
10th edition of SEA
BREST-FRANCE
TECH WEEK
DU 10 AU 14 OCTOBRE 2016

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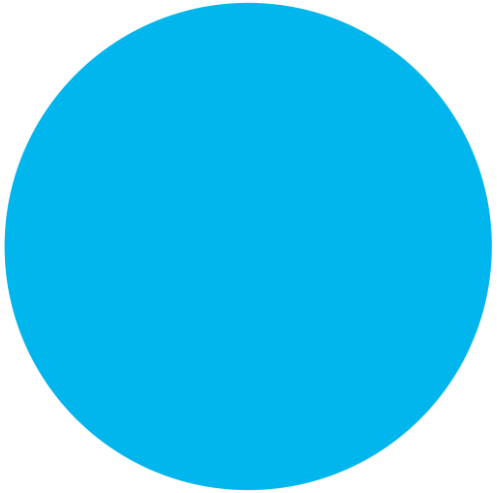
MOCESM'16



# Seapix :
# A Multi-Usage Multibeam Sonar for Hydrography and Robotics Applications

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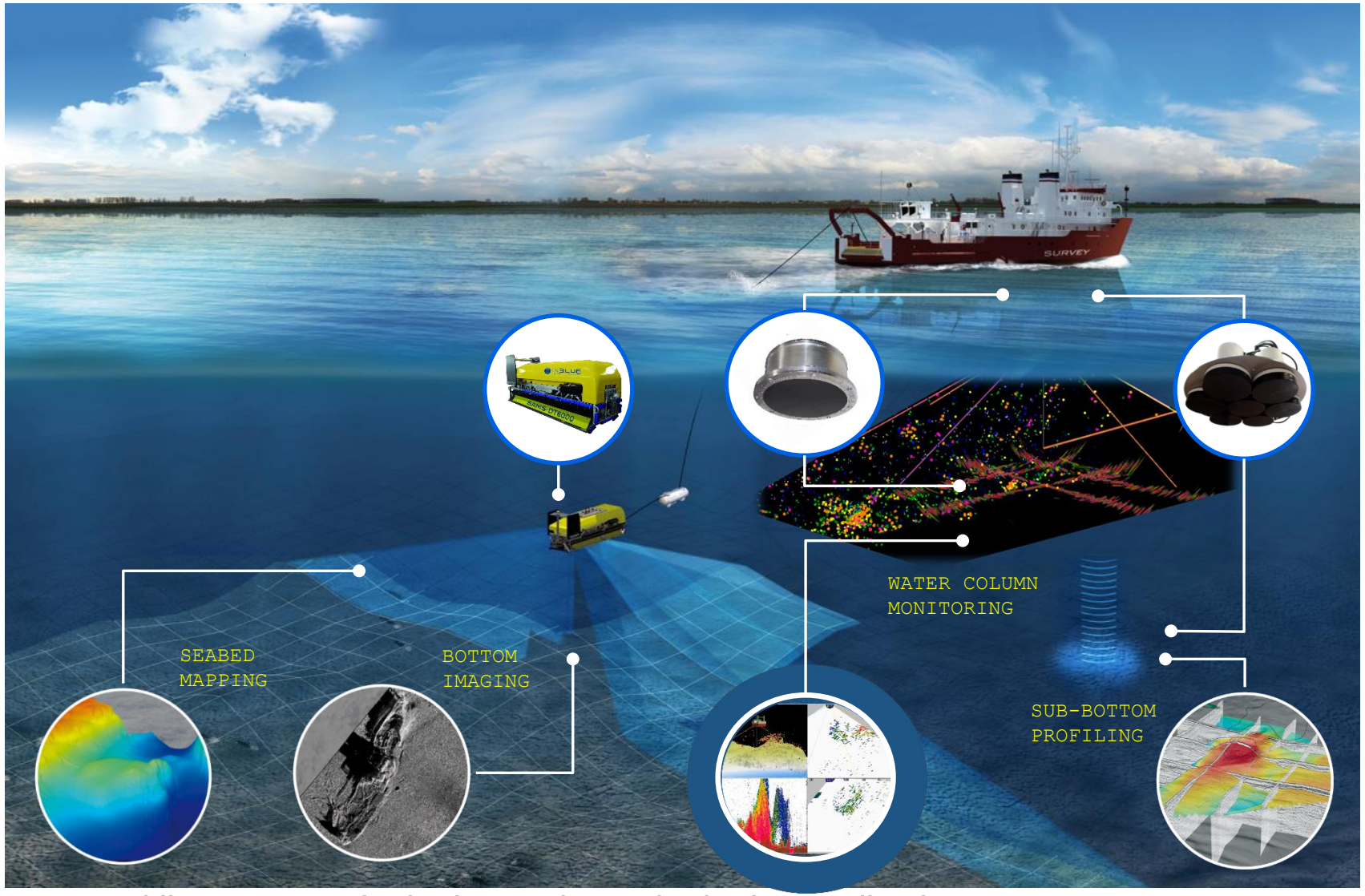
# Table of contents

1

# Sonar Imaging at iXblue

# Sonar Imaging at iXblue : from near surface to subbottom



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2

# Seapix

## Multibeam/Multiswath Echosounder

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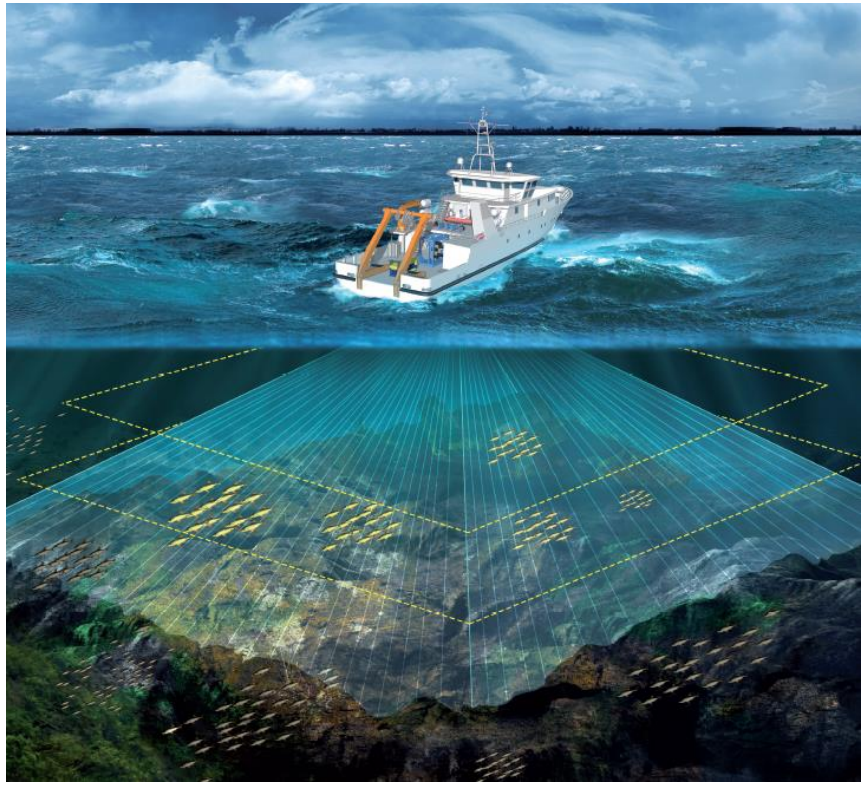
# Seapix

## Project Specifications, Development



**SEAPIX Research&Development**
- start in 2007, First prototype 2010
- 2 FUI (Optipêche/Tactipêche)
- 1 RAPID

**Context&Market**
- Fisheries
- Security/Economic
- Selectivity and Sustainable Policy
- Fisheries resources evaluation in collaboration with scientific (vessel of opportunity )

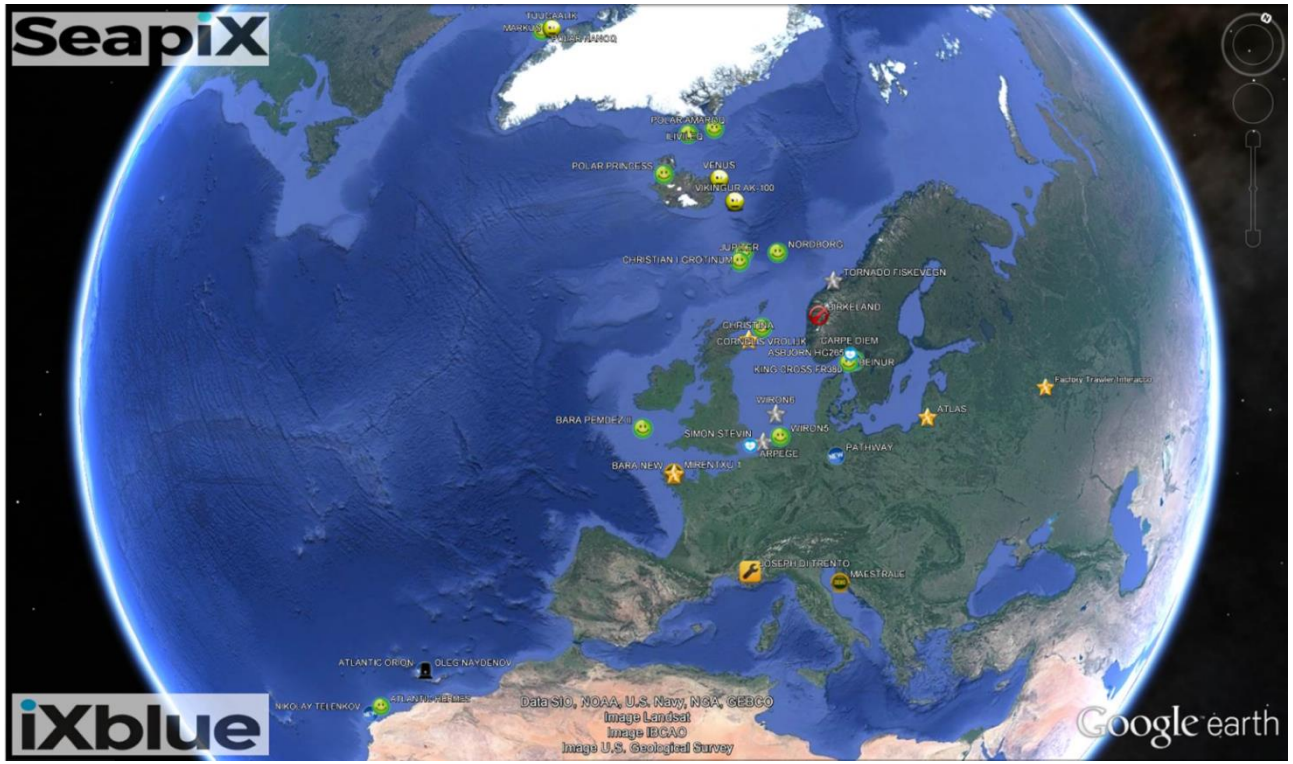
**Requirement Specifications**
- Volumetric scanning of the water column
- Bathymetry up to 400m
- Target detection -35dB up to 200m
- Limited size (Φ< 50cm)
- Bathymetry IHO 1a

**Challenges**
- Tradeoff hardware cost / level of performances
- from single beam to multibeam interpretation

# Seapix

## Market

**Fisheries,Pelagic : 40 systems since 2014**











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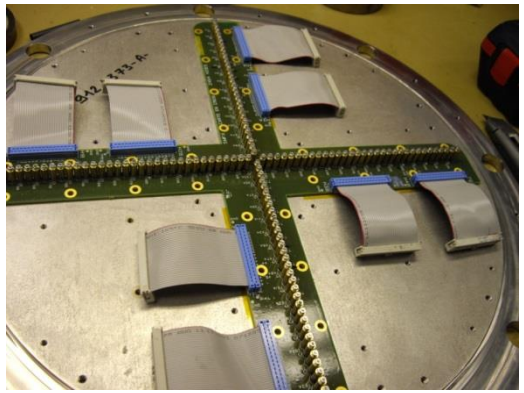
# Seapix

## System Specifications

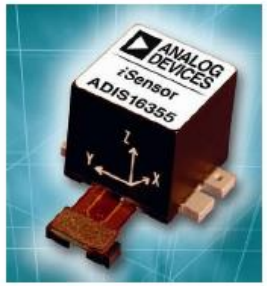


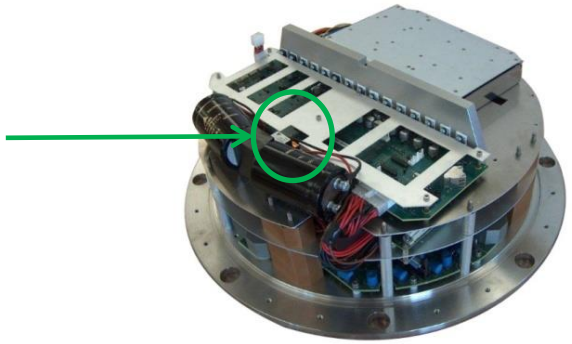
| Specifications | |
|---|---|
| Size | 480mmx180mm |
| Weight | 60/40 kg |
| Power consumption | 200W (500W Peak) |
| Number of transducers | 2x 64 Rx and Tx |
| Max Depth | 20m |
| Beam Stabilization | On transmit and receive |
| Frequency | 150khz |
| Bandwith | 10khz (7.5cm res.) |
| Modulation | CW or FM |
| Beam number | 64 beams |
| Transmit Power | 1kW |
| Beam Steering | +/-60° for/aft port/starboard |
| Transmit Swath width | 120 °x 1.6° |

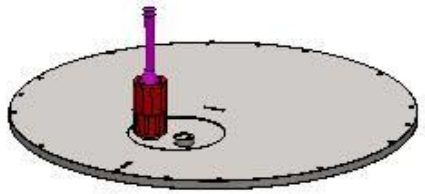
# Seapix

## Sonar Head

MEMS

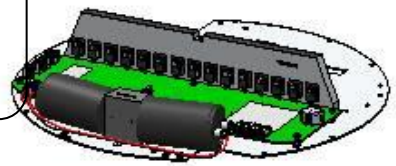




Ethernet

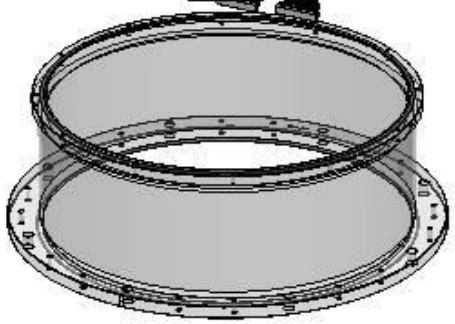
Communication, configuration and Power Supply management, Gyrostabilization



