



## Introduction

Welcome to issue 4 of the NNL RCNDE Newsletter which is distributed to the NNL's RCNDE network across the NDA estate.

NNL is a 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 to longer-term needs of industry.

More information on the RCNDE is available at [www.rcnde.ac.uk](http://www.rcnde.ac.uk)

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# NNL RCNDE Newsletter

## Focus on Warwick University



The Warwick NDT group is a combination of two research groups; the Ultrasonics Group in the Department of Physics led by Prof. Steve Dixon and the Advanced Imaging and Measurement (AIM) laboratory in the School of Engineering led by Prof. David Hutchins.

RCNDE funded research within the Ultrasonics Group is focused on EMATs and Laser Ultrasound. EMATs are non-contact devices that generate and detect ultrasound in electrically conducting or magnetic materials. As they are non-contact and so no liquid couplant is required and inspections can be more rapid, more practical and less prone to measurement error. The EMAT basically consists of a wire coil in a magnetic field. The coil and magnetic field are arranged in such a way that current is pulsed through the coil (a sharp pulse of current can generate broad-band ultrasound), and the motion of the sample surface (ultrasonic arrival) generates current in the coil which is detected with a suitable preamplifier. EMATs can be used up to temperatures of around 200°C for continuous measurement with no cooling work and water cooling has enabled continuous measurements up to temperatures of 500°C for and in excess of 1000°C for momentary measurements.

The obvious advantage of laser ultrasound is that it can be totally remote over relatively large distances. Warwick has developed an experimental technique

that uses laser generated ultrasound to interrogate a welded steel specimen. The pulsed laser generates a number of different ultrasonic modes over the entire range of angles subtended at the sample surface, such that on a flat surface the wavefront is hemispherical into the sample. A line-like detector displaced from the point of generation is used to detect ultrasonic signals that have passed through the joined region.

The data generated from laser ultrasound is qualitative, where the data is best examined by visual inspection in the first instance. The most important feature of any non-destructive testing technique is to primarily determine that a defect is present. It will not always be possible to extract exact qualitative data but this is more than compensated for in terms of test speed, reliability, operation at high temperature and sensitivity to all defect types in any orientation. Even if used just as complimentary pre-screening technique the potential benefits and savings are huge.

The AIM Lab is a multi-disciplinary research group with a wide range of interests including the design and characterisation of novel ultrasonic transducer systems for NDE and other application areas. The group has significant experience with air-coupled ultrasound transducers and applications including air-coupled NDE of materials and structures. In the past the Group

worked on an RCNDE targeted research project on capacitive imaging for NDE.

Currently the AIM Lab is leading the core RCNDE research on New Approaches to

NDE with Micromachined Transducers. These novel micromachining methods have potential for the fabrication of transducers and NDE systems. One such technique, Micro-Stereo Lithography, has

shown promise for the manufacture of miniature flexible arrays for NDE.

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## RCNDE/EDF Radiography Seminar

A radiography seminar and workshop was hosted by EDF Energy at their offices in Barnwood, Gloucester for RCNDE members and supply chain organisations on 23rd November 2011. The morning seminar session was open to both RCNDE members and supply chain organisations. It included a detailed presentation on the use of digital radiography by EDF Energy

followed by further examples of industrial use of radiography in the aerospace and oil and gas sectors.

The workshop session, which was open to RCNDE members, identified radiography research needs and priorities to inform future RCNDE strategy. Overall the day was a great success with significant

information sharing between industry sectors. The event was attended by members of the radiography team from the Sellafield Ltd Inspection and Certification Group. The presentations and workshop output are available to RCNDE members. If you would like any further information on the event please contact Gary Bolton at NNL.

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## Technology Transfer: TSB Grant Award

All RCNDE research is undertaken with an eye to eventual industrial application. The RCNDE has adopted an approach of using Technology Readiness Workshops to assist in targeting research and research outcomes towards satisfying future industrial needs. These workshops bring together participants in the chain of exploitation to review the maturity of the research and recommend next steps to commercialisation. The workshops aim to identify gaps in the underlying science and uncertainties in the performance to inform future research, development

and demonstration activities to bridge Technology Readiness Level (TRL) 4 to 6.

