The ILL Diffraction Group

www.ill.fr/dif/

- Largest of the 5 instrument groups at ILL
- 10 permanent staff scientists
- Total of ~30 scientists, students and technicians
- Building 3 of the first 5 new “Millennium” projects
- 2 more Millennium projects in the second tranche.

The Millennium Programme at ILL -> New Neutron Detectors

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New or Improved 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

The Millennium Programme at ILL -> New Neutron Detectors

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Other Existing Diffraction Group Instruments:

- D1a – first high resolution powder diffractometer
- D1b – first high flux position sensitive detector (CNRS-CRG)
- D9 - first hot source, 4-circle machine (PSD, lifting detector)
- D10 – 4-circle, 3-axis diffractometer (Garry McIntyre et al.)
- D15 – 2-axis/4-circle diffractometer (CENG-CRG)
- D23 – new 2-axis polarised neutron machine (CENG-CRG)
- S42 – Laue camera for crystal alignment (Marmeggi)

The Millennium Programme at ILL
-> New Neutron Detectors

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Investment in reactors & other neutron sources is necessary,

but…

Investment in *detecting* more neutrons is very cost effective

and we need…

Microstrip detectors, neutron image plates, detector arrays…

Powder Diffractometers are Simple

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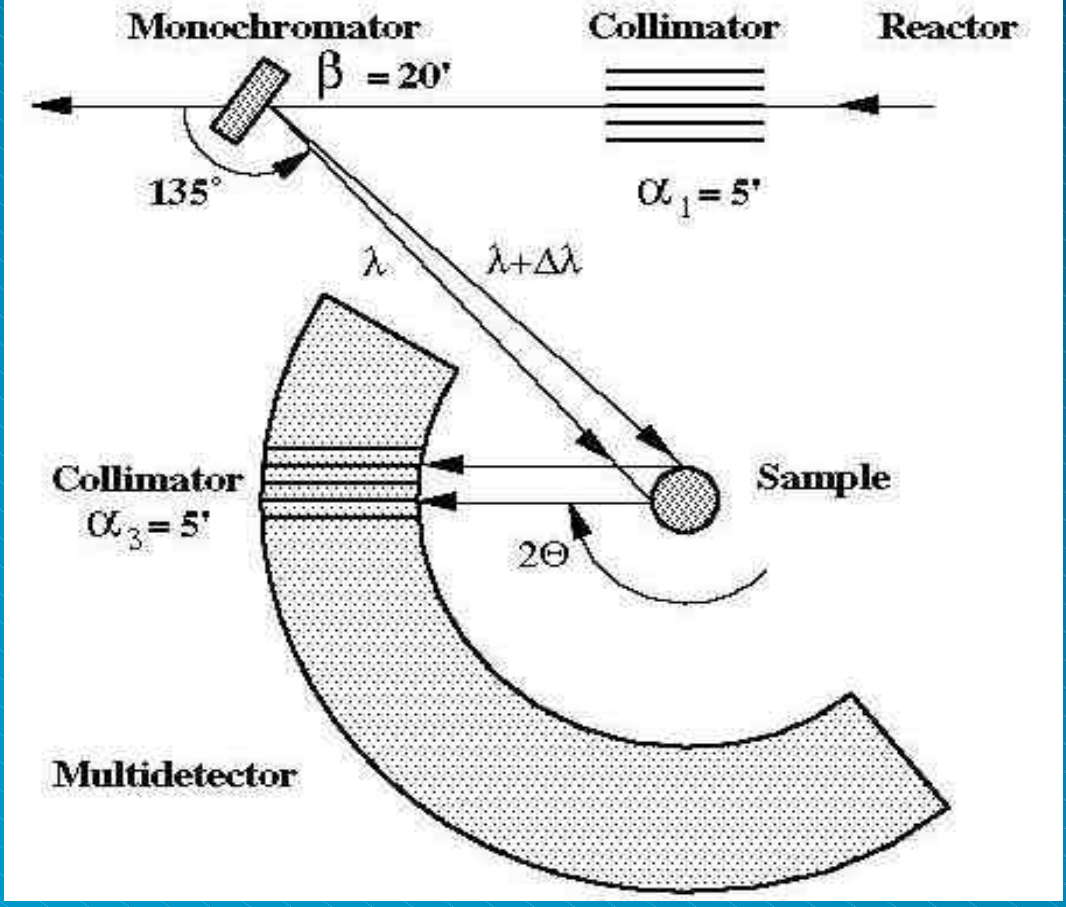

- A continuous neutron source
- Incident collimation
- A Monochromator
- The Sample & environment
- Scattering collimation
- A Detector

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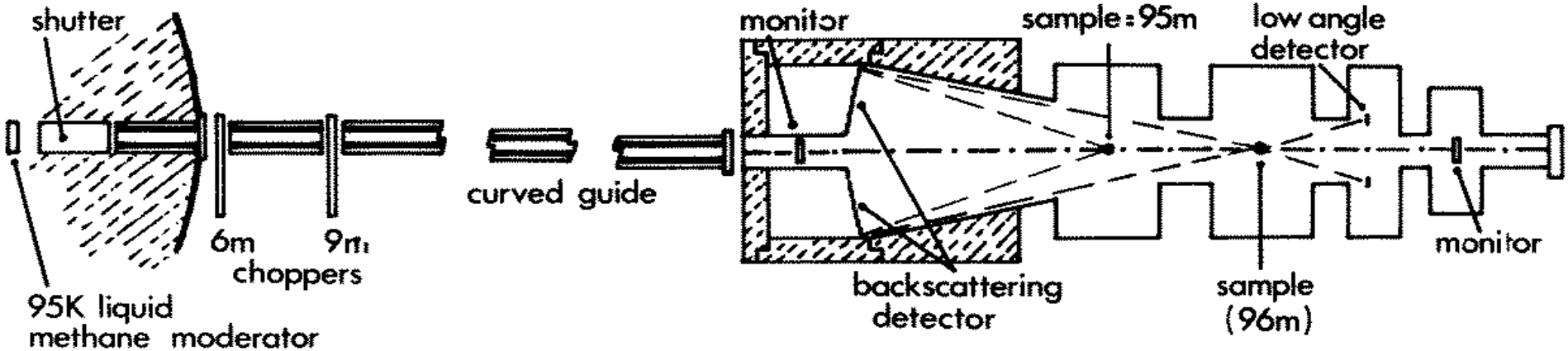
Alternative TOF techniques

- **Time-of-flight diffractometers (E.Steichele, Munich)**
  - **J. Jorgensen, Argonne (SEPD, GPPD)**
  - **B. Fender & A. Hewat, Rutherford Lab.**



- **HRPD ISIS (High Resolution Powder Diffractometer)**
  W. David et al.

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Early Days at ILL Grenoble (1972)

First ILL Powder Diffractometer D1a

- Small soller collimator
- Single detector
- Shared monochromator
- - High Resolution, BUT
  - Very Low Intensity

Early Days at ILL Grenoble (1974)

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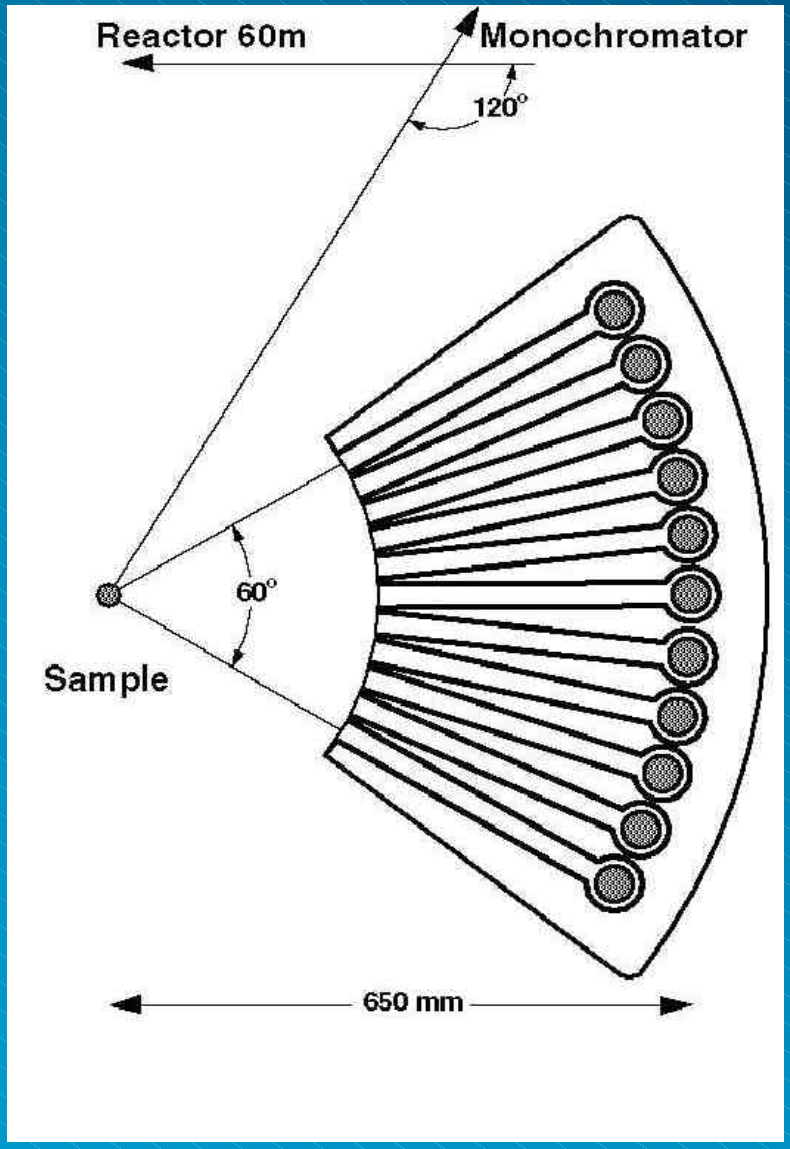

