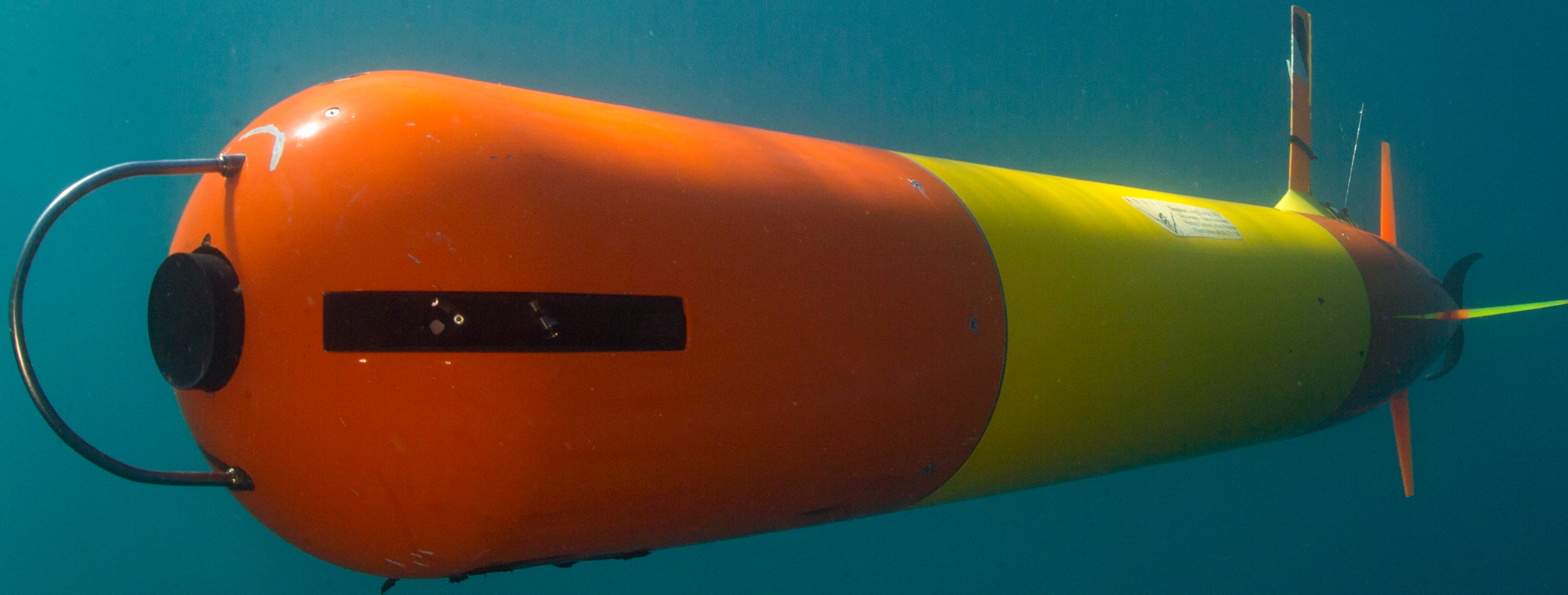
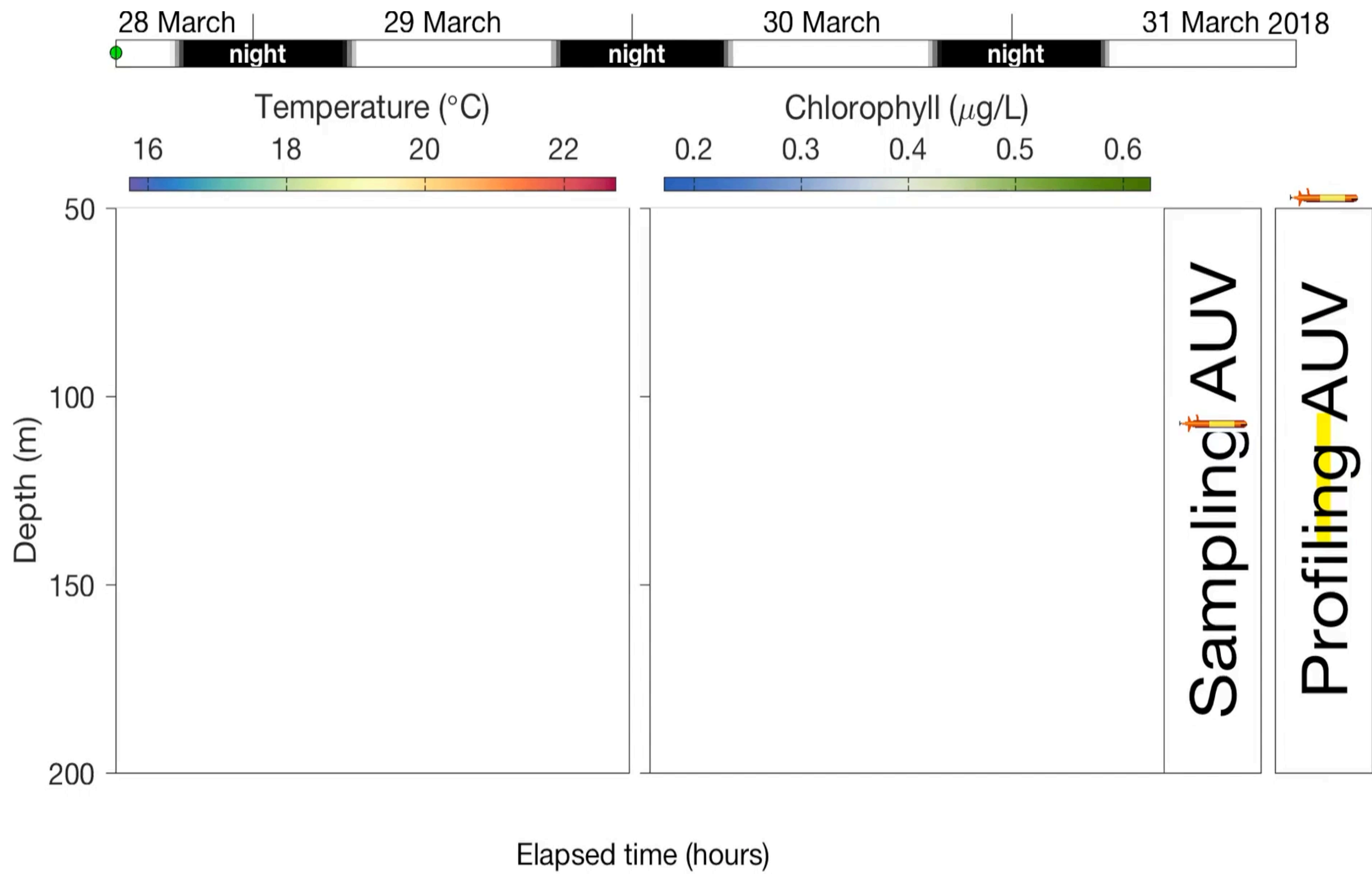


