



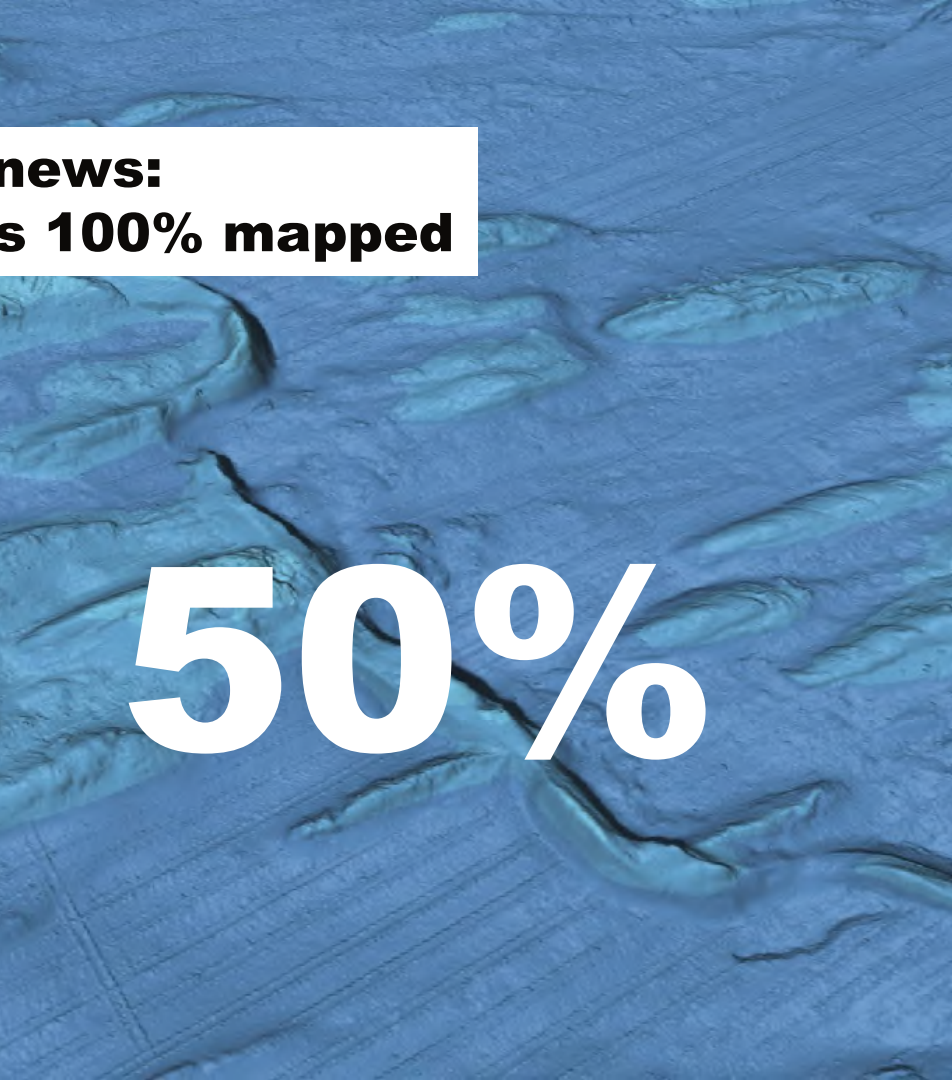
## Concerted surveying for the sake of navigation

Benjamin Hell – Swedish Maritime Administration  
Gunter Liebsch – German Federal Agency for Cartography and Geodesy

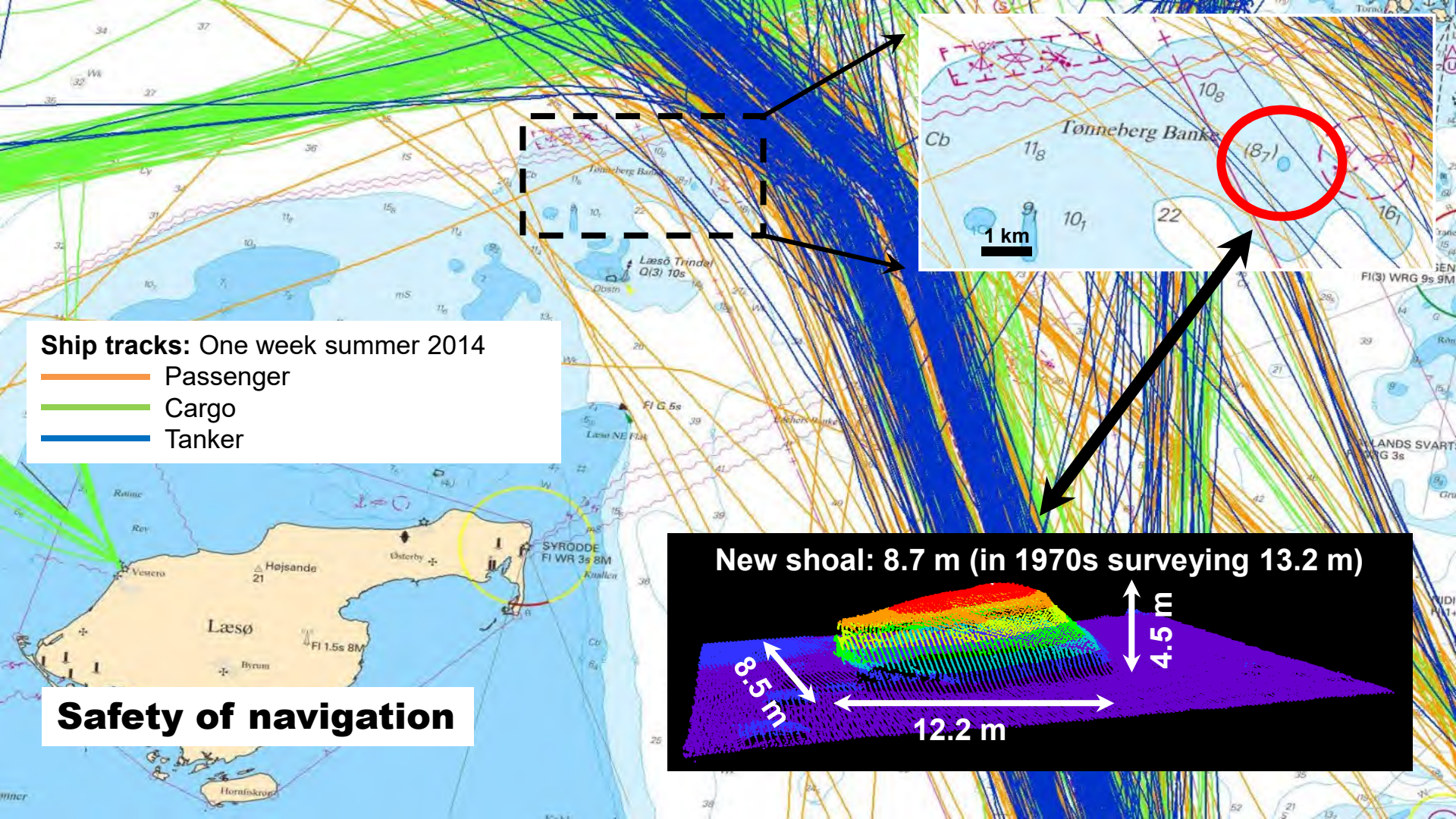


**Good news:  
The Baltic Sea is 100% mapped**

50%



50%





## ”Situational awareness”

- Where am I?
- How much water do I have underneath?
- What happens out there?
- How does that effect me?



