Robotic Inspection of Complex Structures

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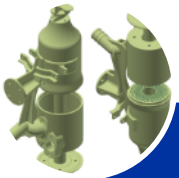
Acknowledgements – The Intacom Team Martyn Lindop, Nathan Hartley, David Carswell and Jonathan Riise

IntA*Com* Programme

Aim

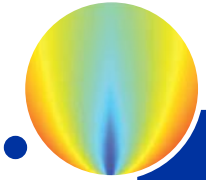
Reduce inspection time for complex geometries without loss of inspection quality

Metrology Solutions



3D Printed Nozzles

Custom Built Software



Advanced PAUT

Automation

New Robot Cell

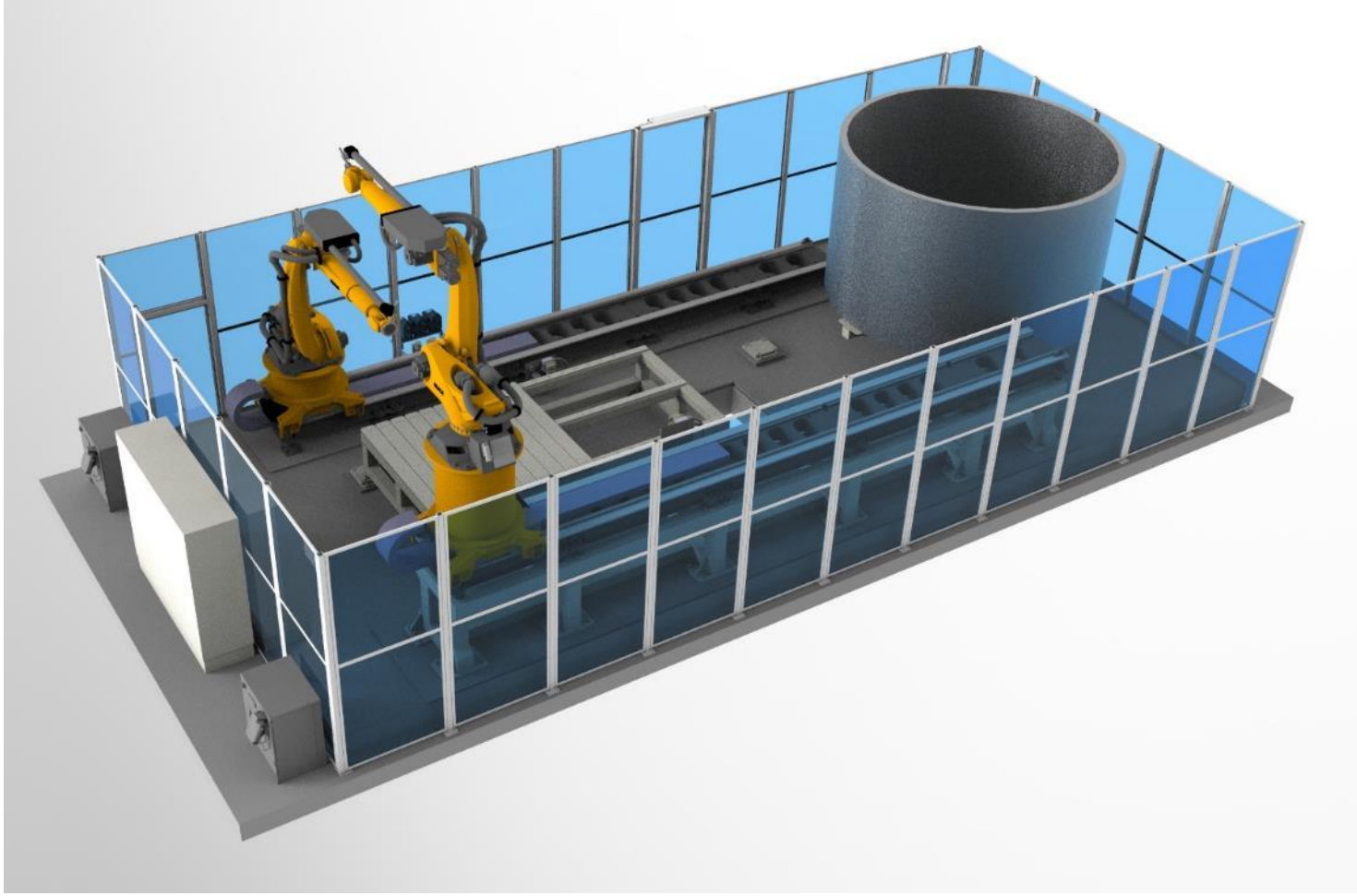
Tracks
10m

Turntable
4m Dia

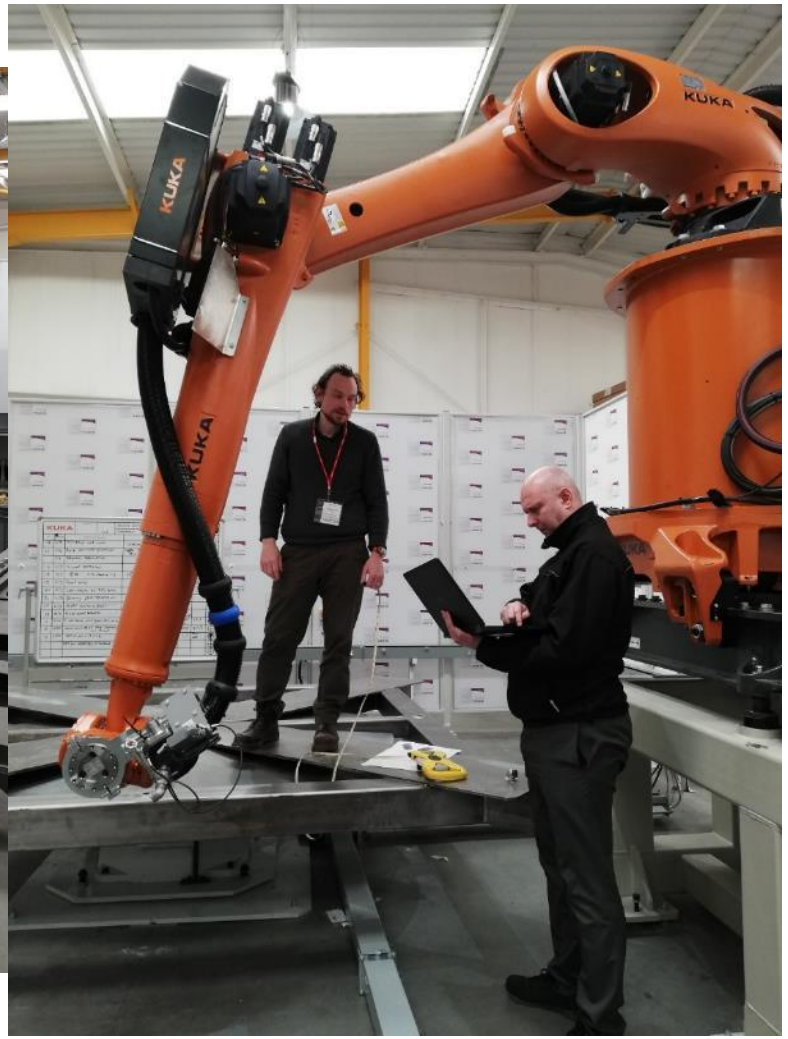
Parts:

