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Partner organisations

The LBI ArchPro is based on an international partnership formed by the following partners:

- LBG - Ludwig Boltzmann Gesellschaft (A)
- ZAMG - Central Institute for Meteorology and Geodynamics (A)
- Uni Vienna - University of Vienna (A) - Vienna Institute for Archaeological Science (VIAS) and Institute for Prehistoric and Historical Archaeology (UHA)
- TU Vienna - University of Technology Vienna (A) - Institute for Computer Graphics and Algorithms (ICG) and the Institute for Photogrammetry and Remote Sensing (IPF)
- NoeL - Province of Lower Austria (A)
- ÖAW - Austrian Academy of Sciences (A) - Institute for the Study of Ancient Culture (IKAnt) and Institute for Oriental and European Archaeology (OREA)
- Austrian Archaeological Institute (ÖAI)
- 7reasons - 7reasons Medien GmbH (A)
- Airborne Technologies (A)
- RGZM - Römisch Germanisches Zentralmuseum Mainz (D)
- NIKU - Norsk Institut for Kulturminneforskning (N) - The Norwegian Institute for Cultural Heritage - Archaeology Department
- Vfk - Vestfold fylkeskommune (N)

- Swedish National Historical Museums (SHMM) - Arkeologerna (S)
- University of Birmingham (GB)

LBI ArchPro Board and Scientific Advisory Board

The LBI ArchPro Board consists of the following members:

- LBG: Claudia Lingner, Jürgen Busch
- NoeL: Franz Humer, Eduard Pollhammer
- Uni Vienna: Gerhard Trnka, Timothy Taylor
- TU Vienna: Norbert Pfeifer, Werner Purgathofer
- ZAMG: Sirri Seren, Michael Staudinger
- OeAW: Barbara Horejs, Andreas Pülz,
- OeAI: Sabine Ladstätter, Martin Steskal
- Treasons: Michael Klein, Günther Weinlinger
- ABT: Wolfgang Grumeth, Benjamin Kabelik
- RGZM: Falko Daim, Detlef Gronenborn
- NIKU: Carsten Paludan-Müller, Knut Paasche
- Vfk: Terje Gansum, Arild Braa Norli
- SHMM: Christina Klotblix, Kent Andersson
- University of Birmingham: Henry Chapman, Paul Garwood

The Scientific Advisory Board of the LBI ArchPro consists of the following members:

- **Prof. Maurizio Forte**, University of California, Merced, USA
- **Prof. Kay Kohlmeyer**, Hochschule für Technik und Wirtschaft (HTW) Berlin, Germany
- **Prof. Julian Richards**, University of York, UK
- **Prof. Joakim Goldhahn**, Linnaeus University, Sweden
- **Prof. Patrick Ryan Williams**, The Field Museum of Natural History & University of Illinois at Chicago, USA

1 Overview

1.1 Motivation and mission

Considering the massive threat of destruction and deterioration of buried cultural heritage and the need for efficient and reliable methods for its identification, documentation and interpretation, large-scale application of non-invasive archaeological prospection methods offer a great potential. Archaeological prospection presents the most appropriate solution in order to provide archaeologists and planning authorities with the necessary spatial information for the protection and possible investigation of threatened heritage at the appropriate scales: the archaeological site as well as the surrounding archaeological landscape.

Considering the state-of-the-art and the future demands for non-invasive professional archaeological prospection, a consortium of European research institutes, heritage boards, public bodies and small and medium enterprises supported by the Ludwig Boltzmann Gesellschaft (<http://www.lbg.ac.at>) established in 2010 the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology (LBI ArchPro).

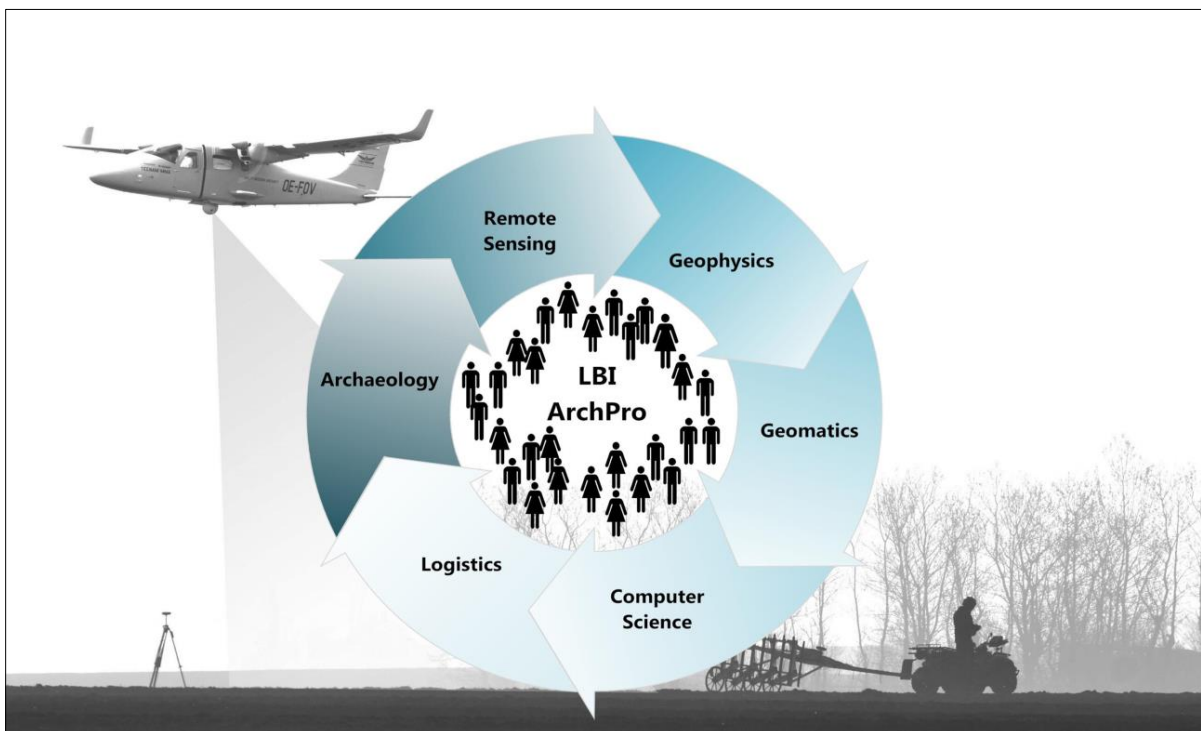


Figure 1: Overview of the LBI ArchPro and its multidisciplinary outline.

The LBI ArchPro (<http://archpro.lbg.ac.at>) is an innovative research centre for the development and large-scale application of advanced non-destructive archaeological prospection methods. It combines latest remote sensing methods, modern high-resolution near-surface geophysics, sophisticated computer science, geomatics and archaeology. It is dedicated to the development of new and highly efficient technologies and methodologies for non-destructive data capturing, data processing, data visualization in virtual reality, and the general advancement of the underlying theory and methodology

of archaeological prospection. An important aim is the public dissemination of new technological developments and generated scientific results obtained within the exemplarily conducted international large-scale archaeological prospection case studies, for the scientific community as well as for the interested general public.

Mission statement:

The Mission of the LBI-ArchPro is to introduce innovative archaeological prospection and digital documentation methods into archaeological research as well as rescue and exploration archaeology. The main motivation lies in the societal necessity to develop efficient means for the reliable identification, documentation and interpretation of archaeological heritage. The large-scale application of non-invasive high-resolution archaeological prospection methods and the exploration of 3D and 4D data sets by means of digital archaeology are seen to be the most appropriate solutions for future archaeology. In addition, an important goal is the broad dissemination of the LBI ArchPro capabilities and approach in order to raise the awareness for the significance of non-invasive investigations and preservation of archaeological heritage.

1.2 Infrastructure

In 2016 38 Förster gradiometer probes were tested for quality control and nine probes were sent for service. Subsequently, the three motorized magnetometer systems were re-equipped with the tested probes. Two light-weight, easy to assemble, manually operable magnetometer carts were designed and constructed for surveys with up to four gradiometer probes.

All motorized magnetometer and GPR systems (MIRA 1 and 2 as well as SPIDAR) have been equipped with dedicated service boxes containing service tools, spare parts and consumables for efficient fieldwork routines.

A novel shielded 80 MHz GroundExplorer (GX) GPR antenna system from MALÅ Geoscience has been successfully tested at Heldenplatz in Vienna. This survey resulted in LBI ArchPro partner ZAMG acquiring an 80 MHz and 160 MHz GX antenna system.

An additional motorized 16-channel MIRA system was assembled on behalf of LBI ArchPro partner NIKU for large-scale high-resolution archaeological prospection pilot studies and research surveys in Norway.



Figure 7: MIRA ground penetrating radar array placed on top of a data visualisation.

Together with partner Uni Vienna a novel 4 channel sub-bottom profiler was successfully tested and purchased to be used for underwater prospection (compare 3.3).

1.3 Highlights 2016

In March 2016 the exhibition "Stonehenge – A Hidden Landscape" on the LBI ArchPro Stonehenge Hidden Landscape Project was opened at MAMUZ Museum Mistelbach in Lower Austria. In this exhibition, curated by Wolfgang Neubauer and Julian Richards, original finds are on display, which have never before left the British Isles. Gigantic stone models in original size can be touched, as well as smaller original stones, and digital animations of the surrounding landscape present the results of the Stonehenge Hidden Landscape Project. The even older circular enclosures of the Weinviertel, the Kreisgrabenanlagen from Hornsburg/Kreuttal, are presented in comparison to the well-known Stonehenge monument. The exhibition attracted over 88.000 visitors in 2016 and was prolonged for another season due to the success.

<http://www.mamuz.at/de/das-museum/museum-mistelbach/ausstellungen-museum-mistelbach/3-stonehenge-verborgene-landschaft>



Figure 8: View on the upper floor of the Stonehenge exhibition at MAMUZ Mistelbach.

2 Evaluation of the LBI ArchPro

After the first six-year funding period, the LBI ArchPro was obliged to undergo an evaluation process in November 2016. A comprehensive evaluation report has been compiled and submitted, providing an overview of the current research, work and results, as well as an outlook on the proposed future research programme. Furthermore, a continuation concept has been comprised describing a proposed future development of the LBI ArchPro.

The evaluation panel consisted of the following scientists:

- Dr. David Griffiths, Oxford University, United Kingdom,
- Dr. Michael L. Hargrave, US Army Corps of Engineers, Champaign, IL, USA,
- Prof. Franco Niccolucci, University of Florence, Italy and
- Bettina Zirpel, DFG (German Research Foundation), Bonn, Germany (reporter).

The evaluation lasted for two days (November 22nd and 23rd 2016) and took place at the MAMUZ Museum Mistelbach and within the premises of the LBI ArchPro at Langenzersdorf.

The exceptionally positive outcome of the evaluation process and encouraging comments made by the evaluation panel are compiled below. Prof. Franco Niccolucci honoured the institute and its members by stating during his visit, that the LBI ArchPro would have been a place where he would have loved to work as a young scientist.

- *“Overall, the LBI ArchPro has been exceptionally productive and has developed very well during the last seven years.”*
- *“... the scientific quality of the research programme is exceptional and outstanding.”*
- *“The research programme is very important, well-defined, well-integrated timely and ambitious.”*
- *“The research carried out by the LBI ArchPro is very impressive.”*
- *“The LBI-ArchPro carried out top-notch, innovative research which has an important impact on the scientific field”*
- *“The strategic partners of the LBI ArchPro benefit tremendously from the work carried out by and in cooperation with the LBI-ArchPro.”* The benefits of the LBI ArchPro partners, as recognized by the evaluation panel, are: (1) Access to an internationally unique pool of technology and expertise, (2) research and testing in the framework of large-scale archaeological case studies, (3) training of staff and (4) visibility.
- *“The principal investigators exhibit impressively high levels of technical and interpretative expertise”*

- *“Overall, the site review revealed a very good working atmosphere and a well-managed organization. The collaborative culture and work environment at the LBI is good.”*
- *“LBI-ArchPro carried out archaeo-prospection fieldwork at a resolution (i.e., data density) and geospatial scale that is internationally unprecedented.”*
- *“The review panel are united in looking forward with confidence and high expectation to the next stage of development and activity by LBI-ArchPro.”*

3 Research topics and results

3.1 Integrated interpretation

3.1.1 GIS based data integration and data fusion

Development of a toolbox for archaeological image fusion - TAIFU

Since the fusion of archaeological prospection data images harbours a yet untapped potential for truly integrated analysis of different archaeological prospection data sets, a dedicated MATLAB toolbox called TAIFU (Toolbox for Archaeological Image Fusion) has been created during 2015. TAIFU serves as a platform for the testing of well-established and state-of-the-art image fusion methods and facilitates the development of new data integration routines. This toolbox is designed in such a way to benefit archaeological interpretative mapping of a diverse range of prospection data sets.

