YOUR PROPULSION EXPERTS

SCHOTTEL

NEW DRIVE SOLUTIONS FOR ENERGY VESSELS

J. MÜLLER | GIJON | MARCH 25

Agenda

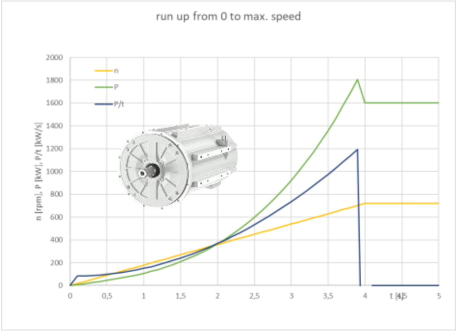
01 SOV operation criteria

Operation:	**6,000h/a** with **80% DP**	
Gangway:	telescopic operational limit **+/- 4.0m**	
DP accuracy:	within **+/- 1.5m**	
Environment:	wave height	**Hs > 3.0m**
	wind speed up to	**21m/s**

➢ Highest DP accuracy requires **more dynamic propulsion**

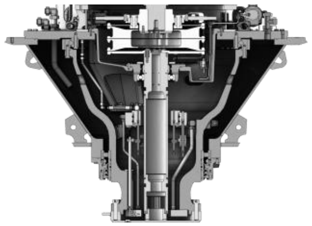
02 SRP-D next level DP performance

Dynamic fast response azimuth thruster



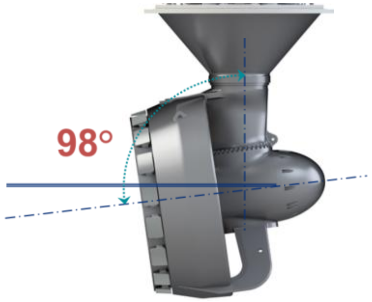
Dynamic fast response L-Drive

- **Fast propeller acceleration**
- **Ramp up time of 4-5 sec (0-100%)**



High-speed azimuth steering

- **Steering speed 5 rpm (180°)**
- **Ramp up time abt. 0,6 - 1,2 sec**



98° Gearbox

- **Minimizing interaction effects**
- **Reduction / elimination of forbidden zones**

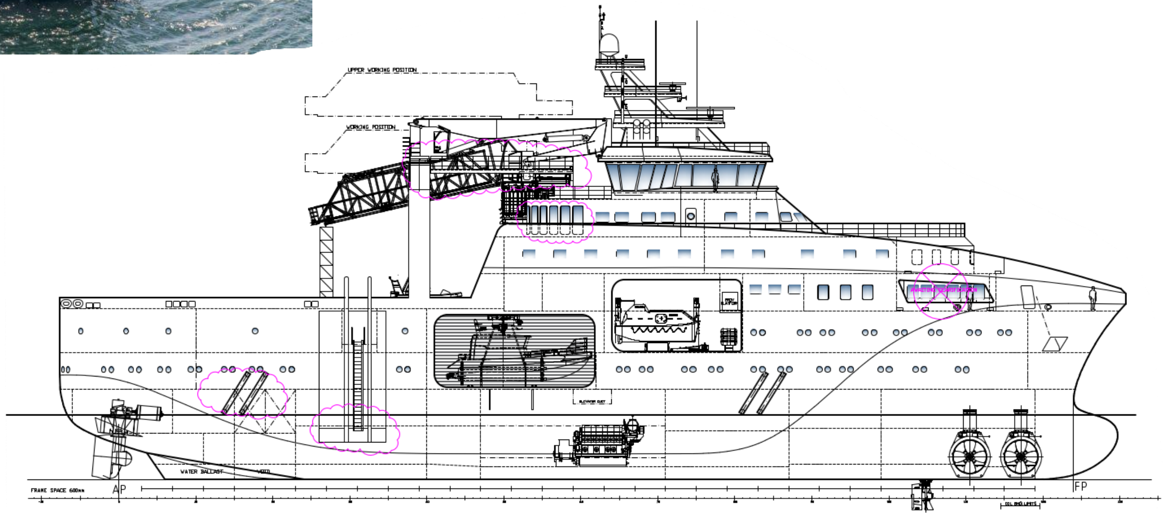
02 SRP-D next level DP performance

Investigation Case

Wind of Change, Wind of Hope
Louis Dreyfus Armateurs
SALT ship design

Loa:	84 m
Bm:	19,4 m
Draught:	5,02 m

Main Azimuth Thruster:	2x SRP430 1660 kW
Retractable Thruster:	1x SRP260R 880 kW
Tunnel Thruster:	2x STT6 1400 kW



2x SRP430 1660 kW

1x SRP260R 880 kW

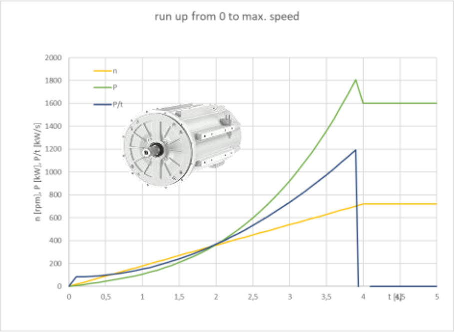
2x STT6 1400 kW

salt
WINDFARM SUPPORT VESSEL

02 SRP-D next level DP performance

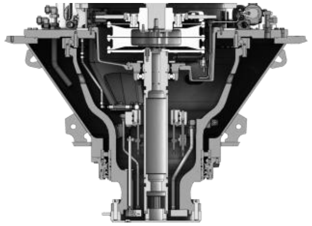
Dynamic fast response azimuth thruster

First round of investigations:



Dynamic fast response L-Drive

- **Fast propeller acceleration**
- **Ramp up time of 4 sec (0-100%)**



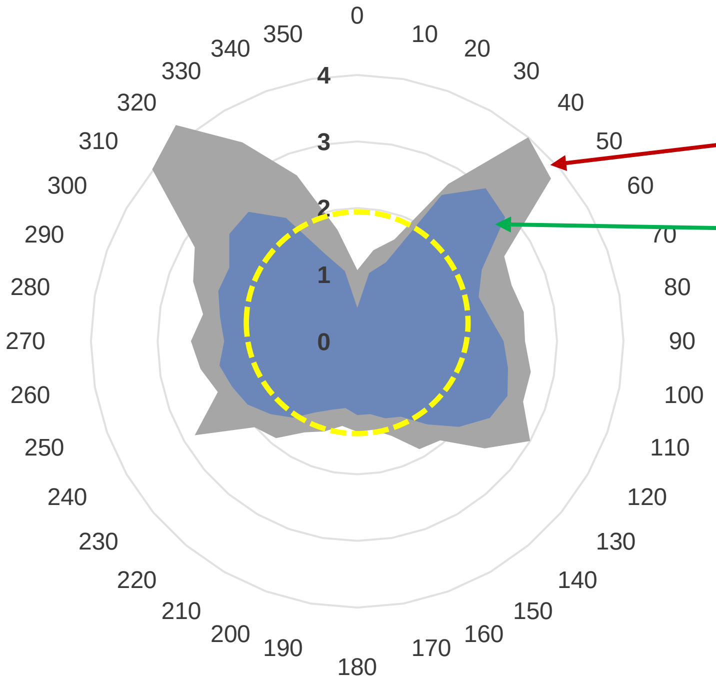
High-speed azimuth steering

- **Steering speed 5 rpm (180°)**
- **Ramp up time abt. 0,6 - 1,2 sec**

03 DNV L3-simulations

Significantly improved DP footprint ~25% overall

Max. position loss [m]

