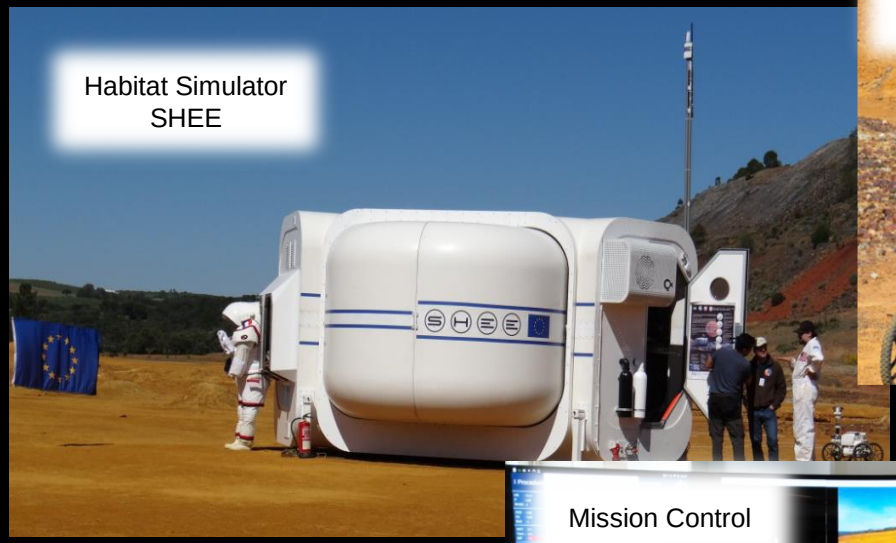
2013 MOONWALK: Robot-Astronaut Cooperation (European Commission)

Mars mission simulation in Rio Tinto, Spain.





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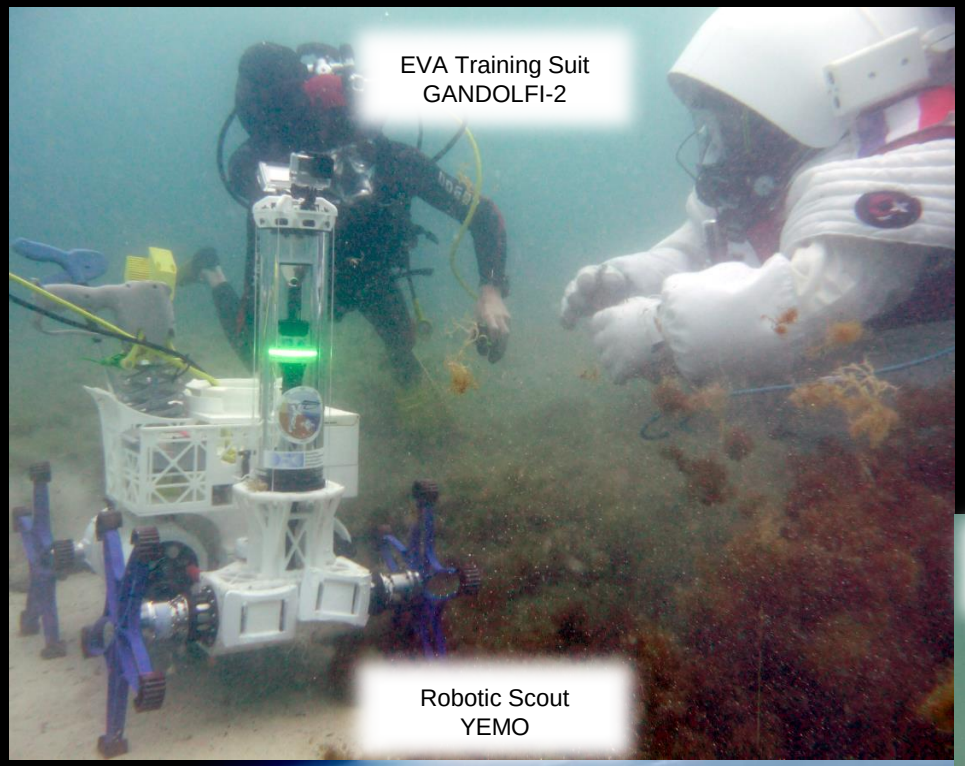
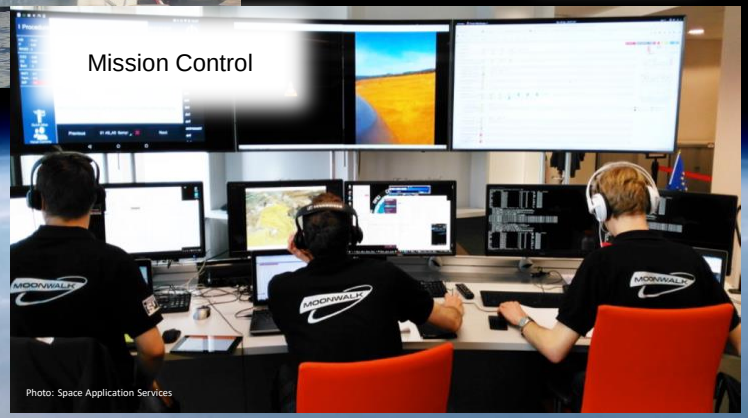
2013 MOONWALK: Robot-Astronaut Cooperation (European Commission)