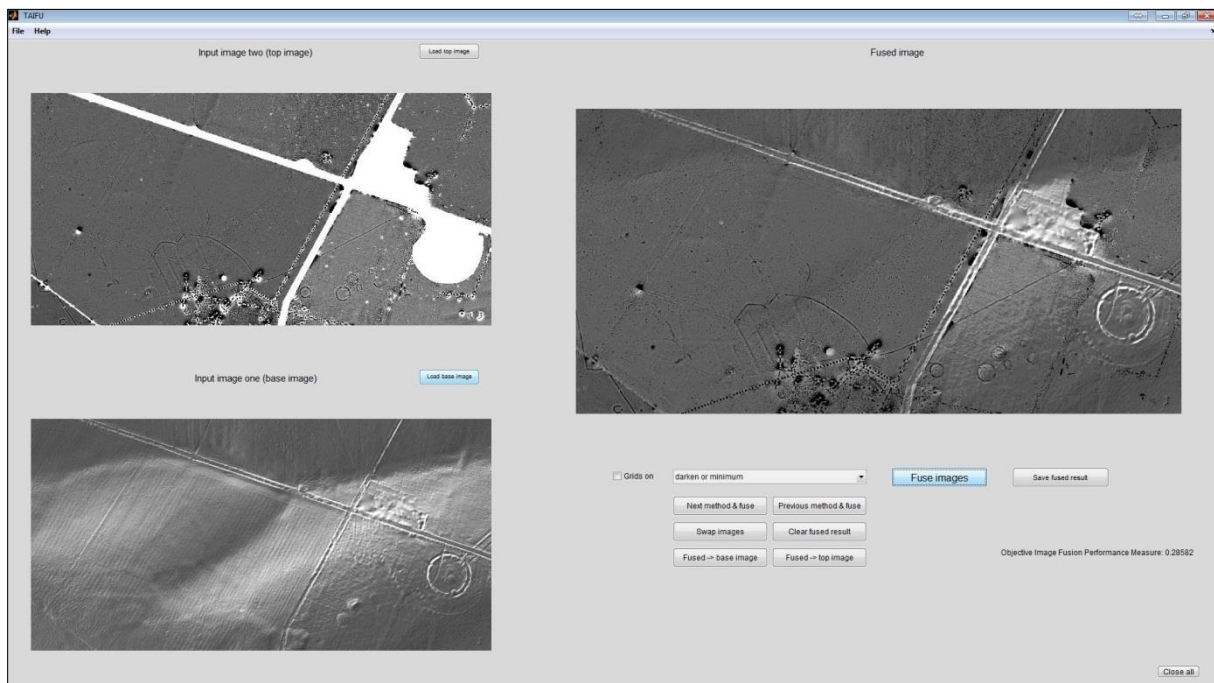


Figure 9: Screenshot of the fusion tool TAIFU with two input images (left) and fused version (right).

For example, the an archaeological prospection magnetogram can be fused with an aerial image or digital terrain model in order to permit the correlation of features contained in the data sets for enhanced information extraction and more reliable interpretations of the buried cultural heritage. In 2016, TAIFU has been further developed and enhanced in several aspects:

- Several pansharpning algorithms were added (normal HIS, adaptive HIS, PCA, wavelet-based and Brovery pansharpning) and explanations for the pansharpning algorithms were included.
- Various functions were reprogrammed and new blending modes were added.
- When two georeferenced files are loaded (be it GeoTIFFs, TIFFs or JPGs with accompanying *.tfw and *.jpw world files or FLT files with *.hdr header files), TAIFU will automatically crop

these images to their overlapping parts and execute the fusion only on this crop. Since TAIFU does not interpret different Coordinate Reference Systems (CRSs), the image files are expected to be in the same CRS.

- In addition, importing geomagnetic data as floating point rasters can also accept percentiles to set the data clipping values. Besides the standard [-4, +6] nT, TAIFU offers now by default the [0.02, 0.98] percentiles display range. When manually defining the clipping values, both percentiles and nT values can be mixed.
- A new version of TAIFU (version 0.3) was compiled and a new logo was created.

In the spring of 2016 a TAIFU workshop was organized for the LBI ArchPro staff. During that workshop the team members were made familiar with the aims of TAIFU, its functionality and its use.

Relevant lectures and publications:

- Verhoeven, G.; Nowak, M.; Nowak, R. (2016): Pixel-level image fusion for archaeological interpretative mapping. In: ARQUEOLÓGICA 2.0 - 8th International Congress on Archaeology, Computer Graphics, Cultural Heritage and Innovation. Advanced 3D Documentation, Modelling and Reconstruction of Cultural Heritage, Monuments and Sites. Valencia, Spain, 05.-07.-09.2016, 404-407.

3.1.2 Development of interpretation workflows and tools

Classification of GPR data

Horizontal GPR depth-slices have been subject of investigation and it has been shown that linear features like walls, dams, utility lines can be easily classified on each slice and subsequently connected to a three dimensional data set. Including also vertical depth slices to the horizontal data cube leads to a tremendous increase in classification accuracy especially for elongated features like walls and utility lines. One important requirement is, that the longitudinal feature lies perpendicular to the classified image plane (in terms of a 3D data cube). This can be achieved while introducing a virtual classification plane which is rotated towards the perpendicular strike direction of the object which is going to be classified. The existing rulesets are modified to utilize them on horizontal and vertical depth slice. Object reshaping has to be developed from the scratch. Up to now the classification suffers of the poor stability and therefore a lot of parameters of to be adjusted.

3.2 Virtual archaeology

Project TED - A Puzzle in 4D

The archaeological discipline has seen major changes in the past, most notably developments in information technology have caused a shift from analogue to digitally-born data. As a result, the TED archive at OREA contains a huge and heterogeneous resource of digital and non-digital photographs, plans, drawings, written documentation and the archive of Minoan wall painting fragments. The development of a standardized digitization workflow to provide a digital dataset of TED excavation record was carried out based on a selected subset of the complete excavation record focusing on a selected area.

The documentation of an archaeological excavation results in a set of recorded and analysed entities such as layers, walls, finds, samples etc. and their 3D geospatial position and extensions, topological (superposition) and temporal relations. For the management and analysis of geospatial information the use of Geographical Information Systems (GIS) has become state-of-the-art. According to stratigraphic principles, superposition (above or below) define the temporal relations, adding the 4th dimension to the three-dimensional spatial entities – time. Digital stratigraphic sequencing tools order archaeological entities in their relative position through time. A standard GIS extended by analysis and stratigraphic sequencing tools was therefore designed and implemented as a powerful tool to combine and analyse different datasets in space and time. Current sequencing systems are based on a simple time model (earlier, later, contemporary) and do not allow allocation of spatially unrelated entities to respective time intervals like periods or phases. To solve this general problem a system developed allows an integrated 4D stratigraphic approach which combines spatial relations with time-interval mathematics based on the Allen relations. As current GIS software is only capable to handle 2.5D data the system is extended for full 3D visualization and analysis.

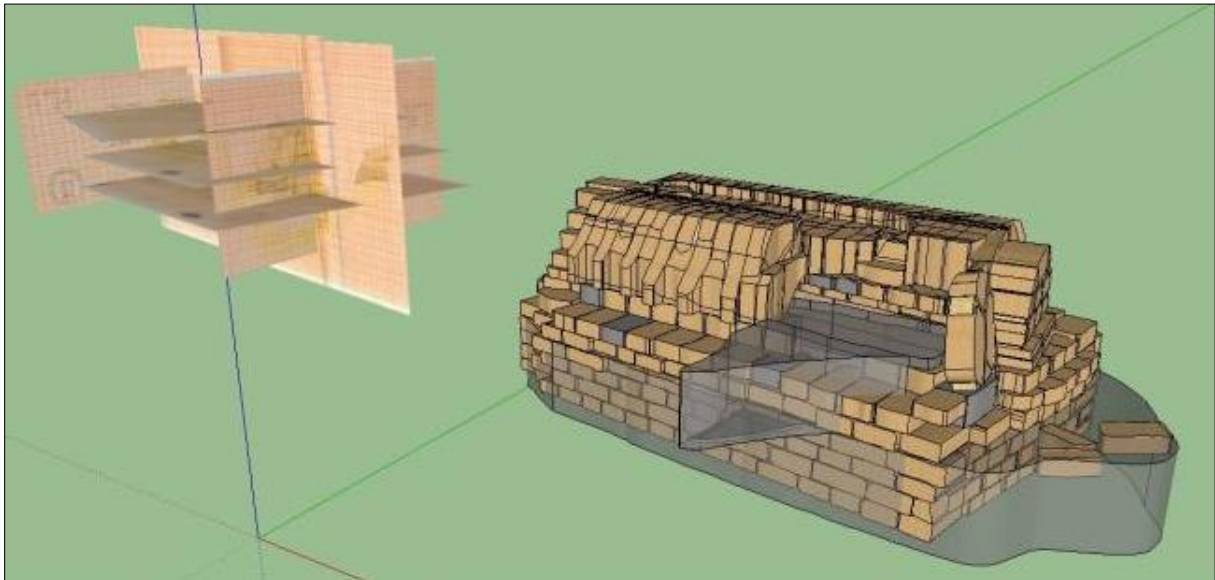


Figure 10: Finished reconstruction of tomb 13 with walls, burial vault and pits in SketchUp

This includes the reconstruction, recreation, anastylosis and restoration of archaeological features with the aim to produce a highly accurate image of the past. A virtual reconstruction of the site provides the potential to present the results of the advanced spatio-temporal analysis of the data in a comprehensive way if the reconstruction process is made transparent by enriching the virtual model with a standardized model description linked to its scientific sources, such as bibliography, images and as well as the documentation of its recreational process. Within the project, a pilot study on a palace will be used for developing a GIS-based stratigraphical methodology for the spatial and temporal expert analysis in a 4D AIS. The maps and 3D models resulting from the spatio-temporal analysis will form the basis for a comprehensive virtual reconstruction of the site, making a main palace including its astonishing and world-famous Minoan wall paintings accessible online for research as well as the interested public.

In 2016 the LBI ArchPro was working mainly on the digitization of the data, development of a 4D Archaeological Information System and virtual reconstruction and visualization of the excavation data.

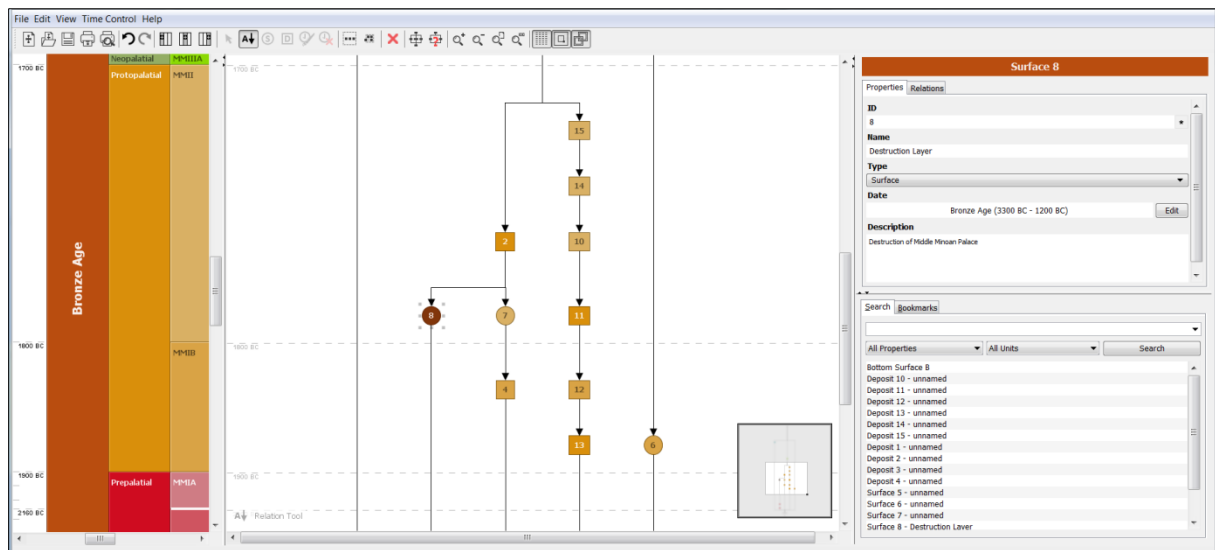


Figure 11: Screenshot of the Harris Matrix Composer plus for spatio-temporal analysis of excavation or prospection data.

