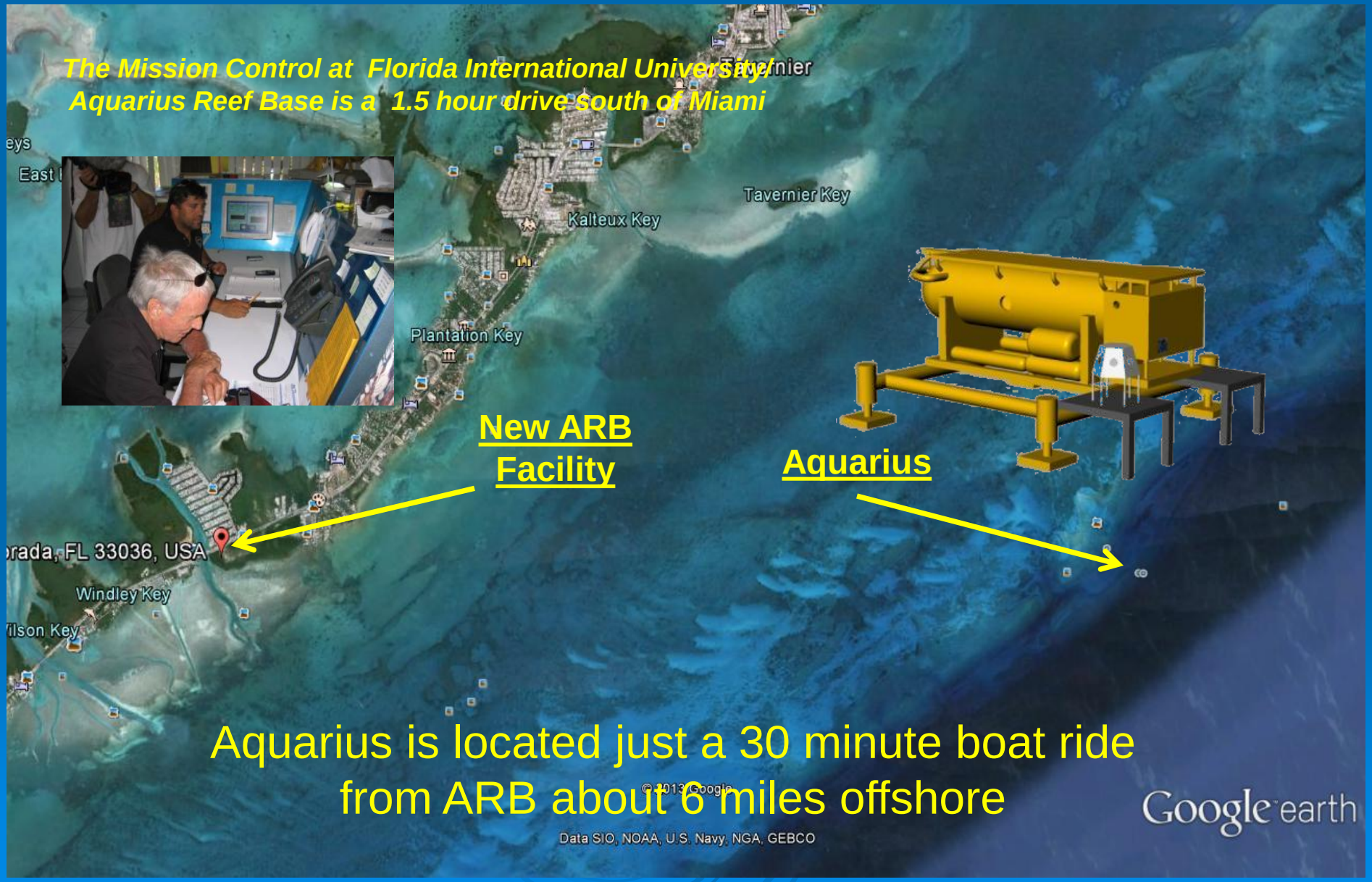
2013 NASA Extreme Environment Mission Operations SEATEST II Overview

Aquarius: The only undersea research facility in the world today…

Hatch depth: 47 feet, Bottom depth 62 feet

Aquarius & FIU ARB



Aquarius Reef Base Shore Facility

Infrastructure and Capabilities
On- Shore Facilities

- Fleet of 6 boats
- NASA Office and MCC
- High Speed Internet, tele-conference, etc.
- Conference and meeting area
- Labs, basic equipment
- Workshop area
- Dive lockers
- Rest area
- Hyperbaric chamber and safety equipment

Project Overview
Why Under the Sea?

- Analogs come in 2 flavors
  - Environmental analogs
  - Mission analogs
- *Environmental*
  - Extreme environment
    - *Immediate return to surface not an option* (~ 17 hr deco)
    - Percentage of crew attention always on safety considerations
  - Isolation factor
  - Surface excursions in reduced gravity
  - Approx size and layout of an ISS module (e.g., Lab or SM)
  - Totally dependent on mechanical life support systems
- *Mission*
  - Highly structured timelines
  - Constant mission pressure
  - Concrete and relevant science objectives
  - High visibility and media interest
  - Tools identical or similar to spaceflight (timelines, procedures, etc.)

- ***Only this facility offers both***

What Makes This Facility Unique?
A High Fidelity Mission Analog

- Ops concept/procedures (vetted thru EAMD)
- Usability and habitability design tradeoffs
- Workforce knowledgeable and experienced on Exploration issues
- Bridging workforce knowledge gap on planning and execution for complex ops
- Early and relevant end-operator input
- Proven PAO tool for keeping the public inspired and engaged in NASA's space exploration goals.

