DE-16 Camera System

ultra high speed direct detection for in situ TEM

Direct Electron®
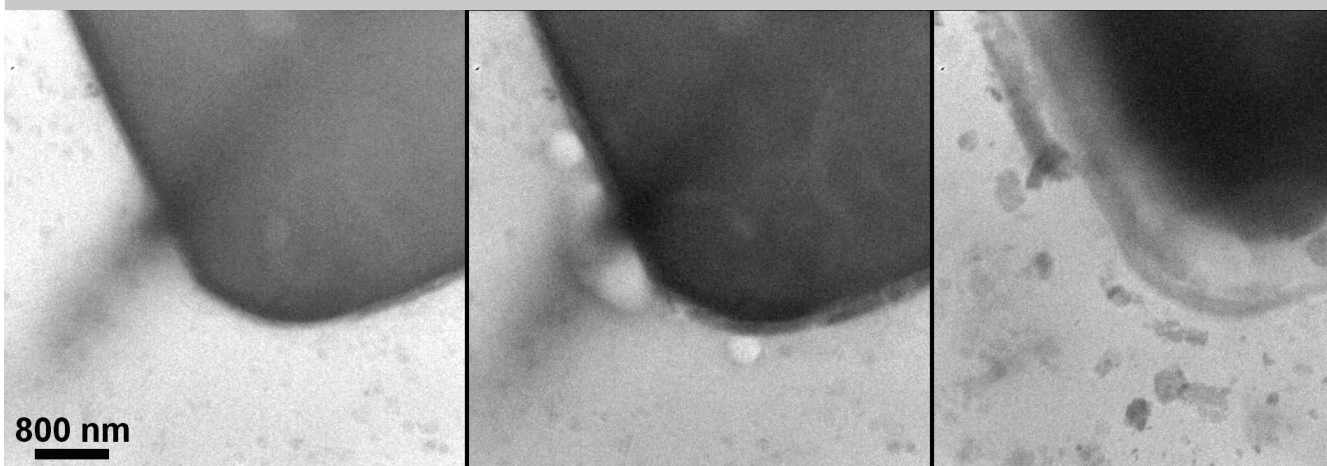
INNOVATION PROPELLING DISCOVERY

Better Science, Faster   –   Brilliant Results in Less Time

- Direct detection device (DDD®) delivers *high resolution, excellent sensitivity, and ultra-low noise*.

- *4k × 4k* (16.8 million) pixels.

- Ideal for materials science with the best dynamic range of any direct detector.

- *High-speed* continuous streaming for *in situ* TEM and "movie-mode" processing (motion correction).

- *Unrivaled features*, such as an integrated survey sensor, Faraday plate, and open-source software.

- *Electron counting* to maximize signal-to-noise ratio, when needed.

- *The best of all the new TEM camera technology in a single integrated system.*

- Low total cost-of-ownership and exceptional support.

Microscopy
TODAY
INNOVATION AWARDS

Direct Electron®
DDD® Camera System

In situ TEM experiment with an electrochemical liquid cell, showing dissolution of an electrode. Data was collected at 75 frames per second (fps). Courtesy of Haimei Zheng, Lawrence Berkeley National Lab. Published in Zeng, et al., *Faraday Discuss* 176 (2014).
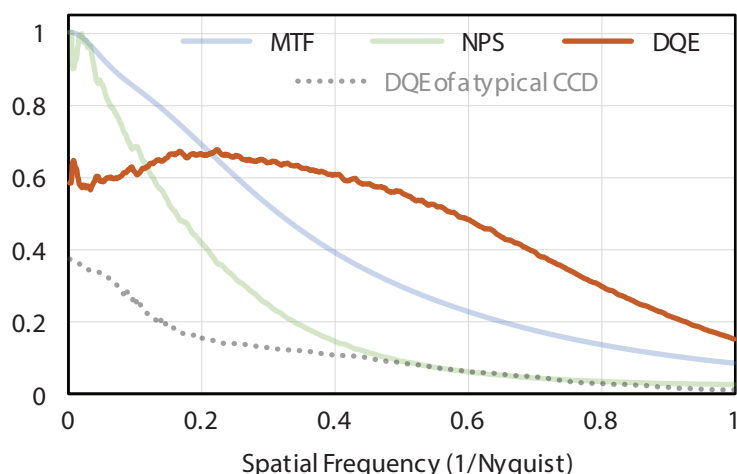
800 nm

DE-16 Camera System

Direct Electron delivers | bigger | better | faster | cameras for electron microscopy

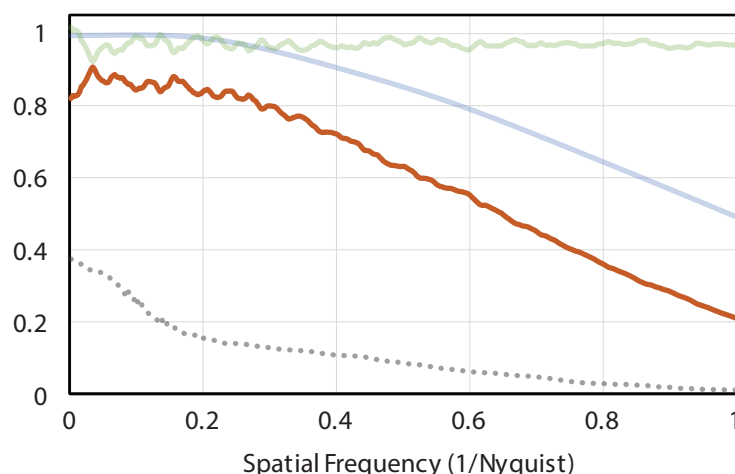|	
detection electron energy	optimized for 80 keV − 1.25 MeV
pixel array specification	4096 × 4096 (16.8 million pixels) │ 6.5 μm pixel pitch
single electron SNR	~50:1 (300 kV)
sensor design	>3T pixel design with correlated double sampling (CDS) │ backthinned │ radiation hardened
acquisition frame rate	60 fps max, unbinned full-frame │ 120 fps, bin 2× full-frame subarray readout up to 1920 fps max
acquisition modes	integrating mode │ counting mode (with optional counting system)
exposure rate	large dynamic range with consistent performance in integrating mode (e.g., 4 − 800 e-/pixel/s)
mounting position	fully retractable │ mounted on-axis TEM bottom port or in JEOL film drawer
"buddy" camera	integrated near-axis 2048 × 2048 scintillator-coupled survey sensor
exposure measurement	integrated Faraday plate for exposure measurement with each acquisition
sensor protection	integrated physical protection shutter │ microscope blanking/shuttering │ failsafe software
computer system	certified high-performance computer system with large >25 TB RAID array for data streaming
image format	image data stored in non-proprietary format to ensure broad compatibility
acquisition & processing software	*conventional acquisition*: DE-IM (full-featured, user-friendly) │ μManager (free, open-source) *in situ movie acquisition*: DE-StreamPix (continuous streaming) *automated acquisition*: Leginon │ SerialEM │ EMTools (TVIPS) │ others using the DE SDK *"movie" processing*: DE image processing software (free, open-source, Python-based) │ others *customization*: software development kit (SDK) for integration with custom software

Integrating Mode
best for maximizing overall productivity

MTF   NPS   DQE
DQE of a typical CCD

Spatial Frequency (1/Nyquist)

Electron Counting Mode
best for maximizing signal-to-noise ratio

Spatial Frequency (1/Nyquist)

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