3D documentation of Cultural Heritage

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Cultural Heritage

- Implies the monuments, but also every kind of document or evidence of civilization
- Carrier of historic memory and ark of national and global civilization.
- Tangible and Intangible Cultural Heritage.

Cultural Heritage is in need of …

- **Documentation** (Geometric, Architectural, Historic etc.) – 2D/3D for archiving, studies, planning etc.
- Accuracy/**accurate measurements** (for restoration, reconstructions, structural studies, protection etc.)
- **Monitoring** of its state (materials, pathology etc.)
- Proper **Management** of its data (for sustainability, risk management etc.)
- **Preservation** possibilities (e.g. digital libraries etc.)
- **Public Outreach** (visualization, dissemination, awareness of the public …)
- …

Protection of Cultural Heritage

- Obligation of all generations
- Preservation of historic memory
- International Organizations for the protection of Cultural Heritage
  - UNESCO
  - ICOMOS (national ICOMOS chapters)
    - **CIPA Heritage Documentation** (with ISPRS)

Contemporary Digital Technologies

- ✓Instrumentation
  - ✓Digital Cameras (optical, thermal etc.)
  - ✓Scanners
  - ✓Satellite navigation and positioning systems (GPS)
  - ✓3D printers
- ✓Digital Data
  - ✓Images or Video
  - ✓Points in 3D space
- ✓H/W & S/W
  - ✓3D data processing
  - ✓Image processing
  - ✓GIS - MIS

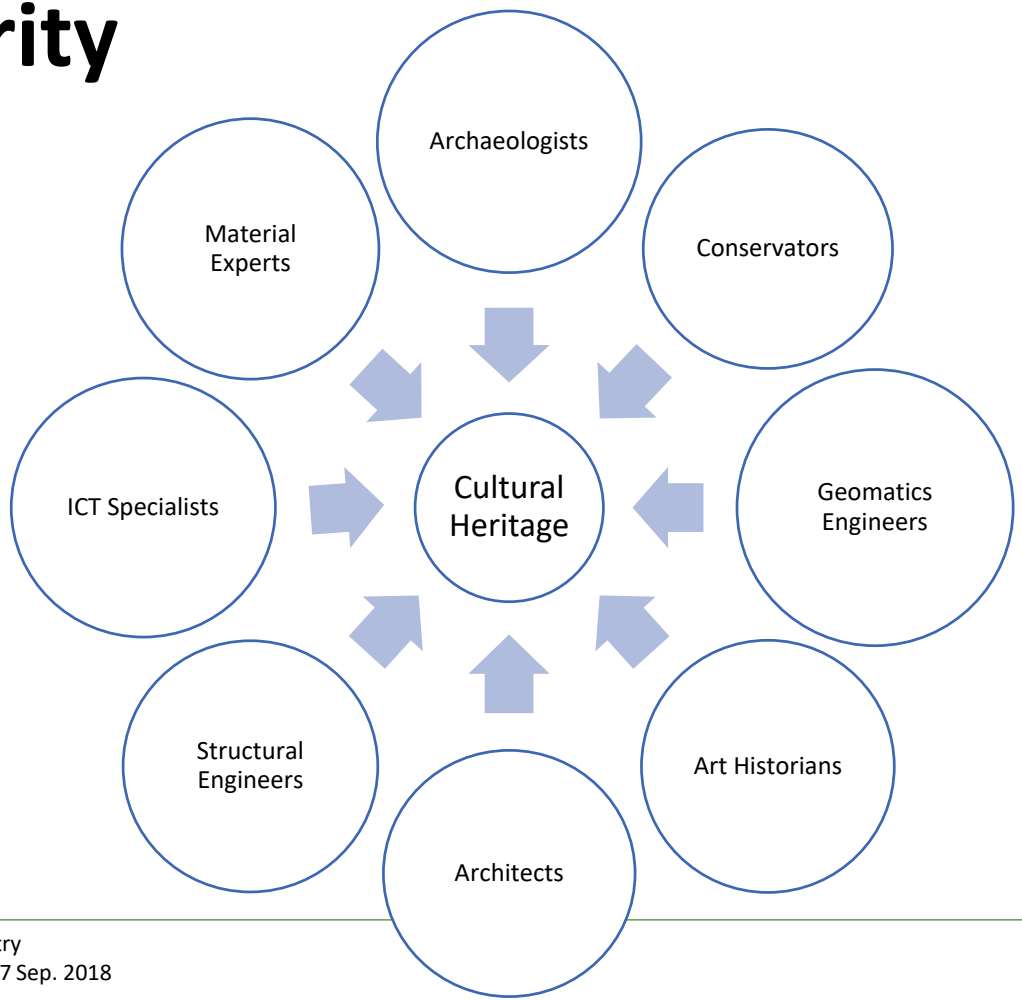
Automation

Speed

Accuracy improvement

New alternative products

Interdisciplinarity



NATIONAL TECHNICAL UNIVERSITY OF ATHENS
Interdisciplinary Research Group for the Monuments Protection

Rehabilitation of the Holy Aedicule of the Tomb of Christ in the Church of the Holy Sepulchre in Jerusalem

Scientific Coordinator:
Prof. A. Moropoulou

Interdisciplinary Research Group NTUA:
Prof. E. Korres, School of Architecture Engineering NTUA, Former Director of the Interdisciplinary Postgraduate Programme "*Protection of Monuments*"
Prof. A. Georgopoulos, School of Rural and Surveying Engineering NTUA, Laboratory of Photogrammetry
Prof. A. Moropoulou, Director of Studies in the NTUA Interdisciplinary Postgraduate Programme Direction «*Conservation Of Building Materials*», School of Chemical Engineering NTUA, Laboratory of Materials Science and Engineering
Prof. C. Spyrakos, School of Civil Engineering NTUA, Laboratory for Earthquake Engineering