14m Long

5m High



New Robot Cell



Managing Large Data Sets

- Limit sub-paths (coordinate indexes) to 1m in x and y
- Acquire every mm, but plot every 100 mm
- Use multiple coordinate files targeting same data
- Only allow loading of 1 (or 2) high res sub-regions

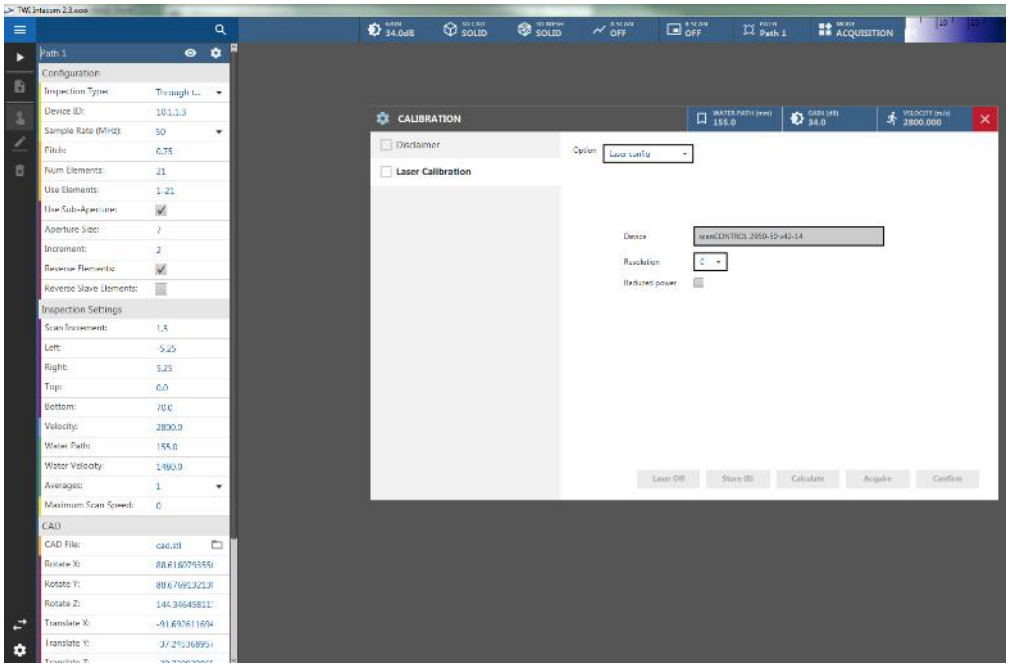
Exaggerated here (screen is 1080p while mesh will be at much higher density)

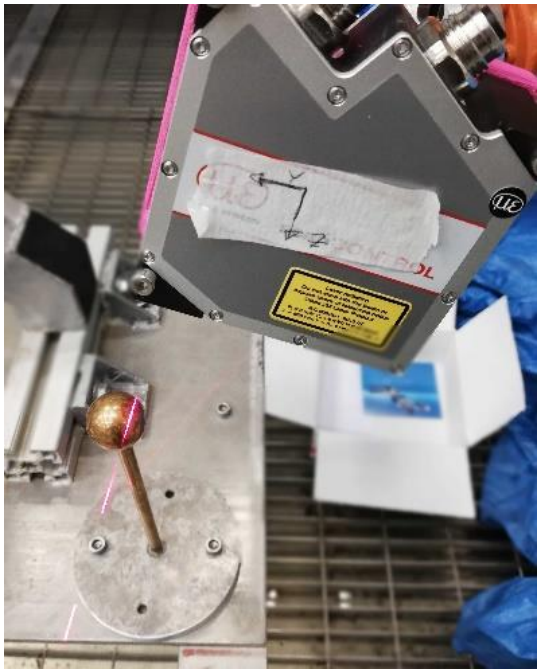
Laser Profiler Integration

Software developments: laser integration in IntACom 2

Software Integration

- High accuracy, automated calibration of component position
- Ability to generate surface point clouds
- Automated TCP calibration procedure (ca. 0.3mm error)





Motion Capture Technology

Mainly used in animation, medical and sports science for tracking humans (or animals!)

Passive markers are tracked by arrangement of cameras to provide 3D position as well as orientation

