Annual Report 2014

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1. LBI ArchPro - Overview

1.1 Goals

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

Considering the state-of-the-art and the future demands for non-invasive professional archaeological prospection a consortium of European research institutes, heritage boards and public bodies 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 application of advanced non-destructive prospection methods. It combines advanced remote sensing methods, high resolution near surface geophysics, sophisticated computer science, geomatics and archaeology. It is dedicated to the development of new and highly efficient technologies for non-invasive data capturing, data processing, virtual reality visualization and the advancement of theory and methodology of archaeological prospection. An important aim is the publication and dissemination of new developments and results of the conducted research and of exemplary international large scale case studies in professional circles as well as to the general public.

Even though the Valetta convention (Malta treaty) has not been ratified by all member states of the LBI ArchPro consortium, it is regarded by the consortium as the major basis and guideline for the future development of archaeological research and the LBI ArchPro research programme.

1.2 Partner organizations

The LBI ArchPro is based on a European partnership formed by:

- **LBG** - Ludwig Boltzmann Gesellschaft (A)
- **NoeL** - Province of Lower Austria (A)
- **NIKU** - Norsk Institut for Kulturminneforskning (N) - The Norwegian Institute for Cultural Heritage - Archaeology Department
- **RAÄ** - Riksantikvarieämbetet (S) - UV Teknik
- **RGZM** - Römisch Germanisches Zentralmuseum (D)
- **VISTA** - University of Birmingham (GB) - The Visual and Spatial technology Centre (VISTA)
- **Uni Vienna** - University of Vienna (A) - Vienna Institute for Archaeological Science (VIAS) and Institute for Prehistory and Early Mediaeval History (UFG)
- **TU Vienna** - University of Technology Vienna (A) - Institute for Computer Graphics and Algorithms (ICG) and the Institute for Photogrammetry and Remote Sensing (IPF)
- **ZAMG** - Central Institute for Meteorology and Geodynamic (A)
- **Airborne Technologies** (A)
- **Vfk** – Vestfold Fylkeskommune: Case study Vestfold (N) has joined as partner organization on 1st January 2014

- **7reasons** – 7reasons Medien GmbH: Virtual Reconstructions (A) has joined as partner organization on 1st April 2014

Collaborative agreements for scientific research tasks and case studies exist with following organizations:

- **Uni Lund** – University of Lund, Department of Archaeology and Ancient History: Case study Uppåkra (S)
- **EAL** – Eastern Atlas GmbH & Co. KG: Magnetic prospection (D)
- **MALÅ** – MALÅ Geoscience AB: Ground Penetrating Radar (S)
- **Riegl** – Riegl Laser Measurement Systems GmbH: Laser Scanning (A)
- **Pico** – Pico Envirotec Inc.: AirMagnet project (CA)
- **GeoEx** – Geo Experts Research and Planning GmbH: AirMagnet project (A)
- **Uni Bradford** – University of Bradford: Geophysics (GB)
- **Uni Gent** – University of Ghent: Carnuntum ArchPro project(B)
- **BOKU** – University of Natural Resources and Life Sciences, Vienna: Remote sensing (A)
- **Wikitude** – Wikitude GmbH: Augmented Reality (A)
- **Interspot** – Interspot Film GmbH: Scientific Documentaries (A)
- **HTL Steyr** – Höhere Technische Lehranstalt Steyr: Hardware development (A)
- **ÖAW** – Austrian Academy of Sciences (A)
- **Holstebro Museum (DK)**
- **HRZ** - Croatian Conservation Institute, Department for Underwater Archaeology (HR)
- **ÖAW –** Austrian Academy of Sciences: Institute for the Study of Ancient Cultures; Institut für Orientalische und Europäische Archäologie (A)
- **Institute of Archaeology, Belgrade** (SRB)

1.3 LBI ArchPro Board and Scientific Advisory Board

The LBI ArchPro Board:

- **NoeL:** Franz Humer, Gerhard Pfahler
- **ZAMG:** Sirri Seren, Michael Staudinger
- **TU Vienna :** Norbert Pfeifer, Werner Purgathofer
- **Uni Vienna :** Otto H. Urban, Gerhard Trnka
- **ABT :** Wolfgang Grumeth, Mario Rathmanner
- **RGZM :** Falko Daim, Detlef Gronenborn
- **RAÄ :** Lars Larsson, Christina Klotblixt
- **NIKU:** Carsten Paludan-Müller, Knut Paasche
- **VISTA :** Vincent Gaffney, Eamonn Baldwin
- **LBG :** Marisa Radatz, Claudia Lingner

The LBI ArchPro Scientific Advisory Board:

Prof. Kay Kohlmeyer, Hochschule für Technik und Wirtschaft (HTW) Berlin, Germany

Prof. Julian Richards, University of York, UK

Prof. Joakim Goldhahn, Linnaeus University, Sweden

Prof. Maurizio Forte, Duke University, Durham, USA

Prof. Patrick Ryan Williams, The Field Museum of Natural History & University of Illinois at Chicago, USA

Two members of the SAB (Maurizio Forte and Patrick Ryan Williams) took part in October 2014 at the LBI ArchPro workshop in Lower Austria.

1.4 The LBI ArchPro Team

The staff of the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology comprised the following fixed employees in 2014:

- Wolfgang Neubauer (Director)
- Michael Doneus (Deputy Director)
- Immo Trinks (Key Researcher)
- Alois Hinterleitner (Key Researcher)
- Nives Doneus (Key Researcher)
- Christina Einwögerer (Administration Manager)
- Roland Filzwieser (Researcher)
- Viktor Jansa (Researcher)
- Karolin Kastowsky-Priglinger (Administration Manager)
- Matthias Kucera (Researcher)
- Klaus Löcker (Researcher)
- Agata Lugmayr (Researcher)
- Erich Nau (Researcher)
- Matthias Nöster (Operations Manager)
- Michael Pregesbauer (Researcher)
- Vlad Sandici (Researcher)
- Elisabeth Schadek (Administration Manager)
- Geert Verhoeven (Researcher)
- Mario Wallner (Researcher)
- Thomas Zitz (Researcher)
- Georg Zotti (Researcher)
- Laszlo Baumann (technician, facility management Langenzersdorf, maintenance of equipment)
- Juan Torrejón Valdelomar joined the team in April 2014. He will work on interpretation and visualization of prospection data and virtual reconstructions.
- Joachim Brandtner joined the team in April 2014. He will work on interpretation and visualization of prospection data and virtual reconstructions.
- Martin Gamon (Researcher) joined the team in June 2014.

Staff in-kind contributions

- Christian Gugl (Researcher) contribution from ÖAW
- Camillo Ressl, contribution from Vienna University of Technology, Department of Geodesy and Geoinformation

- Rainer Schreg, contribution from RGZM
- Lars Gustavsen, contribution from NIKU
- Christer Tonning, contribution from Vestfold fylkeskommune
- Eamonn Baldwin, contribution from VISTA
- Eduard Pollhammer, contribution from NoeL
- Pär Karlsson, contribution from RAÄ

Temporary staff

- Manuel Gabler (Field Director)
- Jakob Kainz (Field Assistant)
- Ranko Manojlović (Field Assistant)
- Hannes Schiel (Field Assistant)
- Petra Schneidhofer (Field Assistant)
- Christopher Sevara (Field Assistant)
- Tanja Trausmuth (Field Assistant)
- Alexandra Vonkilch (Field Assistant)
- Julia Wilding (Field Assistant)

Visiting researchers

A number of researchers visited the LBI ArchPro to transfer knowledge, exchange ideas and discuss forms of scientific collaboration:

- As part of the FemTech grant from FFG two research assistants (Lisa Aldrian and Klara Sauter) have been employed for several months for the work on data acquisition (Carnuntum, Kreuttal) and data interpretation (Carnuntum).
- Philippe de Smedt (Uni Gent) has been employed as part of the Cost Action TU 1208 programme.
- Vuković Miroslav (University of Zagreb, HR) has been awarded a one-month scholarship by the OeAD (Austrian Exchange Service) to conduct research for his master thesis at the LBI ArchPro.
- Pavle Dugonjić, Croatian Conservation Institute (Zagreb, HR)
- Lukasz Banaszek (PL) has started a two-year internship financed by the “Mobility Plus” programme of the Polish ministry of science and education in November 2014.
- Midori Hidaka (J) completed a one-month internship working on the processing and analysis of 3D laserscanning data.
- Andreas Vlachopoulos (University of Ioannina, GR)
- Andreas Inhauser and Florian Wolfbeißer completed a one-month internship in the framework of the “Talents”-programme of the FFG (Austrian Research Promotion Agency).

Initiative College for Archaeological Prospection

The University of Vienna installed within VIAS an interdisciplinary Initiative College for archaeological prospection (ic-archpro.univie.ac.at) at the end of 2011. Research fellows of the IC are working in the close collaboration with the LBI ArchPro staff on the archaeological analysis of LBI ArchPro case study data and various methodological data.

IC ArchPro research assistants:

- Martin Fera
- Manuel Gabler
- Jakob Kainz
- Karolin Kastowsky-Priglinger
- Michal Ruš
- Petra Schneidhofer
- Christopher Sevara
- Tomáš Tencer
- Katalin Tolnai
- Willem Vletter

Associated PhD research fellows

- Valeria Poscetti
- Joris Coolen
- Eamonn Baldwin
- Christine Markussen
- Agata Lugmayr
- Ulrike Fornwagner
- Viktor Jansa
- Mario Wallner
- David Russ

Staff development

Michael Doneus was elected in 2014 the corresponding member of the Austrian Academy of Sciences. In addition, he became head of the Institute of Prehistory and historical archeology at the University of Vienna.

Christian Briese has left the LBI ArchPro for the newly established company EODC. The new "Earth Observation Data Centre for Water Resources Monitoring" works with data from "Sentinel-1A", which is the first EU environmental satellite within the EU Earth observation program "Copernicus". Every day he delivers two terabytes of measurement results. EODC will store data and make it accessible to science.

1.5 Infrastructure

A DualEM 21HS EMI system was bought by the LBI ArchPro and delivered by July 2014. Two additional pairs of PulseEkko PRO 250MHz transducers and corresponding components were purchased and delivered in the beginning of April 2014.

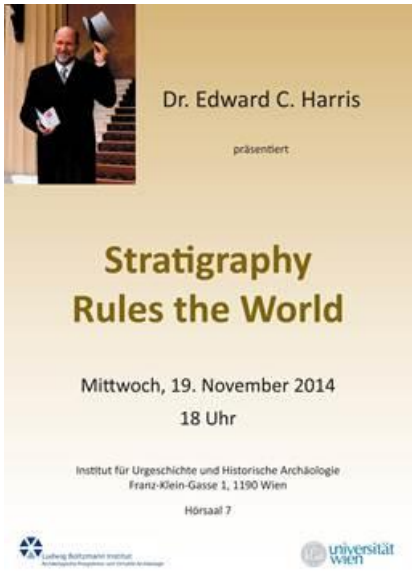
1.6 Highlights 2014

According to the Archaeology.org website the LBI ArchPro research of Stonehenge can be considered the most important discovery of 2014. http://www.archaeology.org/issues/161-1501/features/2828-top-10-archaeological-discoveries-of-2014

The following publication – Clement Atzberger, Michael Wess, Michael Doneus, Geert Verhoeven, ARCTIS—A MATLAB® Toolbox for Archaeological Imaging Spectroscopy – managed in to the top 5 of

most cited papers of the open access journal "Remote Sensing". http://www.mdpi.com/2072-4292/6/9/8617

On invitation of the LBI ArchPro a lecture by Edward C. Harris took place in November 2014 at the University of Vienna. Edward C. Harris is a prominent archaeologist from Bermuda, best known for the development of stratigraphy in archaeology ("Harris matrix"). http://www.harrismatrix.com/



Invitation to the lecture by Edward C. Harris

2. Research topics and results

2.1 Integrated interpretation

GIS based data integration and fusion

In October 2014 an internal LBI ArchPro workshop about "GIS based data integration and fusion" has taken place. Based on the discussion, individual topics like raster algebra, pan-sharpening or information fusion will be integrated into a new toolbox.