- Orders of Magnitude Improvement - D1A
  - Multiple detectors
  - Large efficient collimators
  - Focussing Monochromator

Early Days at ILL Grenoble (1974)

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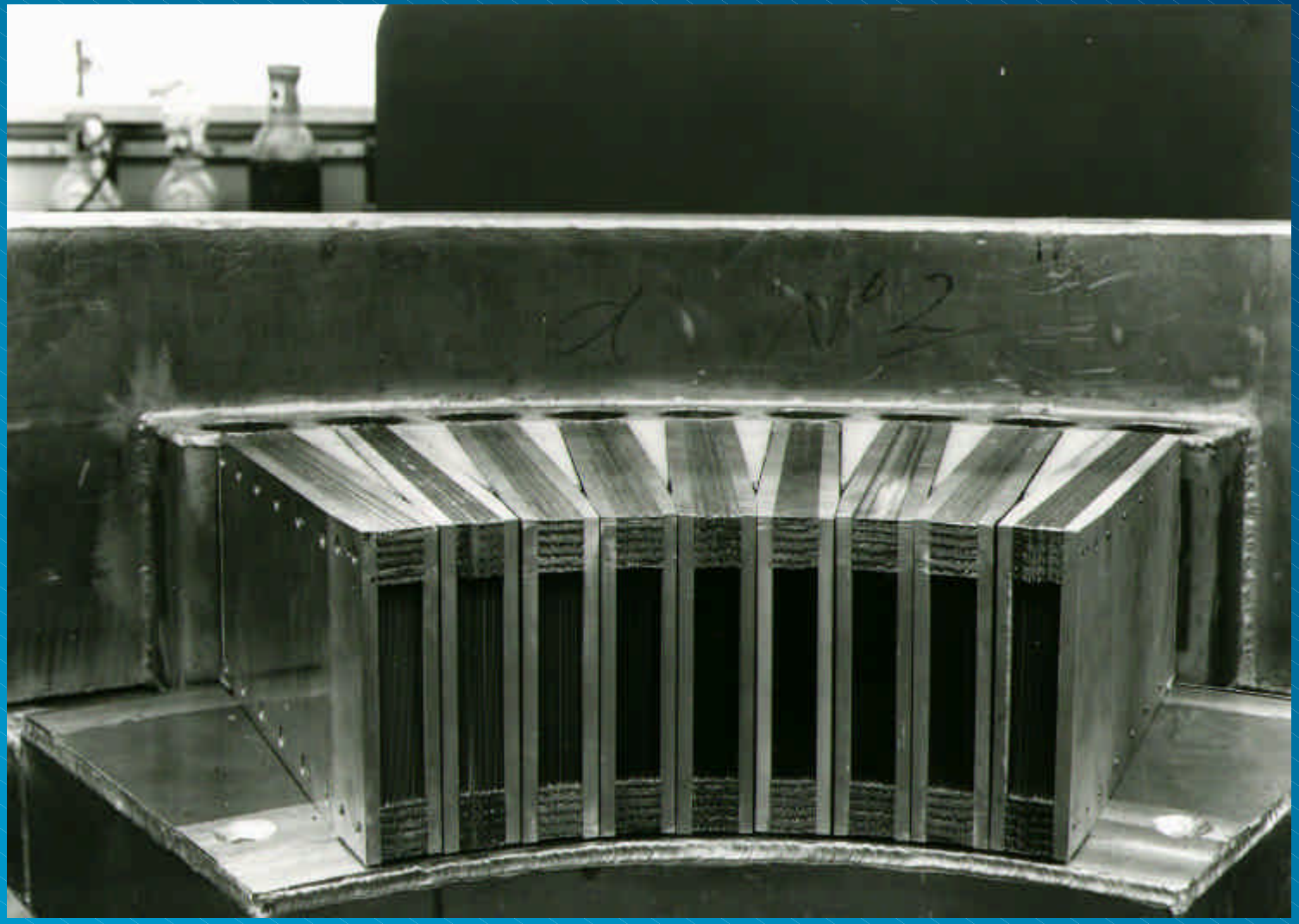

A. Hewat, China Nov/Dec 2000

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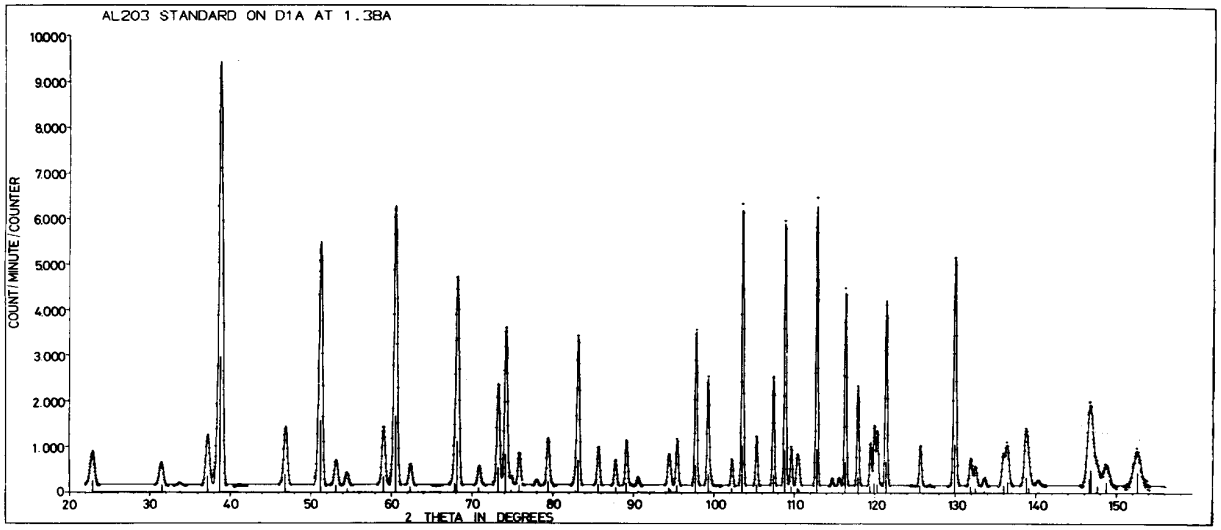
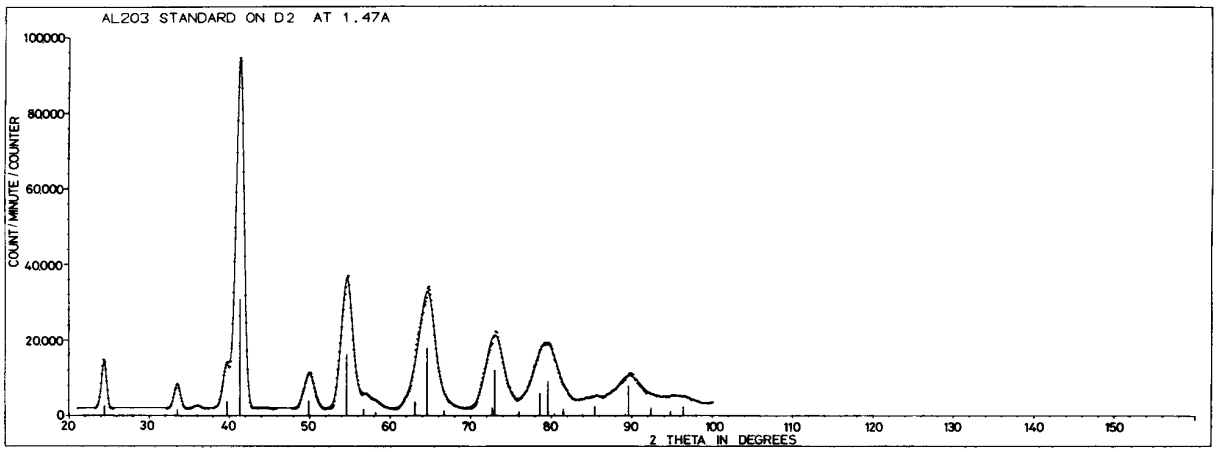
Comparison of D1A with D2 (1974)



(a)



(b)

- The same Al2O3 sample on D1A (top) and the old D2 at ILL.

