# Comparison of Motion Sickness Incidence (MSI) of three Crew Transfer Vessels with different hull forms

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  - what is it?
  - How to estimate it ?
- Methodology
- SWATH - experiments
- Monohull
- Catamaran
- General results & Conclusions

# SEASICKNESS PHENOMENON

## What ?

- Motion sickness phenomena - discomfort associated to all mode of transports
- Results in breathing irregularities, warmth, disorientation and vomiting
- Mismatch theory



# SEASICKNESS PHENOMENON

## How ?

- Motion Sickness Incidence (MSI)
- Algorithm to predict the incidence of motion sickness induced by exposure of vertical sinusoidal accelerations (McCaugley and al. 1976)

$$MSI(\%) = 100 * \Theta(z_a) * \Theta(z_t')$$

Term depending on significant vertical acceleration and peak frequency response (ship response)

Time dependent term

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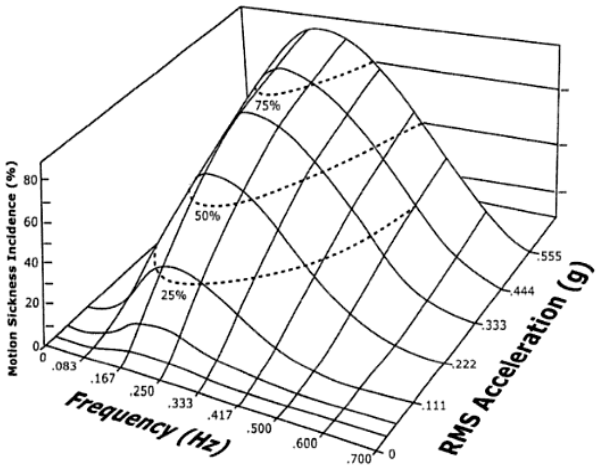
# MOTION SICKNESS – HOW ?




RMS acceleration: highest one third vertical accelerations of the temporal statement.

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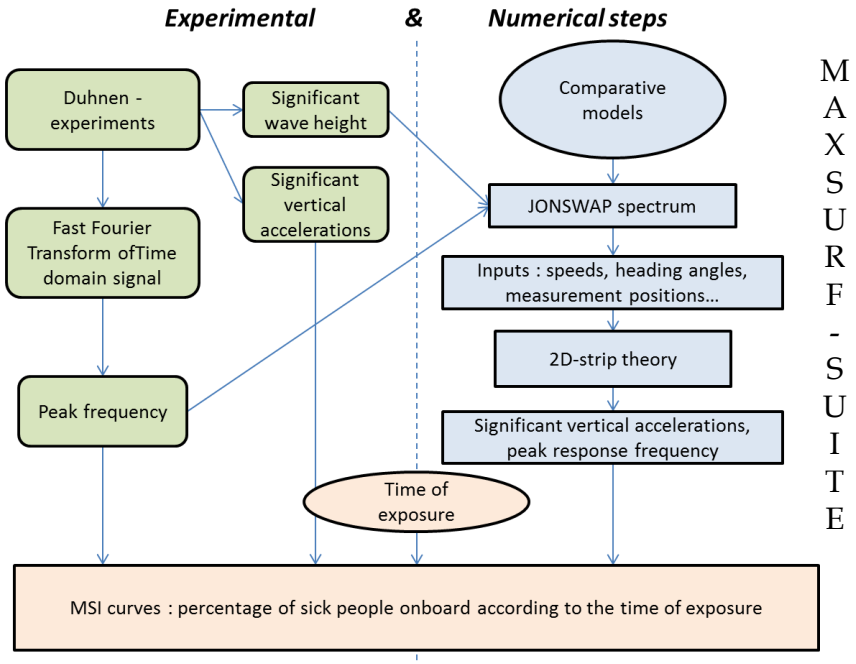
# METHODOLOGY

