Ship bridge allisions

AXEL HÖRTEBORN, RISE SWEDEN
2024-09-04

Agenda

- Where I come from
- AIS data
- Ship failures
- The STAPS model
- Some examples
  - Great belt
  - Halsafjorden
  - Baltimore and USA bridges

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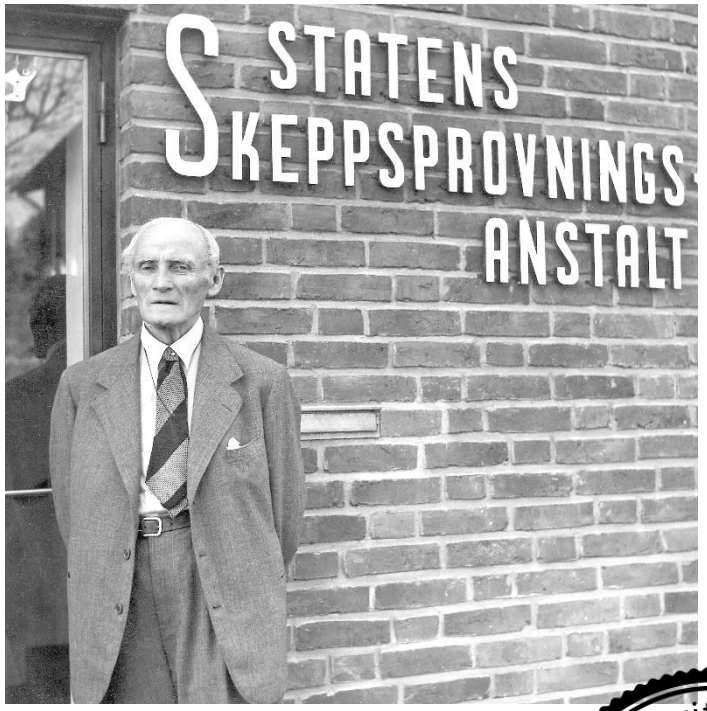
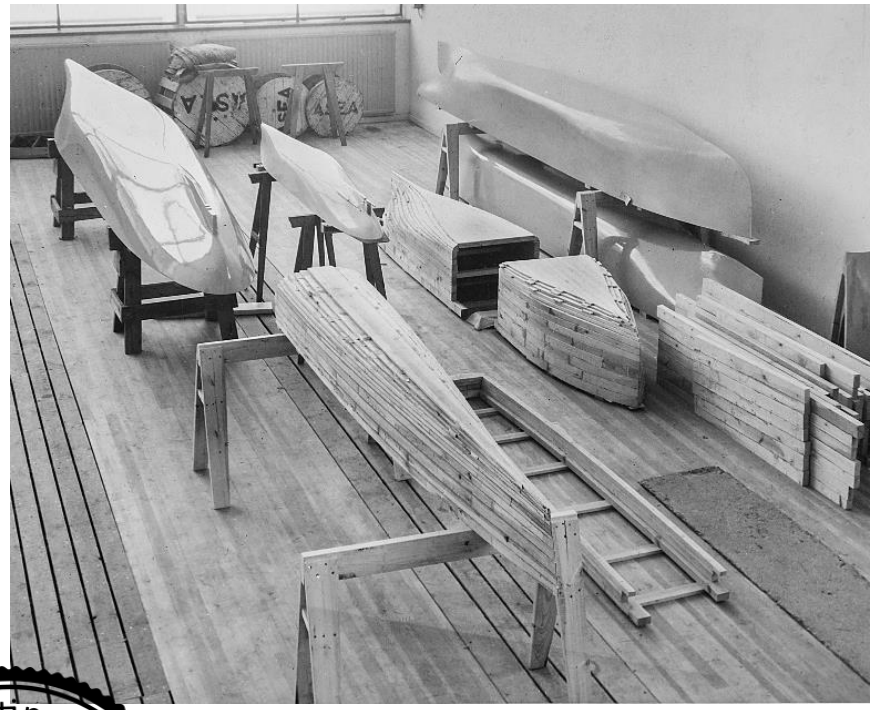
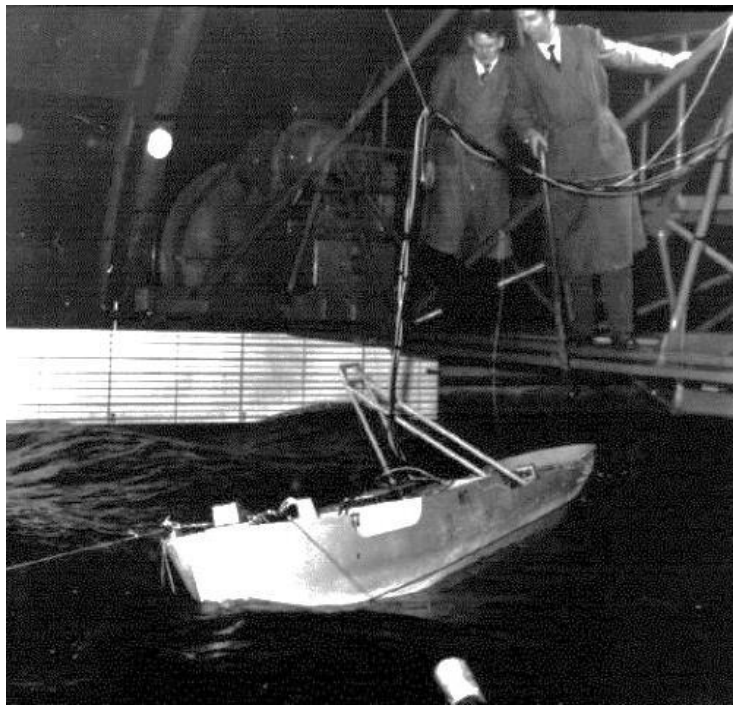
SSPA Maritime Center
Independent maritime consultancy since 1940







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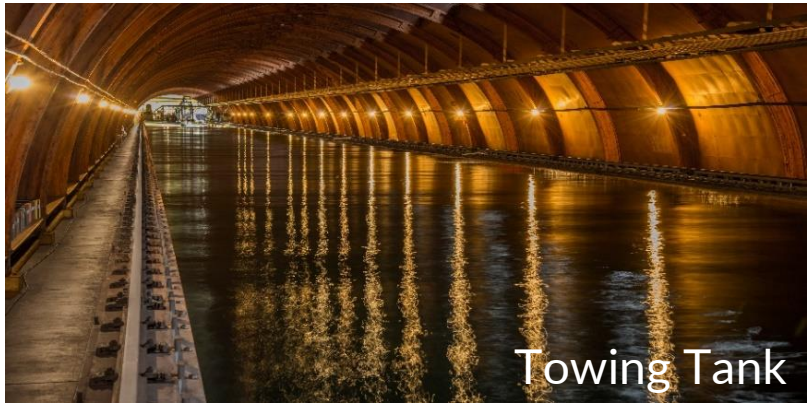

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Member of PIANC Working group 215

PIANC
The World Association for
Waterborne Transport Infrastructure.

