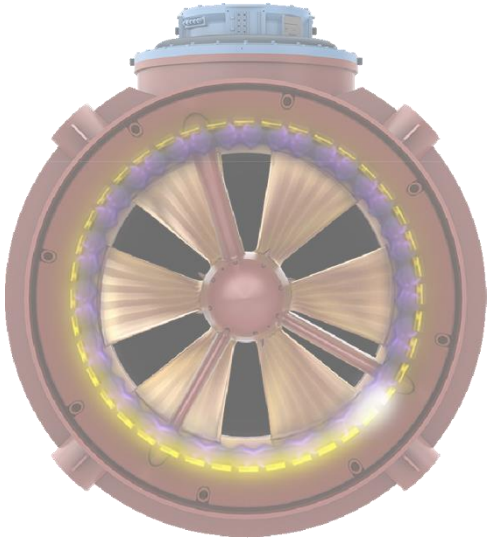
Permanent Magnet thrusters

Why PM thrusters



Gunnar Johnsen, Head of Electrical System R&T

Trusted to deliver excellence

Rolls-Royce

Permanent Magnet Thruster development timeline

1998-2004

Evaluation of technology and development of preliminary design/sketches

50 kW prototype design, build and start-up

50 kW thruster testing (functional and water tank test)

2005-2007

Full-scale (800kW) technology demonstrator development

Installation on "Olympic Octopus"

2008-2010

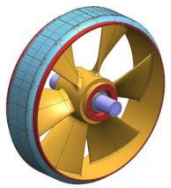
Technology Demonstrator returned to Ulsteinvik

Product testing and design qualification

2010-2011

Assembly of 1st commercial ***PMTT1600, 800kW***

Design approval– modified design (Central Shaft bearing design)



Decision to do quay side testing – October 2011

PMazimuth units installed on R/V Gunnerus

Commissioning of test rig and test start March 2012

PMTT finished October 2012

Commissioning on "Olympic Octopus" Jan 2013

2012-2013

2014

2015

R/V Gunnerus PMazimuth

PMTT sales release at SMM Hamburg September 2012

Design and review of PMazimuth

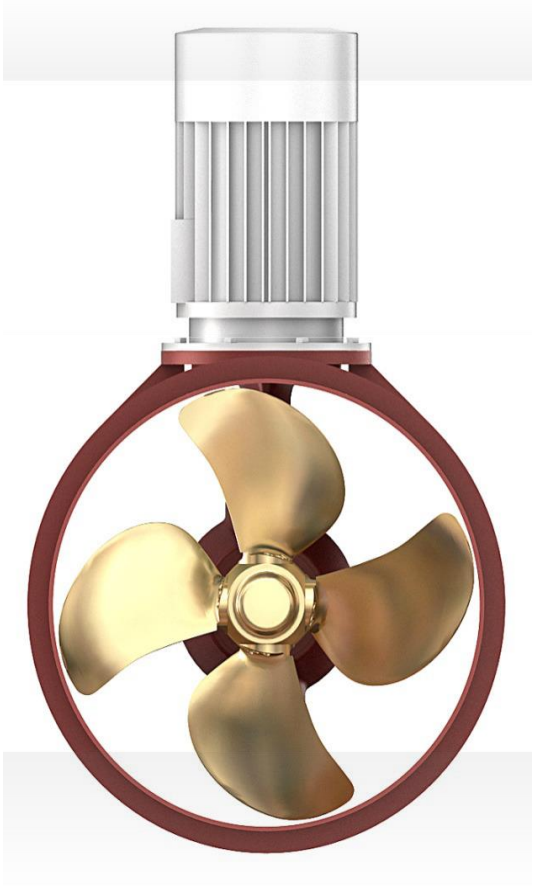
Pmazimuth FAT tests and delvery

PMTT deliveries

Pmazimuth Seatrial

Why PM Technology for Thrusters.

