HELZEL Over-the-Horizon Radar for Ship Tracking

Protect your EEZ and identify fishing pirates or smugglers far behind the horizon

The HELZEL high-frequency over-the-horizon radar OTHR uses fast and accurate software beam-forming utilising an automatic self-calibration technique.

The low-noise non-interrupted FMCW operation mode provides the best range / power performance on the OTHR market. This allows operation with quite low power levels (1000 Watts) to get a range of 200 Nautical Miles.

- **Shore-based system, easy to install and maintain**
- **Dual frequency system for reliable tracking avoiding blind velocities**
- **On-site tracker software reduces volume of data transfer**
- **Multi-sensor tracker and suspicious target identification**
- **Dual-use system suited for applications like Search & Rescue**

HELZEL

Over-the-horizon Ship Detection Radar

Protect your EEZ and identify fishing pirates or smugglers far behind the horizon

OTHR real-time features

Our innovative over-the-horizon radar technology is based on more than 20 years of experience in the field of HF Ocean radar “WERA”. More than 200 HF radar systems of this type are already installed and the OTHR systems are using the same radar core. This HF radar technique is robust against environmental effects. Even strong rain does not reduce the range; just extreme high sea-states are affecting the range performance.

The HELZEL-OTHR uses the fast and accurate software beam-forming that provides high performance for the ship tracking application due to the implemented unique automatic beam calibration. The low-noise non-interrupted FMCW operation mode provides the best range/power performance on the OTHR market. This allows the operation with quite low power levels (< 1000 W_{ERIP}) to get a range of 200 Nautical Miles. This low power operation reduces the risk of interference with other radio-band users.

The transmit antennas are optimized to provide highest gain and directivity for best groundwave radiation. The receive antenna array consists of vertical monopoles with low visual and environmental impact. The real-time tracking software provides update rates of 30 s.

At the Command Control Center the data of multiple OTHR stations, optionally other radar data and AIS data are fused by means of a multi-sensor tracker. The graphical user interface displays cooperative and non-cooperative targets helping to identify suspicious targets.

At the central station, the radar tracks can be compared with received AIS data to distinguish cooperative from non-cooperative targets.

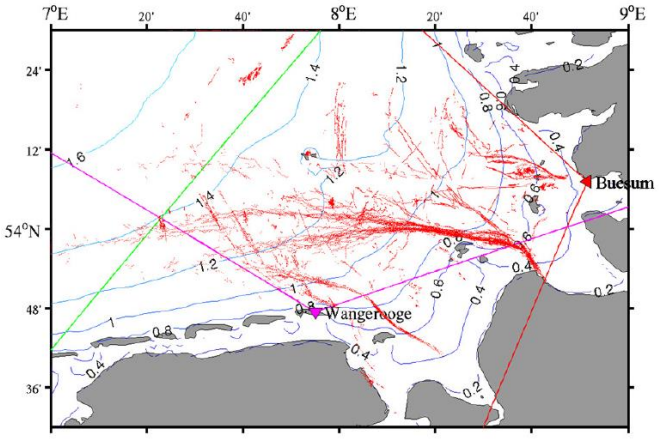
Technical Performance

The FMCW operation mode provides data from near shore (1 NM) to maximum range (up to 200 NM). The detection range depends on operating frequency, day and night cycle, target size and environmental conditions. The given ranges are obtained from measurements with HELZEL-OTHR systems for vessels which fulfil the height limit given in column 4, see table below.

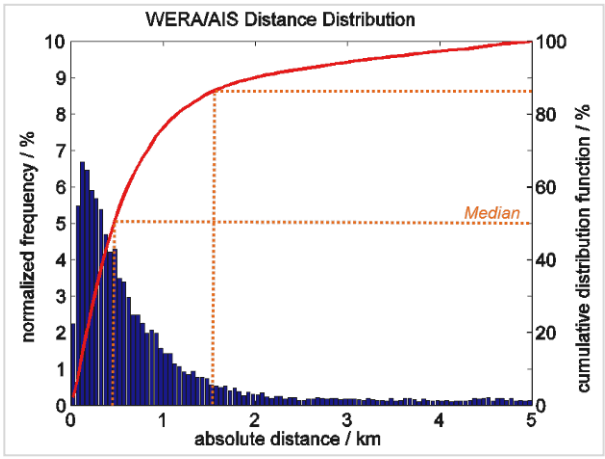
Radar Frequency	Range @ day time	Range @ night time	Vessel height for full range performance
12 MHz	40 NM	70 NM	6.5 m
8 MHz	110 NM	65 NM	9 m
6 MHz	160 NM	90 NM	13 m
4 MHz	>200 NM	160 NM	18 m

Generally all OTHR systems show a significant day to night range variation getting better at higher frequencies. For this reason it is recommended to use the highest possible frequency for the specific application and to use a dual frequency approach.

