Velox Software

The imaging and analysis engine for all your applications

The multimodal acquisition and analysis software for your scanning/transmission electron microscopy (S/TEM) needs.

A superior solution

When designing and optimizing complex nanomaterials, scientists use (scanning) transmission electron microscopy (S/TEM) to collect multimodal information on the structure, morphology, and composition of their samples. The modern and highly efficient S/TEM platforms used for this analysis are delivering increasingly large data volumes, with imaging and analysis software helping to optimize the user experience and maximize productivity.

Thermo Scientific™ Velox™ Software not only makes it easy to acquire, analyze, and store data but also provides complete documentation. Its user interface combines full access to microscope and detector parameters to provide superior experimental control and deliver reproducible, traceable, well-documented, quantitative S/TEM materials science investigations at high yields.

Key features
All-in-one software helps you focus on getting insights
High-quality imaging and compositional mapping with advanced drift compensation methods like DCFI and cross correlations in fast recursive mapping
Outstanding reproducibility, experimental control, and documentation on multidetector tools via interactive detector layout interface and automatic storage of all vital metadata
Dynamic compositional mapping via time resolved XEDS and “peel back” function for recursive mapping to remove individual frames, which helps minimize artifacts when analyzing the composition of beam-sensitive materials
Unique robust XEDS quantification software with compensation for holder shadowing at any tilt and 4 independent detector readout[1,2]
Simultaneous EELS and EDS acquisition helps minimize sample damage and increase efficiency by retrieving all analytical information in one experiment
STEM and TEM movie recording for dynamic studies with export function to standard formats

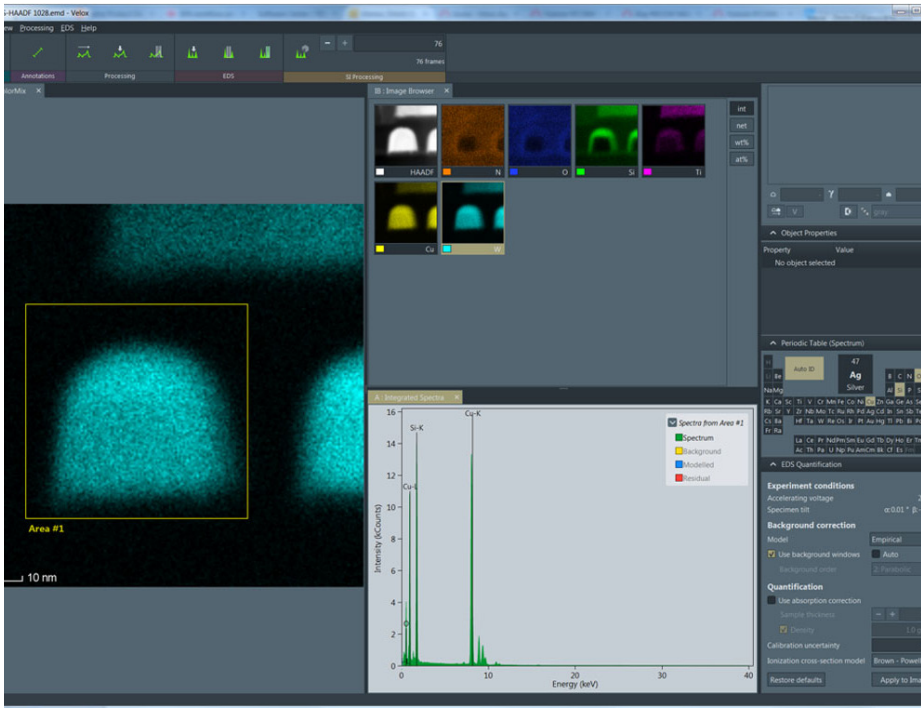

Figure 1: Graphical user interface layout of Velox Software in analytical applications.

