Universität Rostock

Traditio et Innovatio

EMship+ Advanced Design

Self Propulsion CFD Calculations using the Continental Method

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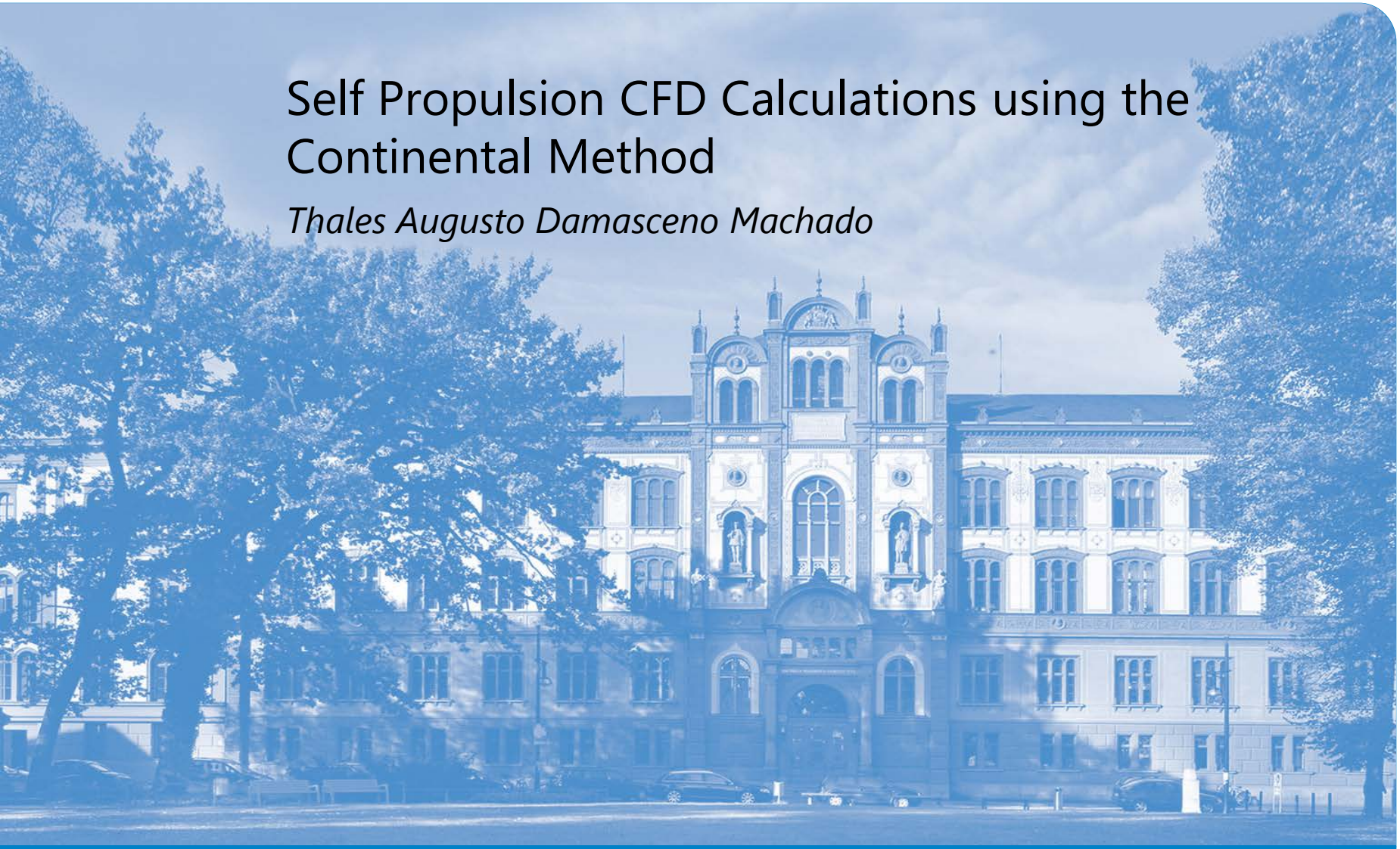


Goal

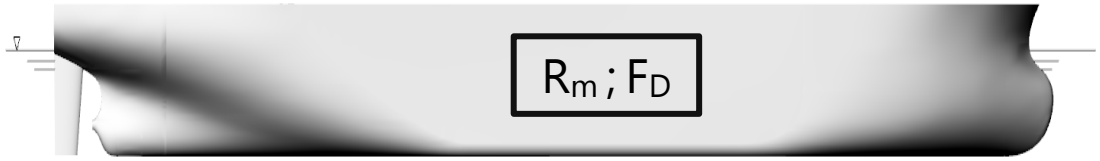
- To develop an alternative set up to estimate self-propulsion parameters (torque, thrust and propeller frequency) :
  - Potential reduction in computational effort;
  - Correct flow representation around hull and propeller.

