



Carnegie
CLEAN ENERGY

HPE Discover 2024
The Sphere, Las Vegas

**Accelerate
innovation with
world-leading
supercomputing**

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ersonal use only

CETO – Harnessing Ocean Waves

Our core technology is unique and avoids known issues

- Water in waves move in an orbit. The buoy is forced to move in the same motion



- This kinetic energy is transformed by the three Power Take-Offs within the buoy
- CETO operates fully submerged, avoiding issues of visual amenity and damaging forces from breaking storm waves
- Artificial intelligence helps us capture more by adapting to every individual wave that passes
- [CLICK TO SEE ANIMATION](#)



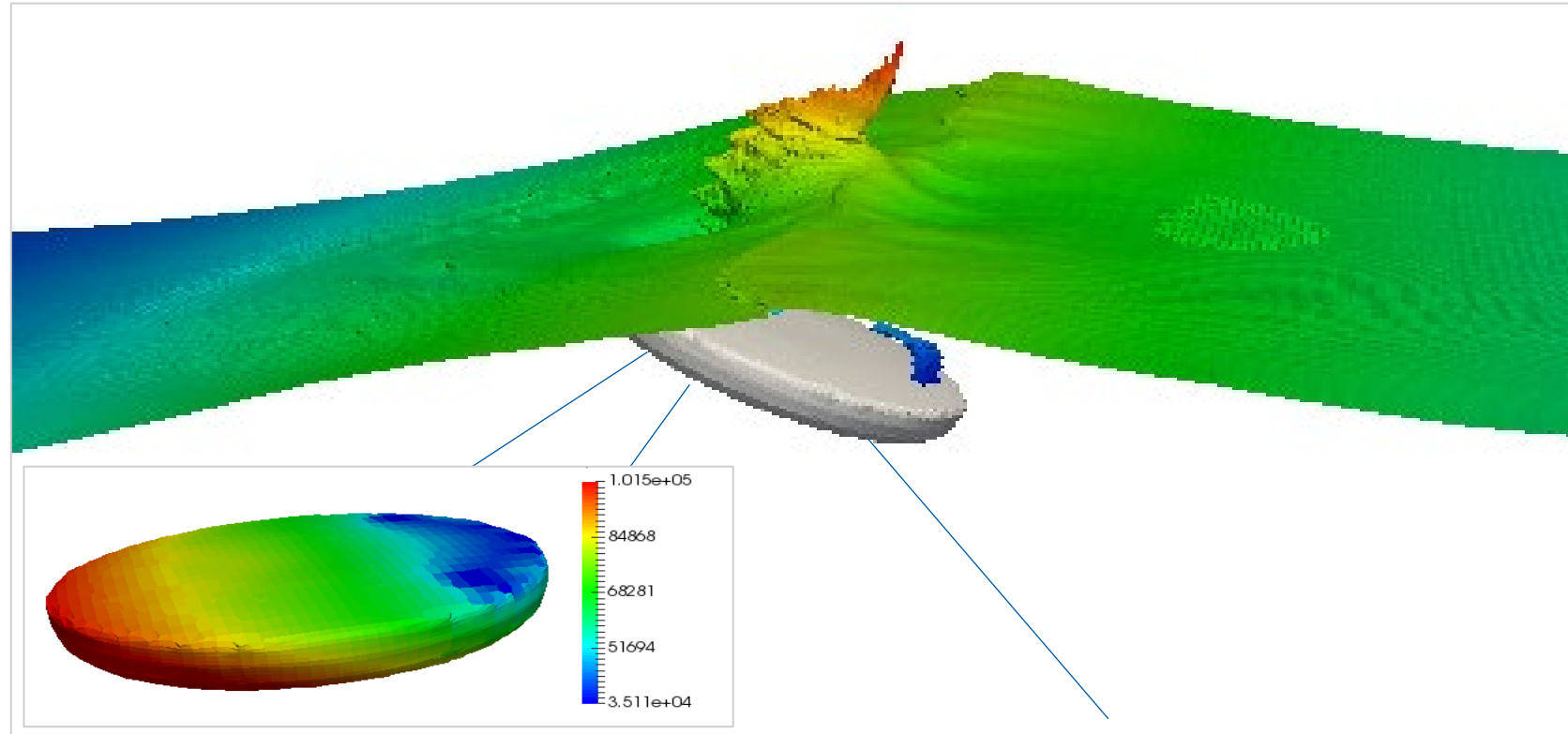
Waves are complex but we have answers

- Waves are complex and somewhat non-linear
- To engineer WECS we need to know the forces, especially damaging ones



