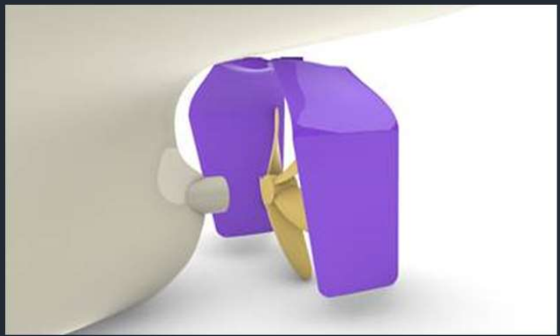
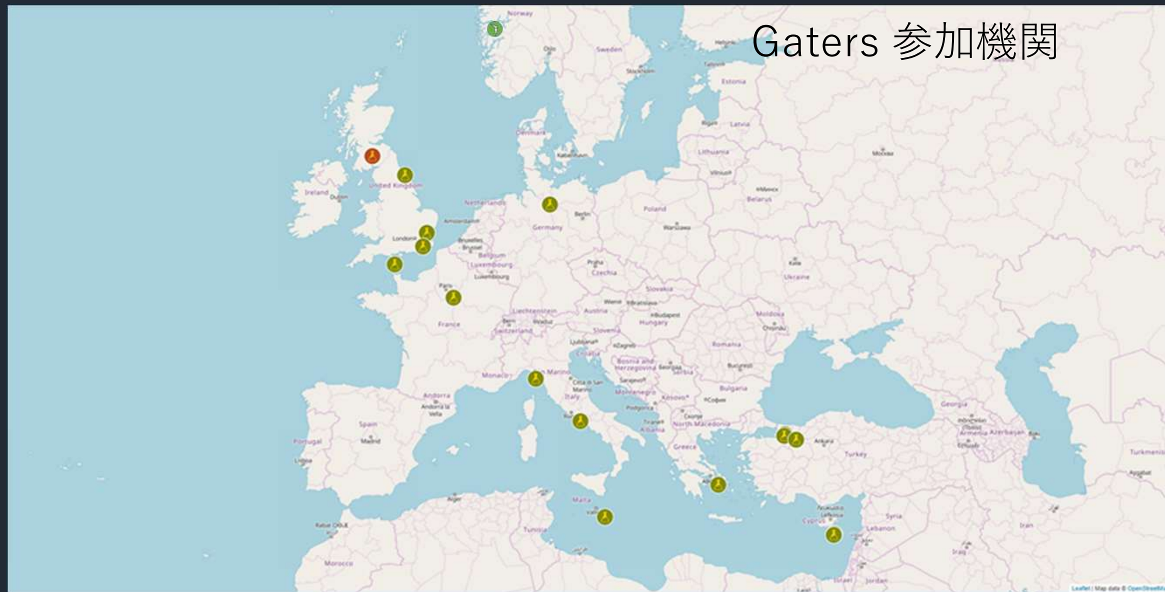
# EUプロジェクト　GATERSの進捗状況

ストラスクライド大学　佐々木紀幸



1．GATE RUDDERとは
2．国内における研究
3．GATERSの進捗状況

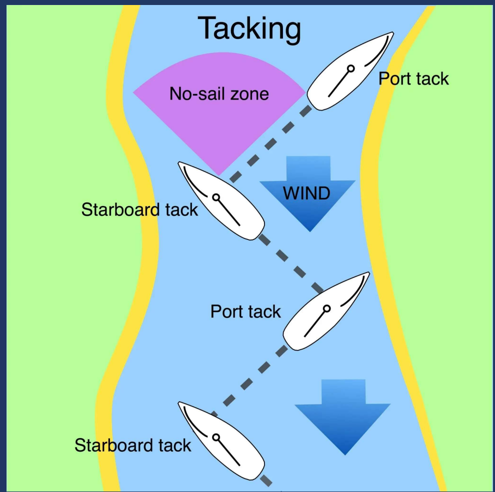



# A sail behind the fan will not work !


Principal of Wind assisted propulsion

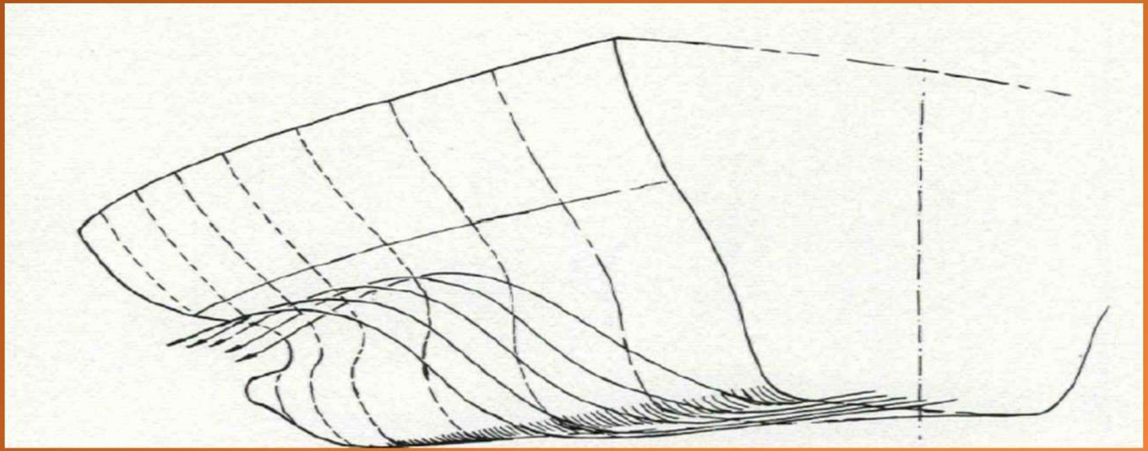
*Tacking*

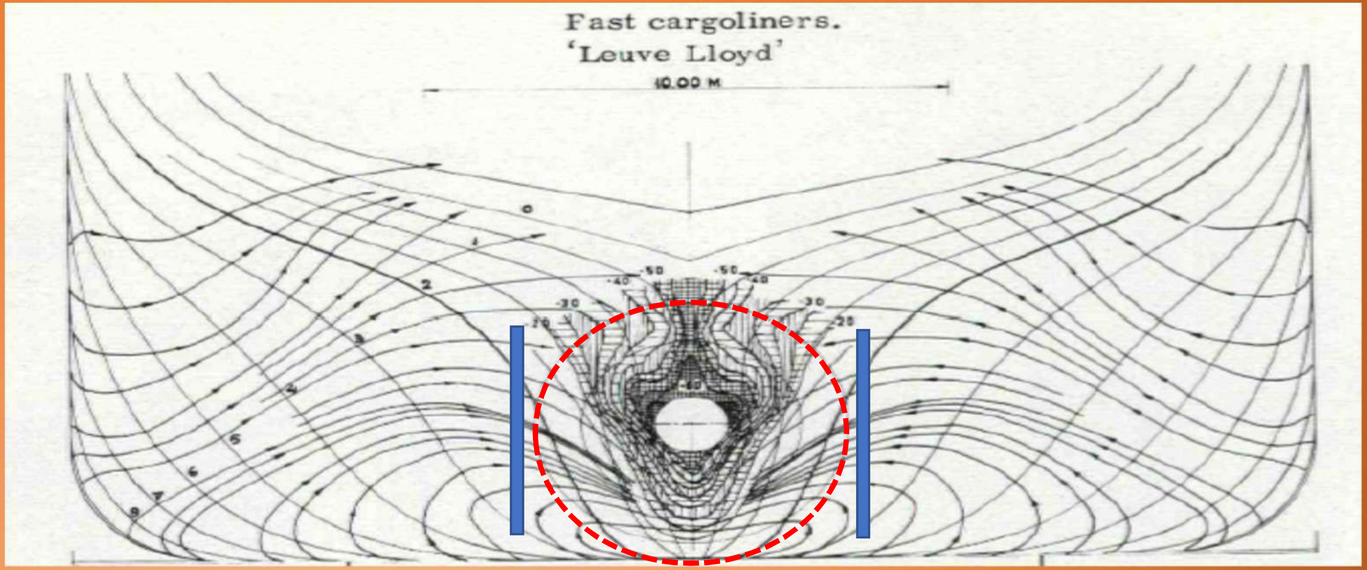
*Tacking + Fan(propeller)*




https://www.safe-skipper.com/tacking-a-sailing-boat/

# Typical Stern Flow



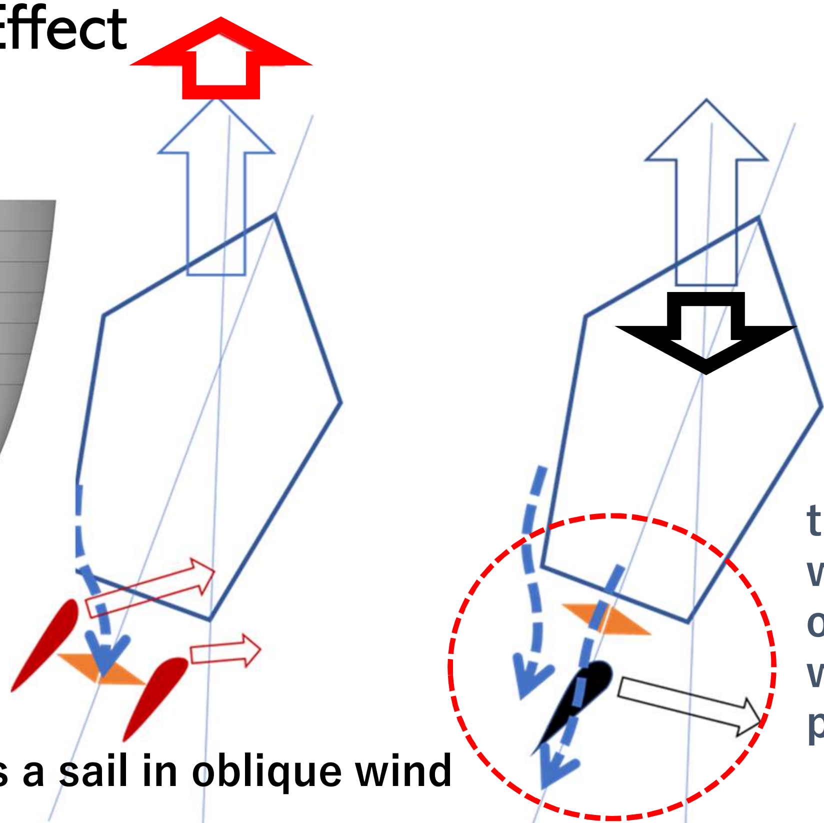



E. Vossanack and A. Voogt
“Development of ship’s after bodies, propeller excited vibrations”
LIPS 2nd Symposium

# Gate Rudder is under water ship sails

**Tacking Effect**

Tacking operation of yacht



**Working as a sail in oblique wind**

**the conventional rudder works in the deflected flow of a propeller slipstream which deteriorates the sail performance**

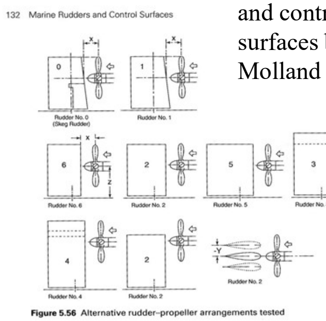
**Yawing condition (Rolling condition is the same)**

