# DETECTOR SYSTEM FOR HIGH RESOLUTION DIFFRACTOMETER OF «SFINKS»-TYPE

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The value of the resolution of a neutron powder diffractometer is one of the most important parameters. For example, with the help of the high resolution it is possible to study very subtle structural properties, very weak changes in crystal lattices upon phase transition. However, the increase of the resolution is related with the increase of time needed for good statistical accuracy of the measured results. In this case of exclusive importance for neutron diffraction is a method which gives an increase of luminosity. One of the most important ways is the use of the time focusing method /1,2/. What is this?

Elastic scattering of neutrons with a wavelength $\lambda$ on a system of crystal planes with an interplane distance D is defined by means of the Bragg formula:

$$\lambda = 2D \sin\theta , \qquad (1)$$

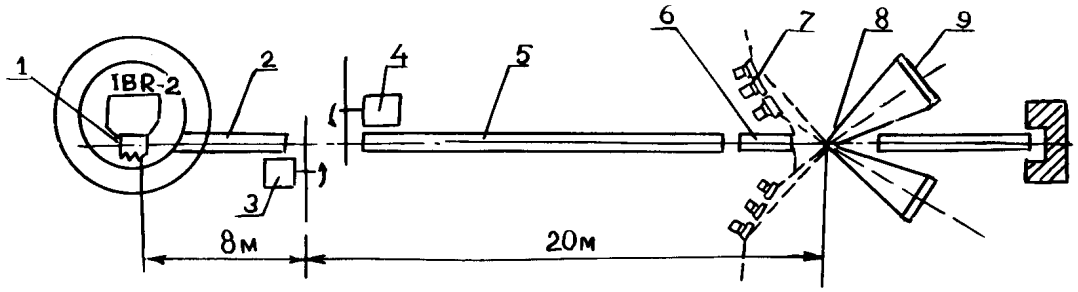


Fig. 1. Scheme of difractometer «Sfinks-IBR-2»:
*1* — moderator, *2* — mirror collimator, *3* — Fourier-chopper, *4* — Fermi-chopper, *5* — neutronguide, *6* — collimator, *7* — detector system with $^6$Li-glass, *8* — sample, *9* — detector with $^3$He

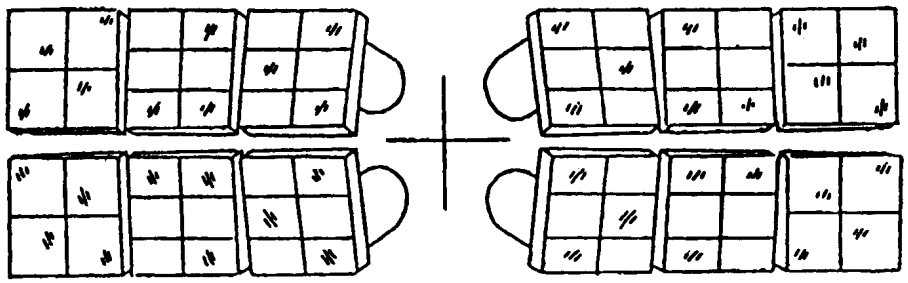

Fig. 2. Detector system, view from sample

where $\theta$ is the Bragg angle. It is known that for TOF-diffraction the wavelenght is defined with the help of time-of-flight $\tau$ and flight distance L. From (1) me get the expression:

$$\frac{dD}{D}=\frac{d\tau}{\tau}-ctg\theta d\theta-\frac{dL}{L}\ . \qquad (2)$$

From formula (2) it follows that the relative displacement of neutron registration on D -axis is composed by means of two main components: the time component depended on $\tau$ and the geometrical part depended on L and $\theta$. Let us analyse the expression for the geometrical component in the approximation of the collimated primary beam and point sample. We can use the following formula:

$$\frac{dL}{L}+ctg\theta d\theta=0\ . \qquad (3)$$

This is an equation of time focusing. If defines the time focusing line in the two-dimentional case and the surface in the three-dimentional one. Any neutrons diffracted on the planes with interplane distance D will cross this surface with the same $\tau$ at any points of this surface.

In practice the approximation of a collimated beam and point sample does not take place. Nevertheless this phenomenon permits to increase the aperture of the detector and the luminosity of the diffractometer and to receive the high resolution. In fig. 1 the scheme of the high resolution diffractometer «SFINKS-IBR» developed in the «SFINKS» project with the assistance of SUOMI-physicists is shown /3/. A peculiarity of this device is the use of the Fourier- chopper which offers high resolution up to the 7 μs level and a high range aperture of the time focusing detector. In fig. 2 the detector system with 12 separate elements is shown. Then every detector element has a light-guide prism with 4—6 surfaces (fig. 2). 1mm-thick $^6$Li-glass was pasted on these surfaces. Such a mosaic structure of the detector system offers good coinsidance of these surfaces with the focusing one. The full relative resolution is $5\cdot10^{-4}$ for interplane distances $D\geqslant2$Å, the aperture is 0.2 sterad. The search of the geometry for the detector system and the profile of the light-guide prisms is done with the help of program «PRISM» especially created for these goals.

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