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Second Generation Machines (1984)

High Resolution with Very Large Detector bank (D2B)

- 64 High Resolution Plastic Foil Collimators
- Large Composite Focusing Monochromator
- High Resolution
- Good Intensity

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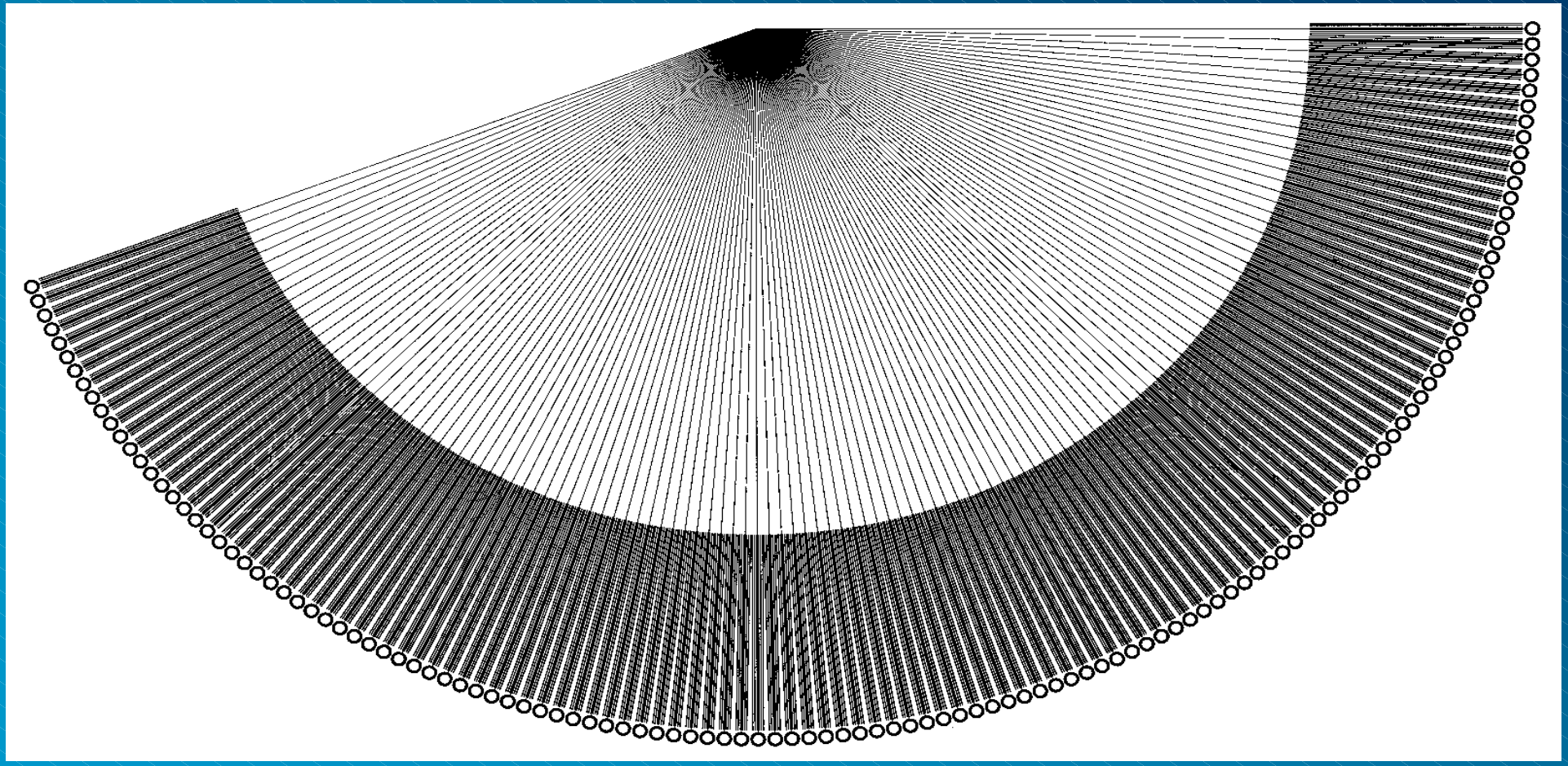
The Future - Big Detectors

Large pseudo-2D PSD (array of linear-wire detectors)



- 2D detector allows both high efficiency & high resolution

A. Hewat, China Nov/Dec 2000

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The Future - Big Detectors

Prototype super-D2B 5’ mylar foil collimator

300 mm high

15 mm wide

5 mm front side plates

New Munich Reactor FRM-II

SPODI Structure Powder Diffractometer cf super-D2B

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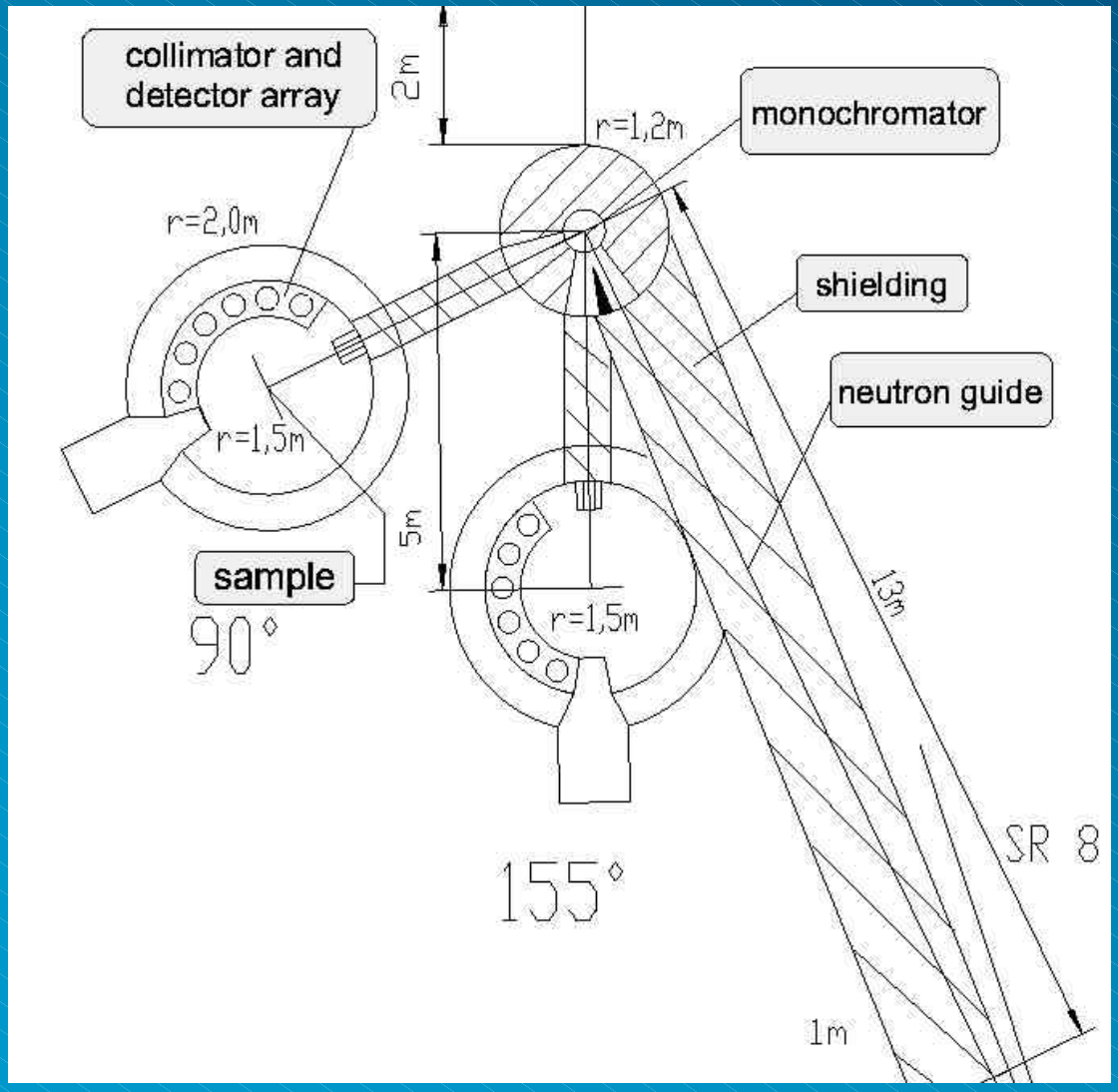

- Source distance 14.5m
  - Neutron supermirror guide
- Monochromator
  - Ge [551] vertical focus
  - Angle 90^0, 135^0, 155^0
  - Mosaic 20'
- 80 Mylar 10' collimators
- 80 He3 detectors
  - 300 cm high
  - Linear wire PSD
- cf ILL super-D2B project.