# Why we have forgotten the self stabilizing function of a rudder ?

Free stream

Propeller slip stream

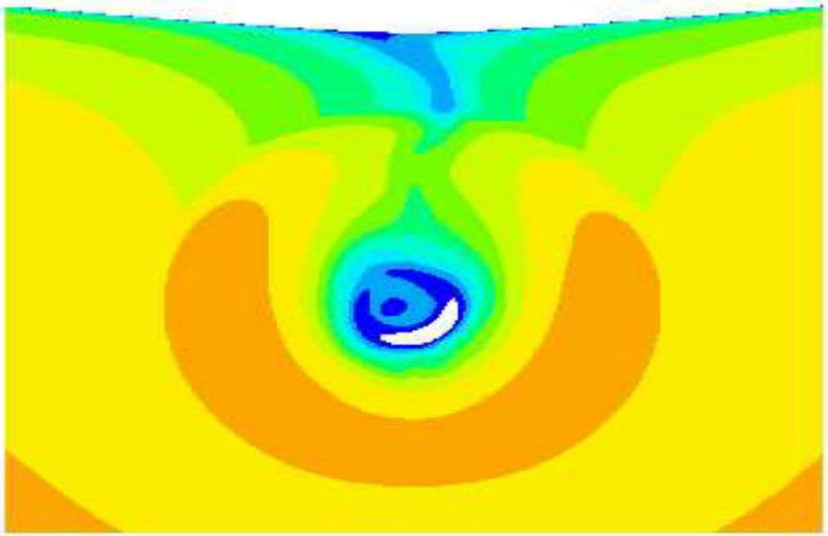
Rudder and propeller interaction



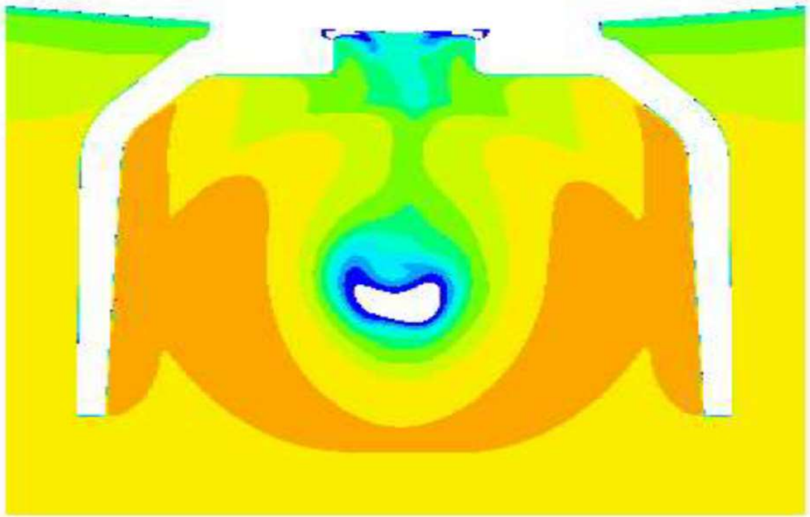

Marine rudders and control surfaces by A. Molland

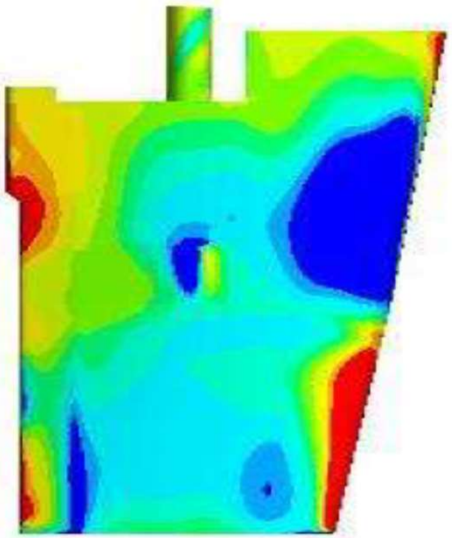

K. Nakatke ⟹ Effect of propulsive efficiency

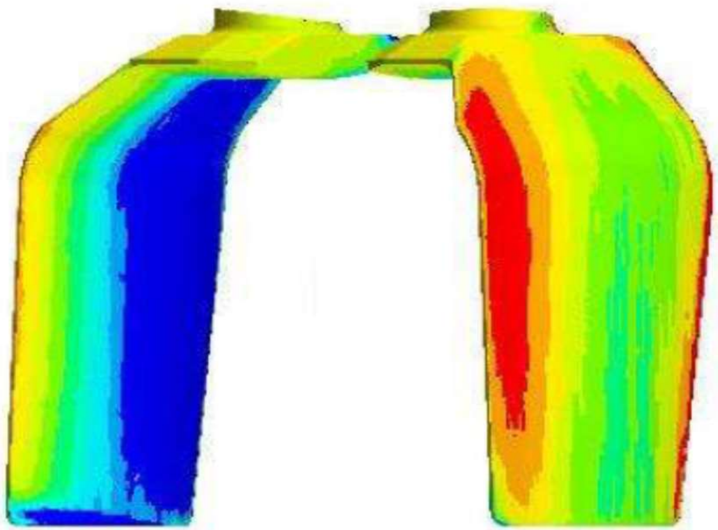
**Plane @ 0D**



**Plane @ 0D**





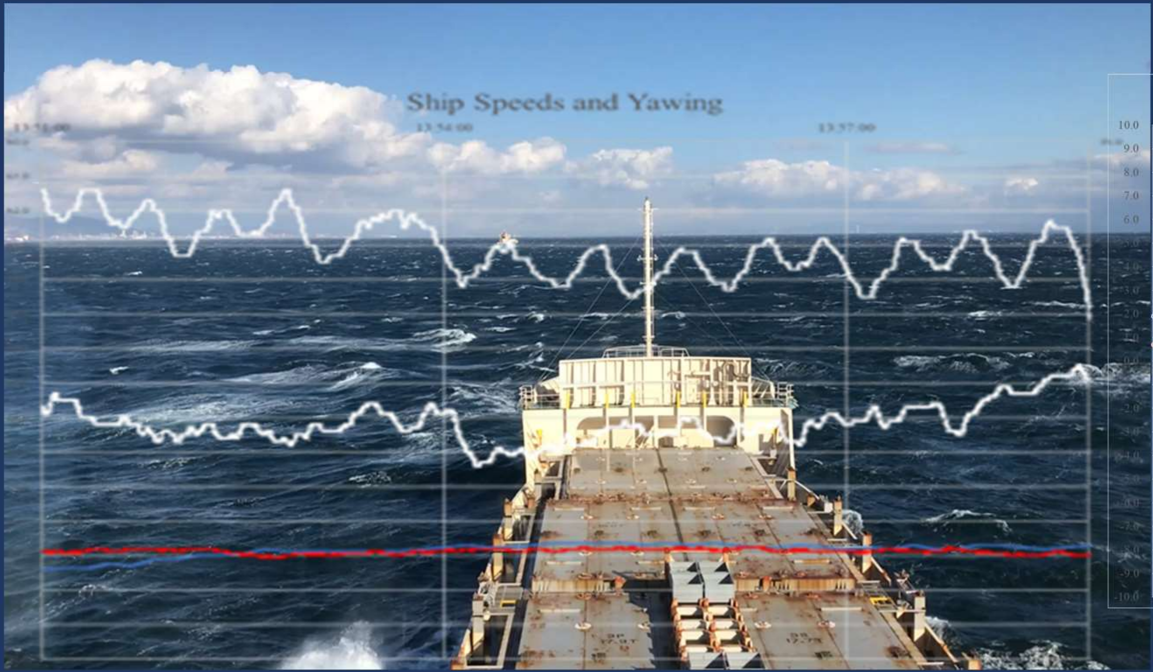


合同試運転で確認できた
ゲートラダー
６つの特徴

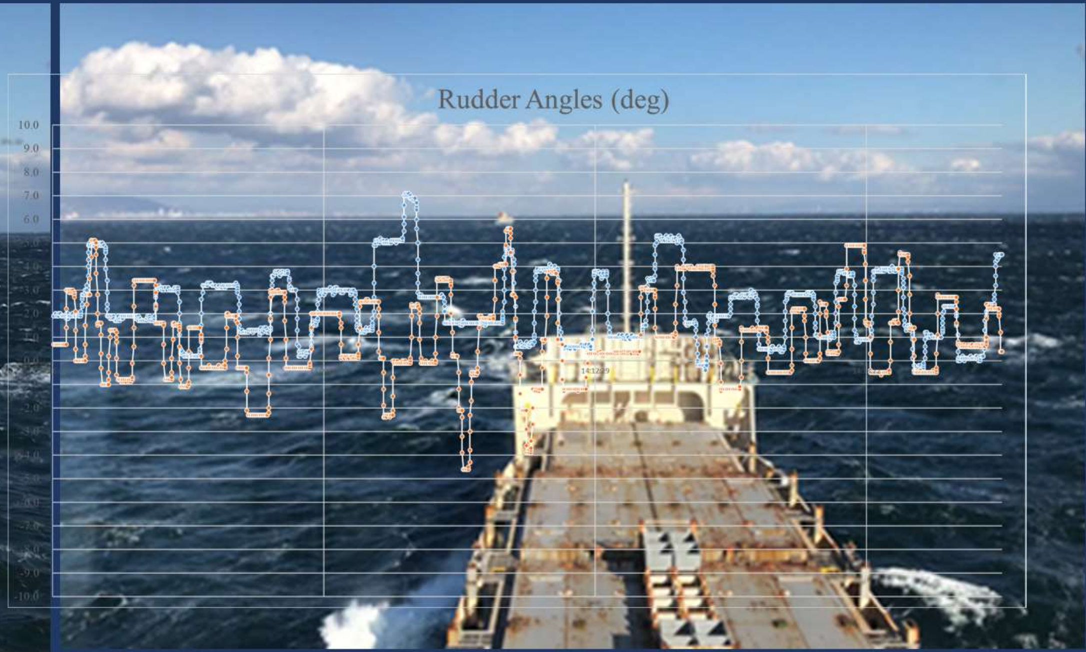
１．燃費の良さ
２．針路安定性の良さ
３．港内操船の良さ
４．揺れない
５．加速性の良さ
６．操舵による速力損失が小

