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Academic Education in NDT at Master Level and Resulting Implications on the NDT Community

Christian Boller & Peter Starke

Chair in Non-Destructive Testing & Quality Assurance (LZfPQ)

Saarland University, Saarbrücken/Germany

&

Dresden International University (DIU), Dresden/Germany

European Research Day at European Conference on NDT (ECNDT)

Gothenburg/Sweden, June 13, 2018

Why an M.Sc. Course in NDT?

- NDT is a science based between different disciplines (applied physics, applied mathematics, computer science, electronics, material science and engineering structural design).
- Organisations struggling to find personnel adequately trained in NDT
- Provide academic teaching in NDT at highest level.
- Highly educated graduates in NDT will shorten the lead time in getting graduates effectively hosted in an NDT working environment.
- Bologna process allows for:
  - an interesting mix between a natural science subject (bachelor) and NDT (master)
  - life long learning.

Why an M.Sc. Course in NDT at DIU?

- Conventional universities have difficulties in providing the breadth of teaching staff required (i.e. academic and departmental autonomies)
- DIU can easily hire excellent staff from virtually anywhere on a time limited basis
- Staff appointed must have the adequate proficiency in English language skills
- Courses can be configured in accordance to any needs
- Short decision processes due to simple organisational structure
- NDT Master Course accredited by Saxonian Ministry of Science & Culture and ZeVA

M.Sc. Program „Non-Destructive Testing“: Network

- For this study program, DIU is the leading institution in the network consisting of:
  - Dresden University of Technology
  - Universität des Saarlandes, Saarbrücken
  - Fraunhofer Gesellschaft
  - German Society of Non-Destructive Testing (DGZfP), Berlin
  - Bundesanstalt für Materialforschung und –prüfung (BAM)
  - ... and more to come.
- Students will be familiarized with modern equipment based on all major methods in NDT
- The program is tailored towards an advanced specialization in mechanical, electrical and civil engineering and can lead to highly promising professional careers.

M.Sc. Program „Non-Destructive Testing“: Structure

- Completed in a consecutive sequence.
- Laboratory sessions within the research modules are carried out in the research labs of academia, BAM, Fraunhofer, and industries.
- The concept covers 5 basic modules, 5 specialized modules, 1 certification module and 2 modules related to own research including the Master Thesis.
- Furthermore, each student can apply for a special certificate of the German Society of Non-Destructive Testing (DGZfP).

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Modules and Lectures

1 Basic Modules (BM): Material Science (Metals; Polymers); Measurement Techniques; Mechanics (Sound & Vibration; Fatigue & Fracture); Numerical Methods & Signal Processing; Introduction into NDT and Quality Management.

2 Specific Modules (SM): Acoustic Methods (Ultrasonics, Phased Array & Imaging); Electromagnetic Methods (Electromagnetics, NMR, Eddy Current, Microwave); Radiology (Fundamentals, Tomography, Imaging); Optical Methods; Thermal & Microscopical Methods

3 Specific Actions (SA): NDT Basic Course of DGZfP (a Gateway to Certified Testing); Research Internship at BAM, Fraunhofer, or others

4 Master Thesis (MT): Performed with one of the Academic Institutions, BAM, Fraunhofer, or others

Reknown Lecturers in their Fields

- Dr. Carsten Becker-Willinger, Leibniz INM (Polymer Materials) Saarbrücken/Germany
- Prof. Dr. Christian Boller, Saarland Univ. LZfPQ & Fraunhofer IZFP, Saarbrücken/Germany (Mechanics)
- Prof. Dr. Gerd Dobmann, Saarland Univ. LZfPQ Saarbrücken/Germany (NDT Introduction; Electromagnetism)
- Prof. Dr. Uwe Ewert, BAM, Berlin/Germany (Radiography Imaging)
- Prof. Philippe Guy, INSA, Lyon/France (Acoustic Methods)
- Dr. Wolfgang Habel, BAM, Berlin/Germany (Optics)
- Dirk Henn, Fraunhofer IZFP, Saarbrücken/Germany (Quality Management)
- Prof. Dr. Johann Hinken, FH Stendal, Stendal/Germany (Microwave & Eddy Current)
- Dr. Ralf Holstein, DGZfP, Berlin/Germany (NDT Course for Basic Qualification)
- Dr. Yan Kai, SWJTU, Chengdu/China (Optoelectronics)
- Dr. Andrzej Klepka, AGH, Cracow/Poland (Numerical Methods & Signal Processing)
- Dr. Andreas Kupsch, BAM, Berlin/Germany (Radiographic Methods)
- Dr. Fabien Léonard, BAM, Berlin/Germany (Radiographic Methods)
- Dr. Peter Starke, Saarland Univ. LZfPQ, Saarbrücken/Germany (Metallic Materials)
- Prof. Dr. Wieslaw Staszewski, AGH, Cracow/Poland (Numerical Methods & Signal Processing)
- Prof. Tadeusz Stepinski, AGH Cracow/Poland (Acoustic Imaging)
- Prof. Dr. Volker Trappe, BAM, Berlin/Germany (Composite Materials)
- Prof. Dr. Frank Walther, TU Dortmund, WPT, Dortmund/Germany (Measurement Techniques)
- Dr. Mathias Ziegler, BAM, Berlin/Germany (Thermography)
- Prof. Dr. Ehrenfried Zschech, Fraunhofer IKTS, Dresden/Germany (Microscopy)
- Dr. Uwe Zscherpel, BAM, Berlin/Germany (Radiographic Tomography)

DGZfP Basic Course in NDT

- DGZfP is the German Society for NDT, the world's oldest NDT society
- DGZfP Basic Course (BC):
  - Is an accredited course
  - Lasts 10 full days
  - Provides a practical and theoretical background into all relevant NDT techniques
  - Allows to directly go for DGZfP Level III certification in the different NDT techniques addressed after relevant experience with the NDT technique
  - Is run at DGZfP headquarters in Berlin/Germany

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First Batch of Graduates in November 2015

