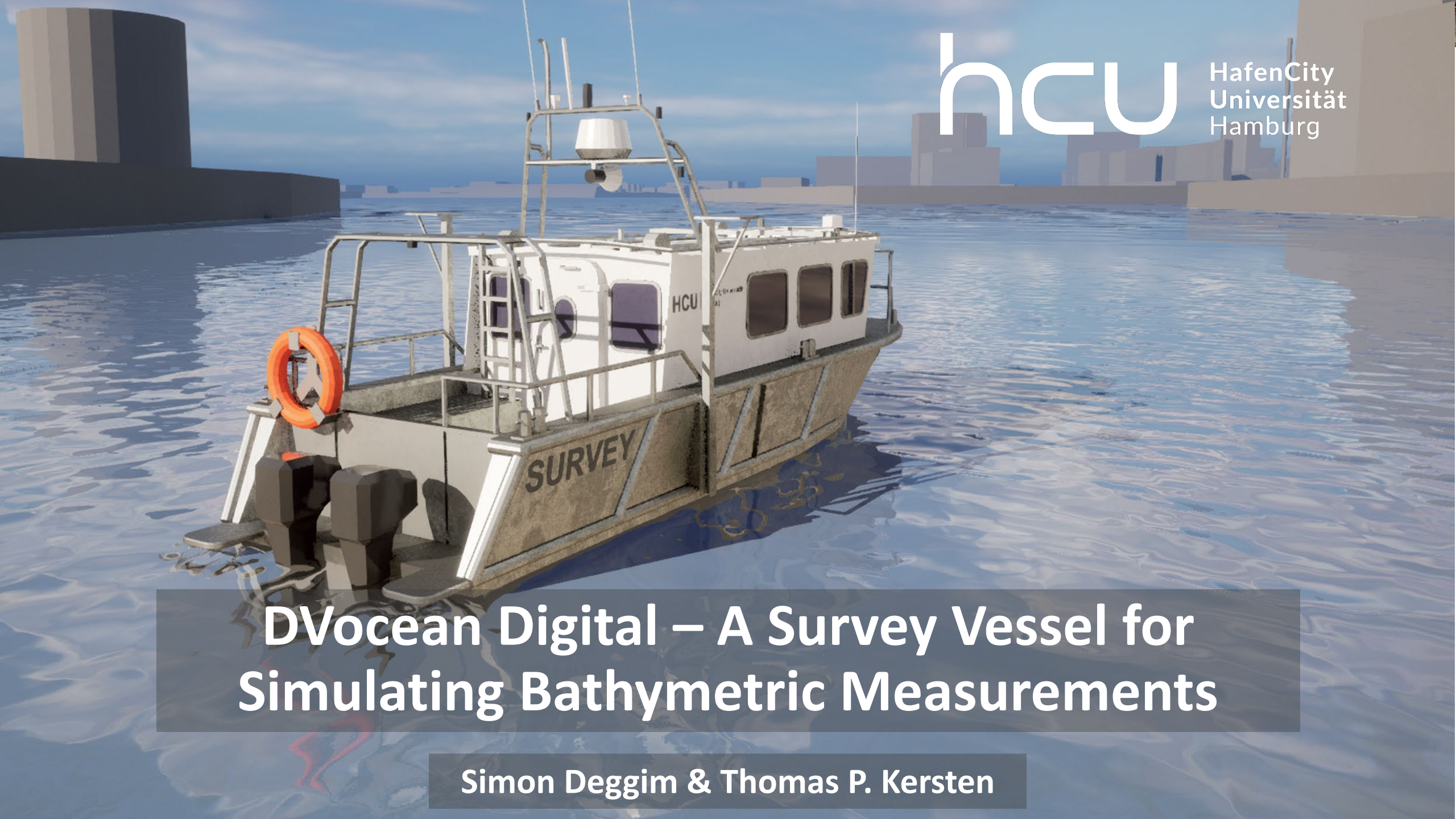


HafenCity Universität Hamburg

DVocean Digital – A Survey Vessel for Simulating Bathymetric Measurements

Simon Deggim & Thomas P. Kersten

HYDRO 2024 Hydrographic Conference

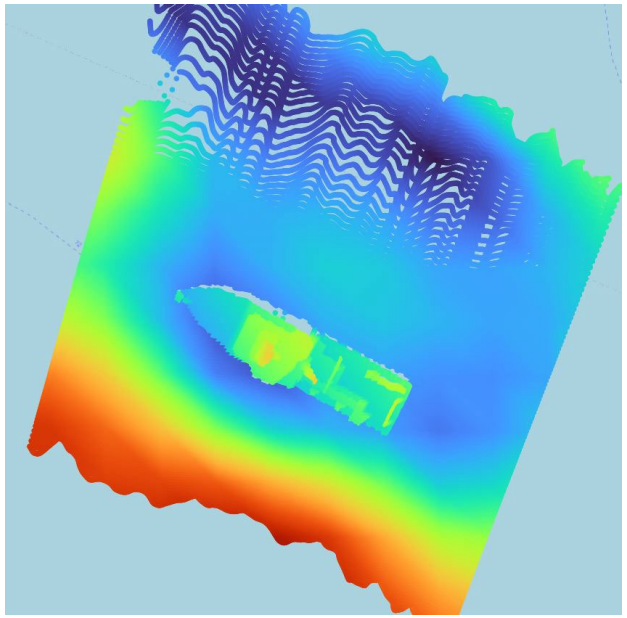
HafenCity Universität Hamburg

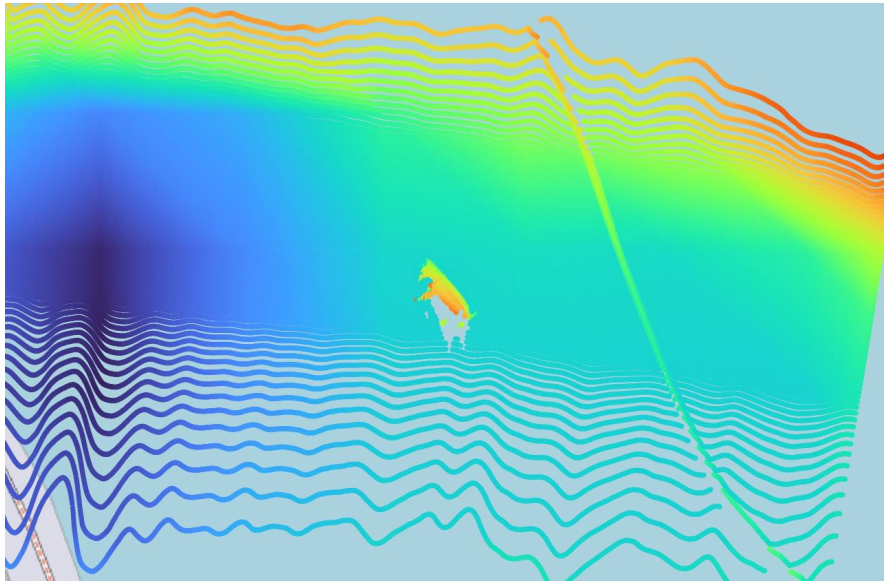
Agenda

- Introduction
- Project partner
- Goals
- Basics
- Application development
- Data acquisition & processing
- Conclusions & outlook

1. Introduction

- The idea



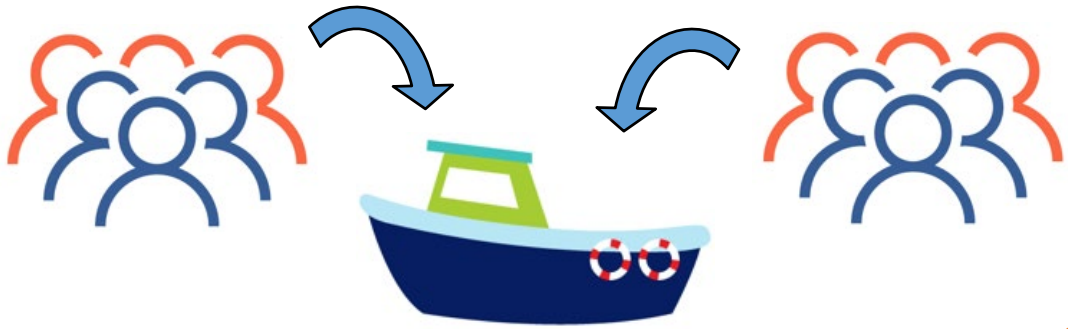


Freepik, macrovector

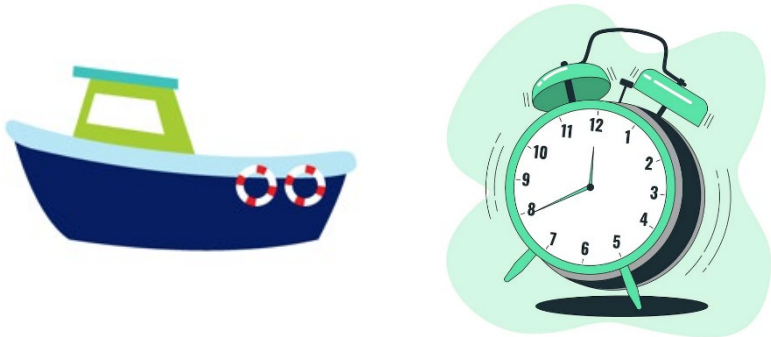
1. Introduction

Motivation

Too many students for a small ship

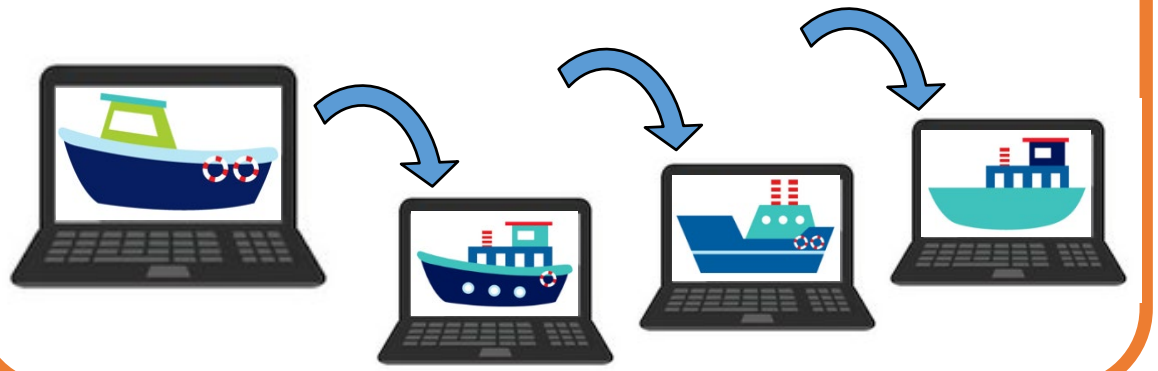


Ship time is valuable (time & cost intensive)



