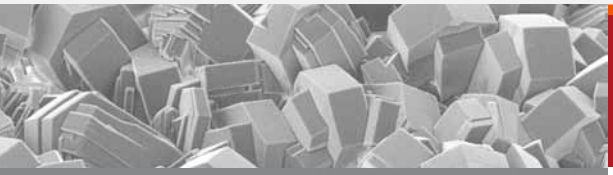


Quanta™ 3D FEG 600

Versitility and precision for demanding 3D NanoCharacterization, NanoPrototyping and *in situ* research applications

The Quanta™ 3D FEG DualBeam™ Family combines the most versatile high resolution, low vacuum SEM and the high throughput FIB for 2D and 3D material characterization and analysis. The Quanta 3D FEG 600 extends the flexibility to handle larger samples with higher precision with the inclusion of the high accuracy system with a 150 mm piezo-driven stage to further enhance positioning accuracy and repeatability. Innovative electron and ion optics combined with Quanta's unique environmental SEM operating mode will expand laboratory capabilities, providing better, faster and more comprehensive materials characterization, analysis and sample preparation.

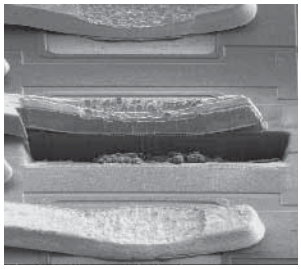
The Quanta 3D FEG field-emission electron source delivers clear and sharp electron imaging, while the increased electron beam current (200 nA) enhances EDS, WDS and EBSD analysis. Featuring three imaging modes – high vacuum, low vacuum and ESEM™, it accommodates the widest range of samples of any DualBeam system.
Quanta 3D FEG is engineered to provide the widest range of data – imaging and microanalysis – from all specimens, with or without preparation. *in situ* study of the dynamic behavior of materials at different humidity levels (up to 100% RH) and temperatures (up to 1500 °C) is also within the Quanta 3D FEG's capabilities.

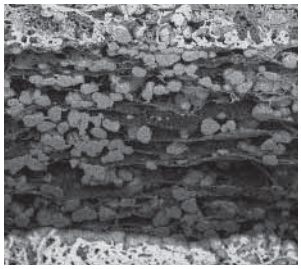
Quanta 3D FEG's unprecedented high-current FIB enables fast material removal. Auto*Slice and View™* software enables collection of serial slice images and can be extended to gather EDS or EBSD data with individual slices. Even non-conductive samples can be simply milled with the automated mode for drift suppression. Automated FIB sectioning recipes enable accurate cross-sectioning and low damage sample cleaning. On top of the site-specific milling and excellent imaging capabilities of the FIB, a large selection of gas chemistries is available to deposit materials or further enhance the FIB milling rate or material selectivity. Quanta 3D FEG features live simultaneous SEM imaging while FIB milling / patterning, making it a superior solution for active monitoring of fast preparation of large samples over a wide range of materials.

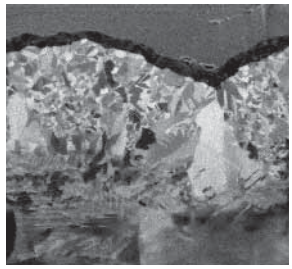
Building on FEI's long experience in DualBeam technology, Quanta 3D FEG 600 provides a very powerful, easy to use solution for the investigation of even more samples. The high precision 150 mm stage helps expand the ability to work with a wider variety of samples and get more data.

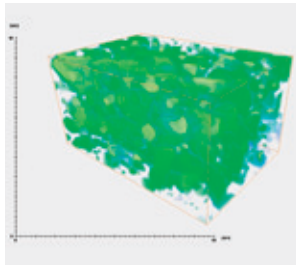
Key benefits

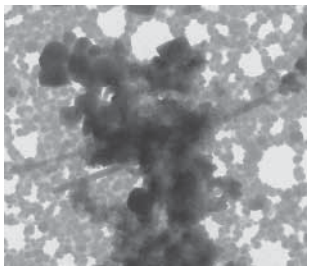
- Versitility to examine surface and sub surface of any sample to obtain quick answers
- Flexibility to examine conductive, non-conductive and high vacuum incompatible samples with the high, low vacuum and ESEM™ vacuum modes
- High quality *in situ* sample preparation for TEM, Atom Probe, or other uses
- Combination of high current FIB and low kV FIB cleaning to quickly cut out samples and produce the highest quality samples
- High precision 150 mm piezo stage for accurate sample placement
- Full complement of software options to perform advanced task: 3D volume collecction and reconstruction, prototyping from GDS files, scripting

