# Expanding the Horizons of Your Research and Exploration

**ZEISS Xradia 630 Versa X-ray Microscope**

Expanded Accessibility. Improved Productivity. Extended Capabilities.

**zeiss.com/630-versa**

ZEISS

Seeing beyond

# Expanding the Horizons of Your Research and Exploration

As the user base for XRM has grown around the world, Versa instruments have left the realm of supporting a select few super users doing novel research at world-leading laboratories, to become part of the everyday characterization eco-system with a broader set of users at a wider level of skills. A growing range of samples are being studied and analyzed at every level to develop new solutions for the increasing challenges that impact our daily lives.

ZEISS Xradia 630 Versa 3D X-ray microscope (XRM) expands the horizon of what users are able to achieve from their research. The system delivers breakthrough resolution performance, takes accessibility to the next level with an intuitive user experience and accelerates productivity with both faster throughput and faster time-to-results. Additionally, it leverages game-changing AI, all of which combine to enable the study of an unprecedented range of samples while accommodating user skill levels from novice to most expert, and unlocking entirely new application capabilities.

We can't wait to see what new questions our users begin to ask about their samples that have never been able to be answered by X-ray microscopy. Until now.

# Simpler. More Intelligent. More Integrated.



### Evolving the User Experience

The physics of X-ray imaging can be complex, so ZEISS XRM researchers studied user habits, dove into their challenges, and employed human-centered design (HCD) principles to enable even the newest user in a busy environment to be immediately productive. NavX™, the new user interface for ZEISS Xradia 630 Versa, guides users through automated workflows with intelligent system insights and delivers experimental results more easily and efficiently while also allowing experienced users to explore the full versatility of the platform. Additionally, the NavX File Transfer Utility (FTU) takes the data that is being produced by the microscope and automatically transfers it to other locations so that users have their data where they need it, when they need it.

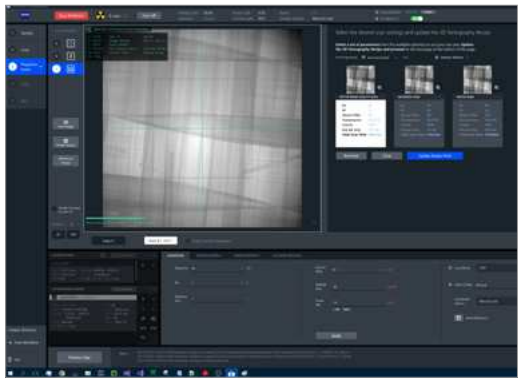
### Breakthrough Resolution Performance

ZEISS Xradia 630 Versa XRM, with the higher energy capabilities of the exclusive 40× Prime (40×-P) objective, enables you to push the limits of submicron imaging like never before. Known for their ability to achieve Resolution at a Distance (RaaD™), ZEISS Xradia Versa platforms allow high resolution imaging of a wide array of sample types and sizes over a long range of length scales. With 40×-P, the system achieves unparalleled resolution performance of 450-500 nm across the full range of source voltage, from 30 kV to 160 kV, defining RaaD 2.0 and unlocking entirely new application capabilities for researchers.

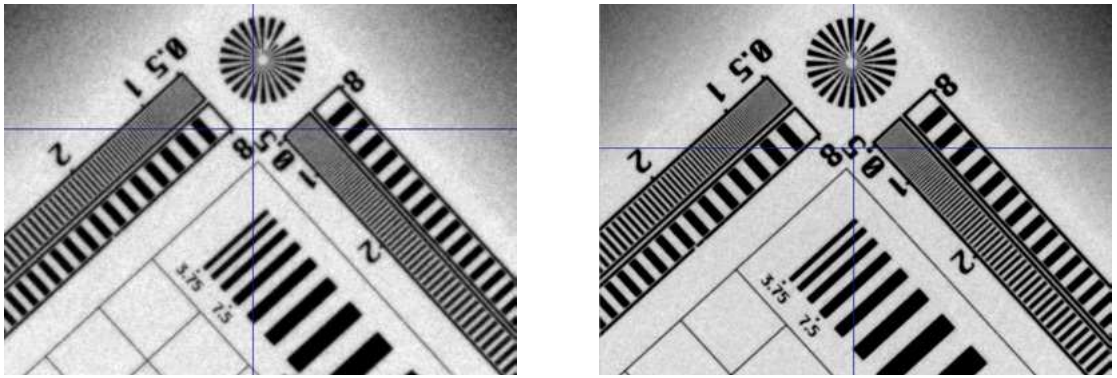
### Accelerate Your Productivity

ZEISS Xradia 630 Versa enables both user and facility to accelerate productivity in ways never before possible. Three fundamental capabilities impact productivity:

1. The reimagined and redesigned user experience of NavX provides a new way to interface with advanced XRM technology, reduces training overhead and rapidly brings the power of XRM imaging to a wider user base.
2. Sample-specific automation and workflow visualization provide a streamlined path to results for beginners and experts alike.
3. AI-based ZEISS DeepScout changes the game for understanding your sample, breaking the dependency of resolution on field of view, and enabling new, previously impossible applications.



*NavX guides users through automated workflows with intelligent system insights to deliver results more easily and efficiently.*



*High kV comparison of highest resolution capabilities at same kV for two objectives: 40× at 800 nm (left) and 40×-P at 500 nm (right), both at 120 kV with the low energy ZEISS LE6 filter (equivalent to 1.3 mm Al (aluminum)).*

# Your Insight into the Technology Behind It

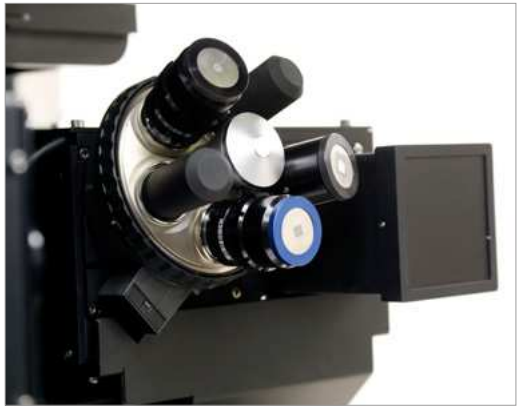


## Highest Resolution Without Compromise

The two major challenges in X-ray computed tomography are maintaining resolution on larger sample sizes and longer working distances while simultaneously maximizing resolution and X-ray flux for greater throughput. Addressing these challenges requires breakthrough innovations, optimized design and system integration. ZEISS Xradia 600-series Versa is uniquely positioned to meet these challenges by integrating dual-stage magnification architecture with high flux X-ray source technology.

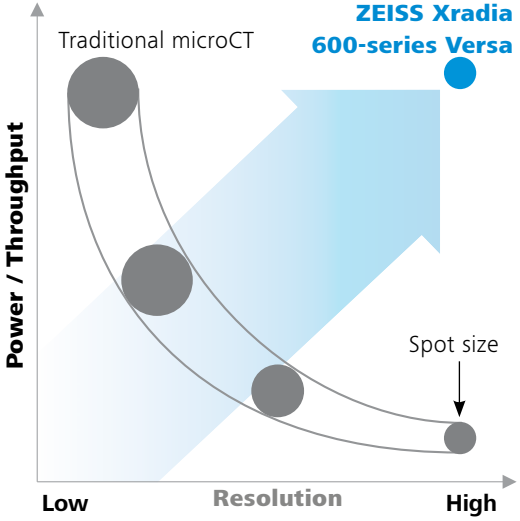
ZEISS specifies XRM on true spatial resolution, which is the most meaningful measurement of a microscope's performance. Spatial resolution refers to the minimum separation at which a feature pair can be resolved by an imaging system. It is typically measured by imaging a standardized resolution target with progressively smaller line-space pairs. With the new objective 40×-P, the system achieves unparalleled resolution performance of 450-500 nm across the full range of source voltage, from 30 kV to 160 kV, delivering RaaD 2.0 and pushing industry standards of submicron imaging resolution.

ZEISS Xradia 630 Versa obtains spatial resolution of 450 nm, a 10% improvement over existing technologies, with a minimum achievable voxel size of 40 nm.