Visualisation and training of survey processes

Beyond HCU: Tool for training and simulation



Freepik, Muammark, storyset, macrovector

2. Project partner

- **Financed by Hamburg Innovation (HI) as part of the Hamburg Authority for Science, Research, Equality and Districts**
- **Partners**

HAMBURG INNOVATION

Hamburg Port Authority

BSH BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

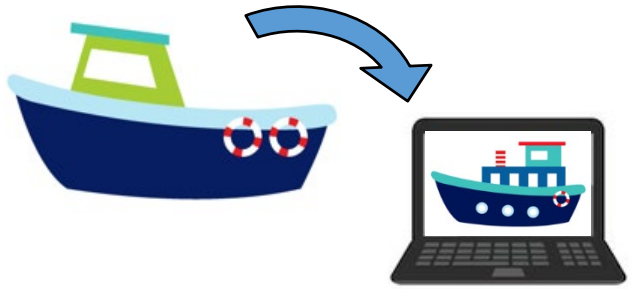
The Federal Maritime and Hydrographic Agency

hcu HafenCity Universität Hamburg

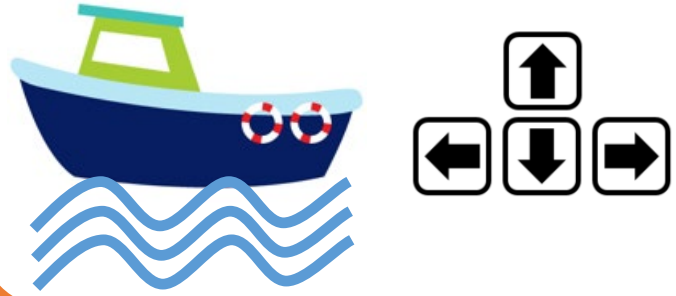
3. Goals

- **Development of a prototype – Dvocean Digital as PC Desktop Version**

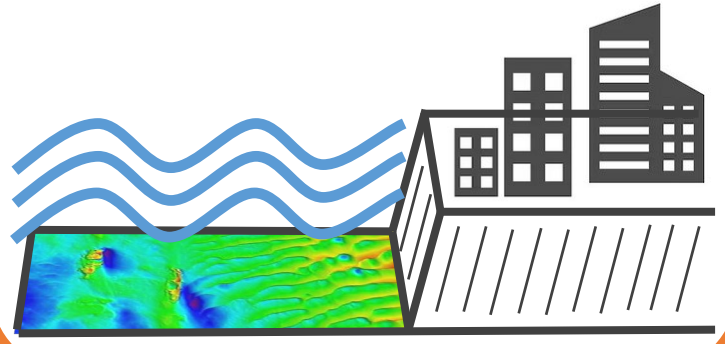
3D model of the DVocean



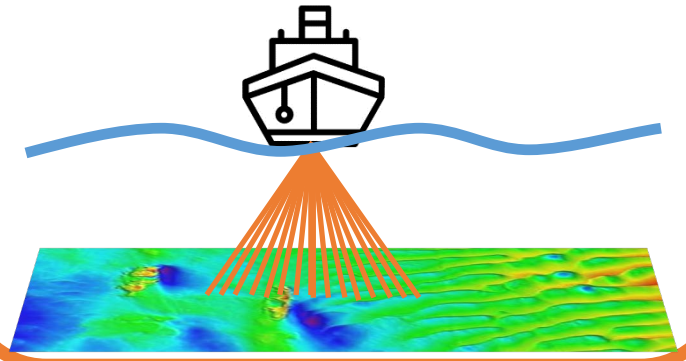
Simulate of basic ship movem.



Virtual Environment

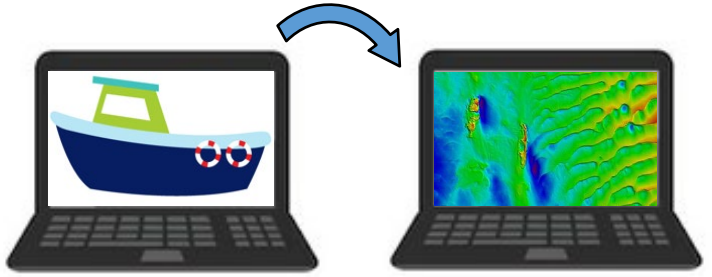


Simulation Multibeam Echo S.



Educational content

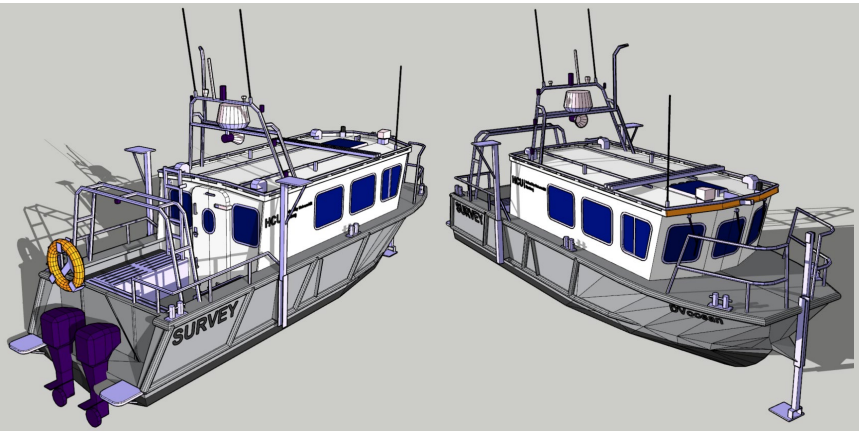
Data export

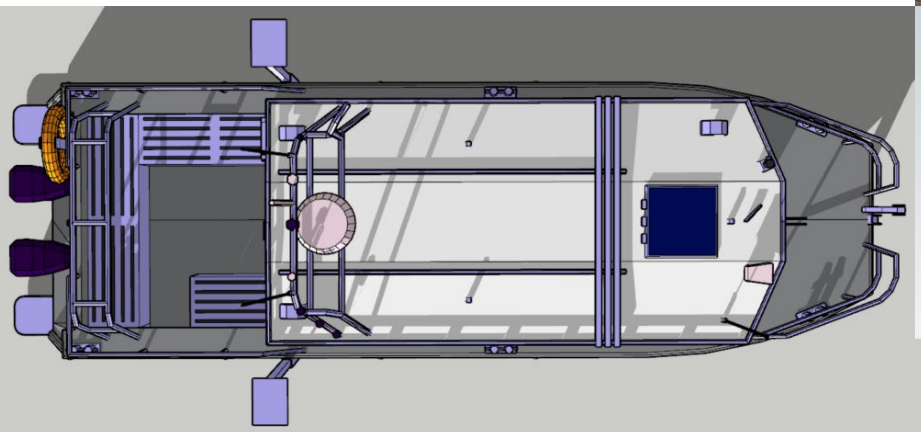


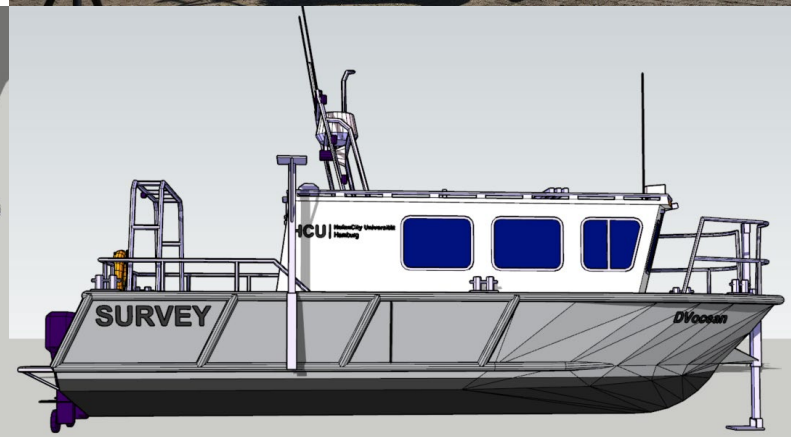
HCU, Freepik, new7ducks, macrovector

4. Basics

- Terrestrial laser scanning of the ship using Z+F IMAGER 5010
- Lecture notes Hydrography and informationen provided by Dilip Adhikari, Mona Lütjens and Ellen Heffner (academic staff Hydrography)
- 3D city model LoD2 (LGV Hamburg)
- Additional information by BSH, IHO & HCU
- 3D modelling of DVocean in the point cloud

