UDT
Undersea Defence Technology
13-15 May 2019
Stockholmsmässan, Sweden

Multiple-Input-Multiple-Output (MIMO-) High-Resolution Monostatic Sonar for Target Detection

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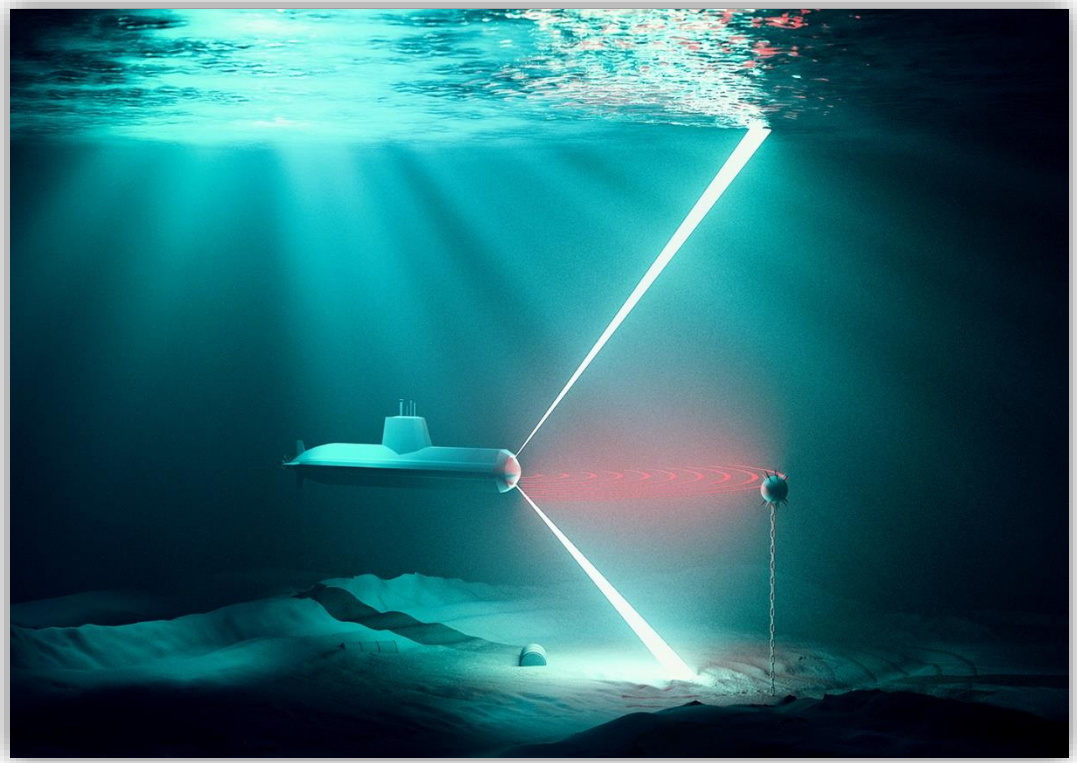
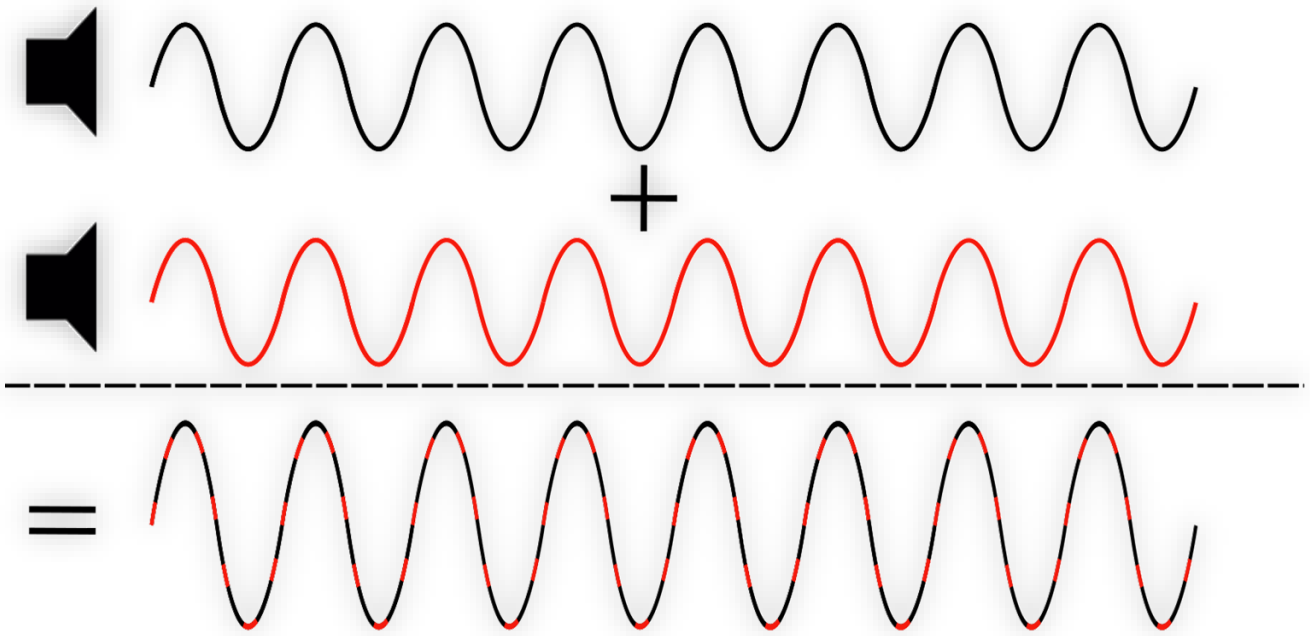
WÄRTSILÄ

