

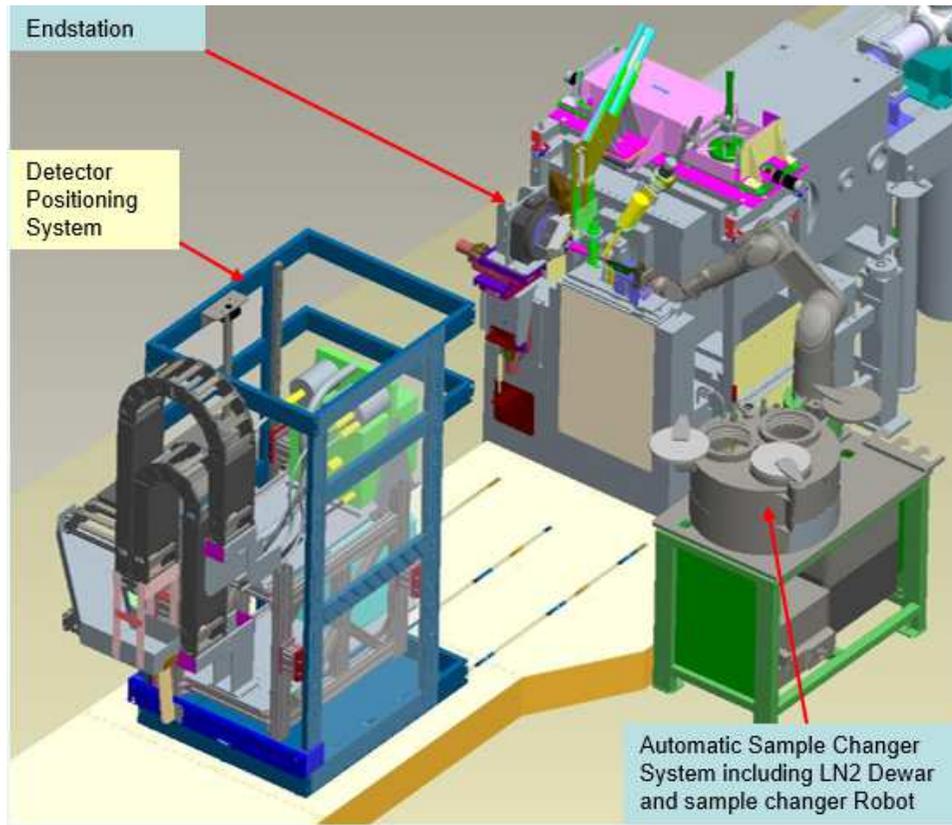
I24 ENDSTATION UPGRADE

Overview and engineering design

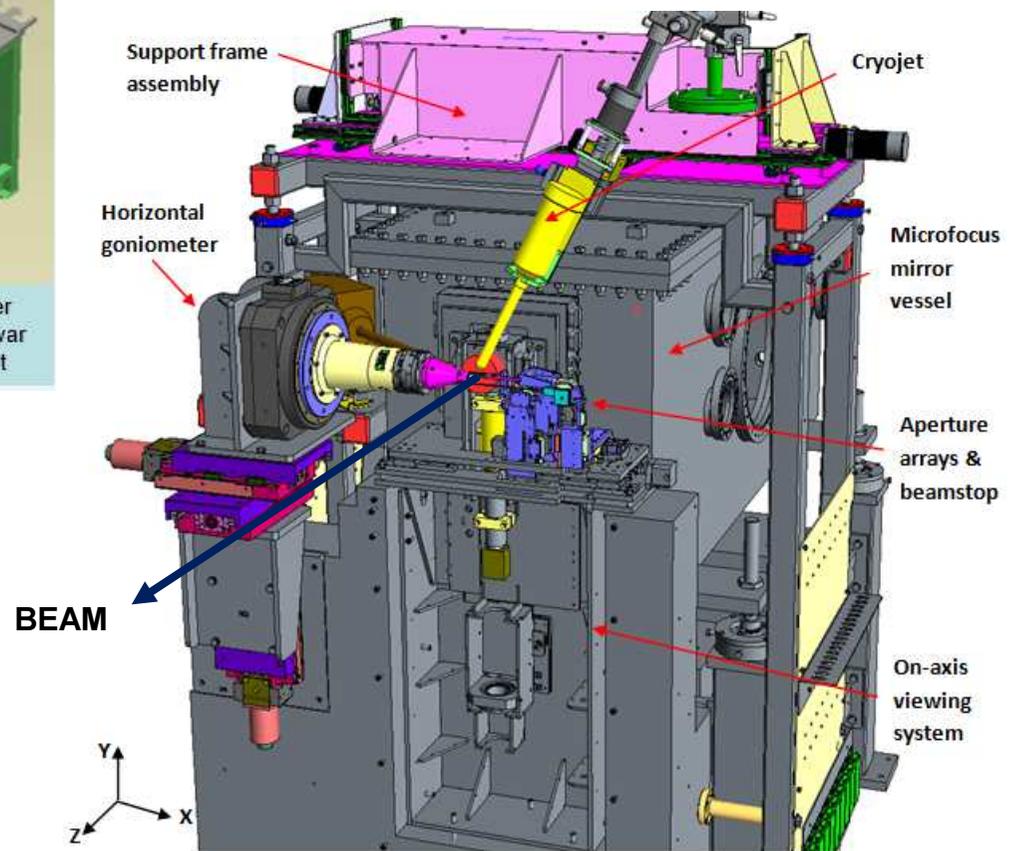
Vinay Grama
Diamond Light Source, UK



I24 BEAMLINE – EXISTING ENDSTATION



- Tunable Microfocus Macromolecular crystallography beamline
- In operation since 2009
- Beamsize - $10\mu\text{m} \times 10\mu\text{m}$



REASONS FOR UPGRADE

- Growing demand from users to reduce the current downtime when switching between *in situ* (crystallization plates / trays) and cryo-crystallography (pins) experiments
- Recently upgraded to a Pilatus3 6M detector – data collection at 100Hz: - current stages are too slow to perform fast scans
- Upgrades to micro-focussing KB mirrors in early 2015 resulting in a beamsize = $2\mu\text{m} \times 5\mu\text{m}$ at sample position

REQUIREMENTS

- Two goniometers

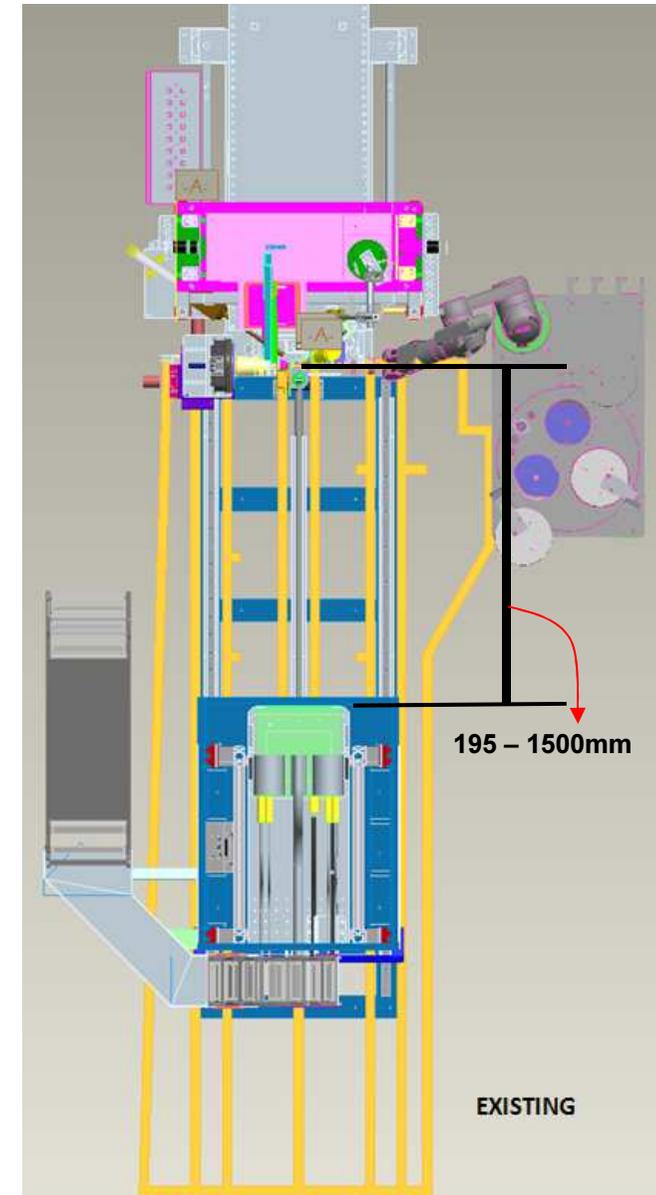
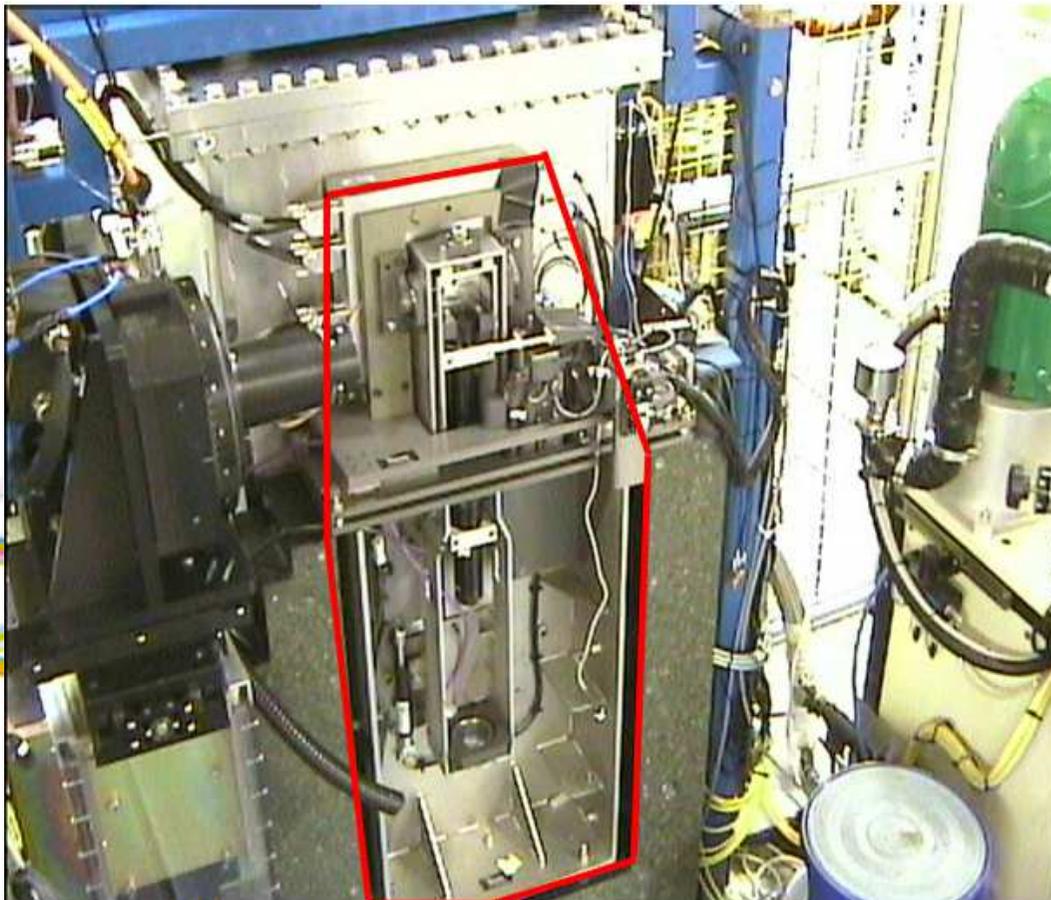
Horizontal dedicated to tray screening

