

# Project SIMON

Smart Water Protection Inspired  
by 4D Underwater Monitoring



# In a nutshell



Autonomous underwater vehicle (AUV)



Smart environmental sensors & AI-based analysis



High resolution monitoring of water quality



Data integration into Digital Port Twin



Funding period: 2 yrs (11/25 – 10/27)  
Funding sum: 1 Mio €  
4 Project partners

Gefördert durch:



Bundesministerium  
für Forschung, Technologie  
und Raumfahrt

**FONA**

Forschung für Nachhaltigkeit

Digital  
GreenTech  
Robotik



# Project partners



**Hamburg Port Authority  
AÖR**

- Coordinates project
- Provides port test environments
- Integrates data into Digital Port Twin



**Universität zu Lübeck**

- Develops AUV platform & software for navigation and data processing
- Integrates all parts into demonstrator

**bbe**  
moldaenke

**bbe Moldaenke GmbH  
Kiel**

- Develops miniaturized sensors for algae & oil leakage detection
- Builds algorithms for data analysis



**Institut für Hygiene und  
Umwelt, Hamburg**

- Provides environmental measurement standards
- Plans and carries out measurement campaigns



# The Hamburg harbor



- Third-largest seaport and largest railway port in Europe
- Third-largest inland port in Germany
- Around 7,000 hectares of port area
- 260 berths for seagoing vessels and 3 cruise terminals
- Over 800 calls by vessels per year with a length of 330 meters or more



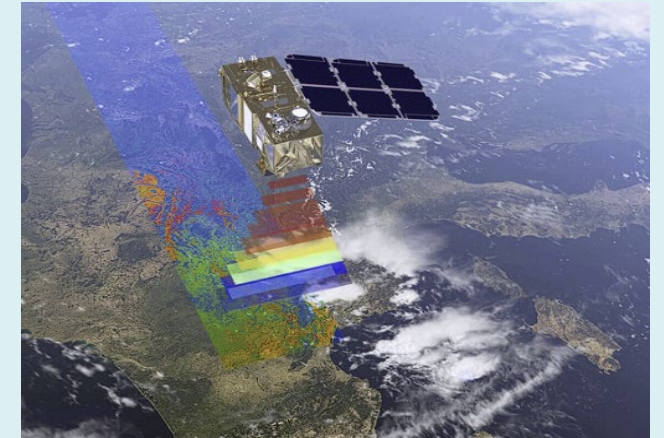
# Ongoing monitoring activities



The **Seemannshöft** monitoring station, located downstream of the Port of Hamburg. Water quality is continuously monitored here since 1994.



The HPA's survey vessel **Reinhard Woltman**, which has been used to carry out regular port surveys since 1995.



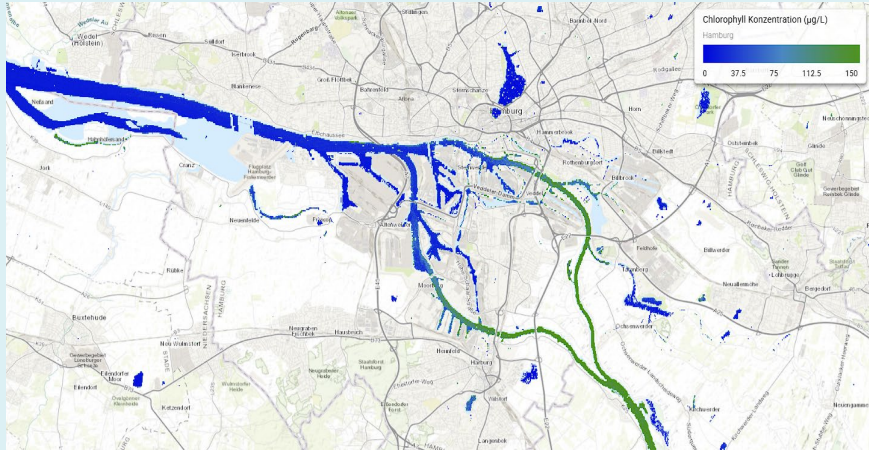
The Sentinel-2 satellite in orbit. © ESA

Monitoring efforts include continuous point measurements at monitoring stations, seasonal area-wide ship-based campaigns, as well as remote sensing.

However: Lack of high-resolution 3D to 4D data



# The Hamburg harbor ecosystem



Decreasing chlorophyll concentrations in the port, captured on 25 September 2025 by a Sentinel-2 satellite. Turbidity (not shown) shows opposing pattern. © ESA, HU



Seasonal dynamics of oxygen (red) and chlorophyll concentrations (green) at the monitoring station Seemannshöft, expressed as daily averages for the year 2025.