# Autonomous vessels

Yes, they will come.

Image: © Rolls Royce



Source: GPS 1  
Mode : ????

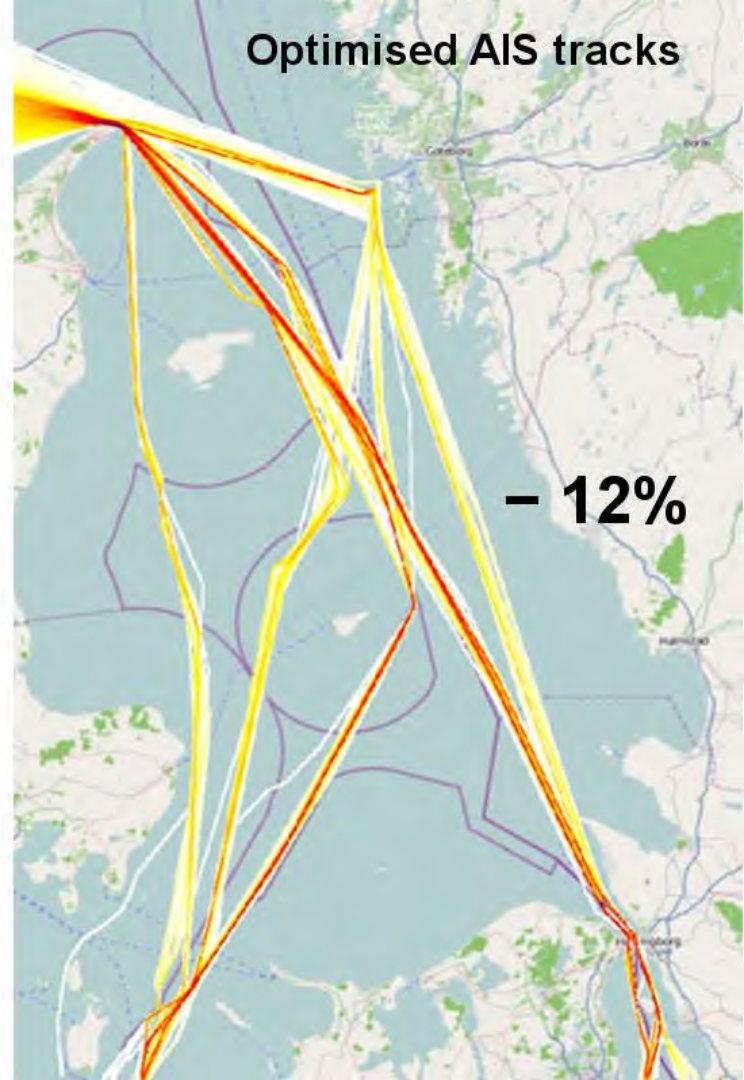
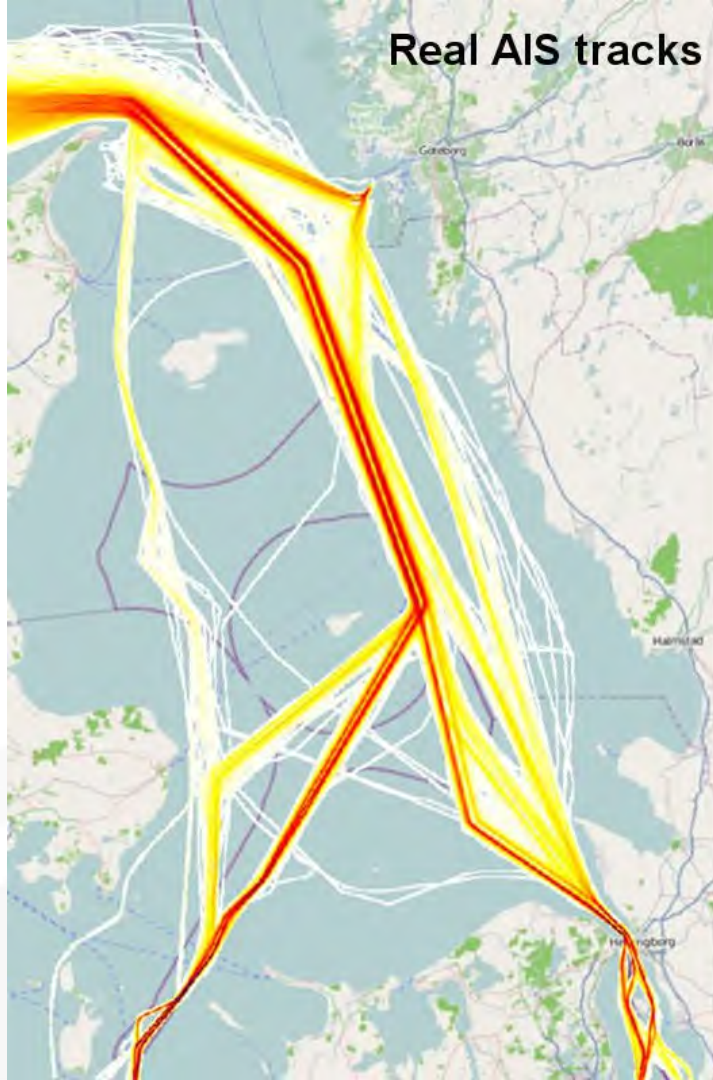
CRS: --- GPS 1  
SPD: --- kn  
HDG: UNK  
Gyro 1