Vertical dedicated to pin experiments – low SoC < 1 micron

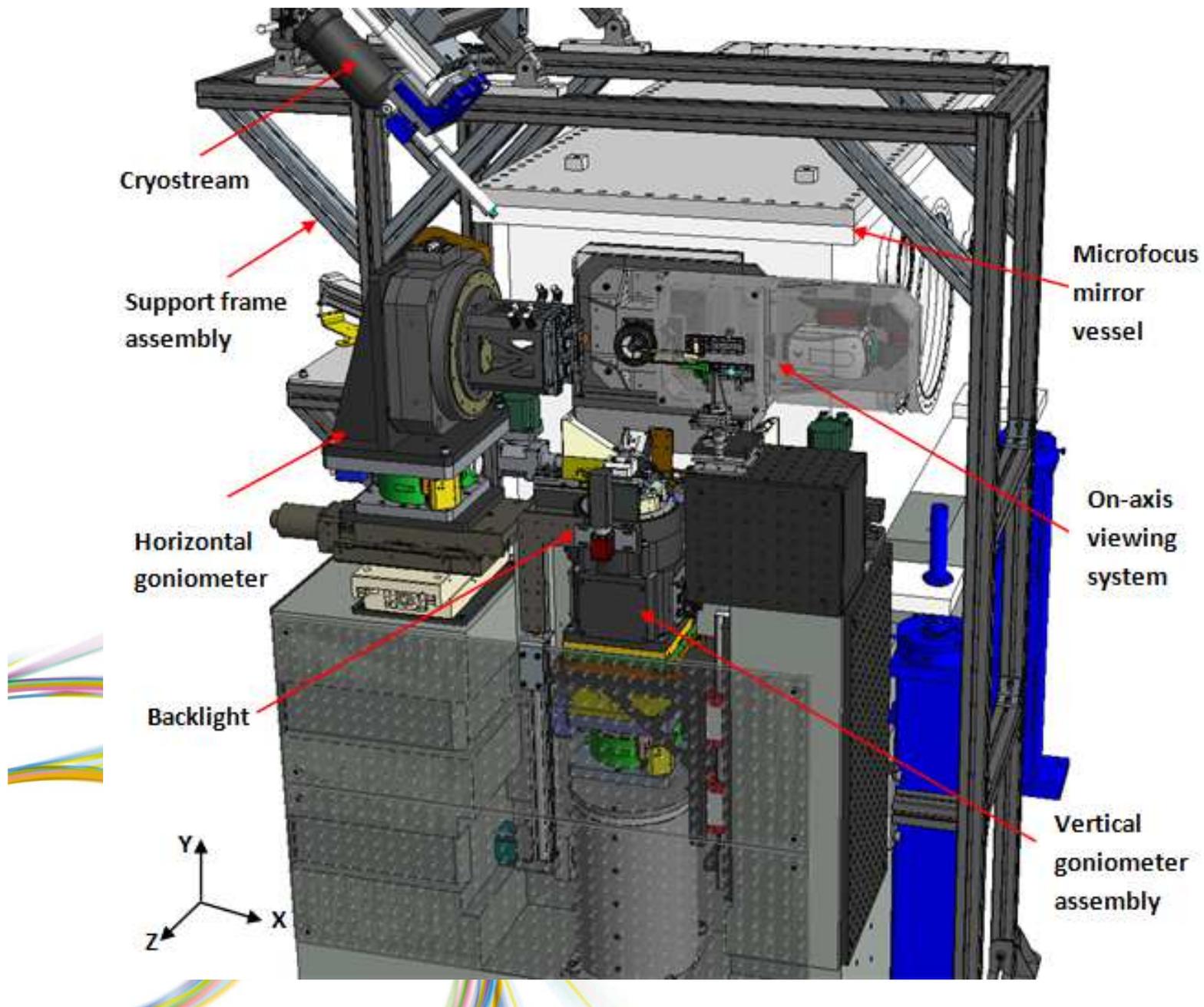
- Optional kappa axis on vertical goniometer for sample reorientation
- Automated switch between modes
- Robot able to mount both trays and pins
- Improved sample viewing with new On-axis viewing system (OAV) – higher resolution

CHALLENGES

- Limited space
 - Mirror vessel – sample position = 200mm
 - Sample position – Detector = 195mm
- Redesign OAV to a better and more compact system

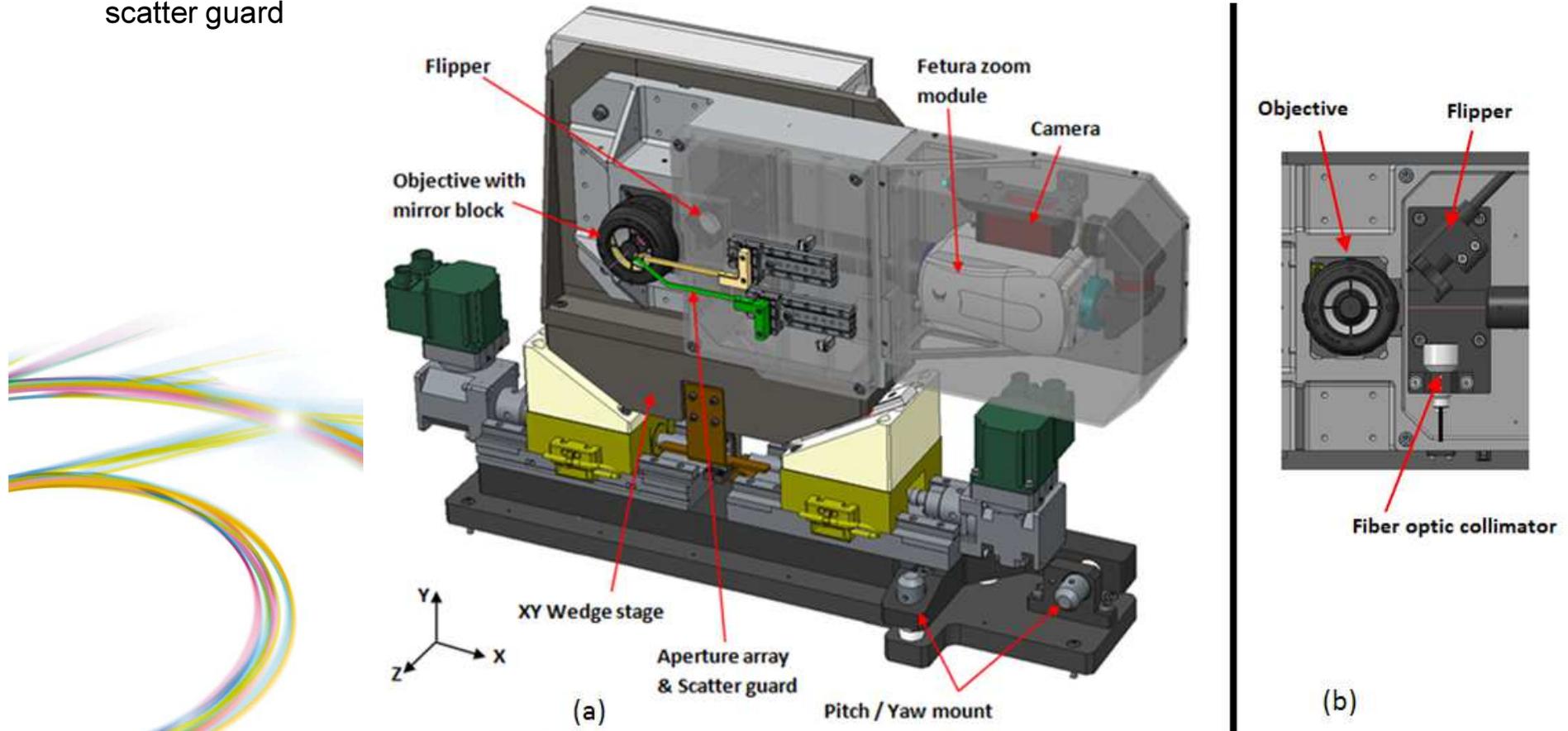


I24 BEAMLINE – NEW ENDSTATION

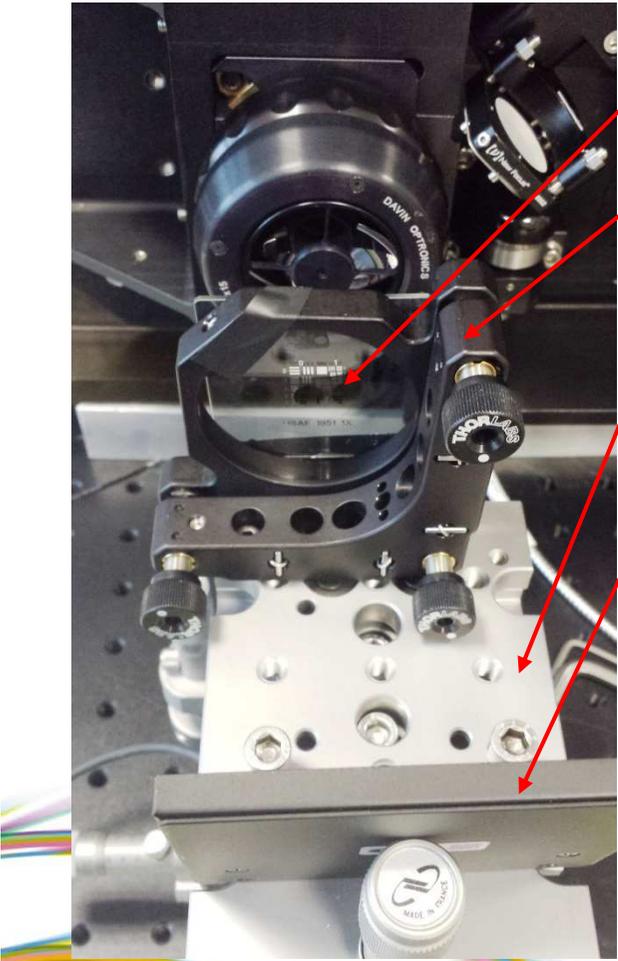


NEW ON-AXIS VIEWING SYSTEM

- Reflector objective – custom design by Davin Optronics
- $\text{\O}1.5\text{mm}$ through hole for X-ray beam
- Fetura zoom module with relay lens – Qioptiq
- Laser excitation for *in situ* spectroscopy
- Motorized XY wedge stage
- Pitch-Yaw mount
- SmarAct stages for positioning Aperture array and scatter guard



