

# Technology in the littorals

Below the surface and in-shore

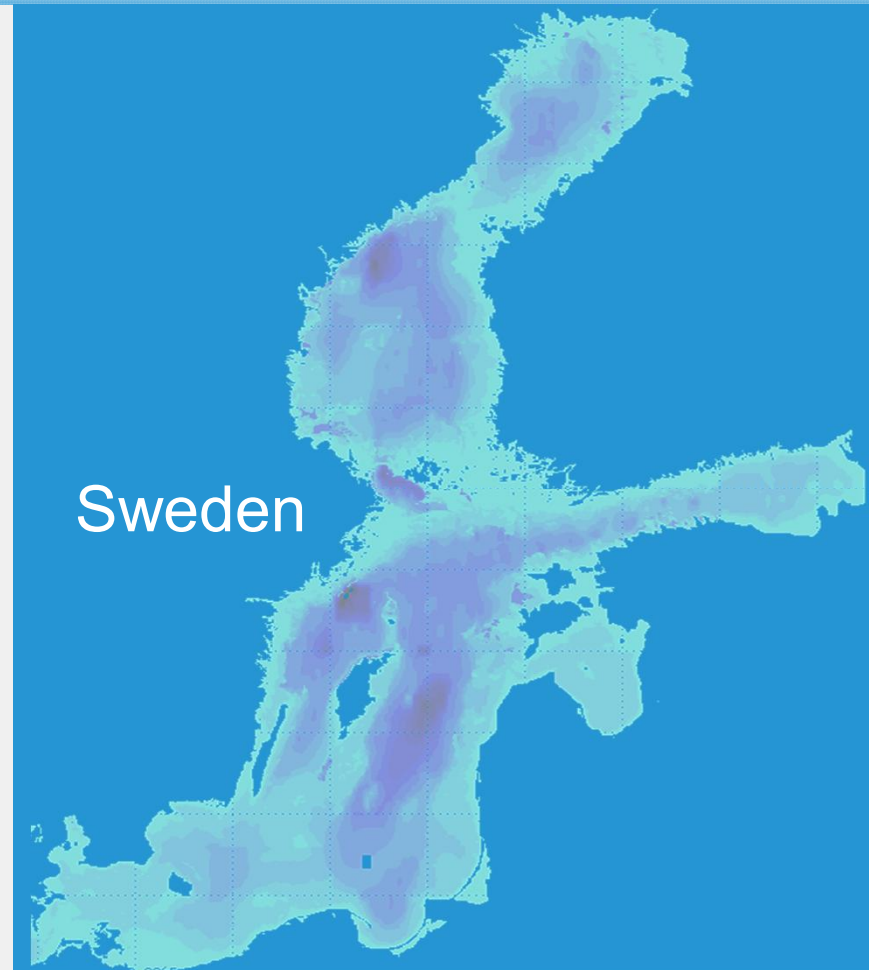
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# The Baltic Sea: Physical environment

- Shallow
  - Mean depth about 60 m
- Large river outlets
- Brackish water,
  - salinity 1/7 of the Atlantic
- Strong seasonal variations
  - Sound velocity profiles vary
- Complicated bottom topography
  - Archipelagos
- Complicated bottom geology
  - Bare rock with pockets of post-glacial clay, sand,...
  - Thick sediments over limestone



# Stockholm archipelago – an extreme littoral environment

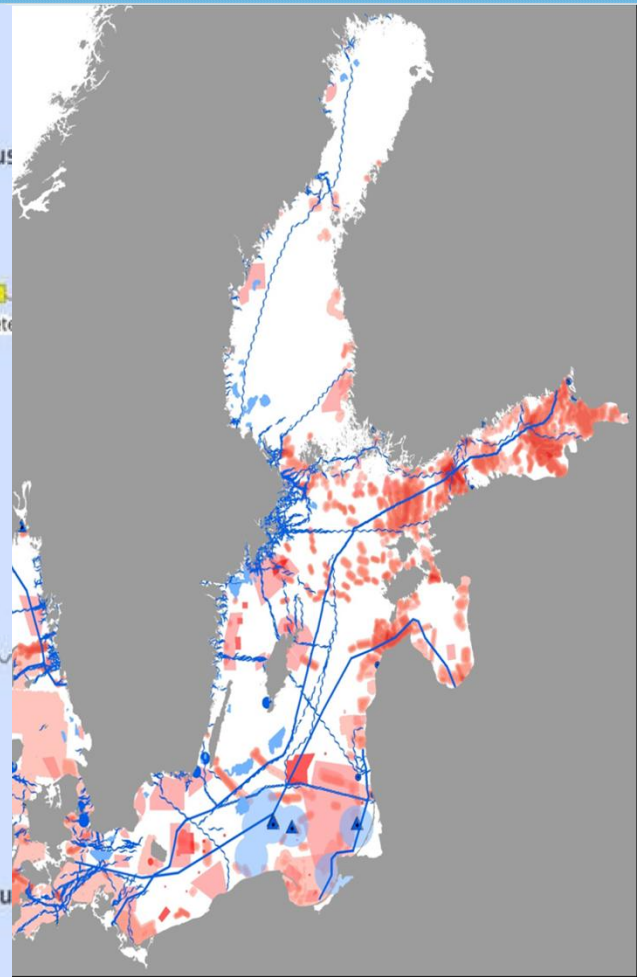
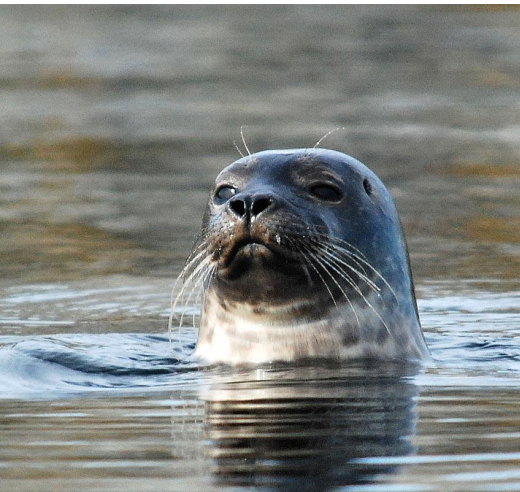


# Stockholm archipelago – an extreme littoral environment



# The Baltic Sea: Operational environment

- Potent naval actors
- Heavy merchant shipping
- Wind power plants
- Oil extraction
- Pipelines & Cables
- Dumping areas
- Former mined areas
- Increased concern of mammals (EU/national legislation)