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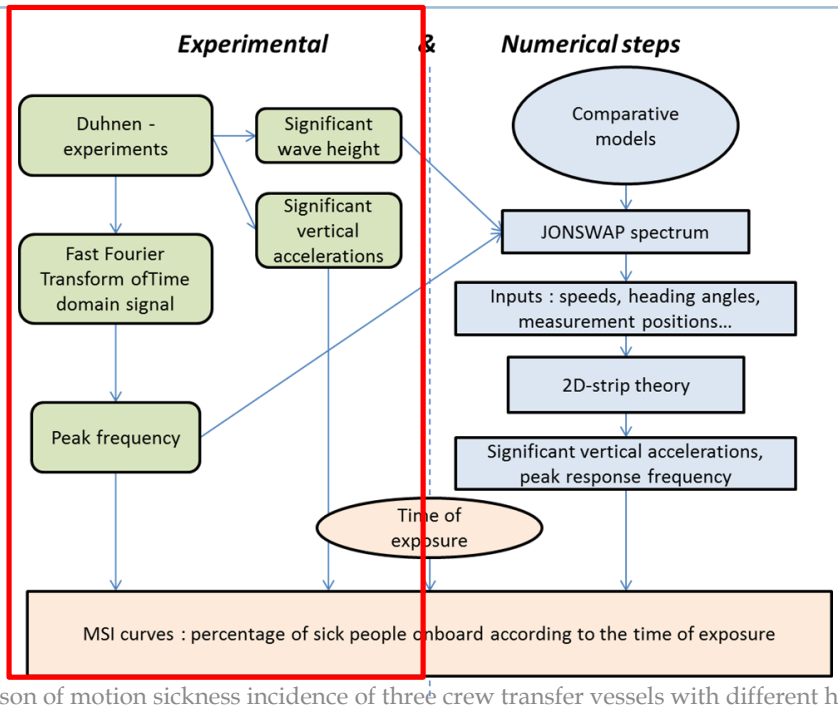
# METHODOLOGY






# SWATH – *DUHNEN*


Accelerometers position on the main deck of the *Duhnen*.

| Speeds [knots] | Significant wave height [m] | Heading angles [°] |
|---|---|---|
| 5 | 2 | All (*) |
| 8 | 2.4 | 180° |
| 10 | 2 | All (*) |
| 12 | 1.5 | 180° |
| | 2.4 | 180° |

* Following seas, Beam seas, Quartering stern and bow seas, Head seas

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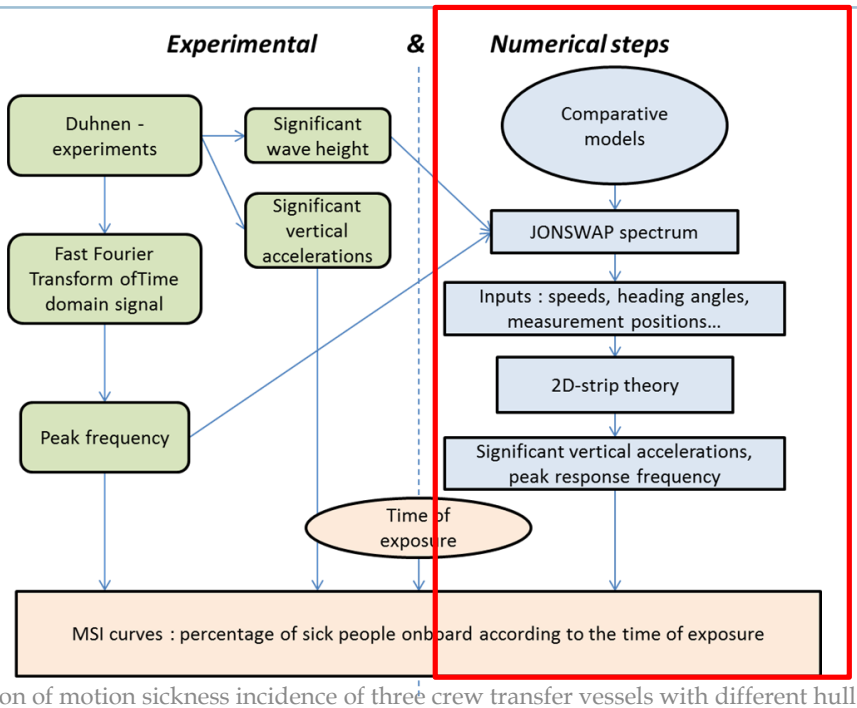
# METHODOLOGY

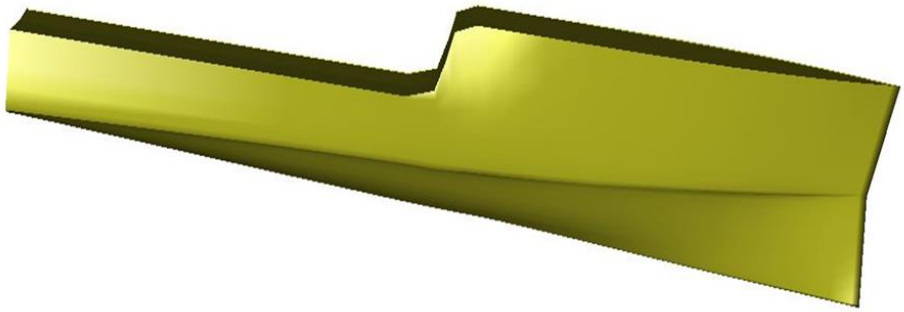





# MONOHULL

# MONOHULL – Preliminary design (1)

- Same displacement than the SWATH
- Axe bow hull form – seakeeping behaviour
- Rough structural design and weigh estimation – vertical position of the centre of gravity



