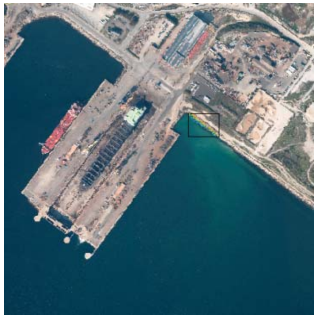
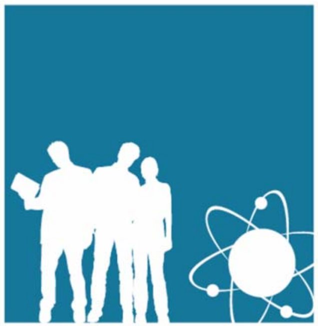
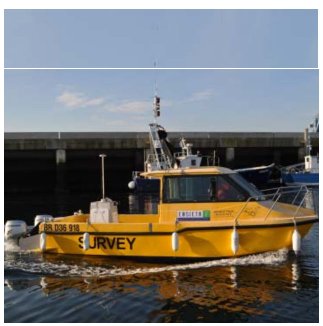






chc2010

Multibeam Echosounder Errors Characterization on Dumped Rocks Areas

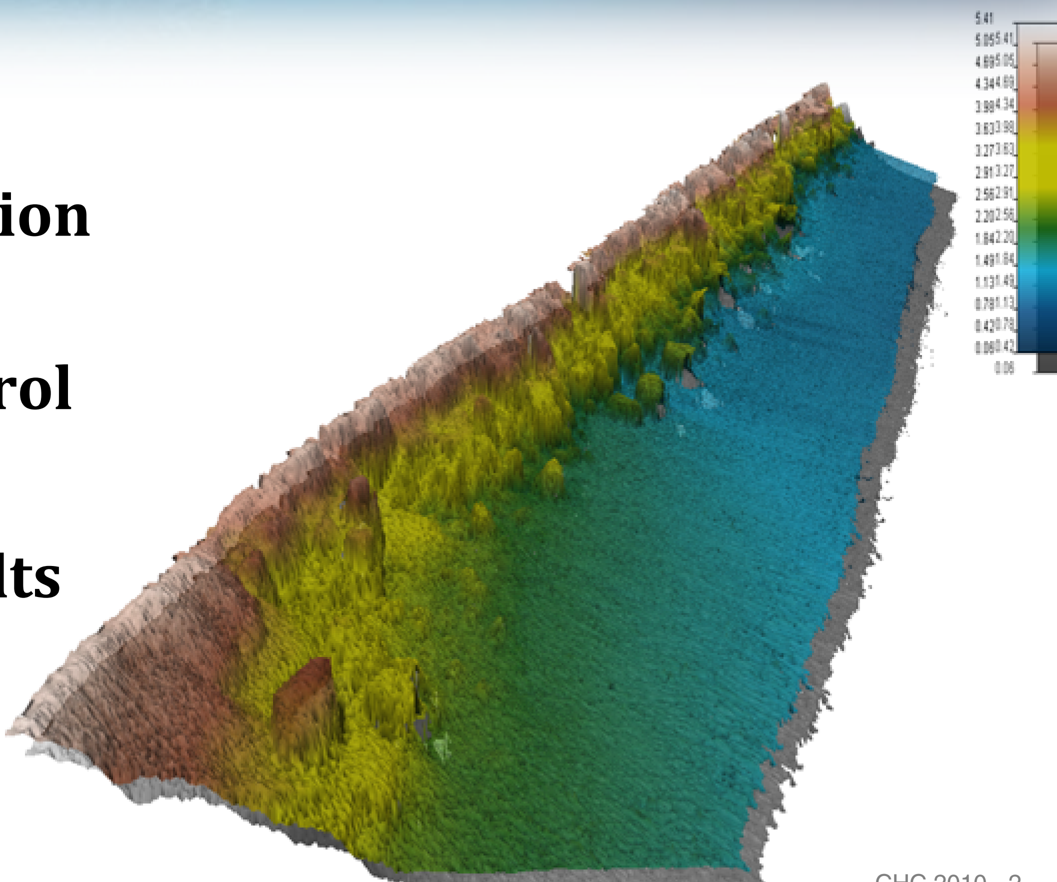
N. Debese[*], L. Heydel[**], T. Neumann[***], N. Seube[*]

ENSIETA
ÉCOLE NATIONALE SUPÉRIEURE D'INGÉNIEURS

* ENSIETA
** IGN
*** BOSKALIS

OUTLINES:

- Introduction
- Datasets description
- Data quality control
- Comparison results
- Conclusion



- Boskalis observation:

  filling up the hole between rocks with concrete was ten centimeter higher than the expected results from the dumped rock survey

- Investigation of systematic depth error made in surveying dumped rocks areas with MBES

  These errors may induce:

  - Dangers for navigation in very shallow water areas
  - Huge costs for coastal engineering contractors who performs rock dumping operation

- Analysis of four different MBES systems

  Comparison to a reference digital terrain model obtained from a fixed 3D laser scanner