AIS Data

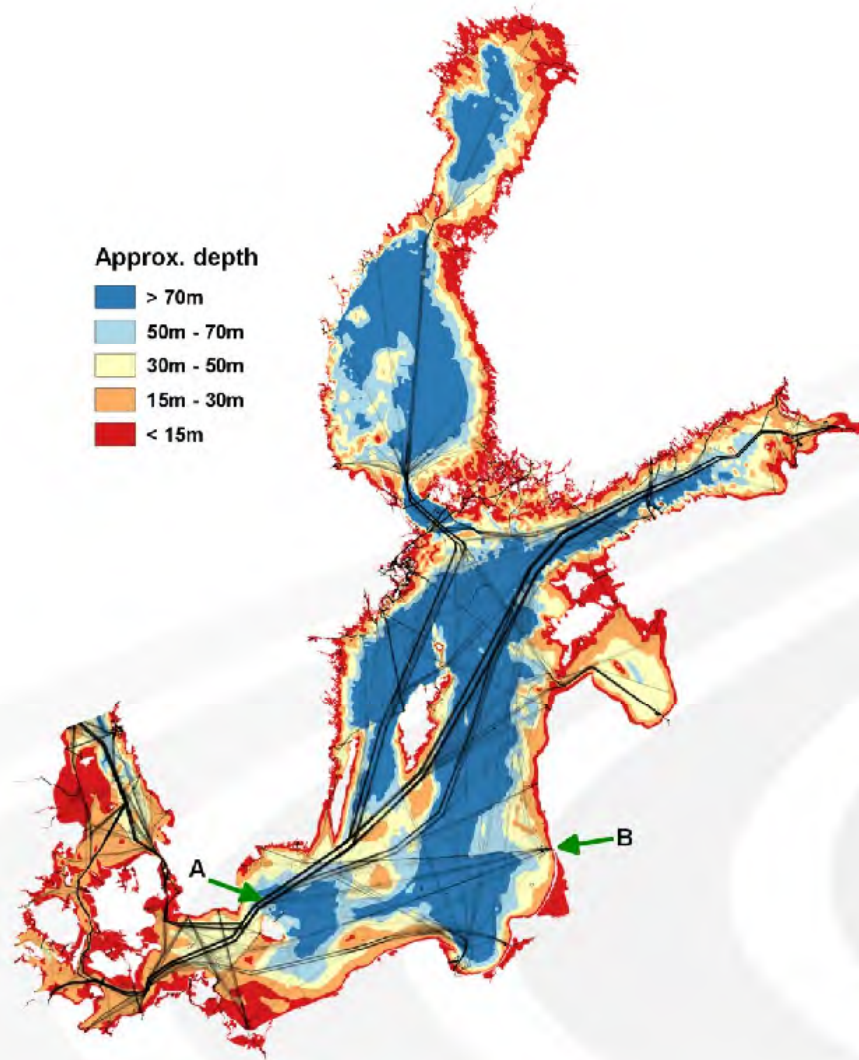
Ship Name	Dist
GULL	N/A
S 12 SILJ...	N/A
THETA AF...	N/A
PILOT L-233	N/A
NORDIC S...	N/A
STERY...	N/A
ESCUCE ...	N/A
MT MAIN...	N/A
RESCUE ...	N/A
SUNA	N/A
SEATRO...	N/A
DELPHIA ...	N/A
PILOT 777 ...	N/A
MAERSK ...	N/A
VIBERO	N/A
AMORELLA	N/A
ECKERO	N/A
TORA	N/A
AHSELL	N/A
OLYMPUS	N/A
PRIMA DO...	N/A
WILSON H...	N/A
TIMCA	N/A
LANGOE	N/A
NAUTILUS	N/A
ESTLAND	N/A

Follow Actual Target

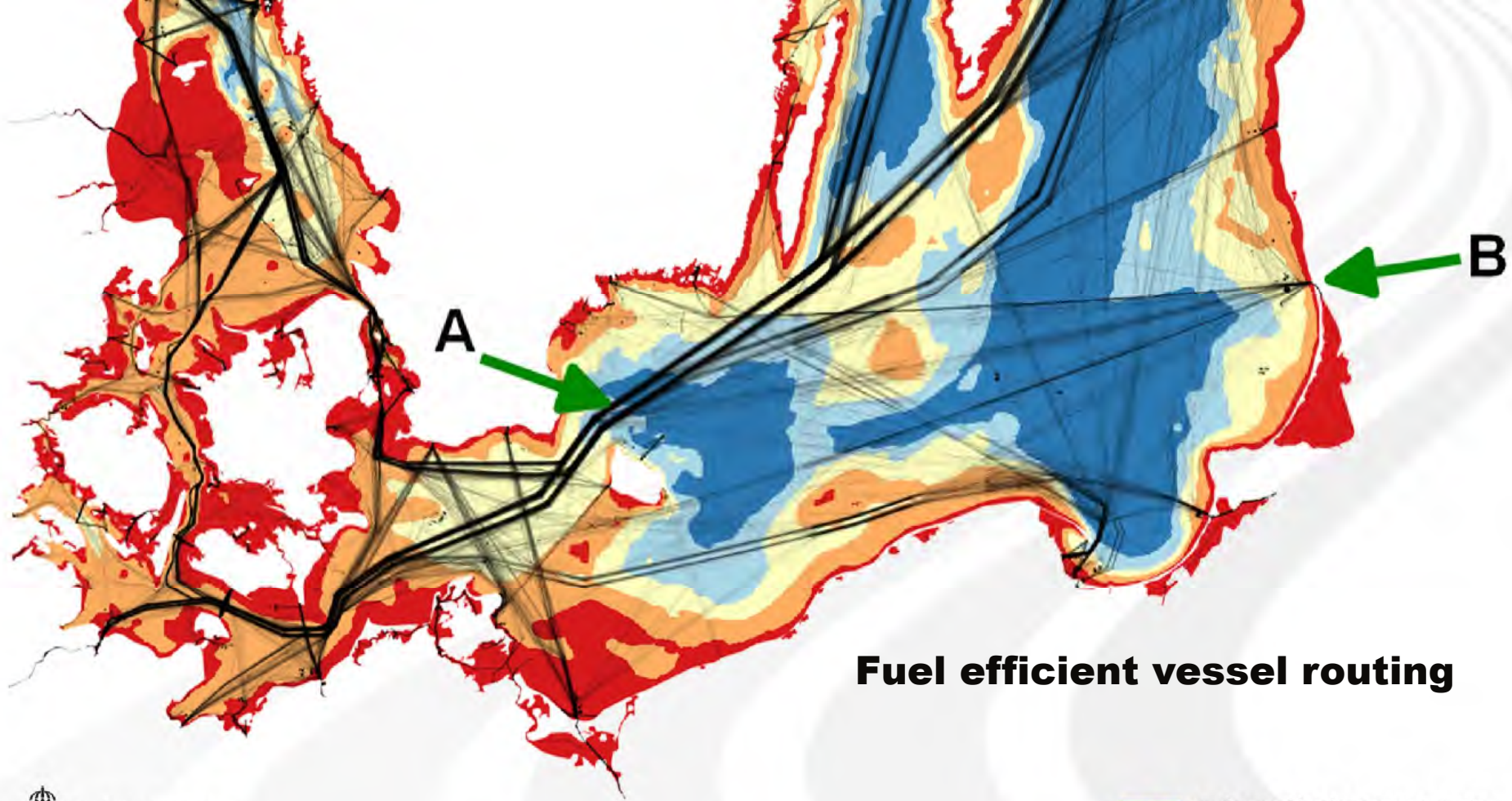
Optimising  
where vessels  
go can save a  
lot of fuel



