

Upgrading a Transmission SAX/WAX Beamline to Allow High Quality GISAX/GIWAX Experiments for Soft Matter Thin Films.

A review of the design to extend the experiment capability to undertake GISAXS experiments for an existing phase one beam line at Diamond Light Source.

By Andy Marshall, Senior Mechanical Engineer

Acknowledgements;

Principle Scientist – *Dr. Nick Terrill*

Beamline Scientists – *Dr. Paul Staniec*

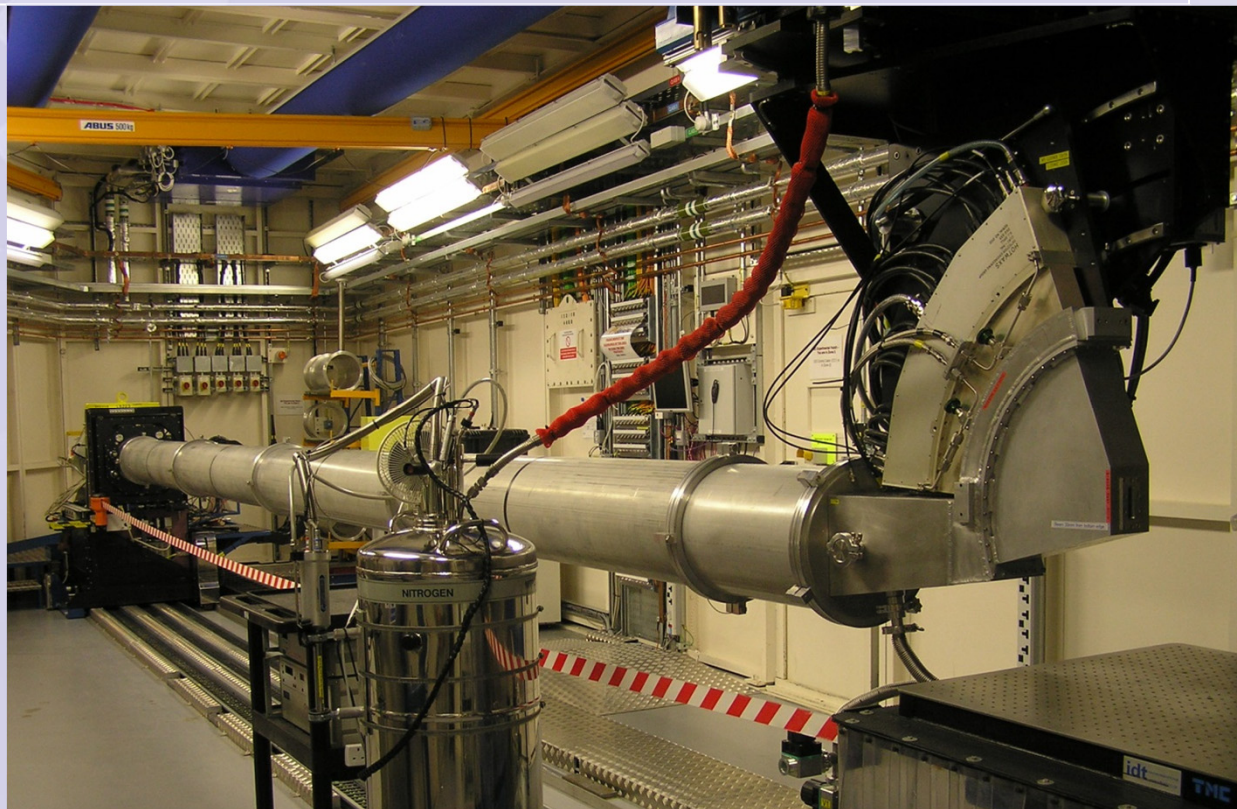
Design team - *Wui Cheng, Xia Liu, Malcolm Lidster, Walter Tizzano, Chris Dodd, Nick Baker, Martin Gilbert.*

