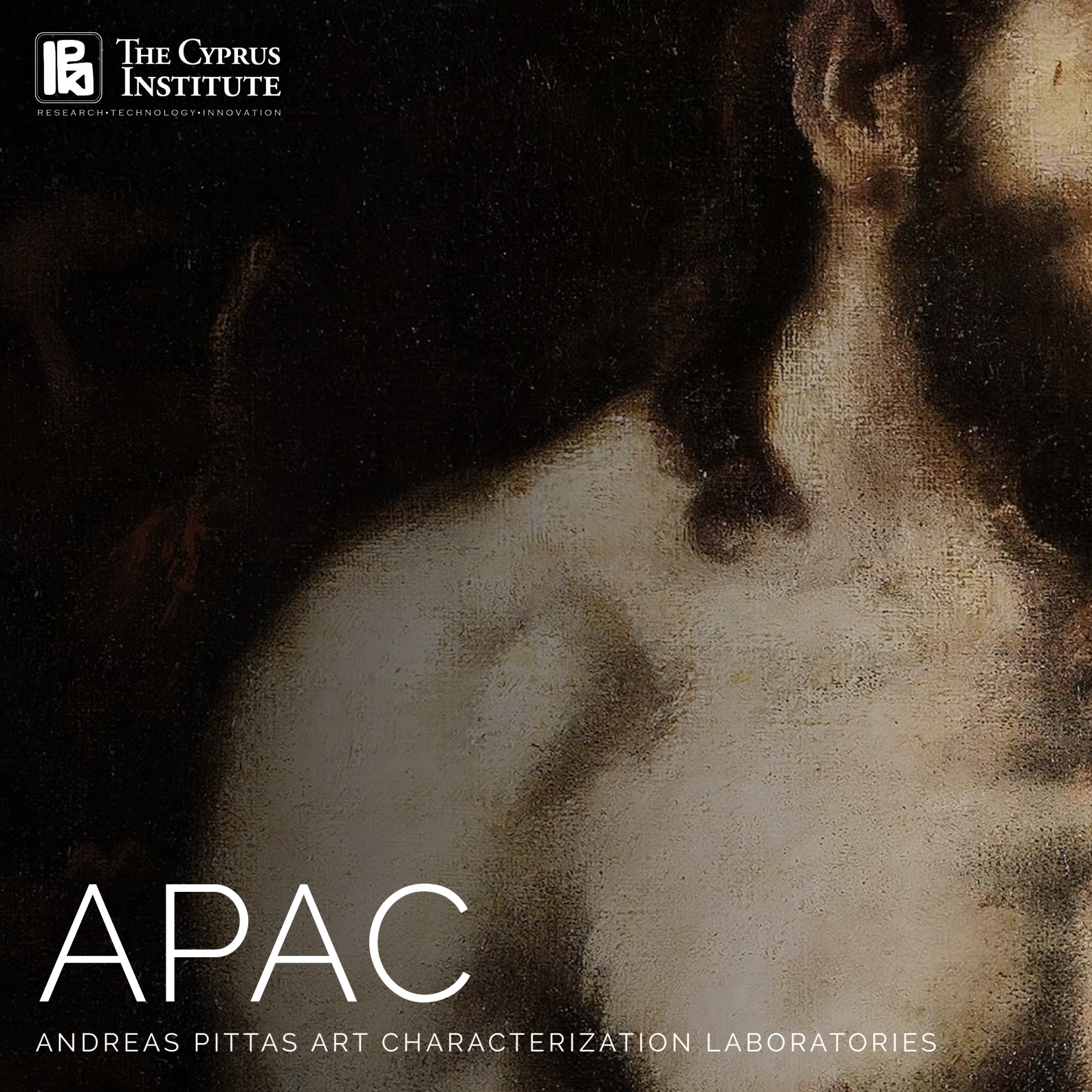

The Cyprus Institute
RESEARCH•TECHNOLOGY•INNOVATION
APAC
ANDREAS PITTAS ART CHARACTERIZATION LABORATORIES

Revealing the secrets and the hidden stories of works of art through the use of science and technology is an exciting journey of discovery and as such it is the core focus of our Art Characterization Laboratories (APAC Labs). From a young age I was mesmerized by the artistic legacy of the Byzantine and Medieval periods in our island of Cyprus. Further on, I was fascinated to discover the ways Early Renaissance artists in Italy responded to the achievements of Byzantine art while opening new venues of artistic expression.

