



Supergen  Offshore
Renewable
Energy

ANNUAL ASSEMBLY

18, 19 & 20 January 2022
University of Plymouth & online

#SupergenORE2022



NHP-WEC



Professor George Aggidis

FIMechE, FIMarEST, FEI, FIET

Head of Energy Engineering

g.aggidis@lancaster.ac.uk



UNIVERSITY
OF HULL

ENERGY AND
ENVIRONMENT INSTITUTE



Engineering and
Physical Sciences
Research Council

Engineering

Lancaster
University



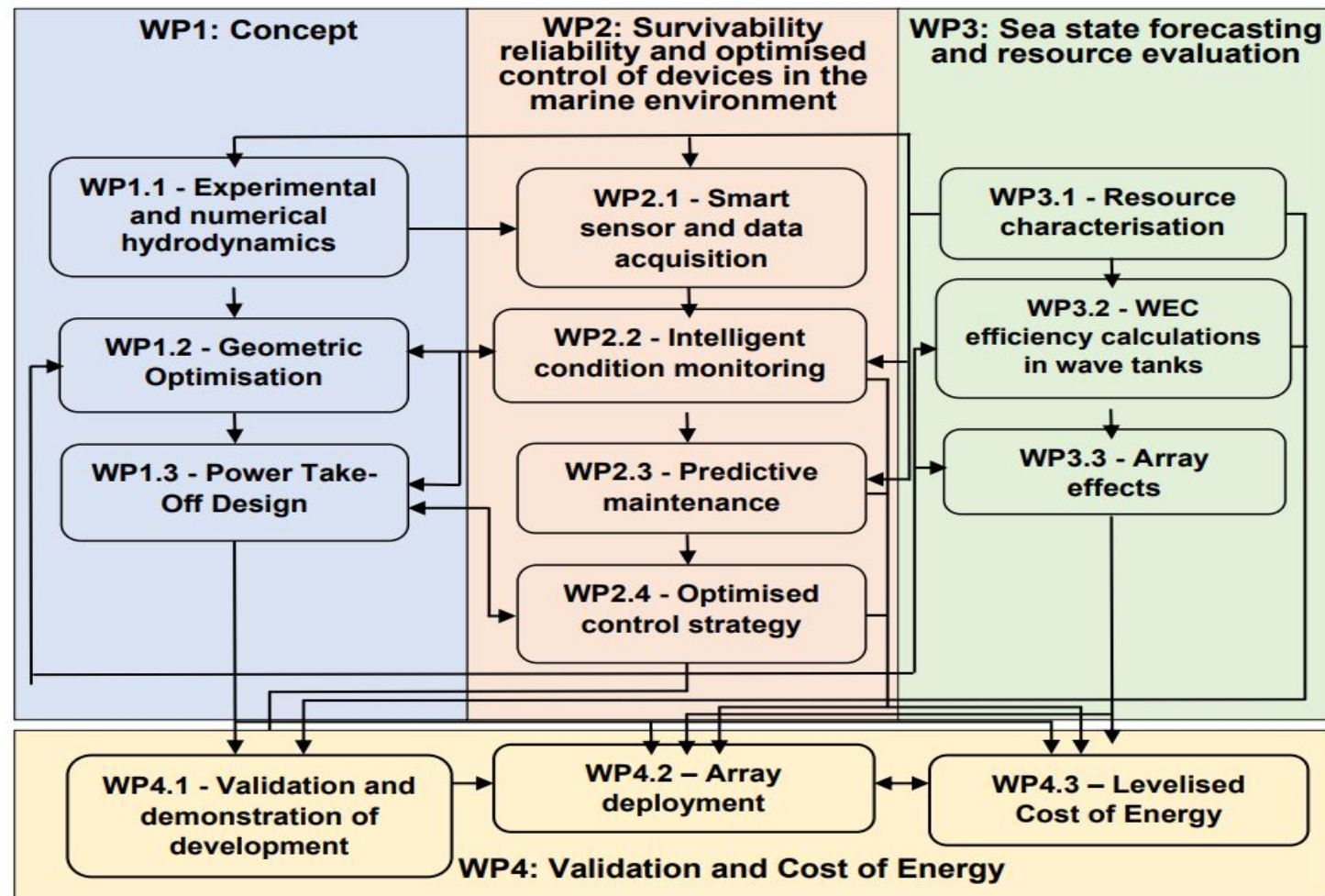
Project Team, WP Structure



- P-I - Professor **George AGGIDIS**
- Co-I - Dr **Xiandong MA**
- Co-I - Professor **C. James TAYLOR**
- PDRA1 - SRA - Dr **Wanan SHENG**
- PDRA2 – RA - **Yueqi WU**