Electrical engineer - *John Emmins*

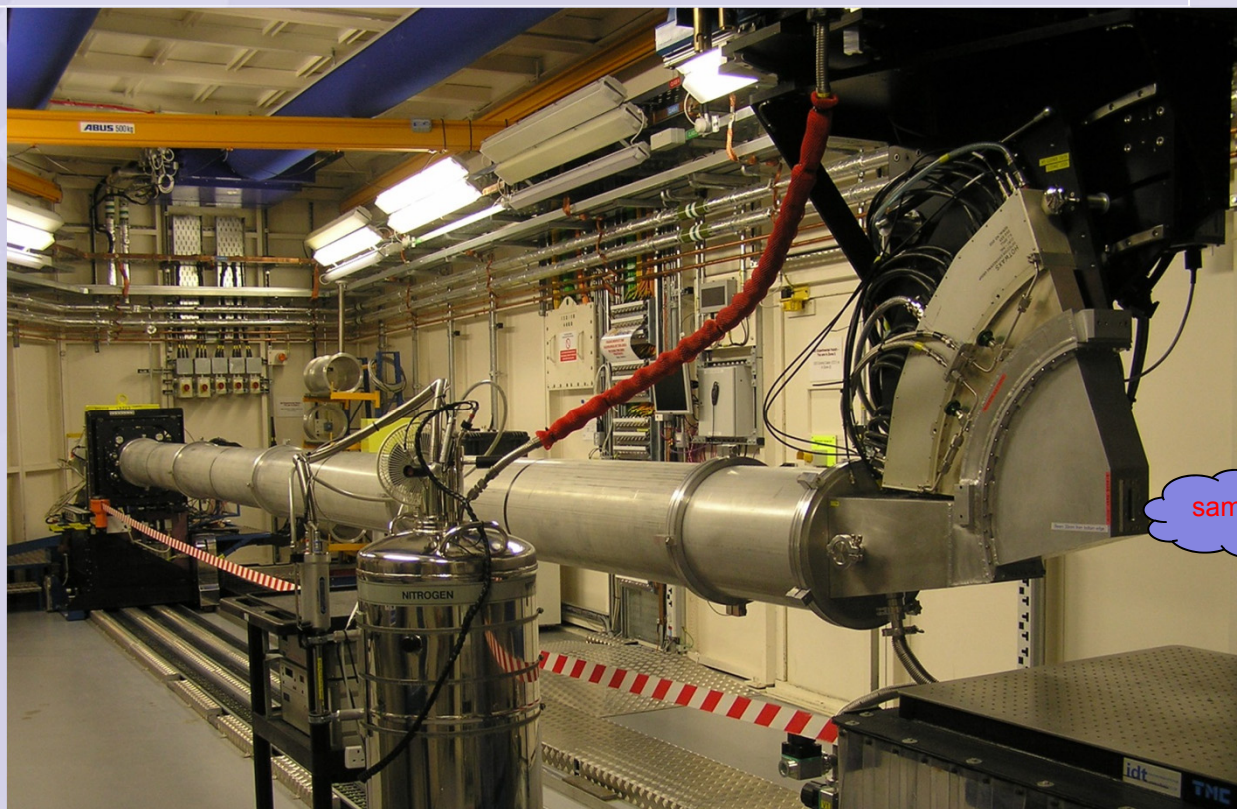
And.... . Many others



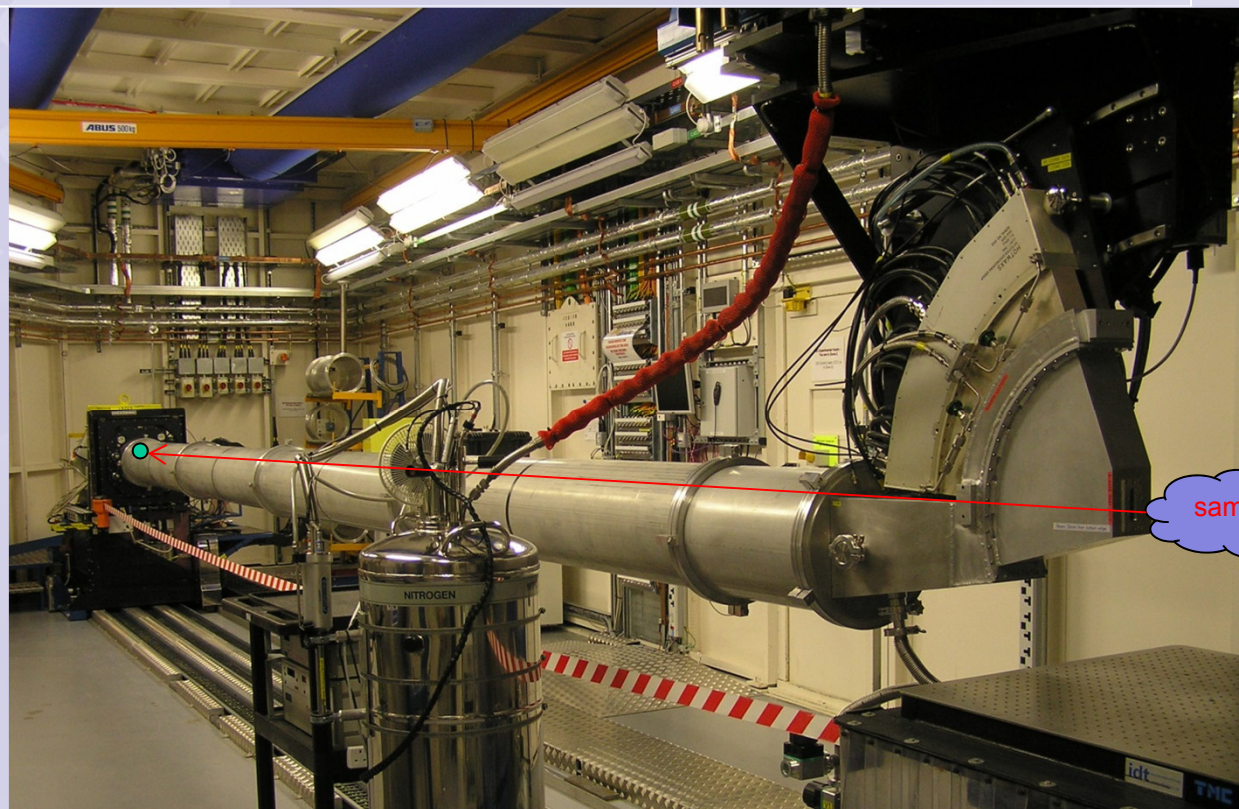
Original Transmission SAX/WAX Camera



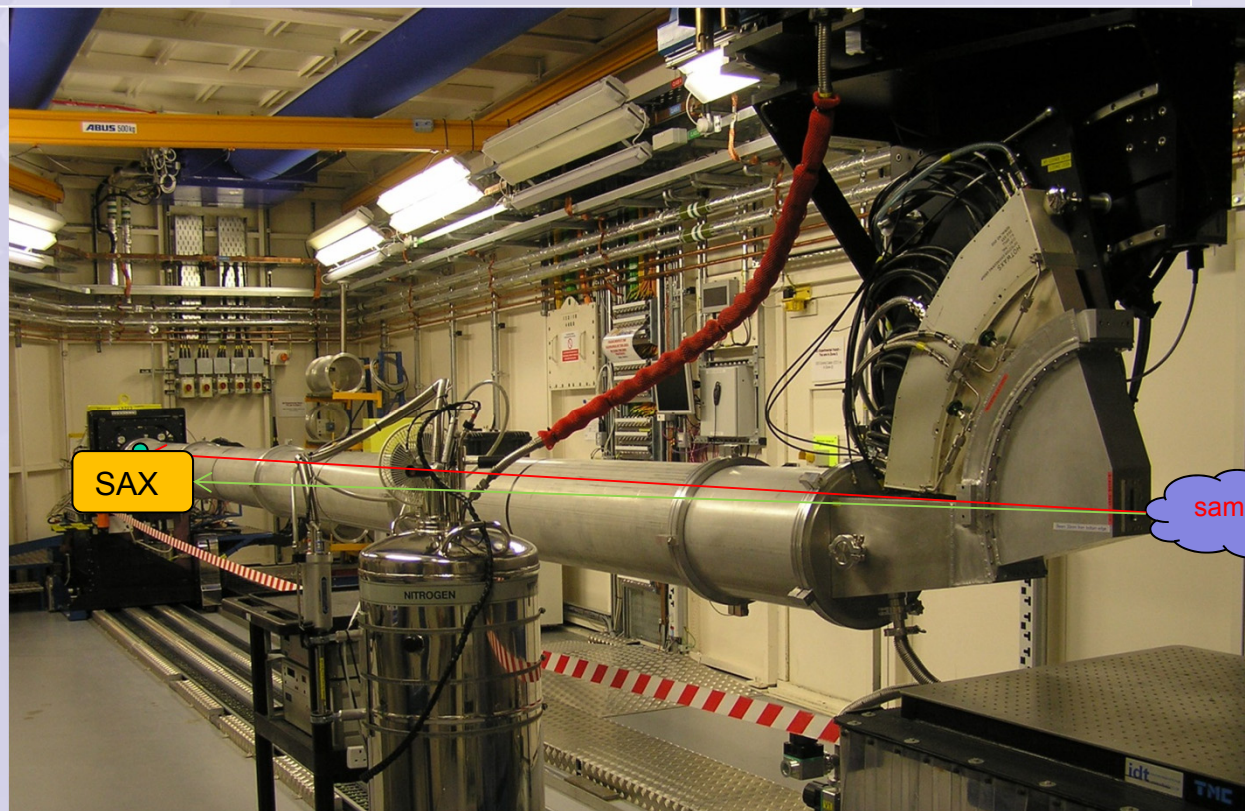
Original Transmission SAX/WAX Camera



