The Future of Web3D: Advancing 3D Standards for AI and the Metaverse

www.web3d.org

SIGGRAPH 2025, August 12, 2025
Vancouver, Canada

web3D CONSORTIUM

Web3D Synergies

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web|3D CONSORTIUM

www.web3d.org

Agenda: New Alliances and Collaborations

Cesium Ecosystem Grant Award

Integrating OGC 3D Tiles with X3D for advanced geospatial visualization

New AI and X3D Working Group

Exploring the intersection of artificial intelligence and 3D web standards

X3D Ecosystem Support

Expanding compatibility with commercial tools and open-source implementations

Discussion on USD Support in X3D

Exploring integration with Universal Scene Description format

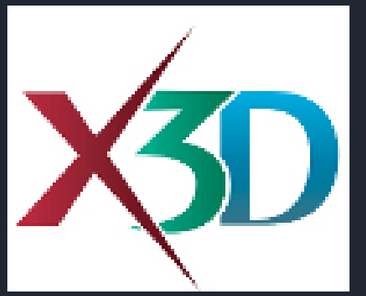
Metaverse Standards Forum

Proposed standards for 3D web interoperability in the metaverse

Web3D® Consortium

Member funded; community driven; nonprofit organization

The Web3D Consortium is dedicated to developing royalty-free ISO specifications, particularly X3D® and HAnim, for interactive 3D graphics on the Web. Our community brings together diverse stakeholders including:



Technical Expertise

Academia, Government, Industry, Research, and Professionals collaborating to advance web 3D standards

Open Standards

Developing royalty-free ISO specifications for interactive 3D Graphics

Implementation

Several open-source implementations available for developers and users

content

with

WWW + X3D: 3D Anywhere

Cross-Platform Capability

3D + VR + AR Capable, runs on multiple devices (phones, tablets, desktops, CAVEs)

Versatile Applications

Used in medical, geospatial, 3D printing/scanning, CAD and more

Rich 3D Features

Interaction, Animation, Archivability, Security

Learn more: www.web3d.org/x3d/why-use-x3d

Open-Source Engines

X_ITE

Modern Javascript Engine with WebGL renderer, optimized for both desktop and mobile performance with comprehensive X3D standard support.

X3DOM

Javascript Engine that enables X3D integration directly into HTML5 DOM, making 3D content as easy to use as regular HTML elements.

Castle Game Engine

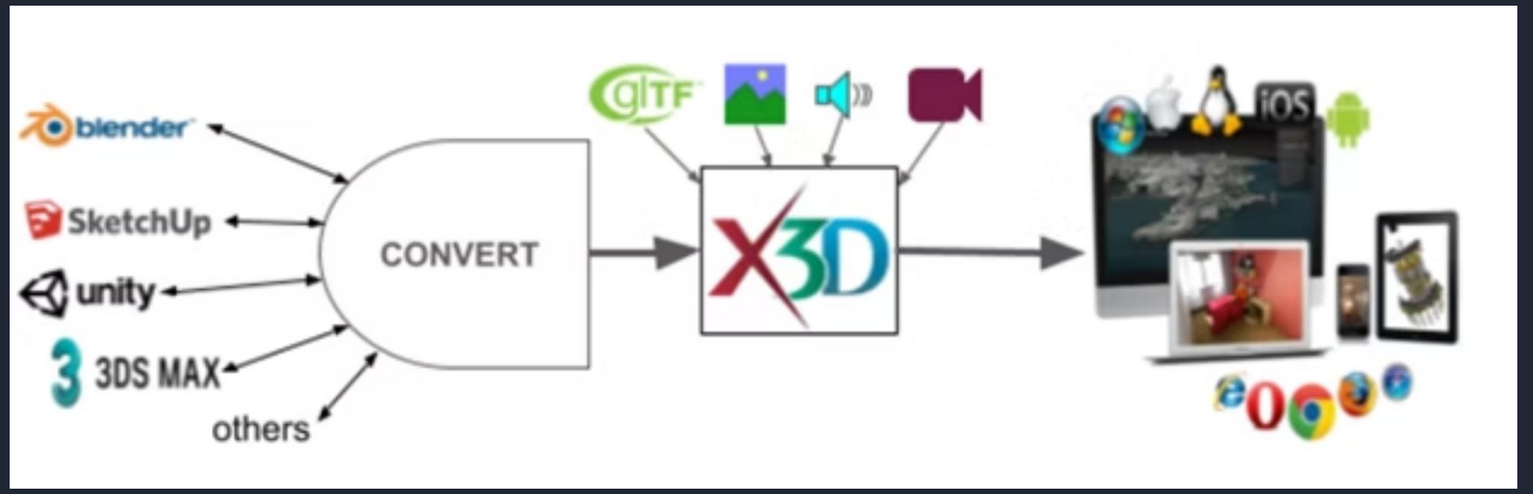
Open-source cross-platform 3D game engine with robust X3D support, featuring powerful tools for game creation and interactive applications.

X3D: 3D Anywhere

Comprehensive Capabilities

- 3D + VR + AR Compatible
- Multi-domain applications
- Rich interaction
- Animation support
- Archival-quality format
- Security features

X3D: A Presentation Layer



X3D Ecosystem

Data Import

Bring data from any domain into X3D format

Add Behavior

Enhance with scene description, interactivity, and animation using time, touch, and space sensors

Publish on Web

Use open-source implementations - X3DOM, X_ite to deploy on the web

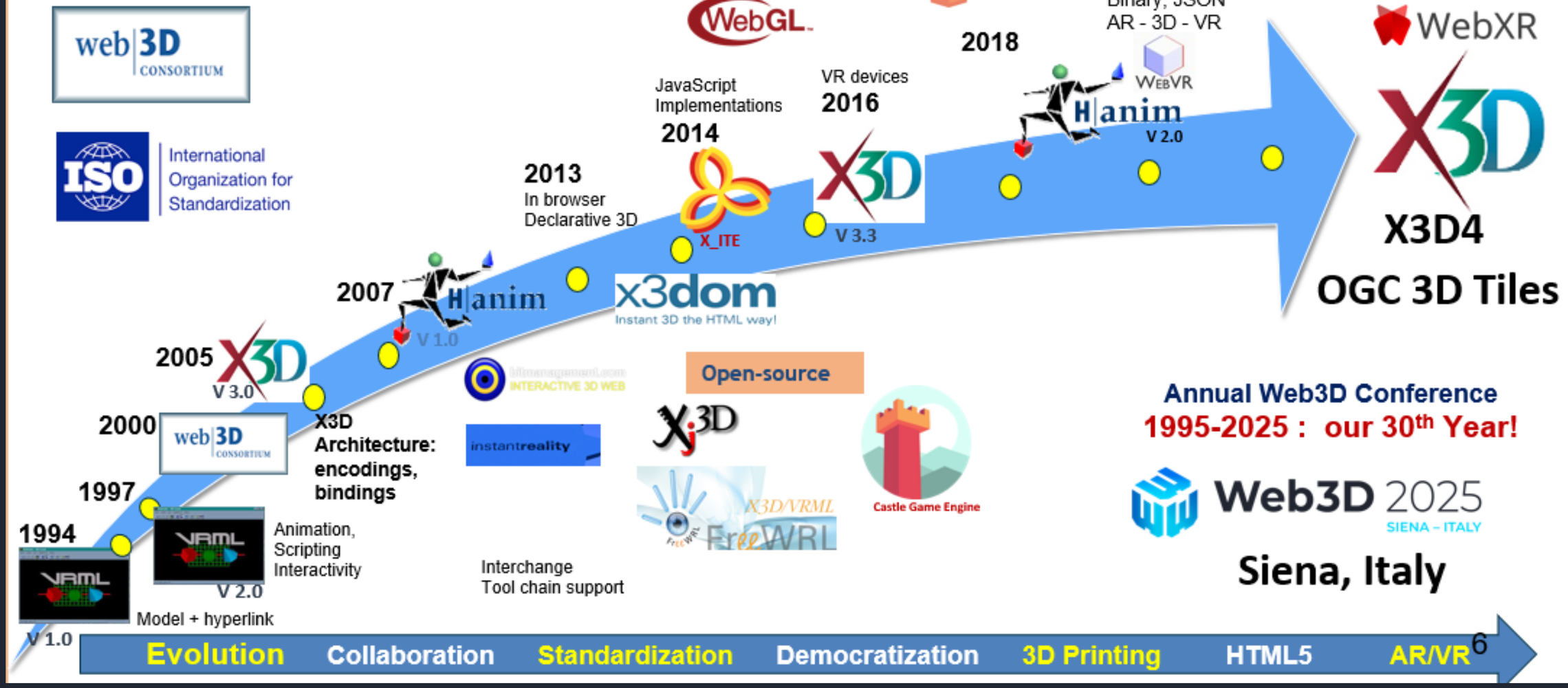
Web3D® Consortium

A 30-year legacy of 3D Graphics for Web

- Standards Development
- Community and Collaboration
- Education and Outreach
- Technical Advancements

web | 3D CONSORTIUM

Web3D Evolution 1995-2025



Web3D 2025
co-located at Digital Heritage in SIENA – ITALY

Join us at our 30th anniversary celebration at Web3D 2025 in Siena, Italy 9-10 September 2025, co-located with Digital Heritage 2025

We welcome contributions from developers, researchers, and industry professionals interested in advancing 3D web technologies.

Join Web3D Geospatial Working Group

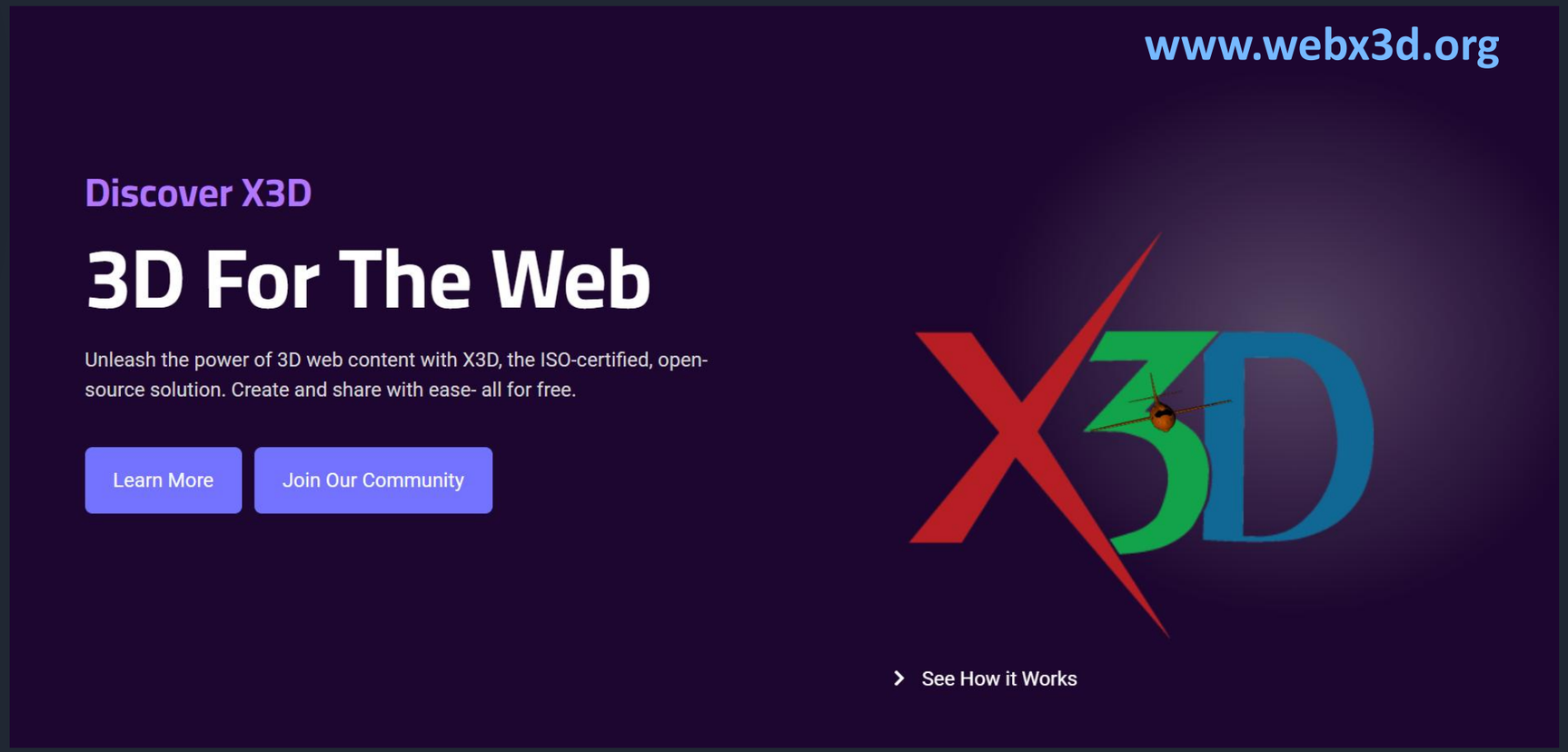
Learn X3D – Resources and Tools

Attend our conferences and webinars

YouTube Channel

Learn X3D – www.webx3d.org

Resources and Tools



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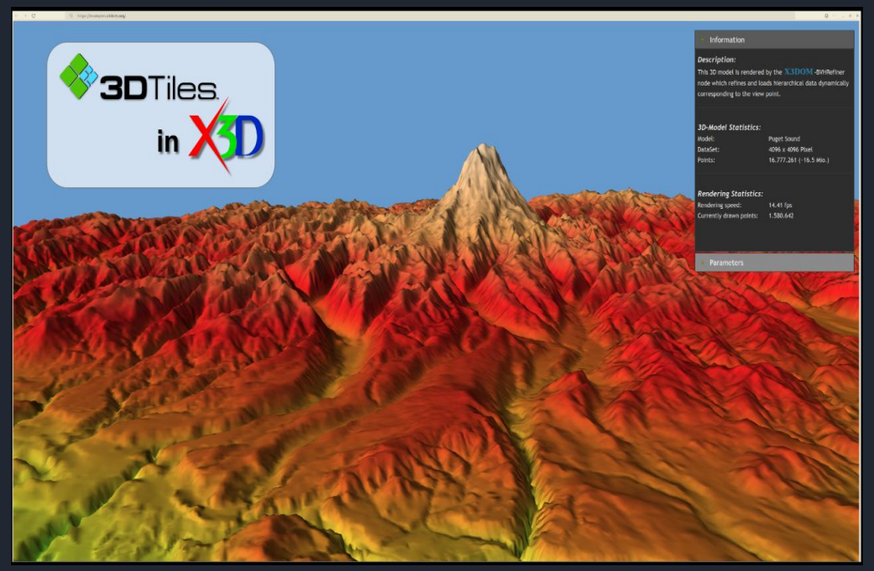
Grant Award: Bentley System's Cesium Ecosystem OGC 3D Tiles in X3D



