

ORMYLIA FOUNDATION ART DIAGNOSIS CENTER

> WORKSHOP on Novel non-invasive technologies assisted by robotic & Artificial Intelligence for Cultural Heritage preservation & documentation September 25th, 2018

Knowledge basis and annotation tools on FTIR spectroscopy, μ-Raman Spectroscopy, XRF analysis, Ultrasonic Scanning and Ultraviolet – Visible spectroscopy data

EU Sca4Reco project

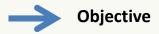
"Multimodal Scanning of Cultural Heritage Assets for their multi-layered digitization and preventive conservation via spatiotemporal 4D Reconstruction and 3D Printing

Introduction



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- Problem: decay of byzantine iconography and metallic objects that need restoration
- Decay obvious by the human eye perspective.
- Are all kinds of decay obvious? Decay that cannot be distinguished by human eye perspective.
- Which and how many are the kinds of decay? How can they be sorted?
- How many kinds can happen in the same time?
- How could kinds of decay be distinguished from the unaffected matrix of the object. Experience is necessary.
 Expertise opinion. Subjective
- Scientific measurements that display the kind and extend of the decay.



Introduction

Scientific documentation of the type of decay of painted and metallic (silver and bronze) objects by crosschecking measurements from different techniques-instrumentation.

Create an assisting tool for the user, that will facilitate the decision-taking.

The close to reality correct diagnosis is based on properly structured database and correct simulation based on aging.

For that purpose a methodology to build up a useful and advisory tool was developed.

reference samples preparation/ artificial ageing/ measurements Construction of Multisensorial platform and motorized mechanical arm/ Multispectral Scanning

Scan4Reco Annotation tool

Spatiotemporal Simulation and Reconstruction Applications trials and evaluation/ utilization of clone icon and pilot icons/

Target

Main aim of Scan4Reco project related to the knowledge base:

Preparation of reference samples/ panel of colors based on materials used, techniques and stratigraphy of byzantine iconography/ metallic samples silver and bronze

Artificial ageing of reference samples (T0 up to T3, under temperature and UV variations)

Tested and studied after every ageing step using FTIR, UV-Vis, XRF, Raman, Ultrasound

Constitution of a concentrated and centered database that will train the spatiotemporal simulation algorithms - they will be used for calibration of the developing scanning techniques and most importantly they will assist in the extraction of the material specific ageing models

The construction of a software that brought all data together and lead to simulation potentialities and to an effort to subjective diagnosis based on ageing models.

Target

How could the scientific documentation be expressed, in order to categorize the decay, evaluate the degree and the combination of decays and propose restoration steps the for a painted object?

How could a documentation be evaluated and serve the purpose of diagnosis?

Does the stratigraphy of pigments influence the documentation results? Do the signals differentiate?

What factors influence the detectability of decay results on artwork?

Creation of knowledge base

Creation and preparation of a wooden panel with combinations of inorganic pigments based on the already existing ones in the Lab of "ORMYLIA" Foundation

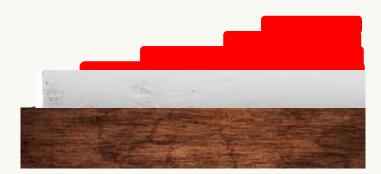


measurements

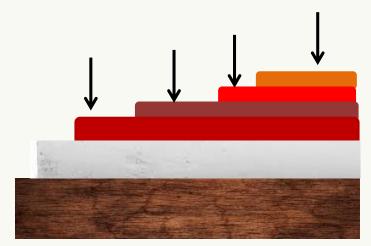
List of inorganic pigments

- massicot
- yellow, red and warm ochre
- hematite
- burnt sienna
- caput mortuum
- minium
- cinnabar
- green earth
- verdigris
- malachite
- ultramarine
- cobalt blue
- prussian blue
- indigo
- azurite
- carbon black

Creation of knowledge base



Layers of a single pigment



different pigment layers

Stratigraphy: Wooden carrier, preparation layer (chalk or plaster), pigment layers, coating (varnish mostly)

Measurements of all cases in order to cover all probable combinations

- Samples with stratigraphy of same pigment in some cases or a single layer of a pigment
- Samples with stratigraphy of different pigments
- Measurements on every layer and after every ageing step, that are called T0, T1, T2 and T3
- Measurements on varnished and un-varnished areas