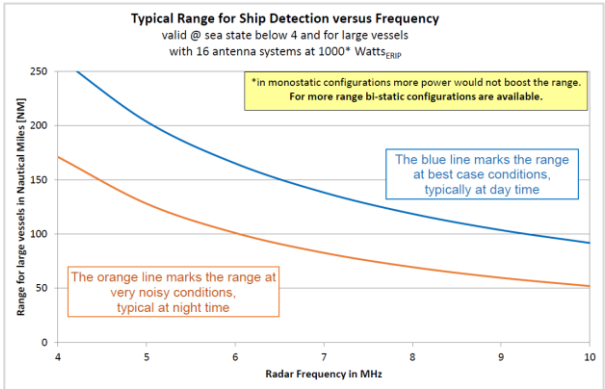
Targets without any vertical metallic structure can’t be detected, e.g. rubber, wooden or plastic boats.



Dual radar ship tracks for 12 MHz WERA systems at the German Bight. Data taken from a scientific paper of S. Maresca (NATO Science and Technology Organization) and J. Horstmann (Helmholtz-Zentrum Geesthacht)



The accuracy of ship positions compared with AIS reported locations is about 400 m for 50 % of all targets and better than 1.5 km for 86 % of all detected targets. (Data from a single 8 MHz WERA system, published by A. Dzvonkovskaya, Hamburg University of Technology)



The range for ship detection strongly depends on the operating frequency and is affected by external noise and interferences which varies with the day/night cycle.

Helzel Messtechnik GmbH • Carl-Benz-Strasse 9 • 24568 Kaltenkirchen • Germany • Tel. +49 4191-95200

e-mail: hzm@helzel.com • www.helzel.com

Development History of HELZEL-OTHR Ship Detection and Tracking

The OTHR system consists of a 4 element Tx antenna array and a 16 element Rx array, which are separated by some 100 meters, see table below.

Radar Frequency	Tx antenna height	Tx array length	Tx to Rx separation	Rx array length
12 MHz	6.5 m	13 m	> 125 m	180 m
8 MHz	9 m	18 m	> 165 m	240 m
6 MHz	13 m	26 m	> 250 m	360 m
4 MHz	18 m	36 m	> 370 m	550 m

Multiple independent studies of our HF radar technique for ship-detection applications are published from independent scientific groups including NATO research centre CMRE, but most results from operational systems are classified.

Date	Development History	Published
1995	First experiments with new low noise radar concept	Yes
2004	First ship detection experiments by University of Hamburg	Yes
2006	Raytheon uses WERA in Germany for ship tracking tests	Classified
2007	Start of Ship detection and tracking software development at HELZEL in co-operation with EADS and Uni. Hamburg	Yes
2008	French researchers using WERA for ship detection test	Yes
2009	NATO Research center (NURC) starts evaluation with WERA and develops multi-sensor tracker	Yes
2010	WERA is registered as Dual-use instrument at German Export Control Authority (BAFA)	Yes
2011	First export of WERA systems for ship tracking	Classified
2011	NATO Research (CMRE) and Helmholtz Institute Geesthacht started WERA ship tracking evaluation in German Bight (on-going)	Yes
2011	First OEM contract with another radar manufacturer to use the WERA radar core for their product. Today two additional partner agreements are active.	No
2018	First OTHR results published by an OEM partner	Yes

Including the civil applications of the dual-use HELZEL-OTHR system, the radar core is used in more than 150 systems world-wide with more than 8 Mio operating hours.

Customer reported Data Availability Data from WERA Systems, operated in Europe	
5 years statistics (2015 until 2020)	
Reported Failures causing “system down” during 5 years of operation	1 time
Reported minor events without losing data but requiring action	9 times
Reported MTBF	**>86,000 h**

A typical OTHR radar unit consists of three racks, the transmitter unit, signal generator, data acquisition and the data server for real-time processing and tracking

Curved Rx antenna array in the Artic at the Atlantic coast of Canada

Tx antenna system for 200 NM range

Helzel Messtechnik GmbH • Carl-Benz-Strasse 9 • 24568 Kaltenkirchen • Germany • Tel. +49 4191-95200

e-mail: hzm@helzel.com • www.helzel.com

Easy integration of HELZEL-OTHR data into coastal surveillance networks

All relevant system parameters, including antennas and cables are automatically monitored. This allows the implementation of an effective preventive maintenance system and ensures the required **highest** system and **data availability**.

All HELZEL-OTHR systems can be configured for **multi-frequency operation**. A dual frequency operation is strongly recommended for ship tracking applications to avoid “blind velocities”. Such blind velocities are caused by oceanographic back scattering which cover a specific velocity with strong ocean clutter signal. This specific clutter (Bragg reflection) correlates with a specific velocity which is linked to the radar’s operating frequency.