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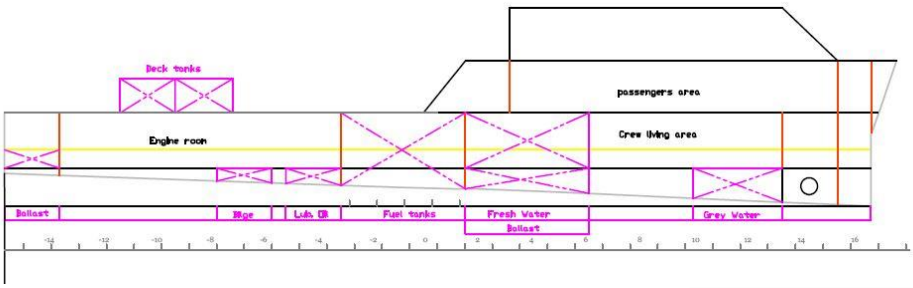
# MONOHULL – Preliminary design (2)




| | Weight [t] | LCG [m] | TCG [m] | VCG [m] |
|---|---|---|---|---|
| Lightship | 58.42 | -3.50 | 0.00 | 2.45 |

+ tank definitions
(full load case) => VCG = 2.48m

| | |
|---|---|
| Length overall | 32.9 m |
| Beam overall | 6.6 m |
| Depth at sides | 3.3 m |
| Draught max | 2.0 m |
| Max. speed | 29 kn |
| Main engines | 3 x C32 C TTA caterpillar |
| Crew | 6 persons |
| Industrial personnel | 29 persons |
| Fuel oil | 35 m3 |
| Fresh water cargo | 25 m3 |
| Sea area (BV classification) | 3 |

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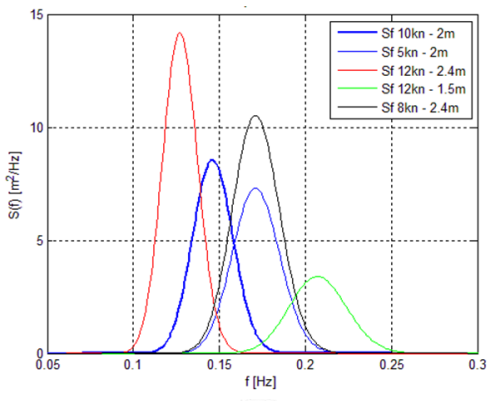
# Wave spectra

- JONSWAP spectra used to represent the North Sea.
- Extracted from experiment results.