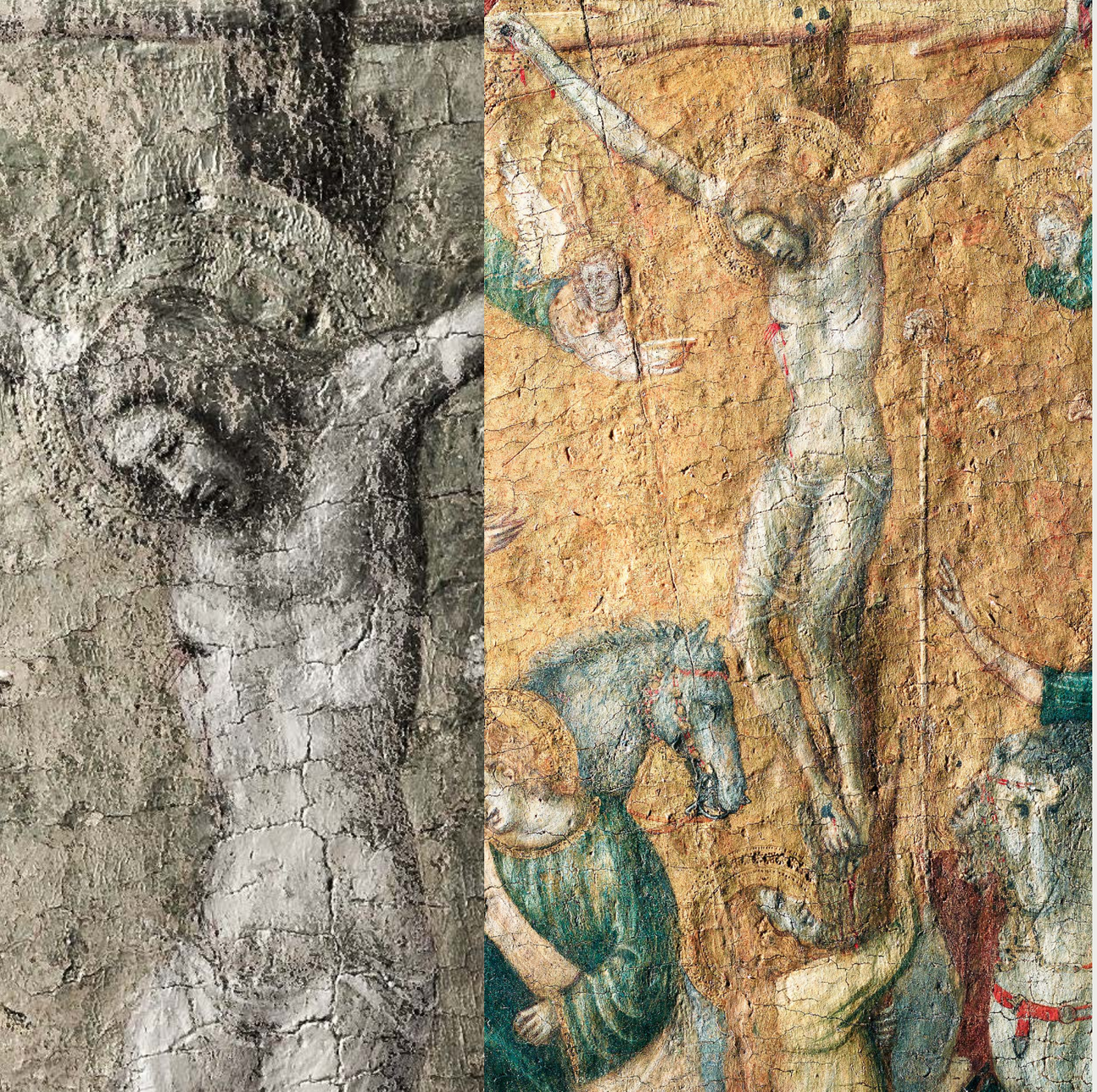
Style, technique and the materiality of paintings mirror the talent of their makers but also contain the cultural sensibility of their patrons and the taste of their audience. Advances in the use of advanced scientific and technological methods have truly revolutionized the ways we preserve but also study art and material culture. We now have at our disposal unthinkable tools and opportunities to unlock new facts and secrets about the work of artists in the past. Hidden paintings, signatures, preparatory sketches, retouching and interventions, materiality and technique details, digital representations and visualization are only some of the exciting venues explored thus far.

Furthermore, scientific and technological innovation enrich our knowledge, our appreciation and our ability to protect our cultural heritage for future generations. Of course, at the heart of these efforts we must carefully retain our humanistic focus and interest. After all, works of art are reflections of society and its cultural life.

I am very proud of the work and achievements of APAC Labs at the Cyprus Institute and I am grateful to all involved for their efforts. I look forward to the next steps of our exciting journey.

Dr. Andreas Pittas

APAC Labs technical imaging analysis of 'Ecce Homo' by Titian, c. 1550s
Front cover: Large format imaging detail from 'Ecce Homo' by Titian, c. 1550s



History and Vision

The Andreas Pittas Art Characterization Laboratories (APAC Labs) at The Cyprus Institute (CyI) pursue key inquiries, research problems and innovation approaches in art history, archaeology and cultural heritage, through the application of advanced science and technology.

Established with the generous support of Dr. Andreas Pittas and commencing its full operational capacity in 2019, APAC Labs consolidated knowledge, expertise and instrumentation acquired under EU funded project STARLAB towards Art Characterization research. Furthermore, the establishment of APAC Labs builds on the collaboration of the Science and Technology in Archaeology and Culture Research Center's (STARC) with the Centre de Recherche et de Restauration des Musées de France (C2RMF). Integrating expertise in art history, digital heritage and visualization, and physico-chemical analyses, the development of an interdisciplinary research pipeline, based on portable and bench instrumentation, aims at the digital, imaging and analytical investigation of works of art, artefacts, monuments and sites.

Moving beyond the confines of a state-of-the-art lab, APAC Labs embrace a holistic approach to art characterization possible through cross-disciplinary scientific exchange that is driven by broad inquiries in art history and the humanities. The laboratories' research is part of key Euro-pean initiatives on Cultural Heritage and Heritage Science, such as ERIHS and IPERION-HS.

Mission

Operating within the broader scope of the STARC's research facilities, APAC Labs provide a broad approach to art characterization, pursuing:

A) Research, to advance the effective use of heritage science and technology in the characterization of works of art, monuments and archaeological material.
B) Innovation, to develop task-specific service protocols related to material characterization, provenance, state of preservation and identification of works of art and heritage artefacts.
C) Training and Education, through workshops and seminars of experts in art history, archaeology and the humanities, for practitioners, students and citizens at large.

