Coupling neutron moderators and optics

Petr Konik[1] and Alexander Ioffe[2]

[1] HUN-REN Centre for Energy Research, Budapest, Hungary
[2]Jülich Centre for Neutron Science (JCNS) at Heinz Maier-Leibnitz Zentrum (MLZ)
Forschungszentrum Jülich GmbH, Germany

In the last decade, low-dimensional neutron moderators made from almost pure parahydrogen (pH2) have been introduced [1]. Thanks to large difference in scattering crosssections of thermal and cold neutrons in pH2, moderators in the form of tubes or disks provide significant brightness improvements over traditional voluminous cold moderators. According to the study by the ESS [2], potential gains of up to 2-3 times in the useful neutron flux are possible when the moderator height is reduced from 12 cm to 3 cm, especially for high-resolution instruments that use well-collimated beams. However, the small size of the moderators in some cases makes it difficult to properly illuminate the sample, leading to non-uniform divergence profiles. Therefore, larger neutron moderators with reduced brightness are preferred for some instruments. To determine the optimal moderator size, we have developed a new approach that takes into account instrument parameters such as sample size and angular resolution. It is based on phase space considerations and extensive Monte Carlo simulations have been conducted to validate it. This method is particularly useful for designing new neutron instruments and neutron sources. We also present a new analytic approach to calculate the brightness of pH2 moderators. It is shown that the brightness gain is a near-the-surface effect, so that a narrow cold moderator shaped as elongated rectangular parallelepiped provide a substantially higher cold neutron brightness. The obtained results are in excellent agreement with MCNP calculations.

REFERENCES

[1] K. Batkov et al., Nuclear Instr. Meth. A 729 (2013) 500.
[2] L. Zanini et al., J. Phys.: Conf. Ser. 1021 (2018) 012066