



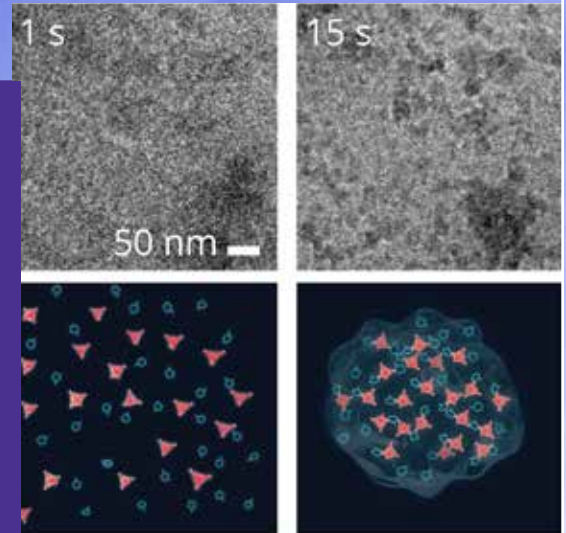
DE-16 CAMERA SYSTEM

Exceptional DQE & Enormous Area For Cryo-EM

Delivering Bigger | Better | Faster | Cameras For Electron Microscopy

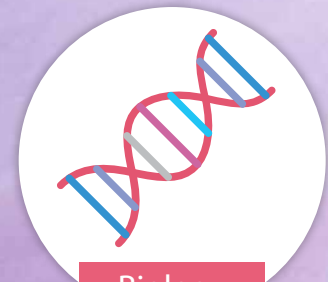
TEM DIRECT DETECTION WITH STUNNING SENSITIVITY

- The most advanced direct detection sensors, delivering high speed, extraordinary resolution, and ultra-low noise.
- Superior DQE delivers higher resolution and better contrast for high-speed single frames.
- 4k × 4k (16.8 million) pixels.
- High-speed continuous streaming for in situ TEM, 4D STEM, and microED.
- Global shutter eliminates artifacts in high-speed applications.
- Versatility for a wide range of TEM experiments.
- Electron counting to maximize SNR for low-dose applications.
- High-dynamic range (HDR) counting for 4D STEM & EELS.
- Optional ER sensor optimized for 30 - 300 kV.

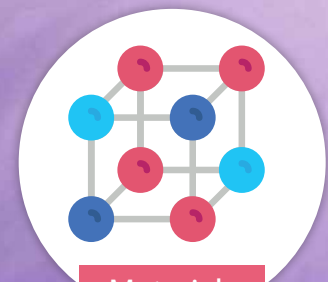


Metal-organic framework (MOF) formation via liquid phase in situ TEM using a DE-16 camera in counting mode with an ultra-low beam dose of 0.05 e-/Å²/s. Figure based on Liu, et. al 2021 (<https://doi.org/10.1073/pnas.2008880118>)

DETECTOR APPLICATIONS:



Biology



Materials

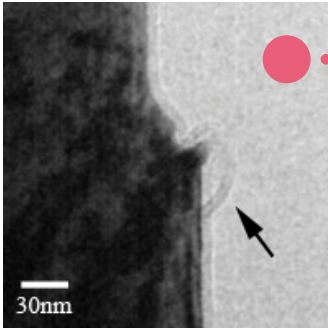
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OPTIMIZED FOR DEMANDING TEM APPLICATIONS

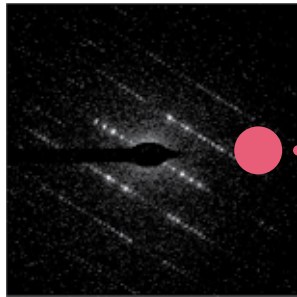
In situ TEM & Environmental TEM (ETEM)

