BRIDGING NATURAL SCIENCES, GERMAN INSTITUTIONS AND CULTURAL HERITAGE IN THE MIDDLE EAST

3 - 4 December 2024, at SESAME in Allan, Jordan, and in Amman, Jordan

SUMMARY REPORT OF THE WORKSHOP

Organizers: Deutsches Elektronen-Synchrotron (DESY), Helmholtz-Zentrum Dresden-Rossendorf (HZDR), and SESAME.

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Impressum

Summary Report of the Workshop on

Bridging Natural Sciences, German Institutions and Cultural Heritage in the Middle East

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DESY-PROC-2025-01
ISBN 978-3-945931-55-4
DOI:10.3204/PUBDB-2025-01075

Published by
Verlag Deutsches Elektronen-Synchrotron DESY
Notkestraße 85
22607 Hamburg
Germany

Program and talks are available on https://events.hifis.net/event/1993/

1. Introduction

Synchrotron radiation sources have made profound impacts on the study of cultural and natural heritage, including non-destructive investigations of archaeological / historical objects, artworks and artefacts as well as human remains.

The synchrotron radiation facility SESAME (www.sesame.org.jo) is located north of Amman in Jordan and is operated by an intergovernmental organization, fostering scientific collaboration among members (Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian territories, Türkiye) across the Middle East, Africa, and beyond. It offers scientific access in the region of the Middle East that is known for its richness in archaeological, cultural and natural heritage.

Germany is one of the observer countries to the SESAME international organization and maintains close scientific links with SESAME via the Helmholtz Association and its research centers.

As part of a wider initiative to support SESAME, a special workshop "Bridging Natural Science, German Institutions and Cultural Heritage in the Middle East" was organized on 3-4 December 2024 at SESAME and in Amman aiming to highlight the advanced experimental capabilities of the SESAME synchrotron facility in cultural heritage research.

The event organized by Deutsches Elektronen-Synchrotron (DESY), Helmholtz-Zentrum Dresden-Rossendorf (HZDR), and SESAME brought together 40 participants, including experts, scientists, and cultural heritage officials, mostly from German and Middle Eastern institutions. On the first day the workshop took place directly at the research facility SESAME including a tour of all beamlines and experimental stations. The second day of the workshop was held at the Jordan Museum.

The program and all talks are available on the following website https://events.hifis.net/event/1993/.

Figure 1: Group Picture of the workshop participants in front of the Jordan Museum. Photo taken on the second day of the workshop. Credit: Katrin Zerbe, DESY.

2. Goals and overview of program

The workshop aimed to bridge natural sciences and cultural heritage by showcasing research applications and the potential of advanced synchrotron radiation research, particularly at SESAME, for analyzing archaeological and historical artifacts from the region. The workshop was organized from a "German perspective", i.e. it was focusing on fostering collaboration between German research institutions who are active in the area and Middle East organizations while promoting the regional study of cultural heritage. At the workshop the participants were encouraged to discuss the analytical needs and demands coming from the archaeological side and to transform ideas into actionable projects, leveraging synchrotron radiation to preserve and study cultural artifacts in the region.

The program featured 27 speakers in six sessions over two days, with discussions, facility tours, and networking opportunities to strengthen partnerships and contribute to global efforts in applying natural science methods and techniques to archaeological and historical questions.

Highlights included

- Overview and case studies of SESAME's potential in cultural heritage studies
- Topics on analyzing written artifacts and the experimental demonstration of using synchrotron radiation for uncovering hidden texts on Egyptian Papyri
- Studying ancient ceramics and pottery, and Hellenistic-Roman paintings
- Research on ancient metals, human remains, and excavation sites.
- Insights into human evolution, iron technology, and the preservation of archaeological discoveries.

The workshop participants discussed also cooperation projects and ways to explore funding opportunities, as well as administrative frameworks, and best practices for using SESAME's facilities. Moreover, presentations on building international cooperation networks and ongoing EU-funded projects such as SUNSTONE were given.

As part of the workshop, participants were given an in-depth tour of the SESAME synchrotron facility, which showcased its advanced experimental capabilities and research infrastructure. A networking dinner provided an opportunity for informal discussions and collaboration building among attendees. Additionally, a guided visit to the Jordan Museum highlighted efforts in cultural heritage preservation and offered insights into the region's rich historical and archaeological significance.

The workshop concluded with a wrap-up and discussions on key takeaways and strategies for future projects leveraging SESAME's capabilities.

This comprehensive agenda underscored SESAME's role as a bridge between cutting-edge science and cultural heritage in the Middle East.

3. Session summaries

Session 1 – Opening and Introduction

The welcome speeches and the opening words were given by ***Khaled Toukan***, Director-General of SESAME and by ***Rolf-Dieter Heuer***, the President of the SESAME Council, highlighting the importance and significance of the workshop theme for SESAME. The motivation and goals of the workshop were given by ***Frank Lehner*** from DESY, one of the organizers of this workshop.

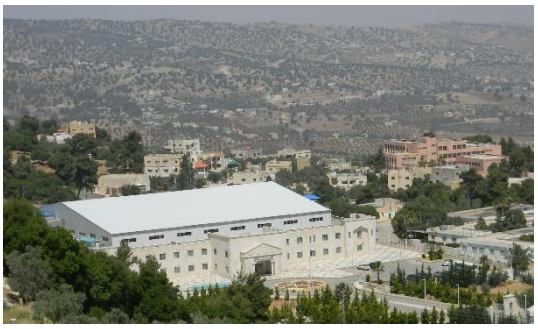


Figure 2: A photograph of the research center SESAME north of Amman.

"Overview of the SESAME and opportunities in cultural heritage"

Andrea Lausi, Scientific Director SESAME

Established under the auspices of UNESCO, SESAME is a cooperative venture by scientists and governments of the region set up on the model of CERN. SESAME addresses distinct scientific and regional goals, offering access to beamlines tailored to a wide array of scientific inquiries. Two bending magnets and three insertion device beamlines are presently open to users, covering IR, soft X-ray and hard X-ray energy ranges. The presentation provides an overview of SESAME and its potential in supporting cultural heritage thanks to its non-destructive, high-resolution analytical tools.

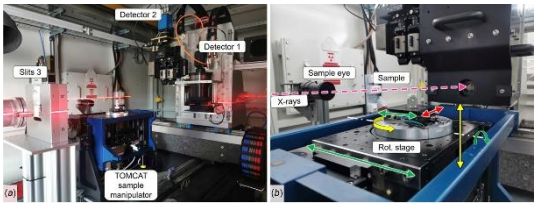


Figure 3: Left: BEATS X-ray radiography and tomography endstation with detectors 1 and 2 for white beam applications installed. Right: Detail of the tomography sample manipulator indicating the axes of sample motion. Pictures taken from: BEAmline for synchrotron X-ray microTomography at SESAME [Iori et al. (2024). J. Synchrotron Rad. 31, 1358-1372.

"The importance of synchrotron radiation in archaeology and cultural heritage studies of Southwest Asia: why now?"

Gonca Dardeniz, Istanbul University, Department of Protohistory & Near Eastern Archaeology

The contribution by Gonca Dardeniz was about the diversity and complexity of data that archaeology produces and its resemblance to the modern world. Archaeology provides us with a time capsule of materials, events, and challenges along with an enormous amount of data which can be turned into knowledge by deeper examination through cutting-edge techniques. Synchrotron light provides archaeologists and cultural heritage scholars a new interdisciplinary way to investigate complex layers of their material.