We thank Bentley Systems for this award!
Press Release

This fulfills a critical need for X3D & 3D Tiles users, integrating large scale OGC 3D Tiles content with X3D geospatial content

Grant Award

In August 2025, the Web3D Consortium received funding from the Cesium Ecosystem Grant program to advance OGC 3D Tiles support in X3D formats

Project Goals

Enhance interoperability and streamline integration of large 3D geospatial data sets into various applications

Collaboration

Working with Web3D members to align these important standards and advance geospatial visualization capabilities

Web Geospatial Ecosystem

Web3D Consortium Specification

- Interactive 3D scenes on the Web in real-time
- Wide range of 3D graphics features
- Multiple coordinate projections
- Double-precision data types

OGC Specification

- Efficient delivery of industrial geospatial datasets
- Streaming and rendering large-scale data
- Hierarchical Level of Detail (HLOD)
- Optimized for real-time applications

Khronos Specification

- Efficient transmission format for 3D scenes
- Optimized for runtime performance
- Physically-based rendering materials
- Lightweight 3D model delivery

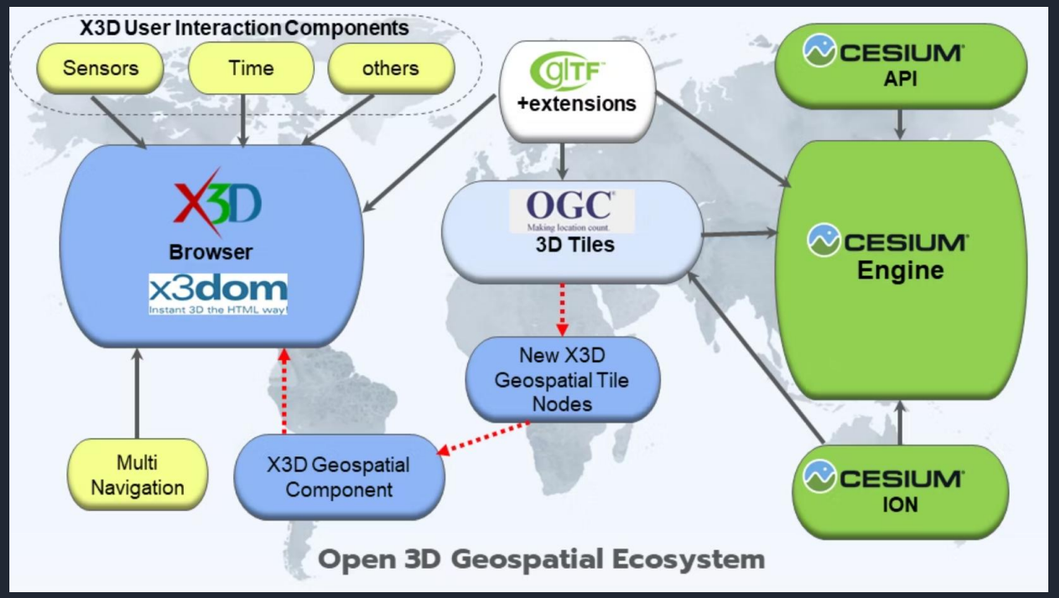
These complementary standards create a robust ecosystem for web-based 3D geospatial visualization, each addressing different aspects of the technical challenge.

Integration Proposal

- OGC 3D Tiles content can be assigned a geoSystem value during X3D integration
- Stream only those tiles from large datasets that are most important for a given 3D view
- Optimize performance while maintaining visual quality
- Implementation planned for open-source frameworks like X3DOM

OGC 3D Tiles support in X3D

Benefits



Standards Convergence

Creating connections between three key standards (X3D, OGC 3D Tiles and glTF) for seamless interoperability

Enhanced Visualization

Transmitting and visualizing large-scale 3D scenes including industrial 3D geospatial datasets, buildings, terrain, and point clouds in real-time with additional 3D graphics features

Broader Adoption

Encouraging content creators to adopt 3D Tiles for streaming industrial 3D geospatial datasets embedded in X3D's rich 3D feature set

X3D

Web3D and AI

https://www.web3d.org/working-groups/ai-x3d

Working Group

X3D

Metaverse Standards Forum

3D Web Interoperability for the Metaverse

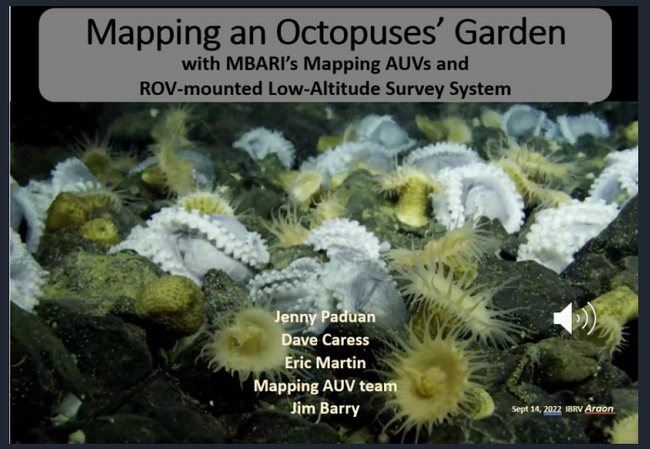
Discuss the directions of the 3D Web Interoperability Domain Group from the Metaverse Standards Forum. Web of Worlds – This project to link virtual worlds highlights a compelling analogy between the World Wide Web—a unified system of URL-addressable, interconnected interactive experiences—and what we envision as a cohesive metaverse platform. This envisioned platform comprises numerous addressable and interconnected spatial experiences, or virtual worlds, collectively forming what we call the “Web of Worlds.” Just as websites create a networked digital ecosystem, these spatial-first experiences would interconnect to create a seamless virtual world.

X3D Use Cases

Versar: Geospatial and Digital Solutions

Versar leverages X3D's geospatial capabilities to create interactive environmental analysis tools. Their applications help clients visualize environmental impact assessments, infrastructure planning, and resource management scenarios through intuitive 3D interfaces that integrate multiple data sources into cohesive geospatial visualizations.

MBARI: Mapping of the Seafloor



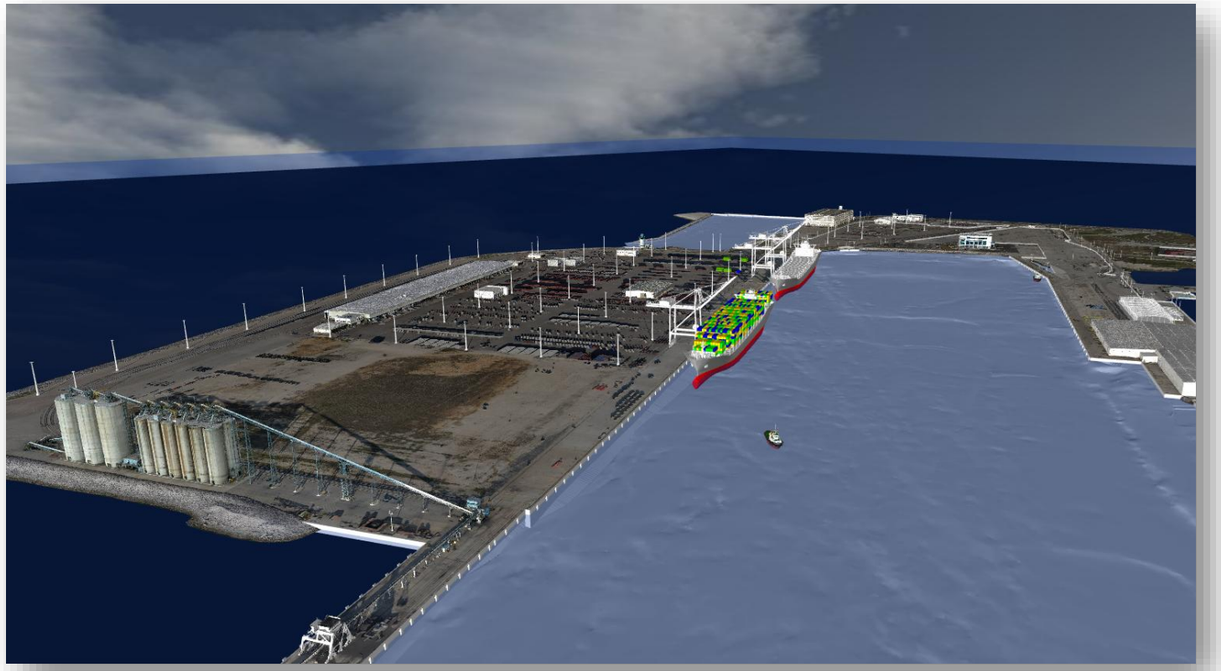
The Monterey Bay Aquarium Research Institute uses X3D for visualizing complex underwater terrain and biological habitats. Their systems combine bathymetric data, underwater photography, and biological observations into interactive 3D environments that help scientists study marine ecosystems in unprecedented detail.

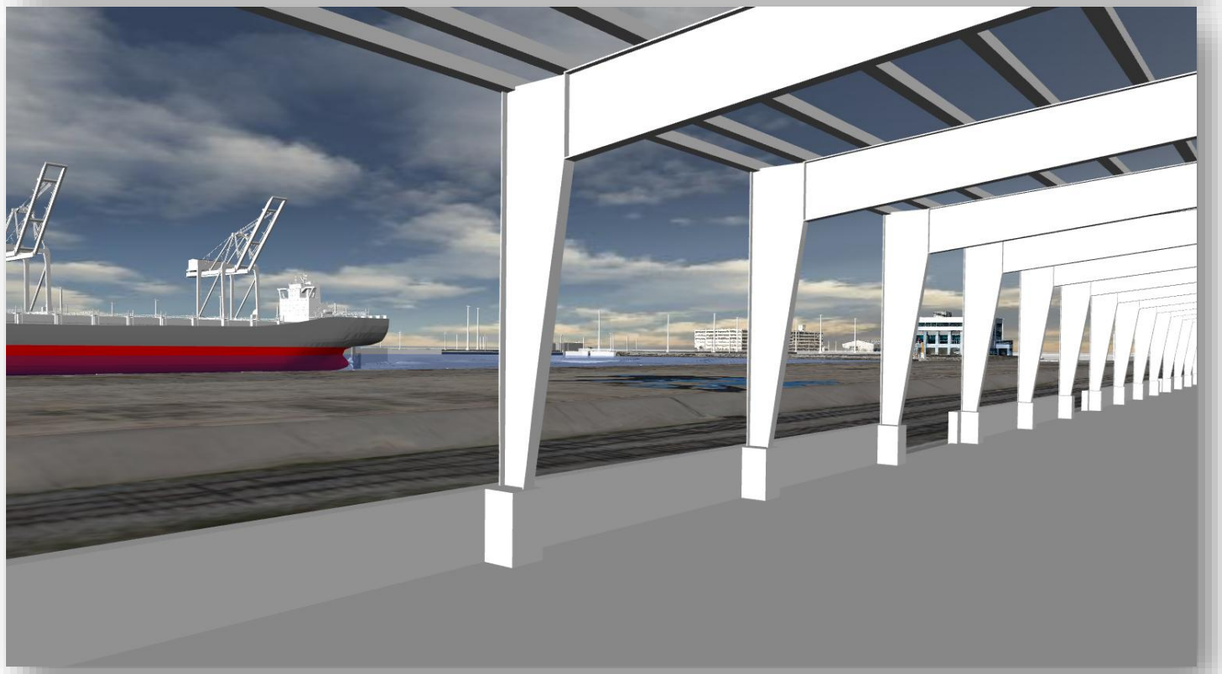
X3D provides the tools needed to create meaningful interactive visualizations that help stakeholders understand complex spatial relationships

