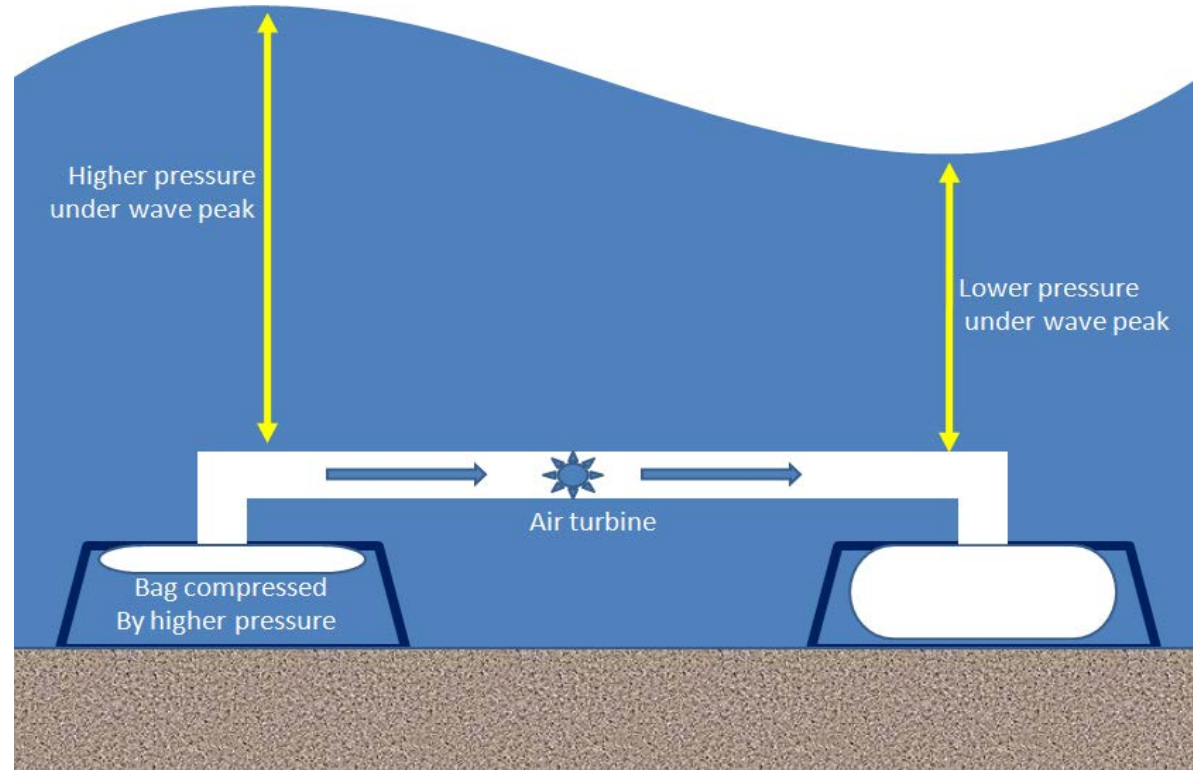
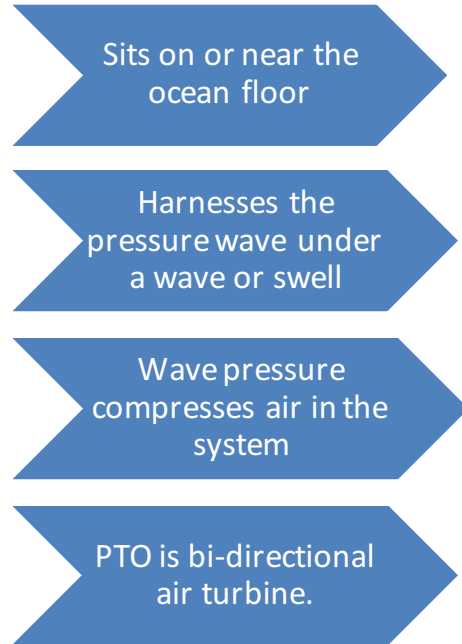


Power Under the Waves M3 Wave, LLC

Mike Morrow, P.E.

M3 Wave's APEX Device

How it works:



Benefits of Submerged



No impact on ocean view

Surface view,
2014
Deployment



No surface conflicts; Not an impediment to shipping traffic, fishing, recreation



Storm survivability. Safe from wind loads and extreme surface dynamics.