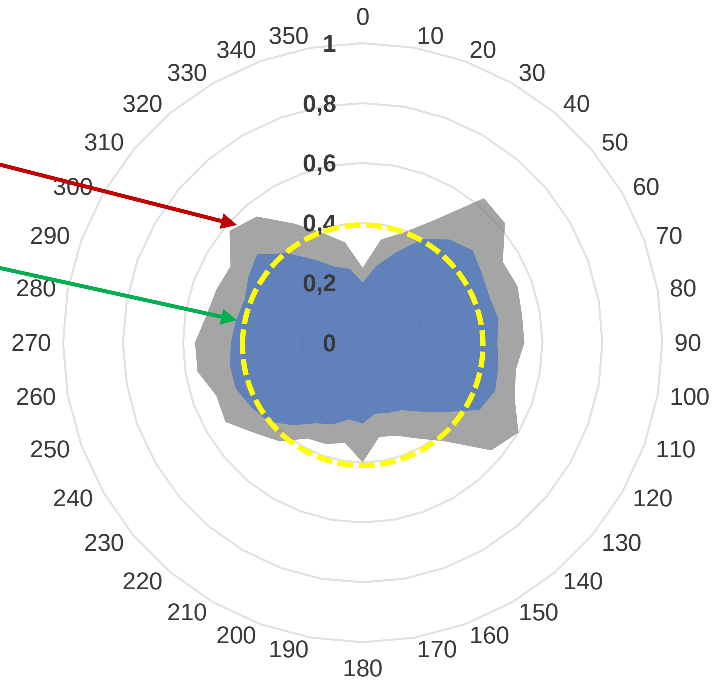


Significant wave height **Hs = 2,5 m**

Standard SRP

SRP-D

Mean position loss [m]



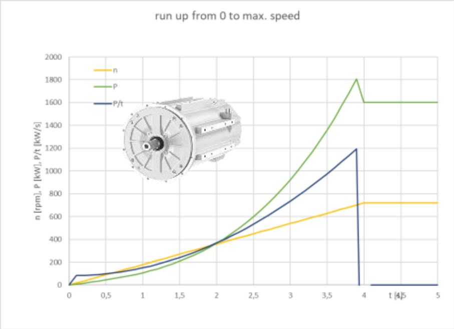
Environmental conditions:	
Significant wave height	**Hs = 2,5 m**
Wave peak period	T = 8,0 sec.
Wind speed	**21 m/s**
Current speed	**1,0 m/s**

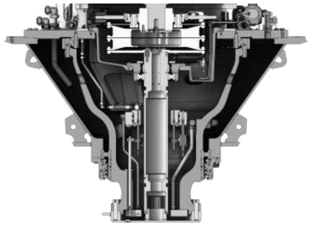
DNV: accumulated result of 180 wave seeds

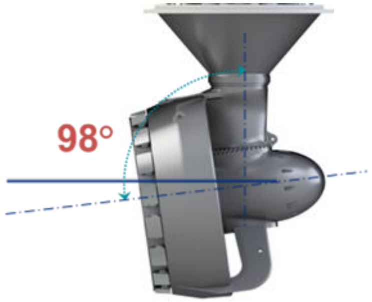
03 DNV L3-simulations

SRP-D next level DP performance

Second round of investigations:







Dynamic fast response L-Drive

- Fast propeller acceleration
- Ramp up time of 4 sec (0-100%)

High-speed azimuth steering

- Steering speed 5 rpm (180°)
- Ramp up time abt. 0,6 - 1,2 sec

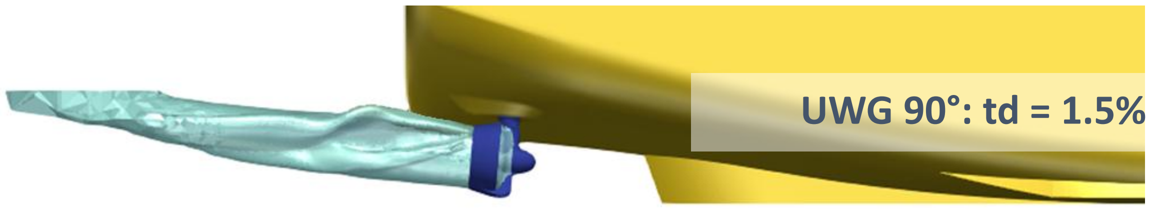
98° Gearbox

- Minimizing interaction effects
- Reduction / elimination of forbidden zones

03 DNV L3-simulations

SCHOTTEL CFD Thruster - Hull Interaction

Bollard pull ahead, thruster angle 0°



- 90° gear box:
  Beam interaction with surface not considered.
  → may result in increase thrust losses

Bollard pull astern, thruster angle 180°

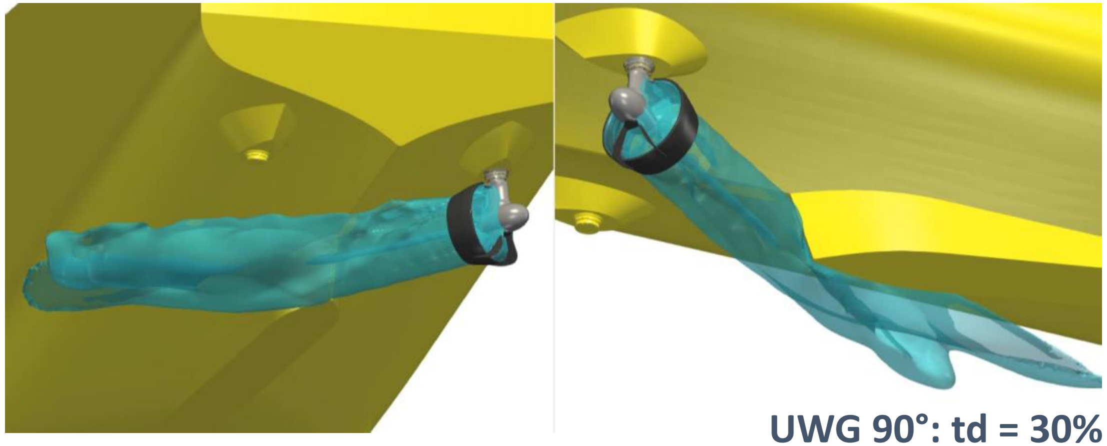
- 98° Gear box:
  Beam moves “parallel” to hull and hardly interacts
  → reduced thrust losses

Thrust deduction $= 1 - \frac{T_{Total}}{T_{Unit}}$ [-]

03 DNV L3-simulations

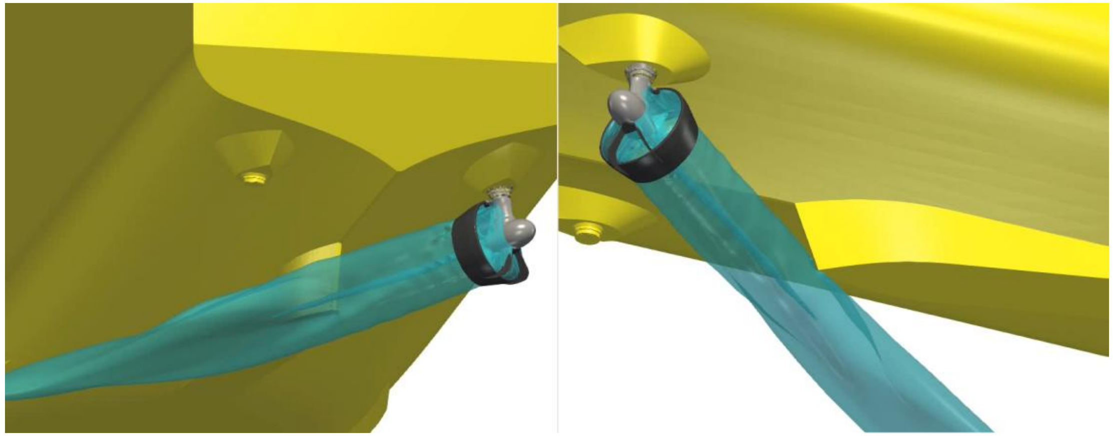
SCHOTTEL CFD Thruster - Hull Interaction

