

Windship Insight

Einblick in Flettner-Rotoren: Technologie, Leistungsvermögen, besondere Eigenschaften

Video Conference
Leer/online

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Prof. Michael Vahs

Hochschule Emden/Leer - Fraunhofer Working Group Sustainable Maritime Mobility

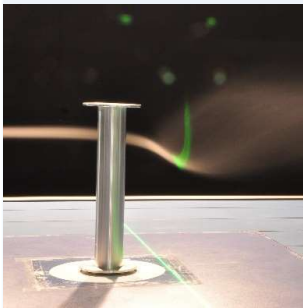
Overview

- Introduction – Functional Principal of Flettner Rotors
- Decision Drivers for specific Wind Propulsion Systems (Focus: FR)
 - Technology
 - Operation
 - Economy
- Conclusions

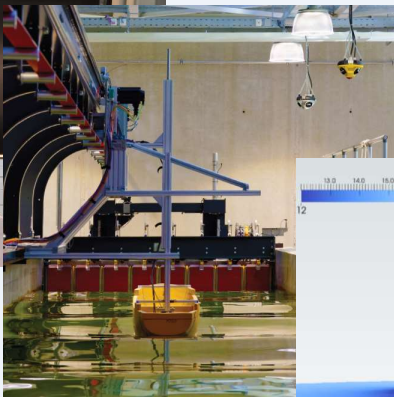


Research Field - Work Group „Sustainable Maritime Mobility“

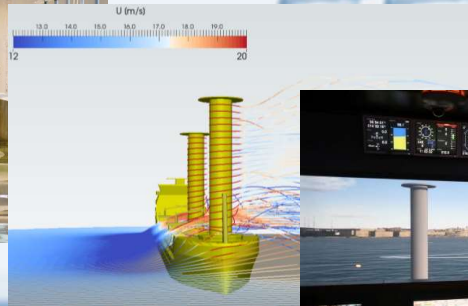
From Lab to Prototype ...



Wind Tunnel



Towing Tank



**CFD-
Modeling**



**Bridge
Simulator**



**Prototype
Trials**



Upscaling

WASP Retrofit: 5...25 % Savings (now available!)



Gavin Allwright, General Secretary IWSA at SMM24: "... last year alone there were more than 40 new installations of wind propulsion technologies on commercial ships and our forecasts predict around 10,000 ships worldwide with installed wind (auxiliary) propulsion by 2030 and up to 40,000 ships by 2050.'

Some Technologies are more mature than others

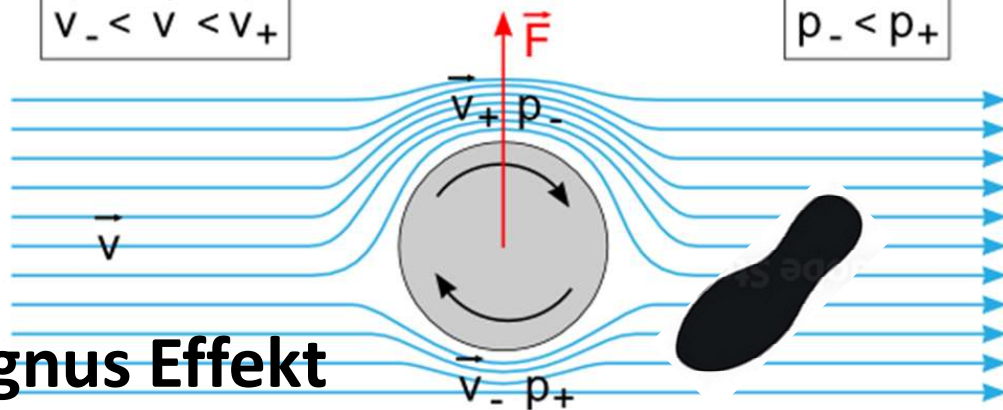
Technology – Functional Principle of Flettner Rotors

Prinzip „Bananenflanke“!



$$\vec{v}_- < \vec{v} < \vec{v}_+$$

$$p_- < p_+$$



Magnus Effekt



Various WASP Technologies: What makes the Difference?



