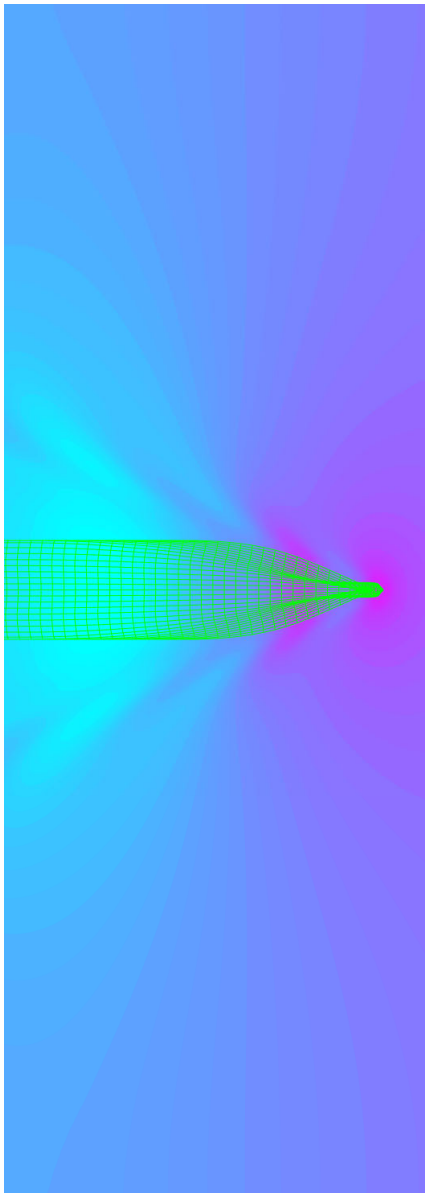
Measured and modelled flow around container ships

Presented to Royal Institution of Naval Architects, Fremantle, 9th October 2024

Tim Gourlay, Perth Hydro



Why do we need to model the flow around container ships?

1. **For naval architects: minimizing the wave pattern to make an *efficient hull***
2. **For the port: knowing how ship speed and waves affect *under-keel clearance***
3. **For pilots: knowing how speed and depth affect *manoeuvring***
4. **For shipping companies: knowing what wave conditions may cause *loss of containers***

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Safmarine Makutu (292 x 32.2 m), Fremantle

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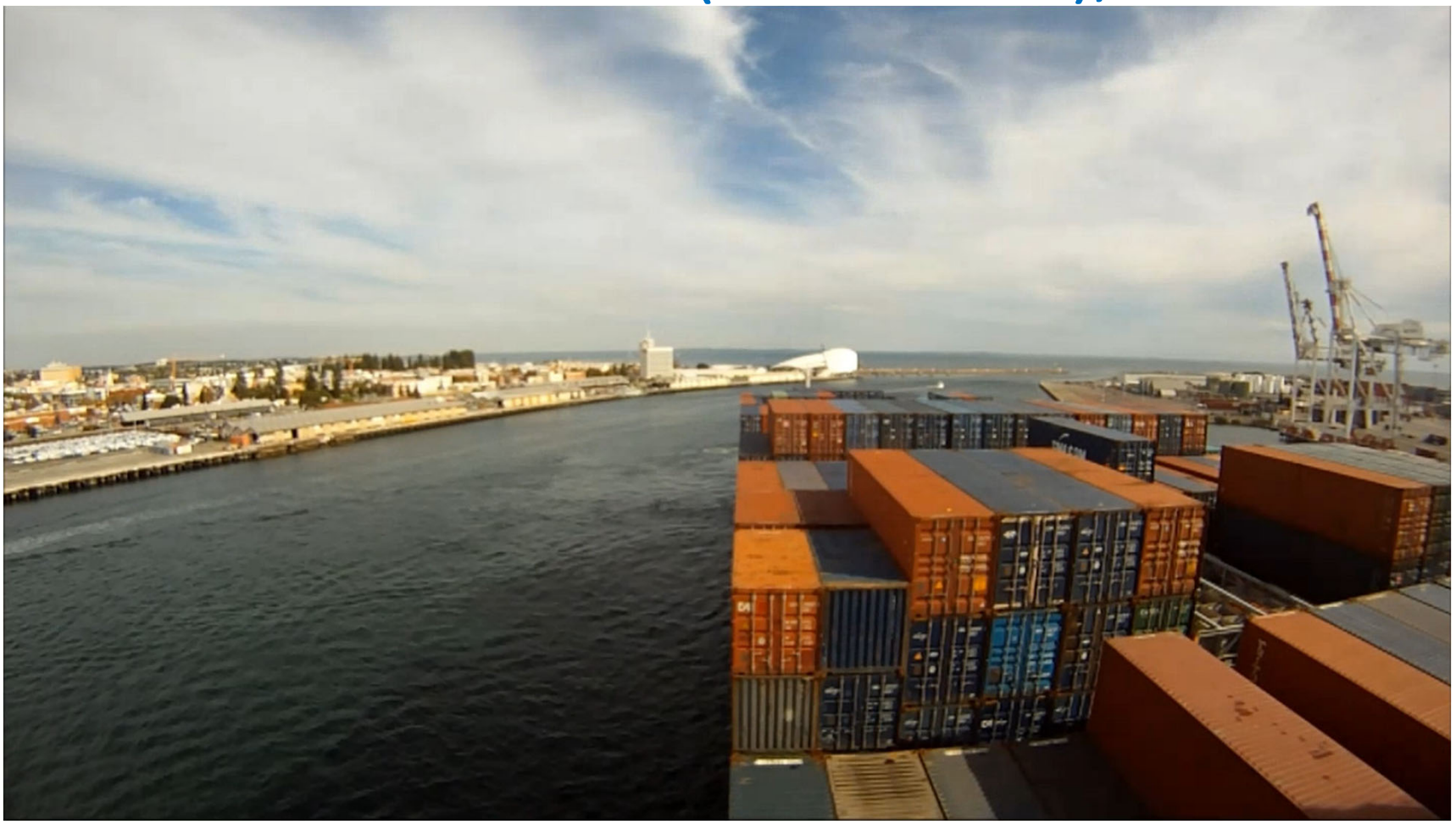
CMA CGM Lamartine (299 x 40 m), Fremantle