Efficiency	***Robustness*** *(Simplicity)*	***Compactness***

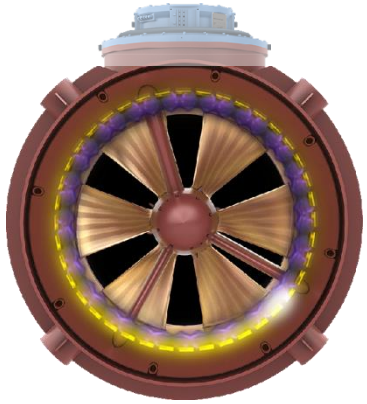


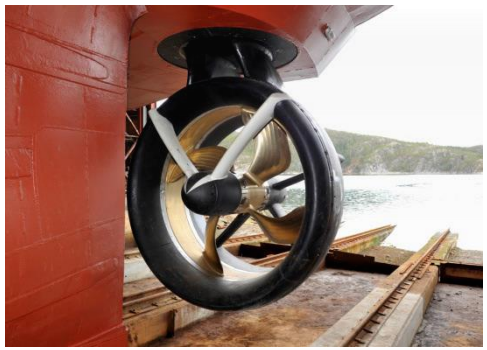
synchronous induction motor

\+

Oil filled, geared thruster unit

Integrated synchronous permanent magnet machine

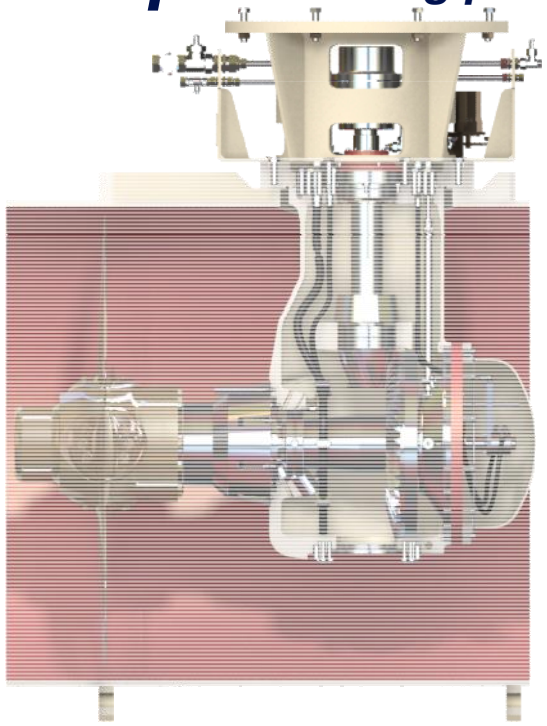




Why PM Technology for Thrusters?

Efficiency	**Robustness** (Simplicity)	Compactness

Multiple ***moving parts***

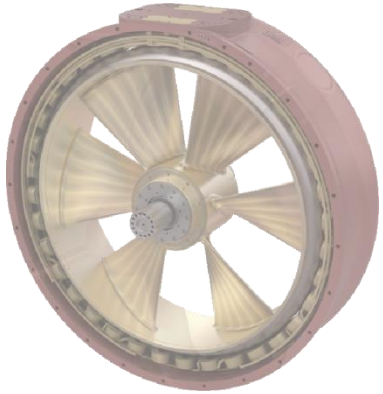


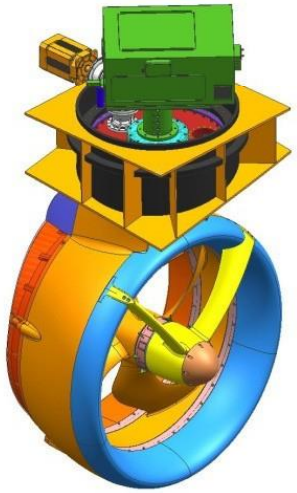
-Nozzle got 1 moving part (propeller)
-Steering gear with improved classic design

