



11/09/2017

The seaCHIRP 2D - Presentation

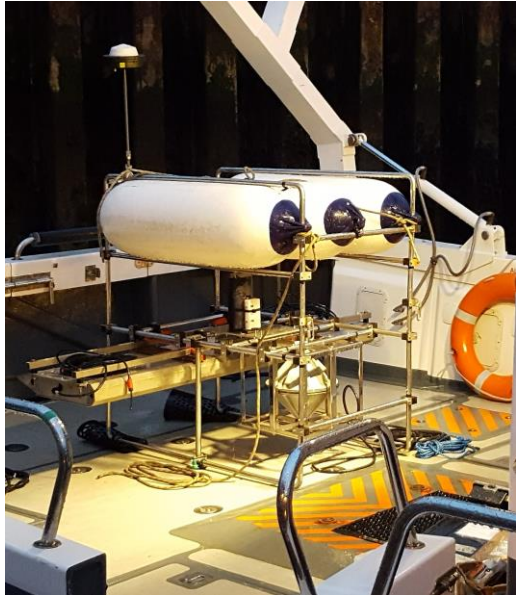
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# The seaCHIRP 2D

Precise and efficient seabed and geohazard assessment



- Sedimentary studies
- Critical surveys
- Complex seabed conditions

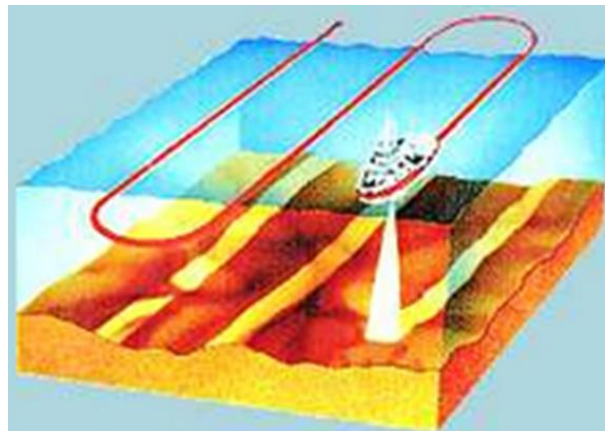
- Super wideband SAS Subbottom Profiler
- Shallow water 3-50 m
- Vertical resolution 7 cm @ 1500 m/s
- Along-track resolution up to 30 cm
- Narrow beam (15°)
- High speed (up to 5 knots) / high firing rate

- Rugged, compact and lightweight (90 kg)
- Versatility to meet client requirements/available vessels
- Quick and easy set-up

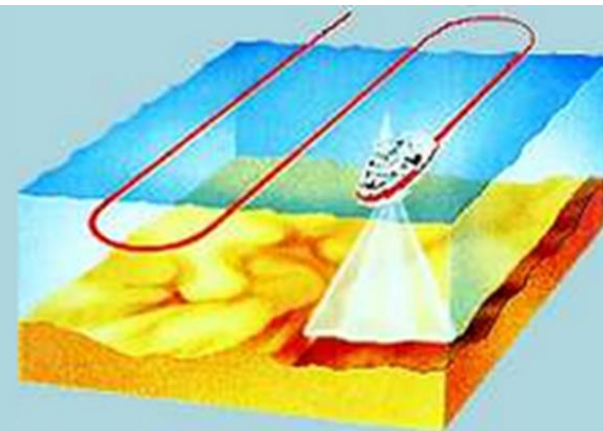
# The seaCHIRP versions

seaCHIRP 2D (single beam) → Detailed stratigraphy assessment

seaCHIRP 3D (multi beam) → Buried object detection and localization



The narrow beam sounder leaves large unrecognized areas between passes



The multibeam sounder allows complete mapping of the seabed

*Courtesy: Kearns and Breman et al., 2010*

## SINGLE BEAM

- Swath:  $\approx 0.26 \times$  water depth
- Beamwidth:  $15^\circ$
- Number of beams: 1

## MULTI BEAM

- Swath: up to  $1,7 \times$  water depth
- Beamwidth (central):  $10^\circ$
- Number of beams: up to 81



# Main track records (2D and 3D)

## Offshore sedimentary studies

- **SIZEWELL** (UK) for EDF Energy – 2014 – Nuclear energy
- **SAINT NAZAIRE** for EDF EN – 2014 – Wind farm
- **FECAMP / COURSEULLE** for EDF EN – 2014 – Wind farm
- **RAZ BLANCHARD** for GEOCEAN/ADEMIR – 2015 – Tidal energy

