

# On the way to E-RIHS.DE / Auf dem Weg zu E-RIHS.DE

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## Abstracts

Organized by Deutsches Archäologisches Institut (DAI)  
and Rathgen-Forschungslabor, Staatliche Museen zu  
Berlin – Preußischer Kulturbesitz (RF/SPK)



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## Scope

Since March 2016, the E-RIHS initiative (<http://www.e-rihs.eu>) has been included as a project in the ESFRI (European Strategy Forum on Research Infrastructures) roadmap. ESFRI roadmap projects have a compulsory preparatory phase. The approved application has a term from 01.02.2017 to 31.01.2020. German representatives are the German Archaeological Institute in conjunction with the Rathgen-Forschungslabor of the Staatliche Museen zu Berlin - Preußischer Kulturbesitz.

E-RIHS defines itself as: »E-RIHS supports research on heritage interpretation, preservation, documentation and management. It comprises: E-RIHS headquarters and national hubs, fixed and mobile national infrastructures of recognized excellence (FIXLAB & MOLAB), physically accessible collections / archives (ARCHLAB) and virtually accessible heritage data (DIGILAB).

The aim of this preparatory phase in Germany is, of course, to carry out the tasks assigned in the application. Much more, however, is the attempt to explore the possibilities of forming and structuring a community that supports E-RIHS with its activities in the medium to long term.

On the one hand, the meeting should provide information about E-RIHS, but on the other hand provide a first and in no way conclusive overview of the German stakeholders and key figures in the narrower range of scientific data that is reflective of human activities and derived from human and cultural artefacts.

## European Networks

### European – Research Infrastructure for Heritage Science (E-RIHS)

Dr. Luca Pezzati  
E-RIHS coordinator  
e-mail: luca.pezzati@cnr.it

Heritage is a key component of the European identity. The study and preservation of cultural and natural heritage is a global challenge for science and the European society at large. The European Research Infrastructure for Heritage Science (E-RIHS) supports research on heritage interpretation, preservation, documentation and management. State-of-the-art tools and services will be provided by cross-disciplinary groups of researchers to cross-disciplinary users and scientific communities working to advance knowledge about heritage and to devise innovative strategies for its preservation. E-RIHS connects researchers in the humanities and natural sciences and fosters a trans-disciplinary culture of exchange and cooperation. E-RIHS pursues the integration of European world-class facilities to create a cohesive entity playing a connecting role in the global community of heritage science.

Fragmentation, duplication of efforts, isolation of small research groups put at risk the competitive advantage of European heritage science research, spearheaded so well in the past by its unique cultural heritage. The long-term tradition of this field of research, the ability to combine science with innovation, and the support provided by EU-funded projects and integrating activities such as EU-ARTECH, CHARISMA and IPERION CH in conservation science, and ARIADNE in archaeology, represent the background of E-RIHS. E-RIHS exploits the synergy of the cooperation among the academy, research centres, museums and cultural institutions. Both the scientific and the socio-economic importance connected with heritage science are nowadays evident.

The research community has achieved the maturity necessary to make the leap towards a permanent European research infrastructure that will impact broadly on society and economy.

E-RIHS advanced services to the scientific community will be provided by coupling cutting-edge tools with human resources holding first-class capacities in both heritage diagnostics and data interpretation. E-RIHS will provide four types of access to its users: ARCHLAB – access to heritage archives and collections; DIGILAB– remote access to data and tools for heritage research; FIXLAB - access to large-scale facilities and advanced laboratories; MOLAB – collections of mobile instruments providing in-situ diagnostics.



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E-RIHS is a pan-European distributed infrastructure supported by 15 Member States plus Israel and participated by six more EU and associated countries. E-RIHS star-design structure has its Central Hub and headquarters in Florence (IT) and comprises National Hubs – possibly organized in Regional Hubs in some countries – encompassing specialized knowledge, fixed and mobile national facilities of recognized excellence, physically accessible collections/archives and remotely accessible heritage data.

The global lead that the EU holds in this research field, supported today by an unstable combination of national and EU measures, requires a joint and resolved effort. The potential global role of E-RIHS is under discussion within the GSO, Group of Senior Officials on Global Research Infrastructures, since 2014.

International initiatives are carried on for connecting and including partners and facilities outside EU, in cooperation with the intergovernmental organization ICCROM ([www.iccrom.org](http://www.iccrom.org)).

