Dynamic Positioning Committee
Marine Technology Society

DYNAMIC POSITIONING CONFERENCE
OCTOBER 9-11, 2017

RISK

Influence of Thruster Response Time on DP Capability by Time-Domain Simulations

Dirk Jürgens, Michael Palm
Voith Turbo

Influence of Thruster Response Time on DP Capability by Time-Domain Simulations

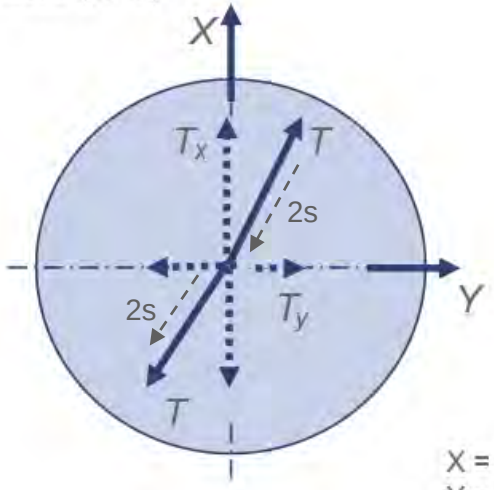
Dirk Jürgens, Michael Palm - Voith Turbo, Heidenheim, Germany

DP Conference Houston 2017

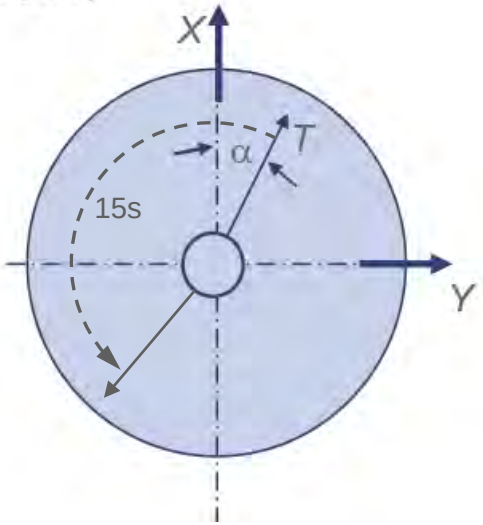
Voith Schneider Propeller

Thruster concepts

VSP Thrust Control:
According to rectangular coordinates (*X, Y*)



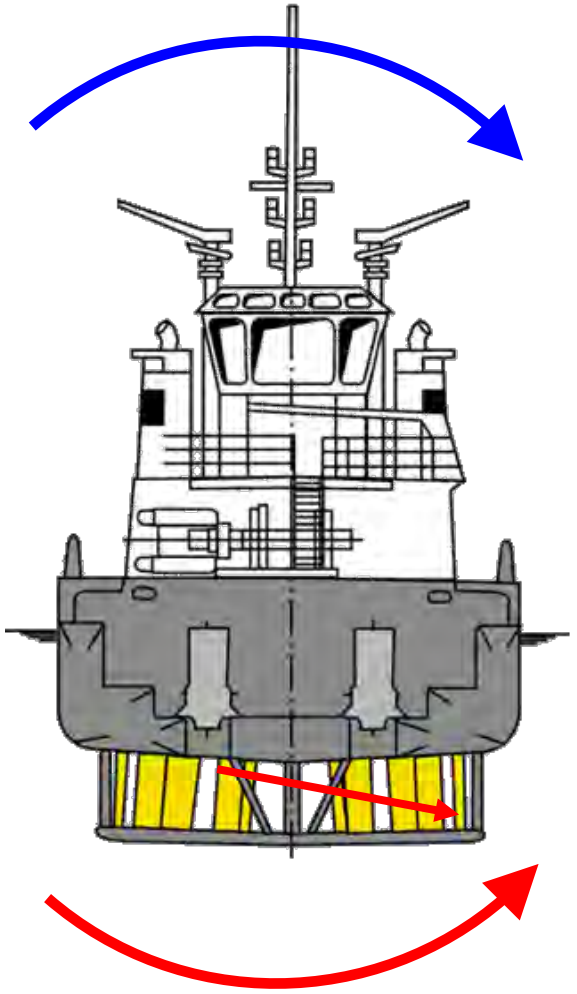
Z-drive Thrust Control:
According to polar coordinates (α, *T*)



X = longitudinal ship axis
Y = transversal ship axis

Voith Roll Stabilisation (VRS)

M_{wave} - Exciting wave moment



VSP Thrust

M_{VSP} - Stabilizing Moment by the VSP

VOITH

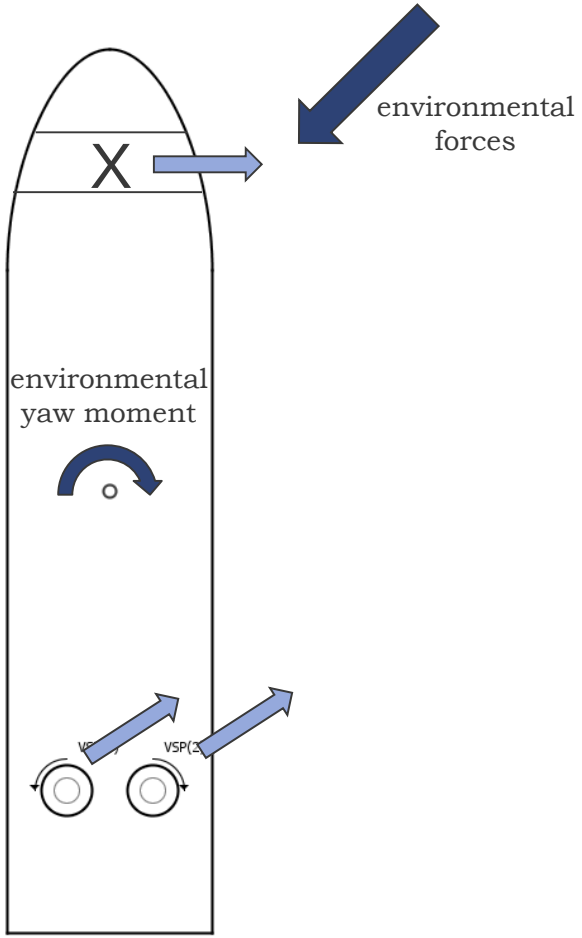
Voith Roll Stabilisation

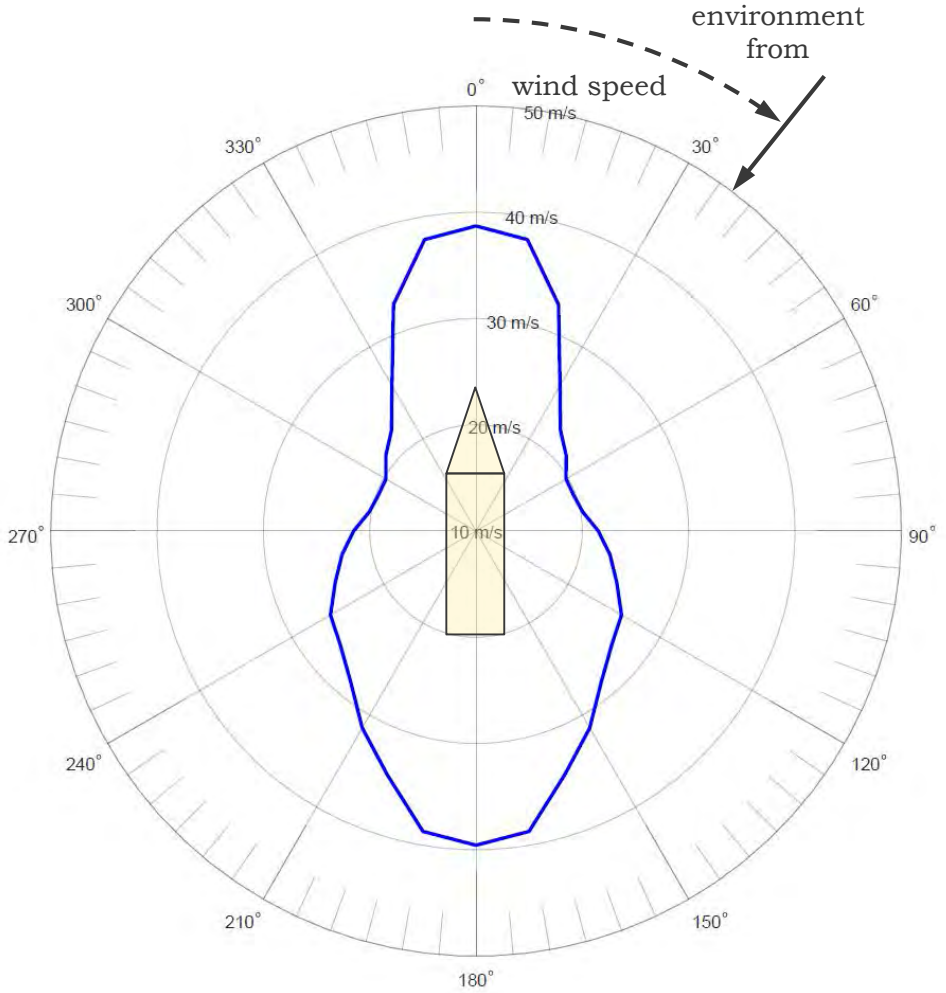
H_s = 4.0m

vessel speed = 9kn

Evaluation of DP capability

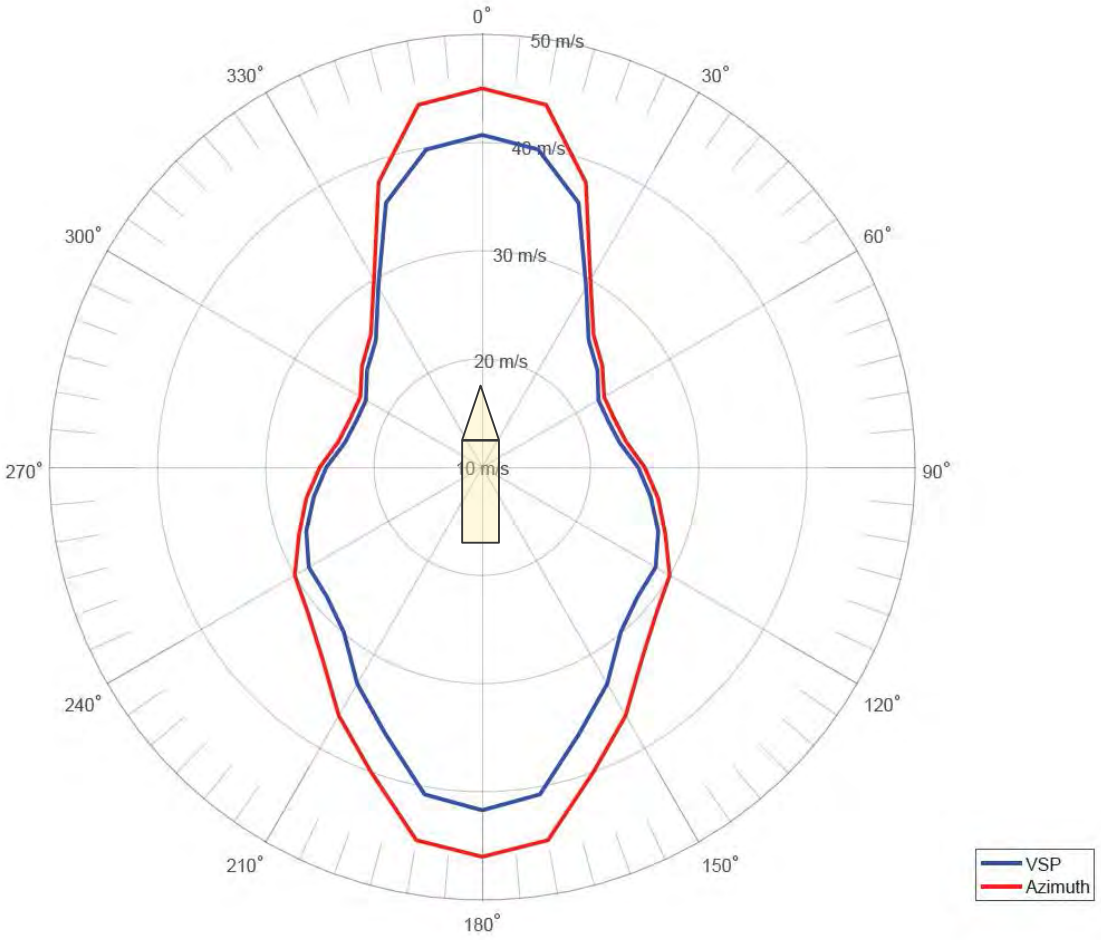
static capability plots





Intact wind envelope for azimuth and VSP

static analysis



DNV·GL

STANDARD

DNVGL-ST-0111 Edition July 2016

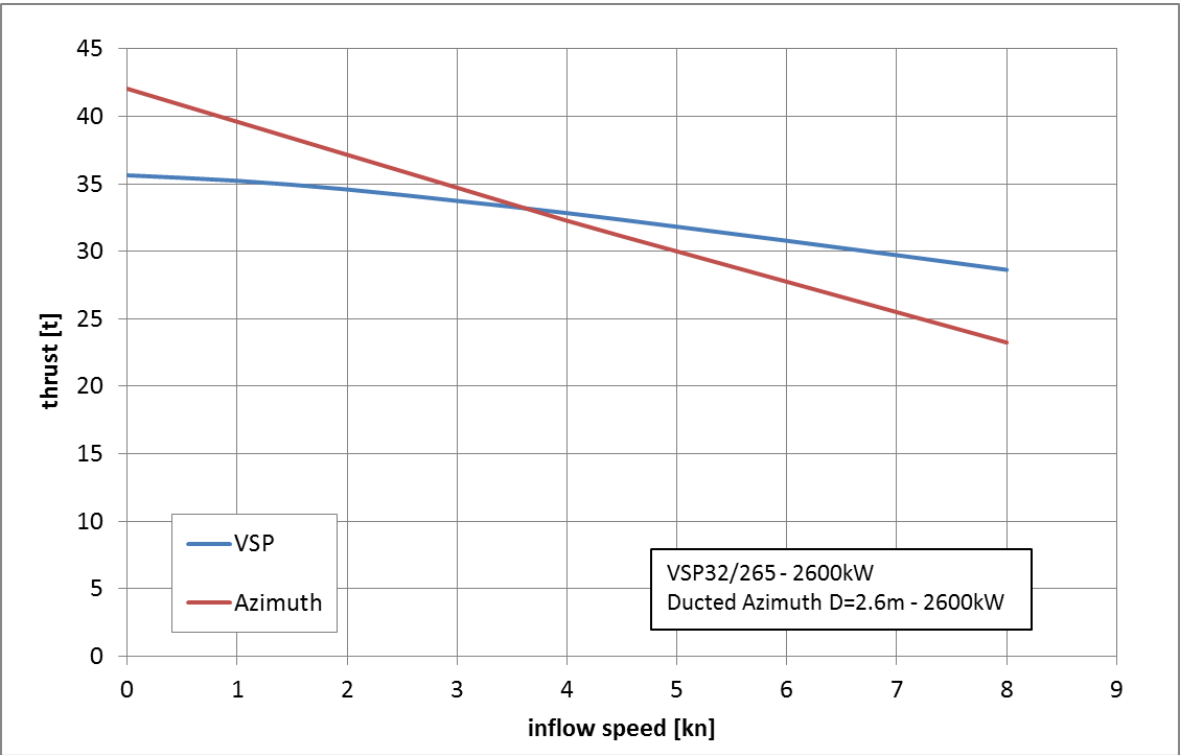
Assessment of station keeping capability of dynamic positioning vessels