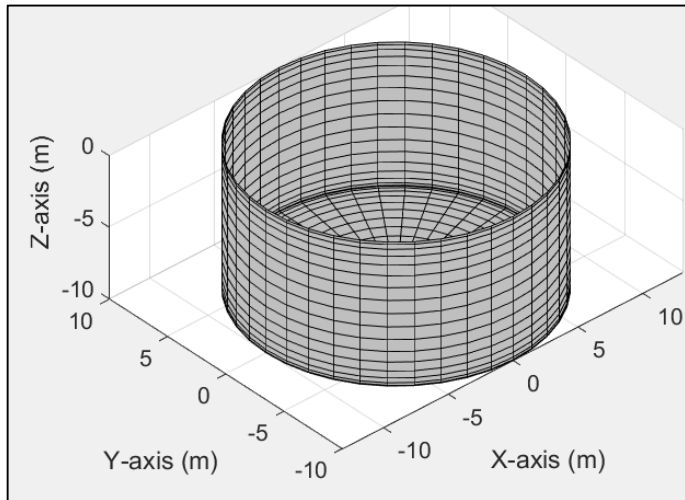


- Co-I - Dr **Robert DORRELL**
- Co-I - Professor **Daniel PARSONS**
- PDRA3–SRA–Co-I - Dr **Evdokia TAPOGLOU**

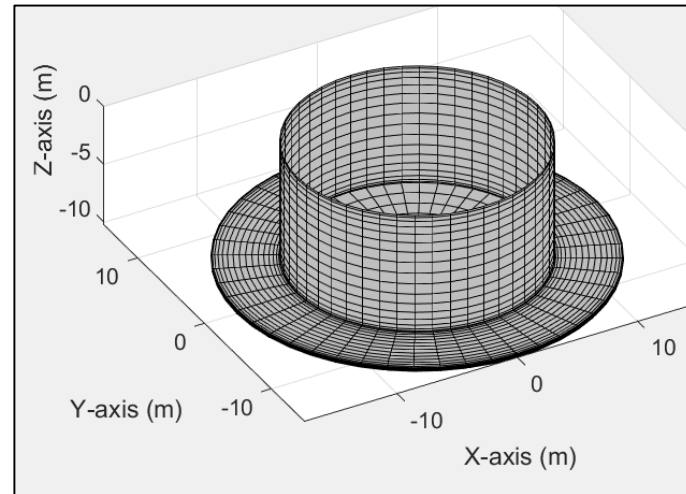


Paper 1: Code comparisons

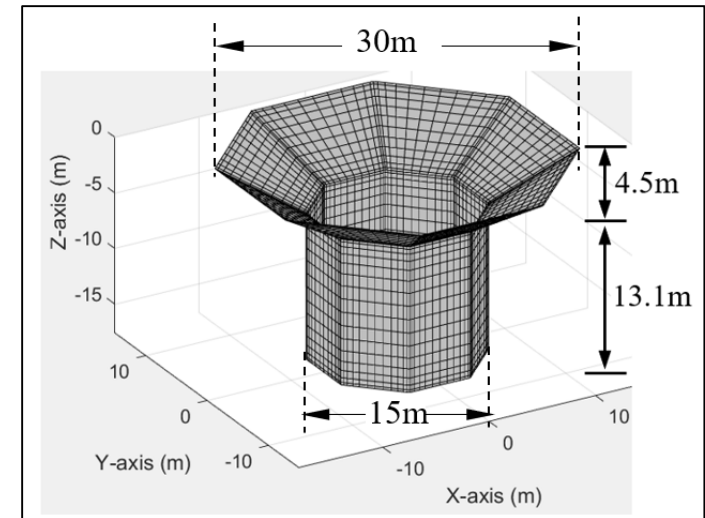
- 1) WAMIT (**commercial**): Wave Analysis MIT
- 2) Nemoh (**open source**, released by ECN, France)
- 3) HAMS (**open source**, Released by Dr. Yingyi Liu): Hydrodynamic Analysis of Marine Structures