Life Support buoy : LSB

-(2)40 KW generators

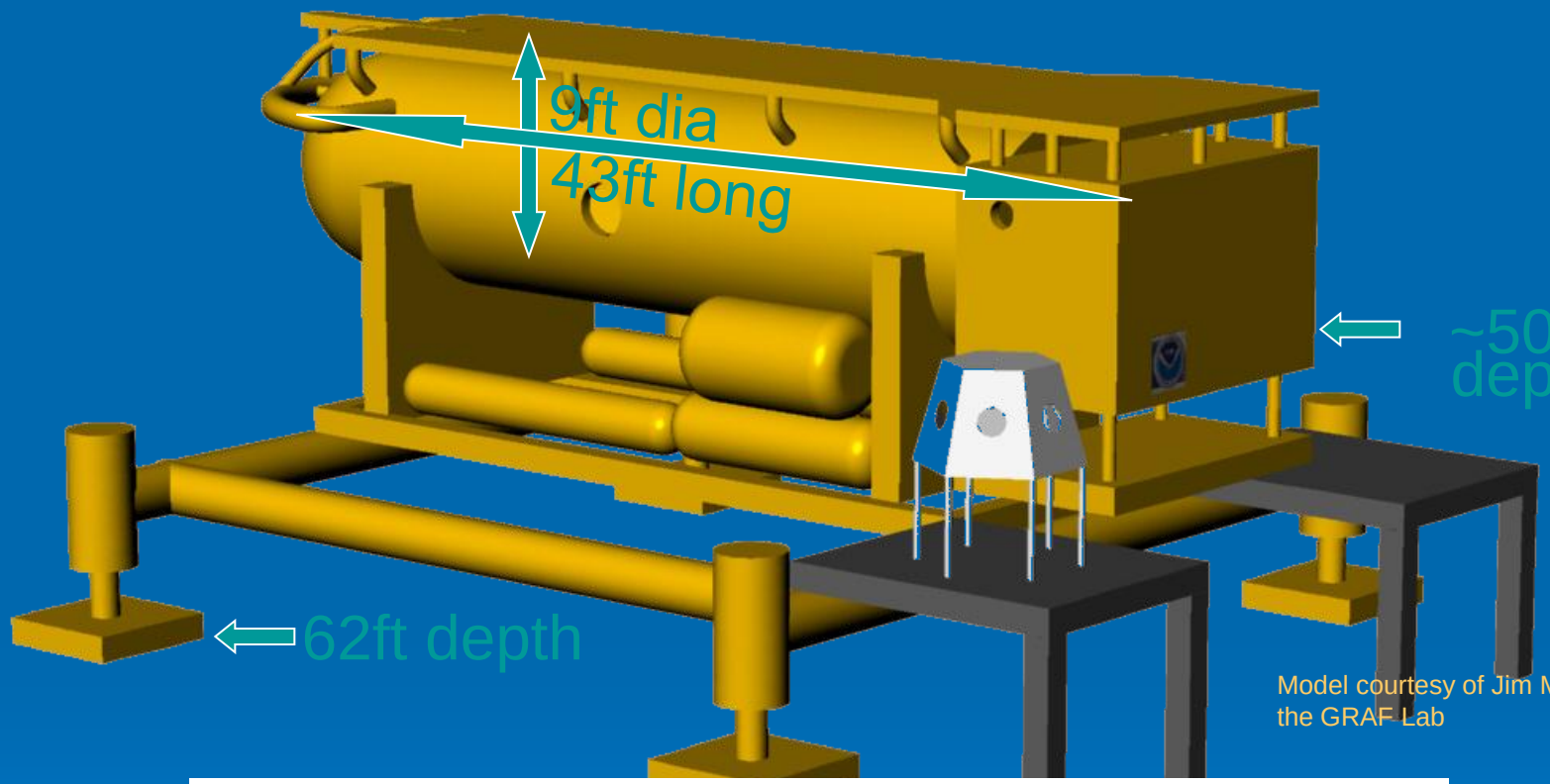
-(2) Mako compressors

-Communication antenna to shore

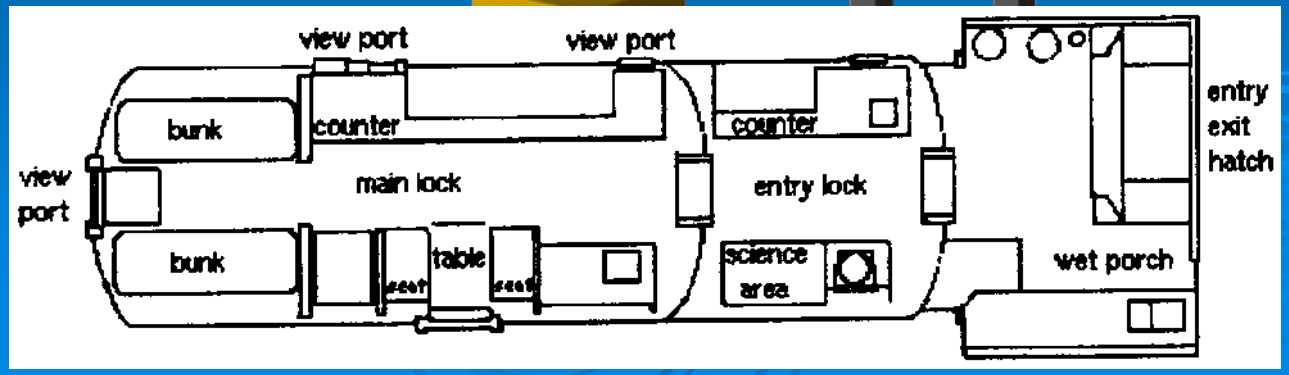
-Sits directly above Habitat

Infrastructure and Capabilities

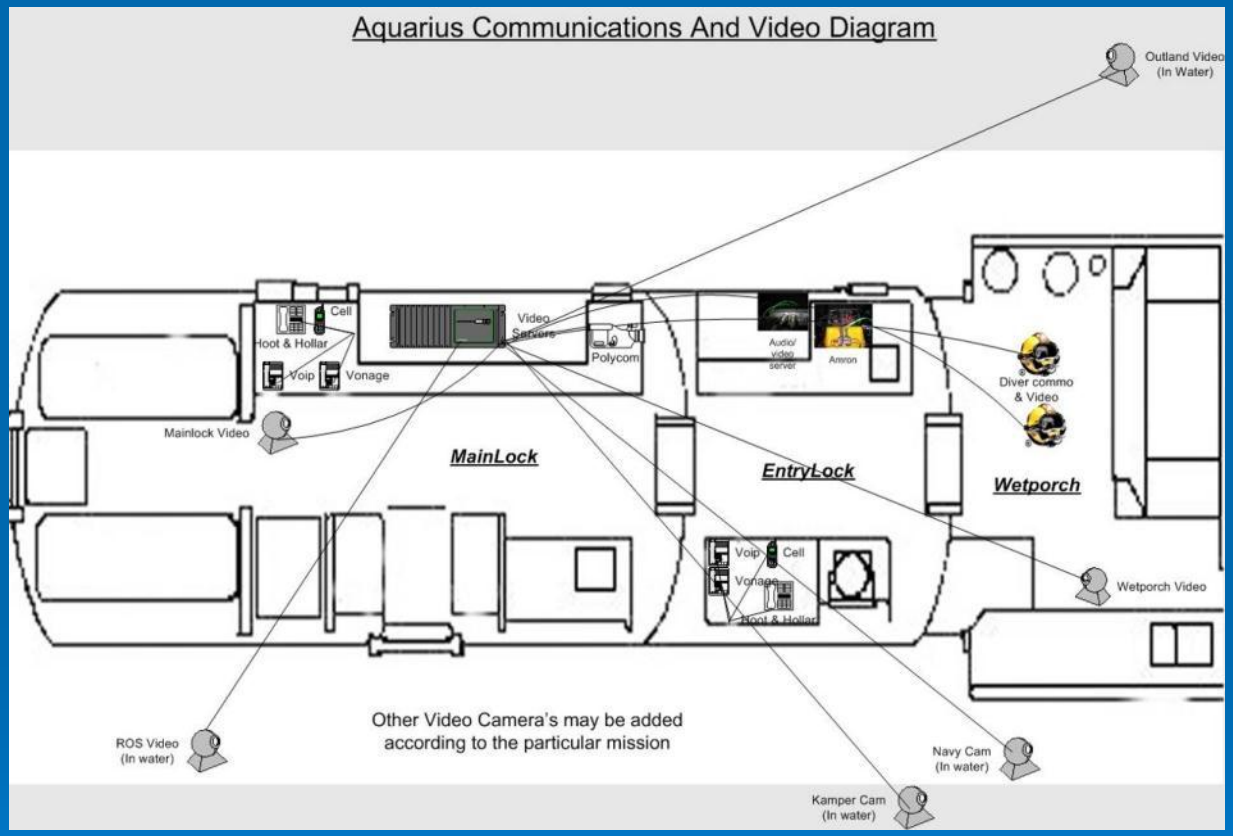
What is Aquarius ?