- MBES survey systems

SIMRAD EM3002

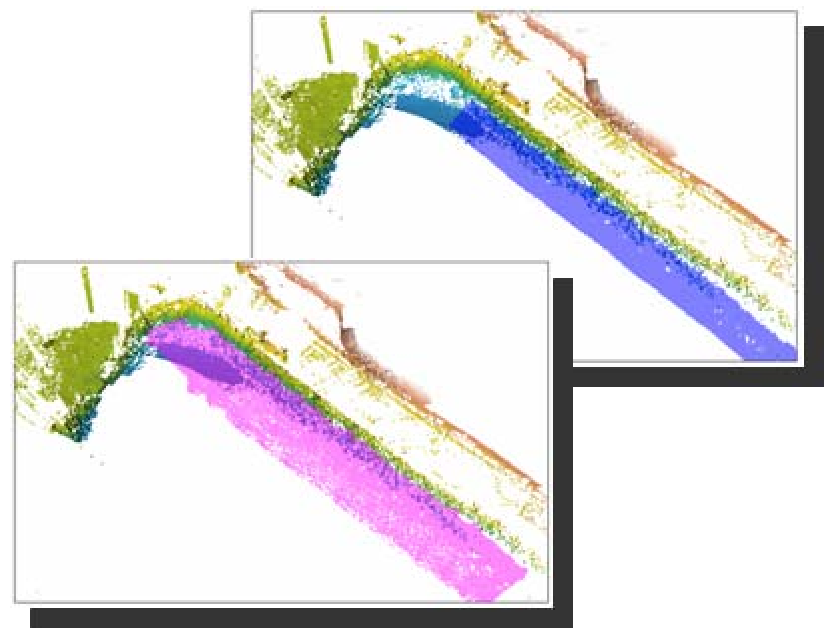
Reson 8101

Sonic 2024

Tritech Horizon

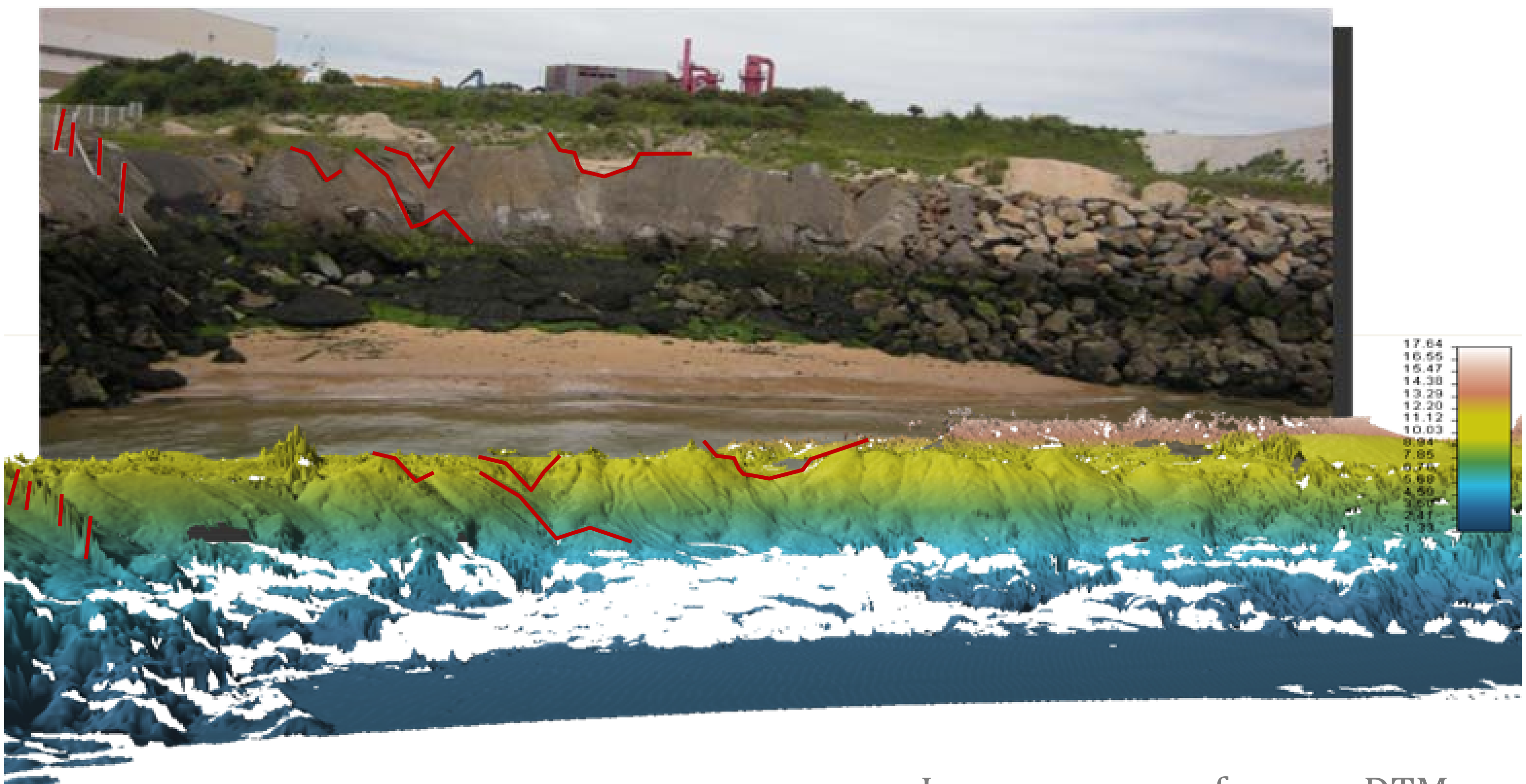
Leica HDS6100
Laser

- installed on the quay in front of the rocky area.



Swath line	Sounding number	Mean density (number of soundings per meter square	Swath number
EM3002	2 060 137	1 290	3
Reson 8101	1 279 735	493	4
Horizon	5 684 552	3 337	12
R2sonic	1 549 953	634	2
Scanner 3D	685 745	448	-

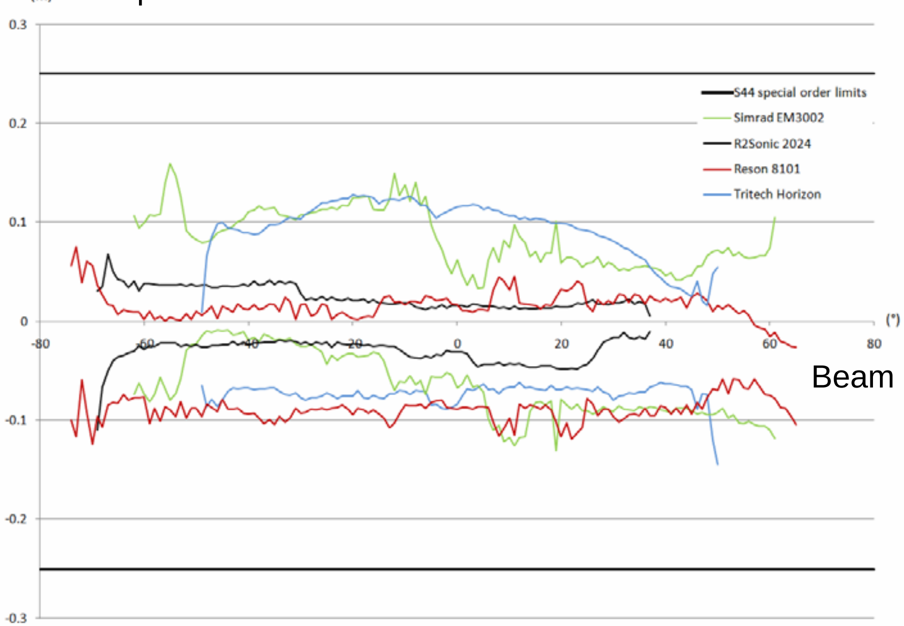
MBES swathes versus Laser Scanner DTM on the beach



