Schiffbautechnische Gesellschaft

Sprechtag FA Schiffs-Hydrodynamik, October 9th, 2014

Six years Mewis Duct® - Six years of hydrodynamic development

Friedrich Mewis
Mewis Ship Hydrodynamics (MSH), Dresden

Six years Mewis Duct® - Six years of hydrodynamic development

Main partner

Becker Marine Systems, Hamburg

Financing, marketing, managing, steel design

IBMV, Rostock

CFD-calculations, hydrodynamic design

Mewis Ship Hydrodynamics, Dresden

Concept, hydrodynamic design up to 2012

Further companies involved considerably:

13 towing tanks worldwide

3 manufacturers in Spain, Singapore, China

about 25 shipyards worldwide

Six years Mewis Duct® - Six years of hydrodynamic development

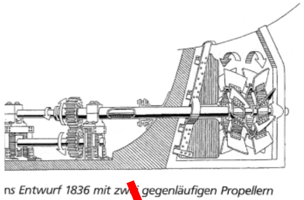
Contents

- Background history
- Loss analysis around running propeller
- Results in model scale
- Hydrodynamic development
- Results in full scale
- Side effects
- Combination with other ESDs
- Summary

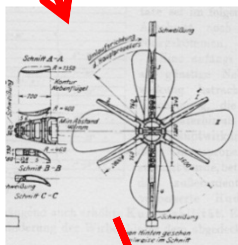
Background
Mewis Duct®

Reduction of rotational losses

1836
Contra Propeller
Erikson
UK/Sweden

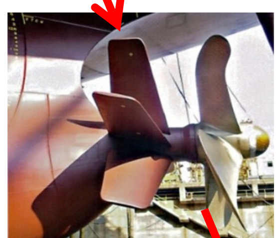


1904/1929
Contra Propeller Princ.
K. Wagner
Germany



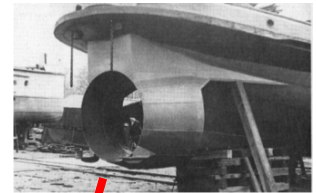
1984
SVA Fin System
H. Peters, F. Mewis
Germany