Digital

Emission and reception
Digital signal processing

Receiver Analog Filters
Emission Power



Analogic

Impedance Matching

Transducers

Acoustic



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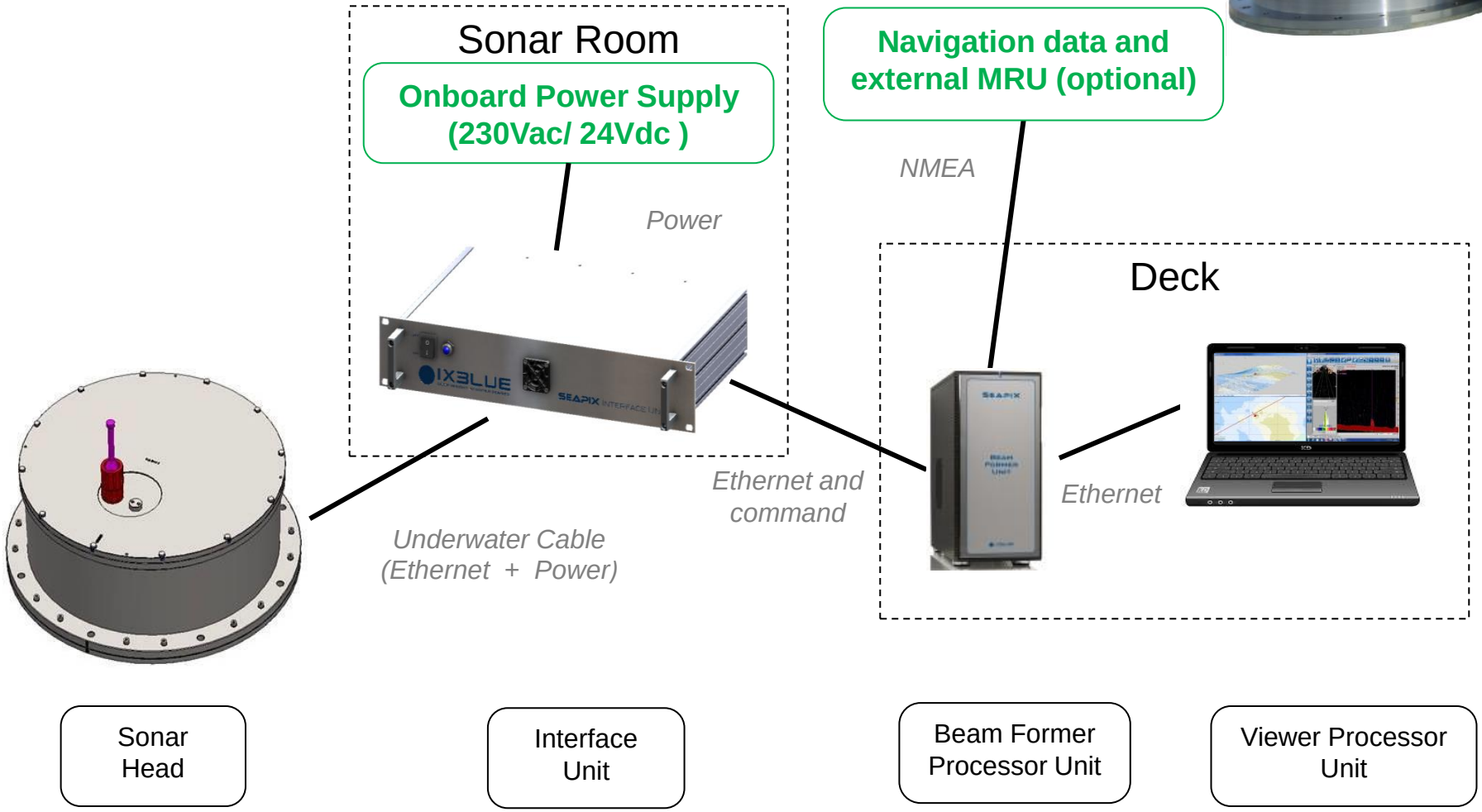
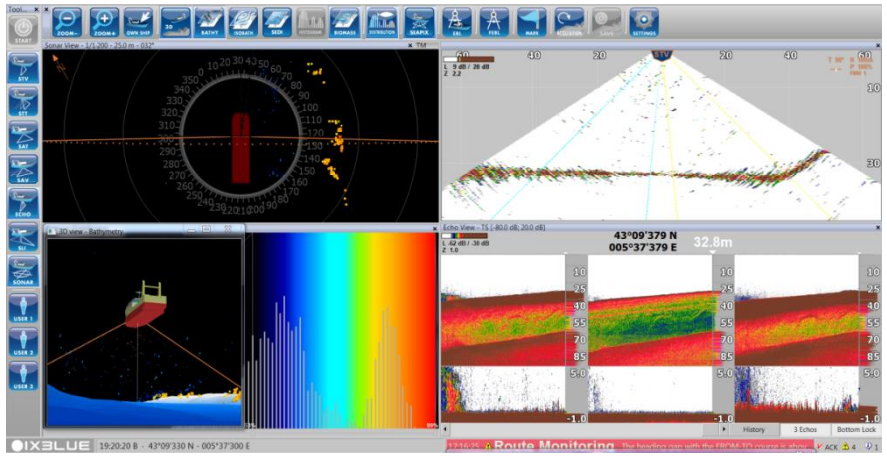
# Seapix

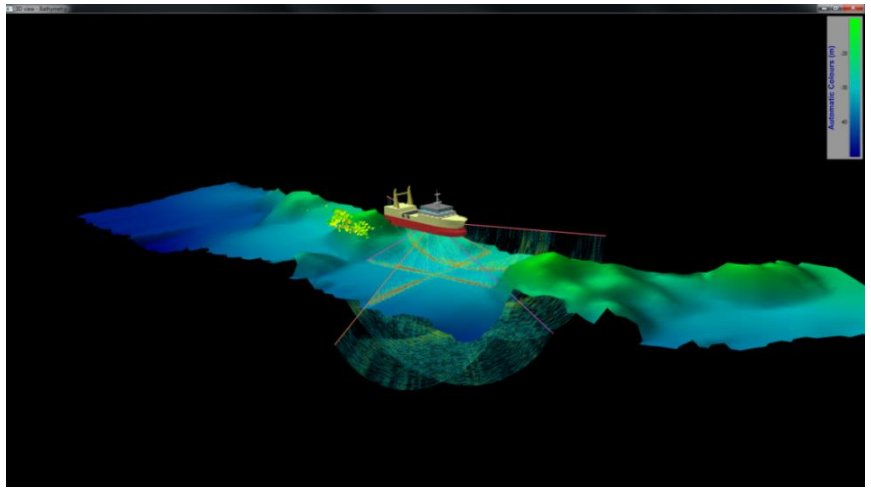
## System Architecture



# Seapix

## Software



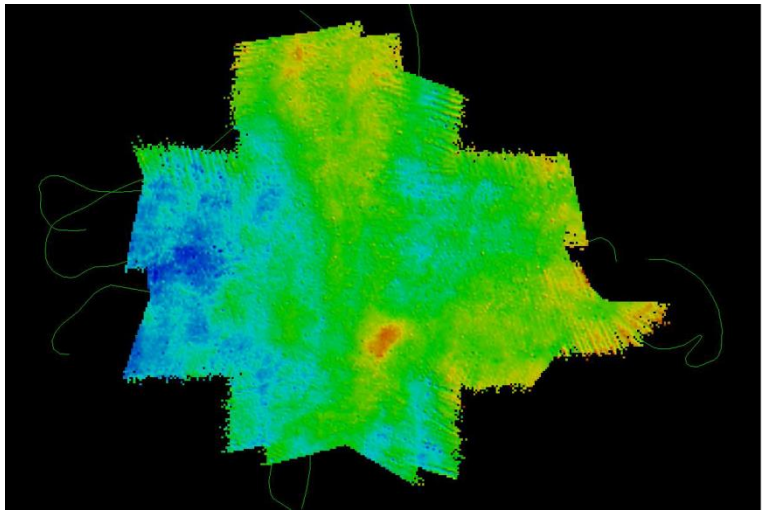


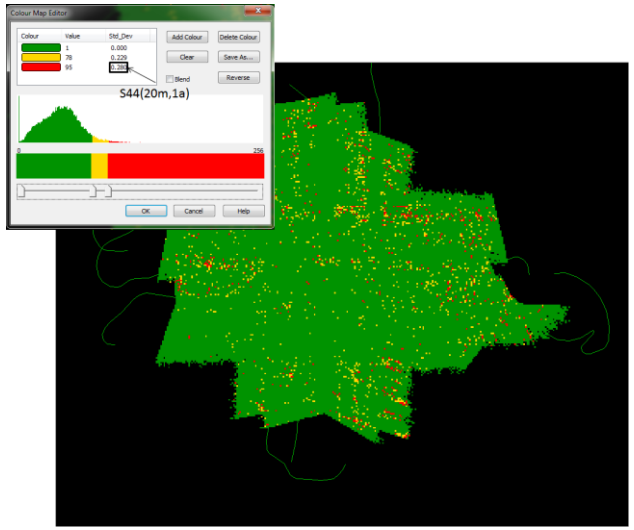
### Key features

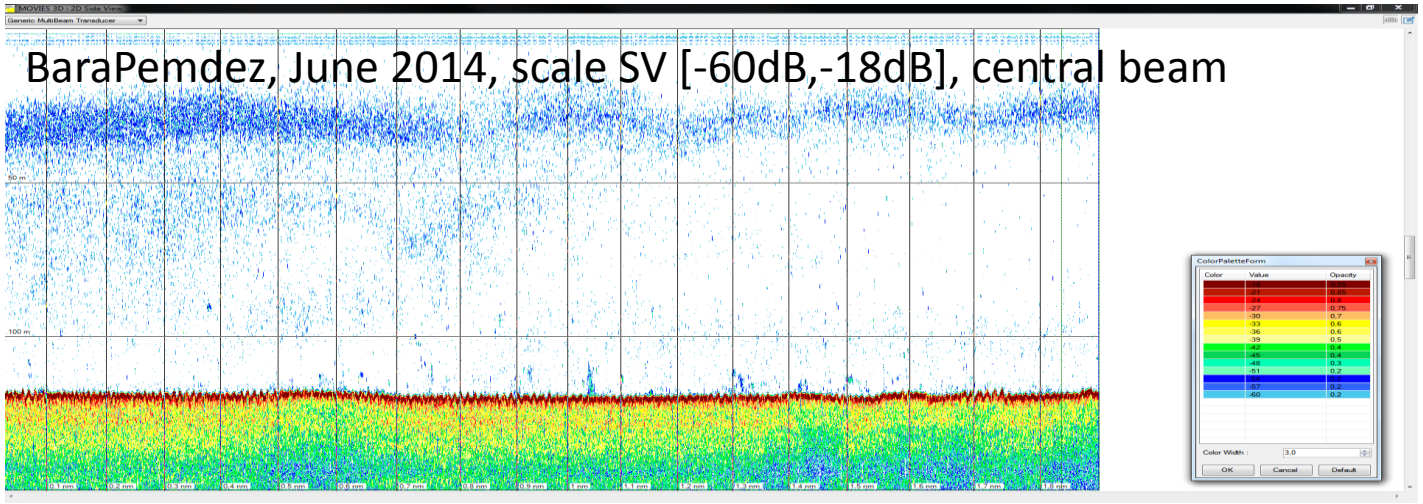
- 2D/3D Bathy
- 2D/3D Backscatter
- 2D/3D Echograms
- Multiple Echogram
- TS/SV Analysis
- HAC format (EchoView,Movies3D)

# Seapix

## Performances






**Bathymetry , ENSTA (2015) :**

- IHO order 1a with MEMS


**Detection Level**

- Noise Level , 24 dB re 1µPa/Hz
- SV -60dB , 200m



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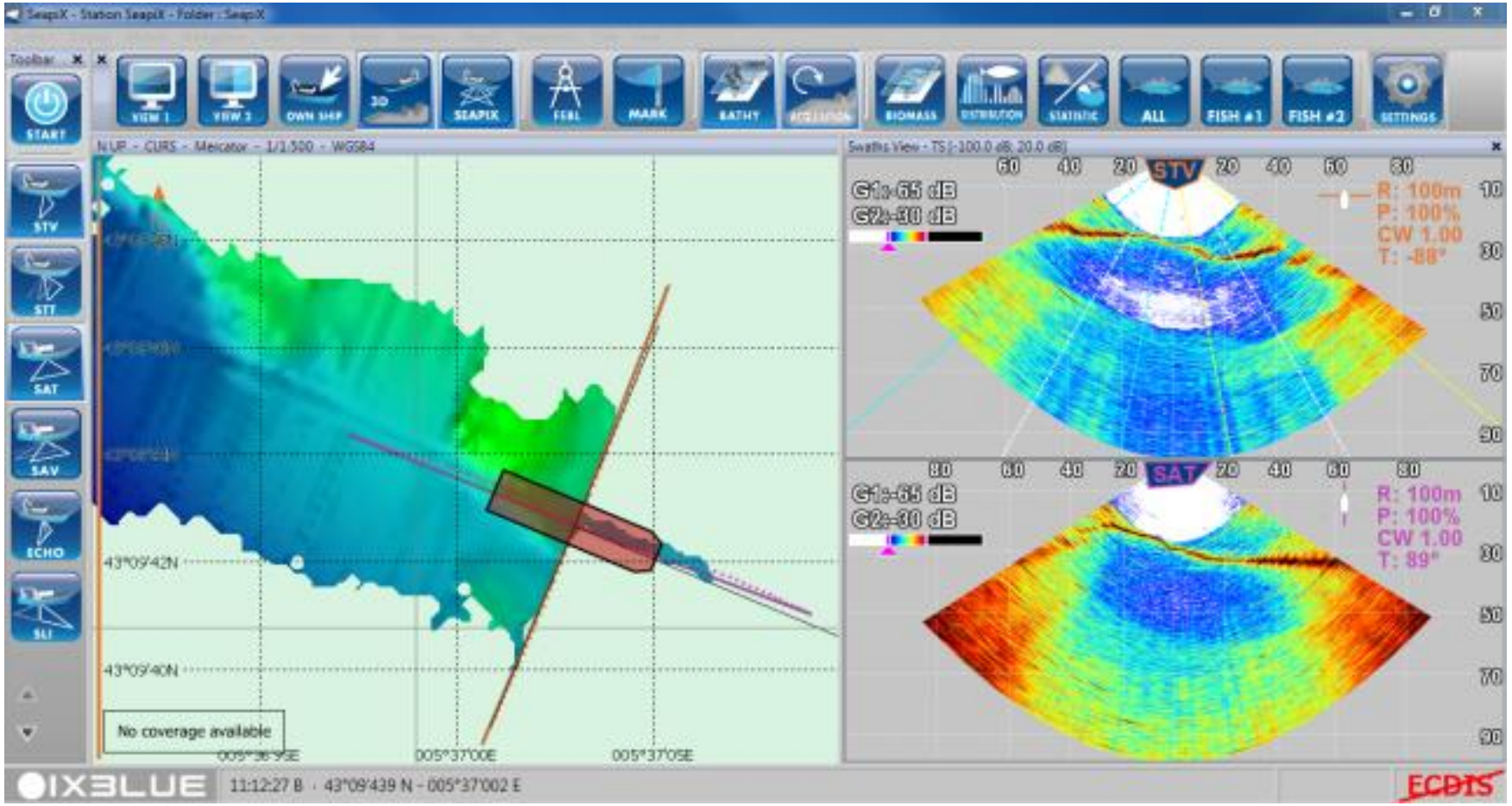
# Seapix

## Multiple Swath Imaging




**Versatile Configuration**

- User defined insonification scenario
- CW/FM
- Switch Rx/Tx antenna
- Steering angle interval and increment