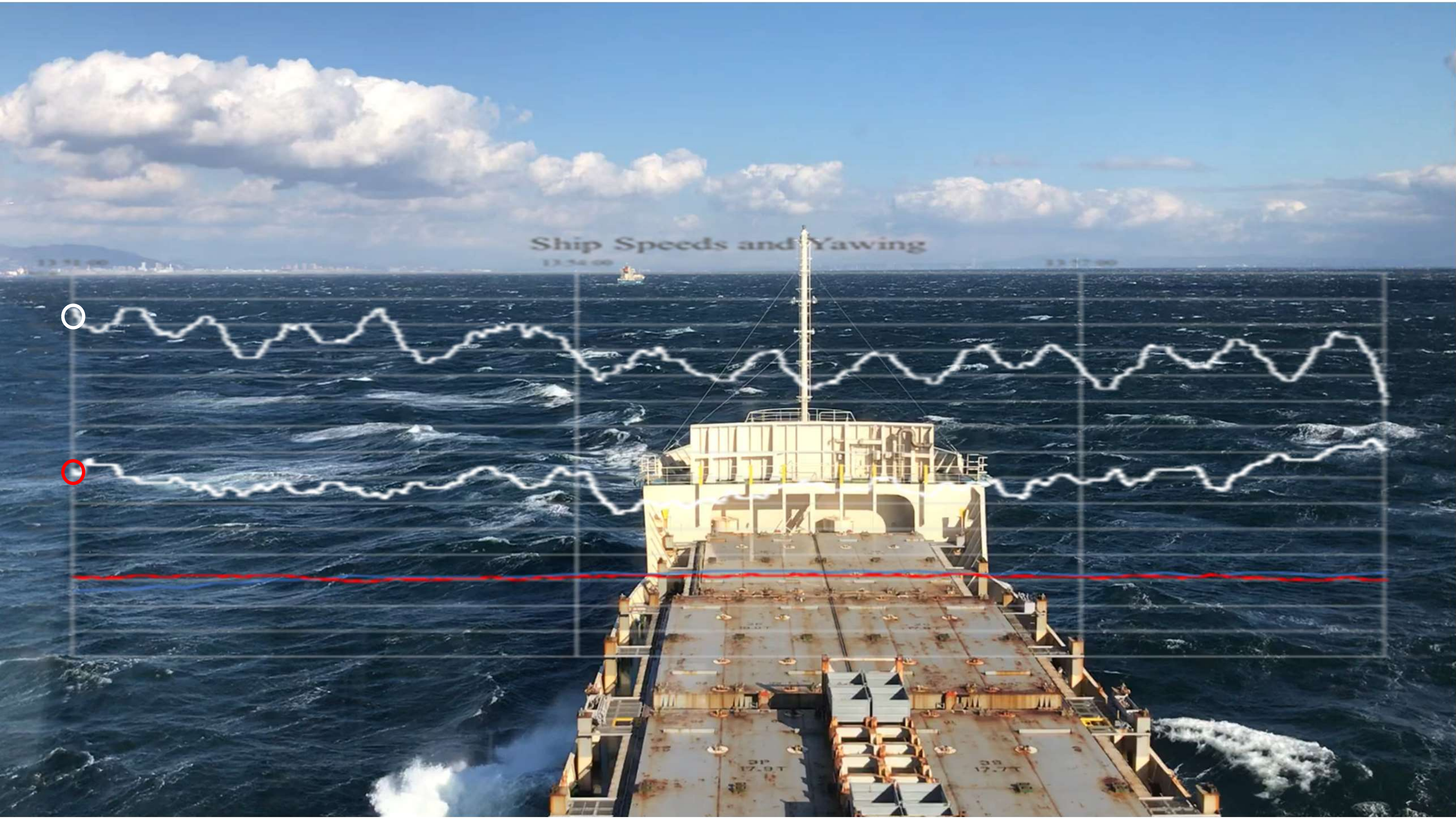


Ship motion




Rudder Angle




Ship Speeds and Yawing

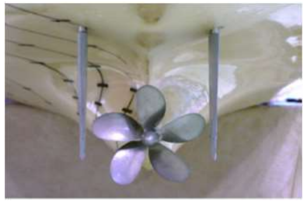
# 経緯

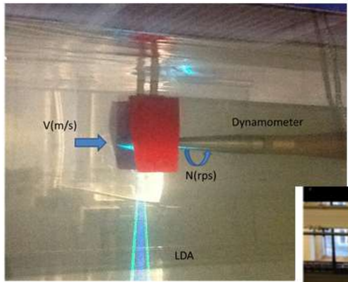
2010 2012 2014 2016 2018 2020

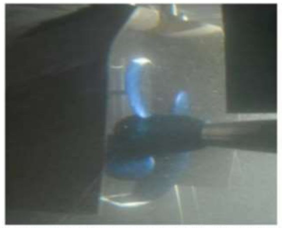
栗林商船ー海技研共同研究

ニューキャッスル大学での研究

ストラスクライド大学での研究





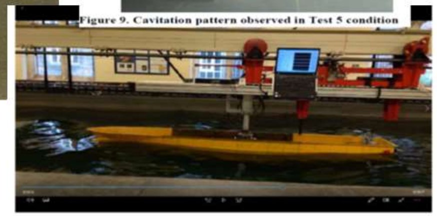
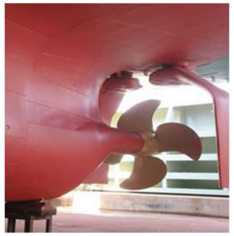



Figure 8 Active GATE RUDDER® Control Tests in waves

GATERS申請


かもめプロペラ
日本財団助成事業申請
（ゲートラダー製作費等）



合同試運転

栗林商船ー海技研特許

海技研ー栗林特許

井本商運
「しげのぶ」建造計画

GATERS

## H2020 GATERS – Project (*)

**Project number**: 860337
**Project Acronym**: GATERS
**Project title**: GATE Rudder System as a Retrofit for the Next Generation Propulsion and Steering of Ships
**Call (part) ID**: H2020-MG-2019-Two-Stages
**Topic**: LC-MG-1-8-2019 (Retrofit Solutions and Next Generation Propulsion for Waterborne Transport)
**Fixed EC Keywords**: Maritime, Low emission technology in transport
**Free keywords**: Novel propulsion and manoeuvring system; Retrofit technology; Short sea shipping operations; Oceangoing shipping operations; Generic and flexible propulsion system; IMO requirements for Emission
**Starting Date**: TBD
**Duration**: 36M
**Funding:** 5.894,822.5 M EUR (Total); 4,999,510.0M ER (EU contribution)
**Call (part) ID**: H2020-MG-2019 -Two-Stages
**Partners no**: 18 (11 Industry + 7 Research Institutes)
**Country no:** 9
**Partners names**: UoS(UK); HSVA(DE); BV(FR); GME(GR); CNR(I); HYD(TR); ITU (TR); TWI (UK); NAS (MT); CAPA(TR); SINTEF(NO); DANAOS(CYP); SMP(UK); GURD(TR); UNEW(UK); STARB(CYP); LLI(UK); CETENA(I)
**Coordinator:** University of Strathclyde (UoS); Prof Mehmet Atlar (mehmet.atlar@strath.ac.uk) ; Tel: +447900890228 (mob); +441415484947 (W)

University of Strathclyde Glasgow

**Project fund**

| Total Project Fund [EUR] | EU Contribution [EUR] | Industry Contribution [EUR] |
|---|---|---|
| 5,878,364.25 | 4,999,509.98 | 878,854.27 |

7億 7 千 6 百万円

Prof Mehmet Atlar Project Investigator & Coordinator | Prof Noriyuki Sasaki Project Consultant & GR Patent Holder | Dr Batuhan Aktas Research Fellow & Project Manager | Mr Ahmet Gurkan Research Associate | Prof Osman Turan Project Investigator | Prof P Fitzsimmons Project Consultant | Dr Erkan Oterkus Project Investigator | Dr Weichao Shi Project Investigator | Mr Yildirim Dirik Research Assistant | Dr Tahsin Tezdogan Project Investigator | Dr Dogancan Uzun Research Associate

## LIST OF PARTICIPANTS

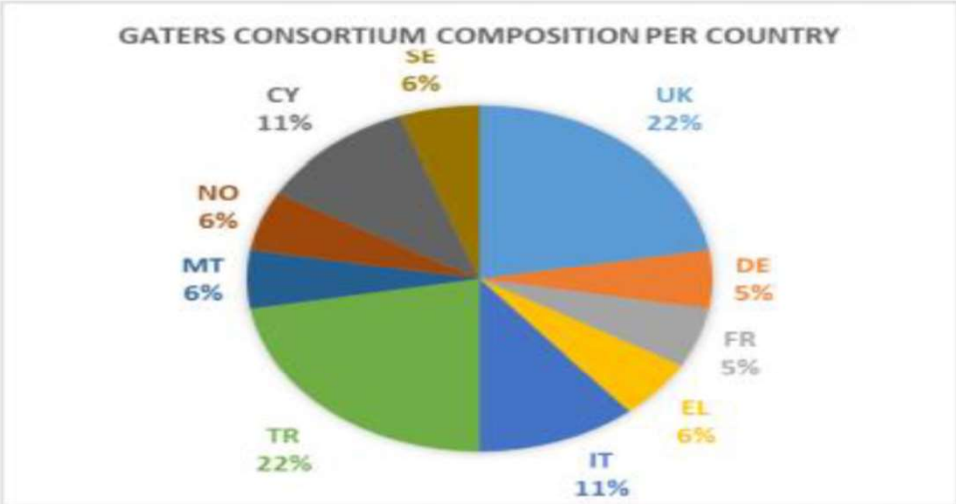
| Participant No. | Participant organisation name | Acronym | Country |
|---|---|---|---|
| 1 (Coordinator) | UNIVERSITY OF STRATHCLYDE | UoS | UK |
| 2 | HAMBURGISCHE SCHIFFBAU- VERSUCHSANSTALT GMBH | HSVA | DE |
| 3 | BUREAU VERITAS MARINE & OFFSHORE REGISTRE INTERNATIONAL DE CLASSIFICATION DE NAVIRES ET DE PLATEFORMES OFFSHORE | BV | FR |
| 4 | GLAFCOS MARINE EPE | GME | EL |
| 5 | CONSIGLIO NAZIONALE DELLE RICERCHE | CNR | IT |
| 6 | HIDROTEKNIK YAT GEMI DENIZ YAPILARI TASARIM TEKNOLOJILERI SANAYI VE TICARET LIMITED SIRKETI | HYD | TR |
| 7 | ISTANBUL TEKNIK UNIVERSITESI | ITU | TR |
| 8 | TWI LIMITED | TWI | UK |
| 9 | NAVAL ARCHITECTURAL SERVICES LIMITED | NAS | MT |
| 10 | CAPA DENIZCILIK NAKLIYAT SANAYII VE TICARET LTD | CAPA | TR |
| 11 | SINTEF OCEAN AS | SINTEFF | NO |
| 12 | DANAOS SHIPPING COMPANY LIMITED | DANAOS | CY |
| 13 | STONE MARINE PROPULSION LIMITED | SMP | UK |
| 14 | GURDESAN GEMI MAKINA SANAYI VE TICARET ANONIM SIRKETI | GURD | TR |
| 15 | UNIVERSITY OF NEWCASTLE UPON TYNE | UNEW | UK |
| 16 | STAR BULK SHIPMANAGEMENT CO. (CYPRUS) LTD | STARB | CY |
| 17 | INFORMA UK LTD (LLOYD'S LIST INTELLIGENCE) | LLI | UK |
| 18 | CETENA S.P.A. | CETENA | IT |

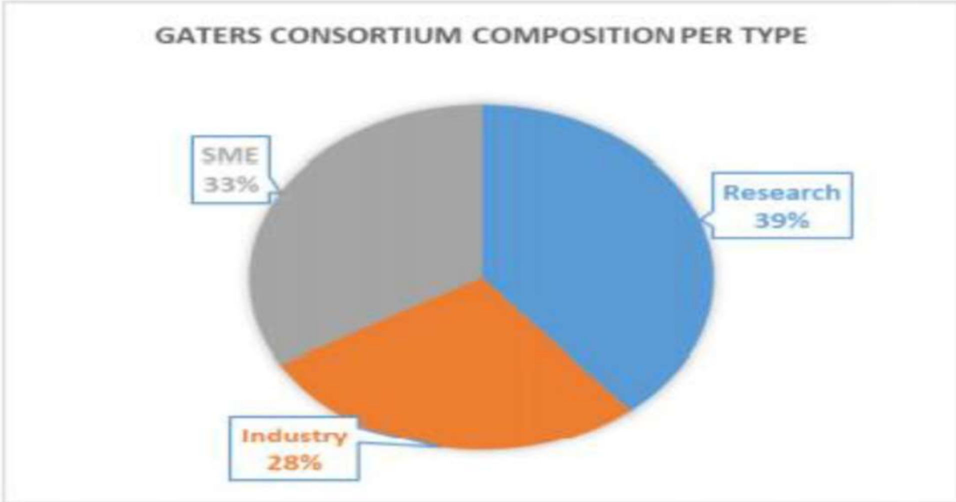
IAB

- Royal Caribbean Cruises
- Wartsila
- Hellenic Tankers
- Shell International
- OSCAR propulsion ,
- Kuribayashi Steam Ship

かもめプロペラ・東京計器にも参加要請があったが、事情により不参加 を表明

# GATERS – Partners background summary




**Distribution of GATERS Partners' background by Country (Left) & Type (Left)**

## GATERS – Management, Communication, Dissemination & Exploitation Activities Support Boards

### GATERS - Innovation and IP Management Board (IPMB)

| Project Members | GME | HYD | SMP | TWI | UoS |
|---|---|---|---|---|---|

宣伝に注力

### GATERS - Communication, Dissemination and Exploitation Board (CDEB)

| Project Members | CAPA | GME | HYD | SMP | TWI | UNEW | UoS |
|---|---|---|---|---|---|---|---|

### GATERS - Industry Advisory Board (IAB) and representatives

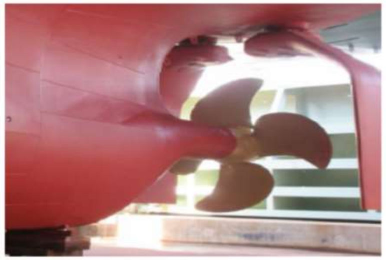
| Member Institution / Company | Royal Caribbean Cruise Ltd | Wartsila Netherlands BV | Hellenic Tankers Co Ltd | Oscar Propulsion Ltd | Kuribayashi Steam Co Ltd | Shell Int'l Trad & Shipping Co Ltd |
|---|---|---|---|---|---|---|
| Member's Representative | Dr Tor E Svensen | Dr Elias Boletis | Dr Christos Verventos | Mr David Taylor | Mr Hirohisa Inada | Mr James Cocks |

# A brief history of GATE RUDDER SYSTEM (GRS)

- GRS had its origin in "**Frame Rudder**" proposed and tested by *Mr Sadamoto Kuribayashi* of Kuribayashi Steam Co Ltd, Japan in 2011.
- Frame Rudder was tested and further improved by R&D conducted in NMRI of Japan by *Dr Noriyuki* Sasaki and this led to the 1st (Japanese) patent for the early version of GRS with a single rudder stock [ # JP 2014-73815 A]
- Further R&D work in Japan and the UK at the Newcastle and Strathclyde Universities led by Dr Sasaki as the Visiting Professor resulted in the current shape of the GRS with two separate rudder stocks and the 2nd (European) Patent [ # EP 3103715 A1]
- GRS was first applied on a 400TEU Japanese Container vessel "**Shigenobu**" through the R&D project sponsored by Nippon Foundation and a Japanese Consortium in 2017. The comparison of performance with her sister ship "**Sakura**" was well above the predictions.

