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Evaluation of a method for time-of-flight, wavelength and distance calibration for neutron scattering instruments by means of a mini-chopper and standard neutron monitors

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Accurate conversion of neutron time-of-flight (TOF) to wavelength is of fundamental importance to neutron scattering measurements in order to ensure the accuracy of the instruments and the experimental results. Equally important in these measurements is the determination of uncertainties, and with the appropriate precision. Especially in cases where instruments are highly configurable, the determination of the absolute wavelength after any change must always be performed (e.g. change of detector position). Inspired by the manner with which neutron spectrometers determine the absolute wavelength, we evaluate for the first time, in the author's knowledge, a commonly used method for converting TOF to neutron wavelength, the distance of a monitor from
the source of neutrons and we analytically calculate the uncertainty contributions that limit the
precision of the conversion. The method was evaluated at the V20 test beamline at the Helmholtz Zentrum Berlin (HZB), emulating the ESS source with a long pulse of 2.86 ms length and 14 Hz
repetition rate, by using a mini-chopper operated at 140 Hz and two portable beam monitors (BMs),
as well as accompanied data acquisition infrastructure. The mini-chopper created well-defined neutron pulses and the BM was placed at two positions, enabling the average wavelength of each of the pulses created to be determined. The used experimental setup resulted in absolute wavelength determination at the monitor positions with a ⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠ of 1.8% for ⊠ > 4 Å. With the use of a thinner monitor, a ⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠ of 1% can be reached and with a modest increase of the distance between the reference monitor positions a ⊠⊠⊠⊠⊠⊠/⊠⊠⊠⊠⊠ of below 0.5% can be achieved. Further improvements are possible by using smaller chopper disc openings and a higher rotational speed chopper. The method requires only two neutron measurements and doesn' t necessitate the use of crystals or complex fitting with sigmoid functions and multiple free variables, and could constitute a suitable addition to imaging, diffraction, reflectometers and small angle neutron scattering instruments, at spallation sources, that do not normally utilise fast choppers.

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