Technical examination of 'The Crucifixion' by Giovanni Baronzio, end of 1320s

Research Pipeline and Instrumentation

The organization and methodological approach of APAC Labs are based on the premise that the effective use of science and technology enables and enhances fundamental research questions in art history, archaeology, and more broadly, cultural heritage. Thus, APAC Labs offer a research pipeline that integrates art history and archaeology with heritage sciences and digital technologies to support the productive dialogue between previously separated disciplines and fields of expertise.

The research agenda of APAC Labs is based on three fundamental goals:
A) – conduct art history, archaeology and heritage research with high relevance to the region's culture and society;
B) – develop research methods, theories and workflows in a cross-disciplinary framework;
C) – perform diagnostic and characterization methods based on non-invasive and non-destructive approaches.

The laboratories' investigation pipeline is based on a broad and multi-scale diagnostics approach that integrates physico-chemical methods with reflectography, multi-spectral imaging and surface 2D imaging and 3D geometric characterization. These provide information on the state of preservation, materiality, authenticity and provenance, manufacturing techniques, and diachronic interventions of the analysed object as well as serve as a basis for specific research inquiries. Acquired data are archived in digital knowledge repositories for reuse in science and innovation, developed in the context of DIOPTRA: The Edmée Leventis Digital Library for Cypriot Culture, with the support of CyI's HPC facility.

APAC Labs operate state-of-the-art instrumentation in digital microscopy, spectroscopy point-analysis, technical and multi-spectral imaging and high-accuracy 3D documentation. A distinct application area, following the development of the laboratorie's integrated pipeline, is its implementation on various archaeological objects, with the primary scope to characterize their chain of operation, i.e. modes of production, manipulation of raw materials and use. Moreover, APAC Labs data is integrated in AriadnePlus, the European Research infrastructure on Archaeological Data, which engages more than thirty heritage institutions across Europe, the Americas and Asia.

Digital microscopy study of a terracotta statue fragment from Salamis, Cyprus

Technique, Materiality and Authenticity of Medieval and Early Modern Works of Art

APAC Labs research builds on previous work and expands the analysis of works of art and the related interpretation of the results of digital 2D and 3D imaging and analytical methodologies towards a better understanding of the painting technique, materials and style of past artists.

Among the highlights of our laboratories' research has been the focus on selected works by El Greco and Titian, which have been explored through the integrated application of non-invasive and non-destructive physico-chemical methods, multi-spectral and technical imaging and 3D surface characterization. Whether examining the transformation of El Greco's artistic technique between Crete and Venice or unveiling the hidden secrets of the stratigraphy of Titian's paintings, APAC Lab's art characterization pipeline has offered new insights and knowledge about the work of the great masters.

Another important research activity was the analysis of Giovanni (da Rimini) Baronzio's 14th century Crucifixion panel, which aimed at mapping the complex history of numerous painting interventions closely linked with the provenance of the artwork. Being able to study the compositional, stylistic and material aspects of these interventions, which mirror efforts to restore but also to 'correct' the painting's narrative, provided an exciting context for the exploration of an array of art historical themes and problems. Furthermore, our laboratories' research focused on a series of Byzantine and post-Byzantine icons from the Limassol Bishopric and the monastery of Agia Napa. APAC Lab's flagship project is related to the development of an advanced integrated multi-sensor (XRF, PL and FORS) scanner and will focus on the materiality and technique of works of art, such as wall paintings, icons, statues and archaeological artefacts.

Details from 'St. Francis receiving the Stigmata' by Domenikos Theotokopoulos (El Greco), c. 1570

Interdisciplinary Approaches to World Heritage: The Painted Churches of the Troodos Mountains

Working in collaboration with the Department of Antiquities, APAC Lab's study of the rich heritage of the famous Painted Churches of the Troodos Mountains, inscribed in the UNESCO World Heritage list, exemplifies the value of interdisciplinary research work in the study of art and cultural heritage.

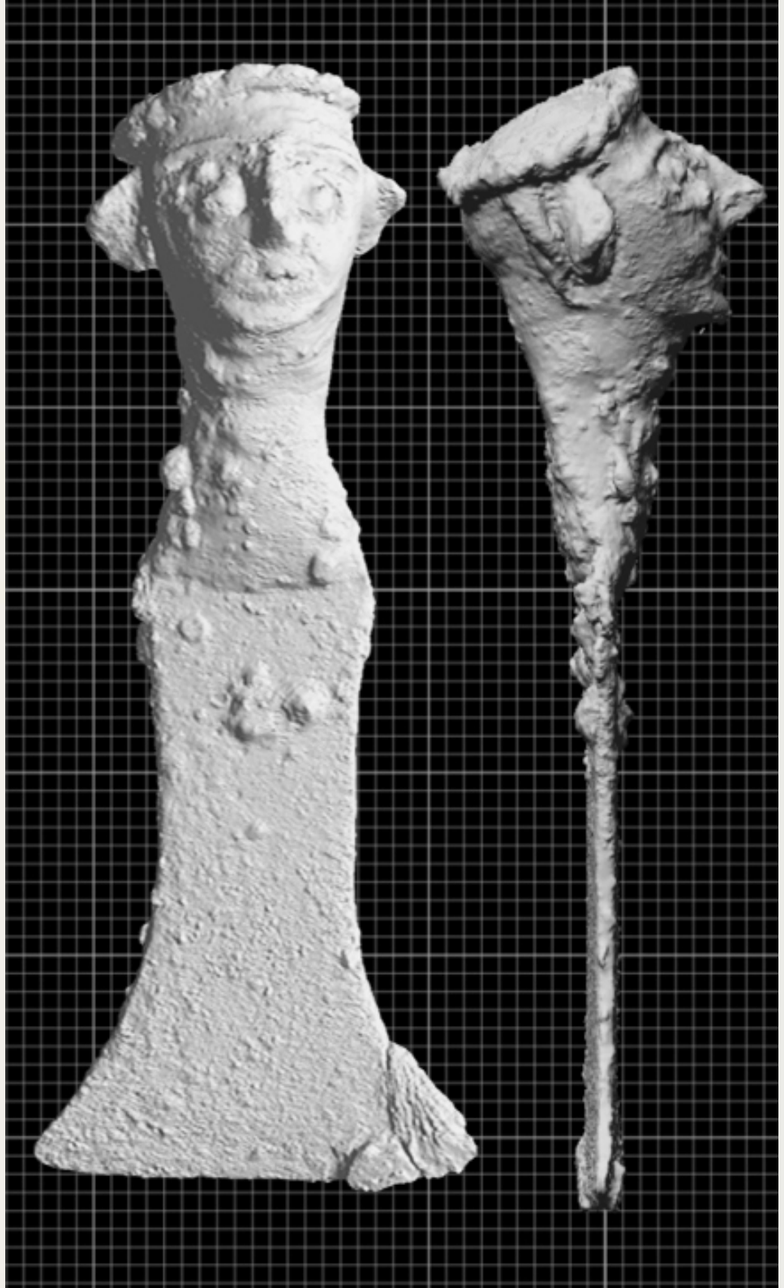
Overall, there are ten church monuments included on the World Heritage List, all richly decorated with murals, providing an overview of Byzantine and post-Byzantine painting in Cyprus. These sites feature art and architecture that reflect the cultural life of Cyprus in the Byzantine and Medieval periods, which was located at the crossroads of Mediterranean maritime connections and cultural exchanges between East and West.