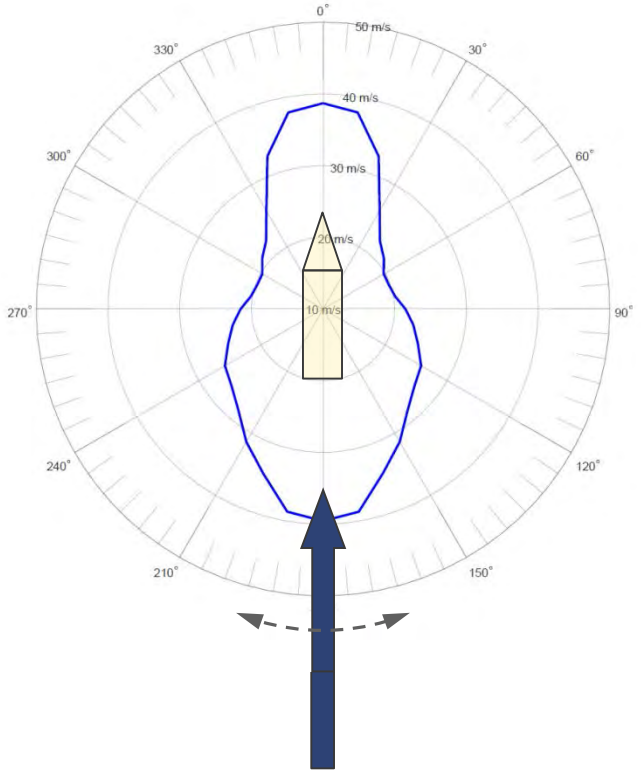
$$T_{Nominal} = \eta_1 \eta_2 (D \times P)^{2/3}$$

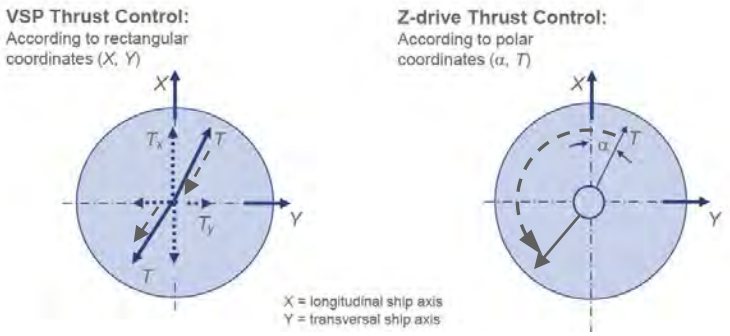
Evaluation of DP capability

neglected effects in static DP plots

- vessel is at rest
- no dynamic loads from environment
- only dependent on BP, not on response time







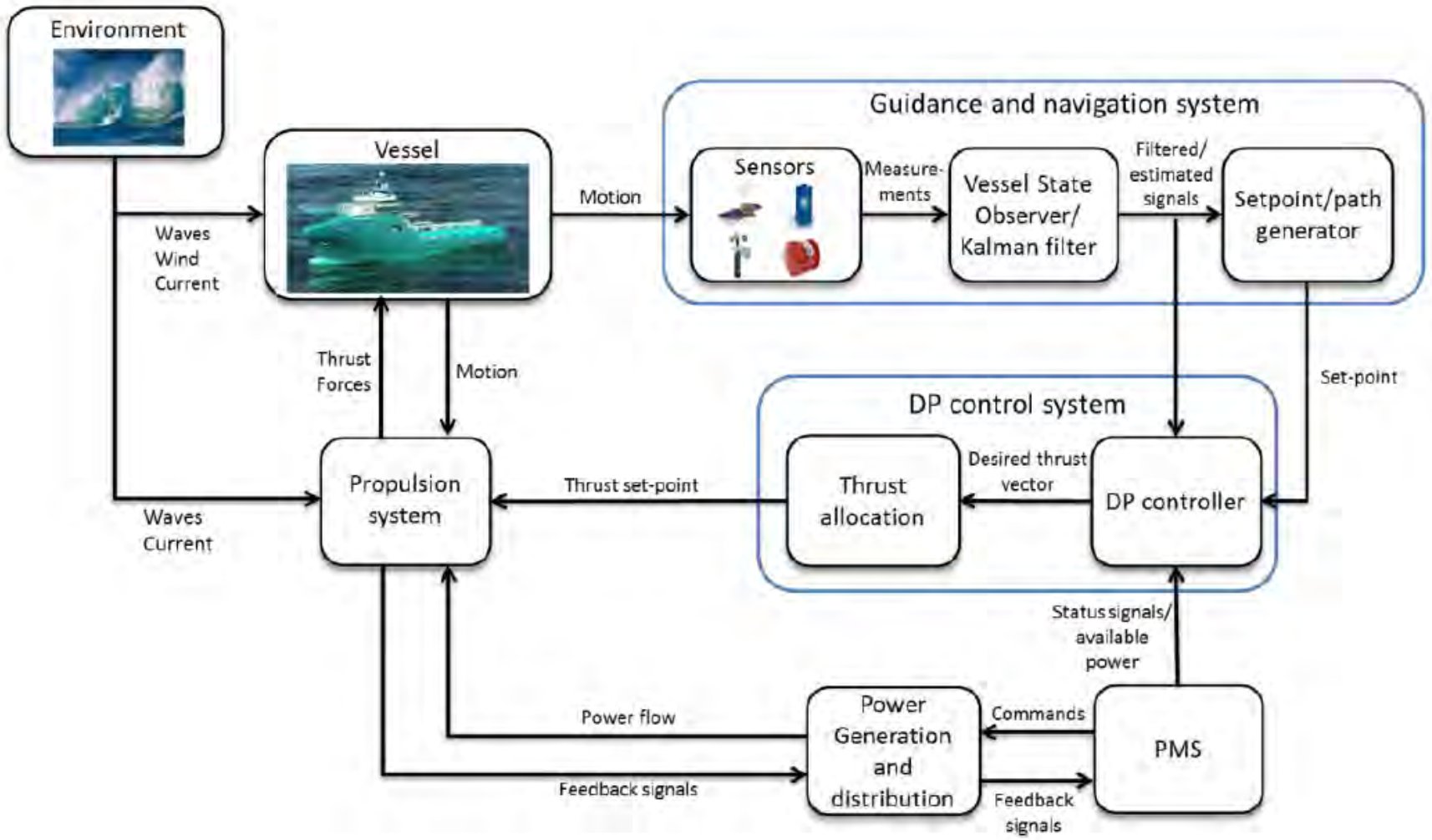
Motivation

- Determine the differences between static and dynamic capability plots
- Quantify the benefits in DP by means of a highly responsive propulsor