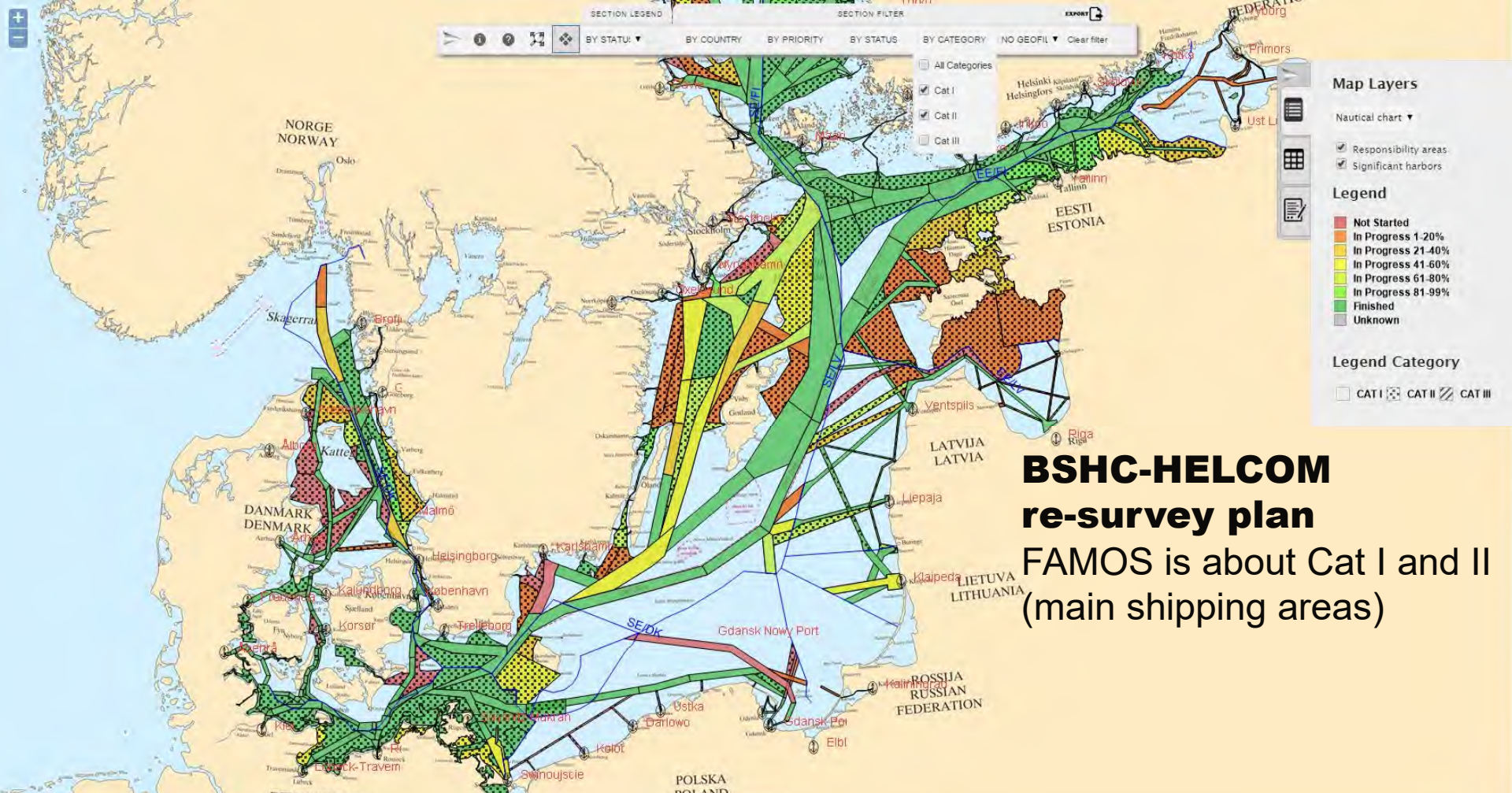
**- 12%**







## Fuel efficient vessel routing



<https://helcomresurvey.sjofartsverket.se/>



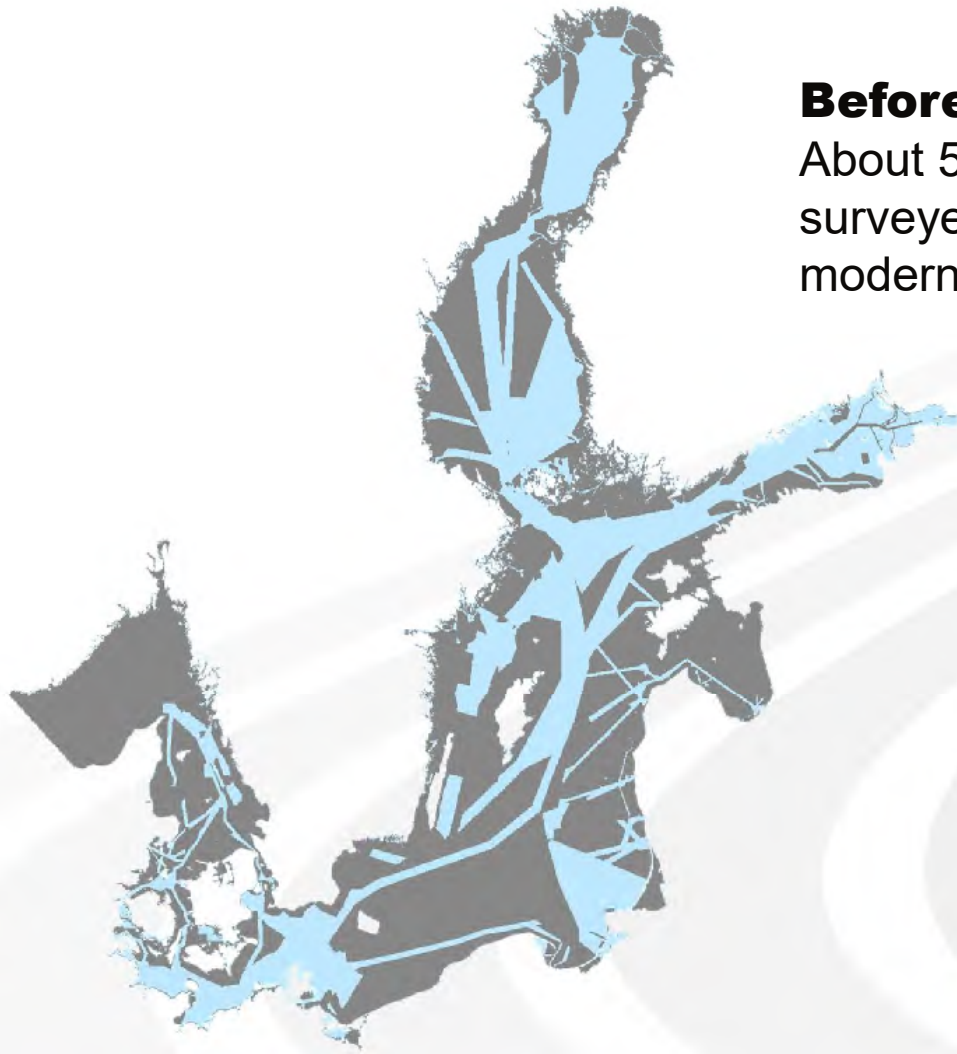
## HELCOM Copenhagen Ministerial Declaration