Integrated ergonomic user interface

Velox Software provides a workflow-based interface for S/TEM imaging, energy-dispersive X-ray analysis (EDS), and electron energy loss spectroscopy (EELS). For TEM applications, it's used to control Thermo Scientific Ceta™ Cameras and Falcon™ 4 Direct Electron Detectors. And for S/TEM imaging and analysis, it's used to control the triple brightfield/darkfield and Thermo Scientific Panther STEM Detector signals as well as signals from Thermo Scientific™ Dual-X, Super-X, Ultra-X, and Iliad™ Detectors.[1] During analysis, the software displays these signals in real time and provides analysis functions for image processing, including metrology, image filters and Fourier transforms, and quantification of EDS signals. The software's multimodal architecture makes it possible to acquire multiple EDS, EELS, and S/TEM signals simultaneously. Plus, it automatically stores data and complete metadata to help you document your experiment, recreate results, and perform quantitative analysis and simulation offline.

Velox Software provides a variety of predefined layouts. Convenient buttons at the top of the interface to help you easily switch between different TEM modes, select the right detectors, and choose between different data displays for optimal experimental control and analysis. The interactive beam diagram shows the status of the experimental setup in TEM and S/TEM modes, helping you control the sample's exposure to the electron beam and choose the right detector and conditions for the experiment at hand, as shown in Figure 4. After exposure, the automatic beam blanker function helps minimize the total electron dose that the sample receives.

S/TEM imaging and recording

In addition to standard imaging functions like exposure time, frame size, and binning settings, Velox Software can sum images to provide higher image quality. This is accomplished with the drift-corrected frame imaging (DCFI) mode, which takes a series of images, automatically applies drift correction, and displays the results live. The algorithm even works with periodic objects like HR S/TEM images (Figure 2), which standard methods typically fail to align. It also allows you to rotate images in real time in both TEM and STEM modes to align features of interest to the frame shape. This ability to both correct drift and rotate images in STEM and TEM modes simultaneously makes imaging easier and provides significantly better image quality compared to conventional imaging methodologies.

When performing STEM imaging, Velox Software can display up to four imaging signals simultaneously—including brightfield (BF), annular brightfield (ABF), darkfield (DF), and high-angle annular darkfield (HAADF)—in single-shot or continuous mode. A switchable, live focus window and histogram display on the images helps you quickly optimize imaging parameters. And the optional iDPC mode makes it possible to image light elements with outstanding contrast and extremely low electron doses.[1]

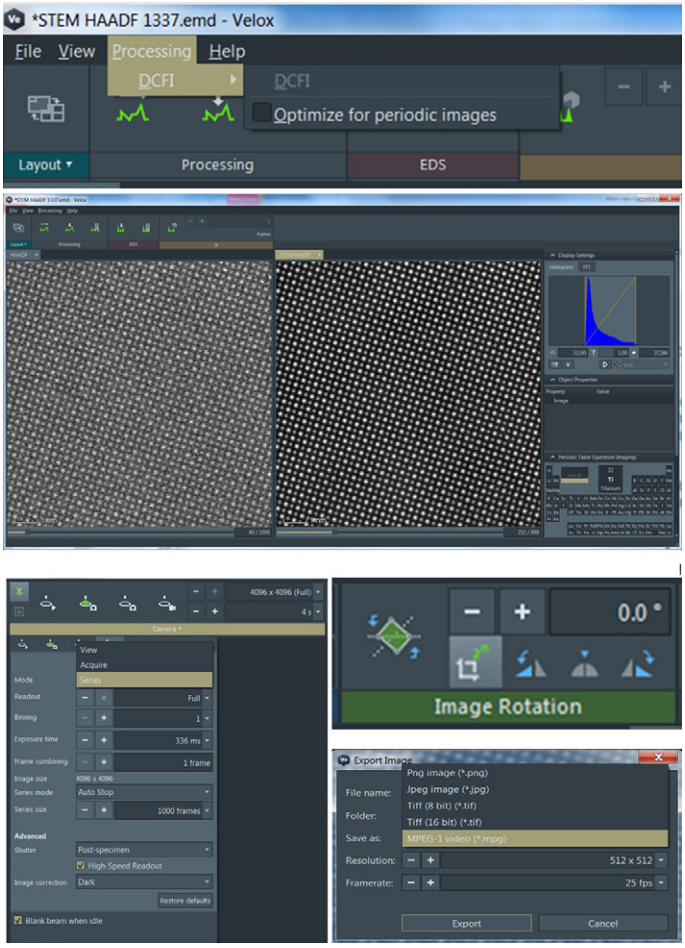

Figure 2: Interface images of DCFI STEM imaging (top), setup of the exposure settings for TEM imaging (bottom), image rotation in TEM interface and exporting of images or movies (bottom).