Moon mission simulation in Marseilles, France





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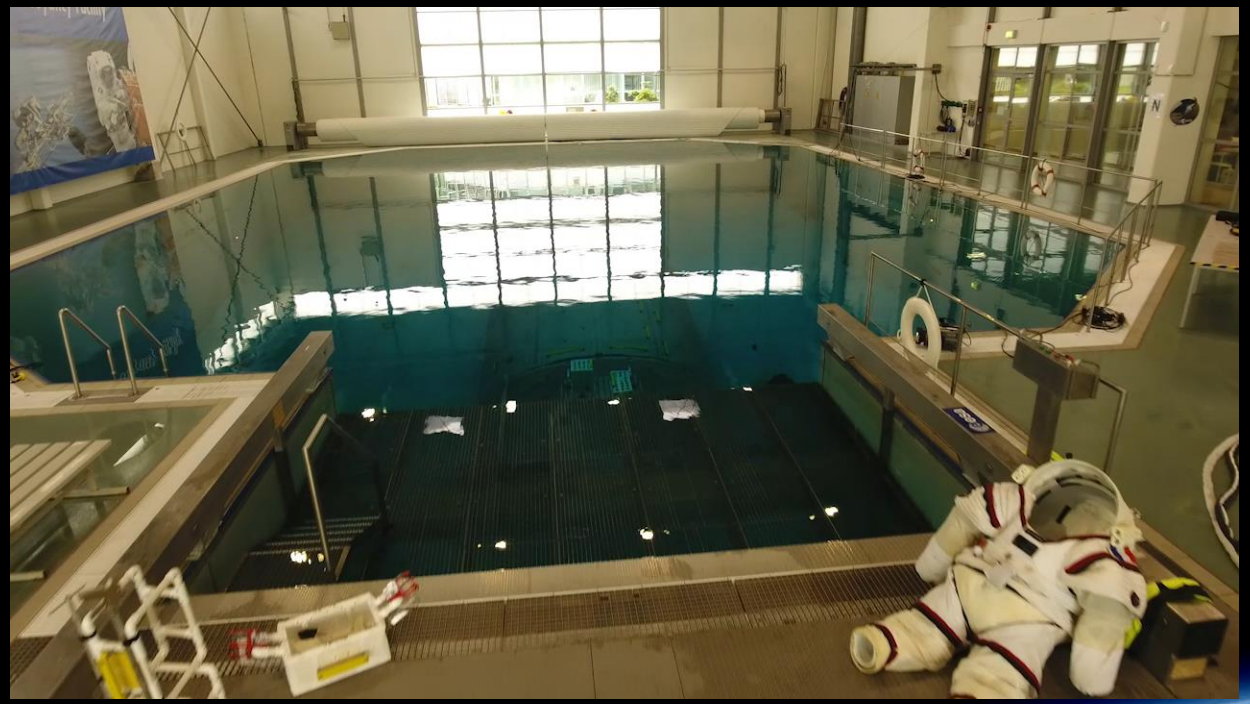
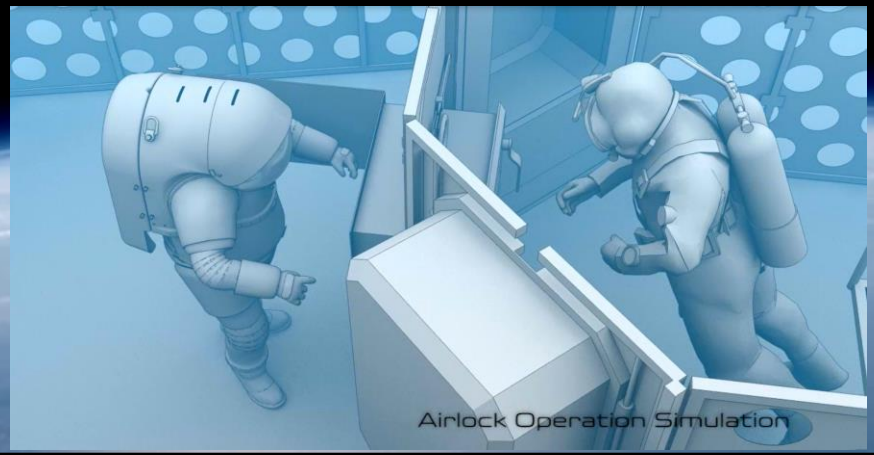
2015 MOONDIVE: Development of underwater simulations for human missions to the Moon or asteroids (ESA)





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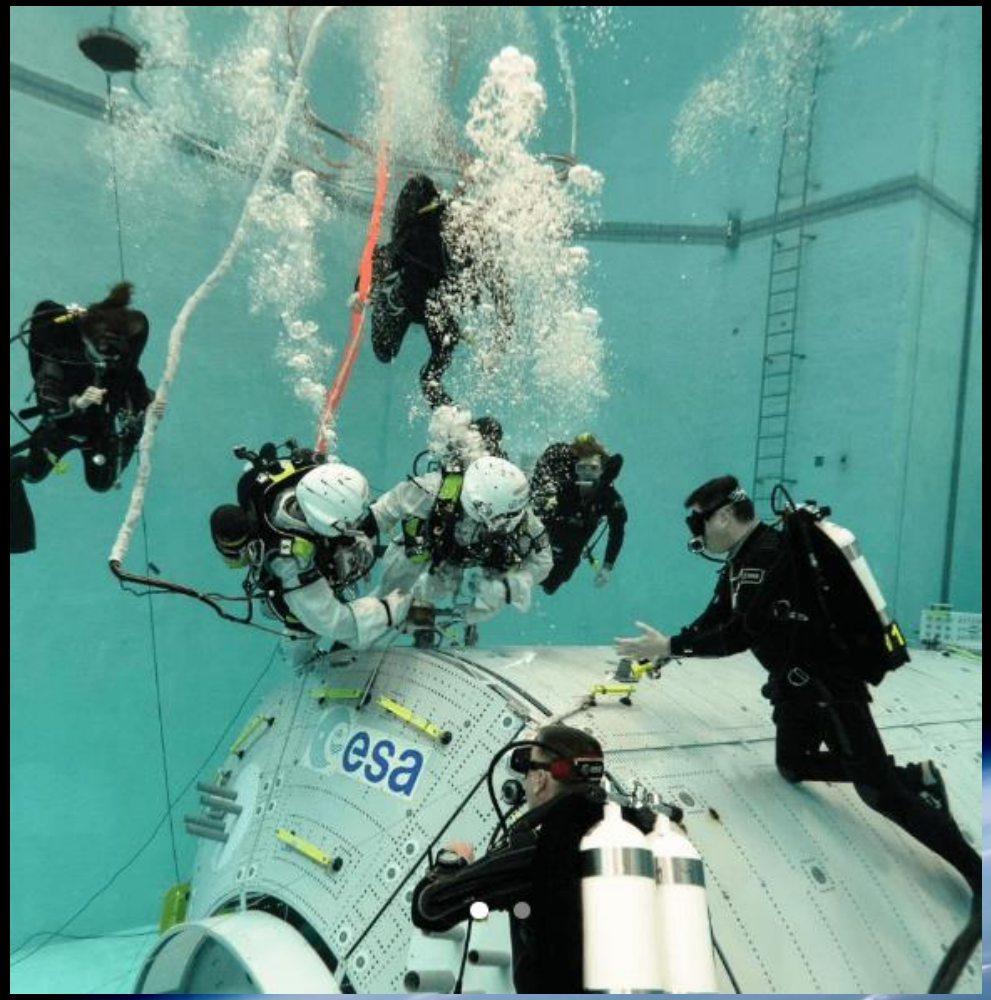
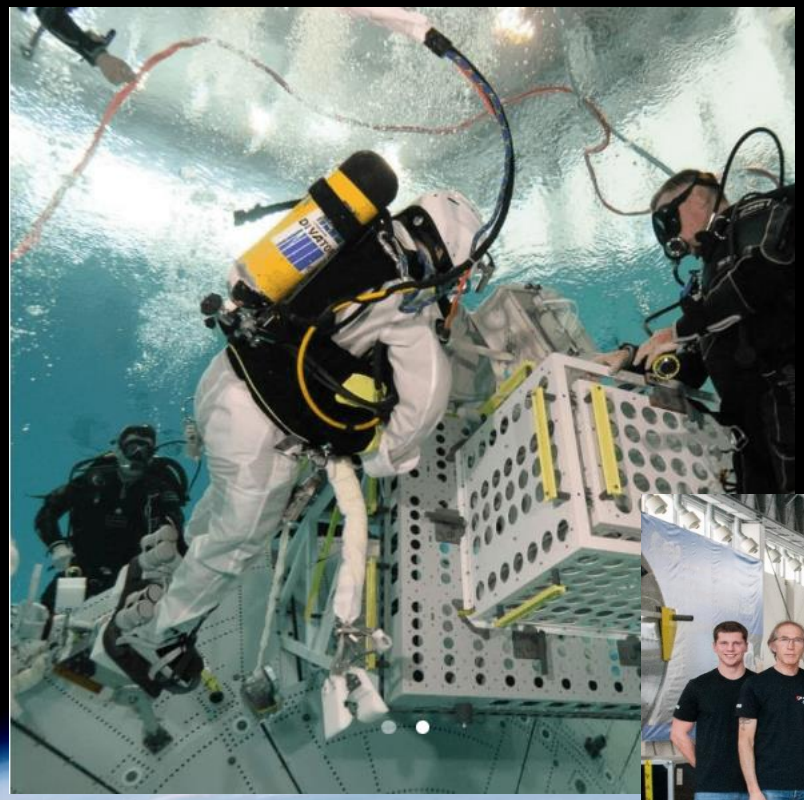
2019 Support to the underwater training of astronauts at EAC in Cologne (ESA)





