PIMEGA 135D-L DETECTOR

The PIMEGA 135D-L is a hybrid-pixel X-ray detector with noise-free, single photon counting, and high frame rate detection capabilities up to 2000 Hz. The silicon or cadmium telluride sensors and the 55 µm pixel size can cover a wide range of energies and are suitable for many experimental techniques at synchrotron facilities. This 800 kP resolution camera can operate without dead time in continuous mode offering two adjustable energy-discriminating thresholds based on CERN Medipix3RX ASICs.

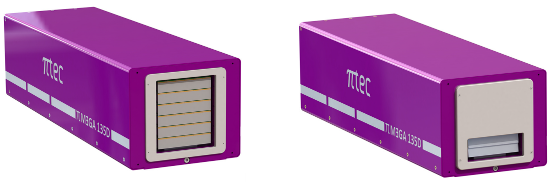

Figure 1: PIMEGA (left) 135D with 2.6 MP coplanar silicon sensors and (right) 135D-L with 800 kP overlapped sensors.

PIMEGA detector family has two options for sensor head assembly: overlapped sensors for gapless configuration (medium to far distance sample positioning applications), and coplanar sensors configuration (close distance positioning applications).

Figure 2: PIMEGA 135D detective surface with (left) coplanar and (right) overlapped silicon sensors.

APPLICATIONS AT SYNCHROTRON BEAMLINES

APS 1-ID Beamline

1-ID is a beamline at the Advanced Photon Source (APS) located at Argonne National Laboratory (ANL) operated by the Material Physics and Engineering Group of the X-ray Science Division. 1-ID provides high-energy X-ray beams for many scientific applications, such as high-energy small- and wide- X-ray scattering, diffraction microscopy, tomography, pair-distribution function, and fluorescence.

PIMEGA 135D-L Use Case at 1-ID

PIMEGA 135D-L with overlapped silicon sensors was mounted at 1-ID-C in March 2023 for preliminary detector testing. The detector was placed approximately 680 mm downstream of the CeO2 (NIST 674b) sample. High energy monochromator supplied 42 keV photons. Figure 3 illustrates the testing setup. The purpose was to validate the detector response and operation, as well as its unique point of sensors overlapping that mitigates the dead area using PIMEGA image restoration package.

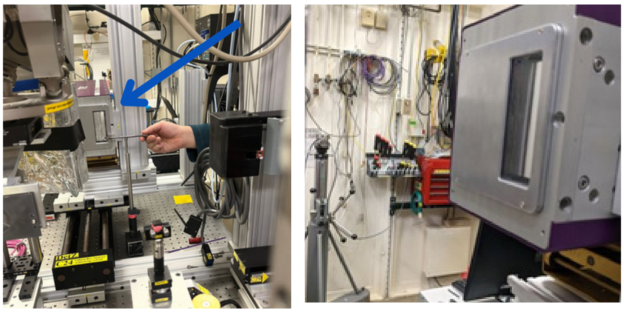

Figure 3: PIMEGA 135D-L at 1-ID-C beamline at APS. (left) Detector pointed by the blue arrow and (right) magnified view.

CeO2 Diffraction Sample

Partial diffraction patterns were obtained using CeO2 (Figure 4). The sample to detector distance was changed to place the diffraction patterns at various locations on the detector, particularly in the overlapped region.

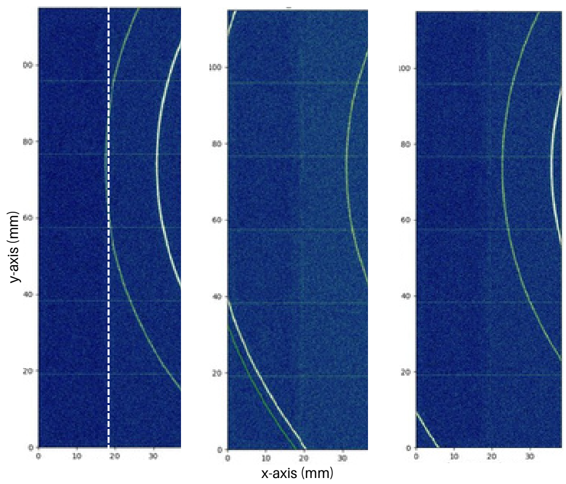

Figure 4: Raw X-ray images of the diffraction pattern from the CeO2 sample positioned (left) 731 mm (center) 631 mm and (right) 691 mm distant from the detector. Note that only the left image has a small part of the diffraction ring crossing the overlap region between the sensor rows highlighted by the dotted line.

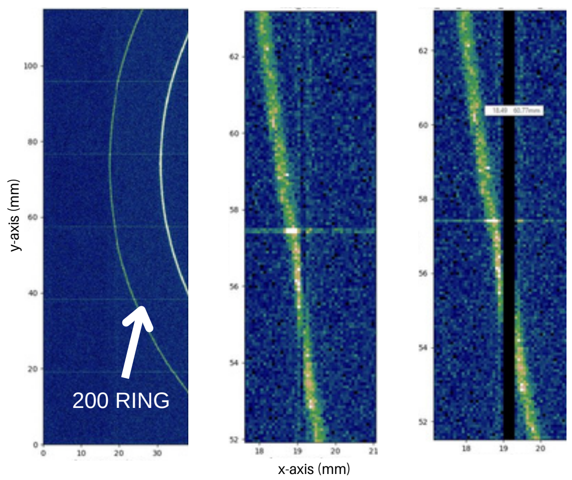

Figure 5: (left) restored X-ray image of CeO2 sample at 731 mm from the detector with the geometric correction algorithm to compensate for the overlapping sensors' distortion. A magnified view of the sensor's crossing region shows the 200 ring in (center) the raw image and (right) the restored image.

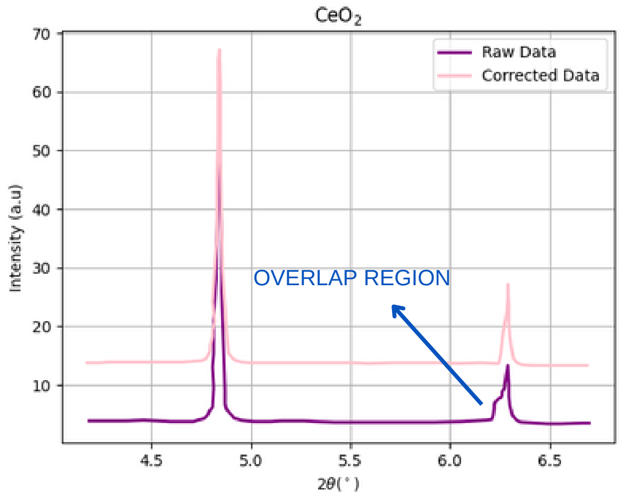

Figure 6: Integration of unrestored data (raw data in purple) and corrected data (with geometric correction in pink) of the CeO2 sample at 731 mm from the detector. A very small part of 220 ring crosses the overlap region, where is evident a split in the 220 peak.

Conclusions

It was possible to verify that diffraction rings that cross the overlap region of the detector present a split in the 2θ integration peak, as shown in peak 220 of the purple curve in Figure 6. However, with the application of the geometric image correction algorithm, it is possible to see in Figure 5 that the ring is aligned and the kink in 220 peak in Figure 6 appears mostly corrected by restoration. The restoration data process takes into account the distance from the sample to the detector and therefore the overlapping sensor should be used for greater distances if one desires to minimize the dead area, once in small distances the distortion effects are increased.

Acknowledgement

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