SUB C MARINE
UNDERWATER SERVICES

Olivier SAMAT

High-resolution inspection of large-scale hydraulic structures using MPES

EdgeTech
The Leader in Underwater Technology

Olivier SAMAT[1,2], Richard HILL[3], Geraud NAANKEU WATI[1], Benjamin TAIZIERES[1]

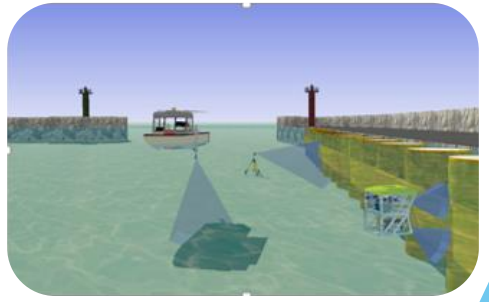
Géomatique, hydrospatial, inspection d'infrastructures

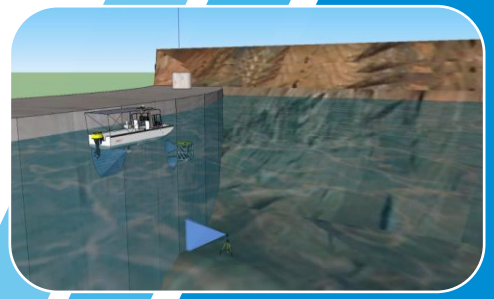
[1]SubC-Marine / [2]OS-Geoconsult / [3]EdgeTech

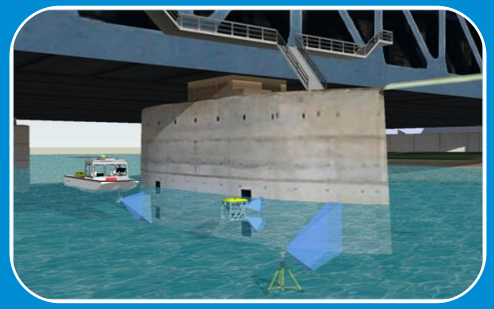
A SUB-C MARINE, about us

Type of business: service company
Provider of Geographic data

Staff : 24



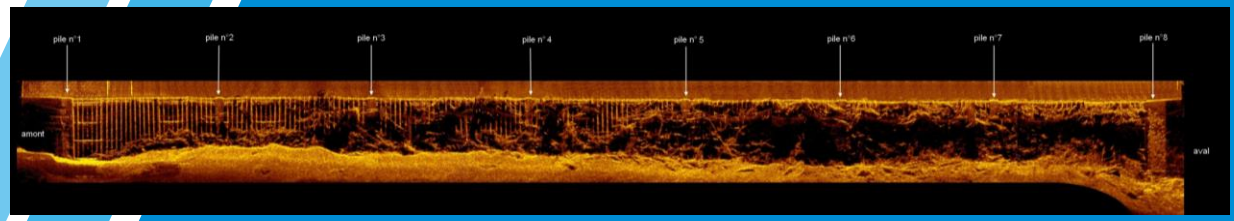


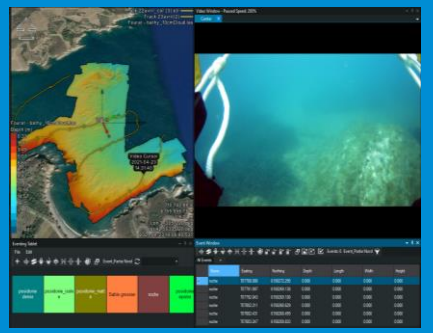


Feyzin, siège social

Rochemaure, base opérationnelle bathymétrie et ROV

Mudaison, base opérationnelle, relevé aérien, topographie, traitement



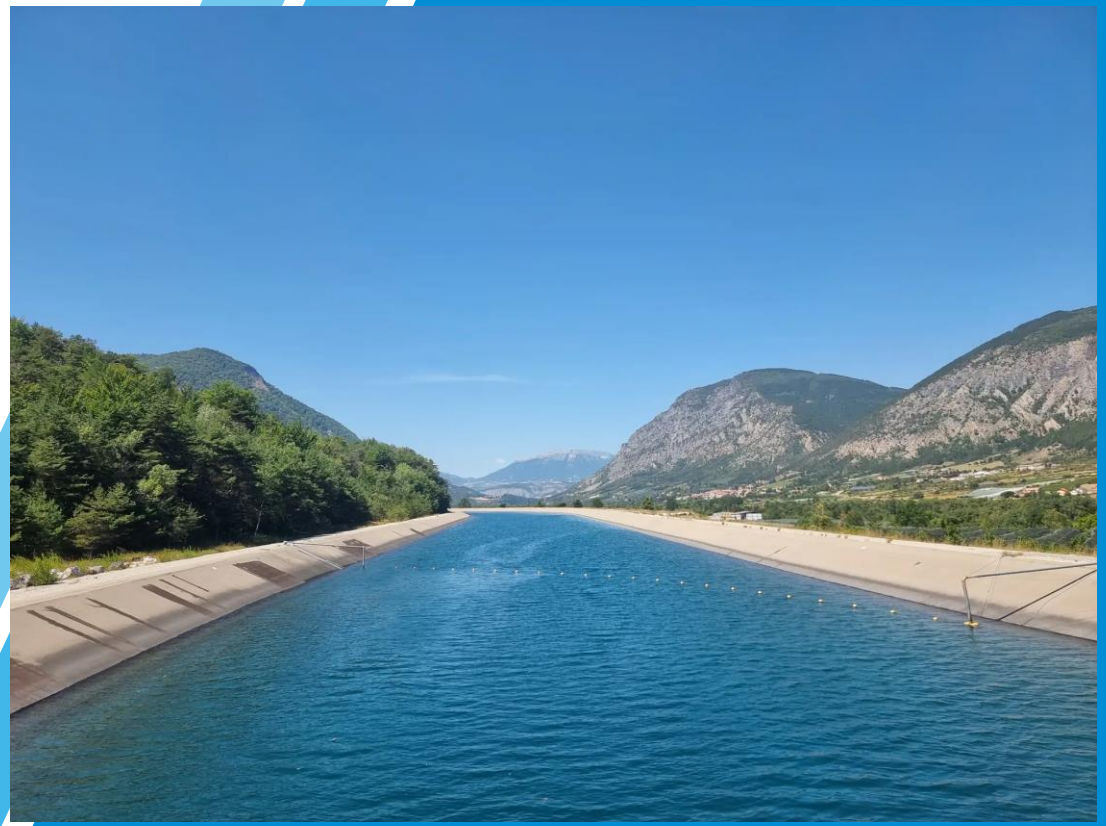


B

Inspection of large-scale structures

The inspection of long, linear hydraulic structures (possibly hundreds of kilometers in length and typically 50m in width and up to 15m in depth), such as canals whose primary function is to store and guide water, is subject to a Comprehensive Assessment (CA) by French regulations.

