



# Contributions of photometry to the 3D-digitization of heritage

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## ► To cite this version:

Antoine Laurent, Jean Mélou, Thomas Sagory, Carole Fritz, Jean-Denis Durou. Contributions of photometry to the 3D-digitization of heritage. Valérie Gouet-Brunet; Ronak Kosti; Li Weng. 4th Workshop on Structuring and Understanding of Multimedia heritAge Contents (SUMAC 2022), Oct 2022, Lisbonne, Portugal. ACM Digital Library, Proceedings 4th Workshop on Structuring and Understanding of Multimedia heritAge Contents (SUMAC 2022), 10.1145/3552464.3555683 . hal-03809779

HAL Id: hal-03809779

<https://hal.science/hal-03809779>

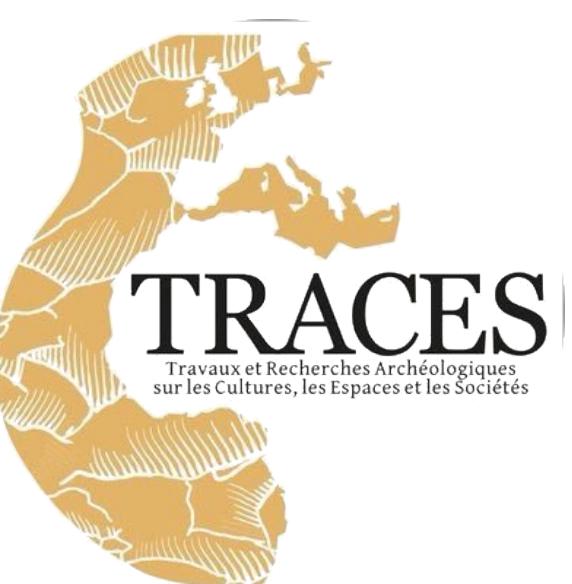
Submitted on 10 Oct 2022

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# CONTRIBUTIONS OF PHOTOMETRY TO THE 3D-DIGITIZATION OF HERITAGE

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## NEED FOR 3D-DIGITIZATION

Three main objectives in 3D-digitization of cultural heritage:

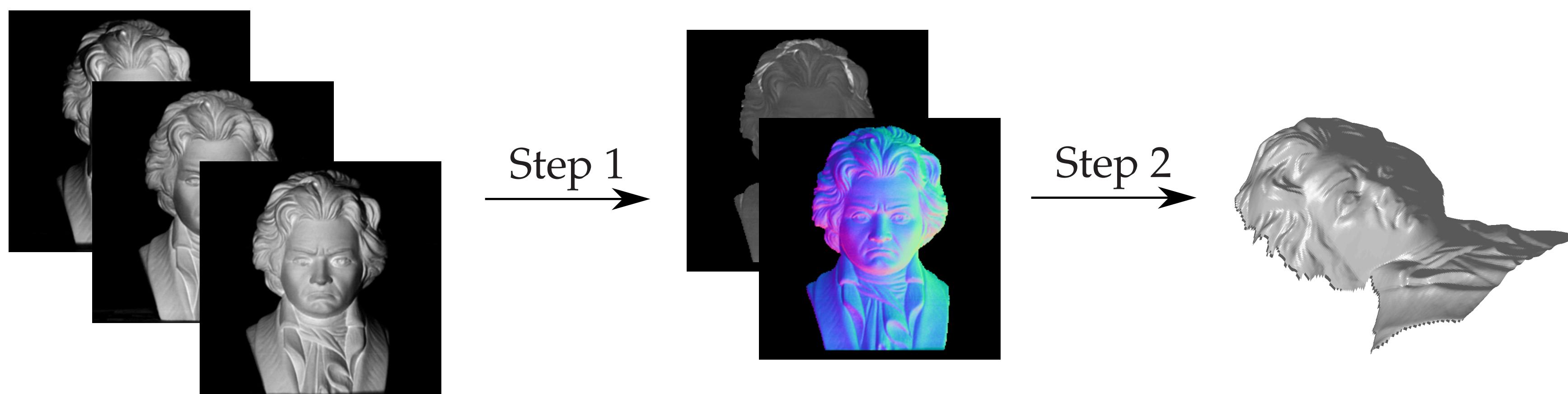
- Conservation of the remains
- Analysis of the artifacts
- Transmission of heritage

## 3D-SCANNING TECHNIQUES USED IN ARCHAEOLOGY

- Lasergrammetry and photogrammetry: reconstruct the scene in 3D, but not precise enough for micro-reliefs.
- Reflectance Transformation Imaging (RTI): highlights the micro-reliefs by simulating a grazing light, but without reconstructing them.
- Contribution: adapting photometric stereo to archaeology reconstruct micro-reliefs.