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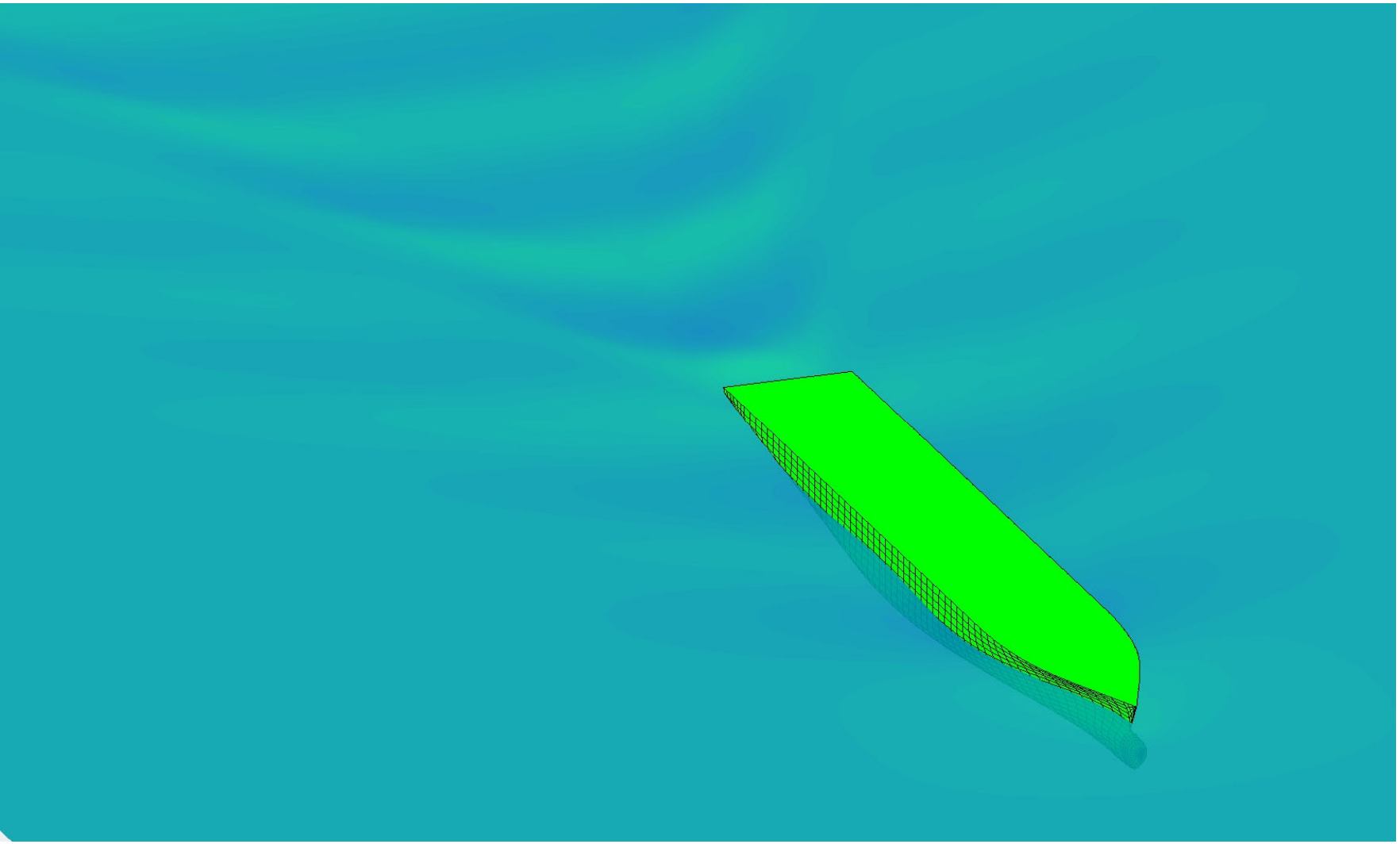
How do we design an efficient hull?

