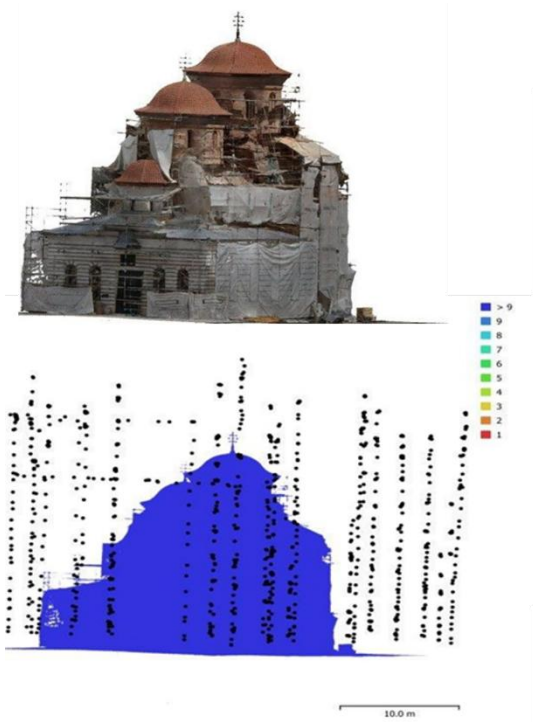
NEWSLETTER
Project iPhotoCult

Intelligent advanced photonics tools for remote and/or on-site monitoring of cultural heritage monuments and artefacts

Funded by
the European Union

iPHOTOCULT





THE PARTNERSHIP

Public and private subjects from 6 EU countries participate in the project iPhotoCult, which was approved within HORIZON-CL2-2023-HERITAGE-01-01 call

FORTH - Foundation for Research and Technology-Hellas (Coordinator)
CNR - National Research Council of Italy
CARTIF Foundation (ES)
INOE-National Institute for Research and Development in Optoelectronics (RO)
Tecreando B.V. (NL)
EAGLEprojects S.p.A. (IT)
UNIWA – University of West Attica (GR)

CCR Foundation - Centro Conservazione e Restauro "La Venaria Reale" (IT)
LSA GmbH – Laser Analytical Systems & Automation (DE)
Associated Partners
NGN - National Gallery – Museum of Alexandros Soutsos (EL)
CRRS-Consorzio delle Residenze Reali Sabaude,
AMTh-Archaeological Museum of Thessaloniki
HCYL - Consejería De Cultura y Turismo De La Junta De Castilla Y León
TECN - Technopolis, the Industrial Gas Museum of Athens

R&D Results

INOE: new documentation campaign at Romania's Tismana Monastery. The UAV tool enabled high-resolution aerial investigations to map structural defects, degradation patterns and evaluate environmental impacts, guiding predictive conservation strategies.

CARTIF: first in-situ demonstration of the UGV tool at pilot site of the Roa Church in Burgos (Spain) enabled multi-modal acquisition of 2D and 3D imaging data for early detection of structural pathologies and the inspection of heritage structures.

CNR-IFAC and CCR analytical successfully on-site campaign at the Reggia di Venaria (Turin) testing and publicly showcasing the improved version of the Hybrid tool for compositional analysis at considerable heights above floor level

Safeguarding the Future of Our Past: A Strategic Policy Roundtable. The iPhotoCult Project is hosting a high-level Policy Roundtable to bridge the gap between scientific innovation and EU policy.

Over the course of the fourth semester (M18–M24, December 2025 – May 2026), iPhotoCult has reached an advanced stage of implementation, approaching a pivotal phase. The project has encompassed a broad range of interconnected activities, including:

- In-situ preliminary condition assessments using traditional tools and methodologies across the nine Cultural Heritage Pilots (CHPs)
- Development and optimization of the iPhotoCult prototypes
- Laboratory testing of prototypes on representative model samples
- Proof-of-concept demonstration for the iPhotoCult tools
- Development of the cloud-based Software Services Platform (iSSP) and integrated AI modules