Truncated cylinder



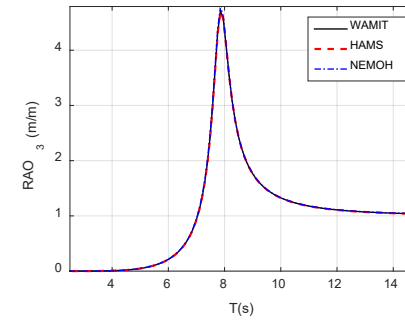
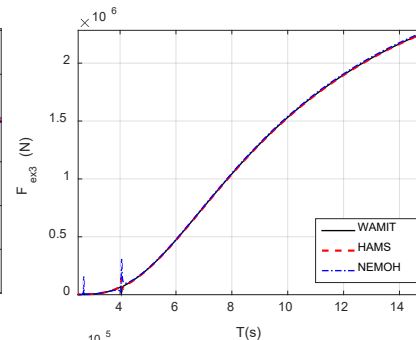
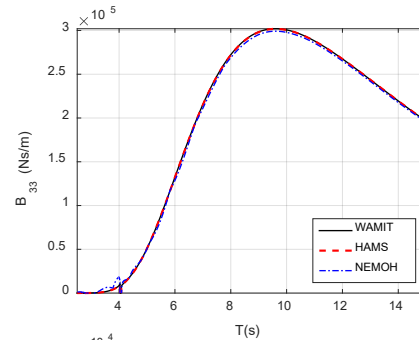
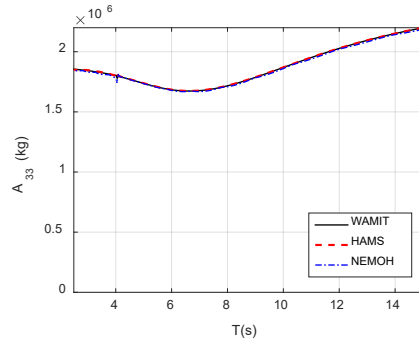
Truncated cylinder
+heave plate



TALOS I

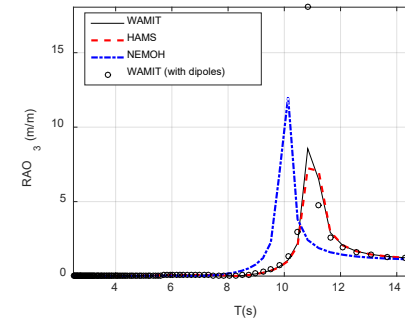
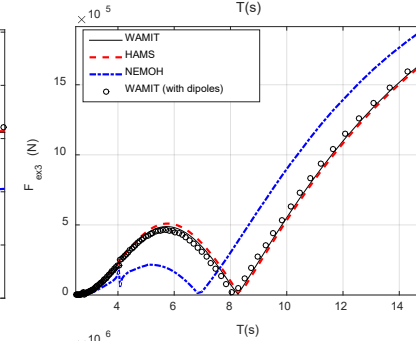
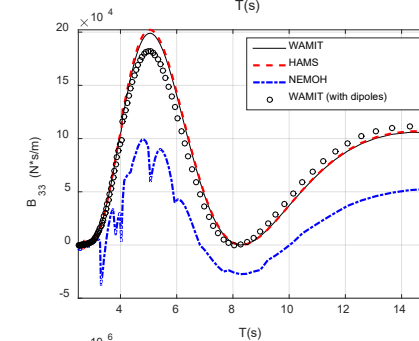
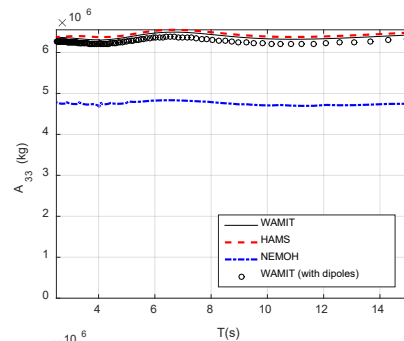
Paper 1: Code comparisons