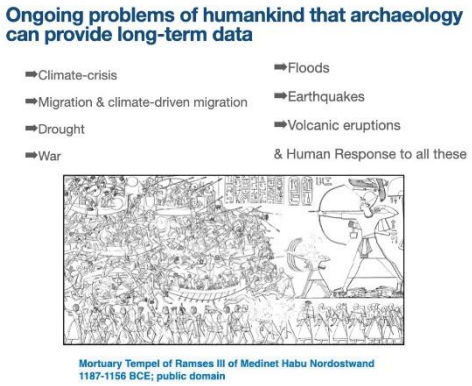


Figure 4: Slide from G. Dardeniz' talk on the ongoing problems of humankind.

Session 2 - Ideas, Projects, and Analytical Needs: Written Artefacts

This session featured diverse presentations on cutting-edge techniques in cultural heritage studies on written artefacts.

"Accessing hidden text on papyri – Elephantine and beyond"

Verena Lepper and Heinz-Eberhard Mahnke
(Ägyptisches Museum und Papyrussammlung SMB SPK)

After showing within the "Elephantine" project that absorption tomography was successful when metal ions containing ink was used in folded or rolled papyri, we have started the next phase with a feasibility study at BEATS towards identifying text written with carbon ink by demonstrating the potential of SESAME (e.g. beam stability) with absorption-edge sensitive tomography using mockups prepared with modern papyrus.

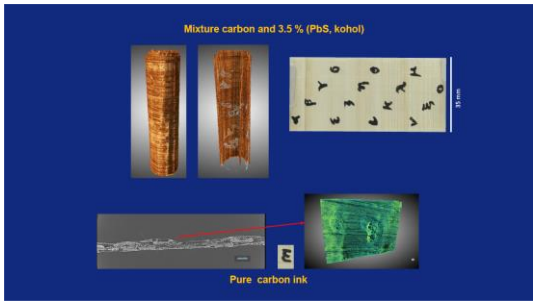


Figure 5: Slide from the presentation of V. Lepper/H.-E. Mahnke on the feasibility tomography studies on rolled papyri done at the BEATS beamline at SESAME.

The next step, already scheduled for May 2025 at the BEATS beamline, will be to take tomographic data of ancient objects from the Papyrus Collection of the Egyptian Museum Berlin written with carbon ink, and with red ink for testing the sensitivity. We hope to obtain high-quality data for the carbon ink papyri so that applying the new mathematical methods and computational tools will successfully reveal hidden symbols and text; our collaborating colleagues, led by Daniel Baum, at the Zuse Institute Berlin (ZIB), are continuing to improve the tools.

"Unrolling Papyrus: Documentation, Conservation and Display"

Eid Mertah, Conservator of Archaeological materials, Egyptian museum, Cairo

This presentation explored the unrolling, analysis, and preservation of two ancient Egyptian papyri: Ahmose's Papyrus from the Ptolemaic period (305–30 BC) and Hemaka's Papyrus from the Early Dynastic period (3150–2686 BC). Ahmose's Papyrus, discovered in December 2021 in Saqqara, offers insights into ancient manufacturing processes and its owner's identity. Advanced conservation techniques, including visual and multispectral imaging, 3D modeling, and X-ray fluorescence, were utilized to examine and document the papyrus. Careful unrolling and flattening were done culminating into the second-longest papyrus in Egypt. Future investigations, in particularly virtual unfolding, should focus on Hemaka's Papyrus, promising further contributions to our understanding of early Egyptian heritage.

Figure 6: Papyrus roll of Hemaka as presented in the talk by Eid Mertah. The papyrus dates back to Early Dynastic Period (3150–2686BC)

"Early Islamic Dipinti from Archaeological Contexts"

Hagit Nol, Goethe-Universität Frankfurt

Primary written sources from the Islamic World prior to the mid-9th century are limited in scale and in geography, mainly including coins, engraved graffiti and – mostly in Egypt – papyri. Another type of source, not as common and often understudied, is the dipinti (lit. painted): texts which are inscribed by ink or pigment. Dipinti comprise writings on structures, objects, artefact fragments, and raw materials. The main advantage of these texts is the physical durability of the materials which has led to their world-wide survival in various conditions. My new planned project will focus on literacy in the Islamic world between the late 7th and the early 8th century. My main interests include techniques of writing and writing-materials, agents in the process such as scribes or consumers, and the motors which brought about (what seems to be) a growing literacy.

Figure 7: An inkwell from Frange's working space, Thebes, Egypt. Photograph by Laurent Bavay.

The project is divided into four different 'packages' or research directions, one is devoted to ink and use archaeometry. A shift in ink composition (or 'recipe') has been observed on papyri documents and manuscripts from Egypt – from carbon ink to iron-gall ink. The shift was dated to the 5th to 8th century CE. Recent results of research on Egyptian papyri from the 8th century (not published yet) imply different recipes for documents initiated by the authorities (iron-gall) and by private individuals (carbon ink). Our research (a collaboration with Prof. Claudia Colini from Hamburg University) will look at the ink composition of writings by one monk, Frange, who lived in the 8th century in Egypt, produced writings on various media – including papyri and pottery sherds (ostraca) – and even left an in-situ inkwell at his 'home office'!. The ink recipe will be compared to the previous results. In case that Frange used carbon ink, different than the iron-gall ink used by the Arab/Muslim administration, we could assume with more certainty that the iron-gall recipe was introduced by the administration.

According to the protocol developed by BAM and CSMC, the ink will be examined using Near Infra-Red (NIR), Ultraviolet (UV) reflectography and microscopy, X-Ray Fluorescence spectroscopy (XRF), Raman spectroscopy and, for the inkwell, Atmospheric Solids Analysis Probe Mass Spectrometry (ASAP-MS). One main challenge we face is detecting the ink composition on pottery sherds, overcoming the (uneven) signals of the clay itself. Very limited research has been done until now on ostraca (from 10th-6th century BCE) and a successful protocol is yet to be developed. Another challenge would be getting permission to test Frange's inkwell, which is situated at the Coptic Museum in Cairo. SESAME might be the place which assist us in addressing these challenges.

"Digging up History: Archaeological Investigations at the Caves of Qumran"

Marcello Fidanzio, Università della Svizzera Italiana - Facoltà di Teologia di Lugano and Cluster of Excellence Understanding Written Artifacts, University of Hamburg

The Qumran Dead Sea Scrolls were discovered in eleven caves in the vicinity of the Qumran settlement, in the Judaean Desert. The caves were excavated between 1949 and 1956 by the Department of Antiquities of Jordan, the École Biblique et Archéologique Française de Jérusalem, and the Palestine Archaeological Museum. In 1952, the American School of Oriental Research of Jerusalem joined the survey of the cliff west of Qumran and the excavations at Caves 2Q and 3Q.

Figure 8: Strips of the Copper Dead Sea Scroll at the Jordan Museum in Amman. Photo credit: Osama Shukir Muhammed Amin FRCP(Glasg), CC BY-SA 4.0, via Wikimedia Commons

The best-preserved scrolls were found in Cave 1Q and Cave 11Q, located on the rocky cliff. Cave 4Q, a manmade cave dug on the marl platform, was the richest in manuscript fragments (15,000 fragments from over 600 manuscripts). The most enigmatic of the Dead Sea Scrolls, a list of treasures engraved on copper, was found in cave 3Q. The Qumran Caves Publication Project (École Biblique et Archéologique Française de Jérusalem and Swiss Italian University, Faculty of Theology of Lugano, led by the present author) aims at providing the final report on the excavations carried out at the Qumran caves. It was possible to reconstruct the archaeological contexts of caves 1Q and 3Q and collect minor evidence from other caves. This allows us to investigate how the scrolls were deposited in the caves and why.

A recent trend in Dead Sea Scrolls research has focused on the scrolls as archaeological artifacts, starting from their place of discovery (the caves) and their physical characteristics. Important archaeological materials that are part of this heritage are preserved in the Jordan Museum in Amman and in the warehouses of the Department of Antiquities of Jordan: jars, lids and linen fabrics, which formed the packaging of the scrolls deposited in the caves of the rocky cliff, as well as the Copper Scroll and four important parchments from caves 1Q and 4Q.