E-RIHS is in its preparatory phase until January 2020 under the project E-RIHS PP. E-RIHS is expected to deliver all documents necessary to start the ERIC application in springtime 2019. E-RIHS ERIC will hopefully be launched in 2021.

## The European network IPERION-CH shortly presented

PD Dr. Heike Stege  
Doerner Institut  
e-mail: heike.stege@doernerinstitut.de

IPERION CH (Integrated Platform for the European Infrastructure Research ON Culture Heritage) is a European network that brings together 24 national institutions from various European countries and the Getty Institute in the US as an associate partner with recognized excellence in the field of interdisciplinary cultural heritage research. The project was approved as part of the EU call Horizon 2020 INFRAIA-1-2014 / 2015 "Integrating and opening existing national and regional research infrastructures of European interest".

The program aims to establish a permanent research infrastructure (RI) with sustainable, robust and long-term planning. The integrated institutions use a wide range of high-tech tools, scientific methods and databases to promote knowledge and innovation in the preservation of cultural heritage. IPERION CH connects researchers from the humanities and natural sciences and promotes the transdisciplinary exchange of science that serves to collaborate throughout the European Research Area (ERA).

The IPERION CH program thus creates a stable integration of European world-class institutions and resources in cultural heritage research.

Three German institutions are involved in the network: the Doerner Institut, the Rathgen-Forschungsinstitut as a scientific institution of the Staatliche Museen zu Berlin-Preußischer Kulturbesitz and the Rheinisch-Westfälische Technische Hochschule Aachen. They strive for active participation in this European initiative, the transfer of knowledge at national and European level.

## German contribution on E-RIHS PP

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Dr. Wolfgang Schmidle  
Deutsches Archäologisches Institut  
e-mail: wolfgang.schmidle@uni-koeln.de

Prof. Dr. Reinhard Förtsch  
Deutsches Archäologisches Institut  
e-mail: reinhard.foertsch@dainst.de

Dr. Ina Reiche  
Rathgen-Forschungslabor, Staatliche Museen zu Berlin – Preußischer Kulturbesitz  
e-mail: i.reiche@smb.spk-berlin.de

E-RIHS PP is corresponding to the preparation of E-RIHS, the European Research Infrastructure for Heritage Science (HS). E-RIHS will help the preservation of the World's Heritage by enabling cutting-edge research in HS, liaising with governments and heritage institutions to promote its constant development and, finally, raising the appreciation of the large public for cultural and natural heritage and the recognition of its historic, social and economic significance. The Deutsche Archäologische Institut (German Archaeological Institute, DAI) is, together with the Stiftung Preußischer Kulturbesitz (Prussian heritage foundation, SPK) as a third party, member of the European program consortium. Specific project objectives of E-RIHS PP are directed towards strategic challenges in setting up the E-RIHS, considering the requirements for its successful implementation, and following the recommendations of the ESFRI reviewers. Among others, E-RIHS PP will define common data policies and procedures for data management. DAI (and SPK) will especially take part in this objective by leading a task "Standardization and interoperability". The task addresses a core objective of E-RIHS, the construction of a pan-European access called DIGILAB. DIGILAB will consist of distributed cloud-based repositories and will provide access to research information as well as high-quality services for working with the data. This requires that results, both raw and processed data, are obtained on well-defined, common and standardized procedures and are stored in a way enabling their interoperability.



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## Current German Networks

### Archäometrienetzwerk Berlin / Brandenburg (ANBB)

Dr. phil. Christin Keller M.A.  
Freie Universität Berlin  
e-mail: keller82@zedat.fu-berlin.de

The ArchäometrieNetzwerk Berlin-Brandenburg was founded in 2015 under the umbrella of the Berliner-Antike-Kolleg. The network unites more than 20 institutions and laboratories of various disciplines of Natural Sciences and Conservation and Restoration Sciences. Our members operate in university and extramural research. In addition to the universities and colleges, also renowned museums and research institutions are belonging to the network: Such as the Rathgen Research Laboratory of the Staatliche Museen zu Berlin and the German Archaeological Institute. Furthermore various private companies are counting to our members. Recently we notice a growing interest of our archaeological working colleagues in the ArchäometrieNetzwerk Berlin-Brandenburg, hence we are pleased to a steadily increasing number of following researchers.

The network promotes the interdisciplinary dialogue to prepare the ground for the implementation of innovative research projects and cooperations. The scientific landscape of Berlin-Brandenburg with its high density of various research facilities offers an outstanding environment for the development of new ideas and research structures.