Development Chronology



DMP Gen 1



DMP Gen 2



DMP Gen 3



DMP Gen 4

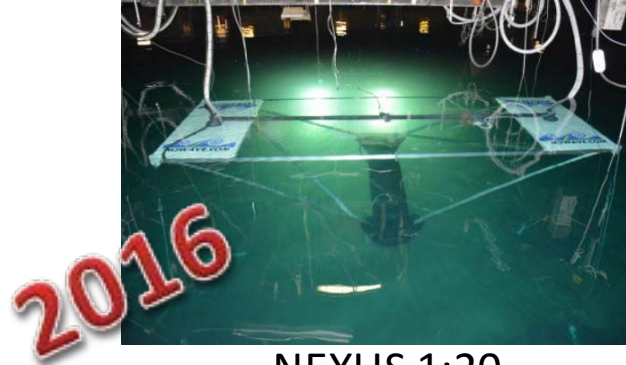


APEX

Development Chronology (cont)



NEXUS 1:50

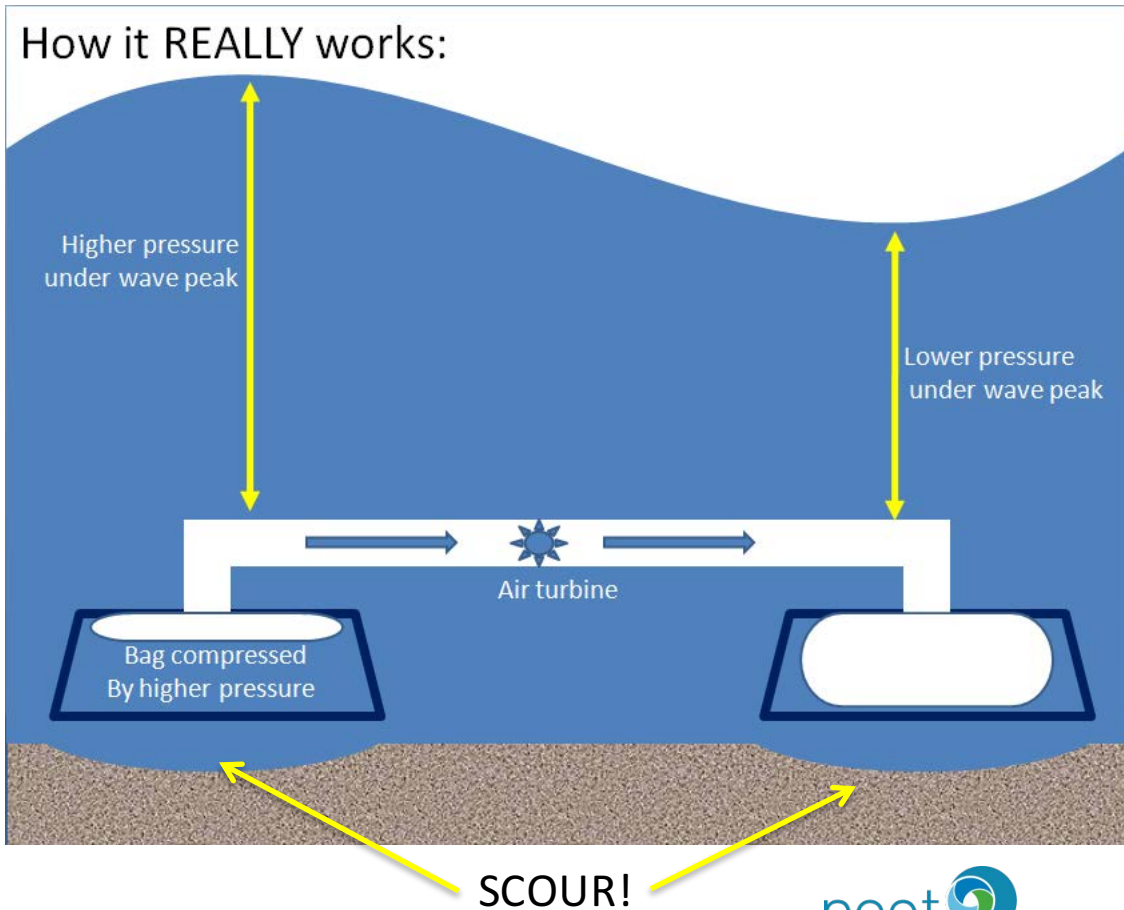
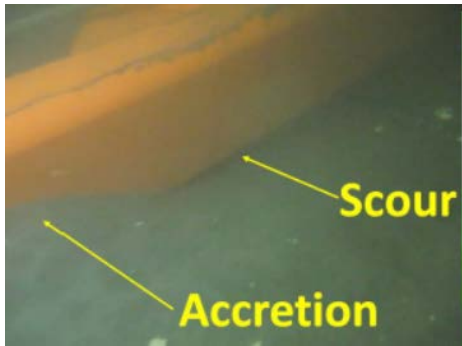
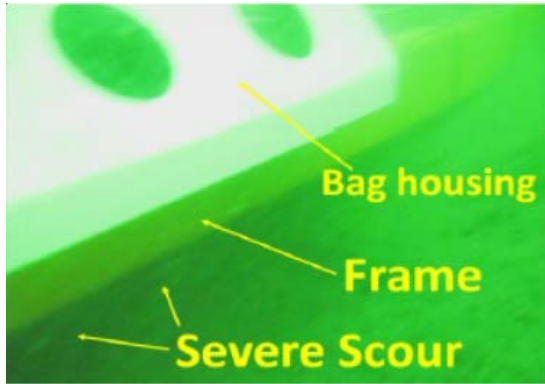


