Orbital order in the bilayer manganites and soft x-ray scattering instrumentation at Diamond

Presented by Thomas Beale

10th June 2009

Durham University

Outline

1) Soft x-ray resonant diffraction

2) Orbital Order in $Pr(Sr_{0.1}Ca_{0.9})_2Mn_2O_7$

3) Soft x-ray resonant diffraction at Diamond

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with thanks…

Peter Hatton, Durham University
Stewart Bland, Durham University
Andrew Boothroyd, University of Oxford
D. Prabhakaran, University of Oxford
Sarnjeet Dhesi, DLS
Richard Mott, DLS
Mark Roper, Daresbury Laboratory
Júlio Cezar, ESRF

Gerrit van der Laan, DLS
Paul Steadman, DLS
Andrew Marshall, DLS
Linda Pratt, DLS
Suren Patel, DLS

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Soft x-ray diffraction

Direct probe of 3d electrons through
2p - 3d transition.

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J.M. Tonnerre *et al*., PRL **75**, 740 (1995)
S.S. Dhesi *et al*., PRL **92**, 056403 (2004)

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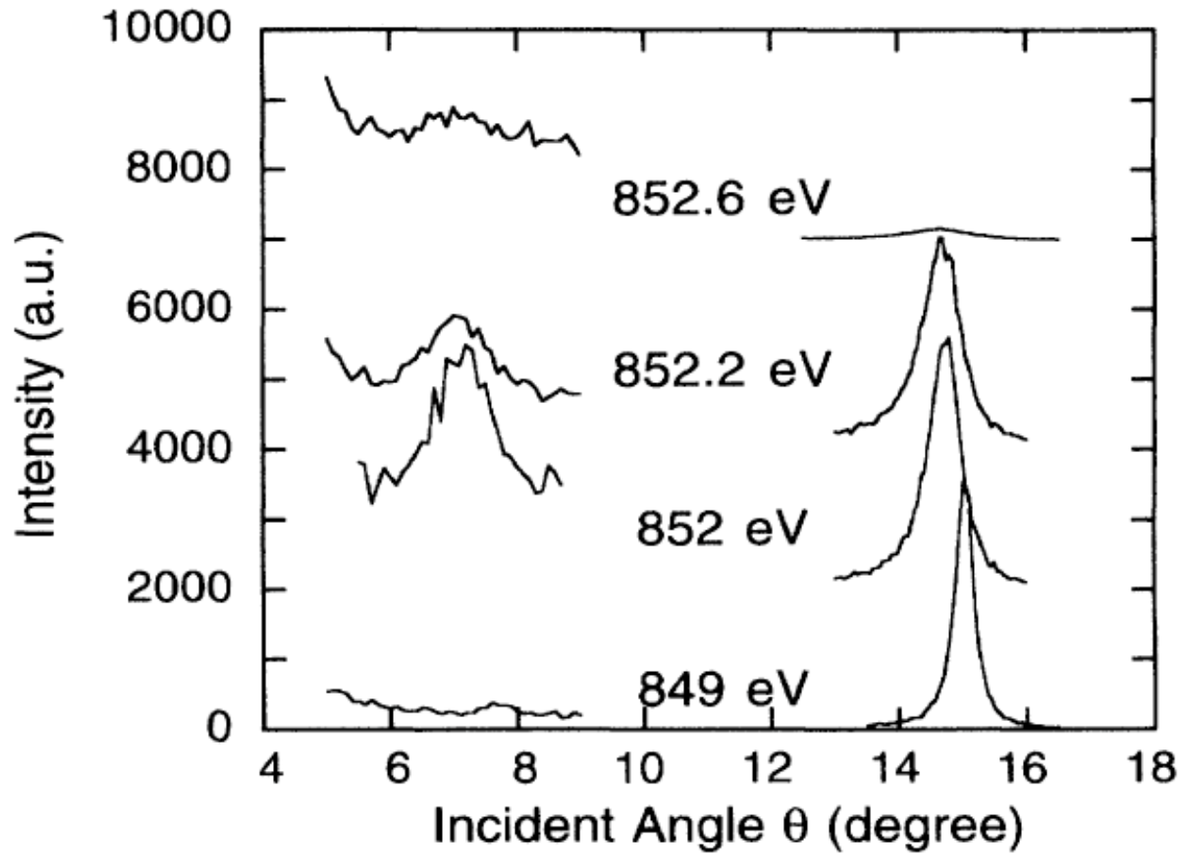
First measurements “manmade structures” i.e. multilayers



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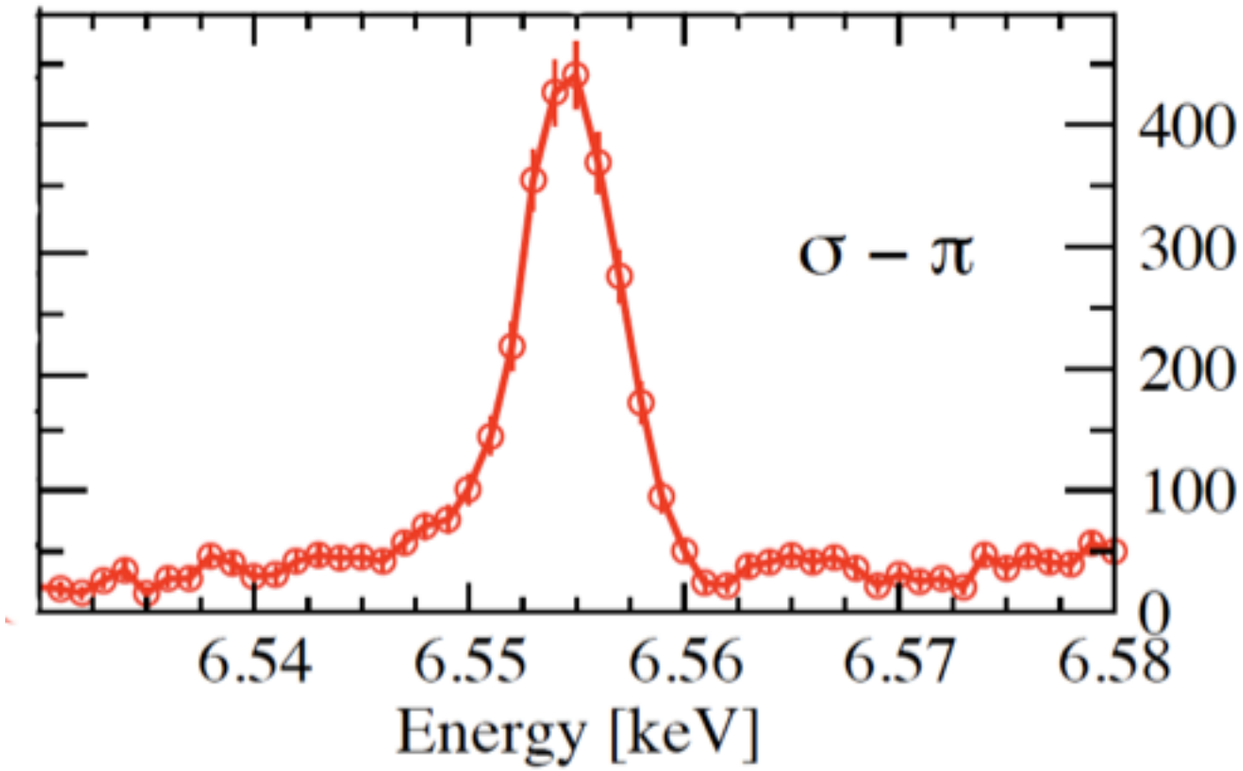

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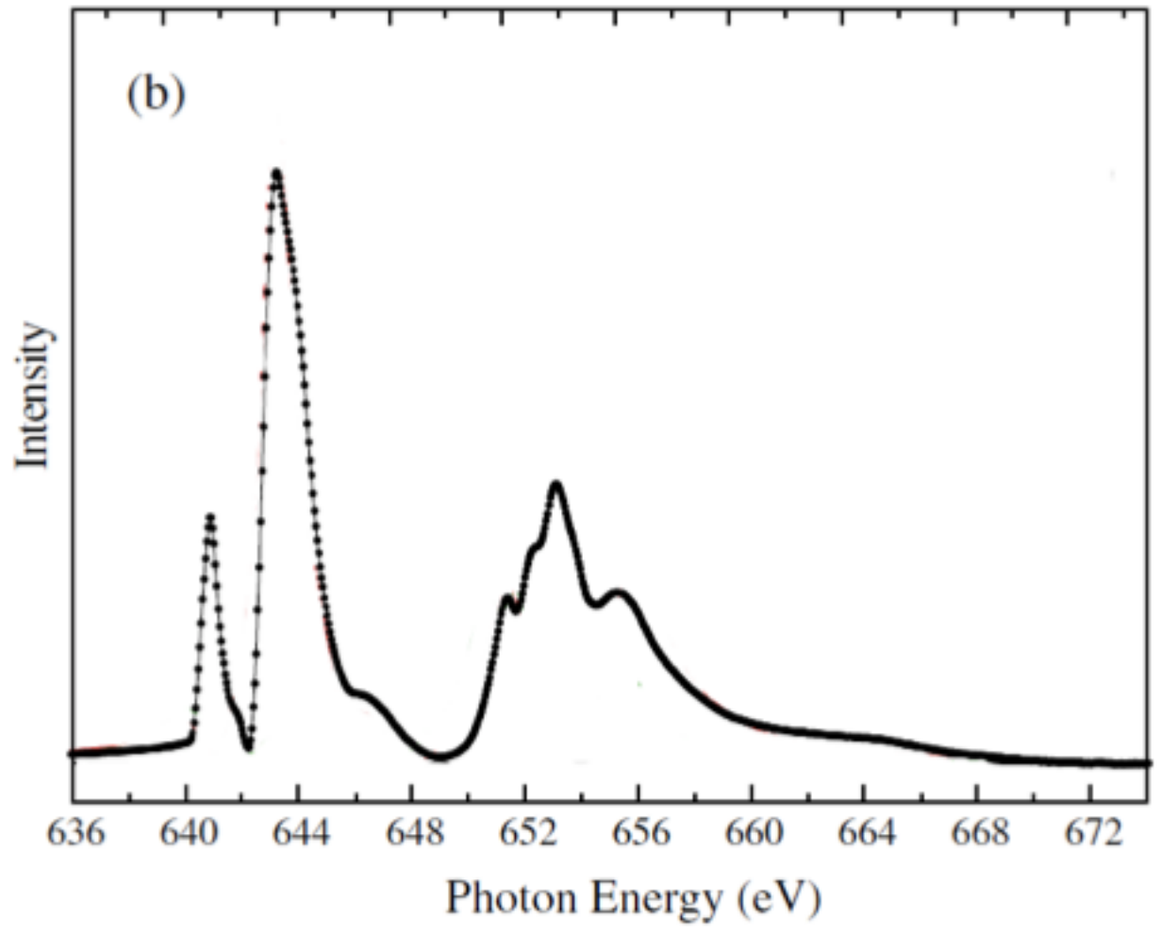

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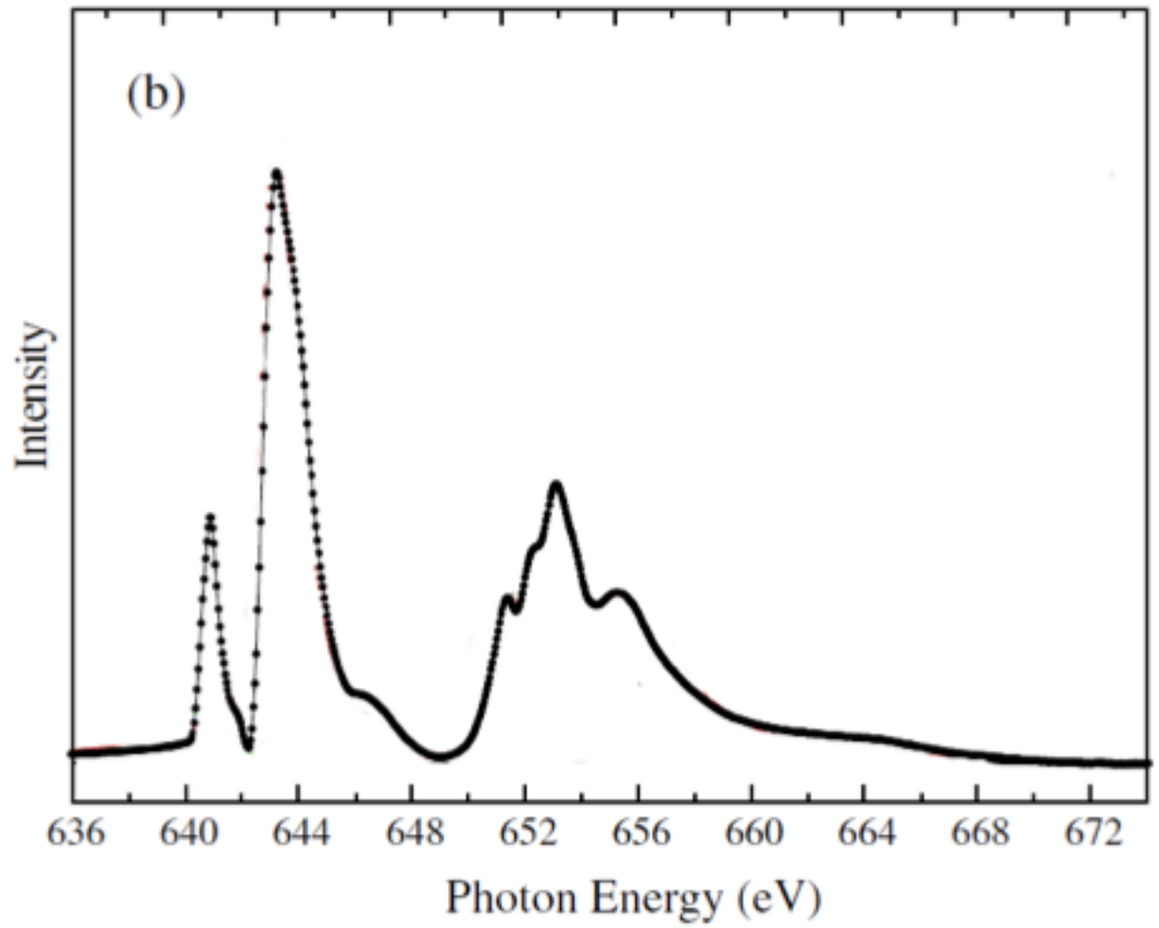
Resonance *of a diffraction signal* gives you spectroscopic information.