Velox Software can also record video in TEM and STEM modes with live view. It automatically stores videos with all experimental metadata for later quantitative analysis, which also makes it easier to repeat experimental conditions. The speed of video recording depends on the hardware used, whether the system has a Ceta Camera speed upgrade for TEM imaging[1], and the STEM specifications of the TEM.

Velox Software makes it easy to export data for further analysis in other programs. It exports to standard formats, including PNG, JPG, 8- and 16-bit TIFF, and MPEG-1. The batch raw image exporter can conveniently convert a large series of images to 16-bit TIFF, even with pixel size calibration.

Energy dispersive X-ray analysis

When used with Super-X, Dual-X, and Ultra-X Detectors, Velox Software's robust mapping engine delivers unique on-the-fly drift correction with recursive mapping for EDS applications. It stores each iteration of the mapping area individually, which allows for time-resolved mapping and recovery of accurate mapping. This ensures that no data is lost, even when the sample may have been damaged during the experiment. With a simple push of a button, the "peel back" function removes individual frames until it reaches the point of the first visible sample damage. This process also recovers the underlying spectrum data, enabling quantitative analysis of the high-quality data.

Applying live filter functions to the raw data helps you obtain fast, noise-reduced compositional maps. When paired with a Super-X G2 Detector, Velox Software can simultaneously record the four individual sensor signals, making it possible to exclude from quantification any detector signals that were shaded by unfavorable sample geometries[1]. The software's advanced quantification engine enables fast, automatic peak ID, background subtraction, and on-the-fly quantification of maps. Plus, unique compensation for holder shadowing helps you achieve accurate, reproducible quantification under varying tilt conditions when using our high-visibility, low-background analytical holder.

Figure 3a: EDS spectra of four independent readouts from four Super-X EDS detectors with quantification (left). Velox Software gives easy access to each individual spectra and spectrum image. In this example, the shadowing effect on a carbide precipitate is shown (top right).

Beam induced Pd clustering on SnO_x/Pd nanoparticles

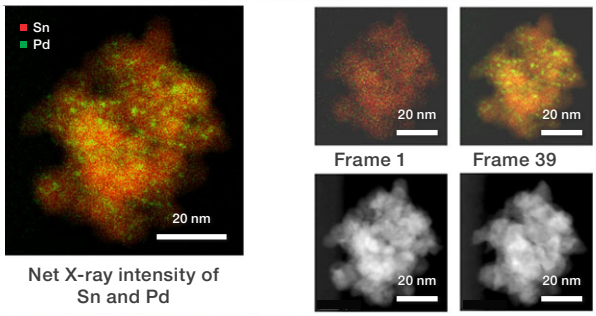

Figure 3b: Time-resolved mapping on Pd agglomeration during exposure of a nanoparticle. Velox Software records and stores each individual frame of the acquisition series.

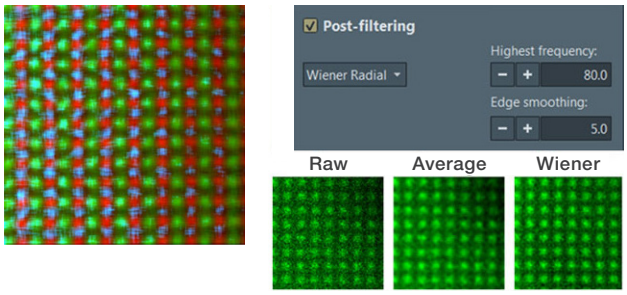

Figure 3c: Velox Software image filter function example on $SrTiO_3$ showing the average filter and the Wiener filter.

Figure 4: Example of interactive detector layout. The active detectors are indicated (light blue). The examples show SmartCam imaging (top), STEM HAADF imaging (bottom left), and a blanked beam condition (bottom right).