2002
PSS
DSME
Korea

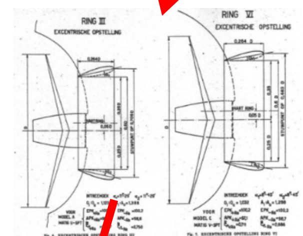


Reduction of wake losses

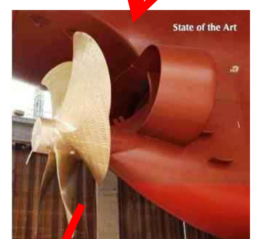
1927
Kort Nozzle
L. Kort
Germany



1949
Lammeren Duct
Van Lammeren
The Netherlands



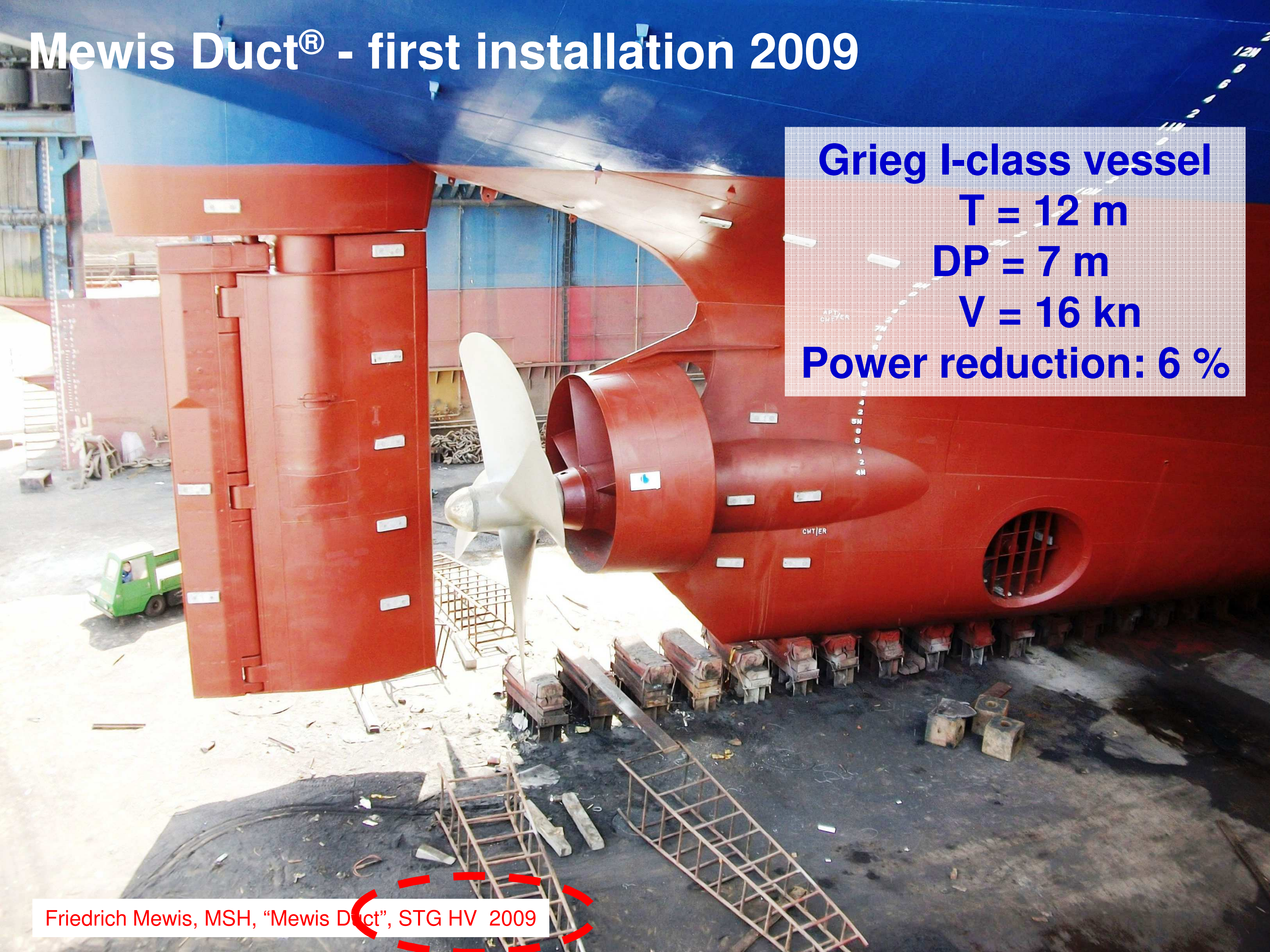
1982
WED
H. Schneekluth
Germany



1996
SILD
Sumitomo
Japan

2008
Mewis Duct® (MD)
Becker Marine Systems
Germany

Mewis Duct® - first installation 2009



Grieg I-class vessel

T = 12 m

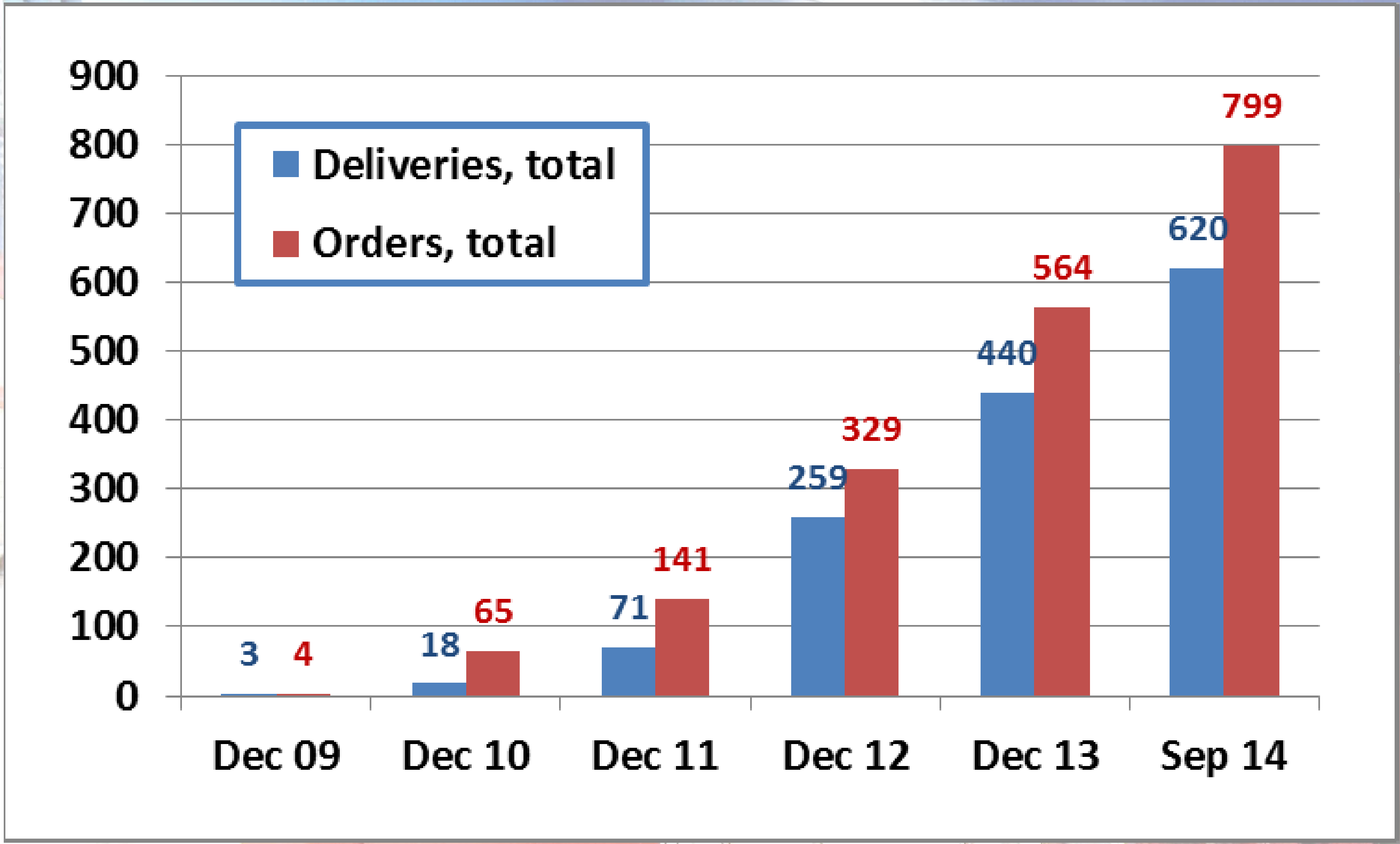
DP = 7 m

V = 16 kn

Power reduction: 6 %

Friedrich Mewis, MSH, “Mewis Duct”, STG HV 2009

Mewis Duct® - Numbers of orders and deliveries



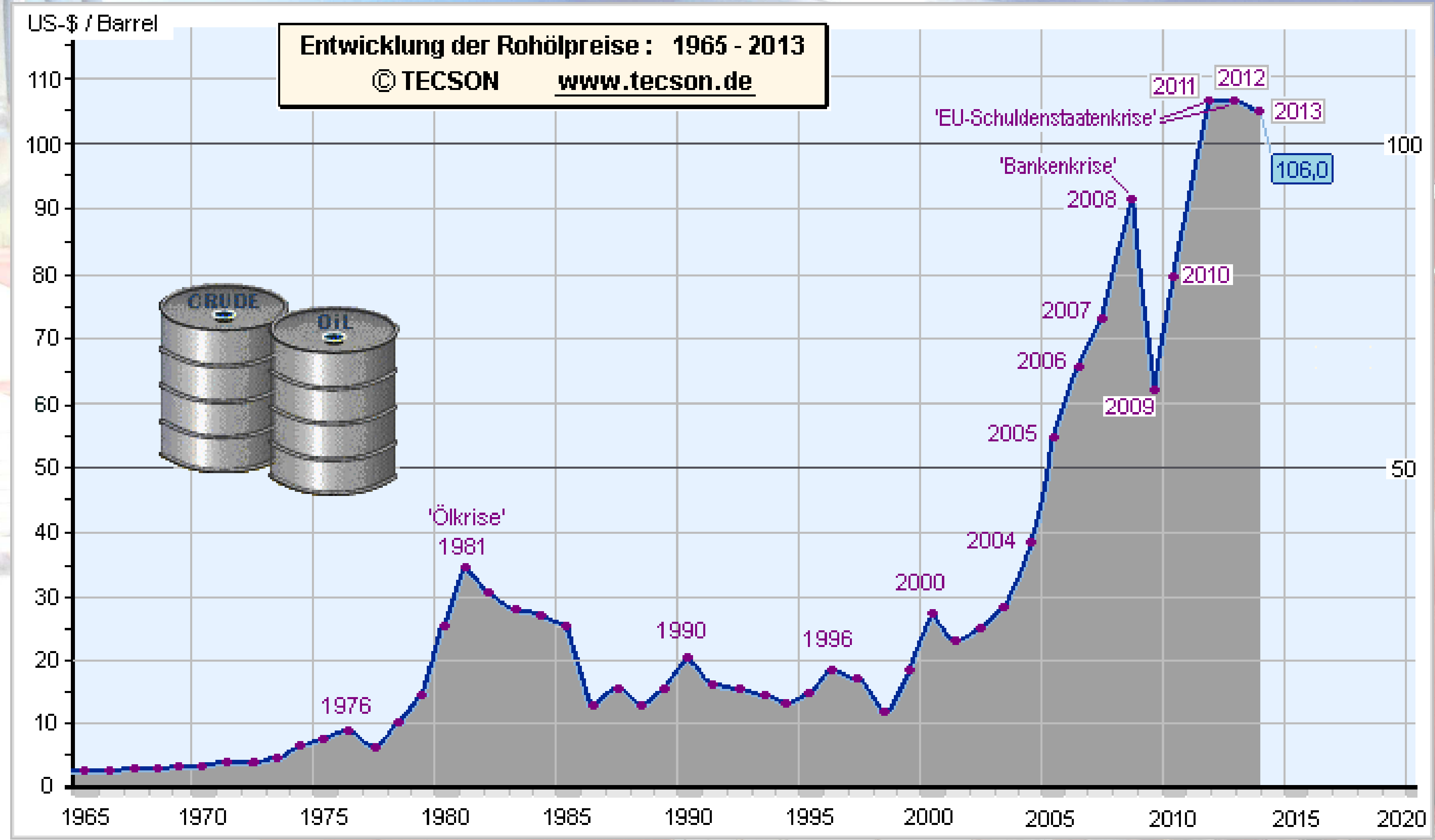
Friedrich Mewis, "6 years Mewis Duct", STG FA, Oct. 09th, 2014

Mewis Duct® - Reasons for exceptional success

Commercial reasons

1. The oil price has been stable at a high level for about 4 years
2. The power reduction by MD is stable and high (average 6%)
3. Based on 1. and 2. the ROI is less than 1 year
4. The MD is suited to both new-build and retrofit applications
5. The MD is efficient also under off-design conditions
6. BMS is a very well suited company for marketing ESDs
   - worldwide network build up over 60 years
   - high qualification in marine applications
   - strong organisation
   - no cure – no pay guarantee of power reduction

Mewis Duct® - Reasons for exceptional success



Friedrich Mewis, "6 years Mewis Duct", STG FA, Oct. 09th, 2014

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Mewis Duct® - Reasons for exceptional success

Non commercial reasons

1. The Mewis Duct is an ESD which reduces two independent losses in the flow around an operating propeller
   - Pre-duct: reduced losses in the wake
   - Fin-System: reduced rotational losses in the slipstream
2. The MD-design has been highly developed from the beginning
   - use of personal experience in developing and testing ESDs
   - use of CFD-calculations for design and optimisation
   - custom tailored design for each ship series
   - use of experience from abt. 170 MD-projects to date
3. Tremendous progress in CFD-tools and experience within 6 years
   - all calculations are carried out with running propeller
   - calibration of CFD-results to model tests for about 160 projects

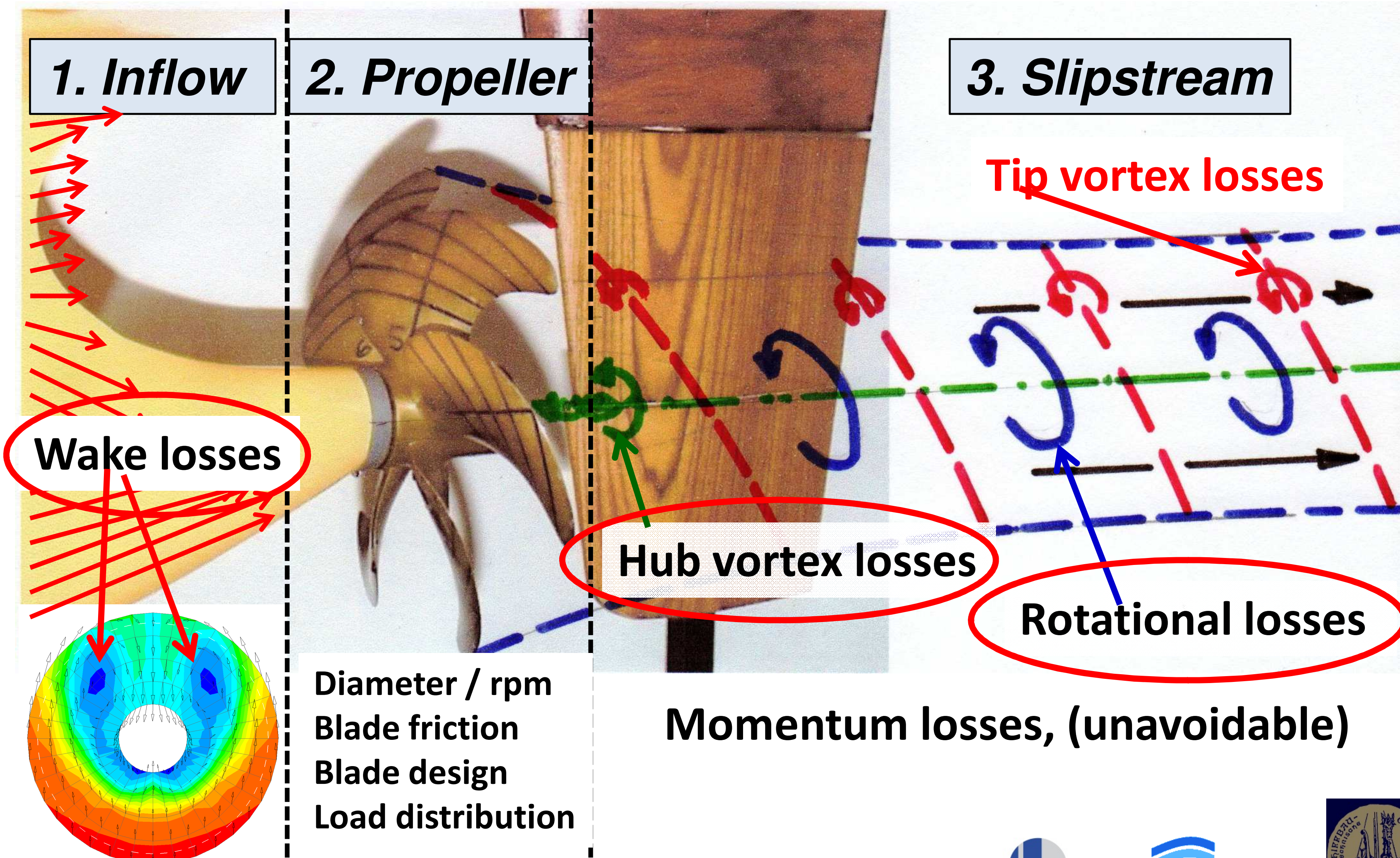
Hydrodynamic Energy Saving Devices, losses around running propeller behind ship

Dyne, Gilbert, SSPA Gothenburg, EIGHT WEGEMT SCHOOL , 1983:
“Ship propulsion improvement – principles and a survey of alternative propulsion systems”

Rules for shaft power reduction (summary, word-for-word):

1. **Increase the quantity of fluid passing the propeller disk in unit time**
2. **Decrease the slipstream rotation simultaneously as other losses are kept down or reduced**
3. **Decrease the drag force on the propeller blades**
4. **Move the propulsion units to areas where the frictional wake is high**
5. **Do not believe everything you are told!**

Hydrodynamic Energy Saving Devices, losses around running propeller behind ship



Friedrich Mewis, “6 years Mewis Duct”, STG FA, Oct. 09th, 2014

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Hydrodynamic Energy Saving Devices

