Poster

Real-time data analysis at the DanMAX materials science beamline

F.H. Gjørup[1,2], T.E.K. Christensen[2,3], I. Kantor[2,4], & M.R.V Jørgensen[1,2]

[1]Dept. of Chemistry & iNano, Aarhus University, Aarhus, Denmark, [2]MAX IV Laboratory, Lund University, Lund, Sweden, [3]DTU Compute & [4]Dept. of Physics, Technological University of Denmark, Lyngby, Denmark

fgjorup@chem.au.dk[1]

In situ and *operando* experiments are the studies of real-time reactions, but while the diffraction measurements might be real-time, the data analysis often take days, weeks, months or even years. At the DanMAX beamline we aim to reduce that time significantly – at least for the preliminary analysis. Part of the motivation for this is of course to reduce the time from experiment to publication, but it is also an important way to improve and optimize the often complex time-resolved experiments. By performing real-time data analysis we help users interpret their data and allow *ad hoc* control of the experiments during the beamtime and aid in the preliminary analysis of the huge amount of data that a 2 megapixel area detector recording at 250 Hz produce. At DanMAX our flexibility and large variation and experiment types means that we need equally flexible and varied analysis methods to best help our users get the most out of their beamtime. We accomplish this by having a broad range of python-based data analysis scripts freely available to all users through our powerful jupyterhub servers.

The real-time analysis is for the large part made possible by the live azimuthal integration pipeline using the MatFRAIA algorithm[1], which allows us to integrate the detector images to both 1D and 2D (azimuthally binned) diffraction patterns at the same rate as the image acquisition. This means that the reduced data are ready for analysis the moment the measurement finishes, along with the corresponding meta data.

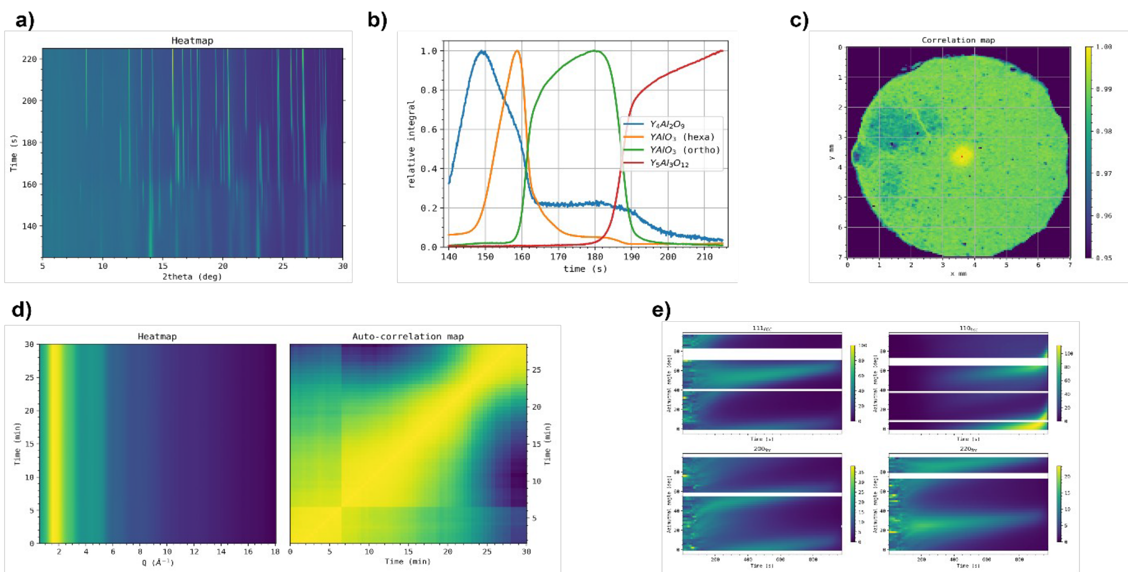

Figure 1. **a)** Diffraction heatmap of an Ultrafast High-temperature Sintering (UHS) synthesis of yttrium aluminium garnet (YAG). Several phase transitions occur in less than a minute. **b)** Relative numerical peak integral for selected peaks in a), showing the time-resolved progression through the Al_2O_3-Y_2O_3 phase diagram. **c)** Pixel-wise correlation map of a battery displaying beam damage after an *operando* experiment. The values correspond to the Pearson correlation with the highlighted (red) pixel in the centre of the area exposed during the *operando* experiment. **d)** Total-scattering heatmap and auto-correlation map of an *in situ* synthesis of nano particles. The auto-correlation map shows regions of similarity that are not clearly visible to the naked eye in the heatmap. **e)** Azimuthal intensity variation during an in-situ shear strain experiment on stainless steel, showing the development of texture and change in preferred orientation direction, caused by the deformation of the sample.

[1] Jensen, A. B., Christensen, T. E. K., Weninger, C., & Birkedal, H. (2022). Very large-scale diffraction investigations enabled by a matrix- multiplication facilitated radial and azimuthal integration algorithm: MatFRAIA. *Journal of Synchrotron Radiation*, *29*(6), 1420-1428.

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