



## FEI Helios NanoLab 460F1 FIB-SEM

Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons  
(ER-C), Forschungszentrum Jülich and RWTH Aachen \*

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**Abstract:** The FEI Helios NanoLab 460F1 is a highly advanced dual beam FIB-SEM platform for imaging and analytical measurements, transmission electron microscopy (TEM) sample and atom probe (AP) needle preparation, process development and process control. For these purposes, the FEI Helios NanoLab 460F1 combines an Elstar™ UC technology electron column for high-resolution and high material contrast imaging with the high-performance Tomahawk™ ion column for fast and precise sample preparation. The FEI Helios NanoLab 460F1 is additionally equipped with the MultiChem™ gas delivery system, an EasyLift™ nanomanipulator, a cooling trap, an inert gas transfer (IGT) holder load-lock, a quick loader, a FlipStage 3™, an EDX-System and an STEM III detector. This instrument is one of the few dual beam systems which combine an IGT holder loadlock with a FlipStage 3+™ EasyLift™ nanomanipulator. Typical examples of use and technical specifications for the instrument are given below.

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## 1 System Overview

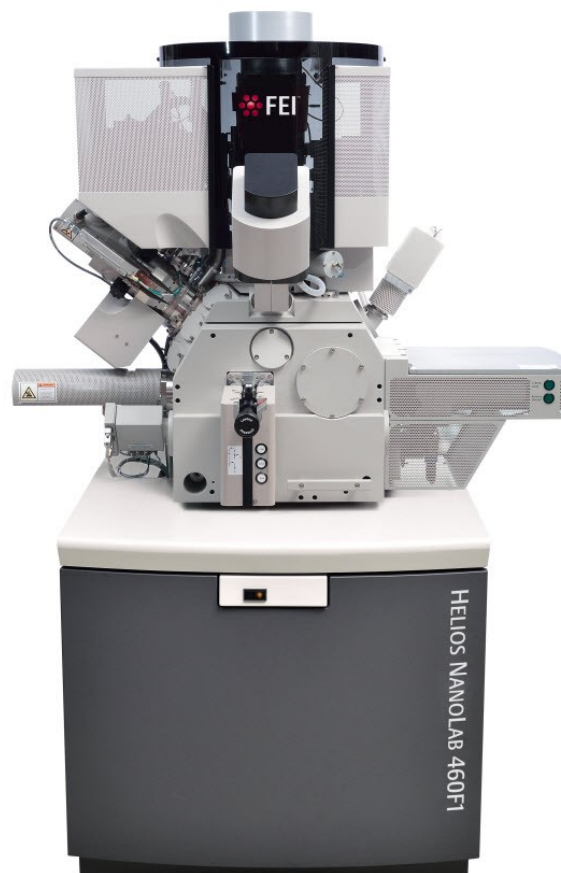


Figure 1: FEI Helios NanoLab 460F1 DualBeam (photograph by courtesy of FEI company).

## 2 Typical Applications and Limitations of Use

The configuration of the FEI Helios NanoLab 460F1 allows a variety of advanced imaging and preparation techniques to be applied to wide bunch of solid state materials. These techniques include TEM sample preparation (normal- and backside milling) without breaking the vacuum (with Flipstage 3), STEM imaging on thin TEM samples (with STEM 3 detector), slice and view operation (automatic), needle preparation for tomography, atom probe sample preparation, plan-view preparation and the preparation of lamellas on heating chips for TEM annealing experiments. Making use of the IGT-loadlock, even samples who are not allowed to be supposed to air can be prepared on any of the previously described ways except needle and atom probe preparation.

The FEI Helios NanoLab 460F1 is not intended for the investigation of aqueous, ferromagnetic or organic samples without further discussions with both of the instruments officers and the ER-C general management.

## 3 Sample Environment

The vacuum is about  $10^{-7}$  mbar under normal operating conditions.

## 4 Technical Specifications

- electron landing voltage 20 V ... 30 kV
- ion landing voltage 500 V ... 30 kV
- electron beam current  $\leq 0.1 \mu\text{A}$
- ion beam current  $\leq 65 \text{ nA}$
- electron source Schottky thermal field emitter
- resolution optimal WD (SEM) @ 2 ... 15 kV < 0.6 nm
- resolution optimal WD (SEM) @ 1 kV < 0.7 nm
- resolution optimal WD (SEM) @ 200 V with beam deceleration < 1.5 nm
- resolution (STEM) < 0.6 nm
- ion source Gallium liquid metal
- resolution (FIB) 30 kV < 4 nm
- resolution (EDX) < 30 nm

## 5 Detectors

- ETD – Everhart Thornley detector
- TLD – through-the-lens detector
- ICE – in-chamber electron
- ICD – in-column detector
- STEM 3+ – STEM detector (BF, DF, HAADF)
- MD – mirror detector
- CBS – retractable backscatter detector
- CCD – charge-coupled detector
- Nav-Cam – in-chamber navigation camera

## 6 Specimen Stages

- Flipstage 3 with in situ STEM 3 detector
- 5 axis all piezo motorised
- 100 mm XY motion
- IGT-Loadlock
- Quick Loader

## 7 MultiChem Gas Delivery System

- Pt, C, W for deposition
- TEOS for insulator deposition
- H<sub>2</sub>O etching gas

## 8 EDX System

- TEAM software for measurement and analyses
- "Octane Super" Detector
- Active Area: 60mm<sup>2</sup>

## 9 Miscellaneous

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