Summary

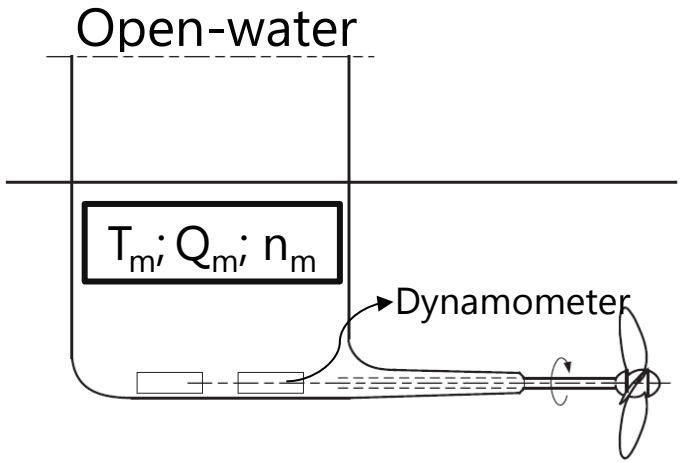
- Ship Powering
- Experimental self-propulsion methods
- RPM Controller
- Application to study case (KVLCC2)

Ship Powering

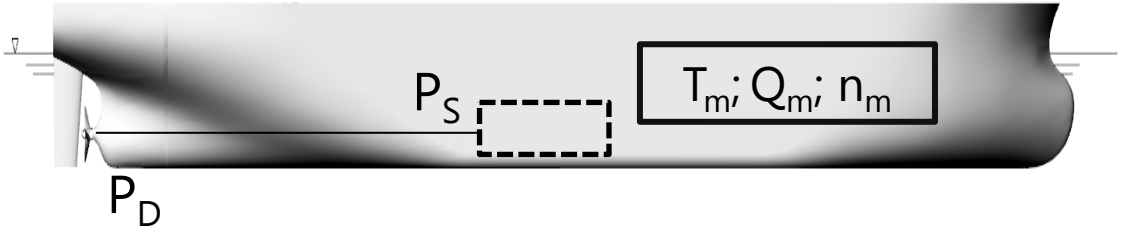
Naked resistance + appendages



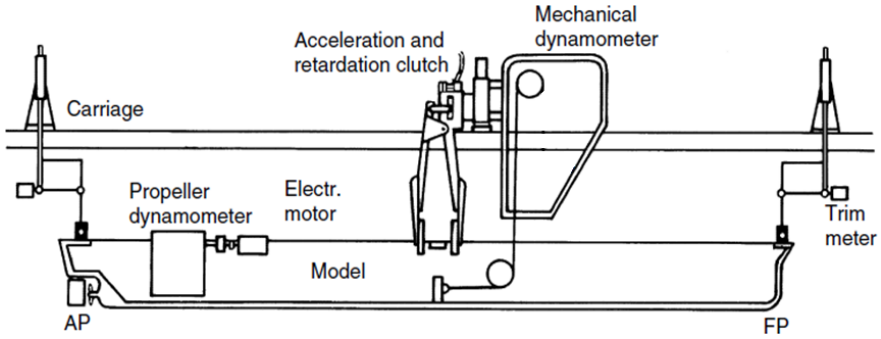
Open-water



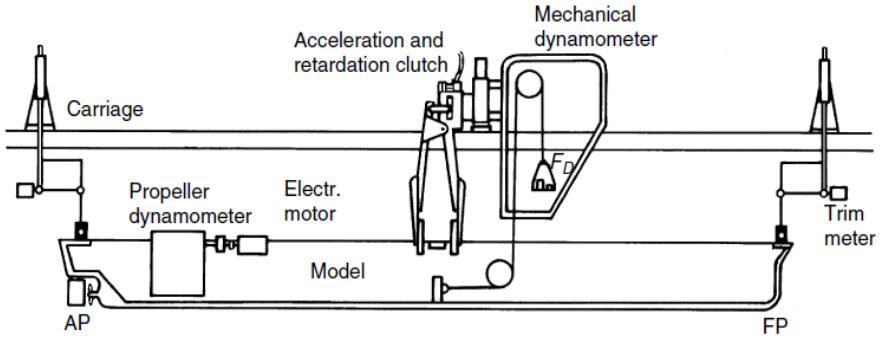
Self-propulsion



British x Continental method - Experimental



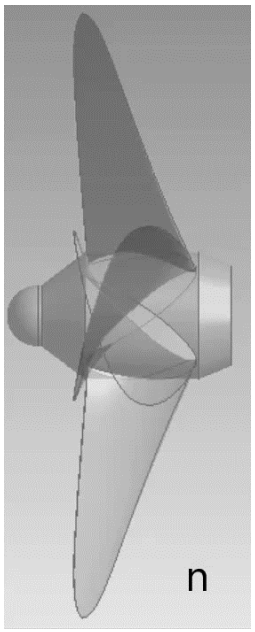
Test set-up for British method [1]



Test set-up for Continental method [1]

[1] - Bertram V. Practical Ship Hydrodynamics. Elsevier, 2012.

