Hybrid-Pixel Electron Detectors for Modern EM: The DECTRIS Portfolio

Berk Küçükoğlu[1]*, Jan Vavra[1], Luca Piazza[1]

[1]DECTRIS AG, Taefernweg 1, 5405 Baden-Dättwil, Switzerland

*berk.kucukoglu@dectris.com

Modern electron microscopy workflows such as 4D-STEM, diffraction/microED, EELS and cryo-EM demand detectors that can record single electrons at high speed without saturation or risk of detector damage. DECTRIS hybrid-pixel electron detectors deliver single-electron sensitivity with negligible dead time and extended dynamic range, with robust operation even for the most intense diffraction patterns.

Here we present a detector portfolio matched to key EM modalities. ARINA is an ultrafast 4D-STEM detector (up to 120,000 fps) supporting virtual detectors, center-of-mass imaging and ptychography. In materials science, these capabilities enable high-throughput ptychographic imaging and diffraction-based workflows [1,2]. In life sciences, high-speed 4D-STEM supports approaches toward imaging thicker specimens and 4D-STEM-based cryogenic tomography workflows [3]. ELA is a rectangular detector optimized for EELS, combining high speed with high dynamic range for chemical mapping [4]. QUADRO enables fast diffraction experiments, including microED and strain mapping, at 4,500 fps full frame [5]. SINGLA supports cryo-EM single-particle acquisition and microED, and is compatible with SerialEM. All detectors include a well-documented API for straightforward integration.

In addition to detector hardware, DECTRIS is working towards the Novena software solutions: We develop Novena Acquire for data acquisition with access to key detector parameters, and Novena Analyze as a processing toolbox, envisioned as a central environment to import and analyze datasets in depth.

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A new platform for advanced nanomaterial analysis

Dr. Felix von Cube

Hitachi High-Tech Europe GmbH, Europark Fichtenhain A12, 47807 Krefeld, Germany

felix.voncube.fv@hitachi-hightech.com

The continuous reduction of feature sizes in semiconductor devices and the rapid development of advanced functional materials are driving an increasing demand for scanning electron microscopes (SEMs) capable of delivering both ultra-high spatial resolution and efficient data acquisition. To address these requirements, Hitachi High-Tech has developed the SU9600, a next-generation flagship cold field-emission scanning electron microscope (FE-SEM) designed to support sub-nanometer-scale observation while maintaining high throughput and operational stability.

In addition, the SU9600 platform supports advanced STEM-based analytical and multidimensional imaging techniques, including electron energy-loss spectroscopy (EELS) and 4D-STEM at accelerating voltages of 30 kV and below. These capabilities enable access to high-resolution structural, diffraction, and spectroscopic information within an SEM-based workflow, without the need for aberration-corrector alignment.

A key technological component of the SU9600 is its low-aberration in-lens objective lens, which effectively suppresses spherical and chromatic aberrations by minimizing focal length. In combination with Hitachi's proprietary ExB detection system, which efficiently collects secondary electrons without disturbing the primary beam trajectory, the instrument delivers high-contrast, high-resolution images across a wide range of probe currents. These capabilities support stable observation of nanostructures down to only a few nanometers and below.

Beyond raw imaging performance, the SU9600 introduces enhanced scanning capabilities and workflow-oriented automation functions aimed at improving productivity in both research and industrial environments. By combining ultra-high resolution with increased throughput and reproducibility, the SU9600 provides a powerful platform for the characterization of next-generation semiconductor devices and advanced materials, supporting efficient and reliable nanoscale analysis

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GATAN AND EDAX IN 2026 – WHAT'S NEXT?

Jordan Moering[1*], Saleh Gorji[1], Ray Twesten[2]

[1]Ametek GmbH, Gatan+EDAX, Rudolf-Diesel-Str. 16, 64331 Weiterstadt, Germany
[2] Gatan Inc., Pleasanton, 5794 W Las Positas Blvd., USA

[*]Jordan.moering@ametek.com

With a legacy of innovation spanning more than 60 years, Gatan has led development in spectrometer design and detector technology that have enabled unprecedented new capabilities in the modern Transmission Electron Microscope (TEM). With tremendous developments in electron optics and detector design in the past 5 years, many in the TEM community are asking what's next. Attend the talk to find out.

Pushing the Boundaries in Precession-Enhanced Electron Diffraction and 4D-STEM

Martijn Fransen[1*], Athanassios S. Galanis[1], Alejandro Gomez-Perez[1], Joaquim Portillo[1], Evangelos Grivas[1], Christos Psaras[1], Partha Pratim Das[1], Stavros Nicolopoulos[1]

[1]NanoMEGAS, Rue Emile Claus 49 bte 9, 1050 Brussels, Belgium

[*]martijn@nanomegas.com

As NanoMEGAS, we strive to push the boundaries in our field of expertise: *advanced tools for electron diffraction*. In this pitch we aim to highlight two examples of this: increasing data collection speed and measuring local magnetic fields.

