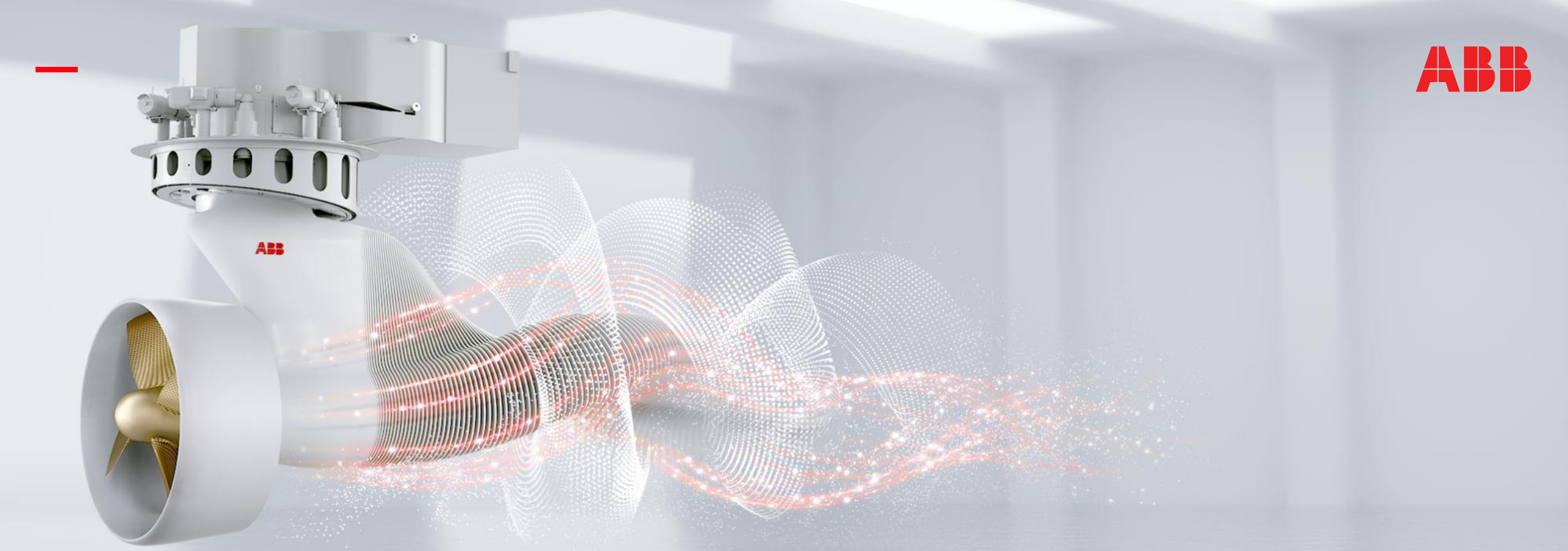


AZIPOD® USER GROUP, 2017-06-14

Hydrodynamic Simulation

Computational development

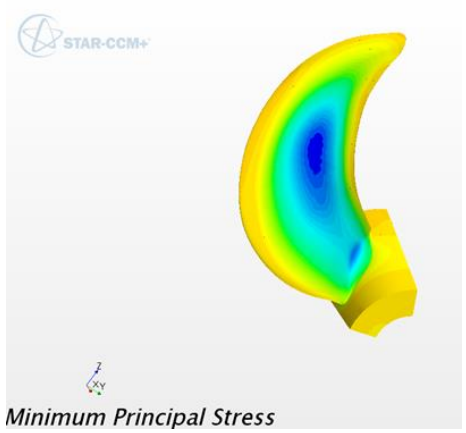
Andrei Korsström, Product Manager

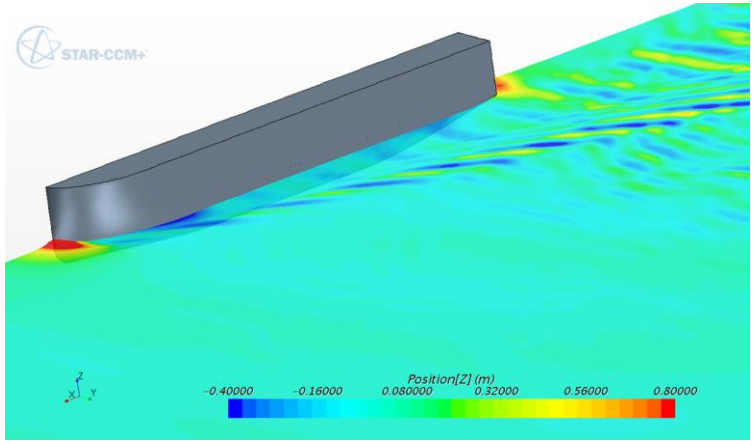
Agenda

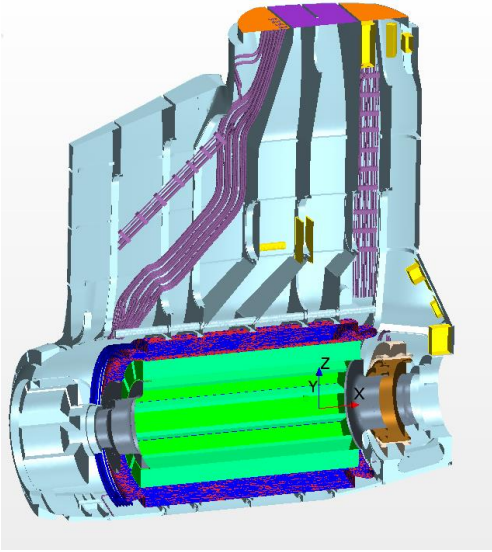
Current State of CFD at ABB Marine and Ports