# The Baltic Sea

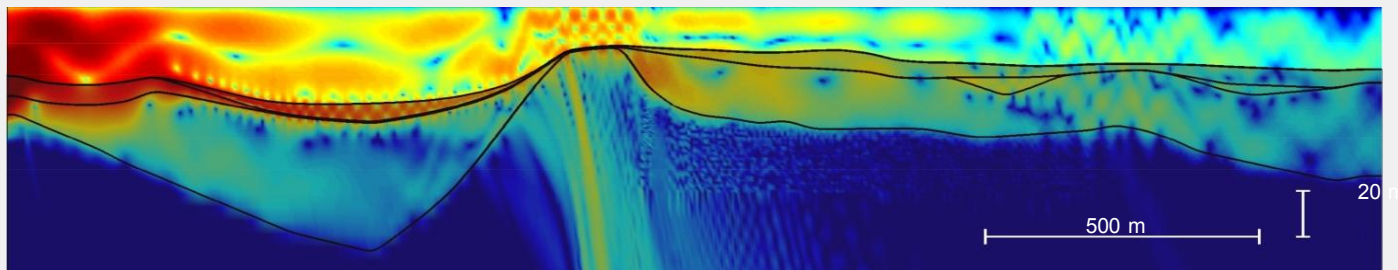
## Technological aspects

### Physical environment

- Salinity and use of “HF” acoustics
- Electromagnetic sensor systems
- Wave propagation & reverberation
- Signature management
- Tactical decision aids
  - Access to physical parameters

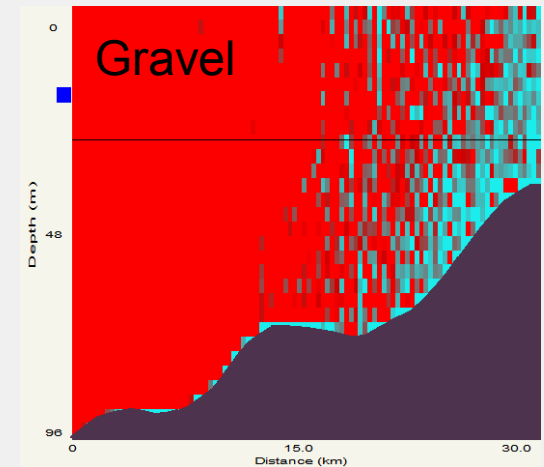
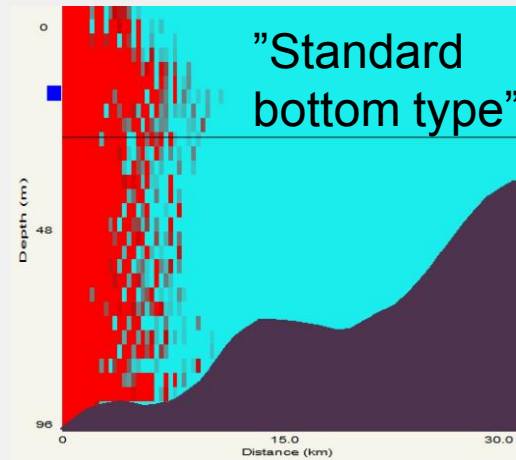
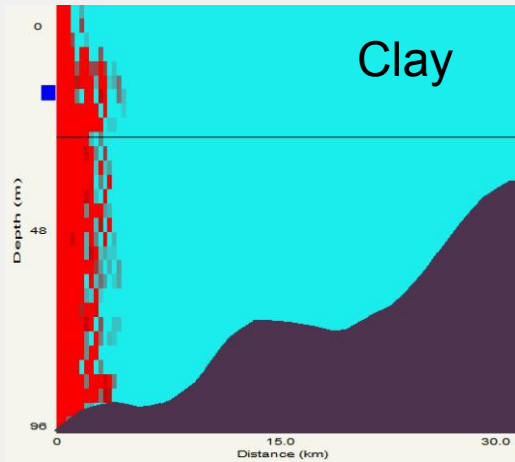
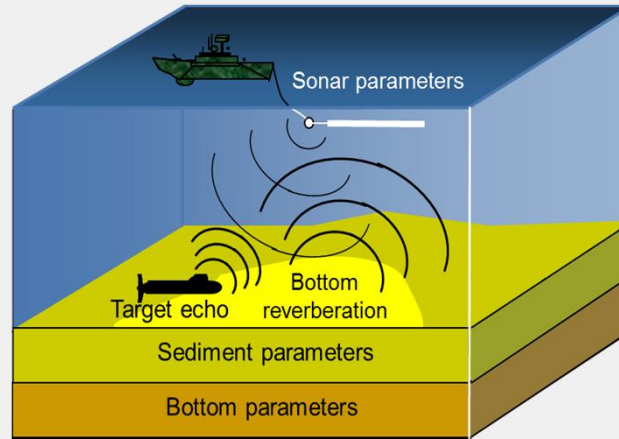
### Operational environment

- Threat analyses
- Noise and interference analysis & suppression
- Safety issues (mines, mammals, etc)

