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Company founders: Tristan Lowe, Sam Johnston & Andrew Bowfield

The development and evaluation of image quality metrics in industrial X-ray CT

- Authors: Tristan Lowe, Sam Johnston, Andrew Bowfield & Steve Alderton
- Contributing Authors: Wenjuan Sun, Adam Thompson & Kenny Watson

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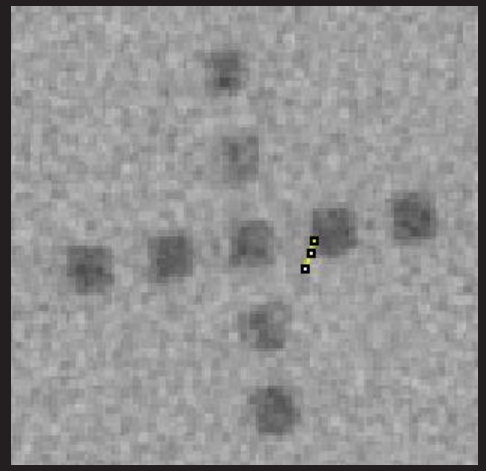
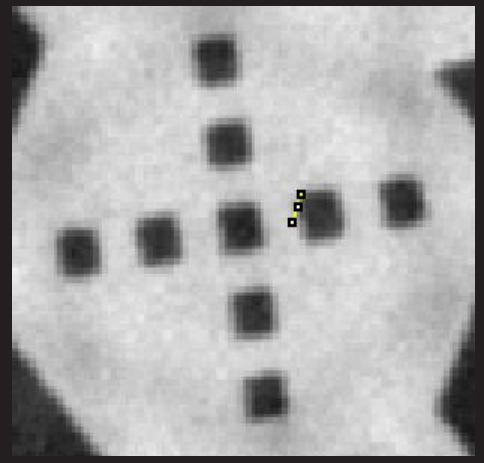
Overview

- The two sides of CT metrology
- Development of voxel calibration
- Image quality, resolution and measurement confidence?
- Application to industrial imaging
- Industrial Market Trials: Instrument calibration & tracking





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Two sides of CT metrology

Correct voxel calibration

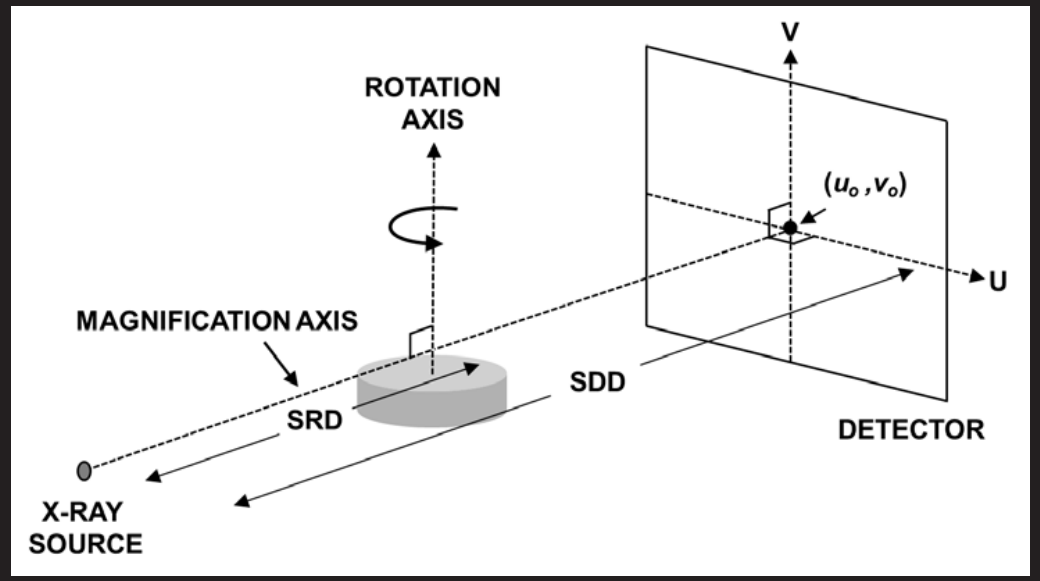
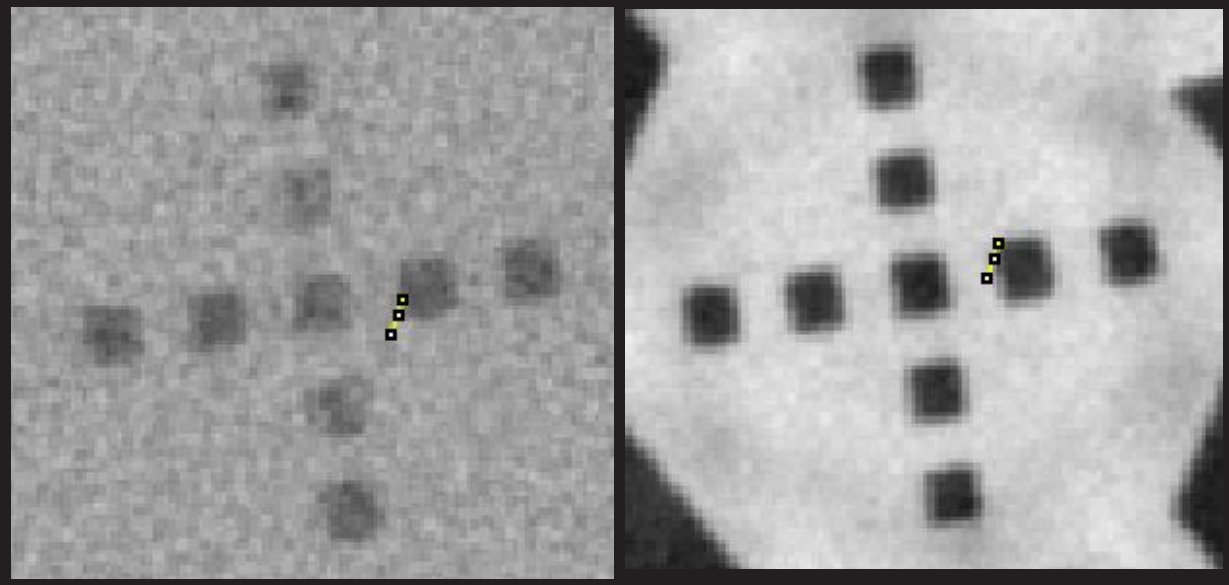