Automatic classification

The classification of geophysical data has been started by defining a test area. A GPR dataset of the forum of Carnuntum was chosen as it contains a big variety of different archaeological features which are subject for an automatic classification. The feasibility was carried out by utilizing eCognition. As a step by step development the following tasks have been identified and are subject of the development: identifying and masking of individual reflectors, multi layer classification, top up joining of overlapping objects and forming of 3D objects. Line extraction canny and filter have been tested and can give additional information as long as we deal with urban structures like buried houses etc. The classification code developed was presented in May 2014 at the GEOBIA 2014 (Advancements, trends and challenges, 5th Geographic Object based Image Analysis Conference, Thessaloniki, Greece). Further tests on various GPR datasets from Carnuntum and Stonehenge have been done since. Especially the import routine and the server processing capability were enhanced. There is now the capability to import a series of GPR data cube tiles. During the "Interpretation

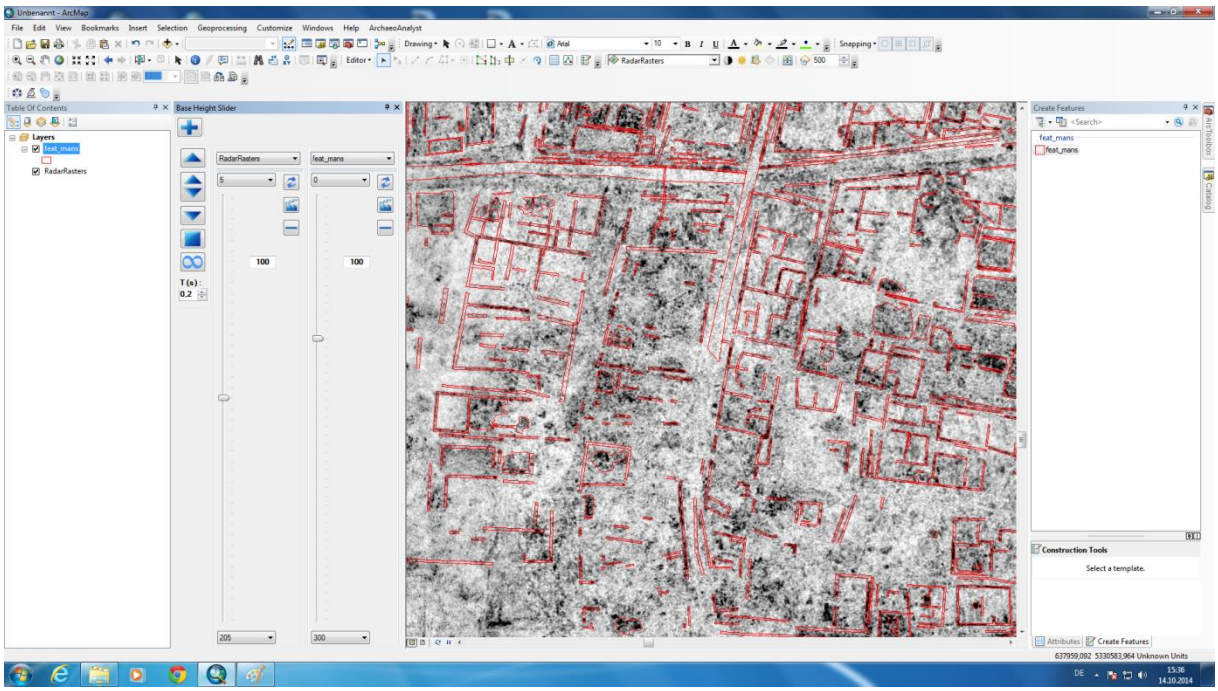
workshop Stonehenge" (20 to 24 October 2014) a workflow for reducing the visibility of “iron noise” in magnetograms – by detecting and grey-covering the most prominent dipoles – was developed.

Development of Visualization Workflows & Tools

For the Stonehenge press conference on September 5th a Voxler volume visualization of the long barrow from the GPR depth slices was developed. The problem with this dataset was that only little difference was visible between archaeological traces of the barrow walls and the surrounding soil. For visualization purposes, a mixed scene was done. A usable Isosurface was exported in Voxler’s Inventor .IV format, and then converted to OBJ with AWK converter script developed in Q2 and finally imported the OBJ in Meshlab. Parts of the isosurface which were of no archaeological interest were trimmed away; the rest can further be simplified by MeshLab’s Quadric Edge Collapse. The OBJ can then be colored by depth with another AWK script or left colorless, and converted back to .IV for re-import in Voxler, or converted to VRML for import to ArcScene. The edited Isosurface, re-imported to Voxler and mixed with the volume visualisation, helped to enhance the visibility of the wall structures.

Development of ArchaeoAnalyst 1.0

Several features were implemented in ArchaeoAnalyst in the last months. The “Loading of unified depth slice layers” allows representation of the GPR depth slices from different measuring areas in a single layer. This is a quality performance improvement, since in the old workflow all the depth slices were loaded as separate layers. The “Base height” slider was improved. It is possible to navigate through the GPR prospection data as well as the interpretation data. For the interpretation data an automatic edit template adaptation has been programmed which can automatically set the base height according to the selected depth in the base height slider. It is also possible to use several base height sliders as well as an animation control.



ArchaeoAnalyst: Base height slider.

In late 2014 ArchaeoAnalyst got extended with several new features. The "GPR Depth Composer" leverages the power of the Mosaic dataset into one intuitive control. It is basically a vertical slider with a depth scale. It allows the user to select a depth range and the raster composing function in that range. The GPR Depth Composer also features an Animation control, allowing the user to animate the depth view. Last but not least this control can handle any numerical data type with automated orientation facing downwards.

Another addition to the ArchaeoAnalyst is the "Spatial Cleanup Tool". This tool was developed for the processing of the results of the "Locate iron" and "Locate pit" functions of ArchaeoAnalyst. This tool allows a spatial selection based on spatial relationships between locator generated layers and other feature classes. The advantage of this tool is that it allows a spatial query over huge dataset, which ArcGIS doesn't offer as a standard feature.

New development in the ArchaeoAnalyst is the integration of the magnetic datasets in the ArchaeoAnalyst "Creation" workflow, for both the prospection and the interpretation data.

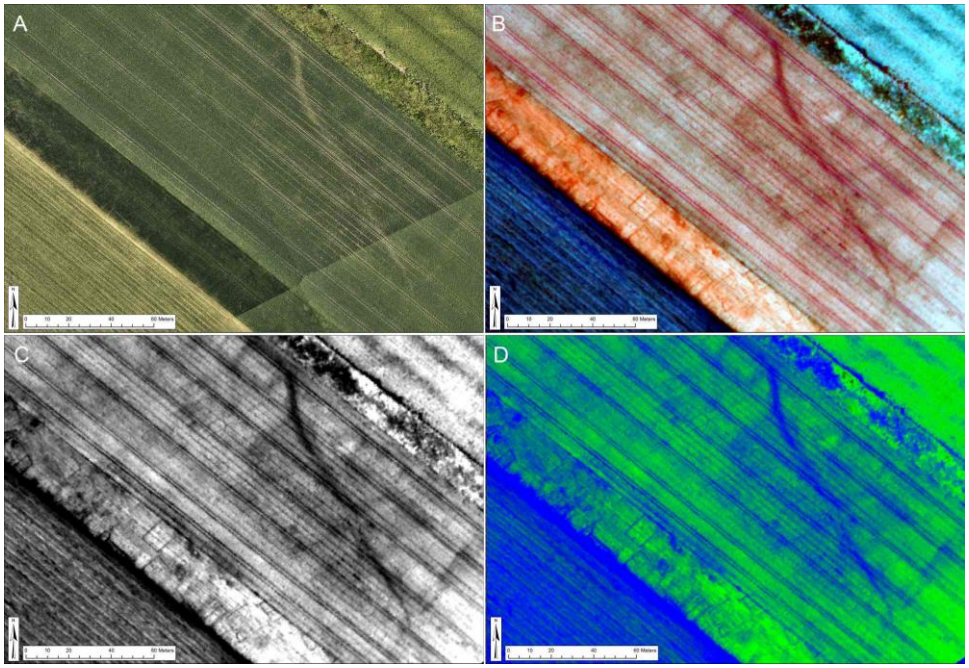
The prospection database was extended with a raster catalog for magnetic data both for float and gray scale data types with the relevant metadata. The geodatabase feeder software was also extended for this purpose. The geodatabase feeder software got also an area assignment feature, intended for large case study areas. The "Layer loader" tool inside ArchaeoAnalyst allows now the loading of magnetic raster as unified layers or individual raster layers.

The magnetic interpretation data can also be loaded through the "Layer loader" tool, also allowing the user to preset the symbology for the layer. A new system for symbologies was implemented alongside the magnetic interpretation layer loading function. This new feature allows the symbology and the edit templates to be defined by the user through an ArcGIS layer file stored in the ArchaeoAnalyst file space.

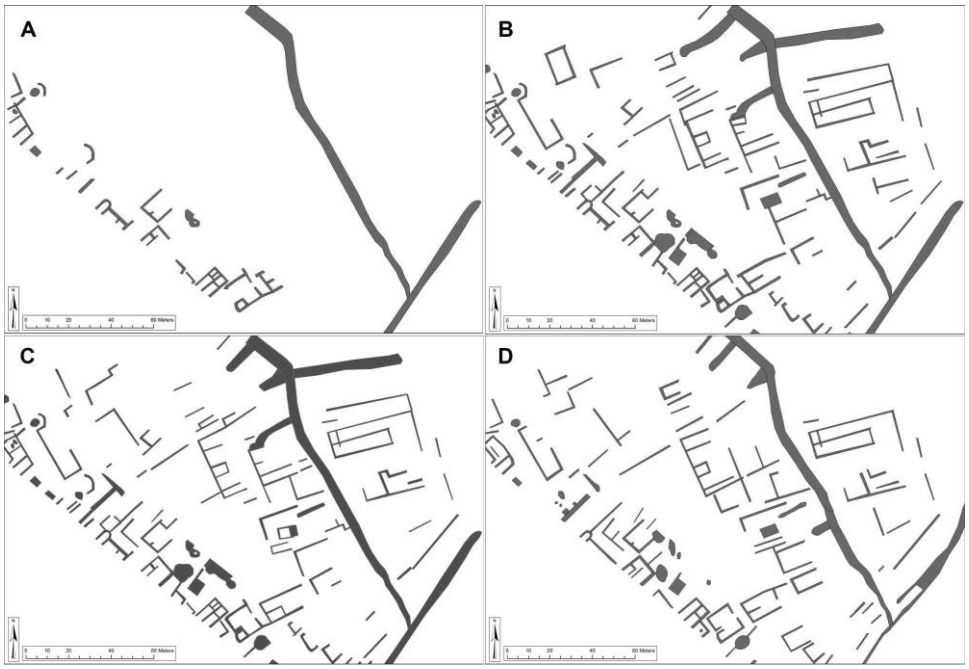
GIS-based interpretation of each AIS visualization

The evaluation of the AHS toolbox has shown that using newly developed tools from the toolbox ARCTIS (ARChaeological Toolbox for Imaging Spectroscopy) substantially more archaeological information can be visualized from hyperspectral datasets. The toolbox, which was developed by the LBI ArchPro partner Uni Vienna, is now open for download at http://luftbildarchiv.univie.ac.at. Related articles can be found in:

- Doneus, M.; Verhoeven, G.; Atzberger, C.; Wess, M.; Ruš, M. (2014): New ways to extract archaeological information from hyperspectral pixels. *Journal of Archaeological Science* 52, S. 84–96. DOI: 10.1016/j.jas.2014.08.023.
- Atzberger, C.; Wess, M.; Doneus, M.; Verhoeven, G. (2014): ARCTIS — A MATLAB® Toolbox for Archaeological Imaging Spectroscopy. Remote Sensing 6 (9), S. 8617–8638. http://www.mdpi.com/2072-4292/6/9/8617.