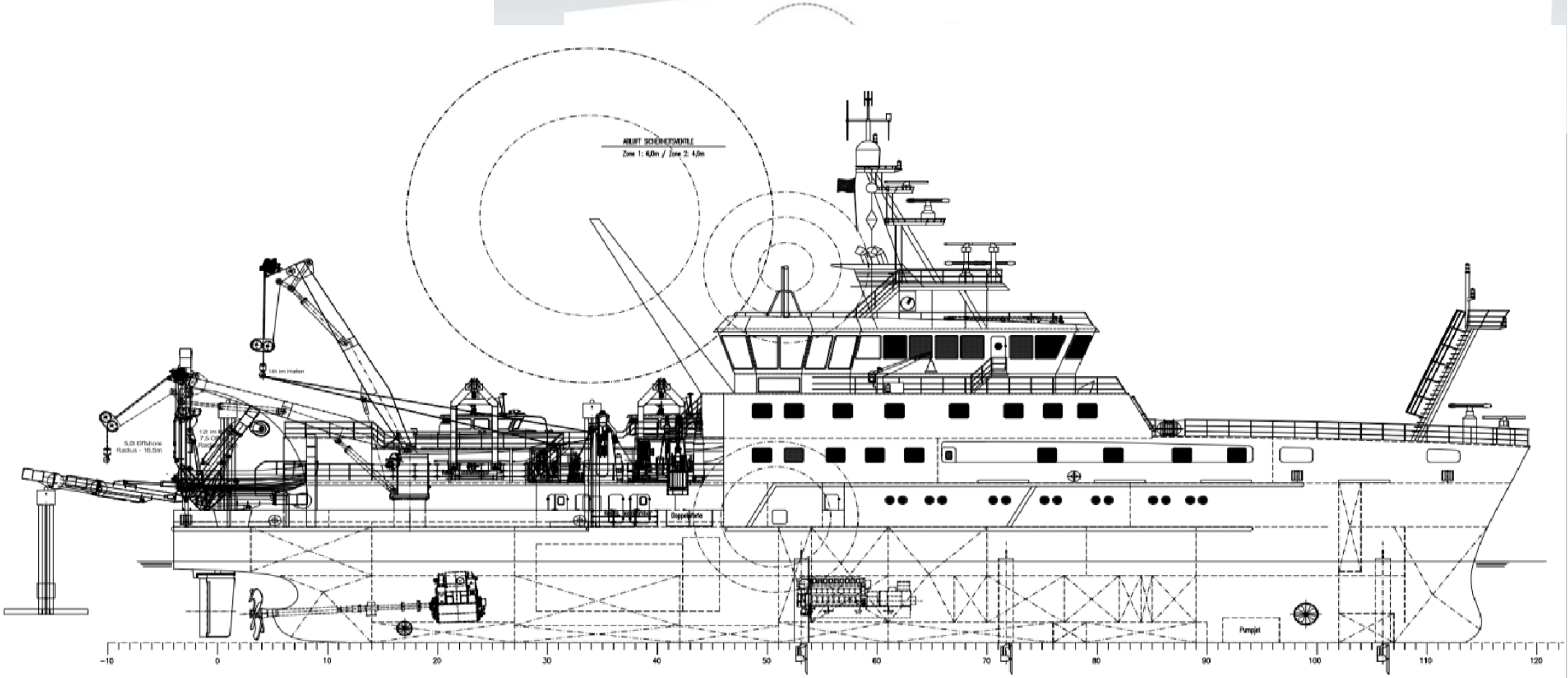






4. Basics

- 3D modelling of the ship Atair from BSH using drawing plans



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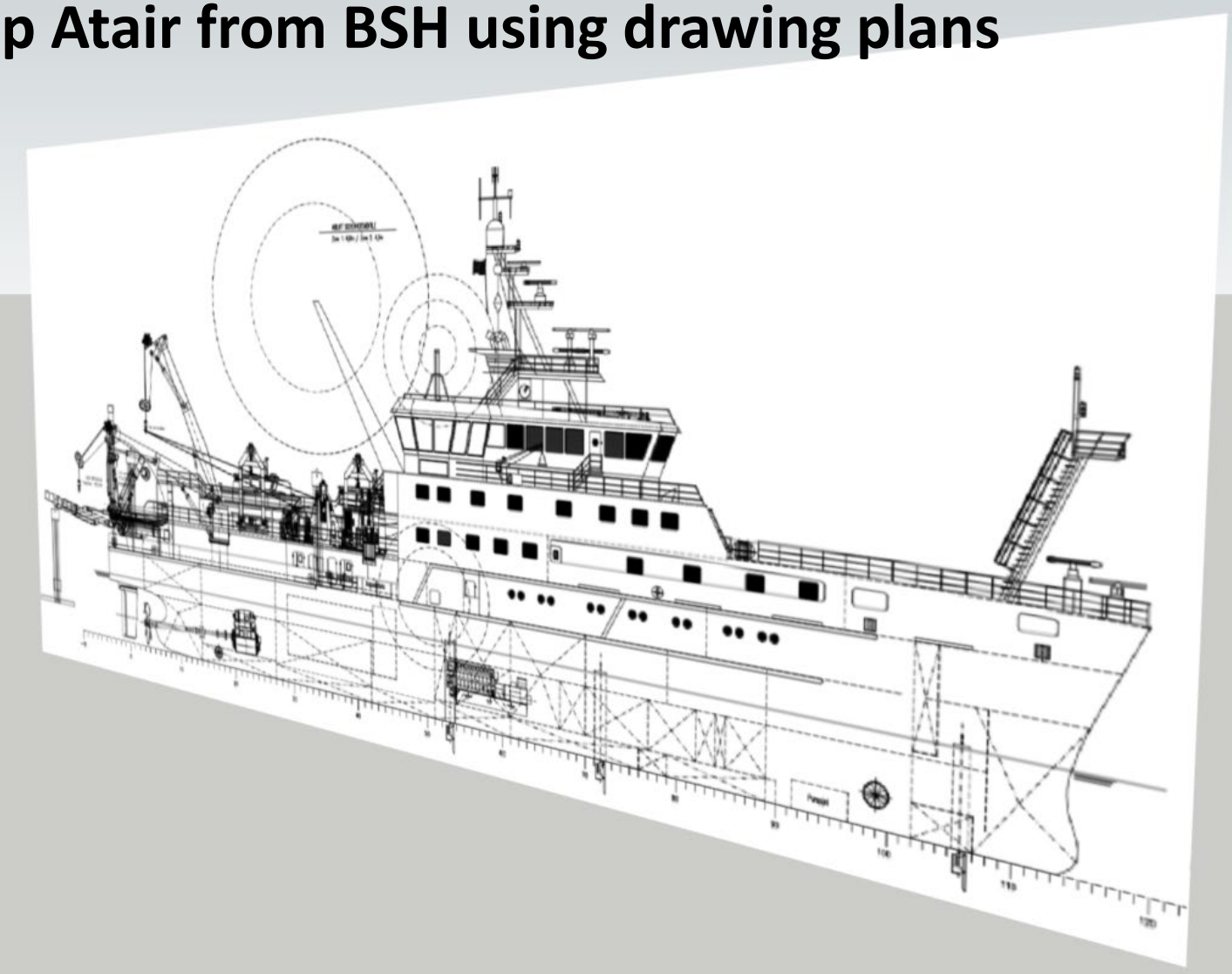
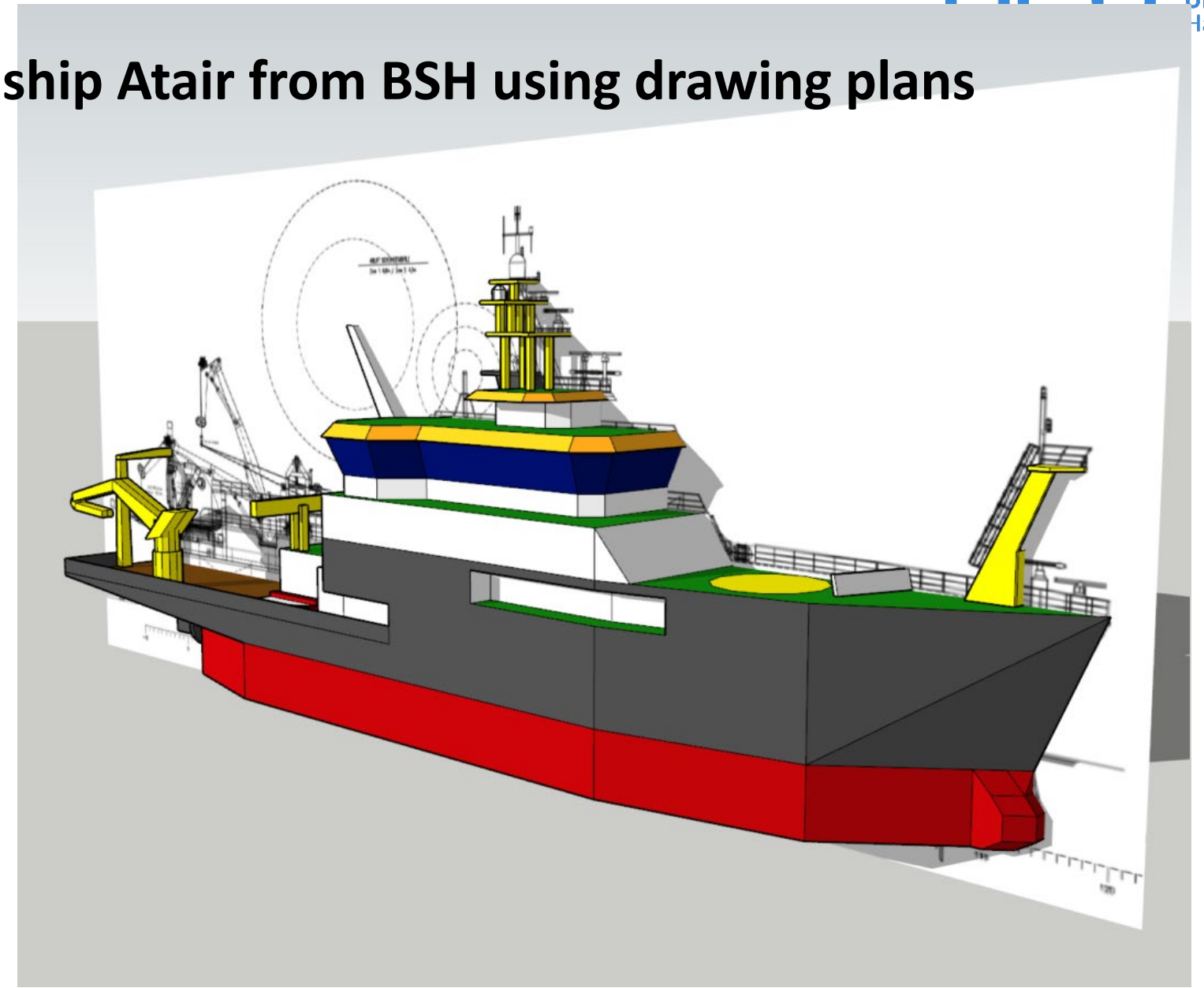
4. Basics

- 3D modelling of the ship Atair from BSH using drawing plans



4. Basics

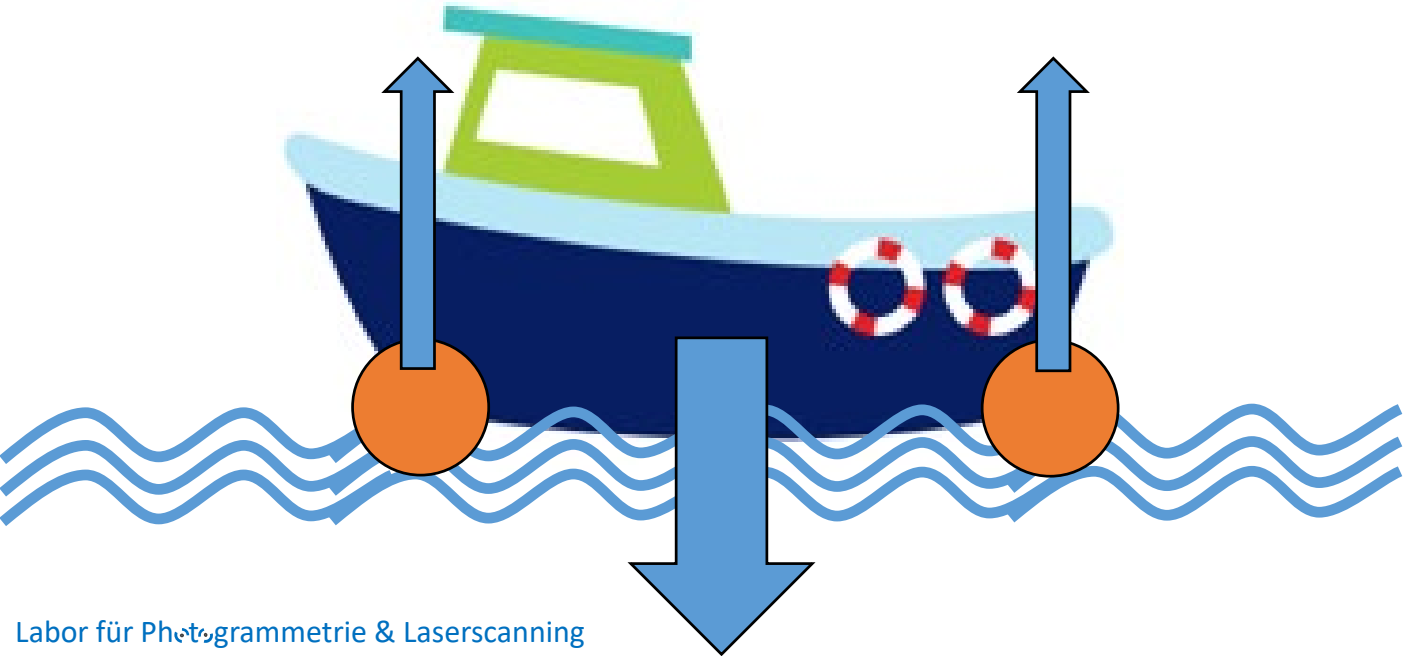
- 3D modelling of the ship Atair from BSH using drawing plans

