

Wavebox: A novel framework for floater modelling in accelerated frames

XI Marine Energy Conference

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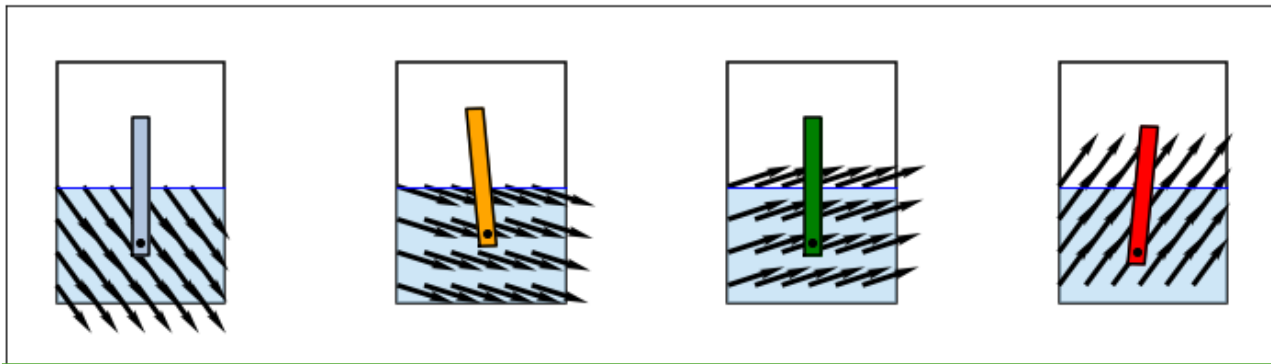
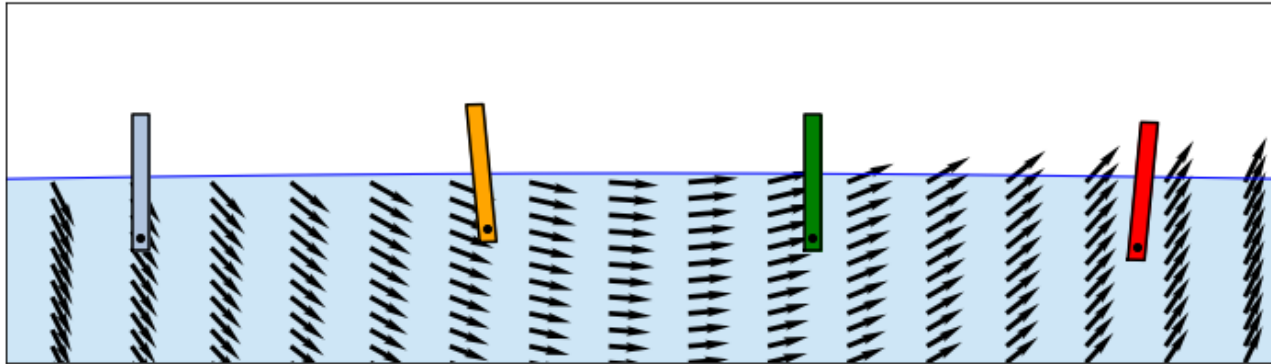
General objectives

Develop and test a working prototype, and a validated numerical simulation framework

Assess the viability and applicability of the Wavebox concept:

- Which **types of floaters** can it realistically represent?
- Under **what dynamic regimes** (e.g., heave, surge, orbital motion) is it accurate?
- Can **sloshing be partially mitigated** using **porous foams**, at least in the central region of the tank?
- ¿What is the fidelity achieved using this method compared to a wave tank?

The Wavebox Concept: Mimicking Wave Forces via Tank Motion



Idealized dynamic equivalence of the Wavebox concept and a wave tank.