*The ZEISS 40× Prime objective (blue) efficiently converts X-rays into visible light at high energies, enabling the imaging of high Z materials like metals, as well as the highest resolution interior tomographies.*

| | Resolution on Traditional microCT Systems | Higher Resolution on ZEISS 3D X-ray Microscope (XRM) |
|---|---|---|
| **Spot size** | Suffer from spot-size dependent blur. | Unique dual-stage magnification enables performance not limited by spot size. |
| **Sample size** | Only able to achieve high resolution on smallest sample sizes. | ZEISS RaaD technology enables the highest resolution across diverse sets of sample sizes and working distances. |
| **Sample type** | Limited to small, low Z samples using low kV X-ray beam. | Energy-tuned, contrast-optimizing detectors enable the highest resolution across a broad range of sample types and densities and also interior tomographies. |
| **Throughput/flux** | Higher throughput/flux requires larger spot size limiting resolution. | Higher flux and faster scans can be achieved without compromising resolution. In addition, optional modules such as ZEISS DeepRecon Pro and ZEISS OptiRecon can provide up to 10× throughput improvement, while deep-learning based ZEISS DeepScout enables reconstruction of large samples 100 times faster. |
| **Instrument setup** | Require installation of different source targets/ filaments for different operating needs. | Source is designed to operate across the entire application space with a wide range of detectors, eliminating the need for manual hardware reconfigurations |



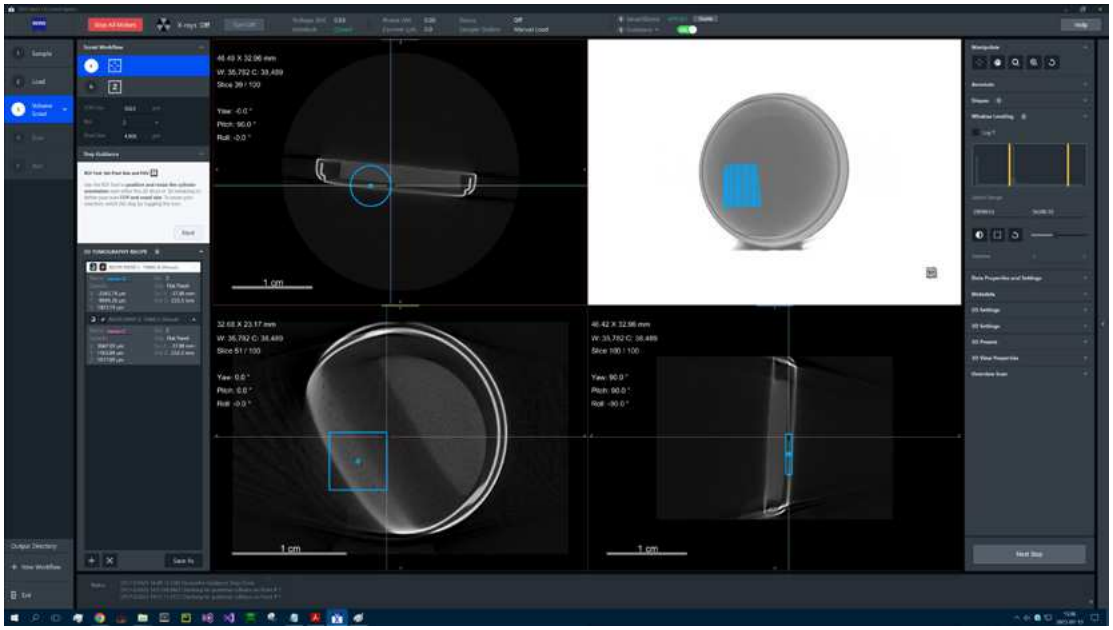
# Your Insight into the Technology Behind It



**Powering Accessibility with Human-Centered Design Principles**

To design NavX, ZEISS researchers studied XRM users to develop a solid understanding of the issues and challenges you face, including your biases, how you compensate, and what work-arounds you employ. With that data in hand, our expert team developed a systematic approach of built-in guidance, automated workflows and intelligent system insights to enable novice users to achieve experimental results more easily and efficiently.

If you are an expert user, NavX offers significant efficiency benefits and the system is "unlocked" to allow you to explore the full versatility of ZEISS Xradia 630 Versa. NavX enables you to automate your workflow and provides guidance on the impact the parameters you've chosen will have on your setup. That guidance is directly embedded in the software, taking you through choices in a natural and familiar way.