Laser scanner reference DTM

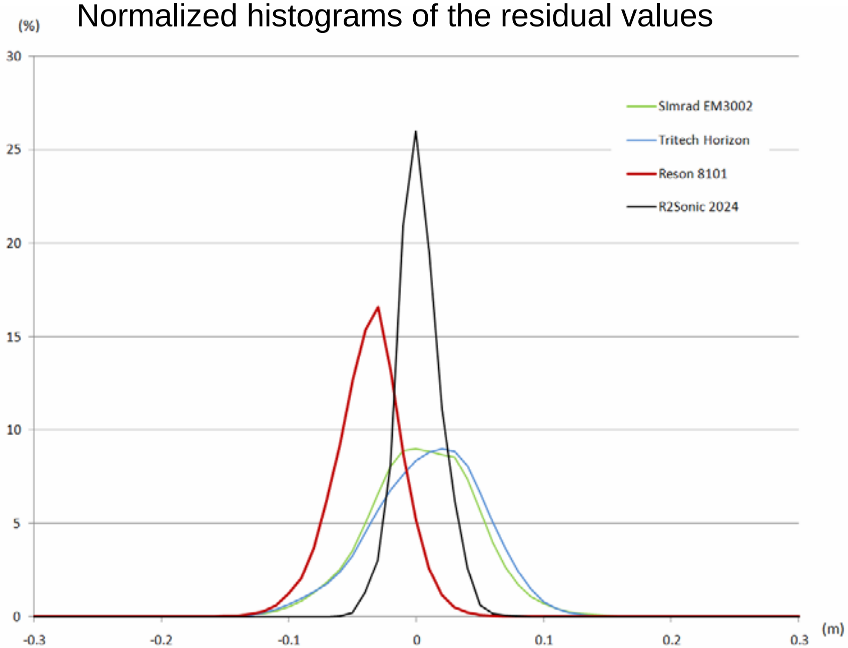
MBES performances results

Depth uncertainties at the 95% confidence level

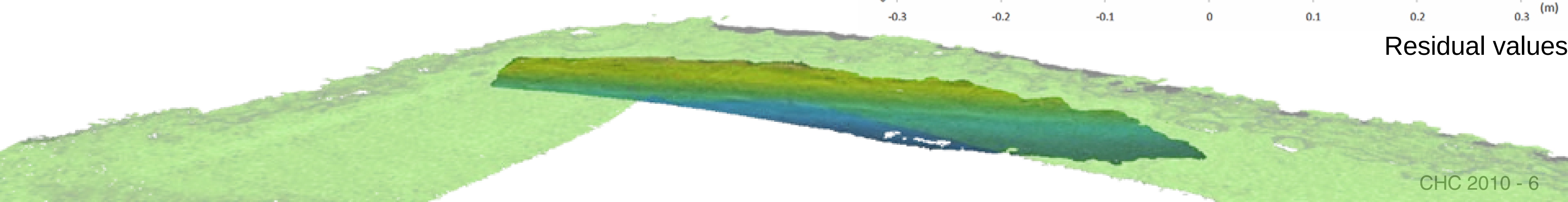


Beam angles

Normalized histograms of the residual values



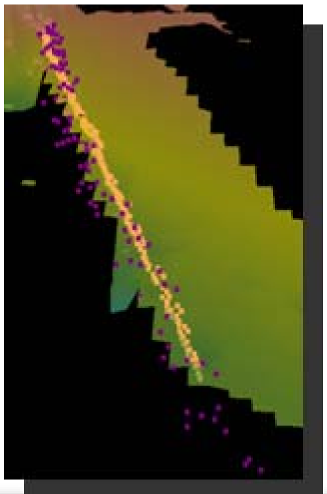
Residual values



Tests were carried out on a concrete beam

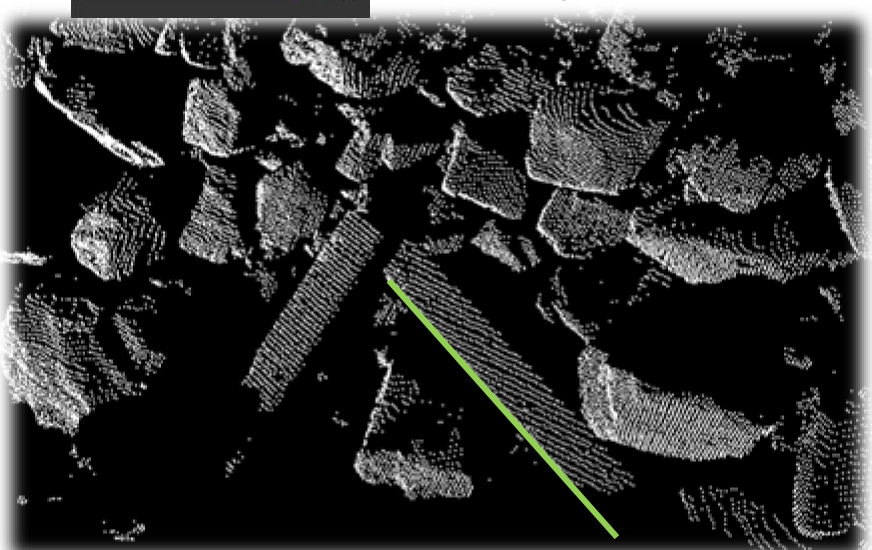
A straight line was fitted to the laser soundings belonging to this front using a least square procedure

X and Y distances between nadir beam MBES soundings and the reference line were then computed