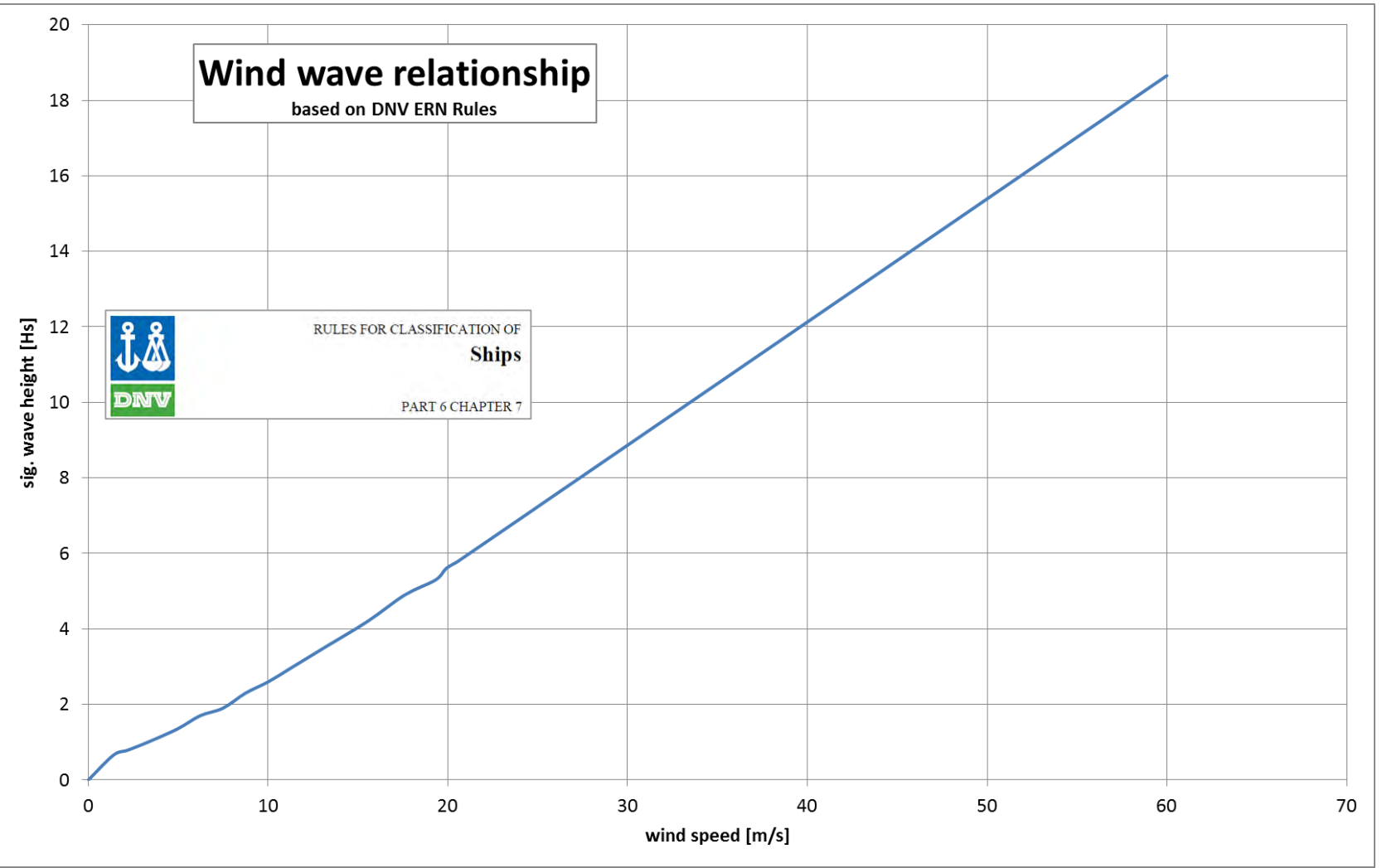
time domain DP simulations at

MARINE CYBERNETICS
a DNV GL company

Simulation approach

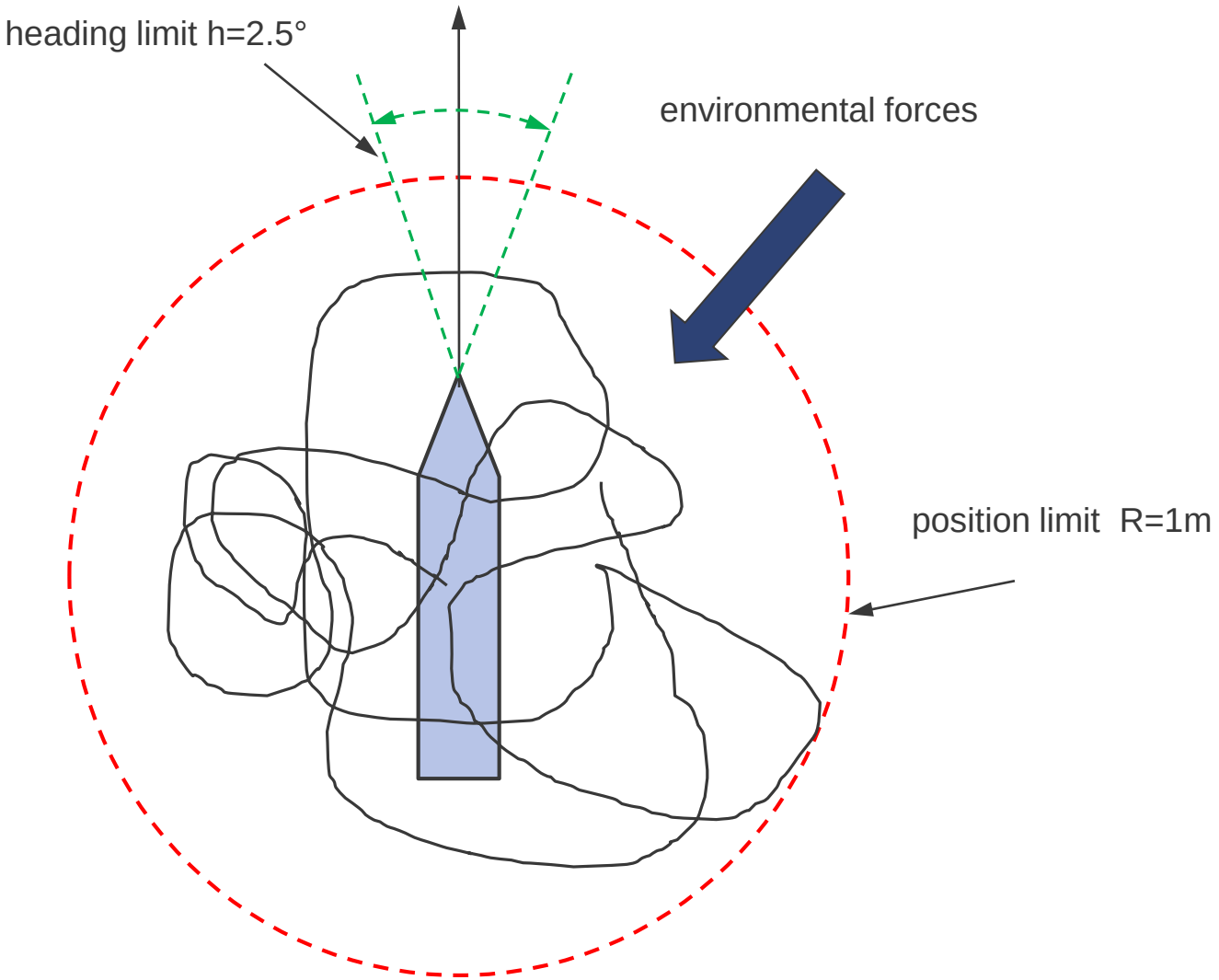


Environment data



wind-wave relationship based on DNV rules
current speed: 0.9m/s (1.75kn)
all collinear

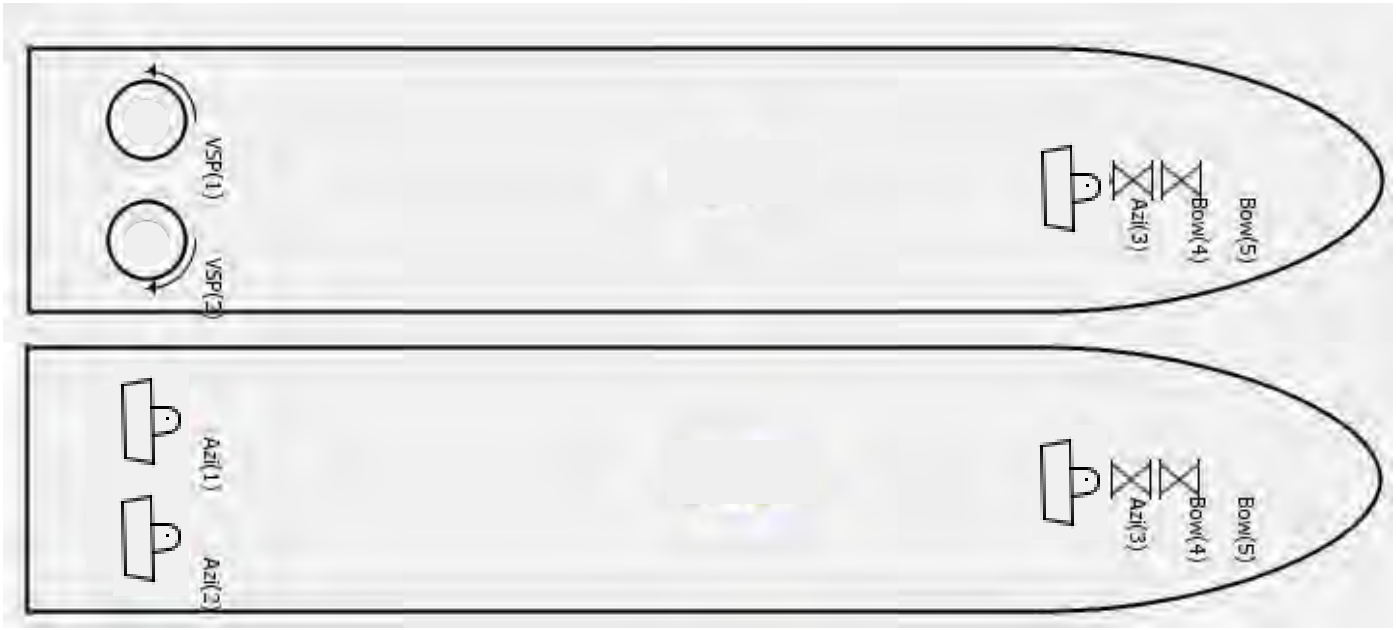
Dynamic DP simulation



Vessel configuration

Service Operation Vessel

Length	80m
Breadth	18m
Draught	6m
Displacement	6500t



Propulsion aft:

2 VSP28/234 P=1850kW BP =255kN

2 Azimuth Thruster CPP D=2.4m, Azimuth speed 3rpm P=1500kW BP =258kN

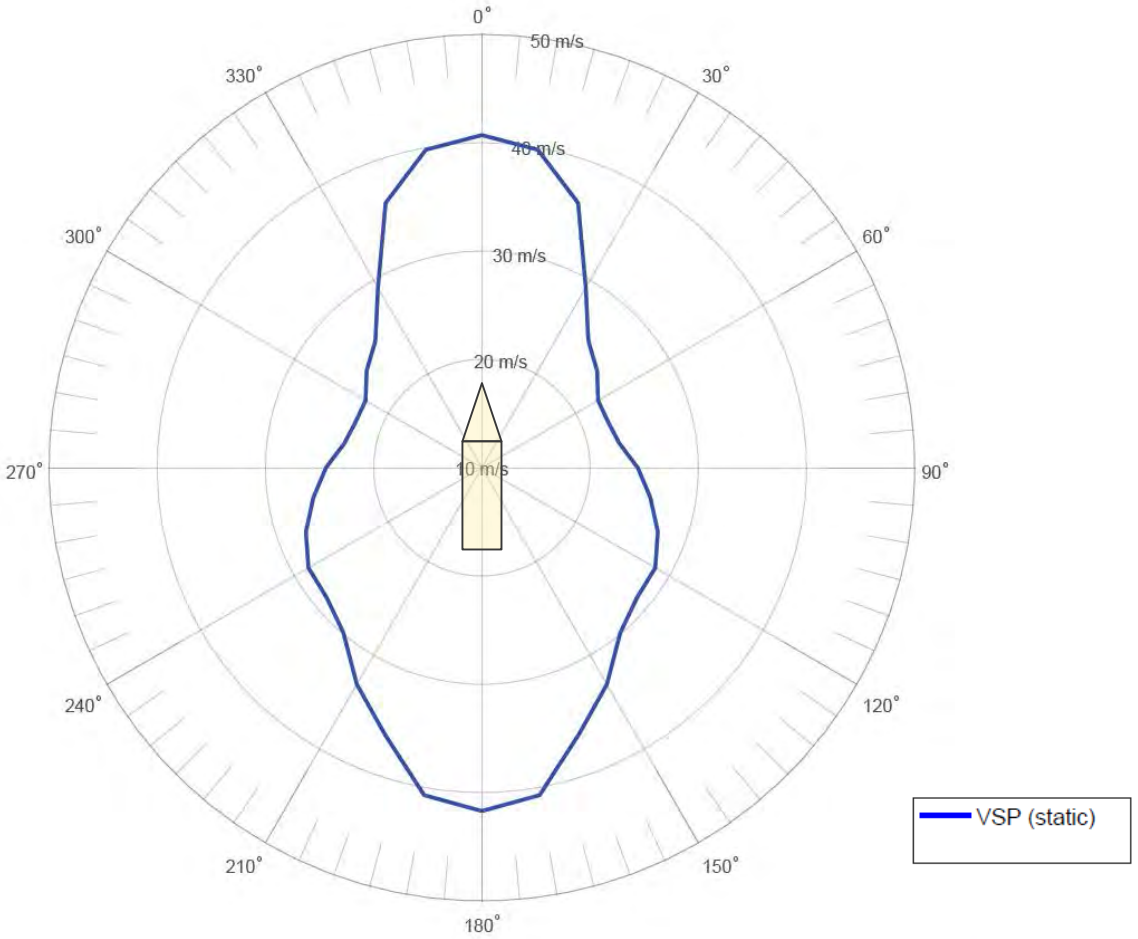
Propulsion bow:

2 tunnel thruster D=2.2m 1200kW and

1 Azimuth Thruster CPP D=1.6m 850kW

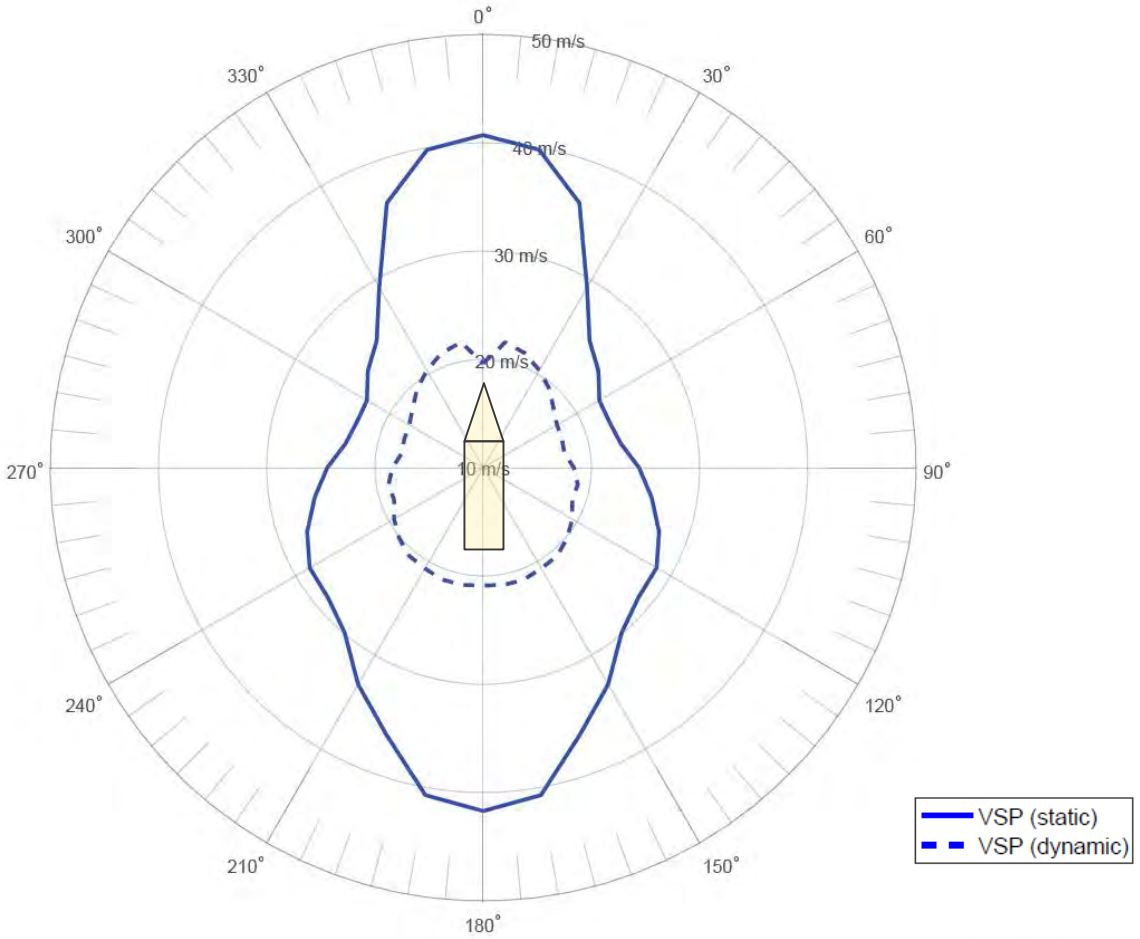
Intact wind envelope for azimuth and VSP

