R-Mode Baltic- Status Update

Maritime signals of opportunity for terrestrial positioning

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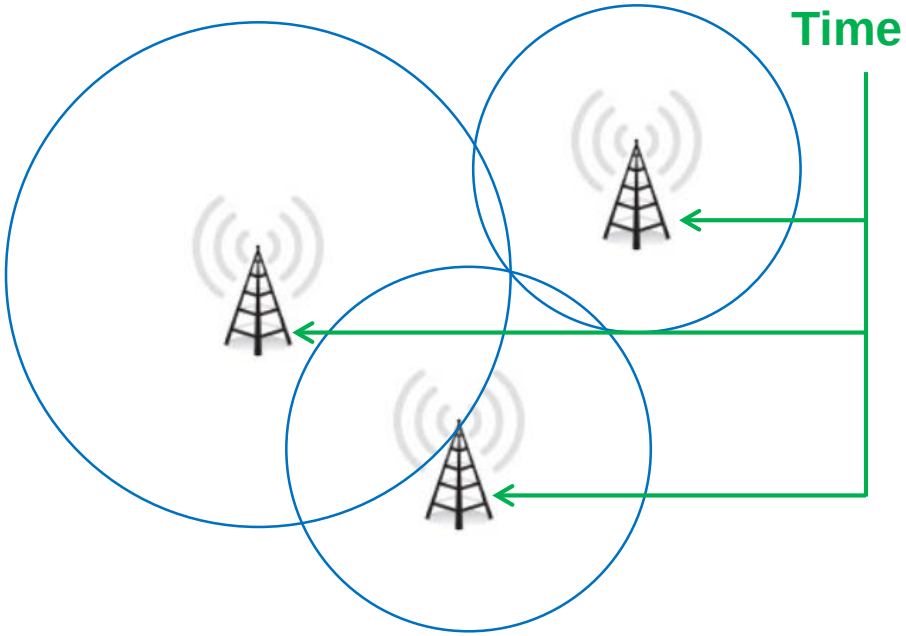
International Steering Committee of PA Safe and PA Ship
Virtual Meeting, 10th November 2020

R-Mode terrestrial positioning system

A backup/contingency system to GNSS

- R(anging)-Mode is a positioning system that
  - transmits timely synchronised ranging signals
  - using the communication channel of existing maritime radio infrastructure
- Possible sources of ranging signals: Medium Frequency (**MF**) marine radio beacons and **VDES** base stations using VHF transmissions



DLR

Minimum user requirement on a backup system

IALA R-129 based on IMO Resolution A.915(22)

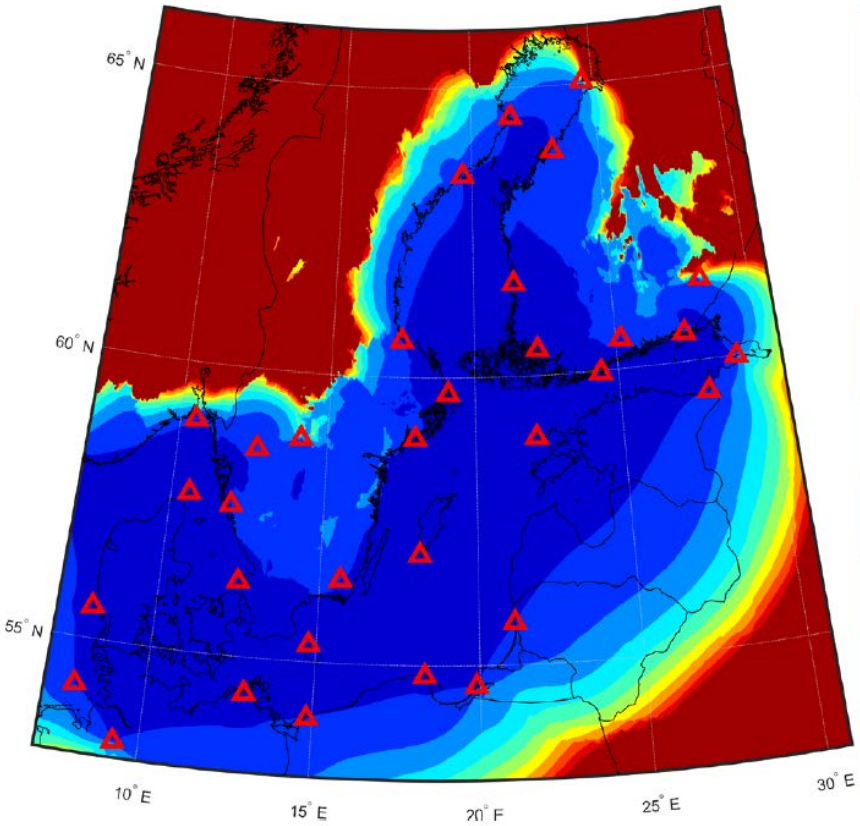
	System level parameters				Service level parameters			
Maritime region	Absolute Accuracy	Integrity			Availability % per 30 days	Continuity % over 15 minutes	Coverage	Fix interval (seconds)
	Horizontal (meters)	Alert limit (meters)	Time to Alarm (seconds)	Integrity Risk (per 3 hours)				
Ocean	~~1000~~	~~2500~~	Not covered by MF or VHF transmitter signals					60
Coastal	100	250	30	10^{-4}	99	N/A²	Regional	15
Port approach and restricted waters	10	25	10	10^{-4}	99	99,97	Regional	2
Port	1	~~2.5~~	Not reachable		99	99,97	Local	1
Inland Waterways	10	25	10	10^{-4}	99	99,97	Regional	2