## Inland

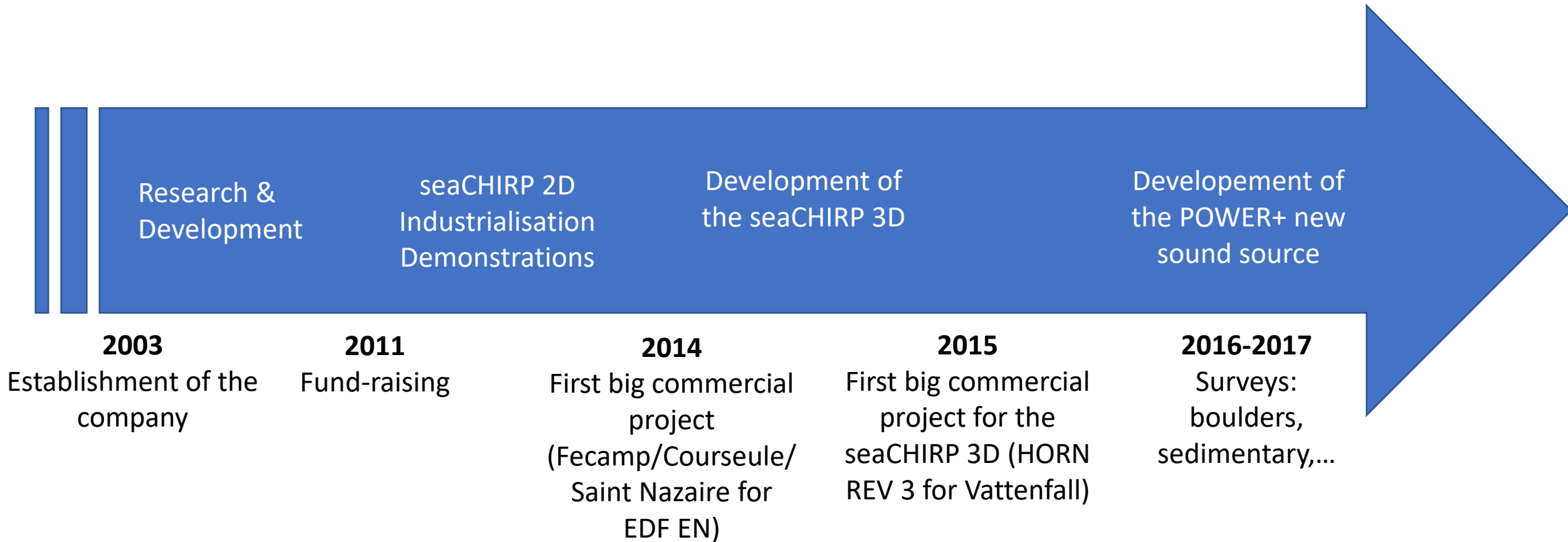
- **KEMBS** for EDF – 2015 – Hydroelectric energy
- **PUYVALADOR** for EDF – 2015 – Hydroelectric energy
- **BORDEAU** for BALINEAU – 2017 – Civil engineering

- Linear kilometer surveyed from 2014 > **1600 km**
- Vessels from **4,5 m to 40 m long**
- Waves **up to 1,2 m height**