Existing Knowledge base

"ORMYLIA" Foundation Database from over 20 years of study on artworks and byzantine iconography

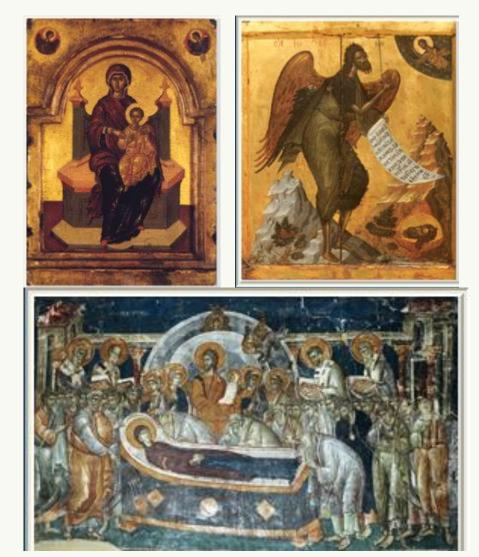
Research – Documented knowledge – Interdisciplinary study



Existing Knowledge base

"ORMYLIA" Foundation Database from over 20 years of study on artworks and byzantine iconography, over 8,500 samples

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Knowledge base

 "Ormylia" Foundation Database from over 20 years of study o byzantine iconography

Scientific techniques – instrumentation

Contribution

X-Ray Fluorescence

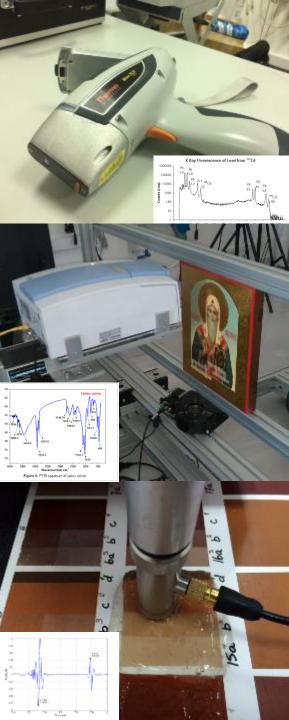
Elementary analysis

FTIR Spectroscopy

Detection of variations of organic carrier - matrix of inorganic pigments

Ultrasonic scanning

Imaging of internal structure – changing of roughness of the surface – surface layers, μTomography



Knowledge base

- Ormylia Foundation_Database from over 20 years of study iconography
- Scientific techniques instrumentation

Contribution

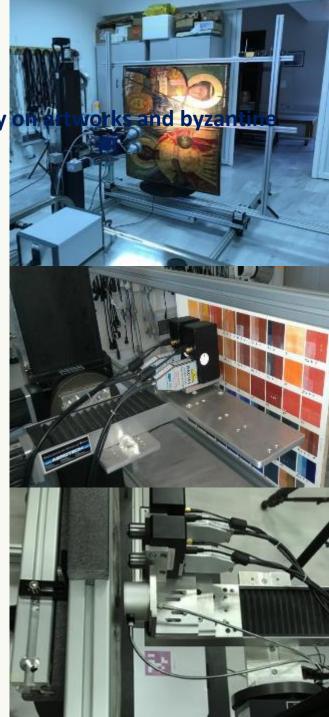
IR Imaging

Reveal underpainting and initial drawing, technology and style of creation, Pentimenti,