- **By modelling the flow around the ship, then optimizing the hull shape to minimize the resistance**
- **Useful tools for wave pattern and wave resistance:**
  - **phFlow, RAPID, SHIPFLOW**
- **Useful tools for afterbody shape and propeller efficiency:**
  - **OpenFOAM, Star-CCM+, ANSYS**

phFlow



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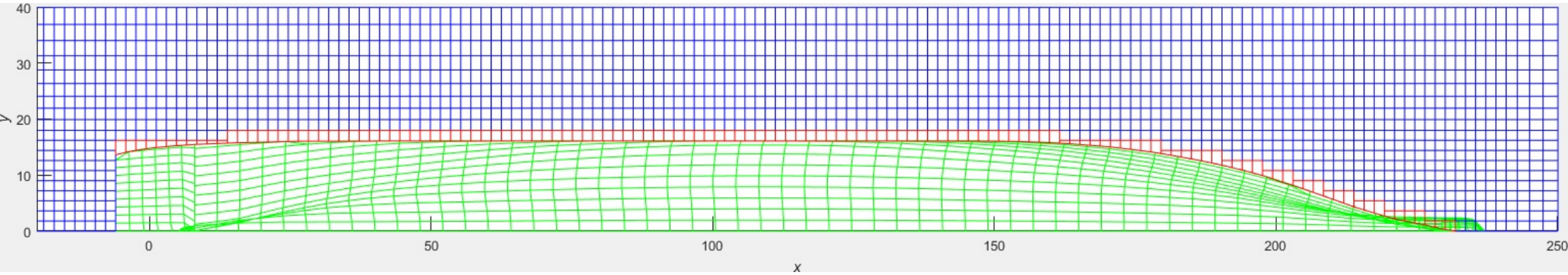
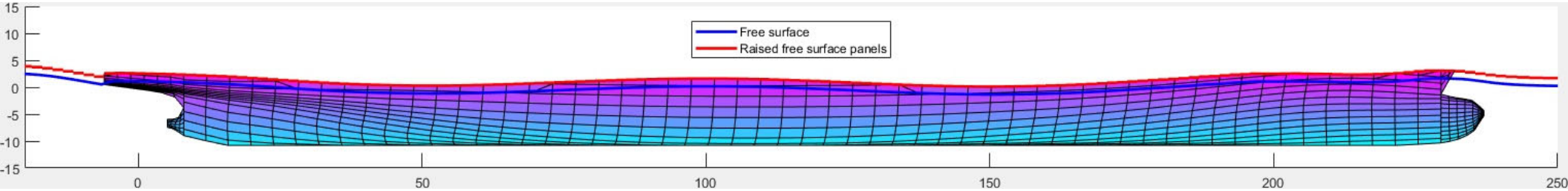
phFlow meshing – KRISO container ship





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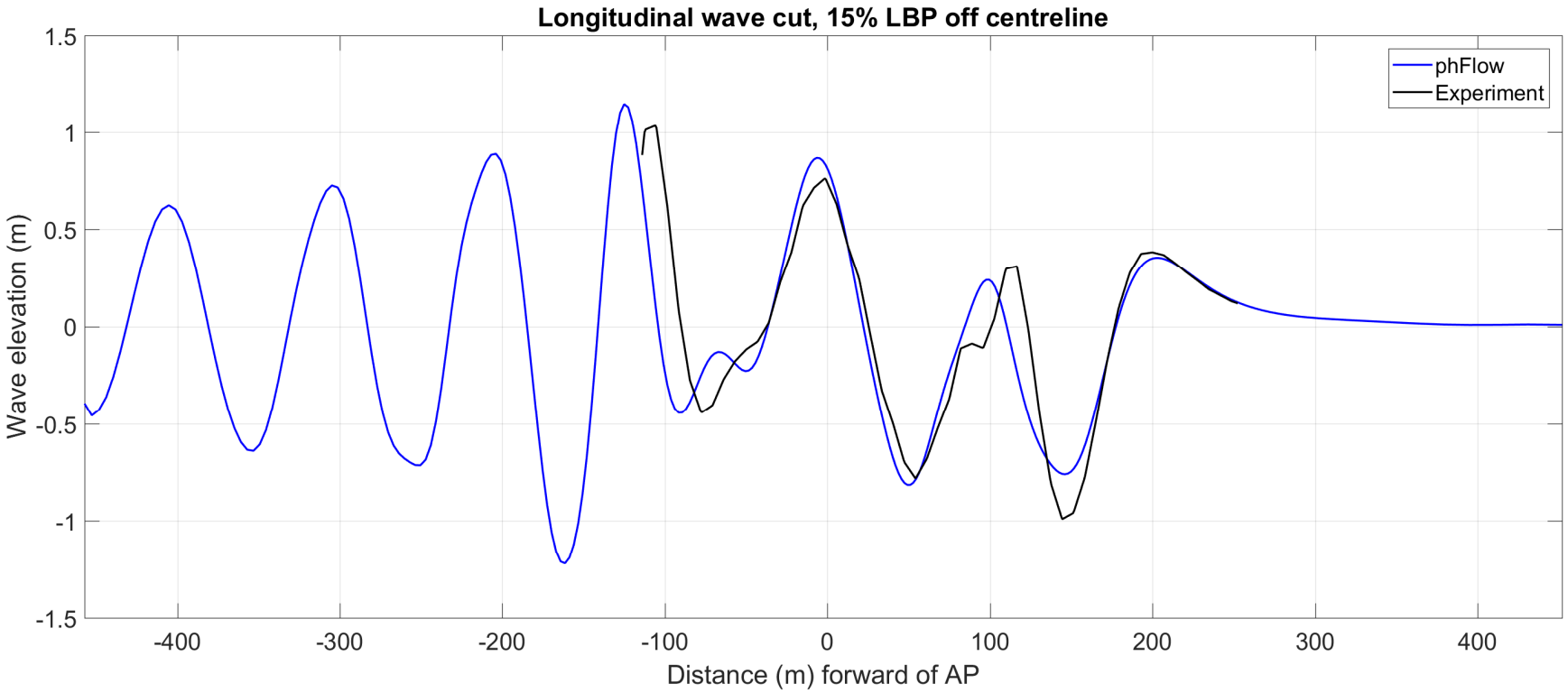
phFlow validation, KCS deep water @ 24 knots



