



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

The Scan4Reco Project (Scopes & Achievements)

WORKSHOP on novel non-invasive technologies assisted by Robotic & Artificial Intelligence for Cultural Heritage preservation & documentation

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- **Grant Agreement No.:** 665091
- **Project acronym:** Scan4Reco
- **Project title:** Multimodal Scanning of Cultural Heritage Assets for their multi-layered digitization and preventive conservation via spatiotemporal 4D Reconstruction and 3D Printing
- **Start date:** 01/10/2015
- **Duration:** 36 Months - **Currently @ M30**
- **Project website:** www.scan4Reco.eu



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Participant organisation name	Short Name	Country	Org. Type	Logo
CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	CERTH	Greece	Research	
IDRYMA ORMYLIA	OF-ADC	Greece	Research/ End User	
FRAUNHOFER INSTITUT	FRH IGD	Germany	Research	
UNIVERSITY OF VERONA	UNIVR	Italy	University	
OPIFICIO DELE PIETRE DURE	OPD	Italy	End-User	
CENTER FOR ADVANCED STUDIES, RESEARCH AND DEVELOPMENT SARDINIA	CRS4	Italy	Research	
BWTEk Europe GmbH	BWTEK	Germany	SME	
Avasha AG.	AVASHA	Switzerland	SME	
RESEARCH FOR SCIENCE, ART & TECHNOLOGY (RFSAT) Ltd	RFSAT	UK	SME	

With respect to Cultural Heritage documentation & preservation, the following holds:

- **enormous European Cultural Heritage (CH)** including a vast and rich variety of cultural items
- different **materials** with different **ageing patterns**
- different **restoration procedures**
- **multi-factorial** reasons for the CH **deterioration**
- lack of detailed & efficiently collectable **documentation**

- **enriched 3D representations** (printed or digital) is valuable for conservators
- limited **accessibility to public**

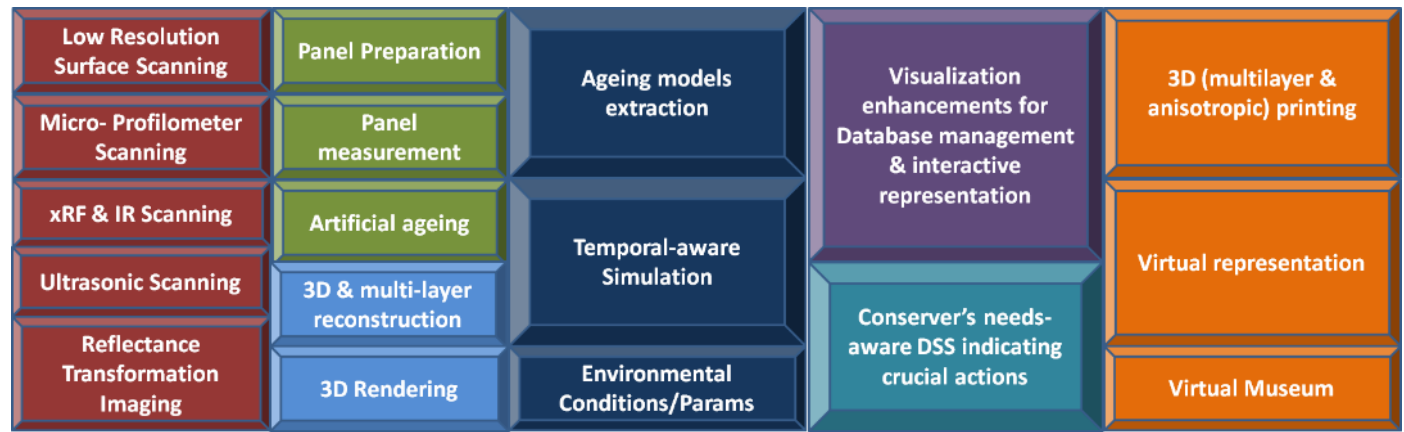
- The **study of the cultural assets** and archeological findings/remains from past periods of the human history helps us better understand the origins and the way human and human societies have evolved over the centuries.
- Europe has a particularly **rich & diversified cultural heritage**, monuments and objects of all sizes, composed of a great variety of materials.
- High importance CH objects are **preserved in museums** effectively protected conditions against environmental influences to secure them against effects of **relative humidity, temperature and exposure to light**, etc.
- There is an **increasing tendency for the digitization** (virtual reconstruction & representation) for:
 - dissemination
 - educational reason (i.e. via digital copies),
 - research (i.e. detailed computerized analysis)
 - conservation & restoration.

