Ludwig Boltzmann Institute
Archaeological Prospection and Virtual Archaeology

ANNUAL REPORT

Content

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Partner organizations

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

ABT	Airborne Technologies (A)
LBG	Ludwig Boltzmann Gesellschaft (A)
LWL	Federal state archaeology of Westphalia-Lippe (D)
NIKU	Norsk Institut for Kulturminneforskning (N) - The Norwegian Institute for Cultural Heritage - Archaeology Department
NoeL	Province of Lower Austria (A)
RGZM	Römisch Germanisches Zentralmuseum Mainz (D)
TU Vienna	University of Technology Vienna (A) - Institute for Computer Graphics and Algorithms (ICG) and the Institute for Photogrammetry and Remote Sensing (IPF)
Uni Vienna	University of Vienna (A) - Vienna Institute for Archaeological Science (VIAS) and Institute for Prehistoric and Historical Archaeology (UHA)
Vfk	Vestfold fylkeskommune (N)
ZAMG	Central Institute for Meteorology and Geodynamics (A)
7reasons	7reasons Medien GmbH (A)

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Prof. Julian Richards, University of York, UK

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1 Overview

1.1 Motivation

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 high-resolution non-invasive archaeological prospection methods offers 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 on 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).

The LBI ArchPro (http://archpro.lbg.ac.at) is an innovative research centre for the development and large-scale application of advanced archaeological prospection methods. It combines latest remote sensing techniques, modern high-resolution near-surface geophysics, sophisticated computer science and precise geomatics with archaeology. The institute is dedicated to the development of new and highly efficient technologies and methodologies for non-destructive data capturing, data processing, and data visualization in virtual reality, as well as the general advancement of the underlying theory and methodology of archaeological prospection. An important aim of the institute is the public dissemination of new technological developments and of the generated scientific results obtained within the exemplarily conducted international large-scale archaeological prospection case studies, targeting the scientific community as well as the interested public.

1.2 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's capabilities and approach in order to raise the awareness for the significance of non-invasive archaeological investigations and the preservation of archaeological heritage.

1.3 Highlights 2017

Press conference Carnuntum: Panem et circenses – Bread and games in Roman Carnuntum

The press conference was organized together with the LBI ArchPro partner organisations County of Lower Austria, ZAMG and 7reasons and took place on the March 30th 2017 at the Archaeological Park Carnuntum.

Since 2012, the LBI ArchPro and ZAMG (Austrian Central Institute for Meteorology and Geodynamics), on behalf of the County of Lower Austria, together with international partners, have explored the ancient town of Carnuntum with custom made, high-resolution magnetometer and ground-penetrating radar systems. The recently completed prospection maps reveal for the first time, and in unprecedented detail the substantial buried Roman remains that have been hidden in the soil for two millennia.

After the discovery of the school of gladiators at Carnuntum, prospection surveys were conducted in the area around the excavated amphitheatre of the civil town. The subsequent prospection results revealed an entire city quarter complete with the necessary infrastructure for the gladiatorial games. The route to the spectacles led the people through the city gates past taverns (tabernae), souvenir shops, and food vendors (thermopolia), where street merchants offered their goods for sale and invited the public to linger. Behind one of the taverns, the LBI ArchPro discovered a storage building (horreum) and remains of a large oven, where presumably bread was baked for the up to 13,000 spectators. Wine and other provisions were stored in underground cellars that are still visible in the prospection data.

Just 400 meters to the northeast of the known excavated amphitheatre, hidden under the later rampart of the civil town of Carnuntum, the prospection data revealed the remains of an older and so far unknown amphitheatre that must have been erected as wooden construction.

While it was strategically placed at the crossroads of the road along the Danube frontier (Danube Limes) and the main route leading southwards (towards Rome), it was also placed adjacent to a temple dedicated to the Quadriviae (Roman goddesses of the cross-roads).

Without excavating the ground, the analysis and the presented archaeological interpretation of the geophysical prospection data has added more exciting chapters to the story of Carnuntum. Not only in the capital Rome the ‘bread and games’ were of great importance for the entertainment and appeasement of the masses, but also in Carnuntum – a frontier-town at the edge of the Roman Empire.

Figure 1: Carnuntum: Illustration of the visualization process for the production area with storage building and oven discovered by archaeological prospection near the amphitheatre of the civil town.

2 Research topics and results

2.1 Integrated interpretation

Development of a Toolbox for Archaeological Image FUsion – TAIFU

In 2017, some further new functionality has been included into TAIFU. Firstly, multi-scale and sparse representation image fusion was added. Secondly, several new image quality measures have been included (standard deviation; entropy; revised mutual information; mutual information & Tsallis entropy; sum of correlation of differences). Thirdly, corrupted TAIFU functionality (due to the new MATLAB R2017b release) was tracked down and remedied.

In addition, 'HistogrammerPlus' was developed, which is a tool that can be used stand-alone or called from within TAIFU to conduct basic explorative data analysis. As its name reveals, the software can visualize data in form of various histograms (Fig. 2). So far, HistogrammerPlus can import a wide variety of n-band raster images (e.g. a 20-band GeoTIFF), any amount of GPR depth-slices (even *.flt floating-point data files as well as files containing no assigned numbers – NaNs) and numerical Excel spreadsheet data. In the latter case, various error-handling routines make sure that the data are indeed coming from an Excel file, that the headers are imported, and that the correct worksheet is loaded. Upon import, a (selectable) variety of summary statistics is computed for the entire dataset (for example: the correlation table for all the bands). Afterwards, one can choose to visualize band-specific histograms (normal or cumulative ones, both with various normalization options) and to compute band-specific statistics, such as skewness, kurtosis, maximum, median etc. It is also possible to define the size of the histograms, of the bin count and bin limits used, as well as of the maximum amount of bands-specific data to be displayed at once.

Finally, a new image import function was coded. This functionality will be useful for TAIFU, HistogrammerPlus and all other toolboxes that we might create in the future (although it is not implemented in TAIFU yet). A lot of heavy lifting is done during import (reading all possible metadata such as Exif, IPTC and XMP, computing band specific and summary image statistics, extracting georeferencing information). For the moment, all this information is saved in a MATLAB specific structure. Currently, the import function can handle single files, multiple separate files and image stacks (e.g. GPR depth-slices). It is possible to look for specific files in a folder, and, if needed, one level of subfolders or all possible levels of subfolders. The *.flt file import was completely reprogrammed, in order to make it more robust and to enable it to store (and extract metadata) from both the raw *.flt data as well as its remapped version (e.g. -4 nT to +6 nT).

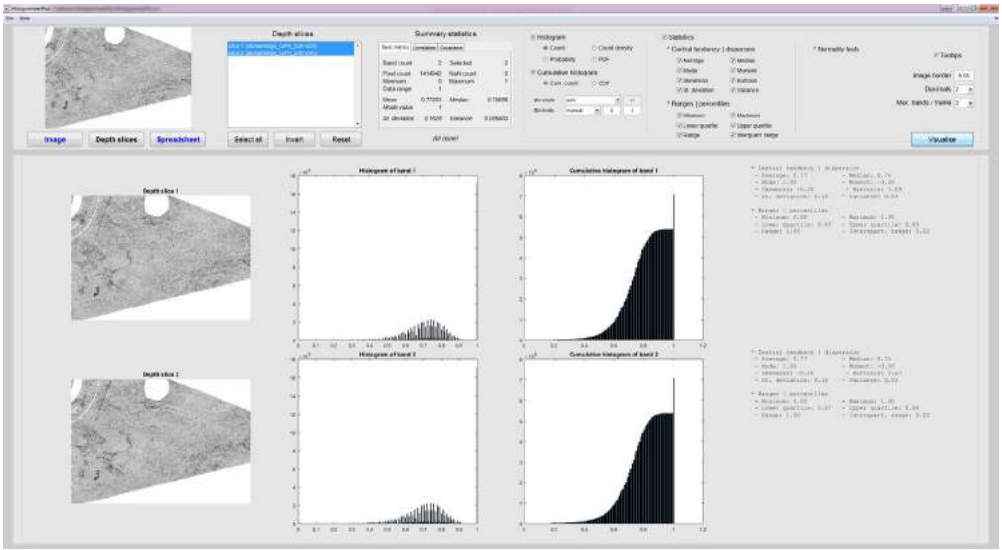

Figure 2: First version of the HistogrammerPlus.

4D Airborne Laser Scanning

In current practice, archaeological structures from Airborne Laser Scanning (ALS)-based Digital Terrain Models (DTMs) are mapped on different levels ranging from a site-based strategy (i.e. identifying and inventorying a distinct group of structures as a site) to a detailed interpretation of each individual archaeologically relevant feature in spatial databases. While all of these approaches aim at a more or less coherent map of archaeological sites and structures, they cannot account for the complex sequence of (pre-)historic occupation of woodland, where areas have become repeatedly subject to a variety of uses. Any systematic mapping of these kinds of 'palimpsest' landscapes will result in a multitude of intersecting lines squares, curvilinear and round features representing its long-term use. In order to understand this 'palimpsest', functional units need to be identified and chronologically put in order.

The LBI ArchPro is currently testing the use of the newly developed version of the Harrismatrixcomposer plus (HMC+) software to build a coherent chronological model of all mapped features from a complex case study at St. Anna. Each intersection displays a temporal succession of its features and therefore functions as a node within a stratigraphic sequence. Linking the resulting Harris Matrix with the GIS-based interpretation map, a relative sequence of archaeological structures can be inferred and functionally interpreted (Fig. 3). The result is a diachronic sequence of human activity in a dynamic landscape.

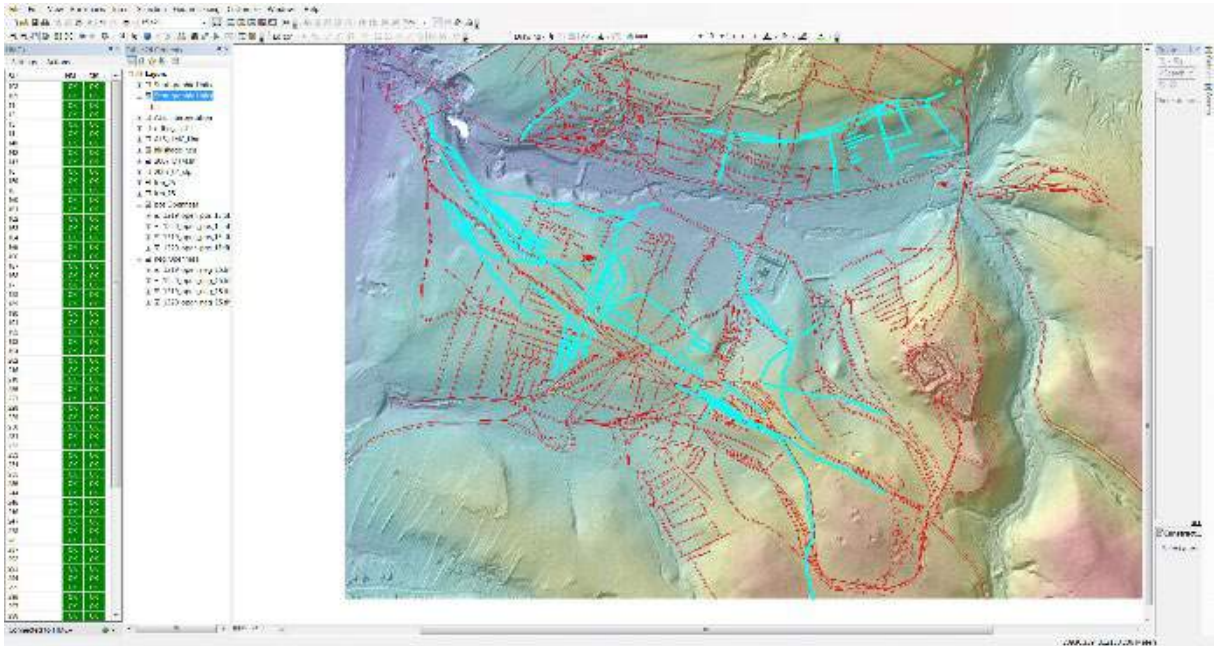

Figure 3: 4D interpretation of ALS data

Interpretation of the prospection data from the Roman town of Carnuntum, Austria

The ongoing process of the archaeological interpretation of the comprehensive archaeological prospection data from Carnuntum focused on the spatio-temporal analysis of all collected datasets, with the aim to identify and map distinct areas of occupation in the centre of the civil town (Fig. 4) and the western suburbium (Fig. 5).

The complex stratigraphy of the various occupation phases within the central part of the civil town was of special interest. Only a detailed analysis of all datasets made it possible to distinguish areas of public usage (forum, temples or taverns) from private households.

The analysis of the western suburbium (Fig. 5) also showed a very well structured layout. Narrow stripe houses (Streifenhäuser) with small shops in the front are aligned along the Roman road, the so called

Figure 4: Interpretation map of the central area of the civil town of Carnuntum with the main features and distinct areas marked.

Figure 5: Detail of the western suburbium of Carnuntum.

'Limes road', that is heading towards the west from the town. The settlement layout changes towards the west into an intermixed area of private houses that are overlaying an older graveyard (Fig. 5). This graveyard extends further to the west, where its expansion is demarcated by a boundary ditch.

Interpretation of the prospection data from the Roman town of Flavia Solva, Austria

The interpretation of the GPR data acquired at the Roman town of Flavia Solva focused on the area of a grand bath complex (Fig. 6). The interpretation process revealed architectural structures such as paved floors, hypocausts, heating ducts, and water pipes, which all support this functional interpretation. Additionally, five insulae have been interpreted, which display a detailed layout of individual spaces. Various activity zones could be identified within the insulae, and a street system and sewers can be seen between them. Several wells were found adjacent to the bath complex, inside the insulae, as well as in the surroundings.

Figure 6: Flavia Solva: Preliminary archaeological interpretation of the bathing complex.

Roman settlement of Jona, Switzerland

GPR measurements conducted in collaboration with the Kantonsarchäologie St. Gallen at Jona (Kempraten) in Switzerland revealed details of a complex Roman settlement orientated along a Roman road that once followed the shoreline of Lake Zürich (Fig. 7). Within the settlement, at least two building phases can be distinguished by the change in orientation. The burial monuments are generally situated closer to the lakeside. An area of special interest is located in the north-western part of the survey area. Here, an east-west oriented building was located within a circular enclosure (Fig. 8). This structure may be interpreted as an early Christian site.