OPTICAL RESOLUTION TESTS

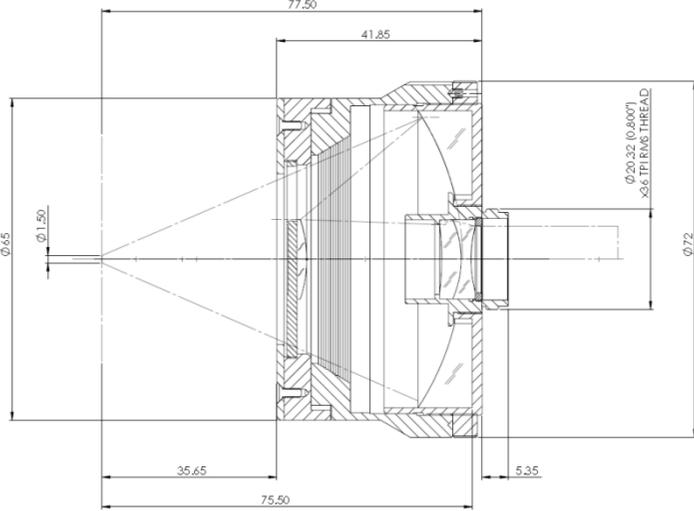


USAF 1951 Hi-res target

Tip-tilt mount

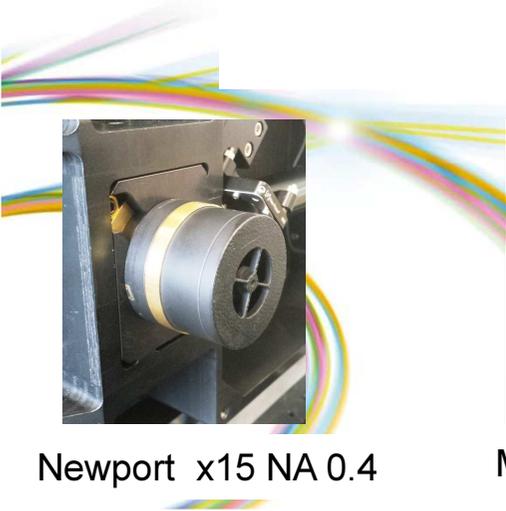
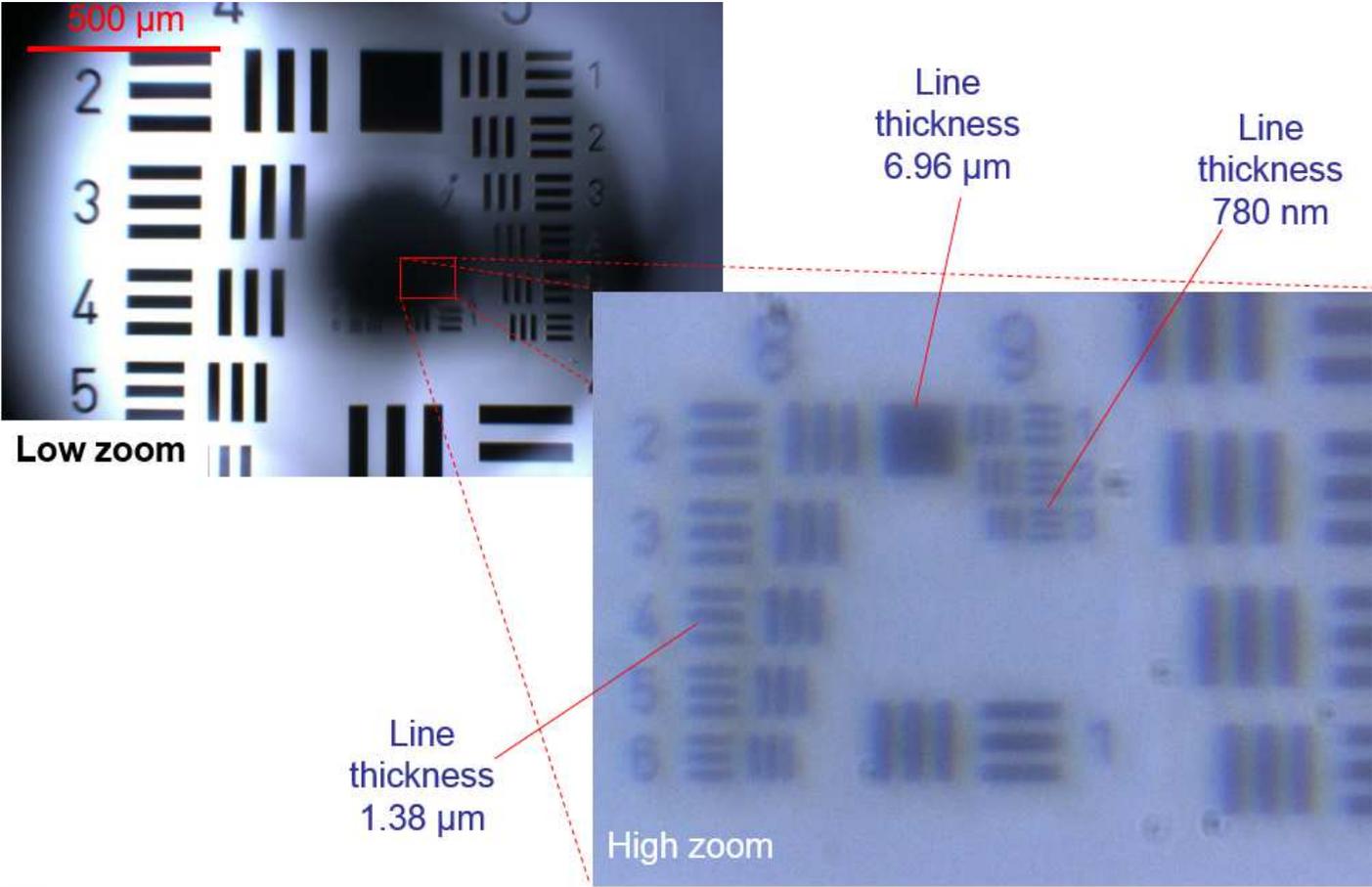
Precision XYZ stage

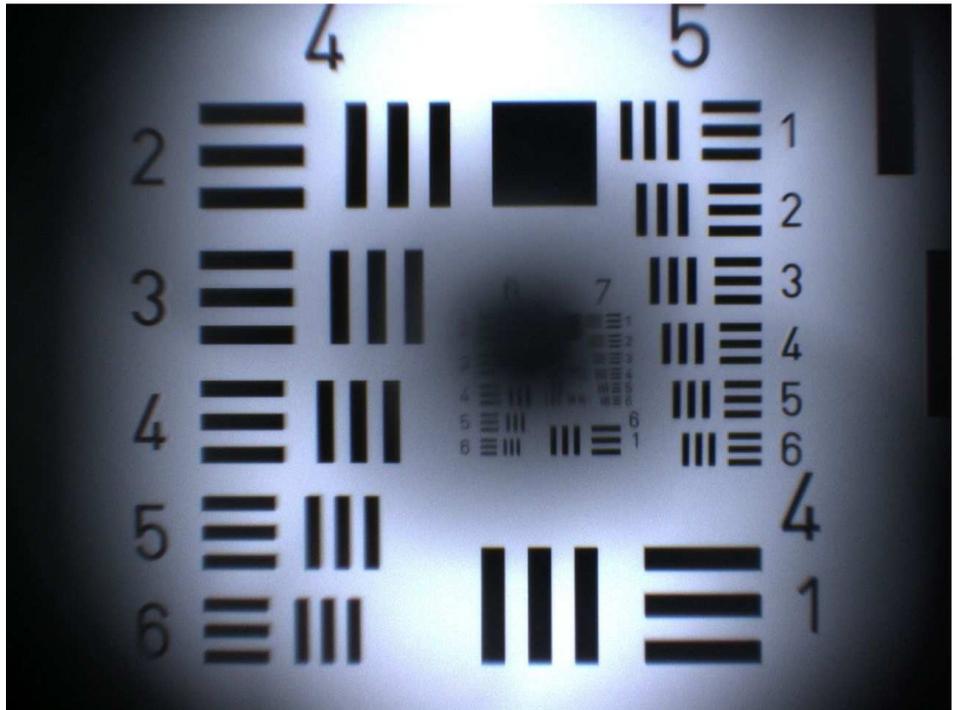
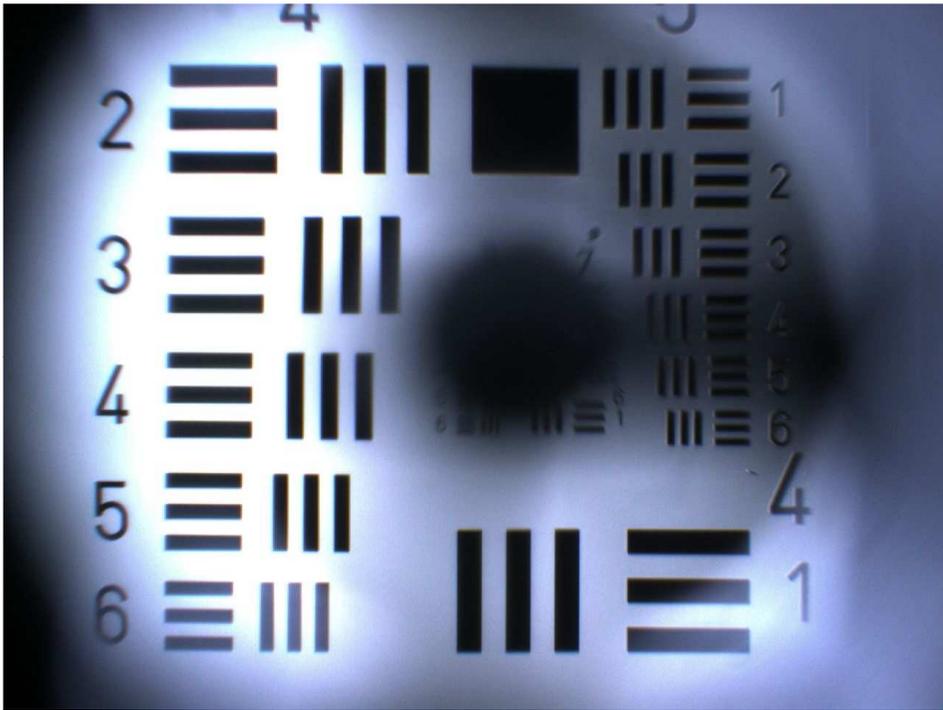
Flat panel diffuse LED backlight



