

# Apereo

## The most versatile high-performance SEM

For researchers investigating material properties, the Thermo Scientific™ Apereo SEM delivers answers in the shortest amount of time by providing superb imaging quality over the widest range of samples and conditions.

As soon as Apereo's beam is switched on, topography and compositional contrast are available through simultaneous in-column detection: with minimal effort, the relevant sample information is quickly acquired and available for sample exploration. At higher magnifications, Apereo shows excellent resolution performance, even when the working distance is still long (for example: 10 mm analytical WD) and the only user action consists of zooming in. For ultimate performance, Apereo's user interface efficiently guides the operator to the optimal conditions where nanometer features are resolved, even on materials that are insulating, beam sensitive or magnetic. This is how Apereo delivers a short time to result no matter the complexity of the research question – ideally suited for multi-user facilities that demand true versatility.

Apereo is the platform of choice for research on nanoparticles, catalysts, powders, and nanodevices thanks to its innovative final lens design that does not compromise on magnetic sample imaging performance. The electrostatic final lens (both Apereo C and Apereo S) enables simultaneous in-column detection at high resolution, while Apereo S combines the electrostatic final lens with magnetic immersion into a compound lens. The compound final lens further boosts resolution performance, providing a resolution of 1.0 nm at 1 kV without additional beam deceleration, while offering unique options for signal filtering.

Apereo ensures a short time to data with its T1 in-lens backscatter detector, which is positioned close to the sample to collect the maximum amount of signal. Unlike other backscatter detectors, this fast detector makes materials contrast available at all times, even when navigating, while tilted or at short working distance. On sensitive samples the detector provides clear backscatter images at currents as low as a few pA. The compound final lens on Apereo S extends the possibilities of the T1 BSE detector even further with energy filtering which enables more precise materials contrast as well as charge-free imaging of insulating samples. Detection is complemented with popular options such as the directional backscatter detector (DBS), STEM 3+ and the

### Key Benefits

**All-round nanometer or sub-nanometer resolution performance** on materials ranging from nanoparticles, powders, catalysts and nanodevices to bulk magnetic samples.

**The most useful backscatter detection** ensures that materials contrast is always available, even at low voltage and beam currents—at any tilt angle— on beam sensitive samples and at TV-rate imaging.

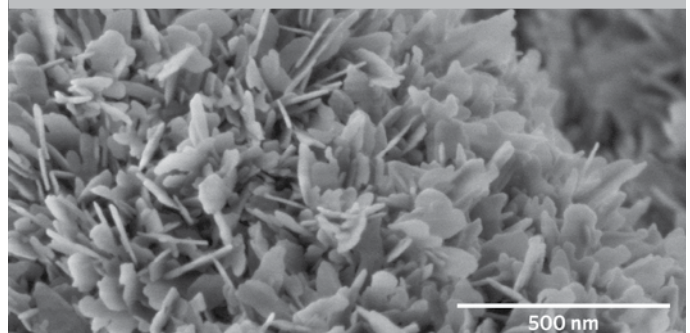
**Unparalleled detector flexibility** allows users to obtain the contrast or signal intensity that matters most by combining information from individual detector segments.

**The widest range of charge mitigation strategies**, including a low vacuum mode with a chamber pressure of up to 500 Pa to enable imaging of any sample.

**A superior analytics platform** provided by high beam currents and a small spotsize. The chamber supports three EDS detectors, coplanar EDS and EBSD, and low vacuum optimized for analytics.

**Easiest sample handling and navigation** with the multi-purpose sample holder and the Nav-Cam+.

**Expert results** for new users through advanced user guidance, presets, and undo functionality.



Low energy (1 keV) secondary electron image of hydroxyapatite crystals imaged in high vacuum.

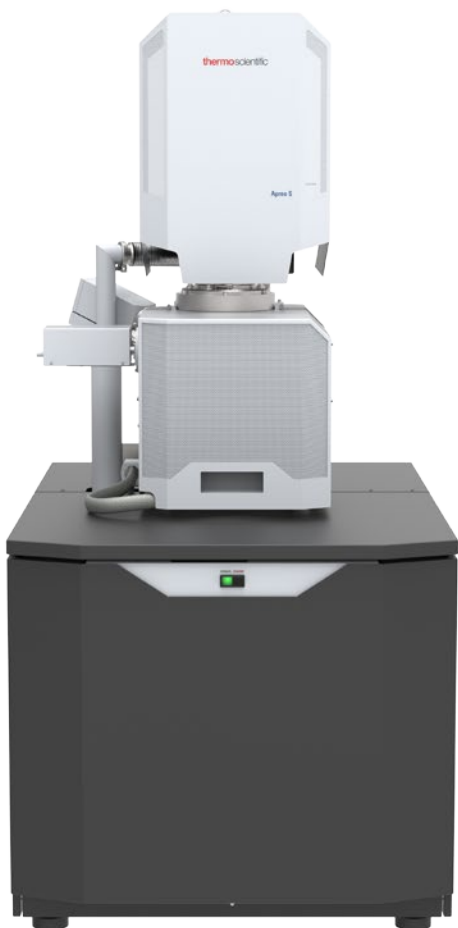
LoVac gaseous analytical detector (GAD). All of these detectors have unique software-controlled segmentation for customized selection of the most valuable sample information.

