JBC test data in NMRI

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Contents

Summary

- With enforcement of Enrgy Efficiency Design Index (EEDI), Energy-Saving device(ESD) has come into the limelight, but we do not have any common benchmark database for especially detailed flows around a ship with an ESD.
- Geometries of a ship with an ESD and detailed flow data must be open in order that all CFDers can use the flow field database to validate their codes.
- Japan Bulk Carrier (JBC) has been newly designed together with a circular duct by mainly NMRI, YNU and SRCJ.
- Resistance, self-propulsion factors,wave pattern and detailed velocity distributions around stern were measured in NMRI towing tank for a ship with and without a duct in resistance and self-propulsion condition.

Design guideline of JBC(Japan Bulk Carrier) and ESD

- Objective is to validate CFD code for a ship with an ESD.
- In order to make strong axial vortex, stern shape should be full.
- Not care about the latest hull geometry (i.e. C_B should be large).
- Simple shape and effective ESD should be adopted.

$\rightarrow$

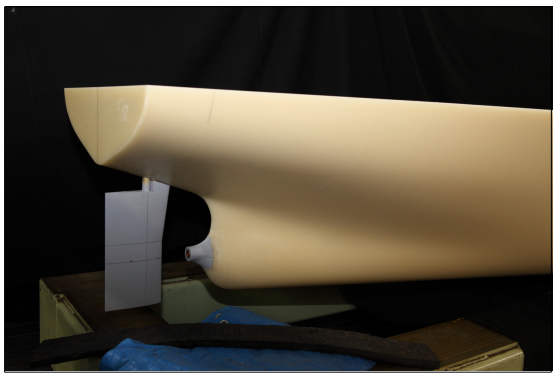
Following this guideline, Cape-size bulk carrier called Japan Bulk Carrier (JBC) with a circular duct was designed as hull form for validation.

Principal particulars and plates of JBC

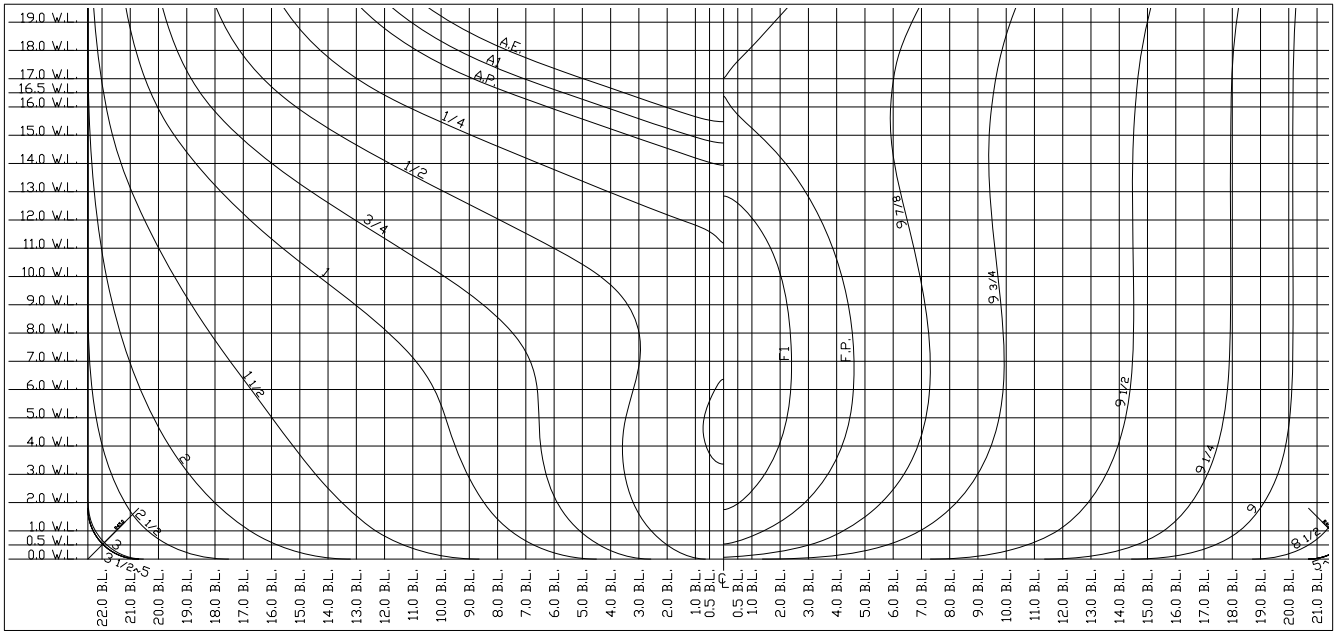
L_{pp}	280.0	m
L_{wl}	285.0	m
B	45.0	m
D	25.0	m
d	16.5	m
C_b	0.858	
C_p	0.860	
C_m	0.998	
C_w	0.925	

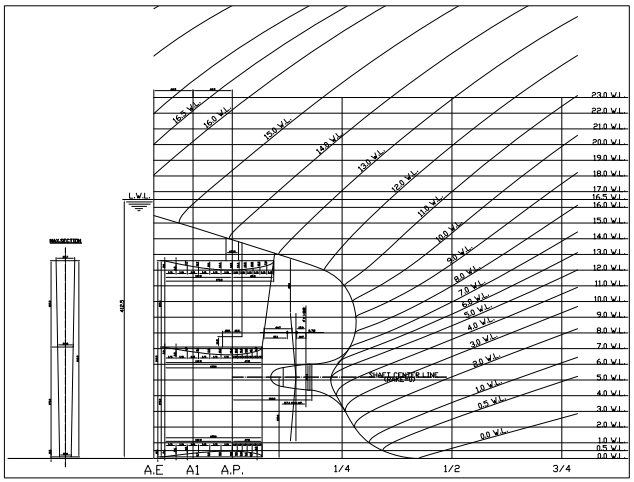
lcb	-2.548	%
V_s	14.5	kn
Z_{shaft}	5.184	m
α	40.0	