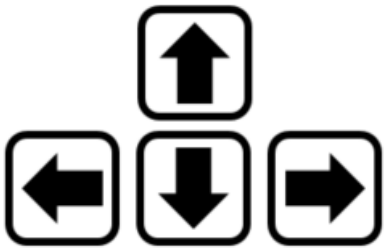


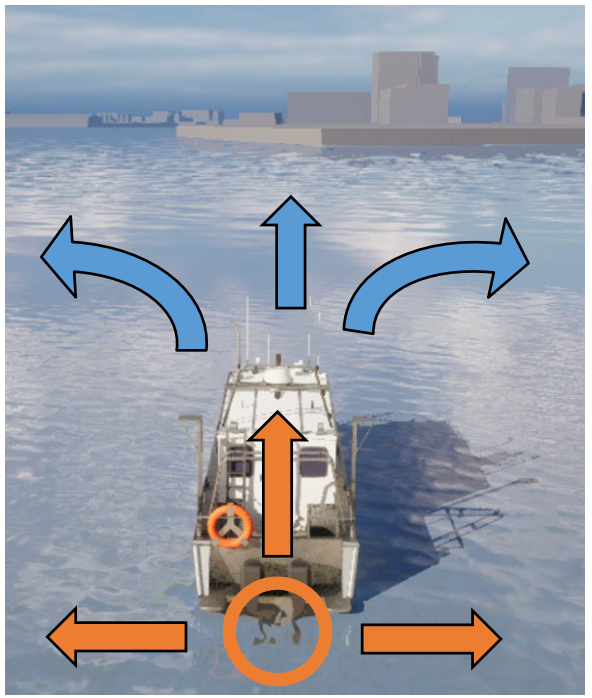
5. Application development

Programming in Unreal Engine 5

- Optimised for real-time applications, 3D graphics & simulation of physics
- Advantage - Good performance, realistic simulation of the waves
- Problem – Tricky buoyancy (uplift) behaviour
- Steering of the ship
- Simulating forces at location of engines







5. Application development

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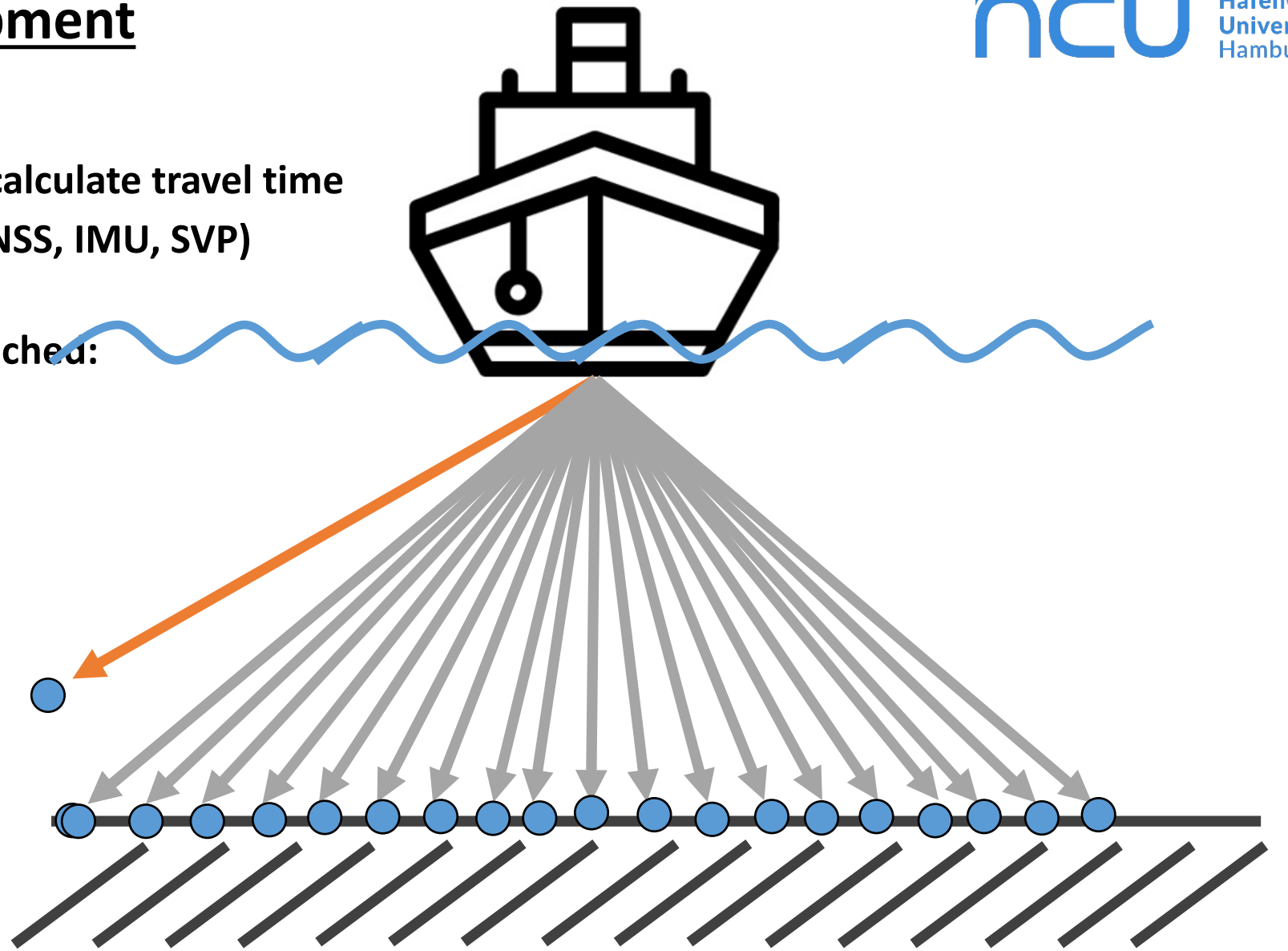
MBES simulation

- Simulate `true` beam, calculate travel time
- Apply uncertainties (GNSS, IMU, SVP) on second beam
- When travel time is reached: -> measured point
- Repeat for every beam



Freepik, flatart

5. Application development

- **MBES simulation**
  - Simulate true beam, calculate [illegible]
  - Apply uncertainties (GNSS, IMU, SVP) on second beam
  - When travel [illegible]
    - measured point
  - Repeat for [illegible]

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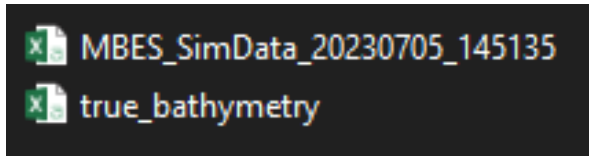
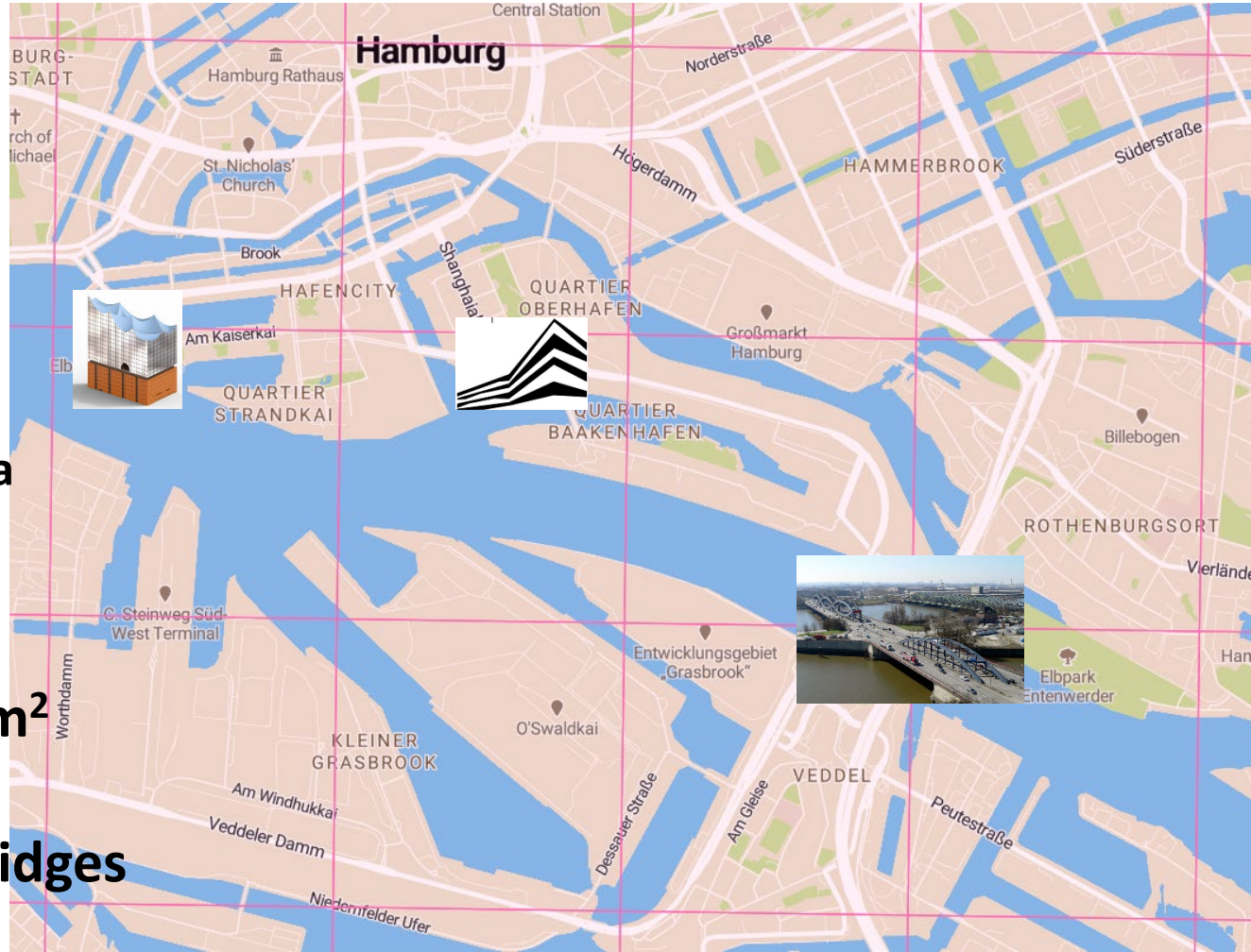
Freepik, flatart

