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DATASHEET

Velox

The imaging and analysis engine for your applications

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

A superior solution

Modern (scanning) transmission electron microscopy (S/TEM) imaging provides multimodal information on structure, morphology and composition of complex nanomaterials. Materials scientists need access to more nanoscale information to design, optimize and understand materials properties. With the increasing data volumes produced by the modern highly efficient S/TEM platforms an imaging and analysis software has to acquire, analyze and store the information as easy and as completely documented as possible to optimize the user experience and maximize productivity.

The Thermo Scientific™ Velox™ user interface with its integrated design combines full access to the microscope and detector parameters to provide superior experimental control to deliver the most reproducible, traceable, well documented, quantitative S/TEM materials science investigations at the highest yields.

Key Benefits

- Ultimate quality in imaging and compositional mapping with advanced drift compensation methods like DCFI and cross correlations in fast recursive mapping
- Highest reproducibility and best experimental control and documentation on multidetector tools via interactive detector layout interface and automatic storage of all vital meta data
- Dynamic compositional mapping via time resolved XEDS and `peel back` function for recursive mapping to remove frame by frame to minimize artifacts on compositional analysis on beam sensitive material
- Unique robust XEDS quantification software with compensation of holder shadowing at any tilt and 4 independent detector readout*3
- STEM and TEM movie recording for dynamic studies with export function to standard formats

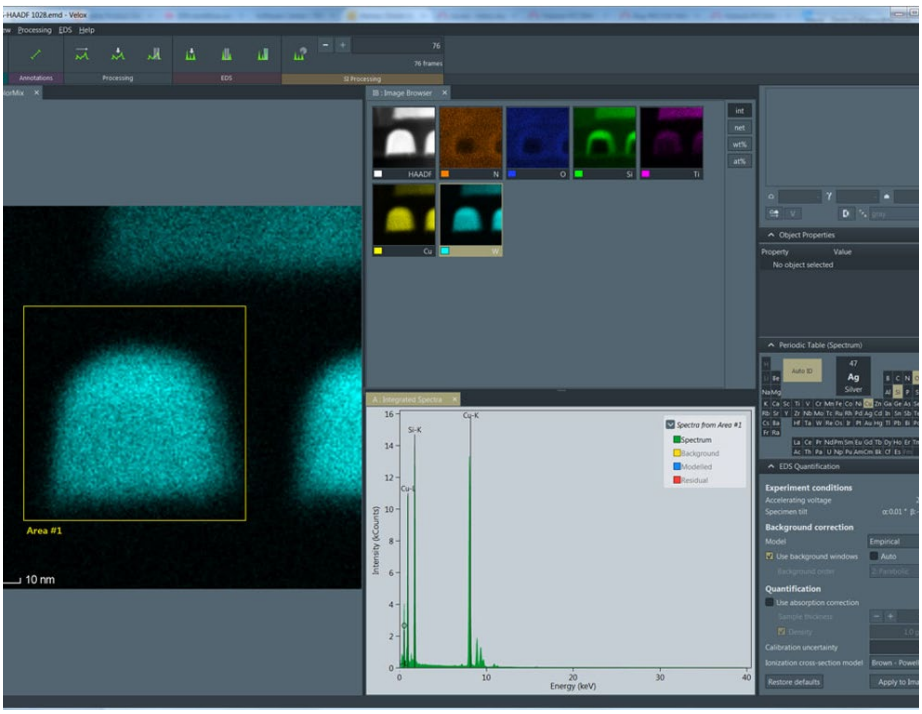

Figure 1: Graphical user interface layout of Velox™ in analytical applications.

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Integrated ergonomic user interface

Velox is a workflow based user interface for S/TEM imaging and energy dispersive x-ray analysis (XEDS) applications. It provides the software interface for the Ceta camera family in TEM applications. In STEM imaging and analysis the triple bright field dark field detector signals and DualX / SuperX XEDS detector signal are handled. The software not only displays the signals live, but provides analysis functions for image processing like metrology, image filters and Fourier transforms or quantification of XEDS signals. The multimodal architecture allows the simultaneous acquisition of multiple EDS detector signals and STEM signals independently. The storage of the data is handled automatically to increase efficiency. Velox includes the most complete metadata handling for excellent documentation of the experiment for reproducibility of results and best quantitative offline analysis and simulation.