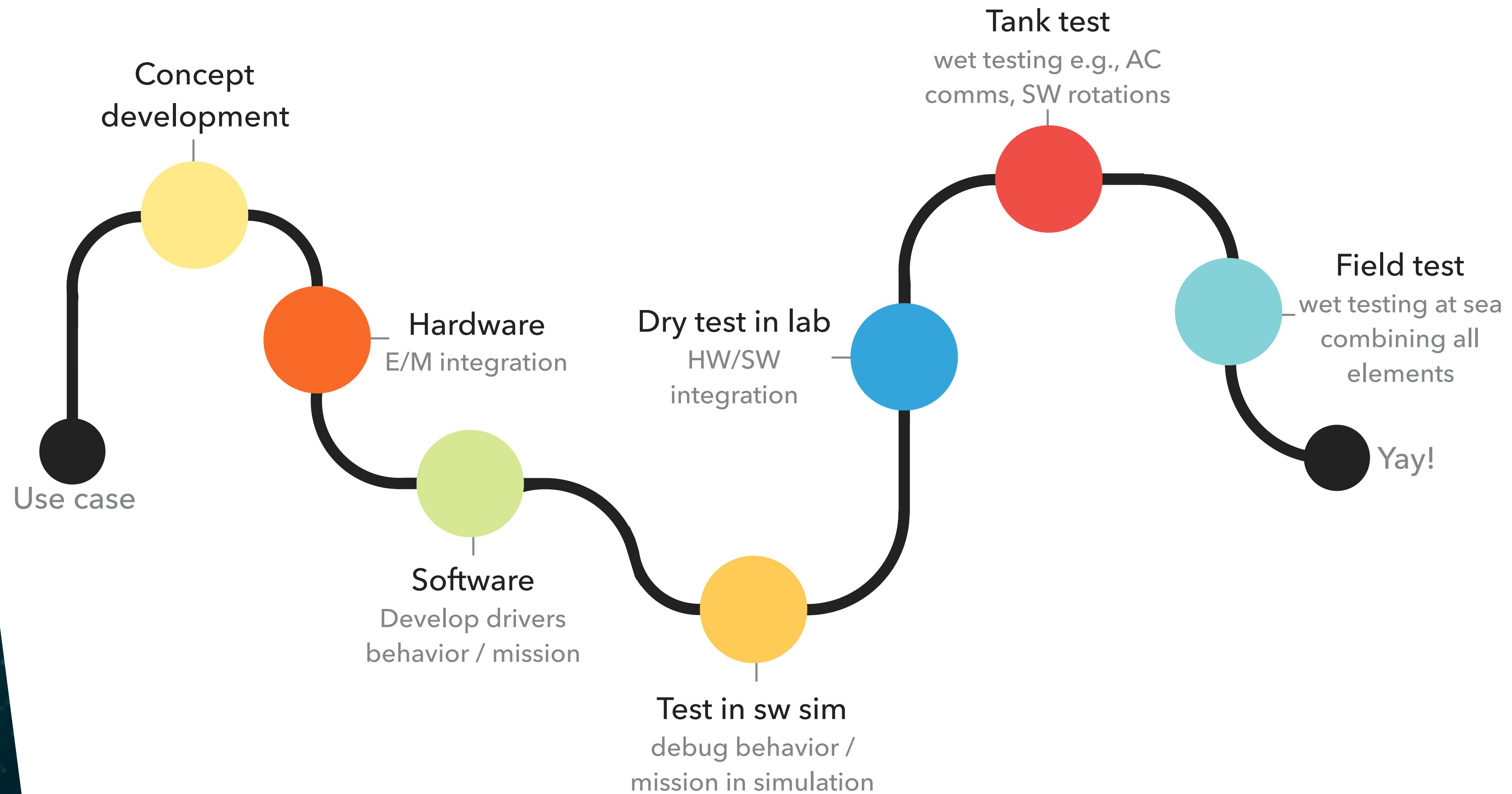
PROJECT PROPOSAL 2020

MULTI-VEHICLE SIMULATION ENVIRONMENT









LRAUV software development pipeline



HOW TO SCALE?