In March and August 2025 two leakages occurred leading to thousands of litres of oil leaking into the Hamburg harbor. Image: Copyright NEWS5 GmbH

An ecosystem under anthropogenic influence – high turbidity, low algae concentrations and oxygen deficiency during summer

Urgent need for highly resolved monitoring covering standard parameters as well as potential oil leakage



# Motivation

- Hamburg harbor: economic activity and ecological needs intersect
- High costs of manual environmental measurements and limitations regarding spatial or temporal resolution
- High turbidity and intense vessel traffic require robust measurement technologies



**Need for efficient & safe monitoring solutions**

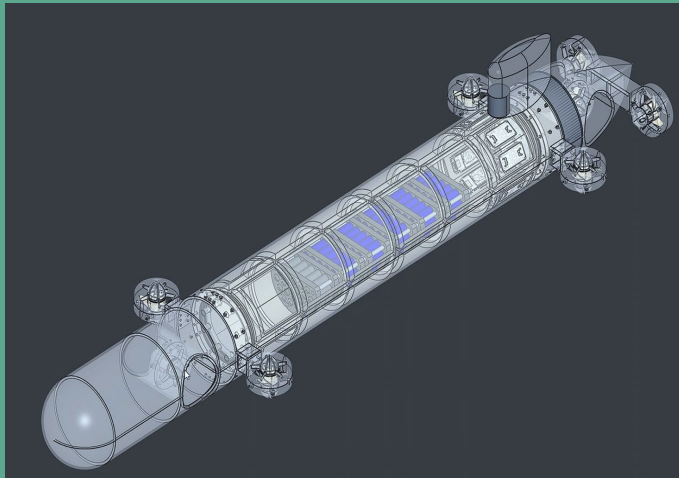


# Project SIMON Objectives

- 1 **Precise & Stable AUV System**
- 2 **Automated 4D Environmental Monitoring**
- 3 **AI-Supported Detection of Environmental Risks**
- 4 **Improved Data Availability & Reduced Workload**



# Technology - Overview



**Autonomous Underwater Vehicle (AUV)**



**Smart Sensor: AlgaeTorch**



**Digital Port Twin**

SIMON combines autonomous navigation, fluorometer tech, AI analytics, and efficient data processing



