

The 'health record' of the church of Santa Maria Assunta in Pontecurone: contamination between historical knowledge and non-destructive testing results

*Original*

The 'health record' of the church of Santa Maria Assunta in Pontecurone: contamination between historical knowledge and non-destructive testing results / Beltramo, Giulia; Naretto, Monica; Volinia, Monica. - STAMPA. - 15:(2023), pp. 153-158. (Intervento presentato al convegno AIPnD art'23 - 14th International Conference on non-destructive investigations and microanalysis for the diagnostics and conservation of cultural and environmental heritage tenutosi a Brescia (IT) nel 2023, November 28th/30th).

*Availability:*

This version is available at: 11583/2984466 since: 2023-12-12T11:12:29Z

*Publisher:*

WriteUp Books

*Published*

DOI:

*Terms of use:*

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

*Publisher copyright*

(Article begins on next page)

# Proceedings of AIPnD art'23

*14<sup>th</sup> International Conference on non-destructive investigations and microanalysis  
for the diagnostics and conservation of cultural and environmental heritage*

*Brescia (Italy) - 2023, November 28<sup>th</sup>/30<sup>th</sup>*

**edited by Monica Volinia, Antonello Tamburrino**



15

CULTURAL  
HERITAGE



Series of History, Analysis,  
Conservation, Valorisation  
of the Cultural Heritage

Direttore scientifico / Editor in chief  
Emanuele Romeo

Comitato scientifico / Editorial Board

Paolo Cornaglia  
Başak Ipekoğlu  
Manuela Mattone  
Emanuele Morezzi  
Monica Naretto  
Zsusanna Ordasi  
José Ramón Ruiz-Checa  
Riccardo Rudiero  
Valentina Russo  
Arnaud Timbert  
Grazia Tucci

Comitato di redazione / Editorial Staff

Giulia Beltramo  
Valentina Bonora  
Giovanna Ceniccola  
Antonietta Cerrato  
Stefania Pollone  
Tommaso Vagnarelli  
Maurizio Villata



Series of History, Analysis,  
Conservation, Valorisation  
of the Cultural Heritage

The Series Cultural Heritage collects scientific contributions concerning the protection, the restoration, the enhancement and the management of Cultural Heritage both in general and in specific aspects. This purpose is pursued through both theoretical and operational contributions about the knowledge of cultural heritage, able to propose conservation and valorization actions, to suggest management strategies, and recommend adequate dissemination channels. The series collects essays on landscape and urban structures; on historic gardens and parks; on the archaeological heritage and on that which has been reduced to a state of ruin; on historical architecture and that belonging to the so-called "modern movement"; on the widespread heritage with traditional characteristics (rural, mountainous, vernacular).

On the cover:  
Brescia Cathedral, picture by AIPnD ETS©

Proceedings of AIPnD **art'23**  
*14<sup>th</sup> International Conference on non-destructive investigations and microanalysis  
for the diagnostics and conservation of cultural and environmental heritage*  
Brescia (Italy) - 2023, November 28<sup>th</sup>/30<sup>th</sup>

edited by  
**Monica Volinia, Antonello Tamburrino**



Organized by

AIPnD ETS - Associazione Italiana Prove non Distruttive Monitoraggio Diagnostica e Laboratori di Prova - Ente del Terzo Settore

Via Corfù, 48 | 25124 BRESCIA  
tel. +39 030 373 9173  
segreteria@aipnd.it  
www.aipnd.it

Copyright WriteUp Books© 2023

www.writeupbooks.com  
scientifica@writeupbooks.com

via Michele di Lando, 77  
00162 Roma

ISBN 979-12-5544-031-4

*No part of this book may be reproduced in any form, by print, photoprint, microfilm, microfiche, or any other means, without written permission from the Publisher.*

1st edition: November 2023



CC 4.0 International  
Attribution-Non Commercial-  
No Derivatives





**AIPnD**

AIPnD ETS - Italian Society for non-Destructive Testing

# art'23

Proceedings of AIPnD art'23

*14<sup>th</sup> International Conference on non-destructive investigations and microanalysis*

*for the diagnostics and conservation of cultural and environmental heritage*

Brescia (Italy) - 2023, November 28<sup>th</sup>/30<sup>th</sup>



**BERGAMO  
BRESCIA**  
Capitale Italiana  
della Cultura



PARTNER ISTITUZIONALE



MAIN PARTNER

INTESA  SANPAOLO



PARTNER DI EDIZIONE



PARTNER DI AREA



Technical Sponsor



IMAGING THE FUTURE SINCE 1947

Gold Sponsors



Sponsor



Media Partner



Organized in cooperation with



Under the patronage of



International Council for Monuments and Sites



ACADEMIA NDT International



Argentine Society for NDT



Italian National Agency for New Technologies,  
Energy and Sustainable Economic Development



International Restoration Trade Show



Italian Coordination Center  
for Non-Destructive Testing



## Honour Committee

**Ezio Tuberosa**

AIPnD President  
IREN Energia

**Giuseppe Nardoni**

AIPnD Honorary President - I&T Nardoni Institute Srl  
Academia NDT International

**Laura Castelletti**

Mayor of the City of Brescia

**Francesco Castelli**

Chancellor of the University of Brescia

**Francesca Bazoli**

Fondazione Brescia Musei, President of Governing Board

**Stefano Karadjov**

Fondazione Brescia Musei, Director

**Fermín Gómez Fraile**

EFNDT President

**Peter Trampus**

Professor Emeritus - Academia NDT International, President

**David Gilbert**

CEO, BINDT  
General Secretary, ICNDT; Comms Secretary & BoD Member, EFNDT  
Council Member NDT Academia International

**Roman Maev**

University Distinguished Physics Professor, University of Windsor, Canada  
and ICNDT: Art Analysis Chair  
Council, Fellow, Academia NDT International

**César Belinco**

AAENDE - Asociación Argentina de Ensayos no Destructivos y Estructurales  
CNEA - Comisión Nacional de Energía Atómica

**Bento Ottone Alves**

Associação de Laboratórios Acreditados de Portugal  
RELACRE

## Organizing Committee

**Marco Giachino**

AIPnD Board Member  
N.D.E. CONTROL srl

**Monica Volinia**

AIPnD Board Member  
AIPnD Study Commission on CH  
Politecnico di Torino, DAD

**Dario Foppoli**

Coordinator of AIPnD Study Commission on CH  
Technical Director Foppoli Moretta e  
Associati srl