- Range of simulation approaches
- Open water and oblique flow simulations
- Dynamic steering
- Stress analysis
  - Solid stress analyses – Zero Pitch Propeller
- Cavitation analysis
  - Cavitation in oblique flow
- Hull resistance & ship self-propulsion
- Internal flows
- Fourier analyses for transient load excitation
- StarCCM+ - Procal (RANS-BEM) coupling

Range of simulation approaches





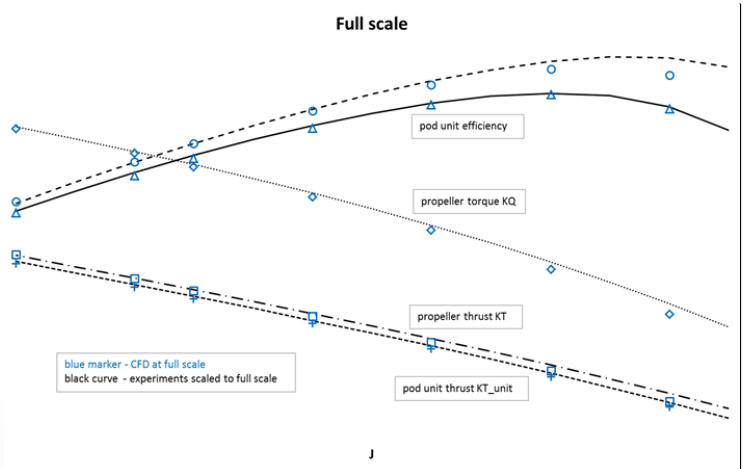


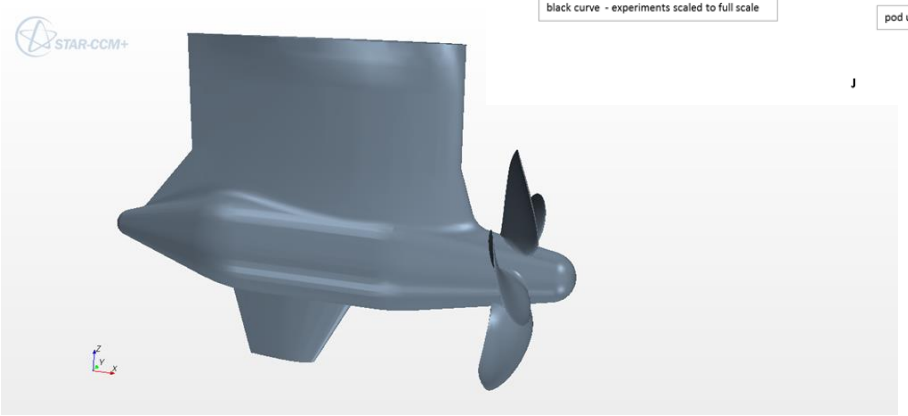
Simulations span from simple single component to complex multi physical.

