Issue 12 - December 2015

RCNDE News

Research Centre for Non Destructive Evaluation

Welcome to Issue 12 of the NNL RCNDE Newsletter which is distributed to NNL's RCNDE network across the NDA estate. NNL is a proud member of the Research Centre for Non Destructive Evaluation (RCNDE) on behalf of the NDA.

The RCNDE, formed in 2003, is an EPSRC (Engineering and Physical Sciences Research Council) sponsored collaboration between industry and academia to coordinate research into NDE technologies and to ensure research topics are relevant to the medium and longer-term needs of industry.

Funding was secured in 2014 to continue RCNDE for a further six year period covering 2014 to 2020.

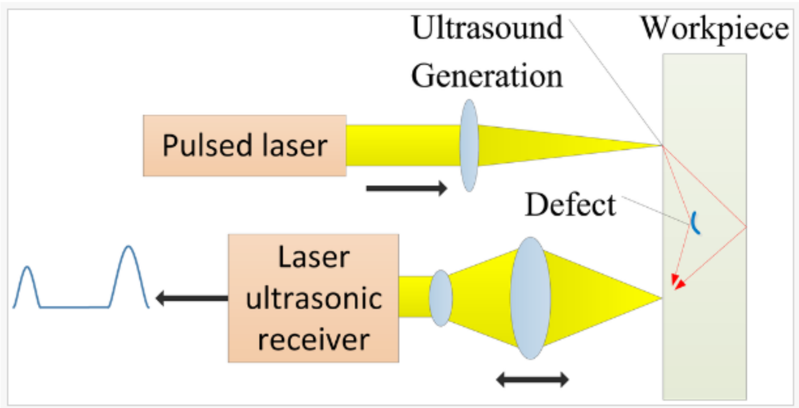
More information on the RCNDE is available at www.rcnde.ac.uk.

Inside this issue

Laser Ultrasonics

The most common form of Ultrasonic NDT generates and detects ultrasonics waves in a sample using piezoelectric transducers (PZT). Due to the ultrasonic impedance difference between air and the sample to be inspected (typically metal) it is common to use a coupling gel or fluid between the PZT and the sample.

Laser Ultrasonics uses lasers to generate and detect ultrasonic waves without making contact with the sample. The basic components of a laser-ultrasonic system are a generation laser, a detection laser and a detector as shown in the schematic.



Schematic of a laser ultrasonic system for NDT

The generation lasers are short pulse and high peak power lasers. The physical principle is of thermal expansion (also called thermoelastic regime) whereby ultrasound is generated by the sudden thermal expansion due to the heating of a tiny surface of the material by the laser pulse.

Ultrasound may be detected optically by a variety of techniques with most inspection systems using continuous or long pulse lasers. The benefits of laser generation and detection of ultrasound for NDT include:

- Non-contact and remote, allowing inspection of samples in difficult to access locations
- Small and adjustable footprint
- Enables inspection of small and complex geometries
- High frequency capable of detecting very small flaws
- Laser beam scanning method for full coverage of inspection samples

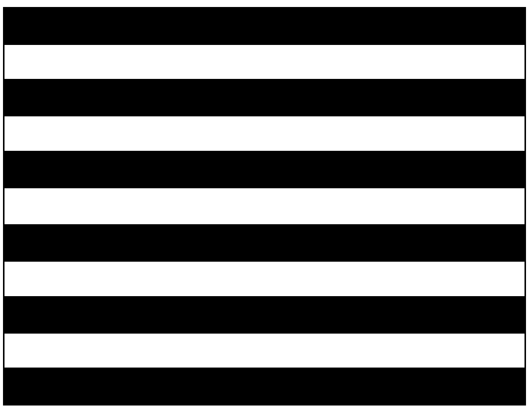
The sensitivity of optical detection of ultrasound is lower than non-optical, contacting techniques.