VERSAR
GLOBAL SOLUTIONS

- Program and Project Management Company
- Geospatial and Digital Solutions Group
- Partners with:
  - Web3D Consortium
  - Open Geospatial Consortium
  - Naval Post Graduate School
  - Virginia Tech

- Government and DOD Customers
  - Engineering
  - Geospatial
  - Planning
  - Management
  - Consultation
  - Training
  - Products and Services





VERSAR
GLOBAL SOLUTIONS

- Information and Connectivity
  - Build on and improve existing data methodologies and pipelines
  - Facilitate creation, interoperability, and access to data

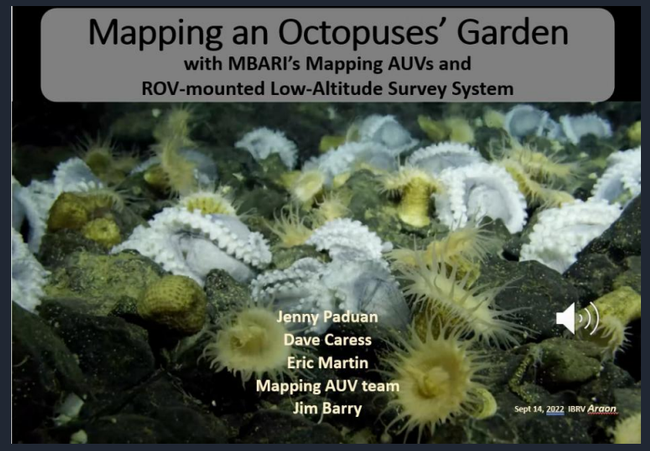
- X3D Virtual Environments and the Internet
  - Non-proprietary solution
  - Implemented and authorized for use by the government
  - Minimal edge computing requirements
  - Access to data regardless of location and software
  - Findable, Accessible, Interoperable, Reusable
  - Efficiency and Standardization

- X3D Capability and Observations
  - Terabytes of data collected or aggregated
  - Conversion and Transformation
  - Gigabytes or Megabytes Rendered and Shared
  - Maintain quality and fidelity of data
  - Data interaction and investigation

- Value to Our Customers
  - Currently being implemented
  - Allows for critical collaboration and decision making
  - Precision
  - Customizable
  - Integrable and relatable
  - Performant
  - Accessible

X3D Geospatial Use Cases

01 MBARI: Mapping an Octopuses' Garden



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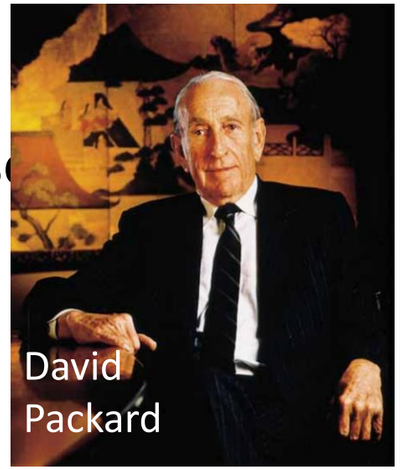
Mapping an Octopuses' Garden

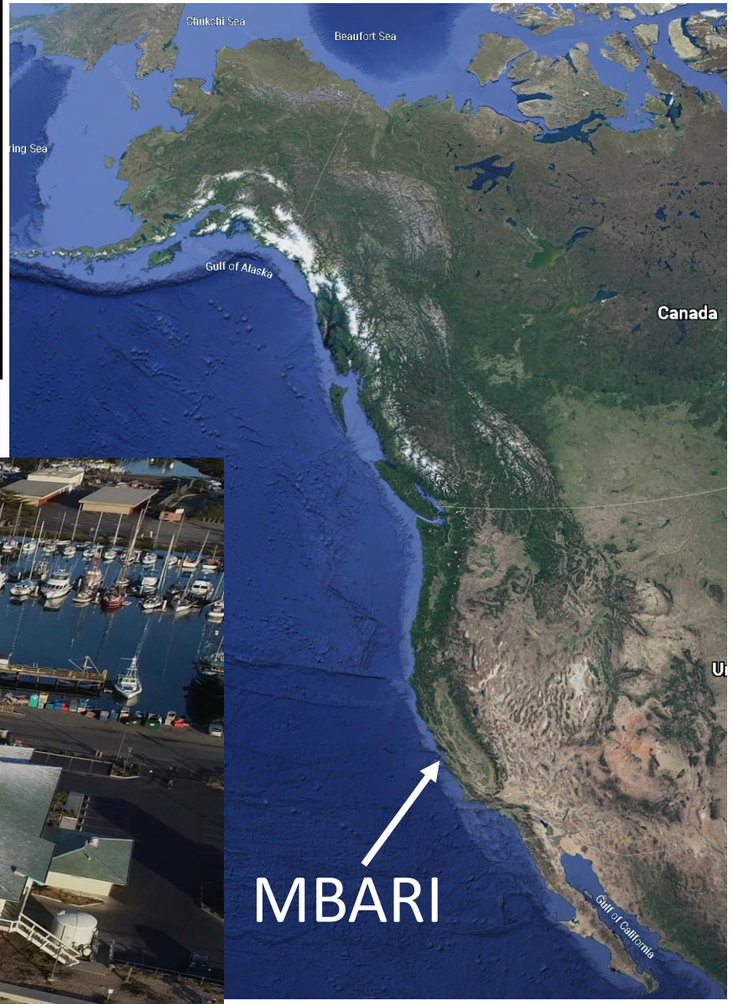
with MBARI's Mapping AUVs and ROV-mounted Low-Altitude Survey System

Monterey Bay Aquarium Research Institute

Founded in 1987

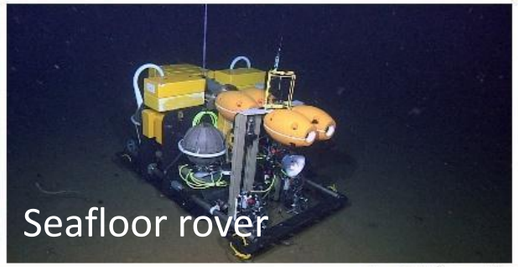
Funding from the David and Lucile Packard Foundation