Hydrodynamic Energy Saving Devices

Possible power reductions by diffrent Energy Saving Devices							
No	Name	Company/ Inventor	Country	Typ of device	Location of device	Main sorces for improvement	power reduction %
One Component Devices							
1	SAVER-Fins	Samsung	Korea	forward pre-fins	far forward to propeller	using energy of ships wake	0 - 3
2	Tandem Fins	Sanoyas	Japan	forward pre-fins	far forward to propeller	using energy of ships wake	0 - 5
3	WED	Schneekluth	Germany	pre-duct	next forward to propeller	equilising of propeller inflow	0 - 4
4	SILD	Sumitomo	Japan	pre-duct	next forward to propeller	equilising of propeller inflow	1 - 6
5	SVA-Fin-System	SVA	Germany	pre-fins	next forward to propeller	reduction slipstream rotation	2 - 3
6	Pre-Swirl-System	DSME	Korea	pre-fins	next forward to propeller	reduction slipstream rotation	2 - 5
7	Kappel-Propeller	MAN	Danmark	propeller tip configur.	propeller tip	reduction propeller tip vortex	1 - 3
8	Gomez-Propeller	SISTEMAR	Spain	propeller tip configur.	propeller tip	reduction propeller tip vortex improved load distribution	1 - 4
9	PBCF	Ochi	Japan	fins at propeller hub	aft end of the hub	reduction propeller hub vortex	1 - 3
10	Rudder Bulb	Costa	Swizerland	rudder bulb	rudder	reduction propeller hub vortex	0 - 3
11	Hybrid-fins	Fukudam	Japan	rudder-fins	rudder	reduction slipstream rotation reduction propeller hub vortex	2 - 4
12	Twisted rudder	BMS	Germany	rudder, leading edge twisted	rudder	reduction rudder resistance reduction slipstream rotation	0 - 2
Multi Component Devices							
13	ENERGOPAC	Wärtsilä	Finland	integrated rudder-propeller hub	propeller and rudder	reduction propeller hub vortex reduction propeller loading	2 - 6
14	PROMAS	Rolls Royce	Sweden	integrated rudder-propeller hub	propeller and rudder	reduction propeller hub vortex reduction propeller loading	2 - 6
15	CRP	Erikson	-	two contra rotating propellers	second propeller direct behind first propeller	reduction slipstream rotation reduction propeller loading	5 - 14
16	Grim Vane Wheel	Grim	Germany	additional vane turbine behind propeller	vane wheel direct behind propeller	reduction propeller loading reduction slipstream rotation	5 - 12
17	Mewis Duct®	BMS	Germany	pre-duct with integrated pre-fin system	next forward to propeller	equilising of propeller inflow reduction slipstream rotation reduction propeller hub vortex	3 - 8
	Note: No 7, 8, 12, 13, 14, 15, 16 are no real ESDs in the sens of extern devices, these are new rudders, propellers or combinations which has to be replaced						

Hydrodynamic Energy Saving Devices, losses around running propeller behind ship

The numbers are valid for a so called optimum propeller and nearly optimum hull lines design

Losses around working propeller behind ship		
Example: Bulk Carrier, V=15 kts, CTh = 2.3		
Type of loss	recoverable losses %	Remark
frictional in the wake	0 to 10	depends very on hull lines
rotation in slipstream	5 to 7	less dependence
propeller tip vortex	1 to 3	depends on load distribution
propeller hub vortex	1 to 3	depends on load distribution and hub diameter

With a well designed ESD is it possible to avoid about 2/3 of the recoverable losses

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Mewis Duct® - Mode of action, possible gains

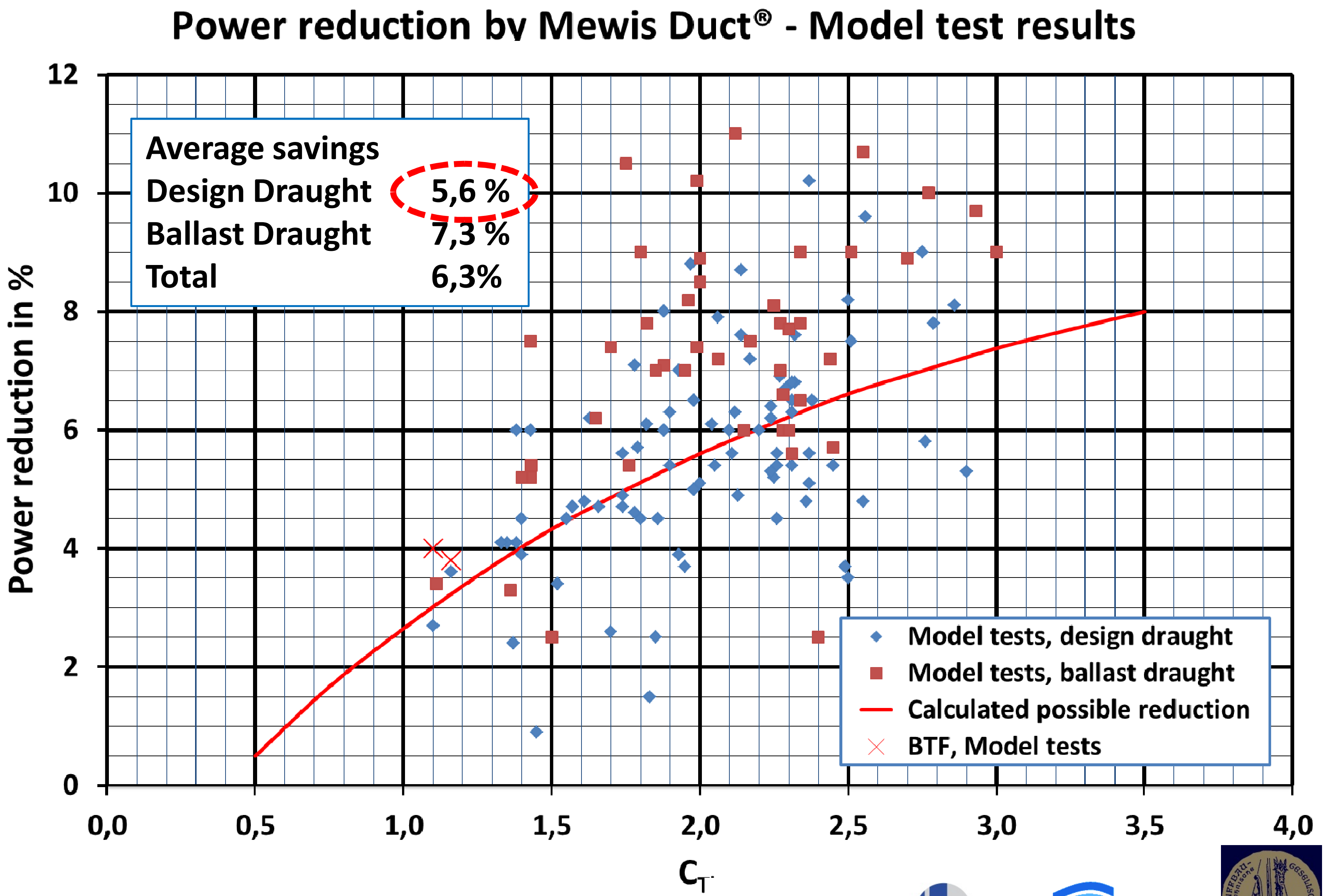
1. The fin-system produces pre-swirl and leads to lower rotational losses in the propeller slip stream,
   Gain very stable, 2% to 4%

2. The pre duct improves the propeller inflow,
   Gain depends on the wake field, 1% to 6%

3. Both together reduce the hub vortex
   Gain small 0% to 1%

Total possible gain	3% to 11%
Realistic possible gain	3% to 8%

Mewis Duct® - Model test results up to 2012



Friedrich Mewis, “6 years Mewis Duct”, STG FA, Oct. 09th, 2014

Mewis Duct® - Model test results in 2014

Nr.	Towing Tank	Country	DWT	Ship Type	V kts	Power Reduction %
1	BSHC	Bulgaria	82k	BC	14,3	5,0
2	SVA	Germany	61k	BC	14,3	6,8
3	BSHC	Bulgaria	318k	VLCC	16,7	5,6
4	BSHC	Bulgaria	82k	BC	14,5	3,6
5	FORCE	Denmark	32k	BC	14,4	7,4
6	SVA	Germany	38k	BC	13,8	5,2
7	HRBI	Croatia	23k	LPG	16,5	8,3
8	HSVA	Germany	37,7k	BC	14,5	9,1
9	FORCE	Denmark	114k	BC	14,5	6,3
10	HRBI	Croatia	47k	PC	15,3	7,5
11	BSHC	Bulgaria	110k	COT	14,7	6,5
12	SVA	Germany	61k	BC	14,3	5,3
13	HRBI	Croatia	158k	BC (w SF)	15,9	4,7
14	BSHC	Bulgaria	260k	COT	14,5	8,0
15	MARINTEK	Norway	60k	LPG	16,0	7,5
16	SVA	Germany	63,5k	BC?	14,1	2,8
17	SSPA	Sweden	156k	COT	13,5	6,3
18	BSHC	Bulgaria	159k	COT	15,2	6,6
19	SRC	Japan	89k	BC	14,0	7,1
20	HRBI	Croatia	105k	TAN	12,2	9,2
21	SSPA	Sweden	110k	COT	15,0	7,0
22	SVA	Germany	37k	PC	15,0	6,5
23	BSHC	Bulgaria	308k	COT	16,4	7,8
24	FORCE	Denmark	28k	Slur. C.	13,0	2,3
25	HMRI	Korea	12k	LEGC	16,0	4,7
26	HRBI	Croatia	110k	COT	14,5	7,1
27	SSPA	Sweden	160k	COT	14,5	6,1
28	HRBI	Croatia	105k	OT	14,9	8,6
29	KRISO	Korea	151k	BC	14,0	3,5
30	HSVA	Germany	320k	VLCC	16,0	6,3
	Average power reduction (design Draught):					6,3

Model test results with Mewis Duct®, January – June 2014

Average power reduction, Design Draught: 6.3%

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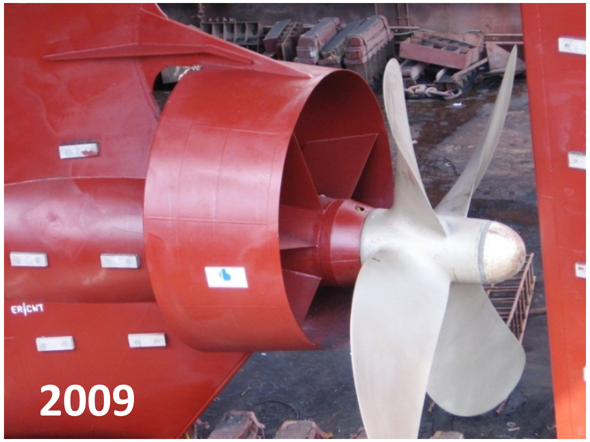
Mewis Duct® - Evolution 2008 - 2014



Average power reduction by MD, design draught, model test results

2009-2011	5.6%
2014	6.3%

6.3 / 5.6 = 1.12

The evolution in power reduction results from the optimisation by CFD-calculations, model tests and full-scale experience.

