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# Multiple 3D approaches for the architectural study of the abbey of Cormery



## STUDY CONTEXT

This poster want to focus on the technical approaches used to study in solo a wide and complex medieval archaeological site like the Benedictine abbey of Cormery founded in 791.

According to the cartulary, the Benedictine abbey was rebuilt several times between the 8th and the 10th centuries and a new church was dedicated in 1054. Many buildings of the abbey were built during the medieval period like the cellar in the 12th century or the stately refectory in the 13th.

The abbey of Cormery was abandoned by the monks after the French Revolution. Some buildings like the abbey church were almost completely destroyed, with a road going through the nave and houses built in the aisles (figure 1).

The exhaustive study of the site is consequently quite complex because the different parts of the abbey are owned by a large number of people.



1 - Map of the abbey of Cormery with the church limits.

## LASER SCANNING CAMPAIGN

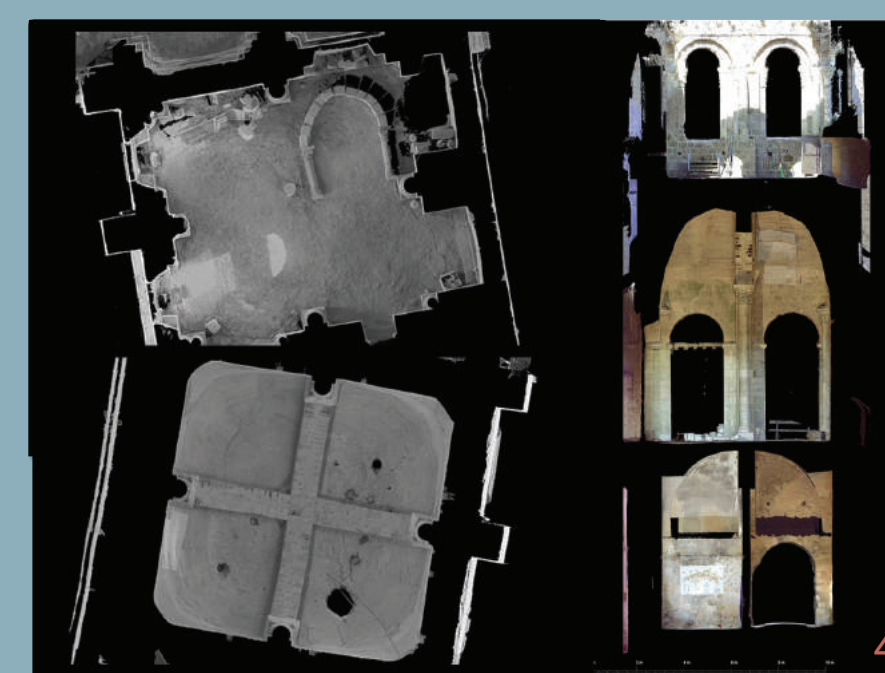
In 2015 a main laser scanning campaign was carried out on the abbey. Ten days were needed to record 250 scans and one month of post-processing to generate the final points cloud (figure 2).