Davin x15 N0.4

OPTICAL RESOLUTION TESTS





Davin

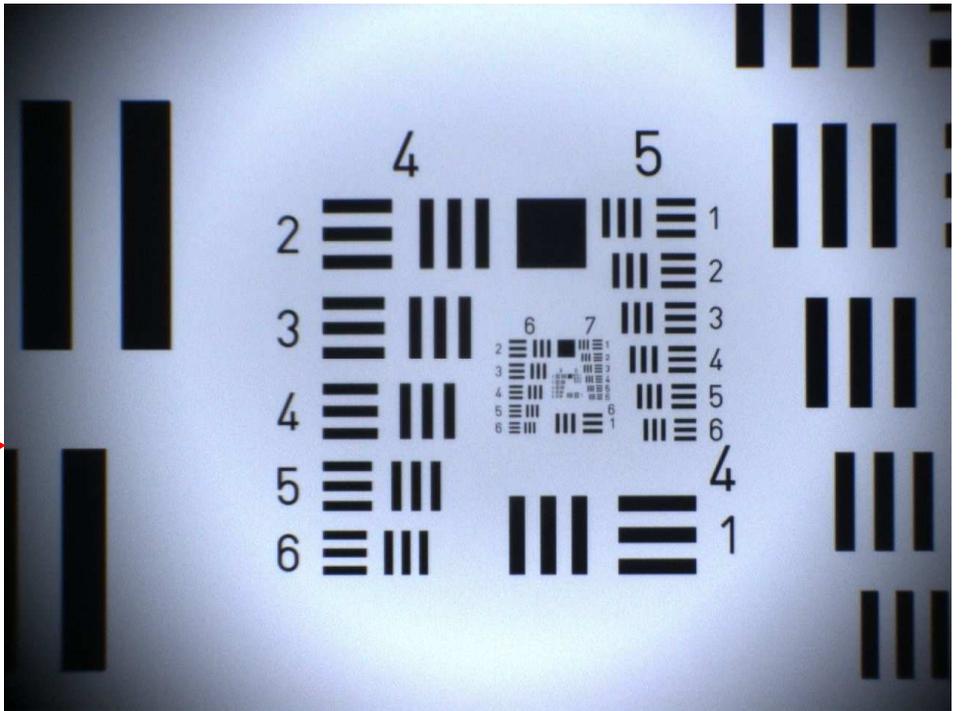


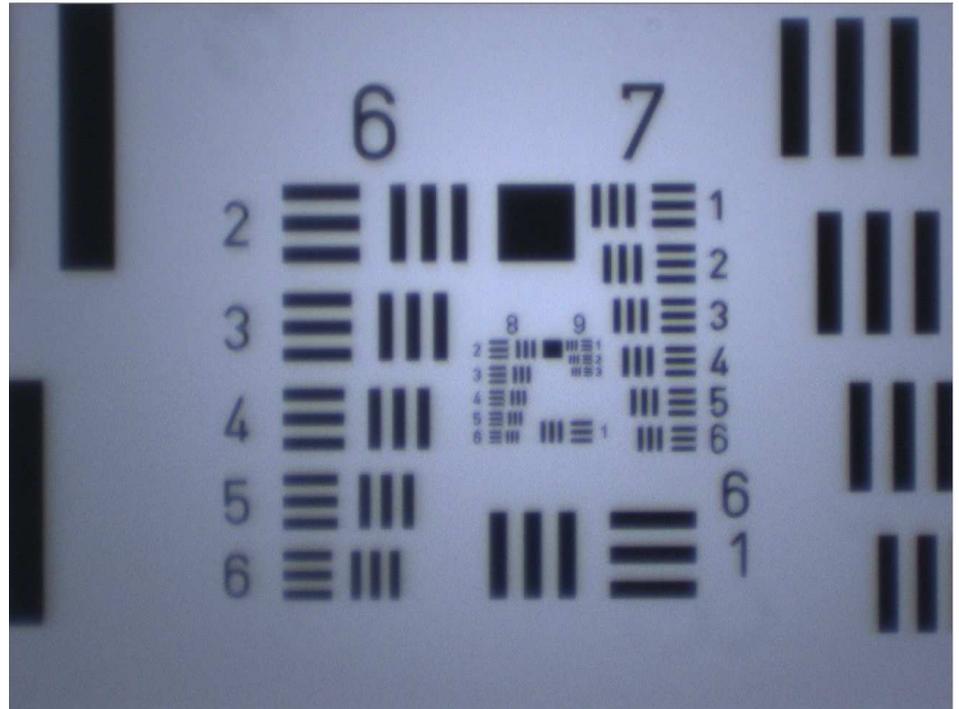
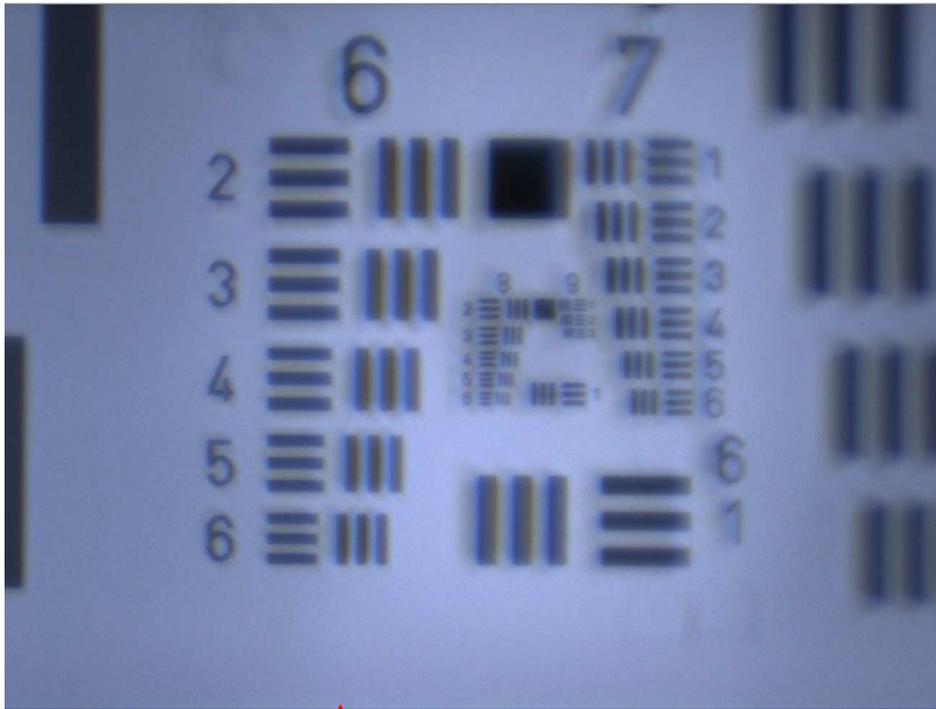
Newport



