

The IMAT Camera Positioning Robot @ ISIS

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Acknowledgements:

Steve Cox, Jim Nightingale,  NatX-ray ,
Winfried Kocklemann, Tino Minniti,
Genoveva Burca, Dan Pooley



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Overview

- Introduction to the IMAT instrument
- IMAT's Camera Positioning System
- Why use a robot?
- System performance
- Are robots dangerous?



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The ISIS Facility

- Oxfordshire, UK
- 1985 Facility Opened
- 2008 TS2 opened
- Pulsed Spallation Source
- Target Stations
 - TS1 160kW 40Hz
 - TS2 40kW 10Hz



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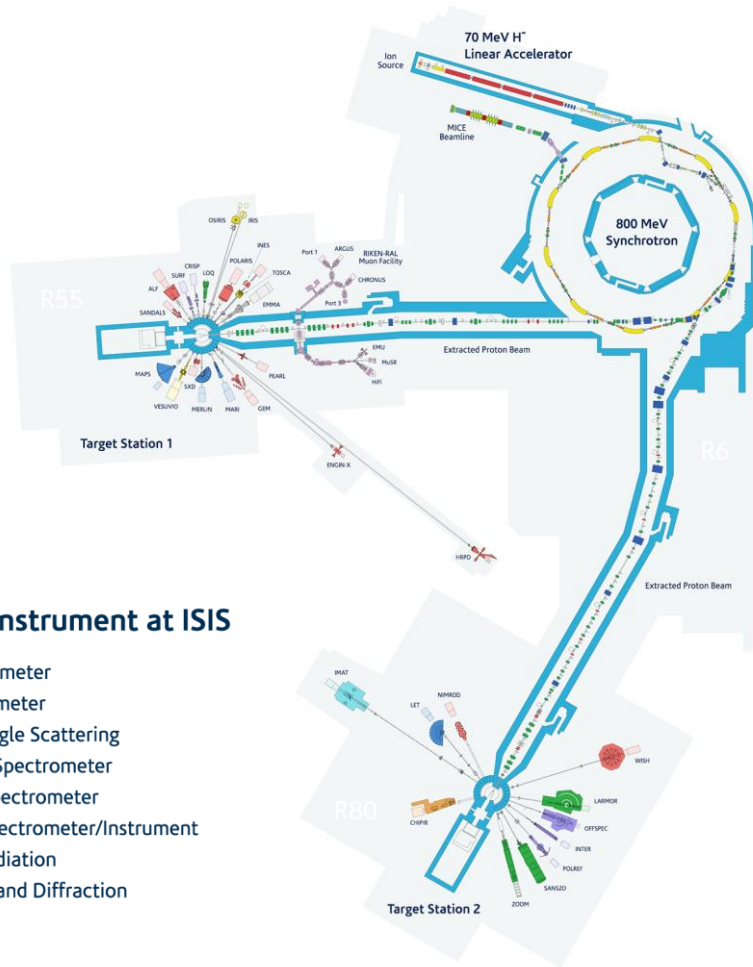
ISIS

The ISIS Facility

- 30 Operational Beamlines
- 350 staff members
 - 24 Instrument Design Engineers

Types of Instrument at ISIS

- Diffractometer
- Reflectometer
- Small Angle Scattering
- Indirect Spectrometer
- Direct Spectrometer
- Muon Spectrometer/Instrument
- Chip Irradiation
- Imaging and Diffraction

