

PROCEEDINGS OF SPIE

Optics for Arts, Architecture, and Archaeology V

**Luca Pezzati
Piotr Targowski**
Editors

**24–25 June 2015
Munich, Germany**

Sponsored by
SPIE

Cooperating Organizations
European Optical Society
German Scientific Laser Society (Wissenschaftliche Gesellschaft
Lasertechnik e.V.)

Published by
SPIE

Volume 9527

Proceedings of SPIE 0277-786X, V. 9527

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Optics for Arts, Architecture, and Archaeology V, edited by Luca Pezzati, Piotr Targowski, Proc. of SPIE
Vol. 9527, 952701 · © 2015 SPIE · CCC code: 0277-786X/15/\$18 · doi: 10.1117/12.2203325

Proc. of SPIE Vol. 9527 952701-1

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Optics for Arts, Architecture, and Archaeology V*, edited by Luca Pezzati, Piotr Targowski, Proceedings of SPIE Vol. 9527 (SPIE, Bellingham, WA, 2015) Article CID Number.

ISSN: 0277-786X

ISBN: 9781628416879

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time)- Fax +1 360 647 1445

SPIE.org

Copyright © 2015, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/15/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.



SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print. Papers are published as they are submitted and meet publication criteria. A unique citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID Number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages.

Contents

- v *Authors*
- vii *Conference Committee*

SESSION 1 NEW METHODS AND APPLICATIONS FOR RESTORATION

- 9527 03 **High-selectivity cleaning of historical paper samples with sizing through femtosecond laser ablation** [9527-2]

SESSION 2 STRATIGRAPHICS AND DEPTH-RESOLVED METHODS

- 9527 05 **High resolution Fourier domain Optical Coherence Tomography at 2 microns for painted objects (Invited Paper)** [9527-5]
- 9527 06 **Surface reconstruction from photometric normals with reference height measurements** [9527-6]
- 9527 08 **Optical coherence tomography complemented by hyperspectral imaging for the study of protective wood coatings** [9527-8]

SESSION 3 3D IMAGING, SCANNING, TOPOGRAPHY AND TOMOGRAPHY

- 9527 09 **Ultrafast pump-probe dynamics of iron oxide based earth pigments for applications to ancient pottery manufacture (Invited Paper)** [9527-25]
- 9527 0A **Resolution limits in holographic display with LED illumination** [9527-11]
- 9527 0B **Light calibration and quality assessment methods for Reflectance Transformation Imaging applied to artworks' analysis** [9527-12]
- 9527 0C **Test monitoring of the Centennial Hall's dome, Wroclaw (Poland)** [9527-13]

SESSION 4 IMAGE PROCESSING AND OTHER DIGITAL DATA PROCESSING METHODS FOR OPTICS

- 9527 0G **Role of the masonry in paintings during a seismic event analyzed by infrared vision** [9527-17]
- 9527 0H **Semi-automatic system for UV images analysis of historical musical instruments** [9527-18]

SESSION 5 INTEGRATED TECHNIQUES AND CASE STUDIES

- 9527 OI **Mid-infrared thermal imaging for an effective mapping of surface materials and sub-surface detachments in mural paintings: integration of thermography and thermal quasi-reflectography (Invited Paper)** [9527-19]
- 9527 OJ **Optical characteristics and visual appearance for artwork materials** [9527-20]
- 9527 OK **Terahertz and multispectral imaging of a Tanda painting** [9527-21]
- 9527 OL **Case study of Sainte-Marie Chapel, Fontaine Chaalis (France): complementarity of different optical techniques** [9527-22]
- 9527 OM **Photogrammetry in maritime and underwater archaeology: two marble wrecks from Sicily** [9527-23]
- 9527 ON **Spectral characterization as a tool for parchment analysis** [9527-24]

SESSION 6 IMAGING AND MULTIMODAL IMAGING

- 9527 OP **Hyperspectral remote sensing techniques applied to the noninvasive investigation of mural paintings: a feasibility study carried out on a wall painting by Beato Angelico in Florence** [9527-26]
- 9527 OQ **Combination of topology and structural information for damages and deterioration analysis of artworks** [9527-27]
- 9527 OR **Measuring environmental impact by real time laser differential displacement technique in simulated climate conditions** [9527-28]

POSTER SESSION

- 9527 OS **Microtopographic characterization of pre-colonial Brazilian archaeological ceramics** [9527-29]
- 9527 OT **Thermal imaging method to visualize a hidden painting thermally excited by far infrared radiations** [9527-30]
- 9527 OU **'Cranach Inc.' A case study determining the nature and extent of Lucas Cranach the Elder's involvement in his industrious workshop using image processing** [9527-31]
- 9527 OV **Quality assessment of the TLS data in conservation of monuments** [9527-33]
- 9527 OW **The influence of environment on corrosion of cast iron and carbon steel representing samples of outdoor metal technical heritage** [9527-34]
- 9527 OX **Painting recognition with smartphones equipped with inertial measurement unit** [9527-35]
- 9527 OY **Limewashed mural paintings as seen by VIS-IR reflectography** [9527-36]