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## **Gesellschaft Deutscher Chemiker e.V. – Fachgruppe Analytische Chemie – Arbeitskreis Archäometrie**

Dr. Stefan Röhrs

Rathgen-Forschungslabor, Staatliche Museen zu Berlin, Stiftung Preußischer Kulturbesitz,  
Vice chairman of the Arbeitskreis Archäometrie  
e-mail: s.roehrs@smb.spk-berlin.de

The Arbeitskreis Archäometrie (Research Group Archaeometry) is an association of individuals from humanities, natural sciences, engineering sciences and conservation, who are interested in the study of cultural heritage objects and monuments out of academic interest or for preservation and restoration. The working group is part of the Fachgruppe Analytische Chemie (Section Analytical Chemistry) of the Gesellschaft Deutscher Chemiker (GDCh, German Chemical Society).

The Arbeitskreis Archäometrie seeks to deepen the trans-disciplinary understanding, to promote contacts and exchange of experiences among the members, to arrange partnerships for the trans-disciplinary cooperation and to inform about activities in the field of activity of the research group.

Together with other associations from the natural sciences, the annual conferences on the subject of Archäometrie und Denkmalpflege (Archaeometry and Preservation of Historic Monuments) are organized at an 18-month interval and their program is peer-reviewed. Furthermore, project groups and workshops on specific topics are part of the activities of the working group. More recently, the focus has been on investigating the photosensitivity of objects through the micro-fading test. In the near future, the work will be continued by a workshop on the interpretation of data from hand-held X-ray fluorescence devices.

## **Gesellschaft für Naturwissenschaftliche Archäologie ARCHAEOMETRIE e.V. (GNAA)**

Prof. Dr. Ernst Pernicka

CEZA, IPERION-CC Advisory board, Vorsitzender der Gesellschaft Naturwissenschaftliche Archäologie und Archäometrie, GNAA

e-mail: ernst.pernicka@cez-archaeometrie.de

The Gesellschaft für Naturwissenschaftliche Archäologie ARCHAEOMETRIE e.V. (Society for Natural Archeology ARCHAEOMETRIE e.V.) seeks the interdisciplinary dialogue between researchers interested in the development and application of scientific methods to study cultural history objects with the aim to contribute to the solution of archaeological, art historical and monument preservation issues. For this purpose, the society organizes specialist conferences, publishes scientific texts and provides relevant information, e.g. by distributing the "Archäometrisches Nachrichtenblatt" twice a year with relevant information on teaching and research as well as on conferences. The Society is also co-editor of the international journal Archaeometry that can be obtained by members of the society at a reduced price. It promotes the cooperation of institutions of similar goals and pursues a relevant public relations work. The society is the contact point for research funding institutions, publishers, other professional societies, foreign partners and academic questions. It is open for all those, who are committed to modern science-based archaeology (archaeometry) and promotes especially students.



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## **KultSam: Cultural historic collections as a digital repository for research, teaching, and public mediation**

Prof. Dr. Bernhard Graf

Institut für Museumsforschung, Staatlichen Museen zu Berlin – Preußischer Kulturbesitz  
e-mail: b.graf@smb.spk-berlin.de

Dr. Britta Horstmann

Leibniz-Gemeinschaft

e-mail: horstmann@leibniz-gemeinschaft.de

KultSam focuses on the development, installation and operation of an inter- and trans-disciplinary virtual research environment for the study of human material culture and the knowledge stored in such objects. Utilizing a wide range of methods, effective tools and information services will be developed and provided, thus supporting both individual and collaborative cutting-edge research in social and cultural sciences as well as the digitization, preservation and crosslinking of collection based knowledge for a variety of different users.

## Important German initiatives and institutions

### Department of Natural Sciences at the DAI

Dr. Julia Gresky  
Deutsches Archäologisches Institut - Zentrale  
Referat Naturwissenschaften, prähistorische Anthropologie  
e-mail: julia.gresky@dainst.de

The Department of Natural Sciences at the DAI comprises four different disciplines: archaeozoology, archaeobotany, dendrochronology, and anthropology. Many excavations from all across the world have provided various data types, including documentation and large collections of samples, which are of great scientific value.

Whereas, for example, the data from archaeobotanical research has culminated in several books and has also been made available as an online database of The Digital Plant Atlas, solutions for the storage of, and access to, anthropological data are still needed. In this case, the aim is not just the storage of acquired data but, in particular, the subsequent processing with the use of various scientific techniques (e.g. computer tomography). This should provide a basis for the combination of anthropological data with other archaeological and biological data from different sites to build an overall picture of ancient people within their environment. Another important aim is the establishment of methods which might aid in further investigations in anthropology, e.g. in the improvement of identification of heavily fragmented human remains or the assessment of age at death. For this, the interaction of large collections of human remains, the accessibility of computer tomography and the programming of a recognition tool is needed.