R-Mode service area

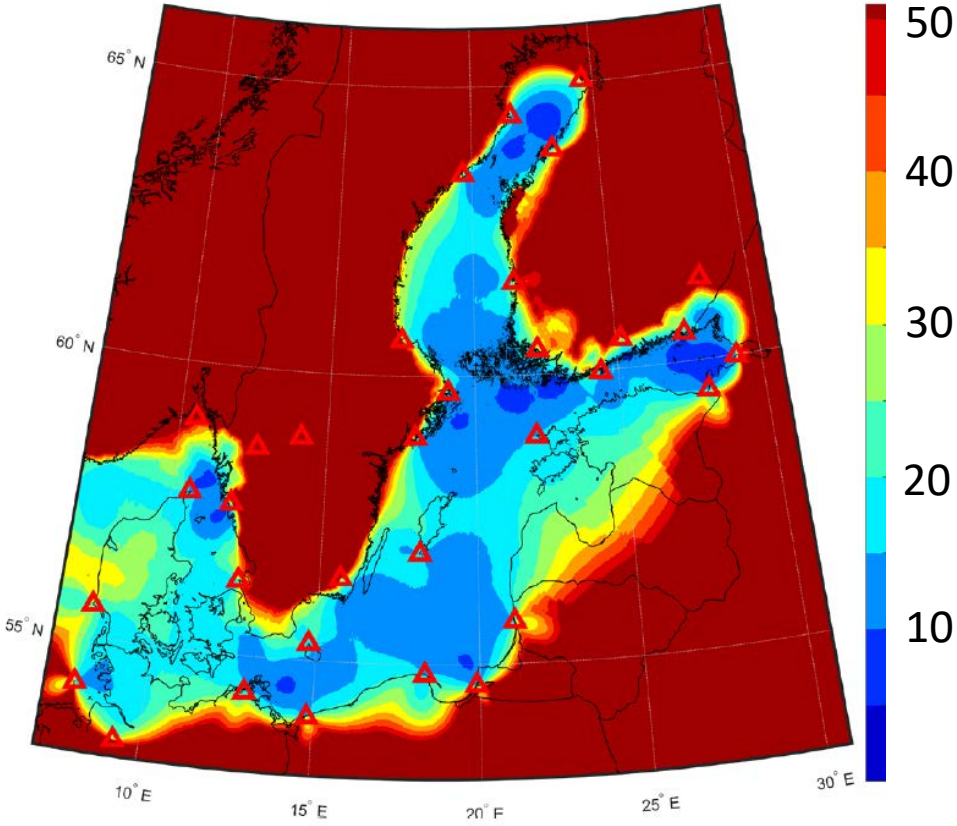
Achievable performance MF R-Mode (theoretical)

Estimated position accuracy based on coverage and HDOP predictions for the Baltic Sea, [1]

Day-time hours, 95% accuracy [m]

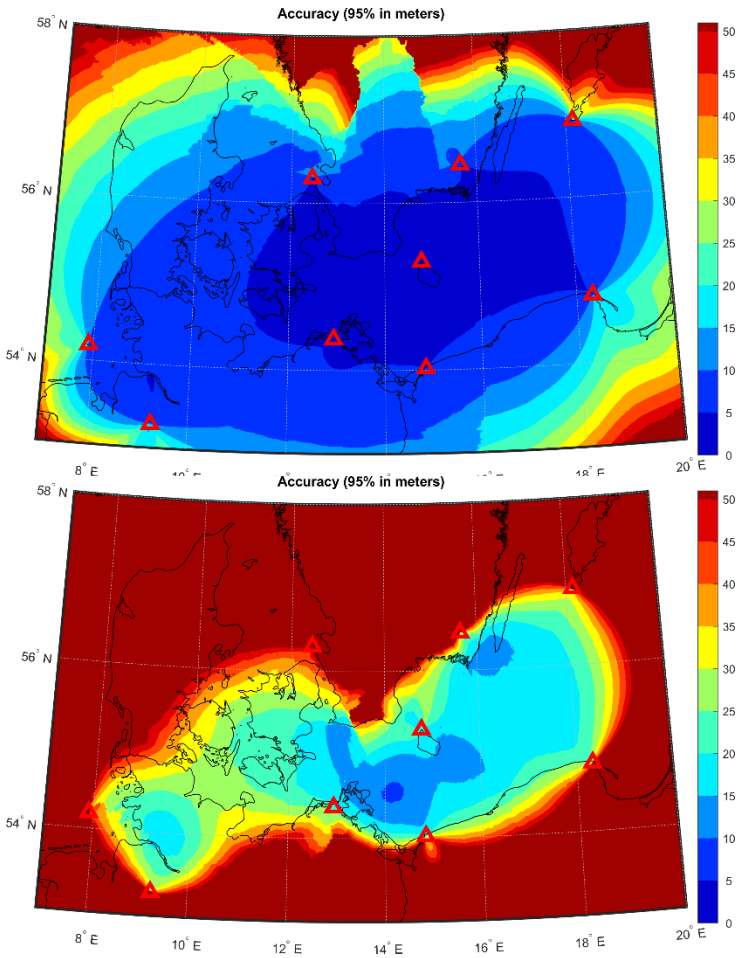


Night-time hours, 95% accuracy [m]



[1] MF R-Mode coverage prediction and accuracy estimation, GRAD, RPT-07-CH-19, March 2019.

