



15/09/2017

The seaCHIRP 3D - Presentation

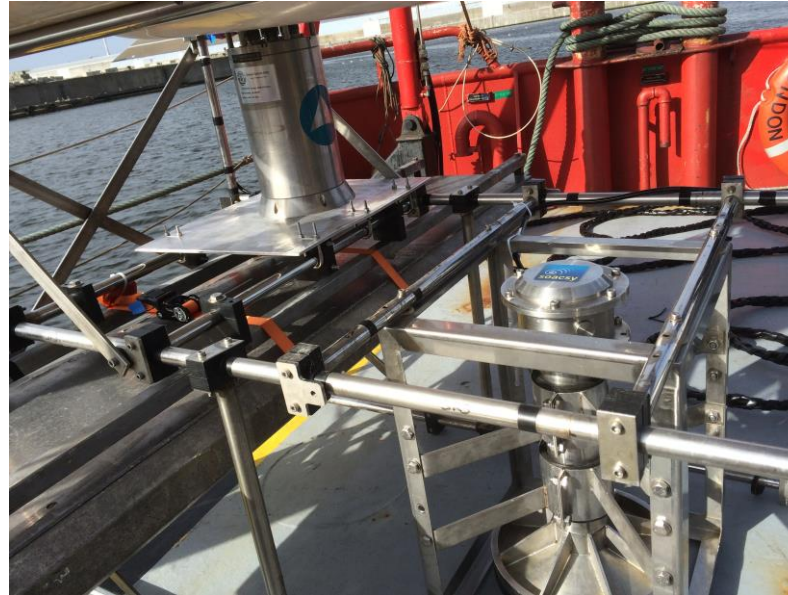
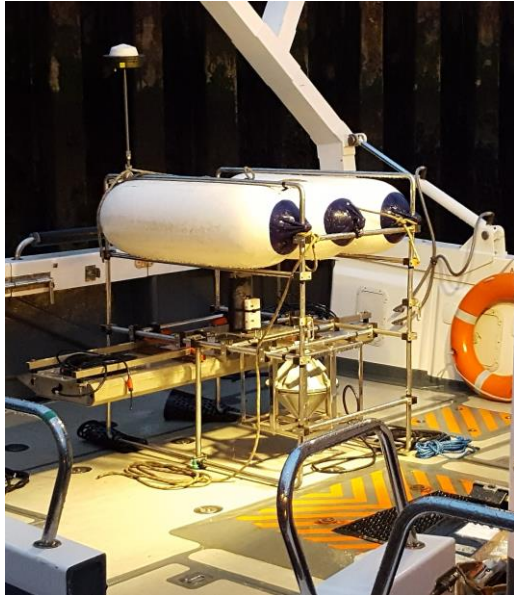
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The seaCHIRP 3D

Precise and efficient seabed and geohazard assessment



- Unexploded ordnances (UXO)
- Boulders
- Buried pipelines / cables
- Sedimentary studies
- Marine archeology

- 3D view of the backscattered arrivals either side of the survey line
- Very High Resolution seismogram along the survey line
- Shallow water 3-50 m
- Large swath (1,7 x water depth) / Narrow beams (10°)
- High speed (up to 5 knots) / high firing rate
- Minimised Acquisition/Processing time

- Rugged, compact and lightweight (120 kg)
- Versatility to meet client requirements/available vessels
- Quick and easy set-up



Main track records

UXO

- **HORN REV 3** (Denmark) for FUGRO/VATTENFALL – 2015 – Wind farm

Boulders

- **NORTHER** (Belgium) for GEOxyz/NORTHER - 2017 – Wind farm
- **ABERDEEN** (Scotland) for FUGRO/VATTENFALL – 2016 – Wind farm

Sedimentary studies (cable/pipe route)

- **SIZEWELL** (UK) for FUGRO/EDF Energy – 2014 – Nuclear energy
- **SAINT NAZAIRE** for FUGRO/EDF EN – 2014 – Wind farm
- **FECAMP / COURSEULLE** for FUGRO/EDF EN – 2014 – Wind farm

Inland

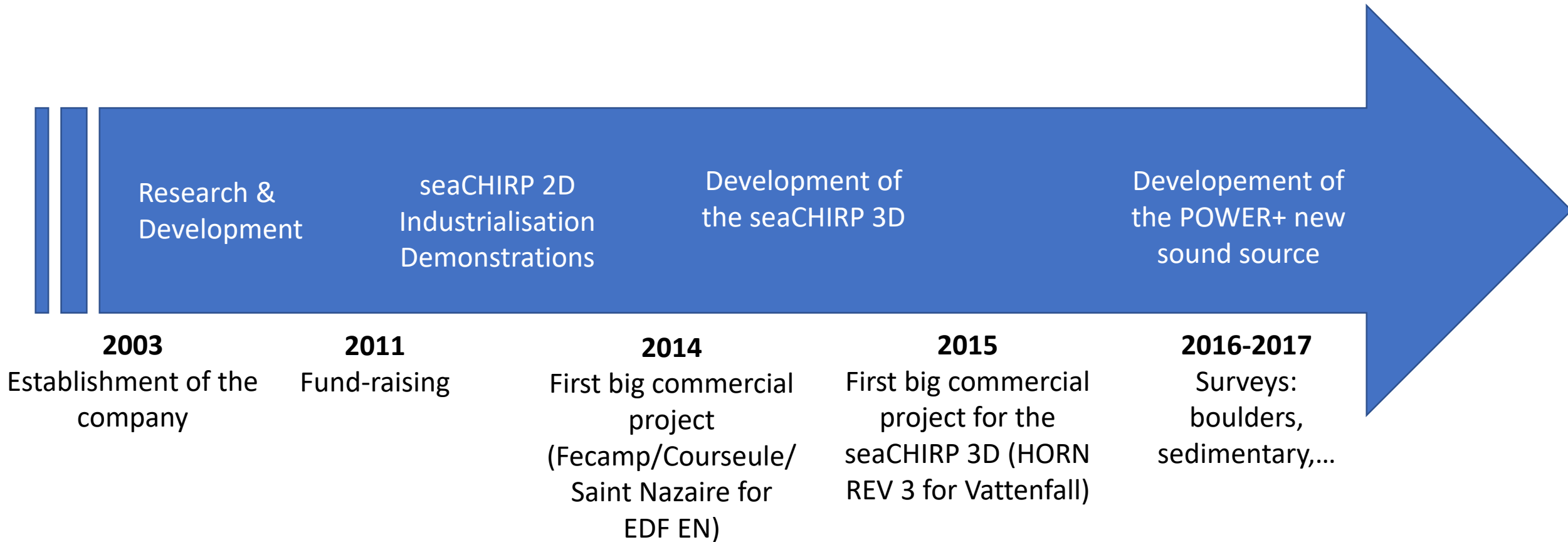
- **KEMBS** (France) for EDF – 2015 – Hydroelectric energy

- Linear kilometer surveyed from 2014 > **1600 km**
- Data volume collected ≈ **1 Terabytes**
- Vessels from **4,5 m to 40 m** long
- Waves up to **1 m** height