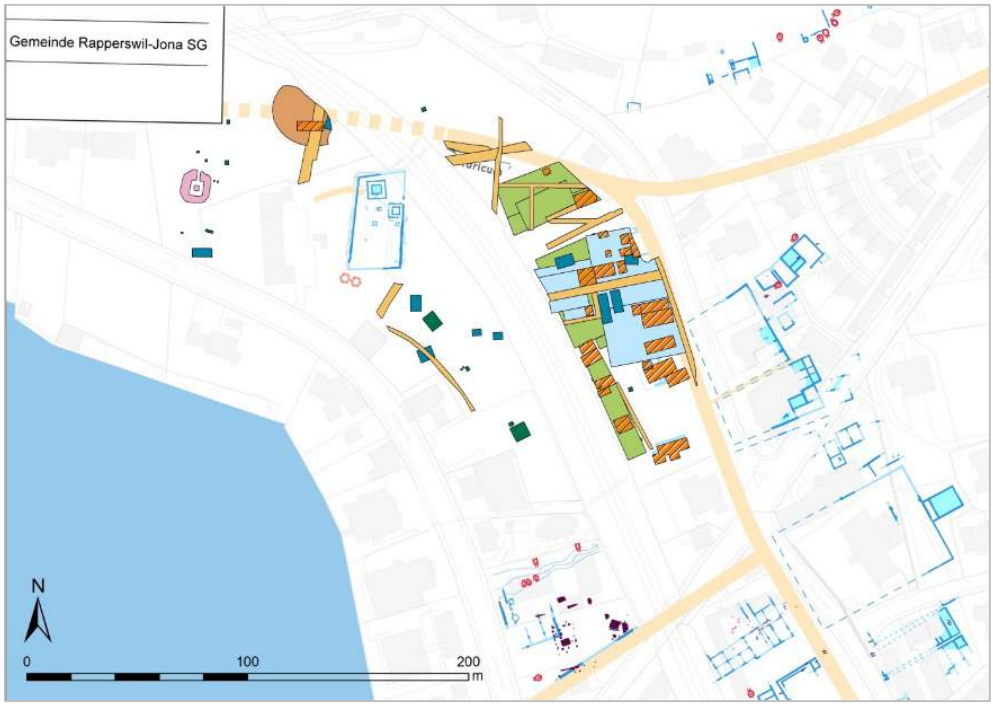

Figure 7: GPR data *interpretation and excavation results* superimposed onto *the modern street map of Jona.*

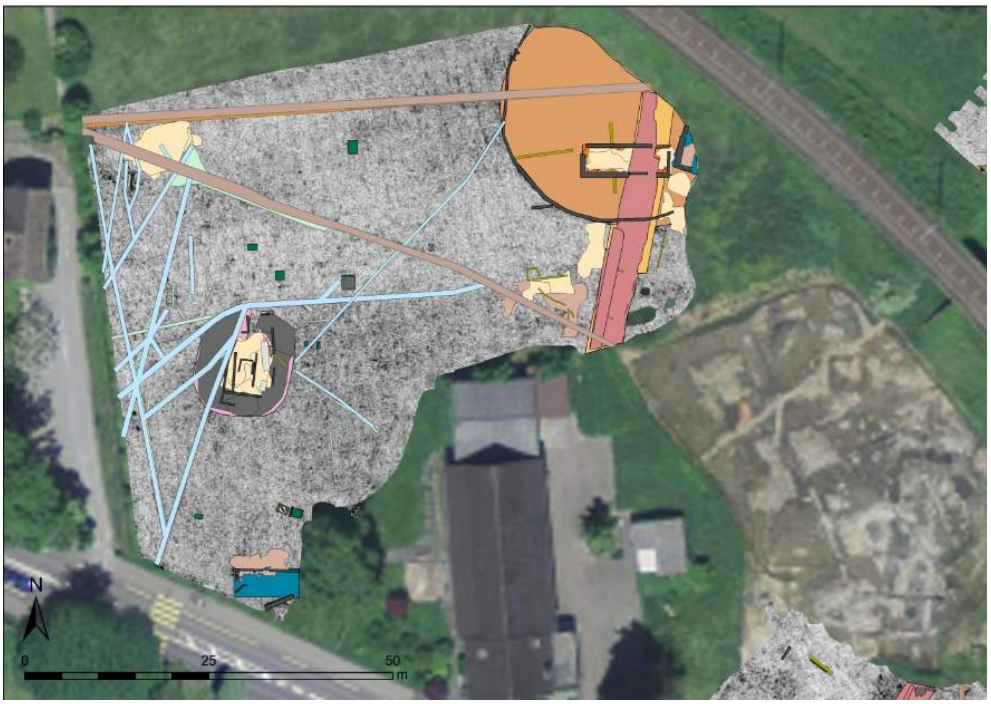

Figure 8: Detail of the GPR data interpretation at Jona, showing a possible early Christian enclosure and the nearby *excavated Roman temple district.*

Archaeological site of Wartau, Switzerland

An archaeological prospection survey conducted in collaboration with the Kantonsarchäologie St. Gallen at Wartau, Switzerland, in 2017 was not able to trace remains of the expected Late Bronze Age settlement, but instead revealed a very dense system of drainage trenches and several modern sewage pipes. At the foot of the nearby mountain a former road surface with integrated sewage canal may have been caused by an old access path leading up to the mediaeval mountain fortress.

Prehistoric settlement at Montlingerberg, Switzerland

During the detailed archaeological interpretation of the GPR dataset acquired on Montlingerberg in Switzerland in collaboration with the Kantonsarchäologie St. Gallen, several dry stone walls with similar orientation could be identified. Up to four different settlement phases, dating from the Middle and Late Bronze Age to the Early Iron Age were identified by spatial analysis of differences in the orientation of the buried wall remains.

In addition, the construction of the massive rampart of the hilltop settlement was also investigated. The GPR measurements were not only able to map several components already known from earlier excavations, but also revealed previously unknown construction details.

Figure 9: Orthophoto of Montlingerberg with a GPR depth-slice showing the extent of the survey superimposed.

Roman settlement at Trier (Herforst), Germany

Magnetic and GPR prospection conducted 2016 in collaboration with the partner Römisch-Germanisches Zentralmuseum Mainz in the vicinity of the Roman pottery production area near Herforst in Germany revealed several distinct anomalies that most likely have been caused by structures dating to the Roman period. The settings vary from complex stone built houses to pit houses with simple roof constructions. Most of the strong thermoremanent magnetised anomalies visible in the magnetic prospection data were also recognizable in the results of the GPR survey, indicating a wide variety of kilns.

In summer 2017, the LBI ArchPro teamed up with its partner RGZM to evaluate the results of the test survey conducted in 2016. This survey delineated hypothetic pottery production sites. Based on the interpretation of the magnetic and GPR prospection data, an area including three anomalies suggesting the remains of pottery kilns and associated infrastructure was opened up and partially excavated (Fig. 10). In order to document in 3D and to be able to virtually reconstruct the excavation process, as well as to generate detailed data for a comparison between the excavated structures and the geophysical prospection data and its archaeological interpretation, the entire excavation was three-dimensionally documented recorded using image-based modelling.

The comparison between the geophysical data interpretations and the excavation results showed good agreement (Fig. 11). All three assumed kilns were correctly located and their structures had been correctly identified in the high-resolution GPR prospection data. One assumed building interpreted from the GPR data was not identified in the excavation. A possible explanation for this could be sandstone layers covered by roughly 50 cm of overburden, which show rectangular cracks that could have been miss-interpreted as remains of a building. The excavation trench, however, was relatively small and thus the existence of further infrastructure associated with the pottery production at the site cannot be ruled out. In order to be able to model the magnetic anomalies found in the geophysical data, in-situ magnetic susceptibility (MS) measurements and samples for further mass-specific MS measurements were taken. Sediments and stratification of the natural background were studied for further geo-archaeological analysis.

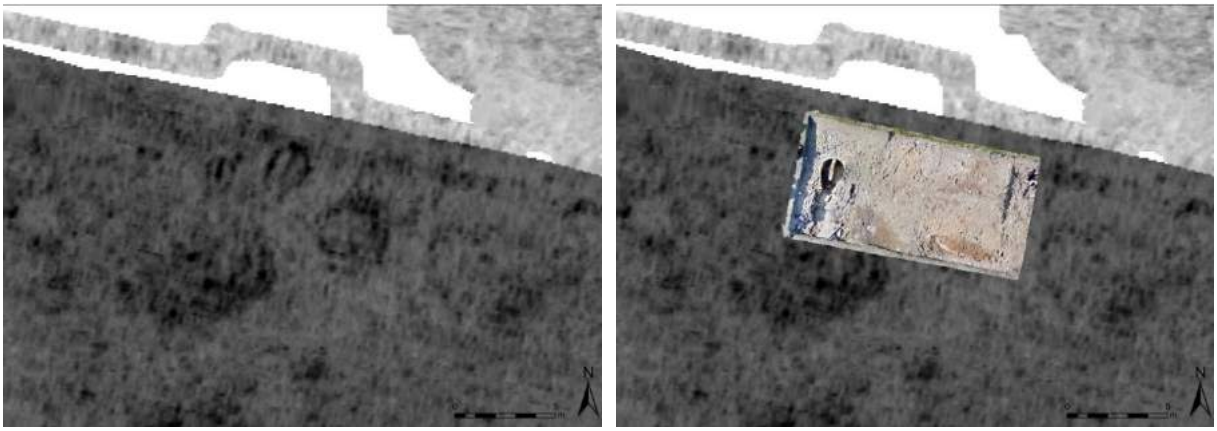

Figure 10: GPR prospection data and excavation orthophoto from the test site near Herforst where the discovery of several Roman period kilns was confirmed by excavation.

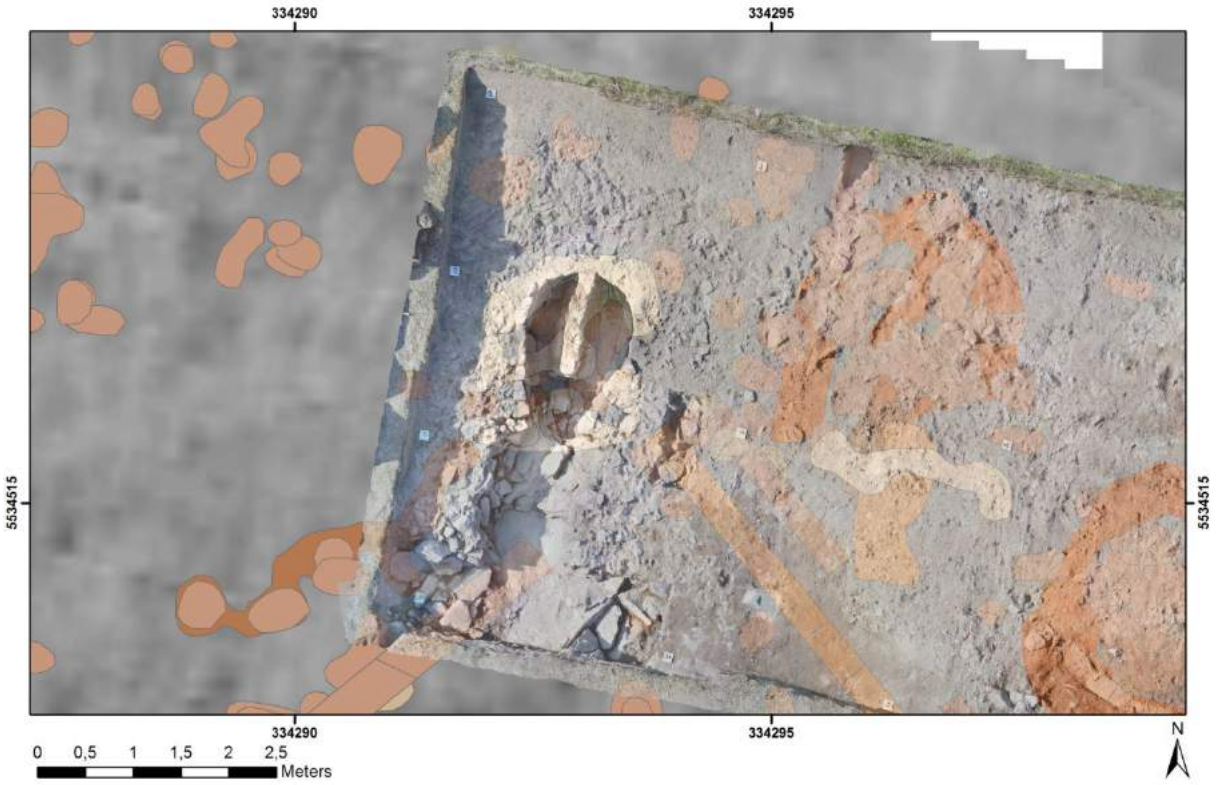

Figure 11: Herforst: Comparison between excavation results (orthophoto) and the interpretation of the GPR data (coloured polygons).

Prehistoric settlement at Durrington Walls, UK

In September 2015, the Stonehenge Hidden Landscapes project (SHLP) announced a remarkable archaeological discovery: Using state-of-the-art ground-penetrating radar and electromagnetic induction technology a series of some 200 strongly reflecting anomalies were discovered underneath the bank of the super-henge Durrington Walls (Fig. 12). Based on the results of earth resistance measurements conducted by British colleagues the geophysical anomalies were interpreted as to have been possibly caused by larger buried stones. However, excavations have revealed that in fact the anomalies had been caused by large postholes with an approximately 3.75 m long ramp, that also had been filled with loose chalk, giving the impression of an oblong body that had been initially interpreted as that of a large block sarsen.

The circle that would have been formed by the massive postholes would have had a diameter of circa 440 m. With a post placed at approximately 4-5 m intervals, we can assume that this structure consisted of up to 300 large wooden posts. This would have constituted one of the largest known post circles in Neolithic Britain, upstaged only by the massive and somewhat earlier post enclosure at Hindwell in Radnorshire, Wales, which was twice the size of Durrington Walls and held larger posts.

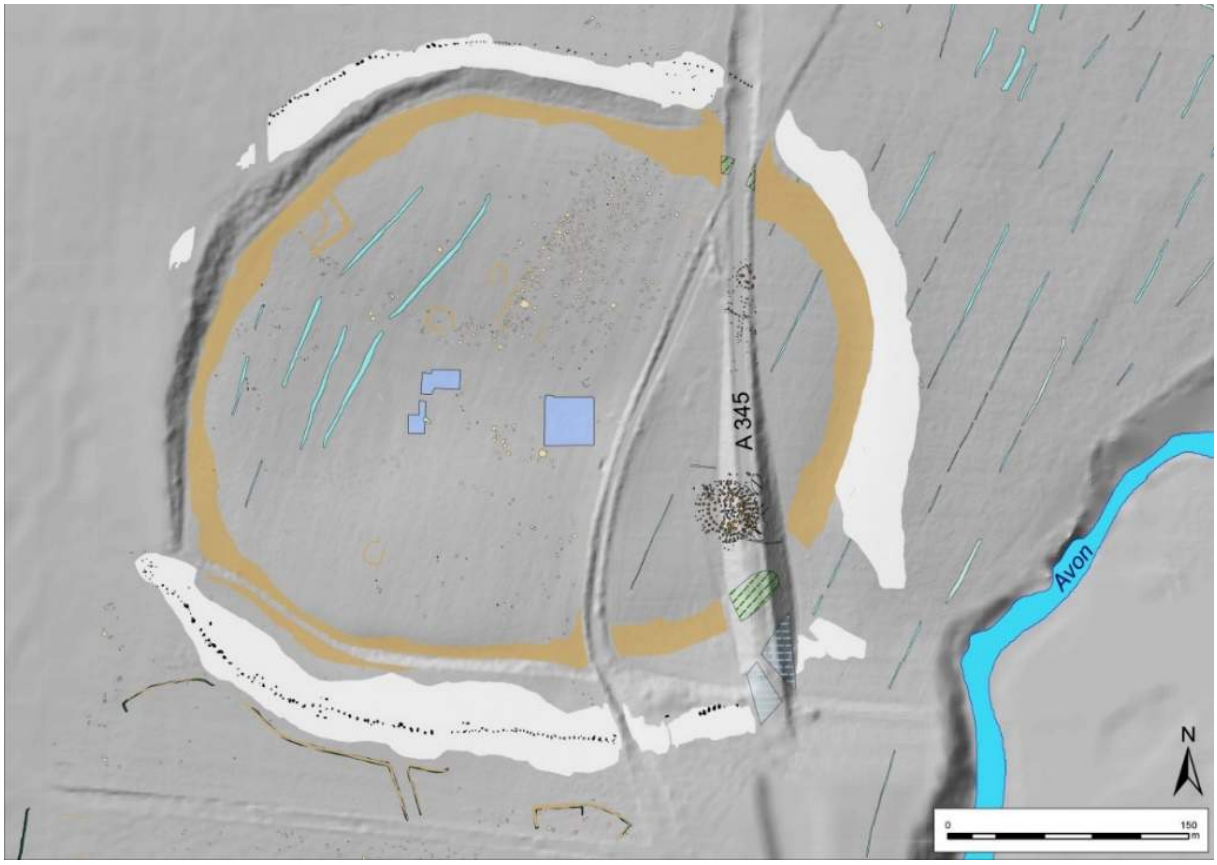

Figure 10: Interpretation map showing the circular arrangement of massive pits/postholes underneath the southern and northern embankment of the Durrington Walls super-henge.