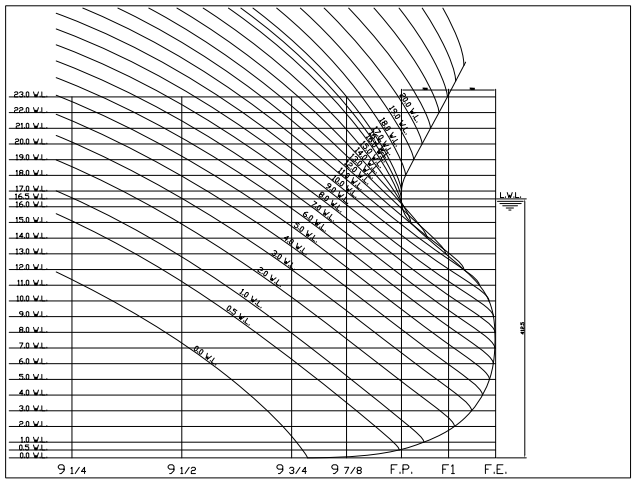
Section	MAU	
D_p	8.12	m
H/D	0.70	
AE	0.54	
Z	5	



Bodyplan and waterlines of JBC

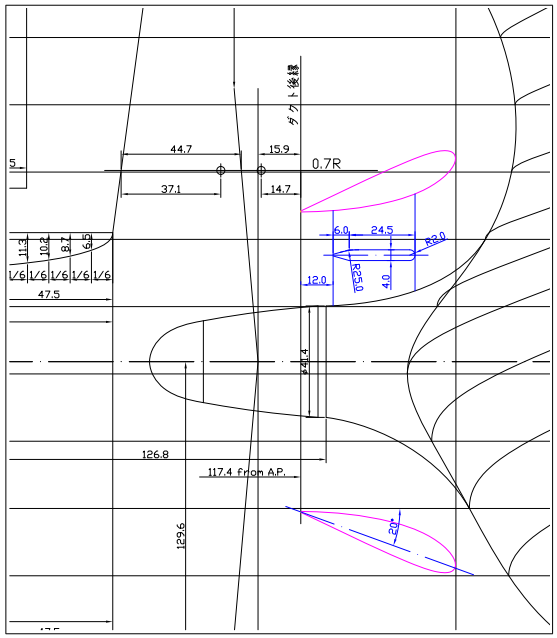






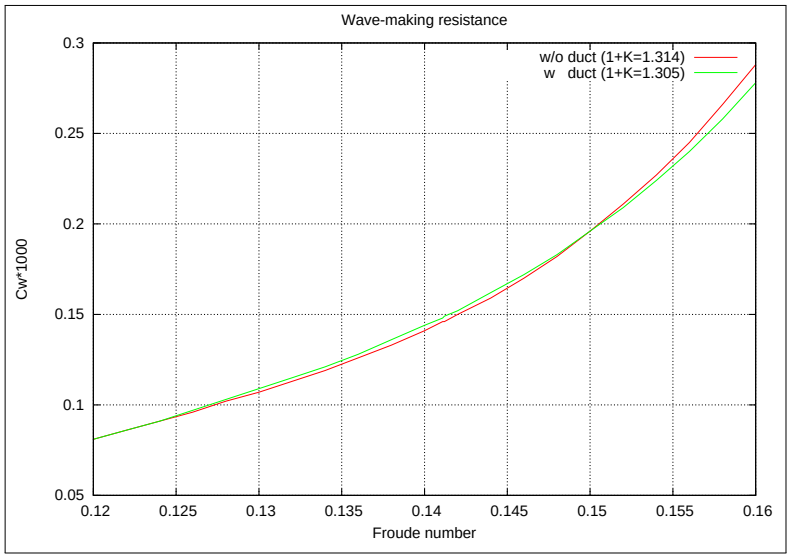
Dimensions and plates of circular duct

Duct diameter outlet	0.55 Dp
Chord length	0.30 Dp
Opening angle	20[deg.]
Foil section	NACA4420