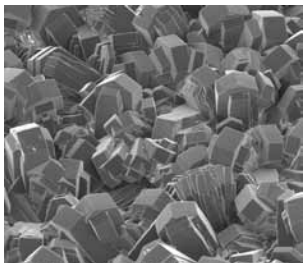

Large-area cross-section

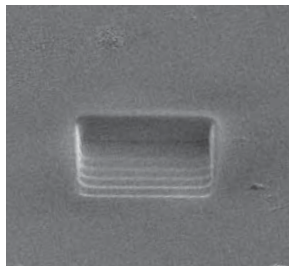

Cross-section made on cryo-cooled sample

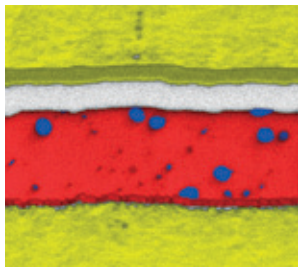

Channeling contrast using FIB-induced SE-Imaging


3D reconstruction based on serial sectioning


Wet STEM analysis


Imaging non-conductive samples


Milling non-conductive sample using charge neutralization mode


EDS analysis on a cross-section

Quanta 3D FEG 600 essential specifications

Electron beam resolution

- High vacuum
  - 0.8 nm at 30 kV (STEM)*
  - 1.2 nm at 30 kV (SE)
  - 1.0 nm at 30 kV(SE)*
  - 2.5 nm at 30 kV (BSE)*
  - 2.9 nm at 1 kV (SE)
- Low vacuum
  - 1.5 nm at 30 kV (SE)
  - 2.5 nm at 30 kV (BSE)*
  - 2.9 nm at 3 kV (SE)
- Extended low vacuum mode (ESEM)
  - 1.5 nm at 30 kV (SE)

Ion beam resolution

- 7 nm at 30 kV at beam coincident point (5 nm achievable at optimal working distance)

Electron optics

- High-resolution field emission – SEM column optimized for high-brightness/ high-current
- 60 degree objective lens geometry with through-the-lens differential pumping
- Heated objective apertures to extend aperture lifetime
- Analytical mode to increase current density for analytical applications
- Accelerating voltage: 200 V – 30 kV
- Probe current: up to 200 nA - continuously adjustable
- Magnification 30 x – 1.28 mx in 'quad' mode
- Fish-eye mode

Ion optics

- High-current ion column with Ga liquid metal ion source
- Source lifetime: 1000 hours guaranteed
- Acceleration voltage: 2 – 30 kV
- Probe current: 1.5 pA – 65 nA in 15 steps
- Beam blanker standard, external control possible
- 15-position aperture strip
- Magnification 40 x – 1.28 mx in 'quad' mode at 10 kV
- Charge neutralisation mode for milling of non-conductive samples

Chamber vacuum

- High vacuum: < $6e^{-4}$ Pa
- Low vacuum: 10 to 130 Pa
- ESEM vacuum: 10 to 4000 Pa
- Pump-down time (high vacuum): < 3 minutes

Vacuum system

- Completely oil free vacuum system
  - 1 x 240 l/s TMP
  - 2 x PVP oil-free (scroll-pumps)
  - 2 x IGP (for electron column)
  - 1 x IGP (for ion column)
- Proprietary through-the-lens differential pumping
- Short beam gas path length: setup for low vacuum analytical applications
- Seamless transition between high and low vacuum
- Imaging gas in low vacuum and ESEM: water vapor or auxiliary gas

Detectors

- Everhardt-Thornley SED
- Low vacuum SED (used in low vacuum)
- Gaseous SED (GSED) (used in ESEM mode)
- IR camera for viewing sample/column
- Solid-State Backscatter Electron Detector (BSED)*
- Retractable low voltage, high contrast backscatter electron detector (vCD)*
- ESEM GAD (Gaseous analytical BSED with ESEM needle detector used for low vacuum analytical applications or for imaging at high pressures in ESEM mode)*
- Retractable STEM detector BF / DF / HA(A)DF*
- In-column detector*
- Electron or ion beam current measurement*
- Secondary electron and secondary ion detector (CDEM)*

* optional

Digital image processor

- Integrated 16-bit digital pattern generator for electron and ion beams
- Dwell: 50 ns – 25 ms adjustable in steps of 100 ns
- Up to 4096 x 3536 pixel resolution
- File type: TIFF (8, 16 or 24-bit), BMP, JPG or AVI
- Single frame or 4-quadrant image display
- 4-quadrant live
- 256 frame average or integration
- Movie recorder

Chamber

- 379 mm left to right
- 21 ports
- 10 mm E- and I-beam coincidence point = analytical working distance
- Angle between electron and ion columns: 52°

5-axes high precision motorized stage

- XY: 150 mm, piezo-driven
- Z = 10 mm motorized (55 mm clearance enables manual sample height adjustment and high rigidity for precision stage moves)
- 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

Sample sizes

- Weight: 500 g (including the sample holder)

Sample holders

- Single stub mount, mounts directly onto stage
- Multi-stub holder (includes pre-tilt mounts)
- Universal Lift-out Holder (ULO) to hold TEM grids and a single sample stub facilitating *in situ* liftout*
- 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 on request*