MBARI
Monterey Bay Aquarium
Research Institute

MBARI operates three ships and an array of seagoing robots to study the oceans

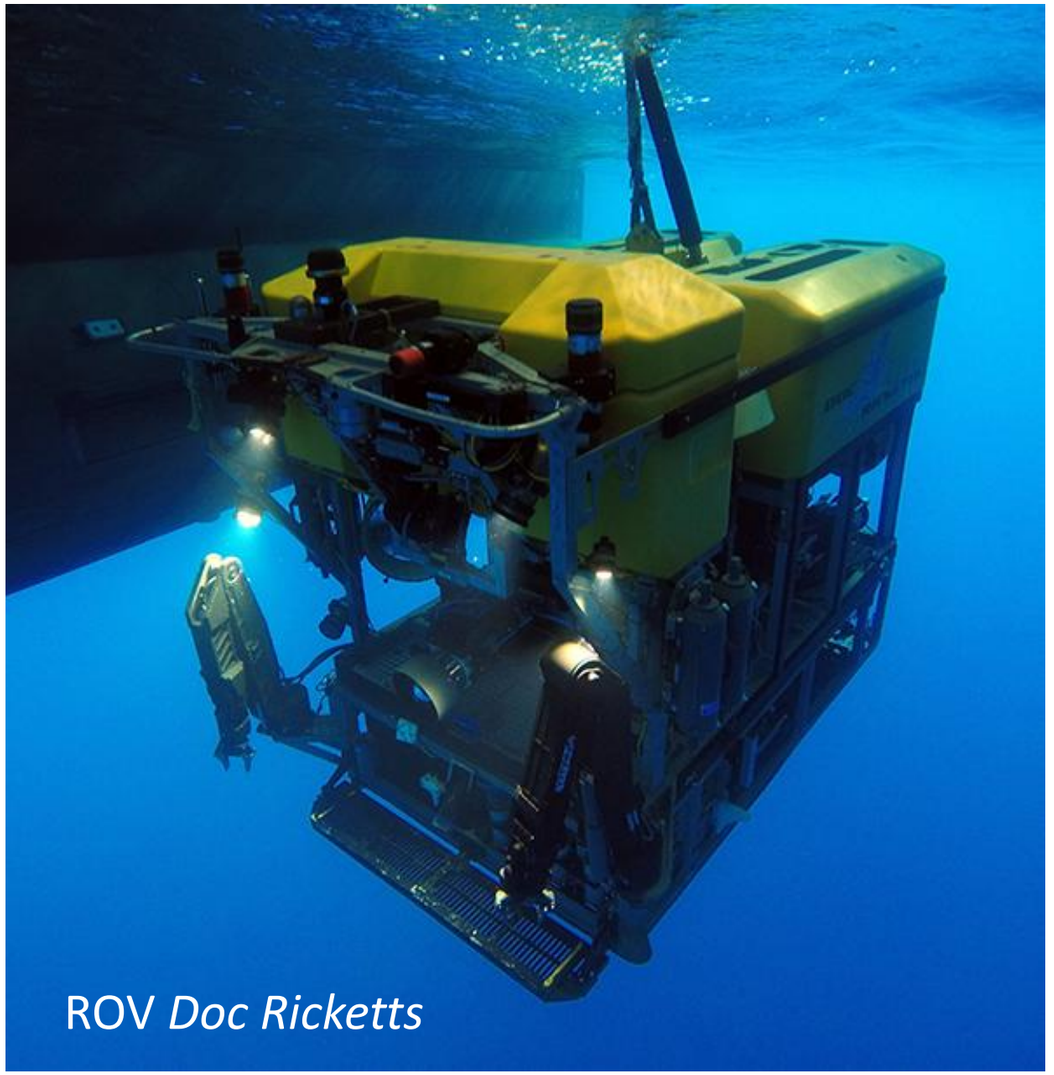


AUV

Autonomous Underwater Vehicle

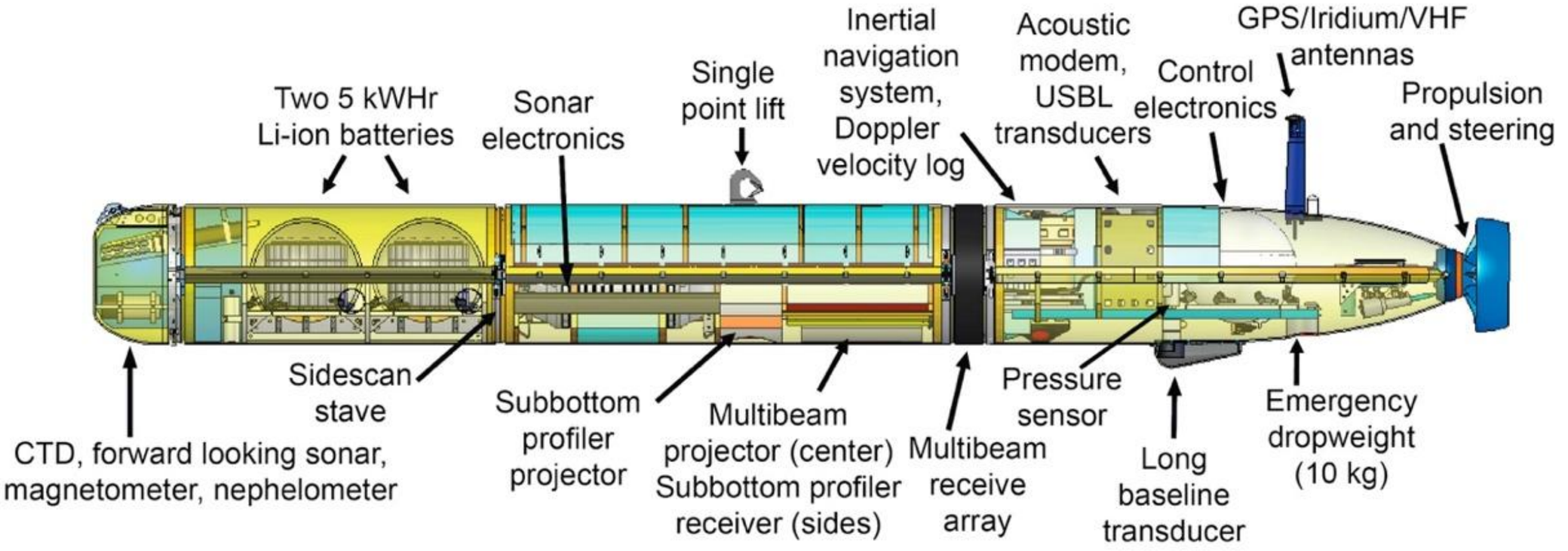
ROV

Remotely-operated vehicle

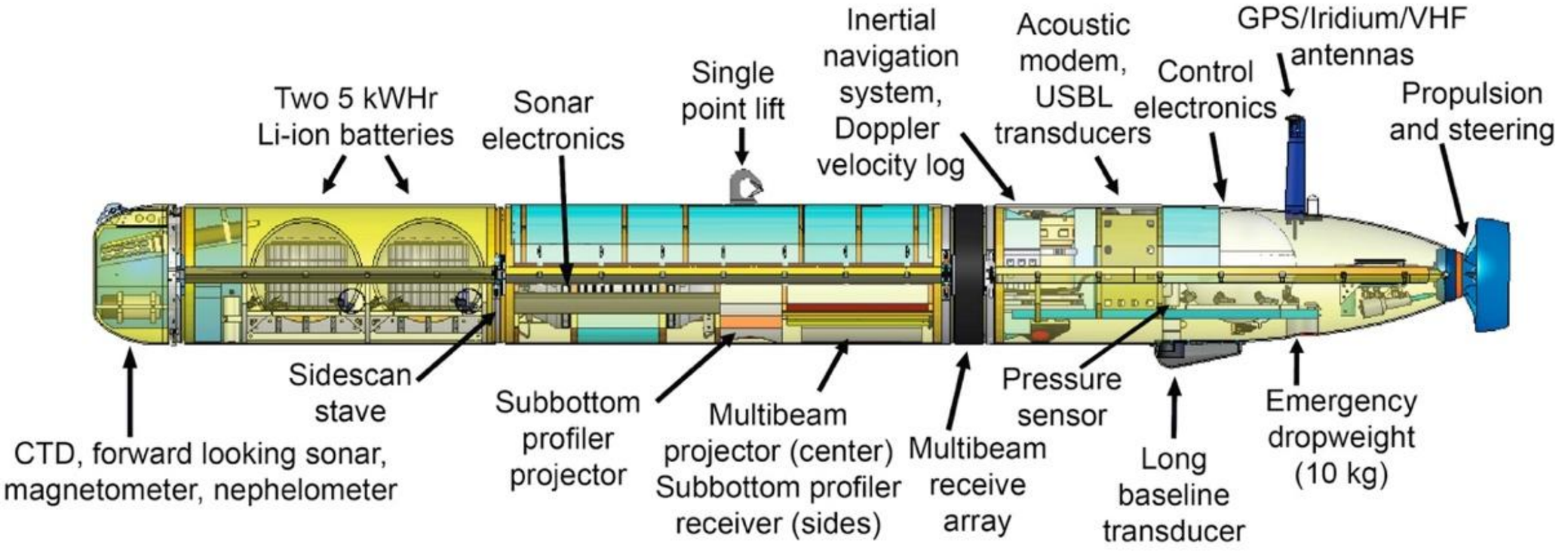


ROV *Doc Ricketts*

Mapping AUV - schematic



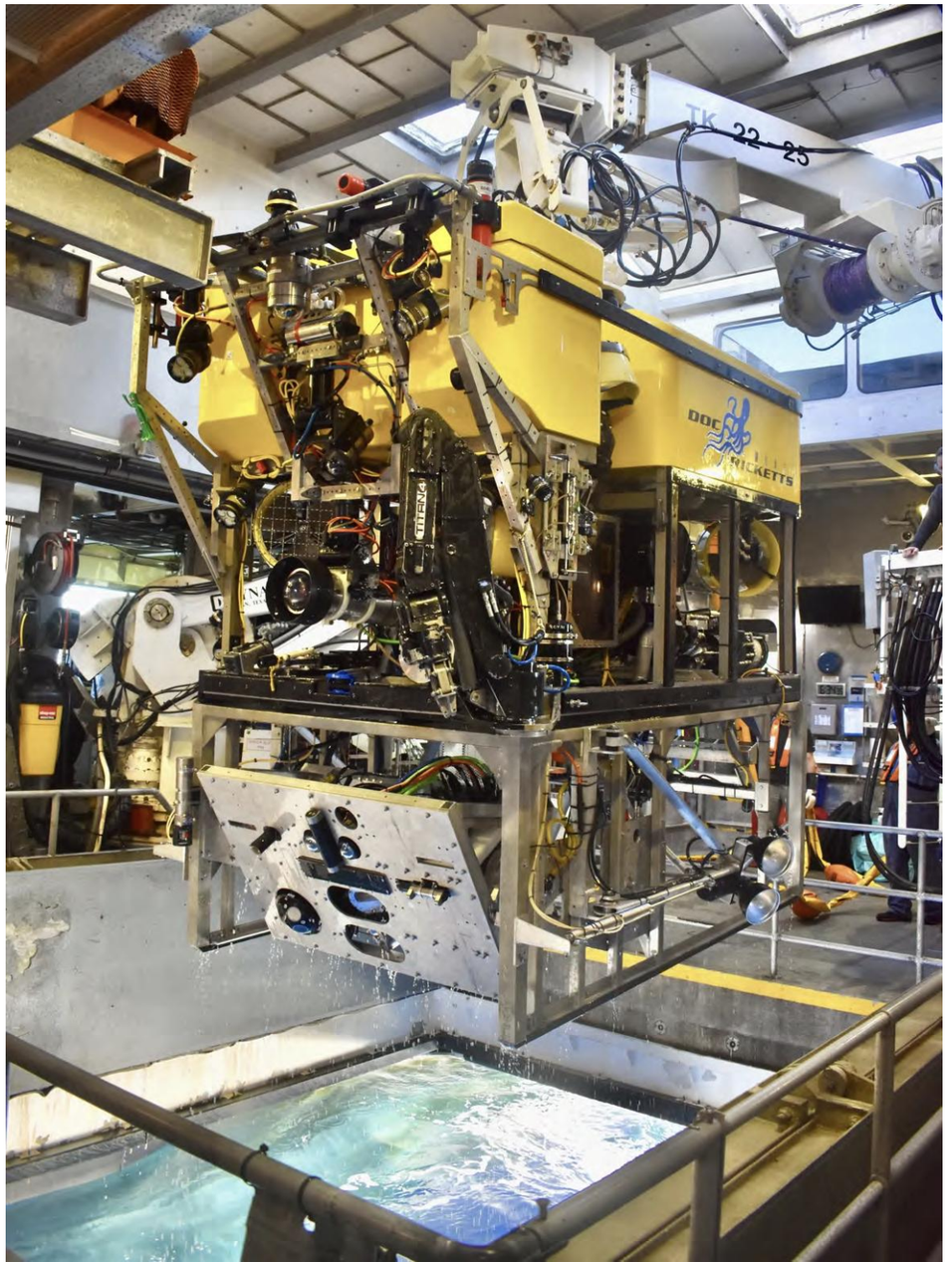
Mapping AUV - schematic



Fly 50 m above the seafloor for 1-m resolution data

Low-altitude survey system (LASS)

ROV *Doc Ricketts*

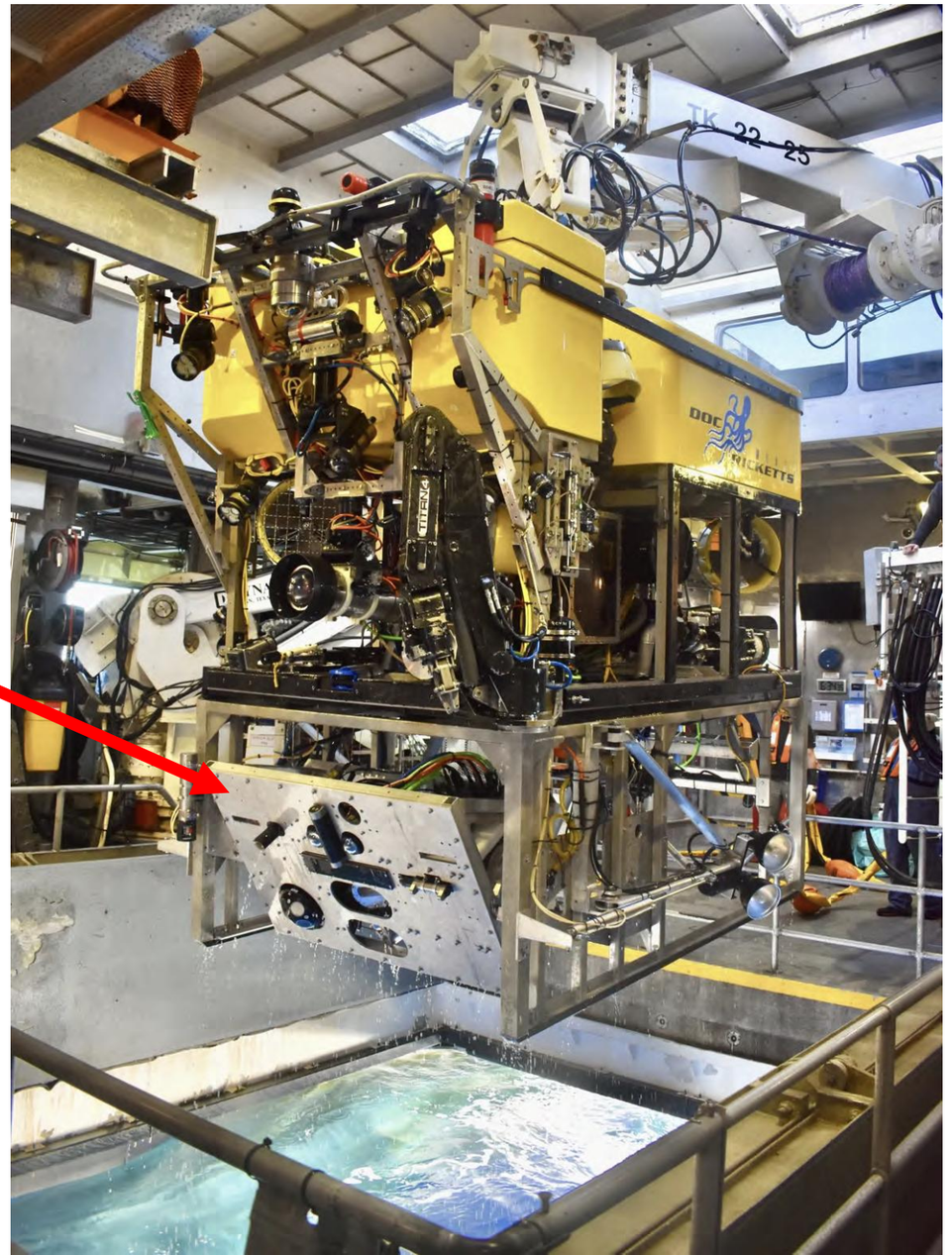


Low-altitude survey system (LASS)

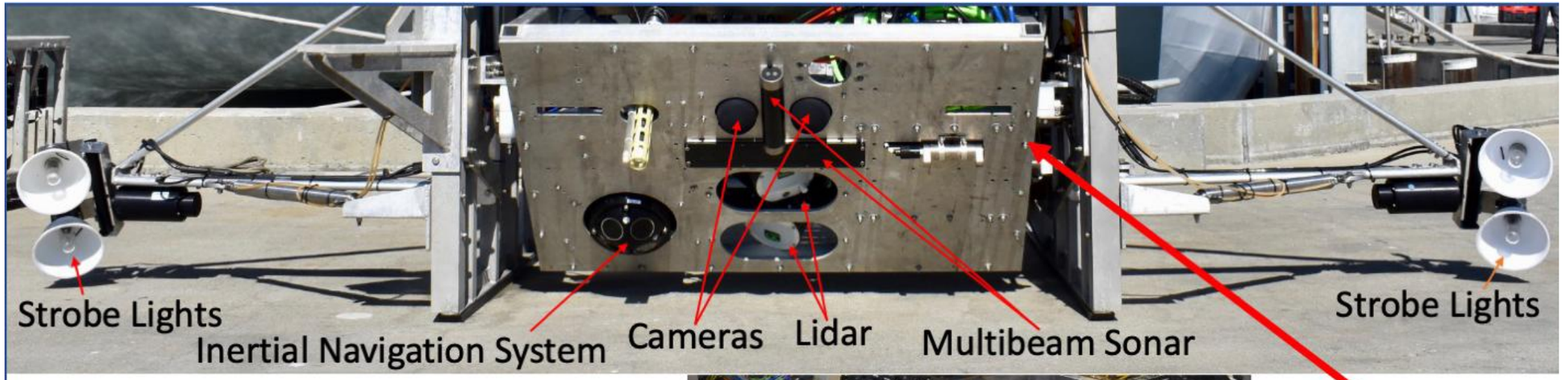
ROV *Doc Ricketts*

LASS toolsled

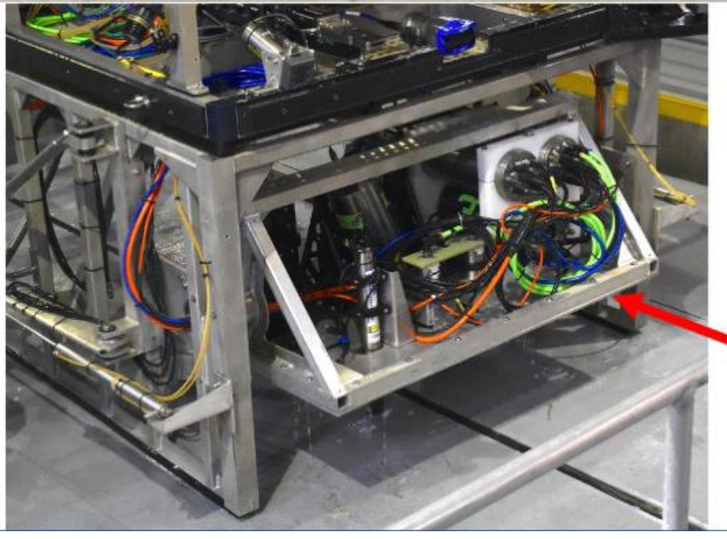
- Flown autonomously
- 3 m above seafloor
- 3 m wide line spacing



