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" MPUF-3A/PROPCAV/HULLFPP/PF2NS – UT OE Group's Tools for the Prediction of Performance of Propulsors and Their Interaction with the Hull "

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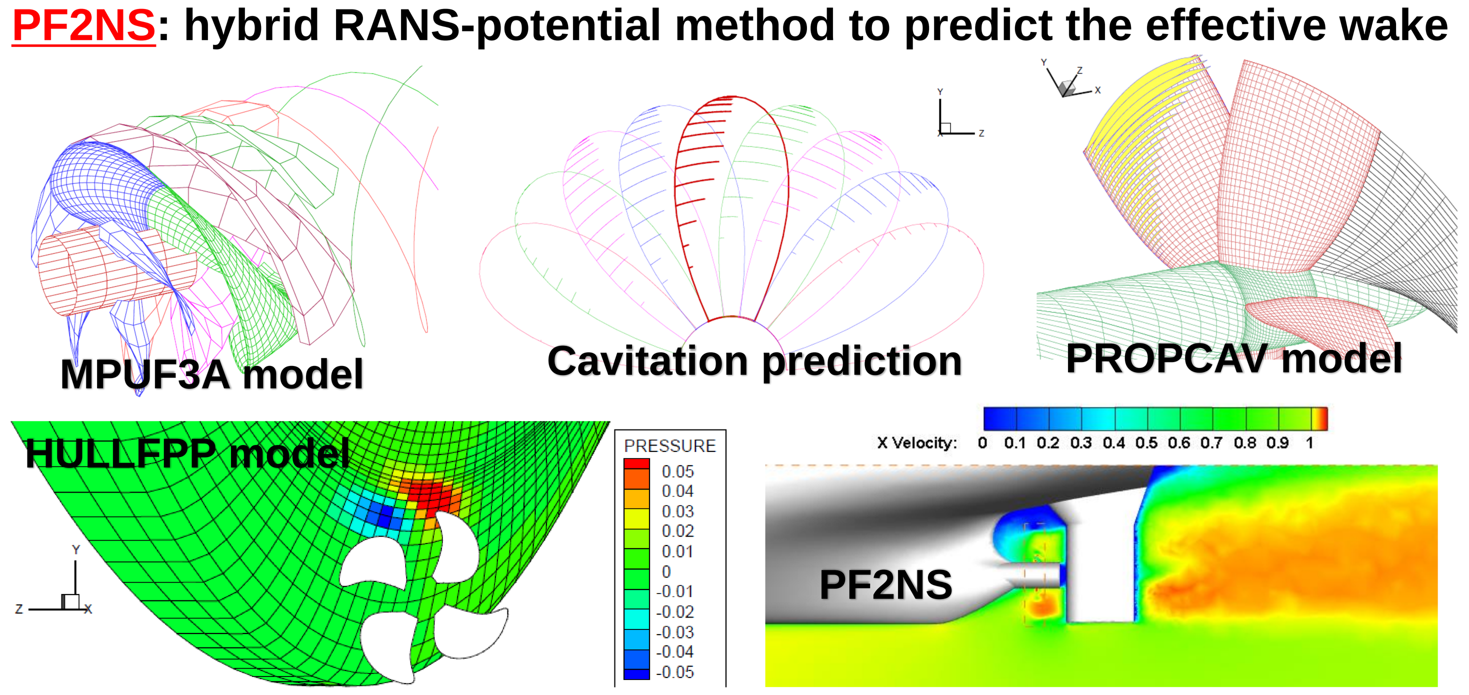
Introduction and Methodologies

