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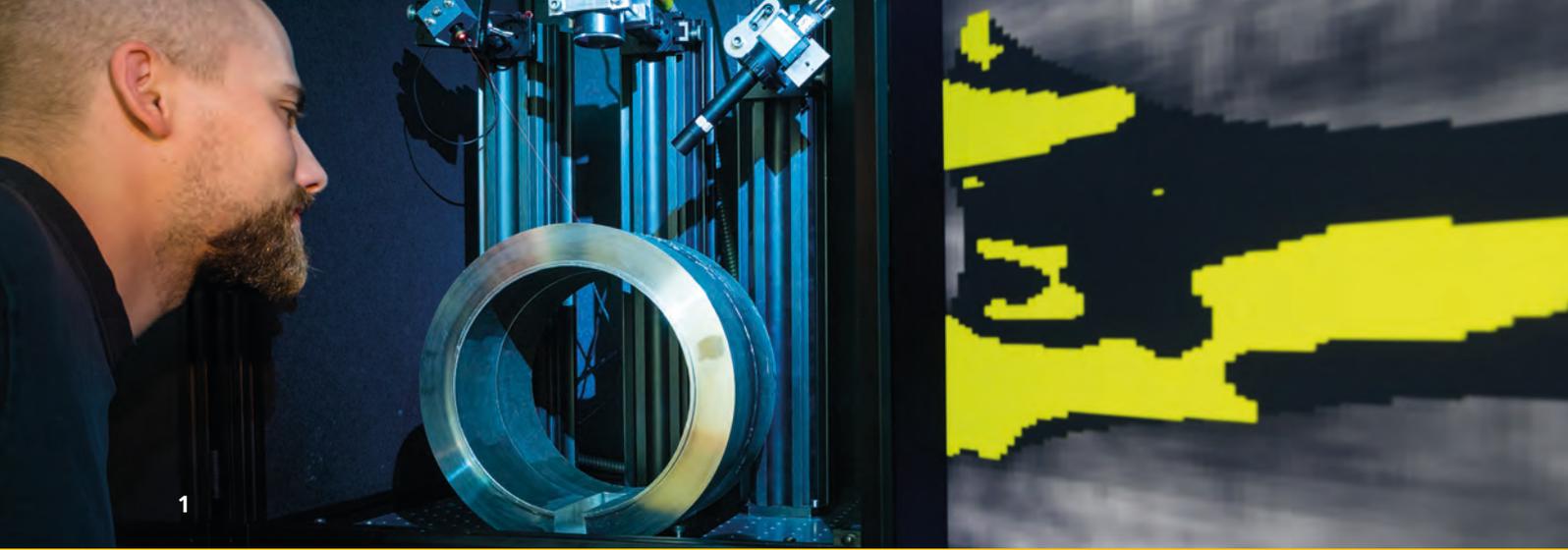
FRAUNHOFER INSTITUTE FOR CERAMIC TECHNOLOGIES AND SYSTEMS IKTS



BUSINESS DIVISION

NON-DESTRUCTIVE TESTING AND MONITORING





NON-DESTRUCTIVE TESTING AND MONITORING

Quality, cost and time are the decisive factors for products and services to succeed in the marketplace. Continuously improving these factors requires deep knowledge of the products: from the development phase, through the production to the application. Quality control through non-destructive testing (NDT) contributes greatly to the accumulation of this indispensable knowledge, its evaluation and use with a view to optimizing processes.

New materials (e.g. composites), manufacturing methods (additive and hybrid methods) and production concepts (flexible production, Industry 4.0) call for novel testing strategies and the necessary components. At the same time, non-destructive testing is expanding its range of application across the entire product life cycle – from raw material evaluation to their usage and recycling.

Testing and monitoring are part of an efficient strategy for making development, production and operation more reliable, economical and competitive. They also meet legal requirements. Fraunhofer IKTS combines its decades of experience in the testing of components and plants with novel measuring technologies, automation concepts and approaches for the interpretation of complex data volumes.

Fraunhofer IKTS is a competent partner for the application and further development of established test methods, such as ultrasonics, eddy current, X-ray and acoustic diagnostics. Depending on the requirements, these can be coupled with or completed by new concepts of laser speckle photometry or optical coherence tomography. If needed, the accredited NDT test lab provides support in the validation and certification of these new methods. The competence portfolio thus goes far beyond that of a classic provider of NDT testing technology.