Low-altitude survey system: sensors



- Wide Swath Lidar (WiSSL)
- Multibeam sonar
- Stereo color cameras + strobes
- Inertial Navigation System
- Sensor frame and strobes rotate to point at the seafloor regardless of slope

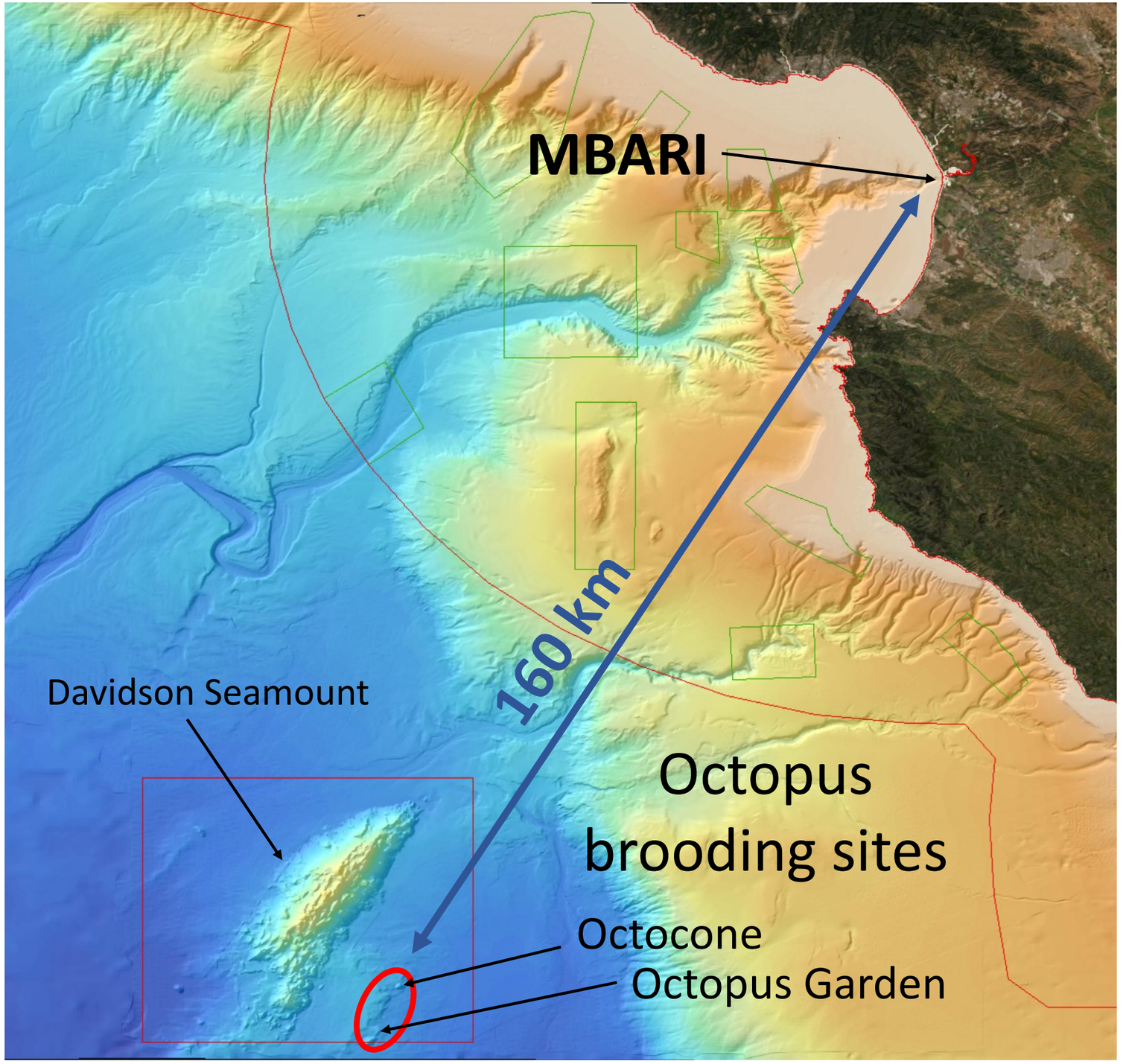


Sensor frame pointing 45° forward

Sensor frame pointing straight down

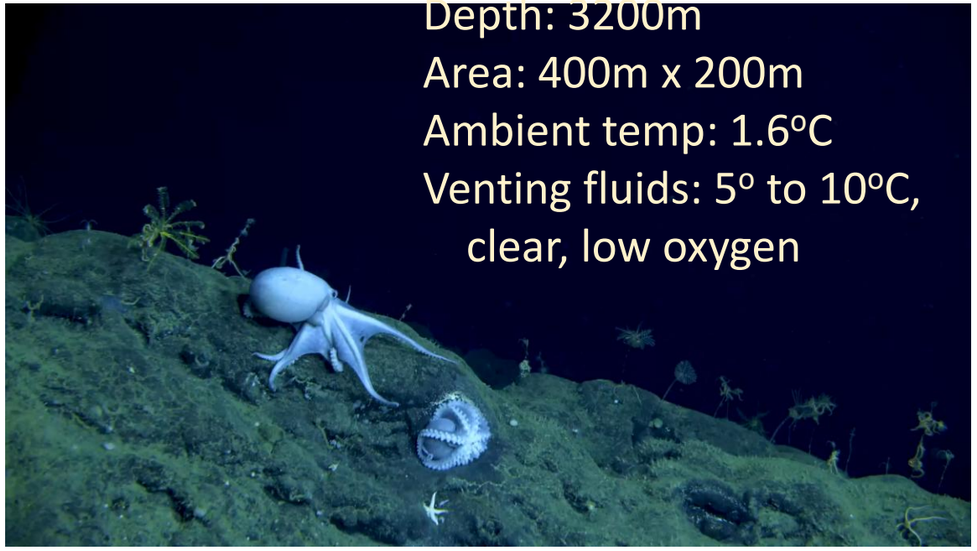
Low-altitude survey system: articulating frame

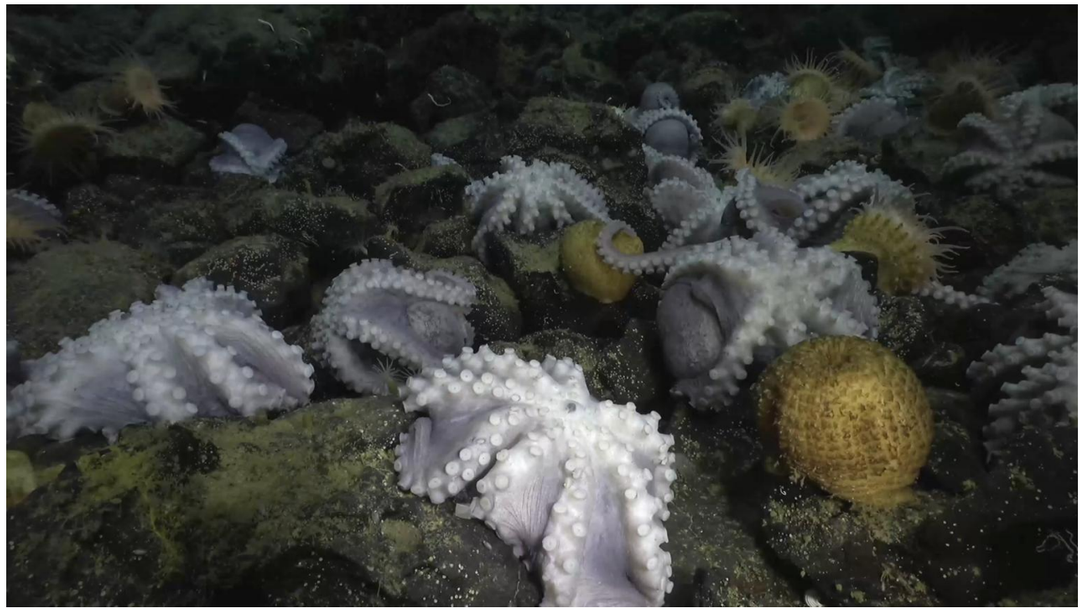
Muusoctopus robustus (a deepwater octopus)


MBARI
160 km
Davidson Seamount
Octopus
brooding sites
Octocone
Octopus Garden

Muusoctopus reproductive biology

Octopus Garden:





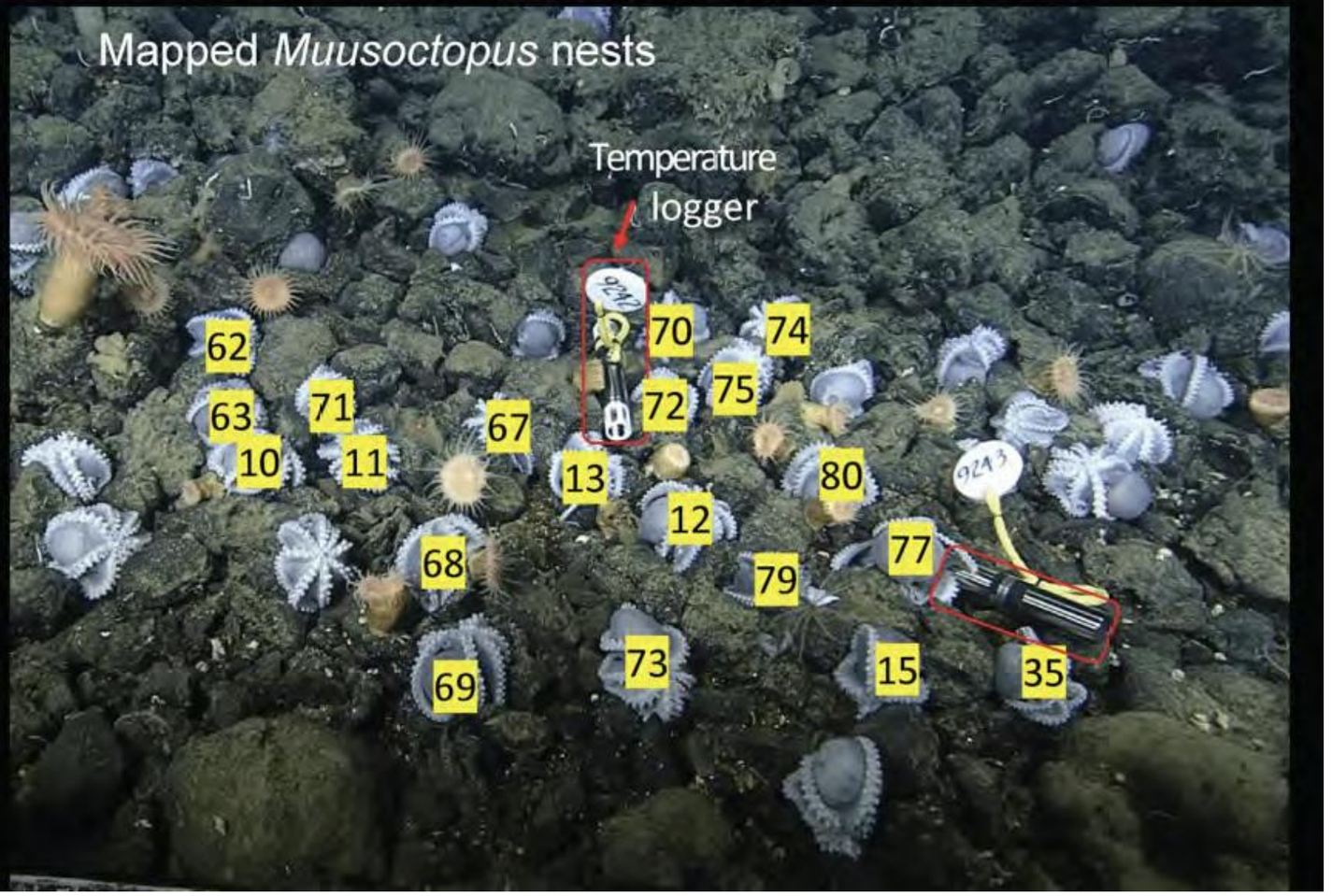
Mapping an Octopuses' Garden

with MBARI's Mapping AUVs and ROV-mounted Low-Altitude Survey System

Muusoctopus reproductive biology

Field program

Revisit marked nests
- Temperature
- Oxygen
- Embryo condition
- Female identity



Questions that can be addressed by our combination of acoustic and optical mapping:

- How many octopuses are there?
- How many are brooding, wandering, or dead?
- How is their distribution related to the shape and character of the seafloor habitat?
- What other animals are there?