- Started 2018
- Almost complete
- Hopefully going to MarCom in October

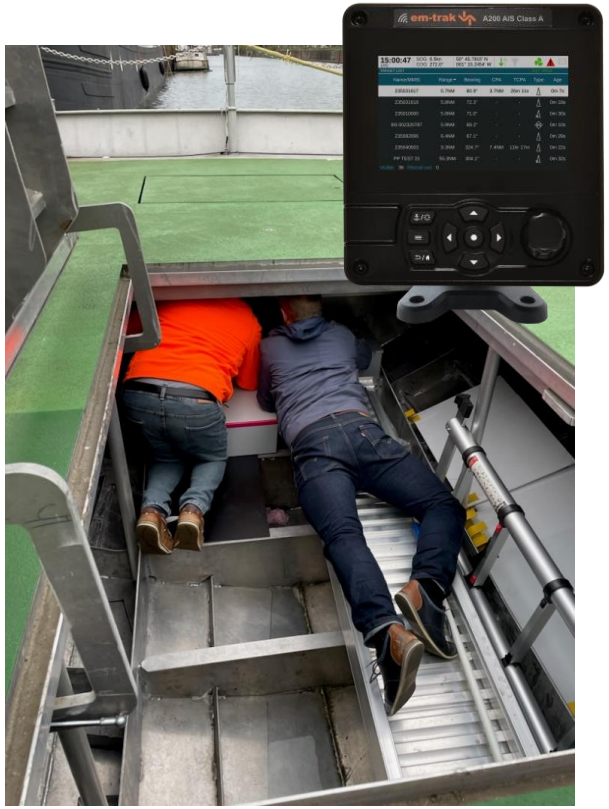
Report No. xxx–

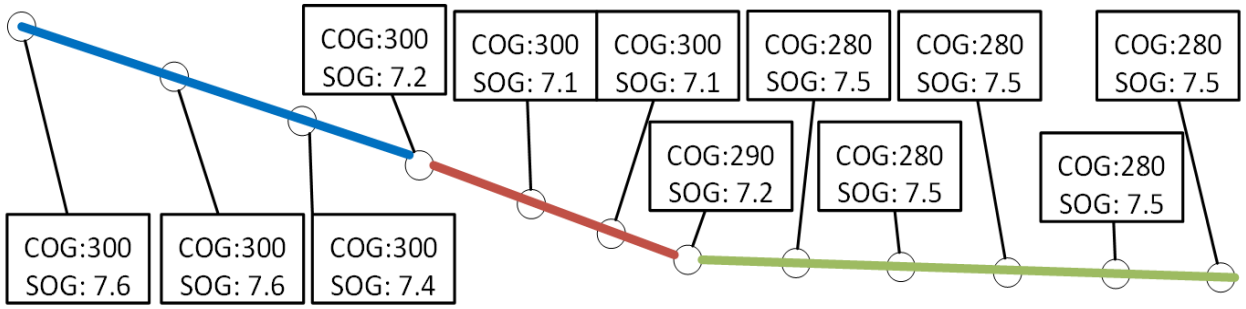
ACCIDENTAL IMPACTS FROM SHIPS ON FIXED STRUCTURES

Design Considerations, Working Group 215

AIS Data

- Mandatory on all ships > 300 GT
- Transponder sends a dynamic signal every 3 – 10 second and static signal every 5 minutes



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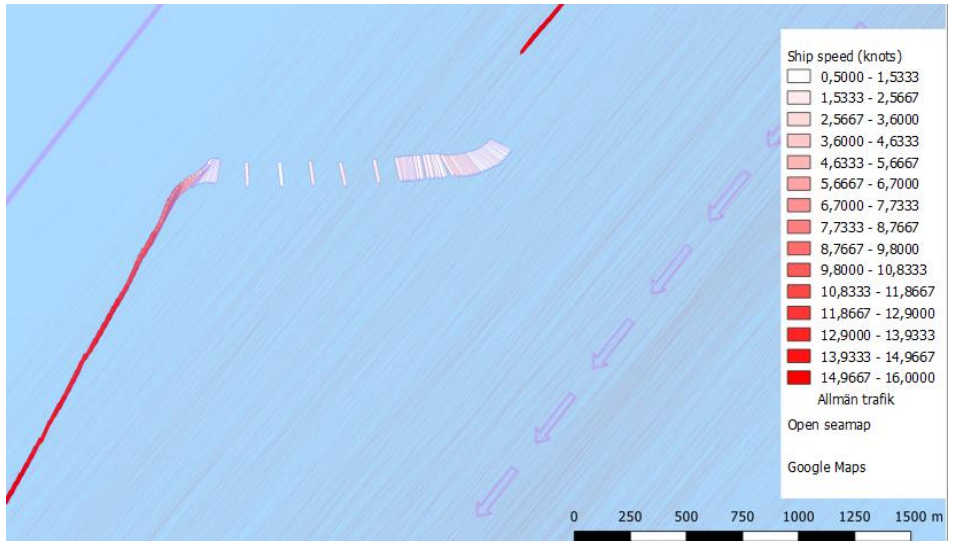
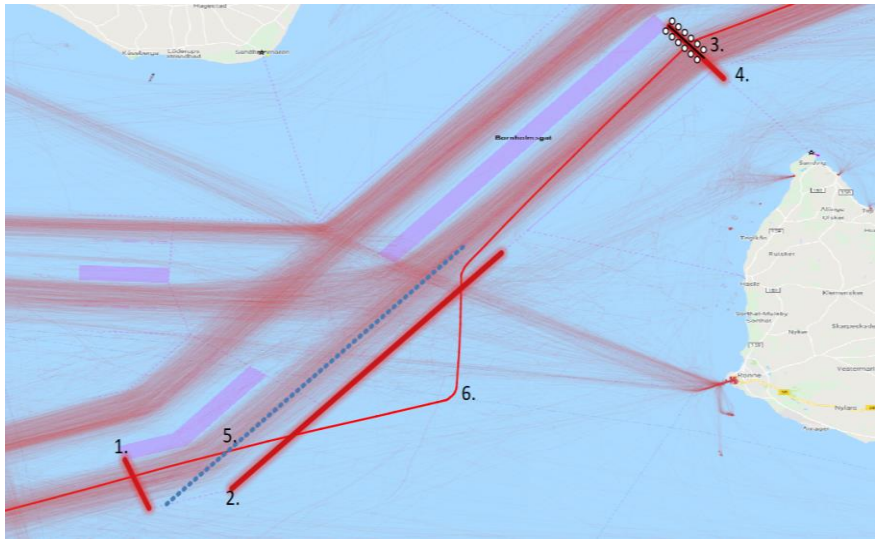
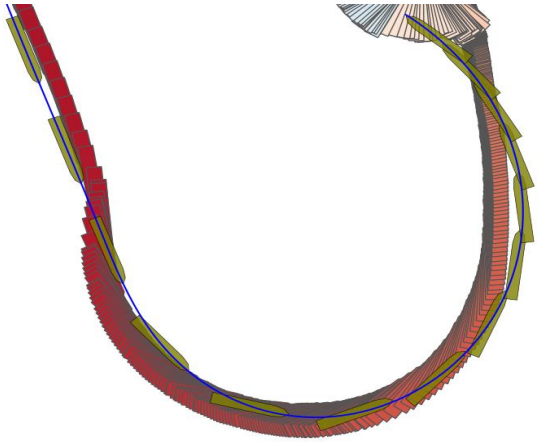
Ship failure (1/3)