**Aldo Canova**

AIPnD General Secretary  
Politecnico di Torino

**Antonello Tamburrino**

AIPnD Scientific Council President  
Università di Cassino e del Lazio Meridionale

**Michael Reggiani**

AIPnD Vice-President  
CICPND, General Manager

## Scientific Committee

### **Affum Hannah**

IAEA - International Atomic Energy Agency (Austria)

### **Alami Rachad**

CNESTEN - Centre National de l'Énergie, des Sciences et des Techniques Nucléaires (Morocco)

### **Bison Paolo**

ITC-CNR Istituto per le tecnologie della costruzione sede di Padova (Italy)

### **Calicchia Paola**

CNR - INM Istituto di Ingegneria del mare (Italy)

### **Calmon Pierre**

COFREND Confédération Française pour les Essais Non Destructifs (France)

### **Cappabianca Claudio**

AIPnD Study Commission on Cultural Heritage - AIPnD Board Member (Italy)

### **Cardinali Michela**

CCR Fondazione Centro Conservazione e Restauro dei Beni Culturali «La Venaria Reale» (Italy)

### **Coli Massimo**

Università degli Studi di Firenze, Dipartimento di Scienze della Terra (Italy)

### **Daffra Emanuela**

Polo Museale della Lombardia, MiC (Italy)

### **Di Martino Daniela**

Università degli Studi di Milano Bicocca, Dipartimento di Fisica (Italy)

### **Domato Abel Jayo**

SOCOTEC (Spain)

### **Foppoli Dario**

Coordinator of AIPnD Study Commission on Cultural Heritage  
Technical Director Foppoli Moretta e Associati srl (Italy)

### **Frosinini Cecilia**

Opificio delle Pietre Dure (Italy)

### **Fukunaga Kaori**

NICT - National Institute of Information and Communications Technology (Japan)

### **Koren Zvi**

The Edelstein Center for the Analysis of Ancient Artifacts,  
Shenkar College of Engineering, Design and Art - Department of Chemical Engineering (Israel)

### **Laprida Sebastián**

SL Ingeniería SA (Argentina)

### **Maghella Seminario Gerardo**

IAEA - International Atomic Energy Agency (Austria)

### **Orero Gabriela**

Universidad de Buenos Aires, Facultad de Arquitectura Diseño y Urbanismo (Argentina)

### **Poisson Olivier**

Conservateur Général du Patrimoine Honoraire (France)

### **Ridl Rosa María**

Universidad de Buenos Aires, Facultad de Arquitectura Diseño y Urbanismo (Argentina)

### **Ridolfi Stefano**

Sapienza - Università di Roma (Italy)

### **Rosina Elisabetta**

Politecnico di Milano, Dipartimento di Architettura, Ingegneria delle Costruzioni e Ambiente Costruito (Italy)

### **Rossi Sandra**

Opificio delle Pietre Dure (Italy)

### **Salonia Paolo**

ICOMOS Italia Consiglio Internazionale per i Monumenti e i Siti (Italy)

### **Serrano Jesús**

AEND Asociación Española de Ensayos No Destructivos (Spain)

### **Volinia Monica**

AIPnD Study Commission on Cultural Heritage - AIPnD Board Member  
Politecnico di Torino, Dipartimento Architettura e Design (Italy)

### **Xargay Hernán**

CNEA Comisión Nacional de Energía Atómica (Argentina)

## **art** Past editions

**1983** Roma (Italy)

**1988** Perugia (Italy)

**1992** Viterbo (Italy)

**1994** Berlin (Germany)

**1996** Budapest (Hungary)

**1999** Roma (Italy)

**2002** Antwerp (Belgium)

**2005** Lecce (Italy)

**2008** Jerusalem (Israel)

**2011** Firenze (Italy)

**2014** Madrid (Spain)

**2017** Torino (Italy)

**2021** Buenos Aires (Argentina)

## Table of contents

<i>Introduction</i> E. Romeo	17	<b>Technical Sponsor Lecture</b>
<i>President's Greetings</i> E. Tuberosa	21	<i>Recent developments in X-ray imaging applied to Cultural Heritage</i> E. Elia, D. Baratto
<b>Plenary Lectures</b>		
<i>The Winged Victory of Brescia. History, research and enhancement of a great roman bronze</i> F. Morandini	25	<i>Infrared Imaging Analysis for in-situ inspection of a work of art: combined SWIR-MWIR methods for a painting on wood investigation</i> M. Rippa, M. Casciello, P. Mormile, B. Balbi, S. Vitulli, M. R. Vigorito
<i>The role of scientific investigation in the conservation project of the Winged Victory of Brescia</i> A. Cagnini, M. Galeotti, A. Patera, S. Porcinai	31	<i>GPR investigation on the Saint John Baptistery at Florence, Italy</i> M. Coli, A. L. Ciuffreda, E. Marchetti, A. Napoli, B. Agostini, P. Papeschi, D. Morandi
<i>Nuclear Analysis of the Shroud of Turin</i> R. A. Rucker	37	<i>Infrared inspection of WW2 camouflage German helmets</i> A. Salerno, C. Colombo
<i>"Difficult" archives for "difficult" heritage conservation: applied value of 20<sup>th</sup> c. project documentation. On the materials of the Wolfsonian-Genoa Collection</i> A. Vyazemtseva	43	<i>Density estimation of historical wooden elements through means of thermographic correlation approach</i> L. Santoro, V. Borghese, S. Santini, R. Sesana, F. Curà, L. Corsaro
<i>Notre-Dame de Paris et sa restauration au XIX<sup>e</sup> siècle</i> O. Poisson	49	
		59
		<b>Part One - Non-destructive testing in Cultural Heritage</b>
		67
		73
		79
		85