## PHOTOMETRIC STEREO (PS) [1]

- Goal: from  $m$  images  $I^i$  and  $m$  light vectors  $s^i$ , estimate a depth map  $z$ .
- Lambertian model:  $\underbrace{I^i}_{\text{Greylevel}} = \underbrace{\rho}_{\text{Albedo}} \times \underbrace{s^i \cdot n(z)}_{\text{Shading}}$
- Two-step pipeline: normal and albedo maps estimation, then normal integration.

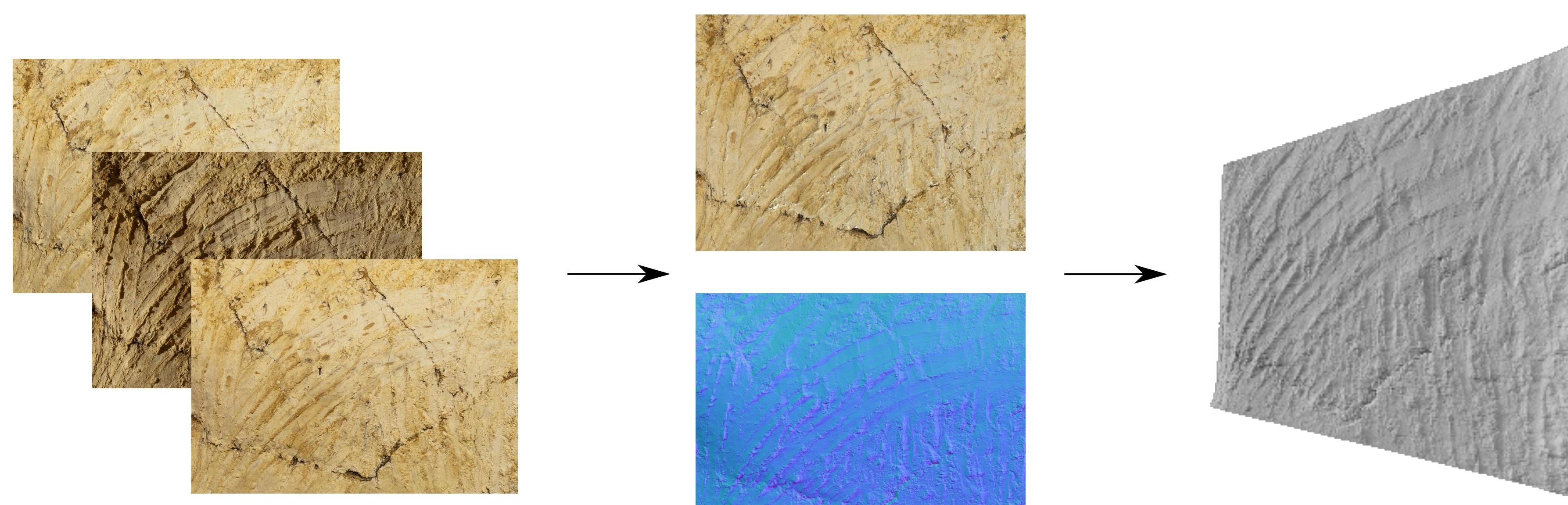


