

Point cloud processing
- scanning, analysing and validating

NPL Freeform Centre of Excellence
launch -1st October

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Contents

- Heat shield tile measurements
- Laser scanner performance analysis
- Freeform software validation

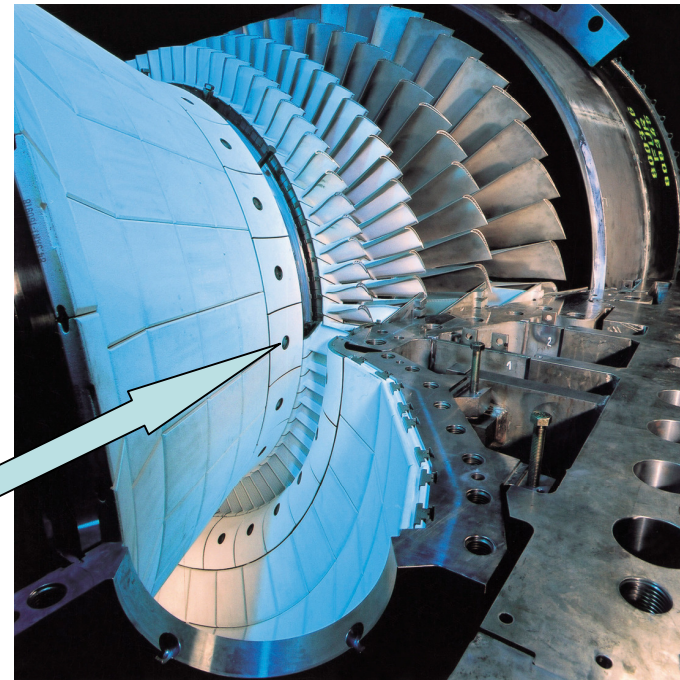
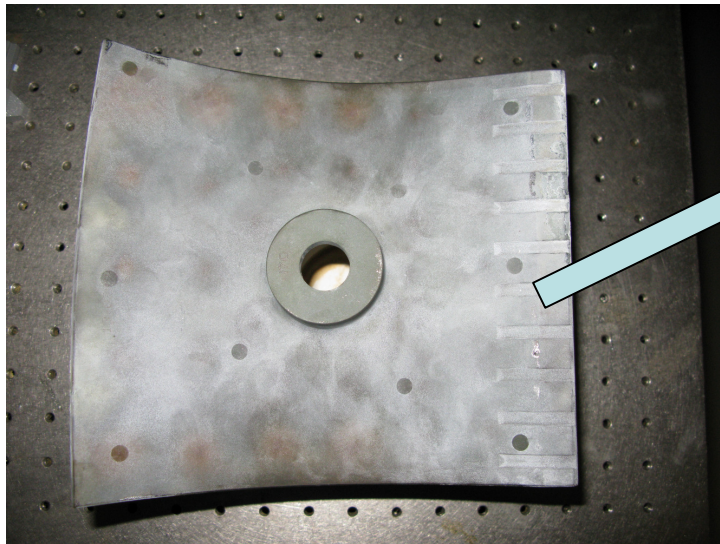
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Problem

