SHIXDOF-AQUAgpusph

SHIXDOF-AQUAgpusph: nonlinear coupled ship motions and sloshing in free surface tanks

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Introduction

- Main goal: Ship motions computation (SHIXDOF)

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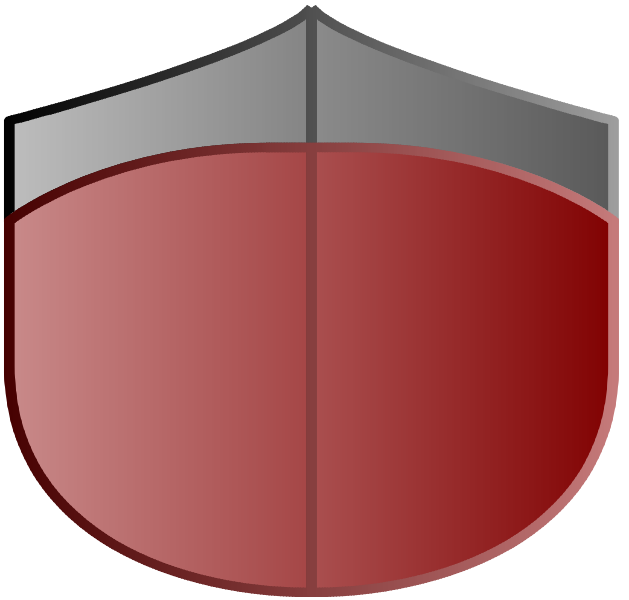
  1)Ship as rigid body



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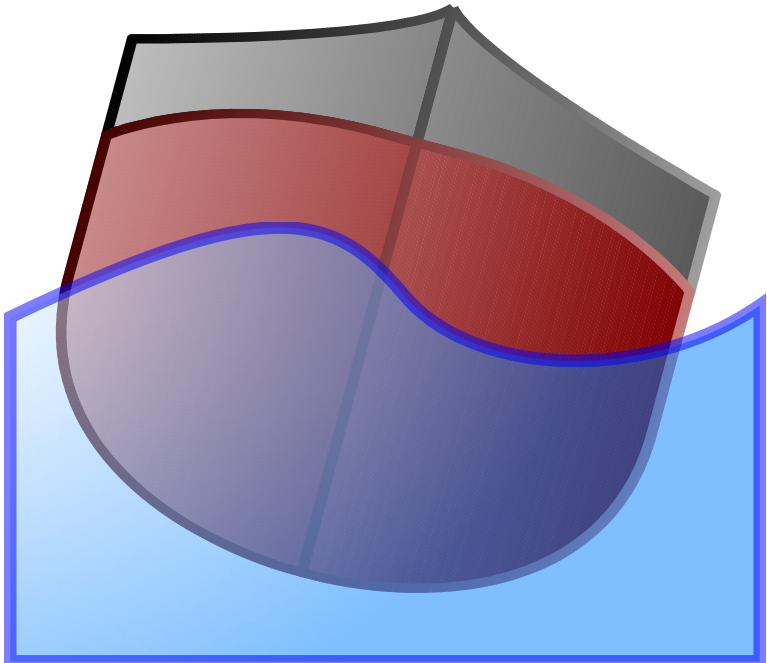
  2)Hydrodynamic forces



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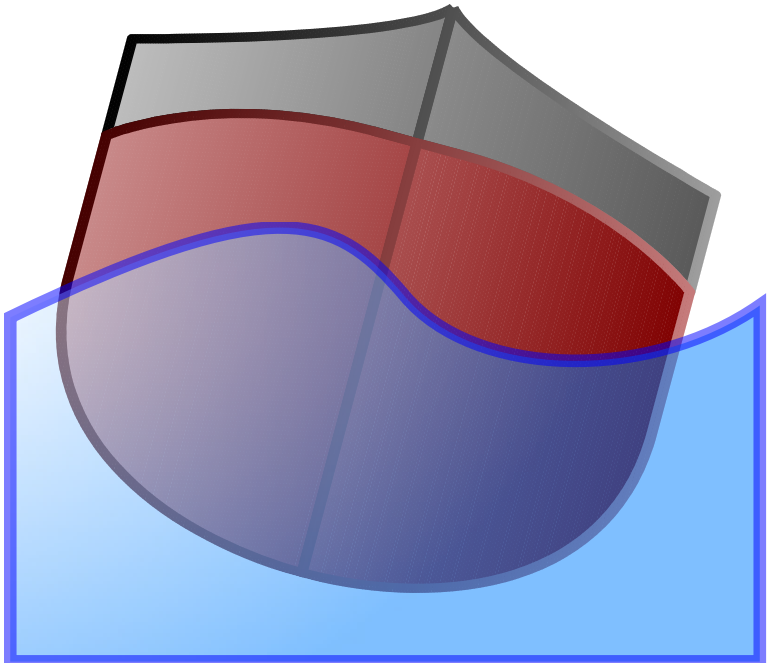
  - Linear models
  - **Non-linear models**



