Quantum DETECTORS

Merlin4X

Merlin4X

Application Notes

Ptychographic imaging at Brookhaven National Laboratories HXN beamline with Merlin4X hybrid pixel array detector

Introduction

Hybrid Photon Counting (HPC) detectors provide state-of-the-art technology for X-ray detection on the beamline or home laboratory. Each pixel is a direct X-ray photon counter, with zero readout noise or dark current which improves the signal-to-noise ratio in reflection measurements. Merlin-4X – using the Medipix3 chip - has rapid readout times of between 14,400 and 600 frames per second depending on bit depth, and combined with gapless readout using the two available pixel counters, a wide range of experiments can be performed. The small size and power consumption of the Merlin detector head, coupled with its room temperature operation, allows it to rely on ambient cooling through the detector head housing. This makes the system very self-contained and easy to install in the sterically constrained environment of a beamline. These features, combined with the exceptional dynamic range of up to nearly 17M counts, makes Merlin4X a flexible and valuable addition to the beamline set-up.

Experimental Overview

A research group lead by Yong Chu at Brookhaven National Laboratory's National Synchrotron Light Source II have achieved spatial resolutions approaching 10 nm implementing the Merlin4X detector for ptychography with multimodal scanning hard X-ray imaging. The multimodal imaging is realised by utilising simultaneously absorption, phase- and fluorescence contrast techniques.

The 512 × 512 pixel Merlin4X detector with a 55 micrometer pixel size was placed 0.5 metres downstream of the target and used to capture the absorption and phase images. At the same time a Vortex three-element silicon drift detector - read out using Quantum Detector's Xspress3 - was used to capture the fluorescence induced spectra.

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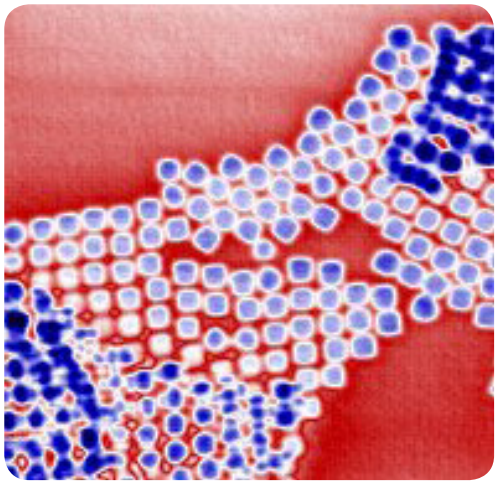
Results

Combining the techniques of absorption, phase and fluorescence contrast allowed to investigate an ionic-electronic conducting ceramic-based membrane material employed in solid oxide fuel cells, as well as membrane separations. The achieved spatial resolutions revealed the existence of an emergent material phase and quantified the chemical complexity at the nanoscale level.



> “Fast readout speeds and zero noise”

Figure. Reconstructed phase image of a Au nanoparticle array, using the Merlin4X detector at Brookhaven National Laboratory’s NSLS-II. Particle size is 50 nm and field of view 1 x 1 μm^2.

Conclusion

This work is an important milestone in hard X-ray scanning microscopy, effectively eliminating the gap between demonstration of optical resolution under ideal experimental conditions and actual imaging resolution for routine scientific measurements. The fast readout speed, zero noise, high spatial resolution, exceptional dynamic range and flexibility of the Merlin4X detector played a crucial role in these experiments.

References

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