Bollard pull, thruster angle 135°



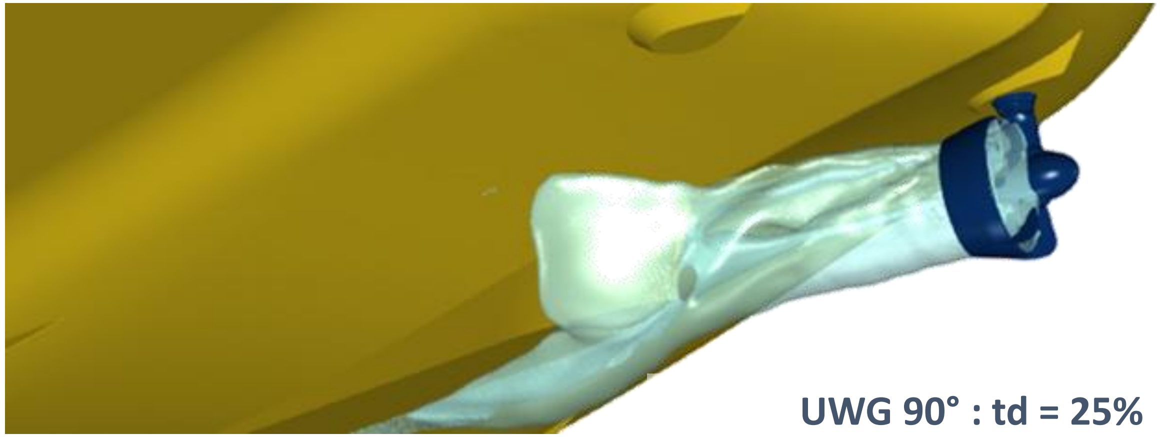
UWG 90°: td = 30%

- Strong hull interactions (COANDA)

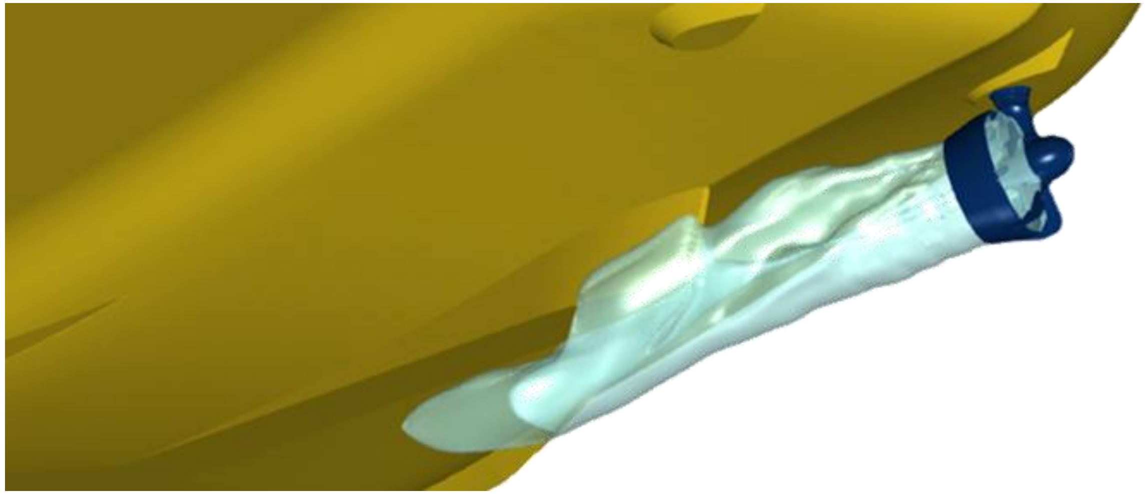


UWG 98° : td = 8%

Bollard pull, thruster angle 150°



UWG 90° : td = 25%



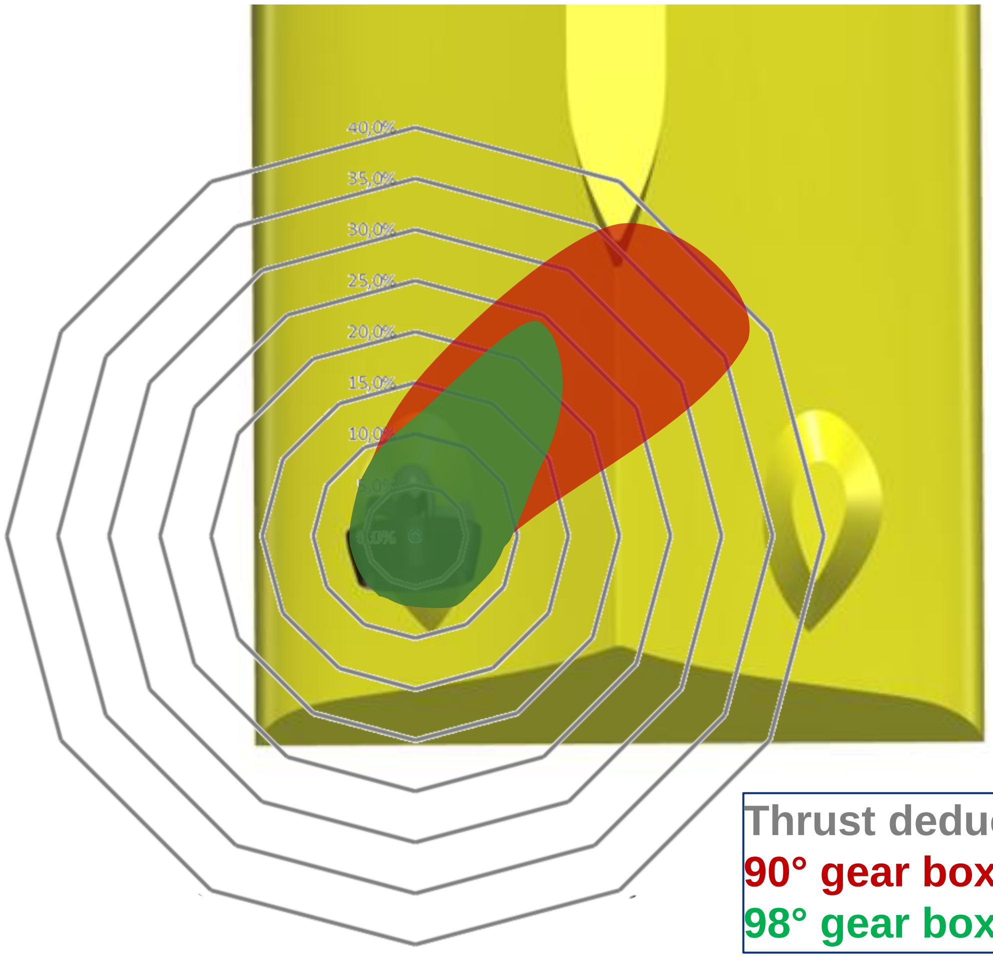
UWG 98°: td = 17%

Thrust deduction = $1 - \frac{T_{Total}}{T_{Unit}}$ [-]

03 DNV L3-simulations

SCHOTTEL CFD Thruster - Hull Interaction

Using a 98° gear box, combined with an appropriate installation reduces the thruster-hull interaction significantly.