*NavX guides users through automated workflows with intelligent system insights, a digital mentor for novices.*

NavX also provides a special visualization capability that helps you to understand the trade-offs of parameters, e.g., between resolution, field of view, and throughput.

Also included is the NavX File Transfer Utility, or FTU, which puts your microscope data exactly where you need it, when you need it, without having to manually transfer from system to workstation, or to save on a hard-drive to carry from place to place.

Additionally, NavX includes an embedded 3D viewer to integrate Volume Scout capability. This streamlines access to RaaD with a 3D volume of your sample to pinpoint and identify specific regions of interest to target for higher resolution imaging.

Lastly, these advancements make NavX much more capable for remote operation,advancing user productivity.

NavX intuitive navigation follows the evolution of the XRM user base, and revolutionizes X-ray navigation and control with seamless and integrated workflows complementing the planning and execution of advanced correlative workflows.

# Your Insight into the Technology Behind It



**Higher X-ray Flux Source – Numerous Advantages**

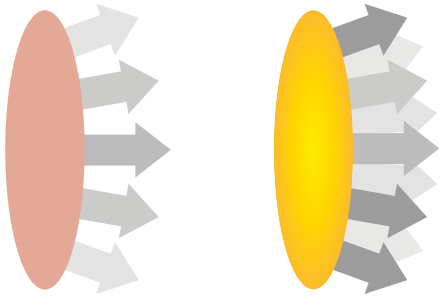
ZEISS Xradia 600-series Versa has breakthrough high power (25 W) X-ray source technology that can provide significantly higher X-ray flux compared to predecessors. The new source pushes the boundaries with improved thermal management, increasing the flux capacity and throughput while maintaining the same stringent spot size performance as that of the already world-class 500-series Versa. A new source control system improves source responsiveness enabling faster scan setup leading to a more satisfying and engaging user experience.

Xradia 500- and 600-series Versa utilize highly optimized sealed transmission X-ray source technology. Sealed sources mean higher vacuum and longer filament life—eliminating costly, time-consuming, and error-prone frequent filament changes that are required in lower vacuum open source systems.

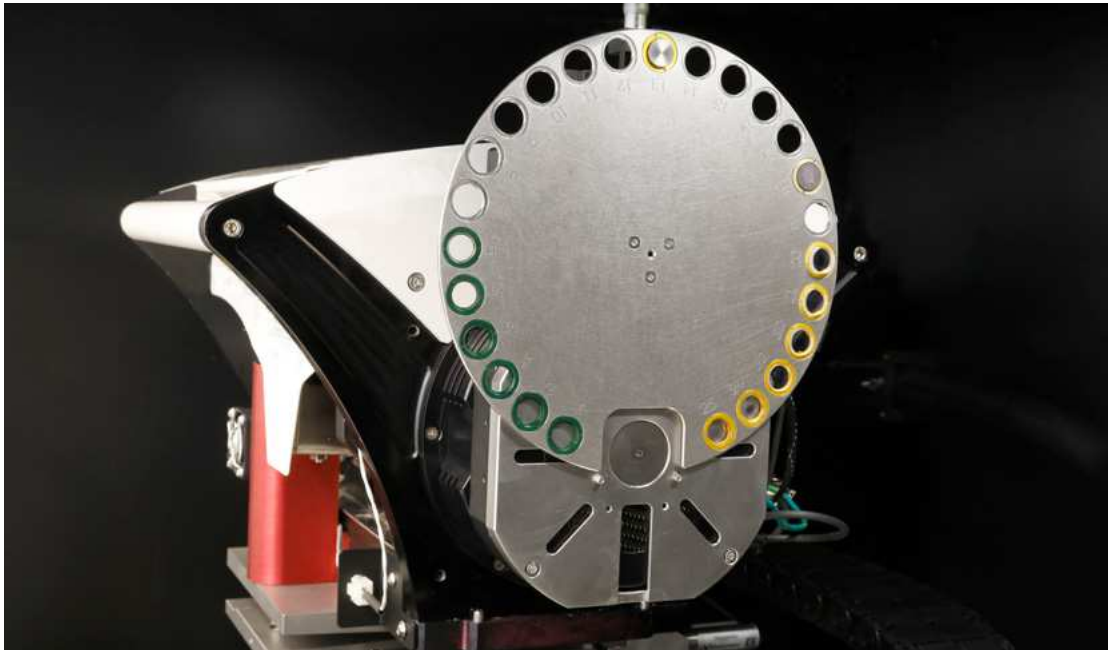
The technological advancements in the 600-series Versa enable higher X-ray flux while enhancing the source stability and reliability.