Model courtesy of Jim Maida and the GRAF Lab

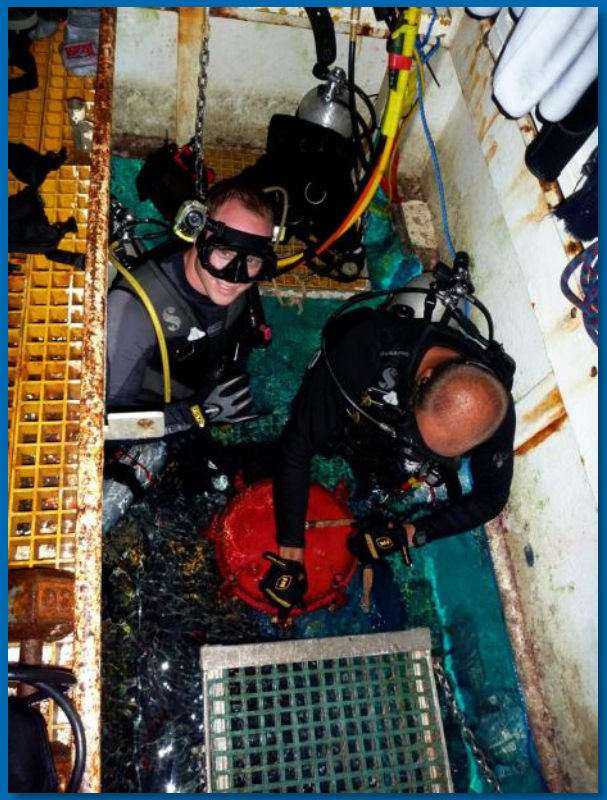


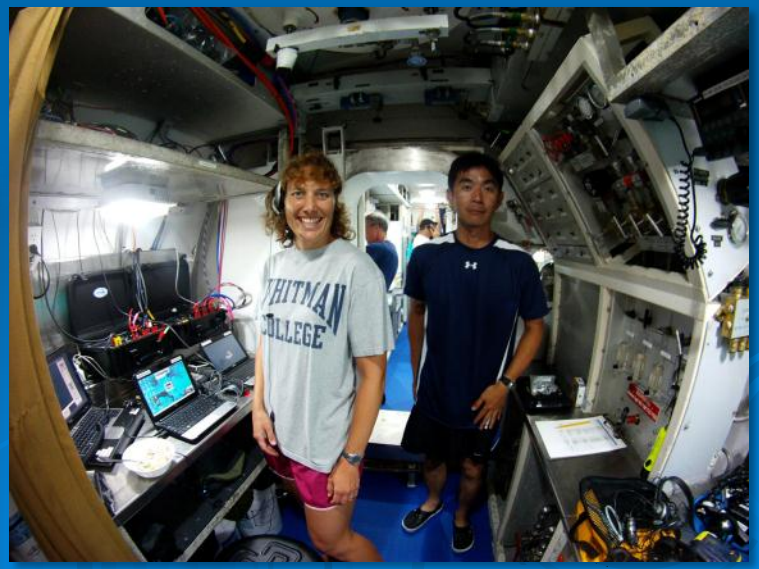
Infrastructure and Capabilities
Aquarius Comm and Video



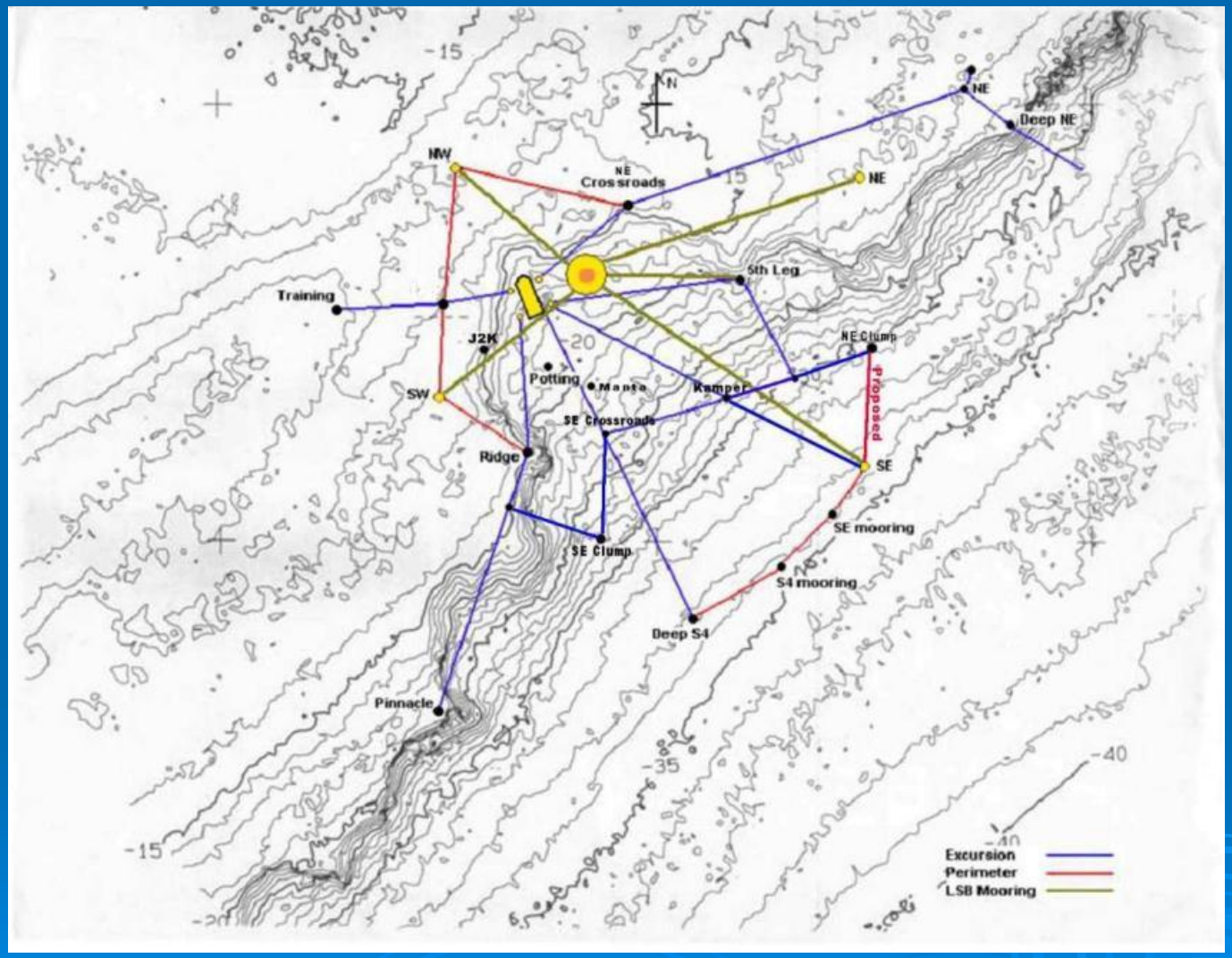
Aquarius is equipped with high data rate network and video capability providing real time video and telemetry monitoring