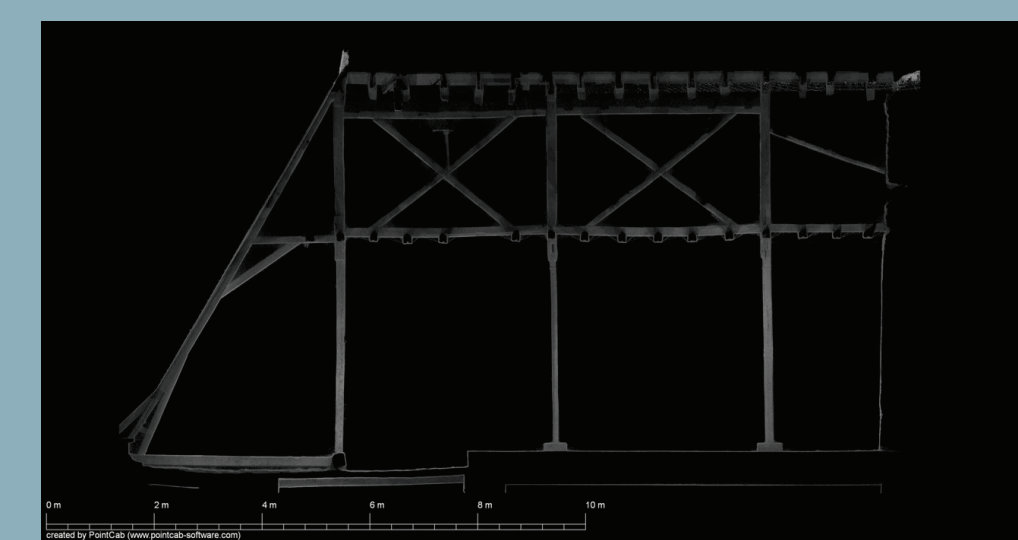
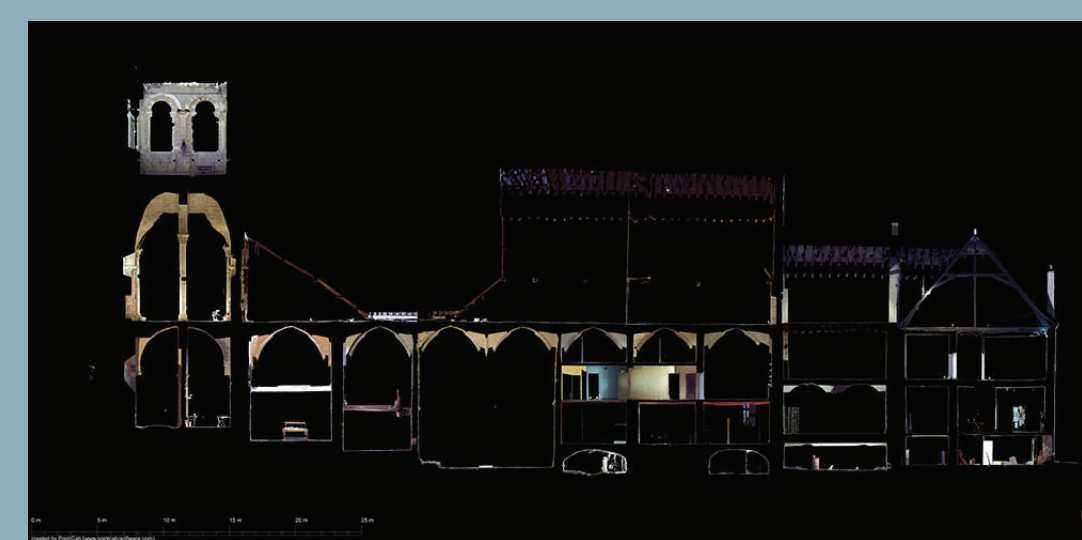
2 - 3D view of the point cloud in FaroScene.

Other small laser scanning surveys were carried out later in 2016 to record the remains located in private houses, basements or garages. The new data were added and registered into the final laser scanning project.

The point cloud is afterwards exploited to generate manually three kinds of documents : ortho-images of the ground, sections and ortho-images of the walls faces (figure 3 - 7).



- 3 - Ortho-plan of the abbey.
- 4 - Section and orthoimages of the tower St-Paul.
- 5 - Ortho-image of the north wall of the Du Puy chapel.
- 6 - Section north-south with tower, refectory and kitchen.
- 7 - Section on the kitchen framework.



Laser scanning was particularly well adapted to produce ortho-image of walls in ashlar, sections on framework or plan of the buildings ground imported in GIS.

It was however not really efficient in some particular cases like the tower-entrance of the church or walls with small-stone apparatus.

## PHOTOGRAMMETRY

To survey correctly the walls face, we use the photogrammetric method (ground and air).

The recent purchase of a small UAV by the laboratory allowed us to try the first flight on St Paul tower and to photograph each wall in a very close range with a low resolution GoPro sensor (72 dpi, 2624 x 1968 pixels).

Pictures were post-processed with Agisoft PhotoScan to finally produce the best orthoimage of the three tested methods. Despite the use of a very small captor (GoPro HERO3+ Silver Edition), the very-close range enabled us to produce the best digital image (figure 8).



8 - Ortho-image of the east face of St Paul tower.

Beside the tower's case, some other parts located inside required the use of photogrammetry to survey in a very short time, like the north part of the transept which was transformed into storage place and was accessible for only one hour (figure 10).



To see the flight of the UAV on the St Paul tower in Cormery

We used a camera Pentax Kr (23.6 x 15.8 mm CMOS sensor, 12 million pixels) and a 18-55 mm lens. The ortho-image have then been produced with the SFM software Mic-Mac.



10 - Ortho-image of the south wall of the south transept church.



9 - Ortho-image of the west wall of the north transept church.

