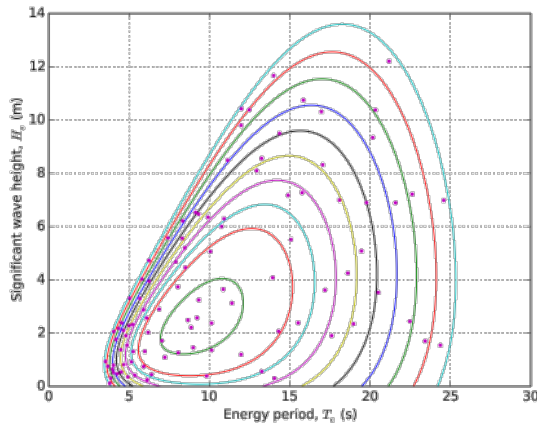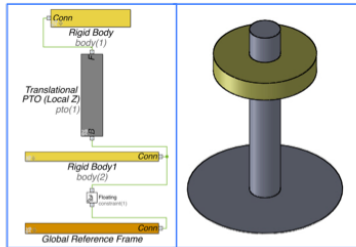# NATIONAL LABS EXTREME CONDITIONS MODELING CAPABILITIES
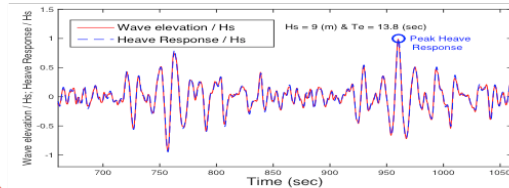
DE-FOA-0001310 webinar, June 2015

Design response/load analysis

Hydrodynamic Model

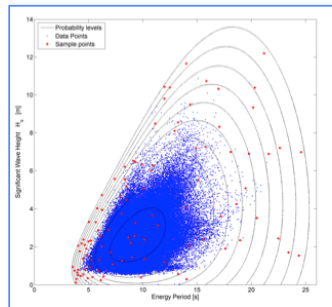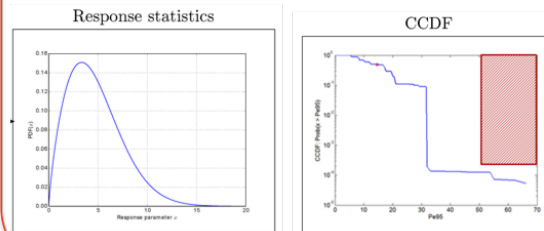
Low/Mid Fidelity Hydrodynamics Simulations

Time Domain Response

High Fidelity Computational Fluid Dynamic (CFD) Simulations

Wave Statistical Data

Statistical analysis to identify the most likely extreme events

Generate Equivalent Design Wave
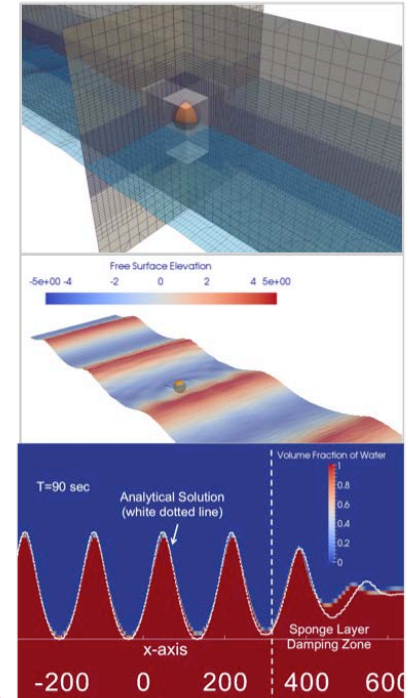
- Search both operational and survival sea states that are likely to cause extreme loading to the WECs using linear frequency domain solutions or mid-fidelity numerical methods.
- Investigate the identified extreme conditions using experimental wave tank tests or CFD simulations