Relevant lectures and publications:

- Torrejón Valdelomar, J.; Wallner, M.; Trinks, I.; Kucera, M.; Lužnik, N.; Neubauer, W. (2016): Big data in landscape archaeological prospection. In: ARQUEOLÓGICA 2.0 - 8th International Congress on Archaeology, Computer Graphics, Cultural Heritage and Innovation. Advanced 3D Documentation, Modelling and Reconstruction of Cultural Heritage, Monuments and Sites. Valencia, Spain, 05.-07.-09.2016, 238-246.

3.3 Underwater prospection

The idea of high-resolution archaeological prospection at unprecedented scale, as advocated, developed and demonstrated by the LBI ArchPro and its partners since 2010, is likewise portable to the investigation of shallow underwater areas. For this purpose, a concept for an innovative survey system suited for very high-resolution shallow to medium depth underwater prospection has been formulated. By joining forces with the experts of the University of Vienna and the archaeologists of the county of Upper Austria, it was possible to generate the required substantial funds for the realisation of a cutting-edge archaeological underwater prospection system. This underwater archaeological prospection system shall comprise latest multi-beam sonar devices for the detailed recording of the bathymetry, a multichannel sediment sonar system, as well as the appropriate real-time positioning technology and highly accurate motion sensors, altogether mounted on a small survey vessel. Within the framework of the jointly formulated research project “ArchPro ÖO Pfahlbauten” the plan is to map in the coming three years prehistoric lake dwelling sites located in Upper Austrian lakes in unprecedented scale and resolution in order to generate new archaeological data, information and knowledge for presentation at the Upper Austrian county exhibition on Lake dwellings in 2020. So far, the bathymetry of the upper Austrian lakes is best known to an accuracy of 10 to 5 m contour lines.

Therefore, in spring 2016, manufacturers of sonar devices suited for very high-resolution bathymetric and sub bottom mapping in shallow waters have been invited to demonstrate their technology at Lake Mondsee in Upper Austria. These test surveys have been planned and conducted by the LBI ArchPro in collaboration with the University for Natural Resources and Life Sciences, Vienna. In total, three multibeam sonar systems have been tested as well as an innovative four channel sediment sonar system. Based on these test measurements the successfully demonstrated four channel sub bottom profiler sonar system has been acquired. Furthermore, a tender process has been initiated through the University of Vienna in order procure a suited professional multibeam sonar system. It is intended to set up the survey system with all components in spring 2017 in order to start the underwater archaeological prospection surveys after system calibration and testing.

Tests for the development and application of underwater image-based 3D modelling have been performed in pools and lakes.



Figure 12: Test survey with the Innomar SES-2000quattro 4-channel sediment sonar in very shallow water at Lake Mondsee in May 2016.

3.4 Data acquisition and processing

3.4.1 Electromagnetic induction system testing

Testing and data processing of the DualEM 21HS EMI system in late 2015 have shown that the instrumentation delivers good lateral conductivity data. The next step is to invert apparent conductivity data to model conductivity and true depth information of. Different approaches are subject to testing. To gain information on the reliability of the inverted data, a synthetic data set has been used for forward modelling. This is to improve inversion algorithms. So far results look promising whereas the statistical noise is the limiting factor to gain stable results. Far more modelling is need to overcome these limitations.

3.4.2 Extension of APSoft 2.0

The software for the efficient processing of near-surface geophysical prospection data acquired at very high-resolution across large areas with motorized prospection systems has been considerably extended and enhanced in 2016. A new, more robust synchronization method has been integrated for positioning of high-resolution MIRA GPR data in both the professional ApRadar Version as well as in the simplified ArchProGPR software for use during fieldwork.

- A major step has been the release of a 64-bit version of ApRadar and ArchProGPR. This new 64-bit version can process unlimited large areas of GPR data, while the old 32-bit version had been limited to a maximum total surveys size of 72 ha. Furthermore, the new software version is about 40% faster compared to the earlier release. The maximum size of the prospection area is with the new version only limited by the hardware of the computer, not by the software anymore.
- Newly encountered problems arising with new GPR data measured at Stonehenge in 2016 have been addressed and solutions developed to handle them.
- A new tool has been developed permitting the direct export of high-resolution GPR data into V3D format for immediate 3D visualization using the freely available Vaa3D data visualization software.
- Possibilities to support MIRA 2 data positioning within ApRadar using robotic total stations for positioning has been evaluated.
- ApRadar has been extended in order to handle MIRA GPR data containing numerous erroneous traces.
- ApRadar has been extended in order to handle multiple stops of the GPR survey vehicle along stretches without GNSS positioning information. Data corresponding to any such stops are automatically detected in the GPR data sets and subsequently removed.
- ApRadar has been extended in order to remove GPR traces with bad positioning data.
- A novel method has been developed in order to filter erroneous traces within GPR-depth slices.
- Issues related to the interaction between the MIRA ProEx and the MIRA PPS mouse have been analysed and a more for of robust processing has been implemented into ApRadar.
- ApMag has been extended in order to support archaeological prospection with a motorized caesium magnetometer system collecting data at three levels of sensor heights.
- The 64-bit ApRadar and ApMag software versions have been further adapted and optimized.

- Efficient manual GPR data acquisition and processing using GNSS positioning has been implemented into ApRadar.
- A conversion of magnetic prospection data for output in UXO format has been implemented.

3.5 Case studies and third party founded projects

3.5.1 Laa an der Thaya, Austria

The Case Study area “Laa an der Thaya” is located in the north of Lower Austria, right next to the to the Czech-Austrian border in the north-northeast of the city Laa an der Thaya. The main reasons for choosing this 8.2 square kilometres large area as a Case Study were on the one hand the lately discovered historic map of the court mathematician Johann Jakob Marinoni from 1711 in which he mentioned, next to many landmarks, three deserted villages from medieval times and on the other hand the aerial photographs and various finds, picked up in the plough soil that suggest a settlement history beginning with the Middle Neolithic period. Also within the prospected area, a temporary used roman field camp was found just a few years ago by analysing aerial photographs.

In 2016 year the focus was on the area around the deserted village of Grafenwasen and the close mound “Runder Berg”, mentioned and located on the 18th century map drawn by Marinoni. The magnetic data of the year before showed that the “Runder Berg” has initially been encircled by a ditch as well. A possible grave chamber could not be seen in the data, the most likely interpretation of this elevation would therefore be a motte-and-bailey castle. Two short surveys have been conducted and took place on March 30th and October 13th 2016. A total coverage of around 7 ha with the magnetic systems could be obtained as well as 2.5 ha with the MIRA I GPR system.

In the ground penetrating radar data, on the southern field, where the mound is located, and the surrounding ditch of the village can be followed further south, east of the mound. Additionally to the circular ditch of the mound, several strongly reflective deposits can be observed beneath the mound as well. The GPR data reveals the surrounding ditch. The radar also shows the internal structure of the mound that corresponds very well with the 19th century excavation trench, investigated in the 1880’s by Josef Szombathy, also known for his discovery of the Venus of Willendorf. In the southern part of the surveyed area, southwest of the Mitterhof, a long linear structure was found on the magnetics. Apart from that, no further structures were observed.

3.5.2 Rechnitz, Austria

During aerial reconnaissance flights in 2014 two circular enclosures (“Kreisgrabenanlagen”) were detected next to the village of Rechnitz, eastern Austria. In 2014 a geophysical survey with a motorized multichannel magnetometer system by a team of the LBI ArchPro and ZAMG was conducted. Next to the circular earthwork the prospection data showed an area with traces of a presumably multi-phased settlement from the early Neolithic, as well as workshop areas dating to the Iron Age. In this first survey campaign it was not possible to either prospect the entire earthwork nor to cover the entire settlement area or to define its limits. Therefore, in 2016 the LBI ArchPro decided to conduct a large-scale geophysical prospection supported by the Austrian Heritage Board and the community of Rechnitz. Within two weeks in 2016 (October 10th and 21st) magnetometry and high-resolution ground penetrating radar (GPR) measurements took place covering some 52 ha with two

different magnetometers and 1.5 ha with two GPR motorized systems. In 2016 a third circular enclosure was detected by UAV flights.



Figure 13: State of survey and interpretation at the Neolithic site Rechnitz with three circular enclosures.

The majority of buildings and settlement pits visible in the data can be connected to a large settlement made up of longhouses which seems to be predating the two KGAs. These timber buildings are typical Early Neolithic longhouses related to the Linearband Culture (LBK). A part of the settlement is surrounded by a very prominent double ditched earthwork that seems to be respected by most of the structures. It might be interpreted as a fortification, probably dating to the final phase of LBK which did see many conflicts as observed with several other contemporary sites. The superposition of longhouses will make it possible to sort out an initial phasing of the site to be verified by targeted future excavations.

Beside the three large circular structures and the extensive settlement, whose complete extent is still unknown, two more interesting structures are prominent in the magnetic data. The first is a longhouse north of the western KGA obviously destroyed by fire. The longhouse, which must have been rebuilt after conflagration, offers a very detailed picture of this type of building due to its thermoremanent magnetisation, and even provides a clue where the devastating fire started. The second observed structure is a burial mound enclosed by a circular ditch on the same field south east of the longhouse, most likely dating to the Iron Age. The mound will be further investigated by GPR measurements and will be excavated in 2017.

The area of Rechnitz is also well known for the mass production of the famous Ferrum Noricum in the second and first century BC at the end of the Iron Age. Therefore it is not surprising to find furnaces, slag tips and workshop areas all over the site. Also the Romans left their traces in form of remains of a single building. Furthermore there are also some medieval field structures recognizable in the data.

The first results of the project have been presented to the local public at an event at the community centre Rechnitz on the 5th of December. The surveys will be completed in 2017 and will be used as major impact for the definition of a large scale case study.

3.5.3 Velm, Austria

In July and September 2016 the circular enclosure of Velm, southeast of Vienna was prospected with the GPR Systems SPIDAR & MIRA II. The purpose for this survey was to get additional information on the archaeological structures, known from aerial archaeology and the magnetic surveys conducted in 2015 and 2003/2004. Similar enclosures from the Middle Neolithic in the Loess area in the Weinviertel have been surveyed with GPR earlier with minor success. The site Velm, situated on gravel and sand promised better soil conditions to resolve the ditches and palisades of the monument.

The collected GPR data shows the three ring ditches and the three palisades in very high detail and up to 2.5 m depth. In the near surrounding even several buildings, known from the magnetic survey and aerial photos, are visible by individual postholes.



Figure 14: Depth slice 40-100cm measured with the MIRA 2 ground penetrating radar array at the Middle Neolithic site Velm, NÖ.

3.5.4 Carnuntum, Austria

In the framework of the cooperation project of the LBI ArchPro and the Institute for the Study of Ancient Culture (IKAnt) at the Austrian Academy of Sciences, the work focused on the interpretation, visualisation and publication of the prospection data in the Roman town of Carnuntum. The interpretation focused on the eastern half of the site, the *canabae legionis*. Several papers were written on the newly discovered garrison of the guard of the Pannonian governor.

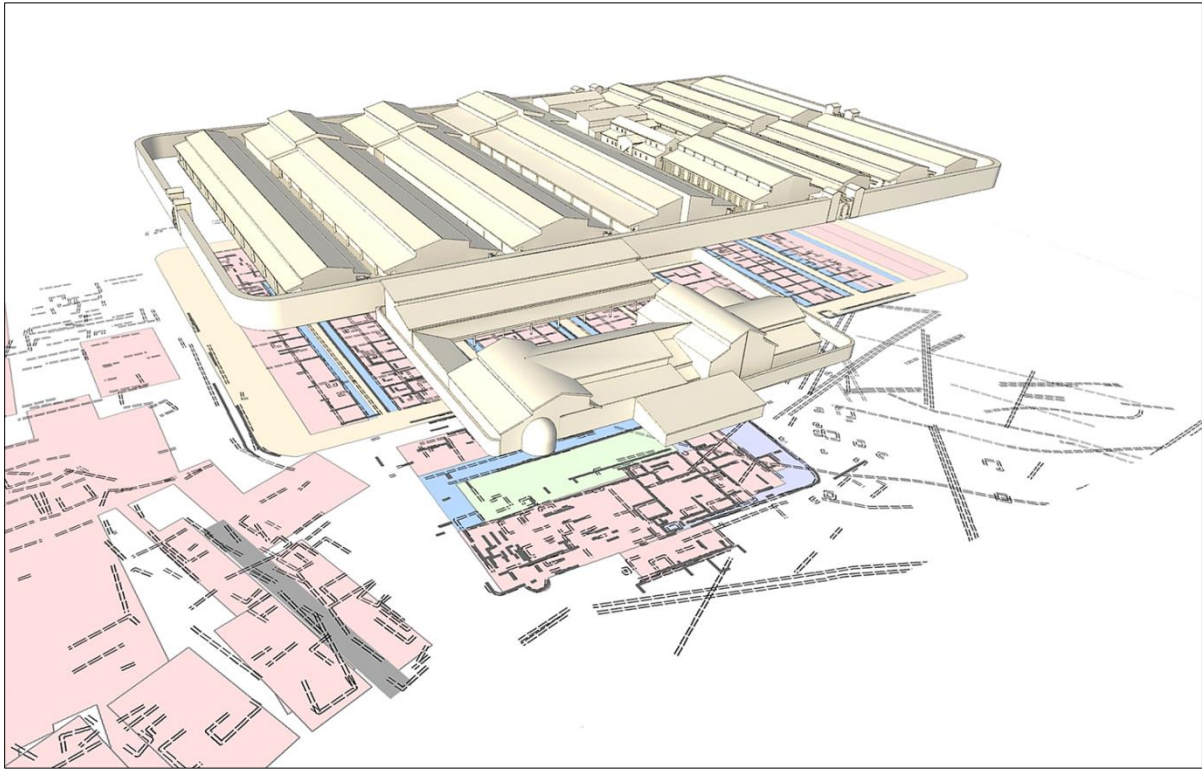


Figure 15: Combined visualisation of the GPR data interpretation and the virtual reconstruction of the castra singularium at Carnuntum.

