The Millennium Programme at ILL -> New Neutron Detectors

ILL Grenoble

Diffraction Group

New Diffraction Group Instruments:

- D20 – microstrip powder diffractometer for chemical kinetics…
- D2b – high resolution powder diffractometer with linear PSDs
- D4c – microstrip detector for liquids & amorphous materials
- Strain Scanner – for mapping strain using microstrip detectors
- D19 – an array of 2D-microstrips for protein/fiber diffraction
- T-LADI – Laue Diffractometer & neutron Image plate detector
- D3c – He3 neutron spin filters and magnetic polarimetry

High Pressure Microstrip Detectors

New D4C Liquids & Amorphous Materials Diffractometer

Henry Fischer, Gabriel Cuello, Pierre Palleau

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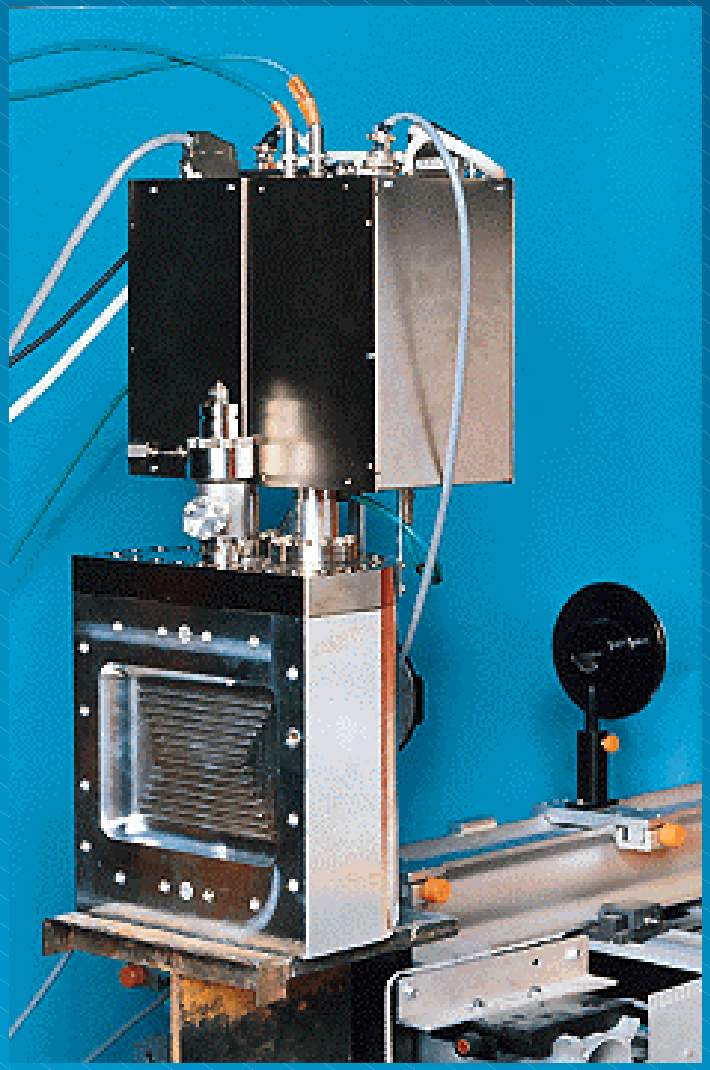

High pressure (15 bar) is needed for high efficiency at the short wavelengths needed for liquids diffraction.

The prototype D4C detector

An array of Microstrip Detectors

New D4C Liquids & Amorphous Materials Diffractometer

Henry Fischer, Gabriel Cuello, Pierre Palleau

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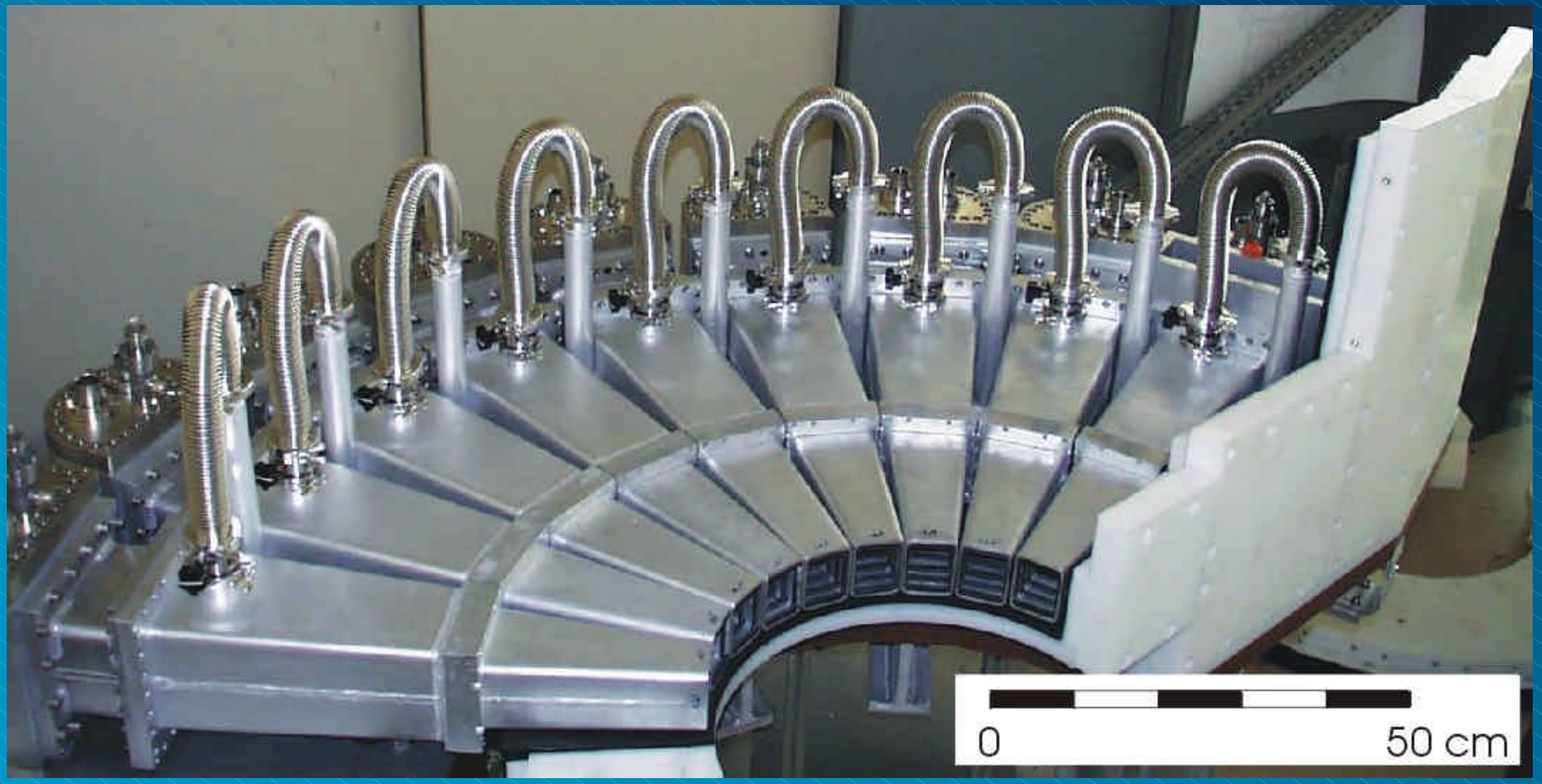

Very high efficiency & stability needed for isotope replacement method

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A 2D Microstrip Detector

D9, D10, D15, Neutron Strain Scanner…

Bruno Guerard, Anton Oed et al.

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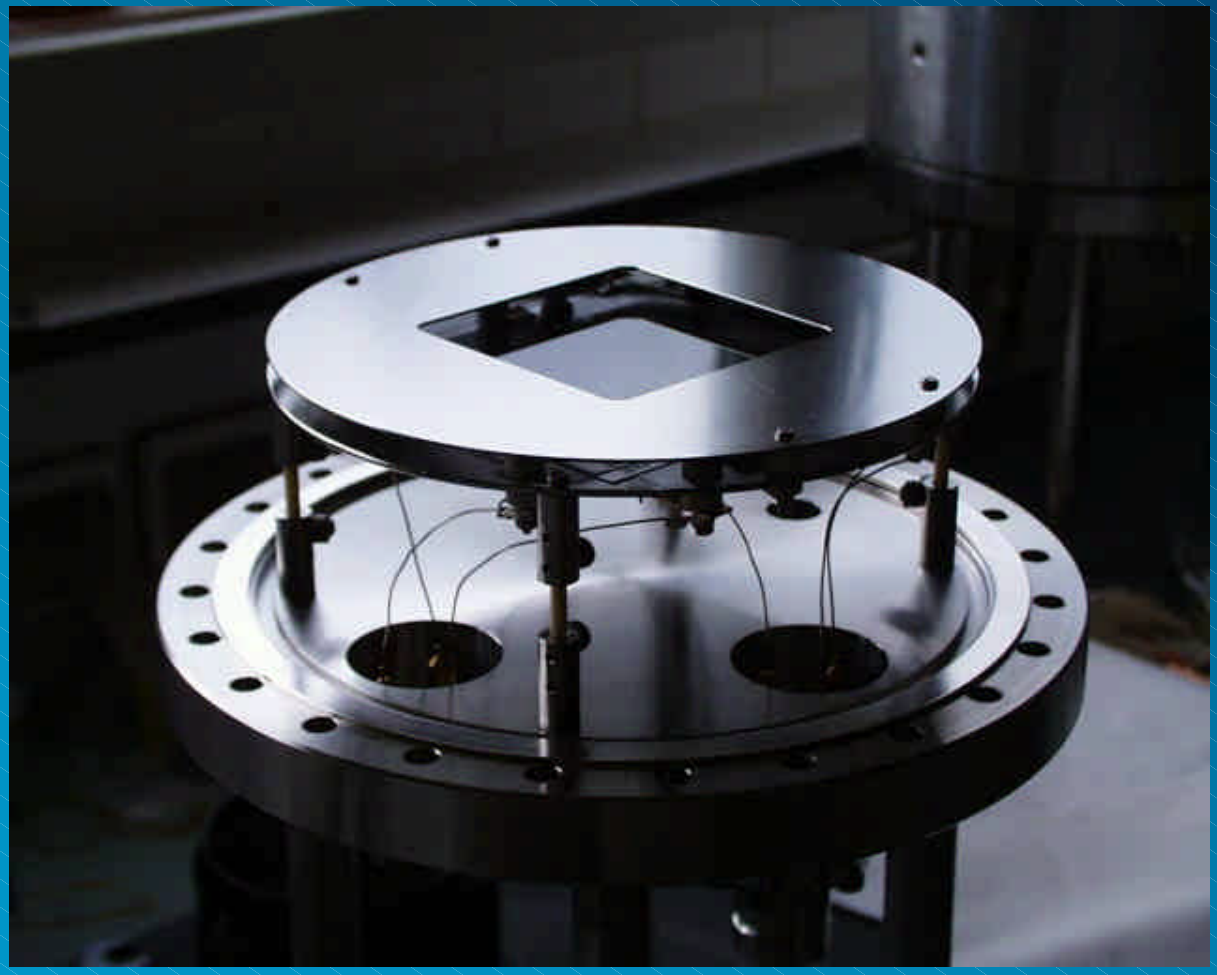

