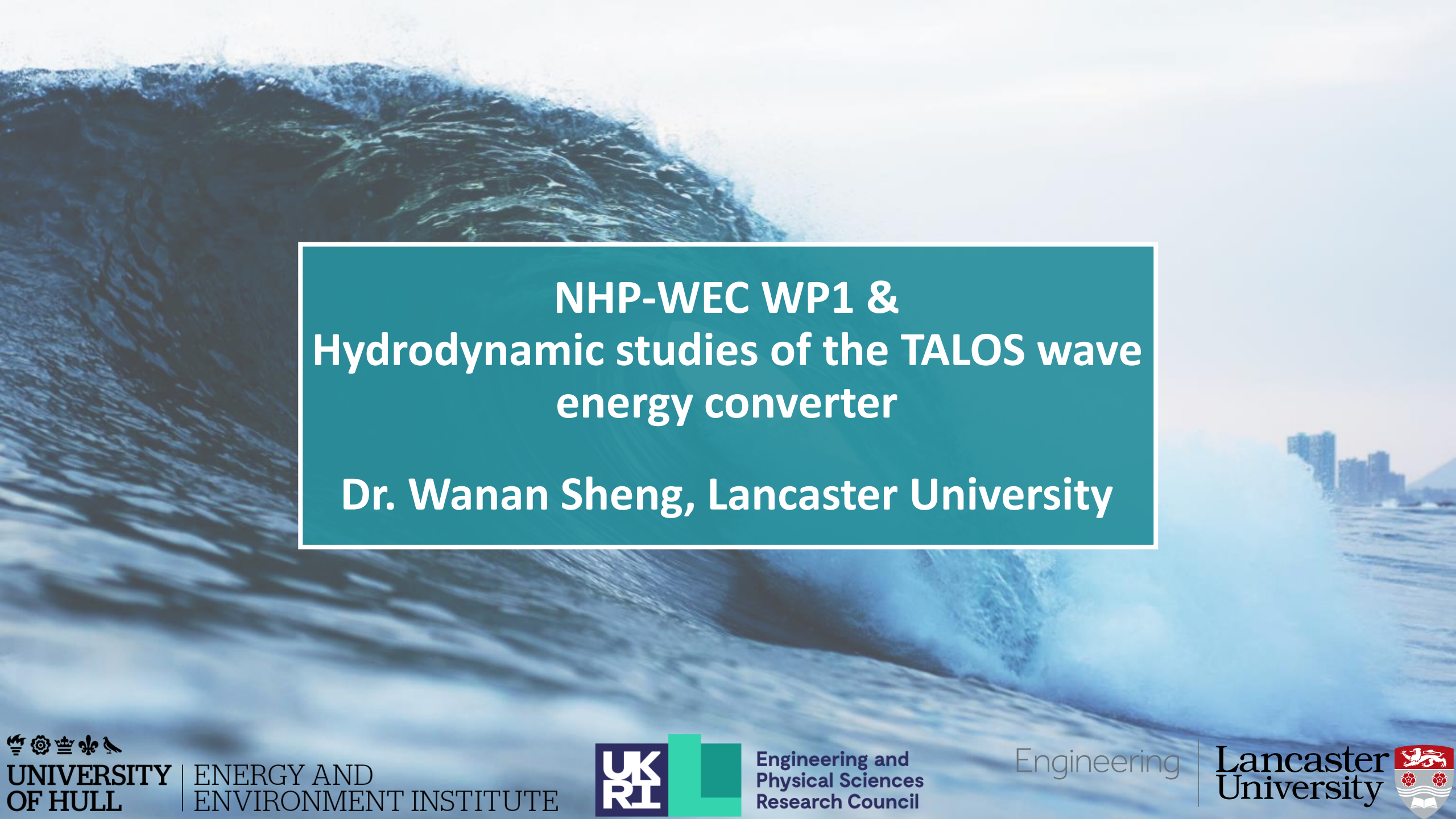


NHP-WEC WP1 & Hydrodynamic studies of the TALOS wave energy converter

Dr. Wanan Sheng, Lancaster University

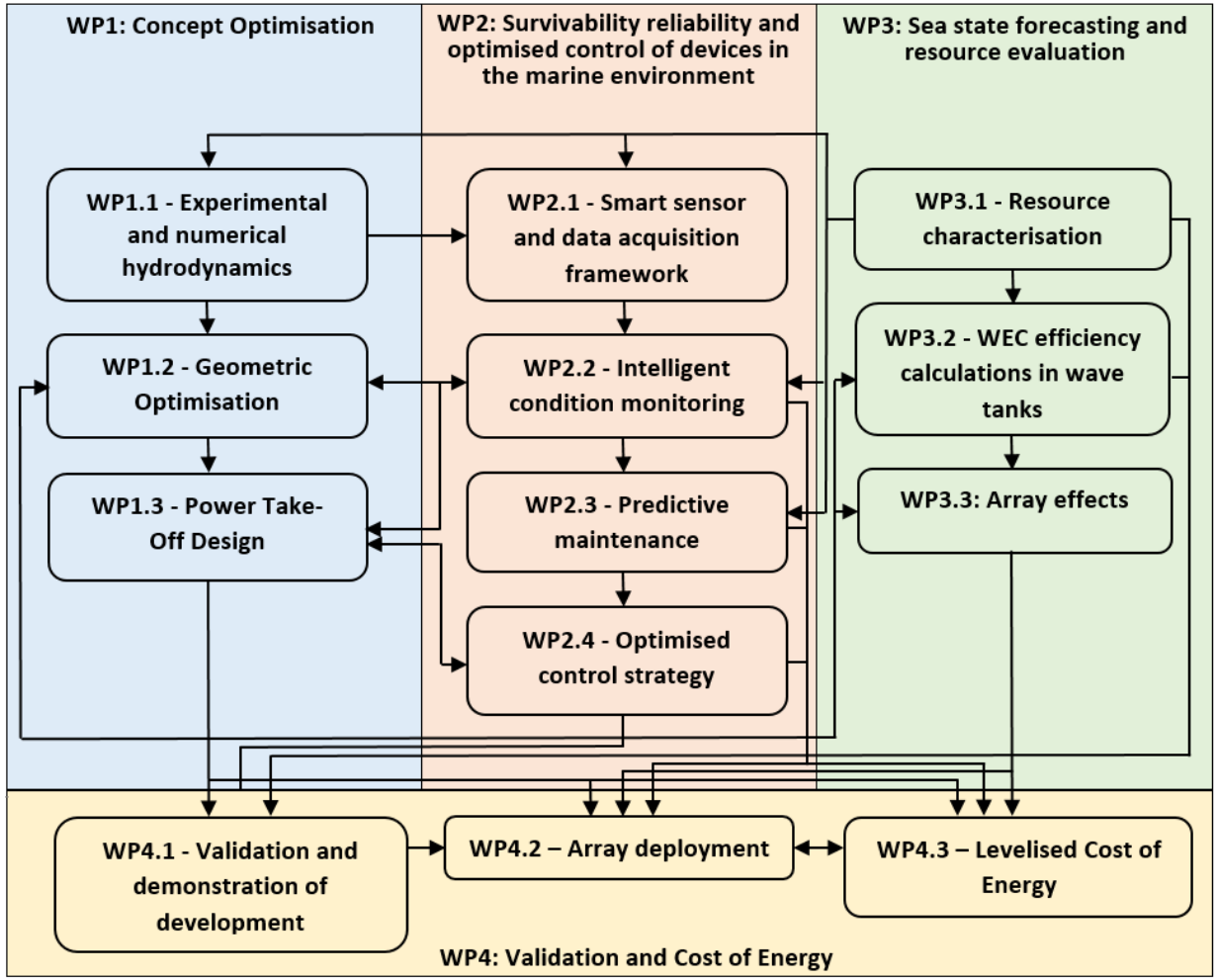
UNIVERSITY OF HULL | ENERGY AND ENVIRONMENT INSTITUTE