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2019 Support of the space suit simulator to the NEEMO mission (ESA)

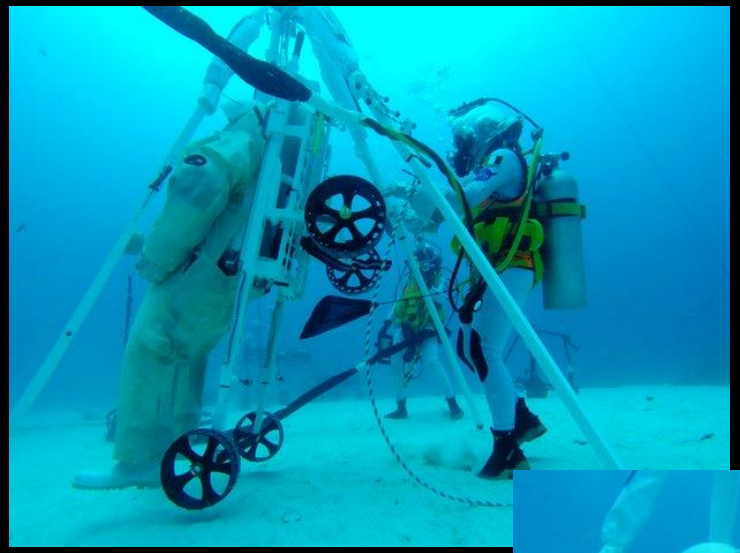
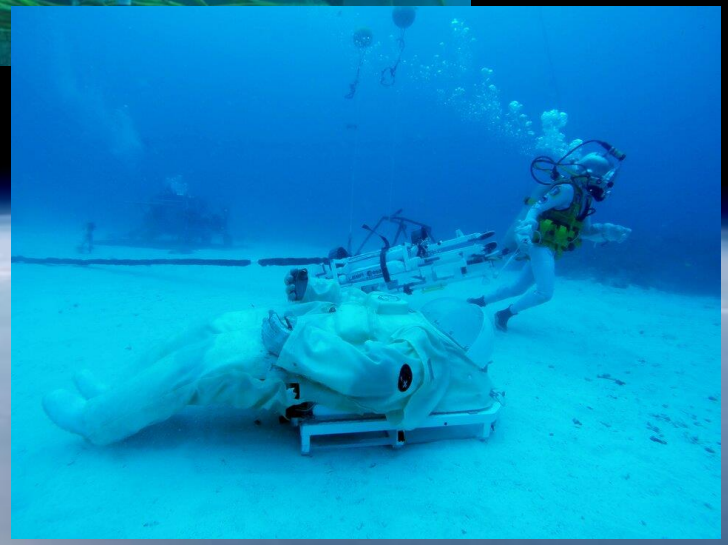


