# Helios NanoLab 660

FEI's exclusive DualBeam — Pushing the limits of extreme high resolution characterization in 2D and 3D, nanoprototyping, and sample preparation

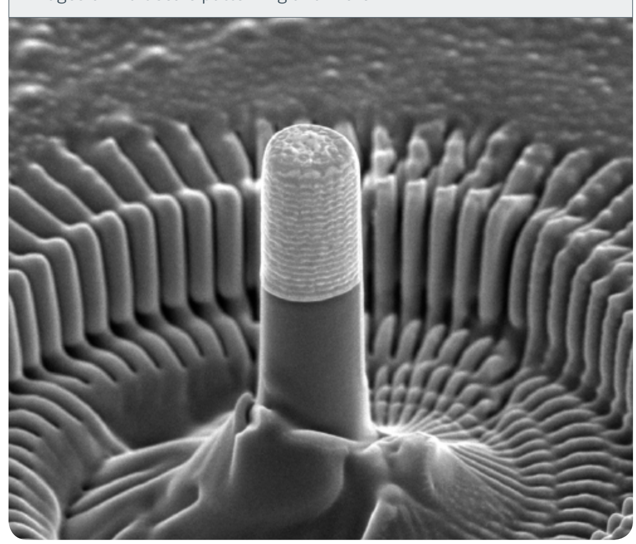
The Helios NanoLab™ 660 features FEI's most recent advances in field emission SEM (FESEM) and focused ion beam (FIB) technologies and their combined use.

As FEI's 11th DualBeam™ platform, it is designed to access a new world of extreme high resolution (XHR) 2D and 3D characterization, nanoprototyping, and highest quality sample preparation.

The Elstar™ FESEM provides the best nanoscale details, using the widest range of working conditions: whether operating at 30 kV in STEM mode to access structural information or at 500 V to obtain charge-free, detailed information from the surface, it delivers well below 1 nm resolution. With its unique triple detector located inside the column and immersion mode, designed for simultaneous operation and angle and energy selective SE and BSE imaging, fast access to very precise, clear information is guaranteed, not only top-down, but also on tilted specimen or cross-sections. Additional below-the lens detectors and a beam deceleration mode ensure that all signal is collected, and no information left behind. Fast, accurate and reproducible results are obtained thanks to Elstar's unique technologies, including advanced auto alignments, constant power lenses for higher thermal stability and electrostatic scanning for higher deflection linearity and speed.

For unsurpassed fast, precise and reliable milling, patterning and ion imaging, the Helios NanoLab 660 relies on FEI's latest ion column, the Tomahawk™ FIB. The Tomahawk's exceptional low-voltage performance is proven to produce the world's best quality thin samples for high resolution STEM or atom probe microscopy.

| KEY BENEFITS |
|---|
| Extreme high resolution (XHR) with sub-nanometer resolution from 500 V to 30 kV |
| Sharp, refined, and charge-free contrast obtained from up to 6 integrated in-column and below-the-lens detectors |
| Clear imaging based on integrated sample cleanliness management and dedicated imaging modes such as SmartScan™ or DCFI |
| Shortest time to precise cross-sectioning |
| High productivity preparation of the thinnest, highest quality samples |
| Fast, accurate and precise milling and deposition of the most varied and complex structures with critical dimensions of less than 10 nm |
| Flexible and intuitive prototyping using the rich built in patterning libraries, materials files and largest selection of beam chemistries |
| Reliable and adaptive automation for the acquisition of 3D data, large images or multiscale patterning and more |




Not only does it boast excellence in ion image resolution, with its integrated differential pumping and time-of-flight correction, it also delivers a tighter beam and a more accurate scan profile for extremely precise ion milling. Creating the most complex structures at the nanoscale is equally possible, thanks to FEI's own extensive range of beam chemistries (gas injection), 16-bit pattern generator and integrated CAD, script or library-based patterning. Robust, precise FIB slicing, combined with a high precision piezo stage and superb SEM performance, open the door to a new generation of automated software for unattended sample preparation or 3D characterization and analysis.

Empowered by its evolutionary xT software platform, the Helios NanoLab 660 addresses both the occasional user with its easy-to-use yet robust and comprehensive interface, and the FIB expert who can rely on the instrument's flexibility and extended controls for advanced SEM and FIB work. Join the Helios NanoLab and FEI FIB communities of scientists and technologists and be the next one to contribute to expanding the boundaries at the nanoscale with DualBeams.

