

Falcon II™

16 Megapixel TEM Direct Electron Detector with Back-Thinned Sensor Technology

Revolutionize Your Image Detection

FEI is changing the world of Transmission Electron Microscopy (TEM) image detection with the launch of its second-generation Falcon II™ Direct Electron Detector. With unsurpassed sensitivity and detector quantum efficiency (DQE), the Falcon II is designed to optimize image detection for beam-sensitive specimens requiring extreme low dose conditions.

FEI's direct electron CMOS technology ensures a direct translation from electrons toward the image—without the interference of an optically coupled device. Plus, our ultrathin, back-thinned sensor ensures a DQE that's over 50% higher at ½ Nyquist than the first-generation Falcon and up to 5x better than any regular CCD. Thanks to FEI innovation, improved spatial resolution and superior image quality are now available for extreme low dose conditions.

Key Benefits

- Fully embedded, easy to use and integrated with FEI's tomography and SPA software
- Dramatically improved signal-to-noise ratio
- Greater spatial resolution without a scintillator
- Razor-sharp 16 Mpixel images
- Ultra-high DQE (up to 5x better than regular CCD)
- Sensitivity performance better than film
- Great for extreme low dose applications such as 3D (dual axis) cryo-tomography or cryo-SPA

Falcon DQE 300 keV

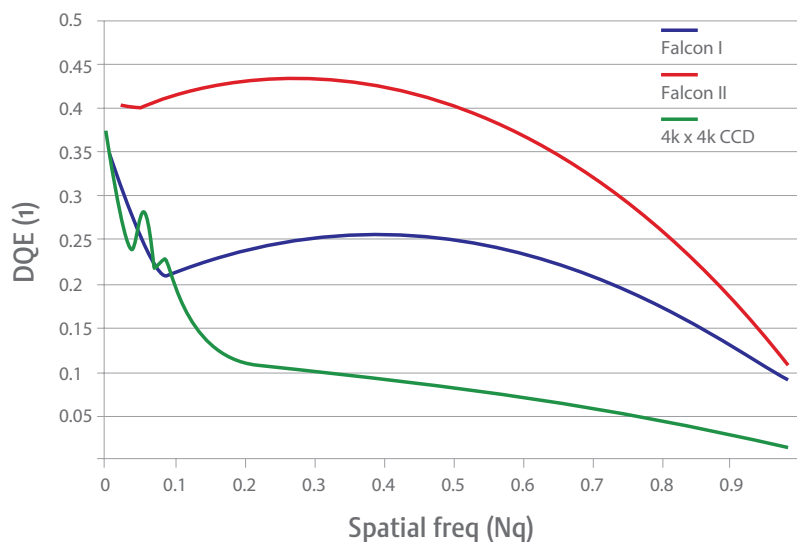


Figure 1: DQE comparison between Falcon I™, Falcon II and high-end 4k x 4k CCD. At ½ Nyquist, the Falcon II improves DQE performance by more than 50% compared to the first-generation Falcon camera, and by 300% compared to a high-performing 4k CCD camera.

Obtain Stunning 3D Imaging from Superb Detection

To observe biological structures as close as possible to their natural state, cryo-fixation is indispensable in preserving a specimen, but this process leaves most biological materials highly beam-sensitive. Thus, electron dose becomes one of the main factors in appropriate imaging.

FEI understands that efficient detection of low-contrast signals is critical, especially in areas such as single-particle analysis (SPA), where large numbers of vitrified, low-contrast molecule/protein complexes are imaged at low electron dose conditions, or cryo-tomography, in which the tomogram resolution increases with the number of images recorded. As such, FEI designed the Falcon II to offer an improved signal-to-noise ratio (i.e., fewer electrons needed for an optimal view) for stronger images under a myriad of conditions and constraints.

Procure Razor-Sharp Images with High Resolution

To improve overall image quality, FEI created the Falcon II with improved direct electron detection—able to convert each single electron from the TEM beam into meaningful

image data. Since a scintillator is no longer required and the sensor is back-thinned, spatial resolution improves significantly. FEI's unique combination of greater dynamic range (16 bit), ultra-high DQE and larger field of view helps meet the most demanding needs in low dose cryo-TEM applications.

