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## University of Bath

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# Integration of Thermal and Dimensional Metrology for Manufacturing Process and Equipment Integrity



# Outline

- Light Controlled Factory Project
- Industrial Partners
- Background – Industry Drivers and Challenges
- Proposed Solution
- Research Progress – Experimentation and Results
- Future Objectives
- Questions



# Light Controlled Factory



- 5 Year Project
- EPSRC Grant £3.75 million
- Researchers at University of Bath, Loughborough University and UCL
- Improving manufacturing capability through optical metrology

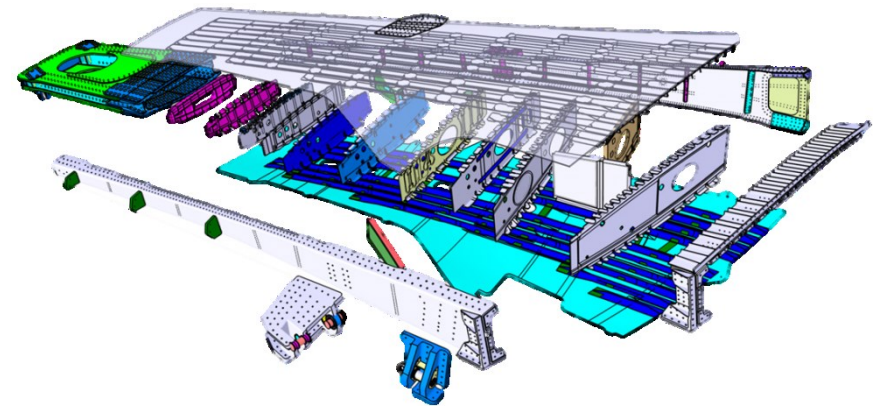


# Industrial Partners



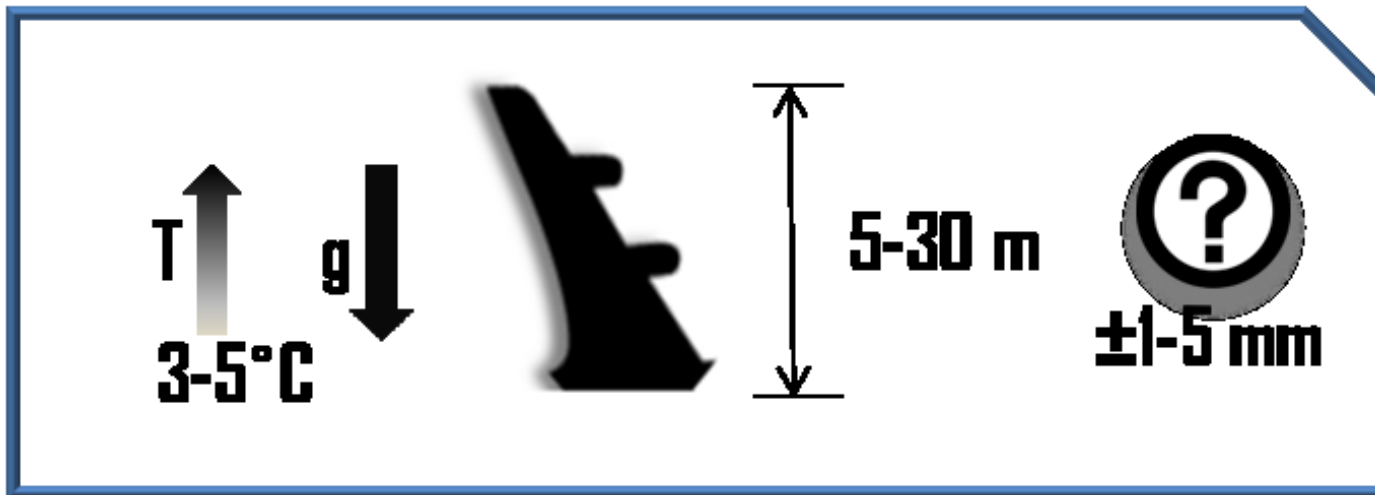
# Background – Industry Drivers

- Tighter tolerances
- Greater quality control
- Reduced measurement uncertainty
- Move towards composite materials
- Increased rate of production
- Need to operate in an **uncontrolled** environment



