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How the frescoed vaults of the ground floor apartments of Palazzo Pitti in Florence were "unrolled" in their full size

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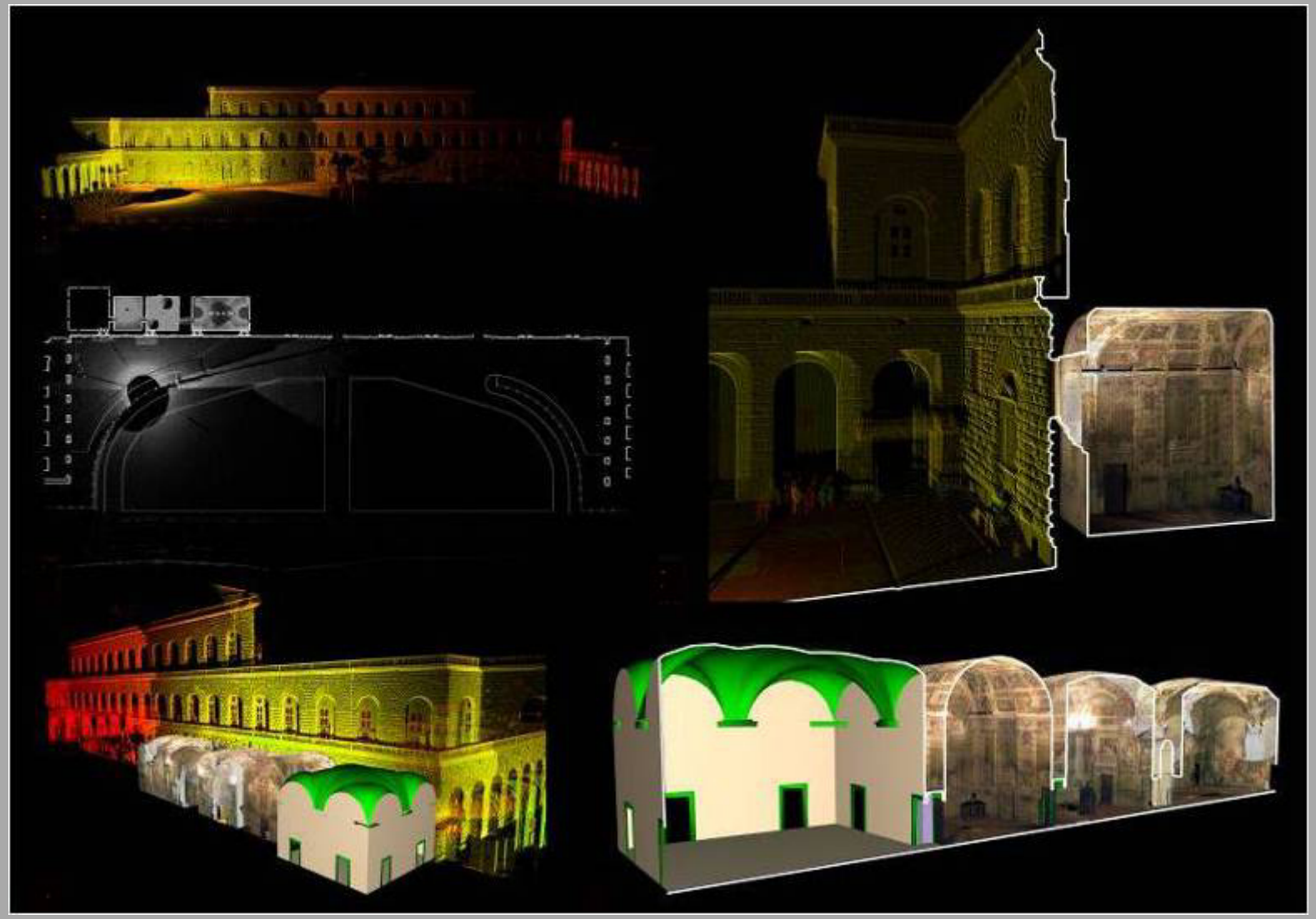
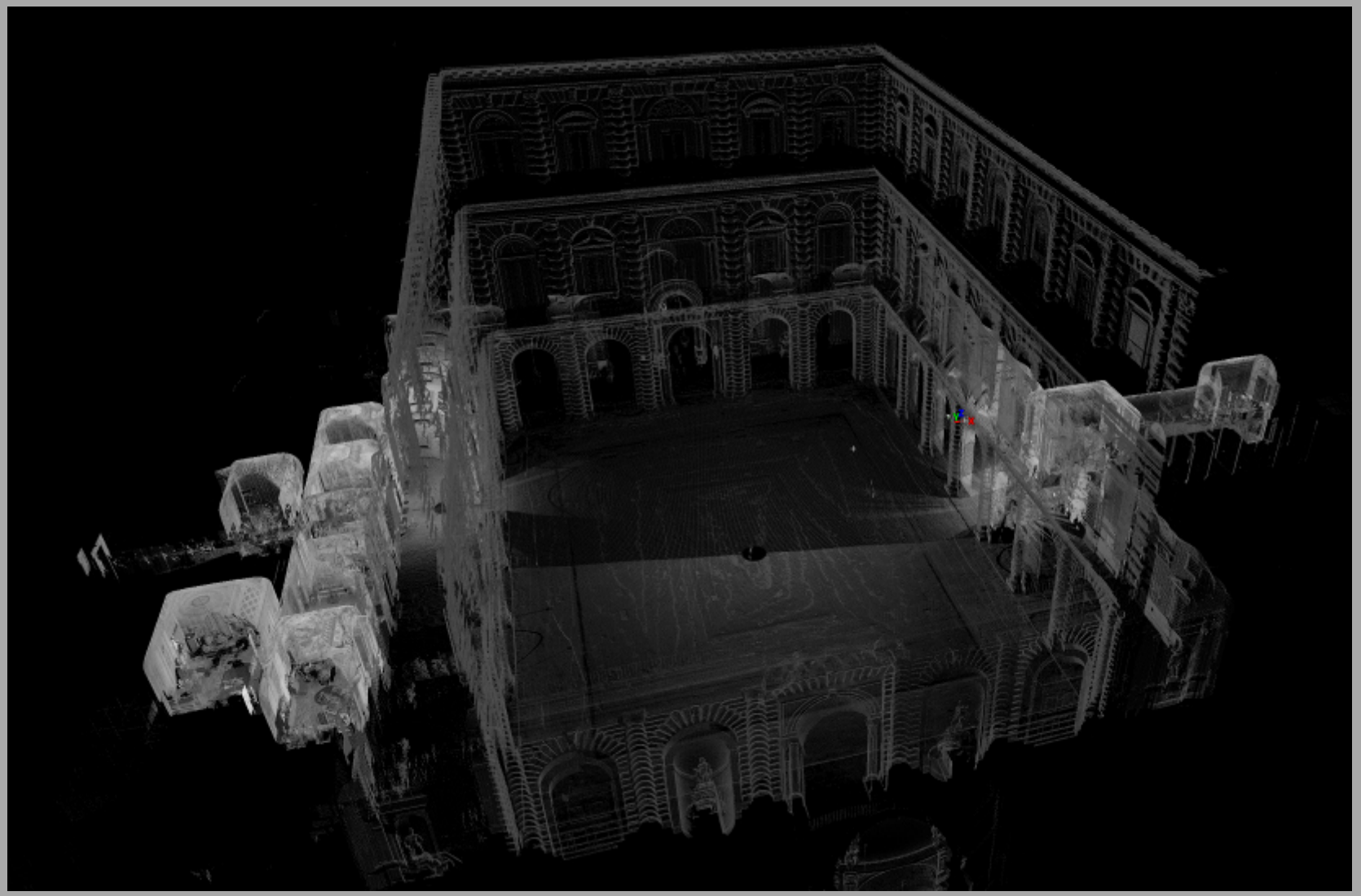
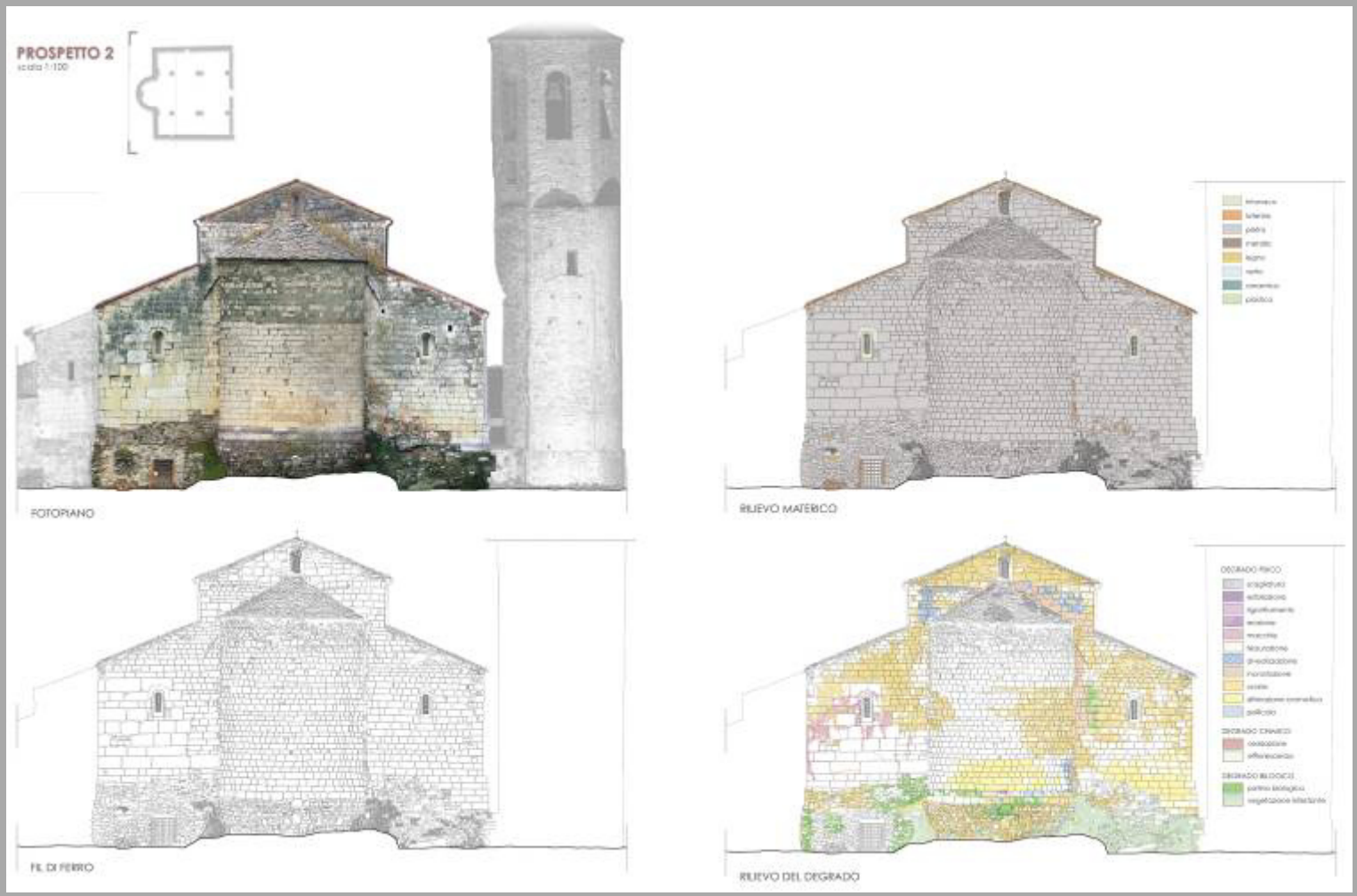