7 of 12 graduates secured PhD position

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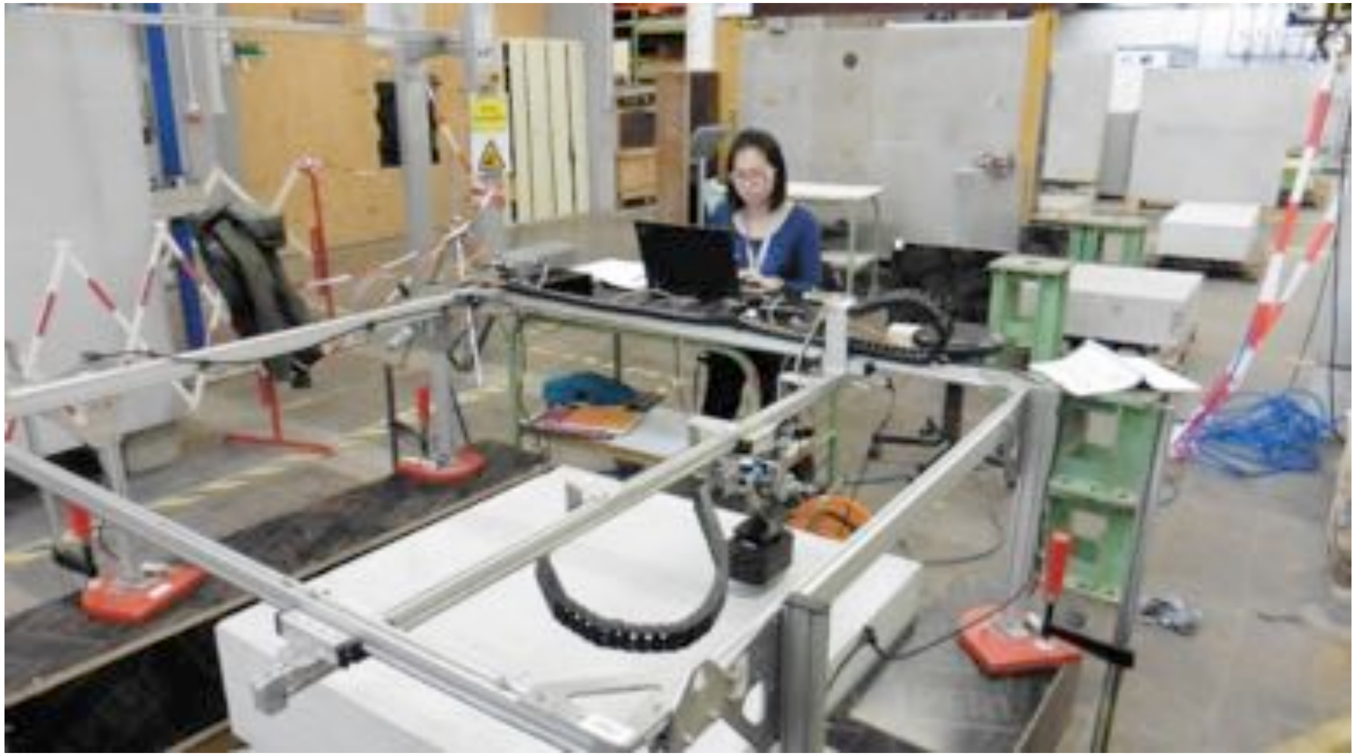
Ting Wang: Characterization of the Interfaces of Ballastless Railway Tracks Based on Ultrasonic Echo Principles



BAM

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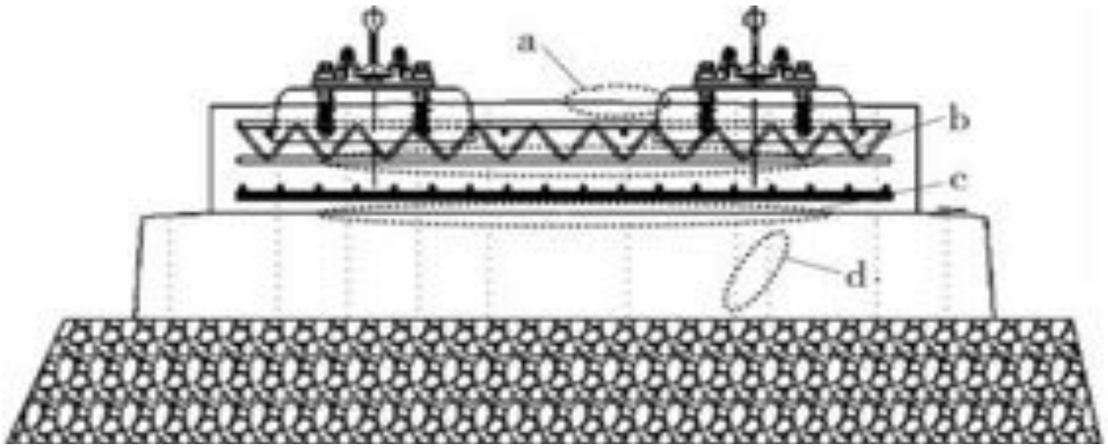
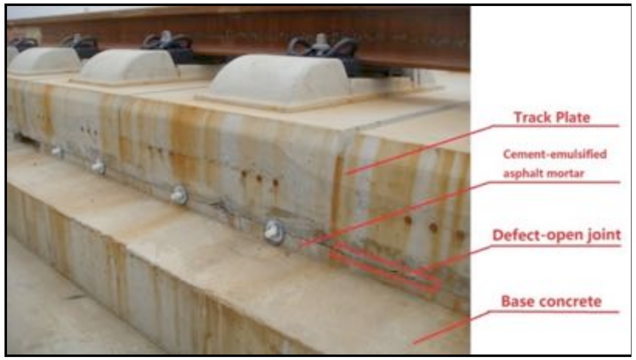
Ballastless Track & Potential Damages