“Truth is like a sculpture - one perspective is never enough for true understanding”
F. Nietzsche

→ Scan4Reco offers a **multi-angle** (in spatio-temporal terms) **view** of the objects ←

- **Automatic approach:** Lack of an end-to-end platform for CH documentation; HQ 3D models generation underdeveloped
- **Multi-sensorial platform:** multi-perspective view on the CH object
- **Assisted Positioning:** Human driven scanning may be unhealthy, imprecise, fatigue sensitive and of limited capacity for simultaneous multi-sensorial scanning
- **DSS:** Conservation decisions & actions are mainly based on heuristic knowledge & punctual information
- **4D Simulation:** Risk estimation & degradation potential of a CH object are not systematically defined
- **3D Printing:** Haptic interaction of the CH object (informatively rich version)
- **3D Reconstruction & Visualization:** CH objects are difficult to be studied out-of-situ in depth; only accessible to limited public (i.e. visitors)

- **Scan4Reco** aims to facilitate the **preservation, conservation, curation, restoration & documentation** via **automatic digitization** of a wide variety of **cultural heritage assets even in situ**, using:
 - **Multispectral scanning & digitization**
 - **Material exploration, identification & modelling**
 - **Accurate 3D reconstruction models**
 - Demonstration in **virtual museums**
 - **Tactile multilayered surrogates** for both **scientific and commercial usage**



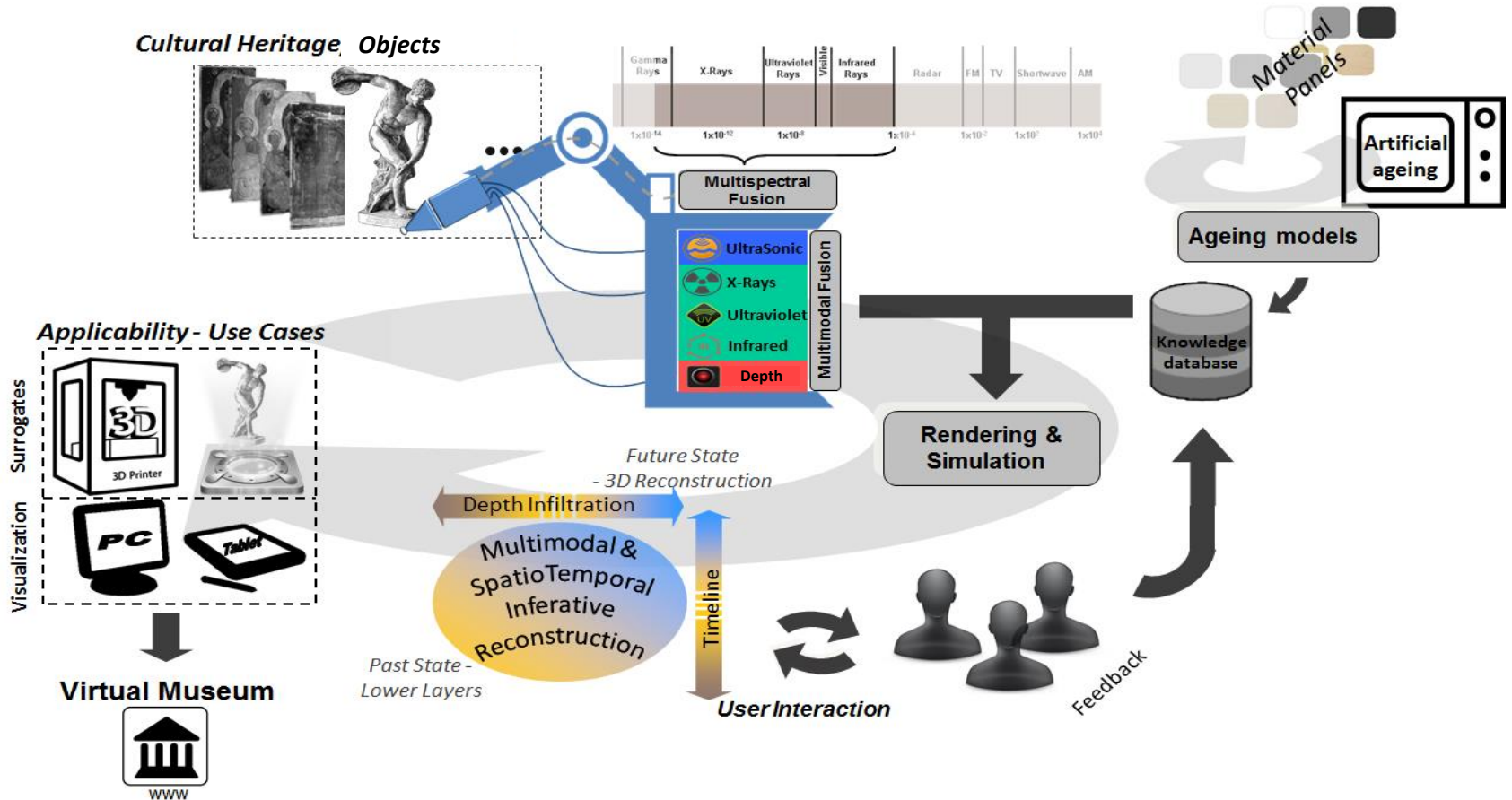
Domain	Research Project
virtual 3D-capture/scanning	3D-PITOTI - 3D acquisition, processing and presentation of prehistoric European rock-art
processing & modelling	3D-COFORM - Tools and Expertise for 3D Collection Formation V-City – The Virtual City
reconstruction via scanning with simple RGB/laser cameras/penetrative THz technologies	c-Space - An affordable tool to turn the space surrounding us into a creative experience INSIDDE - INtegration of cost-effective Solutions for Imaging, Detection, and Digitisation of hidden Elements in paintings
visualization tools arousing a series of senses like vision hearing, touch & as animation/VR	Dreamspace - A Platform and Tools for Collaborative Virtual Production CREATIF - Digital creative tools for digital printing of smart fabrics CultAR – Culturally Enhanced Augmented Realities
dataset enrichment & metadata	DIACHRON – Managing the Evolution and Preservation of the Data Web DECIPHER - Digital Environment for Cultural Interfaces; Promoting Heritage, Education and Research
predictive augmentation technologies for the completion of fragmented/incomplete CH standardized preservation processes	PRESIOUS - Predictive digitization, restoration and degradation assessment of cultural heritage objects FORGETIT - Concise Preservation by combining Managed Forgetting and Contextualized Remembering
interconnections between large, cross-discipline multimedia	PAPYRUS - Cultural and Historical Digital Libraries Dynamically Mined from News Archives PrestoPrime – Keeping Audiovisual Contents Alive KEEP – Keeping Emulation Environments Portable