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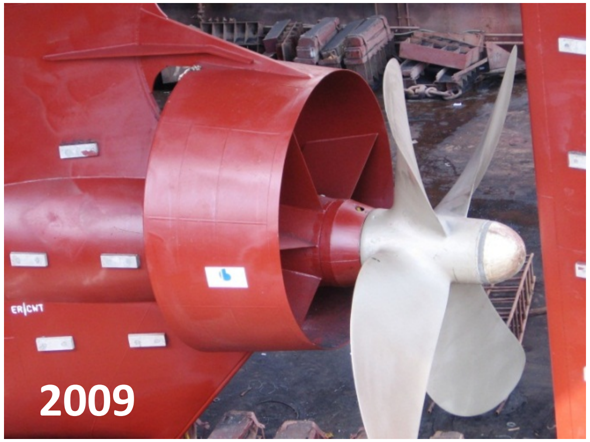
Mewis Duct® - Evolution 2008 - 2014

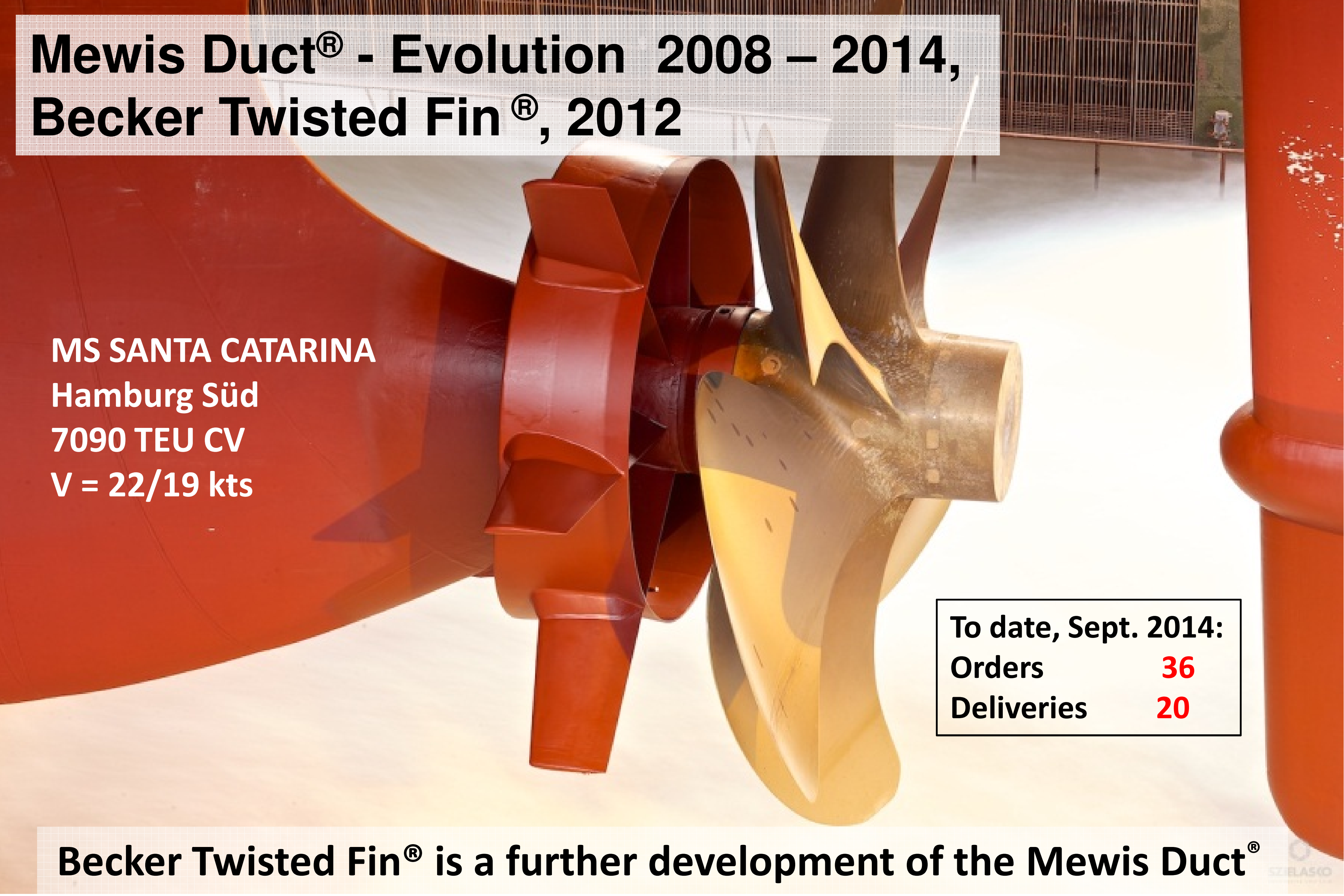


Evolution of MD-main properties

	Initial	Evolved
Duct diameter D_D	0.55 D_P	>0.55 D_P
Duct length L_D	0.5 D_D	<0.5 D_D
Duct position	above	above
Duct profile	ME 4308	ME 4308-12
Fin profile	ME 4312	ME 4312
Number of fins	4	5-6
Fin distribution	3/1	3/2 (+1)

The evolution in main properties results from the optimisation by CFD-calculations, model tests and full-scale experience.

Mewis Duct® - Evolution 2008 – 2014, Becker Twisted Fin®, 2012



MS SANTA CATARINA
Hamburg Süd
7090 TEU CV
V = 22/19 kts

To date, Sept. 2014:	
Orders	**36**
Deliveries	**20**

Becker Twisted Fin® is a further development of the Mewis Duct® for faster ships such as Container Vessels

Mewis Duct® - Model test results / Full scale results

? ? ? ? ?

Friedrich Mewis, “6 years Mewis Duct”, STG FA, Oct. 09th, 2014

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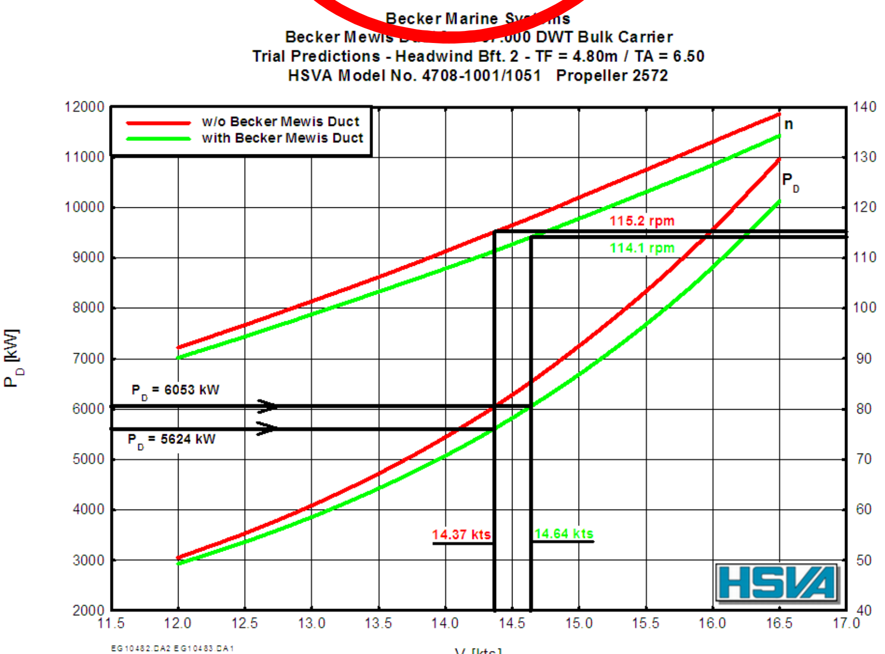
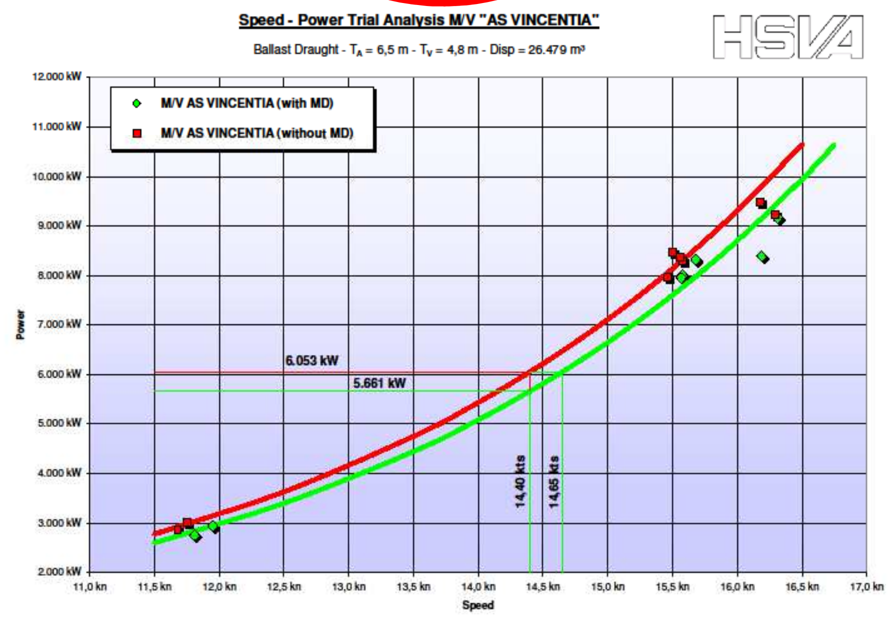
Mewis Duct® - Model tests / Full scale trial

57,000 DWT – Bulker, newbuilding, trial w/o and with MD within 5 days

Model test		Trial result
0.27 kts	Speed gain	0.25 kts
7,1 %	Power gain	6.5 %
T = 4.8/6.5 m	V = 14.4 kts	T = 4.8/6.5 m





Power gain model tests: 7.1 %, from sea trial results: 6.5%

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Mewis Duct® - Model tests / Full scale trial

Sea Trial Results of a 118k Bulk Carrier, 10 sister ships

Vessel w/o Mewis Duct® Trial speed	ship 1:	15.38 kts	(A)
	ship 2:	15.37 kts	
HSVA-model test	ship 3:	15.12 kts	(B)
predicted speed: 15.26 kts	Trial average:	15.29 kts	

Vessel with Mewis Duct® Trial speed	ship 4:	15.52 kts	
	ship 5:	15.44 kts	(A)
	ship 6:	15.59 kts	(B)
	ship 7:	15.56 kts	
	ship 8:	15.55 kts	
	ship 9:	15.54 kts	
HSVA-model tests	ship 10:	15.48 kts	
predicted speed: 15.48 kts	Trial average:	15.53 kts	