# So far, GRS APPLICATIONS

| | SHIGENOBU (1st Application, 2017) | KOHSIN MARU (2nd Application, 2020) | SHINMON MARU (3rd Application, 2020) |
|---|---|---|---|
| **Type of ship** | Container (400 TEU) | General cargo (509 GT) | General Cargo (499 GT) |
| **Lpp** | 101.9 | 69 | 72 |
| **B** | 17.8 | 12 | 12 |
| **T** | 5.24 | 4.11 | 4.13 |
| **$C_B$** | 0.67 | 0.70 | 0.70 |
| **Design Vs** | 14.5 | 13 | 13 |
| **Fn (Lpp)** | 0.2436 | 0.267 | 0.267 |
| **L/B** | 5.72 | 5.75 | 5.75 |

# Current commercial status of GRS

- A Japanese Consortium (JC) involving Kay Seven Co., Ltd., (Kuribayashi Steam Co Ltd); Mr. Noriyuki Sasaki, National Institute of Maritime, Port and Aviation Technology, Yamanaka Shipbuilding Co., Ltd. and Kamome Propeller Co., Ltd owns the Gate Rudder Patent **(European Patent: EP 3103715)**

- Further R&D and promotion activities in the University of Strathclyde (Glasgow) and Visiting Prof Noriyuki Sasaki attracted Wartsila Propulsion to purchase the commercial license from the JC to use the Gate Rudder technology protected by the Licensed Patent in 2020

- GATERS Project funding was granted by the EC (H2020) in December 2019 and the GATERS Consortium signed sub-license agreement with Wartsila Netherlands BV in 2021 on behalf of the Patent Holders hence:

***"GATERS has an official sub-licence agreement with Wartsila Netherlands BV to utilise the Gate Rudder Patent (EP 3103715) at specific retrofit projects of vessels sizes below 15,000. DWT. GATERS is sponsored by the EC H2020 Programme (ID: 860337) with the aims and objectives independent of Wartsila Netherlands BV"***

(11) EP 3 103 715 A1

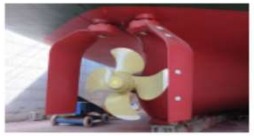
(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(54) STEERING DEVICE, AND STEERING METHOD THEREFOR

EP 3 103 715 A1

(Cont. next page)

## Motivations for GATERS Project



- The proposal responded to the H2020 Innovation Action call under the heading "***Retrofit Solutions and Next Generation Propulsion for Waterborne Transport***" (ID: LC-MG-1-8-2019).

- Although there was one new ship application of GRS (***"Shigenobu"***), ***there was/is no current application of the Gate Rudder System as a "retrofit" device***, and hence it is proposed in GATERS for the first time and this, in fact, was the primary motivation of the GATERS proposal.

- GATERS, therefore, addressed the call text explicitly "***to develop and demonstrate to TRL 6 and higher innovative, cost-effective retrofit solution for marine shipping which will provide substantial improvements regarding environmental impacts and life cycle cost***".

- Recent IMO proposal for introducing the attained ***Energy Efficiency Existing Ship Index (EEXI)*** for ships of 400 GT and above


## GATERS – Aims

GATERS

- 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.

University of Strathclyde Glasgow

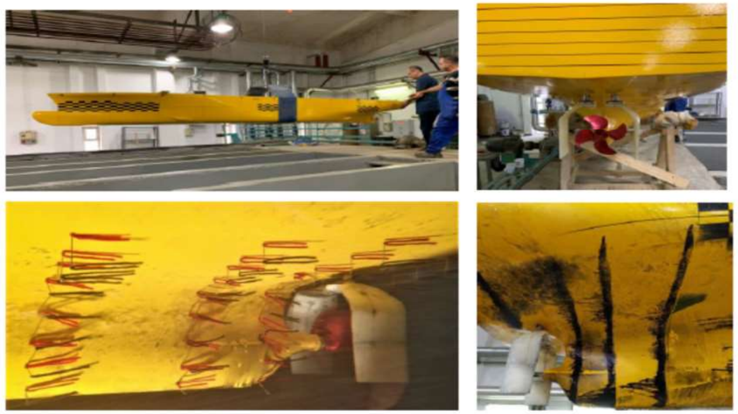
GATERS

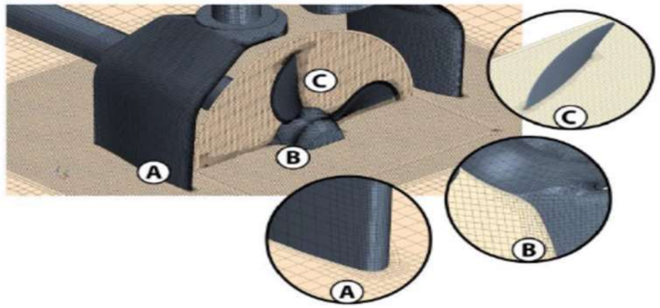
# GATERS – Objectives

1. To investigate technical challenges of the Gate Rudder System (GRS) and to 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 and Minimum power requirements) and the Life Cycle Cost (LCC). + EEXI , CII

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.





University of Strathclyde Glasgow

# Target vessel – MV ERGE To be retrofitted with GRS

- MV ERGE (IMO No: 9508603) 5650 DWT (2993GT) General Cargo ship, built in Weihai PRC and delivered in 2011.
- She operates in European Coastal waters, Black Sea, Red Sea and North African waters
- She is owned by partner CAPA and she has sister vessel MV ERLE with conventional flap rudder

| 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 | $\Delta$ | (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 | | |



# Gate Rudderの設計・製造・レトロフィット・モニタリング

工事前モニタリング

2021.2

設計

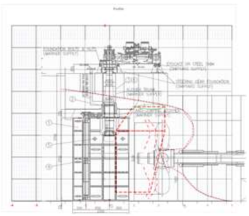
製造

2022.8

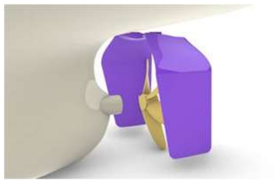
レトロフィット

20%目標

工事後モニタリング



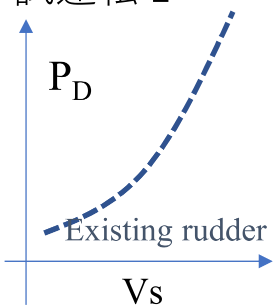

入渠
船体クリーニング



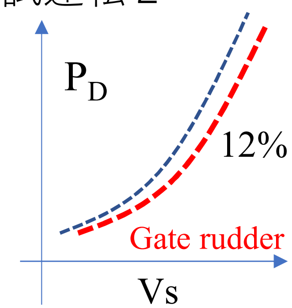
水槽試験
HSVA　12m模型
CNR　6m＆3.6m模型
ITU　3.6m模型

搭載

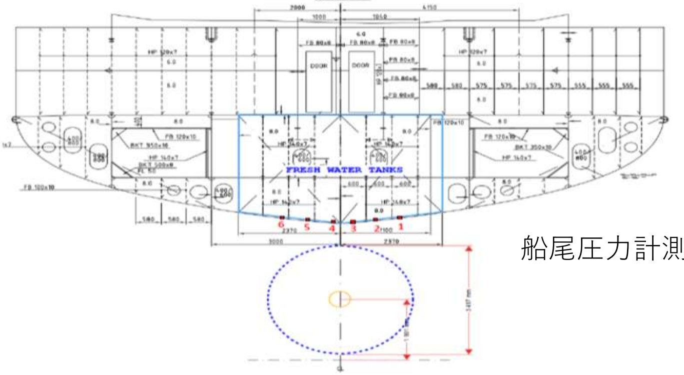
試運転 1




試運転 2




- Shaft torquemeter and pick-up
- Rudder shaft torquemeter
- Rudder angle sensor
- Sailing conditions (GPS, speed, heading...)
- Shaft torque and RPM
- Rudder angle and shaft
- wave height, direction from and period
- wind direction from and magnitude
- current components
- depth




船尾圧力計測

# 計測項目と計測準備状況

| | 燃費性能 | 操縦性 | 耐航性 | 振動・騒音 |
|---|---|---|---|---|
| 就航前 | 主機負荷試験の実施<br>性能モニタリングシステムの搭載、波高計の搭載 | 特に無し | 波浪中の操縦性試験（検討中） | |
| 試運転時<br>(GR搭載前) | 速力試験の実施<br>ブイの設置(検討中) | 旋回試験・Z試験・急速停止試験・後進試験<br>ウィリアムソンターン試験など | 船体運動計測 | 振動・騒音計測<br>プロペラノイズ計測<br>キャビテーション観測 |
| 試運転時<br>(GR搭載後) | 同上 | 旋回試験・Z試験・急速停止試験・後進試験<br>ウィリアムソンターン試験など | 船体運動計測 | 振動・騒音計測<br>プロペラノイズ計測<br>キャビテーション観測 |
| 就航後 | 就航前と同じ | 特に無し | 波浪中の操縦性試験（検討中） | |
| 適宜 | 乗船しての簡易速力試験の実施(検討中) | | 乗船しての船体運動計測<br>(検討中) | |

## SHIP PERFORMANCE MONITORING

*TASKS*

2.1.2 Fitting of a voyage performance monitoring system to the target ship

2.1.3 Conduct of voyage performance monitoring in-service before the GRS retrofitting to measure speed-power and fuel consumption data over short intervals but on a regular basis until the dry docking.