- Development of a novel, portable, integrated, modular **solution** for customized, cost-effective, automatic **digitization** and **analysis** of **Cultural Heritage Objects (CHOs)**, even in situ, using:

✓	Multi-sensorial 3D scanning facilitated by a mechanical arm to collect multi-spectral data used for the application of hierarchical approach for 3D reconstruction of CHOs that will enable multi-layered rendering for analysis & 3D printing
✓	Creation of high precision digital surrogates of CHOs to provide details about surface, volumetric structure, material composition, shape/structure of underlying materials and to render them via visualization techniques or via transparent multi-material 3D printing
✓	Material Analyses to understand heterogeneity of CHO, to identify classes of materials, to monitor degradation over time, to create ageing models per material
✓	Spatiotemporal Simulation of CHOs to render degradation effects, predict and recreate CHOs' future appearance and automatically restore them
✓	A Decision Support System to suggest over appropriate conservation methods for the indicated by Scan4Reco spots/segments of CHOs that are in eminent conservation need
✓	A Virtual Museum to enhance accessibility of the digitized cultural objects to scientific community, field experts, general public

Scan4Reco Conceptual Architecture

Scanning Phase 2



- **Two classes** of cultural heritage objects, i.e. **paintings & metallic objects** will be used as validation **pilots**.

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- Use cases:
 - ✓ **Environmental conditions & metadata definition**
 - Environmental conditions of artwork degradation and the corresponding type of restoration intervention will be defined and studied.
 - ✓ **Cultural Object Scanning**
 - A selected artwork will be digitally acquired to generate (a) a global coarse-resolution 3D representation of the color and geometry of the artwork and (b) local physical and chemical measurements of small, flat areas on the artwork surface/subsurface.
 - ✓ **Spatiotemporal Simulation**
 - Virtually simulating the evolution of artwork condition over time, in order to make reliable prediction on the object behaviour and the effect of the restoration treatments.
 - ✓ **Analysis & Guidelines generation**
 - It will provide curators and restorers with a rendering-based help to take the right operational strategy.
 - ✓ **3D Visualization, Interaction & 3D Printing**
 - Using visualization tools, both virtual and physical, will allow for a real-time, easy interaction between the end-users, scholars, curators and general public, and the cultural heritage assets.

Overview of reference samples

Pigments/samples with varnish

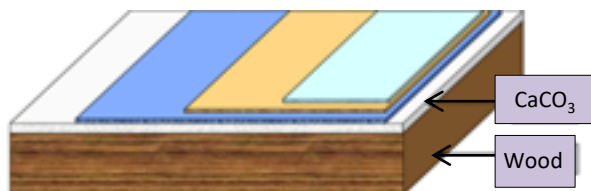


Fig. (up) Pigment panel, (down) Design of the 3d structure of the panel with combination of successive layers of pure pigments or of mixtures of them in each sub layer

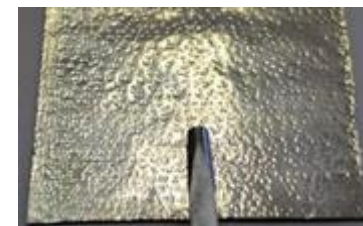
Metallic reference samples

- COATED SILVER SAMPLES

Silver SET1: 16 samples

Silver SET2: 16 samples

Two not treated samples (one smooth and one chased)