Environmental characterization
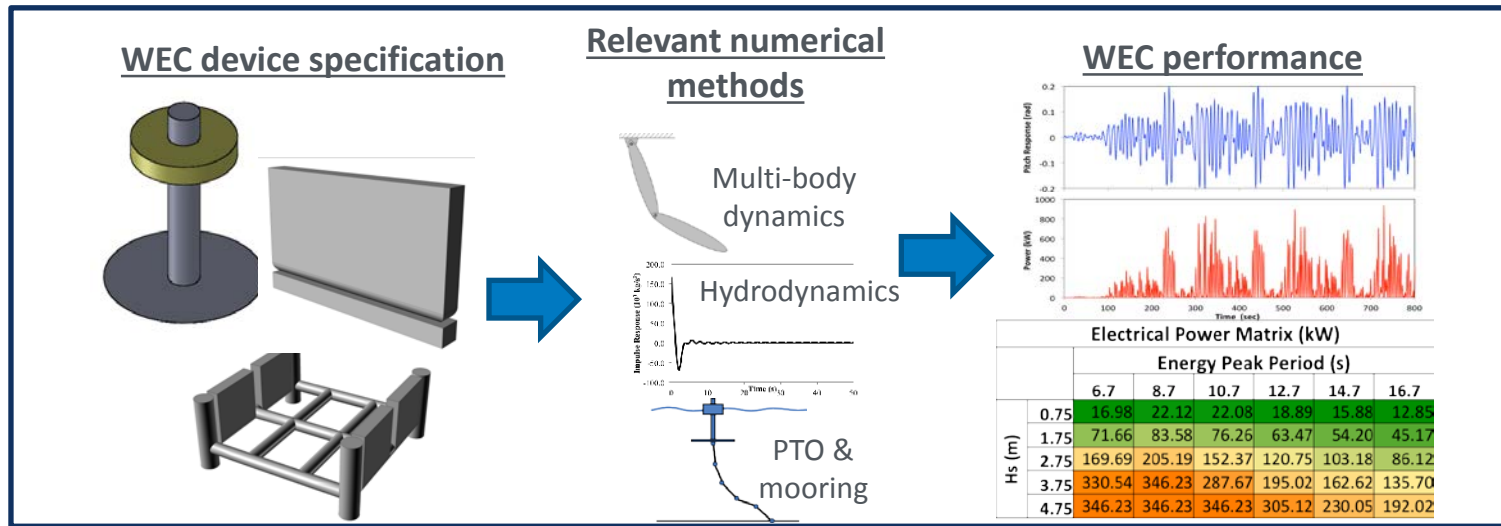
- Characterize wave environment from buoy data
- Perform iFORM analysis to obtain joint probability distribution
- Contour sampling
  - Sample just on contour of interest (e.g. 100 year return period)