Use of Qualisys system for tracking robots and for encoding of on-site scanning

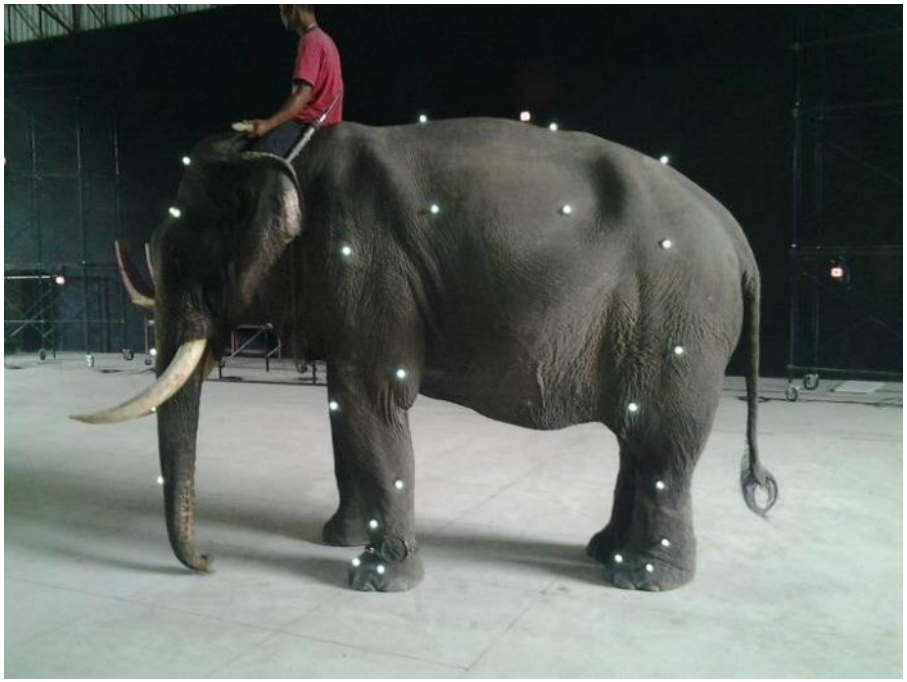
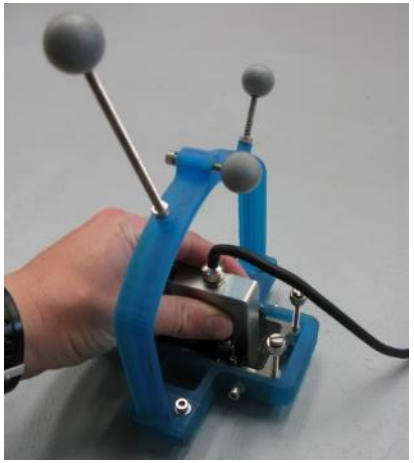


Image credits: Thanya Nualla-ong (https://www.coroflot.com/thanya919/portfolio)

Use Cases

- **Robot tracking**
  - Component position tracking
  - Track robots for path corrections
  - Track cooperating robots simultaneously
  - Encode data at high feedback rates

- **On-Site Scanning System**
  - Track hand-held probes in 3D
  - Manually scanning curved surfaces
  - Interface with IntACOM software to overlay data on CAD
  - Ability to visualise scans from different areas together

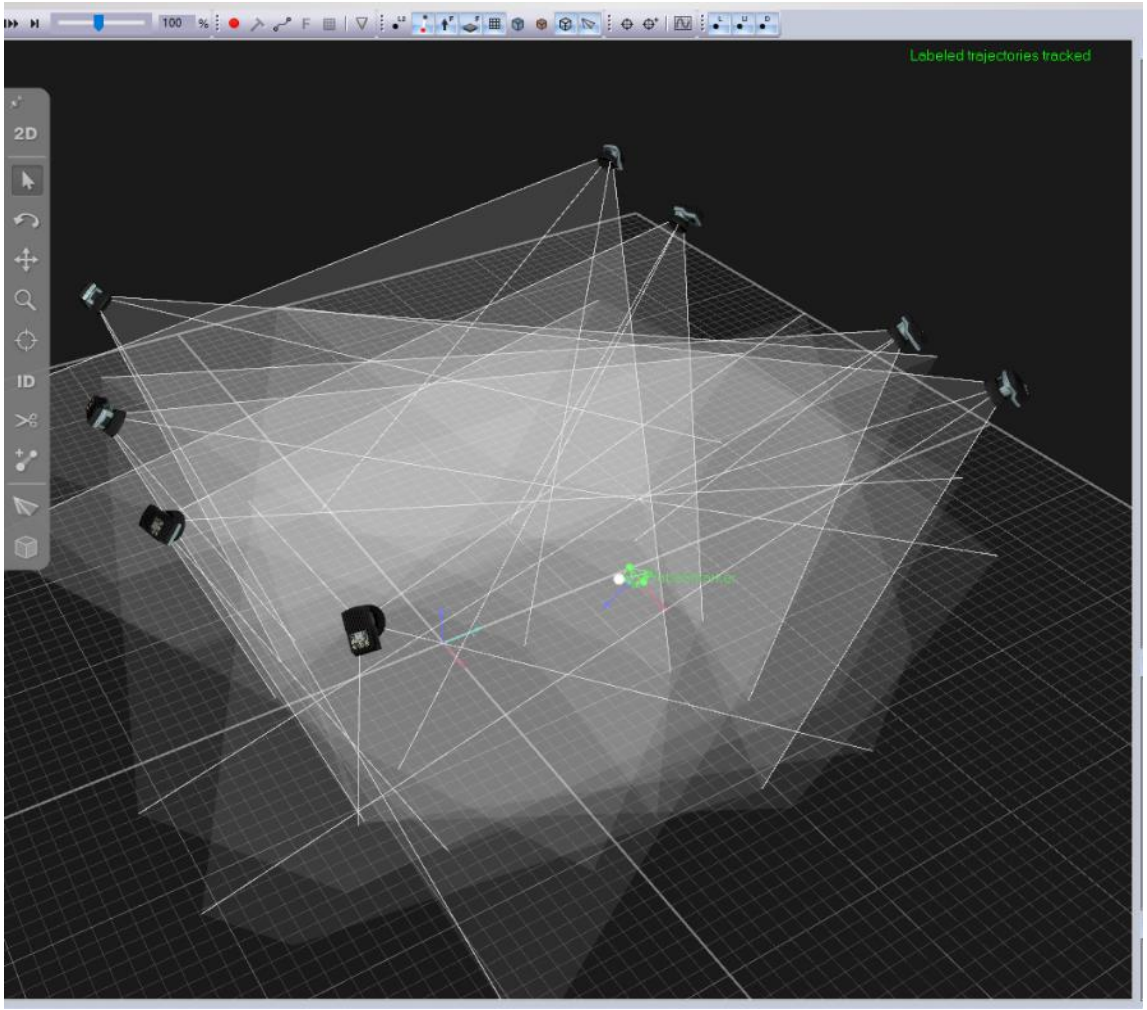


Motion Capture at TWI

- 8 Qualisys cameras installed on lightweight scaffold
  - Can be set up on tripods instead
- Line of sight required to markers from at least 2 cameras
- Tracking volume up to 10s of m^3, depending on camera placement

