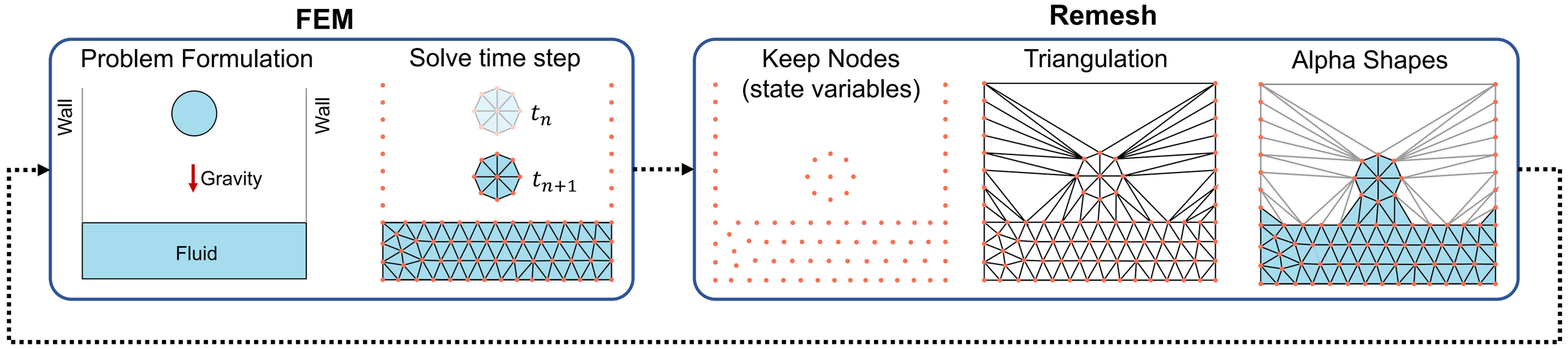
Numerical simulation of sloshing using the particle finite element method

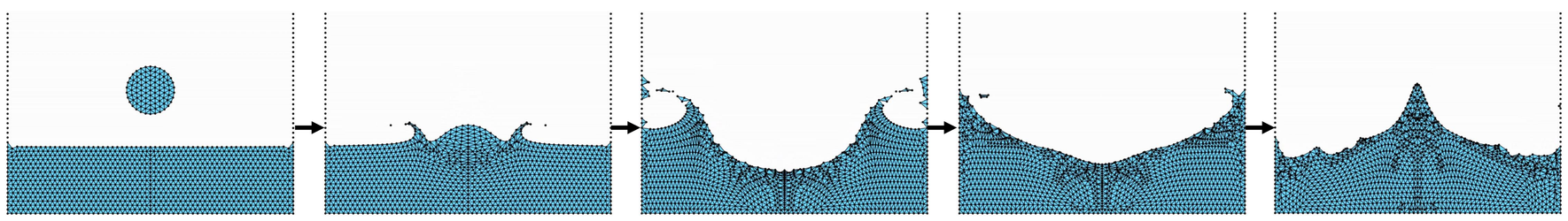
Eduardo Fernández, Simon Février, Martin Lacroix, Dorian Bogucki & Jean-Philippe Ponthot

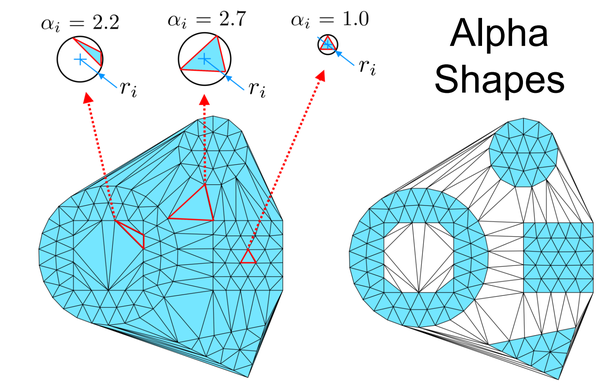
Aerospace and Mechanical Engineering Department
Computational Non-Linear Mechanics Laboratory (LTAS-MN2L)