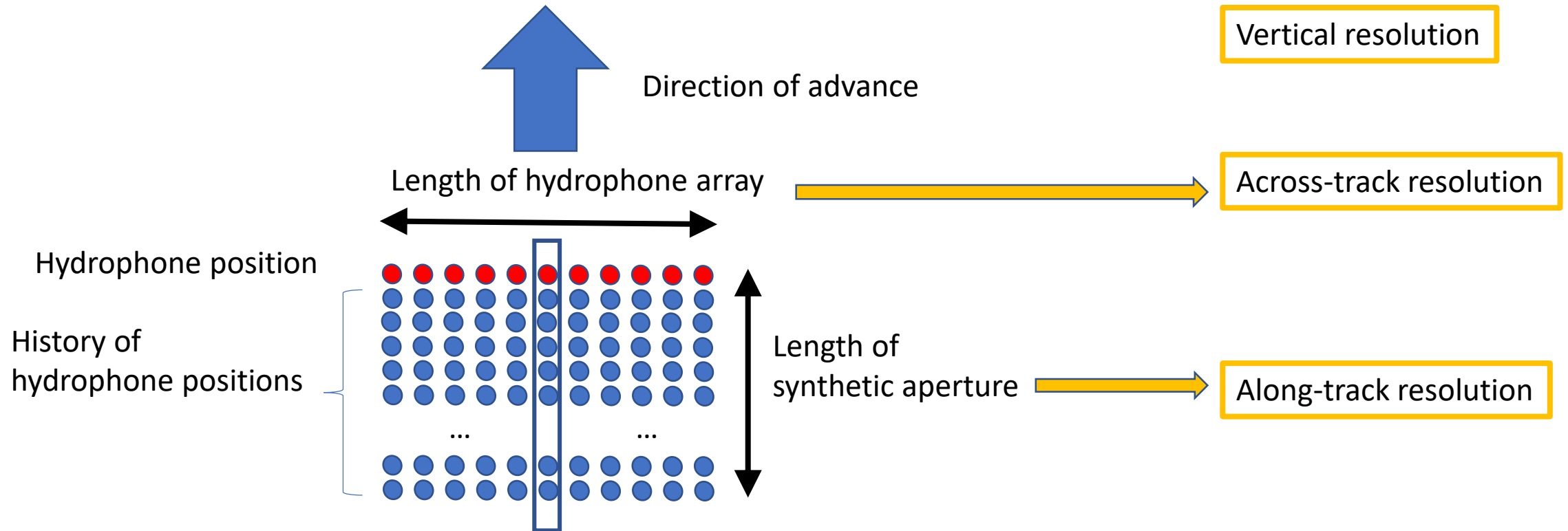
# Timeline





# The Technology

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



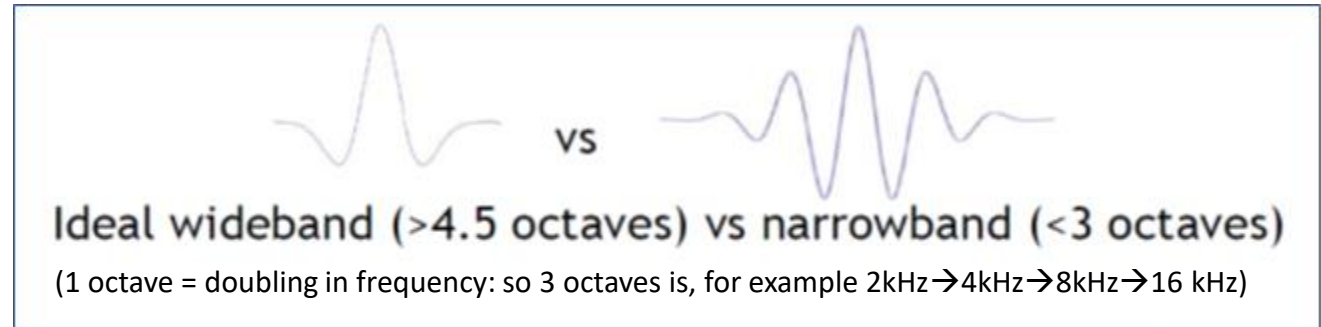


# Super wideband Chirp system

- 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/ $\lambda$   
 $\rightarrow$  **low frequency means better penetration and Signal to Noise Ration SNR (performance)**