5. Application development

- **Data export**
  - Internal database for storing current measurement data
  - Status: Export as XYZ file with ping number and date
  - Automatic data storage of measurement data if too large
  - In addition: Real bathymetry of the entire area in coarse resolution for comparison with the measurement data

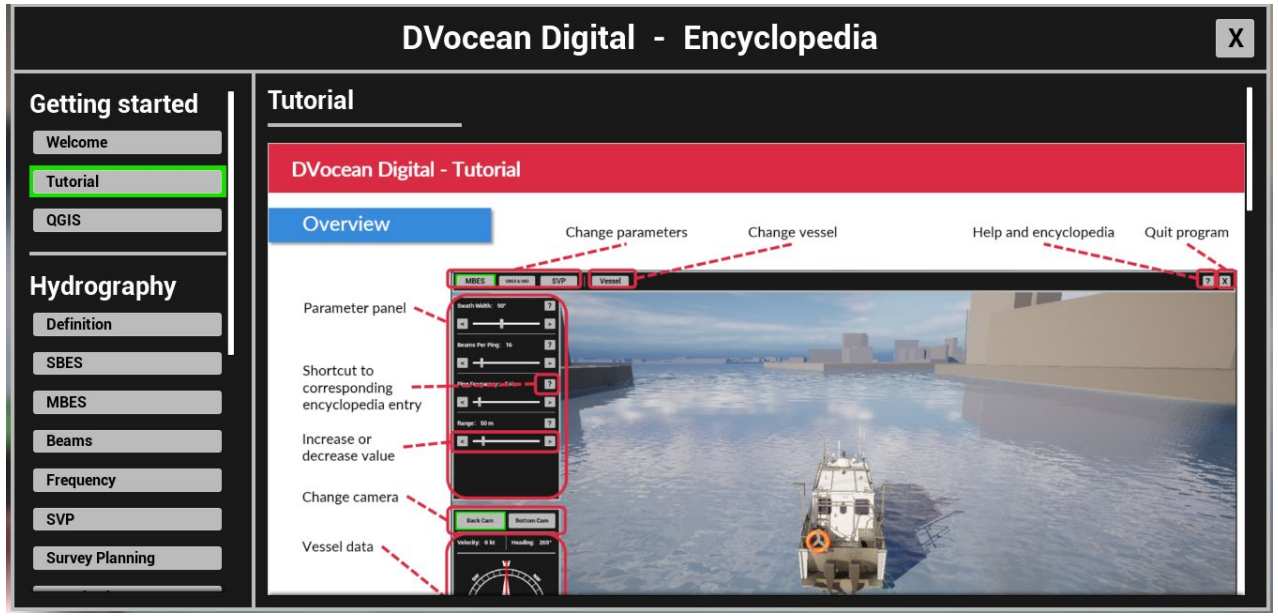


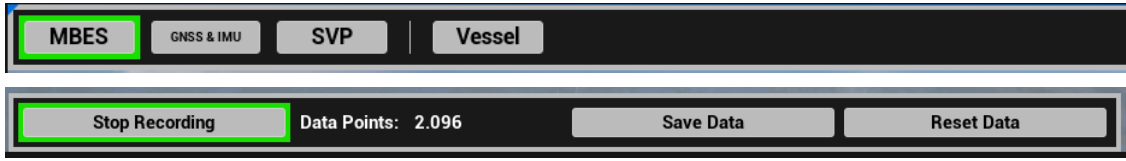
- **Virtual environment - 12 tiles 1 × 1 km² 3D city model (LoD2) from the Elbe Philharmonic Hall to the river Elbe bridges**

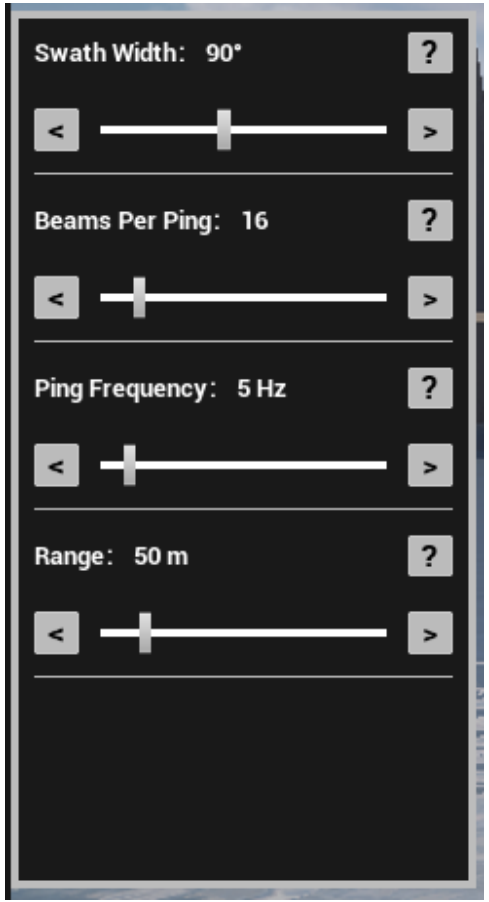


5. Application development

- Encyclopaedia with tutorials and background knowledge in English
- Graphical user interface in English

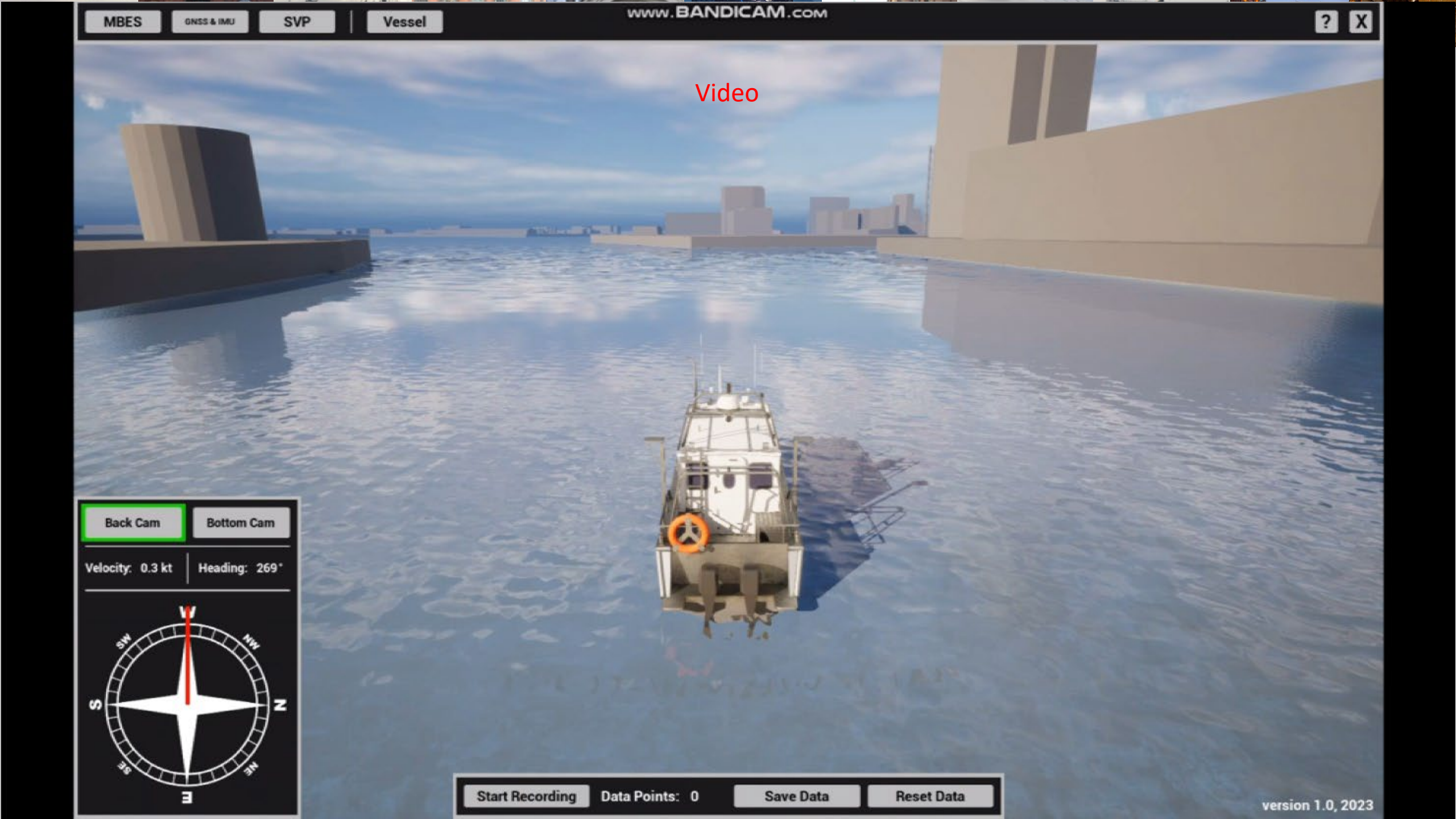






6. Data acquisition & processing

- **Simulation programme**


MBES
GNSS & IMU
SVP
Vessel
www.BANDICAM.com
?
X
Video
Back Cam
Bottom Cam
Velocity: 0.3 kt
Heading: 269°
W
NW
N
NE
E
SE
S
SW
Start Recording
Data Points: 0
Save Data
Reset Data
version 1.0, 2023

