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DATASHEET

Falcon 3EC Direct Electron Detector

High-quality cryo-EM experiments

The Falcon 3EC Detector is the ideal camera for Single Particle Analysis (SPA) and Cryo-Tomography experiments. Thanks to the high Detector Quantum Efficiency (DQE) and large effective area, 3D reconstructions require fewer particles and fewer images.

The Thermo Scientific™ Falcon™ 3EC Direct Electron Detector is the first detector to benefit from our next-generation image processing pipeline. It is seamlessly connected to a fast buffer storage server, which makes waiting for frames to be stored a thing of the past. Images, including individual frames or dose fractions, are processed and transferred to the dedicated buffer storage on-the-fly. The Falcon 3EC Detector's high signal (thanks to the large pixel size) and extreme low-noise levels (thanks to patented technology) combine with the pipeline's capability for on-the-fly drift correction to ensure the highest quality data.

Key Benefits

High DQE for high-quality reconstructions

- In High Quality (HQ) EC mode, the DQE is nearing the theoretical maximum for a pixelated detector
- In Electron Counting (EC) mode, the DQE is perfectly suited for small particle analysis
- In fast mode, DQE is ideal for large biological structures and screening with side-entry holders

Straight forward camera usage

- Fully embedded in Thermo Scientific™ EPU™ Software for single particle acquisition and Thermo Scientific™ Tomography Software
- Intuitive camera operation throughout low- and high-magnification range

High throughput for fast time to results

- Largest effective area and best DQE: fewer images needed for same quality reconstruction
- Next-generation data pipeline for on-the-fly corrections
- Dedicated buffer storage optimized for speed

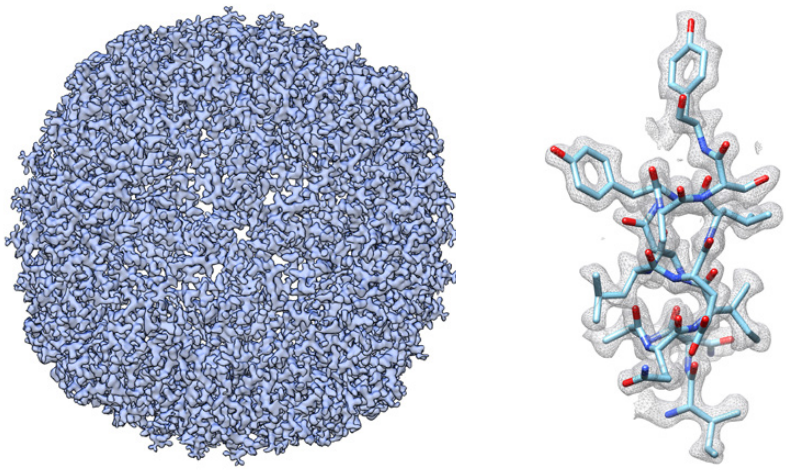

Figure 1. 3D reconstruction of Apoferritin at a resolution of 1.63 Å (overview (left) and detail (right)). Data taken on a Thermo Scientific™ Krios™ G3i Cryo-TEM with Falcon 3EC Detector in electron counting mode. Image processing was done with Relion 3.0. *Courtesy of R. Danev, H. Yanagisawa and M. Kikkawa from The University of Tokyo, Japan*

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Electron Counting mode: Ultimate DQE performance

Thanks to its large pixel design—tailored to low-dose life sciences applications—the Falcon 3EC Detector's sensor has always excelled in high signal and low noise. For the Falcon 3EC Detector the signal-to-noise ratio has even been further improved with patented noise reduction technology. This noise reduction is based on multi frame correlated double sampling (MF – CDS).

At the lowest dose rate in electron counting mode (High Quality (HQ) EC mode), the DQE nears the theoretical maximum sensitivity of a pixilated detector. This makes it the ideal camera for high-resolution SPA of extremely small structures.

The main advantage of electron counting is that fewer particles are needed to create a reconstruction at a specific resolution, because of the combination of high DQE and large effective area. Additionally, the Falcon 3EC Detector, in combination with the Thermo Scientific™ Phase Plate, is a valuable imaging solution for extremely small proteins, as it leverages the combination of best signal-to-noise and highest-contrast performance.

Fast mode: Extremely fast, yet high DQE

In Fast mode (i.e. linear/integration mode), exposure times can be set as low as 0.1 seconds. Combined with the benefits of the optimized data path, this makes data collection very fast. Yet, the penalty on DQE performance is minimal. This makes it an ideal camera for extremely fast high-resolution data collection of larger biological structures. This mode is also particularly useful for fast screening and/or initial modelling, ideally in combination with the Phase Plate. After quick initial modeling (e.g. to check sample quality), the same camera can be used for extended high-resolution data collection by switching to Electron Counting mode at higher DQE.

Straight forward camera usage

The Falcon 3EC Detector is the first electron counting detector to combine full embedding in Thermo Scientific application software (EPU and Tomography) with ultimate DQE performance. The completely revised dose protection software protects the camera from dose damage, yet it does not interfere with your work. And since Low Magnification mode is now supported, there is no longer a need to switch cameras in SPA or cryo-tomography experiments. The result is easier setup of the experiment and increased throughput.