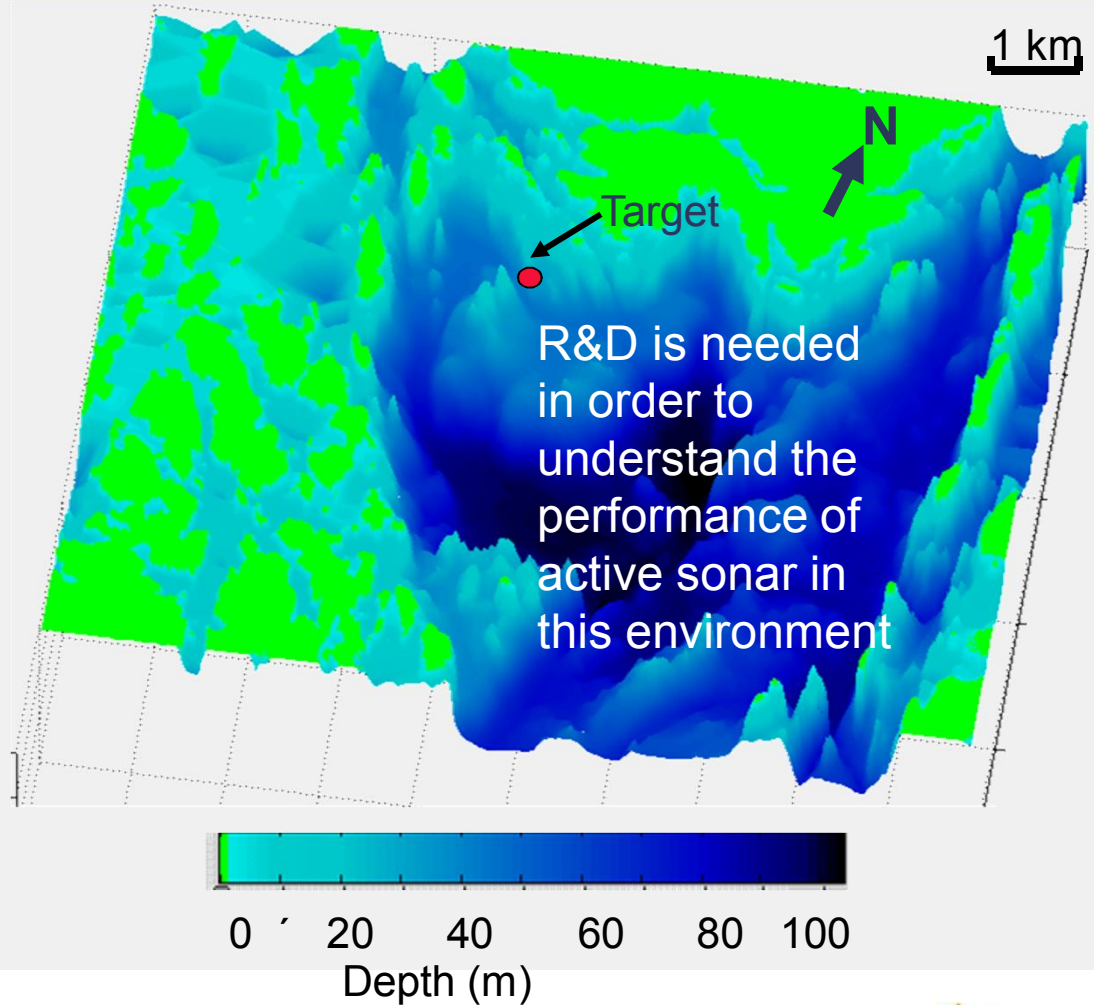
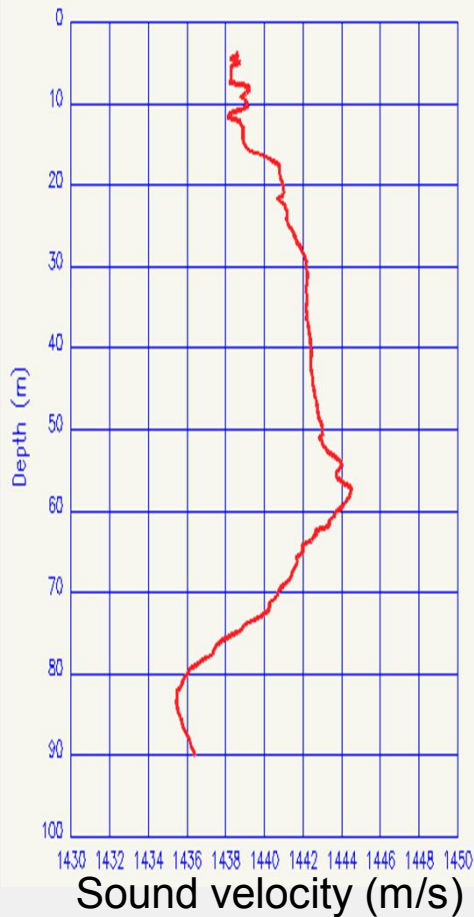


# Sediment and bottom parameters

Effect on detection ranges

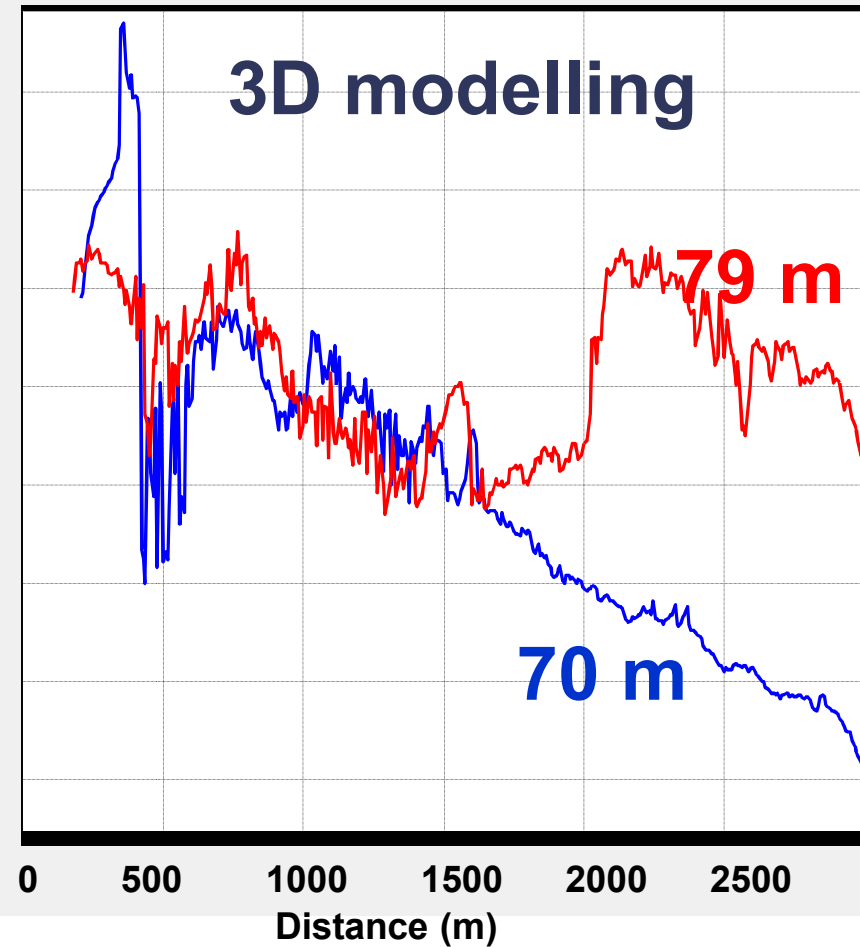
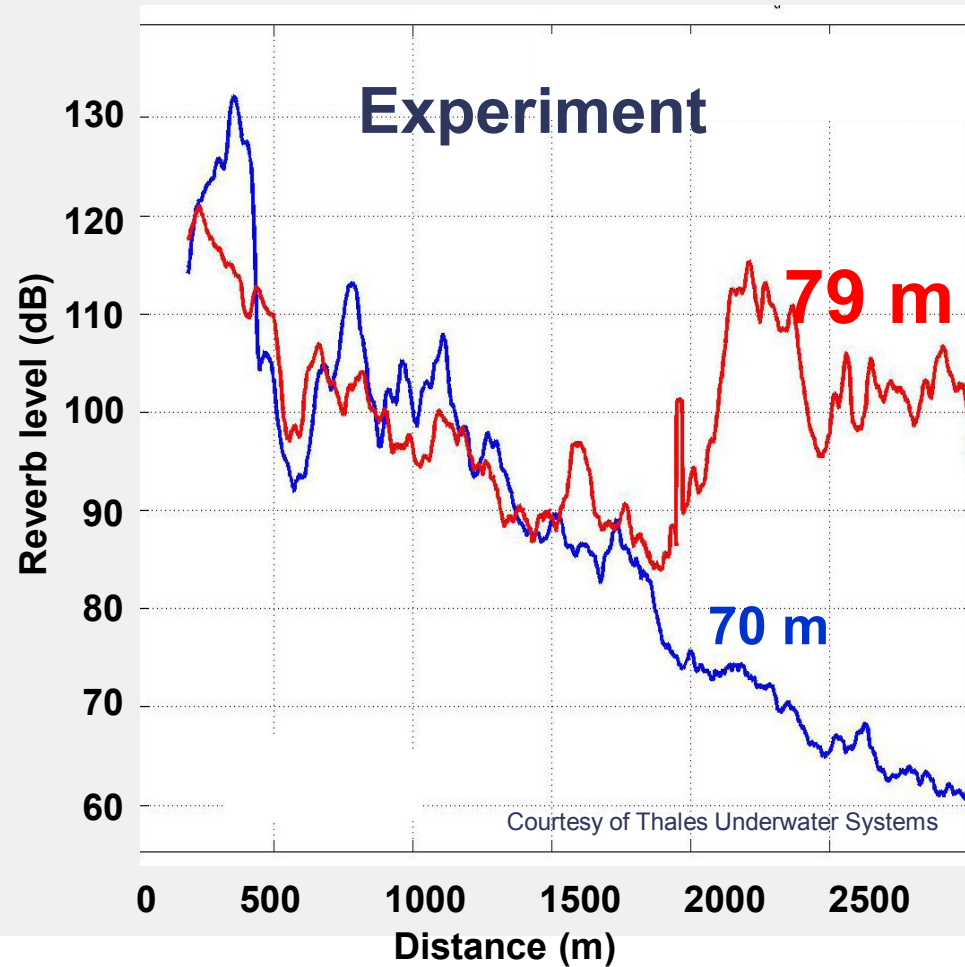