Ultrasonic Inspection Equipment

Image of tomograph A1040 MIRA

Low-frequency ultrasonic flaw detector A1220 MONOLITH

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Elaboration on a Real Ballastless Track Section

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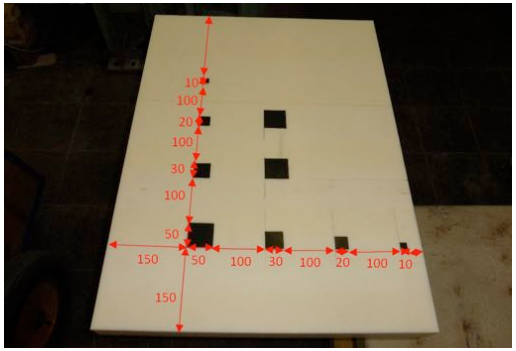
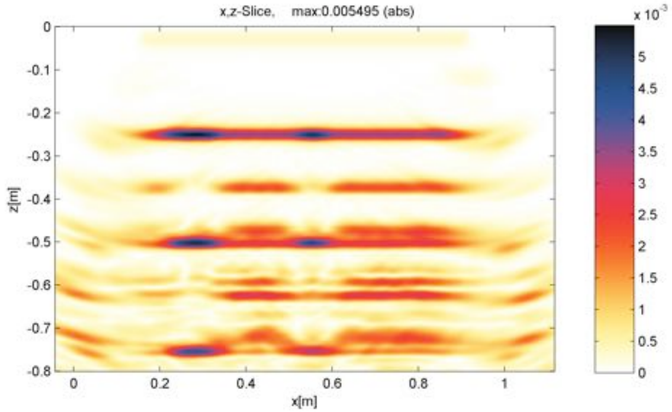
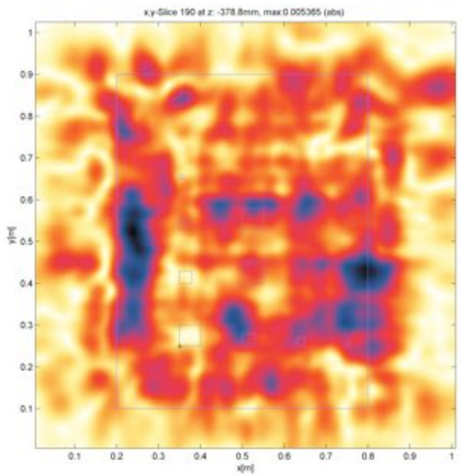
Concrete/Polyamid/Concrete with Defects

BAM



Simulation of shear waves:





Simulation: K. Mayer, Univ. Kassel/Germany

B-scan

C-scan

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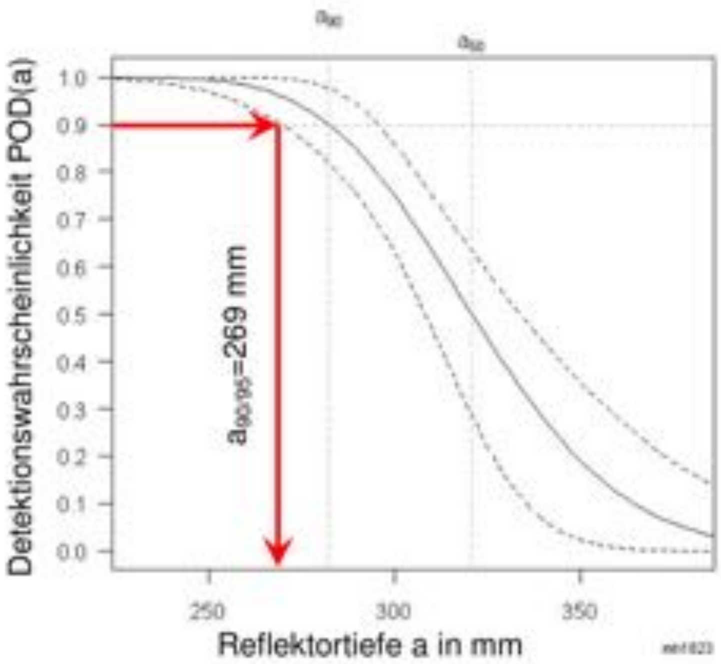
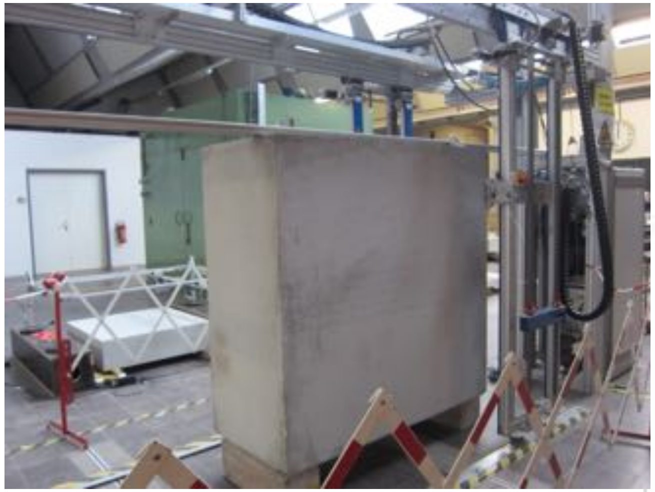
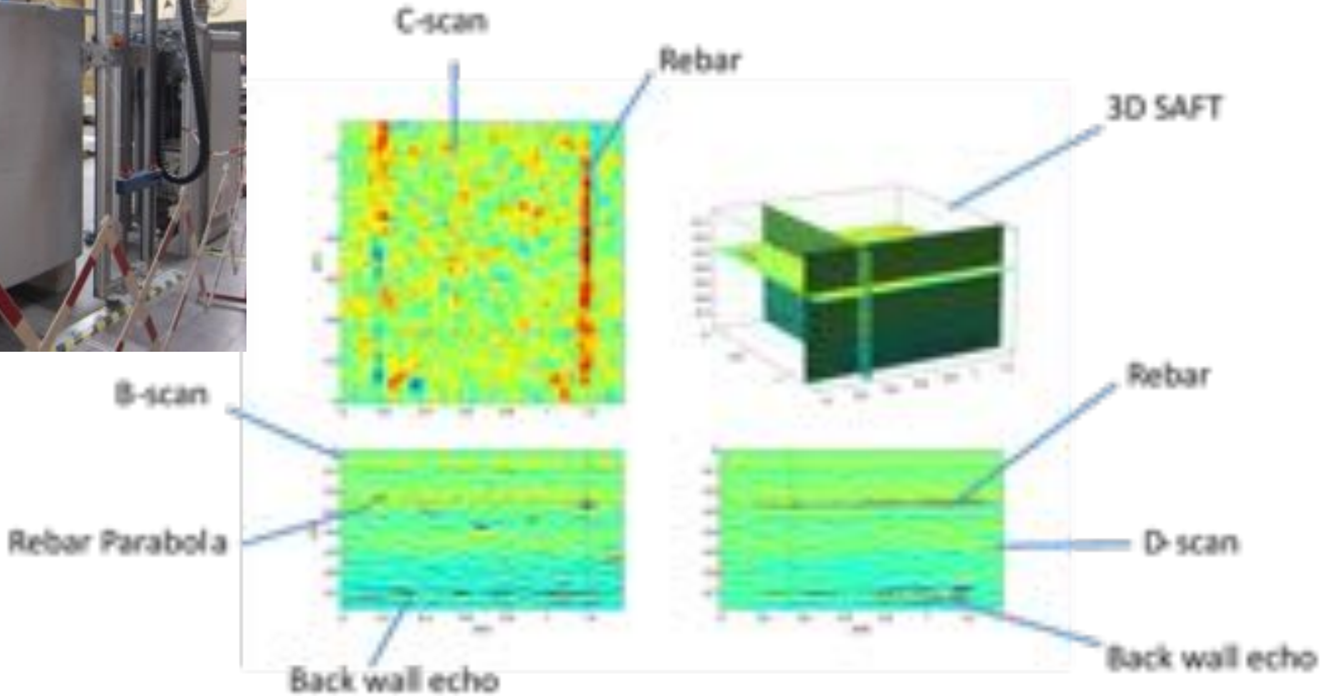
Su Chen: POD Analysis for Single Rebar in Concrete Using Ultrasonic Echo Method