Potentially fitted through various *ab initio* calculations



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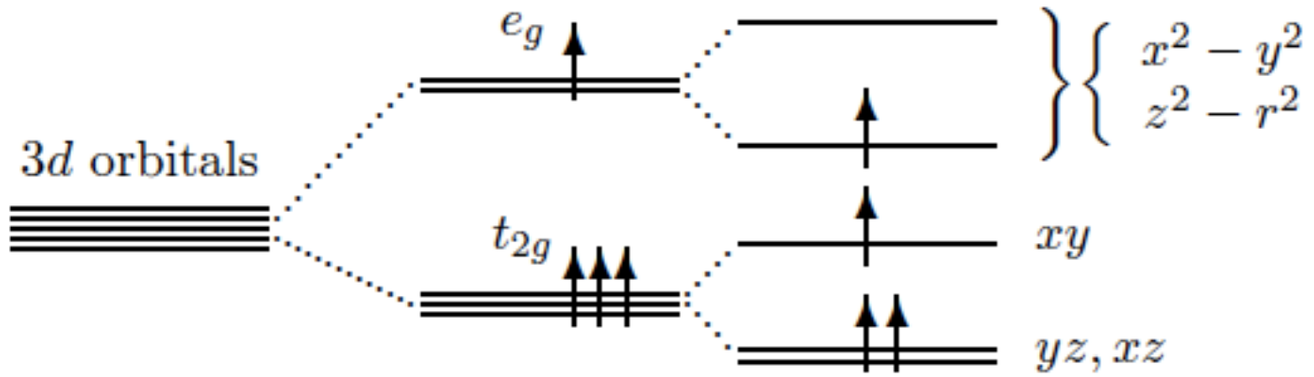
Orbital order

Spontaneous ordering of electron orbitals

In manganites, Mn^{3+} ions have a single e_g electron

Orbital order tends to be accompanied by a Jahn-Teller type distortion



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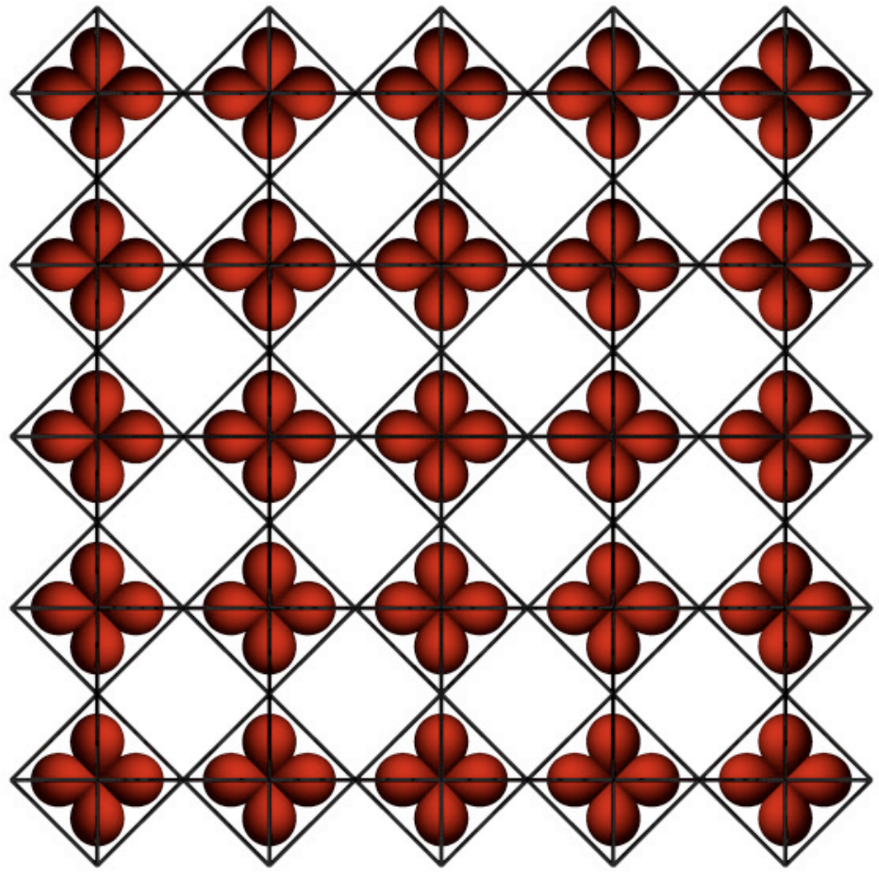

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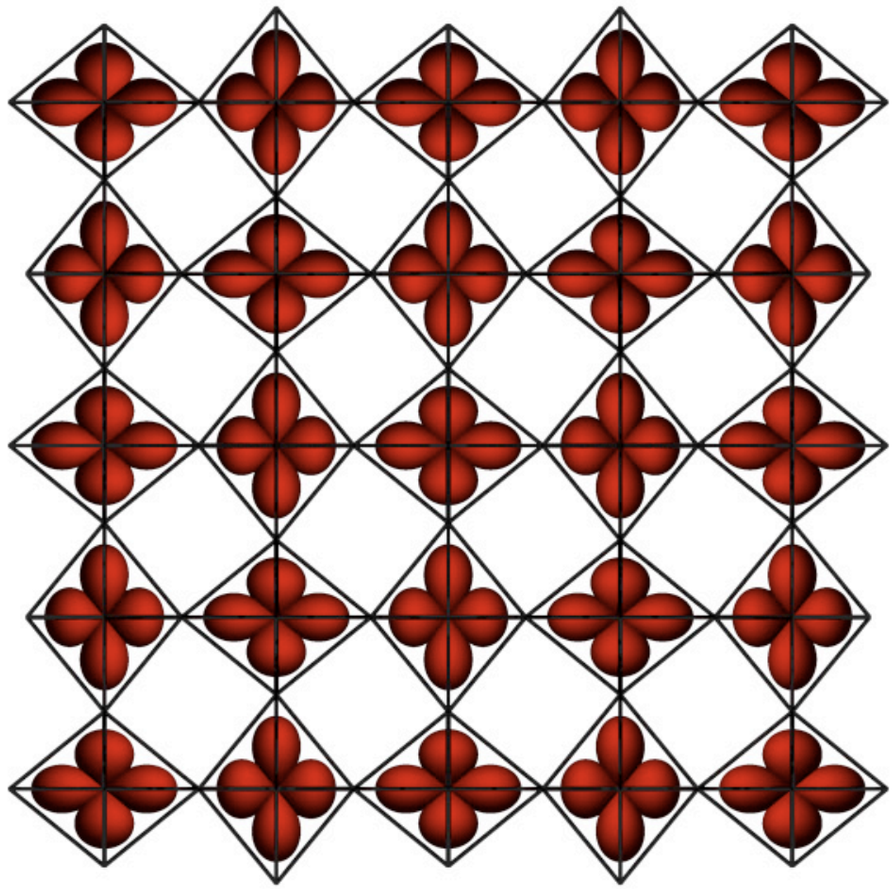

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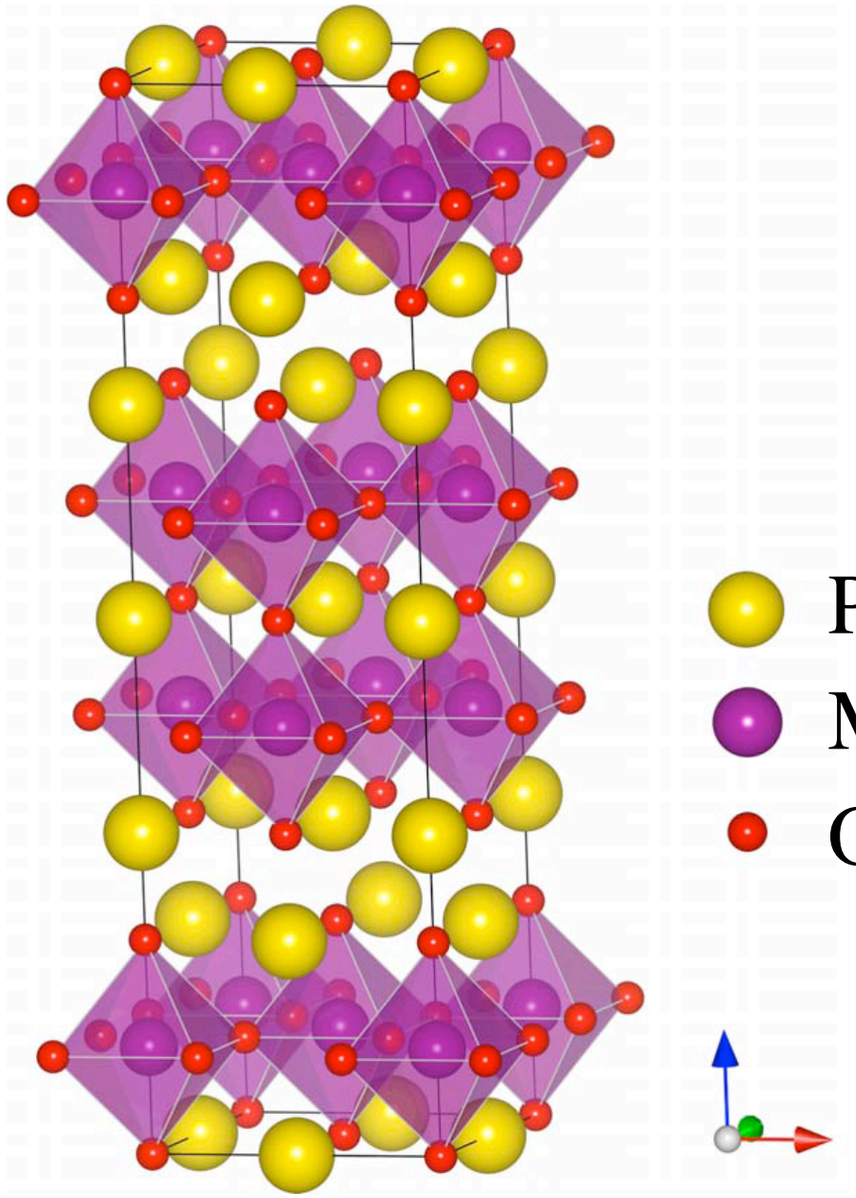
$Pr(Sr_{0.1}Ca_{0.9})_2Mn_2O_7$



Unusual as $a \neq b$

Amam orthorhombic spacegroup

Confines the orbital domains

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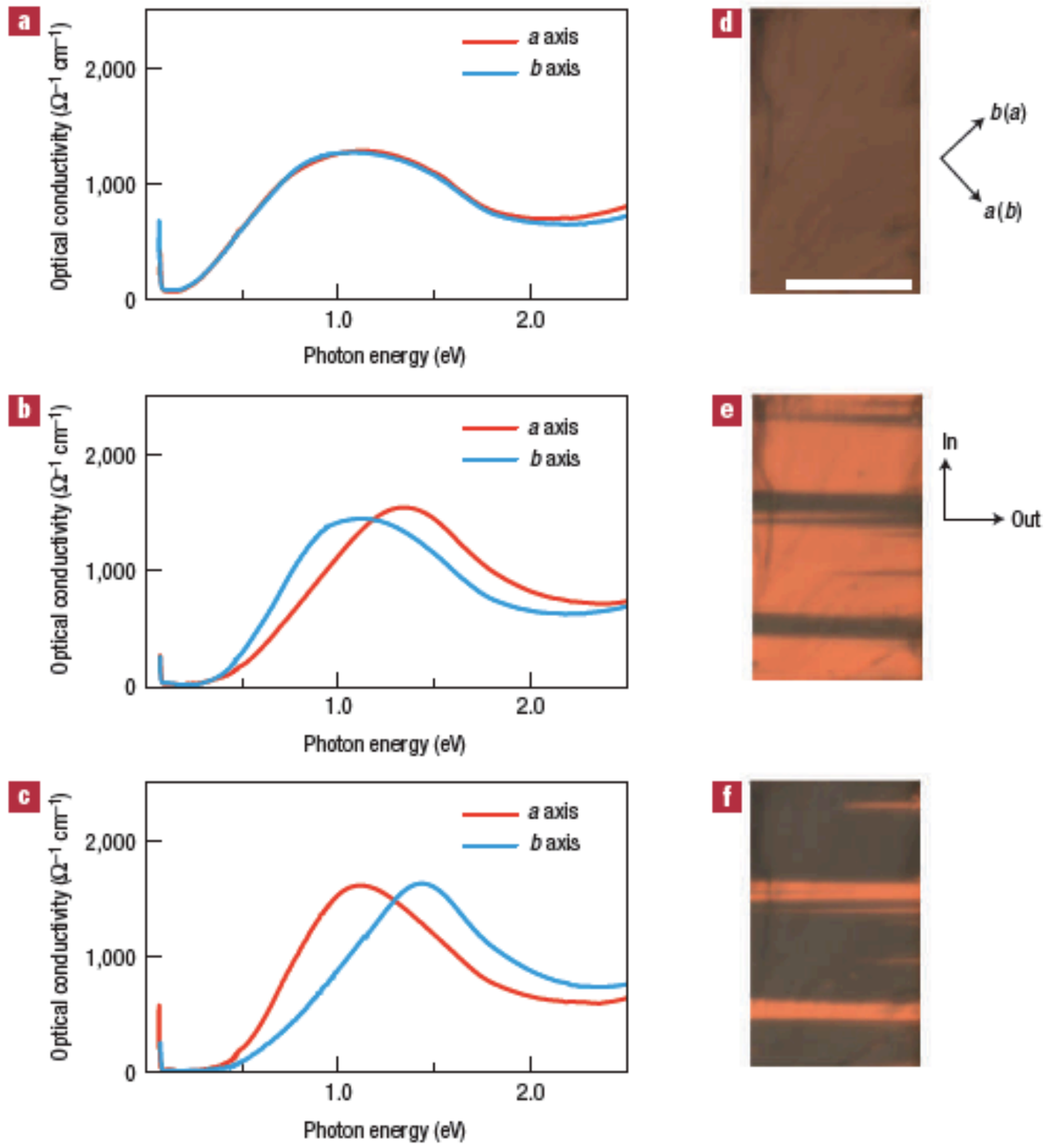
Optical anisotropy of PCSMO

Panel a $T = 423$ K

Panel b $T = 323$ K

Panel c $T = 300$ K



Y. Tounaga, Nature Mat. **5**, 937, (2006)

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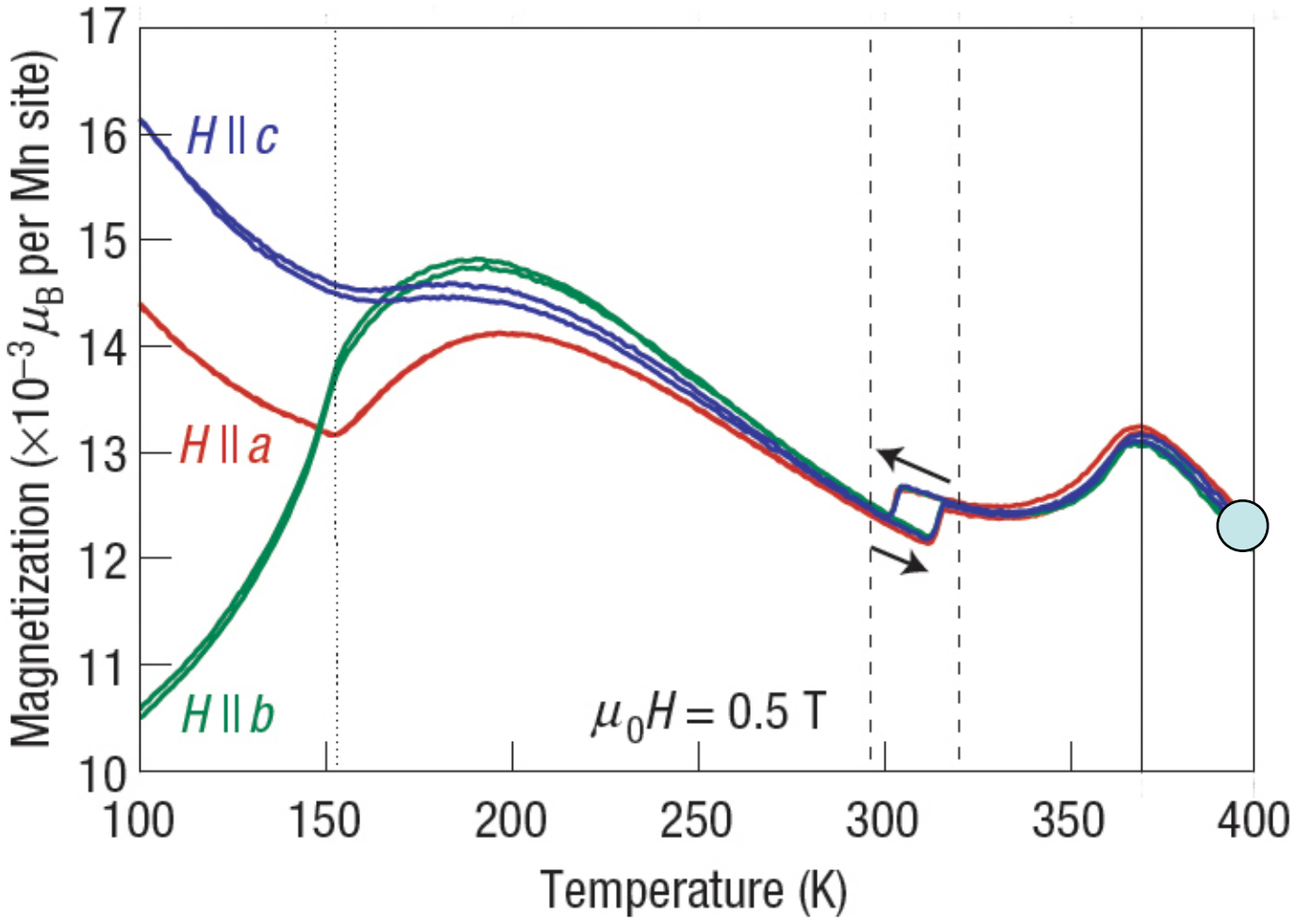
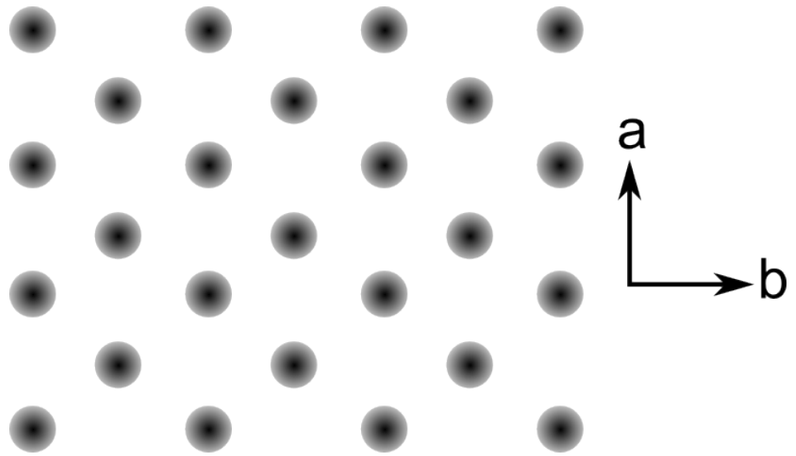
Orbital Rotation sequence