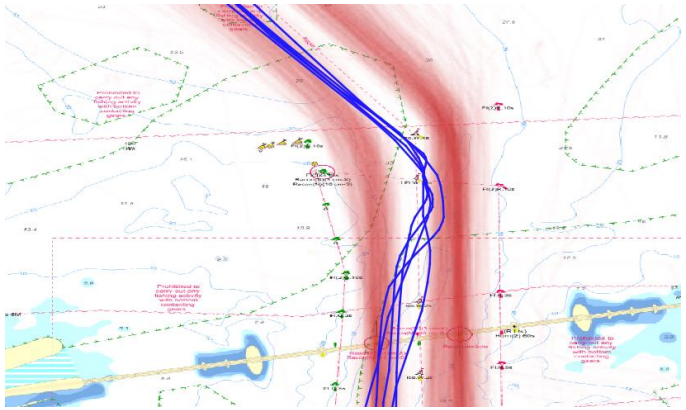
1. Drifting failure



3. Missing turning point

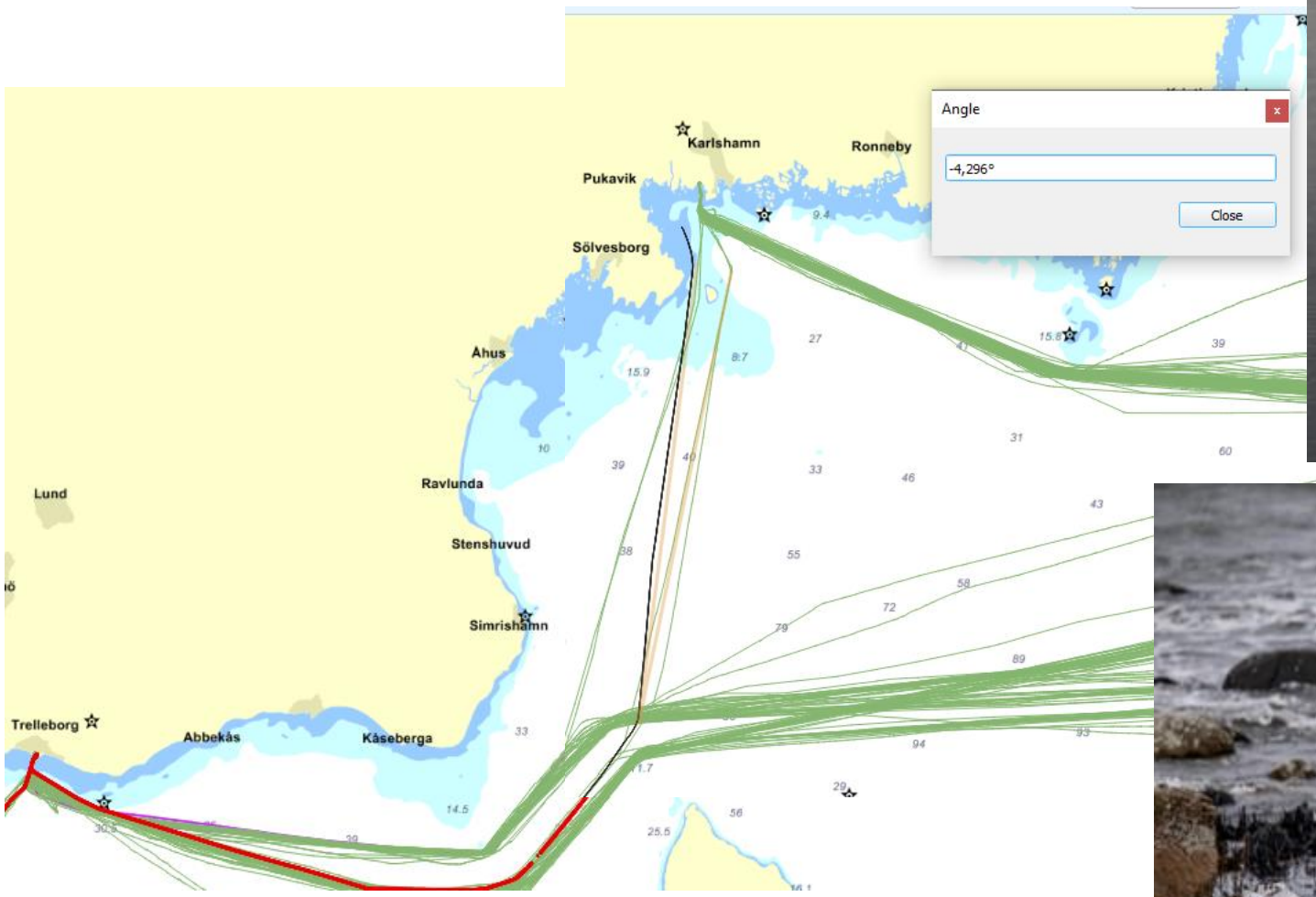


2. Sharp turning



3. Missing turning point

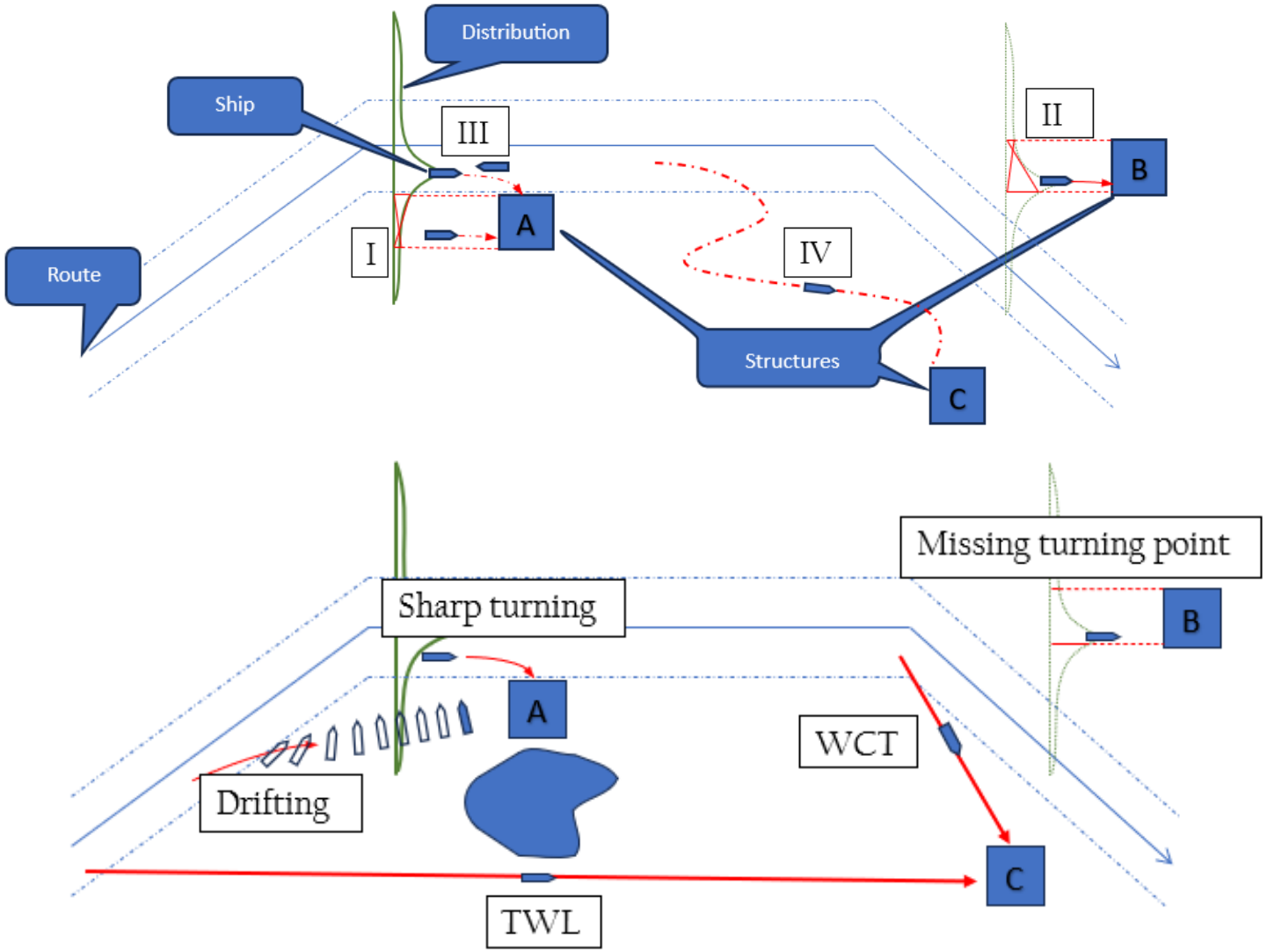
Ship failure (2/3)



Ship failure (3/3)

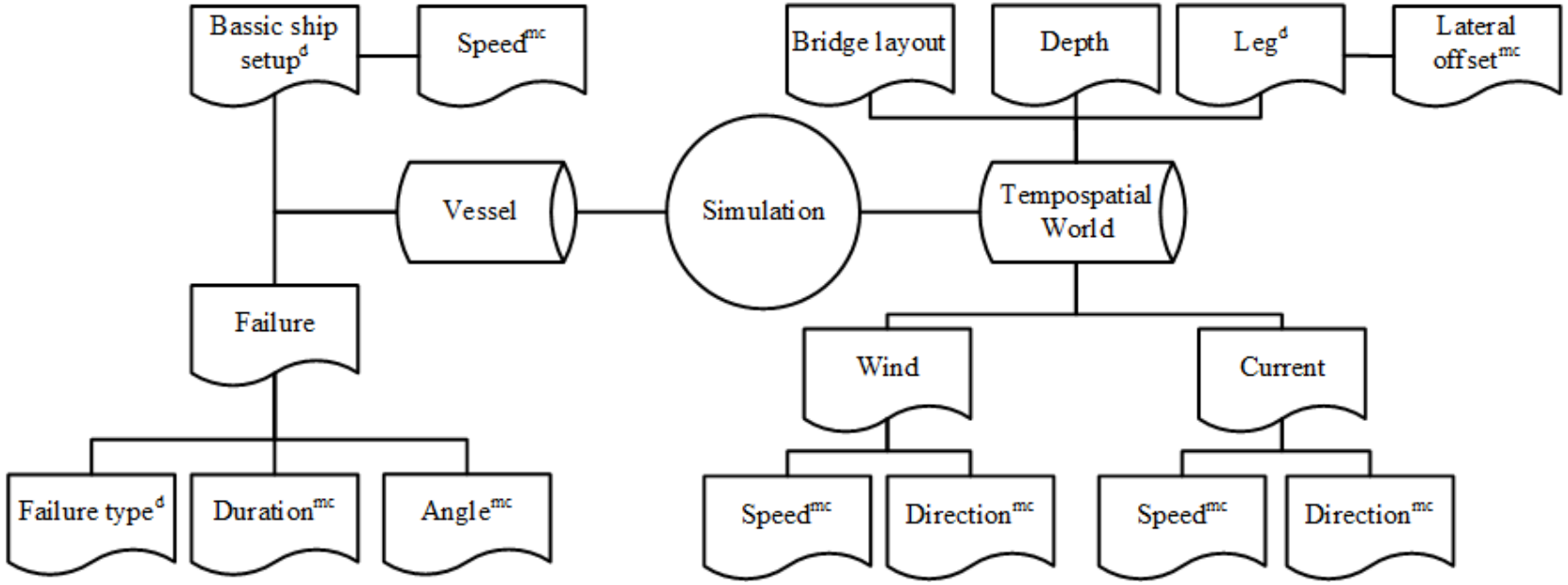
AIS timestamp	COG	Heading	SOG
2023-03-02T02:23:23	151,9	152	9,3
2023-03-02T02:23:33	151,6	152	9,3
2023-03-02T02:23:42	152,3	152	9,4
2023-03-02T02:23:53	241,2	158	1,7
2023-03-02T02:23:59	260,5	154	0,6