## ESSENTIAL SPECIFICATIONS

### Elstar XHR immersion lens FESEM column

- Elstar electron gun with:
  - Schottky thermal field emitter
  - Hot-swap capability
  - UC technology (monochromator)
- 60 degree dual objective lens with pole piece protection
- Heated objective apertures
- Electrostatic scanning
- ConstantPower™ lens technology
- Beam deceleration with stage bias from -50 V to -4 kV
- Integrated Fast Beam Blanker*

### Tomahawk ion column

- Superior high current performance, with up to 65 nA max beam current
- Lowest voltage (500 V) for ultimate sample preparation quality
- 2-stage differential pumping
- Time-of-flight (TOF) correction
- 15 apertures

### Source lifetime

- Electron source: 12 month lifetime
- Ion source: 1,000 hours guaranteed

### Electron beam resolution @ optimum WD

*(site survey required to guarantee resolution specification)*

- 0.6 nm at 30 kV (STEM*)
- 0.6 nm from 15 kV to 2 kV
- 0.7 nm at 1 kV
- 1.0 nm at 500 V (ICD*)

### Electron beam resolution @ coincident point

- 0.6 nm at 15 kV
- 0.9 nm at 5 kV
- 1.2 nm at 1 kV

### Ion beam resolution @ coincident point

- 4.0 nm at 30 kV using preferred statistical method
- 2.5 nm at 30 kV using selective edge method

### Maximum horizontal field width

- E-beam: 2.3 mm at beam coincident point (WD 4 mm)
- I-beam: 0.9 mm at 8 kV at beam coincidence point

### Landing voltage range

- E-beam: 20 V - 30 kV
- I-beam: 500 V - 30 kV

### Probe current

- E-beam: 0.8 pA up to 100 nA
- I-beam: 0.1 pA – 65 nA (15 position aperture strip)

### High Precision 5-axes motorized stage

- X, Y: 150 mm, piezo-driven
- Z: 10 mm motorized
- T: -10° to + 60°
- R: n × 360° (endless), piezo-driven
- Tilt accuracy (between 50° to 54°): 0.1°
- X,Y repeatability: 1.0 µm
- Compucentric rotation and tilt

### Detectors

- Elstar in-lens SE detector (TLD-SE)
- Elstar in-lens BSE detector (TLD-BSE)
- Elstar in-column SE detector (ICD)
- Elstar in-column BSE detector (MD)
- Everhart-Thornley SE detector (ETD)
- IR camera for viewing sample/ column

- In-chamber sample navigation camera (Nav-Cam+™)*
- High performance ion conversion and electron (ICE) detector for secondary ions (SI) and electrons (SE)*
- Retractable low voltage, high contrast solid-state backscatter electron detector (DBS)*
- Retractable STEM detector with BF/ DF/ HAADF segments*
- Integrated beam current measurement

### Vacuum system

- 1 × 210 l/s TMP
- 1 × PVP (dry pump)
- 4 × IGP (total for electron column and ion column)
- Chamber vacuum: < $2.6 \times 10^{-6}$ mbar (after 24 h pumping)

### Chamber

- E- and I-beam coincidence point at analytical WD (4 mm SEM)
- Angle between electron and ion columns: 52°

### Sample size

- Maximum size: 150 mm diameter with full rotation (larger samples possible with limited rotation)
- Maximum clearance between stage and coincidence point: 55 mm
- Weight: max. 500 g (including the sample holder)

### Sample holders

- High-resolution multi-stub mount holder
- Vise specimen holder to clamp irregular, large or heavy specimens to the specimen stage*
- Universal mounting base (UMB) for stable, flexible mounting of many combinations of samples and holders such as flat and pretilt stubs, and row holders for TEM grids*
- Various wafer and custom holder(s) available by request*

### Image processor

- Dwell time range from 0.025 to 25,000 µs/pixel
- Up to 6144 × 4096 pixels
- File type: TIFF (8, 16, 24-bit), BMP or JPEG standard
- Single frame or 4-quad image display
- SmartSCAN™ (256 frame average or integration, line integration and averaging, interlaced scanning) and DCFI (Drift Compensated Frame Integration)