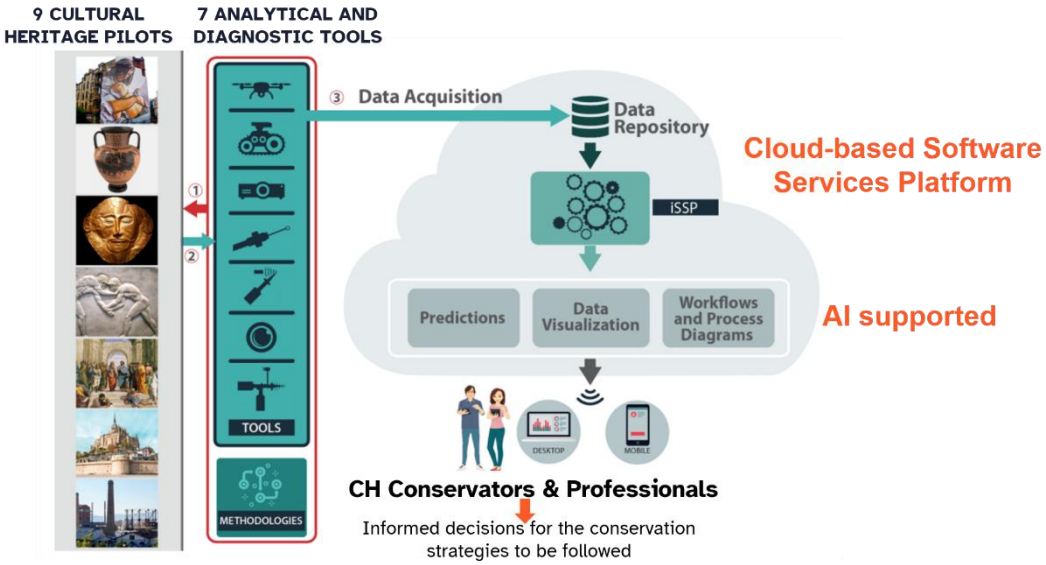


Figure 1. iPhotoCult Conceptual Architecture

UNIWA, together with the leaders of the Cultural Heritage Pilots (CHPs), outlined the methodology and results of in-situ condition assessments conducted across the nine CHPs using traditional tools and methodologies. Special focus was placed on nineteen selected use cases relevant to the iPhotoCult solutions. Comprehensive information on traditional techniques, including visual observation, imaging, and chemical and spectroscopic analysis, was collected alongside the results of both in-situ applications and laboratory analyses of samples from selected CHP areas. Archival research and stakeholder input provided essential background information for each CHP use case, establishing precise details regarding the form, shape, structure, dimensions, and decoration of the cultural objects under study. Further context includes historical background, dating, and cultural significance, alongside technological details regarding material analysis and manufacturing/decoration techniques. Additionally, the exhibition environment for each CHP was described in detail, covering outdoor, indoor, and microenvironmental conditions along with a record of historical documentation and past restoration or conservation interventions. The key environmental and anthropogenic threats identified across the use cases include:

- Variety of Materials: Original construction materials (metals, stone, ceramics, pigments, coatings, binding media, paper, parchment, ink, wood) and their associated deterioration products.
- Material Deterioration Triggers: Environmental pollution, water ingress, salt aerosol, improper storage conditions (light, temperature, relative humidity), biological colonization, and vandalism.
- Structural Issues: Seismic activity, indoor/outdoor exposure risks, and structural stress influenced by public visits or event activities (e.g., concerts and transportation).

These collected data established a baseline for assessing the condition of the use cases, evaluating the effectiveness of traditional monitoring and diagnostic techniques, and identifying specific needs for the in-situ application of the seven iPhotoCult analytical and diagnostic tools (see Figure 2).
Crucially, this baseline knowledge and methodology have been leveraged to validate testing requirements for laboratory-scale applications, document operational challenges of traditional techniques regarding time, cost, and environmental impact, and streamline the upcoming deployment of iPhotoCult tools (see https://iphotocult.eu/en/tools/ for more details). Having reached an advanced stage of development, these tools are now ready for real-world application.