static analysis

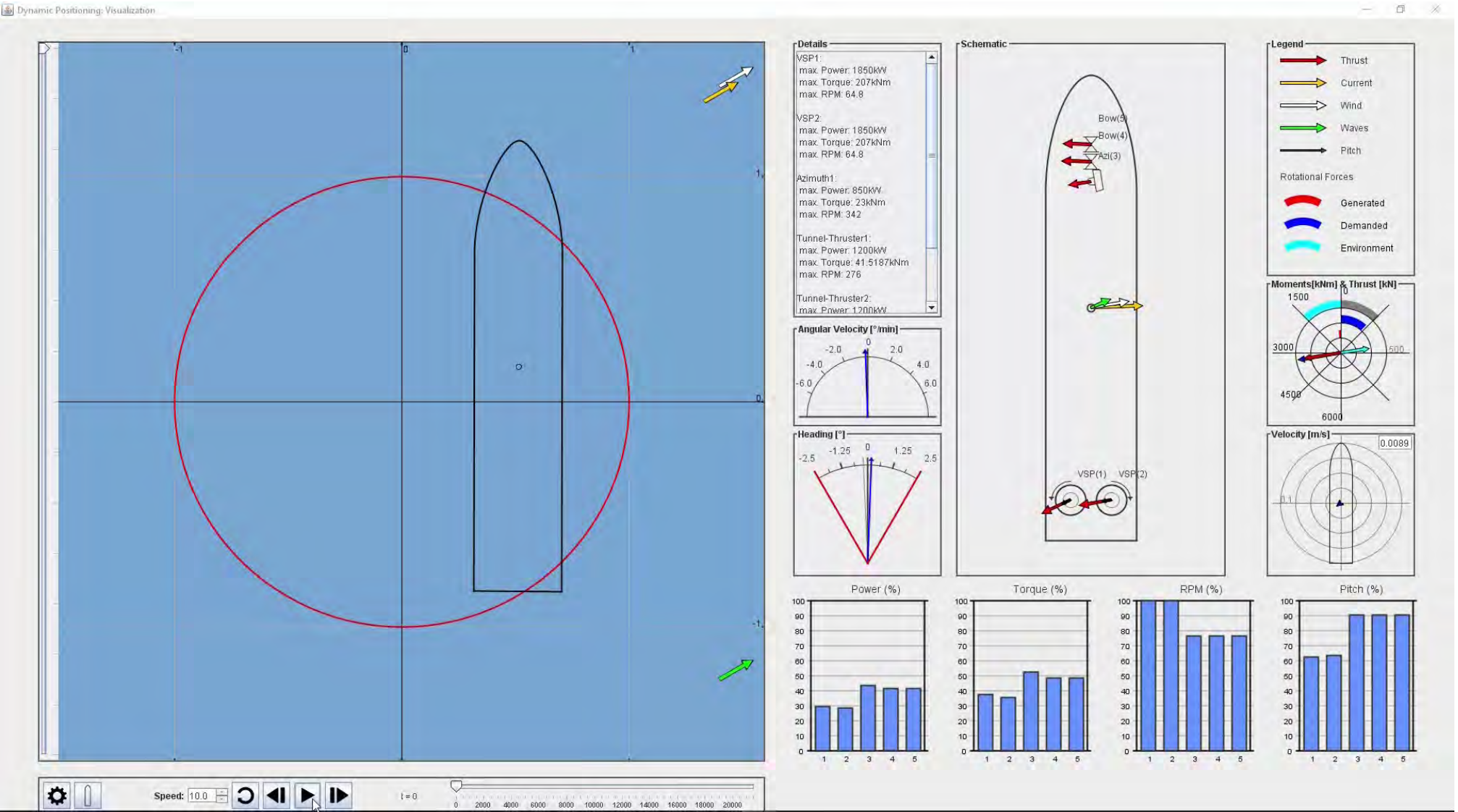


Intact wind envelope for azimuth and VSP

static and dynamic analysis

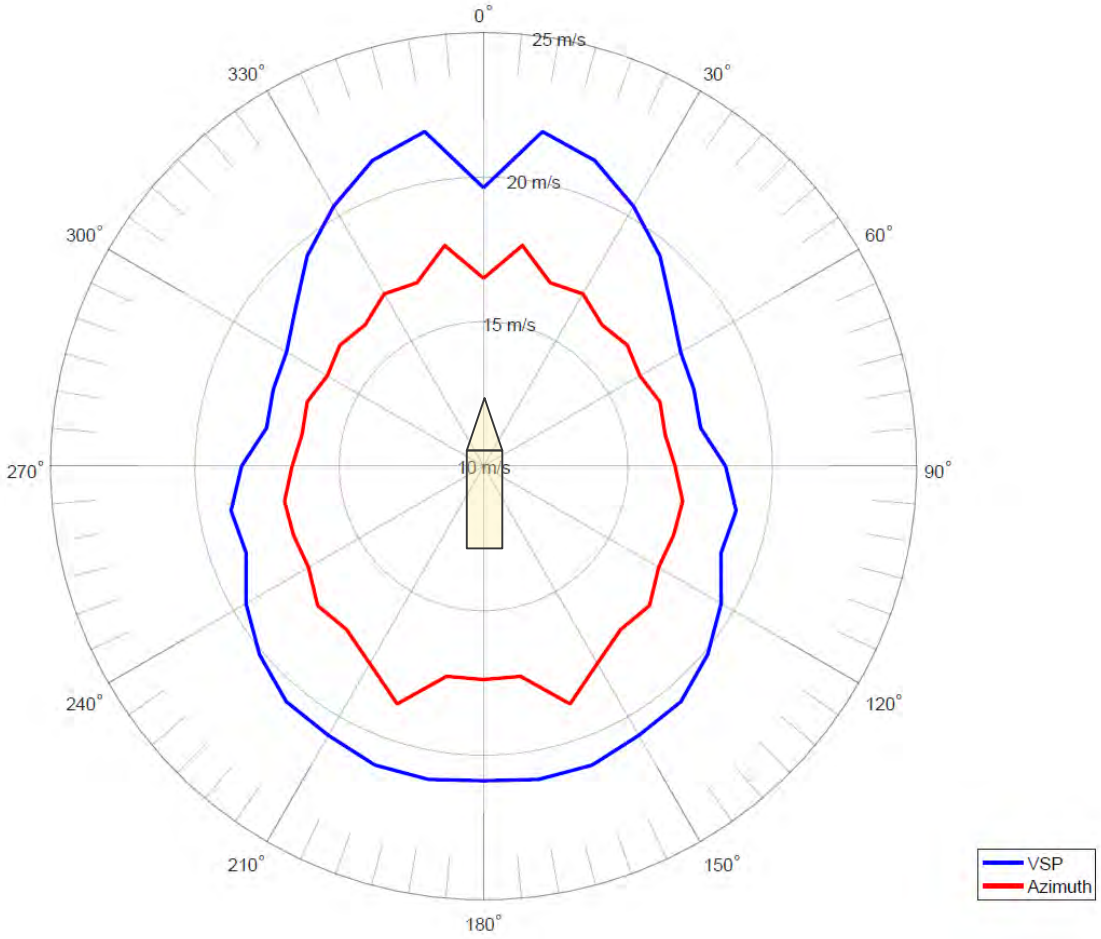


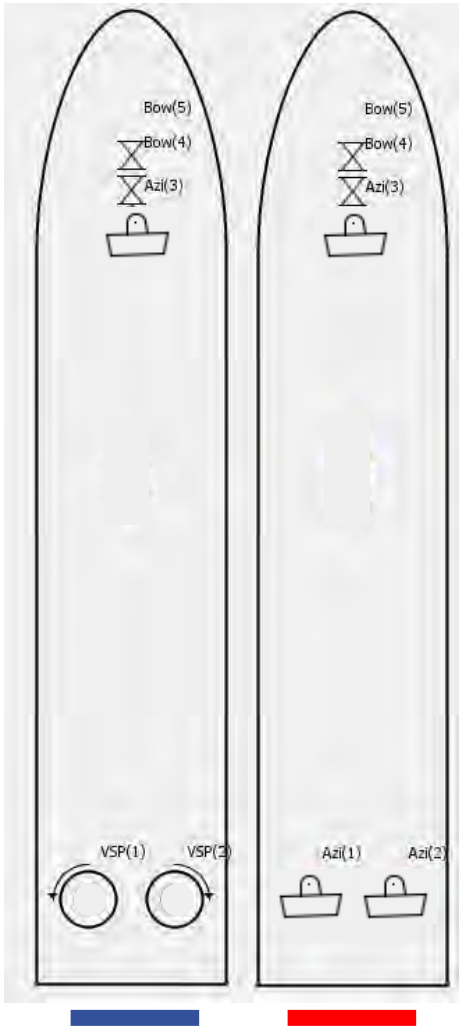
Visualization of transient DP simulations