Prospection of a Roman villa at Sargans, Switzerland

In 2017, a geophysical archaeological prospection survey was conducted at Sargans in Switzerland in collaboration with the Kantonsarchäologie St. Gallen. Different additional settlement features of the well-known, excavated and preserved Roman villa rustica could be located to the East and to the South. Several stone buildings and a water supply/sewerage system were discovered. The largest building measures about 120 m^2 in area and includes up to eight rooms that are divided by massive stone walls (Fig. 13). A central large room measuring approximately 23 m^2 with presumably a paved stone floor in its western part may have been located at the entrance, where a stone doorsill can be seen. The remaining rooms of between 3 m^2 and 14 m^2 size are located to the east, north and west of this area. The aforementioned probable water supply system seems to converge from the two rooms to the east and west of the entrance in the south in a main conduit. A similar situation of two converging water pipes can be observed six meters further to the east.

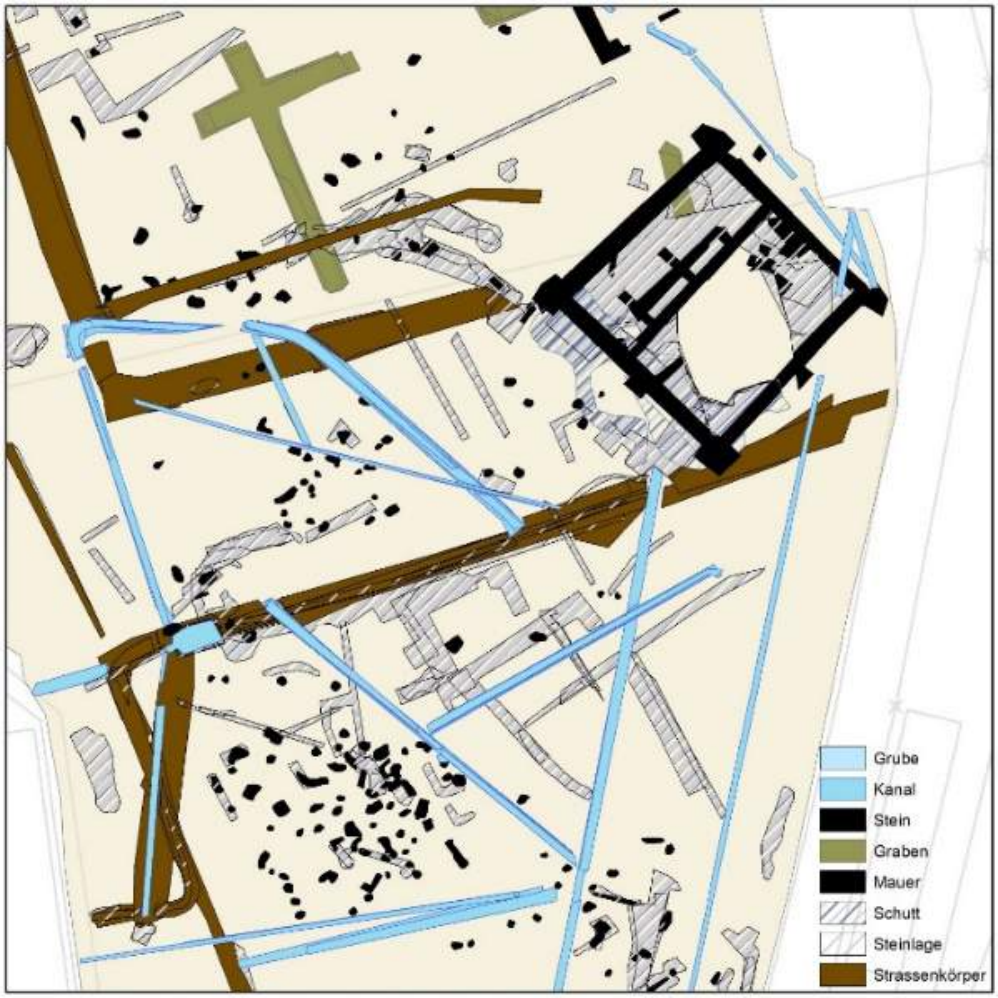

Figure 11: Sargans, interpretative mapping of GPR prospection results showing a multi-phased building.

Archaeological prospection pilot study at the medieval town of Pliska, Bulgaria

In cooperation with RGZM Mainz and the National Institute of Archaeology, Bulgarian Academy of Sciences, an archaeological prospection pilot study was carried out at the Bulgarian site of Pliska in late 2016.

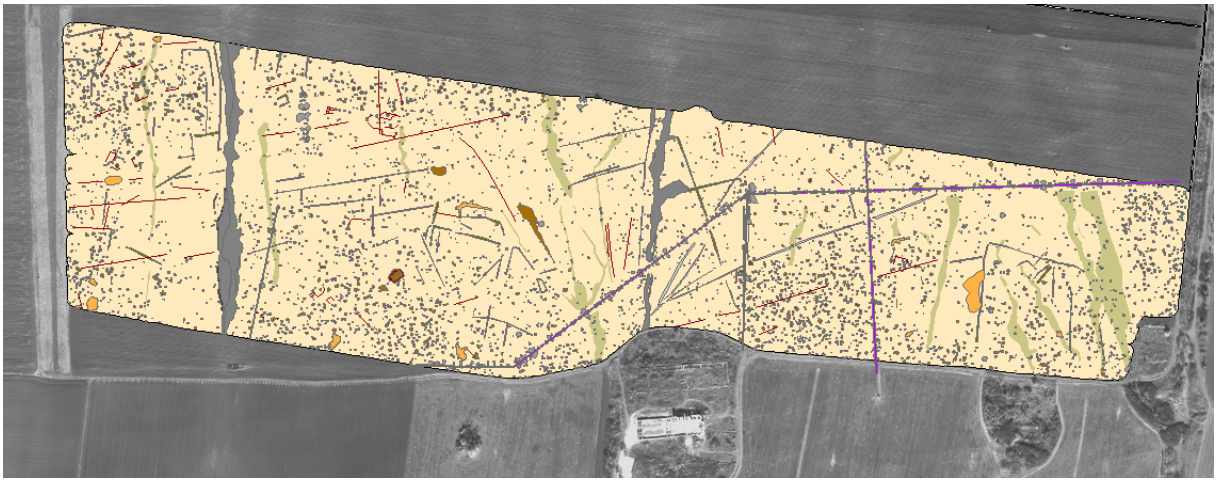

Figure 12: Pliska: Overview of the interpretation of the prospection data from the area north of the so-called Inner City.

The results of the geophysical archaeological prospection measurements show a large number of archaeologically relevant settlement features (Fig. 14). Two main streets are visible in the data, both already known from previous archaeological research. Results include numerous ditches that either overlap one another or form larger ditch systems. They probably date to different periods and are not related to the settlement remains from the Middle Ages. Anomalies in the survey data indicate that hundreds of assumed pits and pit houses are also located in the area. These are not evenly scattered but form distinct clusters that can be interpreted as separate settlement structures spatially separated from each other. This interpretation is in agreement with the results of systematic field walking. In addition to archaeological settlement features, the results from the magnetometry are also showing features that are likely to have their origins in geological, pedological and hydrological structures, indicating transformations in the landscape over millennia.

2.2 Virtual archaeology

ArcGIS Server solution

The LBI ArchPro has collected a huge amount of archaeological prospection data over the past eight years. So far, mainly offline data processing and analysis solutions, such as a file-based geodatabases, are used for the integrated interpretation of the data. The design of the underlying geodatabases has been optimized over the course of 2017. At the same time, new online solutions for an improved workflow were evaluated.

In order to guarantee redundant and effective data storage and interpretation workflow, a system should be designed and available that permits online data access and collaborative operation. As a first step an intranet was installed in the LBI ArchPro office in Langenzersdorf, capable of Gbit/s data transfer rates based on fixed connection via Ethernet cables. Together with data storage devices setup as raids, this forms the basis for the subsequent setup of a server physically placed in Langenzersdorf.

In December 2017 the configuration of the server was finalized, based on the requirements and specifications permitting the use of ‘ArcGIS Server’. This professional software solution enables the collaborative use of server geodatabases, permitting the online analysis of recorded datasets and the generation of joint interpretations. Additionally, it was decided that the internal licensing of ESRI products will in the future be operated by the LBI ArchPro itself, starting in the beginning of 2018, which also requires the setup of a license server.

The physical setup and configuration of the new server for the LBI ArchPro premises in Langenzersdorf is planned for April/May 2018. Once the system is installed and operating, it will guarantee a redundant workflow from storage of raw data to processing and interpretation of the data. The respective server based geodatabases will be provided by the server and will be available online. Specific results can be displayed online for a selected audience using ArcGIS online and the option of ArcGIS Story Maps.

Schwarzenbach training excavation

In July and August 2017 an archaeological training excavation was conducted in Schwarzenbach by the LBI ArchPro partner University of Vienna with supported from the LBI ArchPro, particularly concerning the digital recording of stratigraphic units. The excavation preceded the setup of an exhibition area that is intended to be installed in the summer of 2018. This exhibition will be showing results of the archaeological research undertaken at the site since the early 1990s. For this purpose existing architectural models (Celtic Museum, wall reconstruction) were already partly documented using Terrestrial Laser Scanning and Image-Based Modelling. These models form the basis for a virtual reconstruction of the site for the upcoming exhibition. A virtual tour will cover the temporal and spatial development of the archaeological landscape from the Neolithic to modern times.

Project Tell El-Dab'a

The Tell El-Dab'a (TED) project 'Puzzle in 4D', conducted in cooperation with OREA, Austrian Academy of Sciences, has been an important part of the Virtual Archaeology research program since 2015. During the project, the Harris Matrix Composer (HMC), originally developed in 2008, was adapted for the display of spatial and temporal relationships between stratigraphic units (HMC+). This modification of the HMC is based on Allen's interval algebra. Existing experience in the design and setup of geodatabases was used to implement an interpretation geodatabase especially developed for the project's purposes. The main task in software development was to implement an interface between ArcGIS Desktop 10.2 and HMC+, which turned out to be highly effective. This approach was also tested for the spatio-temporal analysis and display of stratigraphic relations of data gained from remote sensing (Airborne Laser Scanning). For this purpose, the dataset from 'St. Anna in der Wüste' has been used. With the HMC+/GIS interface it became possible to control both temporal and spatial aspects of archaeological data, and to link it with additional archaeological and non-archaeological information. These developments form the basis of a four dimensional geographical and archaeological information system.

Carnuntum

In the run-up to the press conference "Panem et circenses – Bread and games in Roman Carnuntum" a new virtual scene reconstruction was prepared. The main objective was the rendering and the postproduction of the phase of the first amphitheatre, as well as the same area in the later stage of the amphitheatre near the civil town. Additionally, an existing augmented reality app was enriched with further menus, interfaces, video streaming and animated objects. The first beta version of an HTC Vive app, permitting movement through the area and interaction with objects, was built and released for internal use.

Open-Source desktop planetarium Stellarium

Fabien Chéreau started the project "Stellarium" (http://stellarium.org) in 2001. Together with a handful of enthusiastic developers, they developed a graphically appealing astronomical simulation of the sky that runs on all three major desktop operating systems. It gained great popularity among amateur astronomers because of its easy-to-use interface and beautiful visualizations. Since 2012, the LBI ArchPro is involved in the further development of Stellarium. As complete novelty for such a program, a 3D module that allows for the exploration of a 3D landscape with buildings that may have astronomically motivated orientation was programmed together with students from TU Vienna.
Stellarium was further advanced in preparation of the exhibition "Stonehenge. Hidden Landscape" at the MAMUZ Museum in Mistelbach, where it was used to display panoramic sweeps with changing daylight and the famous solstice sunrise on the 5-projector panorama wall in form of an automated light show (Fig. 15). It is now capable of accessing the DE431 ephemeris data from NASA/JPL to simulate the planetary positions back to 13,001 BC. Our latest Stellarium development, presented at the SEAC2017 conference, deals with the temporal evolution of a site model. 3D models in Stellarium can now be prepared to be shown only temporally in the model, when their "live time" fits to the currently simulated time.

For advanced interaction with scene objects or more game-like experiences, a combination of Stellarium with the Unity3D game engine is currently under development and will be presented at the SEAC2018 Conference in August/September 2018 in Graz.

In the field of Cultural Astronomy, Stellarium is now one of the most-used programs for the simulation of past skyscapes, and only with the above described additions and still required further improvements in astronomical accuracy; such research will actually lead to accurate and dependable results. Its ease of use is especially welcome for researchers working in the fields of humanities. Outside this field, Stellarium is very popular among amateur and professional astronomers, where it can be used to control motor-driven telescopes, to simulate views through telescope/ocular combination, to simulate

supernova and nova outbursts, comets, and Solar and Lunar eclipses, or even satellites. It is also typically used in introductory astronomy lectures, to teach and understand celestial coordinate systems and the various motions of celestial objects.

Figure 13: Stellarium simulation of the summer solstice sunrise in the main axis of Stonehenge. Virtual reconstruction and panorama produced by 7reasons based on a photogrammetric survey by the LBI ArchPro.

2.3 Underwater archaeology

LBI ArchPro's research and development concerning underwater archaeological prospection progressed according to plan in 2017. In collaboration with partner University of Vienna (VIAS) and the County of Upper Austria, Direktion Kultur, in addition to the already in 2016 acquired novel Innomar SES-2000 quattro four-channel sediment sonar system, which had been purchased by the University of Vienna with support of the LBI ArchPro, a tendering process for the acquisition of a high-resolution multibeam sonar system through the University of Vienna on behalf of the County of Upper Austria was prepared. From the received tenders the best offer regarding the earlier defined selection criteria was selected, with emphasis having been placed on obtaining a system offering highest imaging resolution. The Reson SeaBat T50-P multibeam sonar including a sound velocity probe was delivered by MBT GmbH in August 2017.

