

Enter the Past/CAA2003  
Vienna, Austria  
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**SESSION: VIRTUAL REALITY**

# Photorealistic 3D modelling of a Byzantine Crypt

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## Outline

- Introduction
- Project motivation and requirement
- Some of the 3D model building steps
- Results
  - Multimedia CDROM
  - Movie: Carpiniana
- Conclusions



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<http://siba2.unile.it>

*SIBA Coordination*, directed by Virginia Valzano, is the structure of the University of Lecce that co-ordinates, manages and develops the Telematic Information System for Research and Education.

It moreover coordinates the development of the University libraries computerization and of the relations with other national and international Universities and Research Centres for the achievement of information systems and other shared projects.



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## SIBA Laboratories

- **Server Laboratory**
- **Laboratory for the acquisition and processing of bibliographical and documentary information**
- **Laboratory for the digital acquisition and processing of images**
- **GIS Lab (Geographic Information Systems)**
- **3D Lab (acquisition and processing of three-dimensional images)**
- **Multimedia Laboratory including an audio-video recording studio**
- **Didactical laboratory equipped for recording and simultaneous translation**



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# Coordinated project of Catania and Lecce Universities I17,I18,I21

- The project foresees the digital acquisition and processing of bibliographic and documentary information
- Digital reproduction of archaeological objects and finds of particular importance
- Acquisition and processing of images and three-dimensional models and environments, for restoration and virtual reconstruction.

<http://siba3.unile.it/ctle/>



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## Coordinated project of Catania and Lecce Universities I18

### 3D Database Project Objectives

Digital acquisition, processing, virtual restoration and three-dimensional reconstruction of archaeological finds, architectural structures, sites and objects of high historical and artistic value, as well as the preservation, enhanced knowledge and increased accessibility.



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# "3D Database" Project

## 3D ARCHEO



Digital acquisition and reconstruction of three-dimensional models of structures and environments of subterranean and sub divo Byzantine churches of the Salento Peninsula.

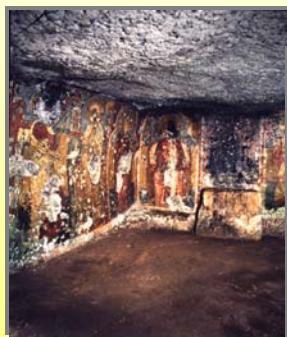


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## 3D BIZANTINO

Crypts in the Salento Peninsula



Nardò (LE)



Supersano (LE)



Veglie (LE)



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## Project Motivations

Site documentation in case of loss or damage

- Complete high-resolution 3D model (shape and appearance) of present state
- The old pillar inside the Crypt is cracked
- Water infiltration from raw sewage is entering the Crypt through the walls.

Virtual tourism & Remote study

- Interaction without risk of damage
- *Virtual restoration*: frescoes & original setting
- Educational resource (CDROM, DVD, Web)



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## Project Requirements

As a user: Practical, Effective & Convivial

- Work can be performed by non-experts
- Based on commercial tools
- Image editing without re-doing the texture mapping, e.g. virtual restoration
- **High** geometric resolution, accuracy and photo-realism



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## 3D BIZANTINO: 3D Crypts

Santa Cristina Crypt, Carpignano (Italy):  
View of 2 entrances leading to the crypt



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## Some photographs

A view inside the Crypt



Pillar

Baroque  
Altar

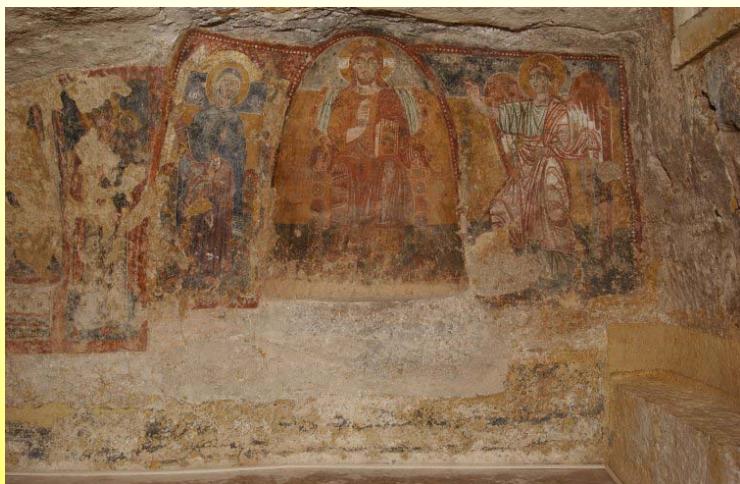
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# Some photographs

The Theophylact group (959 AD)



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## From Preparation to Actual Models

- *Determine uncertainty, resolution!*
  - *Shape:  $Z_{off} \approx 2.5 \text{ m}$ , Depth uncert.  $\sigma_z \approx 0.5 \text{ mm}$ , Lateral resolution  $\Delta x, \Delta y \approx 5 \text{ mm}$*
  - *Texture:  $\delta x, \delta y \approx 0.5 - 1 \text{ mm}$  (Inscriptions)*
- Time to acquire 2D images, range images and build the 3D models
- Pick adequate techniques: Photogrammetry, Laser scans...

