tufe2018

HIGH-LEVEL INTERNATIONAL INTERDISCIPLINARY CONFERENCE

Eugenides Foundation, Athens Greece,
7-10 November 2018

“Towards an INCEPTION (Inclusive Cultural Heritage in Europe through 3D semantic modelling) HBIM creation”

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President of the General Assembly - Technical Chamber of Greece

ΤΕΕ
ΤΕΧΝΙΚΟ ΕΠΙΜΕΛΗΤΗΡΙΟ ΕΛΛΑΔΑΣ

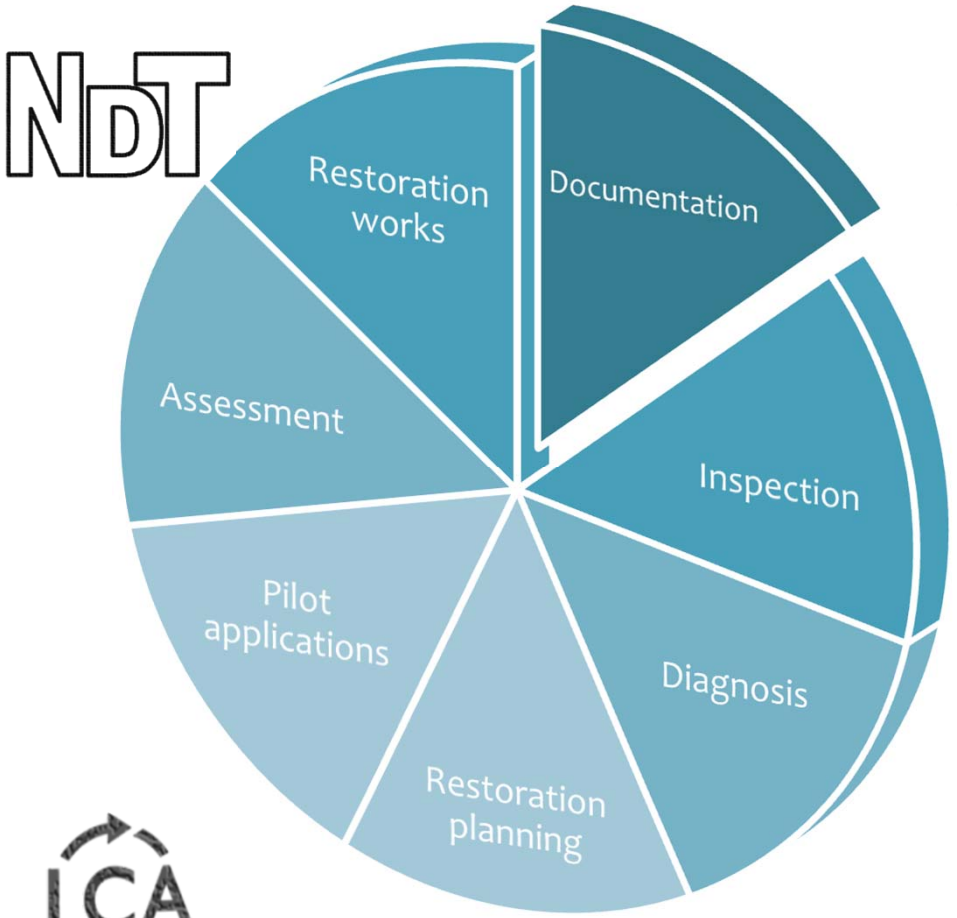
Sustainable Preservation of Cultural Heritage

Sustainable preservation in compliance with international conventions

Heritage driven economies towards a circular economy

Enhancing social awareness and participation

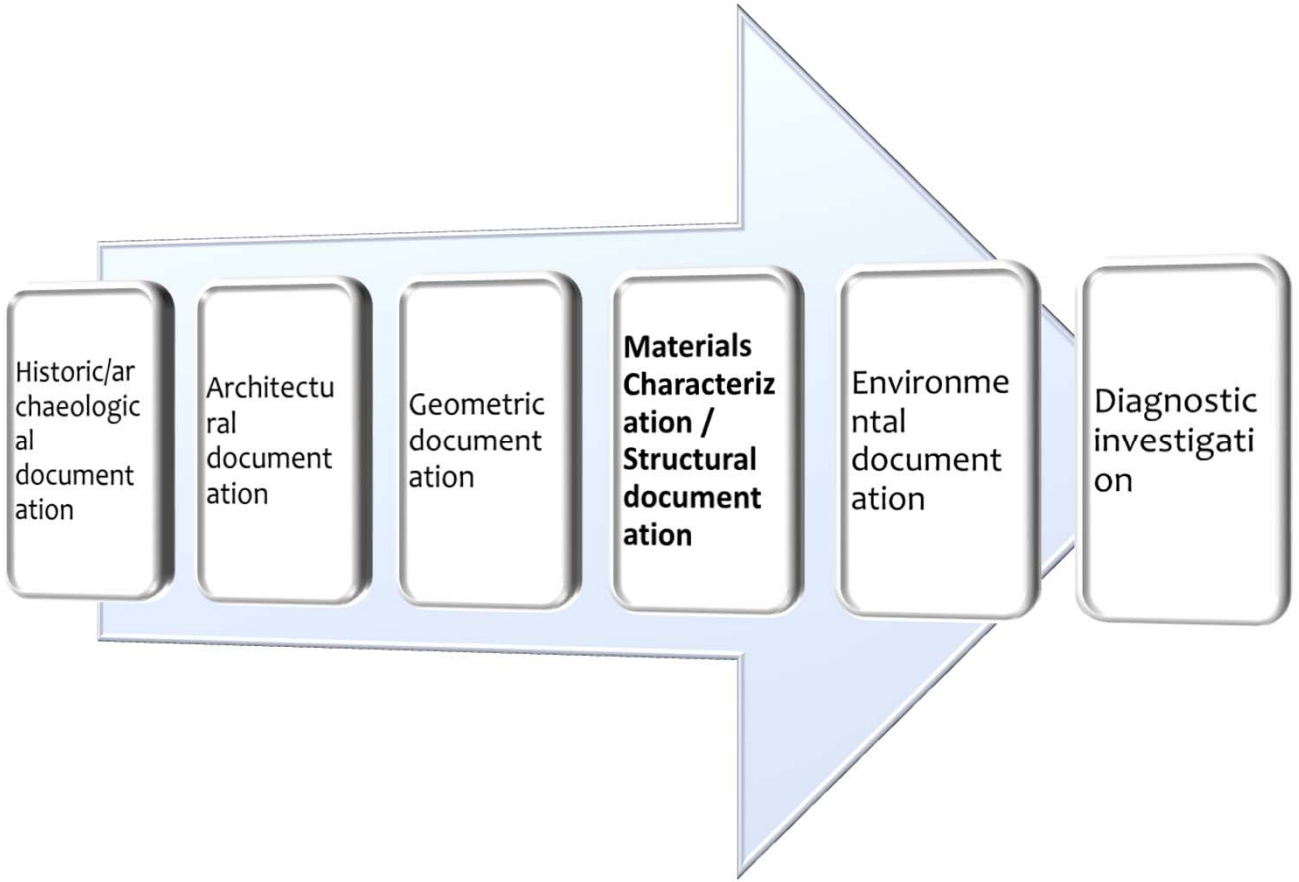
Helps decision-making for Compatibility and Protection by evaluating parameters such as Performance, Sustainability and Impact.



ENVIRONMENTAL FACTORS

MULTIDISCIPLINARY DOCUMENTATION PROCESSES

- DOCUMENTATION DATA THAT INCLUDE NUMERICAL AND DESCRIPTIVE FEATURES, IMAGES, MODELS, DRAWINGS, REPORTS, DIAGRAMS
- INTEGRATION WITHIN AN ITC ENVIRONMENT
- THE DEVELOPMENT OF AN HBIM INCLUDES THE DESIGN OF THE HISTORICAL BIM MODEL, THE ONTOLOGY CREATION OF THE INTERDISCIPLINARY DATA AND THE SEMANTIC ENRICHMENT WITHIN 3D PLATFORMS



BIM

Building Information Modeling – BIM

A ***3D digital representation*** of physical and functional characteristics of any built object.

BIM is a tool that provides the ability to represent buildings. It is:

- object oriented
- parametric modelling combined with a dynamic 3D representation
- feature based database which includes information related to building characteristics

A BIM platform does not only constitute a ***digital representation*** of an infrastructure but also ***includes and incorporates information*** manageable from ***various disciplines*** leading to a ***plethora*** of results and data for ***building management***.

FROM BIM TO HBIM

Heritage - BIM:

Platform for ***modelling historic assets***, monuments, structures, etc., from laser scan and image-based data.

A library of ***parametric objects*** based on ***historical and architectural data***, in addition to a mapping system for plotting the library objects onto laser scan survey data (Murphy, 2013).

The final outcome is the ***creation of a 3D model***, including detail behind the object's surface in regards to its methods of construction and building material used.

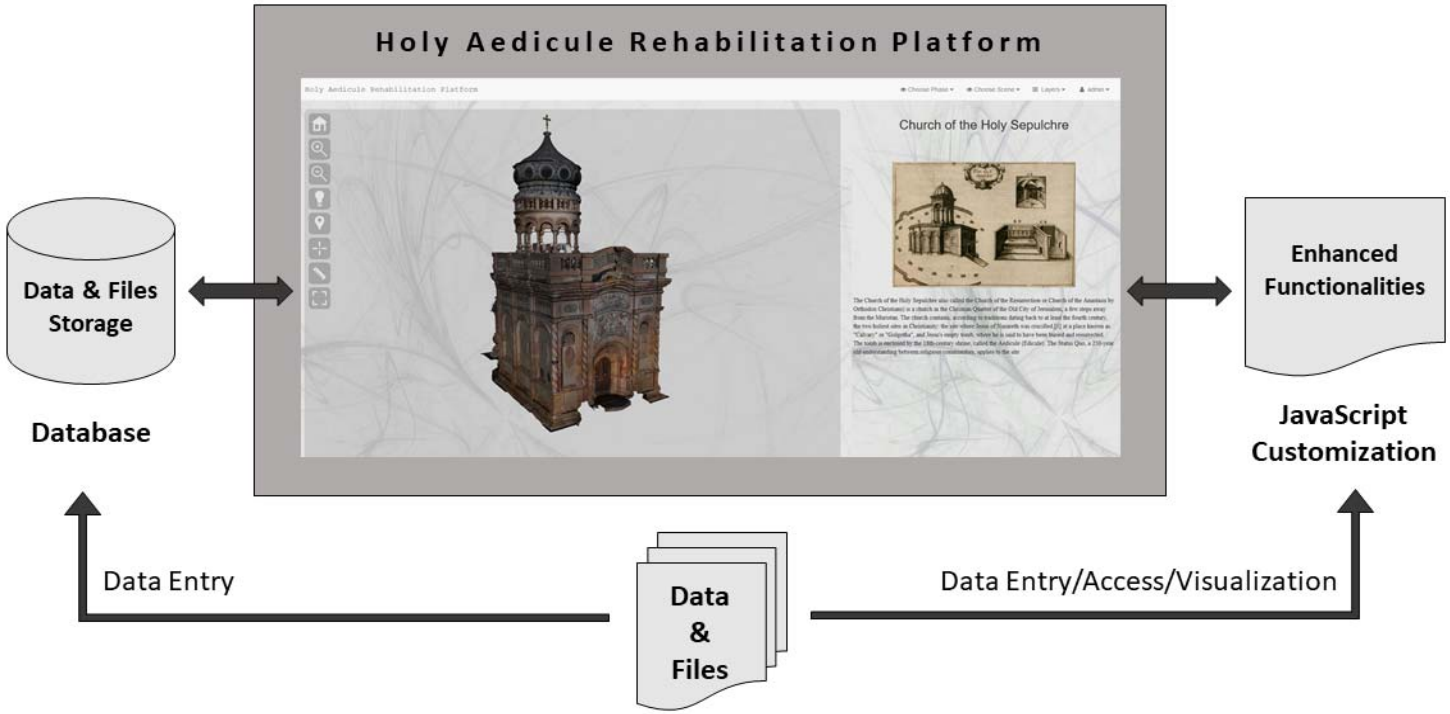
HBIM constitutes a platform that includes ***information*** of cultural heritage assets which ***life circle varies*** and differentiates regarding their construction ***building materials*** through time and ***environmental conditions*** and ***climate change*** cause serious ***impact***.

NTUA contribution

The National Technical University of Athens,

with more than 30 years of experience, contributes to a **proper and efficient data management** within an HBIM environment which promotes the **multi-disciplinarity and the study of building materials as an integral part towards HBIM creation**.

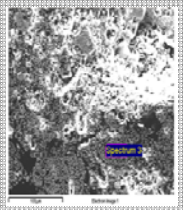
Holy Aedicule Rehabilitation Platform



Types of Data

- Historic and Architecture
- Geometric
- Materials and Structures
- etc.

SEM

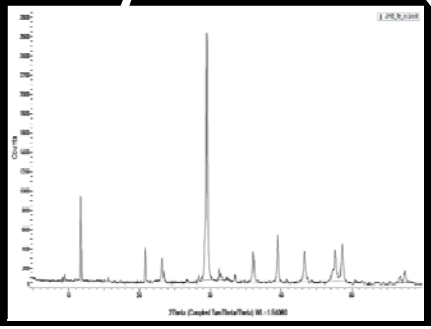


Infra-Red Thermography

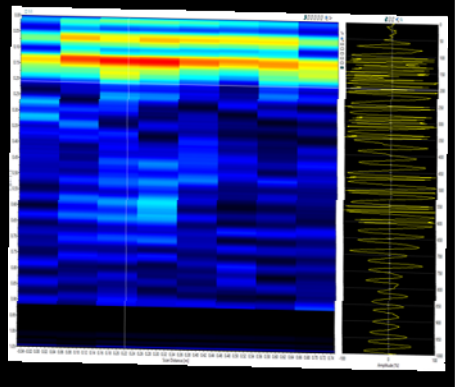
Point Clouds

Images

X-Ray Diffraction



Ultra Sonic Tomography



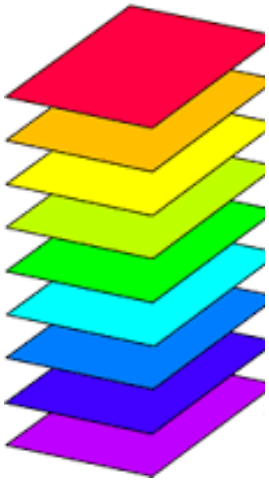
PhD Cand. Alexakis M.

Innovative Multilayer Data Management – Platform Architecture

Content-Based Management through Semantic Data Integration

Multilayer Management of Information
Big Data Integration

- Non destructive Testing
- Analytical Techniques
- Spatial
- Historic
- Time, etc.



Multilayer Data Fusion

Platform as the **cornerstone** for data management, knowledge acquisition and information sharing

inception

Inclusive Cultural Heritage in Europe through 3D semantic modelling

INCEPTION is a four year research project funded by EC's H2020 Reflective Programme in 2014

INCEPTION aims to realise innovation in 3D modelling of cultural heritage through an inclusive approach for time-dynamic 3D reconstruction of artefacts, built and social environments.

INCEPTION's challenge is to improve accessibility and understanding of the CH

THE RESEARCH PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S H2020 REFELCTIVE PROGRAMME FOR RESEARCH AND INNOVATION UNDER GRANT AGREEMENT NO 665220.

Consortium

The project is developed by a consortium of 14 partners from 10 European Countries

- 5 Universities
- 2 Research Centres
- 6 SMEs
- 1 Industry

Coordinated by the Department of Architecture University of Ferrara

The NTUA participates with Prof. Moropoulou as Scientific Coordinator

- **The project coordinator of the INCEPTION project**, ***Prof. Roberto di Giulio***, from the *University of Ferrara*
- **The INCEPTION partners :**
  - **Dr. Federica Maietti**, **Dr. Emanuele Piaia**, **Dr. Silvia Brunoro, Dr Federico Ferrari, Dr Marco Medici** *University of Ferrara*
  - **Prof. Roko Zarnic**, *University of Ljubljana*
  - **Prof. Marinos Ioannides**, *Cyprus University of Technology*
  - **Prof. Vlatka Rajnic**, *University of Zagreb*
  - **Ernesto Iadanza**, *Consorzio Futuro in Ricerca*
  - **Dr. Pedro Martìn Lerones** and Olmedo Vélez, *Cartif*
  - **Rizal Semastian, Oana Schippers – Trifan**, *Demo Consultants BV*
  - **Klaus TH. Luig, Dieter Jansen**, *3L Architects*
  - **Anna Elisabetta Ziri** , *NEMORIS*
  - **Peter Bonsma**, *RDF*
  - **Luca Coltro** , *13BIS Consultants*
  - **Daniel Blersch** , *Zoller + Fröhlich (Z+F)*
  - **Dimitris Karadimas** *Vision Business Consultants (VBC)*
  - **Prof. A. Moropoulou** Scientific Responsible for the NTUA team, **Prof. Ch. Ioannidis, Ass. Prof. A. Doulamis, Ass. Prof. D. Kyriazis, Dr. E.T. Delegou, Dr. K. Labropoulos, Dr. A. Kioussi, PhD. Cand. E. Tsilimantou, PhD Cand. E. Alexakis, PhD Cand. M. Apostolopoulou, PhD Cand. K. Kolaiti, A. Lampropoulou, G. Skoulaki and K. Makantasis**, *National Technical University of Athens*

Development of an integrated methodology
Through an interdisciplinary approach

- Most of the Cultural Heritage assets Studies, are fragmentary studied and correspond to an **unilateral approach** regarding the monument under study. – **Multilateral approach**

- The recommendations and approval of the involved parties should be considered (stakeholders, owners, citizens of the area, et al). – **Users requirements and needs**

Each Stakeholders' category:
Optimal Use Case

For every Use Case:

a selection and an optimal description regarding **the history, the architecture, the geometry, the structure, the materials, information acquisition**, **management** and **dissemination** services that are provided to the stakeholders

<u>Requirements for:</u>

Evaluation of an **Integrated Methodology** and a Specifically-designed **Process Flow** applicable to:

Different Type of Cultural Heritage (archaeological sites, monumental complexes, historical architectures, museums, artefacts, etc.)

Different states of conservation and environmental conditions, subjected to different risk factors

National Technical University of Athens, through the participation in various **interdisciplinary projects**, supports, aids and play a pivotal role for the **strategic planning** for the **protection of Built Cultural Heritage Assets** through the implementation of an **innovative approach**.

Development of an innovative methodology for the elaboration and implementation of interdisciplinary diagnostic studies on Historic Buildings

- ✓ **Interdisciplinarity:** Synergy among all related disciplines (Archaeologists, Architects, Civil Engineers, Chemical Engineers, Surveyor Engineers, et al).
- ✓ **Integrated documentation:** Research, Collection and Classification of interdisciplinary information through innovative documentation protocols.
- ✓ **Diagnosis and Assessment:** Diagnosis of the current state of preservation of a historic building / monument based on the integrated documentation study.
- ✓ **Strategic Planning and Decision Making:** Comprehend, approach and efficiently solve issues. Protection and Restoration of the historic building / monument
- ✓ **Rehabilitation for the benefit of the local society towards social cohesion and development**

Enhanced and holistic approach

An innovative, **multidisciplinary** and **holistic approach** towards the representation and management of :

- Buildings
- Infrastructures
- Monuments

through 3D Digital Platforms **for preservation of Cultural Heritage serving Circular Economy,** in accordance with the **Environmental Impact** and **Climate Conditions** and their **alteration through time**.

INTEGRATED DOCUMENTATION OF CULTURAL HERITAGE

Process of collection, recording of all data regarding a cultural heritage asset during its lifetime

- **Knowledge of an asset, its values, its current condition and alterations throughout time**
- **Permanent archive of critical information**
- **Necessary action before diagnostic or intervention works and periodically**
- **Implemented through literature, archives and the building itself**