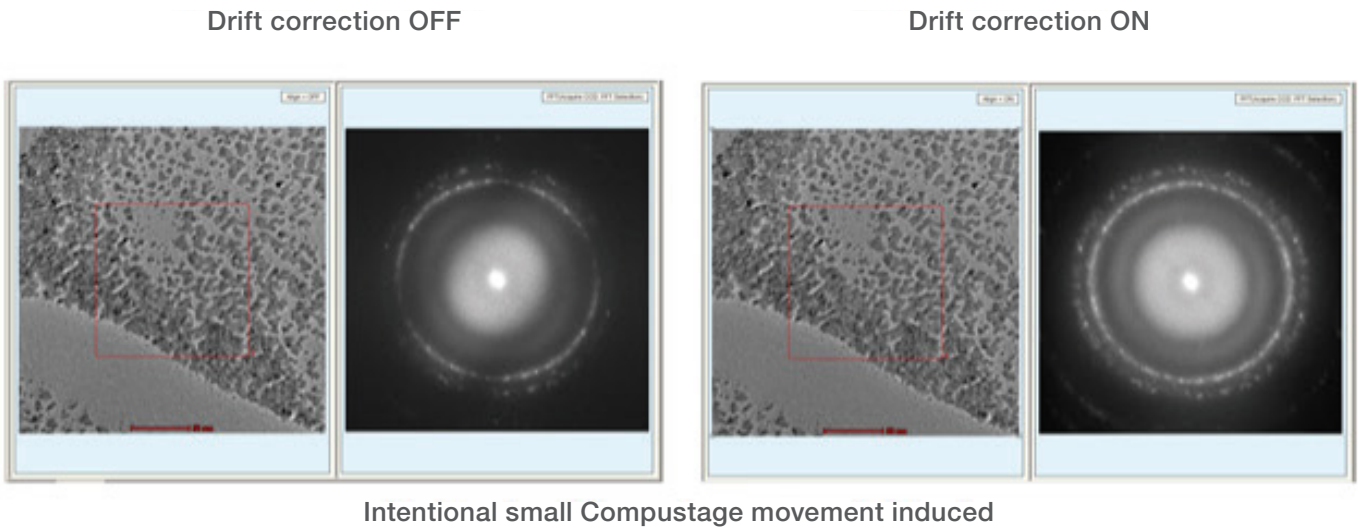

Figure 2. On-the-fly drift correction switched OFF (left) and ON (right). This technology ensures high-quality data without the need to save all the individual frames for post-processing.

System requirements

The Falcon 3EC Detector is available on Thermo Scientific™ Krios™ Cryo-TEM, Glacios™ Cryo-TEM and Talos™ TEM (Win7) platforms; and Titan TEM and Tecnai TEM by Thermo Fisher Scientific (Win7) platforms at 200 kV and 300 kV.

Key Specifications					
Camera architecture	Direct Electron Detection				
Sensor size	4096 × 4096 pixels ~ 5.7 x 5.7 cm				
Pixel size	14 × 14 μm^2				
Operating voltage	200 kV and 300 kV				
Mounting position	On-axis, bottom-mounted, retractable				
Frame rate	40 fps to storage				
Detection modes	HQ EC mode (electron counting) EC mode (electron counting) Fast mode (non-electron counting – integration mode)				
Imaging performance 4k x 4k DQE @ 0.5 Ny					
HQ EC mode	(0.7 e/p/s)	0.7	(300 kV)		
EC mode	(1 e/p/s)	0.6	(300 kV)		
Fast mode	(10 - 120 e/p/s)	0.4	(300 kV)	0.3	(300 kV)

DQE-based detector comparison

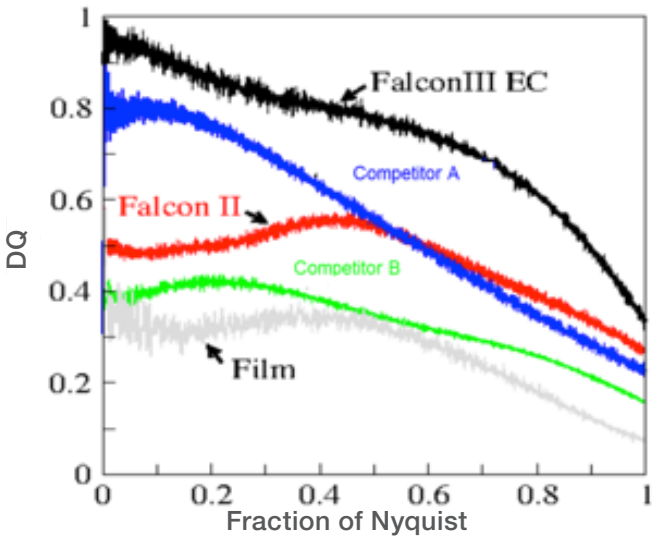

Figure 3. DQE comparison of various detectors by MRC Cambridge (Greg McMullan and Richard Henderson 2017). Competitor A in counting mode, competitor B in integrating mode and Falcon 3EC Detector in HQ EC mode. Falcon 3EC Detector data inserted by the authors in Figure 4 of G. McMullan, et al, *Comparison of optimal performance at 300 keV of three direct electron detectors for use in low dose electron microscopy*, **Ultramicroscopy**, 2014; 147: 156-163

Notes

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