# Shallow waters and complicated bottom topography





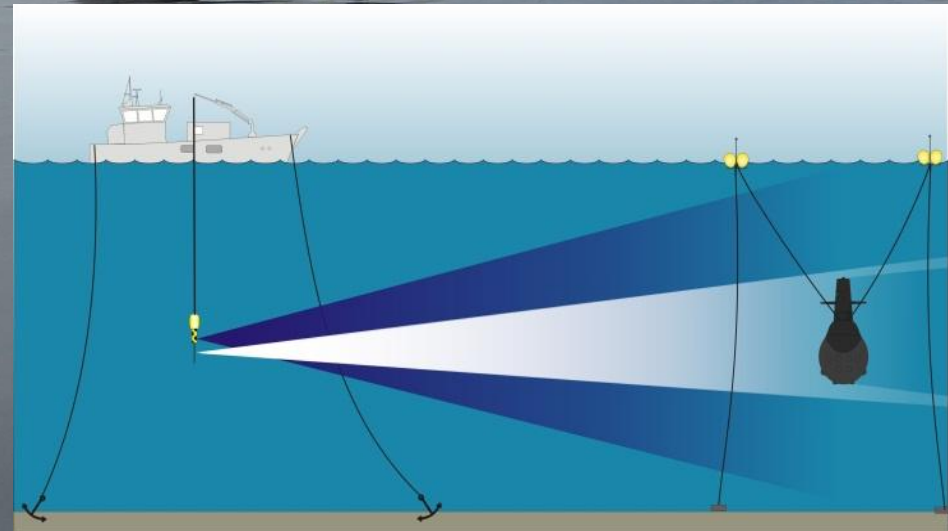
# Reverberation – Source Depth Dependance



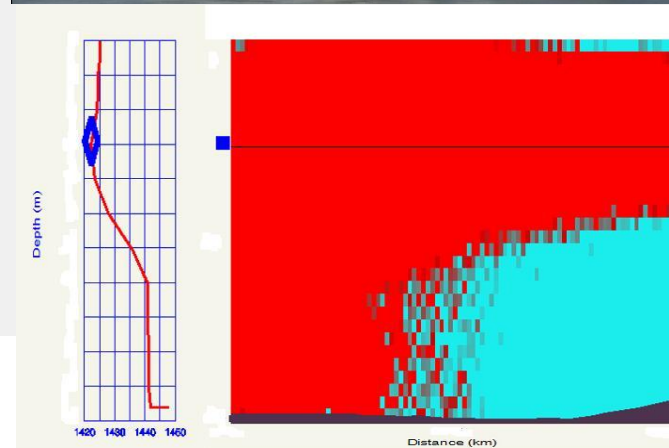
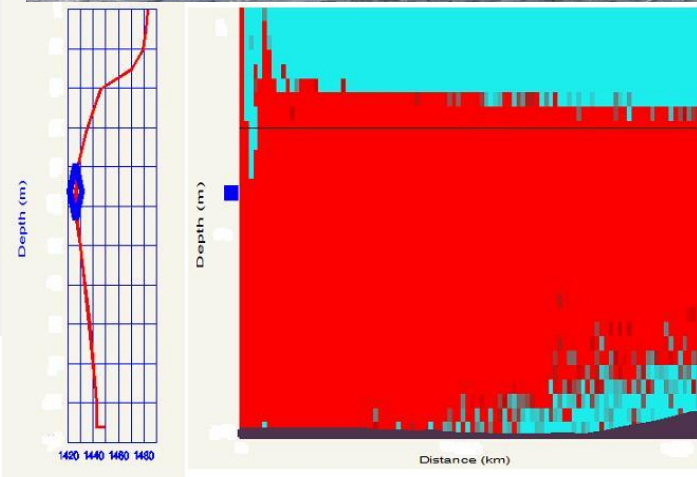
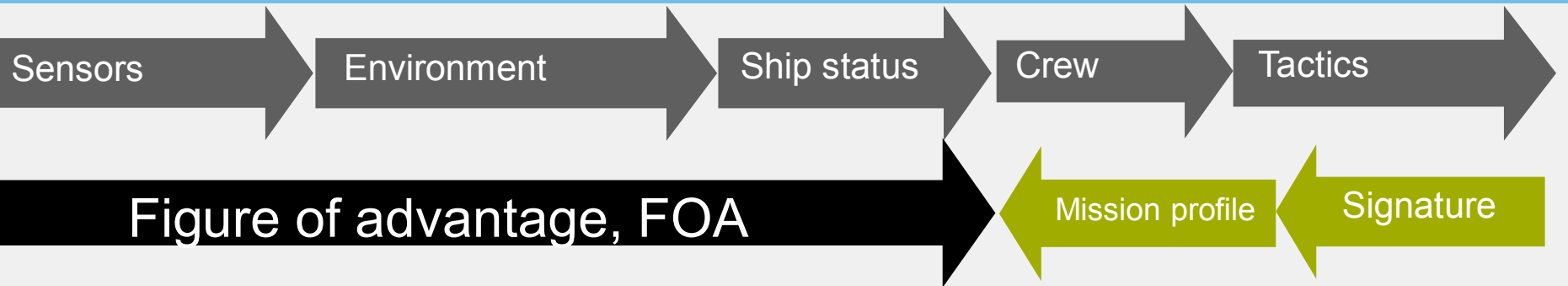
# Signatures and Signature Management



