Iliad Ultra (S)TEM for materials science

The Thermo Scientific™ Iliad™ Ultra (S)TEM is a fully integrated analytical (scanning) transmission electron microscope featuring the new Iliad EELS Spectrometer and Energy Filter with the dedicated Zebra EELS Detector, the new NanoPulser Electrostatic Beam Blanker, and the highly sensitive Thermo Scientific Ultra-X EDX Detection System.

The Iliad Ultra (S)TEM is capable of live high-tension (HT) switching of accelerating voltages between 30–300 kV. Thermo Scientific™ Velox™ Software facilitates access to all microscope modalities, while Thermo Scientific™ AutoScript™ Software enables advanced control of the TEM. The Iliad Ultra (S)TEM, with its outstanding hardware and software integration, allows for precise and reliable analytical investigation, even of highly obstinate and beam-sensitive modern materials.

Overall, the future-proof concept and state-of-the-art instrument design of the Iliad Ultra (S)TEM combine to empower your research at the frontiers of materials science.

Iliad Ultra (S)TEM system energy resolution

Package	System energy resolution
EB: Extreme brightness cold field emission gun (X-CFEG)	0.4 eV
	0.3 eV at reduced extraction voltage
HR: High energy resolution	0.2 eV
UHR: Ultra high energy resolution	0.025 eV at 60 kV

Iliad Ultra (S)TEM: STEM resolution and information limit

Package	STEM resolution (probe corrected)	STEM resolution at 30 kV (probe corrected)	Information limit (image corrected)
EB: Extreme brightness cold field emission gun (X-CFEG)	50 pm with 100 pA probe current	136 pm with 100 pA probe current	70 pm
HR: High energy resolution	50 pm with 30 pA probe current	125 pm with 30 pA probe current	60 pm
UHR: Ultra high energy resolution			

Note: All specifications are at 300 kV using an S-TWIN' lens unless otherwise specified.

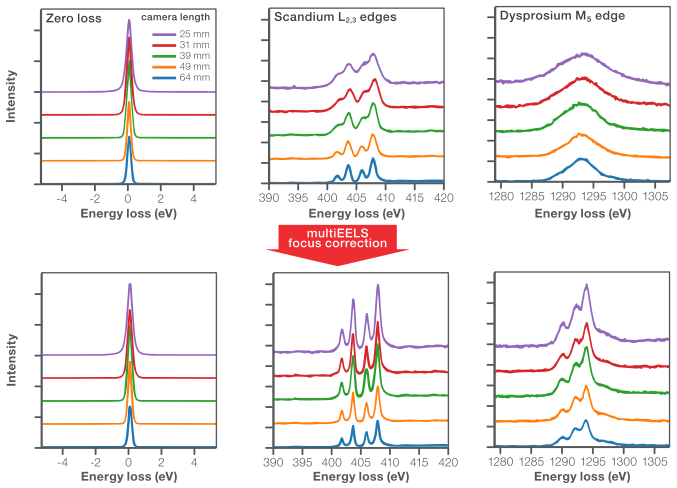
Key features

- Integrated, advanced **EELS and EDX spectroscopy** with the Iliad EELS Spectrometer and Ultra-X EDX Detection System.
- **NanoPulser Beam Blanker** enables dose optimization and time-resolved experiments.
- Live switching between operating voltages **from 30 to 300 kV** quickly optimizes experimental conditions for a broad range of materials and applications.
- **Velox Software** facilitates data acquisition and processing.
- **AutoScript TEM Software** offers advanced microscope control and customized workflow creation.