Several new virtual reconstructions have been realized in cooperation with LBI ArchPro partner 7reasons: the garrison of the singulares, the amphitheater and the gladiatorial school, a gallo-roman temple and a wooden amphitheatre.

Much effort was invested in writing of the Carnuntum monograph, which will offer an overview on the prospection results both from the civil town as well as from the military town. The book format is that of a commentated atlas which includes a collection of maps with identical scales, completed by a selection of more detailed maps highlighting some topographic hotspots. The work on the text started with the military town with a focus on the administrative and military areas (seat of the provincial governor, garrison of the gubernatorial guard, campus etc.) and the so-called “Gräberstraße”, one of the main roads in Carnuntum. The chapters concerning the *canabae legionis* were finished by the end of September. From October until December, the work focused on the interpretation of prospection results in the surroundings of Carnuntum, including the following topics: road system, water supply, field boundaries and temporary military camps.

3.5.5 Prospecting Boundaries: Archaeology along the Mazaro, Sicily

In cooperation with the University of Vienna a FWF-project P 28410 “Prospecting Boundaries: Archaeology along the Mazaro” was conducted during 2016. The project seeks to apply an integrated archaeological prospection approach to a synchronic and diachronic exploration of human activity along the Mazaro River corridor. The River Mazaro connects both the coastal and interior zone of western Sicily and is understood from historical sources to have functioned as a border region during the Greek colonization period. A methodological combination of systematic integrated archaeological prospection techniques and historic landscape characterization are the main means of the project. For the LBI ArchPro the project is an interesting scientific challenge, as the area is difficult for any kind of archaeological prospection (high erosion rates). The LBI ArchPro is mainly involved in the geoarchaeological evaluation of project area based on ALS data. This aims for an integrated 3-dimensional reconstruction of the geological and geomorphological situation and evolution of the investigation area and to analyse the interaction of human and landscape in the context of possible differences between Punic and Greek controlled parts. Furthermore, the LBI ArchPro is working on the integrated archaeological interpretation of remote sensing (aerial archaeology and ALS) and geophysical (magnetics and GPR) data.

During March 2016 a GIS project for the ALS data, (historic) aerial photos and (historic) maps was designed and implemented. Additional works included literature recherche of existing archaeological, historical and geological references and reports. From April to June 2016, remote sensing data were visualized and integrated in ArcGIS. Based on these visualizations interpretation of anthropogenic and geological structures was done, followed in autumn by field work in the case study area.

3.5.6 Bisenzio, Italy (DFG AOBJ:614187 Multi-Disciplinary Research on a major Etruscan center from the Late Bronze Age to the Archaic Period)

Bisenzio is located ca. 30 km north of Viterbo in the northern part of the modern Italian province of Lazio, in the commune of Capodimonte. The Villanovan and Etruscan settlement is centred on Monte Bisenzo, a volcanic hill on the western bank of Lake Bolsena. Monte Bisenzo rises to a height of 102 m above the level of the lake, and is surrounded by a volcanic massif separated from flat plains to the north and south by gentle or steep slopes. To the west are the steep scarps of the caldera rim, which encircles the entire volcanic lake.

Owing to the spectacular finds from the cemeteries, and the huge size of the settled area, Bisenzio is today regarded as one of the major centres of southern Etruria in the Villanovan and Orientalizing periods. The settlement played an important and independent role alongside the great proto-urban centres of Vulci, Tarquinia, Cerveteri, Veio and Orvieto. Together with partner RGZM the LBI ArchPro successfully applied for a DFG project focusing on multi-disciplinary research on this major Etruscan center from the Late Bronze Age to the Archaic Period.

In order to be able to better understand the extent, character and spatial organization of the site the LBI ArchPro is responsible for a large-scale high-resolution geophysical archaeological prospection survey of the Bisenzio area. To this effect a first small-scale archaeological prospection pilot study using ground penetrating radar (GPR) to better plan this task, preliminary work and magnetic susceptibility measurements was carried out in July 2013. Tests Sampling of the magnetic susceptibility of the subsoil, and in particular of the omnipresent volcanic chunks of tuff contained in and on the subsoil, strongly indicate that in general the geological preconditions are not ideally suited

for magnetic archaeological prospection. For these reasons, the work concentrated on the application of ground penetrating radar. The two survey campaigns in 2015 and 2016 showed a heavy amount of destruction due to deep ploughing of the arable land. The interpretation of the collected data made a series of cemeteries and the last remains of the settlement visible. The ongoing GIS-based interpretative mapping will be completed with the data from the last planned survey campaign in 2017.



Figure 16: Ground penetrating radar survey at Bisenzio with view on the caldera and the lake Bolsano.

3.5.7 Ephesos, Turkey

The LBI ArchPro partners ZAMG and Uni Vienna started the systematic geophysical prospection of the antique city of Ephesos in collaboration with partner OeAI in 2000. Since then nearly 2 km² have been covered by magnetic prospection and ground penetrating radar. Starting in 2015 the LBI ArchPro reviewed all surveys carried out with developing hard- and software to compile new geophysical imagery based on the latest data processing software. All available data sets including a digital terrain model, aerial imagery, excavation maps etc. were integrated in a specially designed GIS project for a comprehensive interpretative mapping following the workflows recently developed by the LBI ArchPro.

3.5.8 The Stonehenge Hidden Landscapes Project, Great Britain

Since 2010 the *Stonehenge Hidden Landscapes Project* (SHLP) has undertaken extensive geophysical surveys across much of the world heritage landscape surrounding Stonehenge. Results from these surveys have identified a significant number of new sites whilst providing new information on many previously known monuments. One of the major discoveries using GPR has been a circuit of anomalies beneath the bank of the large henge of Durrington Walls, 2.8km from Stonehenge. Durrington Walls is

one of Britain's largest henges, being a 17ha earthen enclosure with a 5.5m-deep and up to 17 m wide internal ditch and an outer bank.

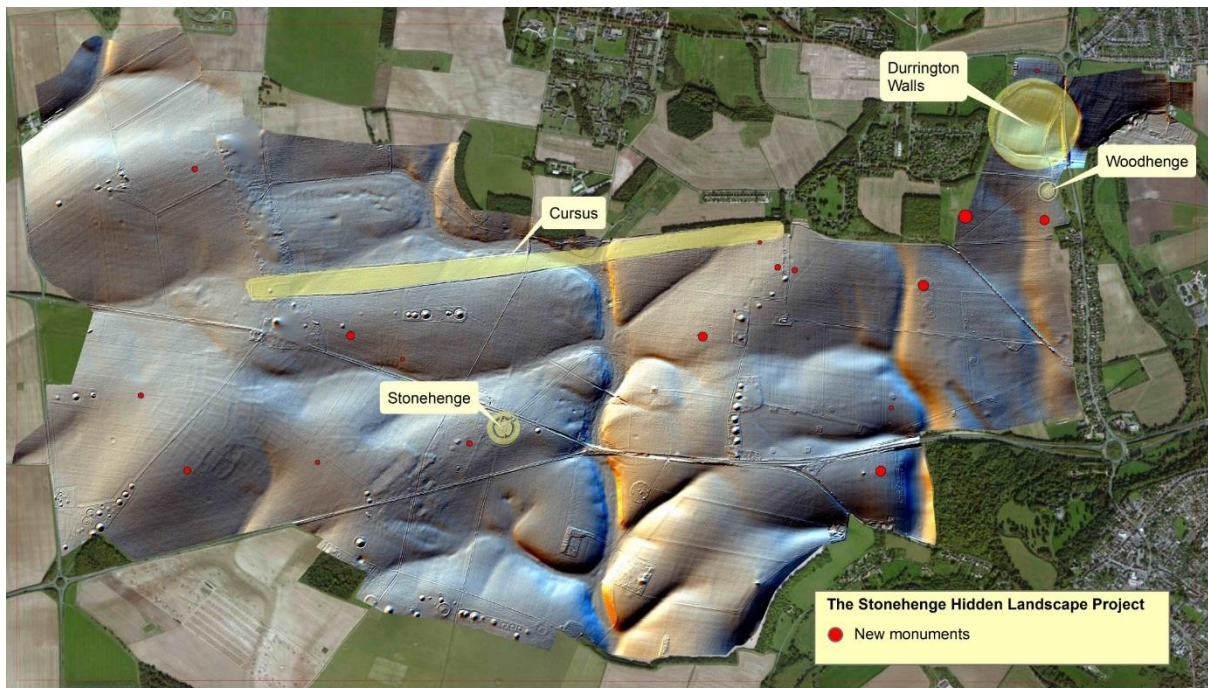


Figure 17: Overview of the new monuments detected by the Stonehenge Hidden Landscapes Project.

To fill up the last gaps of the large area defined by the Stonehenge Hidden Landscapes Project two survey campaigns in February and August were added. The main focus was on ground penetrating radar surveys focusing on Durrington Walls and the huge fields to the east of Stonehenge bottom. Magnetic measurements were conducted at Durrington Walls and next to the new visitor centre.

The project goal to integrate multi-sensor mapping over large areas of the landscape is also providing opportunities to re-interpret the landscape context of individual monuments and, in the case of the major henge at Durrington Walls, to generate novel insights into the structure and sequence of a monument which has attracted considerable research attention over many decades. At Durrington Walls the combined results of multiple prospection surveys have added an entire new phase of construction and use to a monument that has been studied intensively for many years. In doing so, the results exemplify the validity of core premises of the project team that multiple survey methods should always be utilized in order to extract the most information from such work, and that the greatest benefits of carrying out such research accrue at a landscape scale of enquiry. This does not dismiss the need for excavation for verification and refining the results of survey, and recovering the evidence needed for chronological, environmental and social interpretation. In the case of Durrington Walls, this requirement has been fully understood by the team and the potential presence of major stone structures clearly demands further investigation. To this end, an excavation during 2016, jointly run by the SHLP and the Stonehenge Riverside Project teams, was carried out in August 2016 to refine our interpretations of the survey data.

The LBI ArchPro provided a full 3D documentation of the stratigraphic excavation. Data comparison with the excavation data and the GPR-dataset proved the radar to be extremely accurate. All reflective

anomalies were also observed during the excavation. The point cloud generated with 'voxler' is fitting perfectly with the chalk-filling of the two big postholes revealed by the excavation (Figure 18).

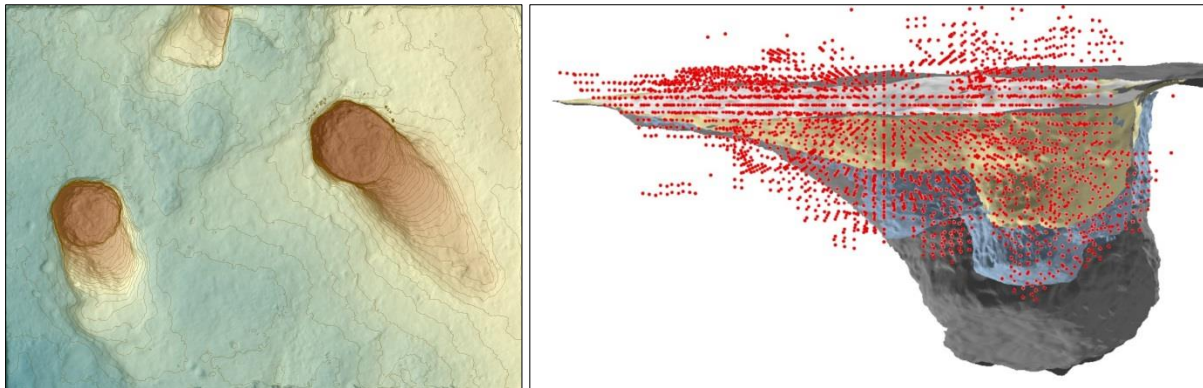


Figure 18: Massive postholes of timber circle excavated at Durrington Walls.