## Rathgen Research Laboratory at the Stiftung Preußischer Kulturbesitz (SPK)

Dr. habil. Ina Reiche, director

Rathgen Forschungslabor, Staatliche Museen zu Berlin-Stiftung Preußischer Kulturbesitz

e-mail: i.reiche@smb.spk-berlin.de

At the Rathgen-Forschungslabor, Staatliche Museen zu Berlin-Preußischer Kulturbesitz (SMB-SPK), chemists, physicists, biologists and conservation scientists work collaboratively on interdisciplinary projects in the field of cultural heritage research. Our overarching objective is to understand and preserve our cultural heritage as a limitless resource of knowledge. The Rathgen-Forschungslabor seeks to meaningfully contribute to this vision. It carries out investigations on a broad variety of materials within the museum collections and focuses its research on scientific issues related to art and archaeological objects in close cooperation with curators, archaeologists, conservation scientists and conservators. It carries forward the tradition of the world's oldest scientific museum laboratory, the Chemical Laboratory of the Royal Museums in Berlin, which was founded on April 1<sup>st</sup>, 1888 and bears today the name of its first director, Friedrich Rathgen.

Thanks to the many competencies at the disposal of the Rathgen-Forschungslabor, the institute has always been well-connected to both national and international research networks. Some noteworthy collaborations include the recently established Archäometrie-Netzwerk Berlin-Brandenburg of the Berliner Antike Kolleg, the Forschungsallianz Kulturerbe (together with the Leibniz-Gesellschaft and the Fraunhofer-Institut), and the Europäische Infrastruktur IPERION-CH (2015-19). The Rathgen-Forschungslabor also makes its expertise available to international bodies such as ICOMOS, ICOM-CC and ICCROM.

# Neutron Imaging and Prompt Gamma Activation Analysis for Cultural Heritage at MLZ

Dr. rer. nat. Burkhard Schillinger  
Heinz Maier-Leibnitz Institut (MLZ), Technische Universität München, FRM II  
e-mail: burkhard.schillinger@tum.de

Technische Universität (TU) München runs the research reactor FRM II, which is scientifically operated by the Maier-Leibnitz Institut (MLZ), a cooperation of TU München, Forschungszentrum Jülich and Helmholtz-Zentrum Geesthacht. The MLZ offers a unique suite of high-performance neutron scattering instruments, which enables state-of-the-art research using neutrons in diverse fields as physics, chemistry, biology, earth sciences, engineering, cultural heritage or material science.

Scientific beam time is free if results are published. Proposal rounds are held twice a year, proposals are evaluated by an external scientific committee, solely based on scientific merit.

To cultural heritage research the three Instruments below have most frequently contributed to:

- The cold neutron Imaging Facility **ANTARES**
- The fast fission neutron Imaging Facility **NECTAR**
- The Prompt Gamma Activation Analysis Facility **PGAA**

Other methods used include neutron powder diffraction, small angle neutron scattering and stress and strain measurements.

## Neutron Imaging

Neutrons interact solely with the nuclei of atoms, not with the electron shell. Interaction depends on the internal structure of nuclei (absorption, incoherent scattering), or their arrangement into crystal lattices (coherent scattering), so their interaction is fundamentally different compared to X-rays.

Hydrogen delivers huge contrast by equal-mass scattering, lead and most metals are rather transparent, while many light elements deliver significant contrast. Often, contrast differs between neighboring elements in the periodic system, and even between isotopes of the same element.

Neutrons can penetrate metal casings (like relics) and reveal organic substances (bones, plant seeds) contained within, they show clear contrast between fossilized bones and chalk beds or

even ferrous red beds that cannot be penetrated with X-rays, even allow distinction of enamel and dentine in hominid teeth where even synchrotron radiation fails, depending on the mineral exchange during the fossilization process. Cold neutrons (**ANTARES**) can even reveal Bragg edges in transmission through metals, and thus reveal different metal phases in medieval weapons that allow inference about the smithing technique. Fast fission neutrons (**NECTAR**) can penetrate huge blocks of fossils and were recently used for huge fossilized dinosaur skulls.