Photo: H.STEVENIN/ESA/NASA

Photo: NASA



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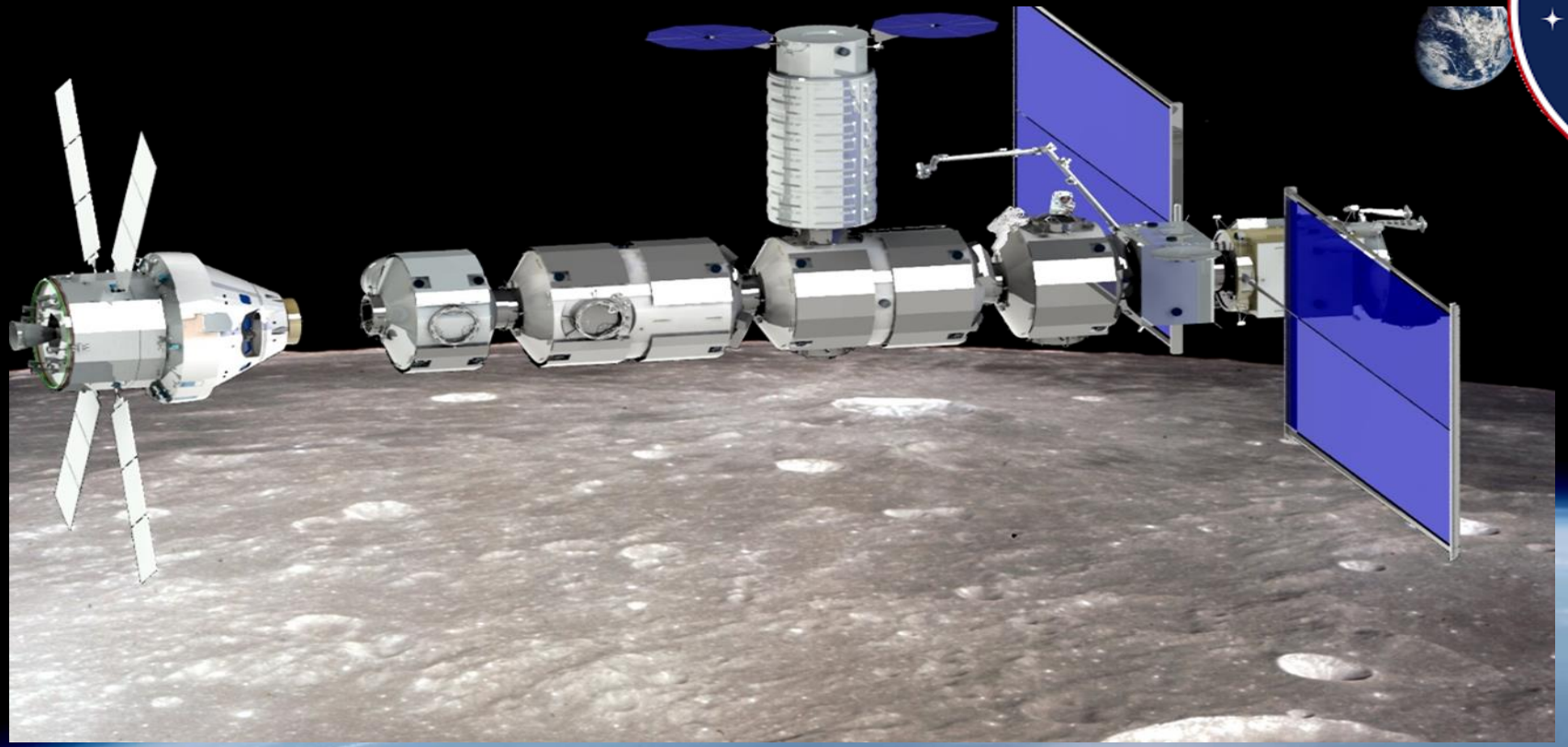
The Lunar GATEWAY



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Lunar Orbital Platform-Gateway

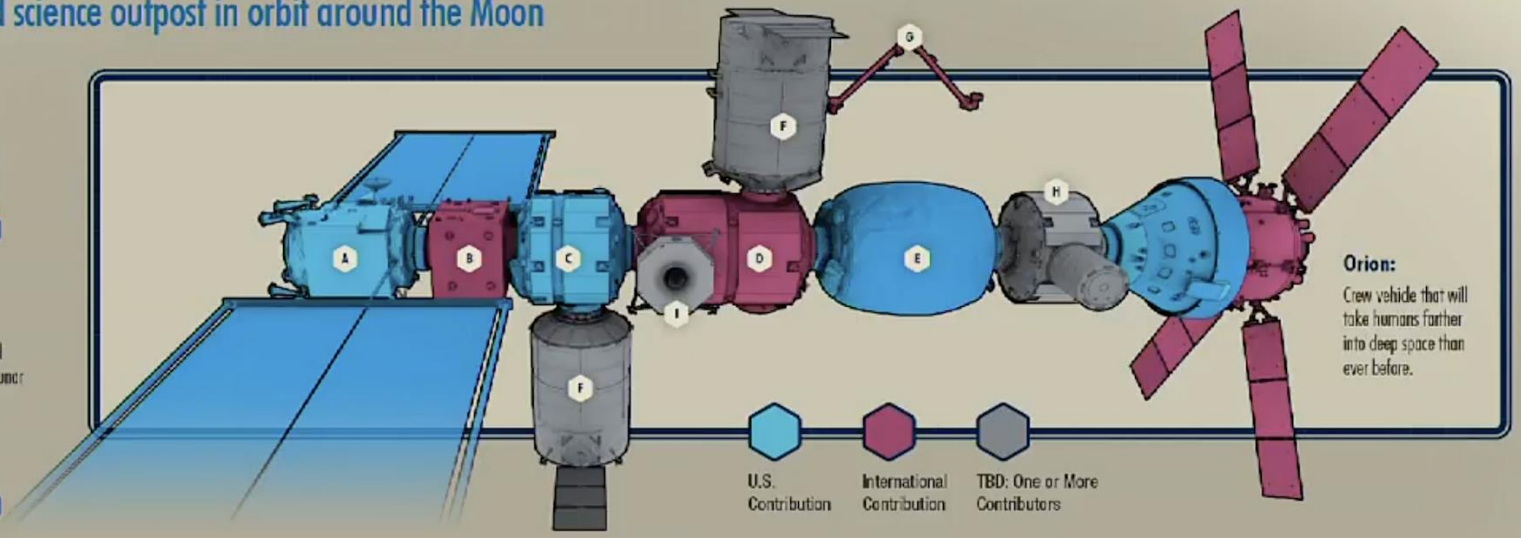
A crew-tended exploration and science outpost in orbit around the Moon

Power and Propulsion Element:
Power, communications, attitude control, and orbit control and transfer capabilities for the gateway.

ESPRIT:
Science airlock including additional propellant storage and advanced lunar telecommunications capabilities

Utilization Element:
Small pressurized volume for additional habitation capability

Habitation Modules:
Pressurized volumes with environmental control and life support, fire detection and suppression, water storage and distribution.