3D SAFT Image Processing for Rebar Detection





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Data Processing: K. Mayer, Univ. Kassel/Germany

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Yevgeniya Lugovtsova: Condition Monitoring of Wooden Poles Using Guided Waves

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Signal Processing Approach

System Transfer Function: $I(\omega) = \dfrac{X(\omega)}{S(\omega)}$

$X(\omega)$ Spectrum recorded

$S(\omega)$ Spectrum actuated

Tichonov's convolution regularisation:

$$I(\omega) = \frac{S(\omega)^* \cdot X(\omega)}{(S(\omega)^* \cdot S(\omega) + \varepsilon) \cdot dt}$$

ε Regularisation factor

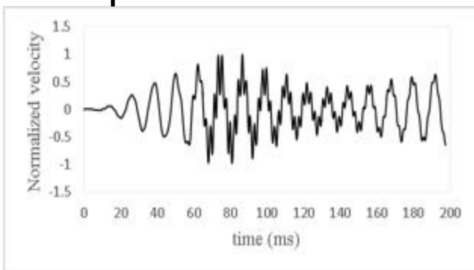
dt Time interval

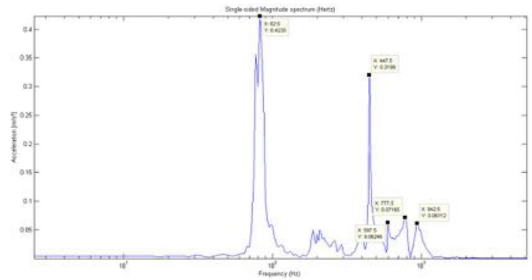
$S(\omega)^*$ Complex conjugate of spectrum

Impuls response function (IRF):

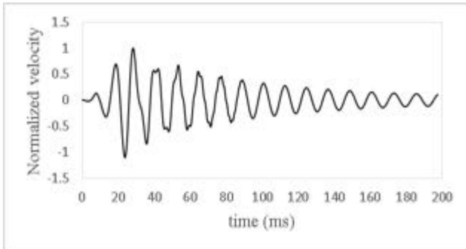
$$i(t) = FFT^{-1}(I(\omega))$$

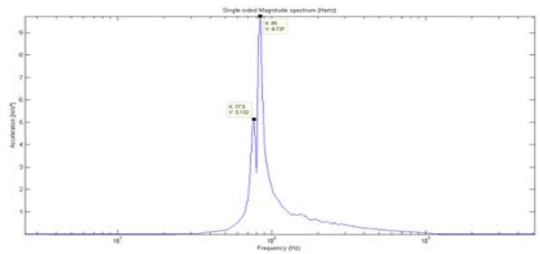
Output:



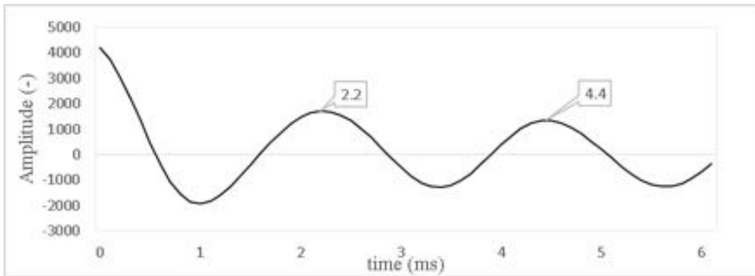


Input:





IRF:



M

MOVERS OF TOMORROW

„During my master studies at Tomsk Polytechnic University I happened to know about the university's cooperation with DIU. This allowed me to participate in the 'non-destructive testing' course in Dresden. Besides the additional degree this study provided me international experience and I happened to know the German education system. What I felt very positive with DIU was that many lecturers made their longstanding professional experience to become a part of their lectures. After my subsequent research placement at the 'Federal Institution of Materials Research and Testing' in Berlin I was also allowed to write my master thesis there and I am now working towards my doctoral degree."

