“An Effective and Quieter Energy Saving for Ships”

H2020 Project GATERS

Presented By
The GATERS Project Coordination Team,
(Prof Mehmet Atlar & Dr Cagatay Koksal)

The University of Strathclyde
Dept of Naval Architecture, Ocean & Marine Engineering
Glasgow, UK

IMO Workshop on the relationship between Energy Efficiency and Underwater Radiated Noise, 18-19 September 2023, London

Gate Rudder System (GRS) & Applications on Newbuilt ships

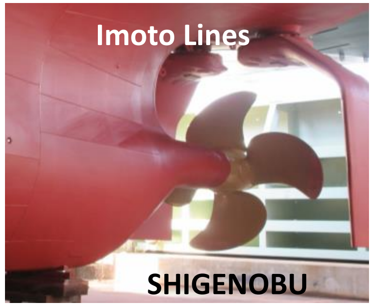
GATE RUDDER SYSTEM (GRS)

CONV' RUDDER SYSTEM (CRS)

	SHIGENOBU (1st appl, 2017)	KOHSIN MARU (2nd appl, 2020)	SHINMON MARU (3rd appl, 2020)	NOGAMI (4th appl, 2022)	OSHIMA MARU (5th appl, 2023)
Ship type	Container (400 TEU)	G/Cargo (509 GT)	G/Cargo (499 GT)	Container (550 TEU)	Training ship (370 GT)
Lpp	101.9	69	72	136.25	47.2
B	17.8	12	12	21	10.6
T	5.24	4.11	4.13	6	3.4
C_B	0.67				
Design Vs	14.5	13	13	16.5	13
Fn (Lpp)	0.2436	0.267	0.267	0.23	0.31
L/B	5.72	5.75	5.75	6.5	4.45
Stern shape	Stern bulb	Stern bulb	V shape	Stern bulb	Stern bulb

2 more ships are in order in Japan for 2023-24:

- 20K DWT Bulker (2023)
- Ro-Ro vessel (2024)



GRS - Energy saving capability

SAKURA			
Length overall	L_{OA}	(m)	111.40
Length between perpendiculars	L_{BP}	(m)	106.40
Breadth	B	(m)	17.80
Design Draught (midship)	T	(m)	5.24
Displacement	Δ	(ton)	4794
Service Speed	V_S	knots	15.5
Rudder			CRS

SHIGENOBU			
Length overall	L_{OA}	(m)	111.40
Length between perpendiculars	L_{BP}	(m)	106.40
Breadth	B	(m)	17.80
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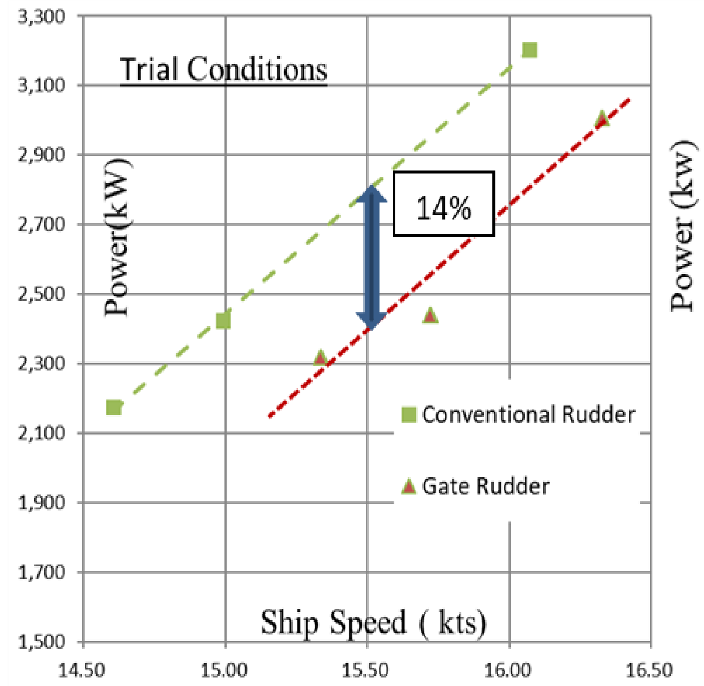
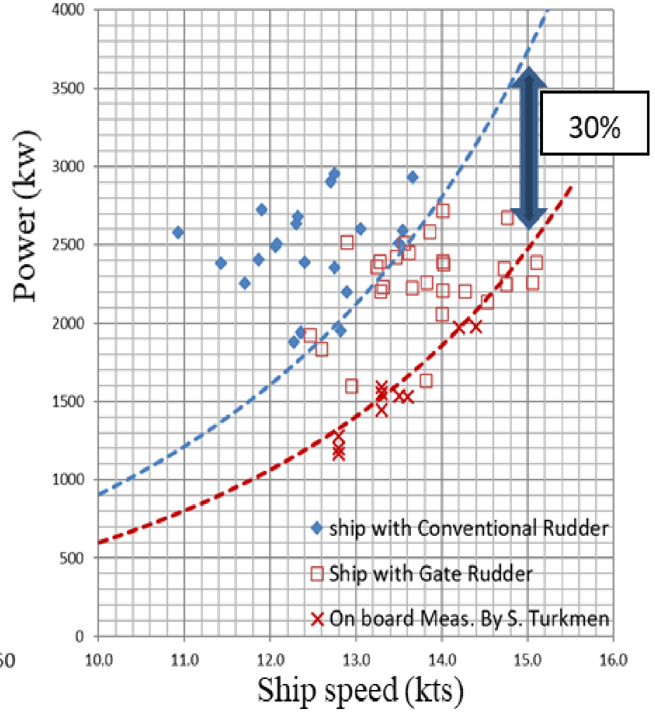
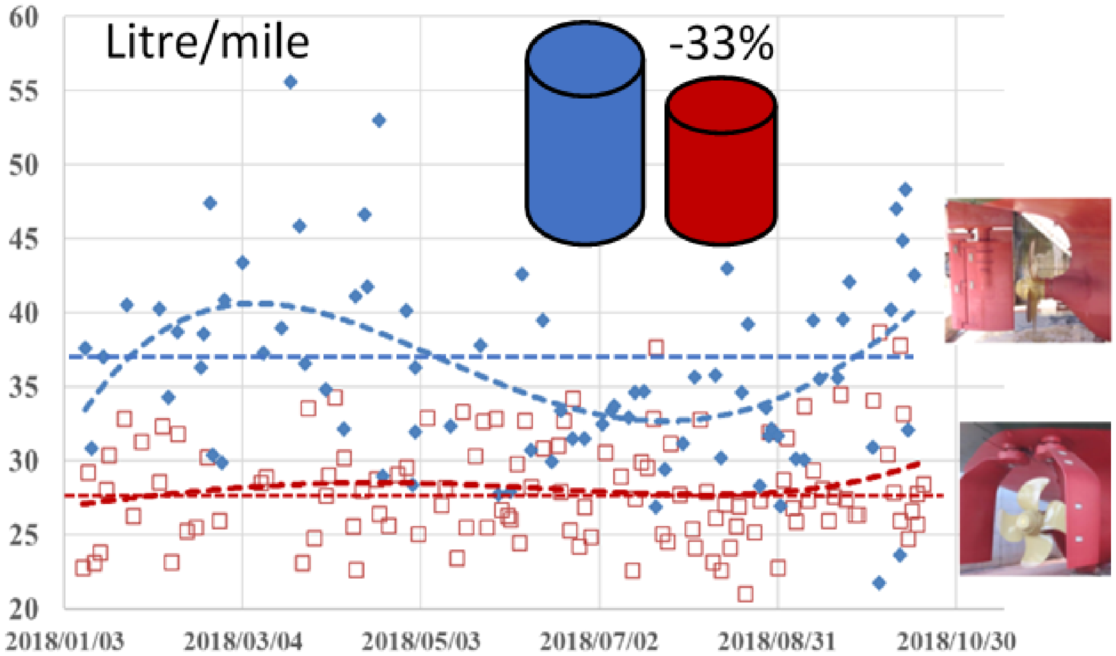