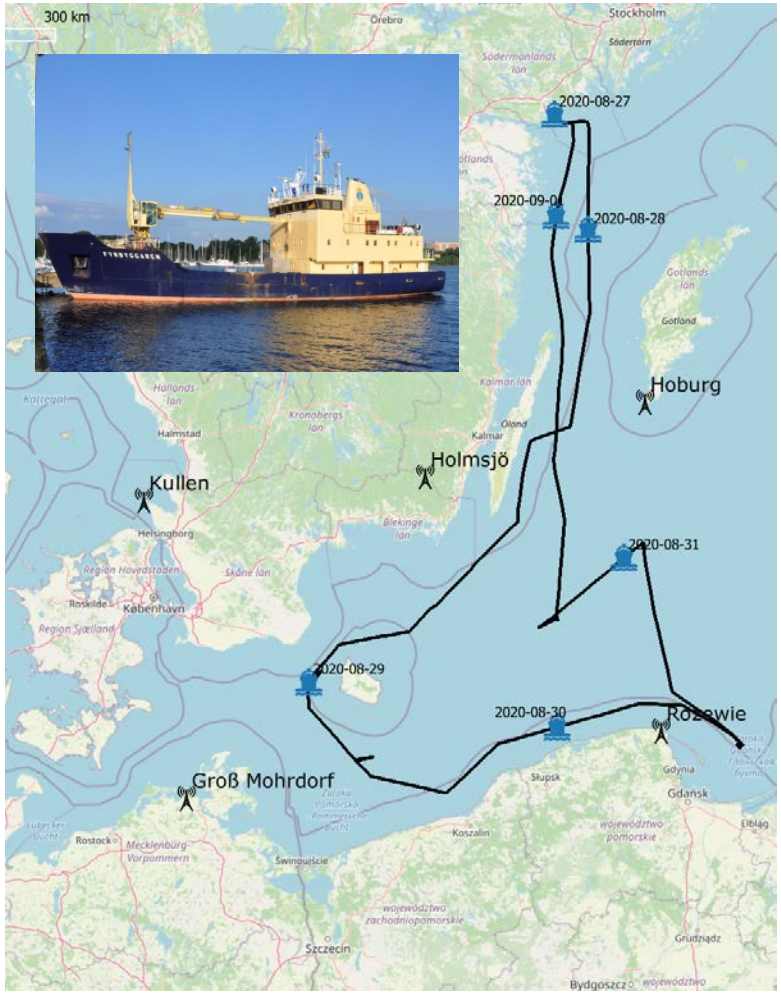
The MF beacon R-Mode testbed in the Baltic



- Implemented during summer 2020 on eight existing DGPS sites in Sweden, Poland, Denmark and Germany

The MF beacon R-Mode testbed in the Baltic

First measurement campaign in the MF R-Mode testbed in the Southern Baltic with Swedish vessel Fyrbyggaren