Pitch system

+

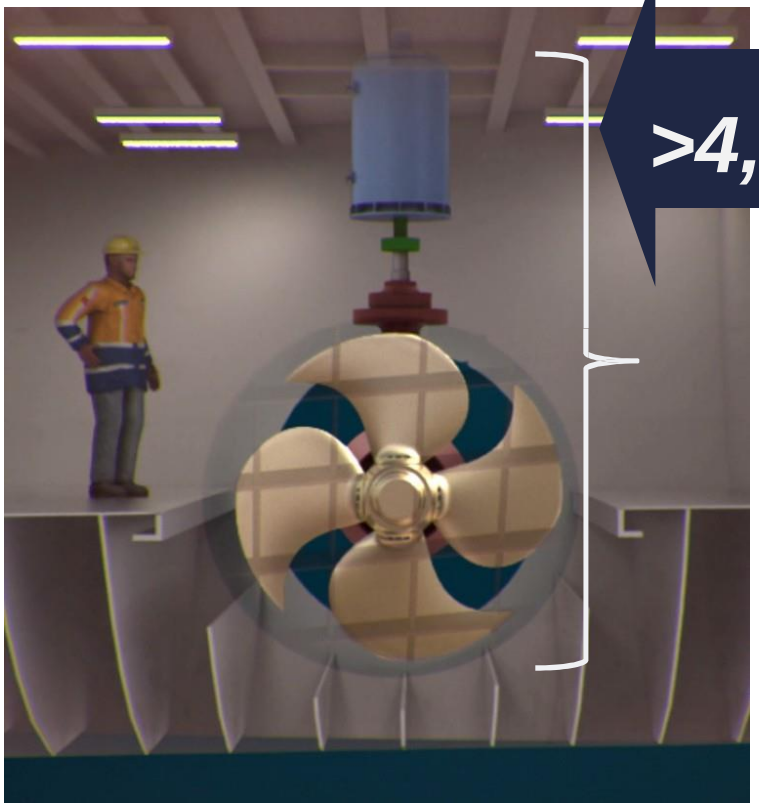
Mechanical transmission line

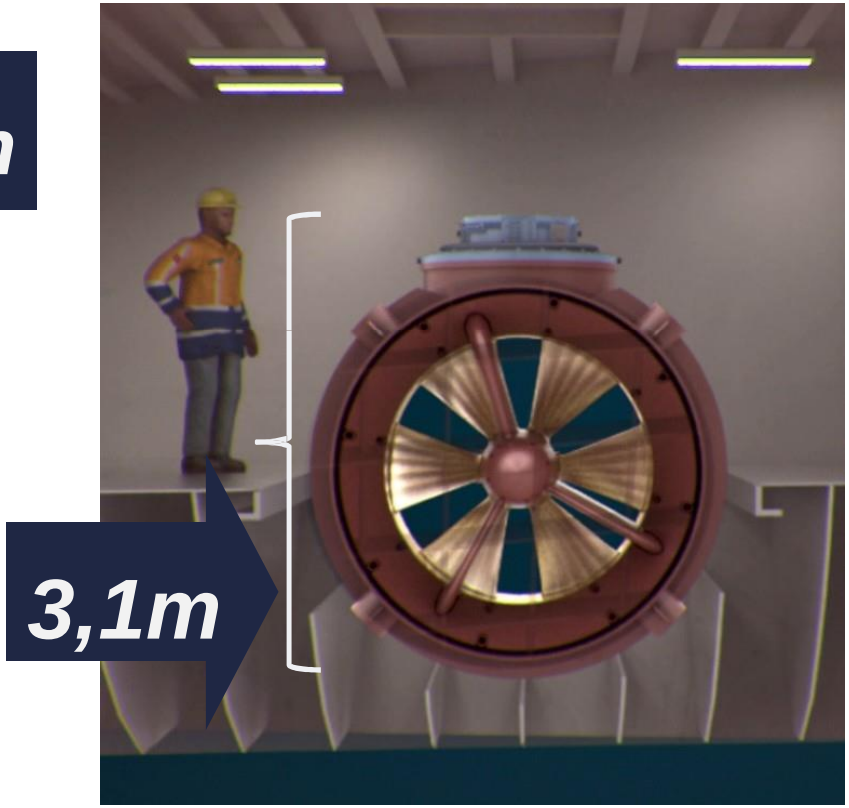




Why PM Technology for Thrusters

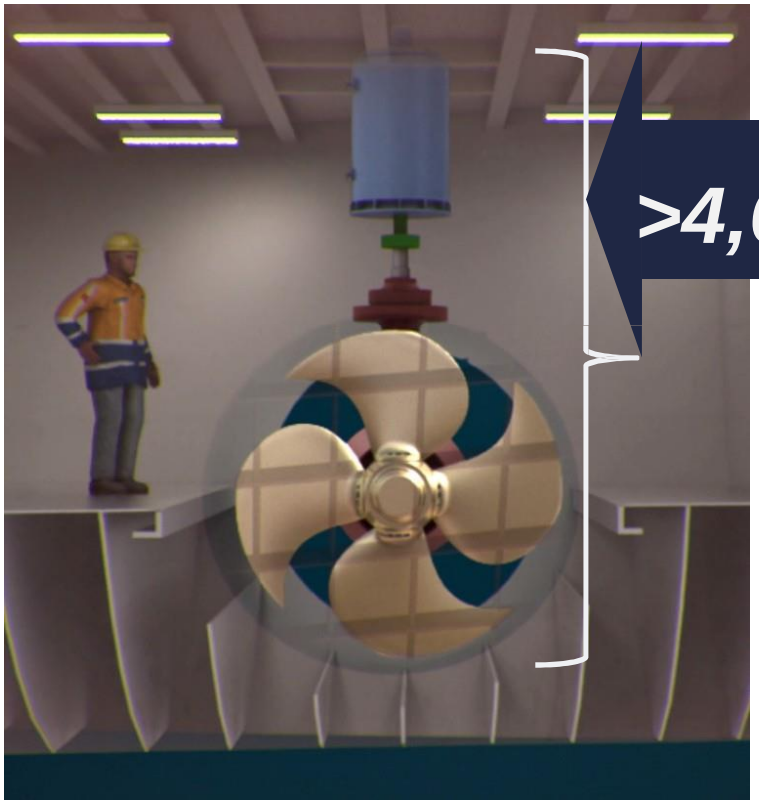
Efficiency	*Robustness* (Simplicity)	*Compactness*





