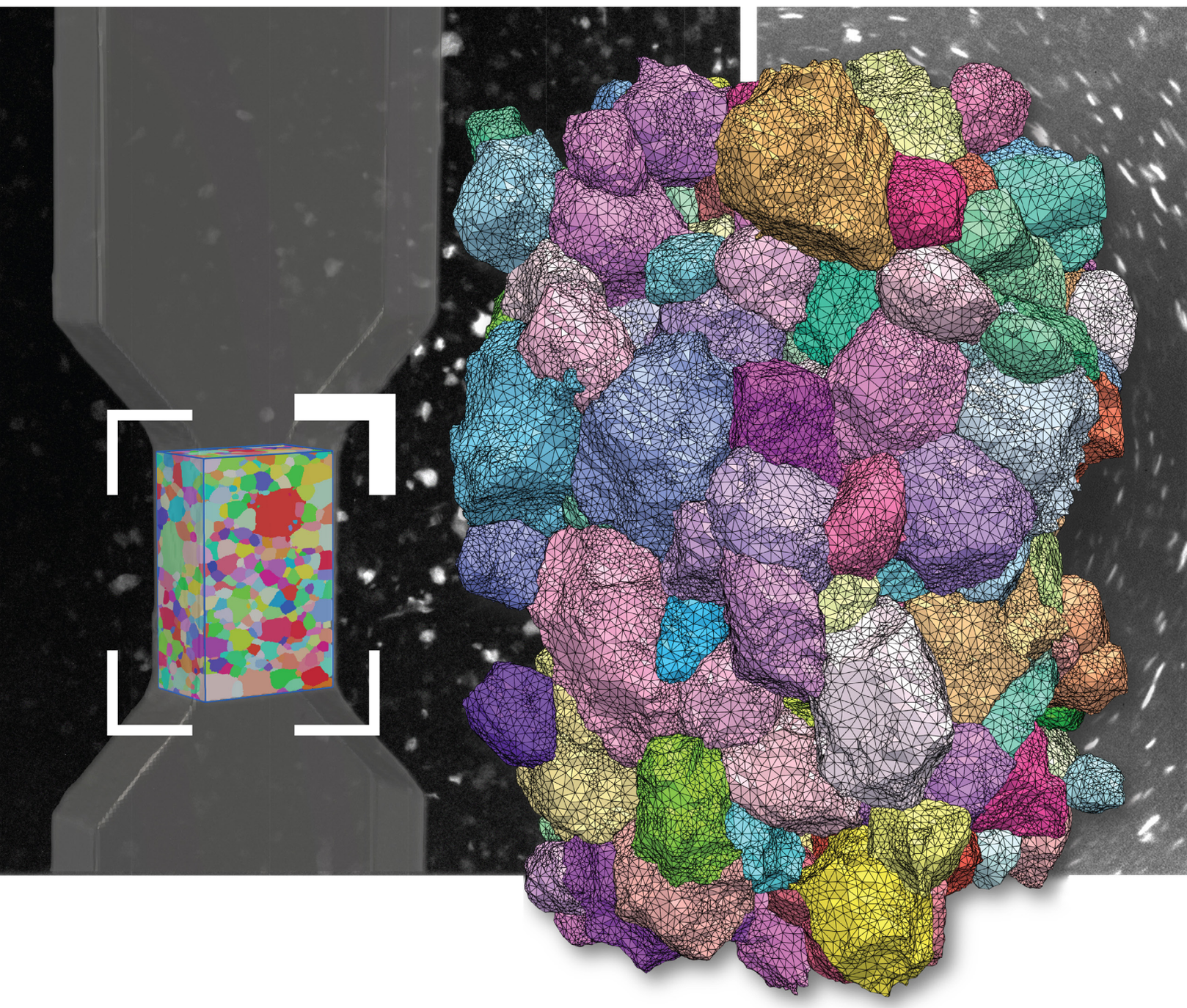
Diffraction contrast tomography in your lab.



LabDCT Pro on ZEISS VersaXRM 730

Product Accessories

ZEISS

Seeing beyond

LabDCT Pro on ZEISS VersaXRM 730

Diffraction contrast tomography in your lab.