The RCNDE research groups are keen to support initiatives in the supply chain to commercialise research findings. An example of such an initiative is the recent grant award by the Technology Strategy Board (TSB) to a consortium of RCNDE members; University of Strathclyde, Doosan Power Systems and Alba Ultrasound, to develop autonomous robotic vehicles for ultrasonic phased array inspection in the power generation

industry. The major innovations of the project will be to embed ultrasonic array technology into a small form-factor robotic vehicle and overcoming issues in ultrasonic coupling, miniaturised electronics and high power density. The output of this project is likely to have potential applications in the back-end of the nuclear fuel cycle.

## From University to In-Service Jet Engine Inspection

The Engineering Doctorate (EngD) Centre in Non Destructive Evaluation is a critical part of the RCNDE's technology transfer activities. Since the early days of the RCNDE Rolls-Royce has been a strong advocate of the EngD in NDE with at least 1 project starting each year.

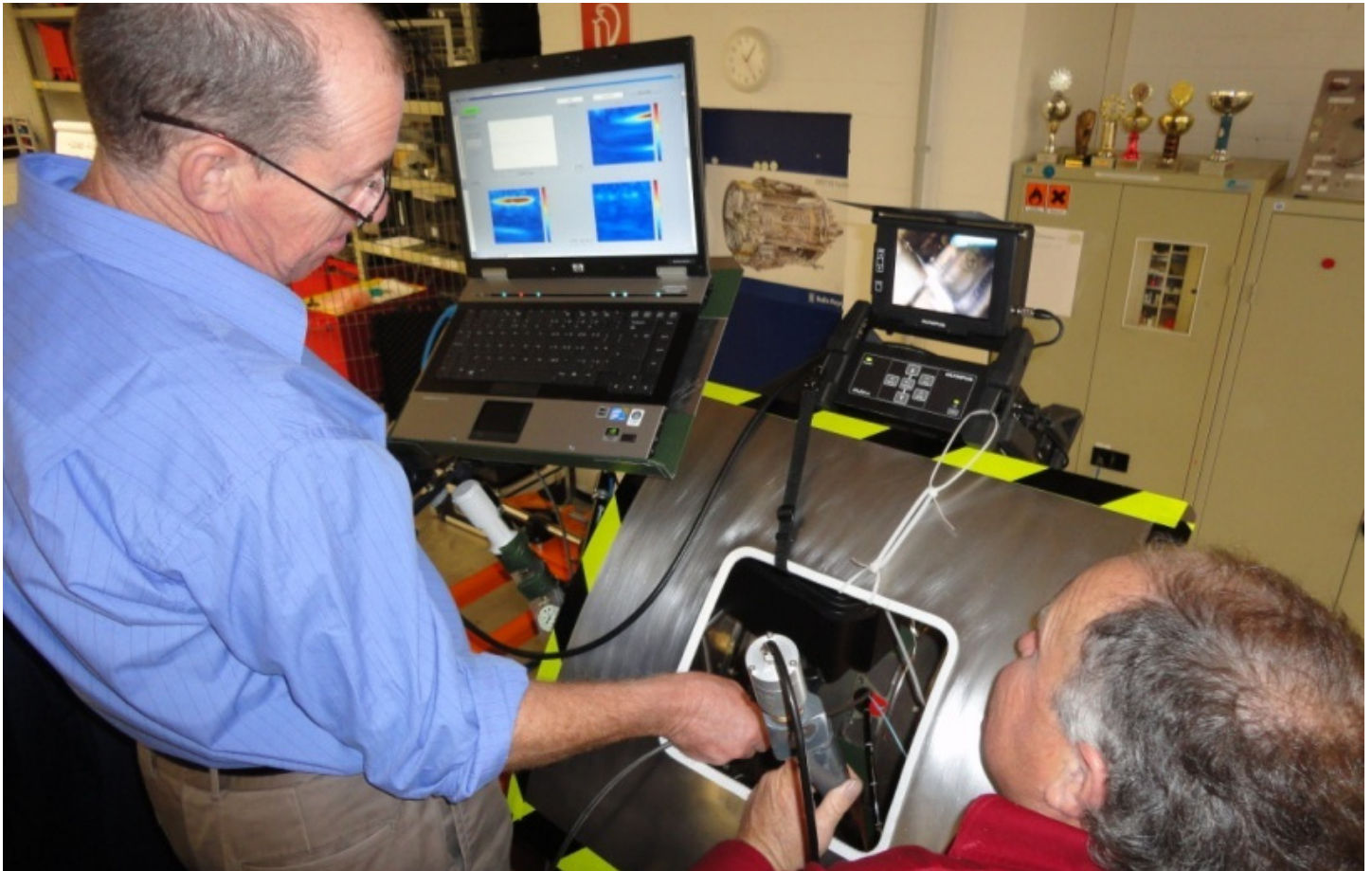
Tony Dunhill (Roll-Royce) described the transfer of a novel NDE technology from University Lab to in-service inspection at Rolls-Royce via an RCNDE EngD project at the recent British Institute of Non Destructive Testing annual conference in September 2011. The industrial requirement was for the development of an ultrasonic array system for the in-situ inspection of single crystal turbine blades to provide a quantitative measurement of detection sensitivity and