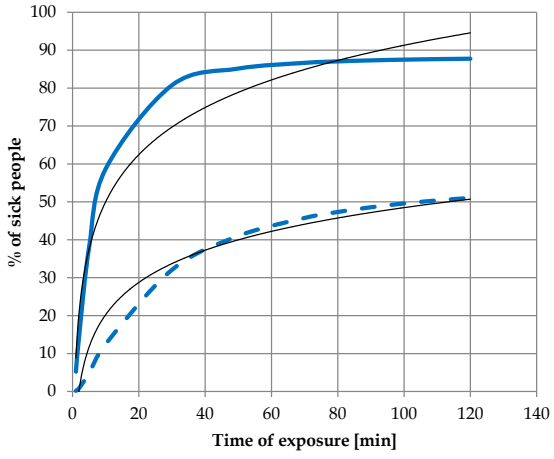

- Linear waves theory in deep water,

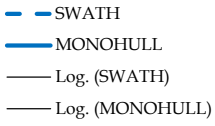
$$\lambda \approx 1.56\,T^2.$$

**36 m < Wave length λ < 97 m**



# MONOHULL – Results 8 knots

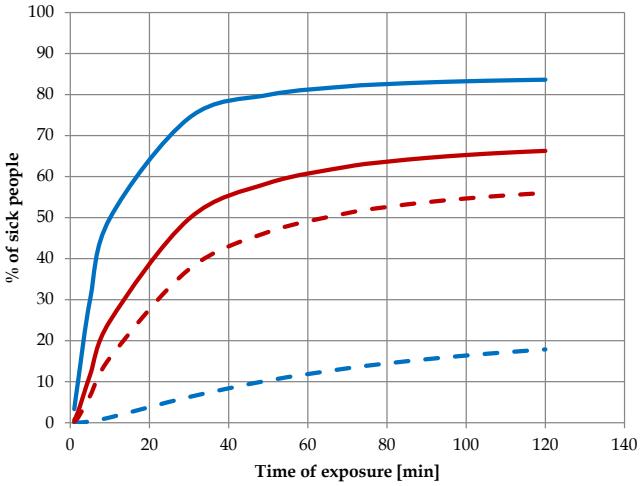



| [min] | SWATH | MONO. |
|---|---|---|
| 10 | 12.5% | 58.8% |
| 70 | 45.8% | 86.7% |
| 120 | 50.4% | 87.6% |

- Head seas
- Wave period 8 seconds
- Worst vertical acceleration locations at stern for SWATH and bow for monohull

# MONOHULL – Results 12 knots




| | 1.5m | 2.4m |
|---|---|---|
| SWATH | 7.9 sec | 4.8 sec |
| Monohull | 5.4 sec | 2.7 sec |

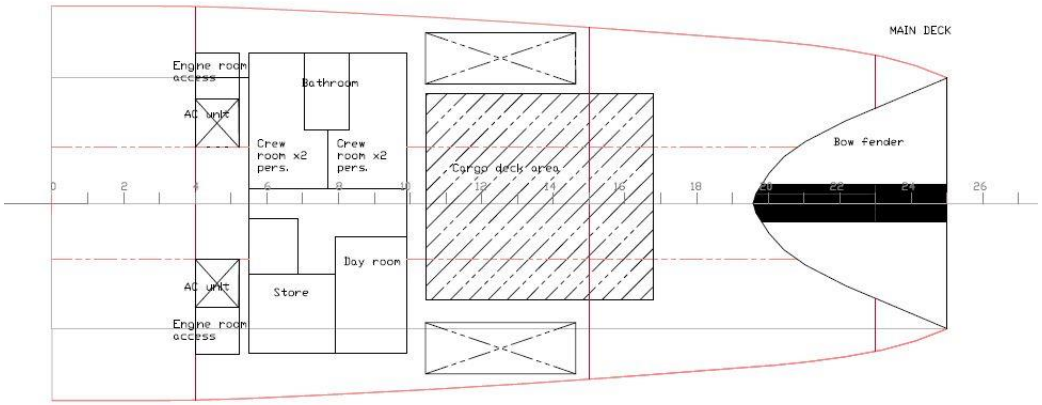
Wave frequency = 5sec



# CATAMARAN

# CATAMARAN – Preliminary design (1)

- Same length than the SWATH
- Lightship weight known, 72.8 tonnes
- Preliminary structural design-*GL*

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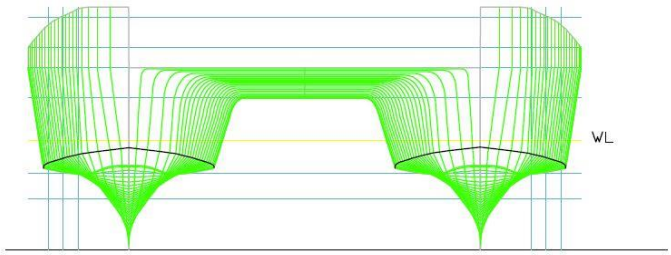
# CATAMARAN – Preliminary design (2)

| | |
|---|---|
| Waterline length | 25.0m |
| Beam overall | 13.0m |
| Maximum draft | 2.7m |
| Max. Speed | 18 kn |
| Full loaded displacement | 97.2 t |
| Spacing of CL demihulls | 7.0m |




| | Go offshore load case | | | | | |
|---|---|---|---|---|---|---|
| | Quantity (1=100%) | Unit mass [t] | Total mass [t] | Longitudinal arm [m] | Transversal arm [m] | Vertical arm [m] |
| Lightship | 1 | 72.800 | 72.800 | 11.252 | 0.000 | 3.080 |
| FuelS | 1 | 7.106 | 7.106 | 15.497 | 3.379 | 2.723 |
| FuelP | 1 | 7.106 | 7.106 | 15.497 | -3.379 | 2.723 |
| FreshWaterS | 1 | 4.868 | 4.868 | 3.502 | 4.160 | 2.581 |
| FreshWaterP | 1 | 4.868 | 4.868 | 3.502 | -4.160 | 2.581 |
| KeelS | 1 | 0.213 | 0.213 | 4.532 | -3.500 | 1.494 |
| KeelP | 1 | 0.213 | 0.213 | 4.532 | 3.500 | 1.494 |
| **Total Loadcase** | | | **97.174** | **11.067** | **0.000** | **2.971** |