Wind envelope for azimuth and VSP

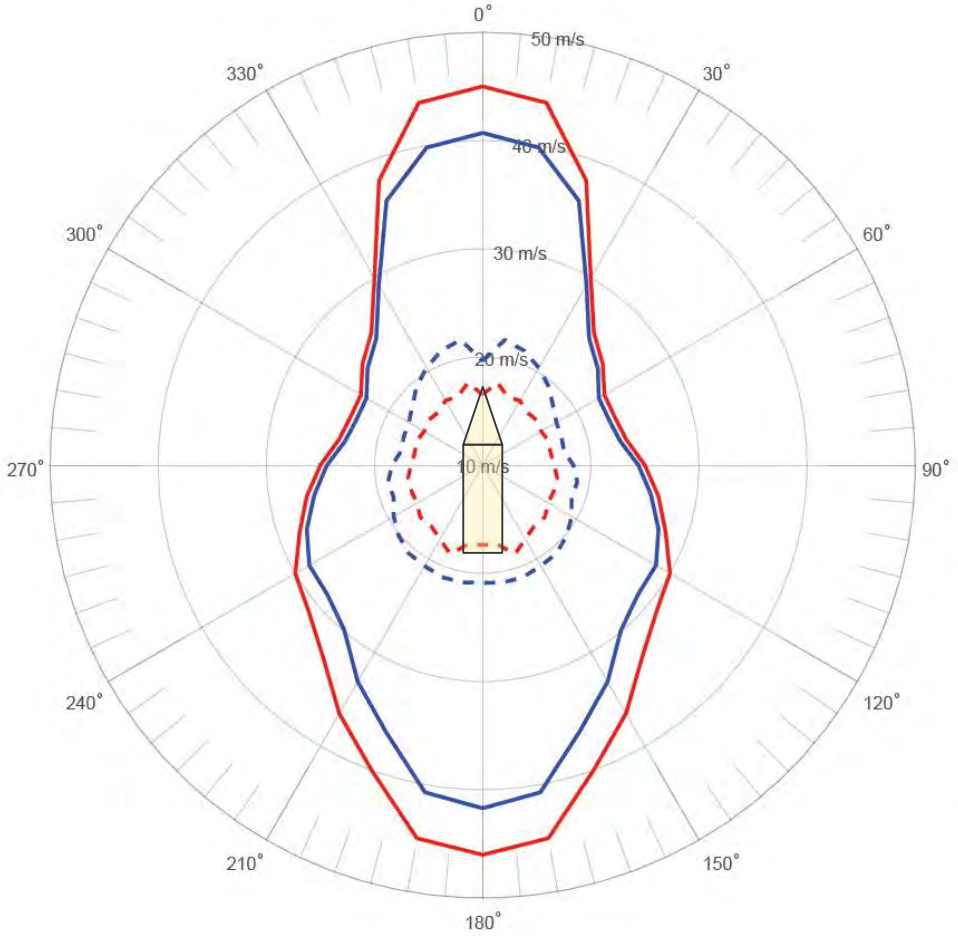
dynamic analysis

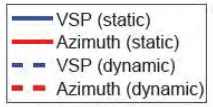


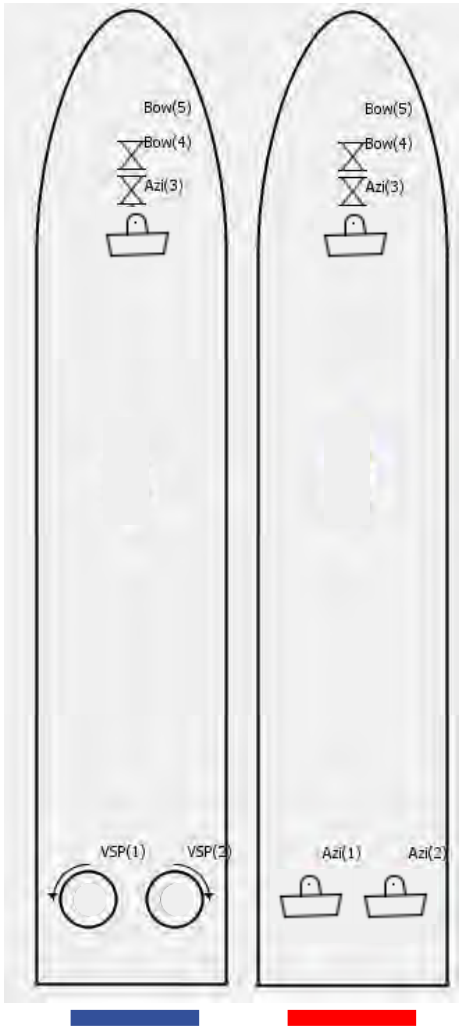


ΔV_w of 3m/s ≈ ΔH_s=1m

Static vs. dynamic simulation approach



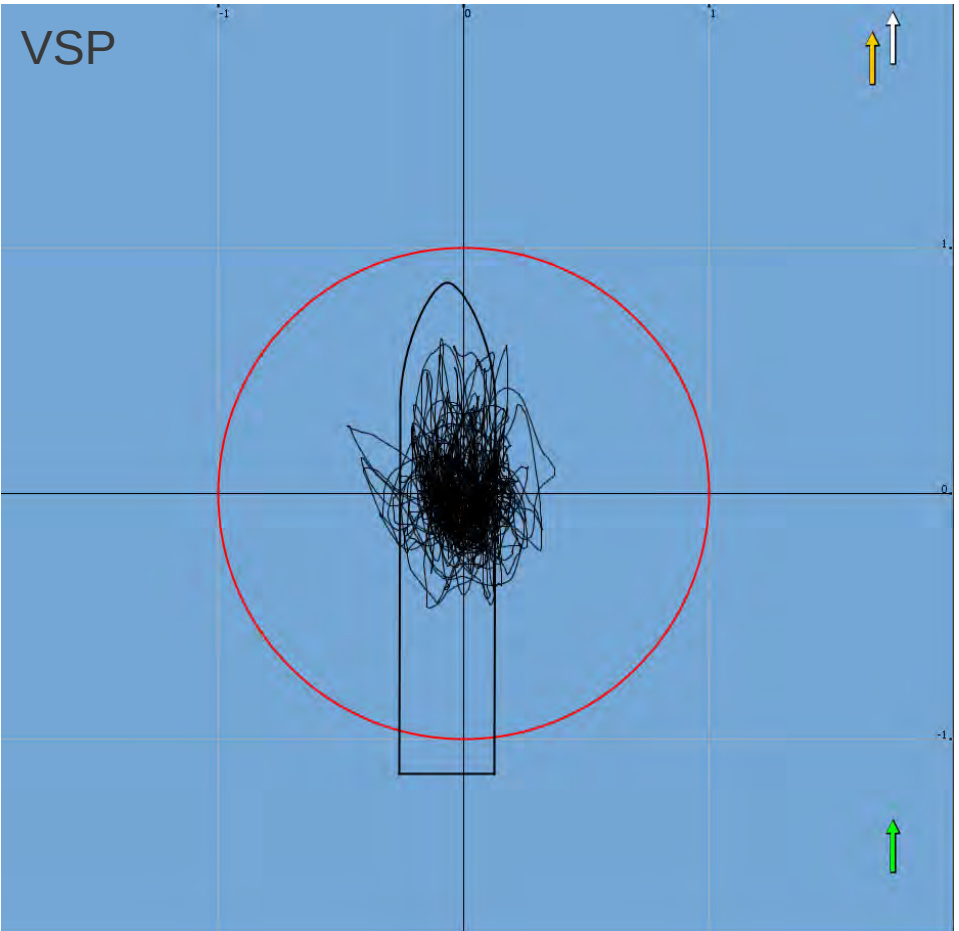


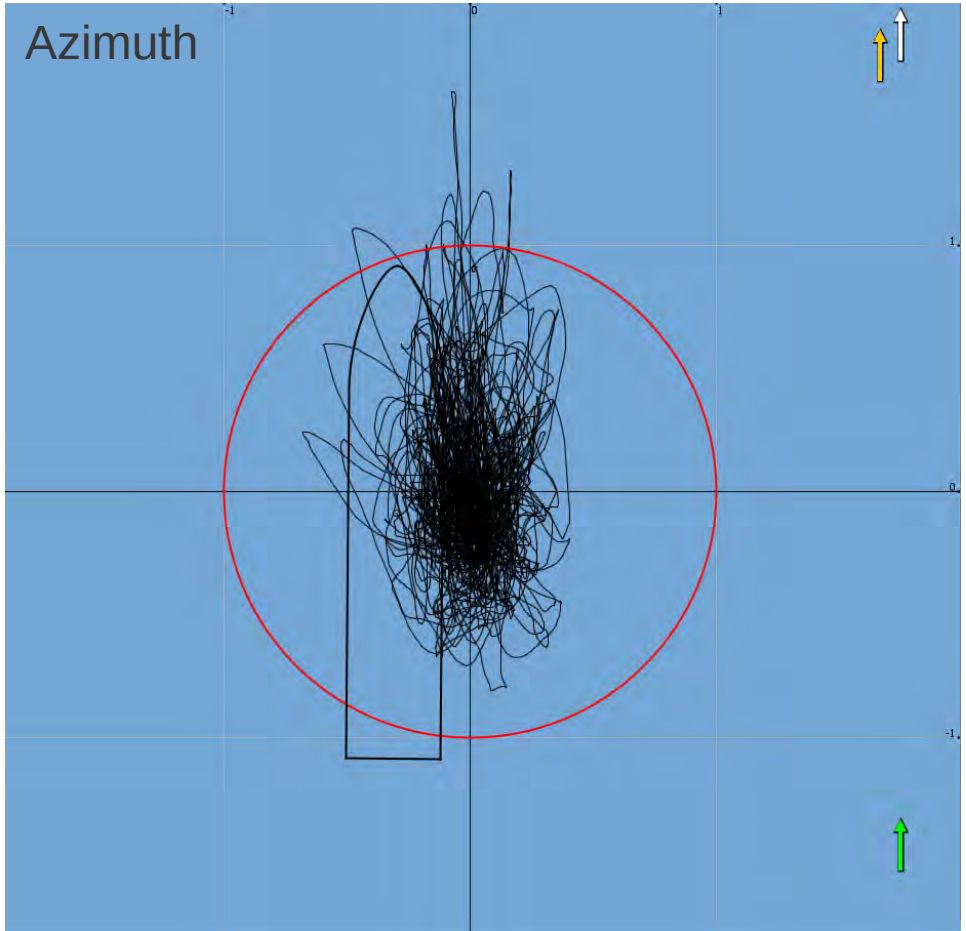


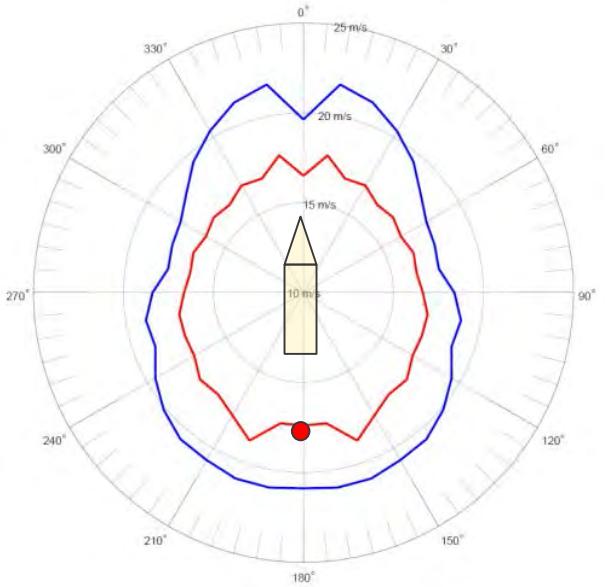
ΔV_w of 3m/s ≈ ΔH_s=1m

Foot print based on dynamic DP runs

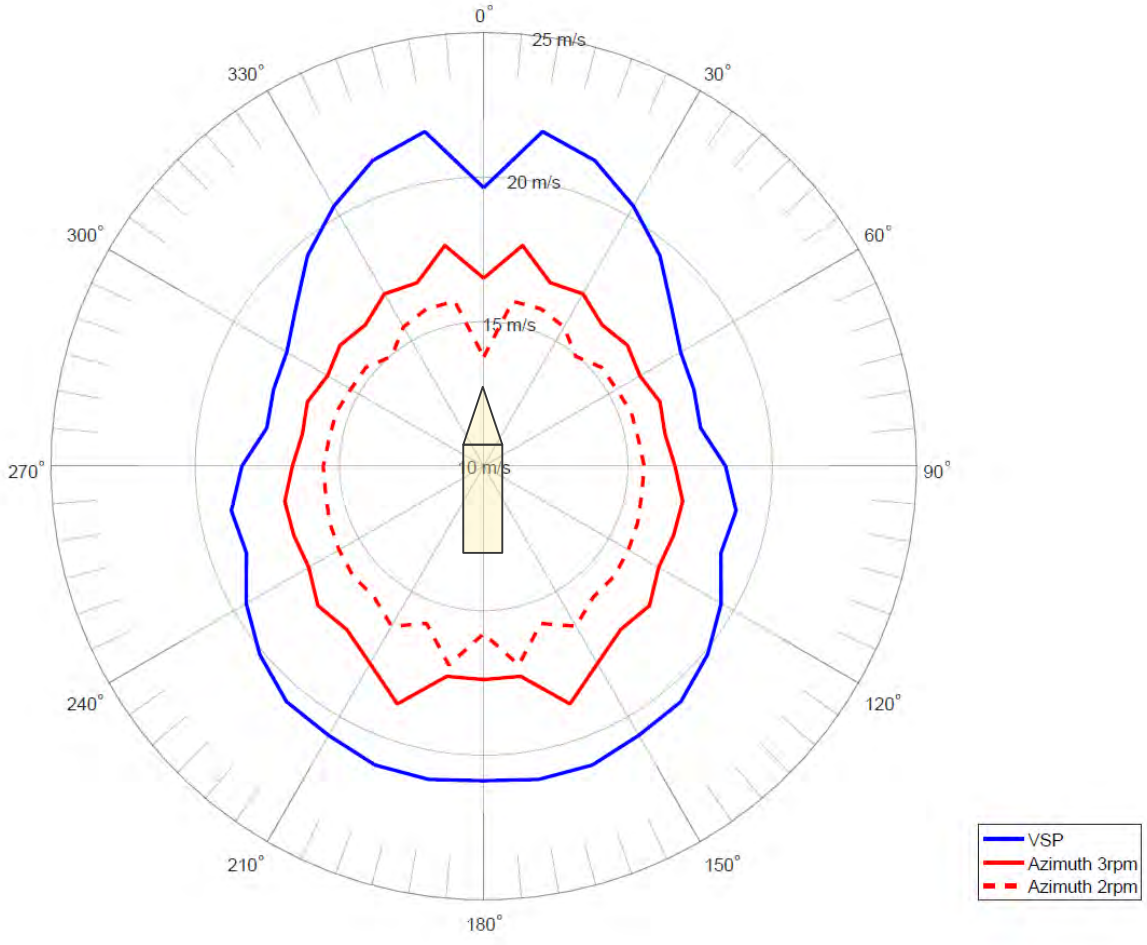
18m/s wind, stern on

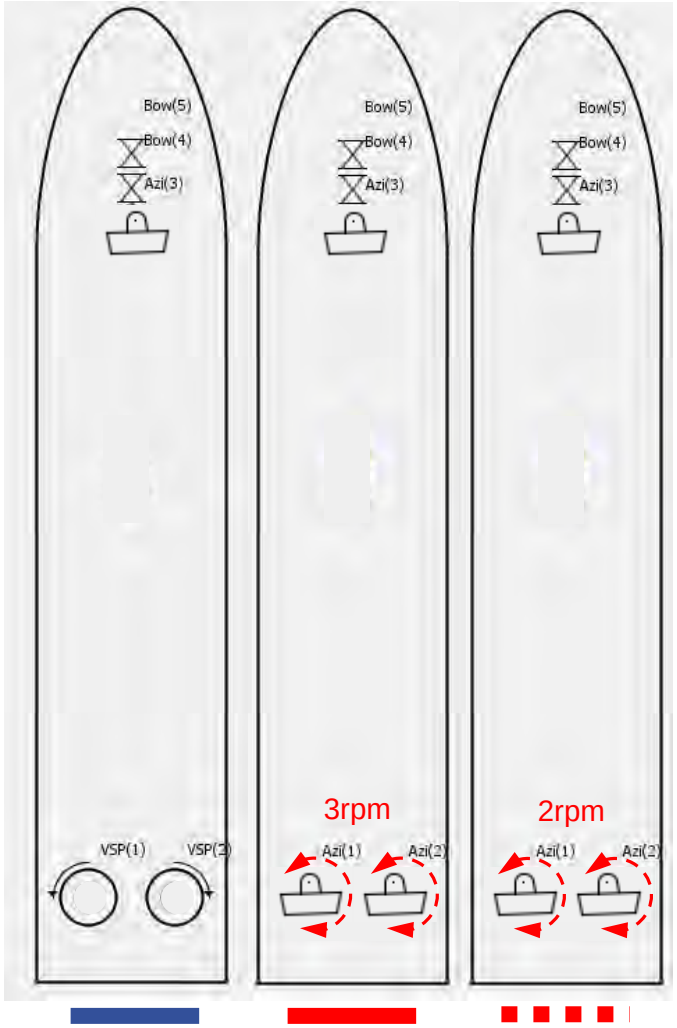






Wind envelope for varying azimuth speed



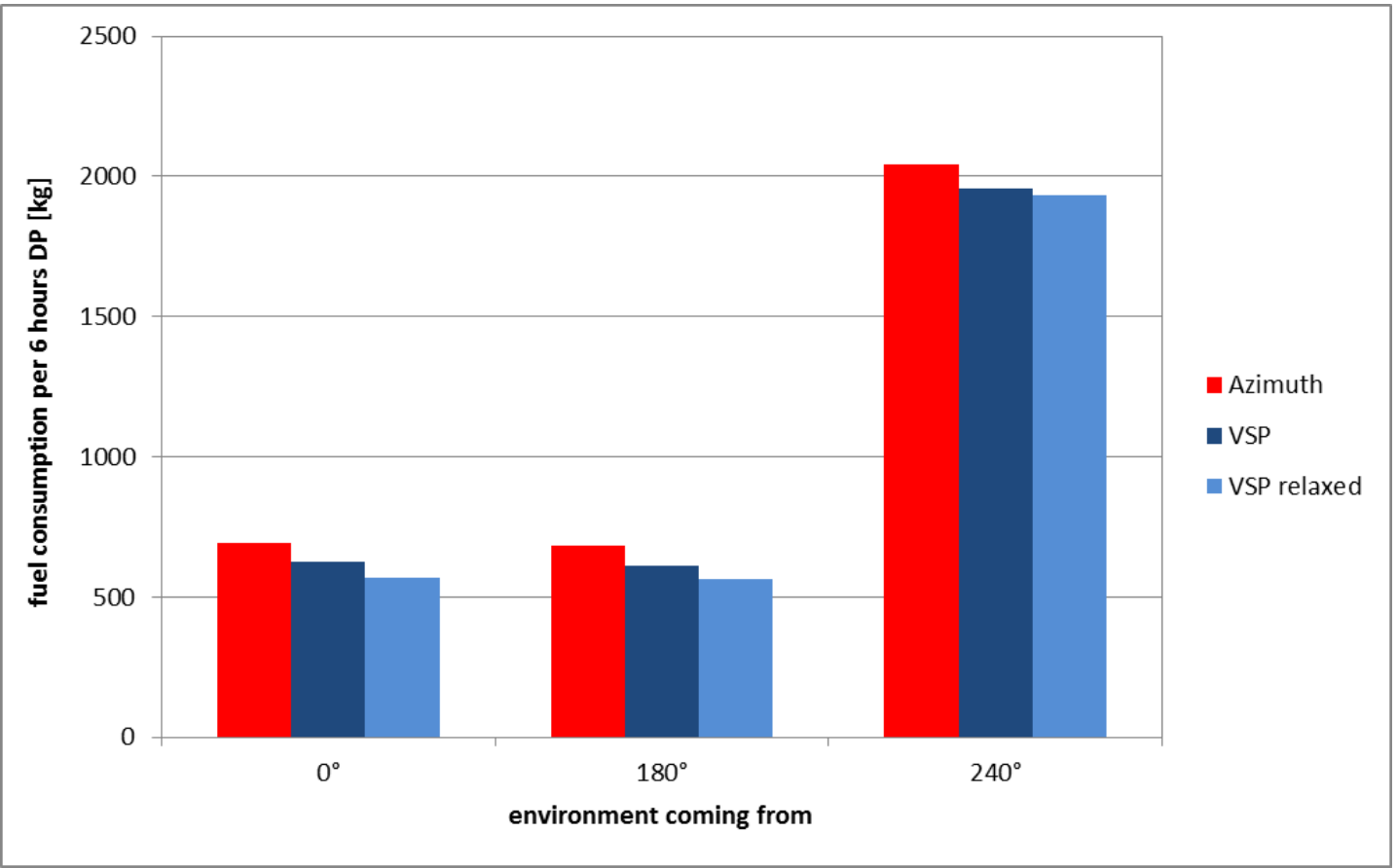


ΔV_w of 3m/s ≈ ΔH_s=1m

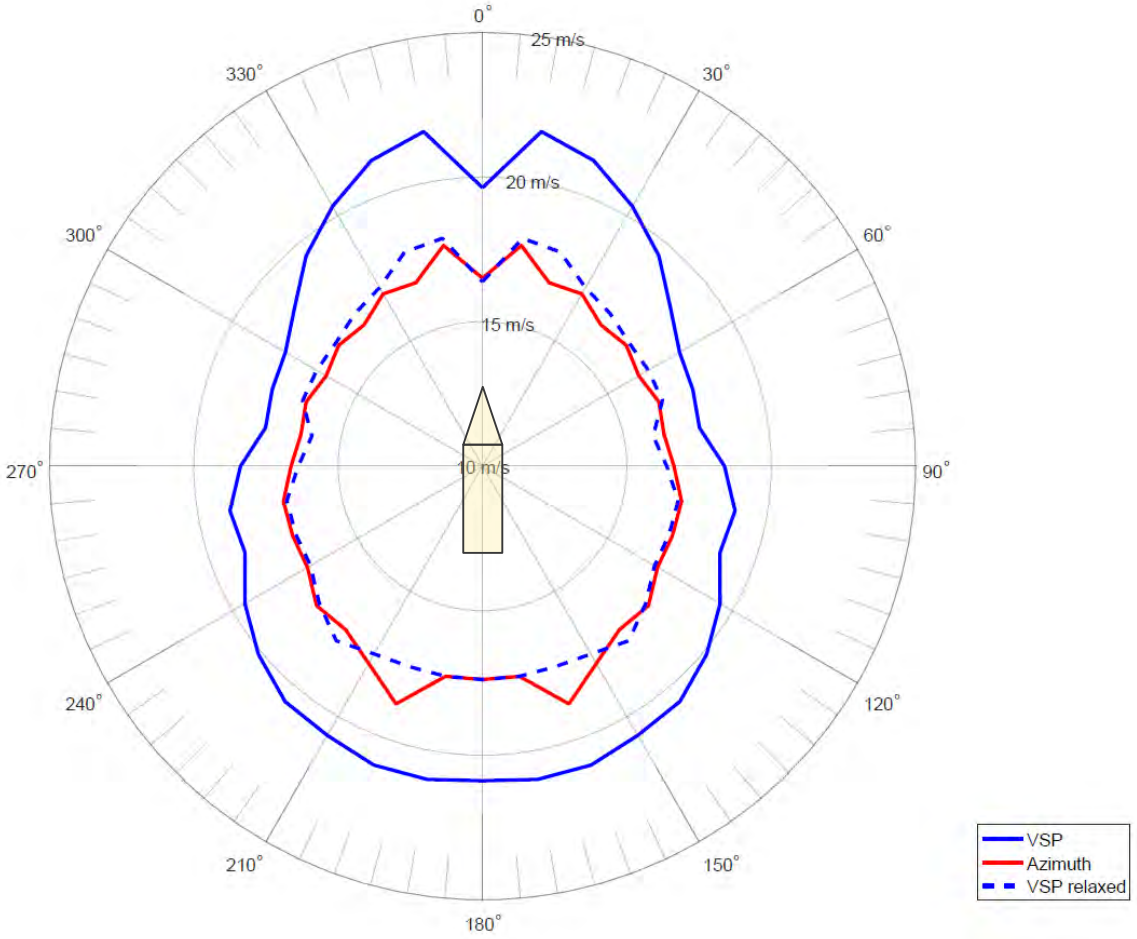