Easy push buttons at the top of the interface and a choice a predefined layouts enable intuitive, fast and reliable switching between different modes of the TEM. Choosing the right detectors and data display for the best experimental control or analysis can also be enabled with ease via these push buttons. An interactive beam diagram gives the operator a clear status overview of the experimental set-up in TEM and STEM mode to control exposure of the sample by the electron beam and to be able to choose the right detector with the right conditions for the experiment at hand (figure 4). The automatic beam blanker function (after exposure) allows the total electron dose of the sample to be minimized.

S/TEM imaging and recording

In addition to the standard imaging functions like exposure time, frame size and binning settings, Velox provides the capability to sum images for higher image quality. Here, in the so called drift corrected frame imaging (DCFI) mode an image series is taken and automatically drift corrected and displayed live. The algorithm also works with periodic objects like HR S/TEM images (figure 2), where standard methods of image alignment typically fail. Images can also be rotated live in both TEM and STEM modes via software control to align features of interest to the frame shape. Having both the ability to rotate images and to correct drift with DCFI in STEM as well as TEM increases the ease of use and overall image quality significantly, compared to conventional imaging methodologies. In STEM imaging up to 4 imaging signals including bright field (BF), annular bright field (ABF), dark field (DF) and high angular annular dark field (HAADF) can be displayed simultaneously in single shot or continuous mode. A switchable, live focus window and histogram display on the images enables fast optimization of the imaging parameters. With the optional iDPC mode light elements can be imaged with unprecedented contrast and extremely low electron doses *2. The speed of movie recording depends on the hardware used and depends on whether a CETA speed upgrade*2 is present for TEM imaging or on the STEM specifications of the TEM (Themis or Talos for example) platform. Velox enables movie recording in TEM and STEM mode with a live view and automatic storage of the movies with a complete documentation of experimental meta-data for later quantitative analysis and repeatability of experimental conditions. Additionally, the export function allows the export of data to other analysis or documentation software packages with standard formats like PNG,JPG,TIFF 8/16 bit and MPEG-1. A batch raw image exporter allows for convenient TIFF 16bit format conversion of large image series even with pixel size calibration.

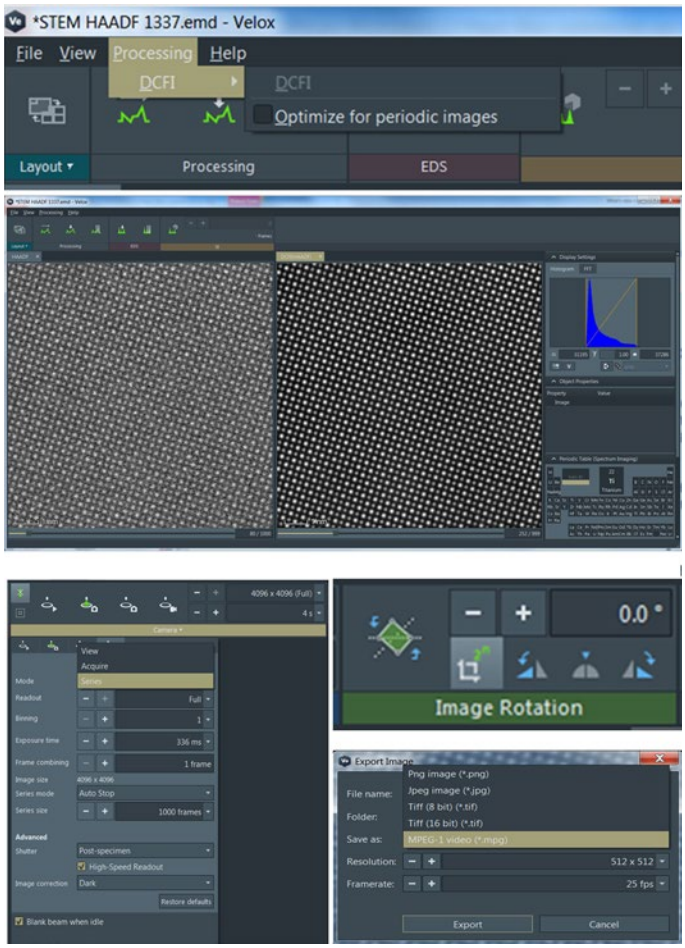

Figure 2: Interface images of DCFI STEM imaging (upper part), set-up of the exposure settings for TEM imaging (lower left), image rotation in TEM interface and exporting of images or movies (lower right)