Boost Image Quality with DQE

The higher the DQE, the smaller the electron dose necessary to preserve image quality. With its ultra-high DQE—5x better at ½ Nyquist than any available CCD camera—the Falcon II is your best choice for low dose imaging. In tomography applications, you'll record significantly more tilt-angles without increasing the total electron dose. In SPAs, you'll achieve more high resolution data from each individual image.

Additionally, the Falcon II performs beyond film quality results, especially past the ½ Nyquist imaging frequency. With data collected at a lower magnification, you'll achieve a lower applied dose on sample alongside a larger field of view.

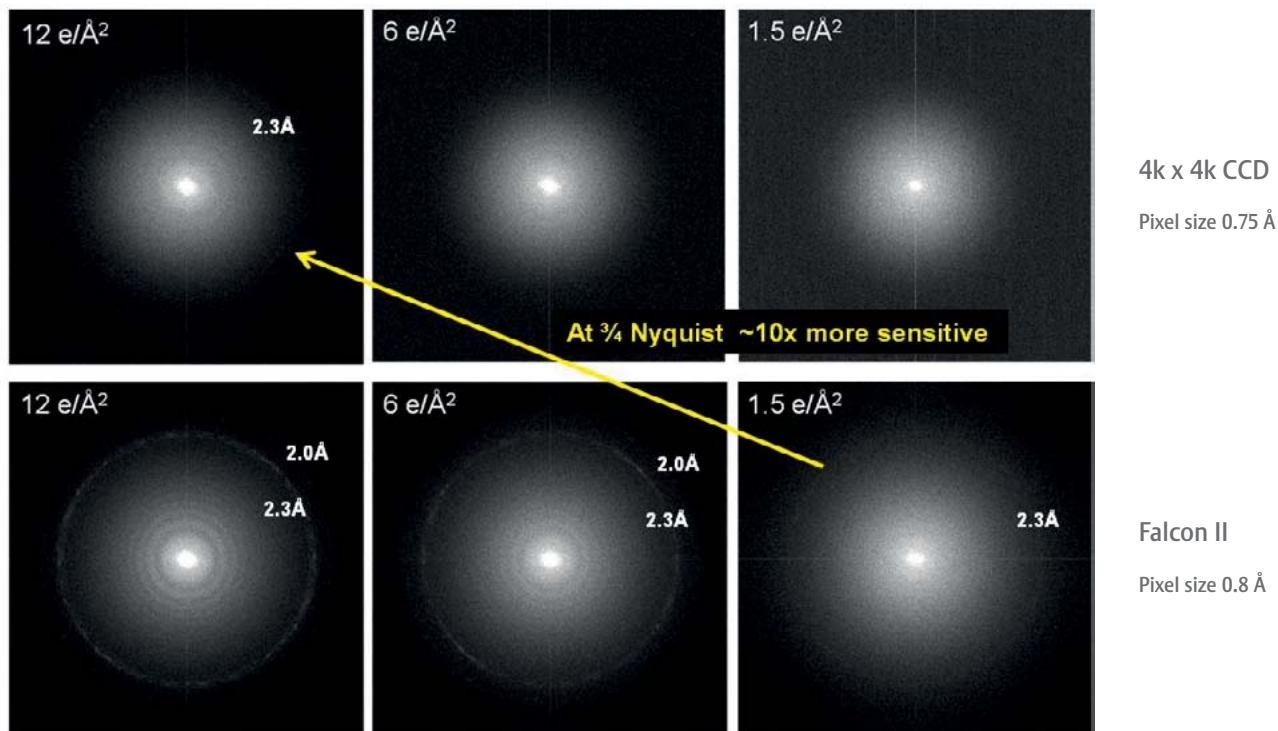


Figure 2: Falcon II compared to sensitive CCD (0.1 DQE ½ Nyquist) at very low dose on cross-grating at comparable pixel size on the same instrument under the same imaging conditions. The Falcon II shows a comparable image quality with the 2.3Å gold reflection just visible beyond ¾ Nyquist but at significantly lower electron dose.