- Premature failure of heat shield tiles

Heat shield tile



Npower Gas turbine engine

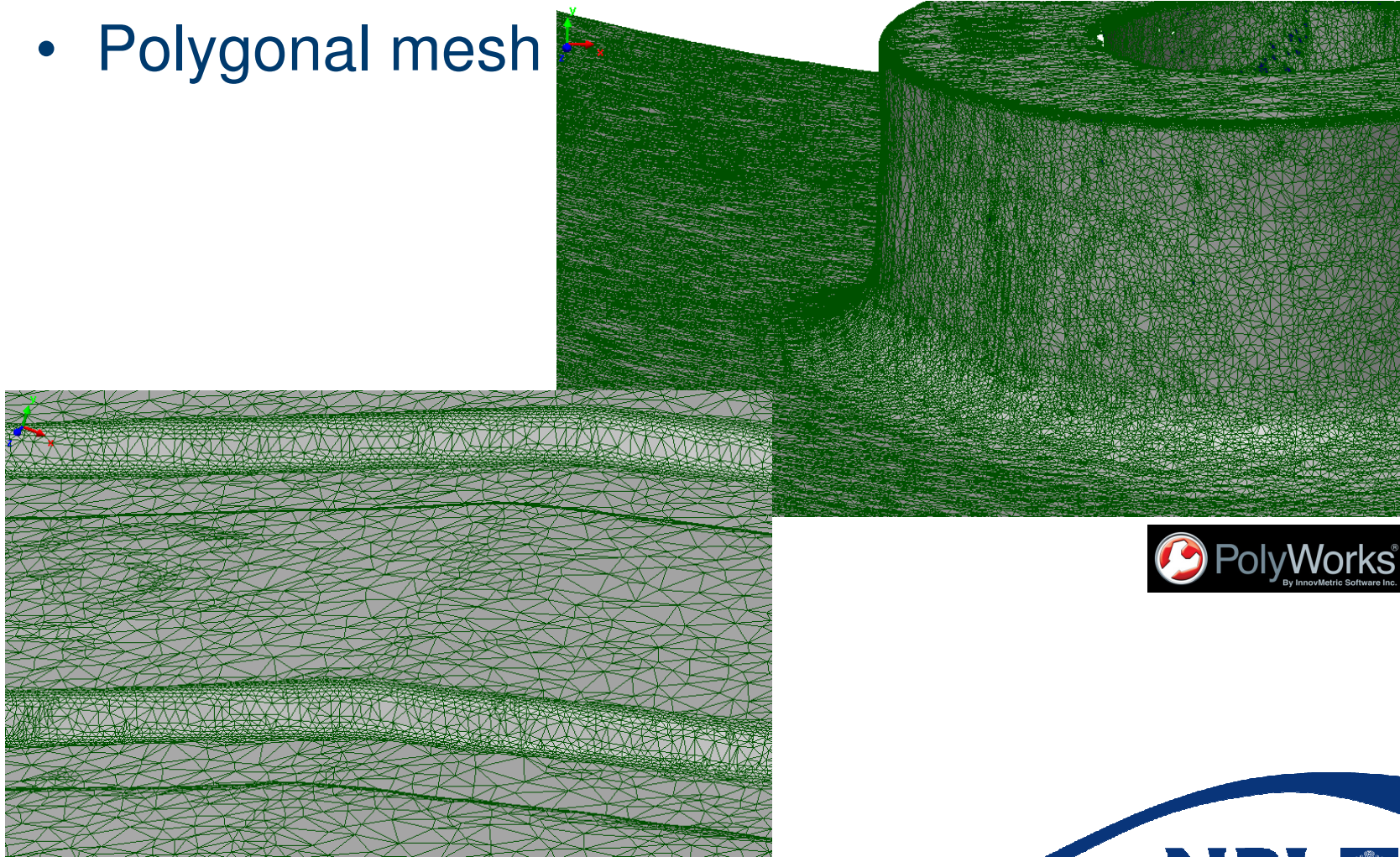
The approach

- Scanning using Faro Platinum arm and v3 laser scanner
- Registration using Polyworks IMAlign