The traditional strength of IKTS – handling noisy signals – is reflected on the equipment level with adapted sensors and own electronics offering an outstanding signal-to-noise ratio. Own software libraries and the most modern methods of machine learning help to open up the information gained for a more sophisticated use. Measured and operational data collected in experiments are combined with the dynamic simulation model of a component, which enables statements on the performance and expected service life based on a digital twin, leading to specific failure models.

At Fraunhofer IKTS, traditional non-destructive testing is extended consistently to obtain a versatile quality assurance tool. Automation, programmable test manipulators, online visualization of measured values via web clients and the use of standardized interfaces and data formats all ensure the best possible integration with clients' processes.

In this way, Fraunhofer IKTS supports partners from science and industry in the use of established processes and in achieving a strategic paradigm change towards Industry 4.0.



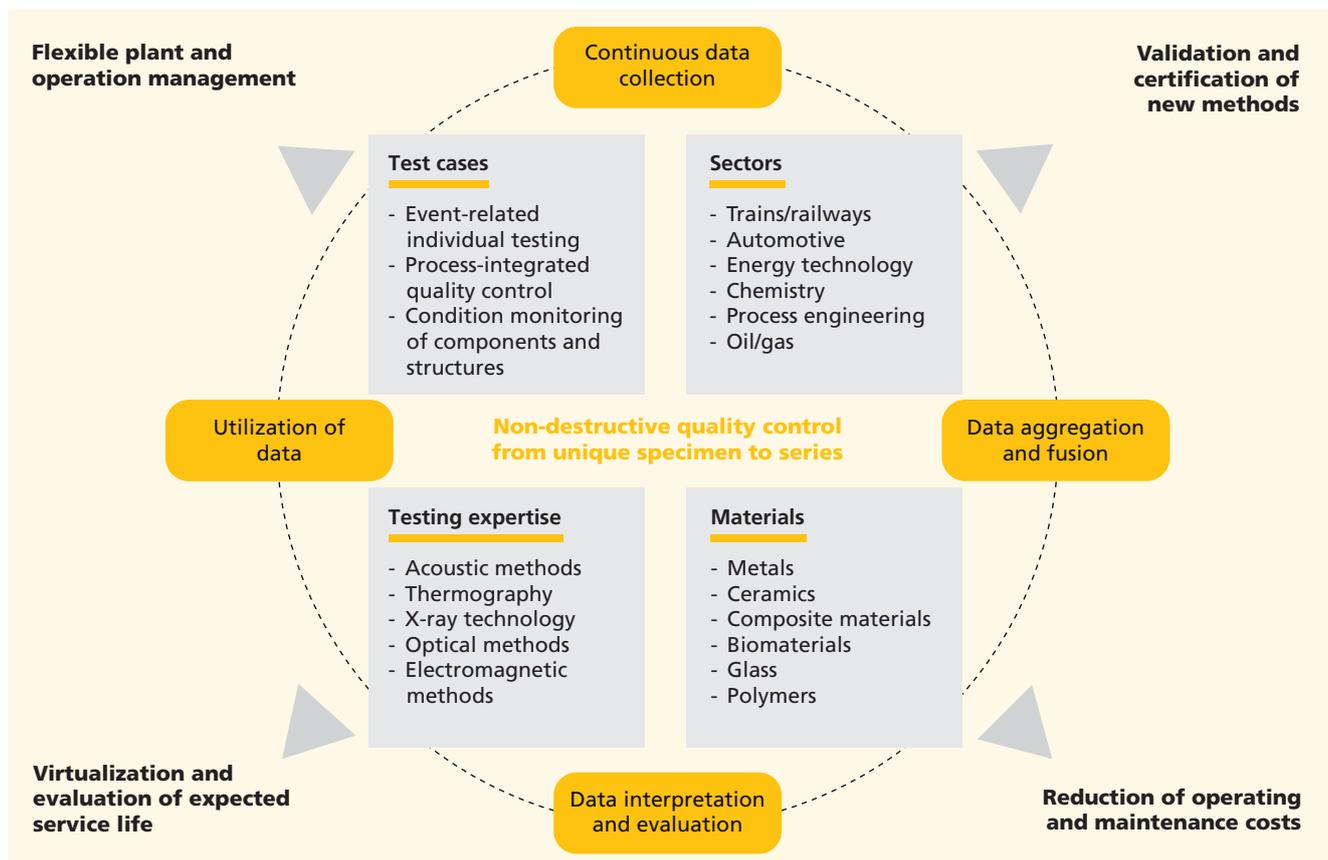
AREAS OF APPLICATION

Development of methods for new applications in traditional NDT

The energy and mobility sector, as a typical field where NDT is used, is currently undergoing massive change. Novel materials and composites, as well as components with optimized properties, are constantly being introduced. New manufacturing processes, such as additive manufacturing, are rapidly evolving. This results in changes in the material behavior, special characteristics, new types of defects and increased demands concerning the testability using non-destructive methods.

