

**Proceedings of  
2021 48<sup>th</sup> Annual Review of  
Progress in Quantitative  
Nondestructive Evaluation  
(QNDE2021)**

**July 28-30, 2021  
Virtual, Online**

**Conference Sponsor**  
Nondestructive Evaluation,  
Diagnosis, & Prognosis Division

**THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS**

Two Park Avenue \* New York, N.Y. 10016

© 2021, The American Society of Mechanical Engineers, 2 Park Avenue, New York, NY 10016, USA  
([www.asme.org](http://www.asme.org))

All rights reserved. Printed in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

INFORMATION CONTAINED IN THIS WORK HAS BEEN OBTAINED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS FROM SOURCES BELIEVED TO BE RELIABLE. HOWEVER, NEITHER ASME NOR ITS AUTHORS OR EDITORS GUARANTEE THE ACCURACY OR COMPLETENESS OF ANY INFORMATION PUBLISHED IN THIS WORK. NEITHER ASME NOR ITS AUTHORS AND EDITORS SHALL BE RESPONSIBLE FOR ANY ERRORS, OMISSIONS, OR DAMAGES ARISING OUT OF THE USE OF THIS INFORMATION. THE WORK IS PUBLISHED WITH THE UNDERSTANDING THAT ASME AND ITS AUTHORS AND EDITORS ARE SUPPLYING INFORMATION BUT ARE NOT ATTEMPTING TO RENDER ENGINEERING OR OTHER PROFESSIONAL SERVICES. IF SUCH ENGINEERING OR PROFESSIONAL SERVICES ARE REQUIRED, THE ASSISTANCE OF AN APPROPRIATE PROFESSIONAL SHOULD BE SOUGHT.

ASME shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B7.1.3). Statement from the Bylaws.

For authorization to photocopy material for internal or personal use under those circumstances not falling within the fair use provisions of the Copyright Act, contact the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, tel: 978-750-8400, [www.copyright.com](http://www.copyright.com).

Requests for special permission or bulk reproduction should be addressed to the ASME Publishing Department, or submitted online at: <https://www.asme.org/publications-submissions/journals/information-for-authors/journalguidelines/rights-and-permissions>

ISBN: 978-0-7918-8552-9

# CONTENTS

## Proceedings of 2021 48th Annual Review of Progress in Quantitative Nondestructive Evaluation (QNDE2021)

### Advanced Modelling for NDE

**QNDE2021-75766** ..... V001T01A001

FEM Simulation of Waves Excited by Array Probe Propagating in Centrifugally Cast Stainless Steel With Hexagonal Column

*Shan Lin and Yasushi Ikegami*

### Design and Application of Metamaterials for Quantitative NDE/SHM

**QNDE2021-76072** ..... V001T02A001

Studies on Novel Hyperlens Concept for Ultrasonic Non Destructive Evaluation

*Pradeep Kumar, Mohamed Subair Syed Akbar Ali, and Prabhu Rajagopal*

### Eddy Current NDE

**QNDE2021-75186** ..... V001T04A001

Reduced False Calls in Eddy Current Images Using Signal Processing

*S. B. Mahalakshmi, Ganesh Seshadri, Aparna Sheila-Vadde, and Manoj Kumar KM*

### Electromagnetic NDE Techniques

**QNDE2021-74433** ..... V001T05A001

Evaluation of Adhesive Interface Properties in Honeycomb Sandwich Structure Using Guided Waves

*Parambeer Singh Negi, Dileep Koodalil, and Krishnan Balasubramaniam*

**QNDE2021-74739** ..... V001T05A002

Coplanar Capacitive Sensing as a New Electromagnetic Technique for Non-Destructive Evaluation

*Farima Abdollahi-Mamoudan, Sebastien Savard, Clemente Ibarra-Castanedo, Tobin Filleter, and Xavier Maldague*

**QNDE2021-75000** ..... V001T05A003

Evaluating Temper Embrittlement in HY-80 Steel Using Magnetic Barkhausen Noise and Microstructural Characterization

*Michael Roberts, Charles D'Ambra, Jason Schibler, Michele Manuel, Thomas W. Krause, and Aroba Saleem*