Unlocking crystallographic information in your lab

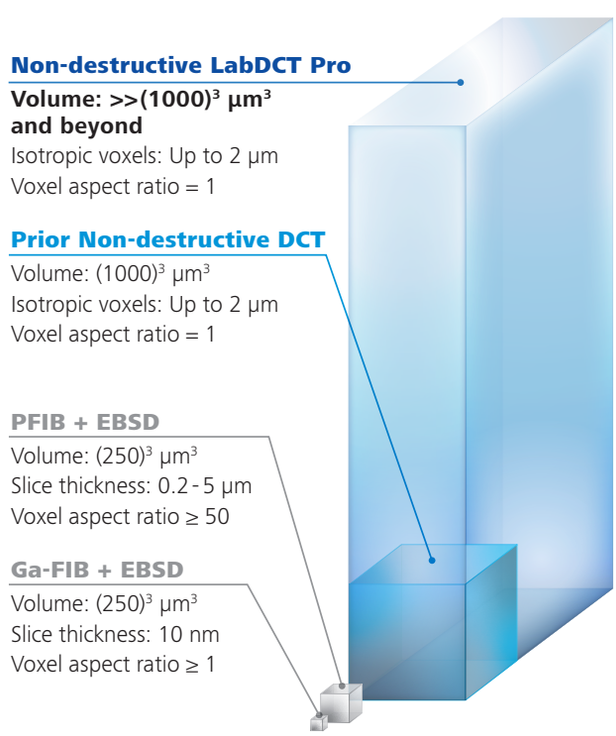
With LabDCT Pro, ZEISS brings you the most advanced capabilities in laboratory-based diffraction contrast tomography. This unique grain imaging analytical technology enables non-destructive mapping of orientation and microstructure in 3D. No longer confined to conventional 2D metallography investigations, direct visualization of 3D crystallographic grain orientation opens a new dimension in the characterization of metal alloys and polycrystalline materials. LabDCT Pro not only enables 3D grain mapping on the objective-based detector system of your ZEISS VersaXRM 730, the imaging module now extends grain mapping capability to the flat panel detector. In combination with DCT advanced acquisition schemes, the high throughput and large detector area of the flat panel allows you to acquire crystallographic data on larger, representative samples.

4D grain map of an Armco iron sample imaged at various annealing steps. t0: initial state; t1: after annealing at 880 °C for 8 hrs; t2: after annealing at 880 °C for 16 hrs. By imaging the sample at three temporal states, the abnormal grain growth of the top, pink-colored grain is captured. Courtesy of Prof. Burton R. Patterson, University of Florida, United States.

Benefits

- Combine 3D grain orientation with 3D microstructural features such as defects or precipitates you have observed in tomography: you will see new possibilities for characterizing damage, deformation, and growth mechanisms.
- Achieve truly representative sample volumes. New innovative DCT scanning modes in LabDCT Pro enable scanning large samples with irregular geometries.
- Complement your grain imaging with 3D grain morphology: routinely acquire grain statistics on larger volumes at faster acquisition times. Crystallographic information provided by LabDCT Pro lets you supplement other analyses like EBSD or synchrotron methods – or even to couple with modeling.
- Investigate microstructure evolution with 4D imaging experiments: LabDCT Pro extends metals research to 3D – and on to 4D with routine tool access for longitudinal studies such as corrosion. Being able to expose your samples to environments in the microscope across days, weeks or even months is a unique strength of laboratory-based XRM experiments compared to the synchrotron.

3D grain map of an Armco iron sample. Half the sample volume is removed to reveal inner grain (small clusters). Faces of a selected grain (left to right): by IPF color, grain boundary normal direction in crystal reference system, misorientation to neighboring grains, and grain boundary curvature.