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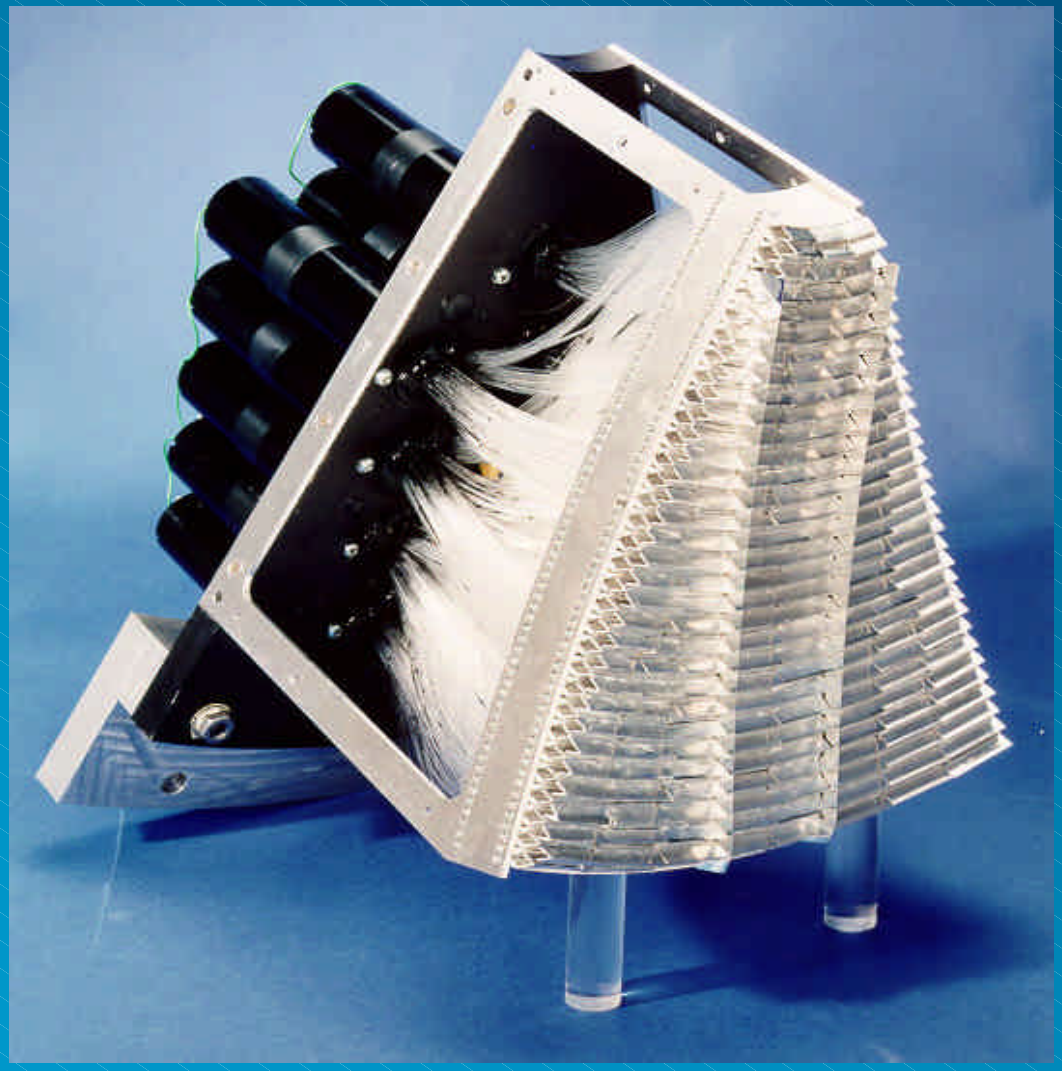
The Future - Big Detectors



- HRPD & GEM, ISIS
  - New scintillator detector element.
  - Project for new 90° (medium resolution) detector bank

Early Days at ILL Grenoble (1973)

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- New types of PSD's
  - Position Sensitive Detector used for the first time
  - Very Fast machine (Faster than X-rays)
  - Moderate Resolution
- In-situ Chemistry with RR (Convert, Riekel ...)

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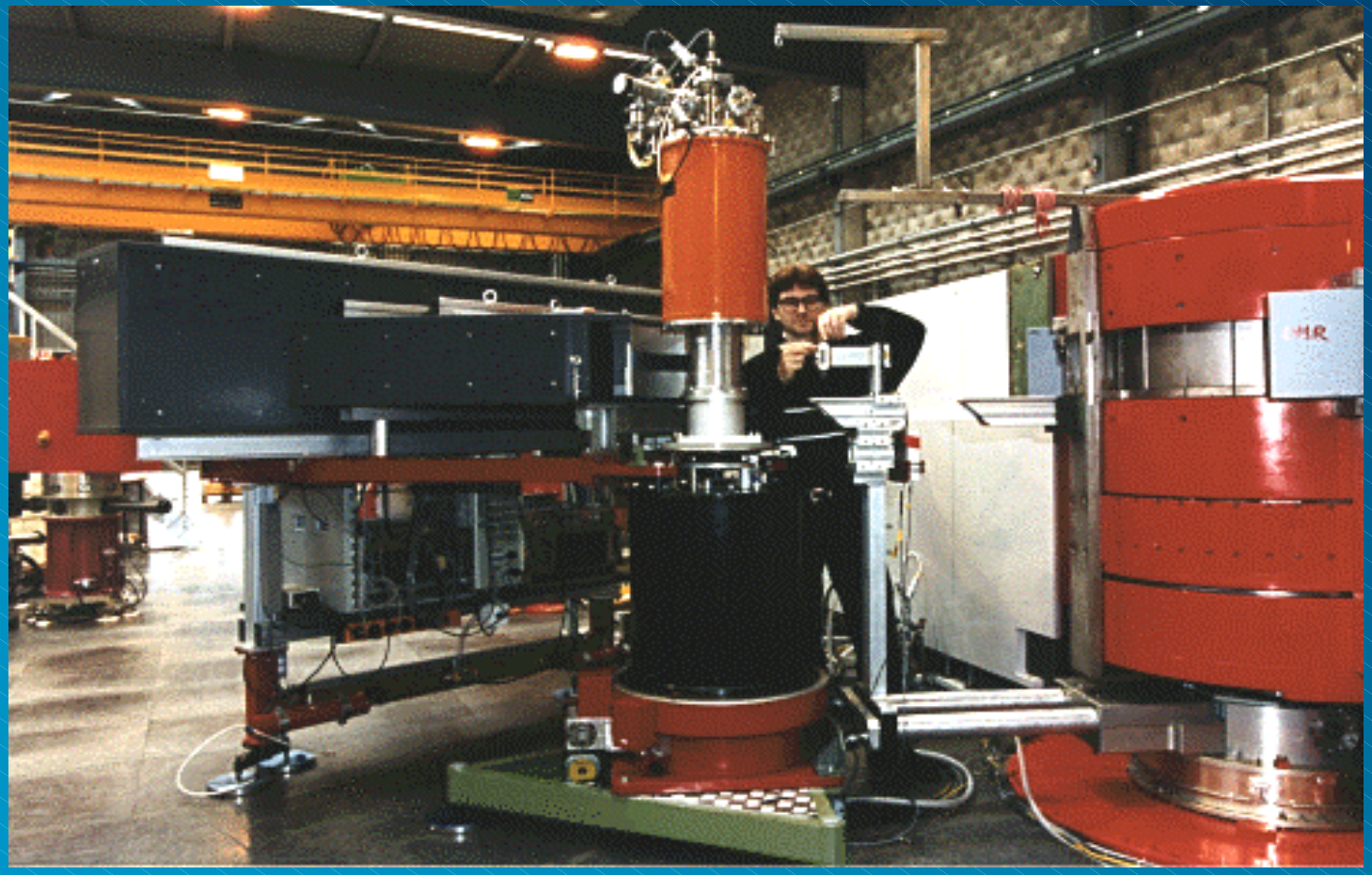
The Second Generation (80's)