Fuel consumption during DP

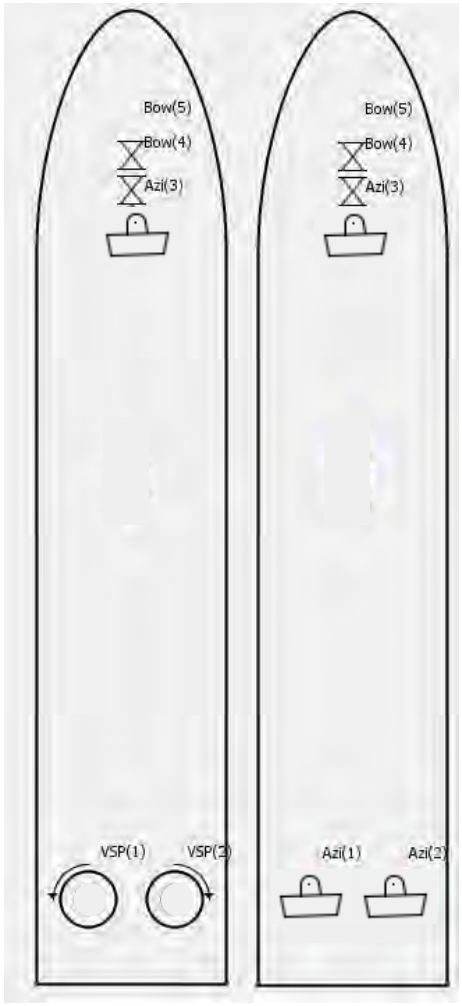
per thruster configuration three encounter angles have been considered.
(0° - bow on, 180° - stern on, 240° - stern quartering)

each configuration experiences exactly the same time history of environmental forces corresponding to a mean wind speed of 13m/s



Wind envelope for relaxed VSP controller parameter

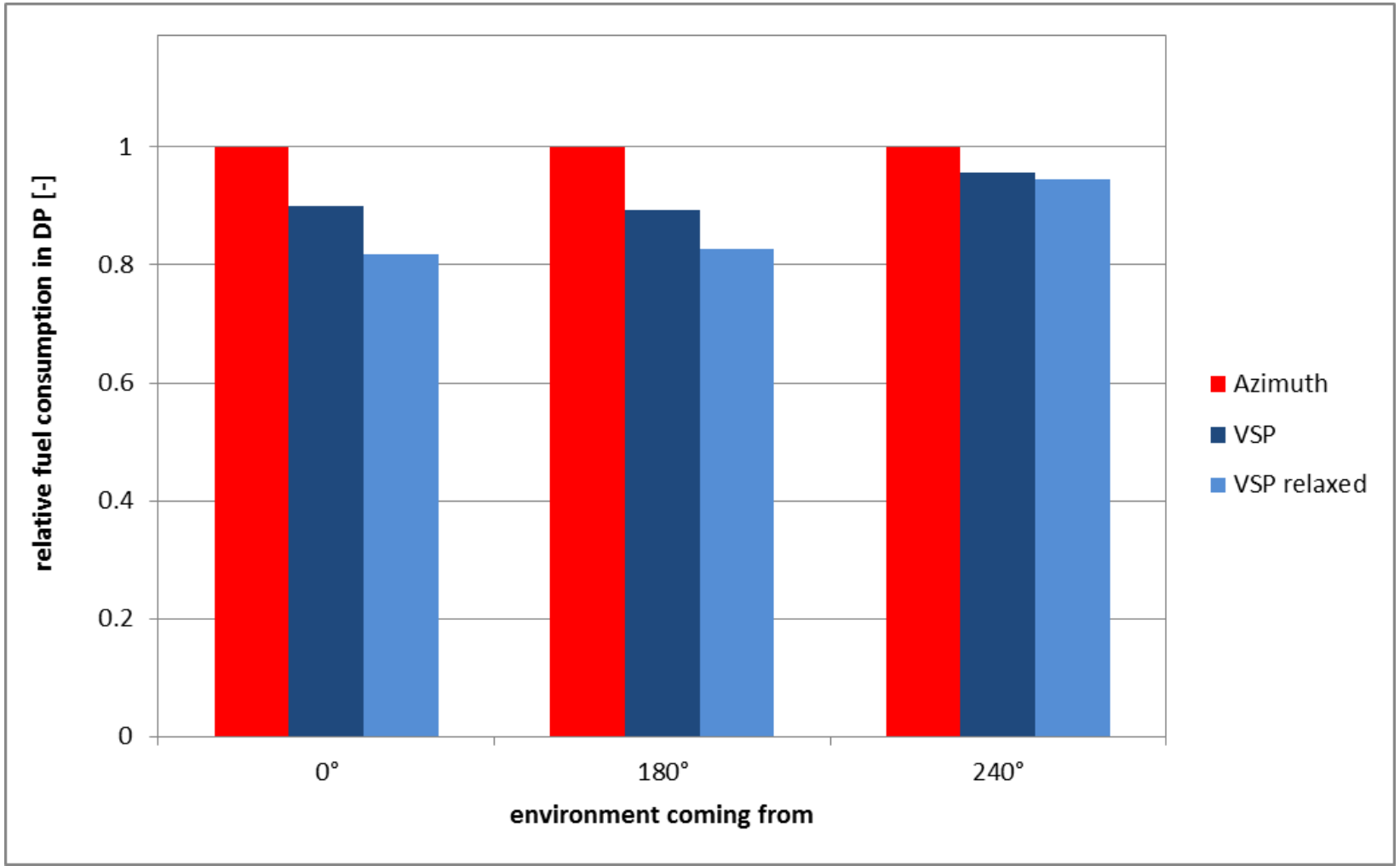




ΔV_w of 3m/s ≈ ΔH_s=1m

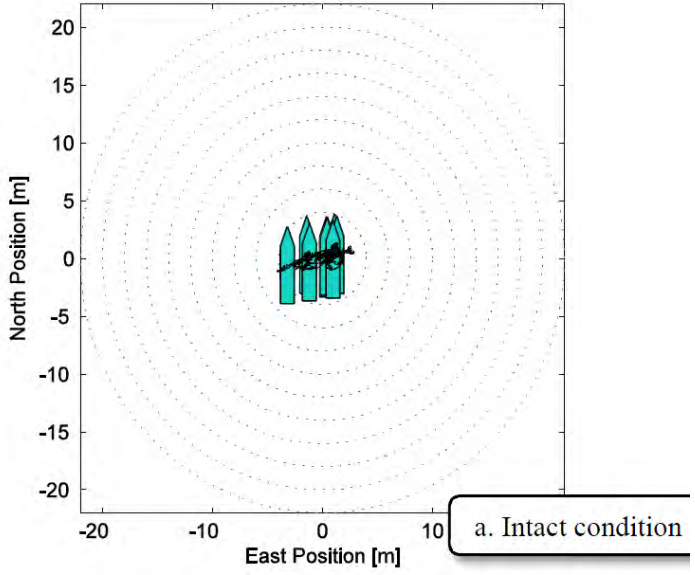
Fuel consumption during DP

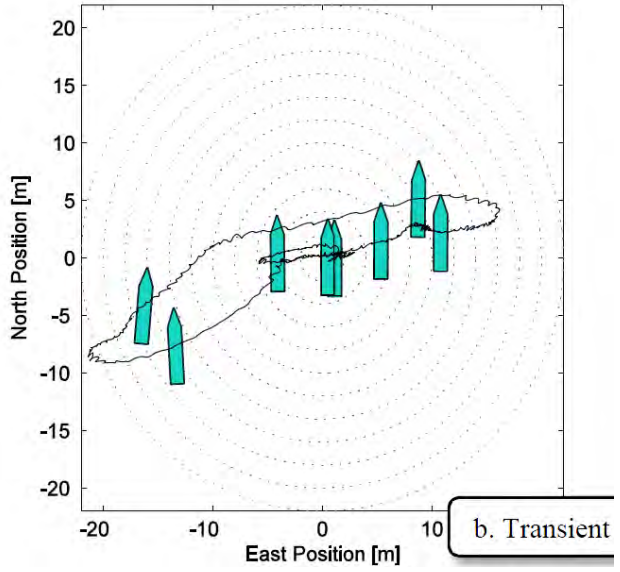
relative comparison

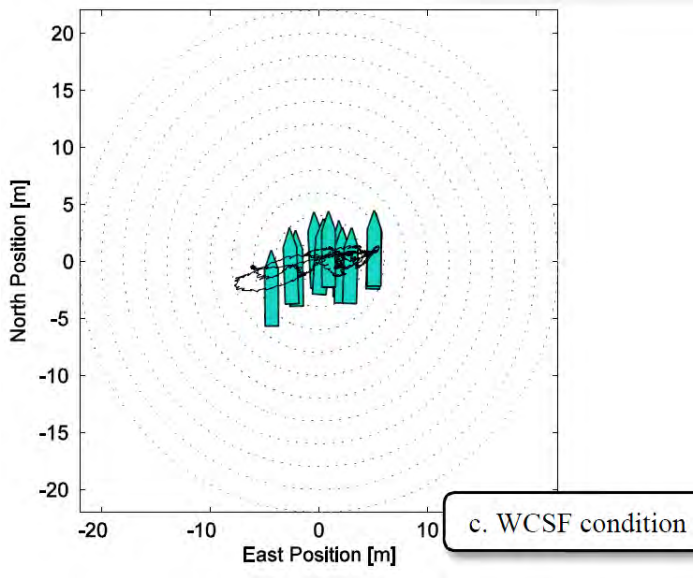


Dynamic effects during DP

transient effects on vessel configuration (failure consequences)