Inside Aquarius



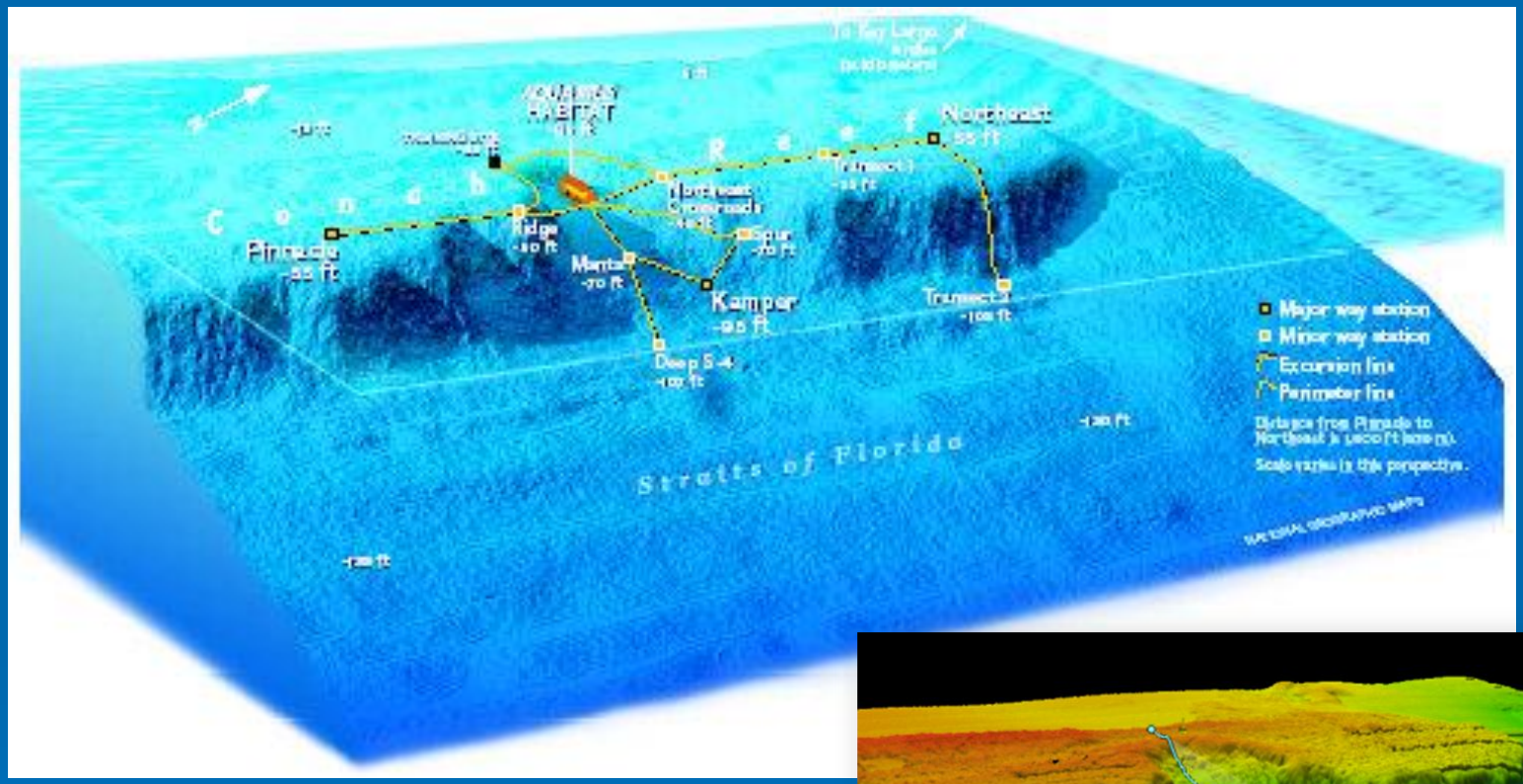


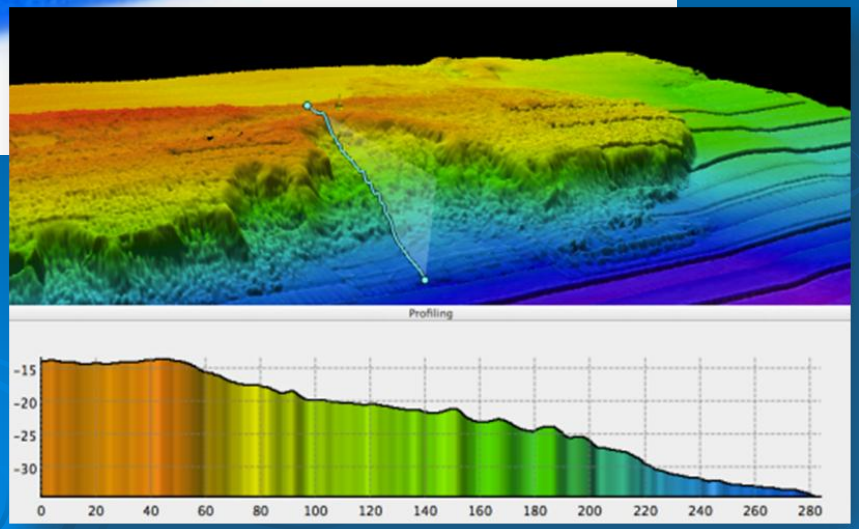
Infrastructure and Capabilities
Aquarius Site Map