A **frequency management system** is integrated to react to variations of the external interference situation and can initiate automatic **frequency hopping**.

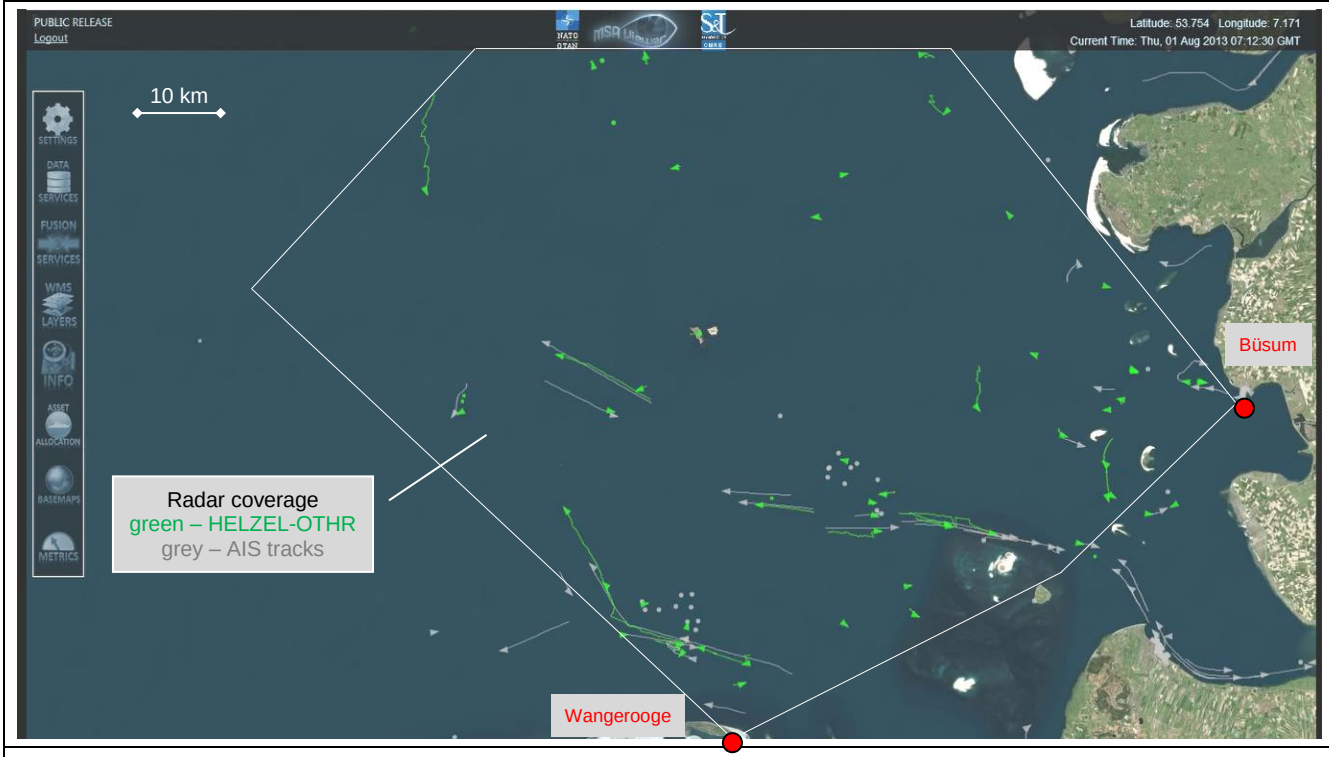
If a monitored area is covered with two stations (as displayed below), in case of interference through external jammers it is possible to combine the bearings from both stations and **locate the jammer**.

Bi-static options are available to enhance the detection coverage or range. This technique can be used as well to reduce the requirement of the occupied coast area for the antenna systems.

MIMO antenna configurations are available, to be used to further improve the beam width (smaller aperture) which increases the range and accuracy.

The **open data interface** allows an easy integration of the OTHR data.

Through our partner network we can offer all required system integration and data analysis software including the **identification of suspicious target behaviour**.



Multi sensor plot generated from two 12 MHz OTHR stations at the German coast combined with AIS tracks.
Data kindly provided by CMRE (NATO research) and Helmholtz Institute (HZG).

HELZEL-OTHR systems in general can be used for oceanographic applications as well providing additional valuable data for applications like *Tsunami Warning* and *Search & Rescue*.

Note: HELZEL-OTHR systems are military grade dual-use systems and thus an export license from the German authorities is required.

Helzel Messtechnik GmbH ● Carl-Benz-Strasse 9 ● 24568 Kaltenkirchen ● Germany ● Tel. +49 4191-95200

e-mail: hzm@helzel.com ● www.helzel.com