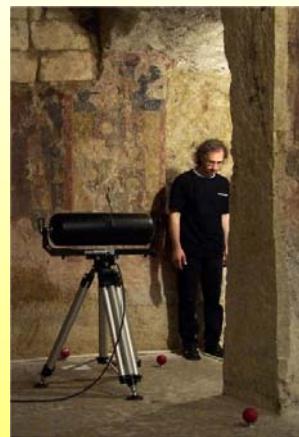
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# Tools

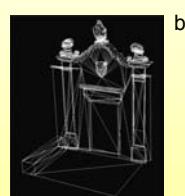
- Mensi-Laser scanner
  - Distance: 0.8 - 10 m
  - Uncertainty: 0.6 mm at 4 m
  - Scanning speed: 100 pts/sec
- Polyworks Modeler
  - Align, Merge, Edit, Compress
- ShapeCapture
  - Photogrammetry & Texture



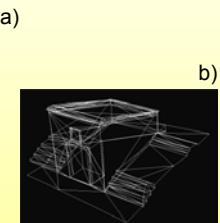
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## Entrances to the Crypt: Built with photogrammetry



Main entrance:  
a) Photograph, b) mesh, c) model with texture.



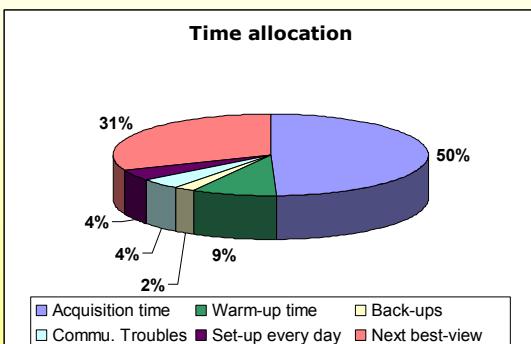
Second entrance:  
a) Photograph, b) mesh, c) model with texture.



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## Time allocation during scan session



Total of 92 hours in the Crypt (20-80 min/image)

- Crypt: 50-3D images
- Altar: 30-3D images
- Lateral resolution
  - Walls 5 mm
  - Ceiling & Floor 15 mm
- Uncertainty
  - Evaluated
    - 0.8 mm @ 2.5 m
  - Predicted
    - 0.5 mm @ 2.5 m



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## 3D models: beyond visualization

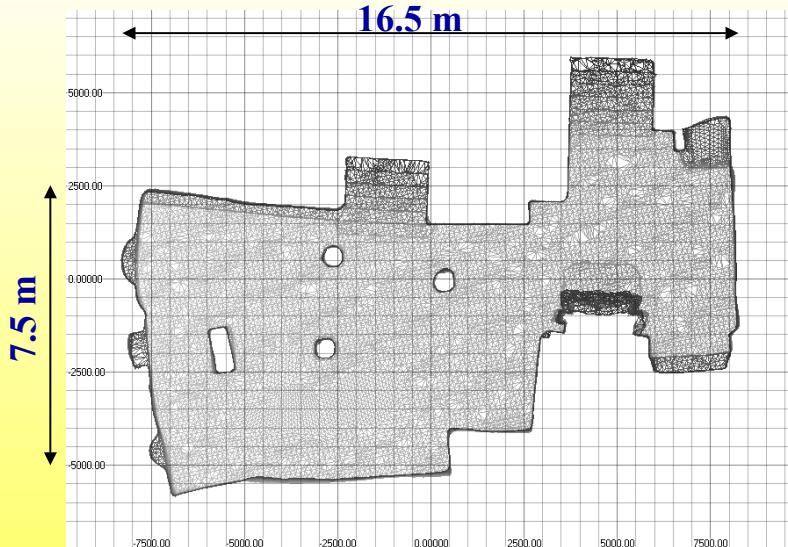
- A 3D model contains a wealth of information that can be analyzed and enhanced.
- The results can be used to enhance the understanding of a site using a multimedia CDROM.