Image quality & Measurement confidence



Development of voxel calibration

Many types of gauges have been developed over the years

- Early influence of radiography
- Today three main designs
- Automated voxel calibration
- Adherence to standards!

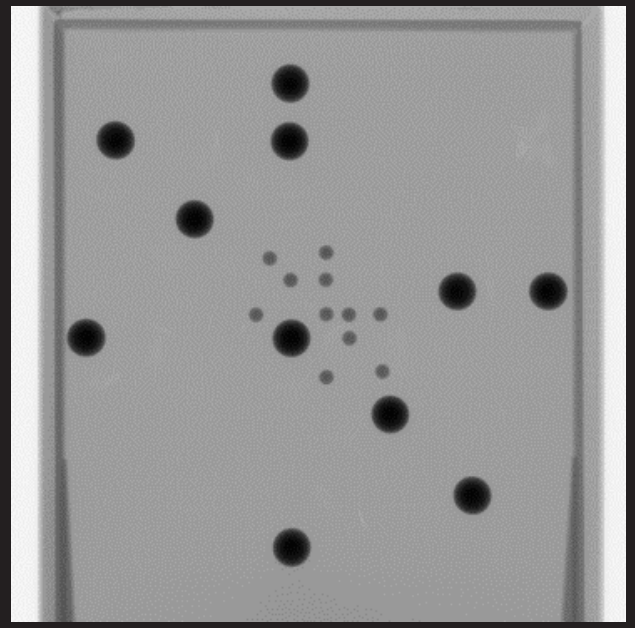


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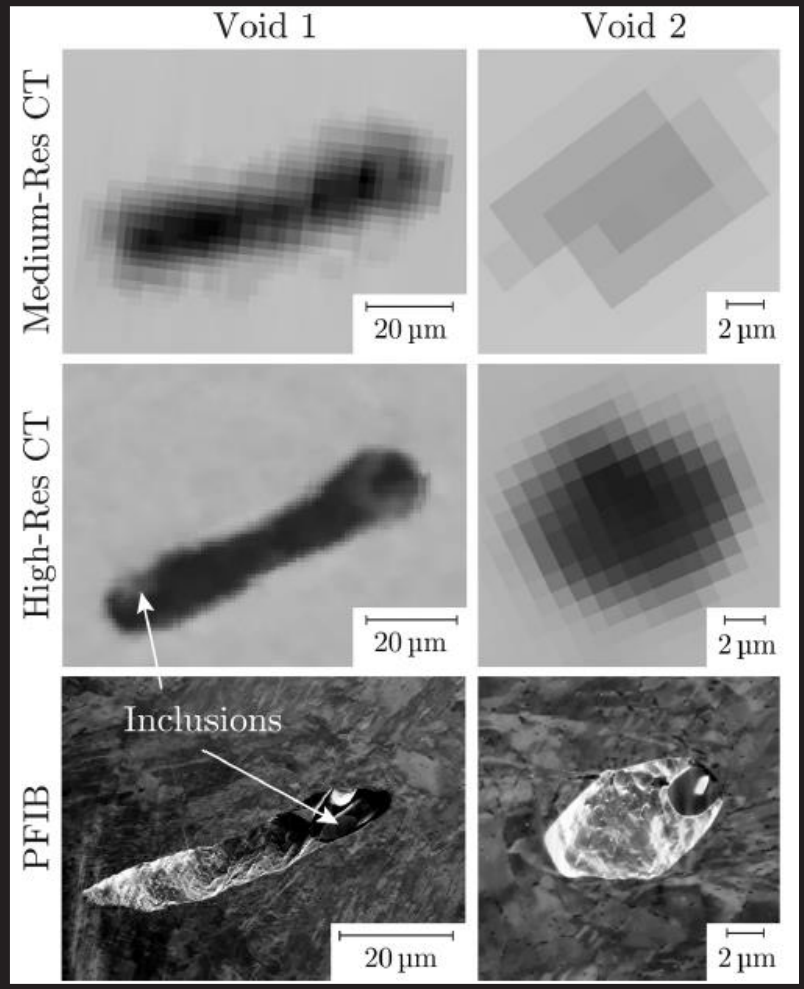
Image quality & spatial resolution

Spatial resolution:

"A measure of the smallest object that can be resolved"

Image Quality:

"The combination of the visually significant attributes to an image"



Daly et al, Acta Materialia (2017) 130, pp.56-68

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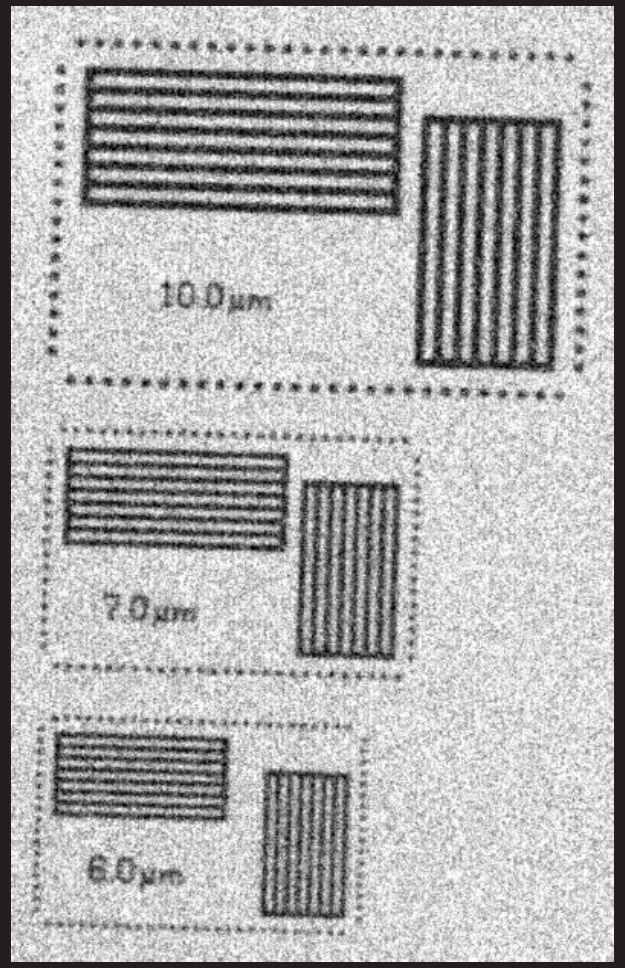
Image quality & spatial resolution