✓ Sustainable Maintenance

– Conservation

✓ Proper Management

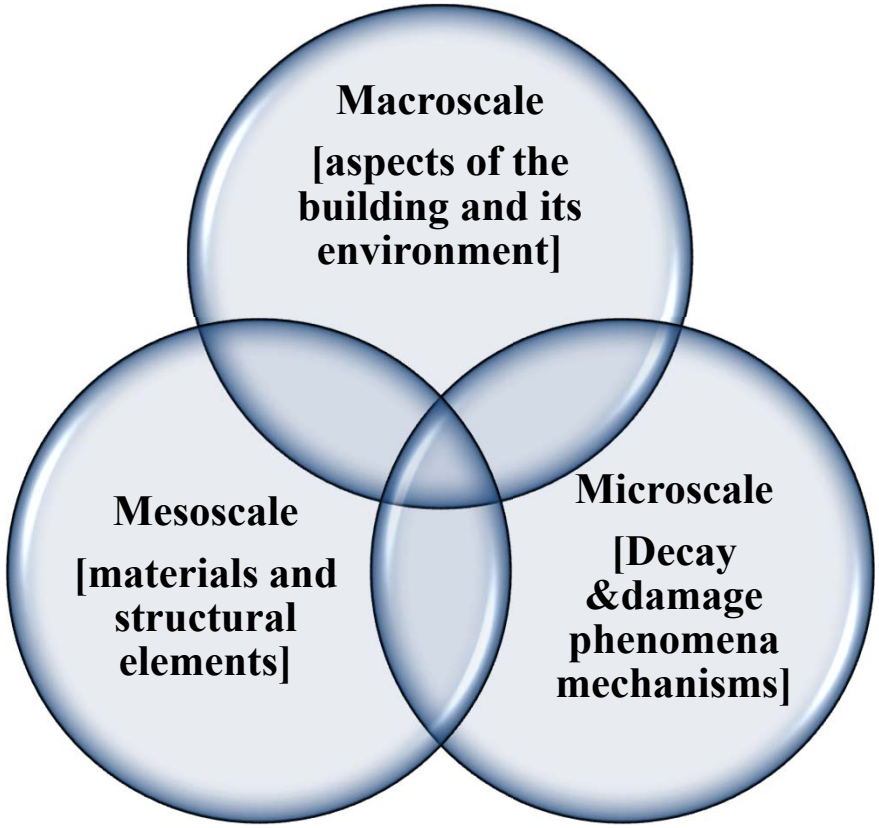
✓ Knowledge based

Decision Making

✓ Stategic Planning

✓ Promotion of CH

Scales of Implementation

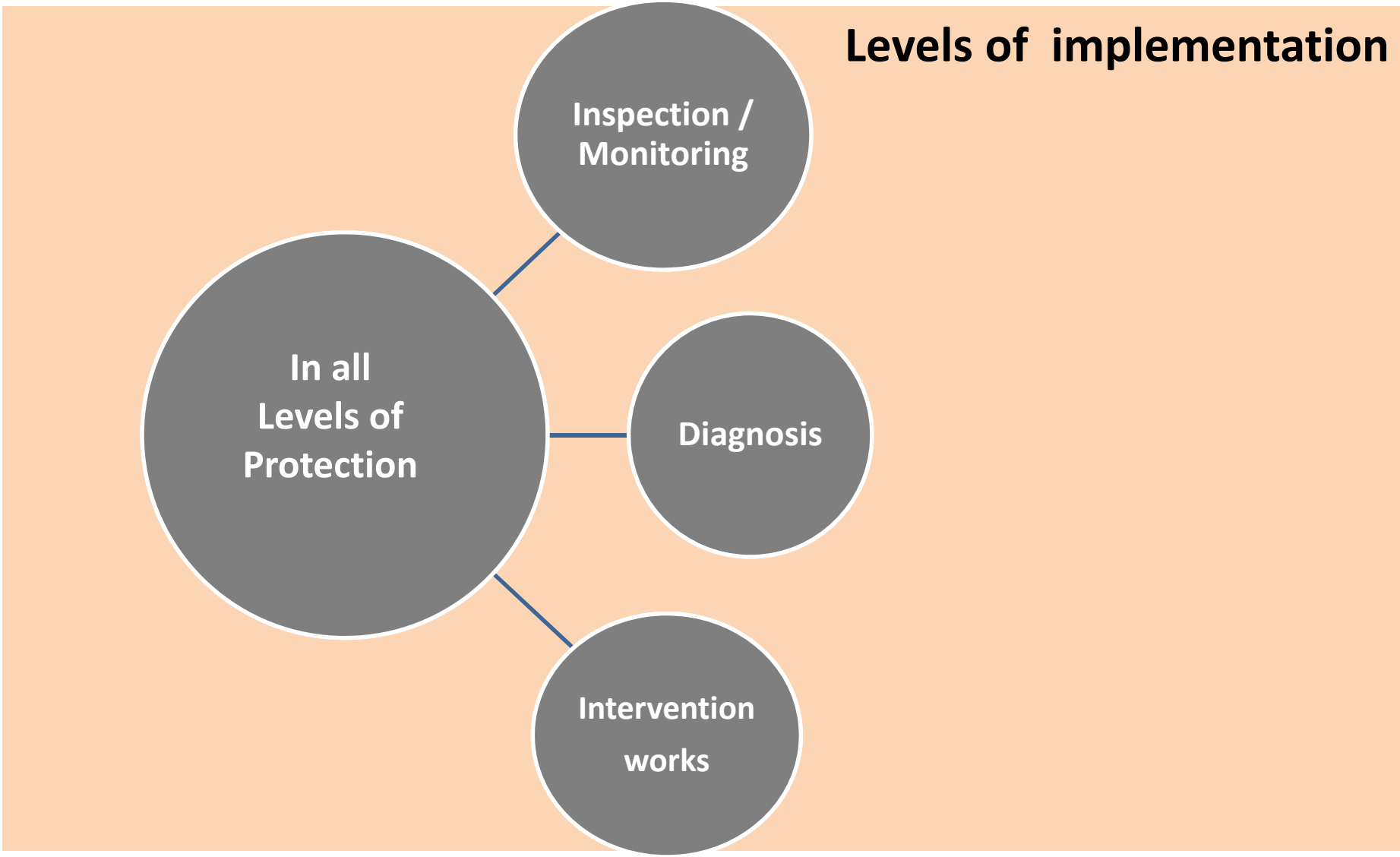


✓**Macroscale:** environmental factors, human impact

✓**Mesoscale:** building and intervention materials properties, structure and vulnerability, values, conservation state, previous interventions, socioeconomic parameters

✓**Microscale:** decay and damage phenomena mechanisms

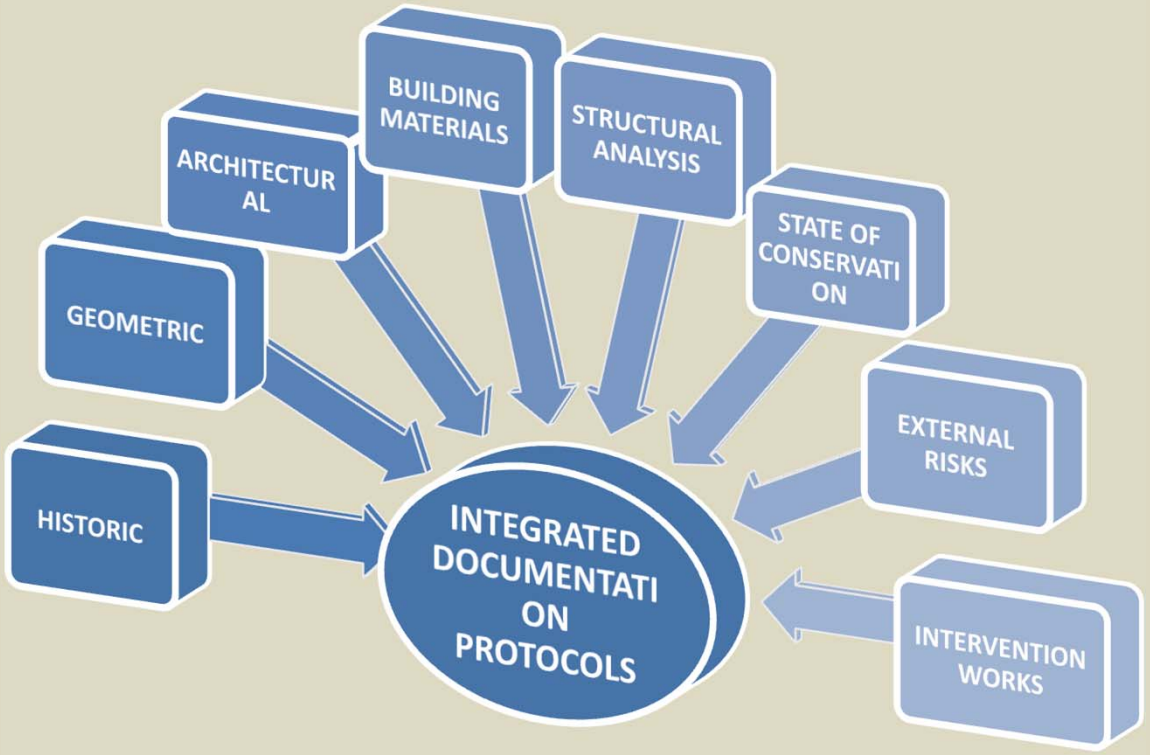
INTEGRATED DOCUMENTATION PROTOCOLS – TOOLS OF INTEGRATED DOCUMENTATION OF CH ASSETS



INTEGRATED DOCUMENTATION PROTOCOLS – TOOLS OF INTEGRATED DOCUMENTATION OF CH ASSETS

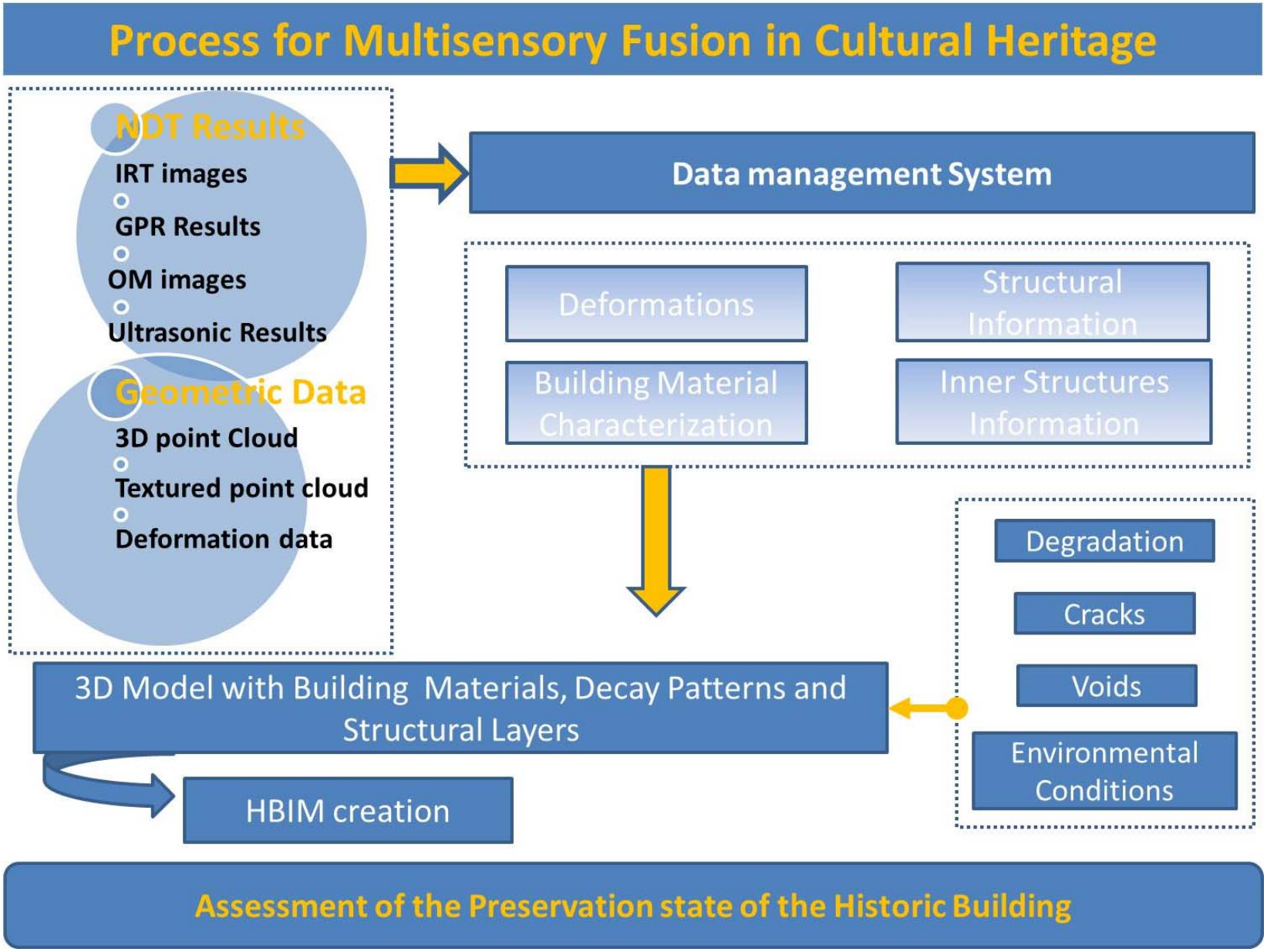
Collection and recording of data follows eight (8) Classification Categories

Content

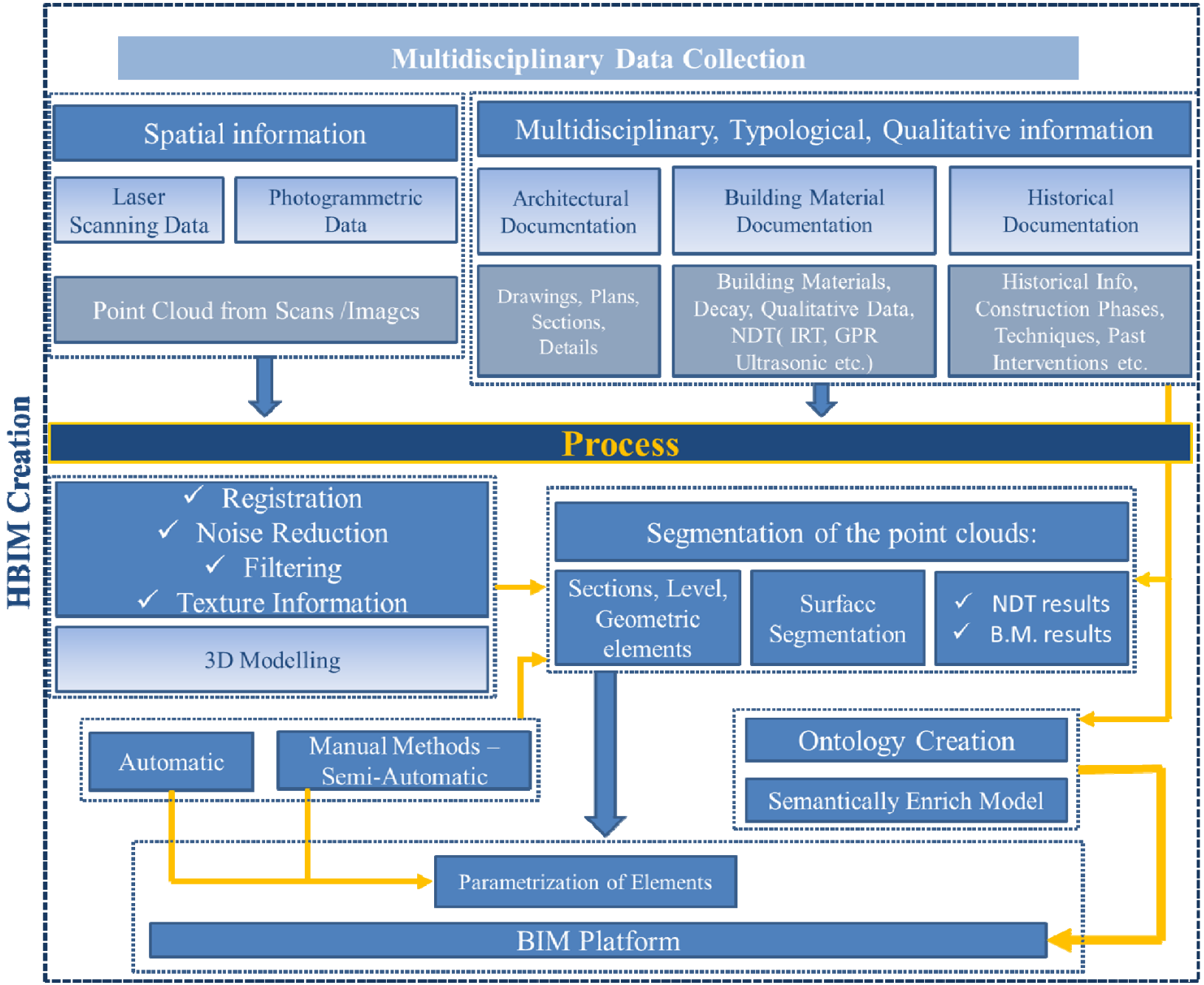


	Classification Categories
I.	Historic
II.	Geometric
III.	Architectural
IV.	Building Materials
V.	Structural Analysis
VI.	Condition Assessment
VII.	External Risks
VIII.	Conservation Interventions

Knowledge based - Dynamic Open Structure


Process for Multisensory Fusion in Cultural Heritage
NDT Results
IRT images
GPR Results
OM images
Ultrasonic Results
Geometric Data
3D point Cloud
Textured point cloud
Deformation data
Data management System
Deformations
Structural Information
Building Material Characterization
Inner Structures Information
Degradation
Cracks
Voids
Environmental Conditions
3D Model with Building Materials, Decay Patterns and Structural Layers
HBIM creation
Assessment of the Preservation state of the Historic Building

Process towards HBIM creation



Why we need a semantic web approach in cultural heritage beam models?

inception

This project is funded by the Horizon 2020 Framework Programme of the European Union

Models are not dependent on data formats

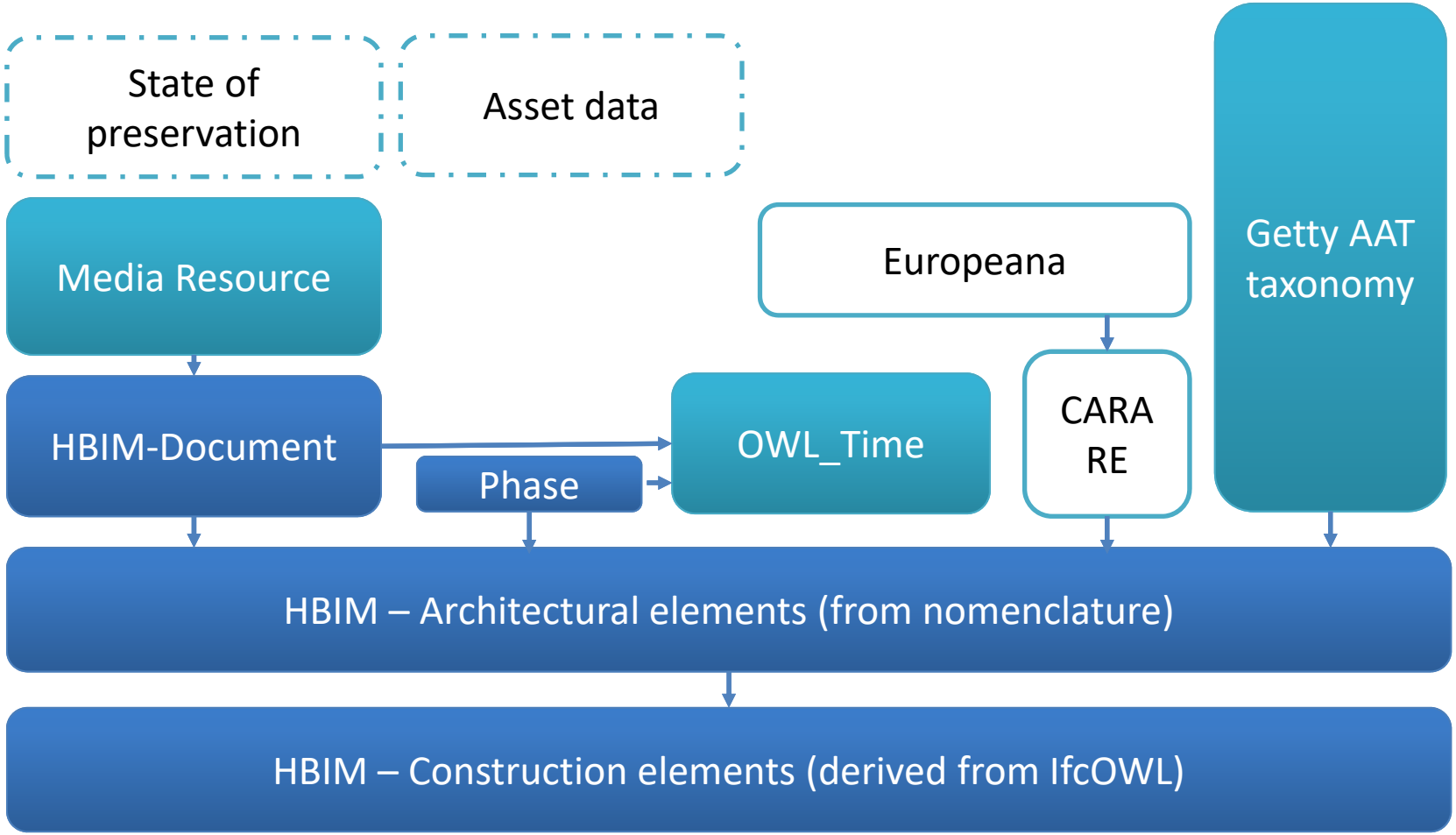
Enriches the 3D model with non tangible content

Represents model components through semantics

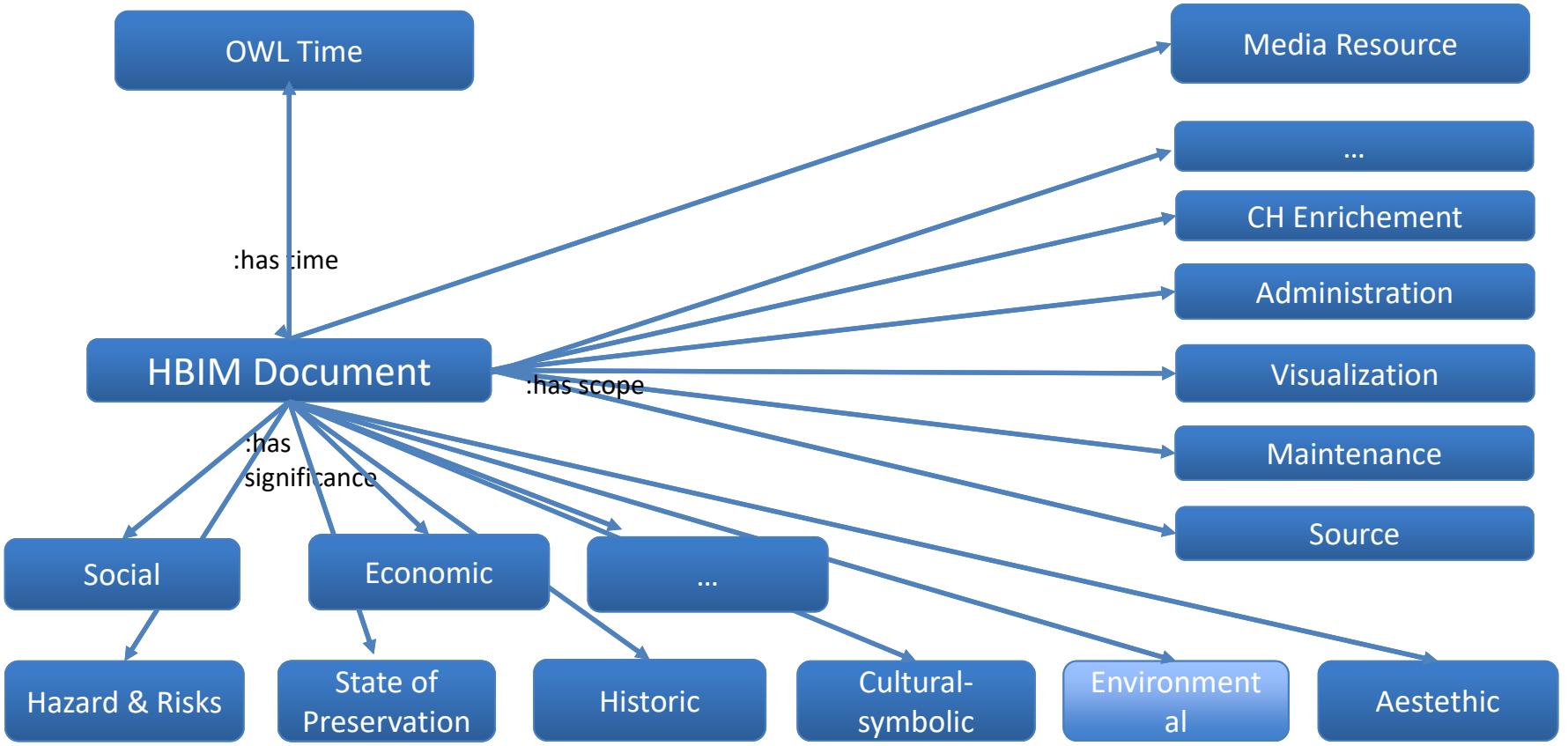
Can be linked to machine readeable CH source of knowledge

Adds heritage holistic documentation

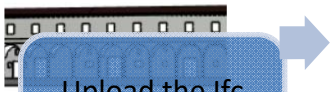
ONTOLOGY MODEL



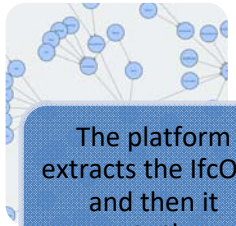
IntangiBle enrichment through DOCUMENTATION



Use case: ARCHITECTURAL data upload

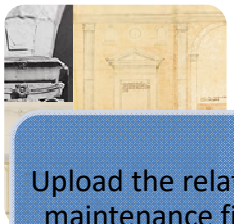


Upload the Ifc Model with the analyzed featured on the Inception platform



The platform extracts the IfcOwl and then it converts the non geometrical part in architectural elements through the HBIM ontology

Identify the reconstructed elements. Update through SPARQL the correct architectural type.

