

# A closed-loop multi-system demonstrator for advanced optical measurement

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Research and Engagement Fellow



# Meet the team



**Dr Samanta Piano**

Director Midlands Centre for Data-Driven Metrology  
Head of the Manufacturing Metrology Team



**Prof David T Branson III**



**Dr Adam  
Thompson**



**Dr Sofia  
Catalucci**



**Dr Luke  
Todhunter**



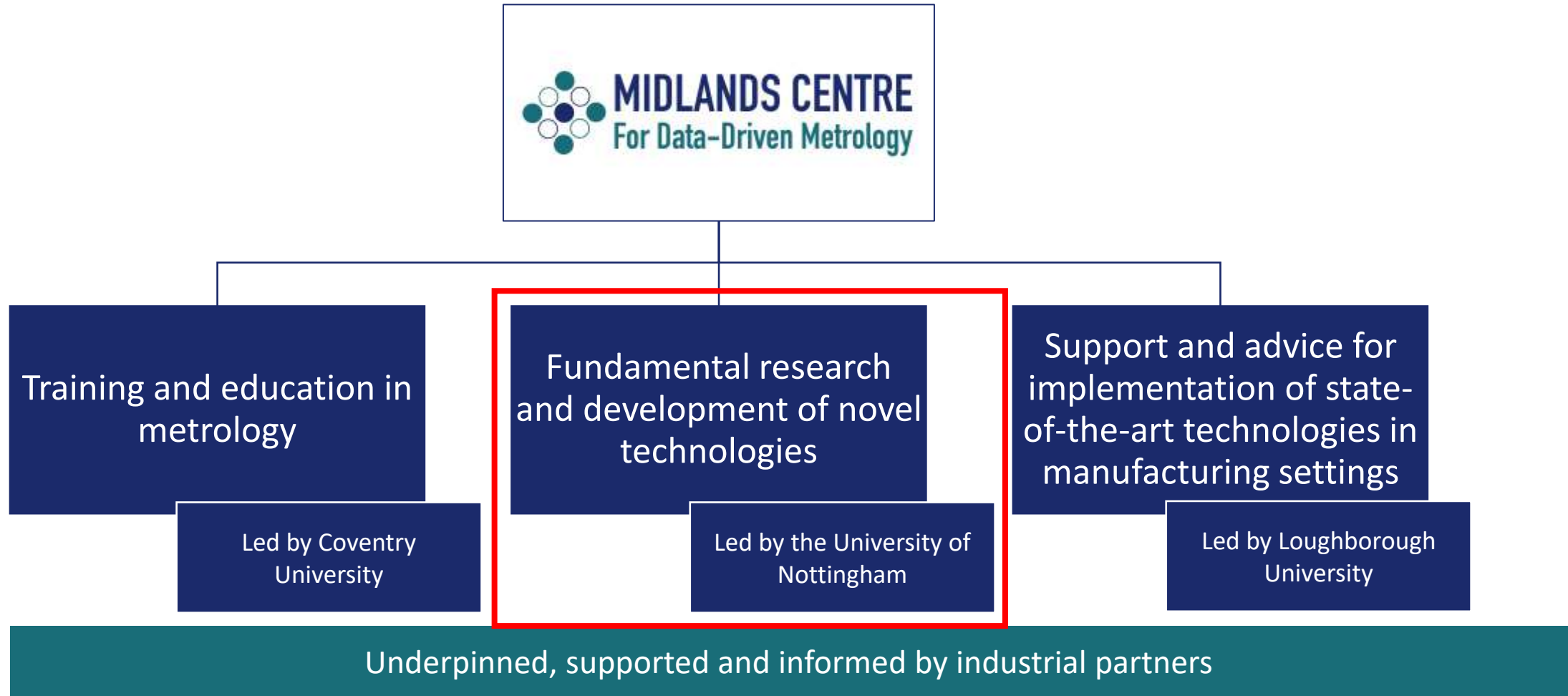
**Ulises Hernandez**



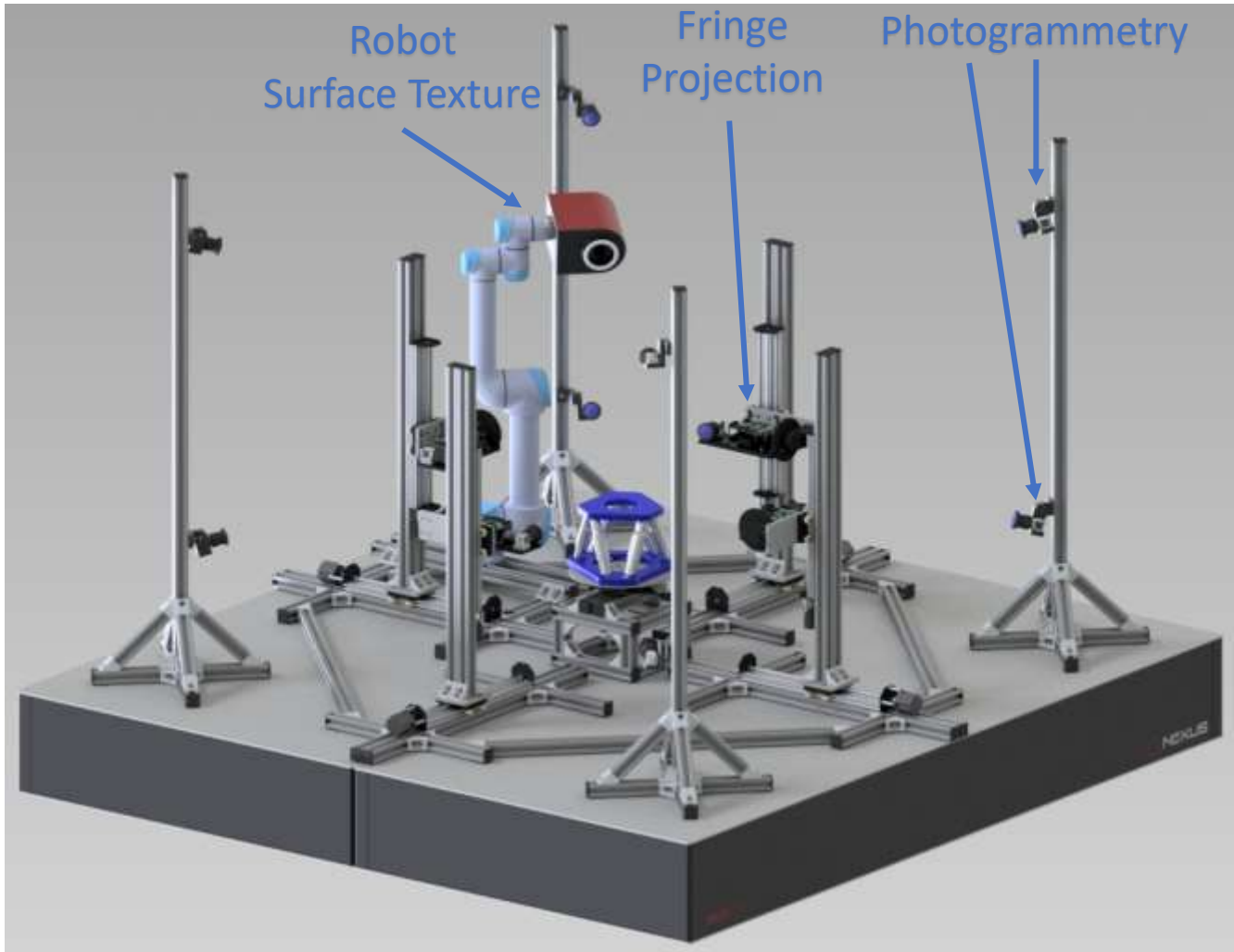