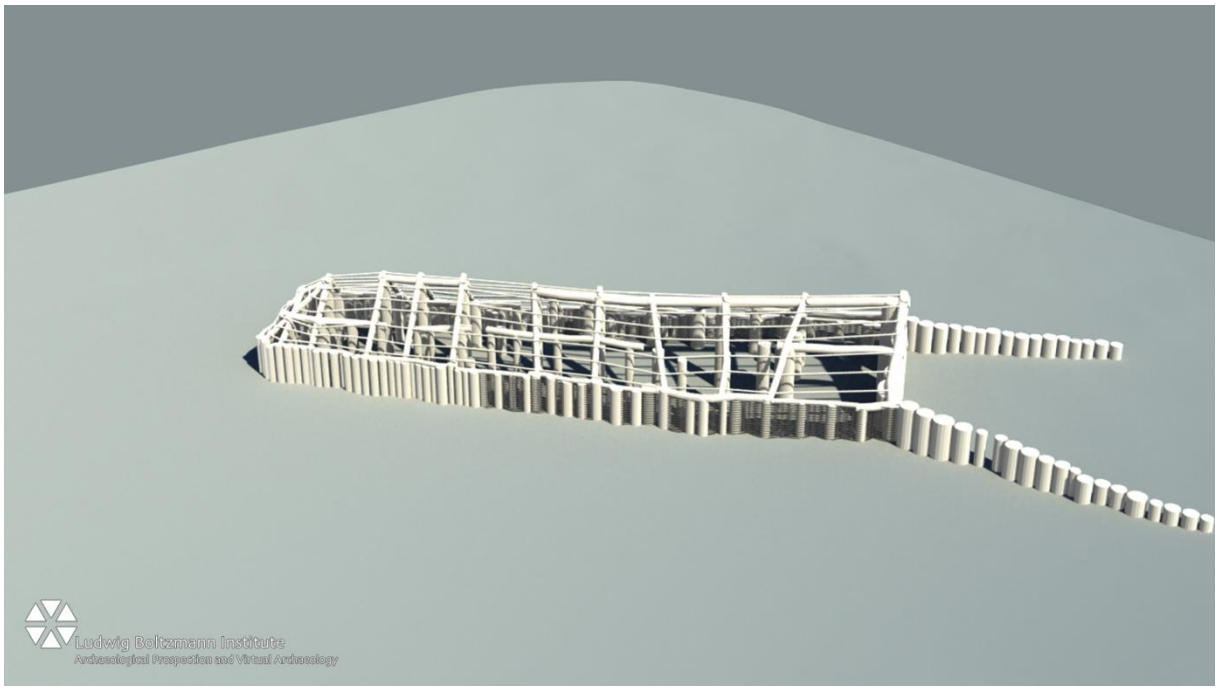
Data from Carnuntum, acquired on May 26th 2011. (A) Conventional orthorectified aerial image, acquired in the visible spectrum. GSD of 0.1 m; enhanced using contrast limited adaptive histogram equalization (***CLAHE***); (B) false colour composite created by means of the REIP algorithm (R= band 1 (wavelength), G = band 2 (slope), B = band 3 (reflectance value)). (C) rate parameter *b* of the gamma distribution fitting; (D) normal distribution fitting (R = NONE, G = band 2 (σ), B = band 1 (μ)). GSDs of (B), (C) and (D): 0.4 m. Figures B, C, and D were subject to the same histogram stretch by means of standard deviation.



Mapping of visualizations from figure above: (A) orthophotograph, (B) REIP, (C) gamma distribution fitting, (D) normal distribution fitting.

2.2 Virtual archaeology

A new workflow for the transfer of digital terrain models into the reconstruction and modelling software was developed and optimized. It allows the fast conversion of ASCII-Files to OBJ-Files. First tests have been done on the data from the case study Kreuttal with a modeling of the circular ditch and its related objects. Some new terrain-texturing and environment improvement workflows have also been developed for better visual results. A precise reconstruction of a long barrow based on the interpretation of the prospection results was made for Stonehenge. Additionally a realistic version of the long barrow including an animation of the building process was produced. Another minimalistic reconstruction and animation of the super-henge Durrington Walls was prepared for the public presentation. These results were amongst others used for the press conference in Birmingham in autumn 2014.



Stonehenge: Visualisation of a long barrow.

In the late 2014 GPR results from the Roman villa of Oberlienz have been used as a basis for a 3D reconstruction which will include a realistic visualization of the different phases of the site as well as several options within the buildings. The aim was focused on presenting an open result where further discussions can take place in respect to the complexity of the detected Roman settlement.

2.3 Underwater archaeology

State of the art analysis

A state-of-the-art overview was prepared and includes detailed information of various methods of underwater archeology. Small-scale GPR test measurements were conducted in May 2014 in Attersee, Salzburg. The goal was to test the field application possibilities of the present LBI ArchPro for underwater archaeology.

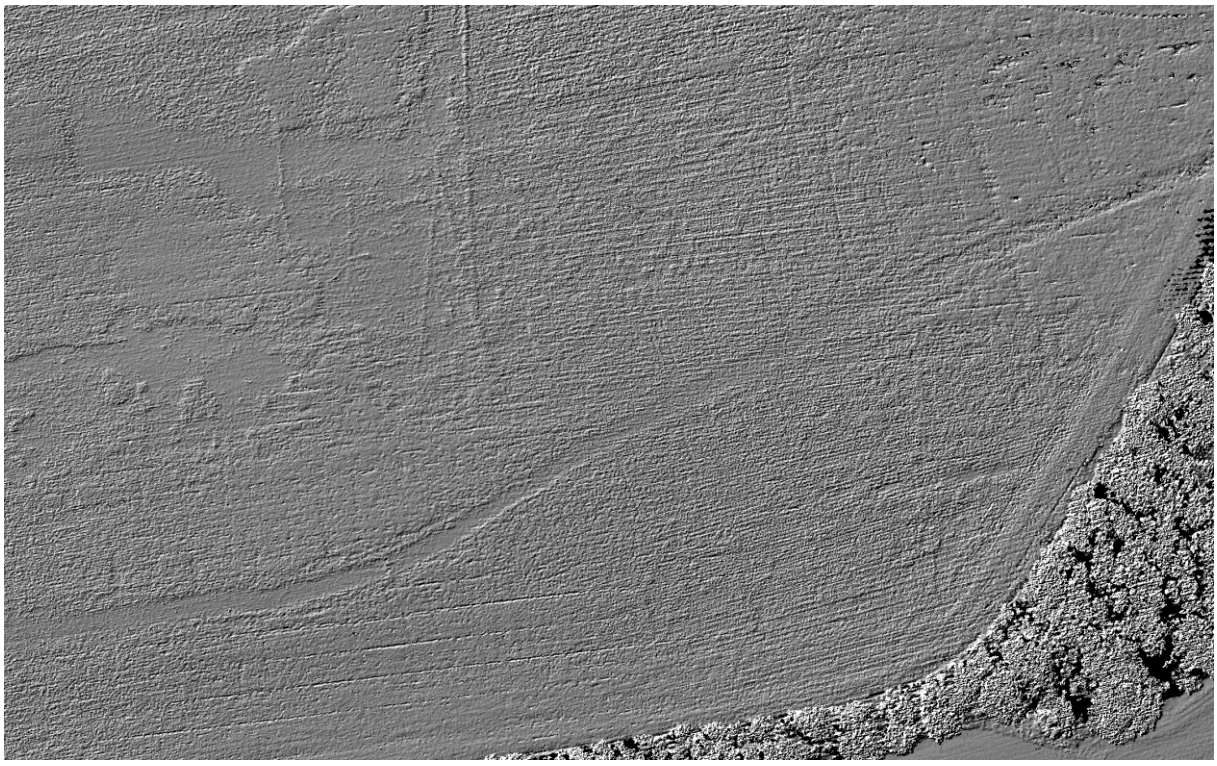
2.4 Unmanned aerial systems

State of the art analysis

A state-of-the-art overview of all commercial and open source unmanned aerial systems for the civil market was summarized in an Excel table. This table enumerates the most important characteristics of all the systems, thus allowing to quickly compare these UAS and sort them after the properties that are deemed most important. Besides the table, a short internal LBI ArchPro report was written that summarizes this Excel table.

Testing UAV-ALS

The testing of the novel Airborne Laser Scanner (http://www.riegl.com/products/uasuav-scanning/new-riegl-vux-1/) for UAV – Riegl VUX-1 has started. A first test flight was already performed by Riegl in April 2014 over CS area Carnuntum. The data show a high resolution, which makes individual vegetation marks visible. This is of potential interest for further research on integrated interpretation, as the relative heights of vegetation marks can be derived which could add information on moisture and nutrients in the buried structures.



Carnuntum: vegetation marks of the western end of the Civil Town, as visualized in a hillshade of the new ALS data.

2.5 Data acquisition and processing

Gamma ray survey

A gamma ray detector measures the decay of natural radioactive radiation which is signification for different materials. Early in 2014 a gamma ray detector was been implemented on a motorized

platform and tested on the archaeological test site of the Forum in Carnuntum. The data has been calibrated and processed with standard workflows. Nevertheless a further processing is needed due to the significant artifacts and noise in the data. For that reason a meeting with the sensor manufacturer “Medusa Sensing” was held in Groningen to gain some support regarding the data processing.

Induced EM system method and testing

A DualEM 21HS EMI system was bought by the LBI ArchPro and delivered by July 2014. The instrument was initially tested at the ring ditch of Hornsburg, case study Kreuttal by setting up a test survey. For this purposes a non conductive sledge was constructed and built. The data was geo-located with a dGPS system. First attempts to process the acquired data were undertaken with the software Oasis montaj. Following tests have been made:

- vertical profile in Hornsburg
- measurement on the site in Hornsburg with a sledge installation using a dGPS device
- static measurements on different conductive soil
- static measurement to estimate the instrument drift
- reoccurring kinematic measurements to estimate a possible direction dependency
- reoccurring measurements over a known profile to estimate the repeatability of the measurement
- comparing GPR profile with EMI profiles

Performance and characteristics of survey systems

Due to the aging of the data acquisition laptops (Panasonic Toughbook CF19, all purchased in 2010) a new concept for the data acquisition system used for the MIRA 1 system was developed. It is based on the computer system used in the MIRA 2 system. A new ruggedized industrial computer and a corresponding sunlight-readable touch screen have been purchased to be mounted into the Kubota tractor. Several modifications on the Kubota were necessary: one of the side windows were replaced by a plank to carry the computer, an aluminum mounting for the screen was build and mounted to the left of the steering wheel, power-supply was modified and equipped with a main power switch to power up the computer and the screen using the internal car battery of the Kubota, the new computer was set up with the latest software versions and successfully tested with the MIRA 2 system.

In February 2014 a meeting was held with a team from Sensors & Software in Canada. Two additional pairs of PulseEkko PRO 250MHz transducers and corresponding components were purchased. Together with the two already existing antenna pairs and SPIDAR components (NICs, Hub, cables) it is planned to design and construct a separate 250MHz SPIDAR array. The respective components were delivered from Canada in the beginning of April 2014 and first ideas towards the design and construction of the new SPIDAR array have been collected. The main idea was to modify one of the existing SPIDAR frames in order to bear both the existing 500MHz array and the newly setup 250MHz array. The existing steel frame was modified and all necessary electronic components (SPIDAR NICs, SPiDAR Hub and all cables) can be used for both arrays. The system was tested during late September within the framework of the CS Vestfold / Norway at the “Heimdal” area at Gokstad. First results look

rather promising. A much deeper penetration depth (approx. 4 m) could be achieved with the new system, which gives further information of the geological setting of the archaeological site.