The ten churches included in the UNESCO list are: Ayios Nikolaos tis Stegis (St. Nicholas of the Roof) near Kakopetria; Ayios Ioannis (St. John) Lambadistis Monastery in Kalopanagiotis; Panayia (The Virgin) Phorviotissa (Asinou) near Nikitari; Panayia (The Virgin) tou Arakou in Lagoudera; Panayia (The Virgin) in Moutoullas; Archangelos Michael (Archangel Michael) in Pedoulas; Timios Stavros (Holy Cross) in Pelendri; Panayia (The Virgin) Podithou in Galata; Stavros (Holy Cross) Ayiasmati near Platanistasa, and the Church of Ayia Sotira (Transfiguration of the Savior) in Palaichori.

Our efforts provide a holistic approach to these important monuments including a broad range of methods such as physico-chemical analysis of the materials used in the wall paintings and the icons of these churches, 3D documentation and visualization, dendrochronology, structural archaeology and the study of Medieval and Early Modern graffiti.

Furthermore, the study of Byzantine and post-Byzantine monasticism and the complex role of pilgrimage, cult and ritual in the formation of cultural identity through time are central themes that provide the necessary context for the effective utilization of science and technology, like in the case of the Troodos churches.

Non-invasive study of frescoes at the UNESCO Byzantine church of St. Nicholas of the Roof near Kakopetria, Cyprus



Three-Dimensional (3D) Documentation and Visualization of Monuments and Sites

The use of digital approaches to investigate monuments, sites and artefacts is a key area of activity for APAC Labs, which builds on STARC expertise in Digital Heritage developed in the context of the STARLAB project. The 3D documentation and visualization of sites such as the church of Panagia Angeloktisti, the prehistoric sites of Pyla, Choirokoitia and Hala Sultan Tekke, Nicosia's walls, significantly enhances their protection, preservation, study and analysis. Moreover, the digitization, analysis and representation of archaeological objects and works of art can provide valuable data and observations on aspects of their manufacture, materiality, technique and use.

Among the highlights of APAC Labs work are the 3D documentation and visualization of the Othello Tower in Famagusta, an invited research activity led by UNDP and in collaboration with the Virtual Environments Lab (STARC), and the documentation and visualization of the Troodos Churches in the context of the IHAT and TREE projects (funded by the Cyprus Research and Innovation Foundation). APAC laboratories' have pursued the documentation of archaeological sites in Jerusalem and Alexandria, as well as in Larnaca and Agia Napa, Pyla in collaboration with the Cyprus Institute's Unmanned Systems Research Laboratory. The 3D visualization of the Nicosia cathedral of St. John was used to study aspects of its state of preservation, to simulate the visitor's experience and to analyze its structural stability in collaboration with the University of Catania and the Polytechnic of Milano.

The 3D documentation, analysis and representation of archaeological objects like ancient cylinder seals, tools and vessels helps to understand their particular use through three-dimensional simulation and visualization. Furthermore, the 3D dogotal restoration of objects which did not survive intact, can offer a valuable visualization tool that allows archaeologists to reconstruct these particular artefacts. The use of APAC Labs' integrated research pipeline is particularly important in the study artefacts, among them coroplastic works, shedding light on their chaîne opératoire meaning their operational sequence, the modes of their production, technique, raw materials and final use.

3D model of a copper alloy tool with an anthropomorphic head from the Bronze Age site Pyla-Kokkinokremos, Cyprus

Next page: 3D digital acquisition of a Cypro-Minoan inscription on the rim of an amphora from the Bronze Age site of Kourion-Bamboula | 3D model of the UNESCO prehistoric site of Choirokoitia, Cyprus


3D Systems

Dendrochronology Research

The establishment of a dedicated lab to dendrochronology in the context of APAC Labs/STARC builds on years of previous collaboration with the Cornell Tree-Ring Laboratory. Being a joint effort by CyI, the Department of Antiquities, the Department of Forests and the Cornell Tree-Ring Laboratory, our specialized lab pursues dendrochronological research in Cyprus and the region. Our work concentrates on the study of the remains of wooden heritage but also provides data related to past environmental and climate conditions as they relate to the history of the island's forests. As a primary pilot study, research focused on the Troodos Painted Churches.