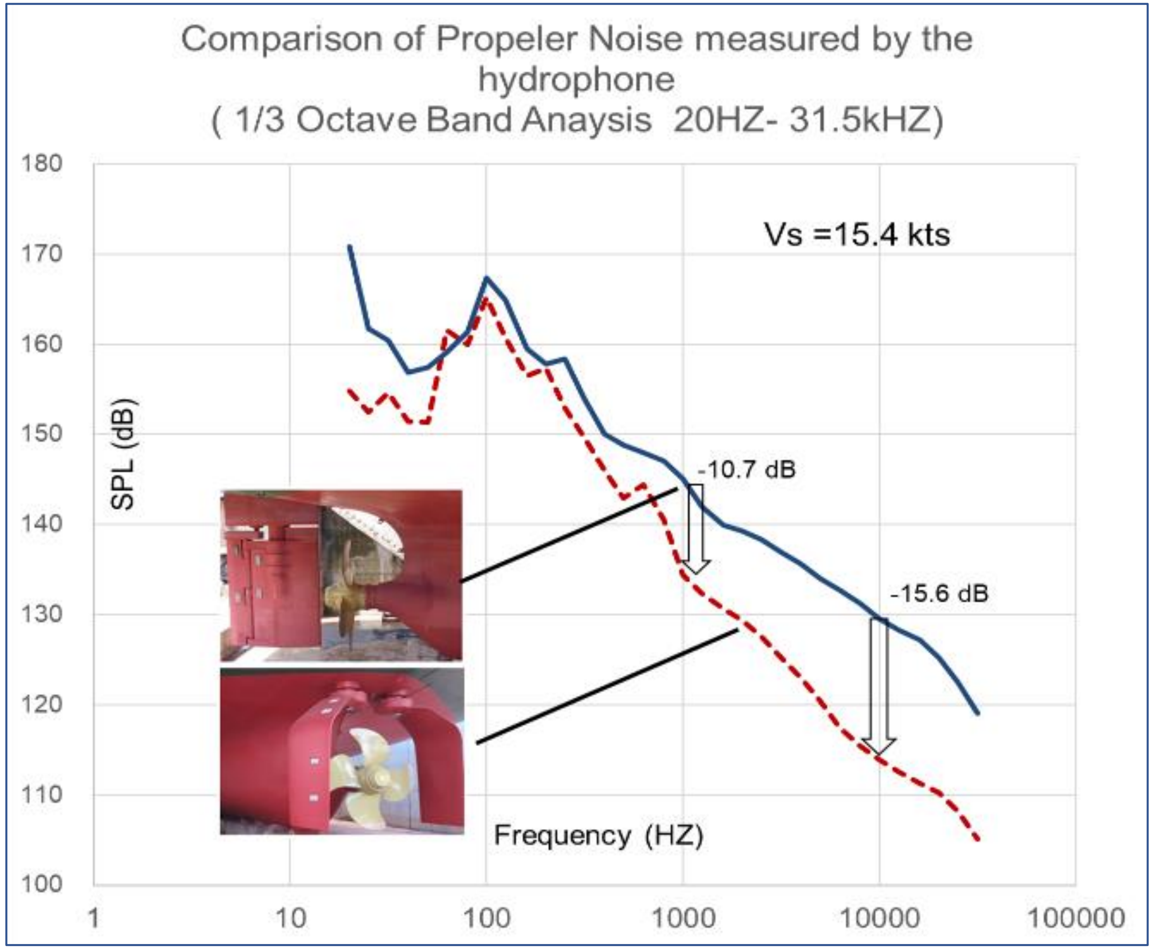




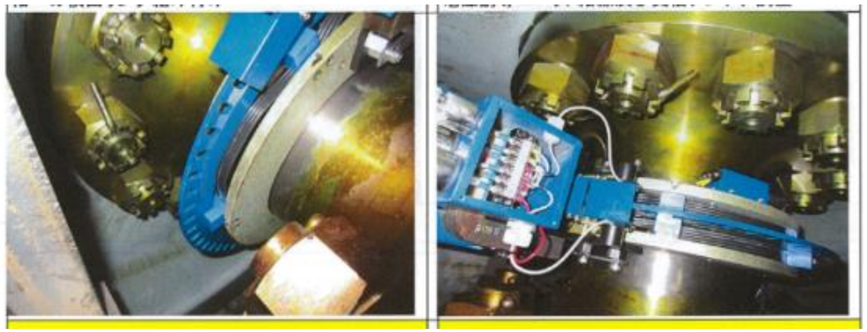
Trials (calm water) and in-service (including rough weather) powering performance comparisons of two sister ships: one ***Shigenobu*** with Gate rudder system **vs.** ***Sakura*** with Conventional flap-rudder system

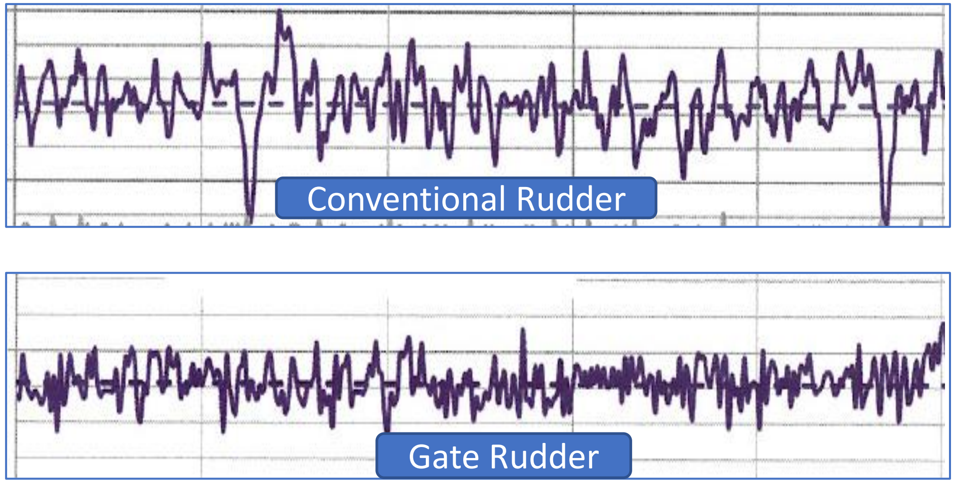
In-service fuel consumption comparisons of two sister ships, ***Shigenobu*** with GRS (red) vs**.** ***Sakura*** with CRS (blue)