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

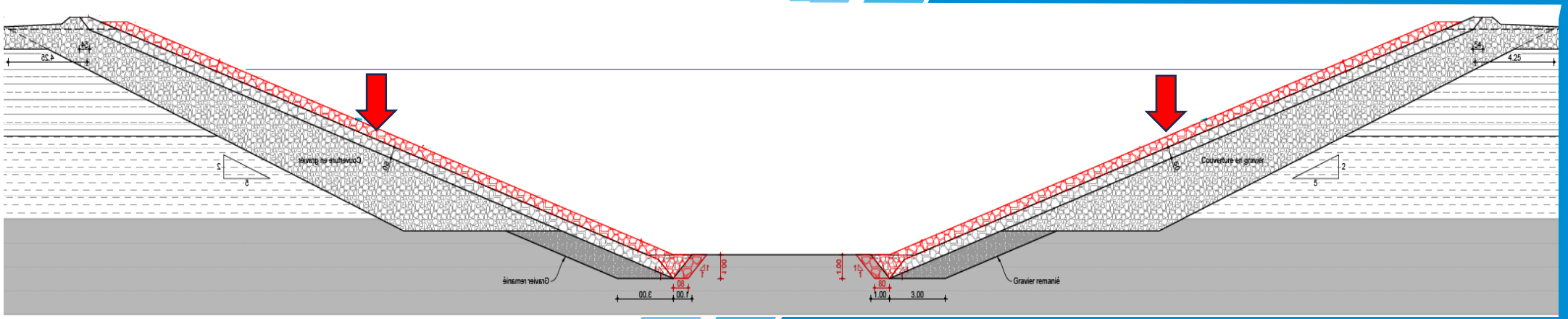


Background

Several layers:

- main slope,
- drainage layer,
- waterproofing layer

This case study focuses specifically on this **final layer**, whether concrete or bituminous concrete.

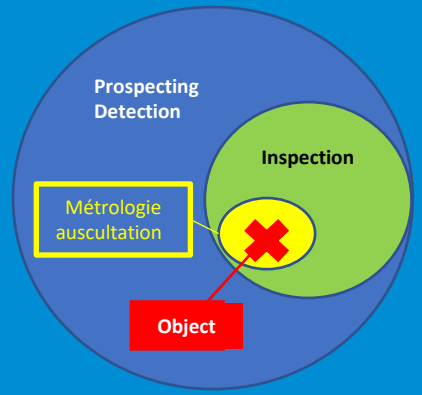


Background

Last 10 years have seen a development of innovative technologies for underwater inspection: moving from point/discrete measurement(s) to the need for continuous monitoring and 3D data results.

Constraints:

- Variable water turbidity
- Kilometric lengths vs. time allocated for inspection (operational constraints of the facility manager)
- Overcoming obstacles (bridges, barriers...)
- Need for maximum accuracy and resolution for a complete detection and diagnosis of centimeter-level defects
- Reproducibility of the process



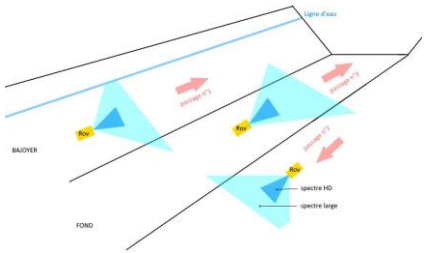
Choice Of Technology

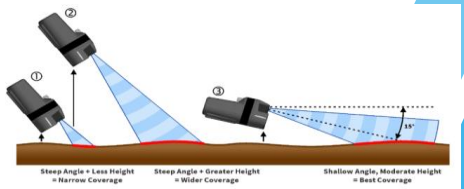
Deploy a system capable, in turbid water, to carry out an inspection over a large area in a minimum amount of time, providing precise 2D and 3D data (accurate to within a few centimeters) over several tens of kilometers.

Acoustic methods favored for the initial tests in **2017**

Acoustic Camera (FLS, Imaging sonar)

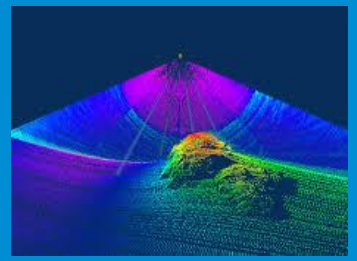
+	-
Resolution	Implementation (in this context)
Image quality	Data collection rate

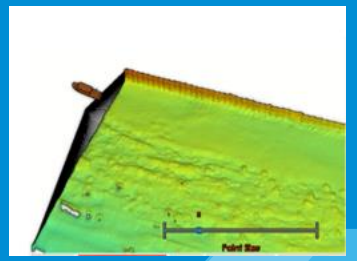




Multibeam Profiler (MBES)

+	-
Precision	Cost
Data collection rate	Data presentation





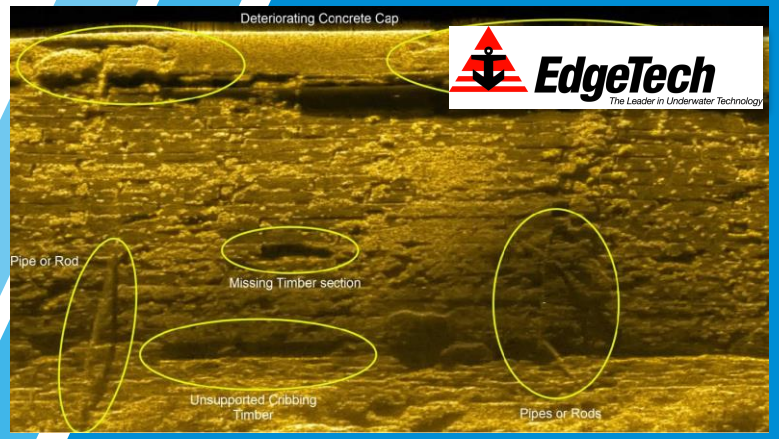
Choice Of Technology

Side Scan Sonar

+	-
Resolution / Image quality	Availability (very high frequency system)
Cost	2D only, not 3D
Implementation	

References before 2017

2019



Implementation and Validation

- **Stage 1:**

  Validate the high-resolution imaging system (technology and frequency)

- **Stage 2:**

  Validate the combined 3D / 2D system
  Optimization of survey lines (number and positions on the channel)