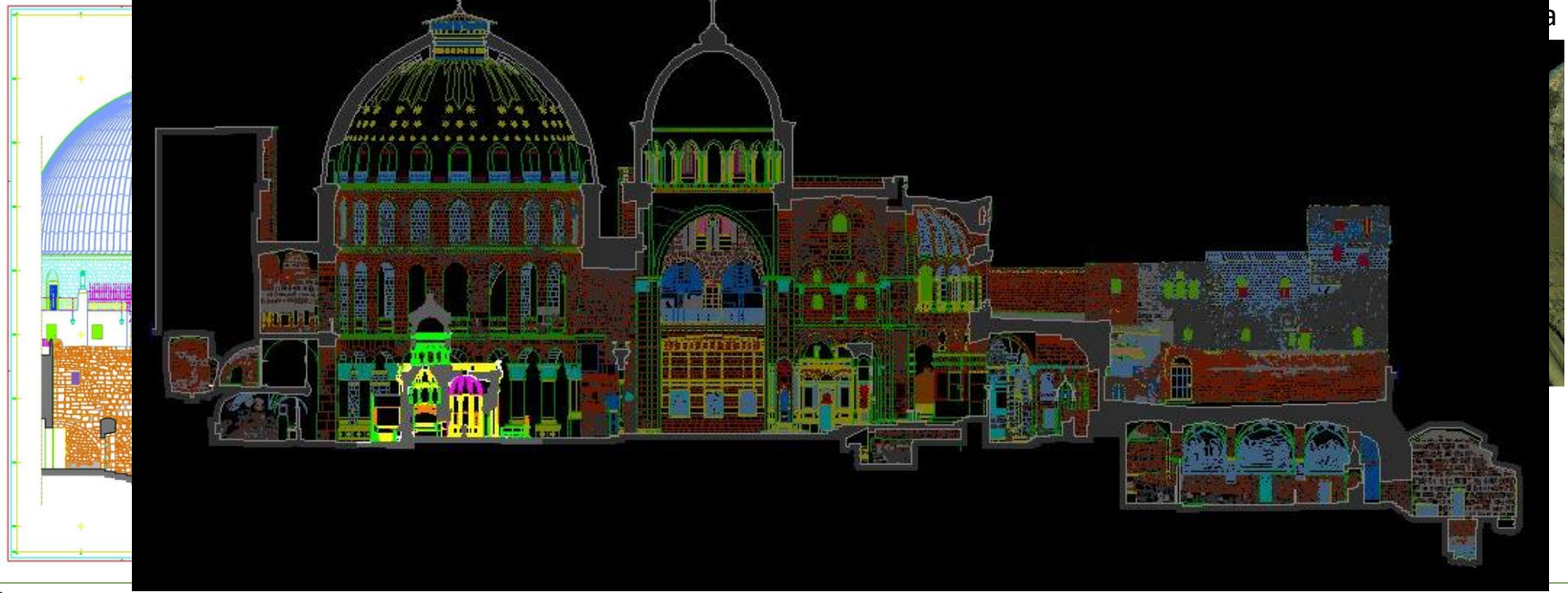
The contribution of the Geometric Documentation to the Rehabilitation

