

# Helios 5 Hydra UX DualBeam

Expand your vision for the life sciences with plasma DualBeam technology

The Thermo Scientific™ Helios 5 Hydra™ UX DualBeam combines high-throughput plasma focused ion beam (PFIB) technology with a high-resolution scanning electron microscope (SEM) for unprecedented capabilities in biological FIB-SEM tomography.

The Helios Hydra DualBeam allows you to find the optimal ion beam for every sample thanks to the state-of-the-art inductively coupled plasma (ICP) focused ion beam with four ion species: xenon, argon, oxygen, and nitrogen. Excellent surface quality is achieved for every sample, regardless of preparation method or resin type. In addition to higher milling throughput and sample compatibility, an advanced software suite facilitates consistent, high-quality, and gallium-free data acquisition for large-volume and 3D analysis.

#### Full compatibility with sample preparation protocols

The Helios Hydra DualBeam is a versatile tool for high-throughput cellular FIB-SEM tomography, compatible with all commonly used sample-embedding media and preparation protocols. Four ion species (Xe, O, Ar and N) can be used independently for site-specific, large-volume material removal for top-down and cross-section analysis in 2D and 3D. By selecting the ion beam that matches the requirements of each individual sample, excellent surface texture can be achieved for complex samples such as sample-substrate interfaces or dental (mineralized tissue) materials.

For example, O+ PFIB provides superior data acquisition efficiency and image quality for embedded samples, regardless if the resins are epoxy- or acrylic-based. Unlike Ga-based FIB, curtain-free surfaces are easily generated for a wide range of materials such as LR-White, HM20 and EPON resins. Superior resin- and sample-processing compatibility allows for targeted FIB-SEM tomography with direct, in-resin correlative imaging of the region of interest (ROI).

#### Key Benefits

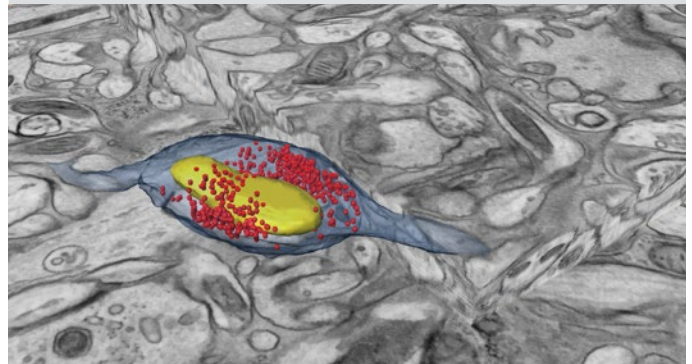
**Milling without artifacts, regardless of sample preparation method.** The multi-ion plasma FIB of the Helios 5 Hydra DualBeam allows you to optimize the ion beam for every sample. Obtain high quality, gallium- and curtain-free surfaces regardless of resin type or sample preparation method.

**Access 10x greater volumes.** Perform fast and efficient milling to access 10x greater volumes without compromising quality. Combined with Auto Slice & View Software, the Helios Hydra DualBeam offers high throughput, fully automated 3D data collection.