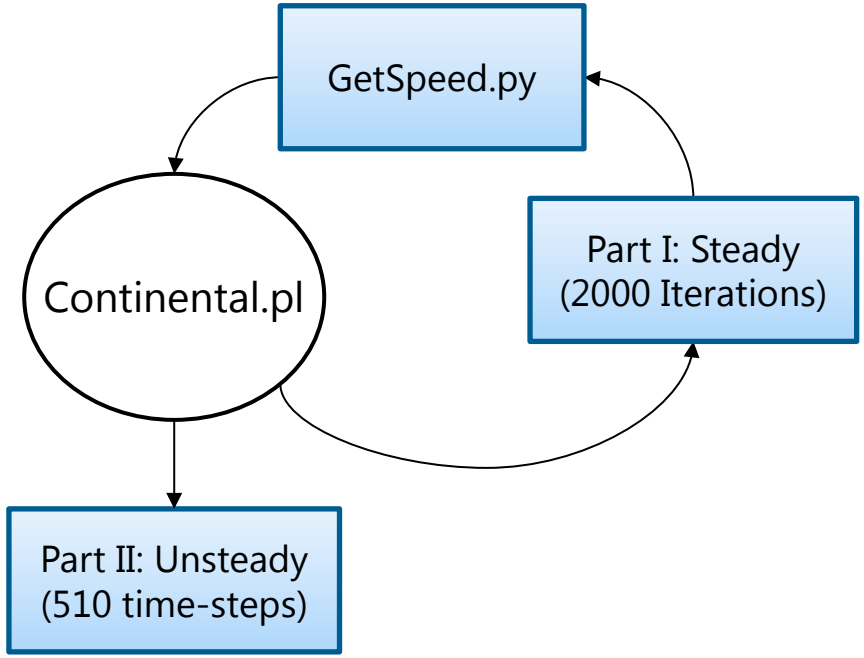
RPM Controller - Functionality



$$\Sigma F = \begin{cases} \Sigma F \leq 0\text{: } Thrust\ should\ increase & \uparrow n_{prop} \\ \Sigma F \geq 0\text{: } Thrust\ should\ decrease & \downarrow n_{prop} \end{cases}$$

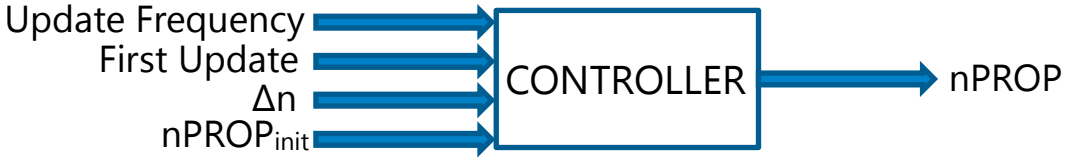
RPM Controller - Strategy

- 2 step-simulation
  - Part I : Steady with controller activated
  - Part II : Unsteady with controller deactivated