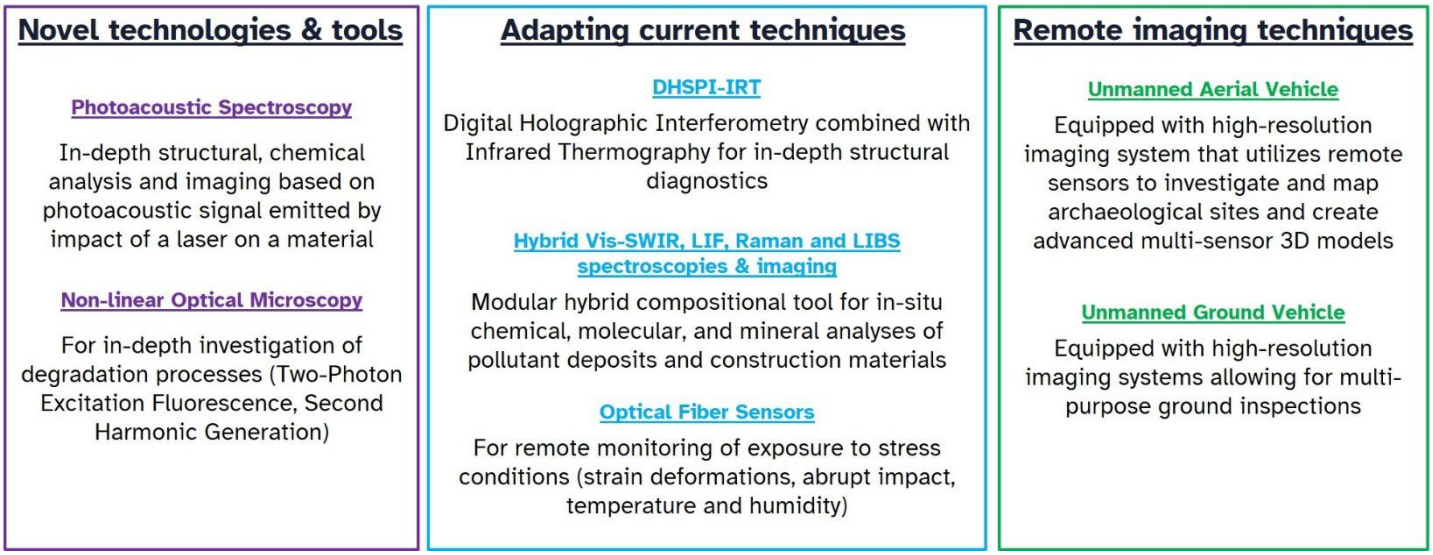


Figure 2: iPhotoCult Tools for remote or proximal applications

The iSSP platform
The iPhotoCult cloud-based iSSP platform (iSSP) has progressed through the architecture and requirement specification phase for all diagnostic tools it will host.