How to develop?

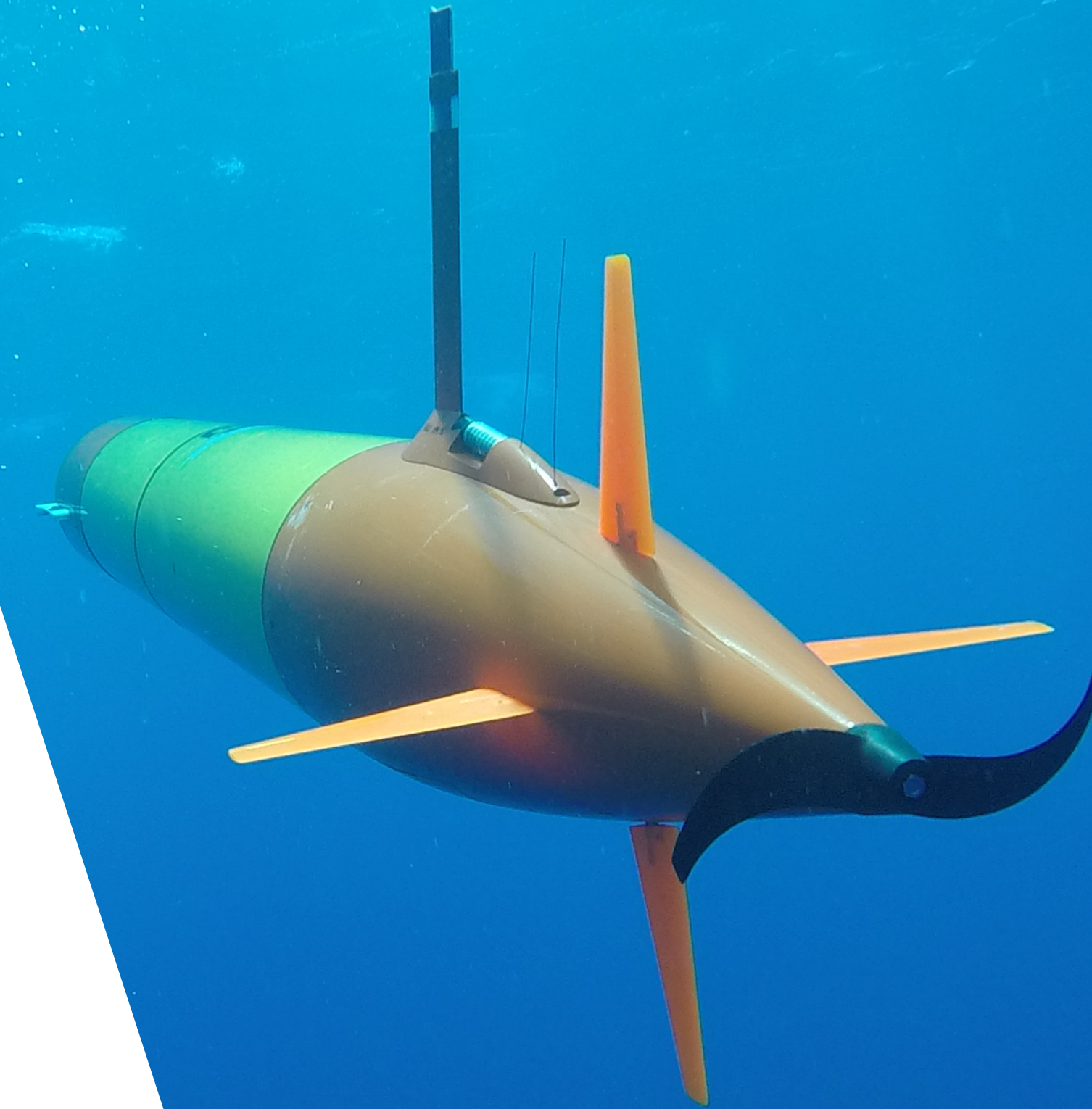
Can we scale up the existing development path for new multi-platform applications? How can we deliver more?

