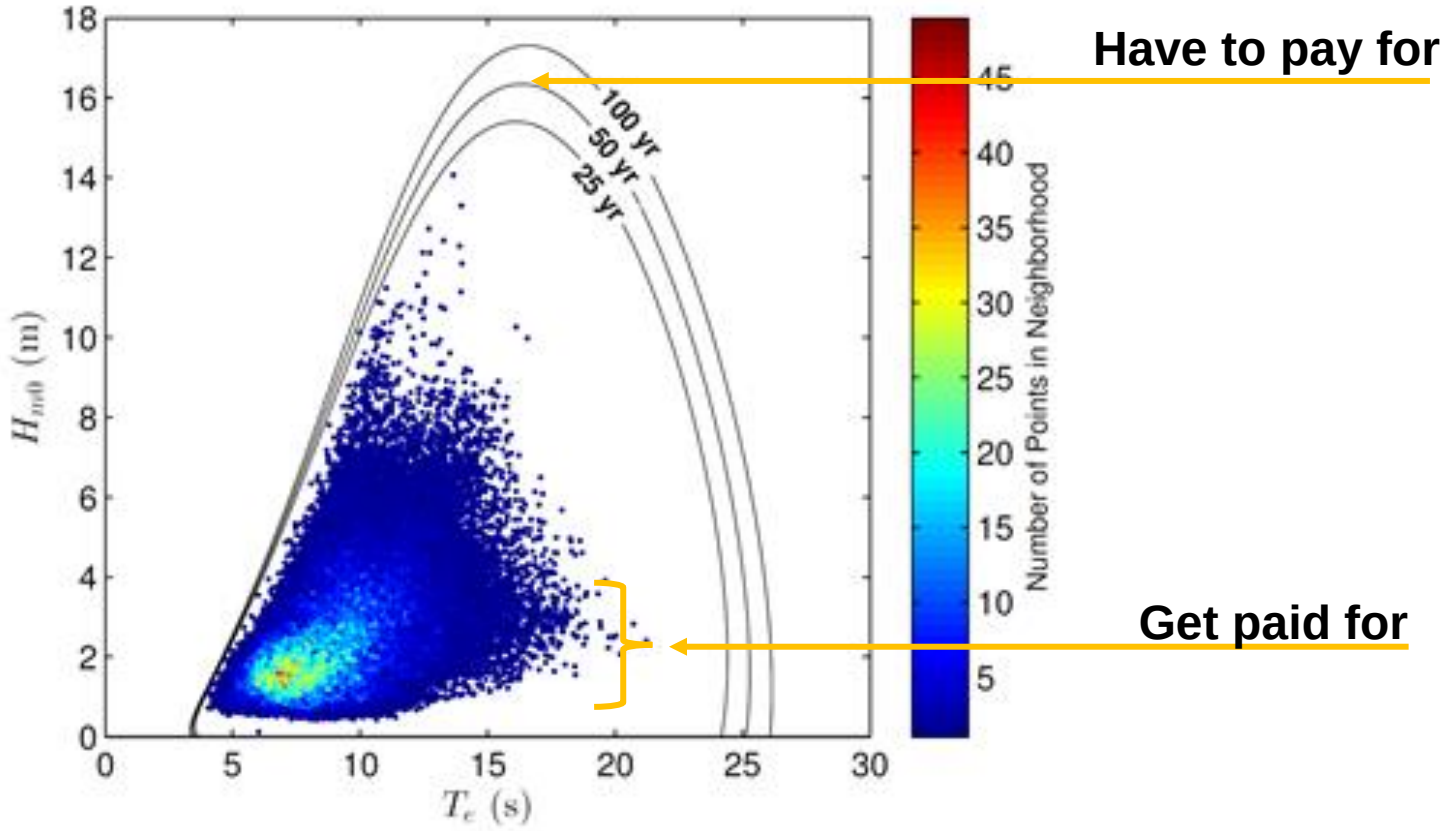
www.calwave.energy
Dan@calwave.energy

CALWAVE

Fundamental Challenge of Wave Energy

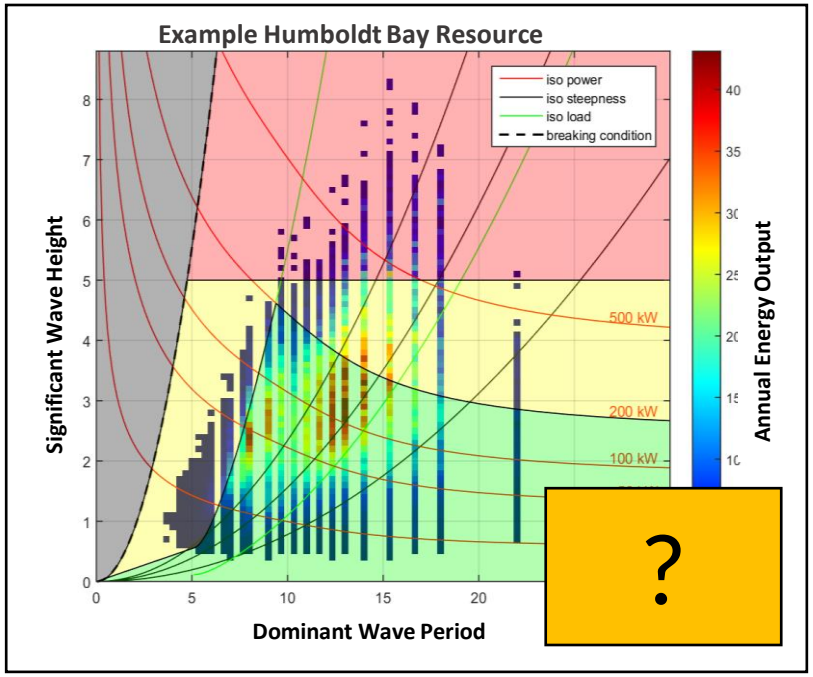
Peak to average load and power



Main Functions of a Wave Energy Converter

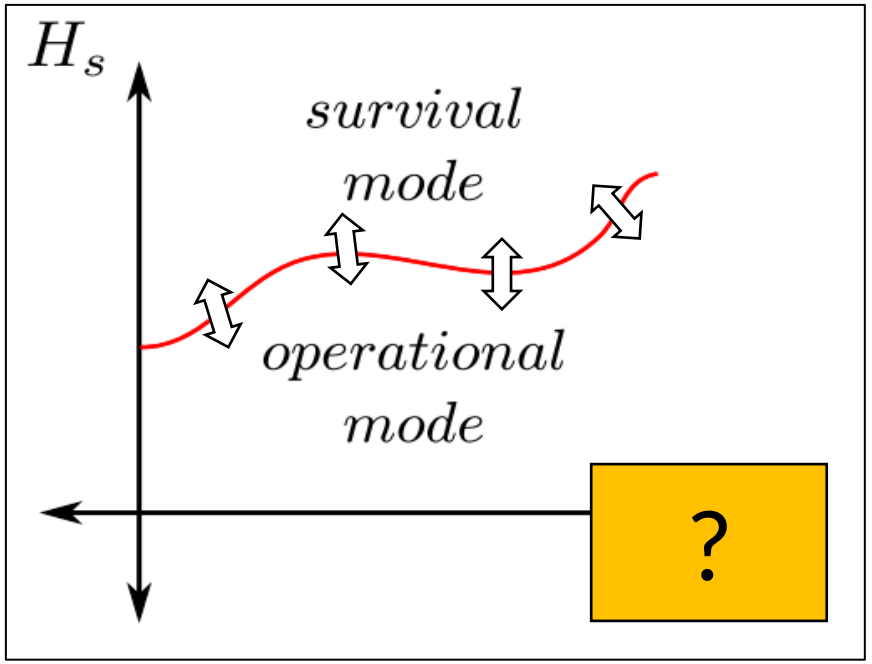
Main Function 1:

High Annual Energy Production



Main Function 2:

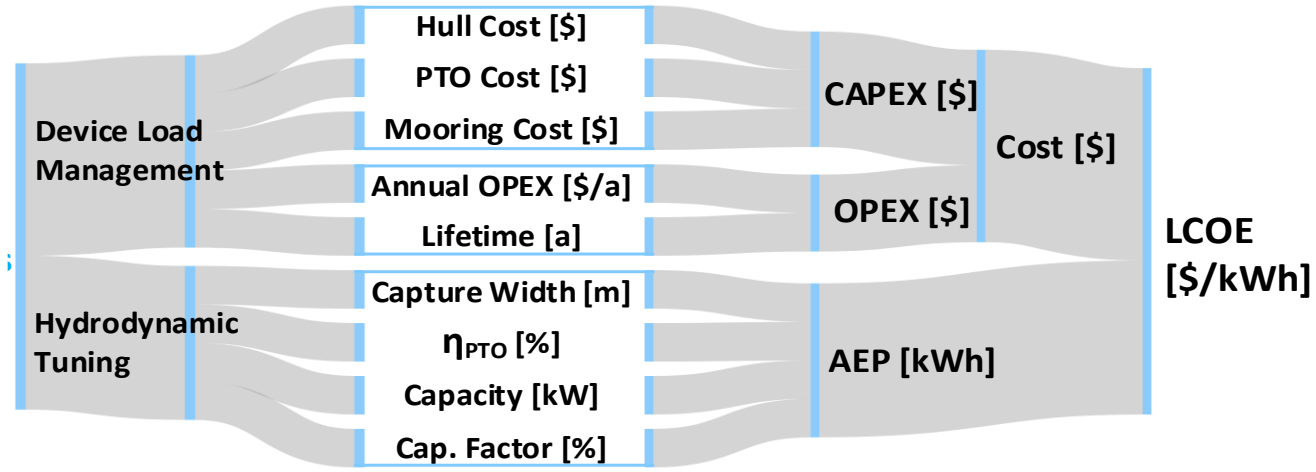
Autonomous gradual and full shut down

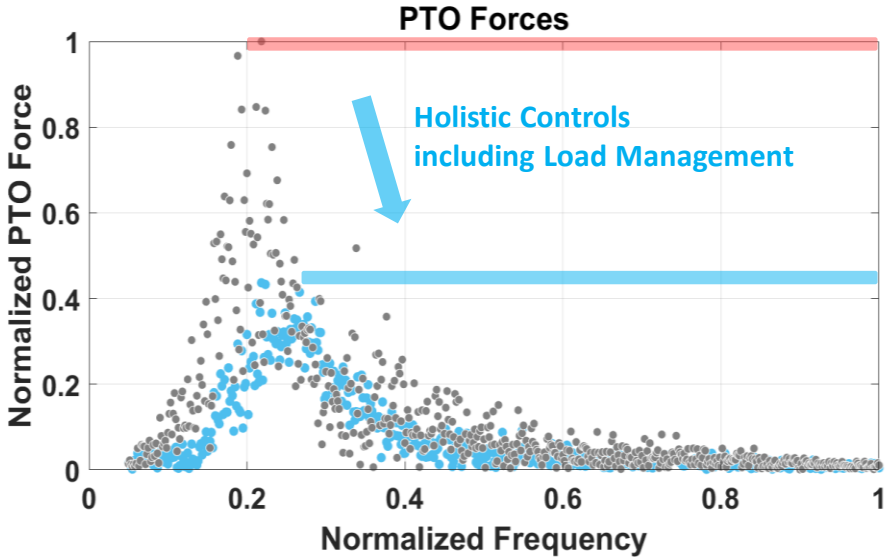


Holistic controls and active load management

CALWAVE

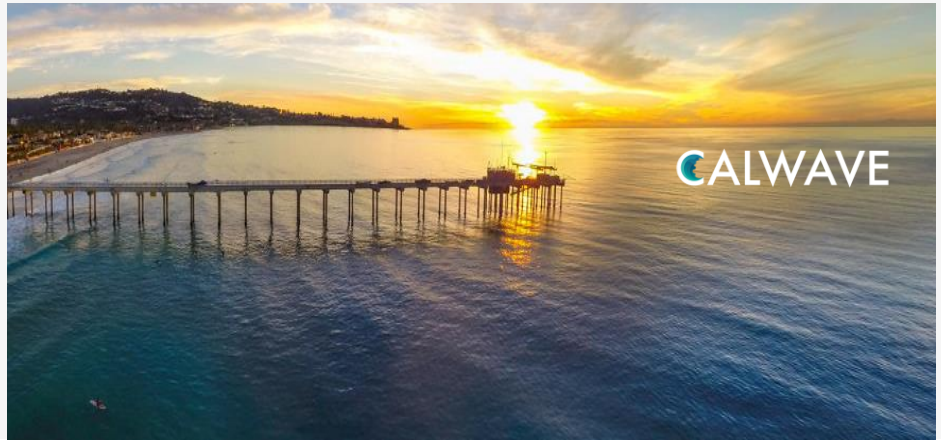
Holistic Controls





→ **Load reduction** in extreme seas by average **factor of 2** (wave tank validated)

CalWave's Timeline

	2015	2016	2017-2018	2019 -2021	2022+
PHASE	Design	Prototype	Design	Construction & Deployment	PacWave
			Open Ocean Pilot		
FUNDING	Berkeley UNIVERSITY OF CALIFORNIA	WAVE ENERGY PRIZE U.S. DEPARTMENT OF ENERGY	2017 FOA U.S. DEPARTMENT OF ENERGY	SCRIPPS INSTITUTION OF OCEANOGRAPHY	2019 & 2022 FOAs U.S. DEPARTMENT OF ENERGY
COMPANY HIGHLIGHTS	cyclotronroad BERKELEY LAB	Small Business Vouchers Pilot U.S. DEPARTMENT OF ENERGY			PacWave

CALWAVE

Growing team

Marcus Lehmann, PhD
CEO, Co-founder

Forbes 30 UNDER 30 · SIEMENS · cyclotronroad · Berkeley UNIVERSITY OF CALIFORNIA

Dan Petcovic, MS, P.E.
COO

LOCKHEED MARTIN

Thomas Boerner, PhD
CTO, Co-founder

Berkeley UNIVERSITY OF CALIFORNIA · Rexroth Bosch Group

Nigel Kojimoto, MS
VP of Engineering, Co-founder

MIT · HNEI Hawai'i Natural Energy Institute, School of Ocean and Earth Science and Technology, University of Hawai'i at Mānoa

Collin Weston, PE
Naval Architect

GIBBS & COX A Leidos Company · TAMU Texas A&M University Galveston Campus · NAVATEK

Julie Mai, MBA
Head of Communications

Human Rights Watch · Dream Corps · University of San Diego

Ryan Davidson, BA
Business Development Associate

Cesar Cordova
Controls Engineer

Berkeley UNIVERSITY OF CALIFORNIA

Several Open & Upcoming Positions

Technical Partners

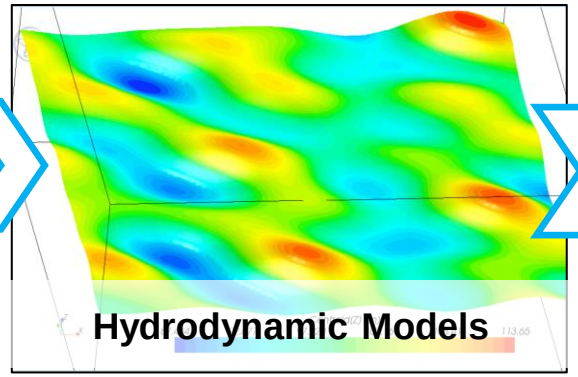
Berkeley UNIVERSITY OF CALIFORNIA · Sandia National Laboratories · NREL National Renewable Energy Laboratory · DNV·GL · EVERGREEN INNOVATIONS · …. Many more