## LIGHT CALIBRATION



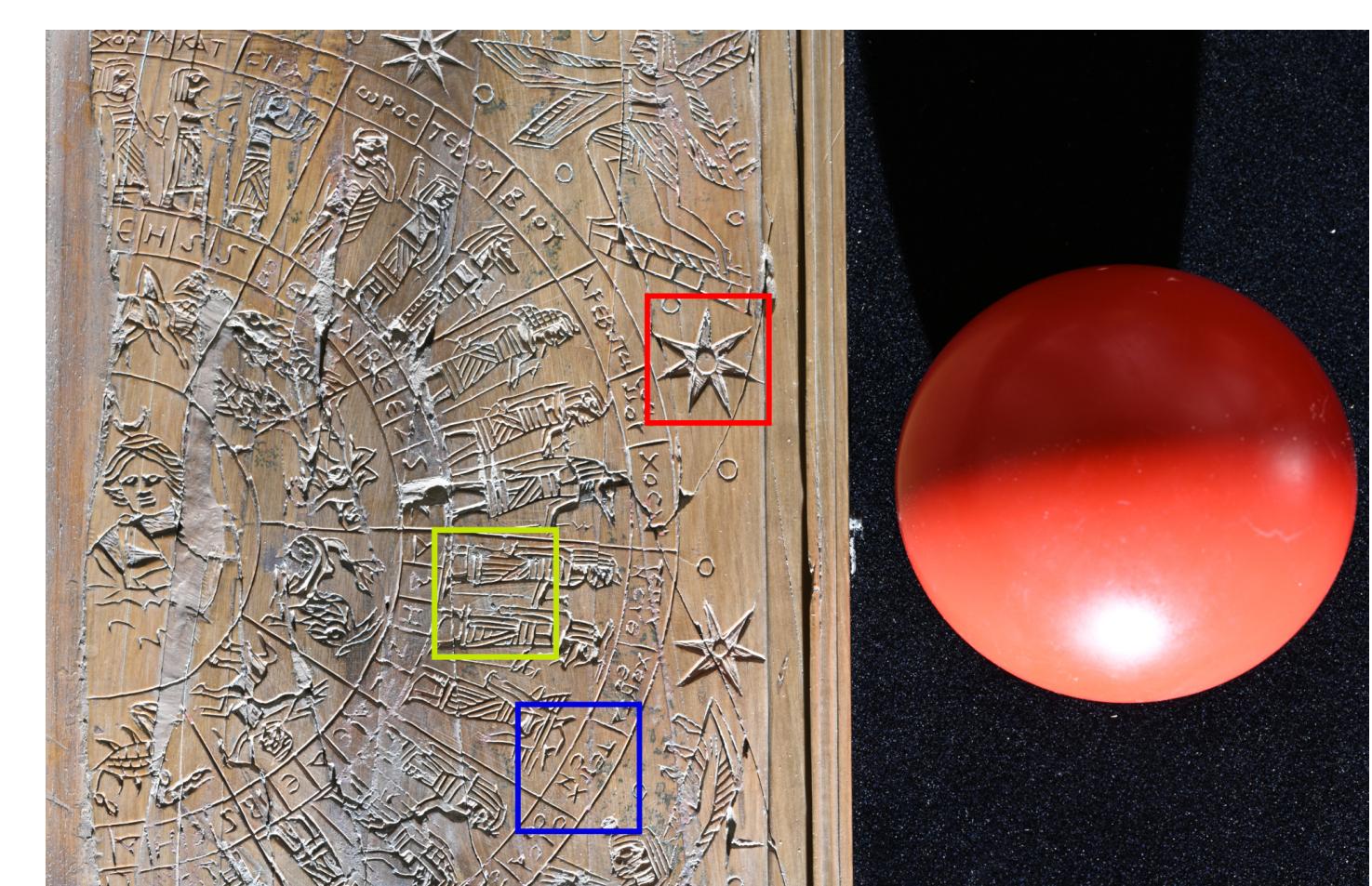
"Panneau des Mammouths raclés":  
A white sphere is used for light calibration.

## CHAUVET-PONT-D'ARC CAVE



From left to right: Zoom on three pictures of the "Panneau des Mammouths raclés"; estimated albedo and normal map; reconstructed depth in perspective view.

## ZODIACAL TABLET



One of the input pictures.