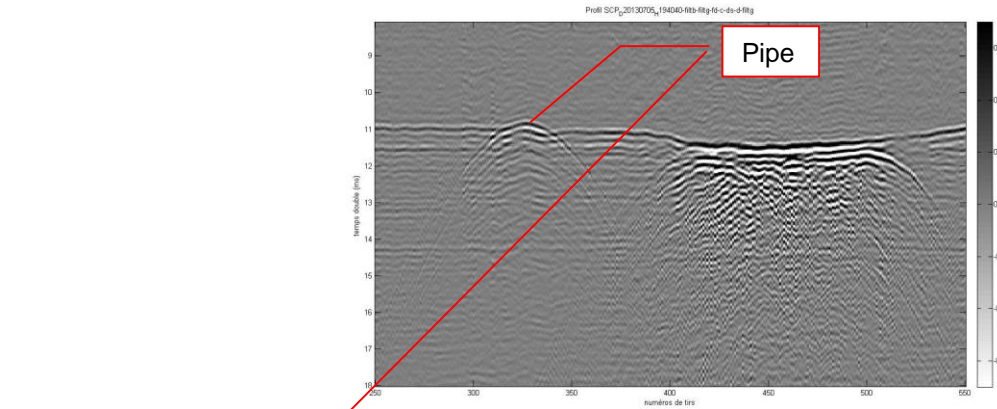
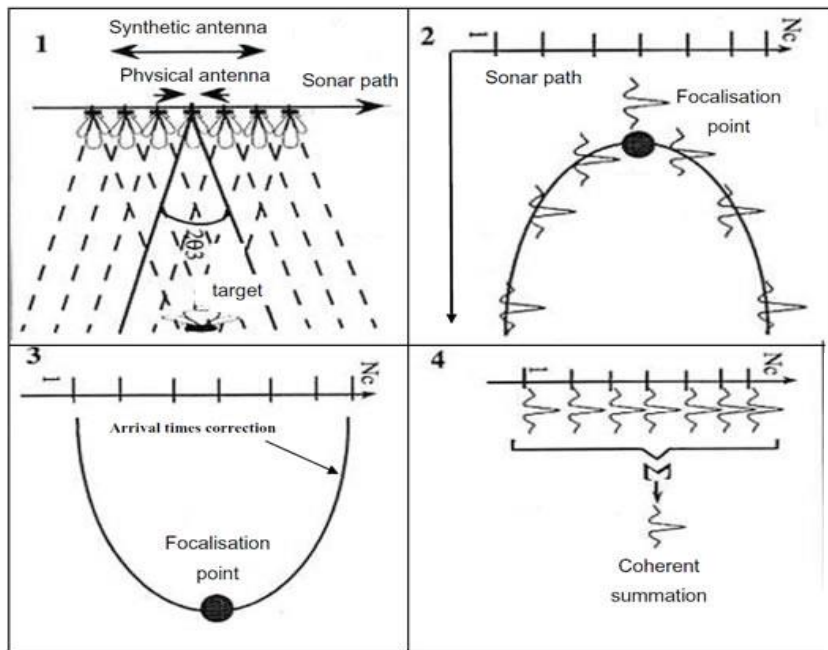
2 m		3 kHz	5 kHz	9 kHz
		-8 dB	-13 dB	-24 dB

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

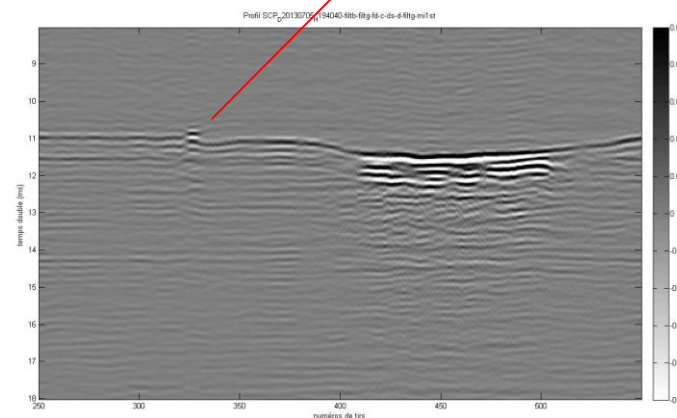


# SAS processing

- 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)

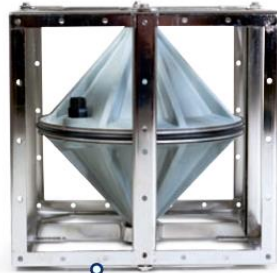


- Achievable resolution  $\approx 1 \lambda$
- $\approx 0.3 \text{ m}$  (full frequency range)
- SNR gain function of water depth
- $> 30 \text{ dB}$  @ 20 m water depth