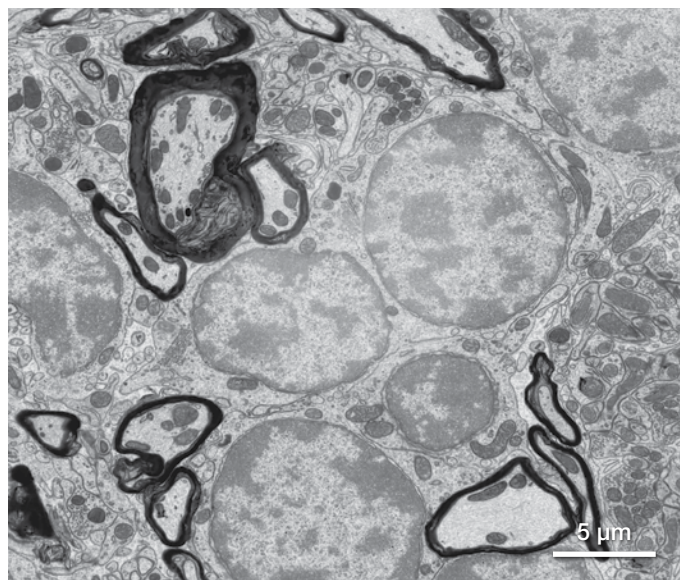
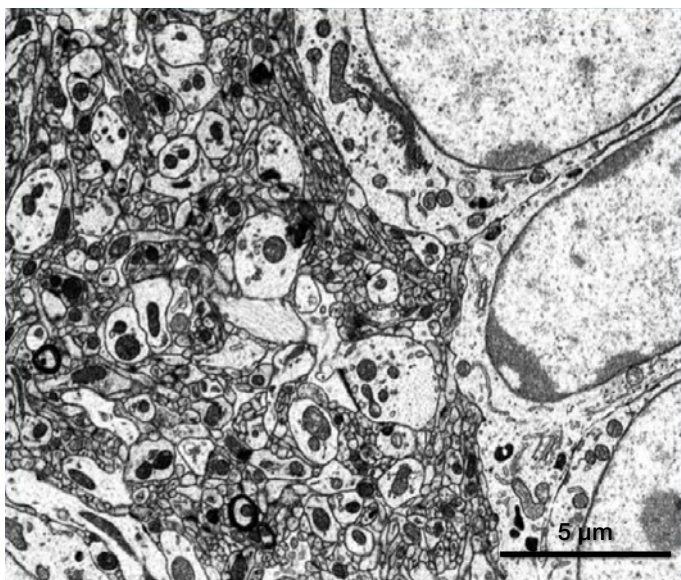
#### Serial sectioning of large horizontal surfaces.

Access large horizontal surface areas, up to 1 mm in diameter, with Spin Mill, providing 3D data acquisition that is similar to serial block-face imaging, but with thinner, nanometer-thick slices.

**Versatile solution for multi-user environment.** The Helios Hydra DualBeam offers the flexibility to address a wide range of samples (e.g. embedding resins, biomaterials) and experimental questions.



3D volume of mouse neuron containing synaptic vesicles and mitochondria (colored) HPF in EPON.



Full compatibility with sample preparation protocols: Selected PFIB slices from mouse brain tissue, chemically fixed with LR White (left) and EPON (right) resin, without any curtaining artifacts.

### Enhanced throughput and large-volume acquisition

Plasma FIB enables efficient, large-volume analysis thanks to a broader, collimated beam delivering currents that are orders of magnitude higher than Ga-FIB (up to 2.5  $\mu\text{A}$ ). Improved sputtering efficiency enhances performance, generating smoother cut faces and reducing curtaining artifacts, further improving throughput and providing fast access to ROIs. The combination of higher currents, higher sputter rates and reduced damage makes it possible to access volumes hundreds of micrometers in size while still observing nanoscale features.

Additionally, Thermo Scientific Auto Slice & View™ Software offers a new Spin Mill application for analyzing large horizontal surface areas up to 1 mm in diameter. With Spin Mill, samples are milled at a near-glancing angle with the PFIB and typical sample preparation for slice-and-view analysis (e.g. protective capping, trenching or the use of fiducial marks) is not required. With such a large milled area, numerous regions can be selected and imaged. Sparse features can easily be identified, and statistically relevant 3D data can be collected from multiple areas. <sup>1</sup>

### High precision and resolution

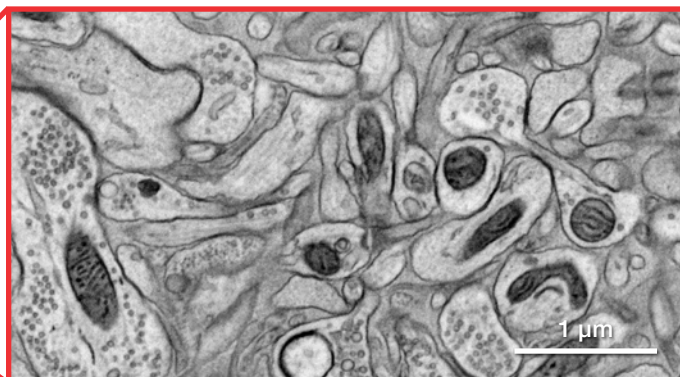
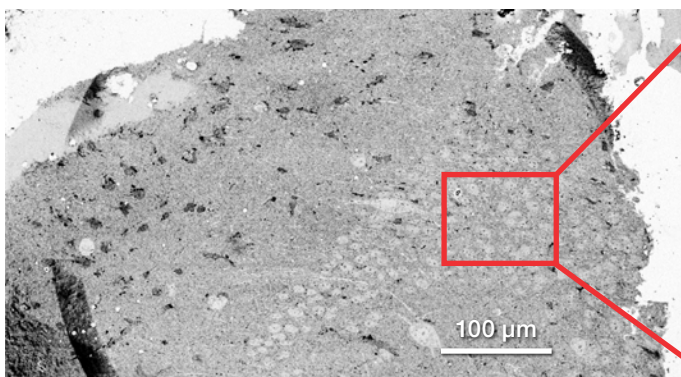
The Helios Hydra DualBeam features an ultra-high-brightness electron source with next-generation UC+ monochromator technology, giving you access to nanoscale details across