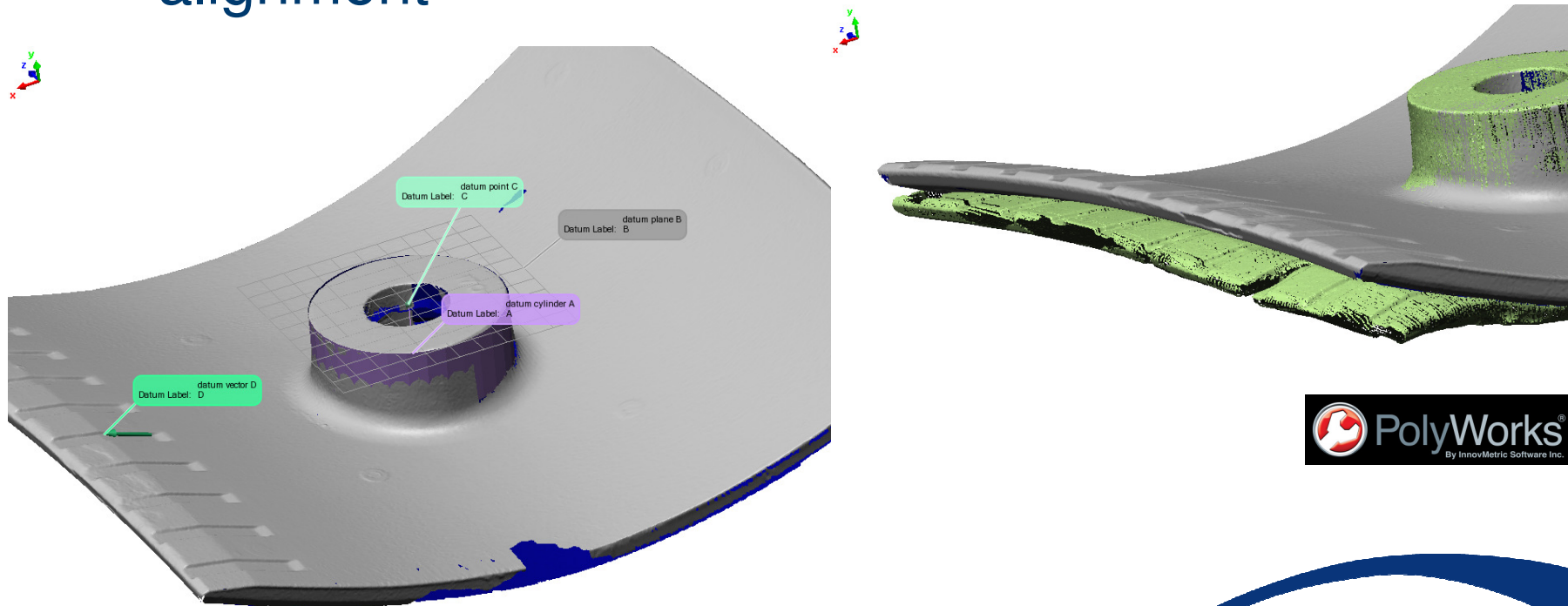
Producing a reference

- Polygonal mesh

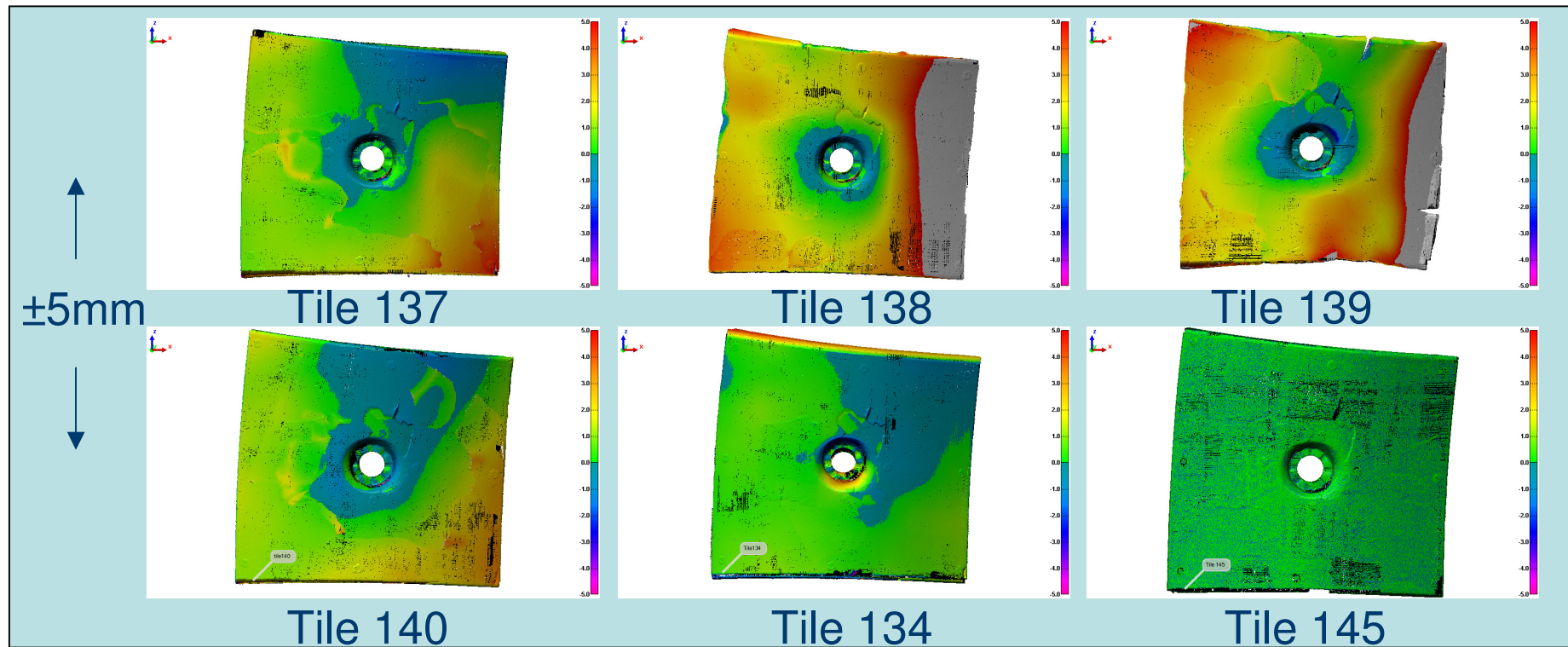
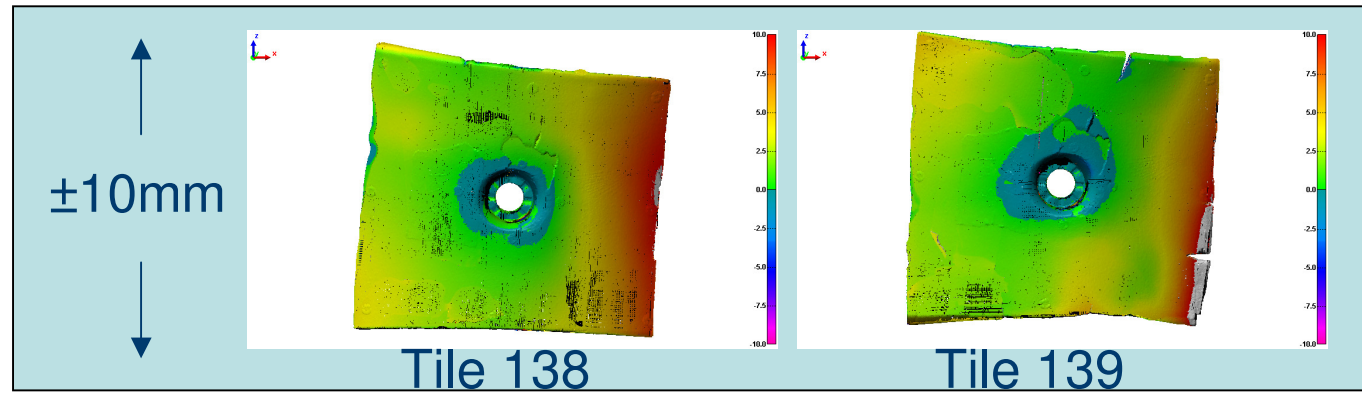


Alignment & comparison

- Aligned on locating feature
- Plane, vector, point alignment



Results



Outcomes

- Digital inspection gave a good insight into what had gone wrong
 - The deformation was worst in one corner
- Rotation of the tiles in the engine may have exposed one corner

