Helios NanoLab™ 650

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

The Helios NanoLab™ 650 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 higher quality sample preparation.

The outstanding imaging capabilities of the Helios NanoLab 650 begin with its Elstar™ FESEM. Thanks to its integrated monochromator (UC) and beam deceleration, it delivers sub-nanometer resolution across the whole 1-30 kV range. The Elstar features other unique technologies such as constant power lenses for higher thermal stability and electrostatic scanning for higher deflection linearity and speed. Its through-the-lens detector, set for highest collection efficiency of SE (secondary electrons) and on-axis BSE (backscattered electrons), is complemented by FEI's latest advanced detection suite including three novel detectors: two multi-segment solid state detectors for stunning low kV SE/BSE and S/TEM (scanning transmission electron mode) performance, and a third dedicated to optimized FIB-SE and -SI (secondary ion) imaging.

For unsurpassed fast, precise and reliable milling, patterning and ion imaging, the Helios NanoLab 650 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. 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 650 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.

Key benefits

- Best-in-class Elstar™ monochromated Schottky FESEM technology and performance, with sub-nanometer resolution from 1 to 30 kV
- FEI's own versatile Tomahawk FIB, featuring excellent FIB imaging, outstanding low kV operation down to 500 V and up to 65 nA beam current
- 150 x 150 mm high precision, high stability piezo stage
- Unique imaging technologies and solutions, including Helios generation II detection and scanning strategies, process monitoring and end-pointing
- Most complete and integrated suite of prototyping capabilities, with the integrated 16-bit pattern generator, advanced patterning features library and largest GIS offering and expertise
- Best-in-class thin sample preparation and 3D characterization and analysis

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

Tomahawk ion column
- Superior high current performance, with
  - up to 60 A/cm^2 beam current density
  - 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
- 0.8 nm at 30 kV (STEM)
- 0.8 nm at 15 kV
- 0.8 nm at 2 kV
- 0.9 nm at 1 kV
- 1.5 nm at 200 V

Electron beam resolution @ coincident point
- 0.8 nm at 15 kV
- 0.9 nm at 5 kV
- 1.2 nm at 1 kV

Ion beam resolution @ coincident point
- 4.5 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: 1.0 mm at 5 kV at beam coincidence point

Landing voltage range
- E-beam: 50 V - 30 kV
- I-beam: 500 V - 30 kV

Probe current
- E-beam: 0.6 pA up to 26 nA
- I-beam: 1 pA - 65 nA (15 position aperture strip)

High precision 5-axes motorized stage
- XY: 150 mm, piezo-driven
- Z: 10 mm motorized
- T: - 10° to + 60°
- R: n x 360° (endless), piezo-driven
- Tilt accuracy (between 50° to 54°): 0.1°
- X,Y repeatability: 1.0 µm

Detectors
- Elstar in-lens SE detector (TLD-SE)
- Elstar in-lens BSE detector (TLD-BSE)
- Everhart-Thornley SE detector (ETD)
- IR camera for viewing sample/column
- Door-mounted NavCam*
- High performance SE and SI (secondary ion) detector (ICE)*
- Retractable low voltage, high contrast solid-state electron detector (DBS)*
- Retractable STEM detector with BF/DF/HAADF segments*
- Integrated beam current measurement

Vacuum system
- 1 x 210 l/s TMP
- 1 x PVP (dry pump)
- 4 x IGP (total for electron column and ion column)
- Chamber vacuum: < 2.6*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
- Single stub mount, mounts directly onto stage
- 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 4096 x 3536 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)

System control
- 32-bit GUI with *Windows® XP*, keyboard, optical mouse
- Two 19 inch LCD displays, SVGA 1280 x 1024
- MagicSwitch™ (software controlled switchbox)
- Joystick*
- Multifunctional control panel*

* optional

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 process monitoring and endpointing
- 'Drift Compensated Frame Integration (DCFI)
- Patterns supported: lines, rectangles, polygons, circles, donut, cross-section and cleaning cross-section
- Image registration
- Directly imported BMP file or streamfile for 3D milling and deposition
- Material file support for 'minimum loop time', beam tuning and independent overlaps

Common accessories
- **Gas Injection System:** up to 5 units for enhanced etch or deposition (other accessories may limit number of GIS available)
- **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
- ***in situ* sample lift-out system** (Omniprobe™ 100.7, AutoProbe or other manipulators)
- **Charge Neutralizer**
- **Integrated Fast Beam Blanker**
- **EDS:** integration kit (EDAX/Oxford Instruments) and options
- **QuickLoader™:** loadlock for fast sample transfer
- **Exclusive cryo solution for DualBeam**
  - FEI/ Quorum PP2000T for universal cryo preparation and cryo stage
  - FEI / Quorum CryoMAT for material science cryo applications
- **FEI acoustic enclosure**