**Nathan Roberts**

<https://www.mcdm.ac.uk>

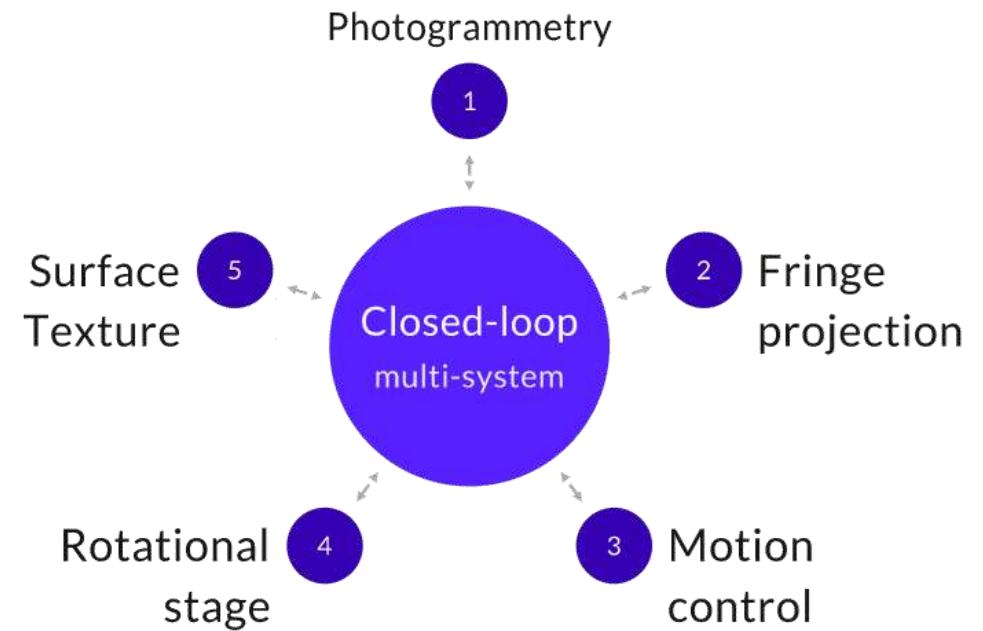
# Primary activity breakdown



# Demonstrator for advanced optical measurements



Maximum measurement volume:  
0.5 m x 0.5 m x 0.5 m





