

# Helios G4 PFIB CXe DualBeam

Enabling breakthrough innovations with DualBeam technology—faster and easier than ever before

Helios G4 PFIB delivers unmatched capabilities for large volume 3D characterization, Ga<sup>+</sup> free sample preparation and precise micromachining.

The Thermo Scientific™ Helios™ G4 PFIB CXe DualBeam™ is part of the fourth generation of the industry leading Helios DualBeam family. It combines the new PFIB 2.0 column and the Monochromated Elstar™ SEM column to deliver the most advanced focused ion- and electron beam performance. Intuitive software and an unprecedented level of automation and ease-of-use provide observation and analysis of relevant subsurface volumes by scientists and engineers.

The PFIB 2.0 delivers superior performance at all operating conditions, enabling users to perform the most challenging and demanding tasks at the micro scale. The CXe DualBeam is an all-in-one instrument without the constraint of choosing between ion columns suited for limited applications or a requirement for complex accessories to improve cut face quality (e.g. milling curtain mitigation). The innovative Elstar electron column with high-current UC+ technology provides extreme high-resolution imaging and the highest materials contrast. The newest chemistries developed by Thermo Fisher Scientific and available via the optional MultiChem or GIS gas delivery systems, further enhance the milling throughput, precision and control.

In addition to the most advanced electron and ion optics, the Helios G4 PFIB CXe incorporates a suite of state-of-the-art software that enables simple and consistent high-resolution S/TEM and Atom Probe Tomography (APT) sample preparation, as well as the highest throughput and quality large volume subsurface and 3D characterization, even on the most challenging samples.

## Key benefits

**Highest throughput and quality** relevant 3D characterization, cross-sectioning and micromachining using next generation 2.5 μA Xenon Plasma FIB column (PFIB 2.0)

**Access high quality**, multi-modal subsurface and 3D information with precise targeting of the region of interest using optional Auto Slice & View™ 4 (AS&V4) software

**Highest quality** Ga<sup>+</sup> free TEM sample preparation thanks to the PFIB 2.0 superior performance at all operating conditions and Guided TEM Sample preparation workflow

**Reveal the finest details** using best-in-class Elstar electron column with high-current UC+ monochromator technology, enabling sub-nanometer performance at low energies

**The most complete sample information** with sharp, refined, and charge-free contrast obtained from up to 6 integrated in-column and below-the-lens detectors

**Most advanced capabilities** for electron and ion beam induced deposition and etching on FIB/SEM systems with optional MultiChem™ or GIS gas delivery systems

**Precise sample navigation** tailored to individual application needs thanks to the high flexibility 110 mm stage and optional in-chamber Nav-Cam

**Artifact-free imaging** based on integrated sample cleanliness management and dedicated imaging modes such as SmartScan™ and DCFI

## Highest quality large volume subsurface and 3D information

Subsurface or three-dimensional characterization is often required to better understand the material properties of a sample. In many cases large volumes, inaccessible by conventional Ga<sup>+</sup> FIB instruments, are necessary to obtain representative and relevant results. Excellent high current performance of the Helios G4 PFIB with optional Auto Slice & View 4 (AS&V4) software enables the highest-quality, fully automated acquisition of large volume 3D datasets in a multitude of modalities, including, among others, BSE imaging for maximum materials contrast, energy dispersive spectroscopy (EDS) for compositional information, and electron backscatter diffraction (EBSD) for microstructural and crystallographic information. Combined with Thermo Scientific™ Avizo™ visualization software, it delivers a unique workflow solution for the highest-resolution, advanced 3D characterization and analysis at the nanometer scale.

## Highest quality Ga<sup>+</sup> free TEM sample preparation

To understand new materials or to find the root cause of failures, scientists and engineers constantly face new challenges that require highly localized characterization of increasingly complex samples with ever smaller features. The latest technological innovations of the Helios G4 PFIB, in combination with the easiest to use, most comprehensive software and our application expertise, enable the fastest and easiest preparation of site-specific, high-quality HR-S/TEM samples for a wide range of materials. In order to achieve the highest quality results, final polishing with low energy ions is required to minimize surface damage on the sample. Our new PFIB 2.0 column not only delivers high-resolution imaging and milling at high voltages, it now extends FIB performance down to accelerating voltages as low as 2 kV, enabling the creation of high-quality, low-damage TEM lamella.

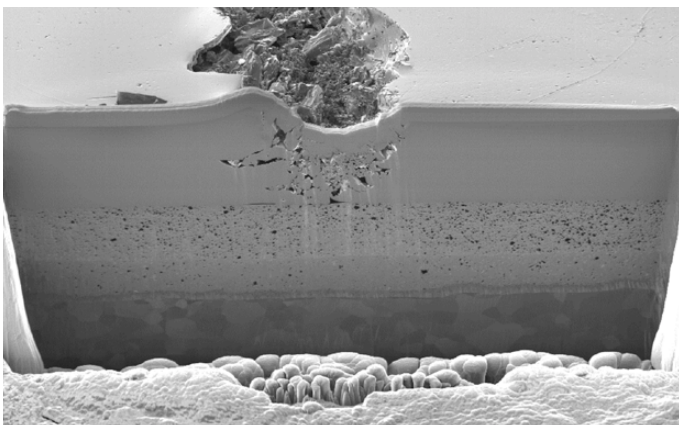


Figure 1. 500  $\mu\text{m}$  wide cross section for scratch testing and adhesion in paint coatings.



