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Polarisation analysis concept for the BIFROST spectrometer at ESS

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The BIFROST spectrometer at the upcoming neutron source ESS in Lund (S) will be a game-changer for the study of quantum materials, such as frustrated magnets, quantum magnets and superconductors. The spectrometer utilizes a multiplexing backend on an indirect geometry time-of-flight (ToF) front end. The primary spectrometer enables an unprecedented polychromatic sample flux exceeding $7 \cdot 10^9$ n/s/cm^2 at 2 MW accelerator power, with a bandwidth of 1.7 Å, whilst retaining a primary spectrometer resolution $\Delta E_i/E_i$ of 4 \%, common in cold neutron spectroscopy. The multiplexing backend consists of 9 Q-channels, each containing 5 fixed analyzers probing a scattered neutron energy range of 2.7 to 5.0 meV. The analyzers utilize the graphite crystal mosaicity combined with position sensitive neutron detectors to gain continuous energy sensitivity, resulting in a back-end energy resolution considerably better than on a classical Triple Axis Spectrometer.

For the study of quantum materials, use of the technique of neutron polarisation analysis will yield additional and crucial information about the structure and dynamics in the materials. However, the wide angular coverage of BIFROST presents a technical challenge to implement polarisation analysis. Futhermore, for many quantum materials studied on BIFROST, polarisation analysis will be used together with high magnetic fields. Together with the requirements imposed by the time-of-flight nature of the instrument, a polarising supermirror based wide-angle analyzer is the only suitable method that is currently available.

In this work, we present current work in progress on McStas simulations of BIFROST together with the design concept of polarisation analysis. The concept consists of a V-cavity polarizer[1] and a device that can perform neutron wide-angle polarisation analysis in an applied field. The analyzer design follows a recent proposal with polarising supermirrors, bent into the shape of a logarithmic spiral [2]. This would reflect neutrons with the unwanted polarisation direction, and let them be absorbed in the BIFROST radial collimator. Hence, neutrons with the desired polarisation direction would continue undisturbed into the BIFROST analyser-detector system. This setup is compatible with having a high-field magnet on the sample position.

[1] see presentation by Wai Tung Lee.
[2] P. Böni, Nuclear Instruments and Methods in Physics Research, A 966 (2020) 163858.

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