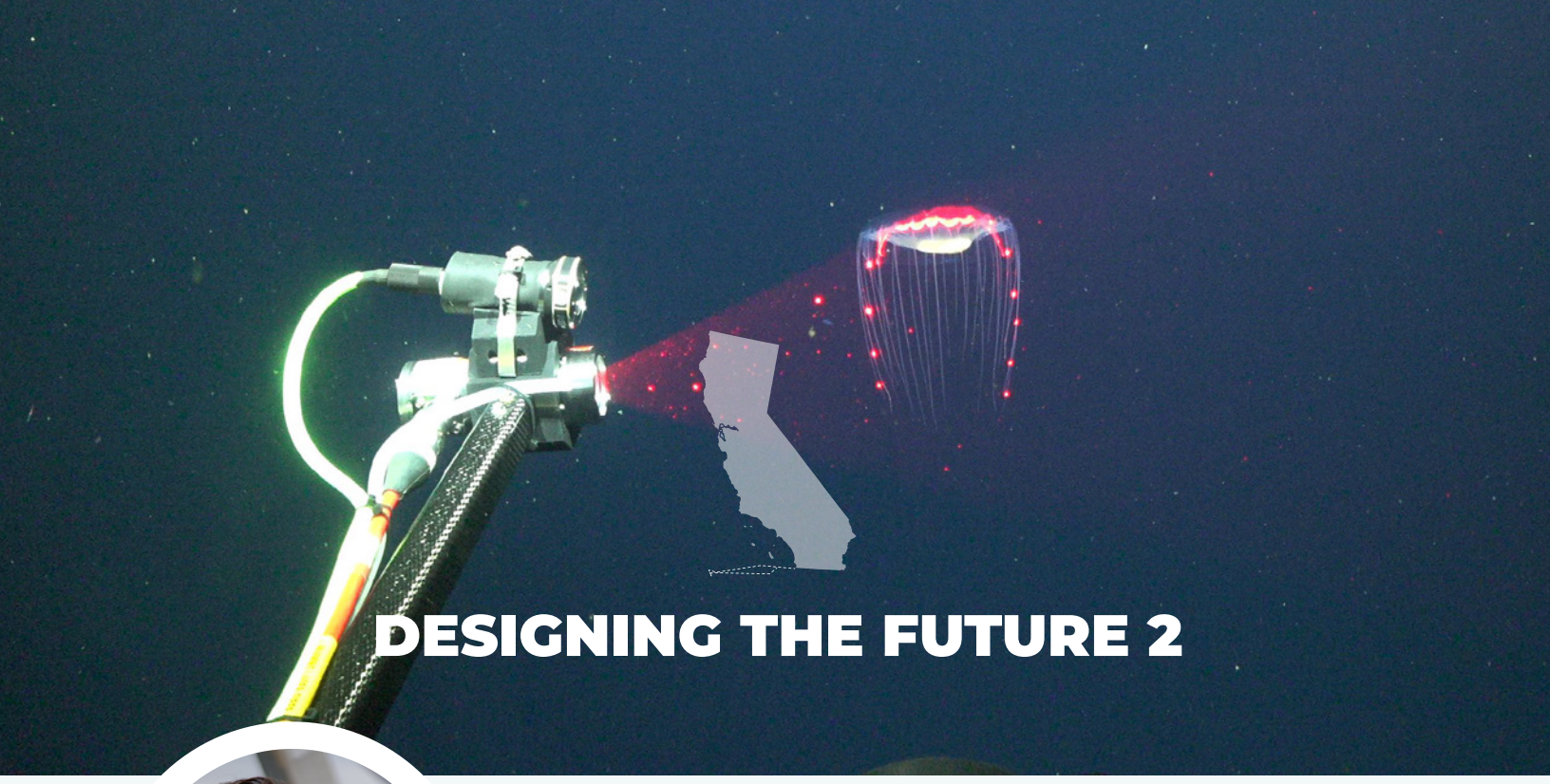


# DESIGNING THE FUTURE 2

## #DesigningTheFuture2

August 12, 2021 – August 21, 2021
San Diego, California, USA
Chief Scientist: Dr. Brennan Phillips
Co-Chief Scientist: Dr. Kakani Katija

University of Rhode Island, MBARI, Harvard University, CUNY/Baruch College, Bigelow Marine Laboratory.

It is estimated that up to a million species remain undescribed in the midwater zone, owing largely to a lack of sampling effort and limited tools available for the direct collection of single undescribed specimens. A significant amount of midwater species also remain undescribed and poorly understood because it is difficult to capture and bring them to the surface intact for further taxonomic inspection. The goals of the expedition involved testing three new sampling technologies developed for addressing these current shortcomings in midwater sampling. The three new pieces of equipment included a robotic encapsulation device outfitted with a tissue sampling system with in situ preservation capabilities, a plenoptic light-field imaging system, and a laser-sheet particle imaging velocimetry (PIV) system. These three systems combined enable the rapid characterization of deep-sea specimens.

The physical tissue samples that were collected and preserved in situ will allow for full-genome sequencing, including gene expression, which has only been achievable in a handful of previous efforts. Advances in the tools available for deep-sea, midwater science will create new windows into pelagic ecology. Ultimately the team developed a new technical approach to exploration, which will set a new benchmark for future midwater expeditions, in both imaging and sampling capabilities.

## Expedition Objectives

**Test a refined version of a next-generation robotic encapsulation device, the Rotary Actuated Dodecahedron Sampler (RAD2)**

**Deploy the deep particle image velocimetry (DeepPIV) instrument, to measure fine-scale movements of water in and around animals and create 3D scans of soft gelatinous animals and mucous structures**

**Integrate a new, real-time 3D imaging system called EyeRIS onto ROV SuBastian.**

**10**
*days at sea*

**8**
*ROV dives*

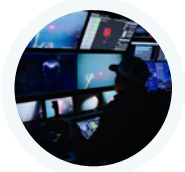
**65**
*ROV samples collected*

During the expedition, the research team demonstrated what is possible by combining new technologies for biological exploration in the deep-sea. The technologies included the RAD2 Sampler with tissue voucher collection and preservation capability; the DeepPIV imaging system, which uses a laser sheet and camera to image sections of midwater animals and is capable of flow visualization and 3D reconstruction; and EyeRIS plenoptic imaging system capable of quantitative imagery of midwater animals. The research team and ROV pilots successfully integrated and demonstrated the capabilities of these three technologies working together in concert. Collecting samples took a very short amount of dive time per organism (15-20 minutes) and the team was able to quantitatively image midwater targets of interest in 3D and collect and preserve tissue vouchers in situ.

Select samples will be sequenced for full genome and gene expression, with the sequence data archived in publicly accessible repositories onshore in the coming months. The results from the expedition offer an example of the rich amount of data that can be collected on a single ROV dive, leading to more efficient and productive operations, and advancing the overall ability to explore the deep ocean biosphere.

The project involved three complex pieces of technology working in concert with each other to achieve rapid advancement in midwater biology exploration.

Imaged and sampled many interesting (and perhaps new) midwater siphonophores, ctenophores, polychaetes, and other delicate invertebrates.



Connected with over 300 students and members of the public during a livestream tech demonstration in partnership with the MATE competition.