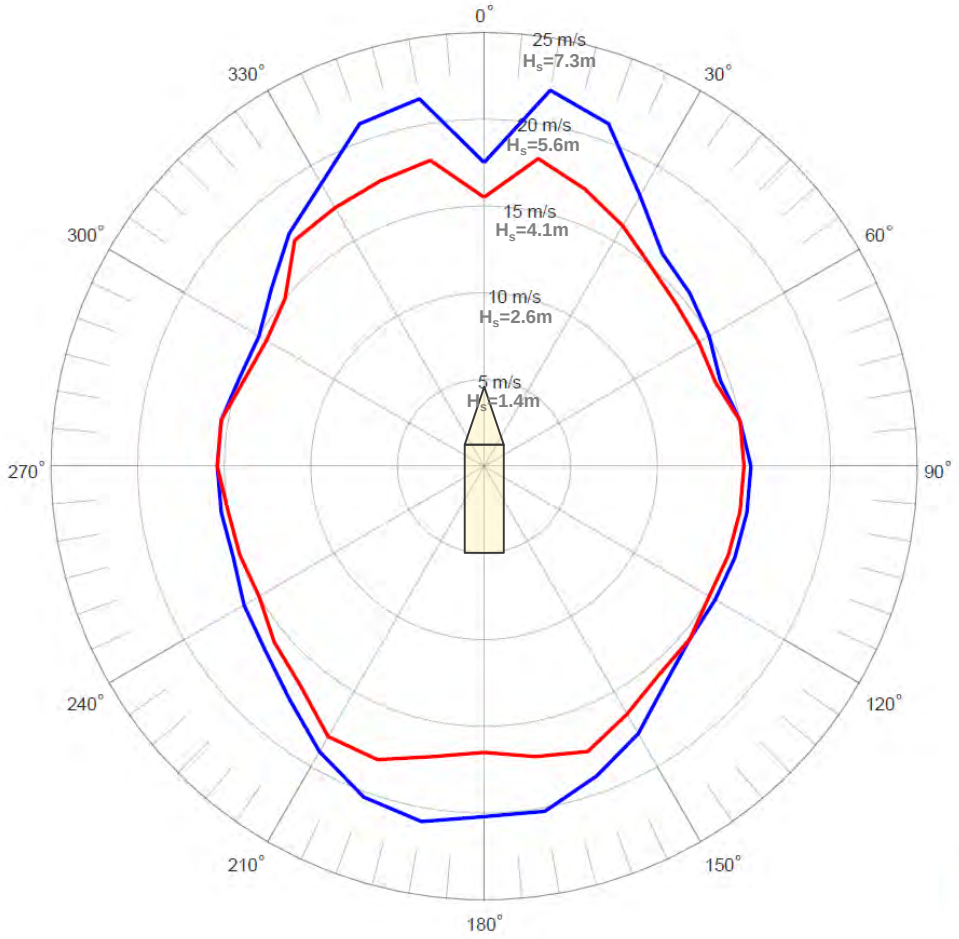




Courtesy of DNV Marine Cybernetics

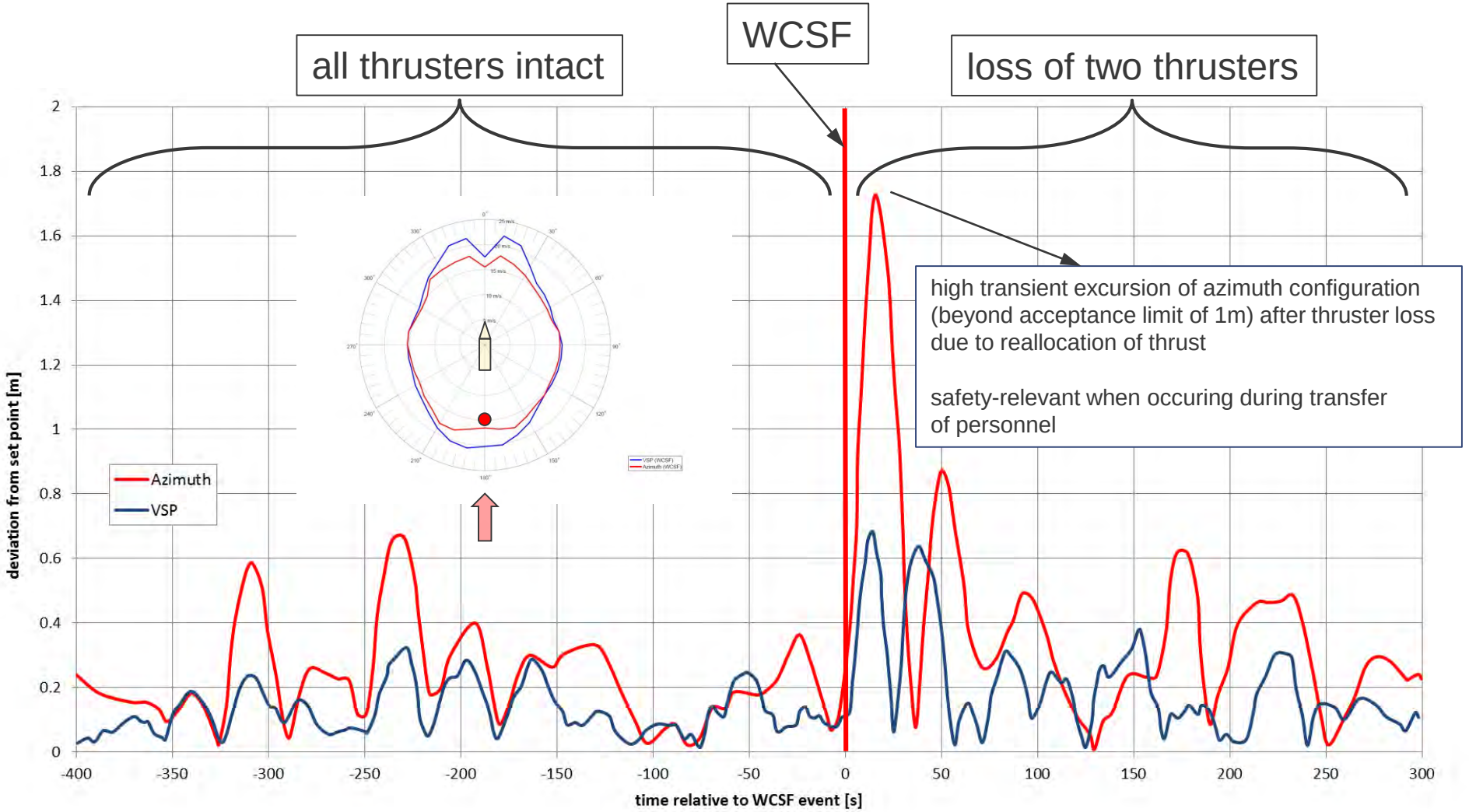
Wind envelope – WCSF conditions

loss of one aft thruster and one tunnel thruster



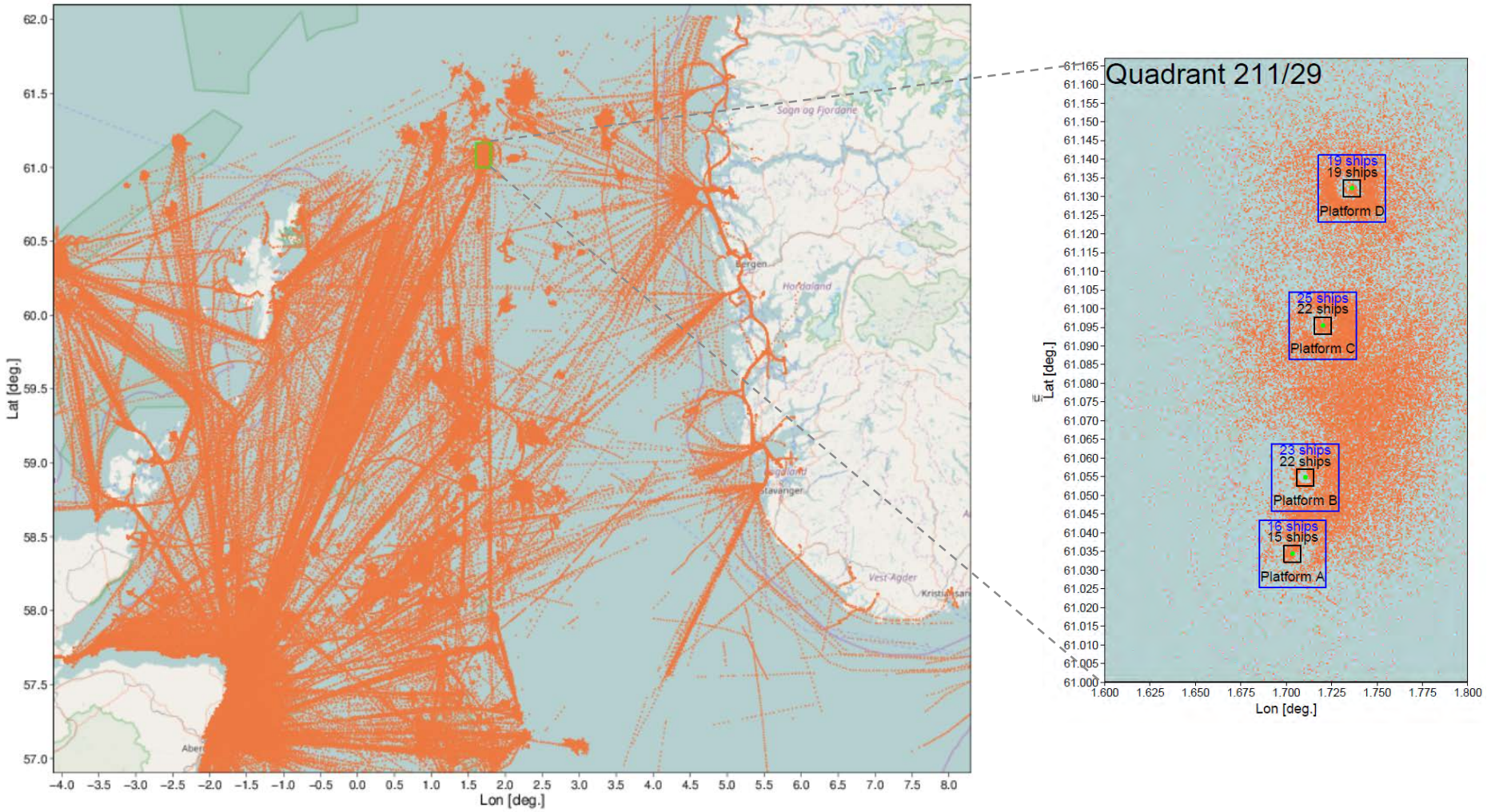
Transient excursion during WCSF

loss of one aft thruster and one tunnel thruster



Statistical analysis of vessel movements

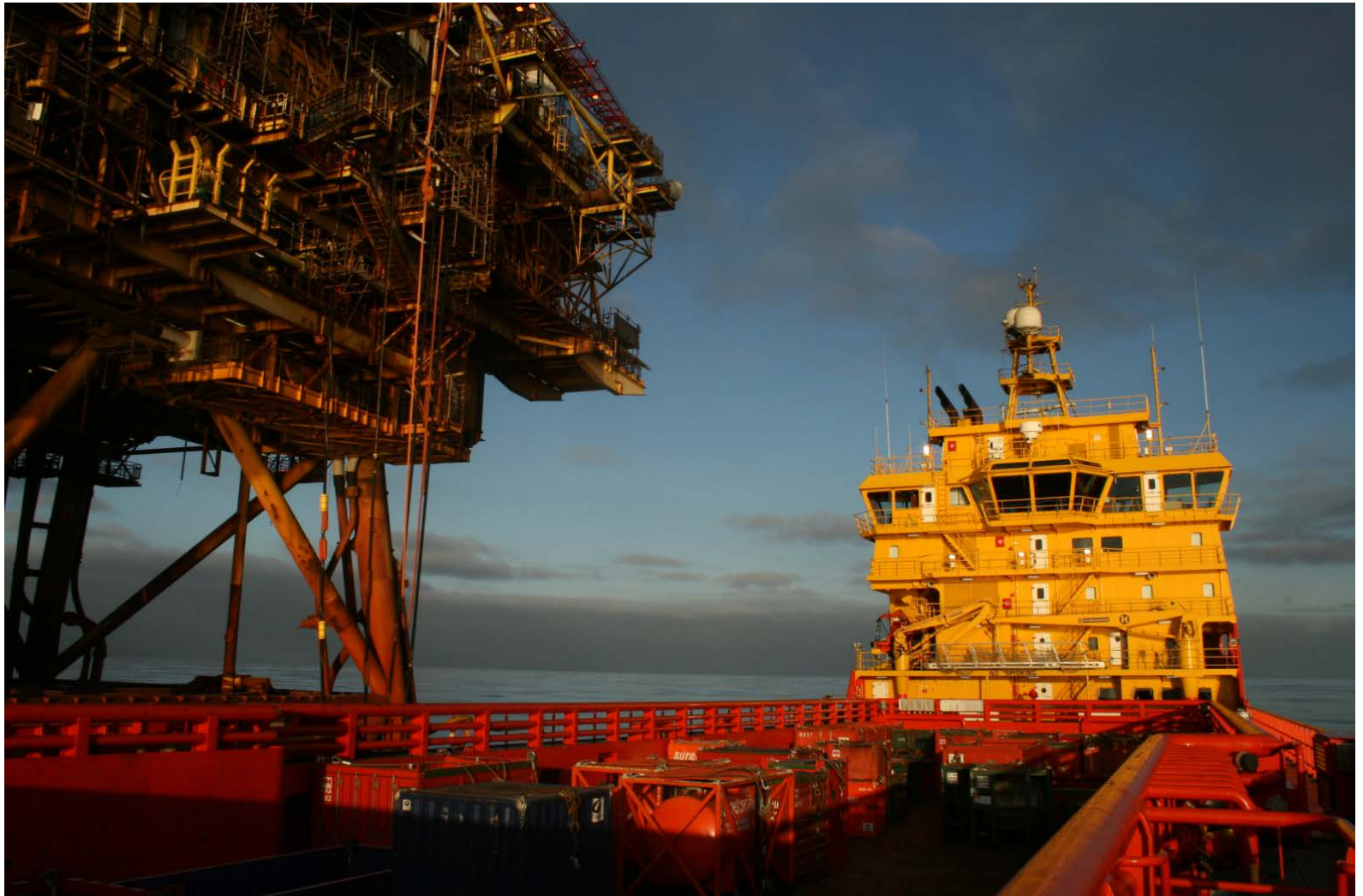
movement of vessel ever approached Brent fields in the period of Oct. 2014 – Oct. 2016