Pedersen's categories vs. failures

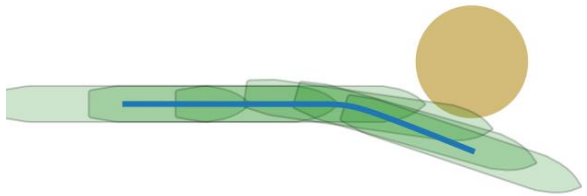


STAPS – Ship Traffic Allision Probability using monte carlo Simulations

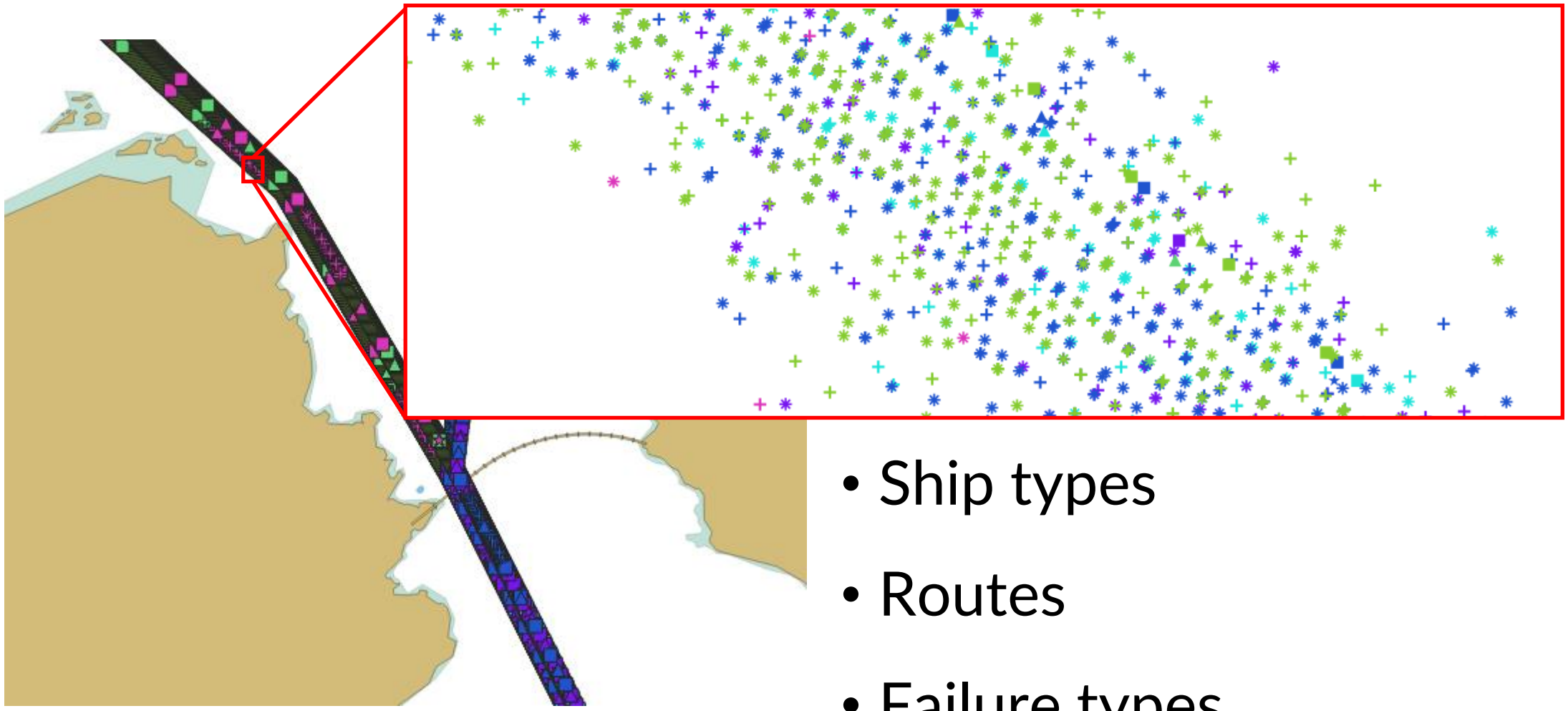
1. Gather input
   - AIS Data
     - Failure rates
     - Traffic volume
     - Route layout
   - Ship models
   - Spatial layout
   - Environmental conditions



2. MonteCarlo simulate input parameters
3. Run manoeuvre simulations in fast time
4. Compile result and analyse mitigation options