Hydrodynamics require physics and compute power

- We divide up the ocean and structure into blocks.
- Can see the discretisation
- We use physics as the basis of our equations
- Then over to supercomputers to do the work

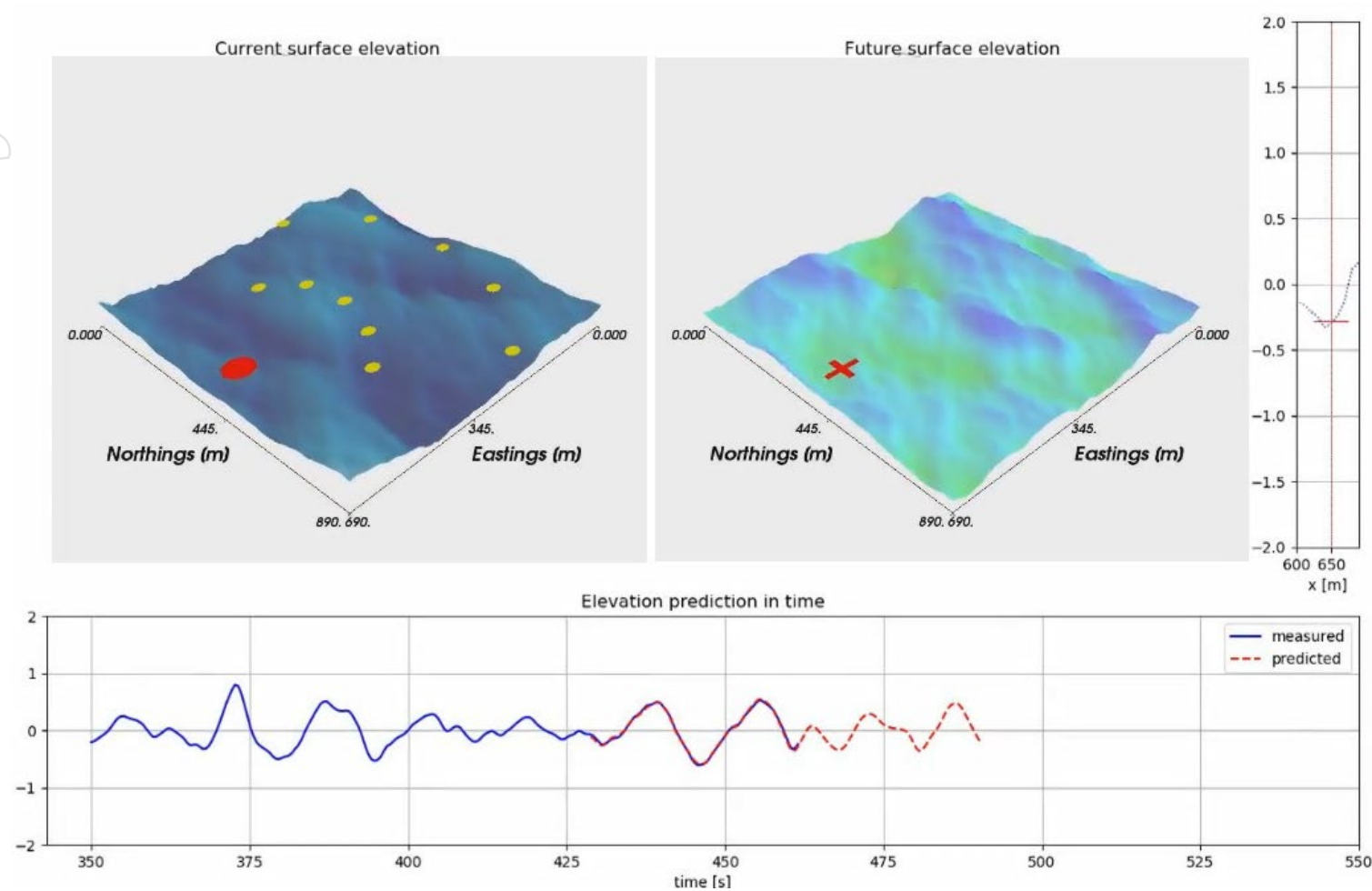


Supercomputer the Physics



- This is Setonix at the Pawsey Supercomputing Centre, in Western Australia, where we're headquartered, with its HPE Cray EX supercomputer
- But knowing hydrodynamic forces isn't enough, we need to optimise control (resistive forces) for power generation and survivability
- Remember we can only control the forces in each of the 3 mooring legs
- The best control decision can only be made if we know about the coming waves