Electron energy loss spectroscopy analysis

In addition to EDS, Velox Software offers extensive support for electron energy loss spectroscopy. The software facilitates easy and accurate data acquisition and analysis on the Thermo Scientific™ Iliad™ (S)TEM's spectrometer and energy filter, so you can perform detailed EELS analysis with confidence, as shown in Figure 5. By acquiring EDS and EELS signals simultaneously at a high rate, Velox Software can help you minimize sample damage and work more efficiently.

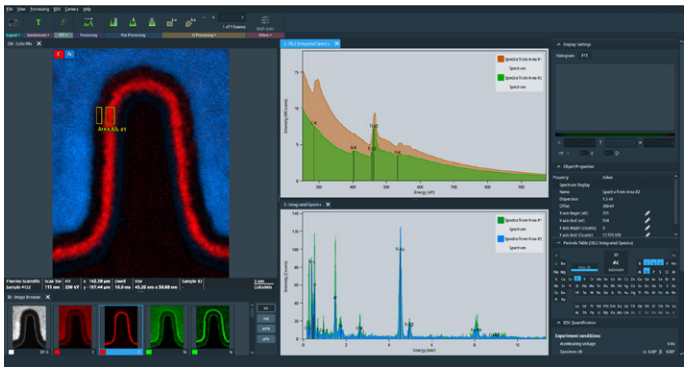

Figure 5: Graphical user interface layout of Velox Software in STEM + EELS applications.

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Velox Software specifications

Navigation	Supported hardware	SmartCam, Ceta Camera, Falcon 4i Detector, OneView, STEM HAADF, STEM with triple BF/DF, Panther STEM
	Navigation modes	Click-move, Click-tilt, live image rotation with stage move adoption
TEM imaging	Supported hardware	SmartCam, Ceta Camera with speed enhancement, Falcon 4 Detector (all models), OneView (requires embedding package)
	Pixels	512 x 512, 1k x 1k, 2k x 2k, 4k x 4k
STEM imaging[1]	Supported hardware	HAADF detector, triple segmented BF/DF detector, Panther STEM Detection System
	Number of signals	Up to 5 STEM signals or up to 11 STEM+EDS signals
	Speed	50 nsec/pixel
Energy dispersive X-ray spectroscopy (EDS)[1]	Supported hardware	Ultra-X Detector, Super-X G1/Super-X G2 Detector, Dual-X Detector, Single Bruker 100mm^2 /Single Bruker 30mm^2
	Independent channel readout	2 channels with Super-X Lite G2 Detector, 4 channels with Super-X G2 Detector, 6 channels with Ultra-X Detector. Ability to remove any channel in post processing.
	Time-resolved spectrum imaging	With all EDS detectors
Electron energy loss spectroscopy (EELS)[1]	Supported hardware	Iliad Detector
4D STEM	Supported hardware	Ceta Camera with speed enhancement
	Number of signals	HAADF + Ceta Camera (with up to 8 live virtual detectors)
	Multimodal	STEM+EDS, STEM+EDS+EELS, and STEM+Camera+EDS
System requirements	Thermo Scientific Talos, Themis, Spectra, and Iliad (S)TEM platforms with Windows 10 64-bit operating systems	
PC for post-processing	Minimal configuration	• Windows 10 or higher • RAM: 16 GB minimum (higher is better) • Graphic board: minimum of 1 GB of memory (NVIDIA is preferred, but other recent boards are supported) • HDD: SSD disk for fast loading/saving of data (500 GB) • CPU: minimum of 6-core CPU
	Recommended configuration	• Windows 11 • RAM: 64 GB minimum (higher is better) • Graphic board: 2 GB of memory (NVIDIA is preferred) • HDD: 2 TB SSD MVE2 disk or larger • CPU: Intel i7 CPU or higher

1. Optional and functions only available if corresponding hardware is part of the column configuration.
2. Only in combination with Super-X G2 Detector. See separate data sheet. Please contact Thermo Fisher Scientific for additional information.

Learn more at **thermofisher.com/em-sales**

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