Truncated cylinder



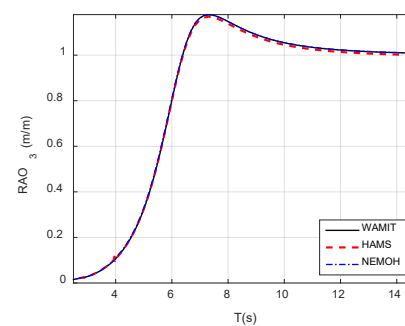
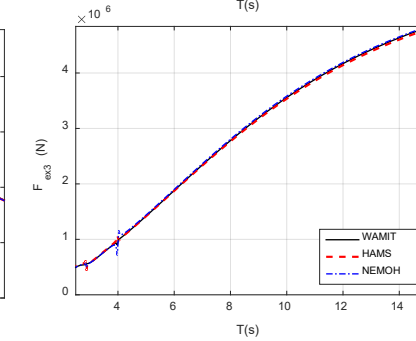
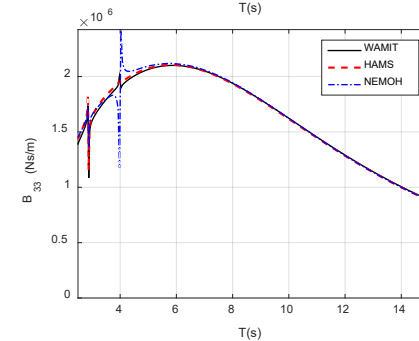
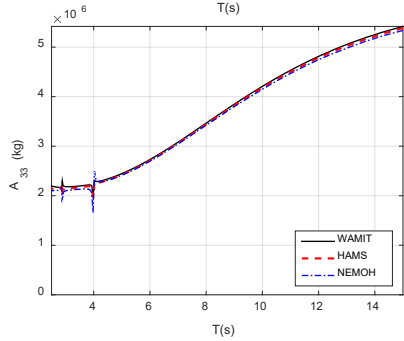
All good