The archaeometric study of these artefacts could provide useful information for reconstructing the depositional context of the scrolls, as well as insights into their production and use, and more broadly for the knowledge of what is considered to be "the greatest manuscript discovery of modern times" (William Foxwell Albright, March 8, 1948).

Understanding Written Artefacts with the CSMC Mobile Lab – Projects, Possibilities and Perspectives

Claudia Colini, Sebastian Bosch, Shervin Farridnejad - Center for the Study of Manuscript Cultures CSMC, U Hamburg

This presentation will highlight the CSMC's (Centre for the Study of Manuscript Cultures) innovative approach to promoting the material analysis of cultural heritage. The focus will be on the three-part laboratory setup, which includes the Mobile Lab, the High-Performance Lab, and the Container Lab, specifically designed to perform non-invasive analyses of cultural heritage artifacts. Recently, CSMC has entered into a strategic partnership with the German Electron Synchrotron (DESY), opening up new avenues for global collaboration. While current partnerships in the Middle East focus mainly on Turkey and Egypt, challenges such as the region's limited availability of mobile equipment and general administrative hurdles related to the transportation of scientific instruments and heritage objects have hindered broader regional engagement. However, successful projects in border regions have demonstrated the potential for expansion. Further initiatives are already planned in Iran. This presentation will highlight projects carried out by the CSMC, demonstrating the enormous potential of on-site investigations and exploring the possibility of establishing a mobile laboratory under the auspices of SESAME, in close collaboration with CSMC as an experienced partner in the region, to promote greater collaboration and resource sharing.

Figure 9: The Mobile Lab at the Center for the Study of Manuscript Cultures (CMSCS) at the University Hamburg.

Study of enclosed cuneiform tablets with mobile x-ray tomography

Katrin Zerbe, DESY

Examples of cultural heritage research done at DESY's synchrotron radiation source PETRA III as part of the close cooperation between DESY and the cluster of excellence "Understanding Written Artefacts" at the University of Hamburg was presented. The talk gave also an overview of DESY's future flagship project PETRA IV, the ultimate x-ray synchrotron radiation source with the goal to deliver extremely bright, high-energy x-rays with unparalleled beam coherence and stability, i.e. unprecedented capabilities for exploring the physical and biological worlds with remarkable precision. In the talk the use of mobile X-ray tomography for studying enclosed cuneiform tablets was presented. Imprints in clay, developed more than 5,000 years ago by the Sumerians in Mesopotamia and used all around in the ancient Near East are one of the earliest forms of writing. In an innovative approach DESY developed together with the University of Hamburg a special mobile x-ray tomography scanner ENCI (Extracting Non-destructively Cuneiform Inscriptions), named after Enki, the Sumerian god of wisdom, to read old sealed cuneiform tablets. The portable tomograph ENCI was already deployed at measuring campaigns in the Louvre Museum in Paris and in the Ankara Museum, enabling non-destructive analysis of these ancient Mesopotamian artifacts. ENCI measurement campaigns play a crucial role in fostering collaboration between the humanities, physics, and computer science. By bringing together experts from these disciplines on-site for an extended period, they facilitate enhanced knowledge transfer and improve communication and problem-solving. Moreover, these campaigns help build trust, establish personal

Figure 10: From the Talk of K. Zerbe. The mobile tomography scanner ENCI with the measurement team in the Ankara Museum.

relationships, and promote cultural exchange, ultimately broadening perspectives and strengthening interdisciplinary cooperation.

Session 3 - Ideas, Projects, and Analytical Needs: Pottery and Ceramics

"Mineralogical Characterization of Khirbat Edh Dharih early Bronze Age pottery"

Hussein Al Sababha, The chair of the Department of Conservation and Management of Cultural Resources, Faculty of Archaeology and Anthropology, Yarmouk University

The presented study focused on the mineralogical constituents of early Bronze Age pottery from the site of Khirbat Edh-Dharih. The site was occupied from the Neolithic period until the late Islamic period and flourished, reaching its peak during the Nabatean period. The study utilized two scientific analysis techniques: petrography and XRD, to determine the mineralogical constituents. Both techniques allowed for the recognition of tempering materials, which pottery makers used to manipulate the plasticity of the clay. By comparing the tempering materials with the local geological formations, the study concluded that pottery makers primarily relied on local materials. XRD analysis provided insights into the firing temperatures, revealed by newly formed minerals such as diopside and gehlenite. Therefore, to gain a better understanding of the pottery sherds, further elemental analysis is needed.

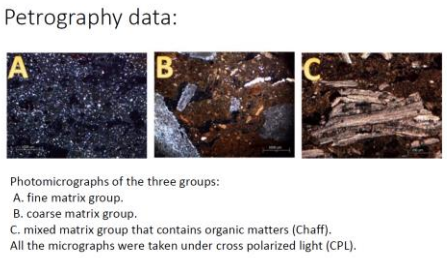


Figure 11: Slide from the presentation by Hussein Al Sababha showing petrography data of pottery sherds.

"Natural Sciences and Cultural Heritage: some Applications on Ancient Egyptian Pottery"

Eman Khalifa, Professor and International Coordinator, Faculty of Archaeology, Cairo University, Egypt

This talk briefly traced the history of excavations and research in Egyptology, and how it changed from treasure-hunting to a science-based discipline. In this discipline, studies of ancient pottery also developed over time. Therefore, this talk gave examples from the presenter's own research, in addition to one example from prehistoric Egypt, of recent applications of natural sciences in archaeology. In conclusion, the talk demonstrated that interdisciplinary work in archaeology can help accept different narratives.

Figure 12: Slide from the Talk of Eman Khalifa on the Qubbet El-Hawa Research Project.

"The use of combined synchrotron radiation FT-IR and XRF for the characterization of Roman Wall paintings from Bayt Ras tomb, Jordan"

Sahar al Khasawneh. Department of Conservation and Management of Cultural Resources, Yarmouk University

The modern-day Bayt Ras in the north of Jordan stands on the ruins of the ancient Roman city of Capitolias, one of the ten cities in the Decapolis League, which was founded by Pliny the Elder during the Hellenistic age. Archaeological research suggests that the city was established at the end of the 1st century AD, as indicated by coins minted by the city. The tomb features dozens of frescoes that depict details of daily life not often mentioned in historical records.

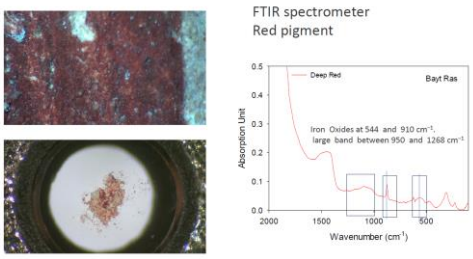


Figure 13: Slide from the presentation of Sahar Al Khasawneh showing FTIR spectroscopy data from red pigments.

In this project, we investigate the composition of the pigments and binding materials used in the wall paintings by carrying out combined synchrotron radiation analysis; FT-IR and XRF techniques. The analysis was performed on selected fragments that were detached from the tomb walls and were not suitable for restoration and relocation on the wall.

The first observation was that all the pigments are incorporated into a calcium carbonate matrix, serving as binding material for the pigments. Red and brown pigments were mainly composed of iron oxides, as revealed by the multiple analytical methods. Red ochre, consisting of iron oxides (Fe2O3 Hematite), is the main source of the red pigment. Black color, being carbon-based, can be easily detected by Raman spectroscopy. The green pigment is a more complicated case. Most likely, the pigment is "green earth" (containing Al2O3 and Fe2O3) as it is the most common green pigment used in the Roman Empire.

Patrick Leiverkus from the Biblical-Archaeological Institute at the University of Wuppertal discussed ongoing challenges and unresolved questions in the archaeometric study of Tall Zira'a.