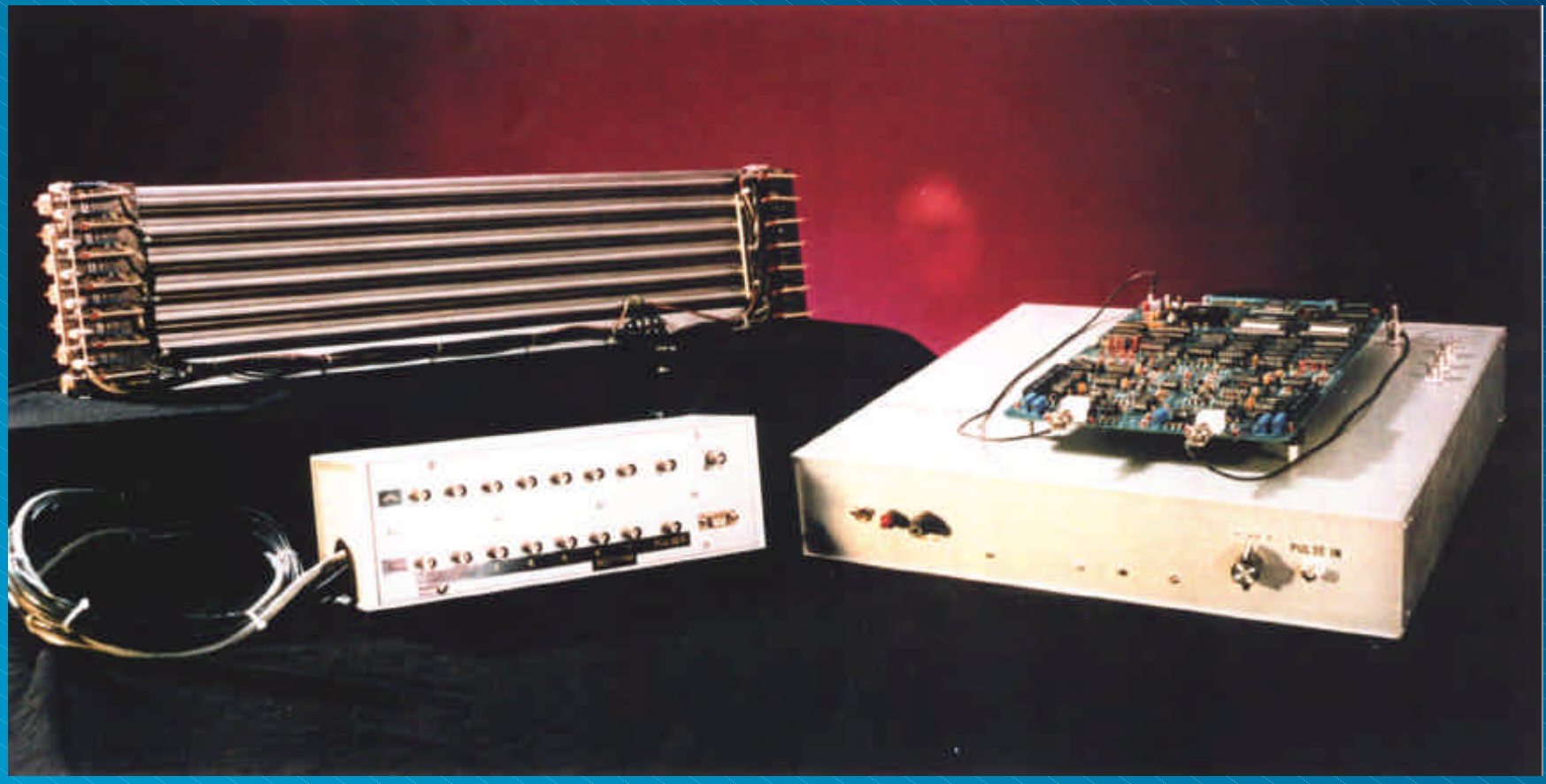


- **DMC high efficiency PSD powder diffractometer PSI (Zurich) P. Fischer et al.**

An Inexpensive but Effective PSD

ILL Grenoble

Diffraction Group

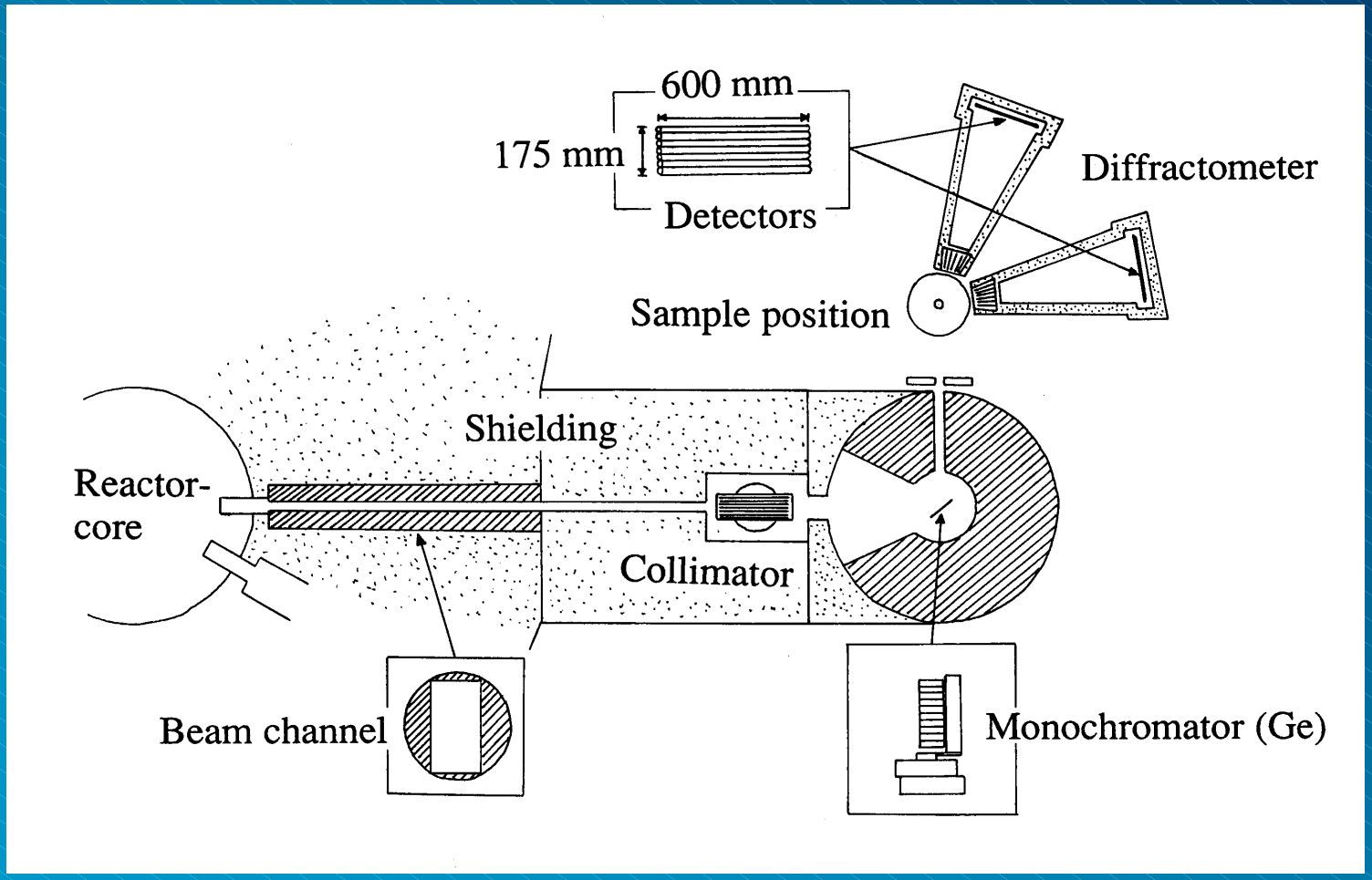


The liner wire PSD powder diffractometer at Kjeller, Norway.

An Inexpensive but Effective PSD

ILL Grenoble

Diffraction Group



The liner wire PSD powder diffractometer at Kjeller, Norway.

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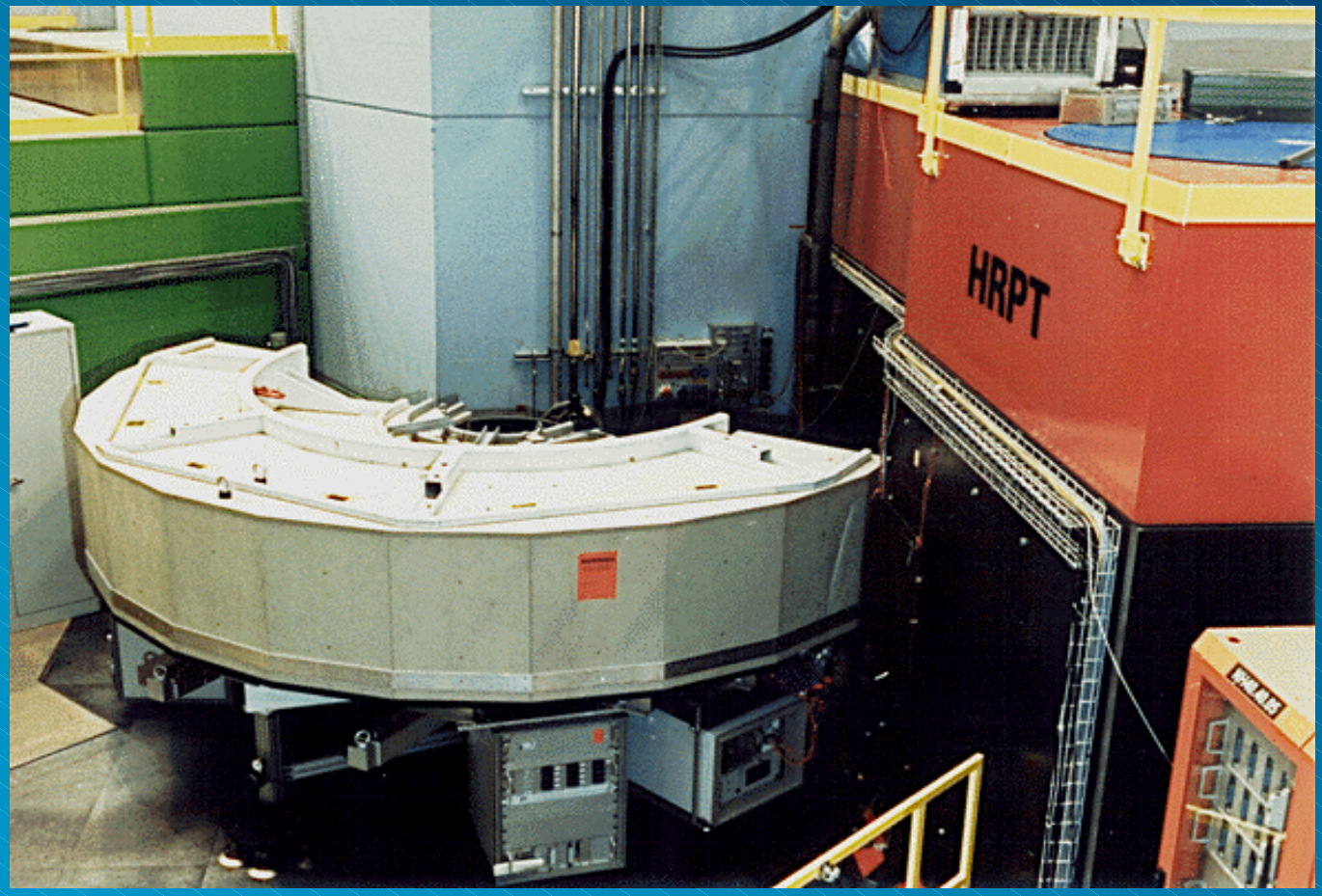
State of the Art Powder Machines