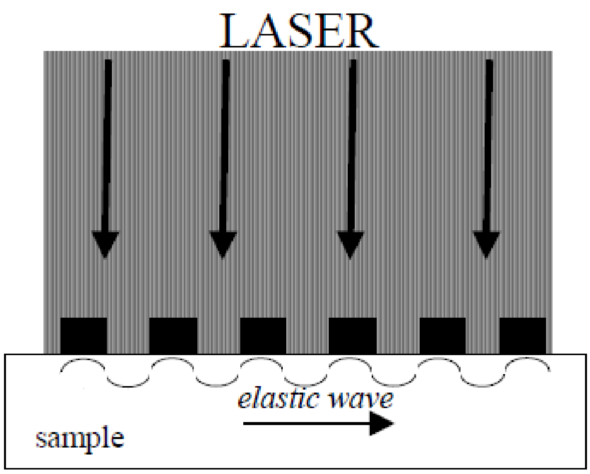
CHOTs

Researchers at the University of Nottingham have been at the forefront of developing Cheap Optical Transducers (CHOTs) that can overcome the limit of optical detection sensitivity by passively amplifying the amplitude of vibration before optical detection and can result in an increase in sensitivity by several orders of magnitude.

CHOTs are ultrasonic transducers that are optically excited by means of lasers. They are 2D patterns that are deposited, etched, attached or in some way applied onto the sample surface. There is a pattern for generation (g-CHOT) and detection (d-CHOT). The g-CHOT creates areas that absorb and areas that reflect light which controls the thermoelastic generation source. In the case of the d-CHOT, the pattern is designed to reflect light and is composed of areas with height difference that creates a phase contrast on the reflected laser light.

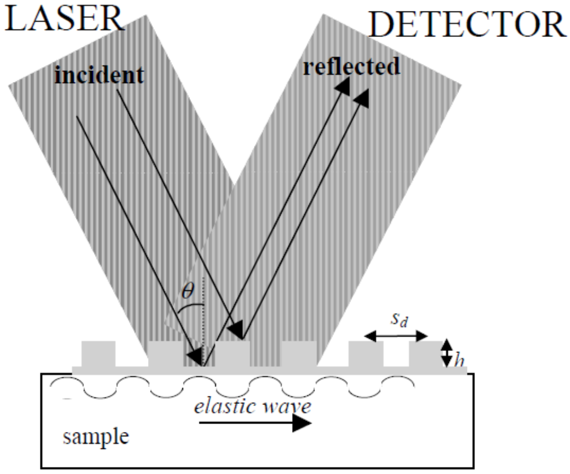
CHOTs are optically excited devices for generating and detecting ultrasound using lasers with significant stand-off distance.





Above: *g-CHOT for creating surface acoustic waves of a chosen frequency*

Right: *d-CHOT for measuring the propagating surface acoustic wave*



Laser Induced Ultrasonic Phased Array

During the last decade, there has been a rapid increase in the use of ultrasonic phased arrays for NDT inspection. An ultrasonic array comprises multiple ultrasonic transducer elements which can be addressed individually to transmit and receive ultrasonic signals. A phased array can control the directivity and focus of the ultrasound by varying the time delay between the firings of the array elements. The benefits of phased arrays are increased image quality and flexibility regarding the range of different inspections (eg plane, focused, steered) that can be done from a single location of the array.

Researchers at the University of Nottingham have recently demonstrated laser induced ultrasonic phased array using Full Matrix Capture (FMC) data acquisition and the Total Focusing Method (TFM). During the data acquisition for the FMC, a 1-D array was synthesised. To synthesise the array the generation laser beam is sequentially focused on 'virtual elements' while the detection laser is scanned across all virtual element positions. The data set is then processed with the TFM algorithm. Since both generation and detection of ultrasound is based on optical means, this technique is broadband, non-contact and couplant free making it suitable for large stand-off distances, inspection of components of complex geometries and in hazardous environments.

Future Events and Further information

25 January 2016, RCNDE Technology Transfer Event, Strand Palace Hotel, London

26 January 2016, RCNDE Board Meeting, Strand Palace Hotel, London

27 January 2016, Industrial Working Group, Imperial College, London

26 April 2016, Centre for Doctoral Training in QNDE, Research Review, Glasgow

27 April 2016, RCNDE Research Review, Glasgow

28 April 2016, RCNDE Board Meeting, Glasgow

For back issues of the RCNDE newsletter, please visit www.nnl.co.uk/rcnde. If you require further information on any of the articles in this newsletter or any aspect of the RCNDE please contact:

Gary Bolton

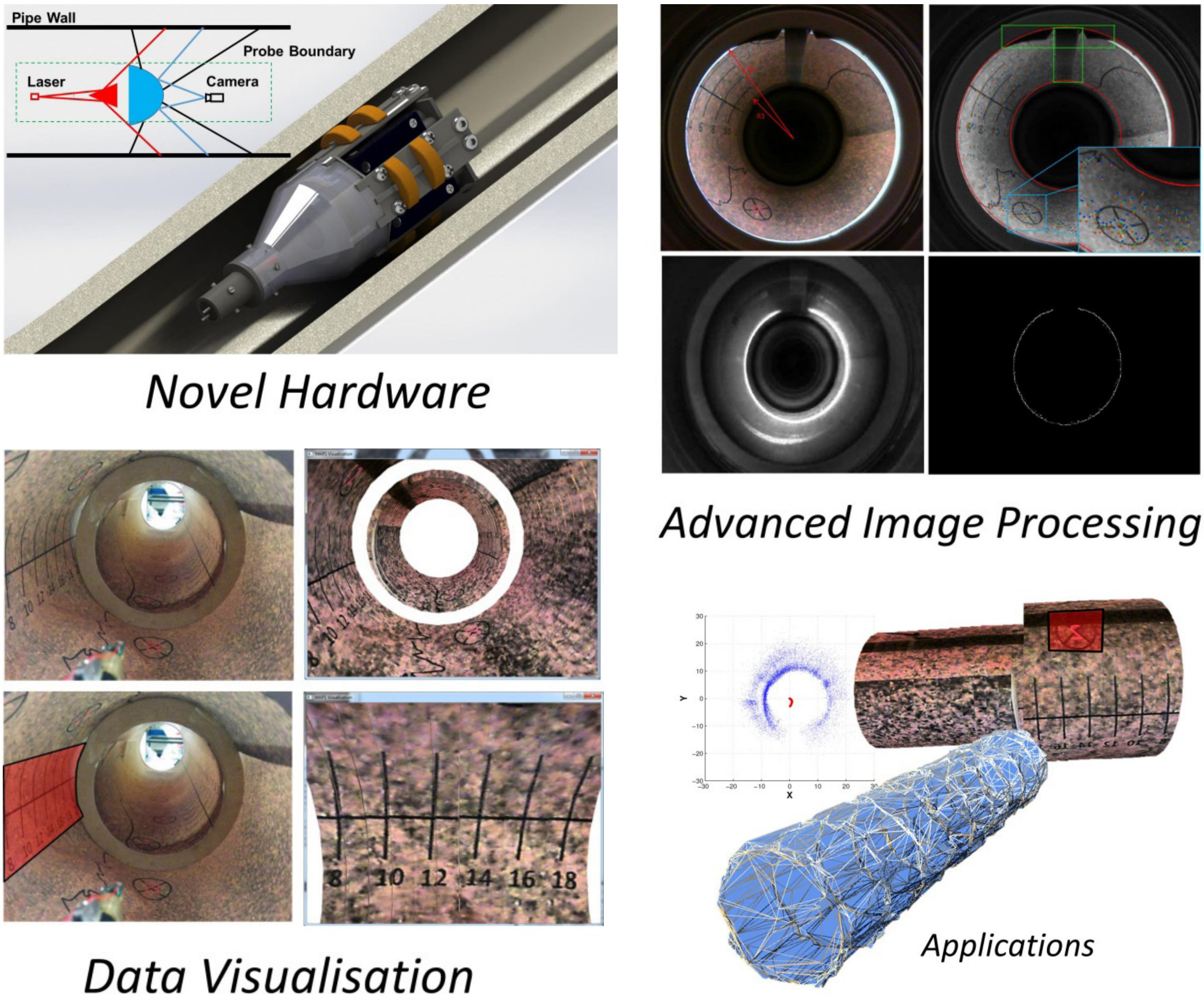
Direct: 01925 289856

Email: gary.bolton@nnl.co.uk

NATIONAL NUCLEAR LABORATORY

Mosaicing for Automated Pipe Scanning

In April 2015 RCNDE members NNL, University of Strathclyde, Inspectahire and Sellafield Ltd, and specialist product design and product development organisation Wideblue with expertise in photonics and optical design started working on the £1.3 m Innovate UK three-year project Mosaicing for Automated Pipe Scanning or MAPS. The project combines novel optical hardware, advanced image processing and image visualisation methods for in-service inspection of pipelines.



A detailed optical model of the inspection system has been created and various combinations of camera lens and mirrors have been examined and optimised. A camera system has been selected for preliminary investigations. Laser line extraction algorithms have been evaluated and the most suitable algorithm is being tested for a range of pipe diameters and image stitching algorithms are being evaluated on pipe work imagery. These algorithms will be designed into the front end of the system.

NDA09976/06/09/02