soundings from one MBES swath

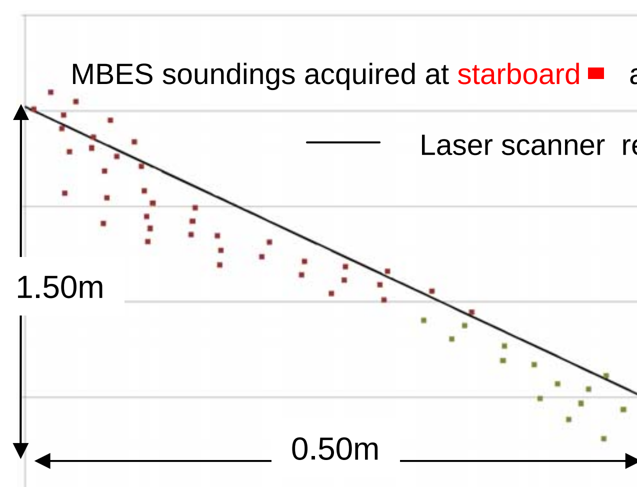
Laser scanner soundings



Statistics based on 9 datasets

Mean values: $(\Delta x, \Delta y) = (-2.2\text{cm}, -0.7\text{cm})$

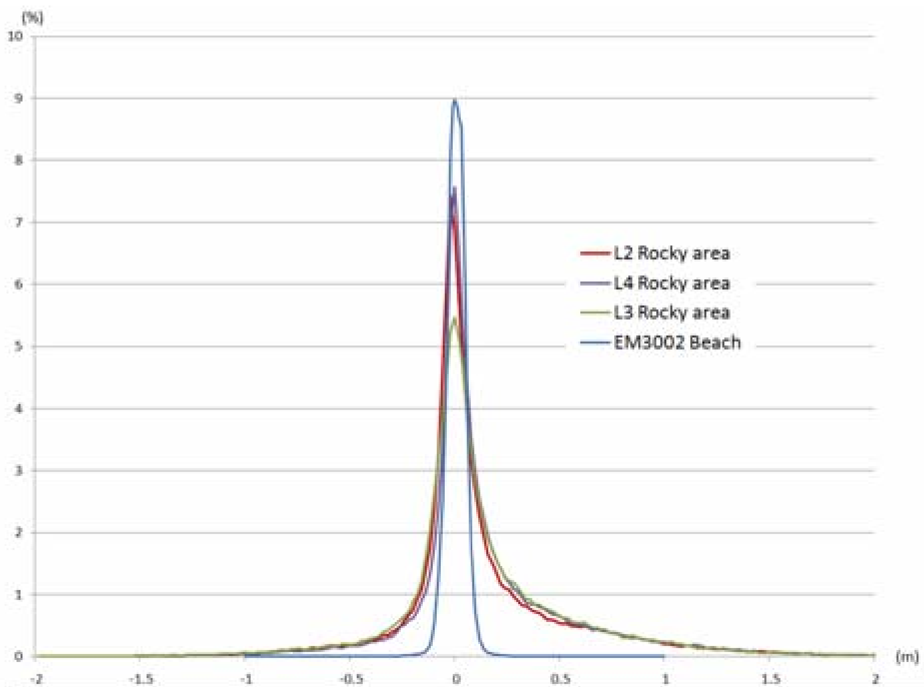
Standard deviations: $(\sigma_{\Delta x}, \sigma_{\Delta y}) = (2.8\text{cm}, 0.9\text{cm})$



MBES sounding datasets compared to the laser scanner reference DTM: EM3002 example

The tendency is the same **whatever the swath**:

Normalized histograms of the residual values – EM3002 swathes

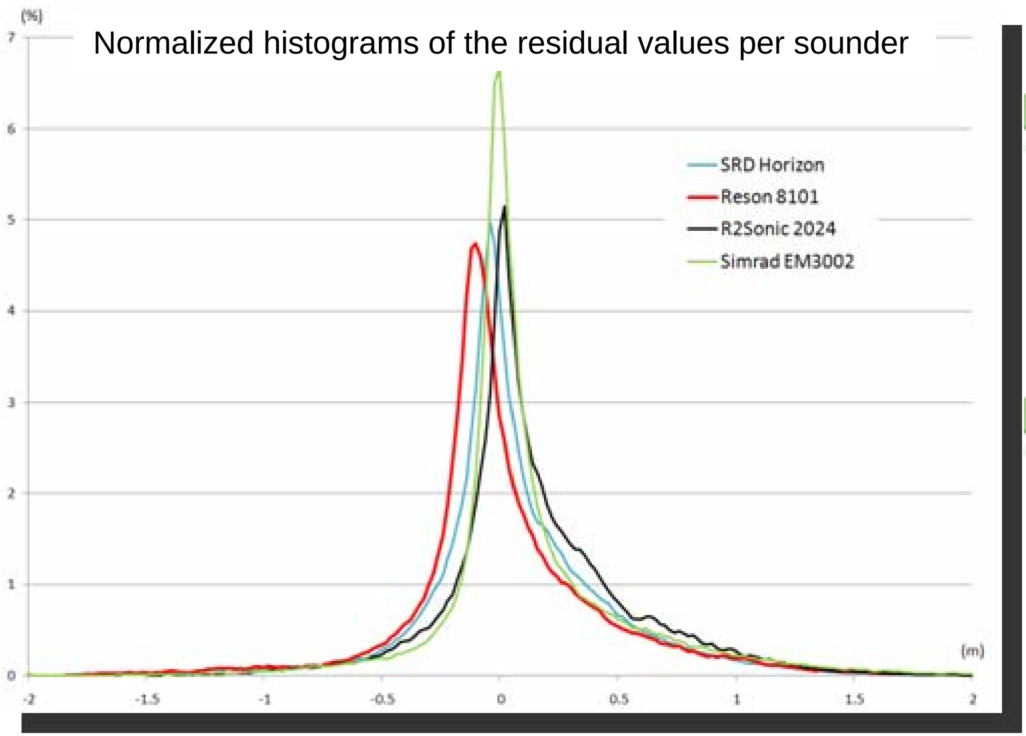


- Compared to the histogram obtained on the beach area, the distribution of the residual values is **asymmetric**

- Positive residual values are in large number meaning that **MBES soundings are deeper** than the scanner laser DTM

MBES sounding datasets compared to the laser scanner reference DTM

The tendency is the same **whatever the sensor**:



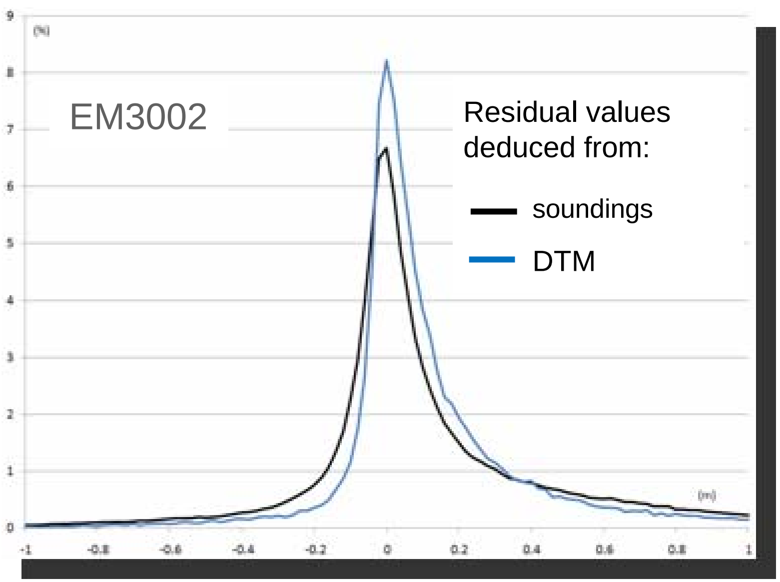
Asymmetric distributions, more or less noticeable depending on the echosounder