NEXUS 1:20

NEXUS: Variant of APEX that is anchored in deep water via Tension Leg Platform



Scour...



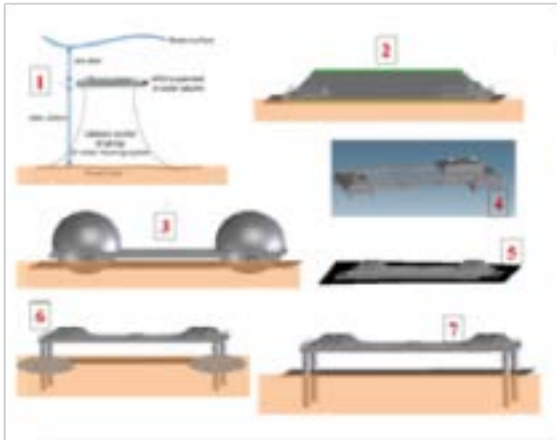
2016-2018

Improved Survivability and Lower Cost in a Submerged Wave Energy Device

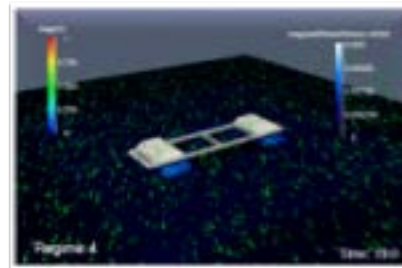
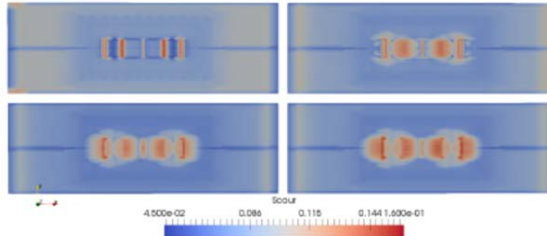
FOA DE-EE-0001310

NEXT GENERATION MARINE ENERGY SYSTEMS - DURABILITY AND
SURVIVABILITY

Brainstorm Sediment Transport Mitigation Concepts



Develop Numerical Models for Sediment Transport



Validate Numerical Models With scale model testing including most promising concepts



How do you validate a sediment transport numerical model?