In May 2017 a 6.35 m long Buster XXL All Weather Condition cabin motorboat with aluminium hull was purchased for the LBI ArchPro in Finland, after positive inspection of the second hand boat from a professional vessel surveyor. This boat offers a protected environment for the sensitive electronics and computer workstation needed for high-resolution geophysical data acquisition. Boats of the same type are used by two professional hydrographic surveying enterprises, while two further hydrographic surveying businesses use the next generation Buster XXL Cabin. The LBI ArchPro decided for the older model since it offers more dry space due to the closed bow section of the boat.

The LBI ArchPro acquired with the Septentrio AsteRx a professional dual head RTK-GNSS system offering NTRIP correction possibilities for precise positioning, and a high-end SBG Apogee-E Inertial Measurement Unit. Christian Klug from Wiener Netze GmbH kindly provided the LBI ArchPro with free access to the EPOSA correction data services, permitting efficient and precise network RTK-GNSS

Figure 14: First commissioning of the new bow-mounted multi-beam sonar system Reson SeaBat T50-P with the Apogee-E IMU sensor and the Septentrio AsteRx dual-head RTK-GNSS on the survey vessel on the Danube in October 2017.

operation. A special high-end workstation computer with two monitors for sensor and data acquisition control and navigation was purchased and installed on the survey vessel after installation of a sonar operator workspace. The boat and boat trailer were officially registered.

A hinged (foldaway) bow-mounted sensor-mounting for both the sediment sonar as well as the multi-beam sonar was designed and commissioned for construction in aluminium. The multi-beam sonar system was assembled in autumn 2017 with support from MBT GmbH and a first successful instrument test was conducted on the Danube.

A license for operation of motorboats on Austrian waterways and rivers as well as national and international lakes was acquired by the technical director of the project, and a team of the LBI ArchPro selected for boat training and underwater prospection. A naming ceremony of the survey vessel was conducted on Lake Mondsee in October in presence of the LBI ArchPro Board and SAB members as well as local stakeholders, where the owner of the Lake, Mag. Nicolette Waechter, baptised the boat on the name “Aurora” (Fig. 16).

2.4 Data acquisition and processing

For the purpose of quickly being able to test the potential of magnetometer prospection a light-weight manually operated push cart was constructed and equipped with a ruggedized Windows based tablet for data acquisition and navigation.

With technical support of the LBI ArchPro the Norwegian partner NIKU acquired an 21-channel 400 MHz MIRA array for efficient large-scale high-resolution GPR surveys in Norway.

The functionality of the ArchProGPR software was extended to handle new single antennas systems with DGPS positioning, supporting MALÅ GX160 antennas and several PulseEKKO singel channel antennas. ApRadar can now compute GeoTiff-files of topographical corrected radargramms and can produce a digital terrain model from the DGPS positions collected during a GPR survey. Several filters were developed to remove external “noise” that can be present/observed in GPR data.

The user interfaces of ApRadar and ApMag were redesigned, and have been adapted to each other. The status reporting of the programs was also redesigned and extended.All software programs (ArchProGPR, ArchProMagnetic, ApRadar, ApMag) were extended to produce GeoTiff files, now including the definition of the projection of the coordinates in EPSG format. A new software called ApEMI was developed to visualize electromagnetic data collected by a DualEM21s system.

3 Case studies and third party funded projects

3.1 Rechnitz, Austria

In the summer of 2017 geophysical prospection surveys were continued in the framework of the Case Study Rechnitz (Fig. 17). Over the course of four days two motorised, RTK-GNSS positioned custom-built Förster Fluxgate Magnetometer Systems were used. New results from the large-scale high resolution archaeological prospection measurements have confirmed the discovery of a third circular ditch system (Kreisgrabenanlage), which had already been detected in winter 2016/17. Furthermore, it was possible to define the boundaries of the large early Neolithic settlement structures detected in 2016.

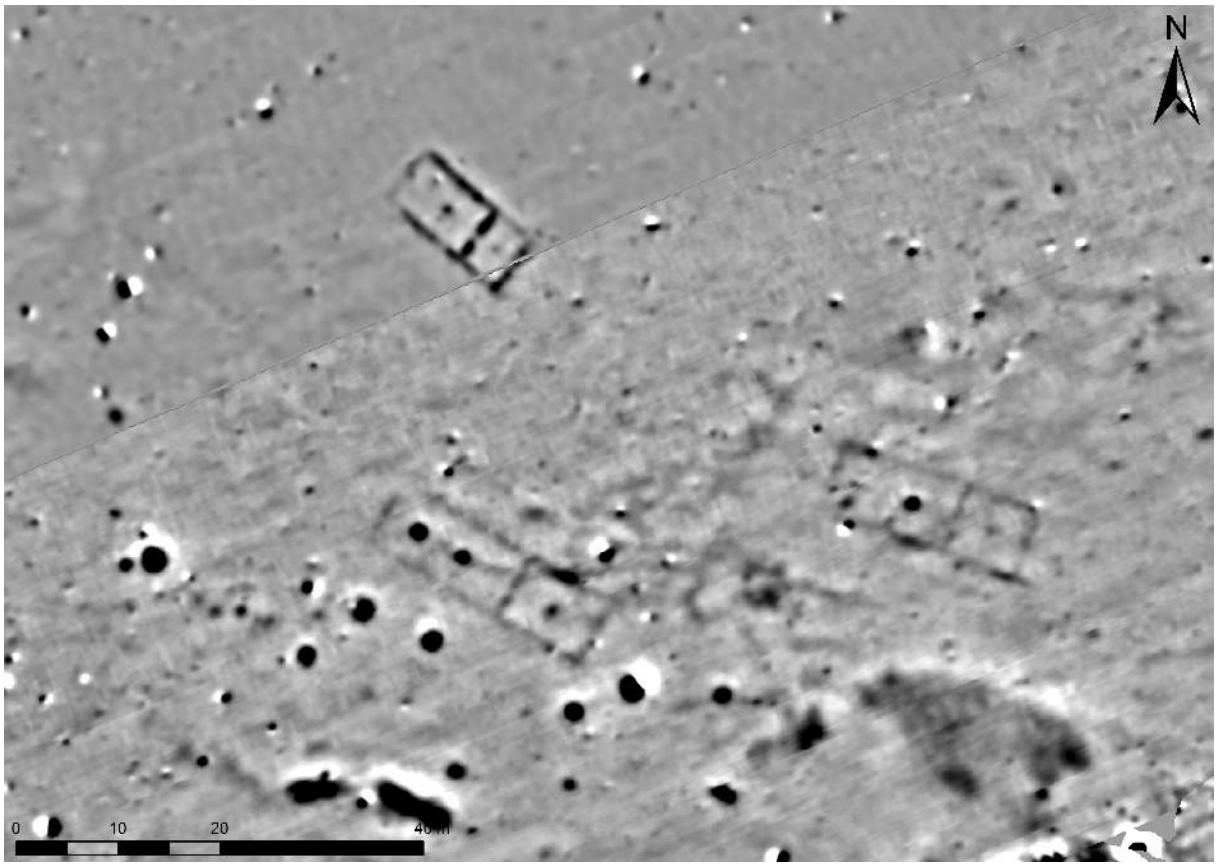

Figure 17: Rechnitz: Results of the magnetic prospection survey conducted in 2017, showing several buildings and settlement structures.

3.2 Velm, Austria

After the exceptional results generated by the high-resolution GPR survey in the area of the triple circular ditch system (Kreisgrabenanlage) near Velm, southeast from Vienna, driving-core sampling was carried out in August 2017 (Fig. 18). The purpose of these targeted coring was to answer specific questions that arose from the previous year's GPR survey. Here, highly reflective anomalies had been detected at a depth between 90 and 120 cm. The anomalies were observed in the area of the palisades as well as in the postholes belonging to individual house structures. These highly reflective anomalies were targeted with several boreholes in order to better understand the physical properties of the underlying structures causing the anomalies them.

In the extracted drill cores, a clearly recognisable concretion can be seen approximately in the same depth range as indicated by the GPR measurement. This concretion has most likely been caused by the compaction due to the former inserted wooden posts. This minimum-invasive investigation yielded important additional information on the construction of the Velm circular ditch system.

Figure 18: Velm: Extracting cores with the motorized vibration coring probe.

3.3 Volders, Austria

The medieval castle "Schönwerth" in Volders in Tyrol dates from the end of the 12th century to the turn of the 14th century. Apart from the surrounding wall, the building has completely disappeared nowadays. It was already partially investigated in 1997 by means of earth resistance measurements. In March 2017 a team of the LBI ArchPro in collaboration with the University Innsbruck, Institute for Archaeology conducted a geophysical prospection survey with the high-resolution GPR system MIRA 1 at the site.

The excellent results of the ground penetrating radar measurement showed the remains of a fortified castle in the central area, which had been enlarged by one or more annexes in a later phase. The central courtyard of the castle and the south-facing entrance are clearly visible in the data. The results also revealed that the fortification was built on the eastern edge of the Voldertalbach delta rubble; abandoned channel features suggest that the geomorphological situation was used to surrounded the fort and its later extension with a moat.

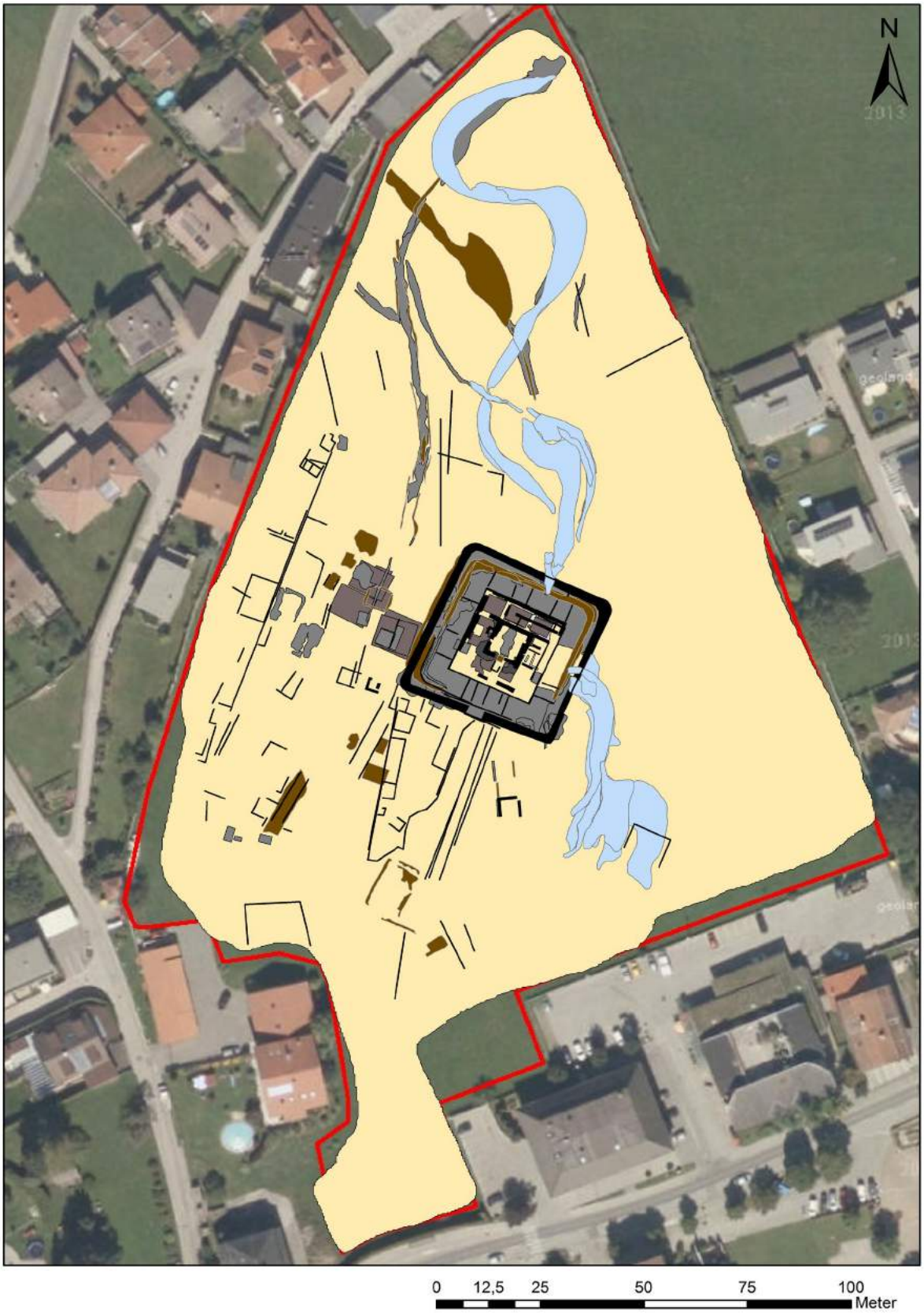

Figure 19: Volders: Interpretation map of GPR survey showing the detected buried remains.

3.4 Schaanwald, Liechtenstein

In autumn 2017, an already known and partly excavated Roman Villa Rustica was surveyed by a team of the LBI ArchPro with motorized high-resolution GPR in Schaanwald, Liechtenstein. The purpose of this survey in cooperation with the archaeological state department of Liechtenstein was to evaluate the applicability of GPR for the pedological/geological conditions of this region and to raise awareness for the non-invasive archaeological prospection approach. The collected data allowed for the interpretation of a well preserved main building of a Villa Rustica as well as of a bath house and further outbuildings. In the western part of the investigated area, anomalies have been detected that could be interpreted as the remains of Roman burials, which is supported by their spatial proximity to a contemporaneous Roman road in this area. The survey area did not cover the full extent of the archaeological site. Therefore, the prospection survey will be continued in spring 2018.

Figure 20: Schaanwald, FL: GPR depth-slice image and interpretation of the discovered remains of the Roman Villa Rustica.

3.5 Westfalen-Lippe, Germany

In collaboration with the county archaeologists of LBI ArchPro partner Landesverband Westfalen-Lippe, some 140 ha motorised and 4.4 ha manual magnetometry were conducted in the spring of 2017. In total, eight sites were investigated in different parts of Westphalia. These studies were used to test the performance of the handheld 4-channel magnetometer system, as well as the potential of the motorised 8-channel magnetometer array. The motorised surveys were carried out at Schmerlecke (100 hectares), Bad Sassendorf (30.5 hectares), Rahden (5.5 hectares), Ibbenbüren (3.6 hectares), and Wilnsdorf (4.5 hectares motorised; 0.6 hectares handheld). Handheld magnetometry surveys were undertaken at Altenberg (0.5 hectares), Seeste (1.1 hectares), Westerkappeln (0.5 hectares), and Sloopstene (1.1 hectares).