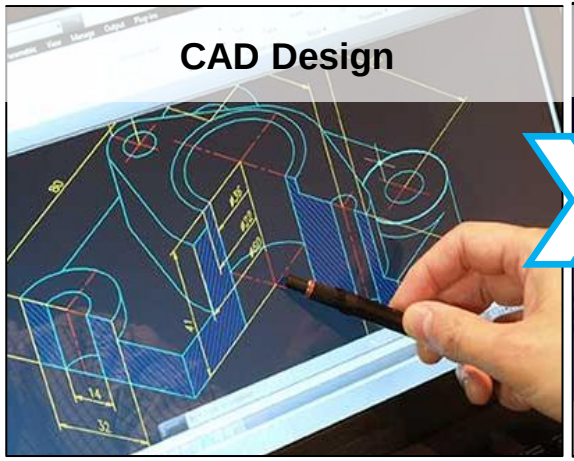
Business Partners

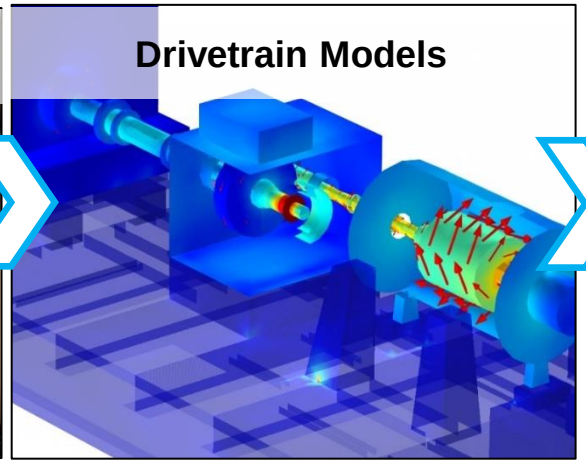
HIGHTIDE FOUNDATION · SOA · SOLARIMPULSE EFFICIENT SOLUTION · AUTODESK. FOUNDATION · Google for Startups · AUTODESK. TECHNOLOGY CENTERS · 1517 · Greentown Labs · LAUNCH ALASKA · startR BLUE UC San Diego · Rady School of Management · Scripps Institution of Oceanography · …. Many more

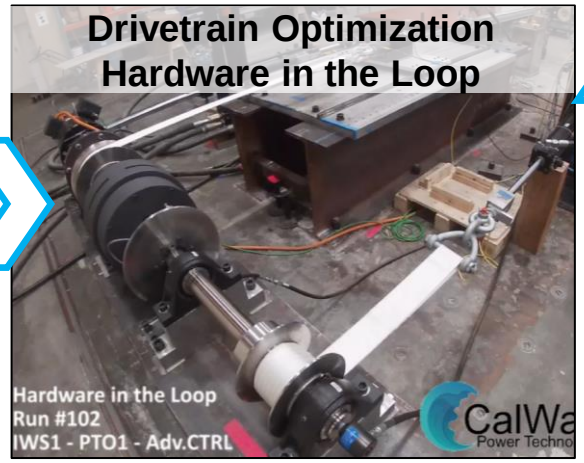
CalWave's core expertise

Device design and **optimization** via experimentally validated approaches



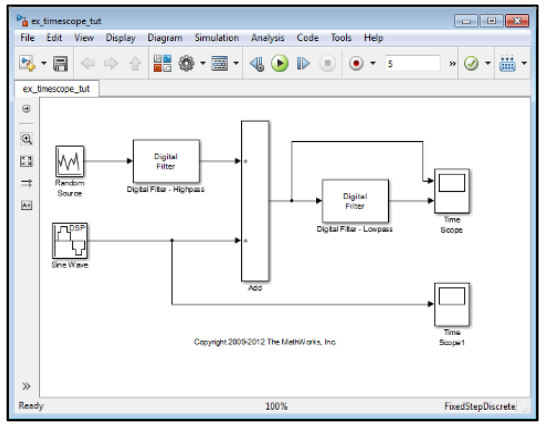






Realtime simulation

Replicate real-world site-specific **offshore conditions** in a controlled environment