Step 1: Build a big basin
inside a big flume



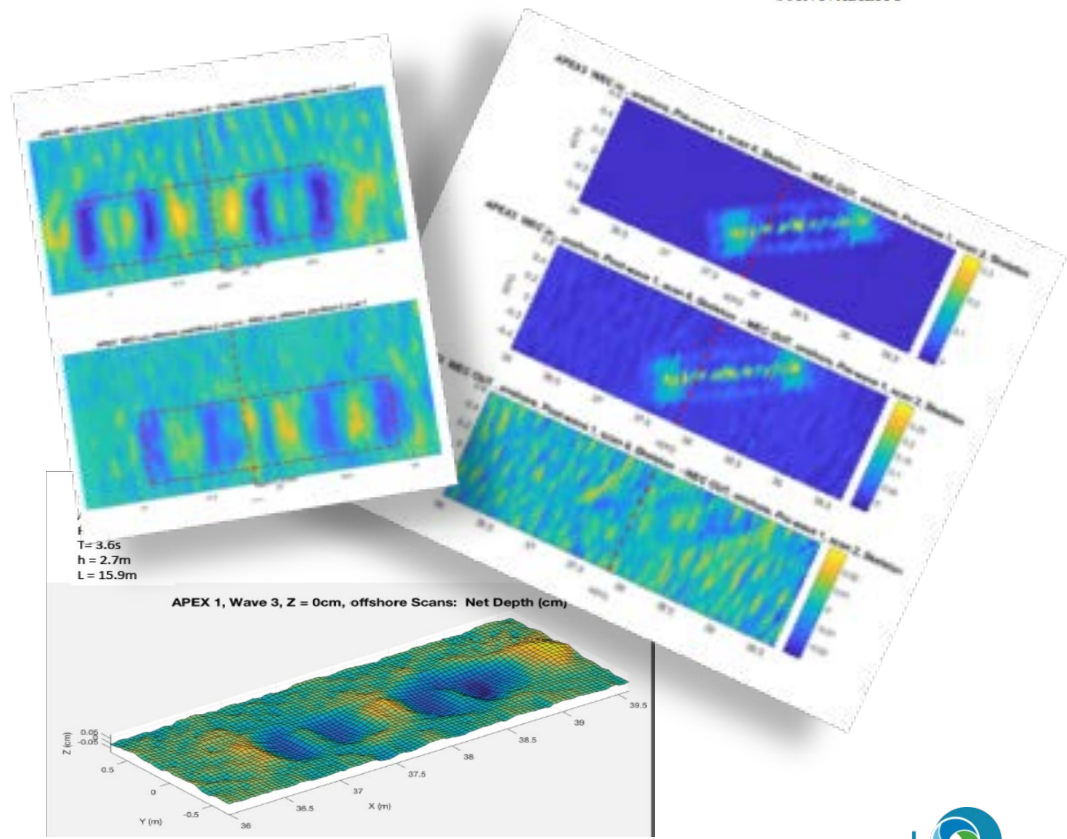
Step 2: Fill it with tons of sand



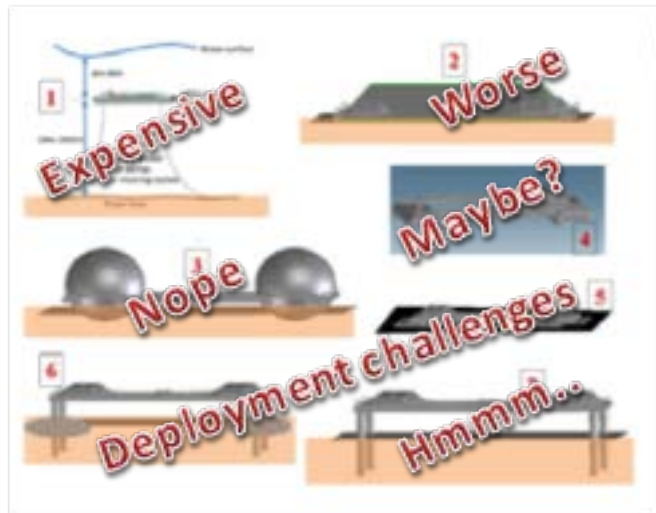
The sand pile can be
seen from space!

How do you validate a sediment transport numerical model?

Step 3: Measure sediment using a scanning sonar array



So what's the answer??



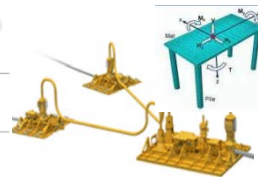
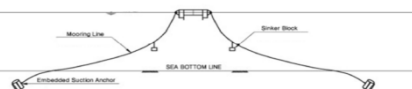
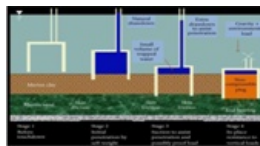
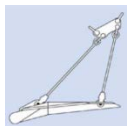
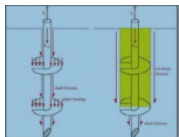
Numerical models, scale testing, and economic analysis indicated the most viable solutions:

- Mount off the ocean floor by a slight amount.
- Minimize cross-sectional area of caisson chambers

Both of these changes tend to allow sediment to “pass through”, ebbing and flowing independent of interactions with device structure.

Next Steps

- **Explore economics of methods for anchoring off the ocean floor.**
(some methods have already been tested using numerical models and scale testing)



- **Derive, validate, and publish a methodology for scaling performance attributes of a hybrid air/water system like APEX**
- **Prototype a new bi-directional turbine (internally funded project)**
- **Continue developing APEX II with significantly lower CAPEX and reduced deployment asset requirements.**

Acknowledgments



U.S. DEPARTMENT OF
ENERGY



Glostén



**Sandia
National
Laboratories**



NREL
NATIONAL RENEWABLE ENERGY LABORATORY



**CATHIE
ASSOCIATES**



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Ocean Renewable Energy Conference
September 18-19, 2018