Decision Drivers for Shipowners:

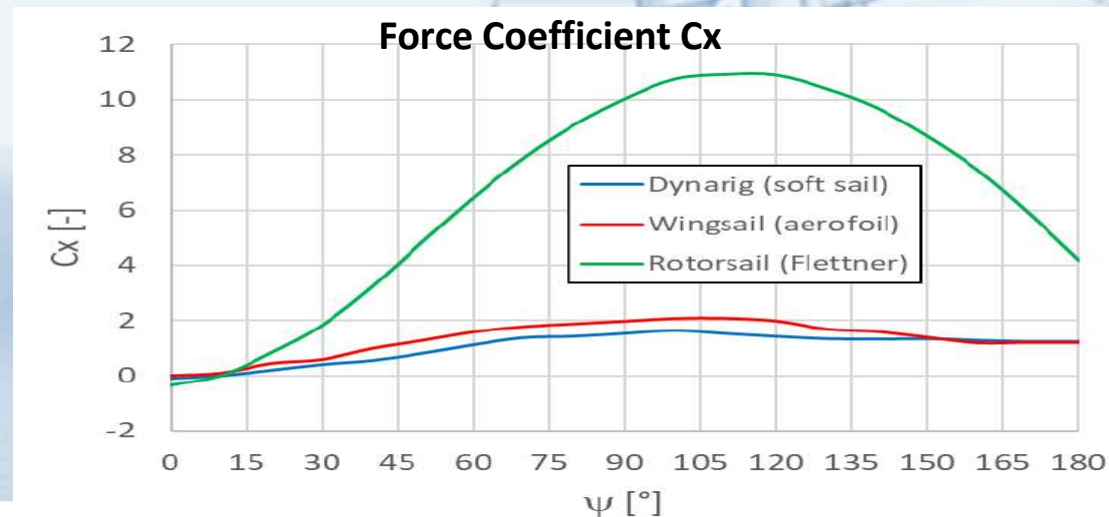
Main	Details
Technology	Performance
	Reliability, Robustness
	Compatibility with Cargo & Ship Design
Operations	Safety
	Automation, easy Handling, Maintenance (Crew)
	Not compromising Ship Operations
Economy	CAPEX, OPEX
	Savings (Fuel/Emissions, Time)
	Other: Climate Targets, Image, ...



Technology

Performance

- Highest power output per area (projected)
- Performance indicator: high range of RPM (guaranteed?)
- Smallest system for a specific power/savings target
- Good beam wind performance, less upwind/downwind



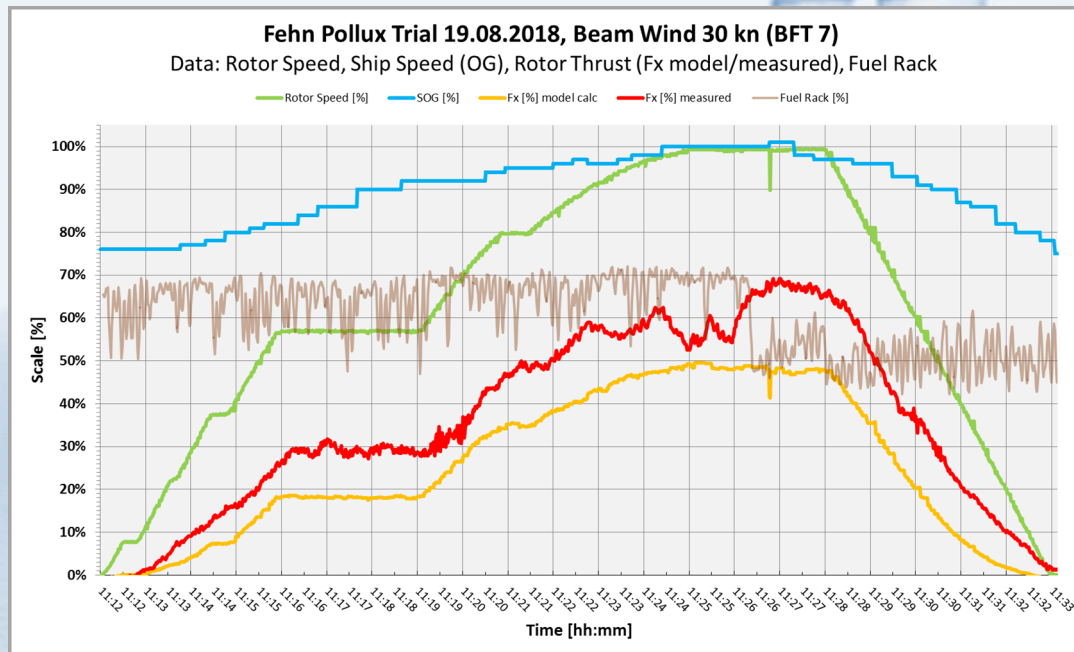
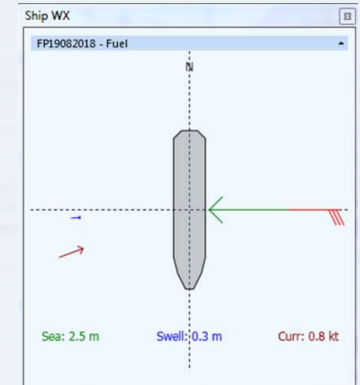
Source: Wienke, J., DNV, 2021



