# On the comparison of the experimental neutron cold spectra obtained for various para- and ortho-hydrogen ratios against Monte Carlo simulations with different codes and nuclear data libraries

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**Abstract**

The High Brilliance Neutron Source (HBS) project aims to develop a High-Current Accelerator-driven Neutron Source (HiCANS) for neutron scattering, analytics, and imaging. It will feature several thermal and cold sources, including a liquid para-hydrogen moderator. At the Forschungszentrum Jülich, time-of-flight measurements were performed with the prototype of such a cryogenic moderator for different ratios between para- and ortho-hydrogen. In order to optimize the design of future instruments that will use this cold neutron source, accurate simulations of the neutron transport are necessary.

This work focuses on the comparison of various simulations performed against the cold spectra experimental results for the different para- and ortho-hydrogen ratios. Several Monte Carlo codes, including MCNP, PHITS, McStas, VITESS, and KDSource, with nuclear data from the ENDF/B-VII.1, JENDL-4.0 and JENDL-5.0 libraries were utilized. The simulations started with the comparison of the proton-neutron yield spectra, continued with coupling the event files before and after the modeling of the neutron guide, and ended with the time-distribution obtained at the detector. A good agreement between simulations and experiments was obtained.

The results provide insights into the strengths and limitations of each Monte Carlo code and nuclear data library combination. Not only the observed discrepancies are discussed, but also the potential sources of error are identified. Also, the conclusions will help to improve the accuracy and reliability of neutron cold moderator designs, especially for projects that will deploy a para-hydrogen cold source such as the HBS.

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