# seaCHIRP 2D equipment



**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 Advanced Design**

**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**

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





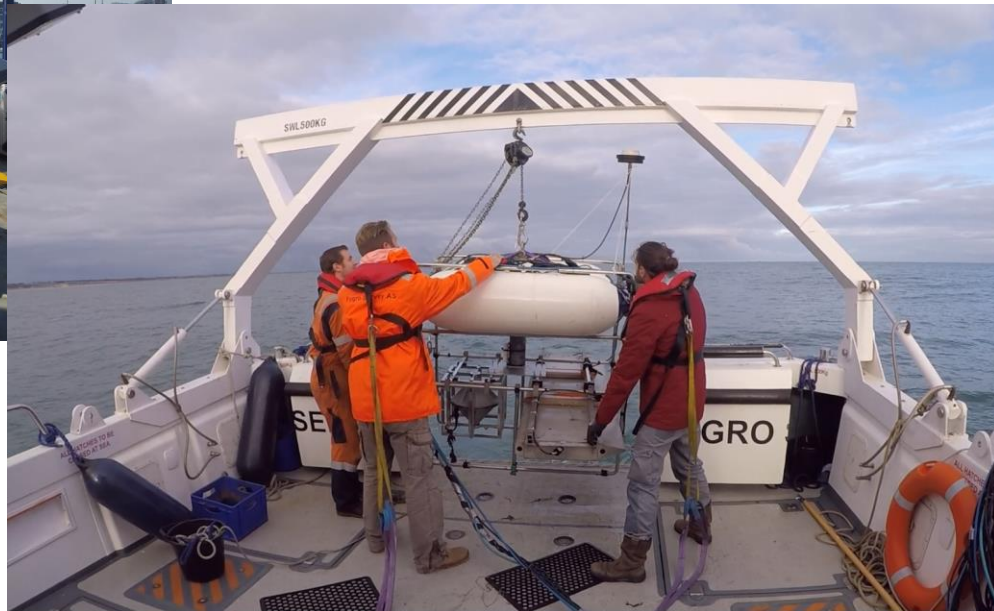
# Mobilisation

- 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

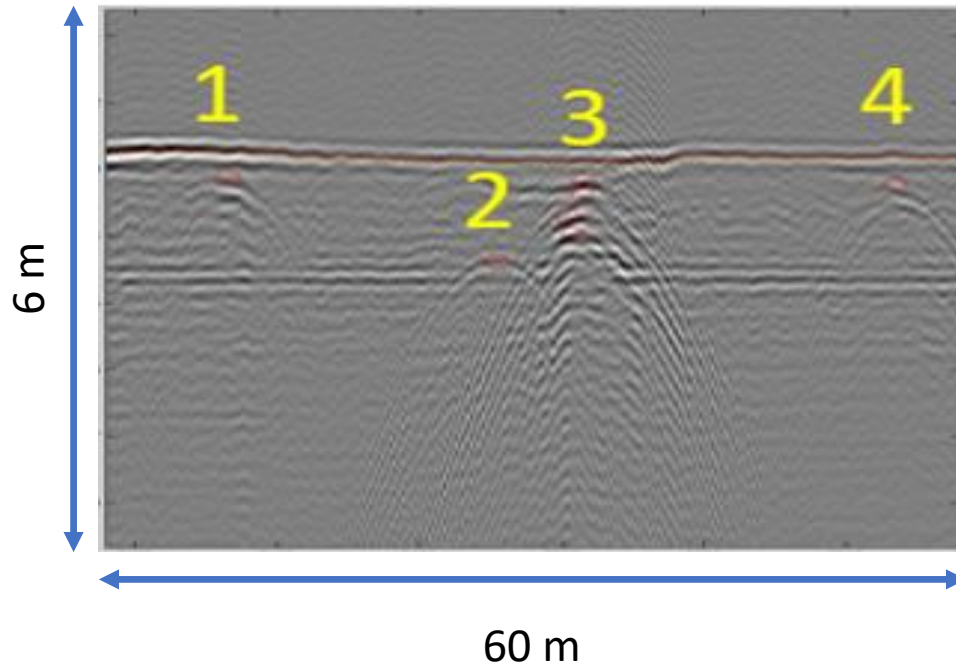




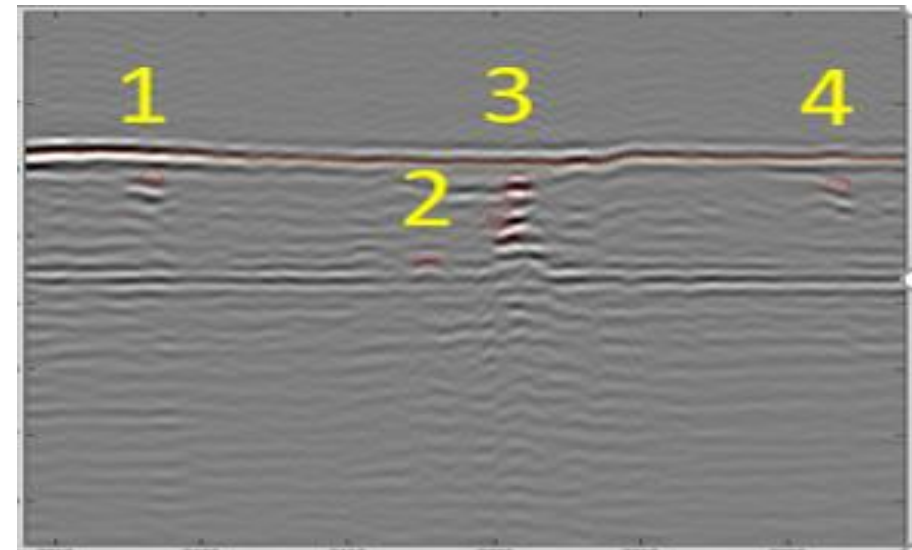
# Data example

Etang de Berre (near Marseille)