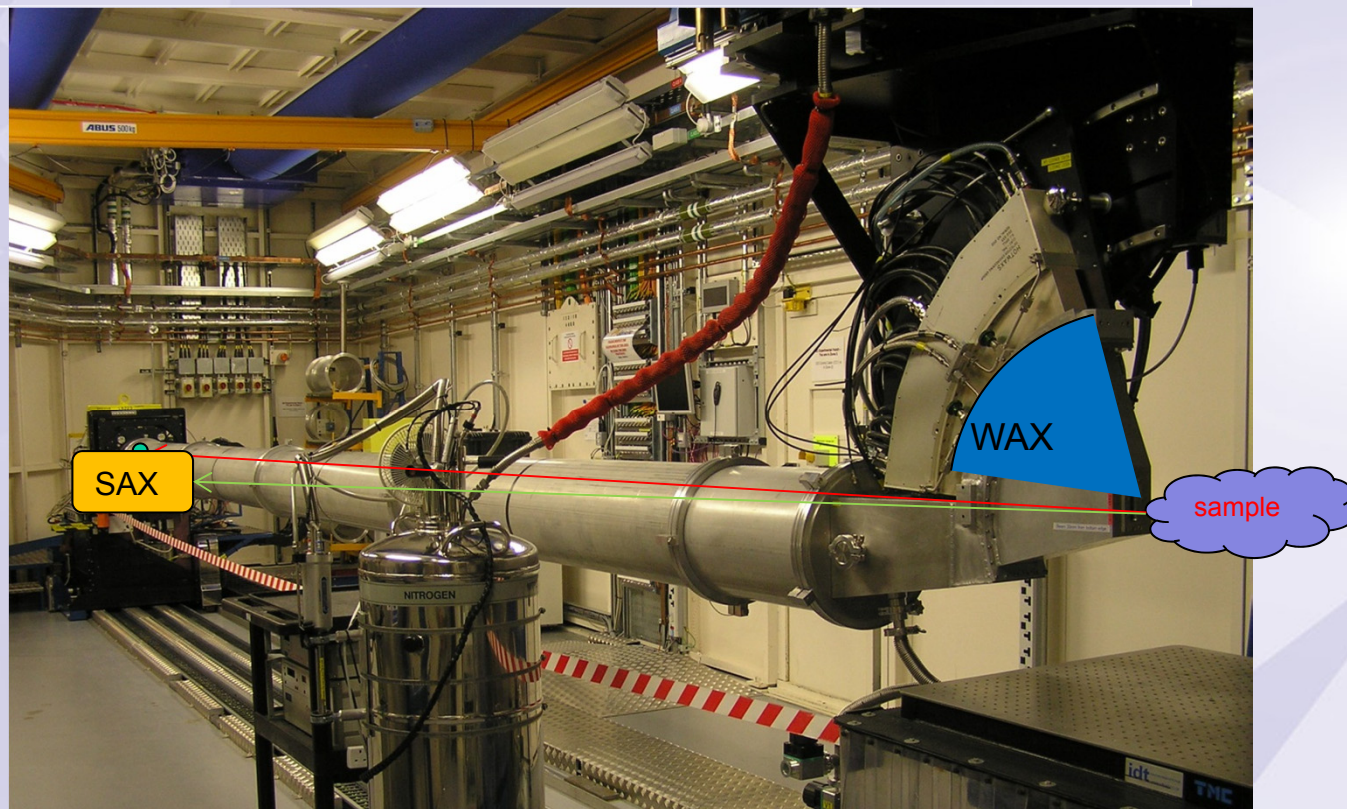
Original Transmission SAX/WAX Camera



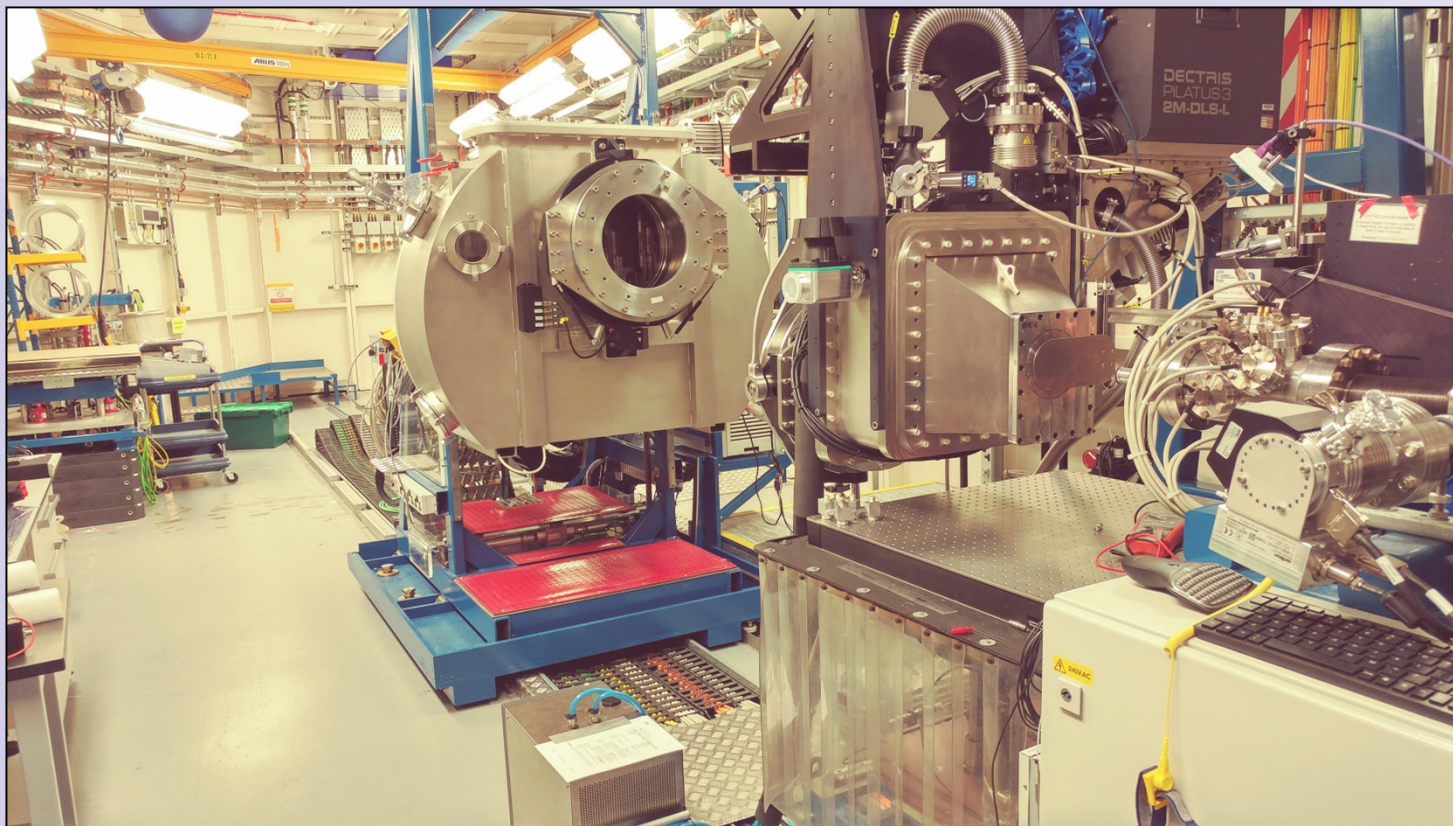
Original Transmission SAX/WAX Camera



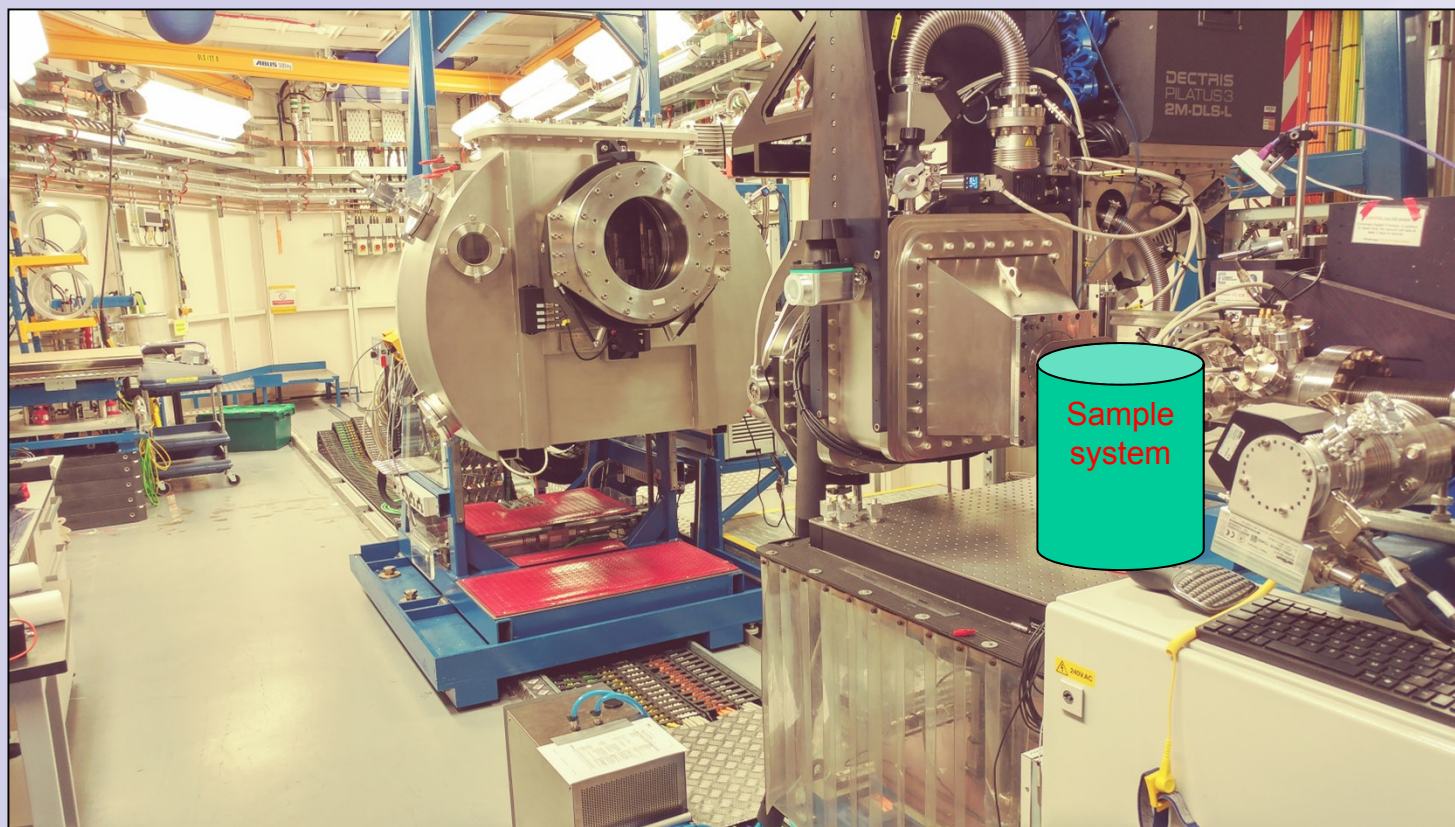
Original Transmission SAX/WAX Camera



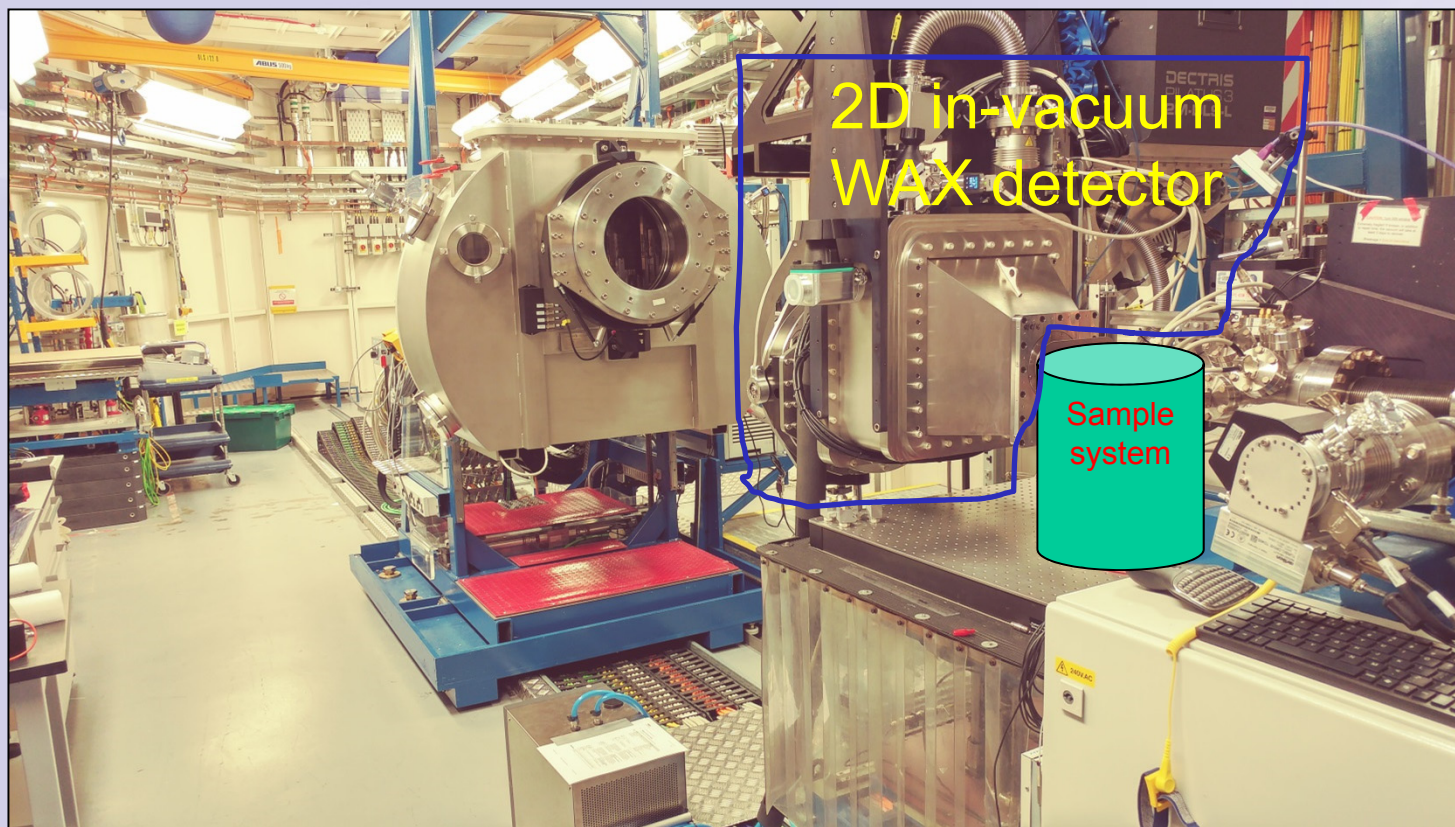
GISAX extended function