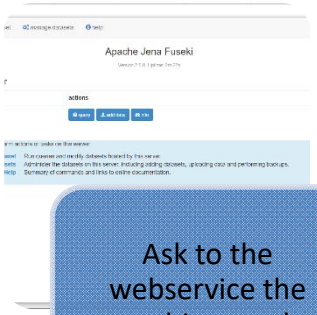


Upload the related maintenance file on the attachments repository

Link it to the identifier with a Sparql query specifying significance (historical), and the related time frame

Use case: architectural data download

Choose the building we want to monitor



Ask to the webservice the architectural elements present in a specific period of time

Select the type of the feature, retrieve the identifier and query the related attachments with significance historical and a given time frame

Download the files with historical data at a given time period

USE CASE: Conservation DATA UPLOAD

Upload the Ifc Model on the Inception platform

The platform extracts the IfcOwl and then it converts the non geometrical part in architectural elements through the HBIM ontology

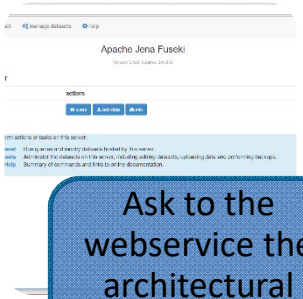
Upload on the Fuseki Web service with the reference HBIM ontology

Upload the related conservation file on the attachments repository

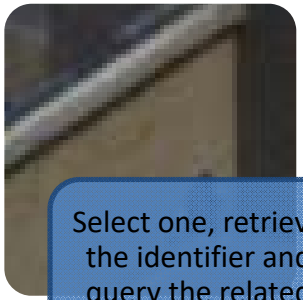
Link it to the identifier with a Sparql query specifying scope (maintenance), time of the detection

USE CASE: CONSERVATION DATA DOWNLOAD

Choose the building we want to monitor



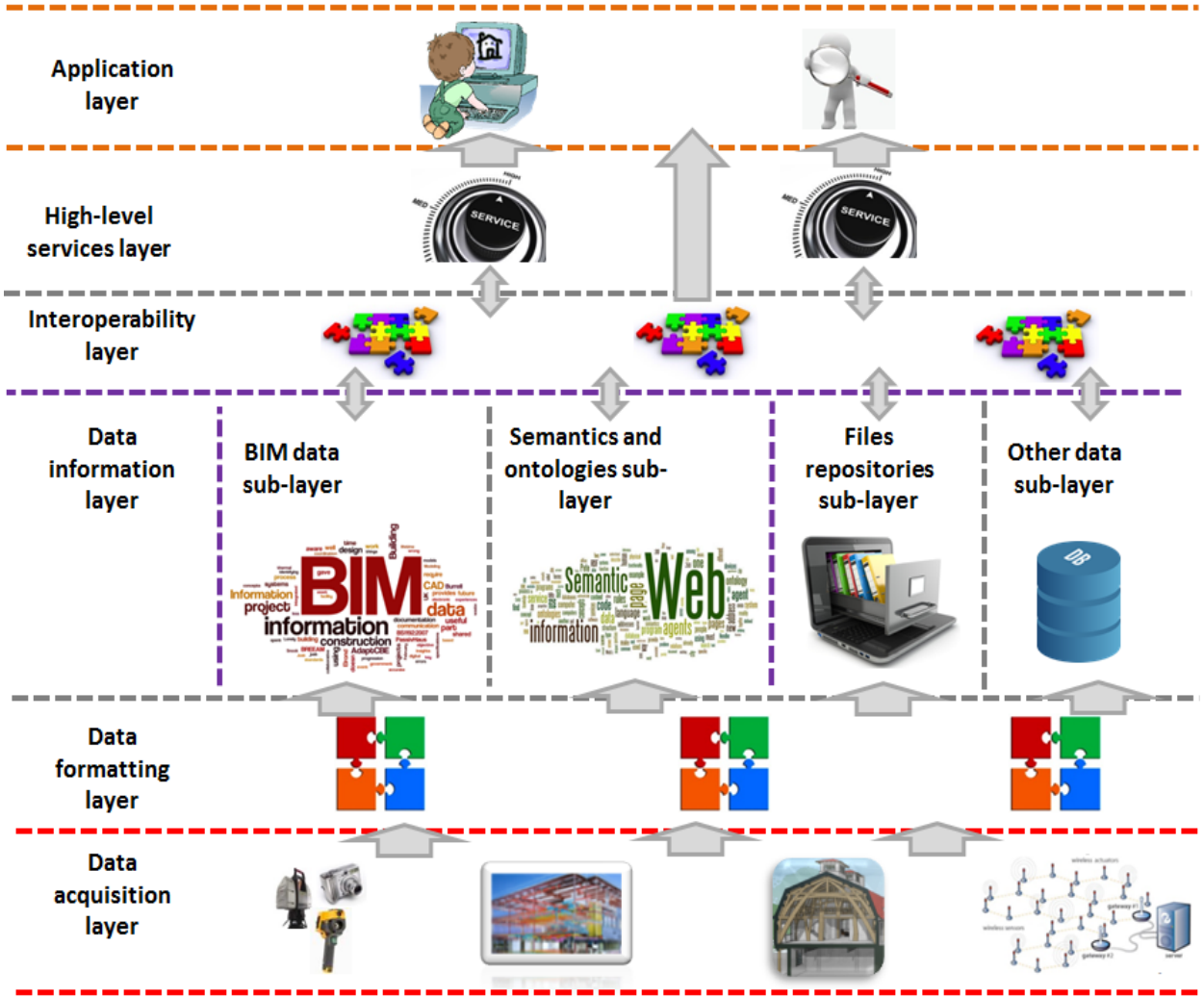
Ask to the webservice the architectural elements with conservation scope attachments



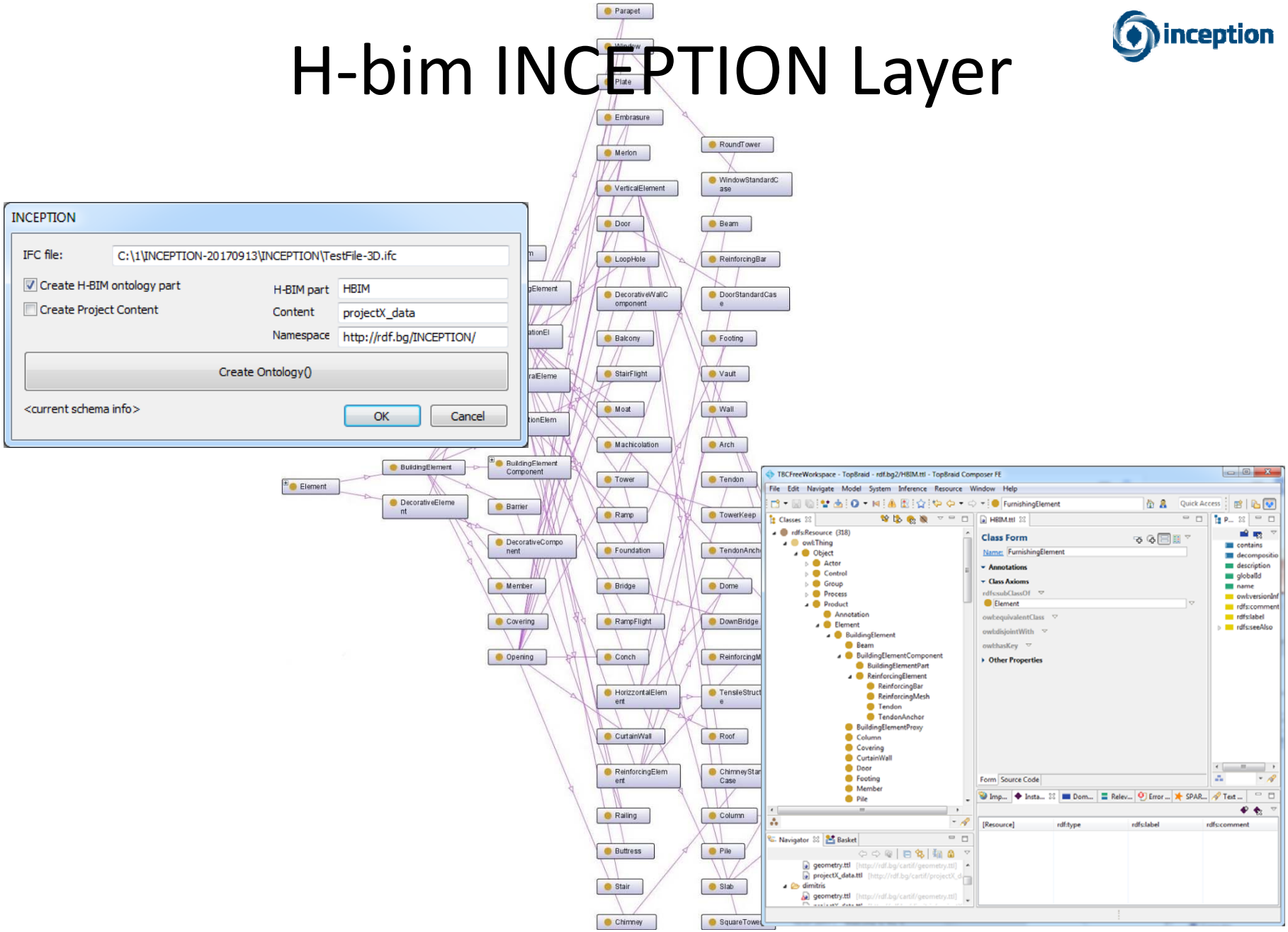
Select one, retrieve the identifier and query the related attachments with scope maintenance and a given time frame

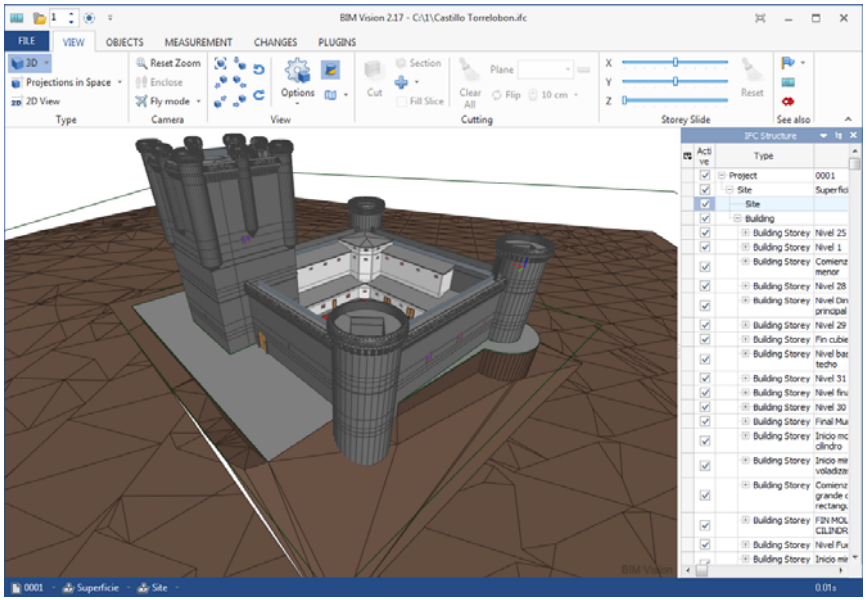
Download the files with conservation data at a given time and compare them (outside the platform)

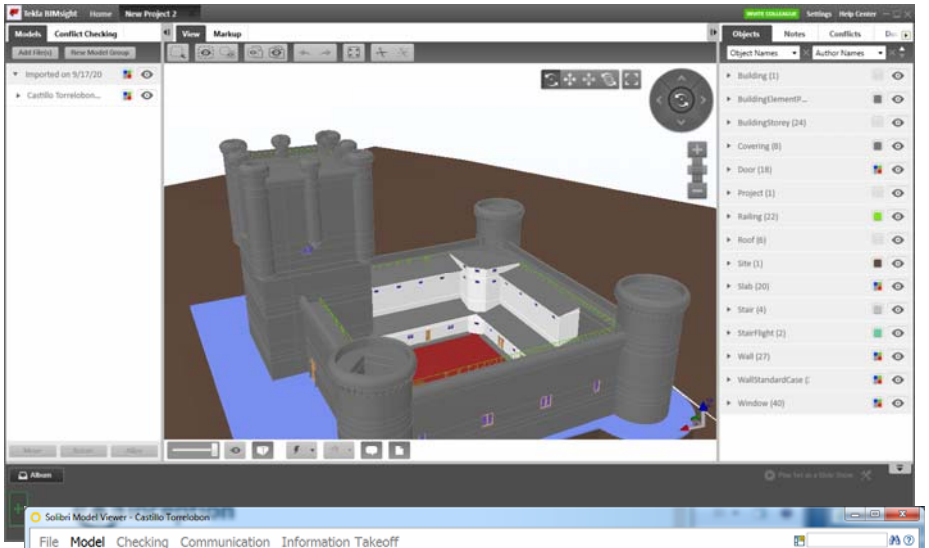
Inception Layered System Architecture

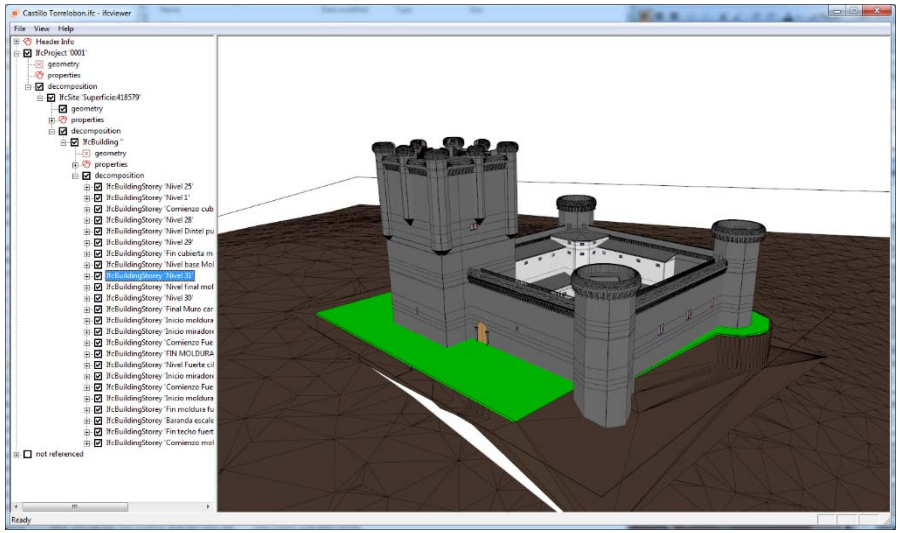


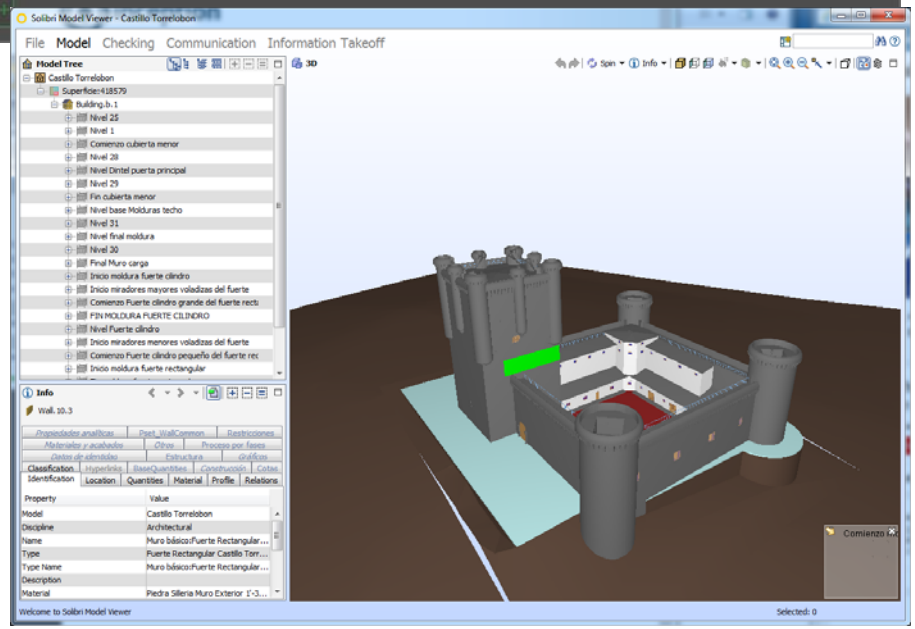
H-bim INCEPTION Layer

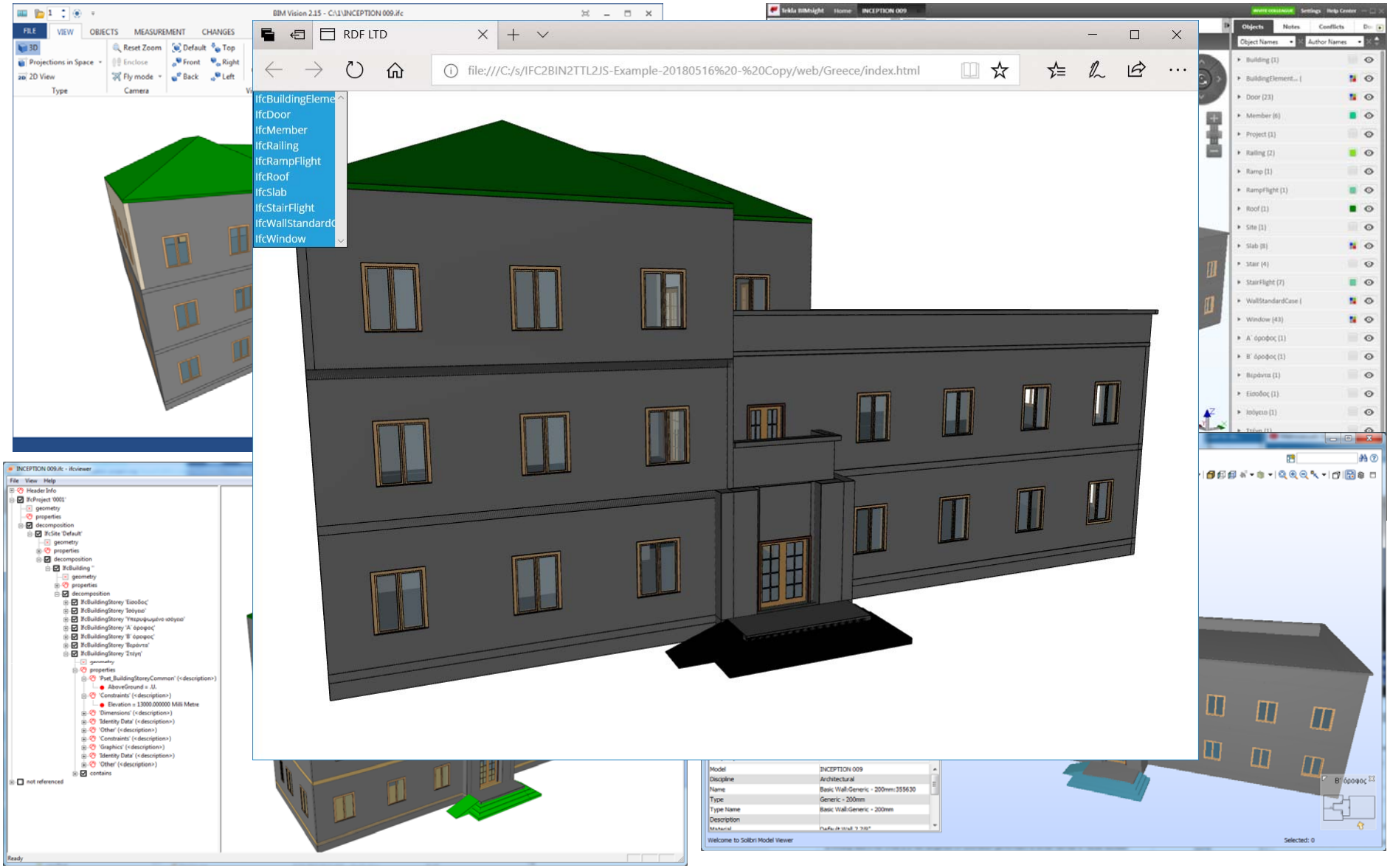



BIM Vision 2.17 - C:\1\Castillo Torrelobon.ifc
FILE
VIEW
OBJECTS
MEASUREMENT
CHANGES
PLUGINS
IFC Structure