Taking Further Action to Implement the Baltic Sea Action Plan  
- Reaching Good Environmental Status  
for a healthy Baltic Sea

14 (M). RECALLING the HELCOM Copenhagen 2001, Krakow 2007 and Moscow 2010 commitments on hydrographic re-survey and COMMENDING WITH APPRECIATION the subsequent **substantial progress made in systematic re-surveying of major shipping routes** in ports in the region according to the HELCOM-BSHC Re-survey Scheme aimed at ensuring that safety of navigation in the Baltic Sea region is not endangered by inadequate source information;

15 **take actions to ensure the completion of the re-surveys for areas used by navigation (CAT I and II) within the time schedules estimated** Re-survey Scheme, to promote wider use of accurate and reliable depth information by e.g. developing existing and/or new products including an enhanced and freely accessible Baltic Sea Depth Model, and to foster CAT III re-surveys of other areas not primarily for safety of navigation purposes, e.g. for environmental protection;

– Baltic Sea environmental ministers, Oct 2013



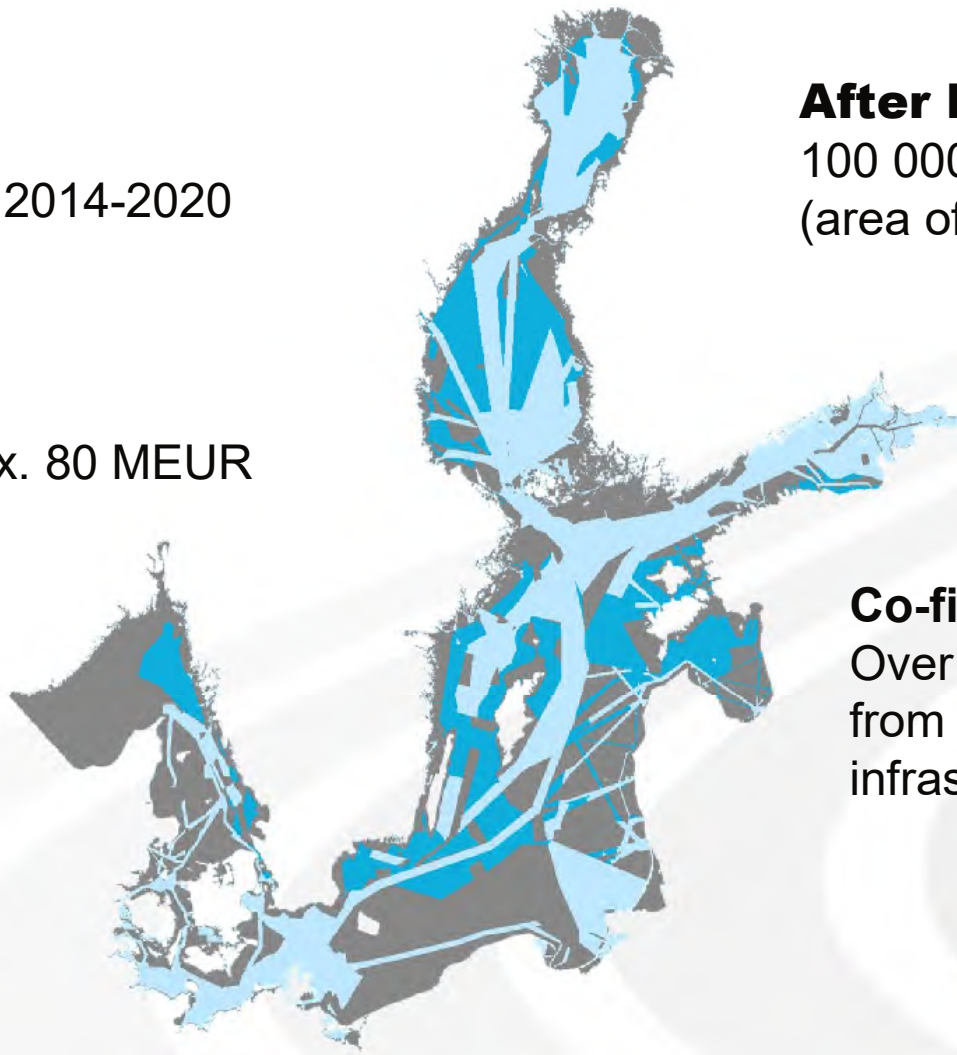
**Before FAMOS:**  
About 50%  
surveyed to  
modern standards

**Timeframe:** 2014-2020

**After FAMOS:**  
100 000 km<sup>2</sup> more  
(area of Portugal)

**Costs:** approx. 80 MEUR

**Co-financing:**  
Over 20 MEUR 2014-2018  
from EU transport  
infrastructure funds





BUNDESAMT FÜR  
SEESCHIFFFAHRT  
UND  
HYDROGRAPHIE



NLS  
FINNISH GEOSPATIAL  
RESEARCH INSTITUTE  
FGI

LANTMÄTERIET

Lik  
enne  
vira  
sto



Geodatastyrelsen  
Danish Geodata Agency

SMHI



TALLINN UNIVERSITY OF  
TECHNOLOGY

SSPA



Bundesamt für  
Kartographie und Geodäsie

DTU



SWEDISH MARITIME  
ADMINISTRATION



GFZ

GEOPHYSICAL CENTER  
POTSDAM



Co-financed by the European Union  
Connecting Europe Facility



Source: GFS 1  
Mode: ????