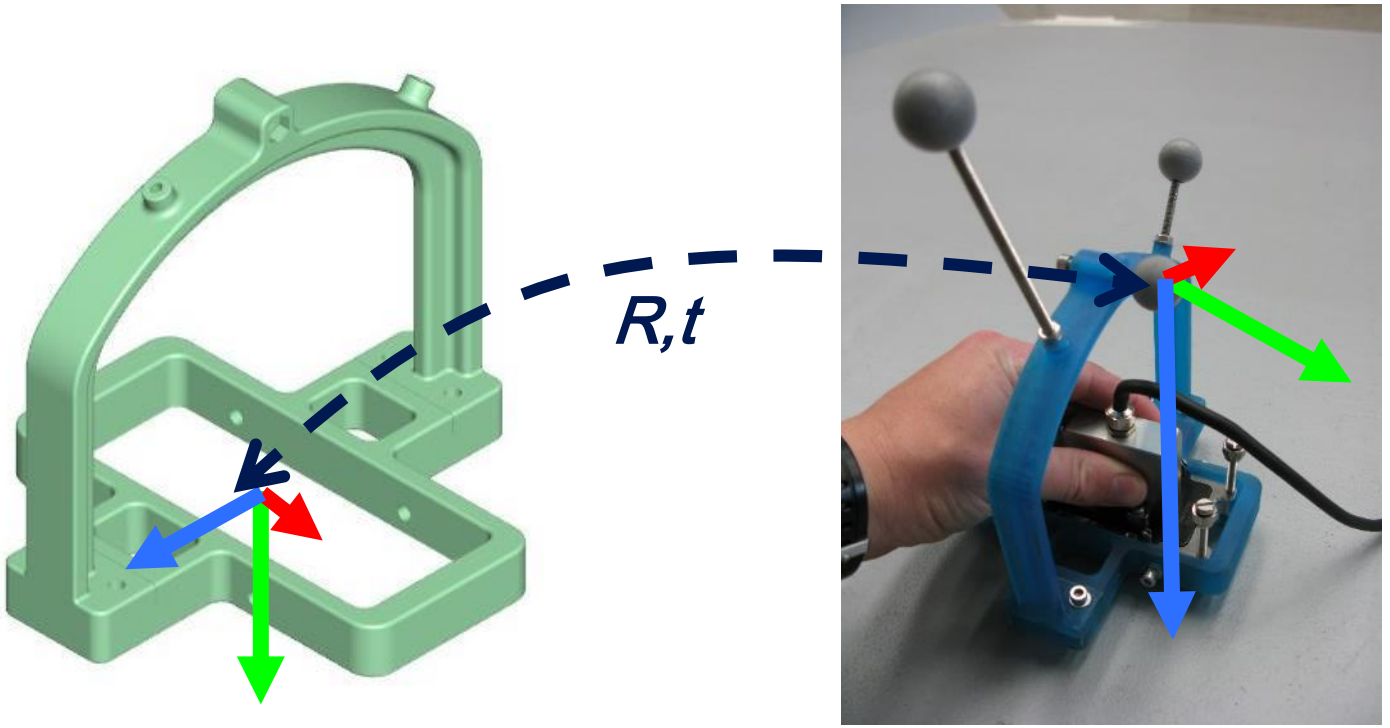
Tracking System

- Covered volume can be checked in software
- Define rigid body to get 6DoF information
- Track up to 1000s of markers at same time
- Resolution of 0.02mm



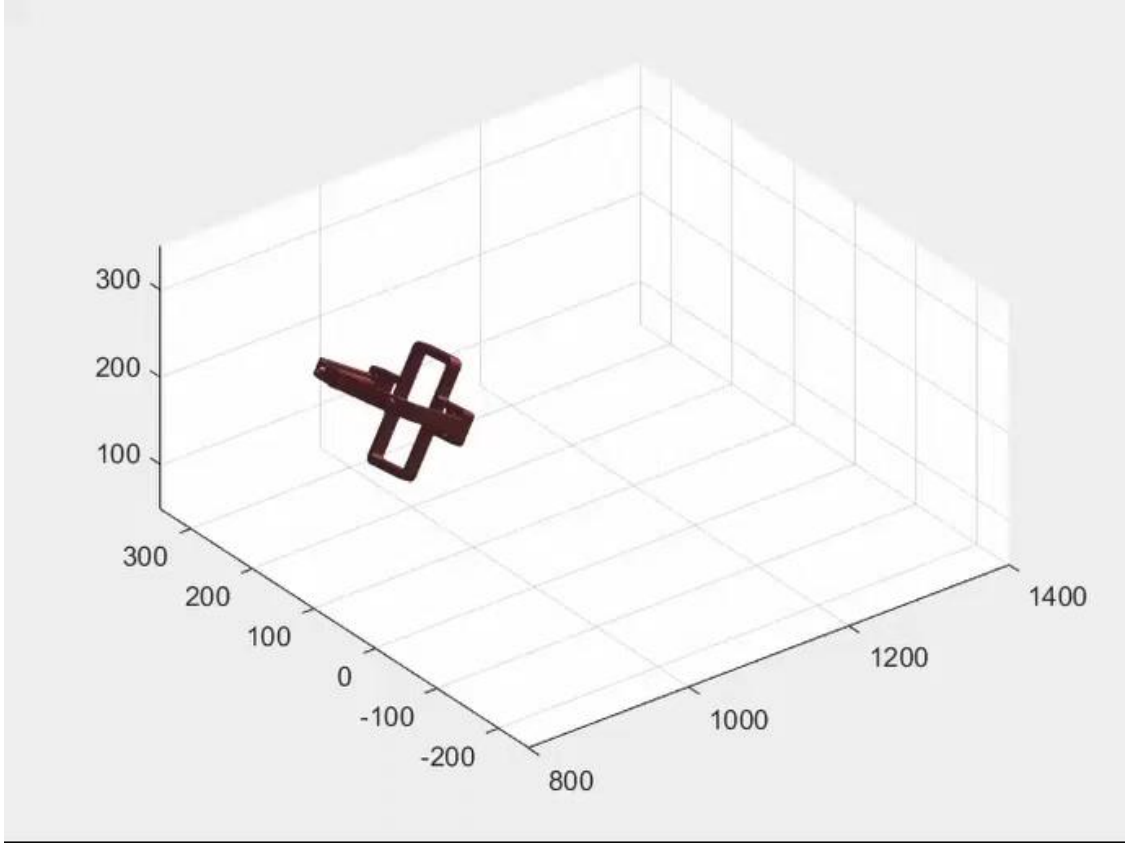
Tool Holder

Attach at least 3 markers to probe
Initial design created for a 5MHz, 64 element probe
Use CAD to find transform between ref frames



