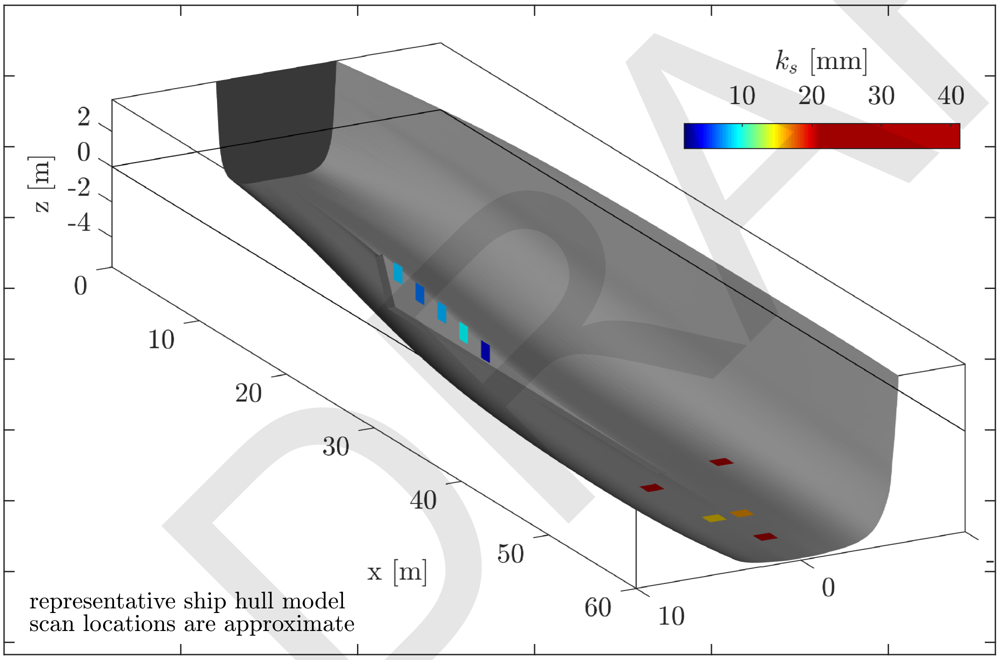
Quantitative assessment of increased frictional drag due to hullfouling using underwater surface scanning

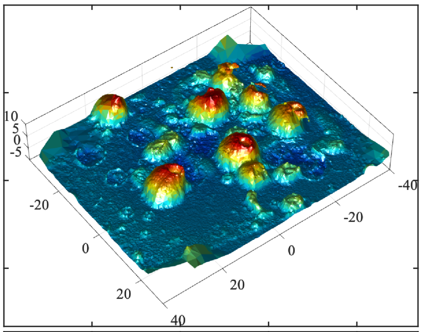
Prepared for: Franmarine Underwater Services Pty. Ltd.
Scan location & date: Fremantle Port, 16 February 2025

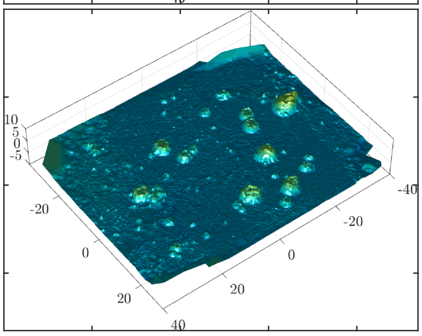
Increased in friction drag, total ship resistance, fuel expenditure, and CO2 emission due to biofouling growth is estimated for Coral Adventurer. To do that, the hull roughness on 14 locations was quantified using 3D underwater surface scanning. The observed underside hull was more fouled than the skeg, where this variation is accounted for when estimating the drag penalties.

- Ship class: Passenger (Cruise) ship
- LOA: 93.4 m [Ref1]
- Gross Tonnage: 5516 [Ref1]
- Engine: 2× Rolls-Royce Azipull [Ref1]
- Cruise speed: 13.8 kn [Ref1]
- Max speed: 18 kn*
- Max engine power: 7,000 kW**

* Assumption on page 2. Need the actual curve.
** from Azipull specs, assumming AZP 120 model (Ref 3)



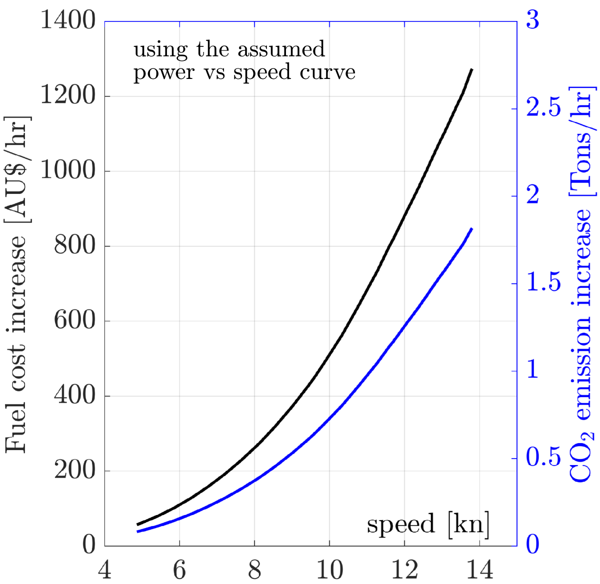




BASELINE:

- paint coating
- previous scan
- **hydrodynamic smooth**

PARAMETERS	
Engine eff.	40%
fuel ϵ	45.5 MJ/kg
fuel ρ	0.87 kg/L
fuel $	$1.92
fuel CO_2/kg	3.16 kg_{CO_2}/kg



At 13.8 knots:
$\Delta C_f = 193\%$
$\Delta R_T = 98\%$
$\Delta \text{fuel} = \$1273/\text{hr}$
$\Delta CO_2 = 1.8T/\text{hr}$

REFERENCES

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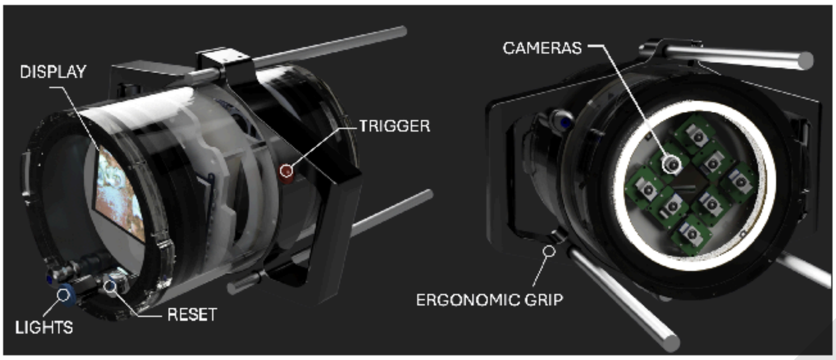
AQUAMARS



ROUGHNESS STATISTICS

Loc	krms	Sk	ES	AHR	ks
1	0.844	2.435	0.372	2.546	8.021
2	0.871	3.195	0.366	2.451	9.142
3	0.531	8.518	0.241	1.876	5.357
4	0.708	3.29	0.309	2.234	6.66
5	0.823	3.903	0.3	2.035	8.186
6	1.131	2.845	0.244	2.829	8.283
7	2.761	0.983	0.525	7.736	21.991
8	1.78	3	0.3	3.271	15.676
9	1.798	2.657	0.287	3.149	14.454
10	0.446	2.927	0.231	1.312	3.176
11	0.777	2.244	0.292	2.577	5.856
12	0.404	1.514	0.239	1.362	2.185
13	1.063	2.362	0.249	2.65	7.263
14	1.17	1.714	0.411	3.784	9.979
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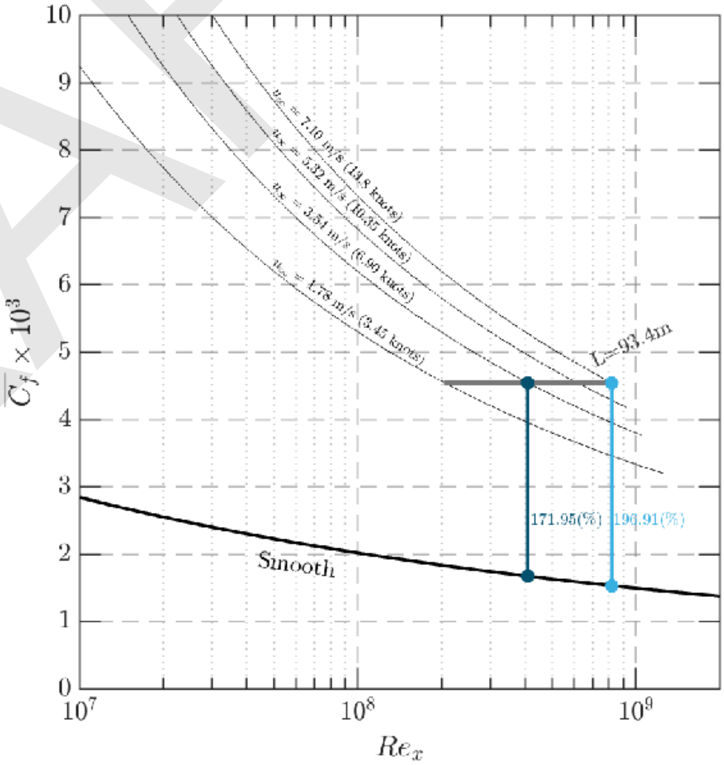
FRICTION COEFFICIENT



BASELINE SPEED vs POWER ASSUMPTION