2.1.6 Conduct of voyage performance monitoring in-service after the GRS retrofitting to measure the speed-power and fuel consumption data over short intervals but regularly until the end of the project

| Activity | Partner | Role |
|---|---|---|
| Set up of the monitoring system and data collection | CETENA | Responsible |
| Hardware installation plan: | | |
| - Shaft torquemeter and pick-up | BV | |
| - Rudder shaft torquemeter | BV | |
| - Rudder angle sensor | BV | |
| - Acquisition unit | CETENA | |
| - Connection with ship automation system | CAPA, HYD | |
| Sharing of ship sailing data to be collected: | | |
| - Sailing conditions (GPS, speed, heading...) | CAPA, HYD | |
| - Shaft torque and RPM | BV | |
| - Rudder angle and shaft | BV | |
| Sharing of environmental data to be collected: | | |
| - wave height, direction from and period | CAPA, HYD | |
| - wind direction from and magnitude | CAPA, HYD | |
| - current components | CAPA, HYD | |
| - depth | CAPA, HYD | |
| - water and air temperature | CAPA, HYD | |

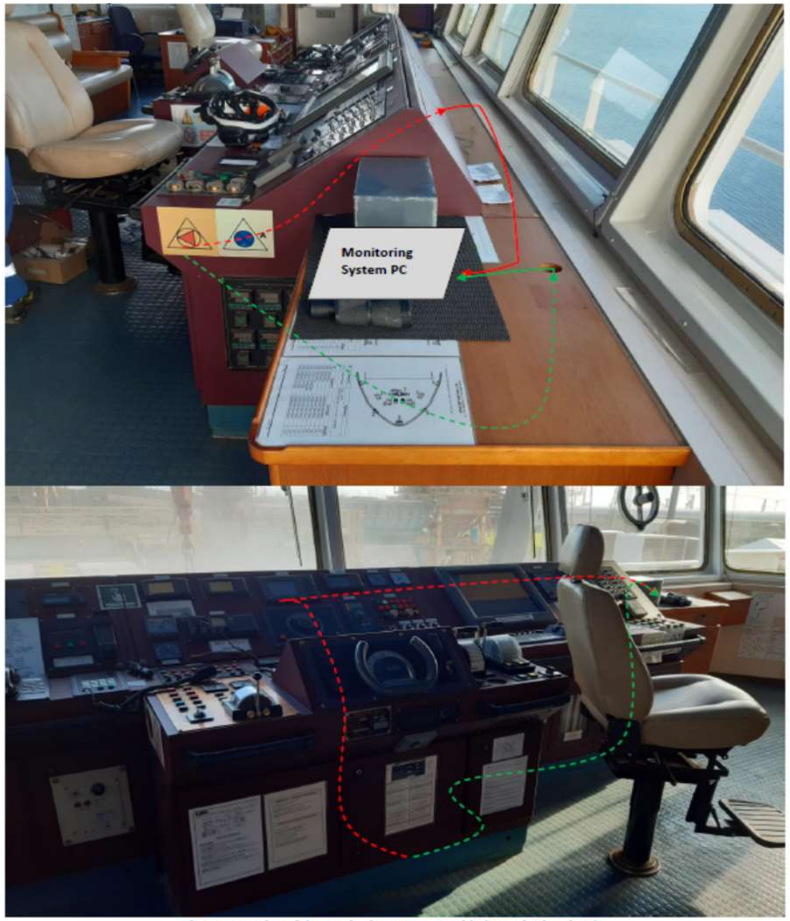
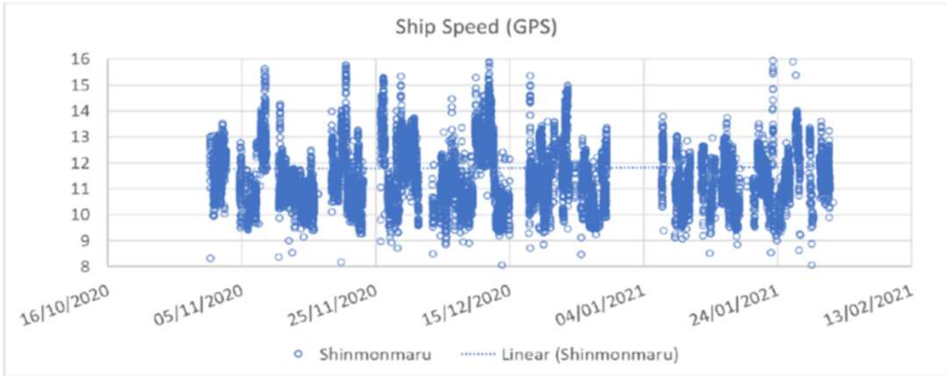



Fig. 1: connection of the monitoring system PC with the navitation signals

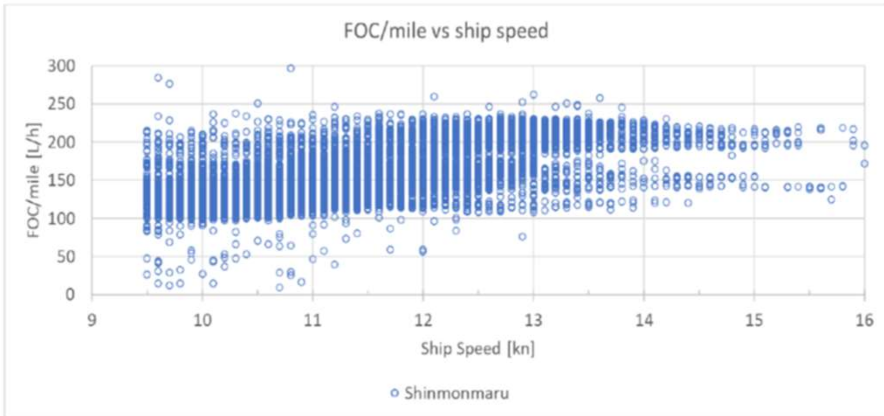
# 神門丸　モニタリング計測例


## 3.2.Ship speed statistics

Measured 5min. interval




## 4.2.Ship speed and Fuel consumption (L/H)



# 神門丸　モニタリング計測データ解析例

## Milage Monitor

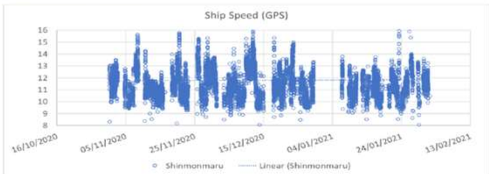
|  |  | Shinmonmaru |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | log | log | log |  | speedxtime | calc | calc | log | calc | log | log | calc | log | calc | log |
|  | RPM | FlowRateL | Speed | distance | Duration | Dist | Speed | Dist | FOC [L] | FOC [L] | L/mile | Total Dist | Total Dist | FOC int | FOC int | FOC/mile |
| 2020/10/31 6:04 | 241.5 | 132.1 | 10 | 0.8 | 5 | 0.833 | 6.06341 | 0.505284 | 7.6 | 11.01 | 9.5 | 0.8 | 0.5 | 7.6 | 11.01 | 9.12 |
| 2020/10/31 6:09 | 254 | 170.9 | 12.2 | 1.7 | 5 | 1.017 | 11.62459 | 0.968716 | 13.8 | 14.24 | 12.58824 | 1.9 | 1.5 | 21.4 | 25.25 | 11.56757 |
| 2020/10/31 6:14 | 254.5 | 353.1 | 12.4 | 2.8 | 5 | 1.033 | 12.08533 | 1.007111 | 16.3 | 29.43 | 13.46429 | 2.9 | 2.5 | 37.7 | 54.68 | 13.07514 |
| 2020/10/31 6:19 | 254.9 | 189.1 | 12.6 | 3.8 | 5 | 1.050 | 12.27581 | 1.022984 | 18.7 | 15.76 | 14.84211 | 3.9 | 3.5 | 56.4 | 70.43 | 14.33898 |
| 2020/10/31 6:24 | 255.1 | 169 | 12.6 | 4.9 | 5 | 1.050 | 12.63485 | 1.052904 | 14.8 | 14.08 | 14.53061 | 5.0 | 4.6 | 71.2 | 84.52 | 14.28763 |
| 2020/10/31 6:29 | 254.7 | 169 | 12.4 | 5.9 | 5 | 1.033 | 12.52923 | 1.044102 | 14 | 14.08 | 14.44068 | 6.0 | 5.6 | 85.2 | 98.60 | 14.16066 |

After Installation of new flowmeter

3 months data After delivery

| | S1038 （第31進宏丸） | | | | | | | | | | | | | | | log | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | log |  | log | calculated | log | calc | log | calc | log | calc | log | calc | log | calc | 0 filter | 0 filter |  |  |
|  | RPM | FOFlowrat | Duration | Speed | Speed | Distance ( | Distance ( | FOC [L] | FOC [L] | Total Dist | Total Dist | FOC int | FOC int | FOC/mile | FOC/mile | FOC [L] | Dist [mile] | dist | L/mile |
| 2016/4/5 8:31 | 212.6 | 2.03 | 10 | 8.7 | 2.539466 | 1.45 | 0.423244 | 23.2 | 20.3 | 1.45 | 0.423244 | 23.2 | 20.3 | 16 | 47.96283 | 23.2 | 1.450 | 1.450 | 16.00 |
| 2016/4/5 8:41 | 213.6 | 2.09 | 10 | 9.4 | 1.859109 | 1.57 | 0.309851 | 23.4 | 20.9 | 3.016667 | 0.733096 | 46.6 | 41.2 | 15.44751 | 56.20002 | 23.4 | 1.567 | 3.017 | 15.45 |
| 2016/4/5 9:31 | 203.8 | 1.48 | 10 | 10.4 | 13.63323 | 1.73 | 2.272205 | 21.8 | 14.8 | 4.75 | 3.005301 | 68.4 | 56 | 14.4 | 18.63374 | 21.8 | 1.733 | 4.750 | 14.40 |
| 2016/4/5 9:41 | 203.8 | 1.52 | 10 | 11.2 | 5.375046 | 1.87 | 0.895841 | 16.6 | 15.2 | 6.616667 | 3.901142 | 85 | 71.2 | 12.84635 | 18.25107 | 16.6 | 1.867 | 6.617 | 12.85 |
| 2016/4/5 9:51 | 205.3 | 1.48 | 10 | 8.4 | 3.192087 | 1.40 | 0.532015 | 17.2 | 14.8 | 8.016667 | 4.433157 | 102.2 | 86 | 12.74844 | 19.39927 | 17.2 | 1.400 | 8.017 | 12.75 |
| 2016/4/5 10:01 | 228.4 | 2.08 | 10 | 10.9 | 10.76596 | 1.82 | 1.794327 | 17.2 | 20.8 | 9.833333 | 6.227484 | 119.4 | 106.8 | 12.14237 | 17.14978 | 17.2 | 1.817 | 9.833 | 12.14 |


**3.2.Ship speed statistics** Measured 5min. interval




**4.2.Ship speed and Fuel consumption (L/H)**

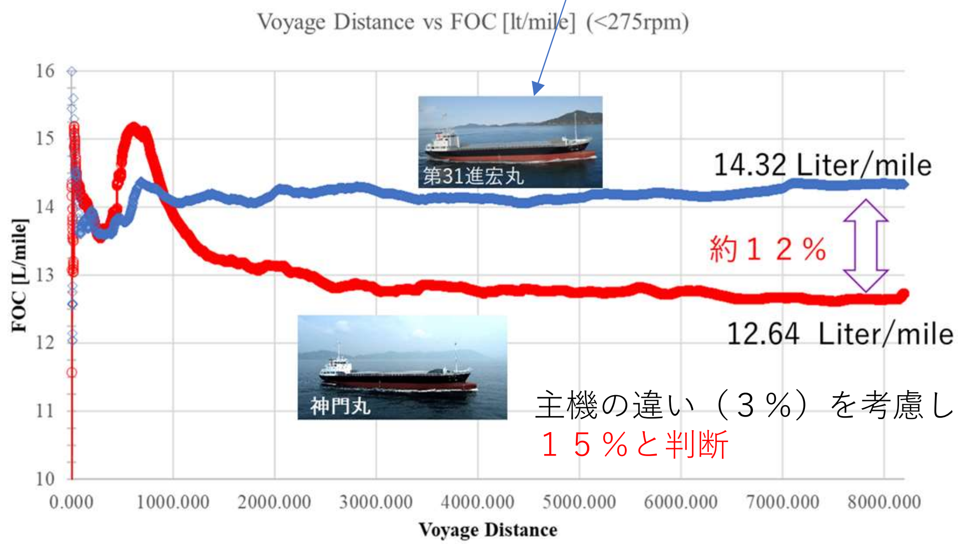

## 比較対象船（最新鋭499船）

JRTT

〇 先進二酸化炭素低減化船は、1990年代初頭船と比較して、トンマイル当たりの二酸化炭素排出量を16%以上低減する船舶。認定された船舶軽減利率には、金利軽減▲0.3%を適用