  - Must apply additional safety factor for variability
- Domain-wide sampling
  - Sample evenly across levels of occurrence
  - Can produce more complete story of design response/load
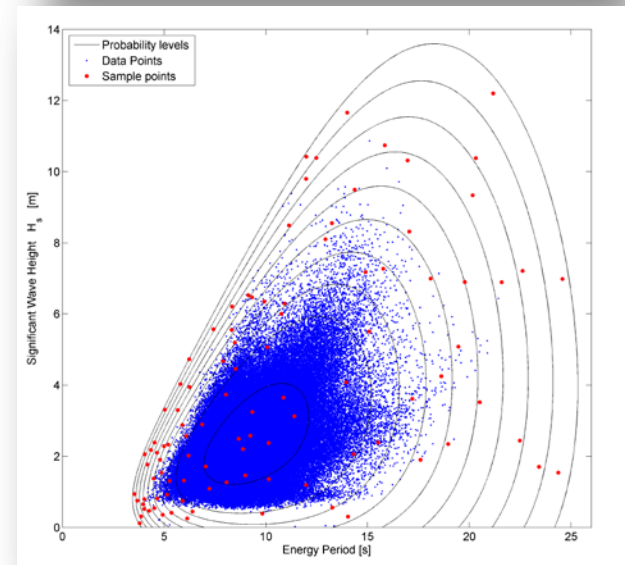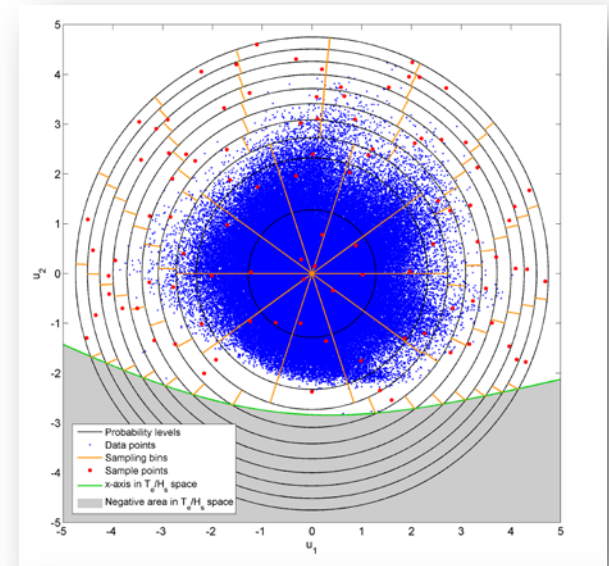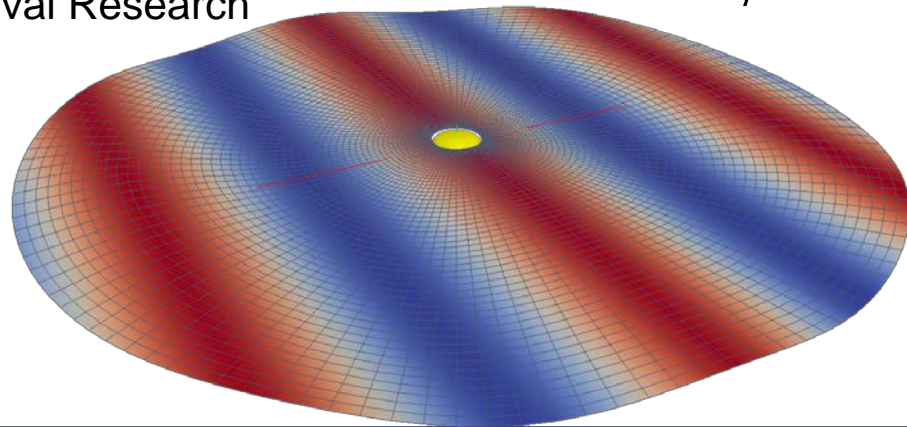
Mid-fidelity modeling

