

Appendix I

Essential specification of FEI Quanta 3D FEG FIB system

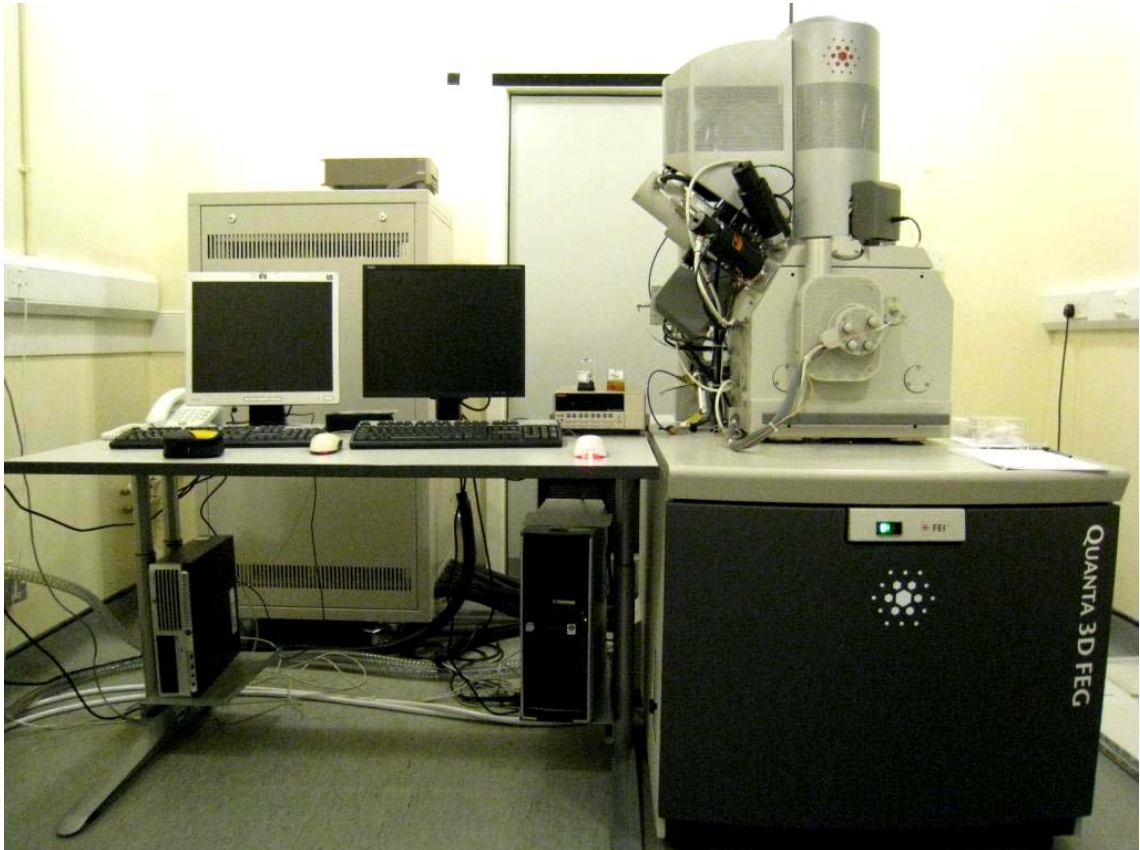


Figure I-1 FEI Quanta 3D FEG FIB system in Heriot-Watt University.

Electron beam resolution

- High-vacuum
 - 1.2nm at 30kV
 - 2.9nm at 1kV
- Low-vacuum
 - 1.5nm at 30kV
 - 2.9nm at 3kV
- Extended low-vacuum mode
 - 1.5nm at 30kV

Ion beam resolution

- 7nm at 30kV at beam coincident point
(5nm 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 and heated objective apertures
- Accelerating voltage 200V – 30kV
- Probe current up to 200nA – continuously adjustable
- Magnification 30x – 1280kx in “quad” mode

Ion optics

- High-current ion column with Ga liquid-metal ion source
- Source lifetime: 1000 hours guaranteed
- Acceleration voltage: 2kV – 30kV
- Probe current: 1pA – 65nA in 15 steps
- Beam blanker standard, external control possible
- 15-position aperture strip
- Magnification 40x – 1280kx in “quad” mode at 10kV
- Charge neutralisation mode for milling of non-conductive samples

Chamber vacuum

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

Digital image processor

- Dwell time: 50ns – 25ms adjustable in steps of 100ns
- Up to 4096×3536 pixel resolution
- 256 frame average or integration

Chamber

- 379mm left to right
- 21 ports
- 10mm electron and ion beam coincidence point
- Angle between electron and ion columns: 52°

5-axis motorized stage

- Eucentric goniometer stage
- X = 50mm
- Y = 50mm
- Z = 25mm
- Maximum sample height: 50mm
- Tilt angle: -15° to $+75^\circ$
- Rotation angle: $n \times 360^\circ$
- Minimum step: 300nm
- Repeatability @ 0° tilt: $2\mu\text{m}$
- Repeatability @ 52° tilt: $4\mu\text{m}$

Gas chemistry

- Platinum metal deposition
- Insulator deposition (SiO_2)
- Selective Carbon Mill