VSP vessels servicing the Brent fields

VSP vessels servicing the Brent fields

VSP vessels servicing the Brent fields

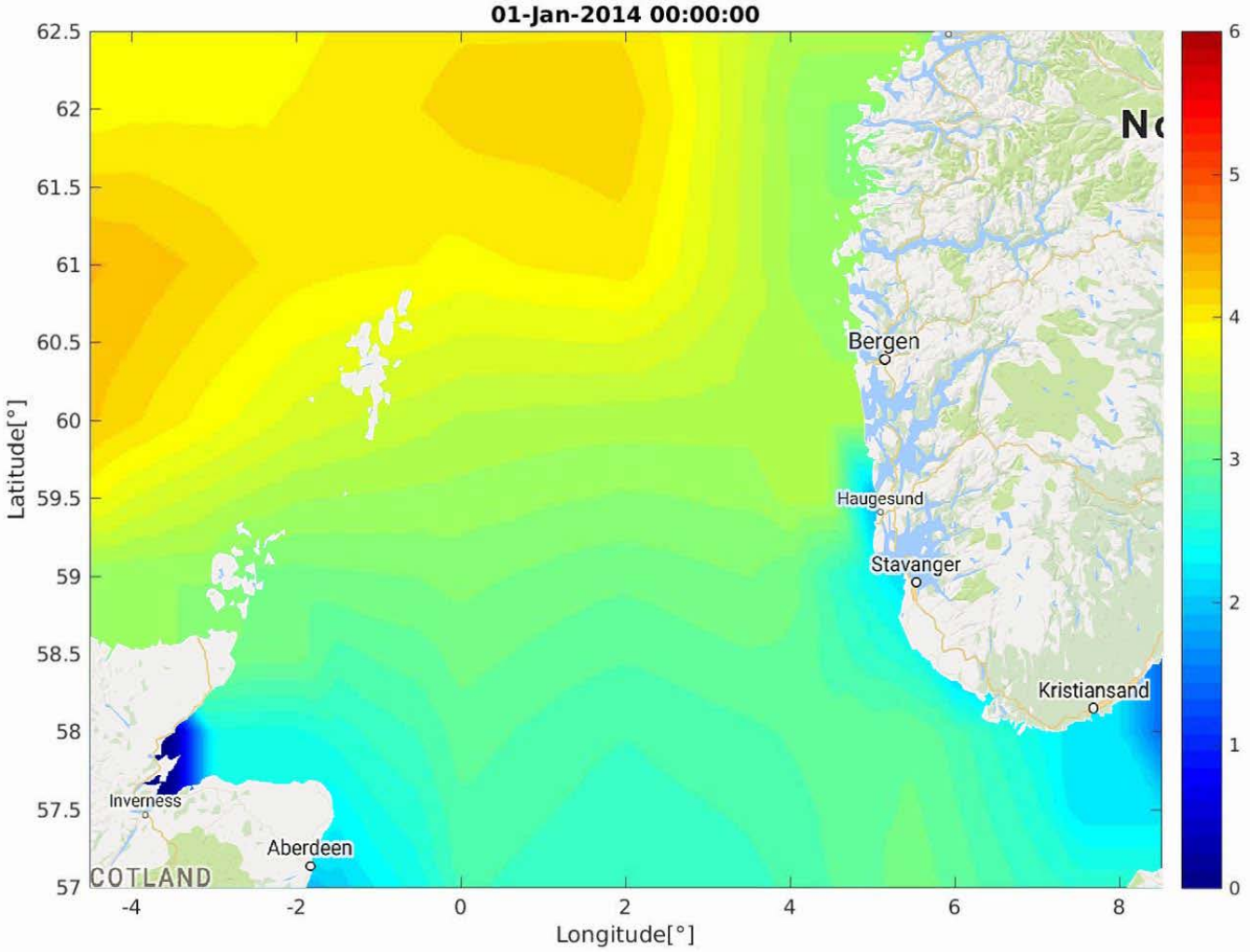


VSP vessels servicing the Brent fields

PSV «Edda Frende»
Brent fields – North Sea
06.09.2015 Deck load operations
VRS on
H_s 3,2m – H_{max} 5-6m – Wind 30 kn
Weather direction 90° - 135°

Additional vessel servicing the Brent platforms

distribution of sign. wave height

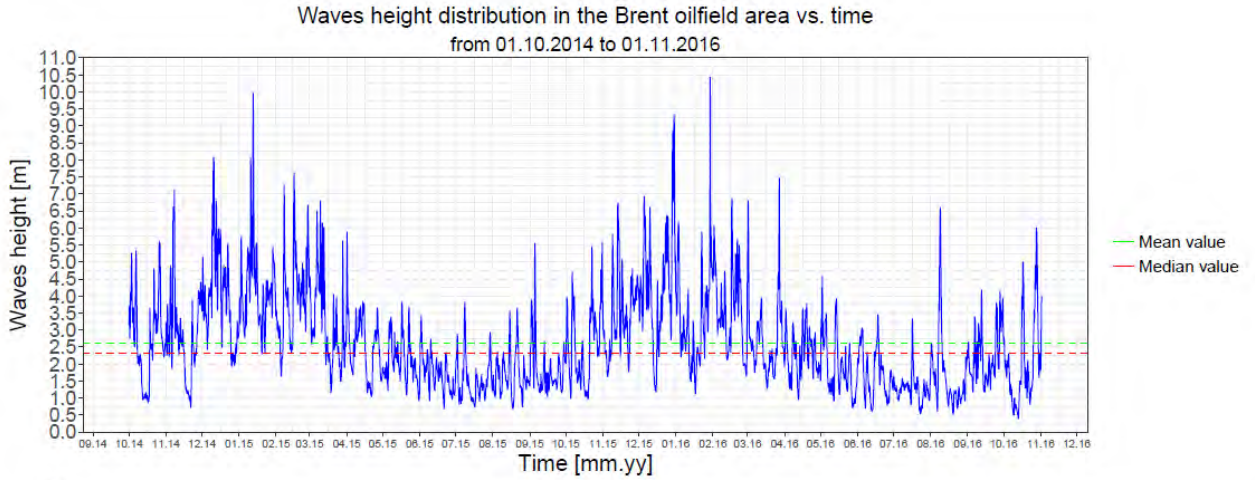


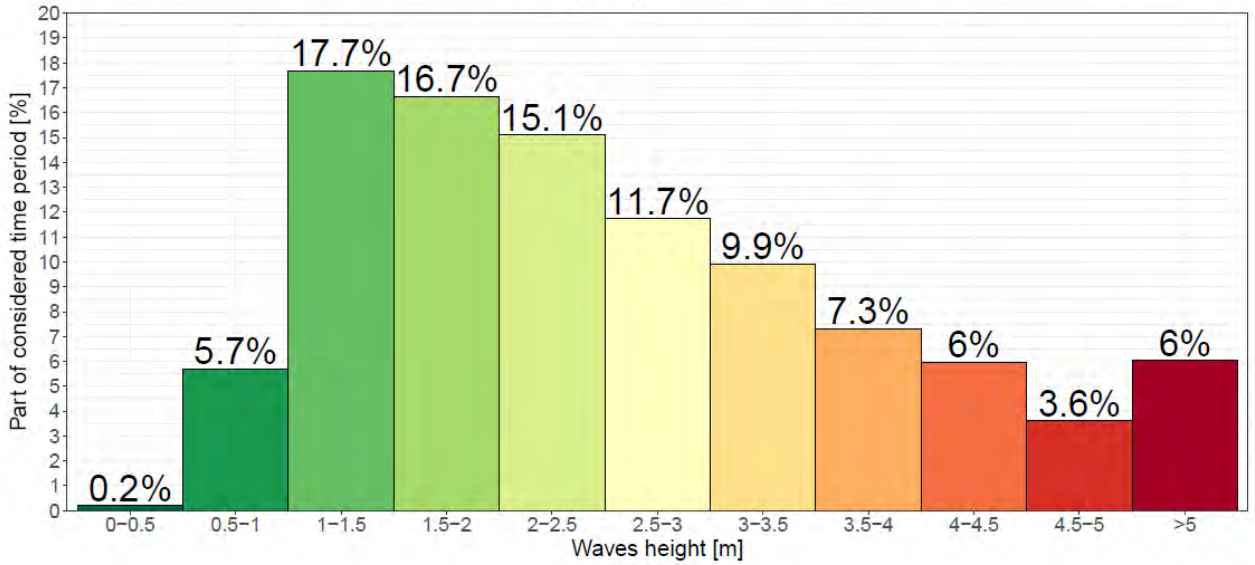
data source:

ECMWF

© European Centre for Medium-Range Weather Forecasts

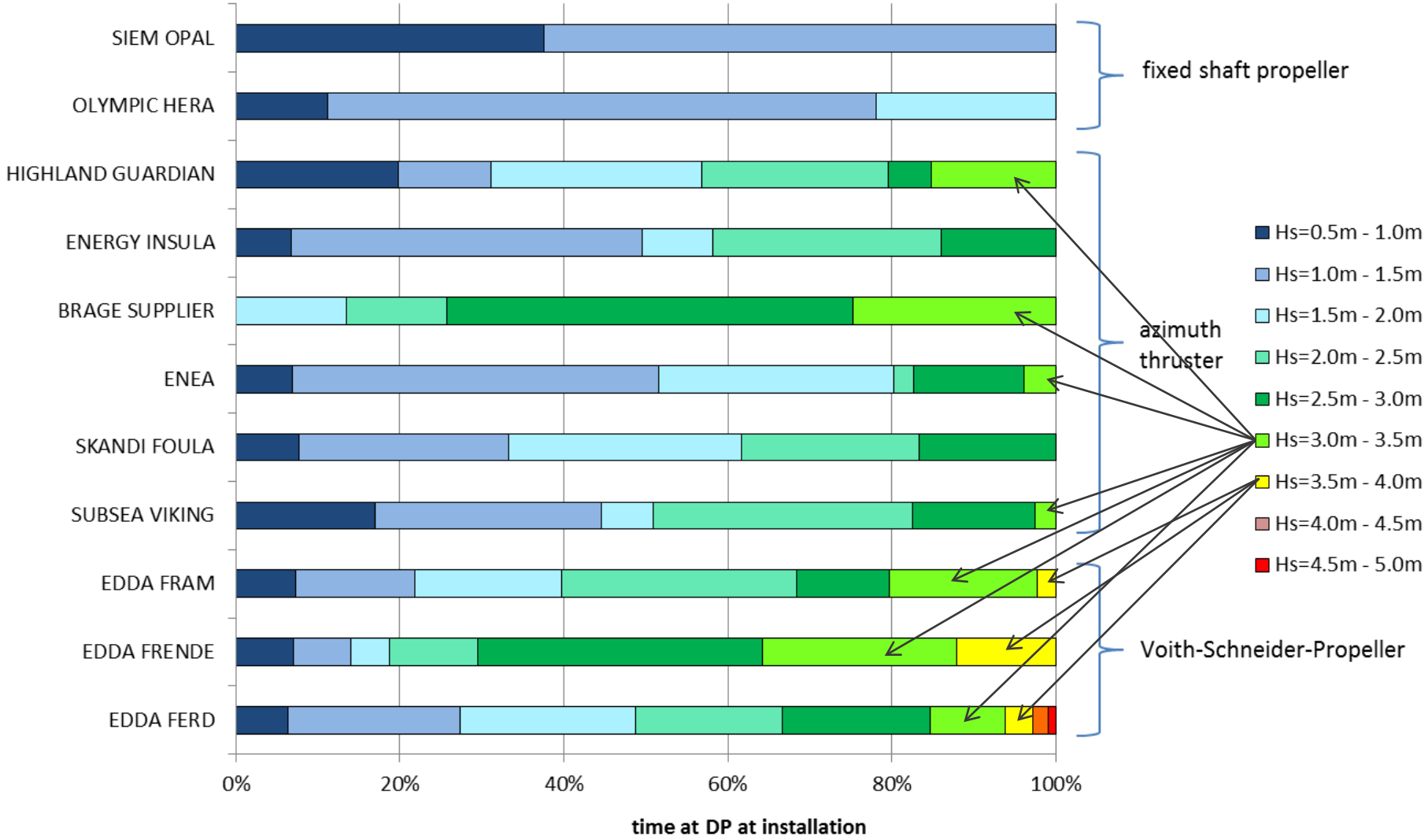
Sign. wave height in the area





ECMWF © European Centre for Medium-Range Weather Forecasts

Time in DP at platform for different wave heights



Conclusions

- static DP plots do not represent DP capability of a vessel properly
- dynamic DP plots provide a much more realistic evaluation of DP capability
- response time of thrusters has a major impact on DP capability

Thanks for your attention!