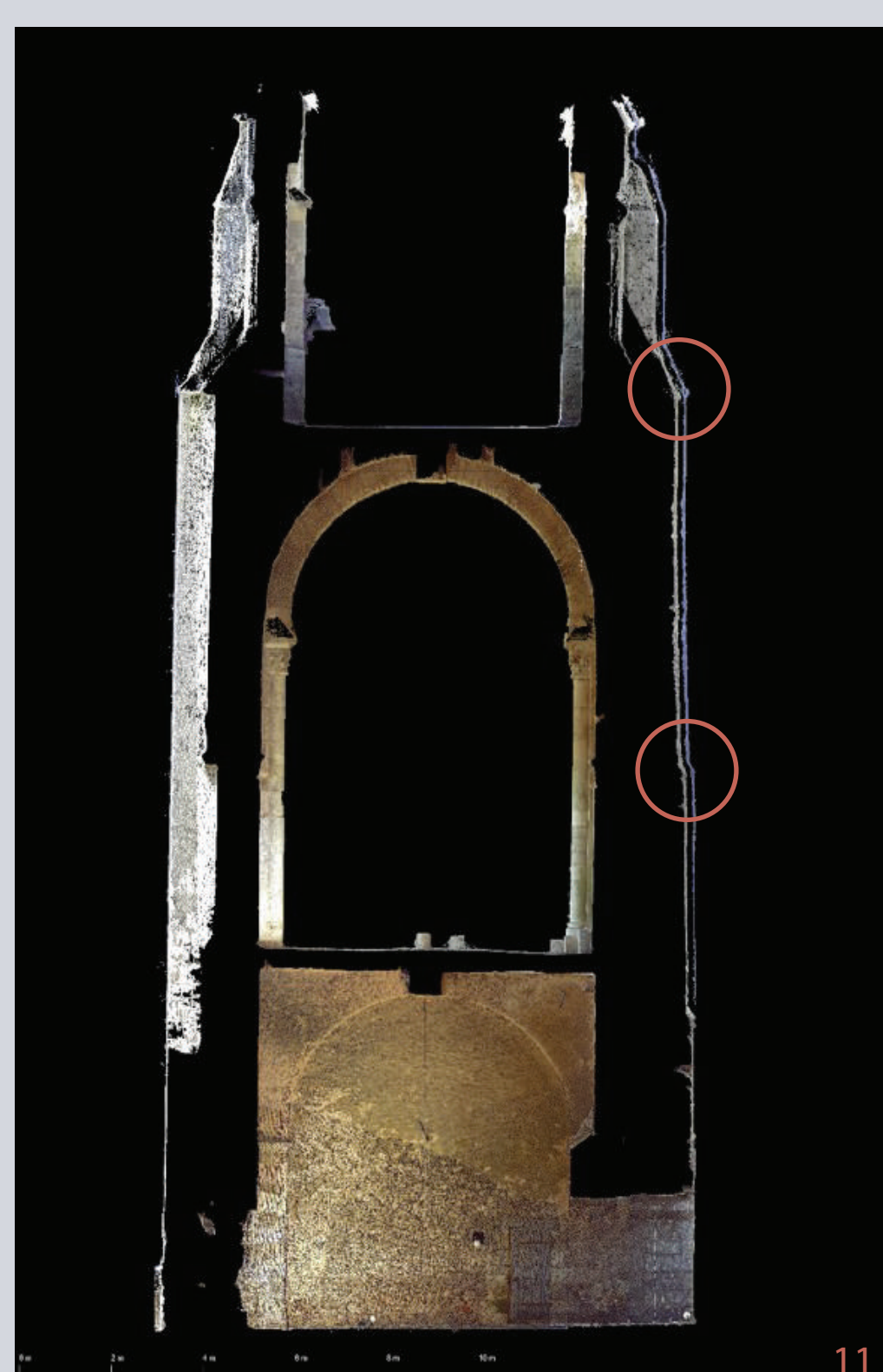
Photogrammetry from the ground was also used to work on the wall built with small stones apparatus which needs a very good precision for stone by stone drawing.

These kinds of walls are usually attributed to the 11th century, but they could also have been constructed during the 10th century because this building method was used all along the early Middle Ages (figure 9).

## STUDY CASE : St PAUL TOWER

The study of sections and orthoimages allowed us to emphasize the existence of projections on the remaining face of the church wall which is stuck on the tower (figure 11).

The upper projection could be the trace of a floor. The lowest projection indicates a distinction between two walls faces and the three potential Carolingian plugged windows placed above it (figure 12).



11 - Section of the tower St Paul with the projections



12 - Projections and plugged windows on the east face of the St Paul tower.

This facade was already hard to understand with two architectural phases modified between the 10th and the 11th century, which are probably the witnesses of a change in the liturgy adopted by the Benedictine monks.

Keeping only two windows (in brown) between the church and the tower, showed the will to respect a more intimate liturgy. Studying the orthophoto, we highlight a third architectural phase (in red) pictured by some arched stones at the left side of the wall (figure 12).

## CONCLUSION

The goal of this 3D use lies in the analysis of architectural features without producing a perfect 3D model. This is not about filling gap in the 3D model or restoring the missing parts of the buildings.

The data are finally produced in 2D and exploited afterwards by drawing and recording the stones and others architectural elements