Orion:
Crew vehicle that will take humans farther into deep space than ever before.

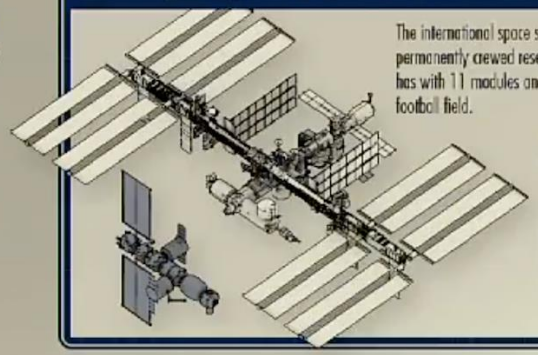
Logistics:
Pressurized cargo volume to deliver consumables and equipment.

Robotic Arm:
Mechanical arm to berth and inspect vehicles, install science payloads.

Airlock:
Enables spacewalks, potential to accommodate docking elements.

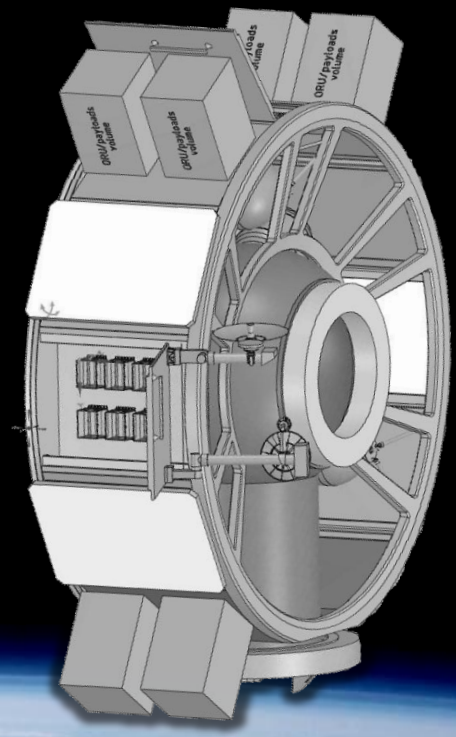
Robotic Lander
Initially a medium-size lander for the delivery of robotic payloads to the lunar surface.

Gateway Compared to the International Space Station



The international space station is a permanently crewed research platform that has with 11 modules and is the size of a football field.

The gateway is a much smaller, more focused platform for extending initial human activities into the area around the Moon.



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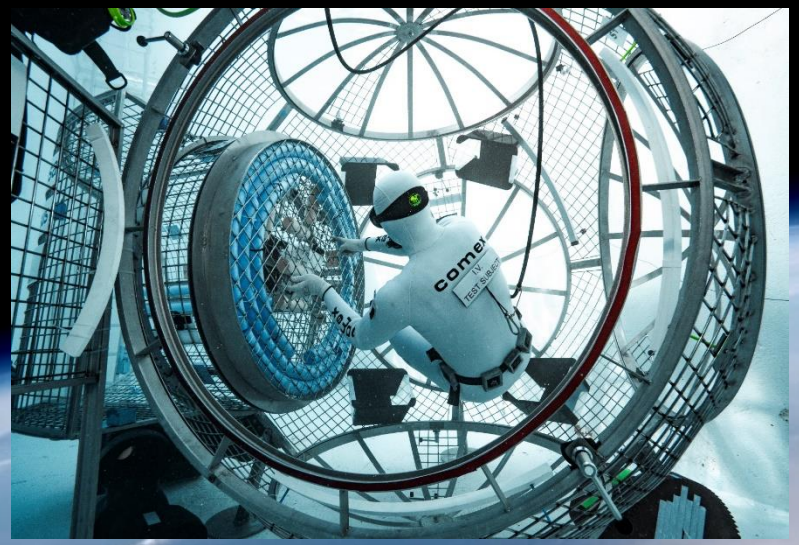
2018 ESPRIT A/B1 Scientific Airlock (AIRBUS / ESA)



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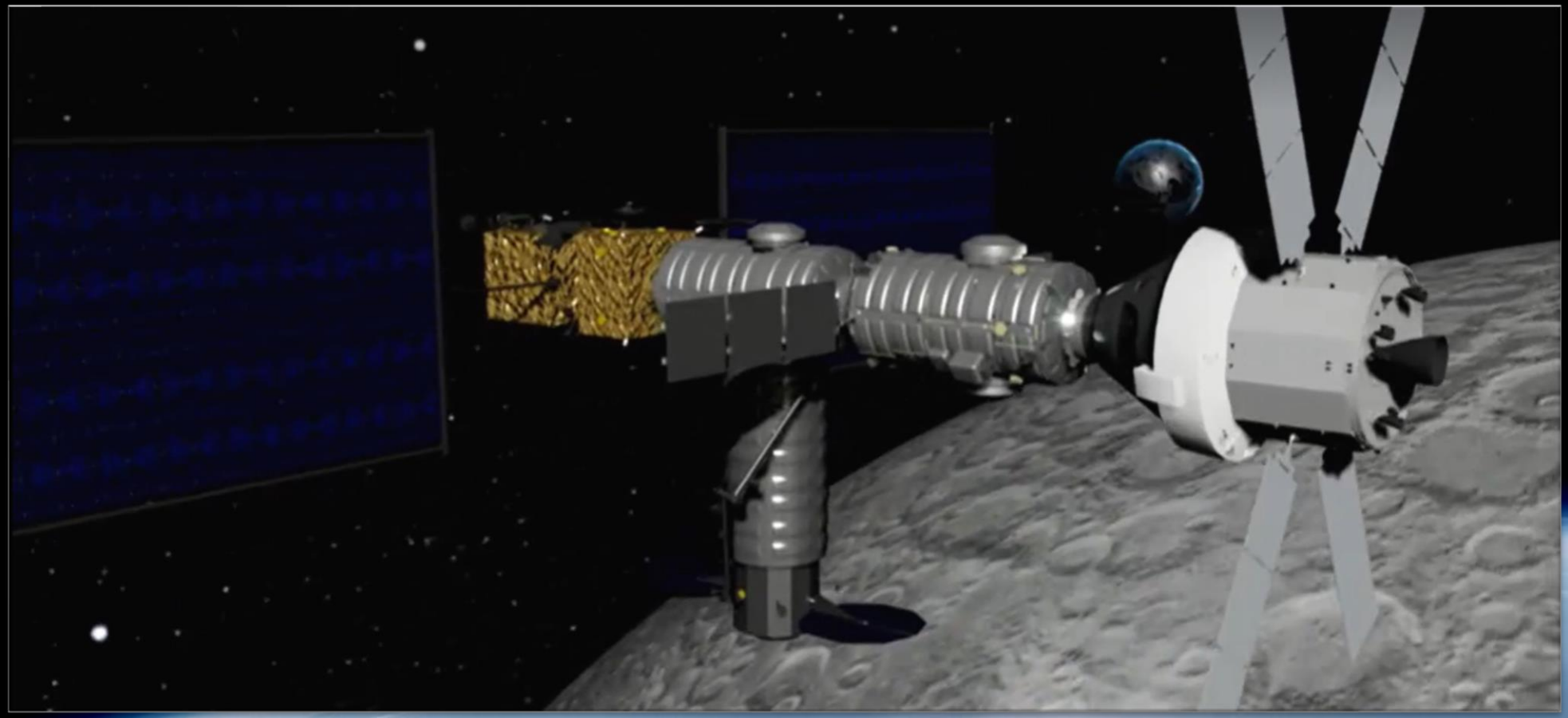
2020 i-HAB (LIQUIFER / THALES ALENIA SPACE / ESA)