- COATED BRONZE SAMPLES

Bronze SET1: 9 samples

Bronze SET2: 9 samples

One not treated sample

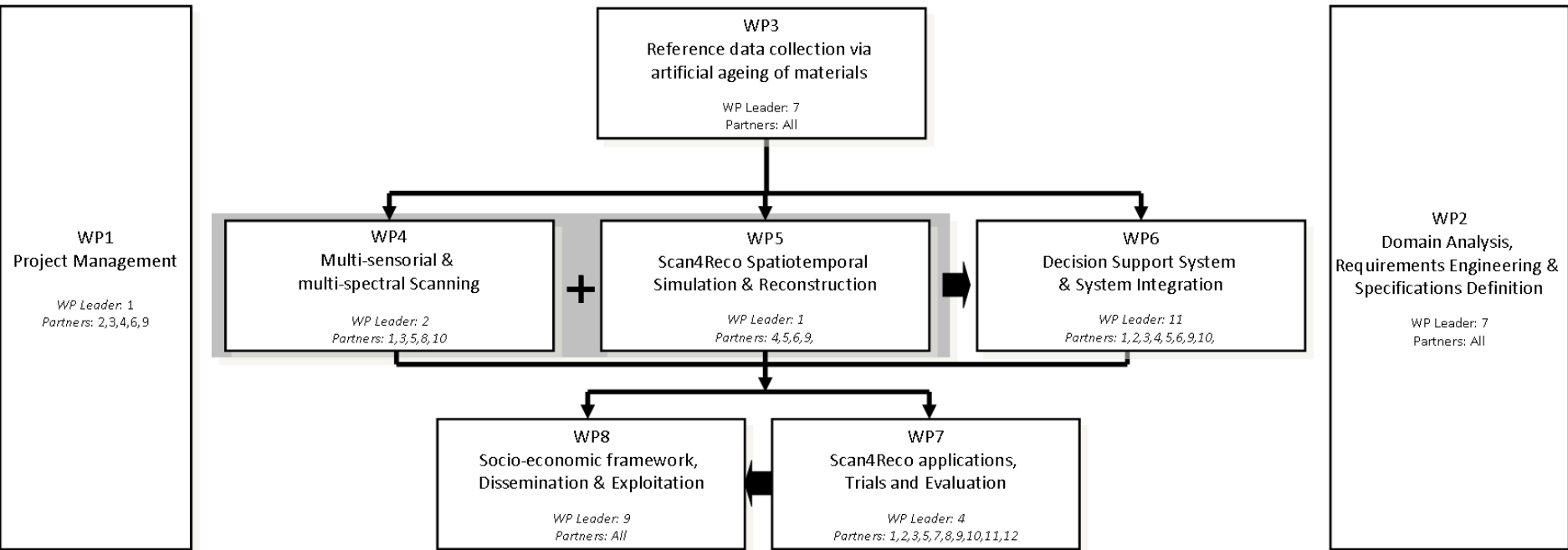


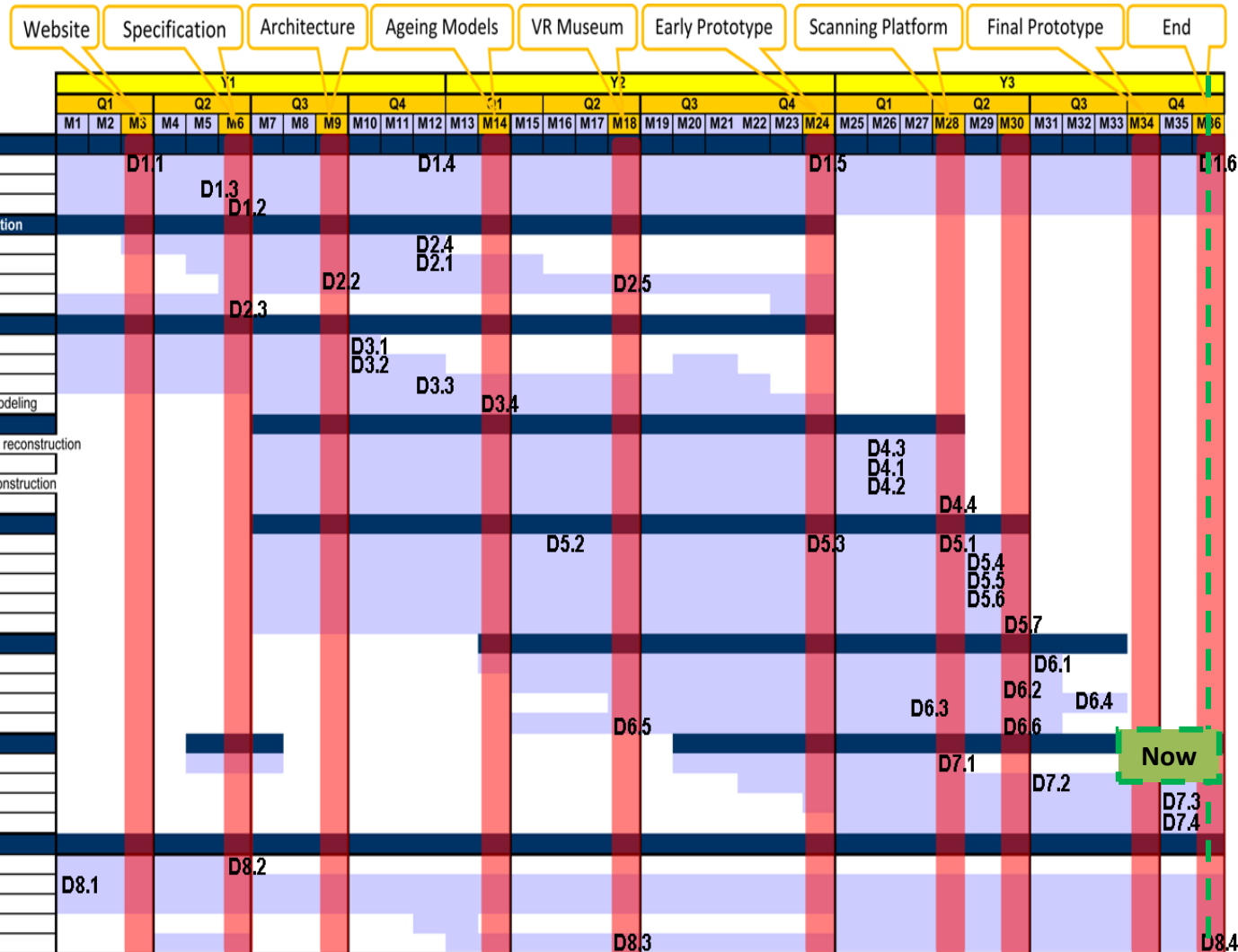
- BRONZE SAMPLES WITH PATINA

Patina SET1: 16 samples

Not treated strips in between areas with patina







- 43 Deliverables produced
 - **32 Public deliverables** to be found at <http://www.scan4reco.eu/public-deliverables>
- **9 Milestones** timely fulfilled
- **>50 Publications** in prestigious (IEEE, ACM Siggraph, etc.) journals & conferences to be found at <http://www.scan4reco.eu/content/publications>
- **4 Newsletters** (+1 in press) have been released, to be found at <http://www.scan4reco.eu/newsletter/scan4reco-newsletter-view>
- **Pilot Evaluation** conducted with professional conservators