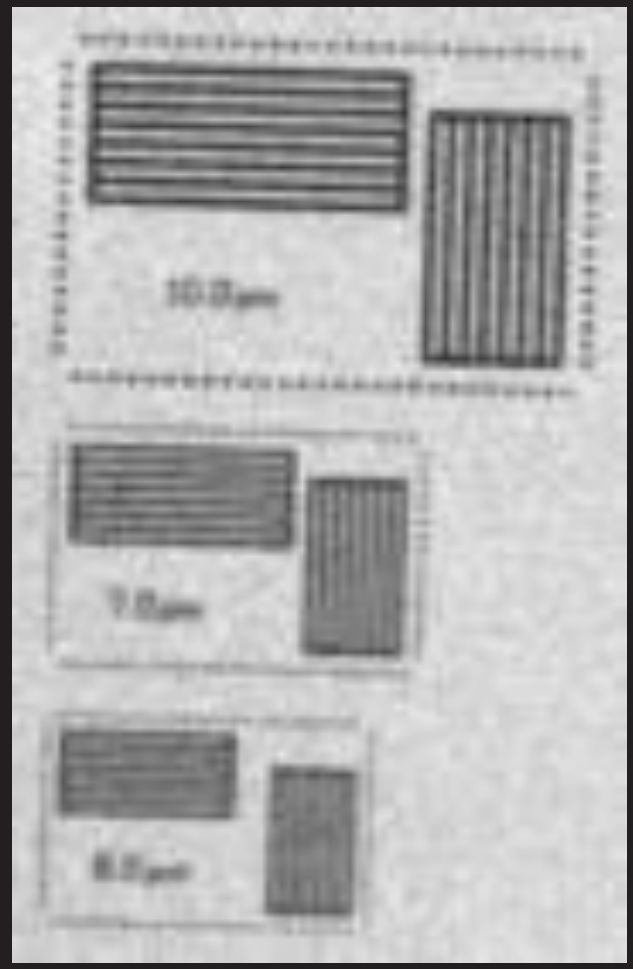
Radiographic image quality

- Effective pixel size
- Image noise
- Feature contrast
- Focal spot blurring

Extension into X-ray CT

- Projection number
- Reconstruction code
- Turn table accuracy





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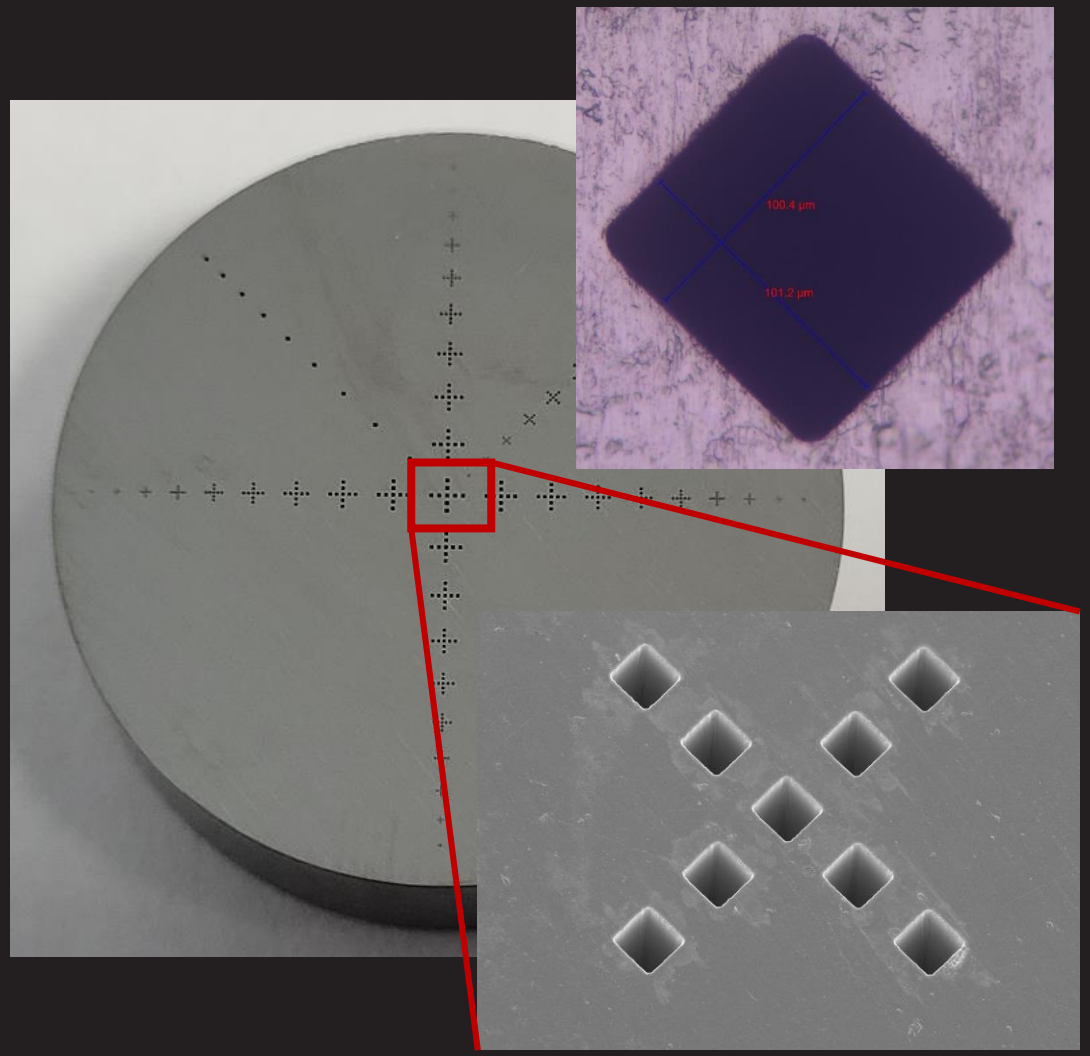
Application to industrial imaging