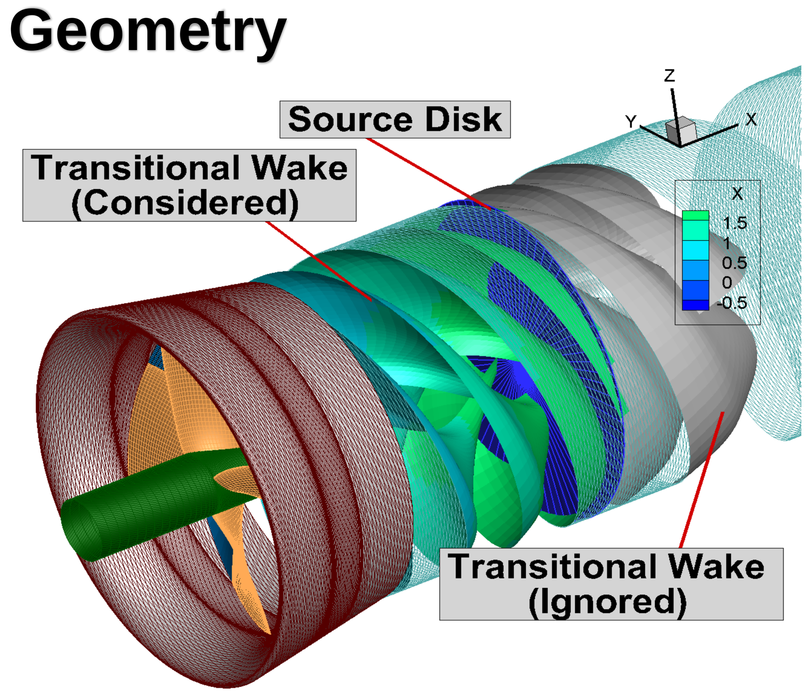
Potential-based methods with different emphases

- **MPUF-3A**: vortex lattice code to predict propeller performance and cavitation behavior
- **PROPCAV**: boundary element code to predict propeller performance and cavitation behavior
- **HULLFPP**: boundary element code to predict propeller-induced hull pressure fluctuation
- **PF2NS**: hybrid RANS-potential method to predict the effective wake



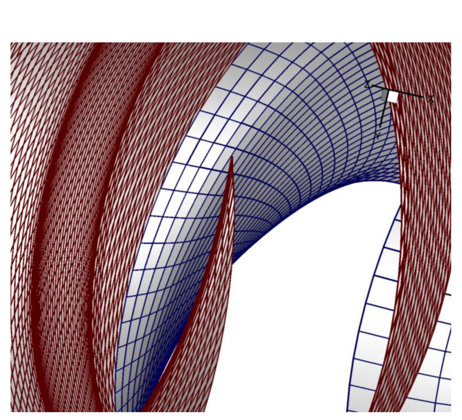
Sample Run: Ducted Propeller

Geometry



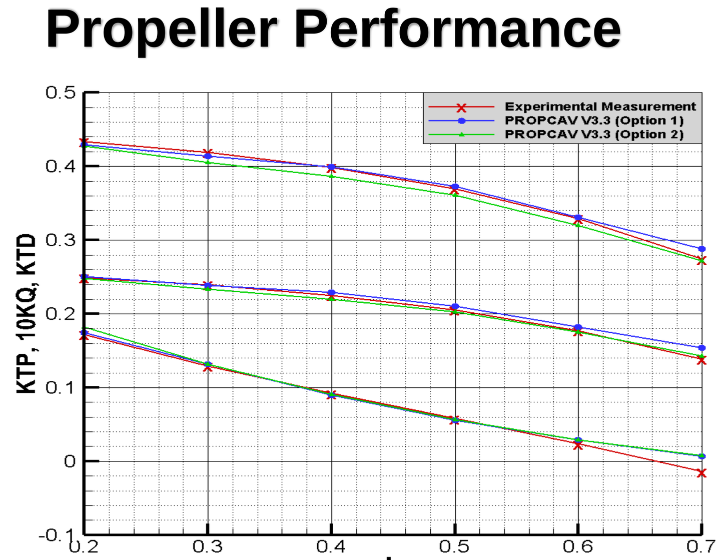
- It is a 4-blade propeller with a square blade tip and a sharp trailing edge duct.
- Duct geometry is 19Am. The duct 19Am is modified by MARIN from duct 19A which has a blunt trailing edge.
- The design advance ratio is around 0.50.
- Zero gap between duct and blade tip is assumed in this case.