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Adam, A. J. L., 08
Aghemo, C., 0J
Akturk, Selcuk, 03
Alves, Márcia Angelina, 0S
Ambrosini, D., 0G
Andrianakis, Michalis, 0R
Balletti, C., 0M
Barucci, M., 0Y
Bednarz, Łukasz J., 0C
Belframe, C., 0M
Bernikola, Eirini, 0L, 0R
Bodnar, J.-L., 0L
Bowen, John, 0K, 0L
Brissaud, D., 0L
Brown, William, 09
Buchta, D., 0Q
Chabane, A., 0T
Cheung, C. S., 05
Chiarantini, Leandro, 0P
Chlipała, Maksymilian, 0A
Clarkson, W. A., 05
Costa, E., 0M
Costa, Manuel F. M., 0S
Cucci, Costanza, 0P
Czyz, K., 0W
Daffara, C., 0B, 0I
Daniel, J. M. O., 05
Davin, T., 0T
Detalle, Vincent, 0K, 0L
Dingemans, L. M., 08
Dondi, Piercarlo, 0H
Ersoy, Tansu, 03
Fischer, Martin, 09
Fontana, R., 0Y
Giachetti, A., 0B
Giovannacci, David, 0K, 0L
Gobbetti, E., 0B
Groves, R. M., 08
Guarnieri, Alberto, 0X
Guerra, F., 0M
Guida, G., 0T
Hatzigiannakis, Kostas, 0L, 0R
Hein, N., 0Q
Hervé, P., 0T
Iacomussi, Paola, 0J, 0N
Ibarra-Castanedo, C., 0G
Invernizzi, Claudia, 0H
Jackson, J. Bianca, 0K, 0L
Jasieńko, Jerzy, 0C
Kozacki, Tomasz, 0A
Krekel, C., 0Q
Leissner, Johanna, 0R
Liang, H., 05
Licchelli, Maurizio, 0H
Liu, P., 08
Lombardi, Luca, 0H
López, F., 0G
Lubashevsky, Ruth, 0U
MacDonald, Lindsay W., 06
Magalhaes, Wagner, 0S
Malagodi, Marco, 0H
Maldague, X. P. V., 0G
Marczak, J., 0W
Mariotti, P. I., 0I, 0Y
Markiewicz, Jakub S., 0V
Martos-Leviv, Dominique, 0K, 0L
Masiero, Andrea, 0X
Mavili, Gurcan, 03
Melis, Marcello, 0K
Miccoli, Matteo, 0K
Mouhoubi, K., 0L
Nowak, Tomasz P., 0C
Ogjen, J., 0L
Osten, W., 0Q
Pampaloni, E., 0Y
Papadakis, V. M., 08
Parisotto, S., 0I
Pawelko, R., 0T
Pedrini, G., 0Q
Pezzati, L., 0Y
Picollo, Marcello, 0P
Pintus, R., 0B
Piroffi, Francesco, 0X
Radis, Michela, 0J, 0N
Raffaelli, M., 0Y
Reghelin, C., 0B
Rossi, Giuseppe, 0N
Rovetta, Tommaso, 0H
Sarzynski, A., 0W
Sereni, Barbara, 0P
Serio, B., 0T
Sferra, S., 0G
Skrzeczanski, W., 0W
Spring, M., 05
Striova, J., 0Y
Strzelec, M., 0W
Tokurakawa, M., 05
Tornari, Vivi, 0L, 0R

Trichereau, B., 0L
Tsigarida, Nota, 0R
Uguryol, Mehmet, 03
Vernier, P., 0M
Vettore, Antonio, 0X
Villafana, Tana Elizabeth, 09
Walker, Gillian, 0K, 0L
Wang, X., 0T
Warren, Warren S., 09
Yaman, Çefin, 03
Zasada, D., 0W
Zatorska, A., 0W
Zawieska, Dorota, 0V

Conference Committee

Symposium Chairs

Wolfgang Osten, Universität Stuttgart (Germany)
Gunther Notni, Fraunhofer-Institut für Angewandte Optik und
Feinmechanik IOF (Germany)
Andrew J. Moore, Heriot-Watt University (United Kingdom)

Conference Chairs

Luca Pezzati, Istituto Nazionale di Ottica (Italy)
Piotr Targowski, Nicolaus Copernicus University (Poland)

Conference Program Committee

Dario Ambrosini, Università degli Studi dell'Aquila (Italy)
John F. Asmus, University of California, San Diego (United States)
Brunetto Giovanni Brunetti, Università degli Studi di Perugia (Italy)
Marta Castillejo, Consejo Superior de Investigaciones Científicas
(Spain)
Alberto de Tagle, Netherlands Institute for Cultural Heritage
(Netherlands)
John K. Delaney, National Gallery of Art (United States)
Raffaella E. M. Fontana, Istituto Nazionale di Ottica (Italy)
Roger Groves, Technische University Delft (Netherlands)
Igor P. Gurov, National Research University of Information
Technologies, Mechanics and Optics (Russian Federation)
Alexander J. Kossolapov, State Hermitage Museum
(Russian Federation)
Haida Liang, Nottingham Trent University (United Kingdom)
Nicola Masini, Consiglio Nazionale delle Ricerche (Italy)
David R. Saunders, The British Museum (United Kingdom)
Robert Sitnik, Warsaw University of Technology (Poland)
Heike Stege, Doerner Institut (Germany)
Vivi Tornari, Foundation for Research and Technology-Hellas
(Greece)

Session Chairs

- 1 New Methods and Applications for Restoration
Piotr Targowski, Nicolaus Copernicus University (Poland)

- 2 Stratigraphics and Depth-resolved Methods
Luca Pezzati, Istituto Nazionale di Ottica (Italy)
- 3 3D Imaging, Scanning, Topography and Tomography
Marta Castillejo, Consejo Superior de Investigaciones Científicas (Spain)
- 4 Image Processing and Other Digital Data Processing Methods for Optics
Roger M. Groves, Technische University Delft (Netherlands)
- 5 Integrated Techniques and Case Studies
Vivi Tornari, Foundation for Research and Technology-Hellas (Greece)
- 6 Imaging and Multimodal Imaging
Haida Liang, Nottingham Trent University (United Kingdom)