Integrated Documentation of the Church of the Holy Sepulchre

Previous documentations

1993-1999, ΕΜΠ & ΕΚΠΑ

D.-D. Balo



The Tomb of Christ is a living monument for all Mankind

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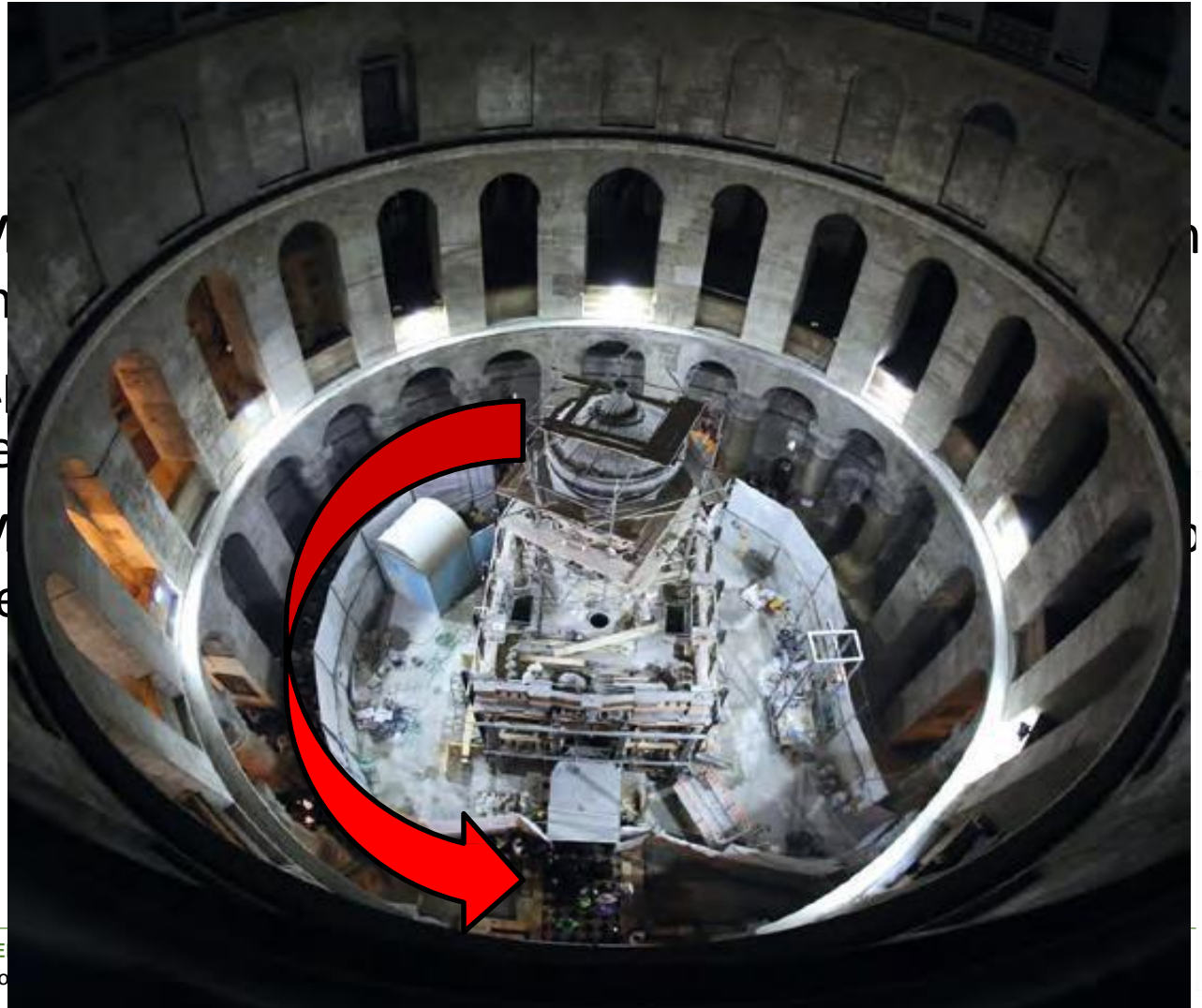
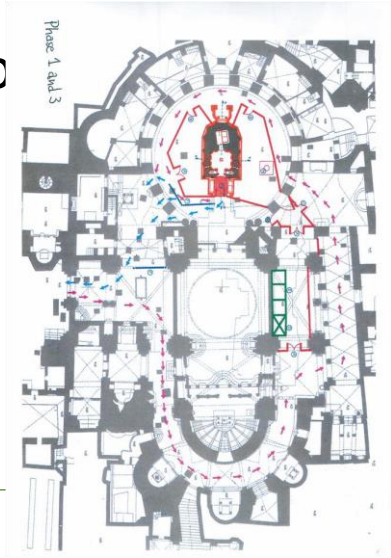
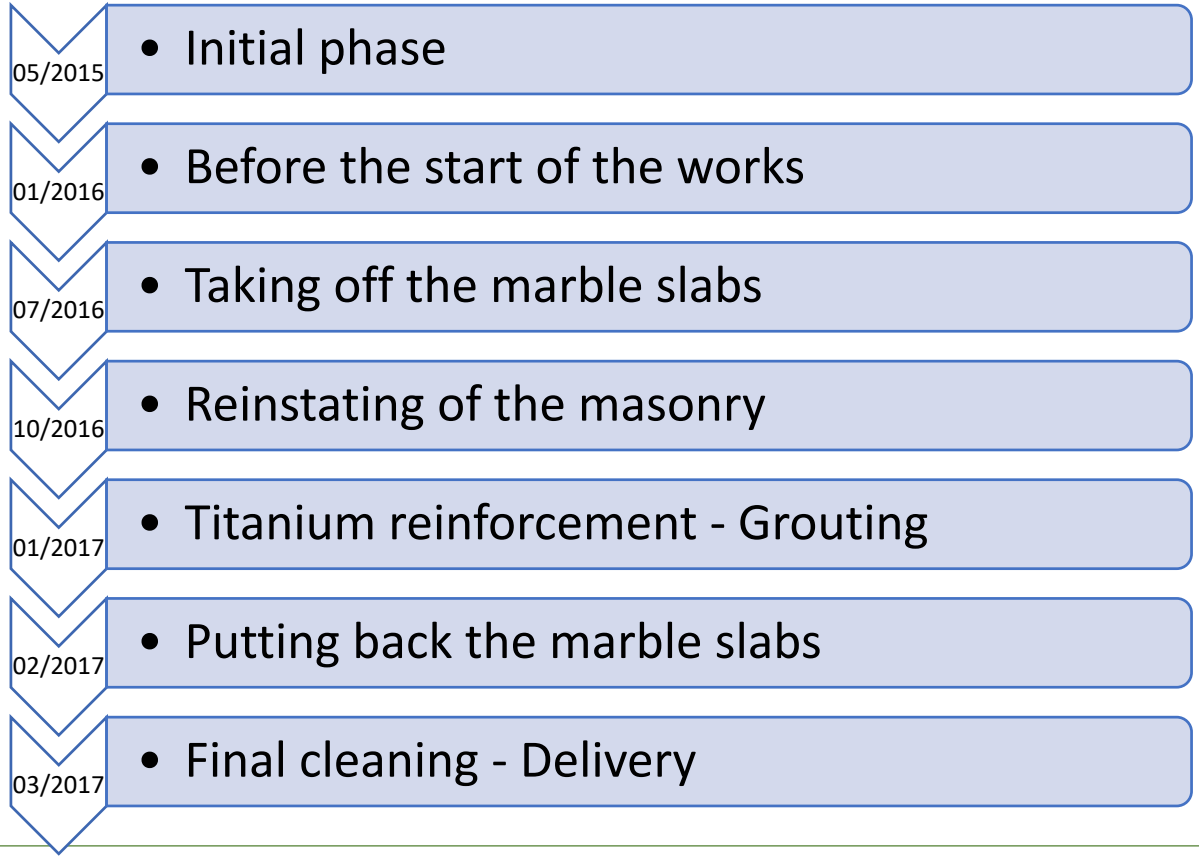




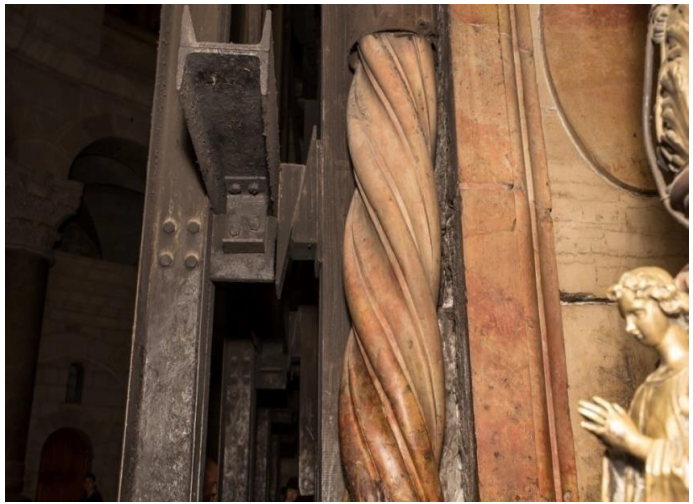
Continuous geometric Documentation of phases of the project