sizing capability. The technology to be exploited was the Total Focusing Method (TFM) developed by Bristol University in 2005 under RCNDE core research on advanced imaging methods at Bristol and on 2D ultrasonic arrays at Bristol and Strathclyde. The EngD project successfully completed the following technology developments tasks:

- Year 1: Correction of TFM algorithm for anisotropic material
- Year 2: Ultrasonic measurement of the crystallographic orientation
- Year 3: Development of prototype array probes
- Year 4: Development of in-situ inspection and demonstration of inspection capability

Roll-Royce estimates that 2D phased array technology has been raised from TRL 3-4 to TRL 6 as a result of this project.

**Below: Rolls-Royce NDE Inspectors examine turbine blades in a jet engine mock up.**





## New Targeted Research Project: New Methods for Ultrasonic NDE of Difficult Materials

A new RCNDE targeted project "New Methods for Ultrasonic NDE of Difficult Materials" started in August 2011 at the University of Strathclyde with industrial support from the National Nuclear Laboratory, Rolls-Royce, Serco Assurance and Shell. In many engineering applications, materials with acoustically scattering microstructure such as austenitic steel, alloys and concrete are employed. In ultrasonic NDE of such highly scattering media, the defect target signal is frequently obscured by clutter echoes, caused by numerous, relatively small, stationary reflectors, which form

part of the internal microstructure of the material. The extent of this clutter can be significant and even defects which are larger than these randomly scattering regions can be difficult to detect.

This project will investigate a range of methods for improved ultrasonic NDE of such materials including ultrasonic beam modelling, novel transducer design and array signal processing methods.

The Strathclyde researchers are collaborating with the Material Performance Centre (MPC) at the University of Manchester. MPC will

use X-Ray Computed Tomography to measure the internal microstructure of the components and materials to be studied during the project in order to construct finite element and diffusion models of the ultrasound propagation medium. The researchers are keen to focus the research on a range of samples of interest to the industrial sponsors. If you have a sample which could be used on this project please contact Gary Bolton at the NNL.

## Materials KTN Supports NDT Working Group

The Materials Knowledge Transfer Network is leading a cross-sector review of NDT supported by a series of workshops aimed at increasing uptake of NDT which is supported by the RCNDE. The working group is chaired by Tony Dunhill who is the Rolls-Royce Aerospace RCNDE representative. The working group's objective is to identify the

current status, gaps and opportunities for technology transfer in NDE, and to inform UK government bodies, such as the Department for Business, Innovation and Skills, Technology Strategy Board, and other stakeholders, about the importance of NDE to industry and key issues for successful innovation.

The first event is a workshop and exhibition "NDT and Business Benefit" to be held at the Oxford University Begbroke Science Park on 1st December 2011. This is in collaboration with Electronics, Sensing, Photonics (ESP) and Transport KTNs

## Future Meetings

- 23rd January 2012 - 4th RCNDE Technology Transfer Event, Bath
- 24th January 2012 - 28th RCNDE Board Meeting, Bath
- 25th January 2012 - Industrial Working Group, University of Bath
- 16-20th April 2012 - World Conference on NDT, South Africa
- 1-3 May 2012 - Annual Research Reviews and 29th RCNDE Board Meeting Venue tbc

## Further Information

If you require further information on any of the articles in this newsletter or any aspect of the RCNDE please contact:  
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**Winner**  
**RESEARCH & DEVELOPMENT**  
**Sector Award**

**Winner 2004 - 2008, 2010 - 2011**  
**Highly Commended 2009**

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