Yevgeniya Lugovtsova, PhD Applicant

Yevgeniya Lugovtsova: Structural Health Monitoring of Composite Pressure Vessels using Guided Ultrasonic Waves

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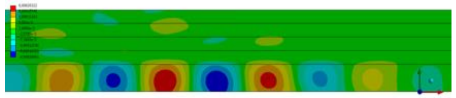
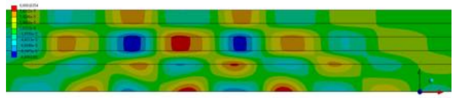


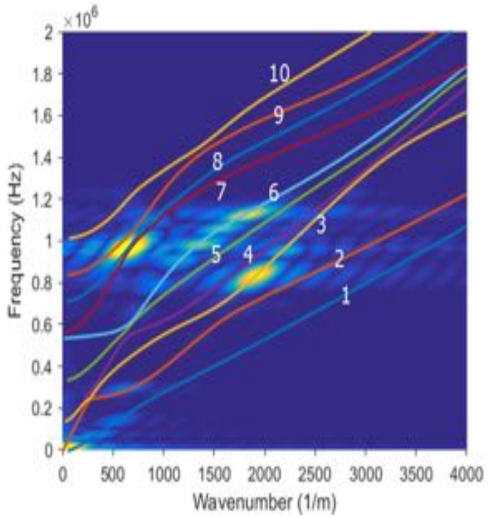
In plane GW in liner



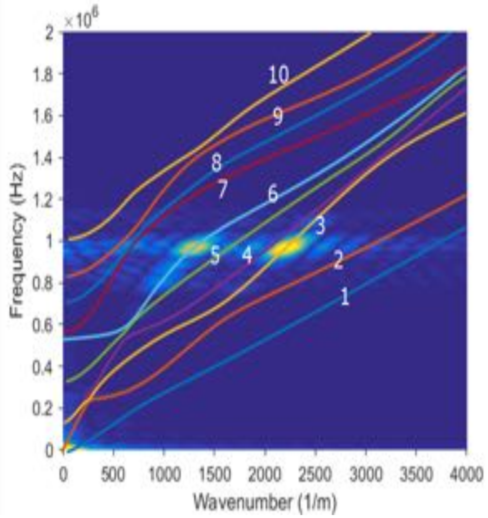
Out of plane GW in composite & liner

Finite Element Modelling

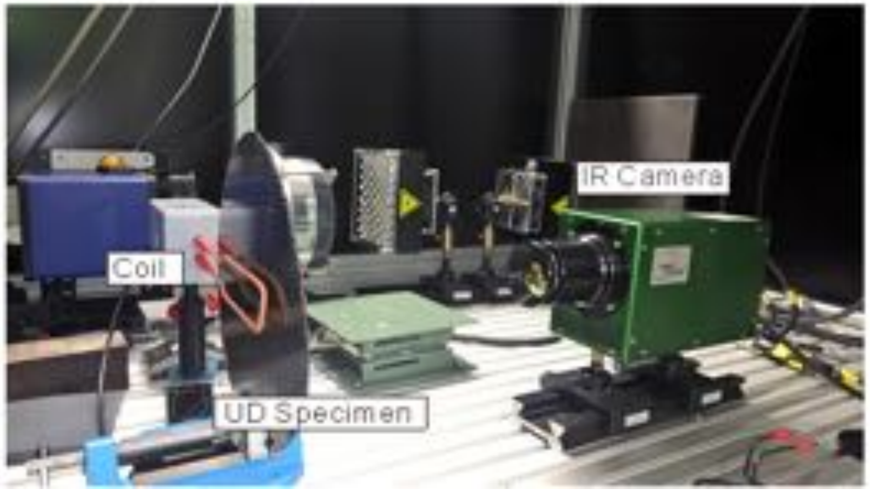
Propagating modes

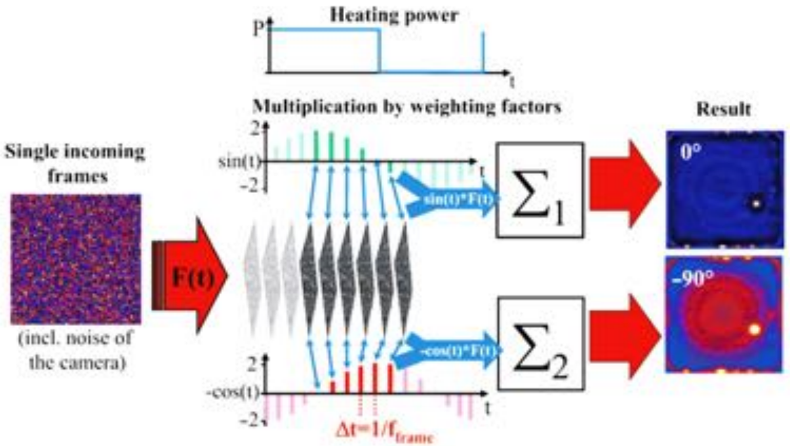