<i>Study of the dynamic behaviour of a timber altarpiece using Laser Vibrometers</i> E. S. Saeed, M. Simonetta, M. Benedetti, O. Niglio, F. Graziotti, G. Giuliani	91	<i>From historic wind instruments to modern copies to rediscover ancient sounds</i> F. Tansella, L. Vigorelli, G. Ricchiardi, A. Re, L. Bonizzoni, S. Grassini, M. Staropoli, A. Lo Giudice	129
<i>Observation of the internal structure of gilded and multilayered paintings by using THz Pulsed Time Domain Imaging and Pulsed Phase Thermography</i> K. Fukunaga, Y. Ueno	97	<i>Advanced system for Frequency Resolved Acoustic Imaging for on-site investigations of Cultural Heritage: an example of public-private partnership (PPP) of centers of excellence</i> P. Calicchia, F. Colao, P. Tassin, S. Mingarelli	135
<i>Engineering Archaeological Research: submillimetric X-Ray CT Scan of metal and hard stone objects in ancient Egyptian Mummies</i> S. Galli, L. Limena, C. Rossi, M. Carboni	103	<i>NDT of fine Renaissance manufactures via on site X-Ray Diffraction</i> G. Berti	141
<i>Diagnostic campaign to assess the seismic vulnerability of the Castello Scaligero of Sirmione in Italy</i> D. Foppoli, M. Bellanova, S. Zanzani	109	<i>Contact angle as a non-destructive method to determine wettability changes induced by sub-aerial biofilms on built heritage porous substrates</i> L. Berti, F. Villa, F. Cappitelli, S. Napoli, A. Barbieri, L. Toniolo, D. Gulotta, S. Goidanich	147
<i>Non-invasive and micro-invasive investigations applied to large paintings. The case of the frescoed ceiling by Anton Raphael Mengs in Sant'Eusebio in Rome</i> S. Ridolfi, R. Porfiri, I. Carocci	115	<i>The 'health record' of the church of Santa Maria Assunta in Pontecurone: contamination between historical knowledge and non-destructive testing results</i> G. Beltramo, M. Naretto, M. Volinia	153
<i>Glass-gems Exploration by Multidisciplinary Methods, Analyses and Experiments: the GEMMAE project</i> D. Di Martino, E. Gagetti, G. Marucci, M. P. Riccardi	119	<i>Italy-Switzerland Interreg Project shares methodologies for knowledge of Cultural Heritage</i> P. Clementi, M. C. Giangregorio, V. Caspani, E. Zanolari, D. Foppoli	159
<i>Non-invasive and micro-invasive investigations on Cultural Heritage to support the modern training of restorers. The case of the Scientific Laboratories of the Istituto Restauro Roma</i> S. Ridolfi, S. Insogna, T. Rinaldi, R. Luciani	125	<i>Knowledge coordination tool for the conservation of the church of Sant'Agata</i> A. Paneroni, D. Foppoli, B. Scala, M. Andreoli	165



<i>X-Ray analysis of Winged Victory</i> M. Lauriola, T. Radelet	171	G. Cadelano, N. Stecchetti, P. Bison, A. Bortolin, G. Ferrarini, S. Rossi	219
<i>Comparison of radiographic techniques for Cultural Heritage</i> M. Lauriola	177	<b>Part Two - Microanalysis and Conservation of Cultural Heritage</b>	
<i>Application of Virtual Wave thermography for the inspection of paintings</i> R. Zito, S. Laureti, M. Ricci	183	<i>The frescoes of the Novalesa abbey complex, from restoration to preventive conservation through non-destructive diagnostics</i> M. C. Capua, G. Rollo, M. Volinia, M. Girotto, M. Di Salvo, L. Garavoglia, F. Perossini	227
<i>Inspection and documentation of the condition of historic timber structures</i> F. Rinn	189	<i>3D Printing of architectural elements of Cultural Heritage using Fiber-Reinforced Mortar: a novel approach for rehabilitation and conservation</i> D. Ungureanu, C. Onuțu, N. Țăranu, D. A. Ghiga	233
<i>The potential of Thermal Quasi-Reflectography to advance the Non-Destructive Testing image-based protocol in Cultural Heritage</i> C. Daffara	195	<i>Converting an industrial hall into a Museum of Industrial Archeology: approaches and plans for the transformation of 'The Tobacco Storehouse' in Iași, Romania</i> D. A. Ghiga, D. Ungureanu, C. Onuțu, E. Antohie, I. A. Spiridon, N. Iftime, N. Țăranu	239
<i>A fast procedure for the assessment of historical floor timber beams in presence of pictorial decoration</i> G. Cardani, M. Cucchi, C. Tiraboschi	201	<b>Part three - Monitoring of Cultural Heritage</b>	
<i>Masonry dome spandrels in an early 16<sup>th</sup> century church in Piacenza: non-destructive approach by inspection and infrared thermography</i> C. Colla	207	<i>The microclimates unbalance of subterranean historic spaces in Italy</i> E. Rosina, M. Zala	247
<i>Detecting masonry types in historical buildings by infrared thermography and the case of Maria Luigia's theater in Piacenza</i> C. Colla	213	<i>Aerial thermography applications for energy conservation and retrofit of urban heritage</i> S. Anselmo, M. Ferrara, P. Boccardo, S. P. Corgnati	253
<i>Thermal evaluation of envelope materials in historical buildings through Non-Destructive thermographic Moisture Analysis</i>			

<i>Precettoria of Sant'Antonio di Ranverso, an integrated approach for the study and monitoring of the Jaquerian painting cycles. The process for the definition, implementation and verification of conservation strategies</i> A. Bovero, M.-C. Canepa, M. Cardinali, S. De Blasi, M. Girotto, M. Nervo, A. Piccirillo, M. Volinia	259	<i>Scientific analyses for preservation and restoration of XIII – XV century stained glasses</i> G. Maino, D. Biagi Maino	297
<i>Some data about traditional Venetian building materials characteristics</i> E. Guolo, L. Scappin, P. Bison, F. Peron	265	<i>Evaluation of the porosity of natural and artificial stones by Infrared Thermography</i> P. Bison, M. Volinia, G. Ferrarini, G. Cadelano, M. Gomez Serito, M. Girotto, F. Peron, E. Guolo	303
<i>Non-destructive monitoring as a methodological approach for the conservation of cultural heritage: 10 years of studies on the Chapel of Sant'Eldrado</i> M. Volinia, M. Girotto	271	<i>Some data about rising damp from 30 years of analysis in Venetian buildings</i> E. Guolo, P. Bison, F. Peron	309
<i>Digital Twin Environment for data integration of ICT technological services in Cultural Heritage field</i> M. Mongelli, S. Pierattini	277	<i>What medical imaging has to offer in art conservation</i> C. Hopper	315
<b>Part four - Environmental Control and Protection</b>			
<i>The moisture issue affecting the historical buildings in the Alps region</i> E. Rosina, M. Zala, A. Ammendola	285		
<i>Analysing objects to produce more sustainable conservation environments</i> D. Thickett, A. Melinis, C. S. Cheung, H. Lang	291		