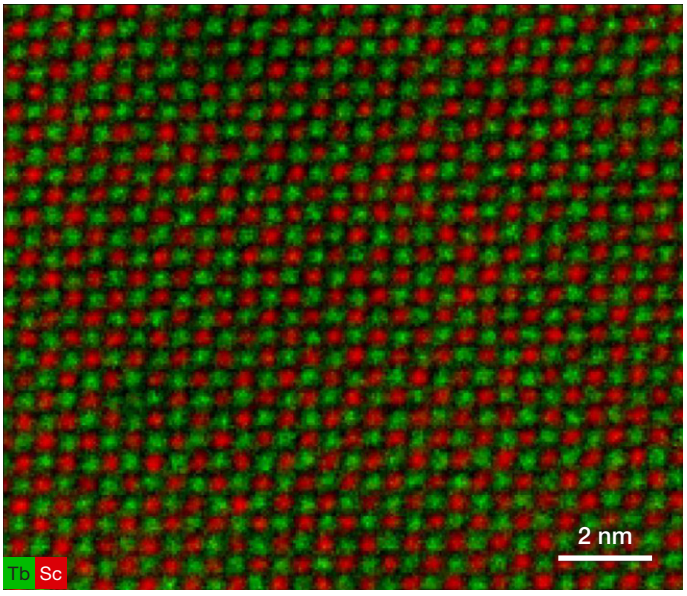
The Iliad Ultra (S)TEM.

Iliad EELS Spectrometer: advanced optical integration for reliable materials analysis

In an optimal electron energy-loss (EELS) experiment, a broad range of electron energies (up to several thousand eV) must be simultaneously transferred through the microscope and spectrometer, from specimen to detector, without introducing any chromatic blur or distortions. At the same time, the TEM operator is continuously switching between different settings to maintain optimal conditions in both the microscope and spectrometer. For accurate transfer of the entire range of experimental conditions, close optical integration needs to be ensured; it is critical that the chromatic defocus in the microscope matches the focus of the spectrum. The Iliad (S) TEM addresses this challenge with its high stability and uniquely integrated optics, resulting in highly optimized EELS data collection.



MultiEELS Mode data collection for $DyScO_3$ at 60 kV, monochromated, with a 30 mrad semi-convergence angle, and 5 mm spectrometer entrance aperture. Data obtained at five different camera lengths. Top) Without correction. Bottom) With on-the-fly auto-correction for chromatic defocus. *Data collected by Dr. Wouter Verhoeven.*

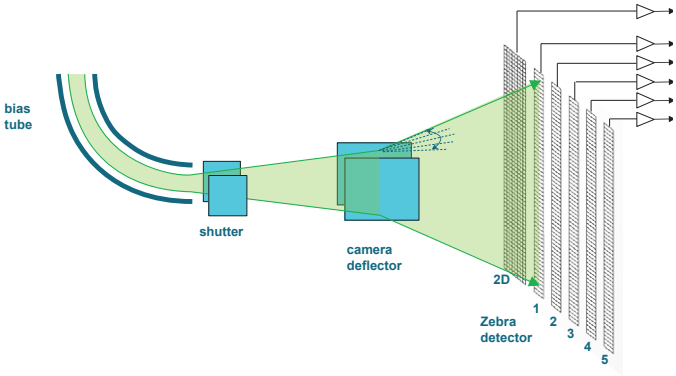


Atomically resolved EELS map of $TbScO_3$ with Tb shown in green and Sc shown in red. 1 eV per pixel dispersion was used. The 256x256 pixel map was recorded in 32 seconds. *Data collected by Dr. Daen Jannis.*

Iliad EELS Spectrometer	
Operating range (kV)	30–300
EELS mode	Yes
EFTEM mode	Optional
Energy range in single spectrum mode (eV)	>4000
MultiEELS Mode	Yes

Zebra Detector designed for EELS data collection

Dedicated for EELS data collection, the Thermo Scientific Zebra Detector consists of five independent 1D-strip detectors and one larger area designed for Iliad EELS Spectrometer alignment. The bias tube is used for fast electrostatic shifting of energy loss during MultiEELS data collection while the camera deflector provides fast electrostatic switching between the strips in the detector. This innovative multi-strip design allows for detection at a fast spectral rate, with readout speeds of up to 10,000 spectra per second. Thermo Scientific™ MultiEELS™ Mode enables the nearly simultaneous acquisition of up to 5 different energy ranges in the EELS spectrum under the exact same experimental conditions.