Duct and Wake Alignment



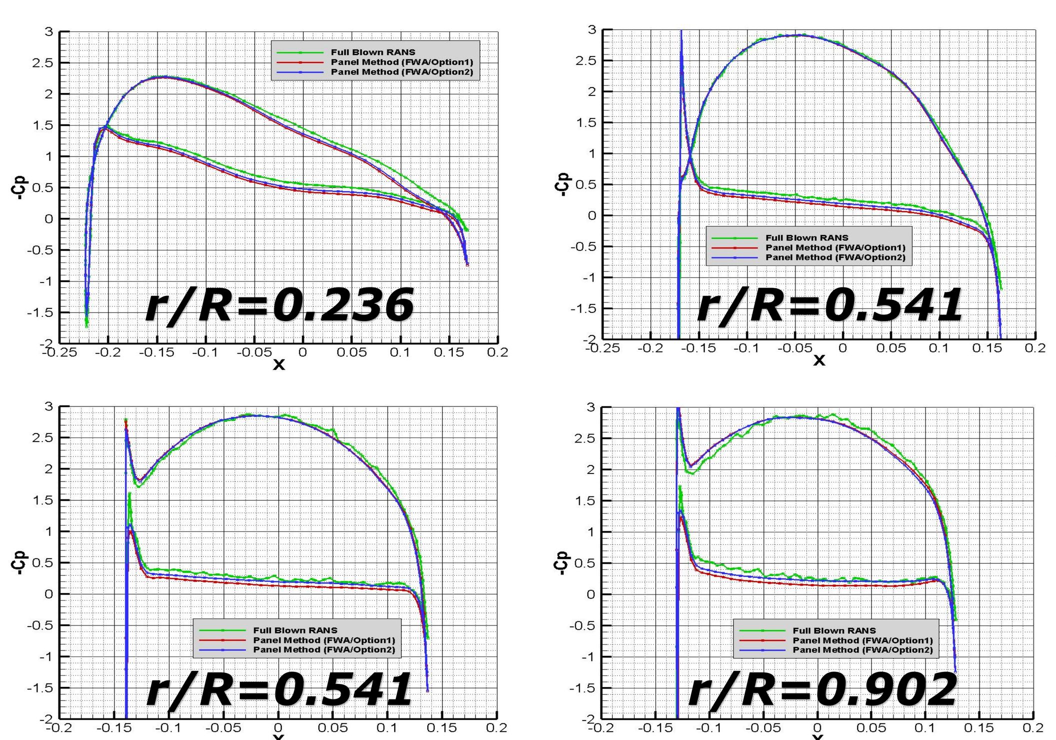
The matched panels between duct inner side and blade wake ensure stable convergence of the final results even at low advance ratio.