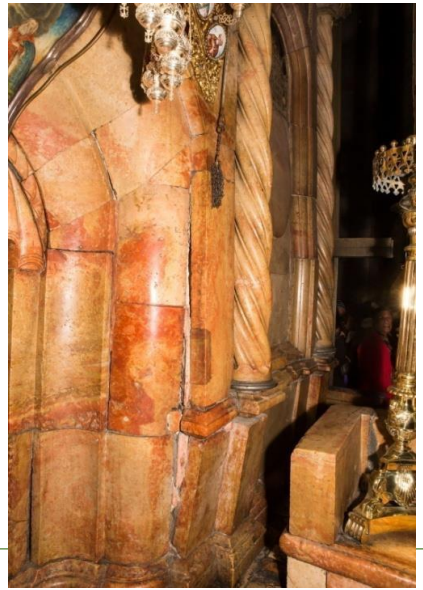


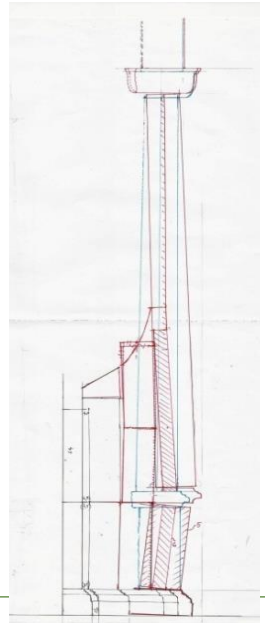
Deformations of the Holy Aedicule

The cause of the deformation is the **deterioration (swelling) of the mortars** caused by:

- **water precipitation** through the open oculus of the dome above the Aedicule, until 1870 (historic cause)
- **the uptake through capillary rise from the surrounding water canals and underground voids,** as investigated by NTUA, which is the **main source of humidity**.



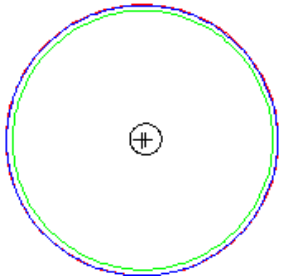




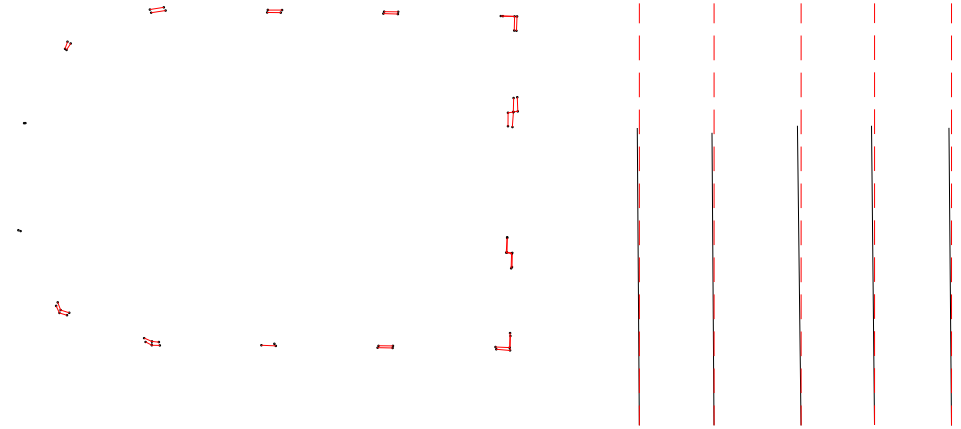
(Em. Korres, 2015).

Assessment of the Deformations of the Holy Aedicule

High precision geodetic measurements



The outer dome of the Aedicule is vertical without significant deviations



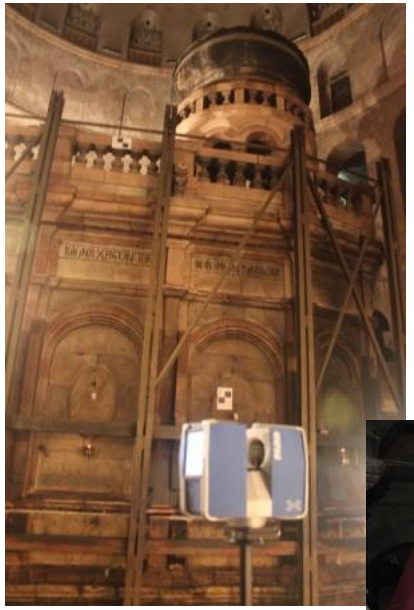
Deformations of the iron cage (British Mandate 1947)

The iron cage is deformed. Pillars present deviations from the vertical 4-9cm

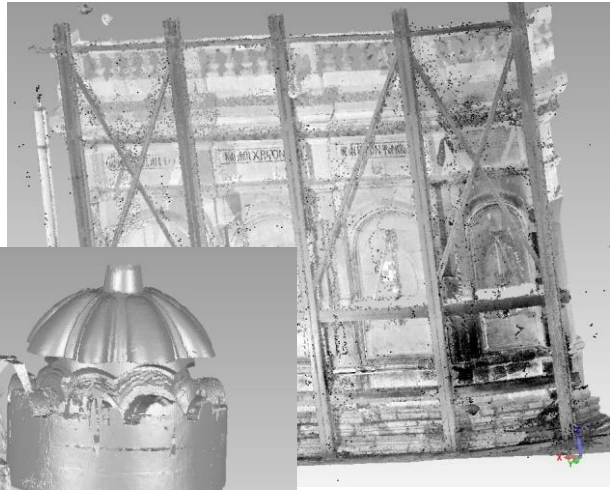
May 2015: Creation of a textured 3D model using high resolution digital images

The 3D model of the outer dome with and without texture

January 2016: Creation of a 3D model using terrestrial laser scanner



Outside



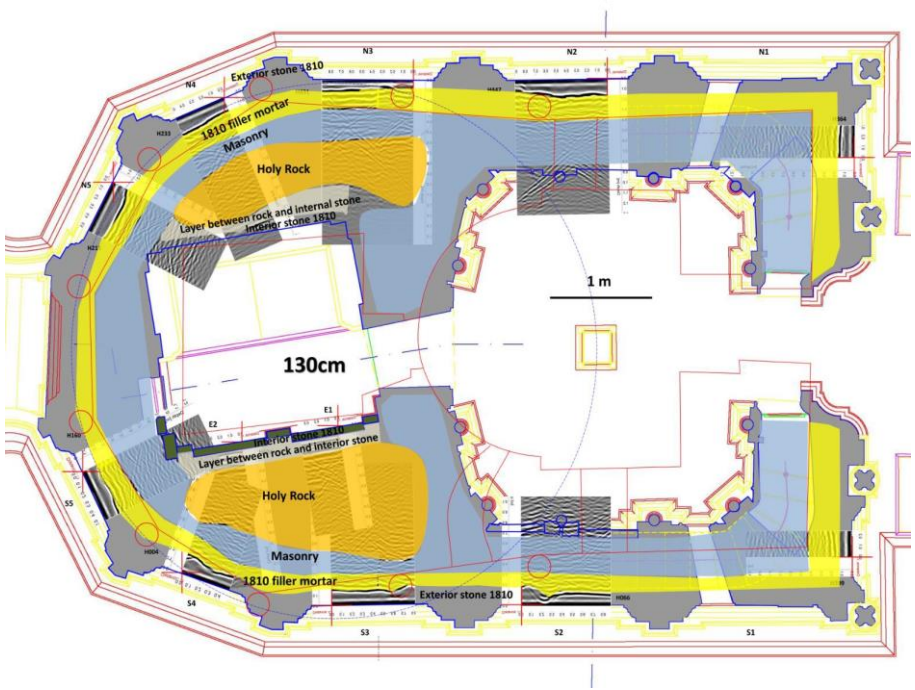
This model was used by the Lab of Earthquake Eng. of NTUA for structural evaluation with FEM software