# Introduction

---

Emanuele Romeo\*

Politecnico di Torino, Italy

\*Editor in chief of the series Cultural Heritage

The series Cultural Heritage collects scientific contributions concerning the protection, the restoration, the enhancement and the management of Cultural Heritage – with a focus on architectural and landscape heritage – both in general and in specific aspects. Theoretical and methodological books alternate research ones, more pertinent to the practical sphere, i.e. regarding conservation and enhancement actions. Further goal of the series is to suggest prevention and maintenance strategies, even through proper channels of dissemination.

The AIPnD ETS - Italian Society for Non-destructive Testing by deciding to publish the proceedings of *art'23 - 14th International Conference on non-destructive investigations and microanalysis for the diagnostics and conservation of cultural and environmental heritage*, enriches the series of new knowledge, providing readers, researchers, scholars with interesting insights into the value, above all material, of architectural heritage.

The publication of the proceedings represents a new specific field until now never dealt with in this series, bringing out strongly the need, if we talk about cultural heritage, to work through the cooperation of different disciplines and different actors: universities, research institutions, specialized companies, professionals, who work together to the preservation of the Heritage, by proposing innovative prevention actions aimed at a more compatible management than in past decades.

The first conference, organized by AIPnD held in 1983, was the result of the far-sighted vision of Giuseppe Nardoni, who wanted to broaden the Association's fields of interest just to include further actors than industry. Since then, the conferences have become even more international, held every 3 years and itinerant, as shown by the last edition in Argentina. This year, a lucky coincidence, art'23 will take place in Italy, and in particular in Brescia, city birthplace of AIPnD and, together with the city of Bergamo, the Italian Capital of Culture 2023.

The Conference and all the contributes in this volume attest the international nature of the event, thanks to the presence of high profiled scientific and organizing committees, of universities and research institutes, but also a connection with the guest country, Italy, due to the sponsors and to the honor committee.

The volume opens with the greetings of President Ezio Tuberosa followed by five Plenary Lectures offering an overview of research on assets with high artistic and historical value in specific territorial realities such as Brescia, Turin, Genoa and Paris, and a Technical Sponsor Lecture on the state of the art and development of radiographic techniques, aimed at the conservation of cultural heritage.

The book is composed by four different sections, and each section concerns Cultural Heritage in the broadest meaning of the expression, i.e. applications on both movable and immovable assets: Non-destructive Testing in Cultural Heritage; Microanalysis and Conservation of Cultural Heritage; Monitoring of Cultural Heritage; Environmental Control and Protection.

The authors of the contributes belong both to research institutions (University, Enea, CNR) but also to companies operating in both public and private field: this represents the significant and innovative multidisciplinary AIPnD way of researching and working. Thus, an interesting international comparison emerges as the result of a combination of academic and practical research, without neglecting specific case studies related to contingent experiences and sites. The cross-reading

of the essays highlights the spillovers that scientific and academic activities have in the operational field, where, for example, evidence that what has not yet been standardized is employed through protocols increasingly channeled within scientific boundaries, even if sometimes dissonant from market needs.

The interdisciplinary perspective is ensured by the presence of different knowledge and skills all aimed at the experimentation and application of techniques and technologies at the service of Cultural Heritage; while the international panorama of studies and research increasingly enriches the field of diagnostic investigations with new experiences, through specific protocols of understanding between research bodies and territorial realities.

And, in addition to these protocols, there are the educational spin-offs: from Bachelor's and Master's degree courses in the Faculties of Architecture and Engineering, to Level III courses and Master's degrees, without neglecting the collaboration with public and private educational and research bodies operating in the same territory.

In fact, AIPnD ETS (founded in 1979) is a nonprofit scientific, cultural and professional organization; and the promotion of scientific and technical knowledge and technological development of non-destructive testing is one of the main purposes of the Association, which is realized through dissemination activities, creation of educational materials, training courses in view of the certification examinations, required and/or necessary to operate in certain fields and, specifically, in the field of Cultural Heritage.

As an example, I would like to cite the Laboratory of non-Destructive Diagnostics (founded in 1992) of the Politecnico di Torino, one of the main actors of the art'23 Conference. The Laboratory purpose is the knowledge of the architectural and environmental heritage in its technological and technical aspects, through the use of non-destructive investigation techniques including infrared thermography, endoscopy and resistography, used for the analysis of the state of conservation and the search for defects or alterations “under the skin”, or not detectable at a direct visual analysis.

I would like to conclude by saying that the authoritativeness of the organizers and of the editors (Monica Volinia, Marco Giachino, Dario Foppoli and Antonello Tamburrino) has granted

the high profile of this book, while the specific skills of all the contributors have enriched the scientific community with new insights into the cultural and material value of architectural, historical, artistic and environmental heritage, by contributing fully and correctly to the dissemination of the research carried out and the results obtained. Mission, this, which for years has been the main objective of the Cultural Heritage series, also thanks to the attention of WriteUp Publishing House in choosing and selecting which studies and research to publish, together with the Scientific Board.



## President's Greetings

---

Ezio Tuberosa

President of AIPnD ETS - Italian Society for non-Destructive Testing



Welcome to the 14<sup>th</sup> art'23 Conference in Brescia.

Italy is the so called “Belpaese”, preserving an unparalleled cultural heritage: in spite of this, it was not easy to choose the conference venue - but in 2023 Brescia and Bergamo are the Italian Capitals of Culture, so here we are.

Art in its broadest meaning covers every human activity, carried out individually or collectively, leading to forms of creativity and expression that are based on technical devices, innate or acquired skills and behavioral norms deriving from study and experience.