Tracking Results

Curved surface



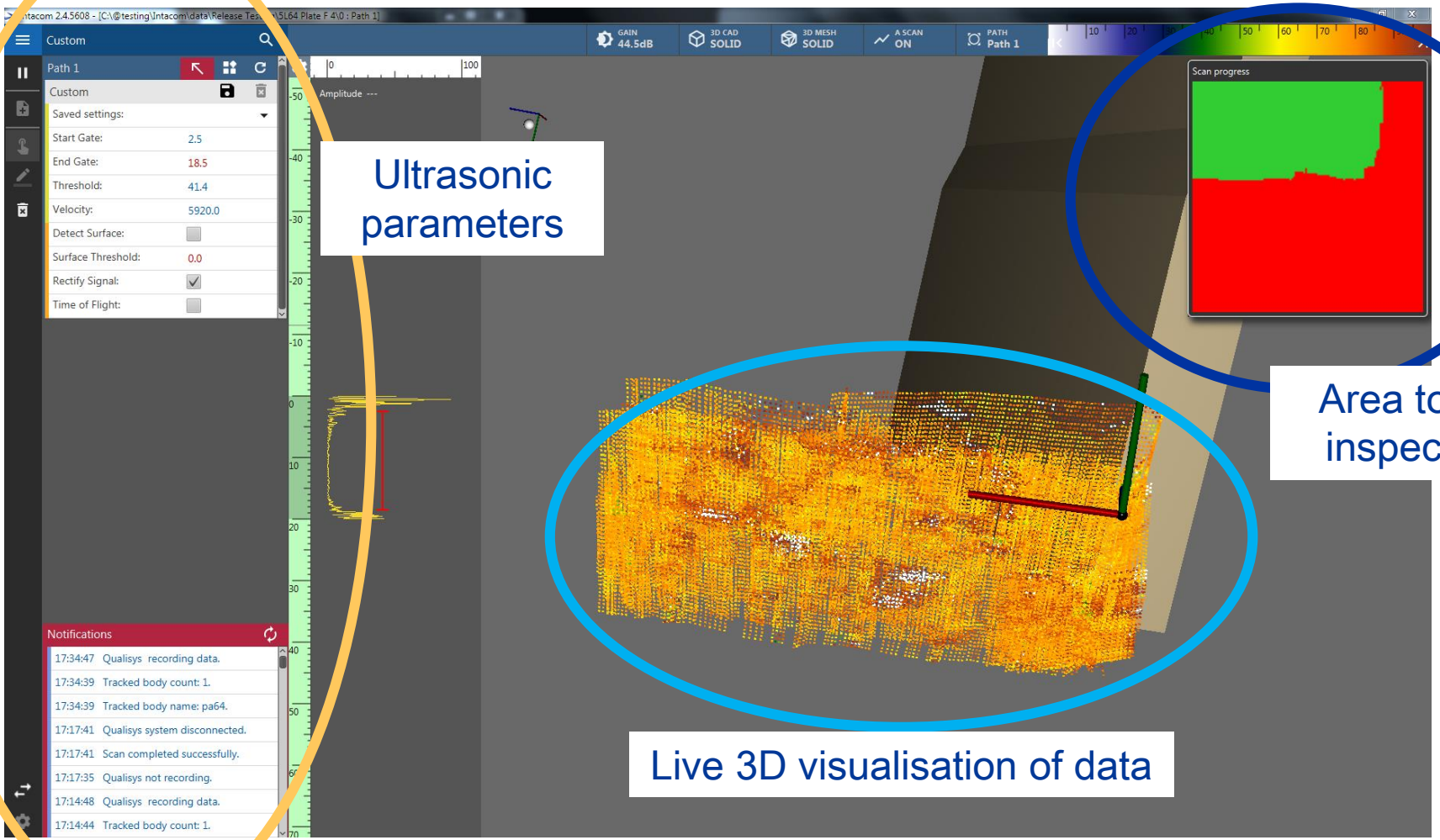
Site Inspections

IntACOM partner RNLI seeking solution for large area inspection on site

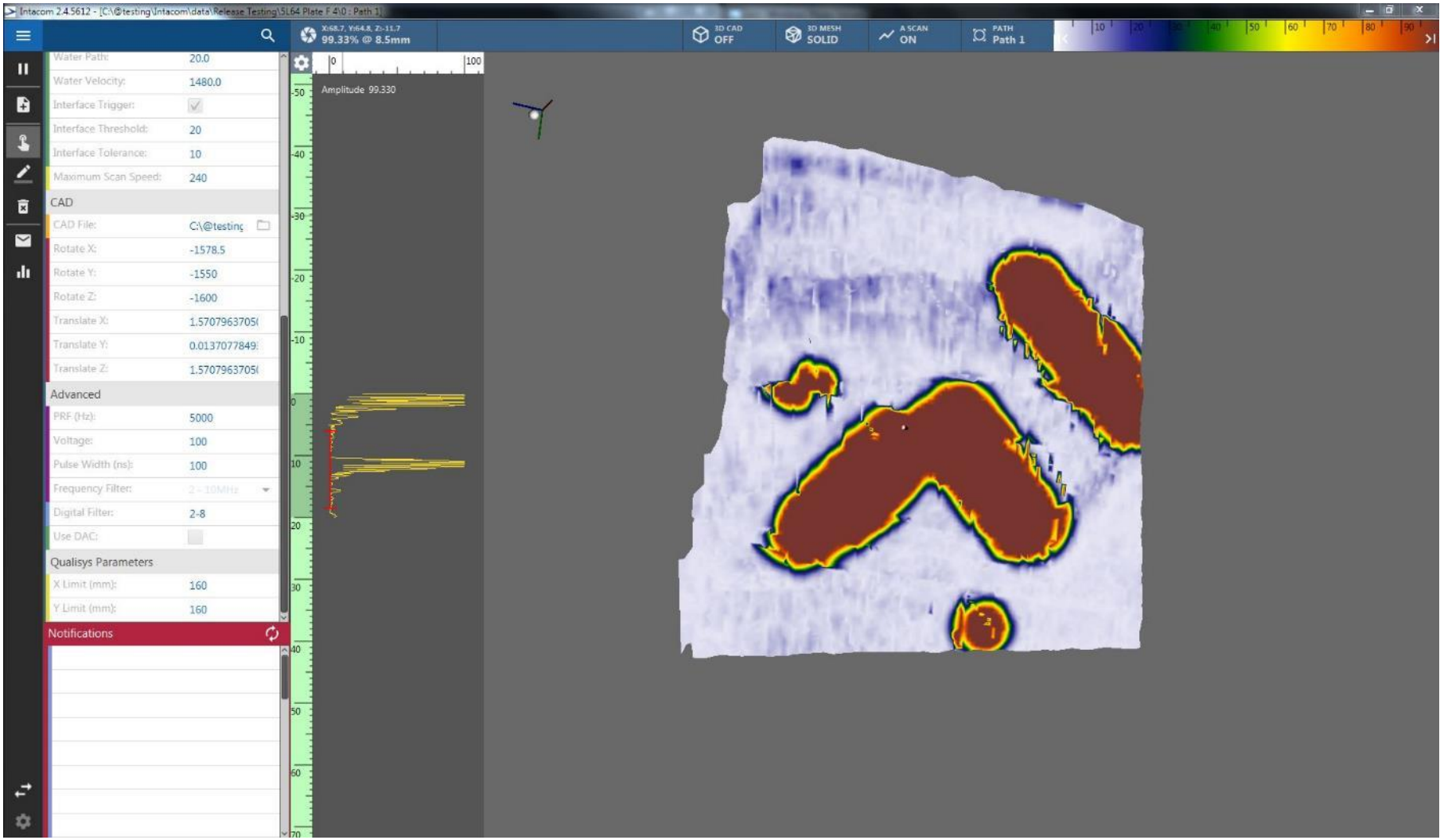
Use of cameras to track probe movements on boat hull