Truncated cylinder
+heave plate



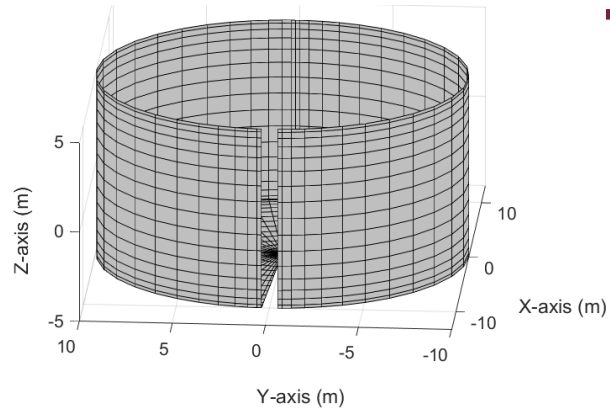
NEMOH is
not good

TALOS I

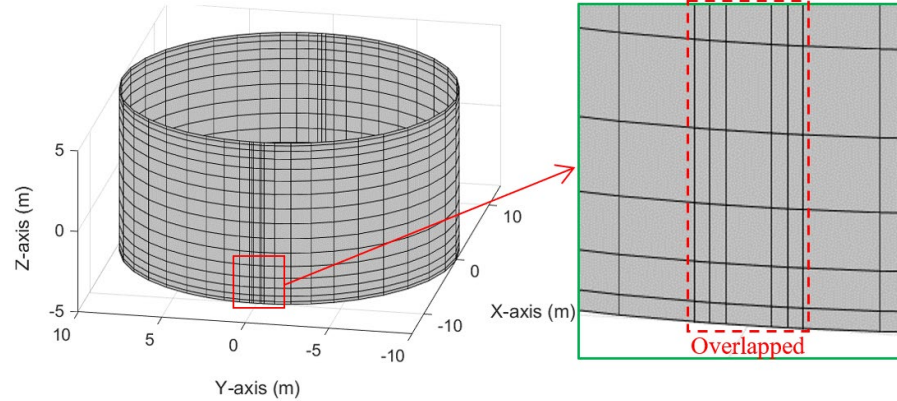


All good

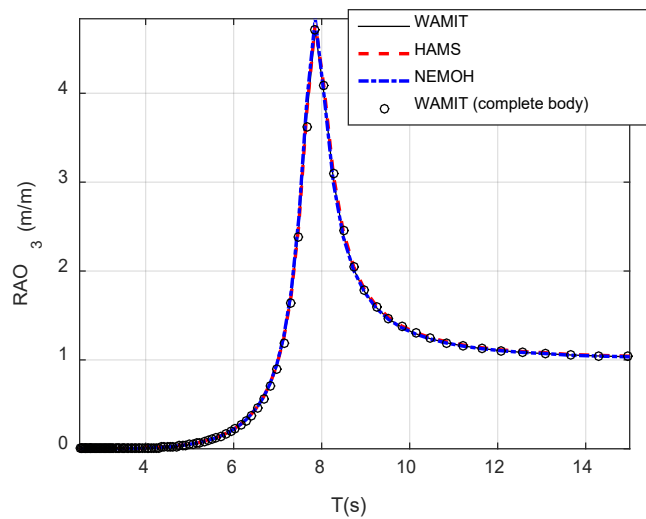
Paper 1: Code comparisons...



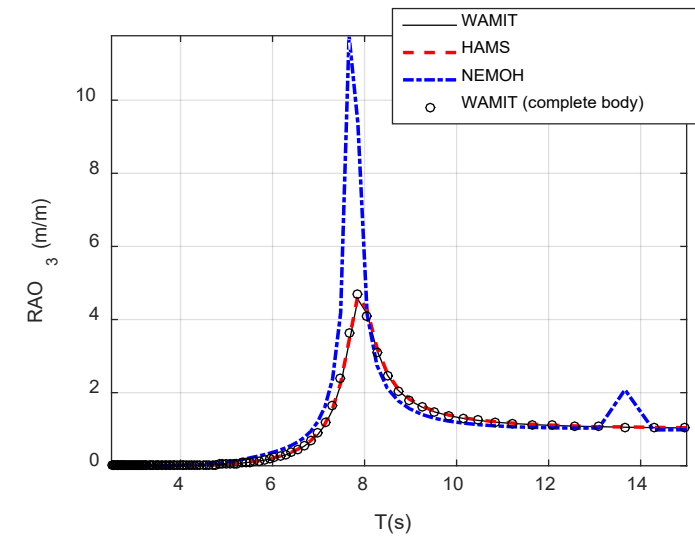
Incomplete cylinder



Cylinder with an overlap



All good



NEMOH is not good

Paper 1: Code comparisons, Status

- Revision has been submitted to **Ocean Engineering** for publication
- Following the suggestion from a reviewer, we are making the mesh files (used in the research) available for public access for those who may be interested in the hydrodynamic analysis of marine structures.

Paper 2: Time-domain implementation

- Apply the open source 'HAMS' for the hydrodynamic analysis of TALOS, with focus on the coupled motion modes
- Comparisons of the transformation from frequency domain and time domain (WAMIT vs. HAMS)
- the implementation of the time domain model of multiple motion modes, including:
 - ✓ Approximations of impulse functions
 - ✓ Approximation of the memory effects
 - ✓ The implementation and solution of the time-domain equation
- Provision of a method for checking the time-domain analysis