Therefore, art is a language, that is, the ability to transmit emotions and messages. However, there is no single artistic language nor a single unequivocal code of interpretation, nor even a term equivalent to “art” exists in most spoken languages.

In its most sublime meaning, art is the aesthetic expression of interiority and of the human soul. It reflects the opinions, the feelings and the thoughts of the artist in the social, moral, cultural, ethical or religious context of his/her historical period.

Art can also be considered a profession of ancient tradition, carried out in observance of a few rules, even if requiring a lot of love for what is created. Today art is widely considered as way to universal communication, and therefore can be the means to transmit a message of equality and peace among peoples: nothing further, unfortunately, from what is happening now in the world.

Thanks, so, to all the “professionals”, to all the “experts”, to all the “lovers” of this wonderful and indecipherable word “ART”, and thanks to the Italian Association of non-Destructive Testing, to the whole Board, who have made it possible to create yet another this wonderful event once again.

*Benvenuti a Brescia alla 14° Conferenza di art'23.  
L'Italia, il “Belpaese” che conserva un patrimonio culturale senza eguali, non ha facilitato la scelta della sede della conferenza, ma quest'anno Brescia e Bergamo sono le Capitali Italiane della Cultura, allora eccoci qui.*

*L'arte nel suo significato più ampio copre ogni attività umana, svolta singolarmente o collettivamente, porta a forme di creatività e di espressione che poggiano su accorgimenti tecnici, abilità innate o acquisite e norme comportamentali derivanti dallo studio e dall'esperienza.*

*Pertanto, l'arte è un linguaggio, ossia la capacità di trasmettere emozioni e messaggi. Tuttavia non esiste un unico linguaggio artistico e neppure un unico codice inequivocabile di interpretazione, addirittura non esiste neppure un termine equivalente ad "arte" nella maggior parte delle lingue parlate.*

*Nel suo significato più sublime l'arte è l'espressione estetica dell'interiorità e dell'animo umano. Rispecchia le opinioni, i sentimenti e i pensieri dell'artista nell'ambito sociale, morale, culturale, etico o religioso del suo periodo storico.*

*L'arte può essere considerata anche una professione di antica tradizione svolta nell'osservanza di poche regole ma richiedente tanto Amore per quello che si crea. Ma l'arte è spesso una forma di comunicazione universale e pertanto può essere il tramite per trasmettere un messaggio di uguaglianza e di pace tra i popoli, nulla di più lontano, purtroppo, da quanto sta accadendo ora nel mondo.*

*Grazie, allora a tutti i "professionisti" a tutti gli "esperti" a tutti gli "amanti" di questa meravigliosa e indecifrabile parola "ART", grazie anche all'Associazione Italiana delle prove non Distruttive e a tutto il Board, che hanno permesso di realizzare ancora una volta questa meravigliosa manifestazione.*



# The ‘health record’ of the church of Santa Maria Assunta in Pontecurone: contamination between historical knowledge and non-destructive testing results

---

Giulia Beltramo, Monica Naretto, Monica Volinia

Politecnico di Torino, Department of Architecture and Design, Italy

## ABSTRACT

The historical architecture of the church of Santa Maria Assunta in Pontecurone (Alessandria, Italy), of late medieval origins and with significant transformations until the 20<sup>th</sup> century, is a clear palimpsest of different construction and decorative phases. Nowadays, although used as a parish church, it shows a critical framework of alterations. The need to best rearrange the data in preparation for a wished restoration program required the involvement of a team of experts from the Politecnico di Torino – as members of a protocol agreement – to verify the current state of conservation of the building.

Between 2019 and 2022, the study focused on examining rich but dispersed and fragmented historical sources, which provided important information for the knowledge of architectural components. In the meantime, an NDT diagnostic campaign to understand non-visible phenomena and structural problems was carried out. In particular, infrared thermography allowed the comprehension of the vaulted systems laying, the mapping of fissures and the reading of the stains caused by infiltration and rising dampness. Moreover, thanks to an innovative application of this technique, it was possible to evaluate the heating system's effectiveness through the survey of the distribution of hot air flows in the room context and on the surfaces. Instead, endoscopic inspections revealed the stratigraphy under the floor level, which is completely damaged, and resistograph analysis verified the quality of the antique roof trusses at some significant points.

The contribution will deal in detail with the systematization of the data in the health record, a tool already tested in other contexts (such as at Chambord Castle, to which this project refers) that can be constantly implemented and easily consulted. Furthermore, it easily communicates and records the knowledge about the building, relating historical information with results obtained from the application of non-destructive testing.

**KEYWORDS:** church of Santa Maria Assunta in Pontecurone, cultural heritage, NDT, health record, building conservation, infrared thermography.

## Methodological foreword. The 'health record' as a knowledge management tool

In the field of restoration, the conservation process of cultural heritage requires a good knowledge of the materials and the history of monuments and sites. For this reason, the approach we are going to explain in this paper, referring to the experience of the church of Santa Maria Assunta in Pontecurone<sup>1</sup> (Fig. 1), represents a method that can be suitable to systematise all the data about the building in light of a hoped restoration programme. Moreover, the development of the several steps of the study is also an example of collaboration between territorial public bodies and scientific experts that work together<sup>2</sup> to discover and highlight the pathologies and problems of the stratified palimpsest. It is urgent to underline that investing in cultural heritage as a promotional factor also means investing in knowledge and detecting complex situations that require planned monitoring and intervention to prevent the development of decay and the irreversible loss of material testimonies<sup>3</sup>. With this aim, the results of all previous studies and campaigns about the church, even if carried out with different methods, have been catalogued, translated and made available in a synoptic and implementable database, here called the 'health record', thanks to which it is possible to define the state of conservation and the priorities for safeguarding the building.

## The case study between historical information and restoration yards

The 'health record' information system arises from the assumption that any new operation on cultural heritage should be profitably based also on its previous conservation history. For this reason, between 2019 and 2022, the research focused on the dispersed and fragmented historical sources, which provided important

information for the knowledge of architectural components and previous restoration yards.