Survey carried out in 2005

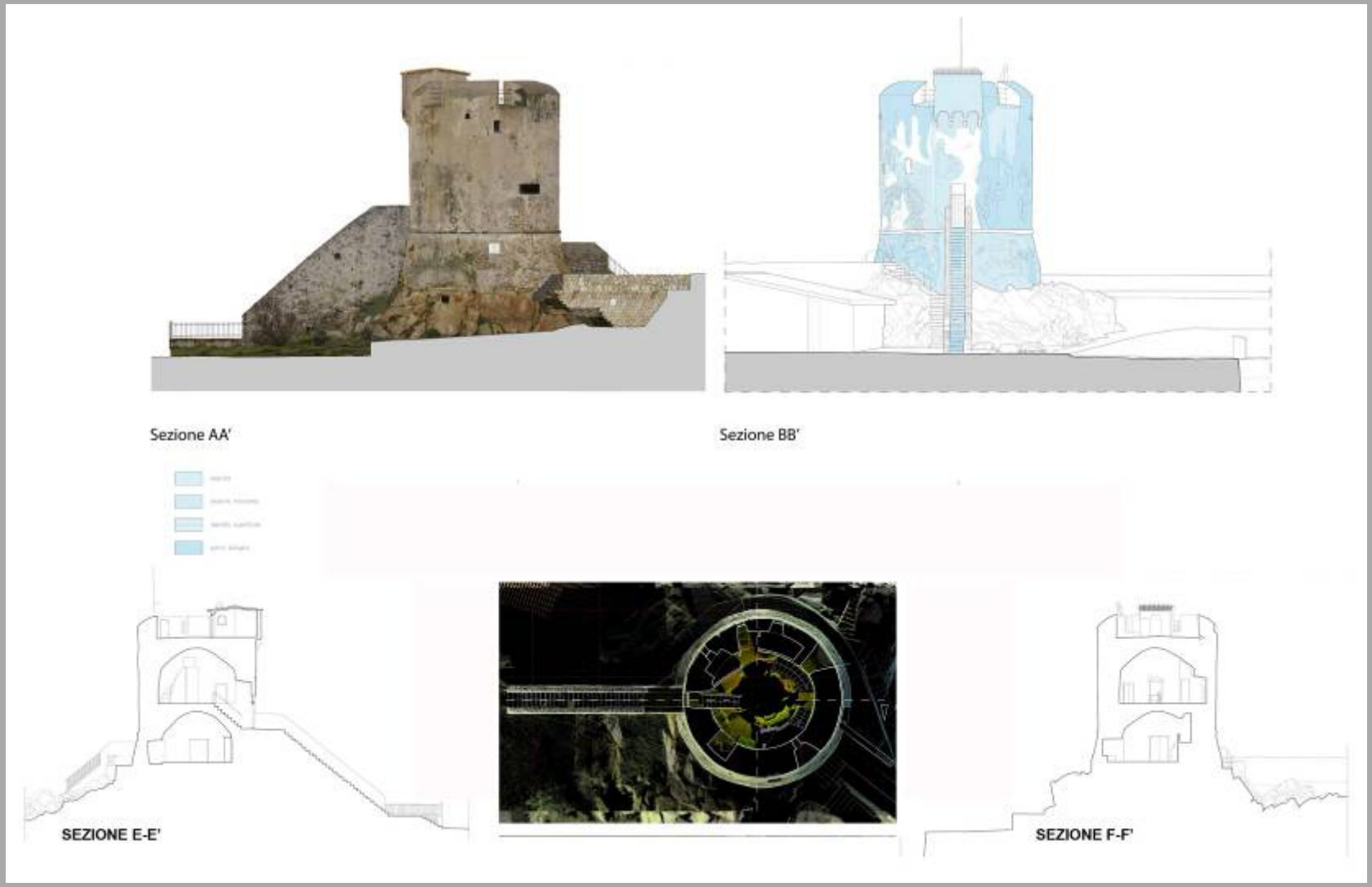


Survey carried out in 2007

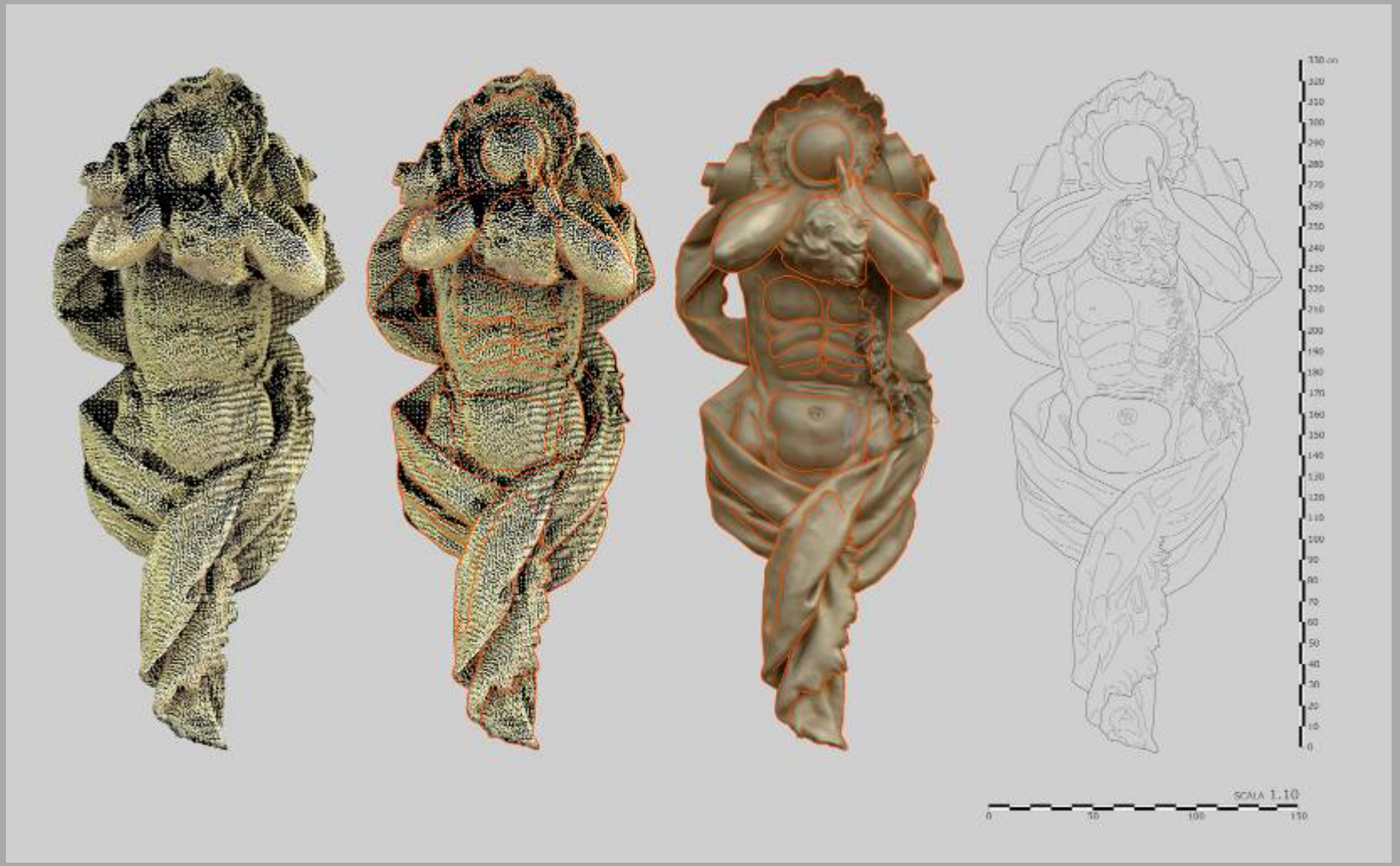
Survey of the Baptistery, part of the Piazza dei Miracoli complex in Pisa in 2002



Examples of themed maps of the Pieve a Socana (AR) – From left to right and from top to bottom: orthophoto, identification of the material, CAD drawing, analysis of decay



The survey of Torre Medicea, with a circular layout , of Marciana Mariana



The atlases of the Eikaterina palace in Pushkin, Saint Petersburg

The photographic survey of the rooms decorated with quadratures presented various technical difficulties in that the images perceived changed greatly depending on the position of filming.

Varying the position of filming not only changed the morphological perception but sometimes even the colour perceived.

-Pitti Palace was originally the town residence of Luca Pitti.
-The palace was bought by the Medici family in 1549.
-It was donated to the Italian people by King Victor Emmanuel III in 1919, and its doors were opened to the public as one of Florence's largest art galleries.

Software instruments used

Survey campaign 2005
Leica HDS 3000 time of flight laser scanner

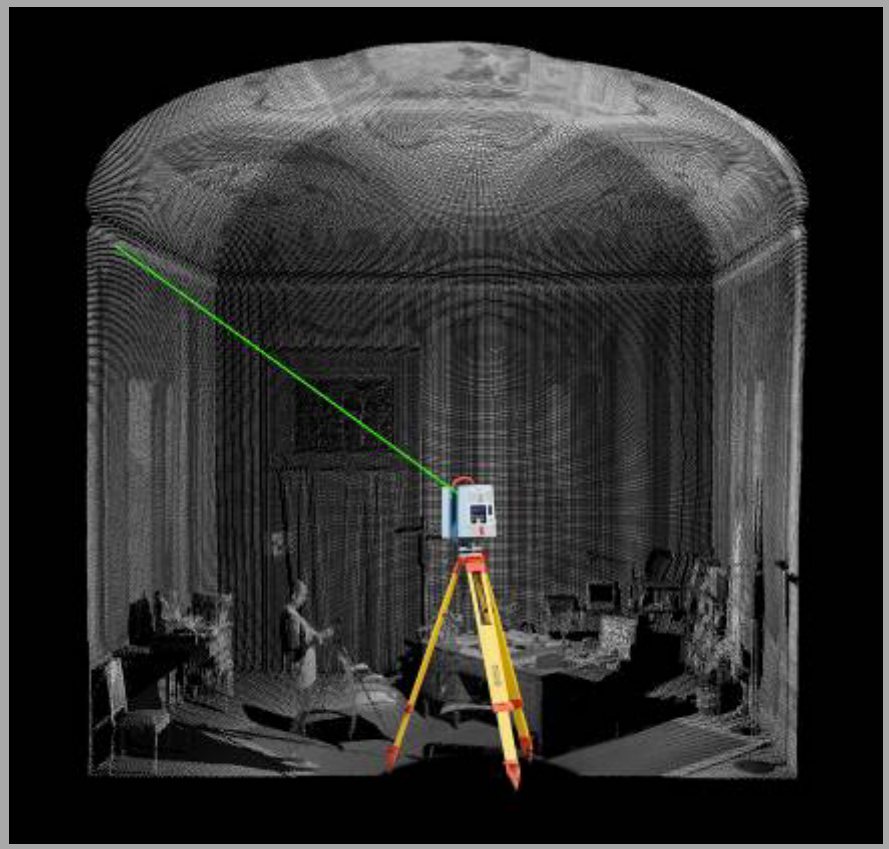
Survey campaign 2007
Leica HDS 6000 phase based laser scanner

Total station
Leica TPS 705

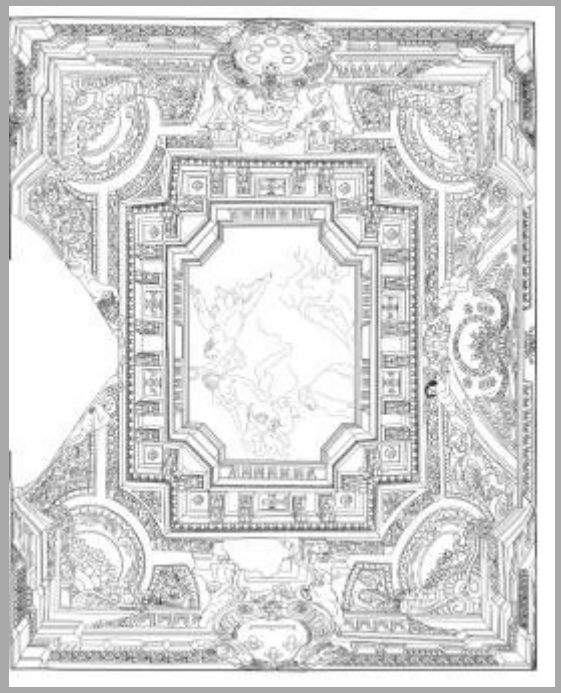
The software used to manage the point clouds was Cyclone

The following software was used to unroll the curved surfaces :

- Adobe Photoshop (orthophotos)
- AutoCAD (drawings)
- Rhinoceros (modelling and unrolling)



