

# An evaluation low cost consumer grade UAS systems for 3D reality capture

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## Introduction

### Background & Motivation

Fuelled by a vibrant community of scientists, professionals and hobby enthusiasts, drones equipped with low cost cameras have developed into capable cost Unmanned Aerial Systems (UAS). However, how accurate and how reliable are geospatial data products generated from such systems? There is need for a better understanding and best practice use of the new easy to use technology.

### RPA's data acquisition technology

Small unmanned aerial systems are rapidly maturing. Capabilities and reliability are improving in ever shorter cycles and prices are decreasing for consumer grade as well as semi professional systems.

- Availability of fully functional low cost turnkey systems are for example available from DJI GoPro and 3Drobotics.



- Flight planning and post-processing software suits are available from a large number of suppliers offering automatic and easy to use solutions for non-experts.



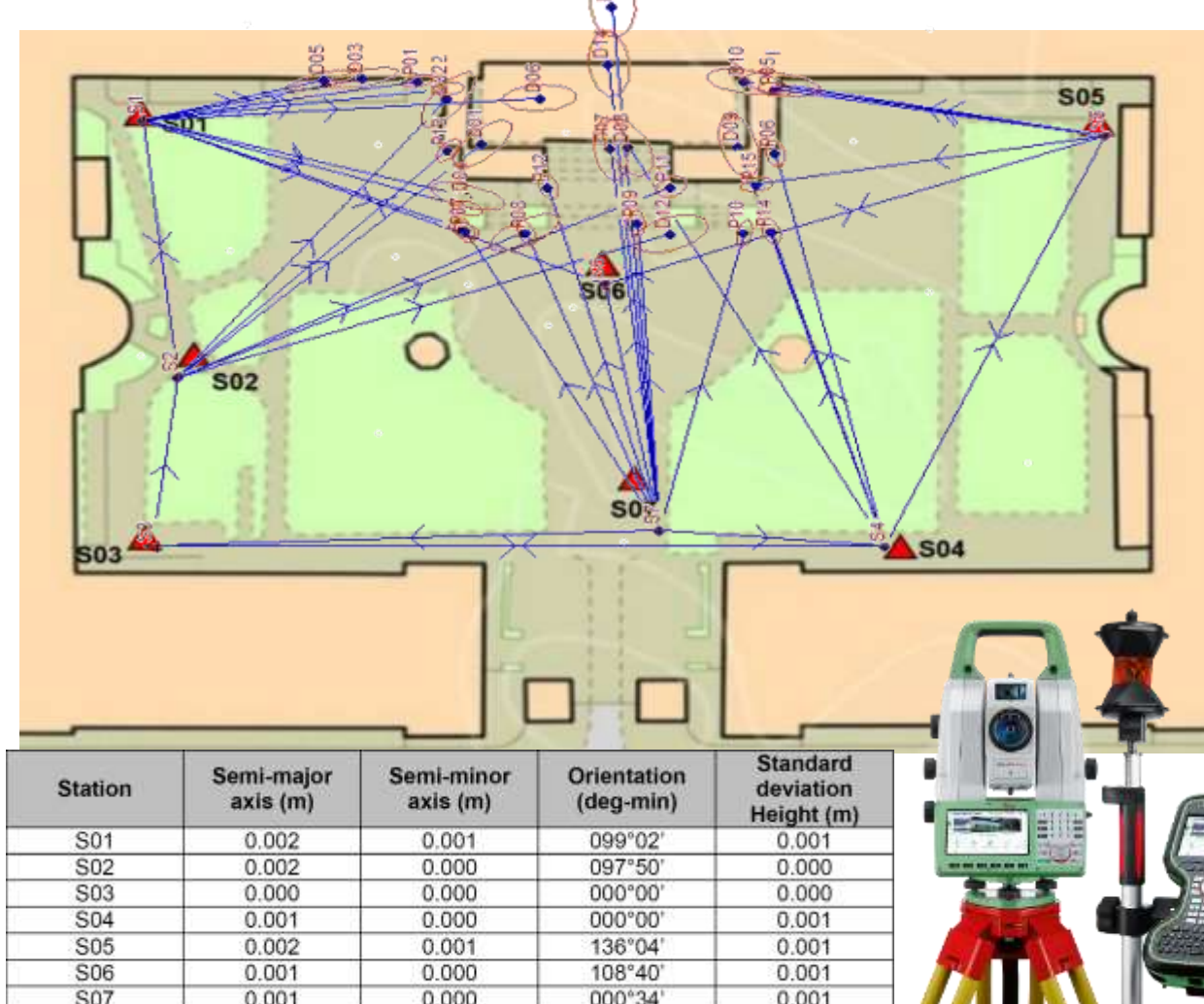
## Test site UCL-Portico

- UCL landmark Portico was chosen as an ideal test site to test and benchmark small UAS as well as post-processing systems.