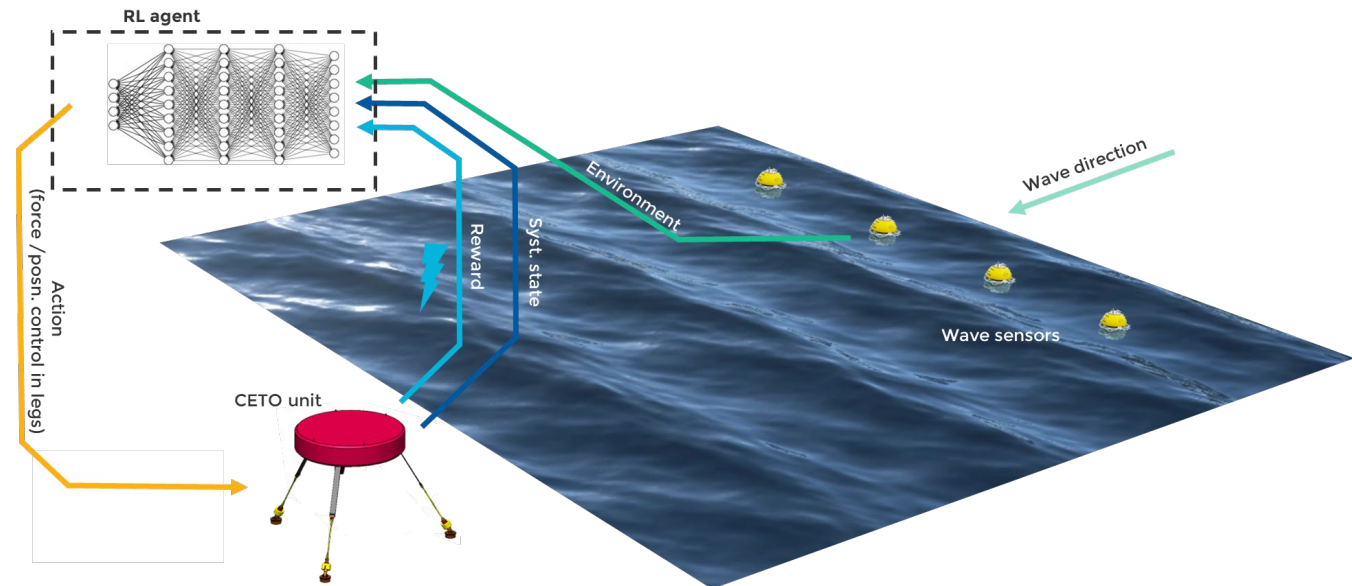
Predicting waves with AI



- We developed a wave predictor using Machine Learning and tested it a wave tank
- It uses sensors measuring the surface position that are up-wave/further out from the point of interest
- We see an excellent match between measured and predicted
- The controllers that we had to use for this prediction are good but are limited to model fidelity and don't improve

Building a controller that learns

- Through conversation with HPE we were introduced the experts at HPE labs and together we developed an RL controller
- Controller reads wave prediction + system state and decides on forces in PTOs
- It is rewarded for the electricity produced
- Throughout its life it adapts and improve
- Reward can be more elaborate like avoiding damage from extreme waves, fatigue and wear
- At array level, learns from its array sisters and helps them
- Can even cooperate to boost overall output even if that means sacrificing individual performance



What's next?

World first deployment of RL in wave energy converter



- HPE Services in Spain is helping implement the RL in CETO's first European deployment as part of the ACHIEVE Programme
- Next year we'll deliver the world's first use of Reinforcement Learning in large scale wave energy converters

Be part of the innovation that will unlock the power of the world's oceans