New GPR system test within the framework of the CS Vestfold.

All motorized GPR systems have been updated and slightly changed. For both MIRA systems the modifications of the wheel suspensions have taken place: All wheels have been demounted and equipped with lubrication nipples in order to guarantee for longer lasting bearings, axles and wheels. A construction of an independent 220V power supply system for the Kubota RTV-900 (MIRA 2) was developed: The traverser of the Kubota has been equipped with a stable and water-proof mounting system for a power generator, compressor and a tool kit, making a completely independent maintenance of the MIRA 2 system possible.

One of the Javad Sigma systems (RTK via GSM using the EPOSA subscription) was used during the first test surveys with the new manual fluxgate system (HELGA neu). Furthermore, one license of the GART2000 software package (Fa. Allsat) was purchased in order to equip one of the Javad systems with a complete survey software (for all kind geodetic survey tasks).

The manual fluxgate magnetometer system “HELGA neu” was also modified. Several of the originally duroplasic bearers have been replaced by aluminum bearers in order to make the cart more stable under real survey conditions in rough terrain. The modified system was equipped with four fluxgate magnetometer probes (Förster CON650) and the Förster PNC datalogger. One of the Javad Sigma systems (RTK via GSM using the EPOSA subscription) was mounted in the centre of the array; this should allow a quick setup and survey progress within Austria. The system was first tested on the Middle Neolithic circular-ditch system of Puch. First results appear to be rather good but several more tests seem necessary in order to find the best setting for a long-term use of the system in the framework of the LBI ArchPro case studies.

During the main prospection season in the spring and summer 2014 several field related software suits were created and updated; field equipment was evaluated and updated. Here LoggerVis got a few updates. On one hand the navigation surface of LoggerVis can now handle measuring systems

which operate with the GPS receiver which is not in the middle of the sensor array on the X-axis. On the other hand, LoggerVis can now load geo-tiffs as background images. The greatest improvement however was the release of the Version 2.2. This version reduced the number of computations for received GPS positions resulting in a 20% performance gain. Some new “Performance options“, like faster data visualization, were introduced to allow better handling of bigger survey areas.

The main hardware project – the update of the motorized Caesium system – was conducted in the summer months of 2014. The system has been tested by various tests resulting in the discovery of a fault in the power supply of the system. A redesign and some electrical work have finally fixed the problem, so that the system works reliably now.

During one day in November 2014 the MIRA 1 system was tested using all three currently available mounting solutions. 1) the original mainly plastic one (with only few metal components) provided by MALÅ geoscience 2) the custom made steel one (similar to the antenna mounting on the MIRA 2 system) 3) the towing version provided by MALÅ. An area of approx. 0,25 ha in the area of the Roman Forum at Carnuntum was surveyed successively with all three mounting solutions. The resulting GPR data images showed a big difference in the penetration depth and signal to noise ratio of the GPR signal, with the towed mounting system showing by far the best performance. At the moment it remains unclear whether the difference is caused by the varying distance of the GPR system to the Kubota or a different distance above ground. The test is scheduled to be continued during spring 2015.

Extension of APSoft 2.0

A new GUI for APSoft 2.0 was designed and implemented. The name of the software has been changed in "ArchProSoft". Two main parts are ArchProMagnetic and ArchProGPR which represent easy useable and intelligent software products for processing data of motorized prospection systems with DGPS positioning. Most of the software parameters can be automatically set, standardized outputs can be generated. Due to various optimizations the software works more efficiently than previous versions.

Solutions for new emerged problems in ApMag and ApRadar have been implemented like positioning solutions in ApRadar or removing “oscillations” in magnetic sensors due to Sensor moves and modern magnetic fields in ApMag.

A new GUI for APSoft 2.0 designed and implemented with a new name "ArchProSoft". The software package includes ArchProMagnetic and ArchProGPR and was released together with a licensing system. The software is designed for processing data of motorized prospection systems with DGPS positioning and includes three main functions: data processing, data visualization and a tool for combining different prospection fields. Very few processing parameters have to be selected manually, standardized outputs are available and due to various optimizations the software is twice as fast as the previous version.

Development of a Fluxgate Magnetometer Data Logger

In September 2013 the decision was made to start with the a feasibility study for development of an own data acquisition unit for the magnetic measurement devices. Aim of the development is to make pre filtering procedures by the hardware manufacturers not more needed. All data manipulation shall be done on the software side and not, as it is done currently, on the hardware side. Two different A/D logger devices are currently under testing. Additionally a single platine computer shall

be used for the data acquisition. In a moment the hardware design has been finished and needs to be tested in the next period.

Analysis of radiometry of multiple ALS

The work conducted in 2014 includes the analysis of calibrated radiometric images from already acquired flights over Carnuntum. In May 2013, data were acquired within a few days using RIEGL laser scanners operating in the range of 532 nm (green), 1064 nm and 1550 nm (both Infrared). These three radiometrically calibrated datasets have been analyzed in regard to the question if a combination different datasets can provide more archaeological information on vegetation marks. For this purpose, the images were imported into ARCTIS and various visualizations calculated. The analysis has showed that the datasets are problematic as they were not flown at good conditions for crop marks. Here an additional data acquisition at an archaeologically more promising date would be advisable.

NDVI using bands 532nm – 1550nm.

Radiometric calibration of ALS data in forested areas

The aim of the project was to analyze the archaeological content of the intensity of the multiple-laser scan over Carnuntum. Within two flights end of May 2013, the same area in Carnuntum was covered with three different laser scanners operating in 532, 1064 and 1550 nm. In 2014 one paper was published:

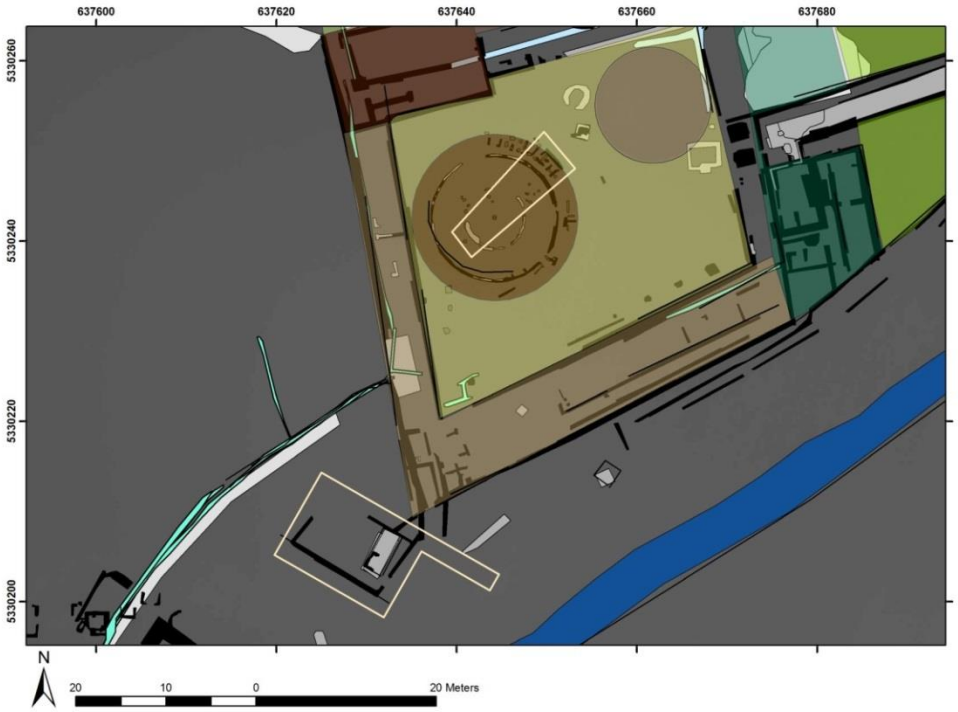
Briese, C.; Pfennigbauer, M.; Ullrich, A.; Doneus, M. (2014): Radiometric Information from Airborne Laser Scanning for Archaeological Prospection. In: *International Journal of Heritage in the Digital Era* 3 (1), 159-178. DOI: 10.1260/2047-4970.3.1.159

2.6 Case studies

Carnuntum, A

An archaeological excavation, organized by the Archaeological park Carnuntum in cooperation with the University of Vienna and supported by the LBI ArchPro, was carried out between June 23rd and August 12th in the area of the school of gladiators in Carnuntum. The excavation trenches were selected based on GPR and magnetometry results from 2011 and placed in the presumable training arena and the graveyard area.

Carnuntum: aerial photography taken during the excavation.



Archaeological interpretation of MIRA GPR data and position of the excavation trenches.

Preliminary results show that the geophysical survey results could be positively confirmed by the excavation. Printouts of the 5 cm MIRA depth-slices were used on site to identify the features in the excavation trench and depth-slices respectively. Little variations could be seen concerning the depth information of the GPR data. These could be used in order to calibrate the GPR processing more accurately.

In trench 1 the amount of archaeological material was low. Ten Roman coins, mainly form late Roman period, fragments of scale-armour (*lorica squarmata*) and pottery were the most important finds. In the trench two remains of Roman tomb installations were identified. Although the tomb is just partly preserved, three burials of new or dead-born children, parts of at least one adult scull and one cremation burial could be documented. The South-eastern extension of trench two showed a high amount of findings, mainly pottery and animal bones, deposited within downwards sloping layers. The interpretation as a spoil heap just outside the ludus main building is therefore rather likely.

Interpretation of the magnetic data collected in 2014 shows temporary camps, field boundaries, Roman farmsteads, a military defense system from World War 2 and other traces from the past. The interpretation of the western part of the GPR surveyed area (representing the civil town and its surroundings) has been finished and shows the development of the Roman city in great detail.

Kreuttal, A

Several flights were performed over the case study areas Carnuntum and Kreuttal. On March 13th a test flight with an assembled UV-camera (specially treated Canon T3i 600 D with a Noflexar 35mm lens and a Baader 2" U-Filter ZWL 350 nm) was made. It was the first time that photographs could be done from an airplane at high speed resulting in reasonable sharp images.

Magnetic prospection was continued in the area around Kreuzstetten. During this survey several persons where educated and trained in terms of overall logistics, operation and maintenance of the system as well as in work safety. The systems operated during the survey where three 8-channel fluxgate magnetometers, where two had data loggers from Eastern Atlas and one from Förster. All systems were supplied with additional safety equipment allowing legal operation on public roads. The Survey started with the 2nd of July and ended on September 29th. Keeping in mind that the area consists of very small fields, the fact that a lot of time was spent for education and training and most of the time only one system was operated, the survey was successful. New archaeological structures were detected and new settlement areas defined. The surveyed area covers now approx. 4 km^2.

Additionally the excavation of the KGA Hornsburg 1, which was started by partner Uni Wien and supported by the LBI ArchPro in 2013 continued from August 22nd till end of October 2014. Various techniques were tested and evaluated during the excavation e.g. P-XRF, susceptibility measurements, HDR Photography, IR and UV Photography. Exposed areas were cored and sampled on a 4 m grid with samples from top and bottom of brown soil layer. These samples will be subject to phosphate, magnetic susceptibility and possibly multi-element chemistry if other results prove interesting. The Brucker pXRF was borrowed from Geology, University Vienna and used to measure selected areas.

24 Region um Wolkersdorf

Woche 27/2014 NÖN

„Ein riesiger Fleckerlteppich“

Spuren der Vorzeit | Im kommenden Jahr werden Experten des Ludwig Boltzmann-Institutes mit modernsten Techniken nach Artefakten und Zeugnissen der Urzeit im Boden suchen.