"Hellenistic-Roman wall painting in Jordan: Questions from archaeology on material analysis"

Brita Jansen, German Protestant Institute of Archaeology (GPIA) Amman

When asked to contribute to this meeting, I was initially unsure since I haven't worked with SESAME before, and scientific analyses play only a minor role in my archaeological work, aside from methods like archaeobotany or C14 dating. However, as a representative of the German Protestant Institute for Archaeology (GPIA) in Amman, it is important for me to explore SESAME's potential for our work, and I appreciate the opportunity to be here today.

Figure 14: Fragments of painted plaster from Tall Zar´a.

While I have some experience with pigment analysis from previous research on Roman and Hellenistic wall paintings, including fragments from Tall Zar'a, the possibilities SESAME offers for understanding material composition and techniques are particularly exciting. The limited comparative data, especially for early periods like the 2nd century BCE, highlights the need to expand the research base for better insights into pigment trade, workshops, and techniques.

Another area of interest is glass analysis, inspired by studies on Jerash finds that revealed details about raw material origins, recycling, and fuel use. For our ongoing project in Umm Qays, where we've found similar glass fragments, SESAME's capabilities could help us answer questions about local production and environmental impacts.

My biggest challenge is bridging the gap between scientific results and archaeological interpretation. Meetings like this are vital for fostering collaboration and making these methods more accessible to archaeologists. Thank you for bringing us together and showcasing this incredible facility!

Figure 15: Workshop Participants on Day 2 in the Foyer of the Jordan Museum. Photo by Andrea Lausi.

"Searching for the origins of iron technology"

Ernst Pernicka, Michael Brauns, Ivan Stepanov, Curt-Engelhorn-Zentrum Archäometrie gGmbH, Mannheim

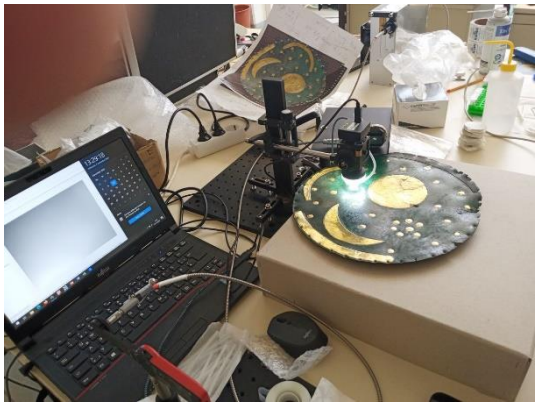


Figure 16: Laser sampling of the Sky Disc of Nebra. Courtesy of Ernst Pernicka.

Of the seven metals known in antiquity (gold, silver, copper, lead, tin, iron, mercury) iron is the most abundant one in the Earth's crust. Yet it came late in the history of mankind but played a decisive role once the production technology from oxidic iron ores was mastered. Despite the generally acknowledged importance of iron on the societies after the end of the Bronze Age little is known about its origin and the spread of its production technology. A major obstacle was the difficulty to determine the provenance of iron by chemical or metallographic analysis. While the provenance of base metals including silver has often been successfully resolved by the combination of trace element analysis combined with lead isotope ratios this approach appears less useful for iron for several reasons. Now a new methodological approach comprising the analysis of siderophile elements with highly sensitive techniques combined with isotope ratios of osmium, which is practically absent in the environment but present in most iron ores. Since the osmium isotope ratios are not changed by the metallurgical processes during iron production, it is a unique link between iron ores and iron objects. Systematic analyses of well dated iron objects from the Near East and the Mediterranean offers the chance to find out, if the earliest iron objects originate from a single ore deposit or from several different ones and if the spread of early iron reflects the trade of iron metal or the transmission of iron production technology. Synchrotron radiation could mainly be used for micro tomography of early iron objects to identify their production technology and to differentiate between meteoritic and terrestrial iron.

„Studying human evolution using synchrotron radiation and microCT"

Alexander Stoessel, University of Jena and the Max Planck Institute for Evolutionary Anthropology

The talk showcased how SR and microCT enhance the study of human evolution through fossil analysis. The use of non-invasive microCT and synchrotron-based tomography has revolutionised both biology and archaeology in the last two decades. These methodologies have greatly advanced the study of human evolution in particular, as both the shape and the inner structures of rare and precious fossils and artefacts can be studied with unprecedented accuracy and without prior destruction. In addition, digital replicas of these objects ensure their preservation and accessibility for research and humanity in general. In my talk I will present cutting-edge research examples utilising microCT and synchrotron data for the study of human evolution and highlight opportunities for cooperation with SESAME.

"Answering key questions in Human Bioarchaeology with Synchrotron radiation enabled approaches at SESAME"

Kirsi O. Lorentz, BioMERA Platform & Science and Technology in Archaeology and Culture Research Center (STARC), The Cyprus Institute (CyI)

Figure 17: Slide from the talk from Kirsi O. Lorentz

SESAME, the first synchrotron located within the region known as the cradle of civilisation, opened its doors with the first official beam time focusing on ancient human remains. This presentation focuses on the ancient peoples from the SESAME region - real individuals, who contributed significantly to how we live today. In so doing we also focus on the advances, challenges and potential of synchrotron-radiation-enabled approaches to Human Bioarchaeology. The presentation takes stock of use of SR in human bioarchaeology from its inception, globally, and traces the increasing use of SR enabled approaches within this discipline. The talk includes showcase examples of research case studies employing a wide range of SR techniques - including SR-FTIR, SR-microXRF mapping, SXCT, EXAFS and XANES, among others - responding to key questions in human bioarchaeology.

Session 5 - Ideas, Projects, and Analytical Needs: Excavation Sites

"Exploring the twin hills Tulūl adh-Dhahab: Excavations, Discoveries, and Analytical Needs"

Asuman Lätzer-Lasar, Philipps-Universität Marburg.

Figure 18: Slide from the Presentation by Asuman Lätzer Lasar on the the local and imported vessels at the Tulul adh-Dhahab.

The two hills known as Tulul adh-Dhahab (gold hills) are located at the river az-Zarqa (blue river), which originates in proximity to the contemporary capital, Amman. In its final stretch, the river flows east to west before merging with the Jordan River near the centre of the Jordan Valley (Finkelstein et al., 2017). The region's strategic importance, owing to its location on the edge of the Fertile Crescent, with its seasonal winter rains and ample water supply, has been recognised since the 4th millennium BCE, fostering a settlement-friendly environment. The distinctive topography of the hills amplifies their geostrategic significance, positioning them at the intersection of vital trade and communication networks from the Iron Age to the Roman period.

This prominence derives from their geographical role as a key interface between Eurasia and Africa, linking major cultural and economic spheres. It is evident that the site gained trans-chronological and supra-regional significance, as evidenced by archaeological analysis, particularly during the 1st millennium BCE. Despite the wealth of archaeological material, there remains a notable scarcity of scientific provenance analyses to substantiate or refine existing findings. This gap is particularly pronounced in the study of stone artifacts (such as reliefs and building materials), metal objects (including coins and military weapons), glass items (vessels and jewelry), and ceramic materials (such as terracotta figurines and vessels). Provenance research is a critical area of focus for artifacts from Transjordan, as the production processes, manufacturing sites, and associated trade networks remain

largely undefined. Given the profound cultural, religious, ethnic, and political significance attributed to these objects, advancing our understanding of their origins, and also the techniques they were made of, offers substantial potential for illuminating early human history. Additionally, such research could provide invaluable contributions to cultural-historical studies, particularly in the context of the Old Testament.