GRS – URN & Vibration reduction capability



Comparative Underwater Radiated Noise (URN) levels of *Sakura (CRS)* and Shigenobu (GRS) from trials





Comparative shaft torque records for GRS and CRS using the same torquemeter

H2020 Project - GATERS

The EC-H2020 Project

GATERS

GATE Rudder System as a **R**etrofit for the Next Generation Propulsion and Steering of **S**hips

GATERS – Aims

To bring together 18 technology experts and prime stakeholders, including the patent holder, to demonstrate and exploit the benefits of this system by two main deliverables:

- **To demonstrate the GR system for the European short sea shipping operations by installing and operating on a target coastal vessel.**
- **To explore the GR system, conceptually, for the oceangoing shipping operations, including fleet level.**

Hence to demonstrate if the Gate Rudder System can be the next generation propulsion and steering system for the waterborne transport.

www.gatersproject.com
https://cordis.europa.eu/project/id/860337
https://twitter.com/gatersproject ;
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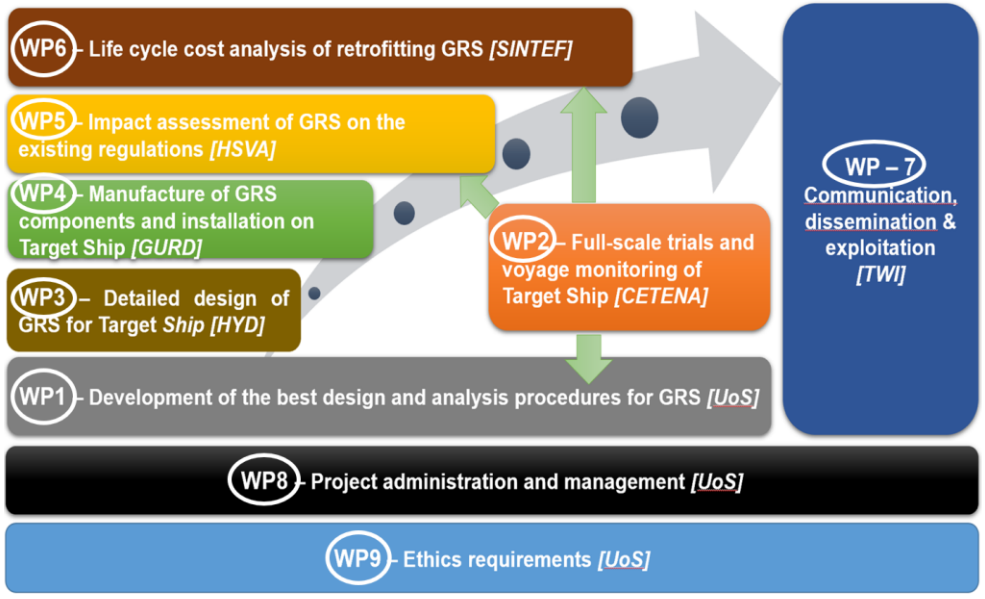
GATERS – Objectives

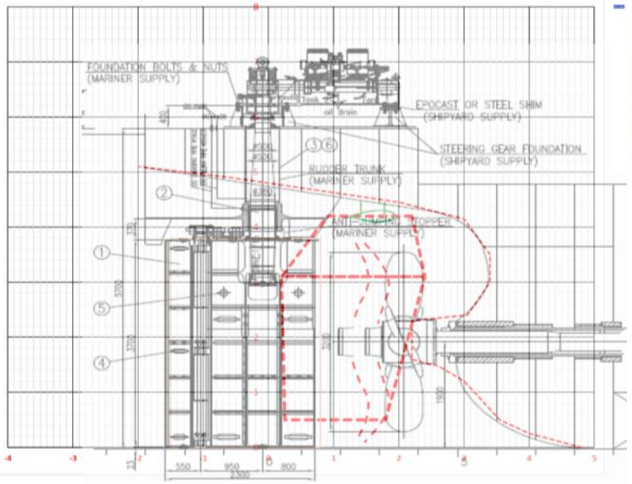
1. To investigate the technical challenges of the Gate Rudder System (GRS) and **establish the best practice of application as a retrofit** by using a combination of the computational, experimental and full-scale procedures.
2. To design a retrofit GRS at a detailed level, **to manufacture and install on the coastal target cargo vessel**. Hence, to demonstrate the effectiveness of the GRS by sea trials and voyage monitoring as well as its impact on the existing IMO regulations (i.e. EEDI, EEOI, EEXI, CII and Minimum power requirements) and the Life Cycle Cost (LCC).
3. **To assess the overall impact of the retrofit GRS applications** to major ship types for the European SSS operations and the Oceangoing Shipping (OS) operations on the existing (IMO) regulations and Life Cycle Cost (LCC) for both individual vessels as well as the fleet-level services.

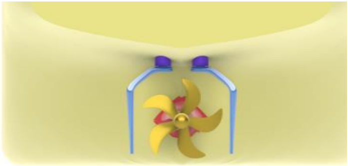
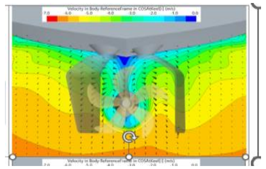
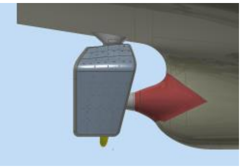
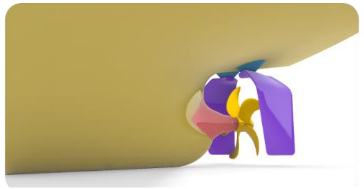
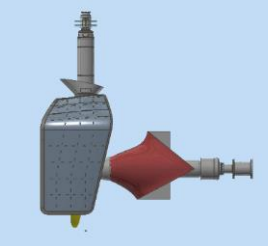
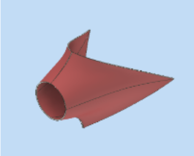
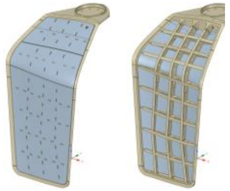