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# Section of Crypt

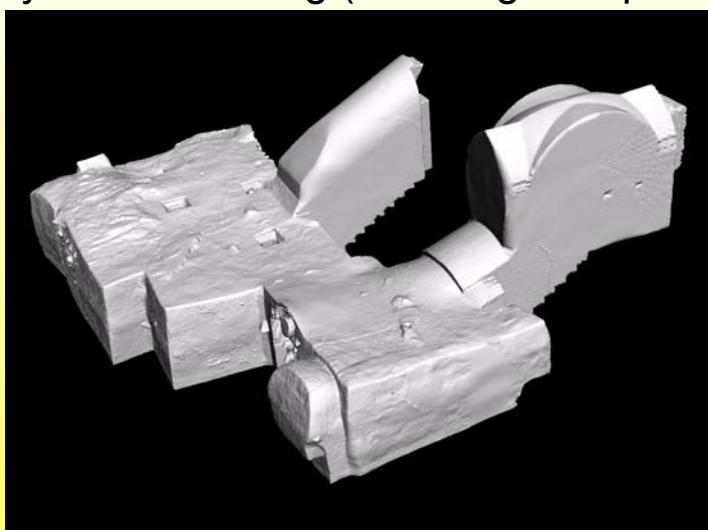


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View from the outside rendered using synthetic shading ( $\approx 12$  Mega 3D points)



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## Searching for the lost column

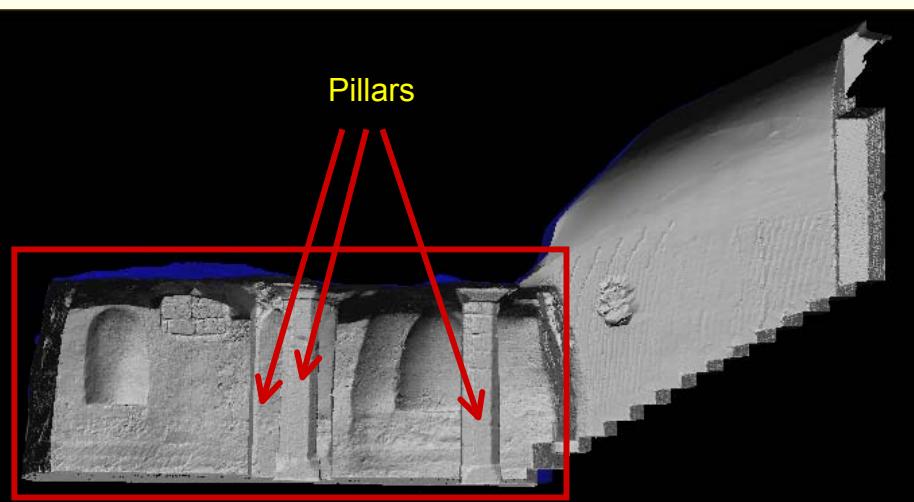


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## Cross-section of 3D model



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## Virtual restoration





[the crypt](#) | [location](#) | [history](#) | [site](#) | [frescoes](#) | [virtualization](#) | [movie](#) | [archive](#) | [exit](#)

# carpiniana

**Virtual representation of the Crypt of Santa Cristina in Carpignano Salentino**

## gli spazi

[◀ menu](#)

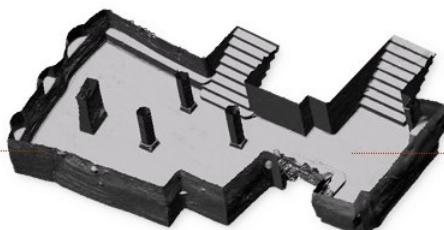
**Sezioni longitudinali AA e A'A'**

**Sezioni longitudinali BB e B'B'**

**Sezione trasversale CC e C'C'**

**Pianta quota +450 cm**

**Pianta quota -150 cm**



[zoom](#)

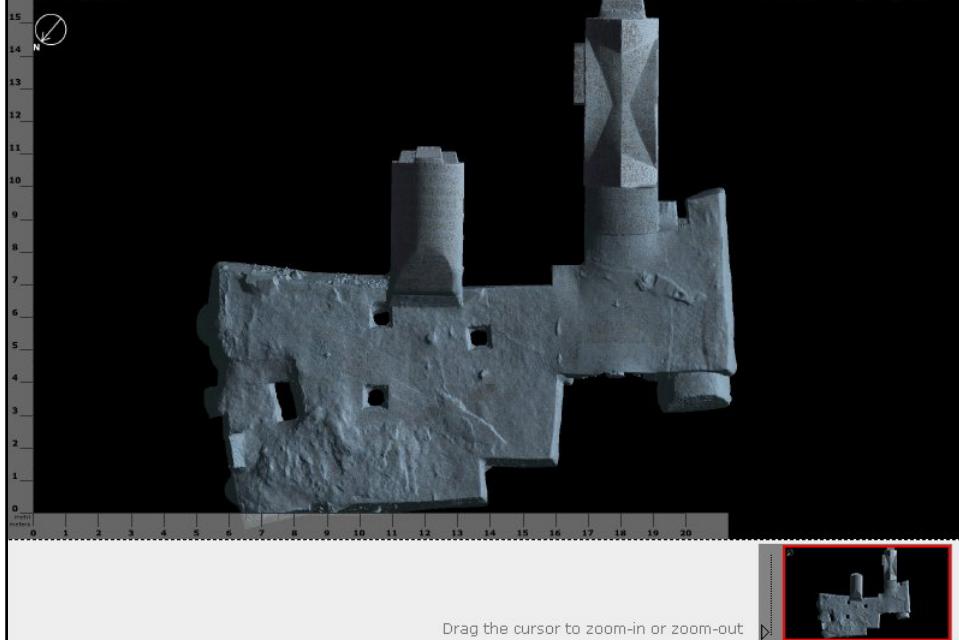
Selezione un piano di sezione  
o un livello di quota