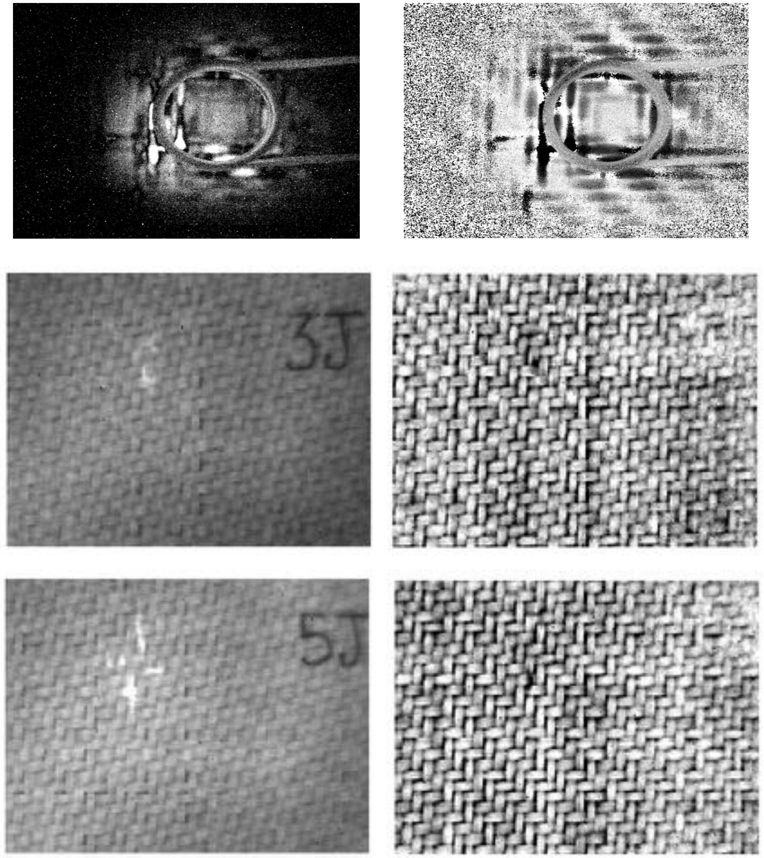
Reflection from a 1 mm crack in the aluminium liner



Jianguang Guo: InductionThermography of Carbon Fibre Reinforced Plastics







Amplitude

Phase

Fraunhofer

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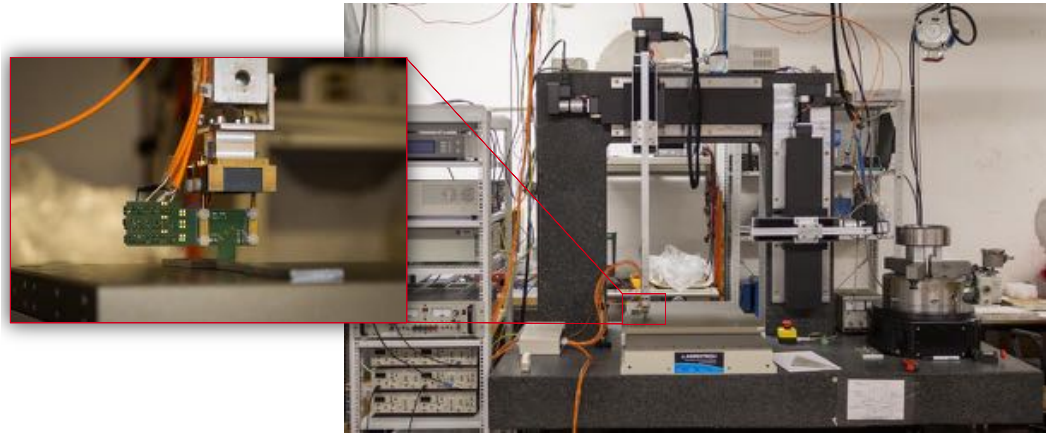
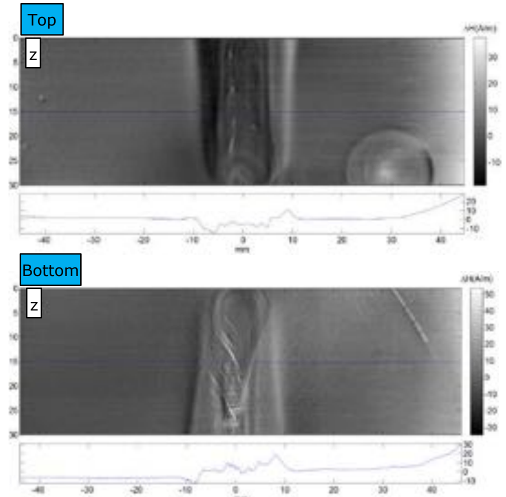
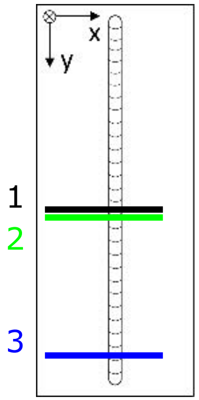
Viktor Lyamkin: Correlation of Residual Stress Measurements by Neutron Diffraction and Metal Magnetic Memory Testing in Ferritic Steel Welds