A printed circuit on BOTH sides of the glass substrate

Neutron Strain Scanner

80x80 mm 2D Microstrip Detector on D1A

Thilo Pirling, Robert Wimpory

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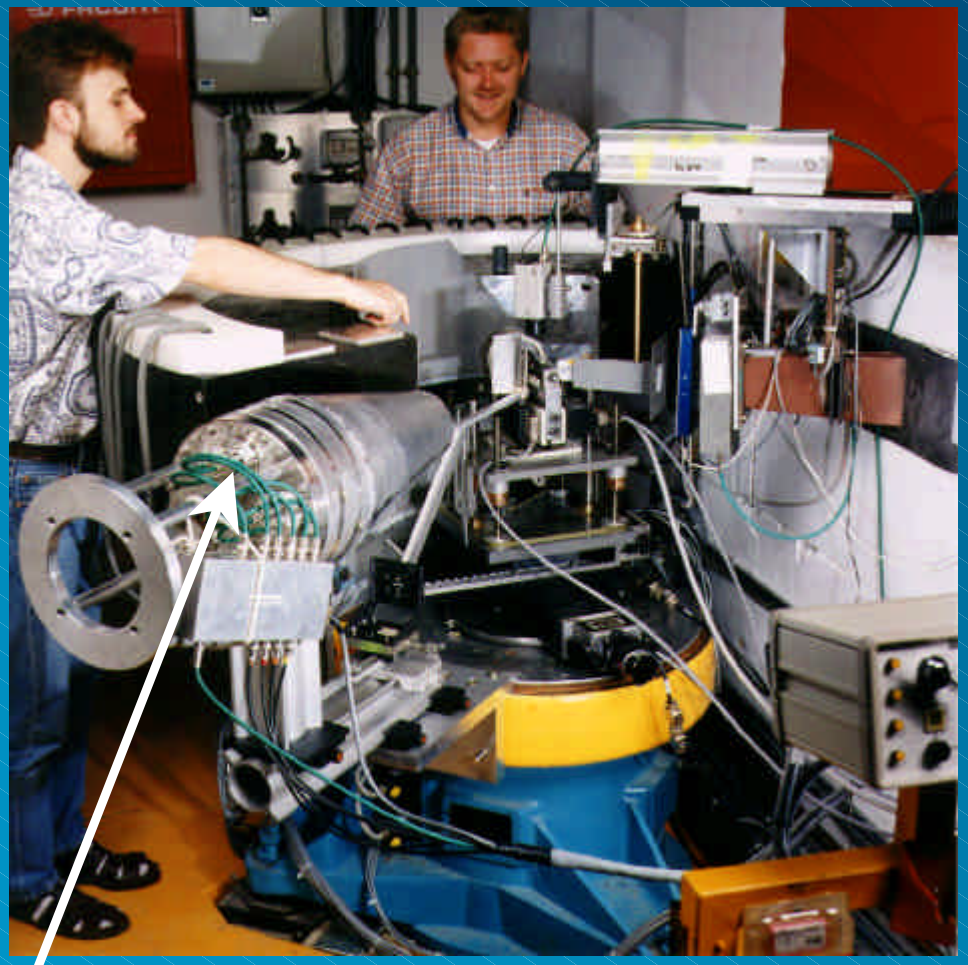

The 2D microstrip detector is used to obtain the complete line profile all at once

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Neutron Strain Scanner

80x80 mm 2D Microstrip Detector on D1A

Thilo Pirling, Robert Wimpory

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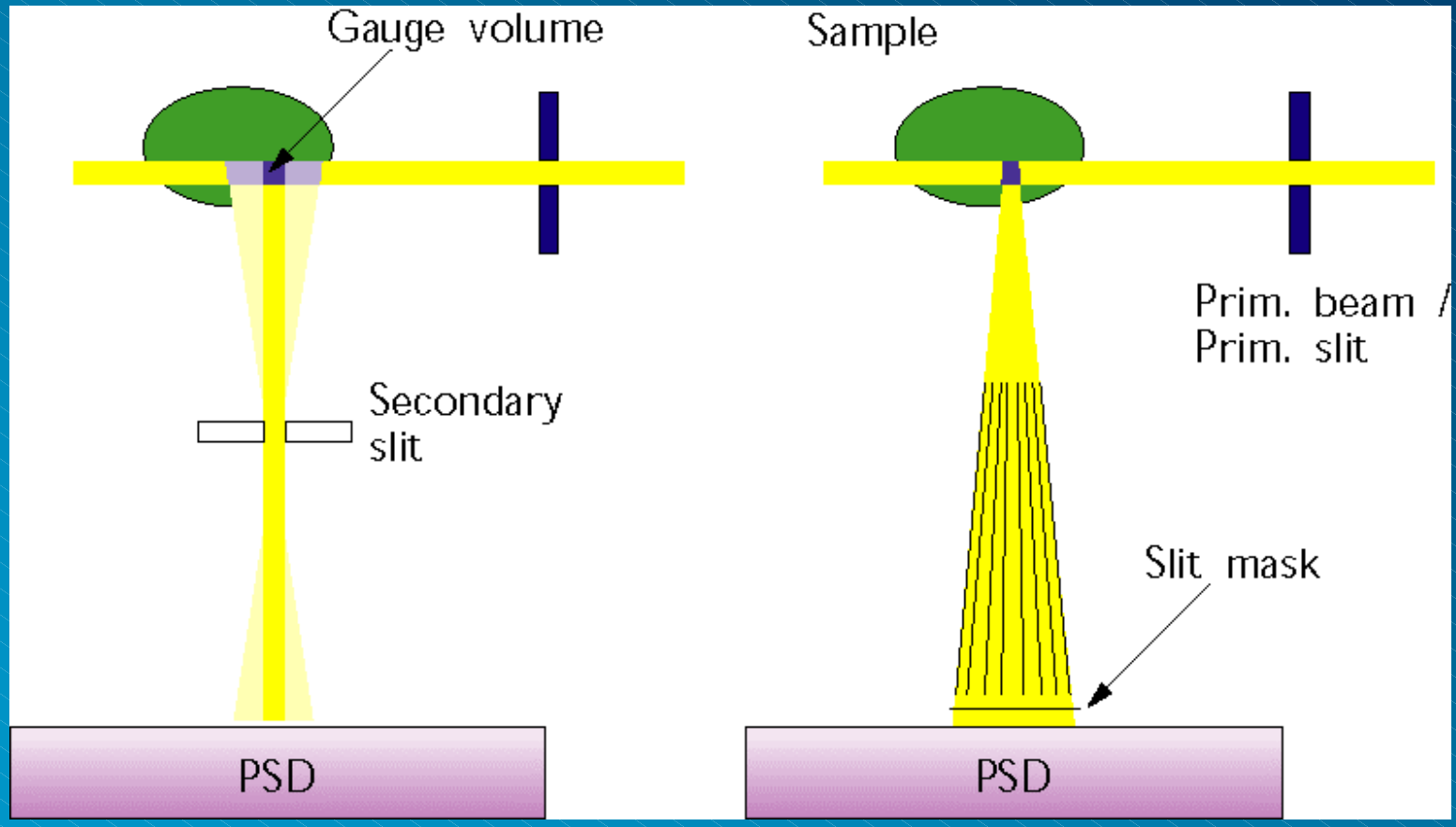

A large convergent collimator is used with the 2D microstrip detector

Note the very small sampling volume with this setup (right)

Neutron Strain Scanner

80x80 mm 2D Microstrip Detector on D1A

Thilo Pirling, Robert Wimpory

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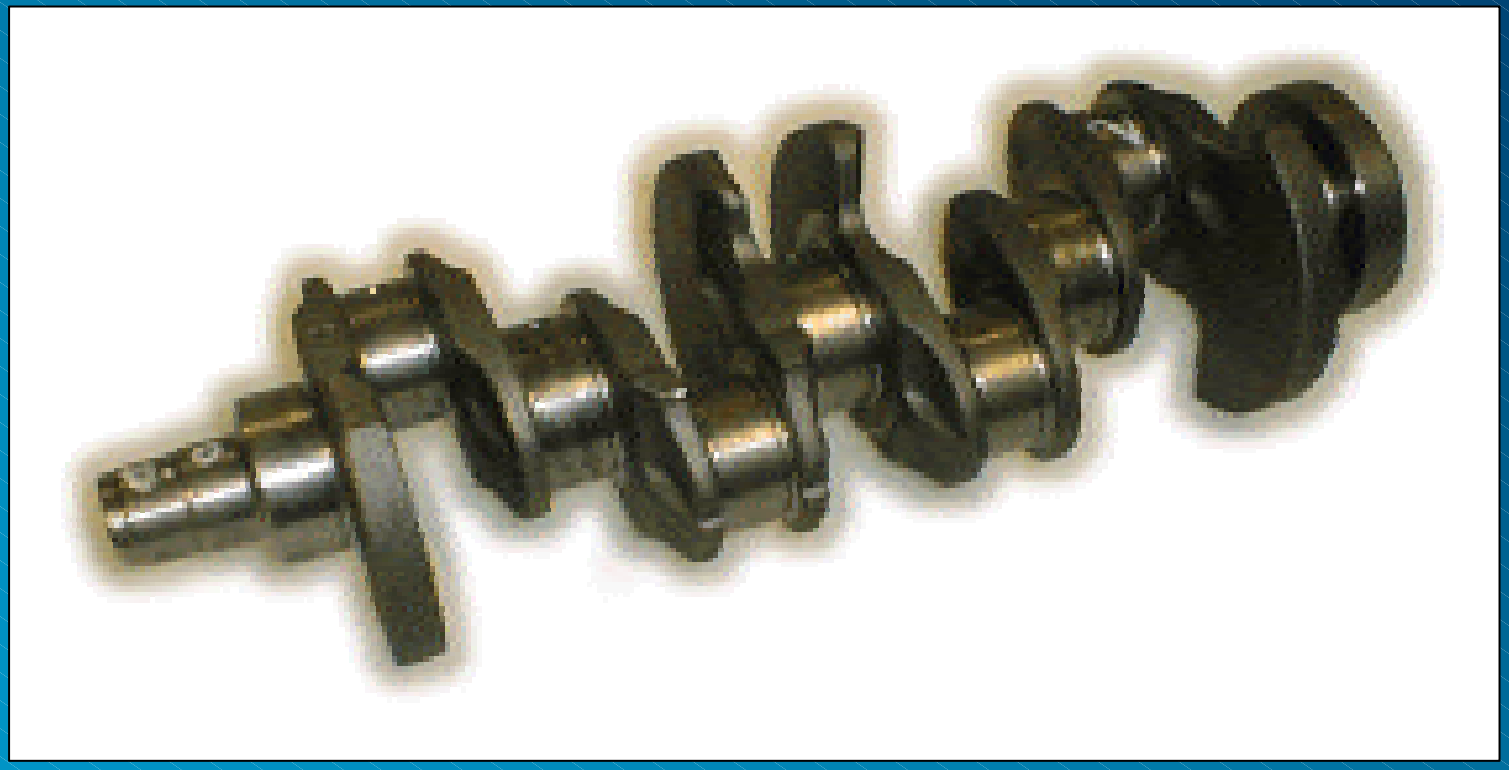

The stress distribution in critical regions of this experimental crankshaft from Volkswagen was determined on the strain scanner at ILL.