"The Qubbet el-Hawa Research Project"

Martin Bommas, Director, Qubbet el-Hawa Research Project (QHRP), Editor-in-chief, Studies in Egyptian Archaeology and Sciences (SEAS), former Professor and Museum Director at Macquarie University, Sydney, Australia

From its beginning in 2015, the Qubbet el-Hawa Research Project operating in Aswan/ Egypt was designed and established as a meeting ground for archaeological fieldwork and scientific research. Main combined activities include ceramological research including residue analysis as well as restoration and conservation. The latter analyses ancient materials both in the field and in Cairene labs to establish the use of scientifically informed and lab-based reconstruction of ancient construction materials in the built-up of West-Aswan's first archaeological park. When examination and analysis needs exceed the lab facilities available in Egypt, non-destructive research methods become paramount to be conducted at SESAME, including Egyptian and European partners.

Figure 19: Slide from the presentation by Martin Bommas showing the research of pottery and vessel content.

"The Scientific infrastructure at LEIZA: past - present – future"

Roland Schwab, LEIZA

In this talk the evolving role of the Center for Archaeology (LEIZA) in supporting cultural heritage research was discussed. The past achievements, current capabilities, and future developments of LEIZA's advanced scientific infrastructure were highlighted. LEIZA supports restoration, conservation, and material analysis through advanced laboratories, such as the Laboratory for Archaeometry and the Laboratory for Pyrotechnological Studies and Experiments (PyroSEr). State-of-the-art tools include XRF, Micro-LIBS, 3D imaging, and computed tomography for non-destructive analysis. The presentation showcased also projects like the restoration of Tutankhamun's treasures, numismatic studies on Roman coins, and the analysis of Byzantine copper on Elephantine Island underlining LEIZA's pivotal role in advancing archaeological research and technology.

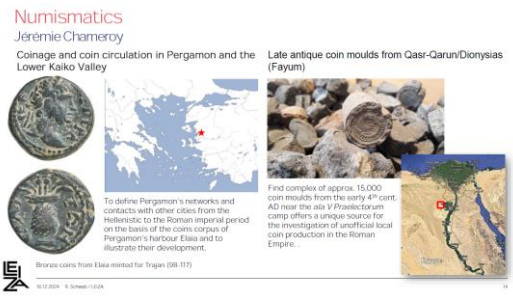


Figure 20: Example of a current project of LEIZA in the Near East on numismatics.

"Building a Cooperation Network Germany – Jordan"

Maram Na'es, TU Berlin

The talk focused on Heritage Science as a 'multidisciplinary integrative Archaeology-Conservation-Natural Science research'. Examples of cooperation projects between Germany and Jordan in both cultural heritage (CH) and natural sciences (NS) sectors were presented. An example of combined CH and NS project (Petra Painting Conservation Project) where SESAME synchrotron facility was incorporated was also presented.

Figure 21: Slide from the presentation of Maram Nae'es.

Key points were:

- Highlighting the need for and usefulness of fostering knowledge and resources from various fields, specifically CH and NS, to provide excellence in Heritage Science at the Synchrotron.
- Raising awareness about Heritage Science at the Synchrotron by reaching out and bridging academic and research institutions in Jordan and Germany.
- Suggesting working phases for interdisciplinary cooperation from which researchers and potential users can start at.
- Suggesting establishing a network platform where researchers from CH and NS fields can foster cooperation towards establishing a strong analytical case and a fruitful use of the synchrotron.
- Mapping the way for a productive cooperation network based on shared interests and the will to excel in researching heritage.

"The SUNSTONE Project"

Mariangela Cestelli Guidi, INFN and on behalf of the SUNSTONE training group

The SUNSTONE project aims to strengthen the international dimension of ESFRI and/or ERIC research infrastructures, consolidating the SESAME structure. This 42-month project (June 2024-December 2027), with a budget of €1.5 million, is coordinated by ESRF and involves various beneficiaries, including ALBA, CYI, DESY, ELETTRA, ESRF, INFN, SESAME, and SOLEIL. The project focuses on several work packages, including promoting SESAME's sustainability, developing it as a training center, and strengthening its user services.

The main objective of WP3, led by SOLEIL and INFN, is to grow the SESAME user community, reduce barriers to synchrotron access, and enable users to carry out most of their projects independently. This WP aims to implement a training program through which SUNSTONE will offer a unique opportunity for the archaeology community by combining theoretical training with practical experience in the use of synchrotron radiation techniques at SESAME.

Specifically, the thematic school on cultural heritage will focus on the use of computed tomography on the ID10-BEATS beamline. This technique allows obtaining high-resolution 3D images of objects, artifacts, and archaeological finds, offering archaeologists a powerful tool to analyze the internal structure of objects without damaging them, identify the materials used in their manufacture, virtually reconstruct fragmented objects, and study the evolution of artifacts and techniques over time.

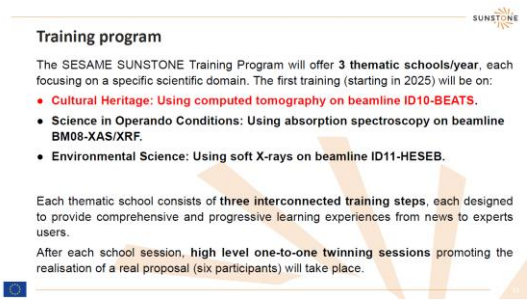


Figure 22: Slide from the presentation by Mariangela Cestelli Guidi on the Training Program of the SUNSTONE project.

Participation in this training program will enable archaeologists to acquire advanced skills in the use of non-invasive analysis techniques, collaborating with experts in the field and with other international researchers. The training program has been designed to be accessible even to inexperienced users, ensuring a gradual and complete learning path.

The training program, structured in three phases, includes:

Phase 1: General online lectures on the fundamentals of synchrotron radiation and its applications in the field of cultural heritage. This initial phase, conducted online and integrated with on-site sessions during the annual SESAME user meeting, offers a general introduction to synchrotron radiation techniques and their applications. The lectures will focus on the fundamentals, sample preparation, data analysis, and key research topics, making the content accessible even to those unfamiliar with synchrotron radiation. The target audience is broad and includes both current and potential SESAME users, including those who are approaching this technology for the first time. The training materials, including recorded lectures, will be available online, offering users the opportunity to learn at their own pace and review concepts as needed. The training program provides a gradual progression of skills, starting from the basics and moving on to advanced training sessions. This approach allows participants to become familiar with the fundamental concepts before tackling more complex topics.

Phase 2: Practical workshop at SESAME, with thematic lessons on the use of computed tomography for the analysis of archaeological finds and hands-on sessions on the ID10-BEATS beamline.

Phase 3: High-level twinning sessions with experts in the field to develop a real research proposal and its implementation at SESAME. This personalized support allows participants to receive specific guidance for their research projects and to develop the skills necessary to use synchrotron radiation techniques effectively.

4. Discussion and Action Items

The workshop continued with a session of productive discussions that highlighted the importance in bridging natural sciences with cultural heritage. Participants emphasized the interdisciplinary collaboration between German and Middle Eastern institutions, leveraging Germany's observer role at SESAME to build stronger networks. In general, there was seen much value and large scientific potentials in better connecting the various actors from archaeological communities who are active in the region with experts and users at the synchrotron radiation laboratory SESAME.

Several important observations and findings were made at the workshop:

Interface/Liaison between analytical experts – archaeology
It was emphasized by Asuman Lätzer-Lasar that a liaison role of analytic experts and beamline scientists at SESAME and at cooperating universities to archaeology is essential to provide guidance on how to effectively and purposefully utilize resources, such as beam time. Ideally, such an advisory role should also contribute to the discussion and interpretation of results.

Analytics platform around SESAME:
It was mentioned that the advanced analytical capabilities at SESAME'S beamlines and the various complimentary analytical lab instruments and characterization tools available at collaborating universities and institutes, including even mobile lab equipment such as portable XRF, should be set up and integrated into a distributed infrastructure platform to provide wide spanning research opportunities and effective services to the communities.
The Centre for the Study of Manuscript Cultures (CSMC) at the University of Hamburg will be available to offer its expertise to help establishing an additional mobile hub equipped with portable equipment, along with offering training courses in operation and advanced data analysis.