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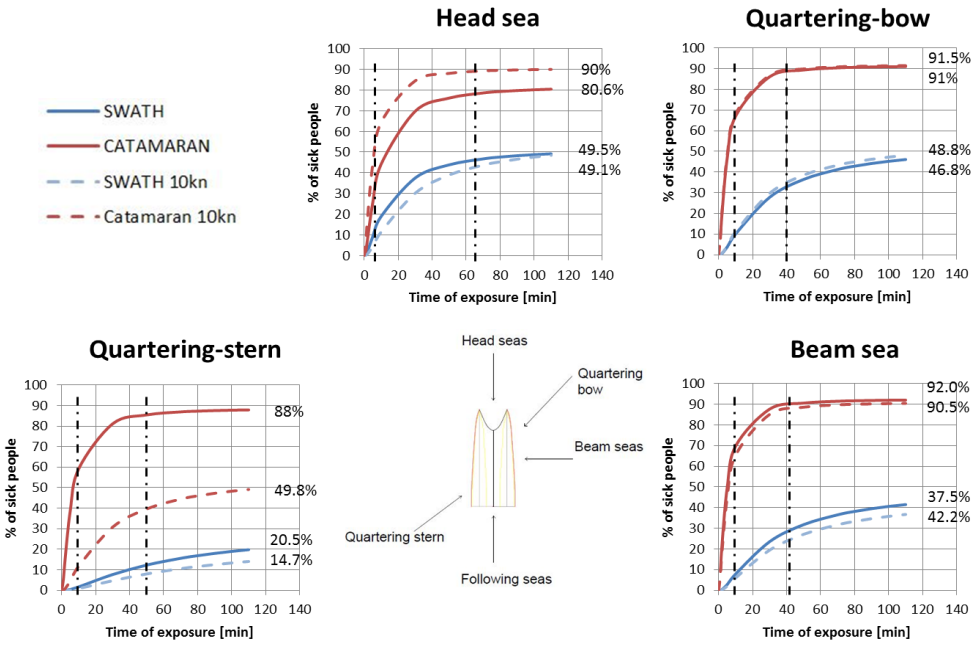
# CATAMARAN – Results 5&10 knots

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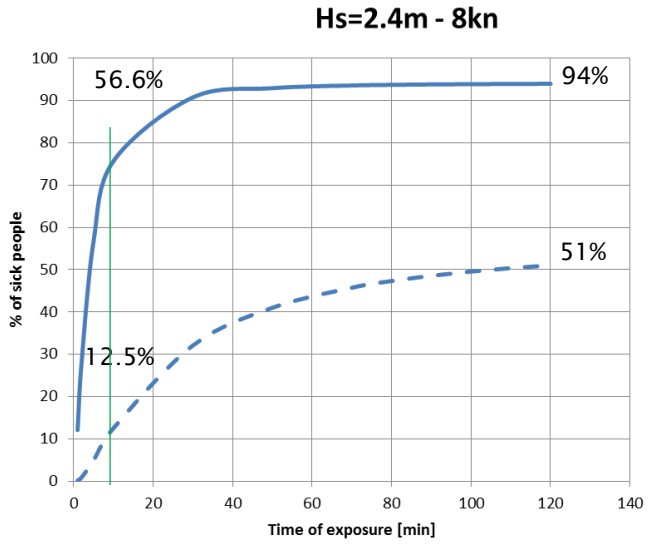
# CATAMARAN – Results 8 knots