# Hardware implementation

## Photogrammetry + fringe projection systems

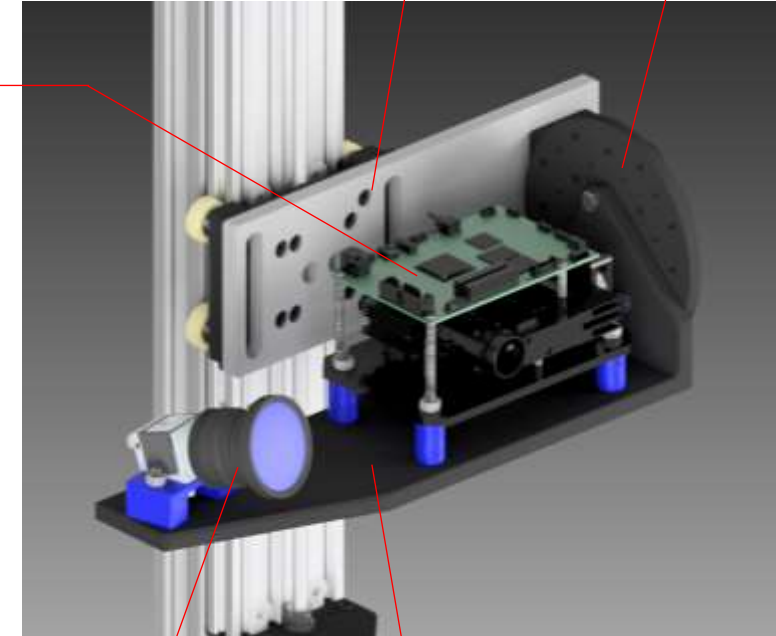


Main structure complete

Projector

Translation stage

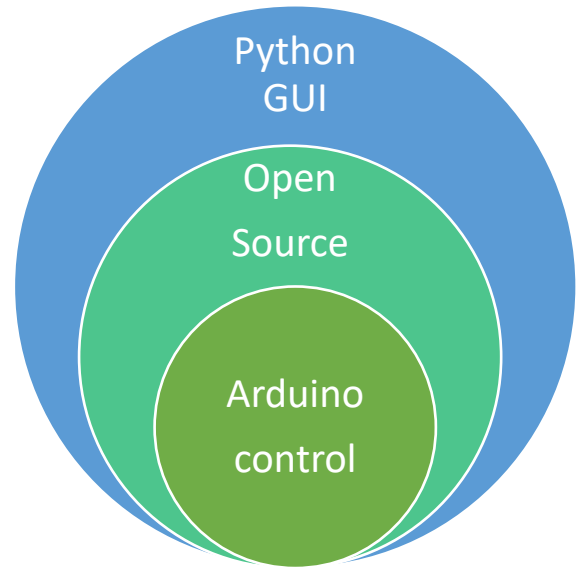
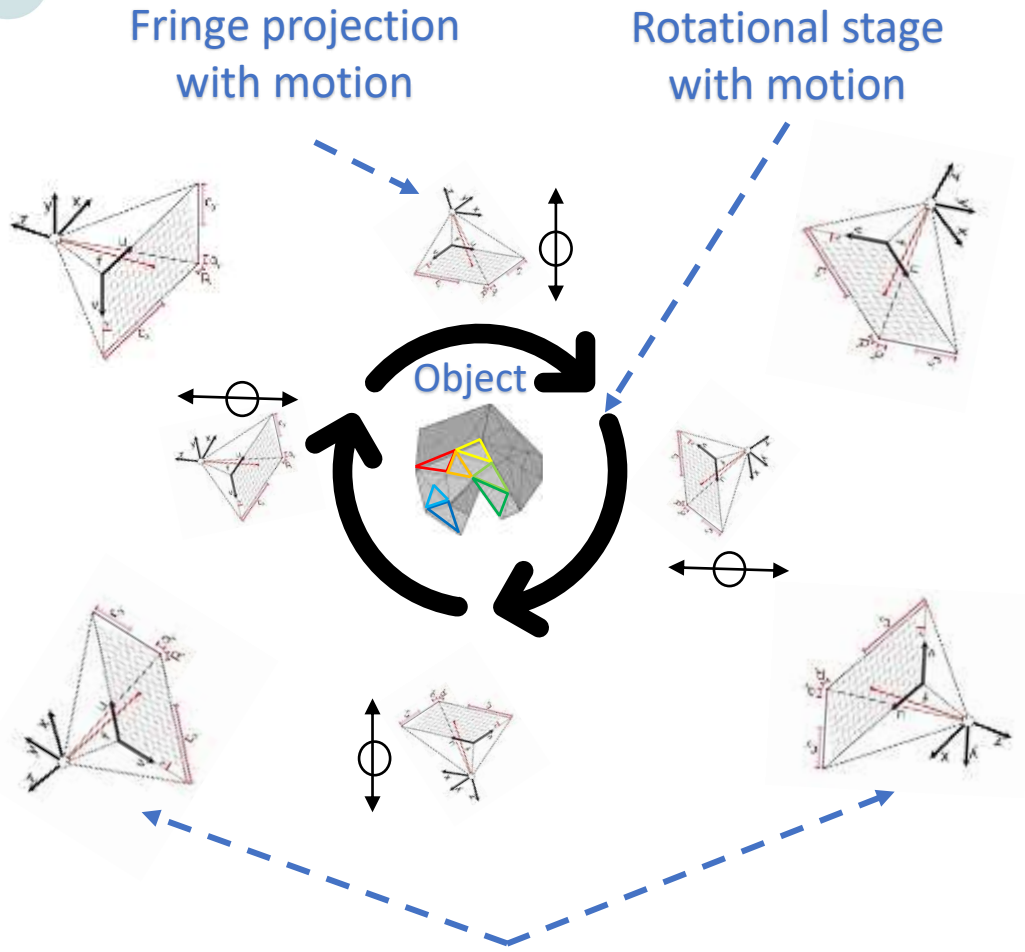
Rotation stage