UKRI Engineering and Physical Sciences Research Council

Engineering | Lancaster University

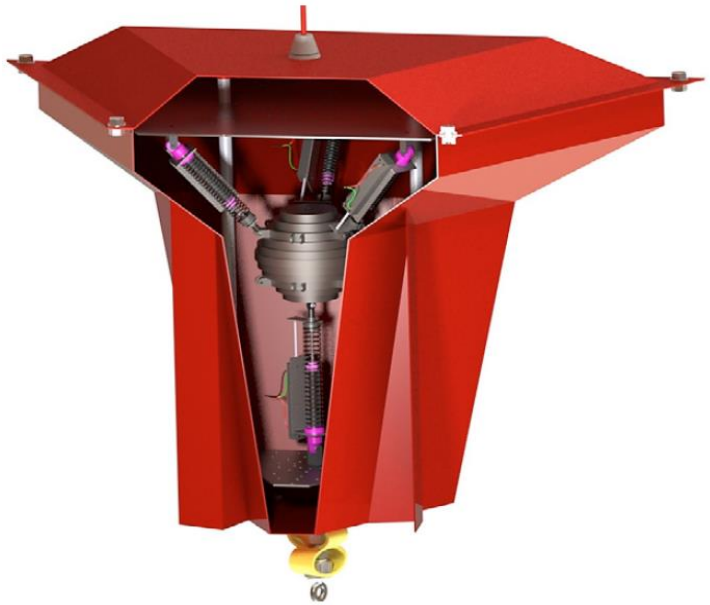
WP1: Concept optimisation

- WP 1.1- Experimental and numerical hydrodynamics
- WP 1.2- Geometric optimisation
- WP 1.3- Power take-off design



Introduction of TALOS WEC

TALOS I



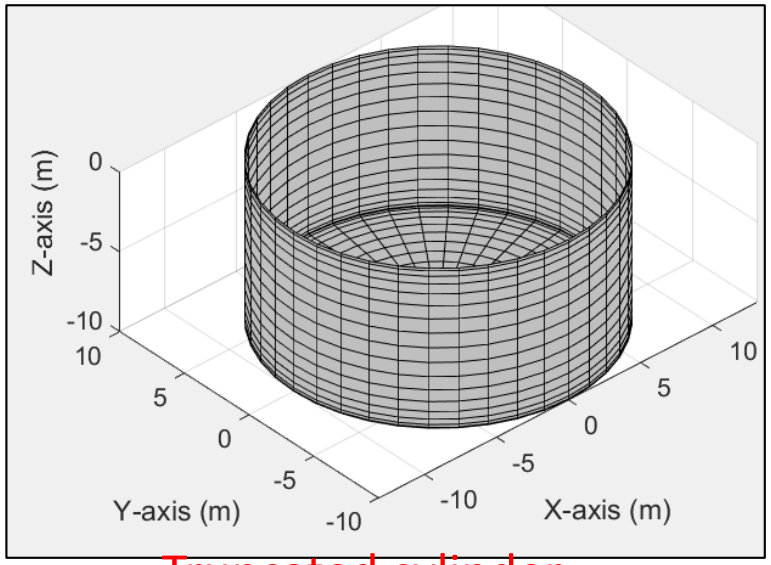
TALOS II

TALOS damper configuration

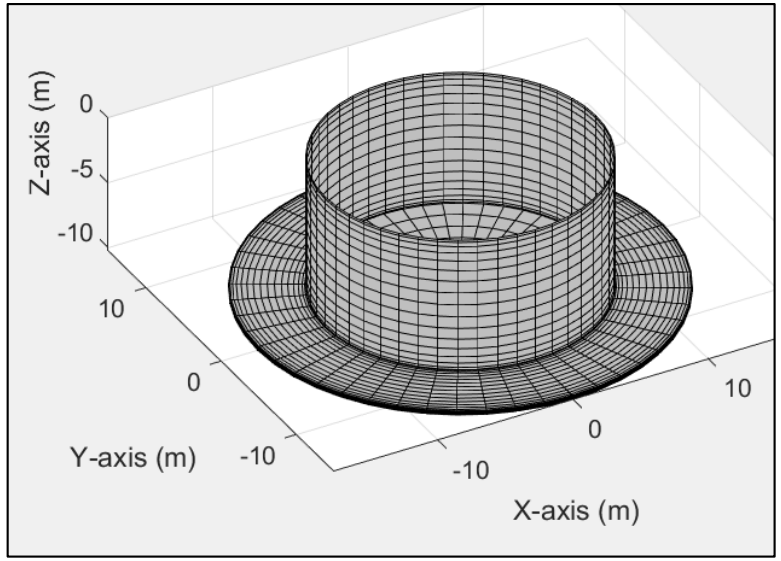
- Multi-axis power take-off
- Fully enclosed system (PTOs…)

Topic 1: code comparisons

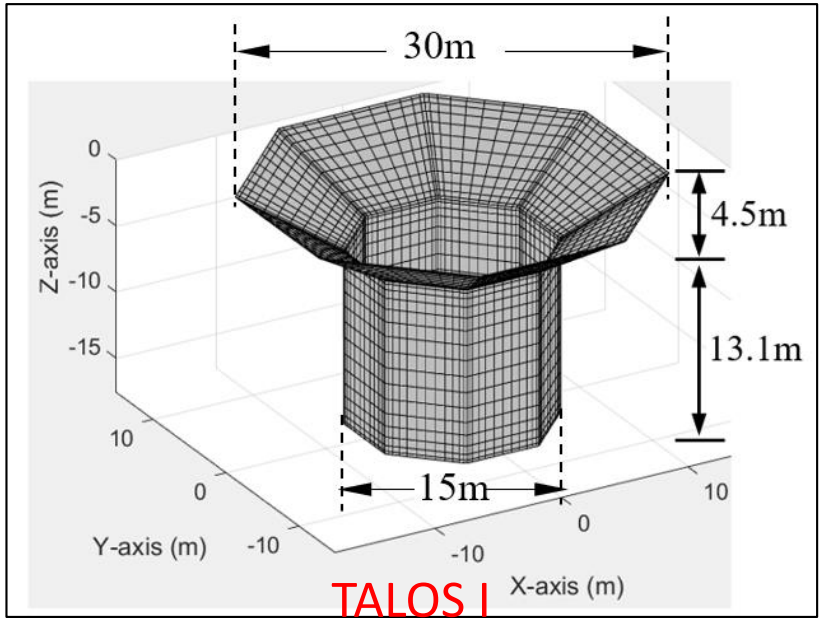
- WAMIT (commercial): Wave Analysis MIT
- Nemoh (open source, released by ECN, France)
- HAMS (open source, Released by Dr. Yingyi Liu): Hydrodynamic Analysis of Marine Structures



