SMALL ANGLE SCATTERING

G 1-2

Small Angle Neutron Scattering facility PACE (isotropic scattering)

Beam tube	Neutron guide G1 (cold source), supermirror coating $2\theta_c$ (cutoff : 3 Å)
Monochromators	Mechanical selector (DORNIER) 2 Å < λ < 40 Å with Δλ/λ between 5% and 10% (hwhm) depending on the tilt angle (between 0 and 10°).
Max. beam size at specimen	2.5 x 3 cm^2
Typical size	0.7 x 0.7 cm^2
Beam collimation	with 2 diaphragms between 0.7 and 2.5 cm diameter, distant from 2.5 or 5 m depending on the distance between sample and detector.
Detector	BF_3 position sensitive multidetector made of 30 concentric rings of 1 cm width. First ring radius : 3 cm ; last ring radius : 32 cm
Typical range of accessible scattering vectors	2 x 10^{-3} < q ($Å^{-1}$) < 0.5
Available sample surroundings	- automatic sample changer for 16 different samples for temperature between 10 and 80°C - cryostat (2 K) and displex (10 K) - furnace (50 < T(°C) < 300)
Data collection and instrument control System	EURO modules from LLB (independent and intelligent IEEE 488 instruments)
Computer driving :	PC and WINDOWS operating system

PACE is a small angle neutron scattering spectrometer dedicated to the study of isotropic scattering. It is equipped with a position sensitive multidetector made of 30 concentric rings centred around the beam. This is its main feature making treatment and rapid estimation of data specially easy.
The monochromator is provided by Dornier Embh, and has the particularity of being very compact that allows retracting it without substantial handling. The experimentalist can thus easily work on white beam using the time of flight method.

The monochromator also allows to reach small wavelengths (down to 2 Å) that offers the possibility of extending the scattering vector range to high values without shadow due to the sample surroundings.
The spectrometer is equipped with a sample changer that allows to plan the automatic measurement of 16 different samples.
It is computer-driven with a WINDOWS software that allows a complete automatic adjustement of the spectrometer (centring of the beam and samples, attenuator optimisation…) and measurement programming.

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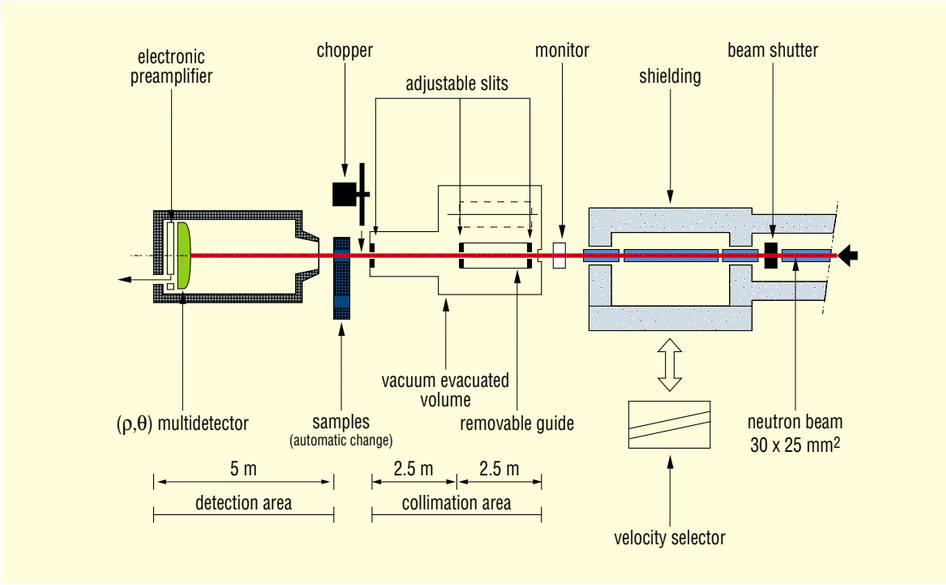

General layout of the spectrometer G 1-2.

