

3rd IMEKO INTERNATIONAL CONFERENCE ON

METROLOGY FOR ARCHAEOLOGY AND CULTURAL HERITAGE

LECCE, ITALY | 23 - 25 OCTOBER 2017



PROCEEDINGS

Proceedings of
3rd IMEKO International Conference on Metrology for Archaeology and Cultural Heritage

MetroArchaeo 2017

October 23-25, 2017

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WELCOME TO THE
3rd IMEKO INTERNATIONAL CONFERENCE ON METROLOGY FOR ARCHAEOLOGY AND
CULTURAL HERITAGE

MetroArchaeo2017

On behalf of the organizing committee, we wish to welcome you to the 3rd *IMEKO International Conference on Metrology for Archaeology and Cultural Heritage - MetroArchaeo2017*.

The growing interest of archaeological sciences to new technologies and analysis techniques, has recently improved the combined use of numerical approach and metrology systems to get more detailed archaeological purpose. Metrology, the science of measurements, includes all aspects both theoretical and practical with reference to the measurements, whatever their uncertainties are, and in whatever fields of science or technology they occur. Consequently, the field of valorisation, characterisation and preservation of Cultural Heritage too is deeply related to the metrological issues for the collection, interpretation and validation of data collected with different analytical tools, physical-chemical and mechanical techniques, digital technologies, new ICT tools, and so on.

The 3rd *IMEKO International Conference on Metrology for Archaeology and Cultural Heritage - MetroArchaeo2017* wants to gather together heritage scientists in universities, research institutions, museums, galleries, libraries, archives, small and medium enterprises. MetroArchaeo2017, therefore, is conceived to foster exchanges of ideas and information, make connections and collaborations, update innovation on “measurements” suitable for Cultural Heritage among material scientists, chemists, physicists, engineers, archaeologists, conservators, restorers.

Following the positive experience of the first two editions hold in Benevento and Turin in 2015 and 2016, respectively, the conference moves to Lecce, a city in the Puglia region and the capital of Lecce Province. It is nicknamed “Florence of the South” thanks to the many Baroque monuments in the city. Lecce has ancient Roman roots and you can still see the remains of the Roman theatre and amphitheatre but Lecce really came into its own in the 17th century. During this prosperous period many palaces and churches were constructed from the soft local Lecce stone. In Lecce’s historic centre wander the charming lanes and discover the Baroque churches like the opulently decorated Basilica di Santa Croce with its façade of allegorical figures. The heart of the historic centre is in Piazza Sant’Oronzo where the Column of St Oronzo, Lecce’s patron saint stands and Piazza del Duomo, where you’ll see the 12th century Duomo and its 70 m high bell tower. The Niccolo’ and Cataldo Church is another masterpiece of embellished decorative arts.

MetroArchaeo2017 will be held at Castello Carlo V, majestic fortification in the heart of Lecce. Just a few steps from Piazza Sant’Oronzo, it marks the point where the old town and the modern downtown area meet. The Castle hosts art exhibitions and cultural events, thus offering visitors the chance to admire its rigorous external architecture, so typical of 16th-century defensive structures, and its rich interior decoration.

We are sure that the universally recognized historical beauty of Lecce will be a perfect frame for this prestigious conference. It is, in fact, a further occasion, not only to meet old friends and new people from all over the world, but, moreover, to engage with them a continuous comparison directed to make wider the views on the technological progress of *Metrology for Archaeology and Cultural Heritage*.

MetroArchaeo2017 organization was a complex task due to the large and increasing interest of our research and application areas. Efforts from many people were required to shape the technical program,

arrange accommodation, manage the administrative aspects, and set up the social functions. We like to take this opportunity to thank all and each of them. We like also to thank the public and private organizations that supported the meeting in different ways.

MetroArchaeo2017 hosts three plenary lectures and 21 oral and poster sessions designed to take advantage of a multidisciplinary approach to give to the Cultural heritage community, from archaeologists to historians, conservators, engineers and material scientists, a complete picture of the measurements utilizations and data treatments with the ultimate goal of increasing knowledge on the characterization and safeguard of archaeological and historic heritage, generally addressed in sectorial conferences. Thanks to all of the Technical Program Committee members and the reviewers who have contributed to make this outstanding program possible.

We received 263 abstracts from all over the world. The technical program encompasses several events and activities.

The keynote speeches will be held by experts in the field of metrology for archaeology;

PLENARY LECTURERS

- Clementina Panella, Sapienza - University of Rome, Italy; *Rome Colosseum Square-Northeast Palatine Hill. The Archaeological excavation between research and transmission of memory.*
- Francesco D'Andria, University of Salento, Italy; *Hierapolis: "From Hell to Paradise". Measuring the Antiquity on the threshold of Hades.*
- Danilo Bersani, University of Parma, Italy; *"New methods and trends in Raman Spectroscopy applied to art and archaeology".*
- Claire Pacheco, Centre de Recherche e Restauration des Musées de France, Palais du Louvre, Paris, France; *"From AGLAE to the New AGLAE: uncertainty evolution of PIXE and RBS experimental data".*

Furthermore, attendees have the possibility to follow a half day of Tutorials;

- *Best accuracy with aerial and terrestrial integrated technologies*, Simone Gianolio, Archeo Digital SRLS
- *Laser Technologies for the conservation of Cultural Heritage*, Alessandro Zanini, EL.EN.
- *Gathering and processing GPR data*, Giovanni Leucci, National Research Council-IBAM, Raffaele Persico, National Research Council-IBAM, Paolo Papeschi, ITS GEORADAR.
- *Non-invasive and Micro-invasive Diagnostic Analyses at the Service of the Cultural Heritage Market: Hints, Trends and Case Studies*, Stefano Ridolfi, Ars Mensurae.
- *Preliminary diagnostics for restoration of architectural and historic-artistic heritage*, Giovanni Quarta, National Research Council-IBAM.
- *Experiencing Innovative and digital approaches for the cultural heritage*, Italo Spada, Consorzio CETMA.

With the aim of providing a common ground for researches to share their findings about the metrology for archaeology, the MetroArchaeo2017 includes a significant number of Special Sessions. A first reason is that so many are the application fields of the metrology for archaeology that a single track could have been too much dispersive. A second reason is that, in spite of a centralized research address definition, a spontaneous aggregation of well-focused themes has been gathered, with specific aim of providing a forum of specific debate very close to the single research field. Therefore, several application-oriented Special Sessions have been organized. We wish to thank the organizers of these Special Sessions for their cooperation and support to the conference organization.

Several Awards will be assigned, in particular to young researchers.

The social programme includes a classic music performance by Polyphonic Choir of the University of Salento, the welcome party is held in the cloister of "*Palazzo del Seminario*" in Piazza Duomo, and the social dinner is held in the "*Torre del Parco*".

The 3rd *International Conference on Metrology for Archaeology and Cultural Heritage*. is about to begin. You are now in a position to enjoy the fellowship of colleagues and experts and to pass free time in natural and artistic beauties. It is up to you to appreciate the conference worth! Be critical! We, metrologists, archaeologists, geologists, colleagues, and friends, we know that this is the best way to improve quality, and to achieve lasting excellences.



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Lucio Calcagnile
University of Salento, Italy



General co-Chair
Pasquale Daponte
University of Sannio, Italy

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Liliana Viglione, *University of Sannio, Italy*

Local Arrangements



CONFERENCE PROGRAM

Monday, October 23rd

Session on Revolution in data. Analytical challenges to archaeological expectations

Room: Miccoli Hall

Chairs: *Mary Anne Tafuri, Sapienza University of Rome, Italy*
Alessandra Pecci, Universitat Politècnica de Catalunya, Spain
Carmine Lubritto, University of Campania "Luigi Vanvitelli, Italy

- 1 Wine before Greeks: the contribution of the organic chemistry analysis**
Barbara Del Mastro, University of Campania "Luigi Vanvitelli", Italy
Jean Pierre Brun, Collège de France, France
Priscilla Munzi, Centre Jean Bérard, France
Nicolas Garnier, Nicolas Garnier Laboratoire France
 - 7 Green Chemistry and Archaeological Biomarkers: a new and safe DES-based approach for the extraction of absorbed lipid residues from archaeological samples of ceramic potsherds**
Florinda Notarstefano, University of Salento, Italy
Antonio Salomone, University of Salento, Italy
-

Session on Radiocarbon dating: instrumental developments, new approaches and applications