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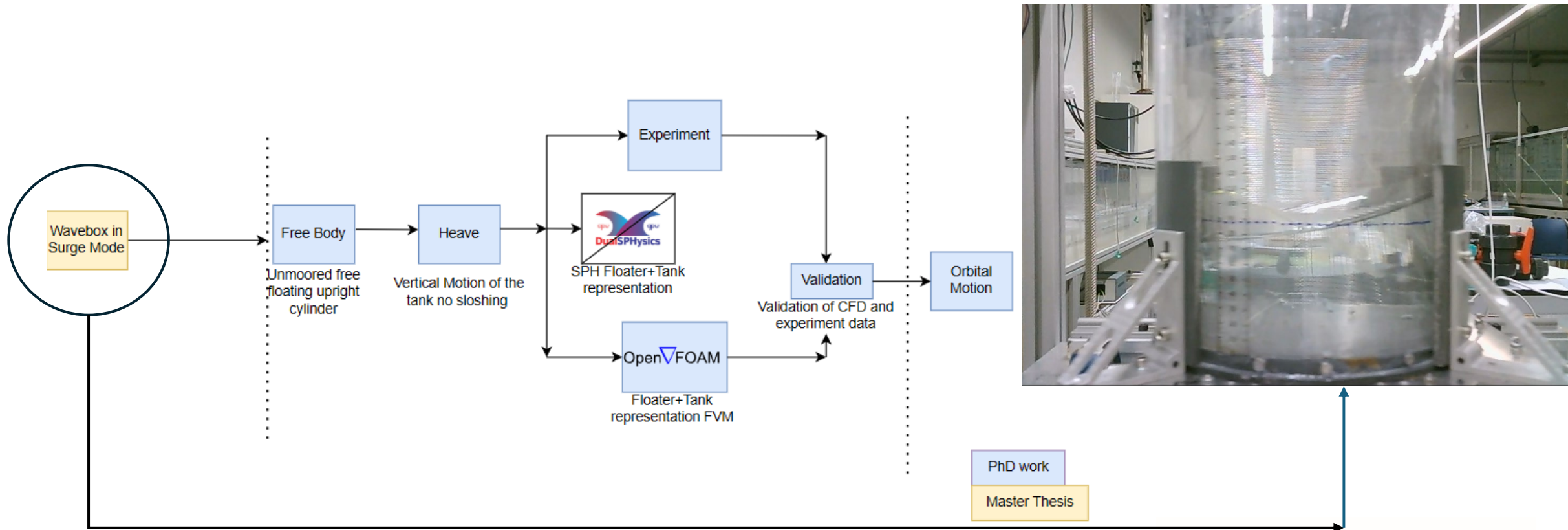
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Illustration of the wavebox concept. It allows us to study floater dynamics without using large wave tanks, by generating equivalent fluid forces through acceleration of the container.

At the **top**: we can see a floater excited by a wave of long period and wavelength.

At the **bottom**: A floater is excited by the relative motion of the tank and the floater, generating a dynamic equivalence (if slosh is assumed non dominant!)

PhD timeline and change of route



Wavebox operation in heave mode



Expected heave response done by openFOAM simulation. As expected in heave there is no slosh response.

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Tank and attachments for the experiments in heave mode.

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Joint collaboration with Uppsala University: Technical Visit and Experimental Planning

- A collaboration with the electrical engineering department at the **Uppsala university** was done for the experimental testing with the Wavebox concept.
- We worked extensively in heave mode.
- As a result of this to continue in the orbital trajectory, I traveled to check with the team and to discuss the new experiments.