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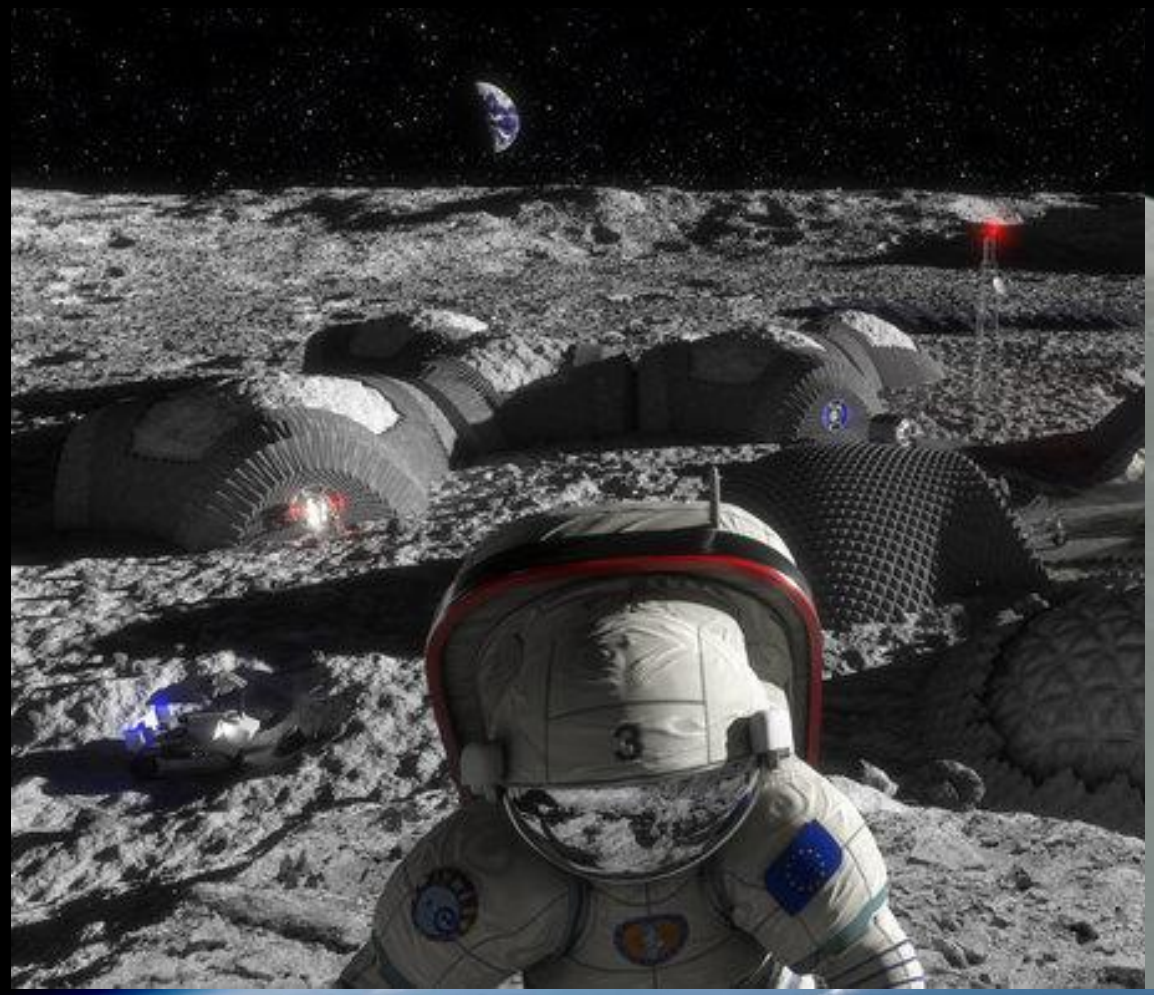
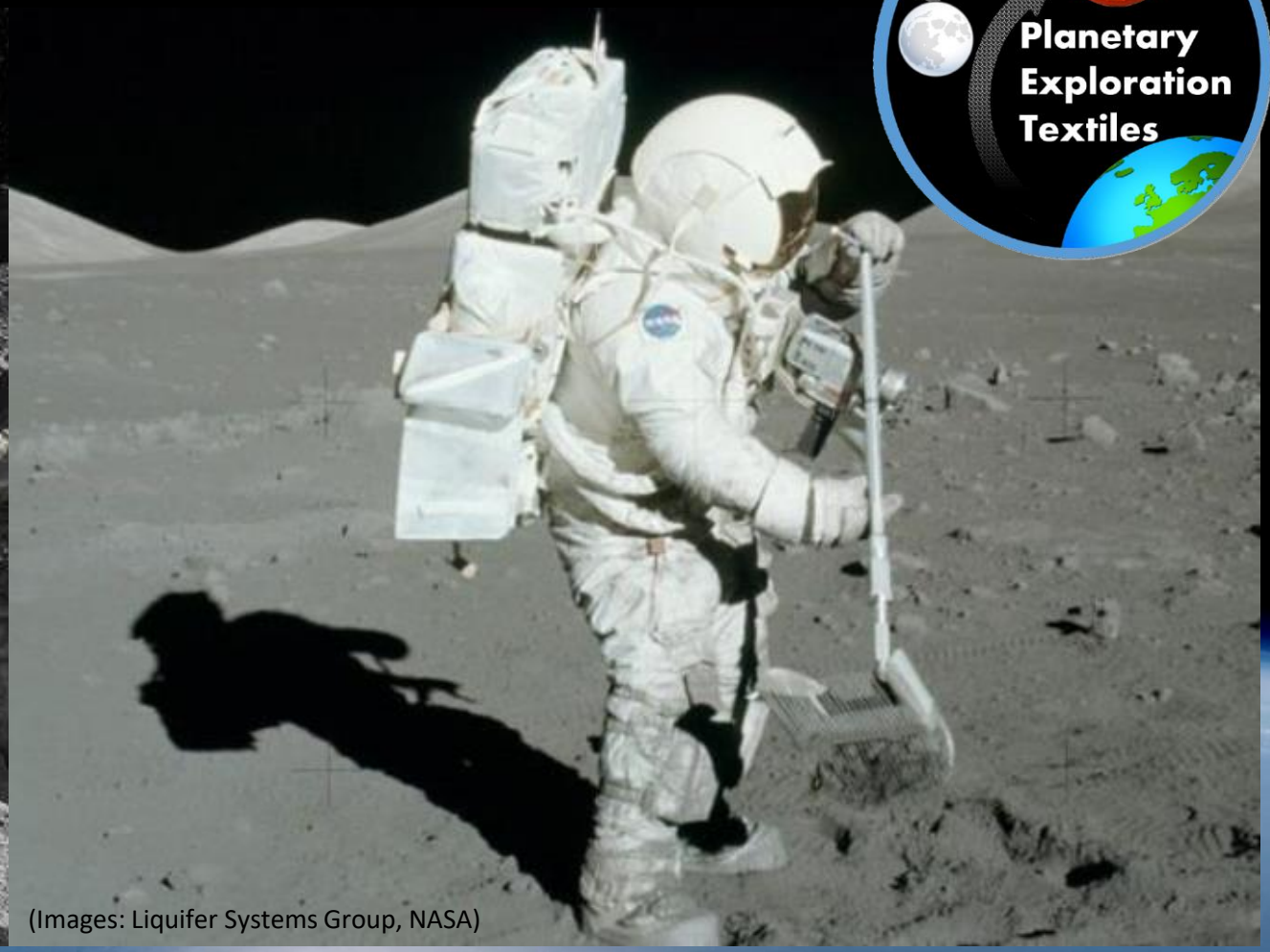
2019 PEXTEX: Materials for future lunar mission space suits (ESA)