### Ground truth:

#### Precise Geodetic Network



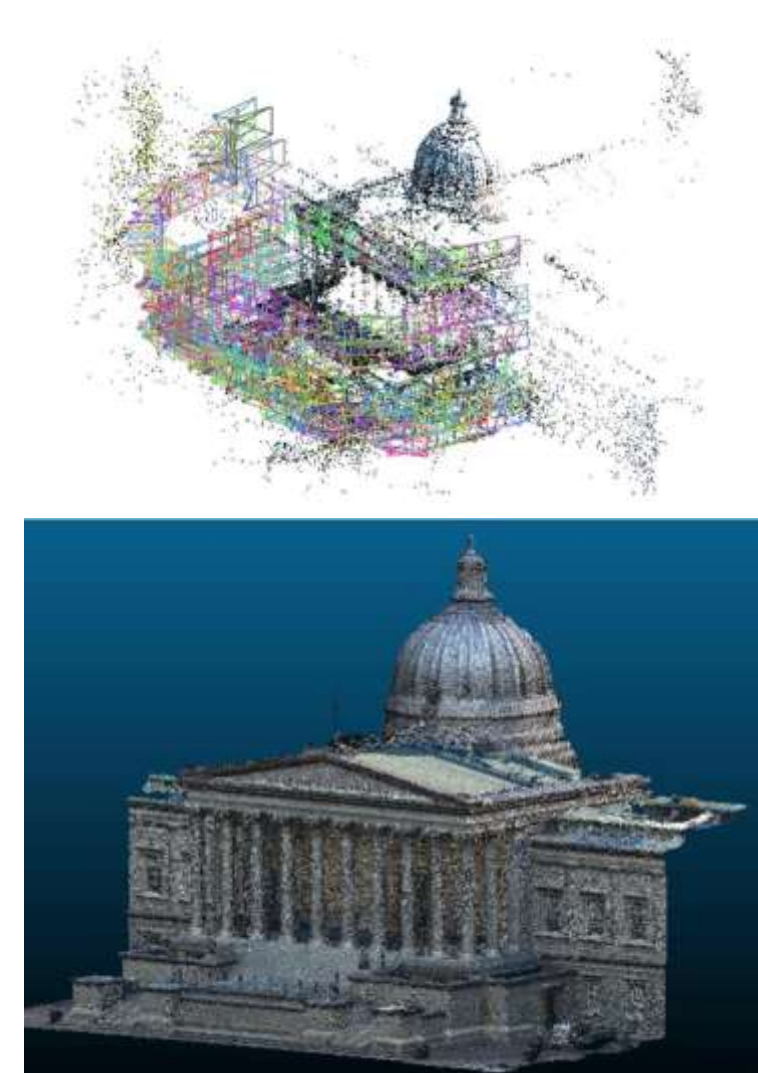
#### Dense terrestrial Laserscan



### Flight campaigns:

- 2014: Phantom 1/2
- 2015: Phantom 3
- 2016: Phantom 4
- Inspire in preparation

Camera		DJI Phantom 3 Advanced	
Sensor Pixels (width and height)		3992	2242
Megapixel Rating		9.95004	
Sensor Width (mm)		0.00617	
Pixel Size	µm	0.00196	1.54466-06
Focal Length	mm	0.0000381	3.61
Required GSD (m)			0.00381
Required Altitude (m)		11.67837925	
Footprint vertical size (m)		11.21	
Footprint horizontal size (m)		19.96	
80% Overlap Vertical Spacing		2.242	
80% Overlap Horizontal Spacing		3.992	
Survey Dimensions Vertical		30	
Survey Dimensions Horizontal		50	
No Images Horizontal (1 Strip)		8.92098501	
No Images Vertical (1 Strip)		13.0269521	
Total Number of Images		116.2002964	