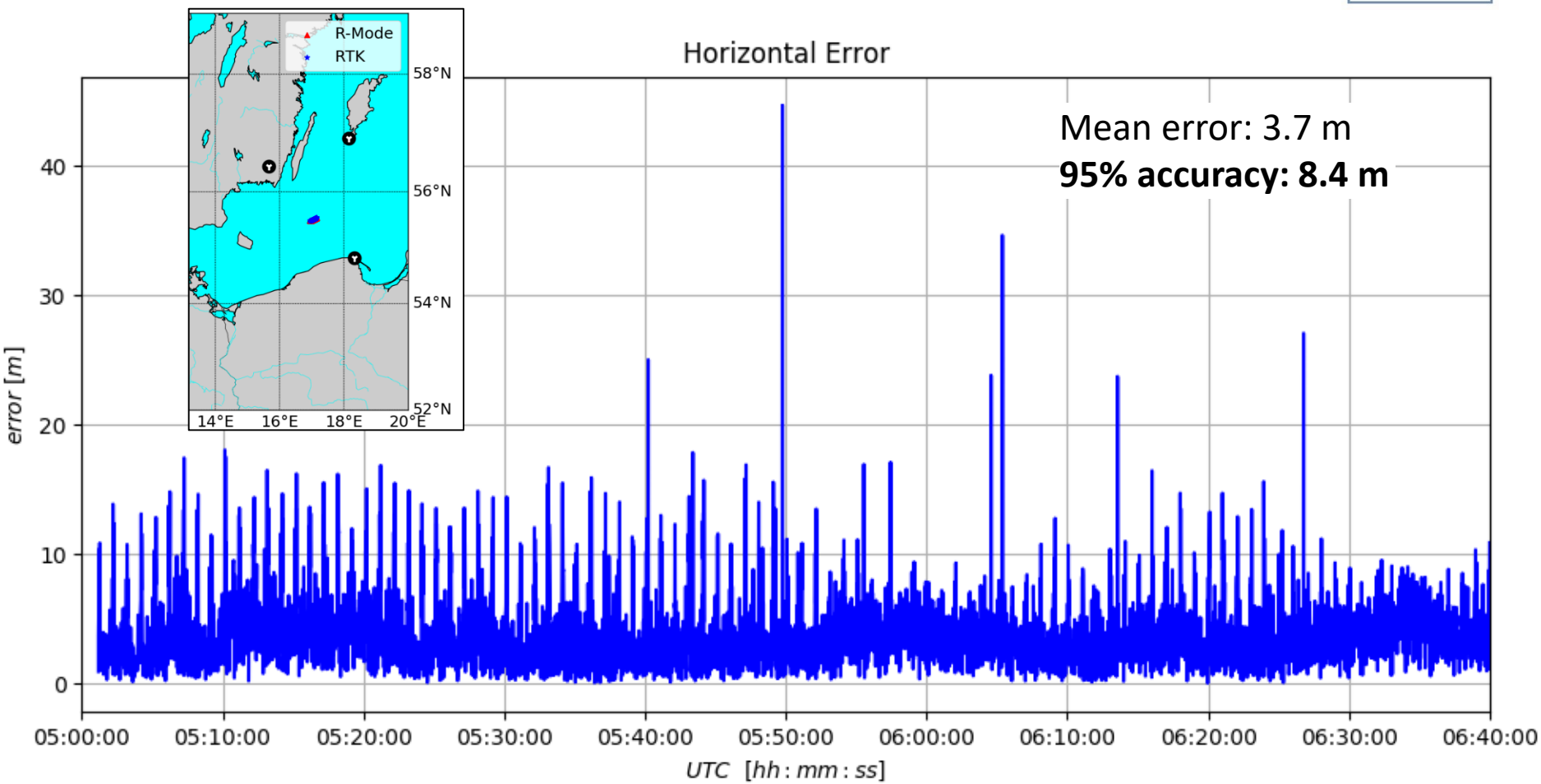


- Time: 28th August to 1st September 2020
- Testbed was based on 7 (5) MF R-Mode sites.

- Most of the time R-Mode signals of four stations could be tracked
- R-Mode based positioning was possible
- MF R-Mode sites so far uncalibrated
- Positioning approach:
  - Self-calibration of R-Mode receiver in the testbed
  - Calculate position based on change of R-Mode signal phase
  - Realtime positioning with 1 Hz update rate

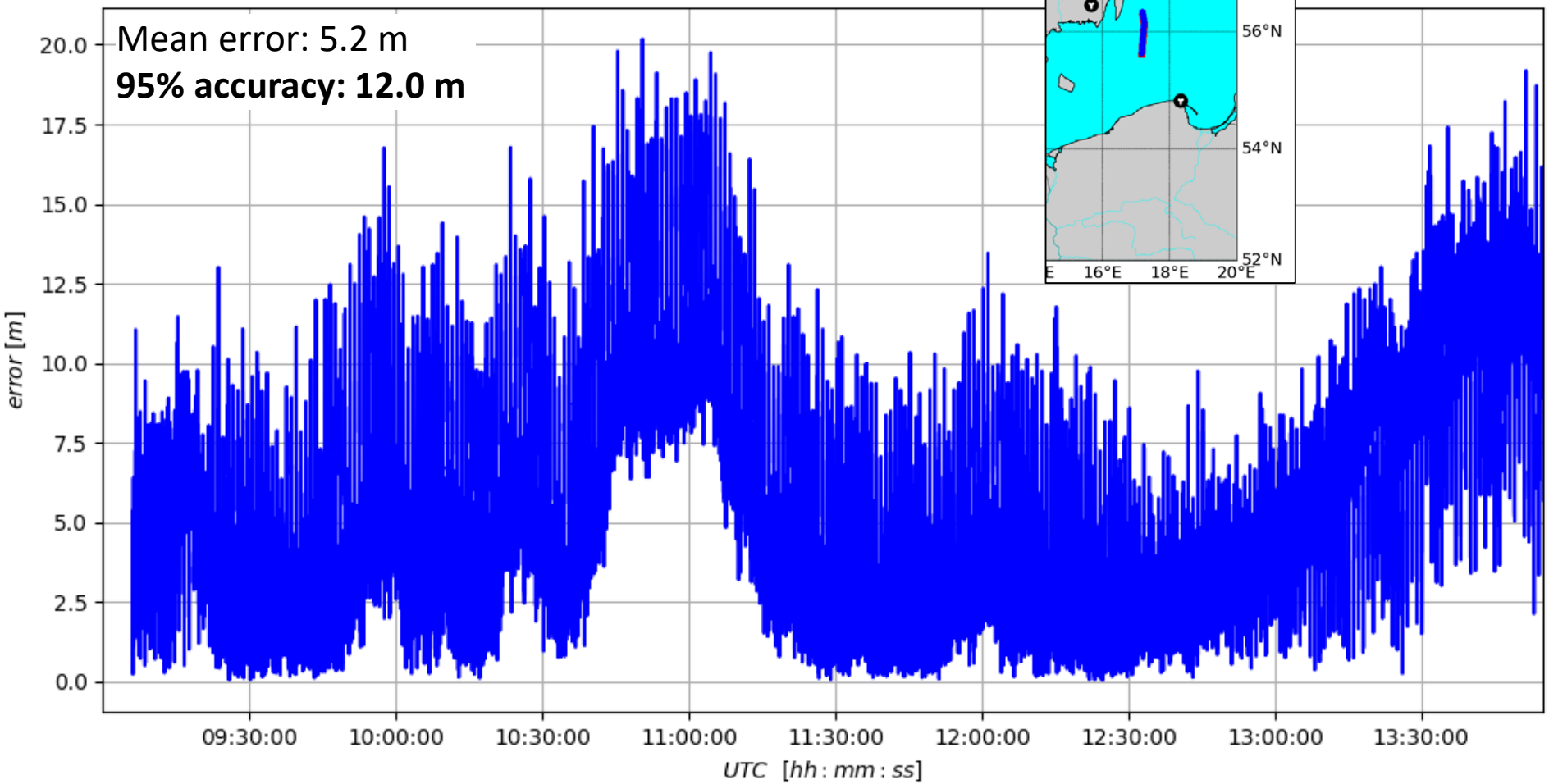
Ship with low speed at day (100 min)