Von Conny Schütz

HORNSBURG | Unter dem Titel „7000 Jahre Kreuttal - Archäologische Sensationen vor Ihrer Haustür“ präsentierten Matthias Kucera und Wolfgang Neubauer vergangenes Wochenende im FF-Haus Hornsburg eine neue Studie des Ludwig Boltzmann Instituts. Die vielen Besucher und Besucherinnen ließen sich die einmalige Chance, gemeinsam mit den Profis auf diesem Gebiet in die Geschichte ihres Heimatortes zurückzublicken, nicht entgehen.

Bereits im Jahr 1988 untersuchten Mitarbeiter des Ludwig Boltzmann Institutes zum ersten Mal die Gegend im Kreuttal. 2009 setzten sich diese den Schwerpunkt, die gesamte Landschaft mittels Luftbildern zu prospektieren. Erst im vergangenen Sommer wurde eine Lehrgrabung an einem der Kreisgräben zwischen Hornsburg und Kreuzstetten durchgeführt. Auch das Projekt für den kommenden Sommer steht schon in den Startlöchern. Vielleicht deshalb weil, wie Matthias Kucera bei seinem Vortrag meinte: „Dieses Gebiet so interessant und facettenreich ist.“

Beim Vortrag wurden den zahlreichen Gästen interessante Details über bisherige Fundstellen in ihrer Heimat erzählt. Denn Fundstellen gibt es im Kreuttal schon einige.

Beispiele dafür wären die beiden Kreisgrabenanlagen, das Beförderungssystem beim Ochsenberg oder die 85 Hektar große Türkenschanze. „Im Moment ist das riesige Gebiet, das wir bisher untersucht haben, ein großer Fleckerlteppich. Diesen gilt es nun so gut wie möglich zusammenzufügen“ so Wolfgang Neubauer.

Und deshalb wird auch in diesem Sommer wieder mit den neuesten Methoden und Techniken wie zum Beispiel mittels Airborne Laserscan nach neuen Details gesucht, die Auskunft über die bereits siebentausendjährige Geschichte des Kreuttals geben sollen.

„Die Forschungsmethode ist im Prinzip die gleiche wie bei der Untersuchung von Stonehenge, nur bewegen wir uns hier halt in einer anderen Zeit“, sagt Archäologe Neubauer. Das gesamte Areal wird unter Zuhilfenahme neuester geophysikalischer und geodätischer Meßtechnologie zerstörungsfrei auf archäologische Spuren hin untersucht.

Mit dem Magnetometer können zerstörungsfrei Artefakte und Spuren der Vergangenheit im Boden sichtbar gemacht werden.
Foto: LBI ArchPro, Geert Verhoeven

Die Hornsburger Kreisgrabenanlage

Die Kreisgrabenanlagen gehören zu Europas ältesten Monumentalbauten und wurden zwischen 4800 und 4500 vor Christus errichtet. Die ersten Kreisgräben kann man erfassen, nachdem um 4900 vor Christus durch große kriegerische Szenarien ganze Landstriche bereinigt und neue Siedlungen geschaffen wurden.

„Kreisgräben waren ein integraler Bestandteil der Siedlungen und hatten große Bedeutung, möglicherweise als Ritualplatz für Initiationsrituale, Hochzeiten und Begräbnisse.

Die Hornsburger Anlage ist sehr mächtig. Der äußere Kreis hat einen Durchmesser von 110 Metern, die Gräben sind sechs Meter breit und drei Meter tief. Es sind drei Gräben, durch die eine Torgasse von außen ins Zentrum führt“, berichtet Archäologe Neubauer.

Der 2013 untersuchte dreiringige Kreisgraben ist bereits die zweite, wissenschaftlich untersuchte Anlage in Hornsburg.

Kreuttal: Press campaign during the fieldwork.

Due to the interdisciplinary approach prospection, geochemical, sedimentary and excavation data have been collected and are beginning to be interpreted for a comprehensive reconstruction of the Hornsburg 1 Kreisgrabenanlagen and its immediate surroundings.

Halbturn, A

Between July 7th and 11th 2014 a short geophysical prospection season for the Case Study Halbturn was conducted. The fieldwork campaign focused on large-scale magnetic prospection with a motorized 8 channel Eastern Atlas/Foerster gradiometer array. An area of approximately 79 ha^2 was surveyed. The first analysis of the data shows some completely new settlement structures (ditch systems, pits and graves). Further archaeological interpretation of the results will show to what extent this new archaeological features can be dated in Roman period.

Combined prospection in Halbturn: aerial archaeology and geomagnetic survey.

St. Anna, A

Geophysical prospection took place in St. Anna beginning of March 2014. Using the MIRA System, the open area surrounding the monastery was surveyed. Preliminary results show several stone building, which could be interpreted as remains of a Roman villa.

St. Anna: geophysical prospection; background image: shaded ALS-derived DTM.

Virunum, A

In the framework of the cooperation project of the LBI ArchPro and the Institute for the Study of Ancient Culture (IKAnt), the work has focused on the interpretation and presentation of the latest GPR measurements in Virunum. In November 2013 measurements with the MIRA 2 system have proved the existence of a Roman military camp on the eastern periphery of the Roman town of Virunum. During this year's summer, the interpretation of this remarkable building complex was finished. It became clear that the Virunum military complex is one of the few examples of Roman provincial centres where the guard of the provincial governor is directly linked to the palace of the procurator. These new results were presented in Rumania (Simpozionului ARA 15) and Slovenia (Conference "The Roman army in the regions of the northern Adriatic and Eastern Alps").

Roman city of Virunum.

Birka, S

Within the framework of a Birka excavation project run by the Historiska museet Stockholm a team of the LBI ArchPro has supported the excavation of the Viking Age burial mound in the Hemlanden area of Birka between May 25th and June 13th. The main aim for the LBI ArchPro was the documentation of the excavation process using 3D laser scanning and digital photogrammetry (structure from motion) in order to acquire data for virtual reconstructions of the burial mound and the burial itself. A larger part of the area surrounding the mound was scanned before the excavation started in order to get a high resolution topography model (to be compared with the existing ALS dataset). After the excavation started further scans were taken whenever one layer was fully excavated. At the same time photos were taken from approx. 30 positions around the excavated area. The images should be used during the processing to texture the resulting surface models from the laser scan. This documentation workflow was tested in order to speed up the documentation process and still get high quality surface models. In three weeks of excavation a total number of 35 layers were excavated and documented with ca. 120 single scan positions and about 2.500 photographs.

Riegl VZ400 at the excavation in Birka.

Vestfold, N

In 2014 two fieldwork campaigns have been conducted in framework of the Case Study Vestfold. The campaigns took place in the period from March 31st to April 11th and from September 7th to October 2nd. The spring campaign focused on GPR prospection at different sites within the RPBA (Regional plan for baerekraftig arealpolitikk) areas defined by Vestfold fylkeskommune. The autumn campaign mainly focused on finalizing the case study area in Slagendalen with GPR and magnetometer prospection as well as starting at the newly defined area of Jåberg / Istrehagen. Several test excavations on previously surveyed areas have been carried out additionally in the framework of the case study. Verification of anomalies as well as geoarchaeological measurements on the respective anomalies was the main objectives of these excavations.

Vestjylland, DK

Two fieldwork campaigns have been conducted in Vestjylland / Denmark in 2014. Based on previously taken aerial photographs a larger fieldwork campaign has taken place from August 31st until September 6th in the area of Vestjylland. Five different sites have been surveyed using motorized GPR and magnetometry systems. A short, one day survey took place at Rysensten on April 11th. First results have been presented at the LBI ArchPro board meeting in late October 2014.

Stonehenge, UK

From July 28th to August 6th 2014 a geophysical survey at the so called triangle field at Stonehenge was conducted. With the GPR system MIRA 1 and the magnetic system EAL 1 the triangle field and additional two smaller fields SE of Durrington Wall have been measured, covering in total some 18,5 ha with magnetic and 22 ha with GPR.

Stonehenge 2014: Magnetic data of the triangle field.

The interpretation of the results from the triangle field has shown seven burial-mounds. Six of them consist of a simple ring-ditch, which was originally enclosed by a bank that is still visible at one of the monuments. The seventh mound has some similarities to the Amesbury 50 monument, which was documented during previous GPR measurements. The henge-monument consists of an inner ring of 24 postholes that are enclosed by two separated groups of huge pits. The postholes can be traced to a depth of ca. 2 m, while the huge pits are only roughly 1,5 m deep. Within the surrounding of the henge monument in the triangle filed the remains of facility buildings and most of the old track ways from the First World War airbase are still recognizable.

Bassianae, SRB

From June 23rd to July 1st 2014 a small team of the LBI ArchPro conducted a geophysical and aerial survey in Bassianae, Donji Petrovci, Serbia in order to try to cover all of the late antique town inside the city walls and some additional areas east of the walls and in the location of Caput Bassianense (Szolnok), Dobrinci, Serbia. Except for some small areas which could not be surveyed because of growing plants (especially thistles) and holes made by mining for ashlar by the local population, the whole project area at Bassianae could be covered with geophysics during this campaign, producing a total coverage of about 19,8 hectares of GPR measurements, 27,4 hectares of magnetometry and 1,3 km² of aerial survey. The areas prospected by GPR and magnetics include the whole site inside the city walls of Bassianae and an area east of the city walls in a meadow used as grazing ground for cattle. In addition to these areas the aerial survey, producing photos and highly accurate DTMs, covered also a small part of the site of Caput Bassianense, which still has been under crop respectively partly got harvested during the time of the campaign and thus remained inaccessible for our geophysical survey.

GPR results from Bassianae.

3.1 Scientific cooperation and third party funded projects

On September 22nd a planning meeting was held in Tanum with Swedish experts on the documentation of rock art, Dr. Johan Ling and Prof. Ulf Bertilsson, from Gothenburg University and the Swedish Rock Art Research Archives. Plans for a joint project application in 2015 for large-scale rock art documentation and archaeological prospection of the relevant areas using laser scanning, SfM and geophysical prospection methods have been discussed.

The project application of LBI ArchPro Partner RGZM Mainz (Dr. Andrea Babbi, Dr. Markus Egg) in collaboration with the University of Mainz (Prof. Christopher Pare) to the German Research Foundation for large-scale geophysical archaeological prospection at the Etruscan site of Bisenzio at the southern shore of Lago Bolsena, which had been jointly formulated and supported through test measurements conducted in summer 2013, has been successful. Planning for a first fieldwork campaign in 2015 is work in progress.

Project "Airmagnet"

The operational project has been successfully finished by the end of June 2014. The final report and the project budget were finished by the end of September due to the extensive coordination between the partners ABT, LBI ArchPro, PICO and Geoexpert. At the final meeting the possibilities for future cooperation projects have been discussed.
Project results can be defined as follows:

- Development of an aeromagnetic survey platform with configurable sensor mountings
- Calibration and compensation of the platform and documentation of procedures
- Data processing workflow for the processing of total field measurements as well as horizontal gradient. development of processing workflows and processing of some test sites

(Eisenberg and Kreuttal)

- Data processing workflow for the processing of gamma ray spectroscopy survey data
- Basic joint interpretation workflows for seismic and magnetic data
- Market research and competitor analysis
- Pre study for future development projects (mainly electro magnetics)

Benefits for the LBI ArchPro are in newly developed concepts for data acquisition of total field data and for joint GPR and geomagnetic interpretation. Furthermore the advantages can be found in the development of gamma ray detectors for archaeological purposes.