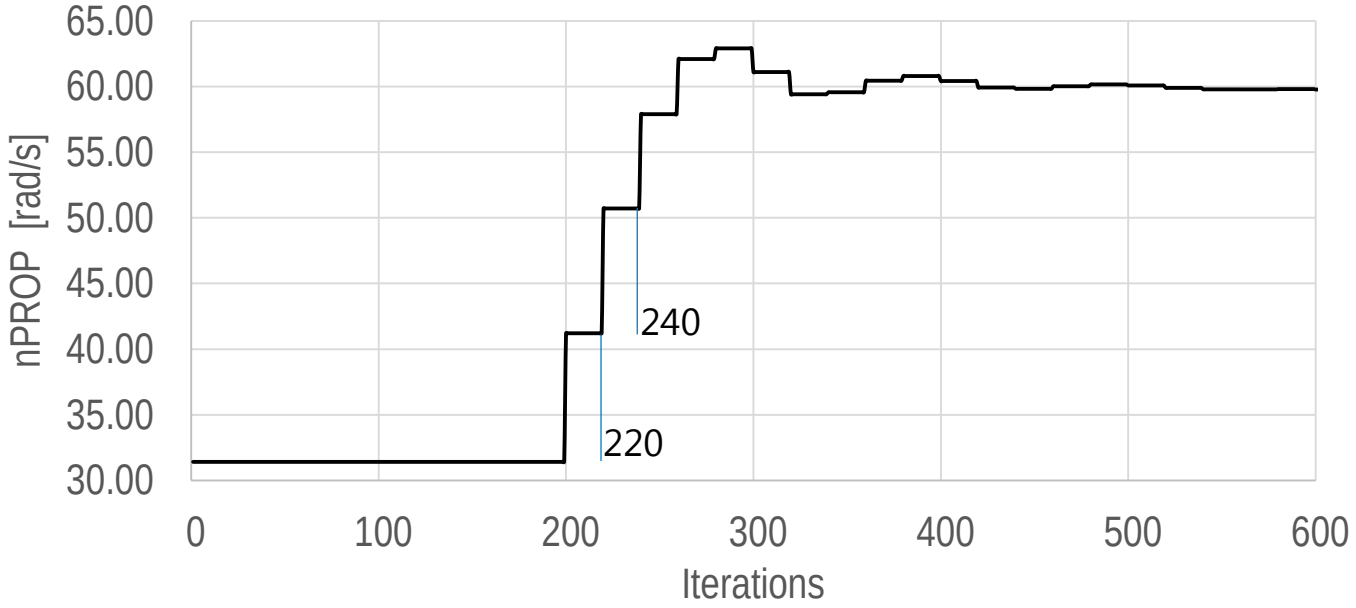


Self-propulsion – CFD Setup

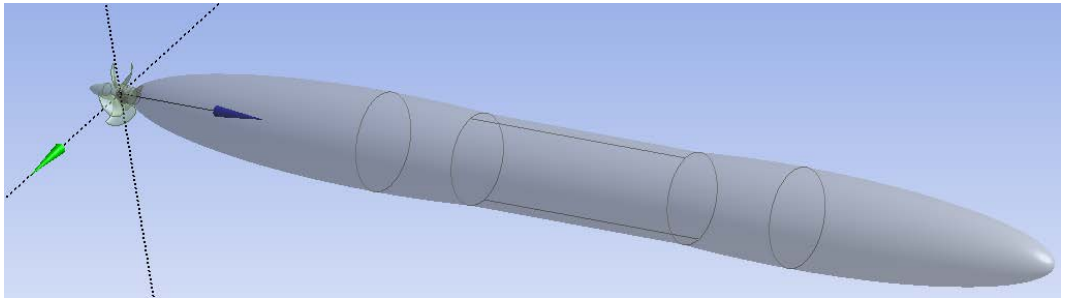
Controller – Parameters

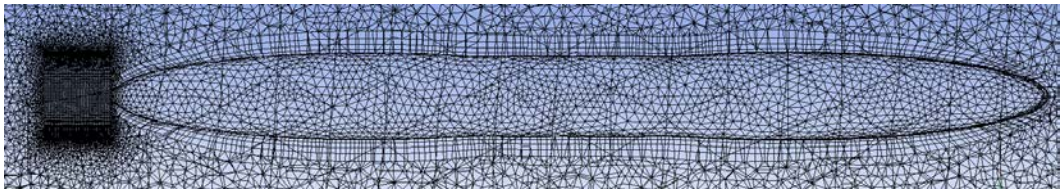


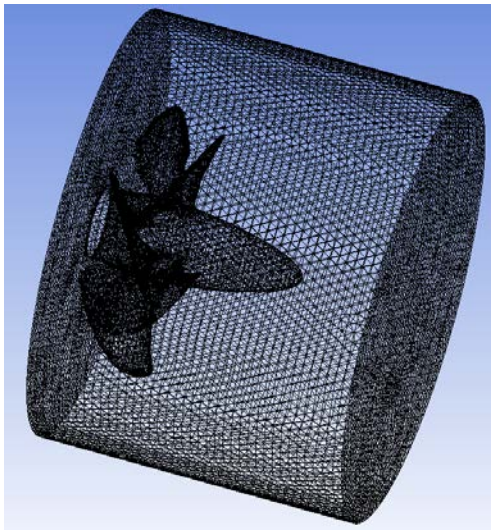
$$nPROP_i = nPROP_{(i-1)} + (\sum Forces_i)*\Delta n$$