Application of a ground truth IQI to assess reconstructed image quality

- Use of established signal processing methods
  - ASTM E1441-19, E1695-20, E2002-15
  - New standard 2023
- Direct measure of spatial resolution
- Feature measurement error
- Feature measurement confidence



Industrial Market Trial: Instrument calibration & tracking

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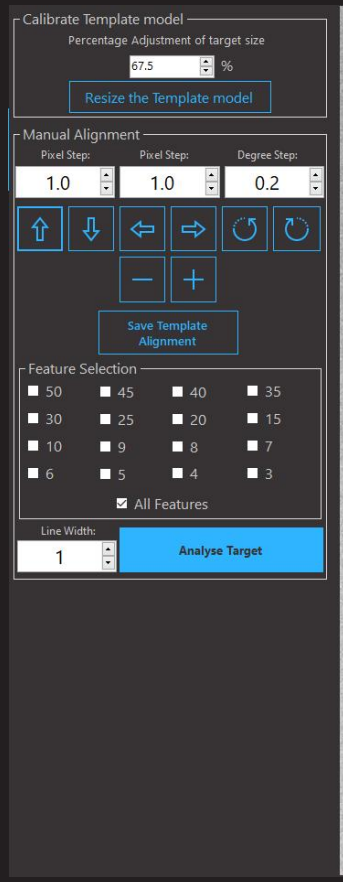
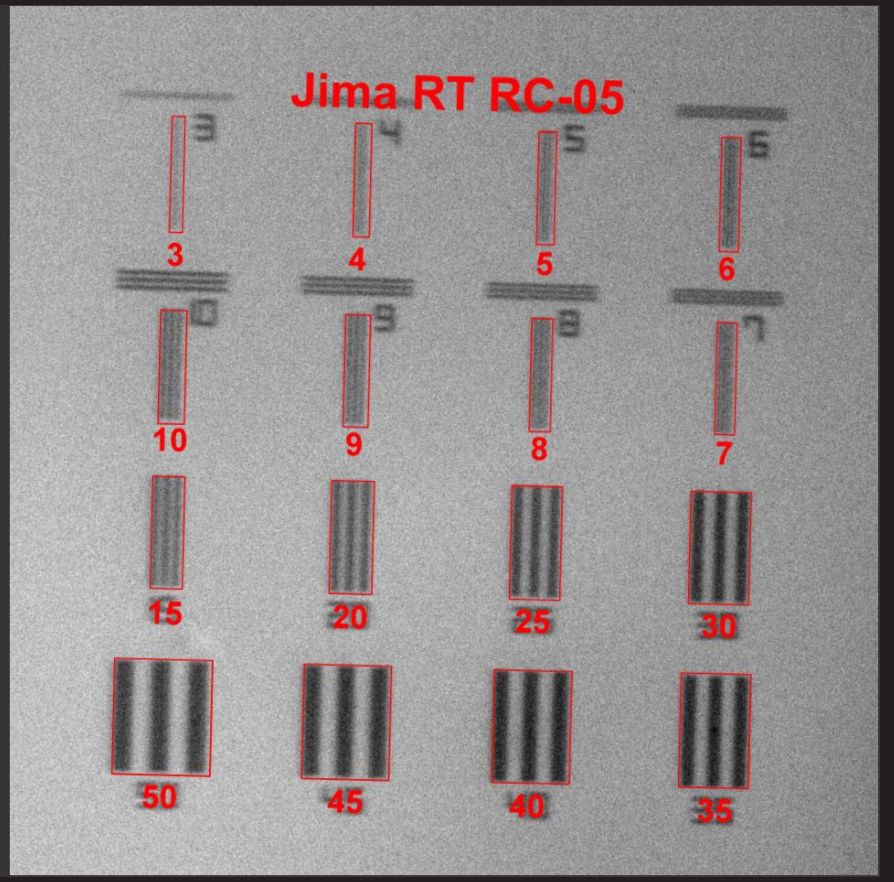
Can we track instrument performance quickly & efficiently for industrial applications?