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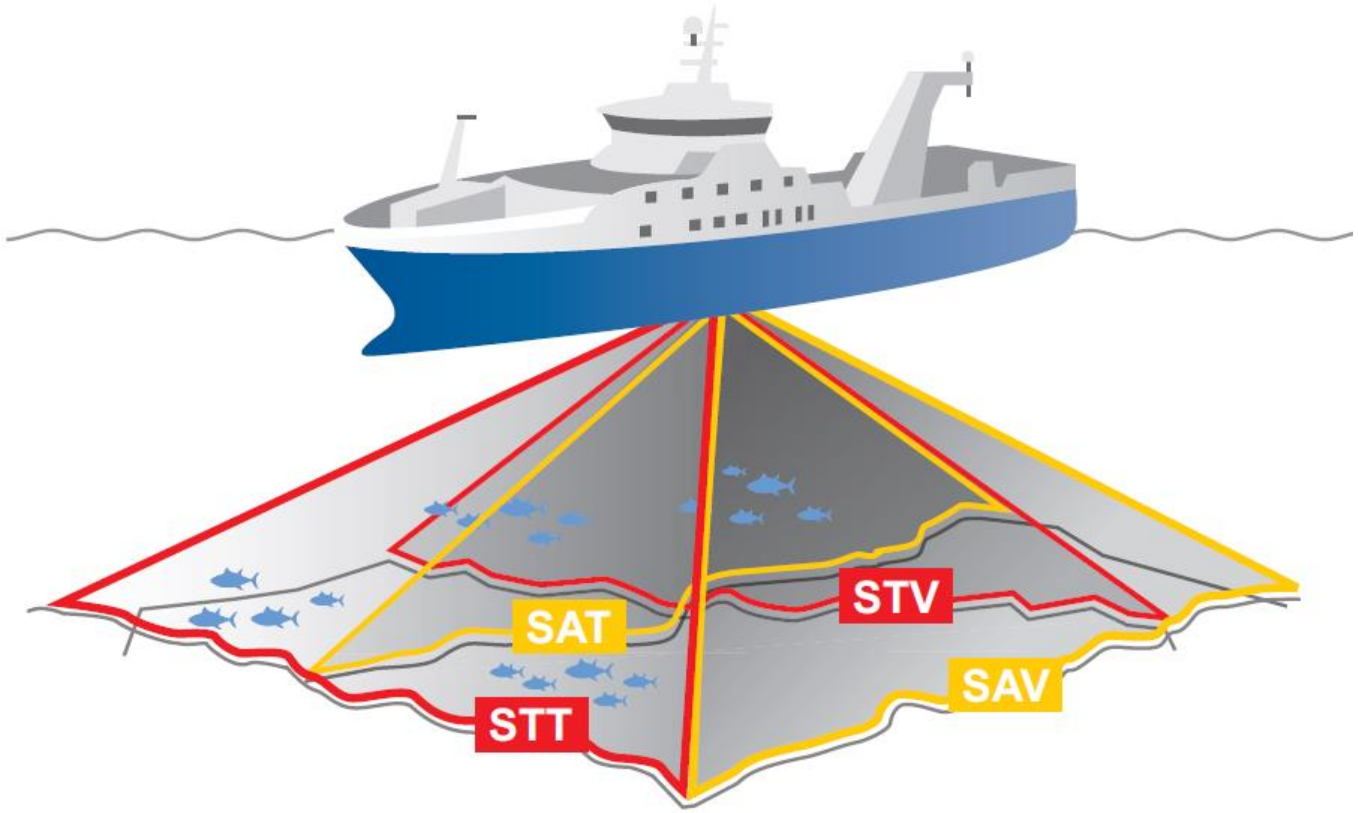
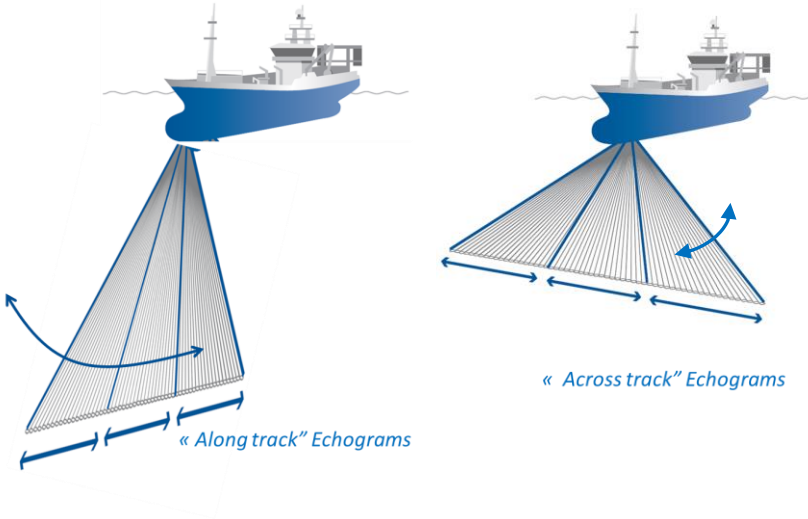
# Seapix

## Downward Looking Configuration




Port/Starboard scanning

Fore/Aft scanning




Volume 120° x 120°
7cm radial resolution
1.6°x1.6° up to 1.6°x3.2° angle resolution



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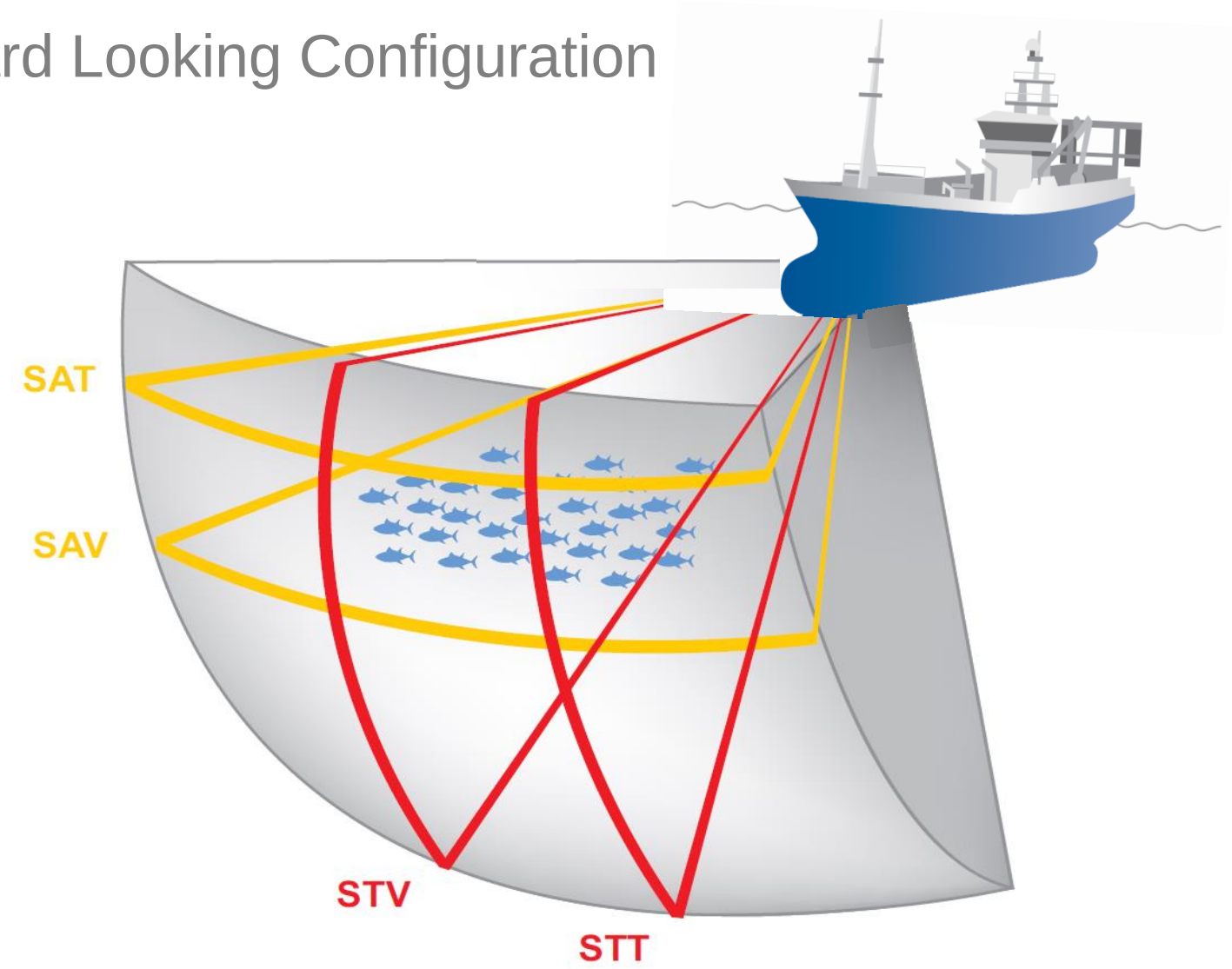
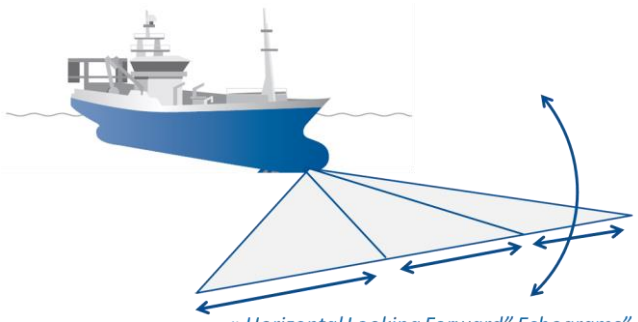
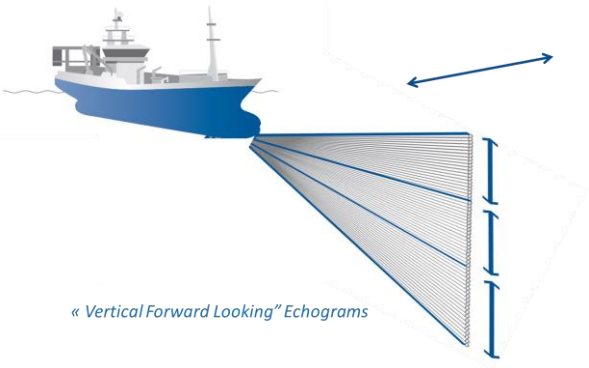
# Seapix

## Forward Looking Configuration



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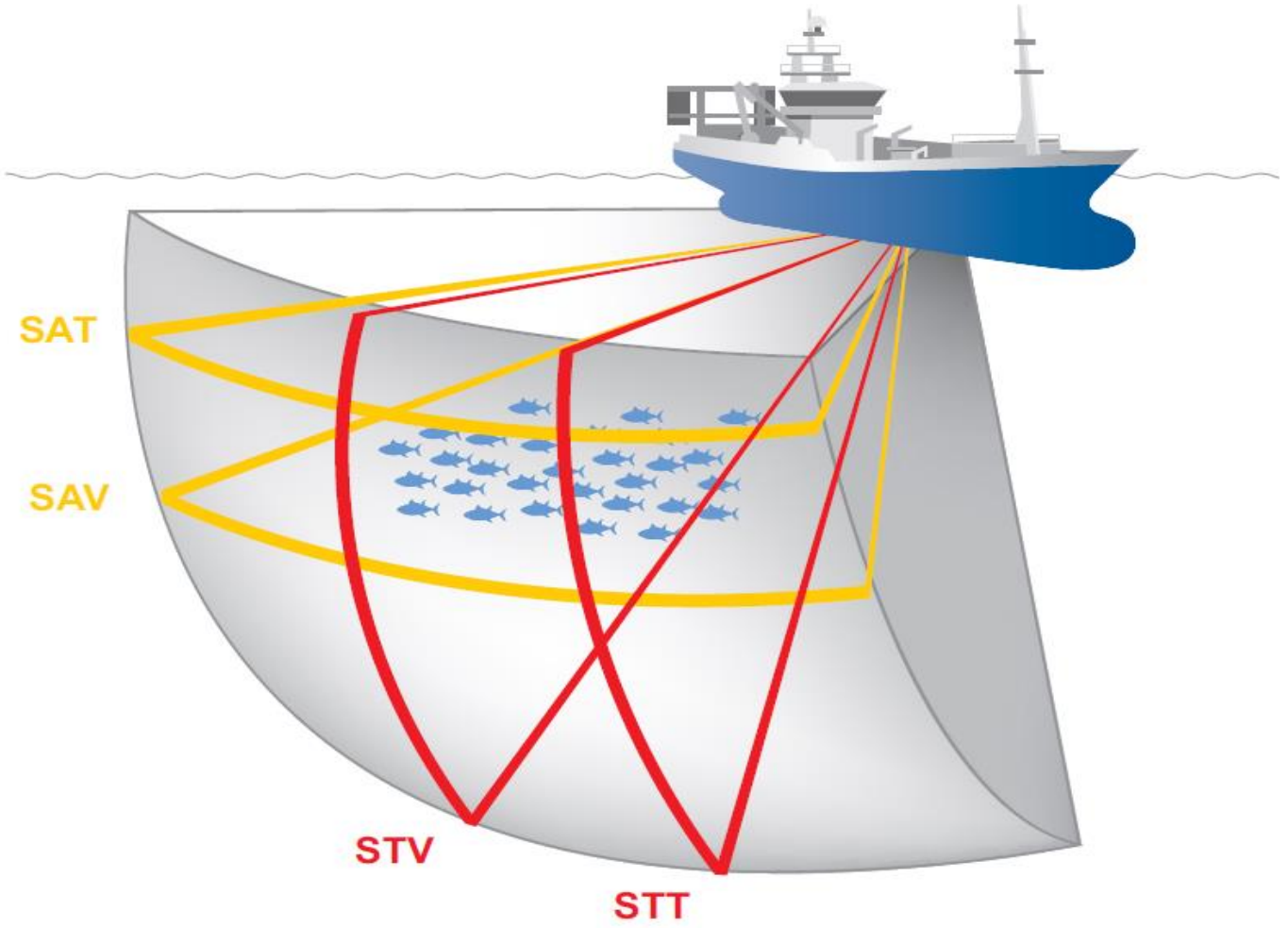
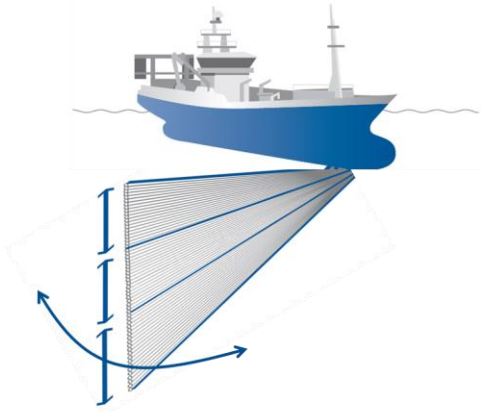
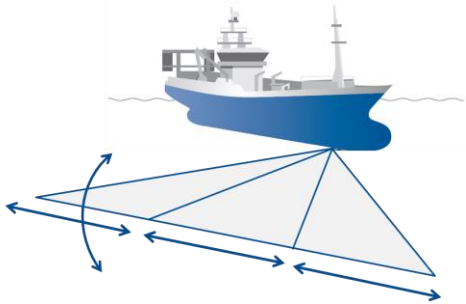
# Seapix