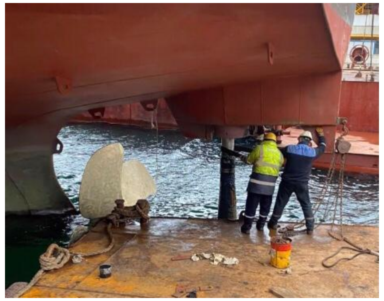
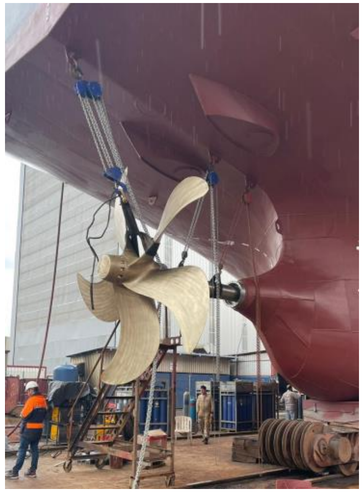
GATERS – Methodology

Target vessel MV ERGE - Retrofitting with GRS

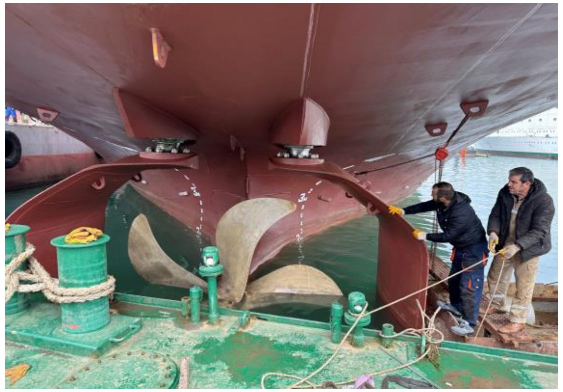
Parameter	MV Erge				
	Symbol	Units	Ballast Load	Design Load	Full Load
Length overall	L_{OA}	(m)	89.95		
Length between perpendiculars	L_{BP}	(m)	84.95		
Breadth	B	(m)	15.4		
Draught (midship)	T	(m)	3.3	5.6	6.45
Draught (AP)	T_A	(m)	3.8	5.6	6.45
Draught (FP)	T_F	(m)	2.8	5.6	6.45
Displacement	Δ	(ton)	3607	6339	7241
Block coefficient	C_B		0.818	0.827	0.84
Prismatic coefficient	C_P		0.823	0.829	0.843
Midship area coefficient	C_M		0.994	0.997	0.997
Waterplane area coefficient	C_{WP}		0.854	0.916	0.944
Longitudinal centre of buoyancy	LCB	(m) (+ fwd)	46.866	45.85	43.025
Longitudinal centre of floatation	LCF	(m) (+ fwd)	46.246	39.748	39.863
Longitudinal centre of gravity	LCG	(m) (+ fwd)	46.903	45.91	43.036
Verticle centre of gravity	VCG	(m)	3.23	5.4	6.095
Speed	V_S	knots	12		





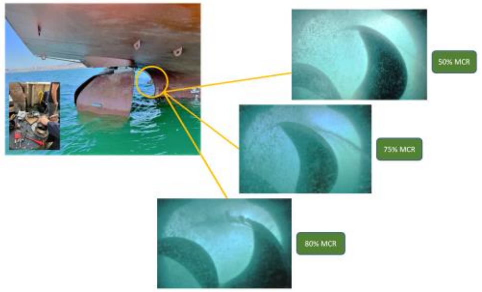


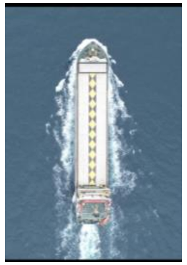


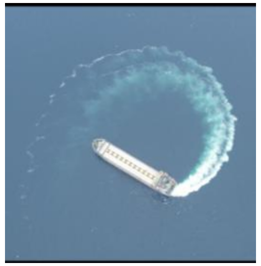
MV ERGE Sea Trials – Pre and Post Retrofitting of GRS

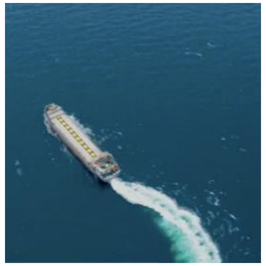
- **Pre-retrofit trials with CRS** were conducted on **23rd of January 2023** Marmara Sea in Turkey and dedicated to "Manoeuvring" and "Speed-Power" trials. **The 2nd day trials on the 24th** were concentrated on the URN measurements using alternative methods. (i.e. Standard equipment with 3 Hydrophones and the HYDRONE® with single hydrophone

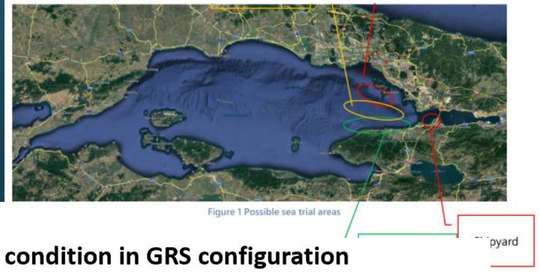
- **Post-retrofit trials with GRS** were repeated the pre-retrofit measurements and conducted at the same trials area on **the 30th of May 2023** but with better weather conditions (i.e. Beaufort 3 vs 4)