- The Scan4Reco DataBase
(accessible at <http://scan4reco.iti.gr/ords/f?p=107:2001:.....>)

Scan4Reco
DB
artificially aged
samples dataset



- The Scan4Reco VR Museum (with Oculus support)
in online & desktop version
(accessible at <http://www.scan4reco.eu/virtual-museum/>)

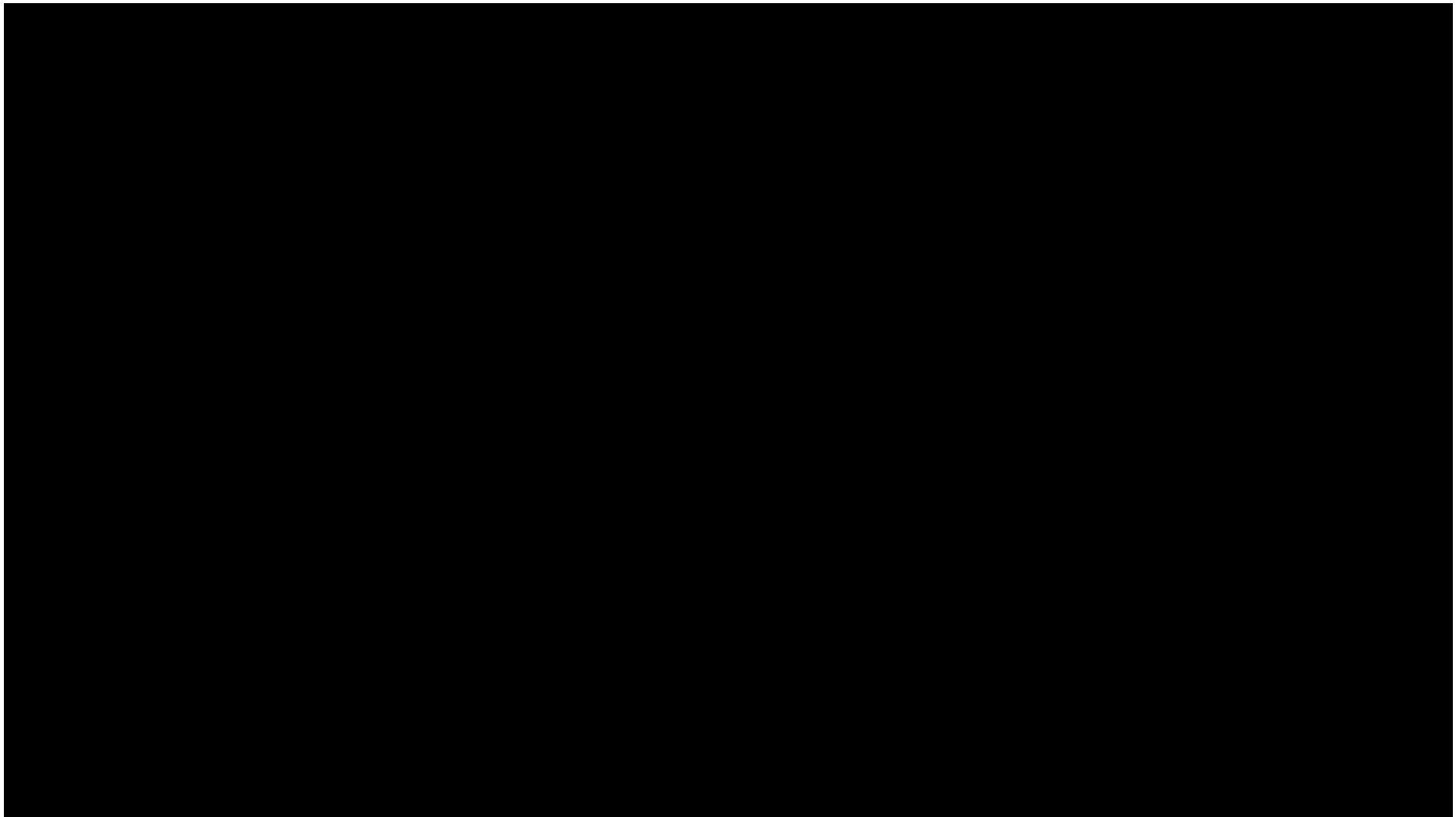
- The Scan4Reco portable integrated solution





D4.3

Surface, MS&RTI and 3D Microprofilometry Prototype



Scientific Achievements

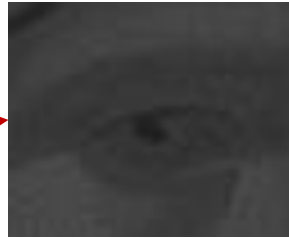
Capturing the Surface (RTI & m-Prof)