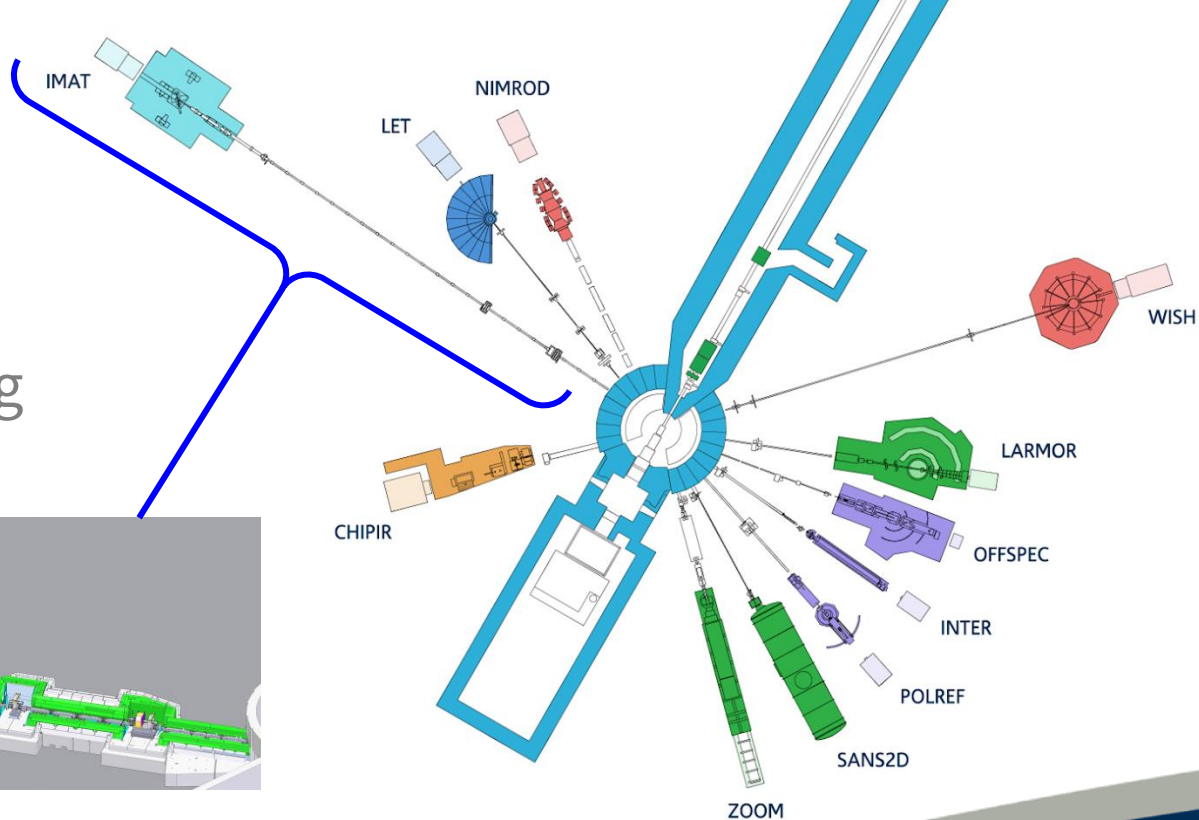
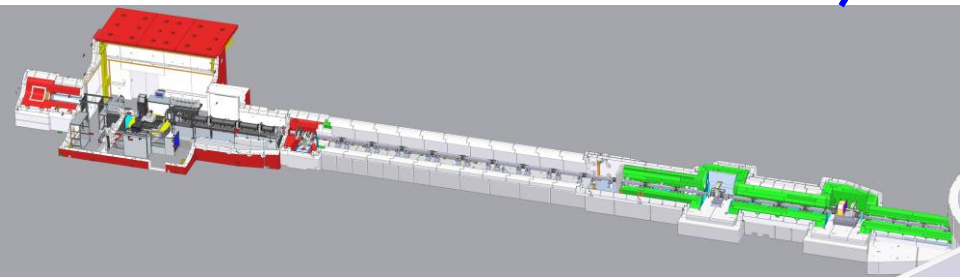