Mapping Octopus Garden with the AUVs

Mapping Octopus Garden with the AUVs

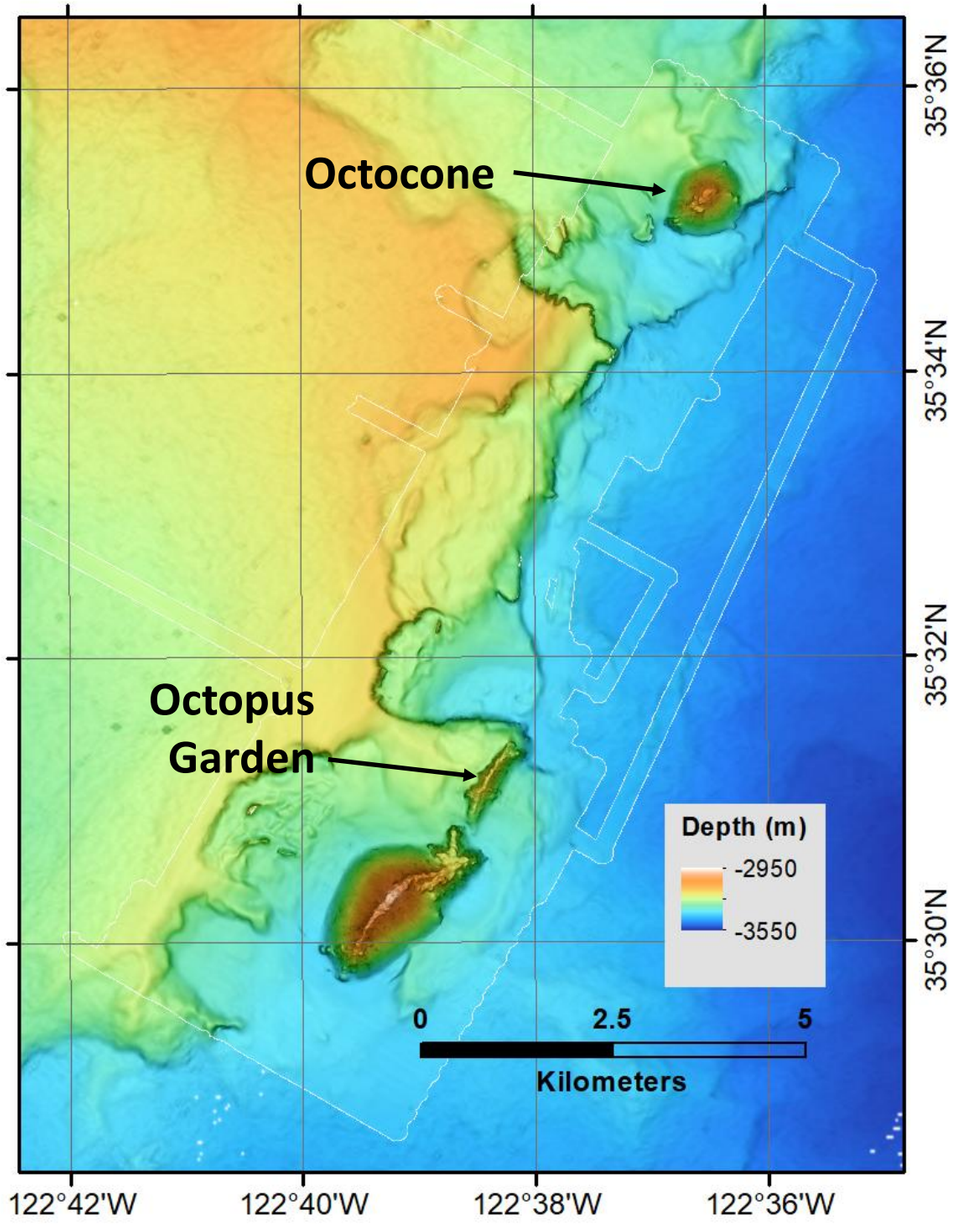
Mapping Octopus Garden with the AUVs

From the R/V *Rachel Carson*
February, 2022

Mapping Octopus Garden with the AUVs

February, 2022

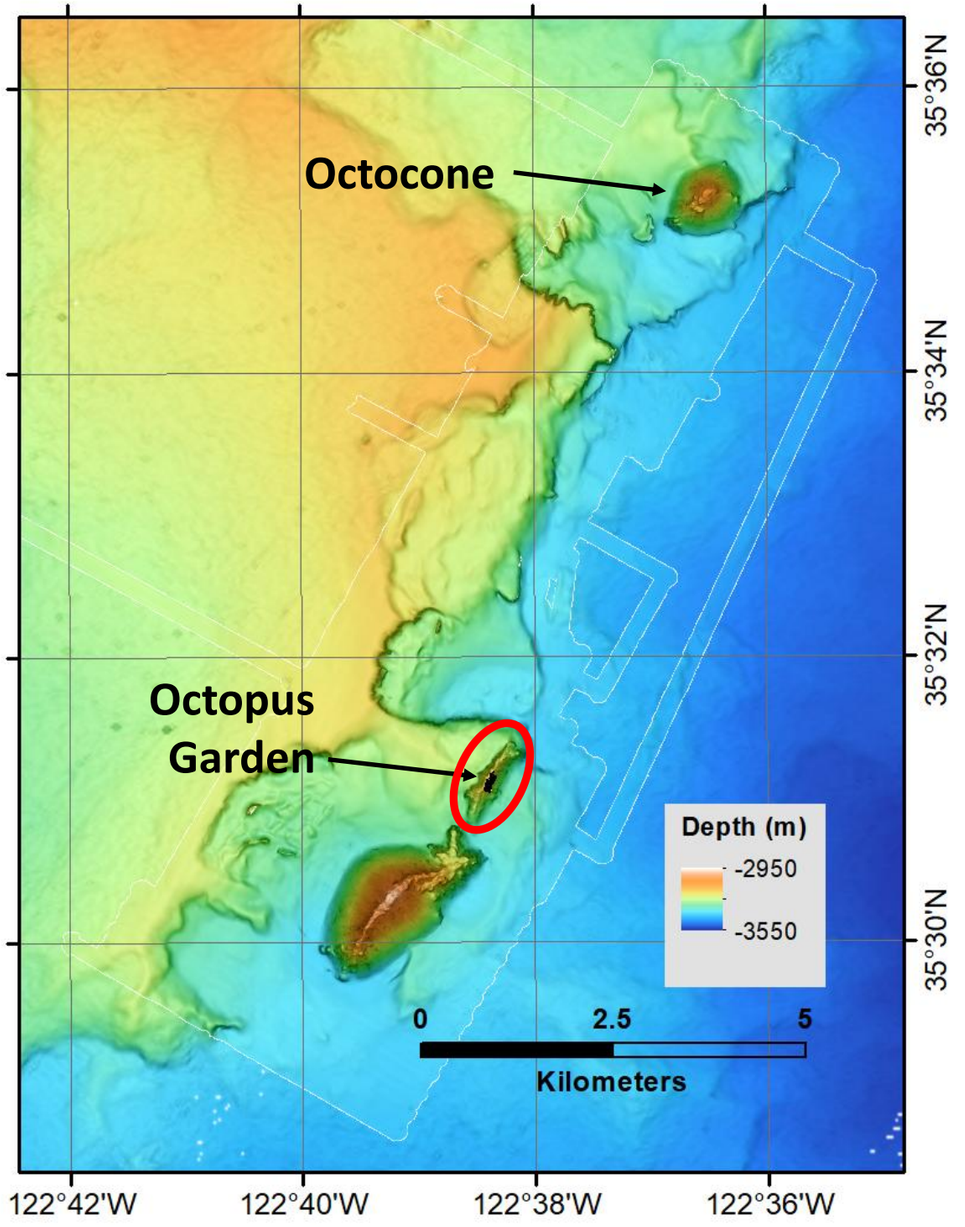
- AUV missions: 6
- Area: 54 km^2
- Both brooding sites covered



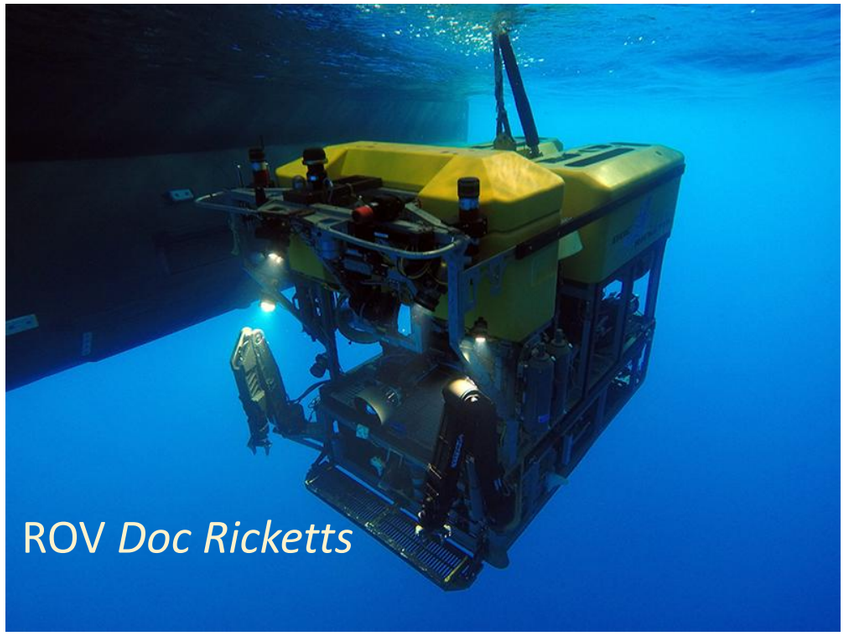
Mapping Octopus Garden with the Low-Altitude Survey System

April, 2021

- LASS missions: 2
- Area: 245 m by ~95 m
- Part of Octopus Garden



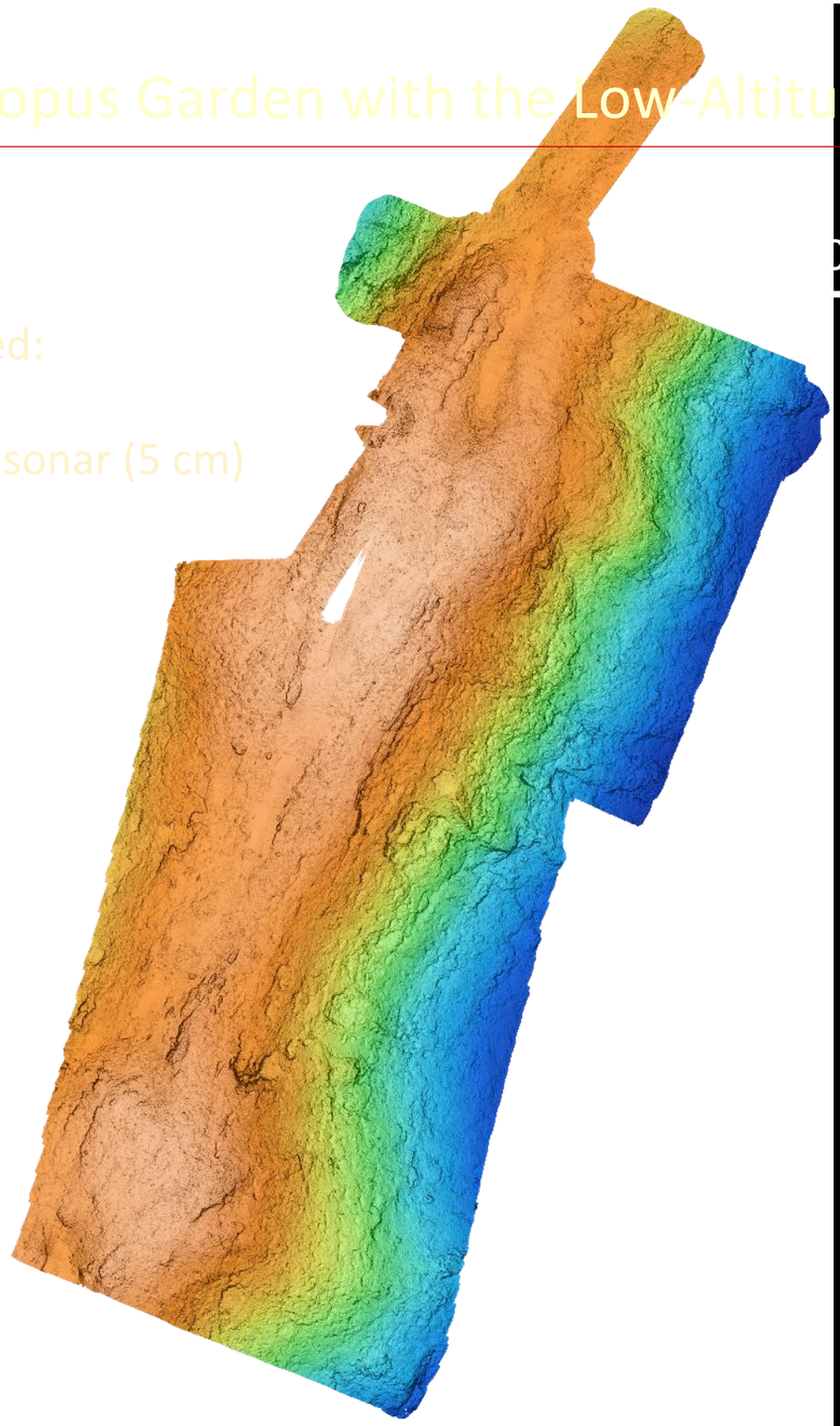
Mapping Octopus Garden with the Low-Altitude Survey System