## Side Looking Configuration



« Vertical Side Looking" Echograms



« Horizontal Side Looking" Echograms



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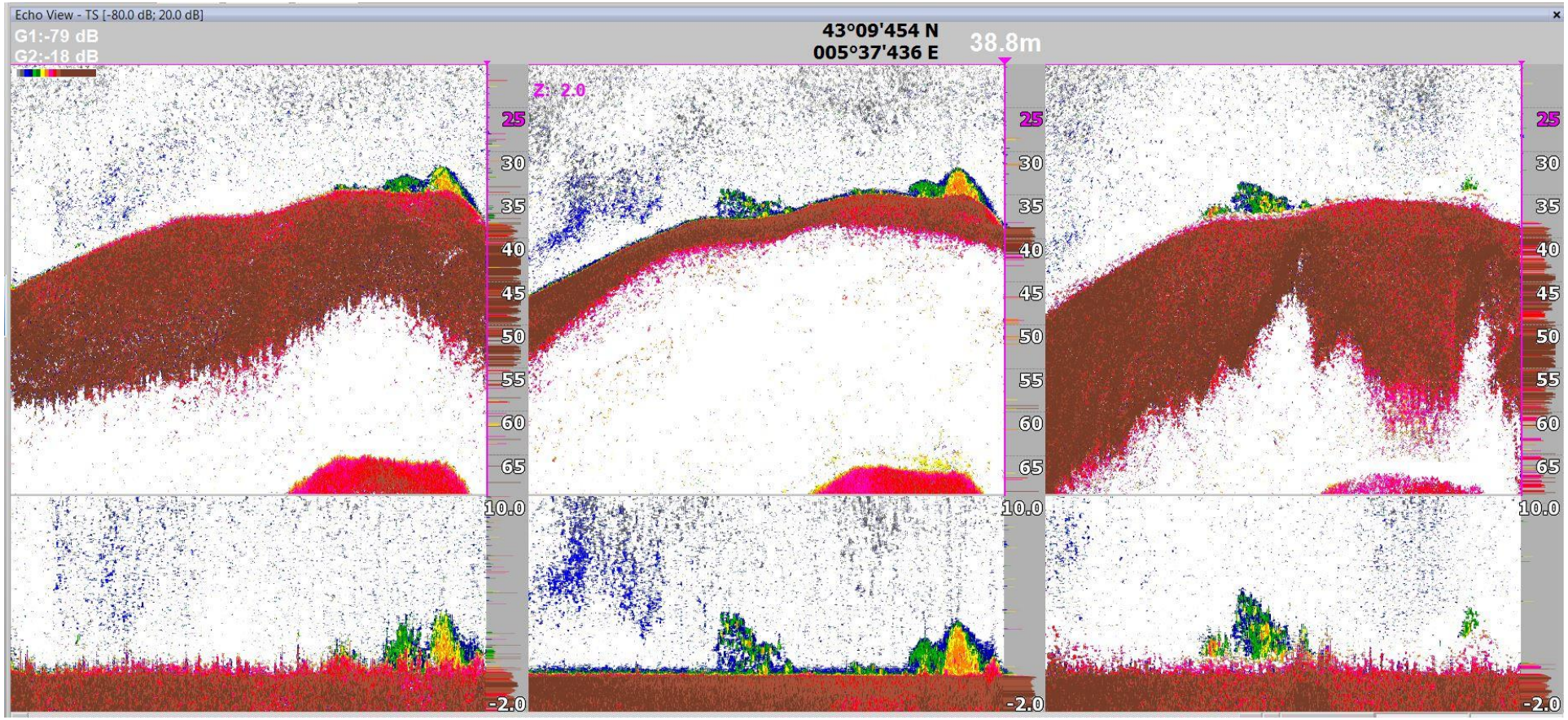
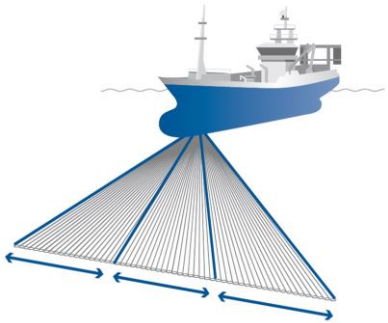
# Biomass Analysis

# Biomass Analysis

## Multiple Echograms Visualization





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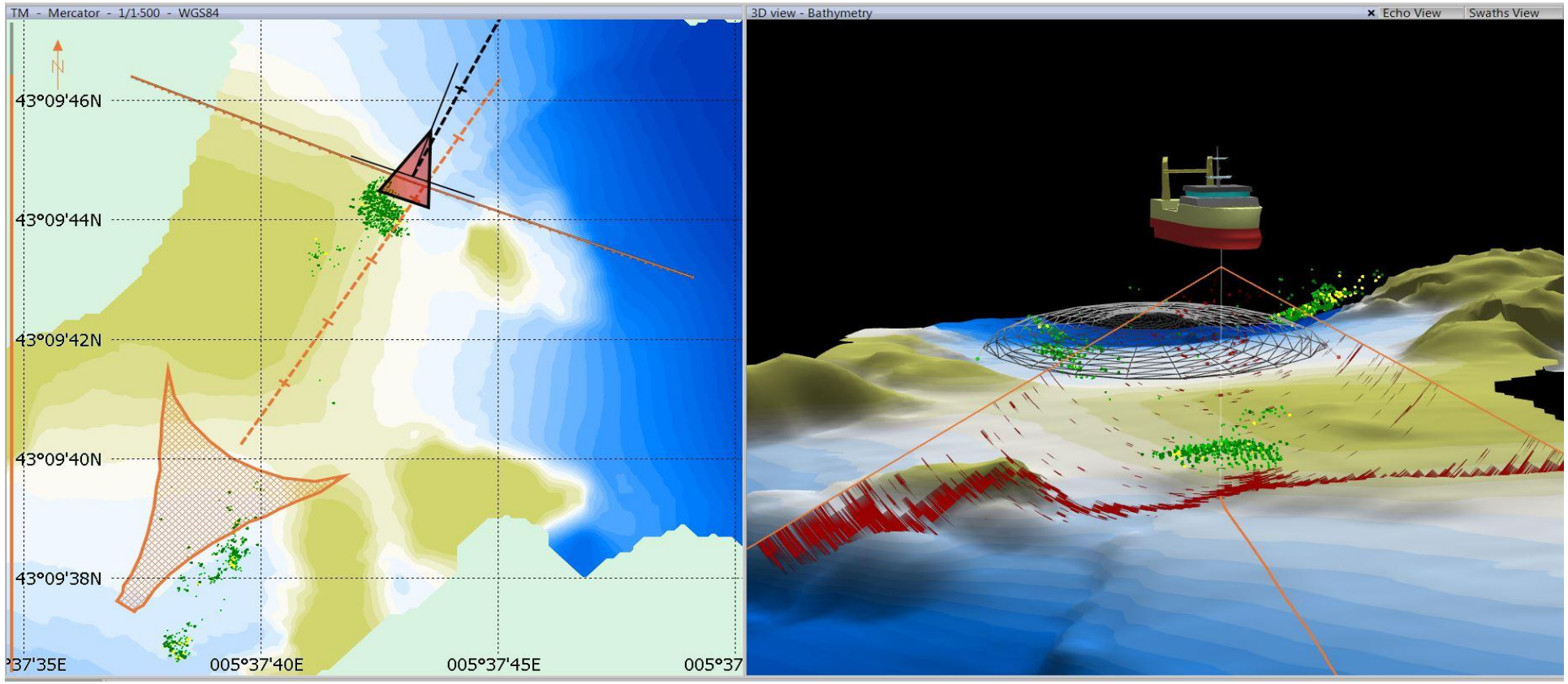
# Biomass Analysis

## Detection with 2D/3D Mapping and Bathymetry



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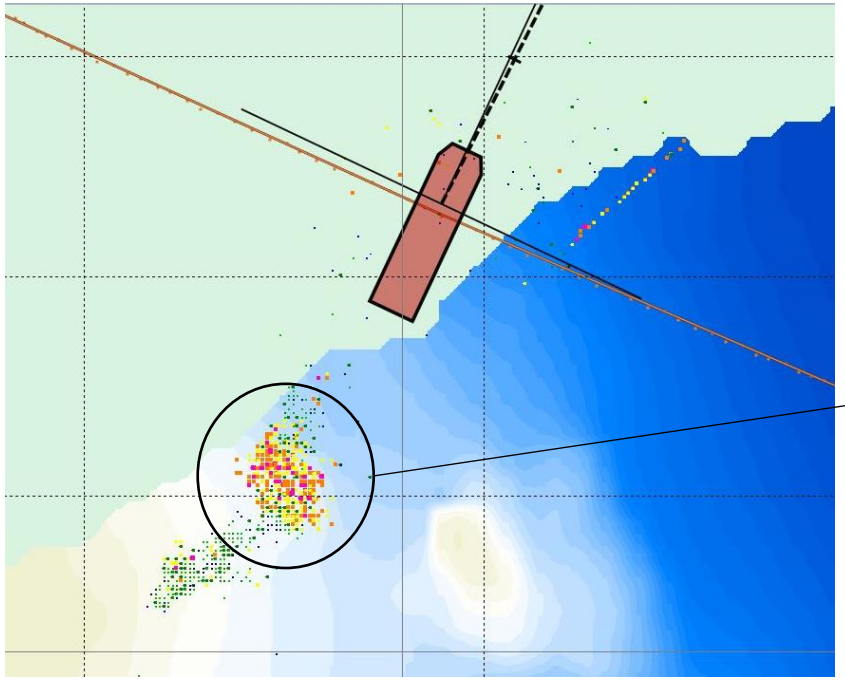
# Biomass Analysis

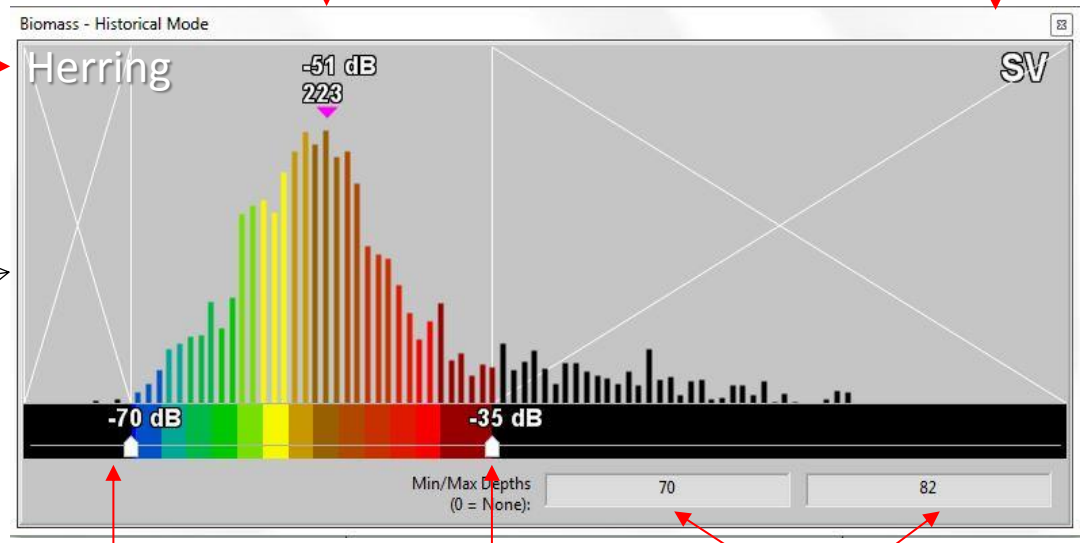
## Geographical Biomass Analyzer



Main Acoustic Response
Nb of individus

TS or SV

Class
Name




Min level Filter

Max level Filter

Water Layer depth



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# 4 Obstacle Avoidance

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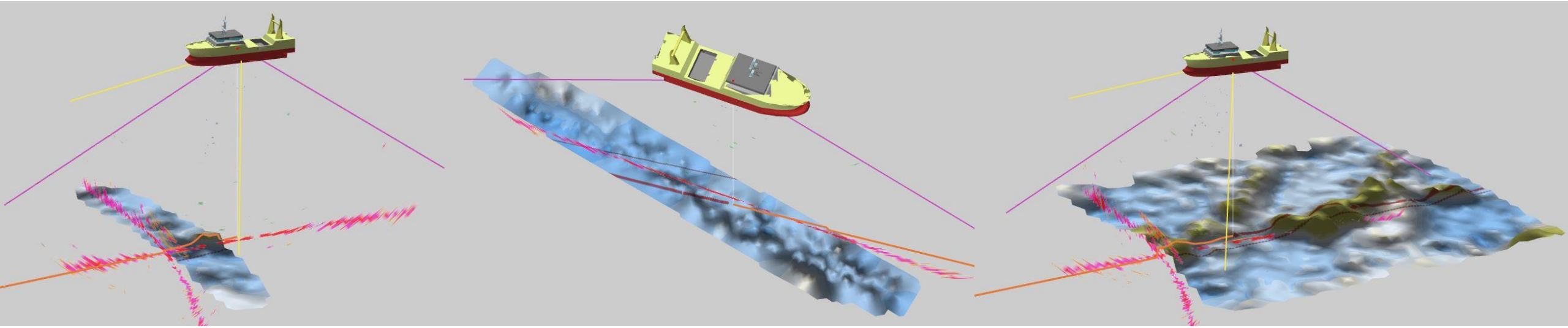
# Obstacle Avoidance