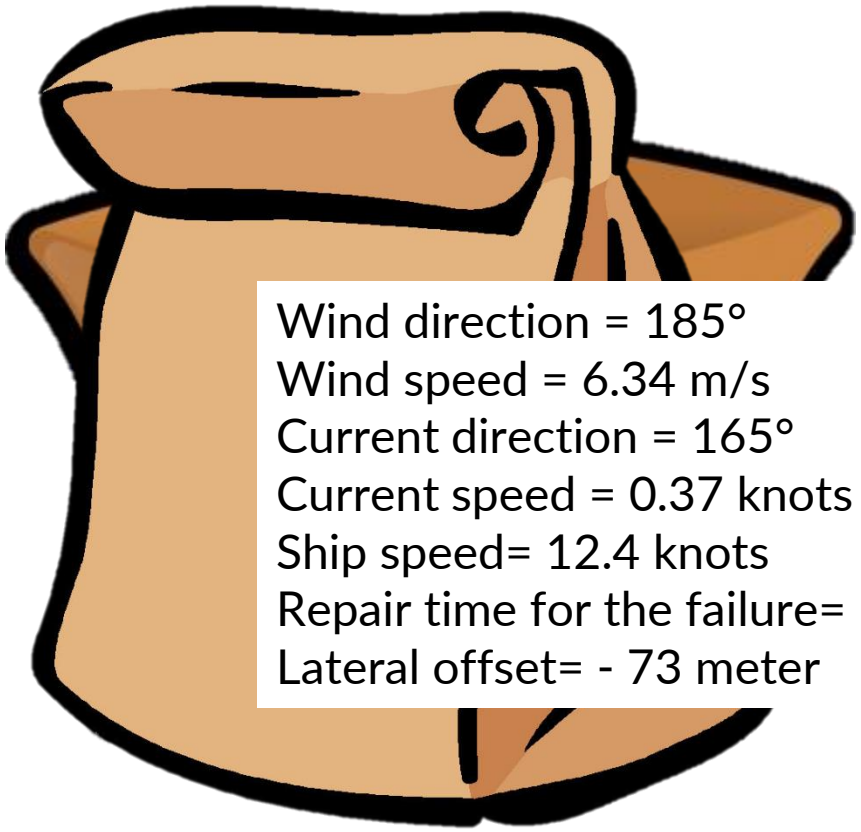


Starting points in a simulation

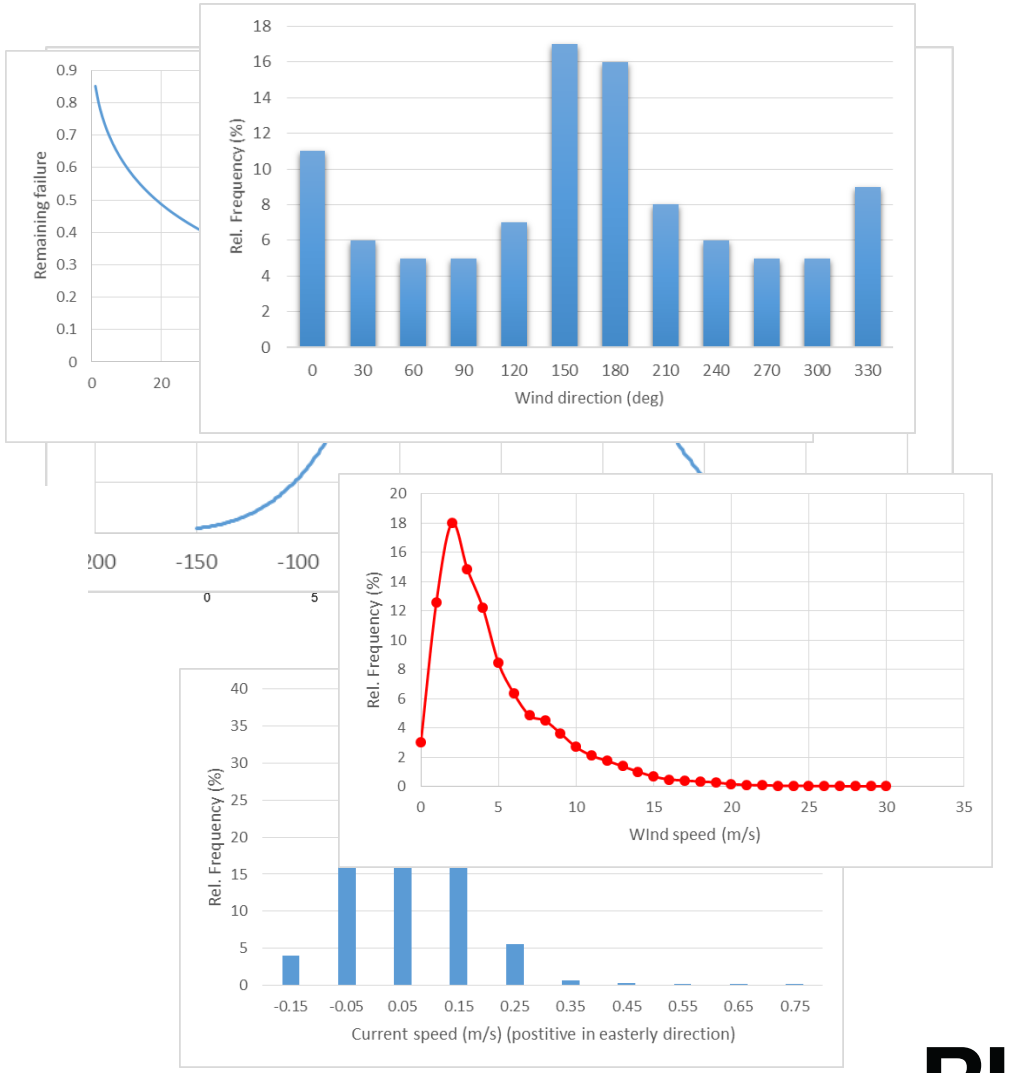


- Ship types
- Routes
- Failure types

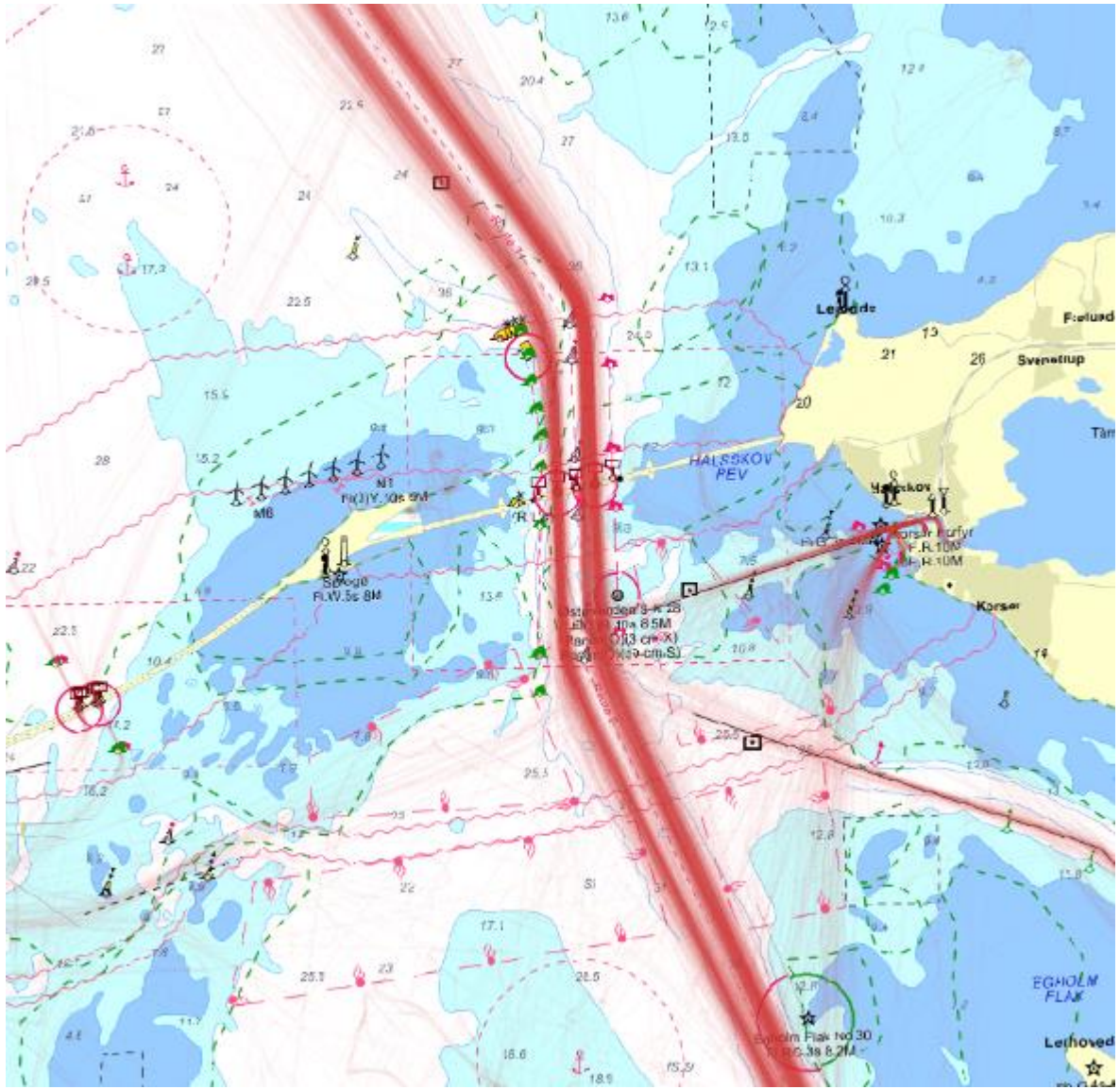
Gathering of start values



Wind direction = 185°
Wind speed = 6.34 m/s
Current direction = 165°
Current speed = 0.37 knots
Ship speed= 12.4 knots
Repair time for the failure= 12 min
Lateral offset= - 73 meter



Great belt bridge (1/3)



Ocean Engineering 235 (2021) 109396

Contents lists available at ScienceDirect

Ocean Engineering

journal homepage: www.elsevier.com/locate/oceaneng

A method for risk analysis of ship collisions with stationary infrastructure using AIS data and a ship manoeuvring simulator

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ARTICLE INFO

Keywords:
AIS analysis
Allision energy
Event identification
Ship-bridge allision
Ship grounding
Ship manoeuvring simulator

ABSTRACT

The study presents a methodology that uses AIS data and a ship manoeuvring simulator to simulate and analyse marine traffic schemes with regard to risks for accidents. An event identification method is presented, which is needed for the accident scenario part of the methodology. This is based on AIS data, where the Great Belt VTS area was used to verify the methodology. Three events that could result in ship-bridge allisions were modelled and simulated in the simulator: drifting ship, sharp turning ship and miss of turning point. The Monte Carlo method was used to perform large number of simulator runs, including a parameter sensitivity analysis. The probability of a ship allision against the Great Belt Bridge was calculated to be 0.007. Analysis of the ship-bridge allision cases was shown to be dominated by the event drifting ship. This event has a relatively low kinetic energy at the impact, and the expected allision energy for a 1,000-year allision corresponds to a 178 m tanker with 57,870 DWT and ship speed 14.6 knots. Finally, this study presents a mitigation analysis, which shows how the probability of allisions can be reduced by reducing the ship speed or altering the traffic separation scheme.

1. Introduction

The advancement in bridge building engineering during the 20th century created an opportunity to build large bridges that span over wide waterways with intensive ship traffic. Risk analysis was used as the method to ensure that the bridge design and waterway traffic fulfilled expected safety standards. Despite this, 34 major bridge collapses occurred in the period from 1960 to 2007 that were caused by ship-bridge allisions (*def.*: ship collision with a bridge), which resulted in the loss of more than 340 lives (AASHTO, 2009). In addition to environmental and service loads that form the basis of the strength design of a bridge spanning over a waterway, the accidental probability of various hazardous events and accidental loads must also be considered.