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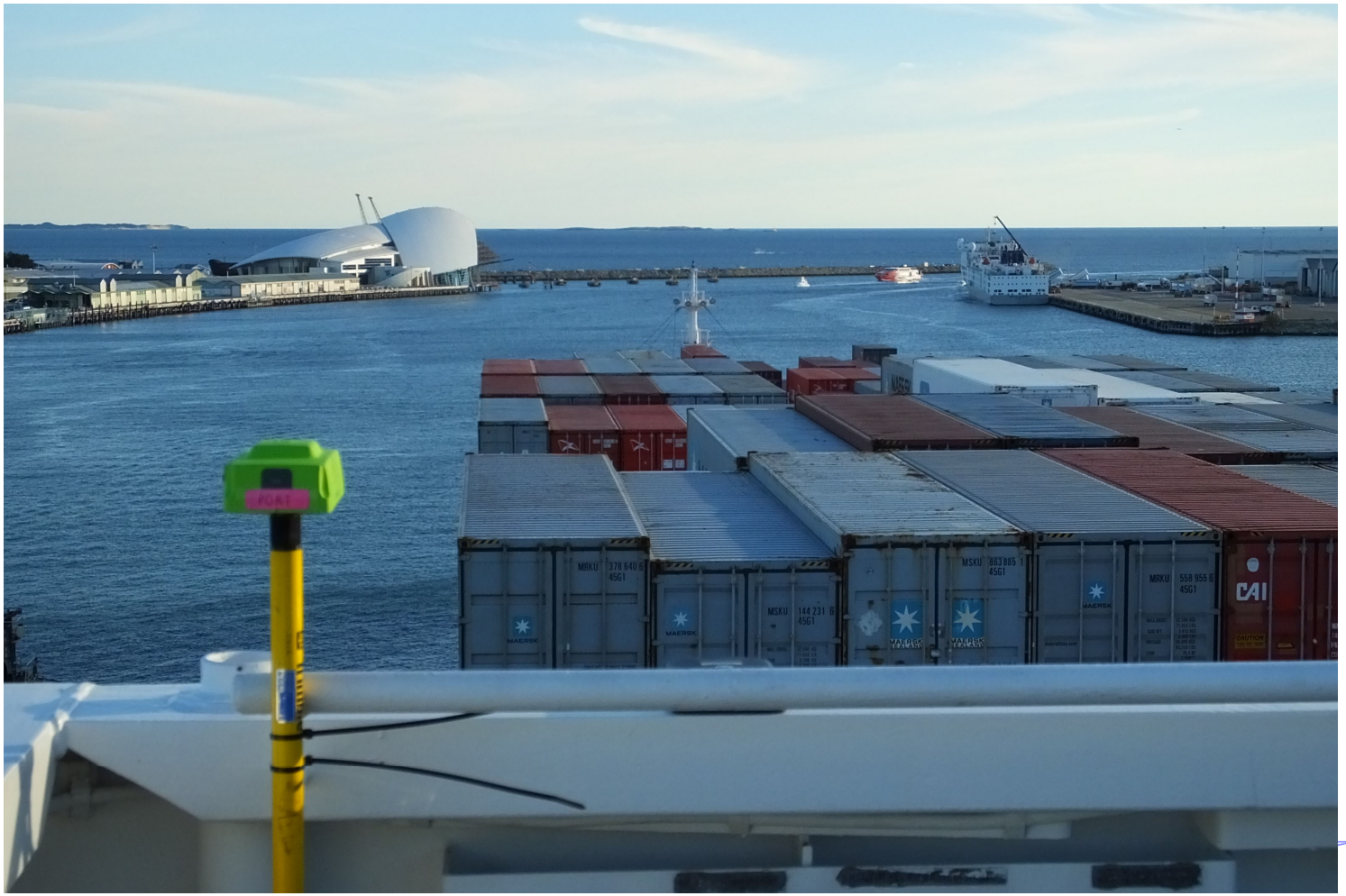
How do we measure ship UKC?



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How do we predict ship UKC?

- **By modelling the flow around the ship, then calculating the dynamic pressure and hence squat (dynamic sinkage and trim)**
- **Useful tool for calculating container ship squat:**
  - **SlenderFlow**

Image: RoRo in Thames Estuary at 20 knots, depth 16 m, courtesy of John Clandillon-Baker

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Flow around a container ship in the River Elbe