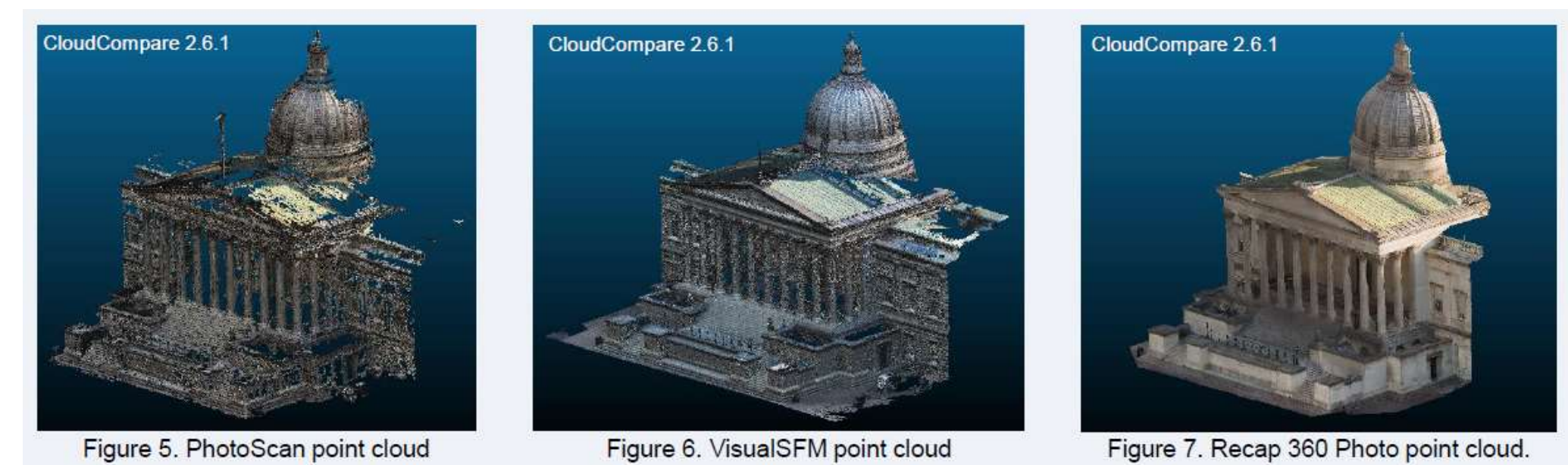
### Photogrammetric Processing:

Software tools deployed in 2015:

- Commercial of the shelf (COTS): Agisoft PhotoScan
- Open source: VisualSFM
- Cloud based solution: Autodesk RECAP360