- **Stage 3:**

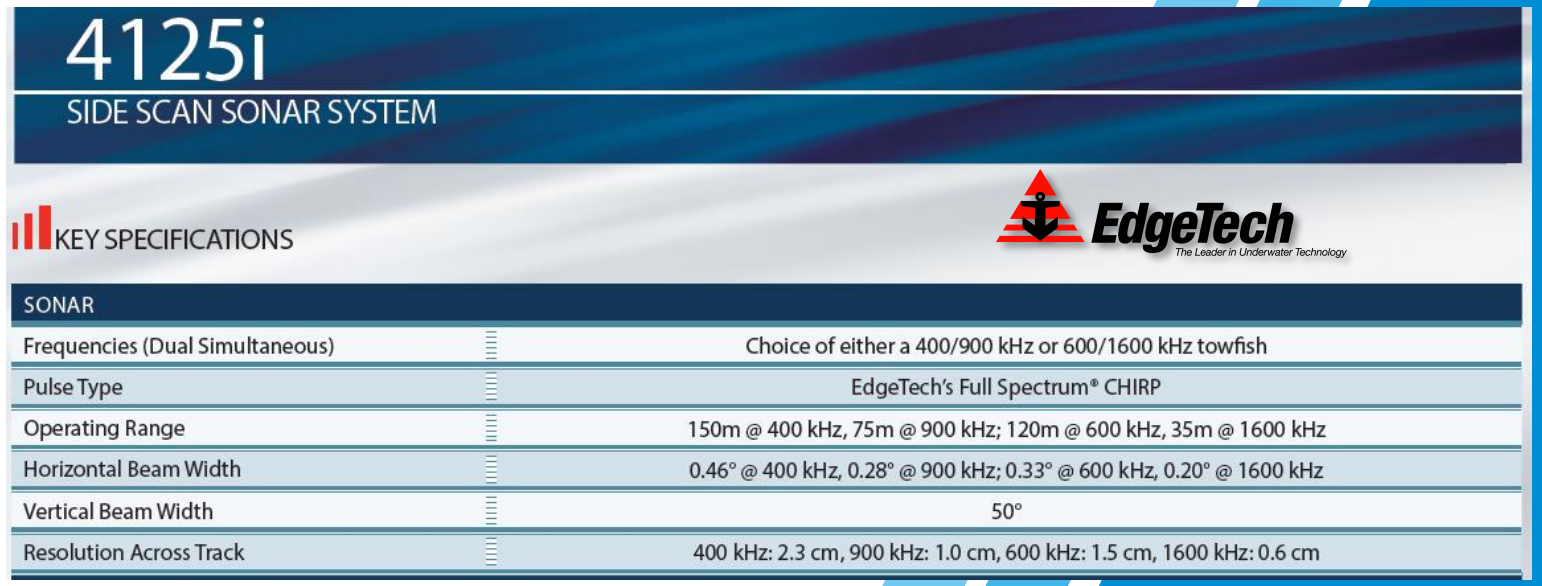
  Validate the integration of the sonar on USV

Equipment selected

EdgeTech
The Leader in Underwater Technology

➢ **Stage 1:**

- Validate the capability of EdgeTech's high-resolution imaging system to detect the finest details of the canal coating layers (concrete layer and bituminous layer);
- Validate the optimal choice of frequency.



4125i

SIDE SCAN SONAR SYSTEM

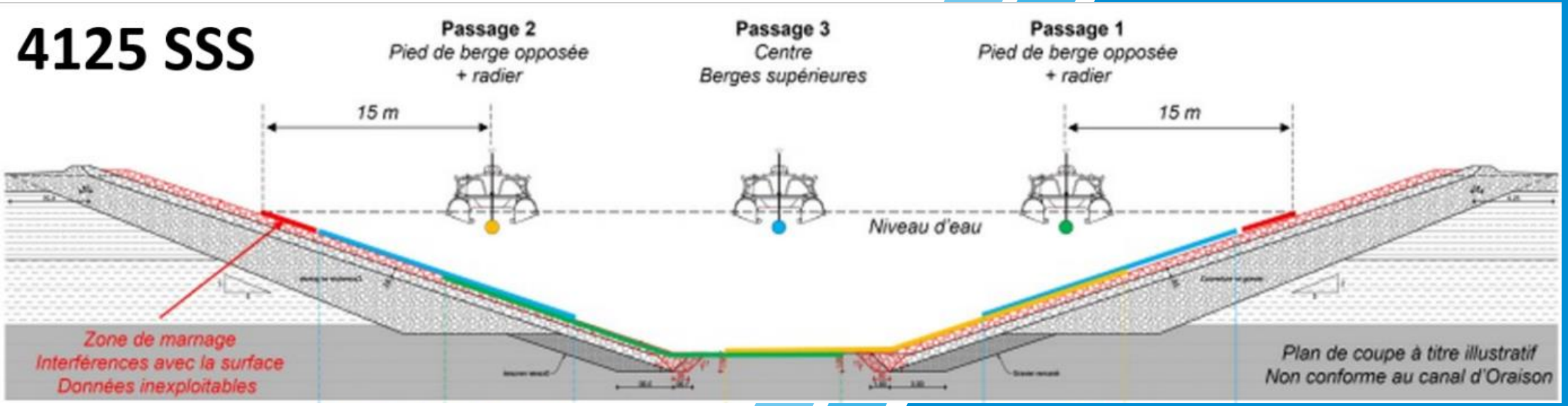
KEY SPECIFICATIONS

EdgeTech
The Leader in Underwater Technology

SONAR	
Frequencies (Dual Simultaneous)	Choice of either a 400/900 kHz or 600/1600 kHz towfish
Pulse Type	EdgeTech's Full Spectrum® CHIRP
Operating Range	150m @ 400 kHz, 75m @ 900 kHz; 120m @ 600 kHz, 35m @ 1600 kHz
Horizontal Beam Width	0.46° @ 400 kHz, 0.28° @ 900 kHz; 0.33° @ 600 kHz, 0.20° @ 1600 kHz
Vertical Beam Width	50°
Resolution Across Track	400 kHz: 2.3 cm, 900 kHz: 1.0 cm, 600 kHz: 1.5 cm, 1600 kHz: 0.6 cm

Acquisition : Discover (EdgeTech)
Processing : Sonarwiz

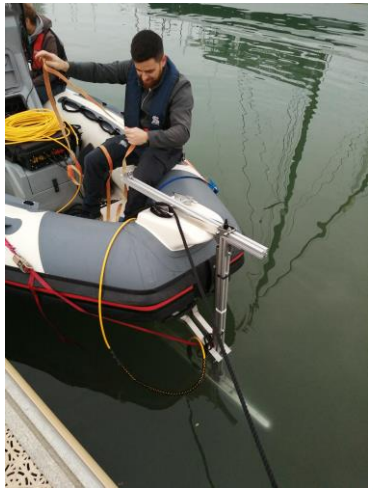
GEOMETRY - 2017 (canal du Rhin) and 2021 (canal de la Durance):