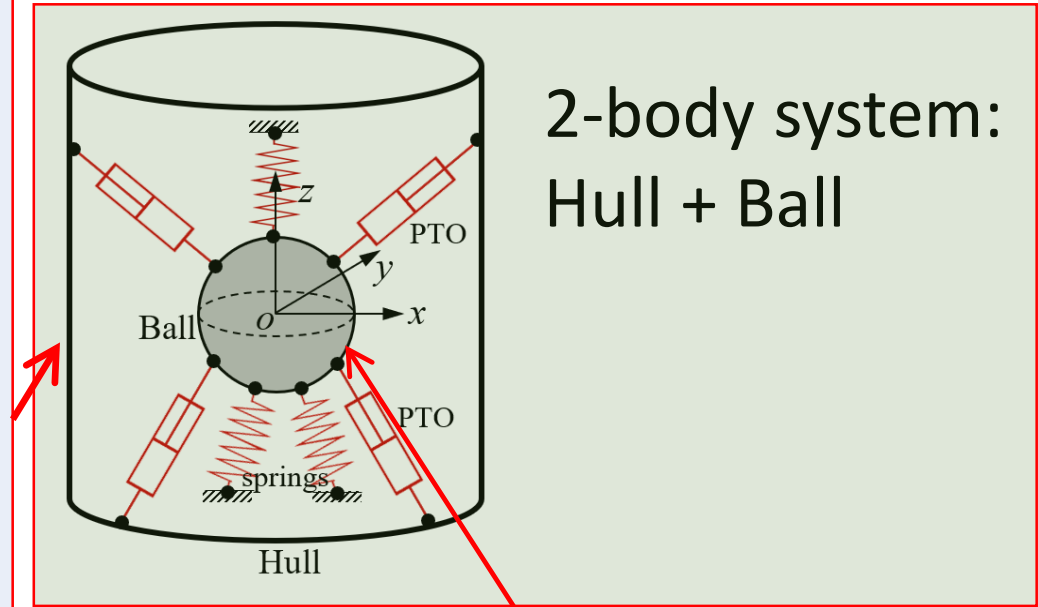
The manuscript (Paper 2) has been submitted to Ocean Engineering for publication

Paper 3: Implementation of TALOS WEC, **ongoing work**

Equations for hull motion

$$\begin{cases} (m_s + A_{11})\ddot{x}_{s1}(t) + \sum_{j=1}^6 \int_0^t K_{1j}(t-\tau)\dot{x}_{sj}(\tau)d\tau + C_{s1}x_{s1}(t) = F_1^{exc}(t) - F_{pto1}(t) - F_{spr1}(t) \\ (m_s + A_{22})\ddot{x}_{s2}(t) + \sum_{j=1}^6 \int_0^t K_{2j}(t-\tau)\dot{x}_{sj}(\tau)d\tau + C_{s2}x_{s2}(t) = F_2^{exc}(t) - F_{pto2}(t) - F_{spr2}(t) \\ (m_s + A_{33})\ddot{x}_{s3}(t) + \sum_{j=1}^6 \int_0^t K_{3j}(t-\tau)\dot{x}_{sj}(\tau)d\tau + C_{s3}x_{s3}(t) = F_3^{exc}(t) - F_{pto3}(t) - F_{spr3}(t) \\ (I_{s44} + A_{44})\ddot{x}_{s4}(t) + \sum_{j=1}^6 \int_0^t K_{4j}(t-\tau)\dot{x}_{sj}(\tau)d\tau + C_{s4}x_{s4}(t) = F_4^{exc}(t) - M_{pto1}(t) - M_{spr1}(t) \\ (I_{s55} + A_{55})\ddot{x}_{s5}(t) + \sum_{j=1}^6 \int_0^t K_{5j}(t-\tau)\dot{x}_{sj}(\tau)d\tau + C_{s5}x_{s5}(t) = F_5^{exc}(t) - M_{pto2}(t) - M_{spr2}(t) \\ (I_{s66} + A_{66})\ddot{x}_{s6}(t) + \sum_{j=1}^6 \int_0^t K_{6j}(t-\tau)\dot{x}_{sj}(\tau)d\tau + C_{s6}x_{s6}(t) = F_6^{exc}(t) - M_{pto3}(t) - M_{spr3}(t) \end{cases}$$

Time Domain



Equations for ball motion

$$\begin{cases} m_b\ddot{x}_{b1}(t) = F_{pto1}(t) + F_{spr1}(t) \\ m_b\ddot{x}_{b2}(t) = F_{pto2}(t) + F_{spr2}(t) \\ m_b\ddot{x}_{b3}(t) = F_{pto3}(t) + F_{spr3}(t) \\ I_{bxx}\ddot{x}_{b4}(t) = M_{pto1}(t) + M_{spr1}(t) \\ I_{byy}\ddot{x}_{b5}(t) = M_{pto2}(t) + M_{spr2}(t) \\ I_{bzz}\ddot{x}_{b6}(t) = M_{pto3}(t) + M_{spr3}(t) \end{cases}$$

Paper 4: Validation, **next steps**



Experimental Modelling
and Validation of the
Computational Modelling
for TALOS WEC

