



# DE-64 Camera System

exceptional DQE & enormous area for cryo-EM

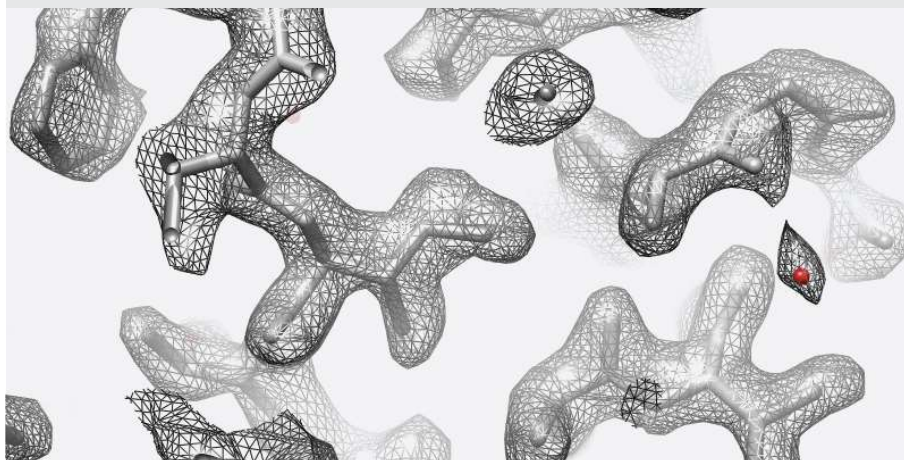
delivering | bigger | better | faster | cameras for electron microscopy

## Direct Detection for Transmission Electron Microscopy

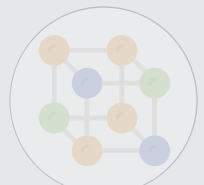
- The most advanced direct detection sensors, delivering high speed, extraordinary resolution, and ultra-low noise.
- Superior DQE delivers higher resolution for cryo-EM.
- 8k × 8k (67.1 million) pixels.
- Electron counting with large pixels & CDS for the very best image quality.
- Movie-mode imaging for motion correction, dose filtering, etc.
- Continuous streaming for microED (diffraction) & continuous-tilt tomography.
- High-dynamic range, global shutter readout, & integrating mode for microED.
- The most impactful and cost-effective upgrade to a TEM's capabilities.



Cryo-EM at 2.3 Å resolution structure of lumazine synthase from the DE-64 counting on a JEOL CryoARM300.  
*Figure courtesy of David Bhella (University of Glasgow, Glasgow, Scotland, UK).*



Applications



MATERIALS



BIOLOGY

Direct Electron<sup>®</sup>  
INNOVATION PROPELLING DISCOVERY

# Optimized for Ultra-High-End Cryo-EM Applications

**High-Throughput Automation**  
ultra-large search mode images without montaging

**High-Resolution Single-Particle**  
counting with large-pixels & CDS maximizes DQE

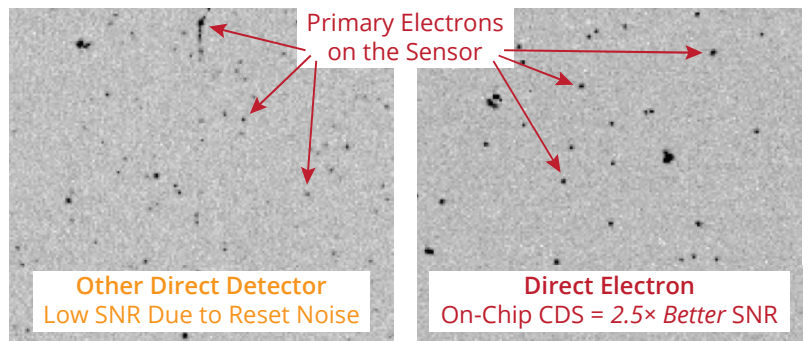
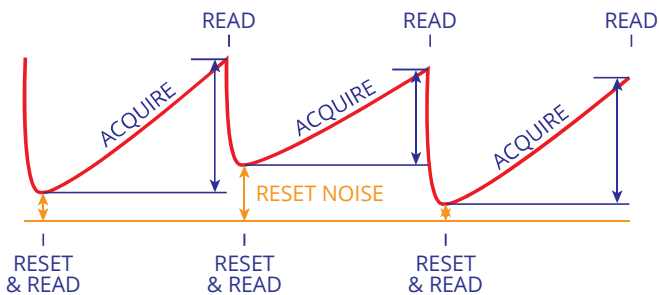
**Continuous-Tilt Tomography**  
tilt-series acquisition in under 3 minutes