Room: d'Enghien Hall

Chairs: *Gianluca Quarta, University of Salento, Italy*

- 12 Concerning the extinction of the wild horse in Italy and the newly introduction as domesticate: recent evidence from Grotta dei Cervi - Porto Badisco (Otranto, south Italy)**
Giorgia Aprile, University of Salento, Italy
Lucio Calcagnile, University of Salento, Italy
Jacopo De Grossi Mazzorin, University of Salento, Italy
Claudia Minniti, University of Salento, Italy
Roberto Montefinese, University of Salento, Italy
Gianluca Quarta, University of Salento, Italy
Ida Tiberi, University of Salento, Italy
 - 16 Radiocarbon dates from prehistoric sites in the Badisco area (Otranto – Le)**
Giorgia Aprile, University of Salento, Italy
Elettra Ingravallo, University of Salento, Italy
Ida Tiberi, University of Salento, Italy
Gianluca Quarta, University of Salento, Italy
Lucio Calcagnile, University of Salento, Italy
 - 20 A new combined IRMS-AMS system for the measurement of small samples at CEDAD**
Eugenia Braione, University of Salento, Italy
Lucio Maruccio, University of Salento, Italy
Gianluca Quarta, University of Salento, Italy
Lucio Calcagnile, University of Salento, Italy
-

Session on Measuring in the past: ancient instruments

Room: Torremozza Hall

Chairs: *Emma Angelini, Politecnico of Turin, Italy*
Oliver Tošković, University of Belgrade, Serbia and Montenegro

- 24 Ghost in the shell – Collection of old scientific instruments of laboratory for experimental psychology**
Oliver Tošković, University of Belgrade, Serbia and Montenegro

- 29 **Angelo Mosso: Transmission and Measure of Physiological Signals**
Mara Fausone, ASTUT, Archivio Scientifico e Tecnologico dell'Università di Torino, Italy
Marco Galloni, ASTUT, Archivio Scientifico e Tecnologico dell'Università di Torino, Italy
- 33 **The mechanism of Plana's Calendar**
Andrea Bacciotti, Politecnico of Turin, Italy
- 36 **The Scientific Instruments in the Museum of the Politecnico di Torino**
Margherita Bongiovanni, Politecnico di Torino, Italy
Emma Angelini, Politecnico di Torino, Italy
-

Tuesday, October 24th

Session on Full-field Techniques for Artworks Monitoring

Room: Miccoli Hall

Chairs: *Paolo Castellini, University of Marche, Italy*
Milena Martarelli, University eCAMPUS, Italy

- 40 **Damage Detection on Frescoes Paintings by Active IR-Thermography Soft-Sensing**
A. D'Antuono, Politecnical University of Marche, Italy
M. Martarelli, Politecnical University of Marche, Italy
P. Castellini, Politecnical University of Marche, Italy
- 45 **Structural identification through dynamic tests on historic buildings: some experiences**
Lorenzo Jurina, Politecnical University of Milano, Italy
Edoardo Oliviero Radaelli, Politecnical University of Milano, Italy
Andrea Antonio Bassoli, Politecnical University of Milano, Italy
- 51 **Diagnostic Survey on Frescoes Paintings in Pompeii by Active IR-Thermography**
P. Castellini, Politecnical University of Marche, Italy
M. Martarelli, University e-Campus, Italy
S. Lenci, Politecnical University of Marche, Italy
E. Quagliarini, Politecnical University of Marche, Italy
Michele Silani, University of Bologna, Italy
-

Session on 3D data analysis of archaeological pottery

Room: d'Enghien Hall

Chairs: *Paolo Di Stefano, University of L'Aquila, Italy*
Christos Anagnostopoulos, University of the Aegean, Greece

- 57 **A new 3D information system for archeological pottery**
Luca Di Angelo, University of L'Aquila, Italy
Paolo Di Stefano, University of L'Aquila, Italy
Caterina Pane, University of L'Aquila, Italy
- 64 **A practical investigation for 3D pottery acquisition**
Juraj Sarkisjan, Charles University in Prague, Czech Republic
Martin Kampel, Vienna University of Technology, Austria
- 69 **Constant radius geometric features segmentation in archeological pottery**
Luca Di Angelo, University of L'Aquila, Italy
Paolo Di Stefano, University of L'Aquila, Italy
Caterina Pane, University of L'Aquila, Italy
Anna Eva Morabito, University of Salento, Italy
- 75 **Inner surface reconstruction of 3D scanned vessels**
Stefan Spelitz, Austrian Academy of Sciences, Austria, Austria

81 3D Modelling of Petrified Trees: Laser Scanning vs Photogrammetry

Eustratia Chatzi, University of the Aegean, Greece
Stamatis Chatzistamatis, University of the Aegean, Greece
Nikolaos Soulakellis, University of the Aegean, Greece
Nikolaos Zouros, University of the Aegean, Greece
Christos Nikolaos Anagnostopoulos, University of the Aegean, Greece

Session on Ground Penetrating Radar for archaeological prospection and cultural-heritage management

Room: Torremozza Hall

Chairs: *Lara Pajewski, Sapienza University of Rome, Italy*
Raffaele Persico, National Research Council, Italy

87 Ground Penetrating Radar for archaeological investigations and cultural-heritage diagnostics: Research activities in the COST Action TU1208

Lara Pajewski, Sapienza University of Rome, Italy
Raffaele Persico, National Research Council -IBAM, Italy
Marco Salucci, Eledia Research Center, Italy
Mercedes Solla, Centro Universitario de la Defensa, Spain

92 Innovative possibilities in time domain reflectometry

Raffaele Persico, National Research Council, Italy
Andrea Cataldo, University of Salento, Italy
Egidio De Benedetto, University of Salento, Italy

96 Non-Destructive Assessment of a Historic Masonry Arch Bridge Using Ground Penetrating Radar and 3D Laser Scanner

Amir M. Alani, University of West London (UWL), Italy
Fabio Tosti, University of West London (UWL), Italy
Kevin Banks, KB GPR Surveys
Luca Bianchini Ciampoli, Roma Tre University, Italy
Andrea Benedetto, Roma Tre University, Italy

100 Shifting Zoom on a Linear Inverse Scattering Algorithm Applied to GPR Data

Raffaele Persico, National Research Council, Italy
Giovanni Ludeno, National Research Council, Italy
Francesco Soldovieri, National Research Council, Italy
Albéric De Coster, Université Catholique de Louvain, Belgium
Sébastien Lambot, Université Catholique de Louvain, Belgium

105 Wire-grid modelling of metallic targets for Ground Penetrating Radar applications

Fabio Mangini, Sapienza University of Rome, Italy
Pietro Paolo Di Gregorio, Sapienza University of Rome, Italy
Marco Muzi, Sapienza University of Rome, Italy
Lara Pajewski, Sapienza University of Rome, Italy
Fabrizio Frezza, Sapienza University of Rome, Italy

Session on Multidisciplinary approach and geophysics in archaeological and cultural heritage science

Room: Miccoli Hall

Chairs: *Giovanni Leucci, National Research Council - IBAM, Italy*
Raffaele Martorana, University of Palermo, Italy
Giuseppe Cacciaguerra, National Research Council - IBAM, Italy
Antonio Mazzaglia, National Research Council, Italy
Rita Deiana, University of Padova, Italy

109 Machine Learning: a Toolkit for Speeding Up Archaeological Stratigraphic Identification

I. Cacciari, Italian National Research Council, Italy
G. Pocobelli, Archeological Cooperative, Italy

- 116 **The virtual reconstruction of the lake Fucino's emissary**
R.L. Di Angelo, University of L'Aquila, Italy
P. Di Stefano, University of L'Aquila, Italy
R. Fasciani, University of L'Aquila, Italy
D. Gaudenzi, University of L'Aquila, Italy
C. Pane, University of L'Aquila, Italy
- 122 **Measuring the roman building sites. The case of the opus reticulatum in the Necropolis of the Porta mediana in Cumae**
Marina Covolan, University of Padua, Italy
Bastien Lemaire, Université Paul-Valéry Montpellier III, France
- 129 **Multidisciplinary investigations at the Kamarina archaeological site (southern Sicily, Italy)**
Antonino Pisciotta, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Carla Bottari, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Patrizia Capizzi, Università degli Studi di Palermo, Italy
Antonino D'Alessandro, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Raffaele Martorana, University of Palermo, Italy
Salvatore Scudero, Istituto Nazionale di Geofisica e Vulcanologia, Italy
- 133 **Integrated archaeological and archaeometric research in Hierapolis of Phrygia (Turkey): new light on ancient building sites**
T. Ismaelli, National Research Council, Italy
G. Scardozi, National Research Council, Italy
- 139 **Metric analysis and interpretation of the unit of measurement in the Late Roman Fort of Umm al-Dabadib (Egypt)**
Fausta Fiorillo, Politecnico di Milano, Italy
Corinna Rossi, Politecnico di Milano, Italy

Session on Non-invasive systems and techniques for "on site" monitoring and diagnosis - PART I
Room: d'Enghien Hall