**What Higher X-ray Flux Offers**

- Faster tomography scans
- More sample runs
- More regions of interest
- Higher contrast-to-noise ratio
- Stronger diffraction patterns
- Long/multi-scan workflows (*in situ,* DSCoVer, stitching, DCT)




*Higher power translates to more X-rays that mean better images and faster imaging for your applications.*



*ZEISS Xradia 600-series Versa X-ray source.*

# Your Insight into the Technology Behind It



**Higher X-ray Flux –**
**Up to 2× Higher Throughput**

3D X-ray images are constructed from a series of 2D projection radiographs, each of which requires exposing the sample with X-ray photons for a certain exposure time. Higher X-ray flux enables shorter exposure times per projection, collectively resulting in faster tomography scans. ZEISS Xradia 600-series Versa with 25 W high power source is able to achieve faster scans without compromising renowned Versa sub-micron resolution performance. Throughput improvement depends on the sample type. Denser, larger, and high Z samples require higher X-ray energy such as that offered by ZEISS Xradia 630 Versa to penetrate and image. The higher power (25 W) source gives exceptional performance at high energy (kV), without compromising resolution.

| | Natural Resources | Materials Science | Electronics | Life Sciences |
|---|---|---|---|---|
| **30 – 60 kV** | Small Rock (1 mm) | Polymers, Wood | Camera-lens Assembly | Small Bone (<5 mm), Insects |
| **60 – 90 kV** | Medium Rock (5-10 mm), | Fiber Composite, Electrodes | De-packaged Components, Battery Electrode | Medium Bone (5 mm-10 mm), Tooth |
| **90 – 120 kV** | Large Rock (25 mm) | Concrete, Ceramics | Multi-layer Printed Circuit Board | Large Bones (>10 mm), Jaw |
| **120 – 160 kV** | Whole Core (100 mm) | Full Battery, Metals | Intact Device, Package, Battery | Fossils |

*Typical X-ray microscopy imaging applications.*

| | Power Increase Compared to Xradia 500-series Versa | Estimated Throughput Improvement Compared to Xradia 500-series Versa Baseline Tomography Scan | |
|---|---|---|---|
| | | <2 hours | >2 hours |
| **30 – 60 kV** | 1× – 1.3× | 1× – 1.2× | 1× – 1.3× |
| **60 – 90 kV** | 1.3× – 1.5× | 1.2× – 1.3× | 1.3× – 1.4× |
| **90 – 120 kV** | 1.5× – 1.8× | 1.3× – 1.4× | 1.3× – 1.5× |
| **120 – 160 kV** | 1.8× – 2.5× | 1.4× – 1.7× | 1.5× – 2× |

*Throughput improvement shown is a representative on Xradia 600-series Versa that is sample/application dependent and based on typical tomography acquisition settings.*

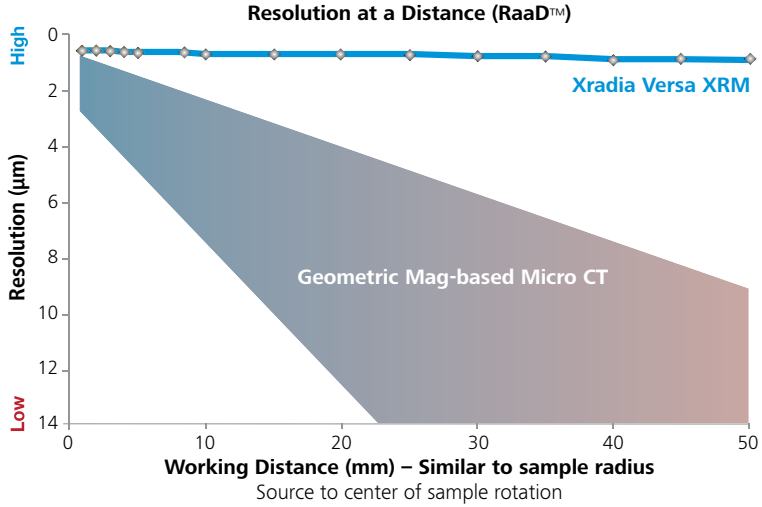
# Your Insight into the Technology Behind It