µRaman Spectroscopy

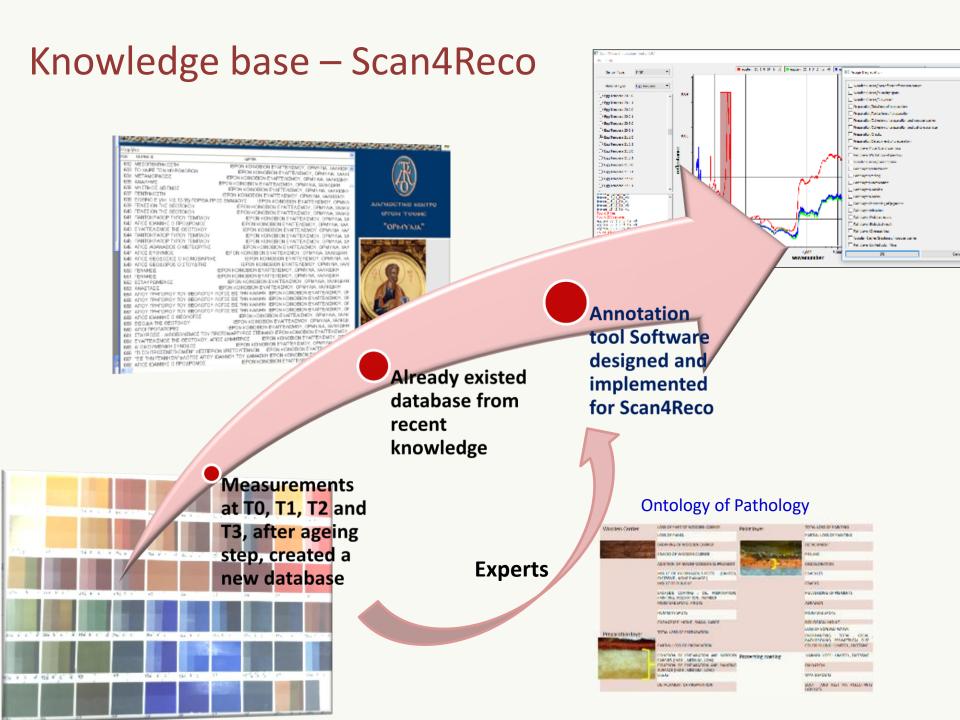
Identification of inorganic pigments

Ultraviolet – Visible Spectroscopy Characterization of color (L*a*b color space)



Annotation tool – Ontology of the Pathology of a painted object

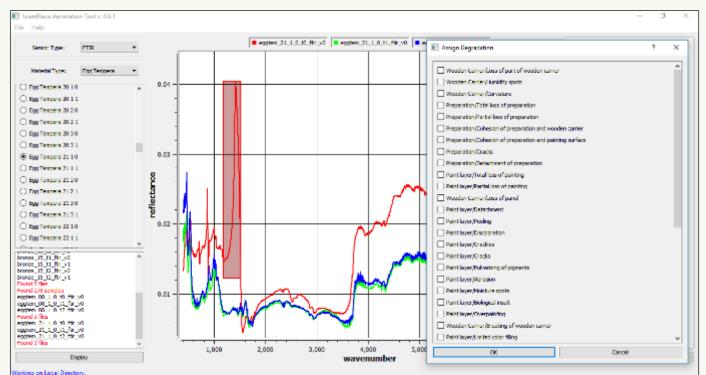
Wooden Carrier	LOSS OF PART OF WOODEN CARRIER	Paint layer	TOTAL LOSS OF PAINTING	
	LOSS OF PANEL		PARTIAL LOSS OF PAINTING	
	BREAKING OF WOODEN CARRIER	State of the state	DETACHMENT	
	CRACKS OF WOODEN CARRIER	The second second	PEELING	
	ADDITION OF NEWER WOODEN SUPPLEMENT	and the second second	DISCOLORATION	
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	BACKSIDE COATING : OIL, PREPARATION, PAINTING, INSCRIPTION , NUMBER		PULVERIZING OF PIGMENTS	
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	HUMIDITY SPOTS		MOISTURE SPOTS	
	CURVATURE : NONE , SMALL, LARGE		BIOLOGICAL INSULT	
	TOTAL LOSS OF PREPARATION		LOSS OF BONDED WATER	
Preparation layer	IOTAL LOSS OF PREPARATION		OVERPAINTING : TOTAL , LOCAL BACKGROUND, PERIMETRICAL, ELSE	
STATUTE SALE AND ADDRESS	PARTIAL LOSS OF PREPARATION		COLOR FILLING : LIMITED , EXCESSIVE	
and the second of	COHESION OF PREPARATION AND WOODEN CARRIER (HIGH , MEDIUM , LOW)	Protecting coating	VARNISH LOSS : LIMITED , EXCESSIVE	
E gandes g	COHESION OF PREPARATION AND PAINTING SURFACE (HIGH, MEDIUM, LOW)		OXIDATION	
ALC: NOTE	Cracks		WAX DEPOSITS	
	DETACHMENT OF PREPARATION		SOOT AND REST AIR POLLUTANTS DEPOSITS	