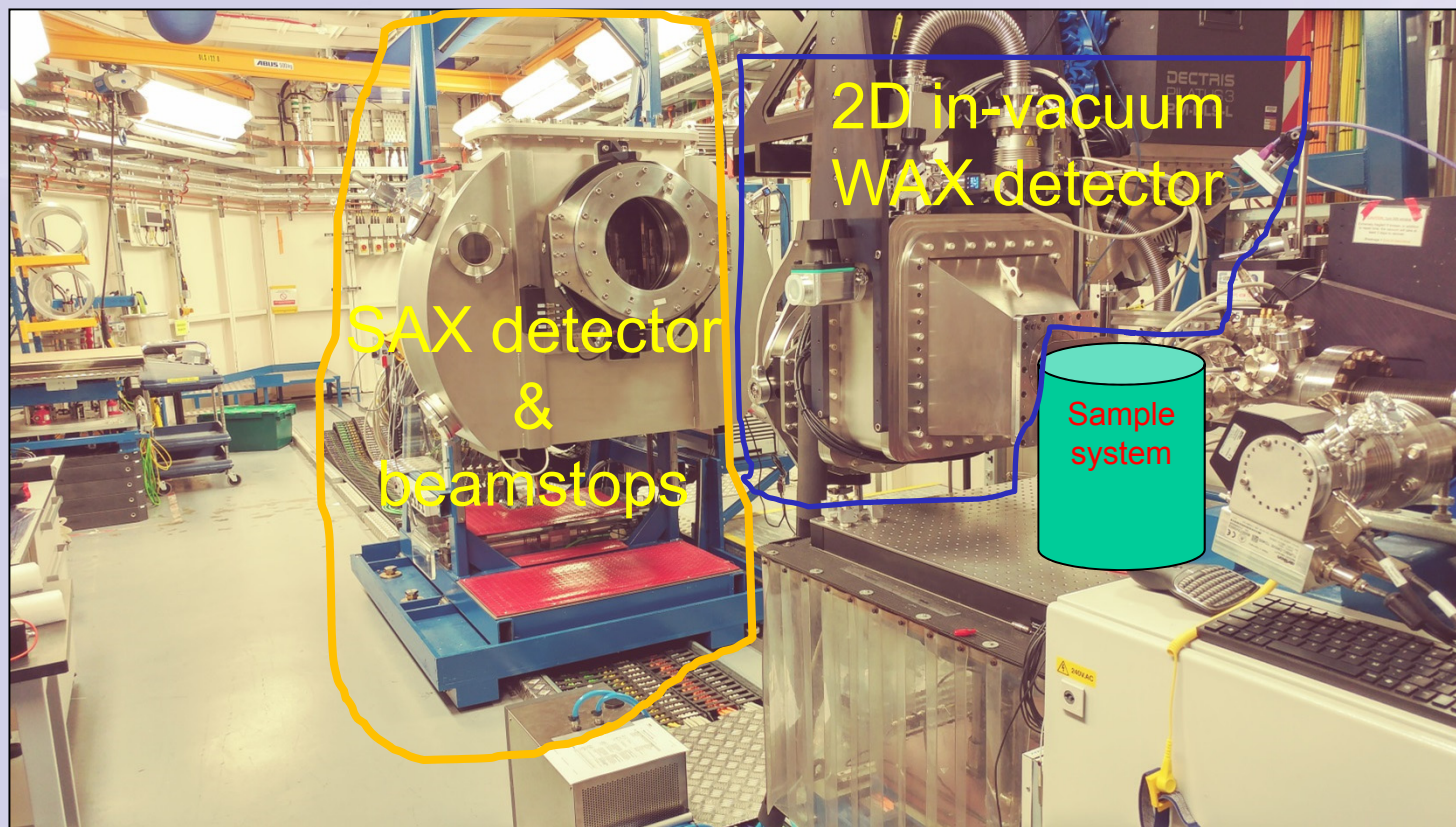
GISAX extended function



GISAX extended function

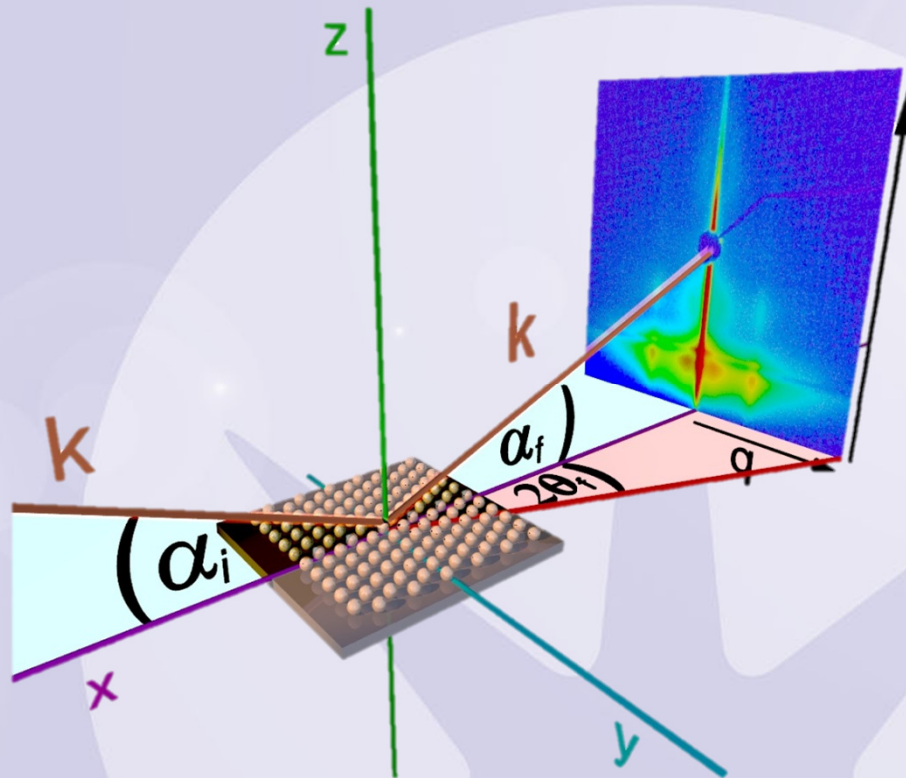


GISAX extended function



The GISAX Experiment Geometry

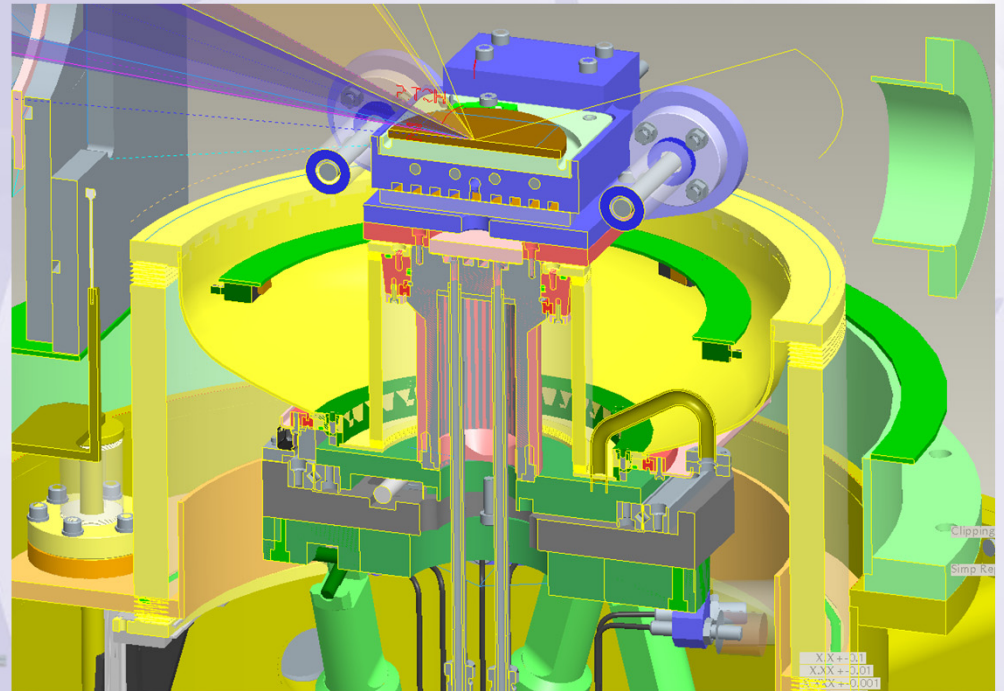
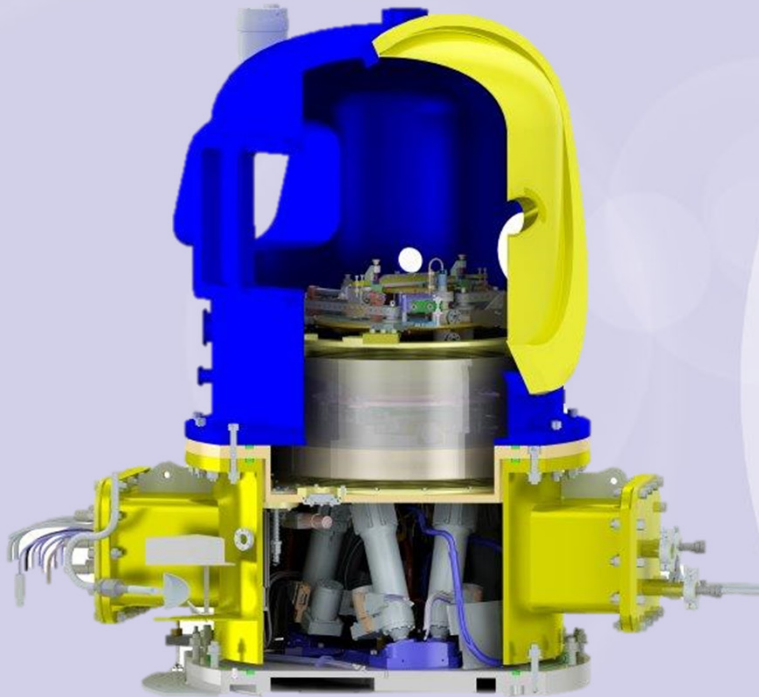