2D Positioning error



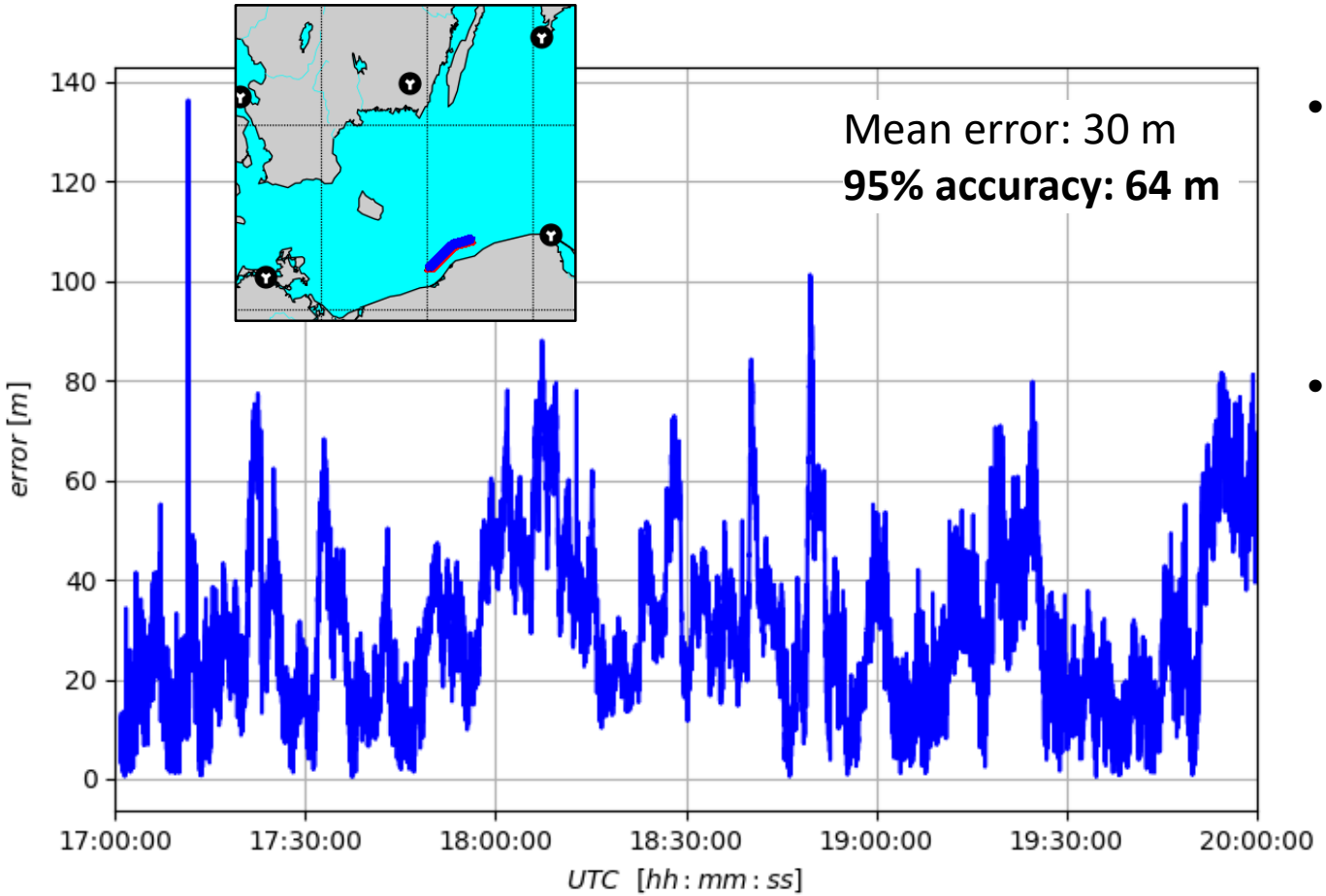
Ship with higher speed at day (5 h)

