

## 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 exclusive Tomahawk FIB, featuring excellent imaging, outstanding low kV operation down to 500 V and up to 65 nA beam current
- Differential pumping and TOF correction for higher resolution ion beam imaging, milling and deposition
- 150 x 150 mm high precision, high stability piezo stage
- Unique imaging technologies and solutions, including generation II of Helios advanced detectors, process monitoring, FEI SmartSCAN™ and DCFI to help imaging charging samples
- Most complete and integrated suite of prototyping capabilities, with 16-bit pattern generator for FIB & SEM, advanced patterning features library, and largest beam chemistry selection and expertise
- Best-in-class thin sample preparation and 3D characterization and analysis
- Most advanced process monitoring and endpointing capabilities

## 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

- 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 SAT
- 1.5 nm at 200 V

### Electron beam resolution @ coincident point

- 0.8 nm at 15 kV SAT
- 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: 1.0 mm at 5 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 26 nA
- I-beam: 0.1 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
- Compucentric rotation and tilt

### 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 Nav-Cam™
- High performance Ion Conversion and Electron (ICE) detector for secondary ions (SI) and electrons (SE)\*
- 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<sup>-6</sup> 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 x 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

- 32-bit GUI with Windows® XP, keyboard, optical mouse
- Three 24 inch widescreen LCD displays, WUXGA 1920x1200 pixels
- Microscope controlling and support computers seamlessly sharing one keyboard and mouse
- Joystick \*
- Multifunctional control panel \*
- Remote control \*

\* = 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 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 streamfile for 3D milling and deposition
- Material file support for ‘minimum loop time’, beam tuning and independent overlaps

### Common accessories \*

- **Gas Injection System (GIS):** up to 5 units for enhanced etch or deposition
- **GIS - Beam chemistry options**
  - Platinum deposition
  - Tungsten deposition
  - Carbon deposition
  - Insulator deposition II
  - Gold deposition
  - Enhanced Etch™ (iodine, patented)
  - Insulator enhanced etch (XeF<sub>2</sub>)
  - Delineation Etch™ (patented)
  - Selective Carbon Mill (patented)
  - Empty crucibles for FEI approved user supplied materials
- **in situ sample lift-out system** (Omniprobe™ or other manipulators)
- **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
- **Exclusive cryo solution for DualBeam**
  - FEI Arctic for universal cryo preparation and cryo stage
  - FEI CryoMAT for material science cryo applications
- **FEI acoustic enclosure**
- **Integrated Plasma Cleaner**
- **FEI CryoCleaner**

### Consumables (partial list)

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

### 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
- **GDSstoDB™** 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)

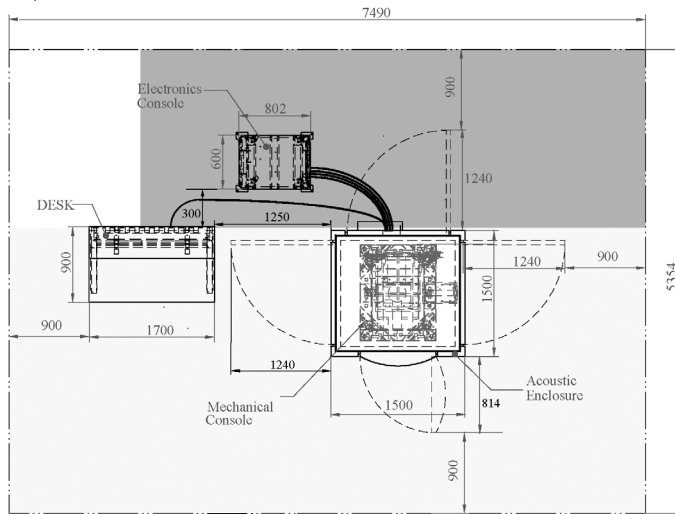
- Power:
  - voltage 100 - 240 V AC,
  - frequency 50 or 60 Hz (± 1%)
- Power consumption: < 3.0 kVA for basic microscope
- Earth resistance: < 0.1 Ω
- Environment:
  - temperature 20 °C ± 3 °C,
  - relative humidity below 80 % RH, 20° C
  - stray AC magnetic fields: < 200 nT a-synchronous, < 600 nT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

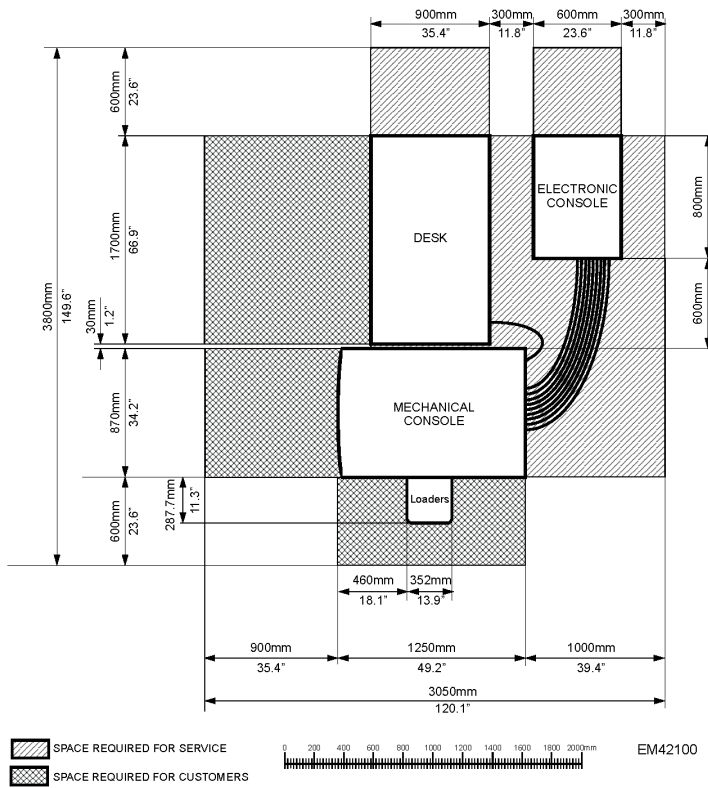
- On-line help
- Prepared for RAPID™ (remote diagnostic support)
- Free access to FEI.com for Owners on-line resources
- Free membership in the FEI FIB UserClub

\* = optional

Floorplan with enclosure



Floorplan without enclosure



Learn more at FEI.com

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