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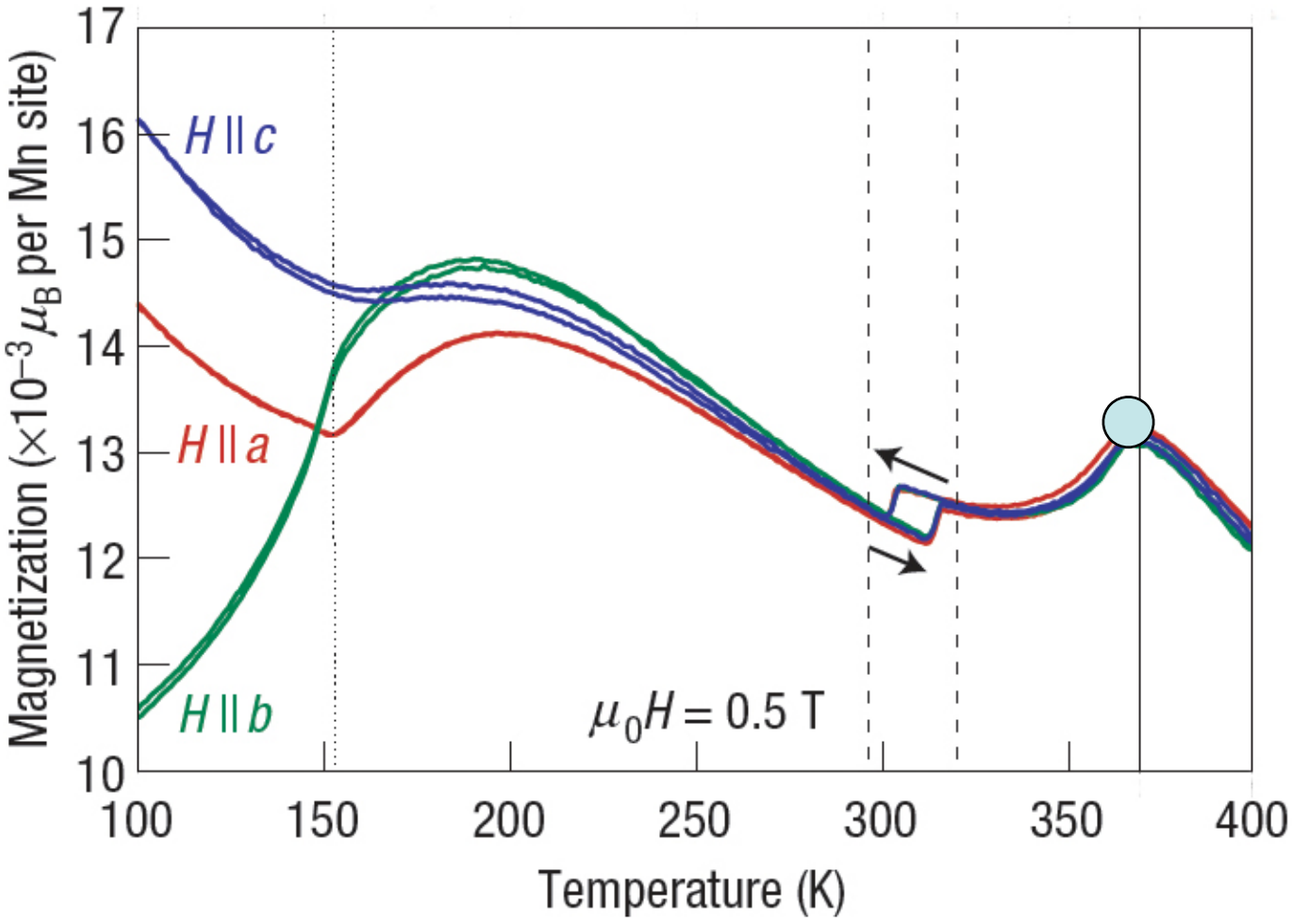

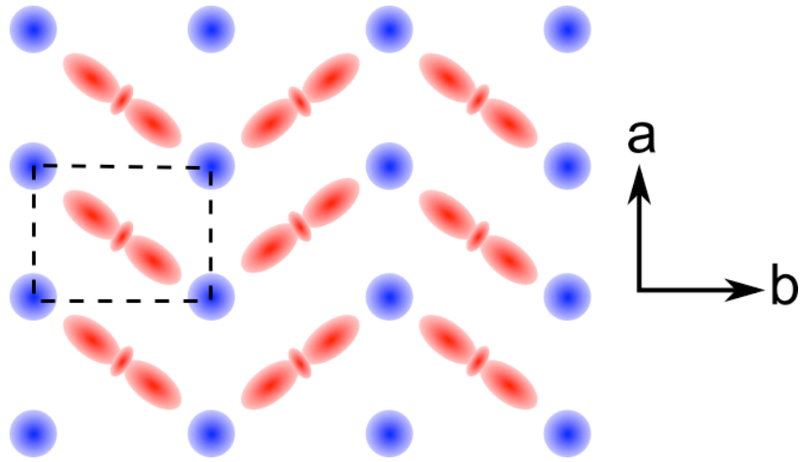

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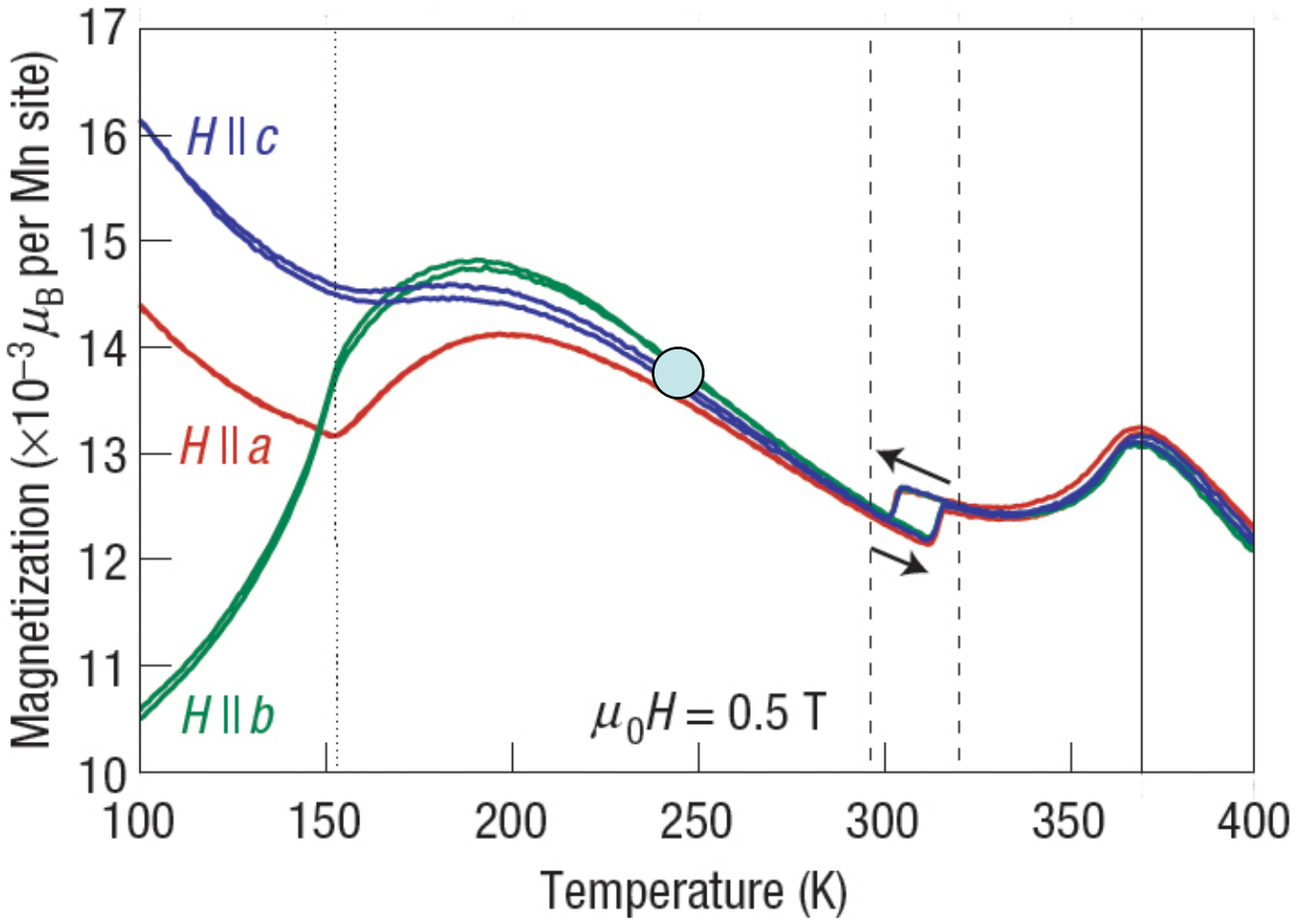

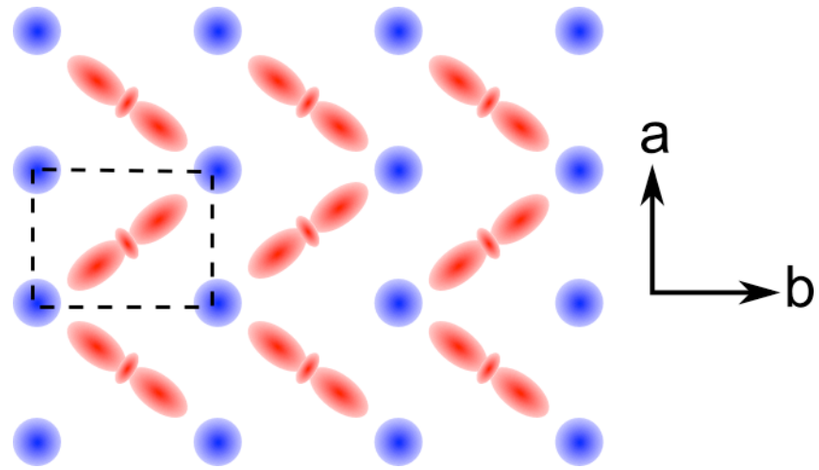

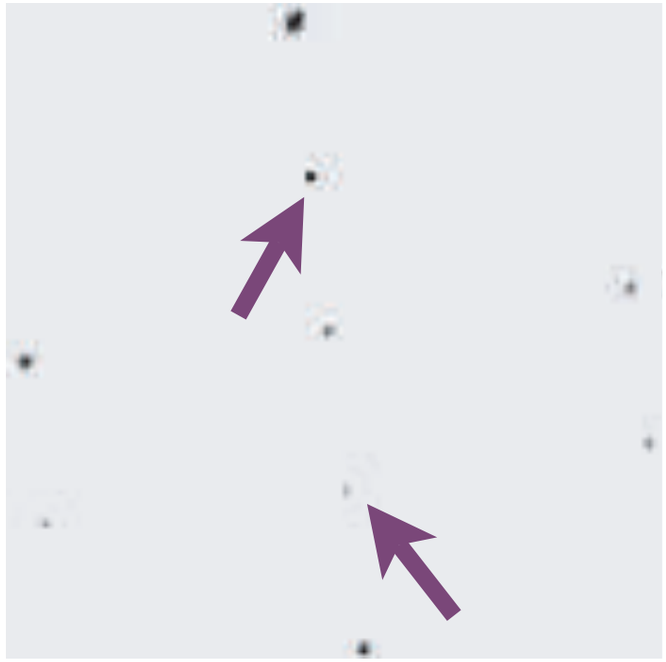

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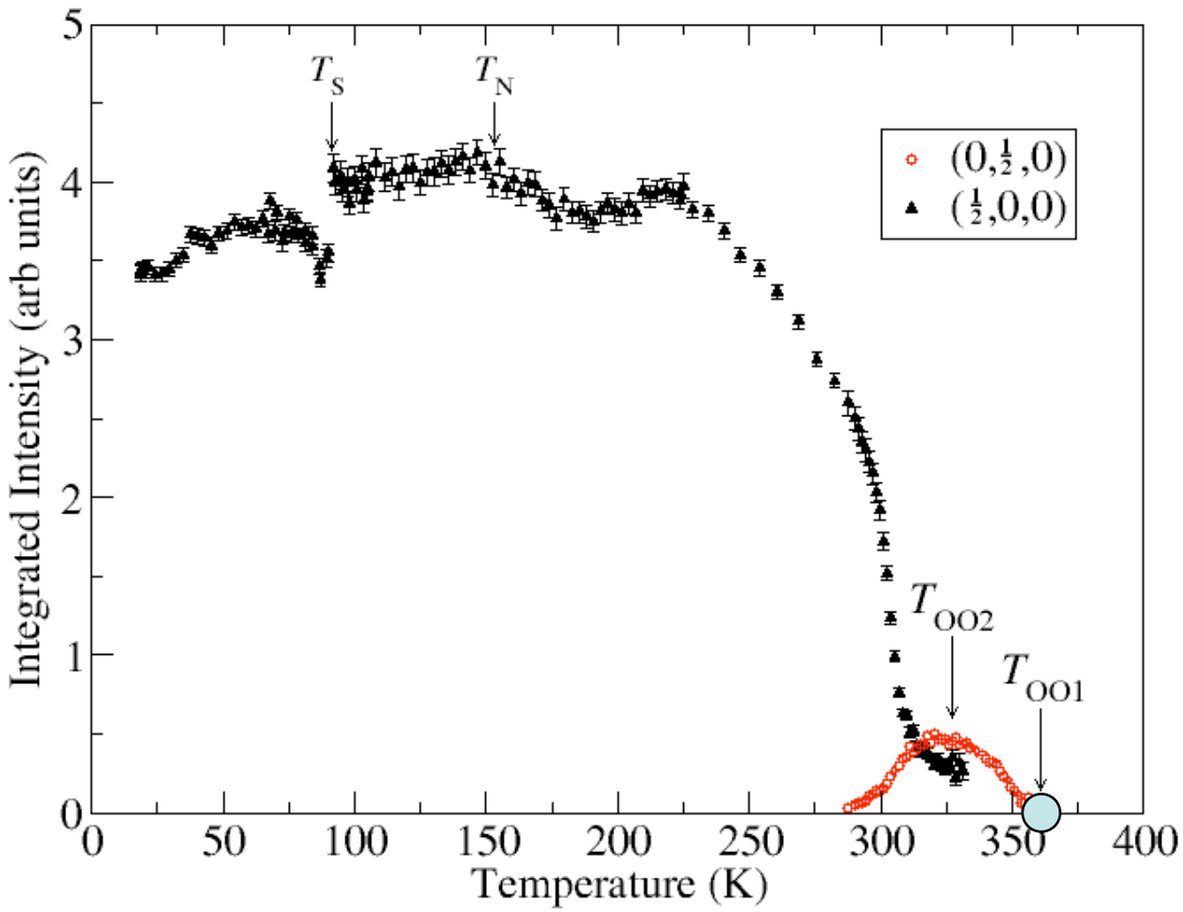
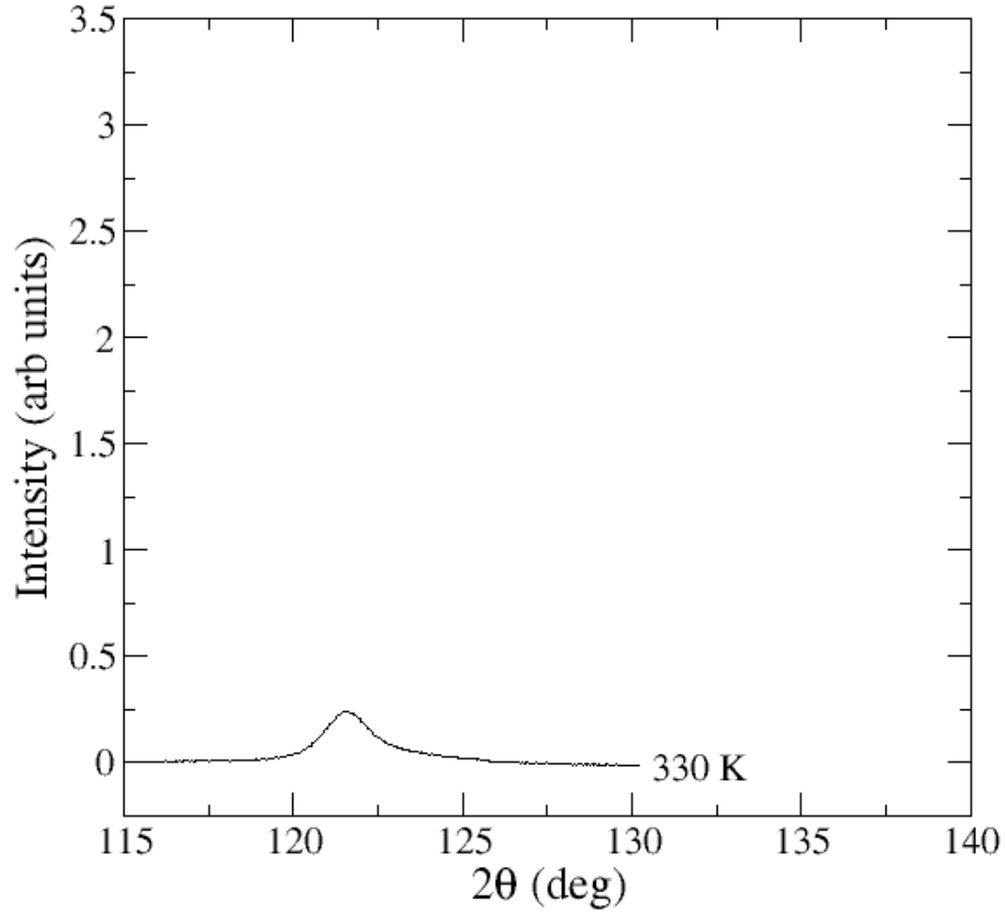
Temperature dependence of (0,½,0) and (½,0,0) reflections