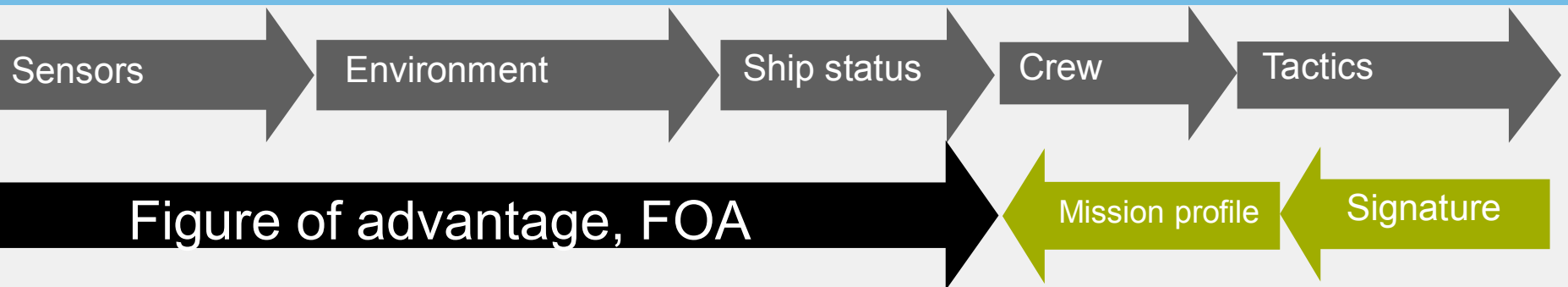
Development of methods for target echo strength measurements in shallow waters



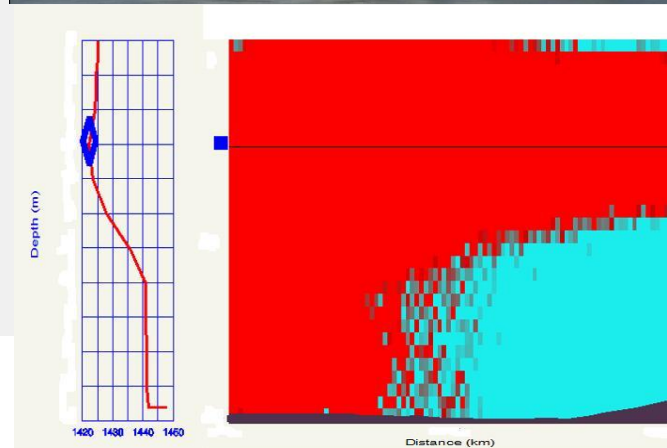
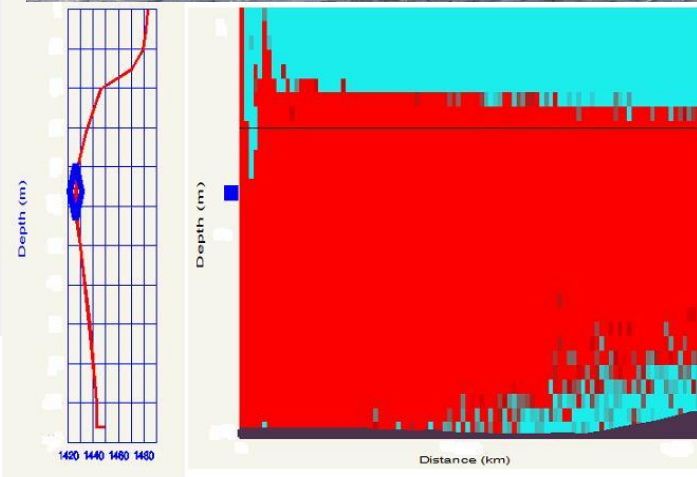
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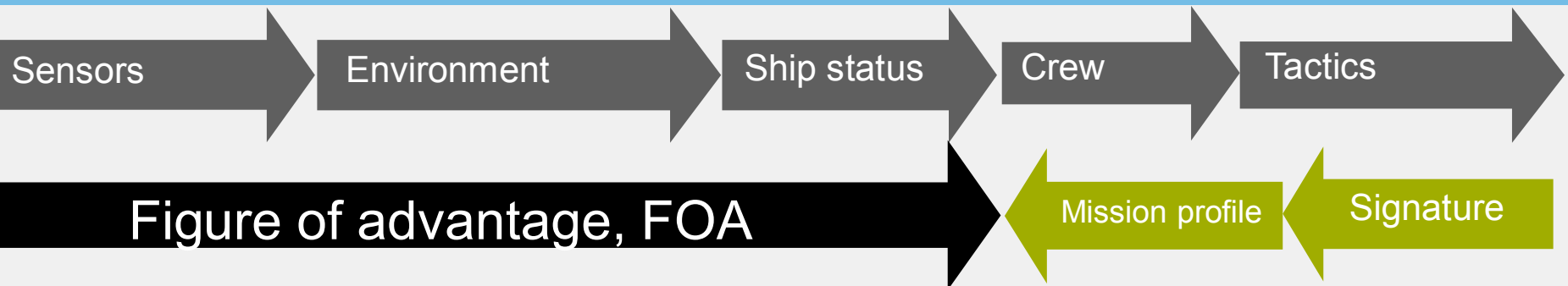
# Signatures and Signature Management



Same geographical location:  
Same bottom topography and same sediment and bottom parameters

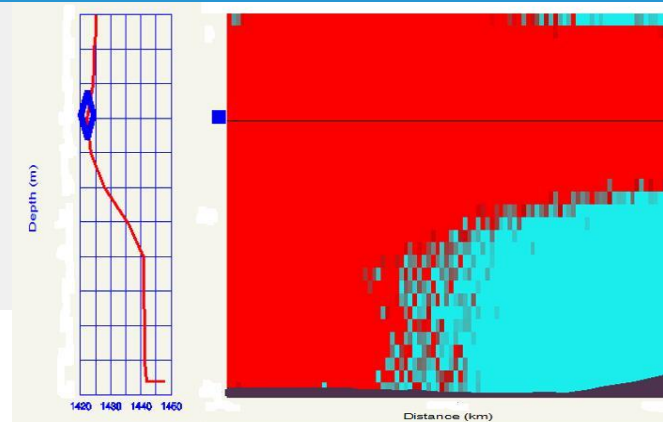
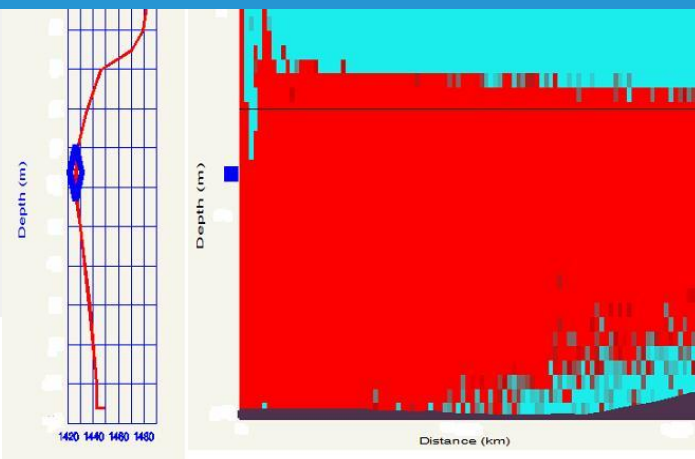