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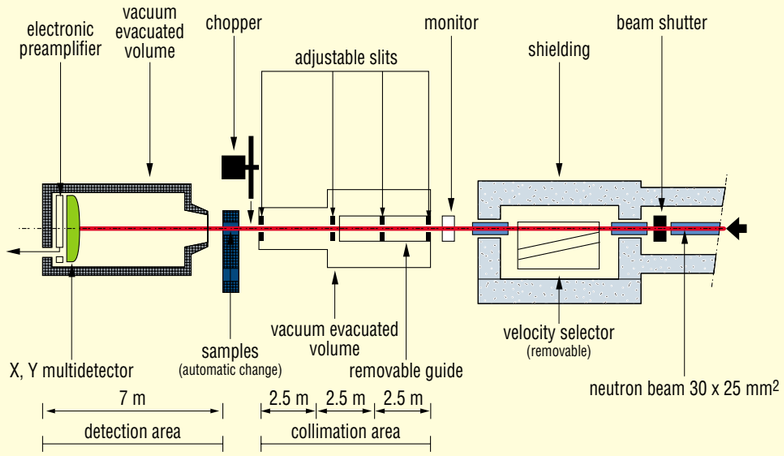
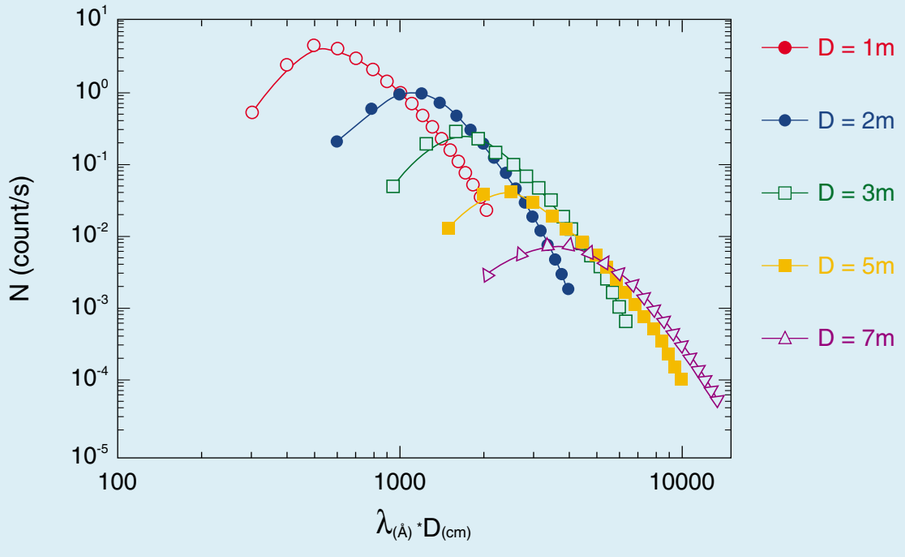
Beam tube	Neutron guide G 2 (cold source), supermirror coating $2\theta_c$ (cutoff : 2.6 Å)
Monochromator	1) Mechanical selector 4 Å < λ < 20 Å Δλ/λ ~ 10%. 2) Neutron guide 4 Å < λ < 20 Å Δλ/λ ~ 30%. 3) Time of flight method
Type of instrument	Small Angle Scattering diffractometer for high resolution (in q-space) studies.
Max. flux at specimen	Strongly dependent on the collimation
Max. Beam size at specimen	2.5 x 3 cm^2 - typical size 1 x 1 cm^2.
Moment transfer range	3 x 10^{-3} $Å^{-1}$ < q < 1 $Å^{-1}$
Distance Sample Detector	1 m to 7 m continuously variable
Scattering angle range (2θ)	0° to 60° (for distance sample detector < 3.5 m)
Collimation	Fitted to the sample detector distance and computer controlled.
Attenuators	Choice between 14 (PMMA) sheets of different transmissions
Detector	BF_3, XY multidetector, 64 x 64 cm^2 15500 cells, each 5 x 5 mm^2.
Data collection	The data treatments are done by using available home made programs on PC and SUN
<u>Ancillary equipment</u>	★ Automatic sample changer (8 positions) with temperature control (-43 < T < 100°C) ★ Furnace (50 < T < 300°C) ★ Cryostat (2 K) and displex (10 K). ★ Magnetic field H < 2 T ★ Computer controlled Couette type viscosimeter ★ Automatic sample changer in electromagnet

PAXY is a small angle neutron scattering instrument designed for experiments requiring a good resolution. It is used for isotropic or anisotropic scattering and for the study of periodical structures. The instrument is installed at the end of the cold neutron guide G 2. Incoming polychromatic neutrons are monochromatized by a mechanical velocity selector ; wavelength may vary from 0.4 nm to 2 nm.
The neutrons are then collimated with two ^{58}Ni guide elements under vacuum. These elements can be moved in (or out) the incident neutron beam. Two circular holes of variable diameter achieve the collimation. The geometry of the incident collimation depends on the beam divergence required.
The sample holder is equipped with a double goniometer (± 20°) and two independent rotating tables, one for heavy charge (~ 800 kg).

Various sample environments can be chosen such an automatic temperature controlled sample changer, cryostat, magnet with or without vertical sample changer, shearing cell (Couette cell or Cone and Plate).
The BF_3 multi-detector, with 128 x 128 cells of 5 x 5 mm^2, can be positioned at any distance between 1 and 7 m from the sample in the horizontal direction in its vacuum tube. This tube can rotate around the vertical axis of the sample to extend the q range.
Smaller q values (down to 10^{-3} $Å^{-1}$) may be reached using the time of flight technique instead of the mechanical selector.
The instrument is operated by a PC computer through a menu-driven interface and an image of the data collected are displayed on a colour monitor.