How to compare?

How can we test and compare new multi-vehicle applications? Is one method better than the other?

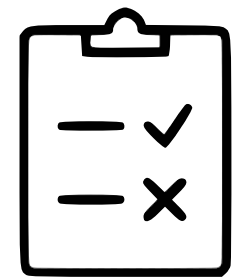
How much to scale?

How will scaling up our presence impact the quality of observations? What is the point of diminishing return?

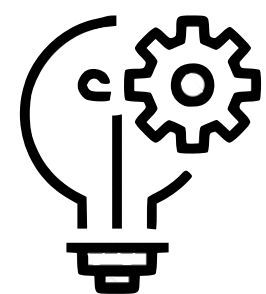


IMPROVE AUTONOMOUS MULTI-PLATFORM CAPABILITIES AT MBARI

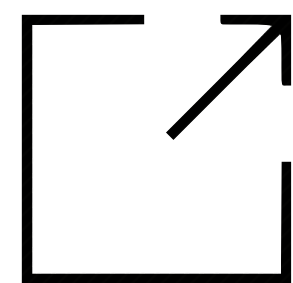
by using reproducible virtual environments



Create validation tools to enable rapid prototyping and testing of new multi-platform applications in reproducible virtual environments

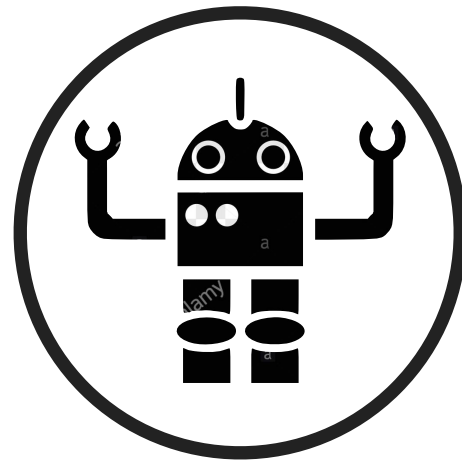


Formalize a design workflow to make development more accessible to MBARI researchers requiring advanced methods of ocean observation (e.g., PI labs developing back-seat applications for LRAUV)