In Europe, the norms and standards for all building codes are described in the Eurocode. In Eurocode 1, general equations are proposed for the calculation of accidental loads to be used in the design of bridges (CEN, 2006). For ship-bridge allisions, these equations are based on Eq. (1) with reference to the research presented by Fujii (1983) and Macduff (1974):

$$N_{AI} = N \times P_C \quad (1)$$

where N_{AI} is the number of allisions, N is the number of ships and P_C is the causation factor. There is limited guidance in Eurocode 1 on how the causation factor should be determined. Pedersen (1995, 2000) proposed that it can be estimated using the number of accidents (or allisions for ship-bridge contacts) divided by the number of ship passages. Since this approach relies on the number of reported accidents and traffic statistics in the area of interest, the accuracy of the value of the calculated causation factor depends on these data. Hassel et al. (2011) and Pearrou et al. (2010) found that only approximately 50 percent of all accidents are reported in accident statistics databases, hence, the causation factor is underestimated (and, thereby, the probability of accidents).

This study presents a new methodology that handles the shortcomings in the determination of the causation factor in the risk analysis. It uses the approach proposed by Hollnagel et al. (2006) to identify scenarios that lead to accidents, together with AIS data, to calculate the probability of ship collisions with fixed infrastructure; this approach is applied in the study as ship-bridge allision. Hollnagel et al. (2006) proposed that there are different "layers" leading to an accident that should be assessed: root cause, event and the accident itself. For example, an officer on watch falls asleep [root cause], the ship continues past a turning point [event] and ultimately grounds [accident]. The

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https://doi.org/10.1016/j.oceaneng.2021.109396
Received 22 October 2020; Received in revised form 11 June 2021; Accepted 25 June 2021
Available online 3 July 2021
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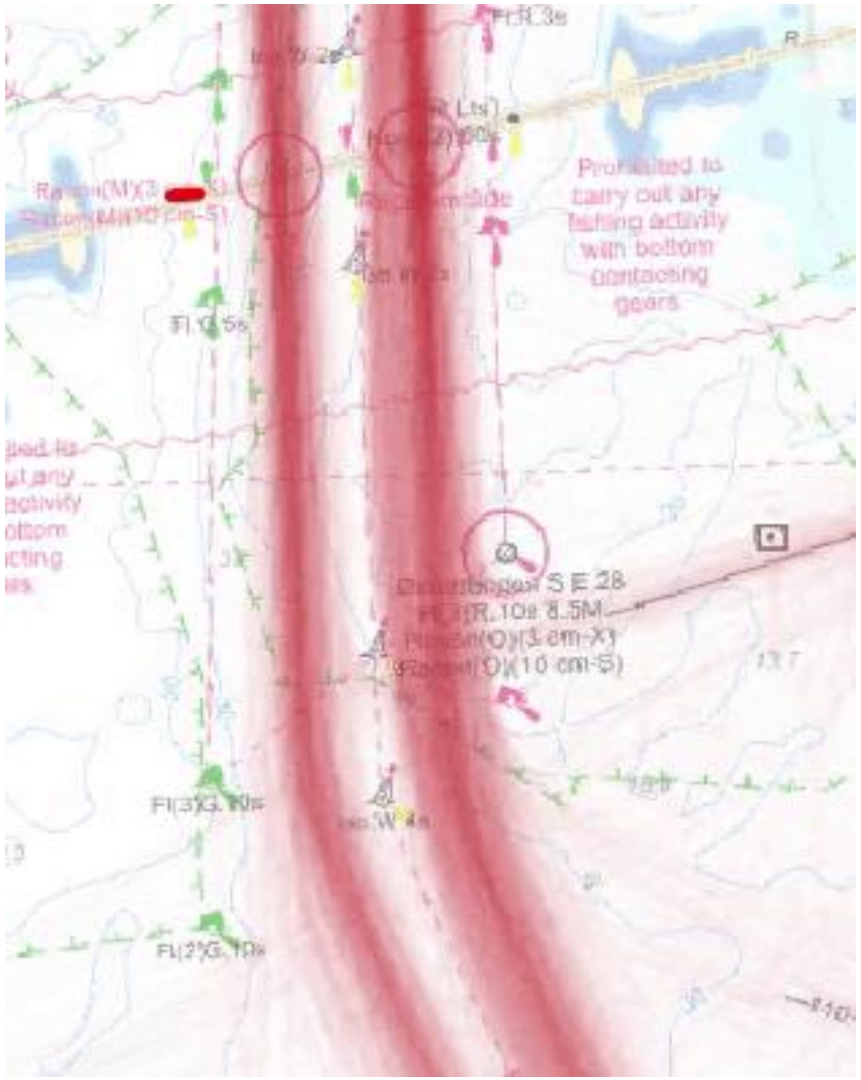
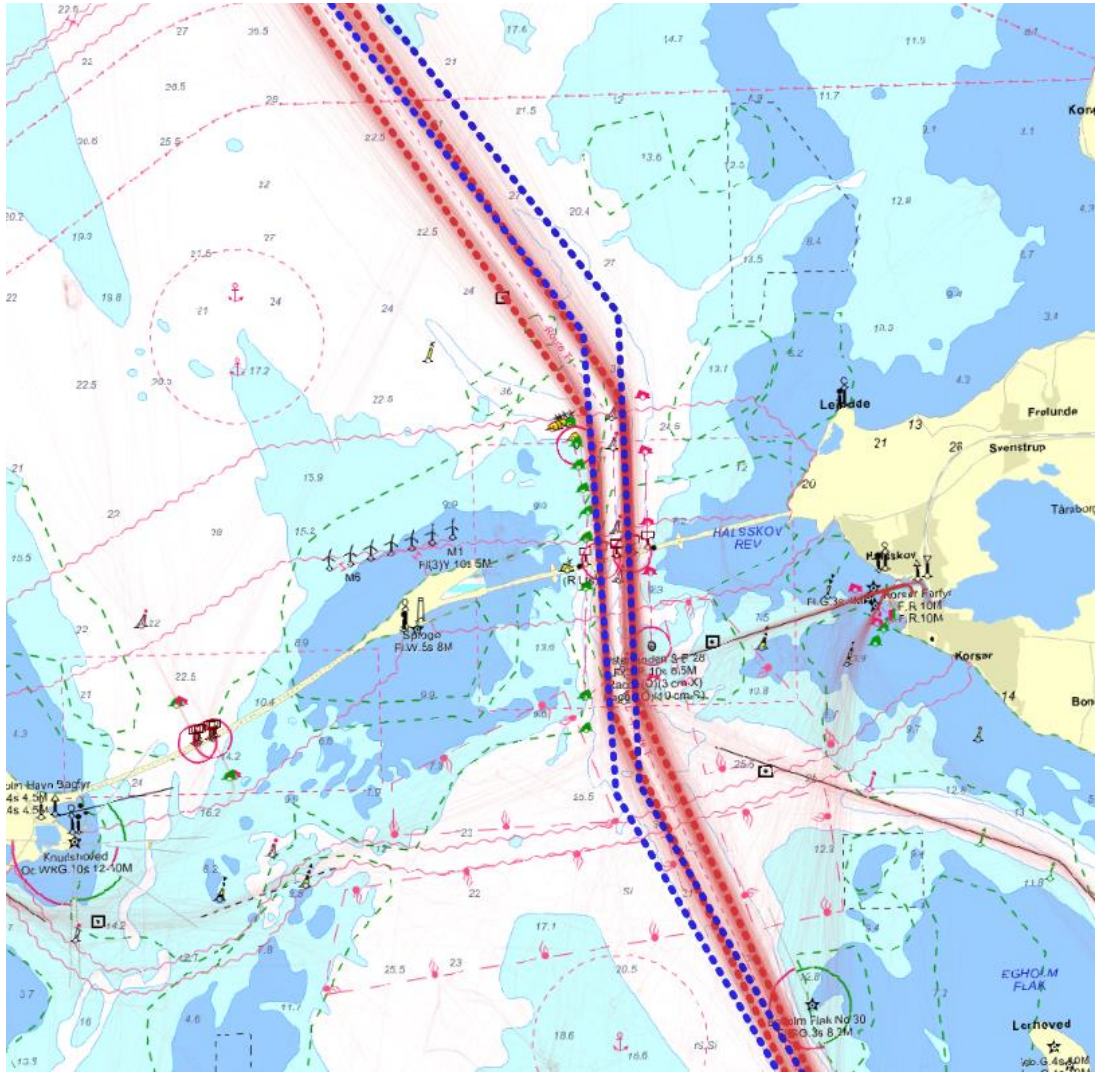
Great belt bridge (2/3)