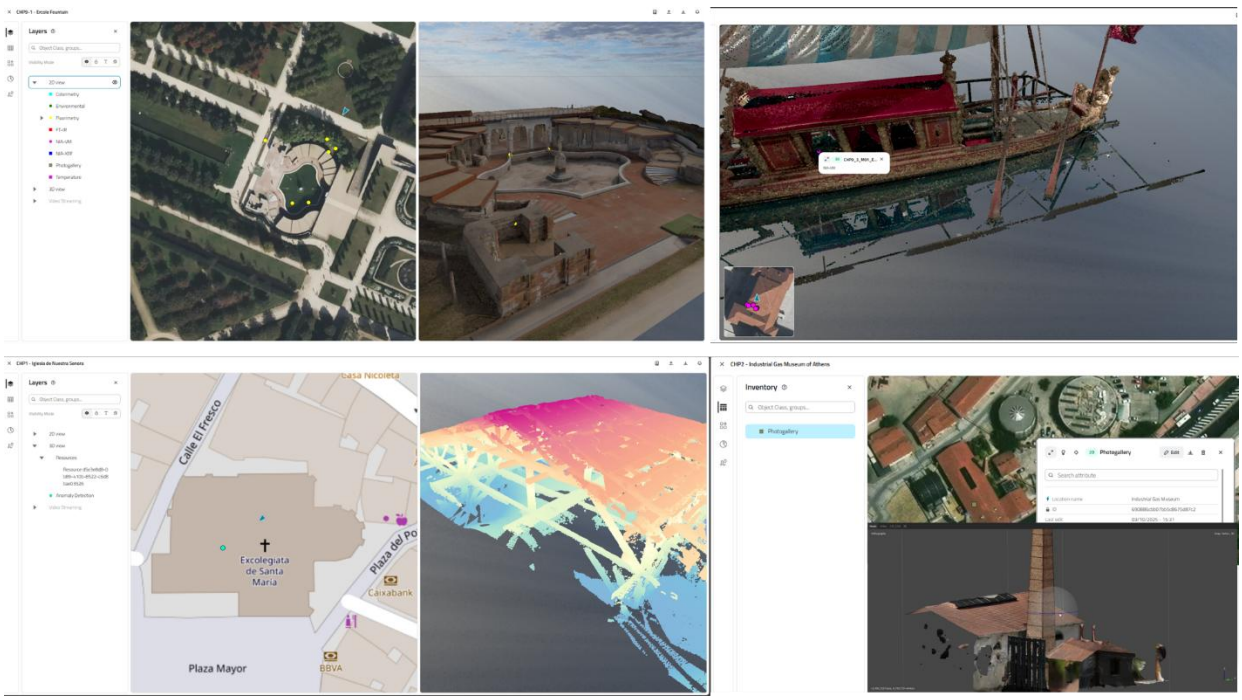


Figure 3 iSSP platform: 3D Artworks & Data Visualization. From the top left: the Hercules Fountain and the Peota (La Venaria Reale, Turin), Church of Nuestra Señora de la Asunción in Roa (Burgos, Spain) and the Industrial Gas Museum of Athens.

EAGLEprojects continue the uploading of the available datasets to the platform aiming to integrate various data types obtained from both traditional and innovative tools (e.g., HYBRID, UGV, UAV, DHSPI, MIR-PA, NLOM, OFS) developed during the project. In parallel, the work has continued in the development activities required for the correct data visualization, data pre-processing workflows and AI-driven analysis, facilitating accessibility, scalability and flexibility of the platform.
In parallel, the work of EAGLEprojects has been continuing in the development of the various AI components and machine learning algorithms for data pre-processing and AI-driven interpretation of complex datasets, laying the groundwork for their progressive integration and validation as data become available. At this stage, the necessary AI models are being developed to process and analyse the data, with ongoing communication with the owners of each innovative tool. The process involves accumulating relevant data and continuously training the AI models to improve their performance and output. This iterative approach aims to refine the AI capabilities, ensuring that the models effectively interpret the data, provide accurate results, and contribute to the overall optimization of the system's functionality.

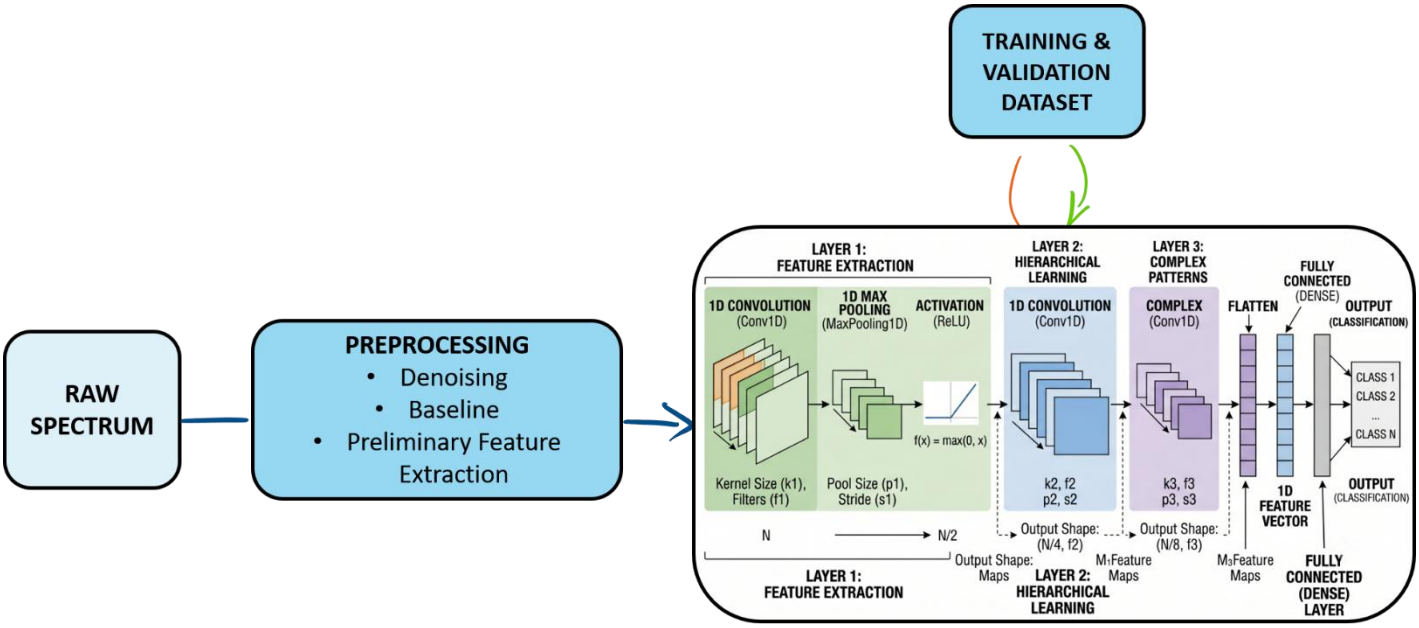


Figure 5: Hybrid tool: example of AI-driven Raman and LIBS workflows developed by Eagleprojects.