(A) lowest gain:
ship 5 – ship 1
ΔV = 0.06 kts
ΔPD = 1,9 %

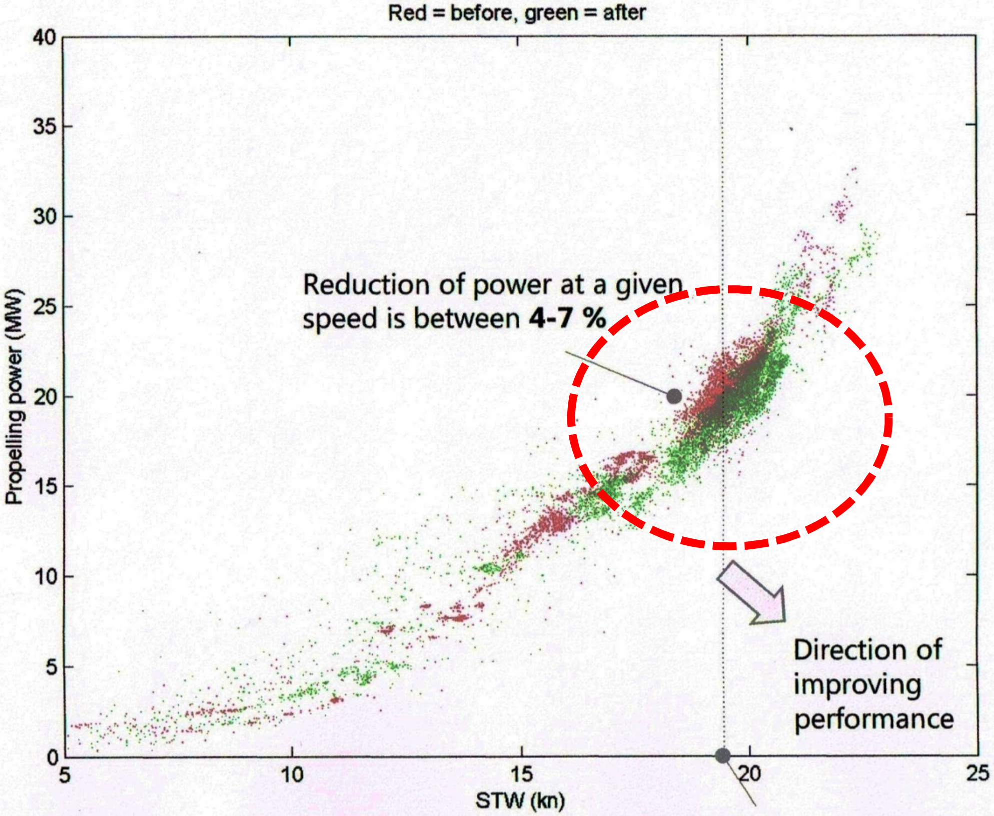
(B) highest gain:
ship 6 – ship 3
ΔV = 0.47 kts
ΔPD = 14.7 %

Speed gain model tests: +0.22 kts, from sea trial results: +0.24 kts

Power gain model tests: 6.9 %, from sea trial results: 7.5%

Mewis Duct®, Becker Twisted Fin®, Power monitoring

IMPACT IN HEAVIER LOAD (DRAFT > 11 M)



- In heavier loading conditions, the improvement in performance can be seen at speeds above 15 knots
- At smaller speeds, there is no remarkable difference in performance before and after the twist fin installation

Speed range	Twist fin impact
Below 15 kn	0 %
15 - 18 kn	1 - 3 %
Above 18 kn	4 – 7 %

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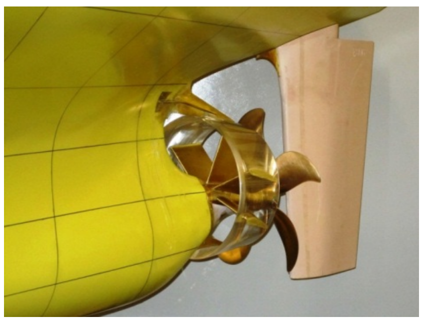
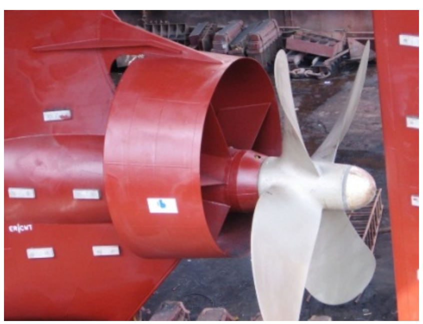
Mewis Duct® - Model tests / quasi Full scale tests

2010-2011, Joint Industry Project: ESD-JILI, MARIN, GSI (Guangzhou); SSSRI (Shanghai)

MARIN, method: "smart ship model"

Result: Power reduction 6.0% in model scale and full scale





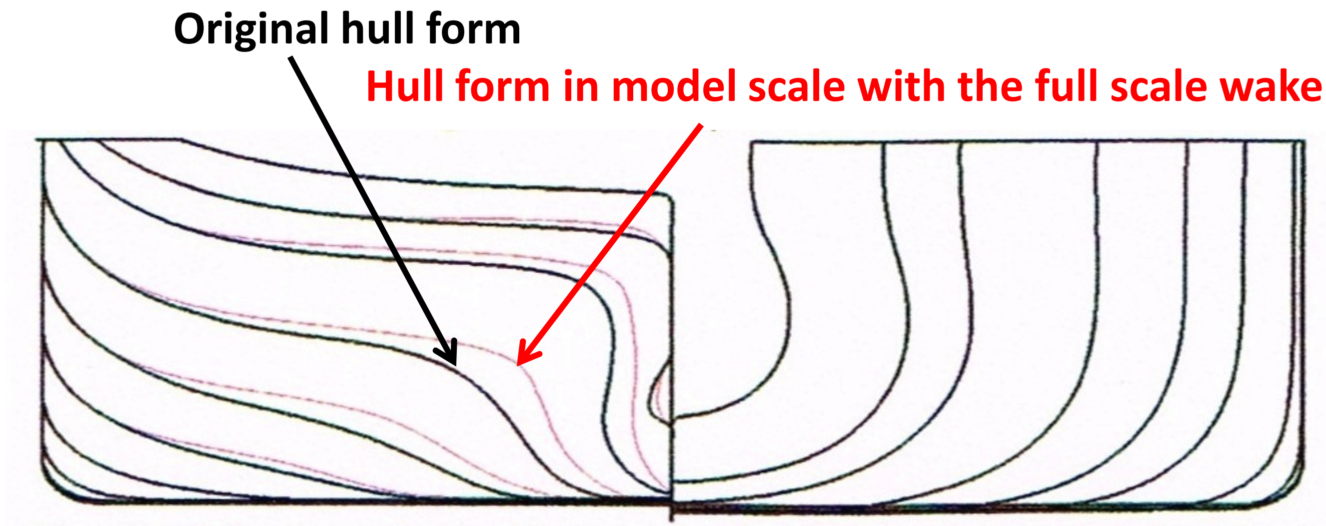
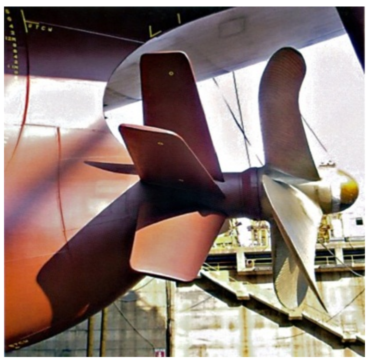


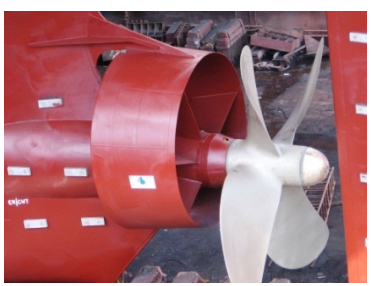
Figure 7 Comparison of the smart ship model (red thin lines) to the original hull form (black thick lines), not to scale.

Source: Dang,J. at all, (2011), An Exploratory Study on the Working Principles of Energy Saving Devices (ESDs), Wuxi, China, CSSRC

Mewis Duct® - Model tests / quasi Full scale tests

2010-2011, Joint Industry Project: ESD-JILI, MARIN, GSI (Guangzhou); SSSRI (Shanghai)





80k BC, designed by GSI Measurements at MARIN		
Device	Power reduction	
	Model scale	Full scale Smart ship model
PBCF	2,0	2,1
PSS	4,4	4,1
MD	6,0	6,0
PSS + PBCF	5,4	-
MD + PBCF	7,0	-

Source: Dang,J. at all, (2011), An Exploratory Study on the Working Principles of Energy Saving Devices (ESDs), Wuxi, China, CSSRC

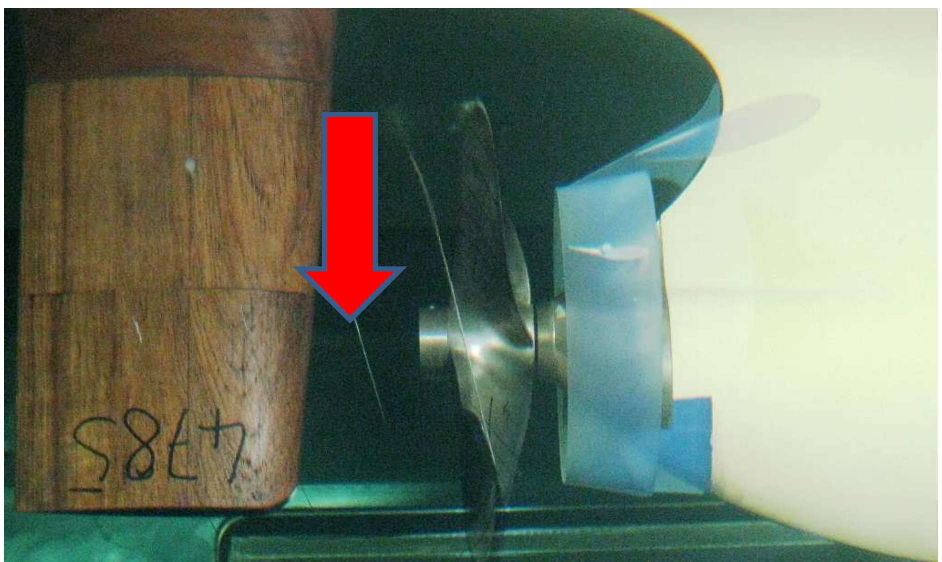
Mewis Duct® - Side effects

- Reduction of hub vortex losses
- Reduction of pressure pulses
- Improvement of course stability
- Better rpm-stability in seaway

Mewis Duct® - Reduction of hub vortex, example

without MD

31,000 tdw MPV



with MD

Friedrich Mewis, “6 years Mewis Duct”, STG FA, Oct. 09th, 2014

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Mewis Duct® - Pressure pulse measurements, examp

PSD017_10_1, F:\k17_10_1\SI100827_003_001.csv, F:\k17_10_1\SI100827_001_001.csv, HYKAT-DS-Auswertung-Version 2.10-rev. 01, PressurePulses.xls-Version 2.0