San Diego Ocean Pilot Q3/2021

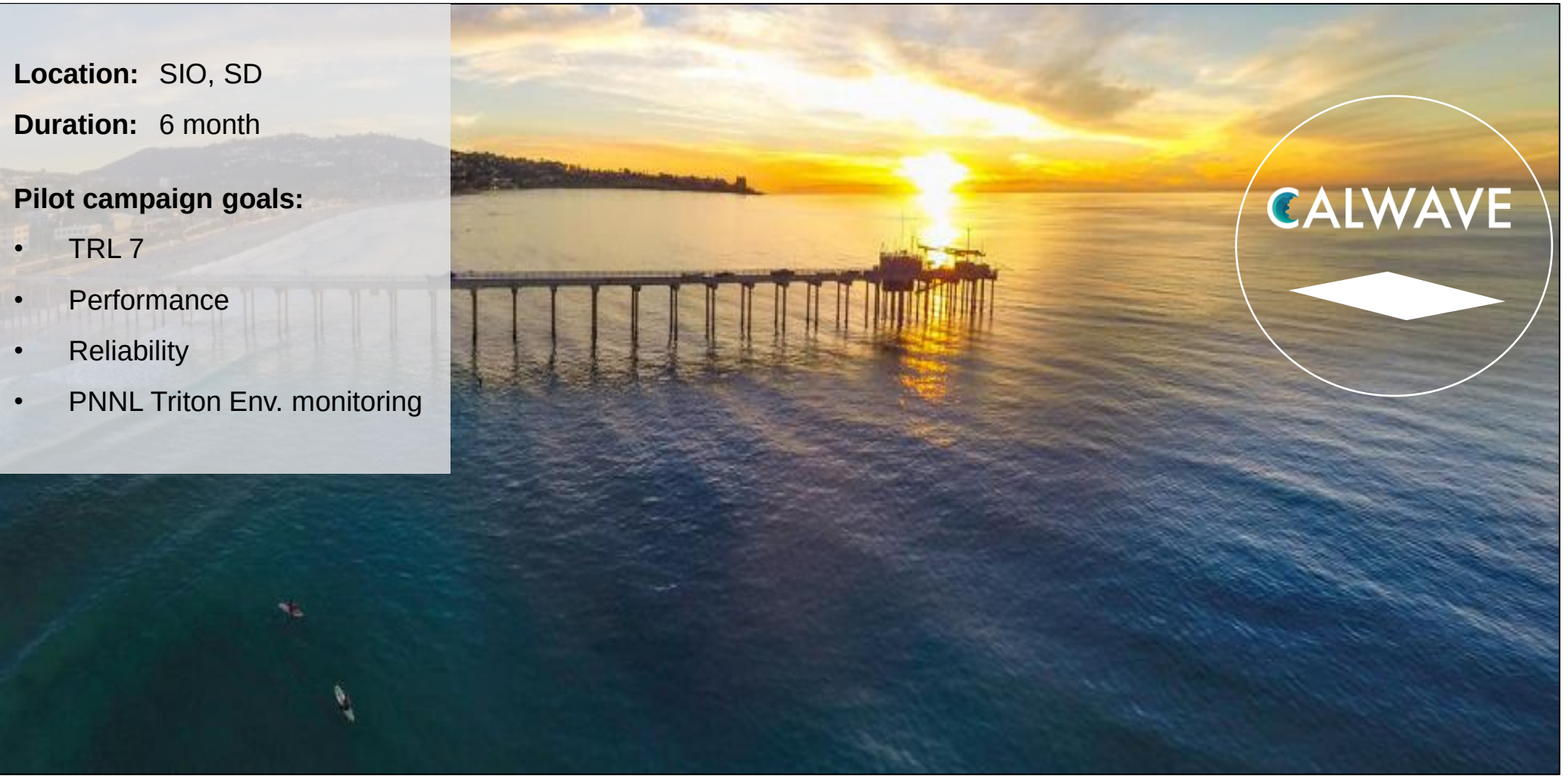
Milestone 2021

Location: SIO, SD

Duration: 6 month

Pilot campaign goals:

- TRL 7
- Performance
- Reliability
- PNNL Triton Env. monitoring



Project partners:

U.S. DEPARTMENT OF ENERGY

SCRIPPS INSTITUTION OF OCEANOGRAPHY