Annotation tool

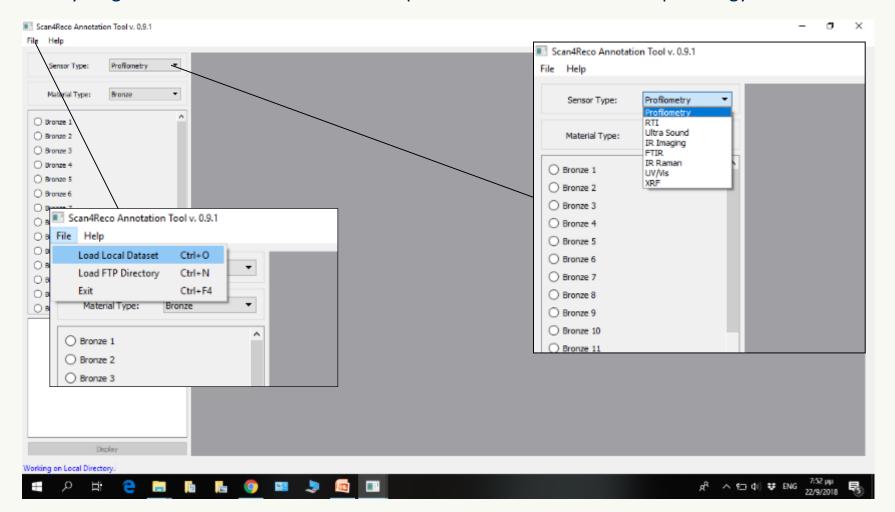
Problem: Too many scientific data, Raman spectra, FTIR spectra, XRF spectra, UV-Vis spectra, profilometry data, Ultrasonic signal values, IR imaging data. Measurements at initial time and measurements at every ageing step. All these data should be rearranged and given in a data base that could facilitate and emerge the impact of ageing on samples by relating the latter to a defined pathology.

Solution: Annotation tool arranged the measurements according to ageing time and according to Infra Structure. Pathology was cross-checked to each peak shift and each variation that could be attributed to decay due to ageing.



Annotation tool

Software that offers the ability to load our dataset, the measurements that a scientist produced, supporting data from 8 different techniques Overlay diagrams allowed the annotation of spectra and connection to the pathology