In short, the church of Santa Maria Assunta is a clear palimpsest of several construction and decorative phases: it was built around 1175<sup>4</sup> and it revealed subsequent and significant transformations<sup>5</sup> unraveled up to the 20<sup>th</sup> century, when a series of interventions were achieved with the aim of structural consolidation, conservation of the architectural organism and the preservation of interior decoration (Fig. 2). The analysis of these restoration yards constitutes the heart of the research because they offer the possibility of identifying returning problems and operational interventions that have already proved effective on the building. Chronologically, between 1925 and 1929, the church was closed to the public due to static problems, so the first structural monitoring was carried out to determine the importance of the overturning phenomena, which led to the installation of a steel beam at the extrados of the nave to which chains were anchored to stop the façade from overturning<sup>6</sup>. On the same occasion, a restoration of the roof took place, with the replacement of some wooden elements and tiles and the installation of new channels for collecting rainwater. In the 1930s, the external plinth was rebuilt entirely to protect the masonry from dampness<sup>7</sup>, the existing single-lancet windows were restored, the 18<sup>th</sup> century semicircular windows were closed and new windows were opened on the façade and the side elevations.

Subsequently, documents attest to the work on the bell tower, the insertion of chains in the naves and extraordinary maintenance works on the roof between 1974 and 1977. In 1979, the problem of dampness was again evident, so a ventilation space with vents along the perimeter walls was built in an attempt to restore the perimeter masonry from rising damp. Finally, the last structural intervention dates back to 1982: it involved the construction of reinforced concrete beams along the perimeter walls and the chaining of perimeter walls and arches of the minor naves with metal tie rods.



Fig. 1 The façade and the South-East flank of the church of Santa Maria Assunta in Pontecurone (2022).

### NDT diagnostic campaign

In addition to traditional disciplinary knowledge, competence regarding new tools for diagnostic investigation nowadays occupies a central role in the definition of the conservation program on the built heritage. The restoration project, in addition to the traditional knowledge campaign, the historical study of the sources, and the architectural and decay survey, cannot ignore tests and analyses in advance of the choices of intervention, which allow for in-depth analysis of the state of conservation, in particular where visual examination and the study of archival sources don't provide suitable results<sup>8</sup>.

In this case study, the NDT campaigns were conducted in 2020-2021 using remote visual inspection, infrared thermography, and resistograph analysis, focusing on several issues: instability of the flooring, decay in masonry, and strength of the wooden beams of the roof system.

Endoscopic inspections were performed inside the disconnections in the cement tiles floor



Fig. 2 The chains in the left nave during the restoration yard of 1974-1977 (Parish Historical Archive).

and showed no cracks, bulges, or moisture on the bedding layer of the damaged tiles.

Thermographic acquisitions, conducted with protocols different (active or passive) depending on the objectives, made it possible to identify the textures of vaulted systems, locate cracks and plaster detachments (Fig. 3),

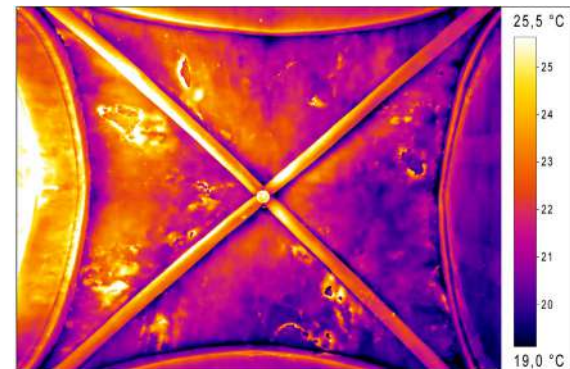


Fig. 3 Right side nave, 4<sup>th</sup> bay. Active IR scan: gaps and plaster detachments (February 24<sup>th</sup>, 2021).



and map evaporative fronts caused by infiltration from the roof and rising dampness. Since the evaporation front is subject to variations, the IR evaluation took place in different seasons and was correlated with the weather and microclimate data acquired over the whole period.

Resistographic testing was applied to a sample of three trusses out of the ten covering the nave to obtain a qualitative indication of the wood element's preservation state. Each truss was analyzed in the most structurally stressed sections. At the same time, the wood's surface moisture was measured using a penetration hygrometer. The results do not reveal any specific critical problems.

In addition to the more common aims of the NDT surveys, an experimental IRT campaign<sup>9</sup> was undertaken to verify the efficiency of the current heating system in the church<sup>10</sup>. On seven strips of cardboard that were fixed to the chains of the three naves and fixed to the floor, the superficial temperature distribution was evaluated over time following the heating (Fig. 4). This method allowed, at the same time, assessing the thermal comfort of the worshippers depending on their position (in space and standing or

sitting) and the thermal stress to which plaster and wooden furnishings are subjected, especially in the higher areas.

### The systematisation of data in the 'health record' as a critical working basis for conservation

As mentioned in the foreword, the study presented in this paper is part of a research program concerning the preliminary investigation of the church of Santa Maria Assunta conservation program. Referring to the debate on knowledge management processes and taking some case studies as examples<sup>11</sup>, the work focused on the definition of a tool that collects historical notes about construction, information about restoration yards carried out since the 19<sup>th</sup> century and the synthesis of the current state of alteration of the monument<sup>12</sup>. Often, in the operational context of restoration, it happens that data on the state of conservation, diagnostic investigations and previous interventions performed are in a fragmented

Fig. 4 Central nave: Infrared microclimate analysis. Scan at 1h45' after the start of heating (April 14<sup>th</sup>, 2021).