CRS: ---  
SPD: --- kn  
HDG: UNK  
AIS Data

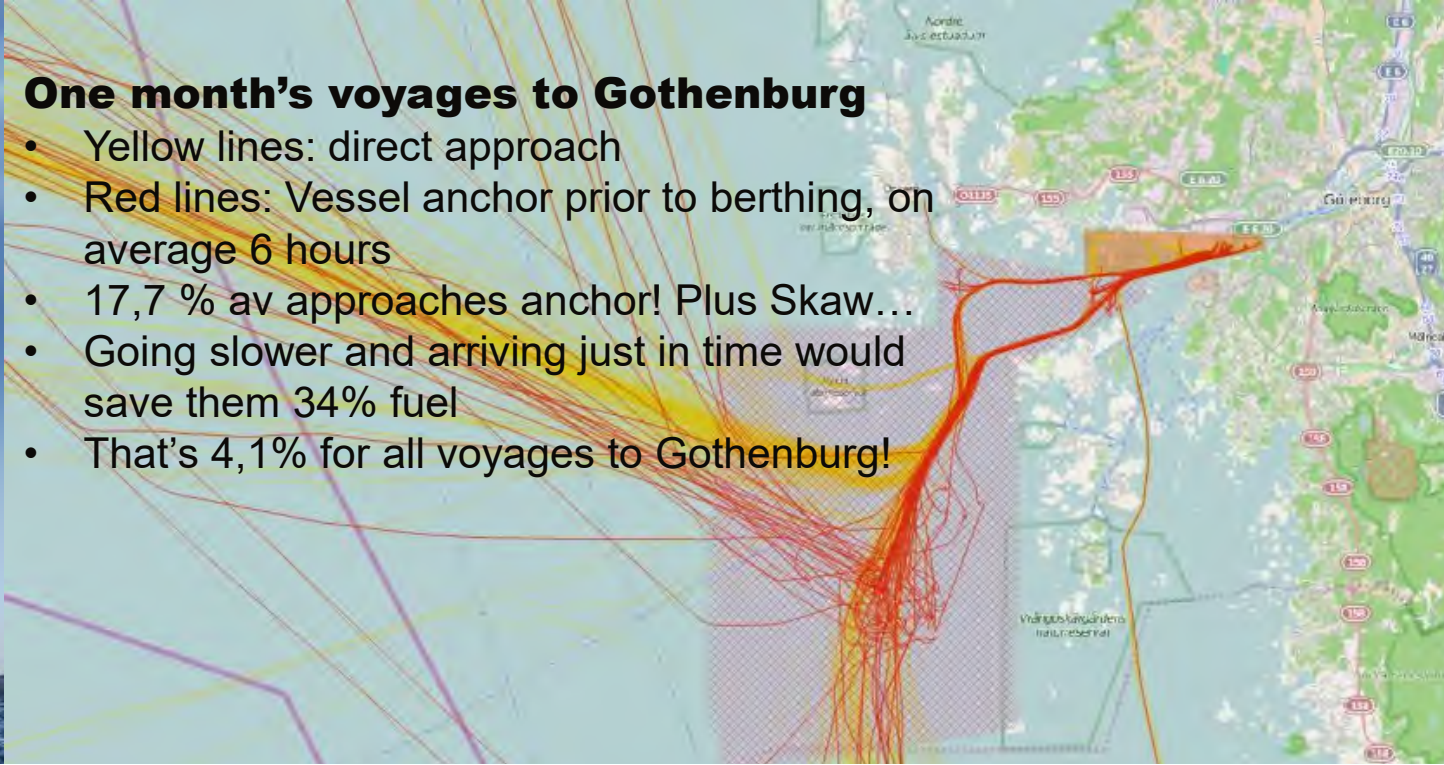
Ship Name	Dist
GULL	N/A
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THE FA AF...	N/A
PILOT L-233	N/A
NORDIC S...	N/A
STERY...	N/A
ESCU...	N/A
WT MAIN...	N/A
RESCUE...	N/A
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OLYMPUS	N/A
PRIMA DO...	N/A
WILSON H...	N/A
TIMCA	N/A
LANGOE	N/A
NAUTILUS	N/A
ESTLAND	N/A

Follow Actual Target



## One month's voyages to Gothenburg

- Yellow lines: direct approach
- Red lines: Vessel anchor prior to berthing, on average 6 hours
- 17,7 % av approaches anchor! Plus Skaw...
- Going slower and arriving just in time would save them 34% fuel
- That's 4,1% for all voyages to Gothenburg!