Excursion lines mounted to the seafloor in every direction from Aquarius provide safe navigation routes during exploration EVA's

Infrastructure and Capabilities





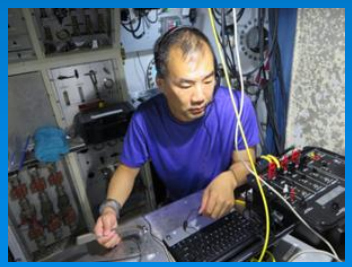
Aquarius sits in the “ Carpenter Basin” which allows easy access to a wide variety of environments to explore

SEATEST II Details



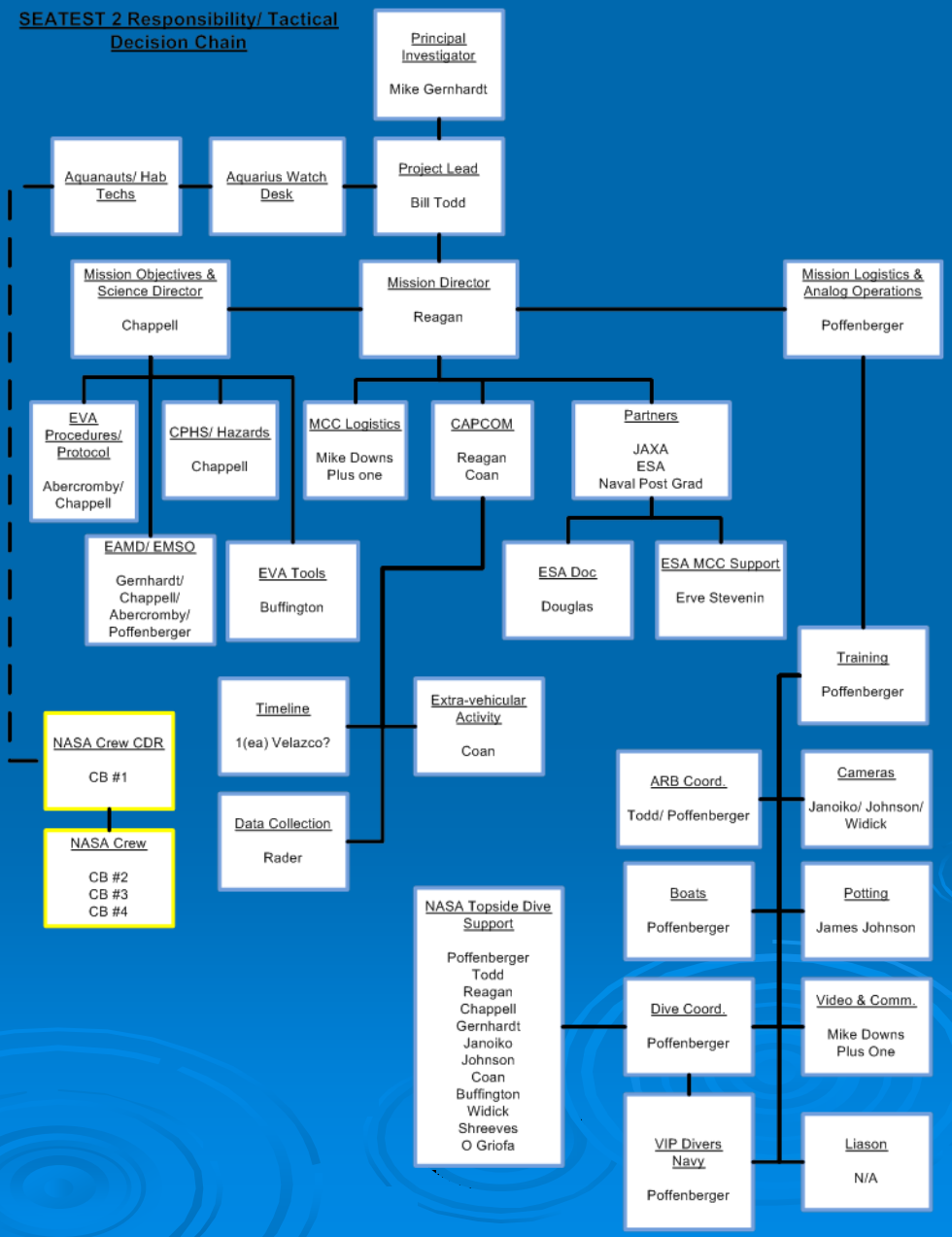


- Saturation Mission Duration- 5 Days
- Saturation Crew Members- Joe Acaba (CDR), Soichi Noguchi (JAXA), Kate Rubins (NASA), Andy Mogensen (ESA), Mark Hulsbeck (Hab Tech), Otto Rutten (Hab Tech)
- Mission Sponsors- FIU, Naval Post Graduate School, ESA, JAXA, MOD/ EVA
- Objectives- Evaluate the New Aquarius Reef Base Shore Facility, Asteroid EVA/ Tools & Techniques, NPS Undersea Robotics/ Mapping, Interior Science including Miniature Exercise Device (MED), Google Glass/ iPad, Just In Time Training and Communications Time Delay testing




SEATEST II Participants

- NASA
- ESA
- JAXA
- MOD/EVA
- FIU
- Naval Post Graduate School
- Miniature Exercise Device (MED)
- EVA Tools