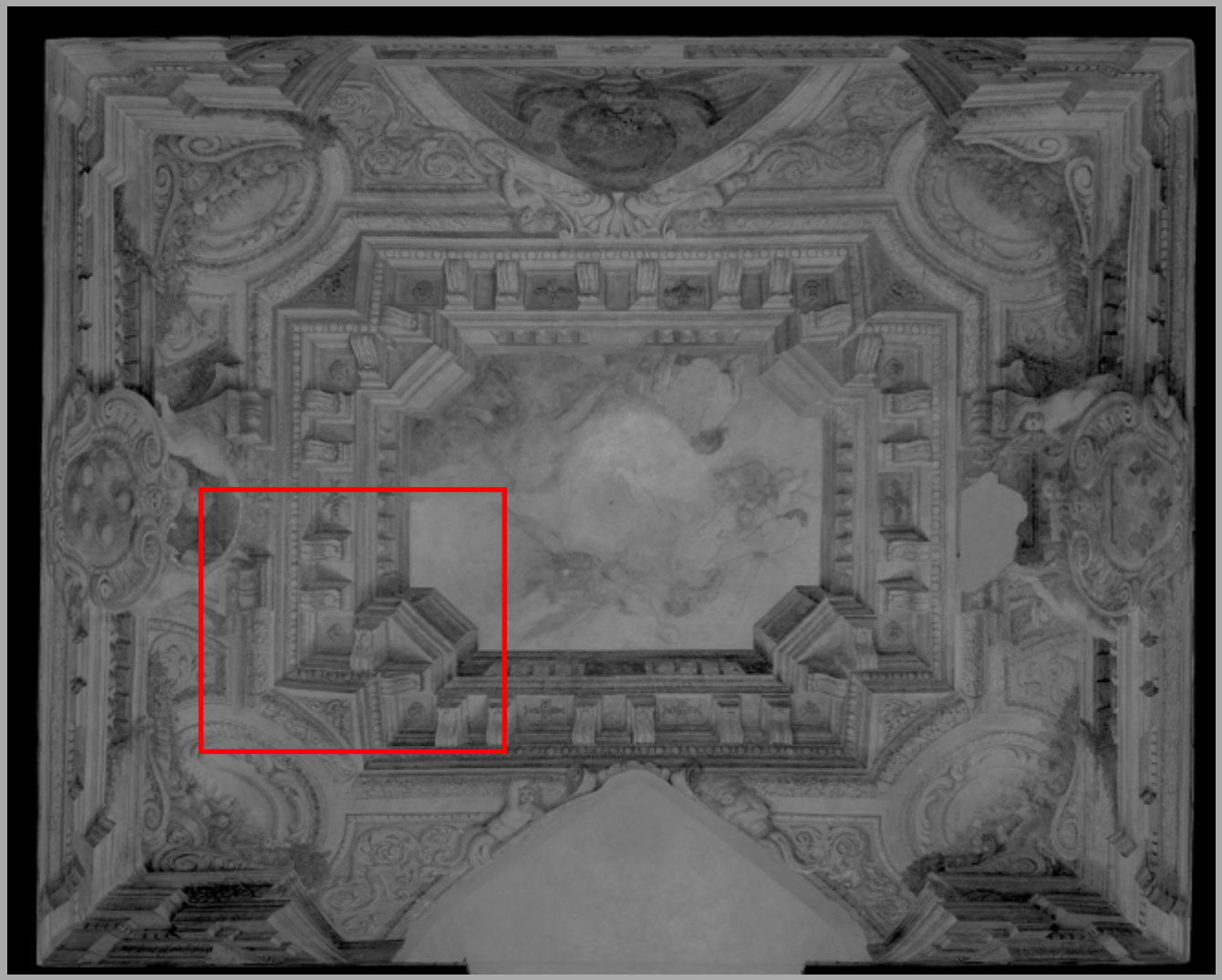
laser scanner instruments perform accurate high density 3D measurements which provide a "reflectance" value as well as the co-ordinates of the point, thereby making it possible to establish the differences in colour between the measured points.