3.2 LBI ArchPro workshops

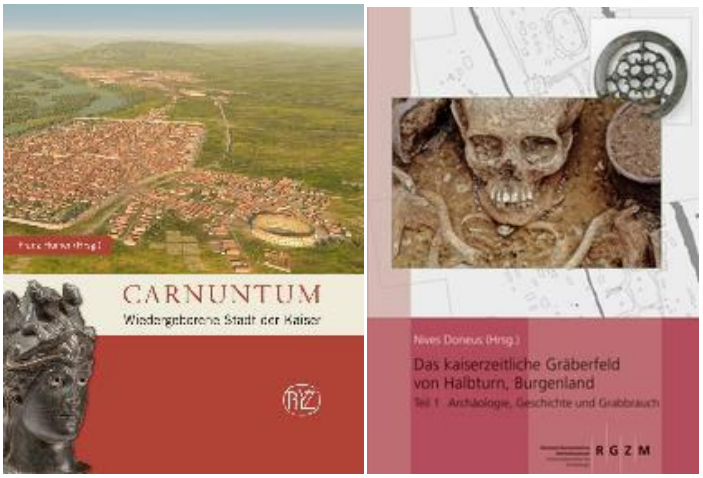
Discussion of the new research programme (2014-2017) was the main topic during the workshop in St. Gilgen, Salzburg on 15th – 17th January 2014.

On October 10th, 2014 a LBI ArchPro workshop took place at the Museum MAMUZ in Asparn an der Zaya / Lower Austria. In two days, and in the course of eight sessions, the latest research results from case studies and different PhD projects (IC ArchPro) were presented. Over sixty representatives of the LBI ArchPro partner organizations attended the workshop, as well as individual members of the SAB.

LBI ArchPro Workshop at the Museum MAMUZ

3.3 Dissemination activities

Next to the publication activities, which include publishing with the LBI ArchPro partner organizations like NoeL and RGZM, different tasks have been accomplished in the last few months. Following up the dissemination workshop with partner Vestfold Fylkeskommune in February 2014 in Obertauern, Salzburg, two trips (April and June 2014) to Vestfold were made to get hands-on practice with the implementation of an LBI ArchPro communication plan regarding a local archaeology project.



New books published in 2014.

The preliminary communication plan for CS Kreuttal which was first set up at the dissemination workshop Obertauern was extended and its implementation started. A visit of the CS-site at Kreuttal with CS-leader Matthias Kucera was made to explore possibilities of PR and tourism concepts. In the run-up to the beginning of the fieldwork in August an information event presenting the work of the LBI at the Kreuttal was organised for the local community at Hornsburg on June 27th 2014. The announcement of the event was made by printed flyers distributed with the help of the municipal offices. The local media (NÖN, Bezirksblätter) was informed and covered the story in their print issues. The event was a big success with approximately 70 people attending. Following up this event an open day was organized for the local communities during this year's excavation campaign at Hornsburg in September; measures included the distribution of flyers in the local communities, personal contact with local authorities and communication with the local press who covered the story in their weekly paper (NÖN).

On April 4th 2014 the LBI ArchPro took part in the "Lange Nacht der Forschung 2014" (Austrian Science Night) – a nationwide initiative to communicate scientific work at Austrian research institutes to the public. At the LBI ArchPro exhibition area at the Austrian Academy of Sciences (Vienna) visitors got the chance to learn interesting facts about non-invasive archaeological prospection methods and virtual archaeology and to get hands-on experience of the institute's work. For this event a free-standing piece of furniture with a horizontal screen and (in the original idea) a stack of printed glass plates was designed that should bring together animated radar depth slices and an interpretation/reconstruction of the data. The piece attracted a lot of attention by visitors and proved useful for the explanation and demonstration of the method. After the event it was set-up on permanent display at the Carnuntum Archaeology Park.

GPR depth slice visualisation item (Carnuntum Gladiator school)

In 2014 a series of press releases and press conference have been organised so far to release new findings and results to the media and to gain general attention for the work of the LBI ArchPro:

- The online APA Science Dossier “Daten statt Spaten” on non-invasive methods in archaeology was produced in close collaboration with the LBI ArchPro in March 2014 (https://science.apa.at/dossier/Daten_statt_Spaten/SCI_20140331_SCI51472495217558888)
- Press release on the “Akrotiri”-story in the National Geographic Germany June issue (June 2014).
- The press conference „The first Romans in Carnuntum“ was held together with Archäologischer Park Carnuntum and partner County of Lower Austria (18th June 2014).

Wolfgang Neubauer talking to the media after the Carnuntum press conference (Photo: Geert Verhoeven).

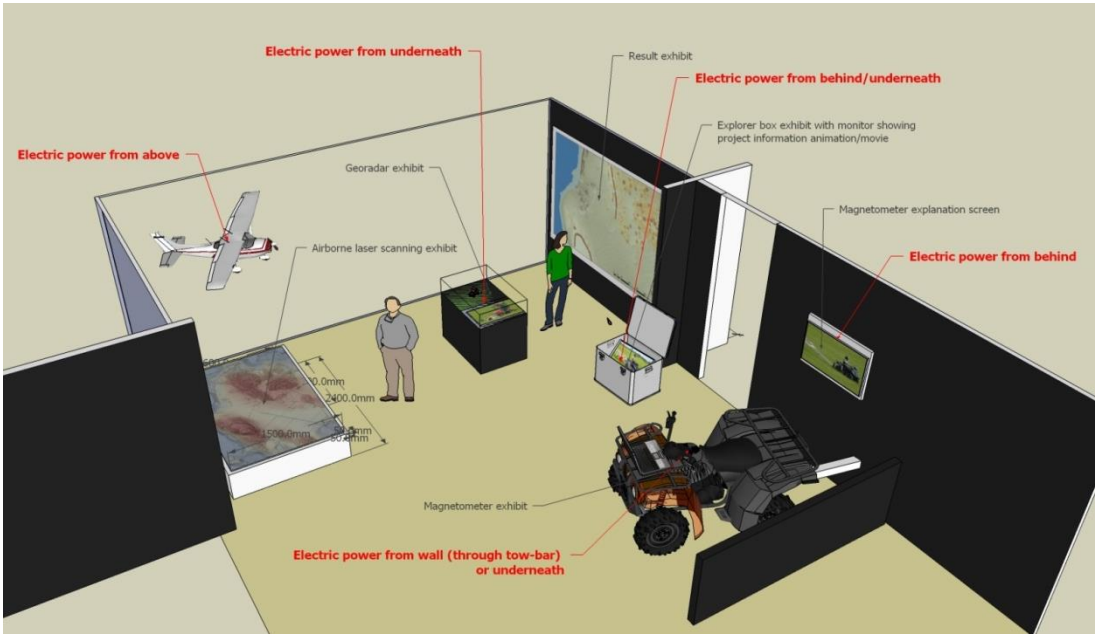
- The Press conference “Auf den Spuren des heiligen Wolfgang” (Falkenstein, Salzburg) was held together with the LBG, LBI Lung Vascular Research and LBI Neolatin Studies (3rd July 2014).

Speakers on the podium during the Falkenstein press-conference: Claudia Lingner, Wolfgang Neubauer, Andrea Olschewski, Josef Pröll, Verena Kremling and Stefan Tilg (from left to right; Photo: Geert Verhoeven).

- The Press conference “Stonehenge” was held together with partner VISTA/University Birmingham in the UK (09.09.2014). At the LBI ArchPro an imagery website was set-up to

create a convenient download link for the press (www.lbiarchpro-imagery.at/stonehenge2014).

In May 2014 a new exhibition was opened at the Birka Museum on Björkö (Sweden). The LBI ArchPro was invited to design an area presenting its methods, research and fieldwork at the sites of Birka-Hovgården. The LBI ArchPro exhibition included a magnetometer exhibit with a modified Quad bike and a LoggerVis visualization, an ALS installation with a LIDAR plane model (2 m wingspan) mounted over a poster showing Birka ALS data and a georadar exhibit with the model of a motorized GPR-system mounted on different slices showing grass covered area, measurement data, interpretation, subsurface archaeology, vertical profile sections (printed on polystyrol sheets).



Design of the exhibition area at the Birka Museum.

Maintenance of the LBI ArchPro websites mainly aimed at creating and updating content e.g. short news articles following press releases and other events. Additionally the LBI ArchPro Facebook-Page was reanimated with weekly updates and postings focusing on the individual team members and everyday stories from the field and the office.

3.4 Teaching activities

In the summer of 2014 some internships for high school students were held in Austria. Subsequently, the interns had the opportunity to write a report. The report by Florian Wolfbeisser and Andreas Inhauser, who were cared for by the LBI ArchPro, is among the 20 best. The award ceremony will be held on April 23, 2015, where the Federal Minister Stoeger will present certificates and prizes to the students.

In October 2014 a Croatian student Miroslav Vuković has visited the LBI ArchPro as part of his OeAD scholarship. The Austrian agency for international mobility and cooperation in education, science and research (OeAD) promotes and supports international cooperation in education, science and research. His master thesis focuses on the use of UAV-s in archaeology, with a special emphasis on the rotor based systems.

Lectures at the University Vienna

Wolfgang Neubauer	Summer 2014	060085 PR Lehrgrabung, Hornsburg, Kreuttal
	Summer 2014	060088 EX Auslandsexkursion Schweden (mit I. Trinks)
	Winter 2014	060088 PV Privatissimum
	Winter 2014	060096 VO Stratigraphische Grabung: Theorie/Praxis
	Winter 2014	060098 SE Stratigraphie und Prospektion
Michael Doneus	Summer 2014	060059 EX Auslandsexkursion Sardinien
	Summer 2014	060060 PR Lehrgrabung 1, Kreuttal
	Summer 2014	060062 PV Privatissimum
	Summer 2014	060063 VO Landschaftsarchäologie
	Summer 2014	060084 UE Vermessungskunde für Archäologen (mit W. Neubauer)
	Winter 2014	060064 VO Einführung Theorie Luftbildarchäologie
	Winter 2014	060069 UE Luftbildarchäologische Interpretation
	Winter 2014	060071 UE GIS-Anwendungen in der Archäologie
	Winter 2014	060072 PV Privatissimum
	Winter 2014	060073 SE Fundstelle und Landschaft
	Winter 2014	060074 PR Flugzeuggetragenes Laserscanning (LiDAR) für ArchäologInnen
Immo Trinks	Summer 2014	060087 VO Bodenradar - Theorie und Praxis
	Summer 2014	060096 VO Akrotiri - Eine Minoische Stadt
	Winter 2014	060065 VO Einführung Theorie Geophysikalische Prospektion
Matthias Kucera	Winter 2014	060083 VO Grundlagen der Experimentellen Archäologie

3.5 Management

A project planning workshop was held on 13th August 2014 with the whole team at LA premises. Several bilateral meetings were held between the programme management and the individual project managers in order to define the project order. The overall research projects and their timing were finalized.

4. Dissemination

Internal dissemination activities have been concentrating on following topics:

- Board meeting Halbturn (15th October 2013)
- Evaluation report (November 2013)
- LBI ArchPro personal reports
- Maintenance of LBI ArchPro bibliographical database
- Cataloguing and labeling of the LBI ArchPro library (books, periodicals, papers, CDs, etc.)
- Archiving of data on LBI ArchPro server
- Tracking of media coverage and archiving of media reports (online, print)
- Provision of information and PR material to media (i.e. Bild der Wissenschaft)

- New case study home pages: the content of the newly upgraded LBI ArchPro website was extensively updated and extended (team member information, media coverage, publication list, events); individual case study websites were created and launched.