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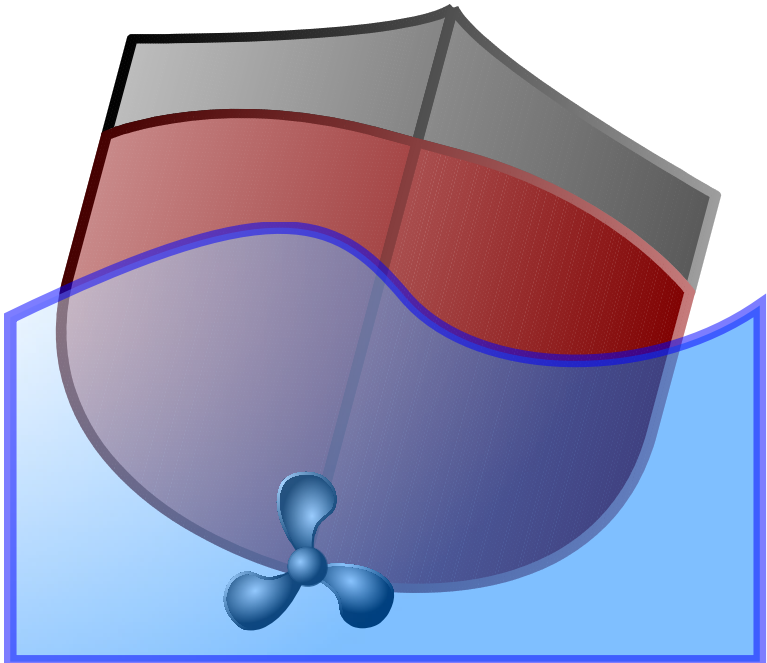
  3)Propulsion and manouvering



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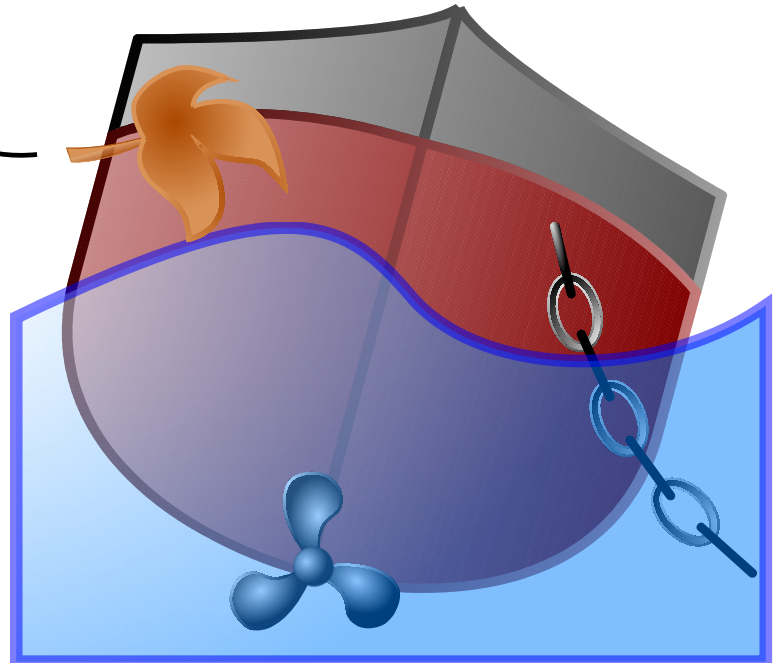