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T.A.W. Beale *et al*. PRB **79** 054433 (2009)

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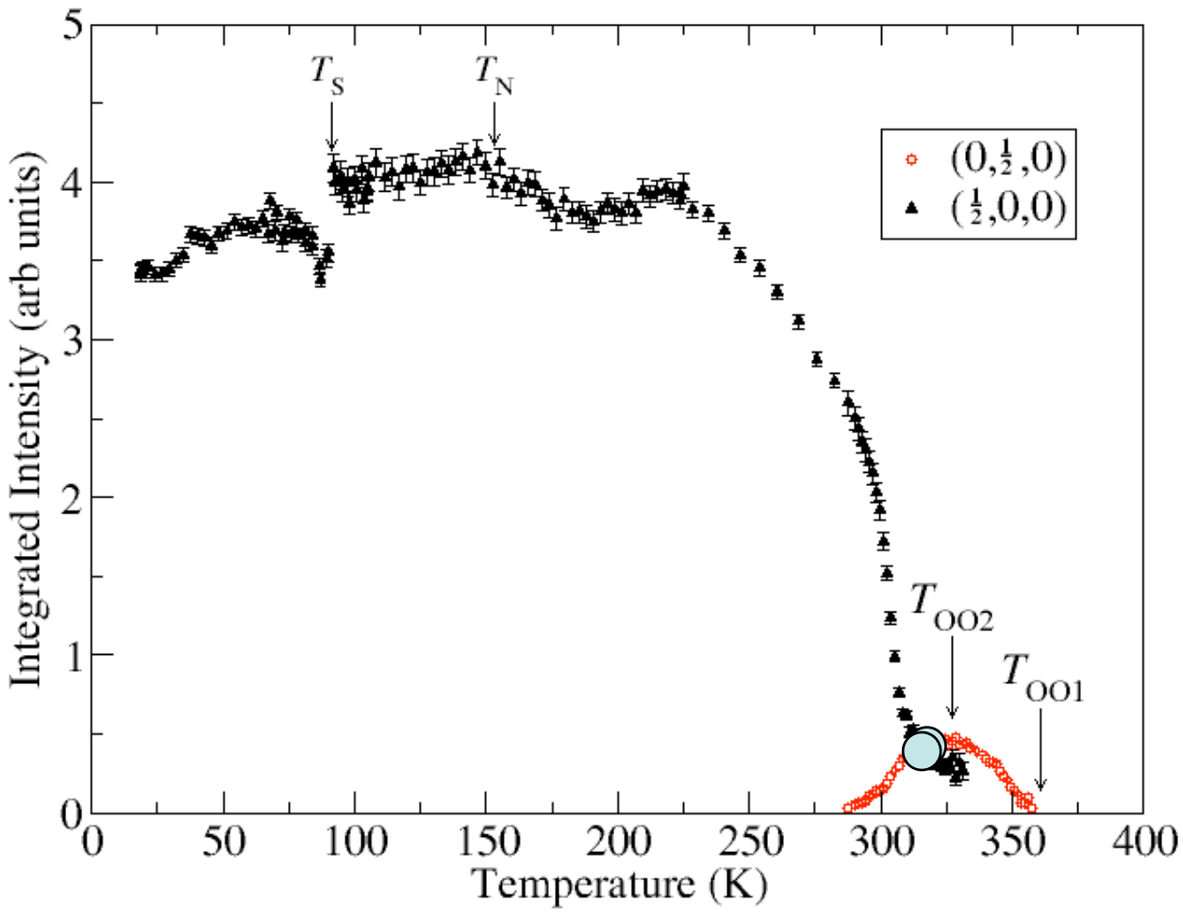

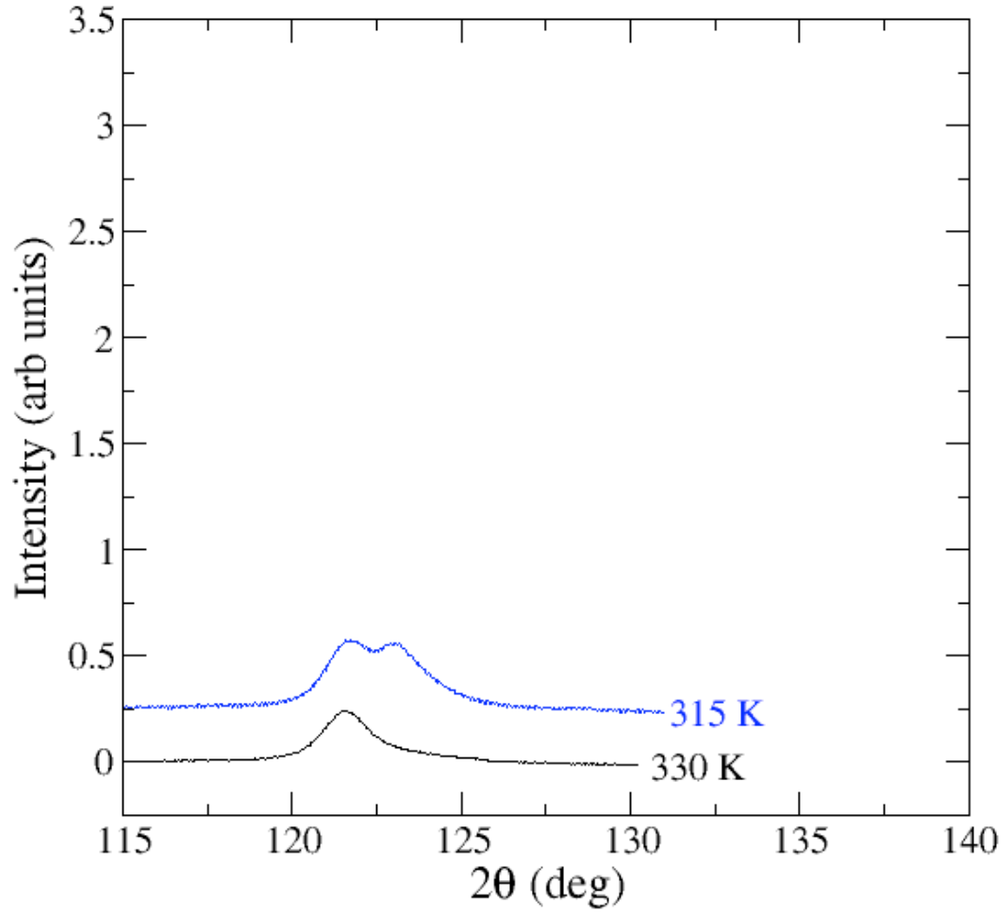

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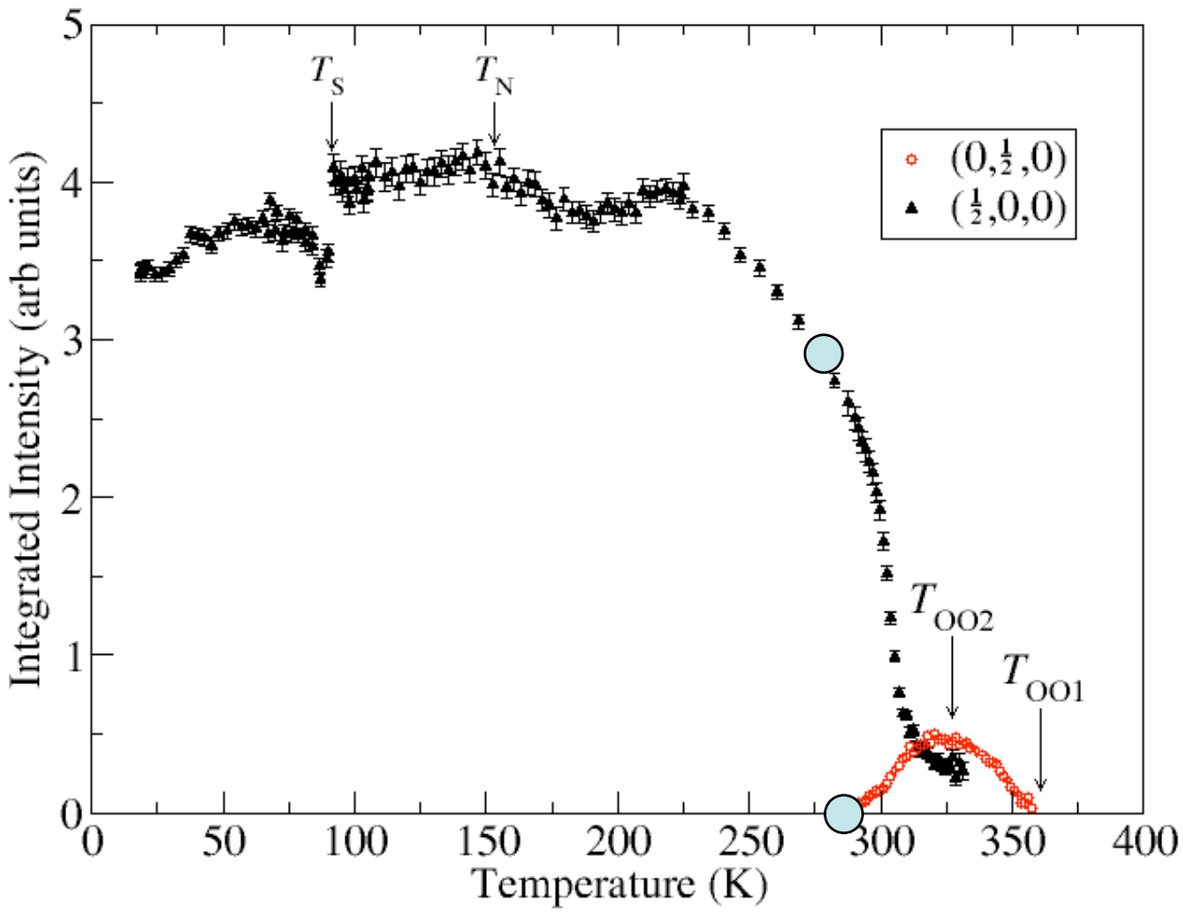

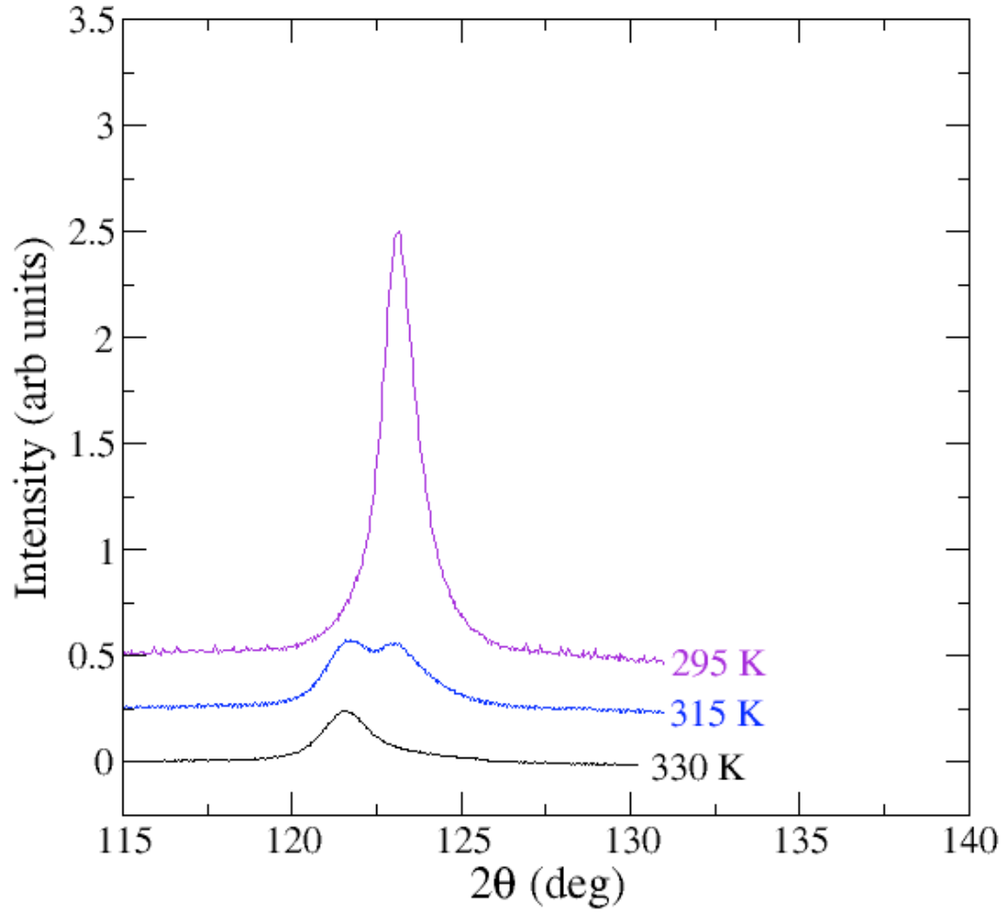

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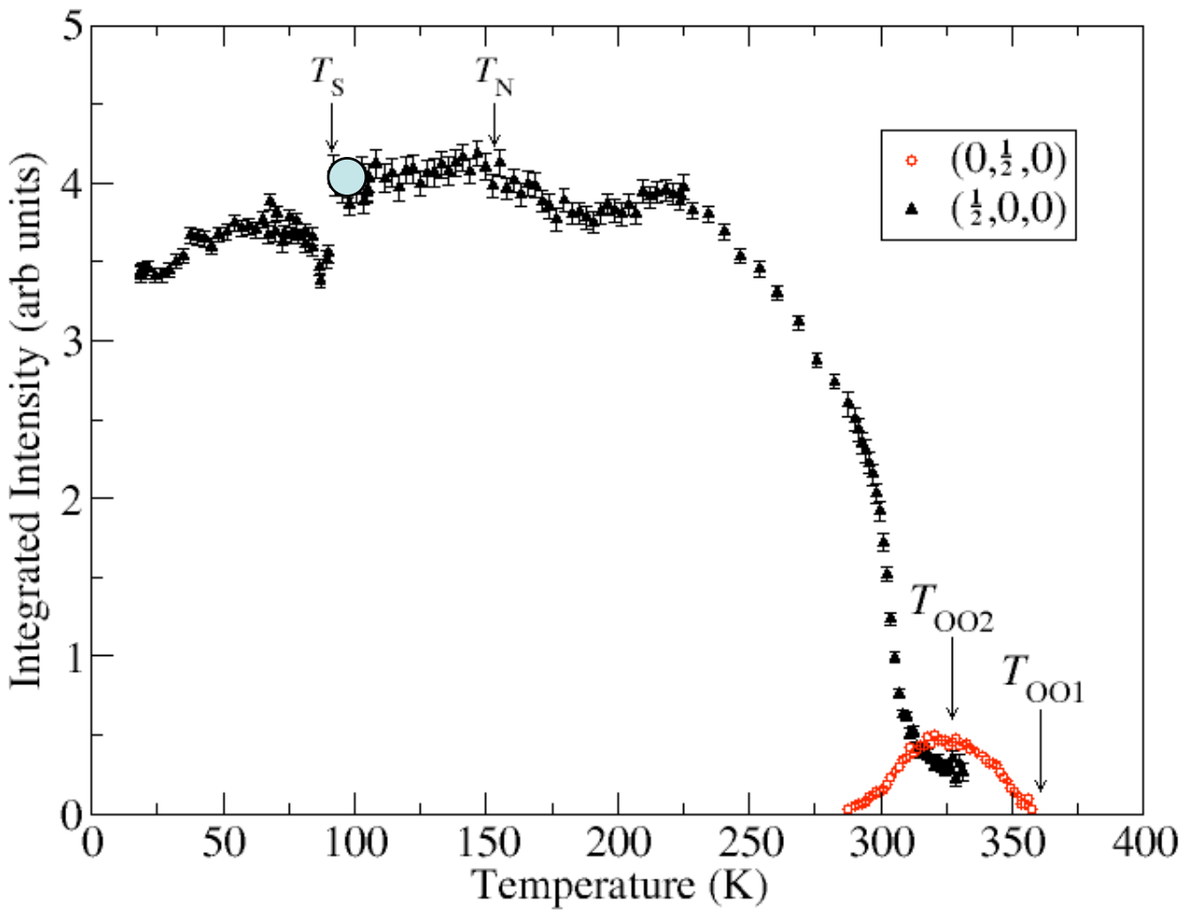