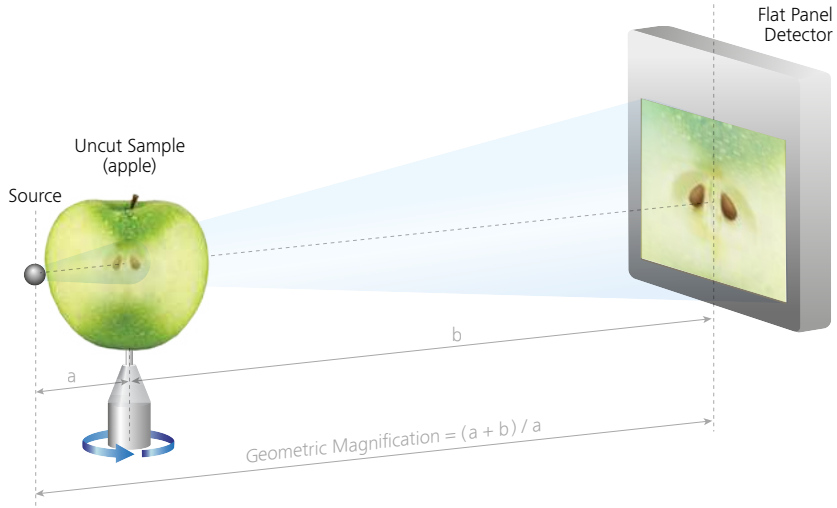


**ZEISS X-ray Microscopes – Designed for Your Advantage**

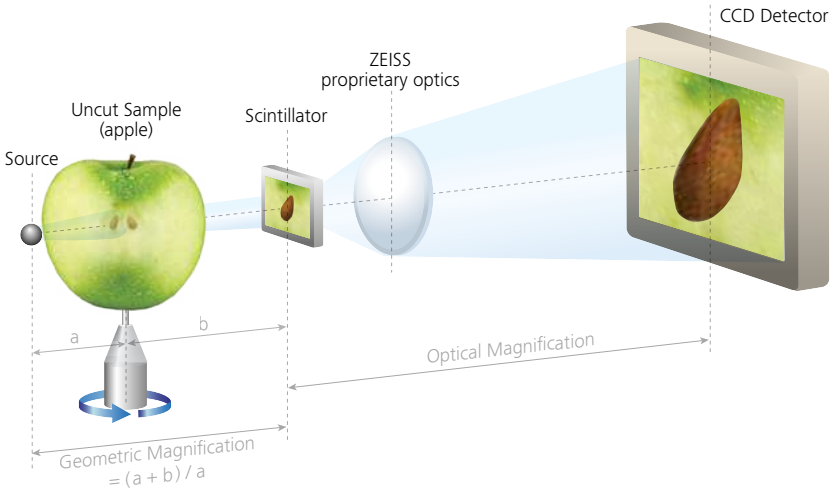
ZEISS Xradia Versa architecture uses a two-stage magnification technique that produces submicron resolution imaging at large working distances (RaaD) for a diverse set of sample sizes and types. Images are initially enlarged through geometric magnification as they are with conventional microCT, but then the projected image impinges on a scintillator, converting X-rays to visible light that is subsequently magnified by an optical objective before reaching the CCD detector.

The flat panel extension (FPX) on your ZEISS Xradia 630 Versa X-ray microscope further increases its versatility. This combination of detector designs allows for the widest range of sample sizes and types to be studied efficiently and accurately. With more X-ray photons available on your Versa, you can now achieve even faster time to results for varied sample sizes without compromising resolution.