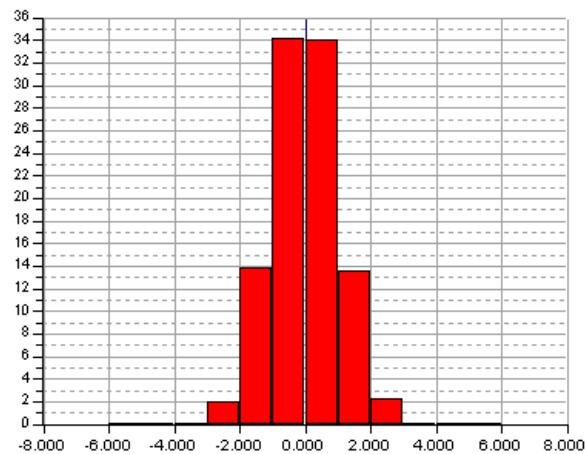
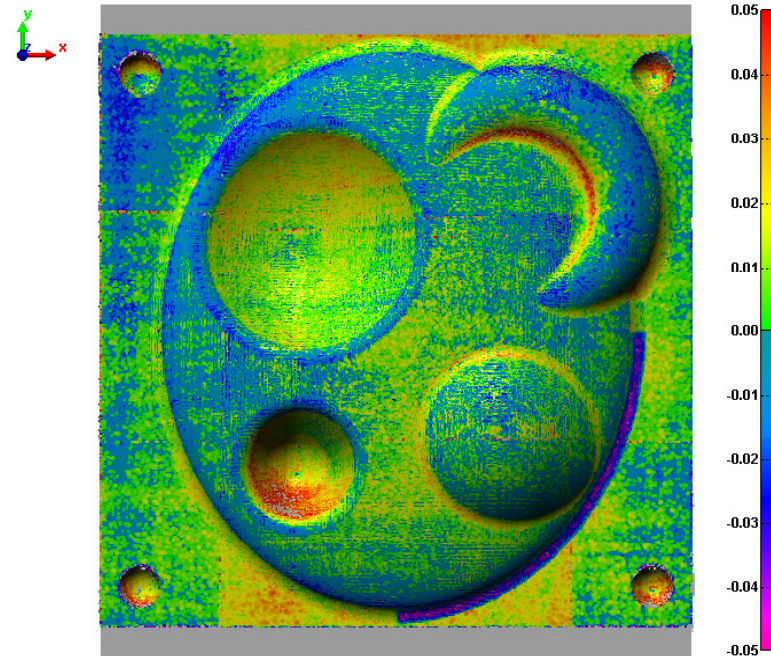
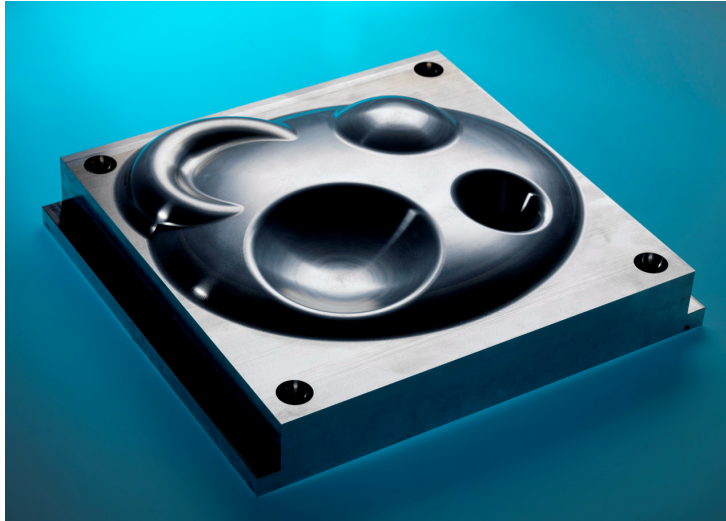
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- **Laser scanner performance analysis**
- Freeform software validation

The problem

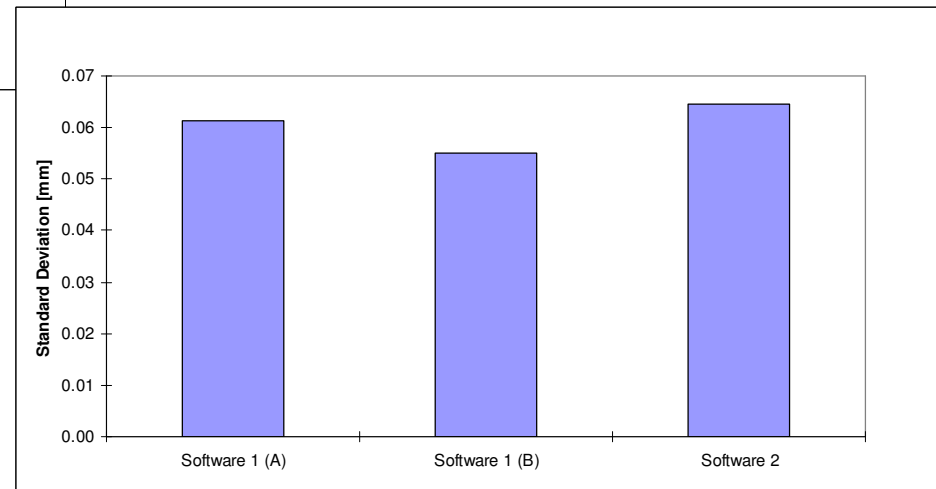
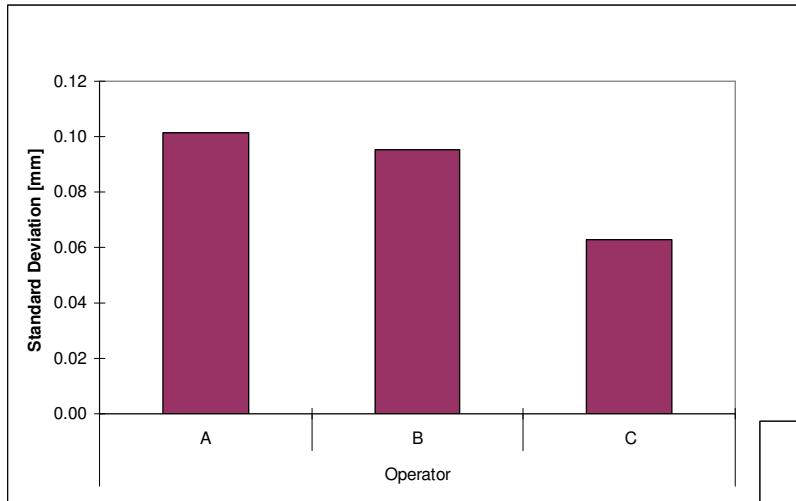
- Variability in scanner performance due to
 - Operator
 - Laser power
 - Distance to subject
 - Surface finish
 - Ambient lighting
 - Environment
- Uncertainty & traceability