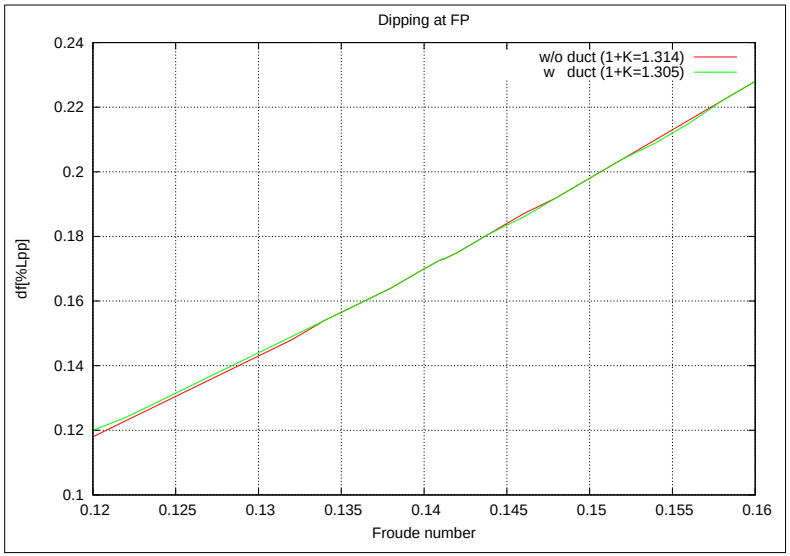


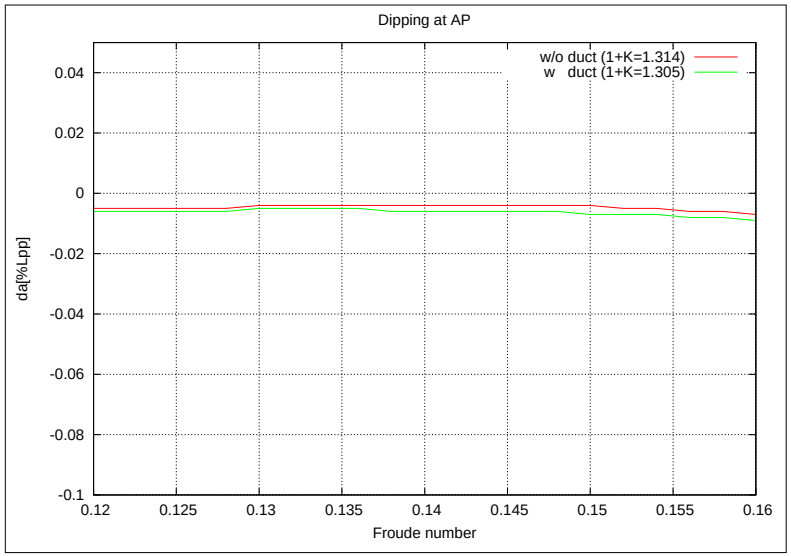
Ship resistance/self-propulsion test-1

Towing in calm water condition (pitch and trim free)	
Withour rudder, with/without propeller, with/without duct	
Ship point ($\Delta C_F = 0.12 \times 10^{-3}$ based on ITTC1957 line.	
Model ship speed(design)	V_m =1.179[m/s]
Froude number(design)	F_r $(=V_m/\sqrt{gL_{PP}}) = 0.142$
Reynolds number(design)	R_e $(=V_m L_{PP}/\nu) = 7.46 \times 10^6$

