

BINDT Aerospace Workshop - NDT for Metallic Airframe Components

UT TFM Inspection of LMDw Parts

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UT TFM Inspection of LMDw Parts - Introduction

Laser Melt Deposition by wire (LMDw)

- > For historical “subtractive” production processes, the requirement for inspection has always been the material providers’ responsibility.
- > LMDw is a new production process where the manufacturer will be responsible for the NDT inspection requirements for these parts
- > GKN has done a down selection of applicable NDT techniques, ultrasonic inspection has been identified as the most applicable technique.
- > Considerations:
 - Inspection part in as deposited state (pictured)
 - Inspection after machining



  Region of interest

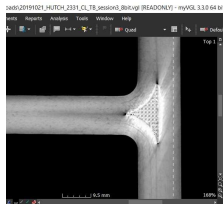


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1.3 Competing Technologies

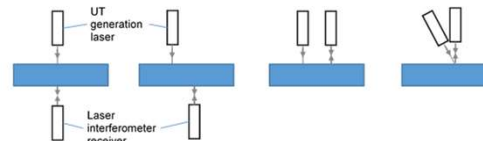
Radiographic Techniques

- > These include, film radiography, digital radiography and X-ray CT
- > Film and digital techniques cannot detect cracks so are discounted
- > X-Ray CT (below) is a significant improvement of the above techniques. It has good resolution /sensitivity which reduces as the part size increases, so only suitable for smaller parts Geometry also effects sensitivity. However cost of equipment rules out using/purchasing equipment until it reduces



Laser Ultrasound

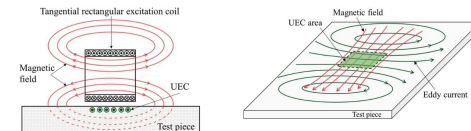
- > This is a non-contact inspection Technique
- > Several modes of operation which have different pros/cons and costs associated
- > It has potential application in In-process NDE.
- > Cost of equipment is high and there are very few companies that have adopted the technology



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Eddy current Techniques

- > This is a also non-contact inspection Technique
- > Currently a manual technique. To be most effective the technique needs to be automated. There is research being done to look at automating eddy current arrays
- > It has potential application in In-process NDE.
- > Potential to defect defects in thin metallic parts only, so will have limited applications. Not suitable for LMDw parts.





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LMDw geometries

<p>Single wall deposition</p> <ul style="list-style-type: none">• Inspection from web• Inspection from base plate		<p>Overhang deposition</p> <ul style="list-style-type: none">• Inspection from web• Inspection of overhang	
<p>Angled wall deposition</p> <ul style="list-style-type: none">• Inspection from web		<p>Sloped wall deposition</p> <ul style="list-style-type: none">• Inspection from web• Inspection from base plate	
<p>T-section deposition</p> <ul style="list-style-type: none">• Inspection from web• Inspection from base plate		<p>Cruciform wall deposition</p> <ul style="list-style-type: none">• Inspection from web• Inspection from base plate	
<p>Double sided deposition</p> <ul style="list-style-type: none">• Inspection from web		<p>Tapered deposition</p> <ul style="list-style-type: none">• Inspection from web• Inspection from base plate	



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Test Pieces

> 2 test pieces were made for Initial TRL3 tests:



Calibration/sensitivity block

- Manufactured from Billet
- Includes 1.2mm and 0.8mm spherical and flat bottomed holes
- From 5mm to 45mm



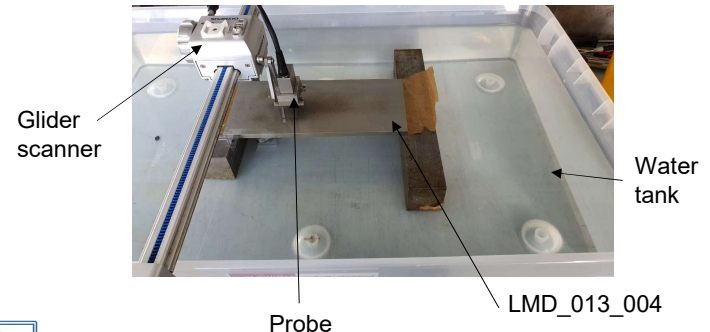
LMDw T-section test piece

- Manufactured by external company
- Max deposition 60mm

TRL 3 tests

> Test setup for TWI test:

- PEAK LTPA (64:128)
- Linked to computer running TWI Crystal software
- Olympus probe (10MHz, 64 elements, 0.5mm pitch)
- Olympus Glider Scanner

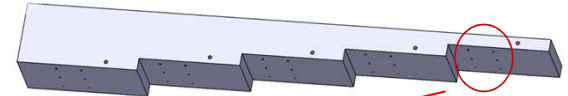




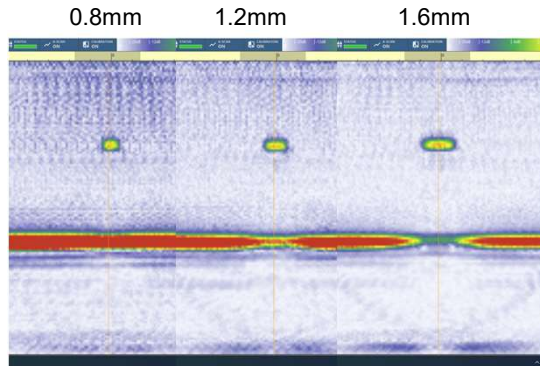
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Test Piece results

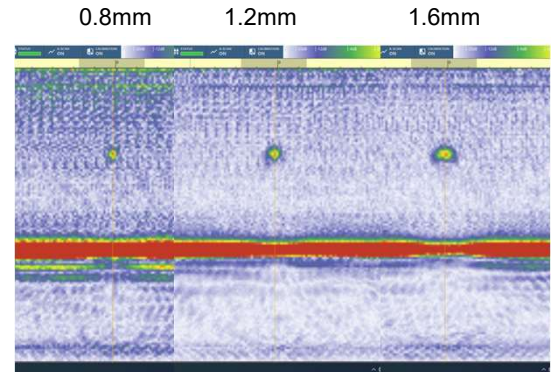
> Spherical Bottomed Holes vs Flat Bottomed Holes @ 5mm



B-Scan images of Flat bottomed holes



B-scan images of spherical bottomed holes



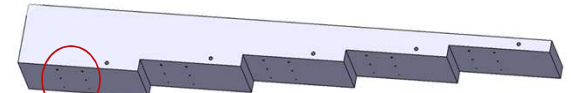
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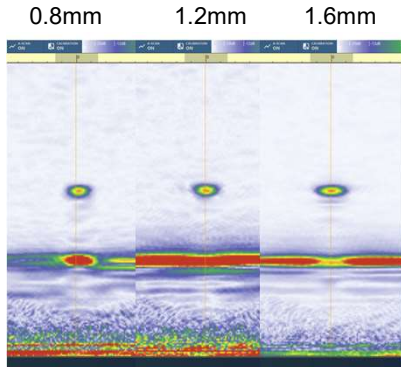
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Test Piece results

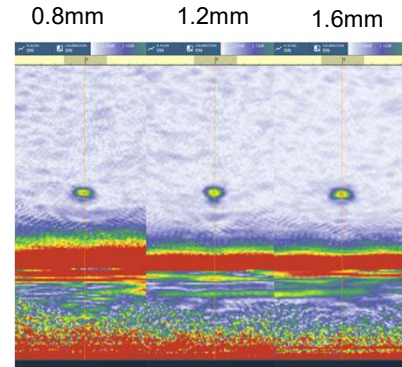
> Spherical Bottomed Holes vs Flat Bottomed Holes @ 45mm



B-Scan images of Flat bottomed holes



B-scan images of spherical bottomed holes



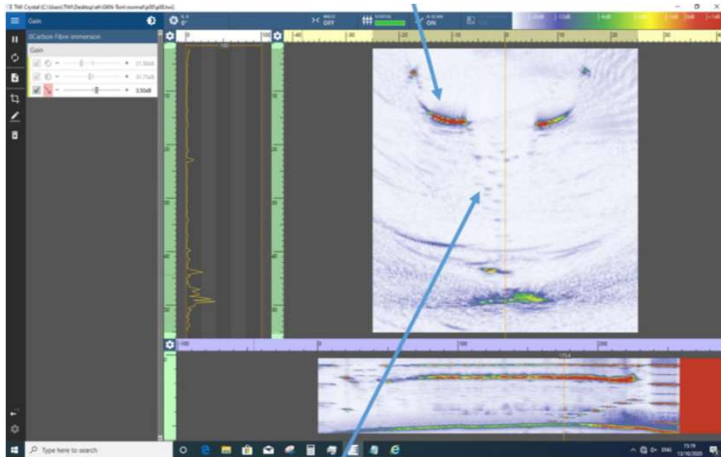


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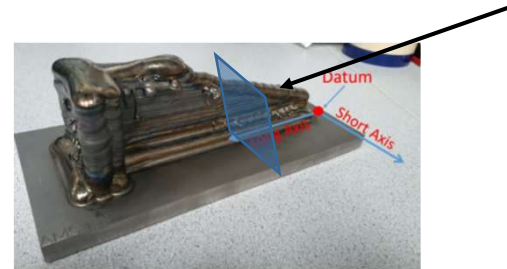
Test Piece results