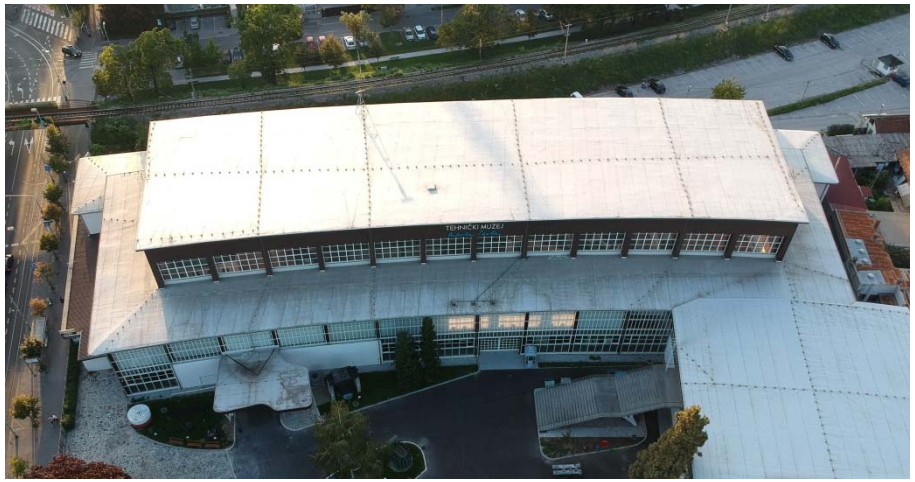

Tekla BIMsight
Conflict Checking

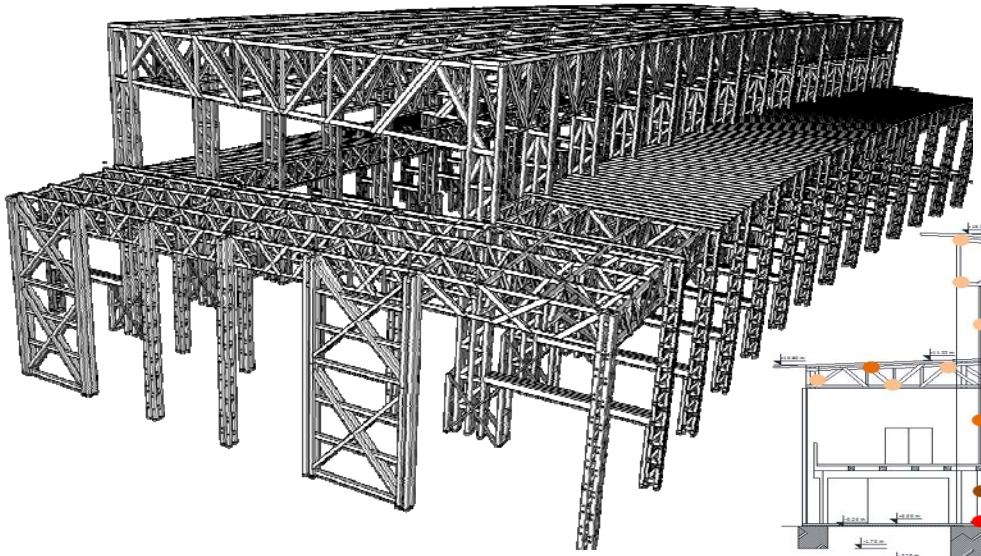

Castillo Torrelobon.ifc - ifcviewer

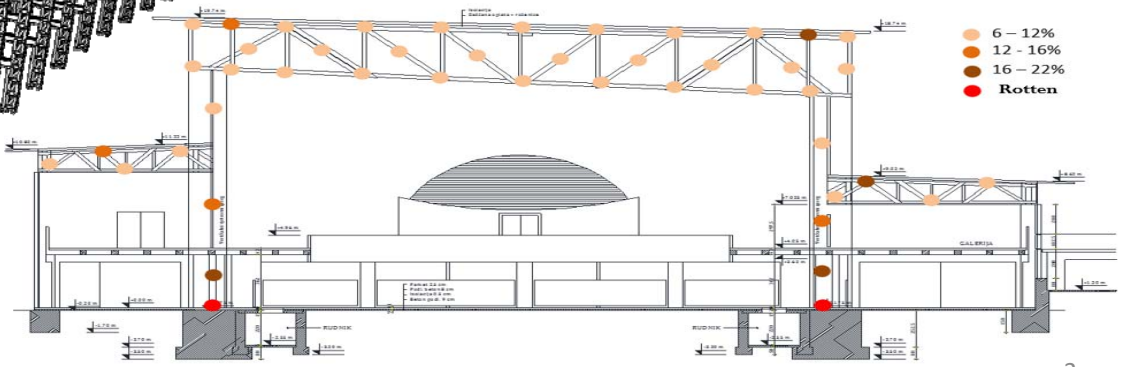

Solibri Model Viewer - Castillo Torrelobon
File
Model
Checking
Communication
Information Takeoff
Model Tree


BIM Vision 2.15 - C:\1\INCEPTION 009.ifc
RDF LTD
file:///C:/s/IFC2BIN2TTL2JS-Example-20180516%20-%20Copy/web/Greece/index.html
IfcBuildingEleme
IfcDoor
IfcMember
IfcRailing
IfcRampFlight
IfcRoof
IfcSlab
IfcStairFlight
IfcWallStandardC
IfcWindow
INCEPTION 009

Technical Museum Nikola Tesla – UNIZAG Demonstration Case

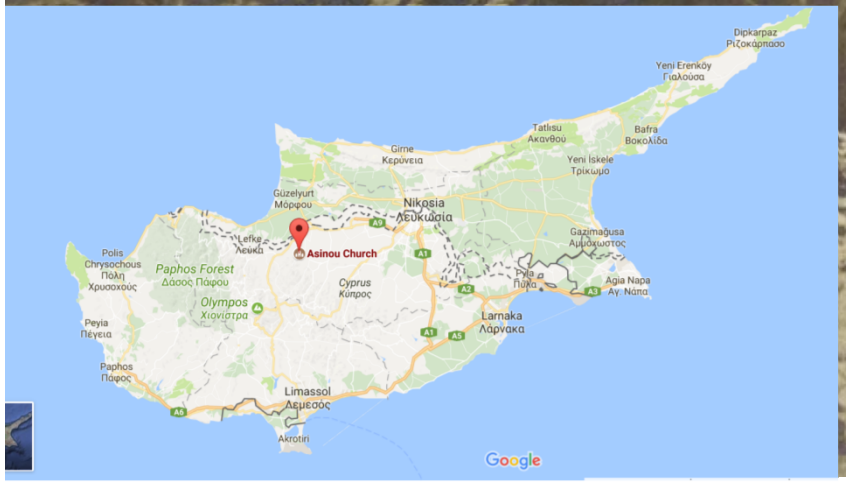






THE CHURCH IN 1909

(Nicosia, State Archives of Cyprus)

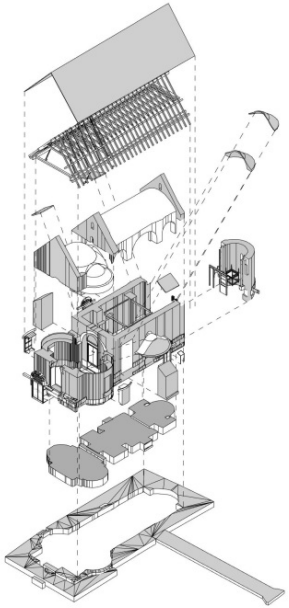


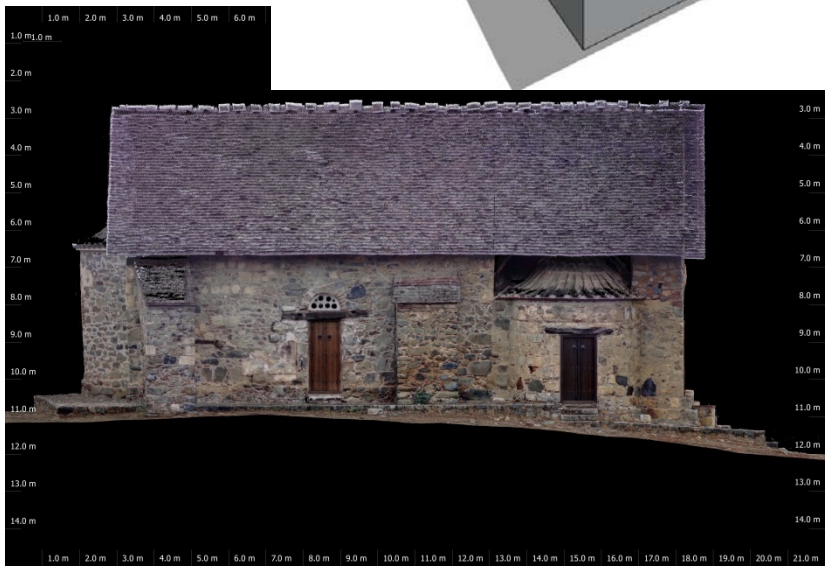
A CHURCH → **A MONUMENT OF OUTSTANDING AND UNIVERSAL VALUE**

United Nations
Educational, Scientific and
Cultural Organization

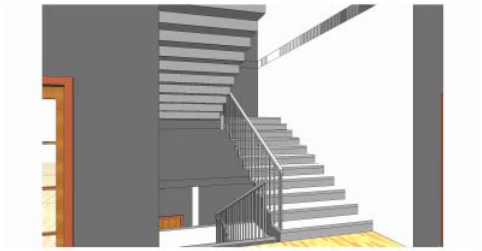
World Heritage
Convention

Cyprus Demonstration case





VBC Demonstration case

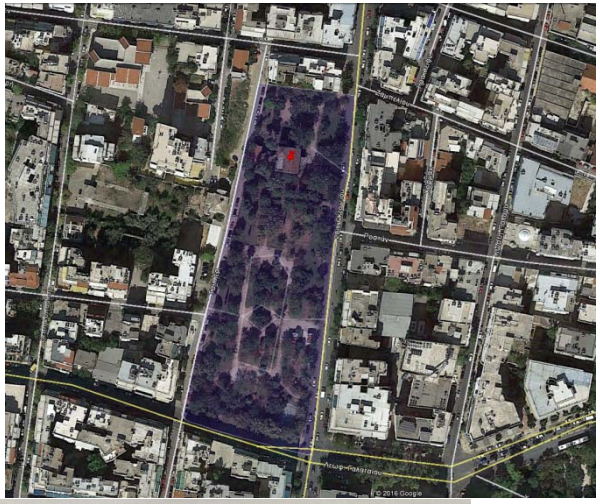


An Integrated Demo Case

NTUA

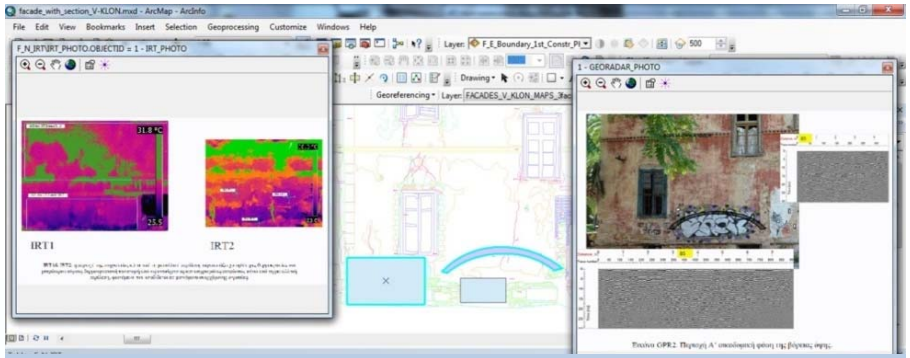
Villa Klonaridi, Patisia, Athens

Villa Klonaridi, is a mansion of the late **19th century** situated in the Patisia district in Athens. It was declared as a monument from the Ministry of Culture in 1994, due to its **significance**, as it is one of the remaining mansions of the era. It was constructed in **three different phases**.



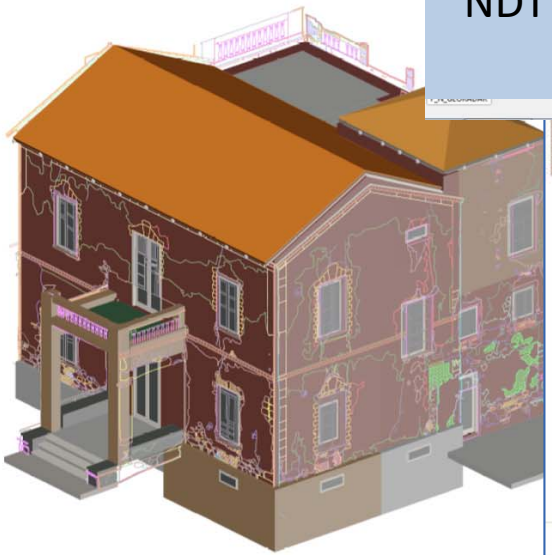
Villa Klonaridi exemplifies a **suburban Villa** in Patisia district area, typical of the era **(19th century)**. Its value is very important, for it represents the living status of the Beer Manufacturers owners, Klonaridi.

The **surrounding area** provide various information regarding the early stage of industrial evolution of the newly created state of Greece



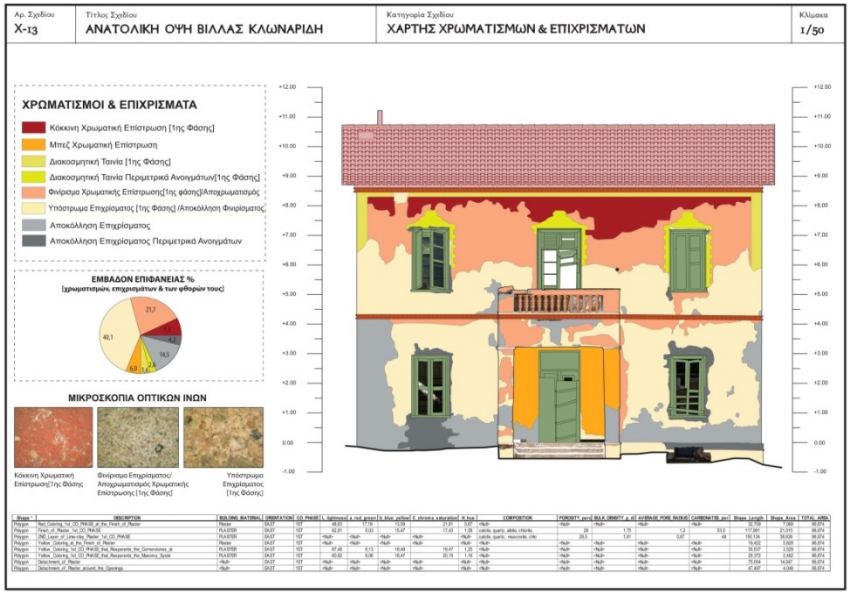
NDT techniques - Geographic Information Platforms

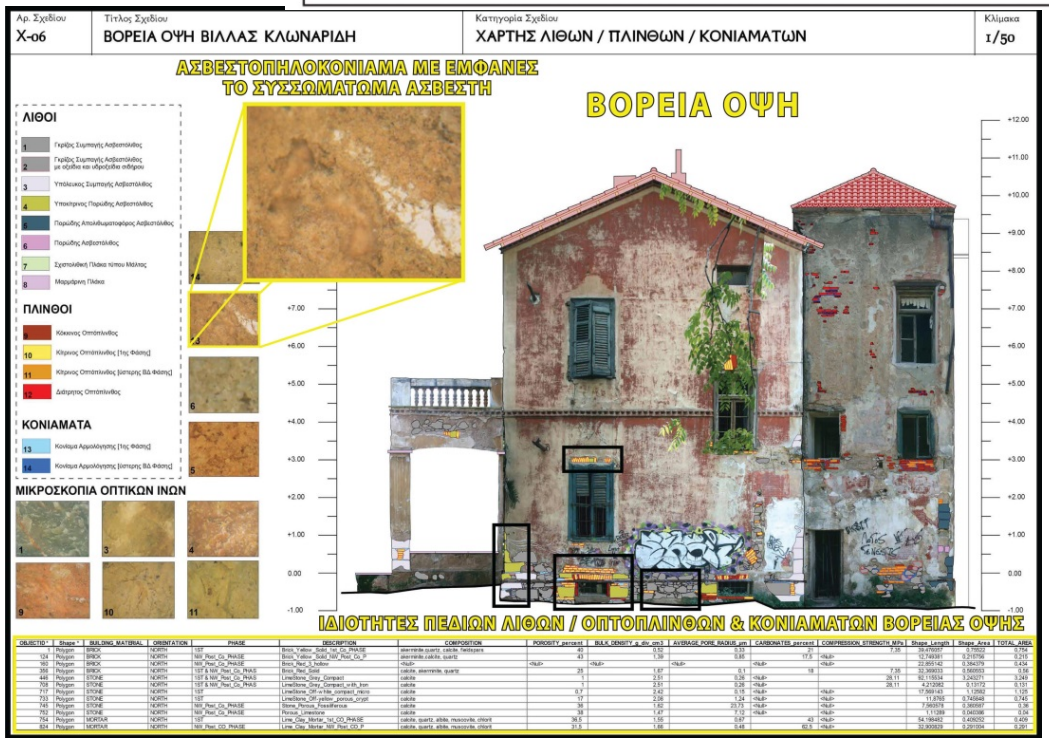
Interdisciplinary NTUA Research team for optimum integration of the multifaceded layers from 2D to 3D on a 3D Platform



❑ Villa Klonaridi Demonstration Case

- Current Preservation State of East Facade
- Documentation of East Facade
- Documentation of North Facade
- Reuse Proposal East Facade



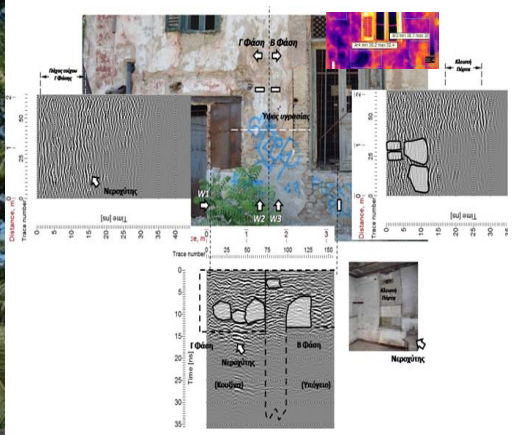


❑ Villa Klonaridi Demonstration Case

*Diagnosis of the **decay** of building **materials** using Non Destructive Techniques (**NDT**) validated by **analytical** tests*

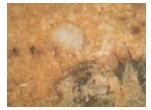
IRT

Georadar

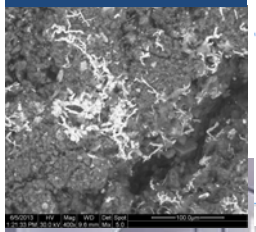


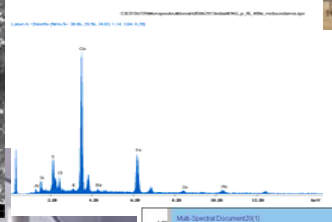
Building Material Samples

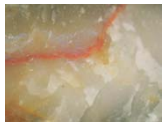
FOM

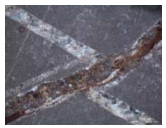


SEM-EDX

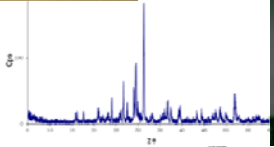




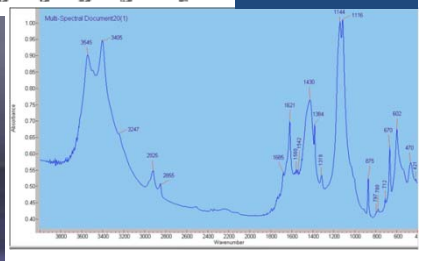




XRD

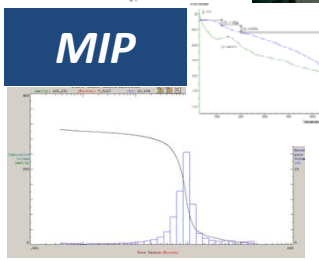


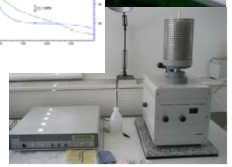
FTIR



OM

MIP





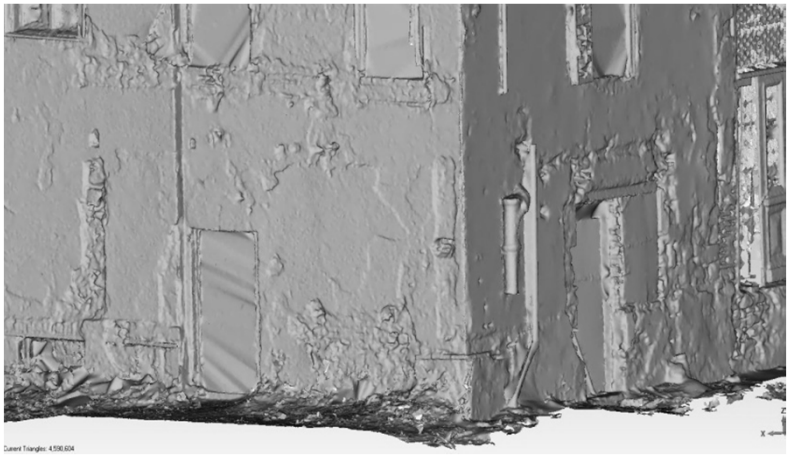
The role of Geometric Documentation

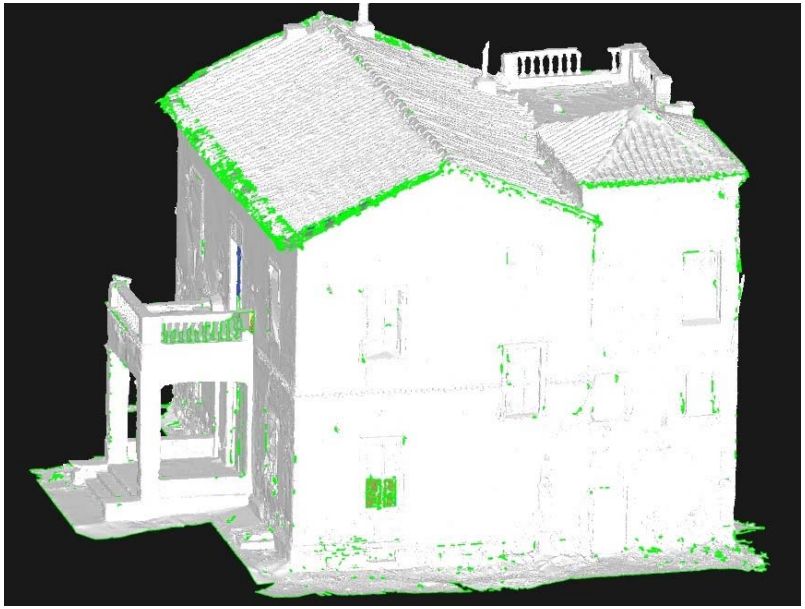
Topographic measurements, photogrammetric techniques, laser scanning of the internal and external facades and spaces, mural and ceiling paintings etc.