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IMAT

Imaging and **M**aterials
Science and Engineering



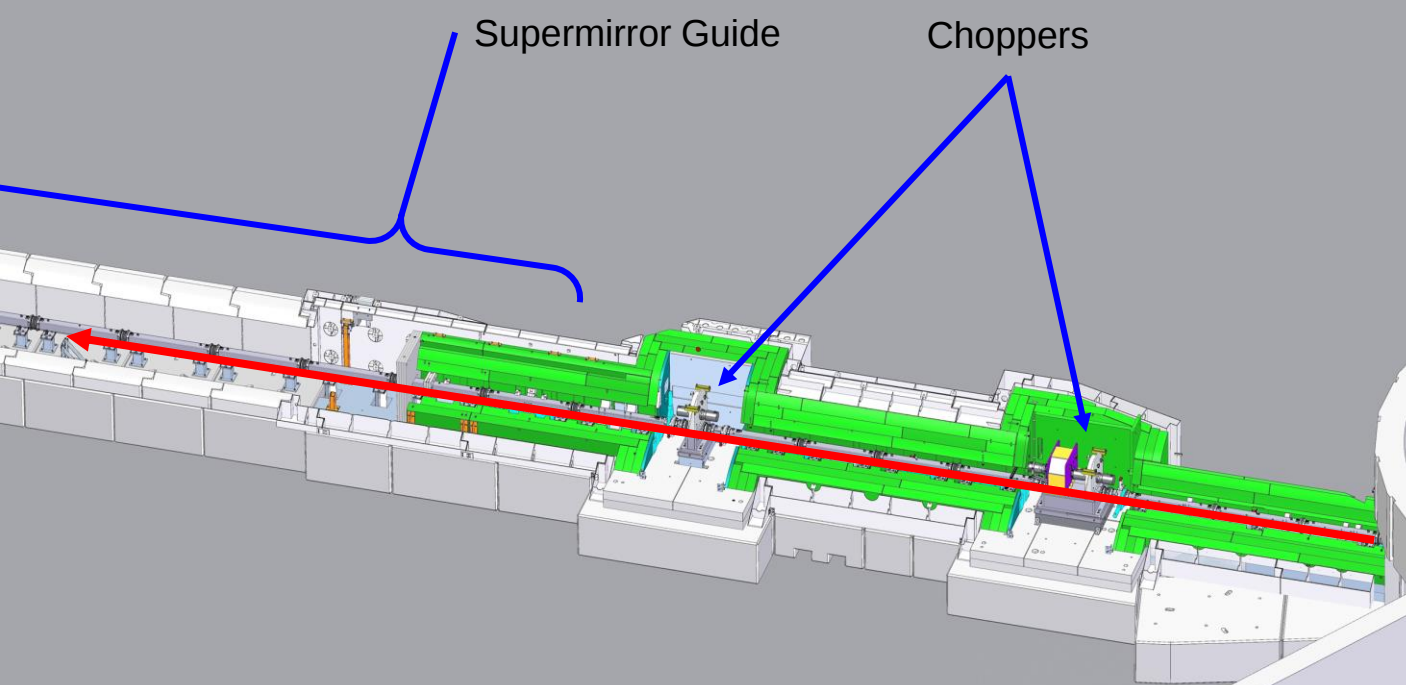
Target Station 2



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IMAT



Target
Station 2



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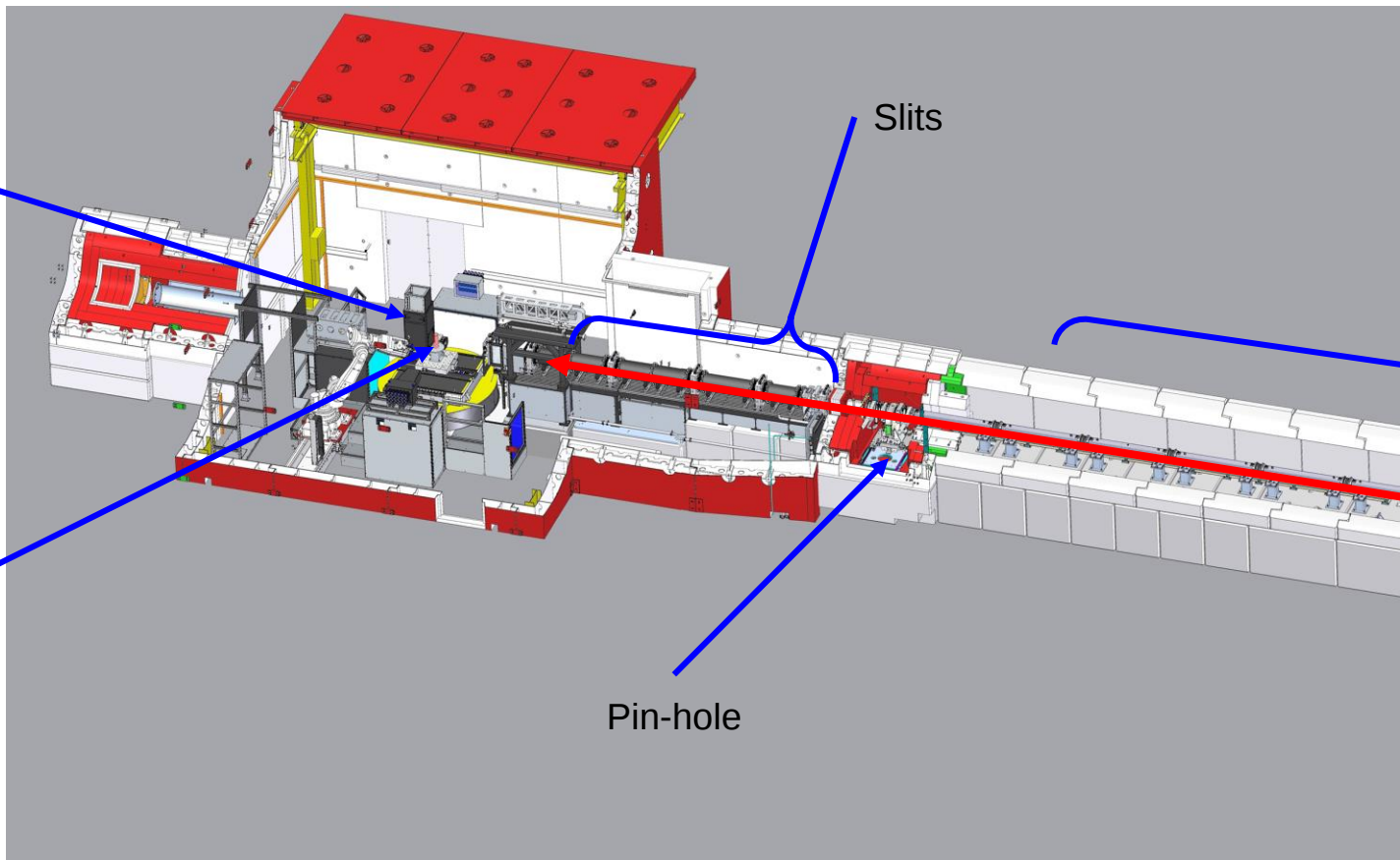
IMAT

Neutron camera

Sample position

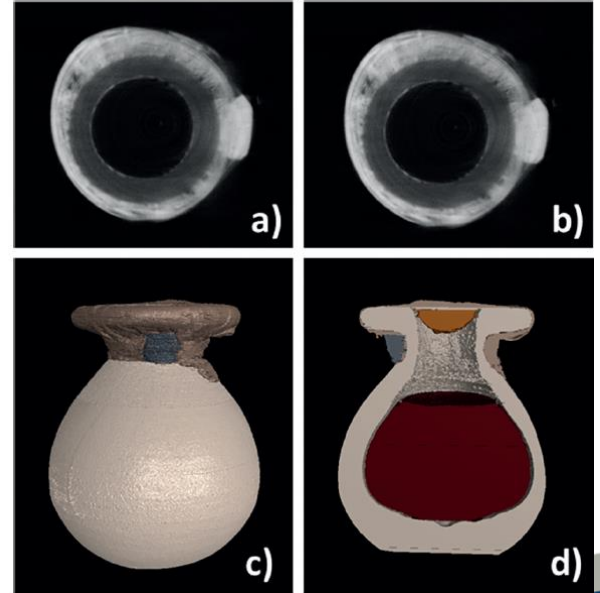
Slits

Pin-hole



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Imaging an Ancient Egyptian Vase