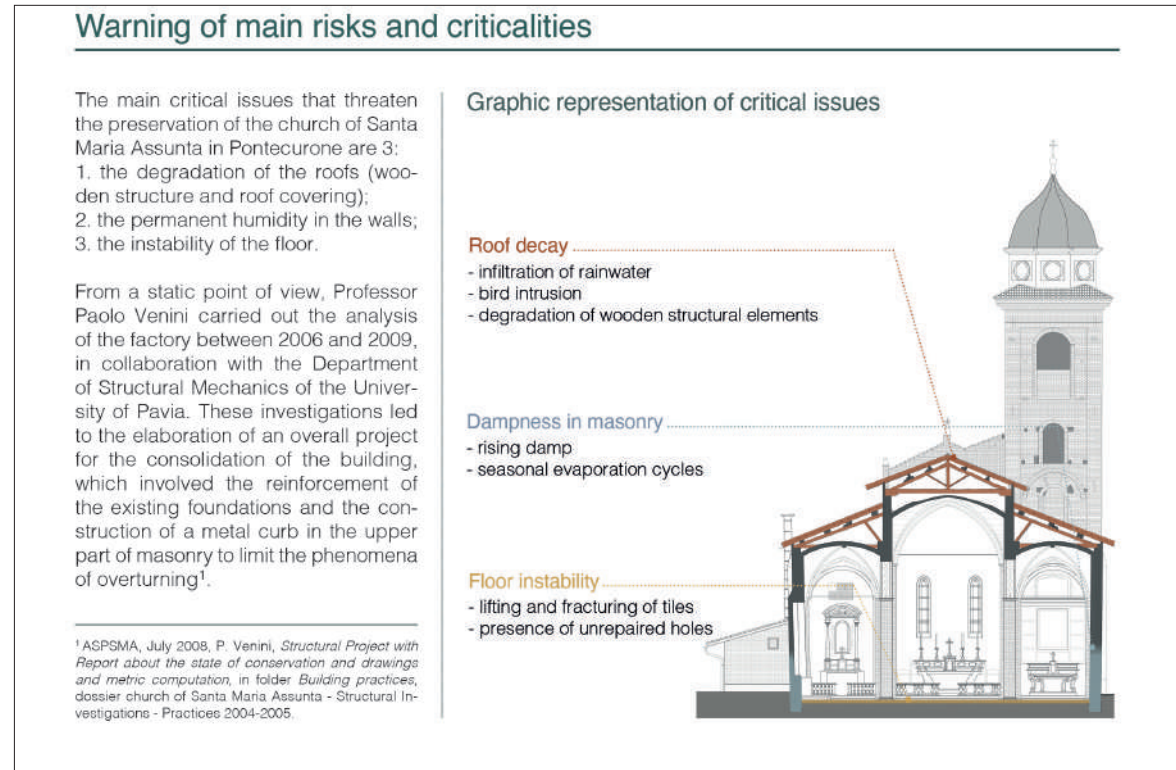


Fig. 5 The three main criticalities of the church summarised in the last section of the 'health record'.

and dispersed state as to be unusable. For this reason, the systematisation of all information is necessary to preserve experience and integrate historical research with the technical-scientific analysis from the diagnostic investigations. The whole of these fundamentals is the basis for the description of monument identity and for the development of its 'health record': a critical working basis essential for the definition of a preservation process, that becomes a precious database over time, also useful for the periodic monitoring of the health of the architecture<sup>13</sup>.

In the case of Santa Maria Assunta, the research tries to translate this theoretical reflection into a concrete tool that represents a process innovation and can be constant-

ly implemented and easily consulted, in which all the mentioned aspects, from historical analysis to the results of NDT diagnostic campaigns, are put together to offer a synoptic scientific reading of the monument and to underline its critical issues and main problems (Fig. 5).

## References

C. Bartolomucci, *Una proposta di 'cartella clinica' per la conservazione programmata*, in «Arkos. Scienza e restauro dell'architettura», n. 5, 2004, pp. 59-65.

A. Bianco, *On-site Diagnostics for architectural conserva-*

tion and restoration, Anchor Academic Publishing, Hamburg 2017, pp. 421-430.

S. Calò, G. Cavagnini, G.L. Liva, *'Cartella clinica': un sistema informativo per progettare la manutenzione del costruito*, in G. Biscontin, G. Driussi (eds), *Ripensare alla manutenzione: ricerche, progettazione, materiali, tecniche per la cura del costruito*, Conference Proceedings, Ed. Arcadia Ricerche, Venice 1999, pp. 291-294.

D. Camuffo, C. Bertolin, V. Fassina, *Microclimate monitoring in a Church*, in D. Camuffo, V. Fassina, J. Havermans (eds), *Basic environmental mechanisms affecting Cultural Heritage*, Nardini, Florence 2010.

C. Coccoli, B. Scala, *Vilminore di Scalve (BS): un piano di conservazione programmata*, in «ANANKE», n. 47, 2006, pp. 118-125.

E. Festuccia, M. Franco, *Diagnostica per la conservazione nella Chiesa Collegiata di Santa Maria Assunta a Pontecurone: letture, analisi, interpretazioni*, Master's Thesis in Architecture, Politecnico di Torino, tutores M. Naretto, M. Volinia, F. E. Lupo, Turin 2021.

D. Fiorani (edited by), *Restauro e tecnologie in architettura*, Carocci, Rome 2009.

P. Gasparoli, *Conservazione e Manutenzione programmata. Andare oltre le buone intenzioni*, in «Recupero e Conservazione», n. 173/174, 2023, pp. 54-61, 46-56.

S. Janvier-Badosa, K. Beck, X. Brunetaud, M. Al-Mukhtar, *Historical study of Chambord Castle: basis for Establishing the Monument Health Record*, in «International Journal of Architectural Heritage», n. 7/3, 2013, pp. 247-260.

G. P. Treccani, *Meglio curare che prevenire. Per una manutenzione del costruito modulata sul soggetto*, in «ANANKE», n. 47, 2006, pp. 110-117.

G. Vanni, *Verso il cantiere di conservazione della chiesa di Santa Maria Assunta in Pontecurone (AL): il libretto della salute come sistematizzazione critica della conoscenza*, Master's Thesis in Architecture, Politecnico di Torino, tutores M. Naretto, M. Volinia, G. Beltramo, Turin 2023.

## Notes

This paper is the result of the joint work of the authors. In particular, however, the foreword is shared, the section on the case study is written by Giulia Beltramo, the one on the NDT diagnostic campaign by Monica Volinia and the one on systematization of data in the 'health record' by Monica Naretto.

<sup>1</sup> Pontecurone is a town in the province of Alessandria, located in south-eastern Piedmont.

<sup>2</sup> In 2020 was activated a Protocol Agreement between researchers and technicians of Politecnico di Torino, the Diocese of Tortona, the Soprintendenza Archeologia Belle Arti e Paesaggio per le Province di Alessandria Asti e Cuneo, the Centro Conservazione e Restauro "La Venaria Reale" and the owner of the building.

<sup>3</sup> Gasparoli 2023.

<sup>4</sup> Year in which the first catalogue of the Diocese of Tortona parish churches attested its existence.