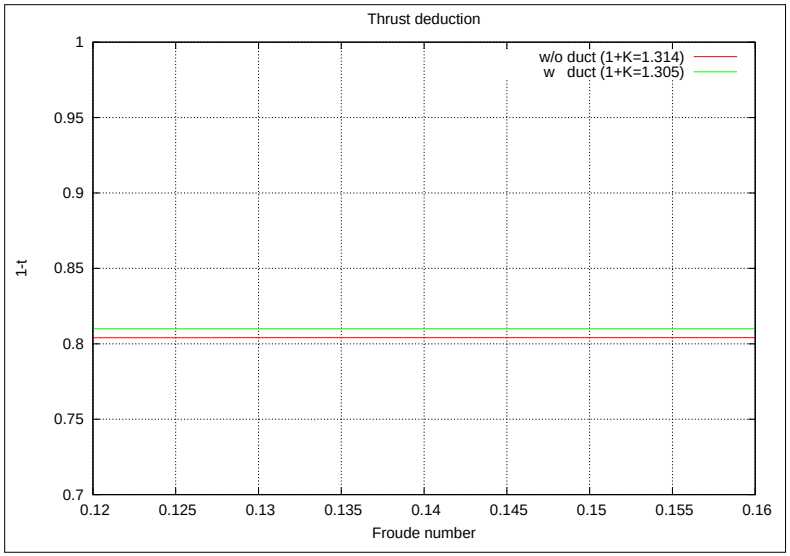


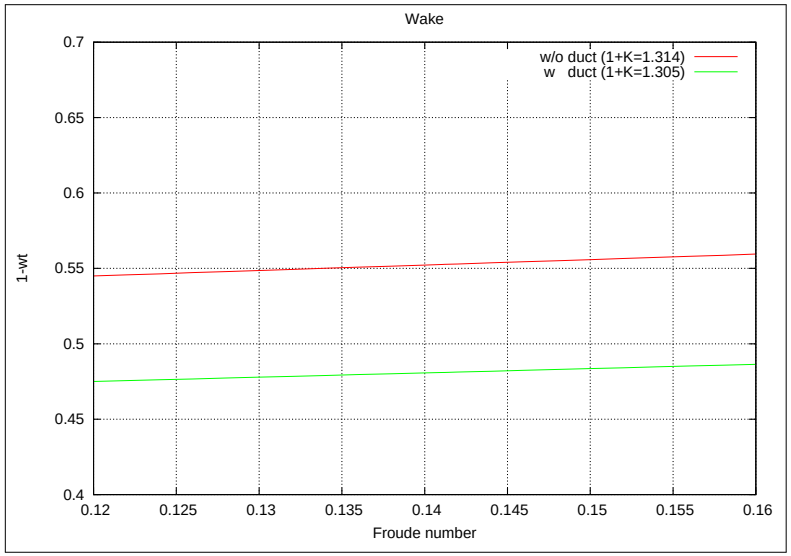
Ship resistance/self-propulsion test-2

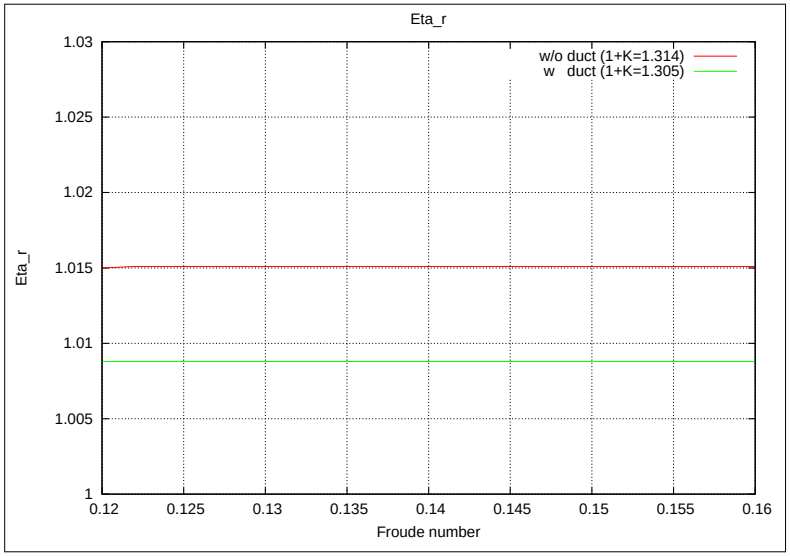


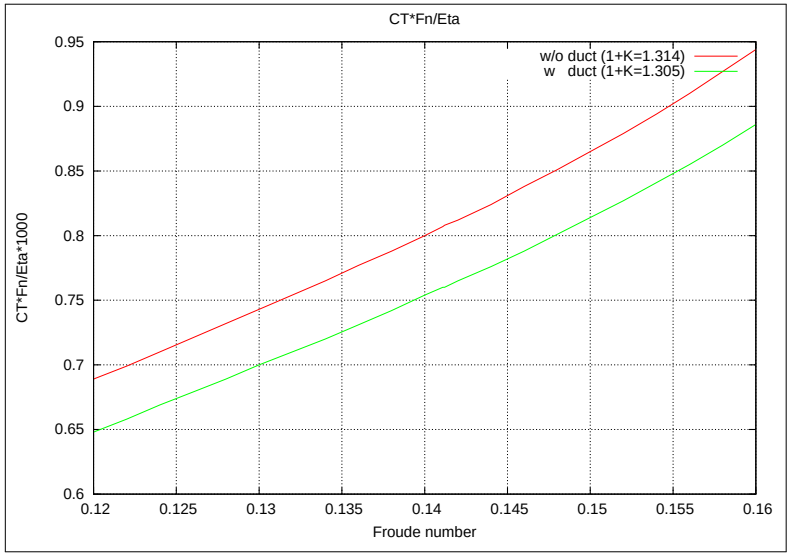


Ship resistance/self-propulsion test-3





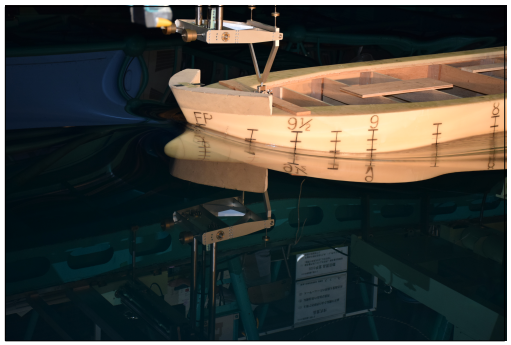




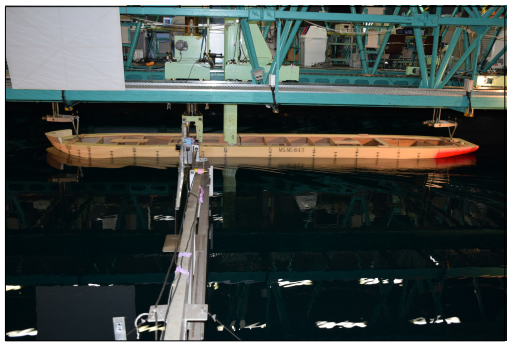
Wave pattern measurement-1

Towing in calm water condition (pitch and trim free)	
Withour rudder, without propeller, without ESD	
Model ship speed	V_m =1.179[m/s]
Froude number	F_r $(=V_m/\sqrt{gL_{PP}}) = 0.142$
Reynolds number	R_e $(=V_m L_{PP}/\nu) = 7.40 \times 10^6$
Measuring lines	wave profile, y/L_{PP}=0.1043, 0.1900
dipping at FP and AP	Δd_F=12.3mm, Δd_A=-0.3mm