# carpiniana

[la cripta](#) | [localizzazione](#) | [storia](#) | [spazi](#) | [affreschi](#) | [virtualizzazione](#) | [video](#) | [archivio](#) | [esci](#)

[zoom](#)

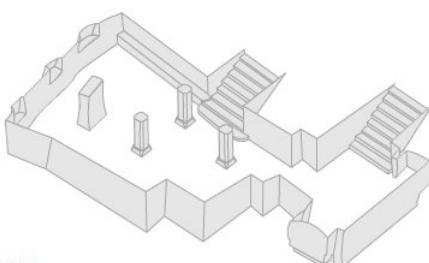
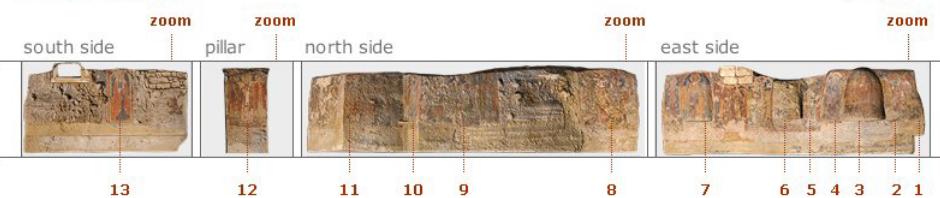
top view

[◀ back](#) [◀ menu](#)

Drag the cursor to zoom-in or zoom-out



## frescoes

[◀ menu](#)[more](#)

The crypt has frescoes all over the side walls.  
The frescoes are presented counter-clockwise  
in an almost chronological order.

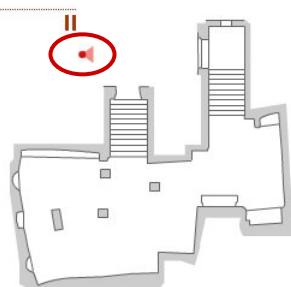
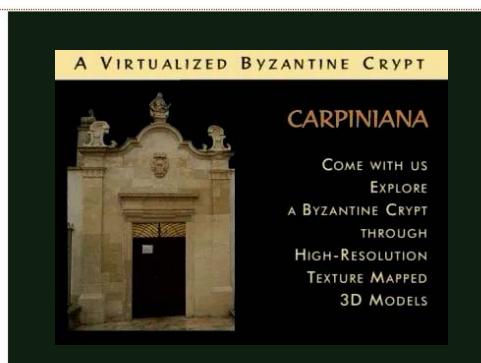
# cardiniana

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## frescoes



## movie



What you are about to see is  
not an actual footage!  
This movie shows a fly-through  
the 3D model of the byzantine  
crypt of Santa Cristina.

# carpiniana

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A VIRTUALIZED BYZANTINE CRYPT

CARPINIANA

COME WITH US  
EXPLORE  
A BYZANTINE CRYPT  
THROUGH  
HIGH-RESOLUTION  
TEXTURE MAPPED  
3D MODELS

ACQUIRED 3D IMAGES WERE ASSEMBLED  
INTO A SEAMLESS 3D MODEL

SHAPE INFORMATION WAS ACQUIRED  
AT A RESOLUTION OF 5 MM.

COLOR INFORMATION WAS ACQUIRED  
AT A RESOLUTION OF 1 MM.

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# Carpiniana: The Movie

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## Conclusion

- 3D Model building
  - Time to acquire a 3D model is predictable
  - Picking a suitable scanner is not easy
  - Not all surfaces can be measured
  - Copyright & Property are important issues
- Texture Mapping with photographs
  - Very valuable to art historians: virtual restoration, fruition
  - *Method should allow the mapping of other image types*
- *Release of the CDROM & Video to the scientific community and to the public followed by a survey will tell us "useful or not!"*



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