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INVITED: Direct electron detectors in electron cryo-microscopy

Wednesday, June 28, 2023 8:30 AM (30 minutes)

In the last decade electron cryo-microscopy (cryoEM) has risen from relative obscurity to being one the most important techniques in structural biology. The rise of cryoEM has been made possible by the introduction of large area direct electron imaging detectors. The higher detective quantum efficiency, (DQE) possible with these is key but also important is ability to take many more images with a large field of view and to acquire these images as a series of frames with which corrections for sample motion and radiation damage dose weighting can be made.

Electron microscopes used for cryoEM are typically operated between 100 and 300 keV and as phase contrast imaging is used, electrons arrive at the detector with essentially their initial energy. The small amount of energy that is lost in passing through the sample due to inelastic scattering events rapidly destroys radiation sensitive biological samples. This limits the number of electrons that can be used to form a useful image and is the reason why the highest possible DQE is required.

Detectors for cryoEM must themselves be radiation hard and to be useful they need to be both fast and have a large field of view. Bigger and faster detectors are always desirable but even with current detectors of ˜16 Mpixels that can take an image every few seconds it is possible to generate over 1 PB of data per year from a single cyroEM system.

The stochastic scattering and associated variable energy deposition of incident electrons in a sensor layer is the limiting factor in degrading the DQE of cryoEM detectors. I will discuss how this overcome and the different strategies that are needed for 100 keV and 300 keV electrons.

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