LAB of Photogrammetry, SCHOOL OF Rural and Surveying ENGINEERING,

RESEARCH GROUP
C.Ioannidis, S.Soile, S.Tapinaki, E.Tsilimantou

GEOMETRICAL DOCUMENTATION
TOPOGRAPHIC MEASUREMENTS-CALCULATIONS





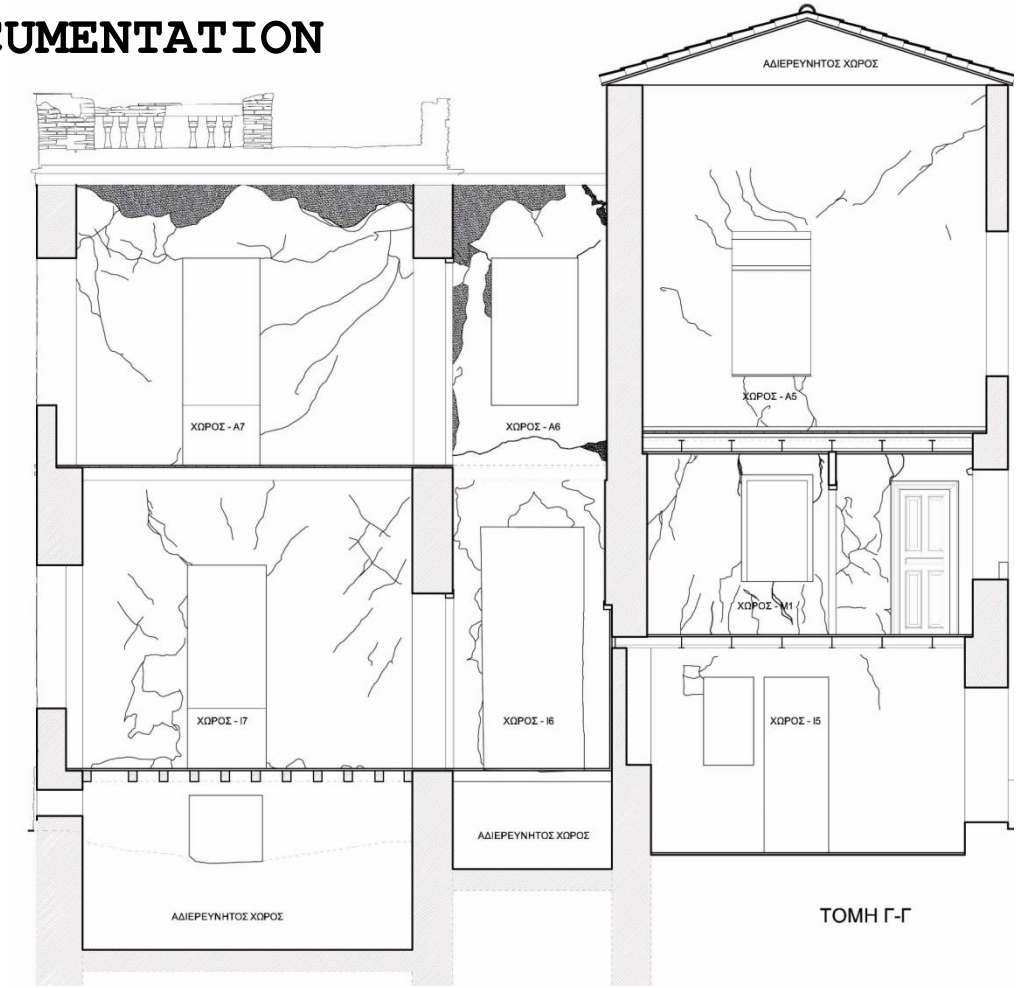
3D model of the exterior of the building - building shell

The role of Architectural Documentation

ARCHITECTURAL DOCUMENTATION

SCHOOL OF ARCHITECTURE NTUA. Research group of Efesiou Architect, Professor NTUA, M.Alexiou, T.Kouimtzoglou, K.Moretti architects MSc, PhD candidates NTUA,postgraduate students: A. Poulou, I.A.Nikitakos architects

ARCHITECTURAL DOCUMENTATION SURVEY



ΤΟΜΗ Γ-Γ

PATHOLOGY DOCUMENTATION

3D Model

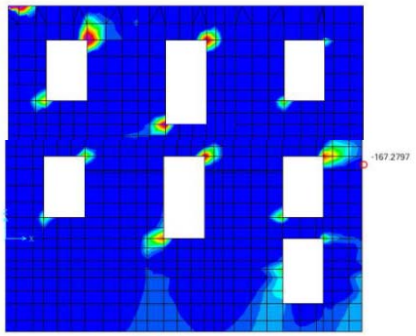
Lab of Architectural Engineering & Moropoulou, A., [Integrated diagnostic study for the decay and pathology of the building materials and constructions], Technical Report – Architectural Documentation, NTUA, The Municipality of Athens, Greece

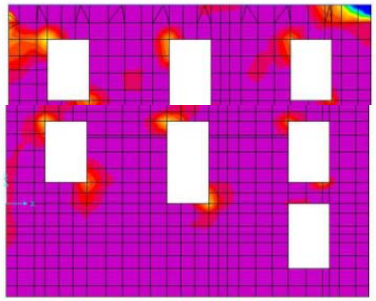
Villa Klonaridi _ 3D Model Incorporating Architectural information with Geometric data

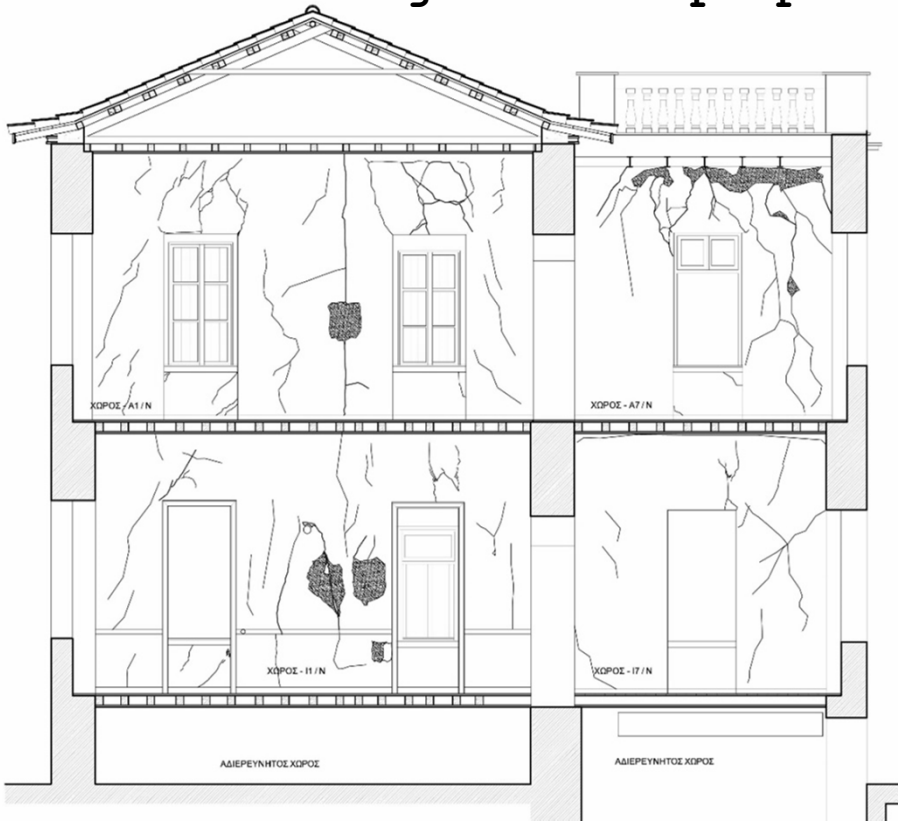
The role of Structural Documentation

STRUCTURAL DOCUMENTATION

Documentation of the load bearing structure of the building, its pathology and studied conservation proposals which are compatible with the existing structure for the building's reuse proposals

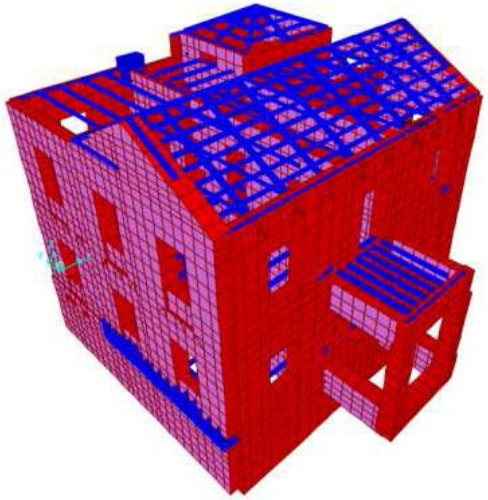


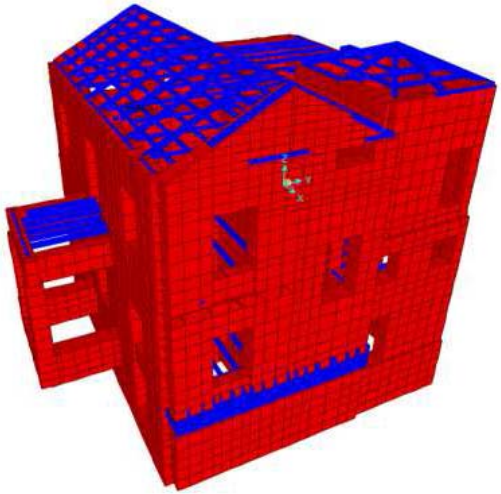


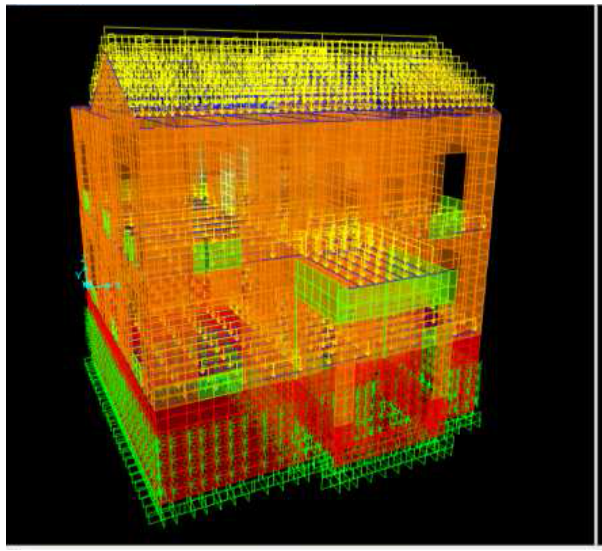


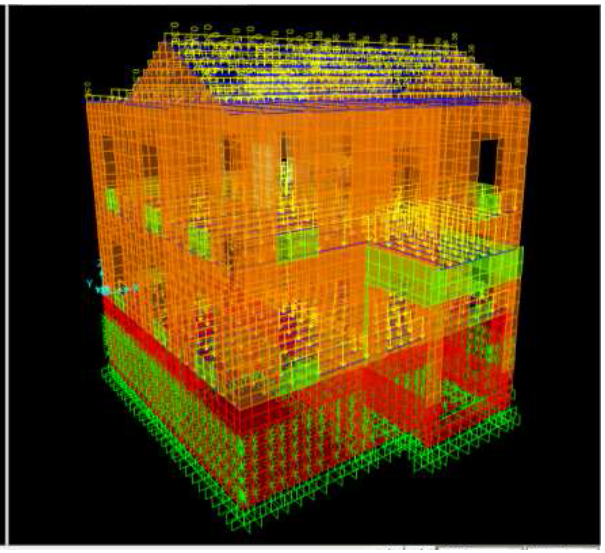
REINFORCED CONCRETE LAB
EVALUATION OF THE EXISTING CONDITION OF VILLA KLONARIDI AND REPAIR-REINFORCEMENT PROPOSALS
Research group
E.Vintzilaiou, C.E.Adami, A.A. Manoledaki, V.Palieraki

MASTER THESIS T.Mougiakos







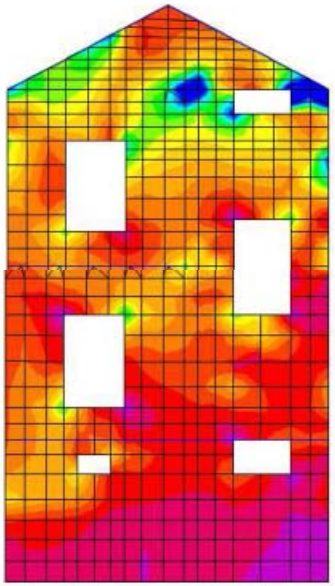


(a) Documentation of the structure of stone walls (radar, endoscopy, thermography)

(b) Sampling and laboratory testing of mechanical characteristics of building materials

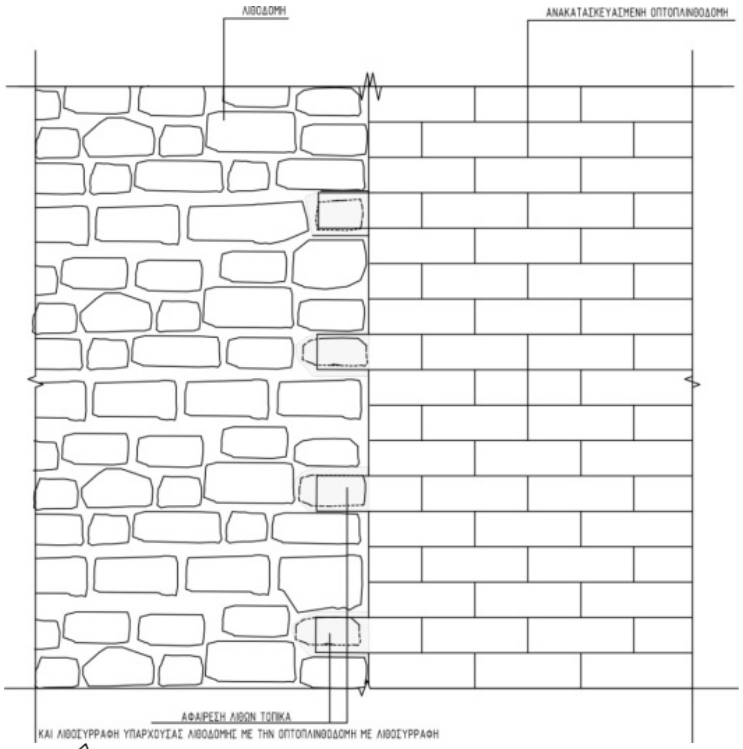
(c) Evaluation of the structural condition of the existing building according to the pathology. Testing and calculation of the structural model

(d) Repair-reinforcement proposals

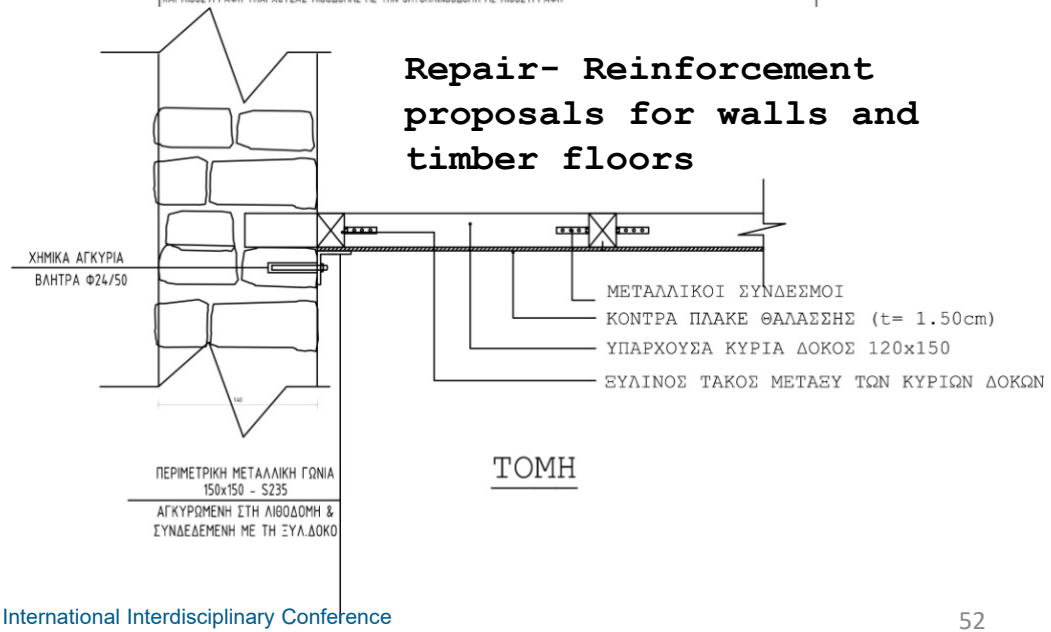


Main tension forces – NORTH FAÇADE – POST CONSTRUCTION PHASE

Laboratory testing of materials

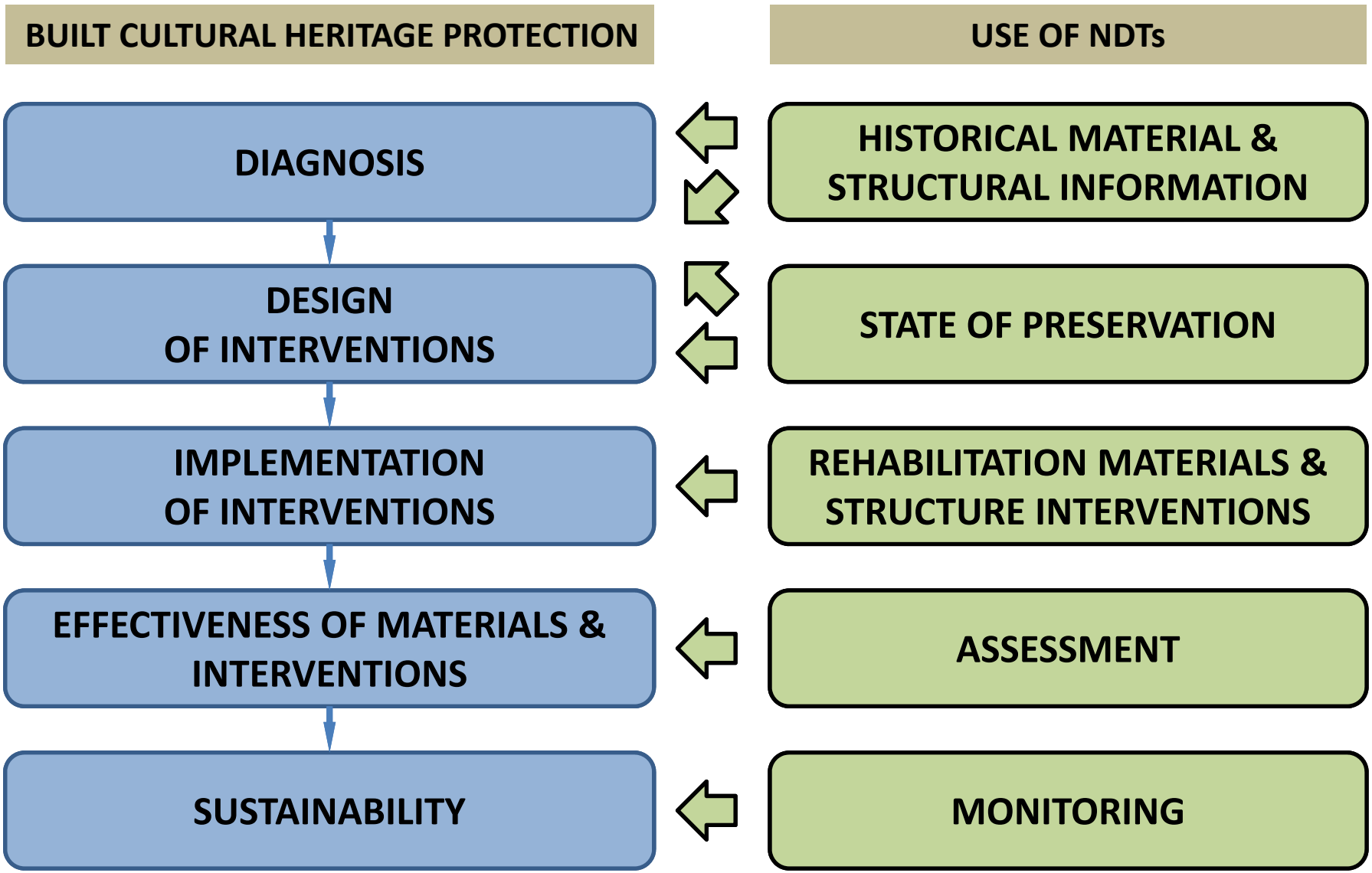


Repair- Reinforcement proposals for walls and timber floors



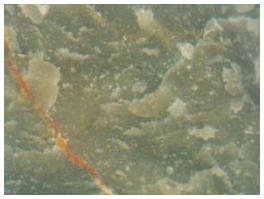
The dynamic role of NDTs in the **documentation of structural phases and pathology**

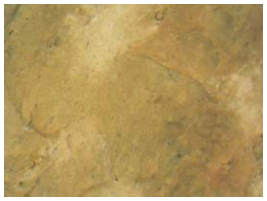
Emerged methodological approach for the use of non-destructive techniques for monitoring and assessing the preservation state of Built Cultural Heritage



In situ investigation for the diagnosis of the state of preservation, by means of non destructive testing

- ***IR-T****hermography to obtain surface temperature*
- ***Georadar*** *for interfaces investigation*
- *Ultrasonic Testing for the morphology and material interfaces*
- *Rebound hardness measurement for stone hardness (**Schmidt Test Hammer**)*
- ***D****igital* ***M****icroscopy for surface morphology examination*





CONSTRUCTION MATERIALS-DAMAGE DIAGNOSIS

MATERIAL SCIENCE AND ENGINEERING LAB, SCHOOL OF CHEMICAL ENGINEERING NTUA

Research group: A.Moropoulou, A.Bakolas, M.Karoglou, K. Labropoulos, E. T. Delegou

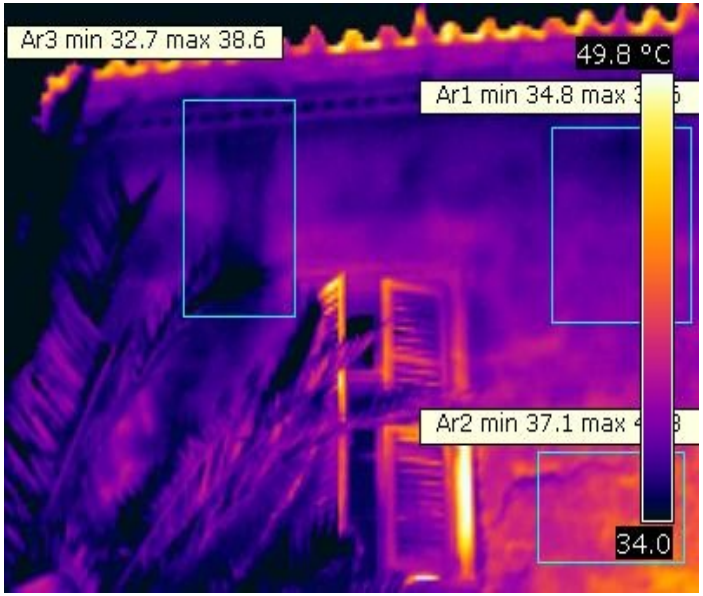
Diagnostic control of construction materials
A. Non destructive diagnostic methods Infrared Thermography, Georadar, Ultrasonic testing
B. Laboratory testing

Lab of Photogrammetry, Orthoimage of the North Facade

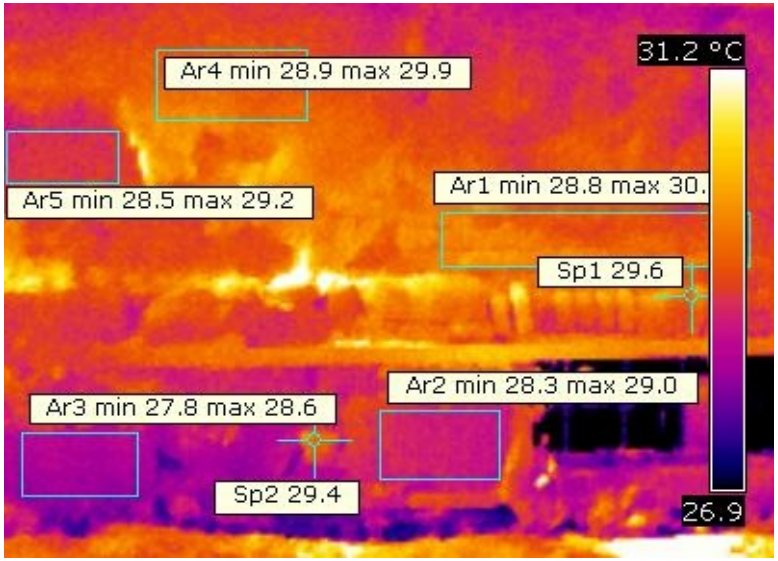
MASTER THESIS OF C.BOURBOS

INFRARED THERMOGRAPHY

Temperature and Humidity measurements, with the **thermo-hygrometer FLIR MR77** was applied in order to calibrate the **FLIRB200 thermo camera** temperature data and to measure the temperature and moisture content of the structure's materials.