Propeller Performance



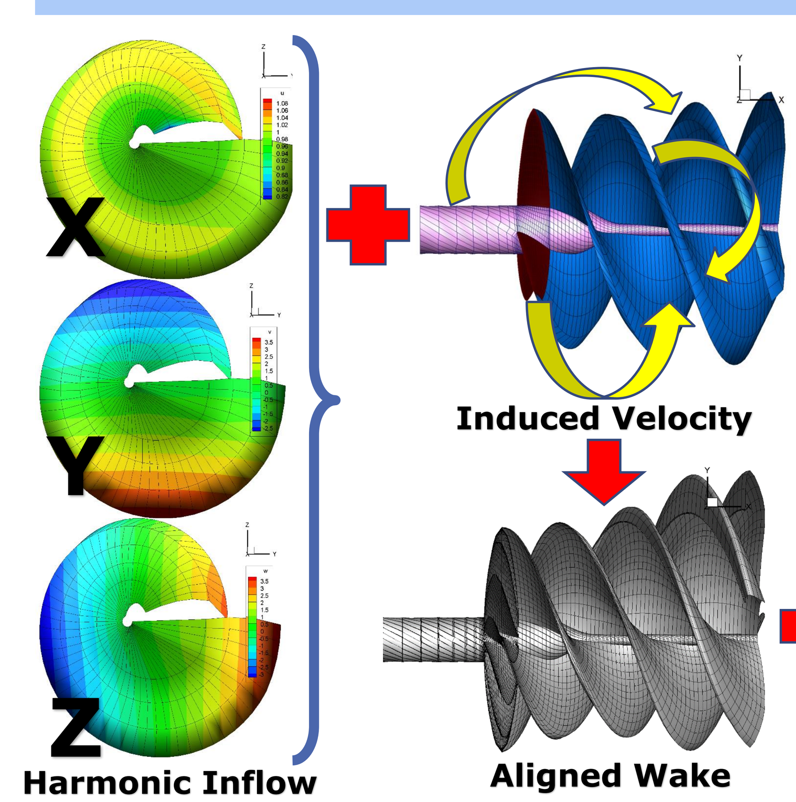
Sample Run: Ducted Propeller

Pressure Distribution on the Blade Sections

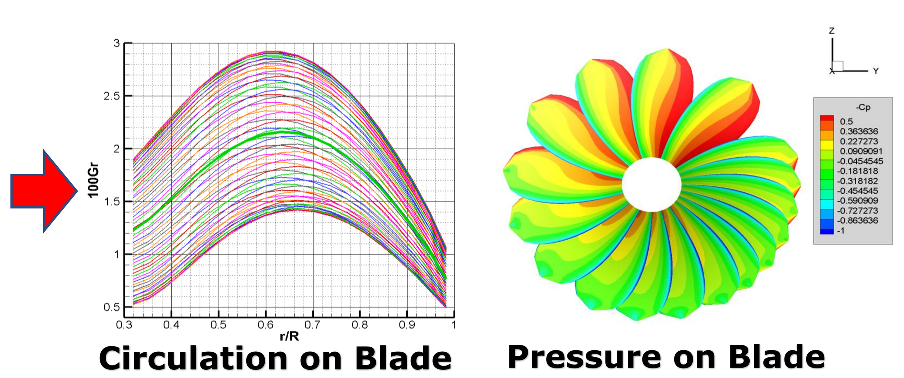


- Pressure distribution along the several blade sections at the design advance ratio are compared to the results from the full blown RANS (Ansys/Fluent).
- The predicted results show that the PROPCAV V3.3 is in very good agreement with the RANS simulations over the most blade sections.