Ship's Trial Loading condition in CRS configuration

Particulars	(m)
Lpp	84.95
Fore Draught	2.80
Mean Draught	3.80
Trim	1.00

Ship's Trial Loading condition in GRS configuration

Particulars	(m)
Lpp	84.95
Fore Draught	2.75
Aft Draught	3.80
Trim	1.05

Table 1. Speed/Power and URN tests in CRS configuration

No	MCR (%)	P_S (kW)	N (RPM)
01	50	786	111.0
02	60	1074	121.0
03	75	1509	134.0
04	85	N/A	N/A

Table 1. Speed/Power and URN tests in GRS configuration

No	MCR (%)	P_S (kW)	N (RPM)
01	50	634	107.0
02	60	808	117.0
03	75	1132	130.5
04	85	1282	137.0

University of Strathclyde

MV ERGE Power & Fuel Saving Performance at Sea trials and Service

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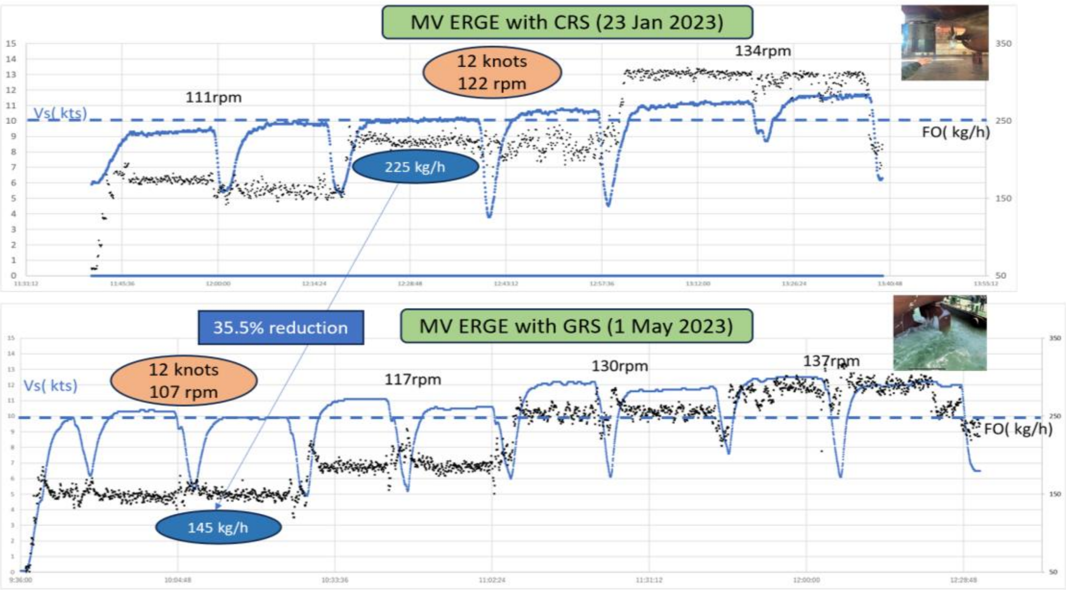
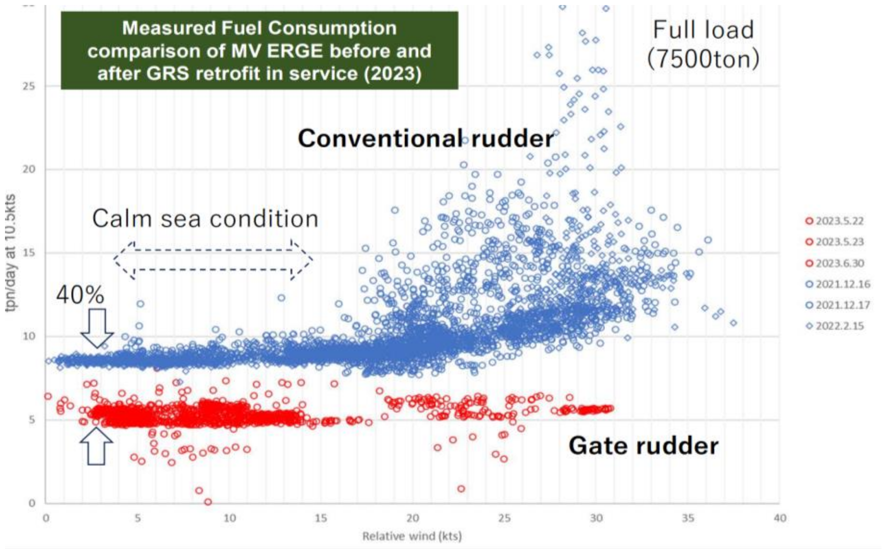
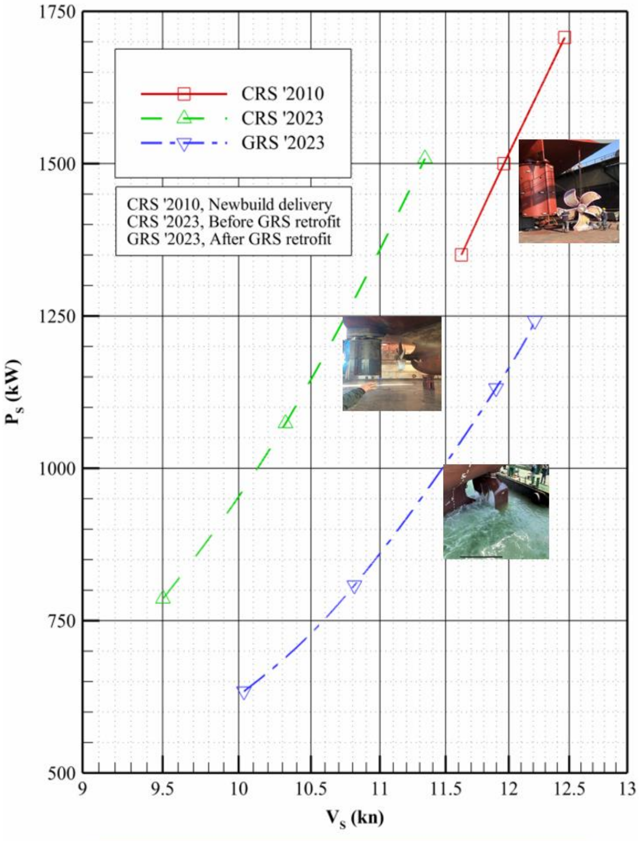
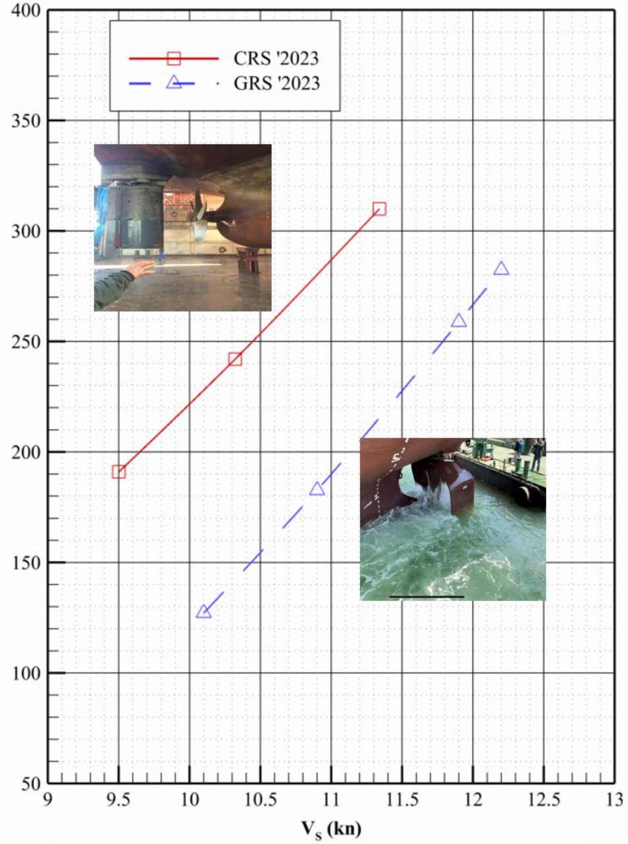


Measured Fuel Consumption comparison of MV ERGE before and after GRS retrofit in trials (2023)





Measured trial shaft power (Ps) comparison of MV ERGE before and after retrofit in the present (2023) and when she was new (2010).