x1 Zoom

Mitutoyo





Davin



Newport

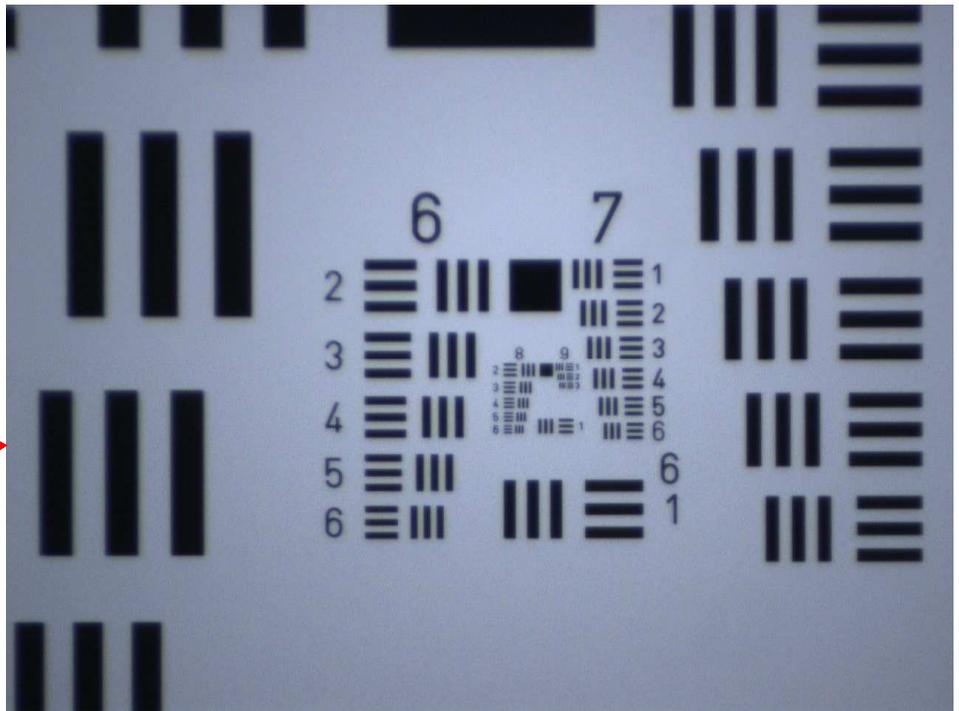


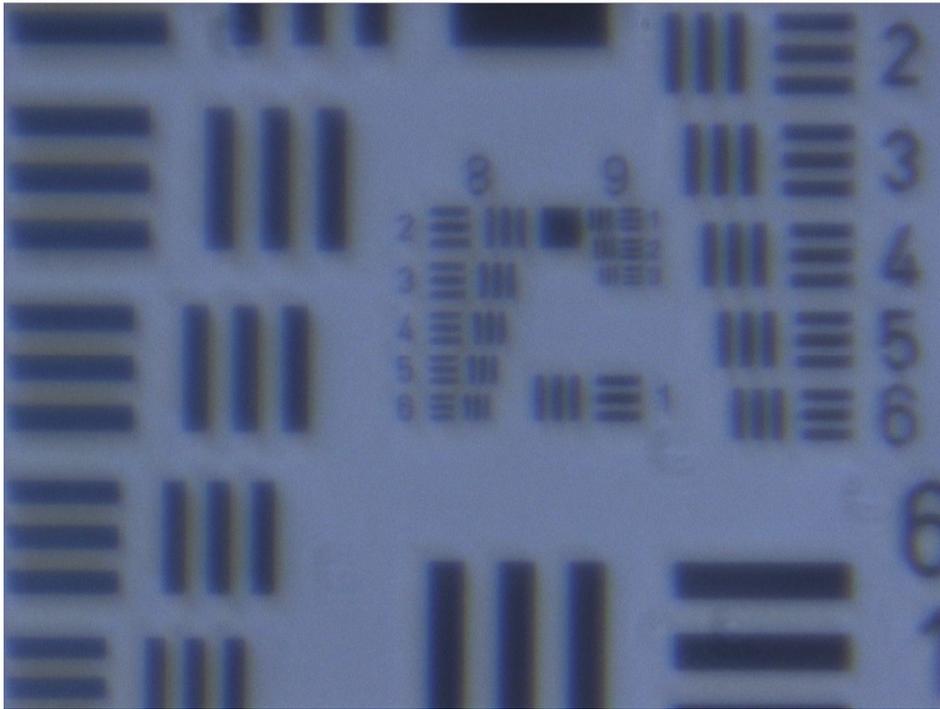
Davin – not Parfocal



x3 Zoom

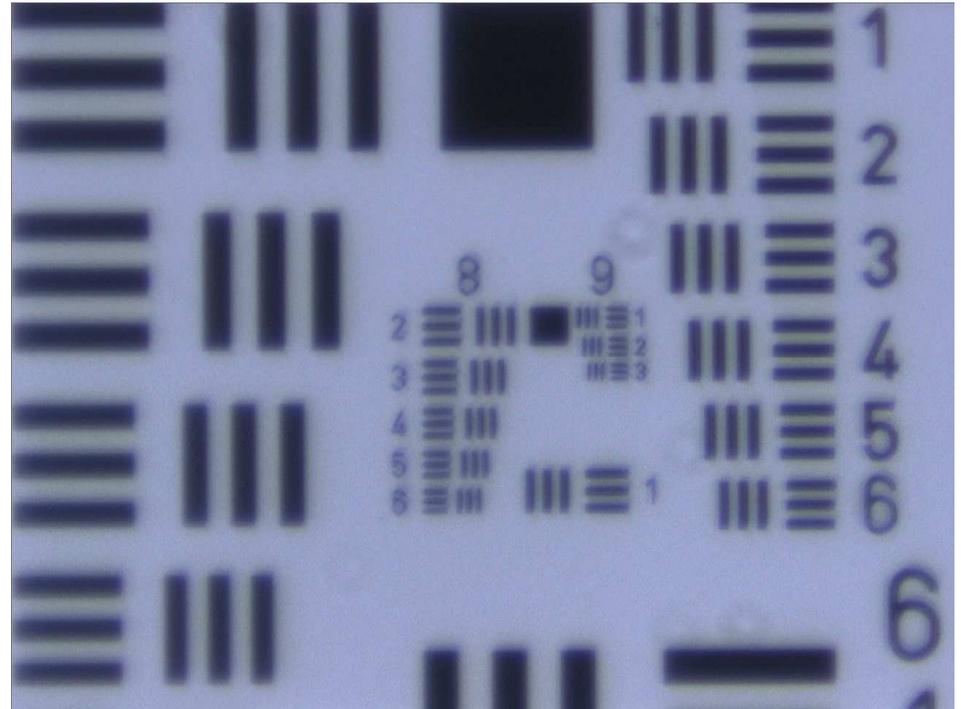
Mitutoyo





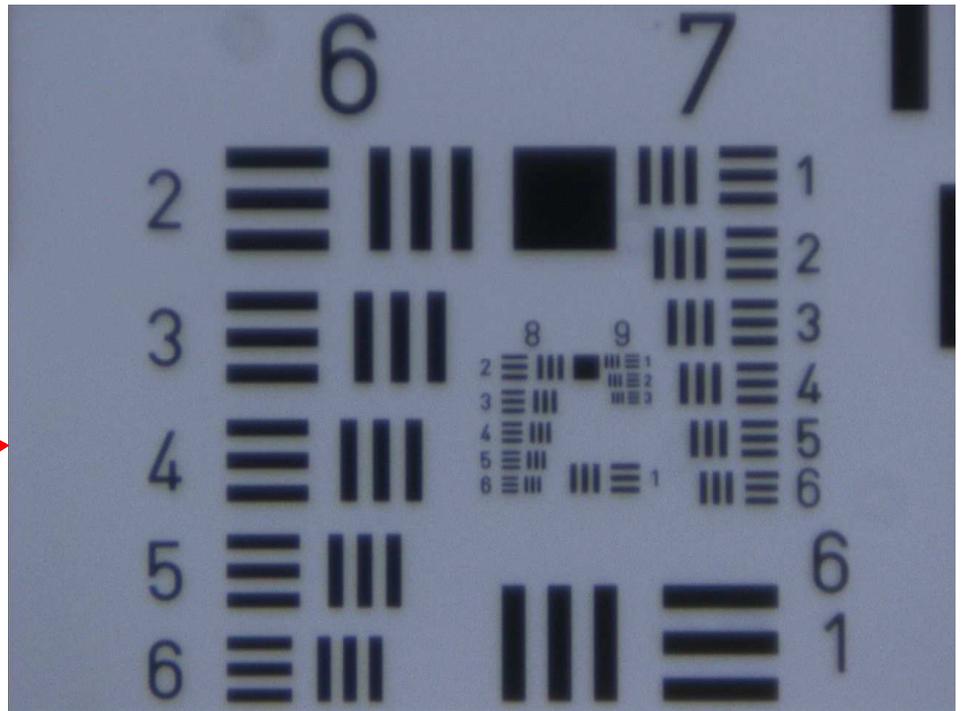
Davin

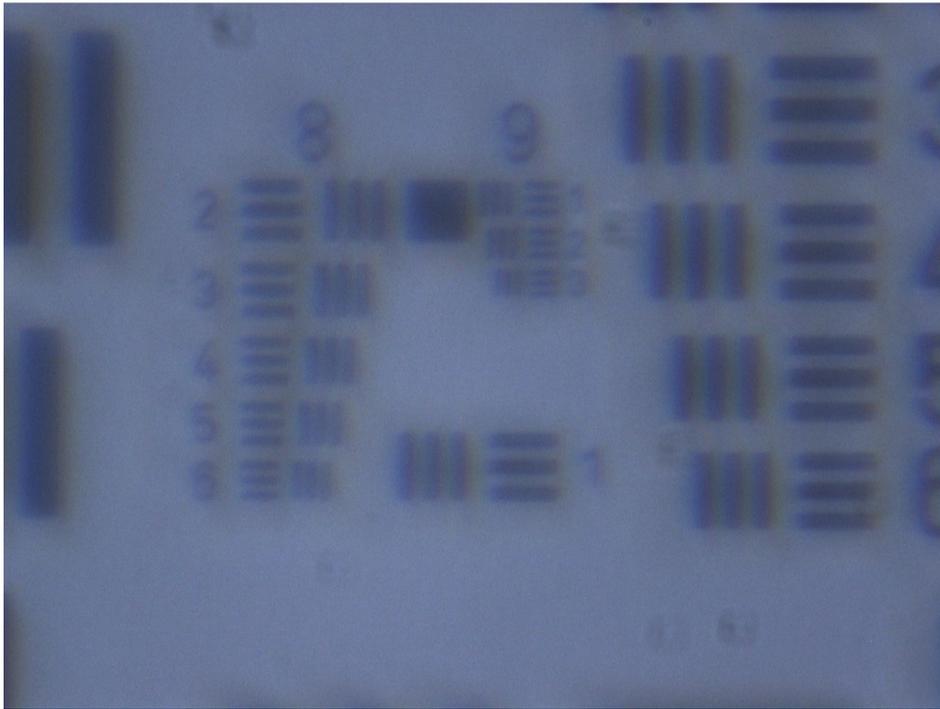
Newport



x6 Zoom

Mitutoyo

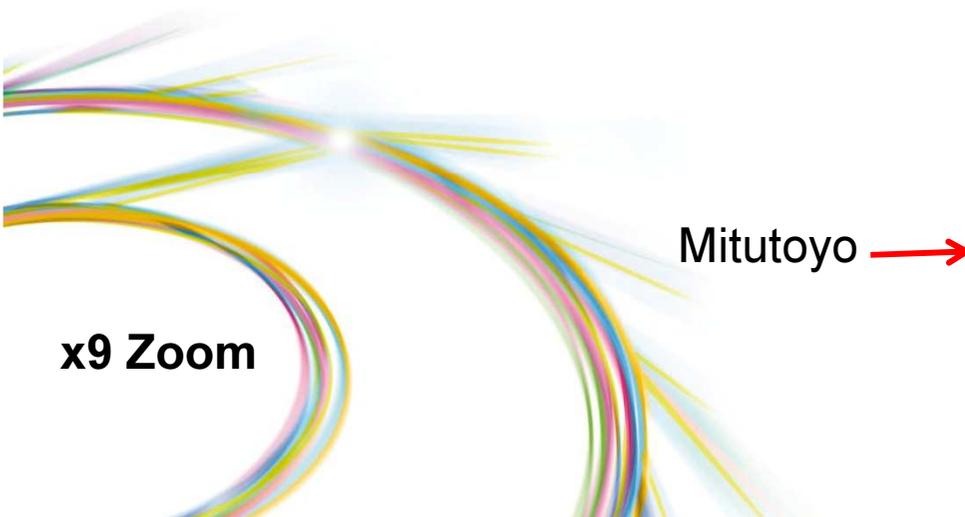
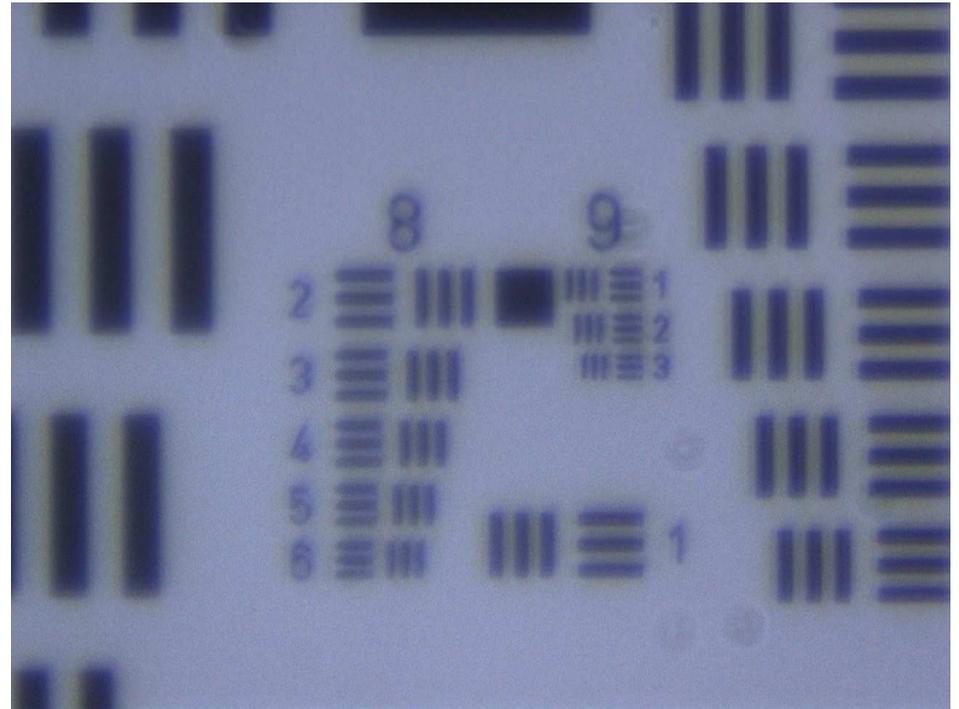