High-speed movies with exceptional contrast



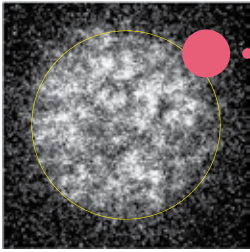
Diffraction/MicroED

Single patterns or continuous rotation with high SNR



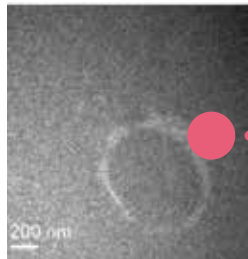
4D STEM/Ptychography

Fast, large-area pixelated STEM detector



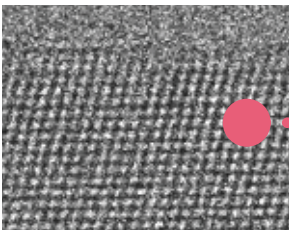
DTEM/UTEM & EFTEM

Enormous area with high resolution



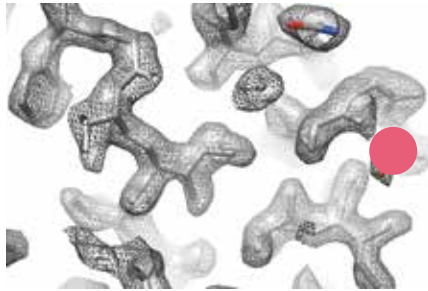
Low-Dose Imaging

Exceptional SNR with electron counting



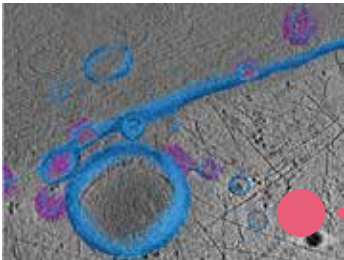
Single-Particle Cryo-EM

High-resolution 3D reconstructions



High-Resolution Tomography

Conventional or continuous-rotation acquisition



THE MOST ADVANCED DIRECT DETECTION SENSOR TECHNOLOGY

Hardware binning and ROI
to increase frame rate up to
4,237 fps (236 μ s / frame)

User-adjustable frame rate
in hardware to optimize SNR
by reducing readout noise

Hardware sync I/O
for high-speed synchronization of
other hardware (e.g., scan generator)
with the camera frame rate

Global shutter mode
to eliminate high-speed artifacts
that affect other CMOS cameras

On-chip CDS
for the lowest noise and
best SNR at high-speed

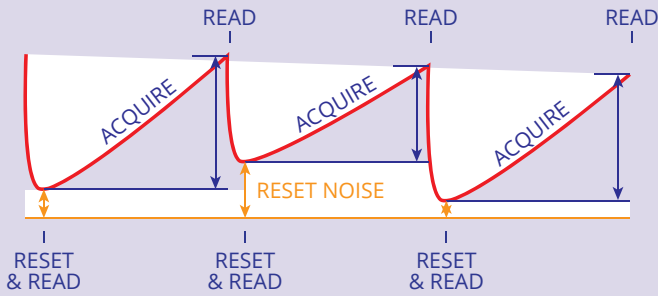
ER sensor option
for direct detection at all
TEM accelerating voltages

Access to all camera frames
at full-speed and full-resolution
without significant delays

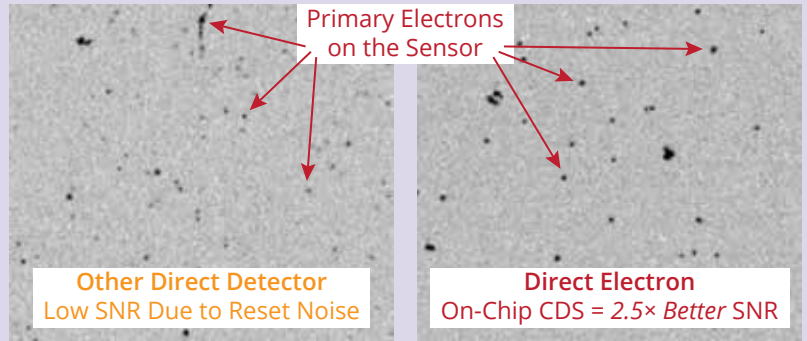
**Can your
direct detector
do this?**

Compressive sensing
readout modes to further
boost readout speed

ADVANCED SENSOR TECHNOLOGY TO DELIVER THE BEST SENSITIVITY



On-chip correlated double sampling (CDS) dramatically improves sensitivity by subtracting reset noise that plagues other CMOS sensors