Monochrome camera + 12mm lens

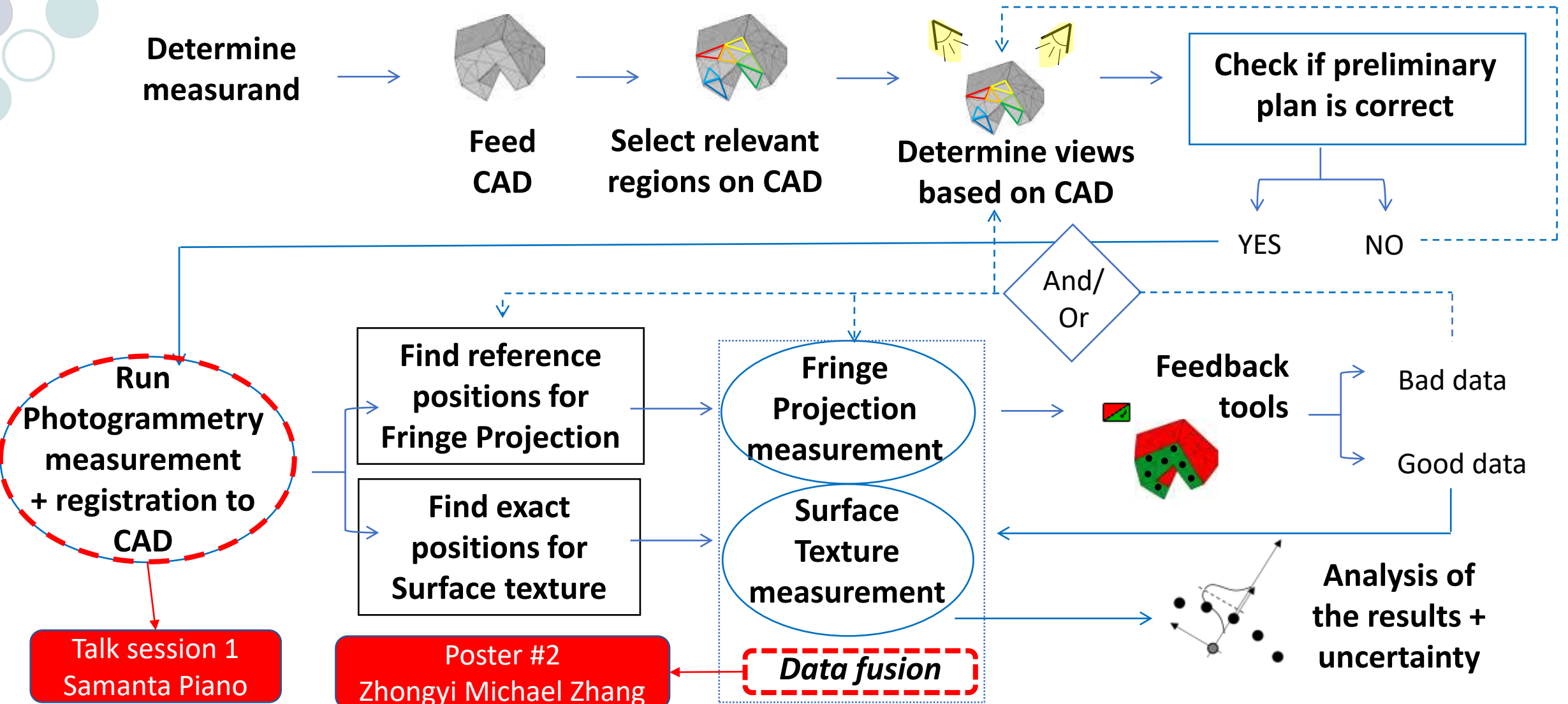
Baseplate

# Motion control

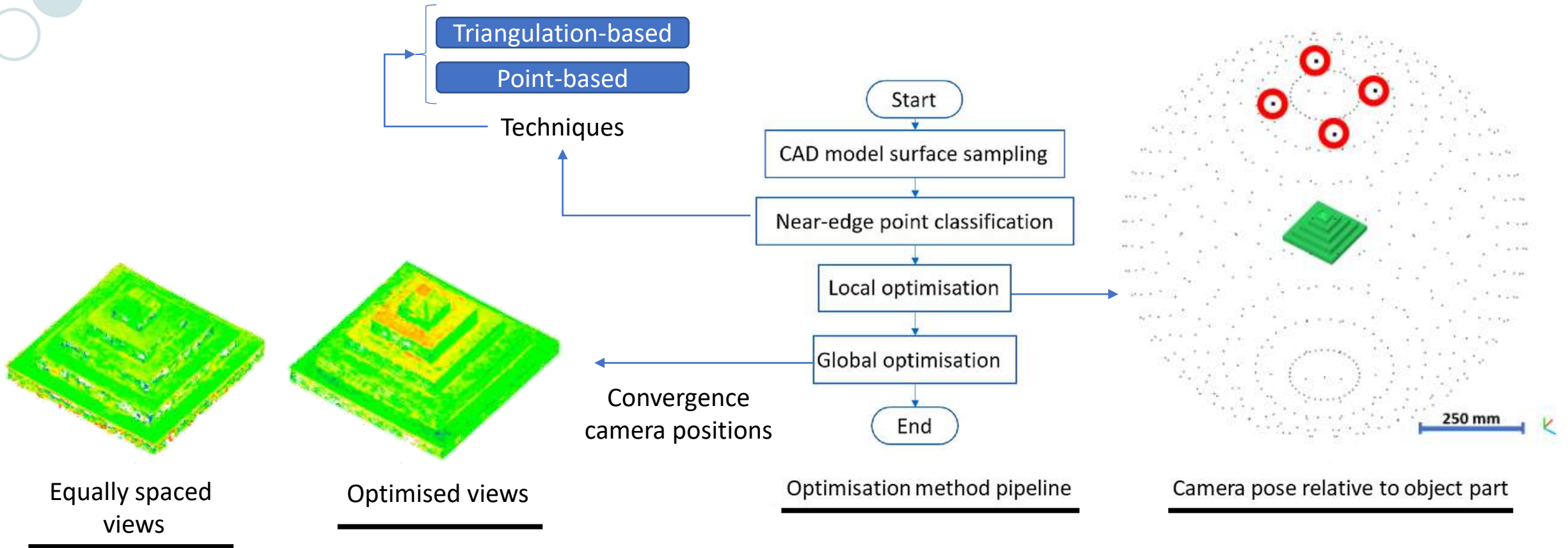


Photogrammetry systems are static

# Software pipeline implementation



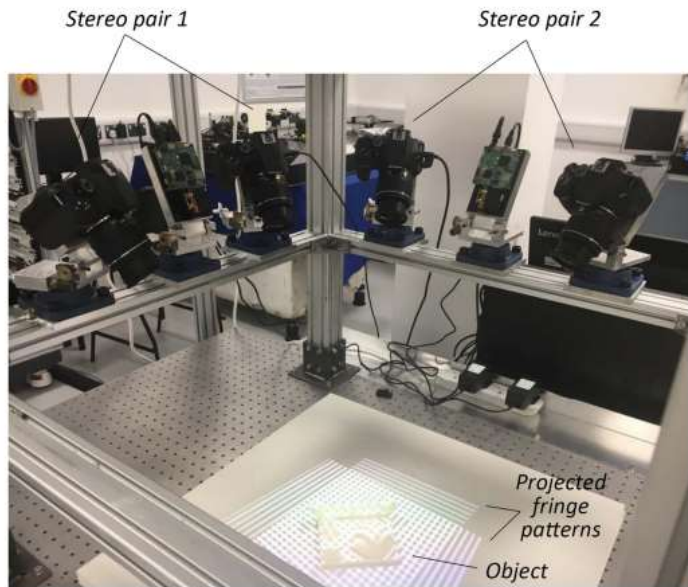
# Optimisation: view planning approach



Zhang H et al. 2020 Optimisation of camera positions for optical coordinate measurement based on visible point analysis *Precis. Eng.