4.1 Press coverage and press releases 2014

LBI ArchPro

- Götter, Gräber und Geräte (Bild der Wissenschaft 1/2014 – print only)
- Arbeit mit Weltgeltung (NÖN, 19/2014 – print only)
- http://science.apa.at/dossier/Daten_statt_Spaten/SCI_20140331_SCI51472495217558888
- http://www.riegl.com/media-events/newsletter/0214-terrestrial-laser-scanning-of-the-landscape-around-stonehenge/
- http://archpro.lbg.ac.at/sites/files/archeo/atv-magazin.com_2014.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/terra_mater_ein_werkzeug_fuer_die_wissenschaft_2.12.2014.pdf

Kreuttal, A

- http://archpro.lbg.ac.at/sites/files/archeo/noen_archaeologie_im_kreuttal_24.6.2014.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/noen_ein_riesiger_fleckerlteppich_1_7_2014.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/kurier_noe_wilde_rituale_vor_7000_jahren_gefeiert_23.9.2014.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/noen_archaeologie_hautnah_23.9.2014.pdf
- http://archpro.lbg.ac.at/sites/files/archeo/noen_ur-hornsburger_feierten_gern_30.9.2014.pdf

Carnuntum, A

- http://kurier.at/lebensart/leben/aeltestes-roemerlager-in-carnuntum-noe-entdeckt/70.985.094
- http://www.wienerzeitung.at/themen_channel/wissen/geschichte/638755_Roemisches-Militaerlager-in-Carnuntum-mittels-Bodenradar-entdeckt.html
- http://derstandard.at/2000002132152/Archaeologen-stossen-auf-roemisches-Militaerlager
- http://diepresse.com/home/science/3825065/Romisches-Militaerlager-in-Carnuntum
- http://www.germandailynews.com/bericht-36644/roemerstadt-carnuntum-wird-mittels-bodenradar-erforscht.html
- http://www.heute.at/freizeit/kultur/art23668,1030930
- http://www.noen.at/nachrichten/noe/kultur-gesellschaft/Wo-die-ersten-Roemer-lebten;art79522,545902
- http://archpro.lbg.ac.at/sites/files/archeo/oesterreich_roemische_garnison_in_carnuntum_entdeckt_19.6.2014.pdf
- http://noe.orf.at/news/stories/2653290/
- http://archpro.lbg.ac.at/sites/files/archeo/noen_die_besten_der_welt_24.6.2014.pdf
- http://www.telegraph.co.uk/earth/environment/archaeology/10912474/Remains-of-Roman-army-base-found-in-Austria.html
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- https://de.nachrichten.yahoo.com/begraben-unter-vulkanasche-akrotiri-wird-mit-3d-scannern-000000102.html
- http://www.baublatt.ch/aktuelles/news/mit-3d-laserscanner-antike-stadt-erhalten
- http://www.archaeologie-online.de/magazin/nachrichten/forschungsinitiative-und-national-geographic-sichern-digital-das-bedrohte-kulturerbe-akrotiri-30636/

Vestfold, N

- Kjøper seg tid med snøscooter (Vestfold Blad, February 2014 – print only)
- http://archpro.lbg.ac.at/sites/files/archeo/lemvig_folkeblad.pdf
- http://www.tu.no/samferdsel/2014/09/10/denne-radartraktoren-ployer-frem-minner-fra-fortiden-langs-nye-e18
- http://www.oblad.no/nyheter/georadaren-ser-etter-arkeologiske-registreringer-pa-nordre-skuterud-og-askjum-1.8583777
- http://archpro.lbg.ac.at/sites/files/archeo/nationen_vestfold.pdf

Osor und Vižula, HR

- http://otoci.net/index.php/u-bastini/2706-otkriti-anticki-osor-bez-kopanja
- http://www.volim-losinj.org/kultura/2321-geofizicko-istrazivanje-u-osoru
- http://www.editfiume.com/lavoce/pola/10126-a-visola-un-connubio-tra-tecnologia-e-scienza
- http://www.regionalexpress.hr/site/more/digitalno-otkrivanje-skrivene-kulturne-batine-u-medulinu
- http://www.ipress.hr/gradovi-i-opcine/pula/digitalno-otkrivanje-skrivene-kulturne-bastine-na-arheoloskom-nalazistu-vizula-34822.html
- http://www.istarski.hr/node/15762
- http://www.medulin.hr/hr/novosti/
- http://www.istra-online.com/clanak/digitalno-otkrivanje-skrivene-kulturne-bastine-na
- http://radio.hrt.hr/radio-pula/clanak/najmodernije-arheoloske-motode-za-istrazivanje-vizule/74555/

4.2 LBI ArchPro Publications 2014

Articles in journals

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

1. Atzberger, C.; Wess, M.; Doneus, M.; Verhoeven, G. (2014): ARCTIS — A MATLAB® Toolbox for Archaeological Imaging Spectroscopy. In: *Remote Sensing - Open Access Journal* 6 (9), 8617-8638. Online verfügbar unter http://www.mdpi.com/2072-4292/6/9/8617.
2. Doneus, M.; Verhoeven, G.; Atzberger, C.; Wess, M.; Ruš, M. (2014): New ways to extract archaeological information from hyperspectral pixel. In: *Journal of Archaeological Science* (52), 84-96. DOI: 10.1016/j.jas.2014.08.023.
3. Draganits, E., Doneus, M., Gansum, T., Gustavsen, L., Nau, E., Tonning, C., Trinks, I., Neubauer, W. (2014): The late Nordic Iron Age and Viking Age royal burial site of Borre in Norway: ALS- and GPR-based landscape reconstruction and harbour location at an uplifting coastal area. Published online May 20, 2014. DOI:10.1016/j.quaint.2014.04.045, in Press, http://www.sciencedirect.com/science/article/pii/S1040618214002699
4. Neubauer, W.; Gugl, C.; Scholz, M.; Verhoe*ven, G.; T*rinks, I.; Löcker, K.; Doneus, M.; Meirvenne, M. Van; Saey, T. (2014): The discovery of the school of gladiators at Carnuntum, Austria. In: *Antiquity* (88), 173-190.
5. Pregesbauer, M., Trinks, I., Neubauer, W. (2014): An object oriented approach to automatic classification of archaeological features in magnetic prospection data. Near Surface Geophysics, 12(5), 651-656, DOI: 10.3997/1873-0604.2014014.

6. Roncat, A.; Briese, C.; Jansa, J.; Pfeifer, N. (2014): Radiometrically Calibrated Features of Full-Waveform Lidar Point Clouds Based on Statistical Moments. In: *IEEE Geosci. Remote Sensing Lett.* 11 (2), 549-553. DOI: 10.1109/LGRS.2013.2274557.
7. Trinks, I.; Neubauer, W.; Hinterleitner, A. (2014): First High-resolution GPR and Magnetic Archaeological Prospection at the Viking Age Settlement of Birka in Sweden. In: *Archaeol. Prospect.* 21 (3), 185-199. DOI: 10.1002/arp.1481.

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

8. Briese, C.; Pfennigbauer, M.; Ullrich, A.; Doneus, M. (2014): Radiometric Information from Airborne Laser Scanning for Archaeological Prospection. In: *International Journal of Heritage in the Digital Era* 3 (1), 159-178. DOI: 10.1260/2047-4970.3.1.159.

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

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A4: articles published in journals without peer-review.

9. Coolen, J.; Doneus, M. (2014): Airborne Laser Scanning. In: J. Coolen und N. Mehler (Hg.): Excavations and surveys at the Law Ting Holm, Tingwall, Shetland. An Iron Age settlement and medieval assembly site. Oxford: Archaeopress (BAR British series, 592), 19-30.
10. Doneus, N. (2014): Höre, Israel: Jahwe ist unser Gott, und es ist ein Jahwe. Das jüdische Amulett aus Halbturn, Österreich. In: R. Gross, Hansen, M. Lenarz und P. Rahemipour (Hg.): Im Licht der Menora. Jüdisches Leben in der römischen Provinz. Ausstellungskatalog. Frankfurt am Main / New York: Campus Verlag, 110-128.
11. Verhoeven, G. (2014): Orthophotoproduction from archaeological aerial photographs using computer vision. In: *Profil* (8), 13-17.
12. Wieser, M.; Verhoeven, G.; Briese, C.; Doneus, M.; Karel, W.; Pfeifer, N. (2014): Cost-effective geocoding with exterior orientation for airborne and terrestrial archaeological photography - possibilities and limitationIn: *International Journal of Heritage in the Digital Era* 3 (1), 97-121. DOI: 10.1260/2047-4970.3.1.97.

Books and book chapters

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

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

13. Doneus, M.; Gugl, C. (2014): Das Umland - civitas Boiorum, Carnuntiner Stadtgebiet und Besiedlung im Hinterland. In: F. Humer (Hg.): Carnuntum. Wiedergeborene Stadt der Kaiser. Darmstadt: von Zabern (Zaberns Bildbände zur Archäologie), 42-47.
14. Doneus, N. (2014): Halbturn I - Ein römerzeitliches Gräberfeld aus dem Burgenland. Struktur und Grabrituale eines ländlichen Gräberfeldes im Hinterland von Carnuntum zwischen dem 2. und 5. Jahrhundert. In: N. Doneus (2014), Band 1, 1-230.
15. Gugl, C. (2014): Das Legionslager. In: F. Humer (Hg.): Carnuntum. Wiedergeborene Stadt der Kaiser. Darmstadt: von Zabern (Zaberns Bildbände zur Archäologie), 64-65.

16. Gugl, C.; Doneus, M.; Doneus, N. (2014): Die Lagervorstadt (canabae legionis). In: F. Humer (Hg.): Carnuntum. Wiedergeborene Stadt der Kaiser. Darmstadt: von Zabern (Zaberns Bildbände zur Archäologie), 67-72.
17. Neubauer, W. (2014): Die Entdeckung des Forums der Zivilstadt. In: F. Humer (Hg.): Carnuntum. Wiedergeborene Stadt der Kaiser. Darmstadt: von Zabern (Zaberns Bildbände zur Archäologie), 88-89.
18. Neubauer, W.; Doneus, M.; Gugl, C. (2014): Die konzentrierte Grundlagenforschung in Carnuntum. In: F. Humer (Hg.): Carnuntum. Wiedergeborene Stadt der Kaiser. Darmstadt: von Zabern (Zaberns Bildbände zur Archäologie), 151-153.
19. Pregesbauer, M. (2014): Der Versuch eines antiken Geländemodells der Region. In: F. Humer (Hg.): Carnuntum. Wiedergeborene Stadt der Kaiser. Darmstadt: von Zabern (Zaberns Bildbände zur Archäologie), 12-14.
20. Trinks, I. (2014): Nondestructive Subsurface Mapping in Field Archaeology. In: Smith, C.: Encyclopedia of Global Archaeology, 5297-5304: Springer.

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

21. Doneus, N. (Hg.) (2014): Das kaiserzeitliche Gräberfeld von Halbturn, Burgenland. 4 Bände: Teil 1: Archäologie, Geschichte, Grabbrauch Teil 2: Intention, Abfall oder Zufall - naturwissenschaftliche Untersuchungen Teile 3-4: Tafeln/Katalog. 1. Aufl. Regensburg: Schnell & Steiner (Monographien des Römisch-Germanischen Zentralmuseums, 122). Online verfügbar unter http://web.rgzm.de/publikationen/rgzm-open-access/open-access-publikationen/monographie-das-kaiserzeitliche-graeberfeld-von-halbturn-mainz-2014.html.

Conference Proceedings

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

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

22. Karel, W.; Doneus, M.; Briese, C.; Verhoeven, G.; Pfeifer, N. (2014): Investigation on the Automatic Geo-Referencing of Archaeological UAV Photographs by Correlation with Pre-Existing Ortho-PhotoIn: F. Remondino und F. Menna (Hg.): ISPRS Technical Commission V Symposium, XL-5. Riva del Garda, Italy, 23.-25.06.2014 (ISPRS Archives, Volume XL-5), 307-312.
23. Trinks, I., Tsourlos, P., Löcker, K., Vargemezis, G., Tsokas, G., Vlachopoulos, A., Doumas, C., Kucera, M., Verhoeven G., Neubauer, W. (2014): Near Surface Geophysical Archaeological Prospection at the Prehistoric Site of Akrotiri on Santorini/Thera. Near Surface Geoscience 2014 - 20th European Meeting of Environmental and Engineering Geophysics. 8 September 2014. DOI: 10.3997/2214-4609.20142106. EAGE Extended abstract.