The sites covered by motorised magnetometry included Schmerlecke, a multi-period landscape where the survey centred on the previously excavated megalithic graves. Further structures identified during this archaeological prospection survey included the remains of grave mounds, an undated enclosure, a section of the Hellweg, and the traces of medieval ridge and furrow plough patterns.

At Bad Sassendorf a Neolithic earthwork (Fig. 21) was investigated in order to understand its total extent. A second area in the proximity, where another earthwork was thought to have been located based on anomalies visible in aerial images, was also surveyed. However, the magnetometry results did not reveal any earthwork there. Other surveys included the mining site of Wilnsdorf, for which manual magnetometer surveys were carried out over the mineshaft area, as well as a motorised survey over an area previously not associated with the site, revealing various newly discovered features. At Ibbenbüren, the survey of an area suspected of containing traces belonging to a medieval structure in the western area of the field, revealed a multitude of highly magnetic anomalies that could relate to activity dating to this period. However, the results were obscured by the old course of the stream, which today runs through the northern part of the site.

Figure 21: The Neolithic earthwork of Bad Sassendorf.

3.6 St. Gallen, Switzerland

The collegiate church of St. Gallen serves as a cathedral to the diocese of St. Gallen (Fig 22) and it has been the church of the St. Gallen monastery since its construction between 1755 and 1766 to 1805. The collegiate church and the collegiate district were included in 1983 into the UNESCO list of World Cultural Heritage Sites. In 2017, the LBI ArchPro was able to conduct a manual GPR survey in the area of the monastery. The aim of this survey was to investigate the accurateness of a 9th century map, which depicts buildings in the area within the monastery walls. The preliminary interpretation of the newly collected data showed that older structures, which correspond to the early medieval east-west oriented grid, are indeed visible underneath the medieval and modern building remains and, thus, confirmed the layout of the map.

Figure 15: Klaus Löcker conducting a manual multichannel GPR survey in search of buried remains of the monastery of St. Gallen.

3.7 Stubersheim, Germany

The large-scale archaeological prospection case study that had been carried out in cooperation with LBI ArchPro partner RGZM on the Stubersheimer Alb since 2011 comprises a total investigated area of 175 ha. In 2017, geomagnetic measurements were conducted to map 31.4 ha in the area of Bräunisheim; to the north and west of the village an area of 8.3 ha were investigated by GPR survey. Two Roman estates dating to the 2nd/3rd century A.D. have been detected.

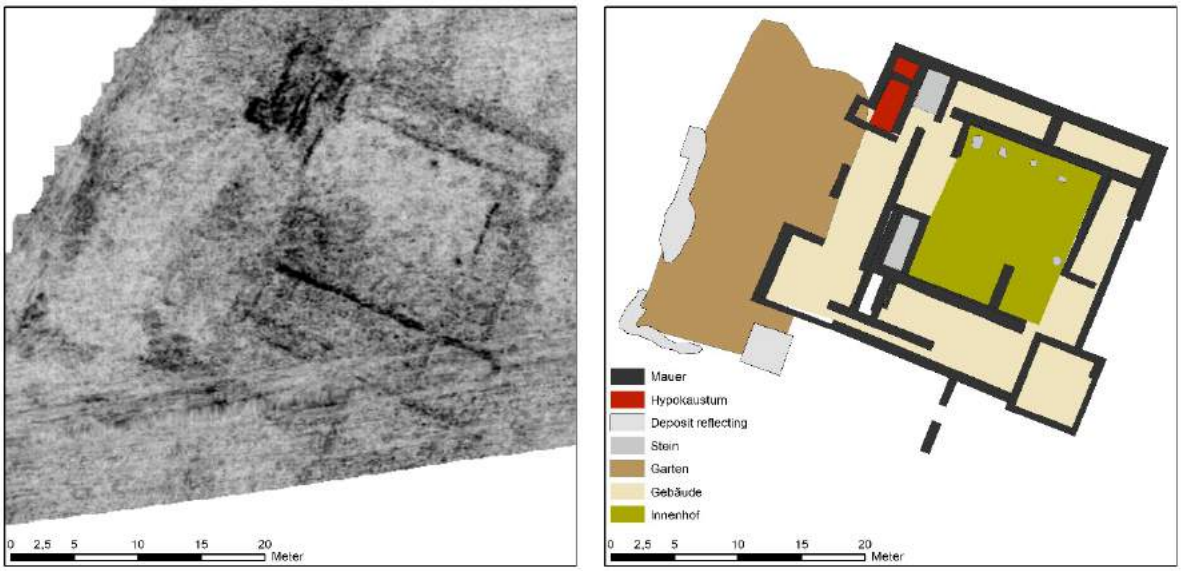

Figure 16: GPR depth-slice and interpretation map of the main building of the Villa Rustica prospected at Tellenäckern/Stubersheim.

3.8 Vestfold, Norway

Between September 16th and October 11th 2017 a team of the LBI ArchPro supported by members of partners Vestfold fylkeskommune and NIKU carried out a fieldwork campaign in the framework of the archaeological prospection Case Study Vestfold. Surveys concentrated on two main areas: Borre and Oseberg/Slagendalen. Measurement systems applied included the GPR system MIRA 2 and the magnetometer system EAL 1 (used for selected areas at Slagen). Additionally, NIKU provided the GPR systems MIRA 3 and MIRA 4 for selected areas at Borre. In total an area covering 76.74 ha was surveyed using GPR, and 11.04 ha using magnetometry.

Apart from few recently ploughed and therefore inaccessible areas in the south-eastern part of the investigation area at Borre, the fieldwork there led to an almost complete coverage of the site with high-resolution GPR. The newly executed high-resolution GPR survey resulted in a much clearer image of the buried archaeological structures, including the large hall building discovered in 2013.

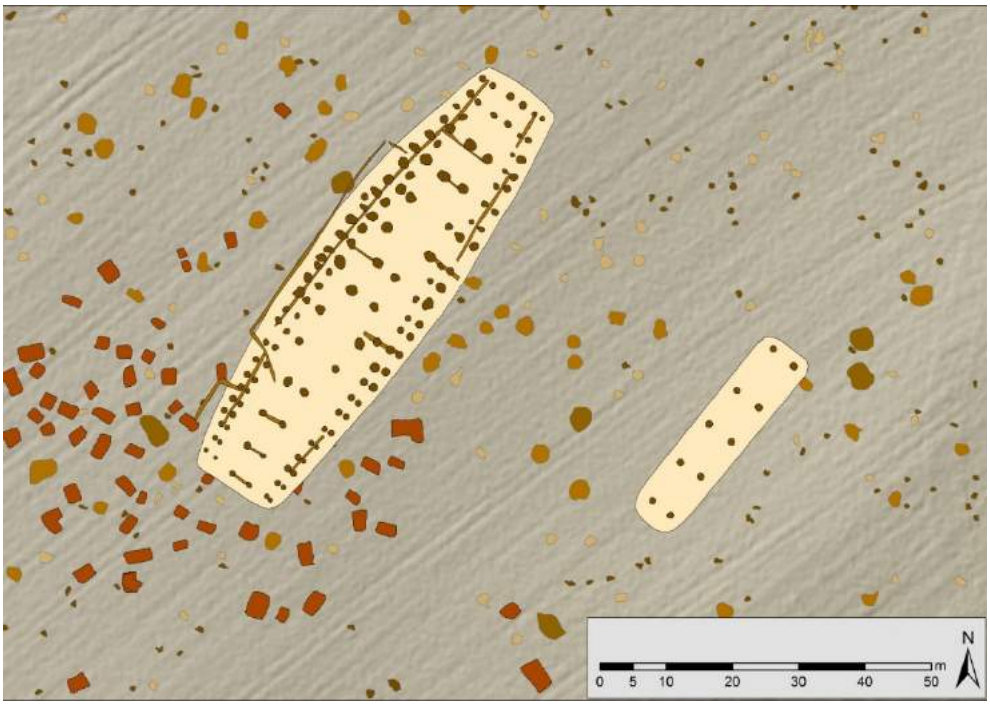

Figure 17: Interpretation of the GPR data showing two hall buildings with surrounding pit structures in the vicinity of Borre park.

Furthermore, the new results imaged traces of a possible burial mound close to Midgard historisk senter, traces of two smaller buildings in the vicinity of the large hall, as well as a number of smaller, possible burials in the south-western part of the survey area. A house structure possibly dating to the Bronze Age was discovered in a cemetery, and will be subject to further archaeological investigations in the summer of 2018.

The survey campaign in Slagendalen was able to complete the GPR measurements in all currently accessible areas within Priority Zone 1, with the exception of one field for which no permission was granted by the owner. Preliminary results include traces of at least two longhouses situated on the flood plain to the west of Rom Østre, close to the river Slagen, probably dating to the Iron Age. These findings are also supported by the magnetic prospection data. Further settlement traces, including those of two houses/building plots, were discovered close to the Rom burial mound on the other, northern side of Slagen river. A number of cooking pits was discovered in a field to the west of the Oseberg ship burial mound. Since 2012, the total area investigated with magnetic prospection in Slagendalen amounts to 156.8 ha, while the areas mapped with high-resolution GPR add up to 179.1 ha.

During the first week (September 18th–22nd), additional fieldwork in the framework of the Borre Monitoring Project was conducted by Vestfold fylkeskommune and the LBI ArchPro, including the removal of soil moisture sensors and of the local weather station, the recording of sections and retrieval of sample material. Additionally, selected areas in halls A and B were investigated by small archaeological test trenches.

3.9 Bisenzio, Italy

The 2017 prospection campaign was the last survey in this three-year project, which had been conducted in collaboration with the LBI ArchPro partner RGZM, the University of Mainz, and funded by German Science Foundation (DFG). The site is marked by the severe destruction of archaeological features due to heavy ploughing; the topography and climate have both been rather challenging to the motorized geophysical prospection approach, caused quite some damage to the survey systems.

In 2017 the temperatures encountered were not too hot and the fieldwork (Fig. 25) progressed well. In total some 40 hectares of high-resolution GPR data were acquired on all remaining accessible areas.

A first report of the fieldwork 2015/2016 has been prepared: A. Babbi, F. Delpino, P. M. Guarino, M. Lucarini, F. Miketta, H. Schiel, I. Trinks, “Project ‚Bisenzio‘ (Capodimonte - VT, Italy). Report of research activities, 2015-2016.”, BABESCH Annual Papers on Mediterranean Archaeology 94.

The final project report is currently being prepared.

Figure 25: GPR prospection with the 500 MHz SPIDAR array at Bisenzio.

3.10 Ancient Lousoi, Peloponnesus, Greece

Over the course of two weeks in July 2017 a geophysical archaeological prospection pilot study was realized at the site of the ancient town of Lousoi in Archaia region on Peloponnesus, Greece. The intention of the survey, conducted on behalf of and in collaboration with the Austrian Archaeological Institute at Athens with support of LBI ArchPro partner ZAMG, was to test the potential of large-scale magnetometry and high-resolution ground-penetrating radar measurements for the mapping of buried architectural remains, with the goal to support the systematic analysis and understanding of the site’s overall urban architectural layout and structure, which is expected to extend over 20-40 hectares.

Using a motorized 8-channel Foerster Fluxgate magnetometer system with 25 cm cross-line gradiometer spacing, as well as a six-channel 500 MHz Sensors & Software SPIDAR GPR array towed with a Quad bike (Fig. 26) and a manually operated 3-channel 500 MHz GPR cart, both as well with 25 cm horizontal antenna spacing, the open areas in the vicinity of the public centre of ancient Lousoi were investigated. The still buried remains of the partly excavated, two aisled stoa were mapped by GPR measurements. Several building remains were newly detected on the terraces to the east of the

stoa, as well as further details of the urban structure. The extent of the built-up area to the low-land in the west could be clearly identified by magnetometry.

A FWF funding application from Dr. Baier for further archaeological prospection at Lousoi has been supported by the LBI ArchPro. The local antiquity authorities were impressed by the first results.

Figure 18: Left: 6.6 ha of GPR survey area covered during pilot study at ancient Lousoi. Right: Georg Ladstätter, Head of the Austrian Archaeological Institute offices in Athens viewing the freshly harvested prospection results in the field.

4 Training and teaching

4.1 Interdisciplinary fieldwork project at Schwarzenbach-Burg (Lower Austria)

In summer 2017 selected areas of the prehistoric settlement of Schwarzenbach were excavated as part of an archaeological training and research excavation (Fig. 27). The archaeological site of "Schwarzenbach-Burg" has been known since 1920. It is located on a raised plateau that had been fortified with a ditch and bank earthwork in prehistoric times, which only becomes visible in geophysical prospection data today. Within the framework of this year's research and training excavation, two field courses were held by the Institute for Prehistory and Historical Archaeology of the University of Vienna. This four-week field school included a basic practical course for first year archaeology students, as well as more in-depth training for advanced students. The LBI ArchPro was responsible for the scientific implementation of the project together with its partners VIAS – Vienna Institute for Archaeological Science, and the Institute for Prehistory and Historical Archaeology of the University of Vienna. Results of the excavation include house floor plans, postholes and pits from the Neolithic, Bronze Age and Iron Age.

Figure 19 Excavation area at Schwarzenbach-Burg in 2017. Reconstructions of Celtic houses at the open-air museum of Schwarzenbach are visible in the background.

4.2 Image-Based Modelling workshop

In September 2017 Geert Verhoeven gave an intensive 5-day course on image-based modelling for LBI ArchPro staff. The workshop involved both theoretical and practical training.

4.3 Teaching activities

Lectures at the University Vienna

Wolfgang Neubauer	Summer 2017	060053 PR Lehrgrabung 2 (vierwöchig)
	Summer 2017	060081 PV Privatissimum
	Winter 2017	060108 SE Seminar Abschlussarbeit
Michael Doneus	Summer 2017	060076 PV Privatissimum
	Summer 2017	060063 UE GIS-Anwendungen in der Archäologie

	Summer 2017	060060 UE Luftbildarchäologische Interpretation
	Summer 2017	060052 PR Lehrgrabung 1
	Winter 2017	060104 SE Seminar Abschlussarbeit
	Winter 2017	060099 UE Flugzeuggetragenes Laserscanning (LiDAR) für ArchäologInnen
	Winter 2017	060096 PR Vertiefende Übungen zur Luftbildarchäologie
	Winter 2017	060080 SE The Archaeology of Western Sicily
	Winter 2017	060069 UE GIS-Anwendungen in der Archäologie
Klaus Löcker	Summer 2017	060059 UE Grundlagen archäologischer Stratigrafie
	Summer 2017	060062 PR Experimentelle Archäologie in der Praxis
	Winter 2017	060059 VO Grundlagen der Experimentellen Archäologie
Immo Trinks	Winter 2017	060057 VO Einführung Theorie Geophysikalische Prospektion
Georg Zotti	Summer 2017	060091 VO Einführung in die Archäoastronomie

4.4 Internships

In 2017 the two talented interns Jona Schlegel and Constantin Hladik joined the LBI ArchPro temporarily and were instructed by LBI ArchPro staff. They experienced and contributed to the interpretation of geophysical archaeological prospection data, the setup and design of geodatabases, IBM data capturing and processing and the online presentation of results based on map stories (ArcGIS online).