## Forward Looking Bathymetry





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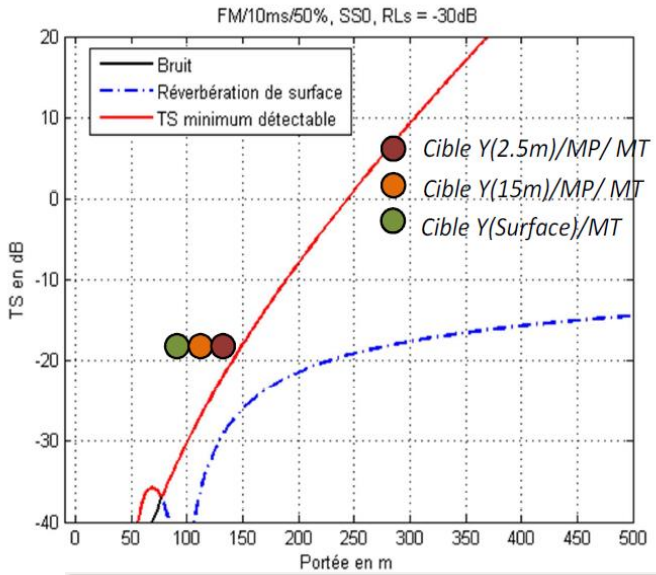
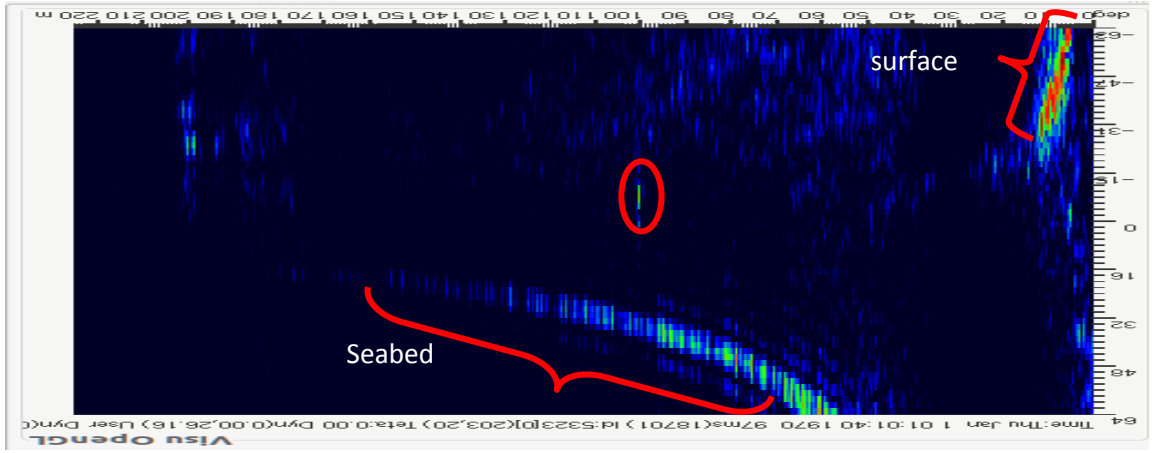
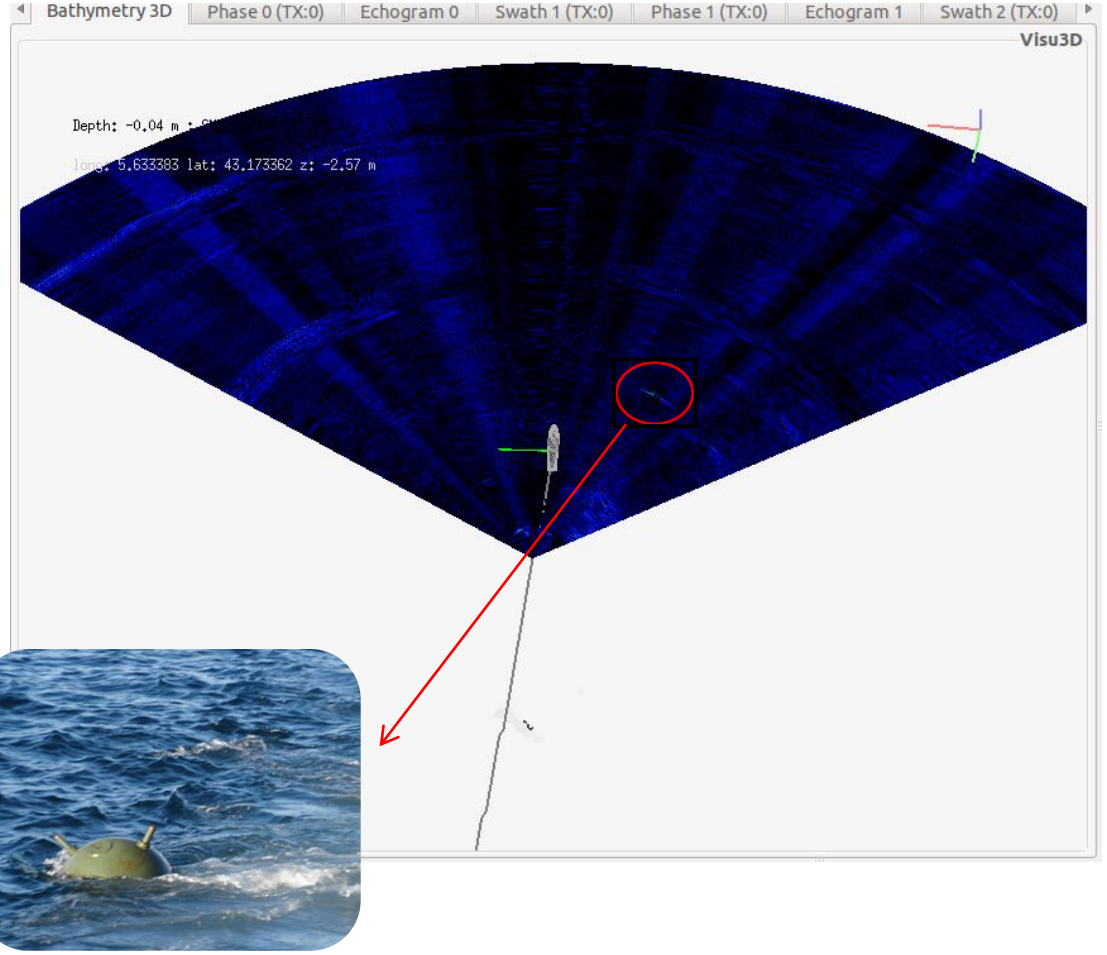
# Obstacle Avoidance

## Detection in the Water Column





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5

# Station Based Imaging

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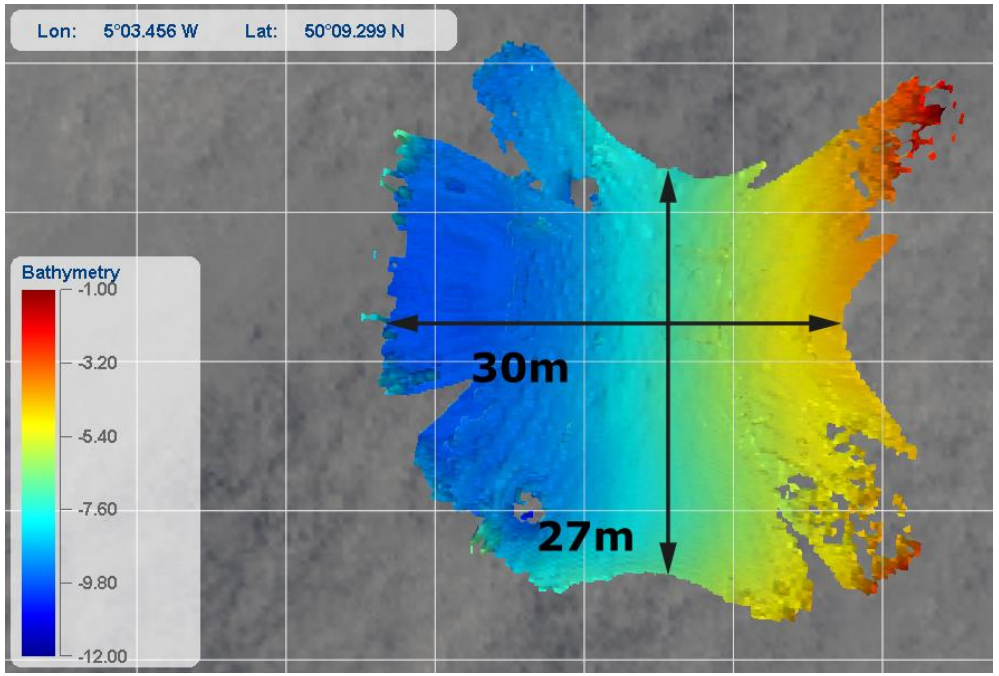
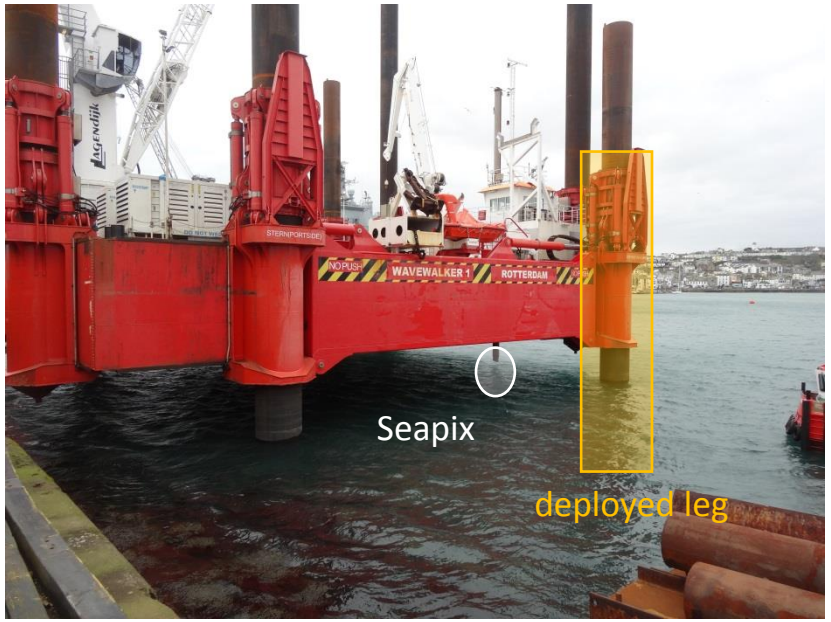
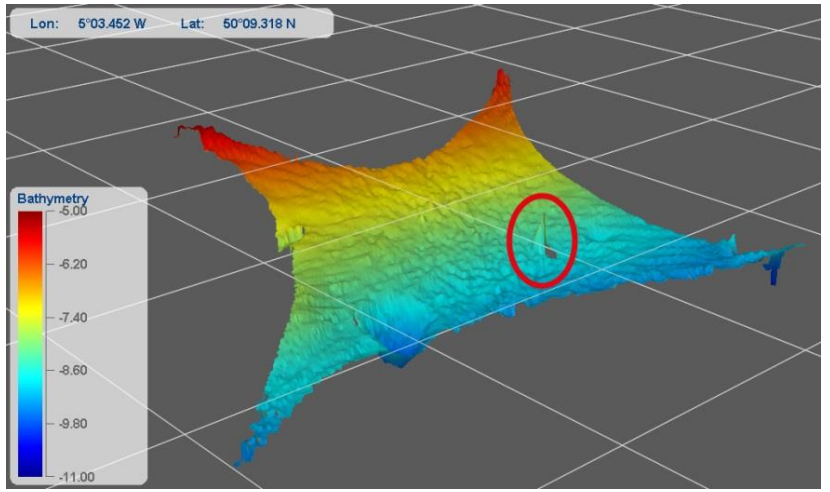
# Station Based Imaging

## Bathymetry

**Seapix is fixed on barge**
**Bathymetry area ~ 1200m² at 10m depth**

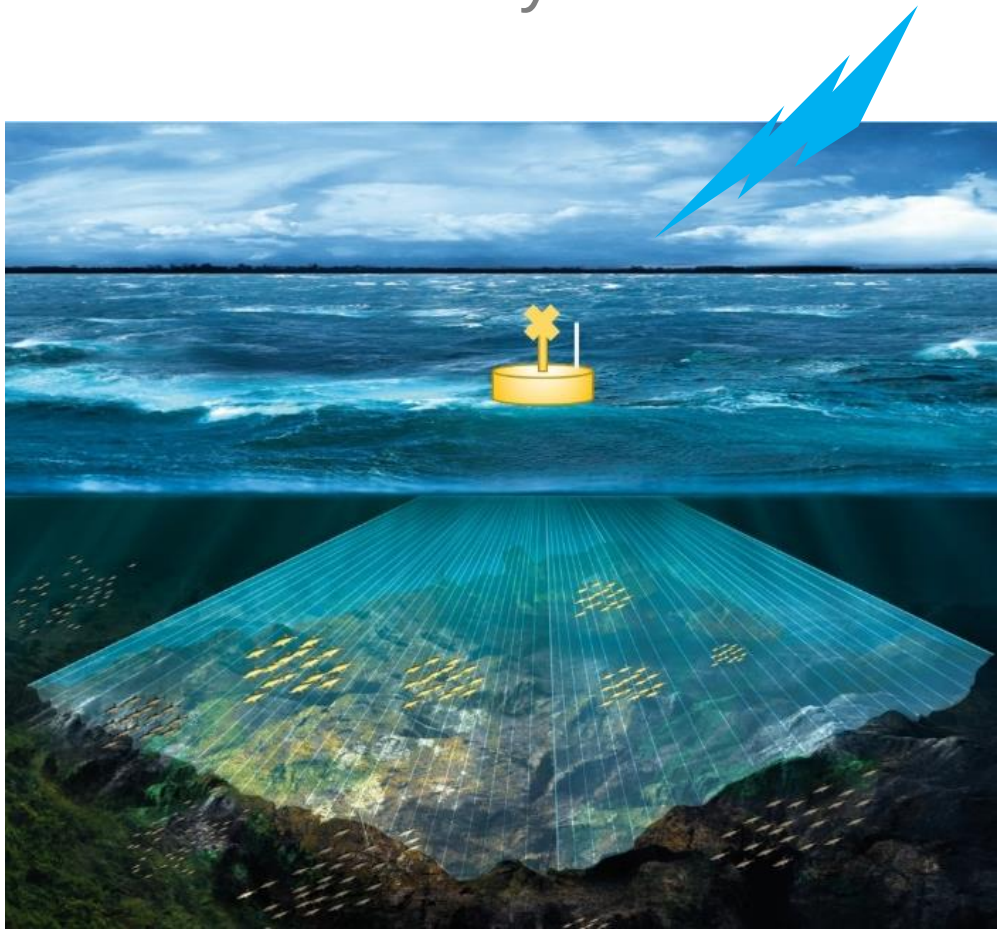


# Station Based Imaging

## Biomass Analysis





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# 6 Backscatter Imaging

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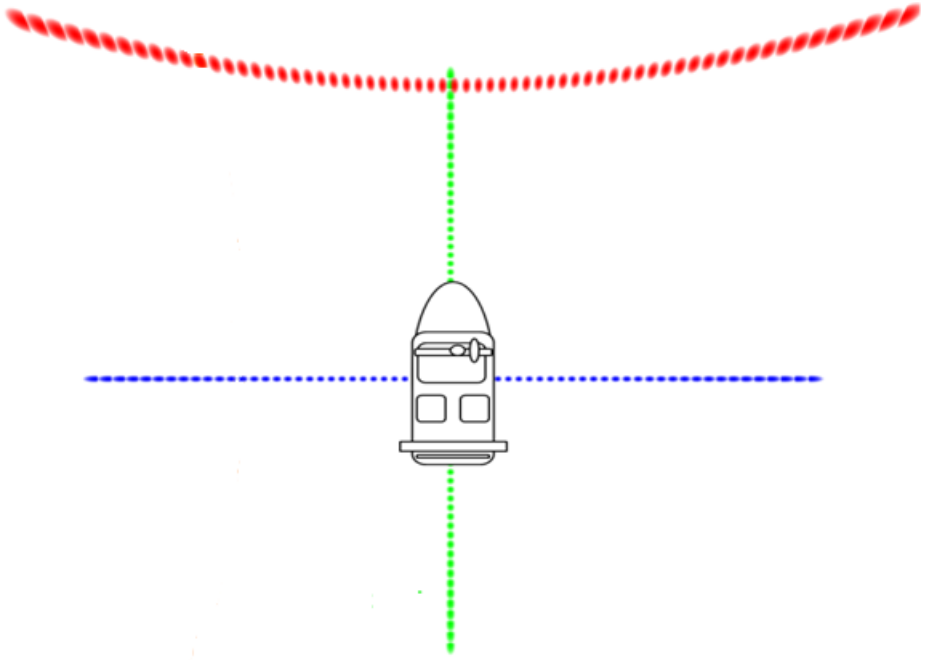
# Backscatter Imaging