- Probe thin films, 10s to 100s nm.
- Grazing incidence beam, up 1° .
- Extended beam sample interaction.
- Reflection geometry.



Sample system design

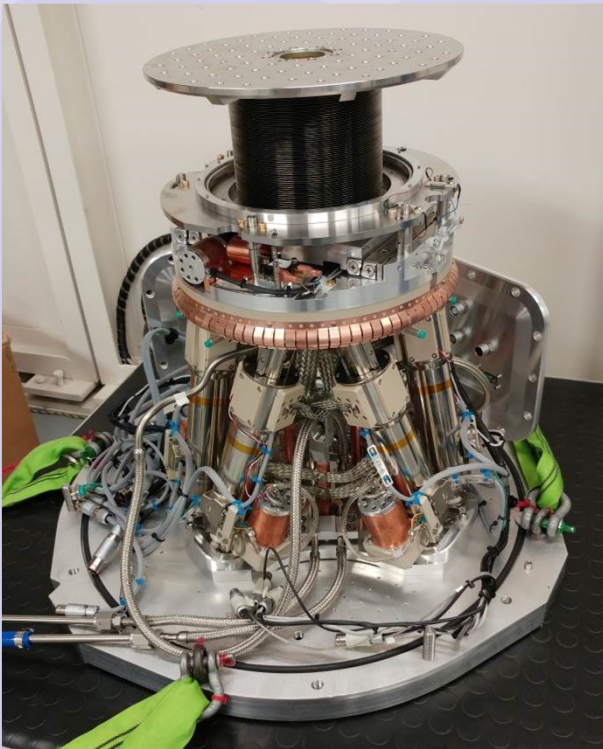
- Vacuum.
- Helium gas.
- Water & solvent vapour.
- Double chamber.
- 150kg weight target.

