DECTRIS

QUADRO

The flexible standard for electron microscopy: Maximizing performance on a single platform

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DECTRIS QUADRO® is a large-area, hybrid-pixel direct electron detector designed for electron diffraction and microscopy applications that demand true single-electron sensitivity. By counting individual electrons directly, DECTRIS QUADRO eliminates any readout noise and dark current that limit conventional cameras. This allows researchers to resolve intense diffraction peaks and faint diffuse scattering within the same frame at speeds up to 4,500 Hz. Featuring a completely redesigned form factor with retractable mechanics, the latest generation of DECTRIS QUADRO ensures seamless mechanical integration into a wide range of electron microscopes.

Across a multitude of published studies, DECTRIS QUADRO noise-free counting, radiation hardness, and speed have proven decisive where samples or physics tolerate no compromise. These features enable users to solve crystal structures from beam-sensitive organic and biogenic materials, tracking picosecond phonon and plasmon dynamics, and capturing real-time battery and catalyst transformations *in situ*. From dedicated diffractometers to state-of-the-art transmission electron microscopes, DECTRIS QUADRO gives researchers ultimate confidence that their data reflects physical reality, completely free from detector artifacts.

Technical Specifications

QUADRO	
Number of pixels (W x H)	510 x 510
Active area (W x H) [mm²]	38.25 x 38.25
Pixel size (W x H) [µm²]	75 x 75
Sensor material	Silicon (Si)
Energy range [keV]	30 - 200
Frame rate (max.) [Hz]	2,250 (16-bit); 4,500 (8-bit)
Frame rate (ROI, max.) [Hz]	9,000 (16-bit); 18,000 (8-bit)
Count rate (max.) [el/s/pixel]	10^7
Detective Quantum Efficiency DQE(0)	0.81 at 100 kV, 0.85 at 200 kV
Detector mounting	Retractable

*All specifications are subject to change without notice.

Key Advantages

Direct Electron Detection: Converts incident electrons into a noise-free signal, ensuring artifact-free imaging and diffraction.

Maximum Dose Efficiency: Provides true single-electron sensitivity and high Detective Quantum Efficiency, preserving structural details in beam-sensitive and low-energy applications.

Continuous Acquisition: Delivers dead-time-free readout, preventing data loss during high-throughput imaging and rapid dynamic experiments.

High-Speed Frame Rates: Captures full-frame data at up to 4,500 Hz, enabling continuous electron diffraction and real-time in-situ imaging.

Wide Dynamic Range: Resolves ultra-faint diffuse scattering and high-intensity diffraction peaks simultaneously within a single frame.

Radiation Hardness: Withstands intense, focused Bragg peaks without the risk of detector damage, ensuring long-term operational stability.

OEM-Ready Integration: Adopted by industry leaders; featuring a compact retractable design; compatible with most microscope configurations.