<sup>5</sup> Festuccia, Franco, 2021; Vanni, 2023.

<sup>6</sup> The same problem is still evident today: direct survey operations have revealed the overturning of the masonry on the main façade (Vanni, 2023).

<sup>7</sup> As in the previous note, the problem of dampness issue represents another analogy with current decay and the criticalities because it has required restoration work also in the past.

<sup>8</sup> Fiorani, 2009.

<sup>9</sup> Camuffo, Bertolin, Fassina, 2010.

<sup>10</sup> Air heating with vents located in the upper part of the presbytery and directed to the naves.

<sup>11</sup> Calò, Cavagnini, Riva 1999; Bartolomucci 2004; Coccoli, Scala 2006; Janvier-Badosa, Beck, Brunetaud, Al-Mukhtar 2013.

<sup>12</sup> The research about the Chambord Castel (Janvier-Badosa, Beck, Brunetaud, Al-Mukhtar 2013) is a significative reference for the development of the 'health record' of the church of Santa Maria Assunta in Pontecurone.

<sup>13</sup> Treccani 2006.

- 
1. *Riflessioni sulla conservazione del patrimonio archeologico*  
Emanuele Romeo, Emanuele Morezzi, Riccardo Rudiero
  2. *Che almeno ne resti il ricordo*  
Memoria, evocazione, conservazione dei beni architettonici e paesaggistici  
a cura di Emanuele Morezzi, Emanuele Romeo
  3. *Castelli canavesani*  
Temi di restauro e valorizzazione  
a cura di Carla Bartolozzi, Francesco Novelli
  4. *Memoria, conservazione, riuso del patrimonio industriale*  
Il caso studio dell'IPCA di Cirié  
a cura di Emanuele Romeo
  5. *Accessibilità e fruibilità nei luoghi di interesse culturale*  
a cura di Michela Benente, Maria Cristina Azzolino, Angela Lacirignola
  6. *Lungo i sentieri dell'architettura*  
Piergiorgio Tosoni
  7. *Riberi 6*  
Ricerca progettuale per il riuso e il rinnovo di una porzione  
di tessuto urbano di matrice storica a Torino  
a cura di Silvia Gron, Alessio Primavera
  8. *Patrimonio e tutela in Italia*  
A cinquant'anni dalla Commissione Franceschini (1964-2014)  
a cura di Andrea Longhi, Emanuele Romeo

9. *Occasioni di dialogo*  
Progetto di recupero urbano a Vinovo: la Piccola Casa della Divina Provvidenza  
a cura di Cristina Coscia, Silvia Gron, Emanuele Morezzi, Alessio Primavera
10. *Eugène Emmanuel Viollet-le-Duc*  
Contributi per una rilettura degli scritti e delle opere (1814-2014)  
a cura di Emanuele Romeo
11. *Cultura e prassi della conservazione in Turchia*  
Emanuele Romeo
12. *Monumenta tempore mutant et mutatione manent*  
Conoscenza, conservazione e valorizzazione degli edifici ludici e teatrali di età classica  
Emanuele Romeo
13. *Dialogues sur Notre-Dame*  
Sous la direction de Samantha Houriez  
Avec la collaboration de Hugo Freby et Arnaud Timbert
14. *Fragile Heritage*  
Manuela Mattone
15. *Proceedings of art'23 14<sup>th</sup> International Conference on non-destructive investigations  
and microanalysis for the diagnostics and conservation of cultural and environmental heritage  
Brescia (Italy) - 2023, November 28<sup>th</sup>/30<sup>th</sup>*  
edited by Monica Volinia, Antonello Tamburrino





Finito di stampare da  
Services4Media Srl  
viale Caduti di Nassirya, 39  
70124 Bari

Non-destructive Analysis has turned out to be crucial methods to achieve more successful and longlasting preservation of works of art and environmental heritage. With the aim to promote education and competence in this field, the "art" logo was created almost forty years ago and it still represents, in national and international sphere, one of the most successful initiatives in this area. The Proceedings of AIPnD art'23 Conference, settled in Brescia, 2023 Italian Capital of Culture together with Bergamo, collect contributions of delegates, conservation scientists and curators, art historians, analytical scientists and architectural researchers, with the aim to offer to the international audience innovative applications of NDT in many important areras related to Cultural Heritage.

Monica Volinia, Architect, Technical supervisor of the Laboratory of Non-Destructive Diagnostics (Politecnico di Torino) since 1996, is Level 3 in "Controls in the field of Conservation of Cultural Heritage with regard to Architectural Structures" for the methods Infrared Thermography, visible and wood according to UNI EN ISO 9712. Since 1994 she deals with the study and development of non-destructive diagnostic techniques for the knowledge and analysis of the historical-architectural heritage through the use of infrared thermography, remote visual inspection and wood penetrometry. She is author and co-author of numerous publications on procedures and non-destructive methods in the study and analysis of cultural heritage. She is a member of scientific committees in the field of NDT and Cultural Heritage. Since 2019 she has been a board member of AIPnD, the Italian Society for Non-Destructive Testing Monitoring Diagnostics.

Antonello Tamburrino, degree in electronic engineering from the Università di Napoli Federico II (Italy) and Ph.D. degree in electronic engineering at Politecnico di Torino, from 2014 to 2018 was a Full Professor of Electrical Engineering at the College of Engineering, Michigan State University (USA). Since 2006, he has been a Full Professor of Electrical Engineering at the Department of Electrical and Information Engineering, Università di Cassino e del Lazio Meridionale (Cassino, Italy). He has authored or coauthored more than 250 papers appeared in refereed international journals, books, and proceedings of international conferences, and he is a co-editor of three proceedings. His current research interests include inverse problems, electromagnetic imaging, nondestructive evaluation, computational electromagnetism, plasmonics, and homogenization methods. Tamburrino is currently an Editor-in-Chief of the scientific journal *International Journal on Applied Electromagnetics and Mechanics*, a Subject Editor of the scientific journal *NDT and E International*, an Associate Editor of the scientific journal *Non-destructive Testing and Evaluation*, and the Chair of the scientific committee of the Italian Association for Non-destructive Testing, Monitoring, Diagnostic.

ISBN 979-12-5544-031-4



9 791255 440314