The approach

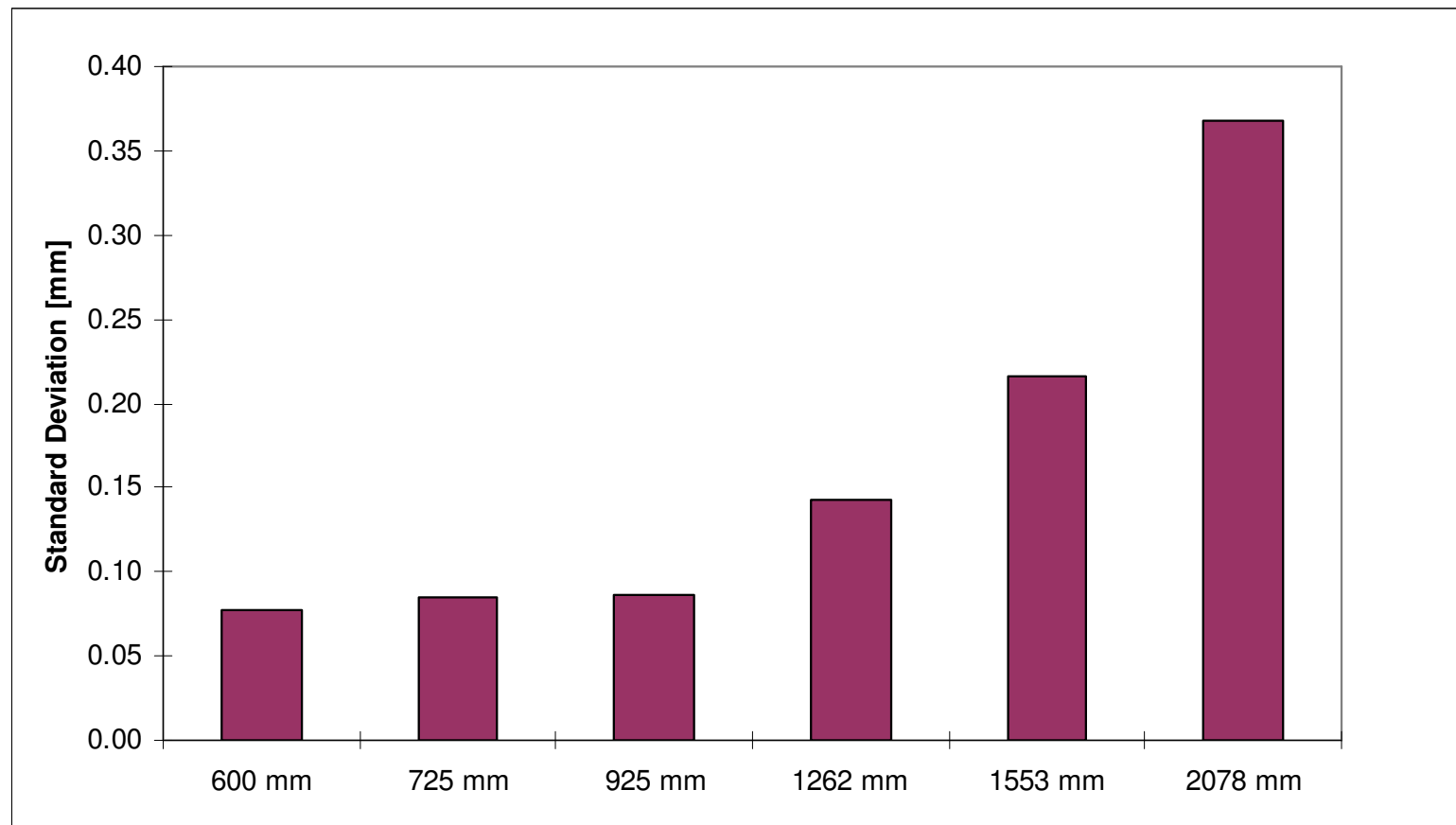


Standard Deviations

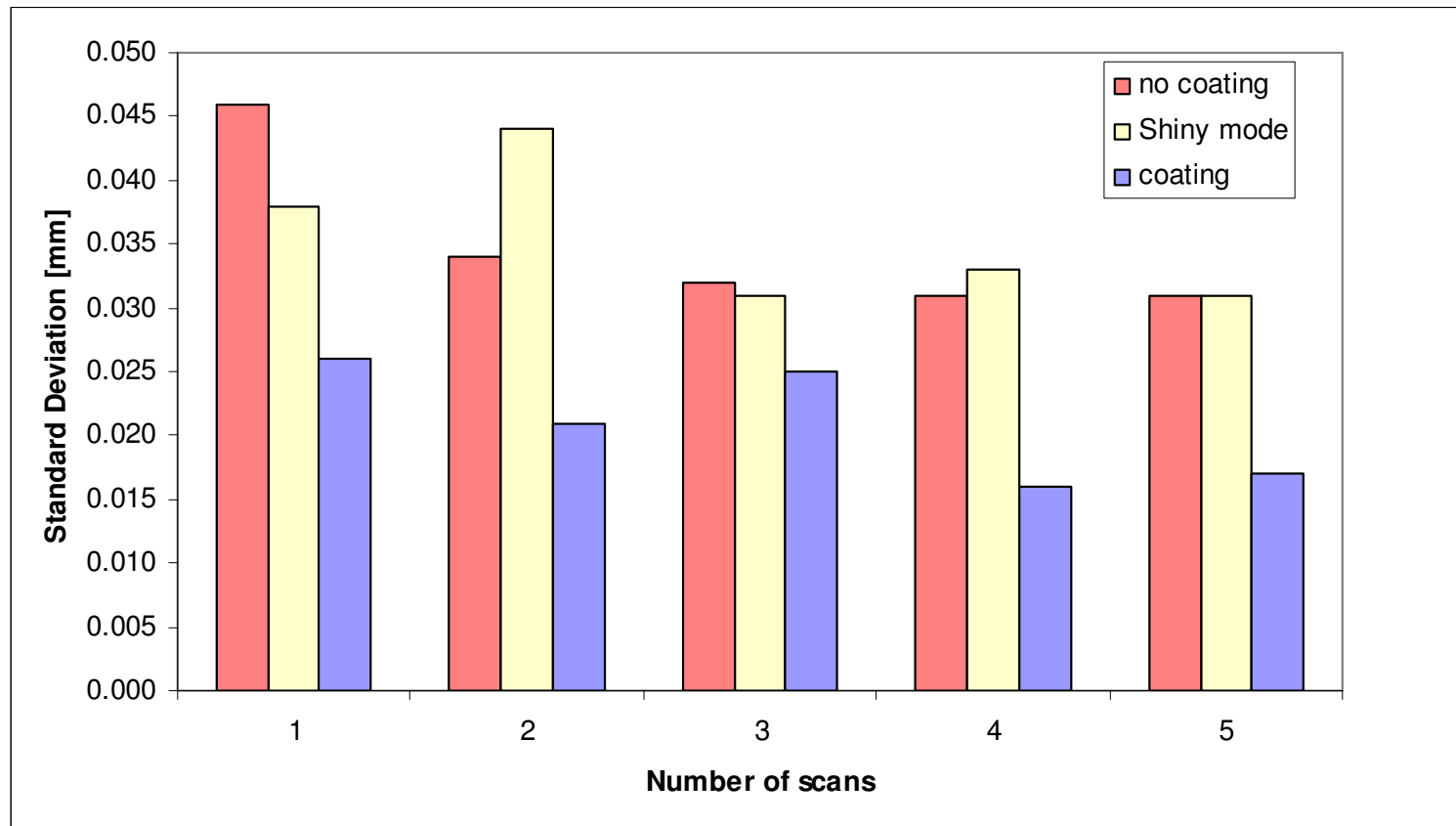
Operator influences



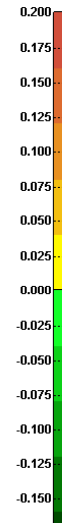