Workshop Evaluation:
As Maram Na'es pointed out, a survey should be conducted or at least feedback from participants collected to evaluate the workshop. Key questions could include: What aspects did they find most rewarding? What were their initial expectations? What did they feel was missing or could be improved? An initial database should be launched to strengthen the network and to serve as a foundation for future collaborative work.

Follow-up workshop, networking and/or other events:
It was strongly suggested by several participants to prepare for a next meeting or workshop which should take place in another SESAME member state. Concrete suggestions came from Maram Na'es and also from Eman Khalifa and Martin Bommas. In order to facilitate a start-up, a workshop/winter school (or both) can be arranged for at Cairo University. This can include different sessions on various topics. Of course, funding will need to be considered and raised. Other possible venues Egypt could be the German University in Cairo, the Grand Egyptian Museum, or the Bibliotheca Alexandrina. This would provide an opportunity to engage more stakeholders and foster international collaboration.

Another point raised by Katrin Zerbe was the networking activity on cultural heritage hosted at DESY and CSMC, aimed at connecting synchrotron radiation experts with archaeologists. Regular meetings are planned, including an online summer format and an in-person workshop[1]. All workshop participants are encouraged to contact Katrin Zerbe (katrin.zerbe@desy.de) to be part of the distribution list. Those interested in measurements at DESY are also invited to reach out to her.

Kirsi Lorentz suggested as synergistic initiative on synchrotron radiation approaches in cultural heritage the upcoming World Archaeological Congress WAC-10[2] to be held on 22 - 28 June 2025 in Darwin,

[1] Please see https://indico.desy.de/event/43734/ as example of the 2024 workshop.
[2] Please see: https://worldarchaeologicalcongress.com/wac10/

Australia. WAC is a global 4-year cycle conference on Archaeology and Cultural Heritage. This can also be considered as a follow up action for this 2024 workshop, and a further opportunity to develop relevant networks within this domain, in support of SESAME and its widespread use within the domain of cultural heritage and archaeology. All those interested in participating in/contributing to this workshop are encouraged to contact Kirsi Lorentz (k.lorentz@cyi.ac.cy).

Training at SESAME, e.g. facilitated through the SUNSTONE project:
Several attendants at the workshop welcomed the training opportunities in the framework of the SUNSTONE project. The website on the training programme is now online:

https://indico.sesame.org.jo/event/31/

Eman Khalifa encouraged the attendees to suggest colleagues from their universities and faculties who use (or develop) archaeometry analyses to visit SESAME and/or attend training at SESAME. This will lead to long-term effects, as the learning outcomes can be passed to students who are future archaeologists. In particular, the representatives from the Qubbet el-Hawa Research Project in Egypt raised large interest as this project has enough finds and requires material analysis, especially in the area of ceramics dating to Egypt's Late Old Kingdom.

Foster genuine interdisciplinary collaboration
This point was mainly raised by Asuman Lätzer-Lasar. She emphasized that it would be particularly important that natural scientists develop their own research questions and explore them within projects specifically focused on archaeological materials. This approach could lead to the development of new instruments or techniques that further advance research in this field. She also welcomed the opportunity to collaborate on joint funding proposals.
Under these conditions, as Asuman Lätzer-Lasar stated, is a clear and long-term potential for equitable, collaborative scientific projects that are designed on an equal footing across disciplines.

Various concrete tasks for future actions and projects emerged from the meeting:

Cooperation with Egyptian Museum of Cairo
Eid Mertah, Conservator of archaeological materials at the Egyptian Museum of Cairo, proposes a collaborative project at the Egyptian Museum, Cairo, focused on conducting a comprehensive investigation of selected Cartonnage pieces, including mummy Cartonnage and wooden coffins. This study will employ a portable laboratory and explores several key aspects, including the analysis of pigments, construction techniques, and material composition. Non-invasive imaging and analytical methods will be used to assess the current condition of the Cartonnage, determine whether the mummies remain inside, evaluate their preservation state, and identify any embedded amulets. The research aims to provide valuable insights into ancient Egyptian funerary practices and material technologies.
Additionally, the Museum is exploring the possibility of expanding the study by transferring select objects to SESAME in Jordan for more advanced analysis and further international collaboration in cultural heritage preservation (but further discussion needs to be done with the head of the supreme council and antiquities). As part of this project, they would also propose organizing training sessions for staff at the Ministry of Tourism and Antiquities to enhance their expertise in these analytical methods.

Cooperation on ancient materials / iron ore production
A follow-up activity to the SESAME meeting was proposed by Ernst Pernicka. He plans a collaboration with colleagues of the Yarmouk University on the continuation of the research on the beginnings of iron production in the Near East. For this purpose, one would need to employ the analytical methodology presented in Amman which is now published in the Journal of Archaeological Science.

This would comprise besides iron ore deposits in Jordan also the study with micro CT of the earliest iron objects found in Jordan.
Furthermore, it would be important to obtain more information on iron objects of the third and early second millennium, if they consist of meteoritic or terrestrial iron in order to shed more light on the beginnings of the pyrometallurgical production of iron.

Proposal for a material analysis of the Qumran scrolls from the Jordan Museum in Amman
As an outcome of Marcello Fidanzio's talk and after the visit of the Jordan Museum in Amman follow-up discussions took place on the Qumran scrolls hosted at the museum. Among the few dead sea scrolls on permanent exhibit in the Jordan Museum is the Qumran Copper Scroll, an extraordinary artifact that stands out among all Qumran discoveries. It is unique in being the only scroll made of nearly pure copper (99% copper, 1% tin), believed to date back to the 1st century CE. Material characterization of the copper is of particular interest, for instance to trace the material origins and provenance of the copper used through elemental and/or isotopic analyses.

Another opinion from conservation science point of view is shared by Maram Na'es in this regard.
The elemental composition of the copper scrolls, being 99% copper indicates their susceptibility for oxidation. The blue-green color visible on all parts of the scrolls is indeed an oxidized copper layer, i.e. a corrosion layer, which is built over time. Evidence of embrittlement of the scrolls and powdering causing metal disintegration nearby cracks is visible. This means, if the scrolls are to be moved out from their showcases to be studied, there is a high risk from losing the embrittled parts as well as accelerating the corrosion process due to change of the surrounding environmental conditions.
Risks from moving or transferring the scrolls, if at all needed, must be assessed and addressed beforehand, if seen safe, then the transfer should be done by a specialized conservator from the owner museum.

According to Taylor J. (2023)[3], in the 1990s the EDF research team has performed metallurgical studies, chemical analysis, and X-ray imagery on the copper scrolls and published the results. If elemental composition was already studied, a provenance study can start based on existing data, rather than risking the scrolls as described earlier. In the best scenario, a portable XRF analyser can be used in the same room where the scrolls are displayed after controlling the environmental conditions of the room. Furthermore, an isotopic analysis study will require an invasive sampling of the scrolls. If the Jordan museum has in its storage fragmentary pieces from the scrolls, those would be recommended to be used for such a study.

Further on-site analysis could be conducted to examine the script's morphology using mobile RTI and 3D microscopy systems, as well as to assess the object's corrosion state with a mobile micro-Raman spectrometer. The CSMC could serve as a potential partner by providing the necessary mobile equipment and experimental expertise.

If synchrotron-based X-ray analyses are proposed, awareness about light-induced damage of organic polymers is expected. Such damage will change the chemical and physical properties of Araldite which will change its performance as an adhesive.