Davin

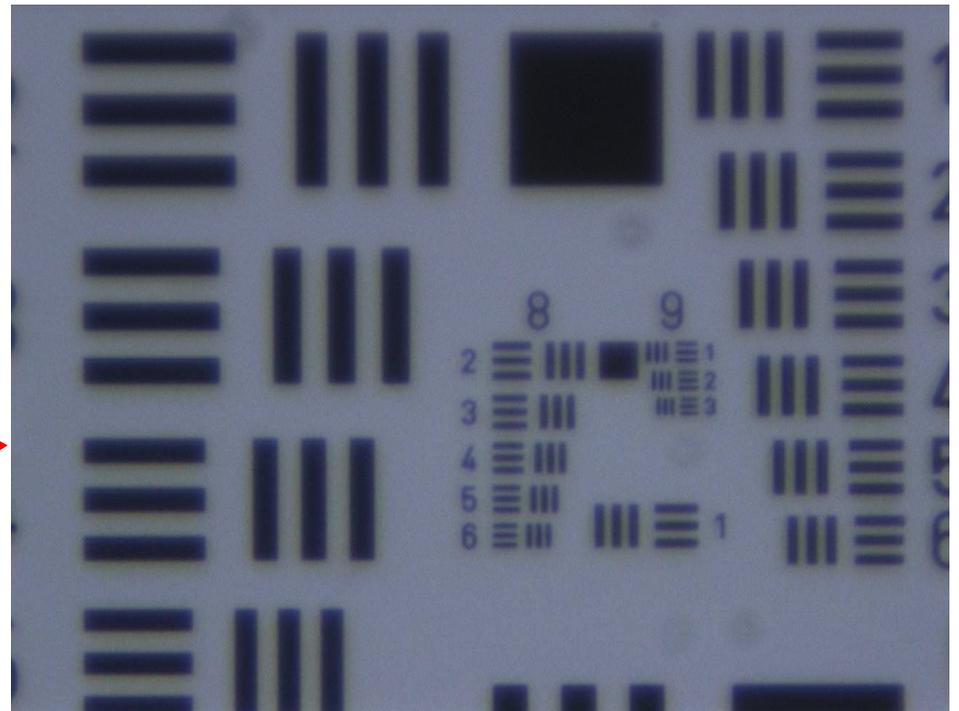


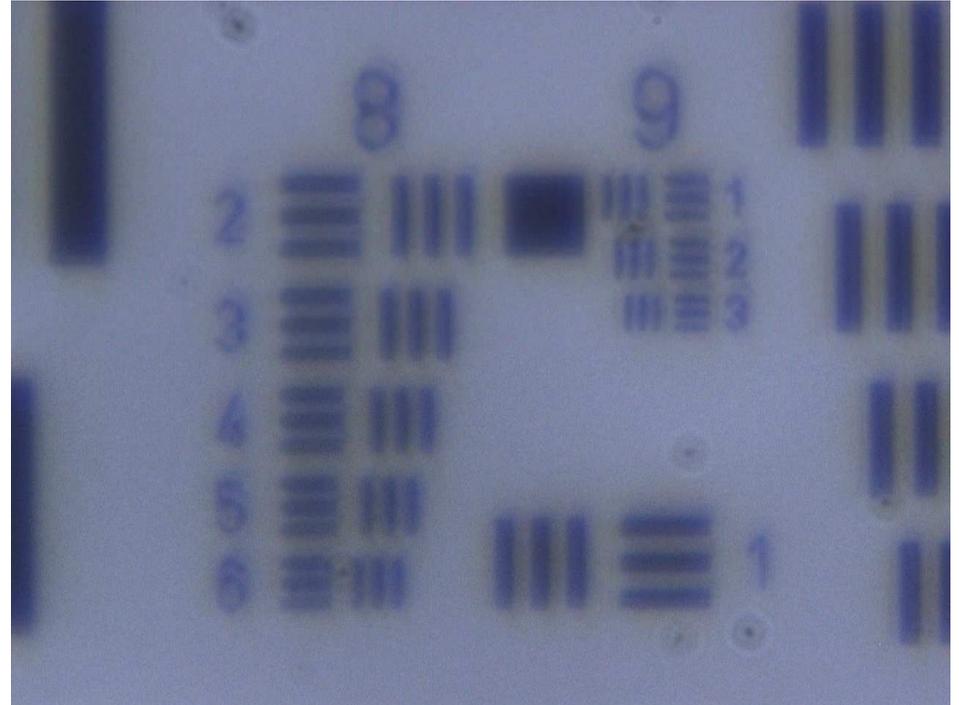
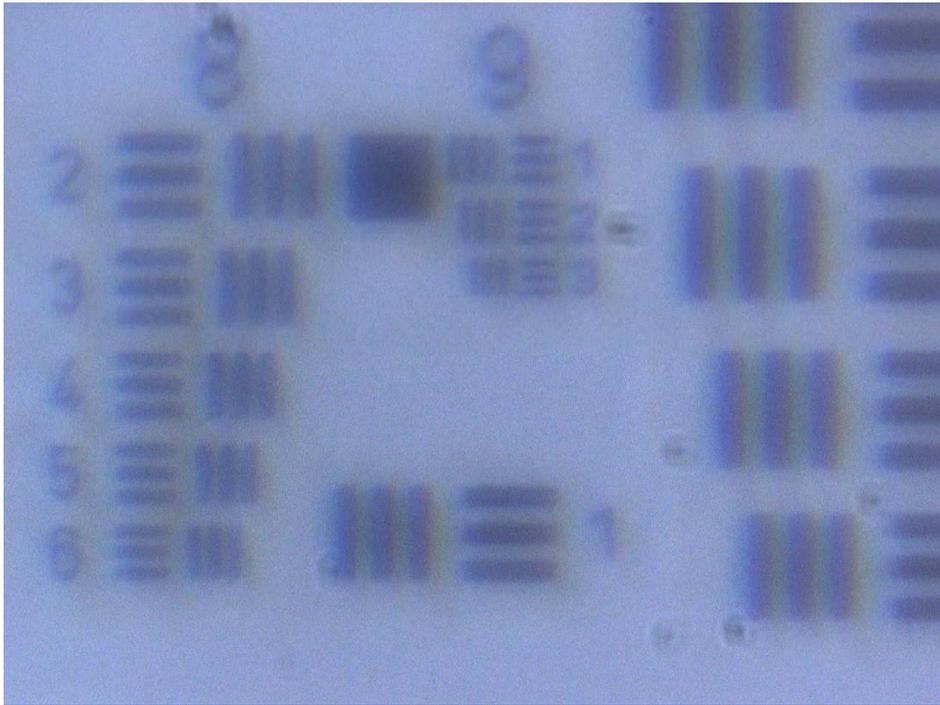
Newport



x9 Zoom

Mitutoyo





Davin

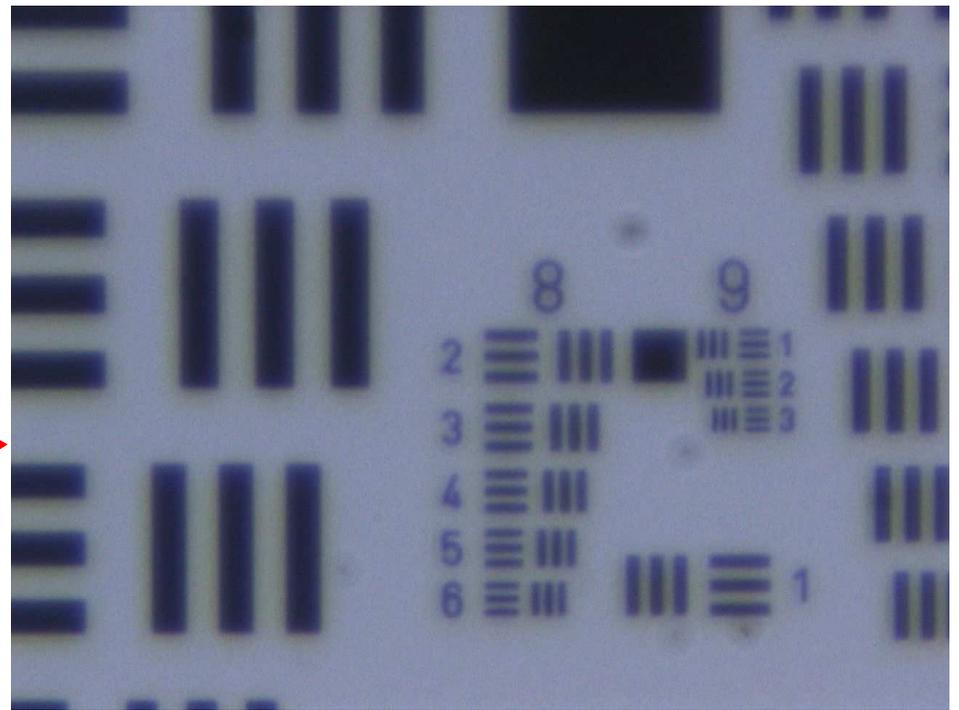


Newport



x12.5 Zoom (max.)