- 2D IQI for radiograph quality
- 3D IQI - reconstructed data quality
- Software solution





Industrial Market Trial: Instrument calibration & tracking

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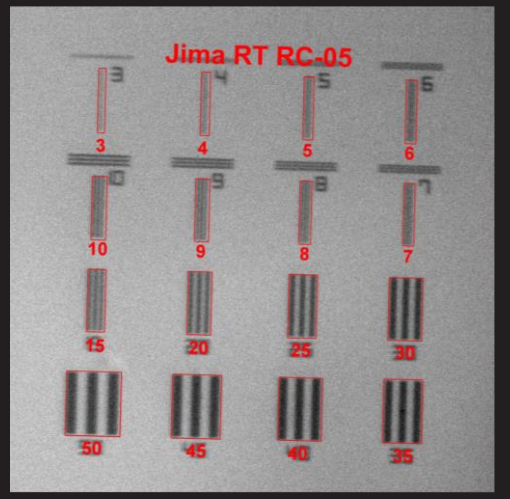
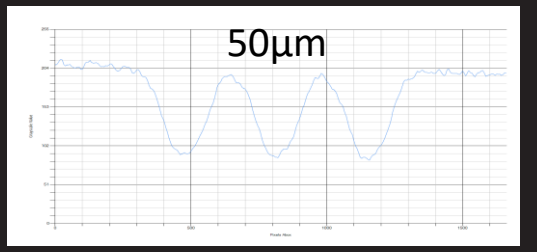
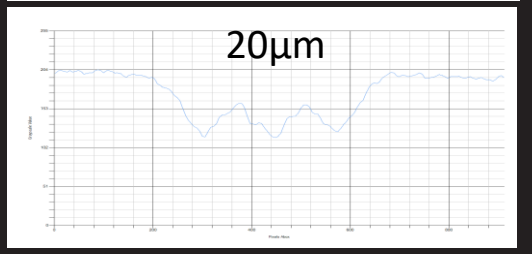
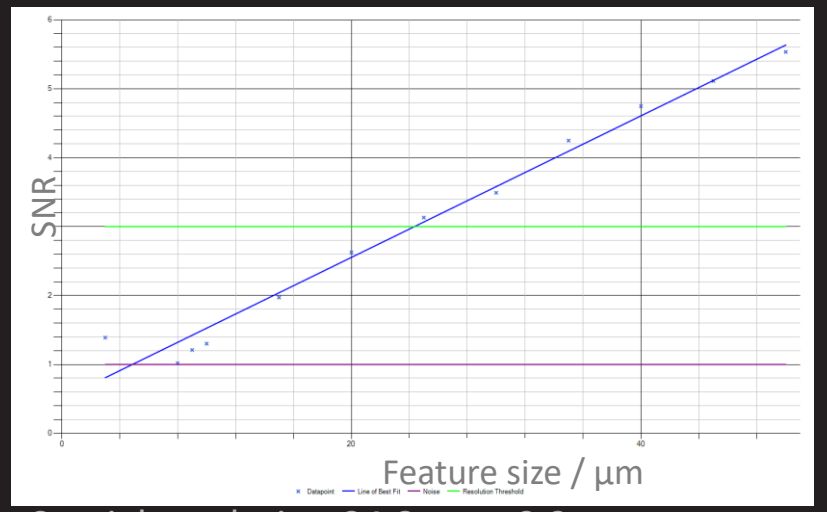
JIMA RT RC-05 used to track performance over 6 weeks?