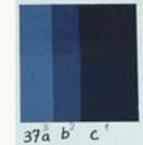


Annotation tool – FTIR overlay spectra



Cobalt blue at T0, T1 and T2 Stable behavior

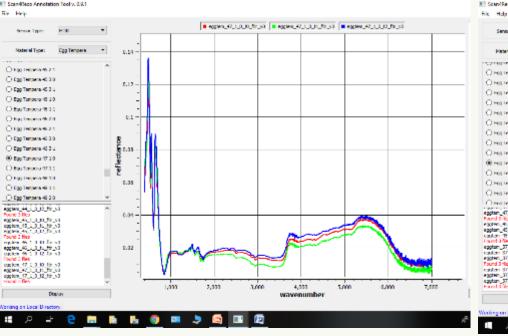


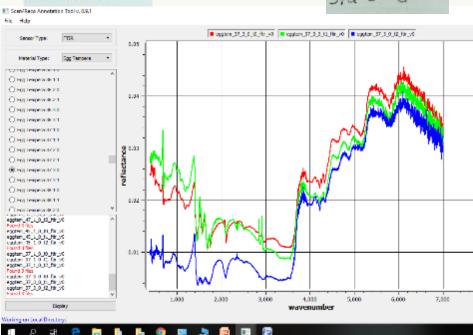


Prussian blue

at T0, T1 and T2 **Pigments peaks** unaffected

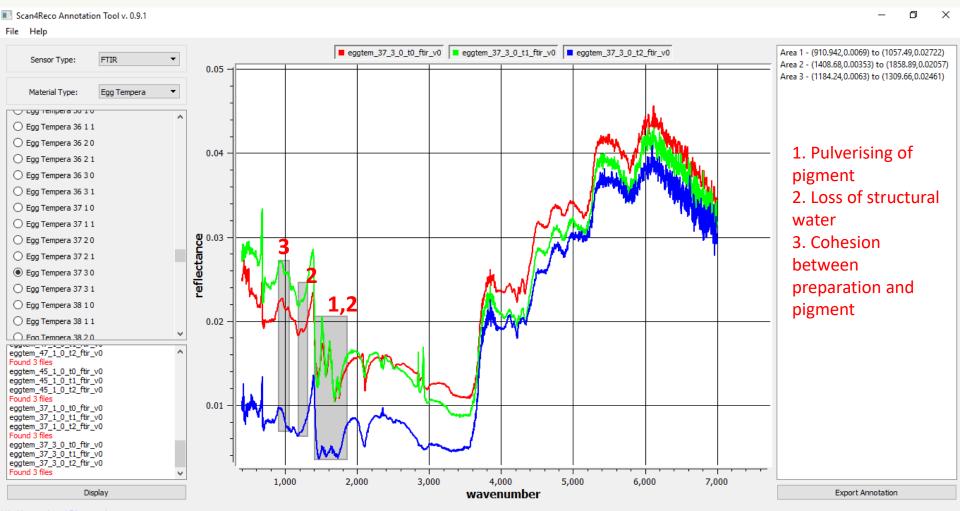






Annotation tool – FTIR overlay spectra

FTIR measurement of Prussian blue at T0, T1 and T2



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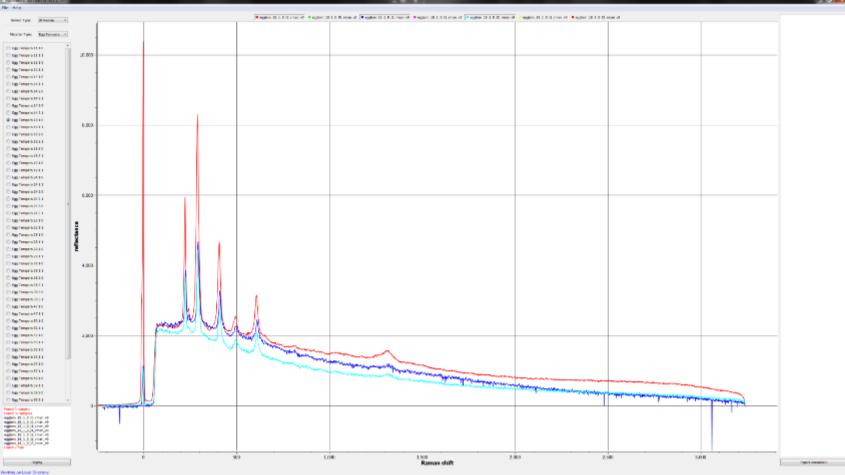
Annotation tool – µRaman overlay spectra



Caput mortuum + azurite at T0, T1, T2 and T3

Quality of pigment remained unaffected. Intensity of signal is connected to pulverizing of the pigment



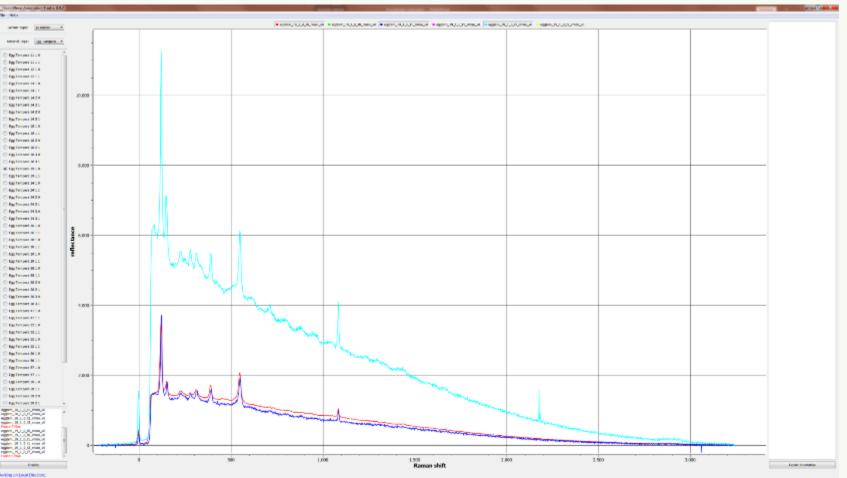


Annotation tool – µRaman overlay spectra



Minium at T0, T1, T2 and T3

Quality of pigment remained unaffected. Intensity of signal is connected to pulverizing of the pigment