Sandia National Laboratories

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Berkeley
UNIVERSITY OF CALIFORNIA

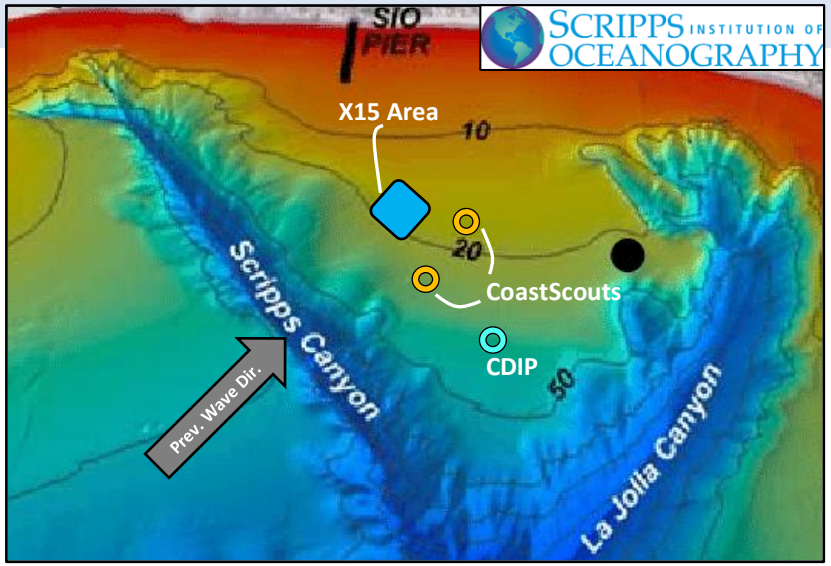
Pacific Northwest
NATIONAL LABORATORY

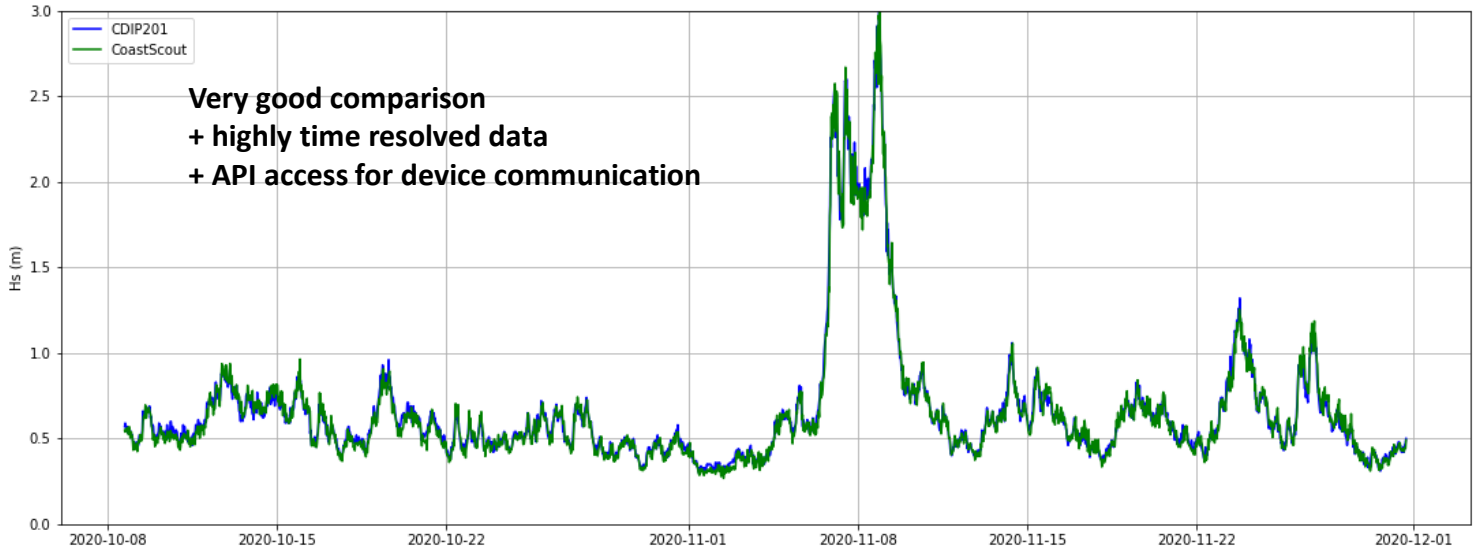
H.T. HARVEY & ASSOCIATES
Ecological Consultants