**QNDE2021-75123** ..... V001T05A004

Assessment of Damage in Metallic Plates by Ultra-Wideband Guided Electromagnetic Waves

*Vittorio Memmolo, Jochen Moll, Duy Hai Nguyen, Viktor Krozer, Jakob Holstein, Rohit Kapoor, and Jonathan Stindl*

### Guided Waves

**QNDE2021-74591** ..... V001T06A001

Modelling Anisotropy Influence on Guided Wave Scattering at Composite Delaminations

*Flora Hervin and Paul Fromme*

**QNDE2021-74926** ..... V001T06A002

In Situ Measurement of Poisson's Ratio of Steel Plates During Thermal Processes Using Resonant Modes

*Clemens Grünsteidl, Christian Kerschbaummayr, Edgar Scherleitner, Bernhard Reitingner, Georg Watzl, Thomas Mitter, and Gerhard Angeli*

**QNDE2021-74927** ..... V001T06A003

Characterization of Roll-Cladded Aluminum Plates With Laser-Based Surface-Acoustic-Wave Measurements

*Clemens Grünsteidl, Georg Watzl, Christian Kerschbaummayr, Edgar Scherleitner, Günther Mayr, and Marin Petre*

**QNDE2021-74942** ..... V001T06A004

Detection of Defects in Titanium Using Shear Horizontal Guided Waves

*Christian Peyton, Rachel S. Edwards, Steve Dixon, Ben Dutton, and Wilson Vesga*

**QNDE2021-75053** ..... V001T06A005

Features of Guided Waves Propagating in a Honeycomb Sandwich Structure

*Lifu Wang, Leonardo Araque, Steffen Tai, Ajit Mal, and Christoph Schaal*

**QNDE2021-75067** ..... V001T06A006

Identification of the Orthotropic Elastic Tensor of Composites Using Full Field Lamb Wave Energy Velocities and Dispersion Curves

*Adil Han Orta, Shain Azadi, Saeid Hedayatrasa, Nicolaas Bernardus Roozen, Wim Van Paepegem, Mathias Kersemans, and Koen Van Den Abeele*

**QNDE2021-75069** ..... V001T06A007

Online Monitoring of Electric Power Box Using Waveguide Sensors

*Jaykumar Fultariya, Nishanth Raja, and Krishnan Balasubramaniam*

**QNDE2021-75100** ..... V001T06A008

Guided Waves Mode Filtering Using Fiber Bragg Grating Sensors

*Rohan Soman, Pawel Kudela, Maciej Radzienski, and Wieslaw Ostachowicz*

**QNDE2021-75249** ..... V001T06A009

Shear Horizontal Guided Wave Corrosion Detection and Quantification in Pipes via Linear Scanning Magnetostrictive Transducers (MST)

*Xin Chen, Sergey Vinogradov, and Adam Cobb*

## **Machine Learning and Statistical Methods in NDE**

**QNDE2021-74428** ..... V001T07A001

Autoencoder-Based Anomaly Detection in Industrial X-ray Images

*Erik Lindgren and Christopher Zach*

**QNDE2021-74889** ..... V001T07A002

Application of Artificial Intelligence for Automated Detection of Defects in Nuclear Energy Domain

*Eleftherios Anagnostopoulos and Yann Kernin*

**QNDE2021-75080** ..... V001T07A003

Estimating Guided Wave Velocity Variation With Neural Networks

*Ori Leibovici, Kang Yang, and Joel B. Harley*

**QNDE2021-75153** ..... V001T07A004

Enhancing Vibration-Based Structural Health Monitoring via Edge Computing: A Tiny Machine Learning Perspective

*Federica Zonzini, Francesca Romano, Antonio Carbone, Matteo Zauli, and Luca De Marchi*

**QNDE2021-75215** ..... V001T07A005

Explainable Machine Learning for Damage Detection: in Carbon Fiber Composite Plates Under Varying Temperature Conditions

*Christopher Schnur, Jochen Moll, Yevgeniya Lugovtsova, Andreas Schütze, and Tizian Schneider*