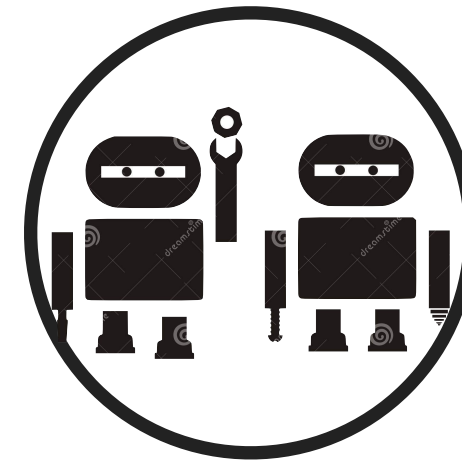


Formulate guiding principles for scaling multi-vehicle operations to inform planning and decision making

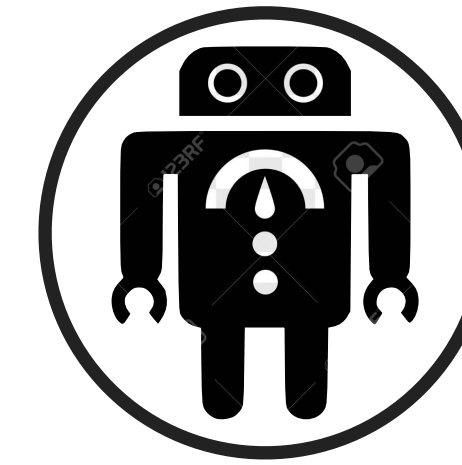
What would we need from a virtual environment?



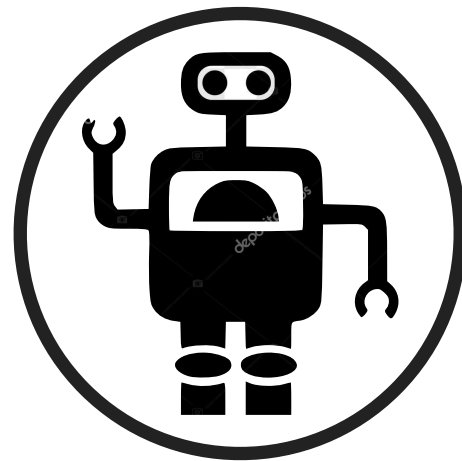
Physical fidelity
simulation of rigid-
body dynamics and
collisions



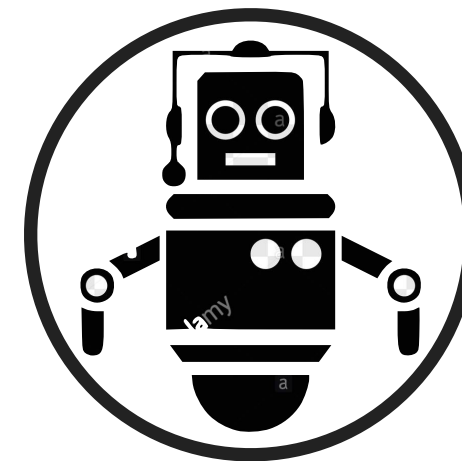
Multi-robot sim
capability of multi-
robot simulation



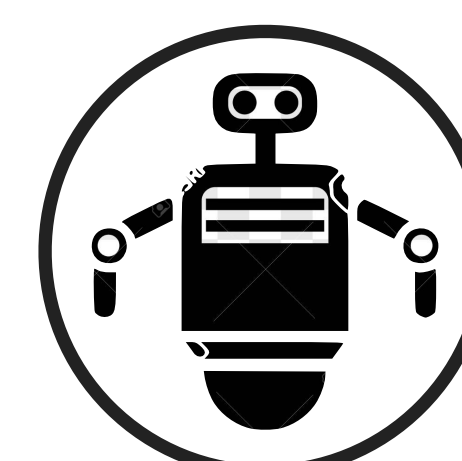
Physics engine
world simulation of
environmental forcers
and sensors



SW interface
interface for existing
MBARI applications



GUI
graphical user
interface to visualize
the scenario



Extensibility
easy integration of
additional modules

Scoping study to assess the technical readiness of existing open-source software for multi-vehicle underwater simulation

ROS/Gazebo middleware interface with a GUI



WorldInsertLayers

GUI
Scene
Spherical Coordinates
Physics
Models

- ned
- ocean
 - ocean_link
- terrain_acciona
- wind_turbine
- wind_turbine_biofouling
- constant_flow_frame

Lights

Property	Value
name	ocean
is_static	☒ True
self_collide	☐ False
pose	
link	ocean::ocean_link