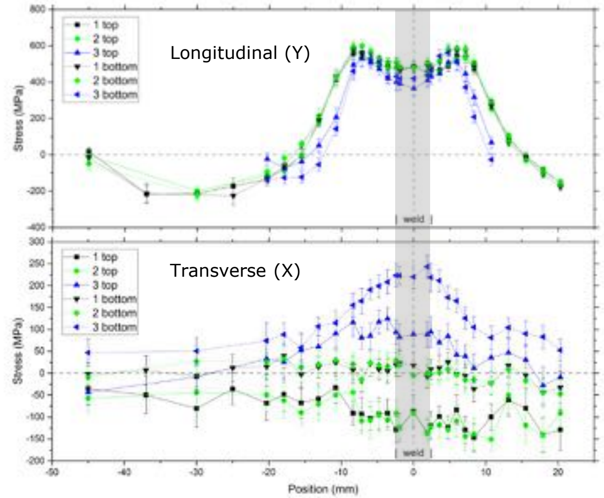
GMR





Position of the measurement

Neutron Diffraction



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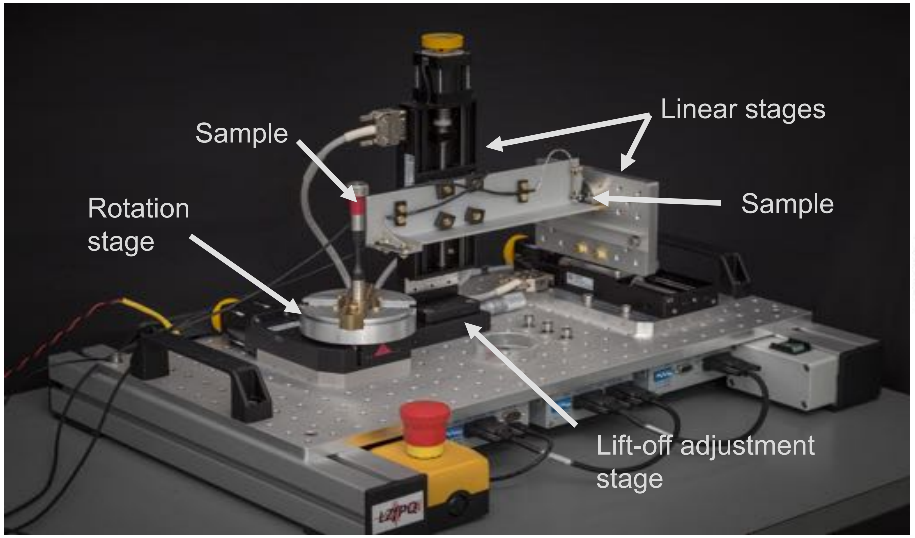
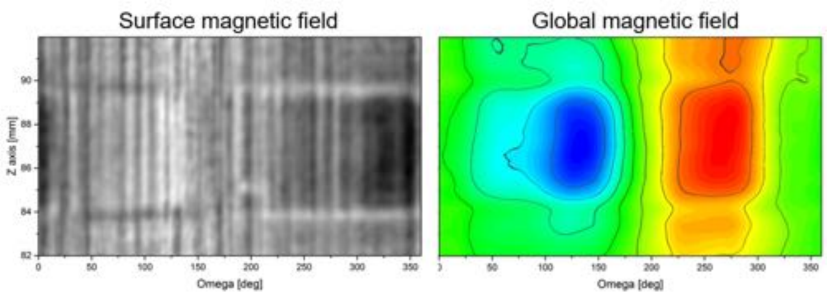
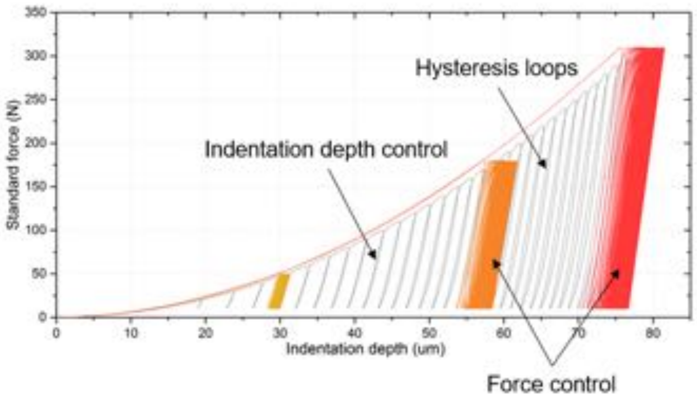
Viktor Lyamkin: Life cycle estimation of metallic components in nuclear industry based on non-destructive detection and interpretation of local material properties







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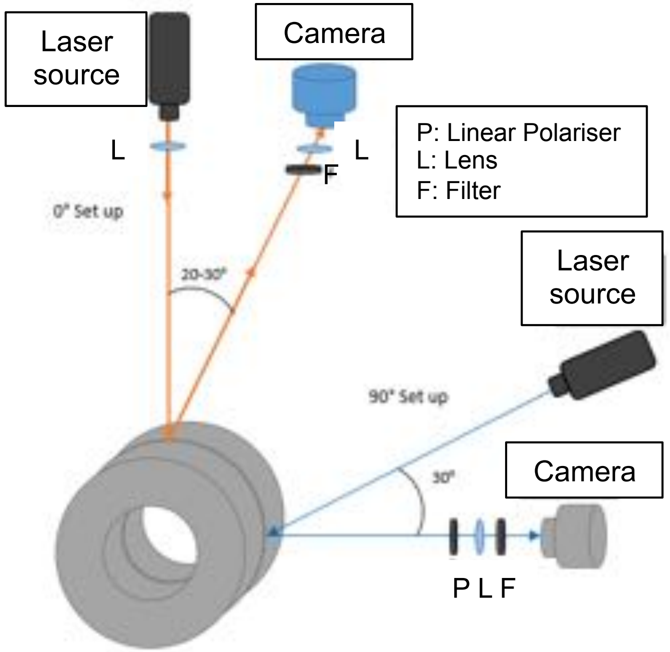
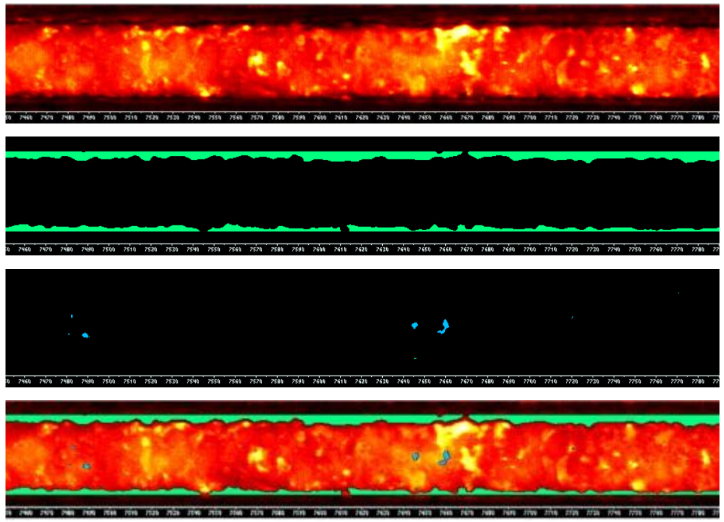
Ruth de Acosta: Defect Detection During Laser Welding by Laser Speckle Photometry