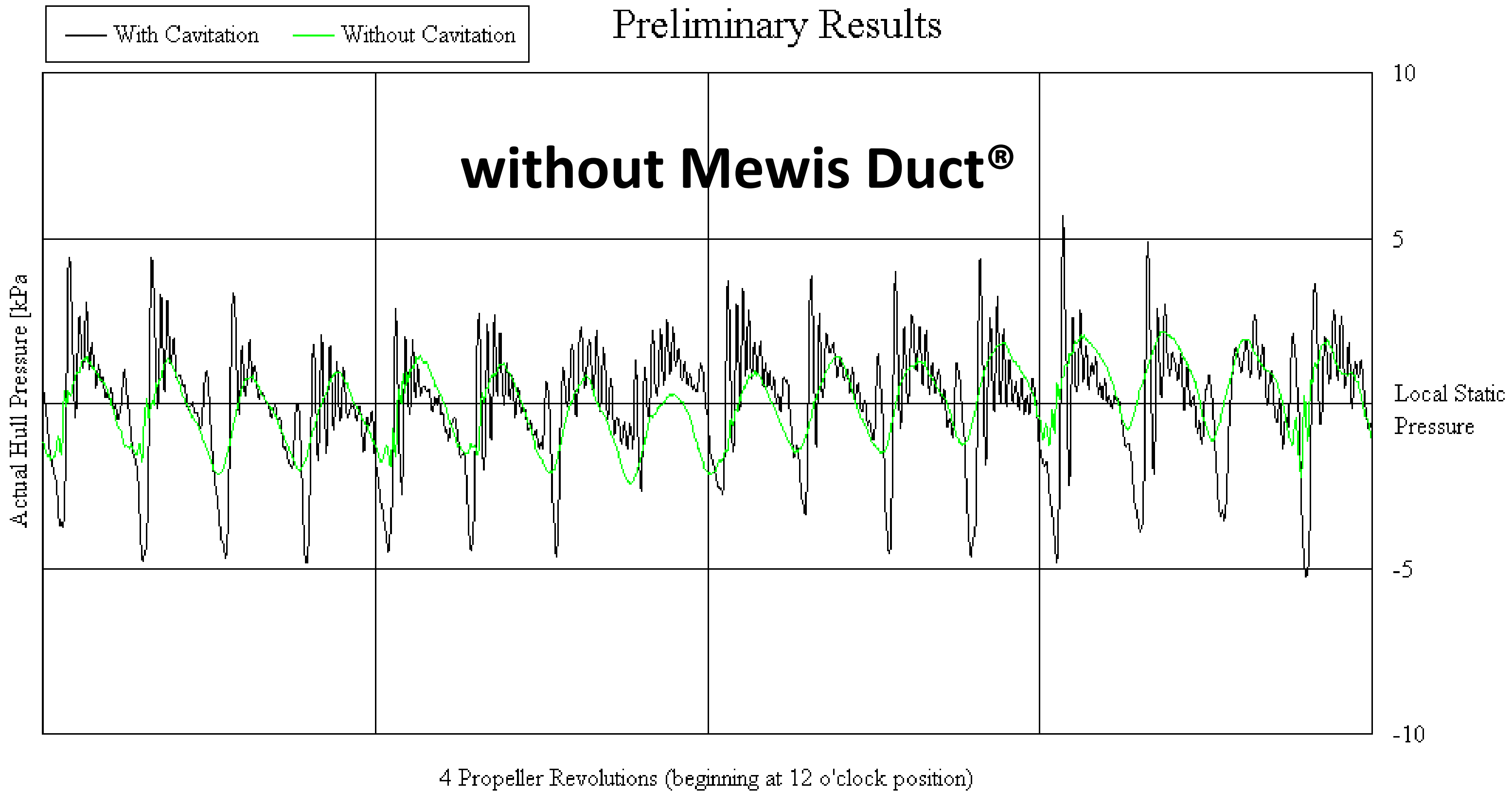

Fig. 5: Piece of the Hull Pressure Time Function at Pick-Up P1 (Full Scale)

Condition 2 - without Mewis Duct - without Saver Fins

Mewis Duct® - Pressure pulse measurements, examp

PSD017_10_1, F:\k17_10_1\SI100826_006_001.csv, F:\k17_10_1\SI100826_004_001.csv, HYKAT-DS-Auswertung-Version 2.10-rev. 01, PressurePulses.xls-Version 2.0

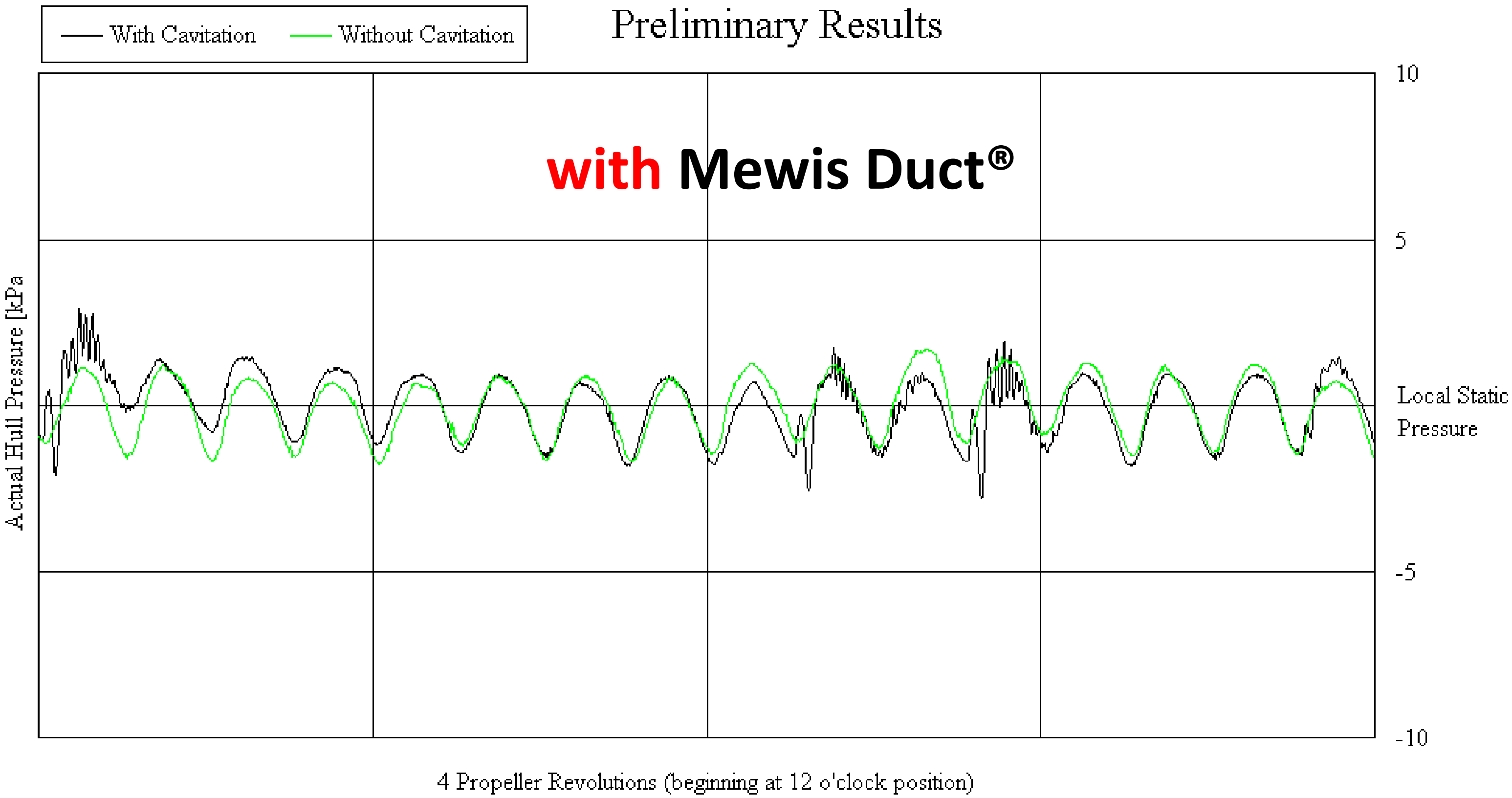

Fig. 5: Piece of the Hull Pressure Time Function at Pick-Up P1 (Full Scale)

Condition 4 - with Mewis Duct - without Saver Fins

Mewis Duct® - Experience Course Stability, example

Model test:	**46,000 tdw Tanker, SSPA**			
Zig-Zag-Tests 10°/10°	**IMO-Criterion**	**w/o MD**	**with MD**	**MD/without**
1st overshoot (°)	**17,2**	**17,0**	**14,5**	**-15%**
2nd overshoot (°)	**31,8**	**40,6**	**31,4**	**-23%**
Tactical diameter/Lpp	**5,00**	**2,75**	**2,84**	**3%**
Full Scale trial:	**163,000 tdw Bulker**			
1st overshoot (°)	**20,0**	**10,5**	**9,0**	**-14 %**
2nd overshoot (°)	**35,0**	**26,9**	**22,0**	**-18 %**

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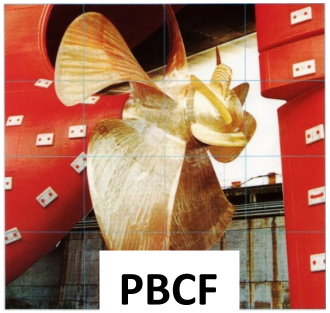
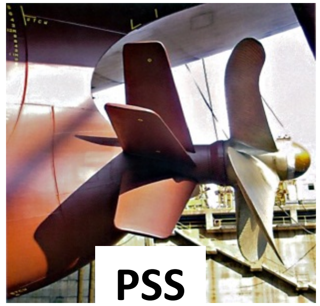
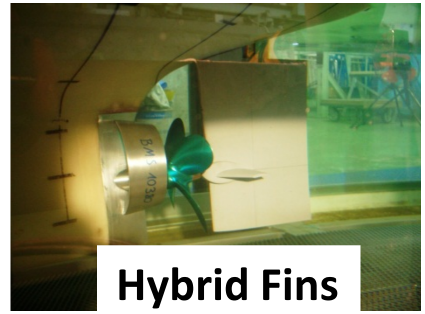
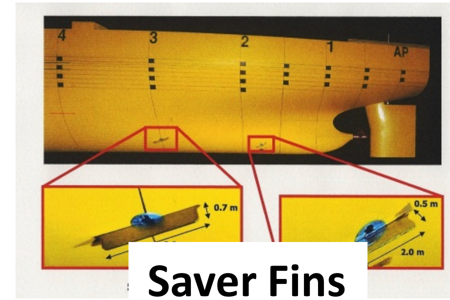
Mewis Duct® - Combination with other ESDs