#UDT2019

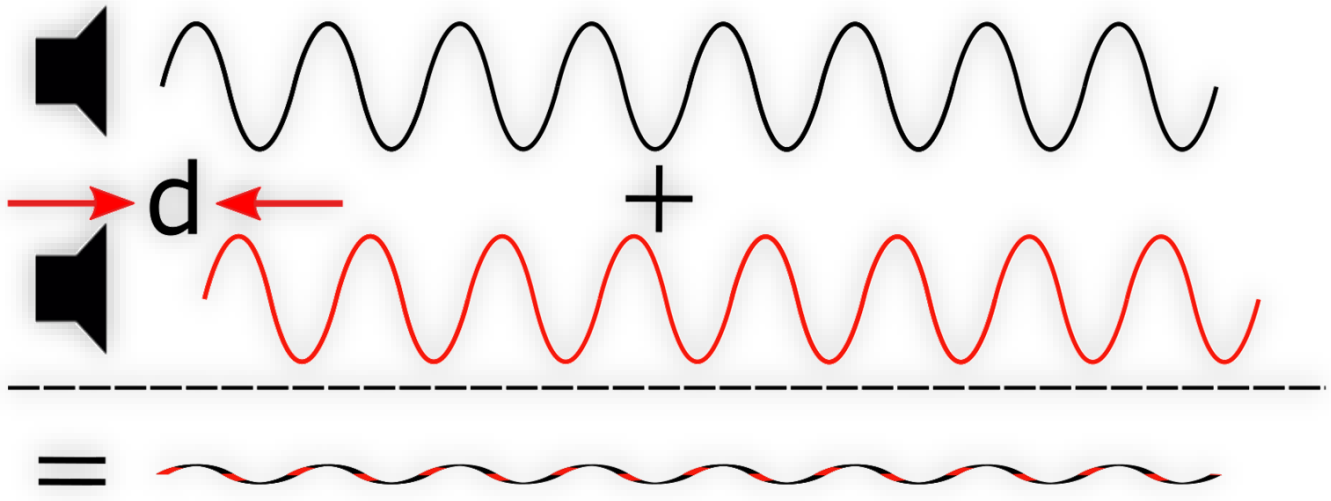
Motivation



Beamforming



Beamforming



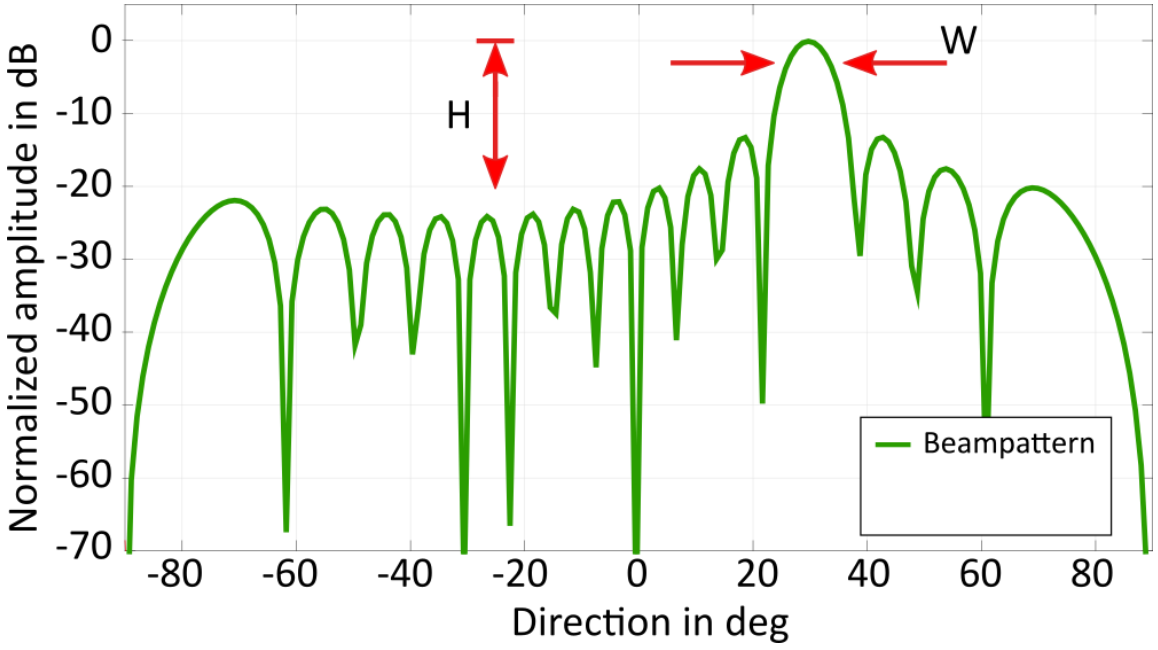
Receive beamforming vs. Transmit beamforming