…. Many more

Wave Climate and Test Plan

- Historical CDIP buoy data (>5 years)
- Two Coast Scout wave buoys from MarineLabs
- Deployed February 2020; Wave data collected since
- CoastScout buoy provide high-resolution time series of wave elevations
- Can be used for post processing: Time resolved comparison of wave elevation and device behavior
- Data binning aligned with **IEC 62600-100** for sea state definition for performance measurement
- Units also serve dual purpose „Aids to Navigation“ (ATON)



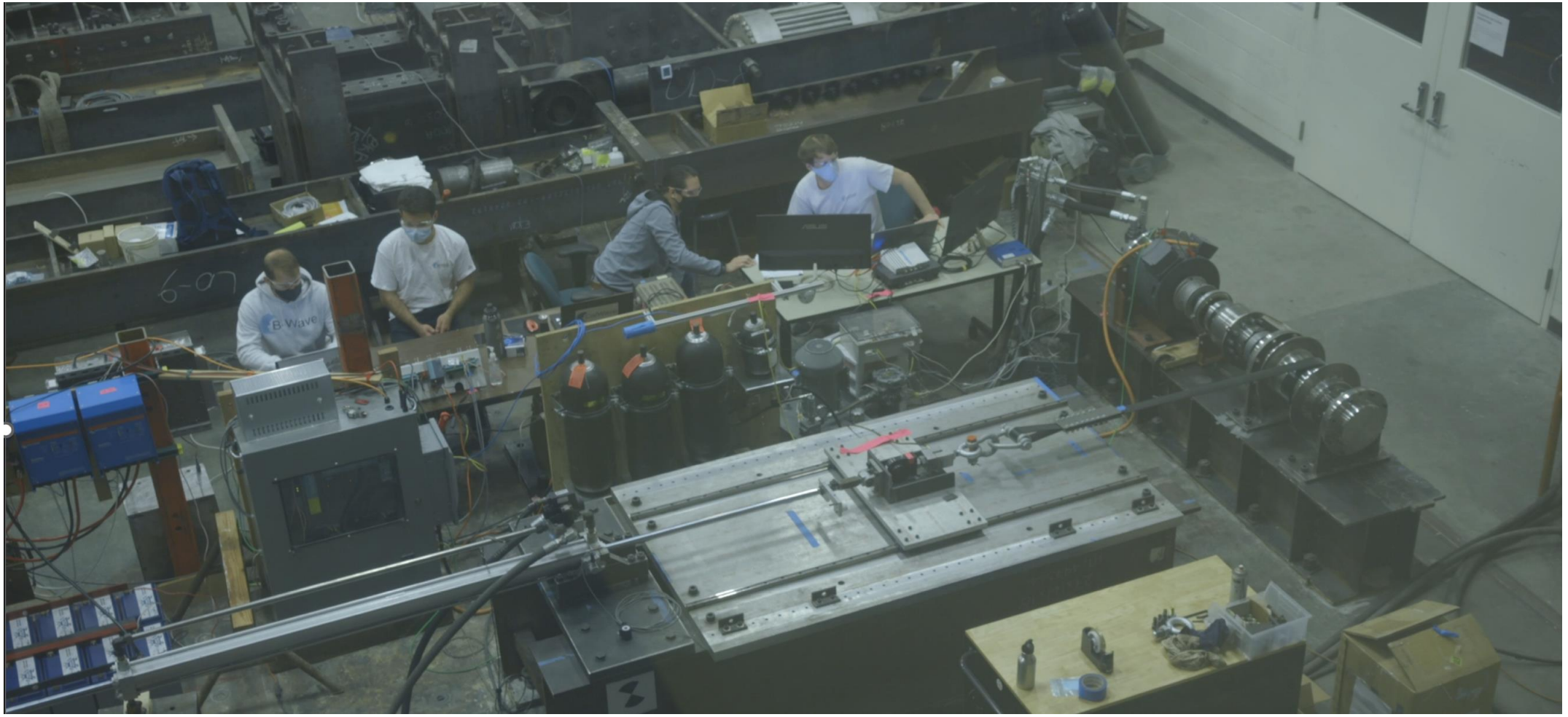


CALWAVE

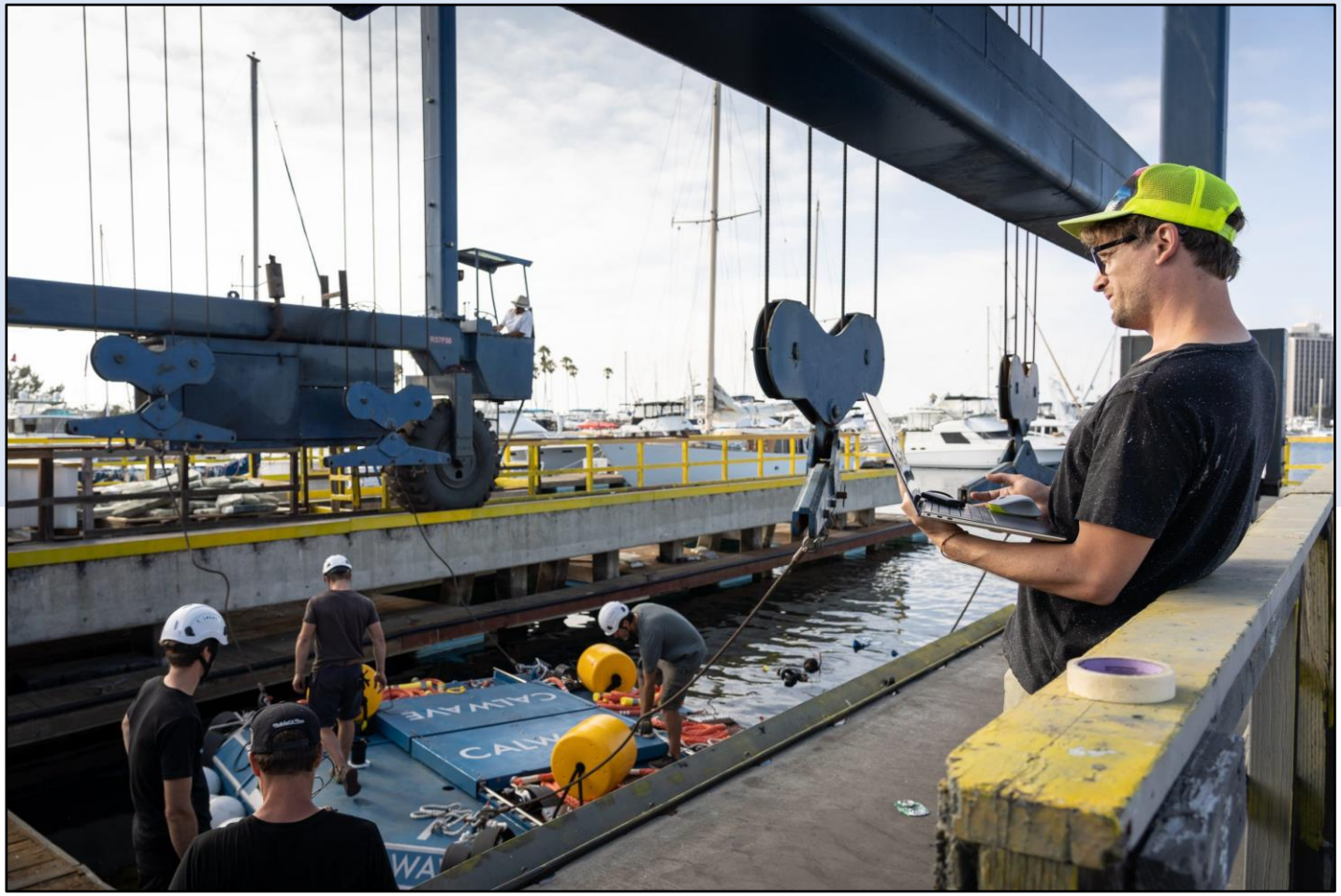
PTO Bench Testing

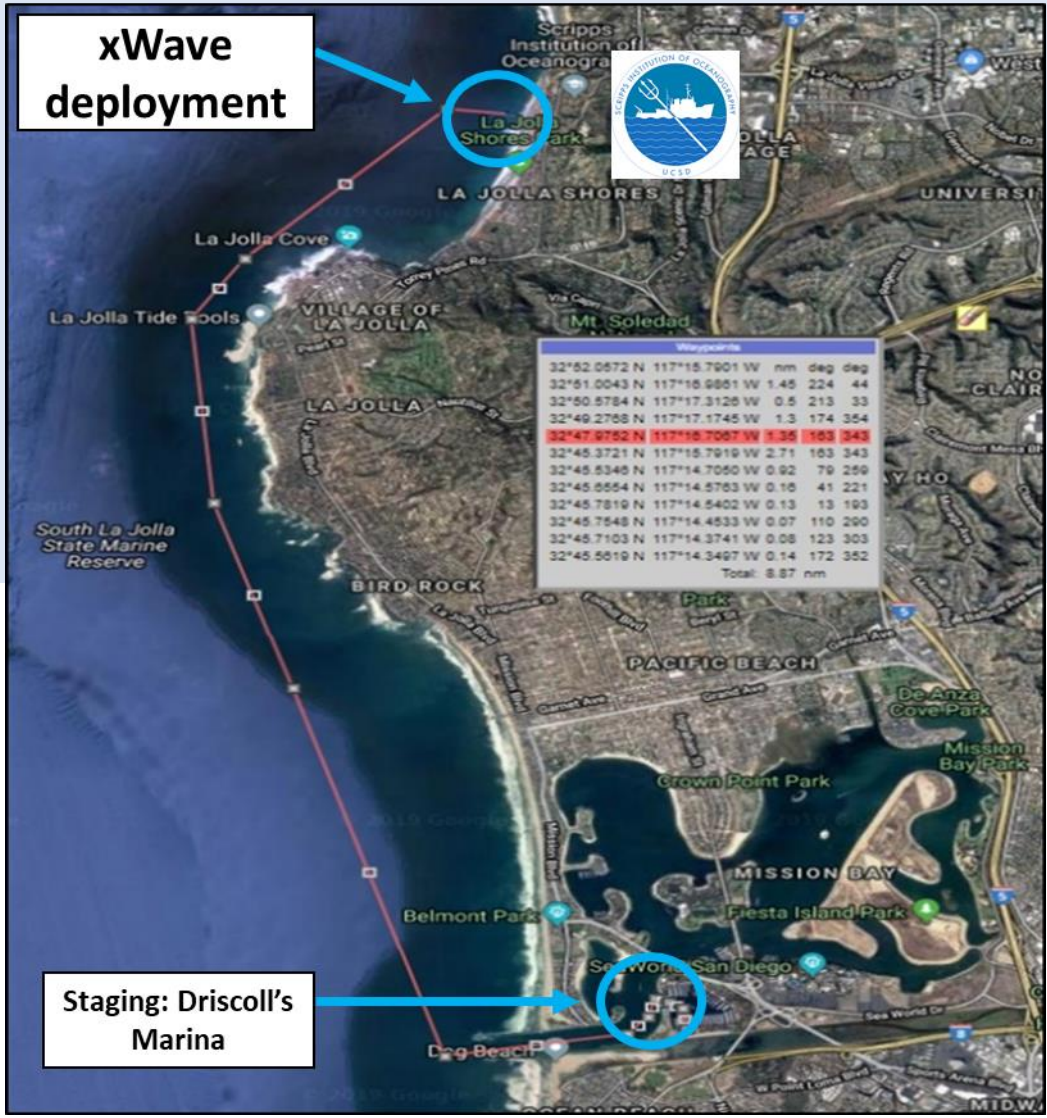
Hardware-in-the-Loop

Berkeley
UNIVERSITY OF CALIFORNIA



Pilot installation preparation





Umbilical installation

September 2021

San Diego Ocean Pilot 2021-2022

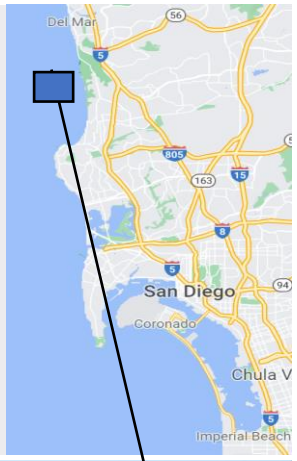
10-months continuous deployment
99.98% uptime
0 maintenance interventions

Location: SIO, San Diego