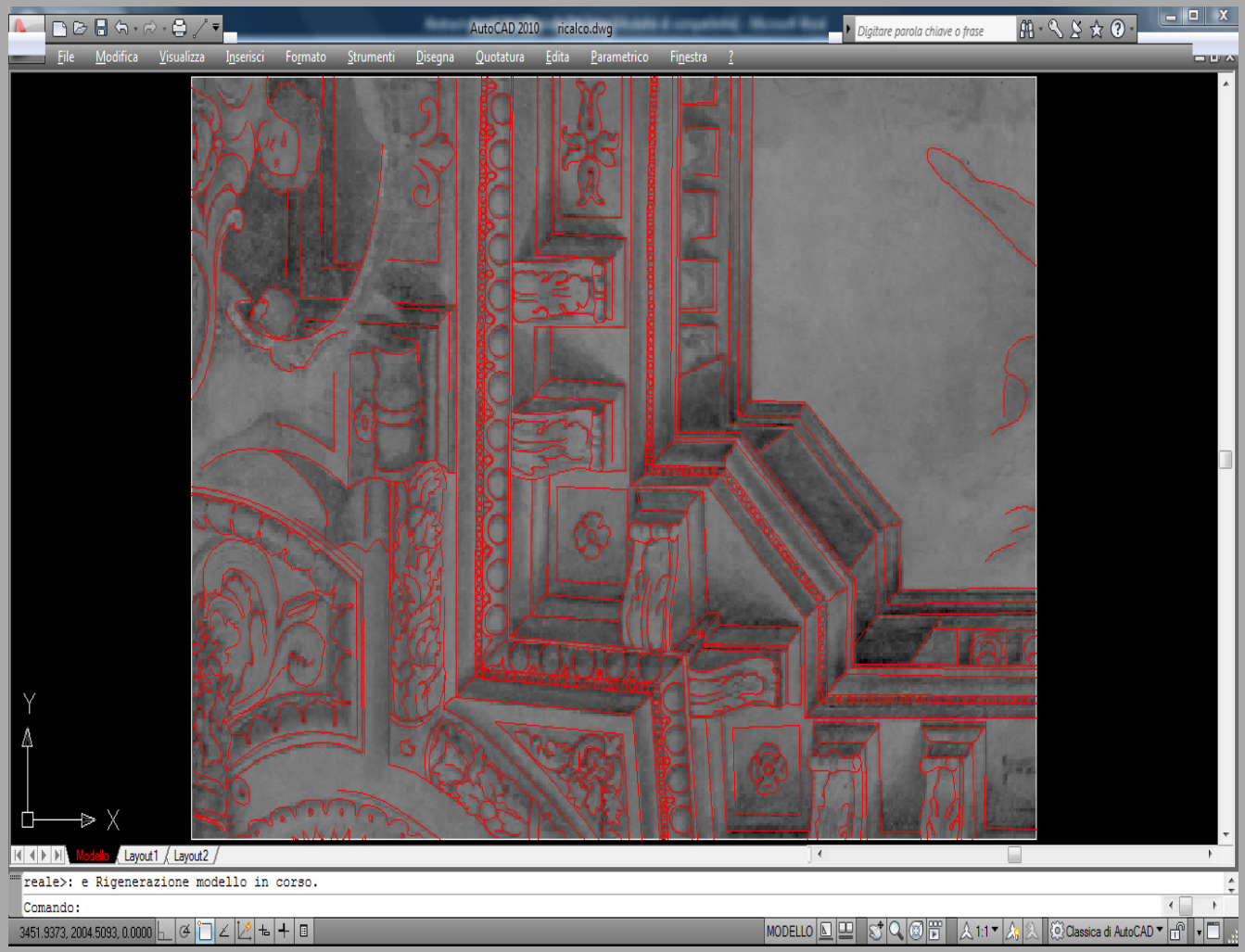


Snapshot from the point cloud → CAD drawing → orthophoto

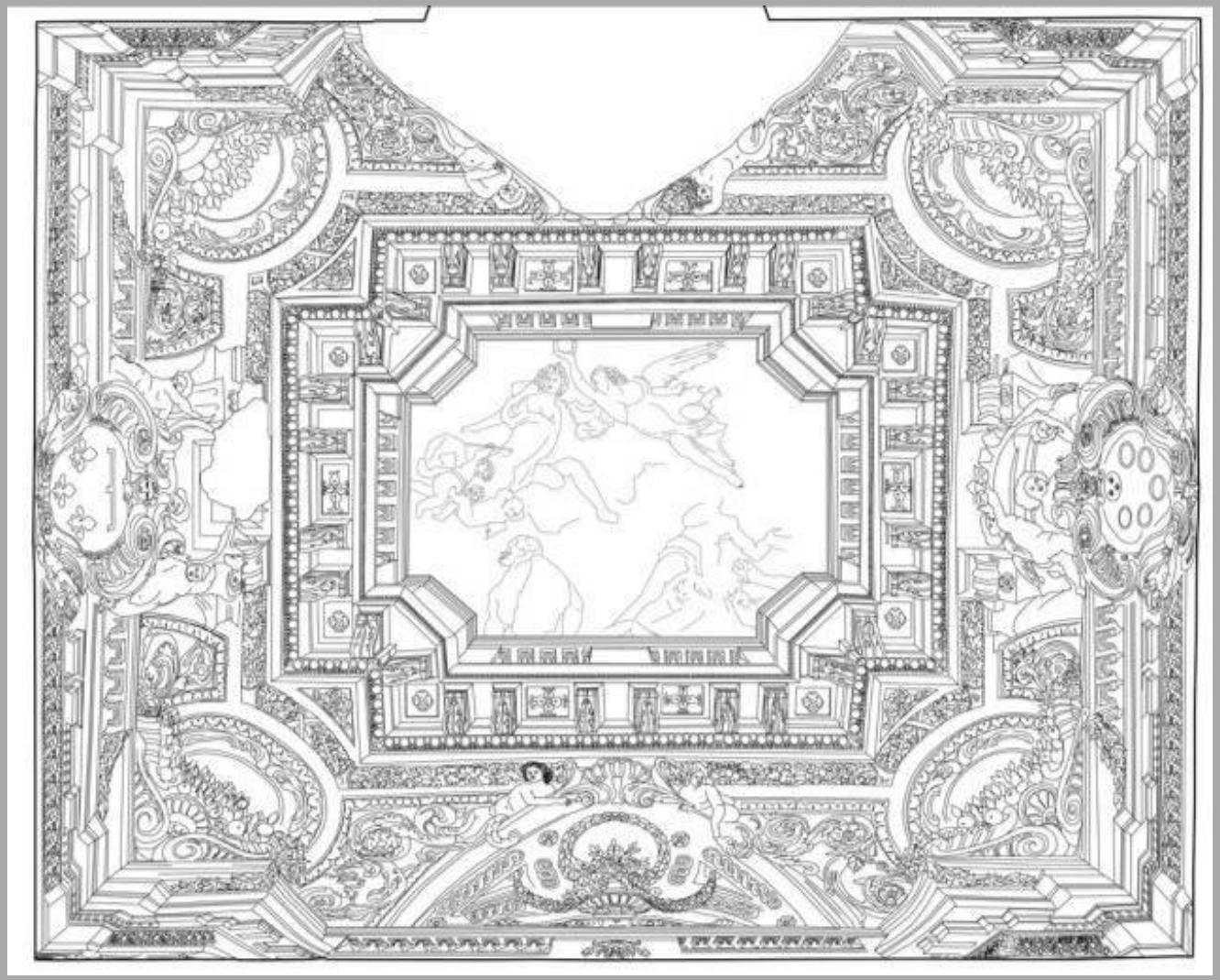
The snapshots of the vaults need to have a very high resolution .

which may vary depending on the scale of representation from 3 to 6 pixels per cm for reconstructions in scale 1:20 or 1:10

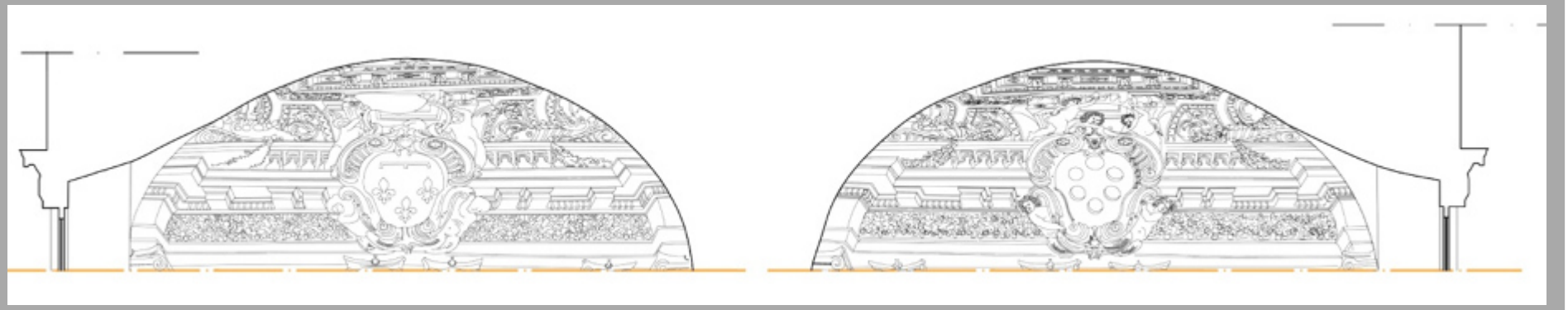




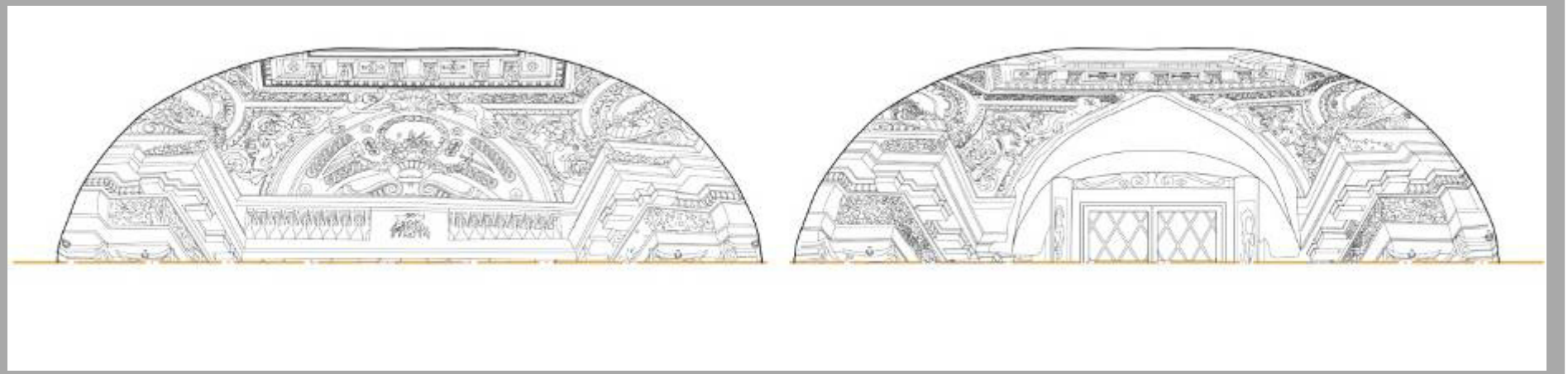