- Template to extract data
- Extracted profiles used as sanity check
- SNR with 30% cut-off used to define spatial resolution
- Data tracking









Spatial resolution 24.3µm ± 0.2µm

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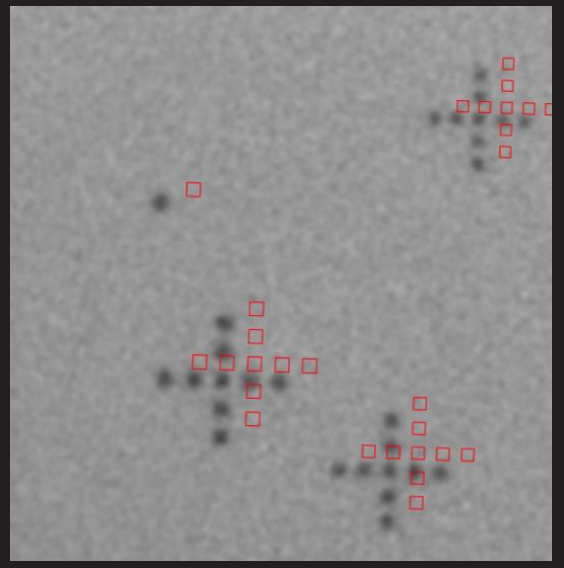
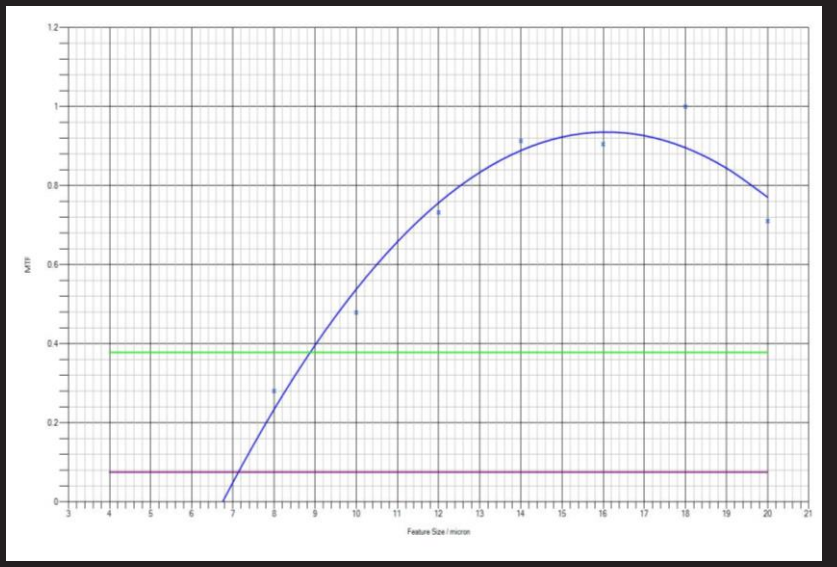
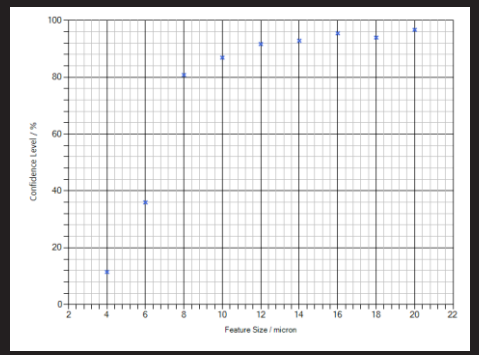
3D data tracking

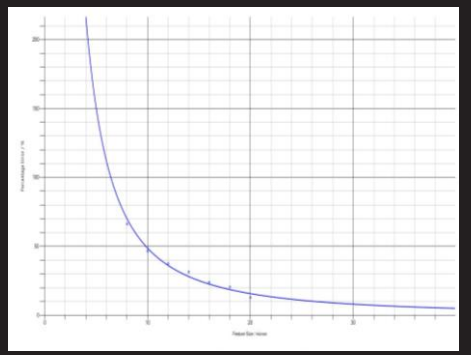
4mm IQI used to assess the reconstruction quality