Truncated cylinder

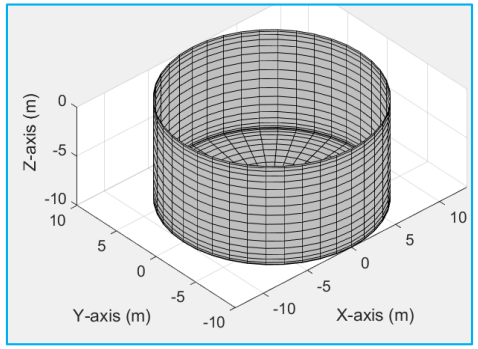


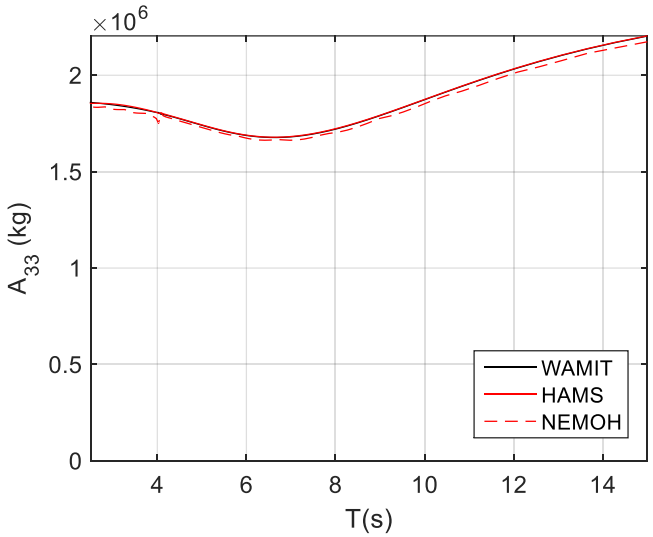
Truncated cylinder+heave plate

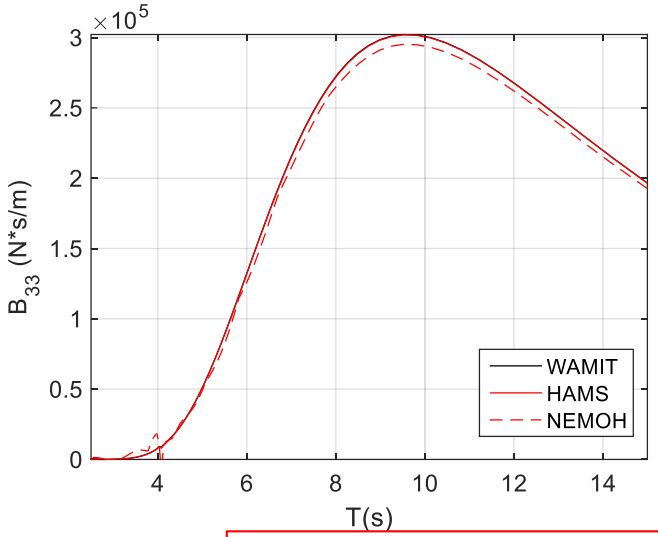


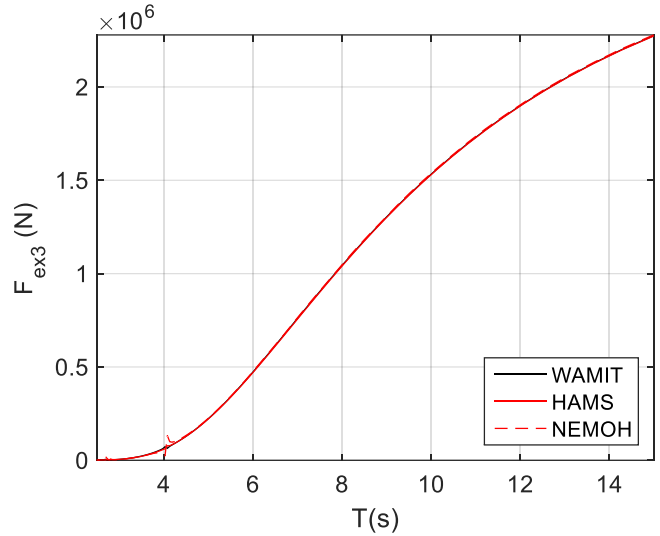
TALOS I

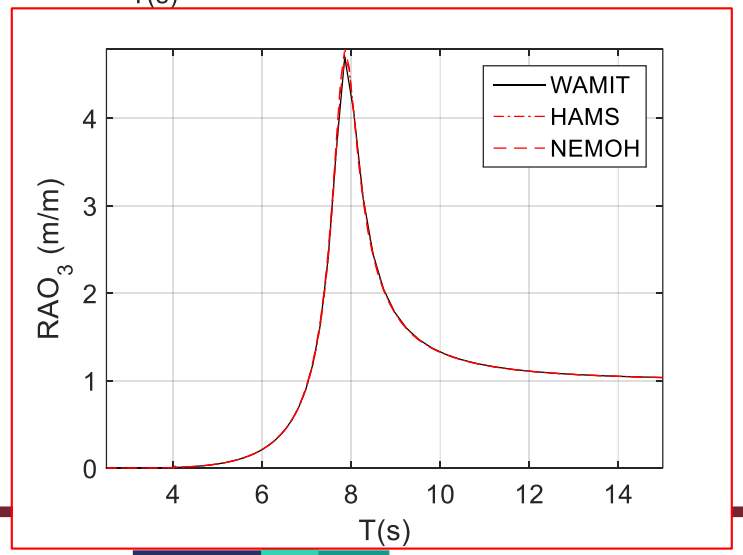
Frequency-domain analysis: simple cylinder