The dendrochronological survey of their iconic roofs, structural remains and furnishings will help revisit their chronologies in their environmental contexts. This effort was awarded three grants: TREE Excellence Hub- Research and Innovation Foun-dation/ RIF (CY), Dumbarton Oaks and National Endowment for the Humanities (US).

A research highlight has been the dendrochronological survey of the wooden door of the Paphos Gate in Nicosia, which provided unexpected results that contribute to the history of the Venetian walls of Nicosia. Similarly, the survey of the Dragoman's House in Nicosia has shed light to the provenance of the wood used in its construction. Furthermore, the analysis of icons and wooden frames of paintings provides invaluable insights regarding the chronology as well as the materiality and provenance of works of art. Finally, it's worth mentioning that the laboratory's non-invasive applications have been included in the Mobile Lab of the IPERION HS project as a European resource.

Dendrochronology survey at the Monastery of St. John Lambadistis in Kalopanagiotis, Cyprus

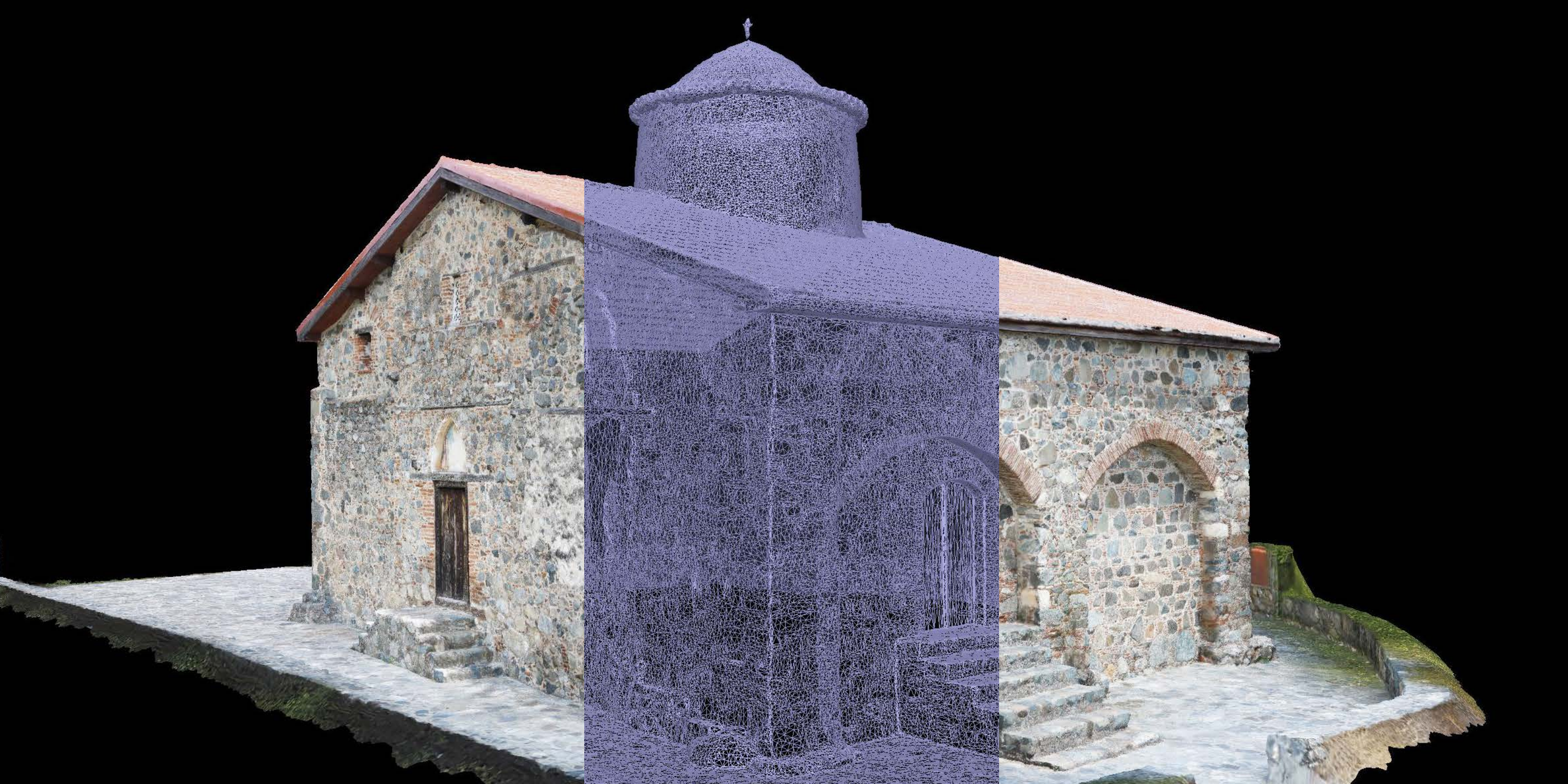
Digital Technologies for Endangered Heritage

An important focus of APAC Labs' activities concentrates in the development of digital technologies for the protection of heritage-at-risk by environmental threats, including climate change, as well as looting and destruction from war and uncontrolled development. These efforts are supported by key regional and international initiatives such as the Climate Change and Cultural Heritage Task Force, part of the Cyprus Climate Change Regional Initiative, and the Confluences partnership for Archaeology, History and Heritage in the Eastern Mediterranean. Furthermore, key European projects such as SHIELD: Safeguard Heritage In Endangered Looted Districts, SIGNIFICANCE: Stop Illicit heritaGe traffickiNg wIth artiFICiAl iNtelligenCE, tackle aspects of the protection of endangered heritage and provide the collaborative network and funding for our work. The collaboration of the Department of Antiquities and the Cyprus Police is of paramount importance. Major European initiatives and infrastructures such as 4CH: Competence Centre on the Conservation of Cultural Heritage further provide a framework for key synergies, collaborations and research opportunities.