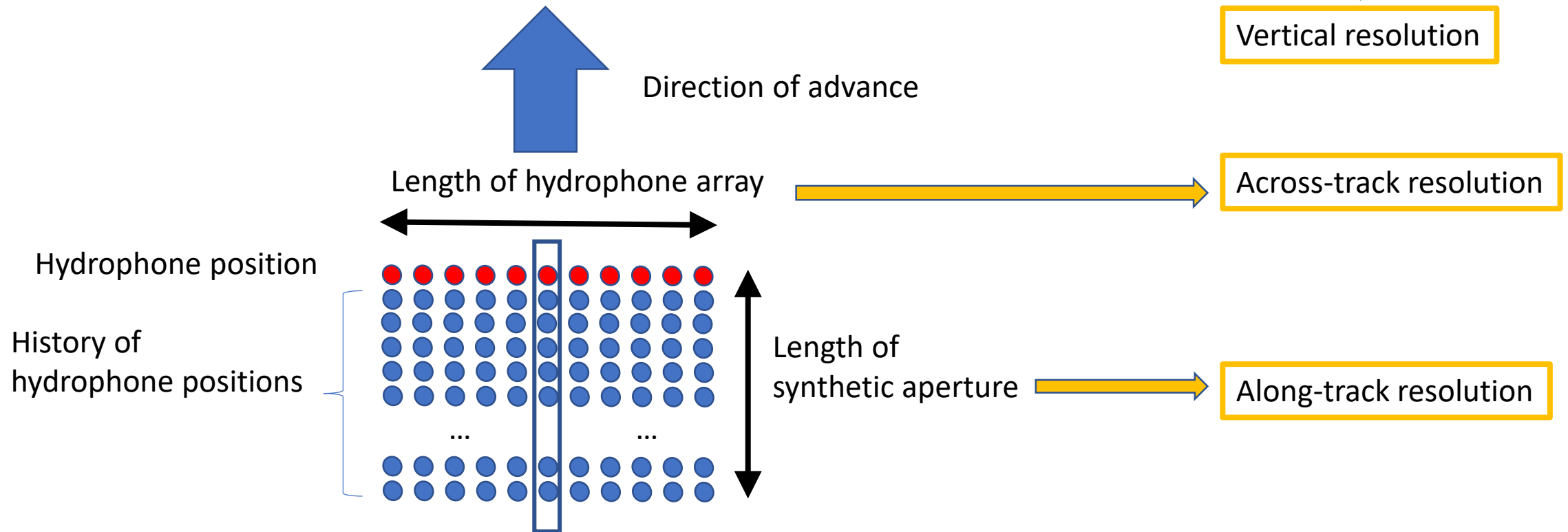
Timeline





The Technology

- Super wideband Frequency Modulated pulse (« Chirp ») transmission (**4.5 octaves**)
- Synthetic Aperture Sonar (SAS) processing in the along-track direction
- Beamforming with transversal hydrophone array



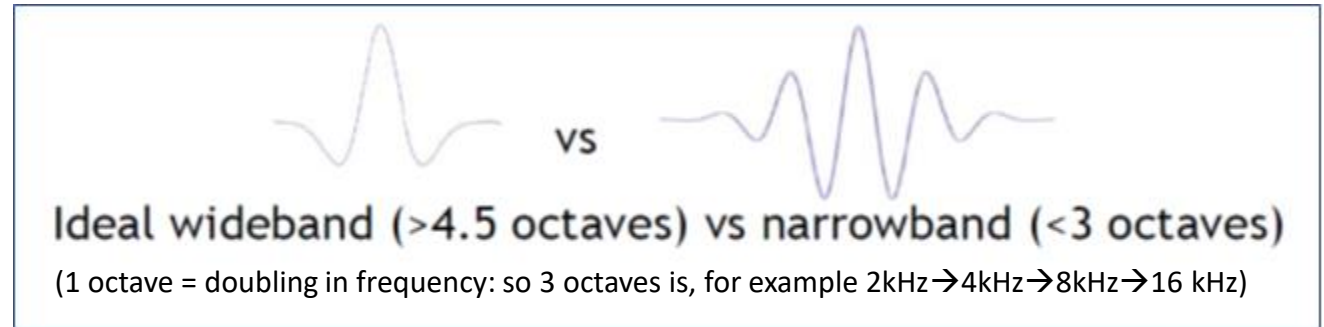


Super wideband Chirp system

- Tunable frequency range between 0.5 and 10 kHz (4.5 octaves)
- Vertical resolution of < 10cm (full frequency range)
- Frequencies below 4kHz give penetration in harder sediments
- PRF up to 13Hz giving along-track sampling $\approx 0,2$ m @ 5 knots
- Energy (hence SNR) can be increased by a longer duration Chirp

Benefits

- Versatility to meet client requirements
- The wavelet (after chirp processing) has less ripples, allowing to use the **full wavelet** and not only the envelop \rightarrow **better resolution and images**
- Sediment attenuation is wavelength dependant: e.g. sand 1 dB/ λ
 \rightarrow **low frequency means better penetration and Signal to Noise Ration SNR (performance)**



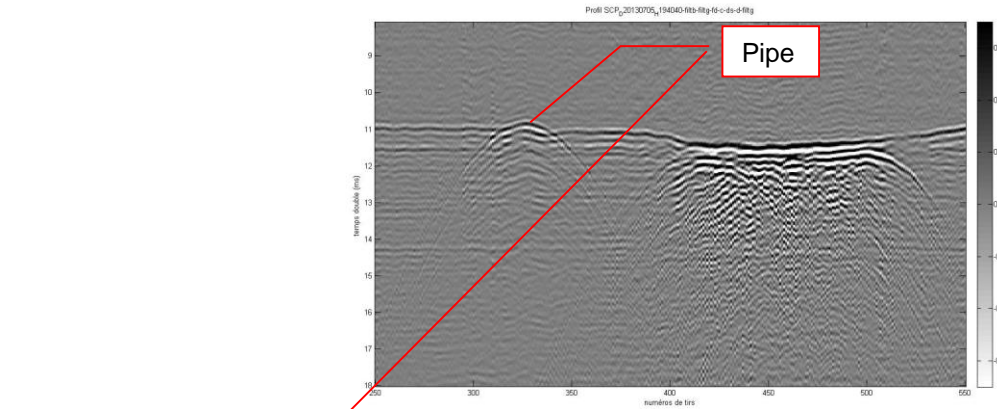
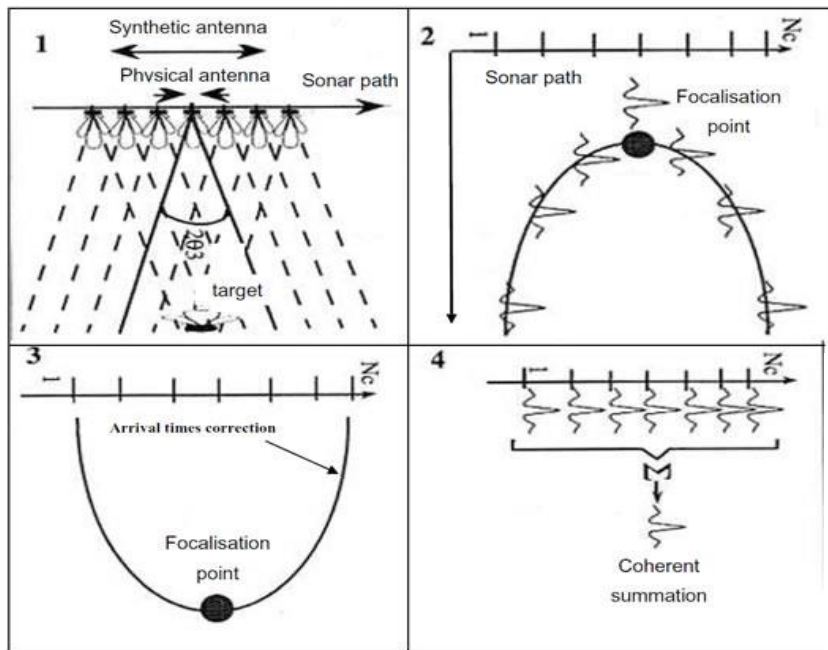
2 m		3 kHz	5 kHz	9 kHz
		-8 dB	-13 dB	-24 dB

5 m		3 kHz	5 kHz	9 kHz
		-20 dB	-33 dB	-60 dB

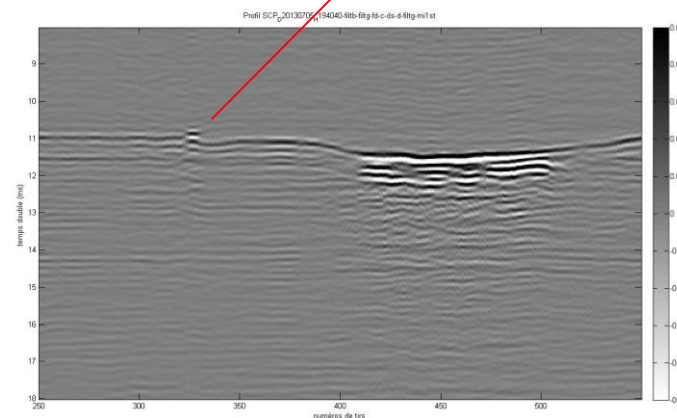


SAS processing

- Each point of the sub-surface is sampled multiple times as the seaCHIRP 3D passes over it
- A coherent reorganization of the collected data enables to create a long synthetic antenna
- The process improves along-track resolution, object positioning, SNR (detection and positioning performance), and collapses diffractions (better images of first 2 m, etc.)