General layout of the spectrometer G 2-3.



Intensity in a cell of the detector versus incident wavelenth (λ) and for various sample detector distances (D).

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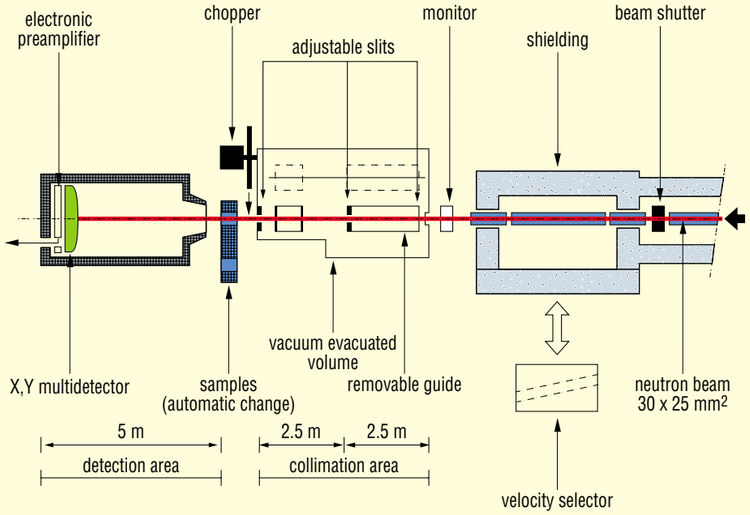
Beam tube	Neutron Guide G5 (cold source)
Monochromator	Mechanical selector $4 \leq \lambda \leq 25$ Å ; $5\% \leq \Delta\lambda / \lambda \leq 15\%$
Type of instrument	Small angle scattering diffractometer
Typical flux at specimen	7×10^5 n cm^{-2} s^{-1} for $\lambda = 4$ Å and a collimation obtained with two slits of 12 and 7 mm, 2.5 m far apart.
Max. beam size at specimen	2.5 x 3 cm^2 Usually, circular with ∅ = 7 mm
Range of momentum transfer	$2 \times 10^{-3} < Q < 0.5$ Å^{-1} (monochromatic beam) $1 \times 10^{-3} < Q < 0.5$ Å^{-1} (time of flight)
Angular range	6×10^{-3} to 0.8 rad
Distance sample - detector	$0.8 < D < 5$ m
Collimation	Adapted to sample-detector distance, through a movable neutron guide element.
Detector	BF_3, XY multidetector, 64 x 64 cm^2 with 4000 cells, each 1 x 1 cm^2
Data collection and Instrument control system	Microcomputer PC
Ancillary equipment	★ Automatic sample changer (16 positions) with temperature control (-43 < T < 100°C). ★ Cryostat 4 < T < 370 K ★ Magnet H < 2 T ★ Furnace (50 < T < 300°C) ★ Displex (10K)

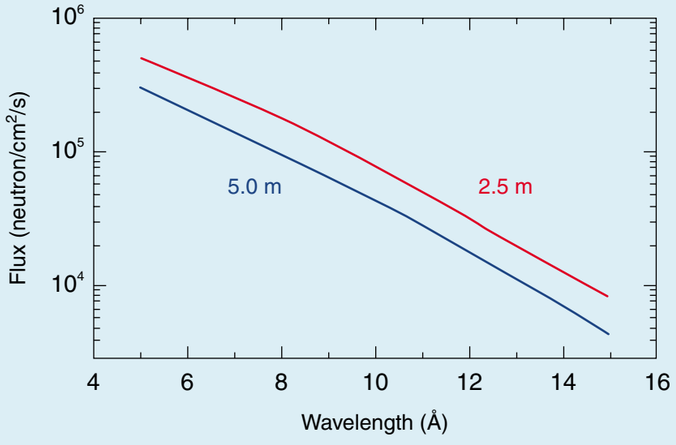
PAXE is a small angle scattering instrument installed at the extremity of the guide G5, which is a straight guide coated with ^{58}Ni. There is a XY position sensitive detector.
Measurements can be performed :
- with a monochromatic beam ($4 < \lambda < 25$ Å), using a velocity selector. The wave-length resolution ($\Delta\lambda/\lambda$) can be chosen between 5 and 15%.
- with a polychromatic beam (time of flight method) using a chopper.

The XY detector, filled with BF_3 contains 64 x 64 cells of 1 x 1 cm^2. It is mounted on a moveable trolley placed within a cylindrical tube kept under vacuum. The sample to detector distance can be chosen between 0.8 and 5 m.