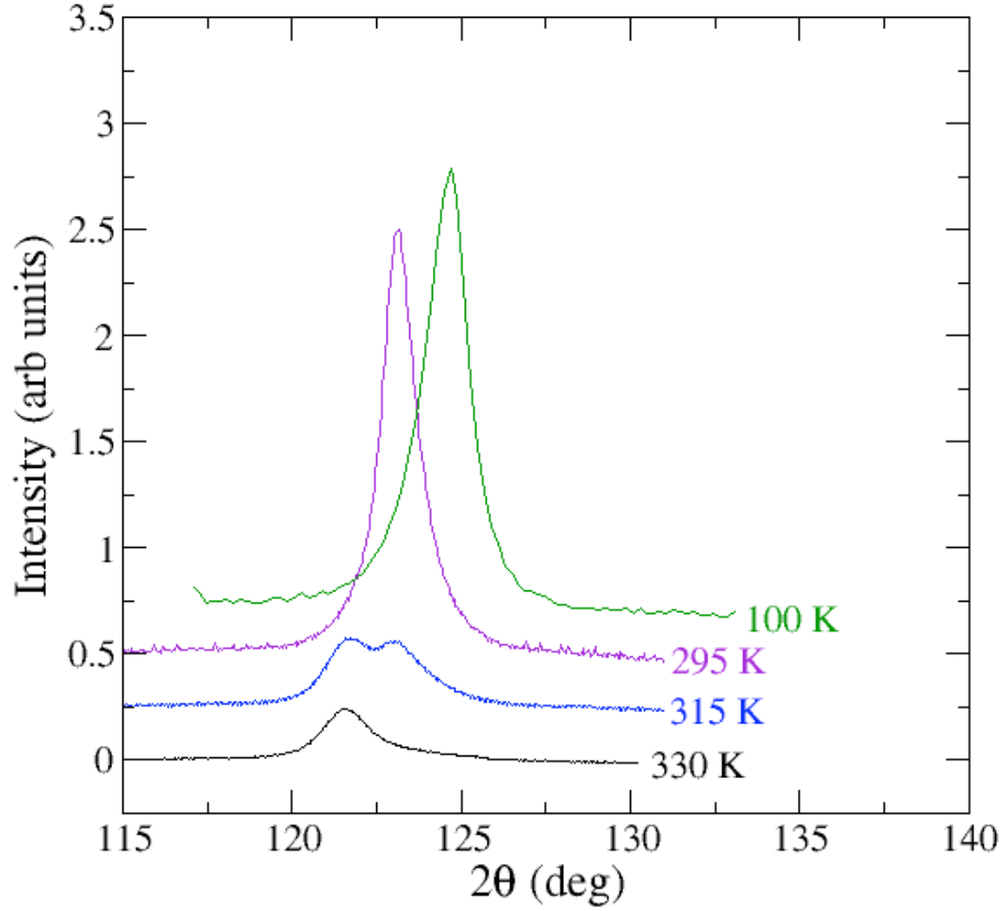

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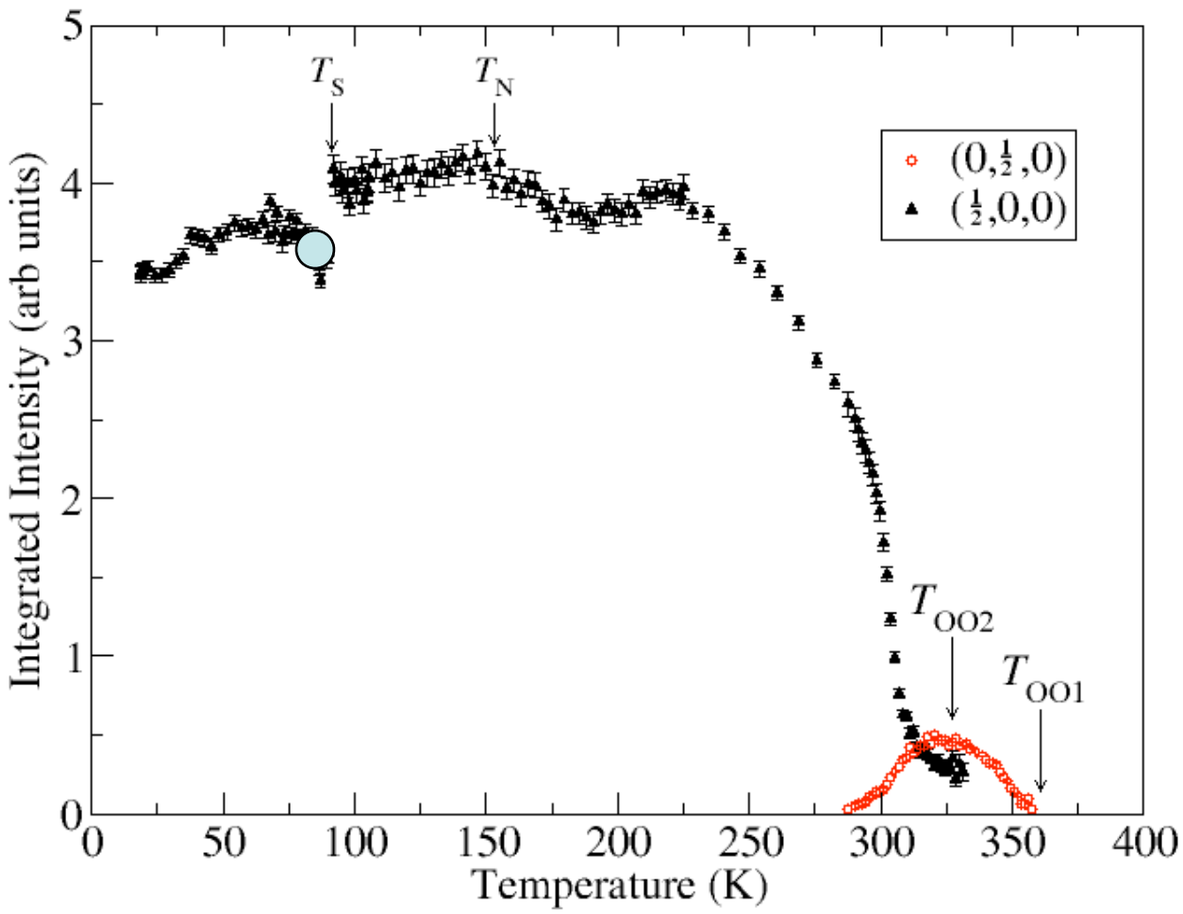