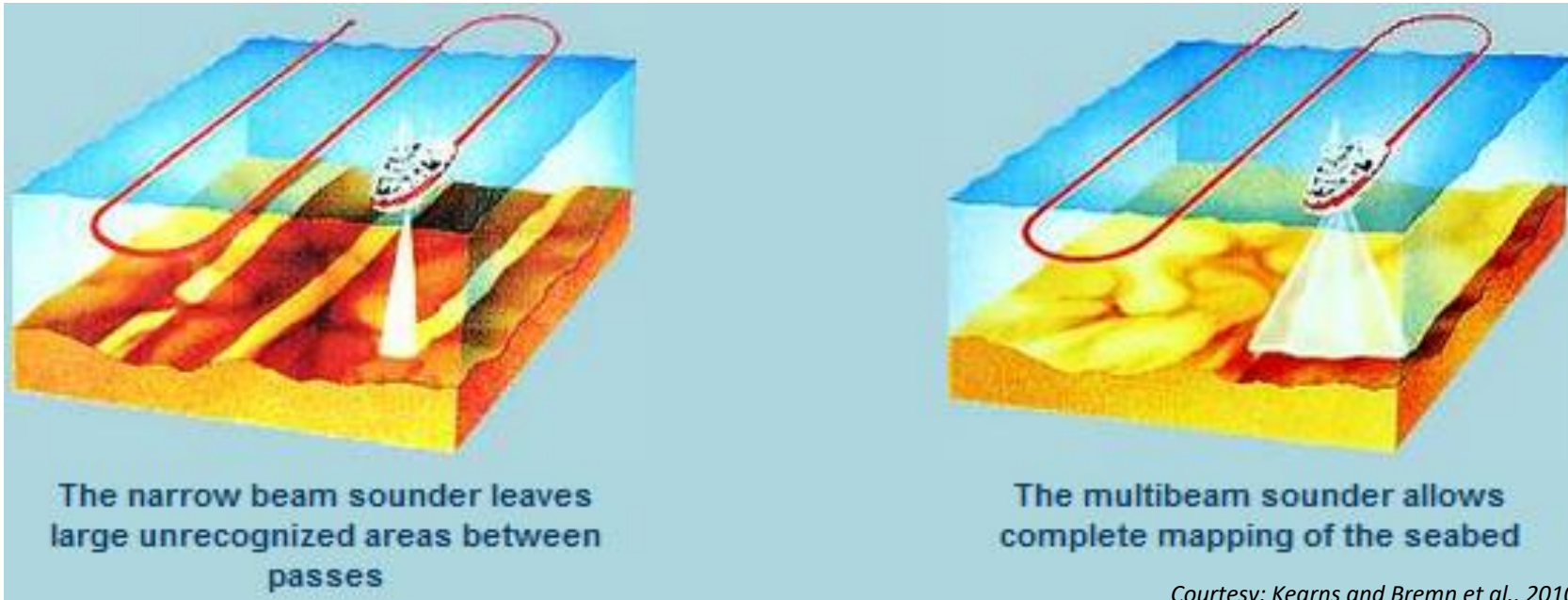
Seismogram before and after SAS processing (Central beam)



- Achievable resolution $\approx 1 \lambda$
- $\approx 0.3 \text{ m}$ (full frequency range)
- SNR gain function of water depth
- $> 30 \text{ dB}$ @ 20 m water depth

Beamforming

- The signals collected on the hydrophone array are re-arranged in order to calculate beams with different steering angles.

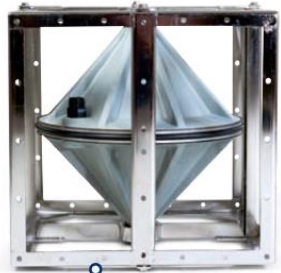


- 80° Swath (1,7 x Water depth)
- 10° beam aperture
- Up to 1° angular sampling (81 beams)

- Total seabed coverage
- Rapid survey
- Good object detection and separation
- Accurate object positioning



seaCHIRP 3D equipement



Emitter

0.4 – 8 kHz [4.5 octaves]



On-board ruggedized electronics

Amplifier: 2.5 kW power output
Acquisition system: 24-bit resolution ADC/ DAC [118 dB dynamic range]



seaWING
STREAMLINED ACOUSTIC ARRAY



SeaWING Advanced Design



Enhance performance by using 2 seaWING at the same time !!

Super wideband chirp technology > Deep penetration with high resolution, enabling analysis of difficult seabeds (coarse or consolidated) - Detection of small buried objects (e.g. 6" pipes).

In April 2017 SOACSY introduced its enhanced POWER+ transducer

Main Features

Frequency	0.5 - 10 kHz
Emitted Level	+6 dB / previous source
Operating Depth	- 40 m without compensation - 350 m with compensation
Weight	~ 40 kg
Dimensions	55 cm x 35 cm