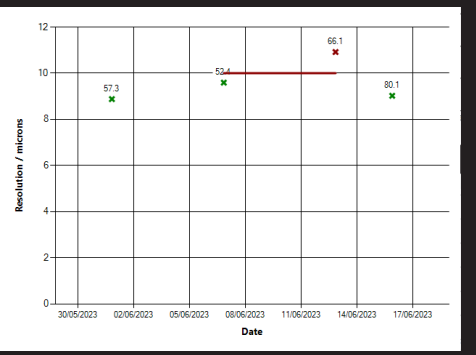
- Template matching
- Data assessment & resolution
- Measurement error & confidence
- Instrument stability
  - Apply limits
  - MTF & SNR











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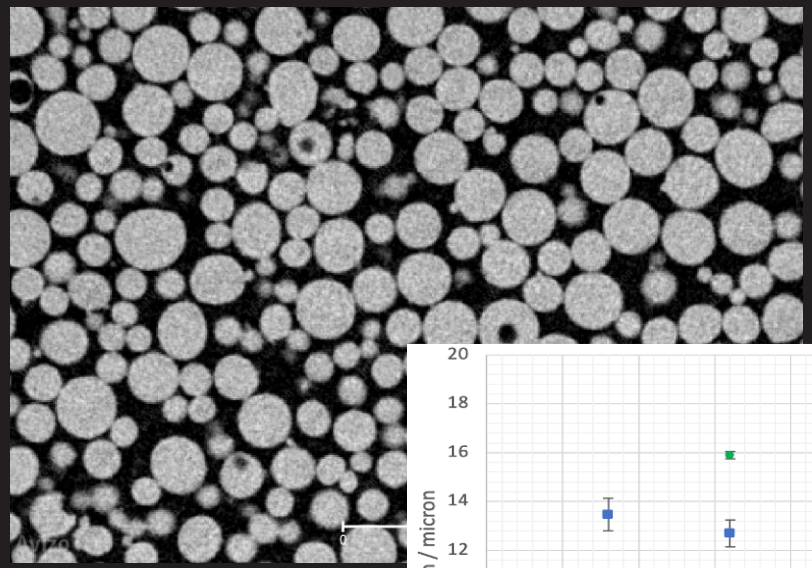
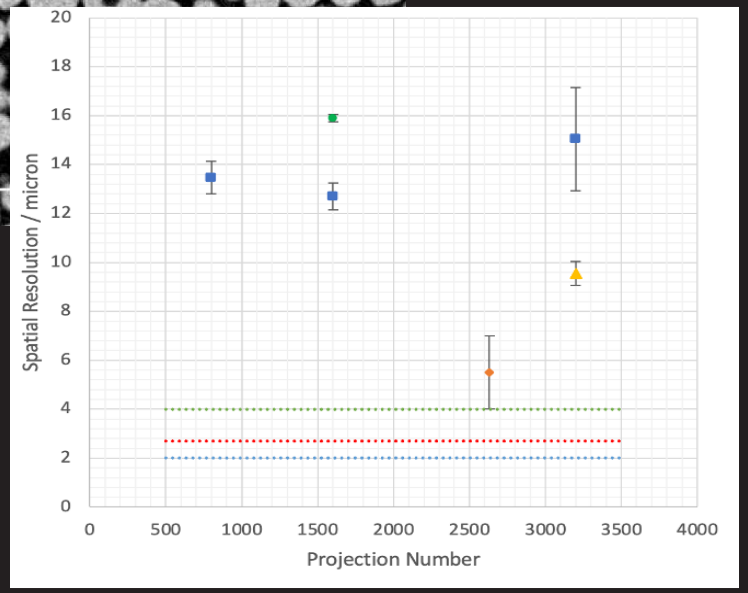
Industrial application

Analysis of raw powder for additive manufacturing quality control:

- Optimise scan setup
- Quantify instrument performance issues
- Direct comparison to other instrument scanning





Data & image courtesy of BAE Systems

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Summary

Image quality is an important aspect in NDE:

- 2D & 3D IQI's are now a real solution to X-ray CT
- Software solutions allow all users to evaluate data quality 2D/3D
  - Optimising scan quality
- Instrument performance quantified and tracked!