Sensitivity Analysis – Body of Revolution

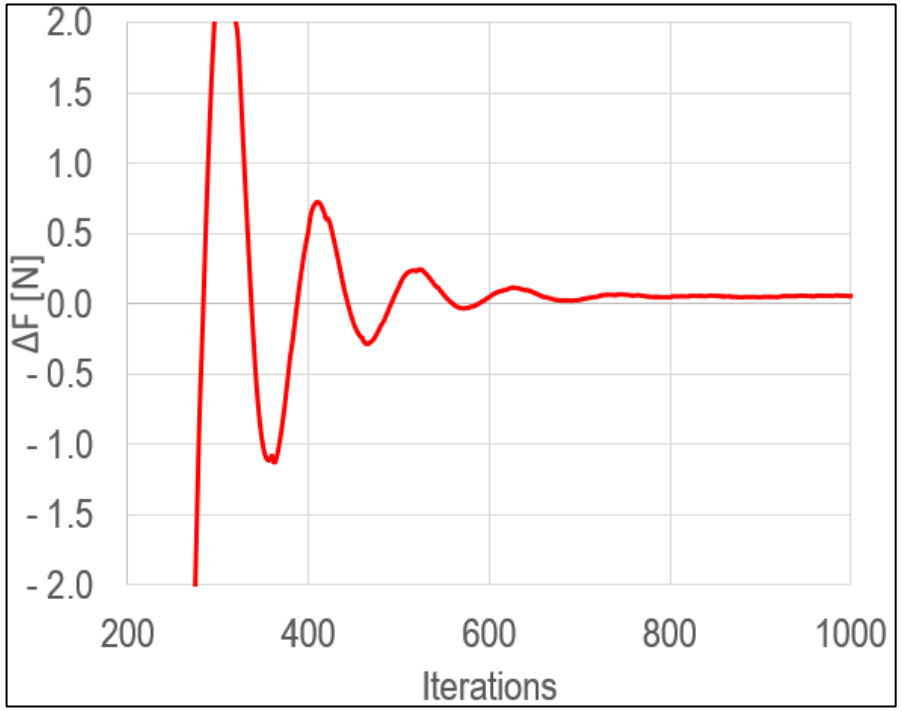




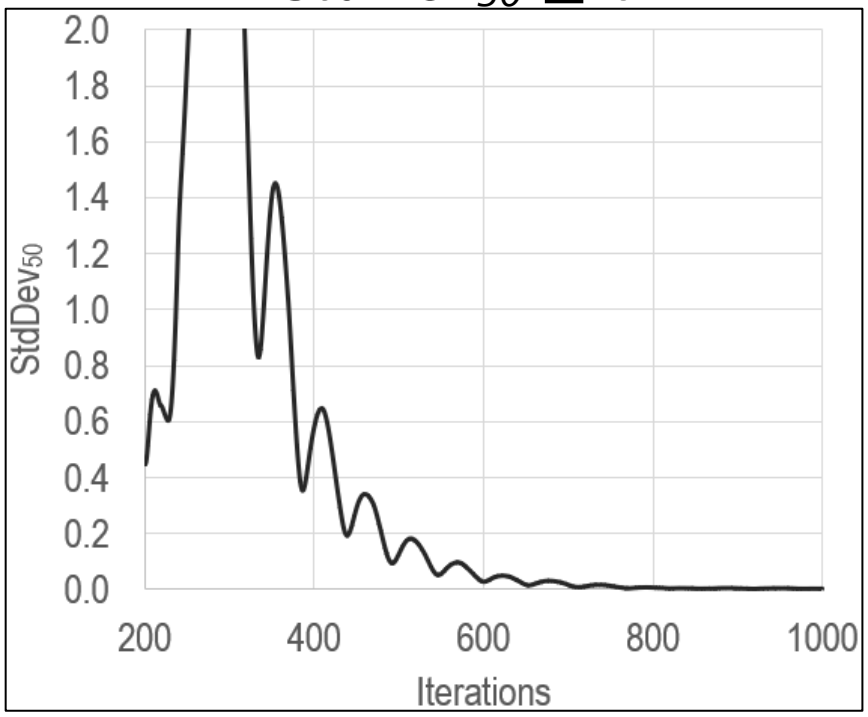


Sensitivity Analysis – Stopping Criteria

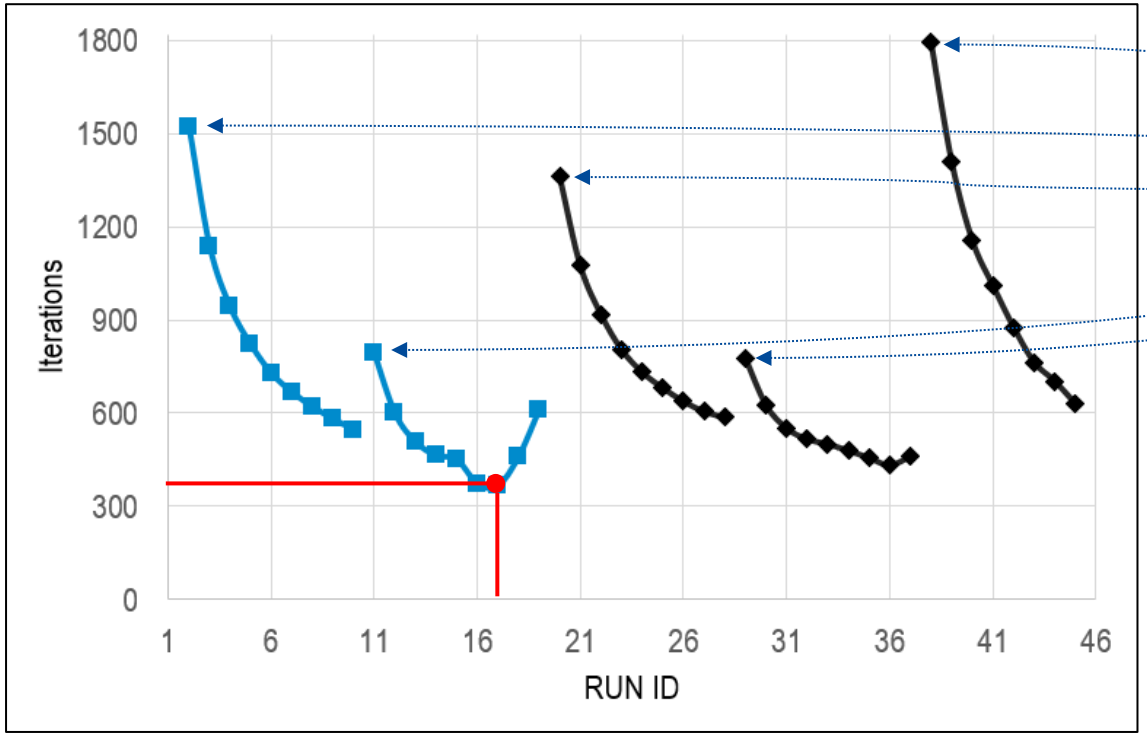
$0\ N \leq \Delta F \leq 0.1$ N



$StdDev_{50} \leq 0.1$



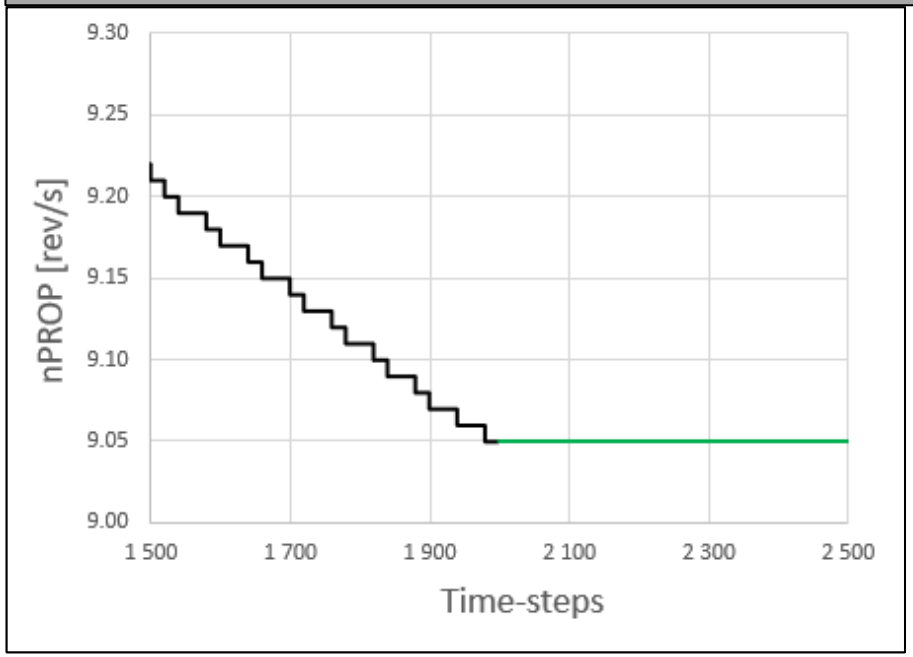
KVLCC2 – Initial Controller's Parameters (Steady)