Site trials conducted to determine feasibility and accuracy

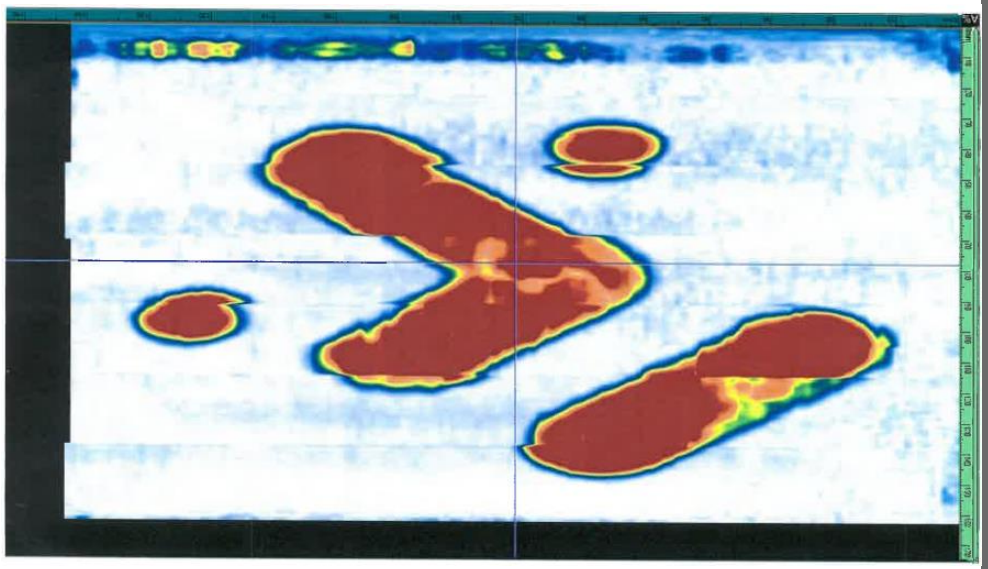
Software Interface during Scan

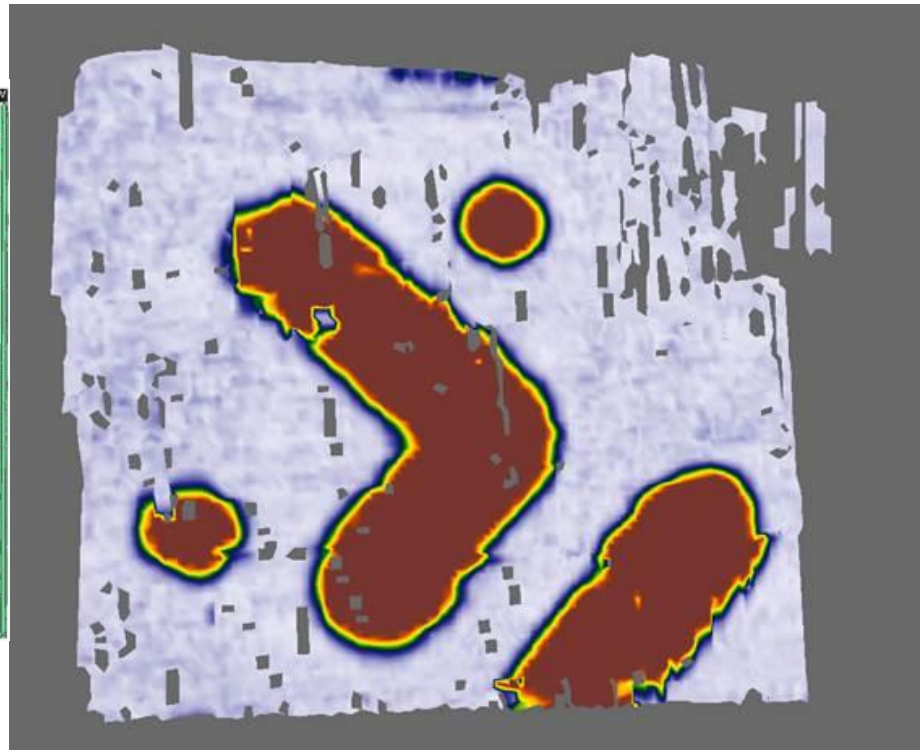


3D C-Scan of Reference Plate



Comparison with OmniScan





OmniScan Manual PA

Qualisys/IntACom

Missing areas: poor reflectivity and high tolerance for triangulation

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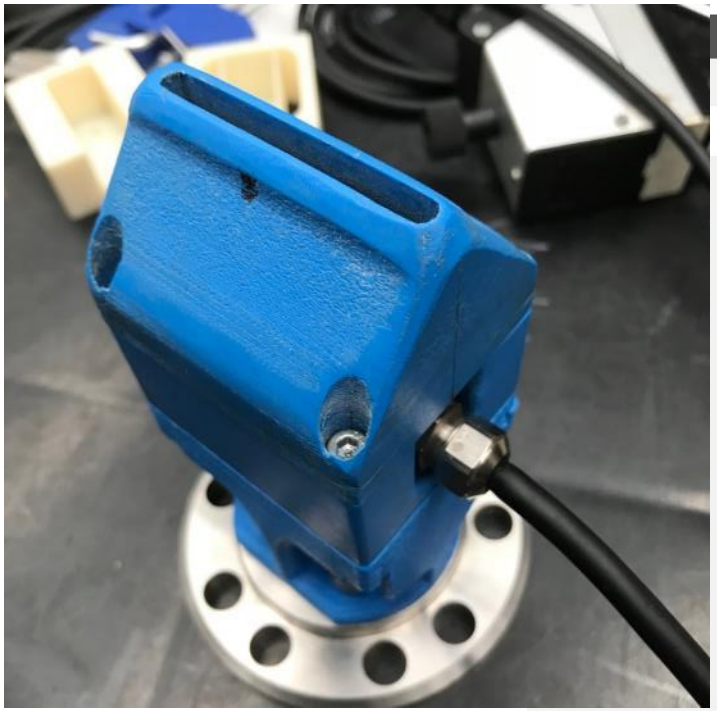
Original nozzle design