6. Data acquisition & processing

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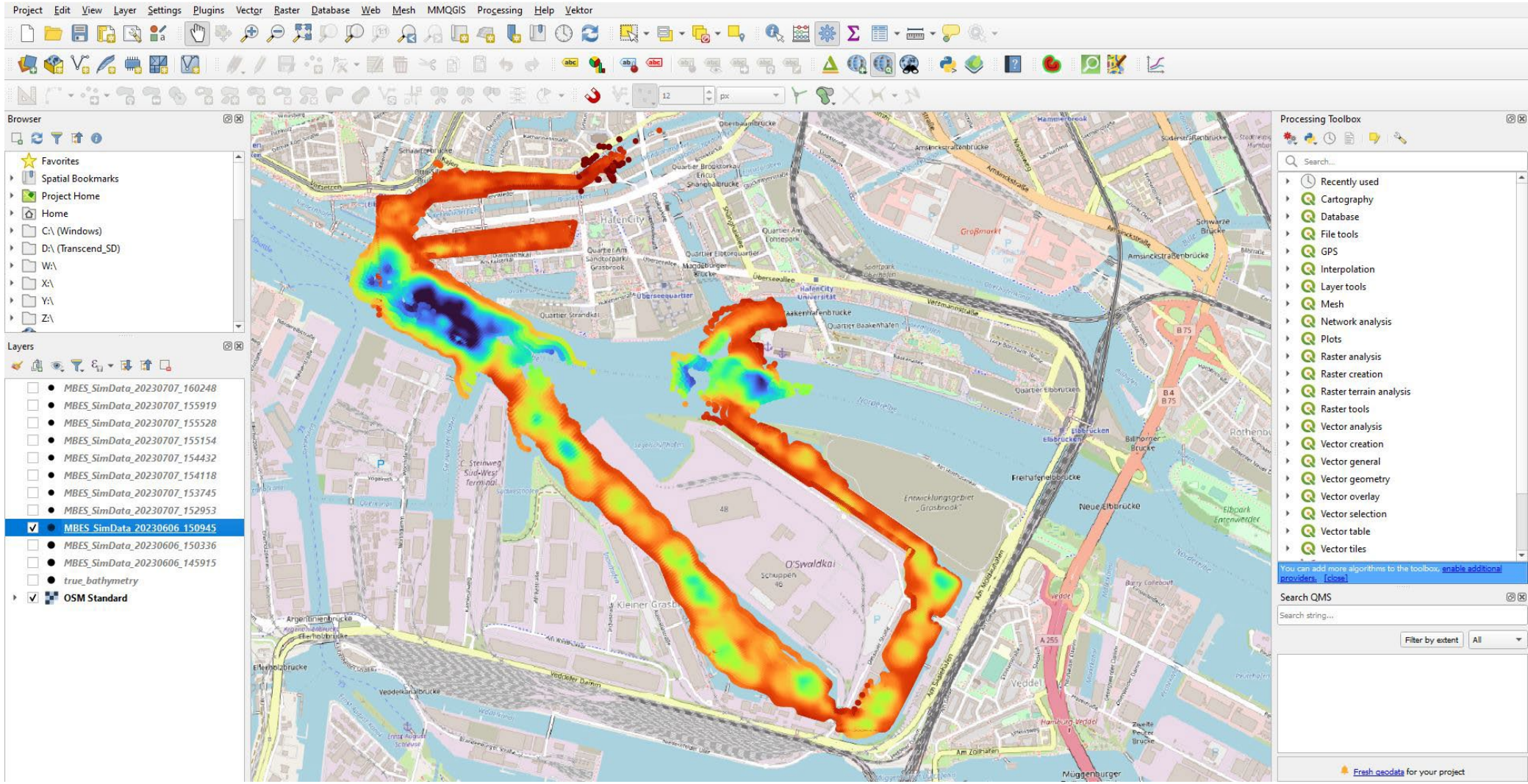
- **Visualisation software QGIS**

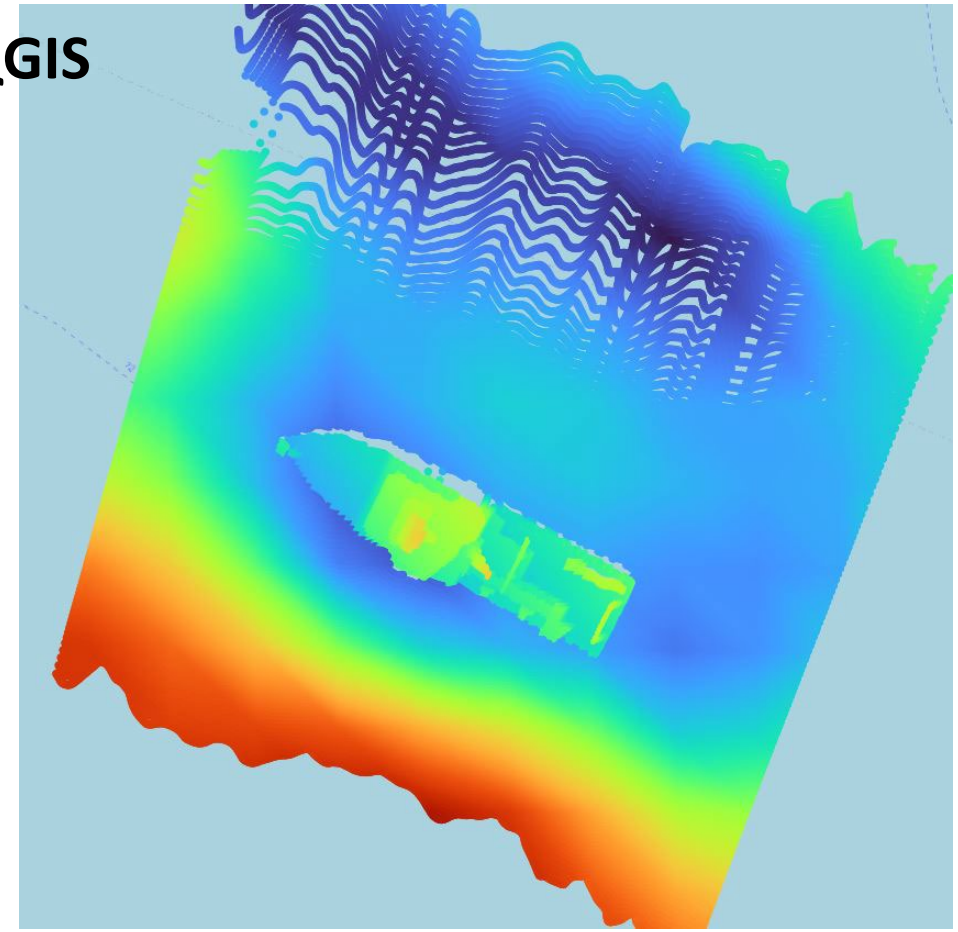


6. Data acquisition & processing

- **Analysis in QGIS**

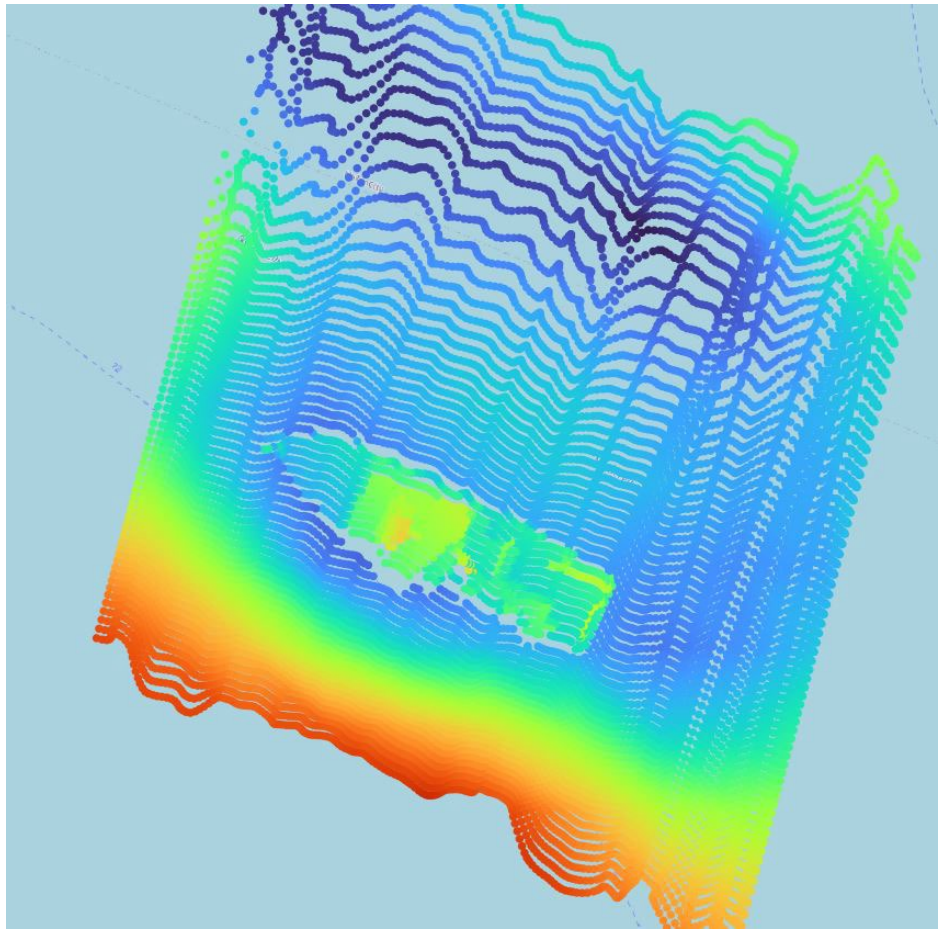
Depth in m

20
30
40
50
60
70



Swadth Width: 160°
Beams per Ping: 128
Ping Frequency: 50 Hz
Range: 300 m

IMU Accuracy: 0,01°
GNSS Hor. Accuracy: 0,6 cm
GNSS Ver. Accuracy: 1 cm
Sound Velocity: 1450 m/s