Geophysicist Ilias Fikos from Thessaloniki University joined the LBI ArchPro for one week in October 2017 to learn about the latest developments in the field of large-scale high-resolution GPR measurements. This exchange was funded by ERASMUS+ Mobility Programme for Training.

5 Dissemination

5.1 Dissemination workshop Traunkirchen, March 2nd-3rd 2017

The scientific and public dissemination of the research and development results of the LBI ArchPro are of fundamental importance to its international scientific recognition. Aside of the scholarly publications for the scientific community, any directly or indirectly publicly funded research demands considerable effort to present a responsible use of the financial means to the public. Since its foundation in 2010, the LBI ArchPro has therefore placed a focus on informing both the general public as well as stakeholders about their novel archaeological prospection approach and related discoveries.

In order to adequately meet this goal, the LBI ArchPro has organized a dissemination workshop in March 2017. During the workshop, the team of the LBI ArchPro as well as of other partner institutions were given the possibility to learn about concepts and tools relevant for research and dissemination activities at the institute, and developed a dissemination strategy for the upcoming research period 2017-2024. The workshop was led by Dr. Marie Theresa Norn, who is an expert in research and innovation policy at the Danish think tank DEA (www.dea.nu).

5.2 Board Meeting and symposium St. Gilgen, October 12th -13th 2017

The 2017 autumn board meeting and scientific symposium took place in the Salzkammergut region of Austria on October 12th-13th. During the symposium, team and representatives of the partner organisations presented major topics and core activities from the current research programme, in order to encourage the scientific exchange and discussion within the consortium. The participants also gained insights into the latest developments of the LBI ArchPro's underwater prospection program, conducted in collaboration with Vienna University and VIAS as well as the Direktion Kultur of the County of Upper Austria, and were introduced to the new survey vessel on Lake Mondsee during the official boat launching and naming ceremony (Fig. 28).

On the evening of October 12th the Heimatmuseum St. Gilgen hosted a public presentation on the Falkenstein project together with political representatives of the region. Falkenstein near Lake Wolfgangsee was the fourth most popular place of pilgrimage from the 14th century onwards. In 2009 experts of the LBI ArchPro discovered the hidden remains of a hermitage dating to the 17th century just below the church at Falkenstein using GPR measurements. Subsequently the site was investigated by archaeological excavations, which yielded fascinating insights into the lives of the hermits and pilgrims.

Figure 28: Sonar survey boat launching and naming ceremony at Lake Mondsee.

5.3 Scientific dissemination

Articles in journals

A1: articles published in journals listed in the ISI Web of Knowledge

Filzwieser, R.; Olesen, L. H.; Verhoeven, G.; Schlosser Mauritsen, E.; Neubauer, W.; Trinks, I.; Nowak, M.; Nowak, R.; Schneidhofer, P.; Nau, E.; Gabler, M. (2017): Integration of Complementary Archaeological Prospection Data from a Late Iron Age Settlement at Vesterager—Denmark. In: *Journal of Archaeological Method and Theory* (online). DOI: 10.1007/s10816-017-9338-y.

Grammer, B.; Draganits, E.; Gretscher, M.; Muss, U. (2017): LiDAR-guided Archaeological Survey of a Mediterranean Landscape. Lessons from the Ancient Greek Polis of Kolophon (Ionia, Western Anatolia). In: *Archaeological Prospection* 24 (4), 311–333. DOI: 10.1002/arp.1572.

Schneidhofer, P.; Nau, E.; Leigh McGraw, J.; Tonning, C.; Draganits, E.; Gustavsen, L.; Trinks, I.; Filzwieser, R.; Aldrian, L.; Gansum, T.; Bill, J.; Neubauer, W.; Paasche, K. (2017): Geoarchaeological evaluation of ground penetrating radar and magnetometry surveys at the Iron Age burial mound Rom in Norway. In: *Archaeological Prospection* 24 (4), 425–443. DOI: 10.1002/arp.1579.

Sevara, C.; Verhoeven, G.; Doneus, M.; Draganits, E. (2017): Surfaces from the Visual Past. Recovering High-Resolution Terrain Data from Historic Aerial Imagery for Multitemporal Landscape Analysis. In: *Journal of Archaeological Method and Theory* (open access). DOI: 10.1007/s10816-017-9348-9.

Verhoeven, G. (2017): BRDF and its Impact on Aerial Archaeological Photography. In: *Archaeological Prospection* 24 (2), 133–140. DOI: 10.1002/arp.1559.

Verhoeven, G. (2017): Mesh is more. Using all geometric dimensions for the archaeological analysis and interpretative mapping of 3D surfaces. In: *Journal of Archaeological Method and Theory* 24 (4), 999–1033.

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

Doneus, N.; Doneus, M.; Ettinger-Starčić, Z. (2017): The ancient city of Osor, northern Adriatic, in integrated archaeological prospection. In: *Hortus Artium Medievalium* 23 (2), 761–775. DOI: 10.1484/J.HAM.5.113761.

Verhoeven, G. (2017): Are We There Yet? A Review and Assessment of Archaeological Passive Airborne Optical Imaging Approaches in the Light of Landscape Archaeology. In: *Geosciences* 7 (3), 86. DOI: 10.3390/geosciences7030086.

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

Gibson, A.; Neubauer, W.; Flöry, S.; Filzwieser, R.; Nau, E.; Schneidhofer, P.; Strapazzon, G.; Batt, C.; Greenwood, D.; Bradley, P. (2017): Excavation of a Neolithic House at Yarnbury, near Grassington, North Yorkshire. In: *Proceedings of the Prehistoric Society* 83, 189–212. DOI: 10.1017/ppr.2016.15.

Tonning, C.; Orten Lie, R.; Lia, V.; Gabler, M.; Neubauer, W. (2017): Er de alle løsfunn? Metallsøkfunn og potensialet for bevart kontekst under pløyelaget. In: *VIKING, Norsk Arkeologisk Årbok* LXXX, 223–242. DOI: 10.5617/viking.5481.

A4: articles published in journals without peer-review

Gugl, C.; Wallner, M.; Neubauer, W.; Doneus, M.; Löcker, K. (2017): Die militärischen Anlagen in Carnuntum. In: F. Beutler, C. Farka, C. Gugl, F. Humer, G. Kremer und E. Poilhammer (Hg.): Der Adler Roms. Carnuntum und die Armee der Caesaren. Katalog zur Ausstellung im Archäologischen Museum Carnuntinum 2017. Ausstellungskatalog. Bad Vöslau (Katalog des Niederösterreichischen Landesmuseums, Neue Folge Nr. 538), 76–85.

Klammer, J.; Doneus, M.; Fornwagner, U.; Fera, M. (2017): Archäologische Prospektion auf Basis von flugzeuggetragenen Laserscanaufnahmen – Erfahrungen und Ergebnisse der Projekte 2013-2016 in Burgenland und Wien. In: *Österreichische Zeitschrift für Kunst und Denkmalpflege* LXXI (1), 54–61.

Trausmuth, T.; Wallner, M.; Vonkilch, A. (in press): Was der Bauer nicht kennt, frisst er nicht! Kulinarik in der Eisenzeit? In: R. Karl und J. Leskovar (Hg.): Interpretierte Eisenzeiten. Fallstudien, Methoden, Theorie.

Tagungsbeiträge der 7. Linzer Gespräche zur Interpretativen Eisenzeitarchäologie, 17.-19.11.2016. Linz: Land Oberösterreich OÖ. Landesmuseum.

Books and book chapters

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

Doneus, M.; Rammer, E. (2017): Lengyel-Keramik und relative Chronologie. In: E. Lenneis (Hg.): Erste Bauerndörfer – älteste Kultbauten. Die frühe und mittlere Jungsteinzeit in Niederösterreich. Wien: ÖAW (Archäologie Niederösterreichs), 332–346.

Doneus, M.; Rammer, E. (2017): Lengyel-Kultur und Stichbandkeramik. In: E. Lenneis (Hg.): Erste Bauerndörfer – älteste Kultbauten. Die frühe und mittlere Jungsteinzeit in Niederösterreich. Wien: ÖAW (Archäologie Niederösterreichs), 20-25.

Gugl, C.; Jernej, R.; Neubauer, W.; Nau, E. (2017): Die Kasernen der singulares des norischen Provinzstatthalters in Virunum. In: I. Dörfler, P. Gleirscher, S. Ladstätter und I. Pucker (Hg.): AD AMUSSIM. Festschrift zum 65. Geburtstag von Franz Glaser. Klagenfurt (Kärntner Museumsschriften, 85), 61–85.

Neubauer, W. (2017): Kreisgrabenanlagen (4850/4750 – 4650/4500 BC). In: E. Lenneis (Hg.): Erste Bauerndörfer – älteste Kultbauten. Die frühe und mittlere Jungsteinzeit in Niederösterreich. Wien: ÖAW (Archäologie Niederösterreichs), 276–296.

Rammer, E.; Doneus, M. (2017): Kult und Religion – Figuralplastik und anthropomorphe Gefäße. In: E. Lenneis (Hg.): Erste Bauerndörfer – älteste Kultbauten. Die frühe und mittlere Jungsteinzeit in Niederösterreich. Wien: ÖAW (Archäologie Niederösterreichs), 320–331.

Van Limbergen, D.; Vermeulen, F.; Verhoeven, G.; Verdonck, L. (2017): Methodological approach. In: F. Vermeulen, D. van Limbergen, P. Monsieur und D. Taelman (Eds.): The Potenza valley survey (Marche, Italy) : settlement dynamics and changing material culture in an Adriatic valley between Iron Age and Late Antiquity (Academia Belgica. Studia Archaeologica, 1), 10–41.

Zotti, G. (2017): Sonnen- oder talwärts? Die Orientierung der Zugänge der Kreisgrabenanlagen Niederösterreichs. In: E. Lenneis (Hg.): Erste Bauerndörfer – älteste Kultbauten. Die frühe und mittlere Jungsteinzeit in Niederösterreich. Wien: ÖAW (Archäologie Niederösterreichs), 297–306.

Conference Proceedings

C1: articles in Proceedings listed in the ISI Web of Science, not included in A1, A2, A3, A4 (full articles – no abstracts)

Doneus, M.; Fornwagner, U.; Liem, J.; Sevara, C. (2017): APIS – A digital inventory of archaeological heritage based on remote sensing data. In: J. Hayes, C. Ouimet, M. Santana Quintero, S. Fai und L. Smith (Hg.): ICOMOS/ISPRS International Scientific Committee on Heritage Documentation (CIPA). 26th International CIPA Symposium – Digital Workflows for Heritage Conservation. Ottawa, Canada, 28.08.-01.09.2017. ISPRS (ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., IV-2/W2), 67–73.

Trinks, I.; Wallner, M.; Kucera, M.; Verhoeven, G.; Torrejón Valdelomar, J.; Löcker, K.; Nau, E.; Sevara, C.; Aldrian, L.; Neubauer, W.; Klein, M. (2017): Documenting Bronze age Akrotiri on Thera using laser scanning, image-based modelling and geophysical prospection. In: D. Aguilera, A. Georgopoulos, T. Kersten, F. Remondino und E. Stathopoulou (Eds.): TC II & CIPA. 3D Virtual Reconstruction and Visualization of Complex Architectures. Nafplio, Greece, 01.-03.03.2017. ISPRS (Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLII-2/W3, 2017), 631–638.

Verhoeven, G. (2017): Computer graphics meets image fusion: the power of texture baking to simultaneously visualise 3d surface features and colour. In: J. Hayes, C. Ouimet, M. Santana Quintero, S. Fai und L. Smith (Eds.): ICOMOS/ISPRS International Scientific Committee on Heritage Documentation (CIPA). 26th International CIPA Symposium – Digital Workflows for Heritage Conservation. Ottawa, Canada, 28.08.-01.09.2017. ISPRS (ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., IV-2/W2), 295–302.

Verhoeven, G.; Missinne, S. J. (2017): Unfolding Leonardo da Vinci's globe (ad 1504) to reveal its historical world map. In: J. Hayes, C. Ouimet, M. Santana Quintero, S. Fai und L. Smith (Eds.): ICOMOS/ISPRS International Scientific Committee on Heritage Documentation (CIPA). 26th International CIPA Symposium – Digital Workflows for Heritage Conservation. Ottawa, Canada, 28.08.-01.09.2017. ISPRS (ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., IV-2/W2), 303–310.

- **C2**: Articles published in proceedings of scientific conferences, not included in the categories mentioned above

Doneus, N.; Schneidhofer, P.; Doneus, M.; Gabler, M.; Schiel, H.; Jansa, V.; Kucera, M. (2017): Mediterranean sites in archaeological prospection: the case study of Osor, Croatia. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 63–65.

Filzwieser, R.; Toriser, L.; Torrejón Valdelomar, J.; Neubauer, W. (2017): Investigation and virtual visualisation of a probable burial mound and later motte-and-bailey castle from Lower Austria. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 81–83.

Gugl, C.; Doneus, M.; Doneus, N. (2017): The Canabae Legionis of Carnuntum: modelling a Roman urban landscape from systematic, non-destructive prospection and excavation. In: Nick Hodgson, Paul Bidwell und Judith Schachtmann (Eds.): Limes XXI. Proceedings of the 21st International Congress of Roman Frontier Studies (Limes Congress) held at Newcastle upon Tyne in August 2009. Oxford: Archaeopress (Archaeopress Roman archaeology, 25), 379–385.

Hinterleitner, A.; Trinks, I.; Löcker, K.; Kainz, J.; Totschnig, R.; Kucera, M.; Neubauer, W. (2017): Not-so good vibrations: removing measurement induced noise from motorized multi-sensor magnetometry data. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 110–111.

Nau, E.; Gustavsen, L.; Kristiansen, M.; Gabler, M.; Paasche, K.; Hinterleitner, A.; Trinks, I. (2017): Motorized archaeological geophysical prospection for large infrastructure projects – recent examples from Norway. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 163–165.

Neubauer, W.; Gaffney, V.; Löcker, K.; Wallner, M.; Baldwin, E.; Chapman, H.; Trausmuth, T.; Kainz, J.; Schneidhofer, P.; Kucera, M.; Zotti, G.; Aldrian, L.; Schiel, H. (2017): Sussing out the super-henge: a multi method survey at Durrington Walls. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 166–168.

Schiel, H.; Neubauer, W.; Löcker, K.; Totschnig, R.; Wallner, M.; Trausmuth, T.; Kucera, M.; Trinks, I.; Hinterleitner, A.; Vonkilch, A.; Fera, M. (2017): Large-scale high-resolution magnetic prospection of the KGAs Rechnitz, Austria. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 215–217.

Schneidhofer, P.; Tonning, C.; Lia, V.; Baldersdottir, B.; Øhre Askjem, J. K.; Gustavsen, L.; Nau, E.; Kristiansen, M.; Trinks, I.; Gansum, T.; Paasche, K.; Neubauer, W. (2017): Investigating the influence of seasonal changes on high-resolution GPR data: the Borre Monitoring Project. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 223–226.

Sevara, C.; Doneus, M.; Draganits, E.; Cusumano, R.; Frazzetta, C.; Palermo, B.; Pisciotta, F.; Stallone, R.; Totschnig, R.; Tusa, S.; Valenti, A. (2017): Testing boundaries: integrated prospection from site to landscape in western Sicily. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 230–232.