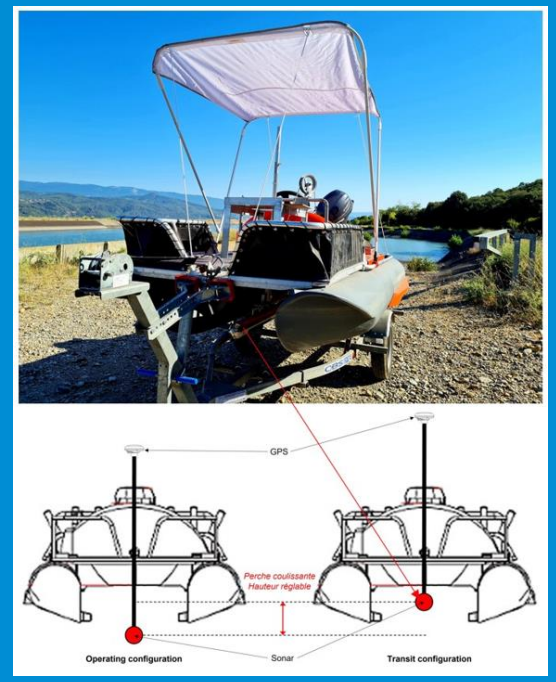
Limitation of a standard side imaging sonar is it's not common to use an accurate Heading sensor, so it can sometimes be tricky to align data from overlapping lines.

Implementation and Validation

2017 (canal du Rhin).



2021 (canal de la Durance).



+	-
Resolution: 2cm	Vessel + Operator
Survey rate: 10km/day	not 3D

➢ **Stage 2:** **2023 (canal de la Durance).**

- **Validate the combined 3D / 2D system**
- **Optimization of the survey lines (number and location in the channel)**

Edgetech 6205S2 + SBG Ekinox

6205 S2

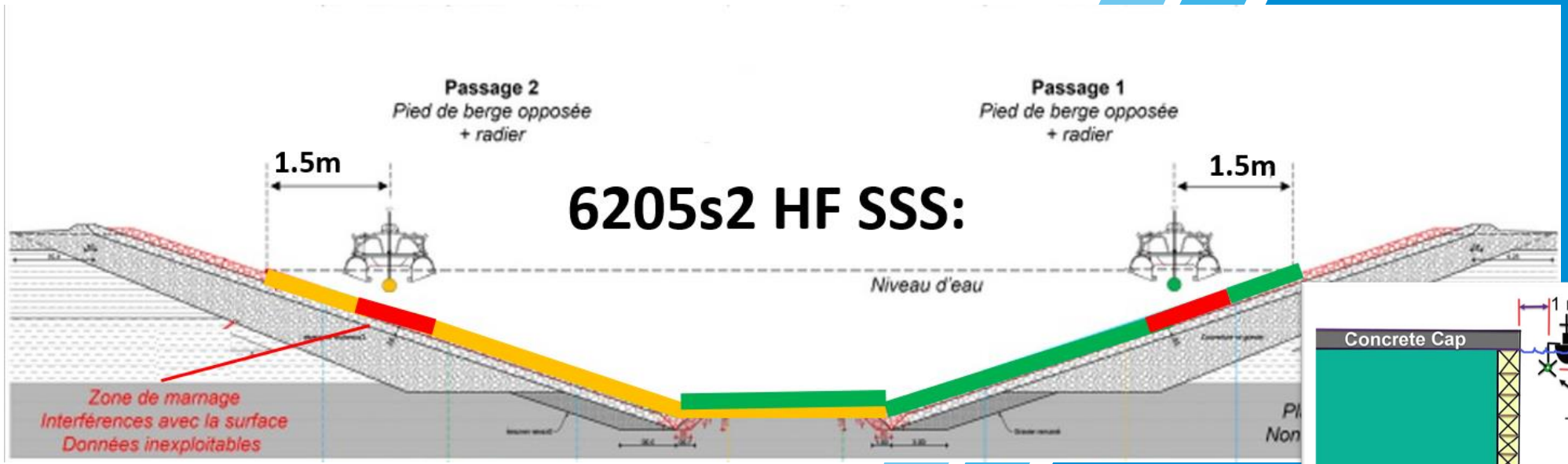
MULTI PHASE WIDE SWATH BATHYMETRY & SIDE SCAN SONAR

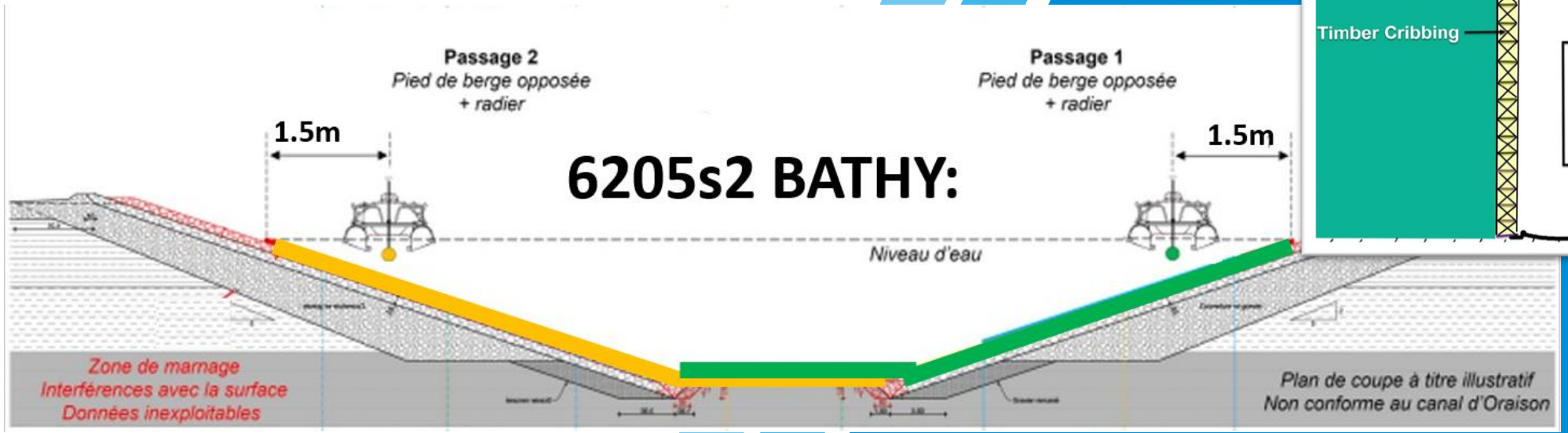
EdgeTech The Leader in Underwater Technology