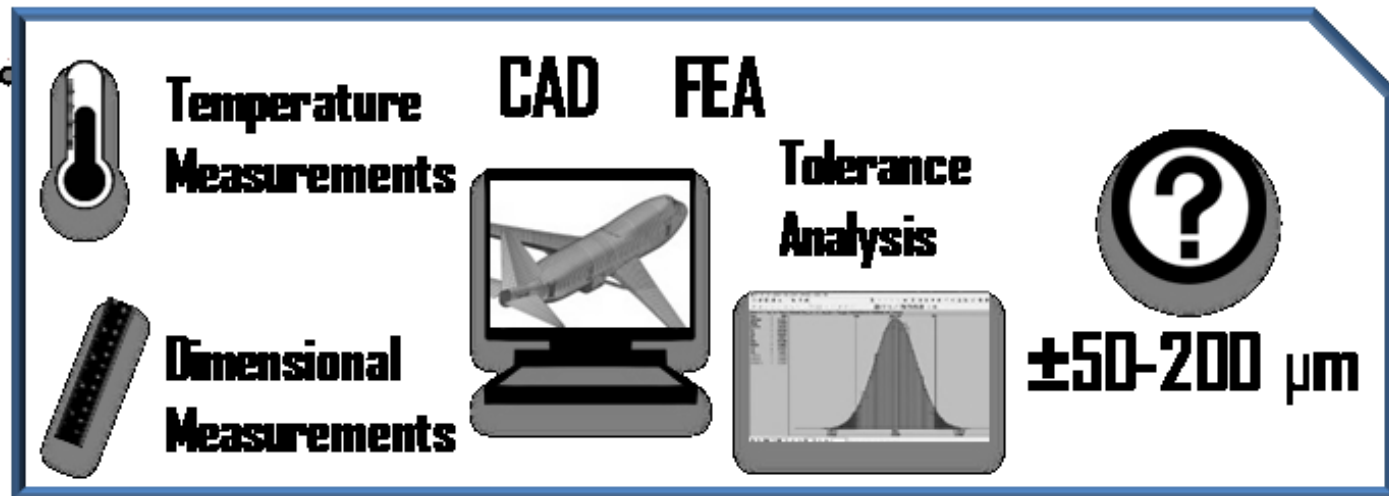
# Background – Key Challenges

- Large compliant parts
- Thermal gradients
- Thermal cycling
- Gravitational distortion
- Monolithic tooling



# Proposed Solution

Monitoring temperature to update computational model enabling quantified prediction of thermal and gravitation effects



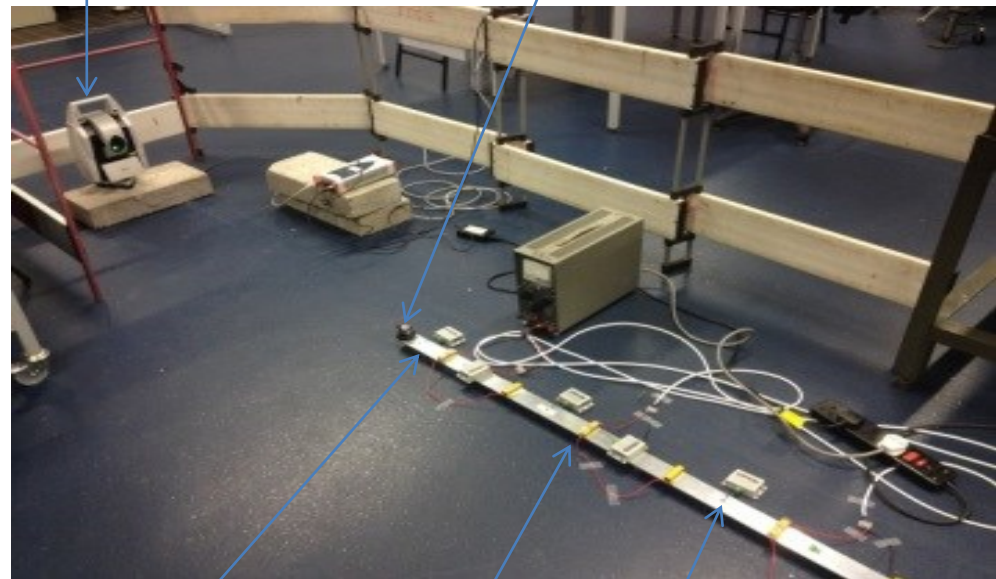


# Research Progress to Date

- Experimentation on simple beam thermal expansion length measurement – 98% agreement with FEA
- Analytical and numerical prediction of thermally induced error
- Development of measurement error compensation strategy