Thrust deduction
90° gear box
98° gear box

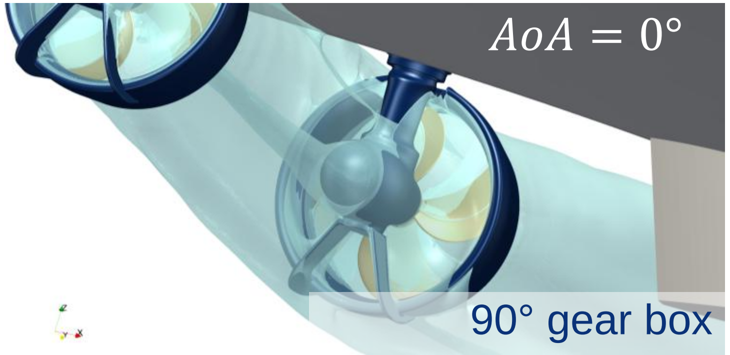
- Increased system efficiency
- Increased maneuverability
- Reduction of Forbidden Zones during DP
- Reduced noise and vibration caused by reduced thruster-hull-interaction

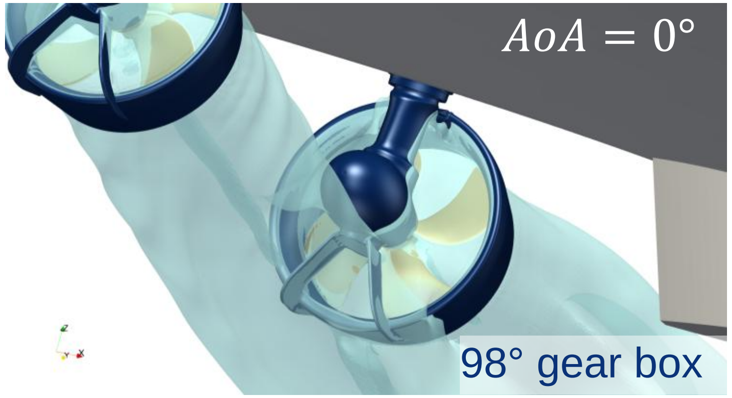
03 DNV L3-simulations

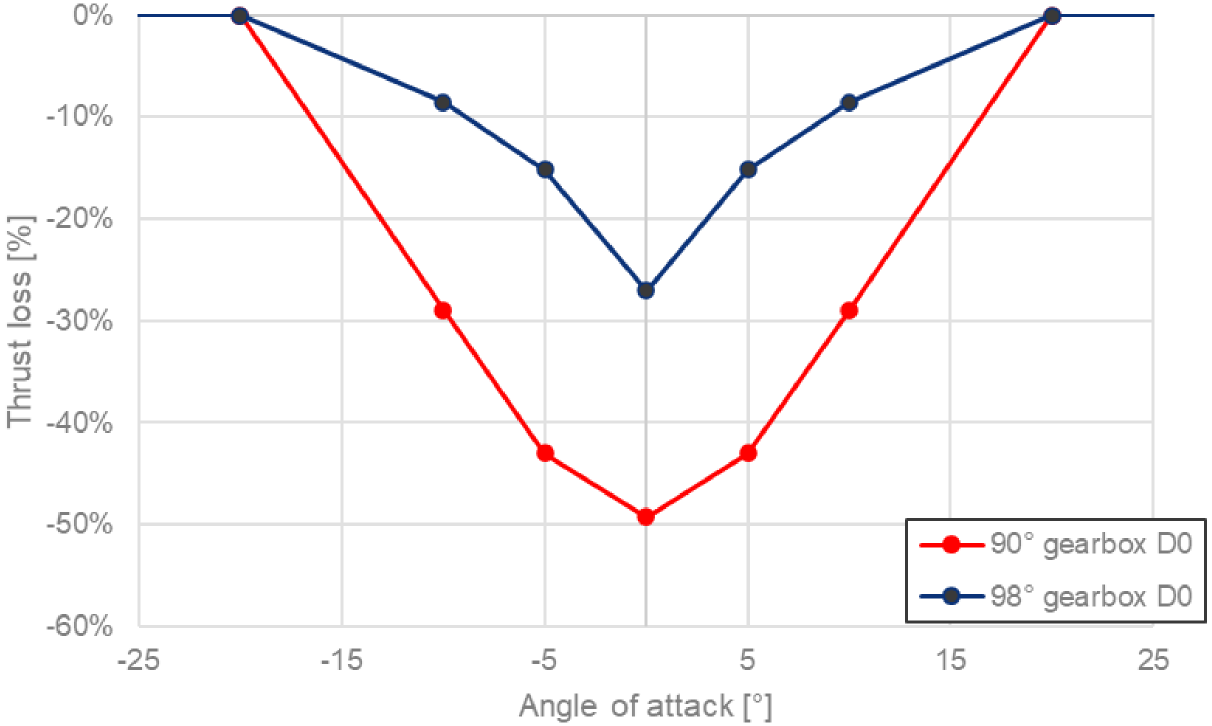
SCHOTTEL CFD Thruster - Hull Interaction

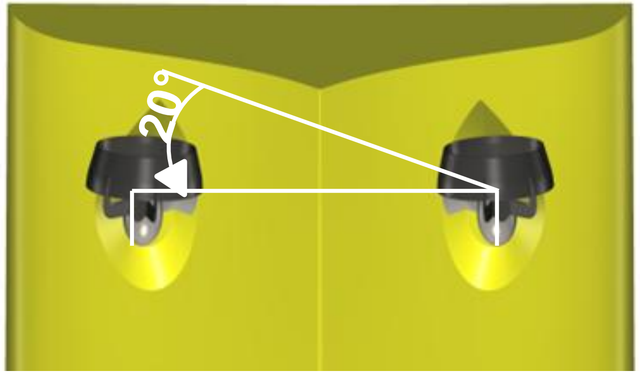
98° gear box performs significantly better