Before SAS processing



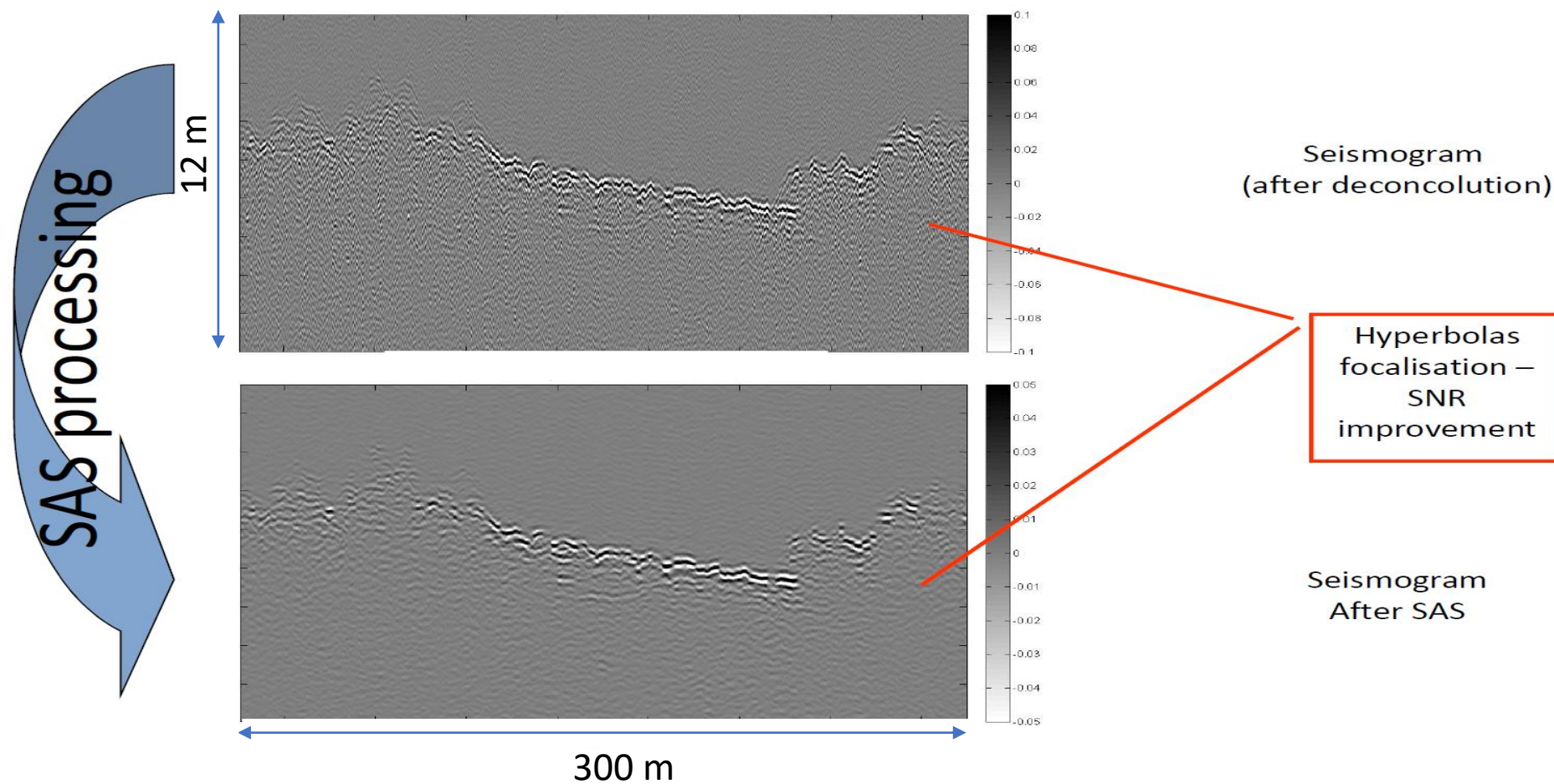
After SAS processing