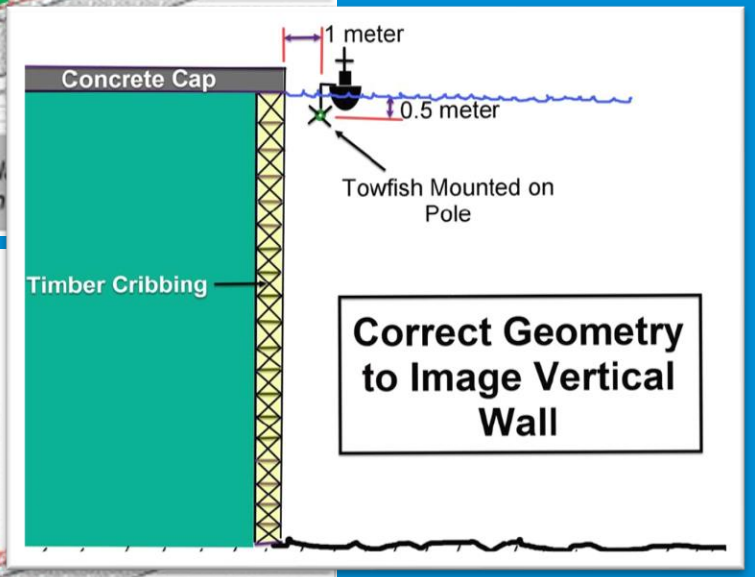
KEY SPECIFICATIONS

BATHYMETRY			
Sonar Frequency	520 kHz		850 kHz
Beamwidths*	1° x 0.5°		1° x 0.4°
Optimal Operating Water Depth**	< 50 m		< 25 m
Max Swath Width***	200 m		75 m
Max Swath Sector	200°		
Max Soundings Per Ping	800		
Sounding Patterns	Equidistant and Equiangular		
SIDE SCAN SONAR IMAGERY			
Frequency	520 kHz	850 kHz	1600 kHz
Horizontal Beamwidth (2-way)	0.36°	0.29°	0.20°
Range Resolution	10 mm	9 mm	6 mm
Max Range**	150 m	75 m	35 m