- Up to 45% increase in thrust for D_0
- Reduction of forbidden zone possible







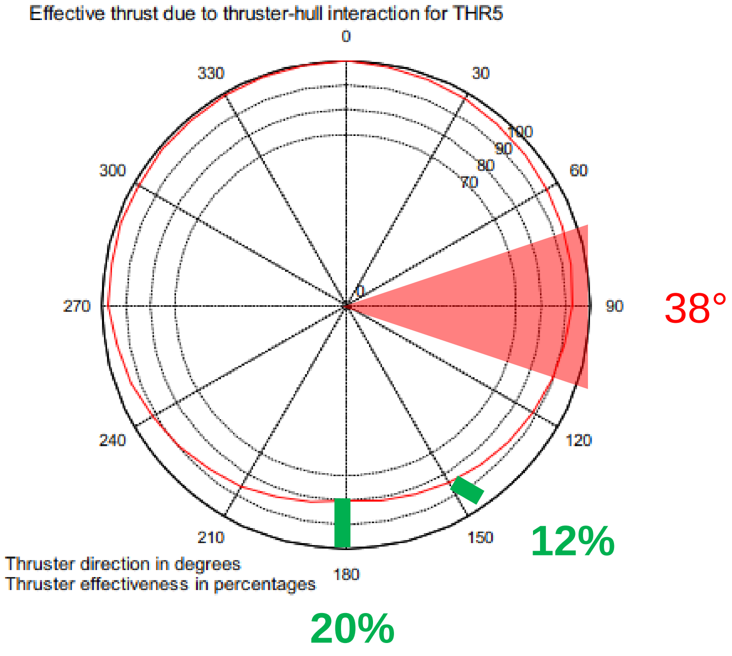


03 DNV L3-simulations

DP footprint calculation

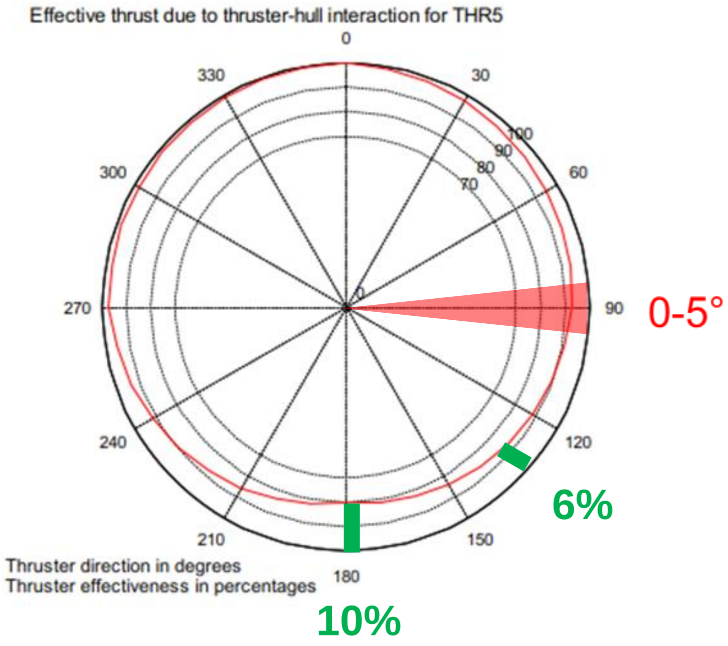
Standard calculation method

90° gearbox



Minimizing of forbidden zones

98° gearbox

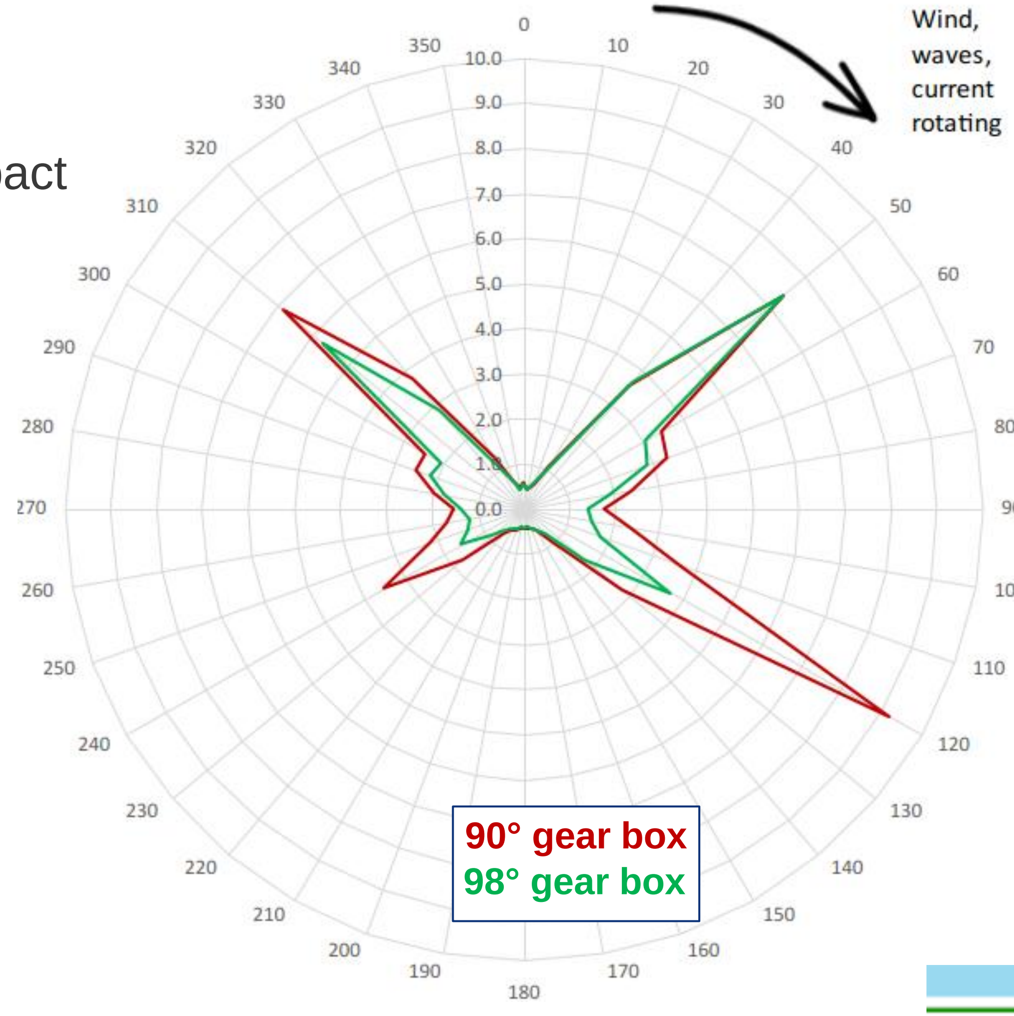


03 DNV L3-simulations

L3-site simulations with **98° thruster** considering thruster-hull and thruster-thruster interaction

- Position deviation improves at 120° and 240° weather impact

- Positioning performance benefit from:
  - less thruster-thruster interaction
  - narrower forbidden zone