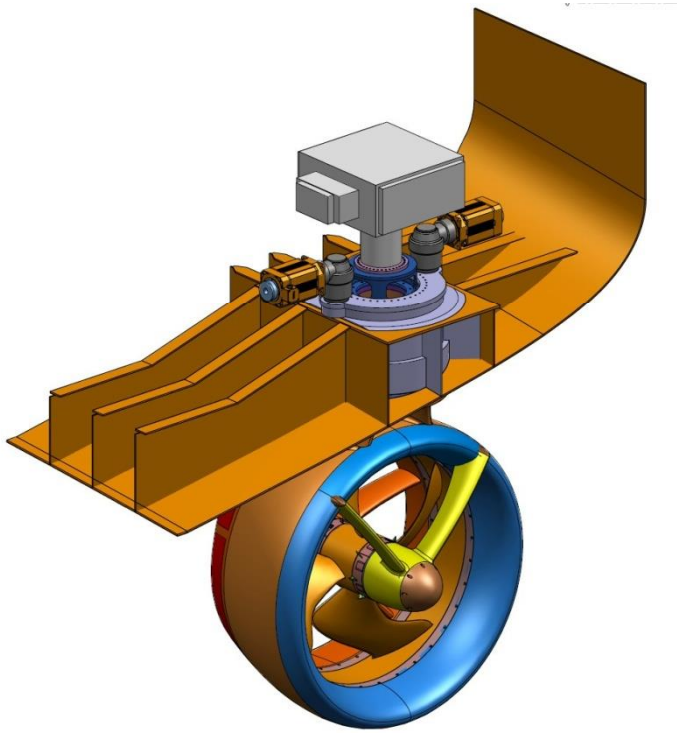
Why PM Technology for Thrusters

Efficiency	*Robustness* (Simplicity)	*Compactness*

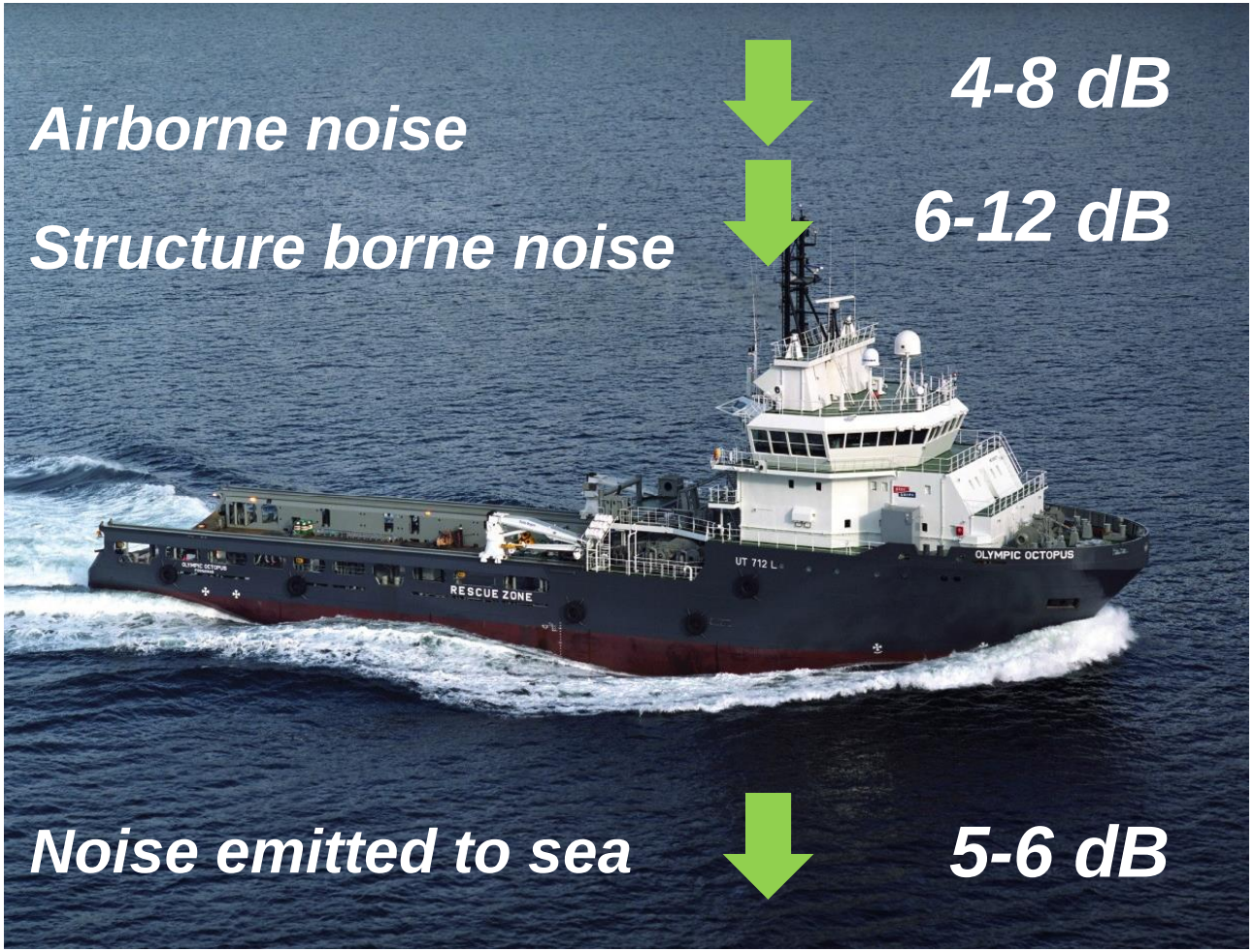


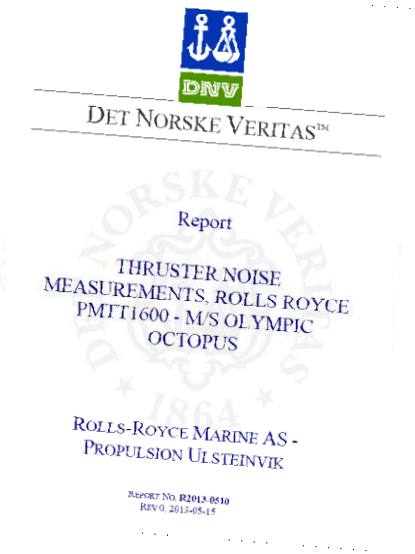
Inside: 1,3M
Hull and
Nozzle: 3,6m