https://www.youtube.com/watch?v=l4sy0luQXXc

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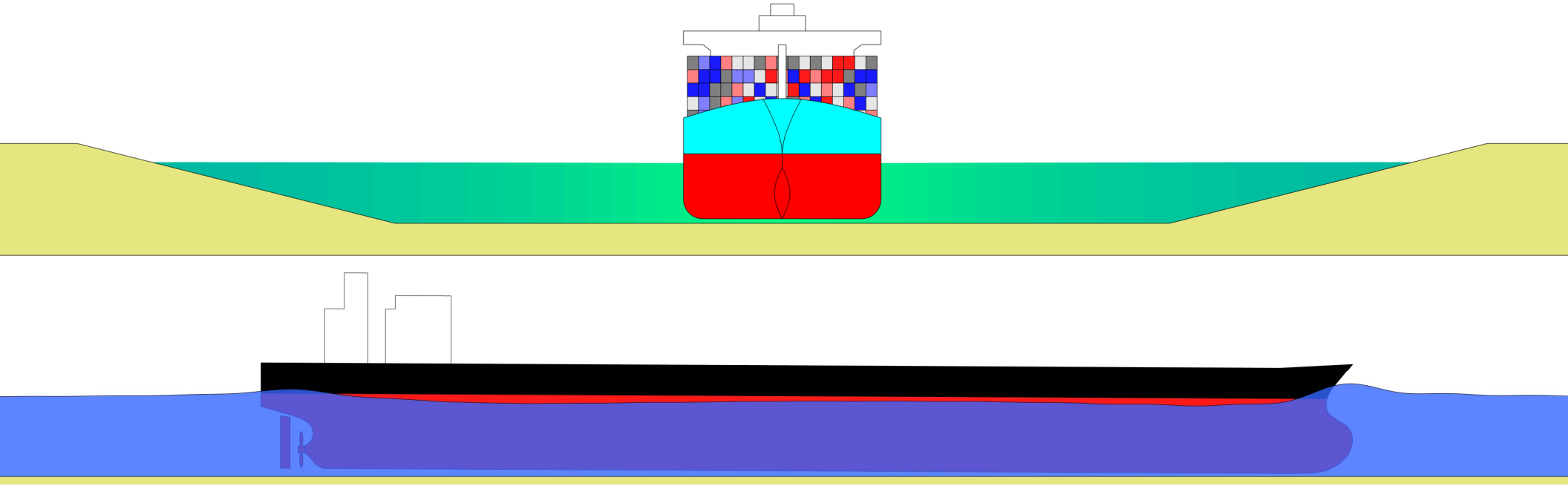
SlenderFlow



- **Slender-body shallow-water software developed at Perth Hydro**
- **Used to calculate squat (dynamic sinkage and trim) of ships**
- **Used for UKC management at Barrow Island and Wheatstone LNG terminals**

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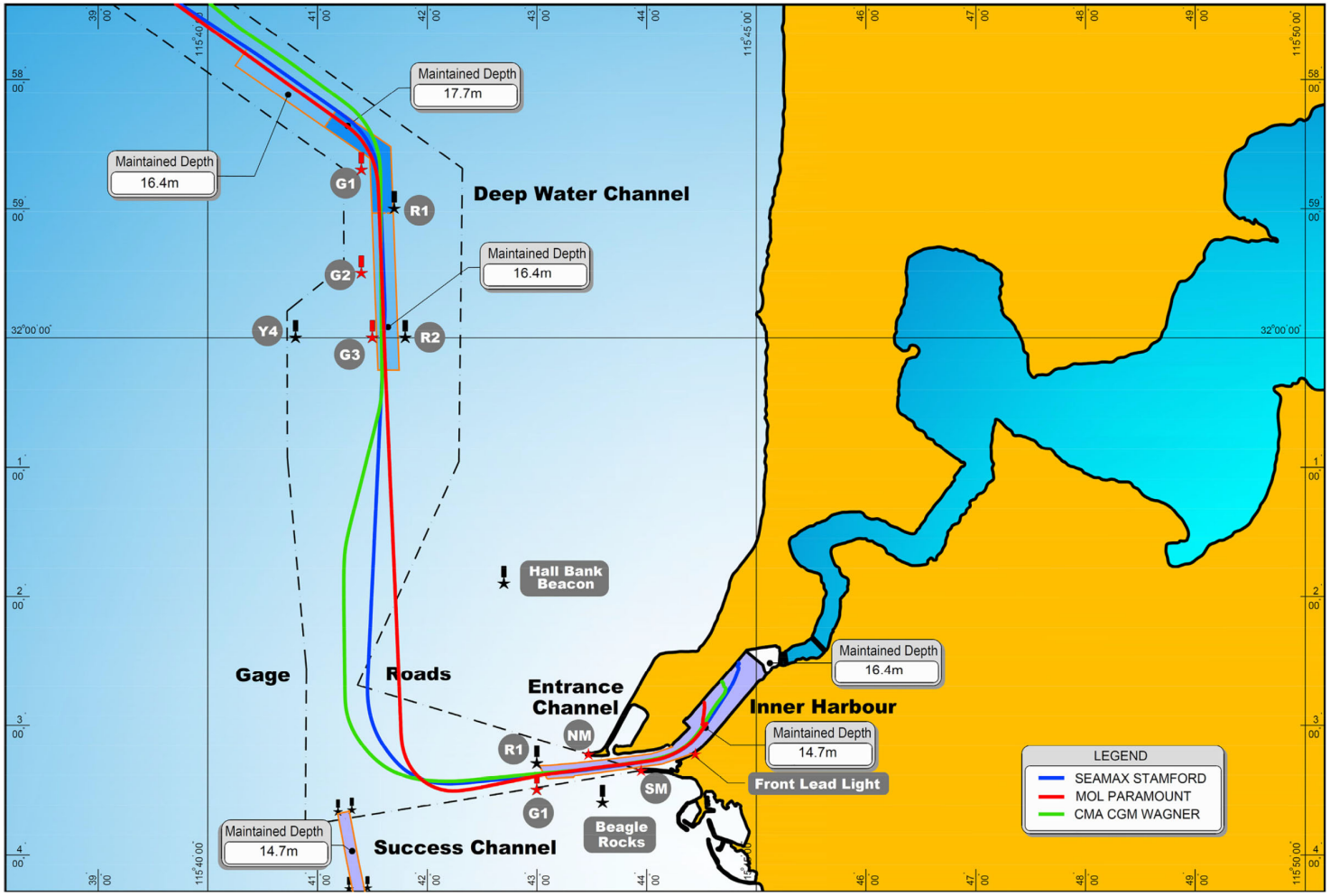
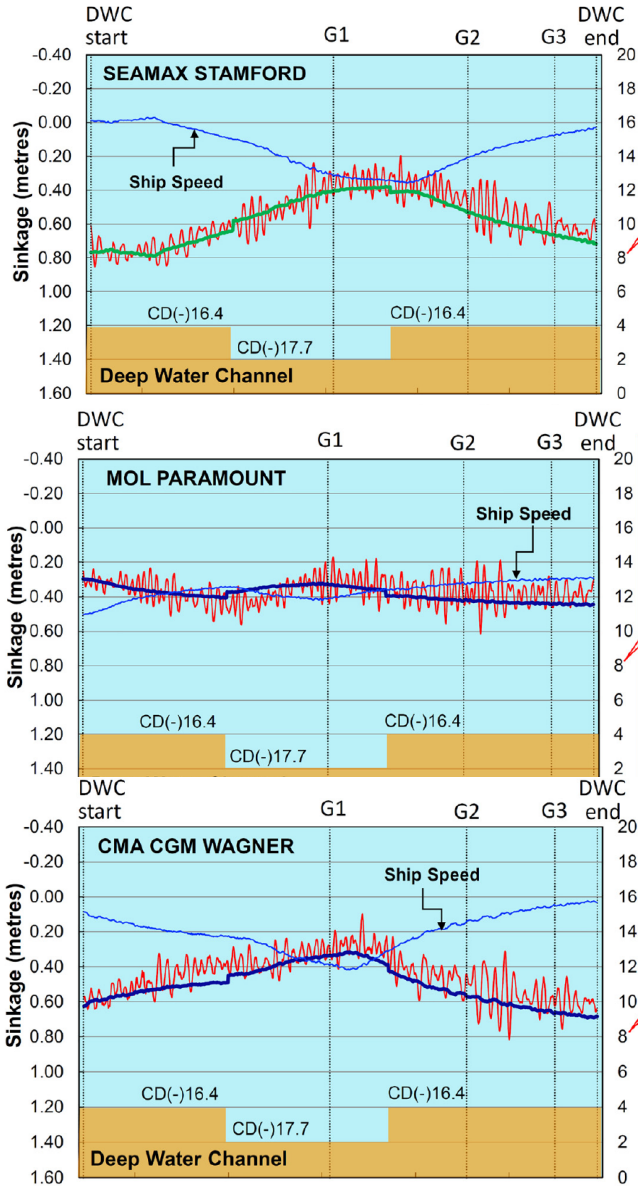
SlenderFlow validation, Fremantle