- Horizontal & vertical samples.
- In-situ film casting.
- Lateral translation.
- Double bellows motion feed through



Sample motions

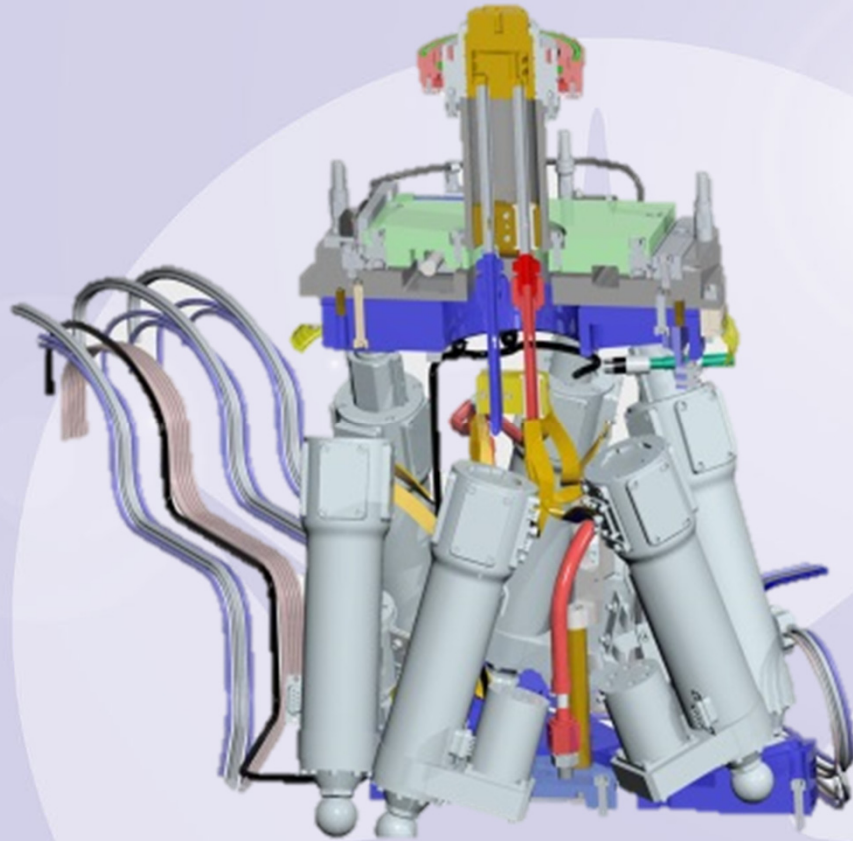
- Vacuum manipulator stack
- Hexapod.
- Lateral stage
- Motion limits



Translation	range	Accuracy	Resolution	Repeatability
	mm	μm	μm	μm
Height	+/- 20	-	1.0	0.5
Lateral	+/- 2.5		1.0	1.0
Longitude	+/- 2.5	-	1.0	1.0
Lateral sample surface	+/- 20	-	1.0	1.0
Rotary	mrad	μrad	μrad	μrad
Pitch	140	17.4	17.4	17.4
Roll	140		17.4	17.4
Yaw	140	17.4	17.4	8.7

Stability of motion stack thermal management and vacuum

- Use of Invar on long members
- Internal water cooling.
- Heat exchanger at sample mount.
- Motors thermally isolated.
- Upper support parts linked to cooling circuit.
- All motors and encoders thermally bonded to cooling circuit
- Isolate vacuum forces in baseplate.

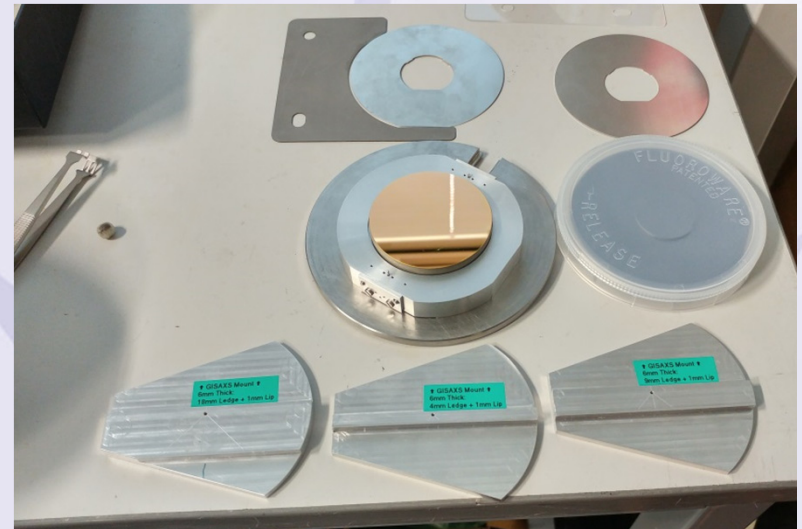


GISAX substrates

- Important part of the sample.
- Polished surface.
- Very flat.
- Silicon wafers ideal.
- Max 100mm diameter & 5mm thick.

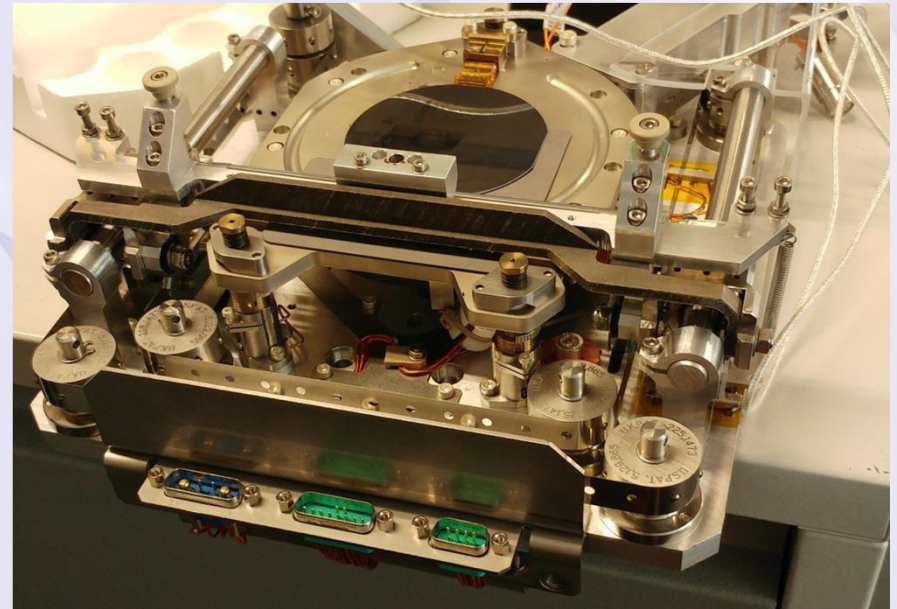
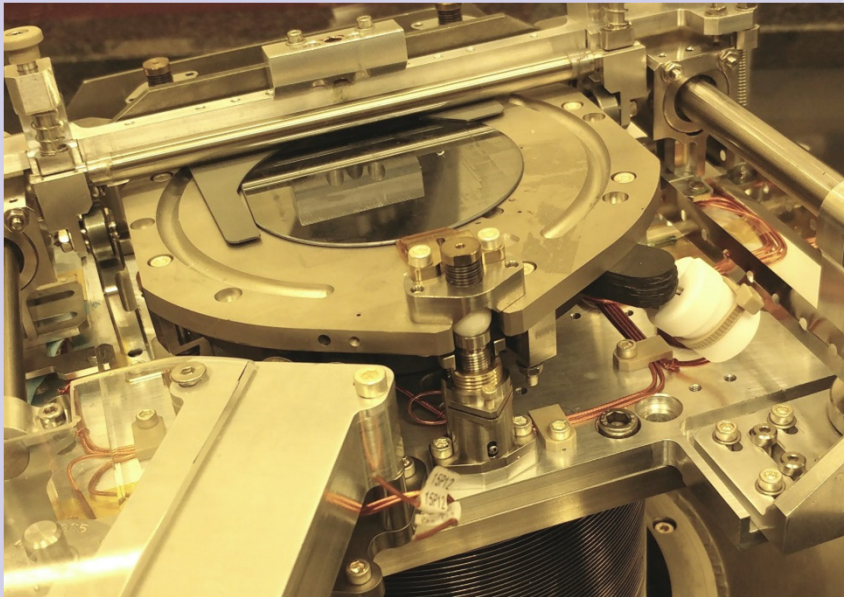


- Various adaptors.
- Alignment tool.
- Electrical isolation.