the widest range of working conditions. Fast, accurate and reproducible results are obtained thanks to the unique design of the Thermo Scientific Elstar™ Column, which includes advanced auto alignments, constant power lenses for higher thermal stability, and electrostatic scanning for higher deflection linearity and speed.

With its unique immersion mode and in-column detection system, the Helios Hydra DualBeam is designed for simultaneous angular and energy-selective secondary electron (SE) and backscattered electron (BSE) imaging. Reveal even the smallest features with additional below-the-lens detectors and an electron-beam-deceleration mode, which ensure fast and easy simultaneous collection of all signals. Novel Thermo Scientific SmartAlign Technology eliminates the need for manual alignment of the electron column, minimizing maintenance and increasing your productivity. In addition, FLASH technology offers image tuning with “on-the-fly” lens centering, stigmator correction, and image focusing, reducing the time spent on image optimization by up to 10x.

### References

1. Li, S., Raychaudhuri, S., Lee, S.A. et al. (2021) Asynchronous release sites align with NMDA receptors in mouse hippocampal synapses. *Nat Commun* 12:677. doi: 10.1038/s41467-021-21004-x



Accessing large area with Spin Mill: Mouse hippocampal organotypic slice culture HPF Freeze Resin EPON. Courtesy of S. Watanabe, John Hopkins University and J. Wang, Thermo Fisher Scientific.



### Electron optics

- Extreme high-resolution field emission (XFEG) Elstar SEM Column with:
  - Magnetic immersion objective lens
  - High-stability Schottky field emission gun, providing stable high-resolution analytical currents
  - UC+ monochromator technology
- SmartAlign Technology: user-alignment-free technology
- 60-degree dual objective lens with pole piece protection for tilting of larger samples
- Automated heated apertures to ensure cleanliness and touch-free aperture exchange
- Electrostatic scanning for higher deflection linearity and speed
- Thermo Scientific™ ConstantPower™ Lens Technology for higher thermal stability
- Integrated fast beam blanker\*
- Beam deceleration with stage bias from 0 V to -4 kV\*
- Minimum source lifetime: 12 months

### Electron beam resolution

- At optimum working distance (WD):
  - 0.7 nm at 1 kV
  - 1.0 nm at 500 V (ICD)
- At coincident point:
  - 0.6 nm at 15 kV
  - 1.2 nm at 1 kV

### Electron beam parameter space

- Electron beam current range: 0.8 pA to 100 nA at all accelerating voltages
- Accelerating voltage range: 350 V – 30 kV
- Landing energy range: 20\* eV – 30 keV
- Maximum horizontal field width: 2.3 mm at 4 mm WD

### Ion optics

The high-performance PFIB column, with a unique inductively coupled plasma (ICP) source, supports four ion species with fast switching capability

- Ion species (primary ion beam): Xe, Ar, O, N
- Switching time: <10 minutes, only software operation
- Ion beam current range: 1.5 pA to 2.5  $\mu$ A
- Accelerating voltage range: 500 V - 30 kV
- Maximum horizontal field width: 0.9 mm at beam coincidence point
- Xenon ion beam resolution at coincident point
  - <20 nm at 30 kV using the preferred statistical method
  - <10 nm at 30 kV using a selective edge method

### Detectors

- Elstar in-lens SE/BSE detector (TLD-SE, TLD-BSE)
- Elstar in-column SE/BSE detector (ICD)\*
- Everhart-Thornley SE detector (ETD)
- IR camera for viewing sample/column
- High performance in-chamber electron and ion detector (ICE), for secondary ions (SI) and electrons (SE)
- In-chamber Thermo Scientific Nav-Cam™ Sample Navigation Camera\*
- Retractable, low-voltage, high-contrast, and directional solid-state backscattered-electron detector (DBS)\*
- Integrated beam current measurement