Topside Dive Support





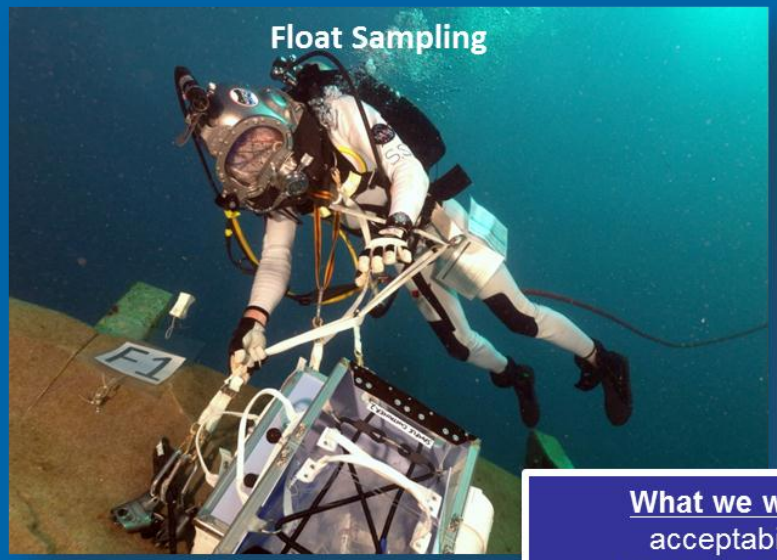




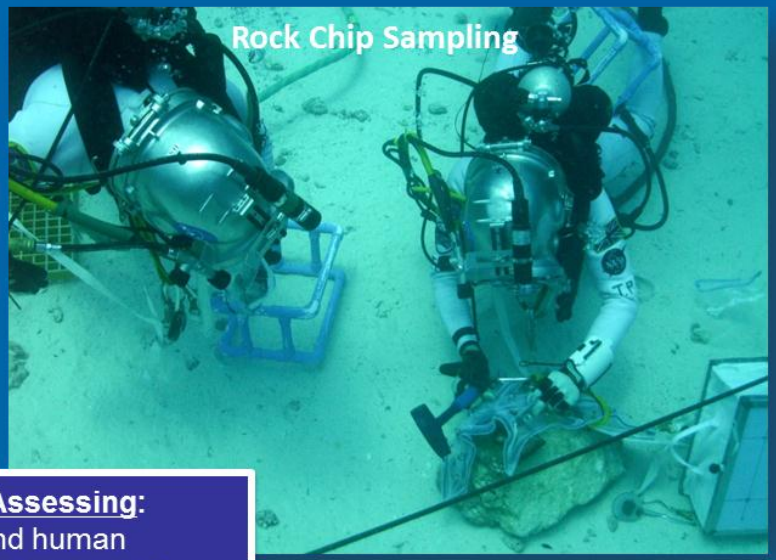




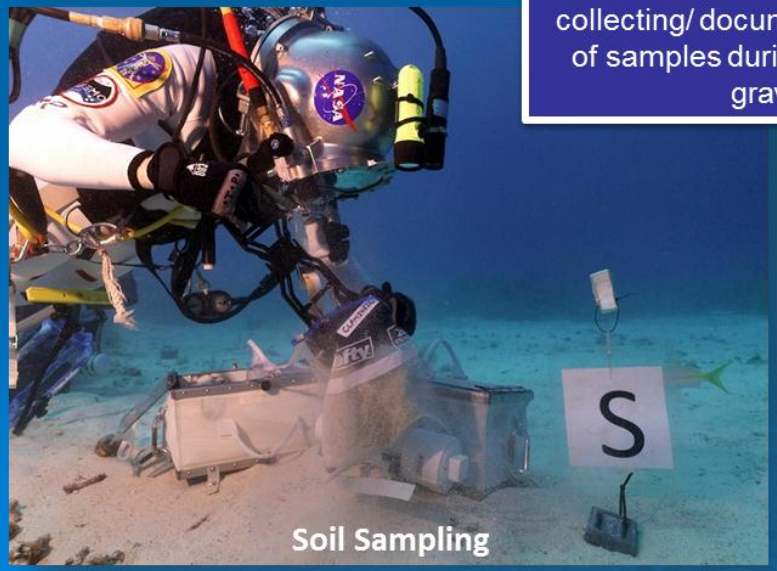
SEATEST II EVA



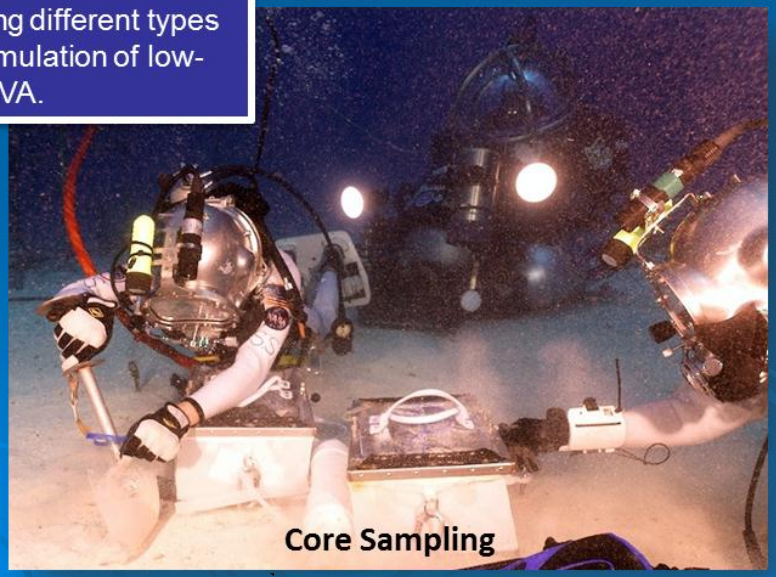
Float Sampling


Rock Chip Sampling

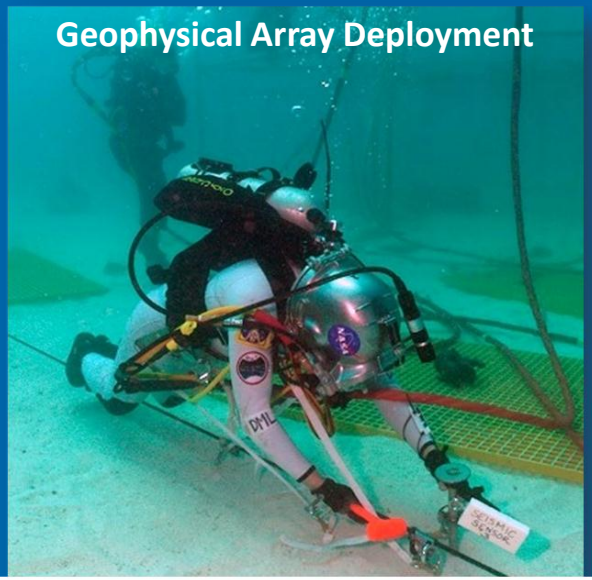
What we were Assessing:
acceptability and human health/performance impacts of collecting/ documenting different types of samples during simulation of low-gravity EVA.