[Festa et al. \(2018\)](#)

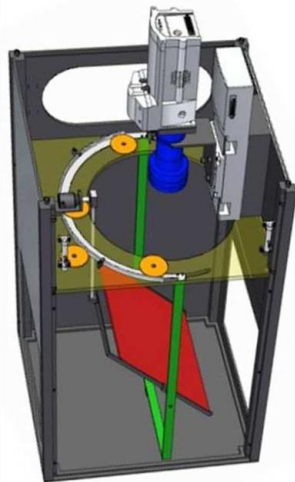


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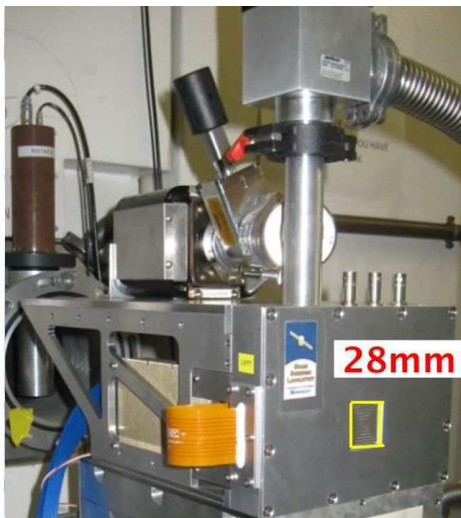
Neutron Cameras

CCD/CMOS

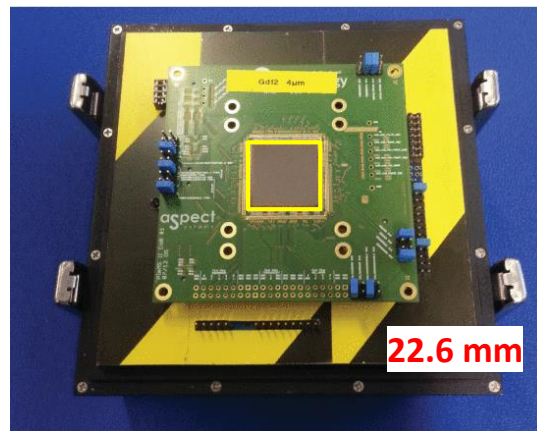


[Kockelmann et al. \(2015\)](#)

MCP



GP2



[Pooley et al. \(2017\)](#)

...more to come!

+

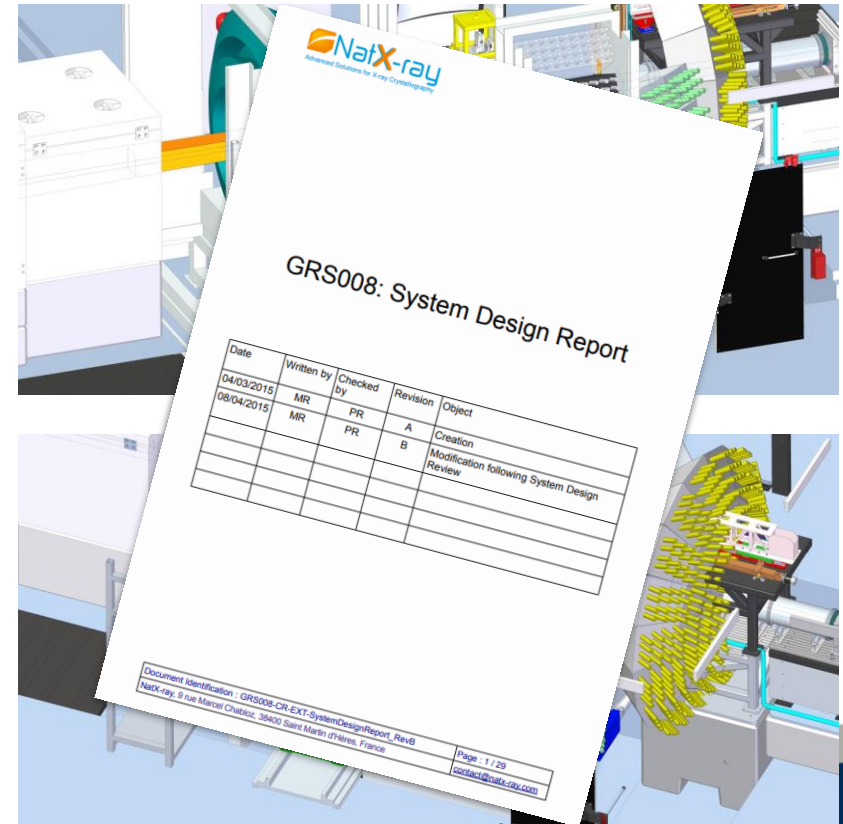


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Tender Specification

- Move camera out of data-collection position
- Move to parking location on storage shelf
- Release camera
- Move to next camera parking location
- Pick up next camera
- Move to data-collection position