Laser tracker

Spherically mounted retro-reflector (SMR)



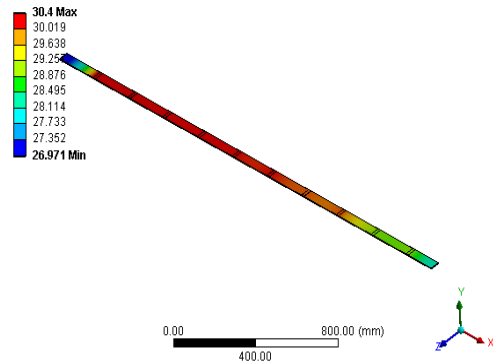
2.5 m aluminium bar

Thermistors

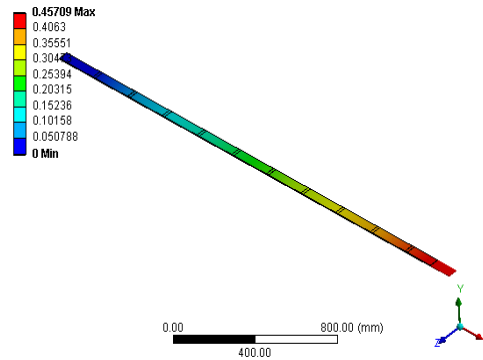
Resistive heating elements

# Research Progress to Date

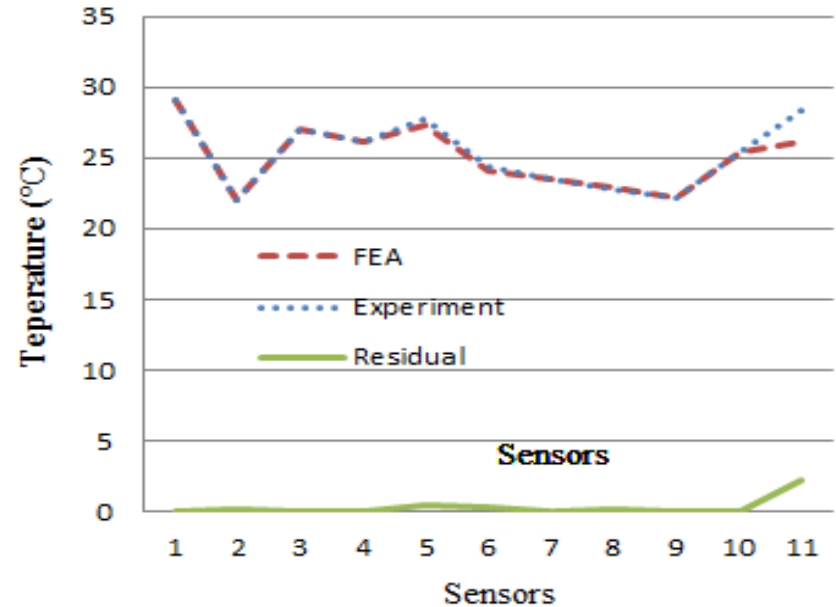
## FEA (ANSYS) model of aluminium bar



Temperature distribution –  
26.97°C – 30.4°C

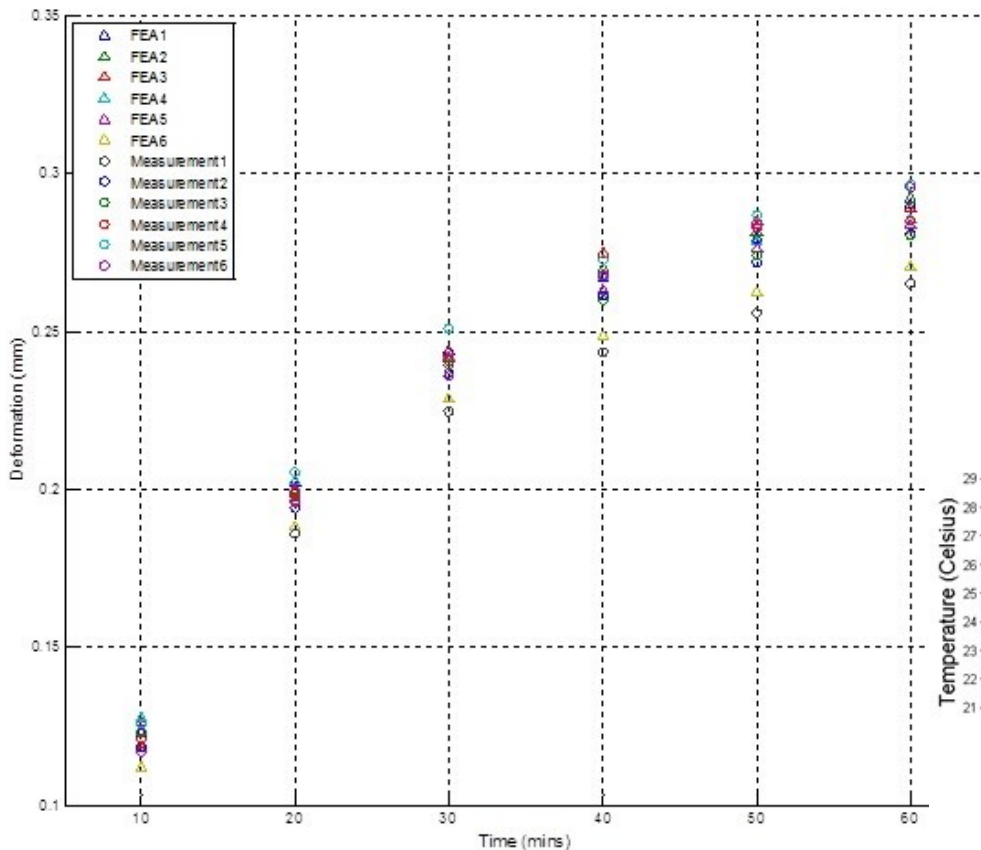


Deformation – up  
to 0.457 mm

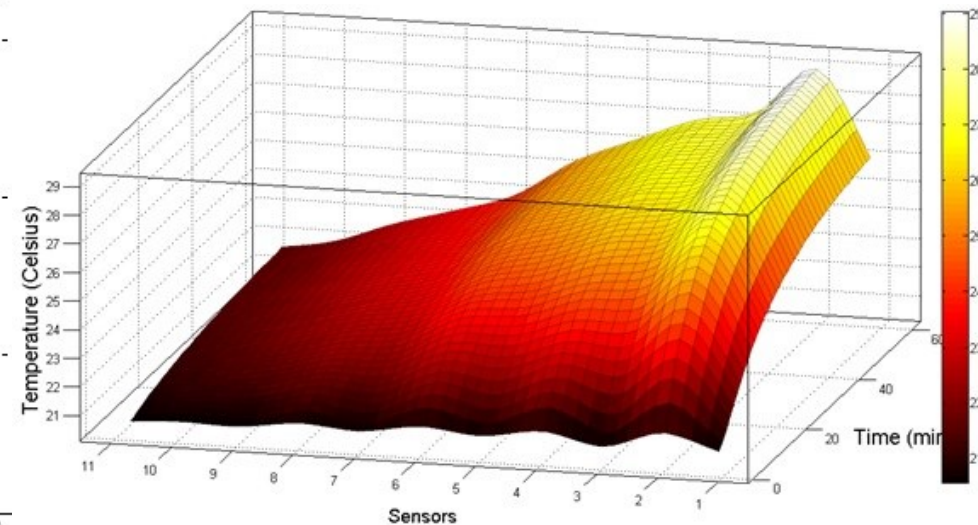


Agreement between FEA  
and experimental data

# Research Progress to Date



Temperature distribution along aluminium bar over 1 hour



Temperature distribution along aluminium bar over 1 hour

# Future Objectives

Hybrid metrology toolkit - theory of method

Coupling of structural and thermal effects

Increase experimental structure complexity

Optimisation of sensing strategy

Technology demonstrator

# Questions

Thank you for listening – any questions?