- **Stage 2:** **2023 (canal de la Durance).**

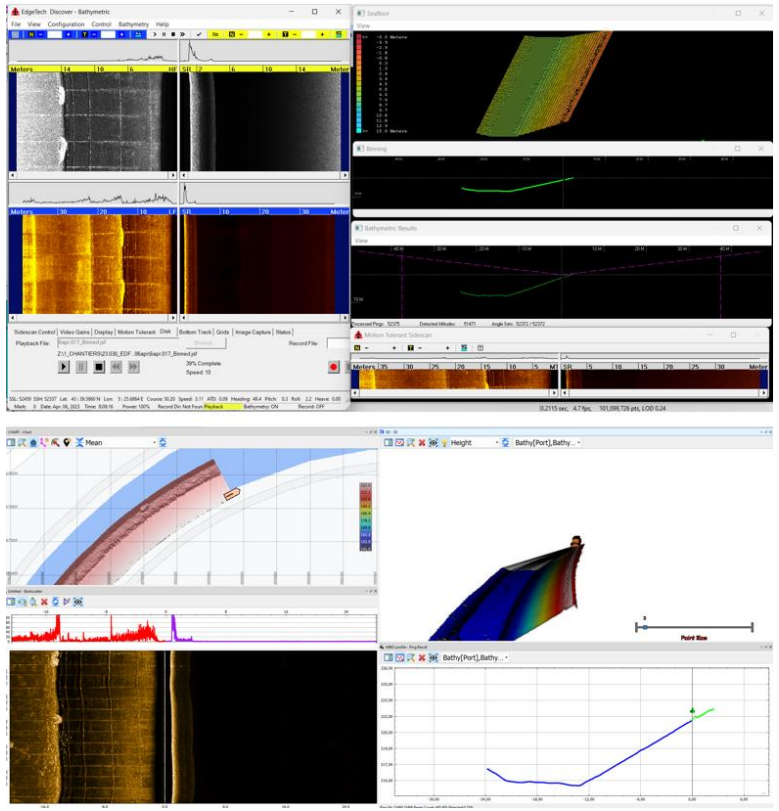




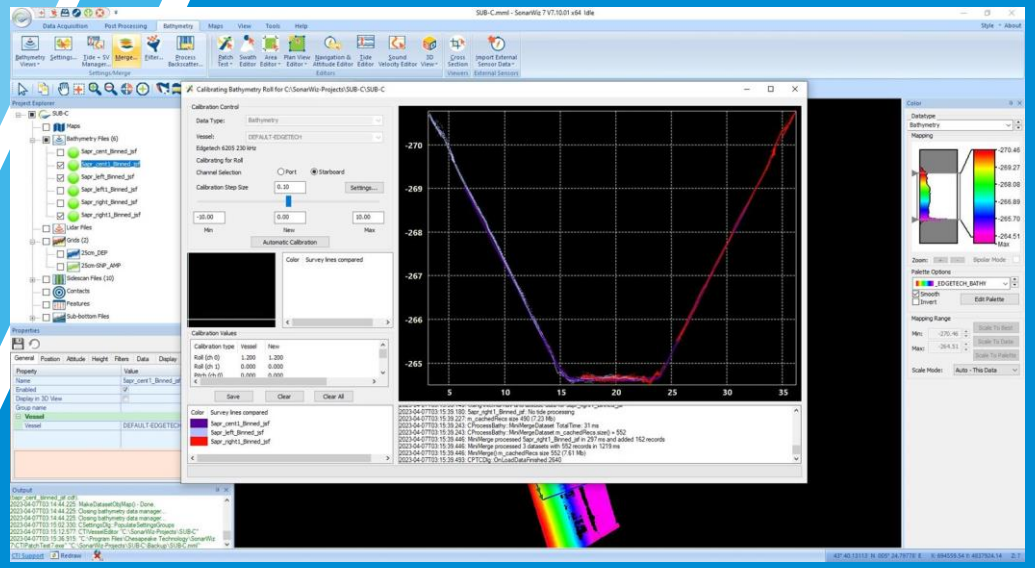


- **Stage 2:** **2023 (canal de la Durance).**

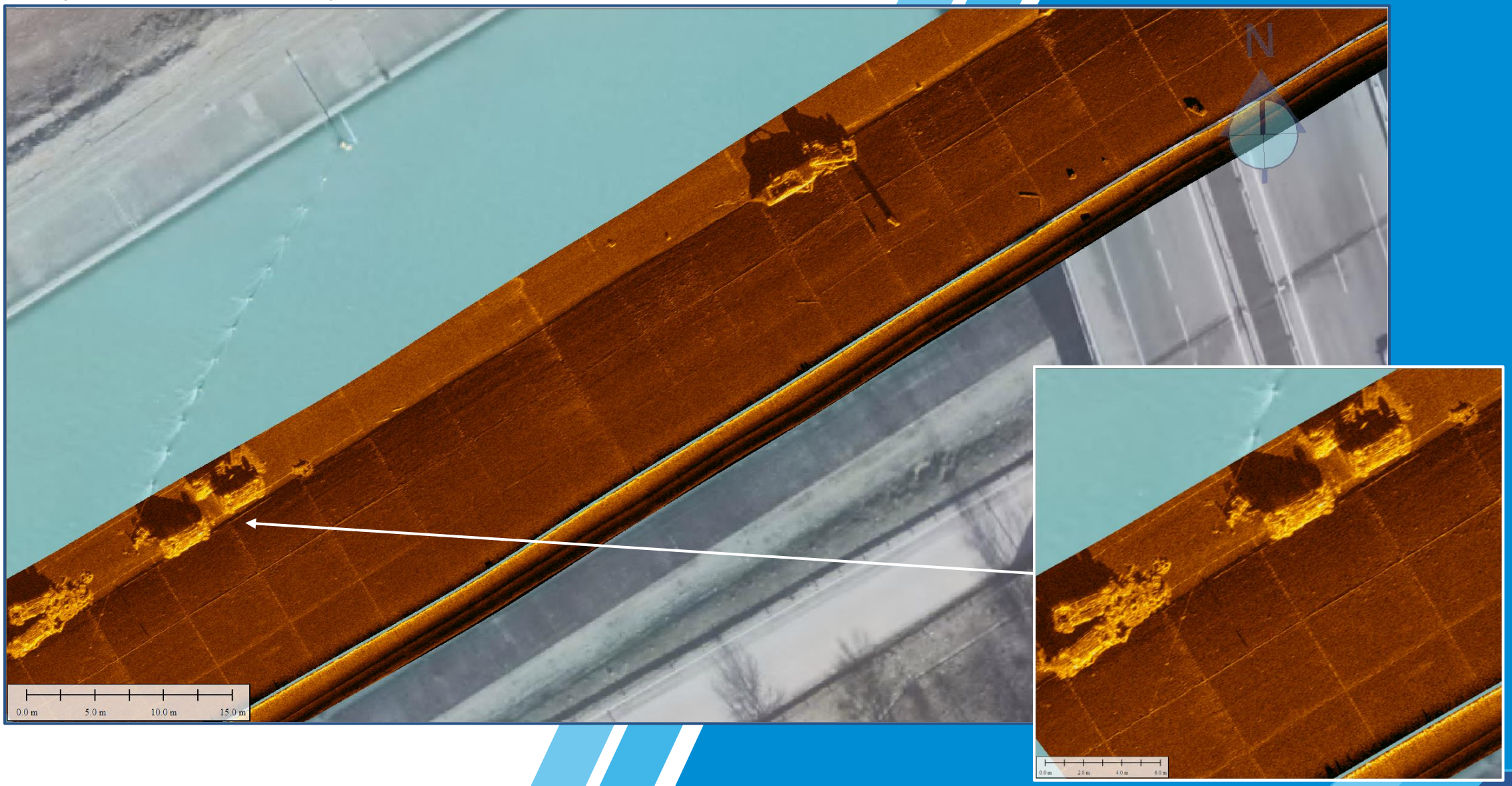
Acquisition : Discover (EdgeTech) and Beamworx



Processing : Sonarwiz (SSS+Bathy)

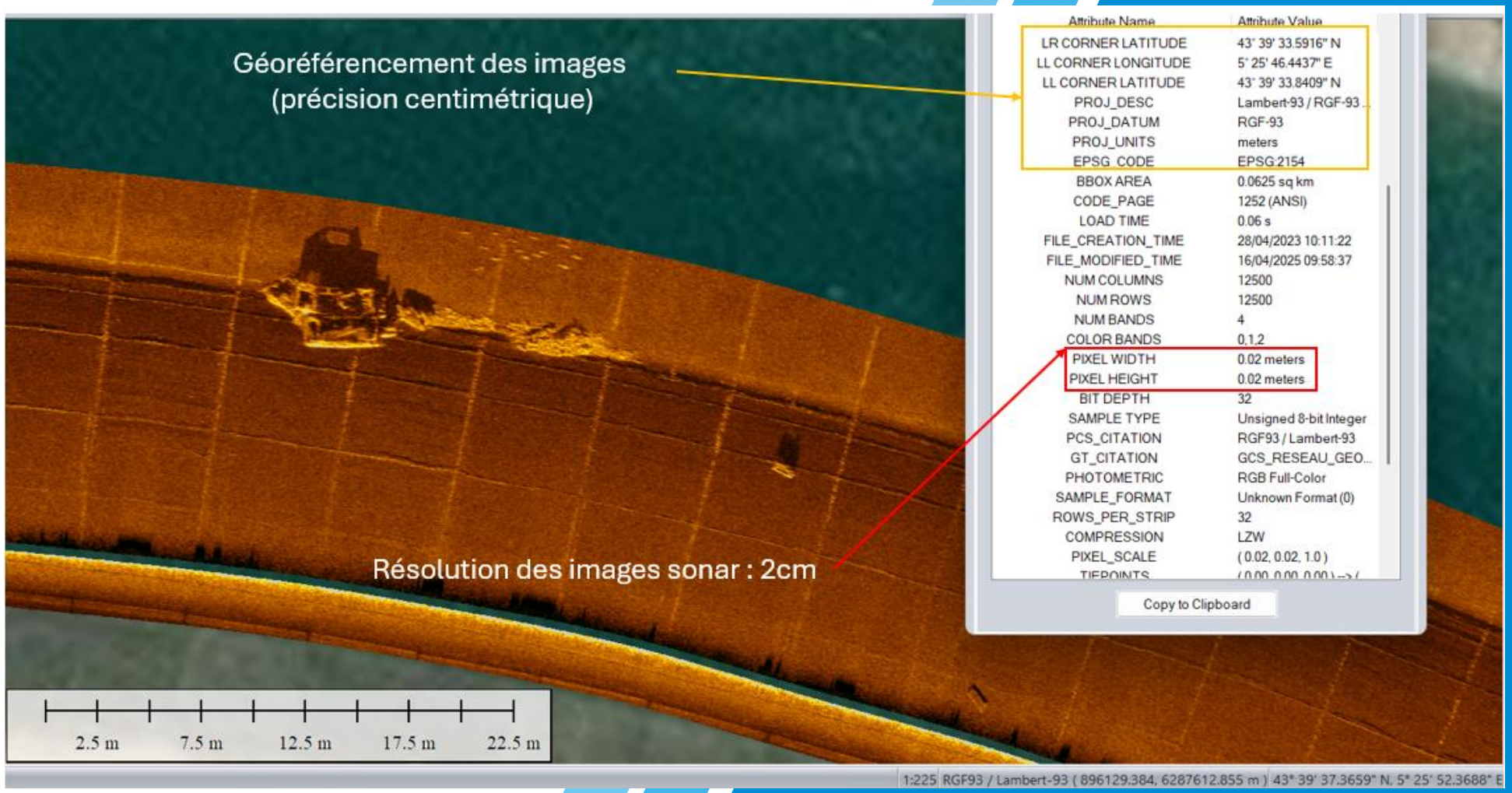


2023 (canal de la Durance).