- Chairs:** *Zaccaria Del Prete, Sapienza University of Rome, Italy*
Emanuele Piuze, Sapienza University of Rome, Italy
- 145 **Application of a novel monitoring technology at "Minerva Medica Temple" archaeological site in Rome**
Livio D'Alvia, Sapienza University of Rome, Italy
Eduardo Palermo, Sapienza University of Rome, Italy
Zaccaria Del Prete, Sapienza University of Rome, Italy
- 150 **Ancient Monument Analysis by Motion Magnification**
Enzo Fioriti, ENEA, Italy
Ivan Roselli, ENEA, Italy
Angelo Tatì, ENEA, Italy
Gerardo De Canio, ENEA, Italy
- 155 **Experimental methodology for measuring the structural dynamic transmission damping of a cultural heritage tower**
Mariella Diaferio, Polytechnic of Bari, Italy
Dora Foti, Polytechnic of Bari, Italy
Nicola Ivan Giannoccaro, University of Salento, Italy
Salvador Ivorra, University of Alicante, Italy
- 161 **Multi-wavelengths 3D laser scanner for investigation and reconstruction of 19th century charcoal inscriptions**
Massimiliano Guarneri, ENEA, Italy
Sofia Ceccarelli, ENEA, Italy
Massimiliano Ciaffi, ENEA, Italy

Session on Process and Method Innovation for Cultural, Archeological and Landscape Heritage
Room: Torremozza Hall

Chairs: *Giovanna Mangialardi, University of Salento, Italy*

- 166 WebGIS, 3D modeling and virtual tours to map, record and visualize the cultural, archaeological and landscape heritage: the VisualVersilia project**
Martina Giannini, University of Modena and Reggio Emilia, Italy
Cristina Castagnetti, University of Modena and Reggio Emilia, Italy
Riccardo Rivola, Geomatics Engineering Innovative Solutions Srl, Italy
- 172 ICV and fine-registration algorithms for an efficient merging of point-clouds**
Domenica Costantino, Politecnical University of Bari, Italy
Maria Giuseppa Angelini, Politecnical University of Bari, Italy
Francesco Settembrini, Politecnical University of Bari, Italy
- 178 BIM models to manage and make use of cultural heritage**
Francesca D'Uffizi, SPraUt snc, Italy
Sara Manarin, SPraUt snc, Italy
- 184 Business Process Management and Building Information Modeling for the innovation of cultural heritage renovation process**
Ada Malagnino, University of Salento, Italy
Giovanna Mangialardi, University of Salento, Italy
Angelo Corallo, University of Salento, Italy
Giorgio Zavarise, University of Salento, Italy
- 190 Hazard and Risk Assessment and Perception in the Analysis of Cultural Heritage**
Mirta Sibilìa, IAEA XRF Beamline, Italy
Franco Zanini, Scuola Interateneo di Specializzazione in Beni Archeologici, Italy
- 194 Mobile app for promoting cultural heritage: geostatistic and textual analysis**
Angelo Corallo, University of Salento, Italy
Laura Fortunato, University of Salento, Italy
Clara Renna, University of Salento, Italy
Marco Lucio Sarcinella, University of Salento, Italy
Alessandra Spennato, University of Salento, Italy

Session on Advanced methodologies for diagnostic and preventive conservation of stone materials in subaerial and underwater environment

Room: Miccoli Hall

Chairs: *Mauro Francesco La Russa, University of Calabria, Italy*

- 202 Diagnosis and methods against rising damp in industrial heritage buildings: a case study in Italy**
Alessandro Sardella, Institute of Atmospheric Sciences and Climate ISAC-CNR, Italy
Paola De Nuntiiis, Institute of Atmospheric Sciences and Climate ISAC-CNR, Italy
Francesca Tittarelli, Università Politecnica delle Marche, Italy
Alessandra Bonazza, Institute of Atmospheric Sciences and Climate ISAC-CNR, Italy
- 209 Monitoring long run performances of multifunctional coatings for environmental protection of stone building surface**
A. Calia, Italian National Research Council, Italy
D. Colangiuli, Italian National Research Council, Italy
M. Lettieri, Italian National Research Council, Italy
M. Masieri, Italian National Research Council, Italy

Session on Non-invasive systems and techniques for "on site" monitoring and diagnosis - PART II

Room: d'Enghien Hall

Chairs: *Zaccaria Del Prete, Sapienza University of Rome, Italy*

Emanuele Piuzzi, Sapienza University of Rome, Italy

- 213 Fiber Bragg Grating Multifunctional pH Sensor for Monitoring the rain in Cultural Heritage**
Lorenzo Dinia, Sapienza University of Rome, Italy
Fabio Mangini, Sapienza University of Rome, Italy
Marco Muzi, Sapienza University of Rome, Italy
Fabrizio Frezza, Sapienza University of Rome, Italy

217 Non-destructive Techniques for the Knowledge and Conservation of Abbey-Castle at Santo Stefano, Monopoli (Bari)

Angela Diceglie, University of Bari, Italy

Luana M. E. Lorusso, University of Bari, Italy

223 Health Monitoring of a Matured Tree Using Ground Penetrating Radar – Investigation of the Tree Root System and Soil Interaction

Amir. M. Alani, University of West London (UWL), UK

Luca Bianchini Ciampoli, Roma Tre University, Italy

Fabio Tosti, University of West London (UWL), UK

Maria Giulia Brancadoro, Roma Tre University, Italy

Daniele Pirrone, Roma Tre University, Italy

Andrea Benedetto, Roma Tre University, Italy

228 3D photogrammetric reconstruction by “Structure from Motion” as monitoring technique for the safety, conservation and improvement of the fruition of cultural heritage

Marialuisa Mongelli, ENEA Research Center, Italy

Irene Bellagamba, ENEA Research Center, Italy

Giovanni Bracco, ENEA Research Center, Italy

Silvio Migliori, ENEA Research Center, Italy

Antonio Perozziello, ENEA Research Center, Italy

Samuele Pierattini, ENEA Research Center, Italy

Andrea Quintiliani, ENEA Research Center, Italy

Barbara Mazzei, Pontificia Commissione Archeologia Sacra, Italy

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Cristina Fragoso-Corti, SUPSI-DACD, Laboratory of Applied Microbiology, Switzerland

Marta Cicardi, SUPSI-DACD, Institute of Materials and Constructions, Switzerland

Ornella Salvadori, Polo Museale Veneziano, Italy

Francesca Piqué, SUPSI-DACD, Institute of Materials and Constructions, Switzerland

Session on Spectroscopic advances for Cultural Heritage

Room: Torremozza Hall

Chairs: *Antonio Serra, University of Salento, Italy*

240 Welding Brazing and Soldering of Gold and Silver by the Moche Tombs Señor de Sipán and Señora de Cao

Roberto Cesareo, University of Sassari, Italy

Angel Bustamante, Universidad Nacional Mayor de San Marcos, Perú

Regulo Franco Jordan, Museo Cao e Fundacion Wiese, Perú

Arabel Fernandez, Museo Cao e Fundacion Wiese, Perú

Soraia Azeredo, Universidade Federal do Rio de Janeiro, Brazil

Ricardo T. Lopes, Universidade Federal do Rio de Janeiro, Brazil

Walter Alva, Museo “Tumbas Reales de Sipán”, Perú

Luis Chero, Museo “Tumbas Reales de Sipán”, Perú

Antonio Brunetti, University of Sassari, Italy

Giovanni E. Gigante, Sapienza University of Rome, Italy

Stefano Ridolfi, Arsmensurae, Italy

- 244 **The Cultural Heritage Platform at Elettra**
M. Amati, Elettra Sincrotrone Trieste, Italy
N. Demitri, Elettra Sincrotrone Trieste, Italy
A. Gianoncelli, Elettra Sincrotrone Trieste, Italy
W. Jark, Elettra Sincrotrone Trieste, Italy
A. Lausi, Elettra Sincrotrone Trieste, Italy
L. Mancini, Elettra Sincrotrone Trieste, Italy
L. Olivi, Elettra Sincrotrone Trieste, Italy
J. Plaisier, Elettra Sincrotrone Trieste, Italy
M. Polentarutti, Elettra Sincrotrone Trieste, Italy
B. Rossi, Elettra Sincrotrone Trieste, Italy
N. Sodini, Elettra Sincrotrone Trieste, Italy
L. Vaccari, Elettra Sincrotrone Trieste, Italy
F. Zanini, Elettra Sincrotrone Trieste, Italy
- 250 **3D Imaging of Paintings by Scanning with a Portable EDXRF-Device**
Roberto Cesareo, University of Sassari, Italy
Stefano Ridolfi, Arsmensurae, Italy
Antonio Brunetti, University of Sassari, Italy
Giovanni E. Gigante, Sapienza University of Roma, Italy
Ricardo T. Lopes, Universidade Federal do Rio de Janeiro, Brazil
- 254 **Photophysics of Artist's Pigments**
Gianluca Accorsi, National Research Council, Italy
Giovanni Verri, The Courtauld Institute of Art, UK
Angela Acocella, University of Bologna, Italy
David Saunders, The British Museum, UK