WEC-Sim

WEC device specification

Relevant numerical methods

Multi-body dynamics

Hydrodynamics

PTO & mooring

WEC performance

Electrical Power Matrix (kW)

|		Energy Peak Period (s)					
		6.7	8.7	10.7	12.7	14.7	16.7
Hs (m)	0.75	16.98	22.12	22.08	18.89	15.88	12.85
	1.75	71.66	83.58	76.26	63.47	54.20	45.17
	2.75	169.69	205.19	152.37	120.75	103.18	86.12
	3.75	330.54	346.23	287.67	195.02	162.62	135.70
	4.75	346.23	346.23	346.23	305.12	230.05	192.02

Aegir

- Nonlinear potential (can be run in "linear-mode")
- Developed for Office of Naval Research
- Modeling WECs
  - Limited multi-body capabilities
  - Basic mooring and PTO modeling

$$\nabla^2 \phi = 0$$

4

High-fidelity numerical modeling

- Response conditioned wave profiles
    - Construct an ensemble of short design wave profiles
    - Evaluate how applicable these methods are and their computational efficiencies
- Validate CFD against experimental study (Weller et al. 2013)

de Hauteclocque, OMAE 2012

Penn State ARL
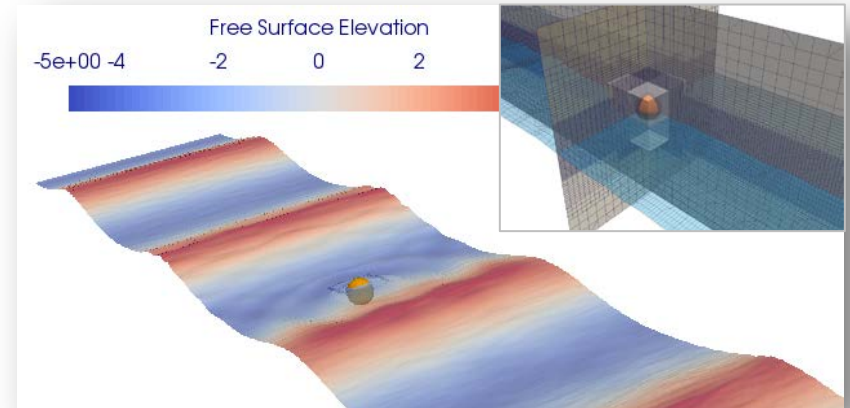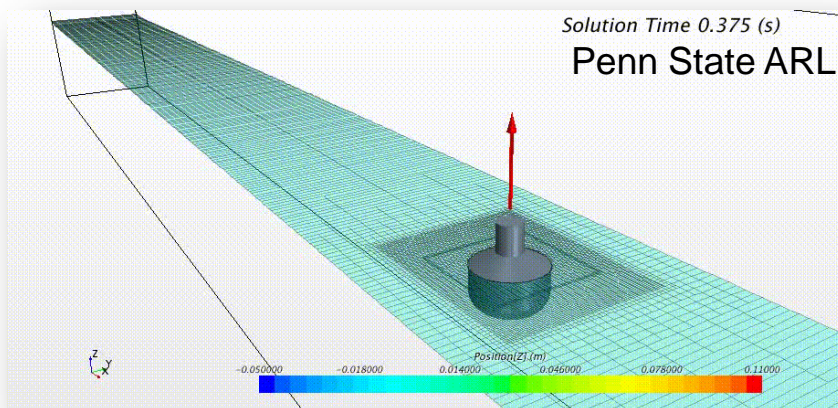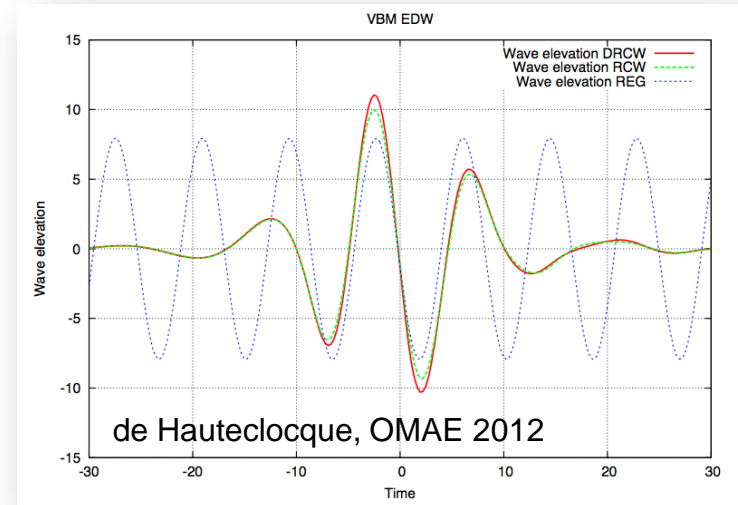
Conclusion

The ECM team from Sandia and NREL will support selected project teams up to 750 labor hours. The specifics of this collaboration/support will finalized throughout the application and selection process.

Questions?: email *MHKFOA1310@ee.doe.gov*

All Q&As related to this FOA will be posted on EERE Exchange
- You must select this specific FOA Number in order to view the Q&As
- EERE will attempt to respond to a question within 3 business days, unless a similar Q&A has already been posted on the website

Capabilities:
- Low/mid-fidelity dynamics modeling (WEC-Sim, Aegir, ...)
- High-fidelity modeling (CFD)
- Environmental characterization and sampling
- Response statistics

Team members:
- Yi-Hsiang Yu
- Michael Lawson
- Carlos Michelen
- Ryan Coe