1. The Particle Finite Element Method (PFEM) = FEM + Remesh



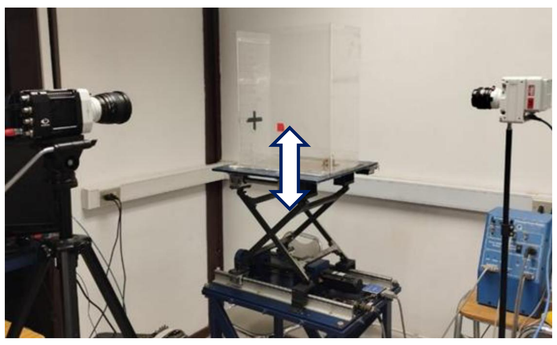
PFEM simulation

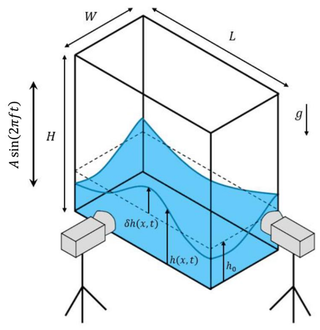




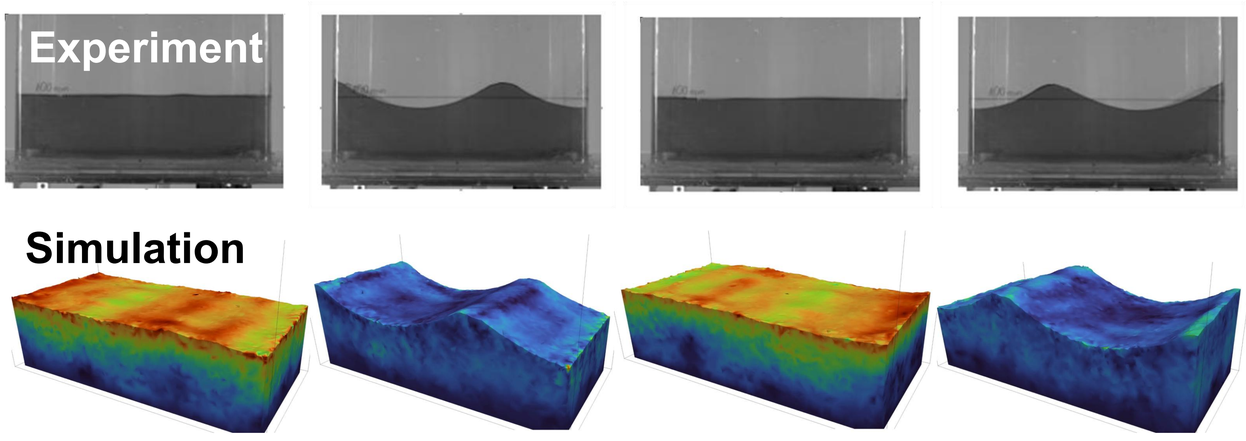
2. Validation for sloshing simulation

Experimental setup for sloshing resulting from vertical displacements



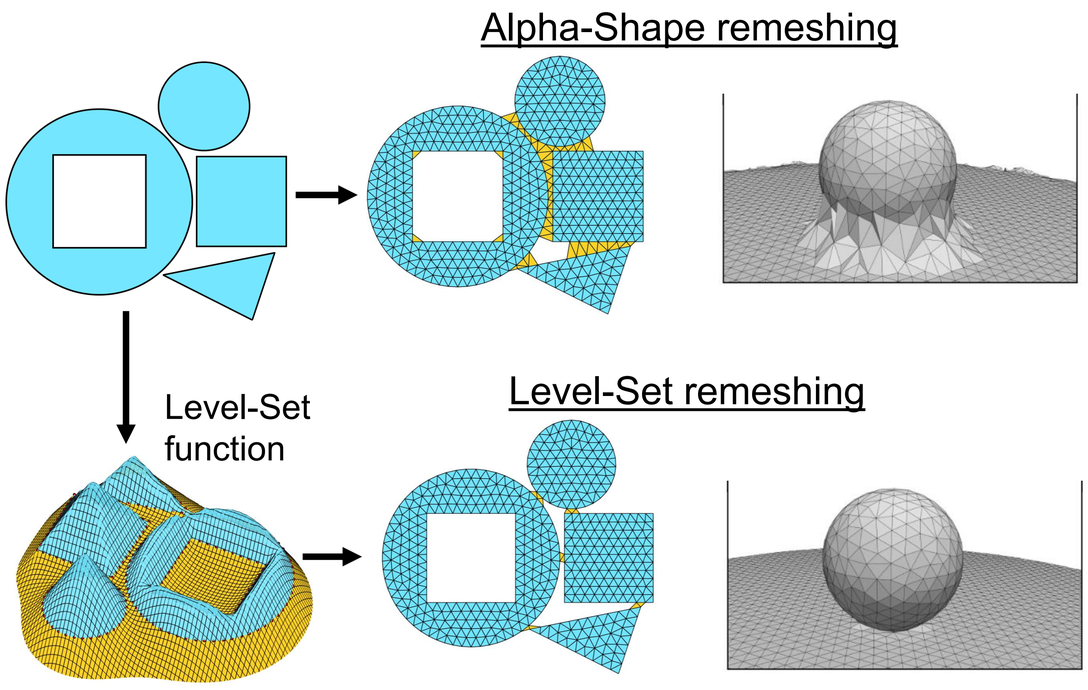


(Experiments conducted at the University of Santiago de Chile (USACH) by Oscar Gonzalez and Marcela Cruchaga)



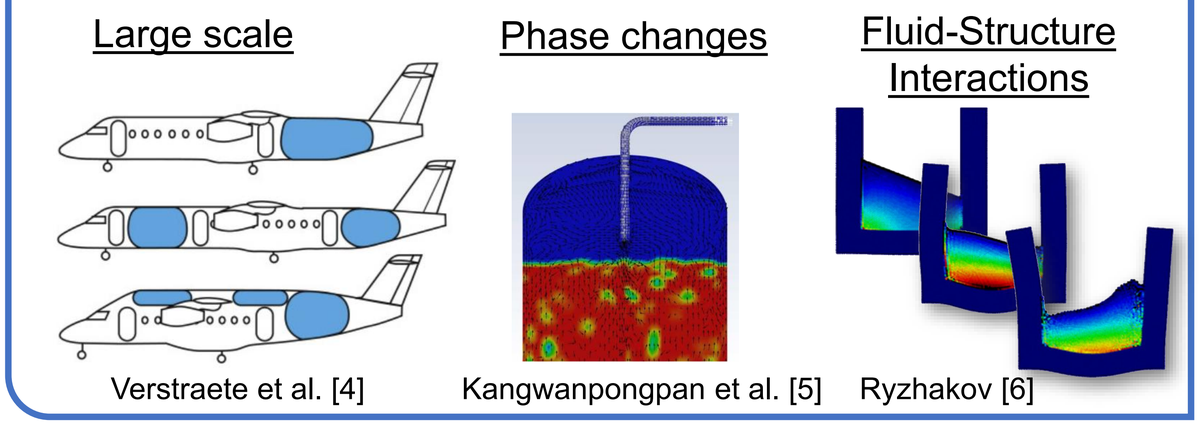
Submitted manuscript : Gonzalez O, Cruchaga M, Fernández E, Lacroix M, Ponthot JP & Celentano D. **Experimental validation of a PFEM framework for modeling up-down sloshing problems in rectangular tanks**. International Journal of Numerical Methods for Heat and Fluid Flow.

3. Mass conservation improvement



To be Submitted : Lacroix M, Fernández E, Simon Février, Luc Papeleux, Romain Boman, Ponthot JP. **A level-set based mesh adaptation for the particle finite element method**. CMAME.

4. Perspectives



References