With the high-resolution snapshot a CAD drawing of the painting can be produced.



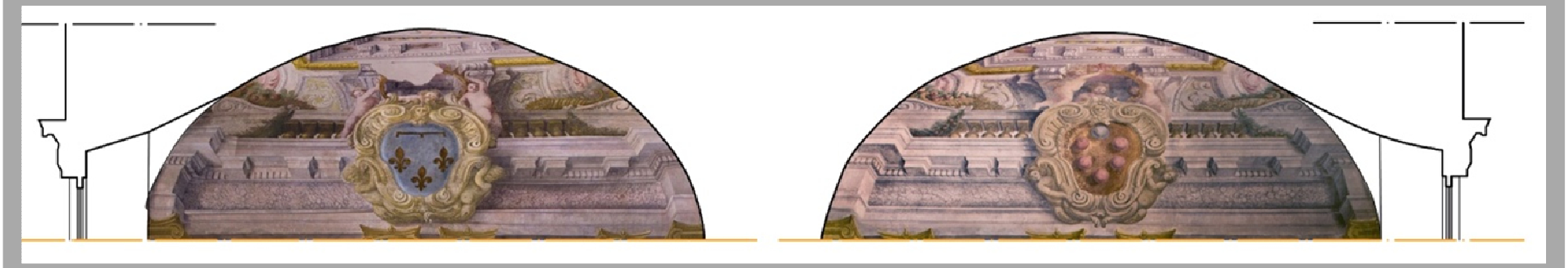
So, thanks to the snapshot we can complete the drawing of the vault, which we see here in a life size projection of the horizontal section.



This is the projection of the vertical sections



Orthophoto of the life size orthogonal projection of the vault, achieved by calibrating the photographic images, here in the horizontal projection.