Wednesday, October 25th

Session on Methods for structural assessment of historical construction – PART I

Room: Torremozza Hall

Chairs: *Maria Antonietta Aiello, University of Salento, Italy*
Francesco Micelli, University of Salento, Italy
Marianovella Leone, University of Salento, Italy

- 259 **Evaluating dynamic behaviour of historical buildings through ambient seismic noise measurement and numerical modelling**
S. D'Amico, University of Malta, Malta
S. Imposa, University of Catania, Italy
F. Panzera, University of Catania, Italy
G. Lombardo, University of Catania, Italy
M. Betti, University of Florence, Italy
R. Muscat, University of Malta, Malta
S. Grassi, University of Catania, Italy
R. Borg, University of Malta, Malta
- 263 **Analysis on the effective bond length of a basalt Textile Reinforced Mortar strengthening system submitted to single lap shear test; the contribution of Digital Image Correlation**
Carmelo Caggegi, University Claude Bernard Lyon 1, France
Denise Sciuto, University of Catania, Italy
Massimo Cuomo, University of Catania, Italy
- 269 **Evaluation of hydric behavior into porous building stones by means of Infrared Thermography (IRT)**
Giulia Forestieri, Universidad de la Sabana, Colombia
Maurizio Ponte, University of Calabria, Italy

- 274 **A multidisciplinary approach to the safety assessment of the archaeological site of Pietrabbondante**
Evelina Volpe, University of Molise, Italy
Adriana Marra, University of Molise, Italy
Adriano La Regina, Istituto Nazionale di Archeologia e Storia dell'Arte, Italy
Giovanni Fabbrocino, University of Molise, Italy
- 280 **Experimental investigations for the mechanical characterization of a soft calcarenite: the role of external factors on UPV measurements**
E. Vasanelli, National Research Council, Italy
A. Calia, National Research Council, Italy
F. Micelli, University of Salento, Italy
A. Aiello, University of Salento, Italy

Session on Non invasive measurements on metallic cultural heritage - PART I

Room: d'Enghien Hall

Chairs: *Elisabetta Di Francia, Politecnico of Turin, Italy*
Luca Lombardo, Politecnico of Turin, Italy

- 287 **In situ EIS measurements on Colombian bronze statues**
Sabrina Grassini, Politecnico of Turin, Italy
Elisabetta Di Francia, Politecnico of Turin, Italy
Emma Angelini, Politecnico of Turin, Italy
Marco Parvis, Politecnico of Turin, Italy
Julieth A. Mejia Gomez, Universidad Antonio Nariño, Colombia
- 291 **Electrochemical measurements and microscopy on hybrid coatings for metallic artefacts**
Leonardo Iannucci, Politecnico of Turin, Italy
Sabrina Grassini, Politecnico of Turin, Italy
Emma Angelini, Politecnico of Turin, Italy
Marco Parvis, Politecnico of Turin, Italy
John Fredy Rios Rojas, Universidad Antonio Nariño, Colombia
- 295 **ToF-SIMS and u-Raman measurements on laser cleaned bronze archaeological artefacts**
Elisabetta Di Francia, Politecnico di Torino, Italy
Ruth Lahoz, Universidad de Zaragoza, Spain
Delphine Neff, NIMBE LAPA IRAMAT, CEA CNRS U, France
Emma Angelini, Politecnico di Torino, Italy
Sabrina Grassini, Politecnico di Torino, Italy

Session on Multidisciplinary techniques and testing systems for diagnosis applications in archaeology - PART I

Room: Miccoli Hall

Chairs: *Egidio De Benedetto, University of Salento, Italy*
Francesco Gabellone, National Research Council - IBAM, Italy

- 299 **Experimental data sharing of shaking table tests on masonry structures by "Staging Storage Sharing" (E3S) system**
Irene Bellagamba, ENEA Research Center, Italy
Francesco Iannone, ENEA Research Center, Italy
Gabriele Giovanetti, ENEA Research Center, Italy
Marialisa Mongelli, ENEA Research Center, Italy
Antonio Perozziello, ENEA Research Center, Italy
Silvio Migliori, ENEA Research Center, Italy
Andrea Quintiliani, ENEA Research Center, Italy
Beatrice Calosso, ENEA Research Center, Italy
Gerardo De Canio, ENEA Research Center, Italy
Ivan Roselli, ENEA Research Center, Italy
Giovanni Bracco, ENEA Research Center, Italy

- 304 **The use of high-frequency electromagnetic radiation to remove biofilms from canvas**
Paola Cennamo, Università degli Studi di Napoli Suor Orsola Benincasa, Italy
Nicola Pasquino, Università di Napoli Federico II, Italy
Aldo Moretti, Università di Napoli Federico II, Italy
- 308 **Application of non-destructive techniques case study: the Madonna del latte**
Maria Celeste Leuzzi, University of Genova, Italy
Mila Crippa, University of Genoa, Italy
Giorgio Andrea Costa, National Research Council, Italy
- 312 **Characterization and provenance of ancient gemstones: Case study of a gold-and-sapphire jewel dating from the Romarchaeon imperial period and found in a tomb in Colonna, Italy**
Enrico Butini, IGN Gemmological Laboratory of Rome, Italy
Flavio Butini, IGN Gemmological Laboratory of Rome, Italy
Flavio Altamura, "Sapienza" University of Rome, Italy
Micaela Angle, Italian Cultural Heritage Ministry, Sanctuary of Hercules Victor, Italy
Pamela Cerino, Cerino DeAngelis indagini archeologiche, Italy
Andrea De Angelis, Cerino DeAngelis indagini archeologiche, Italy
Noemi Tomei, External collaborator SABARP, Italy

Poster Session

Room: Castle Carlo V

Chairs: Andrea Cataldo

- 318 **GIS for cataloging the ancient marbles of Oria (Apulia region, Southern Italy)**
Maurizio Delli Santi, National Research Council, Italy
- 322 **Measure for participatory valorization of Cultural Heritage**
M. Cigola, University of Cassino and Southern Lazio, Italy
A. Gallozzi, University of Cassino and Southern Lazio, Italy
L.J. Senatore, University of Cassino and Southern Lazio, Italy
R. Di Maccio, University of Cassino and Southern Lazio, Italy
M. Molinara, University of Cassino and Southern Lazio, Italy
G. Trovini, University of Cassino and Southern Lazio, Italy
E. Marinelli, University of Cassino and Southern Lazio, Italy
A. Montaquila, University of Cassino and Southern Lazio, Italy
- 328 **Integrated archaeological and geophysical surveys for the knowledge of the Medieval cave village of Casalrotto (Mottola, Apulia)**
G. Di Giacomo, National Research Council -IBAM, Italy
L. De Giorgi, National Research Council -IBAM, Italy
I. Ditaranto, National Research Council -IBAM, Italy
G. Leucci, National Research Council -IBAM, Italy
I. Miccoli, National Research Council -IBAM, Italy
G. Scardozi, National Research Council -IBAM, Italy
- 334 **Archaeometry and archaeology: the case study of Sant'Agata La Vetere church in (Catania Sicily)**
Anna Gueli, Catania University, INFN sez Catania, Italy
Vincenzo Garro, Catania University, INFN sez Catania, Italy
Stefania Pasquale, Catania University, INFN sez Catania, Italy
Giuseppe Politi, Catania University, INFN sez Catania, Italy
Giuseppe Stella, Catania University, INFN sez Catania, Italy
Davide Tanasi, University of South Florida, United States
- 340 **Knowledge, documentation and dissemination of intangible heritage in Archaeology**
Emanuela Chiavoni, Sapienza University of Rome, Italy
Gaia Lisa Tacchi, Sapienza University of Rome, Italy