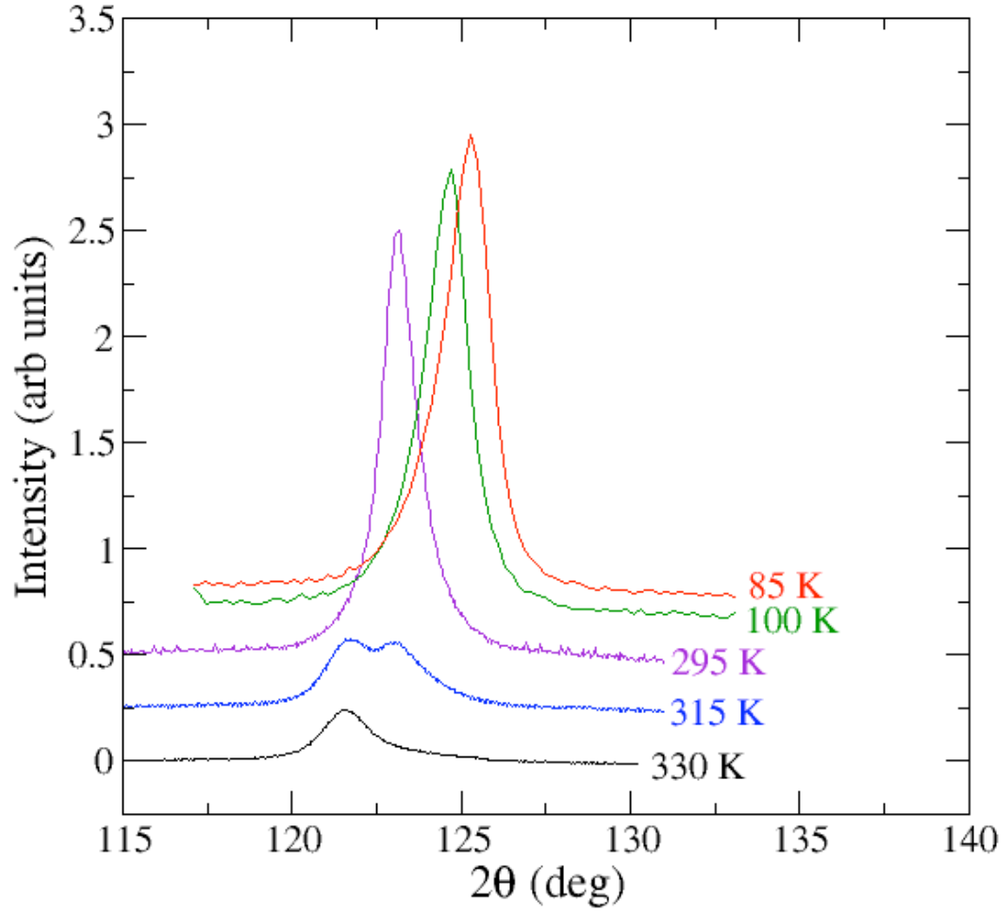

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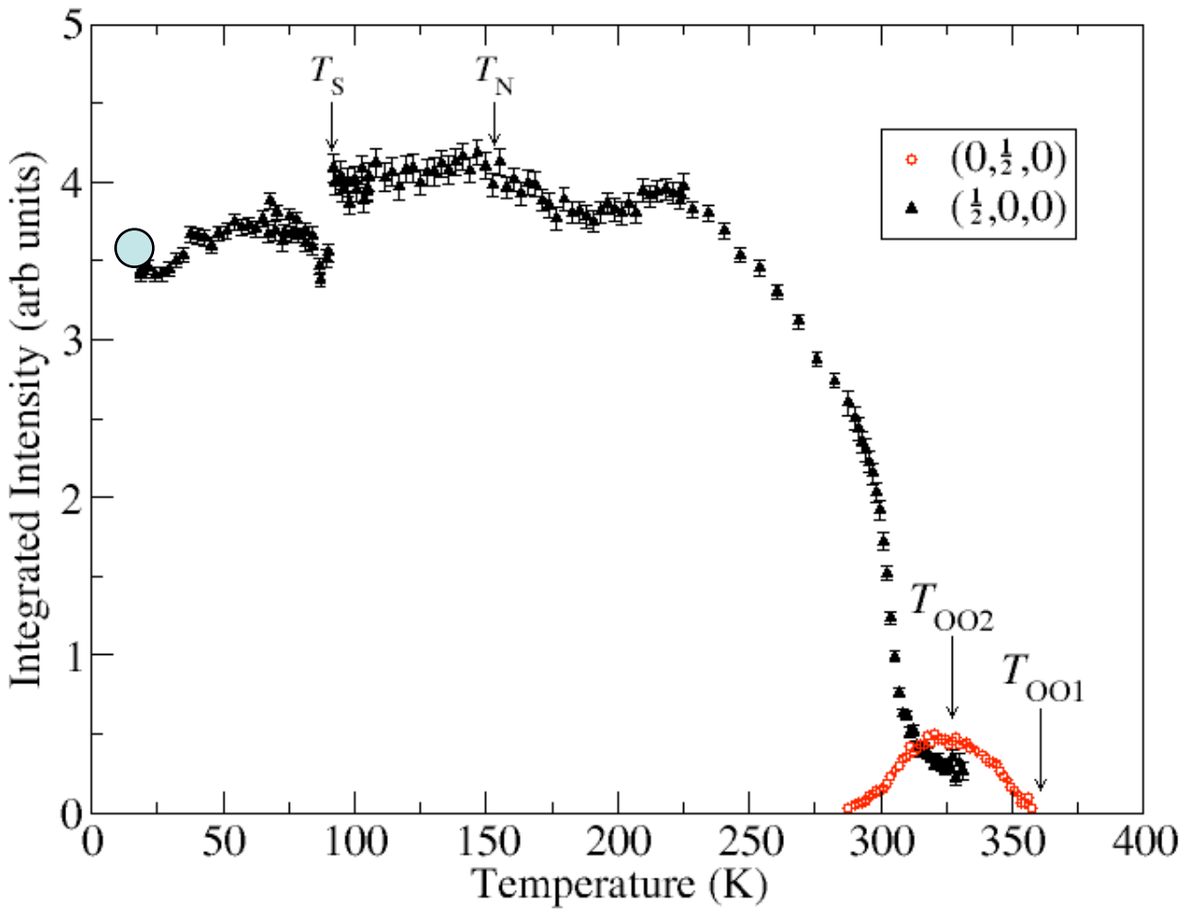
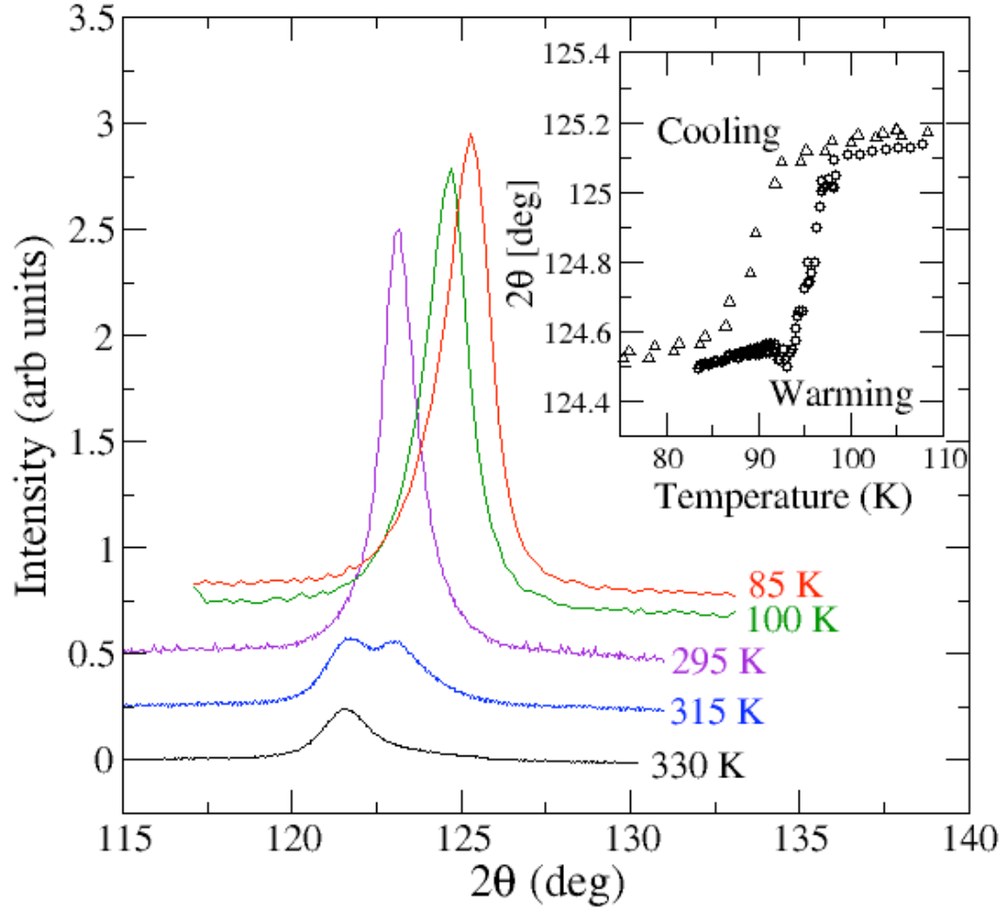
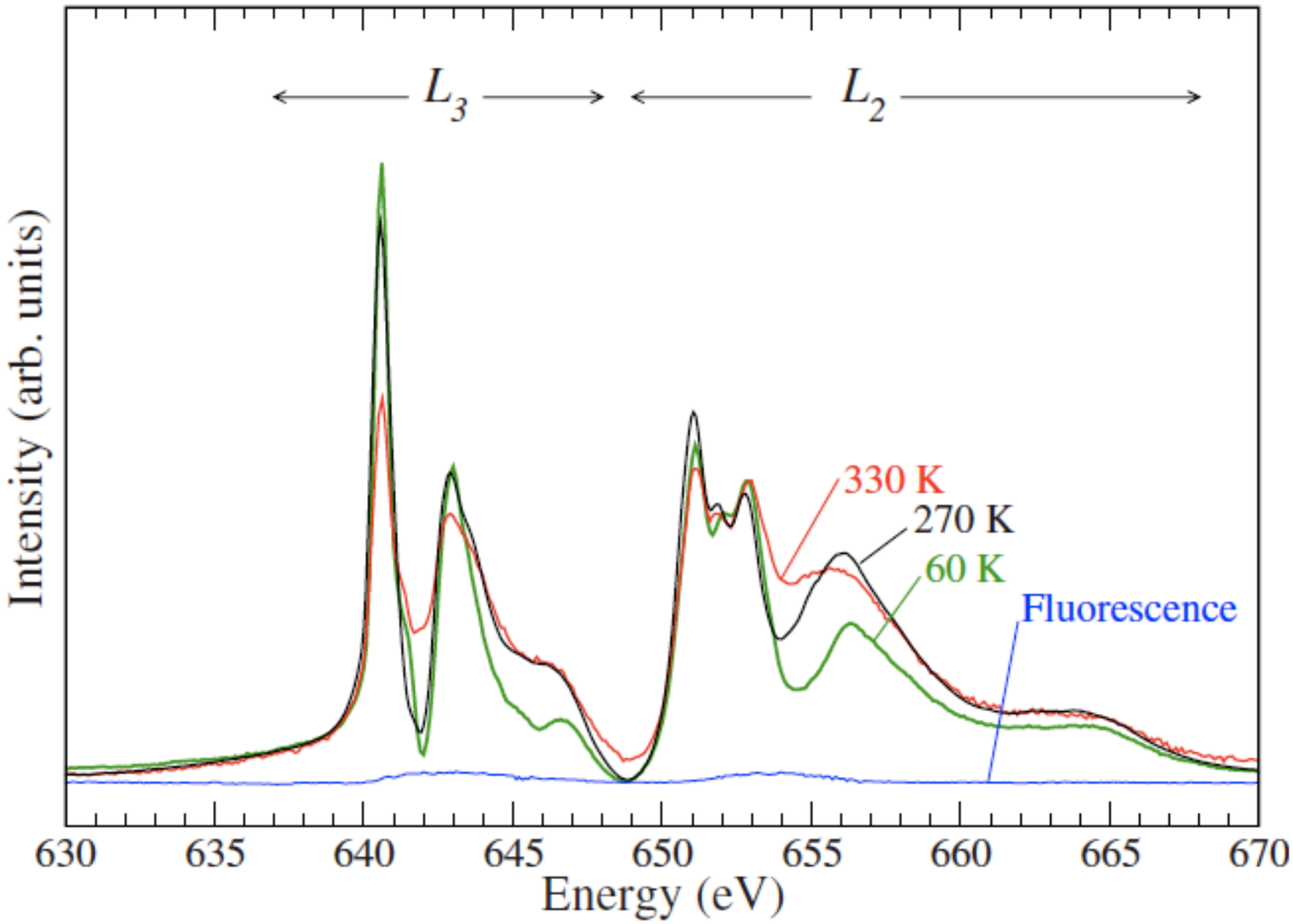




Spectroscopy of orbital order



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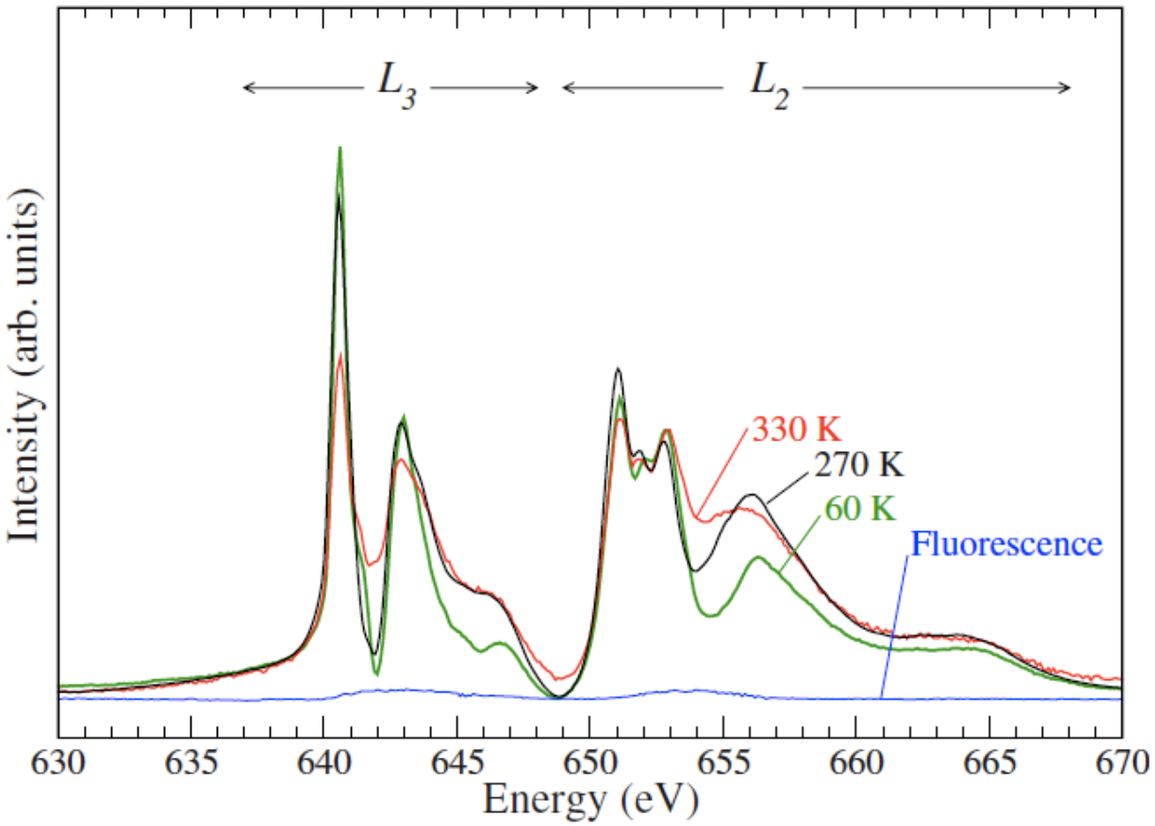

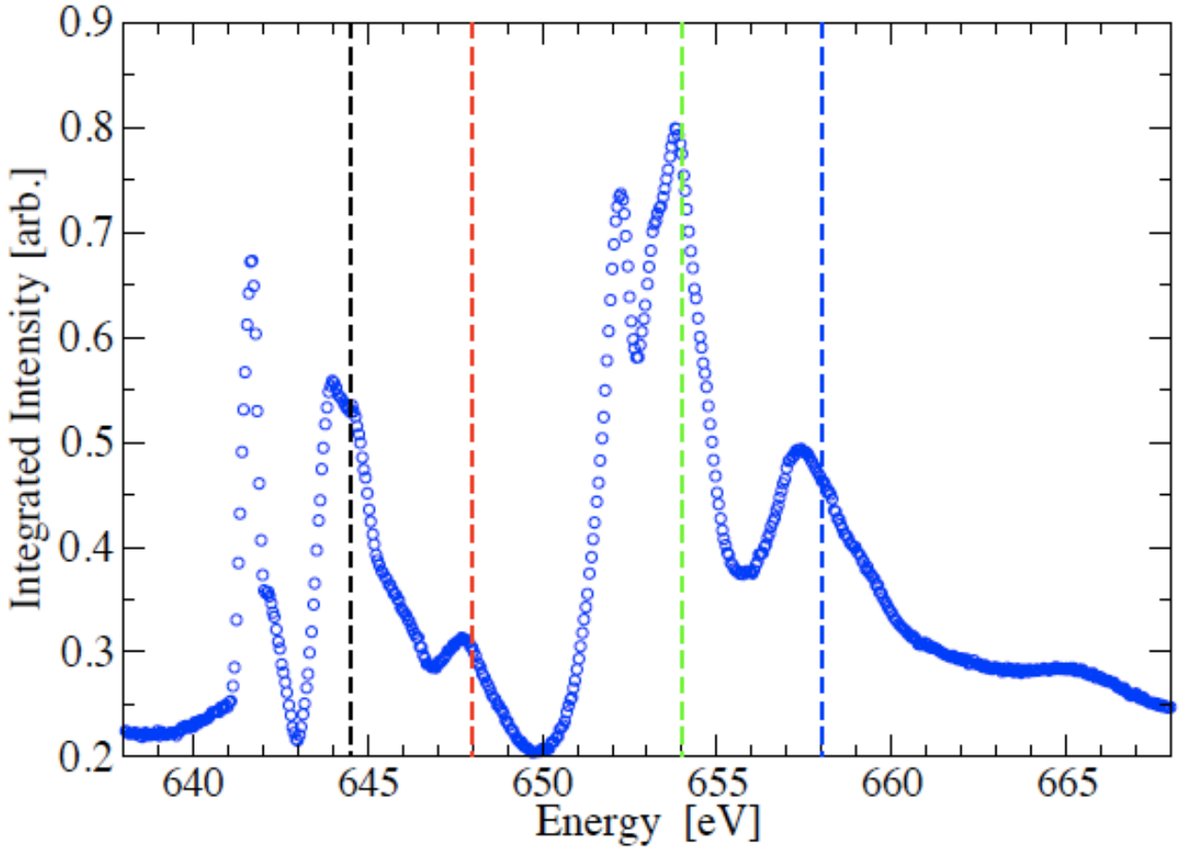

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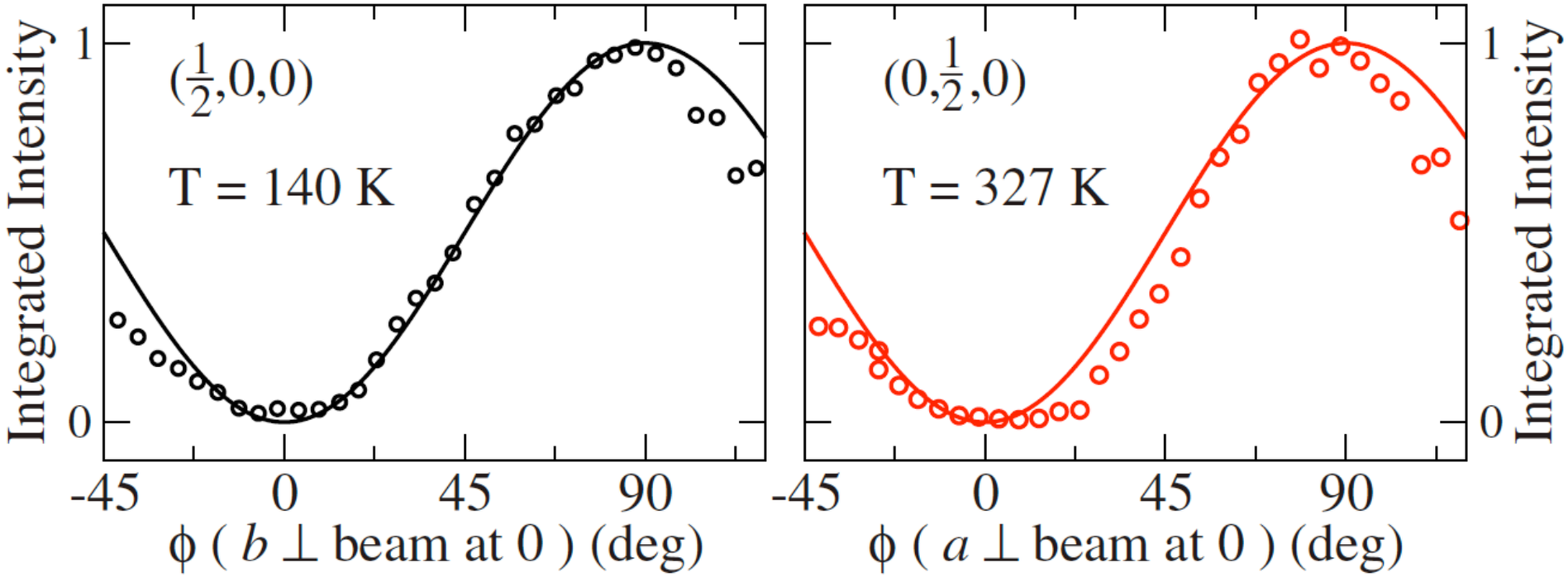