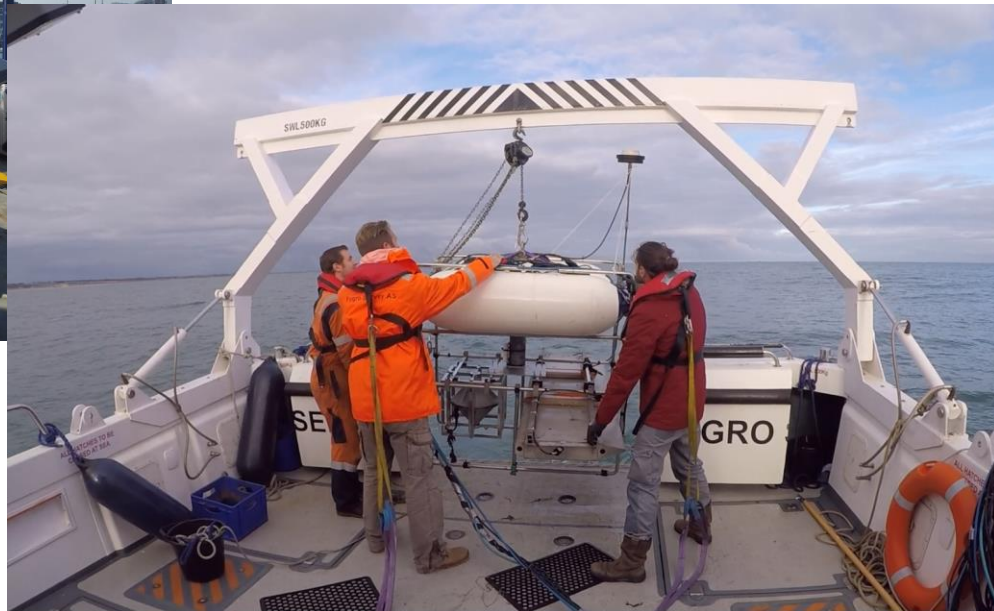
Mobilisation

- Versatility to meet client available vessels
- Quick and easy set-up

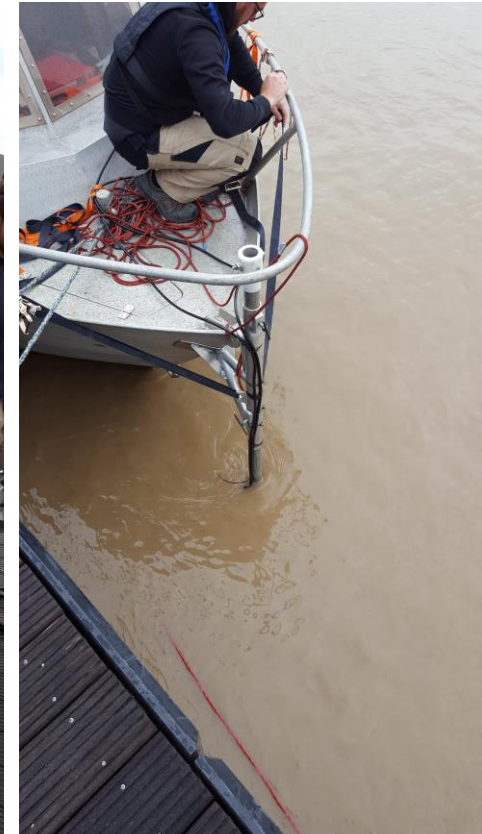
Under the hull of a small boat



On our specific frame



On a pole





Mobilisation

Offshore

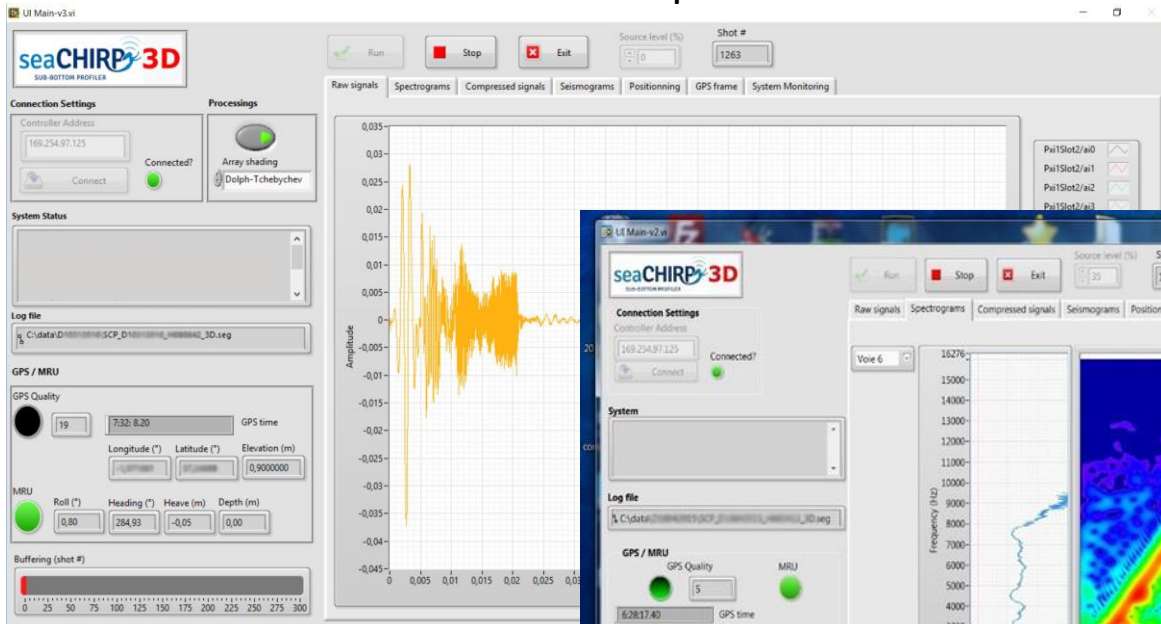
Nearshore / Inland



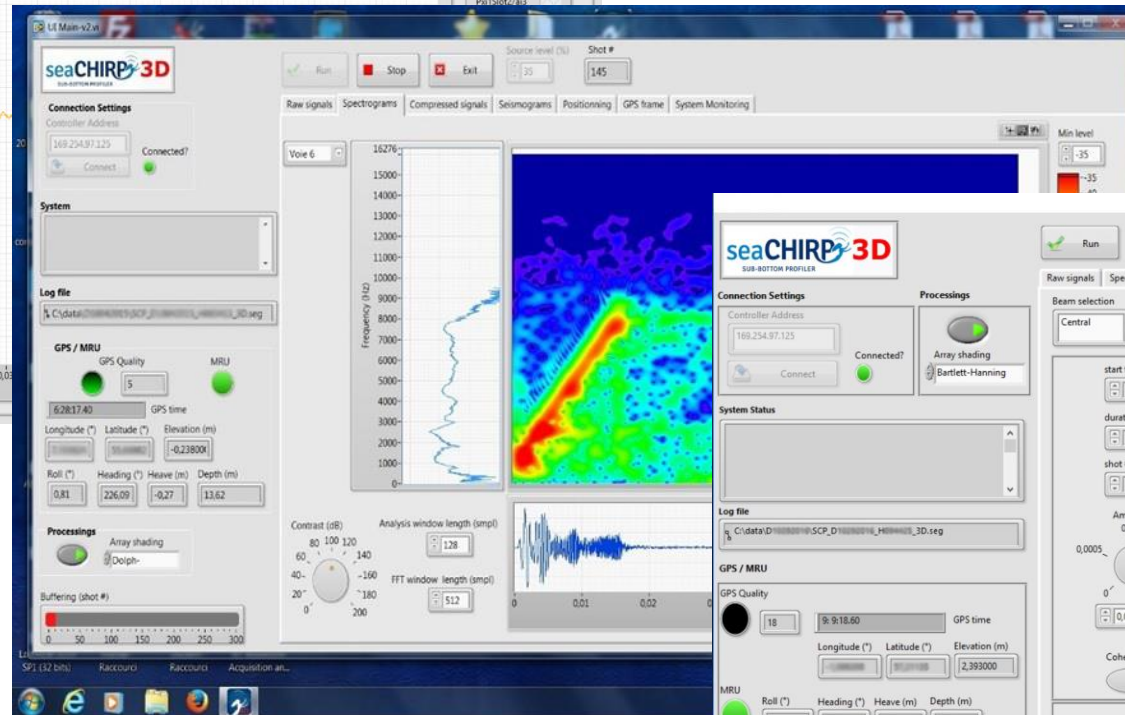


Acquisition and on-line QC

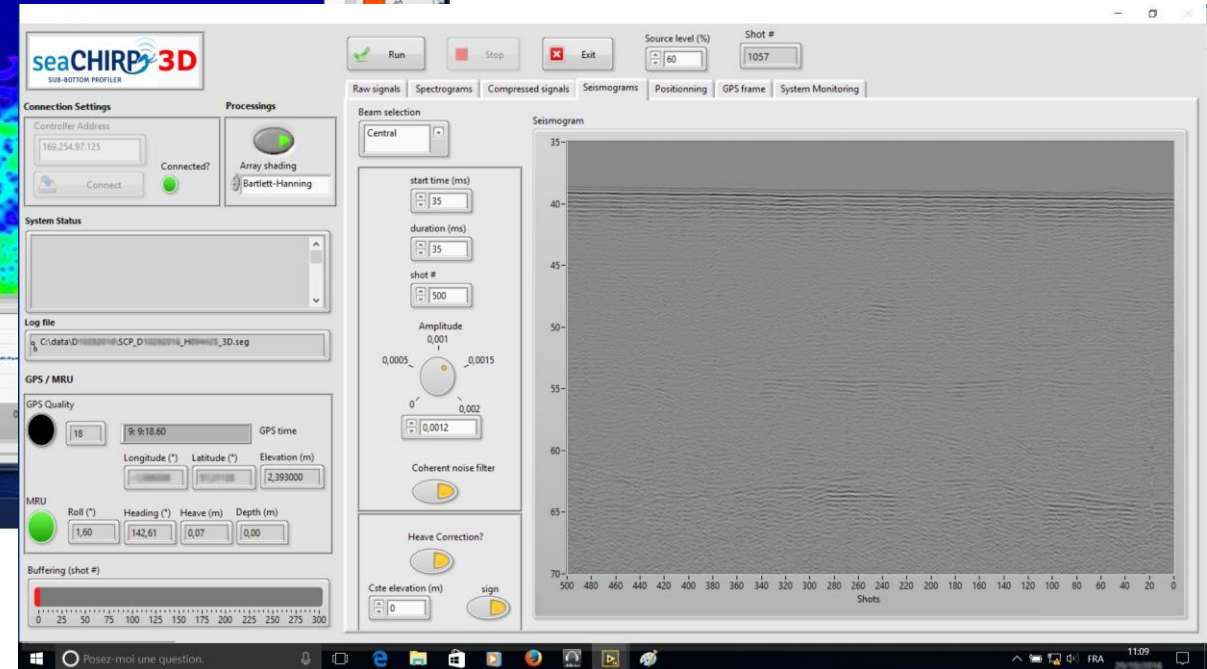
Oscilloscope



Spectrogram (time frequency)