Ultrafast Lorentz
Transmission Electron Microscopy

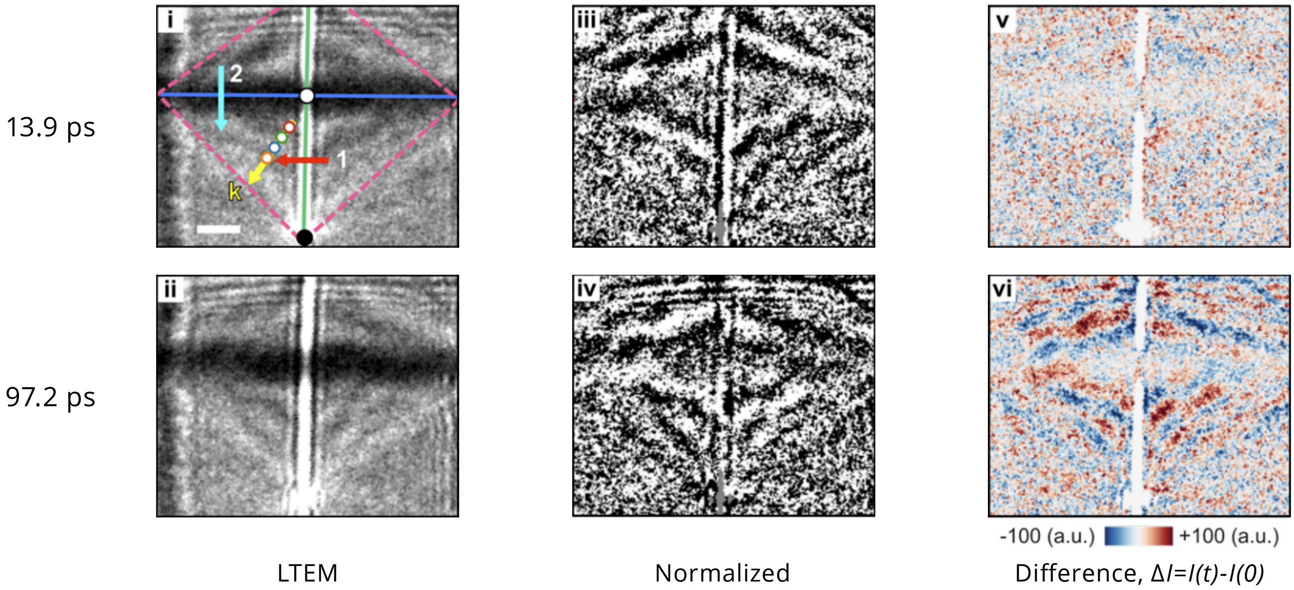

Figure 1. Time-resolved ultrafast LTEM imaging of spin waves. (i)-(ii) Ultrafast Lorentz TEM images, (iii)-(iv) intensity normalized (to the averaged intensity by pixel) images and (v)-(vi) difference images at 13.7 ps and 97.2 ps delay time, LTEM image taken at 0 ps delay time is used as reference for difference image. Scale bar: 0.5 µm. Stripe-like contrast represents the spin-wave wavefronts.

- This paper reports a major milestone in ultrafast electron microscopy: the first real-time nanoscopic visualization of spin waves (magnons) propagating at microwave frequencies in a magnetic thin film, using DECTRIS QUADRO.
- Conventional ultrafast electron microscopes (UEM) rely on laser-driven photocathodes, which introduce large energy spreads, degrade spatial coherence, and cannot achieve the gigahertz-level repetition rates needed to probe RF-excited magnetic dynamics.
- The researchers developed a laser-free, microwave-mediated ultrafast electron pulser. By using a transverse radiofrequency deflector to sweep a continuous field-emission beam across a chopping aperture, they created highly coherent picosecond electron pulses at a 5.25 GHz repetition rate. A downstream demodulation cavity corrected trajectory aberrations to preserve the source's atomic-scale resolution.

Liu, C., Ai, F., Reisbick, S., Zong, A., Pofelski, A., Han, M. G., ... & Zhu, Y. (2025). Correlated spin-wave generation and domain-wall oscillation in a topologically textured magnetic film. *Nature Materials,* 24(3), 406-413. https://doi.org/10.1038/s41563-024-02085-7

Three-Dimensional Electron Diffraction (3D ED)

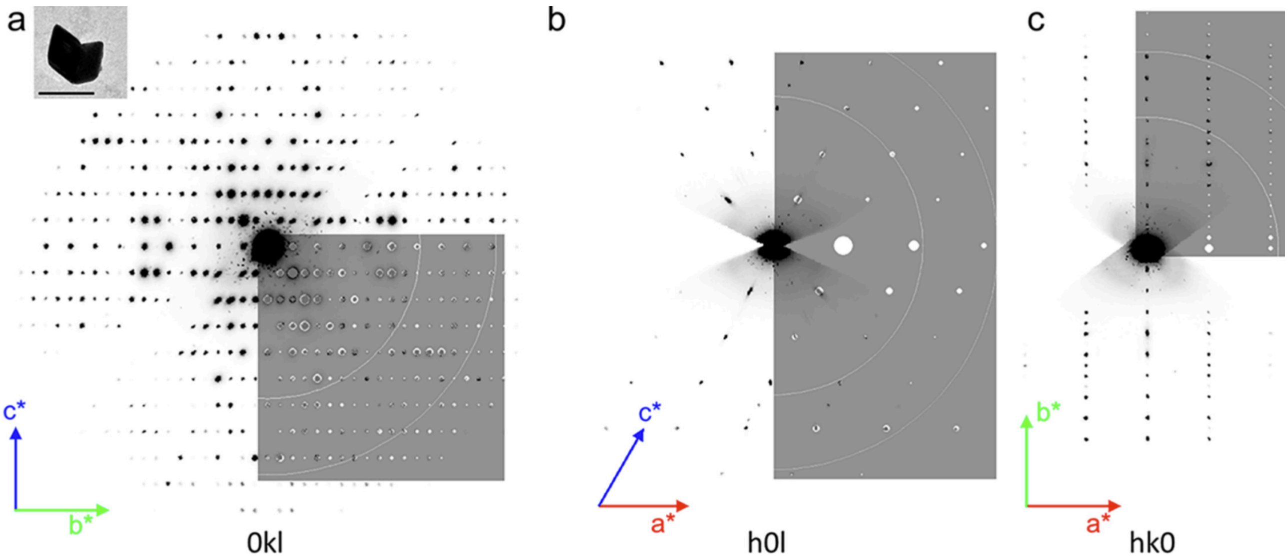

Figure 2. Reconstructed precession images from the 3D ED data recorded for a guanine crystal from a spider showing the reciprocal lattice planes reconstructed from the experimental data. In addition, the gray panels correspond to simulated planes for the crystal structure determined for the spider sample from the 3D ED data. The inset in part (a) shows the crystal from which the data set was collected. Scale bar: 1 μm.