- 344 Investigations on provenance and content of archaic transport amphorae from Castello di Alceste (S.Vito dei Normanni-Br) by chemical analyses through XRF/FP and GC-MS**
Grazia Semeraro, University of Salento, Italy
Florinda Notarstefano, University of Salento, Italy
Renato Caldarola, University of Salento, Italy
Gianluca Quarta, University of Salento, Italy
Lucio Calcagnile, University of Salento, Italy
- 350 Geophysical investigations on hypogeic monuments. The case study of the Crypt of St. Sebastian in Sternatia (Lecce – Southern Italy)**
Giovanni Quarta, National Research Council-IBAM, Italy
Giovanni Leucci, National Research Council-IBAM, Italy
Raffaele Persico, National Research Council-IBAM, Italy
Paola Durante, IN-Cul.Tu.Re. Project, Italy
Sofia Giammaruco, IN-Cul.Tu.Re. Project, Italy
- 353 3D resistivity anomaly probability tomography at the archaeological site of Sagalossos (TURKEY)**
Lara De Giorgi, National Research Council -IBAM, Italy
Giovanni Leucci, National Research Council -IBAM, Italy
- 356 Measuring Layout Features in Mediaeval Documents for Writer Identification**
C. De Stefano, Università di Cassino e del Lazio Meridionale, Italy
F. Fontanella, Università di Cassino e del Lazio Meridionale, Italy
M. Maniaci, Università di Cassino e del Lazio Meridionale, Italy
A. Scotto di Freca, Università di Cassino e del Lazio Meridionale, Italy
- 360 Draping of aerial photographs on DTM LiDAR for the historical reconstruction of the vicus of Aequum Tuticum along the Via Traiana**
Paola Guacci, University of Salento, Italy
Rosanna Montanaro, University of Salento, Italy
- 365 Archaeological data and geophysical survey at Masseria Grasso (BN, Italy): Ancient Appia Landscapes Project**
F. Perciante, Italian National Research Council, Italy
E. Rizzo, Italian National Research Council, Italy
G. De Martino, Italian National Research Council, Italy
C. B. De Vita, University of Salerno, Italy
D. Musmeci, University of Salerno, Italy
A. Santoriello, University of Salerno, Italy
- 369 Geophysical surveys for the study and reconstruction of the sixteenth-century fortifications of Lecce**
G. Di Giacomo, National Research Council -IBAM, Italy
L. De Giorgi, National Research Council -IBAM, Italy
I. Ditaranto, National Research Council -IBAM, Italy
G. Leucci, National Research Council -IBAM, Italy
I. Miccoli, National Research Council -IBAM, Italy
G. Scardozzi, National Research Council -IBAM, Italy
- 374 Evidence of surface faulting in the archaeological site of Santa Venera al Pozzo (Catania-Eastern Sicily): first results from geological and geophysical investigations**
Carla Bottari, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Patrizia Capizzi, Università degli Studi di Palermo, Italy
Danilo Cavallaro, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Mauro Coltelli, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Antonino D'Alessandro, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Luigi Lodato, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Raffaele Martorana, University of Palermo, Italy
Antonino Fabio Pisciotta, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Salvatore Scudero, Istituto Nazionale di Geofisica e Vulcanologia, Italy

- 378 Multi-frequency EMI in archaeological prospection: case studies of Han Hangu Pass and Xishan Yang in China**
Panpan Tang, Chinese Academy of Sciences, China
Fulong Chen, Chinese Academy of Sciences, China
Aihui Jiang, Chinese Academy of Sciences, China
Wei Zhou, Chinese Academy of Sciences, China
Hongchao Wang, Cultural Relic Bureau of Xin'an County, China
Lupeng Luo, Institute of Cultural Relics and Archaeology of Zhejiang Province, China
Lara De Giorgi, Italian National Research Council, Italy
Giovanni Leucci, Italian National Research Council, Italy
- 384 Low-cost Remotely Operated Underwater and Unmanned Aerial vehicles: new technologies for archaeo-geophysics**
Antonino D'Alessandro, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Luca Greco, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Salvatore Scudero, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Giovanni Vitale, Istituto Nazionale di Geofisica e Vulcanologia
Carla Bottari, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Patrizia Capizzi, University of Palermo, Italy
Francesco Croce, Istituto Nazionale di Geofisica e Vulcanologia, Italy
Raffaele Martorana, University of Palermo, Italy
- 387 Integrated Scientific Investigations On Constitutive Materials From Temple N.1205a Bagan Valley (Myanmar)**
Maria Letizia Amadori, University of Urbino, Italy
Paola Fermo, University of Milan, Italy
Yoshifumi Maekawa, Tokyo National Research Institute for Cultural Properties, Japan
Valentina Raspugli, University of Urbino, Italy
Valeria Comite, University of Milan, Italy
Francesco Maria Mini, University of Urbino, Italy
Koki Lin, Department of Archaeology of Bagan, Myanmar
- 393 Hyperspectral approach for the assessment of biocide treatments on archeological walls**
Oana Adriana Cuzman, National Research Council, Italy
Rachele Manganelli Del Fà, National Research Council, Italy
Barbara Salvadori, National Research Council, Italy
Leandro Chiarantini, Leonardo SpA, Italy
Bruno De Nigris, MIBACT - Ministero dei beni e delle attività culturali e del turismo, Italy
Cristiano Riminesi, National Research Council, Italy
- 397 Building a necropolis in roman age: geomaterials from the "Porta mediana" in Cuma**
C. Di Benedetto, University of Naples, Federico II, Italy
C. Germinario, University of Sannio, Italy
S.F. Graziano, University of Naples, Federico II, Italy
V. Guarino, University of Naples, Federico II, Italy
F. Izzo, University of Sannio, Italy
C. Rispoli, University of Naples, Federico II, Italy
- 401 Degradation diagnosis on Gravina Calcarenite – classification and damage indices on the Sassi di Matera site (Southern Italy)**
A.E. Bonomo, University of Basilicata, Italy
G. Prosser, University of Basilicata, Italy
G. Rizzo, University of Basilicata, Italy
M. Sileo, Italian National Research Council, Italy
- 408 A GPR Survey of the Floor of the São Carlos Theater (Lisbon, Portugal)**
Mercedes Solla, Defense University Center, Spain
Simona Fontul, National Laboratory for Civil Engineering, Portugal
Helena Cruz, National Laboratory for Civil Engineering, Portugal
J.S. Machado, National Laboratory for Civil Engineering, Portugal
Lara Pajewski, La Sapienza University of Rome, Italy

- 412 **Geographic multidimensional approach for decay analysis of Gymnasium frescoes in Pompeii. Preliminary results**
Maria Danese, National Research Council -IBAM, Italy
Maria Sileo, National Research Council -IBAM, Italy
Nicola Masini, National Research Council -IBAM, Italy
- 418 **Low frequency sensitive tiltmeters for dynamic structural status evaluation of hystorical monuments**
Fabrizio Barone, University of Salerno, Italy
Gerardo Giordano, University of Salerno, Italy
- 424 **Non-destructive tests for structural diagnosis of the so-called Temple of Minerva Medica, Rome**
Ivan Roselli, ENEA Casaccia Research Center, Italy
Angelo Tati, ENEA Casaccia Research Center, Italy
Vincenzo Fioriti, ENEA Casaccia Research Center, Italy
Irene Bellagamba, ENEA Casaccia Research Center, Italy
Marialuisa Mongelli, ENEA Casaccia Research Center, Italy
Mariarosaria Barbera, Soprintendenza speciale per i Beni Archeologici di Roma, Italy
Marina Magnani Cinetti, Soprintendenza speciale per i Beni Archeologici di Roma, Italy
Roberto Romano, ENEA Casaccia Research Center, Italy
Gerardo De Canio, ENEA Casaccia Research Center, Italy
- 429 **Development of FBG humidity sensors for stone condition monitoring**
Michele Caponero, ENEA, FSN-TECFIS-MNF, Italy
Rosaria D'Amato, ENEA, FSN-TECFIS-MNF, Italy
Andrea Polimadei, ENEA, FSN-TECFIS-MNF, Italy
Gaetano Terranova, ENEA, FSN-TECFIS-MNF, Italy
- 433 **New crack measurement methodology: Tag Recognition**
Fabio Mangini, University of Rome, Italy
Lorenzo Dinia, La Sapienza University of Rome, Italy
Fabrizio Frezza, La Sapienza University of Rome, Italy
Andrea Beccarini, Step Over, Italy
Mauro Del Muto, Step Over, Italy
Enrico Federici, Step Over, Italy
Stefano Godi, Step Over, Italy
Andrea Segneri, Heriot Watt University, United Kingdom
- 437 **Complex Permittivity Measurements for Moisture and Salinity Characterization of Building Materials**
Paolo D'Atanasio, ENEA, Italy
Alessandro Zambotti, ENEA, Italy
Stefano Pisa, Sapienza University of Rome, Italy
Erika Pittella, Sapienza University of Rome, Italy
Emanuele Piuzzi, Sapienza University of Rome, Italy
- 442 **Modified LEACH for Necropolis Scenario**
Fabio Leccese, University Roma Tre, Italy
Marco Cagnetti, University Roma Tre, Italy
Simonetta Tuti, University Roma Tre, Italy
Pietro Gabriele, Fonderie Digitali s.r.l, Italy
Eduardo De Francesco, Se.Te.L. s.r.l, Italy
Rada Durović-Pejčev, Laboratory of Chem, Serbia
Alessandro Pecora, International Resourch Council, Italy
- 448 **Noninvasive Patch Resonator-Based Measurements on Cultural Heritage Materials**
Emanuele Piuzzi, Sapienza University of Rome, Italy
Erika Pittella, Sapienza University of Rome, Italy
Stefano Pisa, Sapienza University of Rome, Italy
Andrea Cataldo, University of Salento, Italy
Egidio De Benedetto, University of Salento, Italy
Giuseppe Cannazza, University of Salento, Italy