APAC Labs' expertise is recognized at the regional level with the invitation to digitize and study the important El-Shat by necropolis in Alexandria, seriously threatened by neglect and deterioration, within the frame of a project supported by the A.G. Leventis Foundation and the Archaeological Society of Alexandria. Furthermore, a range of projects in collaboration with the Israel Antiquities Authority, such as the documentation and visualization of the Room of the Last Supper, also known as the Cenacle, in Jerusalem, have showcased our expertise in the field of Digital Heritage.

The creation of the online 3D Database System for 'Endangered architectural and archaeological Heritage in the South eastern Mediterranean' (EpHEMERA) in the context of the DIOPTRA Digital Library offers the necessary data management and digital tools support.

Terrestrial laser scanning at Othello's Tower in Famagusta, Cyprus and view of the 3D model of the monument
Next Page: 3D model of the UNESCO medieval church of the Holy Cross in Pelendri, Cyprus



Historic Cities and Cultural Landscapes

APAC Labs' interdisciplinary work is driven by key inquiries in the humanities that help to frame the use of advanced science and technology in the study of cultural heritage in Cyprus, the EMME region and the broader Mediterranean. In this framework, historic cities and cultural landscapes provide optimal contexts to probe questions about the perception, use and appropriation of heritage through time. The Getty Foundation supported project 'Mediterranean Palimpsests: Tracing the Art and Architectural Histories of Medieval and Early Modern Cities' has offered a rich collaborative platform to pursue research on layered heritage cities. The cities of Nicosia in Cyprus, Cordoba and Granada in Spain and Rhodes and Thessaloniki in Greece, have been the main case studies of the program, which concentrated on the impact of medieval heritage in the formulation of cultural identity, city narratives and the urban development of cities in the Mediterranean. Our research continues on cities in Cyprus and the region such as Alexandria, Larnaca and Famagusta. Past layers are analyzed in their broader chronological context and in relation to major political, socioeconomic and cultural transitions across the Mediterranean.

Beyond cities, rural landscapes are analyzed along research threads that can shed light on the complex socioeconomic and cultural networks that sustained past societies. For example, the study of medieval monasteries in the great islands of the Mediterranean provides a valuable understanding of the religious traditions that shaped perceptions of cultural identity and collective memory. Moreover, tracing the passage of travelers and visitors, like the Ukrainian monk Barsky or the Asia Minor Karamanli pilgrims on their way to and from the Holy Land, can elucidate the existence of routes of connectivity, trade and cultural interconnection.

Responding to the impact of challenges, such as the Covid pandemic and climate change, on the perception and valorization of heritage is of key importance for Cyprus and the region. Digital technologies and participatory processes for local societies are the focus of projects such as the COST Action "Underground Built Heritage as catalyst for Community Valorization" or the Cyprus government-led regional initiative for climate change.

The Roman bath area at the site of Kom el-Dikka in Alexandria, Egypt | Map of Alexandria by Mahmoud Bey, 1866

Medieval and Early Modern graffiti

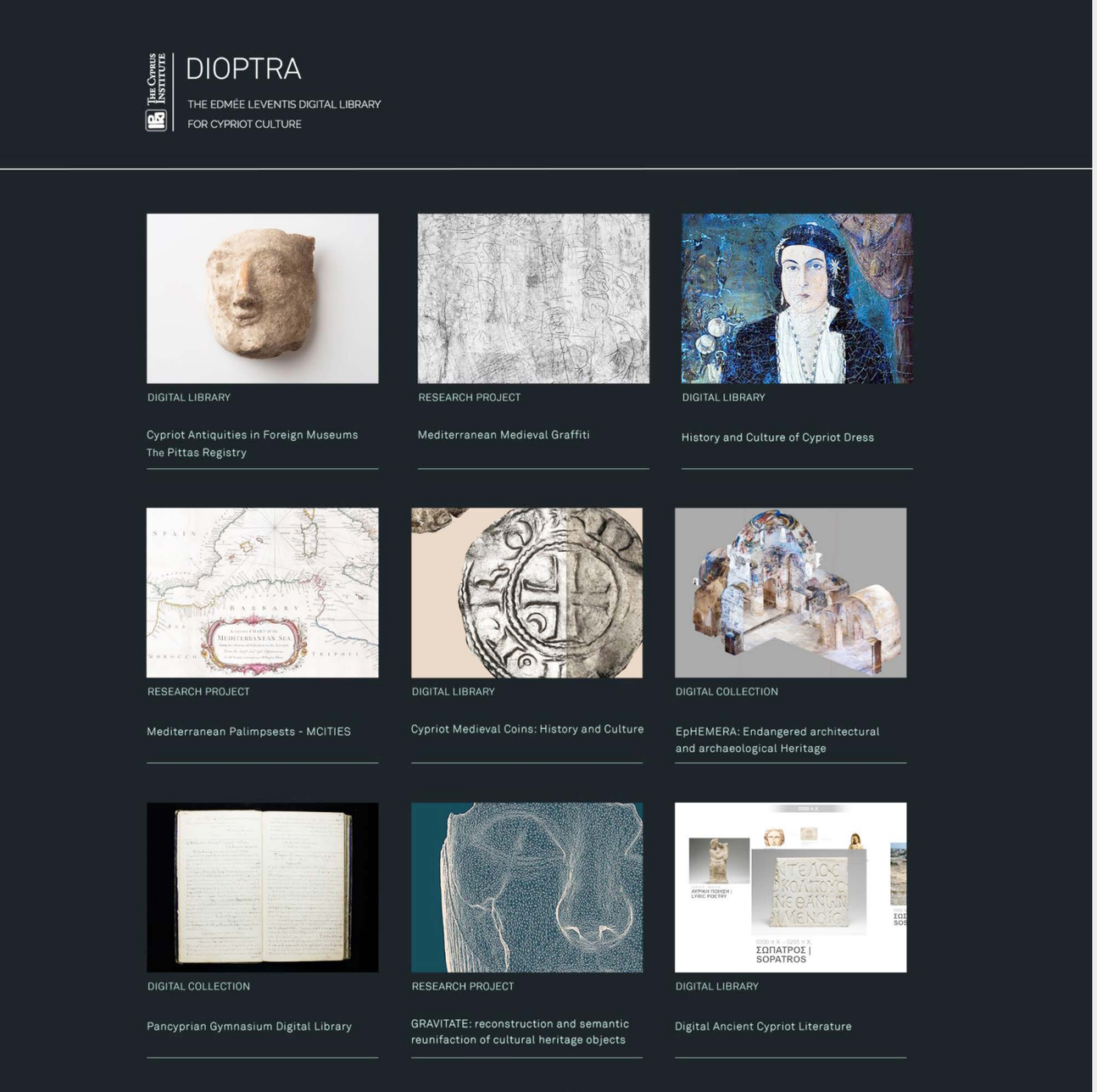
The study of Medieval and Early Modern graffiti in the monuments of Cyprus and along the routes of the Early Modern Mediterranean has added an intriguing new thread of research supported through projects like Grafmedia: GRAFfiti-Mediterranean Dialogue which is funded through the Research and Innovation Foundation (RIF). Graffiti offer a unique source on the mobility of people across the Mediterranean as well as on the visual and literary culture of past societies.