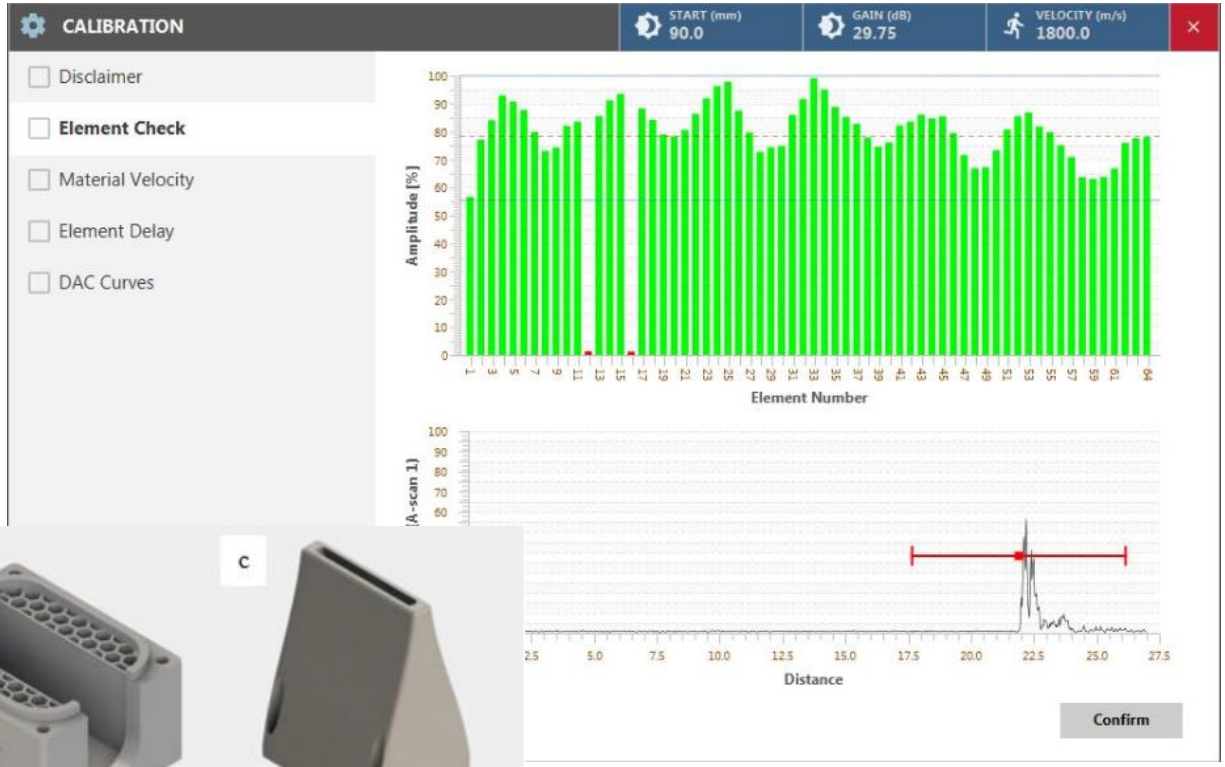


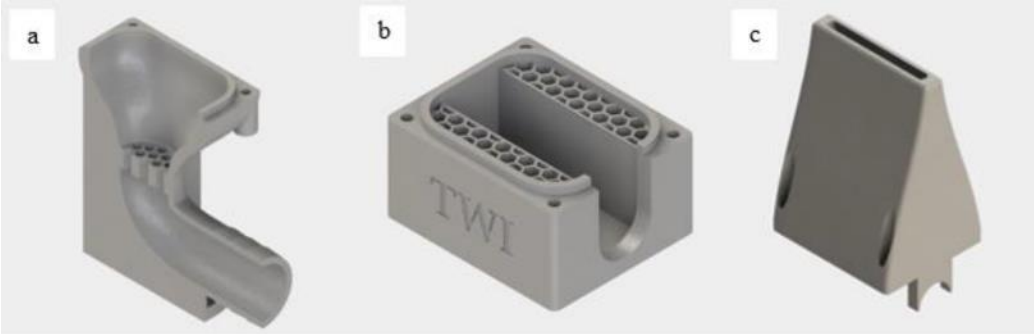
2 Dead Elements

Design created during Intacom 1

MEng Student Project

Improved nozzle design 1st Iteration





All element responses were within a 3dB threshold of each other

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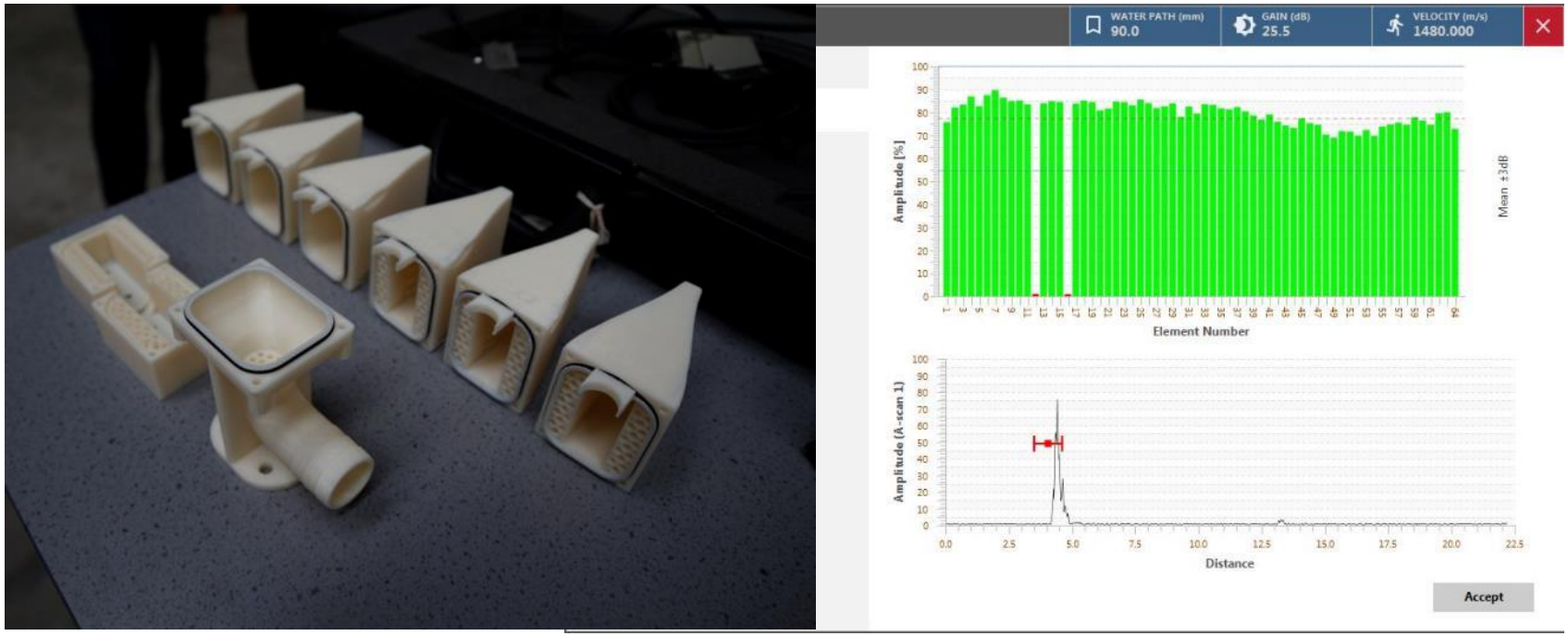
