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Neutron guide system at the Budapest Research Reactor

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Abstract

The 10 MW research reactor was restarted after a full-scale refurbishment in 1993. An important task of the upgrading was the construction of a new experimental hall and three neutron guides have been installed for the instruments located in this area. The in-pile plug contains $25 \times 100 \text{ mm}^2$ section float glass optical elements coated with ^{58}Ni . The guides of the same cross section have the following destination: NV1 has an interruption for the monochromator of a three-axis spectrometer and the prompt gamma activation analysis station is installed in end position. The second guide serves only for the small-angle scattering device and the third one for a reflectometer being constructed.

Keywords: Guides; Neutron instruments; Supermirrors

The Budapest Research Reactor (BRR) was refurbished, upgraded [1] and its regular operation at 10 MW power (core flux: $2.3 \times 10^{14} \text{ n cm}^{-2} \text{ s}^{-1}$) was started in November 1993. This modern neutron source in Central Europe is open for the international user community and serves various tasks, such as basic and applied research in physics, chemistry, biology, materials science, as well as commercial utilisation and education. For neutron beam measurements different types of horizontal channels are available: seven thermal and two fast neutron channels; a tangential beam tube serves for the neutron guide system and a liquid hydrogen cold neutron source (to be installed in 1997–98).

The layout of the neutron guides and experimental facilities (existing and under construction) at BRR are shown in Fig. 1. The horizontal reactor beam tube No. 10 in tangential position is looking

on a $\varnothing 250 \text{ mm}$ socket in the Be-reflector, which is foreseen for the cold moderator cell and – for the moment – serves as source of thermal neutrons for three guide tubes. A vacuum housing in the in-pile plug contains a steel shielding drum with three channels. The 1.65 m in-pile part of the guide system is composed of 550 mm long float glass optical elements coated with isotope ^{58}Ni . The angle between a pair of channels is 1.6° .

The out-of-pile part starts with the beam closure structure. This is a $\varnothing 750 \text{ mm}$ rotating drum (around vertical axes) with three guide sections to pass the neutrons in one position and a 90° rotation of the drum with a radiation absorbing sandwich which closes the three channel beam port. In the next position lifting shutters may provide the individual closing of separate guides.

The three curved neutron guide tubes are composed of float glass optical elements coated with natural Ni and manufactured in JINR Dubna in 1988–90, except the section NV1 ATHOS–NG,

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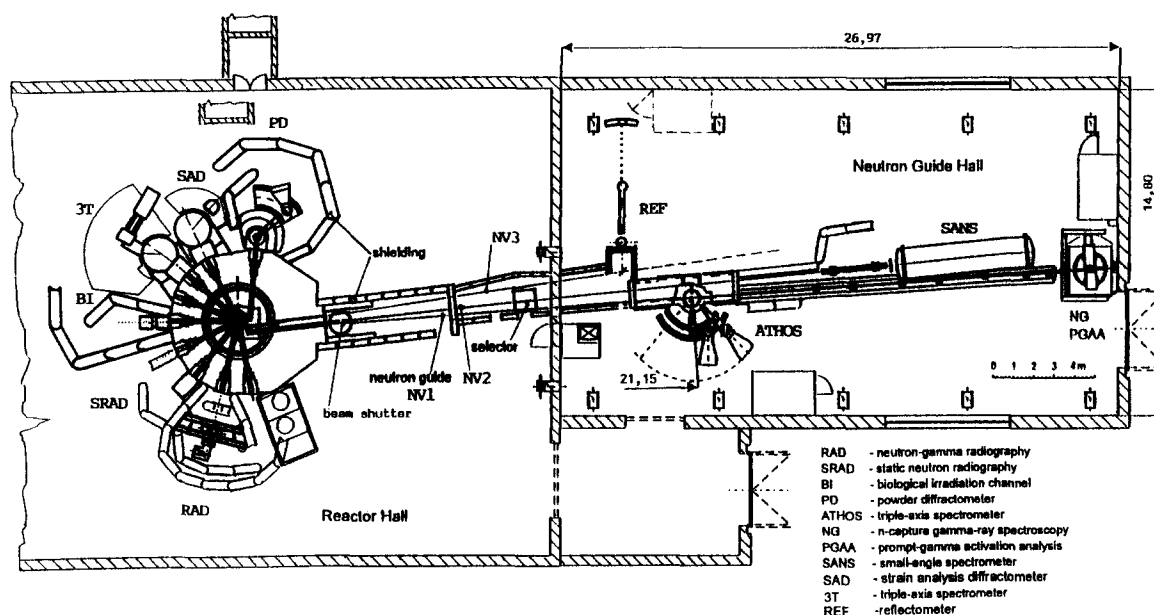


Fig. 1. The neutron guides and experimental stations at BRR.

Table 1
Geometrical characteristics of the neutron guides at BRR

Guide tube	Length (m)	Radius of curvature (m)	Cross section (mm ²)	No. of existing (possible) instruments
NV1	40	4200	25 × 100	2 (3)
NV2	29	3000	25 × 100 (50)	1
NV3	17 (+21)	3000	25 × 100	1 (3)

which is a K8 borosilicate glass guide produced by MIRROTRON Co. in 1995. The guide sections are mounted on ~ 4 m struts, aligned by autocollimating method and glued together to provide vacuum inside. A very low background level in the guide hall is ensured by a complex shielding all along the guide tubes: the surface of the glass elements is covered by ~ 5 mm thick boroncarbide ($\sim 30\%$) plastic foil. Furthermore, the guide tubes are surrounded by 10–20 cm boroncarbide ($\sim 5\%$) containing paraffin bricks, plus 20–40 cm concrete blocks. On the first 12 m path from the reactor, four lead ‘collars’ of 5–10 cm thickness stop gamma radiation.

Geometrical parameters of the guides are shown in Table 1. On the interruption of guide NV1, a three-axis spectrometer [2] is installed for taking off a monochromatic beam by a PG system. The thermal equivalent neutron flux at this position was measured as $\sim 3 \times 10^7$ n cm⁻² s⁻¹. On this guide a second interruption is foreseen for an eventual future monochromator instrument. The next section extends to the NG and PGAA station. In this new experimental station [3] the 2.5×10 cm² guide cross section is presently collimated down to a spot of 2×4 cm² size at the target position about 1.7 m distance from the guide end. An evacuated tube incorporating the sample holder, an adjustable

collimator and a sophisticated HPGe-BGO gamma-ray spectrometer serves as the basic instrument for PGAA.

The Guide NV2 for the small-angle scattering machine (SANS) is interrupted to insert a velocity selector and the second part from the selector is currently being replaced (boron glass) to optimise its geometry ($25 \times 50 \text{ mm}^2$ cross section) and improve the neutron performance: the upper and bottom plates will be coated with Ni–Ti supermirror produced on the sputtering station of the MIRROTRON Company. A further 2.5 m removable guide section will complete the SANS collimator, thus optimising the collimator/detector

path. The flux of the collimated, monochromatic beam on the sample position at $\lambda = 0.4 \text{ nm}$ was measured (Au-foil) as $\sim 10^5 \text{ n cm}^{-2} \text{ s}^{-1}$ (before the guide optimisation).

On NV3, a monochromator will be installed for a vertical slit geometry reflectometer (under construction).

References

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