In relation to the Stonehenge Hidden Landscapes exhibition at MAMUZ museum Mistelbach a complete 3D model of Stonehenge was compiled from 3D laser scanning data and image based modelling (Figure 19). The data were used for various graphics and 3D printed models of the monument up to 1:1 replicas of selected trilithons.

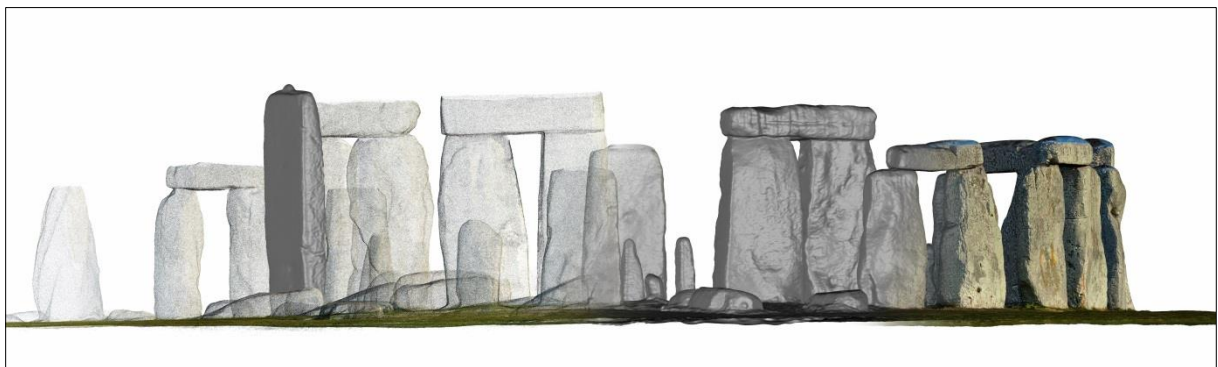


Figure 19: Visualisation of the 3D model of Stonehenge.

3.5.9 Pliska, Bulgaria

In cooperation with the LBI ArchPro partner organization RGZM Mainz, a first test survey was carried out at the Bulgarian site Pliska in early November 2016. The site of Pliska, situated some 60 km from the Black Sea, was in the Early Medieval period the first capital of the First Bulgarian Empire. The whole city area – including villages and farmsteads on the outskirts – amounts to more than 20 km². The pilot project concentrated on the question to what extent geophysical prospection can help to detect and document settlement structures from the oldest city in Bulgaria. Between November 4th and 10th, a total of 67 ha of magnetics and 10 ha of GPR were measured. Above all, the results of geomagnetic prospection are very promising and show numerous early medieval settlements features in the form of streets, paths, enclosures, houses etc.

3.5.10 The Borre Monitoring project, Norway

Two Viking Age hall buildings were found using ground penetrating radar at Borrehaugene in 2007; since then they have repeatedly been investigated with GPR. The buried structures showed up more clearly in some georadar images than in others. In order to investigate this phenomenon, Ludwig Boltzmann Institute ArchPro, Kulturarv i Vestfold fylkeskommune, Kulturhistorisk museum and Universitetet i Oslo (UiO) teamed up to analyse the local environmental settings. Sensors measuring water content, electrical conductivity and temperature were inserted into a posthole as well as two areas free of archaeology in order to monitor relevant physical properties of soils and sediments. A weatherstation was installed to measure local precipitation and solar radiation across the study area. Data are logged every 10 minutes and sent directly to a server where results can be monitored in real time. Geophysical surveys will be conducted at least once a month for a full year and compared to the environmental data in order to investigate seasonal influence on the surveys and ultimately establish guidelines for future applications of geophysical prospection in Norway.



Figure 20: Monitoring station at the archaeological park Borre and the positioning of sensors in one of the re-excavated large postholes of one of the Viking Age hall buildings.

3.5.11 Westfalen-Lippe, Germany

In collaboration with the county archaeologists at the Landesverband Westfalen-Lippe a pilot project has been started in 2016 with a goal of evaluating the potential of geophysical prospection for the diverse environmental settings of the county of Westfalen-Lippe. Between August 3rd and August 22nd a first campaign of fieldwork has been carried out around the town of Warburg in Westfalia. The main aim of the first ten days of fieldwork was magnetic surveys at Borgentreich and Hohenwepel. During the next ten days, both, GPR- and magnetic system have been deployed in the areas around Borgentreich, Hohenwepel and Desenberg Weg and two further sites at Ladbergen and Neuenkirchen, both north Münsterland.



Figure 21: Ground penetrating radar survey using a SPIDAR 500 MHz system at Desenberg, Westfalia.

Within 15 days of fieldwork a total of 130 ha could be surveyed with magnetics as well as 17 ha of GPR within six days of fieldwork. Especially areas that showed interesting structures on the magnetic data were surveyed with GPR and magnetics.

The second campaign was undertaken during December 2016. Measurements were carried out at two locations. The first was to the south of Paderborn where an area of 10 ha was measured with magnetometry. The results highlighted a number of pits and a possible pit house along geological features. The prospection of the WWI prisoner of war camp Neunkirchen – St. Arnold, Münsterland was completed in December 2016. An area of 5 ha was measured which helped outline the extent of the camp.

The surveys were extremely successful, resulting in a full partnership with the county of Westfalen-Lippe for the second LBI ArchPro funding period.

3.5.12 Ringkøbing Amt, West Jutland, Denmark

Holstebro Museums department for archaeology is investigating the potential of state-of-the-art aerial photography for the detection, documentation and protection of archaeological sites and landscapes in Denmark within the frame of an ongoing research project (<http://www.fortidensetfrahimlen.dk/>) started in 2009 and financed by the cultural ministry, Danish Agency for Culture, the regional administration, a series of foundations and the Holstebro Museum. In 2014, a team of the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology joined the research and conducted a geophysical archaeological prospection pilot study at several Iron Age and medieval sites in the area of former Ringkøbing Amt in West Jutland, Denmark; sites that had been discovered earlier by aerial archaeology.

The high-resolution surveys employed motorized ground-penetrating radar and magnetometer systems as well as novel post processing software. The aim of this study was to test the suitability of these methods and the chosen approach to efficiently explore, investigate and document prehistoric settlements on a large scale under the prevalent environmental conditions in this part of Denmark.

Over the course of five days of fieldwork, numerous structures of archaeological interest, such as the remains of longhouses, property boundaries, pathways, pit houses and other buried remains of the settlements, were detected and mapped. The combination of the data gathered by magnetic and GPR prospection with the already existing aerial imagery permitted an integrated archaeological interpretation, resulting in considerable new knowledge about the investigated sites.

To disseminate these results, two papers were submitted for publication. In the first paper, submitted to *Archaeological Prospection*, the general results obtained for a Viking Age settlement at Stadil Mølleby and a medieval village near Rysensten, were presented. The aim of the second paper, submitted to *Journal of Archaeological Method and Theory*, was to determine if, and to what extent, geophysical prospection together with a novel integrative interpretational approach was able to add more detailed information to an Iron Age settlement near Vesterager, also in West Jutland. Results yielded a variety of deeper insight into the separate farms (dated to around AD 400), including the discovery of several new structures, more information about the construction of the longhouses, as well as a first suggestion on how to implement image fusion into the process of analysis and archaeological interpretation of geophysical datasets. In addition to the separate interpretations of the single methods, the implementation of image fusion provides an additional tool to obtain an even higher degree of data integration during the interpretation process. To investigate some possibilities and risks of image fusion, a procedure frequently used in the medical field but rarely applied in archaeology, various algorithms inside a dedicated MATLAB toolbox TAIFU (Toolbox for Archaeological Image FUision) were tested on the geophysical prospection data from Vesterager.

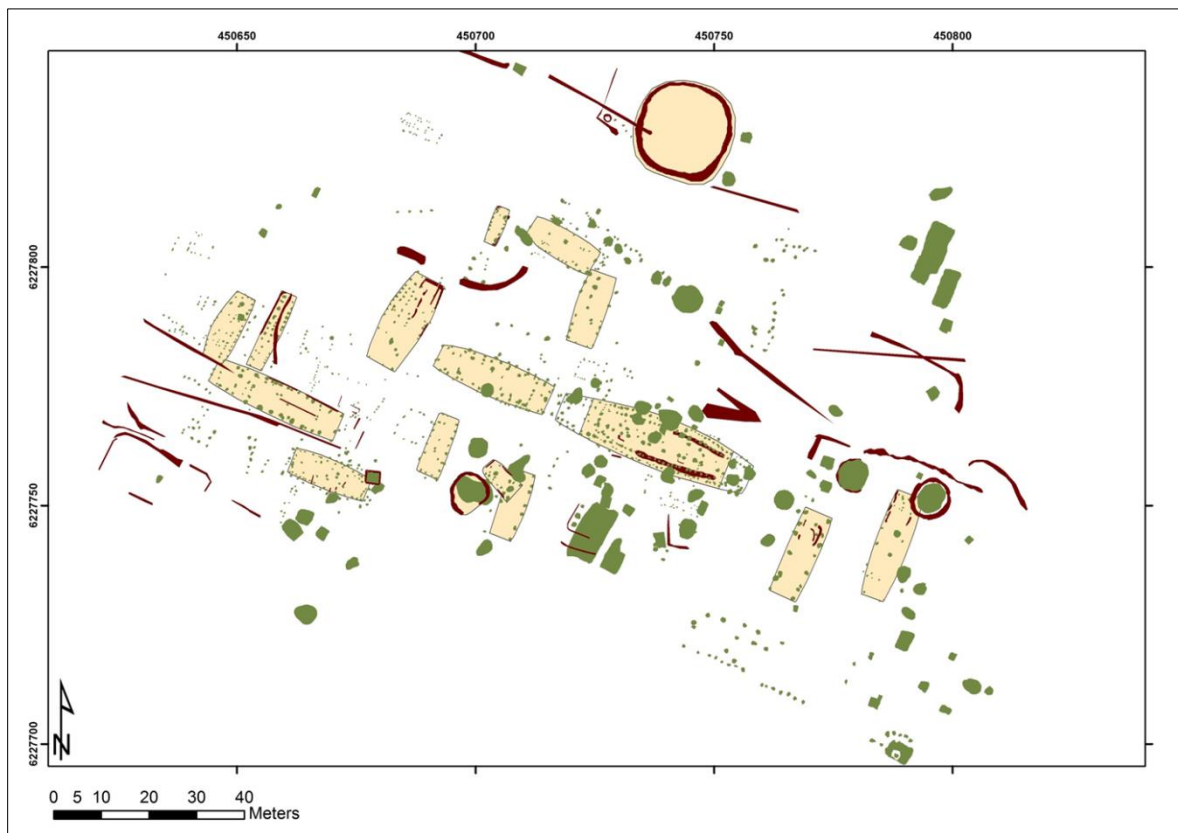


Figure 22: Interpretation of the integrated prospection of the Viking Age settlement Stadil Mølleby in West Jutland.

4 Training and teaching

4.1 Summer school 2016

In September 2016 a summer school funded by the WWTF on “Advanced archaeological prospection, documentation and interpretation for cultural heritage management” has been organised by the LBI ArchPro, the ZAMG and the University of Vienna. The summer school addresses the demand to educate and familiarize students of the fields of archaeology, historical sciences, cultural heritage management and architecture in universally applicable non-invasive archaeological prospection and efficient documentation methods and techniques. Special focus is placed on the archaeological interpretation of remote sensing and near-surface geophysical prospection data and the potential of the generated results to facilitate and guide modern cultural heritage management, as well as implications for rescue and exploration archaeology and policy making.



Figure 23: LBI ArchPro Summer school 2016 at the main lecture hall of the Institute for Prehistory at the University of Vienna.

The summer school was a great success for the students, who throughout have been very positive about their experience, as well as the lecturers, both international and Vienna based, who benefited scientifically and on a social level through the opportunities offered by the summer school. The lecturers attended each other lectures throughout, actively engaged in interested discussions with the students, and interacted with the students on a one-to-one level during the luncheons, coffee breaks and ample social events. The hands-on presentations, demonstrations and inspection of the advanced archaeological prospection survey systems conducted at the premises of the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology in combination with a BBQ in relaxed atmosphere certainly was one highlight for all participants. This event was supported by the entire staff of the LBI ArchPro through preparations and demonstrations.