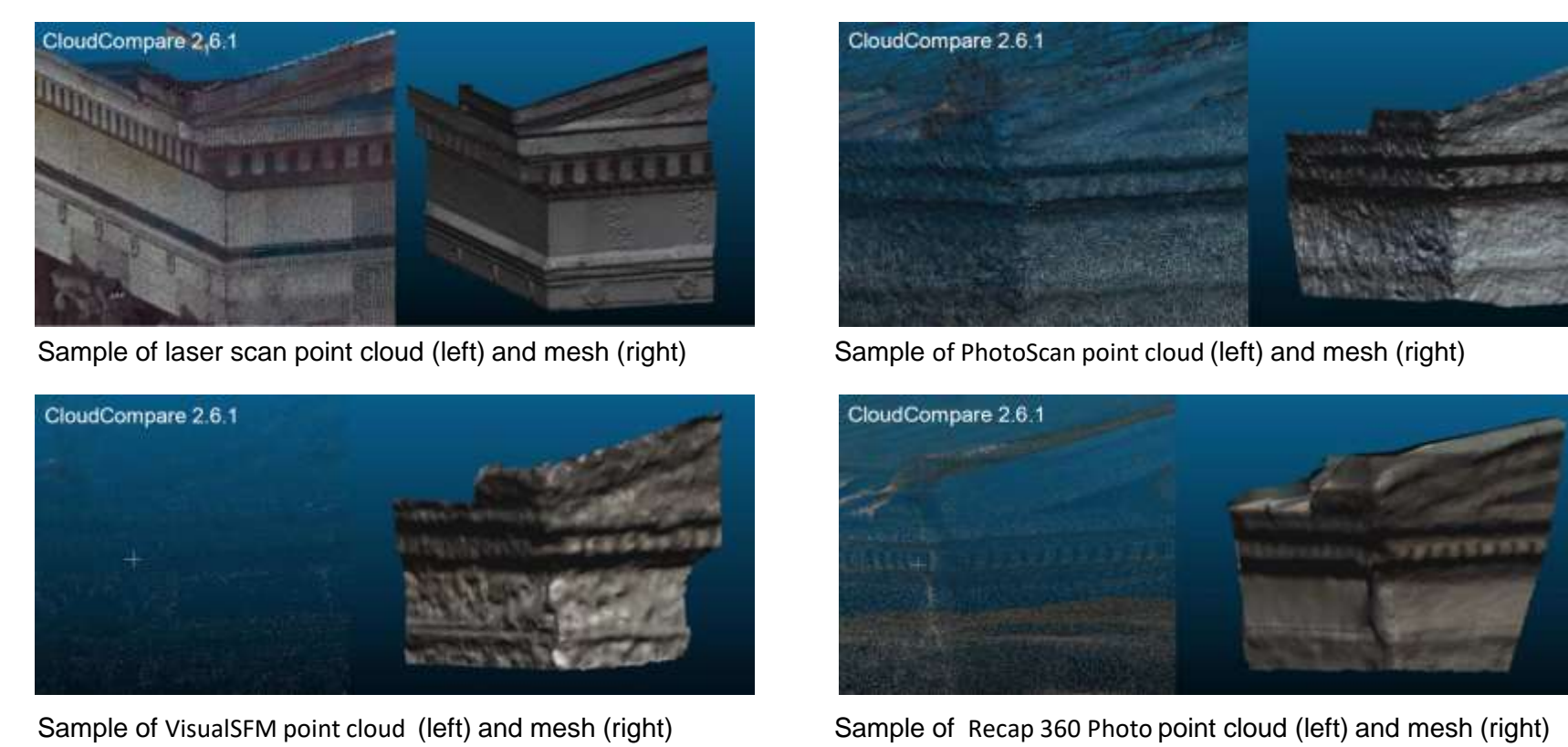
## Current Results

### Results after bundle block and dense matching

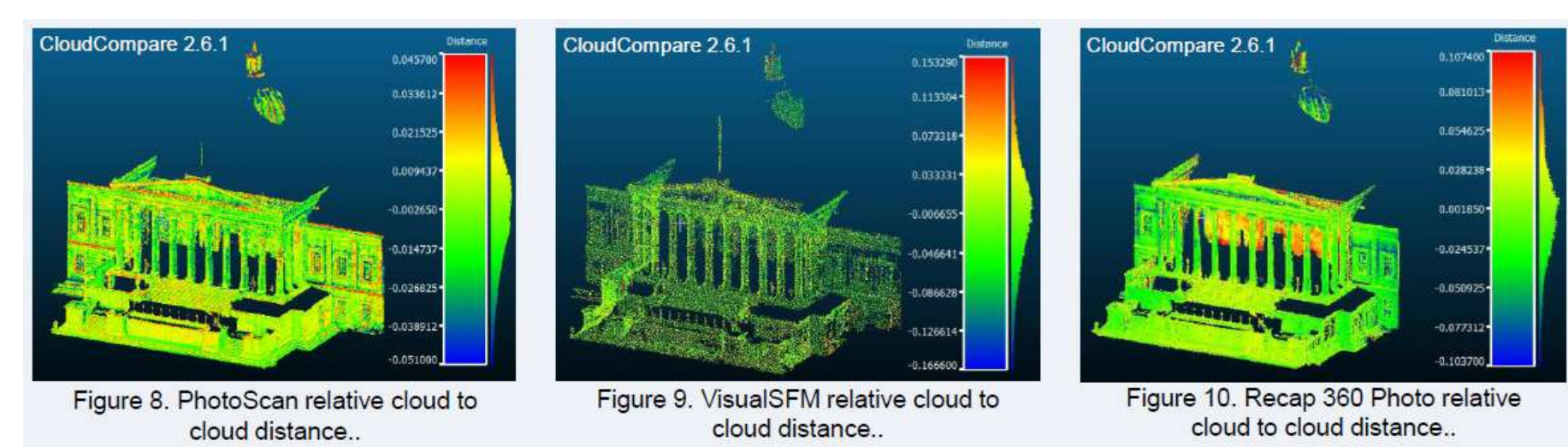


PhotoScan (pre-calibrated)	PhotoScan (self-calibrated)	VisualSFM (pre-calibrated) RMSE (pixels)	VisualSFM (self-calibrated)	Recap 360 Photo
1.149	0.258	2.544	2.563	N/A
<b>RMSE (metres)</b>				
0.013m	0.004m	0.359	0.034m	0.033m (from CloudCompare)

