Image corrections for powder diffraction with thick sensor detectors

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Flat hybrid pixel detectors present the most common instruments for recording x-ray intensities in scattering experiments at photon light facilities as well as in X-ray laboratories. This holds in particular for conventional crystallographic experiments. In order to optimize quantum efficiency of the detection process the ratio of detector sensor thickness and pixel size is often set quite high. A narrow X-ray beam entering such a detector at an oblique angle is absorbed in multiple consecutive pixels. This is causing an effective shift of the detected signal known as the "parallax" effect [1, 2]. Beside this the absorption of X-ray beam in the detector sensor is more complete. The latter is called an "oblique incidence effect" [2]. Appropriate corrections are well established in software for single crystal diffraction data processing [1]. Marlton et al. [2] introduced the parallax effect correction for pair distribution function measurements. The idea is used to improve effective camera resolution in synchrotron and medical imaging [3]. In case of diffraction experiments with a flat powder sample in parallel beam geometry angular resolution is dominated by geometrical effects. In addition, for samples with crystallite size >1 um grain statistics is often not-ideal and azimuthally integrated diffraction profiles are not well defined. Diffraction spots may present blurred signal due to the parallax and oblique incidence effects as shown in Figure 1. Point spread function (PSF) over the detector area was estimated by ray-tracing the detector and the know PSF is deconvoluted from the measured signal in the next step. Results of such diffraction image processing are presented (Figure 1). Different methods for positionally variant deblurring with known PSF were used: direct inversion with regularization, Richardson-Lucy deconvolution [4, 5] and Deep learning approach [6]. Pros and cons of different methods are described, and applicability of the method is briefly discussed.

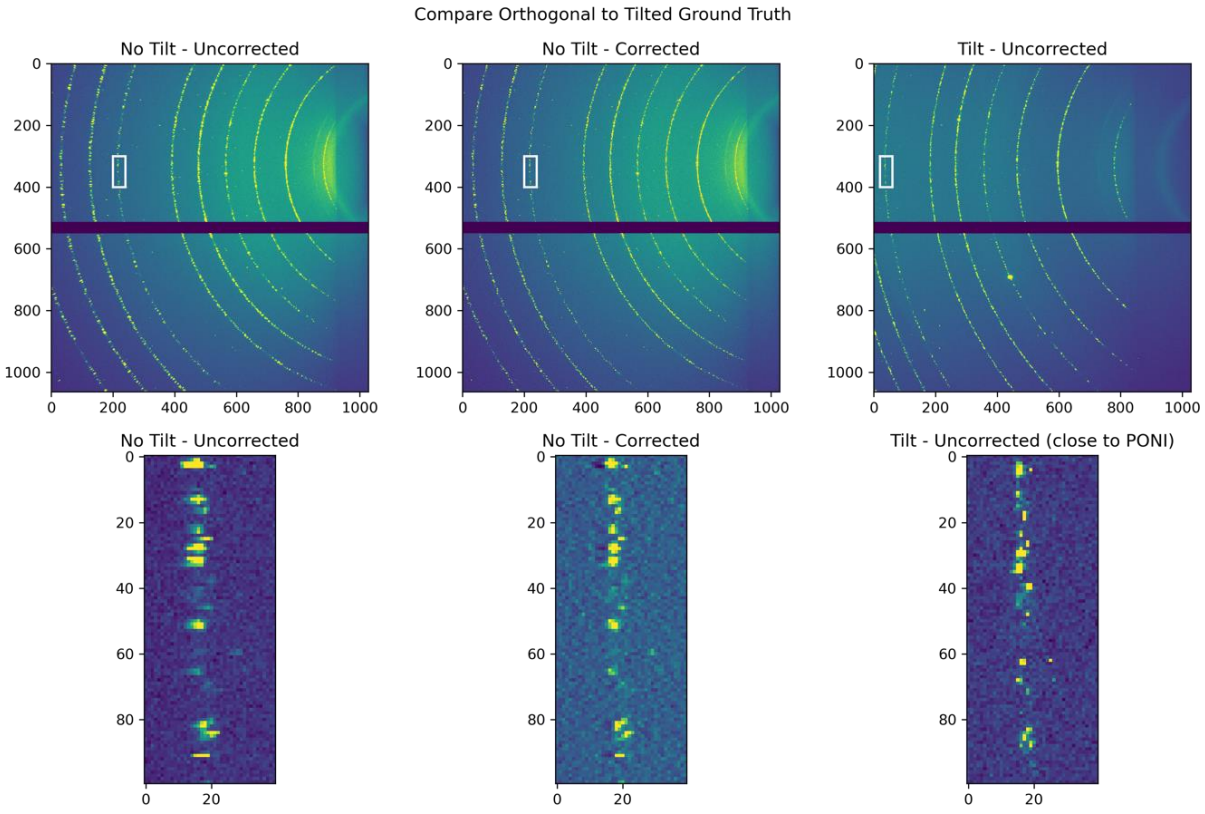

Figure 1. Positionally variant deblurring of X-ray diffraction images with known detector PSF.

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