ILL is part of the EU-RESTAND project with Volkswagen, Rolls-Royce, Airbus etc

A New ILL-EPSRC Strain Scanner

EPSRC grant of ~ 1M Pounds Sterling

Philip Withers (Manchester) et al., Thilo Pirling (ILL)

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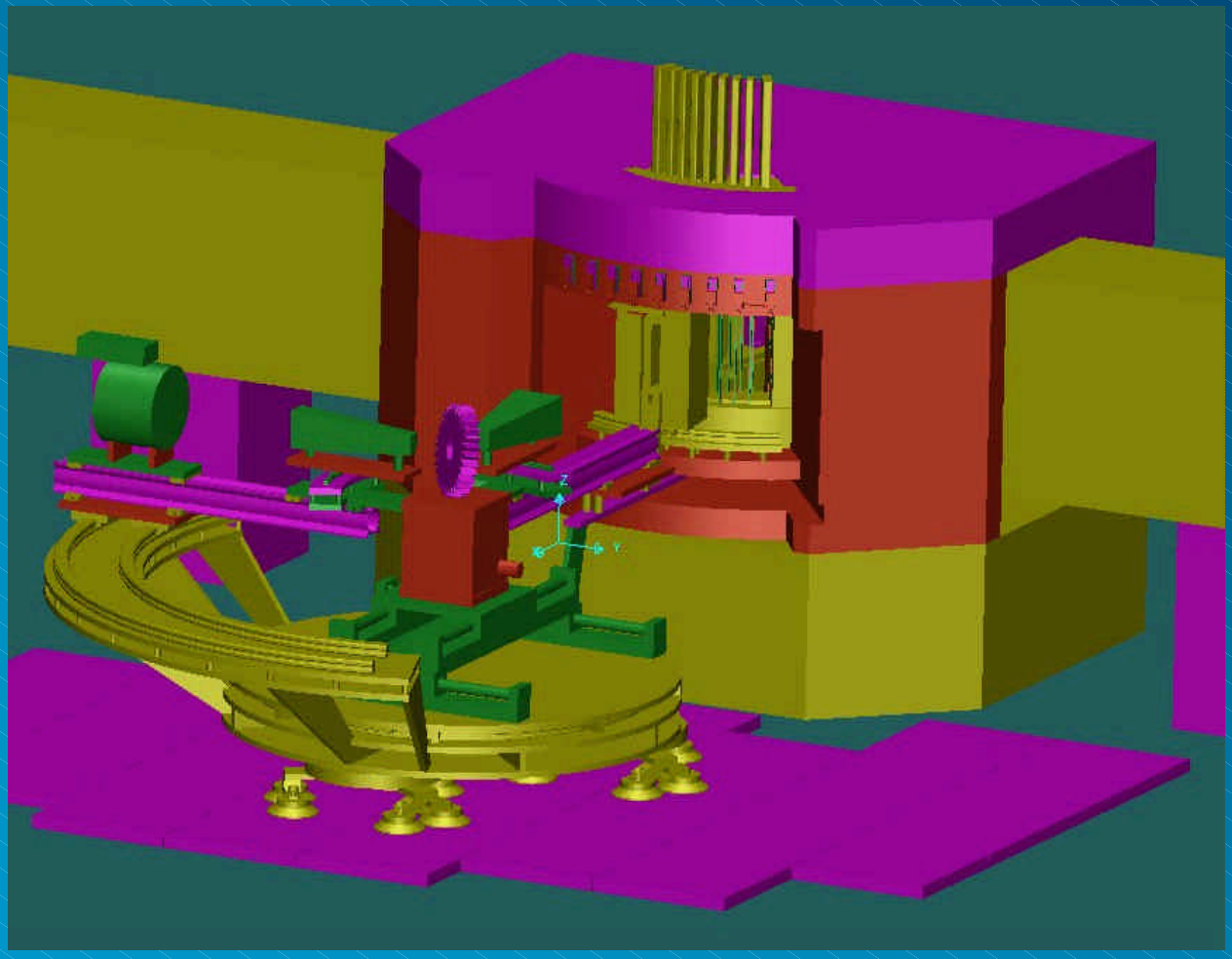

Artists impression of the new ILL-EPSRC strain scanner behind D1A/D1B

An Array of 2D Microstrip Detectors

D19 Fibre & Protein Diffractometer

Sax Mason, Trevor Forsyth, John Archer, Michael Walsh

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200x200 mm 2D microstrip detector for D19 fibre & protein diffractometer

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An Array of 2D Microstrip Detectors

D19 Fibre & Protein Diffractometer

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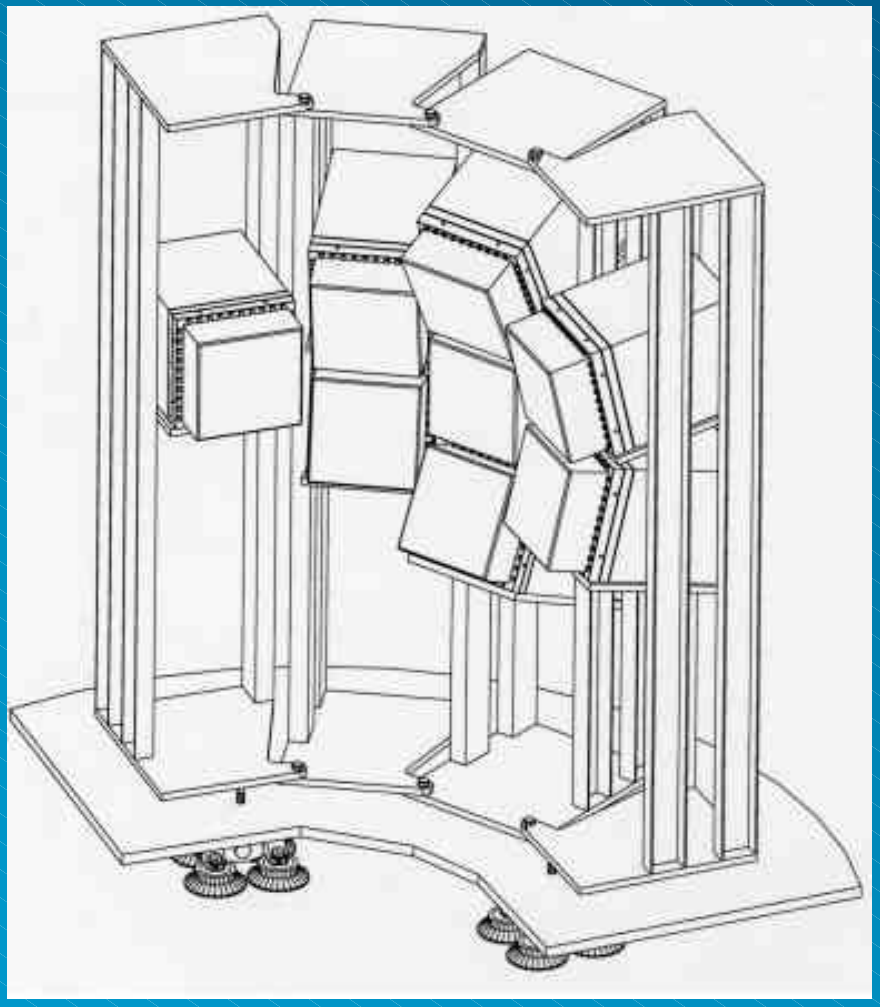
Sax Mason, Trevor Forsyth, John Archer, Michael Walsh



9 Independent 2D microstrip detectors

- 15 year old D19 detector covers only a thin 2D strip
- Replace with an array of high resolution 2D modules
- Increase efficiency x20
- Fibre Diffraction
  Small protein structures
  In-situ hydration studies.

Water in B-DNA sheets on D19

Shotton, Pope, Forsyth, Archer, Denny, Langan, Ye, Boote, (1998)
*J. Appl. Cryst.*31, 758

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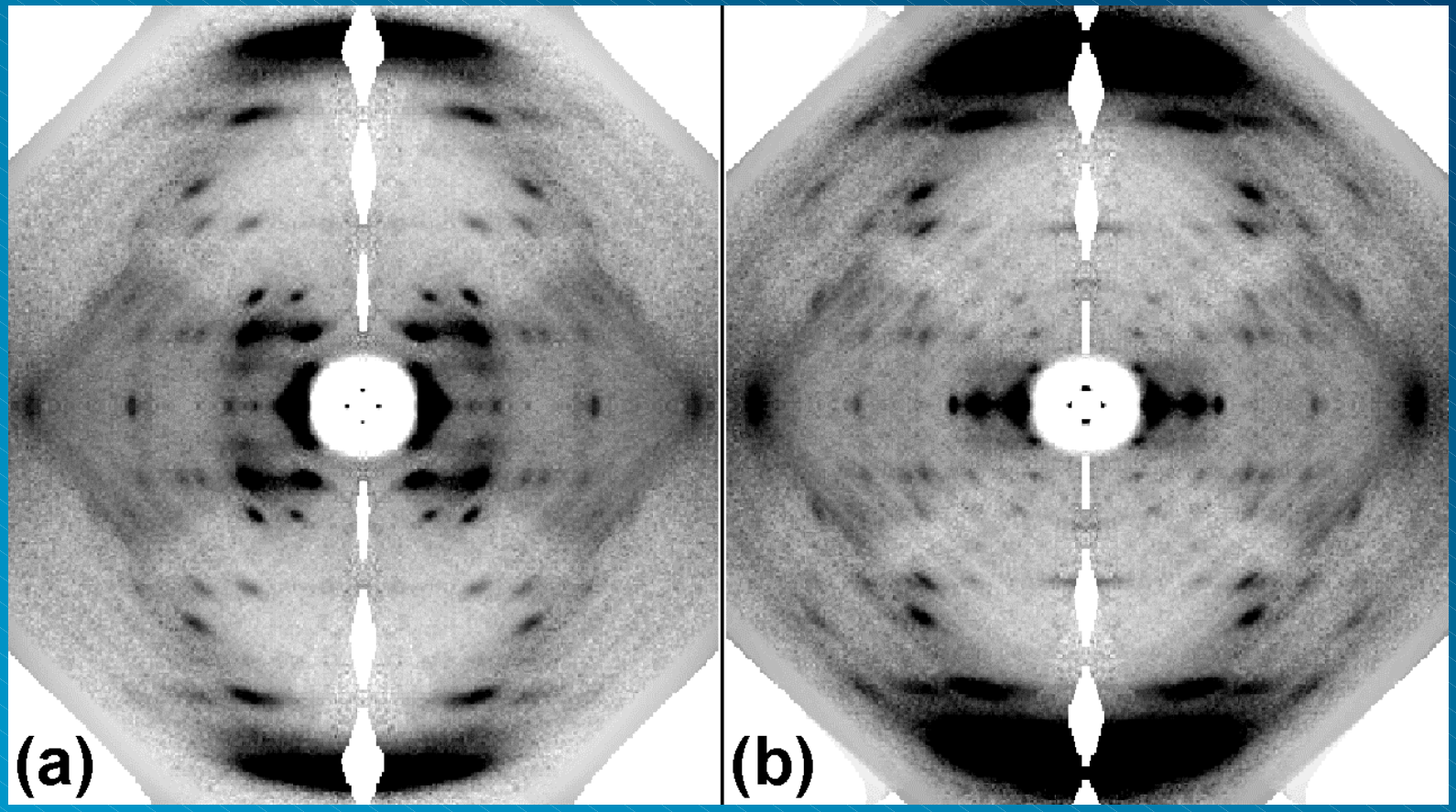