Energy dispersive x-ray analysis

The Velox software includes unique capability for XEDS applications in combination with our SuperX and DualX detector systems. A robust mapping engine allows 'on the fly' drift correction with recursive mapping. Each iteration on the mapping area is stored individually allowing time resolved mapping and recovery of accurate mapping. This ensures that no data is lost even when sample damage may have occurred during the experiment. Here, a `peel back` function allows subtraction frame by frame until the point of the first visible damage with a simple push button function. Moreover, the underlying spectrum data is recovered by this process, which enables quantitative analysis of the high quality data. Live filter functions can be applied to the raw data to obtain fast, noise reduced, compositional maps. In combination with SuperX G2 the four individual signals of the sensors can be recorded simultaneously which enables detector signals which have been shaded by unfavourable sample geometries to be excluded from quantification*2. The advanced quantification engine of Velox enables fast automatic peak ID, background subtraction and on the fly quantification of maps. Additionally, unique holder shadowing compensation ensures that accurate, reproducible quantification can be achieved under varying tilt conditions with our high visibility low background analytical holder. Optionally, high speed acquisition of XEDS with EELS/DualEELS is enabled in combination with Digital Micrograph software of Gatan with up to 1000spectra/s*2.

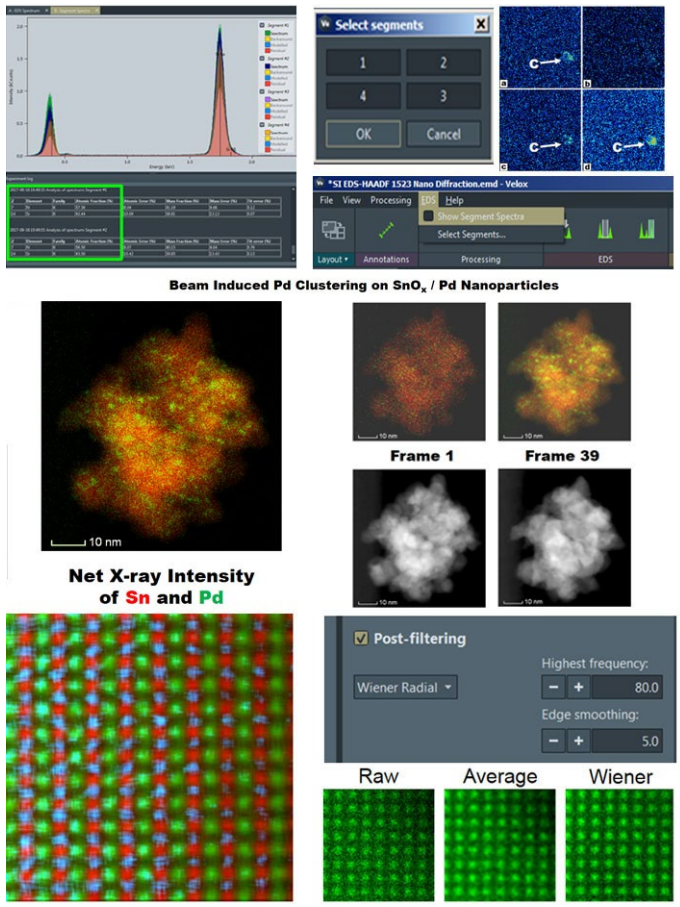

Figure 3: Spectra of four independent readout of 4 XEDS detectors with quantification and an example of the shadowing effect on a carbide precipitate (upper part), time resolved mapping on Pd agglomeration during exposure of a nanoparticle (middle) filter function example on $SrTiO_3$ (lower)