PBCF

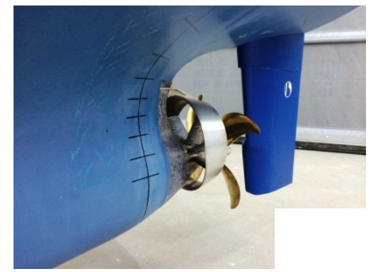

PSS


Hybrid Fins


Saver Fins

Sanoyas
Tandem Fins


Costa Bulb


BMS
Twisted Rudder

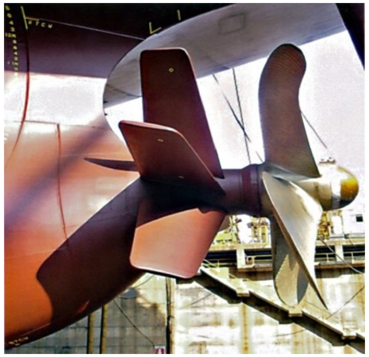
In spite of combining ESD’s, flow losses can only be minimized once

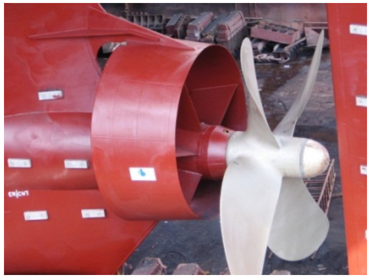
Friedrich Mewis, “6 years Mewis Duct”, STG FA, Oct. 09th, 2014

MSH becker marine systems ibmv

MD, Comparison PBCF - PSS – MD, MARIN 2011

2010-2011, Joint Industry Project: ESD-JILI, MARIN, GSI (Guangzhou); SSSRI (Shanghai)



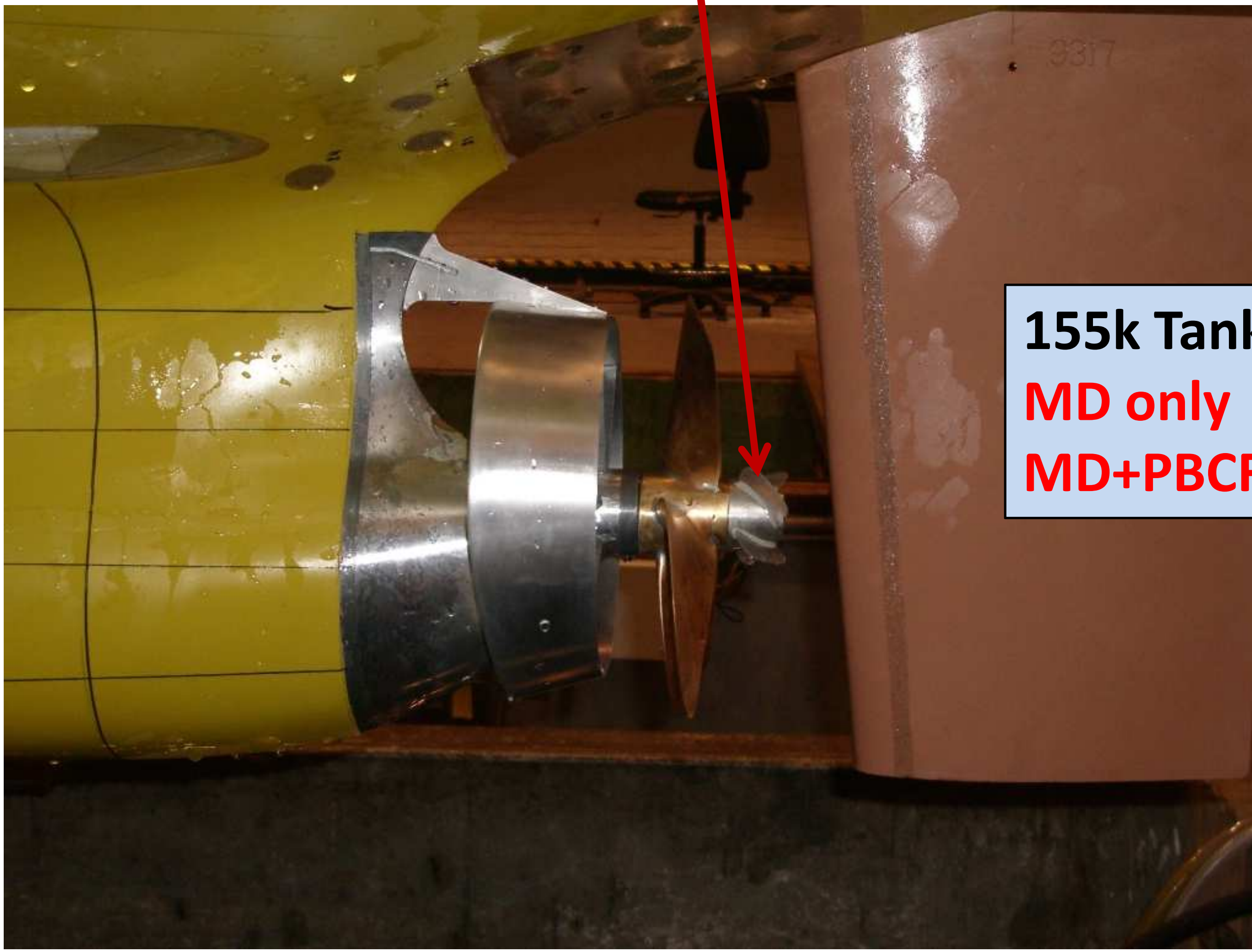


80k BC, designed by GSI		
Measurements at MARIN		
Device	Power reduction	
	Model scale	Full scale
		Smart ship model
PBCF	2,0	2,1
PSS	4,4	4,1
MD	6,0	6,0
PSS + PBCF	5,4	-
MD + PBCF	7,0	-

Source: Dang,J. at all, (2011), An Exploratory Study on the Working Principles of Energy Saving Devices (ESDs), Wuxi, China, CSSRC