fore



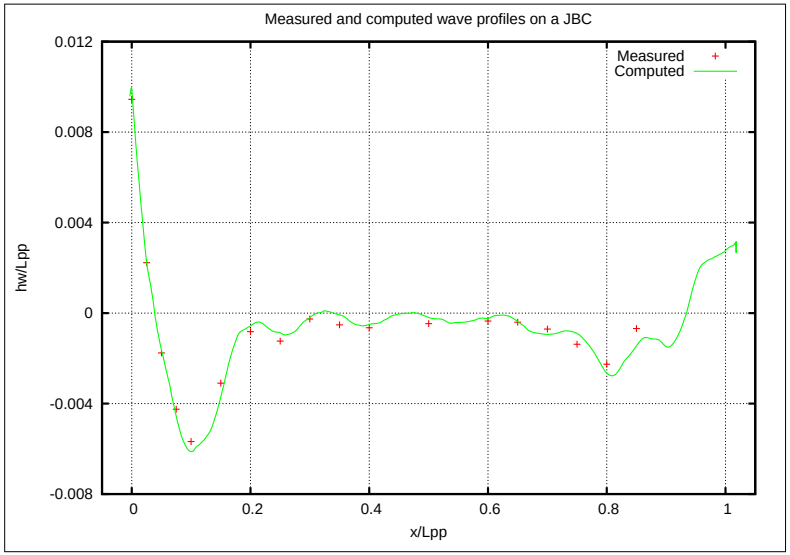
mid



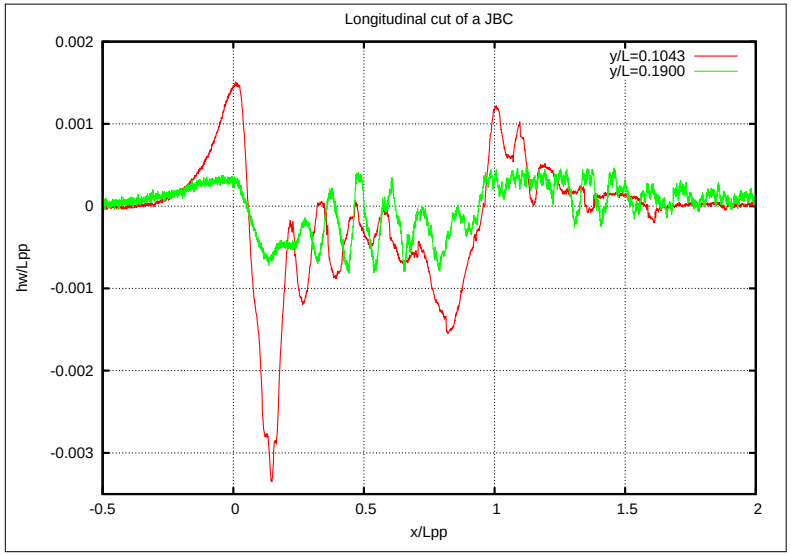
aft

Wave pattern measurement-2

wave profile



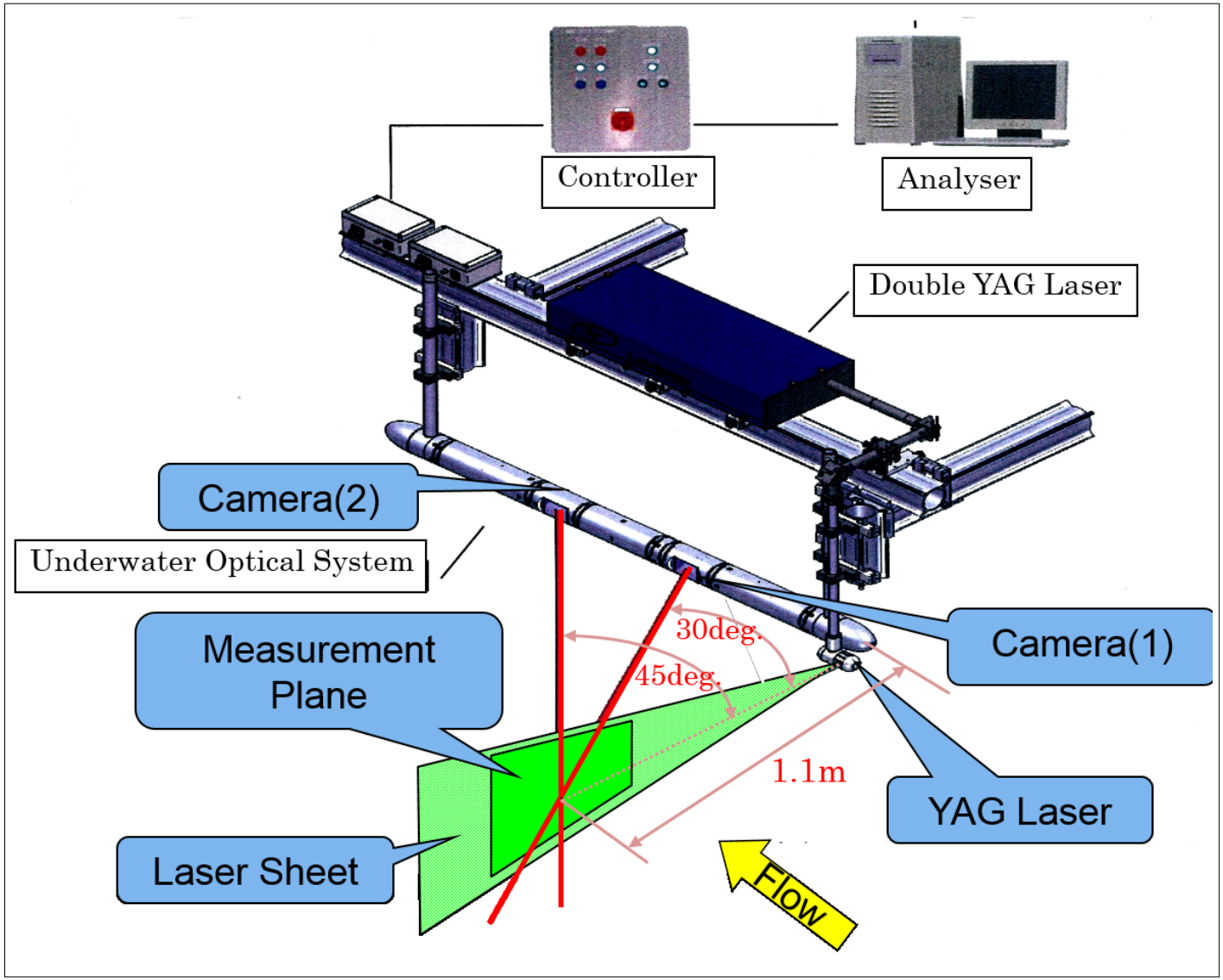
longitudinal wave cuts



Detailed flow measurement-1

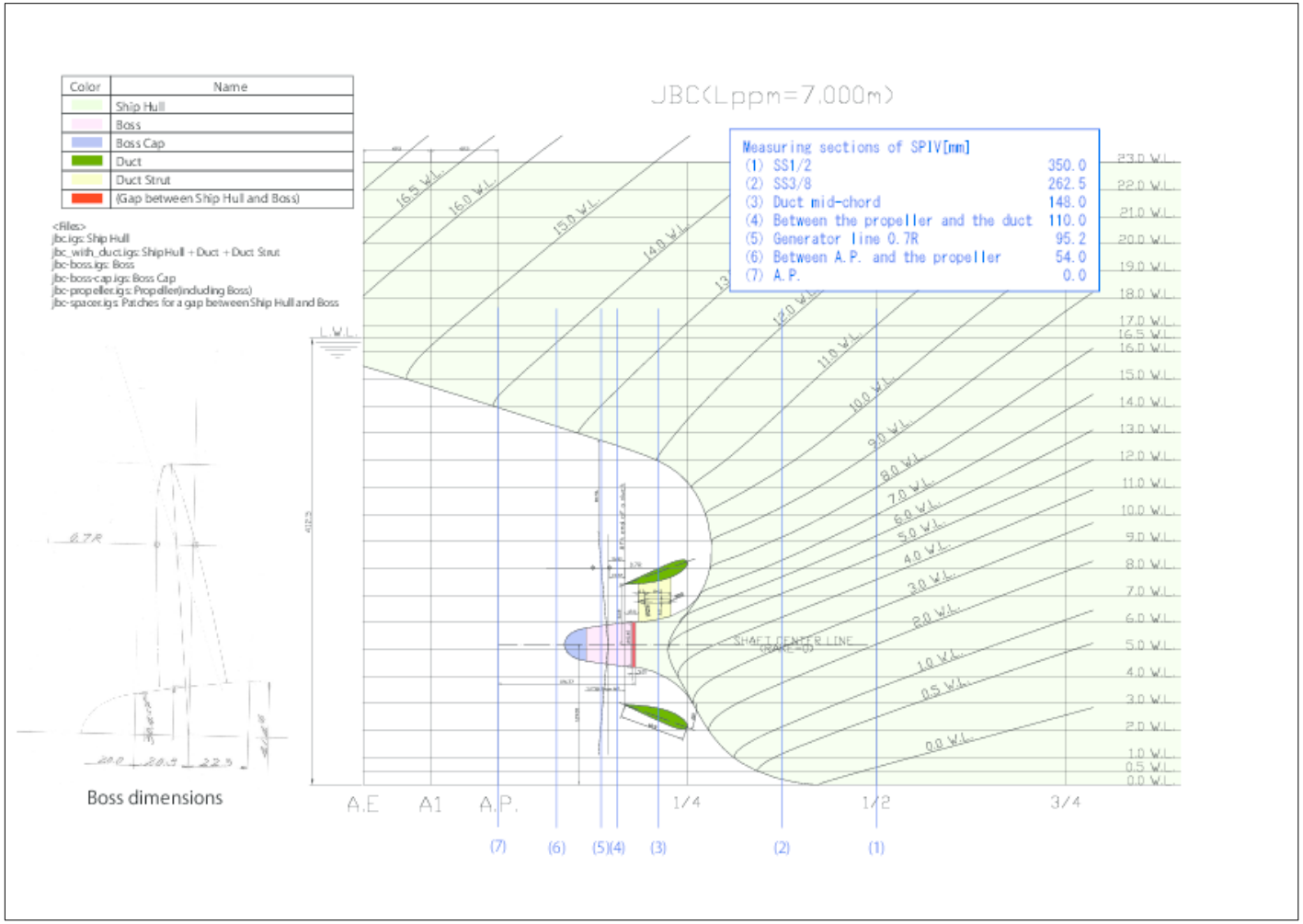
Towing in calm water condition (pitch and trim free)	
Withour rudder, with/without propeller, with/without ESD	
Model ship speed	V_m =1.179[m/s]
Froude number	F_r $(=V_m/\sqrt{gL_{PP}}) = 0.142$
Reynolds number	R_e $(=V_m L_{PP}/\nu) = 7.40 \times 10^6$
Measurement sections	7planes (from SS1/2 to A.P.)
Measurement items	mean flow (U, V, W)