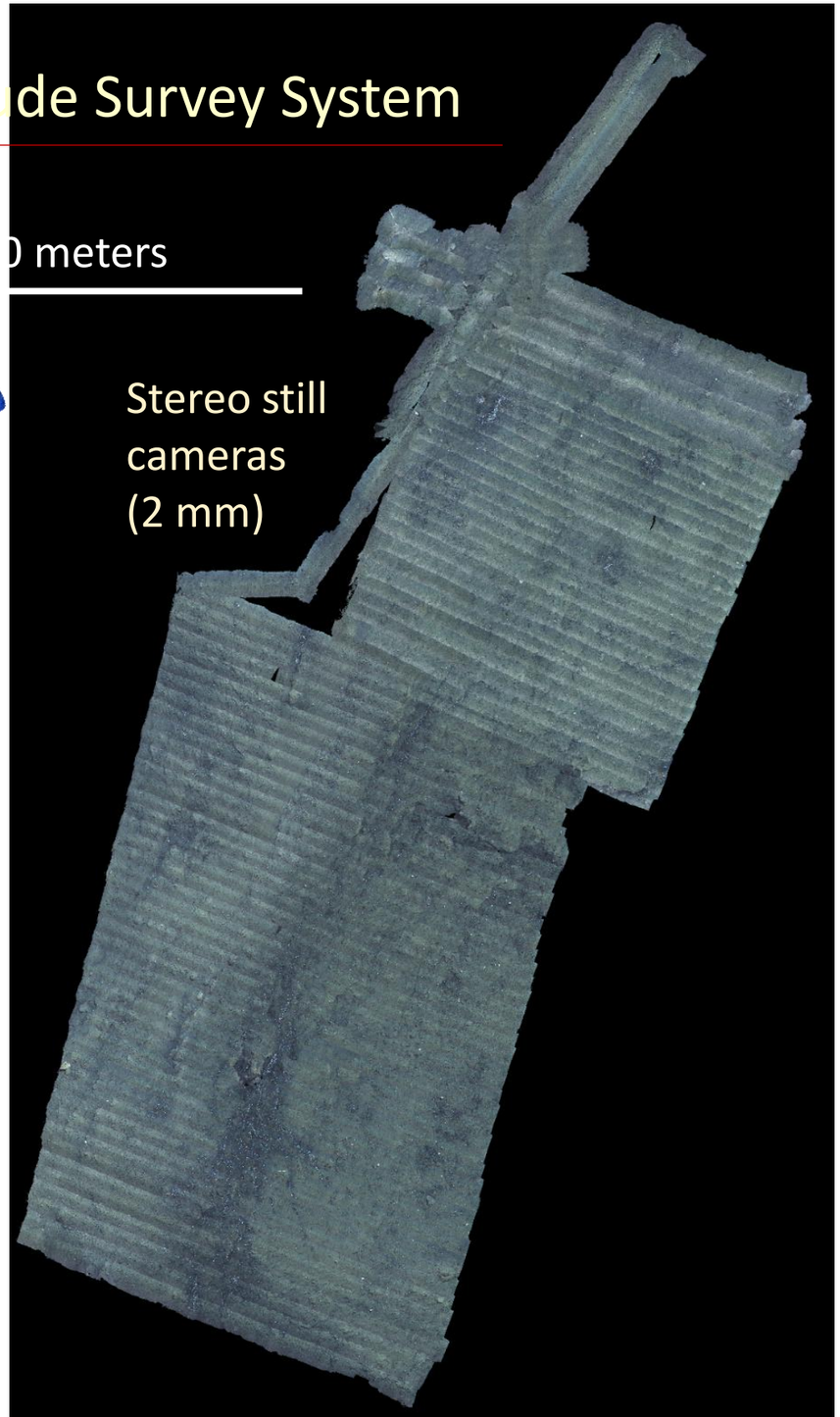


Mapping Octopus Garden with the Low-Altitude Survey System

Co-navigated:

Multibeam sonar (5 cm)





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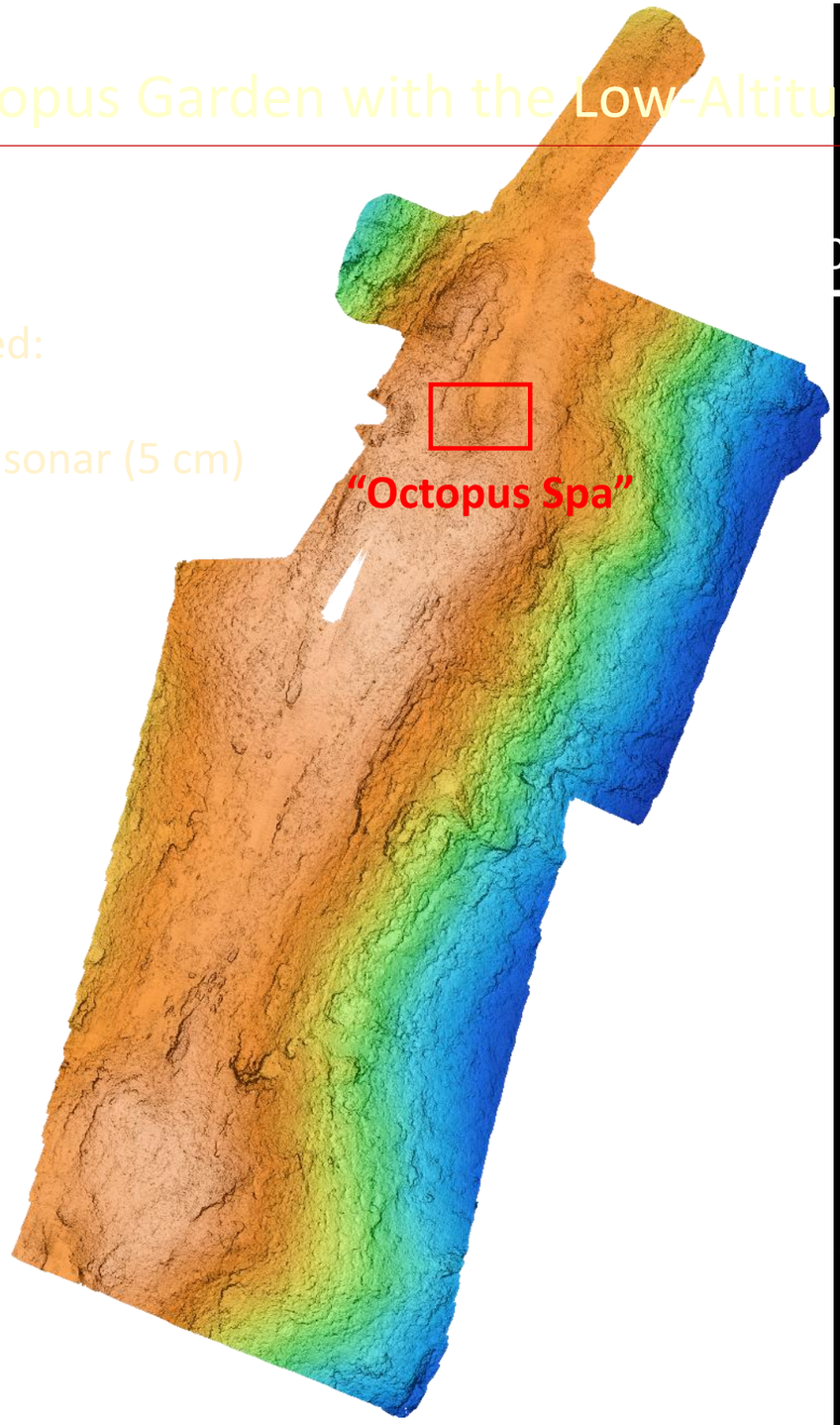
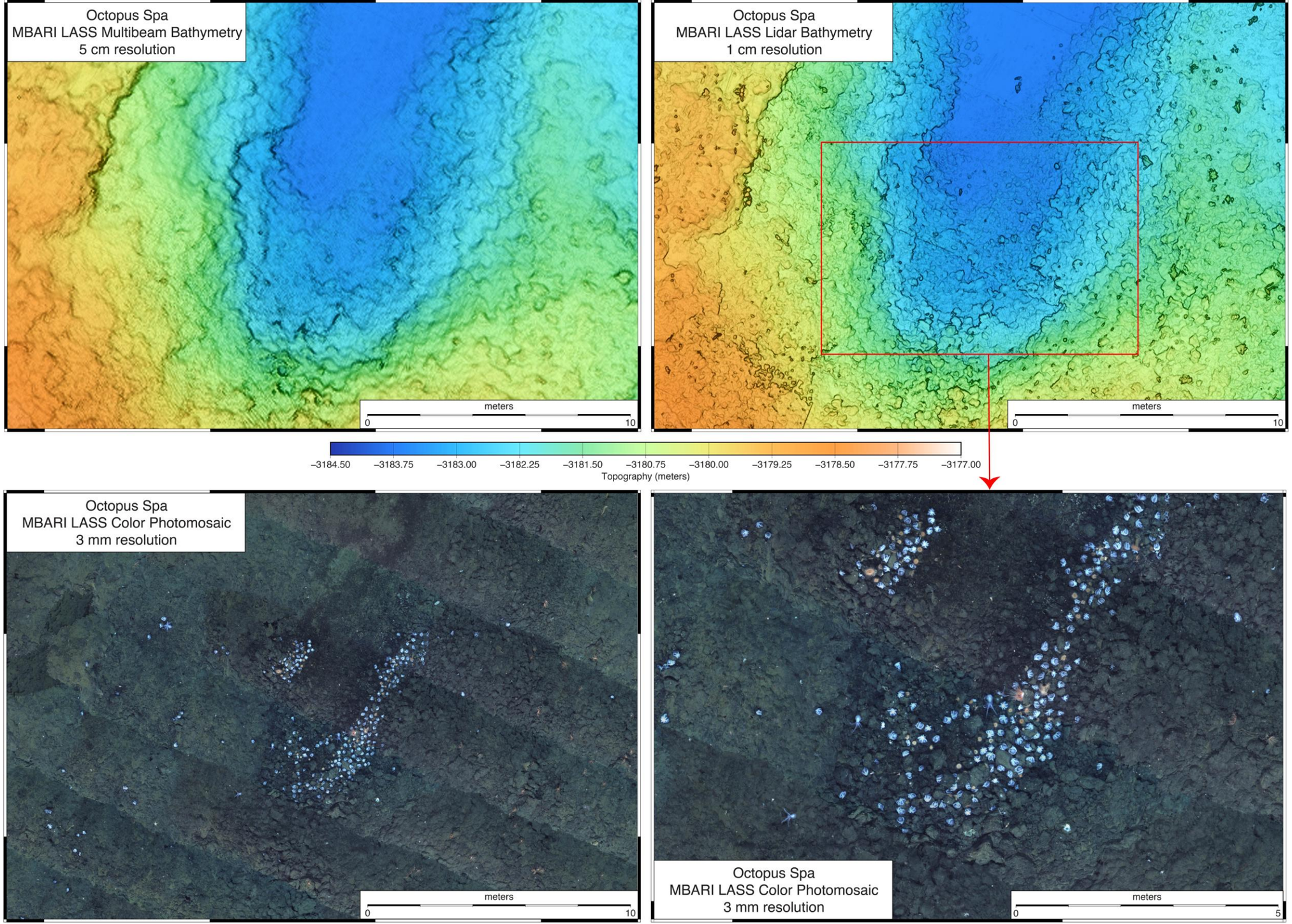