## Multiple Imaging Modes



**Horizontal Forward Looking**

**Conventional Bathymetry & Imagery**

**Longitudinal**



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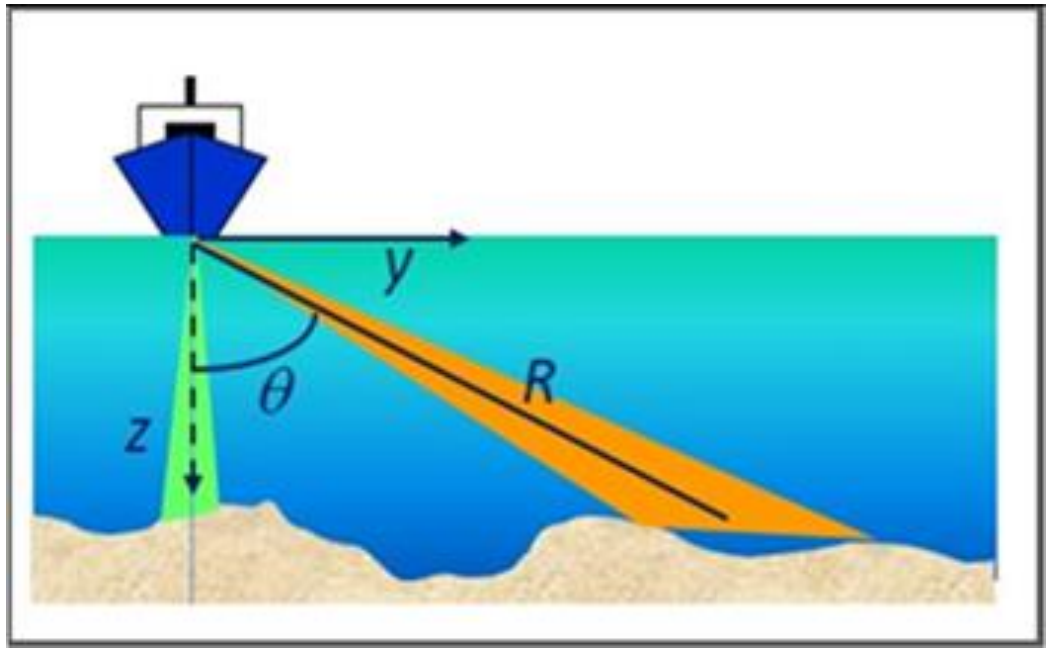
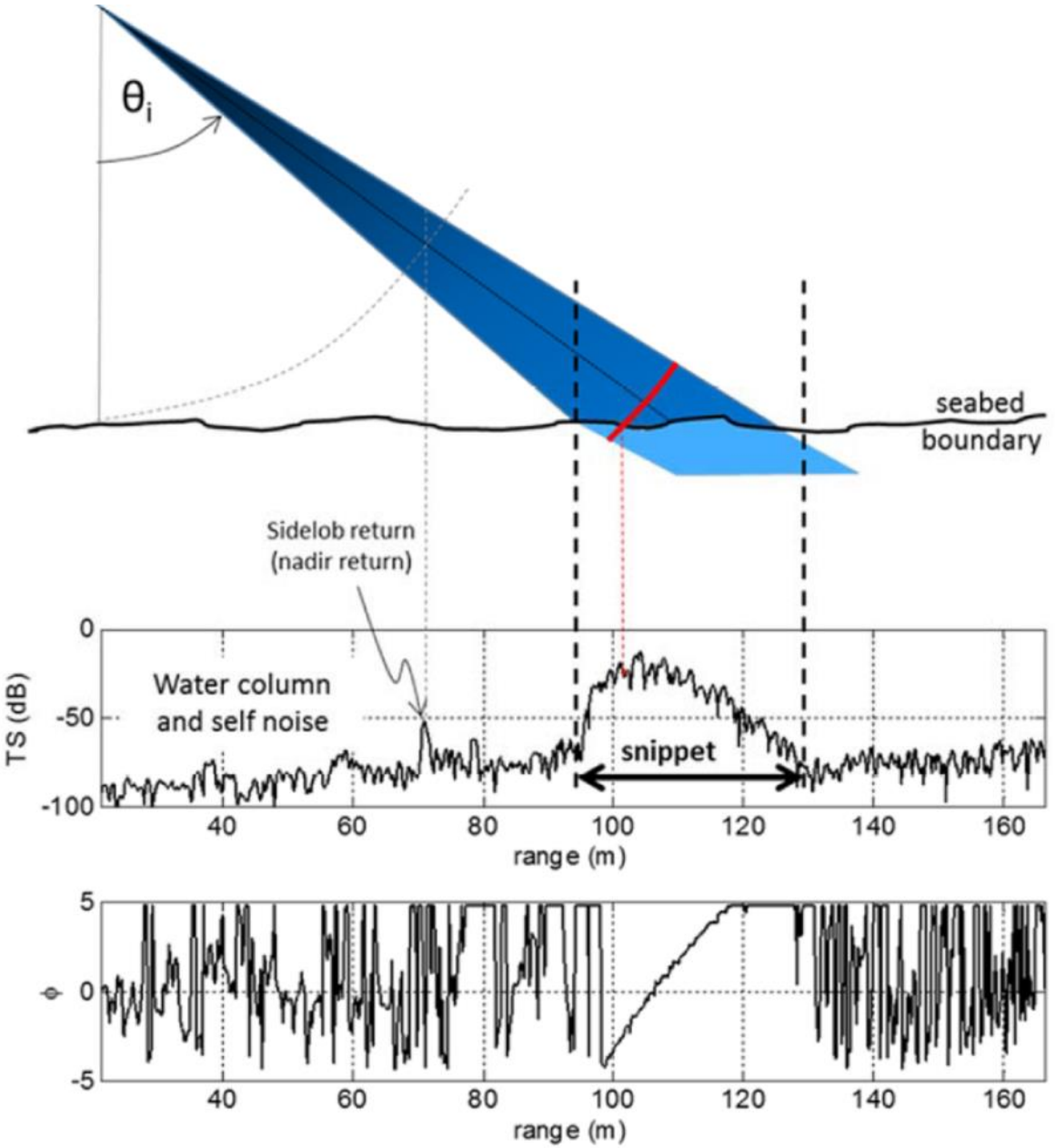
# Backscatter Imaging

## Conventional Imagery Mode



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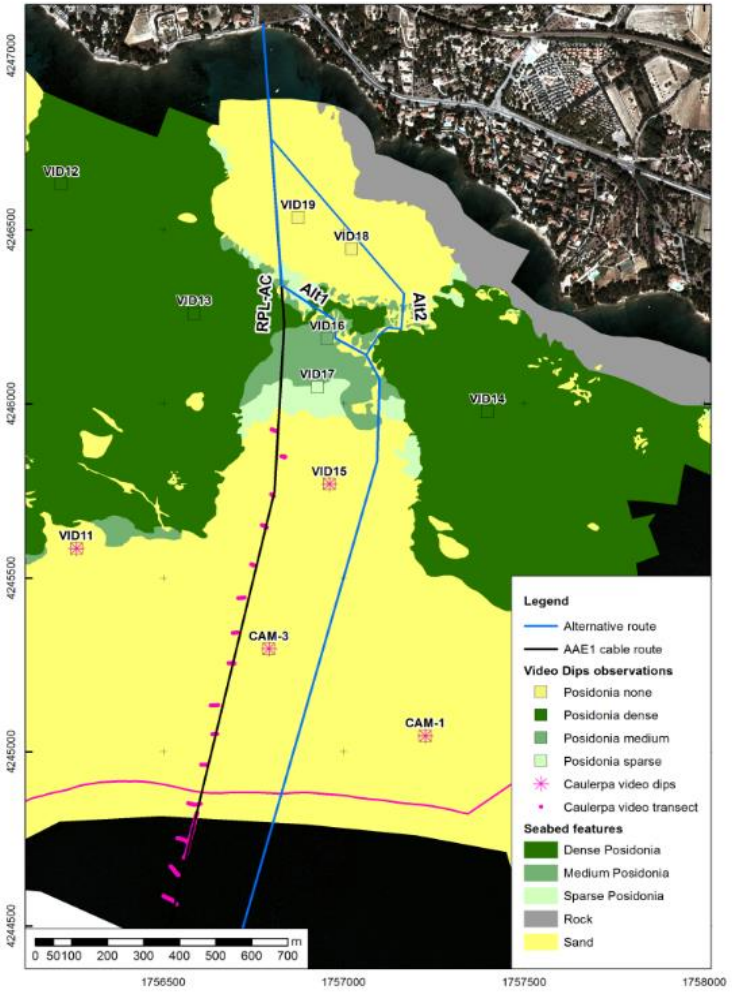
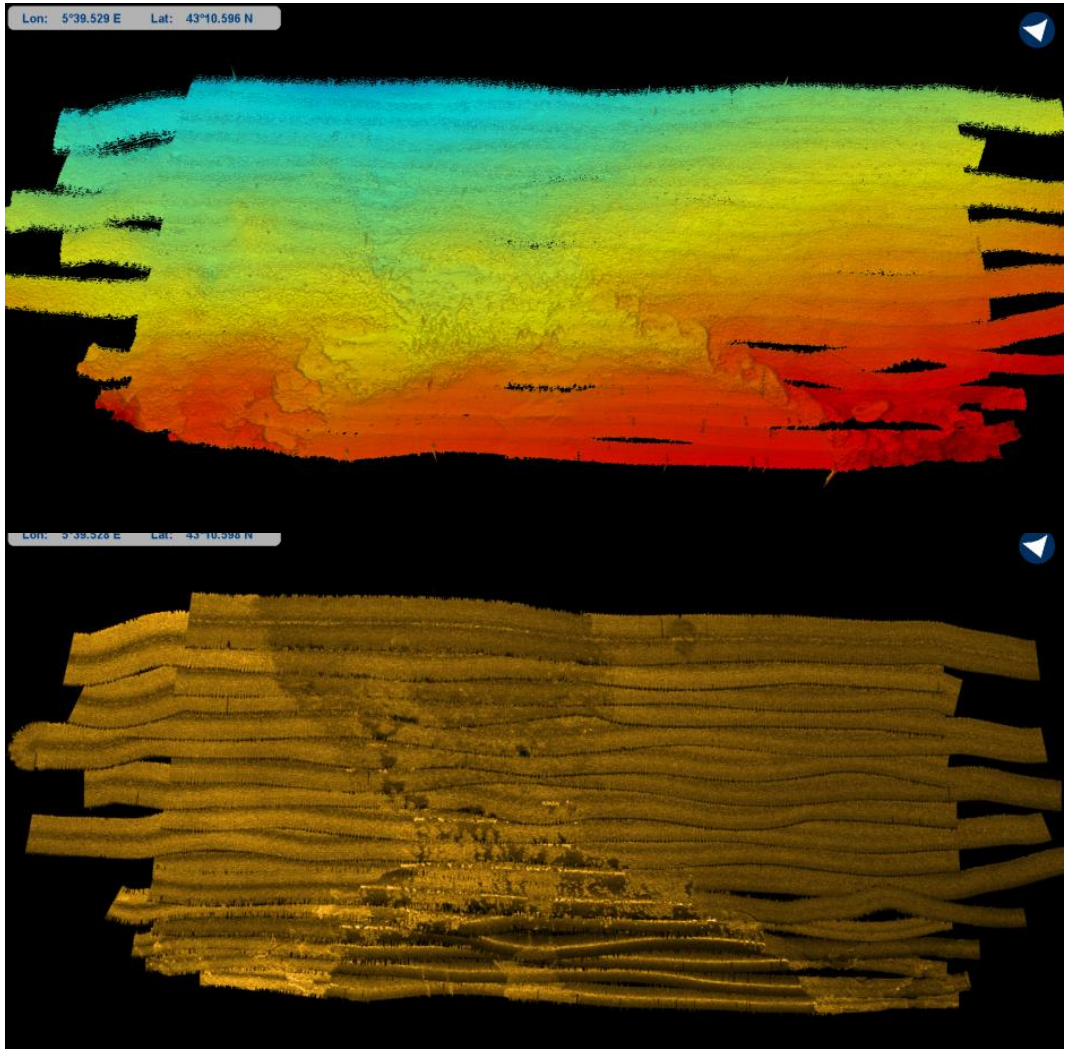
# Backscatter Imaging

## Conventional Imagery Mode with Seapix



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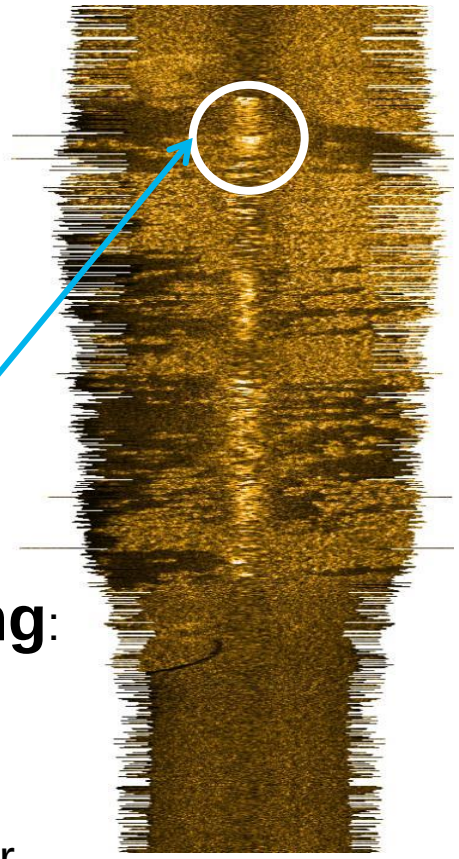
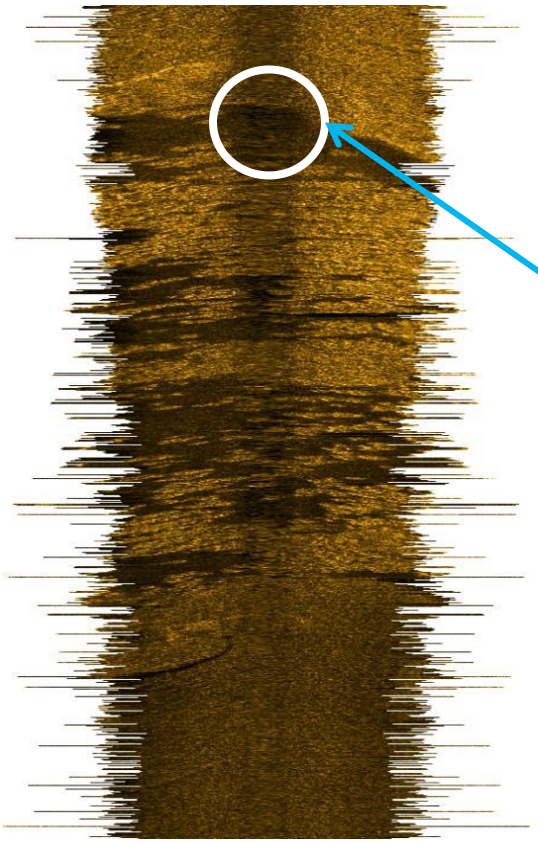
# Backscatter Imaging

## Forward Looking Imaging





**Vertical Imaging**:

•Specular reflection

•Bad contrast at nadir

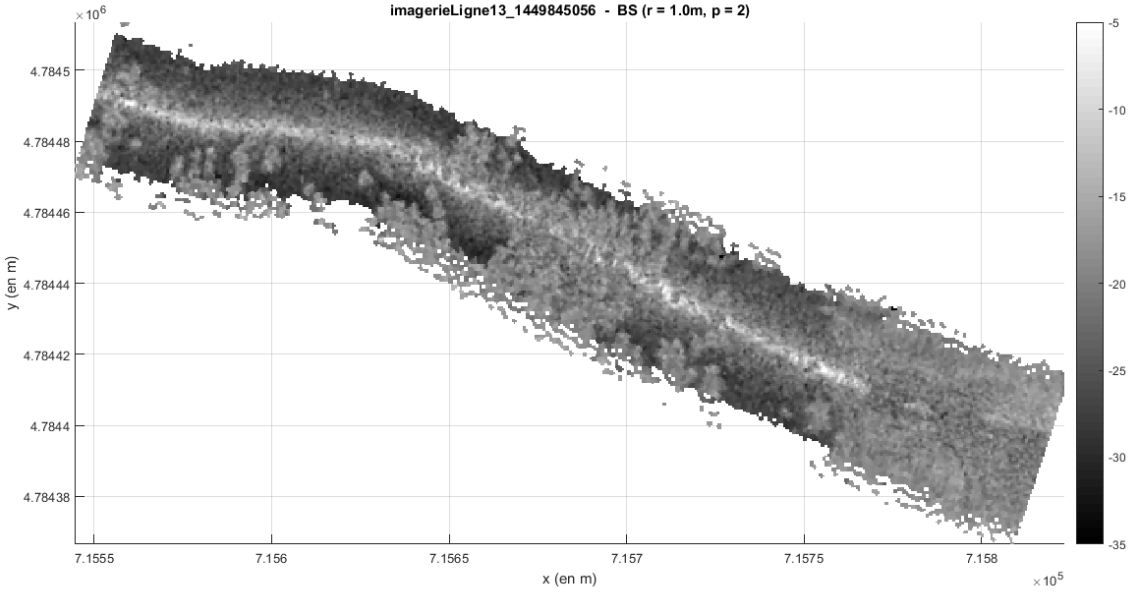
**Forward Looking Imaging**:

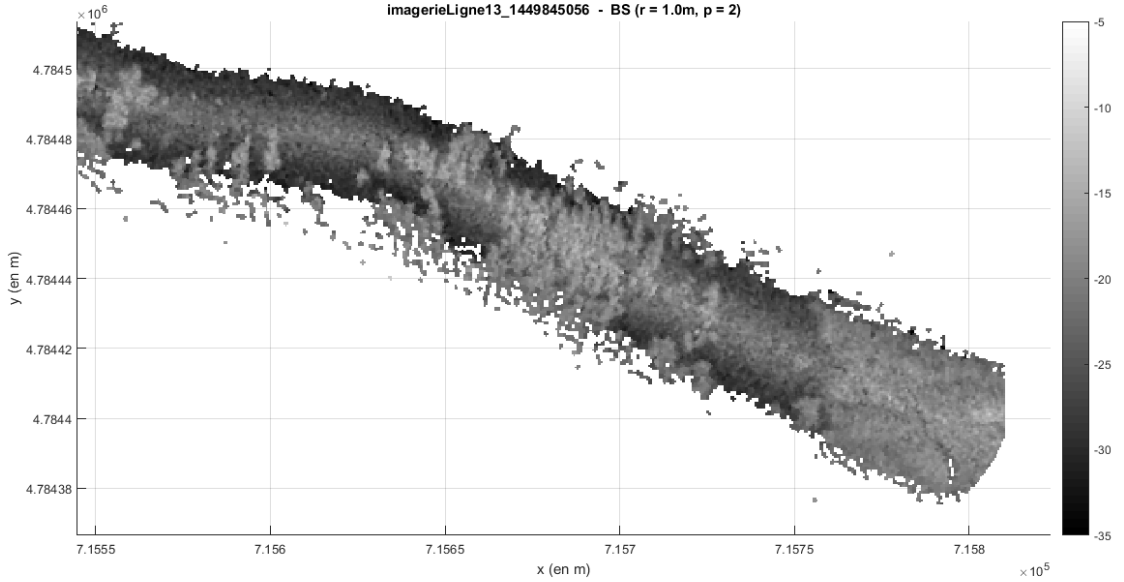
→Specular reflection suppressed

→Higher shadows contrast

# Backscatter Imaging

## Forward Looking Backscatter Imaging



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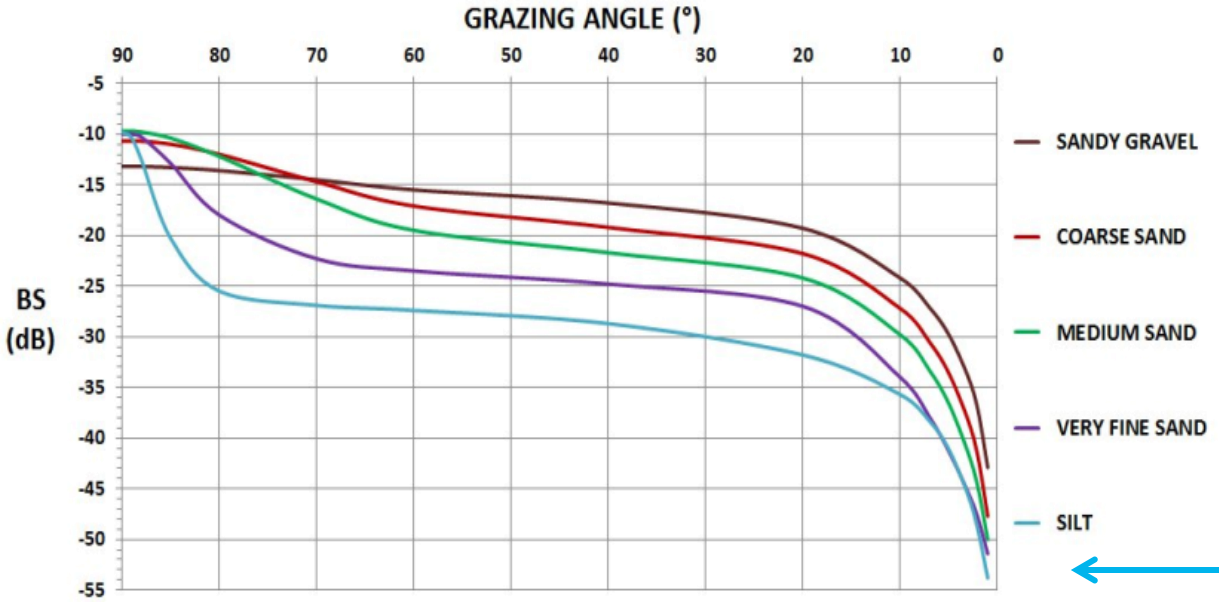
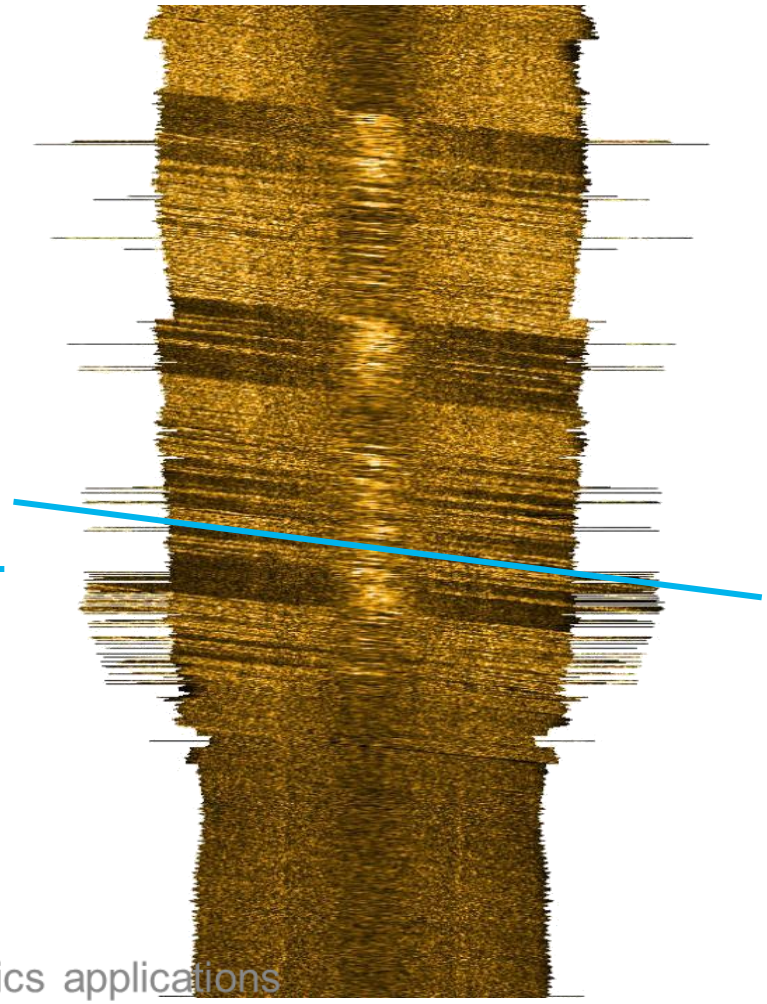
# Backcatter Imaging

## Longitudinal Mode

**Longitudinal Imaging Mode**:

→ Full  BS profil vs Incidence Angle

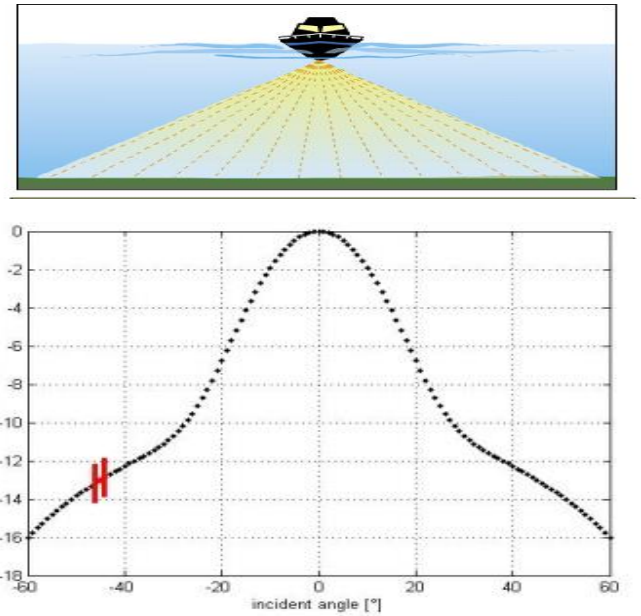


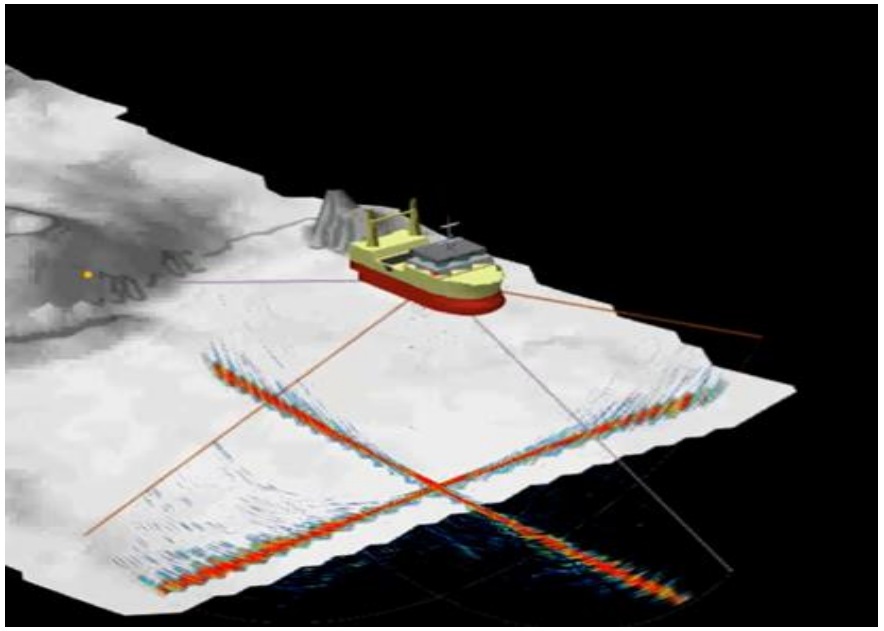



# Backscatter Imaging

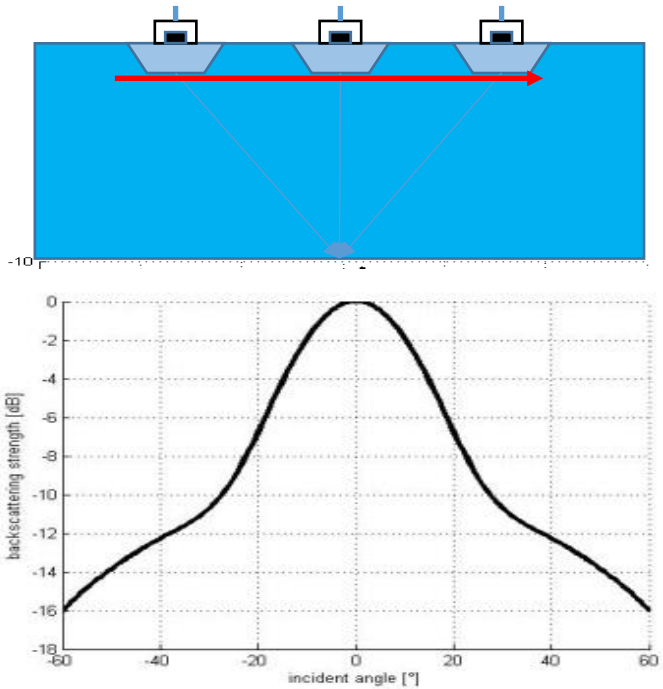
## Seabed Classification : data

### Bathymetry Mode



### Longitudinal Mode




**Level Based Classifier**

Input data:

$\{\theta_x, BS_x\}$ for pixel $x$

**Profile Based Classifier**

Input data:

profile $BS_x(\theta)$for pixel $x$



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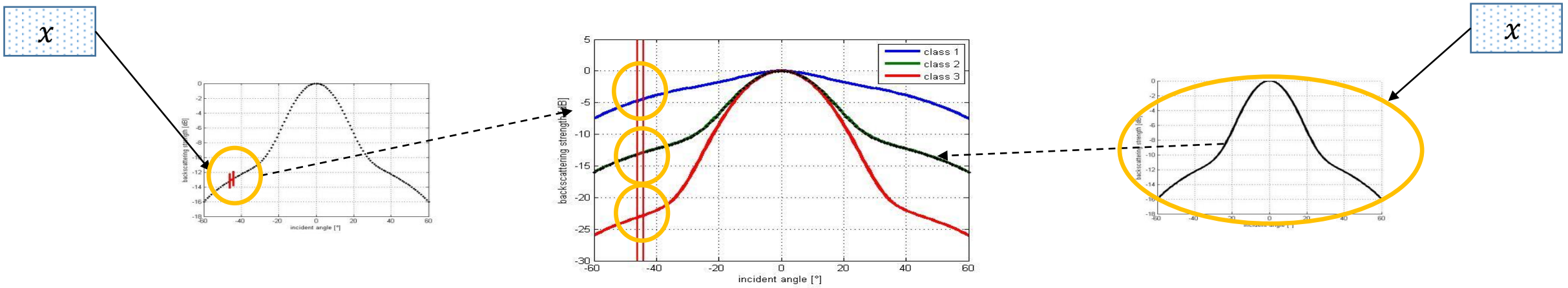
# Backscatter Imaging

## Seabed Classifier

- **Level-based classifier**
  - Input data: $\{\theta_x, BS_x\}$ for pixel $x$
  - For each class, estimating gaussian model of BS level for each angular sector $\theta$: $P_\theta(BS)$
  - $C_x = \underset{C}{\operatorname{argmax}}\, P_{\theta_x}(BS_x|C)$

- **Profile-based classifier**
  - Input data: profile $BS_x(\theta)$for pixel $x$
  - Estimating multi-dimensionnal Gaussian model $P(BS(\theta)) = Gaussian(BS(\theta)|\mu(\theta), \Sigma(\theta))$
  - $C_x = \underset{C}{\operatorname{argmax}}\, P(BS_x(\theta)|C)$