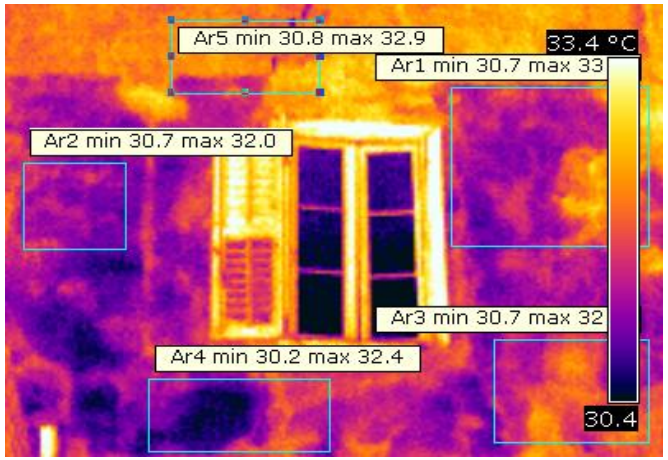
East Façade Thermography



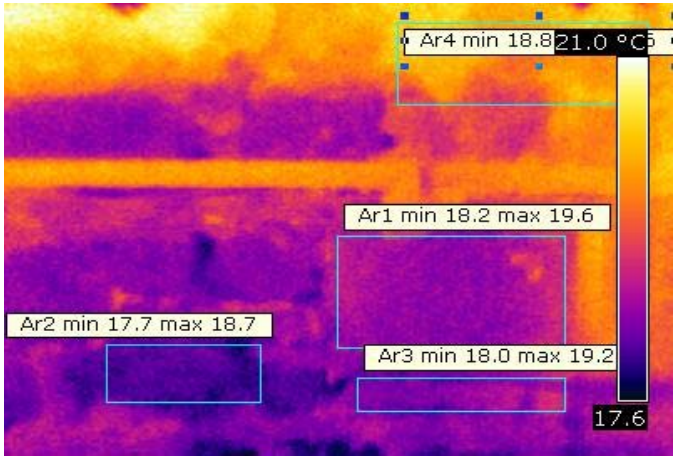
North Façade Thermography

Temperature variation (DT) indicates morphological alterations due to different decay patters

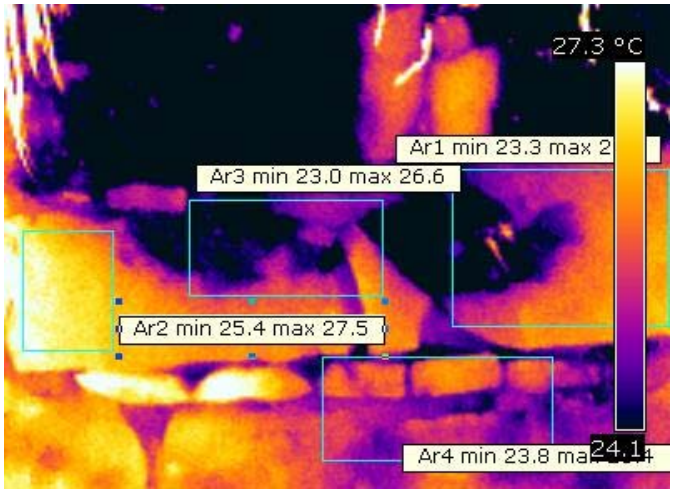
INFRARED THERMOGRAPHY



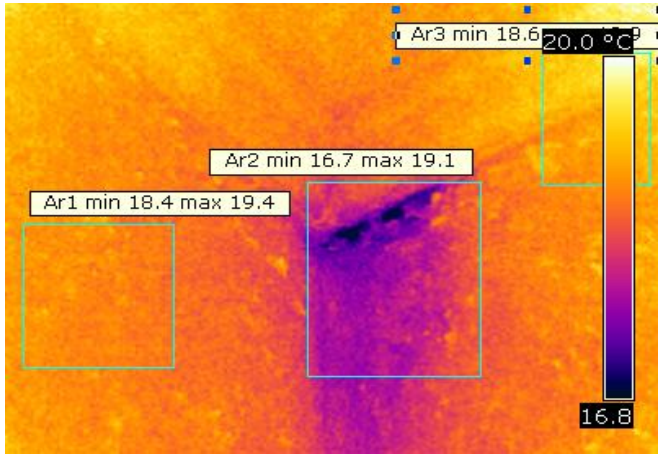
West Façade IRT



North Façade IRT – rising damp

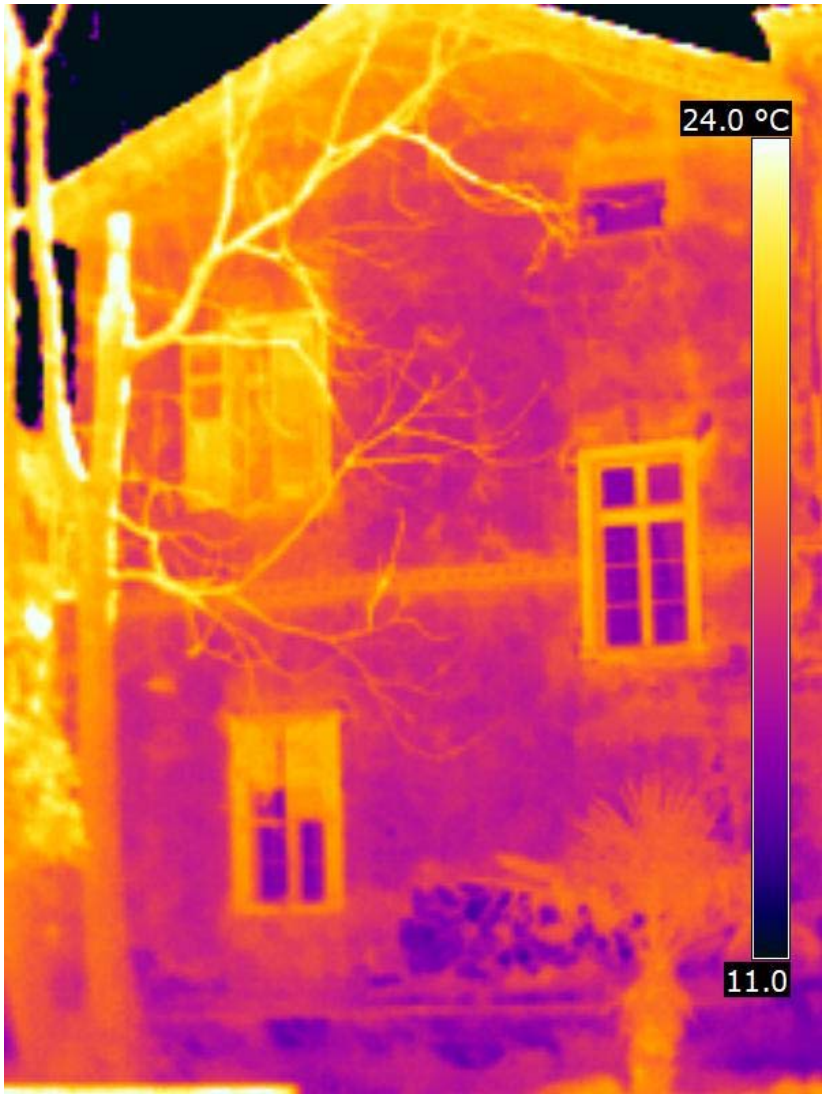


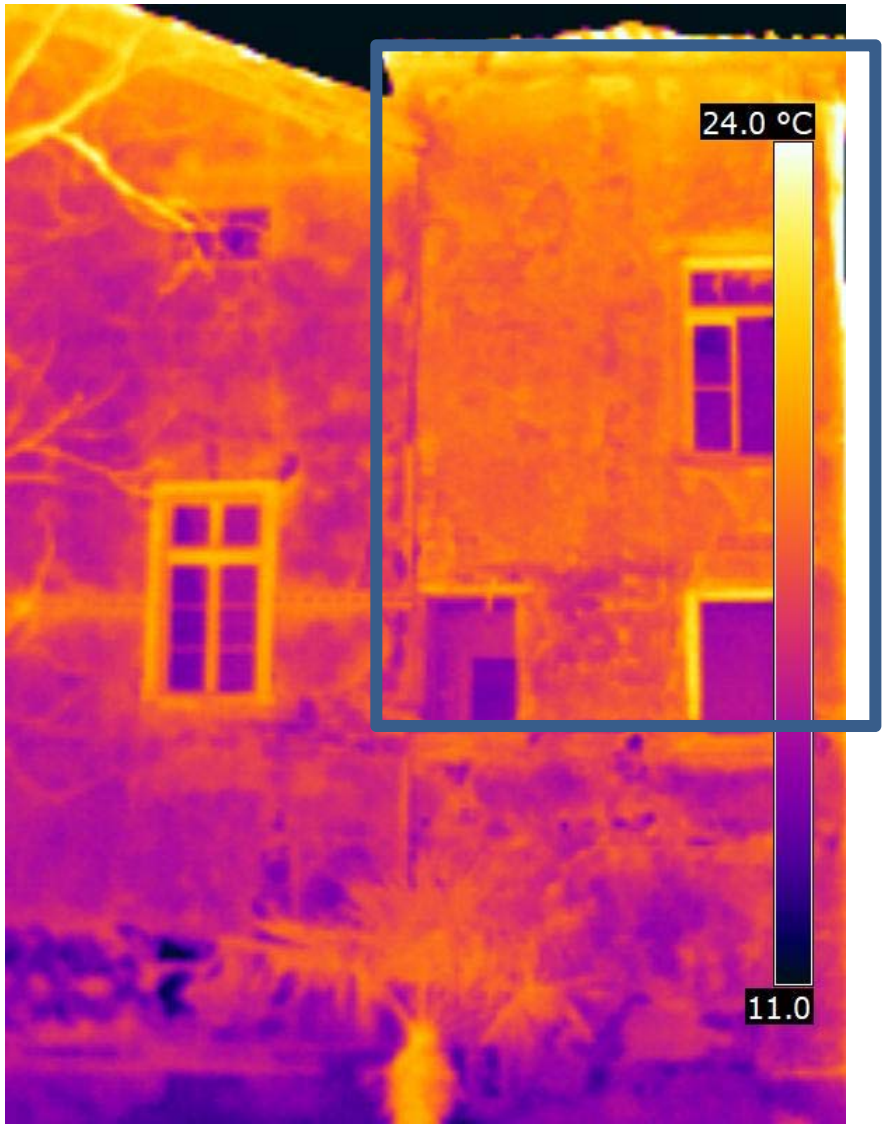
South Façade IRT – different materials disclose different temperatures



South West Interior Room IRT– penetrating damp

INFRARED THERMOGRAPHY

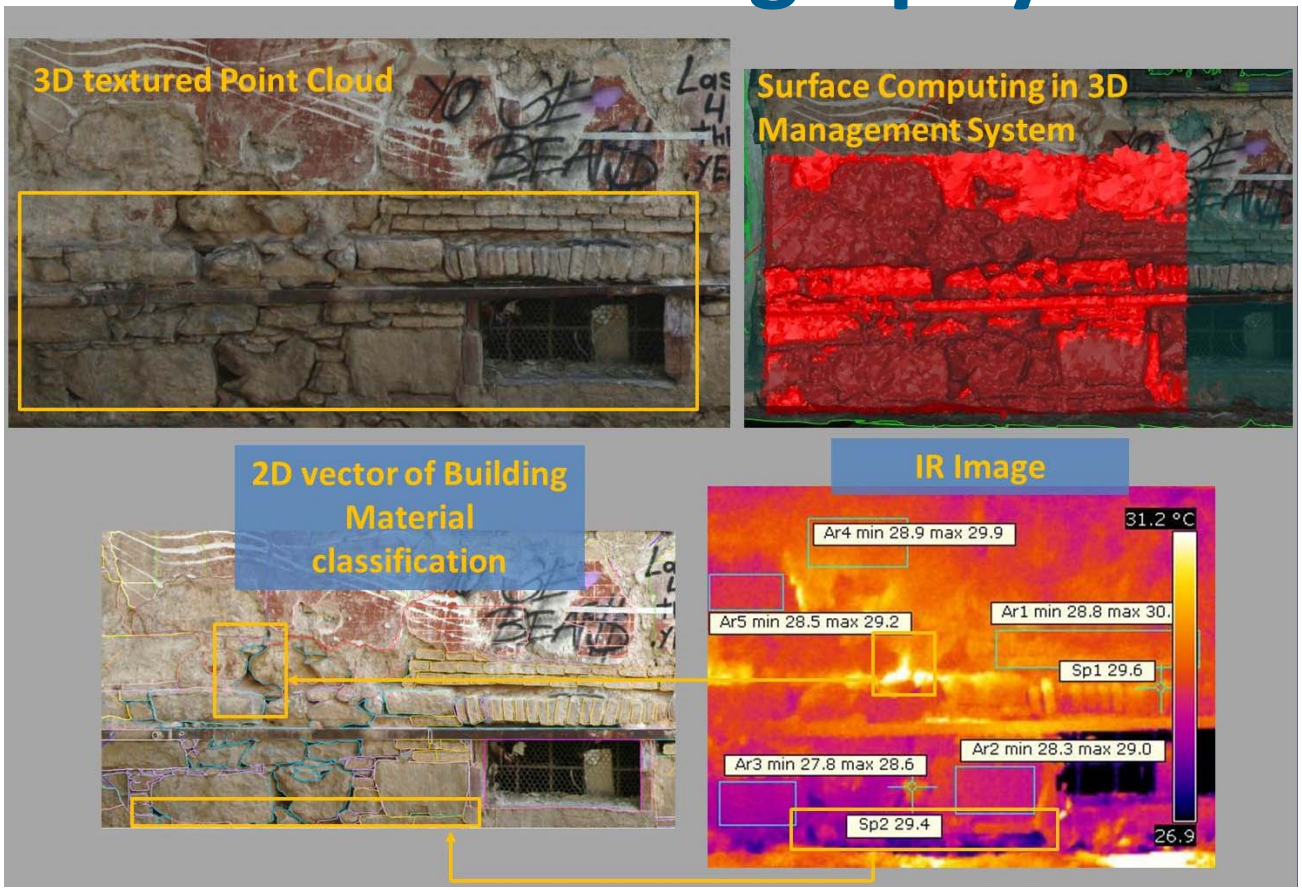




North Façade, Thermal mapping of the façade – indications of different construction phases

Data Fusion

Infrared Thermography



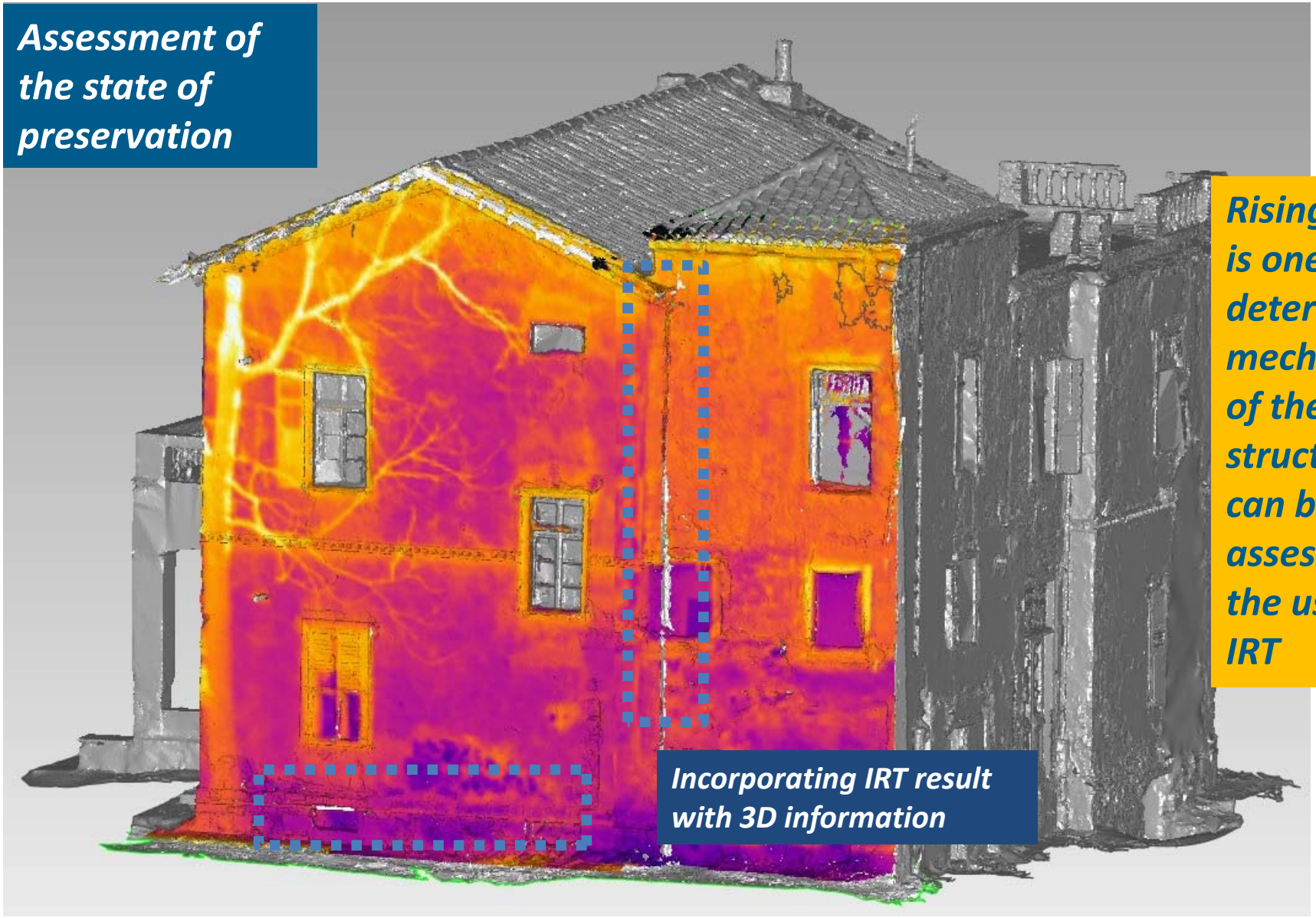
3D mesh *and textured 3d point cloud model indicate* ***the lack of the external layer*** *of the* ***plaster*** *as well as other decay* ***pathologies*** *which can be interpreted by including information deriving from* ***DM images*** *such as* ***efflorescence*** *(salt coating) in the lower part of the building.*

The IRT image results decay patterns, voids, cracks and anomalies of the surface.

Assessment *of the exterior* ***deformation*** *including variation of materials.*

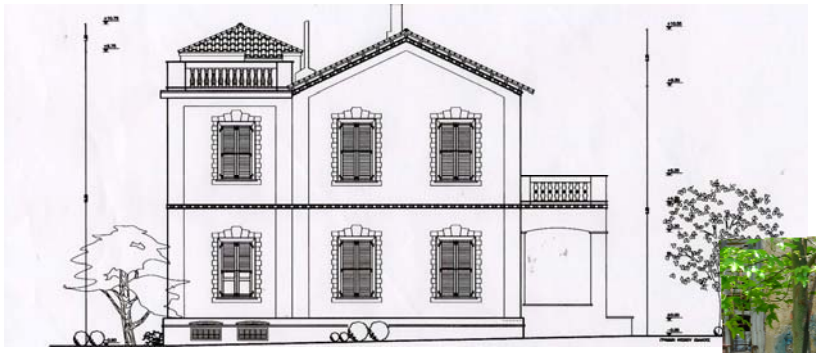
Merging IRT images with 3D model

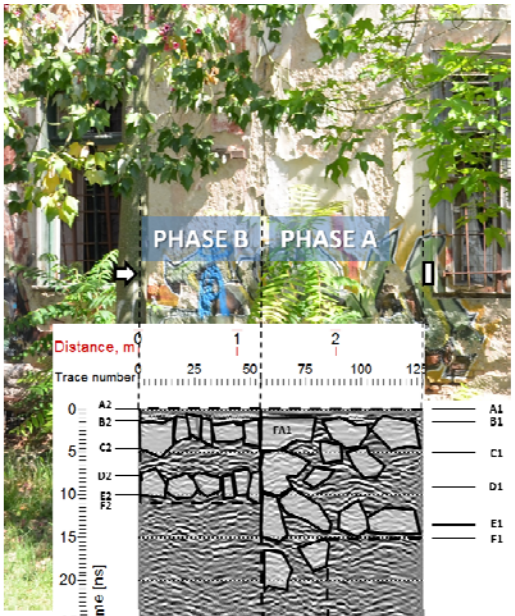
Assessment of the state of preservation

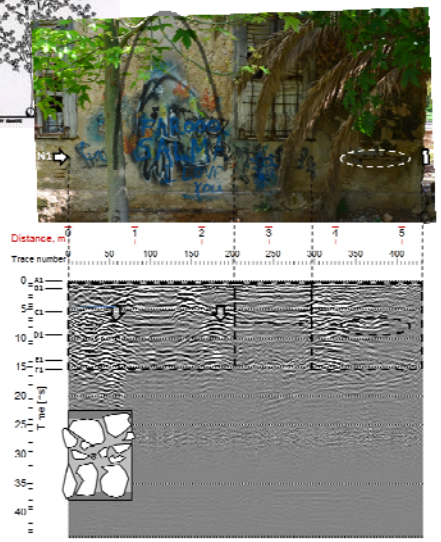


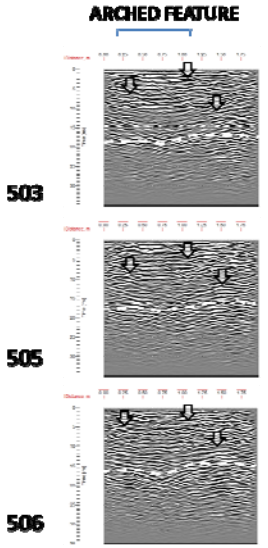
Rising damp is one of the deterioration mechanisms of the structure that can be assessed with the use of the IRT

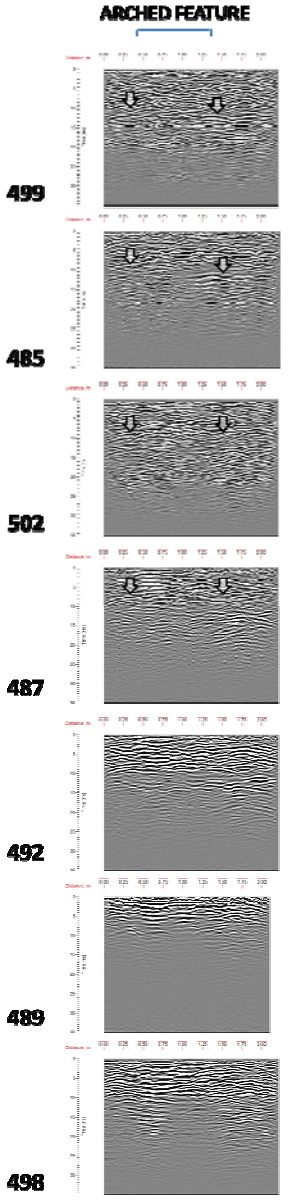
Identification of construction phases
Reveal hidden arches