Fraunhofer IKTS is therefore working diligently on adapting existing test procedures and methods. Well-known methods are improved through new electronic equipment and sensor concepts, and continuously developed further with a view to robot-aided testing – exemplified prominently by the PCUS® series of ultrasonic test devices. Another approach is the combination of several established methods with the aim of improving the yield of information thanks to data fusion.

The development of completely new methods is yet another avenue of research. The HUGO ultrasonic goniometer is an example. Using the newly developed goniometer method, it





becomes possible to greatly increase the measuring sensitivity of the test system, allowing to determine material properties, such as solidification or stresses, with high accuracy.

A third strategy is based on the use of augmented reality solutions and exoskeletons to support manual test tasks. Production data are directly integrated within the AR applications, which decreases error rates in production and increases productivity.

Integrated quality control for processes and plants

The continuous monitoring of critical component parameters is paramount for operating individual manufacturing steps or complete processes efficiently within tight tolerances and without errors. In this regard, the sensors offered by IKTS cannot only be attached to machines, it is also possible to integrate them directly in components or carry them along through processes.

Through their direct interaction between signal and material, NDT methods are an outstanding solution to gaining information on stiffness, structure or freedom from defects. In conjunction with machine and ambient parameters, this information allows, first of all, for regulation on the machine level. If data are then combined on the process or factory levels, it becomes possible to optimize production processes with regard to output, cost and energy consumption. In detail, data rates of the sensor signals and a possible edge processing of the signals have to be considered.

Fraunhofer IKTS has unique experience in the field of acoustic monitoring. Filtering and arithmetic transformations are decisive steps to be performed before assessment or classification with methods of machine learning.