### System control

- Comprehensive graphical UI with basic and advanced user levels, running on MS Windows PC
- Up to four live images showing independent beams and/or signals. Life color signal mixing
- Two 24 inch widescreen monitors (1920×1200 pixels) for system GUI and full-screen image
- Microscope controlling and support computers seamlessly sharing one keyboard, mouse and monitors
- Joystick*
- Multifunctional control panel*
- Remote control*

### Supporting software

- 'Beam per quad' graphical user interface concept, with up to 4 simultaneously active quads
- FEI SPI™, iSPI™, iRTM™ and FIB immersion mode for advanced, real-time SEM and FIB process monitoring and endpointing
- Patterns supported: lines, rectangles, polygons, circles, donut, cross-section and cleaning cross-section
- Image registration
- Directly imported BMP file or stream file for 3D milling and deposition
- Material file support for 'minimum loop time', beam tuning and independent overlaps

### Common accessories*

- GIS (Gas Injection System) – Solutions:
  - Single GIS: up to 5 independent units for enhanced etching or deposition
  - MultiChem™: up to 6 chemistries on the same unit for advanced etching and deposition controls
- GIS – Beam chemistry options**
  - Platinum deposition
  - Tungsten deposition
  - Carbon deposition
  - Insulator deposition II
  - Gold deposition
  - Enhanced Etch™ (iodine, patented)
  - Insulator enhanced etch ($XeF_2$)
  - Delineation Etch™ (patented)
  - Selective carbon mill (patented)
  - Empty crucibles for FEI approved user supplied materials
  - More beam chemistries available upon request
- Manipulators:
  - EasyLift™ + Hitachi *In Situ* Lift-Out License for thin sample preparation
  - Other manipulators available upon request
- FIB Charge Neutralizer
- Analysis: EDS, EBSD, WDS, Cathodoluminescence Imaging and Spectroscopy
- QuickLoader™: loadlock for fast sample transfer
- Electron beam lithography: kits from Raith, Nabity or other vendors
- Cryo solution for DualBeam
  - Exclusive FEI CryoMAT for material science cryo applications
  - Solutions from external vendors
- FEI acoustic enclosure
- Integrated plasma cleaner
- FEI CryoCleaner

## Software options

- **AutoFIB™** package for macro and script based DualBeam automation
- **iFast** for advanced DualBeam automation
- **MAPS™** for automatic acquisition of large images
- **AutoTEM™** wizard automated sample preparation with section wizard
- **NanoBuilder™** – advanced FEI proprietary CAD based (GDSII) solutions for FIB and beam deposition optimized nanoprototyping of complex structures
- **AutoSlice and View™** – automated sequential mill and view to collect series of slice images for 3D reconstruction
- **EBS3™** – automated sequential mill and acquire EBSD maps to collect series of texture or orientation maps for 3D reconstruction
- **EDS3™** – automated sequential mill and acquire EDS data to collect series of chemical maps for 3D reconstruction
- 3D reconstruction software
- Knights Technology CAD navigation
- Web enabled data archive software
- Image analysis software

## Consumables (partial list)

- Replacement Ga-ion source
- Replacement Schottky electron source module
- Aperture strips for electron and ion columns
- GIS refill kit

## 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)*

- Power:
  - voltage 100–240 V AC,
  - frequency 50 or 60 Hz (± 1%)
- Power consumption: < 3.0 kVA for basic microscope
- Earth resistance: < 0.1 Ω
- Environment:
  - temperature 20°C ± 3 °C
  - relative humidity below 80 % RH, 20°C
  - stray AC magnetic fields: < 200 nT a-synchronous, < 600 nT synchronous for line times > 20 ms (50 Hz mains) or > 17 ms (60 Hz mains)
- Minimum door width × height: 0.9 m × 2.0 m
- Weight: column console 950 kg
- Dry nitrogen
- Compressed air 4 to 6 bars; clean, dry and oil-free
- System chiller
- Acoustics guidelines: site survey required as acoustic spectrum relevant
- Vibration isolation table available as option

## Documentation and support

- On-line help
- Prepared for RAPID™ (remote diagnostic support)
- Free access to FEI.com for Owners on-line resources
- Free membership in the FEI FIB UserClub

* optional

** some Beam Chemistries may be available only on the MultiChem or on the Single GIS

Specifications are subject to change.

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TÜV Certification for design, manufacture, installation, and support of focused ion- and electron-beam microscopes for the electronics, life sciences, materials science, and natural resources markets.

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