Future plans from the Qubbet el-Hawa Research Project
Martin Bommas described QHRP's future plans in detail with the aim to work much more closely with SESAME starting from 2025/26 in the following areas:

- inscribed ceramic vessels including ink inscriptions. There are vessels from three unlooted tombs which reveal, for the first time, the funerary culture of the middle class in Aswan/ Elephantine/ Qubbet el-Hawa funerary culture dating to the reign of King Pepi II (ca. 2190 BCE). Any discoveries made by using the synchrotron radiation source SESAME can be prepared to

[3] Joan E. Taylor, 2023. 'The Copper Scroll: The Medium, the Context and the Archaeology.' Chapter 8 in The Dead Sea Scrolls in Ancient Media Culture, Edited by Travis B. Williams, Chris Keith, and Loren T. Stuckenbruck. doi:10.1163/9789004537804009

be compared with ink on papyri of the same period discovered and researched by Professor Lepper of the Egyptian Museum in Berlin. It was already agreed to open up the archive of ink analysis results in Berlin which is the biggest in the world. As it is expected that ink being produced in Elephantine before being applied at the cemetery of Qubbet el-Hawa, it is paramount to tuck into the Berlin database. Also, between the 1950-80s, research at Qubbet el-Hawa focused largely on ink inscriptions, however, without any scientific analysis ever attempted.

With regards to vessel inscriptions, the Qubbet el-Hawa corpus is the biggest known from Egypt. However, with the Lower Necropolis discovered by QHRP in 2016, the inscriptions add the missing link to scribal activities in the area more than 4000 years ago. Martin Bommas excavated on Elephantine Island as a field director between 1990 and 2009, thus being ideally suited to draw archaeological conclusions based on lab research carried out at SESAME (1 Year+)

- Vessel contents: Whenever QHRP discovers complete vessels which contain original content, the entire vessel without contamination is retrieved. However, traditional archaeological methods required the vessel to be emptied to allow for residue analysis. This method is destructive as it destroys the original stratigraphy of vessel contents. With the help of SESAME, one hopes to be able to "see through" vessel rims to be able to study the stratigraphy of contents of vessels that were used as tomb markers and/ or offering vessels in ancient Egyptian funerary rituals around 2200 BCE. In Egyptology, these non-destructive methods have never been applied as they are not available in Egypt (2 years+).
- QHRP would love to have Prof. Eman Khalifa trained at SESAME to carry out the research together with the team available on site.
- QHRP publishes field reports in JEA, Journal of Egyptian Archaeology, the oldest Egyptological journal, open access. A monographic series has been established with HeiUp (University Library Heidelberg) with the first volume on the tomb of Ij-en-shepes becoming its first publication in 2025 as part of the series ASWAN (Archaeology and Science in West Aswan and Nubia), open access/ html publishing. SEAS (Studies in Egyptian Archaeology and Science), the editor-in-chief of which is Martin Bommas, publishes papers that in equal measure discuss Egyptological content and natural sciences. We would love to fully publish the results achieved at SESAME in ASWAN, SEAS as local outlets and Archaeometry and Nature more globally (3 Years+)
- There are substantial challenges in getting monuments out of Egypt, to which extent SESAME in its function as an international organization can help. The SESAME management is already informed about it.
- On a more general level, Martin Bommas pointed out that he believes that major regional markets for SESAME are Turkey and Egypt. A reference/ editorial committee consisting or scientists and archaeologists would be suited to assess the quality of submissions within an international context. SESAME's current EU-funded project is ideally in place to bring such initiatives to fruition. In order to raise awareness, publications (of the workshop) and targeting conferences in Egypt/ Turkey can create platforms to encourage scholars currently not aware of the splendid research facility SESAME provides.

From Petra to PETRA IV – Heritage science across borders and scales

A joint project was proposed by Maram Na'es between PDTRA (Petra Development Tourism Regional Authority), SESAME, Humboldt University Berlin (Institute of Archaeology), and DESY for defining production technology of Nabataean Painted Fine Ware at the atomic level. The suggested duration is 3 years, including the training of a Jordanian scientist on synchrotron techniques used for cultural heritage research. The goal is to measure at SESAME and DESY, compare the results, obtain experimental skills at both synchrotrons, return to Jordan and spread the knowledge.

Maram Na'es also suggested to organize online workshops/seminars with the goal to highlight the use of synchrotron facilities for the service of cultural heritage materials, targeting conservation science and chemistry departments at Jordanian universities (once a month for 6 months). Moreover, it would be very beneficial to have SESAME host PhD student(s) in the field of heritage science collaboratively with a Jordanian university.

Outcomes and Takeaways

The workshop successfully highlighted the potential and growing role of SESAME in advancing research on ancient materials and artefacts in a culture heritage rich area. The meeting emphasized the need to foster international and interdisciplinary collaboration and to broaden awareness of the analytical capabilities at SESAME.

A major outcome of the event was the collective commitment to strengthen the networks and partnerships around SESAME. This includes establishing dedicated liaisons and contacts at SESAME and encouraging scientists from archaeological fields to get more familiar with the methods and techniques at SESAME. The workshop also underscored the importance of expanding training opportunities at SESAME for both regional and international researchers.

Moving forward, participants were encouraged to actively engage with SESAME's research infrastructure, contribute to methodological advancements, and streamline frameworks for international cooperation. With a shared vision for studying and preserving the region's rich cultural heritage, this event has set the stage for continued innovation and collaboration in the field.

Finally, a few concrete tasks for future actions and projects emerged from the meeting.

5. Acknowledgments

We would like to express our sincere gratitude to all speakers and participants for their valuable contributions at the workshop. The open, fruitful and constructive dialogue and discussions during the sessions were very much appreciated and many ideas for future collaborative projects and networking events emerged, ensuring that the momentum generated during this event continues to drive meaningful progress.

We would also like to thank the staff at SESAME for hosting this wonderful event and for providing all the required infrastructure. Many thanks go to Roa Al Natour from the SESAME user office for her dedicated planning of the entire logistics and for all travel arrangements. We also appreciate the hospitality at the Jordan Museum where the sessions on the second day took place.

Finally, we acknowledge the support of the Helmholtz Association within the IK-JOR-001 HESEB project and the financial support by the German Ministry BMBF within the framework of carrying out the observer role on behalf of the BMBF in the council of the SESAME research center in Jordan.

6. Agenda:

In cooperation with

Agenda: Bridging Natural Science and Heritage in the Middle East: German Institutions, Archaeology, Artefacts, and SESAME

Theme:
Promoting Cultural Heritage Studies in Art and Archaeology at the Synchrotron Radiation Source SESAME, Amman/Jordan

An initiative by the German research centers DESY and HZDR, members of the Helmholtz Association, in closest cooperation with SESAME.

This is a draft program and should not be widely distributed. Details are still subject to change.