Unsteady Wake with Inclined Flow

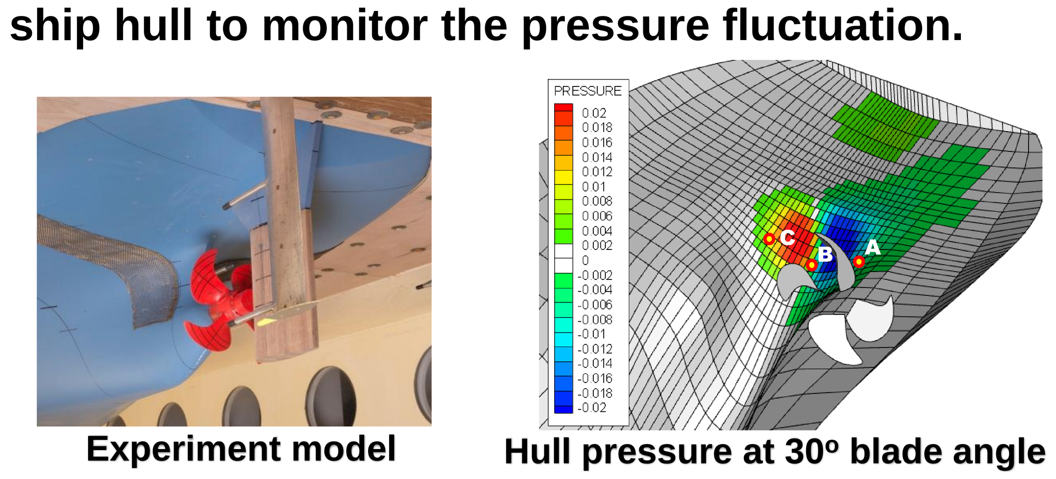


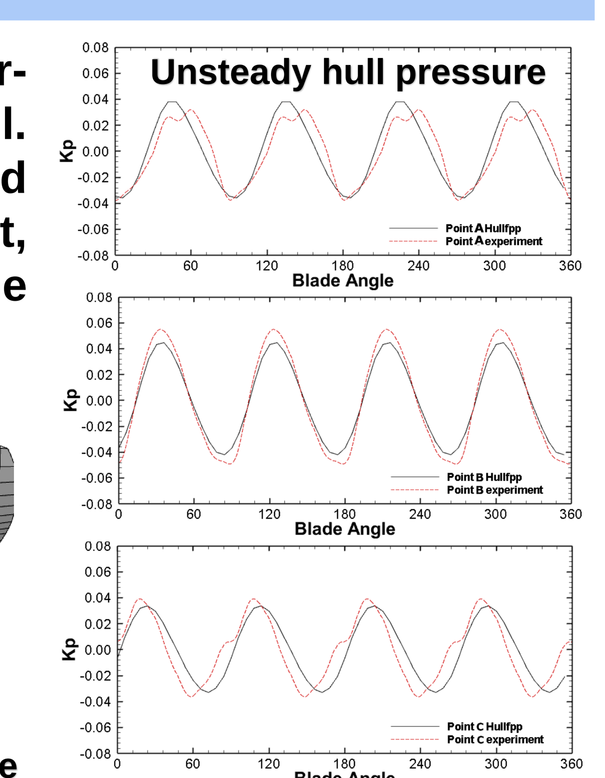
Three components of the induced velocity are added up to those of the harmonic inflow to compose the total velocity in the flow field. Based on this total velocity, wake panels are aligned at every time step to simulate unsteady flow.



Sample Run: HULLFPP

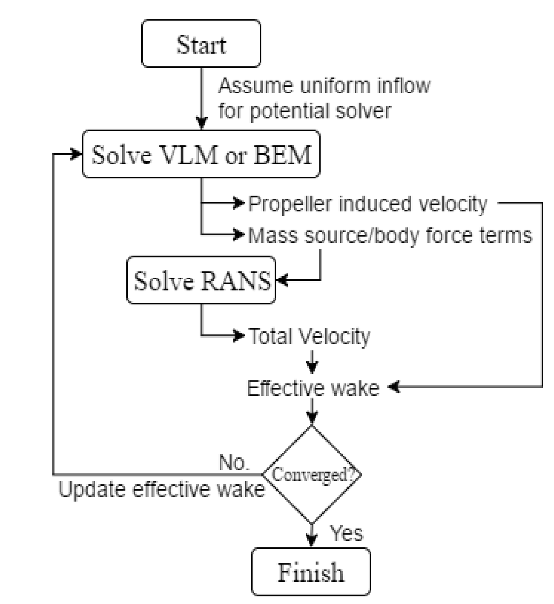
HULLFPP is used to predict the propeller-induced pressure fluctuation on the ship hull. The results (unsteady pressure) are compared with experimental data. In the experiment, several pressure transducers are placed on the ship hull to monitor the pressure fluctuation.