(a) with H_2O (b) with D_2O

Water in A-DNA Fibres on D19

Shotton et al, (1998) Biophys. Chem., 69, 8.
Pope et al, (1998) Physica B241, 1156.

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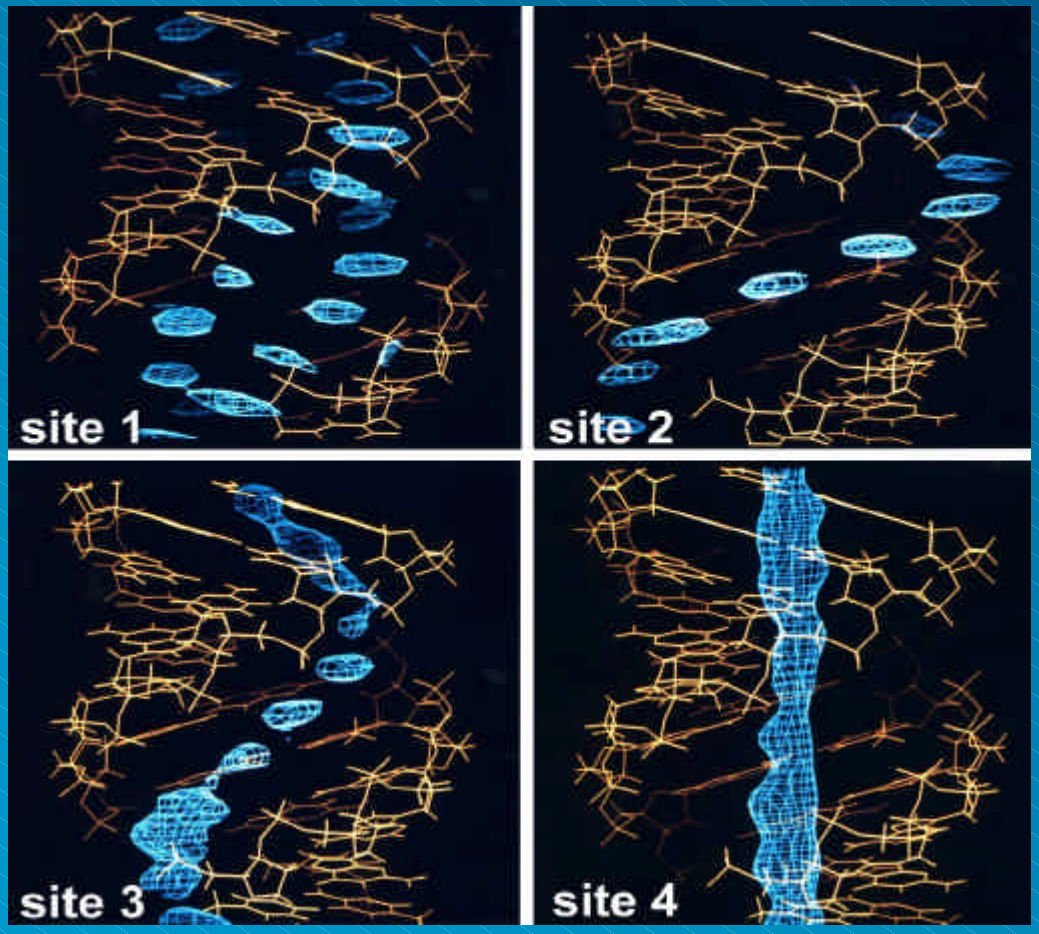

- B-DNA sheets, but A-DNA fibres
- 100 individual DNA fibres in D_2O
- Diffuse fibre diffraction patterns from D19 used to locate water
- 4 distinct water sites located along double helix backbone

1) Bridging phosphate groups
2) Center of opening of major groove
3) Deep inside the major groove
4) Disordered string along helix axis

Why can't we do it with X-rays ?

Density of water in co-enzyme B12

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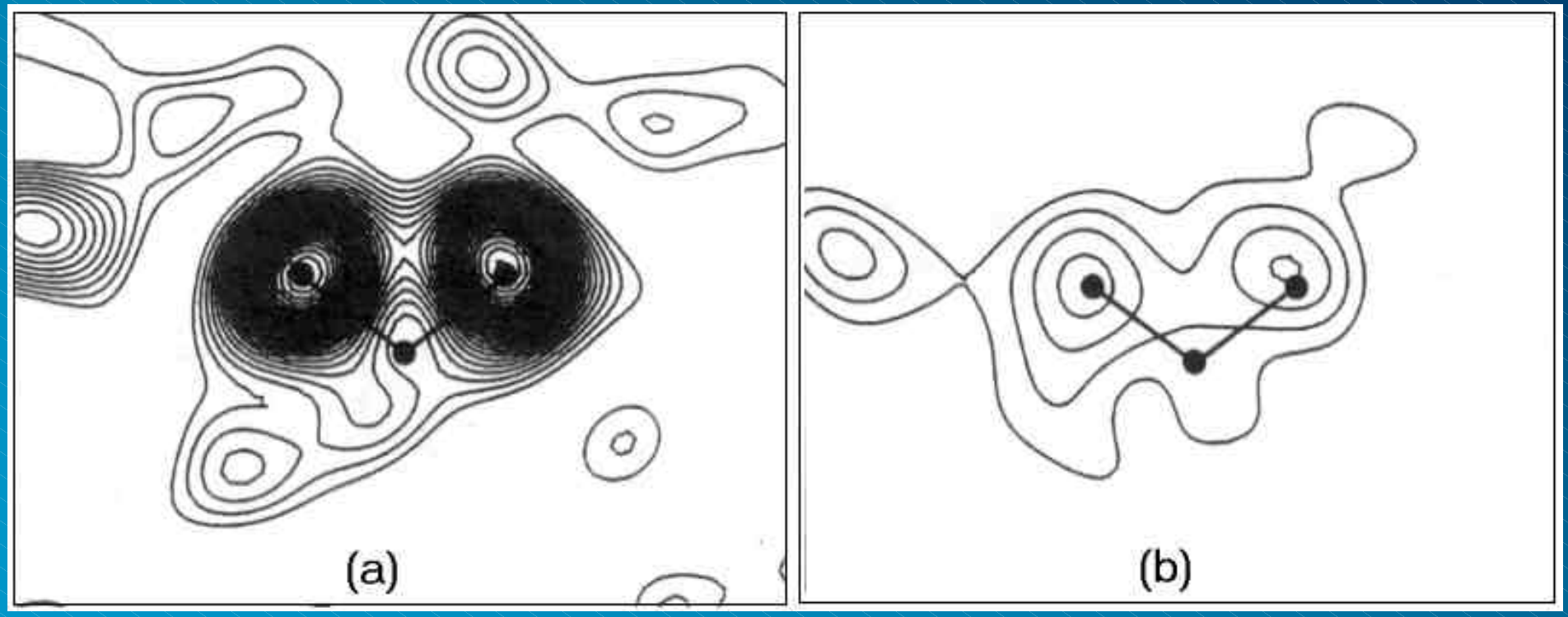
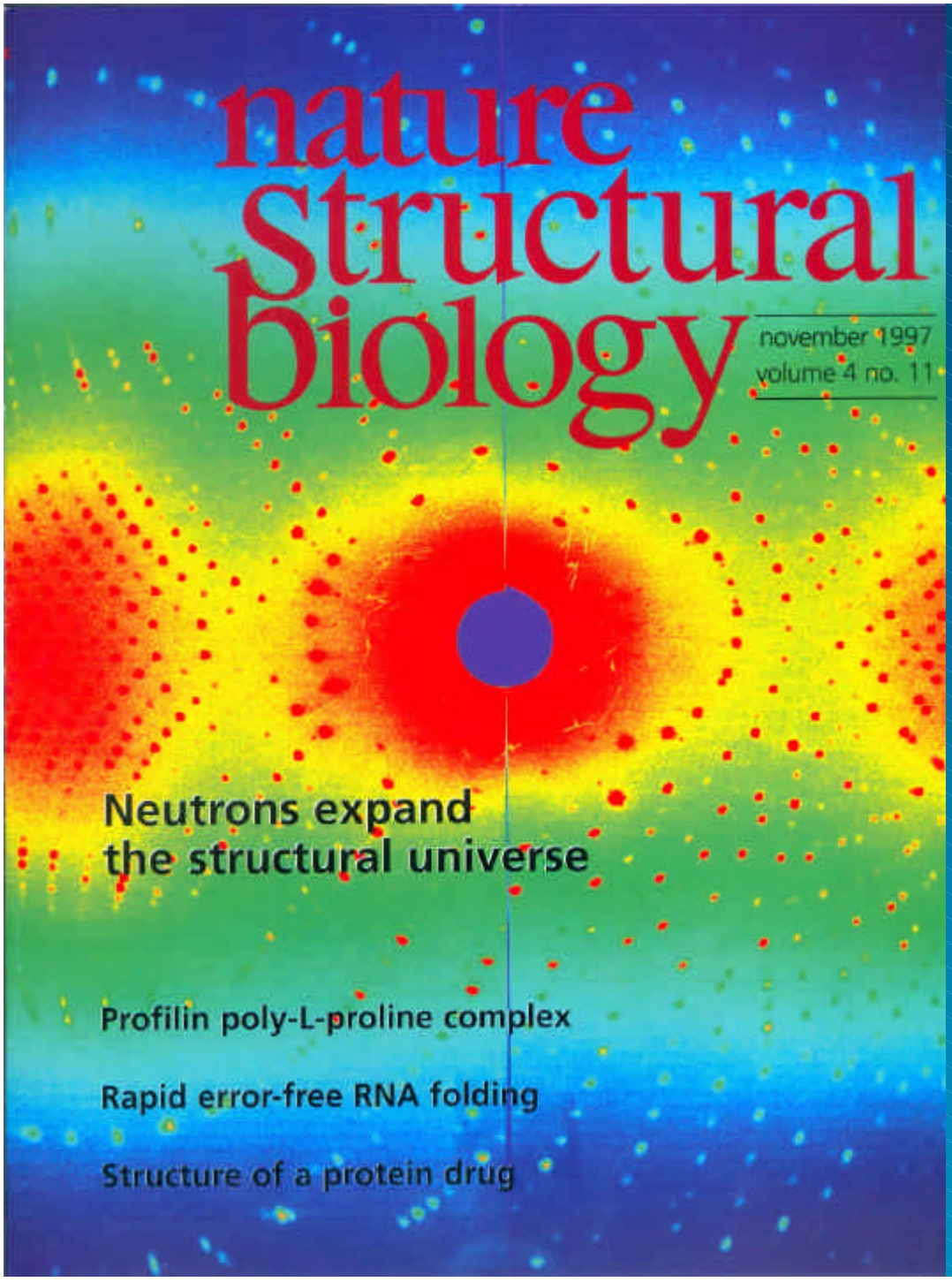
Langan, Lehmann, Wilkinson, Jogl, Kratky (1999) Acta Cryst D55, 51



