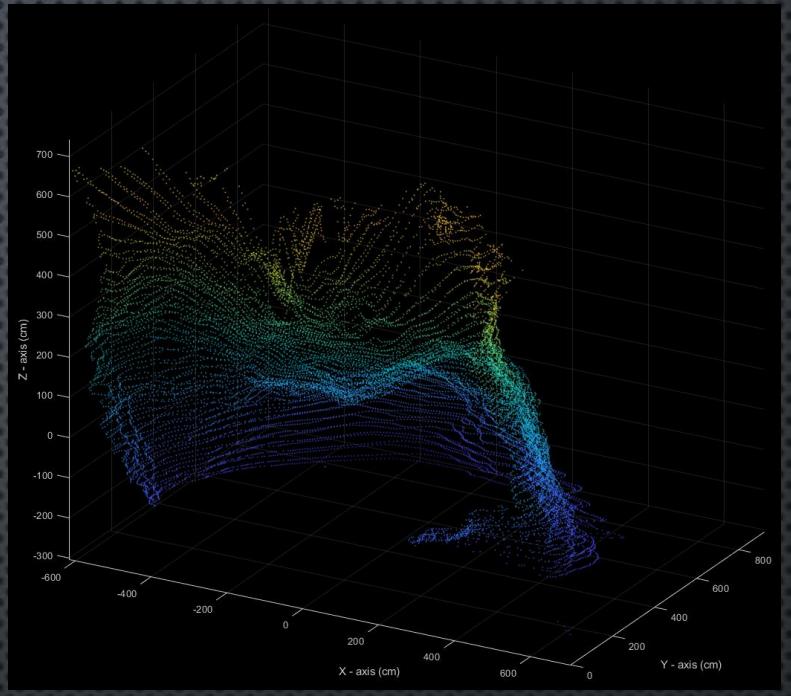
Robotics, stereo vision and lidar for lunar exploration



I. Introduction
II. Material
III. Methodology and results
IV. Conclusion

EuroMoonMars : Thomas Aymeric, Ugo Cesari and Bernard Foing

I. INTRODUCTION

In the context of space exploration, among others, to make possible a manned space mission to the Moon or to Mars, the rovers, that will be sent there as precursors, need to have three dimensions (3D) environment mapping tools. Thanks to them, we will be able to choose the ideal location to build a viable habitat for the future missions. To perform a mapping, there are several techniques. These must be able to work in extreme conditions, like in space on the Moon, where there is no atmosphere or in slightly more lenient conditions like Martian atmosphere (7 mbar). In addition, they must not generate heavy digital data to be transmitted to Earth for analysis.

Our choice fell on two known techniques, which are relatively quick to use and which comply with the recommendations listed above: LiDAR (Light Detection and Ranging) and 3D stereophotogrammetry. In the specific conditions for carrying out this project due to COVID 19, we chose to build our own 3D scanner based on LiDAR sensor, which is easily found on the market and for stereophotogrammetry, we used a camera in our possession Fujifilm X-M1 and a Logitech C920 HD Pro webcam. The objective was to compare these two 3D tools.

This comparison was made by following a protocol that allowed to evaluate its techniques on their precision, their resolution and distance measurement compared to the same scene captured under the same initial conditions.

II. MATERIAL

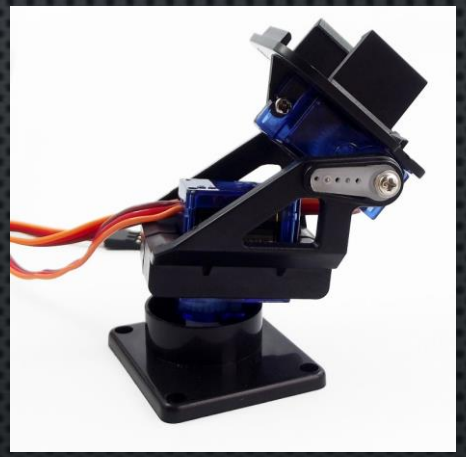
For LiDAR:

- Sensor (TF mini Benewake)
- 2 Servomotors (azimuth/elevation)
- Pan tilt
- Microcontroller (Raspberry Pi 3)
- Power supply (20.000 mAh)
- Python
- Software (Matlab, Meshlab)

33 x 15 x 16 mm

22 x 11.5 x 27 mm

85.60 x 54 x 17 mm



160 x 65 x 25 mm

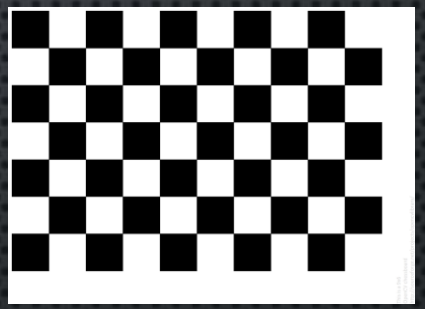
II. MATERIAL

4896x3264 avec FoV: 83° at f=16mm

1920x1080 with FoV: 60°

For Stereophotogrammetry

- Sensor (Fujifilm X-M1, Logitech C920 HD Pro)
- Calibration (Chessboard)
- Software (MicMac, Photomodeler, RealityCapture)



RealityCapture

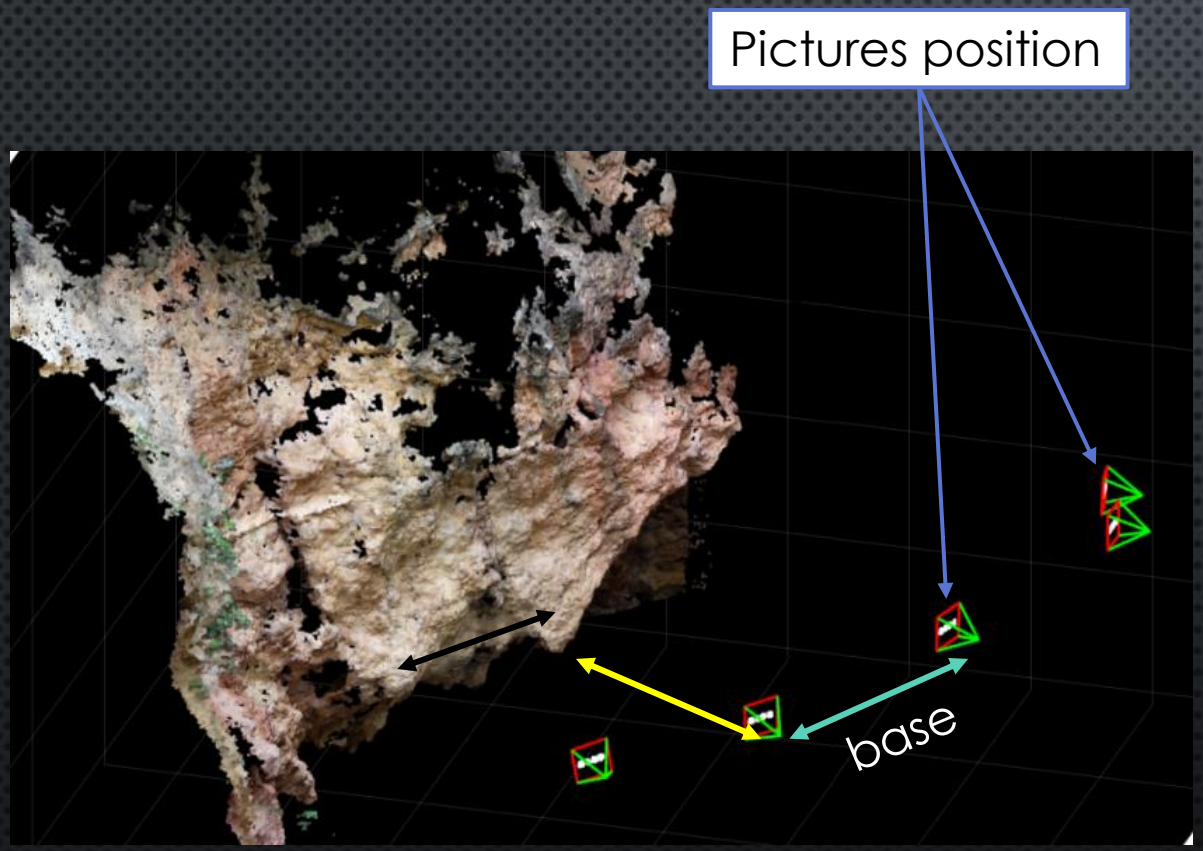
PHOTOMODELER

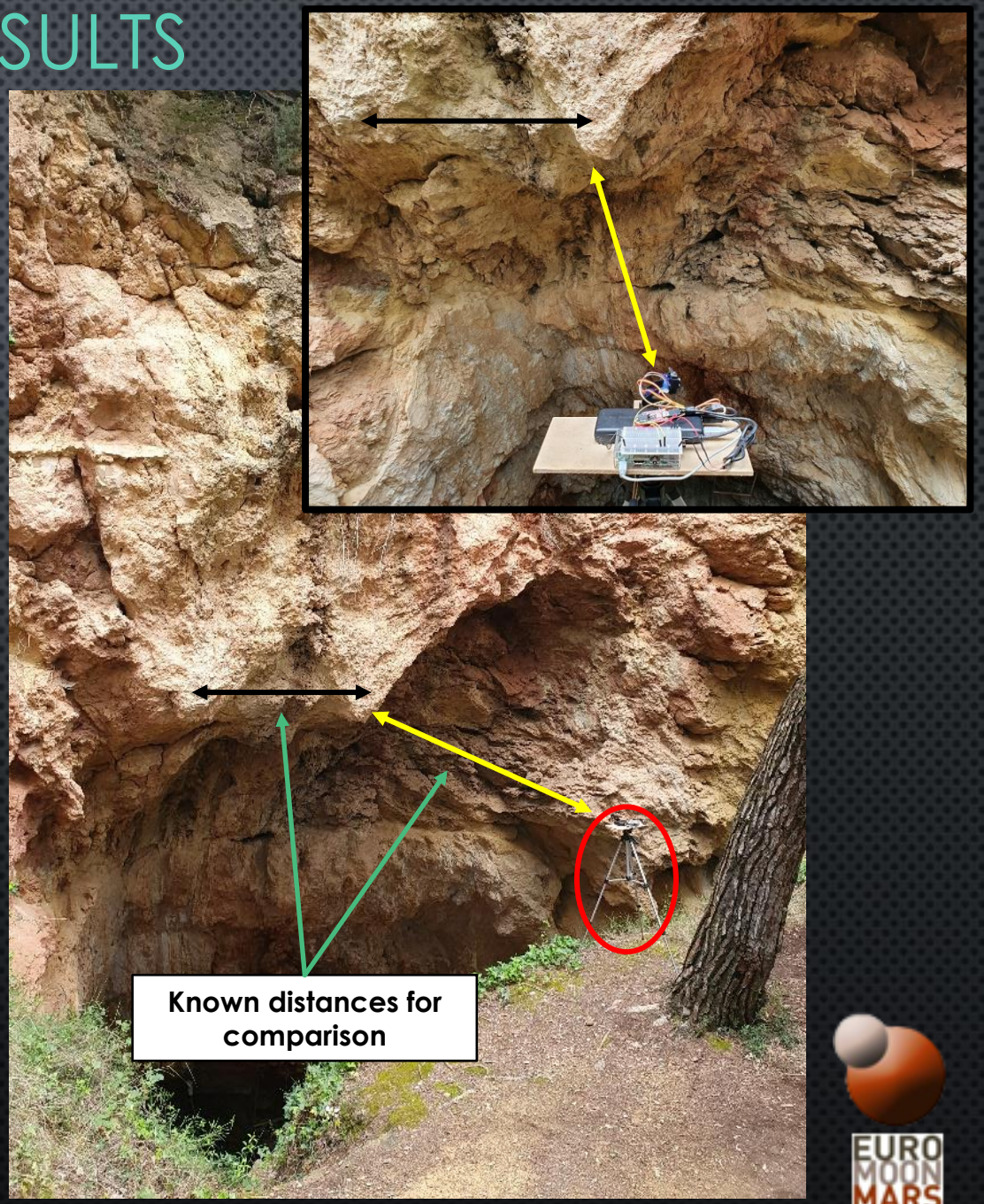
MicMac

EURO MOON MARS

III. METHODOLOGY AND RESULTS

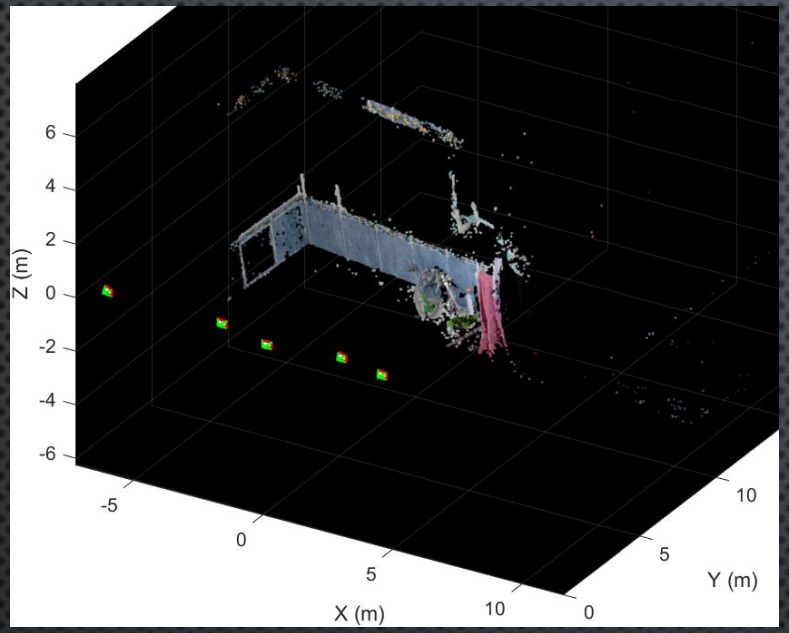
Protocol ➡ Comparison based on
- same conditions
- between same scenes