Mitutoyo



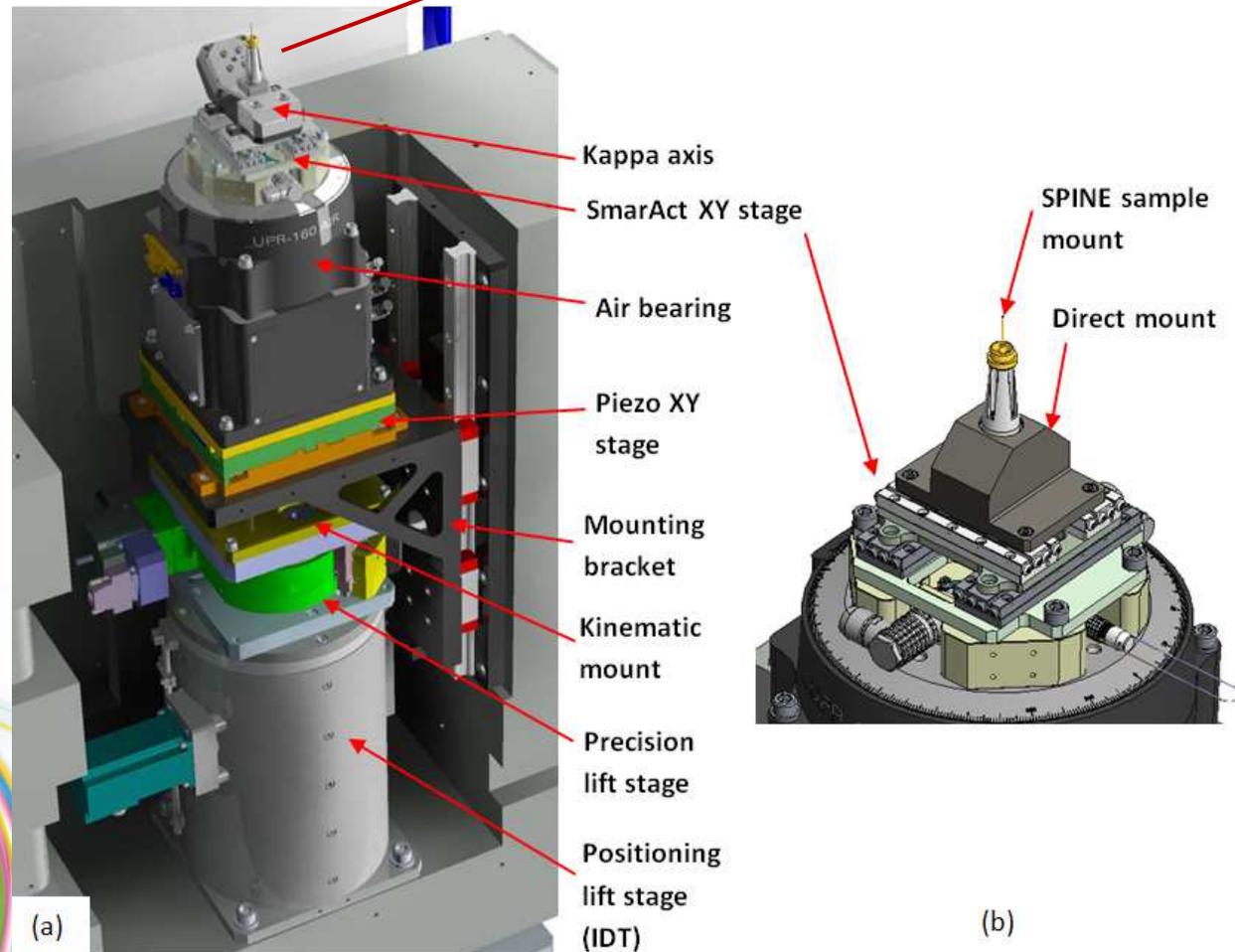
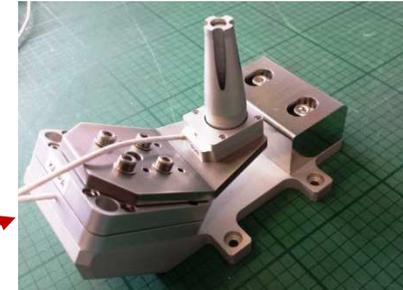
OPTICAL RESOLUTION TESTS

- Performance - Mitutoyo > Newport > Davin
- Mitutoyo does not have any hole in the center
- Image quality and resolution with Newport objective good but working distance is too small
- Qioptiq – manufactures a objective similar to Mitutoyo but has a $\text{Ø}1.6\text{mm}$ hole (to be tested)



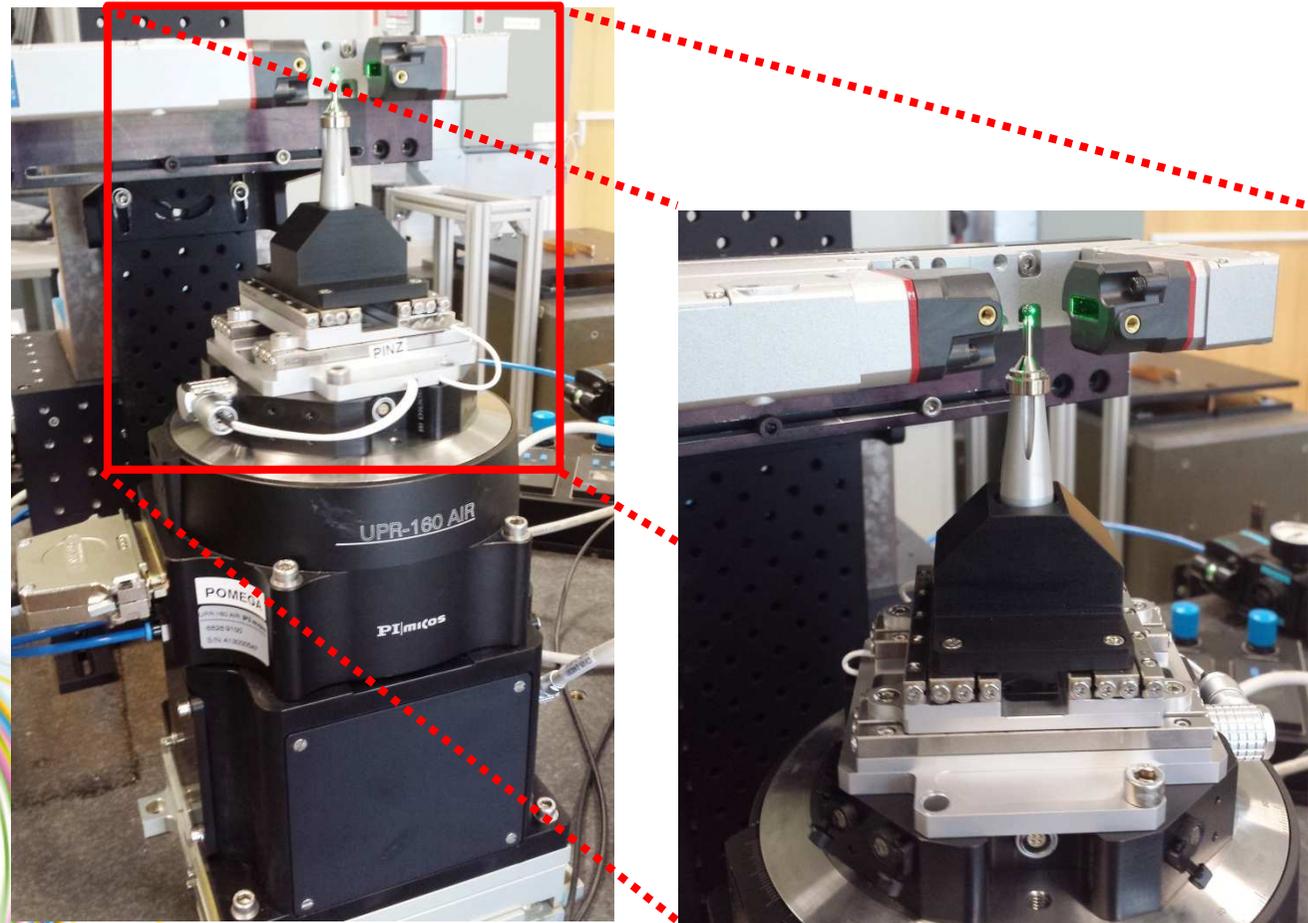
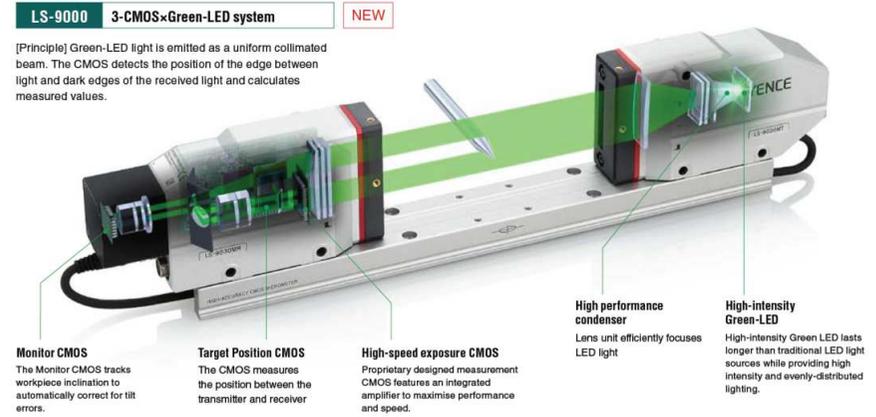
VERTICAL GONIOMETER

- Main rotary stage – PI Micos UPR-160 air bearing
- Centering stage – a set of XY linear stages from SmarAct
- Optional Kappa axis has two SmarAct rotary stages



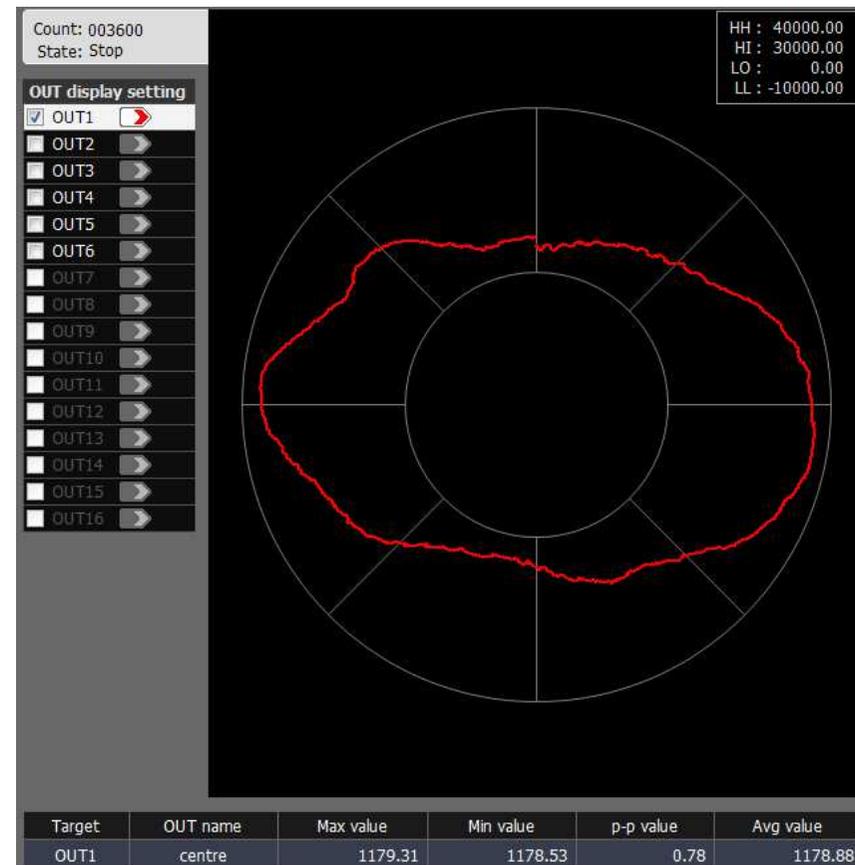
SPHERE OF CONFUSION (Optical micrometer)