## Highest resolution with the most precise materials contrast

Helios G4 PFIB CXe DualBeam features an ultra-high-brightness electron source with the next-generation UC+ monochromator technology to reduce the beam energy spread below 0.2 eV for beam currents up to 100 pA. This enables sub-nanometer resolution and the highest surface sensitivity at low landing energies. The innovative Elstar™ electron column provides the foundation of the system's unprecedented high-resolution imaging capability. It offers the best nanoscale details, using the widest range of working conditions, whether operating at 30 keV to access structural information or at lower energies to obtain charge-free, detailed information from the surface. With its unique detection system located inside the column and its immersion mode, the system is designed for simultaneous detector acquisition for angular and energy-selective SE and BSE imaging. Fast access to the most detailed nanoscale information is guaranteed, not only top-down, but also on tilted specimens or cross-sections. Additional below-the-lens detectors and the electron beam deceleration mode ensure fast and easy simultaneous collection of all signals to reveal the smallest features in material surfaces or cross sections. Fast, accurate, and reproducible results are obtained thanks to the Elstar's unique column design, which includes advanced auto alignments, constant power lenses for higher thermal stability, and electrostatic scanning for higher deflection linearity and speed.

## Productivity for all users

Researchers of all experience levels will benefit from the Helios G4 PFIB streamlined performance, allowing them to obtain high-quality, reproducible results faster and easier. It includes our easiest-to-use and most comprehensive hardware and software, including advanced auto alignments and system optimization, AS&V 4, and our guided TEM sample preparation workflow for unmatched ease of use and throughput. This interactive workflow automatically manages parts of the process while guiding even novice users through the creation of high-quality samples in less than an hour. Helios G4 PFIB combines expanded deposition and etching capabilities, enhanced sample flexibility and control, and an extensive iFast automation suite to create the most advanced DualBeam ever assembled—all backed by the Thermo Fisher Scientific expert application and service support.

## Electron optics

- Elstar extreme high-resolution field emission SEM column with:
  - Immersion magnetic objective lens
  - High-stability Schottky field emission gun to provide stable high-resolution analytical currents
  - UC+ monochromator technology
- 60 degree dual objective lens with pole piece protection allows tilting larger samples
- Automated heated apertures to ensure cleanliness and touch free aperture exchange
- Electrostatic scanning for higher deflection linearity and speed
- 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 month

## Electron beam resolution

- At optimum 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
- 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

High performance PFIB 2.0 column with Inductively coupled Xe+ Plasma (ICP)

- Ion beam current range: 1.5 pA to 2.5 μA
- Accelerating voltage range: 2 kV - 30 kV
- Maximum horizontal field width: 0.9mm at beam coincidence point

Ion beam resolution at coincident point

- <20 nm at 30 kV using preferred statistical method
- <10 nm at 30 kV using 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 ion conversion and electron (ICE) detector for secondary ions (SI) and electrons (SE)
- In-chamber Nav-Cam™ sample navigation camera\*
- Retractable low voltage, high contrast directional solid-state backscatter electron detector (DBS)\*
- Integrated beam current measurement

## Stage and sample

Flexible 5-axis motorized stage:

- XY range: 110 mm
- Z range: 65 mm
- Rotation: 360° (endless)
- Tilt range: -38° to +90°
- XY repeatability: 3 μm
- Max sample height: Clearance 85 mm to eucentric point
- Max sample weight at 0° tilt: 2 kg (including sample holder)
- Max sample size: 110 mm with full rotation (larger samples possible with limited rotation)
- Compucentric rotation and tilt

## Vacuum system

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

## Chamber

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

## Sample holders

- Standard multi-purpose holder, uniquely mounts directly onto the stage, hosts up to 18 standard stubs (Ø12 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
- Each optional row-bar accommodates 6 S/TEM grids
- 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 25 ns – 25 ms/pixel
- Up to 6144 × 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 7, 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 (1920×1200 pixels) for system GUI and full-screen image
- Microscope controlling and support computers seamlessly sharing one keyboard, mouse and monitor3Joystick\*
- Multifunctional control panel\*
- Remote control and imaging\*

## Supporting software

- 'Beam per view' graphical user interface concept, with up to 4 simultaneously active quads
- Thermo Scientific SPI™ (simultaneous FIB patterning and SEM imaging), iSPI™ (intermittent SEM imaging and FIB patterning), iRTM™ (integrated real time monitor) 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
- 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 enabling sample navigation in an imported image
- Sample navigation on an optical image

## Accessories\*

- GIS (Gas Injection System) – Solutions:
  - Single GIS: up to 4 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<sub>2</sub>)
  - Delineation Etch™ (patented)
  - Selective carbon mill (patented)
  - Dx Delaying
  - Low-k Dielectric Etch
  - Empty crucibles for Thermo Scientific approved user supplied materials
  - More beam chemistries available upon request

- EasyLift™ for precise *in situ* sample manipulation
- FIB Charge Neutralizer
- Analysis: EDS, EBSD, WDS
- QuickLoader™: Loadlock for fast sample exchange without breaking system vacuum
- Cryo solution for DualBeam
  - Exclusive Thermo Scientific CryoMAT for material science cryo applications
  - Solutions from external vendors
- Thermo Scientific acoustic enclosure
- Thermo Scientific CryoCleaner

## Software options\*

- Guided TEM sample preparation workflow
- iFast advanced automation suite for DualBeam
- MAPS™ for automatic acquisition of large images and optional correlative work
- NanoBuilder™ – advanced Thermo Scientific 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 slices images, EDS or EBSD maps for 3D reconstruction

- Avizo for Thermo Scientific – 3D reconstruction and analysis software
- CAD navigation
- Web enabled data archive software
- Advanced image 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 RAPID™ (remote diagnostic support)
- Free access to "Thermo Fisher Scientific for Owners" online resources

\* Optional

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

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

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