Data Reduction and Simulation for Novel Detector Geometries in Mantid

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The LOKI instrument, for broadband Small Angle Neutron Scattering, is currently under development for the European Spallation Source in Lund, Sweden. This instrument is planned to use a trapezoidal array of Band-Gem [1] (Boron Array Neutron Detectors, Gas Electron Multiplier) detectors in a large irregular grid pattern. The assembly gives higher pixilation at low scattering angles, with increasing size at larger scattering angles. Each detector panel will be separated into 8 sectors each of which contain between 500-1000 individual (uniquely shaped) detectors. There will be three panels in total which translates to circa 2700 detectors.

Presently, the LOKI instrument is in its concept stage with many development iterations of a proposed implementation of the physical BAND-GEM detector network and associated hardware. There have also been efforts on the part of the detector group at the ESS in prototyping instrument behaviour using McStas simulations [2]. McStas is a neutron ray-tracing simulation tool for neutron scattering instruments and experiments. The outputs of these simulations have provided a basis for development work on prototyping the data reduction workflow for this instrument. This enables the development and testing of the data reduction process in the absence of a physical instrument.

The Mantid framework [3] has been chosen by the ESS to be the main data reduction service. This is currently in use at ISIS, SNS and ILL. Mantid contains an in-memory virtual instrument representation. This supports geometric calculations critical to time-of-flight neutron data reduction. These virtual instruments can be defined using an XML format known as the instrument definition file (IDF). There has also been considerable effort in the past to ensure interoperability between McStas and Mantid, with existing capability allowing the export of McStas data and instruments to Mantid-readable formats.

One of the major challenges in the design of the data reduction workflow is LOKI's irregular detector geometry, for which there was no sensible compatibility within the Mantid framework. Naïve LOKI IDF implementations, based on a historical approach to defining detectors, resulted in major performance issues, and practically made Mantid unusable for the proposed geometry. Amongst many incremental improvements, a new design for topologically regular, but geometrically irregular detector geometries has been provided. This arrangement is known as the StructuredDetector and enables faster, more efficient loading, as well as runtime processing, of the LOKI virtual instrument in Mantid.

This poster will highlight the changes to the Mantid Framework which enabled the inclusion of this additional geometry type and the success of initial processing of LOKI geometries quickly and efficiently. We will also discuss further work undertaken to increase interoperability between the Mantid and McStas frameworks in order to bridge the gap between the simulations and the data reduction processes, and how these processes function together.

References

1. http://cerncourier.com/cws/article/cern/27921
2. http://www.mcstas.org/
3. http://www.mantidproject.org/

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