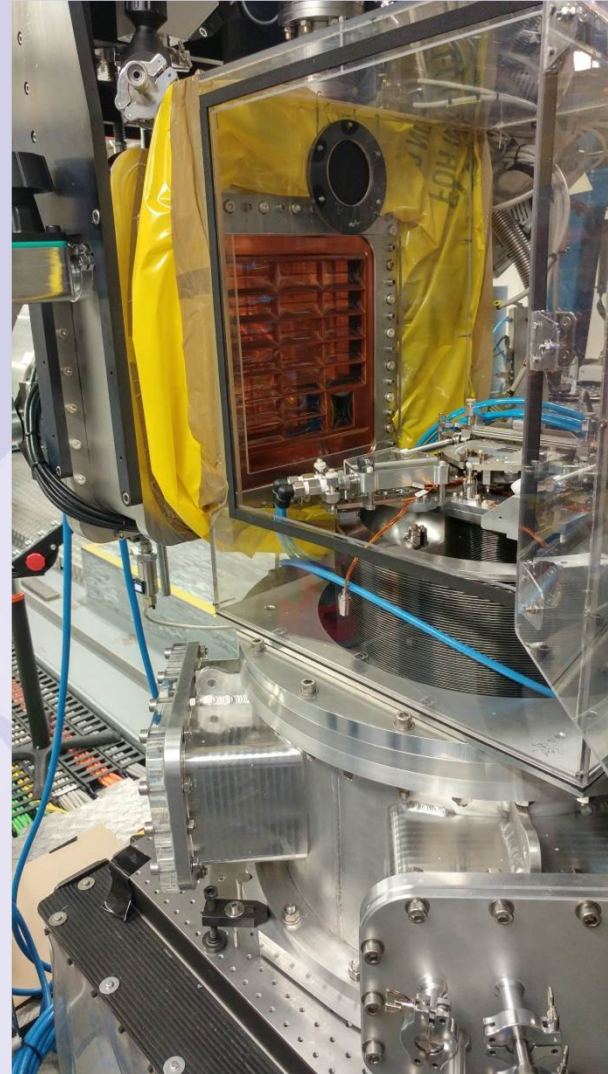
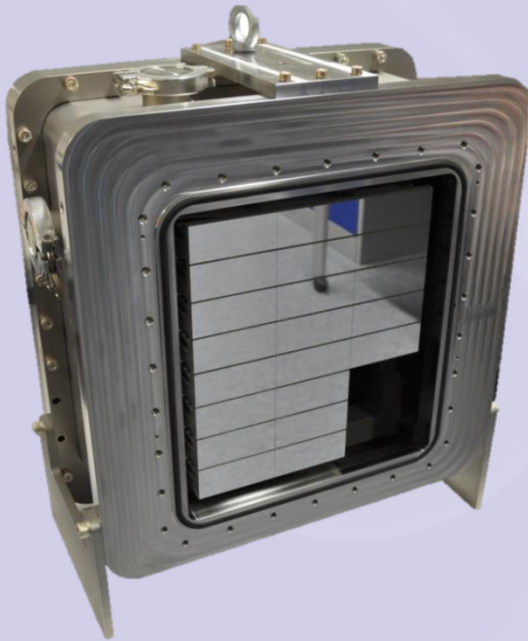
Sample holder – doctor blade, annealing stage

- Up to 250°C.
- Uniform temperature.
- Adjustable.
- Thermally isolated.
- Stable & flat.
- Dr blade; wire wound metering bar.
- Single stroke, lifts clear at end of stroke.
- St steel drive belt.
- Drive motor in vessel.



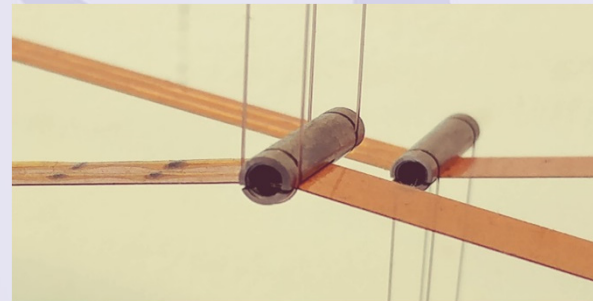
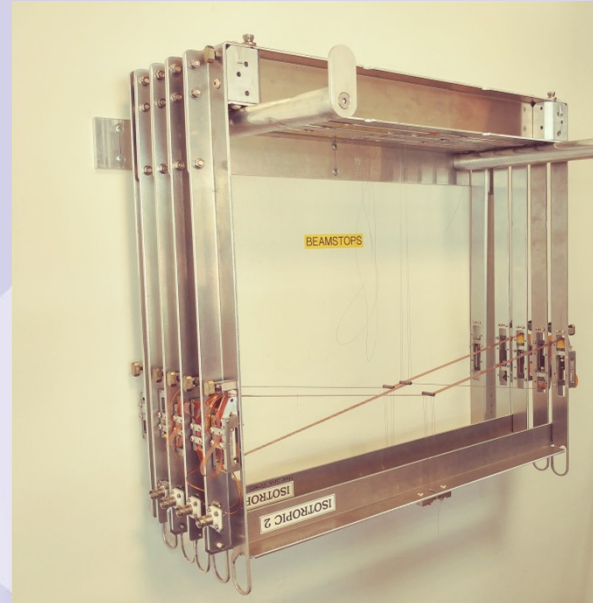
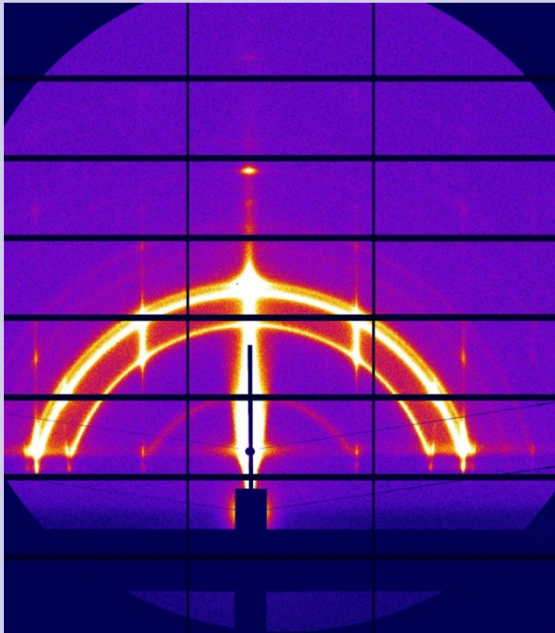
New WAX detector

- In vacuum detector
- Remote electronics
- 2D WAXS data.
- Modules removed for SAXS