- > T-section Test Piece LMD_013_004 - Inspection parallel to short axis

Geometry indications



Small indications

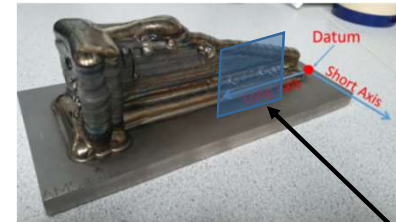
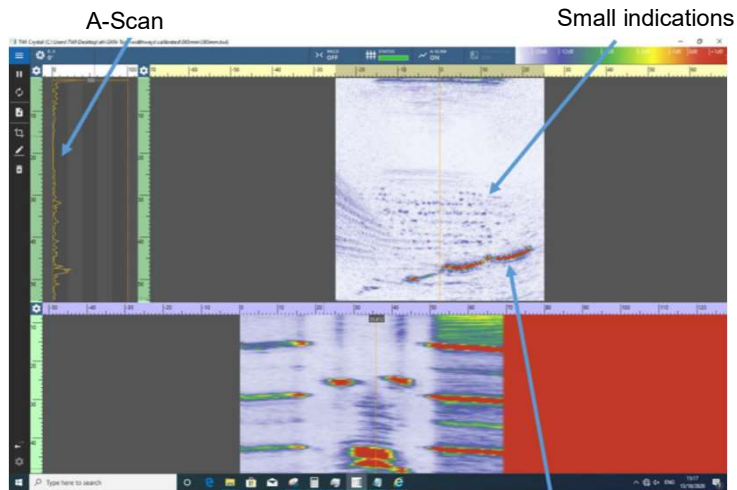




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Test Piece results

- > T-section Test Piece LMD_013_004 - Inspection parallel to long axis



Geometry indications (backwall)

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X-ray CT of Test samples

X-ray CT of cal block

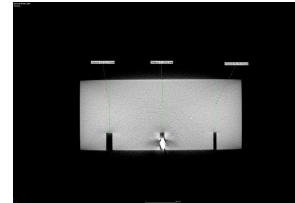
- > X-ray CT was used to check the hole depths on the calibration block.
- > They match the tolerances on the drawing

X-ray CT of T section Test piece

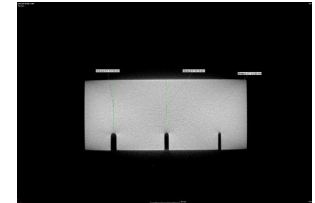
- > Results don't quite stack up with the UT TFM results provided.
- > Re-inspecting the T-section piece with our UT TFM setup would be required
- > We also need to consider cutting up the test piece to see what the indications shown by the UT are

X-ray CT: 2D slice of cal block

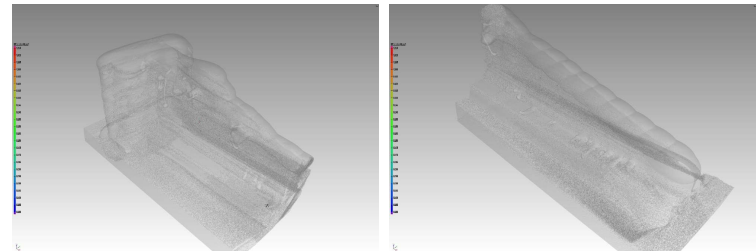
20mm step: Flat Bottomed Holes



20mm step: Spherical Bottomed Holes



CT scan: T section Test piece





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Next Steps

- > New equipment setup for GKN to support the LMDw activities
- > Manufacture more representative test pieces
- > Conduct further tests and support LMDw Cell with inspection of parts as they are manufactured
- > TRL4 Review Nov/Dec 2021
- > Training and Certification requirements review

InspectionWare
NDE Development Platform



PEAK NDT