Open water and oblique flow simulations

Open water simulations

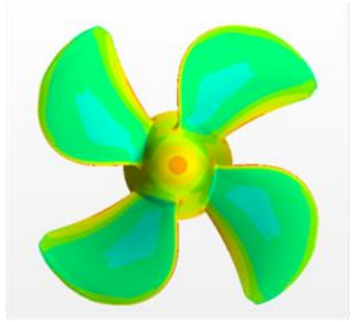
- Homogenius inflow
- Full scale RANS

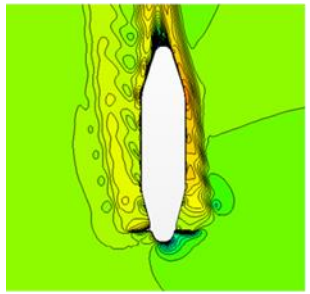


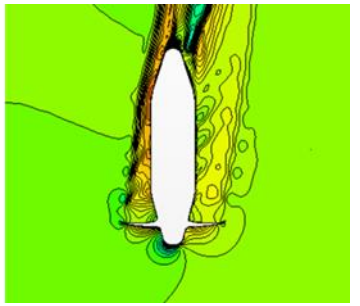


Oblique flow simulations

- Similar to open water
- Oblique inflow
- Input for FEM

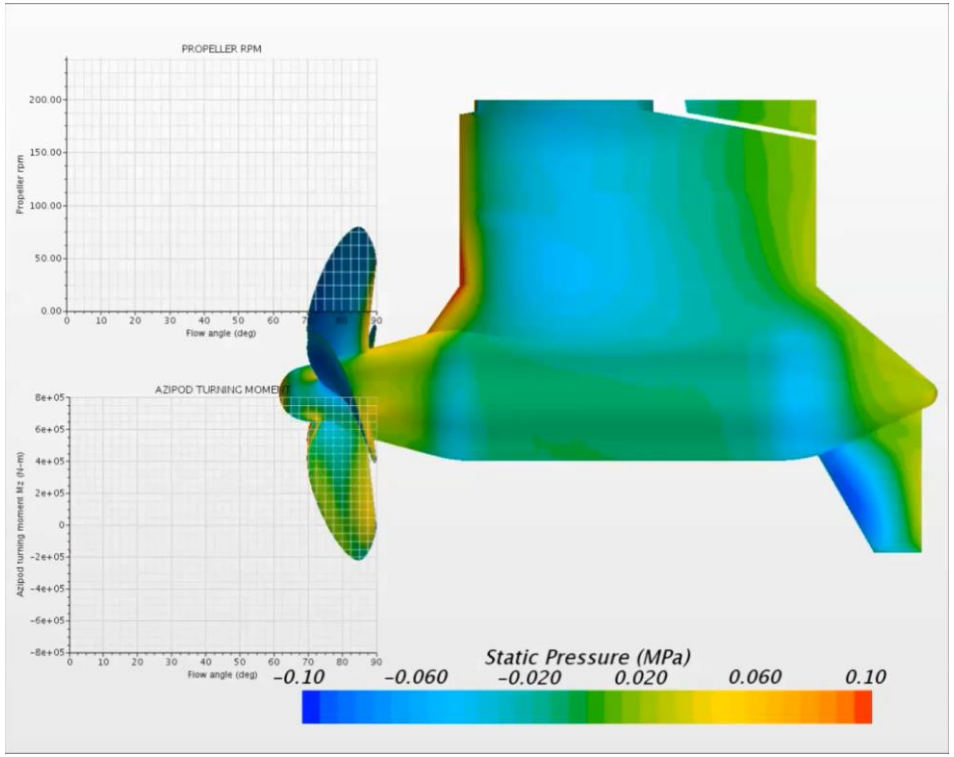




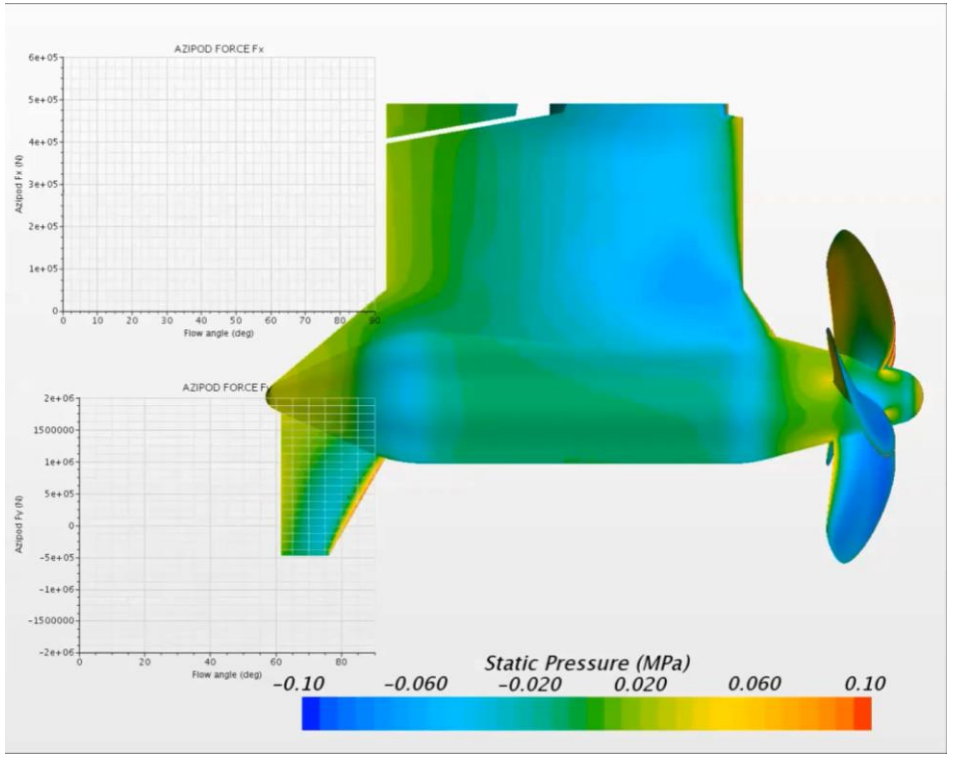


Dynamic steering

Rotation rate and steering torque



Force components