Implementation and Validation

- **Stage 2:**



- **Stage 3:**

  Validate the integration of the system on a USV

EdgeTech 2205 + SBG Equinox

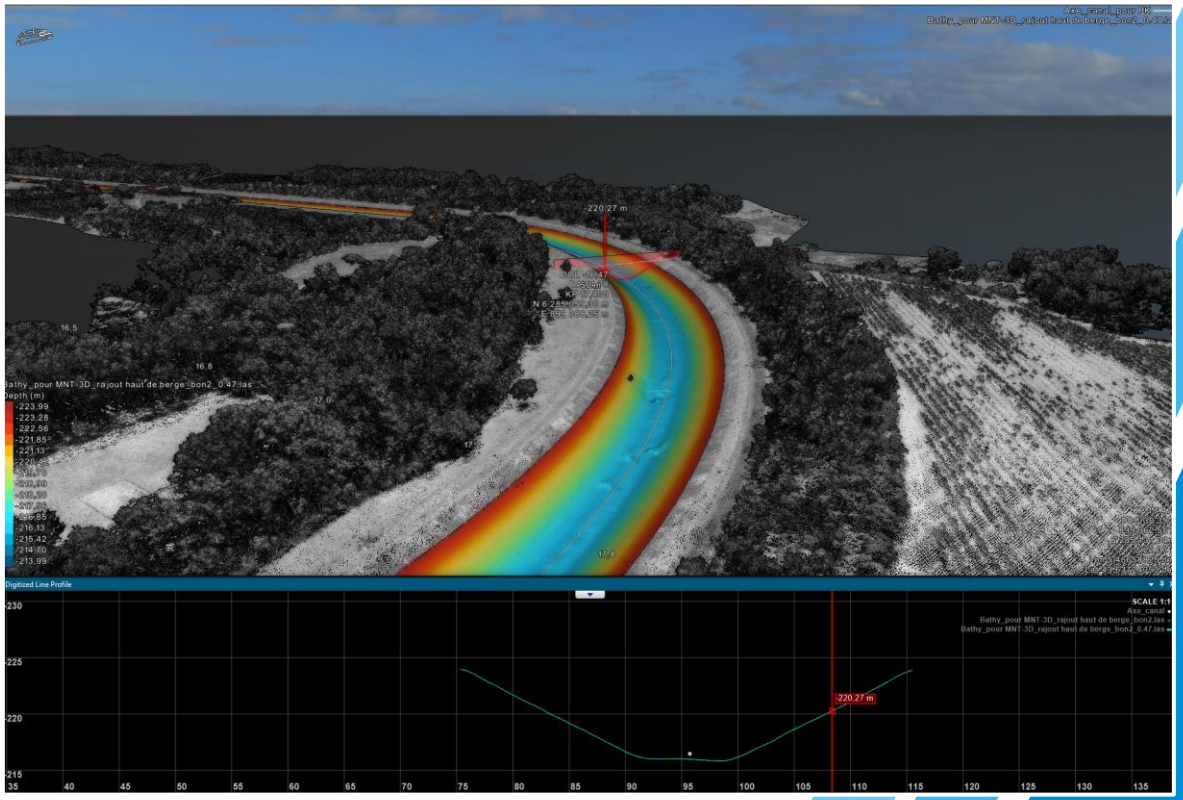
EdgeTech The Leader in Underwater Technology

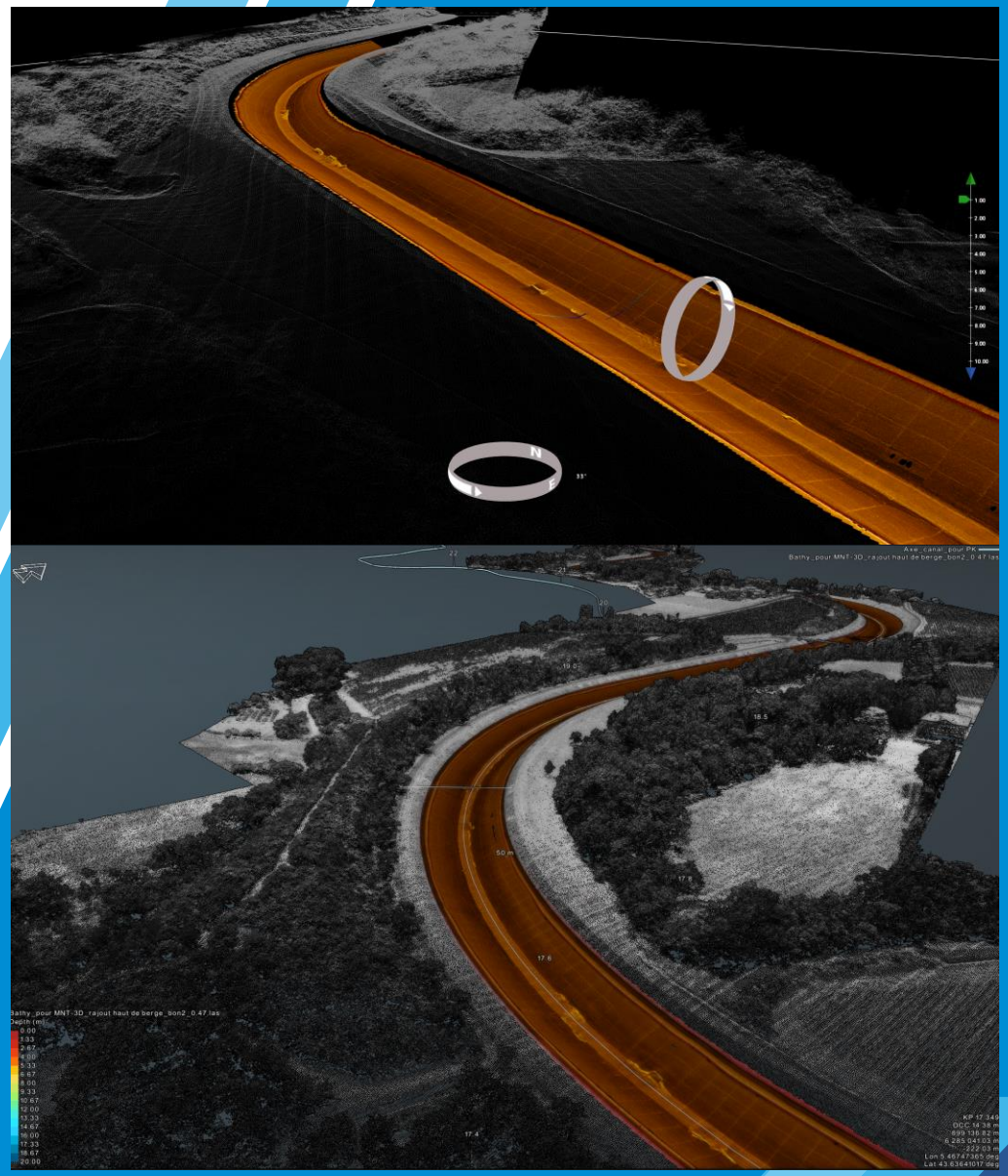
BATHYMETRY			
Sonar Frequency	520 kHz		850 kHz
Beamwidths*	1° x 0.5°		1° x 0.4°
Optimal Operating Water Depth**	< 50 m		< 25 m
Max Swath Width***	200 m		75 m
Max Swath Sector	200°		
Max Soundings Per Ping	800		
Sounding Patterns	Equidistant and Equiangular		
SIDE SCAN SONAR IMAGERY			
Frequency	520 kHz	850 kHz	1600 kHz
Horizontal Beamwidth (2-way)	0.36°	0.29°	0.20°
Range Resolution	10 mm	9 mm	6 mm
Max Range**	150 m	75 m	35 m