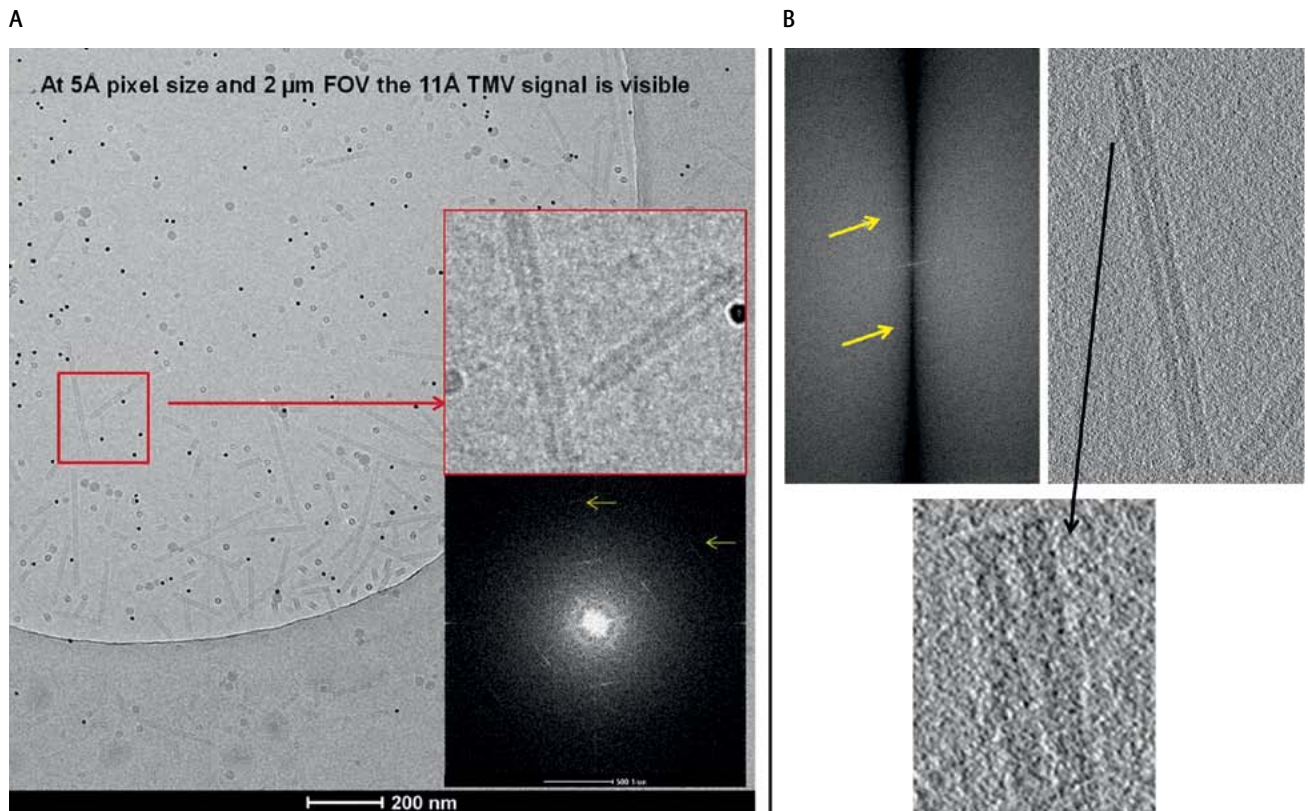


Figure 3: (A) TMV imaged at 5Å pixel size and 10e/A2 dose showing the 23A but also the 11A reflections at Nyquist frequency and 2 micron field of view. (B) In tomography applications, the 2 micron field of view will image the complete foil hole and shows the 23A also in the FFT of the reconstruction of a tilt series ($\pm 70^\circ$, 1° tilt increment and 50 e/A2 total dose). Due to the Falcon II's high sensitivity, more tilt angles can be collected with the same dose with a better quality per image, thus improving the resolution and signal-to-noise ratio.