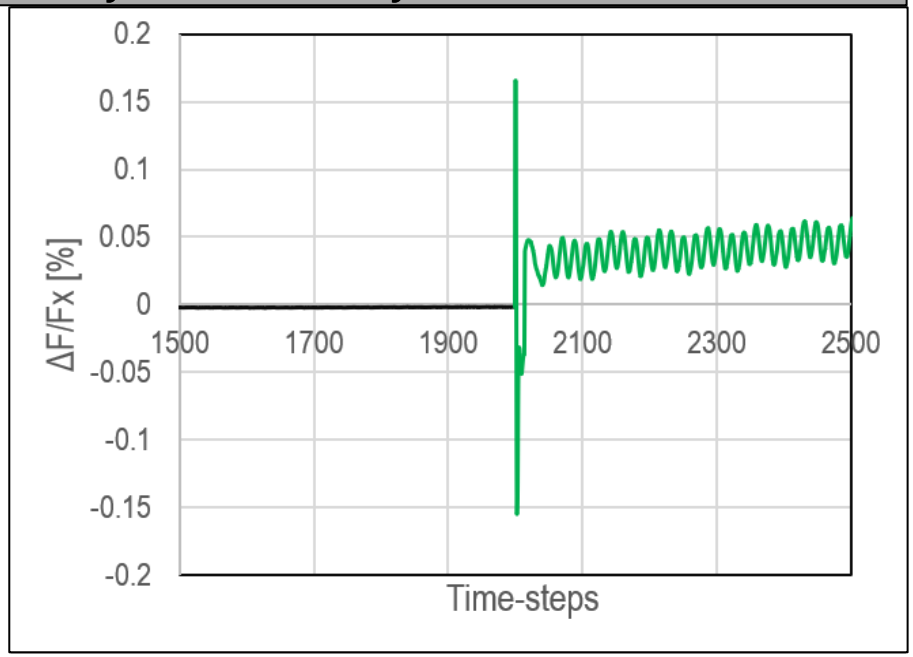


First Update
Update Frequency
nPROPinit
Δn

Results – Continental Setup – KVLCC2

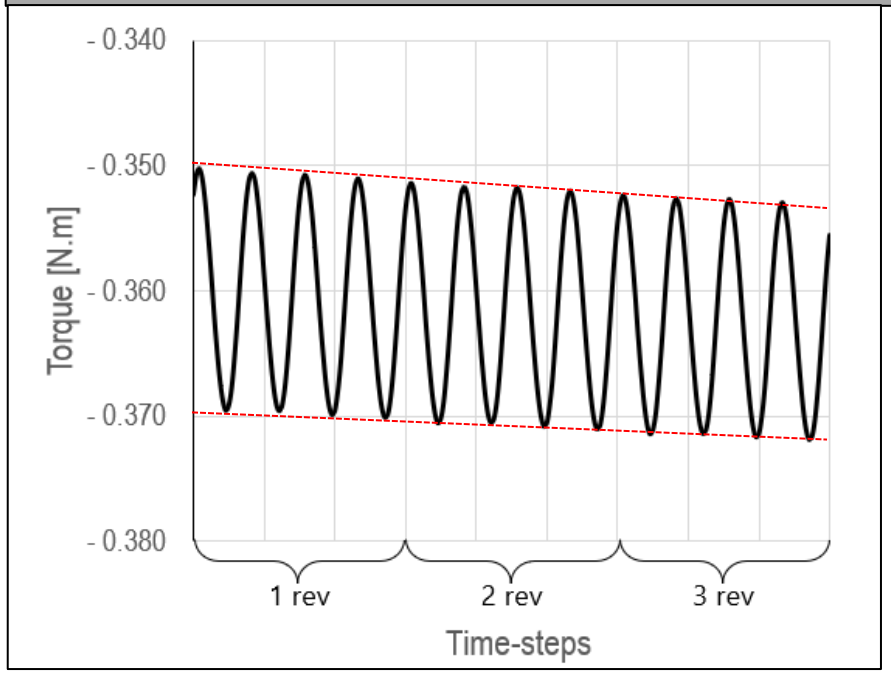
Continental Run (Steady + Unsteady)