**Common situational awareness can lead to enormous savings**





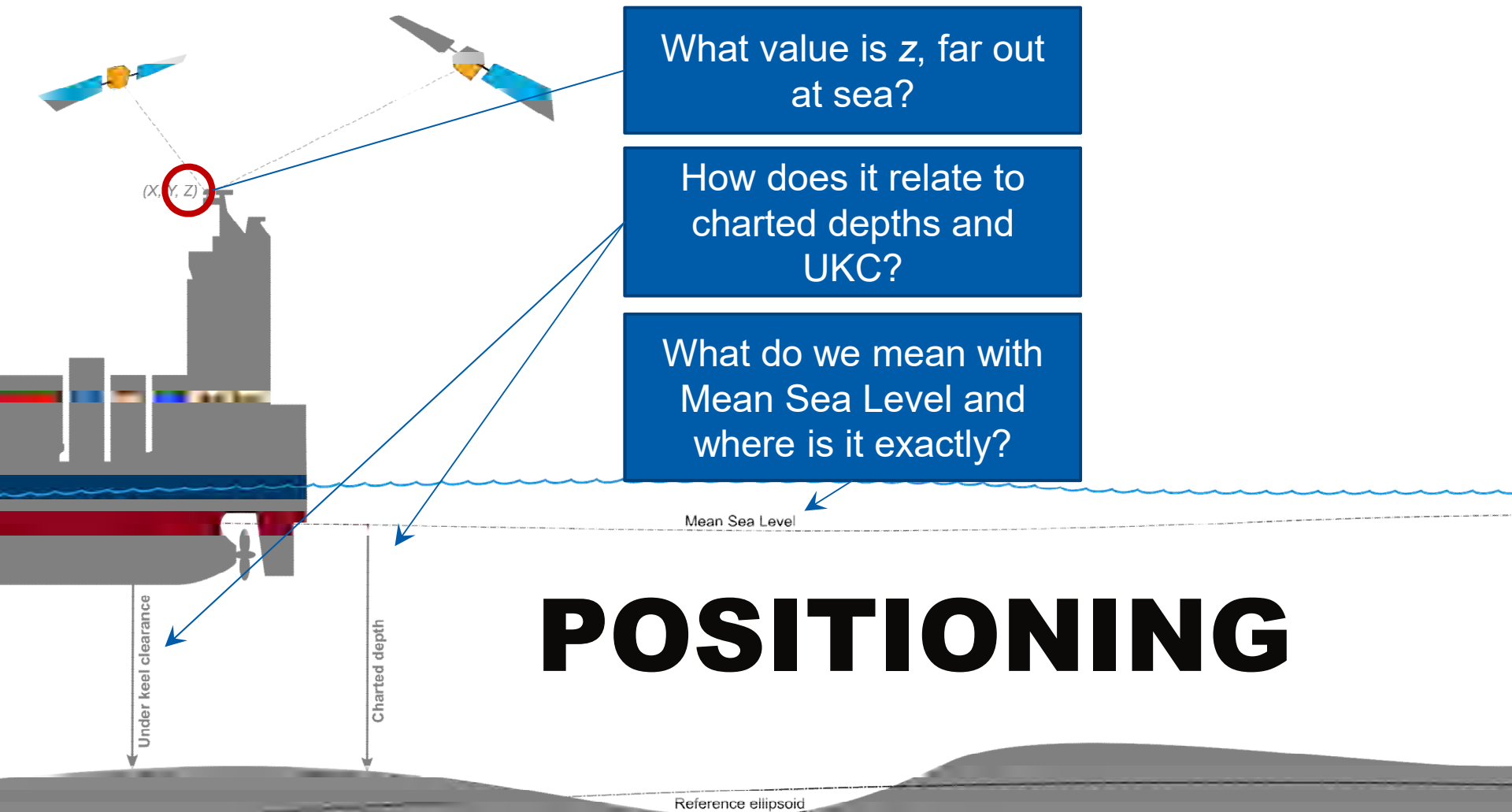


[www.stmvalidation.eu](http://www.stmvalidation.eu)

[https://www.youtube.com/watch?v=03QLivaG\\_jE](https://www.youtube.com/watch?v=03QLivaG_jE)

# **FAMOS activity 2: A new geodetic chart datum for the Baltic Sea**

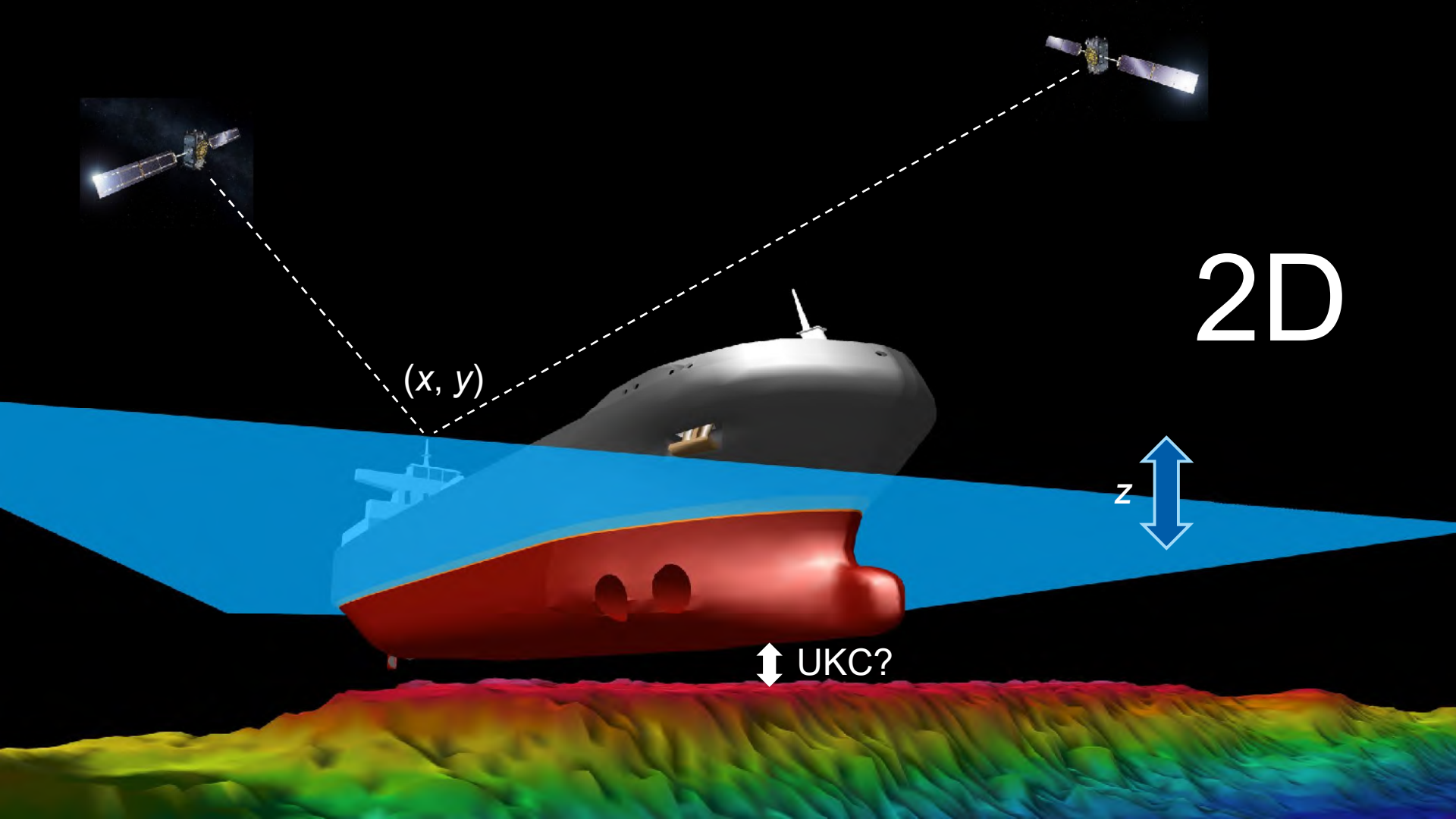
Gunter Liebsch (BKG), Jonas Ågren (Lantmäteriet),  
Wilfried Ellmer (BSH), *et.al.*



# POSITIONING

## Problems

- *Complexity*: We use a multitude of different MSL in the Baltic Sea.
  - harmonize and use one chart datum only
- *Compatibility*: Reference level in nautical charts lacks strong coupling to GNSS coordinates
  - use a geodetic reference
- *Accuracy*: How good are GNSS heights at sea?
  - study and improve if needed
- *Vessel dynamics*: Where is the vessel hull in relation to the water surface?
  - measure vessel position and orientation absolutely instead
- *Hydrodynamics*: Where is the water surface in relation to the chart reference?
  - use the water surface only for planning, not for navigating