**QNDE2021-75247** ..... V001T07A006

A Fast Unsupervised Online Learning Algorithm to Detect Structural Damage in Time-Varying Environments

*Karthik Gopalakrishnan and V. John Mathews*

**QNDE2021-75925** ..... V001T07A007

Benefit of Neural Network for the Optimization of Defect Detection on Composite Material Using Ultrasonic Non Destructive Testing

*P. Trouvé-Peloux, B. Abeloos, A. Ben Fekih, C. Trottier, and J.-M. Roche*

## **NDE for Additive Manufacturing**

**QNDE2021-68491** ..... V001T08A001

Porosity Inspection in Metal Directed Energy Deposition Using Femtosecond Laser Based Transient Thermoreflectance Measurement

*Peipei Liu, Kiyoon Yi, and Hoon Sohn*

**QNDE2021-74686** ..... V001T08A002

Linear and Nonlinear Analysis of Additively Manufactured Material With Different Porosity Induced by Varying Material Printing Speed Using Guided Acoustic Waves

*SeHyuk Park, Hamad Alnuaimi, Anna Hayes, Madison Sitkiewicz, Umar Amjad, Krishna*

*Muralidharan, and Tribikram Kundu*

**QNDE2021-75106** ..... V001T08A003

Estimation of Internal Surface Roughness of Additively Manufactured Components Under Complex Conditions Using Artificial Intelligence and Measurements of Ultrasonic Backscatter

*Mohamed Subair Syed Akbar Ali, Mato Pavlovic, and Prabhu Rajagopal*

## **NDE for Civil Infrastructure**

**QNDE2021-73958** ..... V001T09A001

Stress Monitoring in a Real-Size Reinforced Concrete Column Using Torsional Resonance

*Agustin Spalvier, Santiago Laco, Gonzalo Cabrera, and Gonzalo Cetrangolo*

**QNDE2021-74922** ..... V001T09A002

Non-Destructive Tests for the Assessment of R.C. Buildings

*Mariella Diaferio and Michele Vitti*

**QNDE2021-74945** ..... V001T09A003

Preliminary Acoustic Study of 3D Localization of Buried Polyethylene Pipe

*William Xerri, Gineth Saracco, Ghislain Gassier, Laurent Zomero, and Philippe Picon*

**QNDE2021-74950** ..... V001T09A004

A Remote Solitary Wave-based Technique for Monitoring Corrosion in Steel Structures: Numerical Analysis and Experimental Validation

*Hoda Jalali and Piervincenzo Rizzo*

**QNDE2021-75028** ..... V001T09A005

On the Assessment of Masonry Structures

*Mariella Diaferio, Marilena Venerito, and Michele Vitti*

## **NDE Modeling and Prognostics for Composites**

**QNDE2021-75009** ..... V001T10A001

Edge Illumination X-Ray Phase Contrast Imaging and Ultrasonic Attenuation for Porosity Quantification in Composite Structures