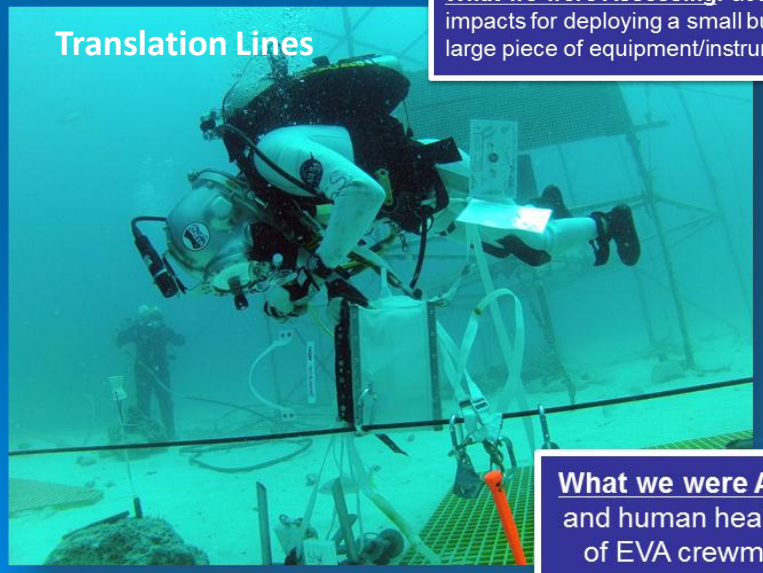
Soil Sampling

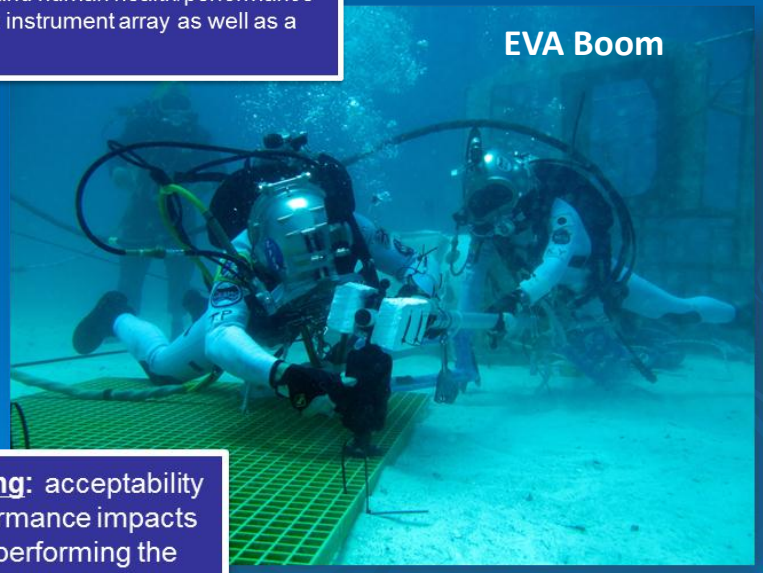

Core Sampling

SEATEST II EVA Continued



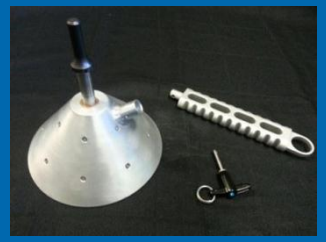
What we were Assessing: acceptability and human health/performance impacts for deploying a small but complex instrument array as well as a large piece of equipment/instrument.

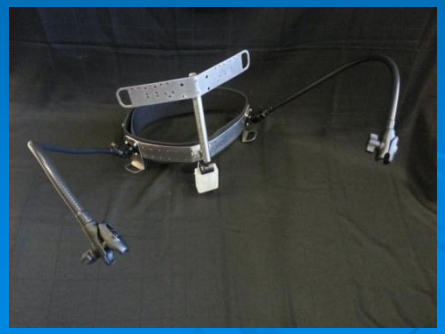




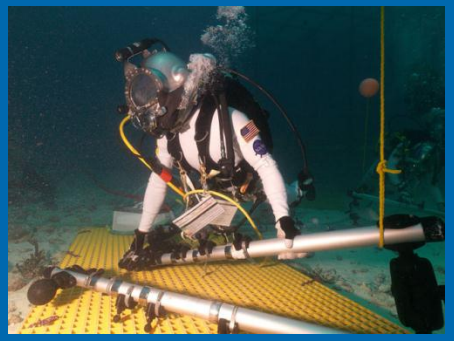
What we were Assessing: acceptability and human health/performance impacts of EVA crewmembers performing the low-gravity exploration circuit tasks via different exploration methods.