(Images: Liquifer Systems Group, NASA)

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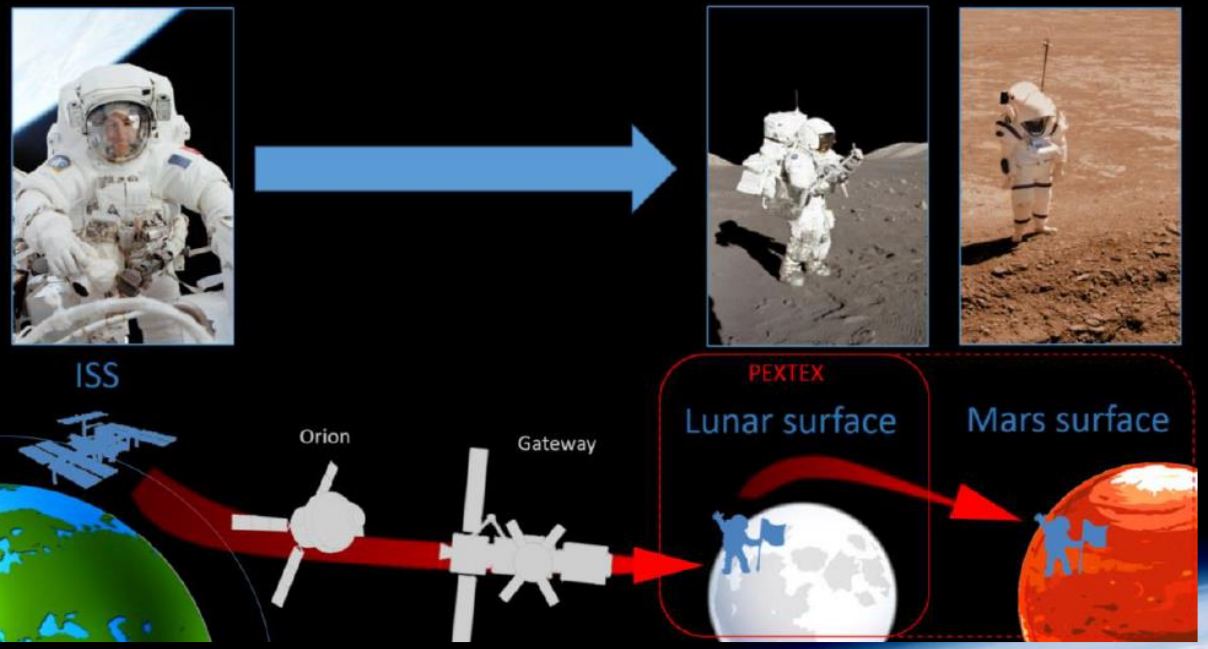
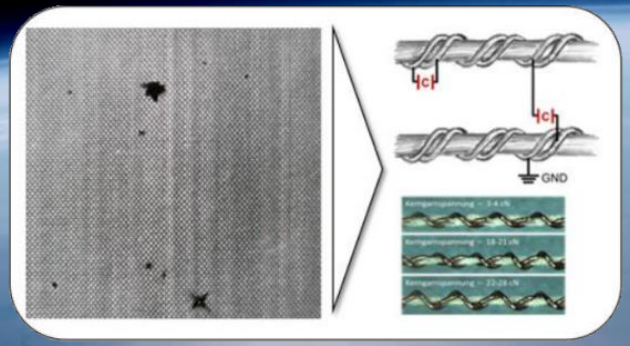
2019 PEXTEX: Materials for future lunar mission space suits (ESA)

Emphasis is given on novel materials, such as smart materials with functionalities such as self-healing, monitoring or dust mitigation.