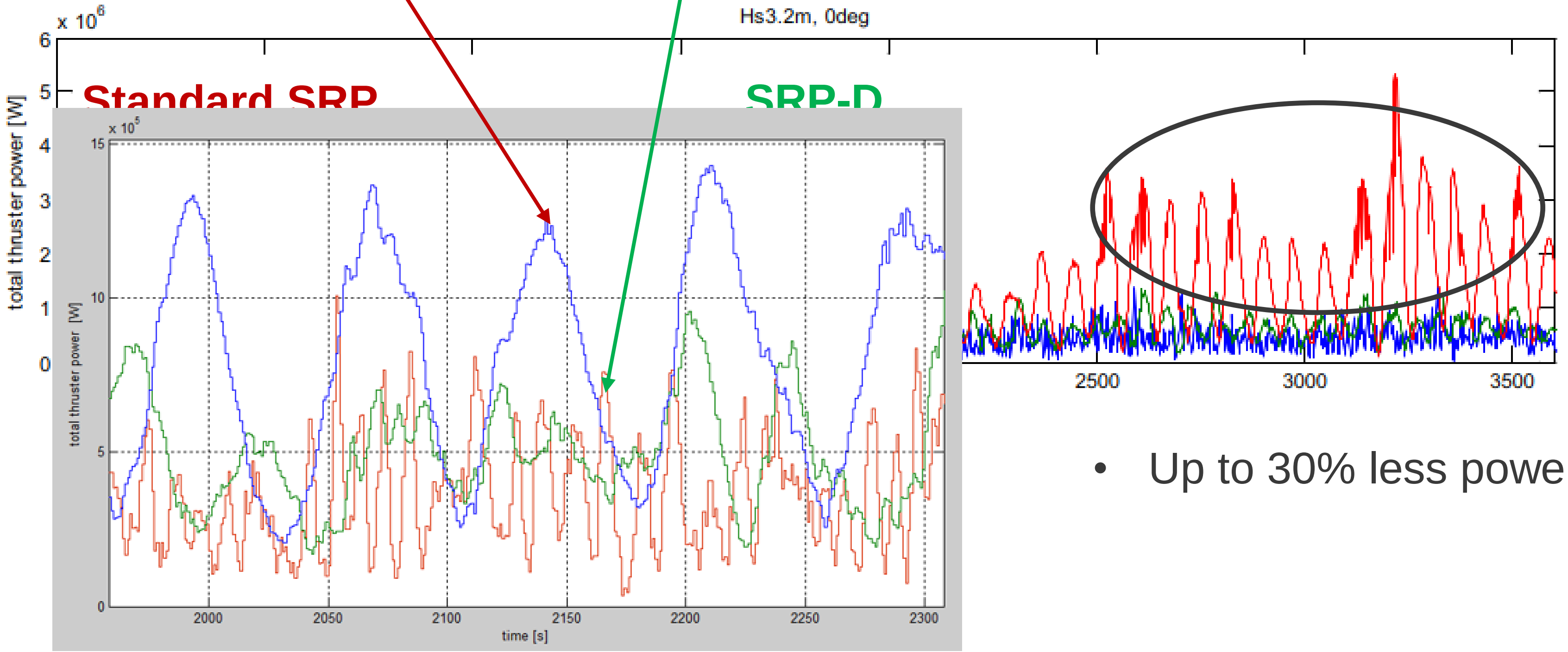


Significant wave height **Hs = 3,2 m**

03 DNV L3-simulations

Propulsion power demand during DP operation

Standard SRP **SRP-D**



- Standard SRP with position loss
- SRP-D remains stable

ases frequency but

- Up to 30% less power consumption during DP

04 NAVIS worst-case-failure simulation

Time-domain simulations by NAVIS Engineering Oy

WCF considered as loss of **Bus1**

Loss of **Port Z-Drive** and **Retractable Azimuth drive**

Wave height chosen within the vessel's static capability with the WCF

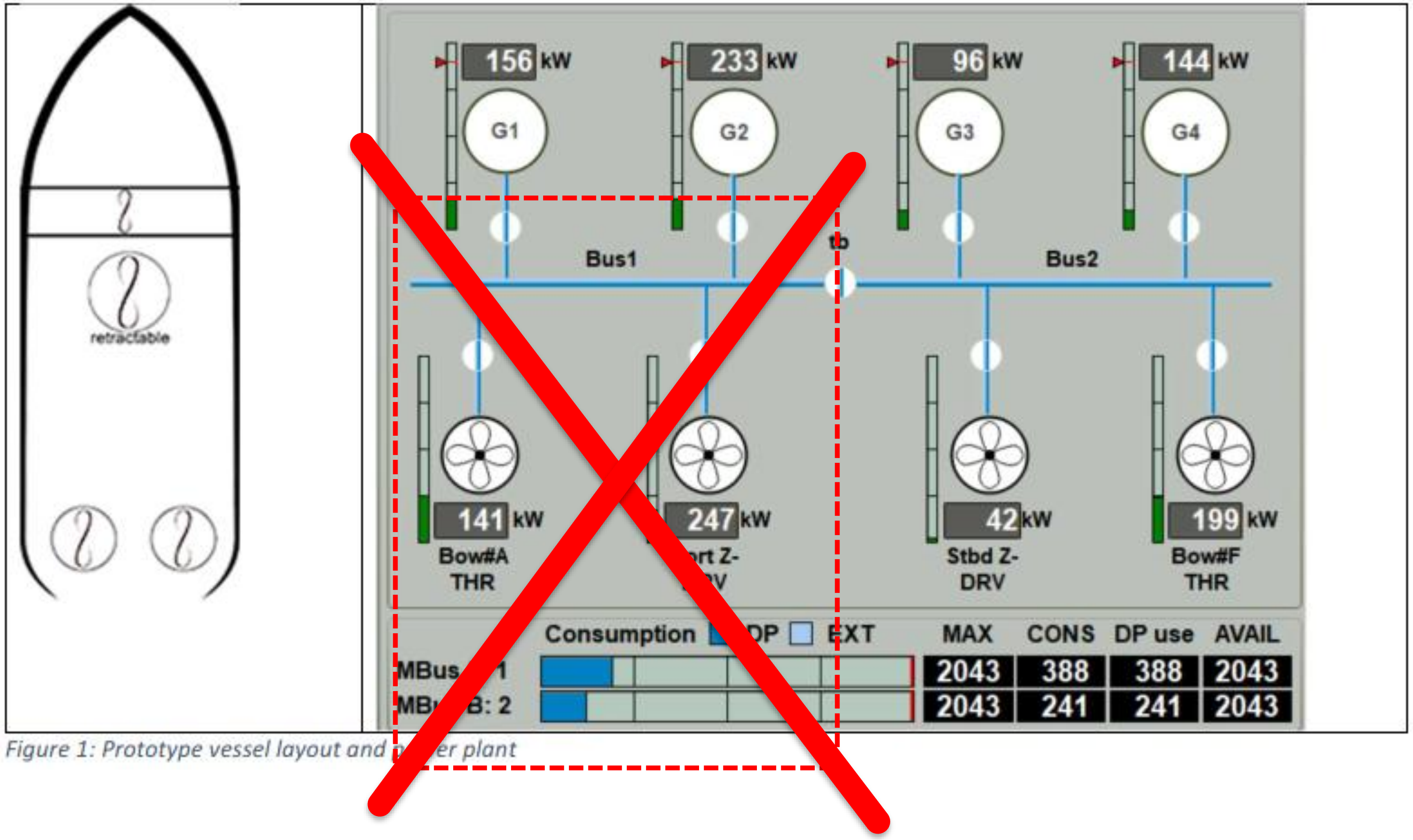
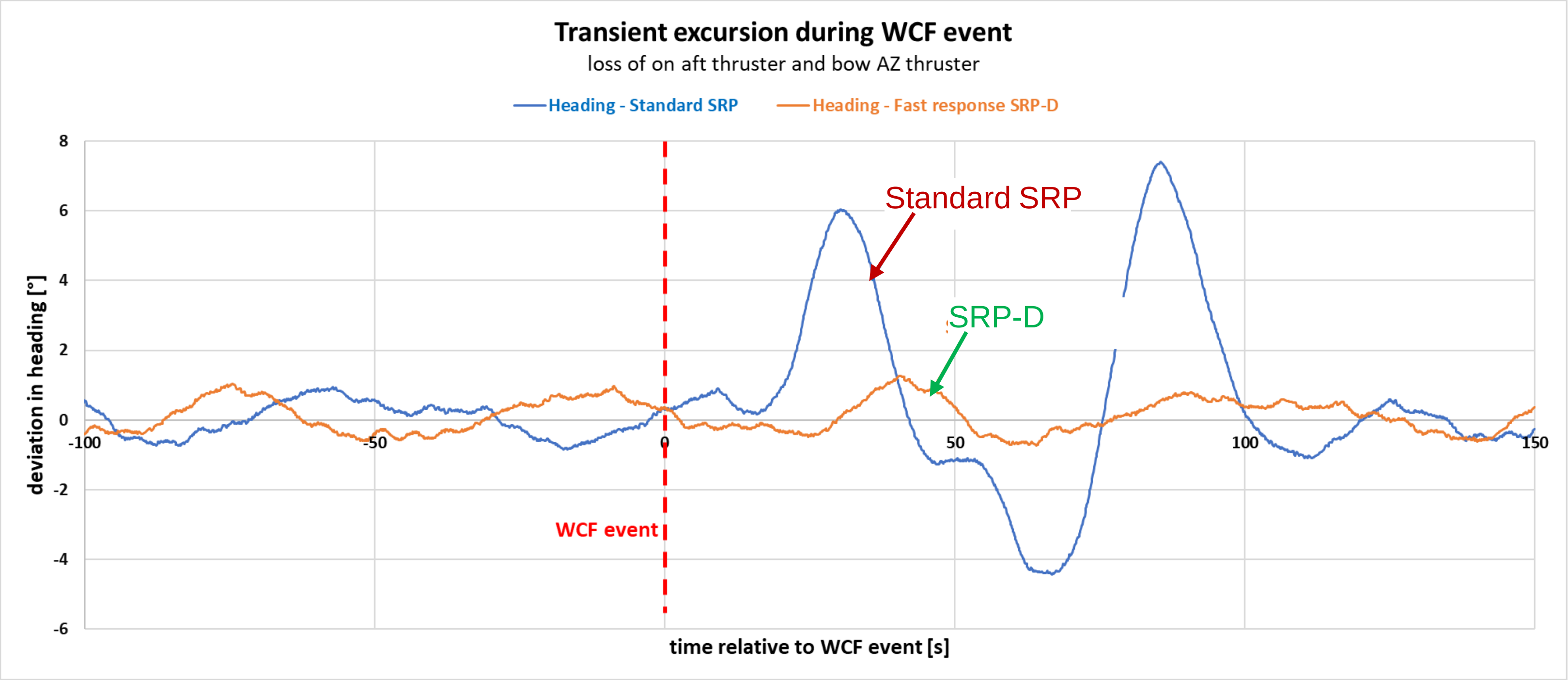