Direct Electron's DDD® sensors have ultra-low noise, which is clearly demonstrated by visualizing individual 300 keV electrons. TEM primary electrons clearly stand-out from the background on the Direct Electron sensor, while they are often lost in the background of other sensors. *Figure courtesy of Greg McMullan, (MRC-LMB, Cambridge, UK).*

ELEGANTLY-DESIGNED TO MAXIMIZE SCIENTIFIC PRODUCTIVITY

Integrated Faraday plate for exposure measurement with each acquisition
(US Patent 7,952,073)

Sensor protection shutter to protect the direct detection sensor from undesired exposure
(US Patent 7,952,073)

High-performance 10th generation DDD® sensor custom-designed and manufactured by Direct Electron

Precision-engineered parts that are widely compatible with TEMs from many manufacturers

Field-replaceable sensor to maximize instrument uptime over the lifetime of the camera

Fully retractable to enable use of other cameras and/or an energy filter mounted under the DE camera

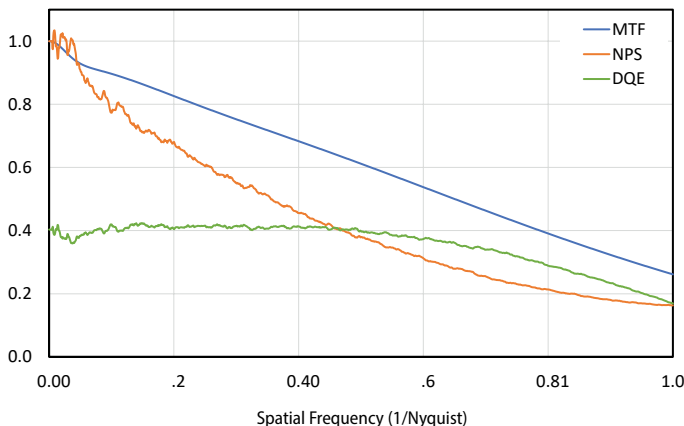
No sliding O-rings to prevent vacuum "hiccups" during insertion/retraction



TEM Electron Energy	Standard sensor optimized for 200 - 300 keV ER sensor optimized for 30 - 300 keV
Pixel Array Specification	4096 × 4096 (16.8 million pixels) 6.5 μm pixel pitch
Single Electron SNR	~50:1 (300 kV)
Sensor Design	Custom-designed DDD [®] sensor on-chip correlated double sampling (CDS) backthinned radiation hardened
Acquisition Frame Rate	92 fps max, unbinned full-frame 281 fps max, binned-2× full-frame, low-noise subarray readout up to 4,237 fps (2048 × 128) user-selectable hardware frame rate
Readout Modes	Rolling with on-chip CDS global with optional off-chip CDS
Acquisition Modes	Integrating mode electron counting mode HDR counting mode (US patent #11,252,339)
Exposure Rate	Large dynamic range with consistent performance (e.g., >10,000 e-/pixel/s)
Tem Compatibility	All major TEM manufacturers & models DE-Freescan requires stem capability
Mounting Position	Fully retractable compatible with a wide-range of configurations typically in TEM bottom port, pre- or post-energy filter, or in JEOL film drawer
Sensor Protection	Sensor protection shutter TEM blanking/shuttering failsafe software
Computer System	High-performance computer Windows 10 Nvidia GPU(s) up to 55 TB storage
Image Format	Non-proprietary HDF5, MRC, TIFF, or TIFF LZW compatible with Fiji, LiberTEM, Hyperspy, Py4DSTEM, etc.
Automation Software	SerialEM open API for custom integrations (with Python, C, C++, C#, etc.)
Integrations	CEFID post-column energy filter (CEOS) precession diffraction (Nanomegas)
Scan Control	DE-Freescan scan controller (also includes 4 analog detector inputs) hardware synchronization signal (BNC) selectable as either input or output

Integrating (Linear) Mode

Best for imaging of viruses and nanoparticles



Electron Counting Mode

Best for imaging of small and/or challenging proteins