- Higher transversal metacentric height,
- Shorter natural periods of Catamaran

| 10 minutes | 120 minutes |
|---|---|
| 4.5 times sicker | 1.8 times sicker |

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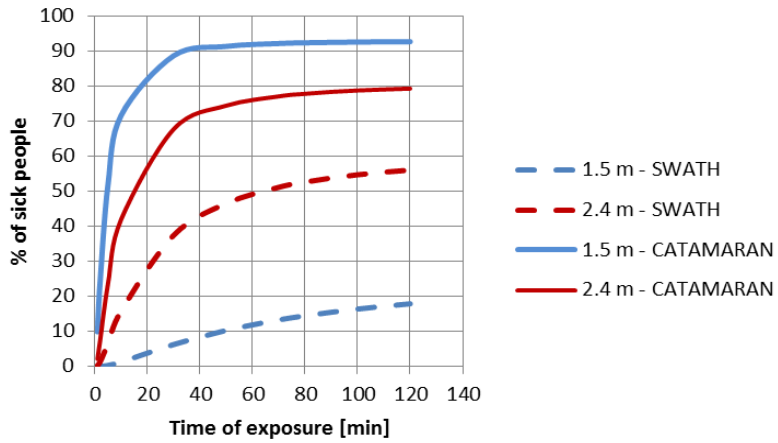
# CATAMARAN – Results 12 knots




- Head seas with peak frequency close to 5 seconds.
- Non-linear phenomenon, depends on wave frequency, wave height, speed.



# GLOBAL RESULTS

- Twice more people sick on-board of catamaran and monohull than SWATH.
- More sensitive during the first 10 minutes than SWATH.
- Non linear phenomenon (Fp, Hs, U…)
- Speed reduction necessary for comparative ships.

# CONCLUSIONS

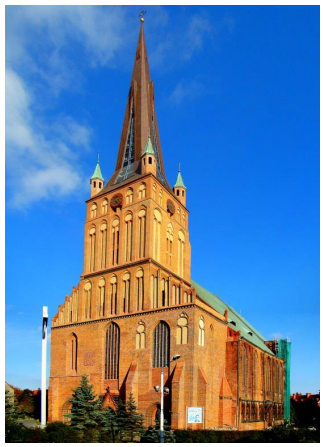
- The purpose of the work has been reached
- Significant peak frequency of ships
- Displacements of catamaran and monohull are different
- Polar plot diagram to optimize the road and speed to reach similar time transfer between comparative ships and SWATH



# ADDITIONAL WORK

- Considering more than just significant wave heights, financial impact
- Active stabilisation systems -> impact on pitch & roll gyradius
- Coupling *Seakeeper* with an optimization software

# Thank you for your attention, dziękuję bardzo



Szczecin ≈ *chtchétchine*
[French pronunciation]

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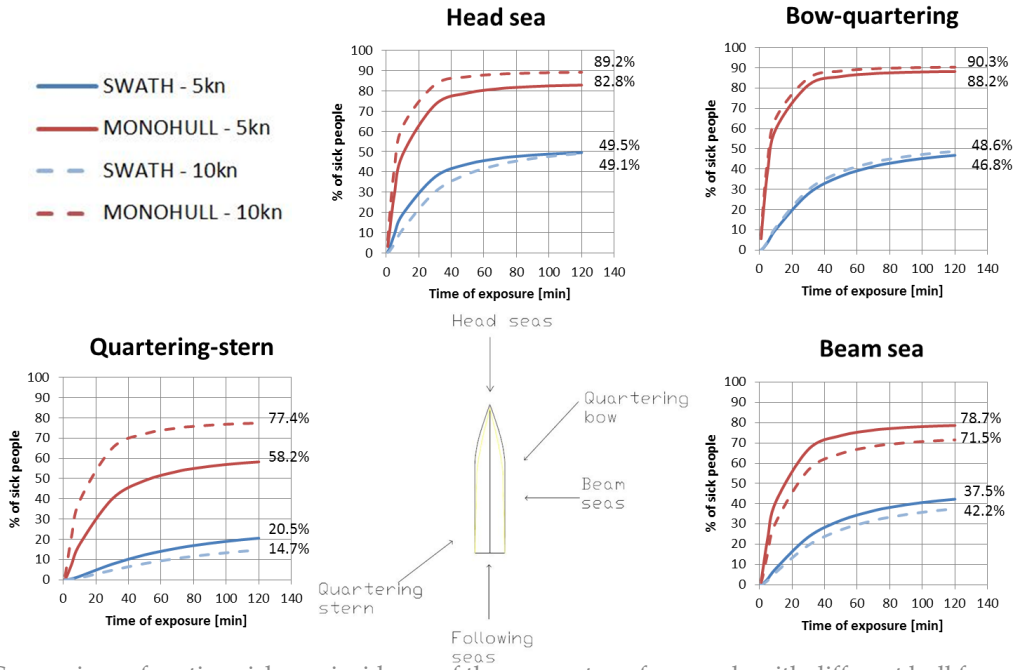
# MONOHULL – Results 5&10 knots

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