4.2 Teaching activities

Lectures at the University Vienna

Wolfgang Neubauer	Winter 2016	060072 Privatissimum
	Winter 2016	060065 Archaeological Prospection
Michael Doneus	Summer 2016	060048 GIS-applications for archaeologists
	Summer 2016	060090 Practical application of aerial archaeology
	Summer 2016	060094 Privatissimum
	Summer 2016	060066 Landscape archaeology
	Summer 2016	060092 Excursion (10 days) Southern Aegean
Immo Trinks	Winter 2016	060037 Theoretical introduction to geophysical archaeological prospection
Erich Draganits	Summer 2016	280038 Quaternary Geology and Geomorphology (NPI)
	Summer 2016	280020 Geological Field Mapping (PI)
	Summer 2016	060092 Excursion (10 days) Southern Aegean
	Summer 2016	300161 Interdisciplinary ecological field course
Christian Gugl	Summer 2016	090087 Moesia inferior: The Archaeology of a Roman Province
Klaus Löcker	Summer 2016	060060 Introduction Stratigraphy
Martin Fera	Summer 2016	060059 Surveying for Archaeologists
Matthias Kucera	Winter 2016	060040 Introduction to Experimental Archaeology
	Summer 2016	060062 Experimental archaeology

On November 25th 2016 Immo Trinks obtained his habilitation in near-surface geophysics at Technische Universität Wien with a habilitation colloquium on “Advancing near-surface geophysical prospection”.

5 Dissemination

5.1 Internal LBI ArchPro dissemination

Internal dissemination activities have been concentrating on following topics:

- LBI ArchPro personal reports
- Maintenance of LBI ArchPro bibliographical database
- Cataloguing and labelling of the LBI ArchPro library (books, periodicals, papers, CDs, etc.)
- Archiving of data on LBI ArchPro server
- Tracking of media coverage and archiving of media reports (online, print)
- Provision of information and PR material to media
- LBI ArchPro homepages and social media channels

5.2 Publication list

Articles in journals

A1: articles published in journals listed in the ISI Web of Knowledge restricted to article, review, letter, note, proceedings paper.

1. Doneus, M.; Wieser, M.; Verhoeven, G.; Karel, W.; Fera, M.; Pfeifer, N. (2016): Automated Archiving of Archaeological Aerial Images. In: *Remote Sensing - Open Access Journal* 8 (3), 209. DOI: 10.3390/rs8030209
2. Filzwieser, R.; Neubauer, W.; Nau, E.; Toriser, L. (2016): Ausgrabung einer neuzeitlichen Klause am Falkenstein bei Sankt Gilgen, Salzburg. In: *Archaeologia Austriaca* 100, 199-221.
3. Grammer, B.; Draganits, E.; Gretscher, M.; Muss, U. (submitted): LiDAR-guided archaeological surveys: Lessons from the ancient Greek polis of Colophon (Ionia, Western Anatolia). In: *Archaeological Prospection*.
4. Schneidhofer, P.; Nau, E.; Hinterleitner, A.; Lugmayr, A.; Bill, J.; Gansum, T.; Paasche, K.; Seren, S.; Neubauer, W.; Draganits, E.; Trinks, I. (2016): Palaeoenvironmental analysis of large-scale, high-resolution GPR and magnetometry data sets. The Viking Age site of Gokstad in Norway. In: *Archaeological and Anthropological Sciences*, 1-27, online. DOI: 10.1007/s12520-015-0312-x
5. Sevara, C.; Pregesbauer, M.; Doneus, M.; Verhoeven, G.; Trinks, I. (2016): Pixel versus object — A comparison of strategies for the semi-automated mapping of archaeological features using airborne laser scanning data. In: *Journal of Archaeological Science: Reports* 5, 485-498. DOI: 10.1016/j.jasrep.2015.12.023
6. Verhoeven, G. (2016): BRDF and its Impact on Aerial Archaeological Photography. In: *Archaeological Prospection* 14 (1). DOI: 10.1002/arp.1559.
7. Verhoeven, G. (2016): Mesh Is More—Using All Geometric Dimensions for the Archaeological Analysis and Interpretative Mapping of 3D Surfaces. In: *Journal of Archaeological Method and Theory* 20 (1). DOI: 10.1007/s10816-016-9305-z.
8. Verhoeven, G.; Sevara, C. (2016): Trying to Break New Ground in Aerial Archaeology. In: *Remote Sensing* 8 (11). DOI: 10.3390/rs8110918.

9. Verhoeven, G.; Vermeulen, F. (2016): Engaging with the Canopy - Multi-Dimensional Vegetation Mark Visualisation Using Archived Aerial Images. In: Remote Sensing - Open Access Journal 8 (9). DOI: 10.3390/rs8090752.

A2: articles published in widely circulated scholarly or scientific journals with international peer review not included under A1.

10. Frischer, B.; Zotti, G.; Mari, Z.; Capriotti Vittozzi, G. (2016): Archaeoastronomical experiments supported by virtual simulation environments. Celestial alignments in the Antinoeion at Hadrian's Villa (Tivoli, Italy). In: Digital Applications in Archaeology and Cultural Heritage 3 (3), 55-79. DOI: 10.1016/j.daach.2016.06.001

A3: articles with peer review published in national journals (i.e. Austrian) not included in A1 or A2.

-

A4: articles published in journals without peer-review.

11. Gugl, C.; Neubauer, W.; Nau, E.; Jernej, R. (2016): Das Militärlager in Virunum (Noricum). Zur Stationierung von römischen Truppen (singulares) an Statthaltersitzen - Teil 2. In: Carnuntum Jahrbuch 2014, 55-66.
12. Gugl, C.; Wallner, M.; Neubauer, W.; Doneus, M.; Löcker, K. (in press): Die militärischen Anlagen in Carnuntum. In: F. Humer (Hrsg.): Der Adler Roms. Ausstellungskatalog.
13. Humer, F.; Neubauer, W.; Konecny, A.; Nau, E.; Fuchshuber, N. (2016): Die Grabungen 2014 im Bereich der Gladiatorenschule von Carnuntum. In: Carnuntum Jahrbuch 2014, 167-172.

Books and book chapters

B1: author or co-author of books (limited to books published by a scientific publishing company, no syllabi, no thesis).

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B2: author or co-author of chapters in books (no proceedings of conferences).

14. Doneus, N.; Gugl, C.; Doneus, M.; Klammer, J. (in Press): Die Römische Villa von Zillingtal - Kleinberg und ihre Nachbarn in Prospektion und Landschaft. In: F. Daim und N. Doneus (Hrsg.) (in Press).
15. Draganits, E.; Weissl, M.; Zámolyi, A.; Doneus, M. (in Press): Lake Neusiedl area: A particular lakescape at the boundary between Alps and Pannonian Basin. In: Embleton-Hamann (Ed.): Landscapes and Landforms of Austria: Springer Verlag (World Geomorphological Landscapes).
16. Grussenmeyer, P.; Landes, T.; Doneus, M.; Lerma, J. L. (2016): Basics of Range-Based Modelling Techniques in Cultural Heritage 3D Recording. In: E. Stylianidis und F. Remondio (Hg.): 3D recording, documentation and management of cultural heritage. Caithness, Scotland, UK: Whittles Publishing, 305-368.

17. Mauthner, F.; Seren, S.; Löcker, K.; Hinterleitner, A. (in Press): Die römischen Gutshöfe von Antau und Zillingtal: geophysikalische Prospektion und archäologische Auswertung. In: F. Daim und N. Doneus (Hrsg.) (in Press).
18. Verhoeven, G. (2016): Basics of Photography for Cultural Heritage Imaging. In: E. Stylianidis und F. Remondio (Hrsg.): 3D recording, documentation and management of cultural heritage. Caithness, Scotland, UK: Whittles Publishing, 127-251.

B3: editor of books (including editor of proceedings).

19. Daim, F.; Doneus, N. (Hrsg.) (in Press): Das römische Zillingtal (Monographien RGZM).

Conference proceedings

C1: articles in Proceedings listed in the ISI Web of Science.

-

C2: Articles published in proceedings of scientific conferences, not included in C1 (full articles).

20. Gugl, C.; Neubauer, W.; Wallner, M.; Löcker, K.; Verhoeven, G.; Humer, F. (2016): „ArchPro Carnuntum“ - Erste Ergebnisse der geophysikalischen Messungen 2012-2015. In: E. Lauer mann und P. Trebsche (Hrsg.): Beiträge zum Tag der Niederösterreichischen Landesarchäologie 2016. Asparn/Zaya (Katalog des Niederösterreichischen Landesmuseums, N. F. 531), 51-58.
21. Torrejón Valdelomar, J.; Wallner, M.; Trinks, I.; Kucera, M.; Lužnik, N.; Neubauer, W. (2016): Big data in landscape archaeological prospection. In: ARQUEOLÓGICA 2.0 - 8th International Congress on Archaeology, Computer Graphics, Cultural Heritage and Innovation. Advanced 3D Documentation, Modelling and Reconstruction of Cultural Heritage, Monuments and Sites. Valencia, Spain, 05.-07.-09.2016, 238-246.
22. Verhoeven, G.; Nowak, M.; Nowak, R. (2016): Pixel-level image fusion for archaeological interpretative mapping. In: ARQUEOLÓGICA 2.0 - 8th International Congress on Archaeology, Computer Graphics, Cultural Heritage and Innovation. Advanced 3D Documentation, Modelling and Reconstruction of Cultural Heritage, Monuments and Sites. Valencia, Spain, 05.-07.-09.2016, 404-407.

C3: abstracts of conferences or papers, unpublished lectures, posters

23. Trinks, I.; Kucera, M.; Neubauer, W.; Amon, P.; Pfennigbauer, M. (2016): Beyond the surface. In: CHNT 20, 2015 - Abstracts. Conference on Cultural Heritage and New Technologies. Vienna, Austria, 02.-04.11.2015.
24. Zotti, G. (2016): Archaeoastronomical simulation in a desktop planetarium. In: CHNT 20, 2015 - Abstracts. Conference on Cultural Heritage and New Technologies. Vienna, Austria, 02.-04.11.2015.
25. Zotti, G.; Neubauer, W. (in Press): Kreisgrabenanlagen - Expressions of Power Linked to the Sky. In: SEAC 2010, in Press. Astronomy and Power. How Worlds are Structures. Gilching, Germany, 30.08.-04.09.2010.

26. Kucera, M.; Neubauer, W.; Müller, S.; Doneus, N. (2016): The Tell el Daba Archaeological Information System: adding the fourth dimension to legacy datasets of long-term excavations (A puzzle in 4D). In: 10th ICAANE. 10th International Congress on the Archaeology of the Ancient Near East. 25.-29.04.2016. Vienna, Austria. Abstract Booklet, 275-276.

Conference proceedings

D1: talk invited.

- Doneus, M. (2016): Non-destructive investigation of archaeological landscapes. NIKU. Oslo, Norway, 13.01.2016.
- Doneus, M. (2016): Verborgenes sichtbar machen. Nicht-invasive Dokumentation archäologischer Landschaften. Forschungen im Bereich der Visuellen Kulturgeschichte - Kulturen und Medien des Visuellen. Wien, Austria, 18.05.2016.
- Doneus, M. (2016): „A new dawn for archaeology? Systematic and integrated archaeological prospection in Europe“. Aerial Archaeology in Europe and the Middle East; Past, Present and Future. University of Oxford. Oxford, UK, 18.06.2016.
- Doneus, M. (2016): Archaeological Remote Sensing in Alpine Environments. Theory and Practice in Historical Geography and Digital Humanities in Vienna. ÖAW. Wien, Austria, 29.09.2016.
- Doneus, M.; Neubauer, W.; Trinks, I. (2016): Archaeological prospection from the air: potential, limitations and latest developments. University of Newcastle. Newcastle, UK, 10.03.2016.
- Doneus, M.; Neubauer, W.; Trinks, I. (2016): Understanding archaeological landscapes through non-invasive approaches. Workshop: Landmarks. Orkney College. Orkney, UK, 12.03.2016. Doneus, M. (2012-2013). DITECUR - Digital technologies in cultural landscape research. ERASMUS Lifelong Learning Programme, Intensive Programme. University of Zagreb. Zagreb, Croatia, 28.01.2012-10.02.2013.
- Klammer, J.; Doneus, M. (2016): Archäologische Prospektion auf Basis von flugzeuggetragenen Laserscanaufnahmen – Erfahrungen und Ergebnisse der Projekte 2013-2016 in Burgenland und Wien. FACHGESPRÄCH 2016. BDA. Denkmalinventare und archäologische Landesaufnahme. Grundlagen – Projekte – Perspektiven. Wien, Austria, 25.08.2016.
- Neubauer, W. (2016): Das Stonehenge Hidden Landscapes Project. 7. Tagung der Fachgruppe Archäologische Ausgrabung im Verband der. Berlin, Deutschland, 14.04.2016.
- Neubauer, W. (2016): Stonehenge und die Prospektion archäologischer Landschaften. Europäisches Forum Alpbach. Club Alpbach Steiermark. Graz, Austria, 23.05.2016.
- Neubauer, W. (2016): Archaeology in space and time. VERA-Seminar. Fakultät für Physik, Isotopenforschung und Kernphysik. Wien, Austria, 09.06.2016.
- Neubauer, W. (2016): Stonehenge - Carnuntum - Wikinger. Prospektionen archäologischer Landschaften. ÖGUF. Wien, Austria, 31.05.2016. Trinks, I. (2012): Moderne geophysikalische Prospektion in der Archäologie. Physikalisches Kolloquium. Bergische Universität Wuppertal, 21.05.2012.
- Neubauer, W. (2016): Stonehenge Hidden Landscapes Project: Wie Technologie aus Österreich die Archäologie revolutioniert! YO!TECH - Lust auf Technik. Wien, Österreich, 28.06.2016.