**Conventional Cryo-Tomography**  
enormous area with high resolution

**MicroED (Diffraction)**  
high dynamic range & large area for crystallography

## The Most Advanced Direct Detection Sensor Technology

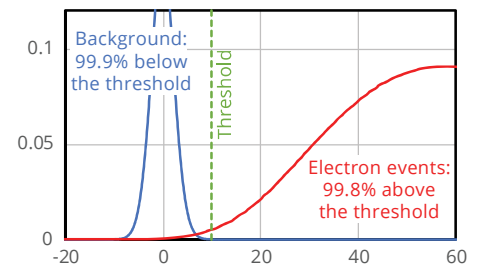
**on-chip correlated double sampling (CDS)** dramatically improves sensitivity by subtracting reset noise that plagues other CMOS sensors



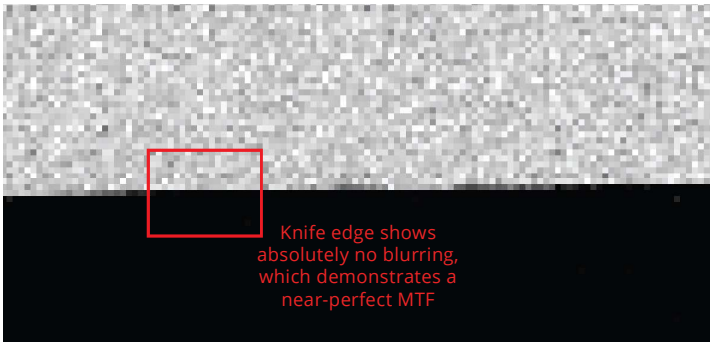
Direct Electron's DDD® sensors have ultra-low noise, which is clearly demonstrated by visualizing individual 300 keV electrons. TEM primary electrons clearly stand-out from the background on the Direct Electron sensor, while they are often lost in the background of other sensors. *Figure courtesy of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



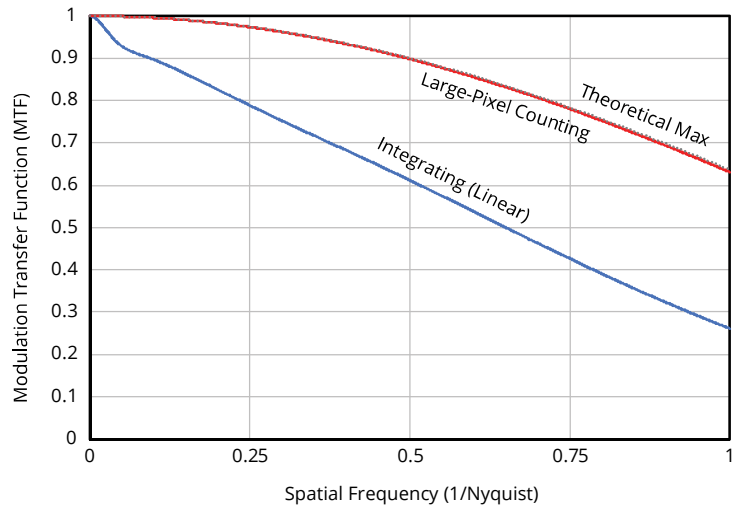
The DE-64 delivers ultra-high DQE(0) because electron events are easily distinguishable from background. The counting threshold is thus highly effective.