D19 Neutron data

Synchrotron data



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Microstrip Detectors vs Neutron Image Plates

Nature (1997) Cover showing LADI data

(LAue Diffractometer with Image plates)

T-LADI Laue Neutron Image Plate for physics and chemistry

Dean Myles, Clive Wilkinson, Garry McIntyre

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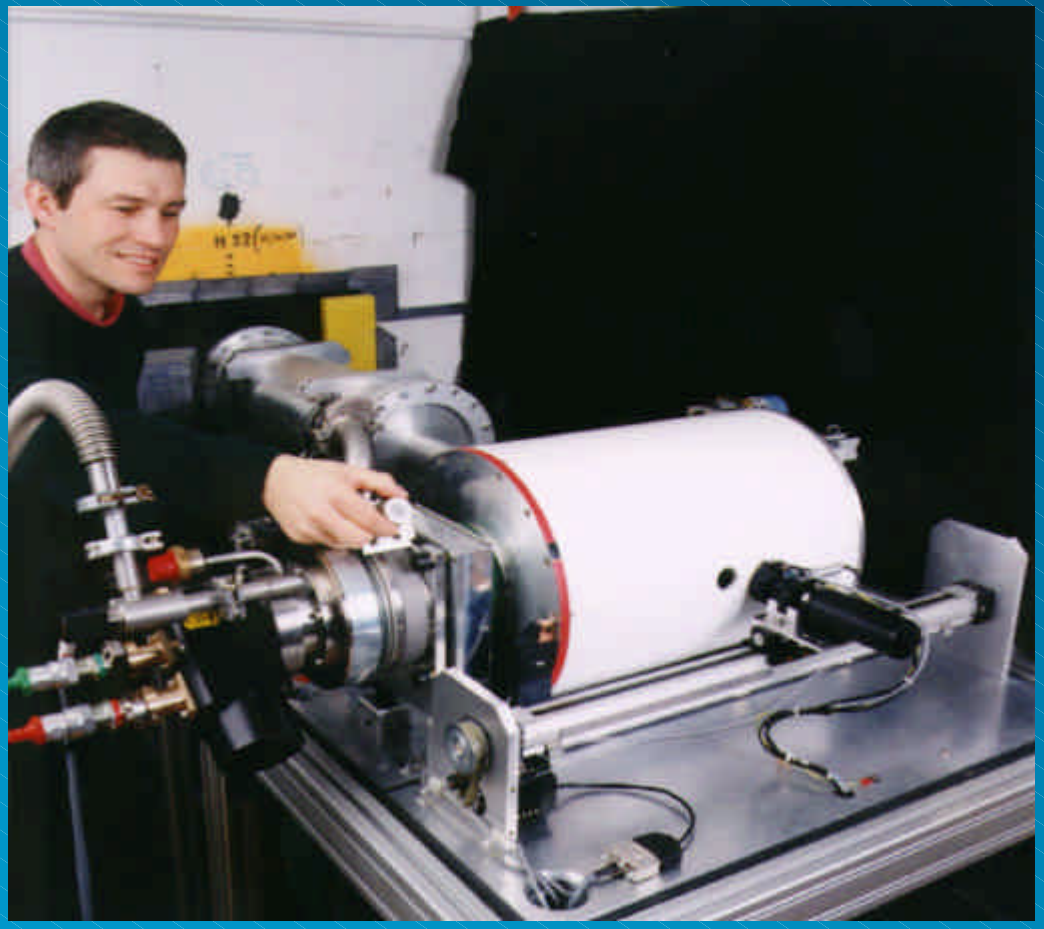
Diffraction Group



- Thermal neutron guide
- Band of neutron energies
- View reciprocal space
- In-situ laser readout
- Unique survey of P/T
- Phase T/Ns, superstruct.

Dean Myles with LADI and cryo-refrigerator on thermal guide H22

A. Hewat, China Nov/Dec 2000

T-LADI Neutron Image Plate for physics and chemistry

Dean Myles, Clive Wilkinson, Garry McIntyre

ILL Grenoble

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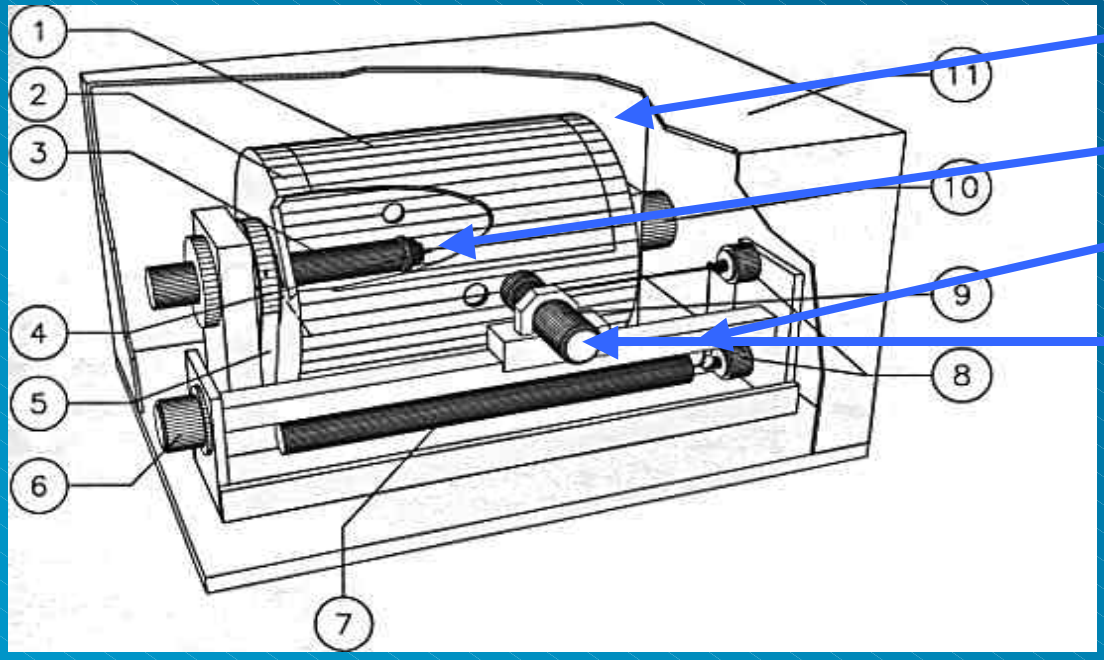

1. Image plate on rotating drum

3. Sample holder

7. He-Ne laser

9. Reader head, photomultiplier

Phonograph readout time 4 min.
4000x2000 pixels of 200 mm

Original LADI (used for biological structures) adapted for materials research

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T-LADI Neutron Image Plate Superstructure in $La_2Co_{1.7}$

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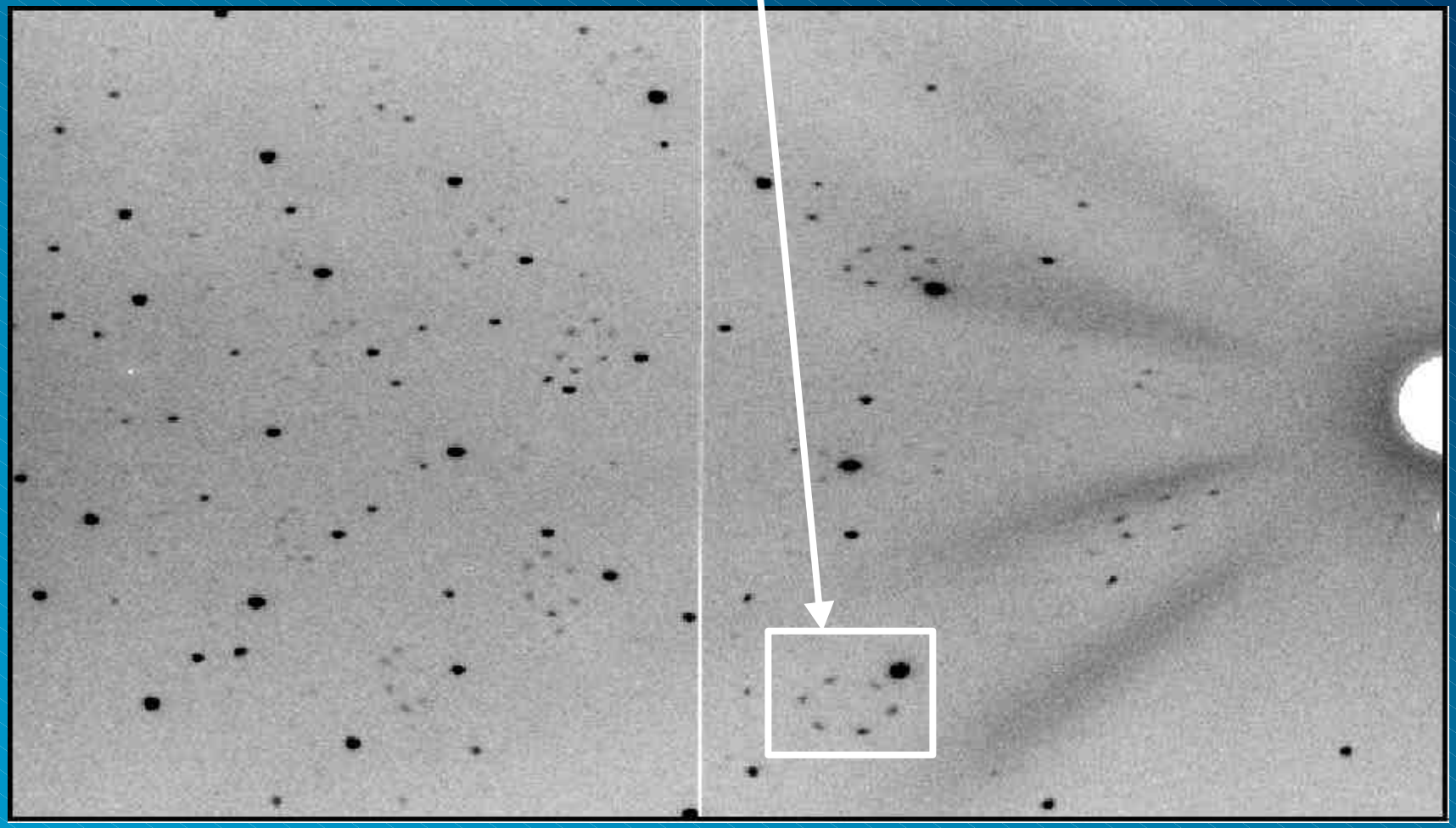