Speed of Data Collection

The continuous developments in direct electron detection technology are helping researchers to extract more information from their samples while reducing the necessary electron dose. The absence of dark current, the very high count rate linearity and the high readout speed offered by the latest detector technologies allow us to push the speed limit in 4-Dimensional Scanning Precession Electron Diffraction (4D-SPED) data collection.

For many years, a readout speed of 50 – 100 frames per second (dwell time per pixel of 20 – 10 ms) has been the standard. Nowadays, the latest detectors allow frame rates exceeding 1000 fps, making a complete precession circle in each frame. Work is ongoing to push this limit even further, e.g. by increasing the precession frequency further and for the support of collecting multiple frames per precession circle.

Measuring Local Magnetic Fields

While the use of precession for accurately mapping local electric fields is become more established (see our poster for the latest results), adding precession when measuring magnetic fields is much more challenging, because the objective lens needs to be (almost completely) switched off [1]. Recently, we have been able to achieve a precession angle of 0.21° at a precession frequency of 50 Hz in a multi-purpose TEM with its objective lens fully switched off. We aim to extend this investigation to other TEMs and ideally would like to run this with some challenging test samples.

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ENABLING ADVANCED ELECTRON DIFFRACTION METHODS FOR ROUTINE STEM CHARACTERIZATION

Daniel Nemecek[1*]

[1]Tescan Group, 63700, Brno, Czech Republic

[*]daniel.nemecek@tescan.com

The introduction of fast pixelated detectors with a large dynamic range has revived the advanced methods of electron diffraction for characterization of a broad range of materials and phenomena by analytical scanning transmission electron microscopy [1, 2]. Electron diffraction maps (4D-STEM datasets) can now be acquired efficiently from large regions of interest in just several minutes. The quality of acquired diffraction patterns can be substantially improved by using beam precession whose rate is faster than data acquisition [3]. The effects of dynamic scattering in the data are then significantly reduced, while the acquired data contain more diffraction spots. Techniques based on template matching, such as phase-orientation mapping, then become more accurate and robust, especially when several phases are present in the sample. Beam precession also results in more homogeneous intensities of individual diffraction spots which facilitates more accurate determination of their position to the sub-pixel level, making the analytical diffraction methods based on "center-of-mass" measurements, such as strain analysis, more accurate and precise.

However, the adoption of beam-precession enhanced electron diffraction methods has been slow due to the complexity and minimal integration of experimental setups as well as limited speed of 4D-STEM data acquisition and small field of view [4]. These challenges have been overcome by the novel approach to precession electron diffraction measurements provided by the Tescan TENSOR analytical STEM microscope. TENSOR enables fast and accurate precession-assisted 4D-STEM measurements even to novice TEM users due to the complete integration of all modules and automatic alignments of EM optics without user intervention [5].

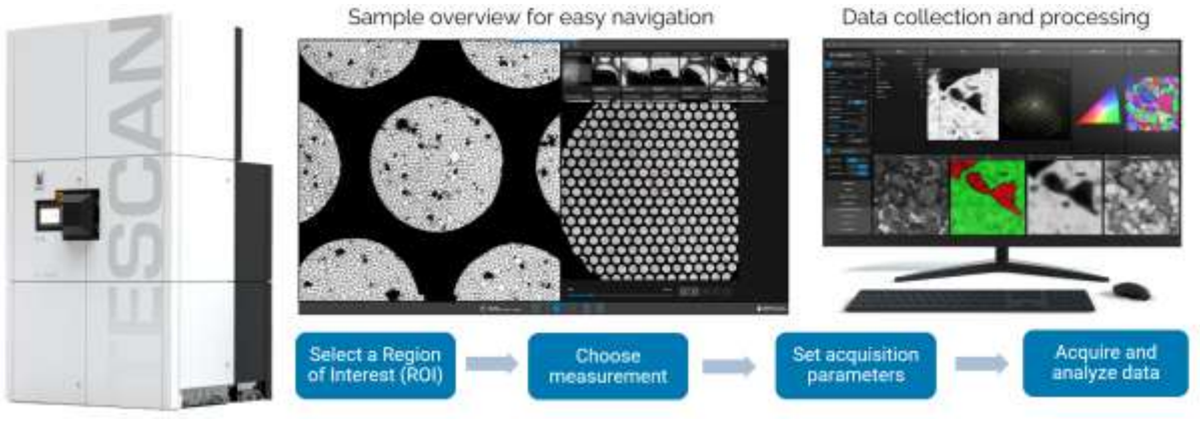

Fig. 1: Streamlined sample analysis workflow using Tescan TENSOR analytical STEM.

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