Furthermore, a remote monitoring bridge infrastructure has been designed with robust communication protocols and hardware specifications, incorporating miniSEED format and ringserver technology for efficient time-series data streaming. This architecture ensures seamless integration of diverse data outputs from all available tools and upload them to the iSSP cloud platform by using the WiFi or 5G, depending on the use case location and network accessibility.

Tool demonstrations at the CHPs

In view of the forthcoming validation and applications diagnostic caimpaigns at the CHPs, tools developers have carried out dedicated laboratory investigations and evaluated instrumentation improvements to better address the specific diagnostic challenges as selected by CHP stakeholders. Preliminary campaigns have been conducted across various CHPs, which allowed preliminarily demonstrating the performance of iPhotoCult solutions and their suitability in addressing complex analytical problems in areas that are not directly accessible. In the following recent updates till M24 about tool under develpoment along with preliminary demonstrations are reported.

On February 2026, CARTIF carried-out in-situ demonstration of the UGV tool at pilot site of the former Collegiate Church of *Nuestra Señora de la Asunción* in Roa (Burgos, Spain). The UGV robotic base optimised within the iPhotoCult project is a mobile diagnostic and monitoring system selected for its superior terrain adaptability, self-recovery capacity, obstacle negotiation, payload capacity, and ease of sensor integration. The platform incorporates VIS-IR cameras, a 3D LiDAR system, and a depth camera, enabling multi-modal acquisition of 2D and 3D imaging data essential for early detection of structural pathologies and the inspection of heritage structures. This sensor fusion is intended to support the visual and geometric documentation of surface conditions, potential deformations, and areas showing signs of moisture in complex environments such as attics, extrados of vaults, and other confined risky or hard-to-access architectural spaces.

Field trials were conducted in the extrados space of the Church, with the aim of collecting data on timber elements, evaluating usability, safety, and performance in real operational environments.

During initial data collection, a number of environmental and physical conditions were identified as unfavourable for technicians or operators involved in inspection and monitoring tasks in this type of structural space. These include:

- Usable height ranging from 0.3 to 0.7 m, obstructed by beams and other elements.
- Irregular surfaces with slopes up to 30°, including loose debris and bird droppings (due to open unprotected vents).
- Minimal natural lighting and limited visibility.
- Uncontrolled cross-ventilation through unprotected openings.
- No safe access and signs of prior deterioration and structural displacements, not yet fully characterised.
- The inspection space is extremely narrow, irregular and fragmented due to the complex geometry of the stone vault extrados and the overlapping timber roof structure.



Figure 4: Left: Nave; Central: Intrados of the ribbed vaults; Right: extrados of the vaults and timber framework

These constraints make CHP of Roa an ideal setting to validate a robotic diagnostic tool such as the the UGV tool, capable of performing observation, documentation and structural pre-diagnosis in difficult to access or directly inaccessible areas, avoiding human risk or physical contact, also minimising load and disturbance on the existing elements. The system allows for non-invasive data acquisition, supporting preventive conservation through high-resolution documentation and early detection of deterioration signs. Beyond its mobility capabilities, a key objective in the development of this tool is to enable structured, geotagged, and repeatable data acquisition. The architectural definition presented ensures compatibility with digital models for future integration into digital conservation workflows.

In March 2026, the CNR-IFAC team, in collaboration with colleagues from CCR, successfully conducted a second on-site campaign at the Reggia di Venaria (Savoy Royal Residence, Turin). The main aim was to test, validate, and publicly showcase the newly improved version of the Hybrid tool.
This modular, multi-analytical system integrates five techniques into a single device (Vis-NIR-SWIR and LIF HIS, Raman, and LIBS). In the campaign at the Reggia di Venaria, Hybrid was deployed to conduct technical monitoring of paintings in the Hall of Diana at heights of approximately 10 meters, areas previously accessible only via scaffolding. Spectroscopic investigations focused on the Bucintoro of the House of Savoy, as well as The Dauphin's painting, Princess Ludovica Maria, and Francesca Maria Cacherana, Countess of Bagnasco in the Sala di Diana.