### **Prompt Gamma Activation Analysis (PGAA)**

Almost all elements absorb neutrons. A nucleus absorbing a neutron achieves an excited state, which relaxes with the emission of a cascade of gamma quanta. These cascades are characteristic for each nucleus and allow analyzing the elemental composition of a sample after the de-excitation (PGAA). Certain isotopes become radioactive, and emit characteristic gamma quanta again, which also can be used for elemental analysis (neutron activation analysis, NAA). In PGAA at MLZ, a sample is exposed to a cold neutron beam, and two high-purity germanium detectors placed in 90° to the neutron beam detect the released gamma radiation of the sample. Elements can be detected in a wide range of concentration – major components are detectable as well as trace elements down to ppm or less.

This non-destructive method is particularly useful for various materials and for the applications in cultural heritage research, such as chlorine content of iron (conservation-restoration research), provenance studies of e.g. pottery and stone materials, composition of coins, beads or pigments in paintings and much more.

At MLZ, NAA and PGAA can be combined to increase the number of detectable elements. It is also possible to get a spatially resolved map of the elemental composition (prompt gamma activation imaging, PGAI) or a concentration depth profile of certain elements of near surface layers (neutron depth profiling, NDP).

A variation of this method is standard activation analysis, where samples are analyzed offline after irradiation, detecting radioactive isotopes with longer lifetimes.

## Curt-Engelhorn-Zentrum Archäometrie gGmbH (CEZA)

PD Dr. rer. nat. Roland Schwab  
Curt-Engelhorn-Zentrum Archäometrie gGmbH  
e-mail: roland.schwab@cez-archaeometrie.de

The Curt-Engelhorn-Centre Archaeometry (CEZA) in Mannheim (Germany) is a nationally and internationally operating research institute in the field of science-based studies of cultural heritage. Founded in 2004, the institute comprises the Laboratory for Material Analysis and the Klaus-Tschira-Archaeometry-Centre for physical dating methods. The former is mainly based on various methods for microscopy, major and trace element analysis as well as isotope analysis with various types of mass spectrometers. The latter is based on an accelerator for AMS radiocarbon dating, various techniques for luminescence dating and dendrochronological dating. The research focuses on production technologies and provenance of cultural heritage objects of inorganic materials, as well as subsistence and mobility of humans and animals. We provide radiocarbon dating by AMS, dendrochronology and luminescence methods. The material characterization and determination of the origins of inorganic materials like metals, glass or ceramics are performed by analyses of chemical and isotopic compositions, whereas classical anthropology and isotope systematics are used to reconstruct age, sex, health status; food and mobility of humans and animals. Besides its research activities CEZA also provides services for contact research in the field of archaeology and the history of art as well as for authenticity investigations.

## The Competence Center Archaeometry – Baden Wuerttemberg (CCA-BW) at the University of Tübingen

Dr. Christoph Berthold

Universität Tübingen, Mathematisch-Naturwissenschaftliche Fakultät

e-mail: christoph.berthold@uni-tuebingen.de

In October 2016 the „Competence Center Archaeometry - Baden-Wuerttemberg (CCA-BW)“ has been established at the University of Tübingen. It is jointly sponsored by the Baden-Wuerttemberg Ministry of Science, Research, and Arts, the Helmut Fischer GmbH Institut für Elektronik und Messtechnik and the University of Tübingen funding from the government's Excellence Initiative. The CCA-BW is interdisciplinary and will strengthen the position of Archaeometry not only among Tübingen's established archaeological disciplines but also nationally and internationally. Additionally the CCA-BW built bridges within Mineralogy, Physics and Chemistry at the university of Tübingen and joint institutions and enterprises.

The center aims to use its broad range of stationary and mobile analytical methods, such as local highly resolved X-ray analytics, vibrational spectroscopy (Raman, IR, ..), optical methods (3D-Videomicroscopy, Laserscanningmicroscopy, ...) not only for questions of material culture, “chaine opératoire” in ancient times and cultural heritage preservation but also for current materials science questions, such as industrial process control, development of materials, and damage analysis.

Together with its industrial partner, Helmut Fischer GmbH Institut für Elektronik und Messtechnik, the CCA-BW is developing a mobile high-resolution, non-destructive, multi-method analysis unit, which will enable archaeologists to carry out key analyses on the spot especially during excavations at remote places, but also in collections and at historic and prehistoric monuments which cannot be moved.

A brief overview of possible contributions of the CCA-BW to FIXLAB and MOLAB will be given in the presentation.



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