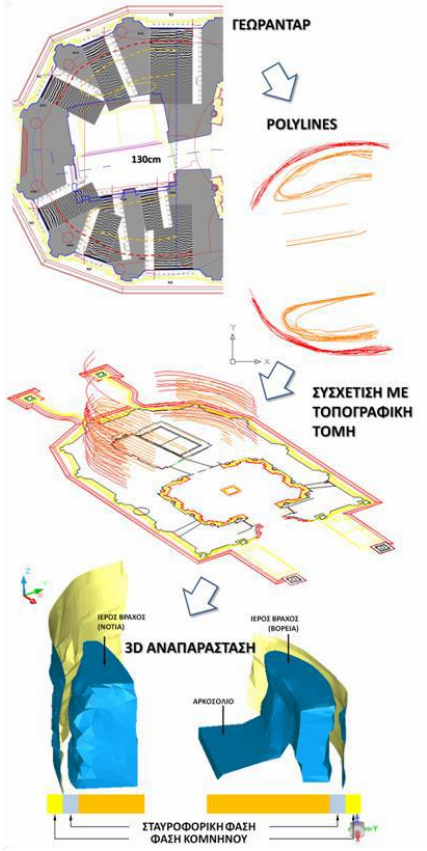
Initial State of the Monument in 2016

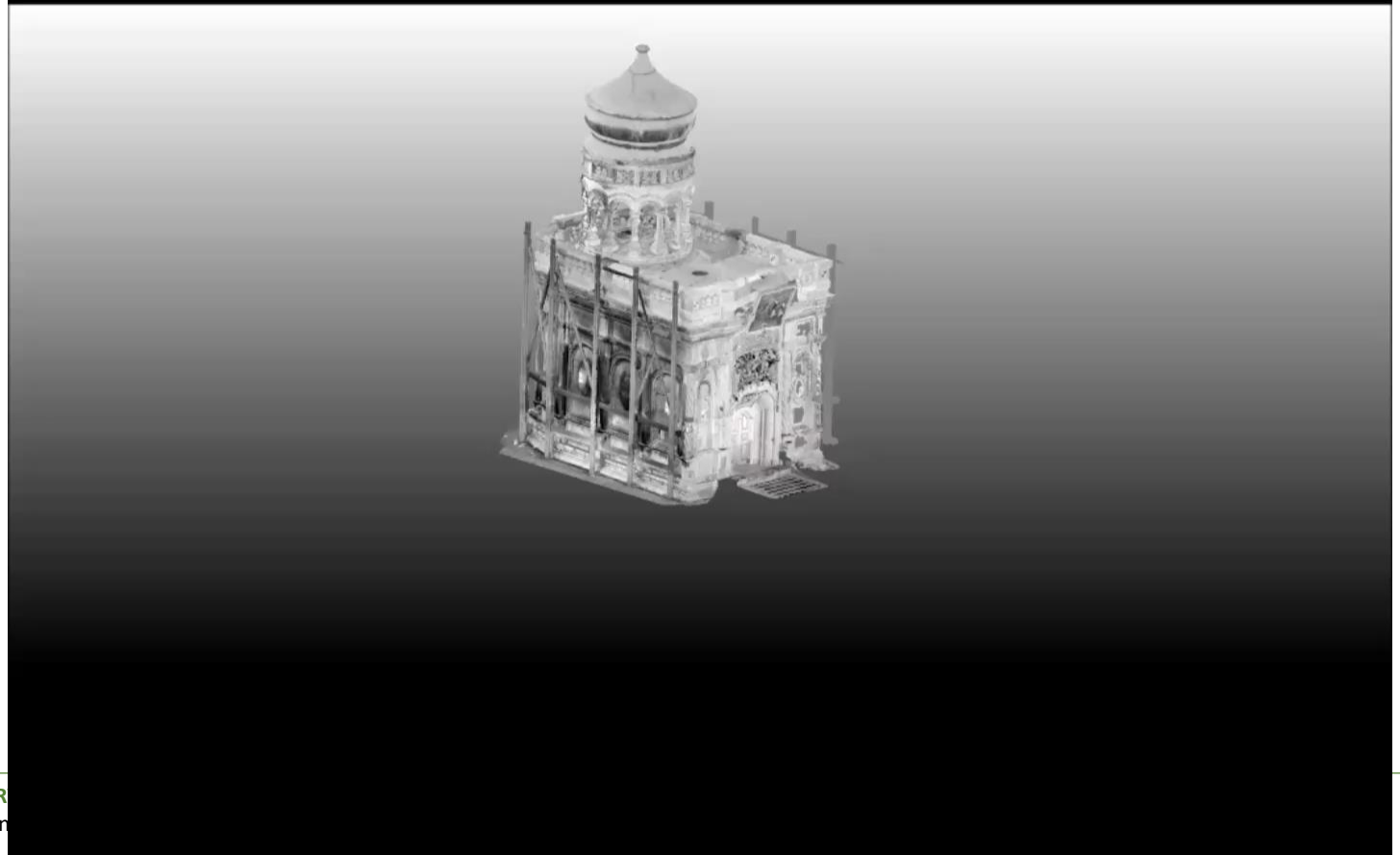
Investigation of non visible layers of the Holy Aedicule

- ***Non-destructive projection of the inner structure of the HA using GPR***
- ***Documentation of the construction Phases***

The 3D reconstruction of the monument allowed for the estimation of the quantity of the restoration and rehabilitation materials