System

ABB iRB6620

Schunk SWS-210-L

GÜDEL TMF-3

2.2 + 0.8m reach

3.5m tall

Max 150 kg load

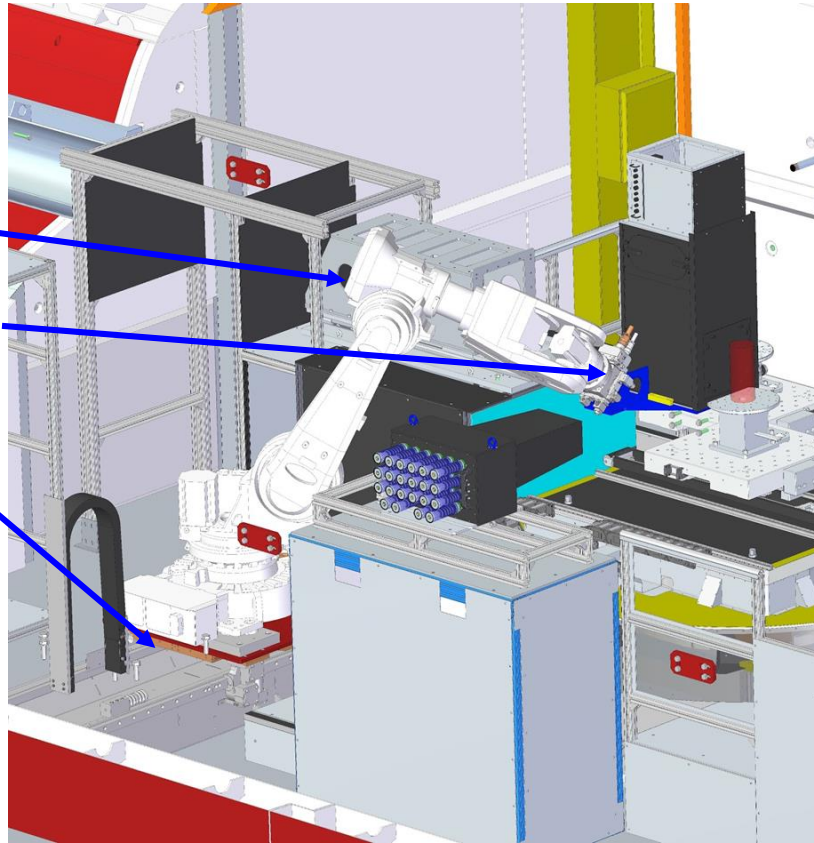


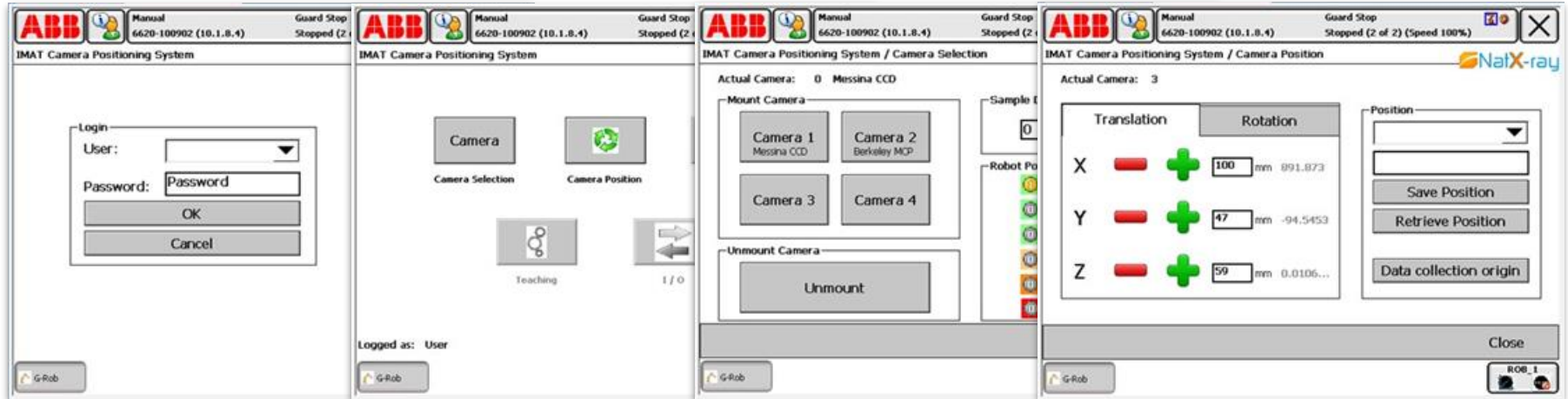
photo S. Kill



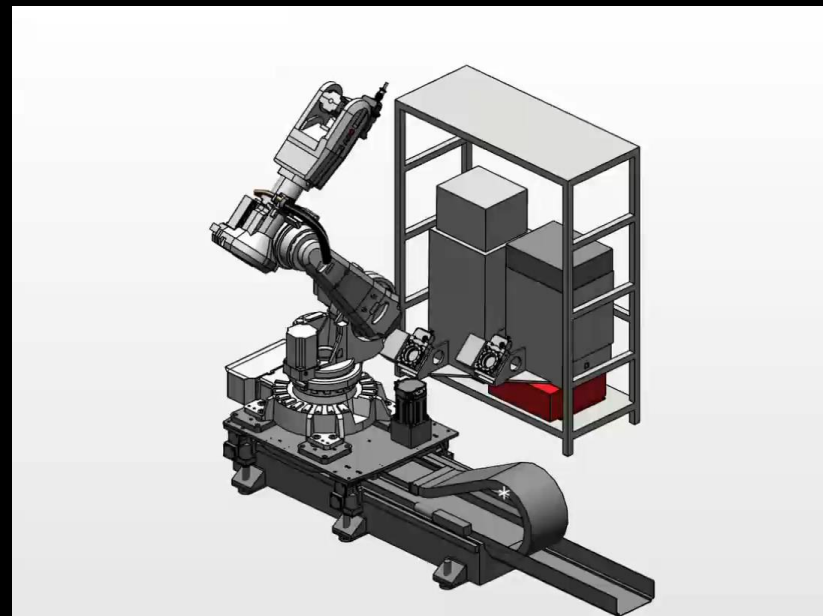
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Operation