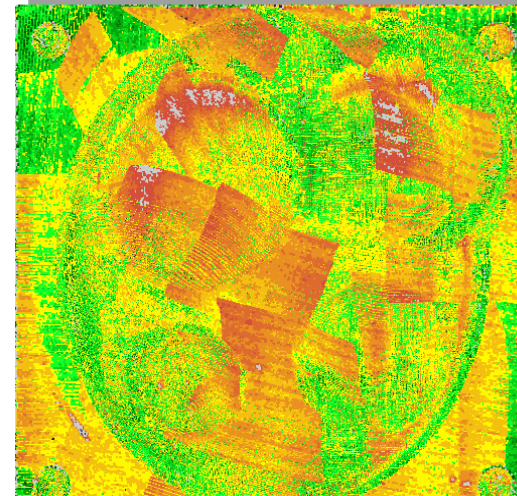
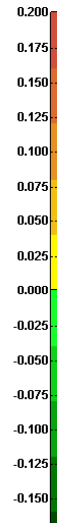
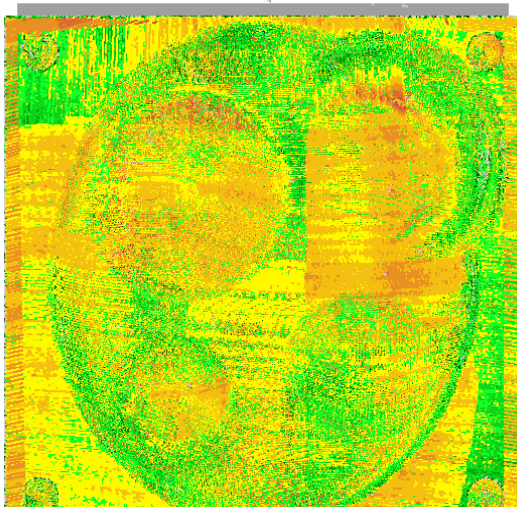
Distance influences