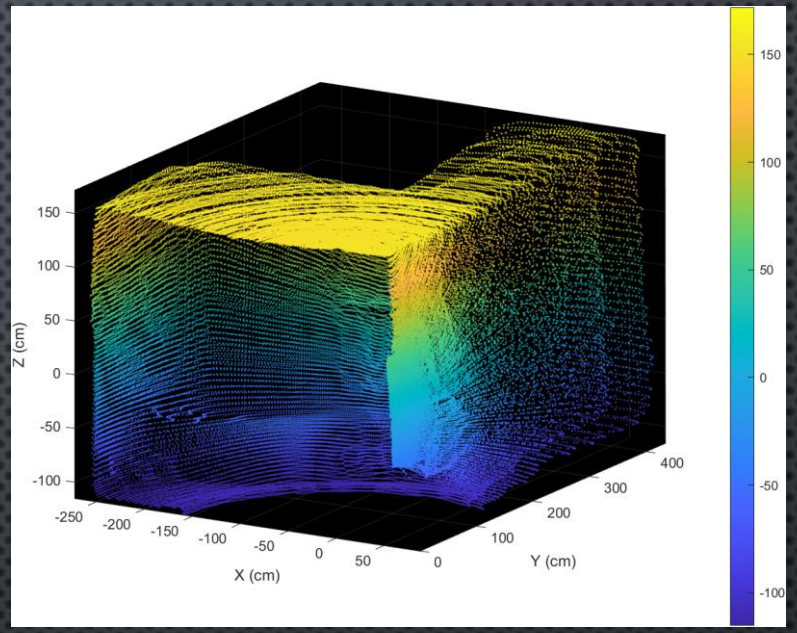




III. METHODOLOGY AND RESULTS

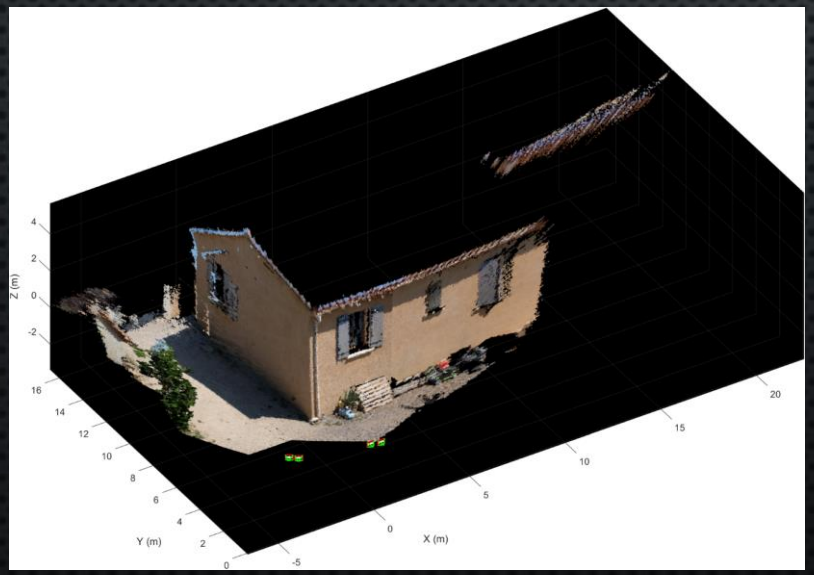
Bathroom stereophotogrammetry

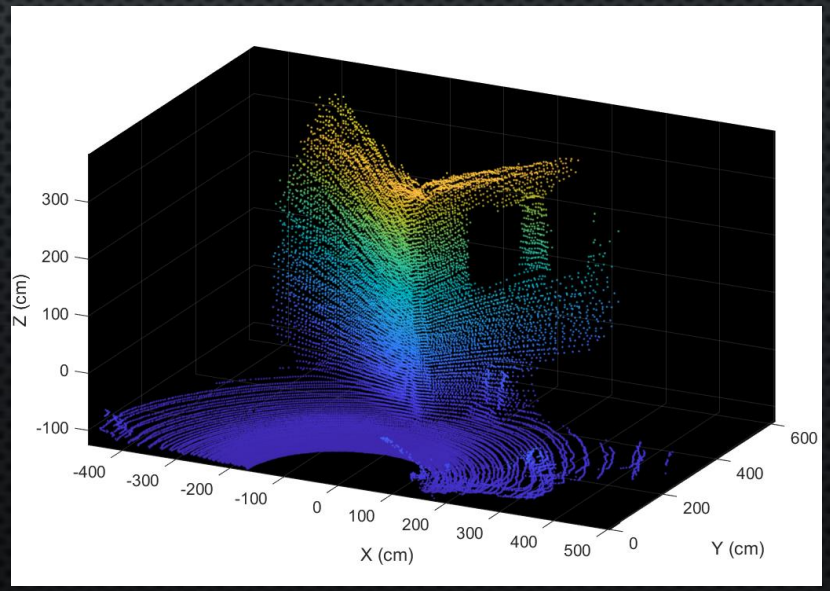




Bathroom Lidar

House stereophotogrammetry

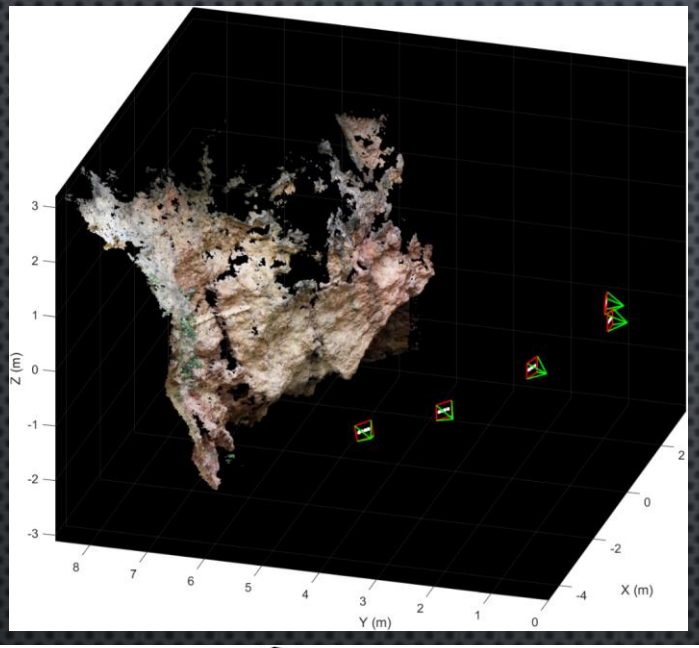


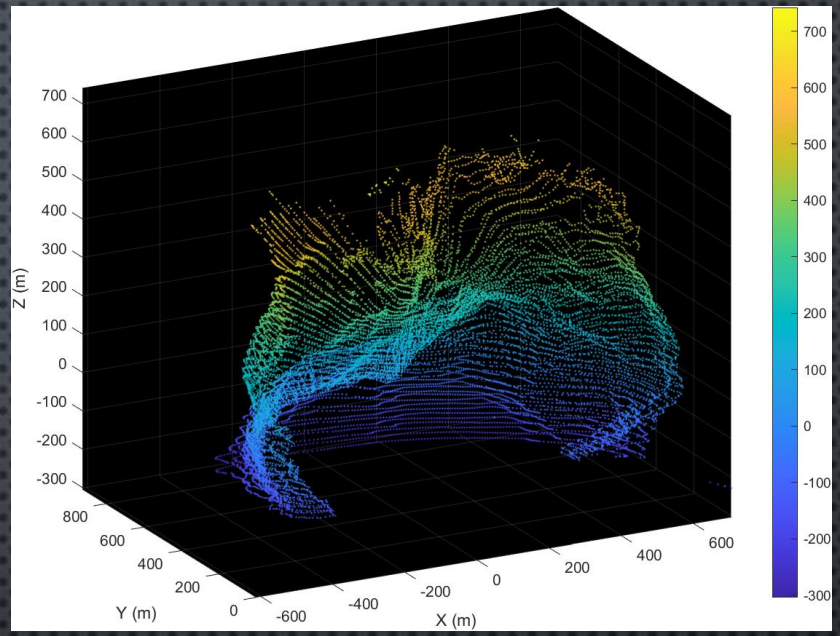


House Lidar