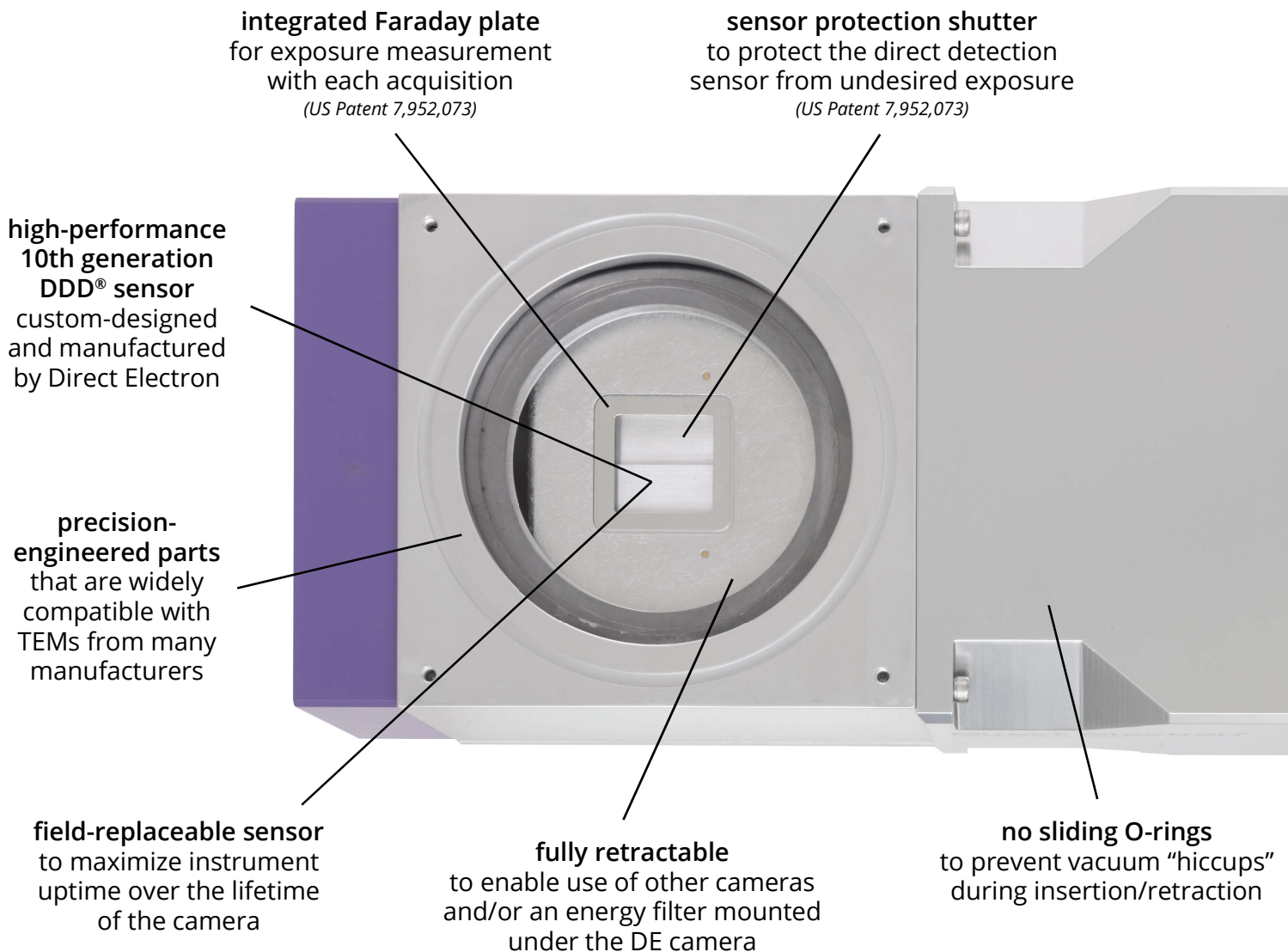
# Large-Pixel Electron Counting Delivers Near-Perfect MTF



Hardware binning by 2× on the DE-64 delivers two key benefits: (1) it matches the pixel size to the event size of electrons on the sensor, eliminating uncertainty in the location of each incoming electron, and (2) it increases the camera frame rate so that single-particle exposures are approximately 8-12 seconds.