Other influences



Laser power



laser power – setting A

laser power- setting B

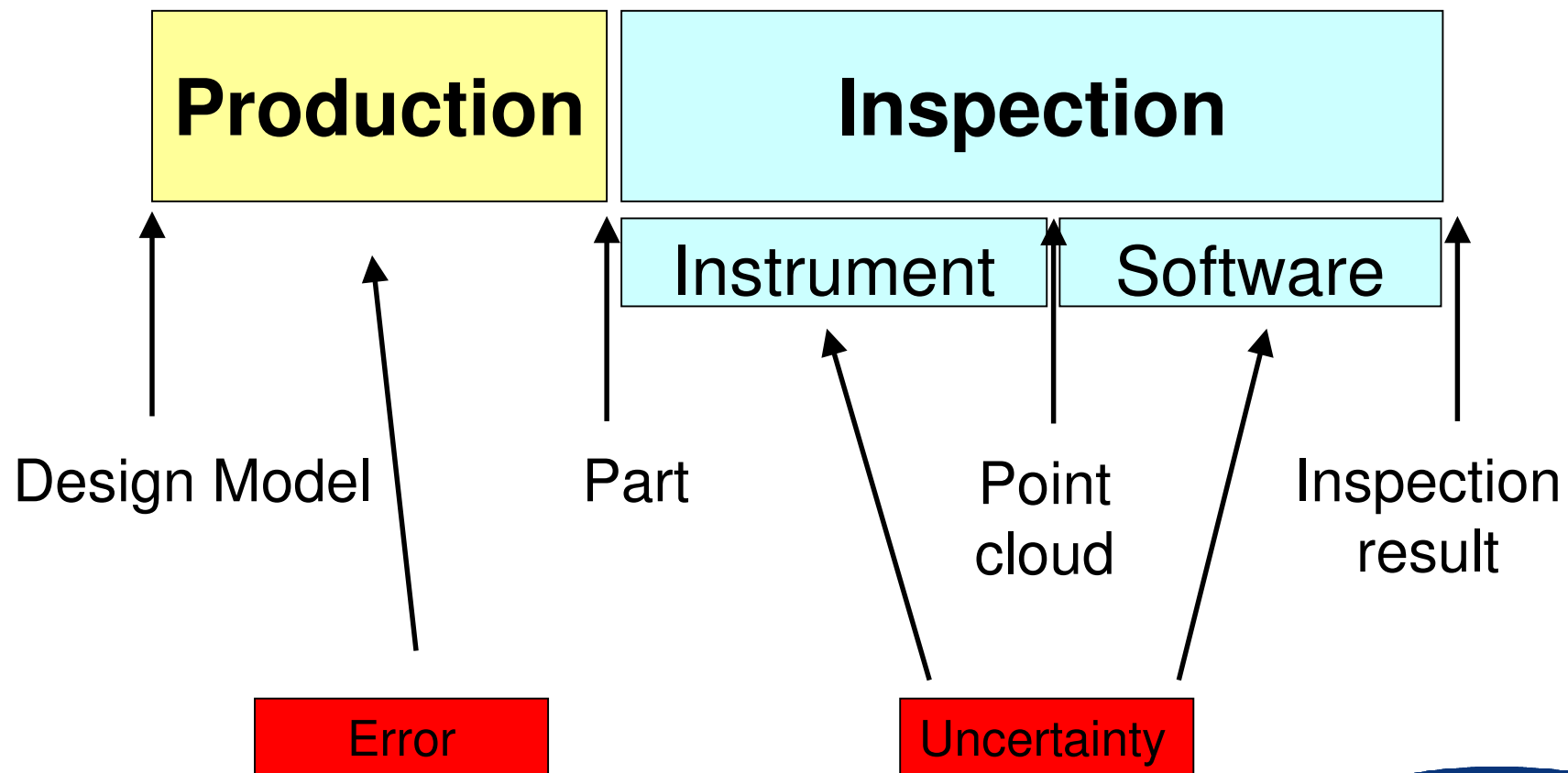
Outcomes

- Demonstrates the variability in performance
- Operator often guided by instinct
- How do we select an appropriate measurement technique?
 - Need for research, standards & validation to give confidence to industry

Contents

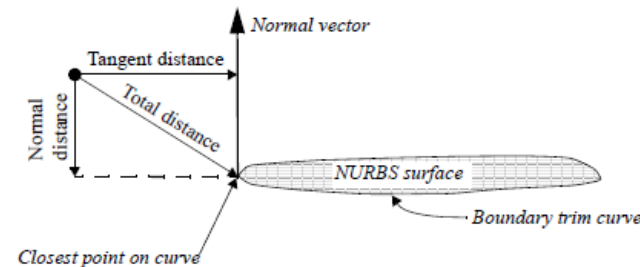
- Heat shield tile measurements
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The problem



The objectives


- To investigate the following functions
 - Alignment
 - Comparison
 - Shape fitting
- Collaboration with
 - NPL's Mathematical Techniques for Metrology Group
- Testing
 - Industry wide point cloud processing software packages