Figure 4. The Hybrid tool in action: *spectroscopic investigations and public engagement initiatives carried out during the four-day campaign at Reggia of Venaria.*

These artworks were specifically selected due to their diverse constituent materials, complex degradation phenomena, and the logistical challenge of accessing their surfaces. During the four-day campaign, CCR organized public engagement initiatives with targeted stakeholders. Focused presentations on iPhotoCult's innovations, the ongoing diagnostic research, and the crucial role of conservation science in safeguarding cultural heritage sparked strong interest among visitors. These events will further support the visibility of iPhotoCult and strengthen its connections with key stakeholders in the fields of science, technology, and cultural heritage conservation.
The public engagement initiatives co-coordinated by CCR during the 4-day Hybrid analytical campaign at the Reggia di Venaria (9-13 March 2026) led to reaching ~250 tourists, general public stakeholders, and 120 high school students via guided visits, roll-up banners, live presentations, and social media engagement (over 15,600 views on Instagram and 12,500 views on Facebook).

From UAV Research to Field Validation at Tismana Monastery

As part of iPhotoCult's research and development activities, INOE 2000 is developing the R1.T2 UAV demonstrator: a heritage-specific system for the non-contact documentation and monitoring of monuments and decorated surfaces. The work responds to a practical challenge encountered at many cultural heritage sites: acquiring reliable, high-resolution data from elevated, extensive or difficult-to-access areas while reducing the need for scaffolding and limiting risks to both operators and fragile historic fabric. Rather than functioning simply as an aerial camera, the demonstrator combines a modular flight platform, multimodal payloads and dedicated acquisition protocols. High-resolution RGB photogrammetry supports detailed surface documentation, damage mapping and 3D reconstruction; thermal imaging enables the screening of moisture-related patterns and other thermal anomalies; and LiDAR provides complementary geometric information. Research also focuses on stable low-speed flight, controlled stand-off distances, safe operation near sensitive surfaces, repeatable data acquisition, metadata recording and quality-control procedures. These elements are essential for transforming UAV measurements into traceable information suitable for conservation assessment and long-term monitoring.
In spring 2026, the system and its operational workflow were tested at Tismana Monastery in Gorj County, Romania, one of the iPhotoCult Cultural Heritage Pilots. The site presents several interconnected monitoring needs: a complex historic structure affected by seismic activity and recurring cracking, valuable mural paintings, multiple construction and decorative layers, moisture-related processes and areas that are difficult to inspect safely using conventional access methods.



Figure 5. UAV-based surveys at the Tismana monastery (by INOE 2000 team). Three-dimensional documentation and view of the monastery and the wall paintings

During the campaign, the INOE 2000 team tested RGB photogrammetric and combined RGB-thermal acquisition strategies over selected areas of the monument. Flight parameters, viewing angles and stand-off distances were adapted to the geometry of the buildings and to the constraints of working within a sensitive heritage site. Complementing UAV-based surveys, remotely operated non-contact acquisition further extends the flexibility of the approach, enabling data collection across a wider range of spaces and site-specific conditions.

The campaign generated datasets for image-based mapping, three-dimensional documentation, thermal screening and future comparative surveys (Figure 5). Equally importantly, it provided direct feedback for refining hardware integration, acquisition protocols and field procedures. The Tismana campaign therefore represents an important step in consolidating a robust and transferable UAV workflow that complements specialist inspection and conservation diagnosis, supporting more timely, repeatable and evidence-based monitoring of cultural heritage.

Synergies And Interaction With External Initiatives

Between M18 and M24 the iPhotoCult project has been actively disseminated within the scientific community through highprofile conferences and disseminations events. Dedicated efforts have focused on the establishment of partnerships with relevant ongoing initiatives and networks, engaging key players from all groups of the defined stakeholders across the relevant domains of CH and photonics technologies. The ambition is to ensure awareness creation and engagement of target stakeholders into the uptake of iPhotoCult technologies and concepts. Being part of the Green Cluster in Cultural Heritage the iPhotoCult aims to strengthen the links between projects with similar goals and vision. A special focus will be given to Horizon Europe ongoing projects funded under the same topic call (HORIZON-CL2-2023-HERITAGE-01, Advanced Monitoring Technologies), which are NERITES (https://nerites.eu), ChemiNova (https://cheminova.eu) and ARGUS (https://www.argus-project.eu). The other Projects of the Green Cluster funded under the topic call HORIZON-CL2-2022-HERITAGE-01-08 (Effects of climate change and natural hazards on cultural heritage and remediation) are TRIQUETRA (https://triquetra-project.eu), RescueME (https://resilientculrurallandscapes.eu), THETIDA (https://thetida.eu) and STECCI (https://steccihorizoneu.com), and under the topic call HORIZON-CL2-2021-HERITAGE-01-01 (Green technologies and materials for cultural heritage) are GREENART (https://greenart-project.eu/), MOXY (https://moxyproject.eu/) and gogreen (https://gogreenconservation.eu/).

