The 'Backscattering And Time-of-flight Spectrometer' (BATS) Option for IN16B at ILL

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Since its commissioning in 2013, the backscattering spectrometer IN16B has proven its outstanding performance in serving the user community for high resolution experiments at the Institut Laue-Langevin (ILL) in Grenoble, France.[1] The most notable difference to its predecessor IN16 is the doubling of the maximum energy transfer range to ±31 μeV with the standard Si 111 monochromator & analyzers, and the increase of count rate by more than one order of magnitude. Low flux has been a long standing weakness of reactor based neutron backscattering, therefore past efforts in development mainly focused on improving neutron intensity. With the progress made in the IN16B project and the high flexibility provided by the instrument, new directions in instrumental development are pursued in the framework of a collaborative research grant („Verbundforschungsförderung") by the German Federal Ministry for Education and Research (BMBF). On the one hand the possibility for significant improvement in energy resolution aiming at 50 neV is demonstrated in a GaAs 200 prototype spectrometer option,[2] while we focus here on the implementation of the Backscattering And Time-of-flight Spectrometer option „BATS".
With the BATS option, IN16B can be transformed into an inverted time-of-flight spectrometer (see Fig. 1).[3] The maximum energy transfer is increased by an order of magnitude, while the energy resolution is slightly relaxed. With the standard Si 111 analyzer the expected energy resolution is tunable in the range of 2–9 μeV, the energy transfer range is ±250 μeV (movable) while the Q-range remains at 0.2–1.8 $Å^{-1}$. This option thus offers μeV-resolution at large Q in a range not accessible for direct geometry ToF instruments. A flexible pulse chopper system is to be installed in late 2016 consisting of two pairs of high speed counter-rotating choppers (diameter 750 mm, 19000 rpm) with multiple slits located 34 m upstream of the sample. The design allows to select from a set of different pulse lengths to optimize intensity vs. resolution for each experiment. Taking advantage of the continuous reactor source, a high pulse repetition rate mode (236 Hz) is available and allows for a fourfold increase in flux, albeit at the cost of reducing the energy transfer range to one third. Due to the extremely short chopper opening time of about 9 μs in order to achieve best resolution of 2 μeV, the chopper slits need to be smaller than the existing large guide cross section. To compensate for losses in flux we explore the possibilities of an adaptive focusing-defocusing guide system before and after the pulse chopper unit. Preliminary ray-tracing simulations are used in conjunction with a particle swarm optimization algorithm to refine a quasi-free guide shape for each chopper configuration separately, yielding a possible flux increase by a factor of 6 for the smallest chopper opening.

References:

[1] B. Frick et al., in preparation; B.Frick, T. Seydel, M. Appel, poster at this conference.
[2] K. Kuhlmann, M. Appel, B. Frick, A. Magerl, contribution to this conference.
[3] L. van Eijck et al., Nucl. Inst. and Methods A **672**, 64-68 (2012)

Figure 1: *Schematic layout of IN16B in (a) conventional backscattering and (b) BATS configuration.*