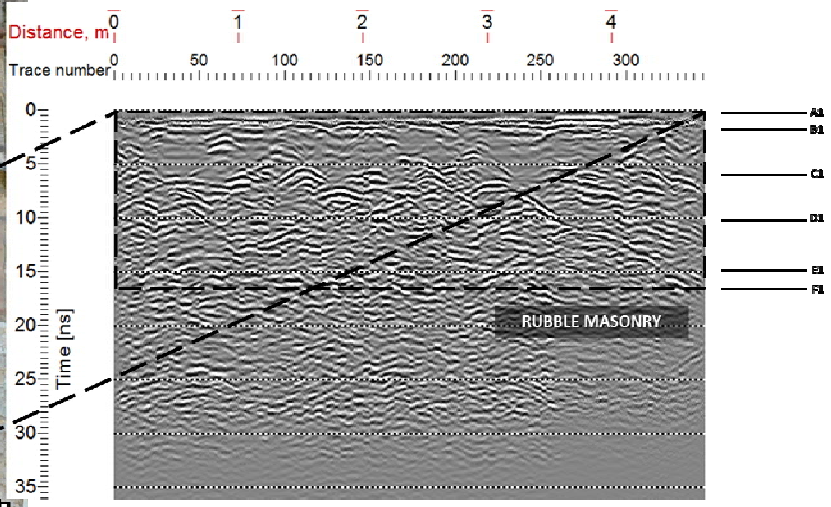


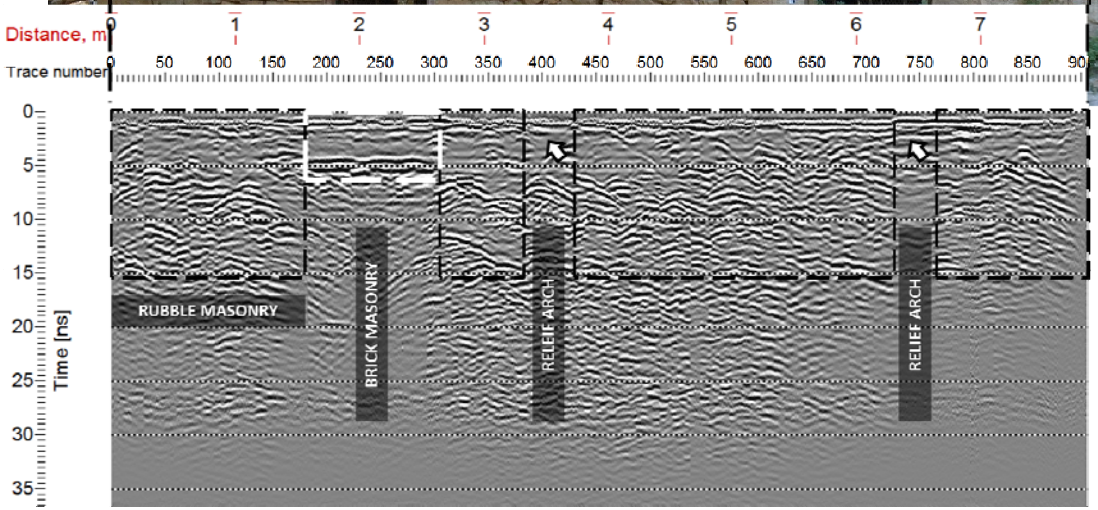








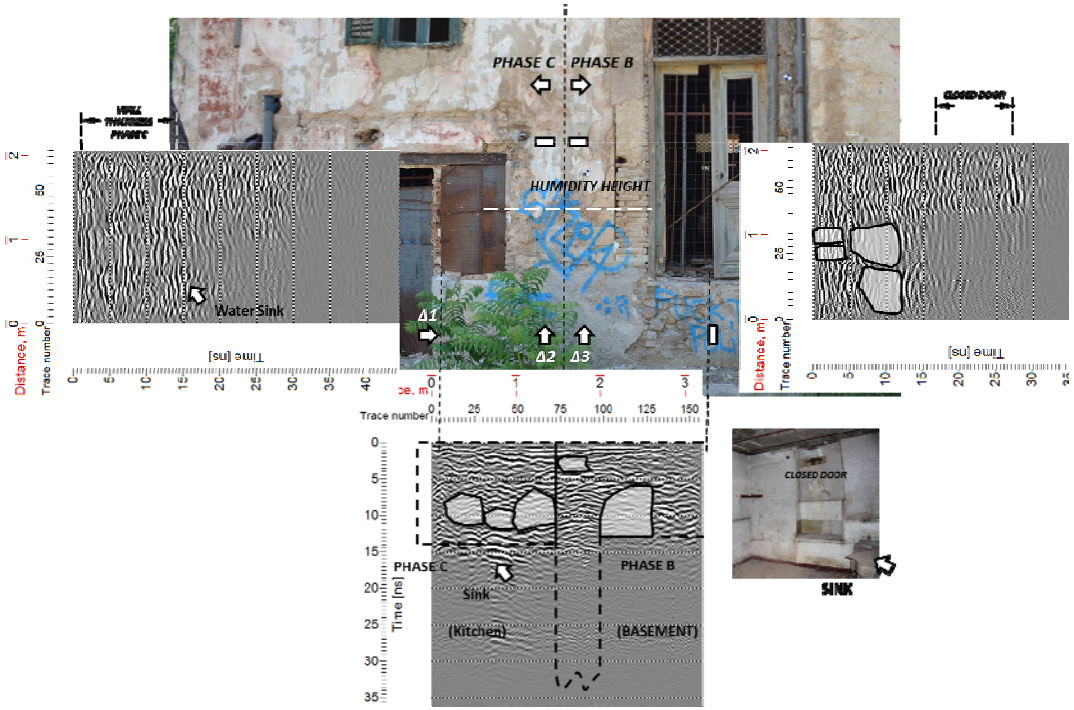




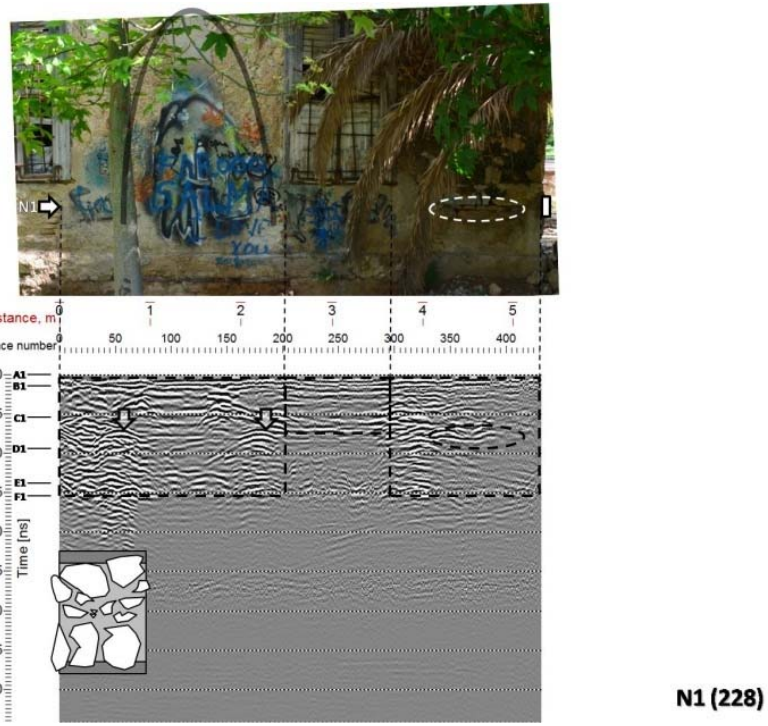
Reveal a hidden “Relief arch”

Ground Penetrating Radar

Geoscience ProEx system with 1.6GHz and 2.3GHz antennae



South Façade Measurements – indicating hidden arch within the structure of the wall

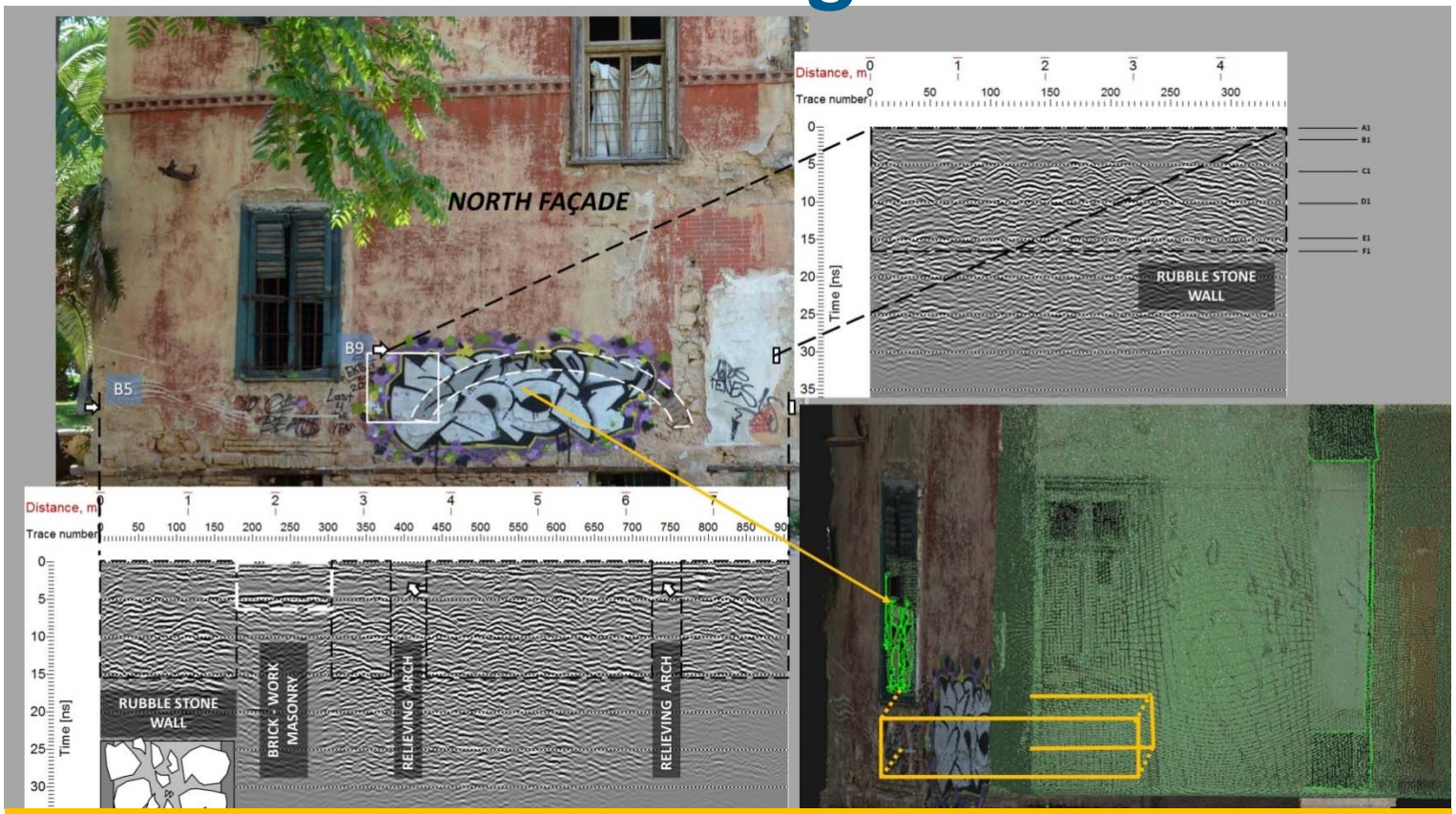


N1 (228)

West Façade Measurements – Indicating Different Construction phases

Data Fusion

Ground Penetrating Radar



Depth *and* ***size*** *of the multilayered structure of the walls.*

GPR results provides information regarding the ***depth*** *and the* ***type*** *of the construction walls, indicating* ***flaws and diffractions*** *buried beneath the surface of the walls*

Spatial correlation *can be performed between the GPR measurements and 3D point cloud deformations resulting in the creation of a* ***3D map of areas*** *which have been* ***affected by decay pathology*** *or* ***inhomogeneity*** *in the* ***multi-layered structure****.*

Ultrasonic testing

Application of ultrasonic test for a length of 5 and 10 cm in 7 different locations in various heights of the wall structure.

For pulse distance of 5cm results:

V_{ind} (704,2 m/s & 943,4m/s) V_{dir} (1387,3m/s & 1858,5 m/s)

E = 3,45 κ΄6,19 GPa

For pulse distance of 10cm results

V_{ind} (699,3 m/s & 885,0m/s) V_{dir} (1387,3m/s & 1743,4 m/s)

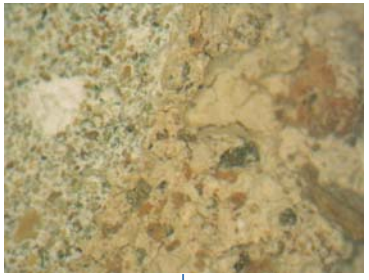
E = 3,65 κ΄5,84GPa

Digital Microscopy

Moritex - i-scope with several magnifying lenses (x30, x50, x120)

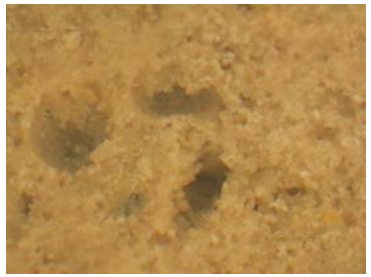
Images x50 & 30
Compact grey limestone – veins, 1st construction phase

Lime-clay mortar – lumps (x50)



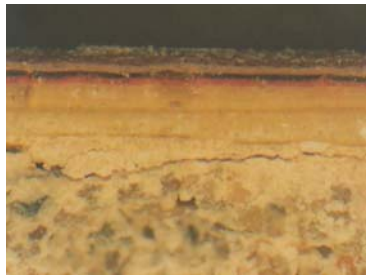
Plaster (x50)

Coarse grain texture, 1st Construction phase stone (x50)



Porous stone 2nd construction phase (x120)

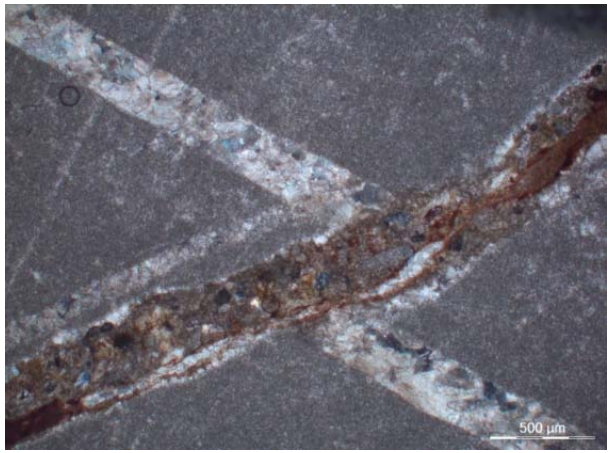
Brick – 1st construction phase - biodecay (x50)

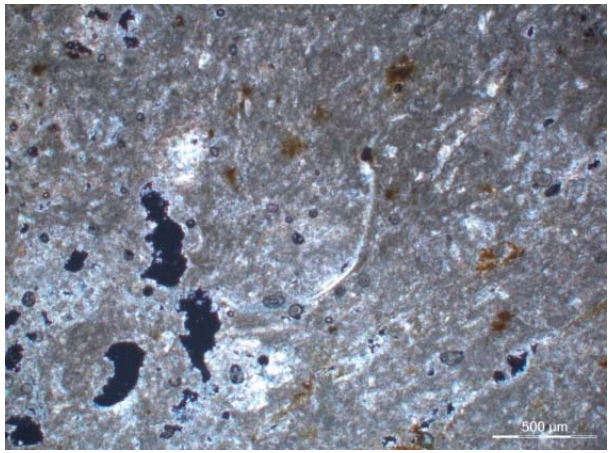


Decorative plaster (x120)

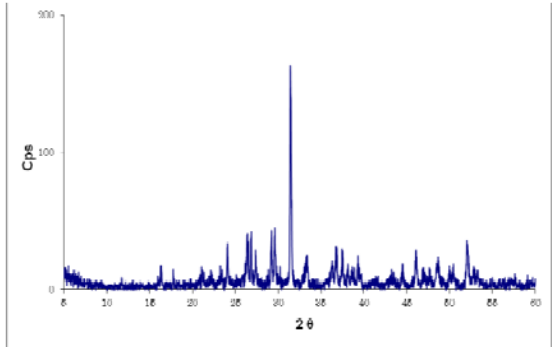
Analytical techniques after sampling for the in depth characterization of building materials and decay diagnosis

- ***O**ptical **M**icroscopy -**OM***
- ***X-ray D**iffraction **A**nalysis-**XRD***
- ***Thermo**gravimetric analysis-**Tg/DTA***
- ***S**canning **E**lectron **M**icroscopy coupled with Energy Dispersive X-Ray Analysis-**SEM/EDS***
- ***M**ercury **I**ntrusion **P**orosimetry, **MIP***
- ***Soluble Salt C**ontent measurements, **SST%***