Detailed flow measurement-2



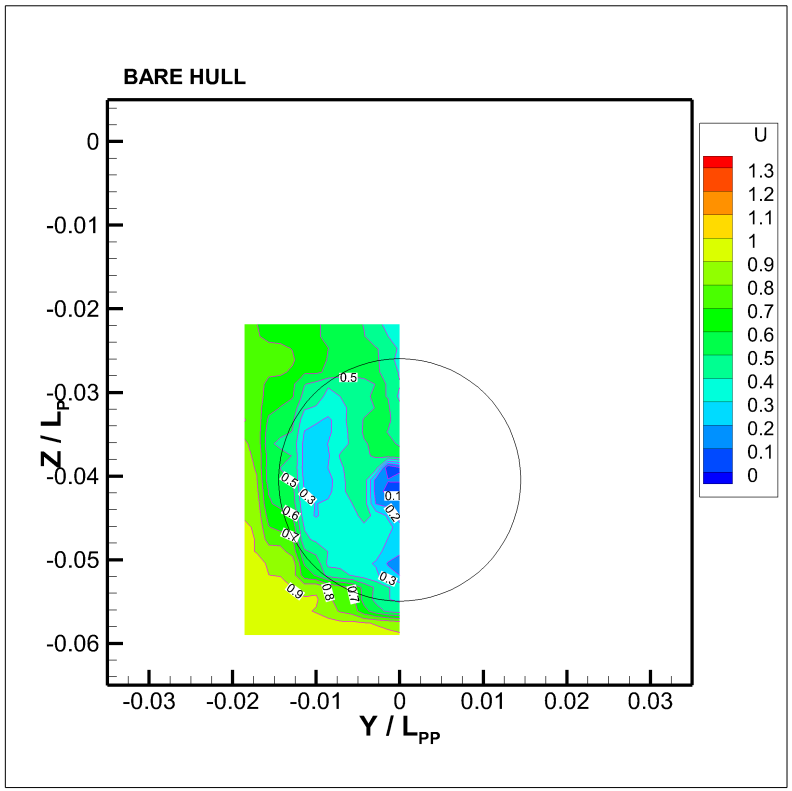
Detailed flow measurement-2

Measuring sections

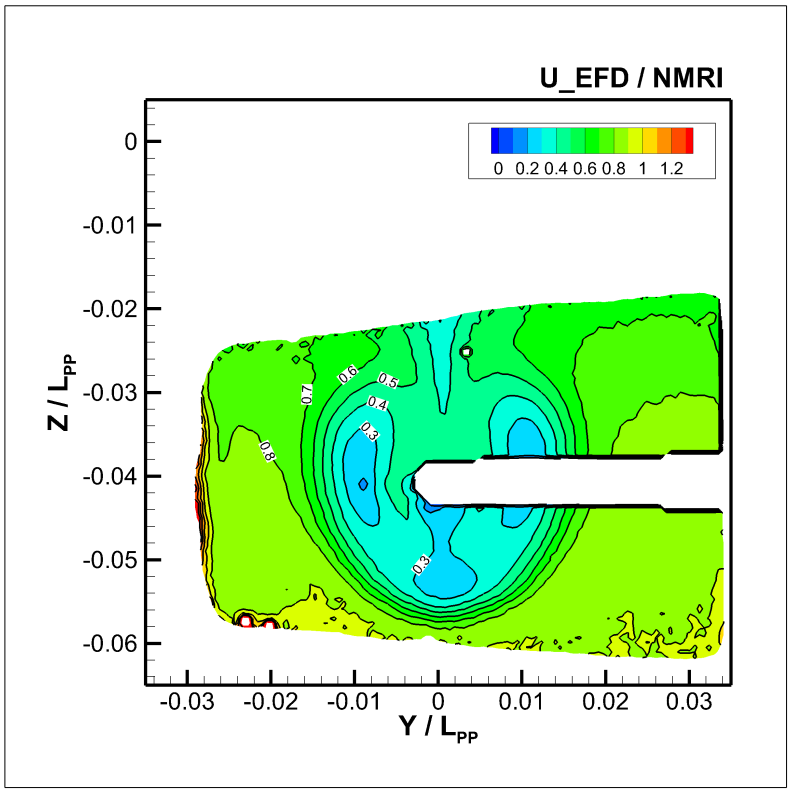


Detailed flow measurement-3

Comparison of 5 hole pitot-tubes and SPIV without a duct in resistance condition at prop pl.(S5)