International Collaboration



Professor Spyros Mavrakos
 Professor John Anagnostopoulos



Ass Professor Constantine Michaelides



Ass Professor Eva Loukogeorgaki



Professor Pierre Ferrant
 Prof Alain Clément
 Dr Aurélien Babarit



Dr Jochem Weber
 Dr Robert Thresher
 Dr Aidan Bharath



Ass Professor Yi-Hsiang Yu



Joint Research Centre
 Dr Evdokia Tapoglou



Ass Professor Carrie Hall



Professor Brad Buckham



Ass Professor Hui Zhang

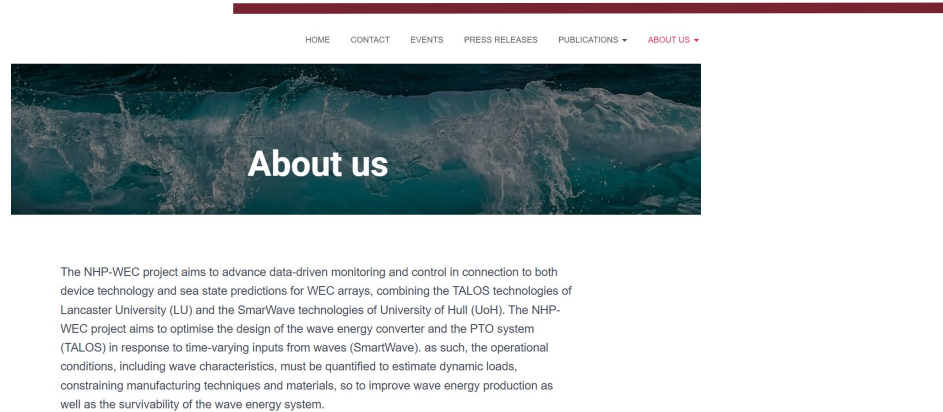


Ass Professor Chenglong Guo



Professor Dahai Zhang

Website, 1st Workshop, Advisory Board



[EPSRC NHP-WEC project: A TALOS and SmartWave Project \(lancs.ac.uk\)](https://lancs.ac.uk)



EPSRC Marine Wave Programme 2020 - Novel High Performance Wave Energy Converter Research Project (NHP-WEC)

The NHP-WEC team would like to invite you to the 1st workshop of their EPSRC funded project: 'Novel High Performance Wave Energy Converters with advanced control, reliability and survivability systems through machine-learning forecasting (NHP-WEC) project. [Find out more about the project in this PDF.](#)



UNIVERSITY OF HULL

ENERGY AND ENVIRONMENT INSTITUTE



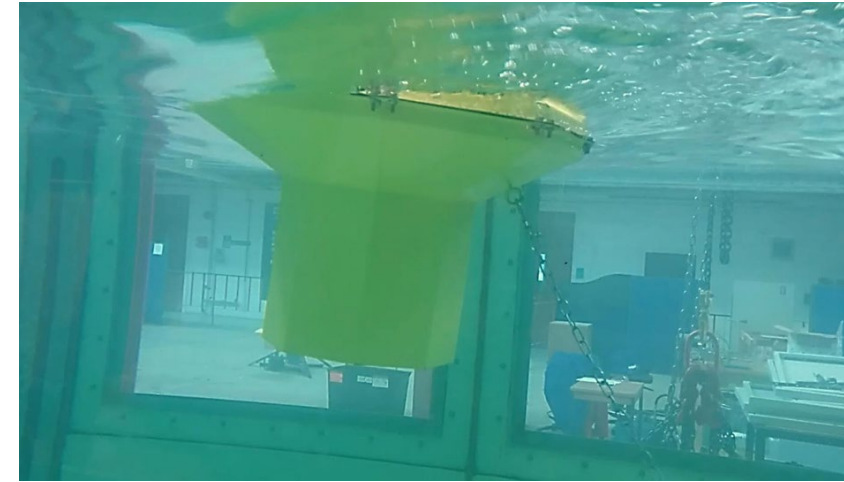
Engineering and Physical Sciences Research Council

Engineering

Lancaster University



Thank you



Professor George Aggidis

FIMechE, FIMarEST, FEI, FIET

Head of Energy Engineering

g.aggidis@lancaster.ac.uk