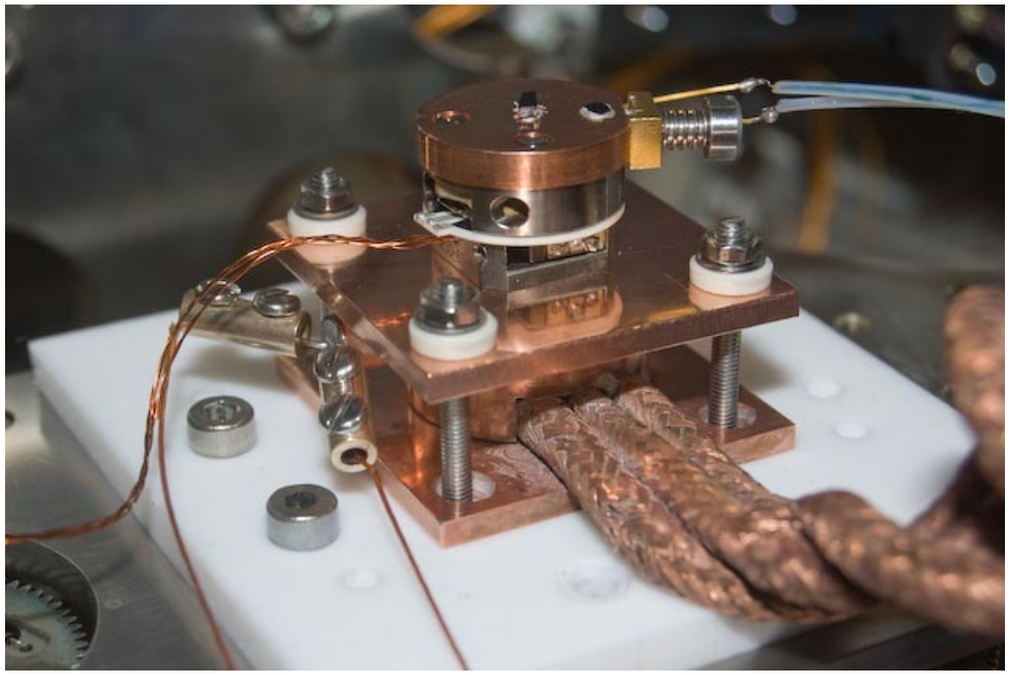

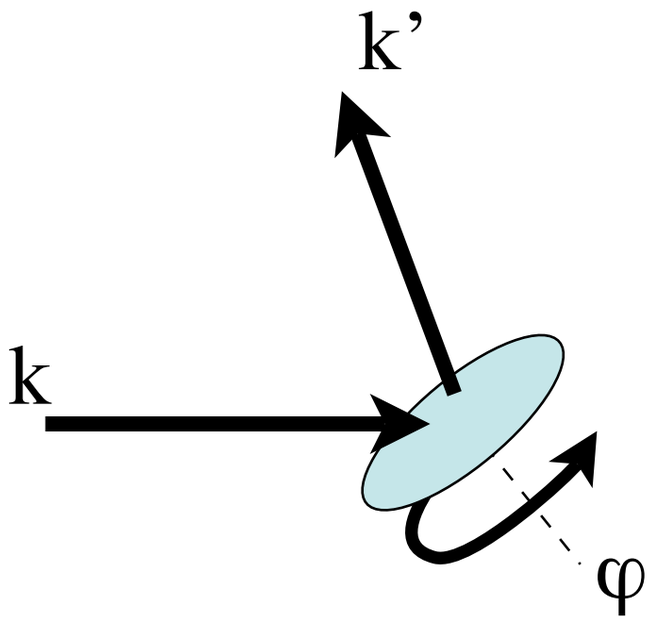

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RASOR

(Reflectivity and Advanced Scattering from Ordered Regimes)

Project brief: To design and construct an instrument for the UK reflectivity and diffraction community optimised for use at Diamond Light Source

Science & Technology Facilities Council

diamond

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- Flexible sample environments (Magnetic field, electric field)

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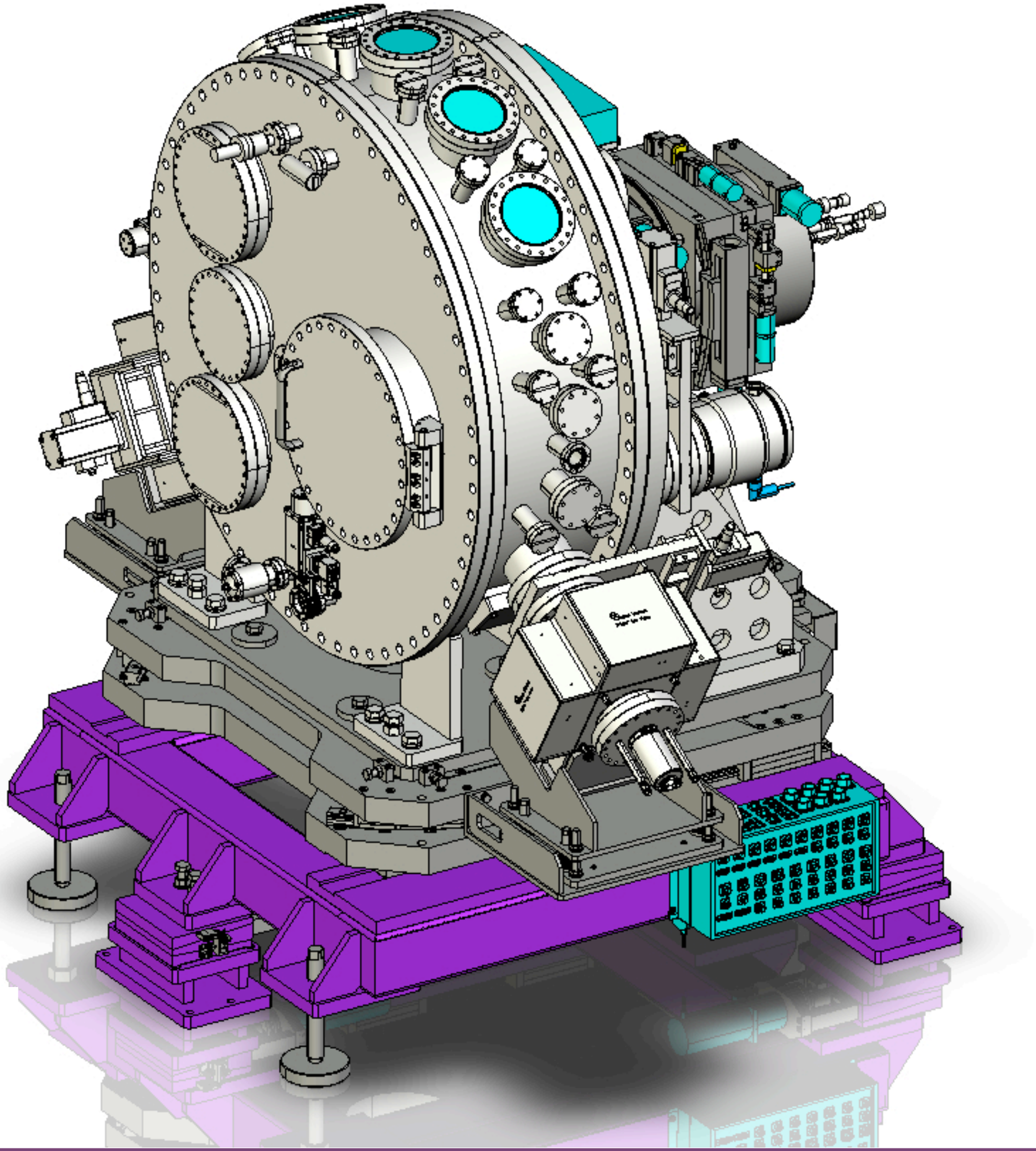

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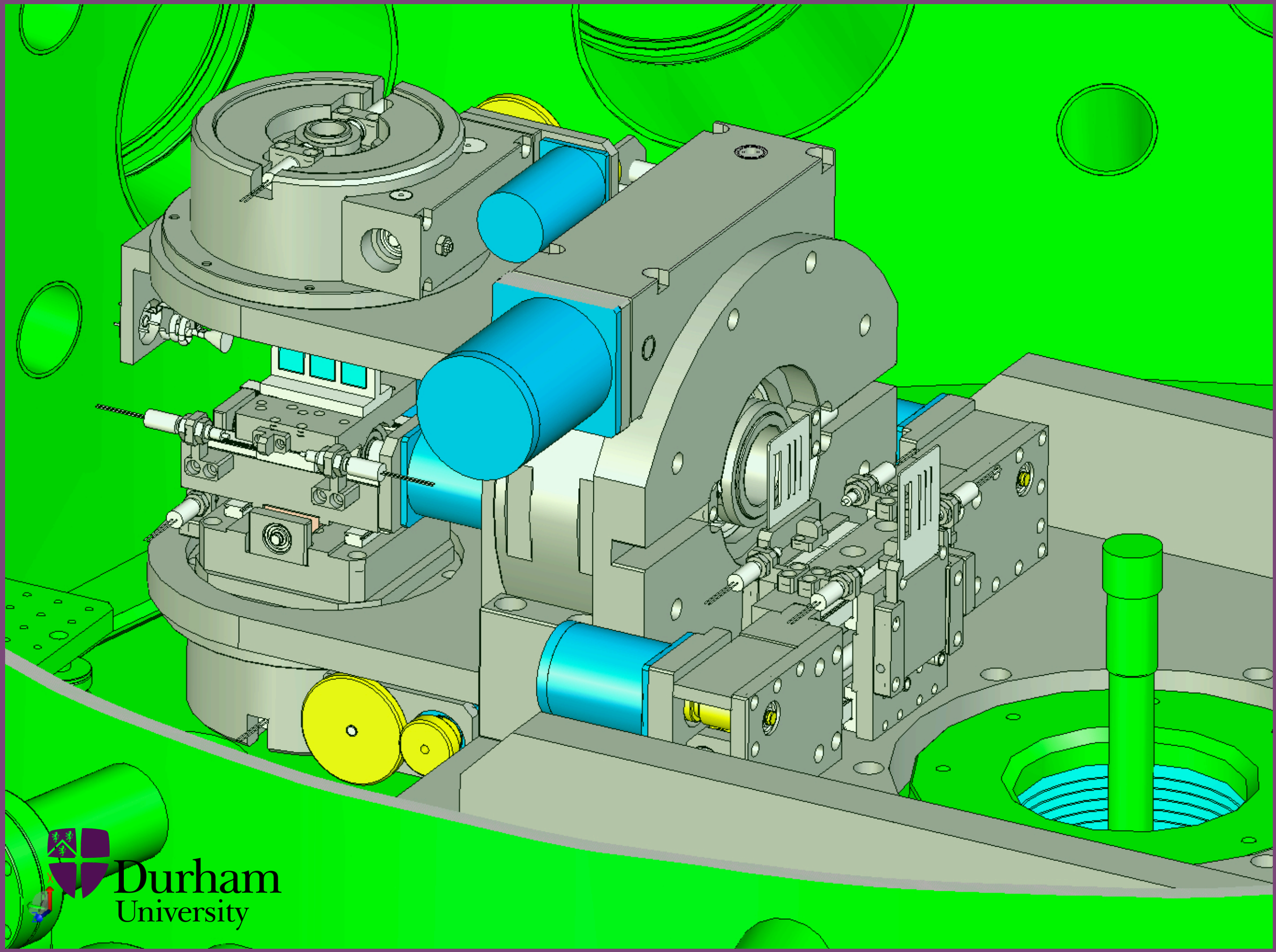

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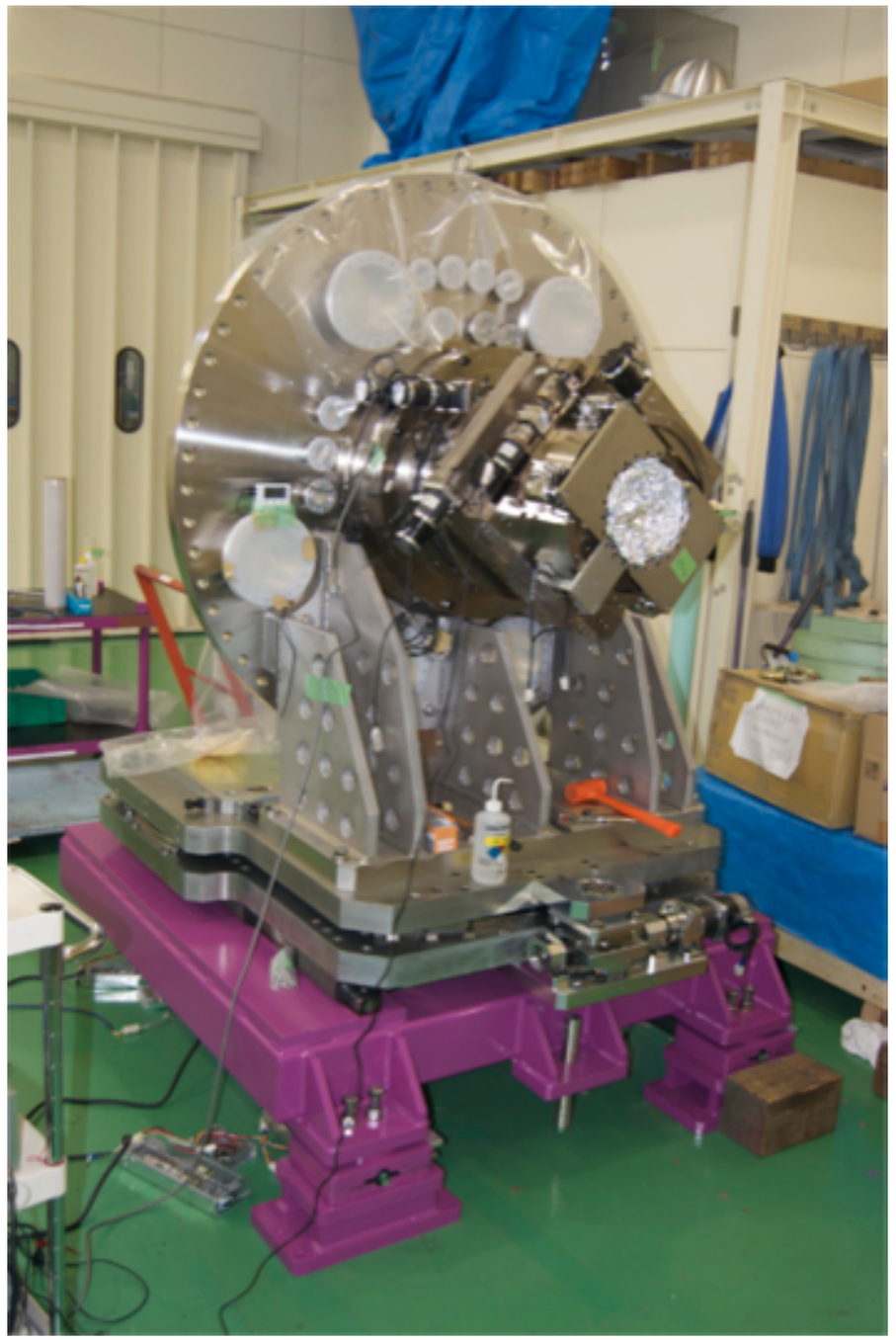

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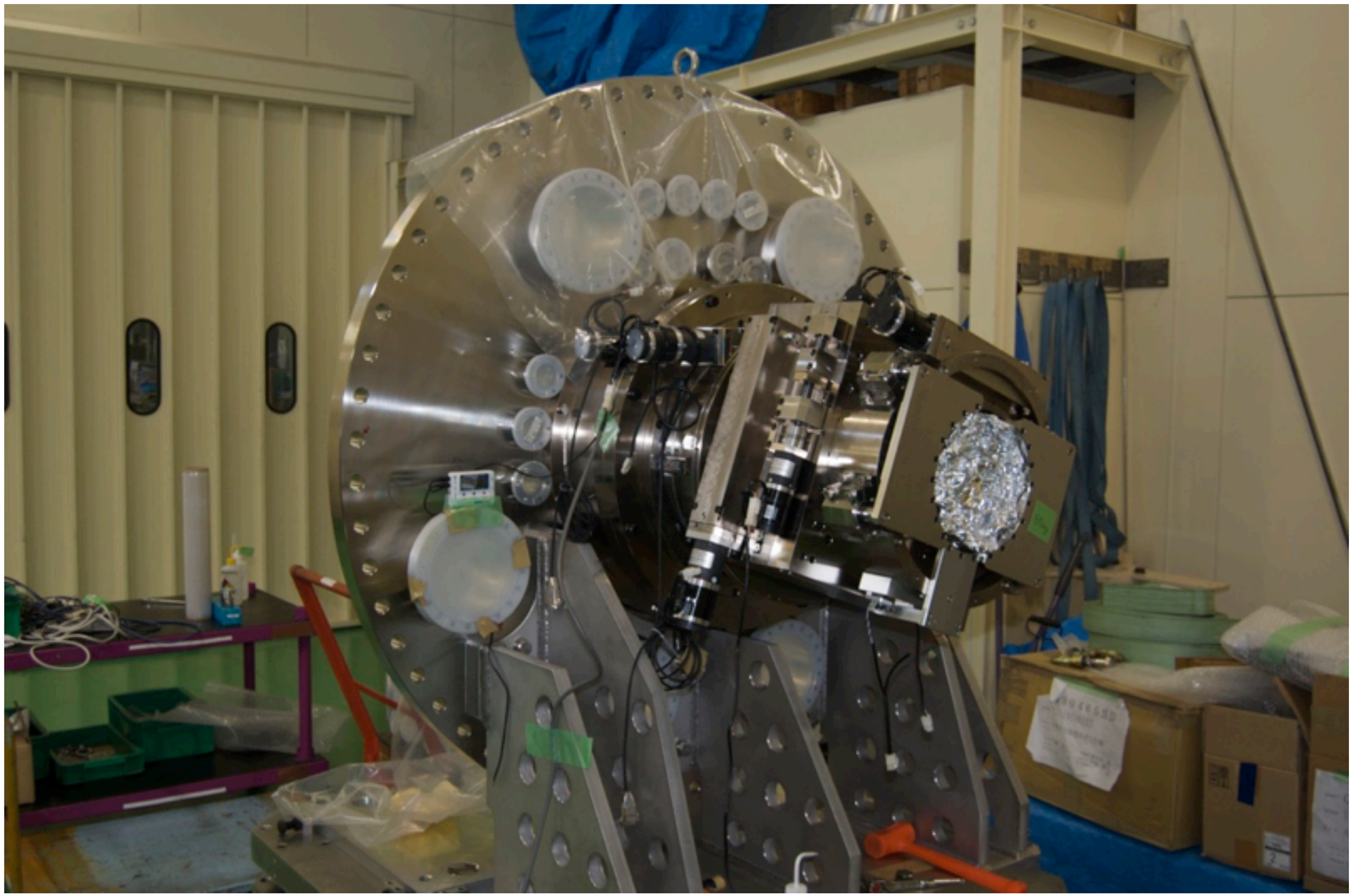