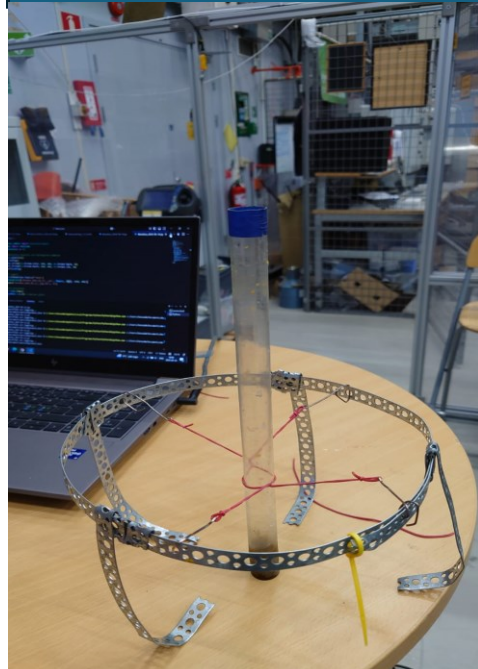


ABB robot used for the experimental testing.

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Joint Tests at Uppsala University: Mooring and Dissipation Effects



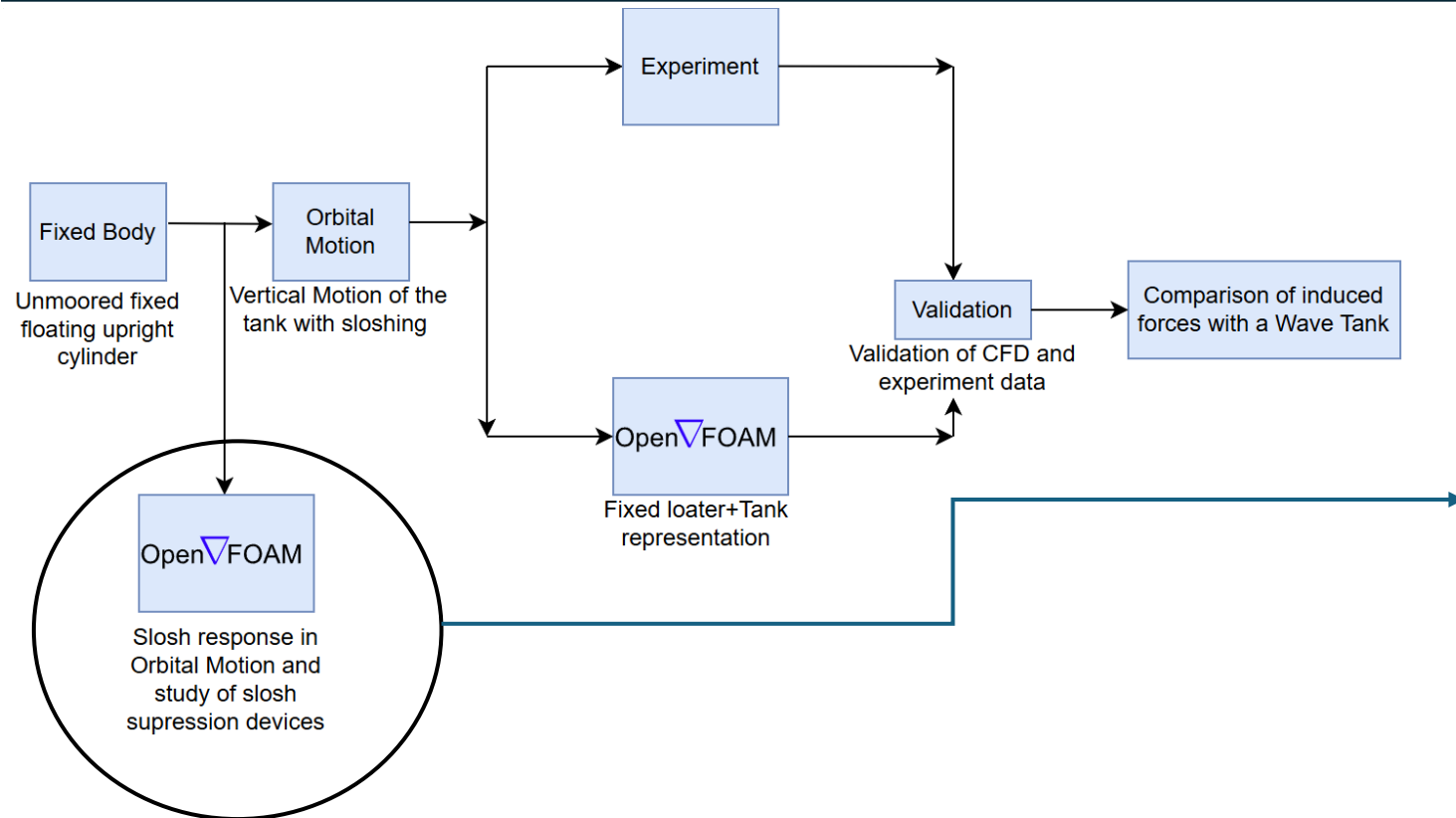
Initial prototype to check the feasibility of a mooring system.