Measured Fuel Consumption comparison of MV ERGE before and after GRS retrofit in trials (2023)

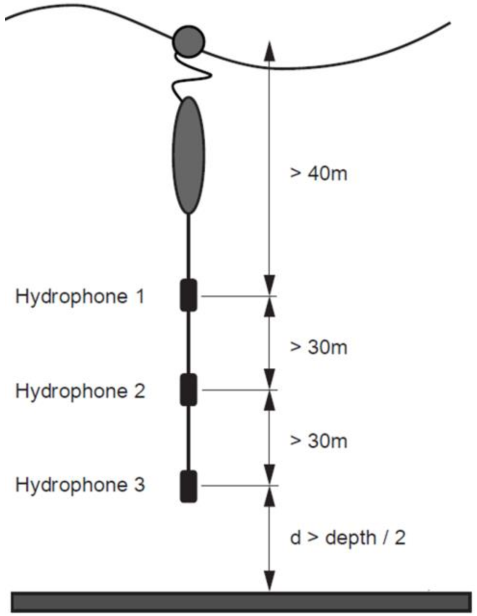
MV ERGE URN Performance at Sea Trials

Sea trials/URN measurements were carried out at the **Marmara Sea**

- The marine traffic is limited in the area
- The wind and wave conditions are better than the west Marmara Sea
- The water depth is 100-200 m, which is suitable for underwater noise measurements as it should be deeper than 100 m
- The current is limited in comparison with most of the Marmara Sea area

The measurement setup used and analysis techniques follow the BV (Bureau Veritas) **NR 614 DT R02 E** Rule Note.

- A representative of BV observed the URN measurements in the support vessel
- Measurement program (loading conditions, propulsion operating conditions and test location parameters) supplied to BV
- The hydrophones were laboratory calibrated
- The distance was measured with a GPS device, achieving the required accuracy (±10 m)

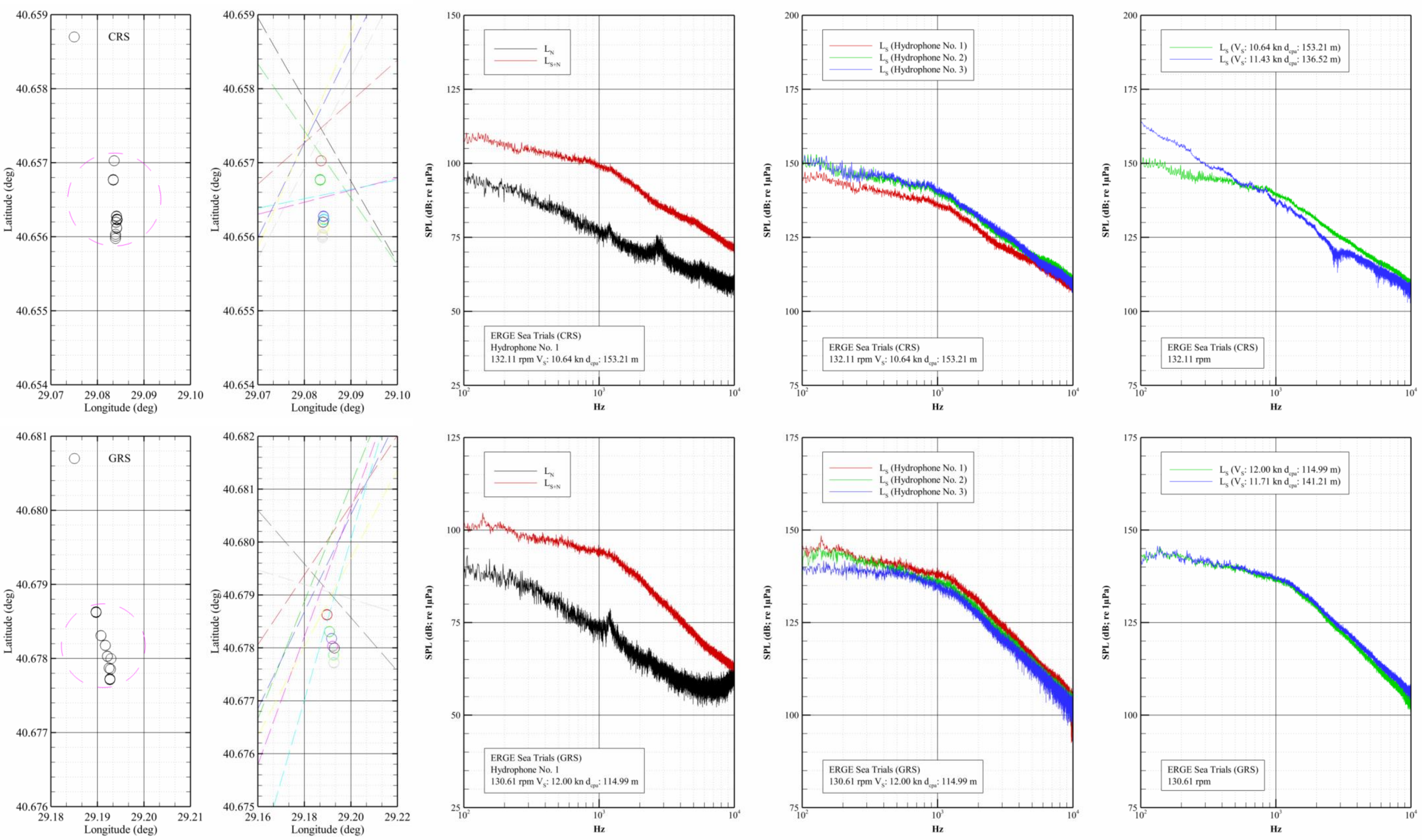


Three hydrophones have been used deployed at three different water depths, at 40, 70, and 100 meter tethered from a support vessel. The three hydrophones were connected to the RTSYS EA-SDA14 data recorder which has been set to sample the hydrophone signal at a sampling frequency 156.25 kHz (24 bit).