- **HRPT 1600 cell PSD powder diffractometer at PSI (Zurich) P. Fischer et al.**

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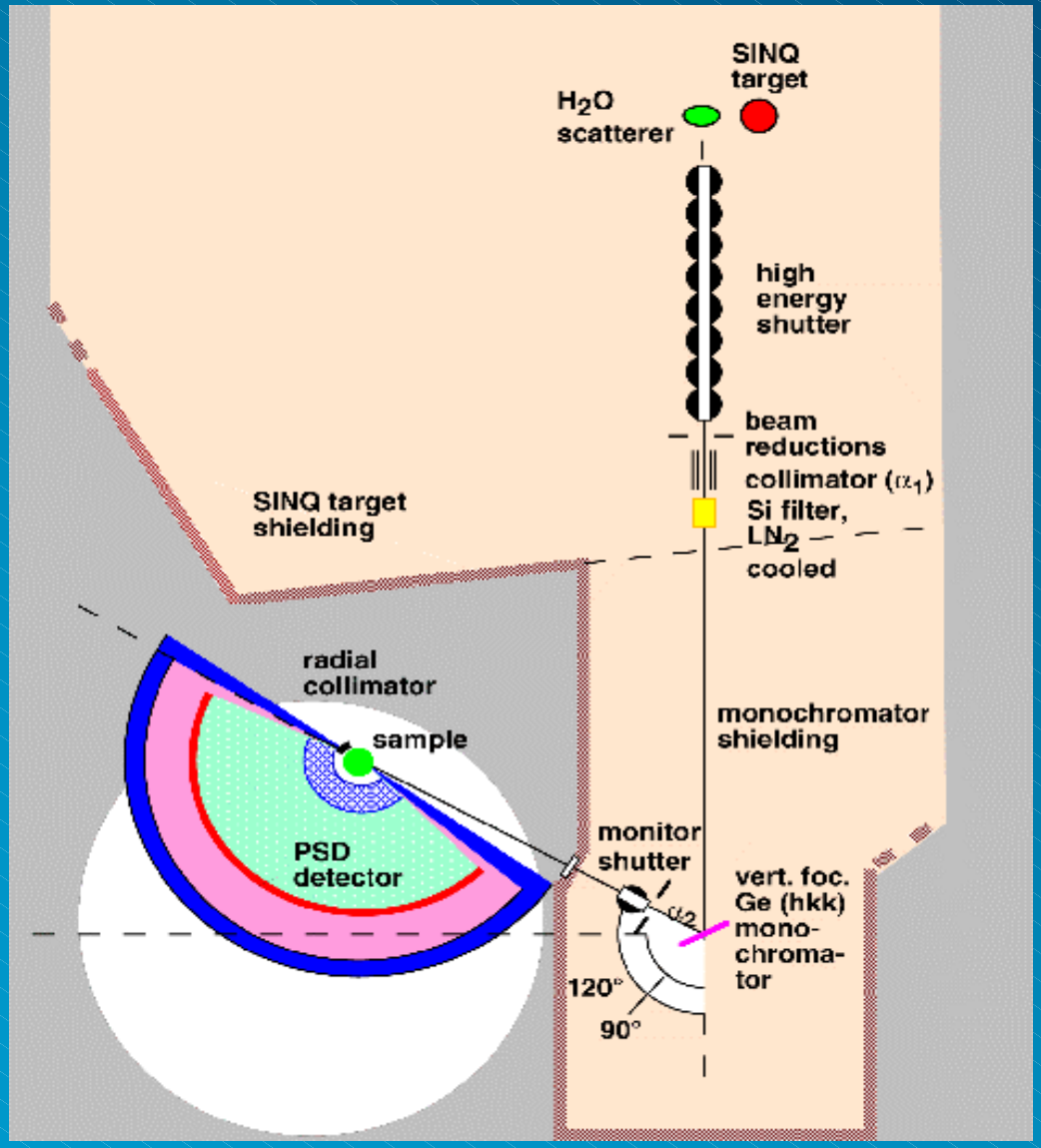
State of the Art Powder Machines



- **HRPT 1600 cell PSD powder diffractometer at PSI (Zurich)**
  P. Fischer et al.

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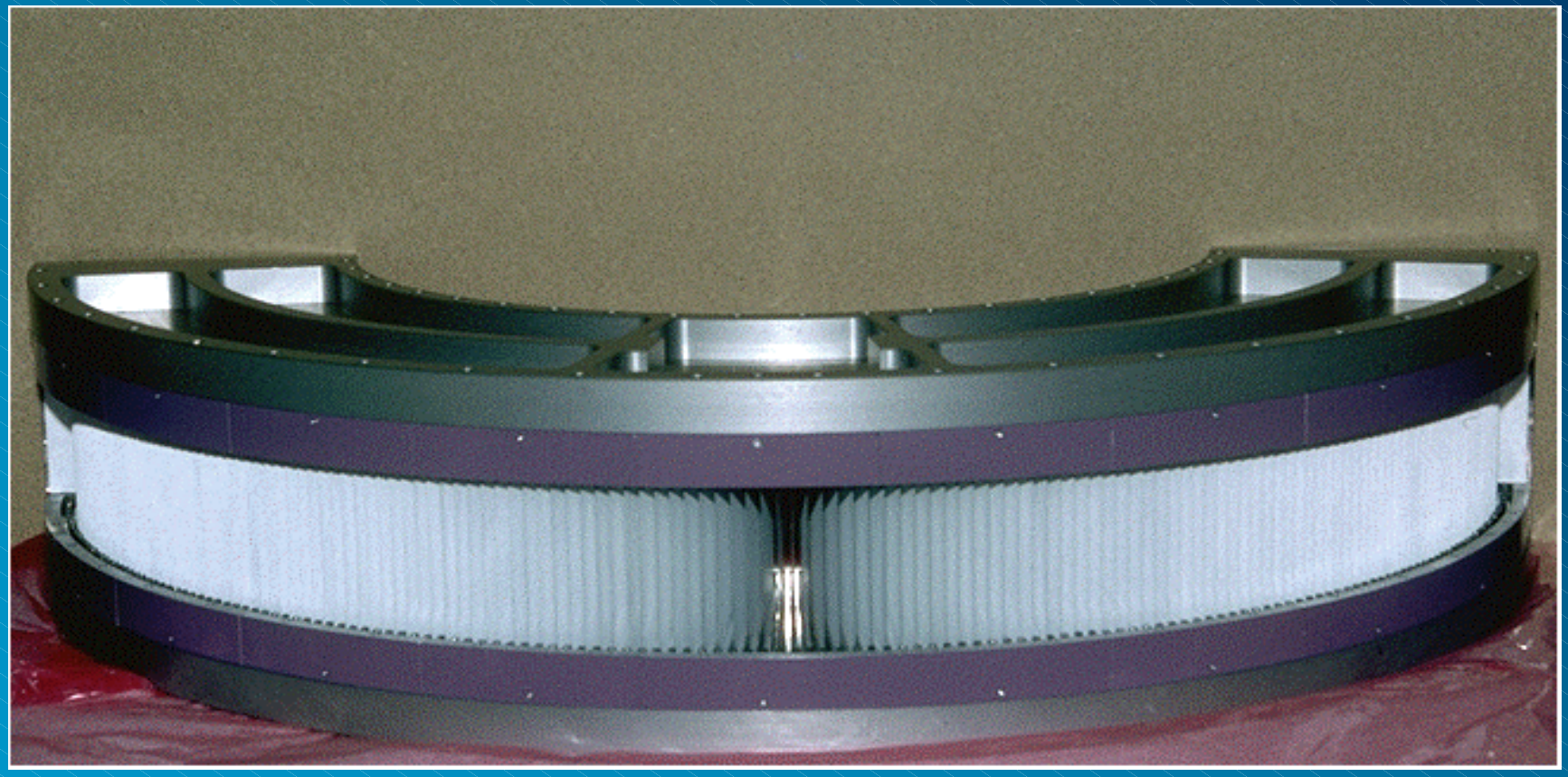
State of the Art Powder Machines

1600 wire PSD on a continuous spallation neutron source



- **Radial Collimator for new HRPT diffractometer at PSI Zurich (Fast, medium-high resolution machine) Peter Fischer et al.**

Microstrip Detectors - Printed Circuits

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"Mr Microstrip" Anton Oed with admirer
(Giovanna Cicognani, ILL Science Secretary)

ILL Detector Group:

- Bruno Guerard (head)
- Jean-Francois Clergeau
- Dominique Feltin
- Michel Gamon
- Giuliana Manzin
- Alexandre Sicard
- Fabrice Horst
- Anton Oed (retired)