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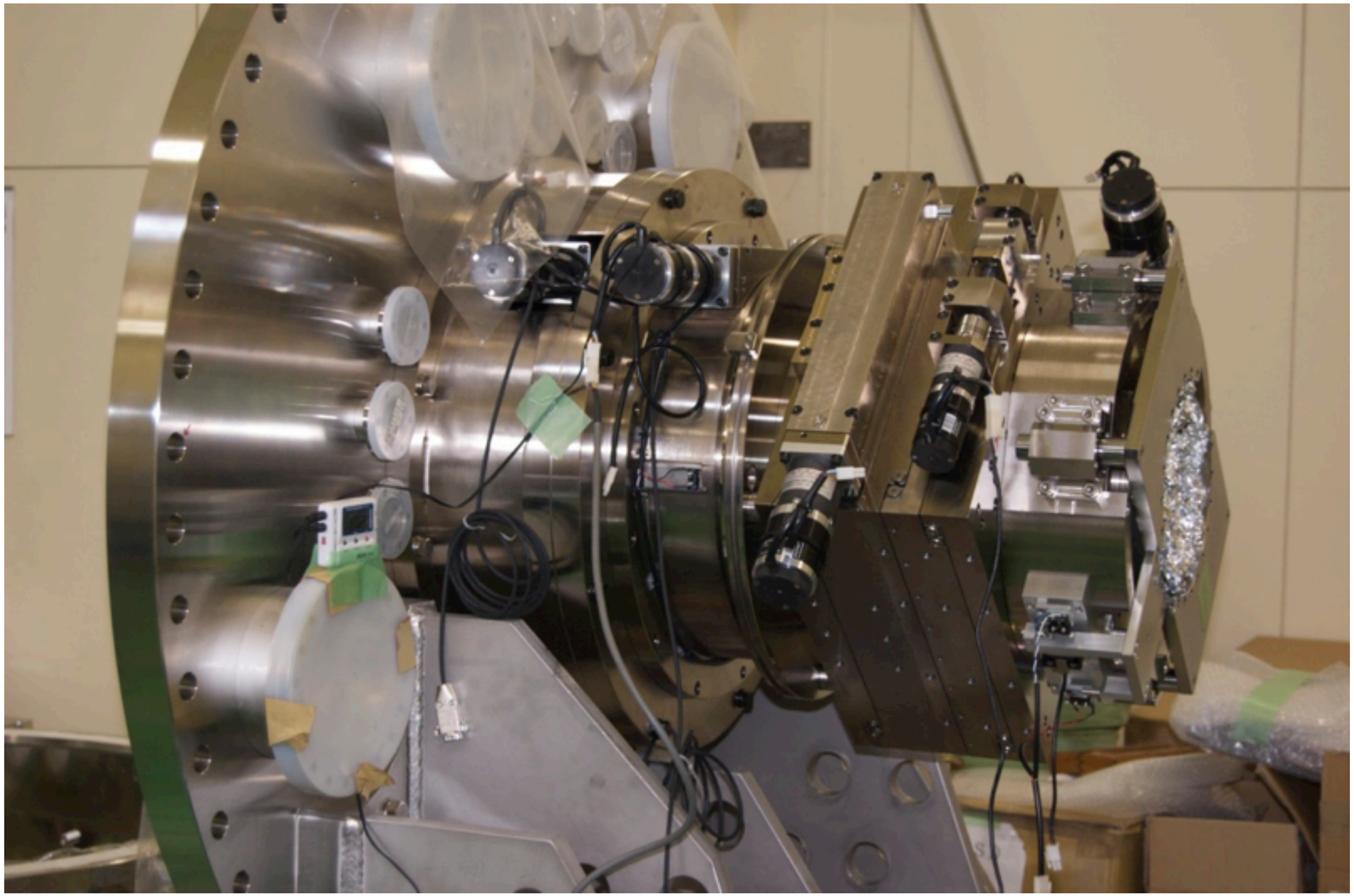

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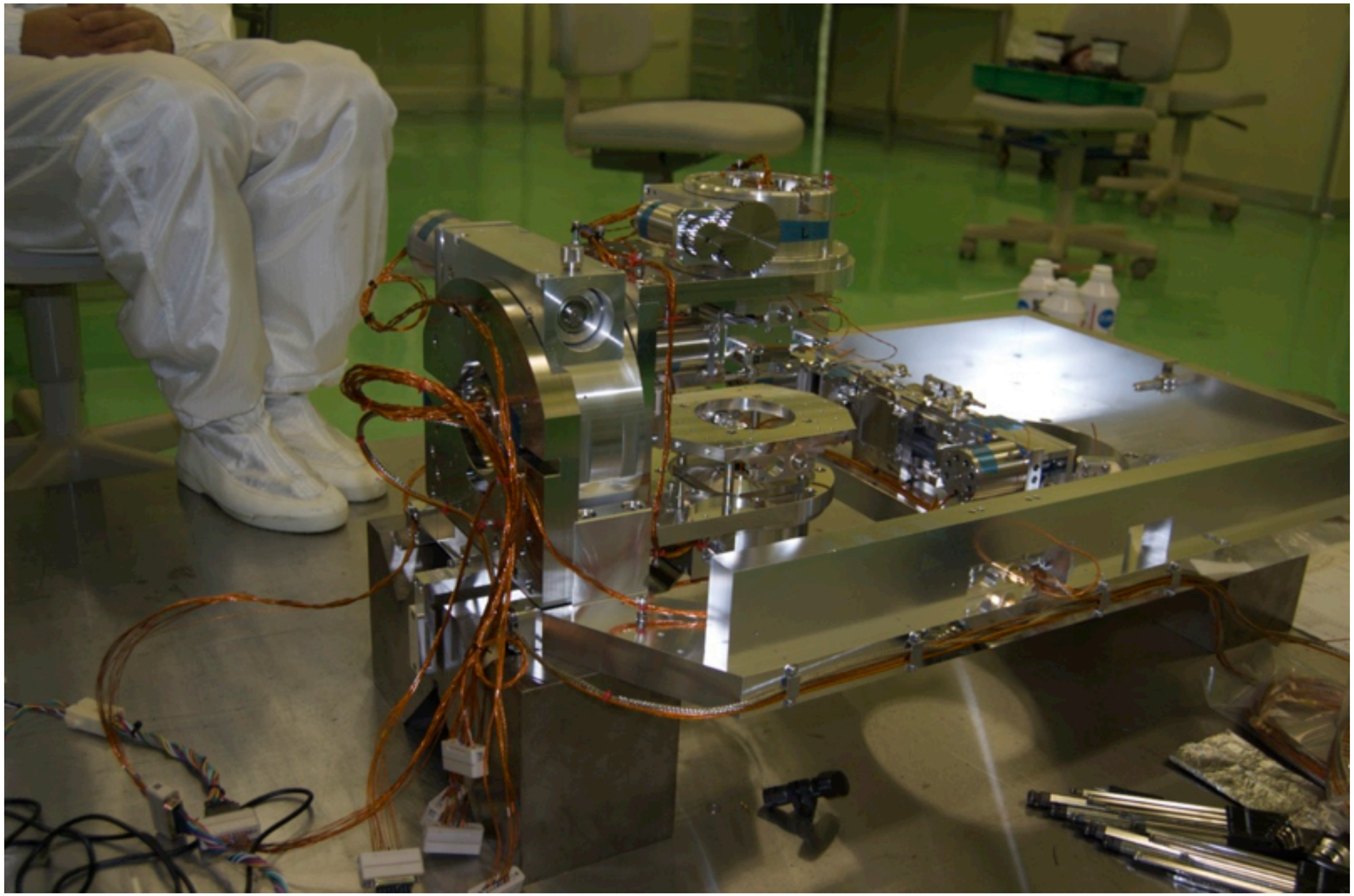

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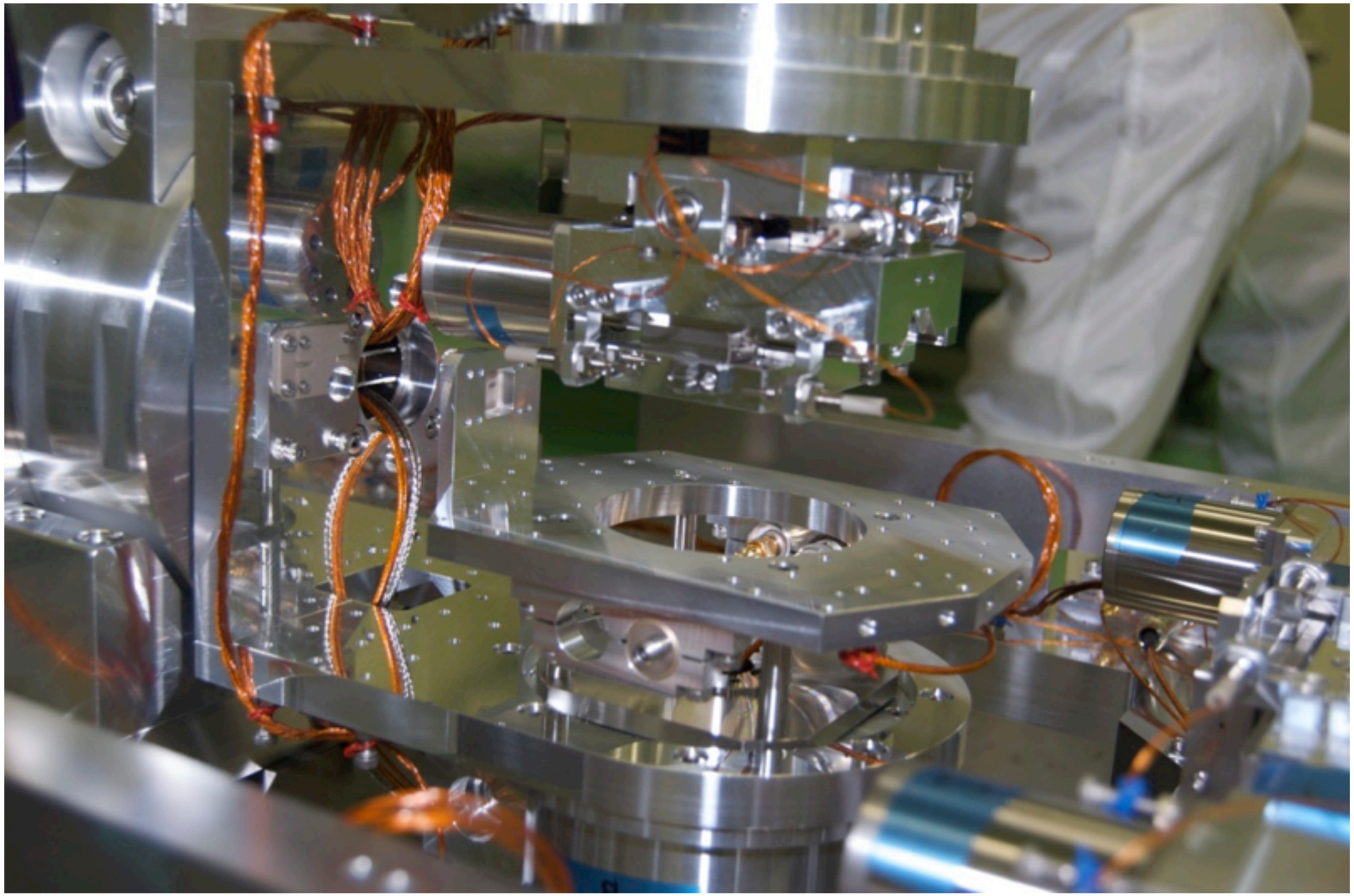

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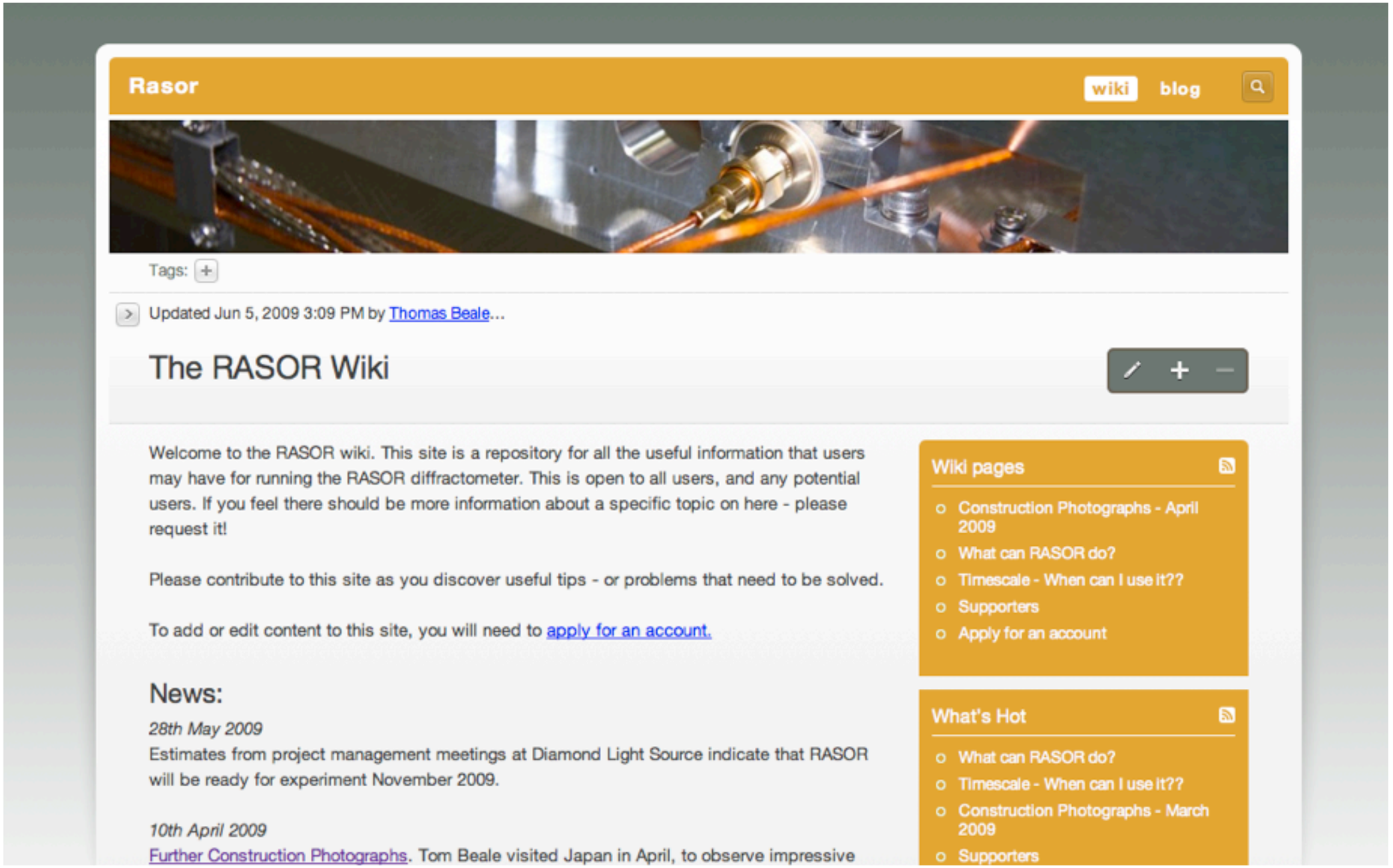
http://www.dur.ac.uk/xray.magnetism/rasor



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