- Keyence optical micrometer
- Precision ball with sphericity = 160nm
- Measurements made in a lab with no temperature control

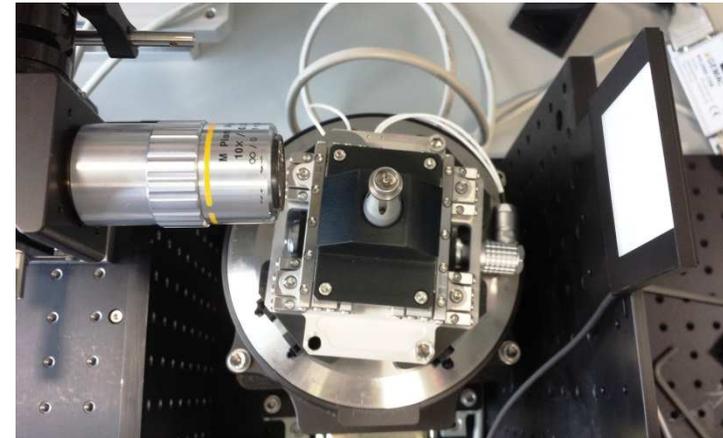
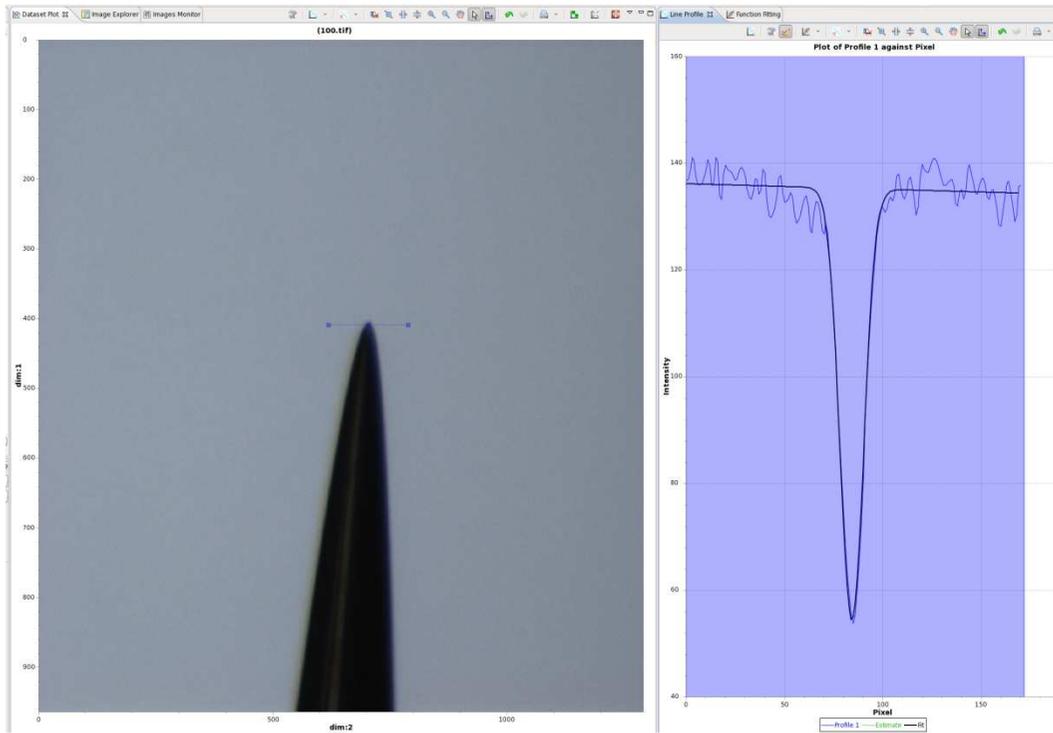


SPHERE OF CONFUSION (Optical micrometer)

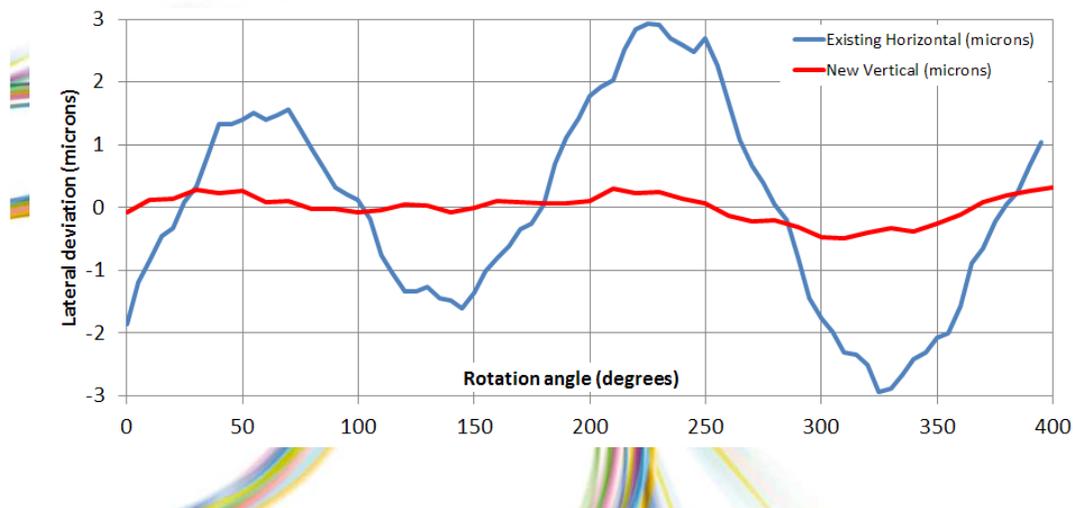
- Rotational speed 90 deg/s
- Sampling rate = 10 samples/deg
- TIR = **780nm**



SPHERE OF CONFUSION (Optical microscope)



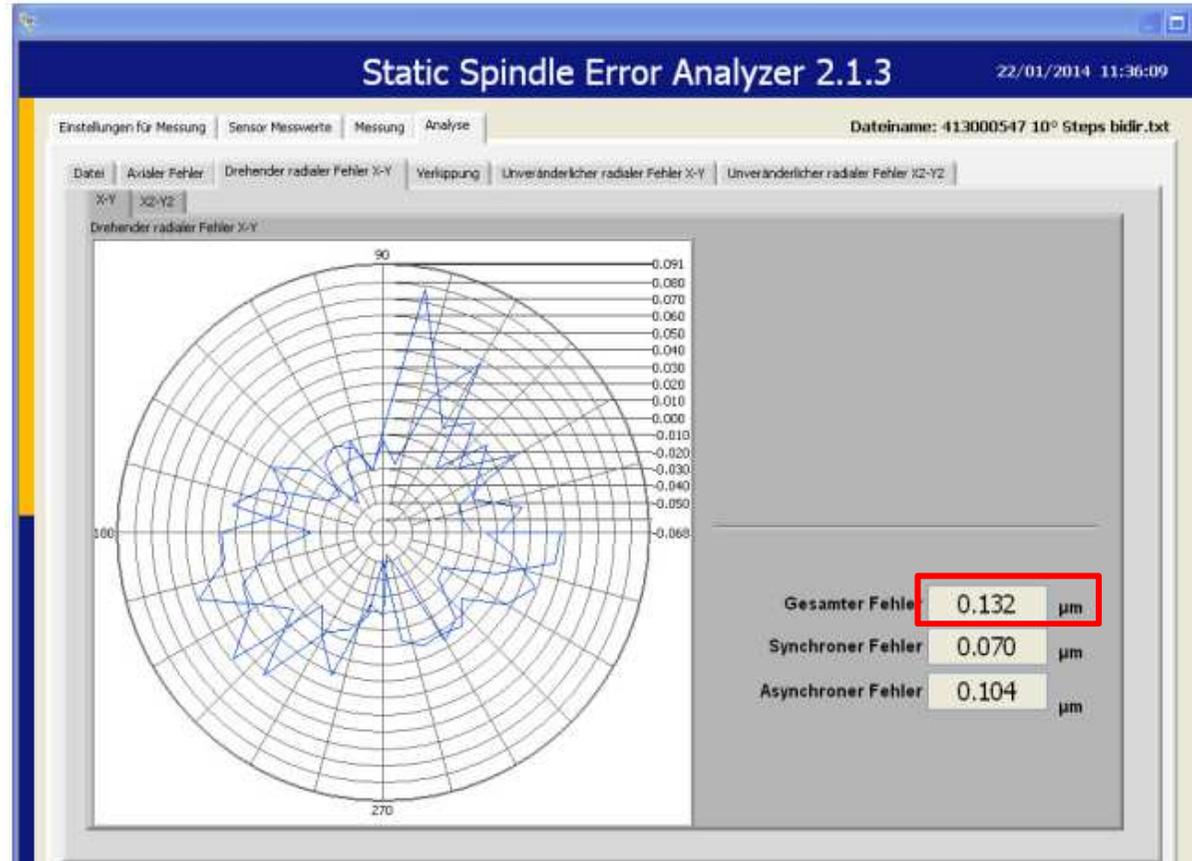
- 1 pixel = 210.6 nm
- Measured SoC ~ 800nm



SPHERE OF CONFUSION (Capacitive sensors - PI Micos)



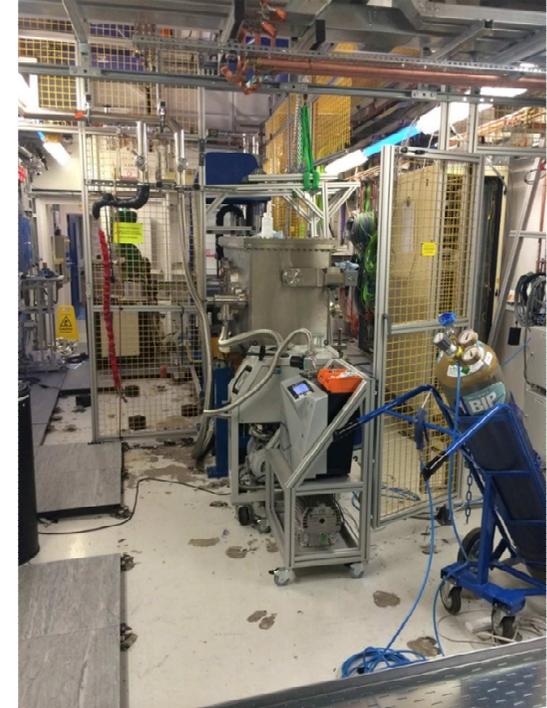
ROTATING RADIAL ERROR X1-Y1



- 800nm < 1µm (requirements met)
- Problems with the air bearing?
- Problems with slipping mount?
- Further testing required

CURRENT STATUS

- New Endstation installed in hutch
- To be completed
 - Cable routing
 - Motion and software commissioning
 - Alignment and further testing
- Target – online on 25th Nov, 2014



THE END