Methods and systems for permanent monitoring of components and structures

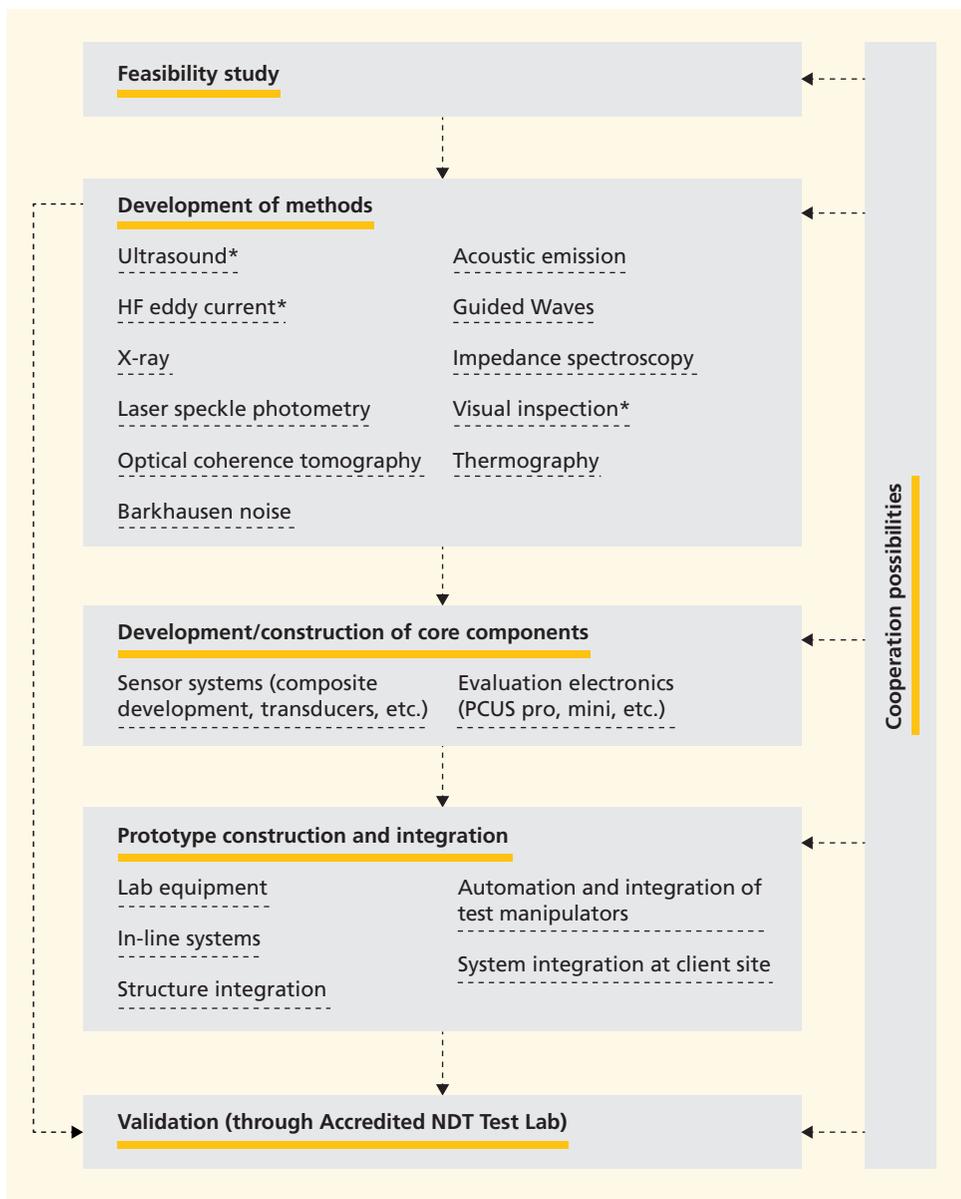
Critical elements of energy, building and traffic infrastructure, such as wind power plants, bridges, railway lines, trains or airplanes need to be monitored regularly and maintained depending on their state or condition. Difficult accessibility, great distances and harsh environmental conditions impair an accurate assessment. Also, the need for staff leads to high costs.

As an alternative approach, Fraunhofer IKTS develops methods and systems for the permanent condition monitoring based on active and passive acoustic methods. It involves the integration of particularly robust, durable and reliable sensors and electronic parts into the components. Ideally, they remain there throughout the whole service life of the component, regularly supplying data on the component's or system's condition at defined intervals. Aspects of energy supply or self-sufficiency, data retrieval and secure transmission are also taken into account. This innovative approach is able to cover various cost-benefit scenarios from the perspective of the different players in the value chain.

- 1** *Monitoring of rapid manufacturing processes using laser speckle photometry.*
- 2** *Ultrasonic front end for automated testing using several transducers.*
- 3** *Monitoring system for corrosion in pipes.*
- 4** *Monitoring system for pressure tanks made of fiber composite materials in automotive engineering.*



EXPERTISE



5 Portable Barkhausen noise analyzer for non-destructive testing in wound or rounded small component areas.

* accredited in accordance with DIN EN ISO/IEC 17025

FRAUNHOFER IKTS IN PROFILE

The Fraunhofer Institute for Ceramic Technologies and Systems IKTS conducts applied research on high-performance ceramics. The institute's three sites in Dresden (Saxony) and Hermsdorf (Thuringia) represent Europe's largest R&D institution dedicated to ceramics.

As a research and technology service provider, Fraunhofer IKTS develops modern ceramic high-performance materials, customized industrial manufacturing processes and creates prototype components and systems in complete production lines from laboratory to pilot-plant scale. Furthermore, the institute has expertise in diagnostics and testing of materials and processes. Test procedures in the fields of acoustics, electromagnetics, optics, microscopy and laser technology contribute substantially to the quality assurance of products and plants.

The institute operates in nine market-oriented business divisions to demonstrate and qualify ceramic technologies and components as well as non-destructive test methods for new industries, product concepts and markets beyond the established fields of application. Industries addressed include ceramic materials and processes, mechanical and automotive engineering, electronics and microsystems, energy, environmental and process engineering, bio- and medical technology, non-destructive testing and monitoring, water as well as materials and process analysis.

www.ikts.fraunhofer.de



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Non-Destructive Testing
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COVER *Robot-guided
non-destructive high-frequency
eddy current testing on carbon
fiber composite materials.*