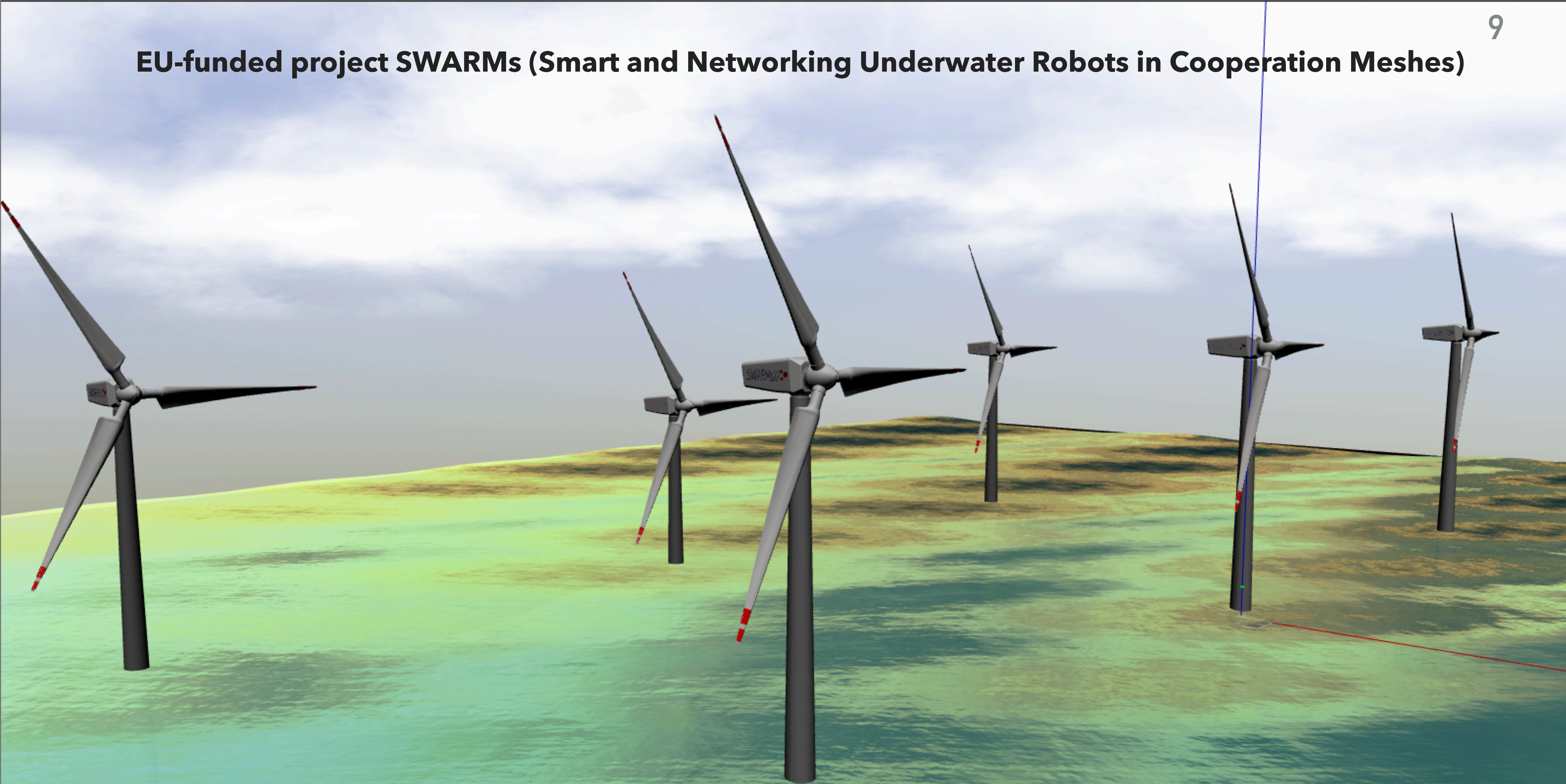


GAZEBO



9

EU-funded project SWARMs (Smart and Networking Underwater Robots in Cooperation Meshes)