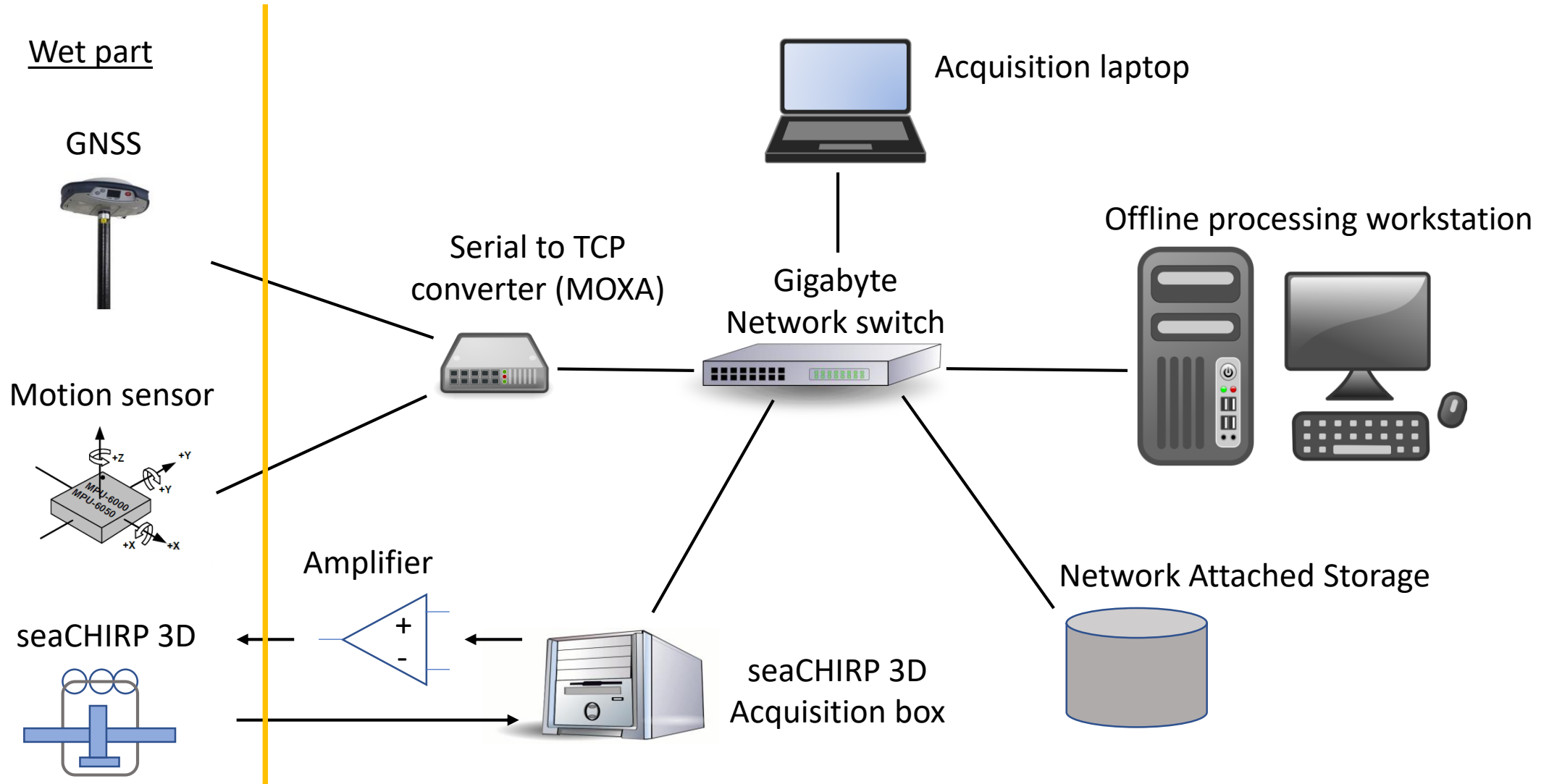


Seismogram for the selected beam



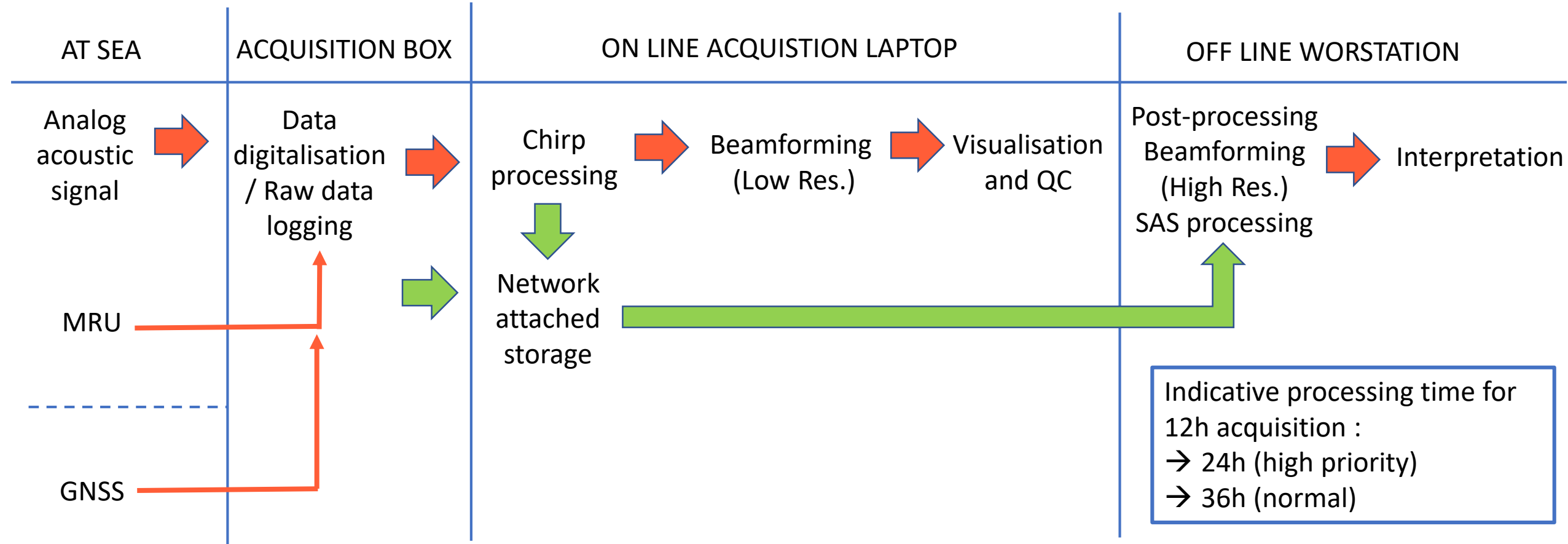


On board network





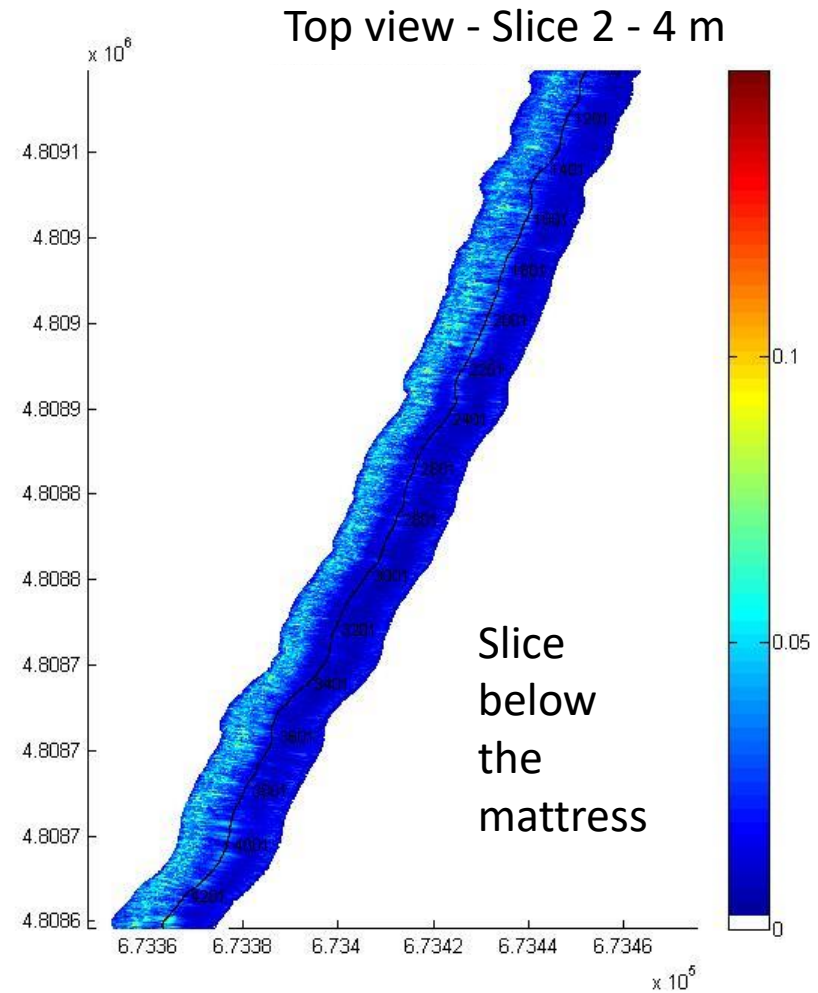
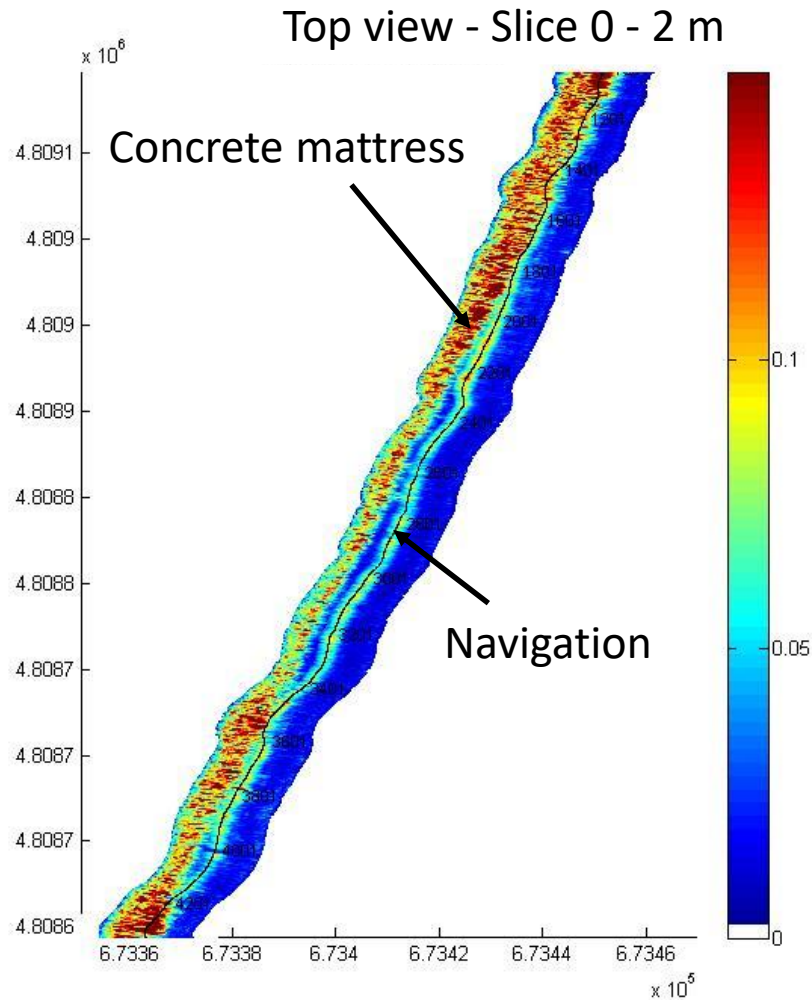
Data flow diagram