- This paper represents a significant milestone in biocrystallography, detailing the first successful structure determination of biogenic molecular crystals directly from 3D electron diffraction (3D ED / MicroED) data.
- Single-crystal XRD is impossible due to the submicrometer size of these crystals. Powder XRD is severely limited by minute sample volumes, crystalline impurities, beam damage, and extreme preferred orientation stemming from plate-like morphologies.
- The authors bypassed these limitations by using continuous-rotation 3D ED on an ELDICO ED-1 diffractometer, equipped with a DECTRIS QUADRO. By rotating the crystal continuously during exposure, they reduced dynamical effects, minimized beam damage, and collected high-quality data over a 60° tilt range in just 120 seconds per crystal.
- Because of the high quality of the 3D ED data, the authors were able to locate hydrogen atoms directly in the electron density maps, outperforming previous structure determinations that relied on powder XRD and DFT calculations.

Wagner, A., Merkelbach, J., Samperisi, L., Pinsk, N., Kariuki, B. M., Hughes, C. E., ... & Palmer, B. A. (2024). Structure determination of biogenic crystals directly from 3D electron diffraction data. *Crystal Growth & Design,* 24(3), 899-905. https://doi.org/10.1021/acs.cgd.3c01290

Low-energy Multislice Ptychography

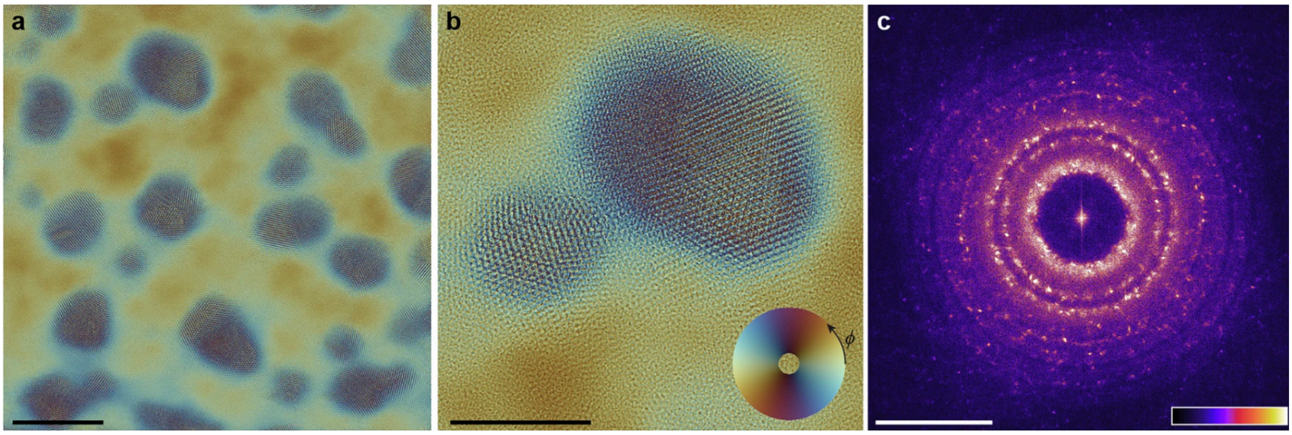

Figure 3. Gold on amorphous carbon reconstruction results. (a) Exit wave produced by simulating the propagation of an electron plane wave through the multi-slice model produced by a ptychographic reconstruction on experimental 20 keV electron diffraction data obtained from gold particles supported on amorphous carbon, and (b) enlarged region of the reconstructed exit-wave. The color scale for (a and b) is in the lower right corner of (b), where the color wheel's azimuthal angle, ϕ, represents the phase (spanning 0 – 2π) and the radial coordinate represents the amplitude of the wave, spanning an amplitude of 0.43 – 2.35. (c) Amplitude of the Fourier transform (FT) of the intensity of the reconstructed exit wave. Scale bars: (a) 10 nm, (b) 5 nm, (c) 1Å^{-1}

- This paper demonstrates a major paradigm shift in high-resolution electron microscopy, achieving a sub-ångström resolution of 0.67 Å using a 20 keV scanning electron microscope (SEM) operated in transmission mode.
- Operating at 20 keV increases the elastic scattering cross-section, which optimizes the contrast-to-damage ratio for thin, light-element samples such as 2D materials and potentially macromolecules below 100 kDa.
- Rather than using complex, hardware-based aberration correctors, the system uses a simplified, low-cost single projector lens. The resulting severe pincushion distortions in the diffraction plane are corrected computationally within the ptychographic reconstruction workflow.
- The experimental platform comprises a modified Hitachi SU9000 SEM with a cold field emission gun (CFEG), an immersion objective lens, a dedicated transmission-mode sample holder, and a DECTRIS QUADRO with a sensor optimized for the detection of low-energy electrons.