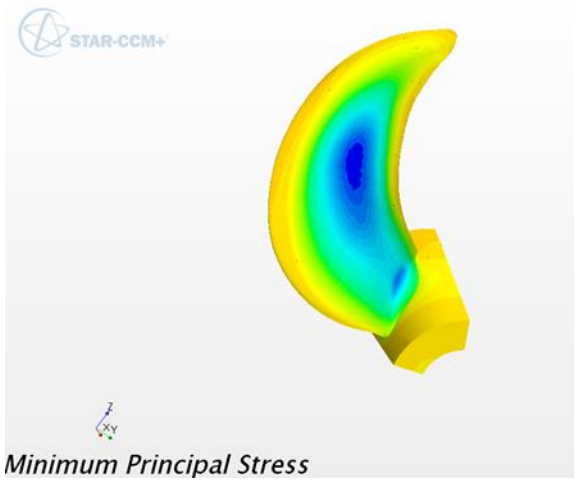
Stress analysis

FE analysis of the propeller within StarCCM+

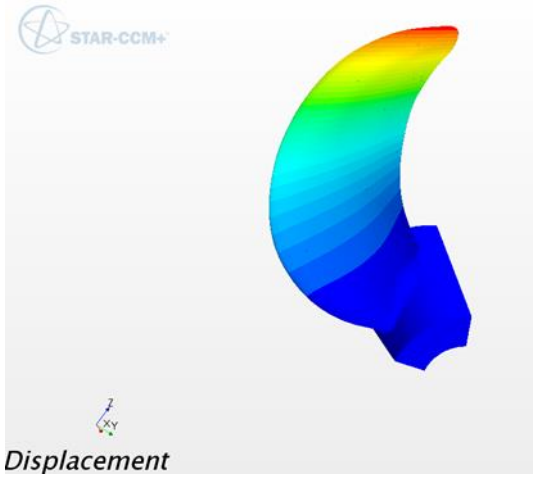
Modeled within one software

- CFD simulation for hydrodynamic loads
- FEM solver for strength

- Typical implementation is propeller blade



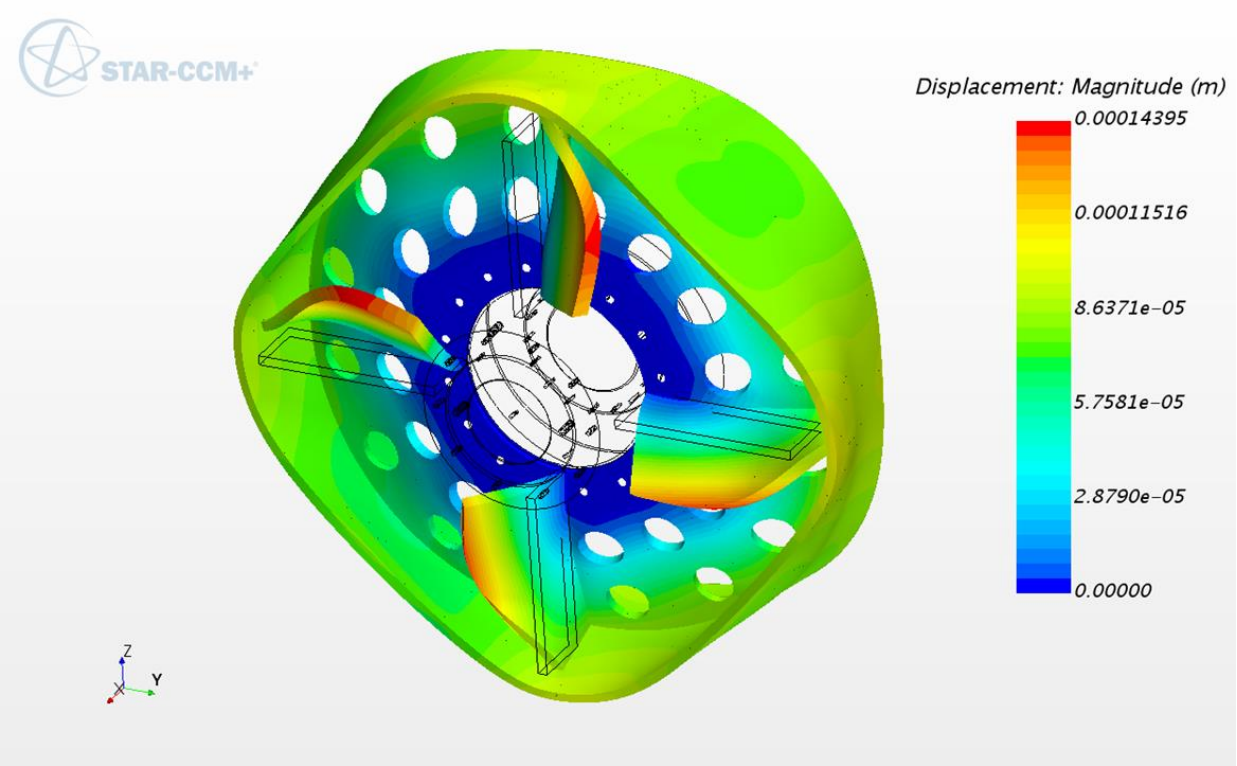
Minimum Principal Stress



Displacement

Stress analysis

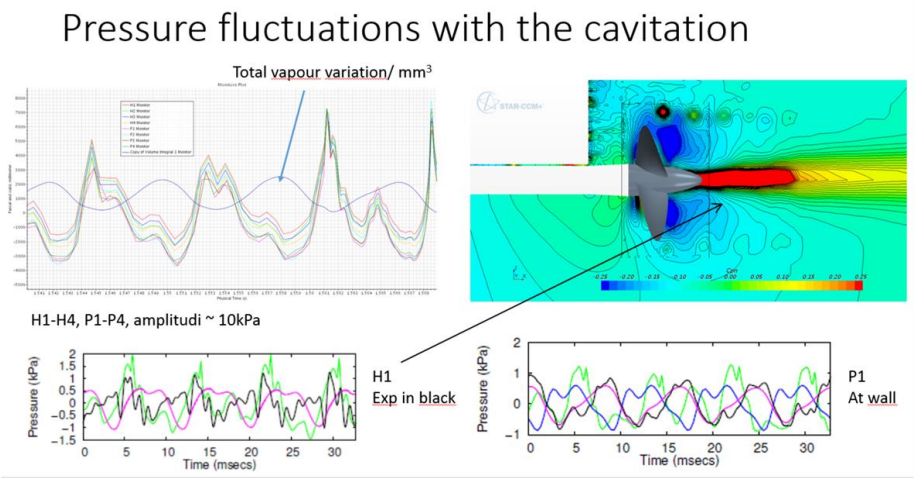
Solid stress analyses – Zero Pitch Propeller