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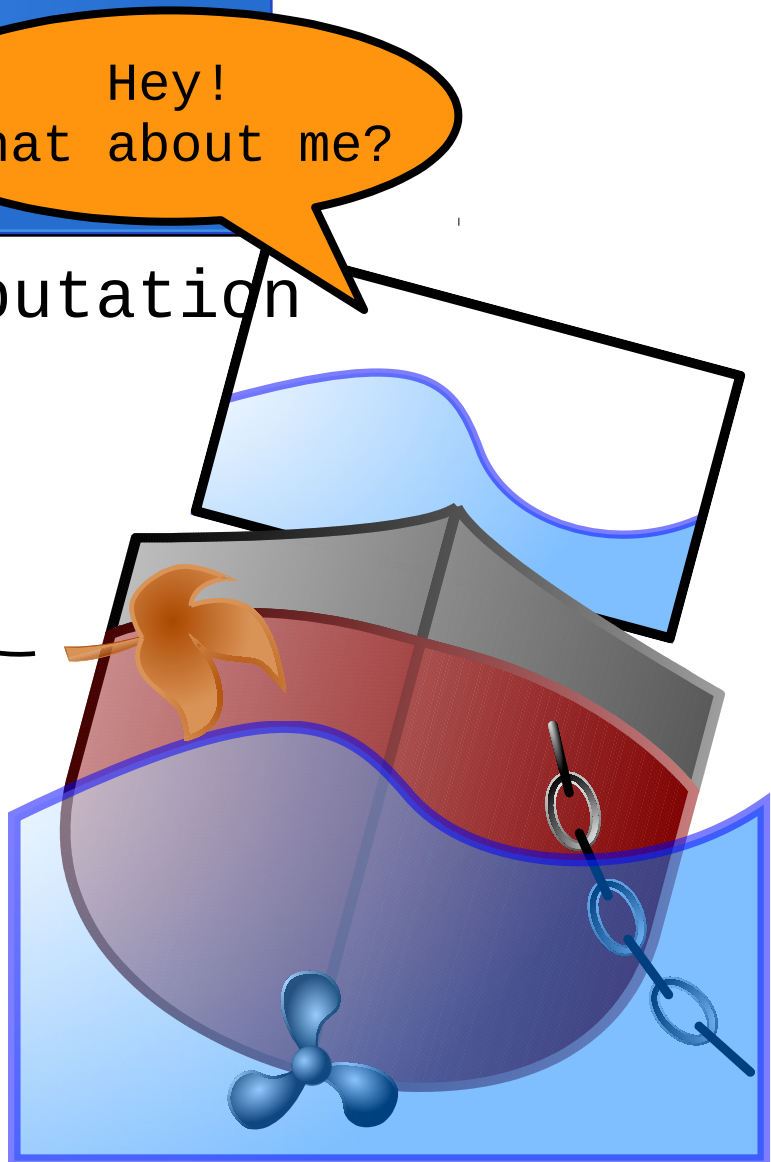

Introduction

- Industrial applications:
  - LNG transport filling levels definition
  - Supply vessels equipped with anti-roll tanks operational windows
  - Load/unload and installation of ROVs
  - Risers, piping, open sea transfer of liquid cargo...

Existing approaches

- Linear ship motions + non-linear sloshing
  - Kim et al. (2007), Bunnik and Veldman (2010), Zhao et al. (2014)
- Non-linear ship motions + linear sloshing
  - Francescutto et al. (1999), Neves et al. (2009), Holden et al. (2012)
- Non-linear ship motions and sloshing
  - Hashimoto et al. (2012), Mitra et al. (2012)

Existing approaches

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  - Fr… …), Holden e… …(2012)
- Non-linea… ship motions and sl…shing
  - Hashimoto et al. (2012), Mitra et al. (2012)

MPS

FEM

Existing approaches

- Already existing approaches require solving a linear system of equations for the tanks internal flow computation.
- **Performance is a critical point in this application.**
- Let's try to use WC-SPH!

Implementation

- Grid computing paradigm: collection of computer resources from multiple locations to reach a common **goal**.
  - Different platforms/architectures
  - Different facilities
  - One single ship, several tanks