Teledyne Z-Boat

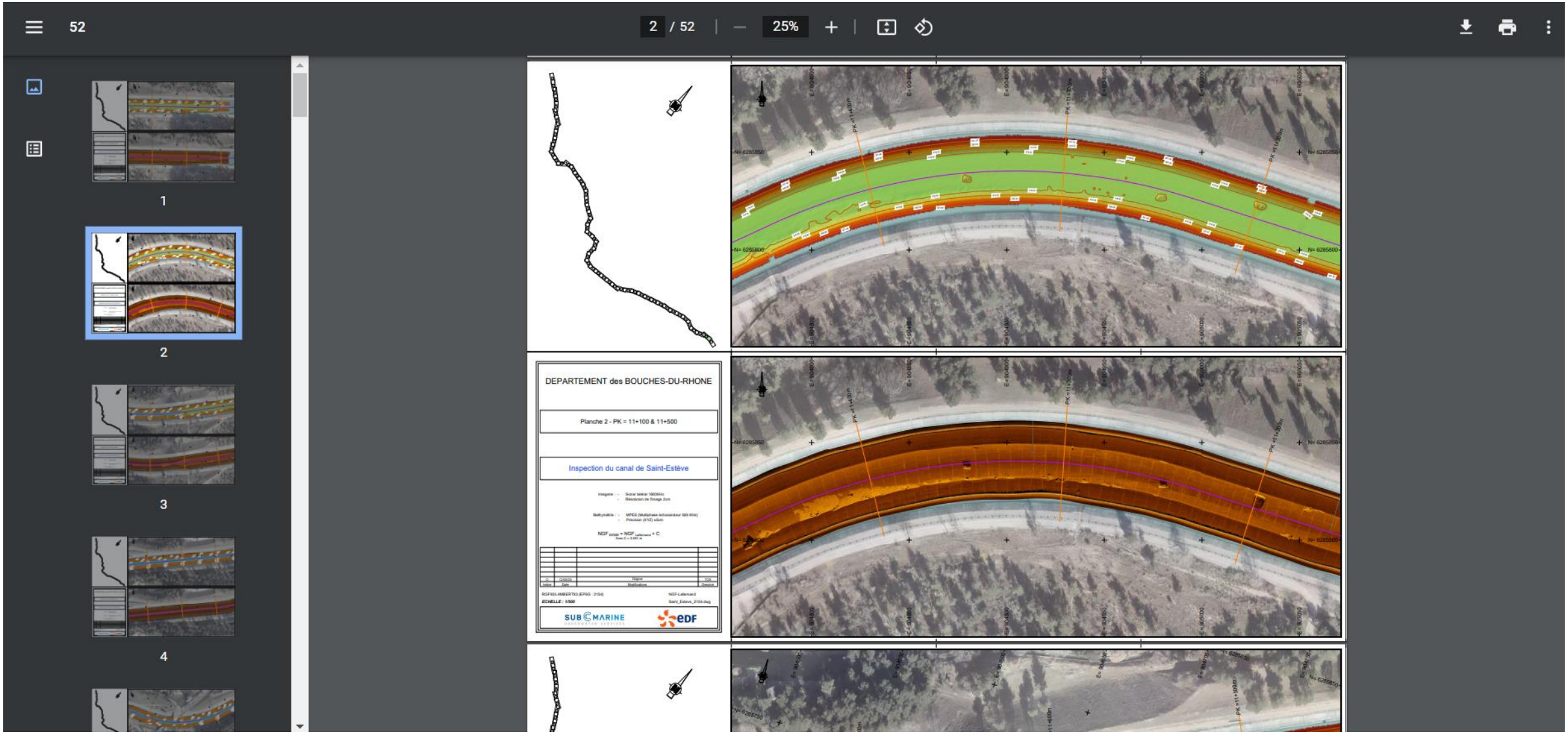
2023 (canal de la Durance).

+	-
Resolution : 2cm	
Rate of data collection	Autonomy
3D (bathymétrie)	





Data Delivered



CONCLUSION

Deploy a system capable, in turbid water, to carry out an inspection over a large area in a minimum amount of time, providing precise 2D and 3D data (accurate to within a few centimeters) over several tens of kilometers.

MPES technology combines high resolution imagery with bathymetry

- Georeferenced image restitution with 2cm resolution
- Geo-location of faults using 3D (bathymetric data) with an accuracy of +/- 5cm
- Over a long distance (several tens of km)
- Ensuring operator safety (USV)

Merci de votre attention

SUB C MARINE
UNDERWATER SERVICES

EdgeTech
The Leader in Underwater Technology

Partners for your inspection works

SUB-C MARINE

https://subcmarine.com/

contact@subcmarine.com