Operation



(speed x2)



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Why use a robot?



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Radiation

Why use a robot?

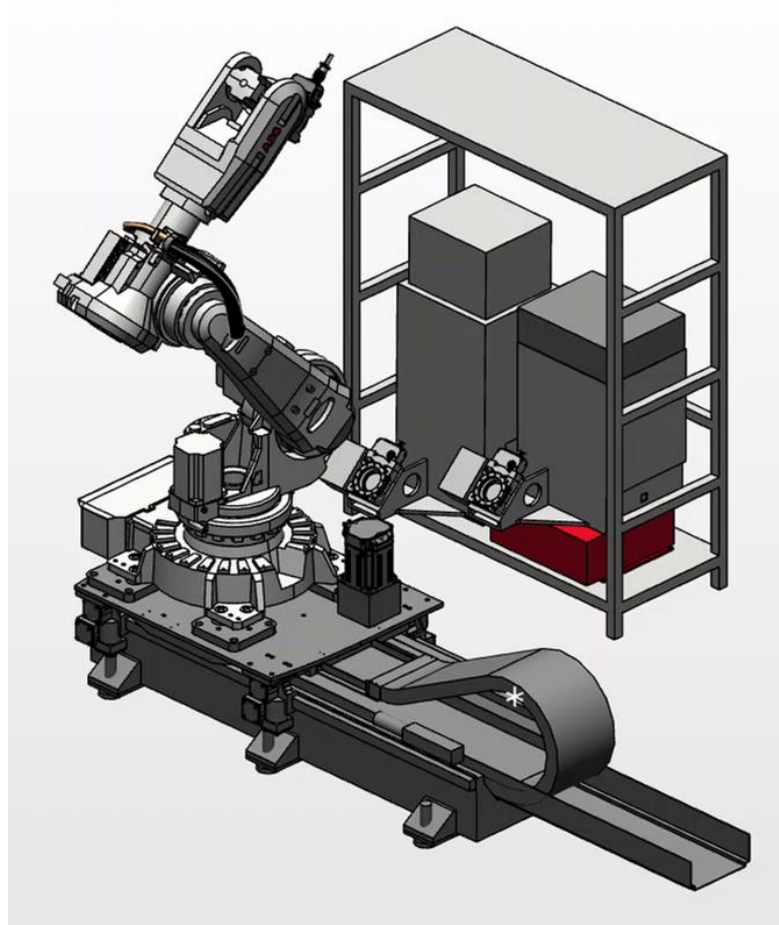


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Flexibility

Why use a robot?



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Space

Why use a robot?