The positive residual values can reach **70%**

Global statistics

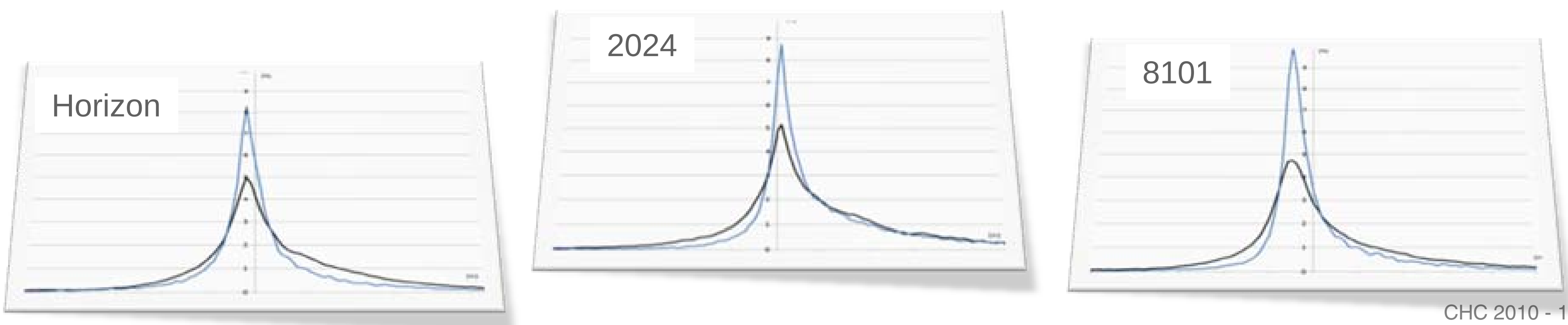
DTM impact on the seabed analysis

Normalized histograms of the residual values



DTM were built from each MBES dataset using a grid cell size of 5cm

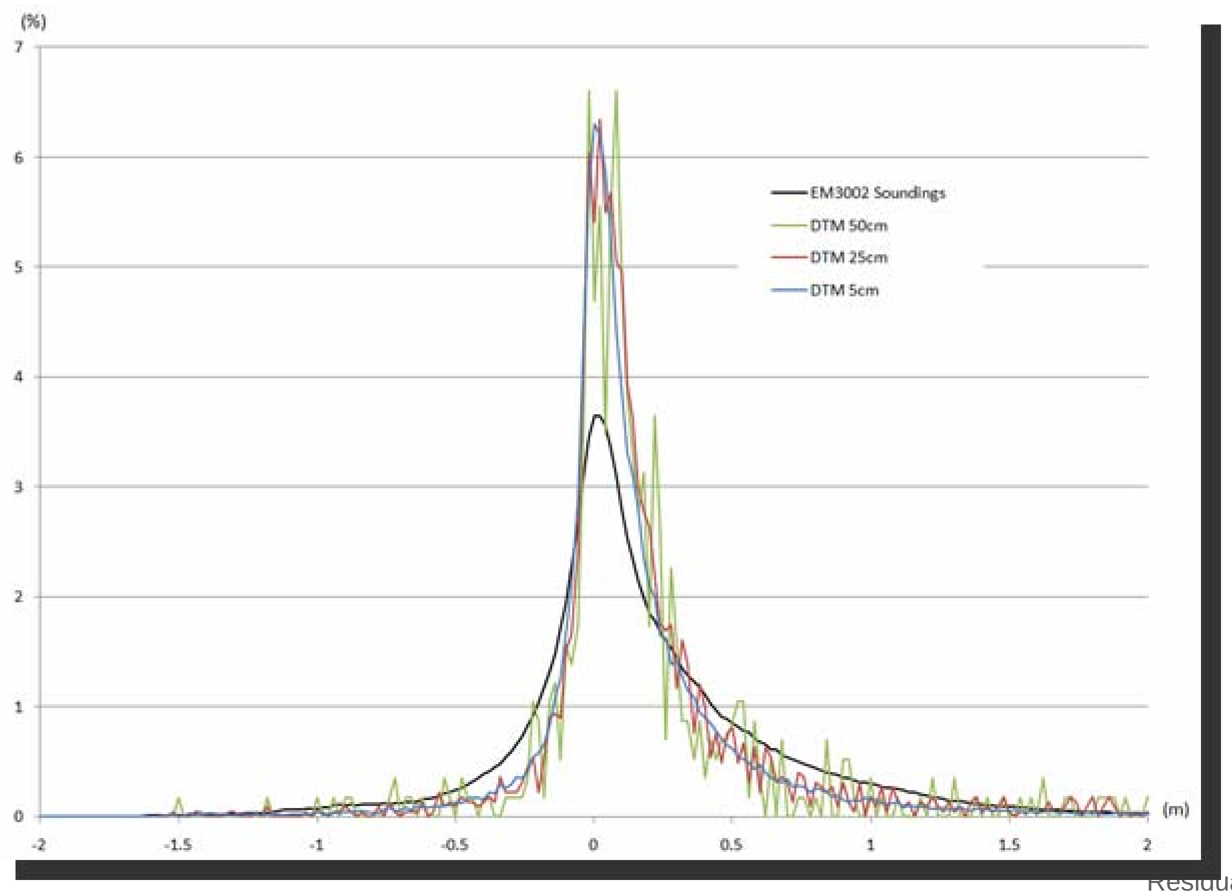
Differences between each of the MBES DTM and the laser scanner reference DTM were computed measuring the interpolator impact



Global statistics

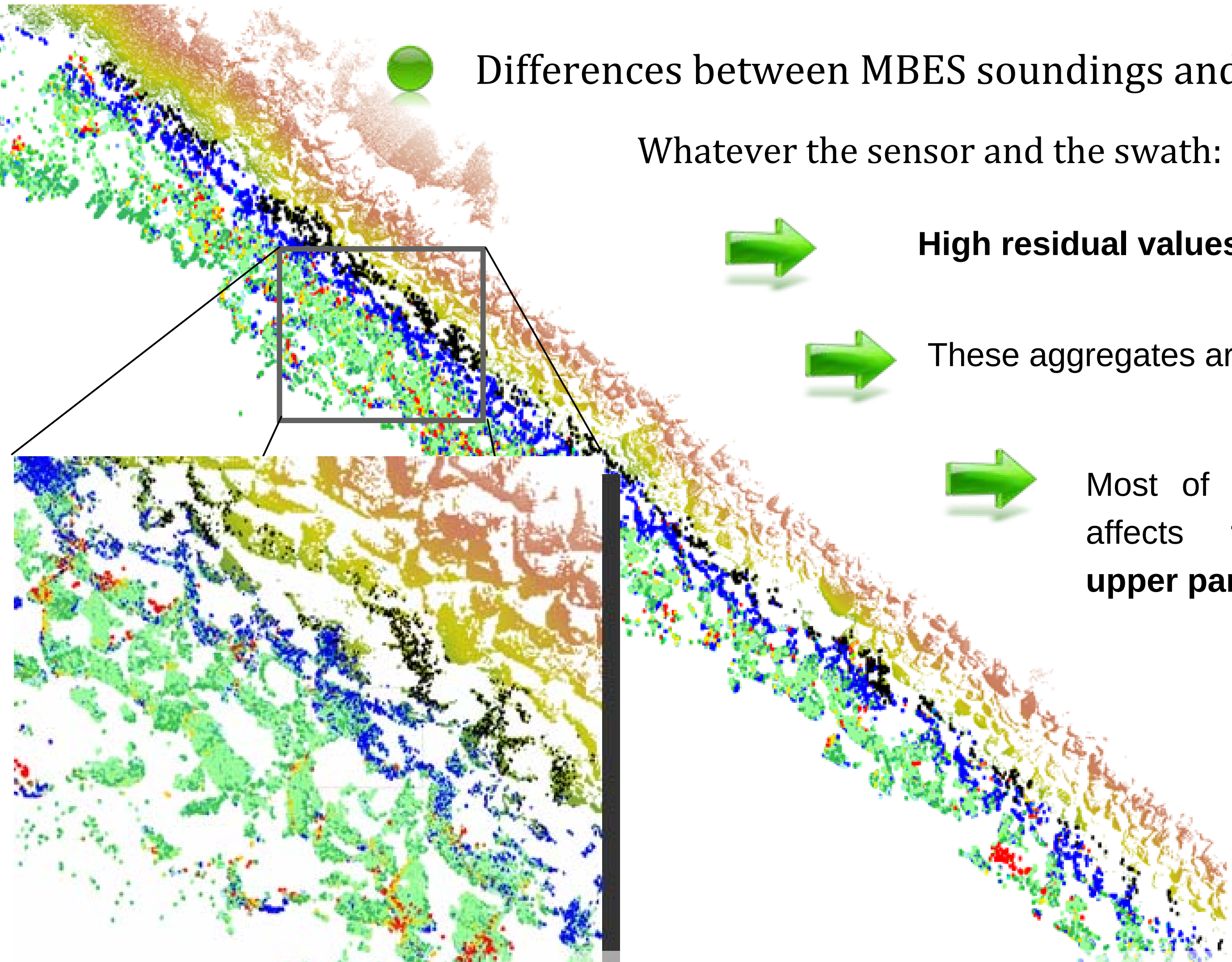
Impact of the grid cell size on the DTM analysis

