

## Advanced Ultrasonic Imaging Techniques for Industrial Applications



**PUBLISHABLE  
SUMMARY**

**23218**

### Background

Phased array ultrasound testing (PAUT) is now a well-established inspection technique and has shown many advantages for a number of industry sectors including aerospace. Due to easy availability of increased computing power it is now possible to apply new ultrasonic processing techniques based on the full matrix capture (FMC) acquisition method, such as total focusing method (TFM) and multi-mode total focusing method (MTFM).

The FMC acquisition technique has been developed at the University of Bristol (UoB) and TWI Ltd for a number of years, and there have been several papers published on the basics of the technique. The FMC technique is based on the concept of firing on a single element in an ultrasonic array transducer while receiving on all elements. The process of 'fire on one and receive on all' then repeats until all elements in the array have fired once. Using a single ultrasonic wave mode, the data is then processed to provide an image where all points within the insonified area are fully focussed. This is achieved using the TFM algorithm.

These post-processing techniques promise higher resolution and more realistic pictorial images of flaws as well as enhanced detection and sizing capabilities. If operators can determine the shape and character of a flaw they will be in a better position to assess its morphology and nature. Better flaw sizing will facilitate more accurate fitness-for-service assessments, leading to enhanced levels of safety and reduced costs for industry.

This project aimed to assess the FMC based technique and provide objective technical information on the potential industrial use of the processing techniques and an assessment of their likely benefit to industry.

TWI is experienced in undertaking this type of technical assessment, and was able to ensure that the project was an objective, independent exercise to demonstrate the performance of the two proposed techniques compared to established PAUT inspection techniques.

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## Objectives

- Provide an independent assessment of FMC based techniques of TFM compared to PAUT (including focussed and unfocussed linear and sectorial scanning) in terms of sensitivity, resolution and S/N ratio.
- Assess inspection capabilities of TFM to determine its ability to size and characterise flaws.
- Development of calibration procedures for linear and annular phased array configurations.
- Develop and optimise a Graphical User Interface (GUI) for all processing and data analysis software to improve the ease-of-use and accessibility of the technique.

## Project Outcome

- Application of the techniques on the sponsor supplied samples and materials.
- Detailed report on the comparison between Full Matrix Capture and Phased Array ultrasonic techniques.
- Full Matrix Capture data acquisition and analysis software package including a graphical user interface.
- Full Matrix Capture calibration procedures

## Benefits

- Greater reliability in defect sizing and characterisation.
- Less conservative design regimes due to improved defect sizing and characterisation, resulting from the potential to detect smaller defects compared to existing ultrasonic techniques.
- Improved reliability of fitness-for-purpose assessments because of more accurate flaw size data, resulting in enhanced levels of safety and reduced inspection costs.
- Clients acquired knowhow needed to identify appropriate applications for this new technique.

## Participants

The Sponsor Group comprised:

- AVIC BIAM
- DSTL

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## Scope of Work

TWI designed and sourced a calibration block that was used to develop an FMC calibration procedure that allows the setup of the inspection sensitivity prior to the testing.

The assessment was in two stages.

### Stage 1 Assessment of basic limitations

- Signal-to-noise.
- Geometric parameter limitations.

The signal-to-noise was initially calibrated and tested against known reflectors such as side drilled and flat bottomed holes.

Further, the baseline data was acquired by using the same array probes in a conventional phased array mode of operation.

### Stage 2 Data analysis capability

The data processing algorithms developed by TWI, including TFM were assessed against current conventional phased array techniques.

Both stages tested the method against a set of known flaws in the TWI designed test blocks and Sponsor supplied samples.

Optimum procedures were developed for the examination of the specimens using the PeakNDT MicroPulse 5PA instrument, together with the developed software. The PeakNDT phased array instrument used has 128 active channels, and was used with a range of phased array probes available at TWI.

## Price and Duration

The project had a duration of two years and a budget of £100,000. There were two Sponsors each making a contribution of £50,000. The fee for additional companies buying back into the project results is £50,000

An additional programme of algorithm development was carried out on an internally funded TWI Project (budget £50,000) and results were made available to Sponsors.

## Further Information

For further information on Joint Industry Projects (JIP) and their operation, please visit:

<http://www.twi.co.uk/services/research-and-consultancy/joint-industry-projects/>

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