Container losses due to wave-induced motions

- **CMA CGM Benjamin lost 44 containers overboard while rounding the Cape of Good Hope in severe weather on 9th July 2024**

Image: www.shipspotting.com

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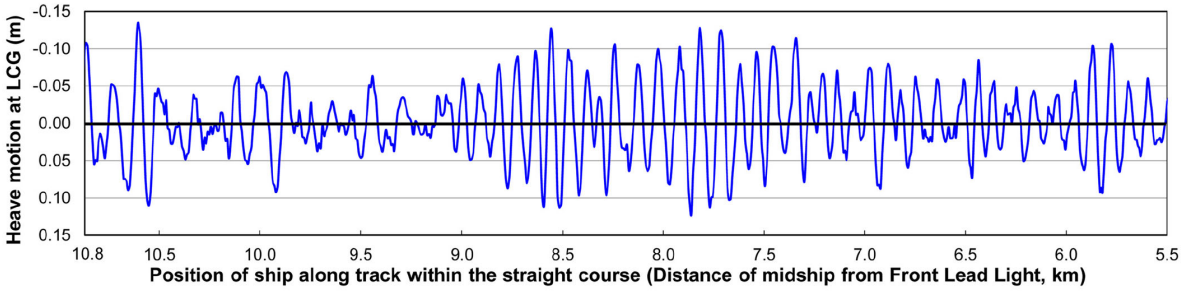
How do we measure container ship motions in waves?



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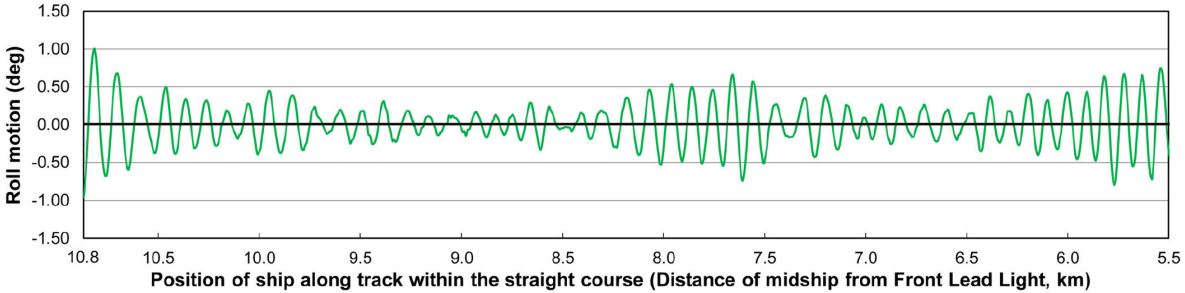