Figure 1: Prototype vessel layout and power plant

04 NAVIS worst-case-failure simulation

Heading deviation results

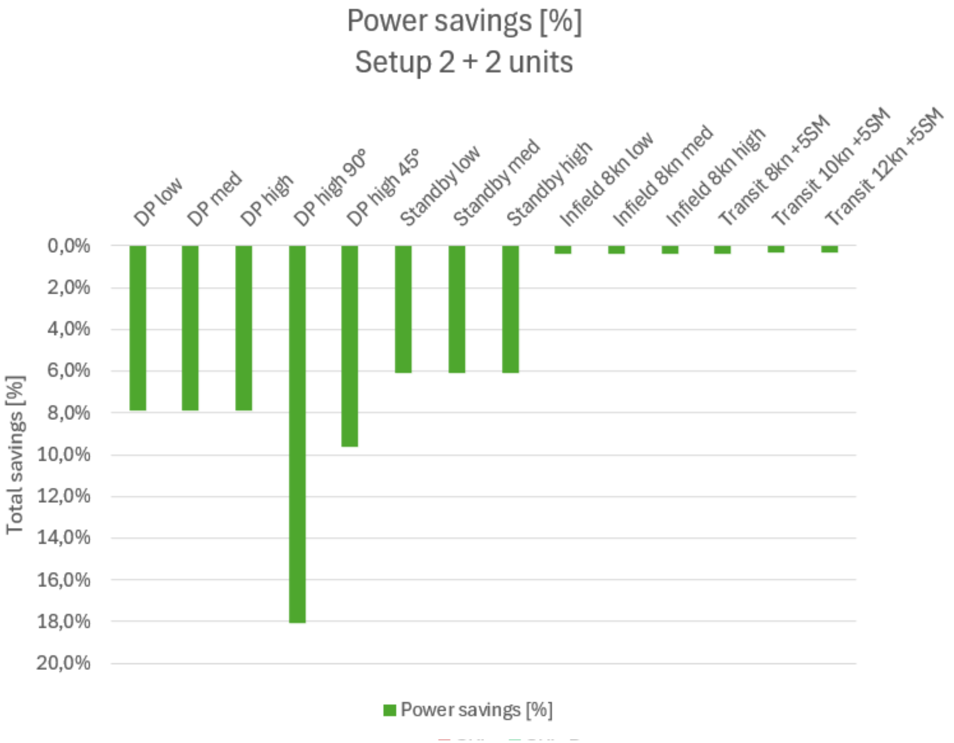


SRP-D significantly improves vessel stability and safety

05 MARIN comparable model test 4-corner design

DAMEN 9022 CSOV

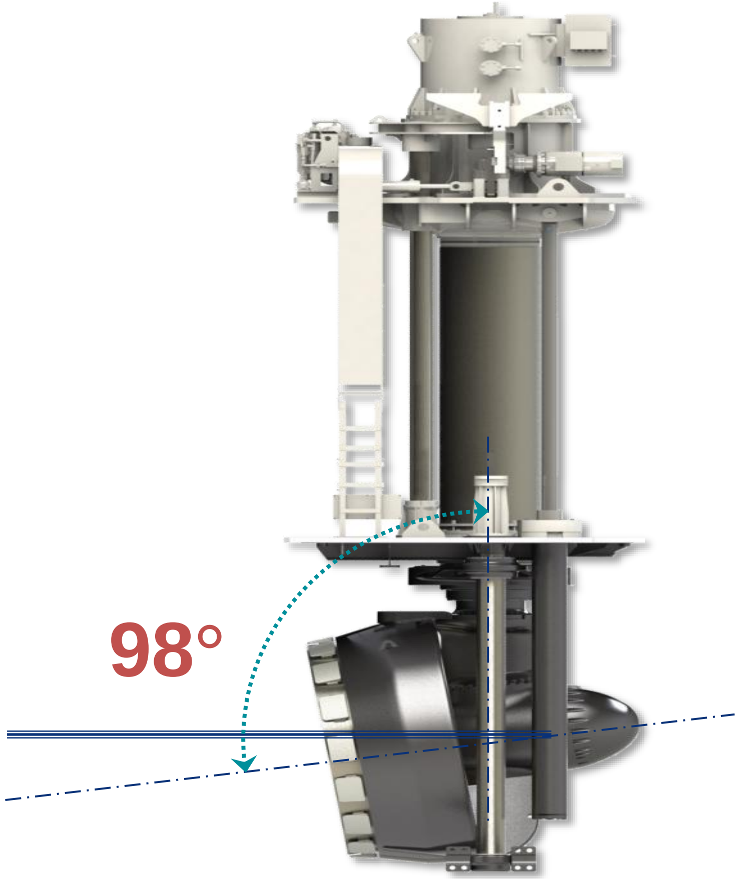
- 10 % reduced energy consumption over the entire operation profile
- 18% Power savings during high DP