Field example

Etang de Berre (near Marseille) – Line along a concrete mattress

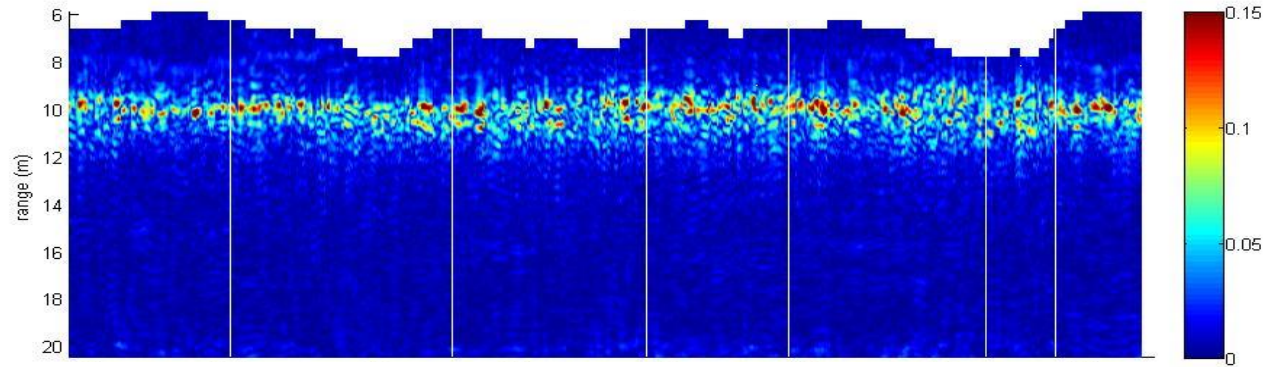
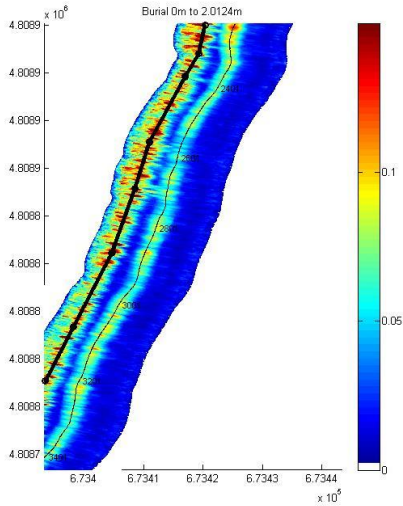




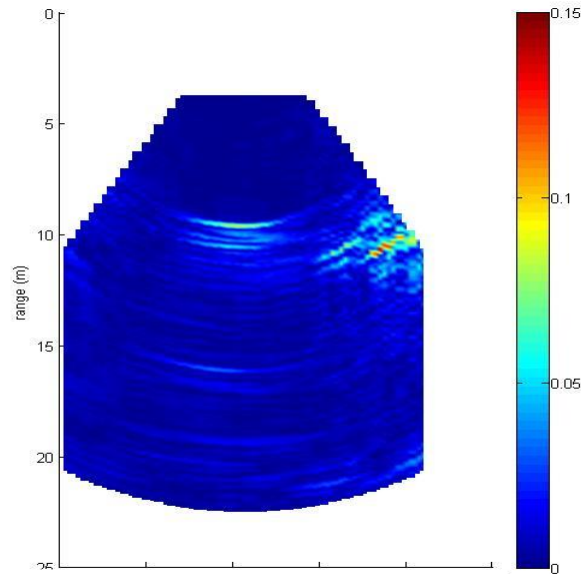
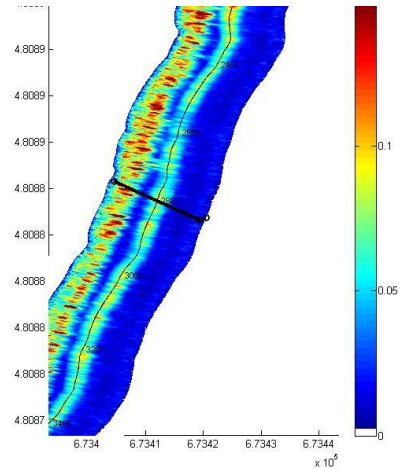
Field example