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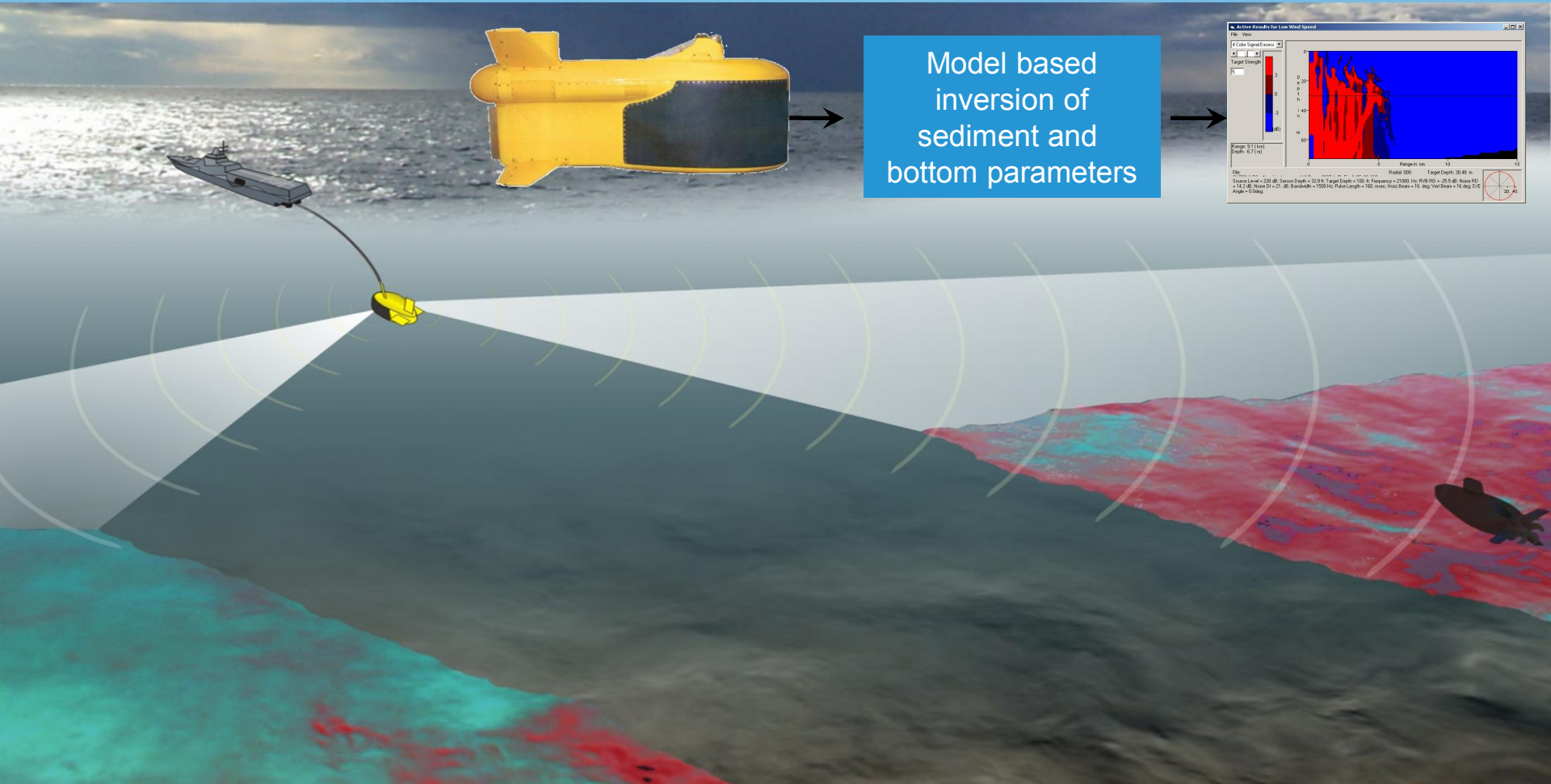
Same geographical location:  
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Strong seasonal variations:  
Variations in sound velocity profiles



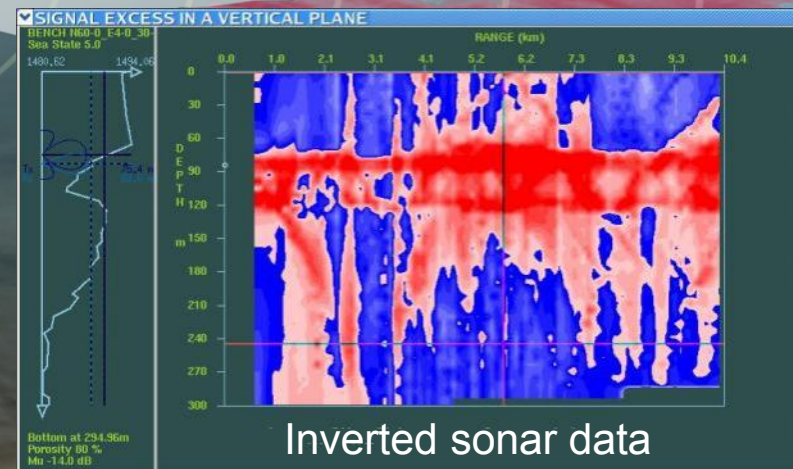
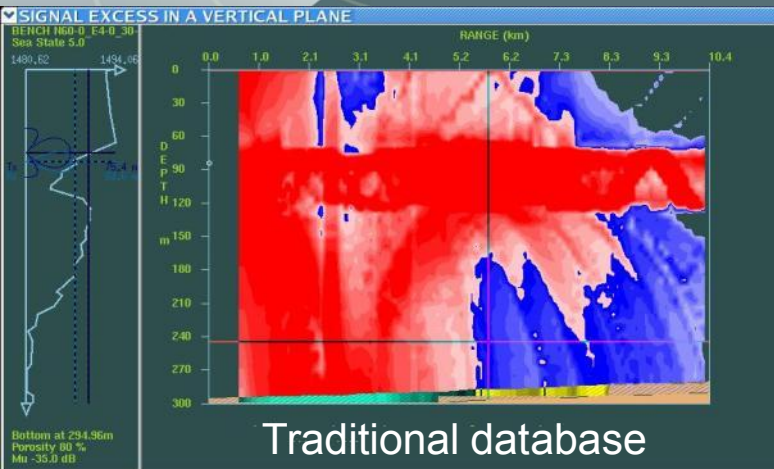
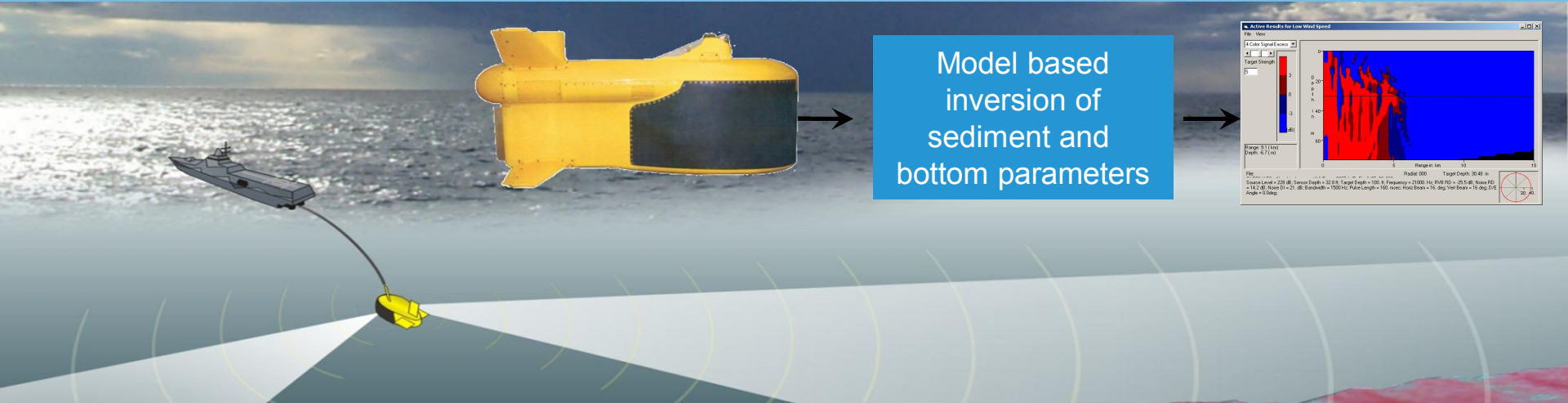
# Signal processing