Day 1: Tuesday, 3 December 2024 – all times are given in local times

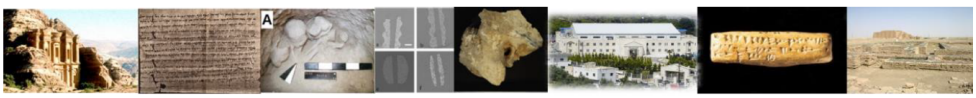
Location: SESAME, Allan, Jordan – Theater Room, SESAME Guesthouse

For online participation – please use the following webex dial-in:
Join directly from the meeting link:

https://sesame-synchrotron.webex.com/sesame-synchrotron/j.php?MTID=ma7f272556fb9cab061157447c72f6477

Webex meeting number (access code): 2370 707 1253
Webex meeting password: xqBJQs68NY3

- **08:30 – 09:30**: Transfer from Hotel Marriott in Amman to SESAME
- **09:30-10:00**: Registration
- **10:00 – 10:20**: Welcome / Opening Session
    - Rolf-Dieter Heuer (President SESAME Council) and Khaled Toukan (Director-General SESAME)
    - Goals of the Meeting – Andrea Lausi, SESAME and Frank Lehner, DESY
- **10:20 – 11:00**: SESAME and Synchrotron Radiation in Cultural Heritage Research
    - Overview of SESAME and opportunities in cultural heritage - Andrea Lausi, Scientific Director SESAME
    - The importance of synchrotron radiation in archaeology and cultural heritage studies of Southwest Asia: Why now? – Gonca Dardeniz, U Istanbul
- **11:00 – 11:30**: Coffee Break
- **11:30 – 13:00**: **Session 1**: Written Artefacts: Ideas, Projects, and Analytical Needs
    - *Accessing hidden text on papyri - Elephantine and beyond*: Contributions by
        - Verena Lepper, Heinz-Eberhard Mahnke (Egyptian Museum and Papyrus Collection, Berlin)
        - Eid Mertah (Egyptian Museum, Cairo)
    - *Early Islamic dipinti from archaeological contexts*
        - Hagit Nol (U Frankfurt)

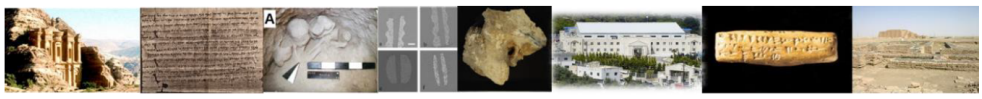


- *Digging up History: Archaeological Investigations at the Caves of the Dead Sea Scrolls by DAJ - EBAF - PAM - ASOR (1949 - 1956)*
  - Marcello Fidanzio (Swiss Italian University) – online

- **13:00 – 14:00** Lunch Break
- **14:00 – 15:00** **Session 2**: Written Artefacts: Ideas, Projects, and Analytical Needs II
  - *Understanding Written Artefacts with the CSMC Mobile Lab – Projects, Possibilities and Perspectives*
    - Joint presentation by Claudia Colini, Sebastian Bosch, Shervin Farridnejad (Center for the Study of Manuscript Cultures CSMC, Hamburg) – online
  - *Study of enclosed cuneiform tablets with mobile x-ray tomography*
    - Katrin Zerbe (DESY)
- **15:00 – 15:15** Short Coffee Break
- **15:15 – 17:15**: **Session 3**: Ceramics/Pottery and Paintings

  Ceramics, Pottery: Ideas, Projects, and Analytical Needs
  - *Petrography and XRD in pottery analysis*
    - Hussein M. Al-Sababha (Director, Jordanian Heritage Museum, Yarmouk University)
  - *Natural sciences and cultural heritage: some applications on ancient pottery*
    - Eman Khalifa (U Cairo)
  - *Tall Zira'a and (unresolved) archaeometric questions*
    - Patrick Leiverkus (Biblical-Archaeological Institute, U Wuppertal)

  Paintings:
  - *The use of synchrotron radiation for the characterization of Roman Wall paintings from Bayt Ras tomb*
    - Sahar al Khasawneh, Department of Conservation and Management of Cultural Resources, Yarmouk University
  - *Hellenistic-Roman wall painting in Jordan: Questions from archaeology on material analysis*
    - Brita Jansen (German Protestant Institute of Archaeology /GPIA Amman)
- **17:15 – 18:30**: SESAME Facility Tour
- **18:30** Departure to Restaurant Tilal Jalad, As-Salt
- **21:00** Back to Hotel / Guesthouse



Day 2: Wednesday, 4 December 2024

Location: Jordan Museum, Amman

For online participation please use the following zoom dial-in:

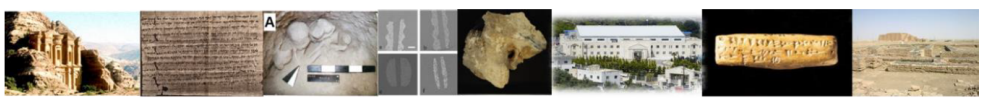
https://desy.zoom.us/j/63151263082

Meeting-ID: 631 5126 3082
Passcode: 244264

- **09:30 – 10:00**: Transfer from Marriott Hotel to Jordan Museum
- **10:00 – 10:15**: Opening Session
  - Welcome Remarks
- **10:15 – 11:30**: **Session 4**: Ideas, Projects, and Analytical Needs – Part III

  Ancient Metals: Ideas, Projects, and Analytical Needs
  - *Searching for the origins of iron technology*
    - Ernst Pernicka (Curt Engelhorn Center for Archaeometry) – in collaboration with M. Brauns, I. Stepanov

  Fossils, human remains: Ideas, Projects, and Analytical Needs
  - *Studying human evolution using synchrotron radiation and microCT*
    - Alexander Stoessel (University of Jena and Max Planck Institute for Evolutionary Anthropology)
  - *Key questions in human bioarchaeology addressed using synchrotron radiation approaches at SESAME*
    - Kirsi Lorentz (The Cyprus Institute)
- **11:30-12:00 Coffee break**
- **12:00 – 13:00**: **Session 5**: Ideas Excavation sites: Ideas, Projects, and Analytical Needs
  - *Exploring Tulul adh-Dhahab: Excavations, Discoveries, and Analytical Needs*
    - Asuman Lätzer-Lasar (U Marburg)
  - *Preservation of cultural heritage at the excavation site of Qubbet el-Hawa, Aswan/ Egypt*
    - Martin Bommas, (Qubbet el-Hawa Research Project QHRP)
  - Discussions
- **13:00 – 14:00**: Lunch Break
- **14:00 – 15:00: Visit / Tour Museum**
- **15:00 – 16:30**: **Session 6**: Forging Cooperation



***Key questions**: Discussions on concrete ideas and collaboration projects, including funding potentials; administrative frameworks for the transfer and handling of cultural objects during analytical characterization; best practices for applying for beamtime and analytical support at SESAME*

- *The Scientific infrastructure at LEIZA: past - present – future*
  - Roland Schwab (Leibniz Center for Archaeology LEIZA)
- *Building a Cooperation Network Germany – Jordan*
  - *Maram Na'es (TU Berlin)*
- *The EU Sunstone Project*
  - *Mariangela Cestelli Guidi (INFN)*

- **16:30** Wrap-Up and Conclusions
- **17:00** Transfer back to Hotel
- **18:00** Dinner Reem Al Bawadi Restaurant

Organizational Details

- **Accommodation**:
  - Amman Marriott Hotel
  - Issam Al Ajlouni Street
  - Shmeissani
  - Amman, Jordan, 11190
  - https://www.marriott.com/en-us/hotels/ammjr-amman-marriott-hotel/overview/?scid=f2ae0541-1279-4f24-b197-a979c79310b0

- **SESAME:**
  - Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME)
  - Next to Princess Rahma University College P.O. Box 7, Allan 19252, Jordan
  - https://www.sesame.org.jo/

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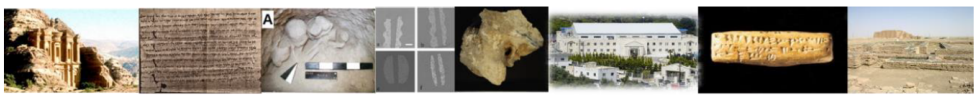

7. Participants and contributors:

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Sahar	Al Khasawneh	Yarmouk U
Zeina	Al Khashashneh	Petra National Trust
Firas	Al-Alawneh	The Hashemite University
Jihad	Al-Deiri	Head of Department Archaeology, Jordan University
Mustafa	Al-Naddaf	Faculty of Archaeology and Anthropology
Hussein M.	Al-Sababha	Yarmouk U
Maher	Attal	SESAME
Martin	Bommas	Director, Qubbet el-Hawa Research Project (QHRP)
Sebastian	Bosch	CSMC U Hamburg
Claudia	Bührig	DAI
Mariangela	Cestelli Guidi	INFN
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