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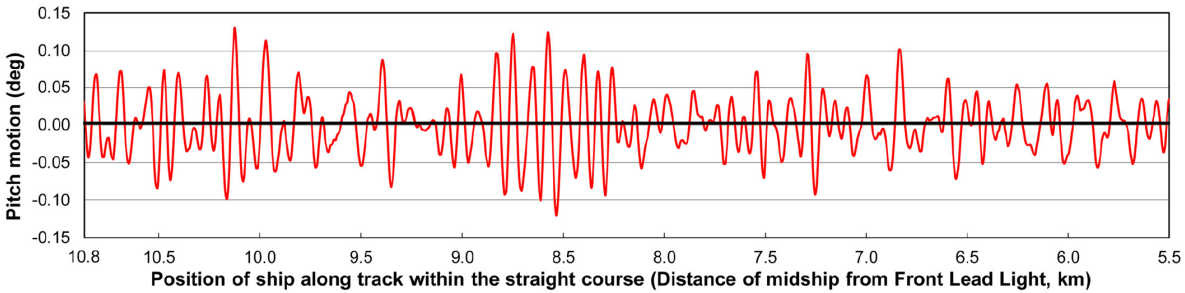

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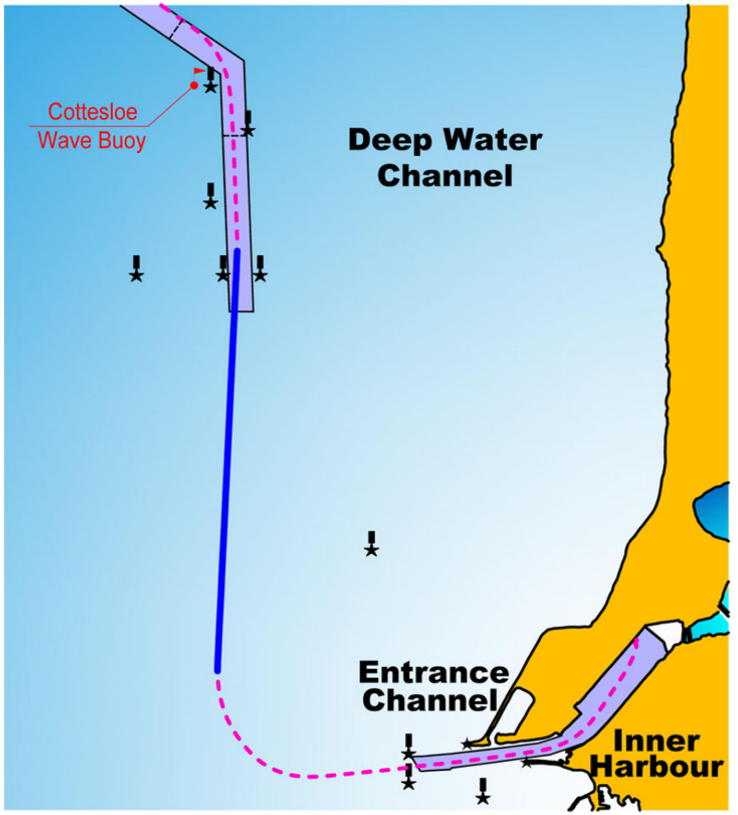

Seamax Stamford (250 x 37.3 m), inbound to Fremantle

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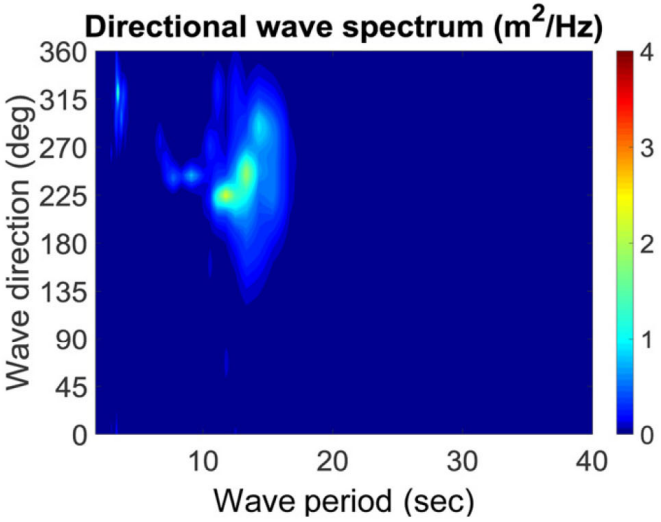
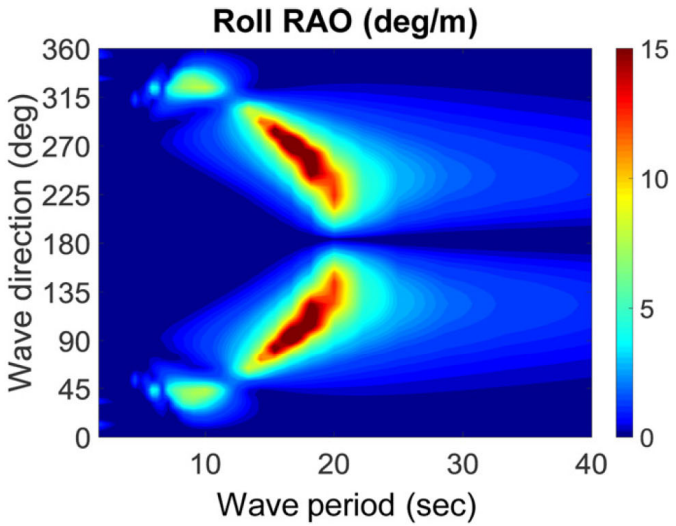
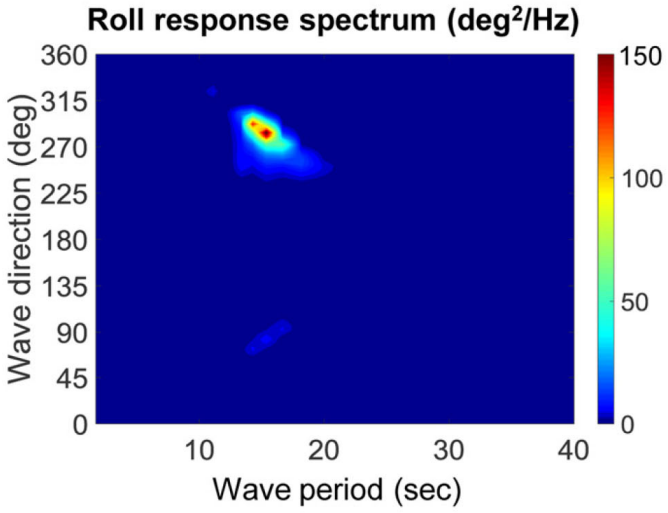
How do we predict container ship motions in waves?