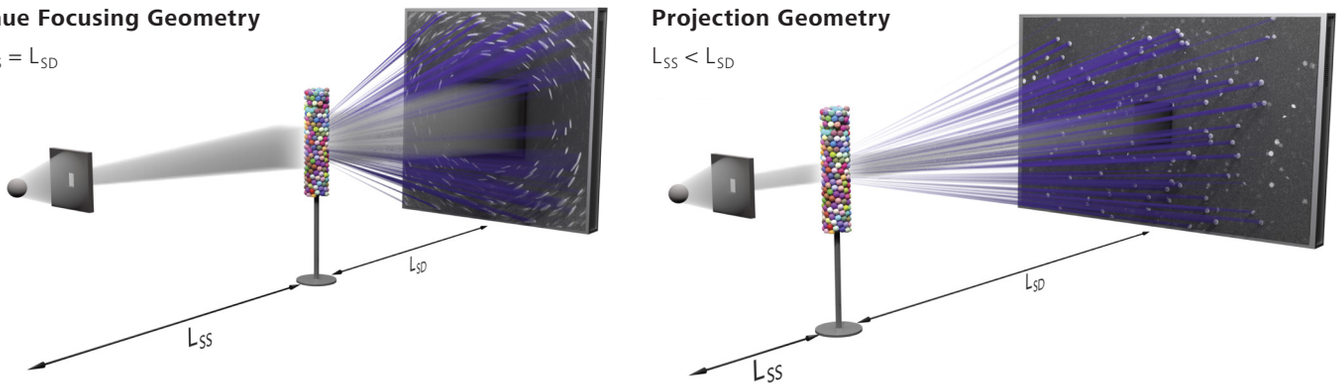


Laue Focusing Geometry

$L_{SS} = L_{SD}$

Projection Geometry

$L_{SS} < L_{SD}$

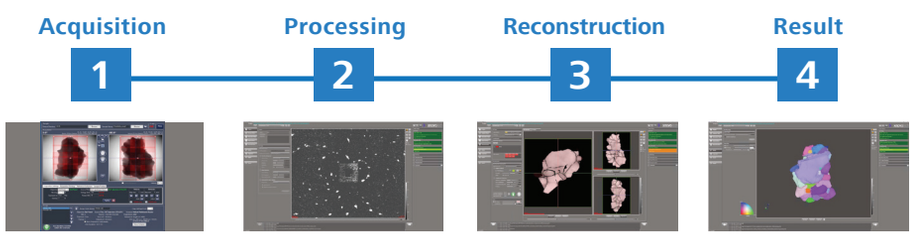


Schematic illustration of LabDCT Pro. Left: Laue focusing geometry on the DCT 4X objective. Right: Projection geometry using the flat panel detector. Exemplifying sample is sapphire spheres stacked in a glass tube.

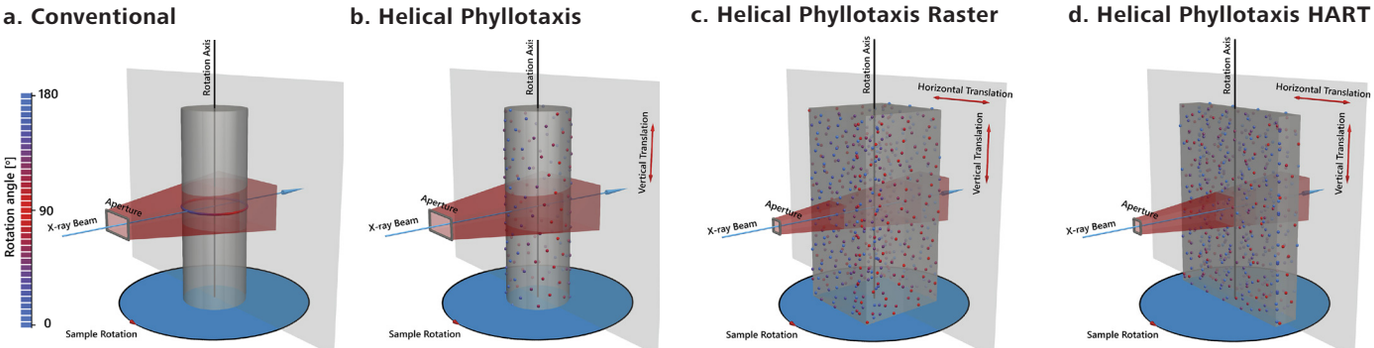
LabDCT Pro is a fully integrated module for the ZEISS VersaXRM 730 X-ray microscope. The sample is illuminated through an aperture in front of the X-ray source. Both the sample absorption and diffraction information are recorded with a high-resolution detection system. 3D grain maps comprising information about grain orientations, morphologies and boundary networks, are reconstructed using GrainMapper3D™ software by Xnovo Technology. Data is exportable in an open data format suitable for additional investigation using custom analysis software or simulation tools.