Blackburn, A. M., Cordoba, C., Fitzpatrick, M. R., & McLeod, R. A. (2025). Sub-ångström resolution ptychography in a scanning electron microscope at 20 keV. *Nature Communications,* 16(1), 8977. https://doi.org/10.1038/s41467-025-64133-3

Precession-Assisted 4D STEM Strain Mapping

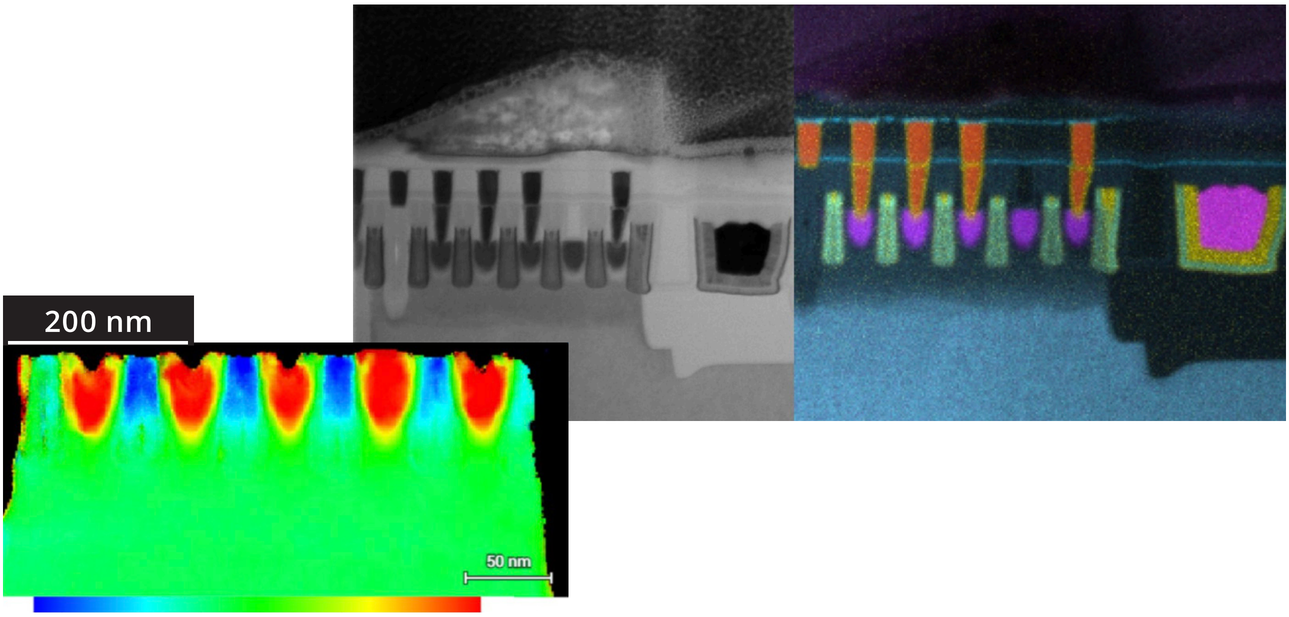

Figure 4. Characterization of a 5 nm Samsung technology device: (a) bright-field STEM, (b) EDX mapping, (c) Strain field of the transistor region, the SiGe stressors, and the compressive strain in the channel region.

- This article from Microscopy and Microanalysis (2024) by Serralta et al. details a fast, automated workflow for measuring nanoscale lattice strain in semiconductor devices using precession-assisted 4D STEM on the TESCAN TENSOR system.
- By precessing the electron beam at a polar angle during scanning, the system averages out multiple scattering (dynamical effects) and the inelastic background. This creates highly uniform, reproducible diffraction spots and excites higher-order reflections, dramatically simplifying automated lattice strain calculations.
- The setup synchronizes specialized deflection coils operating at 72 kHz precession cycles with the DECTRIS QUADRO direct electron detector.

Serralta, E., Moravek, T., Hooley, R., & Chandran, N. (2024). Precession-Assisted 4D-STEM Strain Characterization of Semiconductor Devices. https://doi.org/10.1093/mam/ozae044.080

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