iPhotoCult also engages actively with the Laserlab expert group: Laser science for cultural heritage, leveraging its advisory role and broad network to align the project's developments with current policy directions, share best practices, and contribute to shaping future research and innovation priorities in the field.
The collaboration with these projects will happen on several levels including, but not limited to:

- Co-organisation of events.
- Exchange of information related to project achievements.
- Mutual promotion: dissemination and communication using social media and online presence
- tools.
- Interviews with key stakeholders.
- Invitation for participation in iPhotoCult events, and vice versa.
- Collaboration on other publications.

On the 23rd of March 2026, a new Working Group on Cooperation in Digital Cultural Heritage has been launched in the presence of European Commission representatives. Purpose of this Working Group is the collaboration between projects that have similar scope. These Projects are apart from iPhotoCult, ECHOES, ARTEMIS, ARGUS and 3D-4CH.



On the 12th of May 2026, FORTH organized and hosted online a high-level Policy Roundtable Event: "*Safeguarding the Future of Our Past: Strategic Dialogue on Cultural Heritage Policy*" in Europe. It is recognized that current global geopolitical challenges as well as natural and anthropogenic disasters cause growing threats to protecting, preserving and securing Cultural Heritage (CH). In this context, bold and strategic actions are needed for safeguarding the future of our past.
The Policy Roundtable Event brought together an audience of 45–50 participants, including EU officers, National Representatives of the Cluster 2, representatives of the Green Cluster, research scientists dedicated to the field of Cultural Heritage, industry representatives, digital science and AI experts, and European Commission policy officers (Katja Reppel, Athanasios Gerakis, Ana-Maria Stan, Anna Rosenberg, Despoina Tsiafaki, Sara Mosca, Franco Niccolucci, Alexandre Caussé, Nikolas Bakirtzis, Katrien Keune, George Pavlidis, Noémie Gabay, Jörg Hermsdorf, Anastasia Giakoumaki, Alexandros Selimis).

During this event several priorities related to CH protection were raised, including:

- The continuity gap following the end of a CH research project
- The importance of preventive conservation versus post-damage interventions
- Ways of promoting European soft power and Science Diplomacy through CH research
- Enhancing the impact of AI technologies applied in CH by improving the quality of data fed in relevant AI tools

The results of this dialogue will directly inform policy recommendations for future European funding frameworks.
Organizing Committee:
Costas Fotakis (iPhotoCult Scientific Coordinator), Anastasia Giakoumaki (iPhotoCult Project Manager), Alexandros Selimis (Rapporteur).

Dissemination Events and Conference Participation

On the 10th of December 2025, FORTH's team member Eleanna Pirgianaki gave a talk entitled '*Noninvasive photoacoustic imaging for in-depth cultural heritage diagnostics*' in the framework of Laserlab-Europe webinar series. In this context, a novel reflection-mode PA system integrating near-infrared pulsed excitation light and a spherically focused air-coupled ultrasonic transducer for the detection of the generated PA waves was presented. The system is specifically developed to detect in-depth ageing effects in painted mock-ups and to reveal hidden underdrawings, such as pencil sketches, beneath non-transparent paint layers. To assess the performance of the system in detecting degradation phenomena, PA responses were recorded from different pigmented layers that had undergone controlled thermal or photo-ageing treatments. The measurements revealed a progressive increase in the PA amplitude over time, with distinct deterioration rates observed for various types of paint.

This Laserlab-Europe Talk is part of the **Expert Group** '**Laser science for cultural heritage**', led by Sara Mosca (Central Laser Facility). This Expert Group brings together leading experts within the Laserlab-Europe network, united by a common mission to advance the application of laser-based techniques in the study, conservation, preservation of heritage objects.