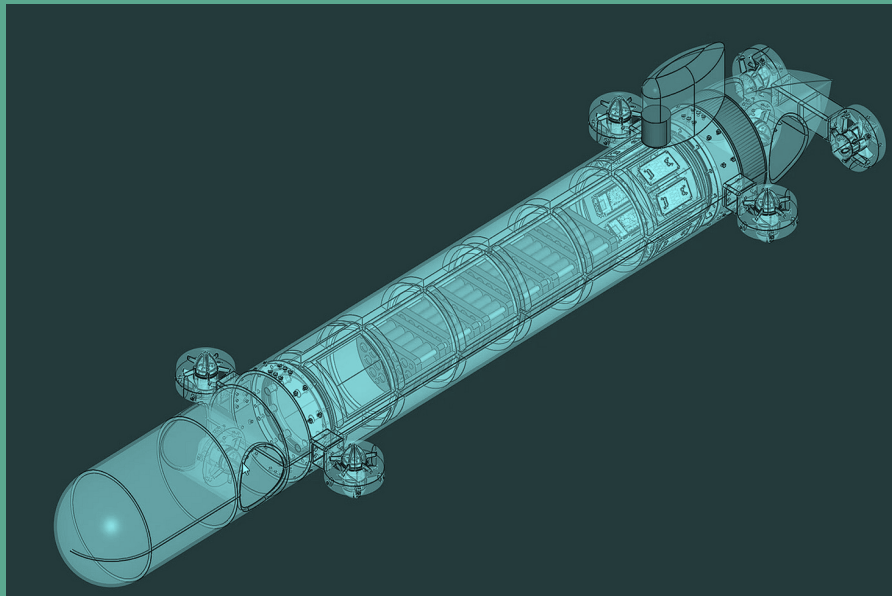
# Autonomous Underwater Vehicle

**Lightweight, modular AUV platform** for reliable performance in complex and demanding environments

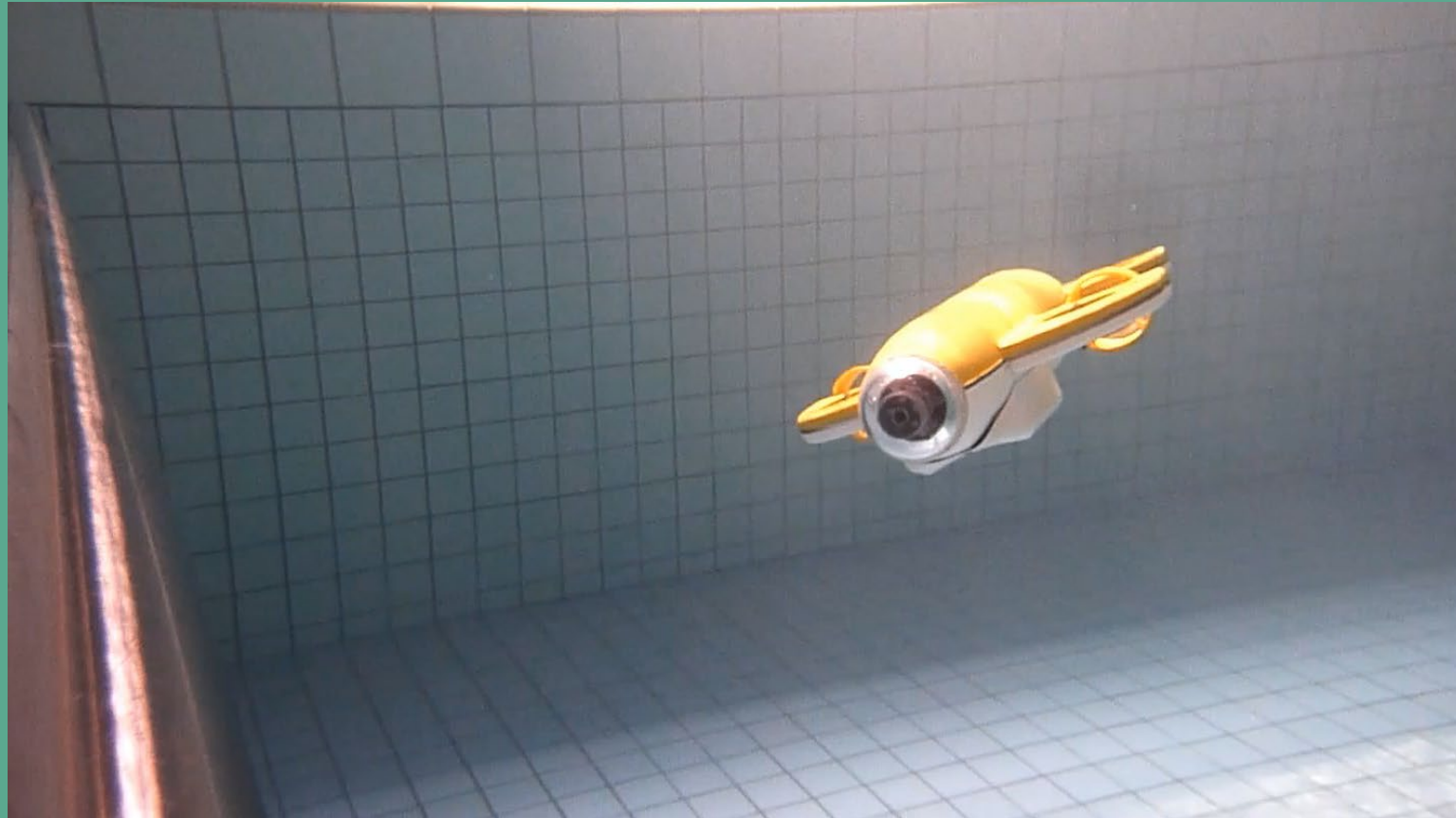
High-precision **navigation through advanced sensor fusion** combining IMU, sonar and an optional camera

Dynamic **stabilization software** compensating for currents and vibrations

**Robot Operating System (ROS)** for seamless route execution, mission planning and leakage detection



# Autonomous Underwater Vehicle



Autonomous navigation tests for precursor project „MONSUN“



# Sensors



Miniaturized **PAM fluorescence & hydrocarbon sensors** will enable accurate, real-time analysis of chlorophyll and algal classes and facilitate detection of oil leakage.



Additional **sensors for oxygen, turbidity, conductivity, temperature, and pressure** will provide a holistic view of water quality.