### Qualitative assessment

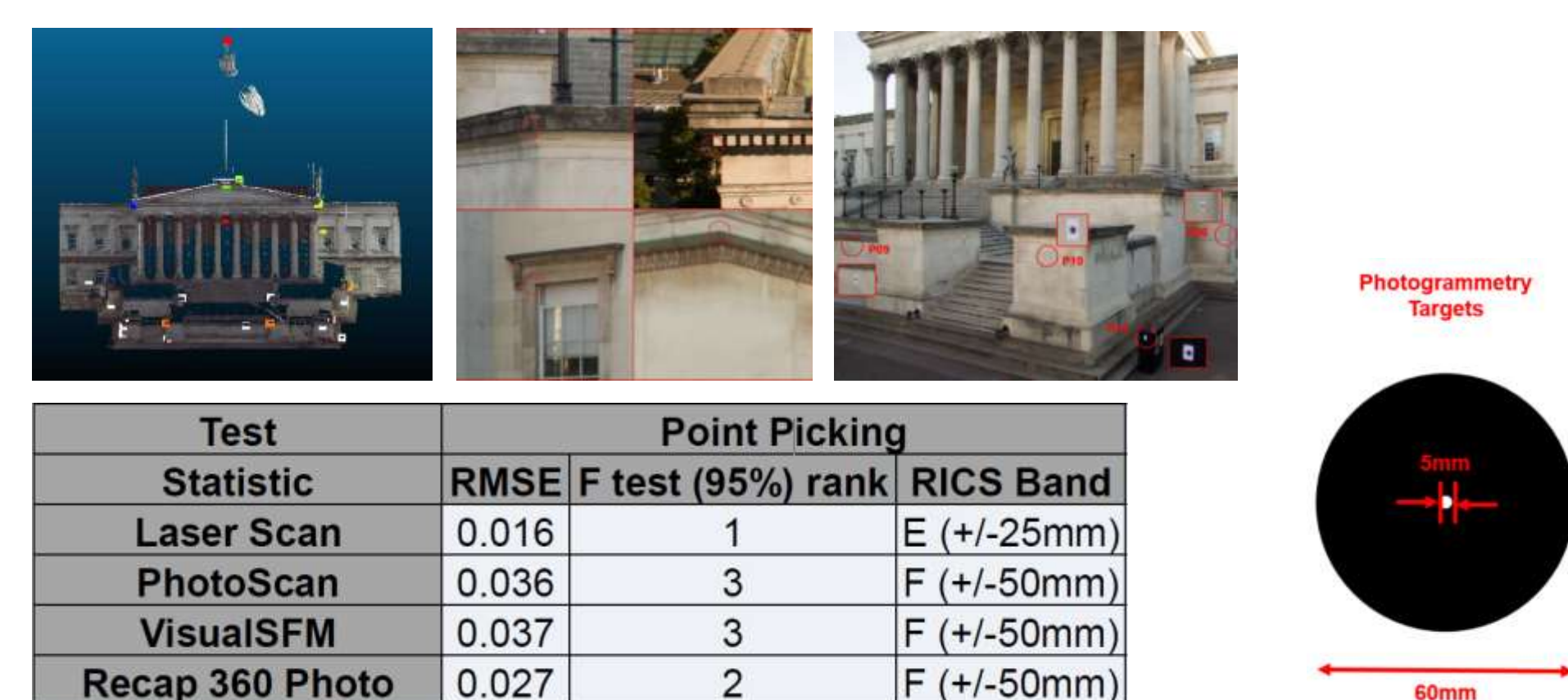


### Quantitative relative assessment (C2C)



Test Statistic	Relative C2C Distance				
	ICP RMSE	Mean	σ	F test (95%) rank	RICS Band (1σ)
Laser Scan	N/A	N/A	N/A	N/A	C (+/-5mm)
PhotoScan	0.03m	0.003m	0.018m	1	E (+/-25mm)
VisualSFM	0.036m	0.007m	0.057m	3	G (+/-100mm)
Recap 360 Photo	0.04m	0.002m	0.037m	2	F (+/-50mm)

### Quantitative absolute assessment



## Case study Blenheim Palace

- Comprehensive dataset of nadir and oblique imagery
- 5 software engines has been tested:
  - Pix4D Mapper
  - Drone Deploy
  - Maps Made Easy
  - Agisoft PhotoScan
  - Propeller



• Varying success, a detailed assessment is ongoing.

## Conclusions and future work

- Guidelines for best practice data capture are needed
- Current SFM & Dense matcher deliver varying results
- Dedicated benchmarking is required
- Need for improved quality metrics