Implementation

- Grid computing paradigm: collection of computer resources from multiple locations to reach a common **goal**.
  - Different platforms/architectures
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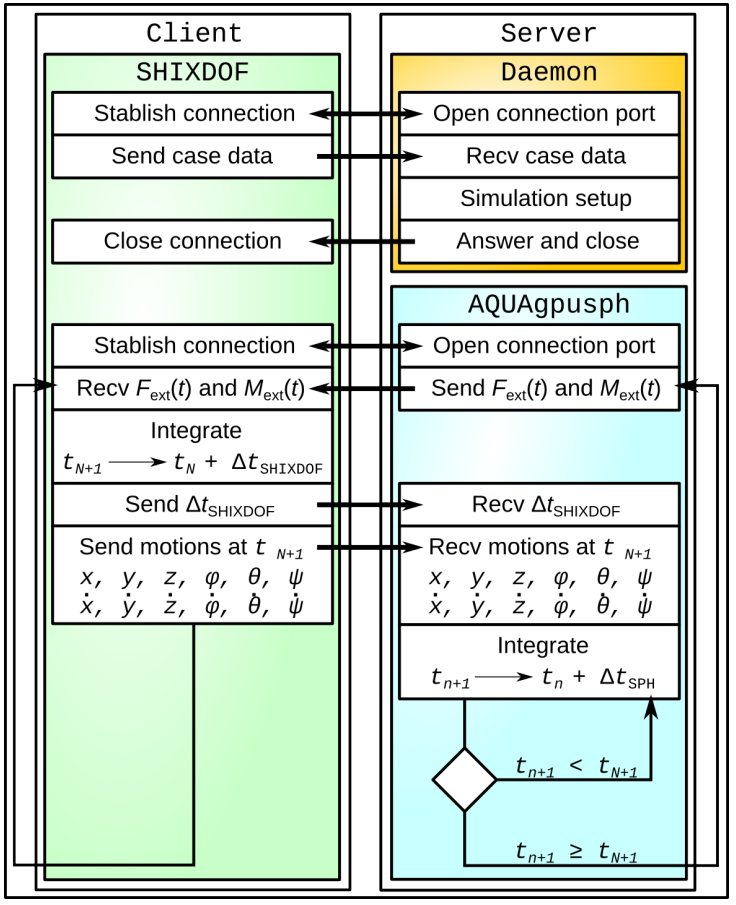
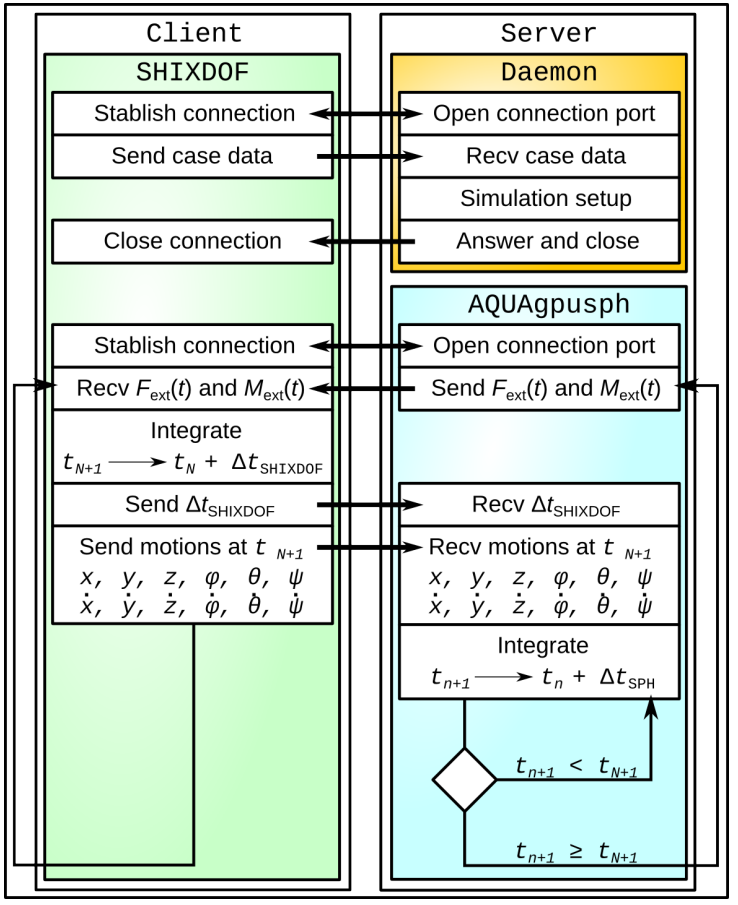
  - One single ship, several tanks
- Client-Server system should be implemented.

Implementation



Implementation



Initialization stage

Simulation stage

Initialization

- The daemon has 3 main tasks:
  - Kill the zombie simulations
  - Receive the initial condition
  - Launch AQUAgpusph

Simulation

Simulation

Forces

Simulation

$\Delta t_{SHIXDOF}$

Catenaccio

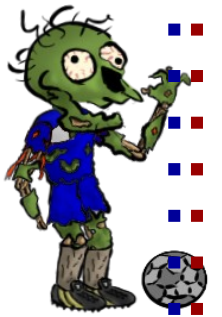
Simulation

Motions
($t_{SPH} + \Delta t_{SHIXDOF}$)