- **By modelling the wave loads and hydrodynamic characteristics of the ship, then combining with the measured or forecast wave spectrum**
- **Useful tools for ship motions in waves:**
  - **WAMIT, OCTOPUS, PDStrip**







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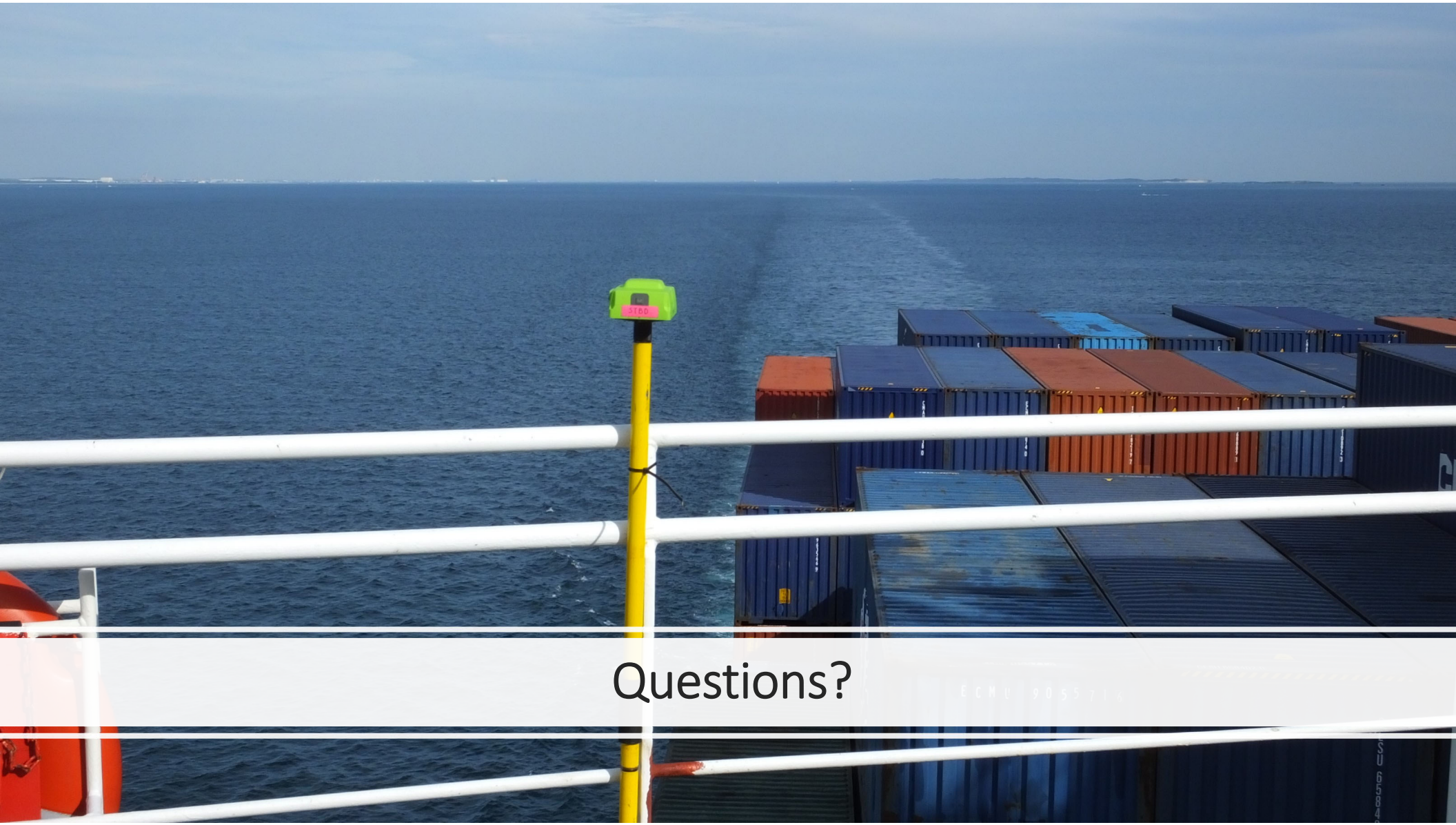

Questions?