Every Apreo comes standard with the widest range of strategies to deal with insulating samples, including: high vacuum techniques such as SmartSCAN™, drift compensated frame integration (DCFI) and charge filtering. For the most challenging applications, Apreo's charge mitigation strategies can include optional low vacuum (up to 500 Pa) to mitigate charge on any sample while providing excellent resolution and large analytical currents with field-proven through-the-lens differential pumping and dedicated LoVac detectors.

With analytical techniques being used more routinely, the Apreo chamber was completely redesigned to better support different accessories and experimentation. The chamber accommodates up to three EDS/WDS ports for fast and sensitive x-ray measurements, a coplanar EDS/EBSD/TKD arrangement, and compatibility with (cryo) CL, Raman, EBIC and other techniques.

All these capabilities are complemented by easy sample handling and the familiar xT UI, saving time for novice and expert users alike. A customizable user interface provides many options for user guidance, automation and remote operation.

With all these advantages, including the compound final lens, advanced detection and flexible sample handling, Apreo's performance and versatility can meet your research challenges for many years to come.



### Electron optics

- High-resolution field emission SEM column with:
  - High-stability Schottky field emission gun to provide stable high-resolution analytical currents
  - Compound final lens: a combined electrostatic, field-free magnetic and immersion magnetic objective lens\*
  - 60° objective lens geometry: allows tilting larger samples
- Automated heated apertures to ensure cleanliness and touch free aperture changes
- Through-the-lens differential pumping for low vacuum\* reduces beam skirting for the most accurate analysis and highest resolution
- Beam deceleration with stage bias from -4000 V to +600 V
- Continuous beam current control and optimized aperture angle
- Double stage scanning deflection
- Easy gun installation and maintenance – auto bake-out, auto start, no mechanical alignments
- Guaranteed minimal source lifetime: 12 months

### Electron beam resolution

#### Electron Beam Resolution @ optimum WD

Model	Apreo C	Apreo S
<b>Final lens</b>	Electrostatic	Compound
<b>High vacuum</b>		
30 kV (STEM)		0.8 nm
15 kV	1.0 nm	0.7 nm
1 kV	1.3 nm	1.0 nm
1 kV (beam decel.)	1.0 nm	0.8 nm
500 V (beam decel.)		0.9 nm
100 V (beam decel.)		1.8 nm
<b>Low vacuum*</b>		
15 kV		1.0 nm
3 kV		1.8 nm

*By default, upon final installation, the resolution is proven in the systems acceptance test at 1 kV and 30 kV in high vacuum and with immersion switched on if applicable.*

### Electron beam parameter space

- Beam current range: 1 pA to 400 nA
- Accelerating voltage range: 200 V–30 kV
- Landing energy range: 20 eV–30 keV
- Max. Horizontal Field Width: 3.0 mm at 10 mm WD (corresponds to 29x minimum magnification).

### Chamber

- Inside width: 340 mm
- Analytical working distance: 10 mm
- Ports: 12
- EDS take-off angle: 35°

- Three simultaneous EDS detectors possible, two at 180°
- Coplanar EDS/EBSD orthogonal to the tilt axis of the stage

### Detectors

Apereo detects up to four signals simultaneously from any combination of the available detectors or detector segments\*:

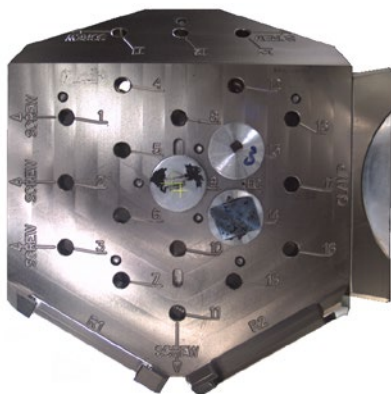
- Trinity Detection System (in-lens and in-column)
  - T1 segmented lower in-lens detector
  - T2 upper in-lens detector
  - T3 in-column detector\*
- ETD – Everhart-Thornley SE detector
- DBS – Retractable segmented under-the-lens BSED\*
- Low-vacuum SE detector\*
- DBS-GAD – Lens-mounted gaseous analytical BSED\*
- STEM 3+ – Retractable segmented detector (BF, DF, HAADF, HAADF)\*
- IR-CCD
- Nav-Cam+™ chamber-mounted camera