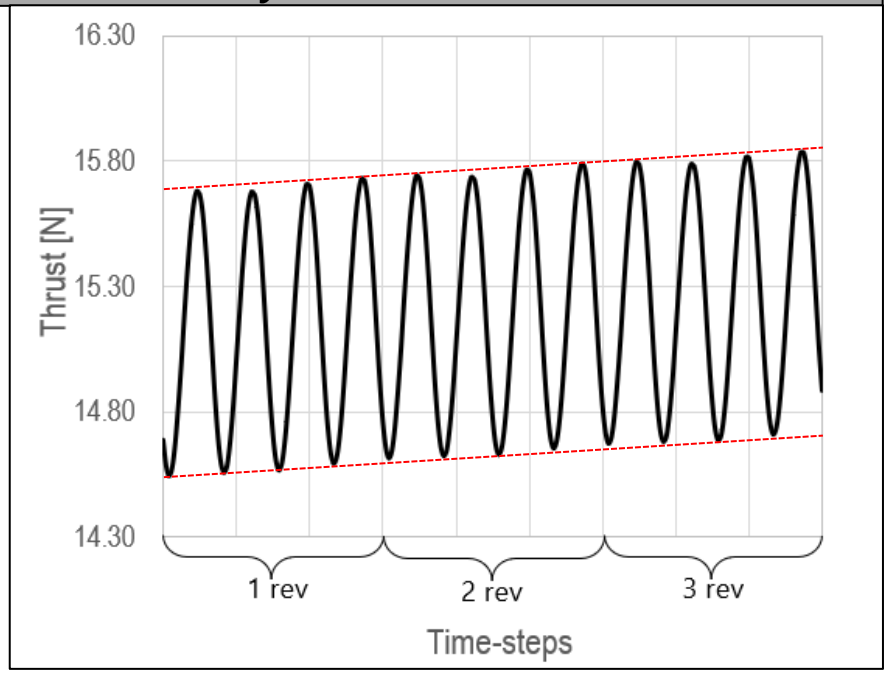




Results – Convergence (Continental) – KVLCC2

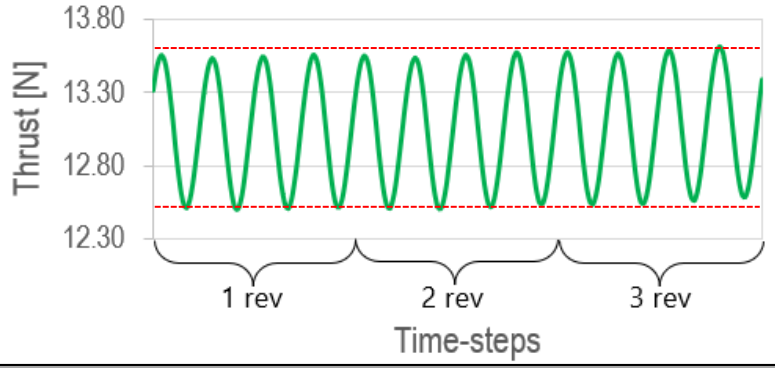
Continental Run (Unsteady)

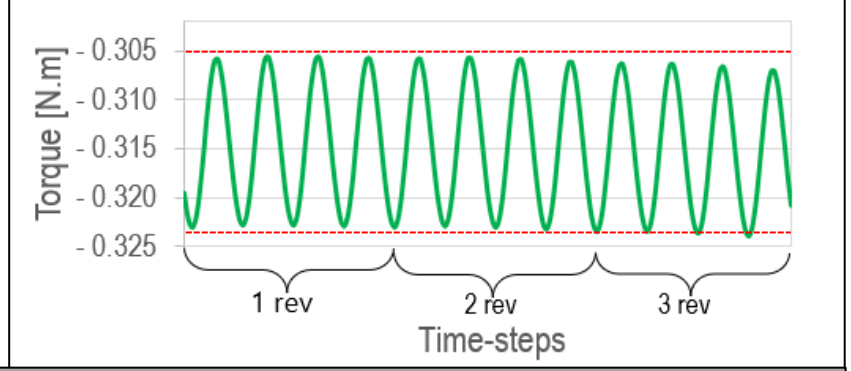




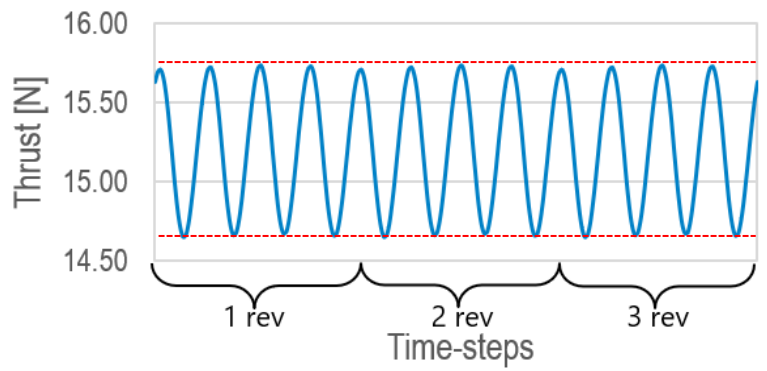
Results – Convergence (British) – KVLCC2