Improved nozzle design 2nd Iteration



Achieving better consistency across the array

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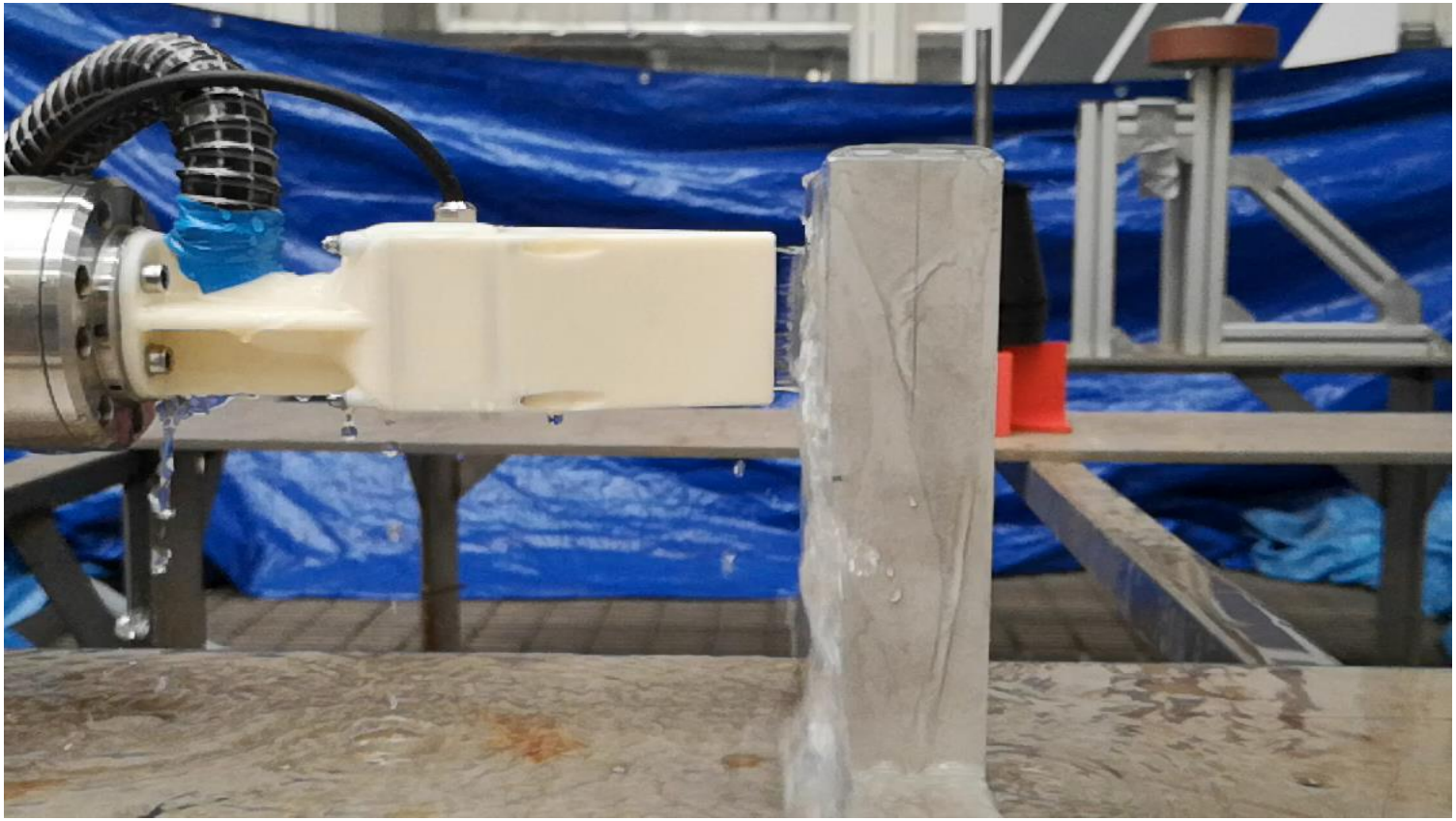

Test A

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Questions?

Thank you for listening

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