*Dana Shoukroun, Sandro Olivo, and Paul Fromme*

## **NDE/SHM for Oil & Gas Industry**

- QNDE2021-74014** ..... V001T11A001  
A Novel Probability of Detection Assessment Considering Model Uncertainty for Lamb Wave  
Detection  
*Chenjun Gao, Jingjing He, and Xuefei Guan*
- QNDE2021-74931** ..... V001T11A002  
Research on Key Technologies of Precise Measurement of Geographic Coordinates of Subsea  
Pipelines  
*Li Jian, Wang Jialin, Zhao Jianyuan, Li Mingze, and Huang Xinjing*
- QNDE2021-74974** ..... V001T11A003  
Study on Pipeline Spanning Detection Using Magnetic Anisotropy  
*Huang Xinjing, Chen Qian, Zhao Jianyuan, Yan Yutian, Li Jian, Zhang Yu, and Feng Hao*
- QNDE2021-74982** ..... V001T11A004  
Improvement Effect of Active Magnetization on Subsea Pipeline Localization  
*Huang Xinjing, Wang Yuan, Jin Zhaosheng, Wu Jialin, Li Jian, Feng Hao, and Zhang Yu*
- QNDE2021-74993** ..... V001T11A005  
Leak Detection and Leakage Assessment of Submarine Pipelines Based on Passive Acoustics  
*Yu Zhang, Zhu Feng, Xiaobo Rui, and Bingpu Wang*
- QNDE2021-75020** ..... V001T11A006  
Guided Wave Imaging Based on Fully Connected Neural Network for Quantitative Corrosion  
Assessment  
*Xiaocen Wang, Min Lin, Junkai Tong, Lin Liang, Jian Li, Zhoumo Zeng, and Yang Liu*
- QNDE2021-75023** ..... V001T11A007  
Robust Guided Wave Tomography Method for Large and Irregular Defects  
*Junkai Tong, Min Lin, Xiaocen Wang, Jiahao Ren, Jian Li, and Yang Liu*
- QNDE2021-75049** ..... V001T11A008  
Combined Inductive and Capacitive NDE Technique for Insulator-Conductor Hybrid Structures  
*Ting Zhu, Kaijie Wen, Chengjie Deng, Xiaokang Yin, Xiaorui Zhang, Xinan Yuan, Wei Li, and Guoming Chen*
- QNDE2021-75051** ..... V001T11A009  
Early Fatigue Damage Evaluation of Nonlinear Guided Wave Imaging in Hyperelastic Materials  
*Chengwei Zhao, Sunia Tanweer, Jian Li, Min Lin, Xiang Zhang, and Yang Liu*
- QNDE2021-75073** ..... V001T11A010  
Acoustic Magnifying Lens Based on Compact Non-Dispersive Spiral Metamaterial Array  
*Li Xiang, Li Jian, and Huang Xinjing*
- QNDE2021-75182** ..... V001T11A011  
Aboveground Storage Tanks Leak Detection Through Acoustic Emission Sensor Nodes  
*Denis Bogomolov, Nicola Testoni, Luca de Marchi, Tommaso Borzone, Antonio Terribile, Giuseppe Giunta, and Alessandro Marzani*
- QNDE2021-75313** ..... V001T11A012  
Accurate Thickness Inversion of Corrosion Using A1 Lamb Wave  
*Min Lin and Yang Liu*

## **Nonlinear Ultrasonic Techniques**

- QNDE2021-74515** ..... V001T13A001  
One Dimensional Nonlinear Wave Propagation in a Rate Independent Pinched Hysteretic Material  
*Pravinkumar Ghodake*
- QNDE2021-74617** ..... V001T13A002  
Evaluating the Degree of Nonlinearity by Applying the Nonlinear SPC-I Technique in the FEM  
Simulation of Materials With Breathing Cracks  
*SeHyuk Park, Hamad Alnuaimi, Umar Amjad, and Tribikram Kundu*

**QNDE2021-75235**..... V001T13A003  
Nondestructive Evaluation of Materials Tensile Strength via Nonlinear Acoustics Data  
*Julian Ehrler, Alexander Solodov, Yannick Bernhardt, and Marc Kreutzbruck*

## **Nuclear Power NDE**

**QNDE2021-74657**..... V001T14A001  
Fatigue Detection and Estimation in Martensitic Stainless-Steel Using Magnetic Nondestructive  
Evaluation Technique  
*Bharath Basti Shenoy, Zi Li, Lalita Udpa, Satish Udpa, Yiming Deng, and Thiago Seuaciuc-Osorio*

**QNDE2021-74928**..... V001T14A002  
Magnetic Methods for the Identification of Incorrect Microstructures in Grade 91 Power Station  
Steels  
*John W. Wilson and Anthony J. Peyton*

**QNDE2021-75014**..... V001T14A003  
Transition to Online Cable Insulation Condition Monitoring  
*S. W. Glass, Leonard S. Fifield, and Mychal P. Spencer*

**QNDE2021-75055**..... V001T14A004  
Results of a Virtual Round Robin Study to Estimate Probability of Detection for Dissimilar Metal  
Welds  
*Ryan M. Meyer, Aimee E. Holmes, Romarie Morales, Iikka Virkkunen, Thiago Seuaciuc-Osorio,  
and Bruce Lin*