## ASW applications: Through the sensor REA



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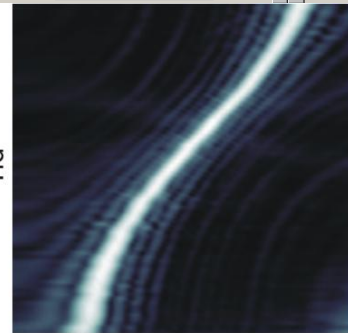
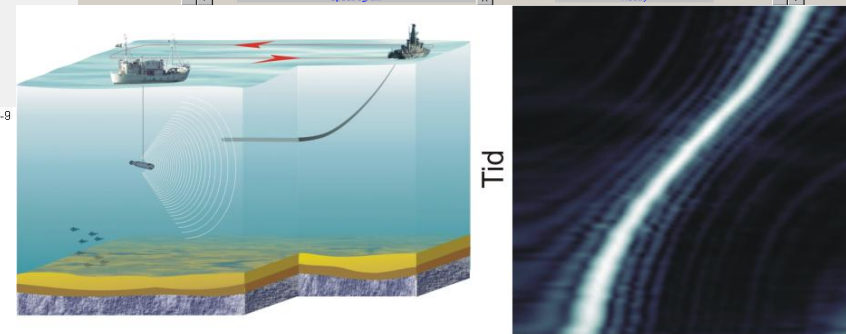
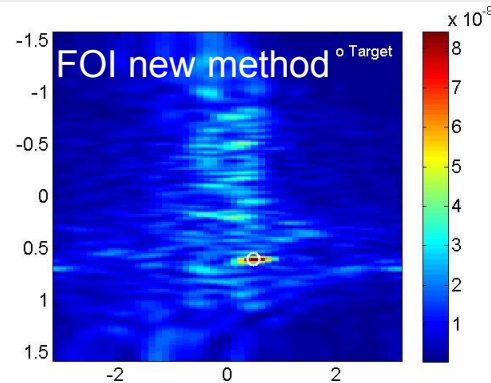
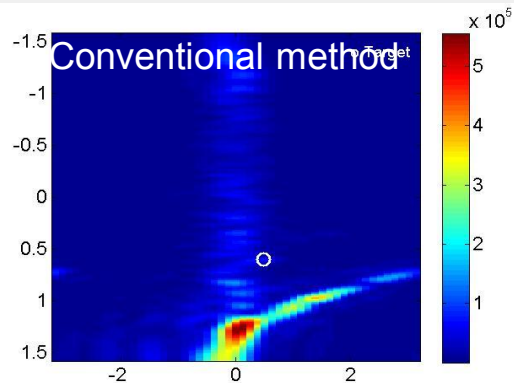
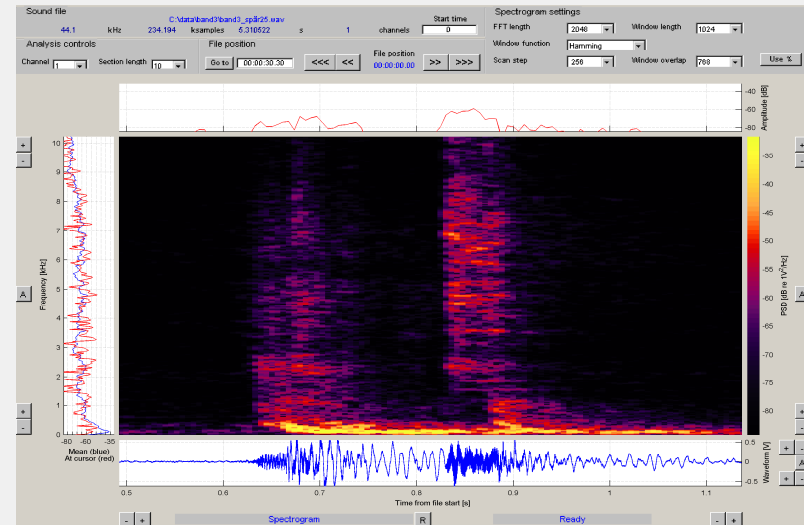


# Signal processing

## Submarine applications

### Development of array processing algorithms for submarines

- Passive ranging/localization and target tracking
- Torpedo warning
- Noise and interference analysis & suppression
- High resolution/adaptive beamforming
- Automatic detection (transients, pings)