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

Talk invited

24. Doneus, M. (2014): Neue Wege in vergangene Landschaften - archäologische Fernerkundung und Quartärforschung. Arbeitsgemeinschaft Quartärforschung. Wien, Österreich, 21.01.2014.

25. Doneus, M. (2014): Non-invasive documentation of buried and submerged archaeological landscapes - potential and latest developments. Keynote. Digital Past 2014: New technologies in heritage, interpretation & outreach. LLandudno, UK, 13.02.2014.
26. Doneus, M. (2014): Airborne Laser Scanning for Archaeology: Potential, Limitations and Latest DevelopmentWhen the Past meets the Future - Workshop on digital and virtual archaeology. Austrian Academy of Sciences. Vienna, Austria, 10.04.2014.
27. Doneus, M. (2014): Perspectives on Airborne Laser Scanning. UHI Archaeology Seminar Series, Orkney College. Orkney College. Orkney, Scotland, 02.06.2014.
28. Doneus, M. (2014): Perspektiven der Prospektion. Thementage Archäologie. Hessen Archäologie. Hugen, Deutschland, 12.09.2014.
29. Neubauer, W. (2014): Ludwig Boltzmann Institute for archaeological prospection and virtual archaeology. Vestfold County Council. Tønsberg, Norway, 19.06.2014.
30. Trinks, I. (2014): Large-scale high-resolution GPR prospection in archaeology - recent developments and new challenges. 15th International Conference on Ground Penetrating Radar - GPR 2014. Brussels, Belgium, 30.06.2014.
31. Verhoeven, G. (2014): Breaking new ground from the air. Some recent technologies for the benefit of aerial archaeology. Seminar series: Applied Earth Observation Techniques for Archaeology and the Environment. University of Barcelona. Barcelona, Spain, 10.04.2014.
32. Verhoeven, G.; Briese, C.; Doneus, M. (2014): Airborne (r)evolution. Some recent developments for the benefit of aerial archaeology. Digital Domains: Remote Sensing of Past Human Landscape. Dartmouth College. Hanover, USA, 21.03.2014.

Talk, poster

33. Briese, C.; Wieser, M.; Verhoeven, G.; Glira, P.; Doneus, M.; Pfeifer, N. (2014): Accuracy analysis of direct georeferenced UAV images utilising low-cost navigation sensors. European Geosciences Union, General Assembly 2014 (27.04.-02.05.2014). In: *Geophysical Research Abstracts* (16), 3611-1.
34. Doneus, M.; Fera, M.; Zámolyi, A.; Draganits, E.; Fornwagner, U. (2014): Remote sensing and environmental archaeology: mapping a river system and predicting the location of archaeological sites in Leitha-Valley (Austria). XVII World UISPP Congress. Burgos, Spain, 05.09.2014.
35. Doneus, M.; Verhoeven, G.; Atzberger, C.; Wess, M. (2014): ARCTIS - A MATLAB® toolbox for archaeological imaging spectroscopy. AARG Annual Meeting 2014. Dublin, Irland, 25.09.2014.
36. Draganits, E.; Doneus, M.; Gansum, T.; Gustavsen, L.; Nau, E.; Tonning, C.; Trinks, I.; Neubauer, W.: Geoarchaeology of the late Nordic Iron Age and Viking Age royal burial site of Borre in Norway. LAC 2014, 3rd International Landscape Archaeological Conference. Rome, Italy, 17.09.2014.
37. Draganits, E.; Doneus, M.; Terje, G. (2014): Geoarchaeology - Research at the interface between earth-sciences and society: The Viking-age royal burial site of Borre (Norway). International Seminar at the Syiah Kuala University. Banda Aceh, Indonesia, 18.02.2014.
38. Glira, P.; Briese, C.; Pfeifer, N.; Dusik, J.; Hilger, L.; Neugirg, F.; Baewert, H. (2014). Accuracy analysis of height difference models derived from terrestrial laser scanning point cloudEuropean Geosciences Union, General Assembly 2014 (27.04.-02.05.2014). In: *Geophysical Research Abstracts* (16), 15987.
39. Gugl, C.; Neubauer, W.; Nau, E.; Jernej, R. (2014): The garrison of the singulares in Virunum. Results of the latest geophysical prospection in the Norican capital. Conference “The Roman

army in the regions of the northern Adriatic and Eastern Alps". Ljubljana, Slovenia, 17.10.2014.

40. Gugl, C.; Neubauer, W.; Nau, E.; Jernej, R. (2014): New research on the military camp in Virunum (Noricum). Simpozionului ARA 15. Bucharest, Romania, 24.04.2014.
41. Gugl, C.; Neubauer, W.; Nau, E.; Jernej, R. (2014): Neues zum römischen Militärlager in Virunum (Noricum). 15. Österreichischer Archäologentag. Universität Innsbruck. Innsbruck, Österreich, 28.02.2014.
42. Horejs, Barbara; Neubauer, Wolfgang (2014): A puzzle in 4D - digital preservation and reconstruction of an Egyptian palace. Österreichische Tage der Digitalen Geisteswissenschaften. ÖAW. Wien, 01.12.2014.
43. Hynek, B.; Binder, D.; Boffi, G.; Schöner, W.; Verhoeven, G. (2014): Application of terrestrial, structure-from-motion' photogrammetry on a medium-size Arctic valley glacier: potential, accuracy and limitations. European Geosciences Union General Assembly 2014. Vienna, Austria, 28.04.2014.
44. Klimczyk-Lugmayr, A.; Fera, M.; Doneus, M.; Briese, C.; Pfeifer, N. (2014): Clearing the wood - evaluation of different software packages for ALS filtering. CAA France 2014. Université Paris 1 Panthéon-Sorbonne. Paris, France, 23.04.2014.
45. Kucera, M.; Neubauer, W.; Fera, M.; Doneus, M. (2014): Monitoring and Analysis of Excavation Processes Using Virtual Archaeology. Annual Meeting 2014. Canadian Archaeological Association. London, Ontario, Canada, 14.05.2014.
46. Miholjek, I.; Doneus, N.; Doneus, M. (2014): Submerged archaeological sites from the air - case study of Kolone, Croatia. Internationale Jahrestagung In Poseidons Reich XIX. Unteruhldingen/Bodensee, Deutschland, 21.03.2014.
47. Nau, E.; Gustavsen, L.; Tonning, C.; Filzwieser, R.; Gabler, M.; Trinks, I.; Neubauer, W.; Hinterleitner, A. (2014): Large-Scale High-Resolution GPR Prospection in the Viking Age Landscapes of Southern Norway. Annual Meeting 2014. Canadian Archaeological Association. London, Ontario, Canada, 14.05.2014.
48. Poscetti, V.; Neubauer, W. (2014): GIS based dynamic interpretation of GPR data volumes. CAA 2014: Computer Applications and Quantitative Methods in Archaeology. Paris, France, 25.04.2014.
49. Poscetti, V.; Zotti, G.; Neubauer, W. (2014): Ground Penetrating Radar prospections at complex archaeological sites: good practice for the 3D archaeological documentation of the subsurface feature5th International Conference on Remote Sensing in Archaeology. Duke University. Durham, USA, 13.10.2014.
50. Pregesbauer, M. (2014): Identifying Hidden Near Surface Structures by Airborne Laserscanning. EAEG Saint Petersburg 2014. Saint Petersburg, Russia, 09.04.2014.
51. Pregesbauer, M.; Sevara, C. (2014): Archaeological feature classification - an object oriented approach. 5th Geobia. Thessaloniki, Greece, 22.05.2014.
52. Pregesbauer, M.; Trinks, I.; Nau, E.; Löcker, K. (2014): Analysis of ground penetrating radar depth slices - an object-oriented approach. 5th Geobia. Thessaloniki, Greece, 24.05.2014.
53. Risbøl, O.; Pregesbauer, M. (2014): Airborne magnetometer and cultural remains - preliminary results from a test and work in progress. AARG Annual Meeting 2014. Dublin, Ireland, 24.09.2014.
54. Schneidhofer, P.; Zotti, G.; Nau, E.; Hinterleitner, A.; Trinks, I.; Neubauer, W. (2014): Landscape Tomography: Creating a work-flow for 3D visualization of palaeo-environmental information contained in large-scale, high-resolution ground penetrating radar data set. CAA

2014: Computer Applications and Quantitative Methods in Archaeology. Paris, France, 25.04.2014.

55. Štuhec, S.; Mlekuž, D.; Verhoeven, G. (2014): Turning stone heaps into pastoral landscapes - Combining airborne and ground-based sensing methods to document and contextualize vernacular stone buildings in the Slovenian karst region. CAA France 2014. Université Paris 1 Panthéon-Sorbonne. Paris, France, 23.04.2014.
56. Trinks, I., Neubauer , W., Hinterleitner, A., Kucera, M., Löcker, K., Nau, E., Wallner, M., Gabler, M., Zitz, T. (2014): Large-scale high-resolution non-invasive geophysical archaeological prospection for the investigation of entire archaeological landscapes. EGU2014-9025. EGU General Assembly 2014. Vienna, Austria, 28.04.2014.
57. Ullrich, A.; Briese, C. (2014): Radiometric Calibration of LIDAR instruments and LIDAR data. EuroCOW 2014, the European Calibration and Orientation Workshop. Castelldefels, Spain, 12.02.2014.
58. Verhoeven, G.; Lupashin, S.; Briese, C.; Doneus, M. (2014): Airborne imaging for heritage documentation using the Fotokite tethered flying camera. European Geosciences Union, General Assembly 2014 (27.04.-02.05.2014). In: *Geophysical Research Abstracts* (16), 15202.
59. Verhoeven, G.; Lupashin, S.; Briese, C.; Doneus, M. (2014): Airborne imaging for heritage documentation using the Fotokite tethered flying camera. European Geosciences Union General Assembly 2014. Vienna, Austria, 28.04.2014.
60. Verhoeven, G.; Neubauer, W.; Trinks, I. (2014): Prospecting Archaeological Landscapes - State-of-the-art in remote sensing and geophysical prospection. International Conference - Archaeology and Conservation along the Silk Road. Northwest University. Xi'an, China, 24.05.2014.
61. Vletter, W.; Briese, C. (2014): (Semi-) Automated extraction from airborne laser scanning (ALS) data for road & path detection in forested areas. CAA 2014: Computer Applications and Quantitative Methods in Archaeology. Paris, France, 23.04.2014.
62. Zotti, G.; Wuchterl (2014): Raising Awareness on Nocturnal Light Pollution around Astronomical Cultural Heritage Sites. SEAC 2014: The Materiality of the Sky. The European Society for Astronomy in Culture (SEAC). University of Malta and Heritage Malta. Valletta, Malta, 22.09.2014.

Miscellaneous

63. Kucera, M.; Neubauer, W.; Flöry S.; Lugmayer-Klimczyk, A. (2014): Terrestrial Laser Scanning of the Landscape around Stonehenge. In: *Riegl Newsletter* (2).

Session chair

64. Briese, C.; Pfeifer, N.; Kleemayr, K.; Verhoeven, G. (2014): Unmanned aerial vehicles for high resolution sensing in the geosciences. European Geosciences Union General Assembly 2014. Session chair. Vienna, Austria, 28.04.2014.

Conference workshop

65. Verhoeven, G. (2014): Structure-from-Motion solutions for heritage 3D documentation: pros and cons, issues and solutions. ISPRS Technical Commission V Symposium "Close-range imaging, ranging and applications". Workshop. Riva del Garda, Italy, 22.06.2014.