Annotation tool – UV-Vis overlay spectra



Minium at T0 and T1

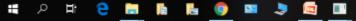
Change of luminescence, change of hue and change of saturation of the color



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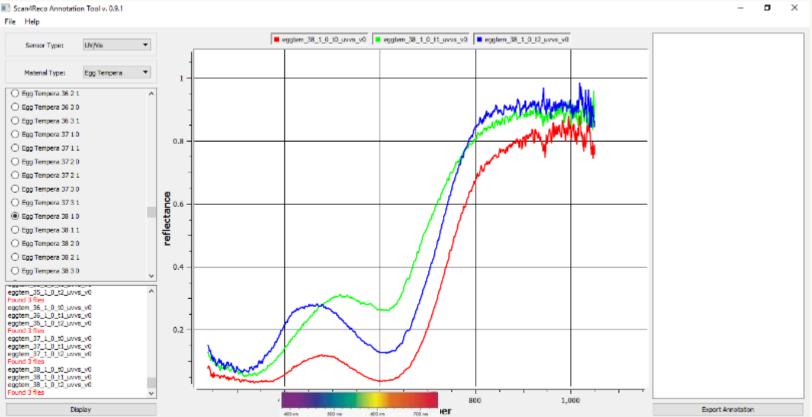
Annotation tool – UV-Vis overlay spectra



Indigo at TO, T1 and T2

Change of luminescence, change of hue and change of saturation of the color





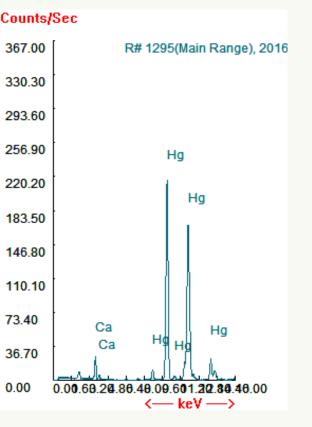
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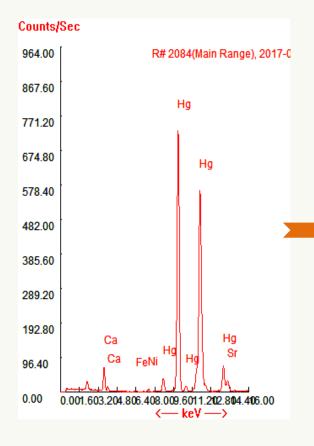
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Annotation tool – XRF

Cinnabar at TO



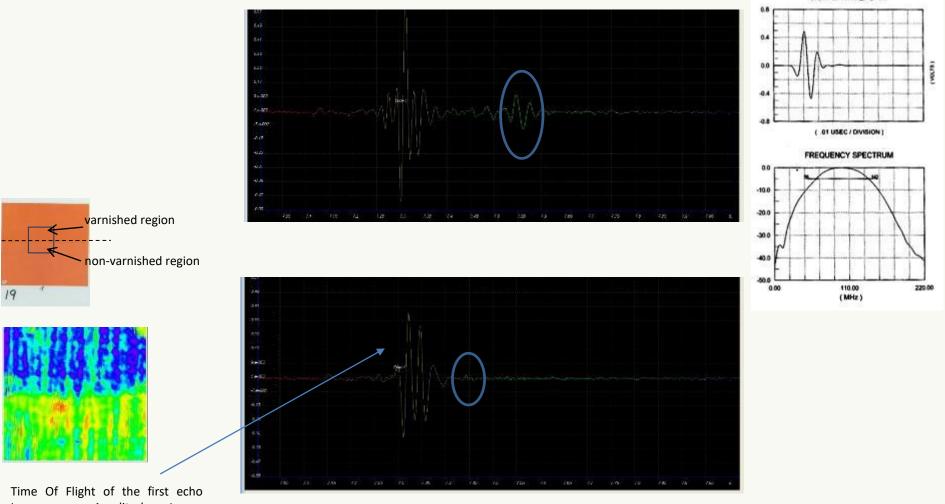
Cinnabar at T2



- 1. Pulverising of pigments
- 2. Damage of carrier of pigment
- Cohesion between preparation and pigment layer