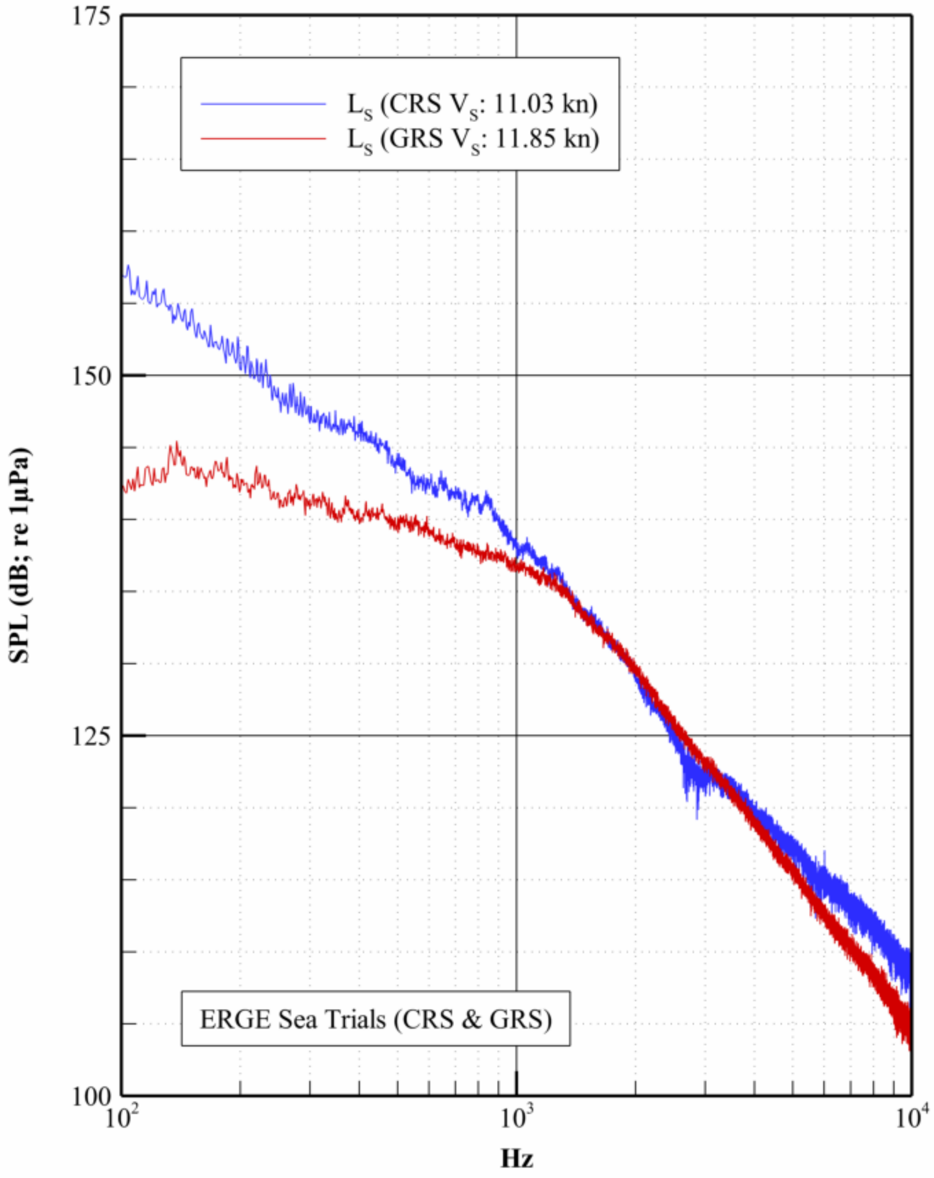
MV ERGE URN Performance at Sea Trials

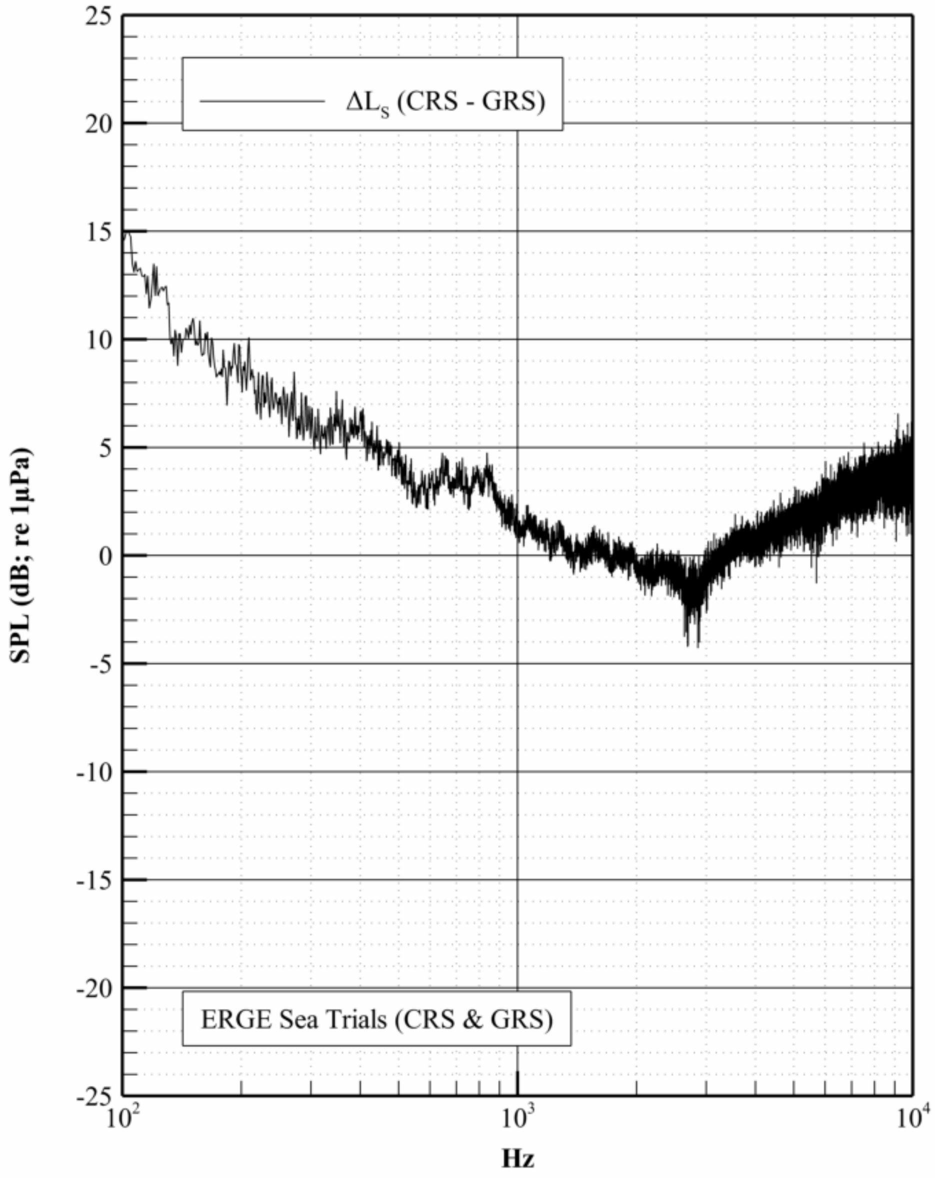
CRS Data

GRS Data

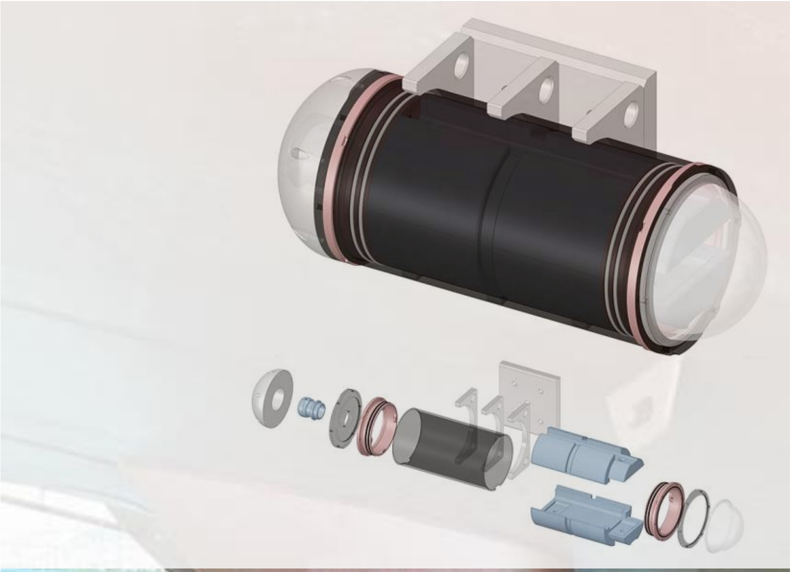


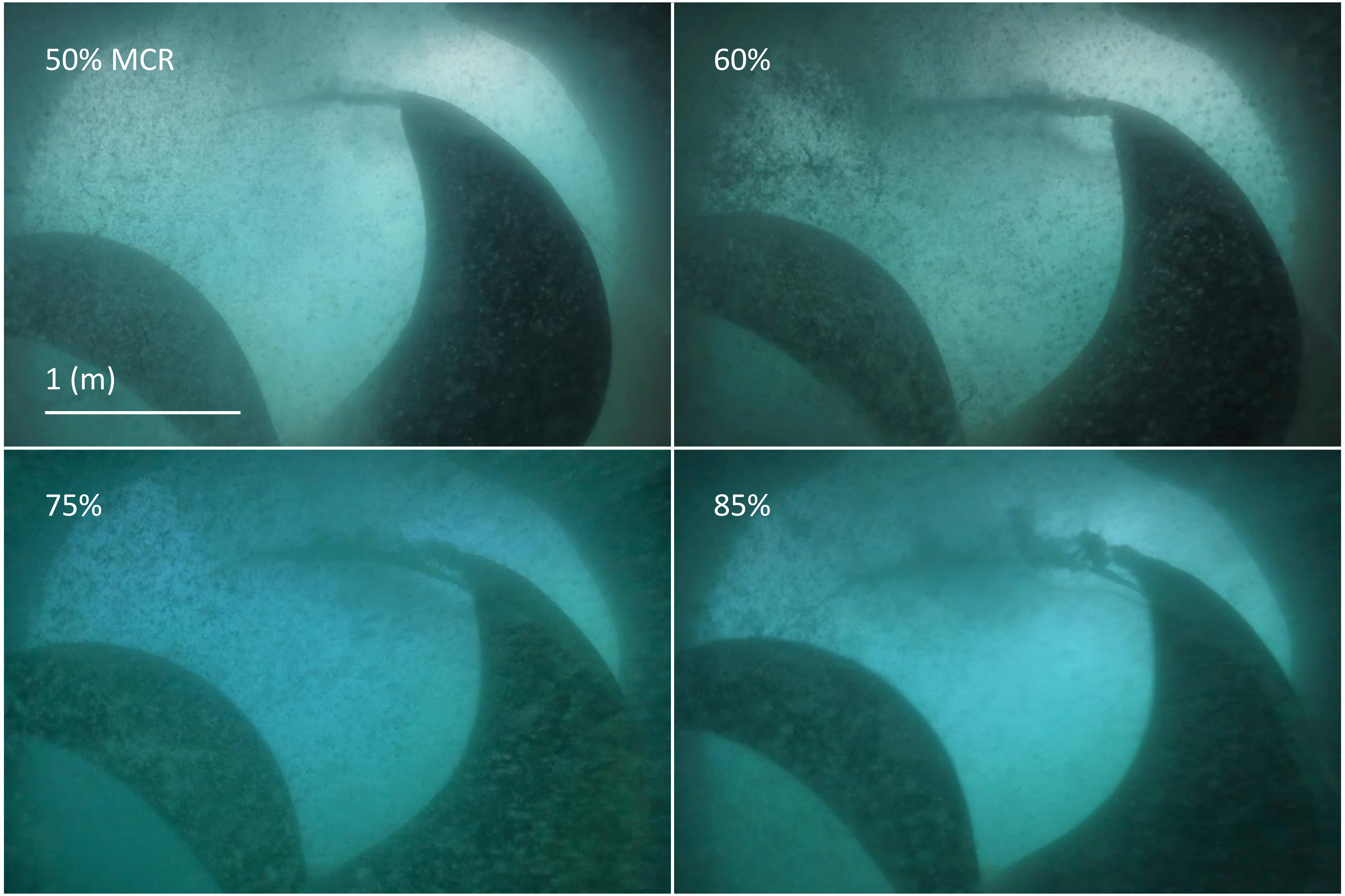
MV ERGE URN Performance at Sea Trials





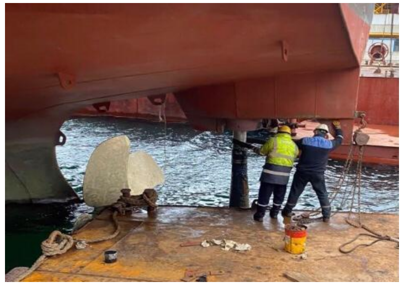
MV ERGE URN Performance at Sea Trials



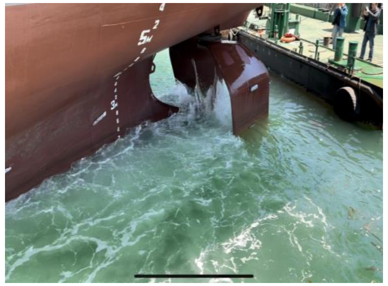


Concluding remarks

- The GRS is a **novel energy saving device** (ESD) for ships, presenting **attractive savings,** which is more than any other ESDs available can provide **as a sole device**.
- Inherent design features of the GRS help **to reduce URN** of ships **without compromising** the saving energy.
- The **application** of GRS on a "**new-built**" coastal container vessel in trial conditions demonstrated that the URN reduction can be as high as 15dB while the energy saving is around 15% compared to her sister ship.
- The "**retrofit**" **application** of GRS on an "existing" coastal G/Cargo vessel in trial conditions can also display up to the same level of URN mitigation while presenting a massive 35% fuel saving
- GATERS project had successfully achieved its most important objective, i.e., design, build and demonstrate **the first retrofit application** of the GRS on a commercial coastal vessel that was also the first application of the GRS **outside Japan**.
- Since her retrofit with GRS, MV ERGE has been **sailing efficiently in the past 5 months** while her powering/fuel performance has been monitored in-service to assess her performance further







THANK YOU

On behalf of The GATERS Consortium & The UoS Team

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IMO Workshop on the relationship between Energy Efficiency and Underwater Radiated Noise, 18-19 September 2023, London