- 452 Evaluation of Flat Jack Test Method Effectiveness for Masonry Structural Investigations**
Lidia La Mendola, University of Palermo, Italy
Elio Lo Giudice, Laboratorio DISMAT, Italy
Giuseppe Navarra, Laboratorio DISMAT, Italy
Giovanni Minafò, University of Palermo, Italy
Vincenzo Valenti
- 458 An innovative Raman scanner for rapid and controlled molecular mapping of painted surfaces**
Andrea Azelio Mencaglia, National Research Council, Italy
Iacopo Osticioli, National Research Council, Italy
Loredana Gallo, Gallo Restauro, Italy
Daniele Ciofini, National Research Council, Italy
Salvatore Siano, National Research Council, Italy
- 462 Non-invasive and Micro-invasive Investigations on Wall Paintings from a XIII century Temple in Bagan Valley (Myanmar)**
Maria Letizia Amadori, University of Urbino, Italy
Mara Camaiti, Institute of Geosciences and Earth Resources, CNR, Italy
Valentina Raspugli, University of Urbino, Italy
Yoshifumi Maekawa, Tokyo National Research Institute for Cultural Properties, Japan
Ko Kyi Lin, Department of Archeology, Myanmar
- 467 Gilding Thickness measurements using EDXRF-ANALYSIS**
R. Cesareo, University of Sassari, Italy
M.J. dos Anjos, Universidade Estadual do Rio de Janeiro, Brazil
J.T. de Assis, Universidade Estadual do Rio de Janeiro, Brazil
S. Ridolfi, Armensurae, Italy
R.T. Lopes, Universidade Federal do Rio de Janeiro, Brazil
R.S. dos Santos, Universidade Estadual do Rio de Janeiro, Brazil
H.S. Gama Filho, Universidade Estadual do Rio de Janeiro, Brazil
D.F. Oliveira, Universidade Estadual do Rio de Janeiro, Brazil
- 472 Virtual Open-Air Museum of Wrecks in the Gulf of Gdańsk. 3D digitalization of underwater archaeological sites**
Tomasz Bednarz, National Maritime Museum in Gdańsk, Poland
- 477 Comparison of two well-established 3D acquisition techniques on a small fragmental artefact of a few cubic centimeters**
Adriana Bandiera, University of Salento, Italy
Francesco Meo, University of Salento, Italy
Angelo Cammalleri, University of Salento, Italy
Catia Bianco, University of Salento, Italy
Jean-Angelo Beraldin, Retired researcher
- 483 Preliminary Findings on Agricultural History of Ancient Tripolis on the Maeander (Denizli – SW Turkey) in the Roman Period**
Gürkan Semiz, University of TURKEY
Bahadır Duman, University of TURKEY
- 487 Building Information Modeling for Cultural Heritage: beyond asset modeling. A pragmatic comparison of literature case studies.**
Carla Di Biccari, University of Salento, Italy
Ada Malagnino, University of Salento, Italy
Angelo Corallo, University of Salento, Italy
Giorgio Zavarise, University of Salento, Italy
- 493 Process Innovation for Cultural Heritage digitalization and valorization**
Angelo Corallo, University of Salento, Italy
Marco Esposito, University of Salento, Italy
Giovanna Mangialardi, University of Salento, Italy
Laura Schina, University of Salento, Italy

- 499 Survey for the enhancement of the archaeological sites of the Phlegraean Fields: the Agrippina Sepulchre in Bacoli**
Francesca Porfiri, University of Rome Sapienza, Italy
Gaia Lisa Tacchi, University of Rome Sapienza, Italy
Raffaele Catuogno, University of Rome Sapienza, Italy
- 504 Innovating Cultural Heritage through virtual and interactive technologies**
Mariangela Lazoi, University of Salento, Italy
Manuela Marra, University of Salento, Italy
Marco Esposito, University of Salento, Italy
Mariangela Sammarco, Archeologia Ricerca e Valorizzazione - A.R.Va s.r.l., Italy
Angelo Corallo, University of Salento, Italy
- 510 A Low Power City-Scale Wireless Sensor Network for the Monitoring of Monumental Structures**
Tommaso Addabbo, University of Siena, Italy
Ada Fort, University of Siena, Italy
Marco Mugnaini, University of Siena, Italy
Enza Panzardi, University of Siena, Italy
Alessandro Pozzebon, University of Siena, Italy
Valerio Vignoli, University of Siena, Italy
- 516 Double-pulse micro-laser-induced breakdown spectroscopy applied to three dimensional mapping of stone monument samples**
G.S. Senesi, Italian National Research Council, Italy
B. Campanella, Italian National Research Council, Italy
E. Grifoni, Italian National Research Council, Italy
S. Legnaioli, Italian National Research Council, Italy
G. Lorenzetti, Italian National Research Council, Italy
S. Pagnotta, Italian National Research Council, Italy
F. Poggialini, Italian National Research Council, Italy
V. Palleschi, Italian National Research Council, Italy
O. De Pascale, Italian National Research Council, Italy
- 520 Diagnostic campaign and innovative conservation treatments carried out on the statue "La Speranza" by Odoardo Fantacchiotti**
Marta Mascalchi, Institute of applied Physics, Italy
Iacopo Osticioli, Institute for the Conservation and Valorization of Cultural Heritage, Italy
Oana A. Cuzman, Institute for the Conservation and Valorization of Cultural Heritage, Italy
Sonia Mugnaini, Department of Physical sciences, Earth and environment (DSFTA), Italy
Marco Giamello, Department of Physical sciences, Earth and environment (DSFTA), Italy
Salvatore Siano, Institute of applied Physics "Nello Carrara", Italy
- 525 Verification and photogrammetric documentation of the archaeological site in Lake Boczna**
Piotr Prejs, University of Warsaw, Poland
Artur Brzóska, University of Warsaw, Poland
Krzysztof Cetwiński, University of Warsaw, Poland
- 528 TDR-based Water Content Estimation on Globigerina Limestone Through Permittivity Measurements**
Andrea Cataldo, University of Salento, Italy
Egidio De Benedetto, University of Salento, Italy
Giuseppe Cannazza, University of Salento, Italy
Sebastiano D'Amico, University of Malta, Italy
Lourdes Farrugia, University of Malta, Italy
Geraldine Misfud, University of Malta, Italy
Evan Dimech, University of Malta, Italy
Charles V. Sammut, University of Malta, Italy
Raffaele Persico, National Research Council -IBAM, Italy
Giovanni Leucci, National Research Council -IBAM, Italy
Lara De Giorgi, National Research Council -IBAM, Italy

- 534 Handheld laser-induced breakdown spectroscopy instrument for the diagnosis of the conservation state of stone monuments**
G.S. Senesi, Italian National Research Council, Italy
D. Manzini, MADAttec s.r.l, Italy
O. De Pascale, Italian National Research Council, Italy
- 537 Photogrammetry for large scale documentation. The case of the microregion of the Minoan site of Gournia**
Rafał Bieńkowski, Polish Academy of Sciences, Poland
M. Buell, Concordia University, Canada
J. McEnroe, Hamilton College, USA
J. Botero, Universitat de Barcelona, Spain
- 541 Some considerations on measurement errors in archaeological survey**
Andrea Angelini, Istituto per le Tecnologie Applicate ai Beni Culturali, Italy
Damiano Portarena, Università degli studi di Roma Tor Vergata, Italy
- 547 Technical study on a piece of Cashmere textile attributed to late Qajar era**
Alavi Dehkordi Sayede Elahe, Art University of Isfahan, Iran
Mehrnaz Azadi, Art University of Isfahan, Iran
- 552 Vulnerability of Historic Religious Buildings in Nera's Valley, Italy**
Giulio Castori, University of Perugia, Italy
Antonio Borri, University of Perugia, Italy
Romina Sisti, University of Perugia, Italy
Marco Corradi, University of Perugia, Italy
Alessandro De Maria, Buildings Survey Office of Perugia, Italy
- 559 The byzantine fresco of Dormitio Virginis (12th century): Diagnosis and Intervention**
Giuliana Taglieri, University of L'Aquila, Italy
Davide Rigaglia, Restorer and conservator of cultural heritage, Italy
Lorenzo Arrizza, University of L'Aquila, Italy
Valentina Romè, Restorer and conservator of cultural heritage, Italy
Valeria Daniele, University of L'Aquila, Italy
Grazia Musolino, Soprintendenza BB.CC.AA. Regione Siciliana, Italy
- 564 Classification and Reconstruction Algorithms for The Archaeological Fragments**
Nada A. Rasheed, University of Babylon, Hillah
Jan Nordin, Universiti Kebangsaan Malaysia (UKM)
- 571 Preliminary cross-correlated archaeometrical analysis on Iron Age representative pottery specimens from ancient Karkemish (Turkey)**
Gabriele Giacosa, University of Bologna, Italy
Daniele Moro, University of Bologna, Italy
Silvano Zanna, University of Bologna, Italy
Gianfranco Ulian, University of Bologna, Italy
Giovanni Valdrè, University of Bologna, Italy