両船とも就航直後からの比較

3 months voyage data after their delivery




主機の違い（３％）を考慮して
１５％と判断

# 振動・プロペラ変動圧・水中プロペラノイズ計測

## プロペラ変動水圧測定位置（船側方向）

| | | |
|---|---|---|
| **2.2** | **Off-board data (URN) measurements with the target ship by sea trials** | |
| *Months:* **17-20** | *Leader:* **CETENA** | |
| **URN TRIALS** | | |
| *TASKS* | | |
| 2.2.1 | Conduct of the URN measurements with the target ship with the CRS (simultaneously with T2.1.3) and analyse the results | |
| 2.2.2 | Conduct of the URN measurements with the target ship with the GRS (simultaneously with T2.1.4) and analyse the results | |
| *DELIVERABLES* | | |
| 2.3 | Report on the dedicated off-board sea trials (URN) of the target ship before and after the GSR retrofit | M20 |
| Activity | Partner | Role |
| Set up and trials conduction | CETENA | Responsible |
| - equipment supply and arrangement | CETENA | |
| - definition of test conditions | CETENA, BV, UoS | |
| - trial conduction | CETENA | |
| Supply vessel rental | CAPA | Responsible |
| Data acquisition | CETENA | Responsible |
| Data processing and analysis | CETENA | Responsible |
| - definition of analysis procedure | CETENA, BV, UoS | |
| - analysis | CETENA | |
| **Deliverable 2.3** | **BV** | **Responsible** |

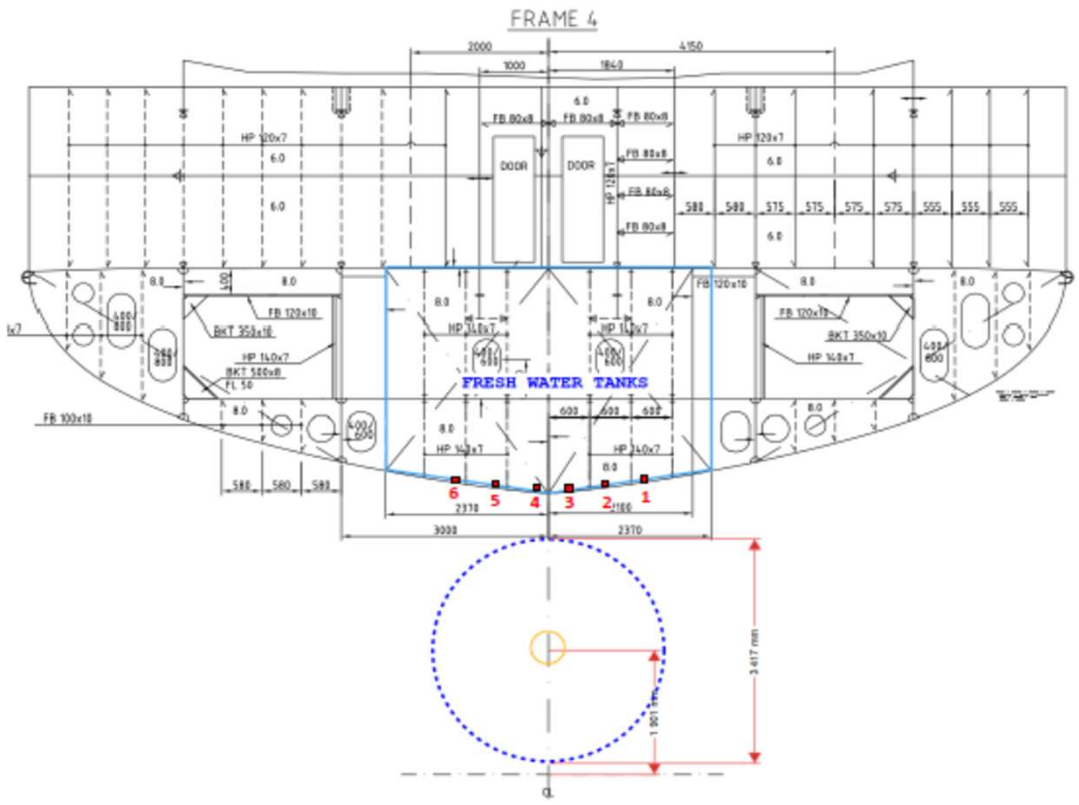
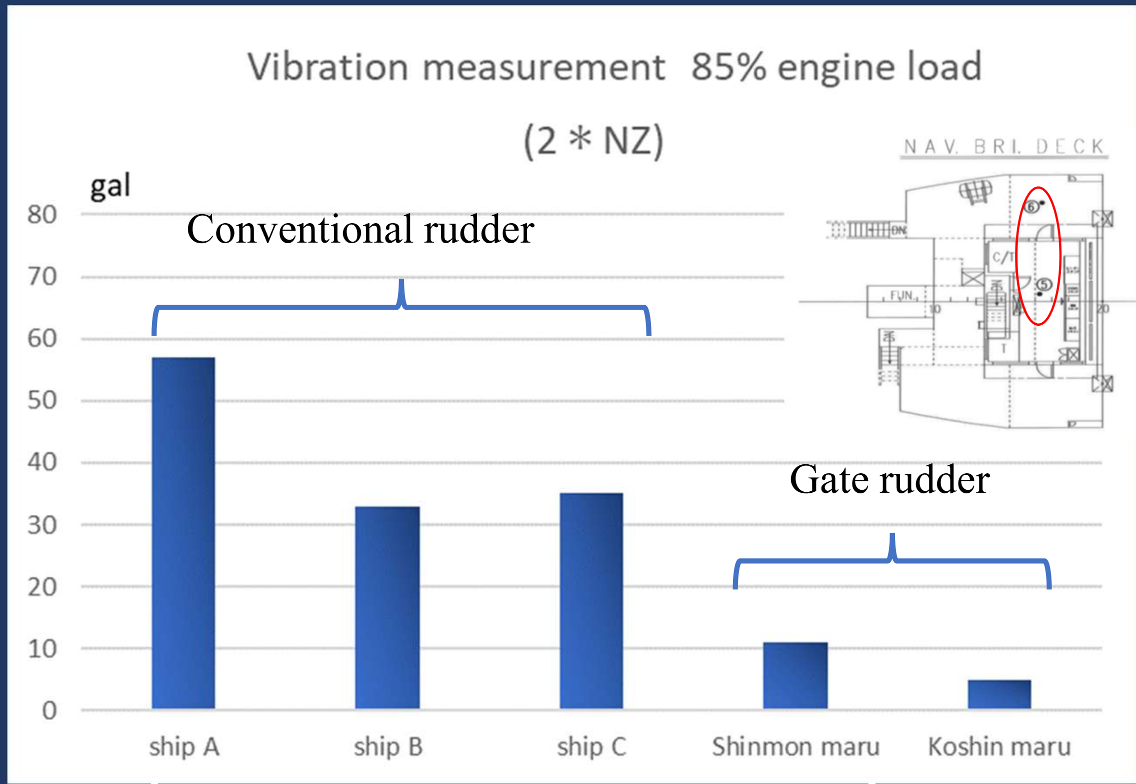