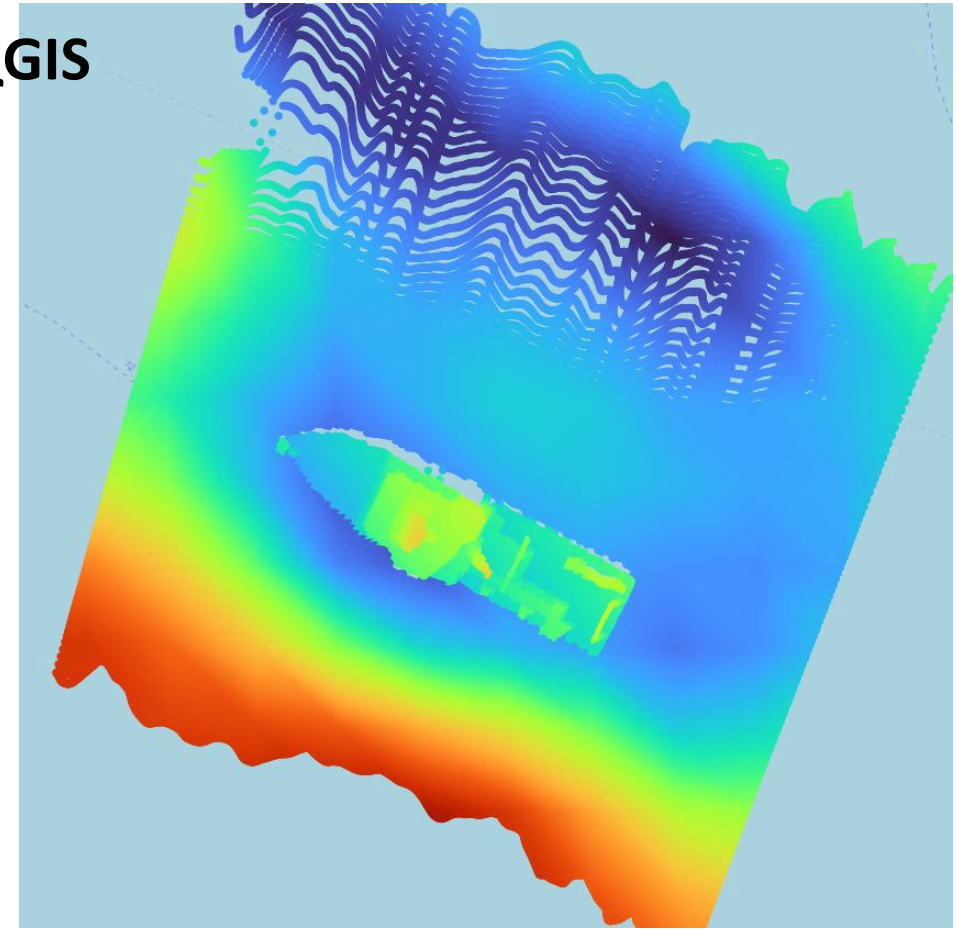


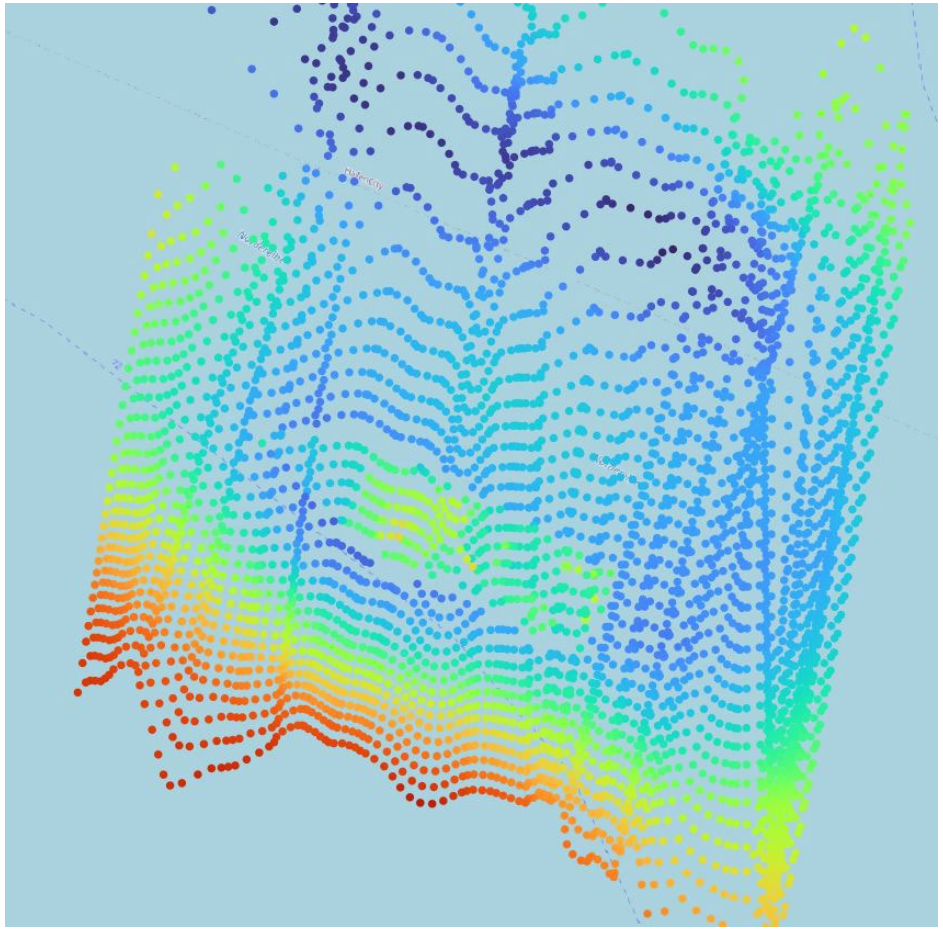
Swadth Width: 160°
Beams per Ping: 64
Ping Frequency: 10 Hz
Range: 300 m

IMU Accuracy: 0,01°
GNSS Hor. Accuracy: 0,6 cm
GNSS Ver. Accuracy: 1 cm
Sound Velocity: 1450 m/s

6. Data acquisition & processing

- **Analysis in QGIS**





Swadth Width: 160°
Beams per Ping: 128
Ping Frequency: 50 Hz
Range: 300 m

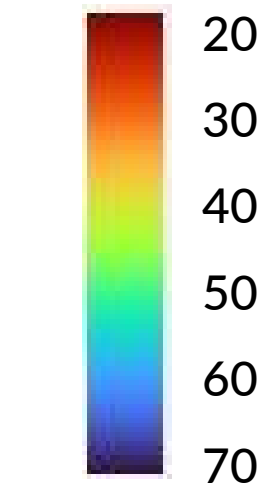
IMU Accuracy: 0,01°
GNSS Hor. Accuracy: 0,6 cm
GNSS Ver. Accuracy: 1 cm
Sound Velocity: 1450 m/s

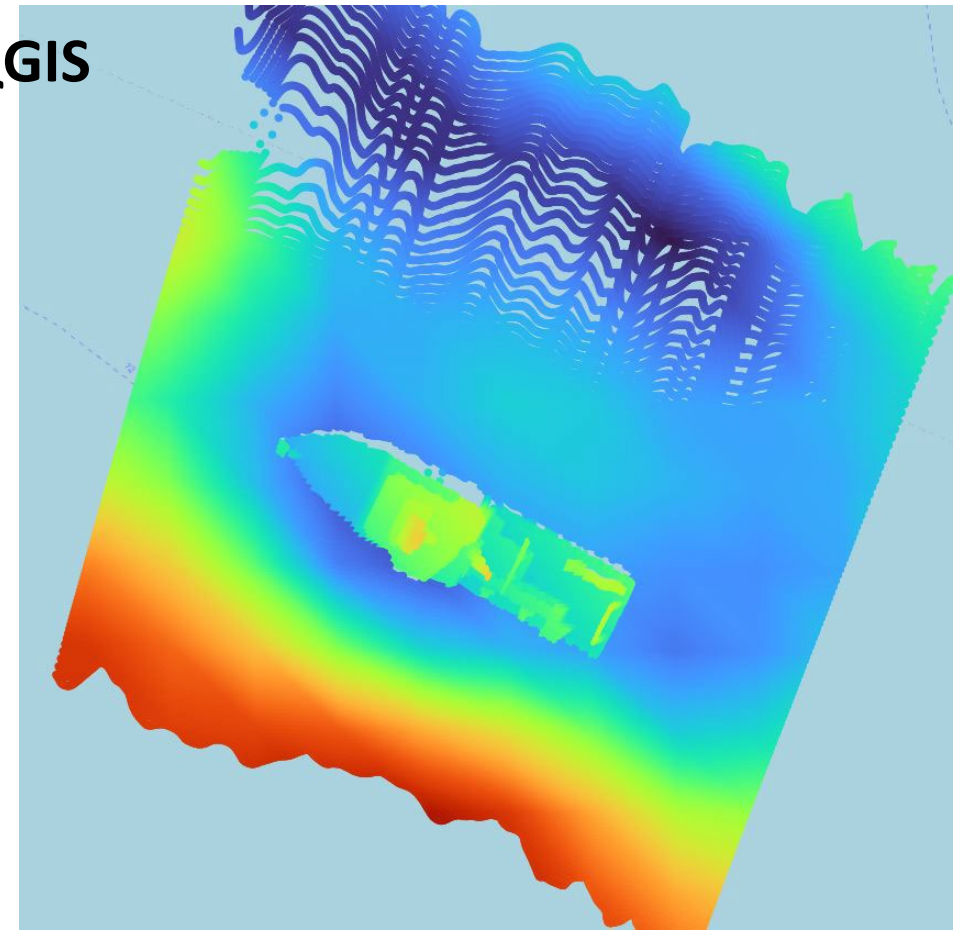
Swadth Width: 160°
Beams per Ping: 32
Ping Frequency: 5 Hz
Range: 300 m

IMU Accuracy: 0,01°
GNSS Hor. Accuracy: 0,6 cm
GNSS Ver. Accuracy: 1 cm
Sound Velocity: 1450 m/s

6. Data acquisition & processing

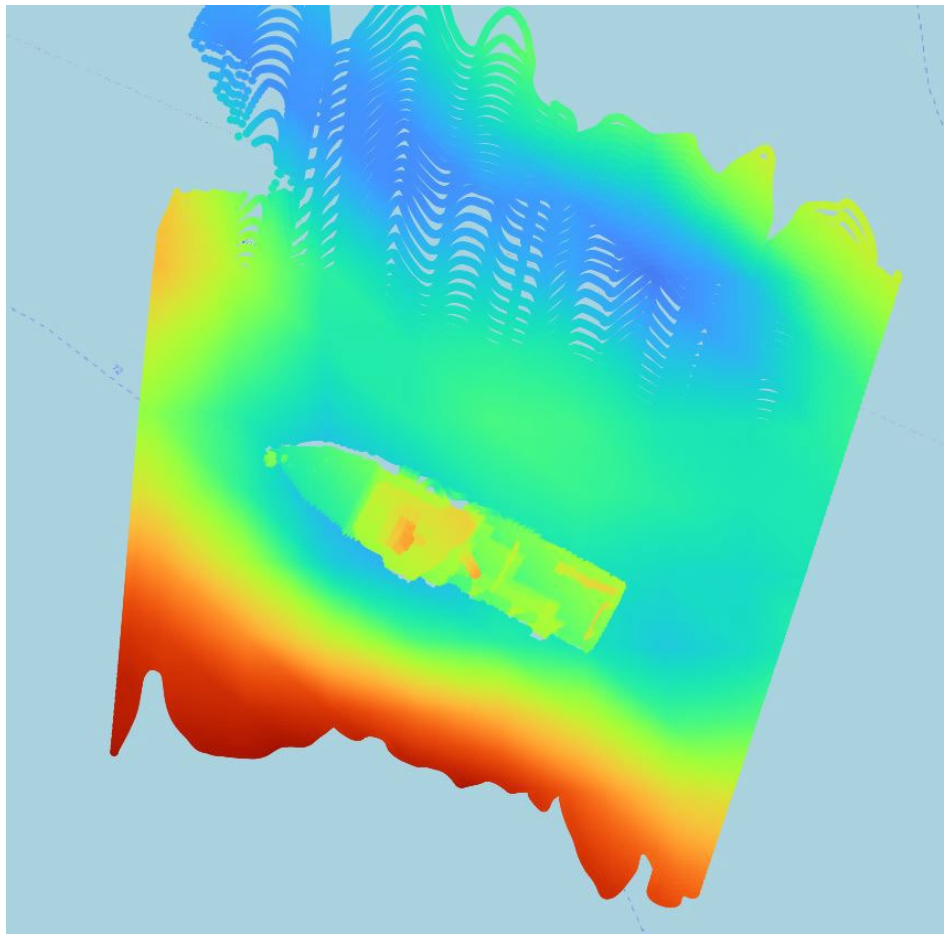
- **Analysis in QGIS**





Swadth Width: 160°
Beams per Ping: 128
Ping Frequency: 50 Hz
Range: 300 m

IMU Accuracy: 0,01°
GNSS Hor. Accuracy: 0,6 cm
GNSS Ver. Accuracy: 1 cm
Sound Velocity: 1450 m/s