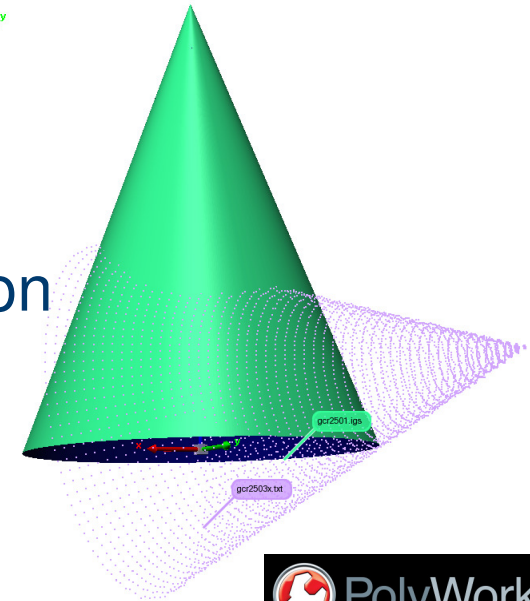


The approach

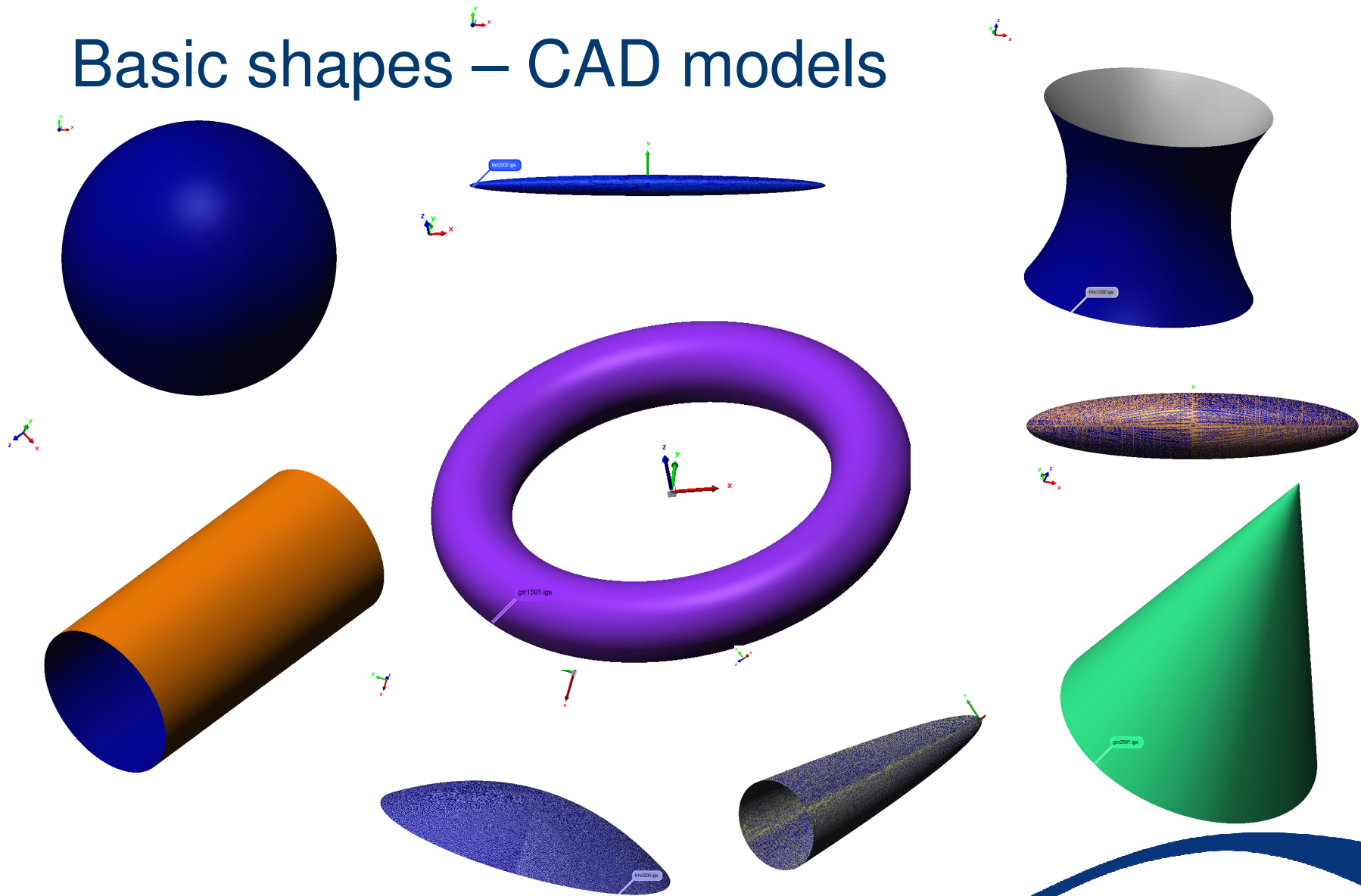
- Algorithms for data generation & fitting
 - generate CAD models in Matlab.
 - reference datasets are generated using null space method
- Perturbations applied, along direction of surface normal.
- For reference data set, compare reference results with test results.
 - standard deviations for inspection
 - geometric parameters for shape fitting
- > 100 datasets (x,y,z's), produced and analysed

Datasets

- Type
 - s, standard (no translation or rotation)
 - e, extended (translation + rotation)
 - x, e + random ordering of points 
- Perturbations
 - fine, 0.001 mm standard deviation
 - medium, 0.01 mm standard deviation
 - course, 0.1 mm standard deviation



Basic shapes – CAD models



Point cloud processing



Results

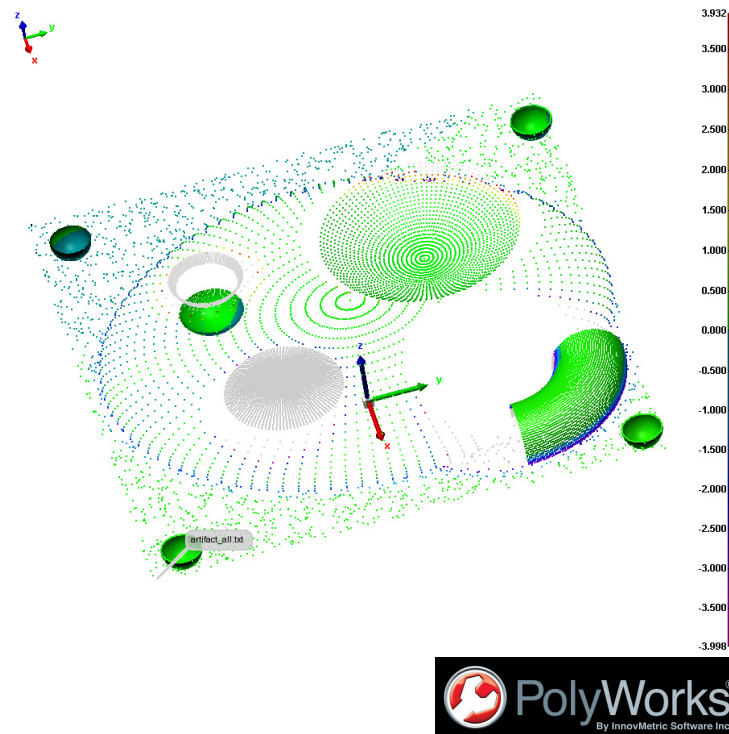
- Mostly the differences in std deviations were below 1% – for more than **98%** of datasets
- For two test cases (with cylinder), the difference was more than 10%.
 - Observed differences are due to the best fit alignment process (default convergence limit)
- Shape fitting for supported shapes was accurate to $<0.005\%$

Observations

- Can't always access the full dataset
 - proprietary information
- Some software tessellates the CAD model
 - can lead to small errors
- Difficult to analyse the alignment process independently
 - multiple solutions

Next steps

- Produce CAD models and datasets for industrial objects/shapes – turbine blade
- Repeat exercise with other software packages



Acknowledgements

- NPL
 - Dr Mike McCarthy, Stephen Brown, Anthony Evenden
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Thank you for your attention!