Mewis Duct® + PBCF, Japan

Propeller Boss Cap Fins, Inventor: Ochi, Japan



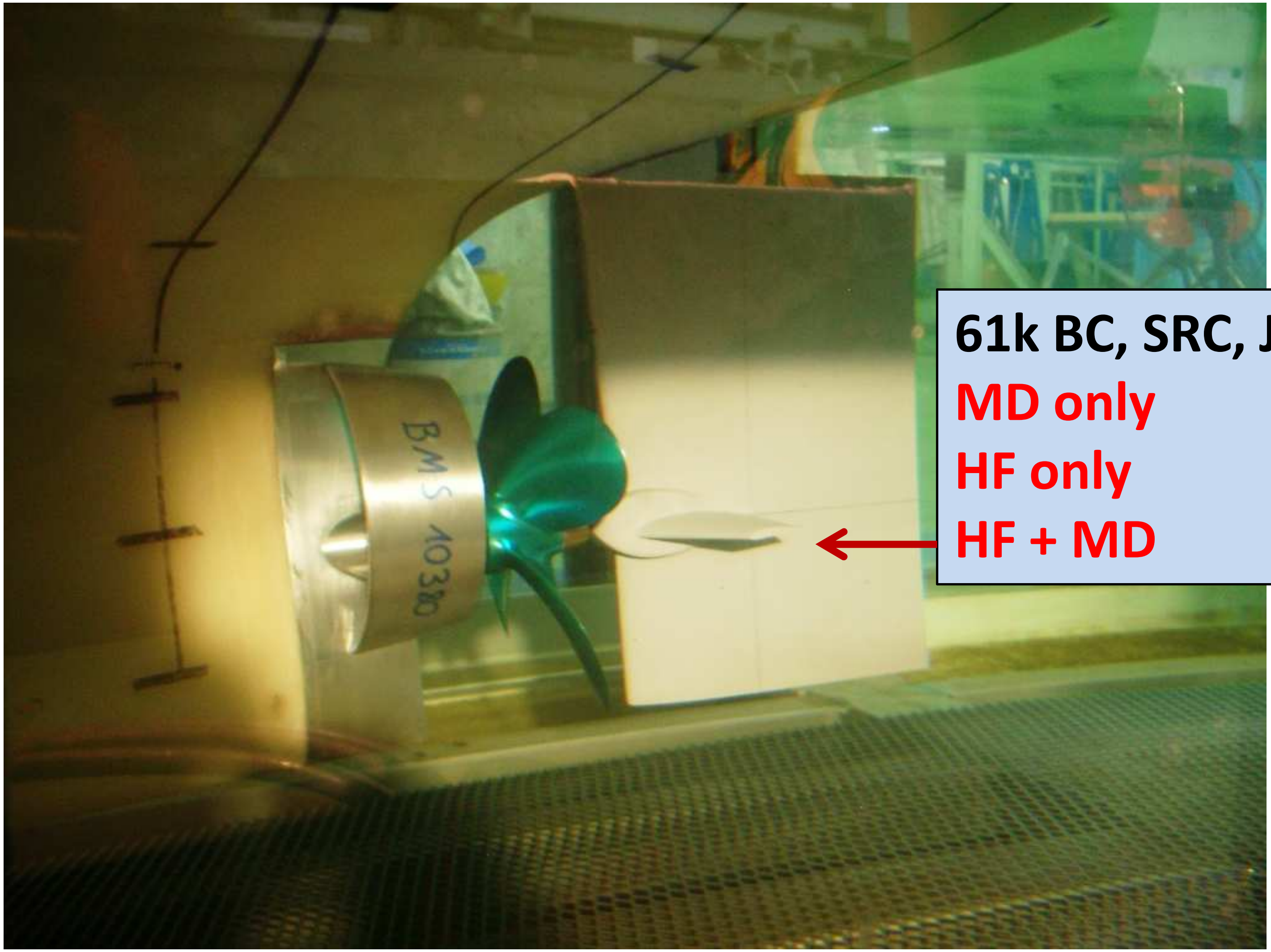
155k Tanker, SSPA

MD only 4.1%

MD+PBCF 4,1%

Mewis Duct® + Hybrid Fins, Japan

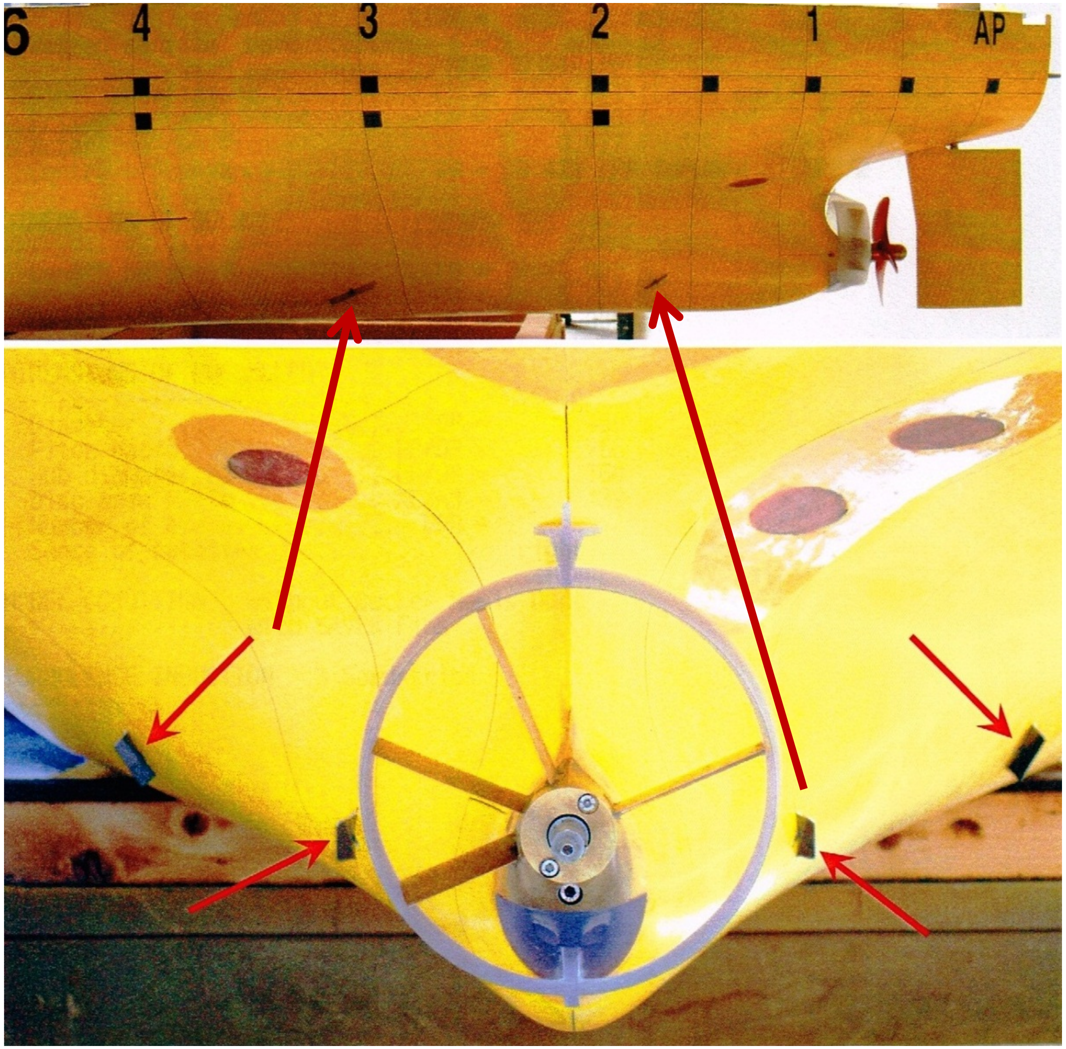
Inventor: Fukudam



61k BC, SRC, Japan	
MD only	6.1%
HF only	3.5%
HF + MD	6.8%

Mewis Duct® + SAVER-FIN (Samsung), Korea

Samsung Vibration & Energy Reaction Fin



158k Tanker, HSVA, 2010

SAVER-FINS only	1.6%
SAVER-FINS + MD	3.8%
MD only	2.1%

158k Tanker, HRBI, 2014

All tests were carried with SF

MD only (additional) 4.7%

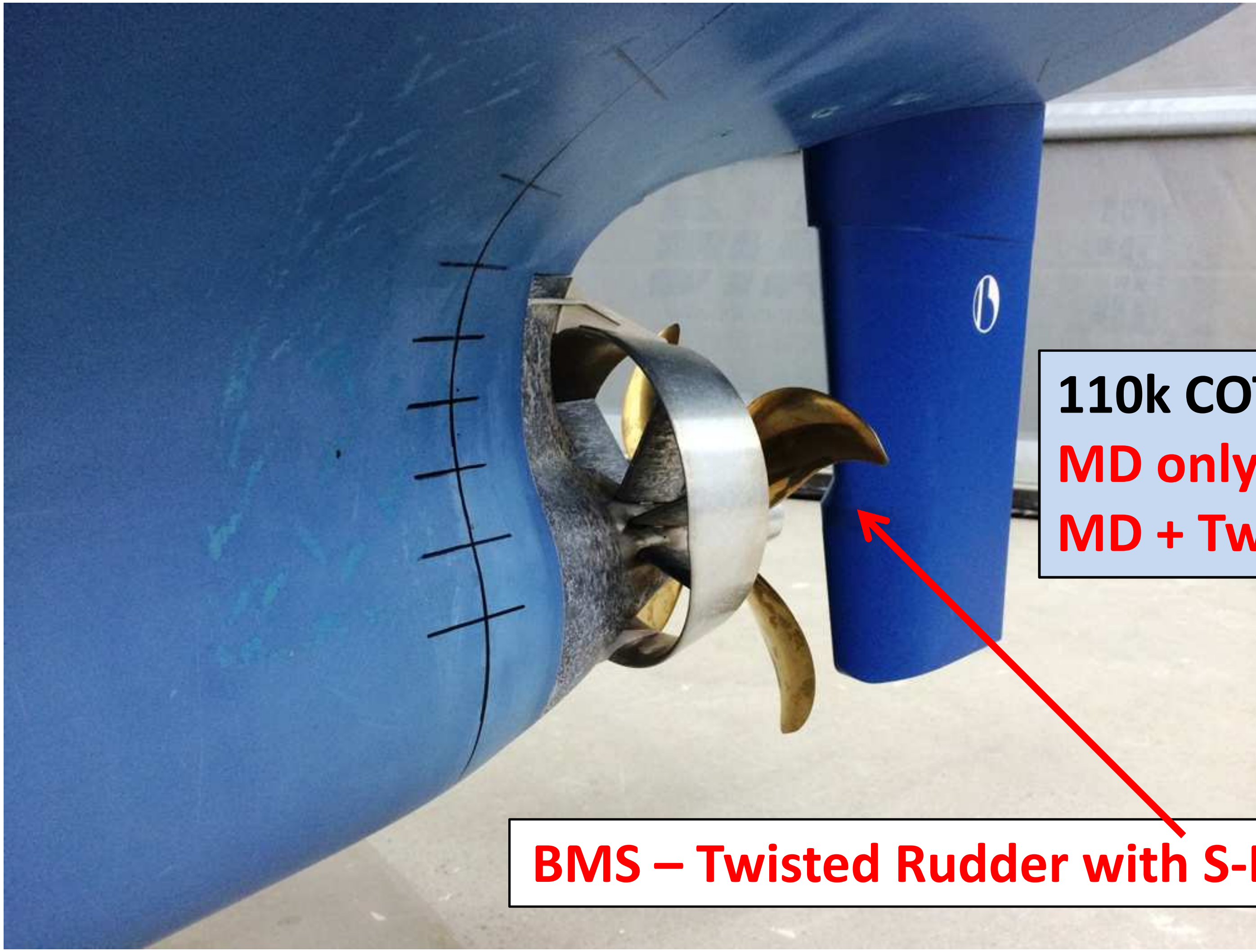
Mewis Duct® + Sanoyas Tandem Fins (STF), Japan

89k BC, SRC, Tokyo, 2014

MD only	7.1%
MD + Rudder Bulb	8.0%
MD + RB + STF	9.5%

Sanoyas is claiming up to 6% power savings by STF only (this variant was not investigated within this test series)

Mewis Duct® + BMS Twisted Rudder (TLKSR ®)



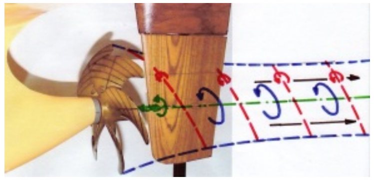
Mewis Duct® - Summary

2013
35.000 DWT BC
power reduction: 7.6%

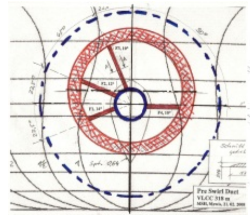
Photo: Courtesy of Ciner Denzcilik, Istanbul

Mewis Duct® - Summary I

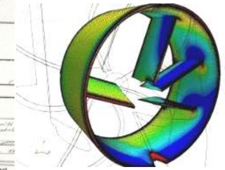
2007



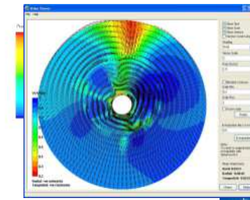
2007



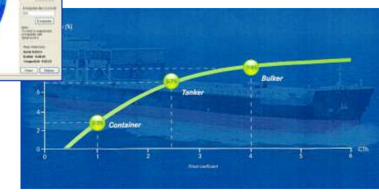
2008



2008

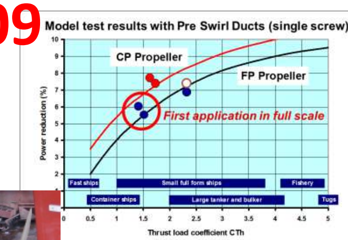


2008



2008

2009



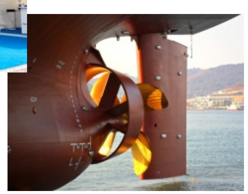
2009

2010

2011

2012

2013



2014

2007


STG-Sprechtag
Möglichkeiten der Energieeinsparung im Schiffsbetrieb
Hamburg am 22. März 2007

Hydrodynamische Maßnahmen zur Verringerung des Energieverbrauchs im Schiffsbetrieb

Dipl.-Ing. Friedrich Mewis, HSVA
Dr. Ing. Uwe Hollenbach, HSVA

MSH HSVA

September 2014:
170 Projects
800 Orders
600 Deliveries

Mewis Duct® - Summary II

The Mewis Duct® is the most successful ESD in recent years

The key reasons are:

- Stable power reduction between about 3% and 8%, nearly independent of speed and draught
- Reduction of vibrations and improvement of course stability
- Suited for both new buildings and retrofits
- BMS guarantees the power reduction with the certification from model tests; no cure – no pay
- The payback time is less than one year

Mewis Duct® - SMM 2010, No of Orders: 45

Dirk Lehmann and Friedrich Mewis
at SMM 2010

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Mewis Duct® - SMM 2014, MD No 750

I would like to express my gratitude to all colleagues at BMS and IBMV who have been involved in the "Mewis Duct" - project, as well as to all the many engineers and experts worldwide who have been involved in this successful endeavour.

Many thanks for your attention!

MSH becker marine systems ibmv