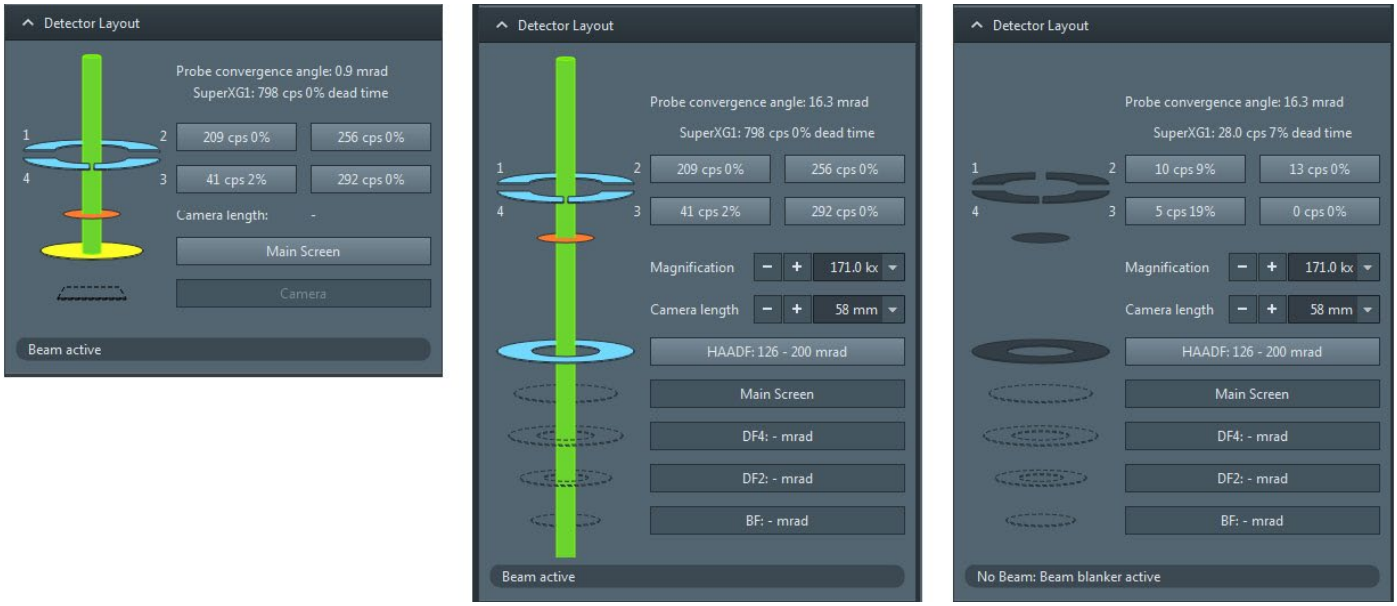

Figure 4: Example of interactive detector layout. The active detectors are indicated (light blue). The examples show Flucam imaging (left), STEM HAADF imaging (middle) and a blanked beam condition (right).

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Velox Key Specifications

TEM imaging	Supported Hardware	Ceta camera
	Pixels	512, 1k, 2k, 4k, binning 2x, 4x, 8x
	Speed	up to 40fps 4k x 4k or 300 fps in 512 x 512 mode*1
	Recording	up to 300fps 512 x 512 mode*1
STEM imaging	Supported Hardware:	HAADF detector and triple (segm.) BF/DF detector
	Number of signals	up to 4 simultaneously
	Speed	100 ns/pixel
	Multimodal	STEM-EDS, STEM-EDS/EELS*1
	Recording	STEM movies up to 10 fps 512 x 512 mode
Energy dispersive x-ray analysis*2	Supported Hardware	SuperX G1/SuperX G2/ DualX
	Multimodal	STEM-EDS, STEM-EDS/EELS*2
	Modes	single Spectrum, Mapping with Drift correction
	Speed	up to 100k spectra/s
	Processing	Time resolved EDS (peel back function), Simultaneous 4 independent detector readout*3 Automatic peak ID, fitting and peak deconvolution Live spectrum integration and intensity profiling
	Quantification	k-factor with / without holder absorption correction Live quantitative mapping Kernel filtering of spectrum images in spectrum space Live filtering of maps (Kernel and Wiener)
Processing	Interactive detector layout interface for reproducible experiment control & set-up • Live S/TEM image summing, drift corrected frame imaging (DCFI) • Live image rotation in STEM and TEM imaging • Live Fourier transformed and image filter functions • Live Focus window and histogram function on up to 4 images simultaneously • Display layout options optimized for efficient view of data • Automatic beam blanking after exposure to avoid unnecessary electron exposure • Advanced data management to keep track of experimental metadata • Automatic storage of data for easy and fast operation • Export function to standard formats PNG,JPG,TIFF 8/16 bit and MPEG-1 and batch raw image exporter (TIFF 16bit) with pixel size calibration	
System requirements	Talos and Titan/Themis platform with Windows 7 64 bit operation system	

*1 optional with Ceta 2 camera
*2 optional and functions only available if corresponding hardware is part of the column configuration.
*3 only in combination with SuperX G2. See separate data sheet. Please contact Thermo Fisher Scientific for additional information

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