2 simulation examples

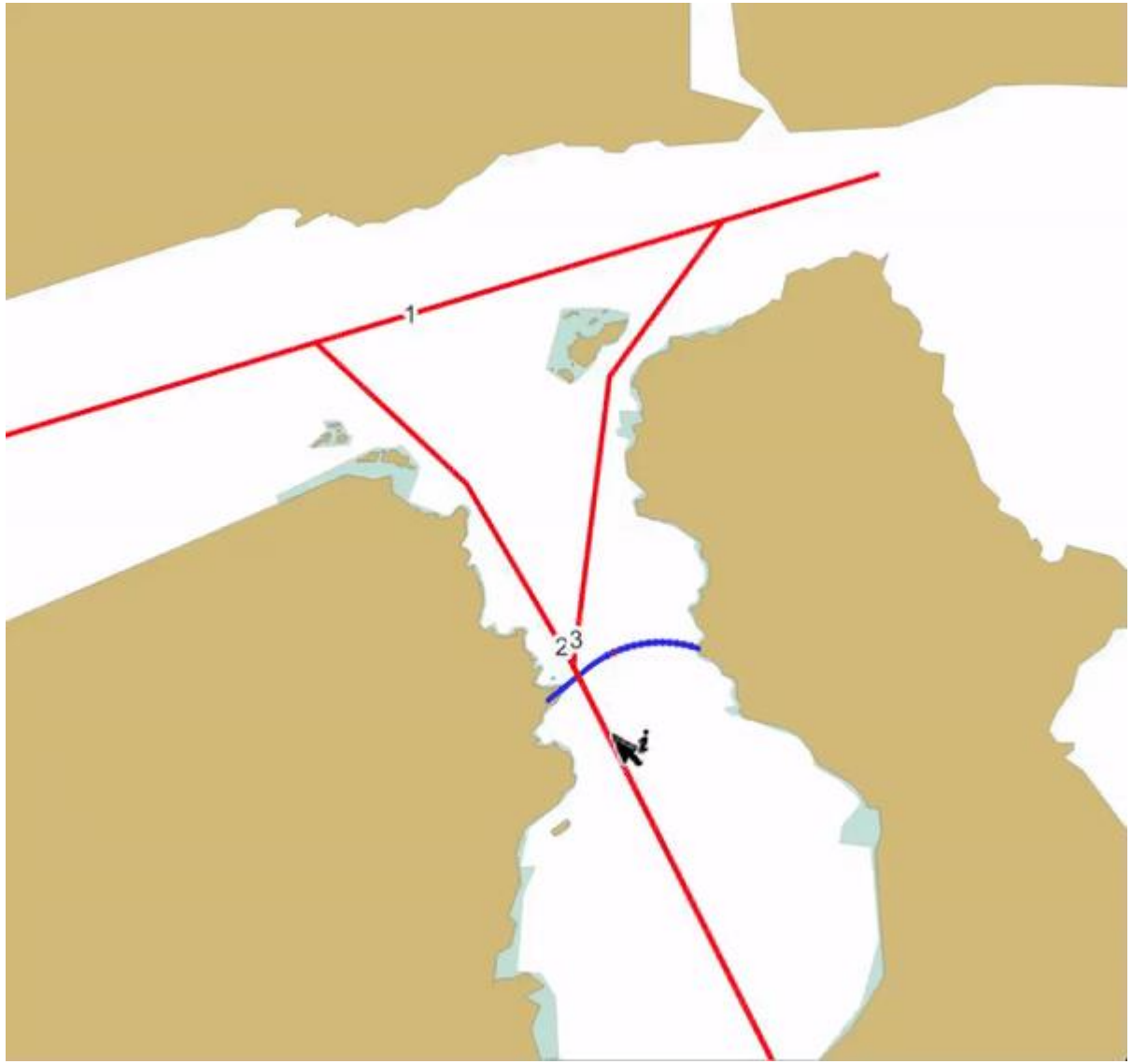
- Missing turning point
- Sharp turning

Great belt bridge (3/3)

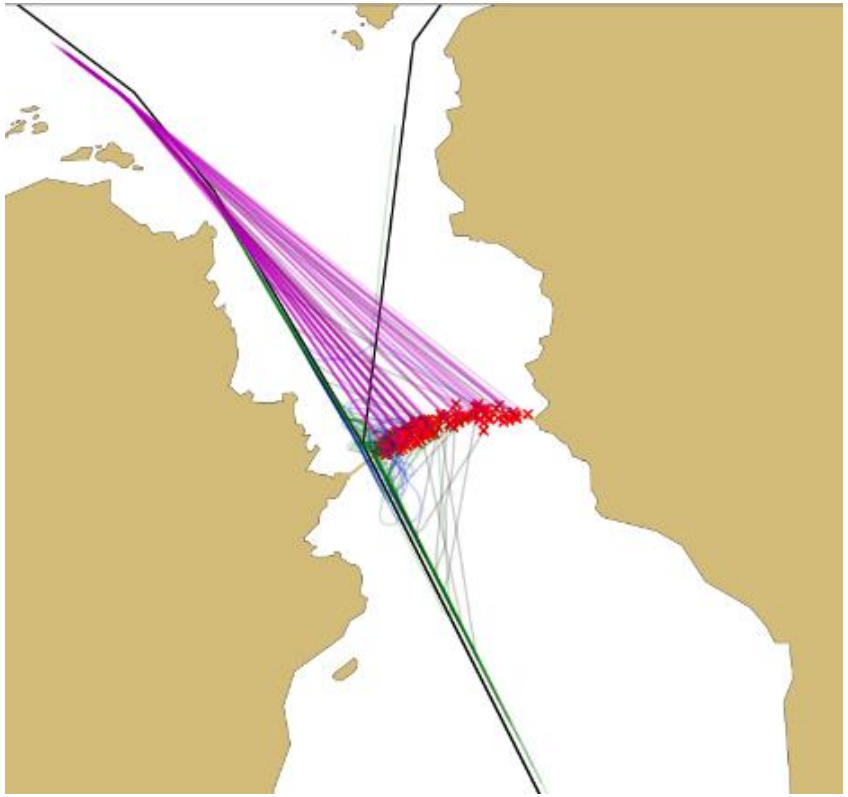


- From one accident every 140 year
- To one accident every 210 year
- Mostly reduced the allisions of ships with high speed