$La_2Co_{1.7}$ on T-LADI showing incommensurable superstructure

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T-LADI Neutron Image Plate Superstructure in $La_2Co_{1.7}$

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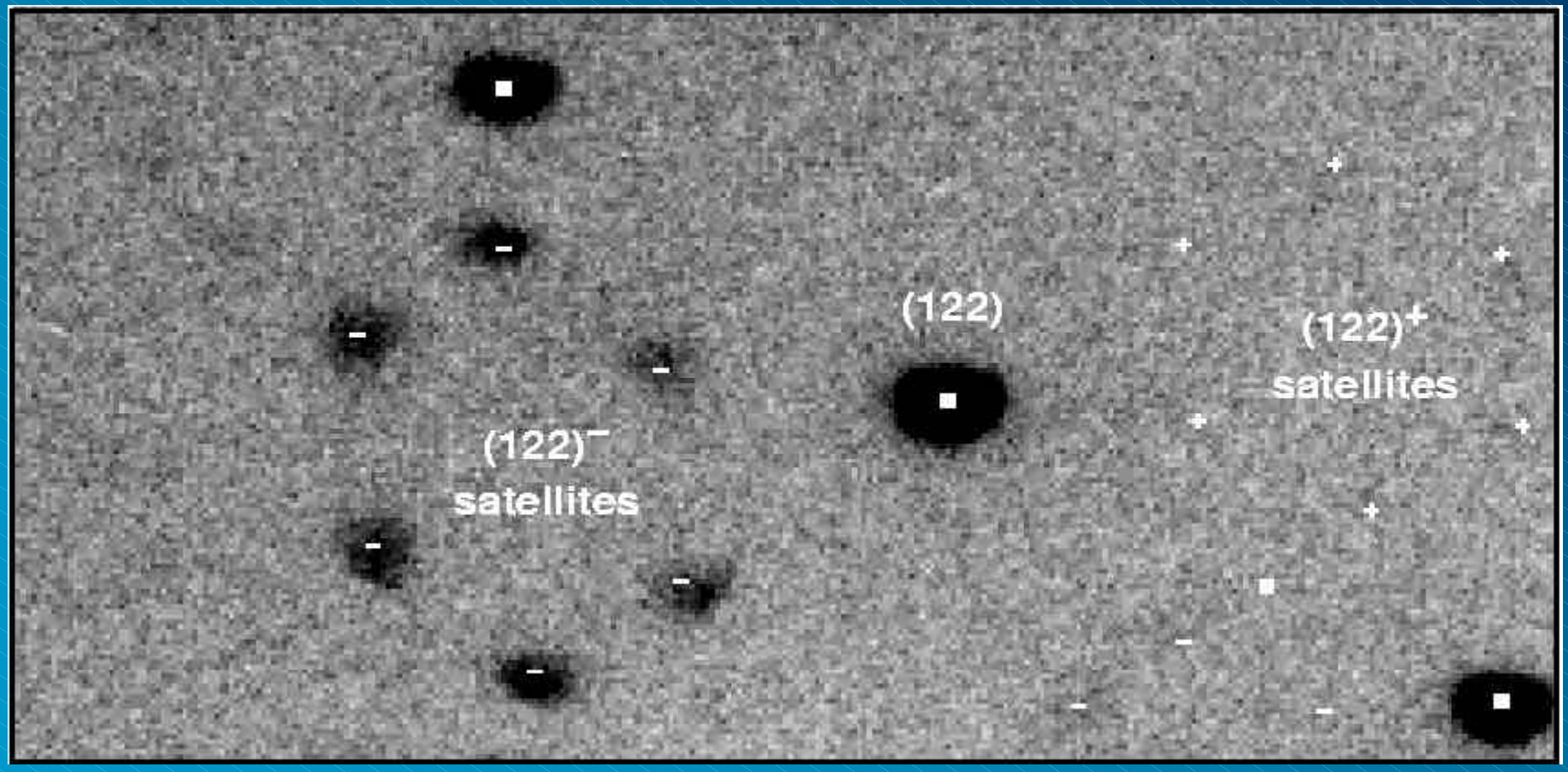
- 6-domain ring of $(122)^-$ superstructure



$La_2Co_{1.7}$ on T-LADI showing incommensurable superstructure

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T-LADI Neutron Image Plate
5-fold symmetry of quasi-crystal

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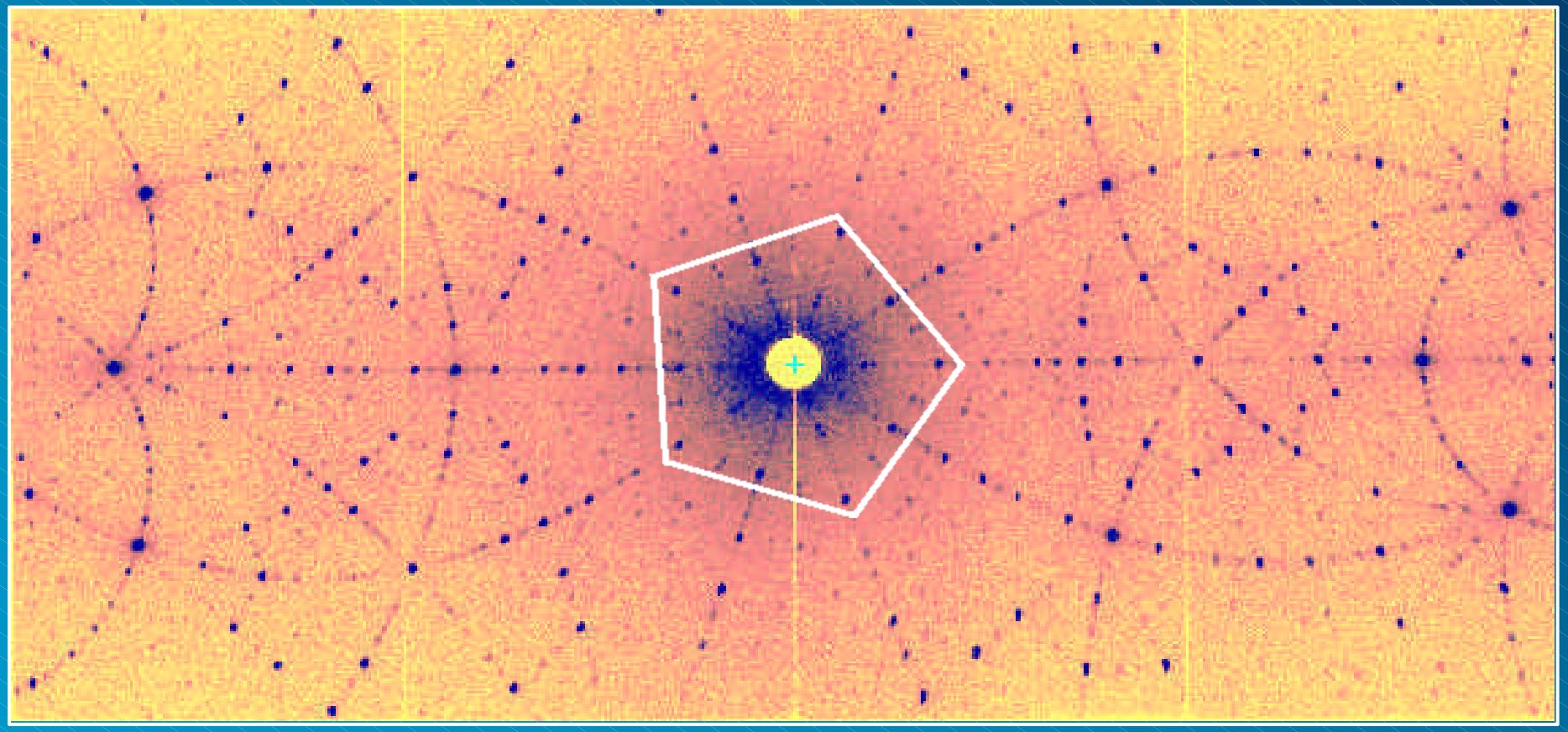
5-fold symmetry axis in ZnMgY quasi-crystal - De Boissieu et al. (1999)