2D Positioning error



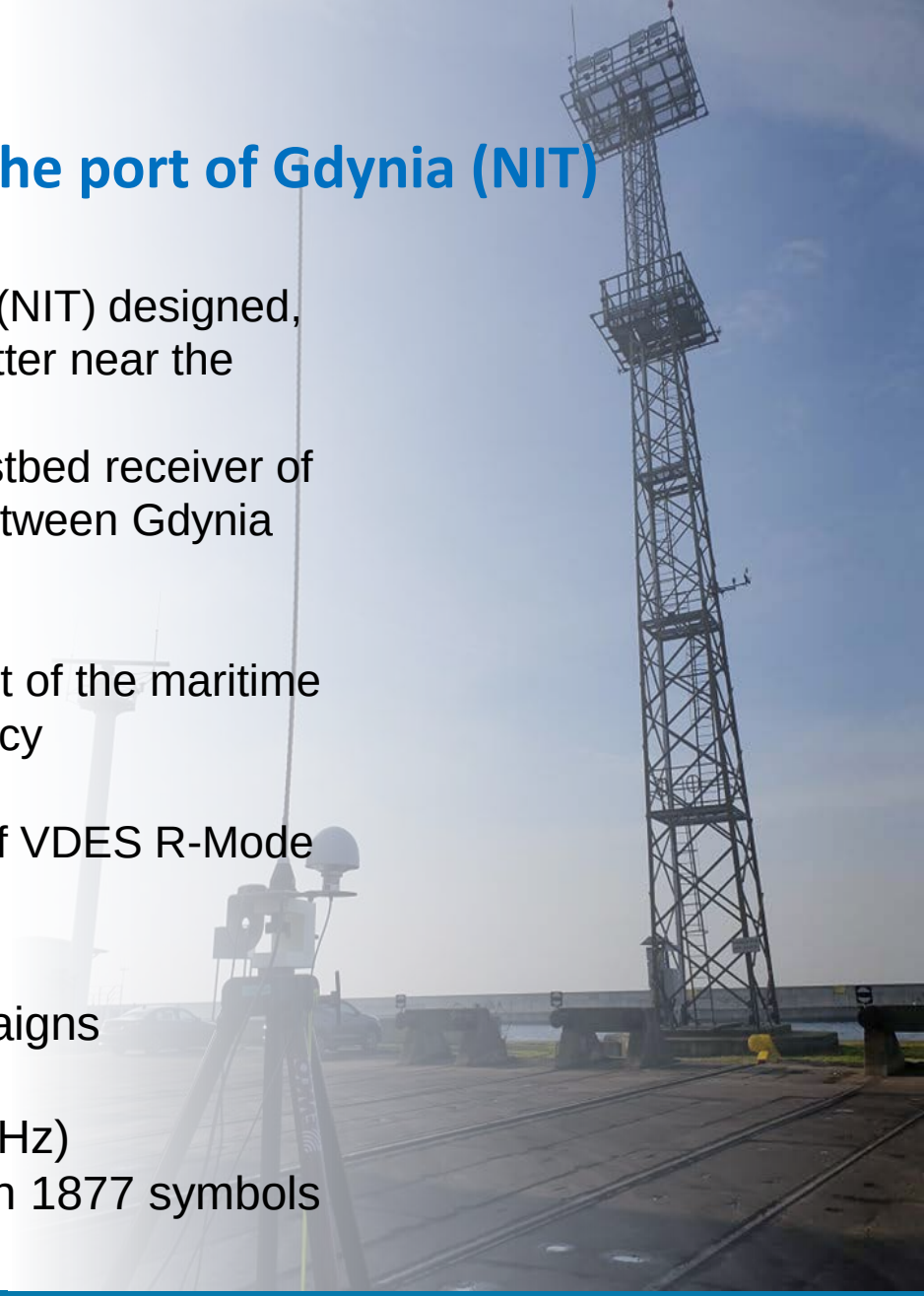
During the night (3 h)

2D Positioning error



- Used signals of four stations in 150 km to 300 km distance
- Data analysis ongoing

VDES R-Mode measurements in the port of Gdynia (NIT)



- National Institute of Telecommunications (NIT) designed, built and installed VDES R-Mode transmitter near the entrance to the port in Gdynia.
- Measurements were performed with a testbed receiver of NIT located aboard the ferry operating between Gdynia and Karlskrona.

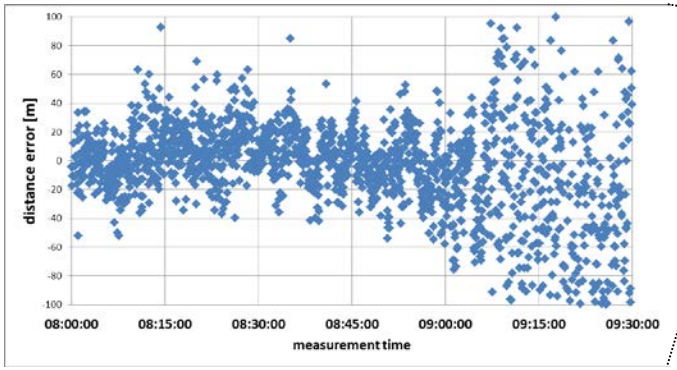
- Goal of measurement: Analyse the impact of the maritime radio VHF channel on the ranging accuracy

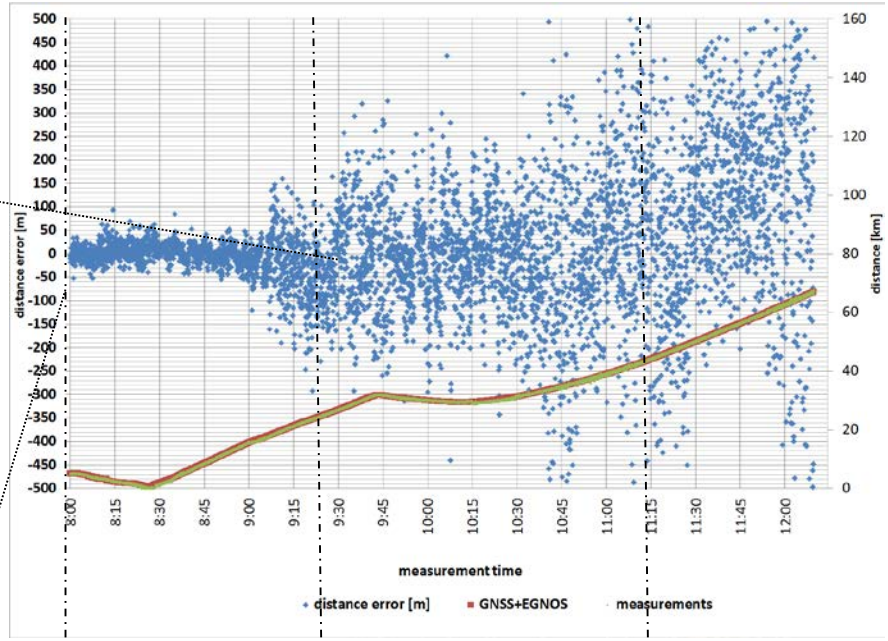
- Transmitter implemented current status of VDES R-Mode standard (IALA ENAV)