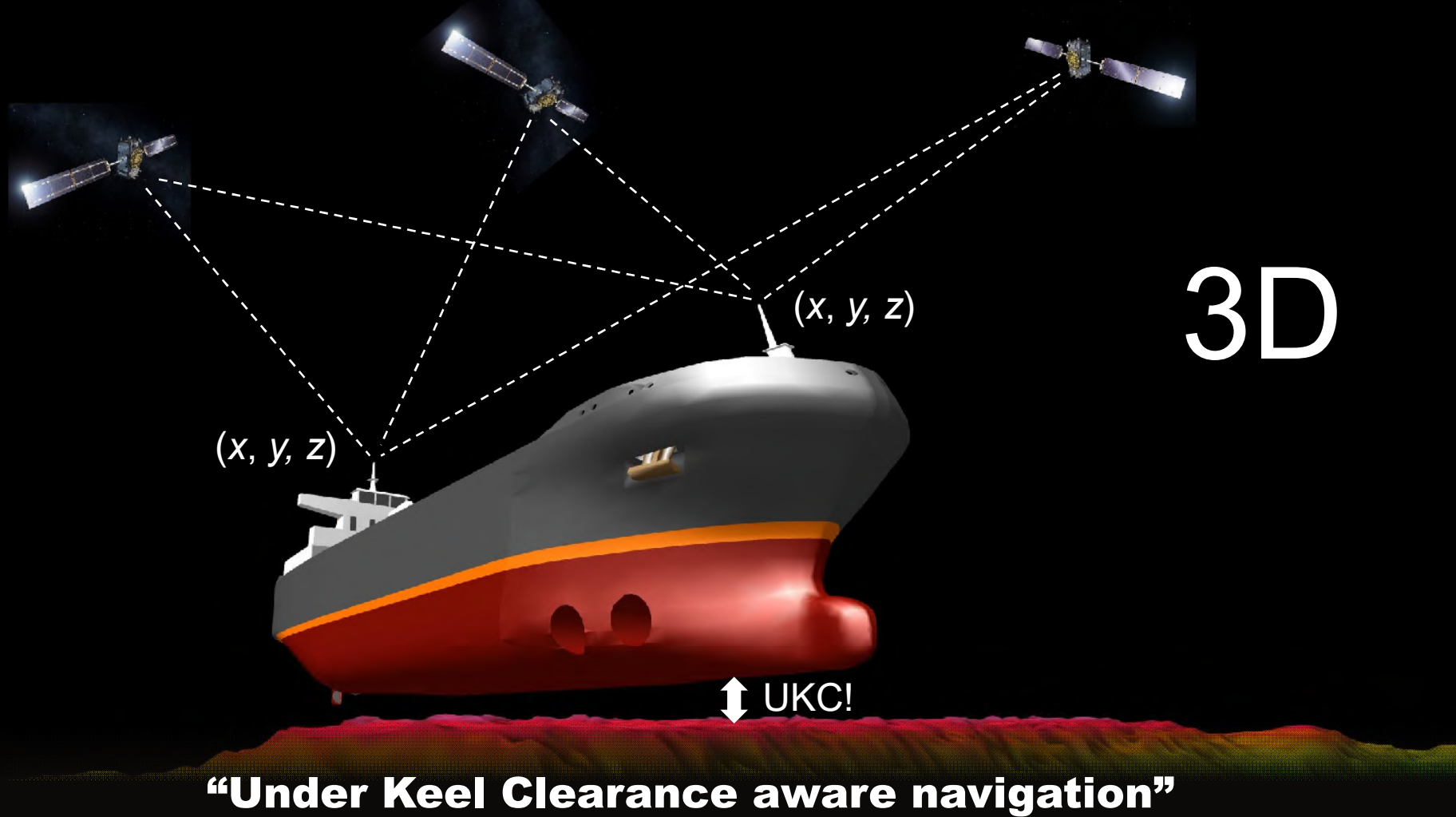


$(x, y)$

2D

$z$

$\updownarrow$  UKC?



# **± 10 cm**

## **(vertically, at sea)**

As soon as we get this, the current maritime 1.1% share of the GNSS market will skyrocket

**+ 10 cm draft → + 20 kUSD profit**  
**(per port call)**

assuming typical Aframax tanker, 3 USD profit per barrel



## A more suitable chart datum: The idealized MSL, called geoid



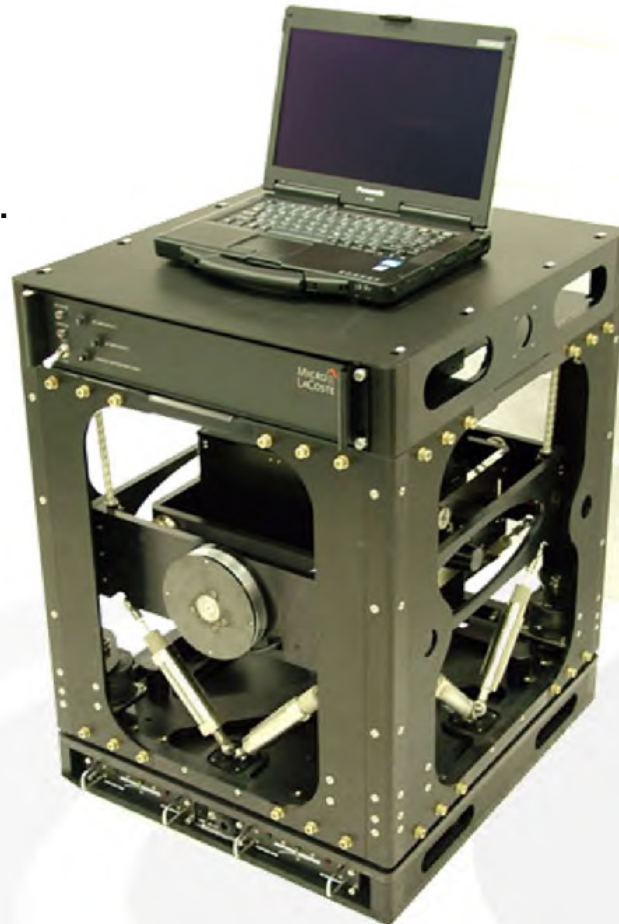
### **Advantages:**

Can be measured rather precisely at the open sea

Has a practical relevance as it coincides well enough with MSL



Measure  $10^{-6}g$   
on a moving platform.  
Pretty cool.



From gravity data, the geoid  
can be modelled.  
Ambition: Uncertainty  $< 5$  cm



**A lot will fall in place within the coming years:**

- Full coverage bathymetry (S-102 in ECDIS!)
- Accurate GNSS heights at sea (Galileo CS!)
- Sea Traffic Management
- The digitalization of the entire maritime logistics chain

**Hydrography is right in the middle of it!**



Thanks!