Simulation

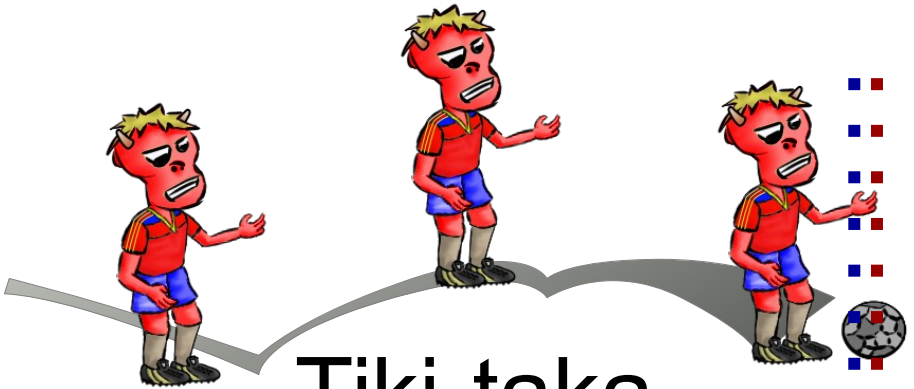
Δt_{SPH}

Simulation



They may not finish at the same time instant

Simulation



Tiki-taka

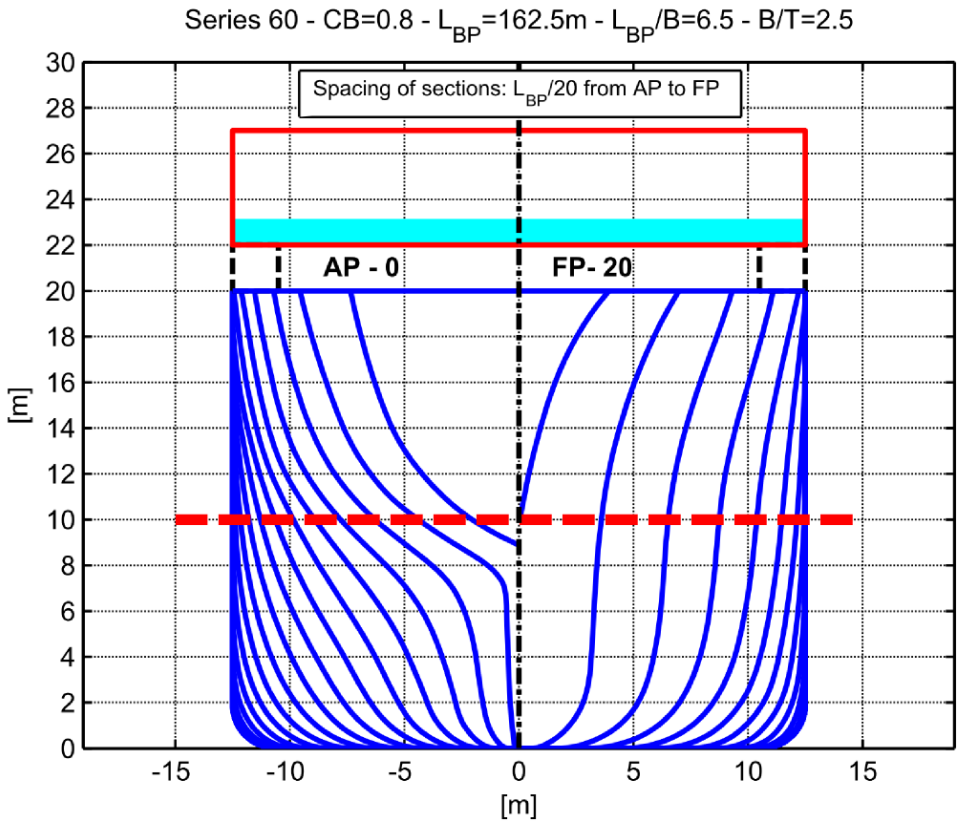
Catenaccio

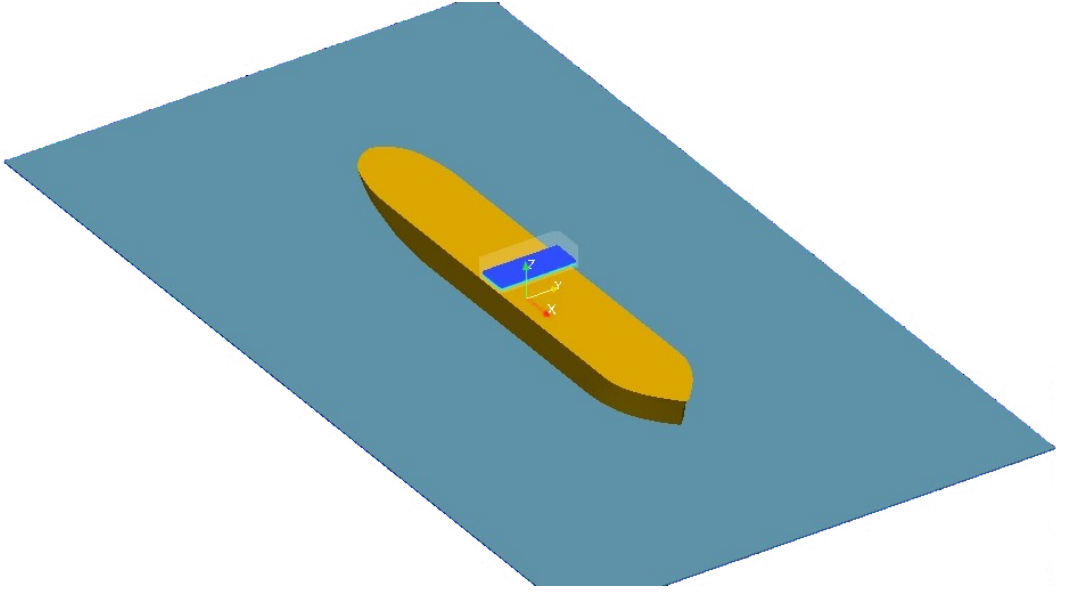
Simulation

Grid computing paradigm:
Collection of computer resources from multiple locations to reach a common **goal**.