Information provided

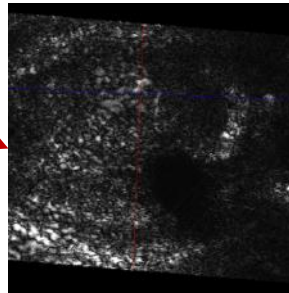
Reflectance coefficient, colour
 topography,
 Thickness measurement of the
 layers
 Material identification
 Initial designs, Underdrawings
 Roughness,
 elastic properties of the
 materials



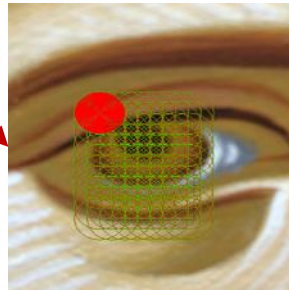
IR imaging 1-5µm



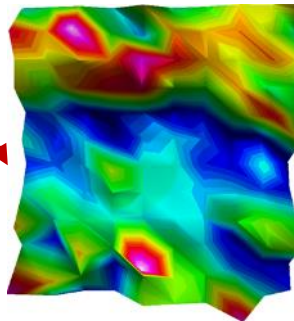
Ultrasound & IR
imaging



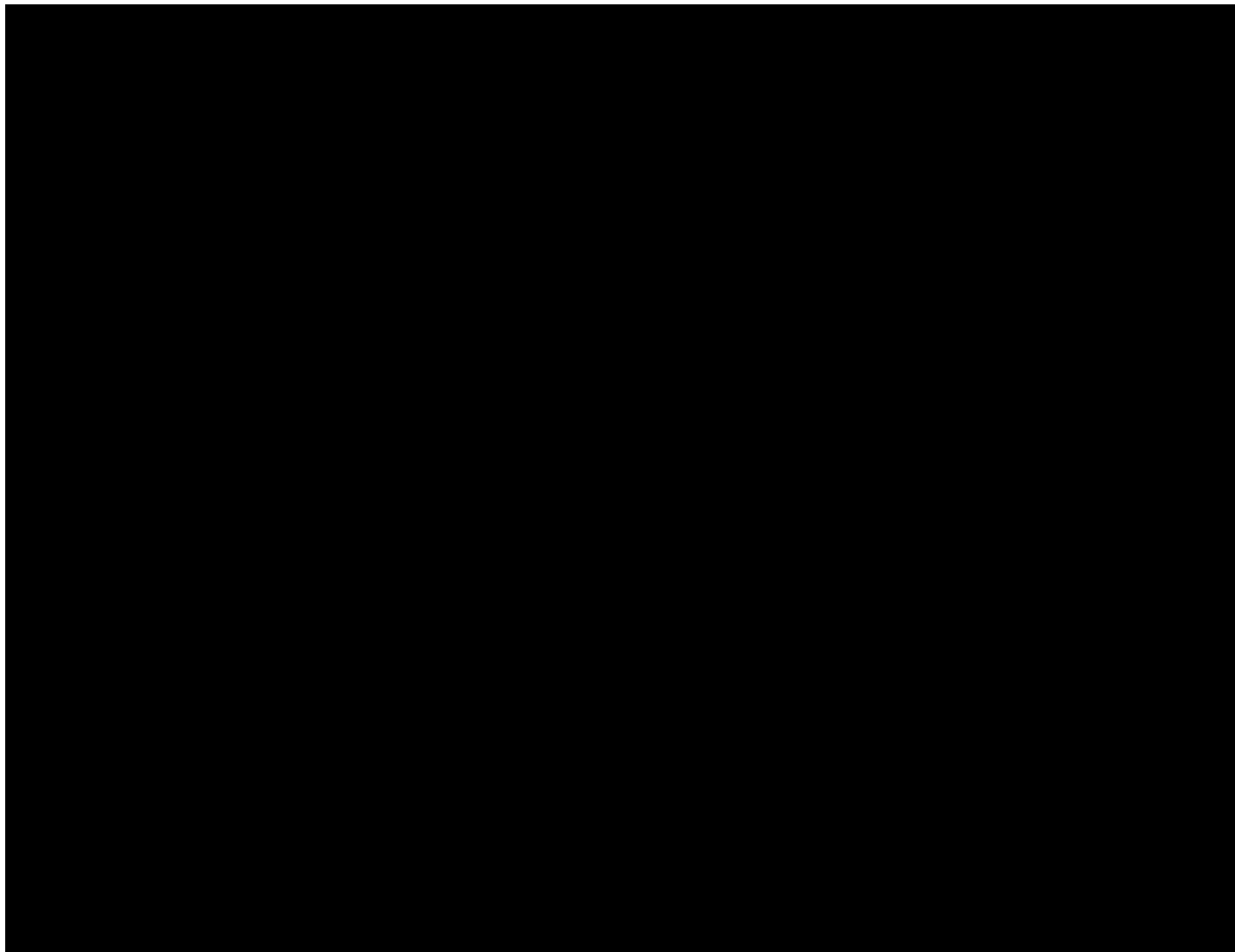
Ultrasoundic µTomography



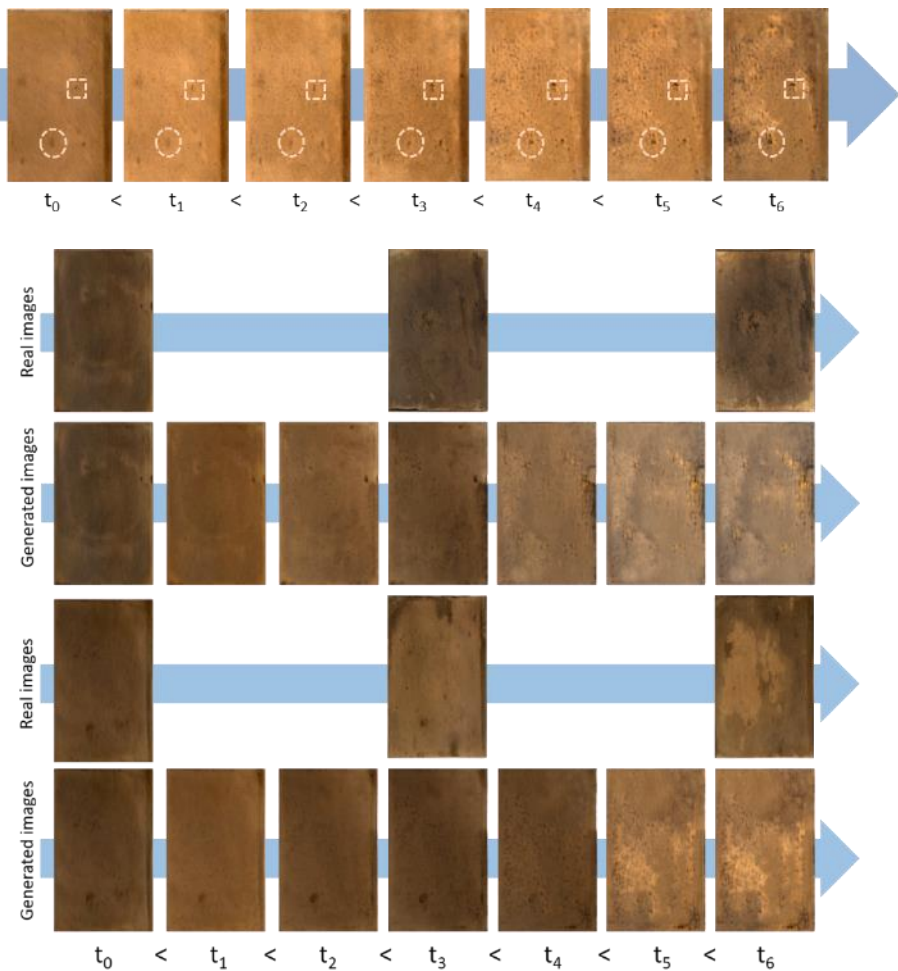
UV-VIS Spectroscopy



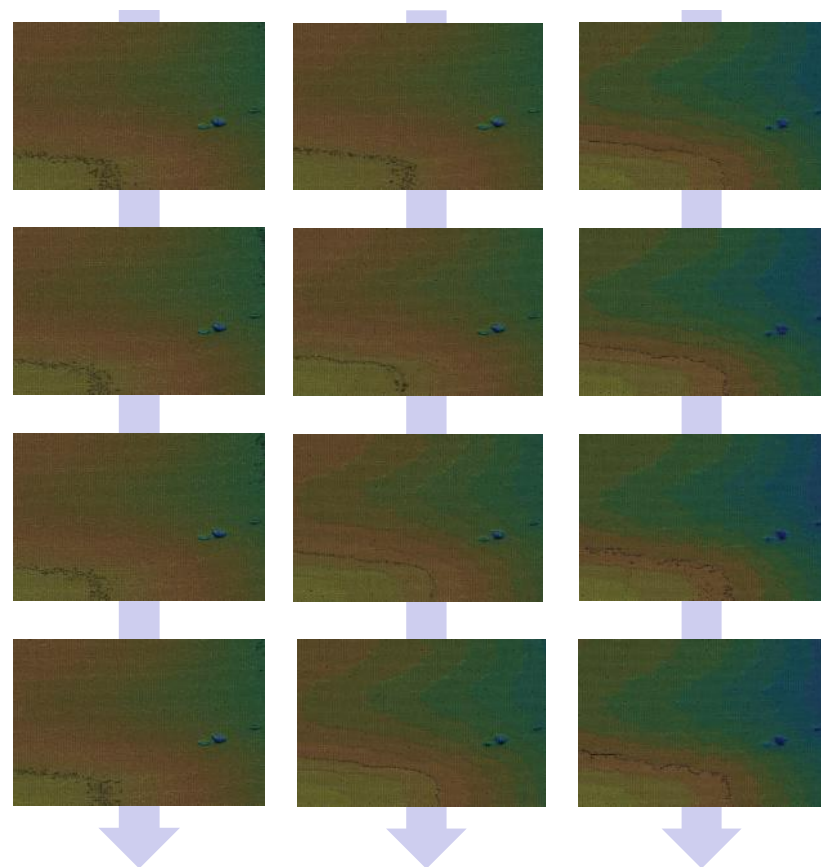
IR Spectroscopy