Gas chemistry

- 'Zero-collision' GIS design concept
  - Individual gas injectors with separate injections systems reconfigurable in the future
  - 5 µm placing accuracy without user interaction
  - GIS control available for automation
- Up to 5 gas injectors for enhanced etch or deposition
- Gas 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

System control

- 32-bit graphical user interface with *Windows® XP*, keyboard, optical mouse
- Easy system operation/control using mouse and keyboard
- Dedicated mouse buttons for focus and selection
- Joystick-like function integrated into the mouse
- Image display: 1 x 19" LCD, SVGA 1280 x 1024
- Support PC (incl. 2nd 19" LCD monitor and DVD R/W)*
- Software controlled keyboard, video and mouse (KVM) switchbox*
- Multi-function control panel*
- Joystick for stage control*

Supporting software

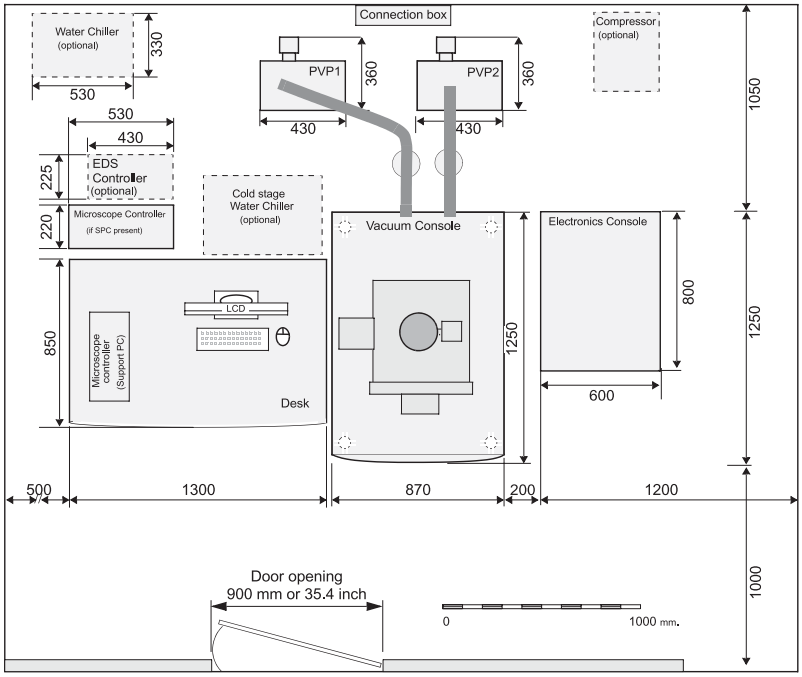
- 'Beams per quad' graphical user interface concept, with up to 4 simultaneously active quads
- FEI SPI™ iSPI™ iRTM™ advanced process monitoring and endpointing through simultaneous patterning and imaging
- Patterns supported: lines, rectangles, polygons, circles, donut, cross-section and cleaning cross-section
- 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
- Digital video recording (.avi)
- SW temperature control for optional heating and cooling stage

Common system 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) solution for FIB and beam deposition optimized NanoPrototyping of complex structures
- **Auto*Slice 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
- **CoppeRx™** proprietary milling strategy
- Knights Technology CAD navigation
- Web enabled data archive software
- Image analysis software
- SW controlled Peltier cooled specimen stage
- SW controlled WetSTEM™ system
- SW controlled 1000 °C heating stage
- SW controlled 1500 °C heating stage
- Remote control/viewing SW
- Video printer
- Fast electrostatic electron beam blanker
- Supplies (compressor, mains matching transformer, UPS)

* optional

Floor plan



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 ESEM User Club

Energy conservation

- Energy Star compliant monitors and PC systems

Common accessories

- EDS
- WDS
- EBSD
- Cryo stage
- Cathodoluminescence
- Sample current detector
- Nanomanipulators
- Lithography systems
- CAD navigation
- Electrical probing
- Plasma cleaner
- Loadlock

Consumables (partial list)

- Replacement Ga-ion source
- Replacement Schottky electron source module
- Aperture strips for electron and ion column
- CDEM detector
- Gas chemistry crucible

Installation requirement

- Power: voltage 230 V (-6 %, +10 %),
  Frequency 50 or 60 Hz (± 1 %),
  Power consumption: < 3.0 KVA for basic microscope
- Environment:
  temperature 20 °C ± 3 °C, relative humidity below 80 % RH
- Stray AC magnetic fields
  < 100 nT asynchronous,
  < 300 nT synchronous
- Acoustics: < 60 dBC
- Compressed air 4-6 bar – clean, dry and oil-free
- Door width: 90 cm
- Weight: column console 700 kg
- Weight: electrical console 150 kg

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