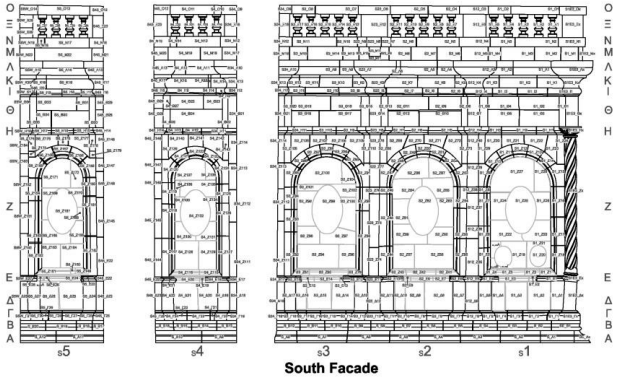


Dismantling and Removal of the Stone Panels

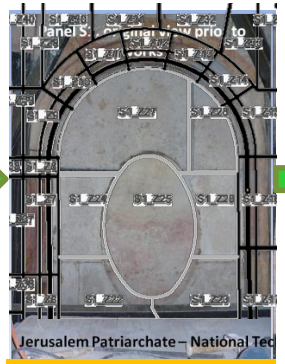
NTUA PHOTOGRAMMETRY

☑ 20.07.2016

Drawing from the 3D GD

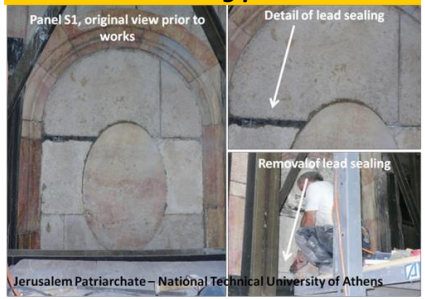


South Facade

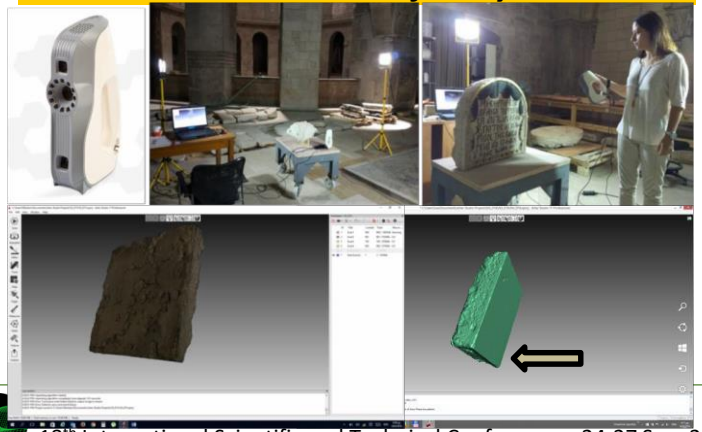


Each stone with code

Dismantling process



3D documentation of every stone

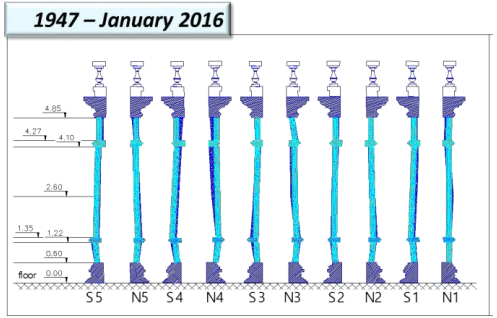


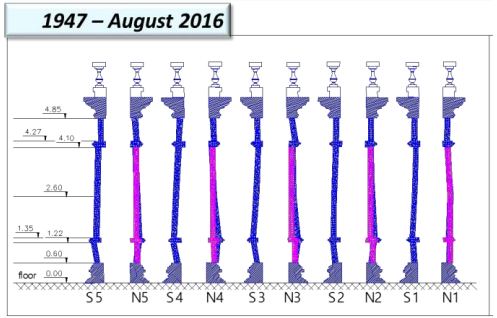
Removal of stone slab, transportation to conservation lab