# Data example

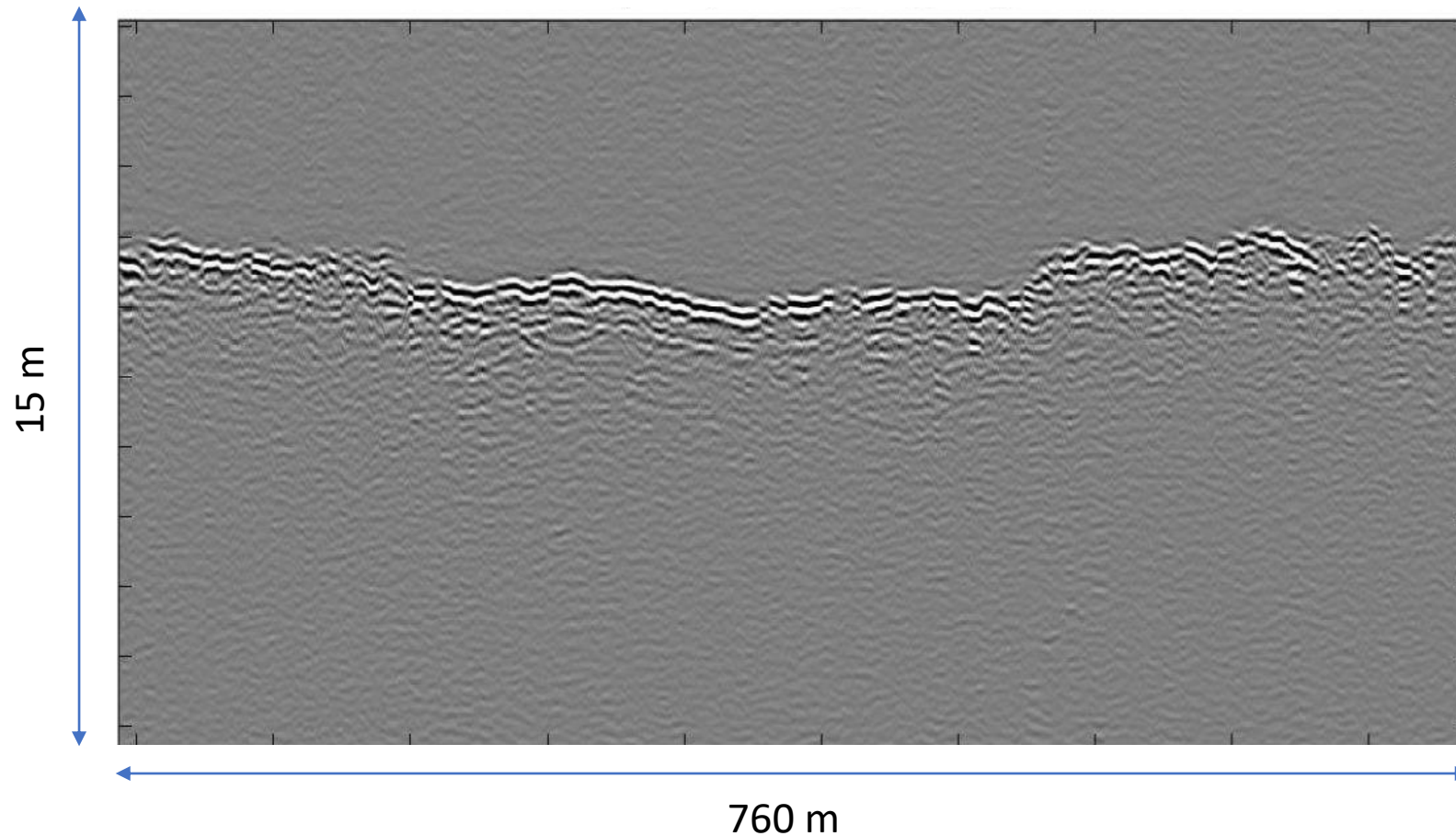
Rocky area (Atlantic ocean –France)