Microstrip Detectors

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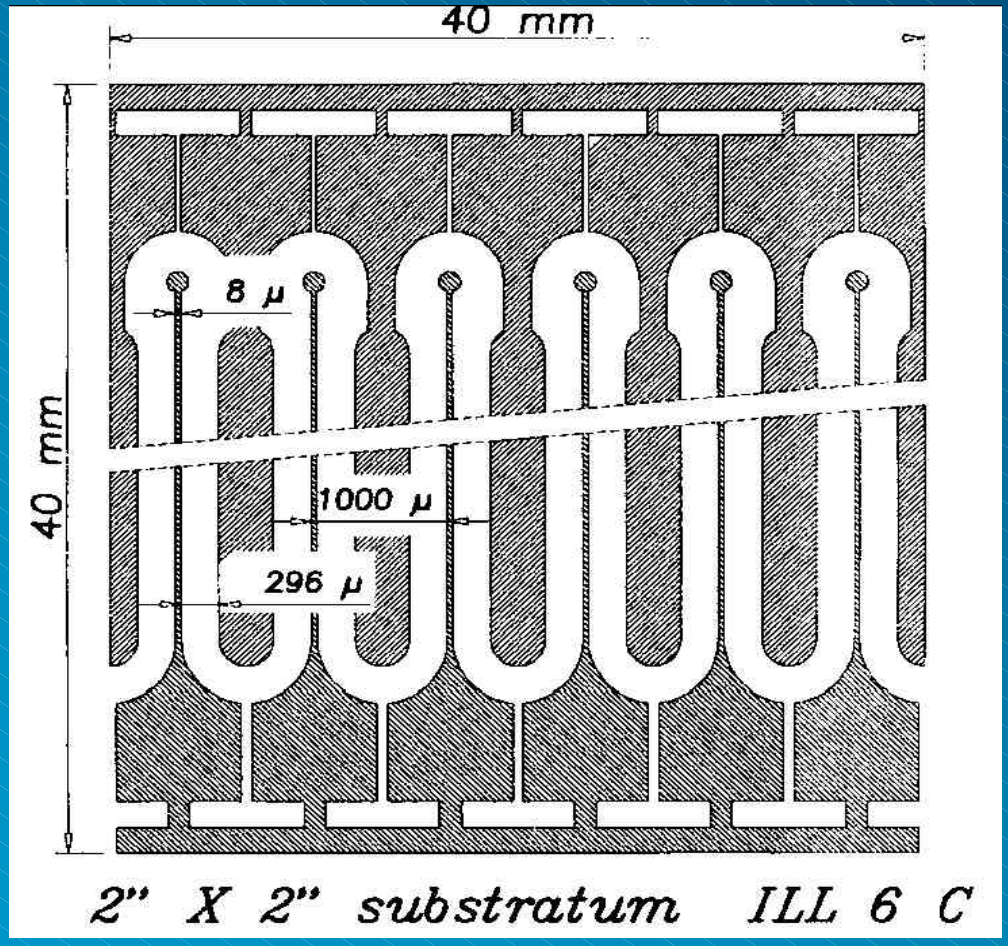

- **The wires are replaced by a printed circuit on a glass substrate**
- **A high electric field is produced around the thin anodes.**
- **The glass substrate is electrically conducting to remove charge build-up**

- PSD for 1600 element microstrip detector D20 at ILL Grenoble (Fast medium-high resolution machine) Pierre Convert et al.

What is a Microstrip Detector ?

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Instead of wires, a printed circuit is used.
This allows high resolution, mechanical stability…

The 160º D20 Microstrip Array

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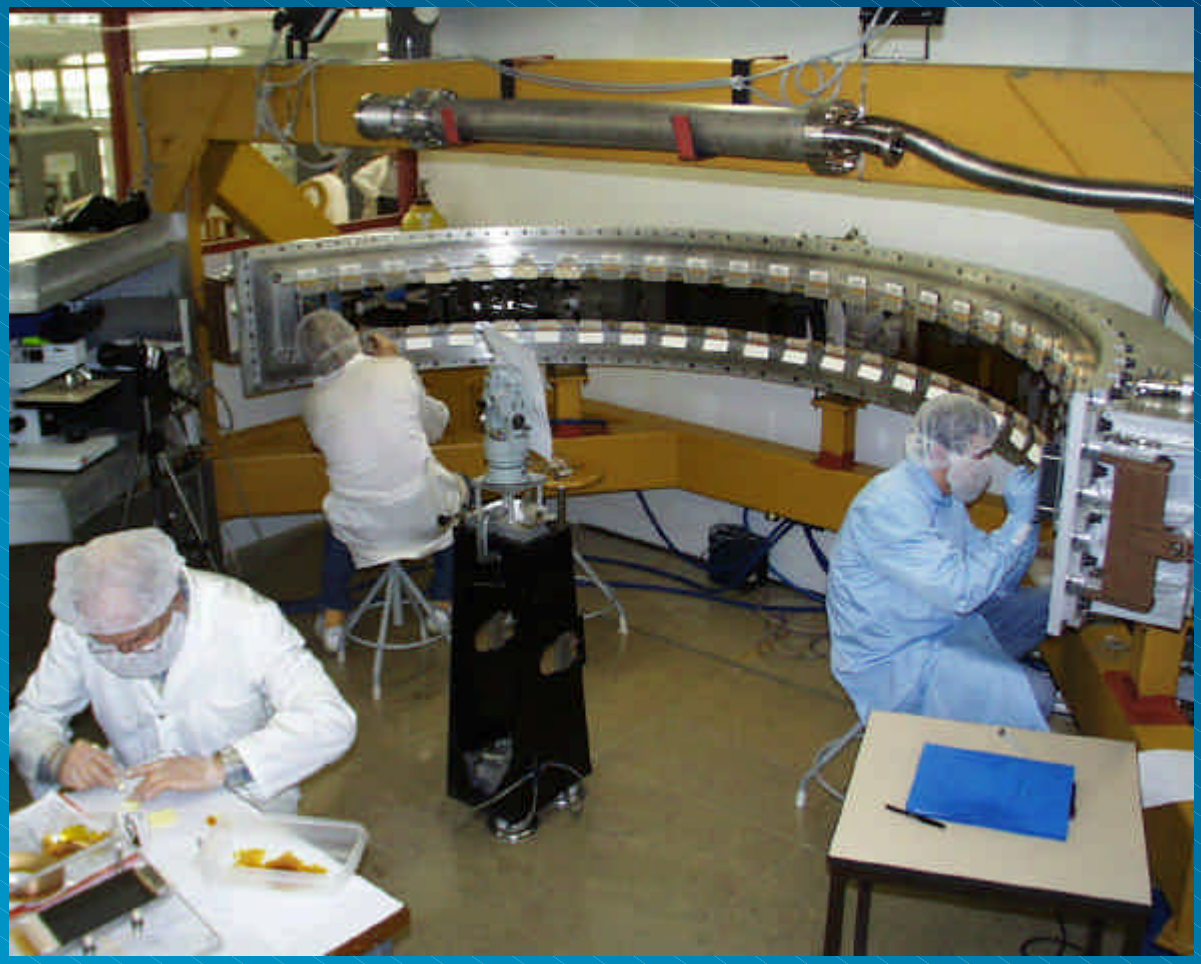


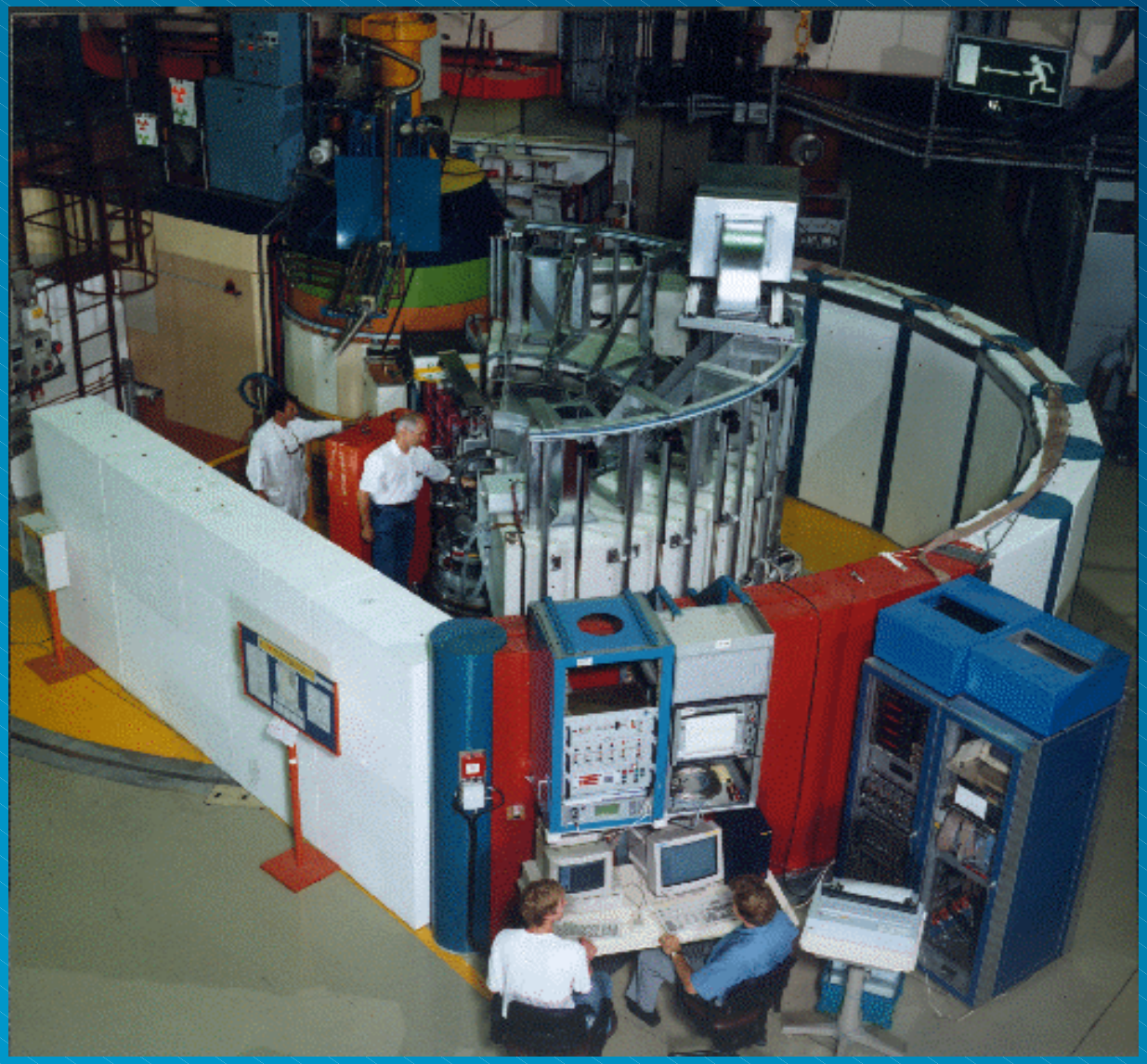
25 plates of 64 electrodes are assembled to produce a 1600-wire detector covering 160º.