All in 1 room



Noise measurements – ”Olympic Octopus”





DET NORSKE VERITAS™

Report

THRUSTER NOISE MEASUREMENTS, ROLLS ROYCE PMTT1600 - M/S OLYMPIC OCTOPUS

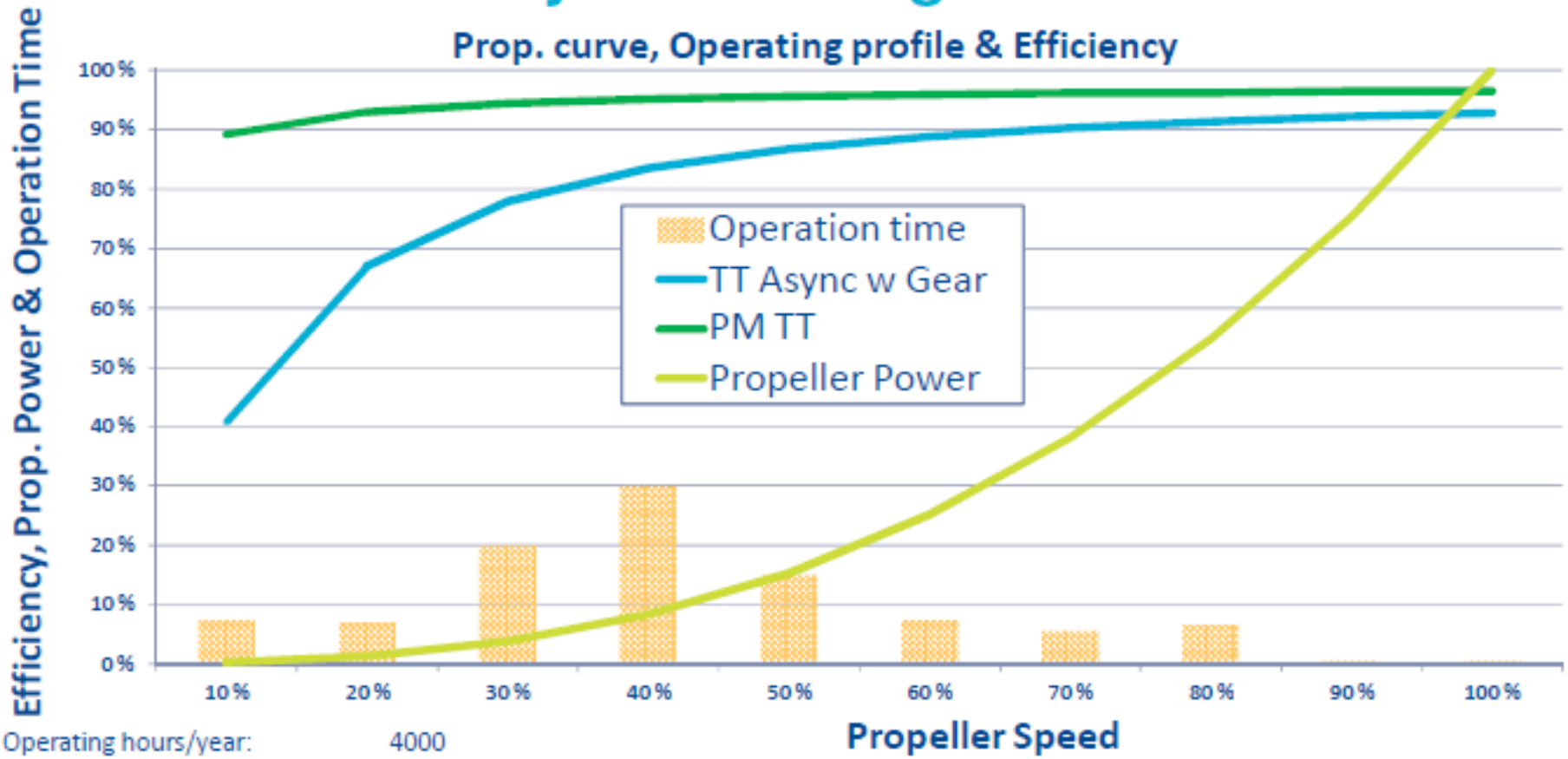
ROLLS-ROYCE MARINE AS - PROPULSION ULSTEINVIK