The numerical values on the table above show the ranges of wavelength and distance. They yield a Q range extending from 3.10^{-3} to 0.5 Å^{-1} ; smaller values of Q (down to 10^{-3} Å^{-1}) may be reached using the time of flight technique.
Collimation is achieved by two circular slits at the two extremities of a tube under vacuum. The collimation length is equal to either 2.5 or 5 m. For a collimation of 2.5 m, a neutron guide is inserted before the collimation section, in order to maximise the flux.
The figure below depicts the total neutron flux at sample position for different wavelengths and distances of collimation, assuming $\Delta\lambda/\lambda = 10\%$.
The data acquisition is done by electronic devices controlled by PC computers connected to the network of the laboratory.



General layout of the spectrometer G 5-4.



Incident flux on sample.

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Small Angle Scattering Diffractometer with Polarized Neutrons PAPOL

Monochromator	Multilayer Ni-Ti on Si Fixed wavelength λ = 8 Å ± 0.5
Polarizer	Flat mirrors in reflection geometry Transmission 45% Polarization 94%
Collimation length	7 m fixed
Sample to detector distance	0.8 m to 3.8 m variable in steps of 1 m
Area detector	64 x 64 cm, resolution 5 mm
Beam intensity	3.10^4 n/cm^2/s at the sample
Data acquisition	Proprietary, PAXY compatible Time resolved acquisition possible
Ancillary equipment	Apparatus for dynamic polarization, with in particular : ★ Superconducting magnet : 3.5 T horizontal split coil with high homogeneity (5 10^{-5}) horizontal access parallel (∅ 89 mm) and perpendicular to the field (∅ 42 mm) ★ Dilution insert to cool the ^{4}He-filled sample holder to T = 0.2 K

PAPOL is mainly dedicated to the development of macromolecular structure studies using the method of contrast variation by dynamic nuclear polarization. Making use of the large spin-dependent scattering length of ^{1}H, this method is an alternative to isotopic substitution H - D in hydrogen-rich samples.

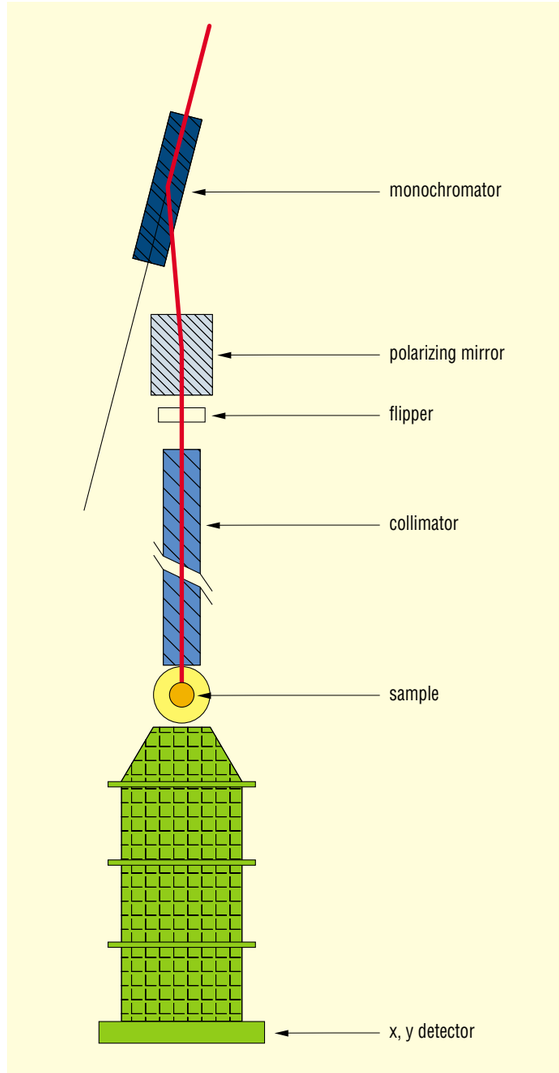
All the equipement necessary to create and to measure the nuclear polarization is available :

- a 3.5 T horizontal field with high homogeneity (5.10^{-5})
- a dilution insert able to cool the sample, inserted in ^{4}He, down to 0.2 K
- microwave sources (70 GHz and 94 GHz) for dynamic nuclear polarisation
- a CW NMR spectrometer to measure and to manipulate the polarization.

PAPOL is also particularly well suited to study magnetic nanoscale objects (Magnetic particles, clusters, vortices, etc…). In addition to the pure magnetic and nuclear contributions, its polarized beam is able to measure with high precision the interference term which is linearly dependent on magnetisation density.

Small Angle Scattering Diffractometer with Polarized Neutrons PAPOL

G 5-5



General layout of the diffractometer G 5-5.

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