- Until now 2 VDES measurement campaigns
  - Modulation: π/4-QPSK
  - Using complete VDES-TER (100 kHz)
  - Ranging sequence: Gold Code with 1877 symbols

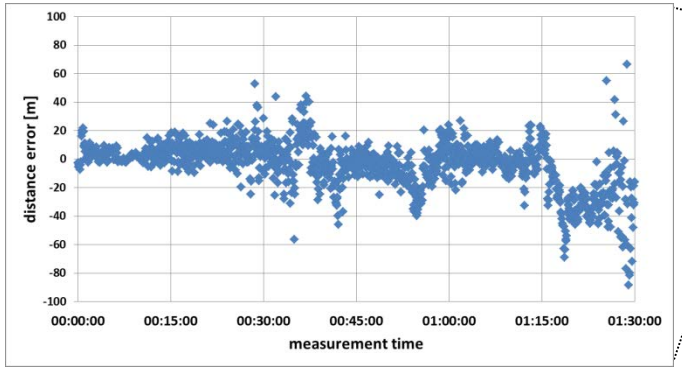
The obtained results of the accuracy of the measured distances from two campaigns

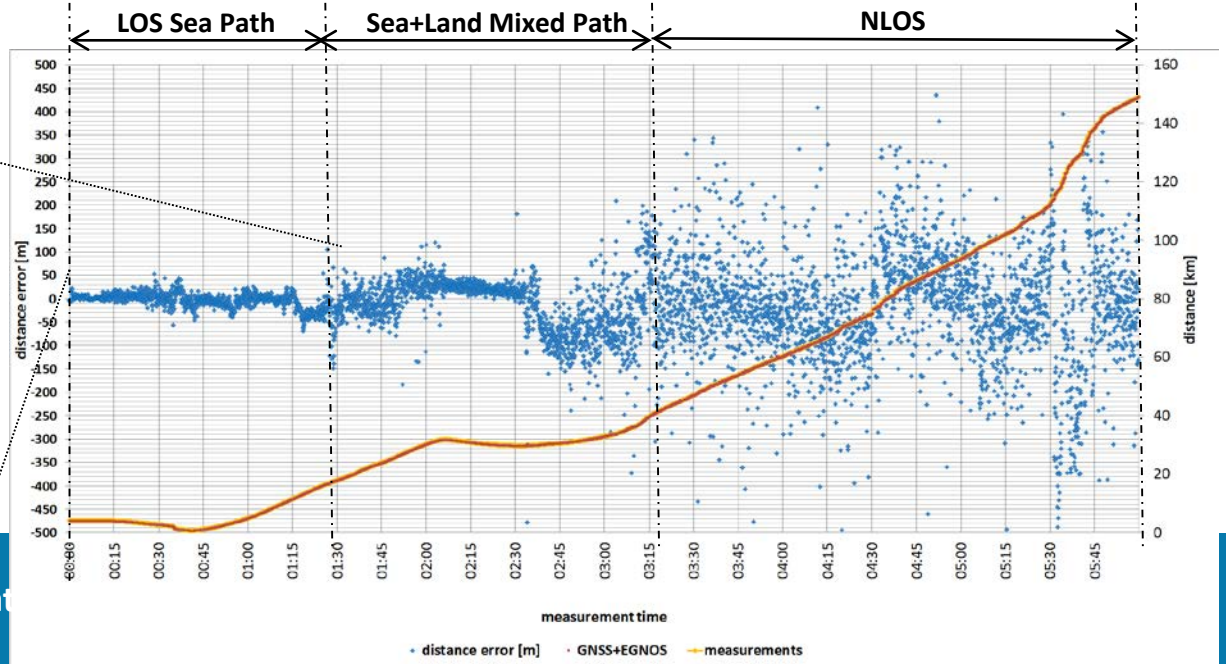
1st measurement campaign: 15-16 November 2019





2nd measurement campaign: 29-30 June 2020.