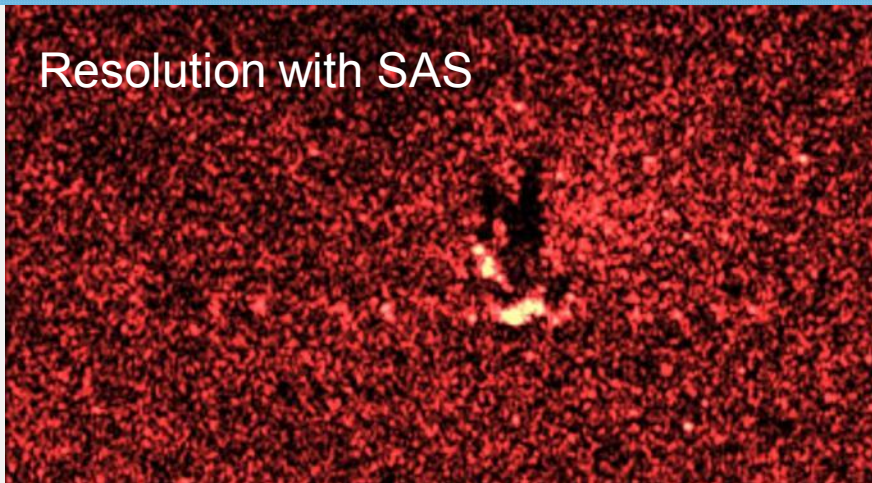
Båring  
LÖSNING



# Signal processing UUV/AUV applications



Resolution with SAS



Resolution without SAS

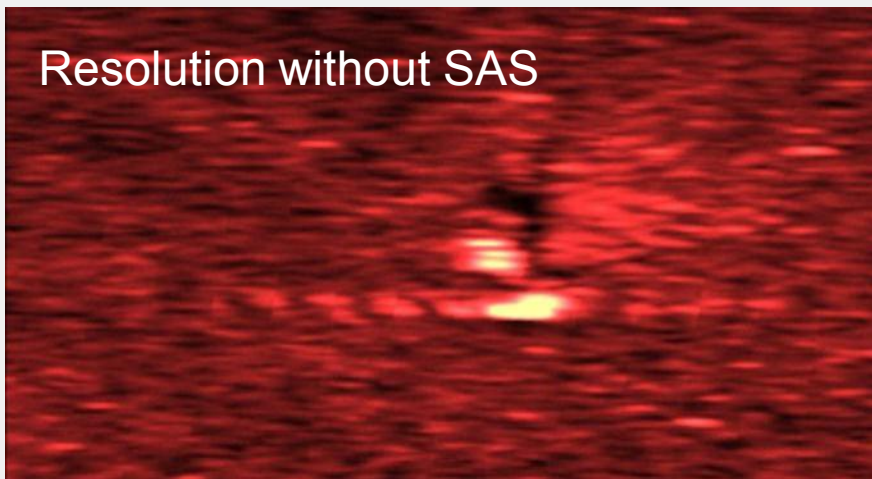
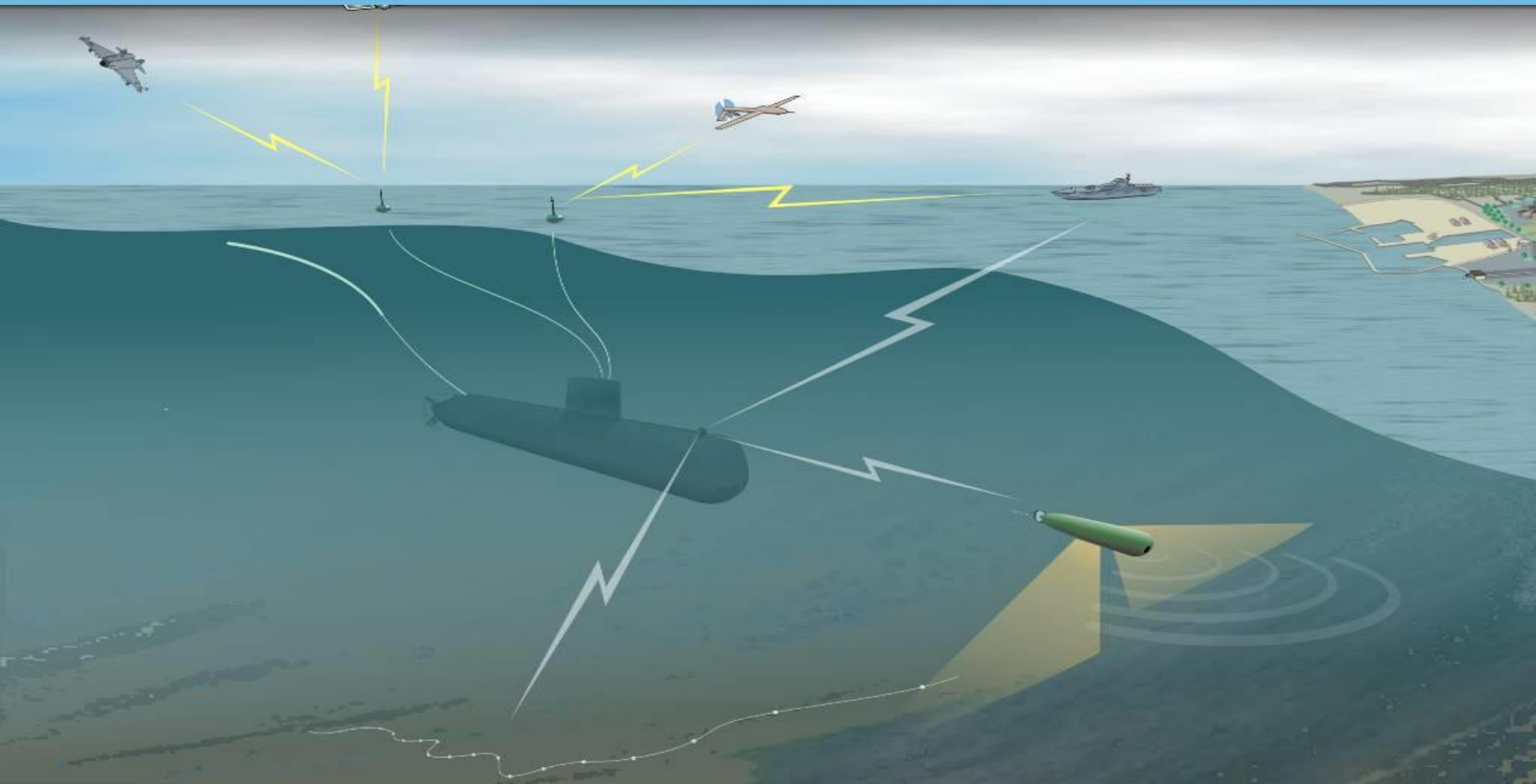


Photo of anchor at bottom



# Signal processing

## Underwater communication



# Signal processing

## Underwater communication

Area	Range	Error free bitrate (infobits per second)
Baltic Gotland Late summer	40 km 60 km	10000 4000
Baltic Bornholm Fall	54 km	Stealth (low data rate)
Archipelago	1 km	54000
Ship to sub making speed	Intentionally blank	Digital speech, SMS, images

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- In depth knowledge of environmental impact on sensors, signatures and signal propagation is essential to win the underwater battle
- There is a need to explore "systems-of –systems capability" in the underwater domain. Solutions for underwater communication is an essential precondition

# Some important conclusions

- The Baltic Sea represents a particularly difficult environment for sensor optimization, signature generation and signal propagation
- In depth knowledge of environmental impact on sensors, signatures and signal propagation is essential to win the underwater battle
- There is a need to explore "CEC-solutions" in the underwater domain
- R&D-support is a decisive factor for succesful operations in the Baltic sea