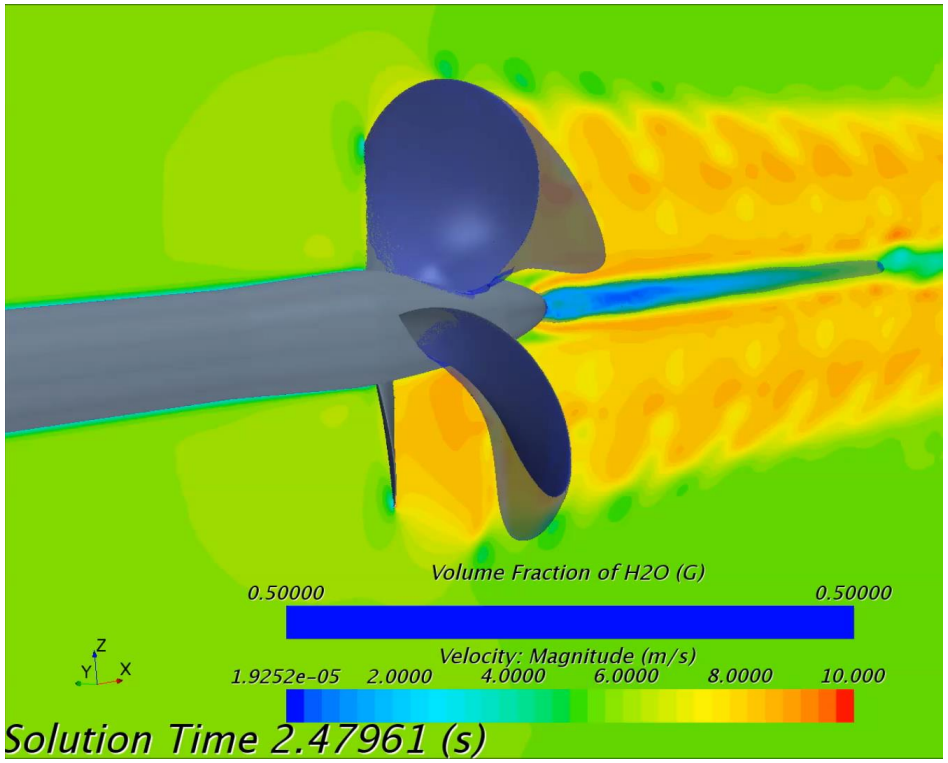


Cavitation analysis

Cavitation study

- Currently done in model scale
- Wake field included
- Verified against: SMP15 paper, Vaz, G. et al., Austin, Texas, USA, June 2015





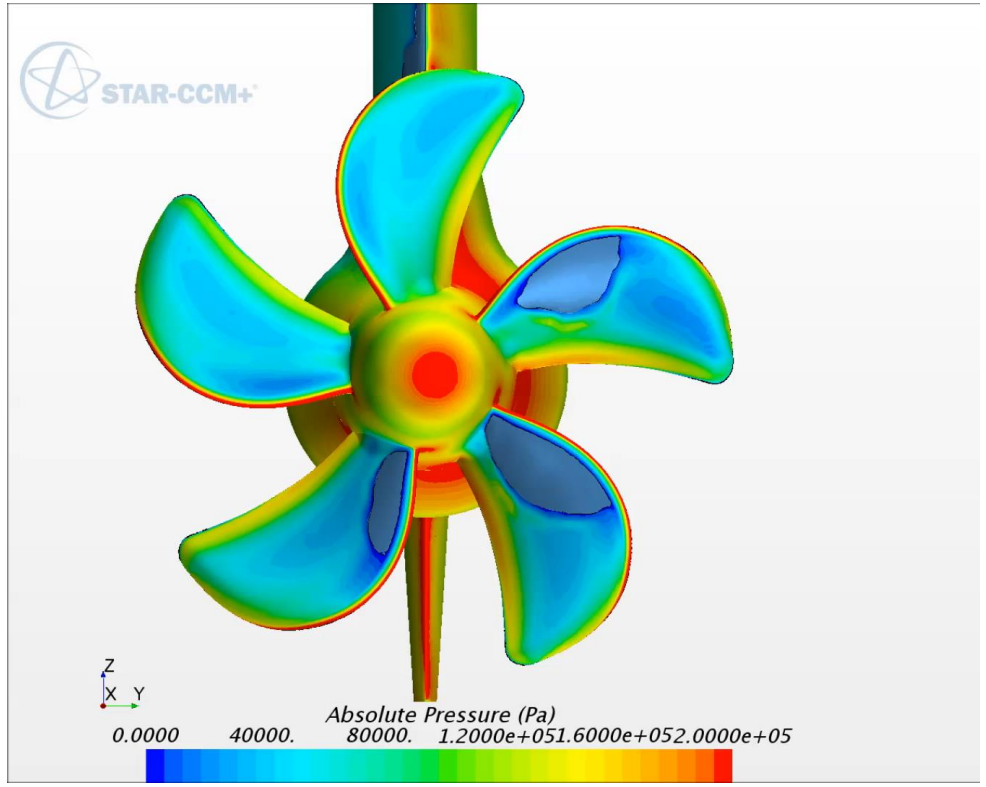
Cavitation analysis

Cavitation at oblique flow (+7°)