[1] Idelsohn SR, Oñate E, & Pin FD (2004). The particle finite element method: a powerful tool to solve incompressible flows with free-surfaces and breaking waves. *IJNME*, *61*(7), 964-989.
[2] Fernández E, Février S, Lacroix M, Boman R, Papeleux L, & Ponthot JP (2023). A particle finite element method based on Level–Set functions. *JCP*, *487*, 112187.
[3] Cerquaglia ML, Thomas D, Boman R, Terrapon V, & Ponthot JP (2019). A fully partitioned Lagrangian framework for FSI problems characterized by free surfaces, large solid deformations and displacements, and strong added-mass effects. *CMAME*, *348*, 409-442.
[4] Verstraete D, Hendrick P, Pilidis P, & Ramsden K (2010). Hydrogen fuel tanks for subsonic transport aircraft. International journal of hydrogen energy, 35(20), 11085-11098.
[5] Kangwanpongpan T, Makarov D, Cirrone D, & Molkov V (2024). LES model of flash-boiling and pressure recovery phenomena during release from large-scale pressurised liquid hydrogen storage tank. IJHE, 50, 390-405.,
[6] Ryzhakov, P. (2017). A modified fractional step method for fluid–structure interaction problems. Revista internacional de métodos numéricos para cálculo y diseño en ingeniería, 33(1-2), 58-64.