Through the study of graffiti, we can recover past people's voices, messages, feelings, and ideas, thus enriching our historical knowledge as well as our understanding of the social and cultural networks of past societies. Graffiti allow us to re-populate natural and constructed spaces through the tangible evidence of people living and experiencing these places. The study of graffiti in the San Marco basilica in Venice, the churches in the outskirts of Famagusta and the churches of the Troodos are some of our research highlights, focusing on a variety of themes and perspectives such as the passage of travellers and pilgrims or the spatial position of graffiti in religious sites.

Moreover, APAC Labs' expertise defines a specific workflow for the documentation, analysis, study and visualization of graffiti. A wide array of technologies for Cultural Heritage documentation available at APAC has been implemented in the study of graffiti at different scales. Sites are documented through the creation of 3D models (photogrammetry and laser-scan), which are enhanced with micro-scale recordings of specific graffiti. Various techniques have been applied to document the inscriptions (RTI, laser scanning, multispectral imaging) always depending on their specific characteristics. A dedicated graffiti ontology, standards and digital tools for the description and management of acquired data follows the FAIR principles and guarantees the interoperability and accessibility of the collected material. The collaboration of NCSA at the University of Illinois at Urbana Champaign has provided key contributions in scientific visualization and dissemination. Overall, APAC Labs provides a holistic, truly interdisciplinary approach to historic graffiti, thus sustaining our leading role in this emerging field of study.

Barsky's graffito at the church of St. Nicholas of the Roof near Kakopetria, Cyprus | Graffiti documentation survey at the Monastery of St. John Lampadistis in Kalopanagiotis

Next page: Reflectance Transformation Imaging (RTI) of incised graffiti on the fresco icon of St. George from the Church of the Virgin Phaneromeni in Nicosia



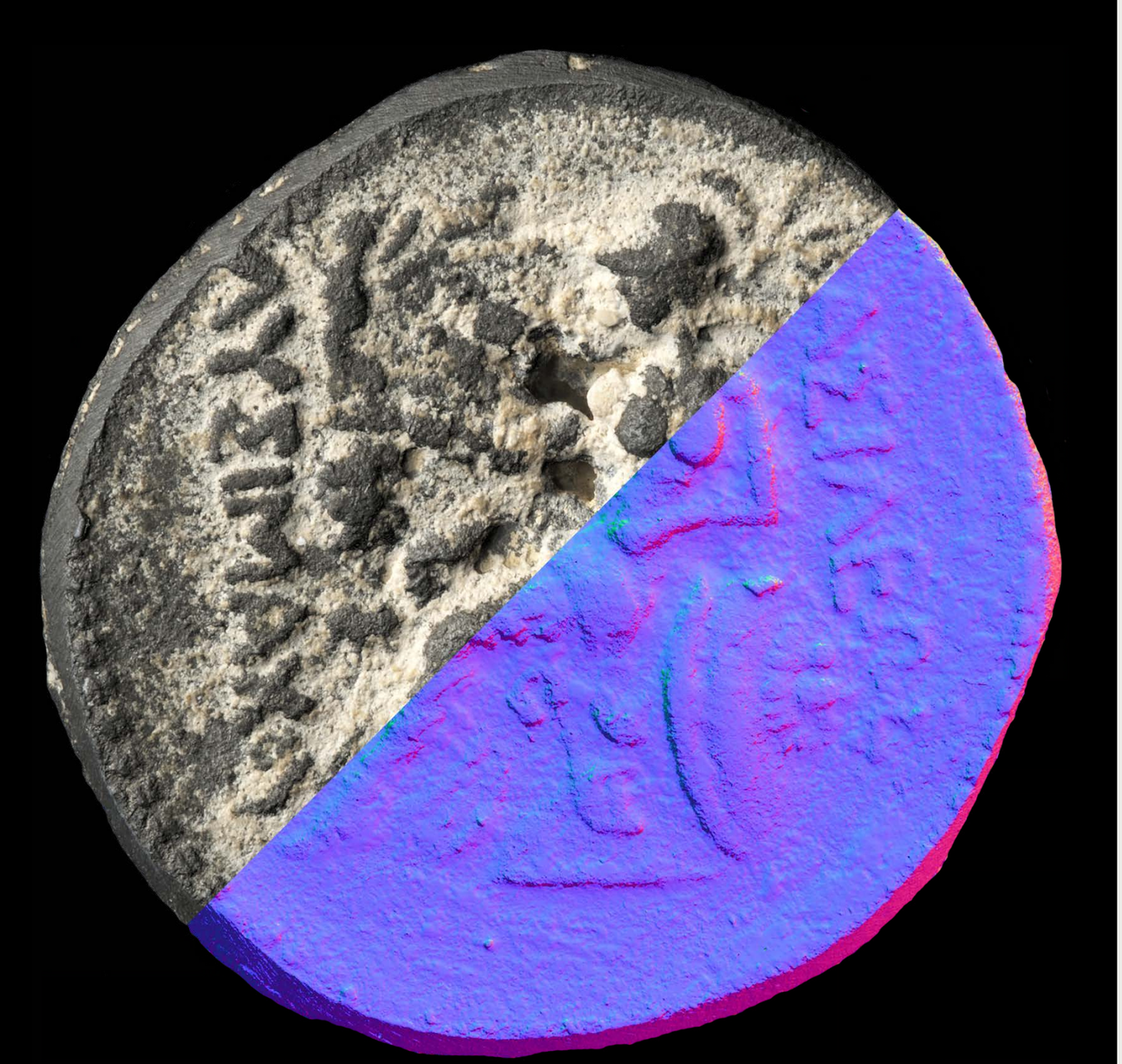
Digital Libraries and Research Data Management