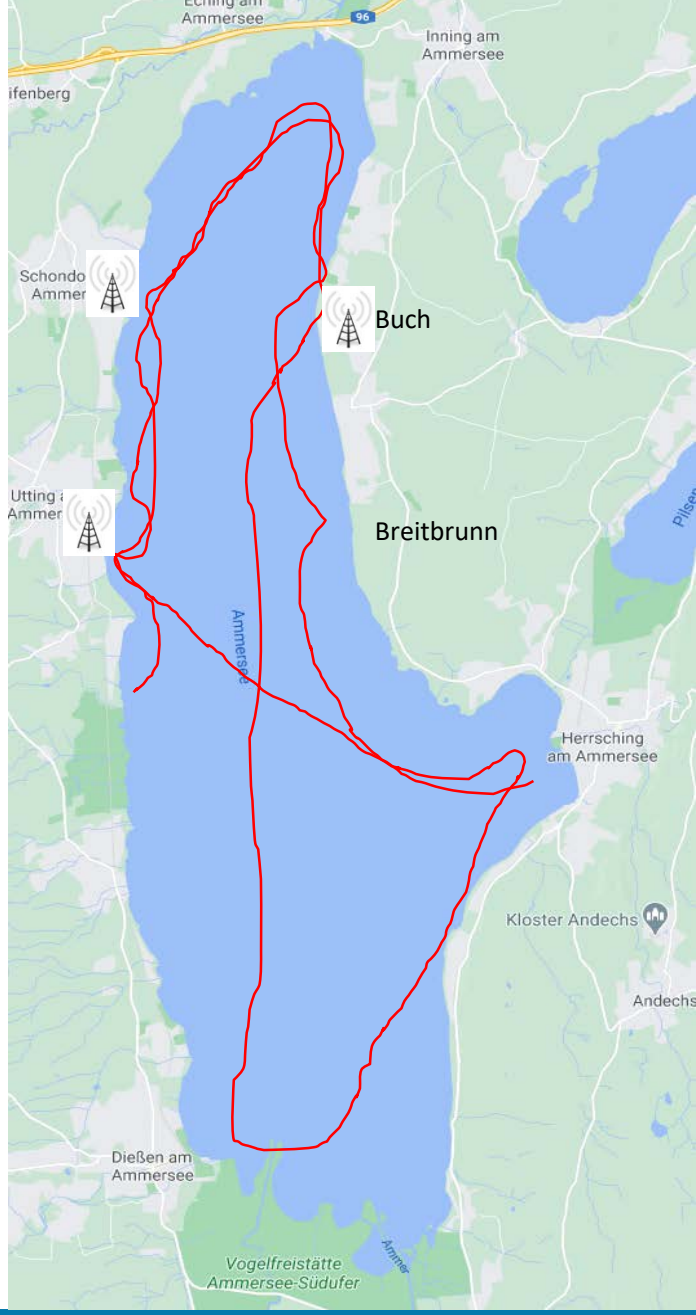




VDES R-Mode measurements on lake Ammer 09/2020 (DLR)

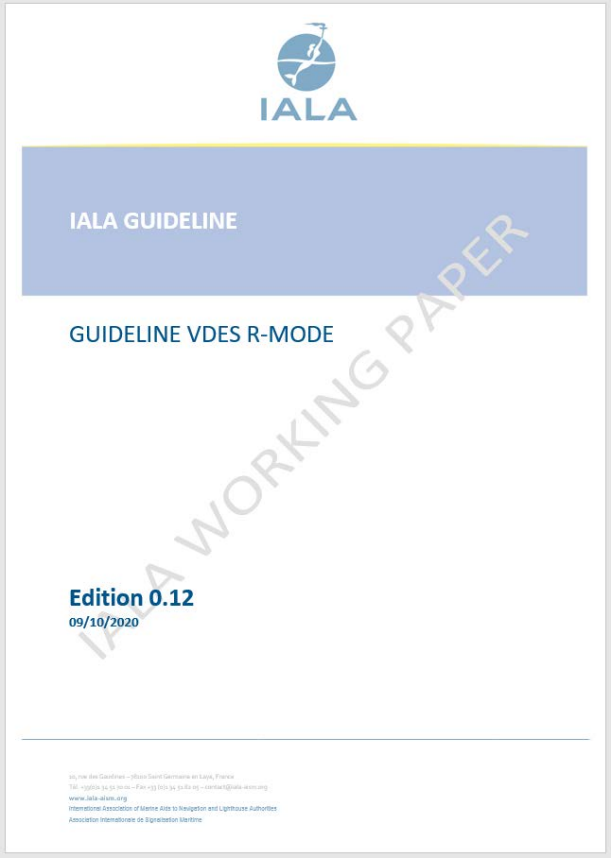
- Three VDES R-Mode transceiver around lake Ammer and one on a boat
- Ranges up to 12 km because of lake size
- Using complete VDES-TER (100 kHz) with alternating sequence
- Goals of measurement:
  - First VDES R-Mode based positioning
  - Analyse influence of signal blocking and reflections on positioning
  - Analyse colocation between AIS and VDE

- Different scenarios of passing a ship
- Boat itself transmits VDES R-Mode
- Data analysis just started



R-Mode Standardisation

- Project team continued work on R-Mode standards in IALA
  - ENAV committee: finalised Draft Guideline VDES R-Mode
  - ENG committee: continued Guideline on Implementation of R-Mode on MF and VHF frequencies


IALA

IALA GUIDELINE

GUIDELINE VDES R-MODE

IALA WORKING PAPER

Edition 0.12
09/10/2020

Summary

- R-Mode testbed for medium frequency (MF) signals completed
- Development of first R-Mode receiver for MF based positioning completed
- First measurements show feasibility of MF R-Mode based positioning
- MF R-Mode results agree with coverage prediction

- 2nd VDES R-Mode campaign in Gdynia shows improvement of ranging performance
- First VDES R-Mode positioning campaign conducted

- Standardisation of R-Mode is ongoing

Contact

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