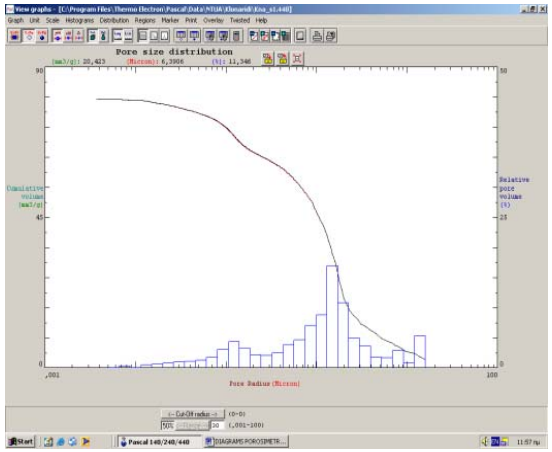




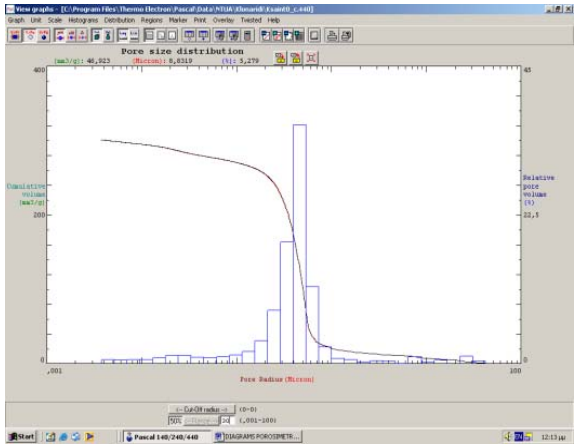
OM results - stone



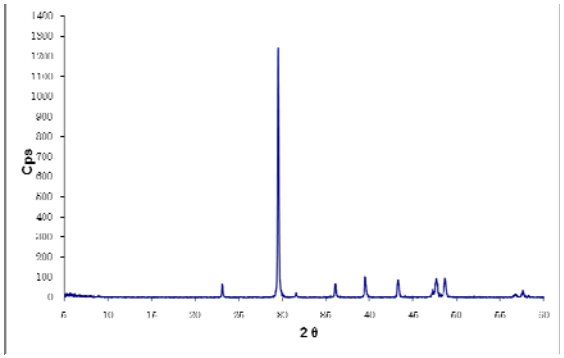
XRD results - brick



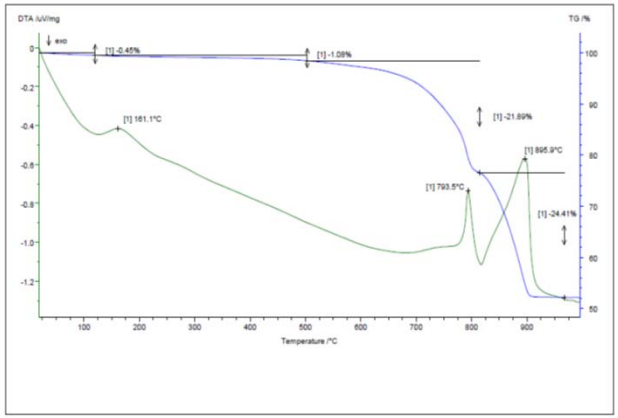
MIP results - stone



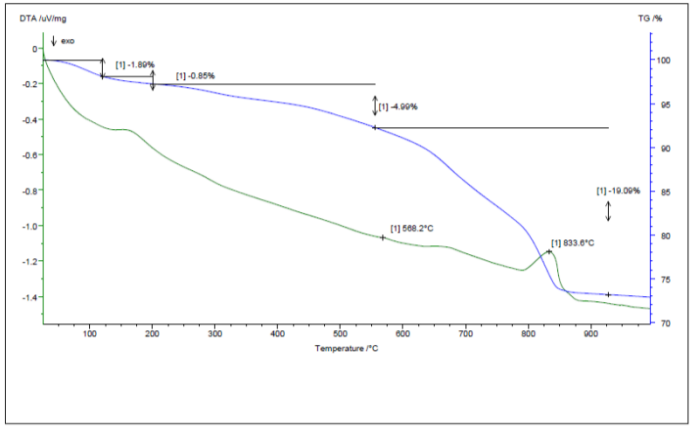
MIP results - brick



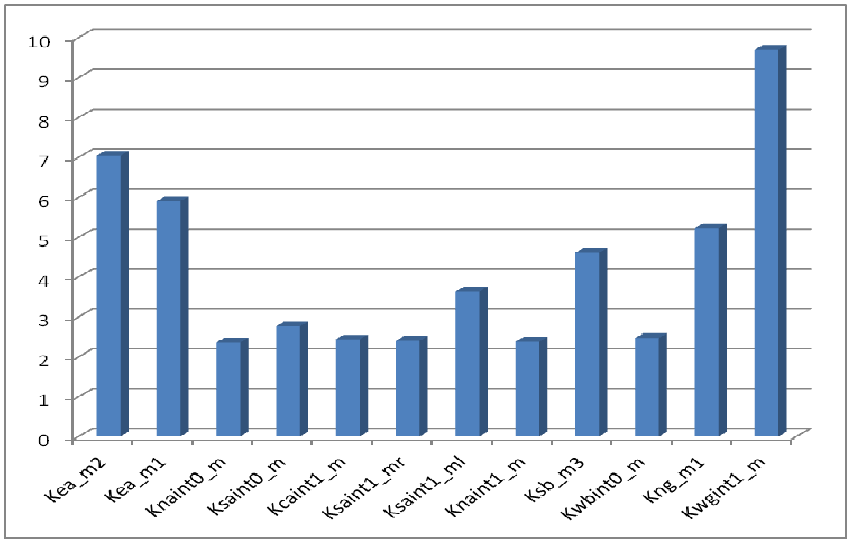
XRD results - stone



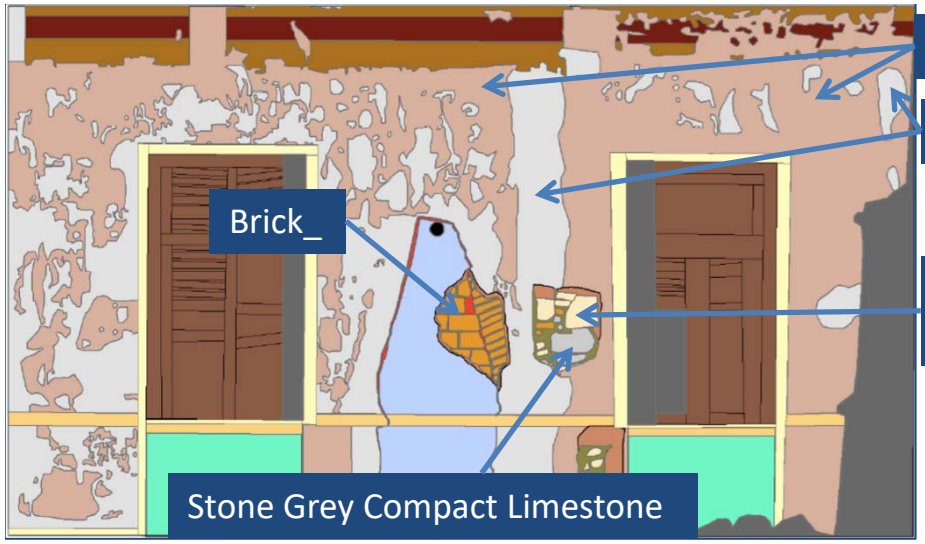
Tg-DTA results - stone



Tg-DTA results - mortar



SST% results - mortars



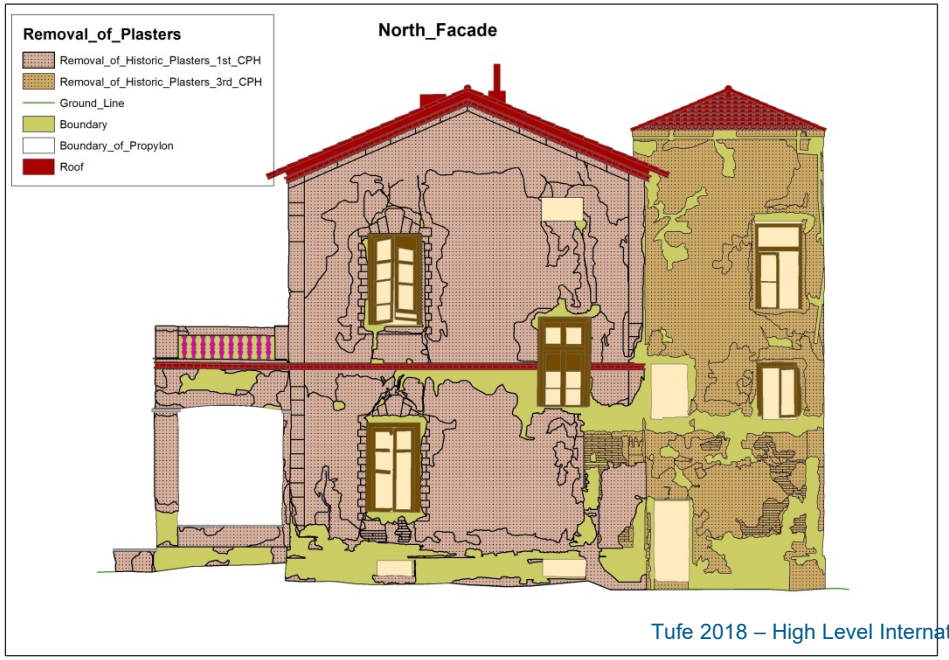
Thematic Map of Building Material and Decay Patterns in the Interior wall in the Southeast room located in the ground floor

Thematic Map Creation

Visualization & statistical analysis

Thematic Map of Building Material and Decay Patterns in the South Façade of the Building

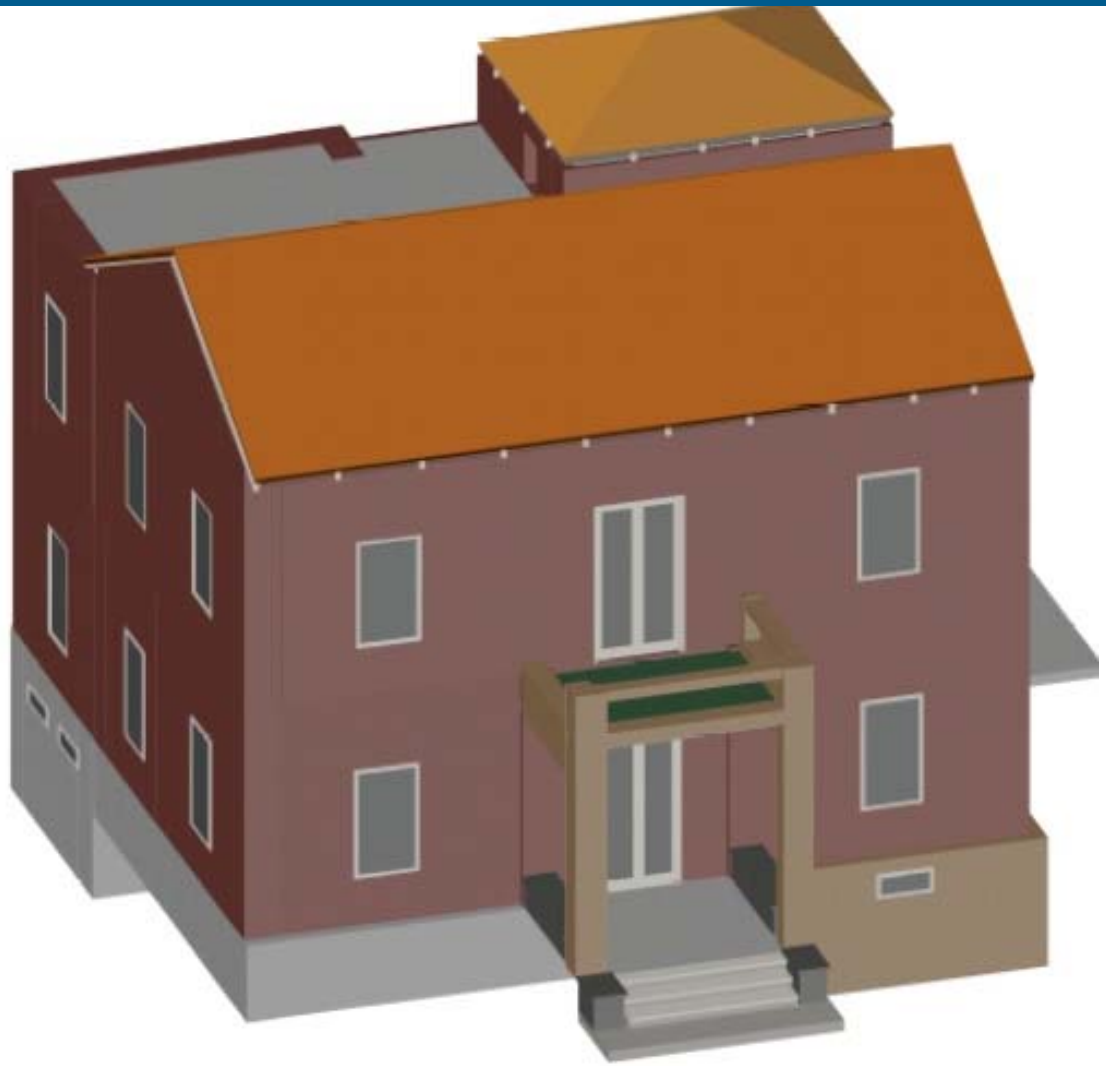
Visualization & analysis



Decision-making for compatible material selection and **conservation / protection interventions**

BIM Model Creation

BIM Model



*Fusion of **Architectural** and **Historical** Documentation*

Villa Klonaridi in ArchiCAD:

Classes

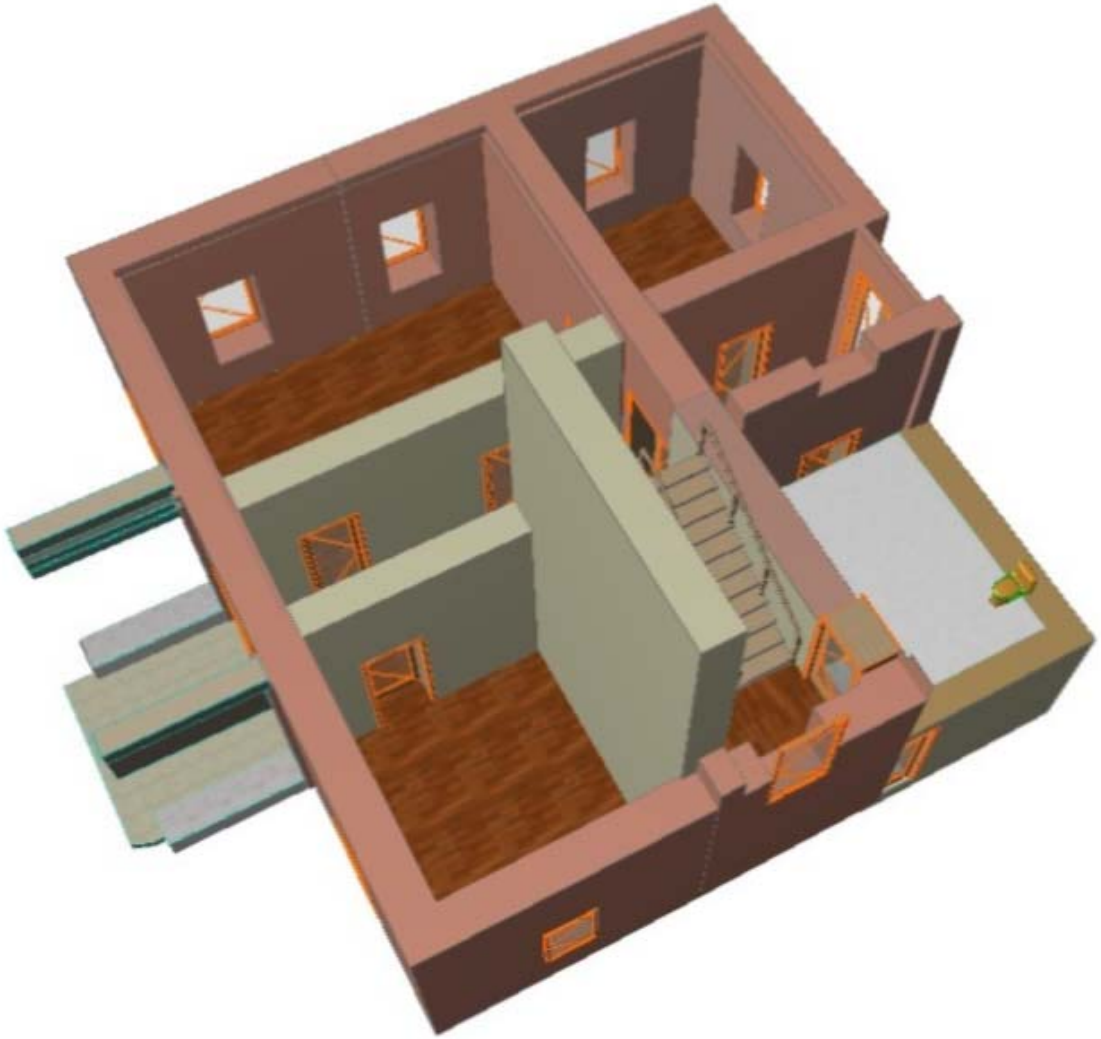
- story (building floor)
- Layer
- material

Layers

- Structural-bearing (walls)
- Structural-combined (staircases)
- Shell-Roof
- Objects (various)
- Interior-partition (interior walls)

Using as basemap the drawings of the architectural documentation first approach in creating a 3D building information model

BIM Model



Villa Klonaridi in ArchiCAD:

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Layers

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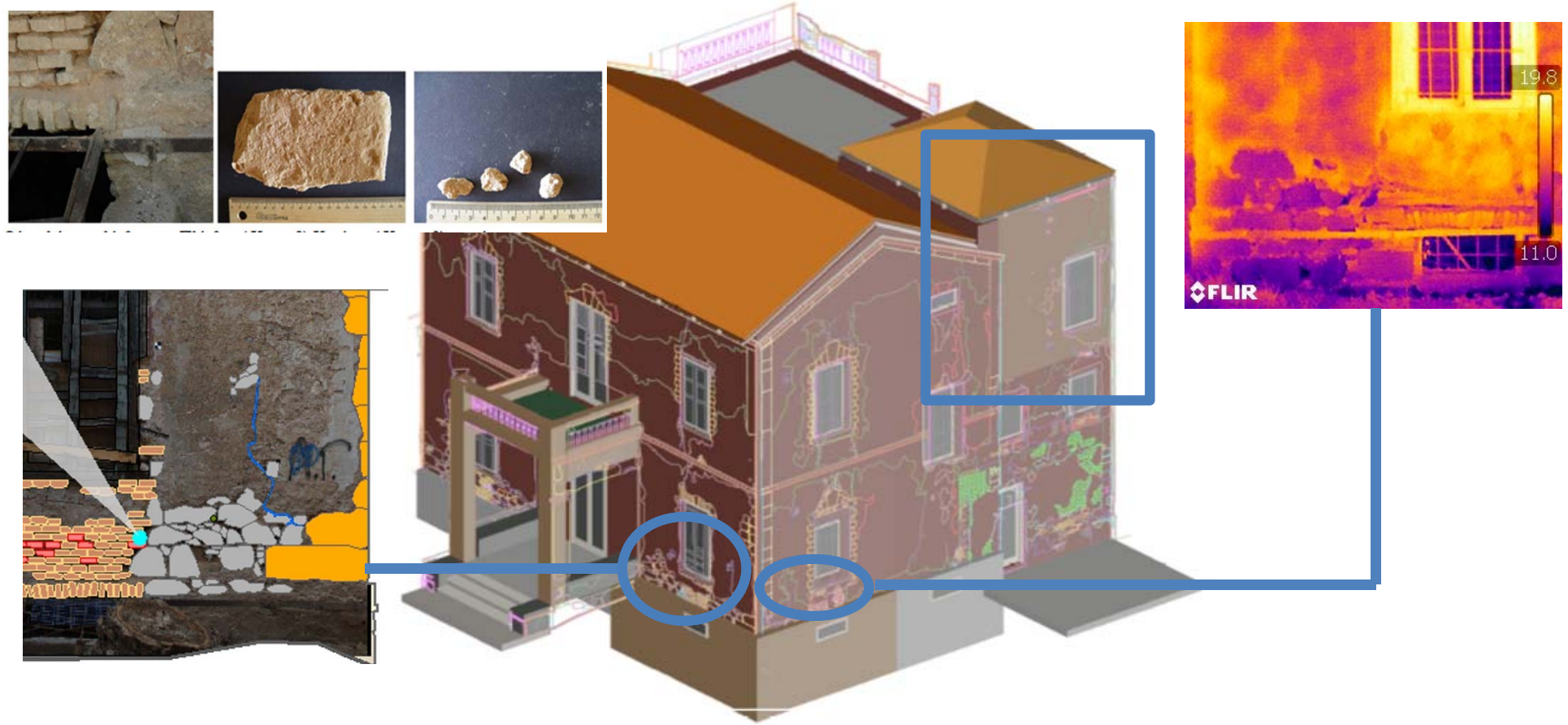
- Shell-Roof
- Objects (various)
- Interior-partition (interior walls)

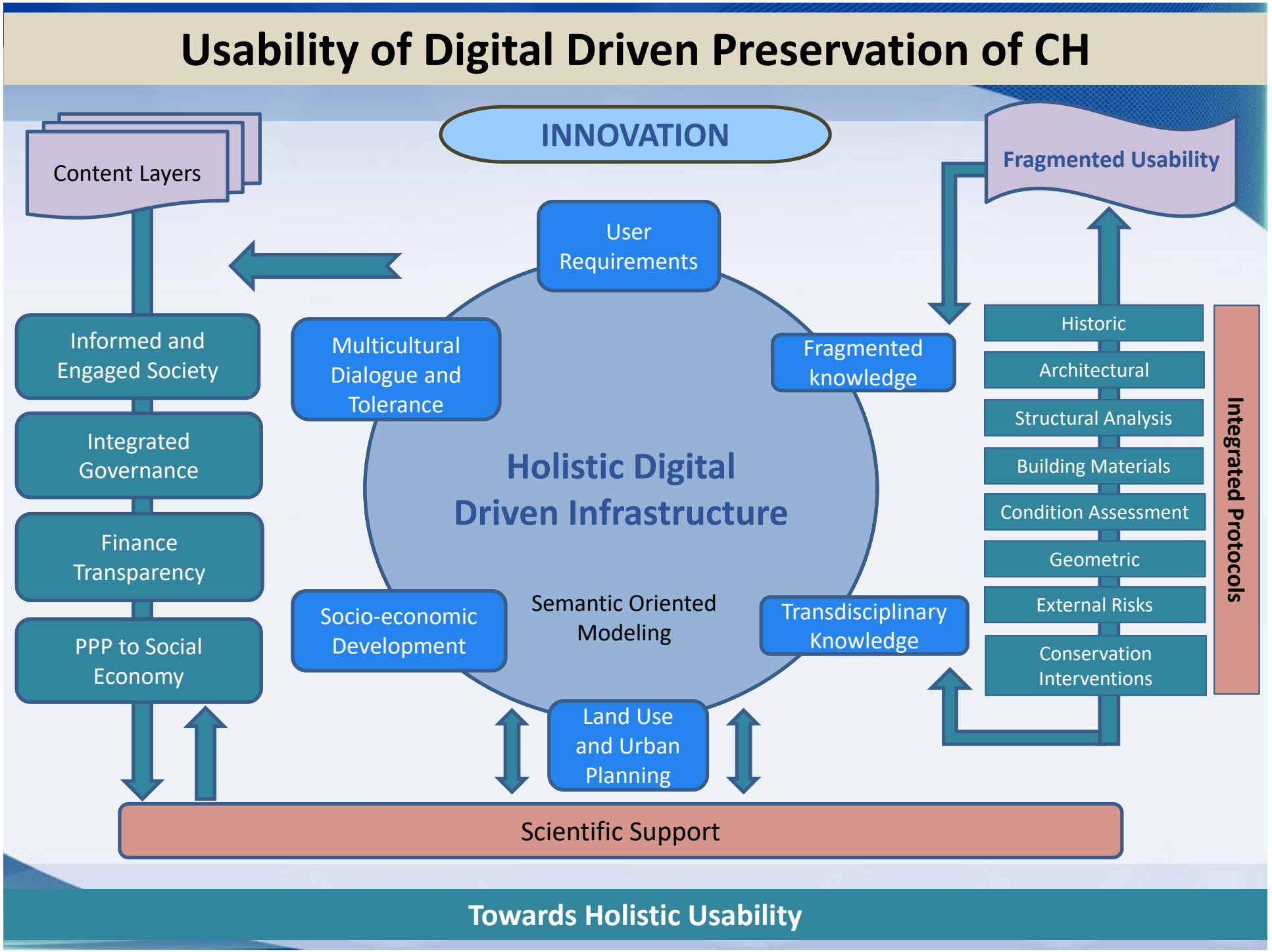
Section of the Building indicating the construction elements

BIM Model integration



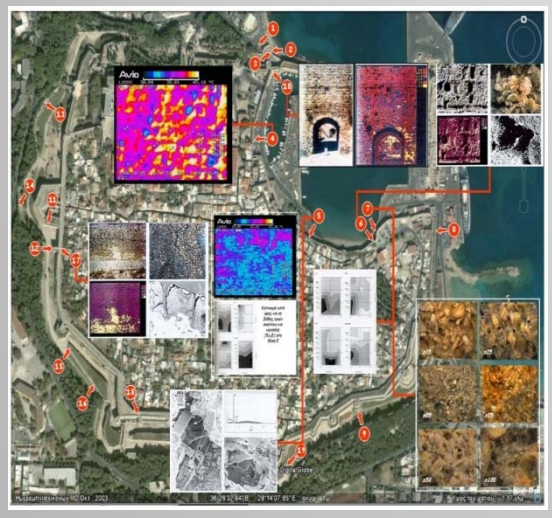
Incorporating**, 2D vector layers, elaborated within 2D GIS environment- imported within **3D management software** to export information regarding **features classification.

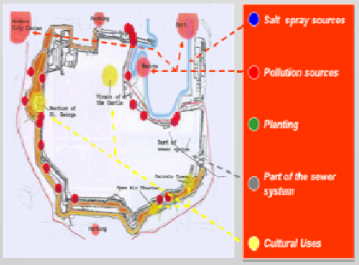
Usability of Digital Driven Preservation of CH



Prospection towards future development for CH preservation

Future Development: Scale up to the level of Historic Cities/Areas





Integrated environmental management for the protection of Cultural Heritage

GIS management of digital information to assess environmental impact on cultural heritage towards strategic planning

Resilience enhancement and reconstruction of Historic Cities /Areas

Digitizing and managing data through geographic information system (GIS)

Innovative funding *can permit the* ***preservation of cultural heritage*** *through its* ***re-use*** *and can bridge* ***Private-Public Partnerships*** *with* ***Social Economy***

Research in Evolution: Towards a 3D digital platform for preservation of Cultural Heritage serving Circular Economy

CLIMATE CHANGE and ENSURING SUSTAINABILITY

- **Sustainable materials**, elements and Works: Preventive maintenance of buildings, systems and infrastructures; Environmental impact, decay, damage assessment; Quality systems; Green materials
- **Materials and multi-functional elements for energy efficiency**: Envelope and structure solutions; Low energy optimized lifecycle buildings; Systems
- **Design, development and characterization** of novel materials and elements: Nanomaterials, nanotechnologies/nanoscience; Recovery of materials for construction (from industrial by-products, recycling, waste treatments etc.)
- **Protection of Built Cultural Heritage:** Documentation; Risk and environmental impact, decay, damage assessment; Interdisciplinary diagnostics/pathology; Evaluation of compatible and performing materials and intervention techniques; Lifecycle optimization; Traditional and advanced intervention materials and techniques; Preservation and management
- **Archaeometry:** Dating and Provenance of archaeological remains; Ancient Technologies used.

ANALYSIS AND ASSESSMENT AIMING TO CULTURAL HERITAGE PRESERVATION

- **Natural hazards assessment** and upgrading of materials and structures: Geohazards (landslides, rockfalls, subsidences, fault reactivation); Seismic vulnerability assessment and redesign, retrofitting materials and intervention techniques; Fire hazard assessment, upgrading of fire-resistance, post-fire interventions

- **Advanced and non-destructive monitoring** and **assessment** multi-scale techniques and warning systems

- **Distributed Knowledge and media systems for sustainable Works**, materials and Cultural Heritage: Pervasive knowledge based learning systems and networks; ICT-based decision support systems; Computer vision; Cloud computing