Technology

Performance

- Performance proof/evaluation: yes, trial data available
- „Fehn Pollux“: > 2kW power per m², 15% savings (Schiff & Hafen 2/2019)



Technology

Rotor Sizes (so far)

- Smallest: Height x Diameter = 18m x 3m = 54m² (> 108 kW MEeq)*
- Largest: Height x Diameter = 35m x 5m = 175m² (> 350 kW MEeq)*

- * based on results from „Fehn Pollux“ sea trials (Schiff & Hafen 2/2019),
MEeq = Main Engine Power equivalent



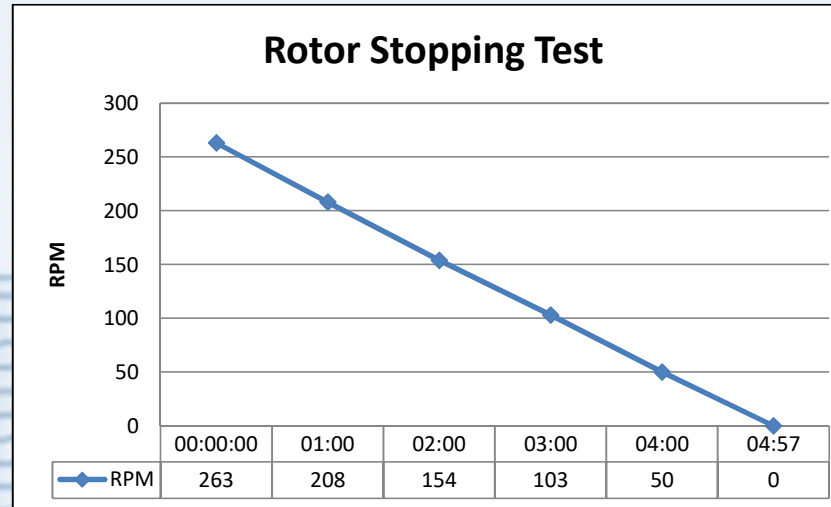
Technology

- **Reliability, Robustness, Maintenance**
 - **Compact and rather simple design**
 - **Challenge: well balanced for low vibrations and high RPM**
 - **Long-term experience: E-Ship 1 (15 years, presented by Enercon)**
- **Compatibility with Cargo & Ship Design**
 - **Relatively good because of compact design**
 - **Small space requirement**
 - **Relatively low load on stability**
 - **Bridge visibility: solutions available**



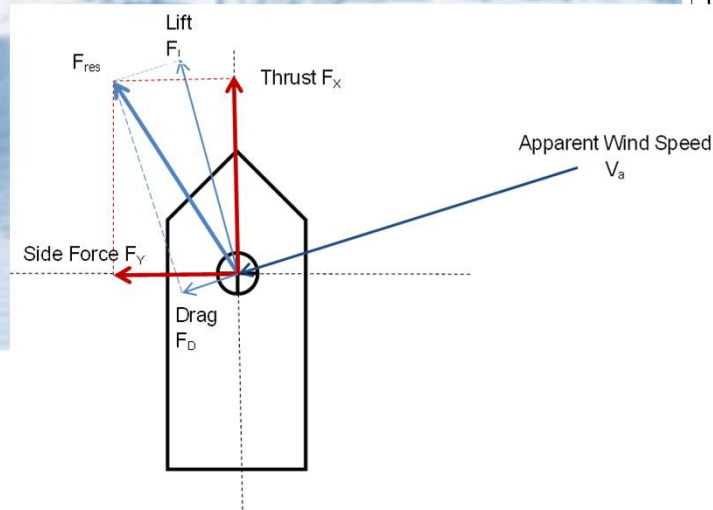
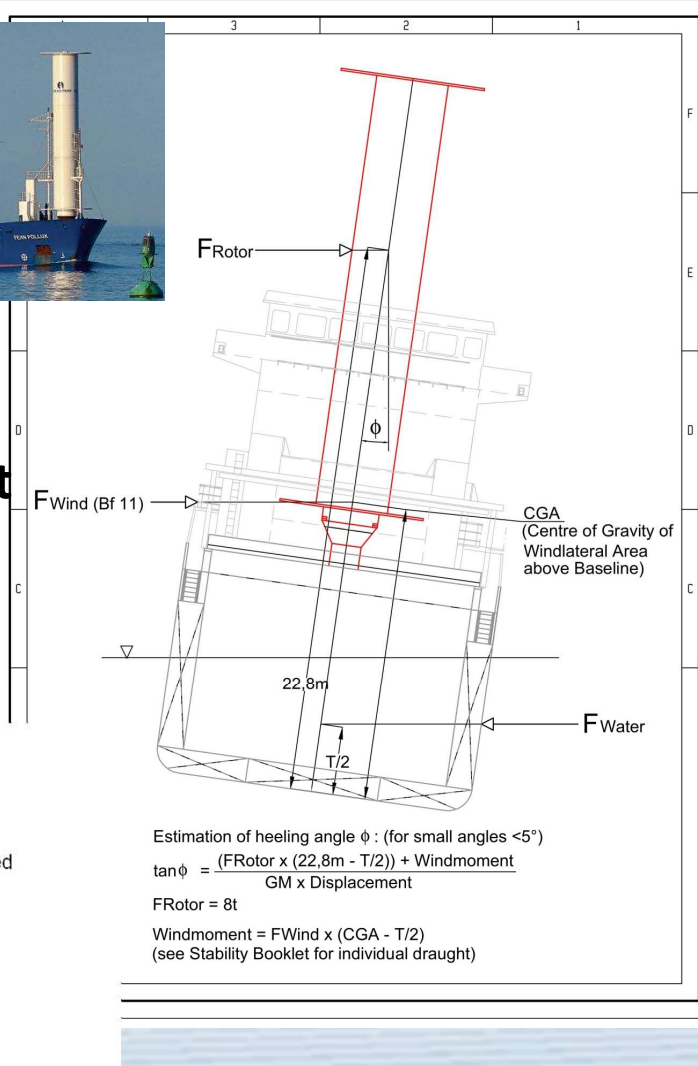
Operations