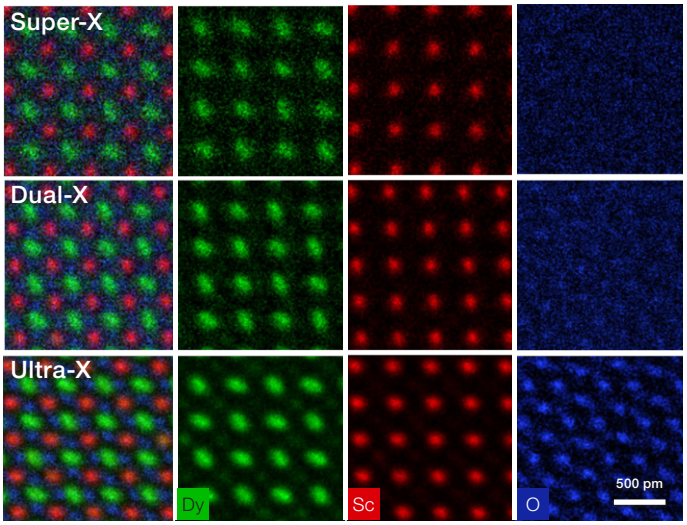
Schematics of the EELS-dedicated Zebra Detector.

Zebra detector

Acquisition area	5 strips of 2048 pixels
Alignment area	1 alignment area of 256x2048 pixels
Pixel size	14 µm
Detector technology	Indirect 5 strip detector
Spectral rate (max. spectra/s)	10,000
MultiEELS Modes	1–5 EELS spectrum ranges

Cutting-edge EDX analysis with the Ultra-X Detection System

The Thermo Scientific Ultra-X Detection System is our leading EDX detector, providing a unique combination of an extremely large solid angle (>4.45 Sr) and cleanliness (<1% spurious peaks), which is comparable to the cleanest EDX solution on the market today. The Ultra-X Detection System is ideal for highly sophisticated experiments, including beam sensitive specimens, providing STEM EDX analysis with less than half the dose required by conventional EDX detectors.



A quantitative comparison between Super-X and Dual-X Detectors for a $DyScO_3$ sample, using the same total electron dose. Sample courtesy of Dr. Lena Kourkoutis, Cornell University. *Data collected by Dr. Cigdem Ozsoy-Keskinbora.*

Ultra-X Detection System specifications

The Ultra-X Detection System features a high-sensitivity, windowless design with a high solid angle and high cleanliness.

Ultra-X Detector	
Output count rate	Up to 1.5 Mcps
Energy resolution	≤136 eV for Mn-Kα and 10 kcps (output)
	≤140 eV for Mn-Kα and 100 kcps (output)
Solid angle (srad)	Without specimen holder: 4.45
	With analytical double tilt holder: 4.04
High P/B ratio	Fiori number >2500
Background signal	Below 1% Fe and Co spurious peaks in EDX system background

Live high-tension switching

The accelerating voltage of the Iliad Ultra (S)TEM can be switched multiple times within a single microscope session, thanks to its unique, constant-power octagon. This is highly valuable when optimizing experimental conditions and for damage mitigation when investigating electron-beam sensitive materials.