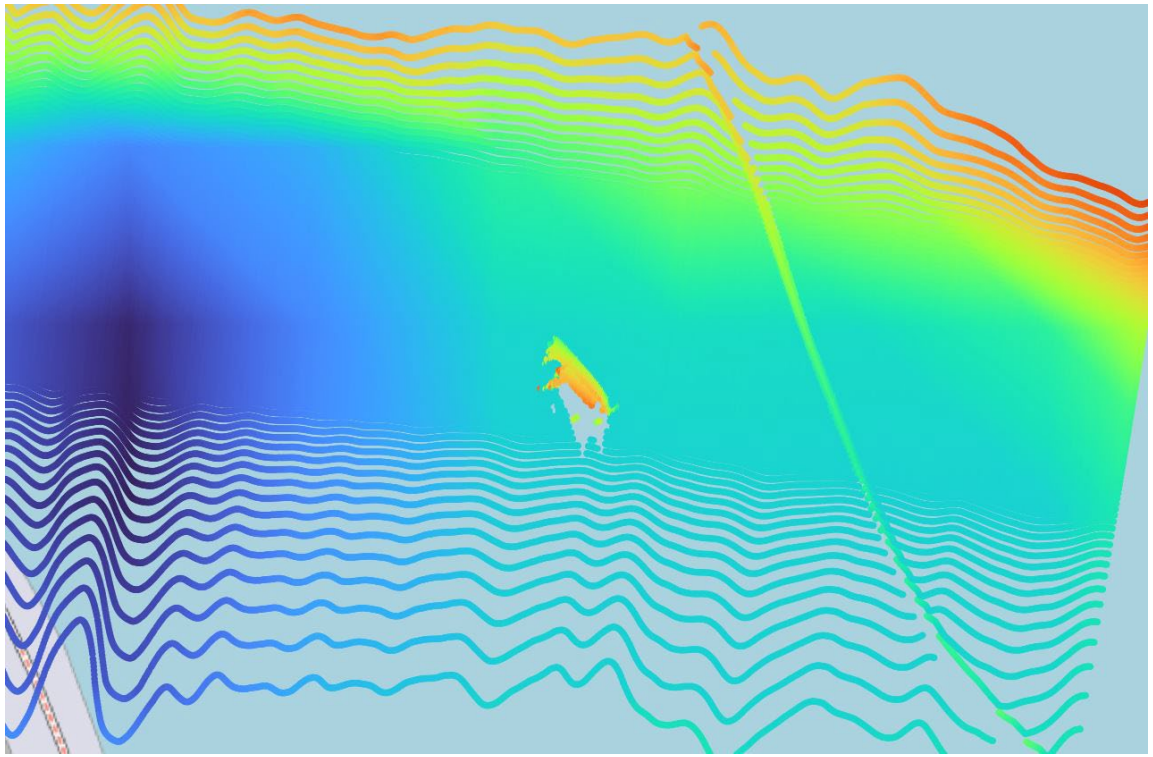


Swadth Width: 160°
Beams per Ping: 128
Ping Frequency: 50 Hz
Range: 300 m

IMU Accuracy: 0,01°
GNSS Hor. Accuracy: 0,6 cm
GNSS Ver. Accuracy: 1 cm
Sound Velocity: 1300 m/s

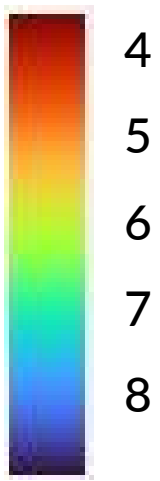
6. Data acquisition & processing

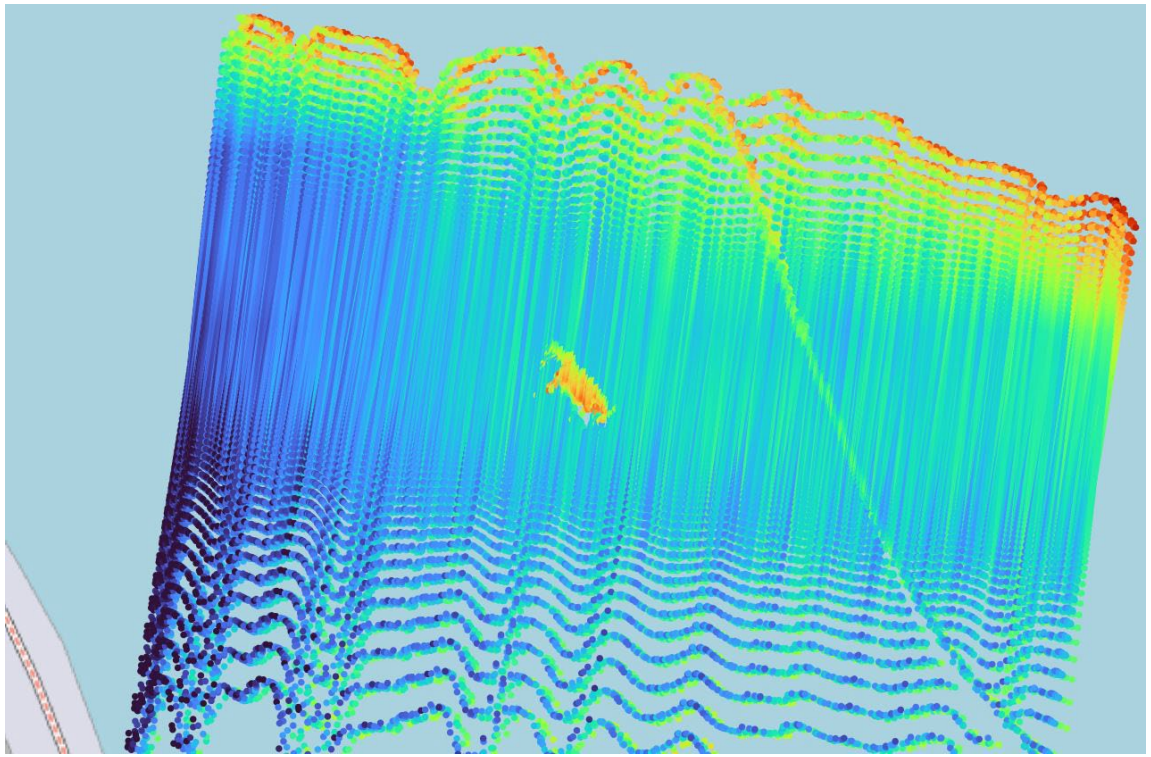
- **Analysis in QGIS**



Swadth Width: 160°
Beams per Ping: 128
Ping Frequency: 50 Hz
Range: 300 m

IMU Accuracy: 0,01°
GNSS Hor. Accuracy: 0,6 cm
GNSS Ver. Accuracy: 1 cm
Sound Velocity: 1450 m/s





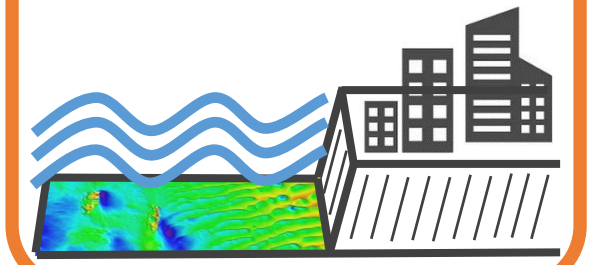
Swadth Width: 160°
Beams per Ping: 128
Ping Frequency: 50 Hz
Range: 300 m

IMU Accuracy: 2°
GNSS Hor. Accuracy: 10 cm
GNSS Ver. Accuracy: 30 cm
Sound Velocity: 1450 m/s

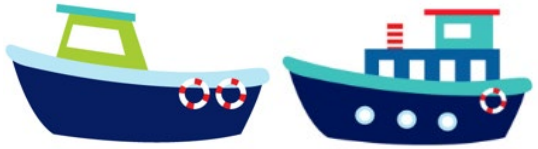
7. Conclusions & outlook

- **Prototype: “DVocean Digital v1“**
- **Standalone software (800 MB)**
- **Simulation water & ships**

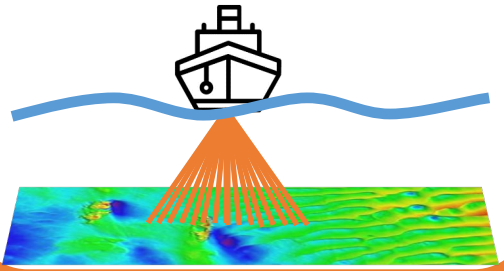
1 environment: Hamburg



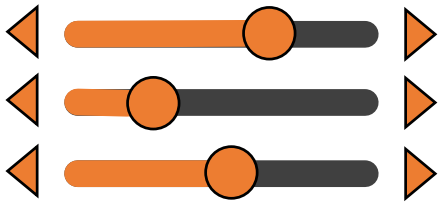
2 ships: Dvocean + Atair



1 instrument: MBES

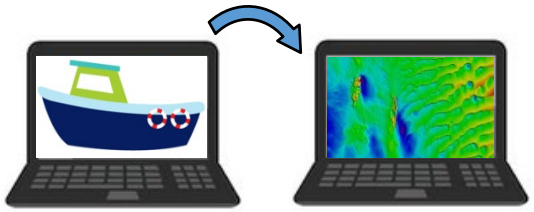


8 parameter



1 encyclopaedia

data acquisition & export



HCU, Freepik, new7ducks, macrovector

7. Conclusions & outlook

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- **Possible improvements**
  - in the instrument simulation with additional parameters
  - in the ship simulation with more realistic behaviour
  - in the performance
  - through textured 3D city model of the harbour

- **Possible extensions**
  - Instruments – side-scan sonar, laser scanner, sediment sonar, …
  - More ships from BSH and HPA
  - Locations – other harbours, deep sea, coastlines, rivers, …
  - Features – Planning of the survey (waypoints), autopilot, …
  - Knowledge - expanding the encyclopaedia, different media, …
  - Virtual Reality – View from the driver's cab, control of the computers on board, …
  - …

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https://www.dhyg.de/images/hn_ausgaben/HN126.pdf

https://www.dhyg.de/images/fachbeitraege/DOI_10.23784_HN126-04.pdf

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https://www.researchgate.net/profile/Thomas-Kersten

Thank you very much for your attention!

Contact – Prof. Dr.-Ing. Thomas P. Kersten

HafenCity University Hamburg, Lab for Photogrammetry & Laser Scanning, Henning-Voscherau-Platz 1, D-20457 Hamburg, Thomas.Kersten@hcu-hamburg.de