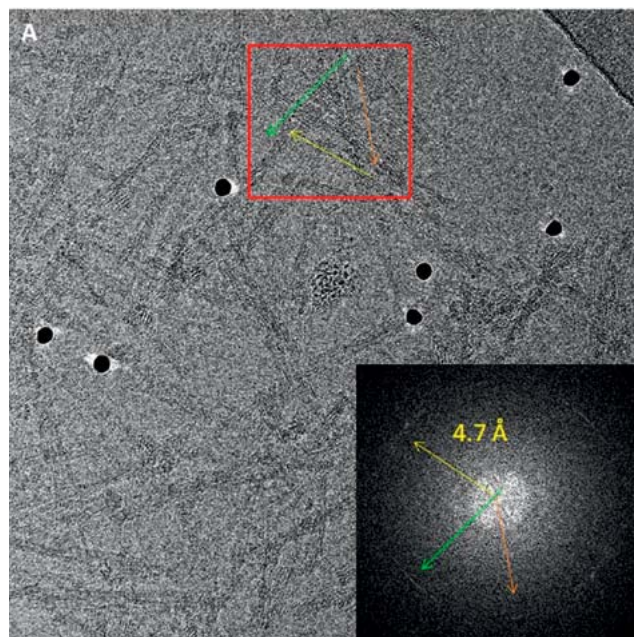


Figure 4: Amyloid fibers showing the distinct 4.7Å reflection of the beta sheet stacking in a single unprocessed raw image. The three directions of the three different fibers (yellow, green, orange) can be clearly seen in the FFT reflection at 4.7 Å close to Nyquist while there is still enough signal. Electron dose is 10 e/A2.

Rely on Tandem Operation

For optimized operation, the Falcon II works in conjunction with a standard 2k x 2k CCD camera, which is included in the package. In addition to extending the Falcon II's lifetime, the camera also can be used for specimen surveying and pre-screening under less low dose and higher dose (e.g., daily alignment tasks) conditions.

Depend on FEI Quality and Reliability

The Falcon II is a bottom-mounted retractable camera, compatible with the Titan™ and Tecnai™ platforms. It's also compatible with other FEI-supported CCD cameras and the GIF (in pre-GIF mode). Its modular design enables simple replacement of the electron detector chip as necessary (approximately every five years). And as the Falcon II is backed fully by FEI's warranty and service, you'll be able to access our professional service organization as needed for assistance.

Integrate Powerful, Intuitive Software

The Falcon II is fully embedded in FEI's microscope software, which runs seamlessly with FEI applications software (e.g., Xplore3D™ Xpress, Low Dose, EPU and AutoAdjust). Select camera, viewing mode, binning, integration time, live FFT, read-out area and more as your work demands.

Specifications Falcon II™	
Operating voltage	Up to 300kV
CCD field of view	5.7 x 5.7 cm ²
CCD size	4096 x 4096 pixels, 14 x 14 μm ²
Binning	1x, 2x, 4x
Mounting position	On-axis TEM bottom, retractable
Magnification on detector with respect to film	1.3 – 1.5x
Peltier cooling	-20 °C (regulated)
DQE (300kV, 10e-1/px)	> 0.4 at ½ Nyquist at 300kV
Readout noise	< 0.05 pe/px (input referenced units = primary electron beam)
Readout area	Full, half or quarter
Acquisition time	2.5 sec/image @ binning 1
Radiation hardness	Electron Dose: 500Me ^{-1/px}
Targeted lifetime	5 years under standard low dose conditions (~ 50 M images of 1 sec exp time)
Bit depth	16 bits
Safety	SW protection against over exposures Second camera (CCD, 2672 x 2672 pixels, 9 x 9 x 14 μm ²) included for routine pre-screening
Software	FEI embedding (included)

Available Falcon camera modalities

1033242 Falcon II camera system 200kV for Tecnai 200kV
 1033244 Falcon II camera system 300kV for Tecnai 300kV
 1033247 Falcon II camera system 300kV for Titan systems
 1033249 Falcon II sensor package upgrade for Falcon I users

1024595 Falcon I camera system 200kV for Tecnai 200kV
 1024597 Falcon I camera system 300kV for Tecnai 300kV
 1024599 Falcon I camera system 300kV for Titan systems

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