Transmit beamforming:

- Steering cannot be changed afterwards
- Transmit direction is irrevocable imposed inside the receive signals

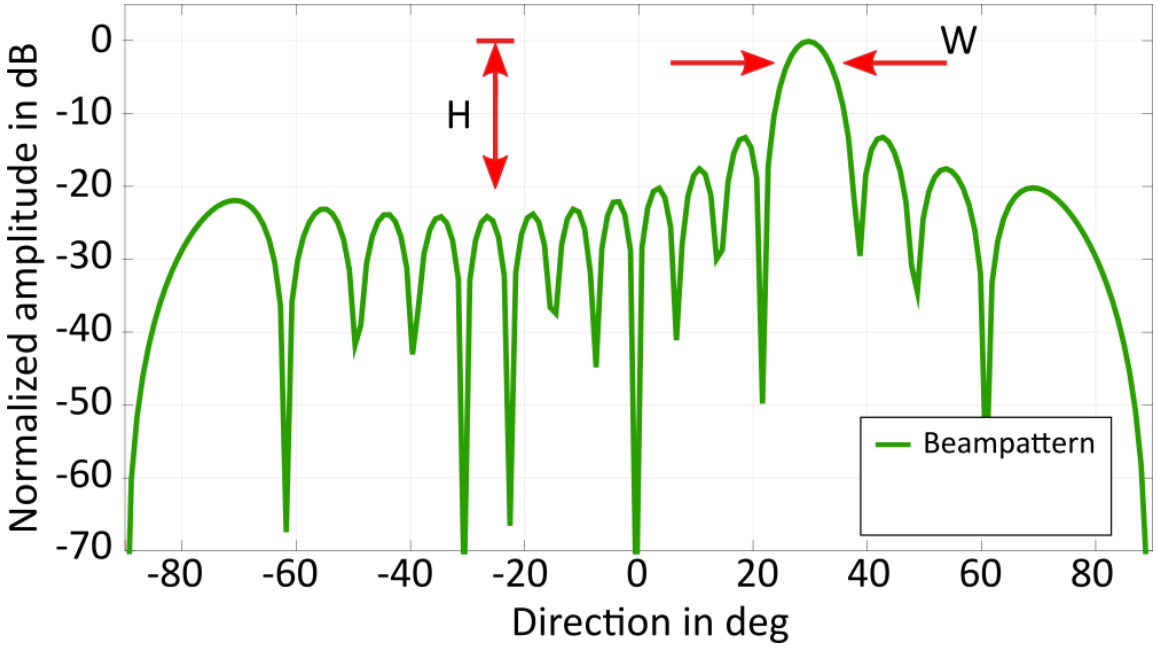
Beampattern

- Important measure for the resolution of the beamformer



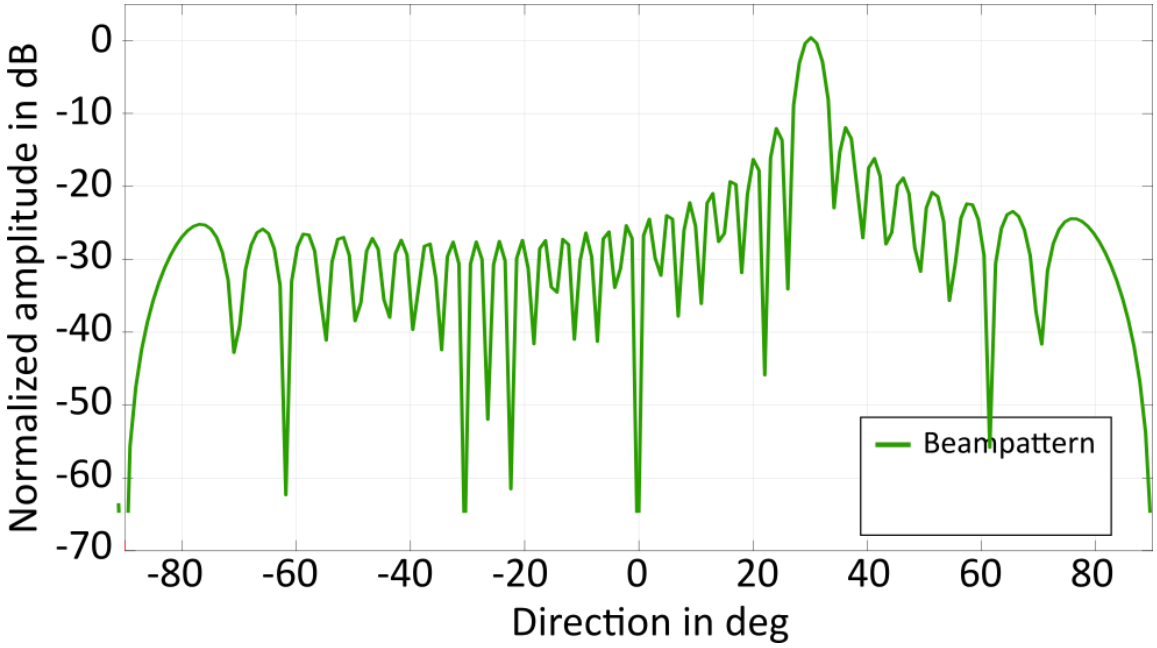
Beamformer performance modification