### Vacuum system

- Complete oil-free vacuum system
- 1 × 220 l/s TMP
- 1 × PVP-scroll
- 2 × IGP
- Chamber vacuum (high vacuum) <math> < 6.3 \times 10^{-6}</math> mbar (after 72 hours pumping)
- Evacuation time:  $\leq 3.5$  minute
- Optional low-vacuum mode
- 10 to 500 Pa chamber pressure

### Sample holders

- Standard multi-purpose holder, uniquely mounts directly onto the stage, hosts up to 18 standard stubs ( $\varnothing 12$  mm), three pre-tilted stubs, cross-section samples and two pre-tilted row-bar holders\* (38° and 90°) and does not require tools to mount a sample



Multi-purpose sample holder

### Stage and sample

<b>Type</b>	Eucentric goniometer stage, 5-axes motorized
<b>XY</b>	110 × 110 mm
<b>Repeatability</b>	<math> < 3.0 \mu\text{m}</math> (@ 0° tilt)
<b>Motorized Z</b>	65 mm
<b>Rotation</b>	n × 360°
<b>Tilt</b>	-15° / +90°
<b>Max. sample height</b>	Clearance 85 mm to eucentric point
<b>Max. sample weight</b>	500 g in any stage position (up to 2 kg at 0° tilt)
<b>Max. sample size</b>	122 mm diameter with full X,Y, rotation (larger samples possible with limited stage travel or rotation)

- Each optional row-bar accommodates 6 S/TEM grids
- Wafer and custom holders\*

### System Control

- 64-bit GUI with Windows 7, keyboard, optical mouse
- 24-inch LCD display, WUXGA 1920 × 1200 (second monitor optional)
- Customizable graphical user interface, with up to 4 simultaneously active views
- Image registration
- Navigation montage
- Image analysis software
- Undo / Redo functionality
- User guidance for basic operations / applications
- Optional joystick
- Optional manual user interface (knob board)

### Image processor

- Dwell time range from 25 ns – 25 ms/pixel
- Up to 6144 × 4096 pixels
- File type: TIFF (8, 16, 24 bit), JPEG or BMP
- Single-frame or 4-view image display
- SmartSCAN (256-frame average or integration, line integration and averaging, interlaced scanning)
- DCFI (Drift Compensated Frame Integration)

### Accessories (optional)

- Sample / chamber cleaning: FEI CryoCleaner, FEI Integrated Plasma Cleaner
- Analysis: EDS, EBSD, WDS, CL, Raman
- QuickLoader™: load lock for fast sample transfer
- Navigation: Correlative Navigation, MAPS Tiling and Stitching

- FEI Gas injection: up to 2 units (other accessories may limit number of GIS available) for beam-induced deposition of the following materials:

- Platinum
- Tungsten
- Carbon

- Manipulators
- Cryo-stage
- Electrical probing / multi-probing stations
- Electrostatic beam blanker

## Software options

- MAPS for automatic acquisition of large images and optional correlative work
- iFast for advanced automation
- Web-enabled data archive software
- Advanced image analysis software

## Documentation

- Online user guidance
- Operating instructions handbook
- Online help
- Prepared for RAPID (remote diagnostic support)
- Free access to “FEI for Owners” online resources

## Warranty and Training

- 1 year warranty
- Choice of service maintenance contracts
- Choice of operation / application training contracts

## Installation requirements

(Refer to preinstall guide for detailed data)

\*Optional, \*\*Beam deceleration, T3 detector (optional)

- Power:
  - Voltage 100–240 V AC (-6%, +10%)
  - Frequency 50 or 60 Hz ( $\pm 1\%$ )
  - Consumption: < 3.0 kVA for basic microscope
- Earth resistance < 0.1  $\Omega$
- Environment:
  - Temperature (20  $\pm$  3) $^{\circ}$ C
  - Relative humidity below 80%
  - Stray AC magnetic fields < 40 nT asynchronous, < 100 nT synchronous for line times, 20 ms (50 Hz mains) or 17 ms (60 Hz mains)
- Minimum door size: 0.9 m wide  $\times$  1.9 m high
- Weight: column console 980 kg
- Dry nitrogen recommended for venting
- Compressed air 4–6 bar, clean, dry and oil-free
- System chiller
- Acoustics: site survey required, as acoustic spectrum relevant
- Floor vibrations: site survey required, as floor spectrum relevant
- Optional active vibration isolation table

## Consumables (partial list)

- Replacement Schottky electron source module

Find out more at [Thermofisher.com/EM-Sales](http://Thermofisher.com/EM-Sales)