- 577 Toward the Virtual reconstruction of Grotta Romanelli, Apulia (Southern Italy)**
Jacopo Conti, Sapienza University of Rome, Italy
Ilaria Mazzini, Sapienza University of Rome, CNR, Italy
Luca Bellucci, Sapienza University of Rome, Italy
Fabio Bona, Sapienza University of Rome, Italy Italy
Francesca Giustini, National Research Council, Italy
Massimo Massussi, Sapienza University of Rome, Italy
Beniamino Mecozzi, Sapienza University of Rome, Italy
Mauro Brilli, National Research Council, Italy
Dawid Adam Iurino, Sapienza University of Rome, Italy
Giuseppe Lembo, University of Ferrara, Italy
Brunella Muttillo, University of Ferrara, Italy
Flavia Strani, Sapienza University of Rome, Italy
Sonia Tucci, Sapienza University of Rome, Italy
Raffaele Sardella, Sapienza University of Rome, Italy
Mario Voltaggio, National Research Council, Italy
Dario Sigari, University of Ferrara, Italy
- 583 Portus Lupiae. New data for a reconstructive proposal**
Ivan Ferrari, University of Salento, Italy
Aurora Quarta, University of Salento, Italy
- 589 iziTRAVELSicilia: a storytelling participatory project**
Elisa Bonacini, University of South Florida, United States
Davide Tanasi, University of South Florida, United States
- 595 A new contribution for the reconstructive study of the theater of Taormina**
Francesco Gabellone, National Research Council - IBAM, Italy
Ivan Ferrari, National Research Council - IBAM, Italy
Francesco Giuri, National Research Council - IBAM, Italy
- 601 Image-based techniques for the virtualization of Egyptian contexts**
Francesco Gabellone, National Research Council - IBAM, Italy
Ivan Ferrari, National Research Council - IBAM, Italy
Francesco Giuri, National Research Council - IBAM, Italy
Maria Chiffi, Technè sas, Italy
- 607 Augmented Reality and UAVs in Archaeology: Development of a Location-Based AR Application**
Maria Concetta Botrugno, University of Salento, Italy
Giovanni D'Errico, University of Salento, Italy
Lucio Tommaso De Paolis, University of Salento, Italy
- 612 An investigation of the structure, manufacturing method of Pin copper alloys from the excavation of the West Chia Sabz in Luristan, Iran**
Hamidreza Bakhshandehfard, Art University Isfahan, Iran
Mahshid Safaei Ghalati, Art University Isfahan, Iran
Morteza Hessari, Art University Isfahan, Iran
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Survey for the enhancement of the archaeological sites of the Phlegraean Fields: the “Agrippina Sepulchre” in Bacoli

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Abstract – In conjunction with a collaboration with the Superintendence for Archaeological Heritage of Naples for an updating of previous surveys with advanced and integrated methodologies and techniques, we would like to present the first results of the study on the “Agrippina Sepulchre” in Bacoli inside the Archaeological Park of Baia Terme.

For a long time closed to visitors the monument, known as the Sepulchre of Agrippina in Bacoli, is part of a restoration and musealization programme that regards the entire archaeological area of the Park of Baia Thermae - in synergy with the Municipal Administration - and which aims to preserve and enhance the site, as well as a historical deepening and knowledge about the original consistency of the Roman-era architecture existing on the area of influence of Baia.



Fig. 1. The Agrippina Sepulchre, aerial view

The monument we are talking about, wrongly known from the 16th century as “Sepulchre of Agrippina”, represents most probably some remains of a Roman-era monument, an important Odeon, most likely executed in Julio-Claudian period and subsequently used as a semi-circular Nymphaeum between the end of the 1st and the beginning of the 2nd century A.D. (Fig. 1). It was a part of a no longer existing monumental maritime villa, overlooking the sea, where, from its surface, some remains are still visible. The scheme of the semi-circular cavea had three storeys, connected by internal and hidden staircases: the lower annular corridor, covered by a barrel-vault and still well-preserved, is characterised by

the presence of three small exhedras which faced three openings, called “vomitoria”, that nowadays are narrow openings at ground level.



Fig. 2. Paolo Antonio Paoli, Agrippina Sepulchre, 1768.

In the middle of the lower annular corridor there is another straight corridor inserted into the ground, in alignment with the centre of the cavea, which is a remarkable example of fine decorations (female figures, sea monsters, swans and dolphins) recalling the theme of water architecture and of the water games that took place inside. This corridor probably led to some rooms behind the Odeon, but in the successive transformations it was closed: this particular circumstance may have meant that

the discovery in the 16th century of the hypogeum environment was confused with a tomb, the Sepulchre of Agrippina, who died in this area. Paolo Antonio Paoli himself, who produced in 1768 valuable prints and historical information, hypothesizes this possibility.

The upper hemicycle, covered by a barrel-vault, led to the median cavea and it opened with doors alternating with windows which are still preserved. The no longer existing summa cavea dominated the odeon bleachers and maybe it didn't exist anymore when the monument became a Nymphaeum. Behind the upper annular corridor there was the third hemicycle, whose some remains are still visible, like in particular the ornamental semicolumns in brick and stucco.

The building transformation from Odeon to Nymphaeum, which occurred between the 1st and the 2nd century, determined the elimination of a part of the steps, the creation of a large terrace with an axial staircase (still visible) and the significant alteration of the orchestra level, which is currently set one meter underground.

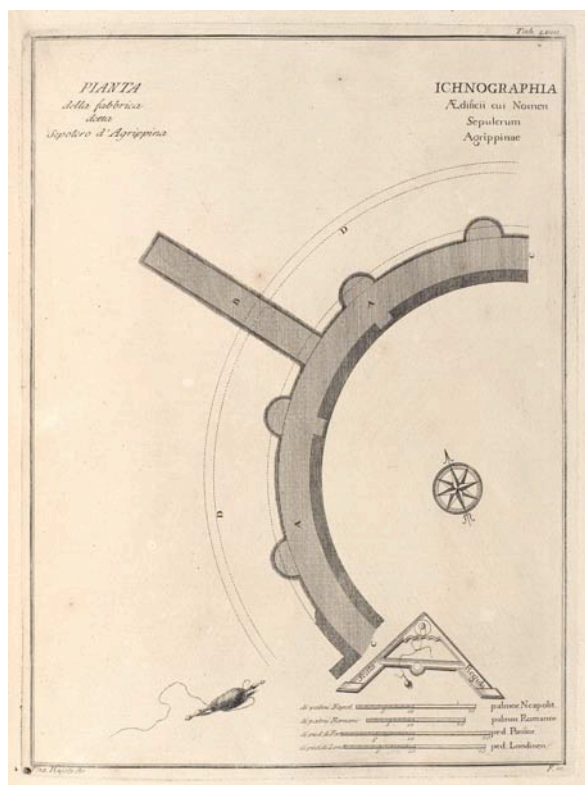


Fig. 3. Paolo Antonio Paoli, *Agrippina Sepulchre*, the plan of the hypogeal corridor, 1768.

The unsafe working conditions of the structure do not yet allow the access to the hypogeal environments, which will be addressed in detail in the next studies; therefore a no-contact survey (with a Drone) has been used for the analysis of the structure, along with a study of the previous surveys. The investigation among them has been

addressed especially to the Paoli's meaningful survey of 1765, which shows a plan at the first-ring level, the hypogeal environments, and an overall view represented in two prints that belong to the collection of the ancient remainders in the area of Naples, Pozzuoli and Baia (Fig. 2-3).

This view deals with the substance of the structure above-ground in the middle of the 1700's and its state of conservation, it shows also some no longer existing elevated structures.



Fig. 4. *The Agrippina Sepulchre*, aerial view

The northern part of the cavea appears to be missing and in its place stands out a modern building.



Fig. 5 *Agrippina Sepulchre*, inside the ambulatory.

The complexity of the surviving rooms and their hypothetical reconstruction is widely reported by Amedeo Maiuri, who conducted an archaeological excavation in the middle of the last century, where he pointed out the preciousness of the decorations on the annular corridors intradoses; in fact he formulated a method of documentation and of in-depth knowledge of this monument, to whom our study wants to give a contribution, more linked to technological innovation of survey techniques which allows new investigations even in limited-access areas where the architectural structures are in precarious conditions.

For the acquisition of morphometric data of the archaeological site in question, Structure from Motion (SfM) algorithms were used to reconstruct the shape of the artefact by collimating points from a dataset of images taken with a non-metric chamber, both on the ground as well as in flight.

Structure from Motion is a digital technology based on feature recognition algorithms (SIFT, SURF), developed under Computer Vision, which allows the creation of a dense stereo matching (raster image) from raster images. The innovation in this technique and its peculiarities can be summarized in the low-cost principle that characterizes this technology, which uses much cheaper instrumentation compared to 3D laser scanner equipment. In fact, for the acquisition, a common digital camera can be used, with appropriate arrangements. In addition, the development of software for processing and post-processing of data is carried out both in the commercial and open source domains.