Normalized histograms of the residual values – EM3002 swathes



Residual values

Residual values map



- Differences between MBES soundings and the scanner laser DTM

  Whatever the sensor and the swath:

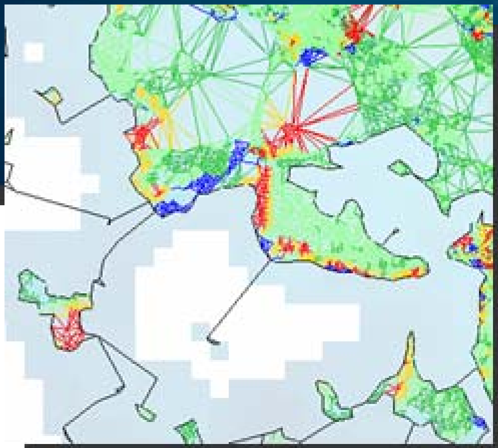
  - **High residual values** are grouped in **aggregates**
  - These aggregates are located **around the rocks**
  - Most of the higher residual values affects **the outer beams,** on the **upper part of the slope**

Color coding scheme

$z_{MBES} - z_{DTM}$

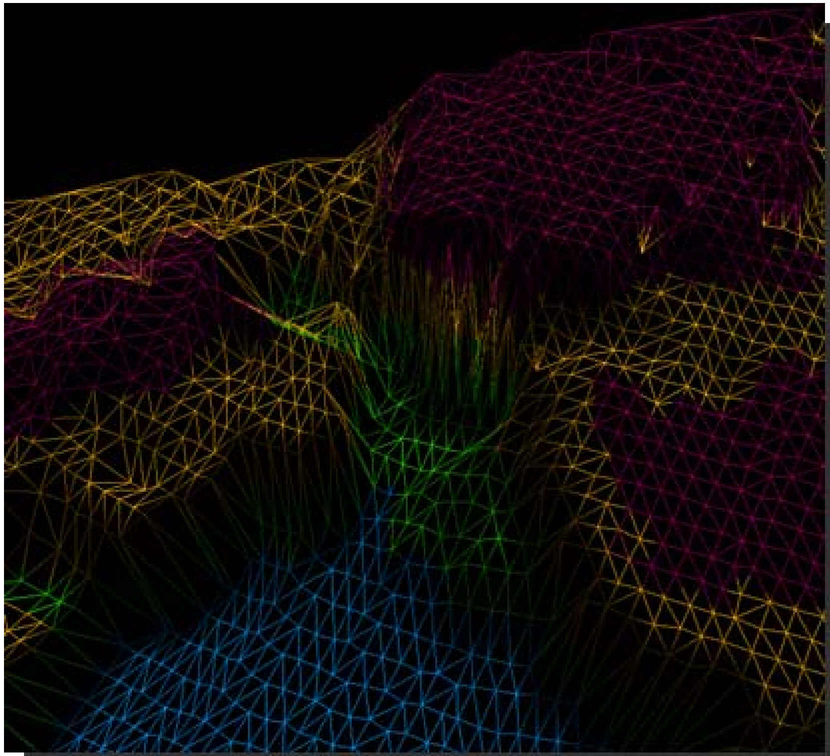
-2	-0.5	red
-0.5	-0.25	yellow
-0.25	0	light green
0	0.25	green
0.25	0.5	light cyan
0.5	3	blue

Residual values map: all the swathes are taken into account

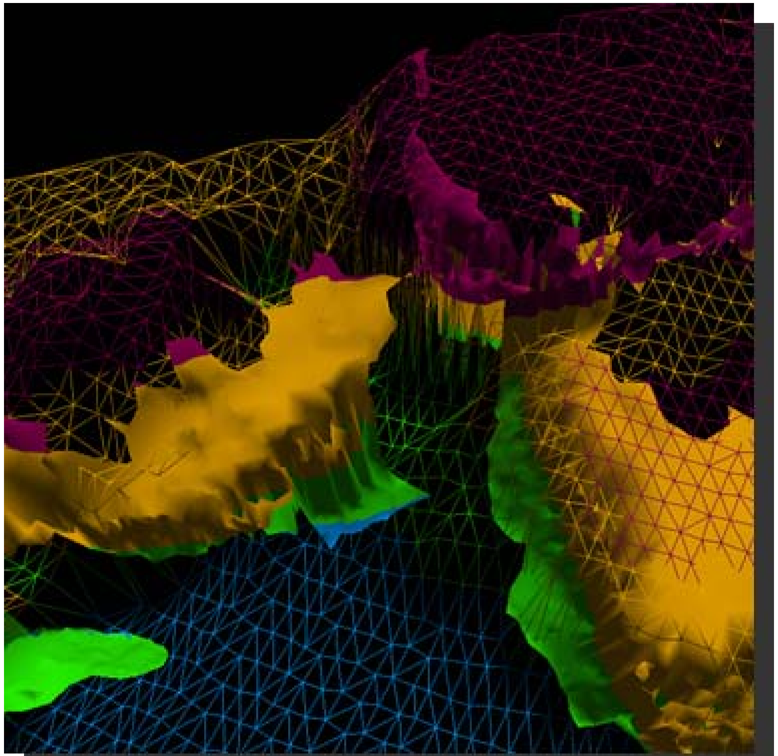


Local analysis

Aggregates of high residual values may be explained by the lack of scanner laser soundings