Fig. 4 Suggested location of pressure gauges above the propeller

# Vibration measurements in the bridge deck


Sister ships

# 操縦性の評価方法

- 操縦性については、通常のIMO操縦性基準の他

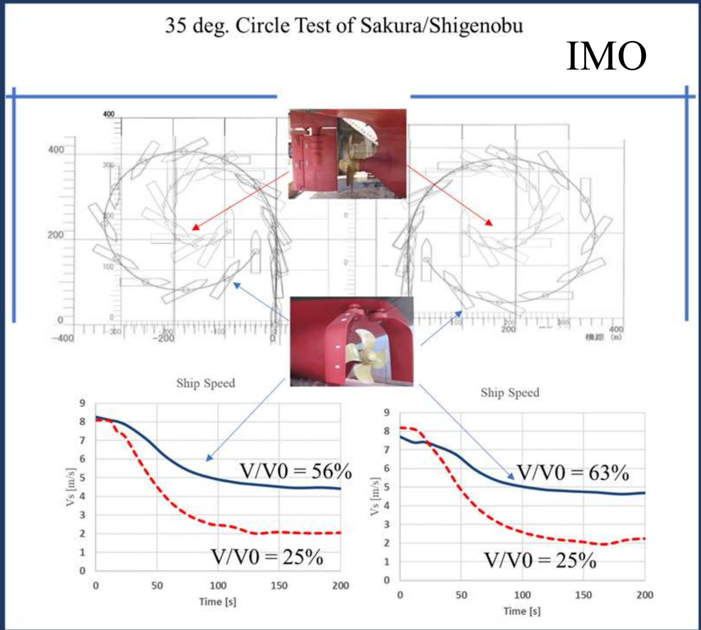
  以下のポイントについても評価する

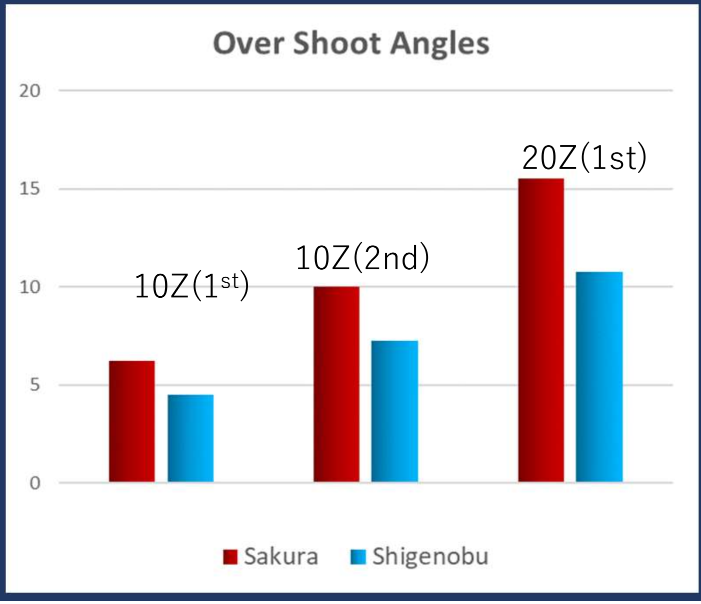
AA　　旋回性能と針路安定性のバランス

BB　　波浪中での操縦性（特に後方からの風浪）

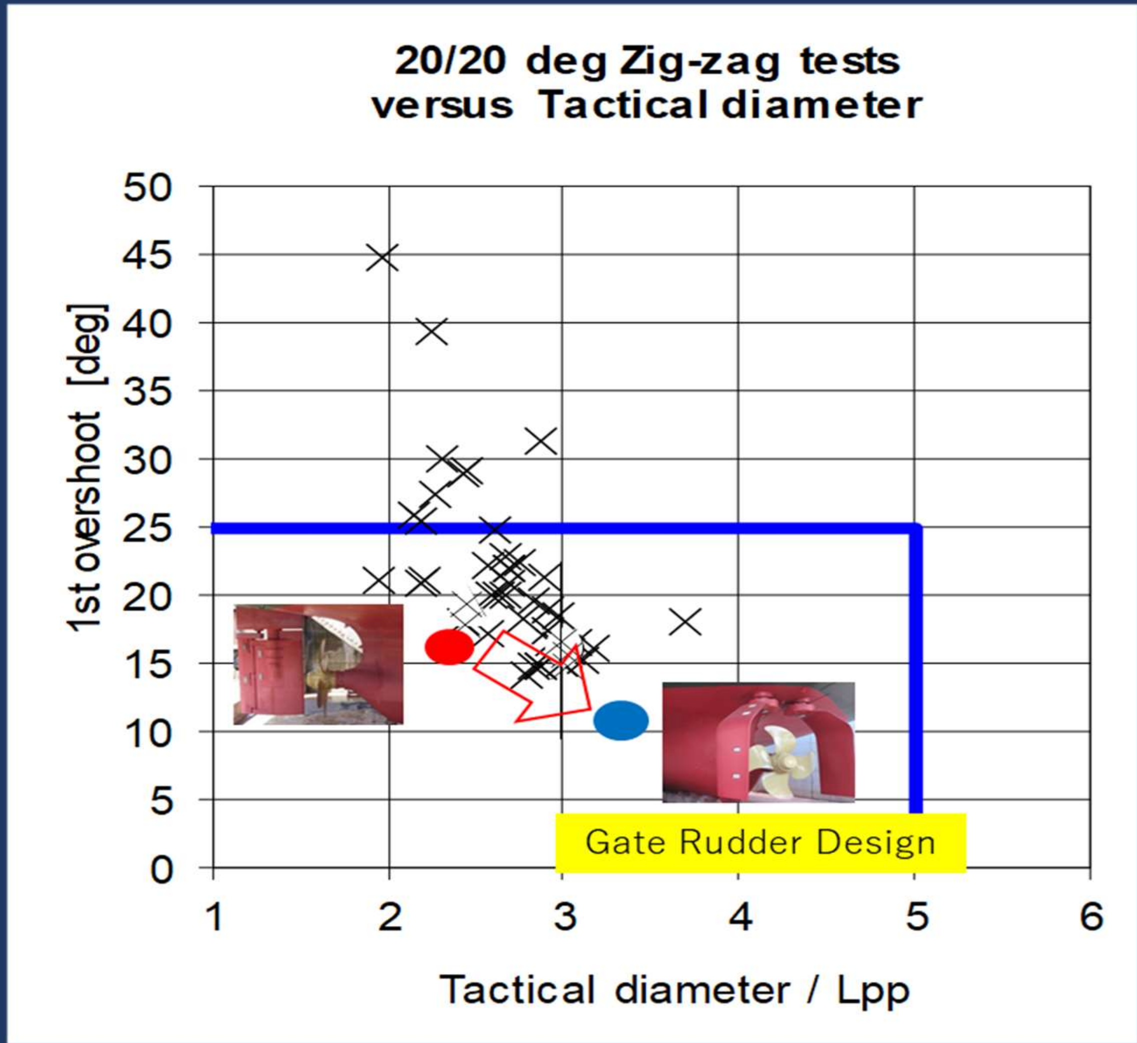
　　ーー　大傾斜しない

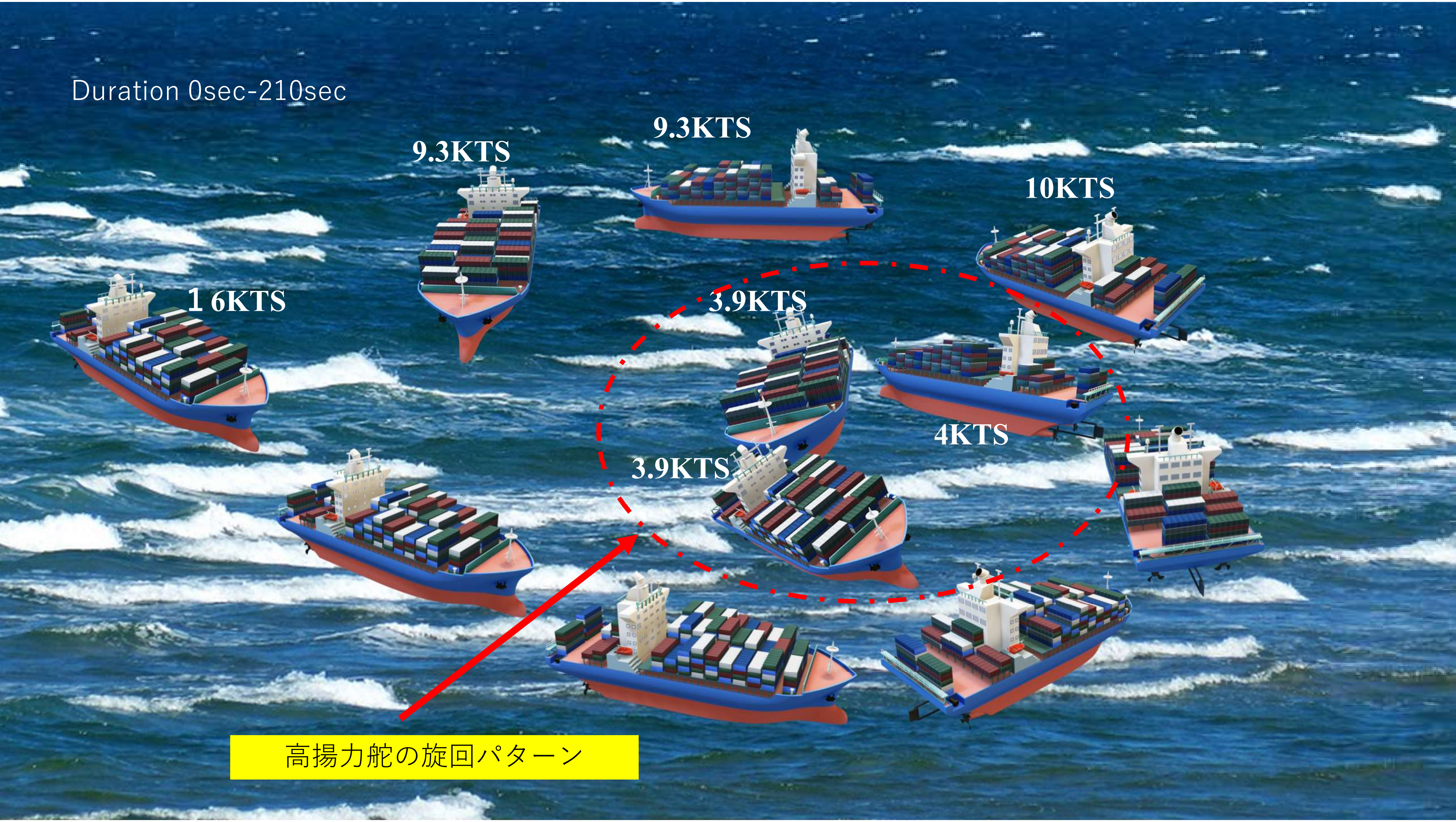
　　ーー　フィンスタビライザーの効き




Source: Peter Trägårdh, SSPA Sweden AB



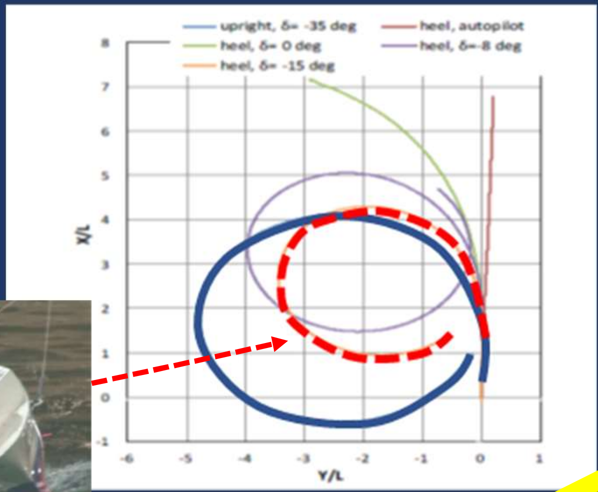


Duration 0sec-210sec
9.3KTS
9.3KTS
10KTS
1 6KTS
3.9KTS
4KTS
3.9KTS
高揚力舵の旋回パターン

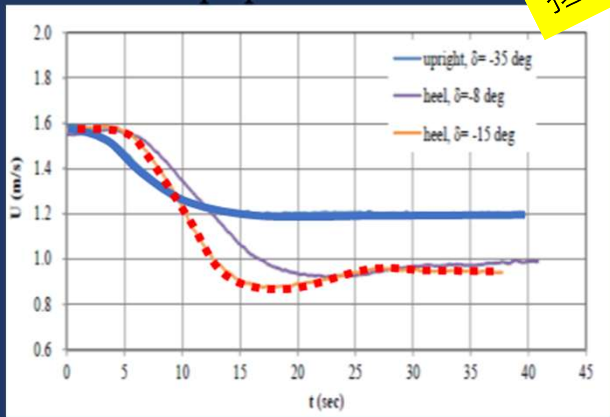
# IMO基準を満足する中ではGate Rudder (青） の方が安全な舵ではなかろうか？

Experimental study about the occurrence of a large Roll Motion of Fast RO/RO Ferry in aa quartering Sea
By H. Miyazaki (NMRI)