REPORT NO. R2013-0510
REV.0, 2013-05-15

Measurements conducted by DNV, April 2013

Rolls-Royce

PMTT Efficiency and savings



Operating hours/year:	4000	
Energy consumption/year:		
Asynch w/gear	1015400	kWh
PMTT	943400	kWh
Energy saved (kWh/year):	**72004**	**kWh**
Energy cost	0,808 NOK/kWh	

Reduction in fuel cost

Euro/ year 6926

Euro /20 year 138 523

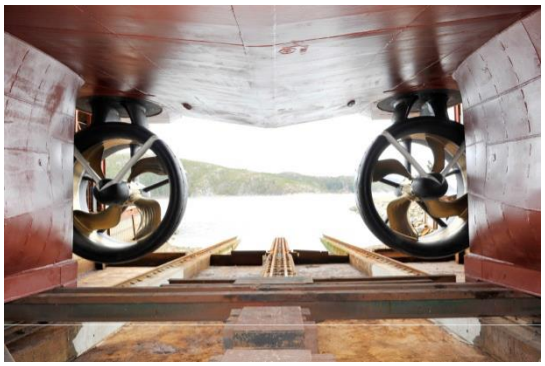
NOK/year	58 176NOK
NOK/lifetime	1 163 590NOK

Rolls-Royce

PMazimuth, main propulsion demonstrator installed on R/V Gunnerus.

Vessel is owned by Norwegian University of Science and Technology

Project funding by Rolls-Royce and Norwegian Research Council



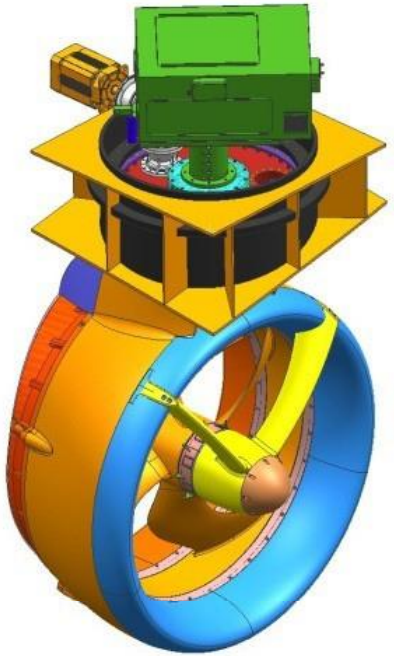
Propulsion system : 2x500kW, 440V 60Hz
"Classic diesel electric "
Length: 31,25m Breath: 9,6m

Remove:
Rudder with steering gear
incl.Nozzle with propeller
Shaftline Gear
Electrical motor
Frequency converter
Bridge control system

Install:
- **Pmazm steering gear**
- **Lubrication systems**
- **Helicon- control system**
- **Frequency Converter**
- **HEMOS**

Design and inhouse testing

- 500 kW azimuth thruster driven by a PM motor placed inside the nozzle.
- Mechanical strength is 1000kW.
- Nozzle have space for a 1000kW PM motor.
- Reuse elements from PMTunnel thruster.
- Helicon-X control system,
- RR PES Frequency converters.
- HEMOS data acquisition system,