III. METHODOLOGY AND RESULTS

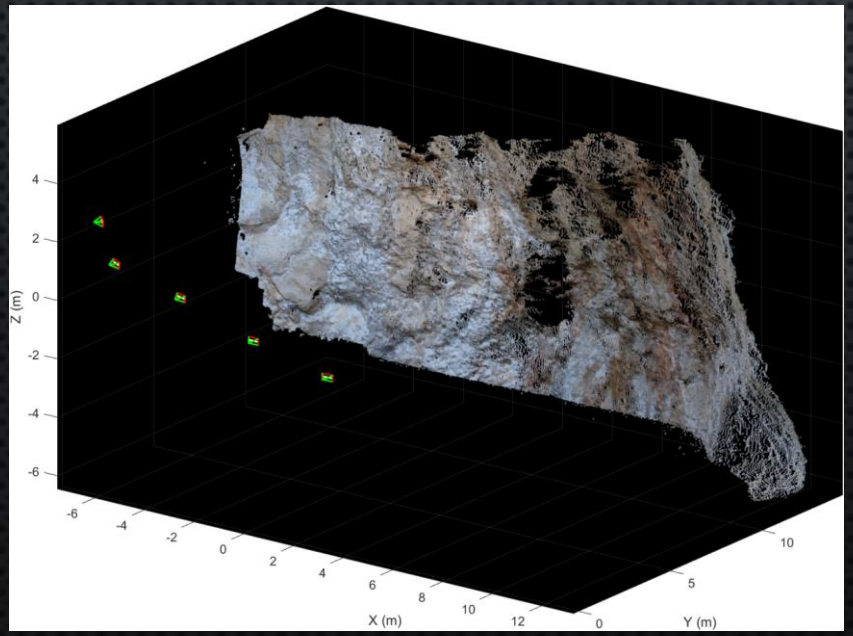
1st cave stereophotogrammetry

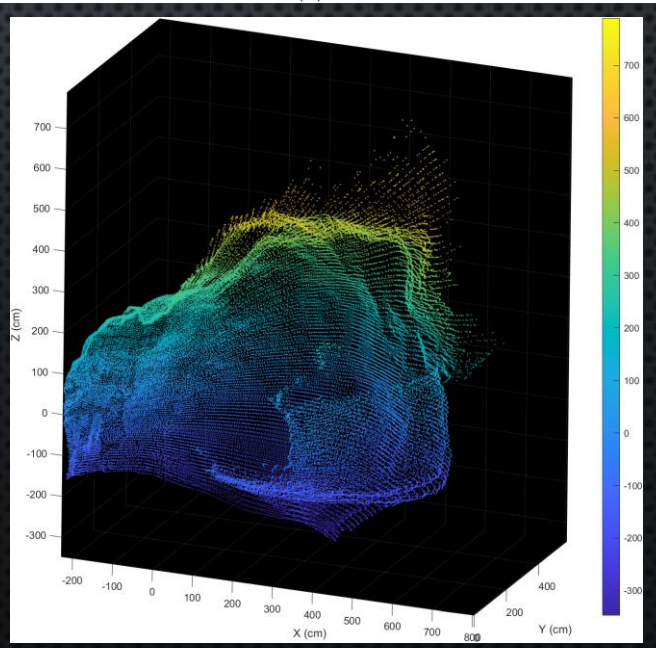




1st cave Lidar

2nd Cave stereophotogrammetry





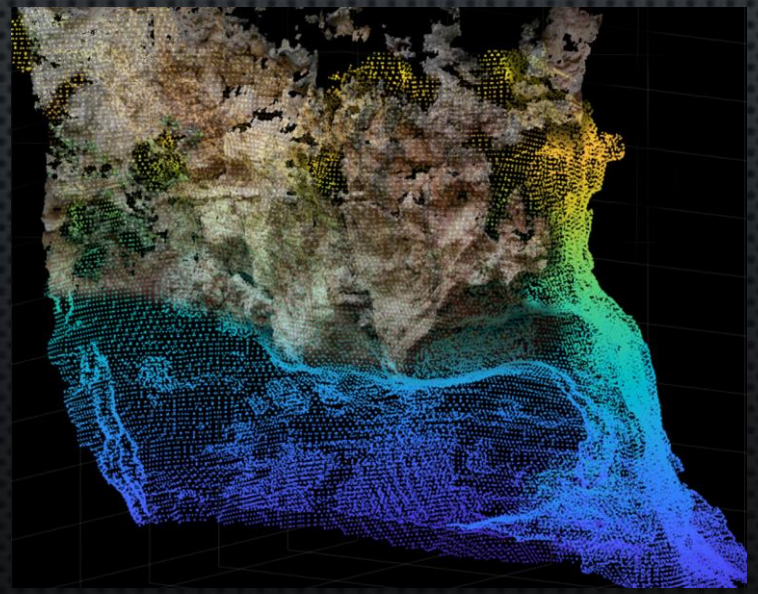
2nd cave Lidar

IV. CONCLUSION

Advantages of each

- ✓ Stereophotogrammetry: realism, FoV, digital data depends on resolution
- ✓ Lidar: precision, smaller utilization of digital data, keeps proportions, obscurity

Our experimentation lead us to choose both tools and to fuse the results. That way we obtain the stereophotogrammetry realism and the lidar precision.



1st cave:
stereophotogrammetry
and lidar results fused