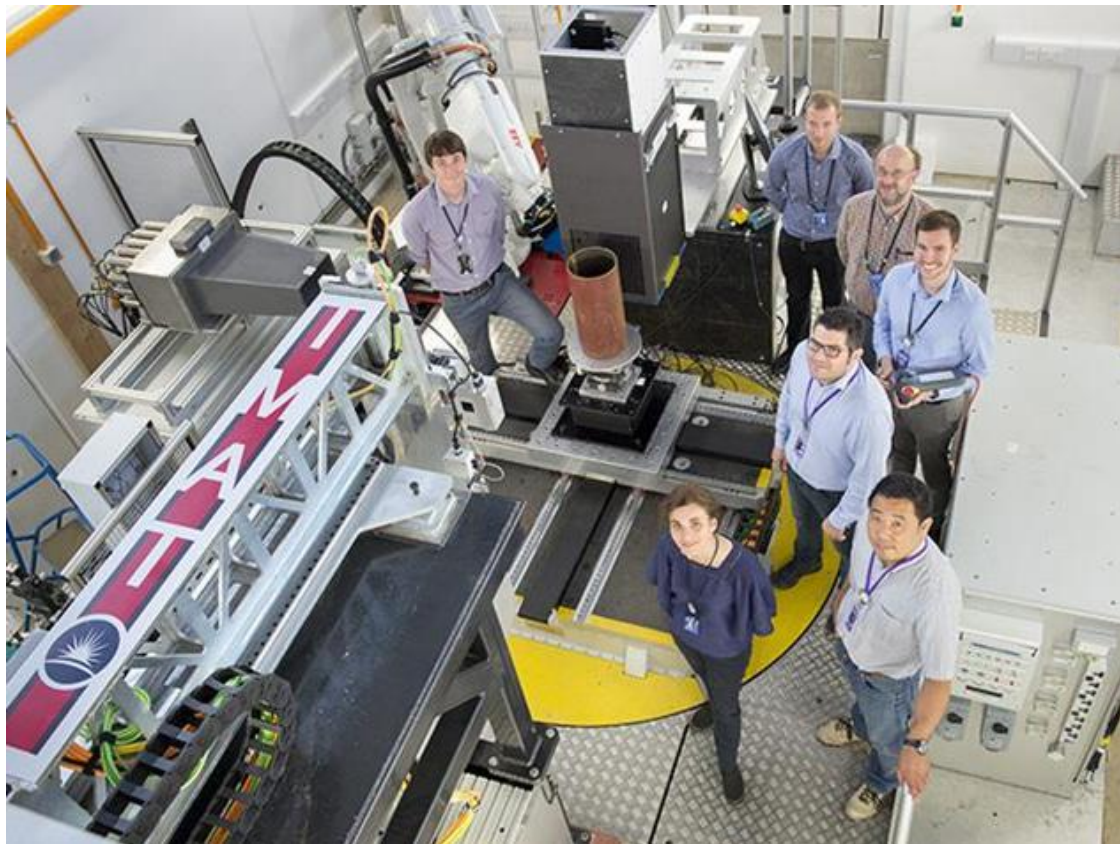


photo S. Kill



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Performance

Requirement		Performance
Positioning repeatability of the mechanical system	< 0.08 mm	31.49 μm
Accuracy (Pose)	< 0.6 mm	65 μm
Holding Stability	< 0.04 mm	14.47 μm
Travel in X direction (in-line with the neutron beam)	700 mm	1400 mm
Travel in Y direction (perpendicular to the beam)	450 mm	450 mm
Travel in Z direction (height)	450 mm	450 mm
Camera exchange time	< 90 s	2 min 45 sec