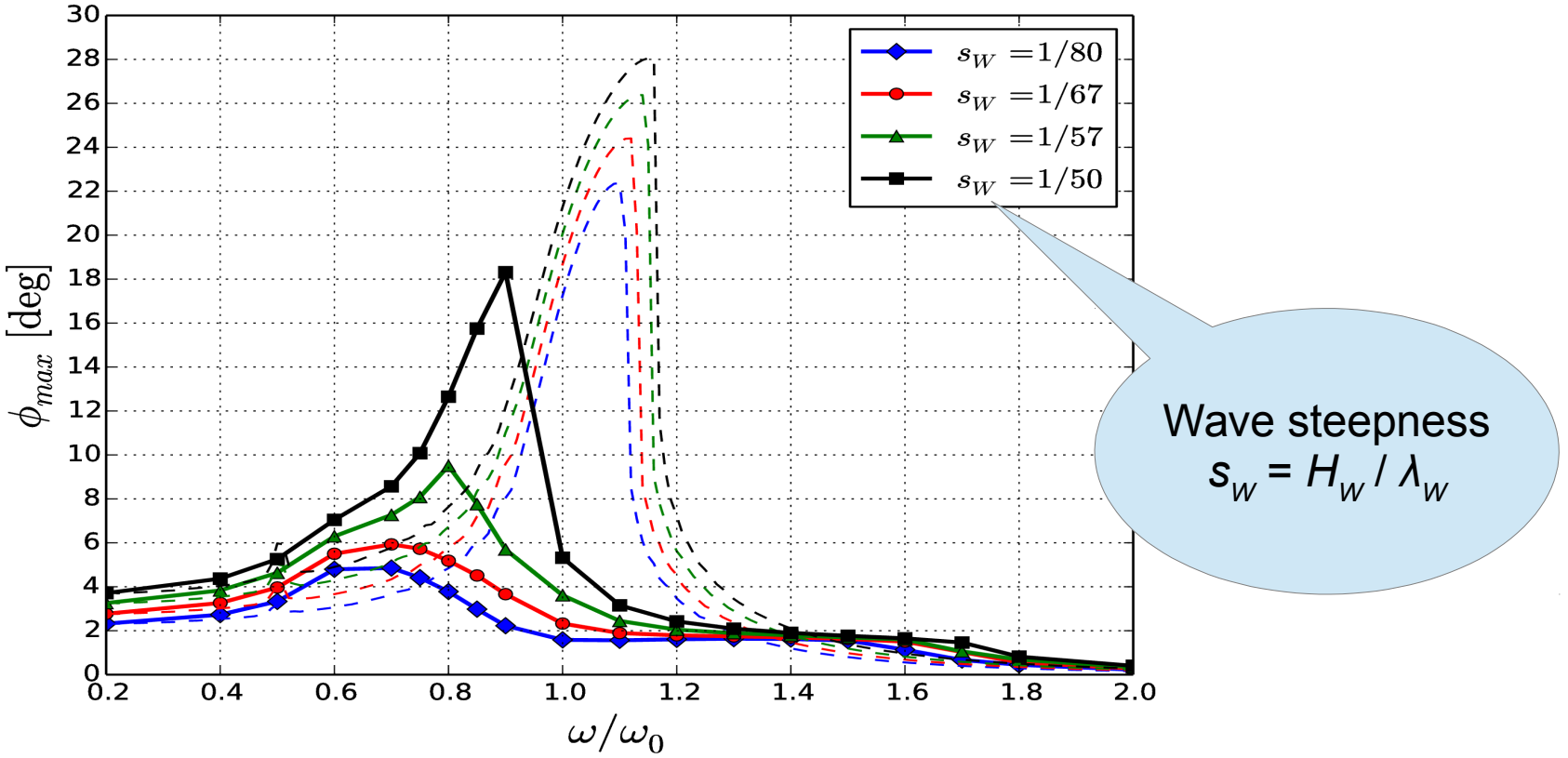
576 lines of Python code

Practical application



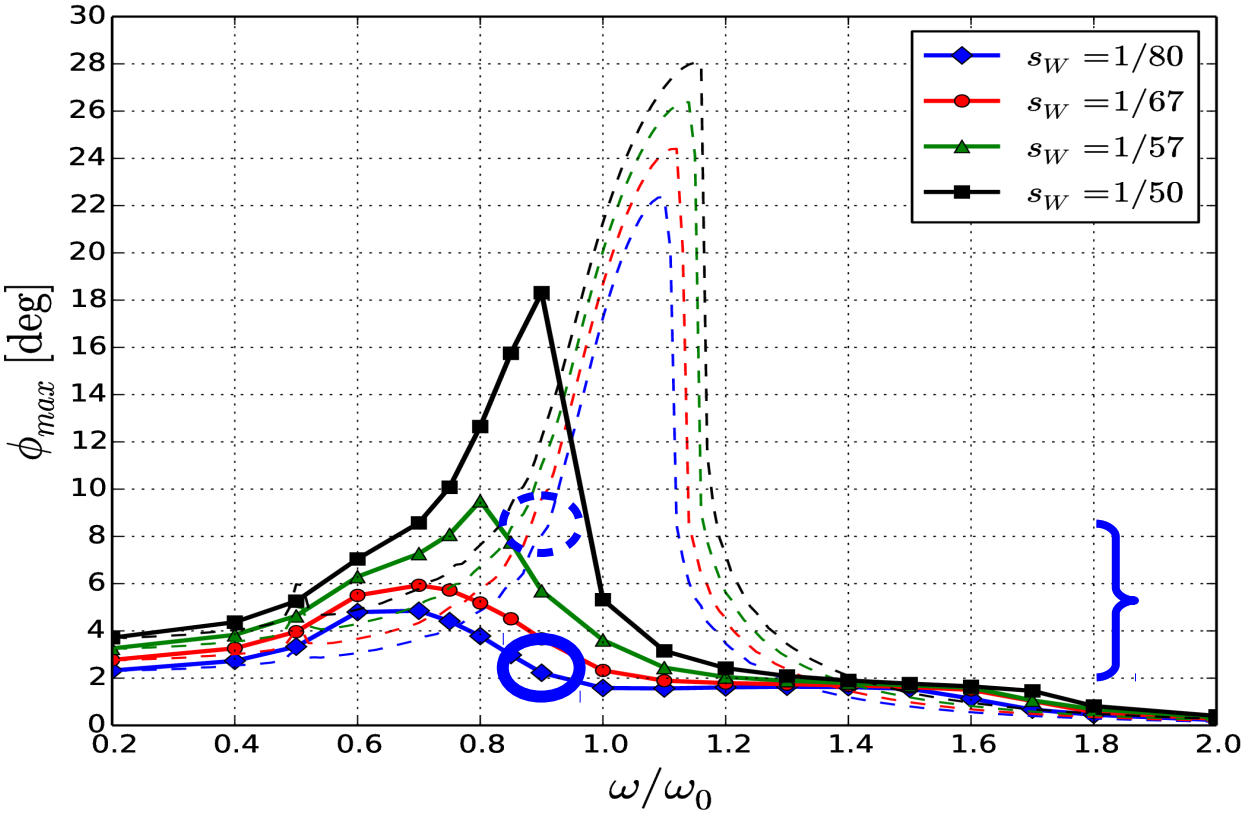


Practical application



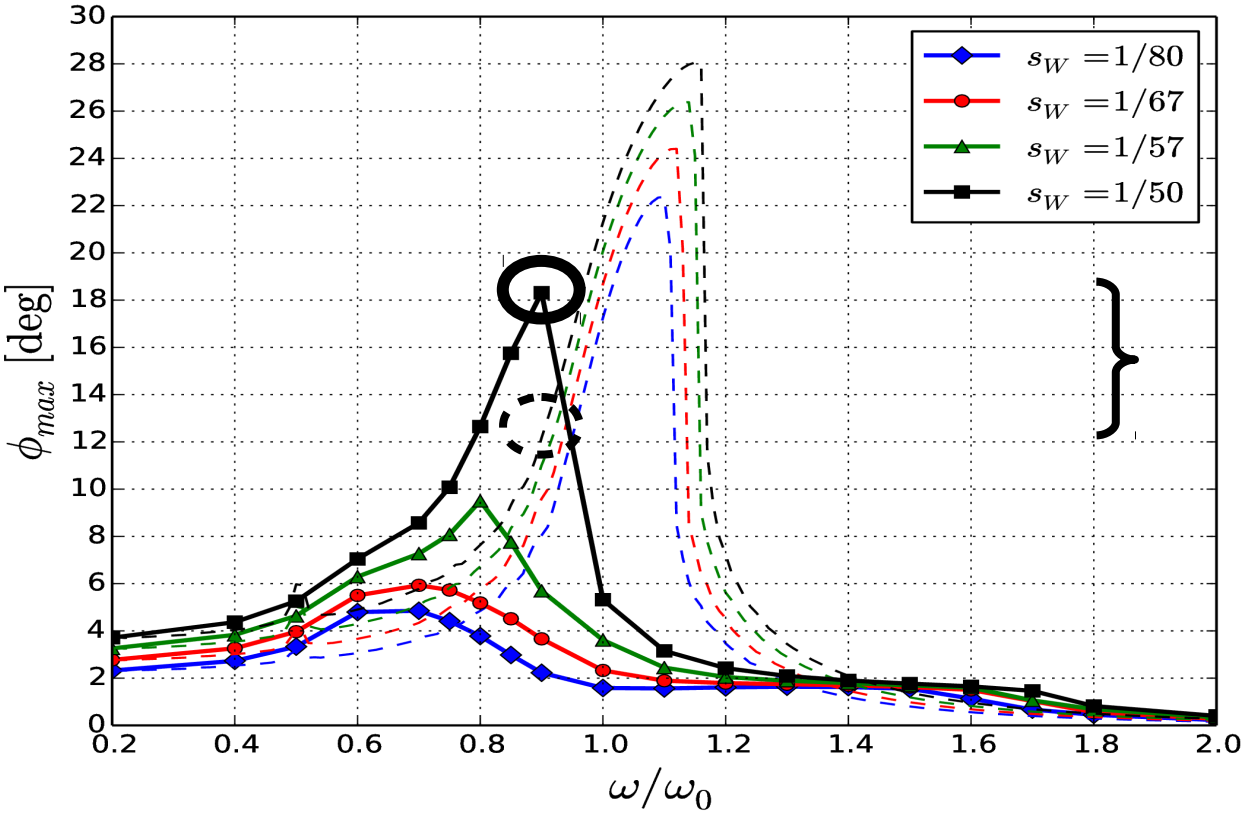
Wave steepness
$s_W = H_W / \lambda_W$

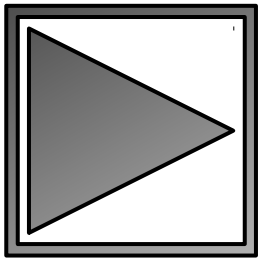
Practical application



~10^4 particles

Practical application