- Goal: Decrease W and increase H



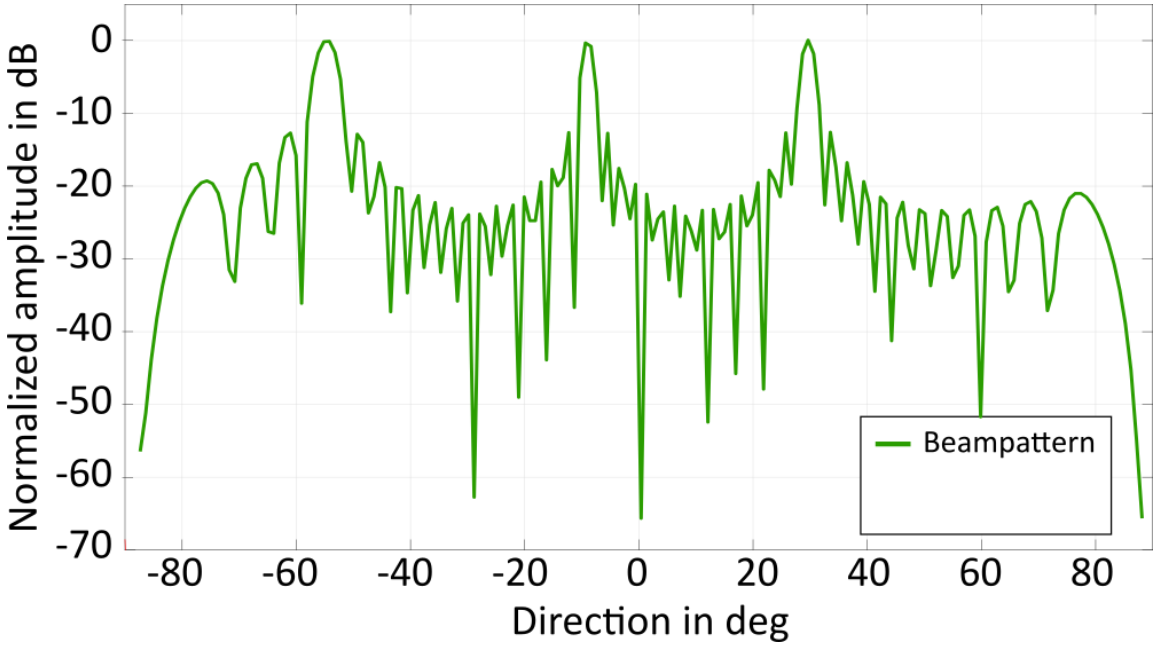
Beamformer performance modification

- Possibility 1: Increase the amount of hydrophones to enlarge the aperture



Beamformer performance modification

- Possibility 2: Increase the hydrophone spacing



The MIMO principle

The typical active sonar system:

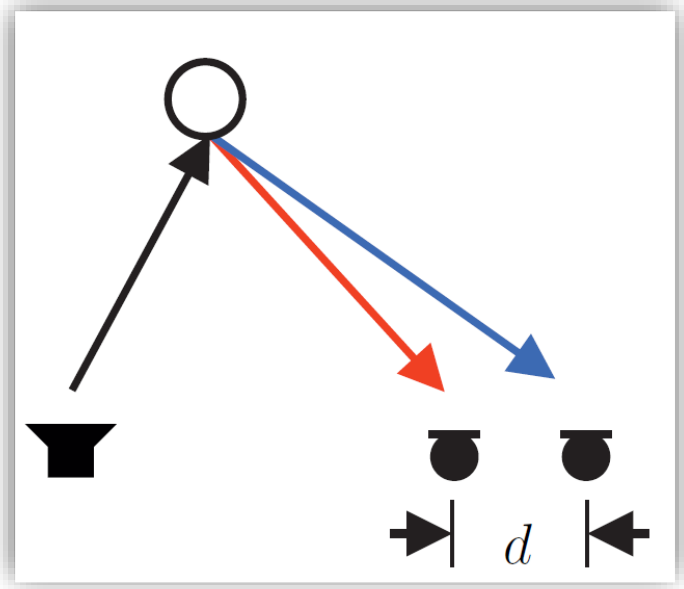
- Single-input-multiple-output (SIMO) sonar
- One coherent transmit signal (e.g. CW or FM) is transmitted

Multiple-input-multiple-output (MIMO) sonar:

- Transmits on every transmitter channel different signals
- Orthogonal signal design

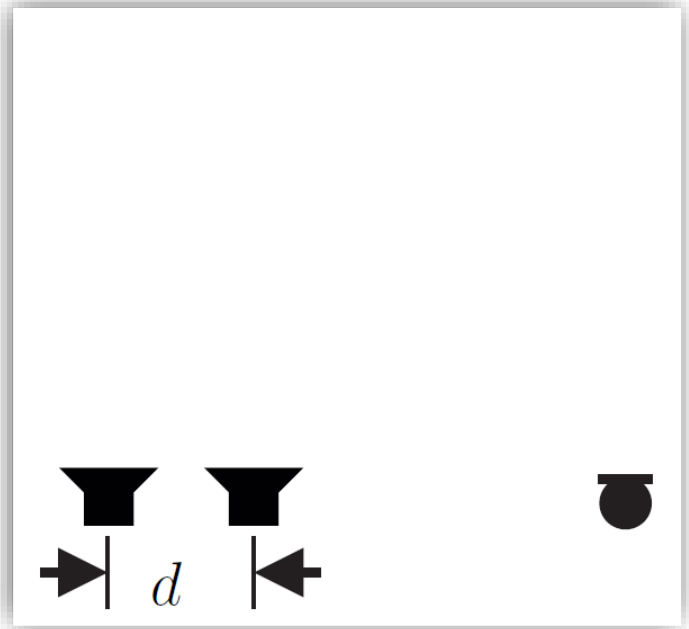
The MIMO principle

The simples SIMO case:



The MIMO principle

Two transmitter, one receiver:



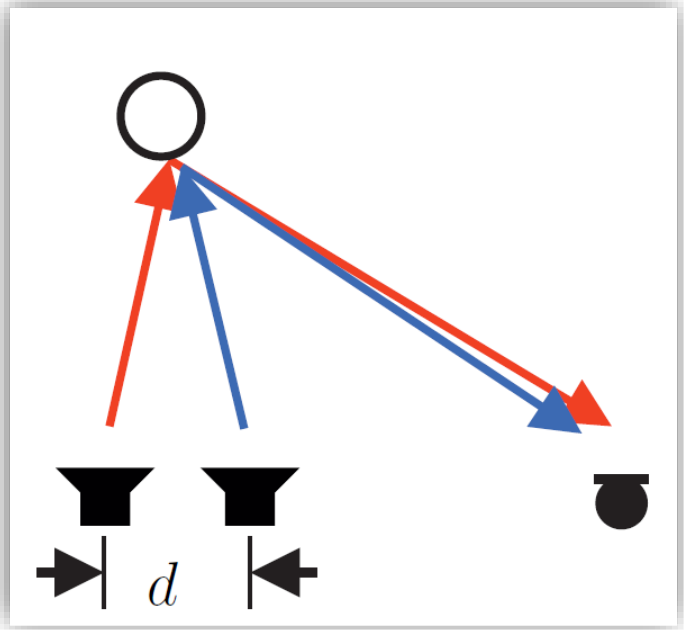
The MIMO principle

Transmitter side:

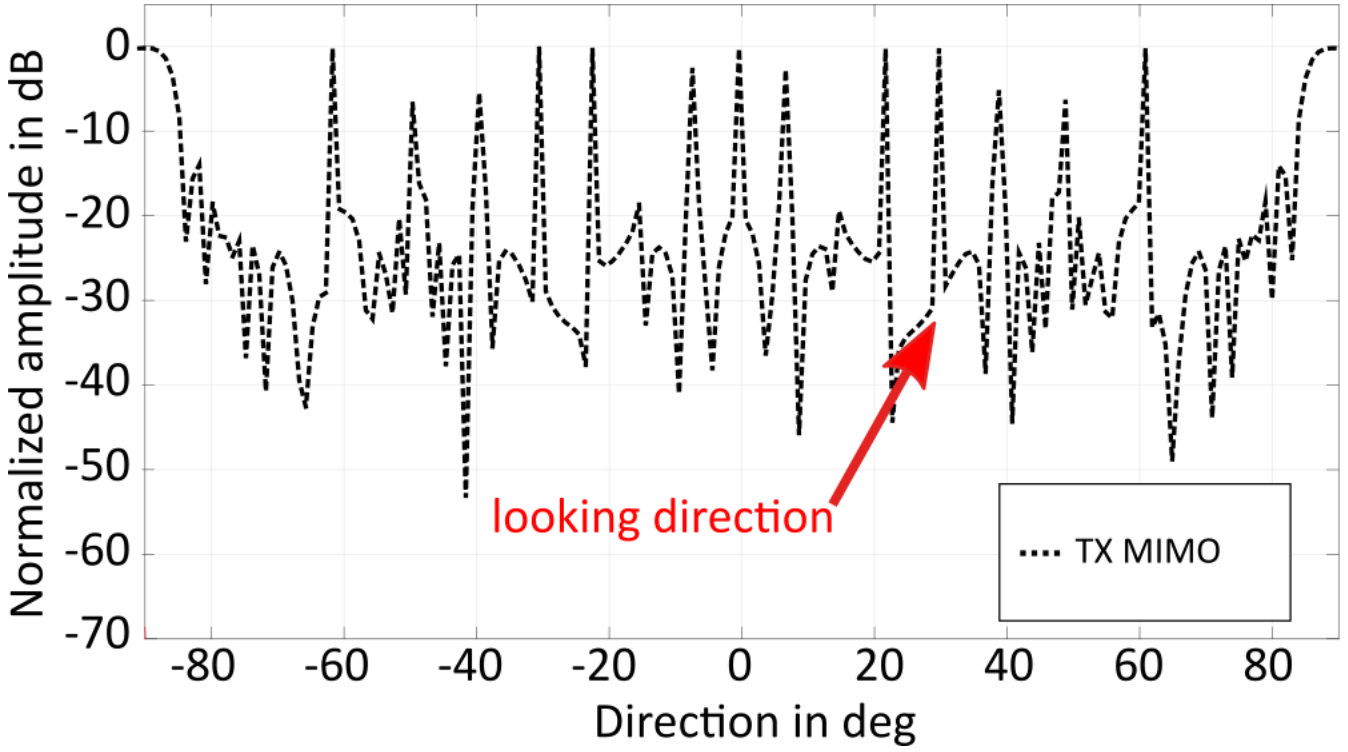
- Independent, *orthogonal* signals
- No transmission beam is formed

Receiver side:

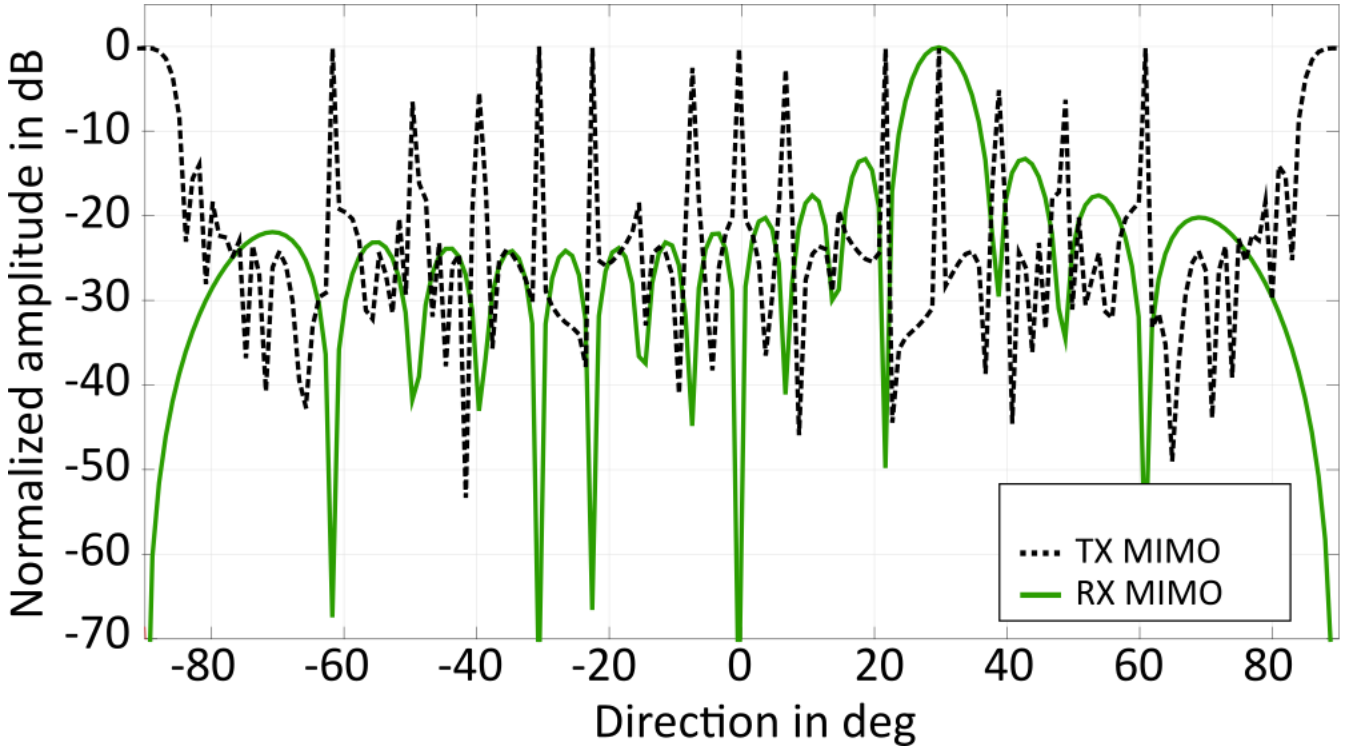
- Divide the signals –matched filter –
- "Re-cohere" the signals with
  ELAC Nautik's MIMO Sonar technique
  - Prior knowledge
  - Restore orthogonality
- Beamforming
- Equivalent to SIMO