T-LADI neutron image plate photo courtesy of G. McIntyre, Oct 1999

T-LADI Neutron Image Plate
5-fold symmetry of quasi-crystal

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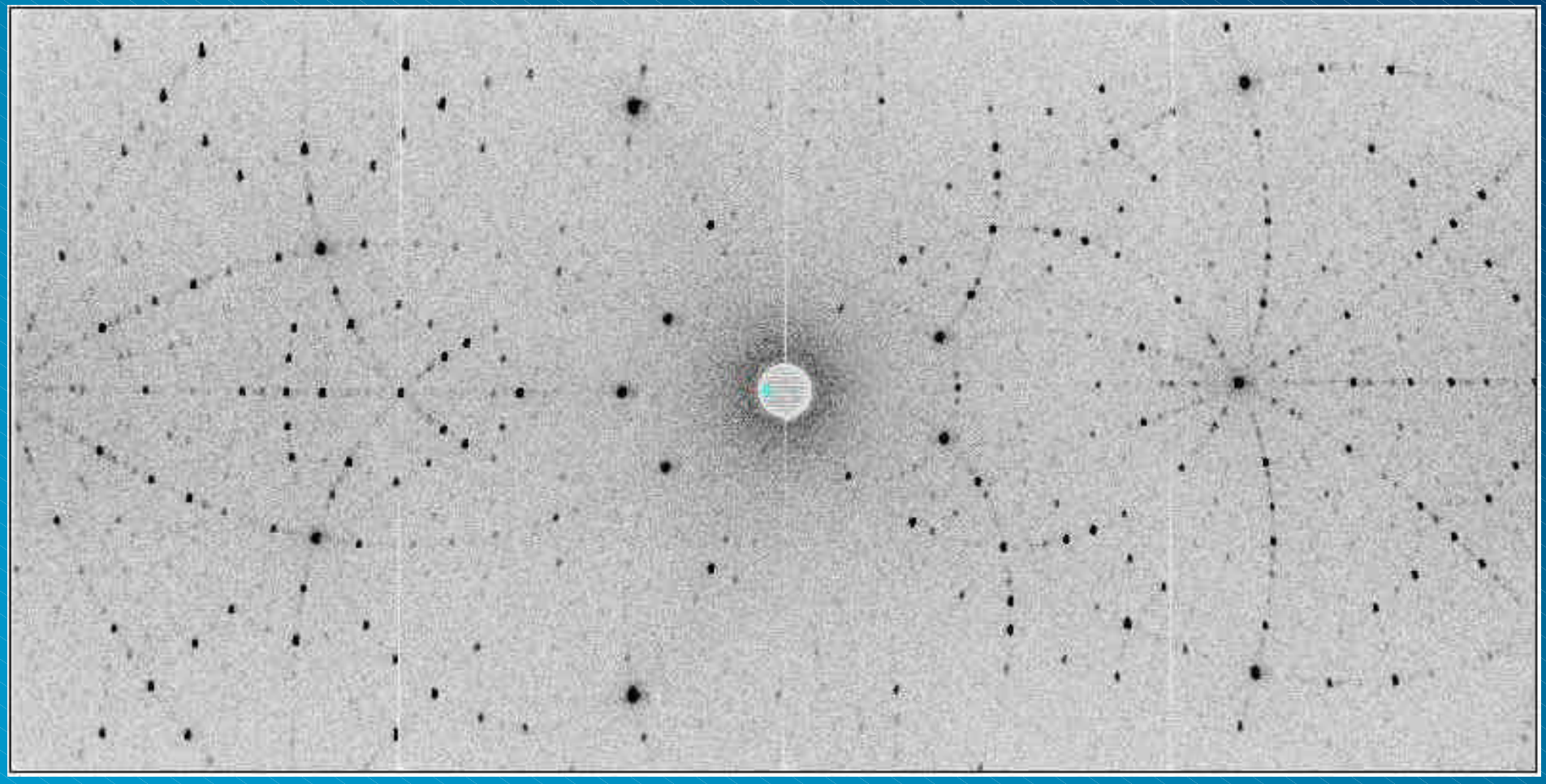
Rocking the ZnMgY quasi-crystal (Dynamics) – McIntyre, Cowan (1999)



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T-LADI Neutron Image Plate
Why Image-plates + Microstrips ?

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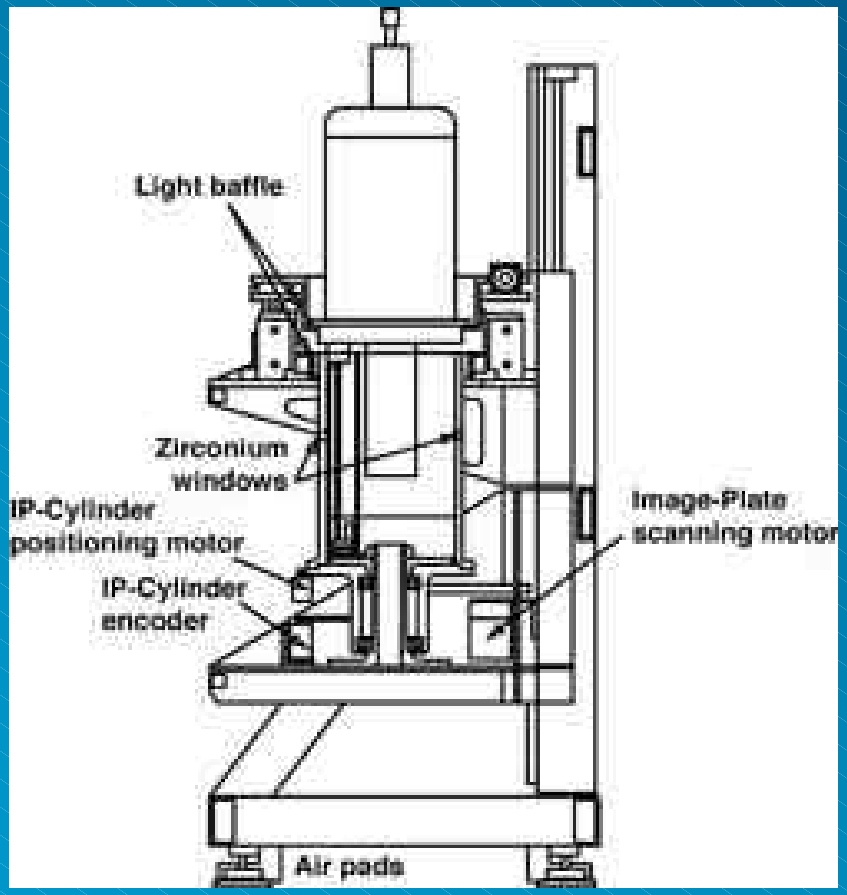

Disadvantages of Image-plates

- Photographic technique
- Accumulate background
- Background from all λ (wide $\Delta\lambda$)
- H-background

For X-rays, photographic techniques are now replaced by electronic PSD's

New T-LADI uses thermal neutrons, more efficient interior read-out optics, vertical geometry allowing use of cryostats, furnaces, magnets, pressure cells

Polarized Neutrons & He^3 Filters

Francis Tasset, Eddy Lelievre, Adrin Hiller, Trefor Roberts

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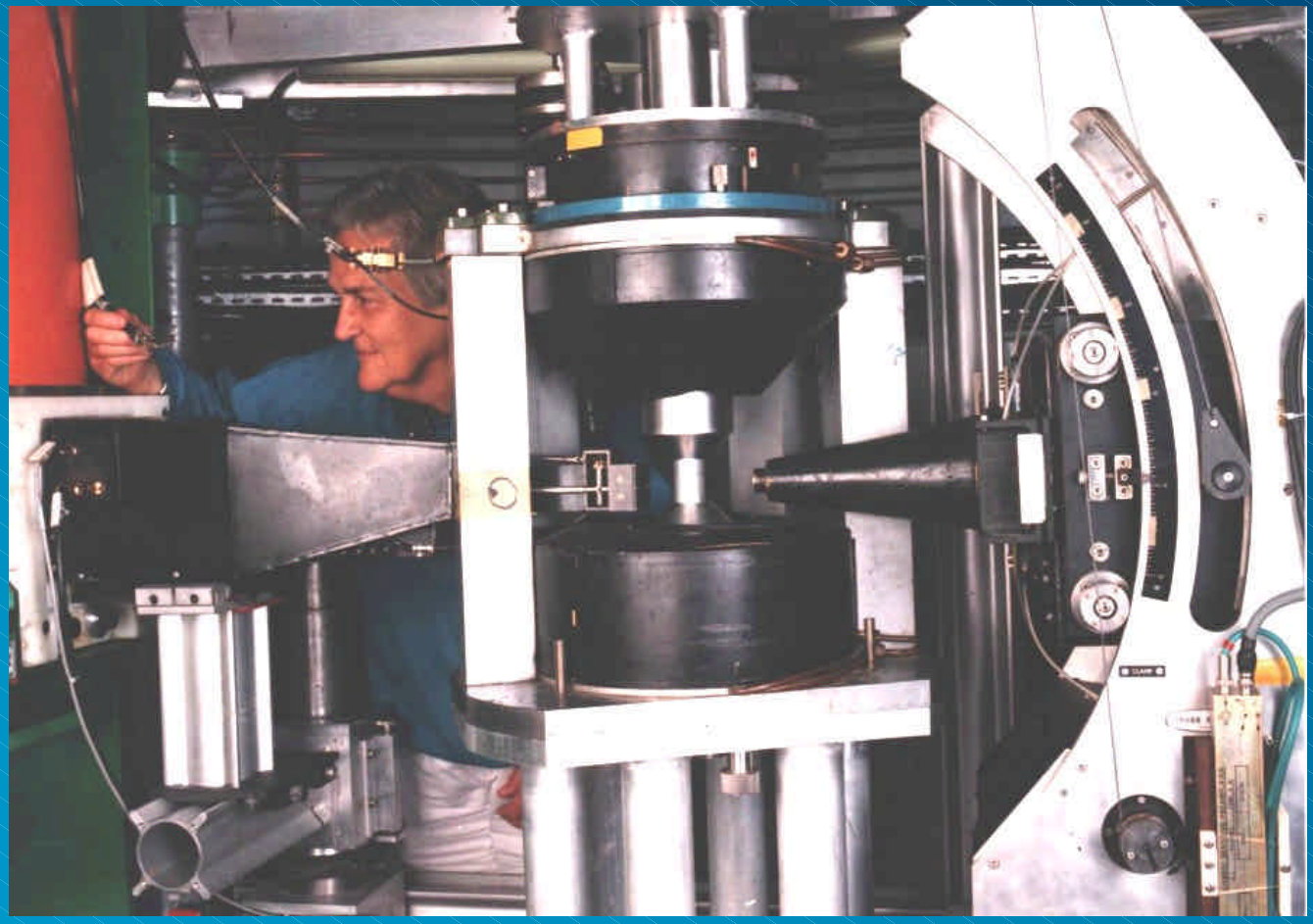

Jane Brown with magnet on D3

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Polarized Neutrons & He^3 Filters

