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Developments in Event Mode Data Analysis

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Event mode data acquisition in neutron and x-ray scattering experiments has already been demonstrated at multiple labs. The main advantage of this technique is that the data reduction is completely flexible after the experiment, so the re-binning of histograms can be tuned to the experimental data. Compared to accumulating histograms in hardware, event mode data acquisition carries orders of magnitude increases in storage and processing requirements, but since storage and processing have become relatively cheap the advantages tend to outweigh the disadvantages. The routine method of analysis is historically based around least-squares fitting. Since any histogram process discards some information along one axis or plane, because of the integration within each bin, by re-sampling with variable histogram bin widths (or equivalently tuning of the Kernel Density Estimation bandwidth) one can maximise the extracted Fisher information - in other words, reduce the uncertainty on the extracted parameters of interest. In this work-in-progress study, we describe a new project to abandon entirely the histogram step and analyse the event data directly. We give examples that are based on weighted Maximum Likelihood Estimation, Bayesian Inference, and Maximum A Posteriori approaches. We will demonstrate the technical challenges and share our identified pitfalls, along with the successes and most promising steps for future development. Such an approach may be particularly attractive for kinetic experiments of sub-second processes, even perhaps single pulse measurements, where the repeatability of the study is almost impossible, for example destructive processes with weak signals and/or large experimental backgrounds.

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