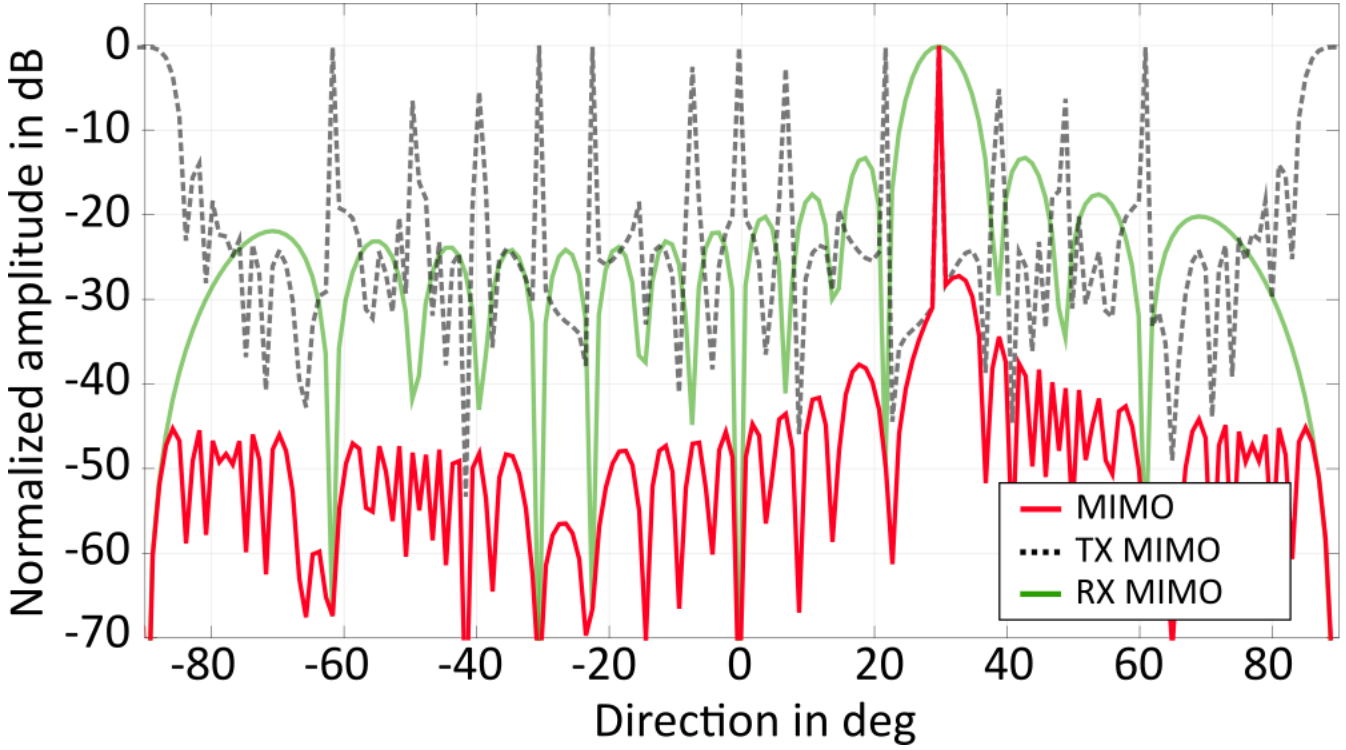
The MIMO principle



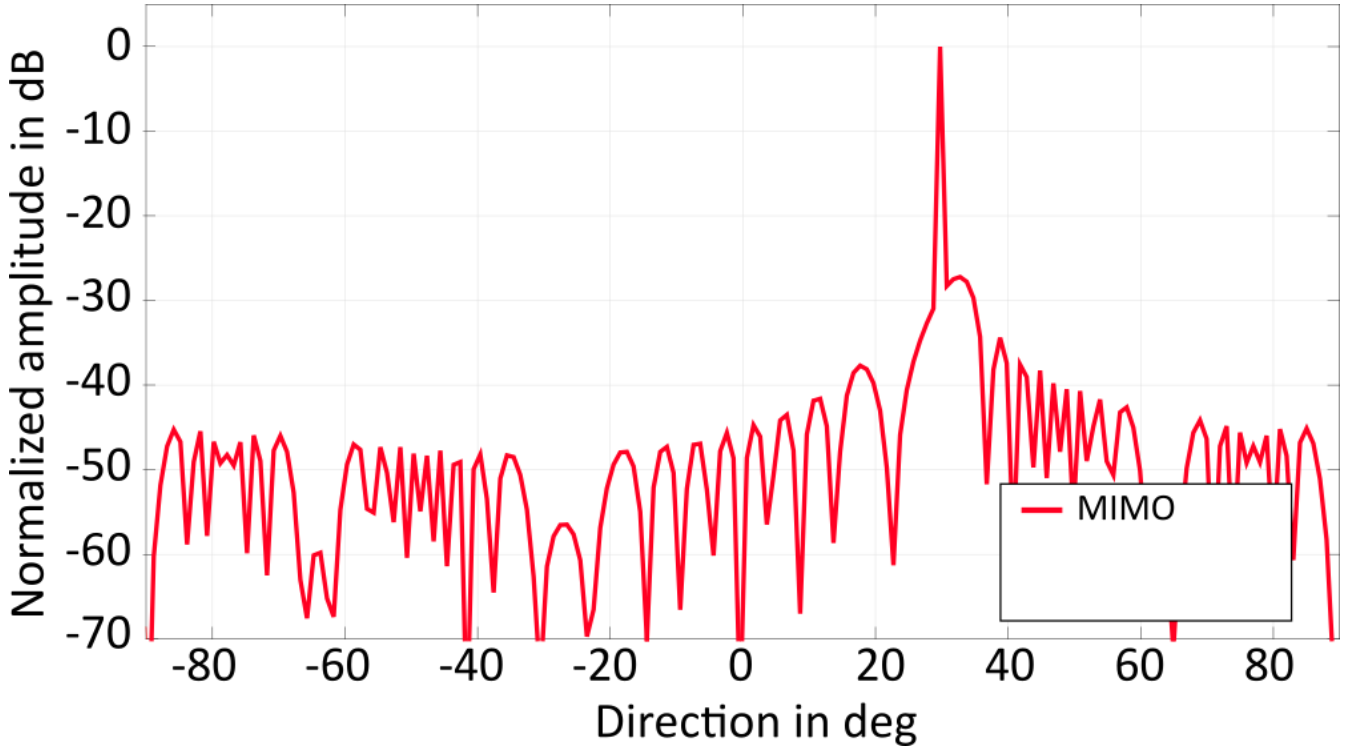
The MIMO principle



The MIMO principle



The MIMO principle



Conclusion

- Subsequent transmit beamforming
- Additional degree of freedom
- Virtually enlarging aperture
- Drastic increase of the spatial resolution