Sloshing becomes dominant with no porous mesh specially at the first second due to sudden acceleration.

- We tested a **mooring** to the floater center of mass.
- **Porous dissipation was also tested.**
- Visiting the university in person allows for fast prototyping and **checking if the experimental setup is adequate.**

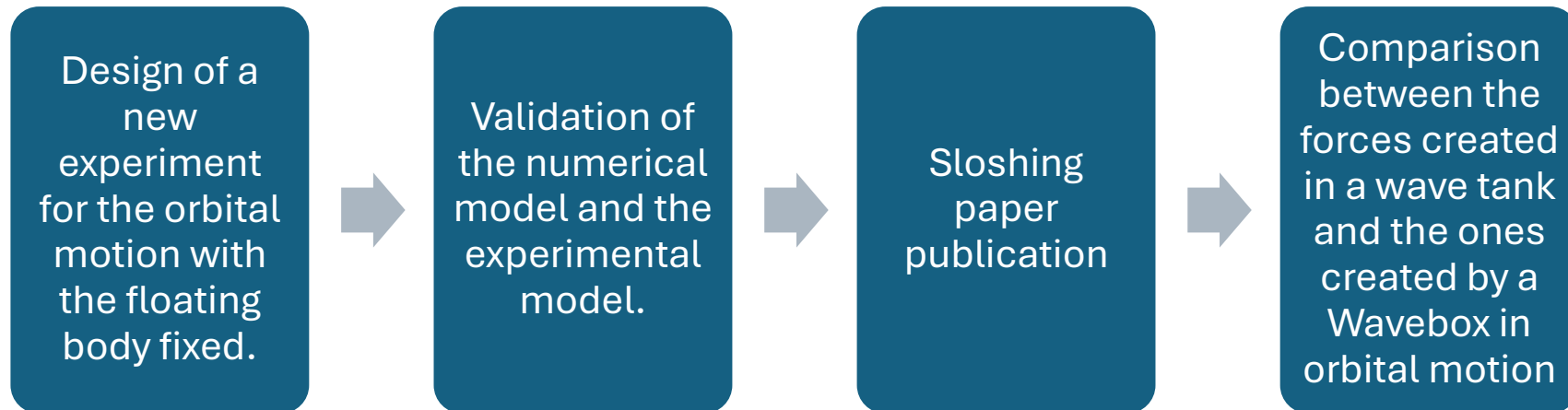
Present Roadmap



Sloshing response for a lightly damped orbital trajectory.



Next Steps



Publications

- Experimental and numerical investigation of a Wavebox system in heave mode I. Zárate, D. Salar, J. Berque, E. Hultman, J. M. Blanco and I. Mendikoa (EWTEC 2025-MADEIRA)
- A new type of wave tank: prototype and proof of concept J. Berque, I. Zárate, J. M. Blanco, I. Bidaguren, I. Touzon, J. M. Blanco and L. Fernández (EWTEC 2023-Bilbao).
- Oncoming publication of Sloshing categorization for heave, surge, combined DOF (Orbital Motion) and slosh suppression mechanisms .