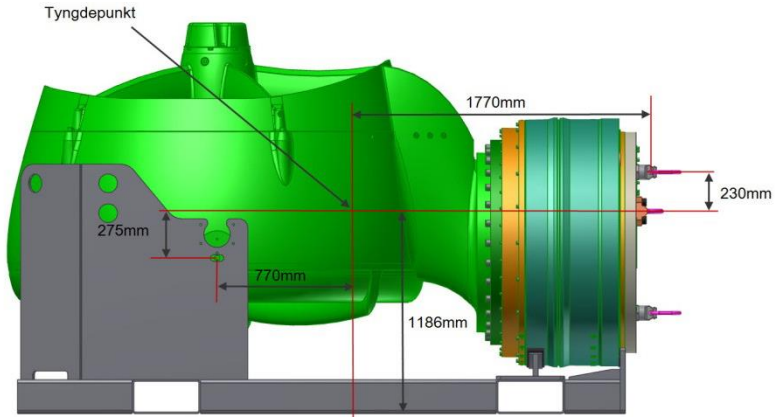
- Design and production: 2012 to Nov 2014
- FAT. Nov-Dec- 2014
- Delivered Dec-14
- Seatrail: March-April-15

Control system and frequency converters

Helicon-X control system and Rolls-Royce frequency converters, well proven products

Installation

Delivered in transportation and installation frame.



Hoisted in place using crane and tackle blocks

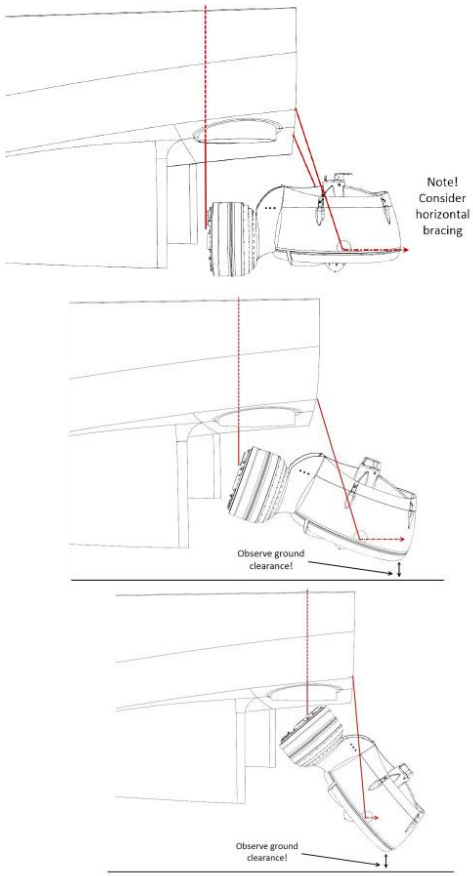
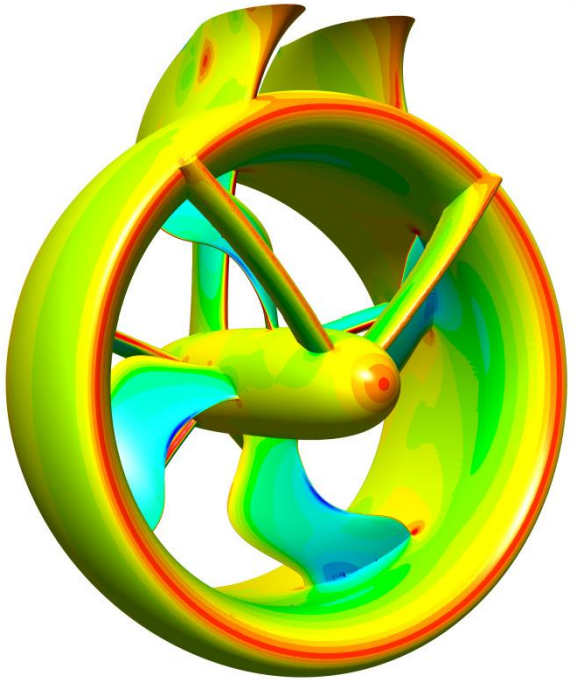


Figure 3.2-9 Lifting and up-ending thruster

R/V Gunnerus with PMAZM

- Two PMAZM1900 prototypes installed at R/V Gunnerus
- Propeller diameter: 1,9 m
- Speed trials March 27th, 2015



SPEED TRIAL SUMMARY - PMAZM - AS MEASURED

DRAUGHT		INFO	SOG	TOTAL POWER	LOAD
m			kn	kW	%
FP	2.20	Run 1	8.575	225	22.5 %
AP	3.60	Run 2	10.35	467	46.7 %
		Run 3	11.3	721	72.1 %
		Run 4	12.1	994	99.4 %