High Flux Powder Diffractometer D20

Pierre Convert, Thomas Hansen, Jacques Torregrossa

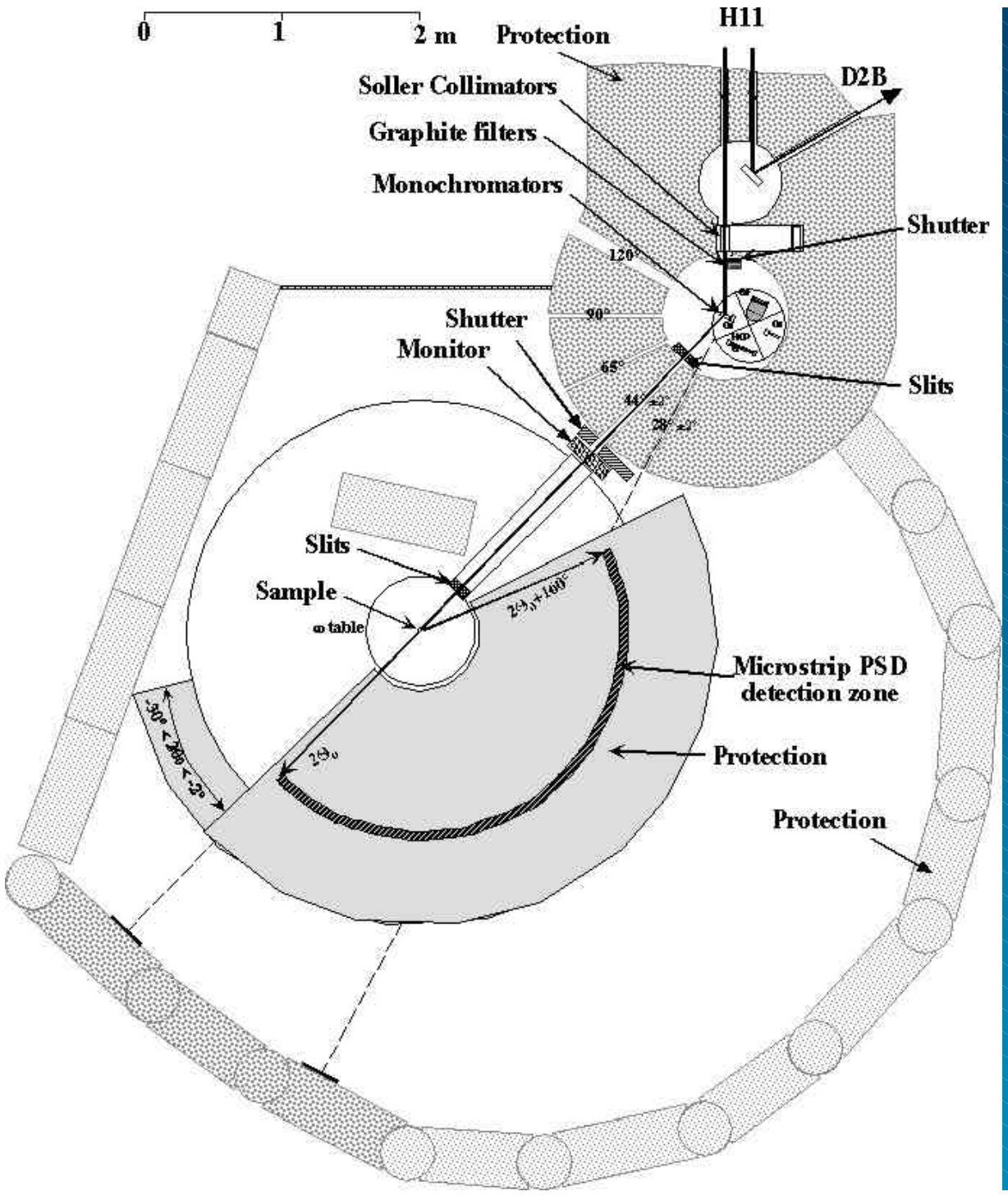
ILL Grenoble

Diffraction Group



D20 in action with
Jacques Torregrossa,
Pierre Convert
& Thomas Hansen

A. Hewat, China Nov/Dec 2000



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High Flux D20
High Resol D2B

A. Hewat, China Nov/Dec 2000

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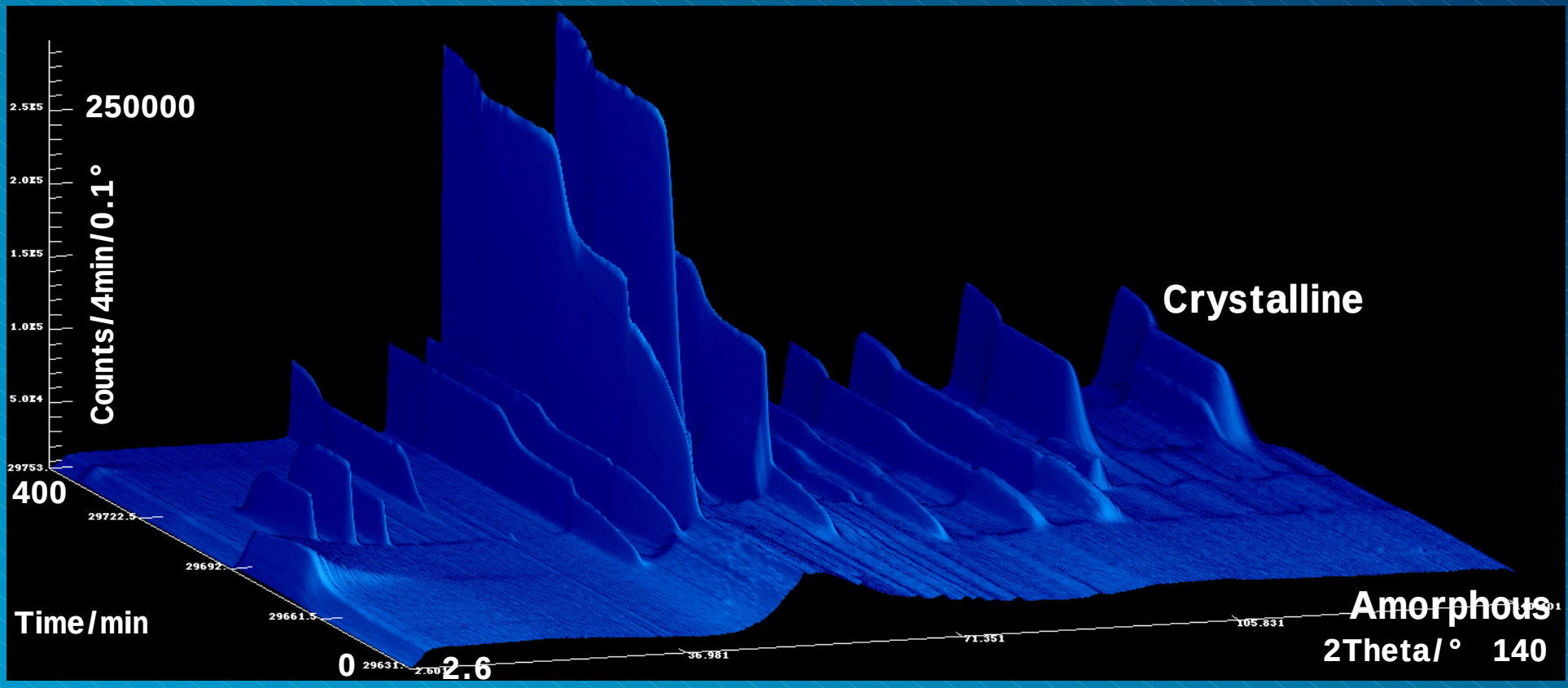
Applications of large fast detectors

Real-time Phase Diagrams

Sue Kilcoyne, Bob Cywinski et al.

Crystallisation of amorphous alloys $Y_{67}Fe_{33}$ with increasing temperature



Complete diffraction pattern in minutes or seconds, scan through temperature

A. Hewat, China Nov/Dec 2000

The Millennium Programme at ILL -> New Neutron Detectors

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