ZEISS LabDCT Pro Analysis with Xnovo GrainMapper3D

- Workflow-based analysis, to guide and increase the productivity of the non-expert user
- Histogram-based parameter selection
- Instantaneous preview of reconstructed grains to optimize parameter selection
- Interactive 3D view with coloring options for orientation and map fidelity
- Easy export of data into an open format for subsequent analysis, i.e., HDF5



a. Conventional **b. Helical Phyllotaxis** **c. Helical Phyllotaxis Raster** **d. Helical Phyllotaxis HART**



Schematic illustration of (a) the conventional DCT scanning mode and three advanced DCT scanning modes: (b) Helical Phyllotaxis, (c) Helical Phyllotaxis Raster and (d) Helical Phyllotaxis HART. Points on sample surface mark the position where the center of the beam intersects with the sample surface for an individual diffraction projection, colored by the rotation angle of the sample.

Scan modes	Conventional	Helical Phyllotaxis	Helical Phyllotaxis Raster	Helical Phyllotaxis HART
FOV vs ROI	ROI fits in FOV	ROI taller than FOV	ROI larger than FOV	ROI larger than FOV
Rotation stepping	360°/N	137.5°	137.5°	137.5°
Vertical translation	No	Yes	Yes	Yes
Horizontal translation	No	No	Yes	Yes – adaptive

Overview of conventional and advanced scanning schemes along with the associated stage motions

Crystallographic Grain Imaging (X-ray Diffraction Contrast Tomography), powered by Xnovo Technology	
Grain Detectability, Orientation Angular Rotation	20 µm, 0.1°
Crystal Symmetries	Cubic, Hexagonal, Trigonal, Tetragonal, Orthorhombic, Monoclinic and Triclinic
DCT Acquisition Modes	Helical Phyllotaxis-Scanning, Helical Phyllotaxis-Raster, and Helical Phyllotaxis-HART

	ZEISS VersaXRM 730 with FPX and LabCT Pro	ZEISS Xradia CrystalCT
Type of X-ray solution	X-ray microscope with Resolution at a Distance (RaaD) with Performance	microCT on the **ZEISS** Versa platform
Diffraction Contrast Tomography		
High resolution, Laue focus mode diffraction contrast tomography, DCT-4X scintillator coupled detector	■	
Large field of view, high throughput, projection mode diffraction contrast tomography, flat panel detector	■	■
Advanced DCT acquisition modes enabling large volume sample representivity	■	■
Xnovo GrainMapper3D, DCT reconstruction and visualization	■	■
Dedicated DCT reconstruction workstation, Dual NVIDIA CUDA-based GPU, 128 GB RAM, Multi-Core CPU, 27" 4K display monitor	■	■
ZEISS Versa *Protect Your Investment*	Upgradeable	Upgradeable to VersaXRM 730 with FPX and LabCT Pro
X-ray Source		
Type	Spot Stabilized, Sealed Transmission	
Tube Voltage Range: 30 – 160 kV	■	■
Maximum Output	25 W @160 kV	10 W @160 kV

Applications

- Metals and alloys (automotive, aerospace, nuclear, biomedical, electrochemical, and additive manufacturing applications)
- Grain growth and recrystallization
- Ceramics and abrasives
- Energetic materials
- Semiconductor materials
- Non-destructive correlation to 2D/3D EBSD or optical methods
- Large statistical input for computational models

Benefits

- Non-destructive 3D X-ray imaging
- Absorption and diffraction contrast imaging
- Best-in-class resolution and image quality
- Crystallographic grain structure characterization
- Large field of view imaging with fast scan times
- Industry-leading 4D and *in situ* capabilities for flexible sample sizes and types
- Continuous access to advanced reconstruction technologies such as OptiRecon and DeepRecon for enhanced performance (e.g., throughput, image quality)
- Field convertible

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