Etang de Berre (near Marseille) – Vertical Sections

Along
the
mattress



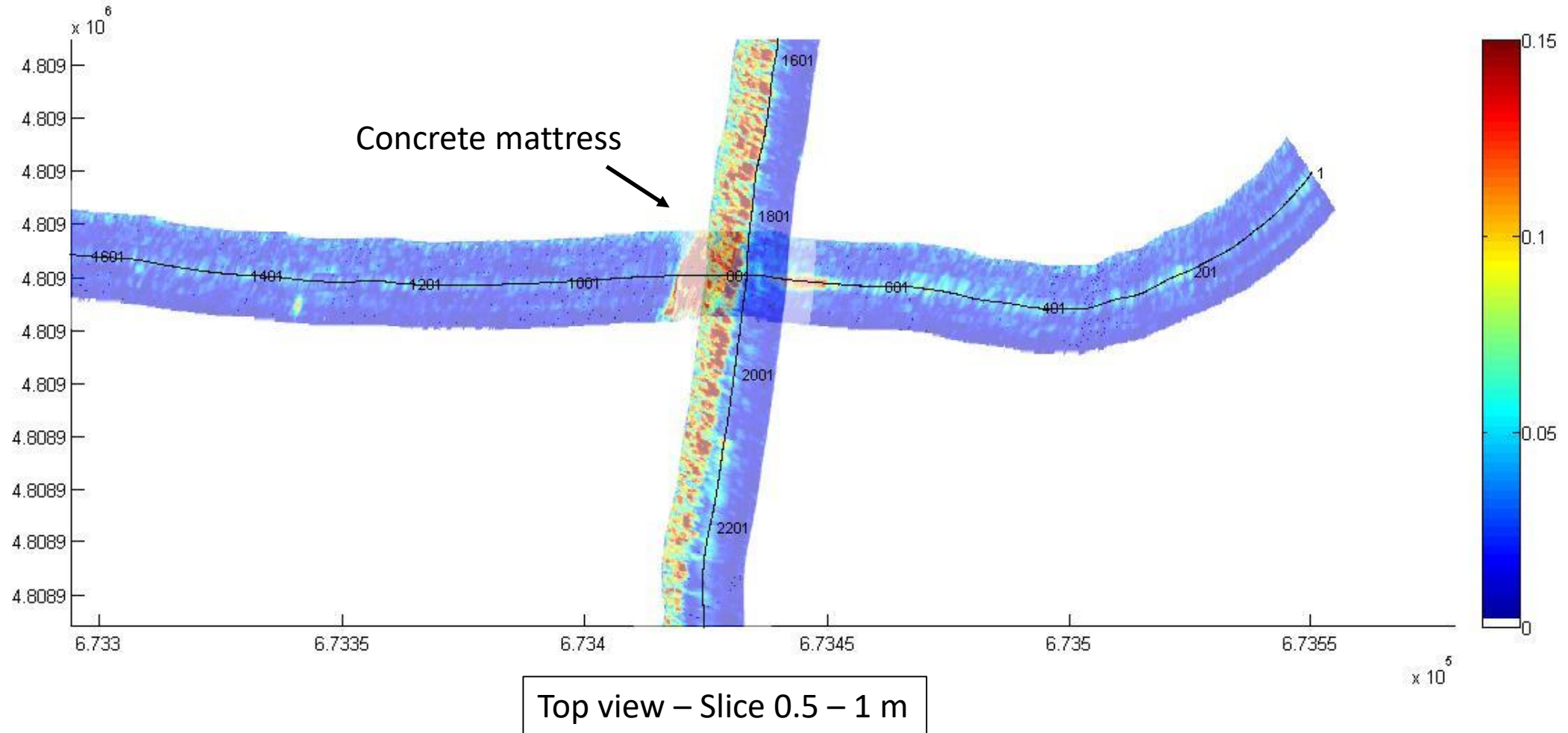
Across
the
mattress





Field example

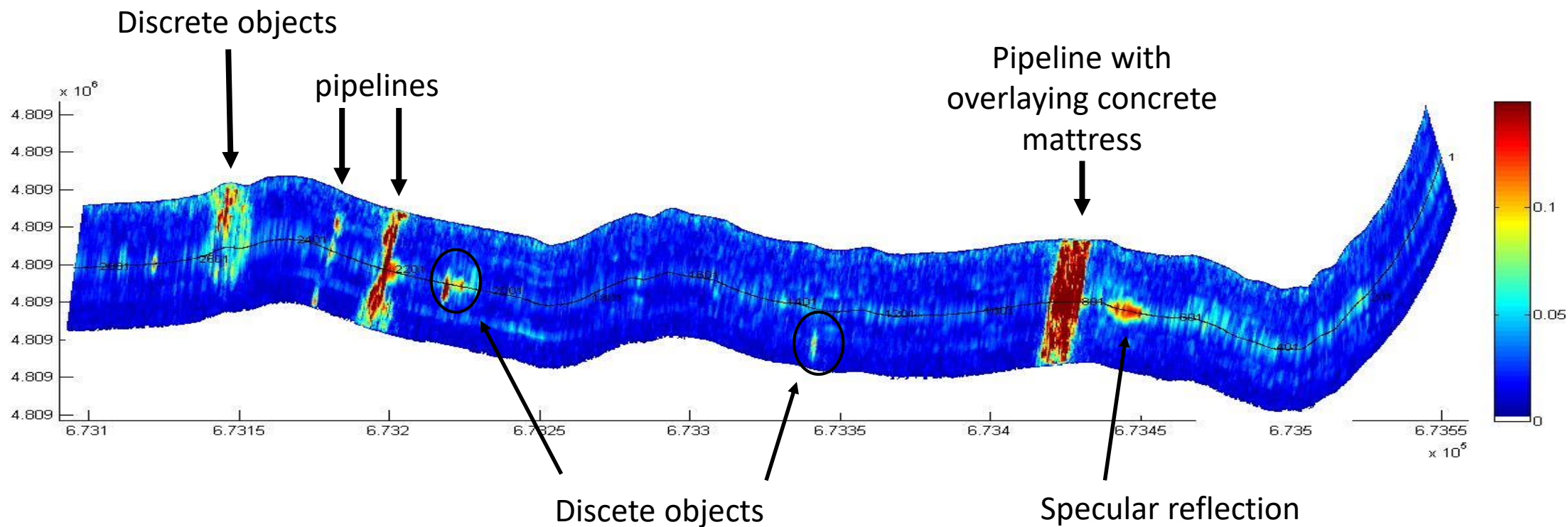
Etang de Berre (near Marseille) – Line and cross line superposition