Preliminary

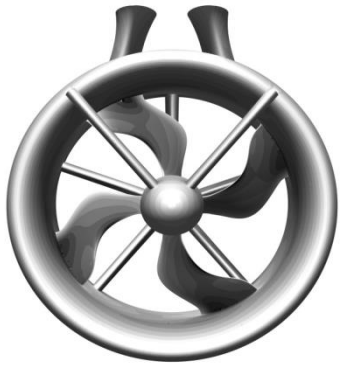
Power vs. speed before / after PMAZM retrofit

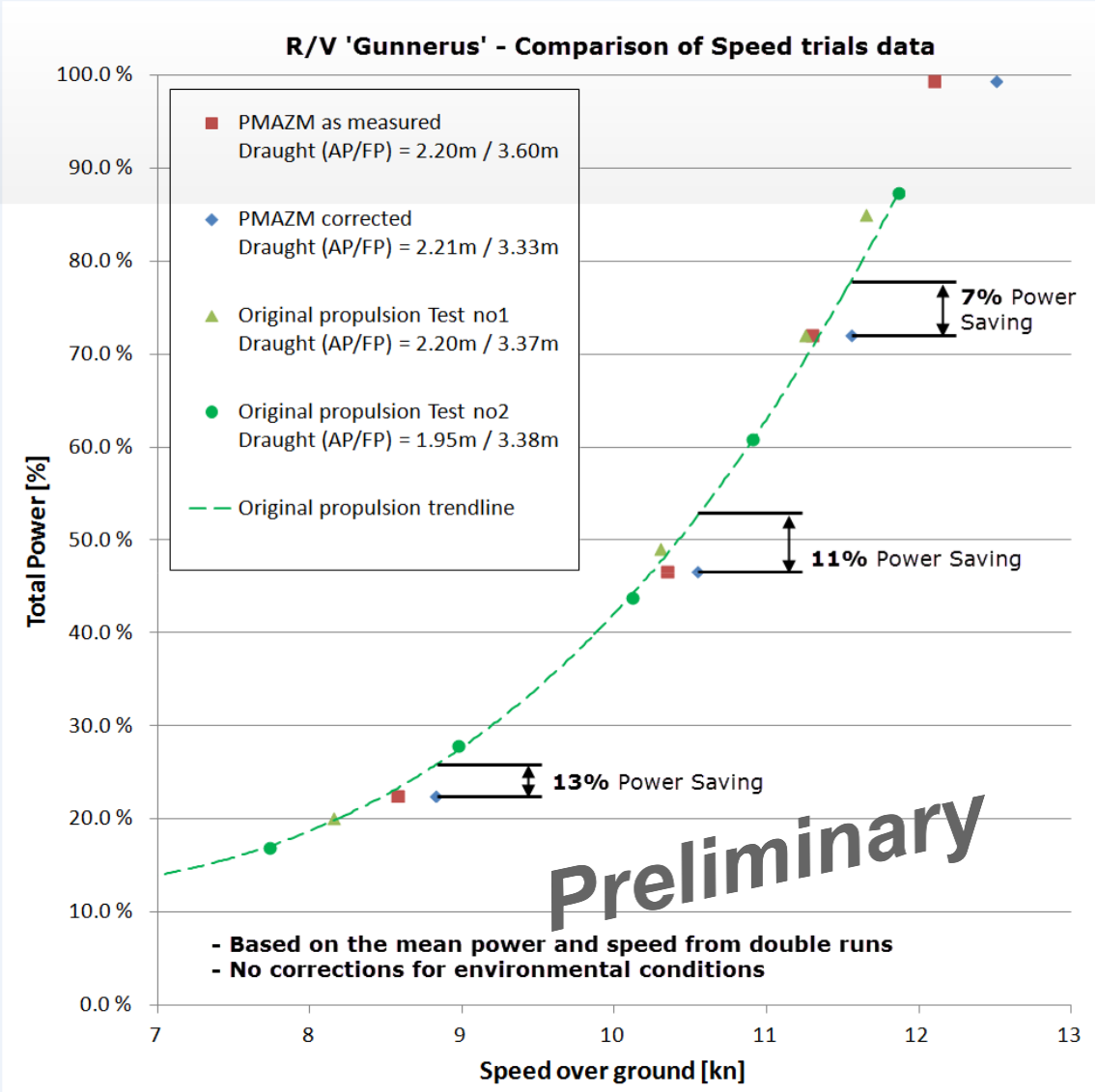
- **Comparison of power consumption .**
- **The results, when corrected for increased displacement, indicate significant power savings:**

8.8 kn ; **13 %** Saving

10.5 kn ; **11 %** Saving

11.5 kn ; **7 %** Saving





PMazm summary

- **Even though the units only have been in operation for some weeks, some of the operational benefits are already clear:**
- **Improved efficiency**
- **Low vibration and noise**
- **Quick response, (azimuth and rpm)**
- **Good manoeuvrability**