D2: talk.

- Doneus, M. (2016): Techniques and Methods in Archaeological Remote-sensing for Cultural Heritage Documentation. The CIPA Workshop on saving the Heritage of Syria – Best Techniques and Methods for Data Capture, Storage and Dissemination. 10th International Congress on the Archaeology of the Ancient Near East. Wien, Austria, 28.04.2016.
- Doneus, M.; Karel, W.; Verhoeven, G.; Wieser, M.; Pfeifer, N. (2016): OrientalAL: Automated rectification of oblique and vertical aerial photographs. AARG 2016. Pilsen, Czech Republic, 07.09.2016.
- Gugl, C.; Humer, F. (2016): Archäologische Prospektion in Carnuntum II: Das neue Bild der römischen Donaumetropole. 16. Österreichischer Archäologentag am Institut für Klassische Archäologie der Universität Wien. Wien, Austria, 25.02.2016.
- Müller, S. (2016): Berichte aus laufenden Projekten des LBI ArchPro: TED. Ägyptologie. Heute. Zur Zukunft der Vergangenheit. 48. Ständige Ägyptologenkonferenz. Wien, Austria, 17.07.2016.
- Neubauer, W.; Trinks, I.; Löcker, K.; Wallner, M. (2016): Archäologische Prospektion in Carnuntum I: Geophysikalische Messungen und interpretatives Mapping. 16. Österreichischer Archäologentag am Institut für Klassische Archäologie der Universität Wien. Wien, Austria, 25.02.2016.
- Schneidhofer, P.; Nau, E.; Gustavsen, L.; Leigh McGraw, J.; Tønning, C.; Gansum, T., Bill, J.; Neubauer, W. (2016): Interdisciplinary investigation of the burial mound at Rom in Vestfold County, Norway. CAA Italy 2016. Sienna, Italy, 30.03.2016.
- Schneidhofer, P.; Nau, E.; Tønning, C.; Trinks, I. (2016): A geoarchaeological approach to selected issues in Norwegian archaeological geophysical prospection. CAA 2016: Computer Applications and Quantitative Methods in Archaeology. Oslo, Norway, 29.03.2016.
- Sevara, C.; Doneus, M.; Draganits, E.; Tusa, S.; Frazzetta, C.; Seren, S. (2016): Prospecting Boundaries. Exploring Landscape Change in Western Sicily. AARG 2016. Pilsen, Czech Republic, 07.09.2016.
- Trinks, I. (2016): The Stonehenge Hidden Landscapes Project – archaeological prospection at unprecedented scale and resolution. Objective, methods, technology and preliminary results. Workshop Science and technology at Stonehenge: new methods and results, Politecnico di Milano, May 18th 2016.
- Zotti, G.; Schaukowitsch, F.; Wimmer, M. (2016): The Skyscape Planetarium. SAEC 2016. Société Européenne pur l’Astronomie dans la Culture. Bath, UK, 13.09.2016.

Public relations

5.2.1 The Vienna Research Festival on Tour 2016

The LBI ArchPro participated in 2016 in Vienna Research Festival, organized by the Vienna Business Agency, which was founded in 1982 as the Vienna Economic Development Fund (Wirtschaftsförderungsfonds) by the City of Vienna, the Vienna Chamber of Commerce, the UniCredit Bank Austria AG (formerly the Zentralsparkasse) as well as the Erste Bank der Österreichischen Sparkassen AG (formerly the Erste Österreichische Sparkasse).



Figure 24: Impressions from the Vienna Research festival on tour.

The Vienna Business Agency prioritises and promotes the defined focal strengths of the city: life sciences, urban technologies, creative industries and ICT. Innovations are the key to commercial success and ensure the long-term development of the business location. The goal of the Research Festival is, together with Viennese companies, universities and research facilities, to demonstrate to a wide cross-section of the public what type of research is being conducted in Vienna, and how it is being done. This year's theme was the path from research to the finished product. An entertaining framework program (experiment reviews, research workshops, children's programs, etc.) has accompanied a large hands-on exhibit

<http://www.openscience.or.at/vol/aktuelles/wiener-forschungsfest-on-tour-herbst-2016->

5.2.2 Archaeology 2.0, Kahlenberg

To celebrate Wolfgang Neubauer, awarded “Austrian Scientist of the Year 2015” the LBG invited their institutes and representatives from science, industry und politics to an evening event on the 1th of June. The event was focused on the work and achievements of the LBI ArchPro under the title “Archaeology 2.0”.



Figure 25: Presentation of the virtual glasses HTC Vive at the Archaeology 2.0 event on the Kahlenberg, Vienna.

Together with partner 7reasons the LBI ArchPro designed a vivid presentation of state-of-the-art virtual and augmented reality application based on the LBI ArchPro case studies, 3D laser scanning and printing, drones and geophysical survey systems in the picturesque environment at the Kahlenberg above the city of Vienna.

<http://www.lbg.ac.at/de/themen/high-tech-fuer-die-archaeologie>

5.2.3 Forum Alpbach, Austria

Together with the LBG the LBI ArchPro designed a presentation stand for Virtual Archaeology for the international forum Alpbach. The stand was visited very well and especially the novel virtual glasses HTC Vive were again the main attraction.

5.2.4 Press conference Carnuntum - The governor's guard

The press conference was organized together with partner organizations County of Lower Austria, ZAMG, ÖAW and 7reasons and took place on 30st March 2016 in Carnuntum.

From 2011 to 2015, the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology (LBI ArchPro) and its international partner consortium were running a large-scale archaeological prospection project at the Roman town of Carnuntum. By systematically applying a multi-disciplinary approach based on remote sensing and high-resolution, near-surface geophysics, most of the extent of the former capital of the Roman province of Upper Pannonia has been surveyed. In August 2014, the garrison of the governor's guard was detected, using ground penetrating radar (GPR) and magnetics. Being situated immediately west to the legionary fortress, the so-called castra singularium formed a part of a huge building complex, which was the administrative centre of the Roman province. A massive wall enclosed this newly discovered military garrison, which consisted of several barracks for soldiers, a central administrative complex and buildings dedicated to logistical purposes. The combination of the governor's palace and the garrison of his guard, in close vicinity to the legionary fortress and the campus, the military training area of the legionaries, make this new discovery unique in the Roman world.

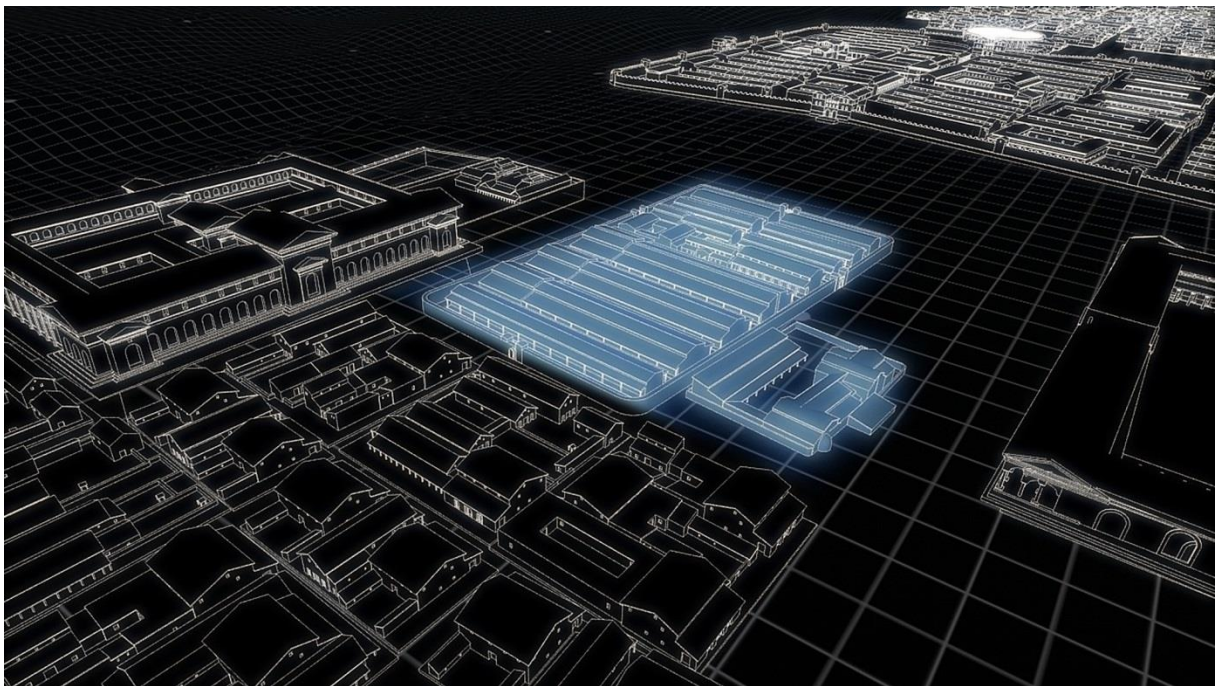


Figure 26: The governor's palace and the garrison of the governor's guard at Carnuntum.

5.3 Press coverage summary

Award Scientist of the year 2015

- <http://science.orf.at/stories/1766020/>
- <http://derstandard.at/2000028671387/Archaeologe-Wolfgang-Neubauer-ist-Wissenschaftler-des-Jahres>
- <http://derstandard.at/2000028548942/Archaeologe-Wissenschaft-erlebbar-und-essbar-machen?ref=rec>
- <http://kurier.at/lebensart/leben/wolfgang-neubauer-ist-wissenschaftler-des-jahres/173.565.046>
- http://www.kleinezeitung.at/k/kultur/4899417/Auszeichnung_Wolfgang-Neubauer-ist-Wissenschaftler-des-Jahres-
- http://diepresse.com/home/bildung/universitaet/4899433/Archaeologe-Wolfgang-Neubauer-ist-Wissenschaftler-des-Jahres-?_vl_backlink=/home/bildung/universitaet/index.do
- http://www.wienerzeitung.at/themen_channel/wissen/forschung/794312_Wolfgang-Neubauer-ist-Wissenschaftler-des-Jahres.html
- http://archpro.lbg.ac.at/sites/files/archo/wneubauer_wissdjahres2015_oenachrichten.pdf
- <http://www.w24.at/Nachrichten/239022> (Video)
- <http://oe1.orf.at/artikel/429156> (Audio)
- http://www.krone.at/Videos/Wolfgang_Neubauer_ist_Wissenschaftler_des_Jahres-Archaeologie-Koryphaee-Video-489960
- http://www.ots.at/presseaussendung/OTS_20160107_OTS0042/karlheinz-toechterle-gratuliert-wissenschaftler-des-jahres-wolfgang-neubauer
- http://www.ots.at/presseaussendung/OTS_20160107_OTS0026/vizekanzler-mitterlehner-gratuliert-wolfgang-neubauer-zur-auszeichnung-als-wissenschaftler-des-jahres
- https://science.apa.at/rubrik/politik_und_wirtschaft/Mailath_gratuliert_Wolfgang_Neubauer_als_Wissenschaftler_des_Jahres_2015/SCI_20160108_SCI39491352027576416
- <http://derstandard.at/2000028671387/Archaeologe-Wolfgang-Neubauer-ist-Wissenschaftler-des-Jahres>
- http://www.mistelbach.tv/index.php?option=com_content&view=article&id=2139&catid=5&Itemid=32
- http://diepresse.com/home/bildung/universitaet/4899420/Archaeologie-und-Informatik_Laufbahn-von-Wolfgang-Neubauer
- http://diepresse.com/home/science/4899787/Wissenschaftler-des-Jahres_Ein-Archaeologe-der-nicht-graebt
- http://www.kleinezeitung.at/s/kultur/4899432/Portraet_Wolfgang-Neubauer_Ein-Archaeologe-ohne-Spaten
- <http://www.moneytrend.at/2012/neu/mehr.php?nr=1182&kat=0>
- <http://www.msn.com/de-at/nachrichten/other/arch%C3%A4ologe-wolfgang-neubauer-ist-wissenschaftler-des-jahres/ar-AAgsS3y?li=AA5a71>
- <http://www.noen.at/nachrichten/lokales/aktuell/mistelbach/Wolfgang-Neubauer-ist-Wissenschaftler-des-Jahres;art2689,699999,B>
- <https://nzz.at/nachrichten/archaeologe-neubauer-als-wissenschaftler-des-jahres-geehrt/>
- <http://www.osttirol-online.at/aktuelles/welt-news/123231-archaeologe-wolfgang-neubauer-ist-wissenschaftler-des-jahres.html>
- <http://www.salzburg.com/nachrichten/wissen/sn/artikel/archaeologe-neubauer-ist-wissenschaftler-des-jahres-179504/>
- http://www.salzburg24.at/archaeologe-wolfgang-neubauer-ist-wissenschaftler-des-jahres/apa-s24_1427555934