# Data example

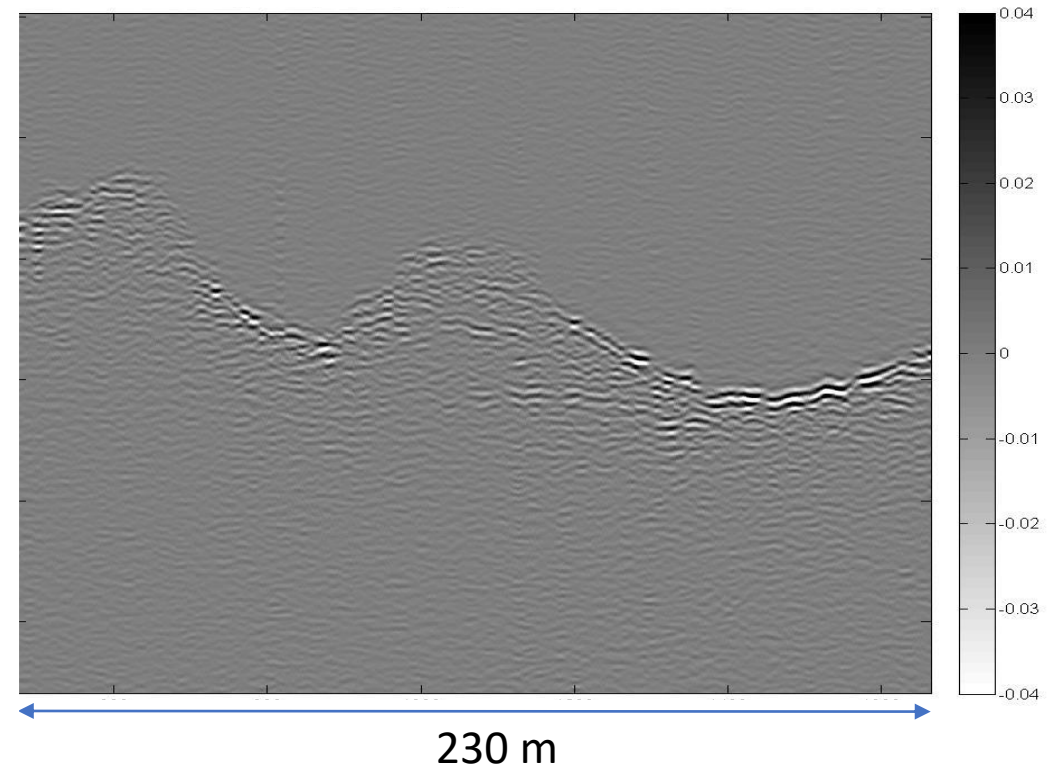
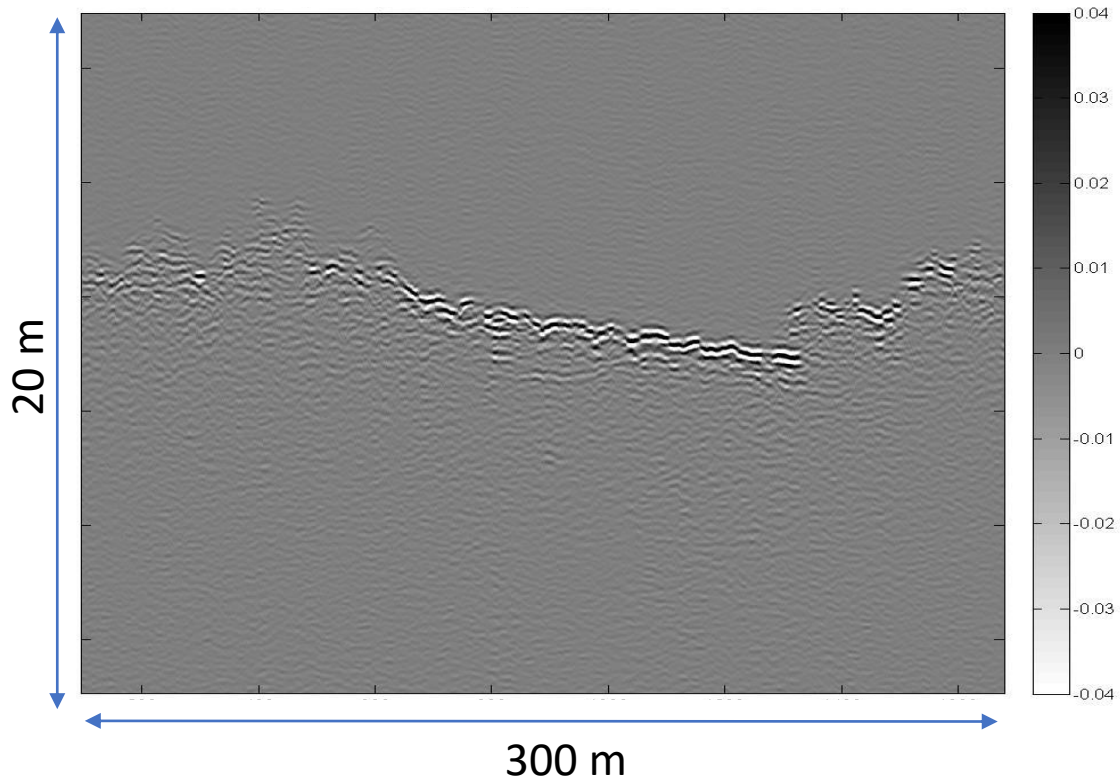
Example in a rocky area (1)





# Data example

## Examples in a rocky area (2)





# Future Developments

- Subsea version







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## Partners



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