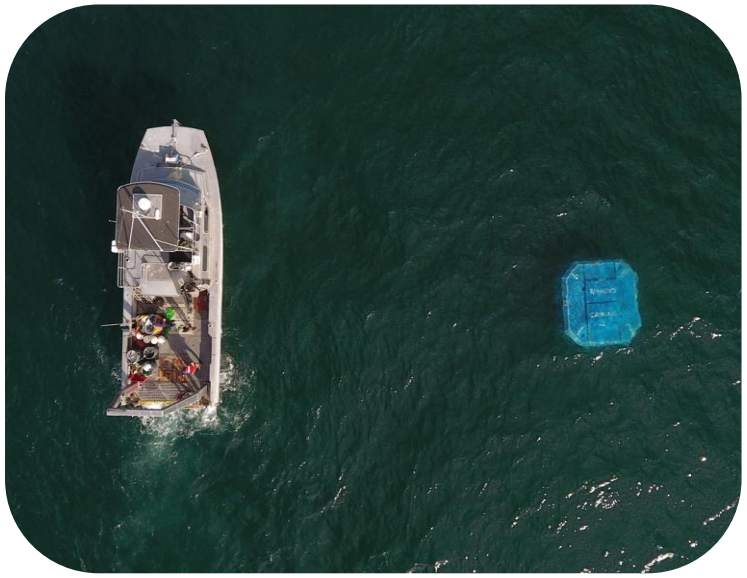
Duration: 10 month

Pilot campaign goals:

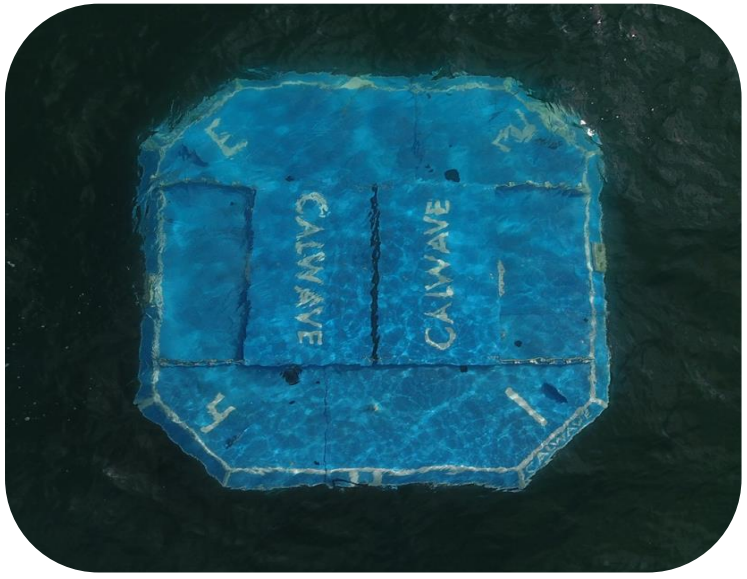
- TRL 7
- Performance
- Reliability



Installation and maintenance on the surface.



Operations and shelter fully submerged!



TRITON INITIATIVE

Pacific Northwest NATIONAL LABORATORY

integral consulting inc.

- *Characterized underwater sound emissions from the CalWave WEC over several months using **stationary hydrophones** fixed at three locations on the seafloor.*

- *Observed several of the CalWave WEC moorings for **biofouling accumulation** and their possible role as a short-term, small-scale change in habitat.*

- *Provide support for Integral Consulting, Inc., to test their patented NoiseSpotter™ technology that characterizes underwater sound emissions using hydrophones and particle velocity sensors.*

These collaborative environmental monitoring efforts will provide empirical data that help to remove barriers to deployment and testing allowing technology improving iterations for developers like CalWave.

Photo 1 – Triton researchers prepare for energetic test site technology tests by performing shakedown tests in a tank at MCRL.
Photo 2 – Triton research builds technology to measure electromagnetic fields under the water and tests the innovative technology from a MCRL research vessel.
Photo 3 – A view of the technology in the tank at MCRL.
Photo 4 - Triton researcher prepares to deploy the SeaSpy for electromagnetic field tests at MCRL.
Photo 5 – Triton researchers deploy the SeaSpy behind a MCRL research vessel in Sequim Bay.
Photo 6 – Triton researchers discuss how they will perform a technology test with an echosounder from the MCRL floating dock.

TRITON

www.pnnl.gov/projects/triton

Recovery & Decommissioning

July 2022

CALWAVE .energy

Join us on our mission!

Thank you to

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

WATER POWER TECHNOLOGIES OFFICE

and many more partners…