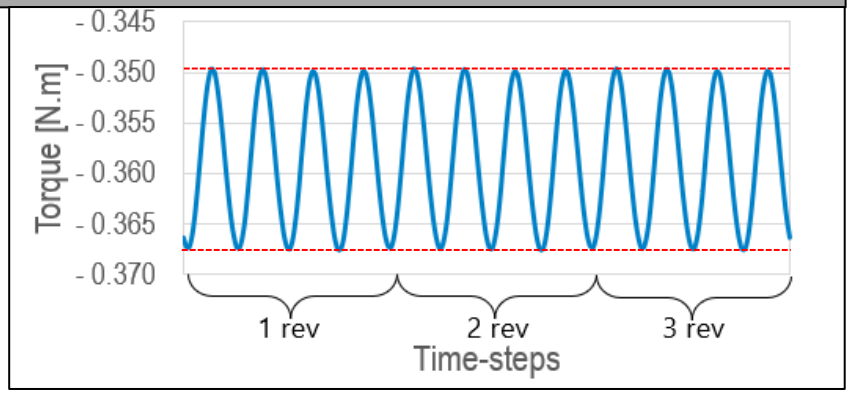
Under-loaded run



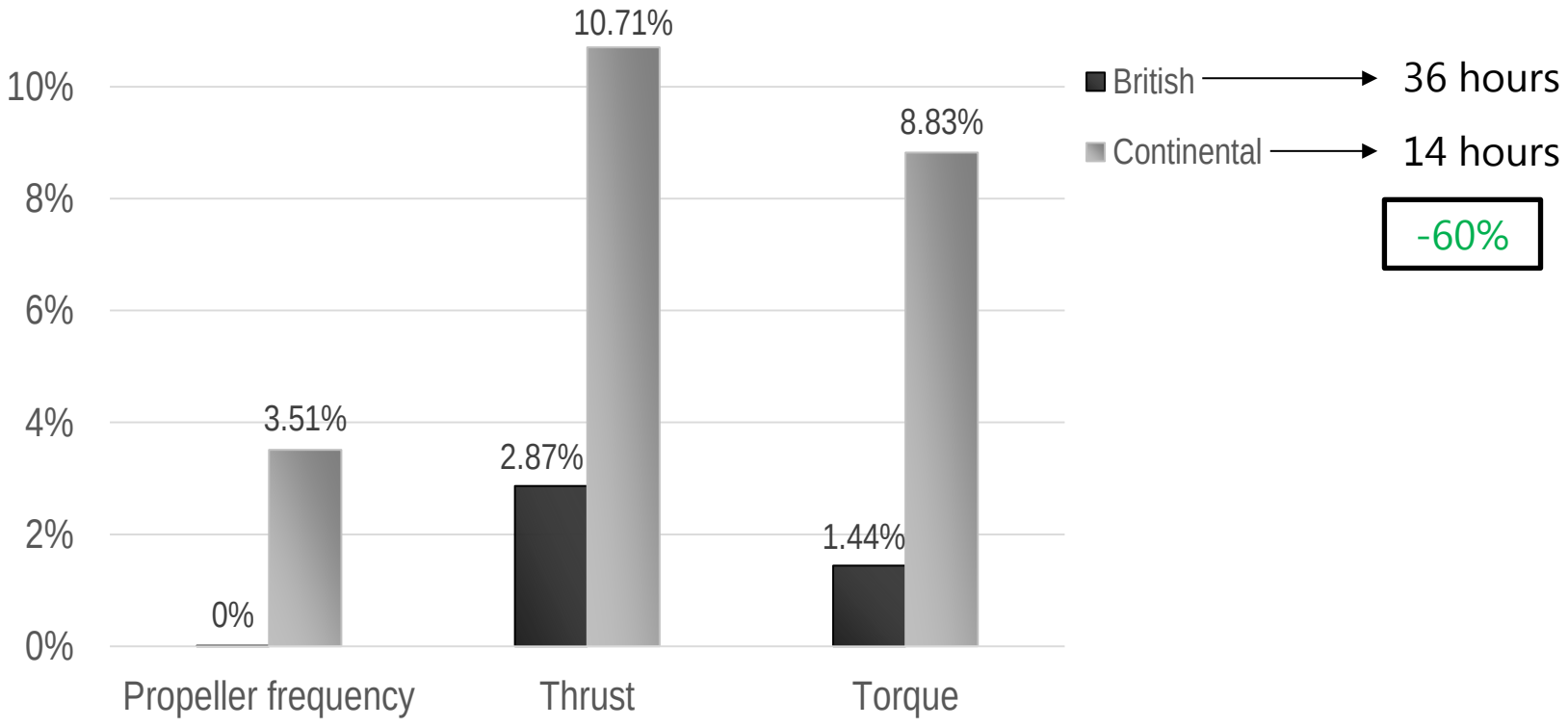


Over-loaded run



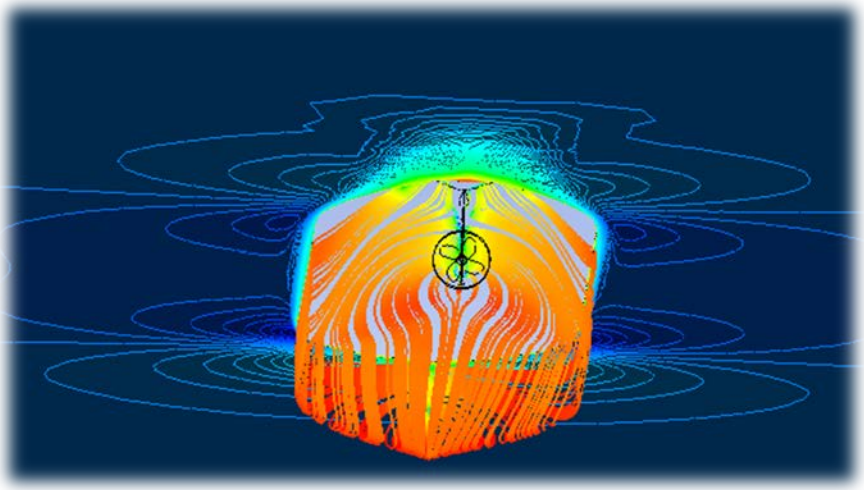


Results – Accuracy comparison (CFD x Model Basin)



Conclusion

- Reduction of computational effort;
- StdDev criteria could be reworked to be linked to the Update Frequency;
- The propeller frequency updated ($nPROP_{updated}$) should be included on the stopping criteria;



Thank you for your attention!