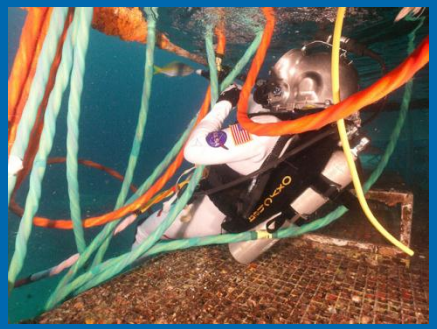
EVA Tools Development

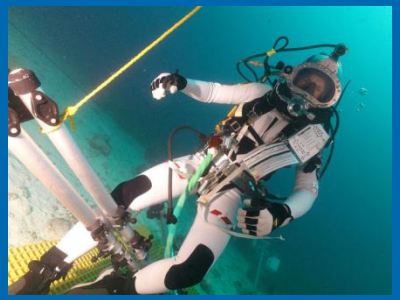


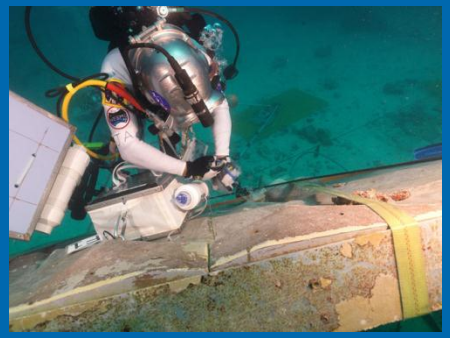


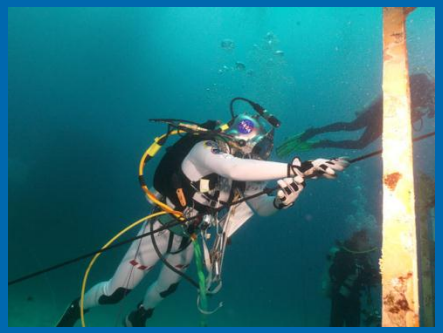
Crew EVA

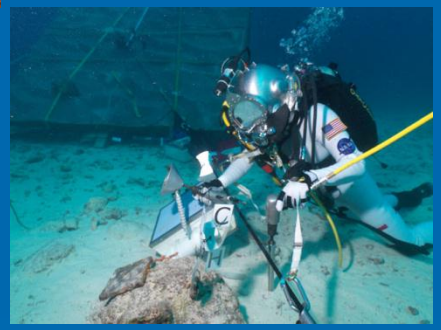


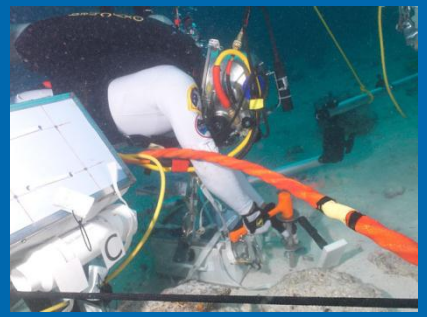


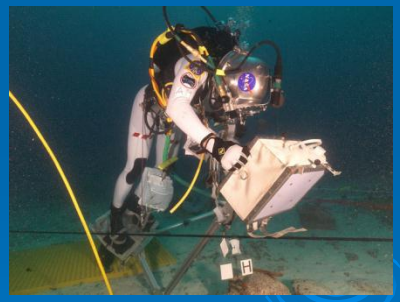


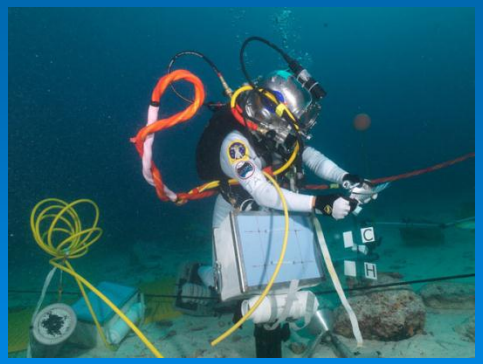


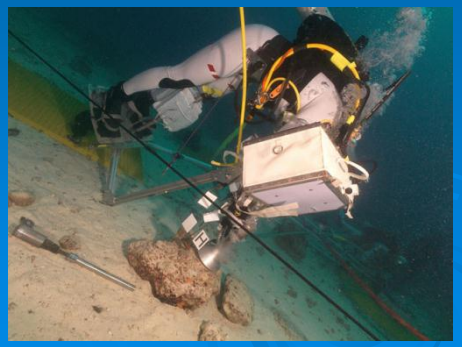


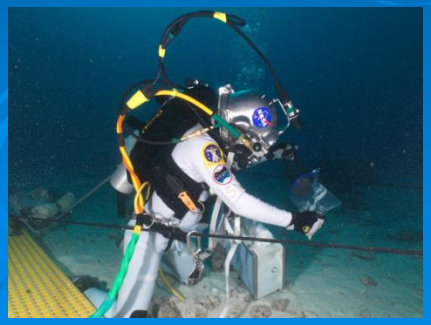












Naval Post Graduate School

NAVAL POSTGRADUATE SCHOOL

CAVR Objective at SEATEST II

- Survey, navigation capabilities (REMUS)
- Autonomous Robotic Diver Assistant
  - Force Augmentation: utility without burden
    - Illumination and alternative perspective
    - Tool transport and recovery (tool mule)
    - Comms and emergency support, etc.
  - Proximal operations
- Develop/evaluate robotic technologies for joint human-robot operations

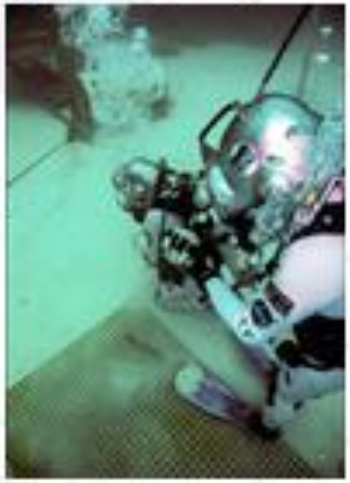
www.seabotix.com

Platform: Modified (tethered, autonomous) SeaBotix VLBV300

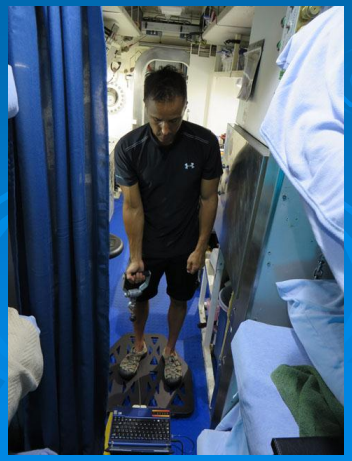
Underwater archaeology diver and task support. http://thunderbay.noaa.gov/

A second NASA Aquanaut supports the first during task execution. http://www.nasa.gov/mission_pages/NEEMO/index.html

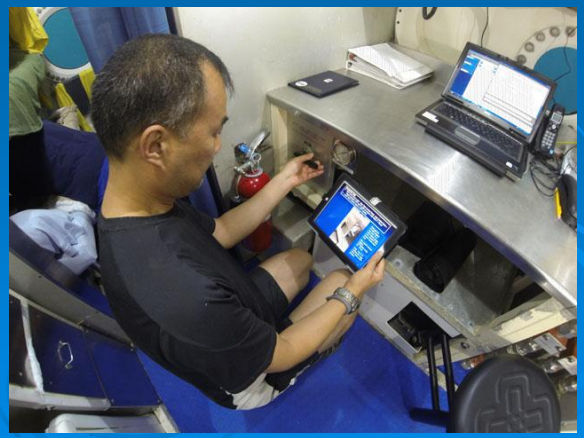
A NASA Aquanaut is stabilized with a manned sub to allow unhindered task execution. http://wiki.nasa.gov/cm/blog/analogfieldtesting/posts/post_1339979223707.html



SEATEST II Interior Science Miniaturized Exercise Device



Interior Science
Just in Time Training



SEATEST II Interior Science Comm. Delay

- Comprehensive comm delay investigation for multi-day human spaceflight mission
  - Consideration of full spectrum of comm types
    - E.g., voice, video D/L, videocon, text, file x-fer, etc.
- Mars mission comm assumptions
  - Worst case comm delay of 20 min (one way)
  - Continuous coverage

Comm. Delay Timeline

	SEATEST 2 - Comm Delay Events			
Purpose	**Use**	**Means**	**Comments**	**Control for 20 min delay**
Ops	Voice Exchange	2-way voice	nominal ops	comm emulator
			quick response/emergency	"
			maintenance	"
	Text Exchange	IM chat	nominal ops	comm emulator
			quick response/emergency	"
			maintenance	"
	Video	video system downlink	Situational Awareness	comm emulator
	File Transfer	2-way file x-fer	Plan Deltas	Manual Timers on MCC side
			Flight products (e.g., proc's, JITT)	"
			Pictures	"
			email	comm emulator
	Telemetry	1-way data link		Not used
	System Commanding	1-way comm link		Not used
Medical	Private Medical Conferences	1- or 2-way file x-fer	PMC	Manual Timers on MCC side
Psych Support	Personal Contact	2-way file transfer	email	Manual Timers on MCC side
			recorded messages	"
	Entertainment	file transfer (uplink)	books, movies, music, news, etc.	use not anticipated this mission
		video system uplink	streaming uplink video (e.g., news, games)	"
	Personal Internet use	2-way IP traffic	real-time browsing	governed by rules/honor system - not allowed
			reading a discrete site	governed by rules/honor system - 3 hr request
	Personal File Transfer	file transfer (downlink)	video, pics to be saved	Manual Timers on MCC side
Outreach	PAO events	file transfer (downlink)	recorded	use not anticipated this mission
	Educational Outreach events	file transfer (downlink)	recorded	use not anticipated this mission