* 67, 178-188



# Fringe projection measurements



Checkerboard

Camera parameters



Project sinusoidal & binary images

Global frame of reference

Three-dimensional reconstruction

Each camera-projector stereo pair

Triangulation principle

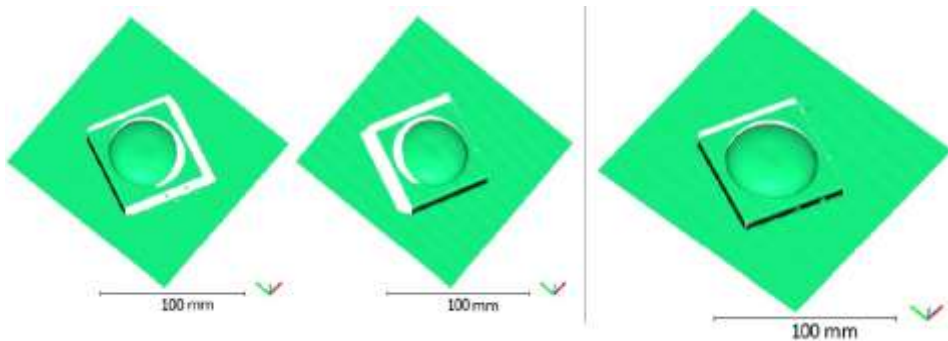
ICP and fine registration of point clouds