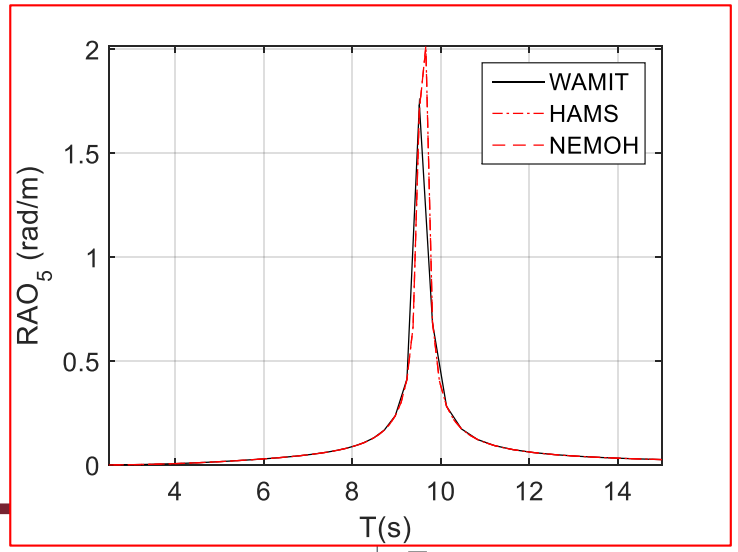


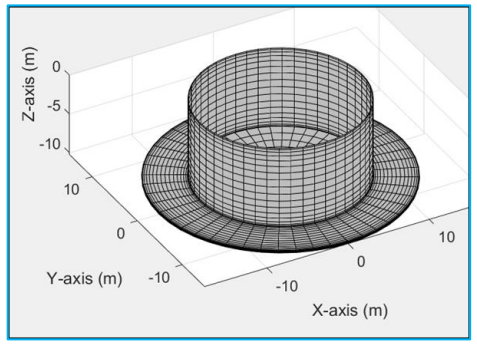




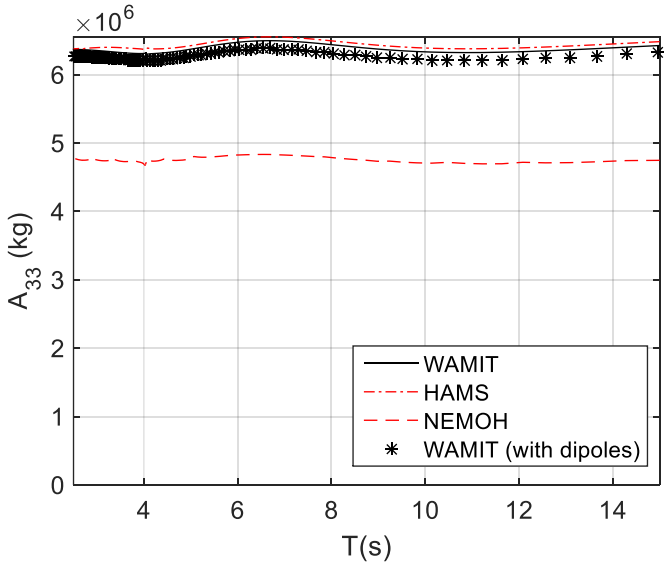


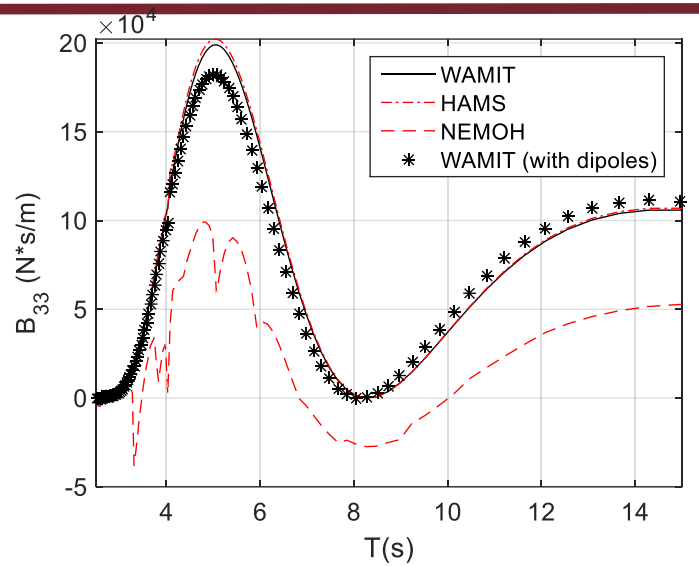


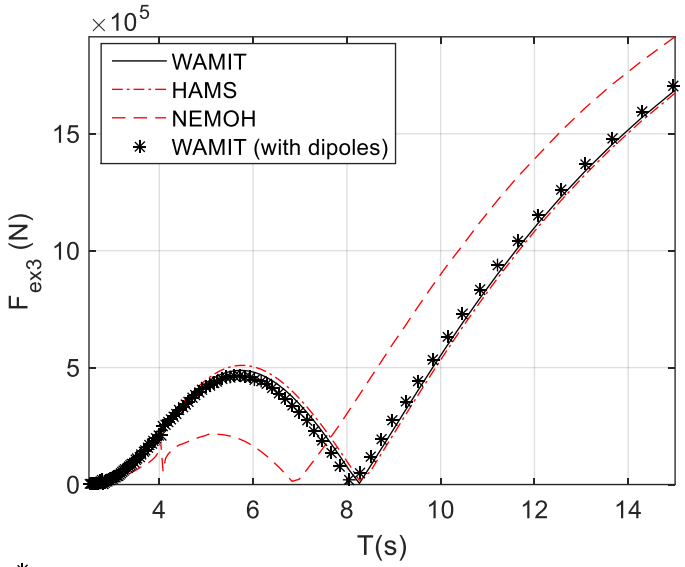


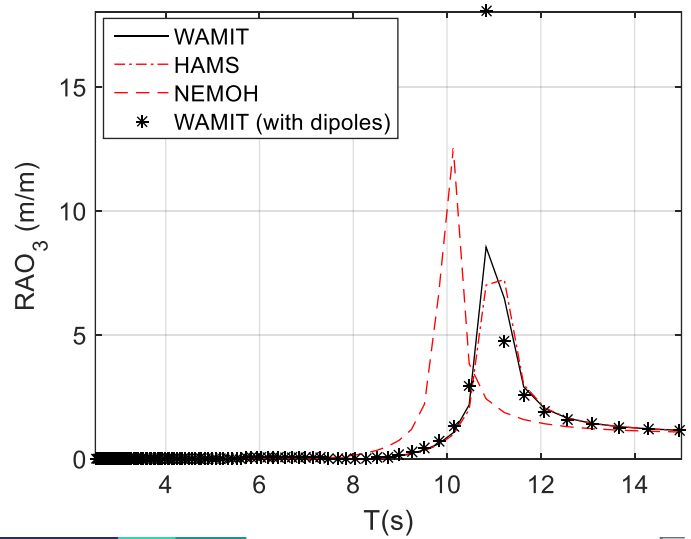


Frequency-domain analysis: cylinder+ plate(10cm)