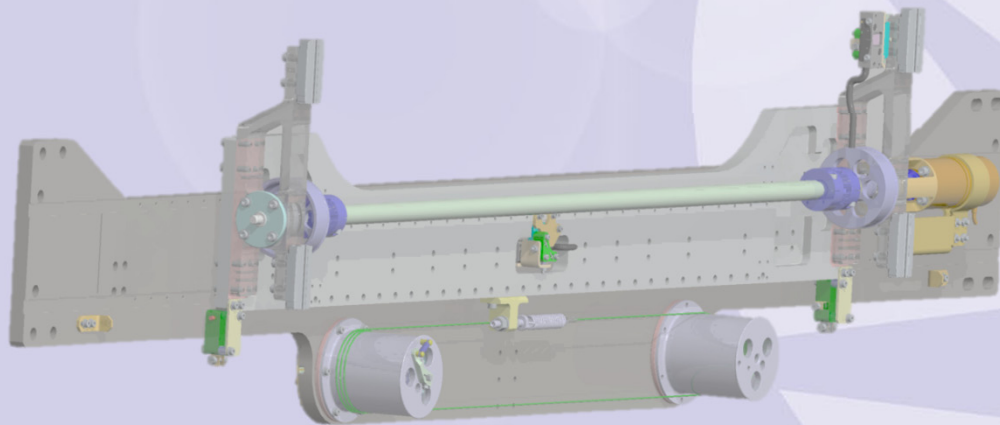
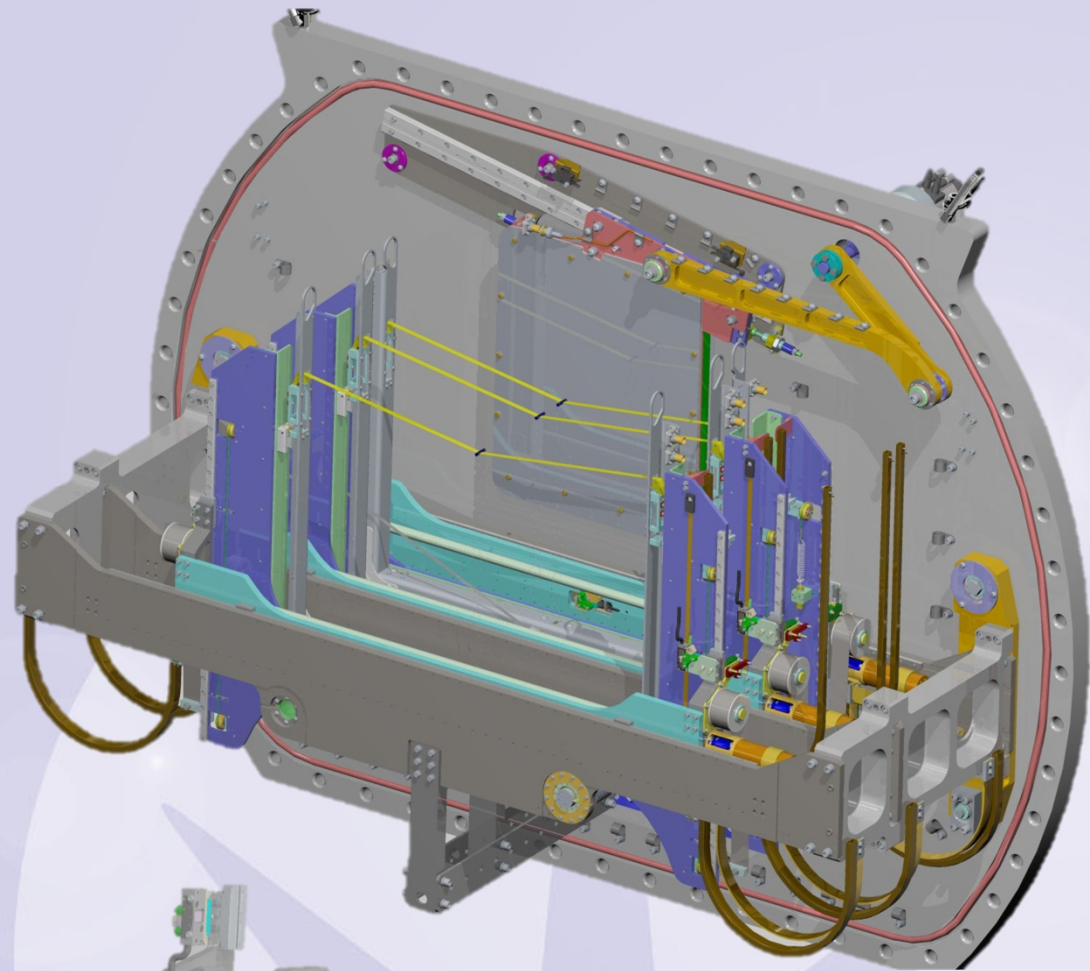
GISAXS scattering patterns

- Three beamstops required
- Transmitted beam
- Reflected beam
- Specular scatter

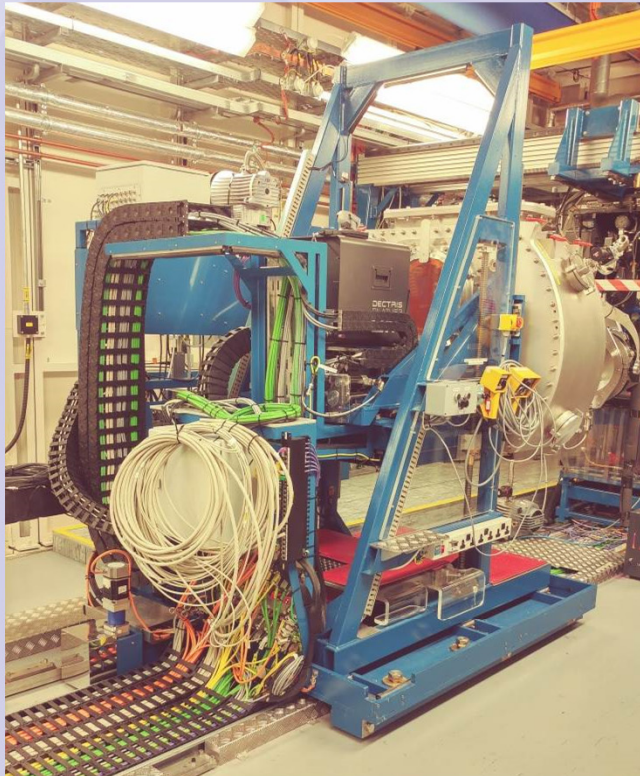


Beam stop vessel

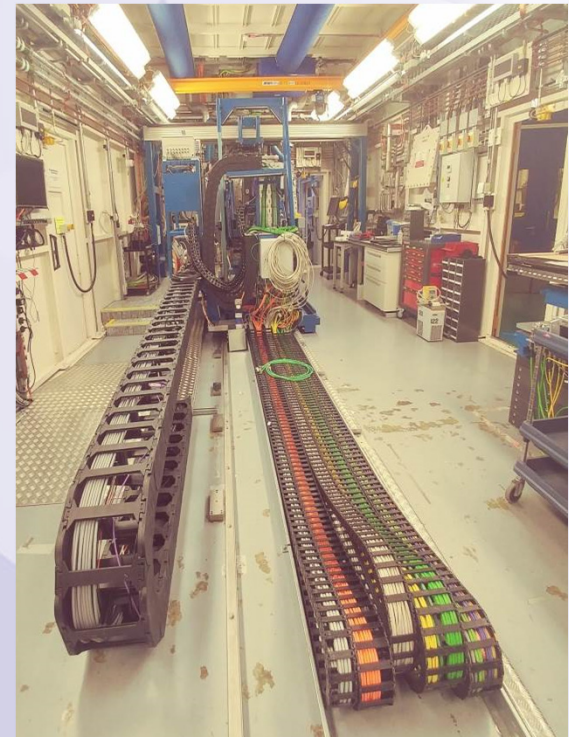
- 3 independent beam stop modules.
- Multiple beam stop mounts.
- X Y motion 250mm x 300mm.
- Capstan cable drive.
- Photodiode instrumentation.
- Detector safety shutter.
- Large kapton window.



SAX Detector Table



- 2.6 tonnes.
- 9m travel.
- 1m vertical.
- $\pm 150\text{mm}$ lateral.
- 14 axes.
- Cooling.
- Compressed air.
- Vacuum.
- Local instrumentation with remote I/O.



Conclusion

Current status;

SAX table installed, commissioned and operational.

WAX Detector and system installed, commissioned and operational.

GISAX sample environment assembled and tested for use in air and under helium , full vacuum operation function not completed.

Further work under consideration.

In-vacuum SAX detector for a windowless camera.

Further I22 development work;

Project to improve beam delivery components and build in micro focus beam facility at the sample position.