Full scale

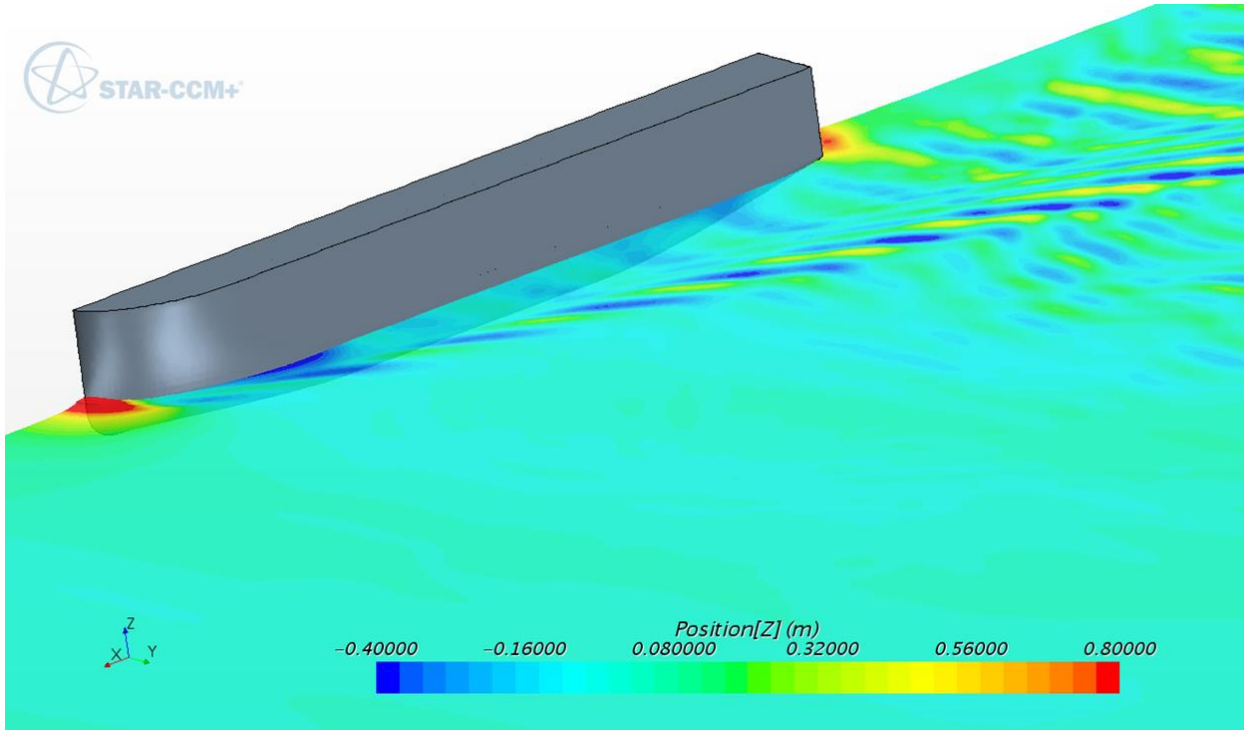
Multi physical model

Homogenous wake

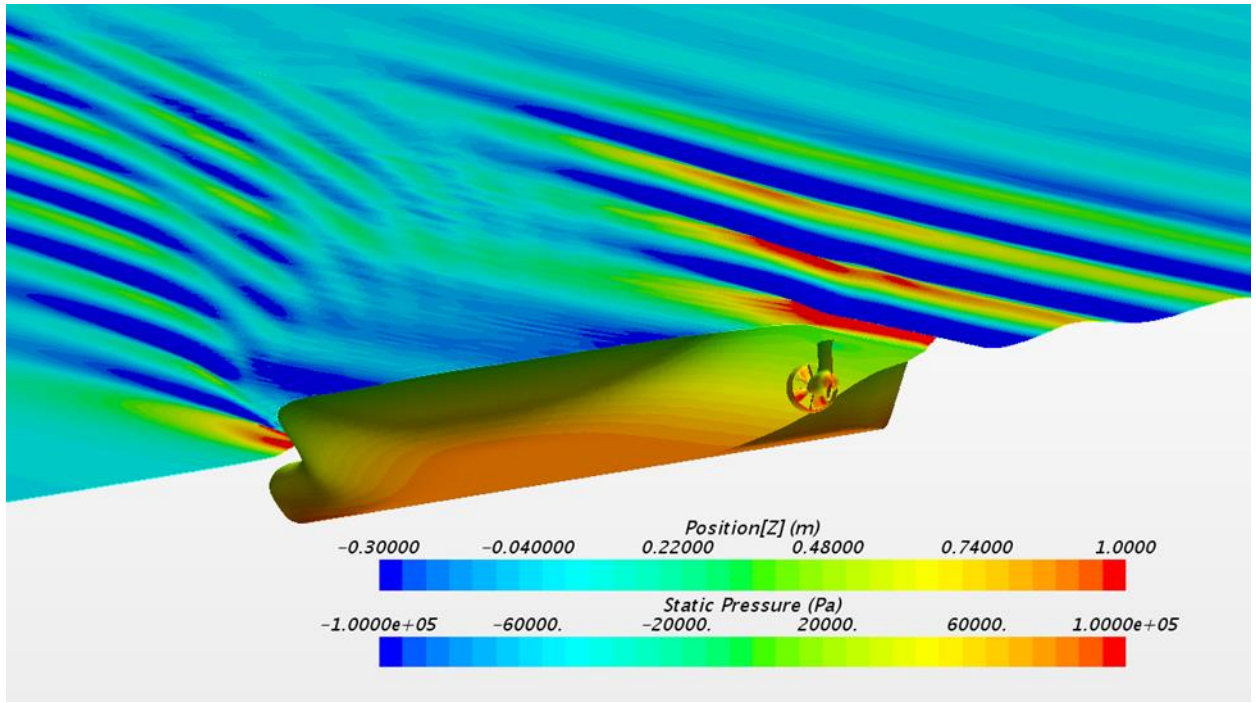


Hull resistance & ship self propulsion

Resistance and wave pattern

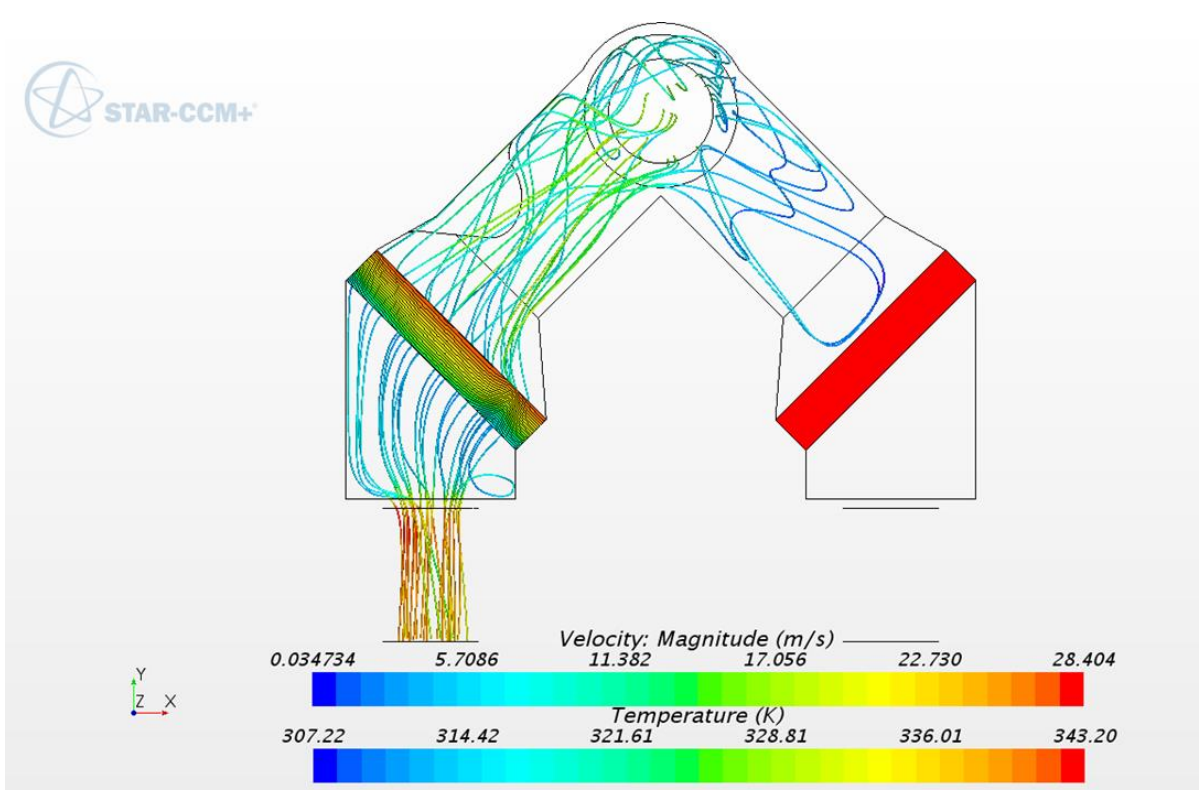


Self-propulsion

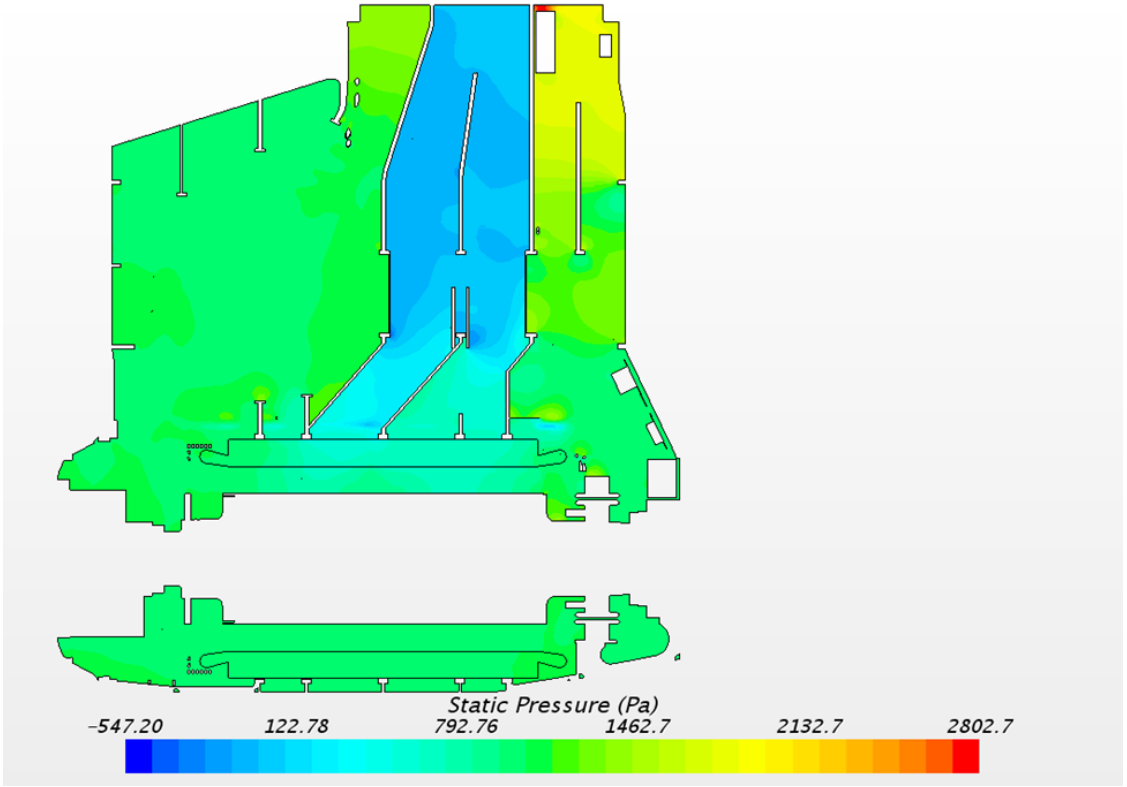