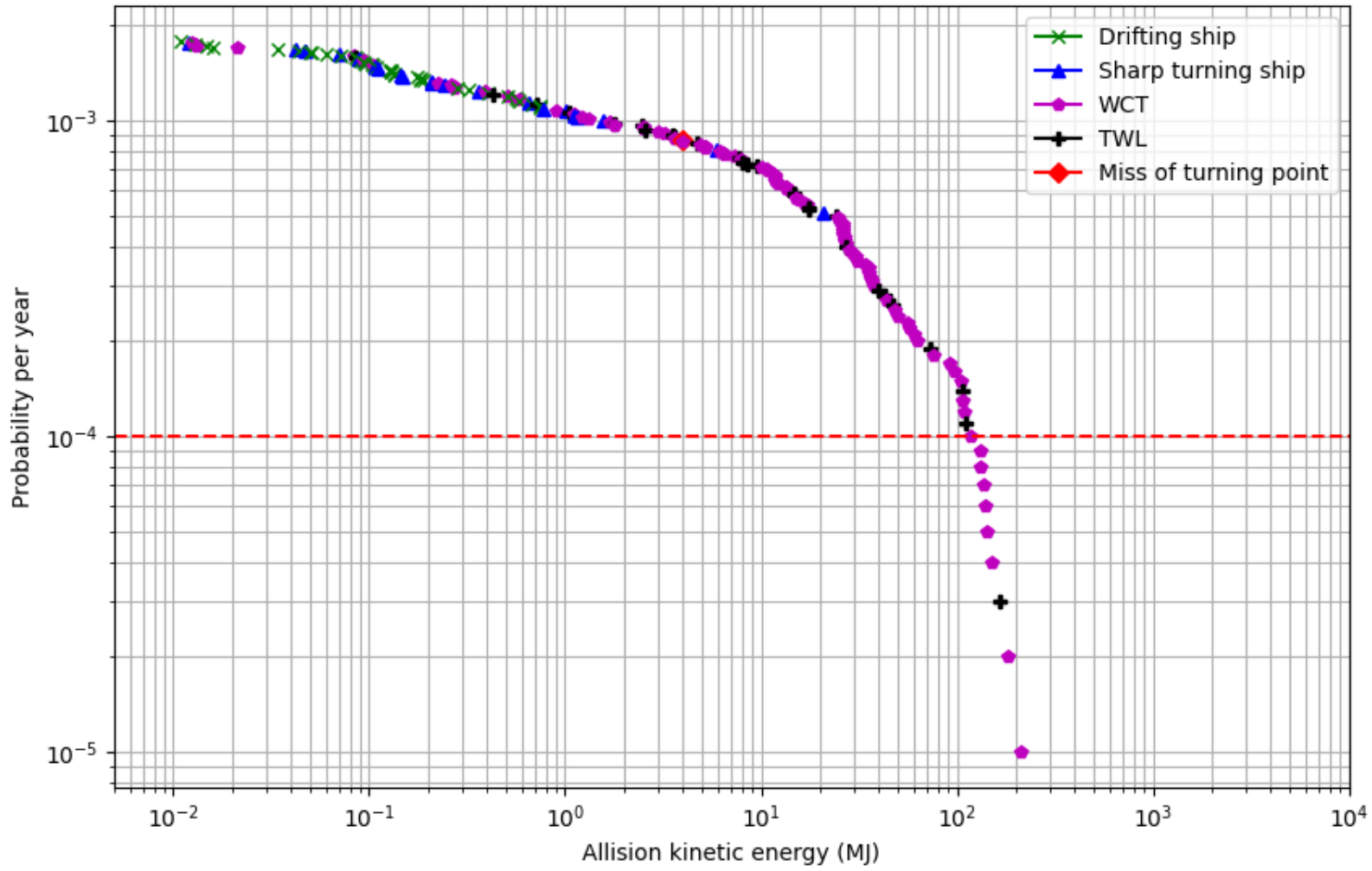
Examples from Halsafjorden



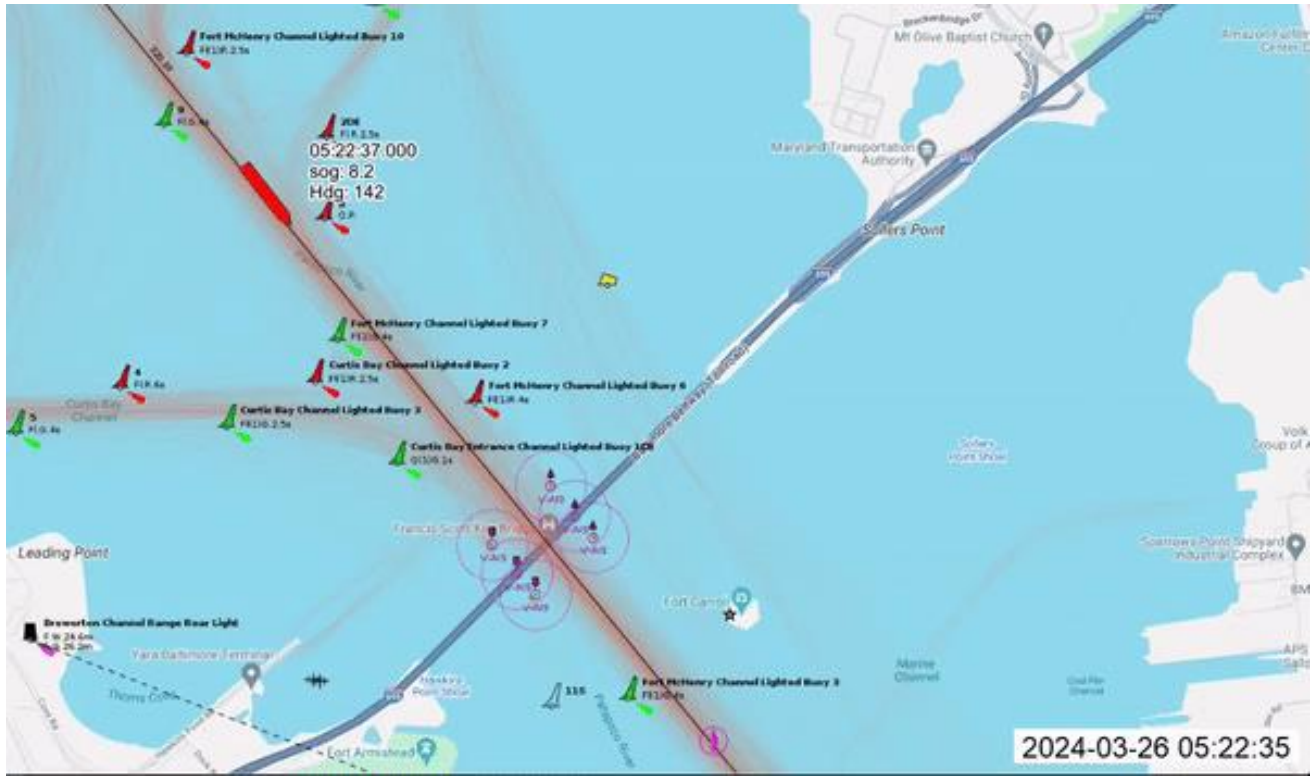
- Turning at the wrong location
- Setting the wrong course at the turning point

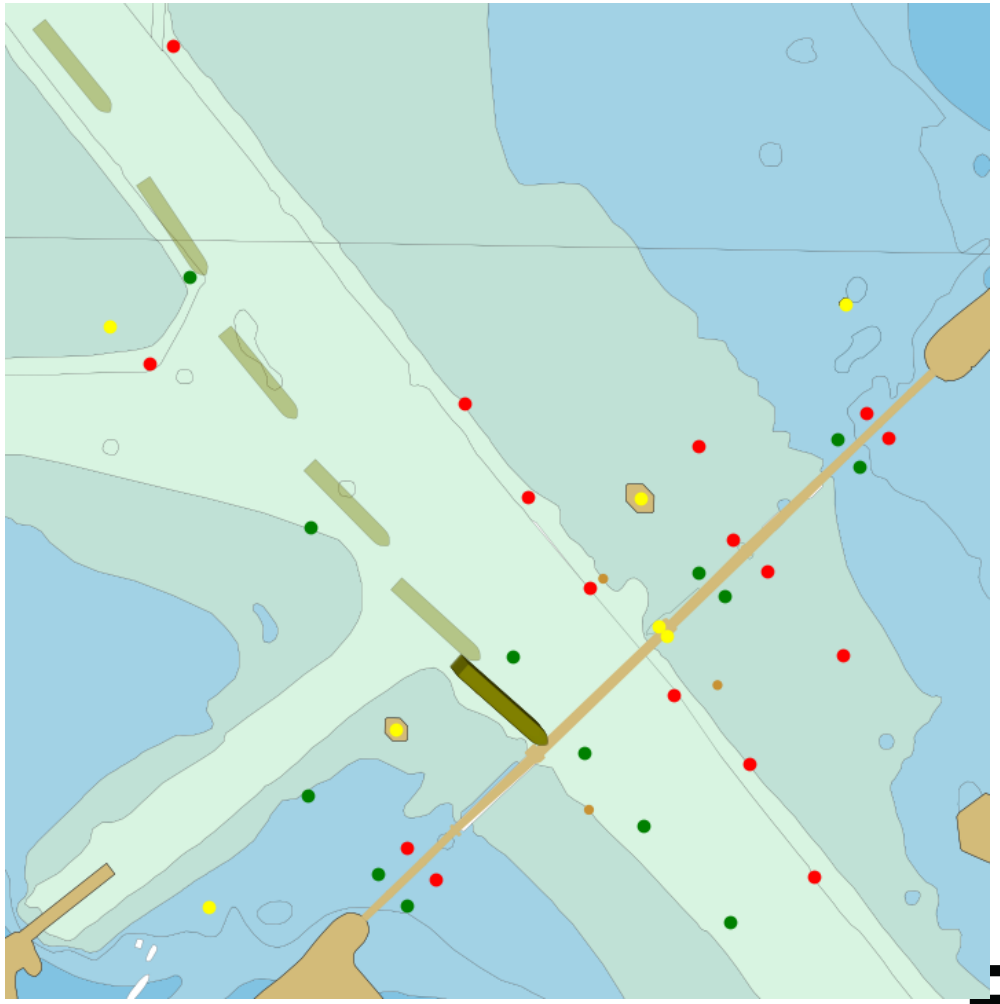


Energy map – Halsafjorden



Baltimore Dali and example





WasingtonPost and NewYork Times

QUESTIONS?

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