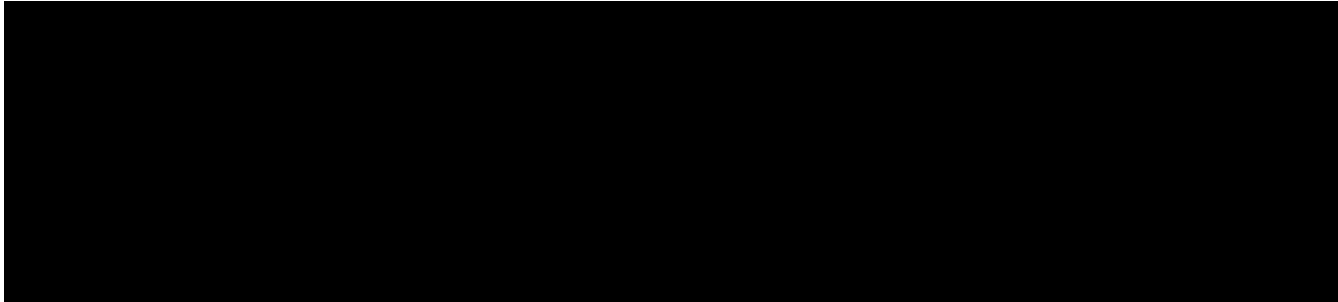


- Texture Simulation



- Shape Simulation



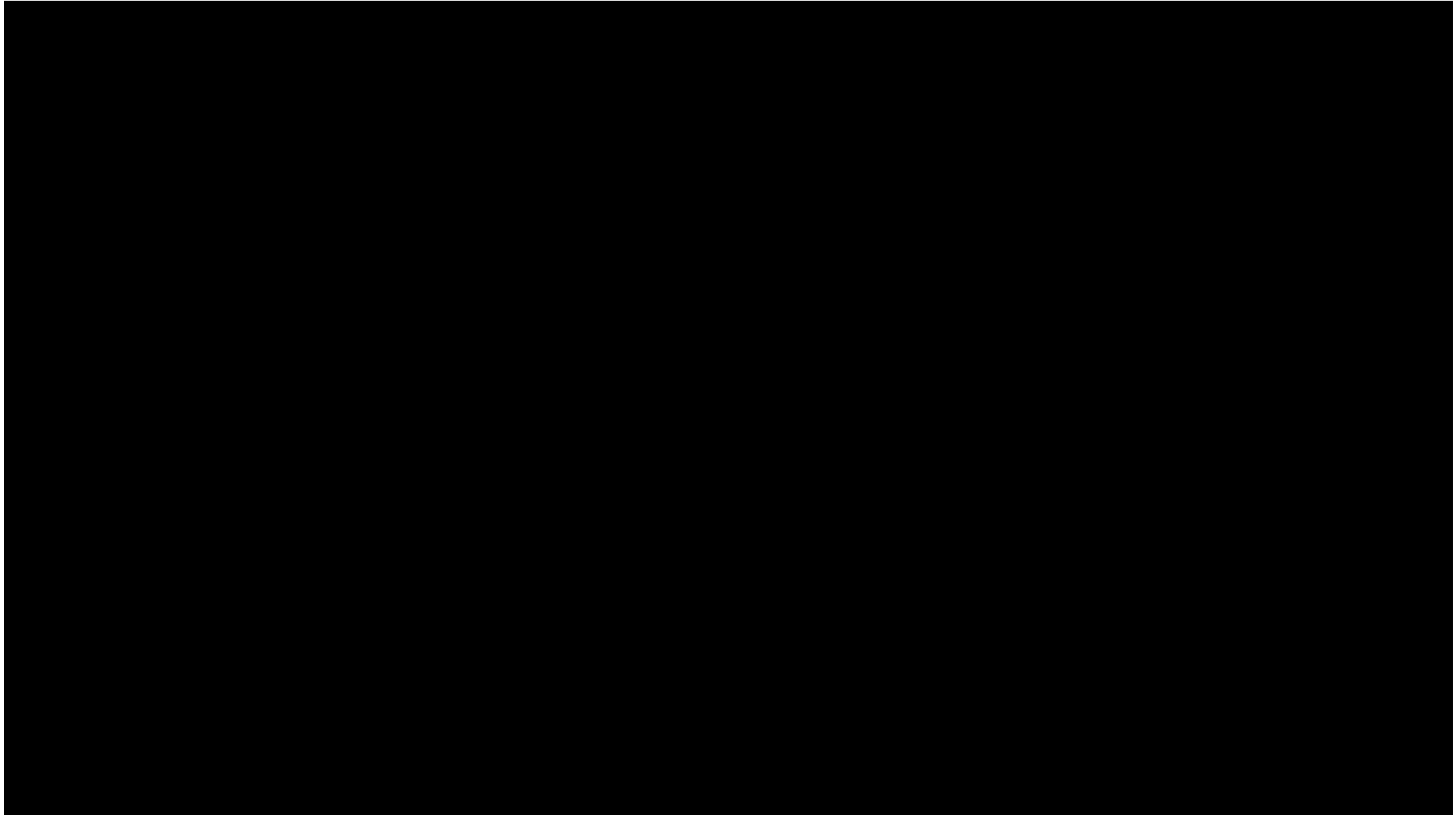


Sim
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Scientific Achievements

Rendering & Exporting to 3D Printing





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