Internal Flows

Cooling Air Unit pressure loss and batteries

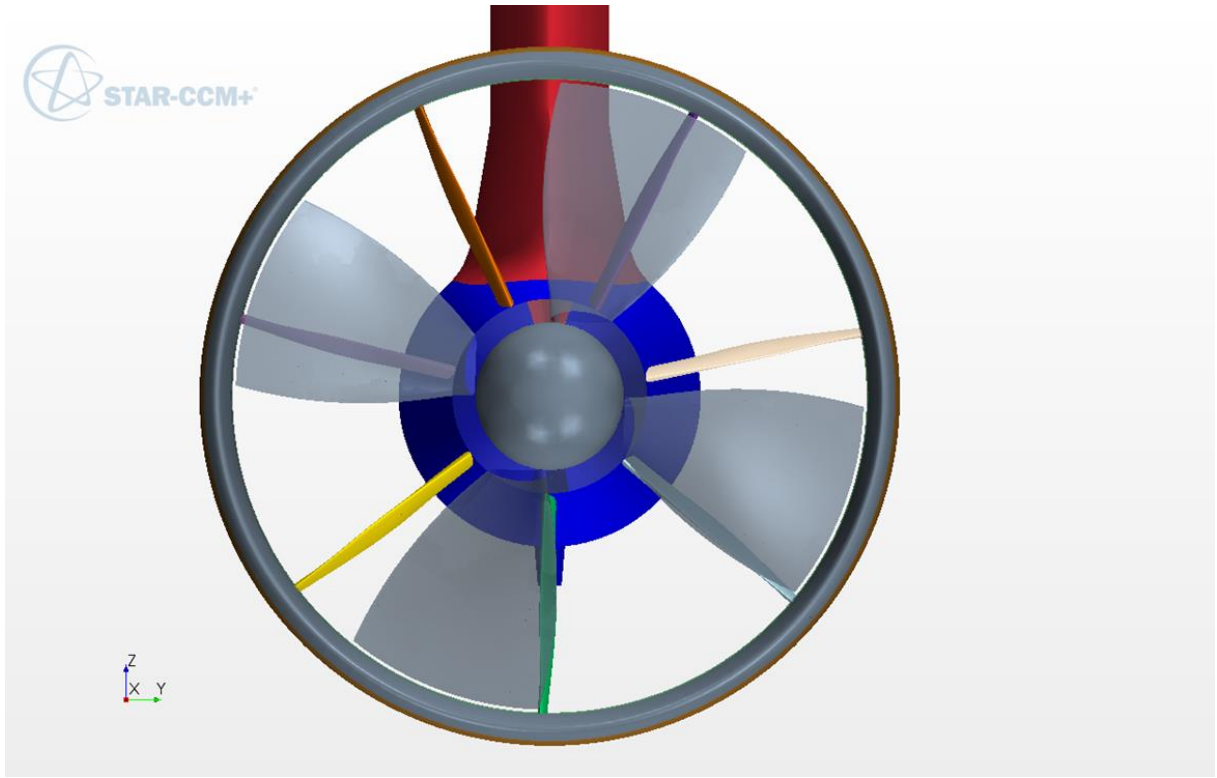


Cooling flow through Azipod hulls

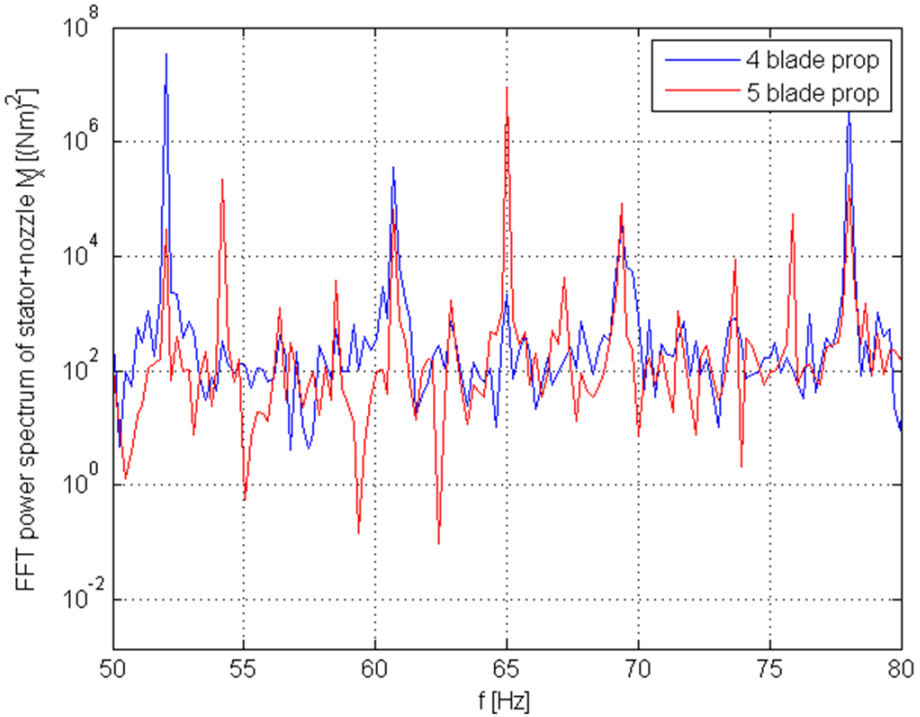


Fourier Analyses for transient load excitation

4 blade rotor – 7 blade stator geometry



FFT Power Spectrum for stator+nozzle Mx



StarCCM+ - Procal (RANS-BEM) coupling

Coupling of codes

RANS generally requires full 3D surface to generate correct flow

BEM code can utilize 3D wake field in propeller calculation

BEM is generally a much faster (although rougher) code, but gives good correlation to model scale results.