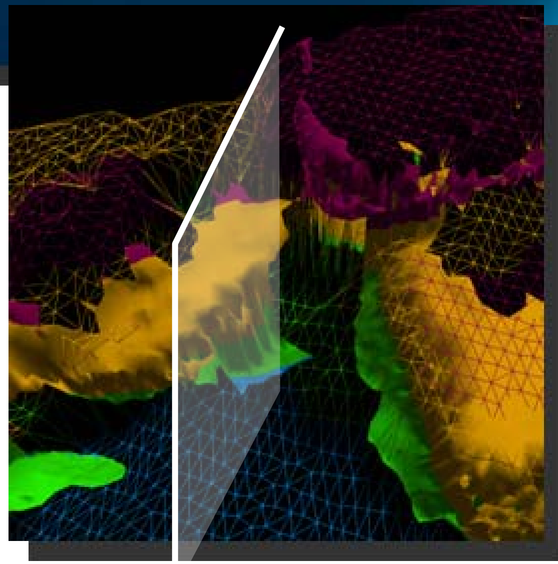
3D representation of the TIN built from EM3002 soundings



The Laser scanner TIN – represented in shaded surface - was superimposed to the TIN

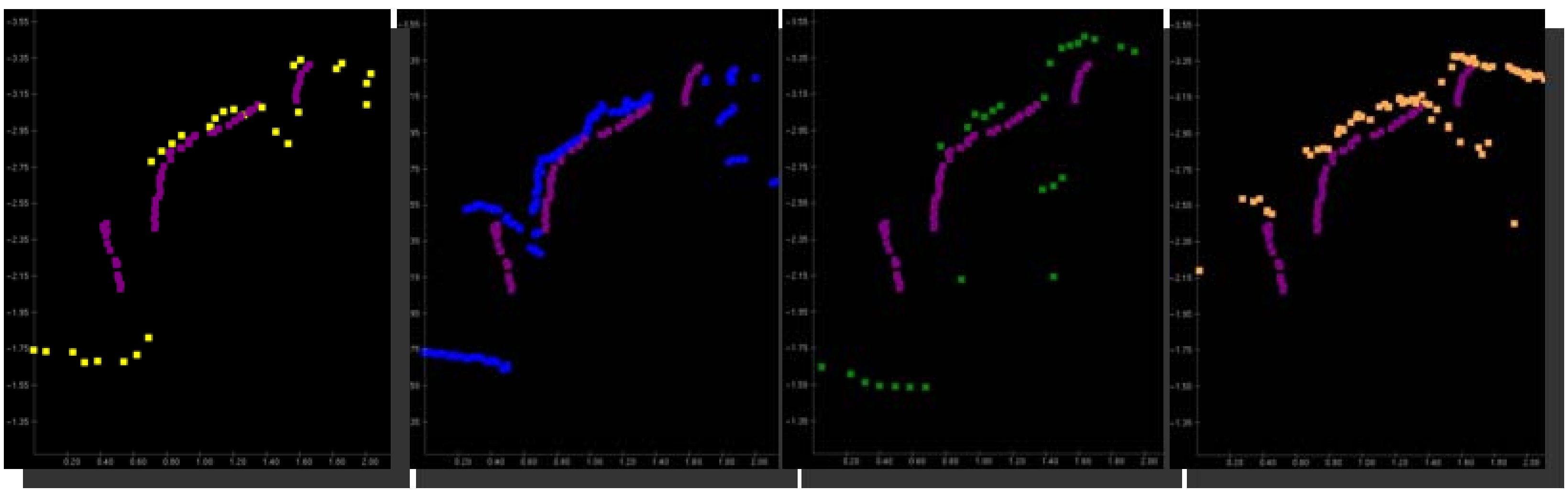
ENSIETA
ÉCOLE NATIONALE SUPÉRIEURE D'INGÉNIEURS

Local analysis

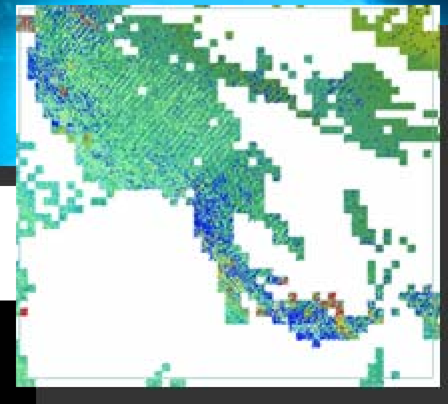


Nevertheless, rocks description differs from one MBES to others

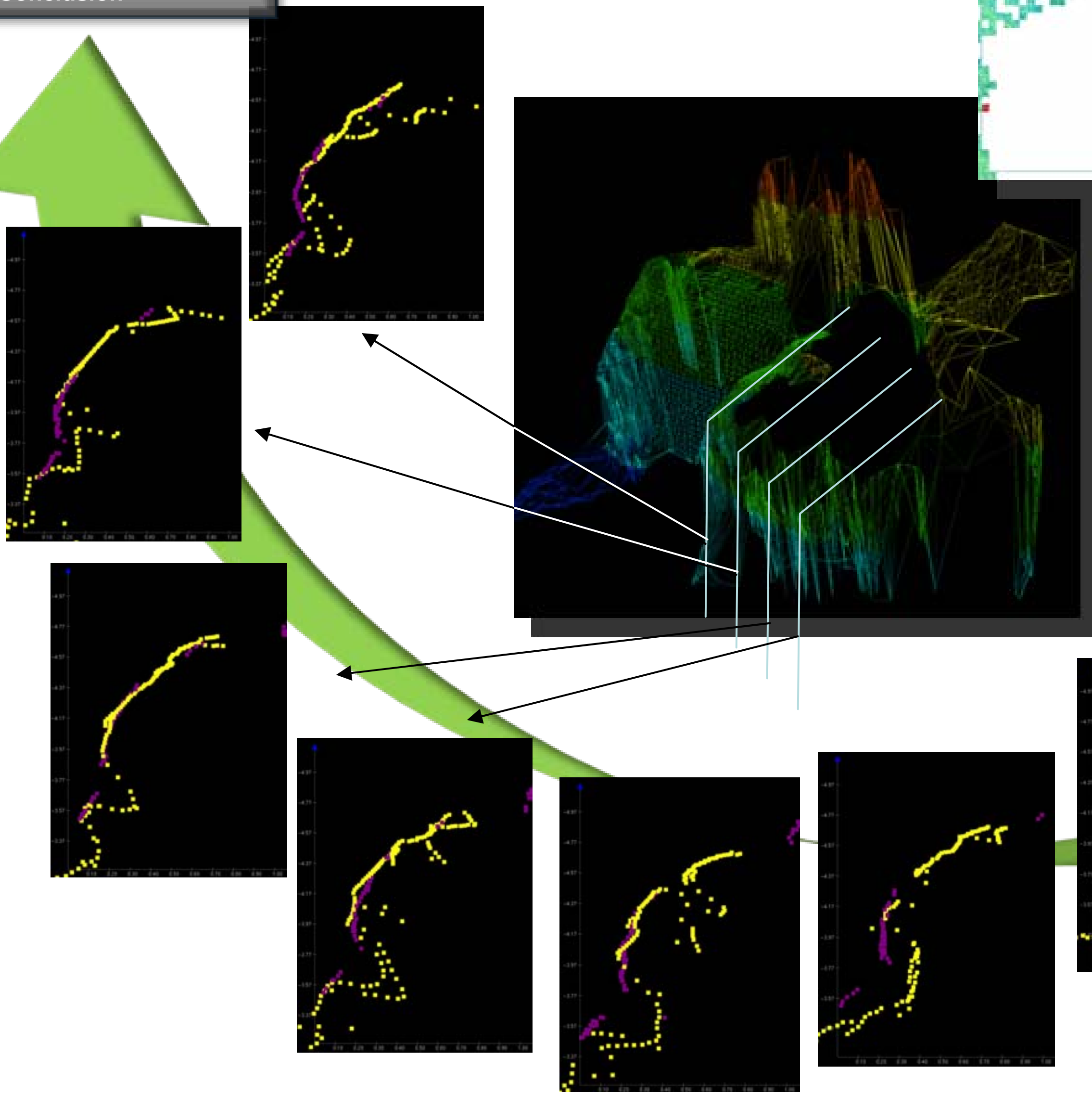
Profile across the rock:



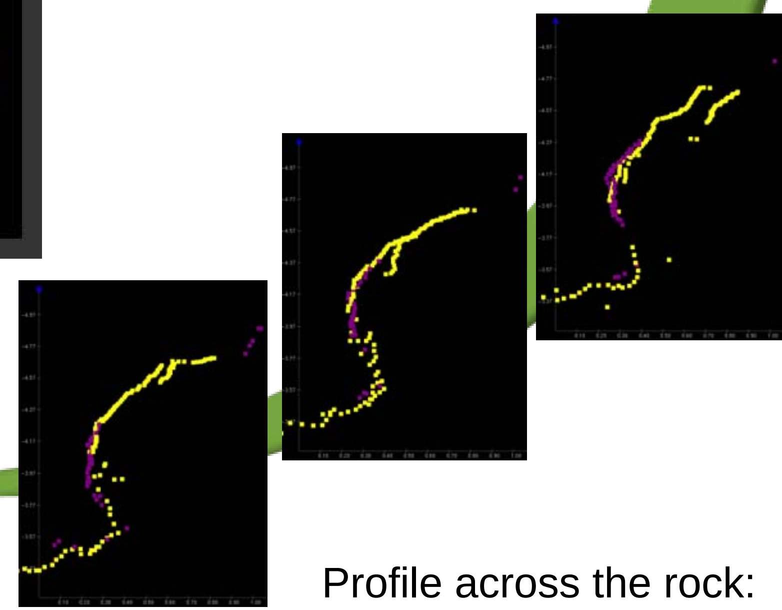
EM3002 soundings
2024 soundings
8101soundings
Horizon soundings
Laser scanner soundings



Local analysis



3D representation of the TIN built from the Scanner laser soundings

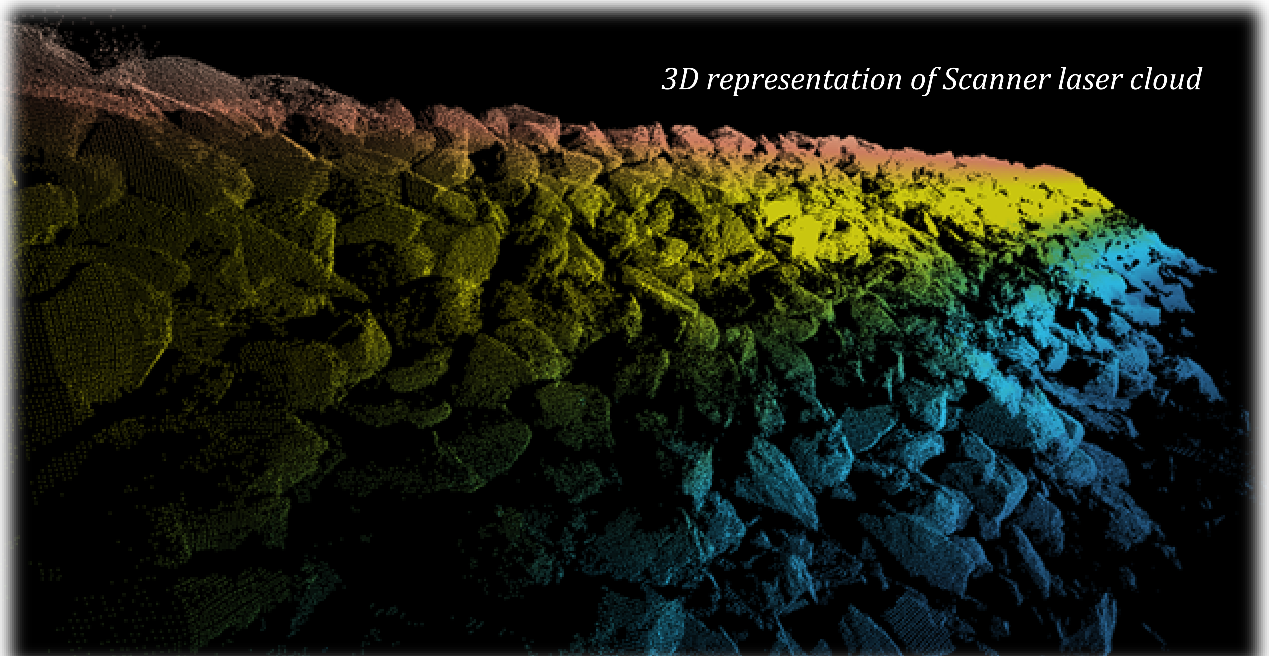


Profile across the rock:

- EM3002 soundings
- Laser scanner soundings

Local analysis

- Laser scanner 3D dataset acquired from one point of view: cavities between are not described
- Multiple returns, side lobe detections or time window filtering may explain high residual values near cavities


3D representation of Scanner laser cloud

CONCLUSIONS:

- Boskalis observation are confirmed

- Analysis has to be carried on:

  With the acquisition of a second laser scanner dataset acquired from a different point of view

  With the analysis of raw data MBES (Tritech Horizon)

- Results in terms of rocks normalized diameter:

  D_{n50} = 120mm → Error = 0.9 D_{n50}

  D_{n50} = 1002 mm → Error = 0.2 D_{n50}