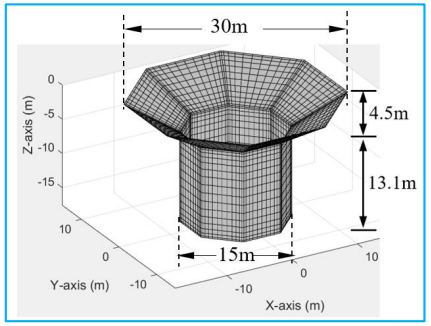


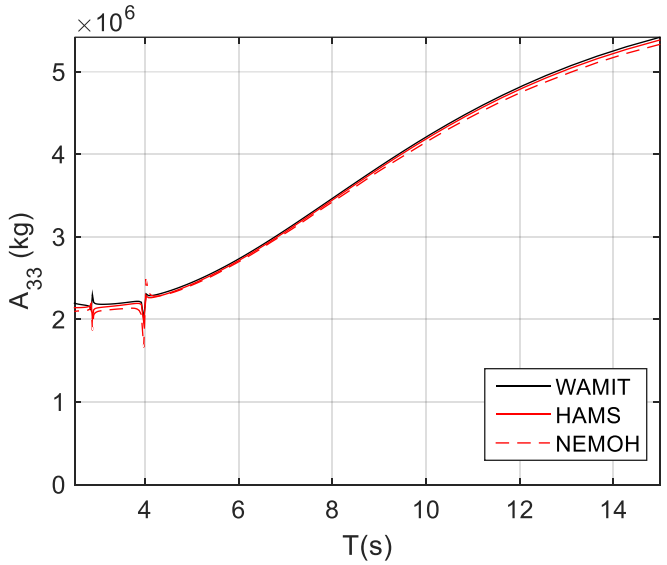


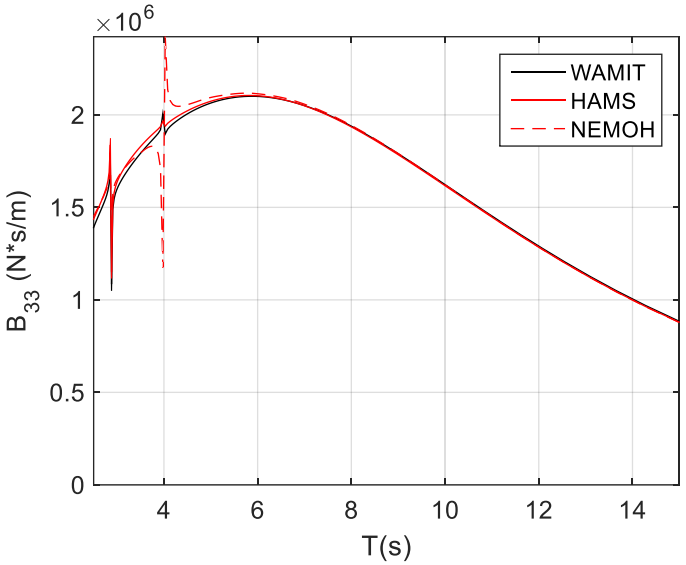


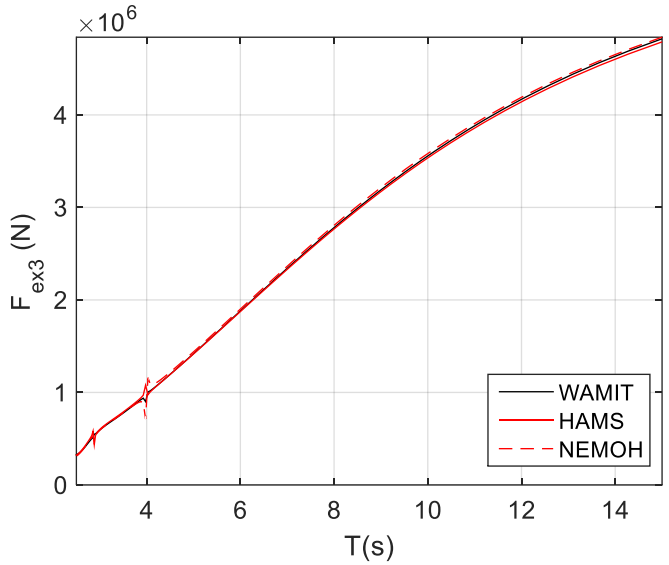


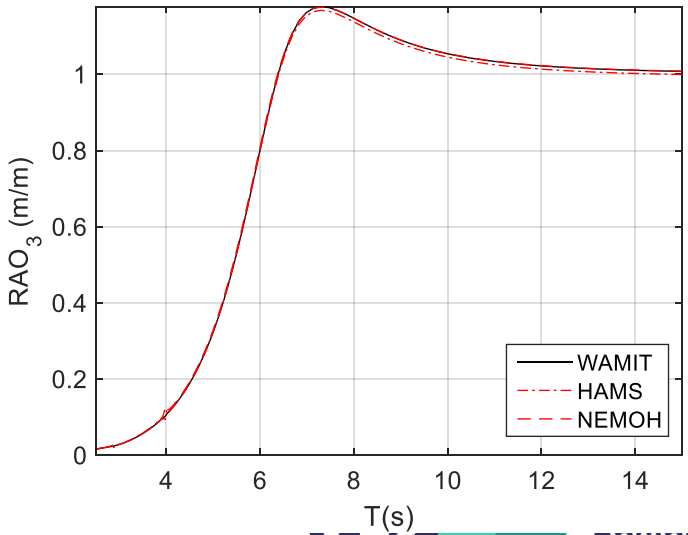
Frequency-domain analysis: TALOS

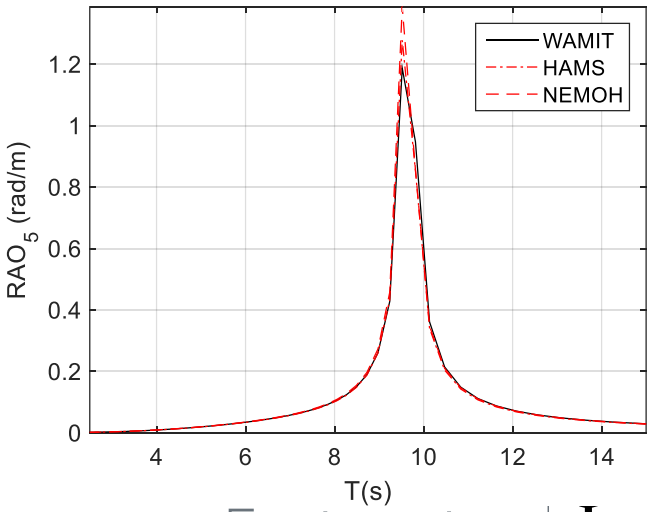








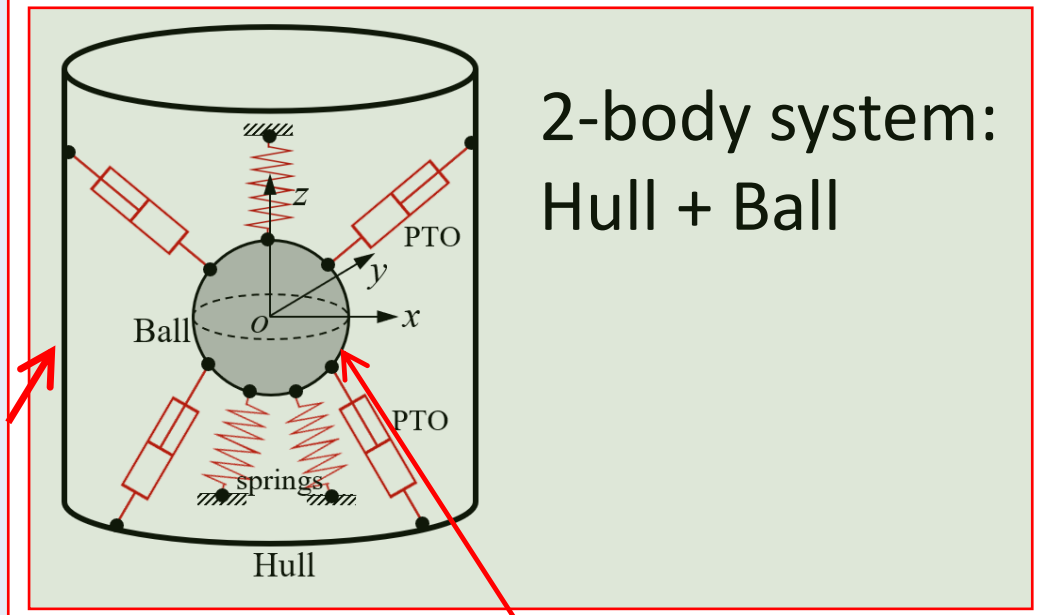




Topic 2: Time-domain implementation

Equations for hull motion

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