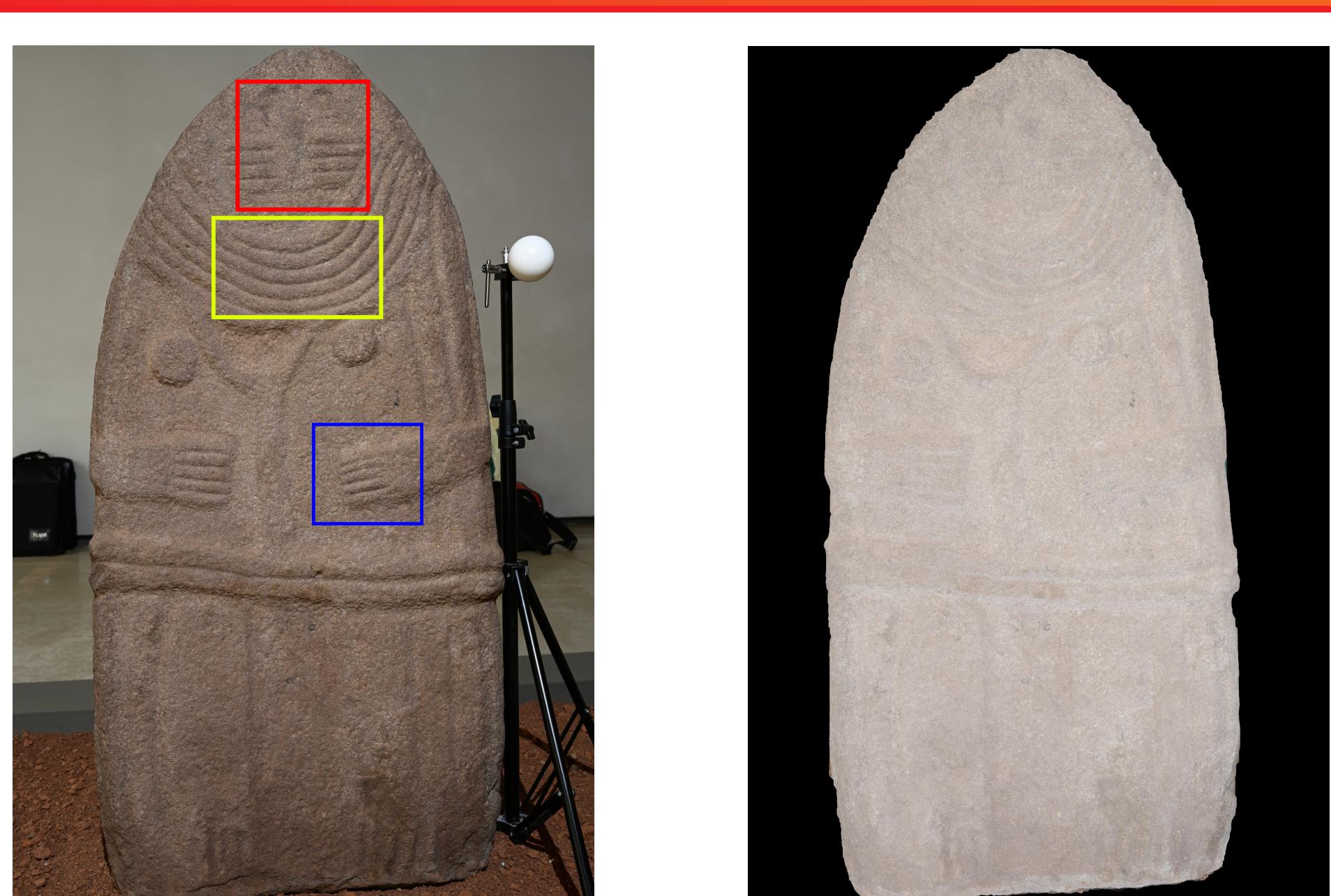


Estimated albedo and normal map.



Zooms on the reconstructed depth in perspective view.

## "DAME DE SAINT-SERNIN" STATUE-MENHIR



One of the input picture.



Estimated albedo.



Estimated normal map. Depth map details.

## CONCLUSION

- Adapting PS to archeology.
- PS: 3D-models + Intrinsic color.
- Accuracy limited by the pixel size.

## PERSPECTIVES

- Light calibration without sphere.
- Transforming RTI data into PS data.
- Multi-view photometric stereo.

## REFERENCE

- [1] Durou, J.-D., Falcone, M., Quéau, Y., Tozza, S. *A Comprehensive Introduction to Photometric 3D-reconstruction*, in *Advances in Photometric 3D-Reconstruction*, Springer, 2020.