06 SRP-D Retractable

SRP-R – 98° GEAR BOX

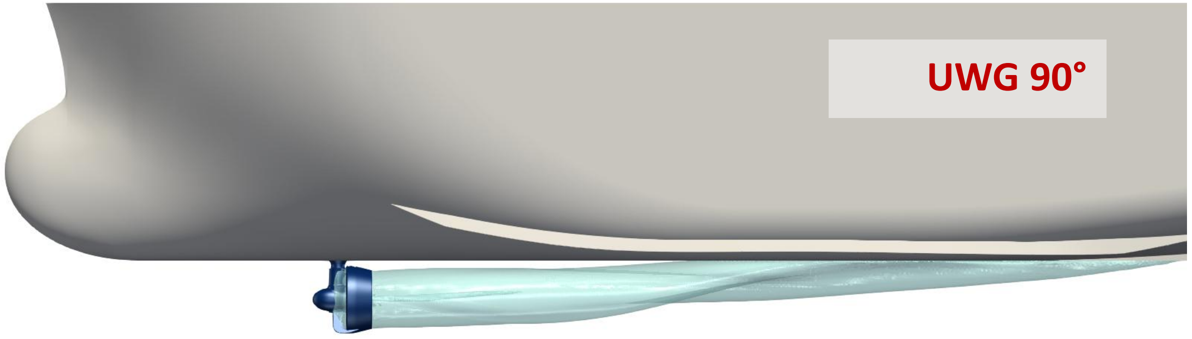
CFD Investigation of thrust deduction and hull-propeller wash interaction



06 SRP-D Retractable

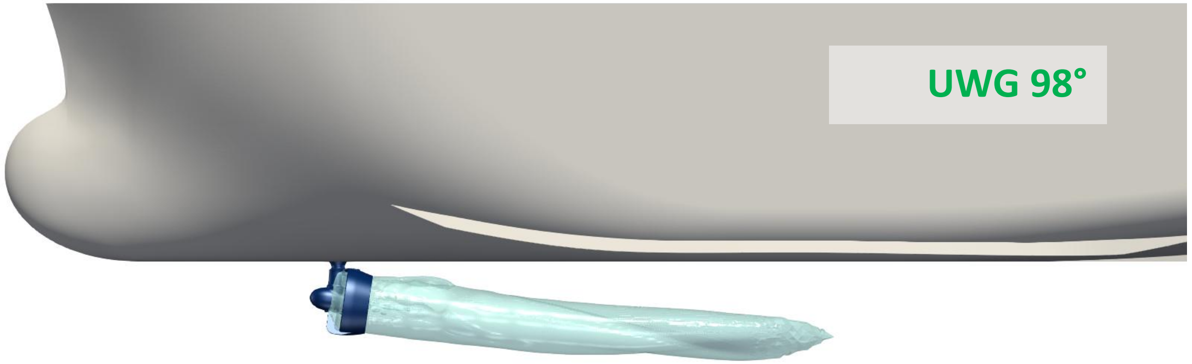
SRP-R under U-frame: thruster angle 0°

- 90° gear box: Thrust deduction = **6.48%**
- 98° gear box: Thrust deduction = **0.82%**



➢ 90° gear box: Beam sticks to hull

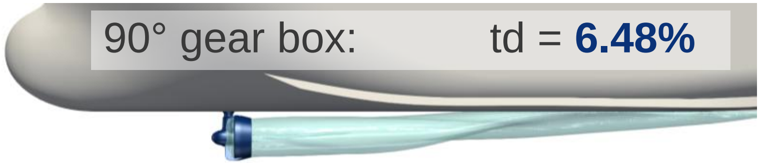
➢ 98° gear box: No interaction of beam with hull
Reduced pressure pulses

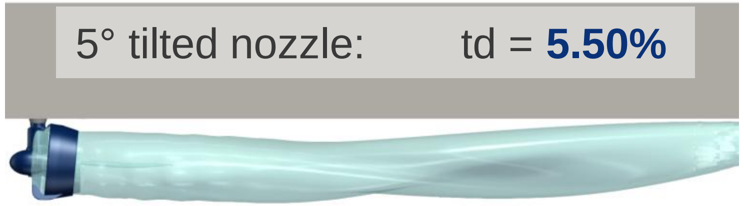


06 SRP-D Retractable

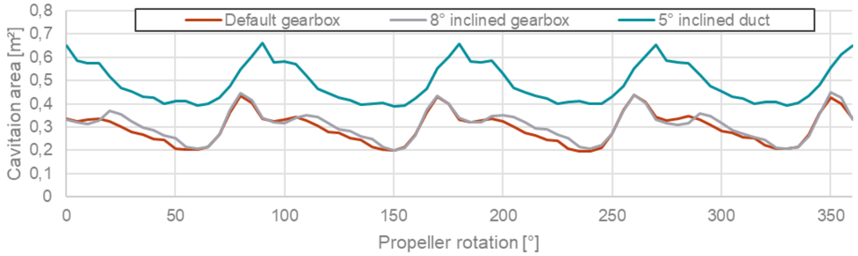
Comparing 90° gearbox, 5° tilted nozzle and 98° gear box

- Comparable open water performance
- 5° tilted nozzle shows hull interaction comparable to 90° gear box
- 5° tilted nozzle shows a significant high cavitation volume
  → High cavitation dynamics (hence noise / vibration)
- 98° gear box shows stable separation between propeller wash and hull.
  → min. thrust losses due to thruster-hull-interaction.
  → minor losses due to downward orientation of propeller wash.

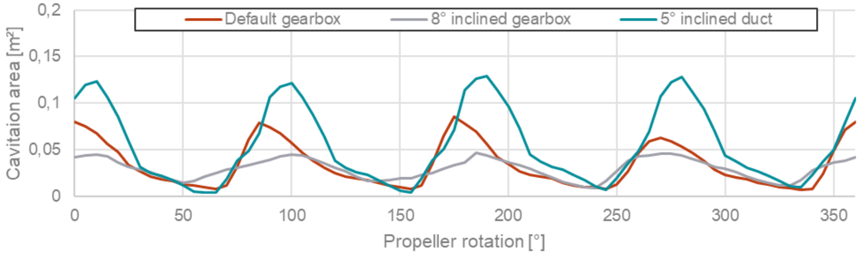




Cavitation dynamics



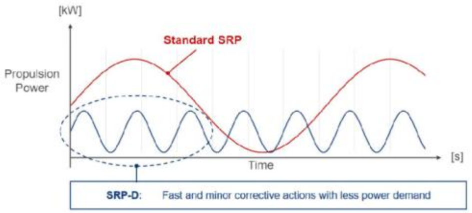
BP condition



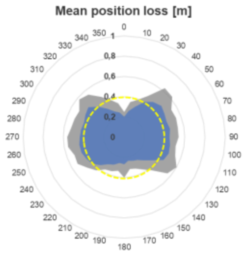
Free sailing condition

07 Conclusion

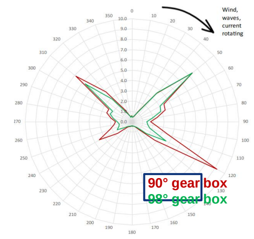
- **Significantly reduced power consumption during DP (18-30%)**



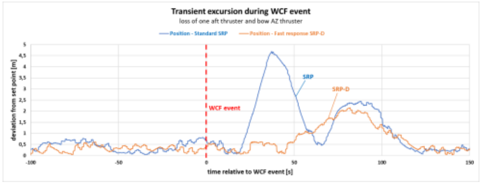
- **Improved position keeping during DP (25%)**



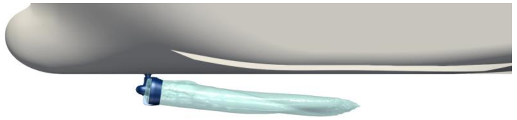
- **Extended uptime and weather window**



- **Improved vessel stability and safety for WCF scenario**



- **Minimised thuster – hull interaction**



ANY QUESTIONS?

I’M HAPPY TO ANSWER THEM.