Trajectory

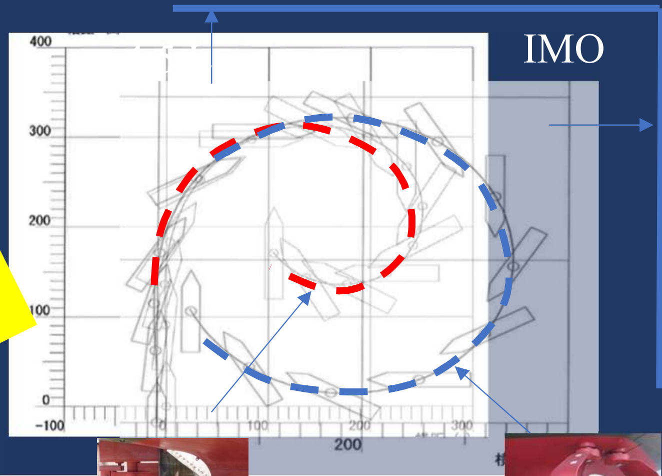


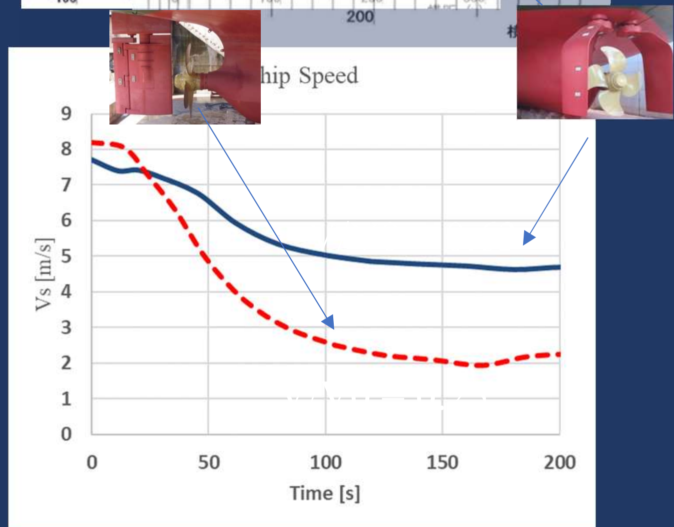

Ship speed



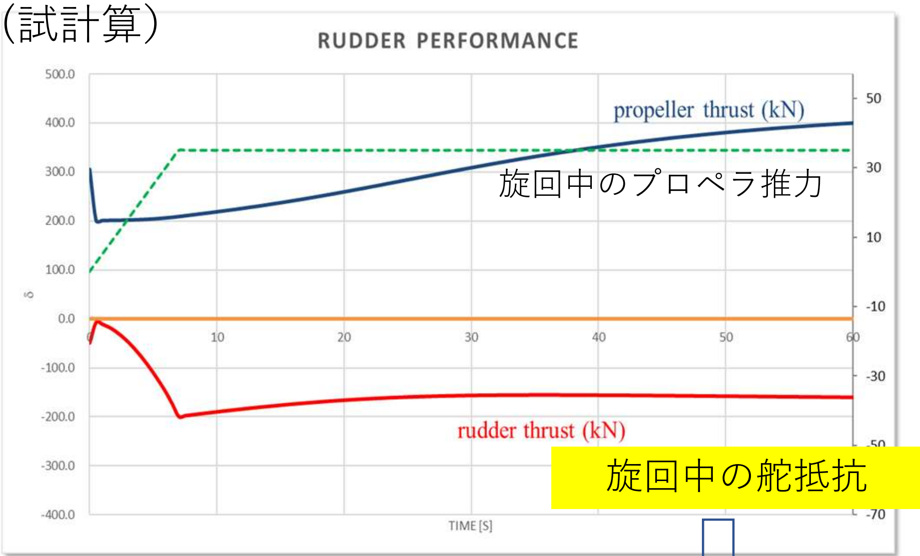

小さい旋回圏は高揚力舵の
抵抗増加によることが判明

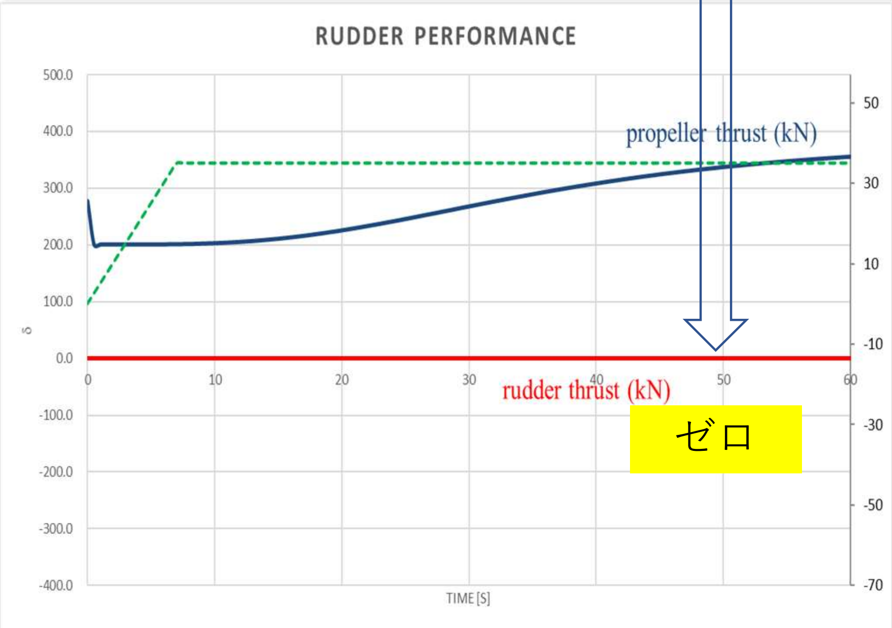
35 deg. Circle Test of Sakura/Shigenobu

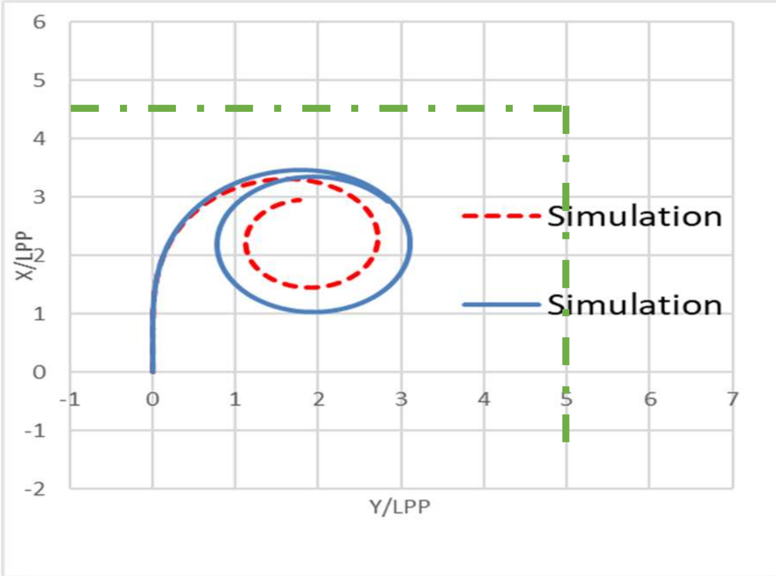


考察(試計算)


RUDDER PERFORMANCE
propeller thrust (kN)
旋回中のプロペラ推力
rudder thrust (kN)
旋回中の舵抵抗
TIME [S]


RUDDER PERFORMANCE
propeller thrust (kN)
rudder thrust (kN)
ゼロ
TIME [S]

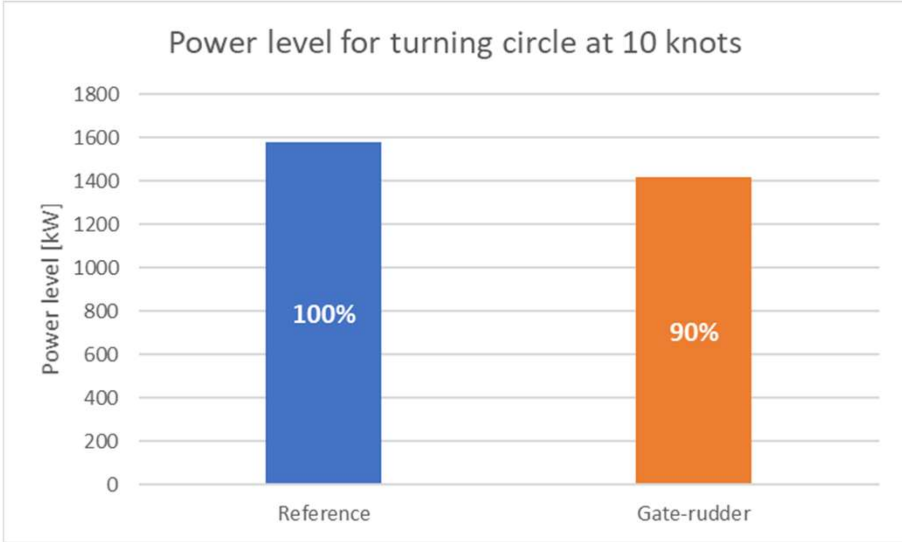

Simulation
Simulation
X/LPP
Y/LPP

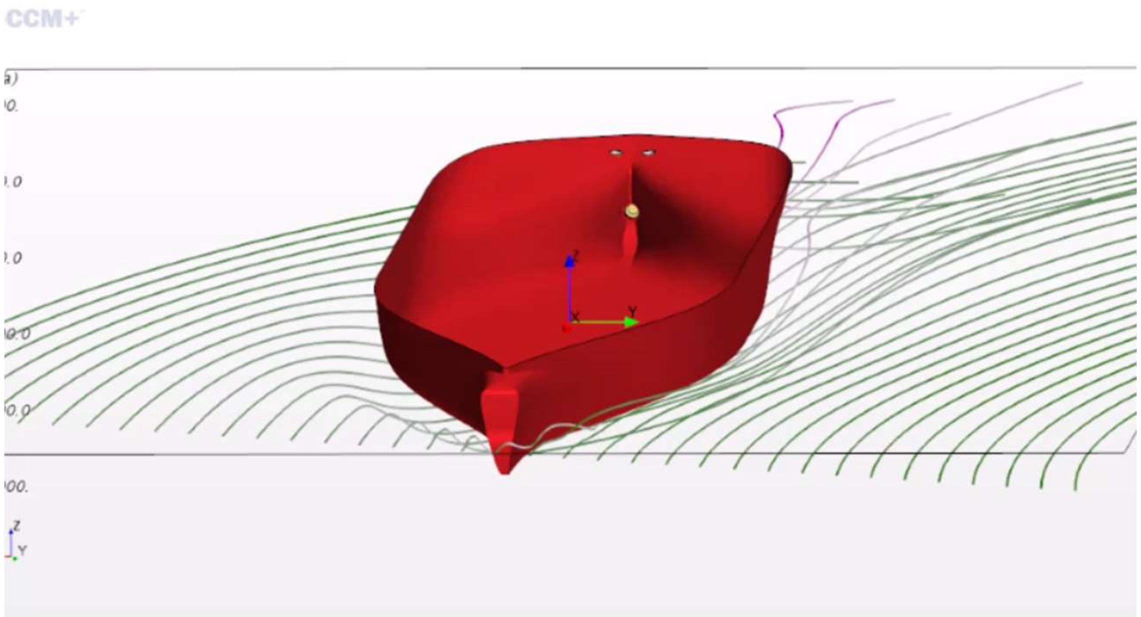

SHIP SPEED
8 KTS
3.9 KTS
Vs [M/S]
TIME [S]
船速は2倍

# Gate-Rudder CFD: Turning Circle capability

- CFD runs are executed for variations of:
    - Vessel speed
    - Propeller RPM
    - Rudder angle
    - Vessel drift angle
    - Vessel turning rate

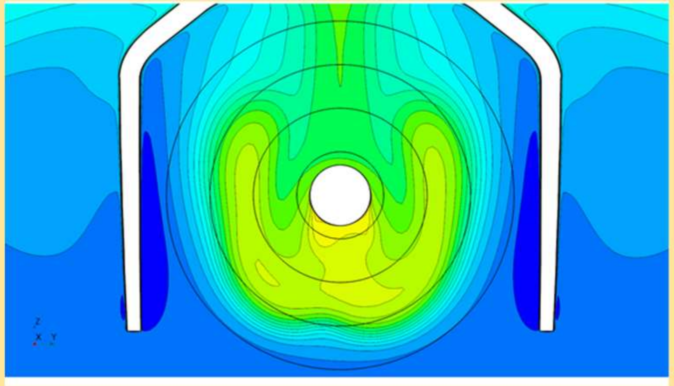
Steady turning rate

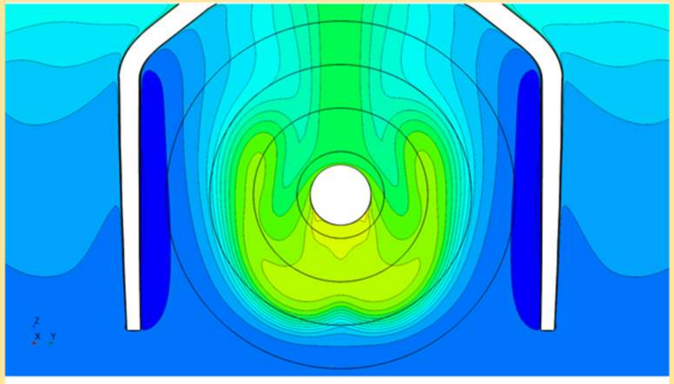


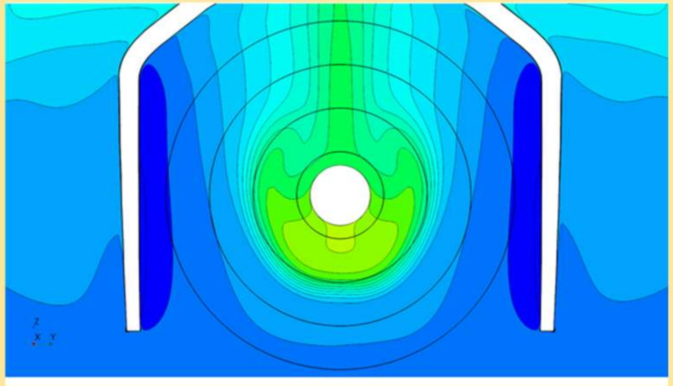



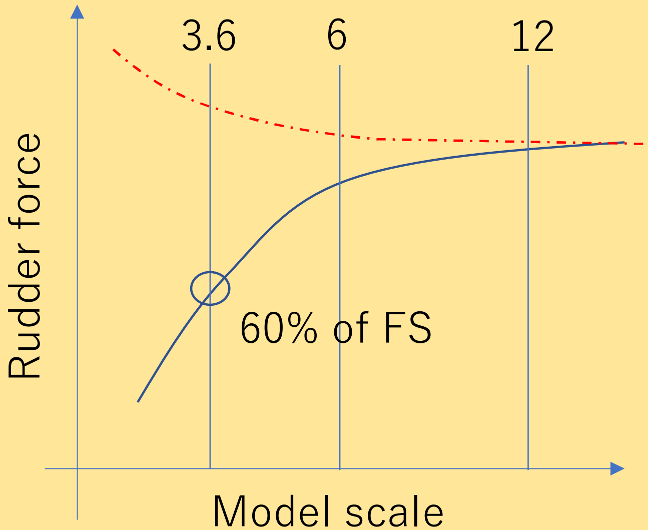
WÄRTSILÄ

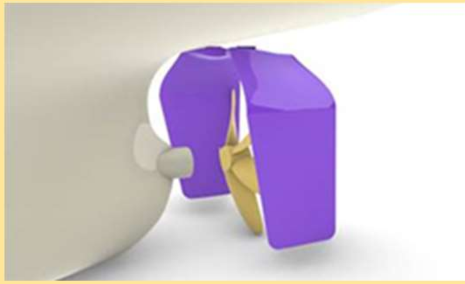
# Scale Effect of Gate Rudder Blade Force


M/V Erge(3.6m model)


M/V Erge(6.0m model)


M/V Erge (Ship)



Gaters WP1

# EUプロジェクト　GATERSの進捗状況

ストラスクライド大学　佐々木紀幸

1．GATE RUDDERとは
2．国内における研究
3．GATERSの進捗状況