**QNDE2021-76573**..... V001T14A005  
Feasibility of Lead Fast Reactor Heat Exchanger Tube Online Monitoring  
*S. W. Glass, M. S. Good, and E. H. Hirt*

## **Resonant NDE**

**QNDE2021-74848**..... V001T15A001  
Elastic Properties of IN718 Fabricated via Laser Directed Energy Deposition (DED)  
*M. M. Rahman, G. Huanes-Alvan, H. Sahasrabudhe, and S. K. Chakrapani*

**QNDE2021-75218**..... V001T15A002  
Vibration Analysis for NDE of Ceramic Components  
*Bernd Köhler, Kilian Tschöke, Mareike Stephan, Sergey Gartsev, and Martin Barth*

## **Structural Health Monitoring**

**QNDE2021-74543**..... V001T16A001  
Quadrature Amplitude Modulation for Acoustic Data Communication in Ultrasonic Structural  
Health Monitoring Systems  
*Octavio A. Márquez Reyes, Jochen Moll, Federica Zonzini, Masoud Mohammadgholiha, and  
Luca De Marchi*

**QNDE2021-75122**..... V001T16A002  
Federal Aviation Administration's Probability of Detection Testing Results for Structural Health  
Monitoring (SHM)  
*Paul Swindell and Danielle Stephens*

**QNDE2021-75192**..... V001T16A003  
Development of a Convolutional Neural Network Assisted Fiber Optics Based Passive Structural  
Health Monitoring System  
*Ainulla Khan and Krishnan Balasubramaniam*

**QNDE2021-75230** ..... V001T16A004  
 Structural Health Monitoring of Electro-Mechanical Actuators in Aviation: Recent Breakthroughs  
 and Further Challenges  
*Vittorio Memmolo, Carmine Vaselli, Nicola Cimminiello, Pasquale Salvato, Ernesto Monaco,  
 and Fabrizio Ricci*

**QNDE2021-75297** ..... V001T16A005  
 Coda Waves for Health Monitoring of Composites Under Low-Velocity Impact  
*Subal Sharma and Vinay Dayal*

### **Ultrasonic Arrays**

**QNDE2021-74694** ..... V001T18A001  
 Remote, Volumetric Ultrasonic Imaging of Defects Using Two-Dimensional Laser Induced Phased  
 Arrays  
*Peter Lukacs, Geo Davis, Theodosia Stratoudaki, Yashar Javadi, Gareth Pierce, and Anthony  
 Gachagan*

**QNDE2021-75025** ..... V001T18A002  
 A Comparison Study of Several Ultrasonic Endoscopy Technology for Tubes' Inspection  
*Ze Xi, Xiangang Wang, and Xiaowei Luo*

**QNDE2021-75107** ..... V001T18A003  
 Adaptive Data Acquisition for Fast Ultrasonic Imaging Using Laser Induced Phased Arrays  
*Peter Lukacs, Theodosia Stratoudaki, Geo Davis, and Anthony Gachagan*

### **Ultrasonic Scattering**

**QNDE2021-74995** ..... V001T19A001  
 Determination of the Case Depth by Ultrasonic Backscatter of Case and Induction Hardened  
 Steel With a Soft Hardness Gradient  
*Paul Graja and Norbert Meyendorf*

**QNDE2021-75223** ..... V001T19A002  
 In-Situ Laser Ultrasound Measurements of Austenitic Grain Growth in Plain Carbon Steel  
*Christian Kerschbaummayr, Martin Rzyz, Bernhard Reitingner, Mike Hettich, Jan Džugan,  
 Thomas Wydra, and Edgar Scherleithner*

### **POSTER ONLY**

**QNDE2021-74998** ..... V001T21A001  
 Determination of the Ultrasonic Velocity on a Recent and Aged Pine Wood  
*Héctor Carreon and Mayra Carrillo*

**QNDE2021-75006** ..... V001T21A002  
 Detection of Segregation in a High Carbon Steel by Non-Destructive Techniques  
*Luis Hernández, Hector Carreón, and Arnoldo Jacuinde*