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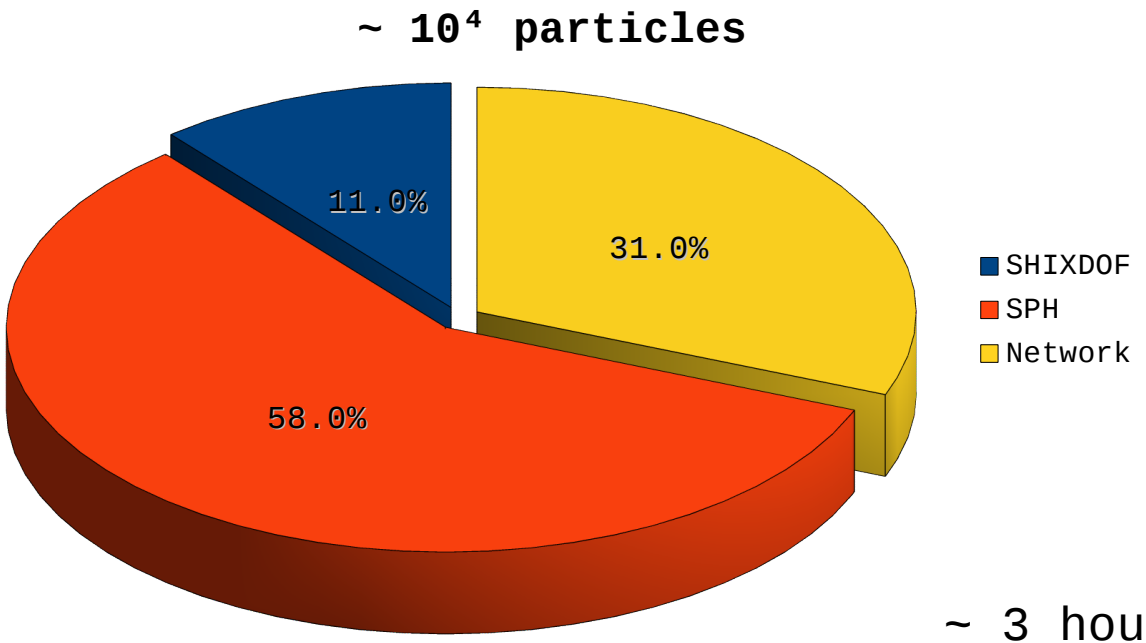

~ 3 hours

Conclusions

- A tool to perform nonlinear ship motion simulations, considering the coupling with the flow inside a tank, has been presented.
- The implementation, following the GRID computing paradigm, has been introduced.
- Results for a well known Series 60 hull geometry have been discussed.
- The global performance of the coupled system has been analysed, showing that it can be considered as a competitive alternative.

Future work

- Explicit time scheme ↔ Courant condition?
- Beowulf systems / clusters
- Optimization (e.g. traffic reduction)
- Multiple tanks
- **Experiments!**

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