APOLLO Camera

ultra-fast electron counting for cryo-EM

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

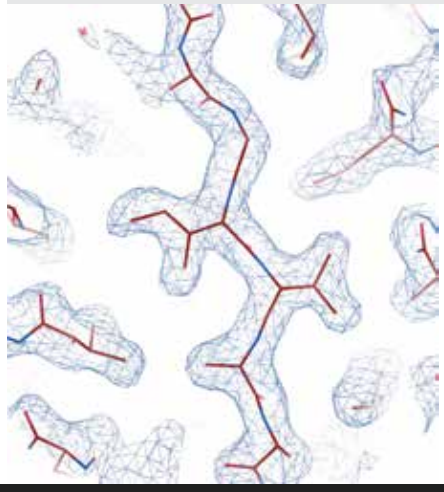
Direct Electron®
INNOVATION PROPELLING DISCOVERY

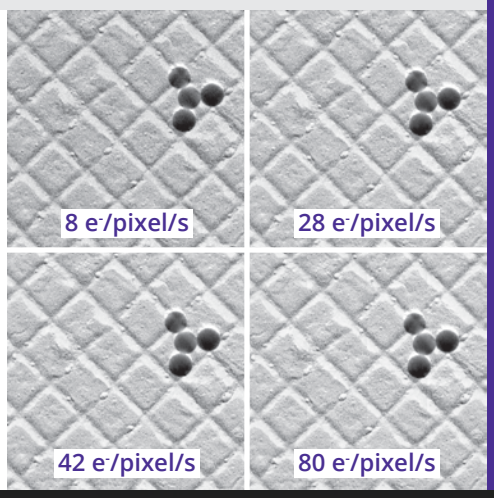
World's First Event-Based Active Pixel Direct Detector

- Our novel direct detection device (DDD®) delivers **ultra-low noise** and **extraordinary resolution** for almost **any beam brightness**.
- **Electron counting in hardware** through a combination of sensor technology & FPGA edge computing.
- **Change the paradigm** for cryo-EM by removing camera limitations.
- **On-chip CDS** minimizes noise and maximizes detection efficiency.
- **4k × 4k** (16.8 million) physical pixels with larger **8 µm pixel size** to maximize resolution (MTF).

- **Super-resolution** 8k × 8k (67.1 MP) readout to the computer at **60 fps** for motion correction, dose filtering, etc.
- Elegant, powerful, and **easy-to-use** for cryo-EM.
- Integrated with SerialEM for **automated** data acquisition.

(*Left*) Example of a 2.0 Å resolution cryo-EM structure from a DE-64 with electron counting. *Courtesy of David Bhella (University of Glasgow, UK).*
(*Right*) Apollo counting images at 200 kV at various exposure rates for 1.5 s.





Applications

MATERIALS

BIOLOGY

Direct Electron
INNOVATION PROPELLING DISCOVERY

APOLLO Camera

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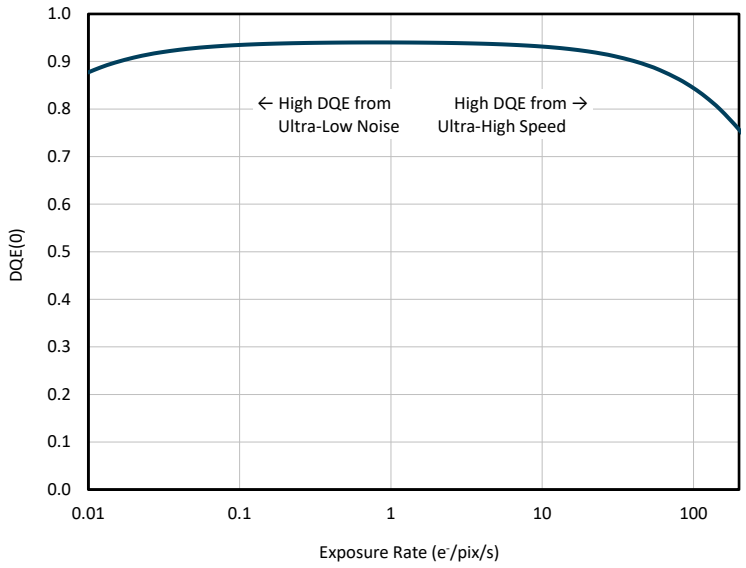
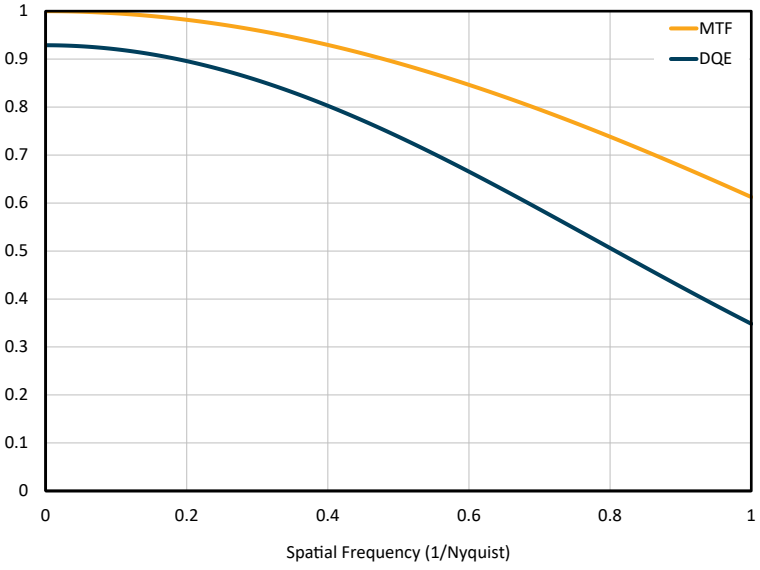
TEM electron energy	sensitive to 80 keV – 1.25 MeV | optimized for 200 - 300 keV
pixel array size	4096 × 4096 (16.8 million pixels) | 8 µm pixel pitch
sensor design	novel event-based ultra-fast DDD® sensor on-chip correlated double sampling (CDS) | on-chip thresholding backthinned | radiation hardened
detection efficiency	>90% for 200 - 300 kV
counting frame rate	~2,400 fpse (frames per second equivalent to conventional direct detector)
external frame rate	60 fps delivered to disk | 8192 × 8192 (67.1 million pixels) super-resolution
acquisition modes	event-based electron counting, always
exposure rate	~0.01 - 100 e^-/pixel/second (ranging 4 orders of magnitude)
linearity	>95% linear up to ~60 e^-/pixel/second
mounting position	fully retractable | compatible with a wide-range of TEM configurations typically in TEM bottom port, pre- or post-energy filter, or in JEOL film drawer
sensor protection	TEM blanking/shuttering | failsafe software
computer system	high-performance computer | Windows 10 | NVidia GPU(s) | up to 55 TB storage
image format	non-proprietary to ensure broad compatibility | MRC or TIFF
acquisition software	image acquisition: DE-Server v.2 | DE-IM | ImageJ / µManager automation: SerialEM | Leginon | JADAS (JEOL) | others
applications	single-particle cryo-EM | tomography





DQE curves are shown for 200 kV electrons with Nyquist meaning the physical (non-super-resolution) Nyquist | 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 Apollo).