Percentage of heavy metals is given as a proportion of measured area

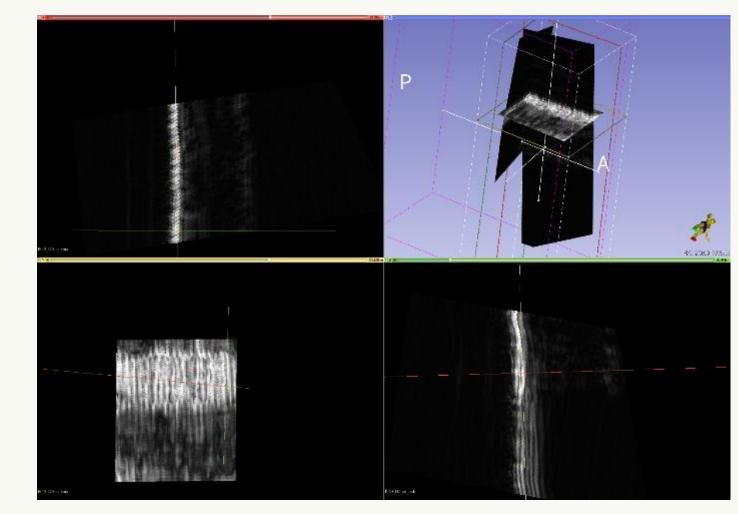
Annotation tool – Ultrasonic scanning



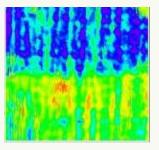
SIGNAL WAVEFORM

Image or Amplitude Image revealing the roughness

Annotation tool – Ultrasonic scanning



varnished region non-varnished region



Time Of Flight of the first echo Image or Amplitude Image revealing the roughness

<u>www.scan4Reco.gr</u> and sign in to a friendly on-line database, containing techniques, measurements at every ageing step, sorted by material type.

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<u>www.scan4Reco.gr</u> and sign in to a friendly on-line database, containing techniques, measurements at every ageing step, sorted by material type.

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	Bronze	Egg Tempera Paintings		
	For this study a 90% copper - 10% in was chosen, since it is representative of most ancient alloys used for statuary, apart from impurities or trace elements. A binary alloy with an approximate tin content of 10% was also much employed in the flemaissance	For this study the painting samples were prepared on a plywood board of 45 x 30 5cm on which comfortably fit 80 samples of 4 x 4cm. The preparation of colour samples, the choices for the preparation conditioning materials, the binder and colours were made		
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	Silver 95%-Copper S% sheet, size 7 cma 2.5 cm, thickness 1 mm On each sample, a strip is left uncoated as reference. The treatments applied are among the most popular ones used by silver heritage conservators.			
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<u>www.scan4Reco.gr</u> and sign in to a friendly on-line database, containing techniques, measurements at every ageing step, sorted by material type.

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			Reflectance Transformation Imaging (RTI)	17		
			UV-Vis	2		
			X-ray fluorescence (XRF)	2		
		Tl	FTIR	2		
			Optical profilometry (MPF)	4		
			Reflectance Transformation Imaging (RTI)	17		
			UV-Vis	2		
			X-ray fluorescence (XRF)	2		
		T2	FTIR	2		
			Optical profilometry (MPF)	4		

<u>www.scan4Reco.gr</u> and sign in to a friendly on-line database, containing techniques, measurements at every ageing step, sorted by material type. **Download of data is available**.

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Conclusions

 The application of annotation tool facilitated the connection of ageing impact on samples to the pathology

 Data from 8 different instrumentation techniques were collected and grouped in a single tool providing the possibility to observe and annotate them in parallel

The decay of materials and pigments in time was recorded and displayed by overlay diagrams, still to be used for the evaluation of measurements on objects under restoration

 Evaluation of the impact of stratigraphy on every measurement technique

Relation of the decay with the pathology

 Information about the ageing behavior of every inorganic pigment separately or not

A useful tool-database for experts on internet