- http://science.apa.at/rubrik/politik_und_wirtschaft/Wolfgang_Neubauer_Vom_Gastarbeiter_kind_zum_gefragten_Gastarbeiter/SCI_20160107_SCI40111351027555828
- http://science.apa.at/rubrik/politik_und_wirtschaft/Wolfgang_Neubauer_Am_Anfang_wurden_wir_als_Spielerei_belaechelt/SCI_20160107_SCI40111351027559102
- <http://www.suedtirolnews.it/d/artikel/2016/01/07/archaeologe-wolfgang-neubauer-ist-wissenschaftler-des-jahres.html>
- <http://medienportal.univie.ac.at/uniview/wissenschaft-gesellschaft/detailansicht/artikel/wolfgang-neubauer-ist-oesterreichs-wissenschaftler-des-jahres-2015/>
- <http://www.vienna.at/archaeologe-wolfgang-neubauer-ist-wissenschaftler-des-jahres/apa-1427555934>
- http://www.volksblatt.at/apa_news/?tx_posapaxmlimport_pinews%5Buid%5D=137719
- http://archpro.lbg.ac.at/sites/files/archeo/anti-archaeologe_wienerzeitung.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/profil_ausgezeichnet_11.1.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/kopf_des_tages_standard.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/archaeologe_der_nicht_graebt_diepresse.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/moderne_hightech_kleinezeitung.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/archaeologe_der_zukunft_kurier.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/wn_wissdjahres2015_tirolertageszeitung.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/wn_wissdjahres_bezirksblaetter_wrneustadt_13_012016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/report_plus_die_top_12_26.1.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/2016-02-07_-_artikel_uber_wolfgang_neubauer_-_ostschweiz_seiten_23-24.pdf
- https://science.apa.at/rubrik/politik_und_wirtschaft/Der_Super-Wissenschaftler_ist_ein_Team/SCI_20160315_SCI40111351028740650
- <http://economyaustria.at/forschung/teamsport-wissenschaft>
- http://archpro.lbg.ac.at/sites/files/archeo/austria_innovativ_eine_botschaft_ins_land_tragen_19.4.2016.pdf
- <http://wien.orf.at/news/stories/2811823/>
- https://science.apa.at/rubrik/kultur_und_gesellschaft/Wissenschaftsball_der_Stadt_Wien_Aphrodisiaka_Rocket_Girls/SCI_20161129_SCI39431352633260446

LBI ArchPro

- http://archpro.lbg.ac.at/sites/files/archeo/archaeologie_ohne_spaten_archaeologieblog_der_standard.pdf
- <http://derstandard.at/2000037194006/Warum-manche-Archaeologin-wird-Sonnenaufgange-ueber-Stonehenge#3680,753718,1463630514>
- http://archpro.lbg.ac.at/sites/files/archeo/neues_deutschland_mai2016.pdf
- <http://derstandard.at/2000039035104/Dafuer-braucht-es-Bastler-Methodenforschung-in-der-Archaeologie?blogGroup=1&ref=rec>
- http://archpro.lbg.ac.at/sites/files/archeo/non_archaologen_finger_schmutzig_22.6.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/terramaterspezial_juli2016.pdf
- <http://scienceblog.at/die-zerst%C3%B6rungsfreie-vermessung-der-r%C3%B6mischen-provinzhauptstadt-carnuntum>
- http://diepresse.com/home/science/forschungsfrage/5051210/Warum-ist-der-Meeresspiegel-nicht-uberall-gleich-hoch?vl_backlink=/home/science/index.do
- <http://diepresse.com/home/science/falsifiziert/5051634/Virtuelle-Rekonstruktionen>
- https://science.apa.at/site/politik_und_wirtschaft/detail.html?key=SCI_20160805_SCI63653414231188878

Carnuntum – Castra singularium

- <http://science.orf.at/stories/1768891/>
- Story on ORF2, NÖ Heute, 30.3.2016, 19 :00
- Newsflash on ORF1, ZIBflash, 30.3.2016, 21 :45
- Ö1-Mittagsjournal (Radio), 30.3.2016, 12:00 (Interview with Klaus Löcker)
- http://archpro.lbg.ac.at/sites/files/archeo/kurier_wo_einst_elitetruppen_wohnten_31.3.2016.pdf
- <http://derstandard.at/2000033866512/Roemische-Garde-Quartiere-in-Carnuntum-entdeckt>
- http://archpro.lbg.ac.at/sites/files/archeo/derstandard_grosse_entdeckung_in_carnuntum_31032016.pdf
- <http://diepresse.com/home/zeitgeschichte/4956523/Quartiere-der-Garde-in-Carnuntum-entdeckt>
- http://archpro.lbg.ac.at/sites/files/archeo/presse_carnuntum_quartiere_der_garde_entdeckt_4.4.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/wienerzeitung_das_hotel_der_kaiserlichen_leib_waechter_31.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/noe-news_carnuntum_castra.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/damals_geschichte_online_carnuntum_castra.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/noen_carnuntum_kaserne_der_garde_entdeckt_7.4.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/carnuntum_castra_meinbezirk.pdf
- http://www.oe-journal.at/index_up.htm?http://www.oe-journal.at/Aktuelles/!2016/0316/W5/33103carnuntum.htm
- http://archpro.lbg.ac.at/sites/files/archeo/neuevorarlbergertageszeitung_sensationsfund_in_carnuntum_31.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/kleinezeitung_sensationsfund_in_carnuntum_31.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/amsblattnoe_sensationsfund_in_carnuntum_11.4.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/carnuntum_castra_archaeologie_online.pdf

Carnuntum

- <http://www.smithsonianmag.com/history/discovery-roman-gladiator-school-brings-famed-fighters-to-life-180959489/>
- <http://derstandard.at/2000047479515/Carnuntum-plant-Ausstellung-zum-roemischen-Militaerwesen>
- http://science.apa.at/rubrik/kultur_und_gesellschaft/Carnuntum_zeigt_ab_2017_Ausstellung_zum_roemischen_Militaer/SCI_20161114_SCI39351351632977042
- <http://noe.orf.at/news/stories/2808548/>

Stonehenge – MAMUZ Exhibition

- [Story on ORF2 Seitenblicke](http://www.oe-journal.at/index_up.htm?http://www.oe-journal.at/Aktuelles/!2016/0316/W5/33103carnuntum.htm)
- http://archpro.lbg.ac.at/sites/files/archeo/noeamsblatt_mamuzstonehenge.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/stadtgemeindezeitungmistelbach_jahresausstellungmamuz2016.pdf
- <http://www.noen.at/nachrichten/noe/kultur-gesellschaft/Im-Boden-tief-versteckt;art79522,702951>
- http://archpro.lbg.ac.at/sites/files/archeo/noen_die_mystik_der_steine_3.2.2016.pdf

- <http://www.meinbezirk.at/mistelbach/freizeit/verborgene-landschaft-stonehenge-d1634629.html>
- <http://www.noen.at/nachrichten/lokales/aktuell/mistelbach/Eine-Ausstellung-mit-Wow-Effekt;art2689,718201,B>
- <http://www.noen.at/nachrichten/noe/kultur-gesellschaft/Nicht-nur-Steine;art79522,717902>
- <http://www.wellbusiness.at/de/artikel/Touristik/STONEHENGEinOesterreich>
- <http://www.seniorkom.at/0/Content/freizeit/ article /id27316>
- http://archpro.lbg.ac.at/sites/files/archeo/niederosterreich_news_das_neue_stonehenge_5.3.2016.pdf
- <http://derstandard.at/2000032135829/Stonehenge-Rekonstruktion-in-Niederosterreich>
- http://archpro.lbg.ac.at/sites/files/archeo/raiffeisenzeitung_stonehenge_zum_begreifen_3.3.2016.pdf
- http://www.wienerzeitung.at/themen_channel/wissen/geschichte/804005_Stonehenges-sonniger-Friedhof.html
- http://archpro.lbg.ac.at/sites/files/archeo/kurier_stonehenge-schau_steine_zum_angreifen_3.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/der_standard_stonehenge_steht_in_mistelbach_16.3.2016.pdf
- <http://www.austria.com/stonehenge-ab-20-maerz-im-weinviertel-zum-greifen-nah/apa-1428505640>
- <http://www.kleinezeitung.at/s/kultur/4937527/Stonehenge-ab-20-Maerz-im-Weinviertel-zum-Greifen-nah>
- http://www.noe.gv.at/Presse/Pressedienst/Pressearchiv/120809_Stonehenge.html
- <http://noe.orf.at/news/stories/2760783/>
- <http://www.osttirol-online.at/aktuelles/welt-news/127975-stonehenge-ab-20-maerz-im-weinviertel-zum-greifen-nah.html>
- <http://www.salzburg.com/nachrichten/oesterreich/kultur/sn/artikel/stonehenge-ab-20-maerz-im-weinviertel-zum-greifen-nah-186223/>
- <http://www.salzburg24.at/stonehenge-ab-20-maerz-im-weinviertel-zum-greifen-nah/apa-1428505640>
- http://science.apa.at/rubrik/kultur_und_gesellschaft/Stonehenge_ab_20_Maerz_im_Weinviertel_zum_Greifen_nah/SCI_20160302_SCI39351351628505642
- <http://www.suedtirolnews.it/d/artikel/2016/03/02/stonehenge-ab-20-maerz-im-weinviertel-zum-greifen-nah.html>
- <http://www.vienna.at/stonehenge-ab-20-maerz-im-weinviertel-zum-greifen-nah/apa-1428505640>
- <http://www.vol.at/stonehenge-ab-20-maerz-im-weinviertel-zum-greifen-nah/apa-1428505640>
- http://www.volksblatt.at/regionales/apa_news/?tx_posapaxmlimport_pinews%5Buid%5D=140411
- <http://www.grenzwissenschaft-aktuell.de/ausstellung-stonehenge-eroeffnet20160330/>
- http://archpro.lbg.ac.at/sites/files/archeo/wiener_zeitung_zeitreise_nach_stonehenge_24.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/noen_mystik_des_steinkreises_23.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/news_die_steinernen_riesen_aus_stonehenge_im_neuen_licht_19.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/kurier_die_arena_der_toten_18.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/die_presse_steinmodelle_zum_anfassen_stonehenge-austellung_startet_19.3.2016.pdf

- http://archpro.lbg.ac.at/sites/files/archo/amtliche_nachrichtern_der_no_landesregierung_mamuz_prasentiert_stonehenge_verborgene_landschaft_15.3.2016.pdf
- http://archpro.lbg.ac.at/sites/files/archo/tirolertageszeitung_stonehenge_zum_angreifen_4.4.2016.pdf
- <http://www.sempre-vita.com/2016/04/stonehenge-verborgene-landschaft-im-mamuz/>
- <http://oe1.orf.at/programm/439852>
- <https://www.meinbezirk.at/mistelbach/lokales/2016-ein-rekordjahr-d1960214.html>

Durrington Walls und Stonehenge, UK

- <http://www.handelsblatt.com/technik/forschung-innovation/raetselhafter-steinkreis-stonehenges-grosser-bruder/12290554.html>
- <http://www.geo.de/magazine/geo-magazin/18925-geo-nr-10-2016-stonehenge-entschlueselt>
- http://huntnews.in/p/detail/4416234566638859?xlang=en&uc_param_str=dnfrpfbivesscpgi_mibtbmtnijblauputogdnw&pos=1474626833602

Other

- <http://burgenland.orf.at/news/stories/2803210/>
- http://archpro.lbg.ac.at/sites/files/archo/89_bvz_oberwarter_zeitung_alte_gebaude_gefunden_09.12.2016.pdf