As mentioned, DIOPTRA: The Edmée Leventis Digital Library for Cypriot Culture is a key resource for APAC work and results. Acquired scientific data are archived in digital knowledge repositories for use in the research and innovation activities. Supported by CyI's High-Performance Computing facility and developing in research modules that respond to key projects and initiatives, DIOPTRA provides the necessary digital platform and tools to support a broad range of research activities.

In direct connection to APAC Labs work, the digital libraries 'Cypriot Medieval Coins: History and Culture', the "Pancyprian Gymnasium Digital Library', the 'History and Culture of the Cypriot Dress', 'Endangered Architectural and Archaeological Heritage in the South-Eastern Mediterranean', 'Mediterranean Medieval Graffiti', to name a few key examples, highlight collaborations with partner heritage authorities, institutions and organizations.

A central priority is the issue of scientific data integration and management, aligned with the European Initiative for Open Science and its related FAIR principles (Findable, Accessible, Interoperable and Re-usable) is of paramount importance for the APAC labs. This effort focuses on the organization of data repositories and a data-driven virtual research environment, to be connected and integrated within similar, pan European structures.

It is important to mention here the development of DIGILAB, the digital data research infrastructure of E-RIHS, with APAC Labs leading a team of more than 70 researchers from leading laboratories, research organizations and museums around the world, such as the Smithsonian, the Getty and national facilities in Brazil, Mexico and most European countries. APAC Labs data is also integrated in AriadnePlus, the European Research infrastructure on Archaeological Data, which engages more than 30 Heritage institutions across Europe, the Americas and Asia.



Innovation and Commercialization

Innovation and commercialization of advanced services have been identified among the pillars of APAC Labs' strategic development. Activities have focused on connecting research with the private and public sectors in an effort to bring our innovative solutions to market. Our laboratories have identified several needs and have addressed them through the development of specific protocols for issues of authentication, state of preservation as well as the overall characterization of works of art and heritage assets. Related to this effort, a major achievement was the selection of APAC Labs by Cyprus Seeds to develop the commercialization of its service capacity as the ARTES (Art Characterization Services) project.

ARTES is a holistic art characterization pipeline, which offers certification and a 'complete' analytical report for a range of artefacts (such as paintings, sculptures, icons, monuments, minor arts), and provides accurate descriptions that facilitate the economic evaluation of these assets. Our service is customized and adapted according to the type of the artefact evaluated while targeting the needs of a wide segment of the art market such as collectors, museums, auction houses, art galleries, insurance companies or law enforcement interested in the materiality, technique and preservation state of works of art and heritage assets. ARTES can also offer science-based, accurate and standardized processes to support the authentication of valuable artefacts.

The development of ARTES addresses issues of IP protection, high-grade standardization of workflows, and calibration of marketing strategies in the field of art characterization. The Innovation and Entrepreneurship Office, established in October 2019 with the aim to develop, expand and manage a portfolio of innovation and entrepreneurial activities of the Cyprus Institute, supports the full commercialization process of our unique art characterization pipeline.

APAC Labs have also identified other areas of interest for innovation development, in particular those related to public outreach, within the broader framework of participatory and community heritage, cultural tourism and digitalization of heritage resources towards their socio-economic valorisation.

Technical photography and digital visualization of a replica coin from the Hellenistic period

Next page: Large Format imaging detail from 'The Baptism of Christ' by Domenikos Theotokopoulos (El Greco), c. 1570
Collaboration with the Historical Museum of Crete, Greece

20 Konstantinou Kavafi Street
2121, Aglantzia
Nicosia, Cyprus
Tel. +357 22208700
https://apaclabs.cyi.ac.cy/

THE CYPRUS INSTITUTE
RESEARCH•TECHNOLOGY•INNOVATION

STARC APAC
LABORATORIES