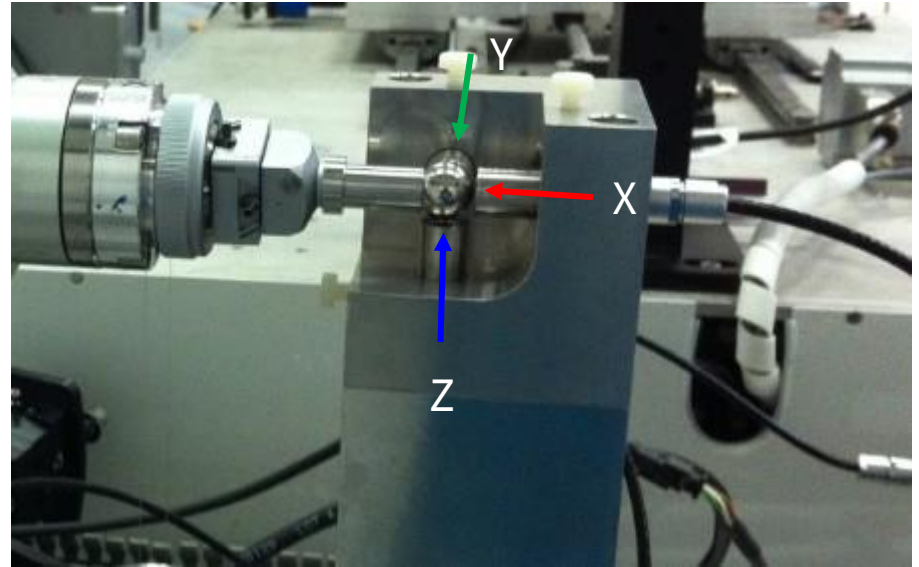
Position Testing

3x capacitive displacement sensor

Micro-Epsilon CS1 & DT6100

Measuring range: 1 mm

Resolution: 1 μm

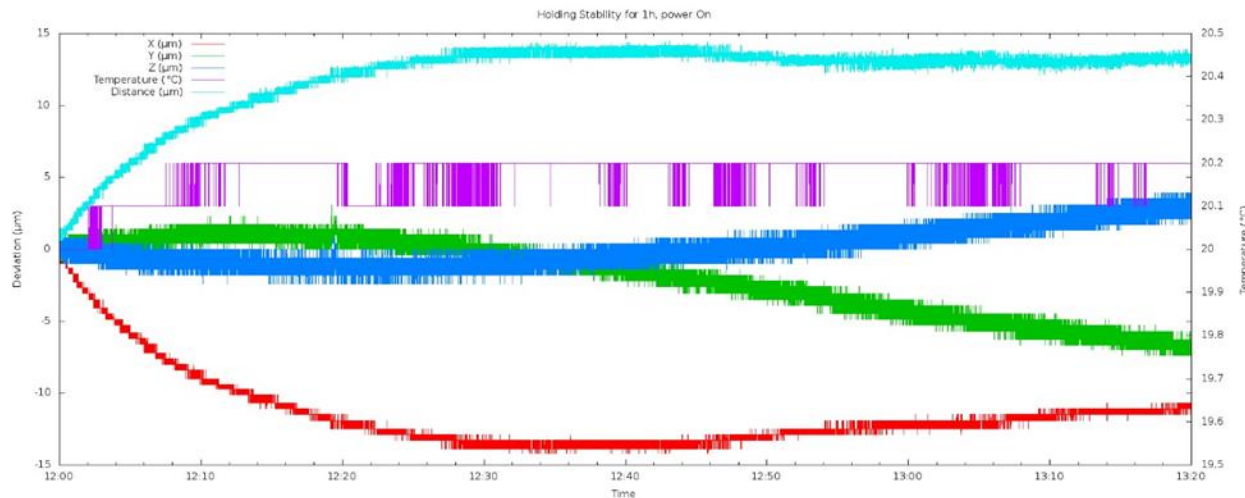


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Stability

maximum deviation of the position is **14.47 μm** over **1h**



X (μm) —

Y (μm) —

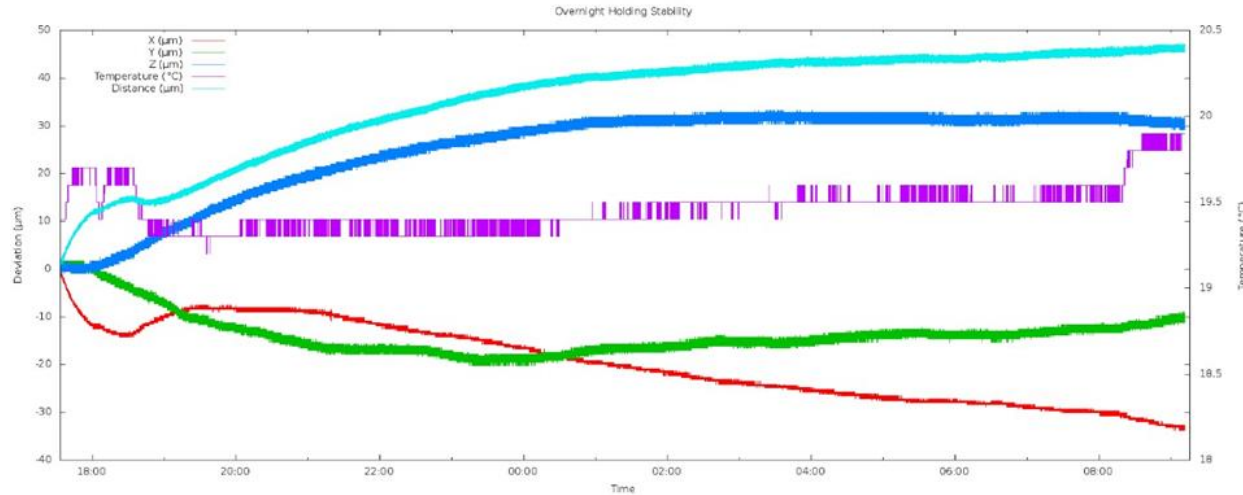
Z (μm) —

Distance (μm) —

Temperature ($^{\circ}\text{C}$) —

Stability

maximum deviation of the position is **45 μm** over **16h**



X (μm) —
Y (μm) —
Z (μm) —
Distance (μm) —
Temperature ($^{\circ}\text{C}$) —

Making robots safer

~~Are robots dangerous?~~



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Standards

- Design process
- Assessment of risks
- Best practice

eg. BS EN ISO 12100,
 BS EN ISO 13849,
 BS EN ISO 10218-2...



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Safety Measures

Emergency stop

Enabling device
("deadman's handle")

Competent
trained operator

+ controlled access

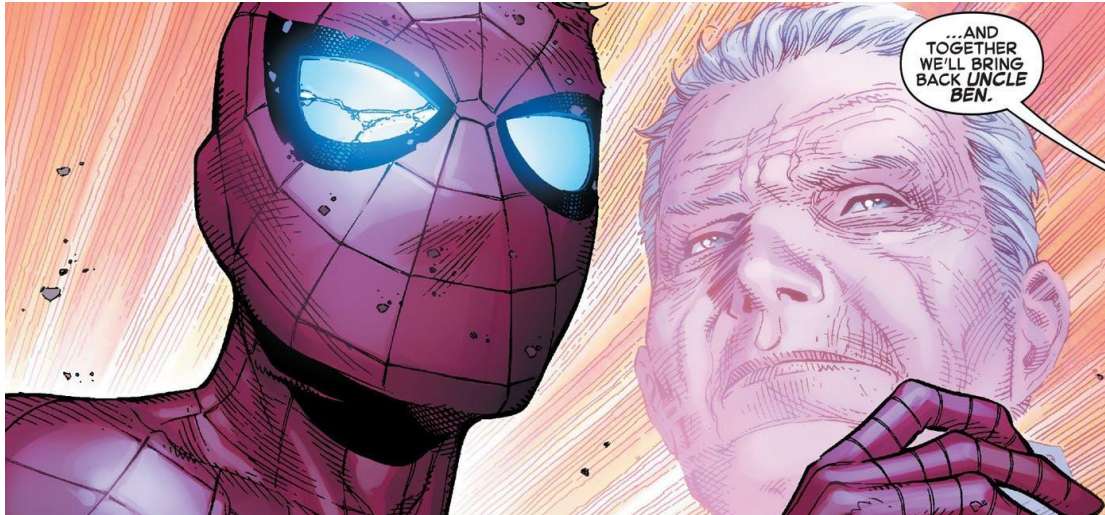


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Operators

- General operators → instrument scientists
- Expert operators → motion engineers
- Maintenance operators → support technicians



Caution
Machinery may start
without warning.
Obey robot operator
at all times.



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Review

- Introduction to the IMAT instrument
- IMAT's Camera Positioning System
- Why use a robot?
- System performance
- Some safety considerations



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