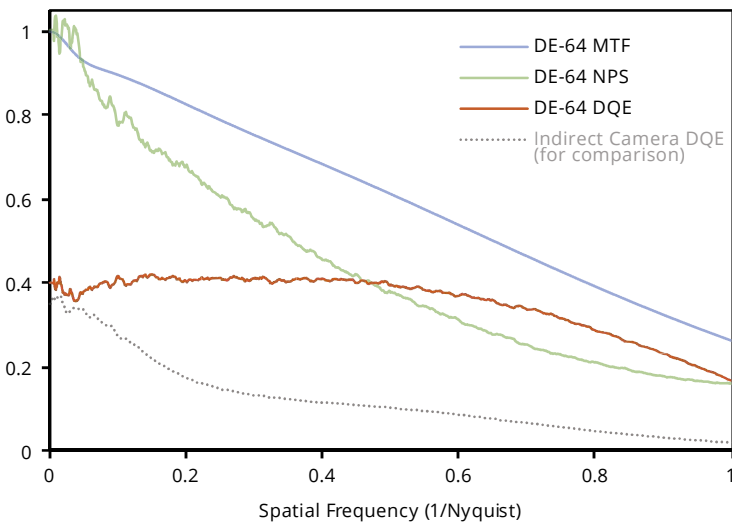
# Elegantly-Designed to Maximize Scientific Productivity



<b>TEM electron energy</b>	sensitive to 80 keV – 1.25 MeV   optimized for 200 & 300 keV
<b>pixel array specification</b>	8192 × 8192 (67.1 million pixels)   6.5 μm pixel pitch
<b>single electron SNR</b>	~50:1 (300 kV)
<b>sensor design</b>	>3T pixel design with on-chip correlated double sampling (CDS) backthinned   radiation hardened   rolling or global shutter
<b>acquisition frame rate</b>	42 fps max, unbinned full-frame   141 fps max, binned-2× full-frame, low-noise subarray readout up to 4,512 fps (4096 × 128)   user-selectable hardware frame rate
<b>acquisition modes</b>	integrating mode   counting mode (with optional counting system)
<b>exposure rate</b>	large dynamic range with consistent performance (e.g., >500 e <sup>-</sup> /pixel/s)
<b>mounting position</b>	fully retractable   mounted on-axis TEM bottom port or in JEOL film drawer
<b>exposure measurement</b>	integrated Faraday plate for exposure measurement with each acquisition
<b>sensor protection</b>	integrated sensor protection shutter   TEM blanking/shuttering   failsafe software
<b>computer system</b>	high-performance computer   Windows 10   NVidia GPU(s)   up to 80 TB storage
<b>image format</b>	non-proprietary to ensure broad compatibility   TIFF, MRC, AVI, MP4, etc.
<b>acquisition software</b>	image acquisition: DE-IM (full-featured, modern GUI)   ImageJ / μManager streaming acquisition: DE-StreamPix (realtime, continuous display and recording)
<b>automation</b>	compatibility: SerialEM   Legion   EMTools (TVIPS)   JADAS (JEOL)   others customization: software development kit (SDK) for integration with custom software

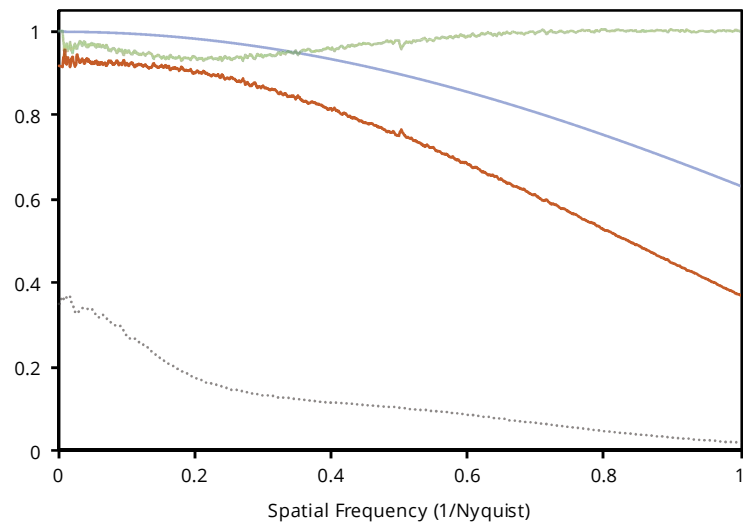
## Integrating (Linear) Mode

best for single particle analysis of viruses and large complexes



## Electron Counting Mode

best for single particle analysis of small and/or challenging proteins



DQE curves are shown for 300 kV electrons | Counting Mode DQE is with 2x-binning and assuming a flat NPS | Specifications and performance are subject to change.  
Example images of various camera applications were collected by researchers using one of Direct Electron's cameras (not necessarily the DE-64).