Torrejón Valdelomar, J.; Wallner, M.; Löcker, K.; Gugl, C.; Neubauer, W.; Klein, M.; Jancsary-Luznik, N.; Trausmuth, T.; Vonkilch, A.; Tencer, T.; Aldrian, L.; Doneus, M. (2017): From integrated interpretative mapping to virtual reconstruction - a practical approach on the Roman town of Carnuntum. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 249–251.

Trinks, I.; Hinterleitner, A.; Löcker, K.; Wallner, M.; Filzwieser, R.; Schiel, H.; Gabler, M.; Nau, E.; Wildling, J.; Jansa, V.; Schneidhofer, P.; Trausmuth, T.; Neubauer, W. (2017): Extensive high-resolution ground-penetrating radar surveys. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 252–254.

Wallner, M.; Torrejón Valdelomar, J.; Trinks, I.; Doneus, M.; Neubauer, W.; Schiel, H.; Trausmuth, T.; Vonkilch, A.; Hinterleitner, A. (2017): Unique details on the structural elements of a Neolithic site in Velm,

Lower Austria - the necessity of integrated prospection and visualization in archaeological prospection. In: B. Jennings, C. Gaffney, T. Sparrow und S. Gaffney (Eds.): AP2017. 12th international conference of archaeological prospection. Bradford, UK, 12.-16.09.2017, 270–272.

Zotti, G.; Schaukowitsch, F.; Wimmer, M. (2017): The Skyscape Planetarium. In: The marriage of astronomy and culture: Theory and method in the study of cultural astronomy. 24th annual conference of the European Society for Astronomy in Culture (SEAC). Bath, UK, 12.-16.09.2016 (Culture and Cosmos, 21/1), 269–281.

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

Fera, M.; Kucera, M.; Schneidhofer, P.; Neubauer, W.; Doneus, M. (2017): The vanished vitrified fort of Schwarzenbach-Burg, Austria - A multi-disciplinary study. In: Building bridges. Abstract book of the 23rd Annual Meeting of the European Association of Archaeologists 2017. EAA 2017. Maastricht, 30.08.-03.09.2017, 68.

Kucera, M. (2017): The interdisciplinary daemon: limits and pitfalls of multidisciplinary and interdisciplinary research projects. In: CE - TAG 2017. Central Europe – Theoretical Archaeology Group. Abstract book. Wien, Austria, 16.-17.10.2017.

Schneidhofer, P.; Tonning, C.; Nau, E.; Trinks, I.; Neubauer, W.; Draganits, E.; Gansum, T.; Paasche, K. (2017): Are we there yet? Environmental settings and geophysical prospection. In: Building bridges. Abstract book of the 23rd Annual Meeting of the European Association of Archaeologists 2017. EAA 2017. Maastricht, 30.08.-03.09.2017, 403.

Sevara, C.; Doneus, M.; Draganits, E.; Frazzetta, C.; Tusa, S.; Totschnig, R.; Schilk, S.-C.; Cusumano, R.; Palermo, B.; Pisciotta, F.; Stallone, R.; Valenti, A. (2017): New investigations in the transition zone: considering a multi-ditched settlement in western Sicily as a node in a complex landscape. In: Building bridges. Abstract book of the 23rd Annual Meeting of the European Association of Archaeologists 2017. EAA 2017. Maastricht, 30.08.-03.09.2017, 261.

Sevara, C.; Doneus, M.; Draganits, E.; Verhoeven, G. (2017): Historic images as spatiotemporal archives: historical 3d data as a form of archaeological source criticism? In: Building bridges. Abstract book of the 23rd Annual Meeting of the European Association of Archaeologists 2017. EAA 2017. Maastricht, 30.08.-03.09.2017, 508.

Dissertations

Schneidhofer, P. (2017): Investigating the potential of palaeoenvironmental information for large scale, high resolution archaeological geopysical prospection data. Dissertation. Universität Wien, Wien, Österreich.

Kucera, M. (2017): Extending the archaeometry toolbox through multidisciplinary data interpretations. Universität Wien, Wien, Österreich.

Miscellaneous

Talks invited

Doneus, M. (2017): Die Zukunft der Vergangenheit – archäologische Methodik im Wandel. 100plus – Das Institut für Urgeschichte und Historische Archäologie feiert. Wien, Österreich, 23.06.2017.

Doneus, M. (2017): Understanding archaeological landscapes through non-invasive approaches. Round Table: Possibilities, advantages and challenges of non-invasive methods in landscape archaeology. Varaždin, Croatia, 26.09.2017.

Doneus, M. (2017): Prospection, excavation and interpretation. Theory and practice. Les prospections géophysiques appliquées à l'achéologie des monuments et des complexes religieux: enjeux, résultats et limites d'une méthode. CNRS. Auxerre, France, 19.10.2017.

Doneus, M.; Fera, M. (2017): From settlement to landscape: the role of archaeological prospection in landscape archaeology. Landschaft und Besiedlung. Archäologische Studien zur vorrömischen Eisenzeit- und älteren Kaiserzeit im Mittel- und Südost Europa. Lublin, Poland, 06.04.2017.

Filzwieser, R. (2017): The Hermitage at the Falkenstein – An interpretational process from historical sources and geophysical prospection to excavation and virtual reconstruction. Les prospections géophysiques appliquées à l'achéologie des monuments et des complexes religieux: enjeux, résultats et limites d'une méthode. CNRS. Auxerre, France, 19.10.2017.

Neubauer, W. (2017): Stonehenge und die Erkundung archäologischer Landschaften. Historisches und Völkerkundemuseum St. Gallen. Heerbrugg, Schweiz, 15.02.2017.

Neubauer, W. (2017): Stonehenge und die Erkundung archäologischer Landschaften. Kantonsschule Heerbrugg, Schweiz, 15.02.2017.

Neubauer, W. (1970): Archäologie ohne Schaufel und Spaten. 64. Wiener Kindervorlesung. ZOOM Kindermuseum. Wien, Österreich, 26.03.2017.

Neubauer, W. (2017): Von der digitalen Prospektion zur virtuellen Kommunikation – Die Fallstudien Stonehenge, Birka, Gokstad, Kaupang und Carnuntum. Festvortrag zur Generalversammlung 2017. Archäologie Schweiz. Chur, Schweiz, 22.06.2017.

Neubauer, W. (2017): Faszination Falkenstein. Heimatkundliches Museum St. Gilgen. St. Gilgen am Wolfgangsee, Österreich, 12.10.2017.

Neubauer, W. (2017): Die Kelten in den Landseer Bergen. Wirtschaftsmuseum Wien. Wien, Österreich, 12.12.2017.

Trinks, I. (2017): Nya rön om Birka. Ekerö, Sweden. Fornminnessällskapet på Mälaröarna, 21.03.2017.

Verhoeven, G. (2017): Digital photography and image-based modelling for archaeology. Ghent, Belgium, 29.11.2017.

Verhoeven, G.; Karel, W.; Doneus, M.; Wieser, M.; Pfeifer, N. (2017): OrientAL – towards (semi-)automated orthorectification of aerial photographs. Applying digital technology in research on building structures of the Lusatian culture fortified settlement in Biskupin, Site 4. Biskupin, Poland, 04.05.2017.

Talk (not published)

Doneus, M. (2017): Non-invasive exploration of challenging archaeological landscapes. The outermost Neolithic Workshop, 22nd – 24th May 2017. Shetland, UK, 24.05.2017.

Doneus, M.; Miholjek, I.; Doneus, N.; Mandlburger, G.; Briese, C.; Verhoeven, G. (2017): Airborne laser bathymetry in the Cres/Lošinj archipelago. AARG Annual Meeting 2017. Pula, Croatia, 14.09.2017.

Doneus, M.; Sevara, C.; Frazzetta, C.; Salisbury, R.; Draganits, E.; Löcker, K.; Tusa, S.; Schilk, S. C. (2017): Prospezione dei confini: Archeologia lungo il Mazaro. Riepilogo dei risultati del progetto. Mazara del Vallo, Italien, 23.09.2017.

Neubauer, W.; Hinterleitner, A.; Kucera, M. (2017): Workshop: Stratigraphie. RISC - Research Institute for Symbolic Computation. Hagenberg, Österreich, 13.02.2017.

Wallner, M. (2017): Der Beginn der zentralisierten Eisenproduktion in Österreich. Conference: The coming of Iron – Anfänge der Eisenverhüttung in Mitteleuropa. Berlin, Deutschland, 20.10.2017.

Zotti, G. (2017): Zeitlich veränderliche 3D-Landschaften in Stellarium. Tagung der Gesellschaft für Archäoastronomie. Hamburg, Deutschland, 30.09.-03.10.2017.

Zotti, G. (2017): Das Astrolabium: das astronomische Rechengerät des Mittelalters. Tagung der Gesellschaft für Archäoastronomie. Hamburg, Deutschland, 30.09.-03.10.2017.

Conference: session chair

De Smedt, P.; Trinks, I. (2017): Method, theory and interpretation: towards an integrated framework for archaeological geophysics. Session chair. In: Building bridges. Abstract book of the 23rd Annual Meeting of the European Association of Archaeologists 2017. EAA 2017. Maastricht, 30.08.-03.09.2017.

Verhoeven, G. (2017): 3D modelling. Session chair. In: D. Aguilera, A. Georgopoulos, T. Kersten, F. Remondino und E. Stathopoulou (Hg.): TC II & CIPA. 3D Virtual Reconstruction and Visualization of Complex Architectures. Nafplio, Greece, 01.-03.03.2017. ISPRS (Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLII-2/W3, 2017).

5.4 3rd Vienna Ball of Sciences

The LBI ArchPro team offered the guests of the 3rd Vienna Ball of Sciences, held in the town hall of Vienna on January 28th 2017, a virtually tour through the reconstructed archaeological landscapes of Stonehenge and Carnuntum. The institute's interactive exhibits were a huge success with the guests. Until the early hours of the following day there was a huge demand by interested ball guests to experience the HTC Vive and Oculus Virtual Reality glasses. It also was a great honour to have Austria's new president Alexander Van der Bellen (Fig. 29) visiting the LBI ArchPro exhibition booth.

Figure 29: On his second day in office, at the 3rd Vienna Ball of Sciences, Austria's new federal president Alexander Van der Bellen visited the booth of the LBI ArchPro and took a virtual tour around Stonehenge.

5.5 MAMUZ „Stonehenge – A Hidden Landscape" exhibition and "Virtuelle Welten – Archäologie und Hightech" event (1st Mai 2017)

Due to its great success, the exhibition "Stonehenge – A Hidden Landscape" at Austria's MAMUZ museum in Mistelbach was extended for another year until November 2017. The exhibition attracted a record number of ca. 150.000 visitors to the museum. It presented latest findings of the Stonehenge Hidden Landscape Project as a result of the collaboration between the LBI ArchPro and the University of Birmingham.

In May 2017, the LBI ArchPro together with MAMUZ organized a one-day public research event at the museum, focused on the topic "VIRTUAL WORLDS. Archaeology and High-Tech". With VR glasses, 3D projector, 3D printer and 3D scanner, visitors were able to virtually experience modern archaeological practice. The exhibits included visualizations, models and reconstructions of archaeological sites and findings from Stonehenge, Carnuntum and Viking Age sites.

5.6 Kids' lecture at Zoom Museum, 26th March 2017

LBI ArchPro's director Wolfgang Neubauer gave an invited lecture on "*What is archaeology and how do archaeologists do research without shovels and spades*?" in the course of the 64th Vienna Lecture Series for Children at the Zoom Children's Museum in March 2017 (Fig. 30). The lecture series invites well-known scientists and scholars to illustrate their field of research to children aged 8 to 12.

As a special acknowledgement of the children's enthusiasm during the lecture, Wolfgang Neubauer invited all participants to visit the archaeological excavation at Schwarzenbach (Lower Austria) in summer 2017. There, the young researchers could put their newly acquired knowledge to the test and supported the archaeologists on site.

Figure 20: Wolfgang Neubauer at the Vienna Lecture Series for Children at the Zoom Children's Museum.

5.7 Forschungsfest NÖ, 15.9.2017 Palais Niederösterreich Wien

In September 2017, the LBI ArchPro participated with an exhibition at the Forschungsfest NÖ, which was organised by the county of Lower Austria at Palais Niederösterreich in Vienna. Researchers from the LBI ArchPro explained to a large audience how archaeologists make archaeological remains that are hidden in the ground visible, by using novel, non-invasive technologies. Visitors could experience a virtual flight over the prehistoric landscape of Stonehenge and gained insight into the world of virtual archaeology through augmented reality applications. The event attracted more than 10,000 visitors.

Figure 31: Forschungsfest NÖ, September 2017

5.8 Press coverage summary

LBI ArchPro

- http://diepresse.com/home/bildung/universitaet/5161655/Der-Ball-der-vielen-PraesidentenSelfies
- https://medienportal.univie.ac.at/uniview/wissenschaft-gesellschaft/podcast-detail/artikel/audimax-6-geoarchaeologe-erich-draganits/
- http://www.ots.at/presseaussendung/OTS_20170118_OTS0134/vom-experiment-zum-staatstragenden-fest-der-3-wiener-ball-der-wissenschaften
- https://science.apa.at/rubrik/kultur_und_gesellschaft/Archaeologe_Wolfgang_Neubauer_in_die_Oesterreichische_Akademie_der_Wissenschaften_gewaehlt/SCI_20170522_SCI39431352636174112
- http://science.apa.at/rubrik/politik_und_wirtschaft/OeAW_waehlte_neue_Mitglieder/SCI_20170413_SCI39491352035502380
- https://www.ots.at/presseaussendung/OTS_20170905_OTS0145/lh-mikl-leitner-neugierig-machen-auf-wissenschaft-und-forschung
- http://www.vienna.at/erste-forschungswochen-niederoesterreich-starten-im-palais-noe-in-wien/5443271
- http://noe.orf.at/news/stories/2864324/
- http://www.noen.at/freizeit/gesund-leben/am-freitag-forschungsfest-noe-forschung-vermitteln-und-feiern/60.699.334#
- Radio-Beitrag auf Radio ORF NÖ (14.09.2017) Prospektionsmethoden
- https://leica-geosystems.com/about-us/news-room/customer-magazine/reporter-81/a-complete-new-view-of-stonehenges-landscape

Carnuntum – Panem et circenses

- http://www.archaeologie-online.de/magazin/nachrichten/panem-et-circenses-neue-entdeckungen-im-roemischen-carnuntum-41048/
- http://oe1.orf.at/player/20170330/465446
- https://latunicadeneso.wordpress.com/2017/04/02/como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo/
- http://gerente.com/ar/rss-article/austria-arqueologia-como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo/
- http://www.nationalgeographic.com.es/historia/actualidad/descubierto-anfiteatro-madera-carnuntum-este-viena_11360
- http://informe21.com/actualidad/como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo
- http://noticias.alianzanews.com/187_america/4440332_como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo.html
- http://espana.servidornoticias.com/31_cultura/4440330_como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo.html
- http://www.msn.com/es-co/noticias/otras/%C2%BFc%C3%B3mo-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo/ar-BBzbiaD
- http://newscaster.ikuna.com/31_cultura/4440330_como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo.html
- http://ecodiario.eleconomista.es/cultura/noticias/8265665/04/17/Como-era-una-zona-de-ocio-romana-Tabernas-y-souvenirs-frente-al-coliseo.html
- http://www.eluniversal.com.mx/articulo/cultura/patrimonio/2017/04/2/como-era-una-zona-de-ocio-romana
- http://www.aguasdigital.com/tendencias/leer.php?idnota=12756414&efenew=1
- http://www.ultimahora.com/como-era-una-zona-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo-n1075111.html