Consumables (partial list)
- Replacement Ga-ion source
- Replacement Schottky electron source module
- Aperture strips for electron and ion columns
- Gas Injection System crucible

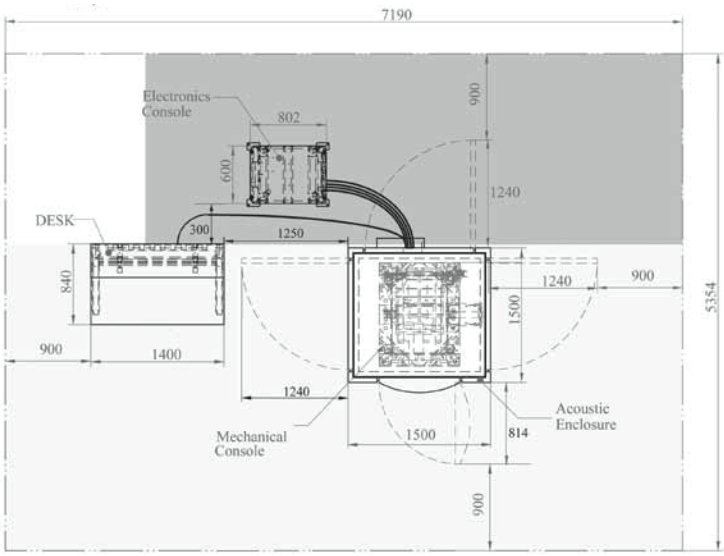
Software options
- **AutoFIB™** package for macro and script based DualBeam automation
- **AutoTEM™** wizard - automated sample preparation with section wizard
- **GDSToDB**™ and **NanoBuilder**™ – respectively basic and advanced FEI proprietary CAD based (GDSII) solutions for FIB and beam deposition 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

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

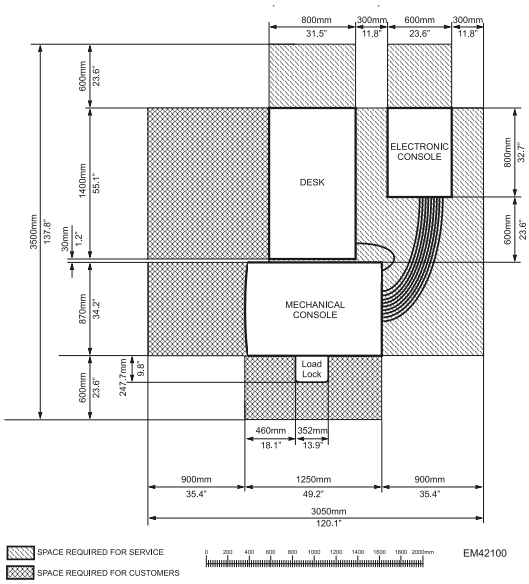
Installation requirements
[Refer to preinstall guide for detailed data]
- Power:
  - voltage 230 V (+ 6 %, - 10 %),
  - frequency 50 or 60 Hz (± 1%)
- Power consumption: < 3.0 kVA for basic microscope
- Earth resistance: < 0.1 Ω
- Environment:
  - temperature 20 °C ± 3 °C,
  - relative humidity below 80 % RH,
  - stray AC magnetic fields:< 100 nT a-synchronous, < 300 nT synchronous for line times > 20 ms (50 Hz mains) or > 17 ms (60 Hz mains)
- Door width: 120 cm
- Weight: column console 850 kg
- Dry nitrogen:
  - system (0.7 to 0.8 bar, max 10 l/min during vent);
  - dry pump (1.0 bar, 2 l/min)
- Compressed air 4 to 6 bar - clean, dry and oil-free
- System chiller
- Acoustics guidelines: < 50 dBC (no acoustic enclosure) < 65 dBC (with acoustic enclosure present) (site survey required as acoustic spectrum relevant)
- Floor vibrations: site survey required as floor spectrum relevant
- Vibration isolation table available as option

Documentation and support
- On-line help
- Prepared for RAPID™ (remote diagnostic support)
- Free access to FEI for owners on-line resources
- Free membership in the FEI FIB User Club

Floorplan with enclosure



Floorplan without enclosure



TÜV Certification for design, manufacture, installation and support of focused ion- and electron-beam microscopes for the Electronics, Life Sciences, Research and Industry markets.

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