Field example

Etang de Berre (near Marseille) – Cross line



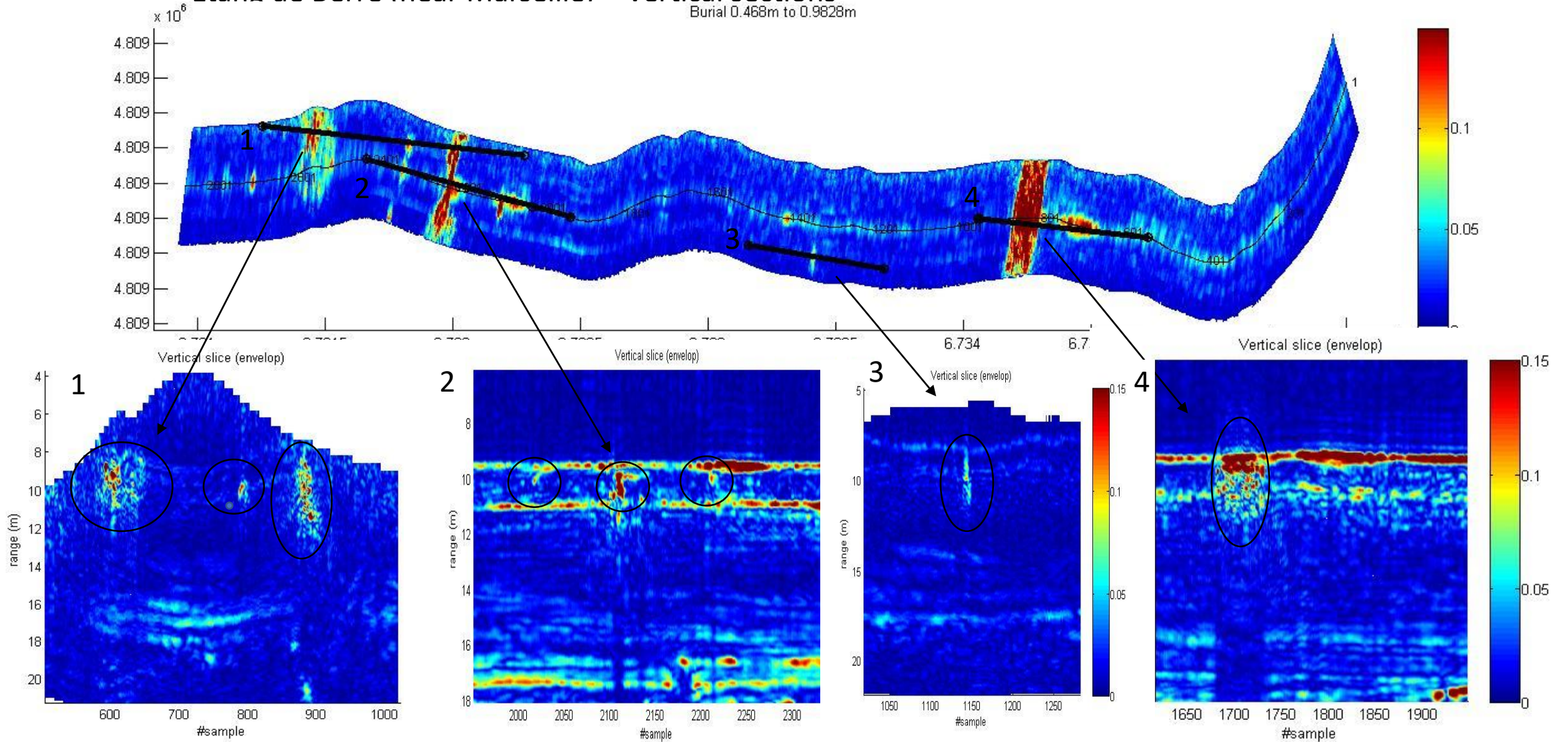
Top view - Slice 0.5 - 1 m



Field example

Etang de Berre (near Marseille) – Vertical sections

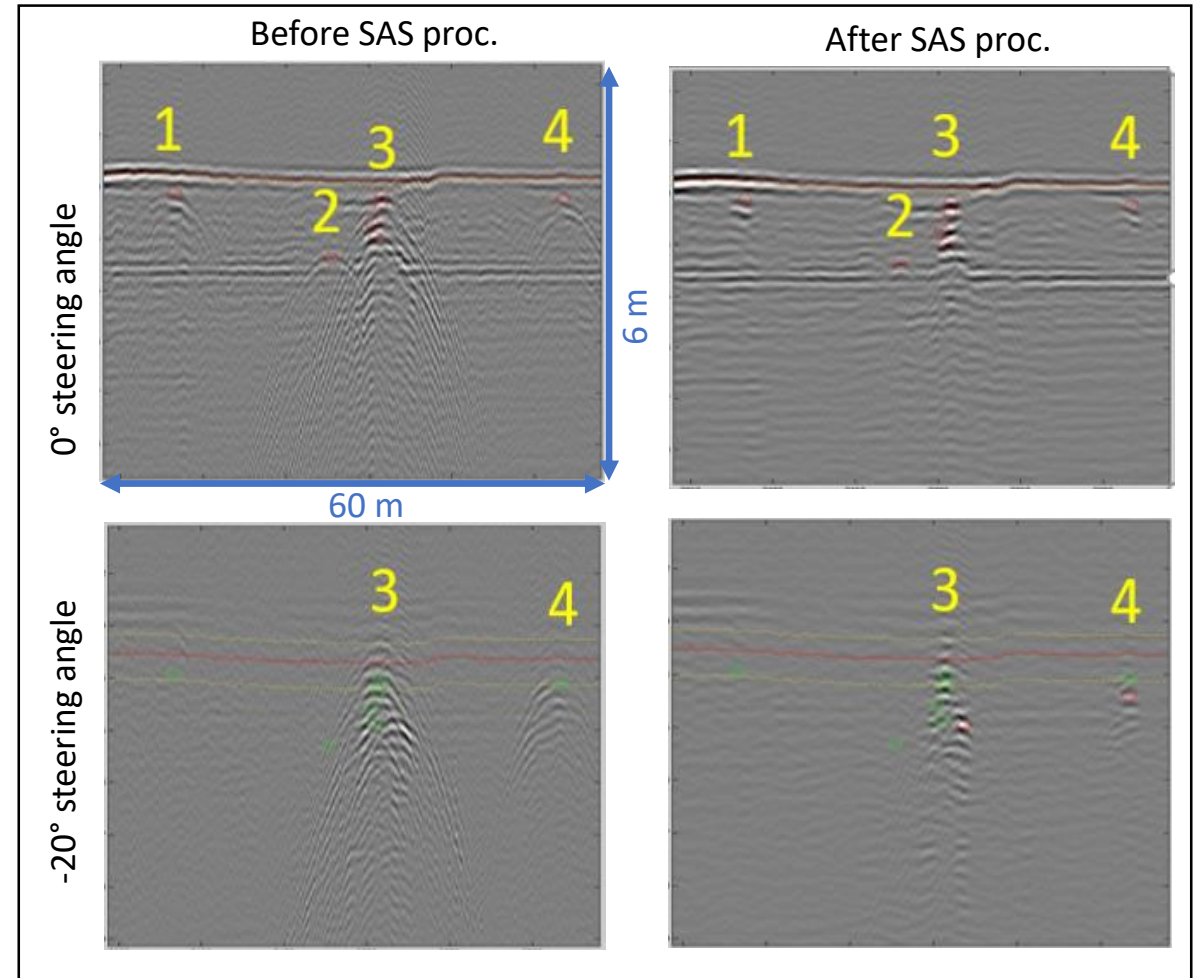
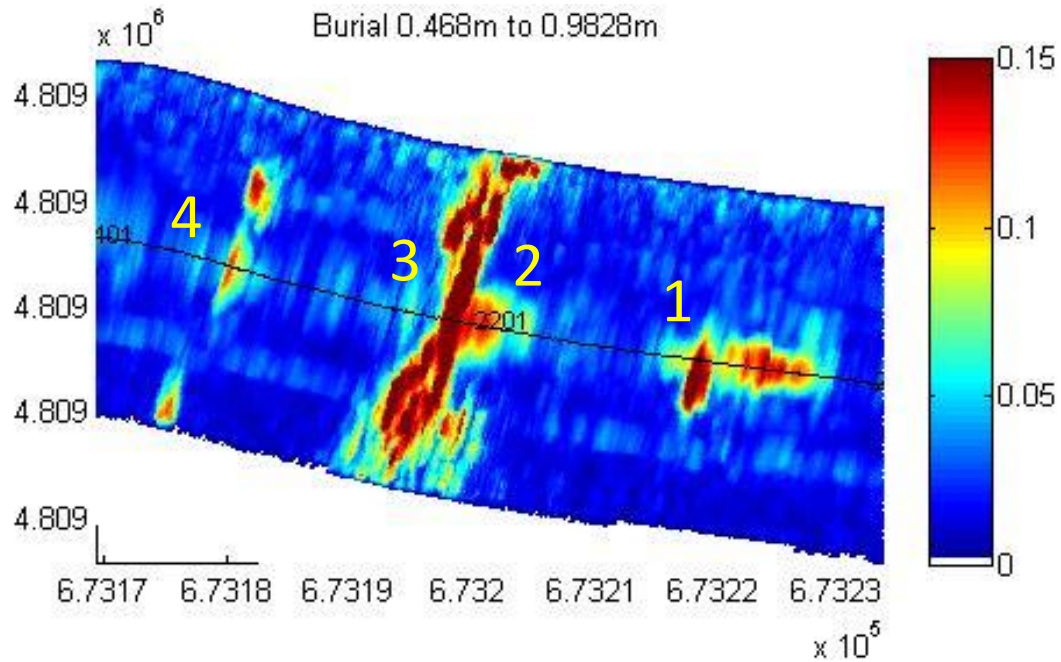
Burial 0.468m to 0.9828m





Field example

Etang de Berre (near Marseille) – Seismogram (full waveform)





Future Developments

- Real time 3D renderer: under progress
- Subsea version: looking for a partner...





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Partners



Sponsors