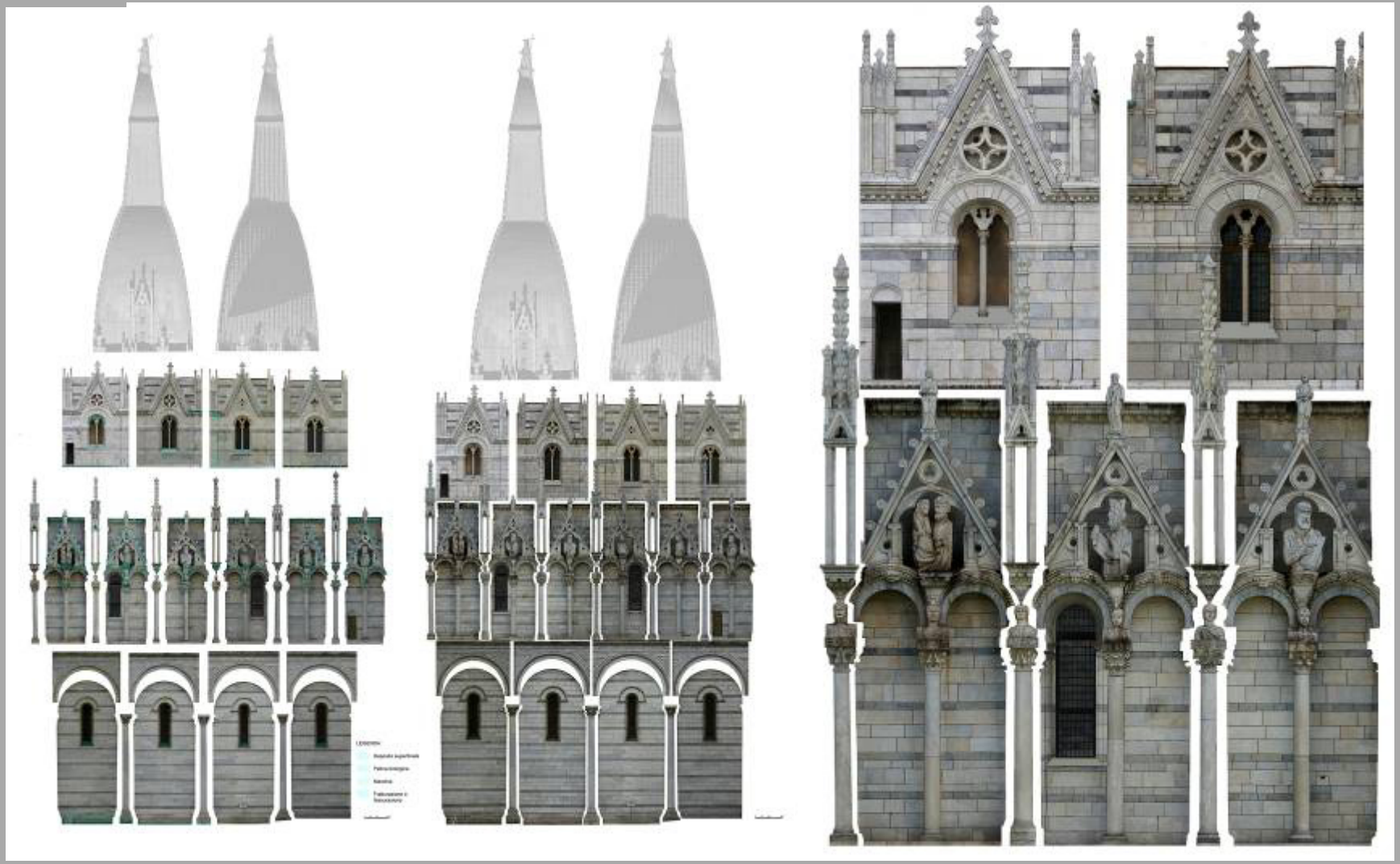
Here in the vertical projections

Purposes of virtually unrolling curved surfaces

The virtual unrolling of curved surfaces makes it possible to produce a graphic representation of the frescoes in life size from the CAD drawings of orthogonal projections.

Life size pictures, produced without using invasive methods, are often needed for restoration operations and in particular make it possible to create extremely accurate maps of the paintings.

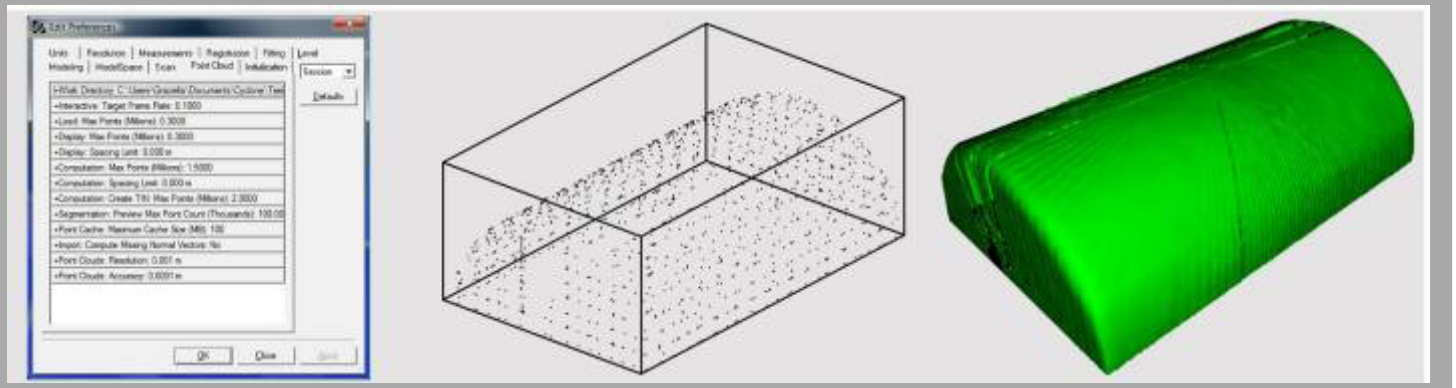
Drawings for measuring and monitoring cracks and studying structural deformation, but also for studying the perspective technicques used to create painted architectural elements.

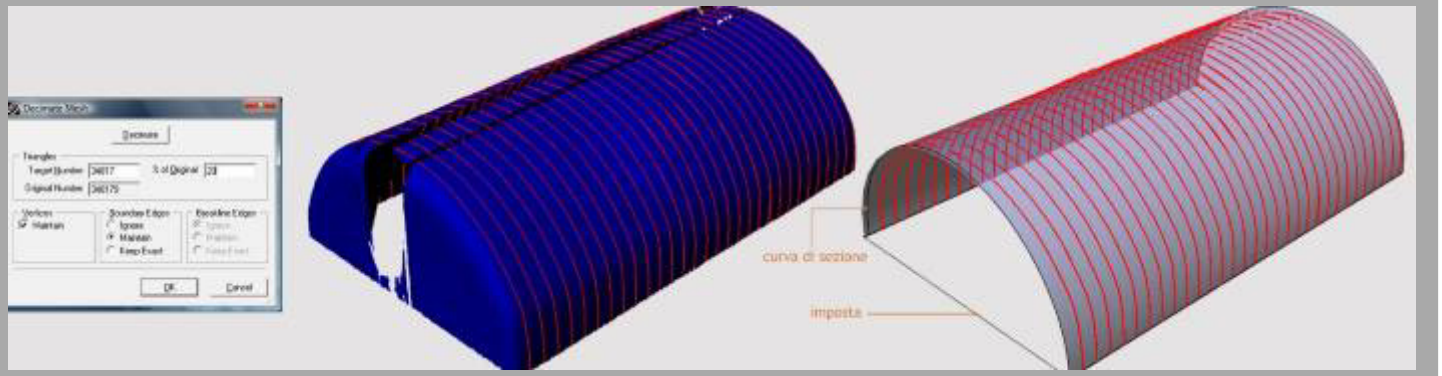


Reconstruction of Pisa Baptistery (circular layout)