**Level Based Data** | **Classifier Models** | **Profile Based Data**

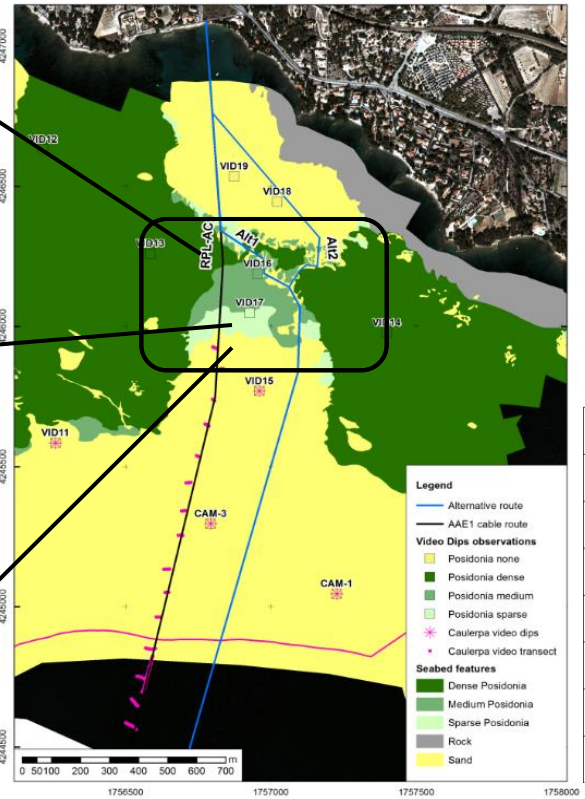
# Backscatter Imaging

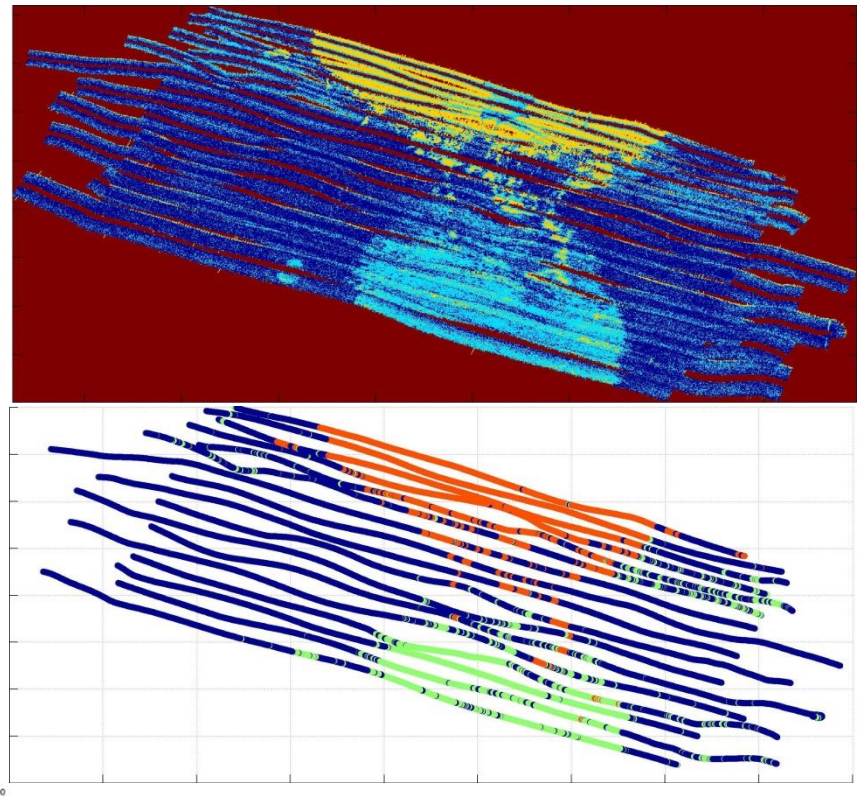
## Seafloor Classification : Results

Posidonia Dense

Posidonia sparse

Sand



### Mode Transversal

| % | P.D | P.E. | S. |
|---|---|---|---|
| P.D. | 87 | 13 | 0 |
| P.E | 10 | 85 | 5 |
| S. | 1 | 2 | 97 |

### Mode Longitudinal

| % | P.D | P.E. | S. |
|---|---|---|---|
| P.D. | 100 | 0 | 0 |
| P.E | 3 | 97 | 0 |
| S. | 0 | 0 | 100 |


# Navigation

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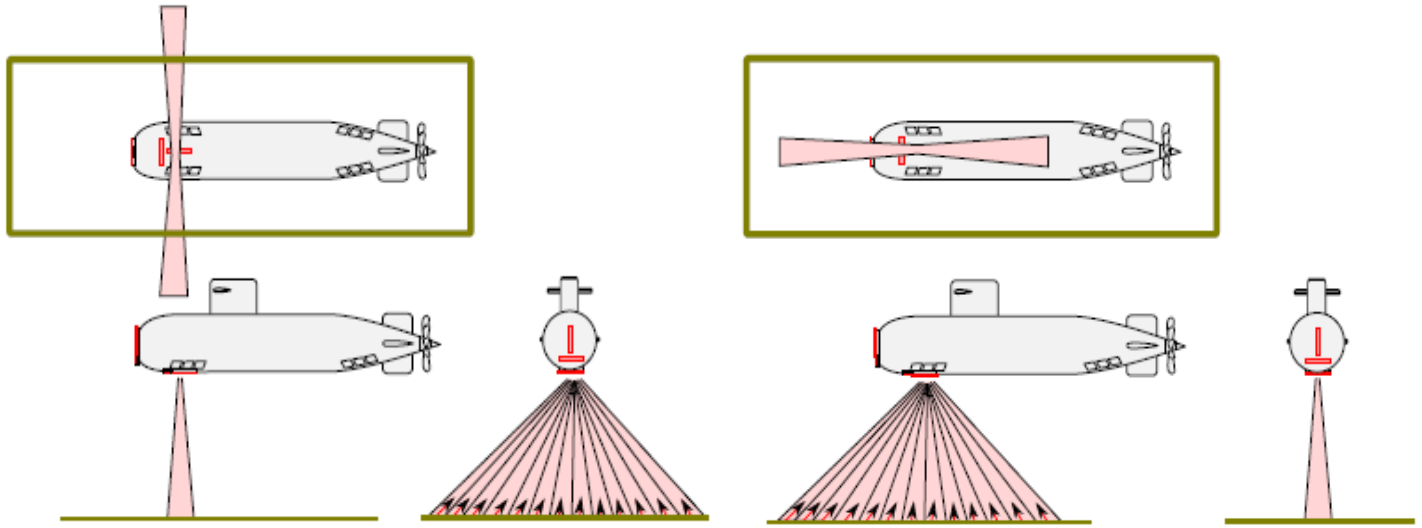
# Navigation

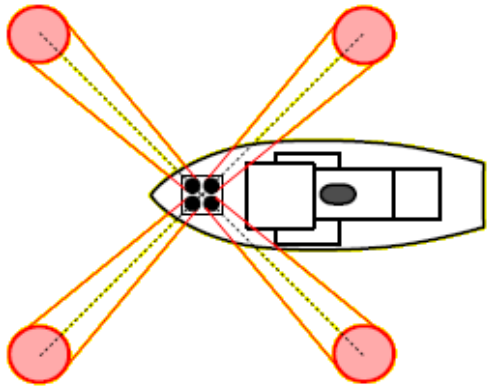
## Doppler Velocity Log

### Multibeam Doppler Velocity Log

- Alternate Longitudinal/Transversal Mode
- 64x64 Beams, 1.6°x1.6°



### Conventional Doppler Velocity Log





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8

# Auto Calibration

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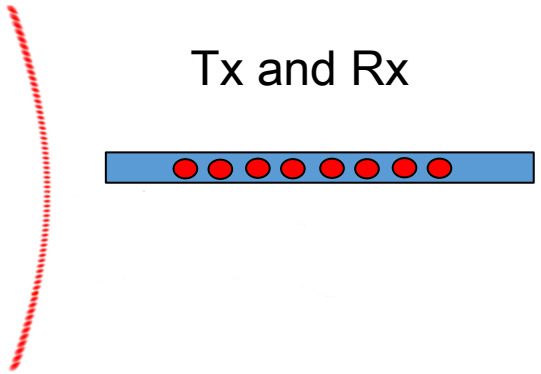
# Auto calibration

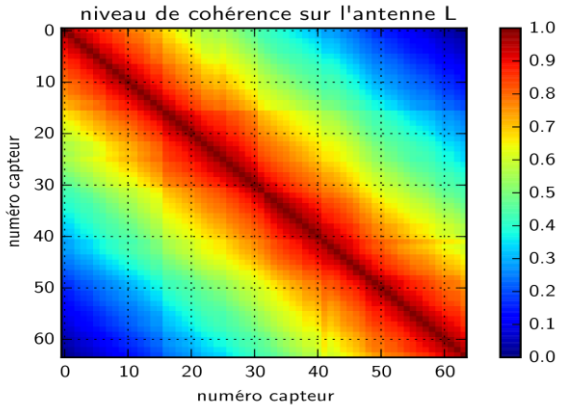
## Sensors Amplitude/Phase Estimation

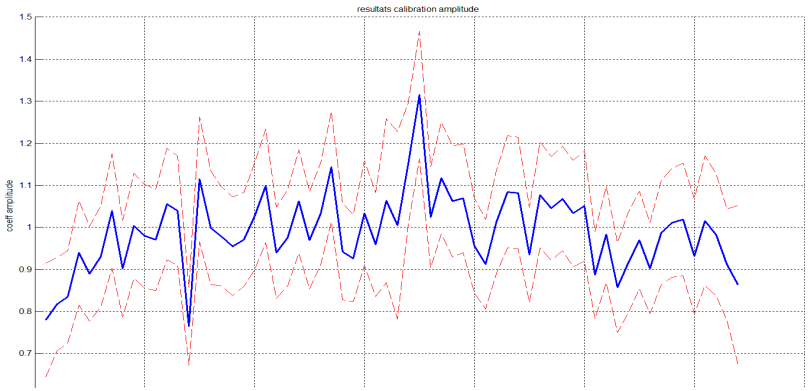
**Using Emission and Reception on the same antenna**

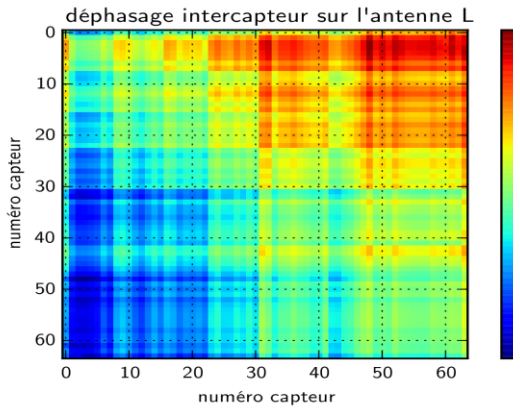
→ Spatial Coherence on L/2

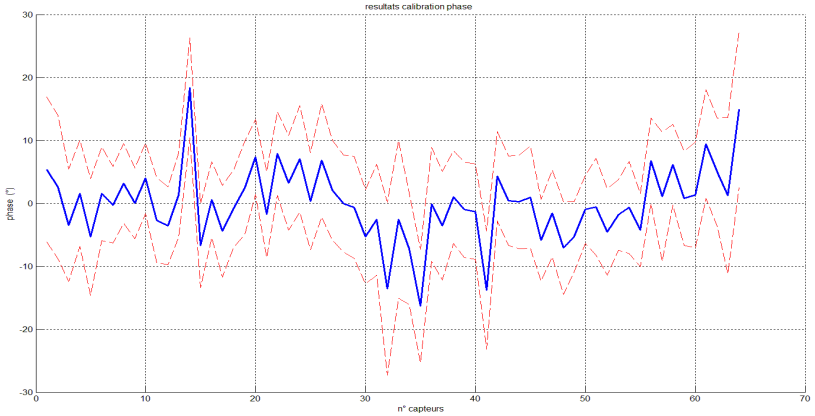
- Compute relative amplitude
- Compute phase difference



3

# Sound Velocity Profile Estimation

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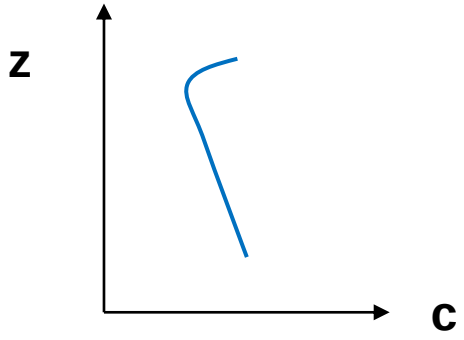
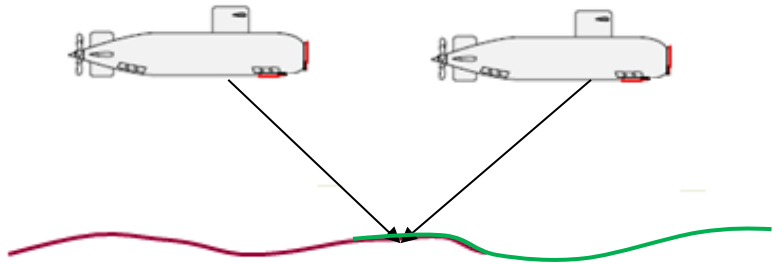
# Sound Velocity Profile Estimation

## Principle

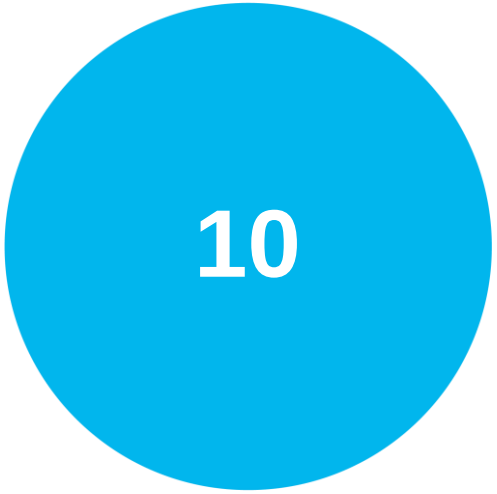
**Using overlapped Bathymetry Profiles on successive pings, longitudinal/transversal**

**Sound Velocity Model**
**C(z,θ)**
**Θ : paramètres**



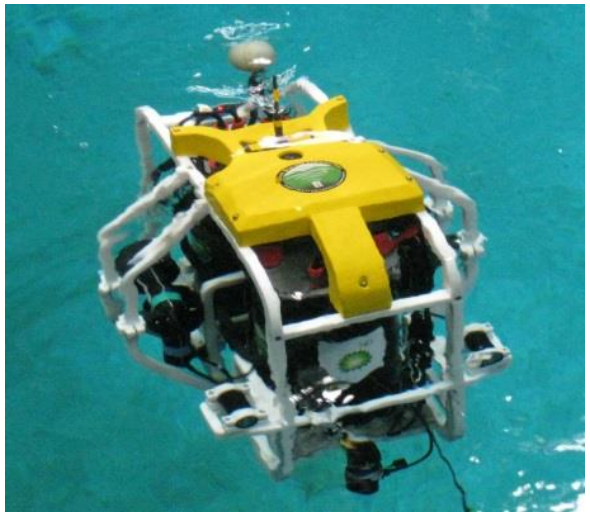

$$\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \sum_{x,i,j} \left[ z(i,x) - z(j,x) \right]^2$$




# Perspectives

# Perspectives

## MultiBeam/MultiSwath System on AUV/ROV/ASV



**One system  for multiple functions**

Navigation Security
- Forward Looking Detection

Hydrography
- Sound Velocity Profile Estimation

Imagery
- GapFiller

Environment Assessment  and Monitoring
- Robust Seafloor classification
- Biomass analysis

Navigation
- Navigation + MBES (DVL, Bathymetry)



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