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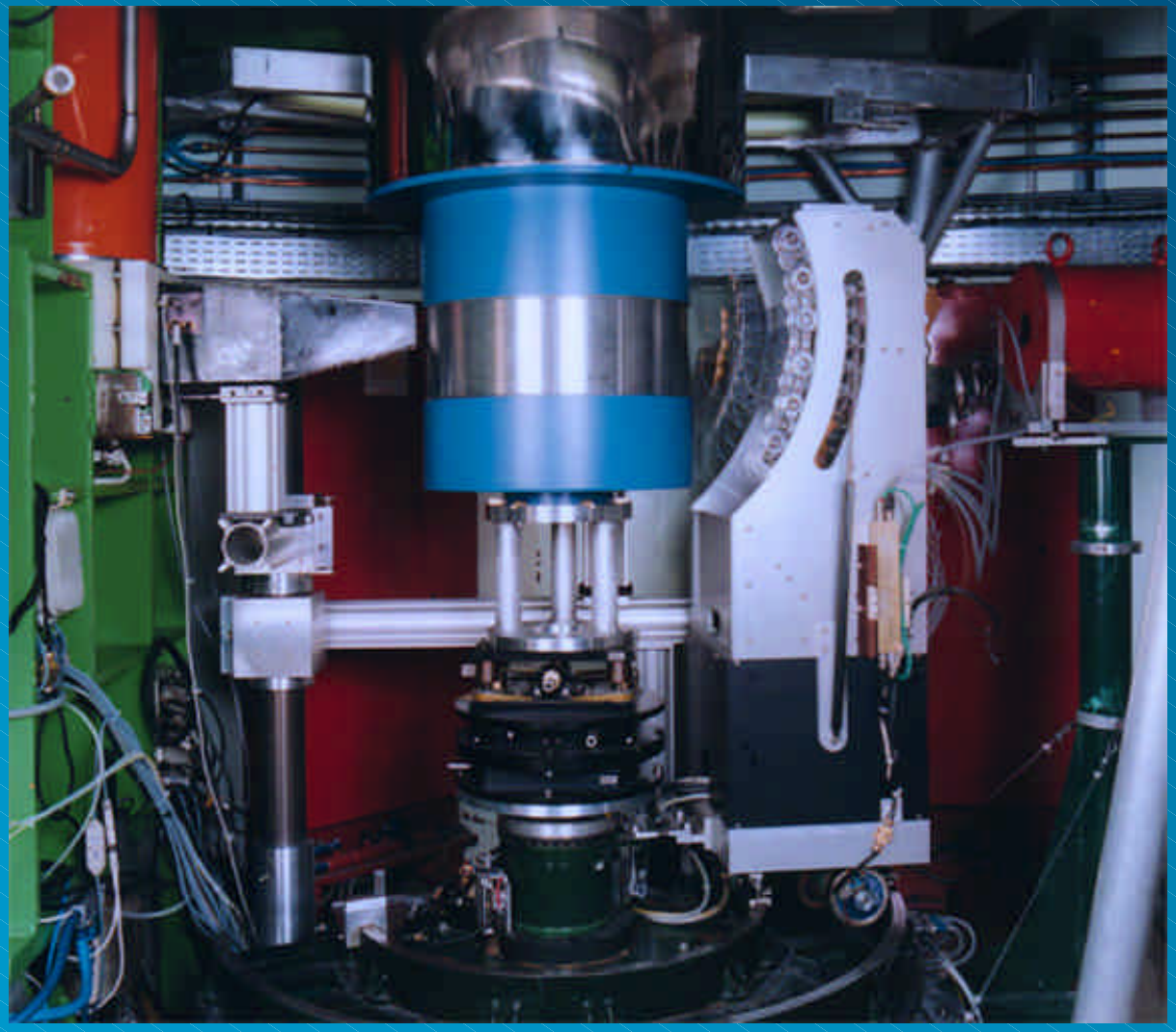

New 10 Tesla cryo-magnet with lifting counter on D3

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D3 Polarized Neutron Diffractometer

Francis Tasset, Eddy Lelievre, Adrin Hiller, Trefor Roberts

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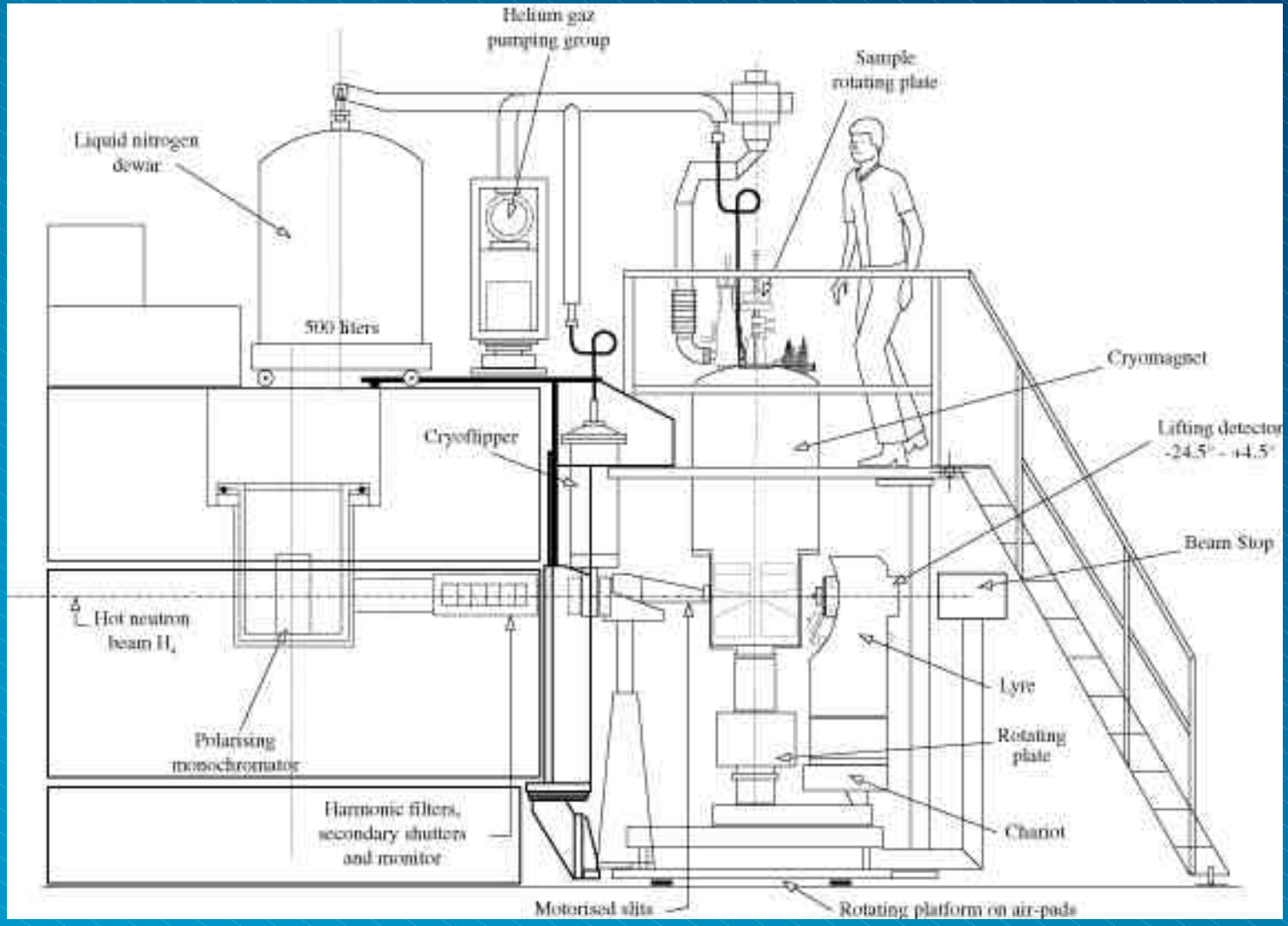

Polarized Neutrons & He3 Filters

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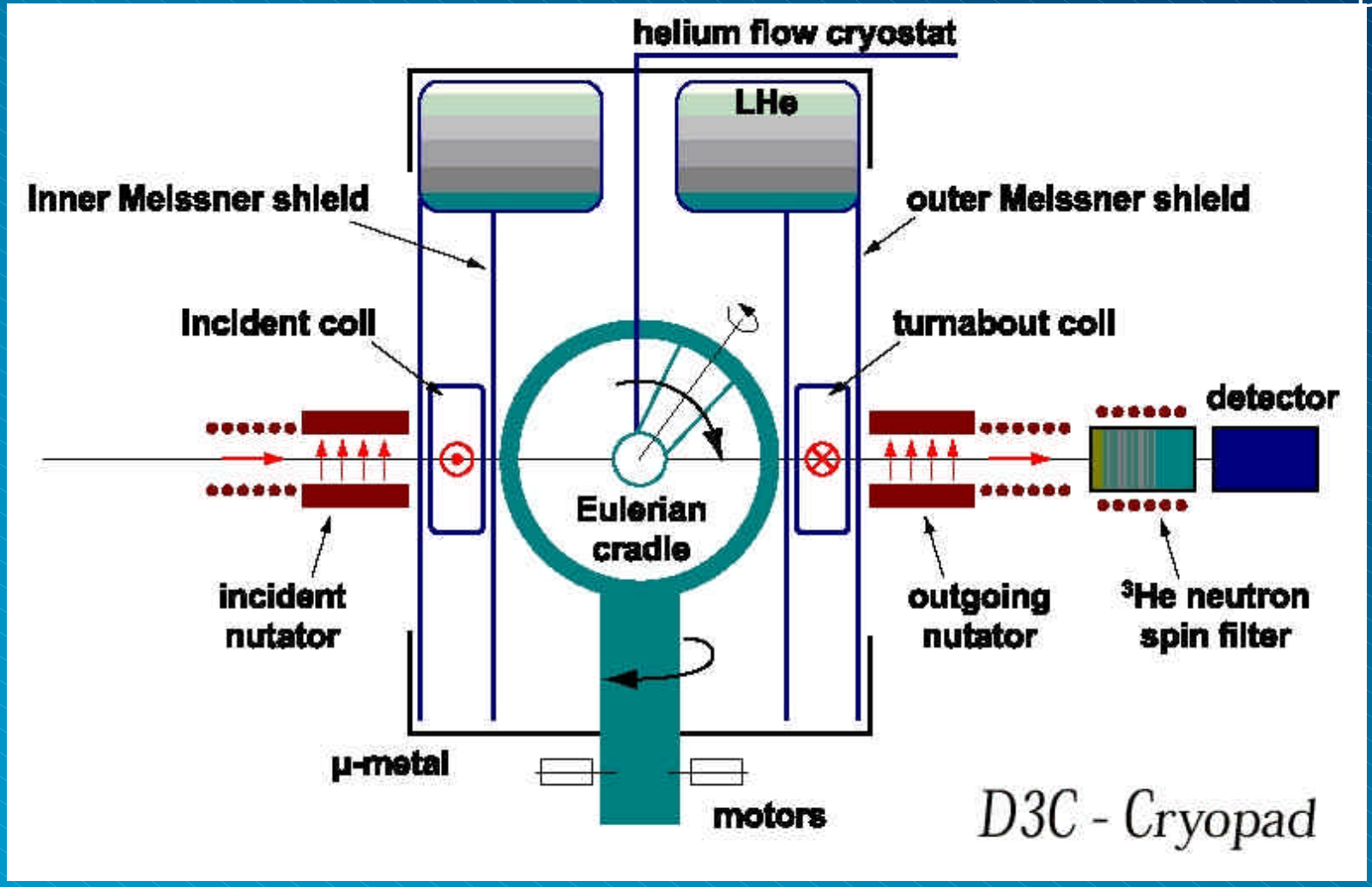

Proposed new cryopad setup on D3C

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