- http://www.entornointeligente.com/articulo/9810180/Como-era-una-zona-de-ocio-romana-02042017
- http://www.elconfidencial.com/ultima-hora-en-vivo/2017-04-02/como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo_1180685/
- http://www.diariodenavarra.es/noticias/magazine/sociedad/2017/04/02/los_romanos_tenian_tabernas_tiendas_souvenirs_524844_1035.html
- http://www.teinteresa.es/ciencia/romana-Tabernas-souvenirs-frente-coliseo_0_1770422975.html
- http://www.espectador.com/cultura/349745/como-era-una-zona-de-ocio-romana
- https://menorca.info/actualidad/sociedad/2017/599198/como-era-zona-ocio-romana.html
- http://www.laconexionusa.com/noticias/20170402256714_lc25671402.asp
- http://www.eldiario.es/cultura/romana-Tabernas-souvenirs-frente-coliseo_0_628887142.html
- http://caracol.com.co/radio/2017/04/02/entretenimiento/1491118060_655508.html
- http://www.wradio.com.co/noticias/sociedad/como-era-una-zona-de-ocio-romana-tabernas-y-quotsouvenirsquot-frente-al-coliseo/20170402/nota/3424940.aspx
- http://terraeantiqvae.com/profiles/blogs/la-arqueologia-virtual-muestra-las-zonas-de-ocio-de-la-antigua-ci?xg_source=activity
- http://www.theclinic.cl/2017/04/03/bella-la-europa-antigua-asi-funcionaba-barrio-del-webeo-la-epoca-del-imperio-romano/
- http://www.pasthorizonspr.com/index.php/archives/03/2017/new-gladiatorial-games-discoveries-in-roman-carnuntum
- http://www.hispantv.com/noticias/cultura/337496/zona-ocio-romana-tabernas-cantinas-coliseo-austria
- http://www.milenio.com/cultura/austria-recrean-imperio-romano-carnuntum-lbi_archpro_0_931706847.html
- http://www.efe.com/efe/america/cultura/como-era-una-zona-de-ocio-romana-tabernas-y-souvenirs-frente-al-coliseo/20000009-3226153
- https://twitter.com/archaeologymag/status/849349610510405636
- https://twitter.com/AustriainUSA/status/849345579335462914
- http://www.archaeology.org/news/5427-170404-austria-carnuntum-shops
- http://www.livescience.com/58521-ancient-shops-found-at-roman-gladiator-arena.html
- http://www.livescience.com/58524-photos-ancient-roman-gladiator-arena-carnuntum.html
- http://archmdmag.com/ancient-concession-stands-shops-found-roman-gladiator-arena/
- http://www.archaeology.wiki/blog/2017/04/04/bread-and-games-in-roman-carnuntum/
- https://www.longroom.com/discussion/412466/ancient-concession-stands-and-shops-found-at-roman-gladiator-arena
- http://www.dailymail.co.uk/sciencetech/article-4379060/Virtual-reality-recreation-1-800-year-old-Roman-city.html
- https://artificialreality.news/shops-bars-and-restaurants-are-found-at-a-roman-gladiator-arena/
- http://www.ancient-origins.net/news-history-archaeology/researchers-discover-gladiator-fans-had-souvenirs-fast-food-and-fresh-baked-021312
- http://mentalfloss.com/article/94027/ancient-romans-hit-food-stands-and-souvenir-shops-gladiator-matches
- https://www.liveleak.com/view?i=4c5_1491393756&comments=1
- http://www.foxnews.com/tech/2017/04/05/gladiator-games-experts-harness-tech-to-reveal-roman-citys-secrets.html
- http://www.worldtechmag.com/virtual-reality-recreation-of-1800-year-old-roman-city-daily-mail/
- https://www.thesun.co.uk/tech/3262978/gladiator-arena-had-restaurants-bars-and-even-a-gift-shop-for-bloodthirsty-romans-to-buy-souvenirs-scientists-discover/

- https://uk.news.yahoo.com/ancient-concession-stands-shops-found-165700908.html
- https://www.yahoo.com/news/ancient-concession-stands-shops-found-165700908.html
- http://top-channel.tv/lajme/artikull.php?id=352077
- http://hungarytoday.hu/~newsinfo/latest/virtual-reality-recreation-of-1800yearold-roman-city
- http://24.hu/tudomany/2017/03/31/igazi-gladiatorkozpontra-bukkantak-pannonia-fovarosaban/
- http://www.rtvslo.si/kultura/drugo/na-obmocju-anticnega-carnuntuma-odkrili-urejeno-infrastrukturo-za-gladiatorske-igre/418747
- http://www.meteoweb.eu/2017/04/come-passavano-il-tempo-libero-gli-antichi-romani-scoperta-una-zona-di-svago-di-fronte-ad-un-colosseo/880857/
- http://www.heute.at/oesterreich/niederoesterreich/story/11641712
- http://tvthek.orf.at/profile/heute-oesterreich/4660163/heute-oesterreich/13922994/Neue-Entdeckungen-in-Carnuntum/14018110
- http://science.orf.at/stories/2834067/
- http://www.wienerzeitung.at/themen_channel/wissen/geschichte/882857_Brot-und-Spiele-in-Carnuntum.html
- http://diepresse.com/home/panorama/oesterreich/5192663/Antike-Vergnuegungsmeile-in-Carnuntum-entdeckt
- http://diepresse.com/home/science/5193702/Carnuntum-hatte-drei-Amphitheater
- http://www.salzburg24.at/forscher-fanden-antike-vergnuegungsmeile-in-carnuntum/apa-1435266644
- http://www.salzburg.com/nachrichten/oesterreich/kultur/sn/artikel/sensationsfund-in-carnuntum-241074/
- http://science.apa.at/rubrik/kultur_und_gesellschaft/Brot_und_Spiele_Forscher_fanden_antike_Vergnuegungsmeile_in_Carnuntum/SCI_20170330_SCI39351351635266642
- http://www.studium.at/553012-brot-und-spiele-forscher-fanden-antike-vergnuegungsmeile-carnuntum
- https://www.suedtirolnews.it/unterhaltung/kultur/sensationsfund-in-carnuntum
- http://www.taxi40100.at/index.php?id=216&action=detail&apaid=1435266644#
- http://www.tt.com/kultur/12806122-91/forscher-fanden-antike-vergn%C3%BCgungsmeile-in-carnuntum.csp
- http://www.vienna.at/sensationsfund-in-carnuntum/apa-1435266644
- http://www.vol.at/sensationsfund-in-carnuntum/apa-1435266644
- http://www.volksblatt.at/apa_news/?tx_posapaxmlimport_pinews%5Buid%5D=158805
- https://kurier.at/chronik/antikes-vergnuegungsviertel-in-carnuntum-entdeckt/255.331.537
- http://derstandard.at/2000055122513/Archaeologen-entdeckten-Vergnuegungsviertel-in-der-Roemerstadt-Carnuntum
- http://archpro.lbg.ac.at/sites/files/archeo/22_universum_magazin_drittes_amphitheater_in_carnuntum_entdeckt_19.04.2017.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/17_non_wo_lucius_ins_wirtshaus_ging_06.04.2017.pdf
- http://www.damals.de/de/8/Vergnuegungsviertel-der-Roemerstadt-Carnuntum-entdeckt.html?aid=192010&cp=1&action=showDetails
- http://www.bvz.at/in-ausland/brot-und-spiele-antike-vergnuegungsmeile-in-carnuntum-entdeckt/43.864.860/print
- http://www.msn.com/de-at/nachrichten/wissenundtechnik/sensationsfund-in-carnuntum/ar-BBz2Lox?li=BBqgbZH
- http://www.noen.at/bruck/brot-und-spiele-antike-vergnuegungsmeile-in-carnuntum-entdeckt/43.864.860
- http://noe.orf.at/news/stories/2834077/

- https://www.osttirol-online.at/aktuelles/welt-news/163278-forscher-fanden-antike-vergnuegungsmeile-in-carnuntum.html
- http://www.kleinezeitung.at/service/newsticker/5192622/Sensationsfund-in-Carnuntum

Stonehenge – MAMUZ

- http://noe.orf.at/news/stories/2824228/
- http://www.noen.at/mistelbach/mamuz-museum-2017-erneuerte-stonehenge-ausstellung-in-mistelbach/36.336.948
- https://kurier.at/leben/neue-stonehenge-ausstellung-im-mamuz-museum-mistelbach/184.527.341
- http://www.seniorkom.at/0/Content/freizeit/_article_/id29041
- https://www.weinviertlerin.at/11025-2/
- http://wellness-magazin.at/travel/alles-stonehenge-oder-was/
- http://www.meinbezirk.at/mistelbach/lokales/die-weltweit-einzigartige-ausstellung-stonehenge-verborgene-landschaft-geht-in-die-verlaengerung-d2016509.html
- http://www.noen.at/mistelbach/mamuz-alles-stonehenge-oder-was/44.664.121
- http://science.apa.at/rubrik/kultur_und_gesellschaft/VIRTUELLE_WELTEN_Archaeologie_und_HighTech/SCI_20170420_SCI39431352635608688
- http://archpro.lbg.ac.at/sites/files/archeo/25_non_mistelbach_virtueller_uberflug_04.05.2017.pdf

Schwitzerland

- http://www.tagblatt.ch/ostschweiz/stgallen/stadt/Der-Klosterplatz-unter-dem-Radar;art197,4950467
- http://archpro.lbg.ac.at/sites/files/archeo/rtau-20170408-p33.pdf
- https://rheintaler.ch/artikel/montlinger-bergli-mit-radar-untersucht/38697
- http://www.thurgauerzeitung.ch/ostschweiz/stgallen/stadt/Der-Klosterplatz-unter-dem-Radar;art197,4950467
- http://www.wilerzeitung.ch/ostschweiz/stgallen/stadt/Der-Klosterplatz-unter-dem-Radar;art197,4950467
- http://archpro.lbg.ac.at/sites/files/archeo/rheintaler_20170718.pdf

Der Standard – Archäologieblog

- http://derstandard.at/2000052668114/Das-hochaufloesende-Georadar-ist-bloed-Wie-Wissenschaftskommunikation-gelingt
- http://derstandard.at/2000061793671/Roadtrip-nach-Scharfbillig-Keramikproduktionin-der-Epoche-der-Roemischen-Kaiserzeit
- http://derstandard.at/2000065809432/Einmalig-Mit-drei-Bodenradargeraeten-am-Feld-und-die-Zeit-im
- http://derstandard.at/2000067877919/Was-Hallen-aus-der-Wikingerzeit-mit-heutigen-Niederschlagsmengen-zu-tun?_blogGroup=1&ref=rec
- http://derstandard.at/2000064907424/Lehrgrabung-in-SchwarzenbachErgeben-zwei-Steine-schon-ein-Haus?_blogGroup=1&ref=rec
- http://derstandard.at/2000060847493/Gokstad-eine-wikingerzeitliche-Landschaft?_blogGroup=2
- http://derstandard.at/2000058556918/Aegypten-Die-Wiederauferstehung-eines-Palastes?_blogGroup=3
- http://derstandard.at/2000055870606/Warum-die-Vernetzung-unter-Wissenschaftern-essenziell-ist?_blogGroup=3
- http://derstandard.at/2000054650721/Die-Roemerstadt-an-der-Donau-Carnuntums-Untergrund-abbilden?_blogGroup=4

- https://www.derstandard.de/story/2000069760330/tausend-jahre-im-boden-die-wiedergeburt-des-wikingerzeitlichen-gokstad-schiffs

LWL – Paderborn, Herforst

- https://www.tag24.de/nachrichten/merkwuerdiges-bild-warum-faehrt-ein-quad-ueber-paderborns-felder-bodenmessungen-archaelogie-205882
- http://www.die-glocke.de/lokalnachrichten/regionales/Mit-Quad-auf-Suche-nach-Burgmauern-2d0e8737-ce82-4827-8d1f-423930906a97-ds
- https://www.swr.de/swraktuell/rp/trier/roemisches-toepferzentrum-bei-herforst-ungewoehnlicher-fund-fuer-die-archaeologie/-/id=1672/did=19859426/nid=1672/1fy16uv/index.html
- http://www.archaeologie-online.de/magazin/nachrichten/mit-quad-und-magnetstrahlen-40835/
- http://www.westfalen-blatt.de/OWL/Lokales/Kreis-Paderborn/Paderborn/2668248-Archaeologen-durchleuchten-Aecker-und-Felder-an-Barkhauser-Strasse-Moderne-Schatzsuche
- http://www.rottenplaces.de/main/aecker-und-felder-in-paderborn-mit-quad-durchleuchtet-26666/
- http://www.owl-journal.de/archaeologen-durchleuchten-aecker-und-felder-in-paderborn/
- https://www.aid-magazin.de/nachricht/artikel/mit-quad-und-magnetstrahlen-archaeologen-durchleuchten-aecker-und-felder-in-paderborn.html
- http://archpro.lbg.ac.at/sites/files/archeo/archaologen_packen_die_schaufeln_aus_-_volksfreund.pdf
- https://die-woch.de/informationen-ueber-ausgrabung/


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Late Iron Age site of Borre, Norway

The datasets from all GPR surveys conducted at Borre were interpreted over the course of two concentrated SCRUM sprints, resulting in the detailed mapping of the archaeological structures discernible in the data. The feature-based archaeological interpretation was the basis for the generation of distinct areas and to outline in detail several identified large hall buildings located outside and inside the archaeological park. The intensive interpretation of the GPR measurements revealed a great number of previously unknown archaeological structures, including countless pits whose shape and size are similar to the burial structures within the park area. However, their interpretation could not yet be verified and still requires further investigation.

Figure 21: Mario and Alois discussing the Borre data during the SCRUM sprint.

Shaftesbury Abbey, UK

The interpretation of the GPR data comprised the area inside Shaftesbury Abbey that was surveyed in June 2017. The interpretation was conducted on 20 cm GPR depth-slices and resulted in a plan of the buried structures. The data shows anomalies that complete the already excavated floor plan of the cathedral, and other features that have been interpreted as the walls of the annexed cloister. Inside the cathedral, various reflecting deposits were interpreted as pavements, which appear to be present in the form of tiled pavements as well as stone deposits. Additionally, anomalies caused by numerous sarcophagi, aligning with the orientation of the cathedral, have been detected. The anomaly of a circular structure may have been caused by the remains of a staircase. The results of the interpretation were combined with the processing outcome of the terrestrial laser scanning data for visualization purposes, which were used on the open day of the Abbey on December 9th, giving the public insights into the progress of the project.

Figure 22: Interpretation map of Shaftesbury Abbey