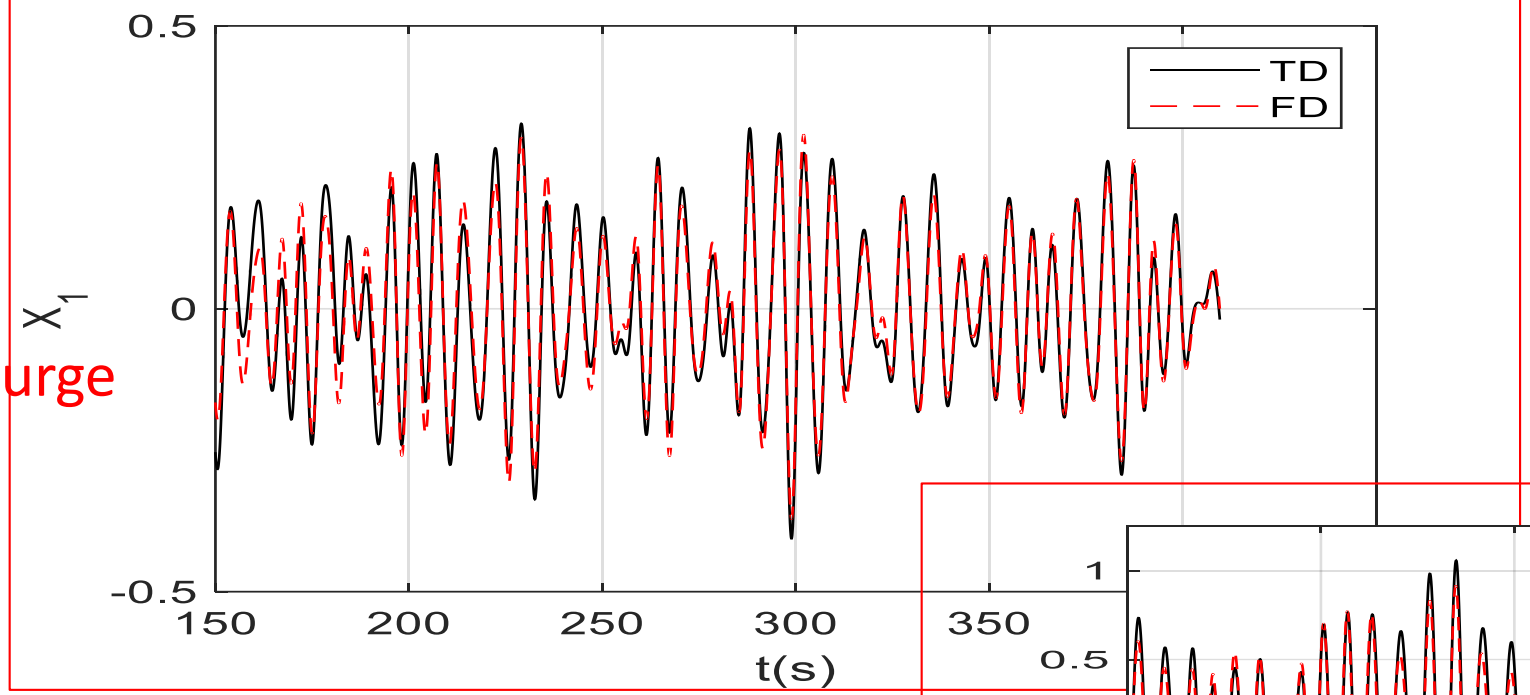
2-body system:
Hull + Ball

Equations for ball motion

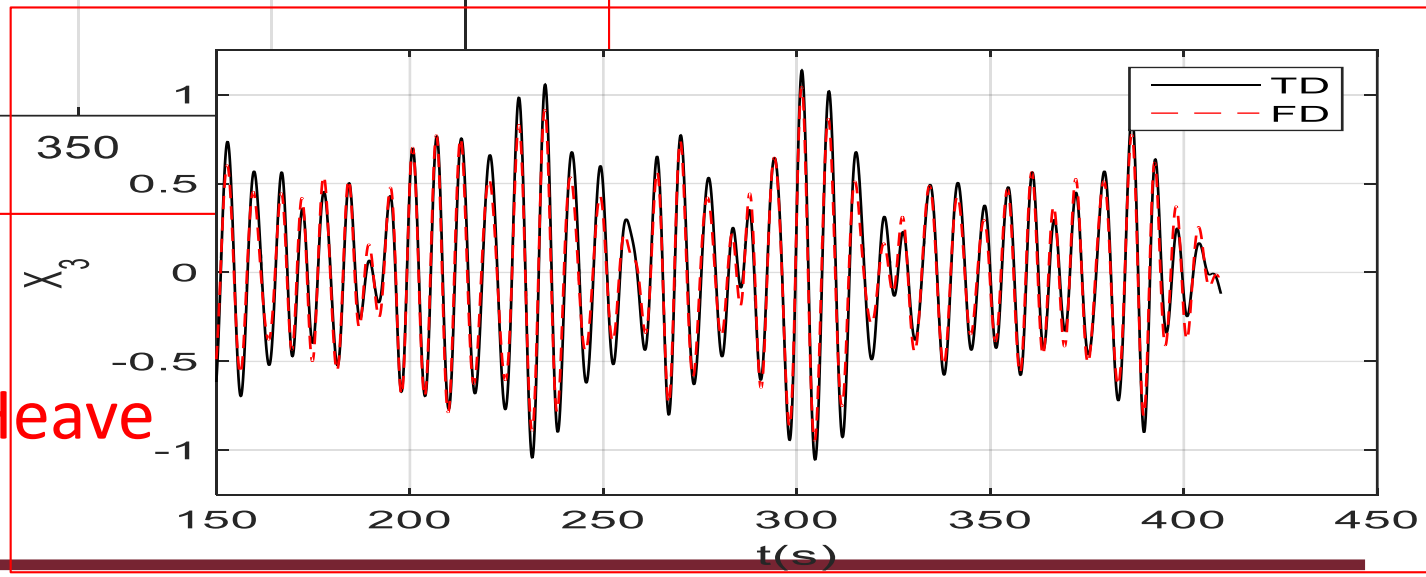
$$
\begin{cases}
m_b\ddot{x}_{b1}(t) = F_{pto1}(t) + F_{spr1}(t) \\
m_b\ddot{x}_{b2}(t) = F_{pto2}(t) + F_{spr2}(t) \\
m_b\ddot{x}_{b3}(t) = F_{pto3}(t) + F_{spr3}(t) \\
I_{bxx}\ddot{x}_{b4}(t) = M_{pto1}(t) + M_{spr1}(t) \\
I_{byy}\ddot{x}_{b5}(t) = M_{pto2}(t) + M_{spr2}(t) \\
I_{bzz}\ddot{x}_{b6}(t)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