CARTIF presented the usefulness of the UGV for inspection in "D+D+D environments" (Dark + Dangerous + Dirty) within historic buildings during the "Conference on Cultural Heritage Conservation in Rural Areas", held on February 19th 2026 in the city of Arévalo (province of Ávila, Spain). Arévalo is declared a Historic-Artistic City of Spanish Cultural Interest. The event was jointly organized with the Regional Government and the Institute for Business Competitiveness of Castilla y León. The iPhotoCult project in general, and the developments carried out on the UGV system in particular, were presented as a reference for supporting preventive conservation and the sustainable management of rural cultural heritage. The workshop was organised in collaboration with the Institute for Business Competitiveness of the Regional Government of Castilla y León (https://www.cartif.es/centratec/patrimonio/).





Other dissemination events:

- Poster presentation at RIANA - Research Infrastructure Access in Nanoscience & Nanotechnology 1st Users Meeting at FORTH, Heraklion, Greece, 17 - 18 of March 2026. The iPhotoCult team had the chance to meet brilliant researchers from many different fields and network for future collaborations
- INOE is organizing the International Conference on Optoelectronics and Heritage Science OPTO-HS, which will be held on 7-9 October 2026 in Bucharest, Romania.
- M. Dinu, L. Ghervase, C. Borș, 'Spectroscopic Pathways to Provenance: Insights into Metal Craftsmanship and Trade in Ancient Eastern Europe', 13th Edition of the Euro-Mediterranean Symposium on Laser-induced Breakdown Spectroscopy (EMSLIBS 2025), 26-30 January 2026, Senlis, France (Poster).
- Educational Field Trips in collaboration with associate partner National Glyptotheque: As part of the dissemination activities for the iPhotoCult project, final-year conservation students (20 in total) participated in two educational field trips to the National Glyptotheque in Athens to engage with cultural heritage collections. Field Trip 1 and 2: Dates: Monday, 4 May 2026 and on Monday 5 May 2025. Activity: Educational visit and study tour of the National Glyptotheque collections and research being carried out within iPhotoCult project for the condition assessment of bronze sculpture.
- EAGLE has started promoting the iPhotoCult project, which is now featured on the dedicated Innovative Projects section on the website https://www.eagleprojects.it/bandi-e-progetti-innovativi/.
- The LSA partner: Dissemination targets cultural institutions and private stakeholders through trade fairs and conferences (e.g., Art Basel, TEFAF), industry magazines and online portals (e.g., The Art Newspaper, Apollo Magazine), and content marketing formats such as white papers and case studies derived from project results. Efforts are staged: raising awareness of iPhotoCult, triggering attention through taskspecific examples (e.g., challenges in monitoring street art vs. structural damage in buildings), and providing detailed information tailored to institutional needs. An initial geographic focus is on Germany (where LSA has an established network), with gradual expansion across Europe. For this purpose, a mailing list of 46 heritage authorities and museums has been compiled, using publicly available contacts in compliance with GDPR. Academic networks will serve as multipliers to reach additional audiences and foster cross-sector synergies.

Publications in peer-reviewed journals

Eleanna Pirgianaki, Vasiliki Kokla, Vasilike Argyropoulos, Costas Fotakis, George J. Tserevelakis, **Uncovering the spectral signatures of historical ink families using dual-wavelength photoacoustic imaging**, Eur. Phys. J. Plus (2026) 141:93. https://doi.org/10.1140/epjp/s13360-026-07344-x

This study presents a novel non-invasive dual wavelength photoacoustic imaging (DWPAI) system developed to detectdistinct spectral signatures of historical ink families with high sensitivity. The recorded images were processed through unsupervisedmachine learning algorithms, to provide a quantitative indicator of the ink type based on the ratio of photoacoustic signals followingexcitation in the visible (532 nm) and near-infrared (1064 nm). The performance of the system was demonstrated using threeinks commonly employed in 19th-century Europe and Greece, specifically Chinese ink, sepia ink, and iron gall ink. Chinese inkprovided signal ratios around 0.9, sepia ink yielded consistent ratios at 0.6, whereas iron gall ink exhibited considerably higherratios in the order of 1.7. Our findings demonstrate the ability of DWPAI to reliably and non-destructively discriminate betweenmajor ink families independent of the writer or the nib type used. Apart from guiding conservators in safe and effective restorationinterventions, DWPAI may provide archaeologists and art historians with complementary insights into the dating, origin, and materialcharacterization of various types of artifacts. Its demonstrated accuracy and versatility establish DWPAI as a powerful diagnostictool for cultural heritage research, archaeology, and conservation science.

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