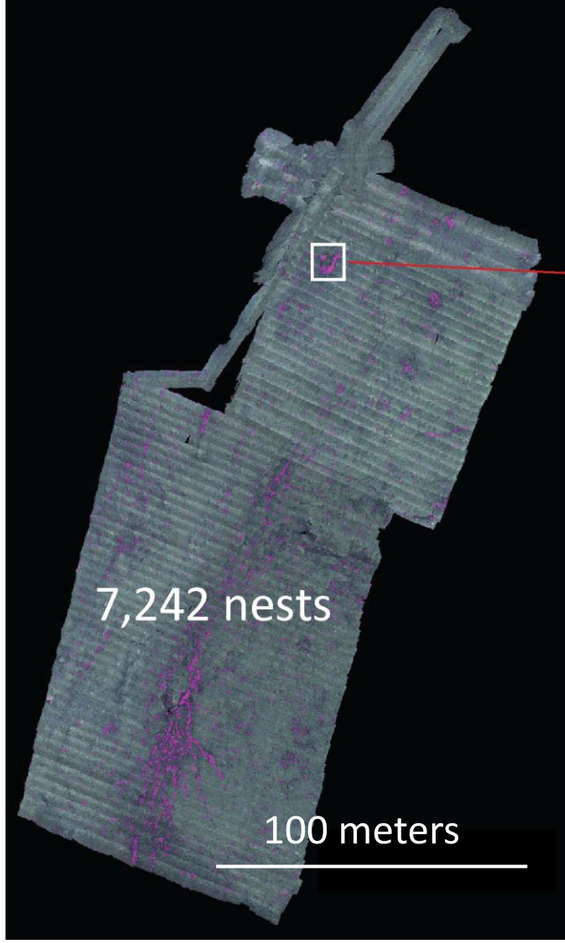
0 meters

Stereo still cameras (2 mm)

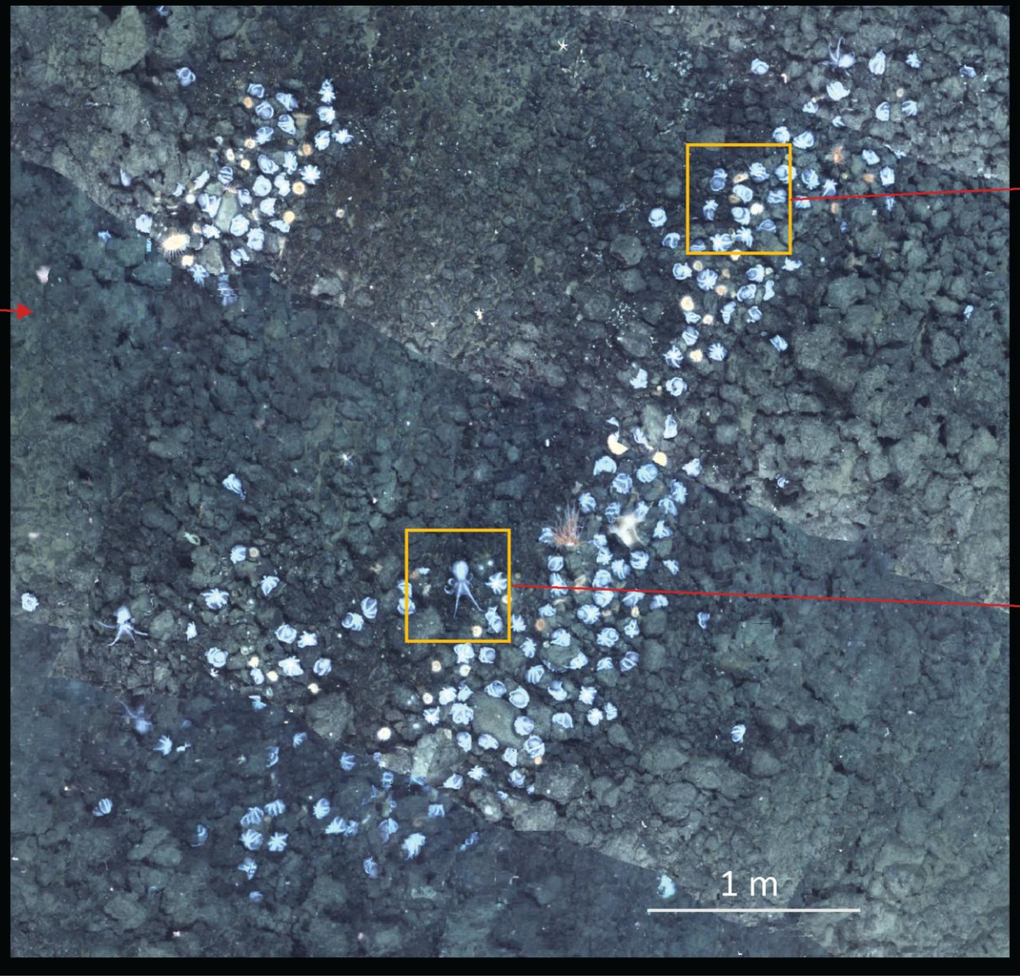

Octopus Spa
MBARI LASS Multibeam Bathymetry
5 cm resolution
meters
0
10
Octopus Spa
MBARI LASS Lidar Bathymetry
1 cm resolution
meters
0
10
−3184.50
−3183.75
−3183.00
−3182.25
−3181.50
−3180.75
−3180.00
−3179.25
−3178.50
−3177.75
−3177.00
Topography (meters)
Octopus Spa
MBARI LASS Color Photomosaic
3 mm resolution
meters
0
10
Octopus Spa
MBARI LASS Color Photomosaic
3 mm resolution
meters
0
5

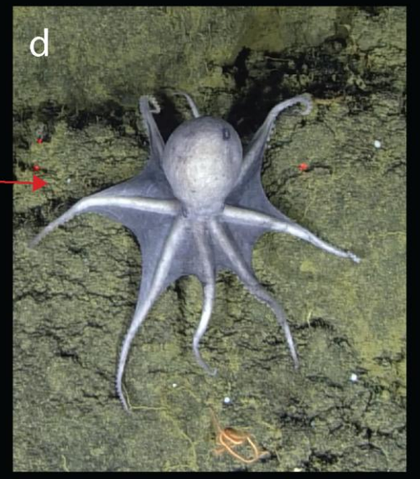
Interpreting the mapping

a) LASS photomosaic

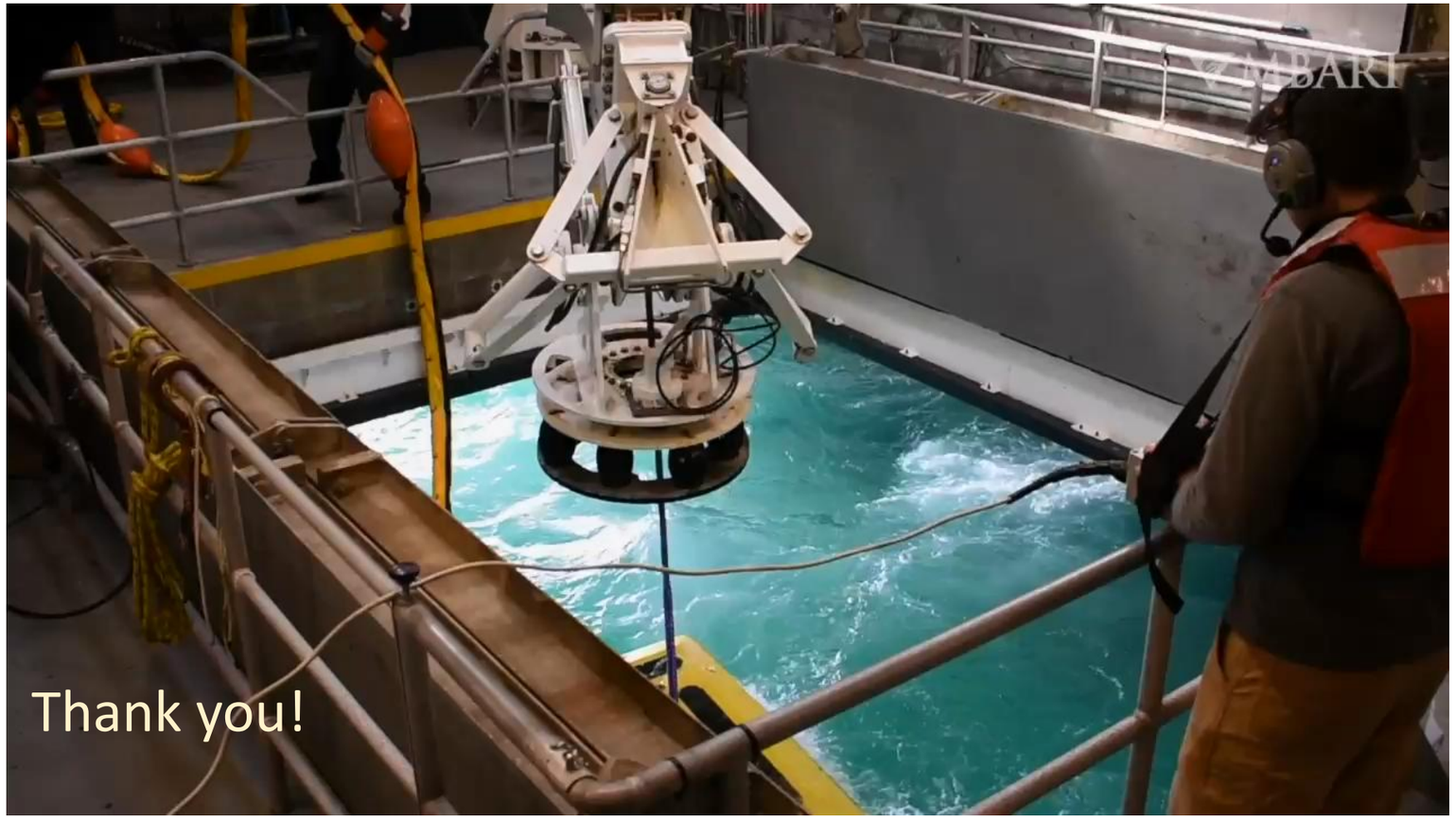


b) Zoom in on photomosaic: individuals brooding and moving



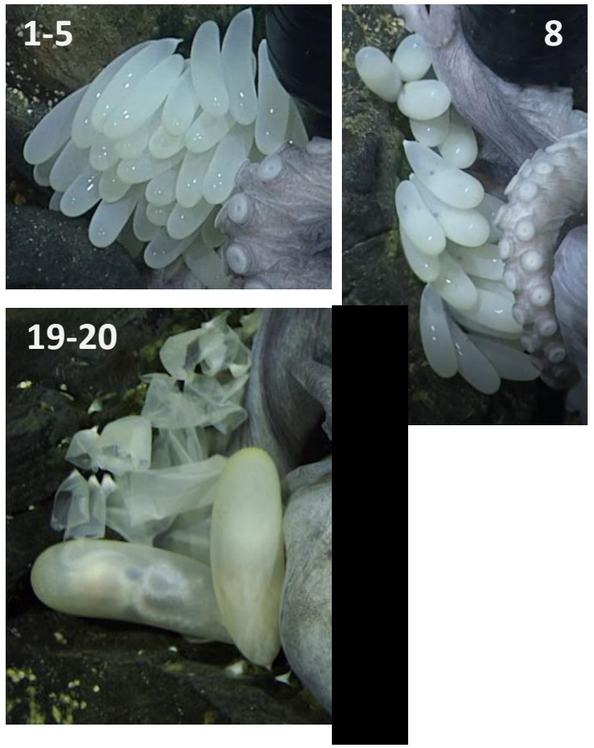


Muusoctopus from ROV video

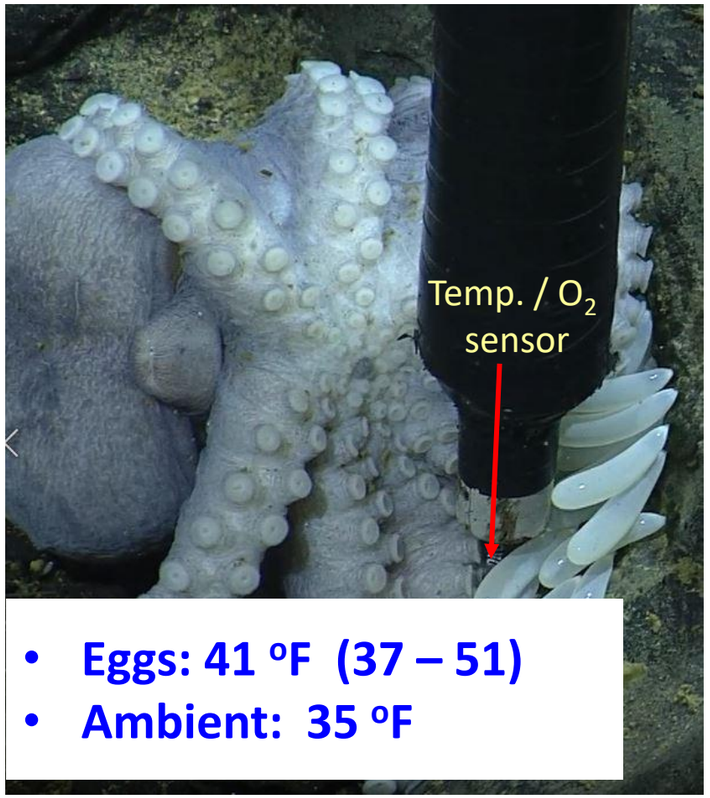

BARI
Thank you!

Measurements of marked nests

Embyro stage rating



Egg temperature / oxygen



- **Eggs: 41 °F (37 – 51)**
- **Ambient: 35 °F**

Female Turnover

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