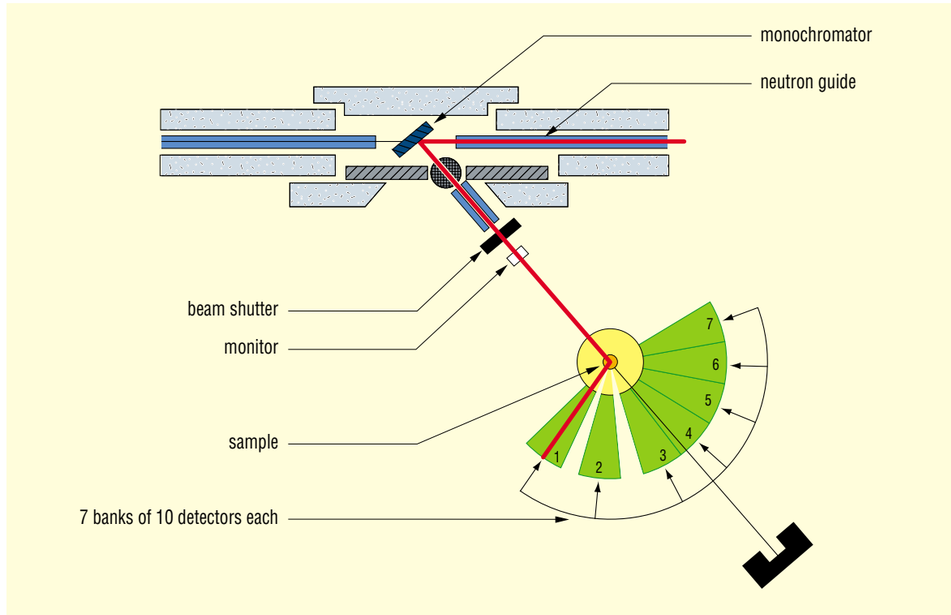
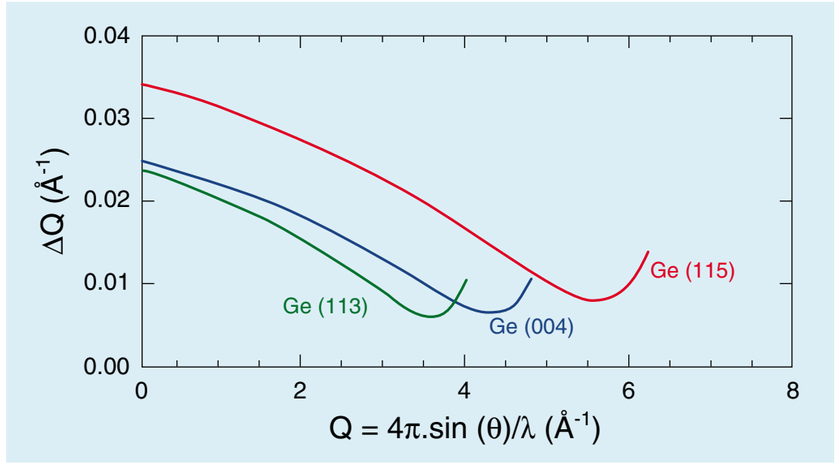
G 4-2 High Resolution Powder Diffractometer

Type of instrument	Two-axis diffractometer
Position	Cold neutron guide G 4, position G 4-2
Monochromator	Focusing Ge ; vertical axis [1 $\bar{1}$ 0] II (115) plane
Take-off angle	$2\theta_M = 112°$
Wavelength	1.80 Å, 2.34 Å, 2.82 Å
Detector system	70 ^{3}He detectors enclosed in 7 sections each containing 10 detectors with a Soller collimator in front of each detector. The angular divergence of the collimators is 13'.
Minimal scanning step (2θ)	0.01°
Working scanning step (2θ)	0.1°
Angular range	$6° < 2\theta < 174°$ ($Q_{max} \approx 7.0$ Å^{-1})
Accessible range of lattice spacing	0.9 Å < d < 27 Å ; 0.12 Å^{-1}< Q < 6.95 Å^{-1}
Best resolution	$\Delta d/d \approx 2.0 \times 10^{-3}$
Data collection and instrument control	PC + CAMAC
Ancillary equipment	★ Cryofurnace : 1.5 K < T < 520 K

This diffractometer was designed and constructed in the Materials Science Research Laboratory of PNPI, Russia. It is installed at the G 4-2 site and has been in operation since january 1997.
The diffractometer is designed for determination and refinement of the crystal and/or magnetic structure of powder materials especially with an elementary cell volume up to 1500 Å^3.
The original feature of the diffractometer consists of the way in which its 70 detectors are arranged, i.e., inside 7 dependent sections (each with a step motor and an absolute position encoder). Each section contains ten neutron detectors with a Soller collimator in front of each detector. The encoder of each section measures the angular position of the first detector in the section with a precision of 18" in the range of 0 - 360°. The other detectors in the section are positioned at 2° from each other. In the stage of preliminary data processing their positions are refined by the angular position of the transmission neutron beam measured by each detector. The sections are set in motion by step motors with the help of three air cushions lifting them over the base surface.
The diffractometer mainly operates in the superposition mode : each part of the neutron diffraction pattern is measured successively by all detectors and the results are added up. The procedure is as follows : the detectors assembly as a whole (all seven sections) starts motion from the initial position at a given step and has the specified monitor counts (or specified exposition time) for each position. At the same time, the smallest technological gap between the sections is preserved. As soon as the first section reaches the specified final position, all sections stop and the transport velocity is switched on, at which the first section moves to the end of the detector assembly. The measuring procedure continues till the second section reaches the final position, then the third, etc… As a result, each detector measures the entire diffraction pattern. In further measurements of the same sample, the movement of the detector assembly can be accomplished in the backward direction. This determines a high luminosity of the diffractometer and considerably simplifies the correction for the efficiency of counting channels and the relative positions of the detectors. Simpler algorithms of operation in the non-superposition mode are also possible. In this case, for calibrating the counting channels and relative positions of the detectors, the efficiency file obtained during measurements in superposition mode is used.
The collimator window is 11 x 110 mm^2, the working length is 200 mm, and the distance between the films is 1 mm ; the collimators are made of a thin polymer film with a gadolinium oxide-based absorber. The mean transmission coefficient measured for all 70 collimators is 85% and the beam divergence is 12 - 13'. The focusing Ge monochromator provides the possibility of using three wavelengths. This allows the diffractometer to be easily adjusted for many physical problems. The neutron monochromator is a set of 11 plates made from a plastically deformed Ge single crystal. The vertical axis is the rotation axis of the monochromator and coincides with the crystallographic direction [1$\bar{1}$0] within an accuracy of several minutes of arc. The plates are arranged one over another in a computer-controlled vertical focusing device which enables precision turning of the plates around the horizontal axis for the monochromator to have the form of a degenerated parabola. Turning of the monochromator as a whole around the vertical axis allows us to use the Ge (115), (004) and (113) reflections in the experiment. At the same time the resolution of the diffractometer changes and the neutron wavelength range changes from 1.8 Å to 2.8 Å. This allows us to optimise the conditions of a particular neutron diffraction experiment.



General layout of the cold diffractometer G 4-2.



Resolution curves.

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