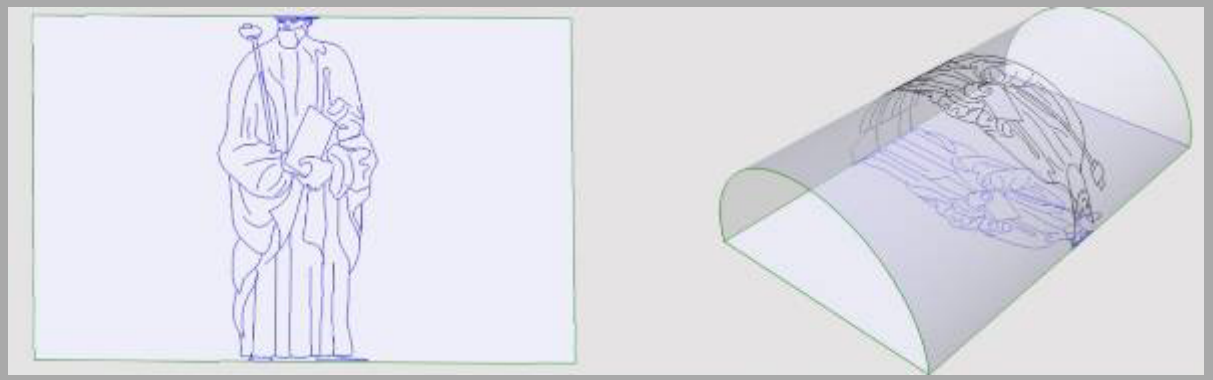
Detail of the facade

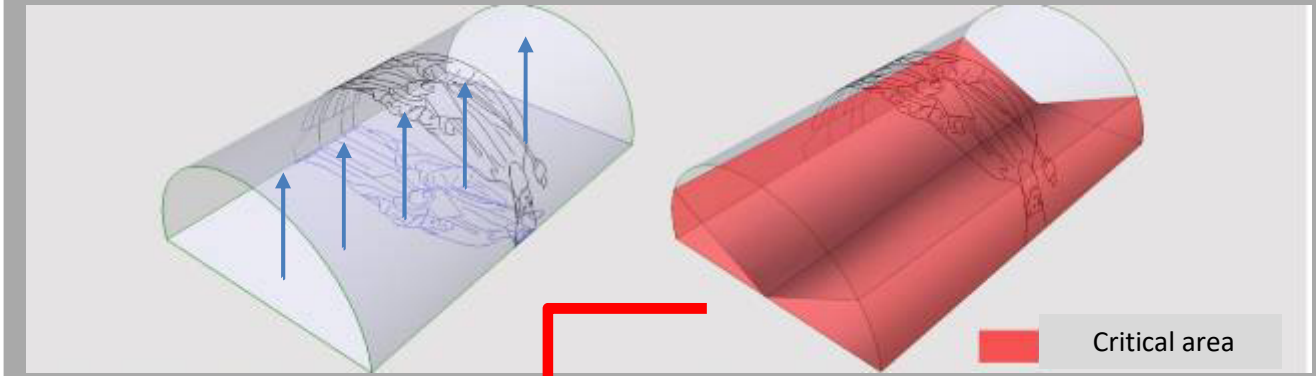
To unroll the painting a model of the vault needs to be made using the point cloud and breaking down the original data so as not to make it too heavy.





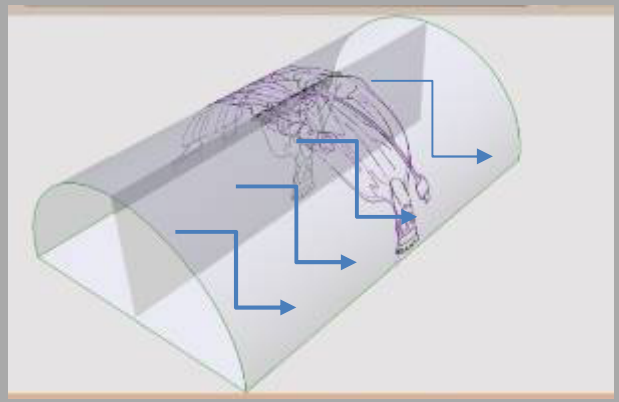
The model is then imported into Rhinoceros® and the design of the vault is projected onto it.





The projection onto a curved surface produces a critical area in the 0 to 30 degree segment

This is caused as a result of the choice of projection plane used to visualise the foreshortened view.
The critical area can even be seen in the photo.



A projection from the vertical plane must also be made to complete the missing part of the data and then proceed with the virtual "unrolling".

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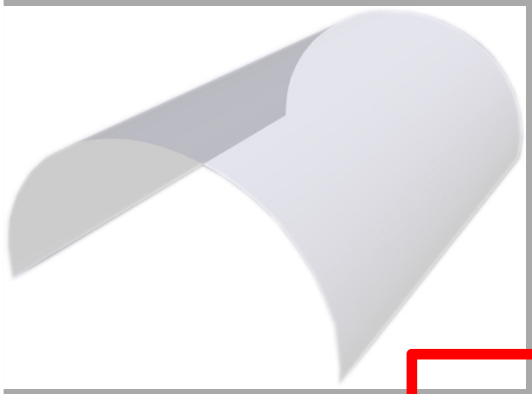
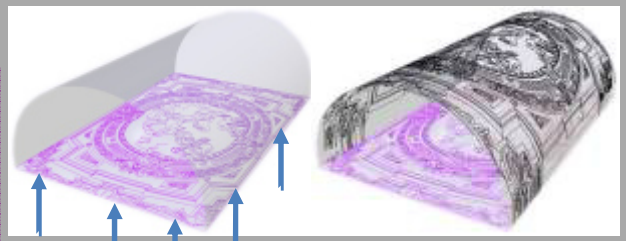
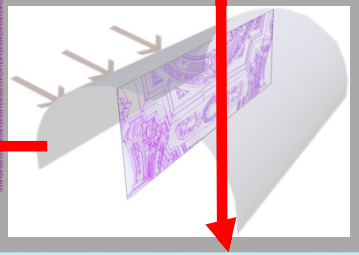
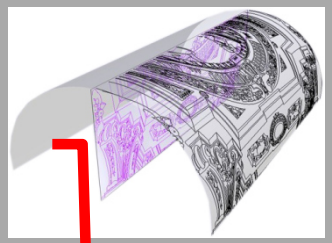
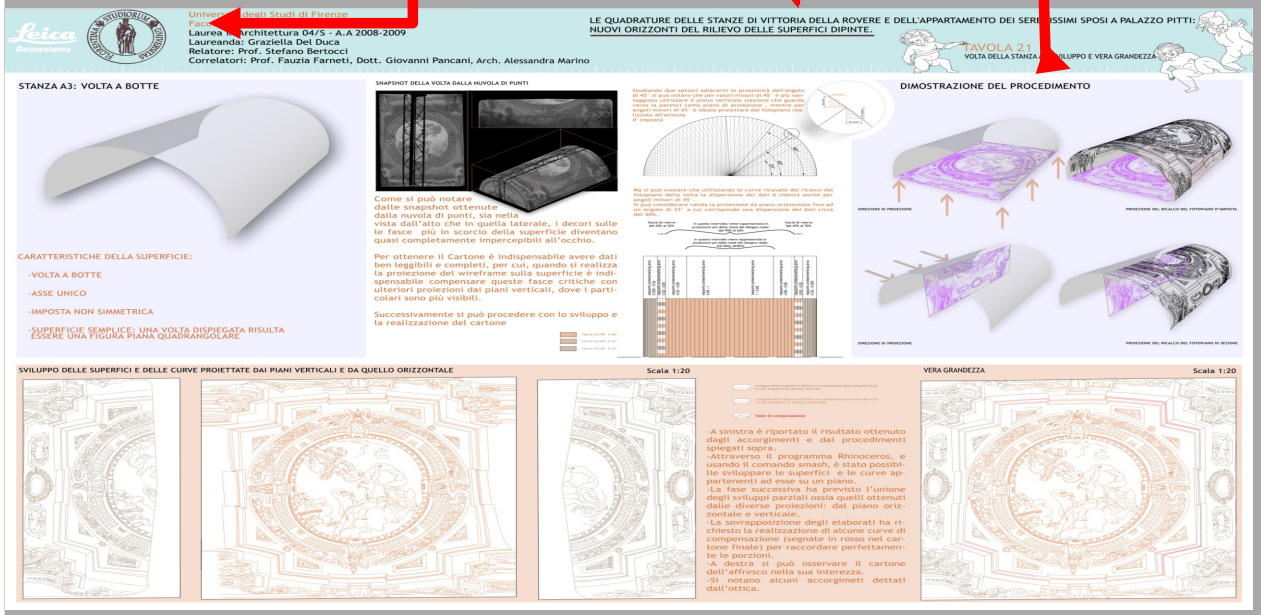
Barrel vault