- **Safety – Emergency Stop**
 - Depower from full to stop in 5 minutes (electric brake)
 - even under black-out conditions (rotational energy)
 - In all critical situations: quick change over to „pure motor“, e.g.
 - Manoeuvring
 - Weather
 - ...
 - **System can remain in operation in coastal traffic**



Operations

- Safety - Lower load on ship's stability
 - Lower sail force COE (F_{Rotor})
 - No excessive high forces in high wind speed – maximum forces at e.g. BFT 6 (max. RPM)
 - No peak forces in wind gusts – forces are about constant (constant RPM)
 - Depower from full to zero force in 5 minutes
 - Rotors completely bridge-controlled



- System can remain in operation at night and in heavy weather
- Side effect: roll motion stabilisation

Operations

- **Automation – easy Handling (Crew)**
 - **System starts automatically when savings are possible (acknowledged by Officer on Watch)**
 - **Control system algorithm finds optimal RPM (patented by Hochschule Emden/Leer)**
 - **Manual operation possible**
 - **Tailor-made routing available**



Operations

- **High Compatibility with ship operations (compact system)**
 - **Port operations and cargo works**
 - **Bridge visibility**
 - **Manoeuvrability**



Economy

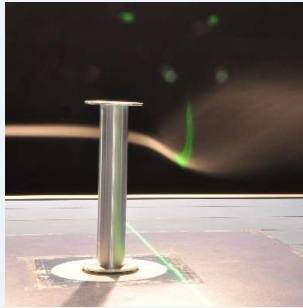
- **Interesting CAPEX**
 - **~ 10 000 EUR per m² rotor area (H x D)**
(for orientation, depending on different factors)
 - **Plus foundation and other costs**
- **Slim OPEX: < 5% of CAPEX p.a.**
- **Fuel Savings: 5% ... 25%**
- **Outlook: high probability of other savings in the future (CO2 levy, ...)**

Conclusions

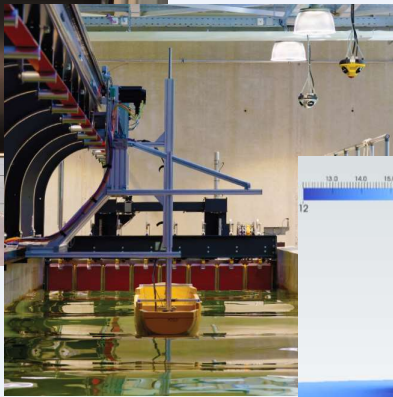
- Flettner rotors are a unique **WASP** technology with convincing advantages in comparison to other technologies
- Strong points: Compact design, high operational safety, and a slim CAPEX/OPEX
- Ideal technology for beginners and those who want to keep it simple
- Ship owners with high ambition and wind-tec competence may check other technologies...

Thank you ...

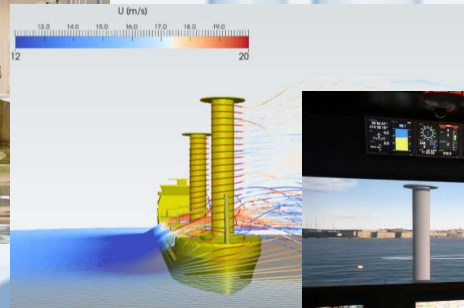
Visit us in our Windship Lab at Leer Maritime Campus!



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Upscaling

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