Time-domain implementation: NO PTOs

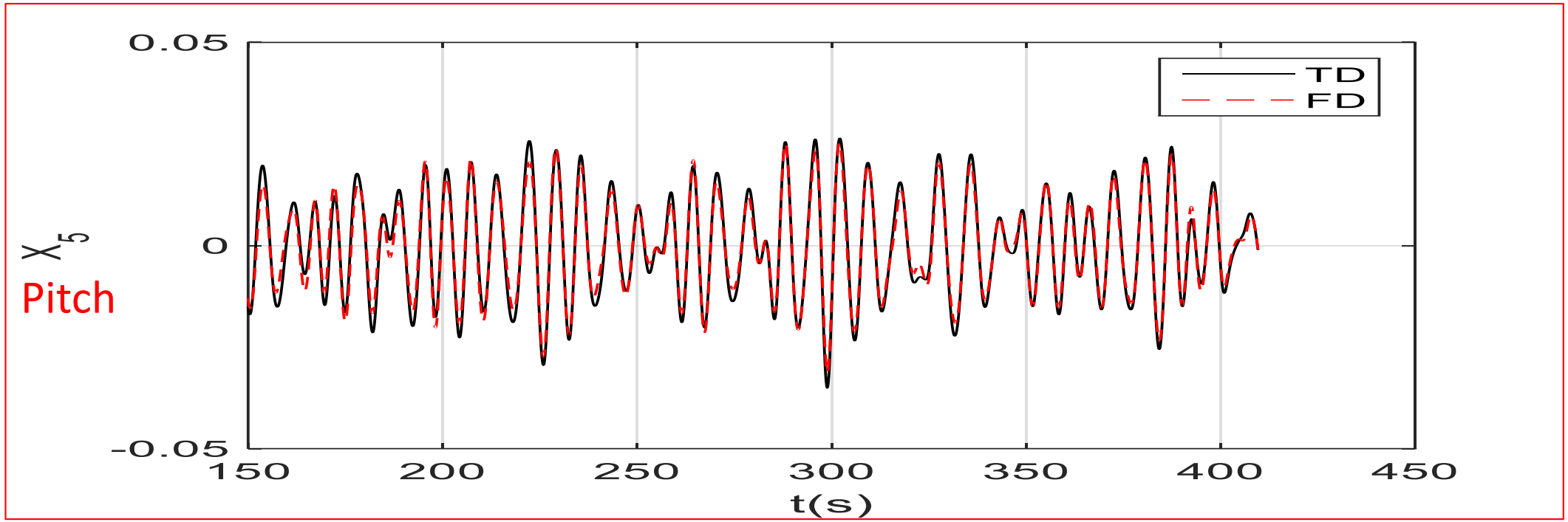
Surge



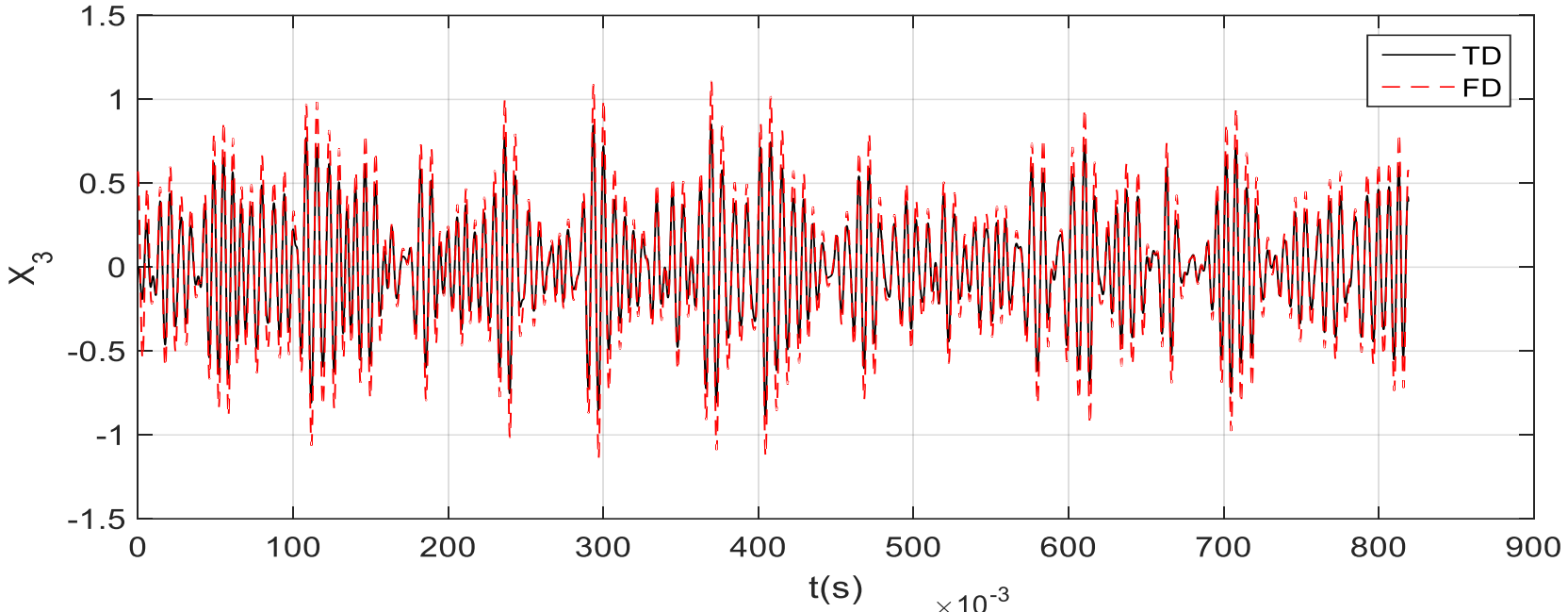
Heave



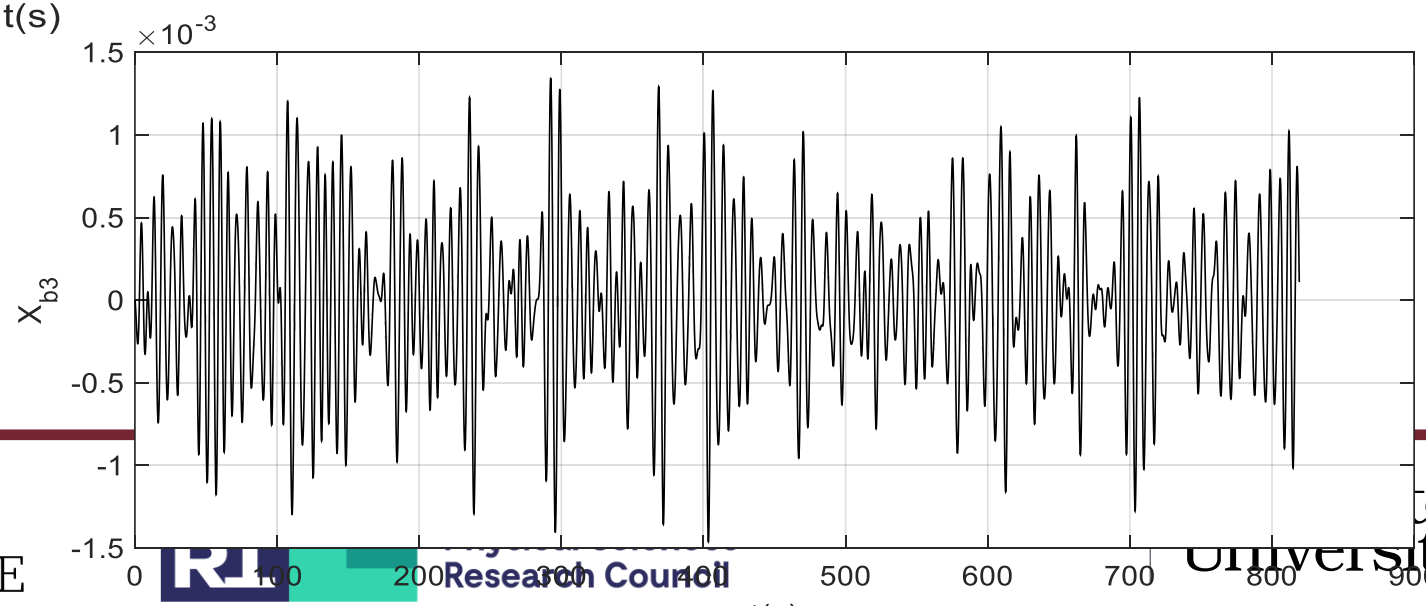
Time-domain implementation: NO PTOs



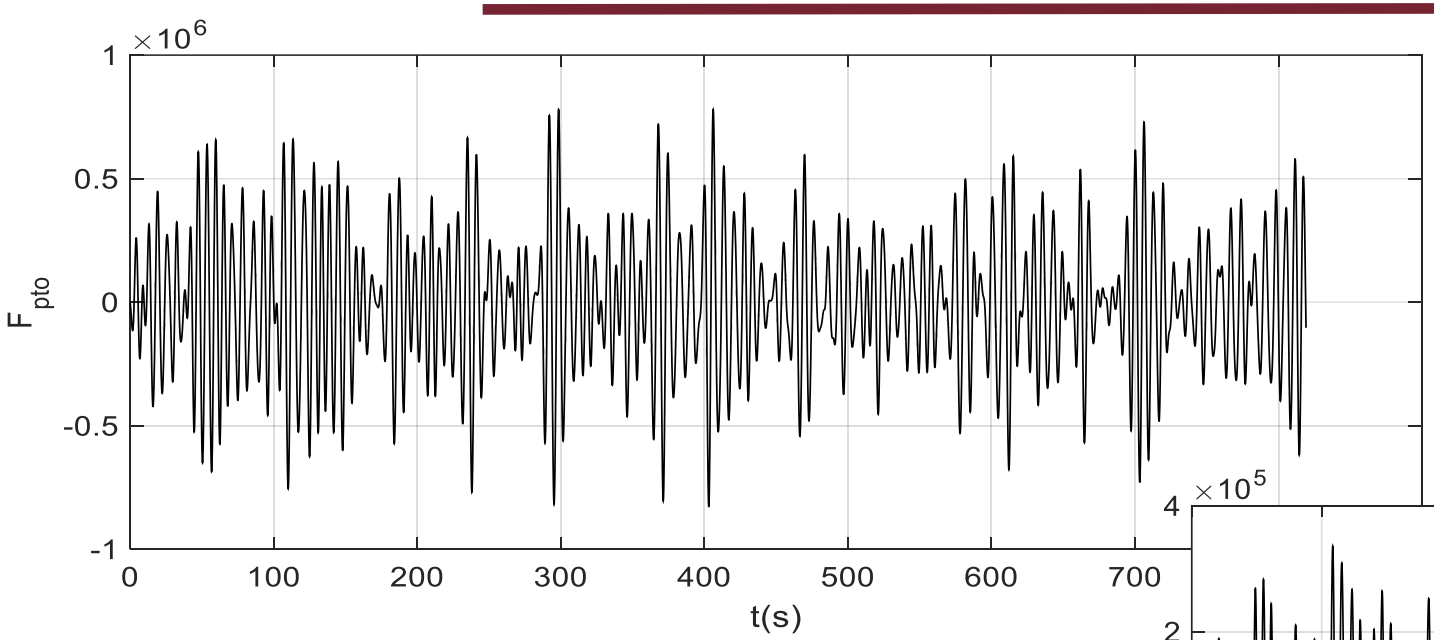
Time-domain implementation with PTOs

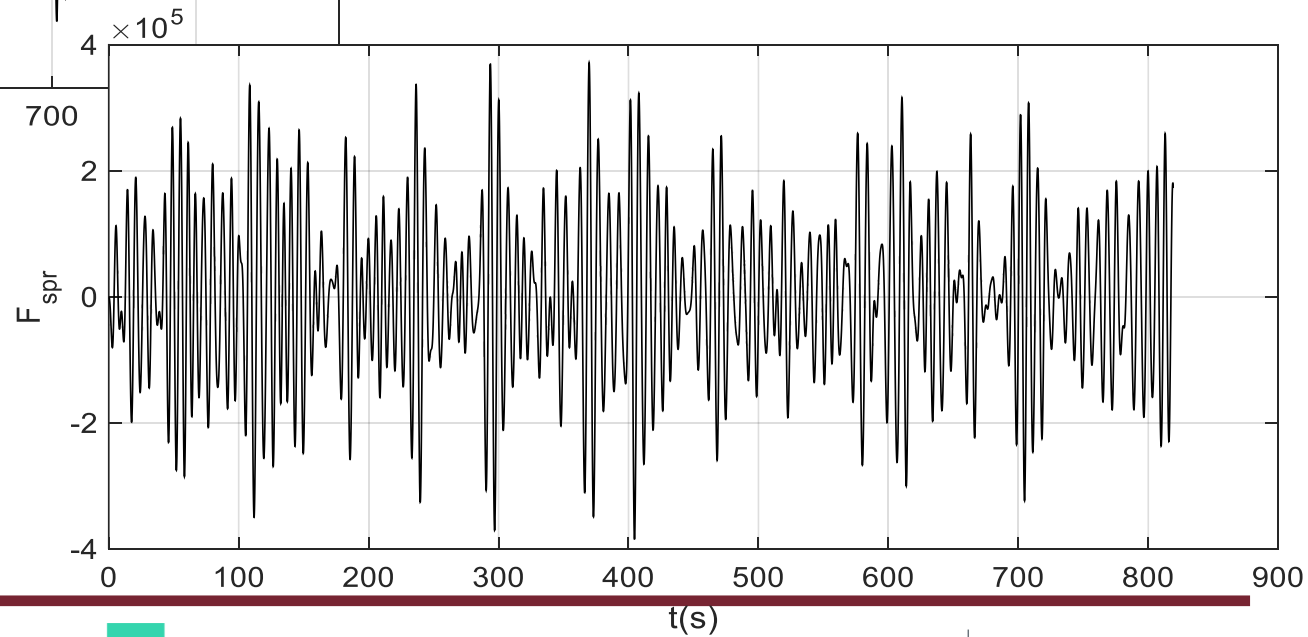


Wave:
Hs=2.0m, Tp=8.5s

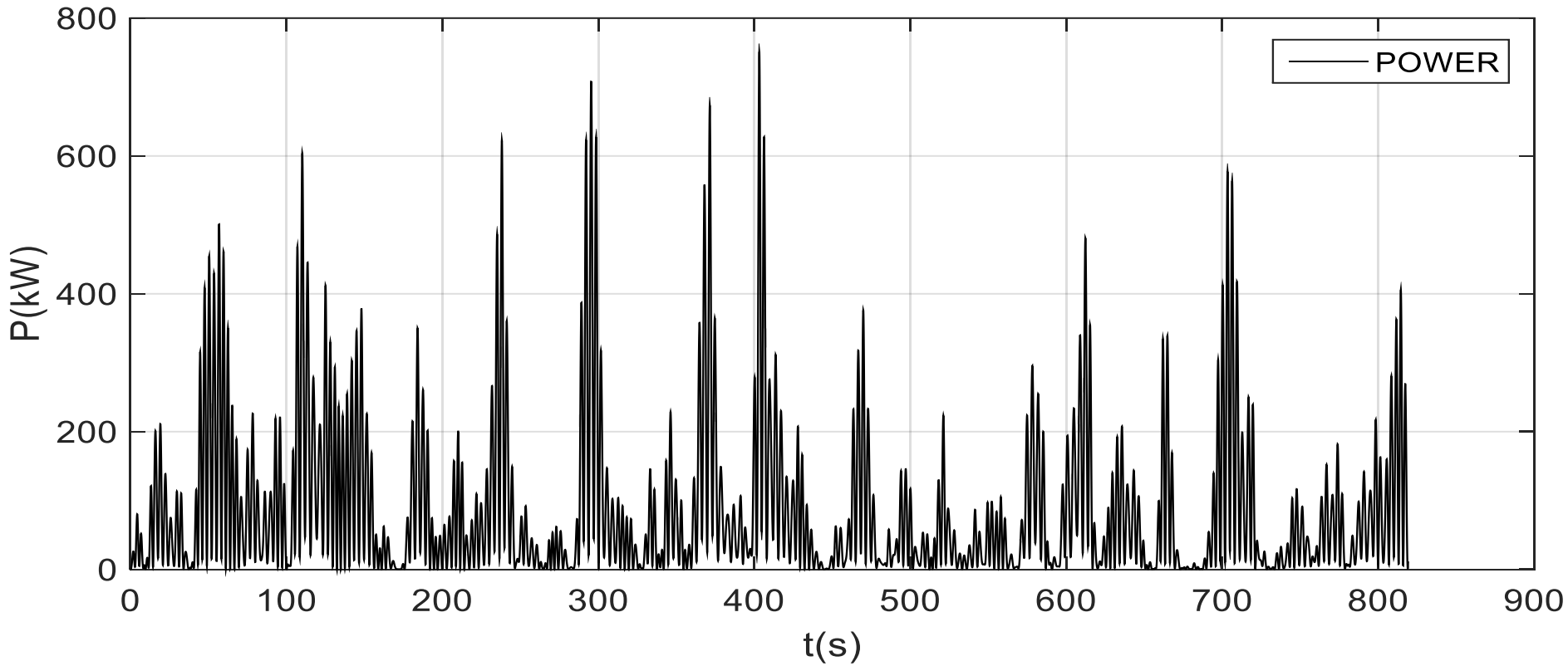


Time-domain implementation with PTOs





Time-domain implementation with PTOs



Future work

- Optimisation of the TALOS structure
- Optimisation of the PTOs and springs
- Model and PTO design and test in wave tanks
- Work with WP2: to provide information for control study
- Work with WP3: to examine the yearly outputs of energy extraction by TALOS
- Work with WP4: to validate and study the cost of energy…
- Paper preparations: (hydrodynamics studies; implementation of TALOS WEC etc)
- And more…