STEP 1

Projection from the horizontal plane

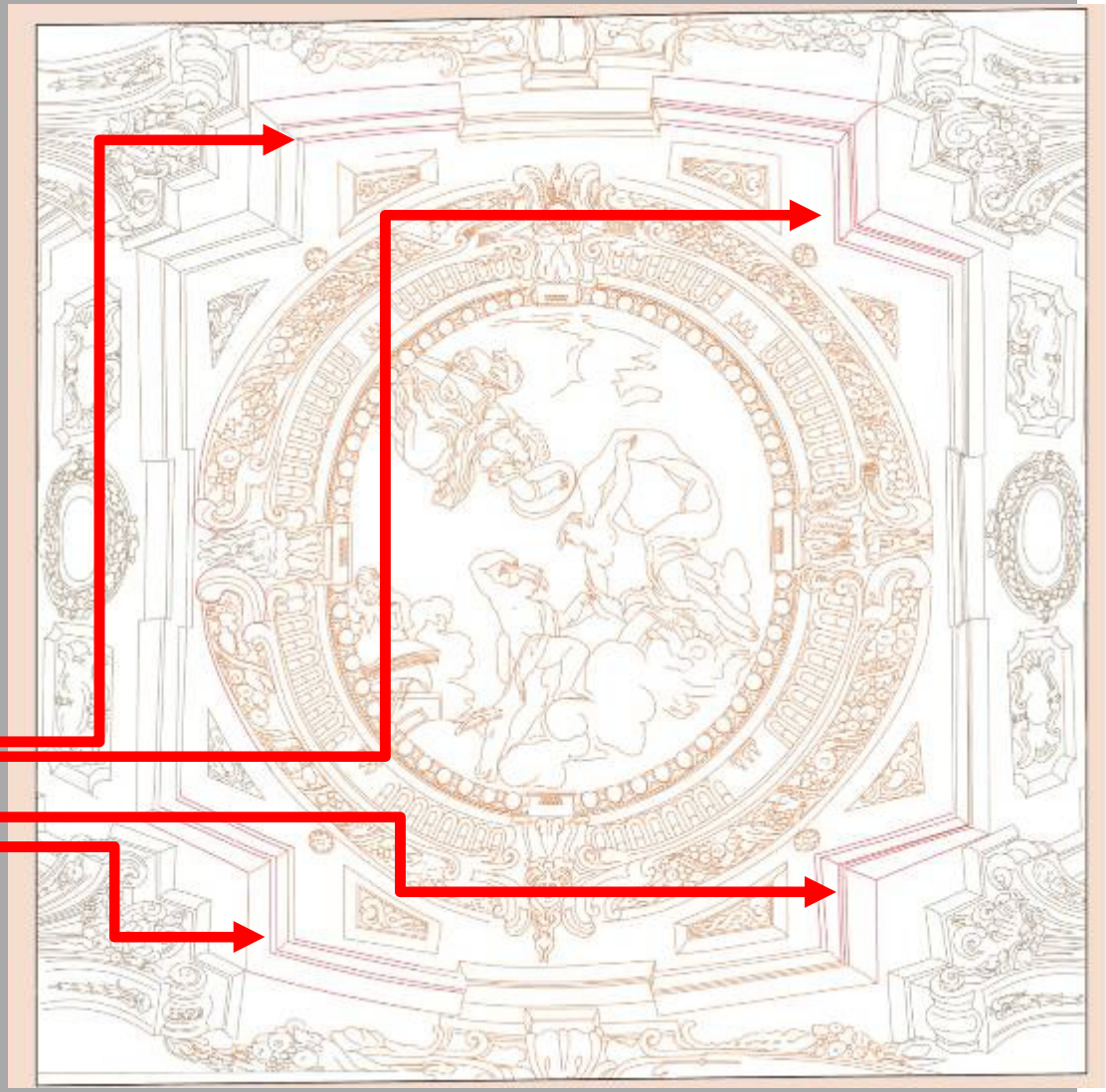
STEP 2

Integration of missing parts with projections from the vertical planes

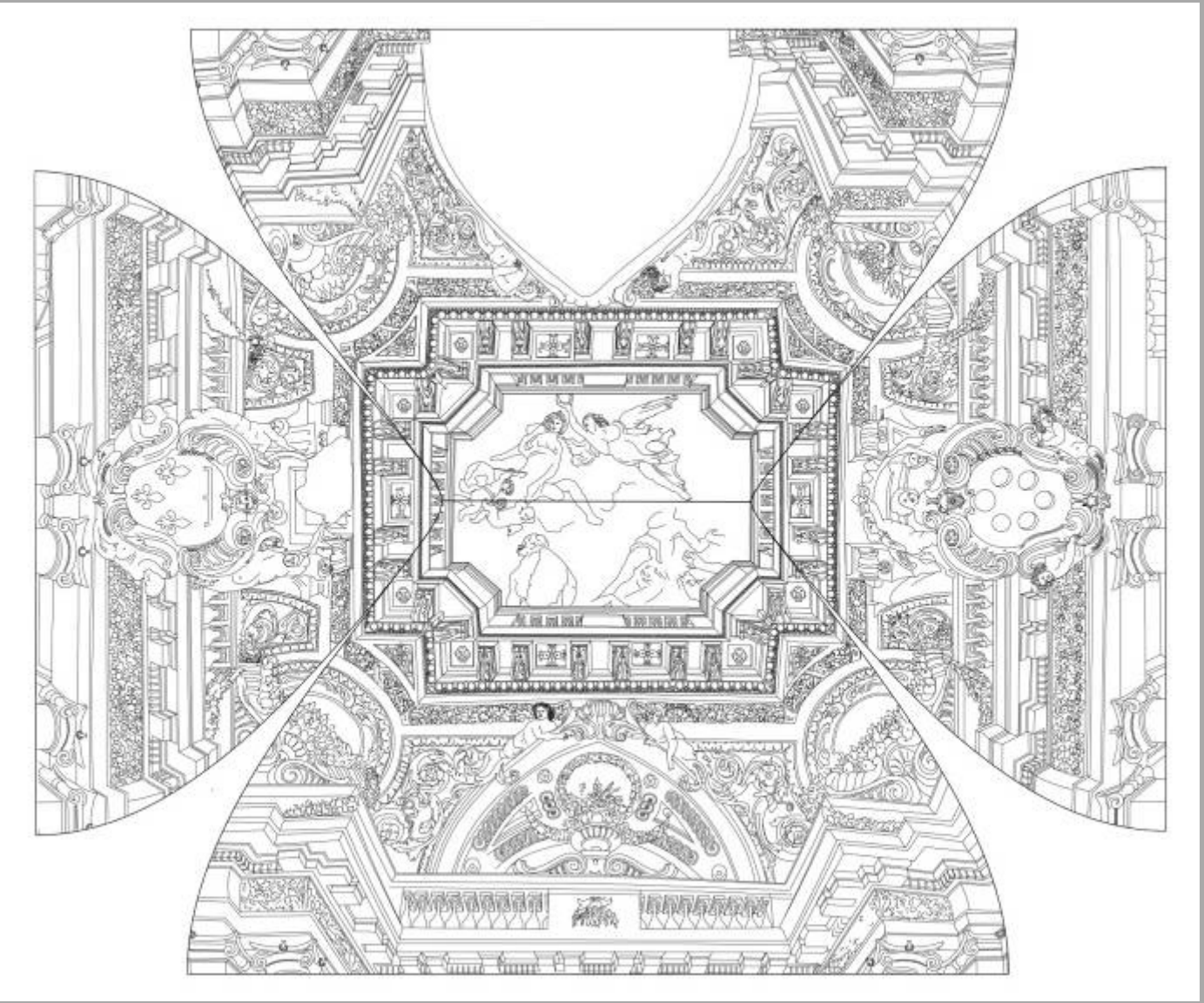
The unrolling operation is enabled using a Rhinoceros function.

"Smash" transforms the curved surfaces into a plane surface: the partial projections described in "step 1" and "step 2"are unrolled one by one and then….

....the three plane drawings are laid together taking care to join them accurately.
If necessary an interpolation between the lines that are not perfectly superimposed may be created.



The result is a two-dimensional reconstruction of the quadratura surveyed representing the frescoes on the vaults in life size!



Complete picture of the CAD drawing of the open cloister vault (unrolled)

After making the CAD drawing a high definition orthophoto of the vault can be made and calibrated onto the CAD drawing

The orthophoto only, made of high resolution images

For an extremely reliable orthophoto the calibration must be painstakingly accurate as can be seen from this detail.

This highly defined detail makes us appreciate the definition of the orthophoto as far as recognising the construction features of the fresco

After the vault hasbeen virtually unrolled a life size orthophoto can be calibrated over it so as to appreciate the finer details. The example shows the vault of Vittoria Della Rovere's chamber.

Detail of the orthophoto with CAD drawing and photographic image only.

This highly defined detail makes us appreciate the definition of the orthophoto as far as recognising the construction features of the fresco and the signs of decay

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Thank you

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