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2014 LUNA Rover Simulator

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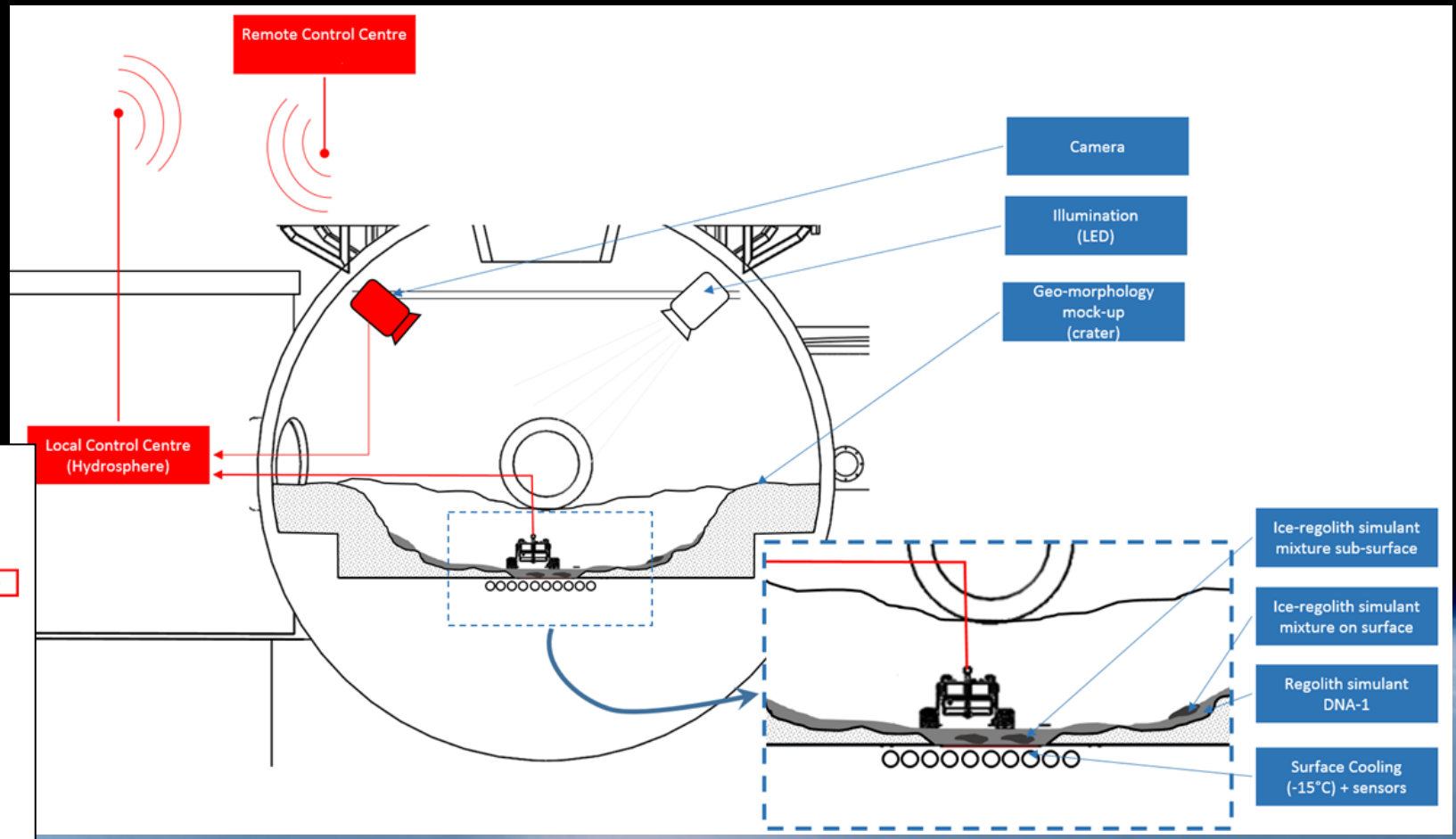
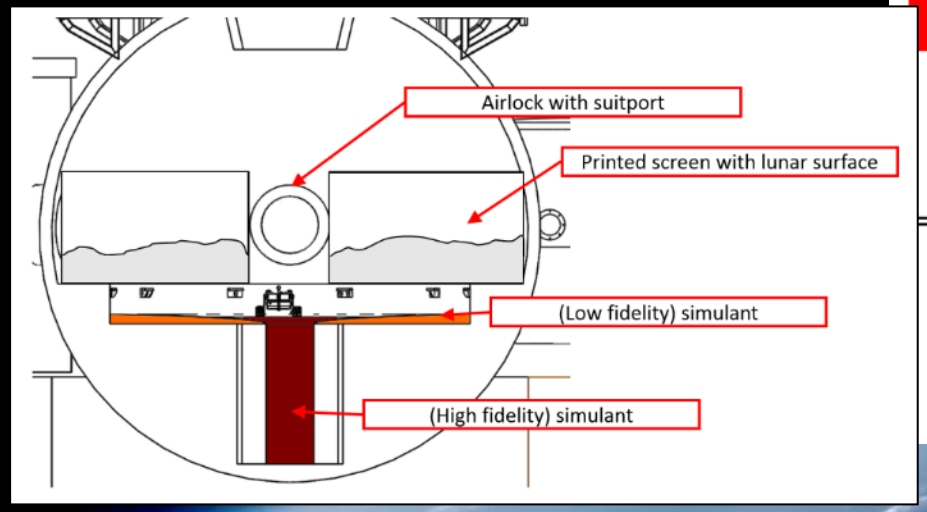
2020 HYDROSPHERE Lunar Surface Simulator

Examples of test configurations:

- Cold spots for PSC exploration
- Drilling and sampling tests
- ISRU validations
- Suit and suitport tests
- Sample exchange devices





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THANK YOU !