Capture horizontal and vertical fringes

Projector parameters

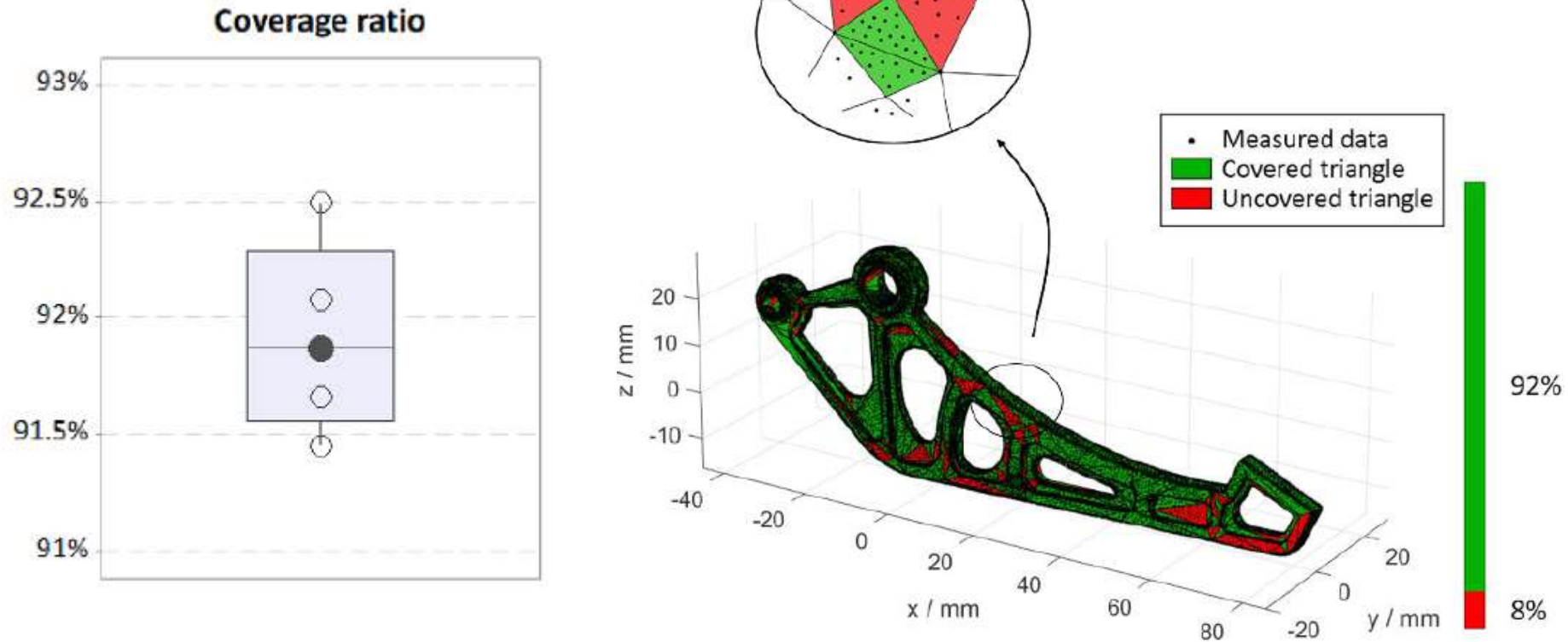


Absolute phase (temporal phase unwrapping)



Shaheen A. et al. 2021 Characterisation of a multi-view fringe projection system based on the stereo matching of rectified phase maps *Meas. Sci. Technol.* 32 045006

# Feedback tools (performance indicators)



Schematic modified from: Sofia Catalucci et al. 2022 Smart optical coordinate and surface metrology *Meas. Sci. Technol.* 34 012001  
 Sofia Catalucci et al. 2020 Measurement of complex freeform additively manufactured parts by structured light and photogrammetry *Meas.* 164 108081