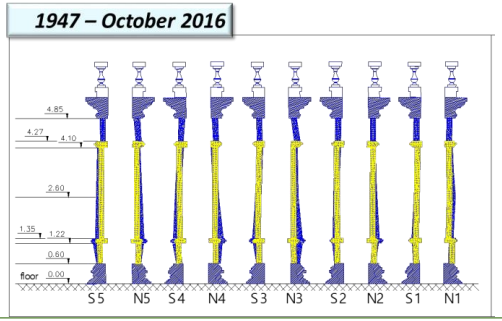
Resetting of Exterior Columns

Process of a column repositioning

Assessment of reduction of deviations from verticality during the works



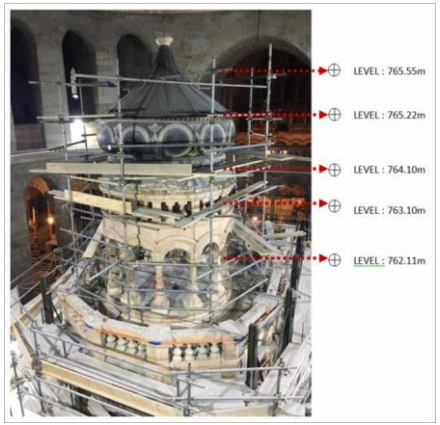


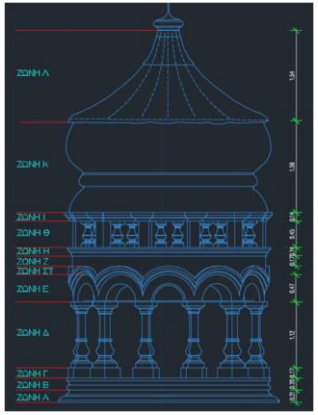


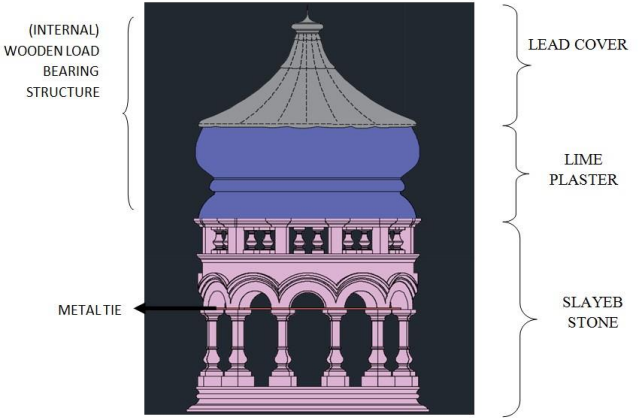
☑ 11.11.2016

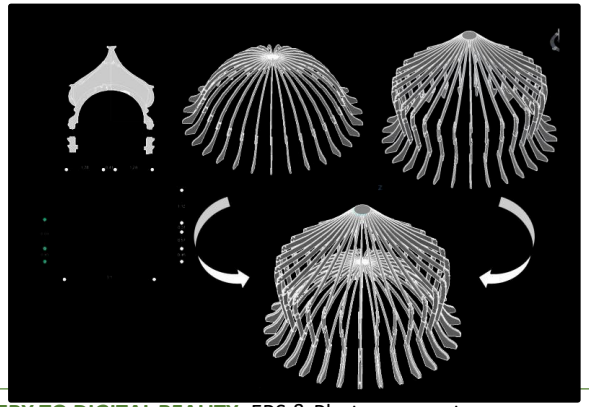
One of the basic requirements, **prior to the reassembly of the panel slabs and the addition of the filling mortar**, between the masonry and the stone panels, is the **resetting of the dislocated columns**.

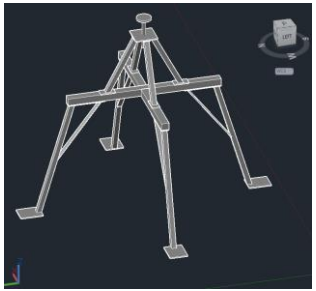
3D Representation and Structural Analysis Formed the Basis for the Design of Conservation, Reinforcement And Restoration Interventions







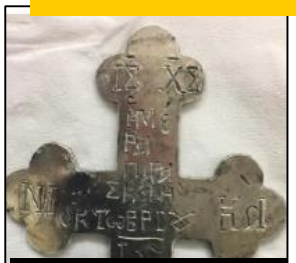




Georeferenced architectural analysis coupled with geometric and materials characterization data

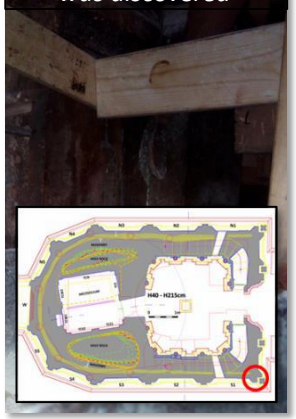
3d Representation of the Onion Dome internal wooden structure

Komnenos' restoration signature found at the SE cornerstone of the Holy Aedicule (15 Oct. 1809)



Komnenos cross after conservation interventions by the conservators

Area where the cross was discovered

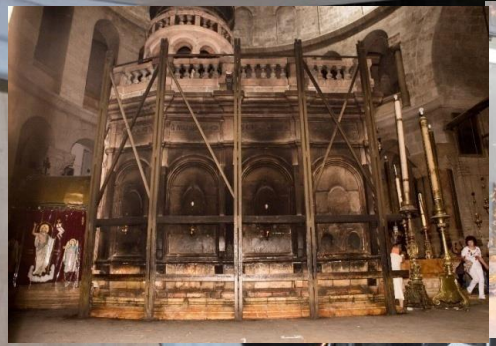


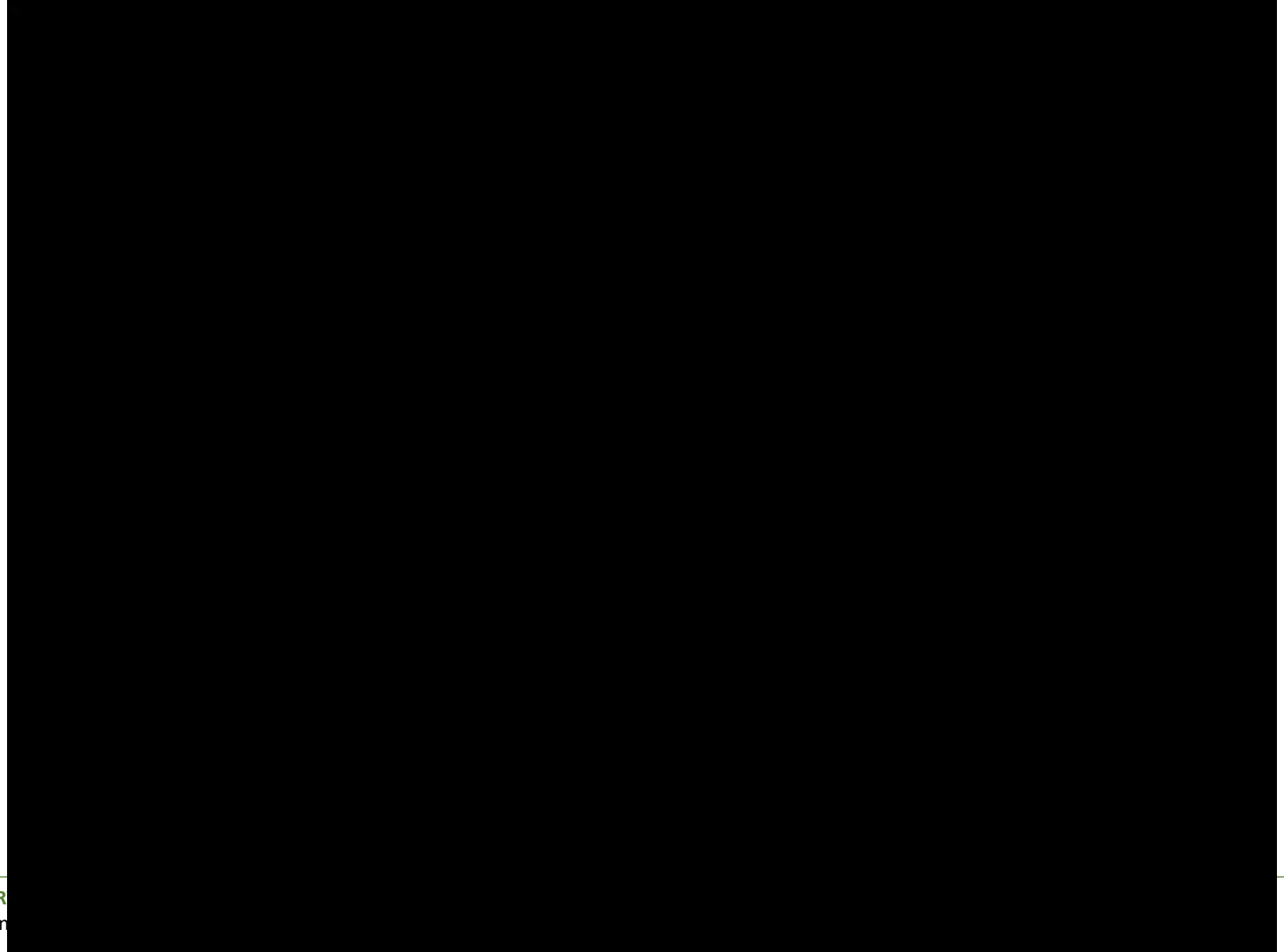
Design by NTUA Photogrammetry team through inverse photogrammetry