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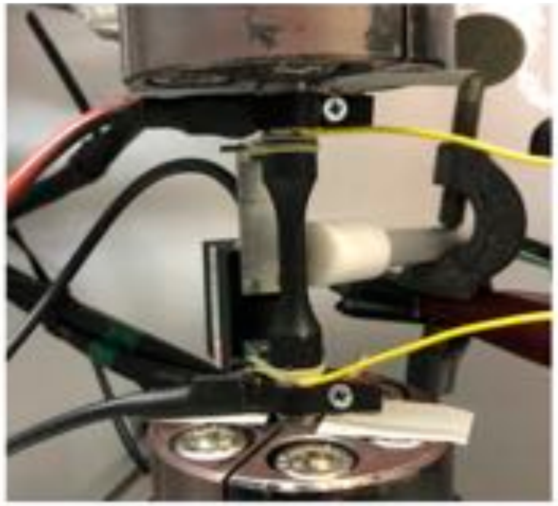
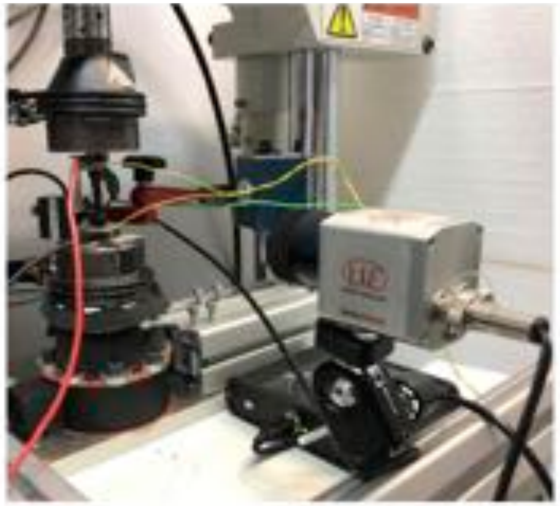
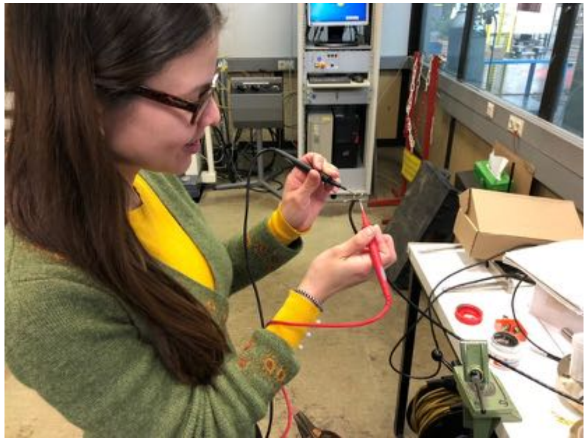
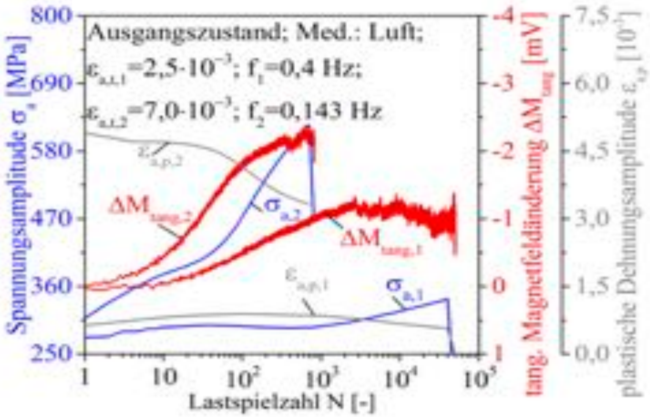
Ruth de Acosta: The Use of NDT for Microstructure Based Residual Fatigue Life Assessment of Metallic Components









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Benefits for Collaborating Organisations

- Provide graduates with a knowledge and experience in NDT better than conventional graduates
  - Shorter lead time to become an NDT expert
  - Qualifies directly to a level III aftrer the respective experience
- Allow for a master degree even after years of professional life (life long learning)
- Combine research placement and master thesis with research related topics of the collaborating organisation
- Explore ideas that would not be possible to be explored within the collaborating organisation
- Establish links with renown academic institutions

Conclusions

- Nearly five years of experience show the course to be feasible, sound, realistic and value added
- Hard work to get the course established
- Appearance has increased with an increasing number of students and partners from academia, research organisations and industry
- Provide a platform of highest academic level in NDT education and research as well as intercultural exchange.

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Contact

DRESDEN INTERNATIONAL UNIVERSITY (DIU)

Your Point of Contact

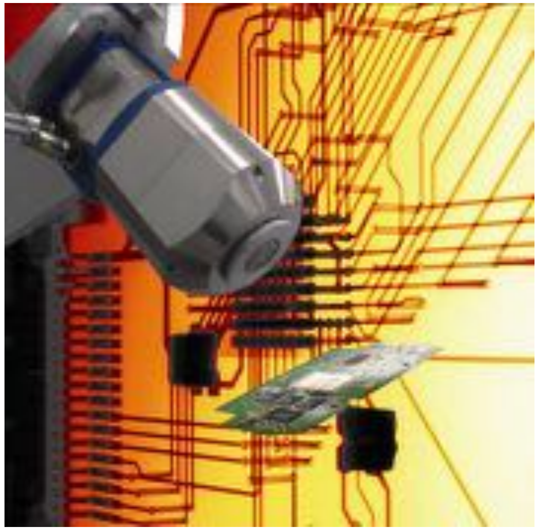
Frau Jana Schulle
Projektmanagement

Prof. Dr.-Ing. Christian Boller
Course Director

Freiberger Straße 37· 01067 Dresden
Tel.: + 49 351 – 40 470 151
Fax: + 49 351 – 40 470 110
jana.schulle@di-uni.de

Visit us on the Internet:
http://www.di-uni.de/index.php?id=507

NDT MasterCourses start every October



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