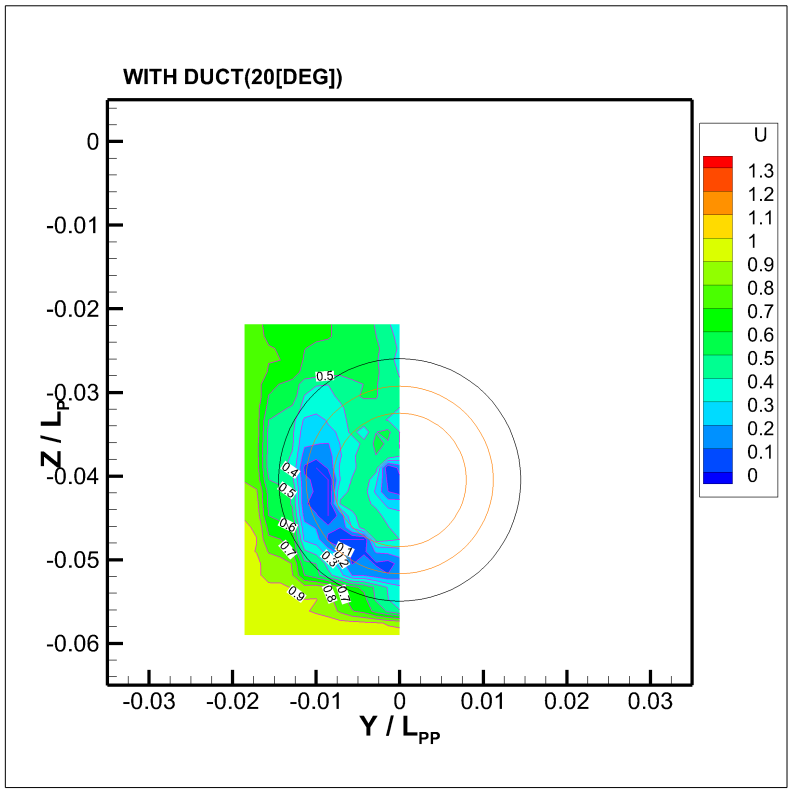
5 pitot tubes



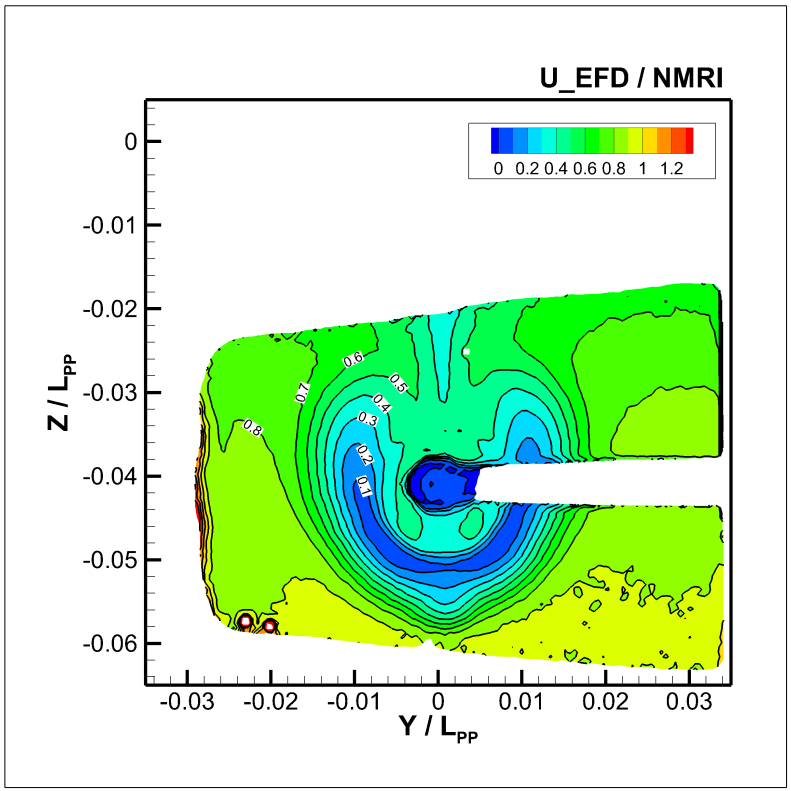
SPIV

Detailed flow measurement-4

Comparison of 5 hole pitot-tubes and SPIV with a duct in resistance condition at prop pl.(S5)



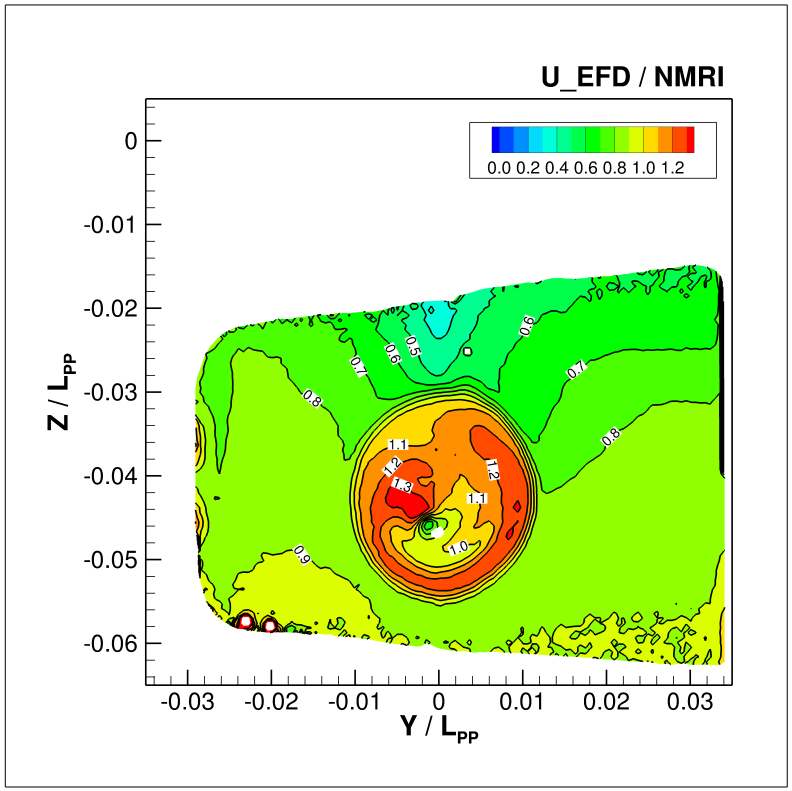
5 hole pitot tubes



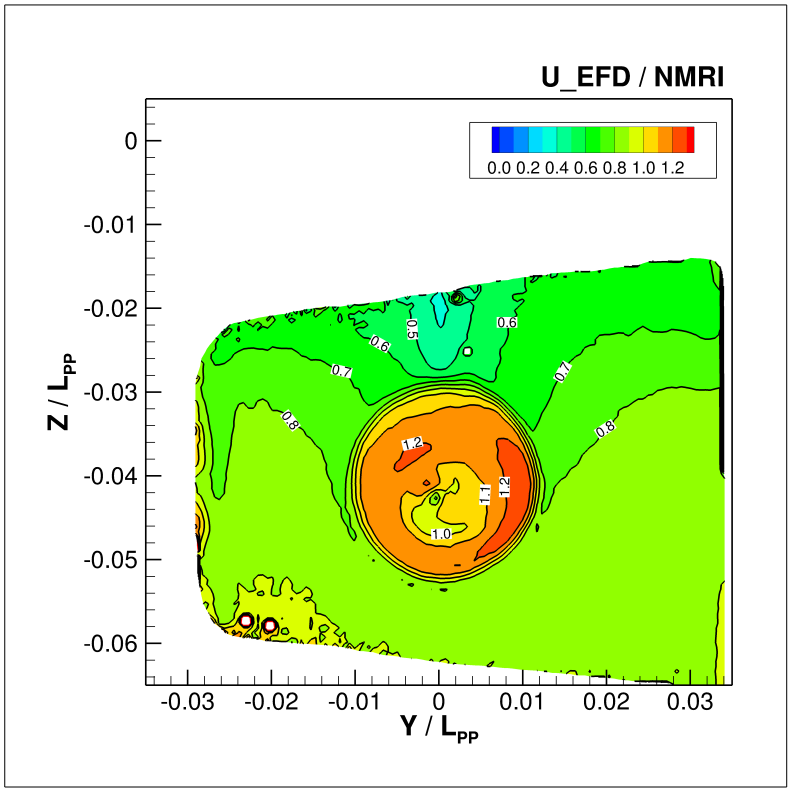
SPIV

Detailed flow measurement-5

Mean flow distribution in self-propulsion condition at A.P.(S7)



w/o duct



with duct

Concluding Remarks

- JBC with a circular duct was designed.
- Based on the resistance/self-propulsion tests. effect of a duct is quite well.
- Wave pattern and wake distribution of mean flow were measured.
- Thus, Data base for CFD validation was established.
- Turbulence properties will be measured in the future.

Acknowledgement

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