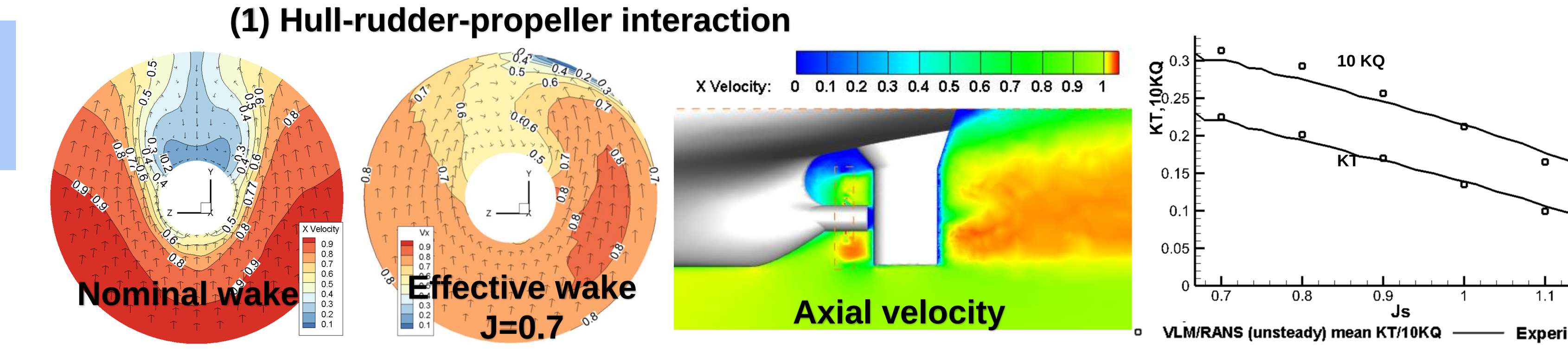
Sample Run: PF2NS

To predict the propeller performance, we need to know the wake field the propeller is working in. However, in hull-propeller interaction cases, the wake field is also influenced by the propeller. The wake field without propeller influence is called the nominal wake while the wake field with propeller influence is called the effective wake.

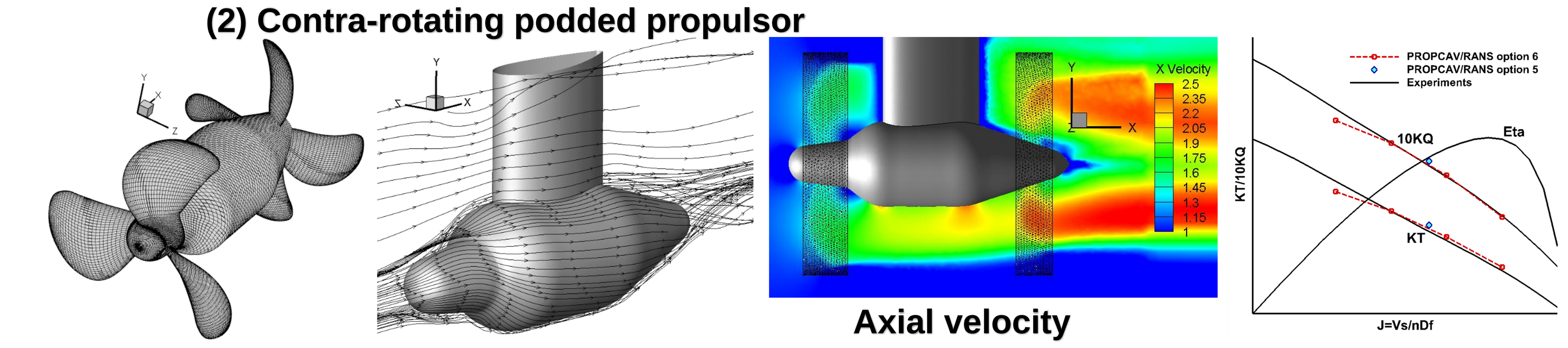


PF2NS is a hybrid RANS-potential scheme to predict the effective wake. The scheme maintains the benefits of a potential solver in predicting unsteady forces/cavitation patterns. It is also able to capture the vortical flow behaviors in a much higher computational efficiency than a full RANS computation.

(1) Hull-rudder-propeller interaction



(2) Contra-rotating podded propulsor



Conclusions and Future Work

- PROPCAV V3.3 using repaneling process on duct/duct wake panels improves the predicted results of the current panel method at most of the advance ratios down to very high loading conditions.
- PROPCAV V3.3 can model the unsteady wake alignment scheme and tip vortex cavitation shed from the blade tip in the inclined flow case.
- HULLFPP solves the diffraction potential and calculates the pressure fluctuations on the ship hull. The results are in good agreement with experiments. The current method assumes incompressible flow which is good for near field pressures. We are in the process of extending it to handle a finite sound speed when far field pressure fluctuations are of interest.
- PF2NS is an efficient scheme to evaluate the time-averaged effective wake field. In the future, this scheme can be extended to evaluate the effective wake field as a function of time.
- The effects of viscosity on the duct can be included via coupling with boundary layer method or RANS.