Photomodeling does not replace the other methodologies but, above all in the archaeological field, it needs to be integrated with 3D data acquisition systems such as photogrammetry or 3D laser scanning. Experimenting and using these new technologies requires the coding of a pipeline for defining a standard during the acquisition phases and, above all, the post-processing of data.



Fig. 6. View of the archaeological complex of the Agrippina Sepulchre.

SAPR (remote pilot aircraft systems) acquisition of aerial images was made nadir at different angles to be used in photo-modeling software. The process was aimed at reconstructing the current state of the monument and at creating three-dimensional models and orthophoto map of the site.

The acquisition of frames with SAPR required a preliminary shooting plan, based on a mapping of areas of interest with Mission Planner, a tool for creating the flight plan via waypoints, by setting the path, the number of shots, and the value of the ground resolution (GSD ground sample distance). Frames have been scanned in succession and in several steps to completely map the surface. Photos were grouped into datasets and subdivided into chunks to be included in the software.

It was therefore possible to ensure maximum coverage of the area to be detected. The factors to be taken into account when drawing up the project, depending on the software chosen for managing the acquired data, are influenced by the lighting condition of the context, the material characteristics of the object to be detected, the correct putting on focus of the objects to be detected in all the frames to use, from the correct shooting position and overlay of images so that the overlapping of frames is approximately 70% and the overlap between the strips is approximately 80 % and, finally, at the required resolution scale for the survey the GSD was 1cm / pixel.

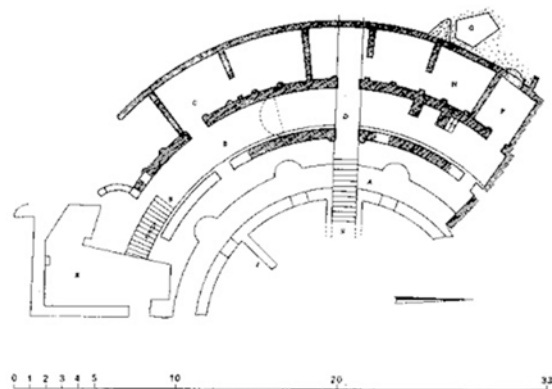


Fig. 7. The Agrippina Sepulchre, plan from Forma Italiae, Florence 1979.

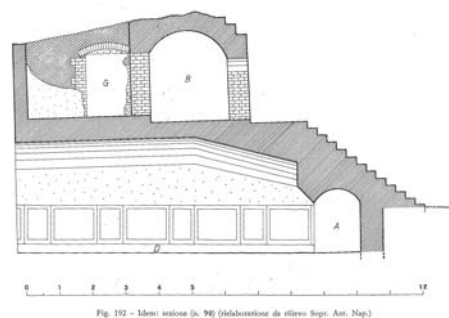


Fig. 8. The Agrippina Sepulchre, cross section from Forma Italiae, Florence 1979.

The workflow is divided into two parts: capturing frames using passive sensor technology and extracting captured data and post-processing them through multiple dedicated software.

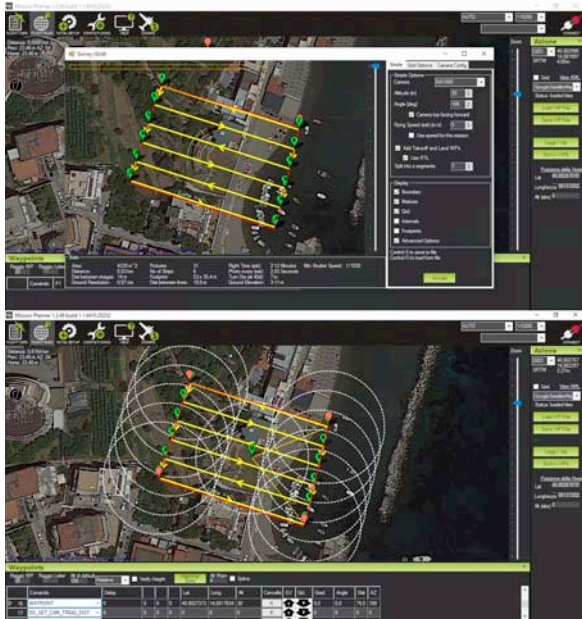


Fig. 9. Mission Planner, Flight Scheduling. Both the input and output parameters determined by the software are visible.

During the first step, the various phases in which it is subdivided can be synthesized, on-site, in the lookout to plan the flight, in the choice of the most appropriate methodologies and technologies, in planning the project of shooting and in the acquisition of metric and photographic data.

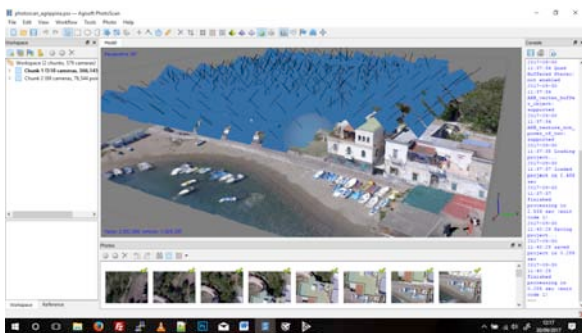


Fig. 10. Agisoft Photoscan, point cloud with position frames from GPS coordinates.

The planned operations consist of capturing image datasets, chunks per single flight, or sequential shots, camera calibration using Agisoft's Agilens software to locate the internal orientation and external orientation of the camera, the calibration can take place both before and after capture by extracting information from the frames.

After selecting the datasets to be inserted, the tie points are extracted for the calculation of correspondence, the

construction of the sparse cloud that in some software coincides with the extraction of homologous points, the dense cloud construction.

Due to the complexity of the site in question, it has been chosen as Agisoft's dot-processing software, Photoscan, which allows to extract a mesh of the entire project and texturize it and extract orthophotos and sections.

Number of images:	521	Camera stations:	510
Flying altitude:	28.9 m	Tie points:	366,145
Ground resolution:	1.02 cm/pix	Projections:	1,083,978
Coverage area:	0.0106 km ²	Reprojection error:	5.47 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC330 (3.61 mm)	4000 x 3000	3.61 mm	1.56 x 1.56 μm	No

Fig. 11. Processing parameters in Agisoft Photoscan.

The use of such technologies in the archaeological site is increasingly common for the acquisition of dimensional, colorimetric and material information, and for the writing of descriptive documentation (graphic and textual).

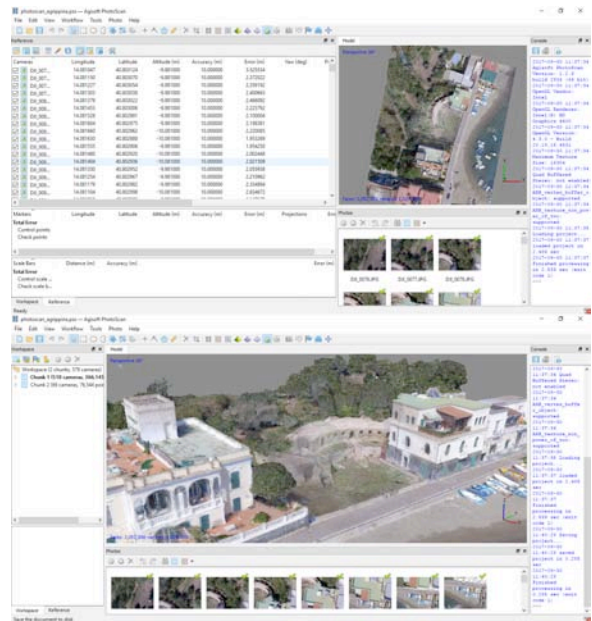


Fig. 12 Dense cloud in Agisoft Photoscan.

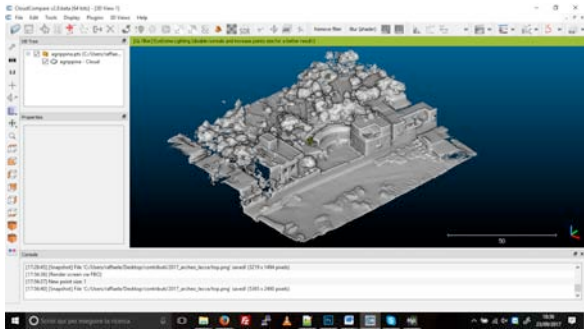


Fig. 13. 3D Model, processing in CloudCompare.



Fig. 14 Orthophoto of the archaeological complex of the so-called Sepulchro di Agrippina, 2017, GSD.

About the workflow we know the limits of use both in the acquisition and in after-processing phase of data. The considerations that arise after having acquired a sufficiently comprehensive knowledge of the archaeological site of the so-called Agrippina Sepulcher are the necessity of direct survey as a fundamental instrument of knowledge of this artefact.

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