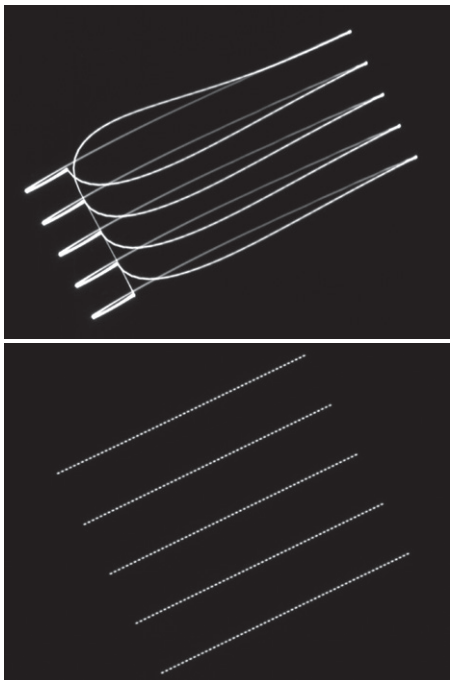
NanoPulser Electrostatic Beam Blanker

The Thermo Scientific NanoPulser Electrostatic Beam Blanker is used to pulse the electron beam and is placed between the electron gun and the condenser module. It blanks the beam by deflecting it away from the optical axis. The NanoPulser Beam Blanker enables nanosecond-scale control over the electron dose rate delivered to the sample, allowing for a wide range of applications from dose-efficient imaging to time-resolved experiments. Free running mode can be applied in both TEM and STEM, while the scan synchronized mode is aimed for STEM operation. In this synchronized mode, the NanoPulser Beam Blanker can make acquisitions up to 40% more dose efficient by eliminating scan overhead before the specimen.

NanoPulser Electrostatic Beam Blanker specifications

Various internal and external inputs are available to synchronize the scan engine, cameras, and free-running dose modulator.

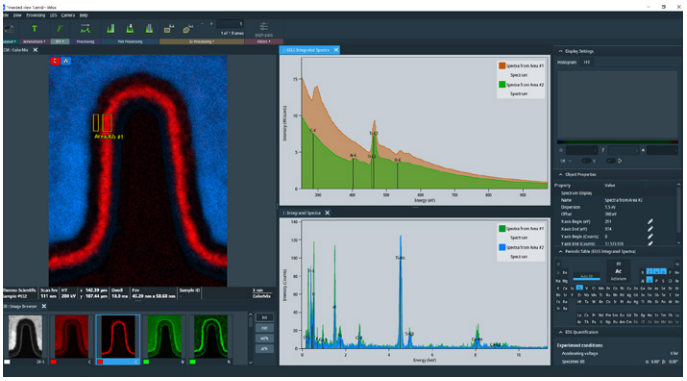
Free running mode		Scan synchronized mode	
Repetition rate	≤1 MHz	Shortest dwell time	1 µs
Shortest unblank time	10 ns	Shortest unblank time	25 ns
Unblank step size	5 ns	Unblank step size	25 ns
Percentage of ON (unblank) time at 1 MHz	1–80%	Percentage of ON (unblank) time at 1 µs	2.5–80%
Percentage of ON (unblank) time at 100 kHz	0.1–98%	Percentage of ON (unblank) time at 2 µs	1.25–90%
		Percentage of ON (unblank) time at 100 µs	0.03–99.8%
		Supports all available STEM resolutions	



Electron beam scanning over a sample with conventional (no blanking) STEM (top) and with a pulsating beam blanker (bottom), which provided 50% blanking during the scan while also completely blanking the flyback signal. *Data collected by Dr. Noopur Jain.*

Velox and AutoScript Software ecosystem for TEM

The Iliad Ultra (S)TEM is powered by Velox Software, which offers cutting-edge, comprehensive experimental control. It facilitates access to STEM optics and detectors, enhancing reproducibility and yield, while also supporting quantitative STEM and TEM material analysis. Velox Software stands out with its integrated, easy-to-use, and ergonomic user interface, providing high-quality imaging and compositional mapping with both EDX and EELS, along with control of the NanoPulser Electrostatic Beam Blanker. Customized workflows often require advanced access to (S)TEM controls as well as the use of AI automation, which is enabled by Autoscript Software.



Velox Software user interface, featuring its intuitive and seamless design.

Learn more at **thermofisher.com/iliad-ultra**