A golden cross, copy of the Komnenos cross, installed on the top of the rehabilitated onion dome of the Holy Aedicule of the Holy Sepulchre

*Removal of the **iron frame** installed by the British (1947)*

☑ **23.02.2017**

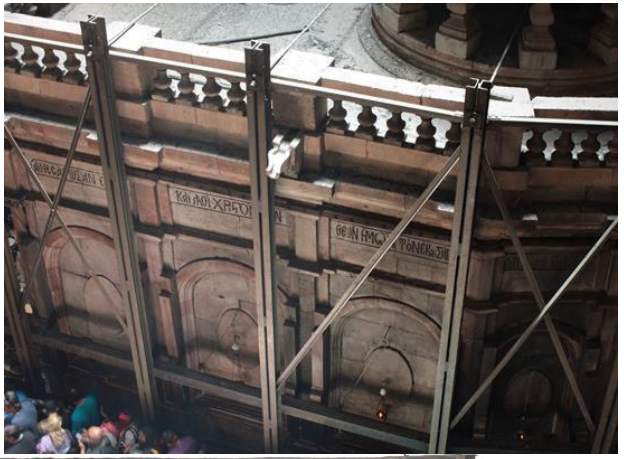




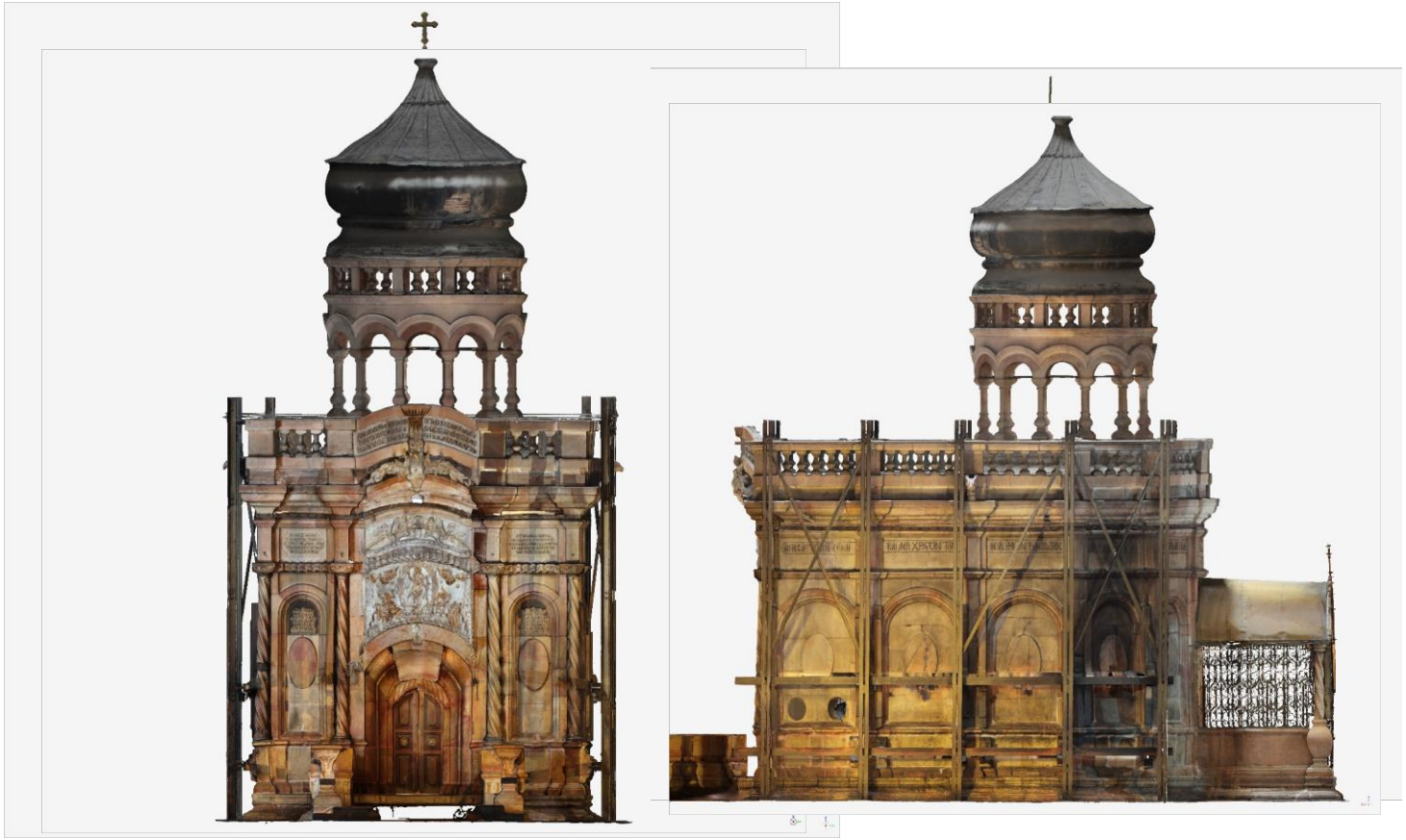
Specimens of Orthophotos

Photography Oct. 2016

The Holy Aedicule before and after its Rehabilitation



The Holy Aedicule before and after its Rehabilitation



The Holy Aedicule before and after its Rehabilitation


May 2015