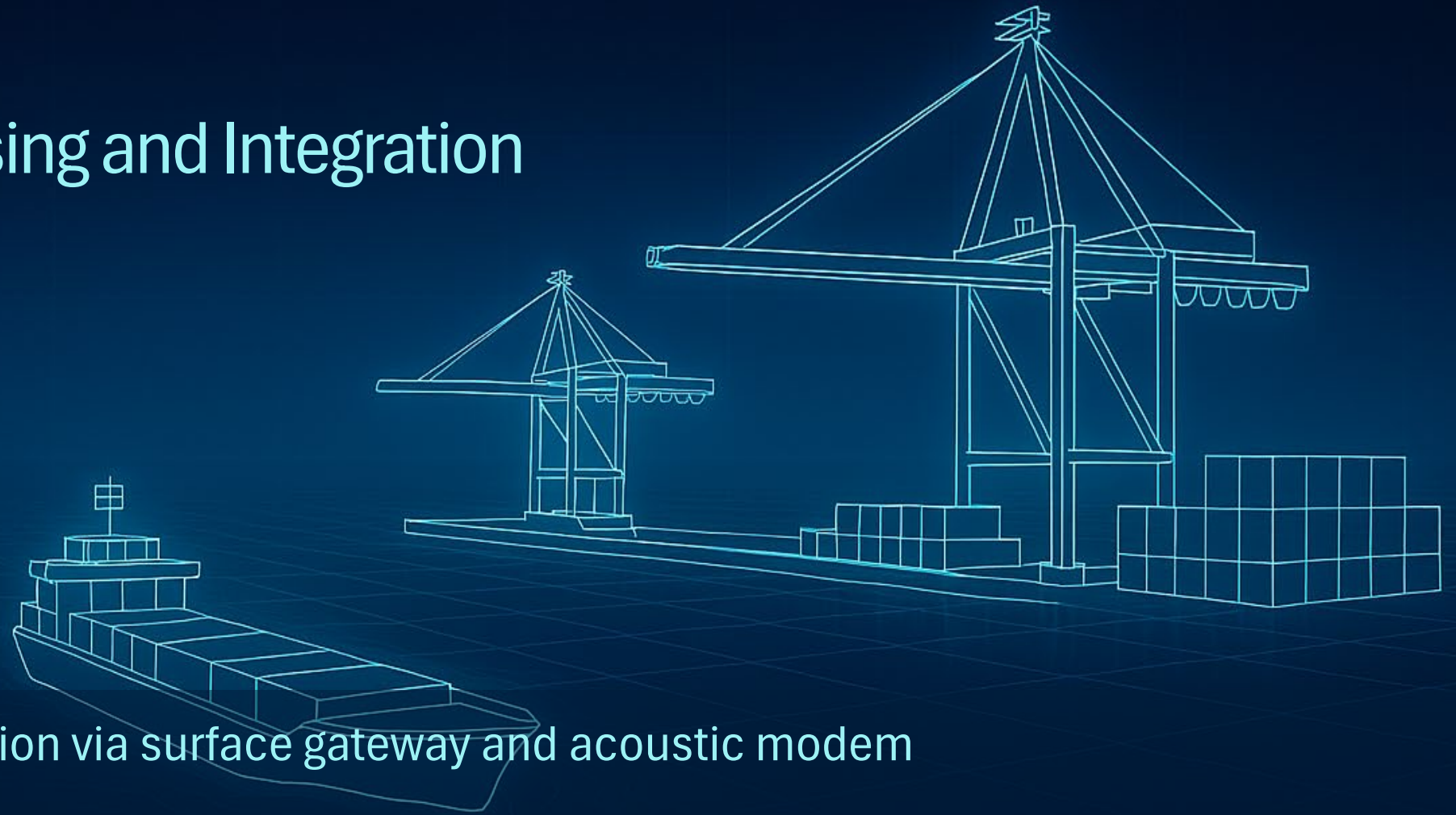




Like plants, phytoplankton  
microscopic organisms living in water



# Data Processing and Integration



Secure communication via surface gateway and acoustic modem

On-board processing to reduce data volume and boost energy efficiency

AI-based detection of anomalies for autonomous route tracking

Seamless data integration into HPA digital systems



# Contribution to Sustainable Development Goals



# Outlook



## Post-Project Development

- Expand HPA's solution portfolio
- Advance project outcomes through iTUBS Braunschweig
- Integrate solution into real-world operations
- Extend application to other water bodies

## Commercialization & Exploitation

- Target: Technology Readiness Level 6
- Drive technology transfer from research to market applications



Feel free to ask us!



# Testing of a precursor project under real-world conditions



UNIVERSITÄT ZU LÜBECK

Institut für Technische Informatik

## Untersuchungsergebnisse am Lübecker Konstinkai

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Thank you!