### Stage and Sample

High-precision, five-axis motorized stage with piezo-driven XYR axes

- XY range: 150 mm
- Z range: 10 mm
- Rotation: 360° (endless)
- Tilt range: -38° to +60°
- XY repeatability: 1  $\mu$ m
- Max sample height: 55 mm clearance to eucentric point

- Max sample weight at 0° tilt: 500 g (including sample holder)
- Max sample size: 150 mm with full rotation (larger samples possible with limited rotation)
- Compucentric rotation and tilt

### Vacuum system

- Complete oil-free vacuum system
- Chamber vacuum: < 2.6 $\times$ 10<sup>-6</sup> mbar (after 24-hour pumping)
- Evacuation time: <5 minutes

### Chamber

- Electron- and ion-beam coincidence point at analytical WD (4 mm SEM)
- Ports: 21
- Inside width: 379 mm
- Integrated plasma cleaner

### Sample holders

- Multi-purpose specimen holder with adjustable height
- 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 or pretilt stubs and row holders for TEM grids\*
- Various wafer and custom holder(s) available by request\*

### Image processor

- Dwell time range from 25 ns – 25 ms/pixel
- Up to 6144  $\times$  4096 pixels
- File type: TIFF (8, 16, 24-bit), BMP or JPEG standard
- SmartSCAN (256 frame average or integration, line integration and averaging, interlaced scanning)
- DCFI (drift compensated frame integration)

### System control

- 64-bit GUI with Windows 10, keyboard, optical mouse
- Up to four live images showing independent beams and/or signals.
- Live color signal mixing
- Local language support: Check with your local Thermo Fisher Scientific Sales Representatives for available language packs
- Two 24-inch widescreen monitors (1920 $\times$ 1200 pixels) to show system graphical user interface (GUI) and full-screen image

- Microscope control and support computers seamlessly share one keyboard, mouse and monitors
- Joystick\*
- Multifunctional control panel\*
- Remote control and imaging\*

## Supporting software

- “Beam per view” GUI concept, with up to 4 simultaneously active quads
- SPI (simultaneous FIB patterning and SEM imaging), iSPI (intermittent SEM imaging and FIB patterning), and iRTM (integrated real-time monitor) Software, as well as FIB immersion modes for advanced, real-time SEM and FIB process monitoring and end-pointing
- Patterns supported: lines, rectangles, polygons, circles, donuts, cross sections and cleaning cross-sections
- Directly imported BMP file or stream file for 3D milling and deposition
- Material file support for “minimum loop time,” beam tuning, and independent overlaps
- Image registration enables sample navigation in an imported image
- Sample navigation on an optical image

## Accessories\*

- GIS (gas injection system) solutions
  - Single GIS: up to four independent units for enhanced etching or deposition
  - Thermo Scientific MultiChem™ Gas Delivery System: up to six 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

- Thermo Scientific Enhanced Etch™ System (iodine, patented)
- Insulator enhanced etch (XeF2)
- Thermo Scientific Delineation Etch™ System (patented)
- Dx Delayering
- Empty crucibles for Thermo-Fisher-Scientific-approved user-supplied materials
- More beam chemistries available upon request

- FIB charge neutralizer
- Analysis: EDS, EBSD, WDS
- Thermo Scientific EasyLift™ NanoManipulator for precise in situ sample manipulation
- Thermo Scientific QuickLoader™ Vacuum Technology: load lock for fast sample exchange without breaking system vacuum
- Cryo solution for DualBeam
  - Exclusive CryoMAT Module for materials science cryo applications
  - Solutions from external vendors
- Thermo Scientific acoustic enclosure
- Thermo Scientific CryoCleaner Decontamination Device

## Software options\*

- Thermo Scientific AutoTEM™ Software for automated (S)TEM sample preparation
- Thermo Scientific AutoScript™ 4 Software: advanced automation suite for DualBeam instruments
- Thermo Scientific Maps Software for automatic acquisition of large images and optional correlative work
- Auto Slice and View Software: automated sequential mill and view to collect a series of slice image, EDS or EBSD maps for 3D reconstruction
- Thermo Scientific Amira Software: 3D reconstruction and analysis software

## Warranty and training

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

## Documentation and support

- Online user guidance
- User operation manual
- Prepared for remote diagnostics with Thermo Scientific RAPID Support

\* Optional

\*\* Some beam chemistries may only be available on the MultiChem or Single GIS Systems

Find out more at [thermofisher.com/HeliosHydra](https://thermofisher.com/HeliosHydra)