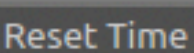


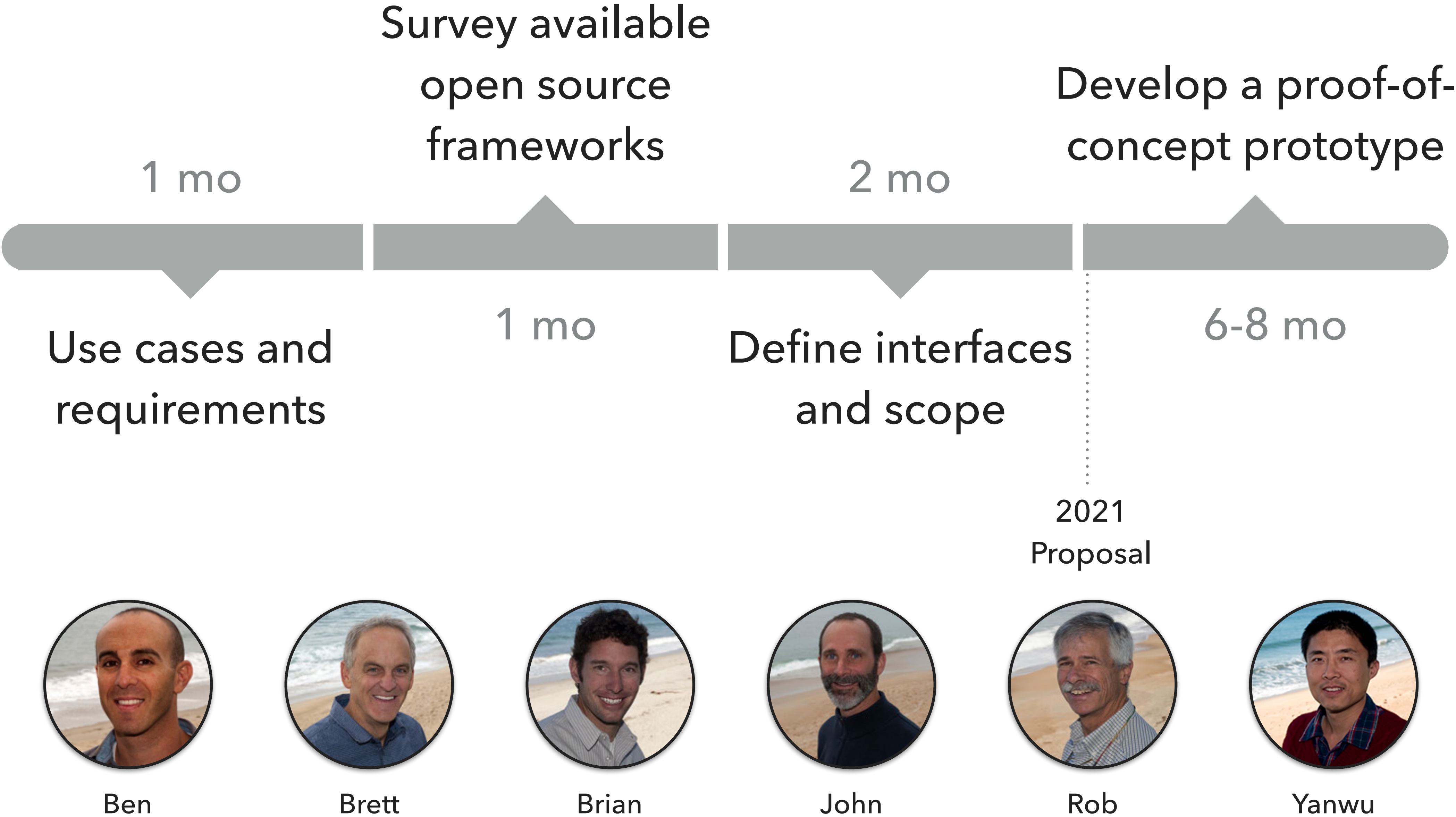
UUV Simulator: https://github.com/uuvsimulator/uuv_simulator

Manhaes, Musa Morena Marcusso, et al. **"UUV simulator: A gazebo-based package for underwater intervention and multi-robot simulation."** *OCEANS 2016 MTS/IEEE Monterey*. IEEE, 2016.

 Steps: 1 ▾ Real Time Factor: 1.00

Sim Time: 00 00:01:28.134 Real Time: 00 00:01:28.344 Iterations: 44067 FPS: 12.3122





Accessible software development

provide an effective development avenue for MBARI researchers requiring advanced methods for ocean observation

Reproducible test environments

inform guiding principles for MV app. open the option for iterative learning approaches for automated planning and command and control

Open source tools and community

reuse of existing tools presents an opportunity to network and collaborate with researchers that are part of the open source community