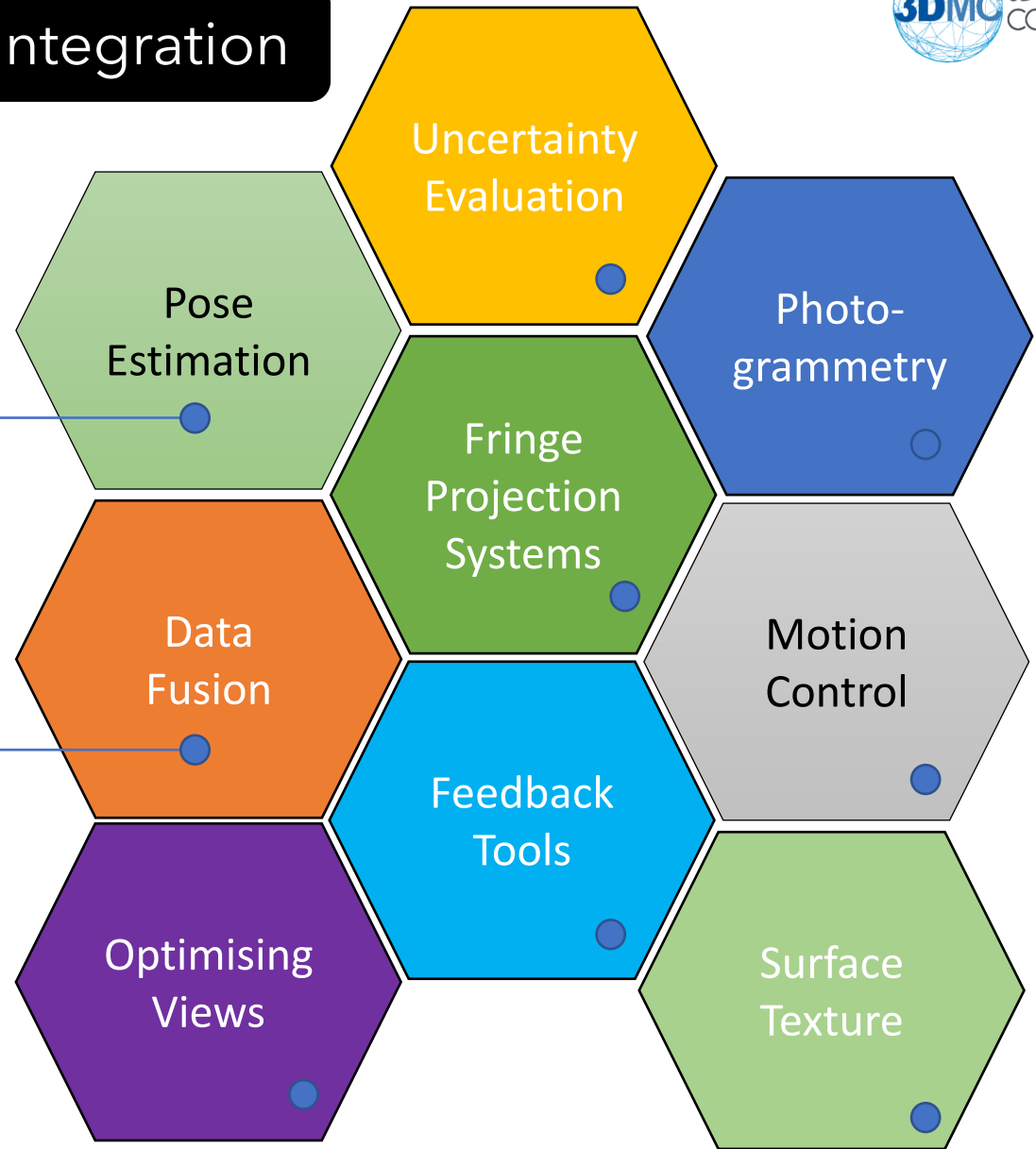
# Work in progress: System integration

Talk session S1: Samanta Piano

**Determining the 6DOF pose of a manufactured part from a stereo image and CAD model**

Poster #2: Zhongyi Michael Zhang

**A novel method for point cloud-to-point cloud registration**




# Conclusions and takeaways



- ❖ Work in progress: system integration
- ❖ Novelty: Combination of multiple research projects into one system
- ❖ Continuously updated with future research projects

 MMT: working towards smart optical coordinate and surface metrology

 2023: Open Day and invitation to showcase demonstrator to industry partners and researchers interested with collaborations.

<https://www.mcddm.ac.uk>



Questions?



**Thank you for listening**

**Thank you to all members**

**Manufacturing Metrology Team / MCDDM**

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