*Conventional microCT architecture. Sample must be close to the source to achieve resolution.*




*ZEISS XRM two-stage magnification architecture. Sample imaged independent of distance to source, enabling interiors of larger samples to be imaged non-destructively at higher resolution.*

# Your Insight into the Technology Behind It



**Gain An Edge In Contrast**

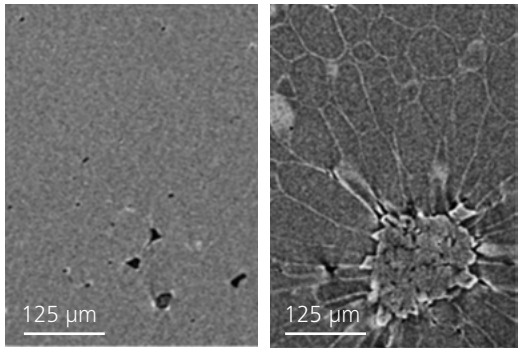
Your imaging requires superior contrast capabilities to reveal details necessary to accurately visualize and quantify features. ZEISS Xradia Versa delivers flexible, high contrast imaging for even your most challenging materials – low atomic number (low Z) materials, soft tissue, polymers, fossilized organisms encased in amber, and other materials of low contrast.

The Xradia Versa family of 3D X-ray microscopes (XRM) increase material imaging flexibility by employing several contrast enhancing features. These unique system features enable ZEISS X-ray microscopes to provide superior contrast for a range of difficult-to-image materials.

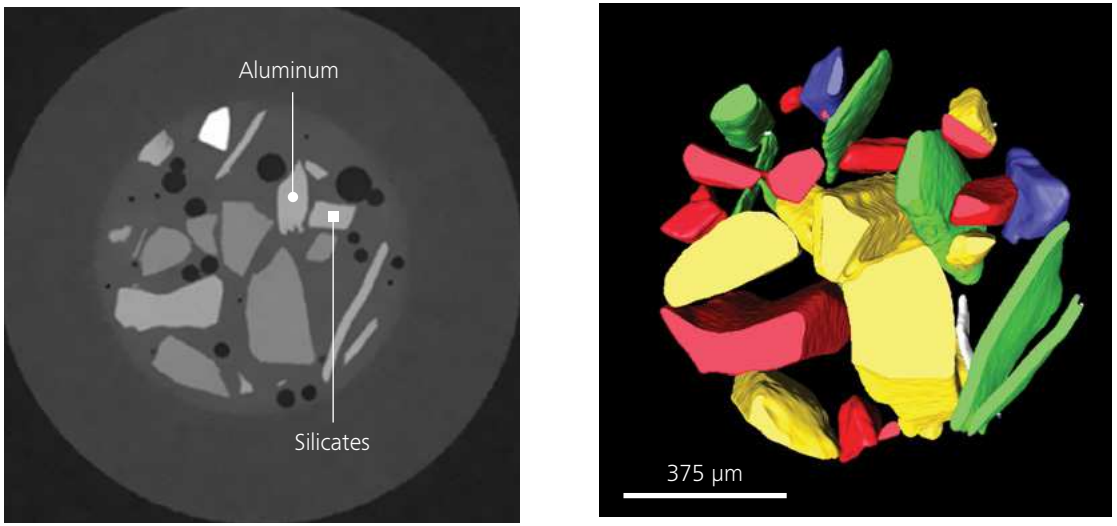
1. Enhanced absorption contrast: ZEISS' detector system consists of multiple highly specialized proprietary detectors that are each optimized to maximize collection of contrast-forming low energy X-ray photons.

2. Tunable Propagation Phase Contrast: The unique phase contrast modality measures the refraction of X-rays and is different to standard absorption contrast, which measures the absorption of X-rays. Phase contrast enables visualization of materials with poor absorption contrast.

3. Dual Scan Contrast Visualizer (DSCoVer), exclusive to Xradia 630 and 620 Versa, extends the detail captured in a single energy absorption image by combining information from tomographies taken at two different X-ray energies. DSCoVer takes advantage of how X-rays interact with matter based on effective atomic number and density. This provides you with a unique capability for distinguishing, for example, mineralogical differences within rocks as well as among difficult-to-discern materials such as silicon and aluminum.




*Pear imaged with absorption contrast – no visibility of cell walls (left), and pear imaged with phase contrast, showing details of cell walls in normal cells and stone cells (right).*




*A single energy scan shows that aluminum and silicon are virtually identical (left), with very similar grayscale contrast. DSCoVer enables separation of the particles. 3D rendering shows Aluminum/green; Silicates/red (right).*

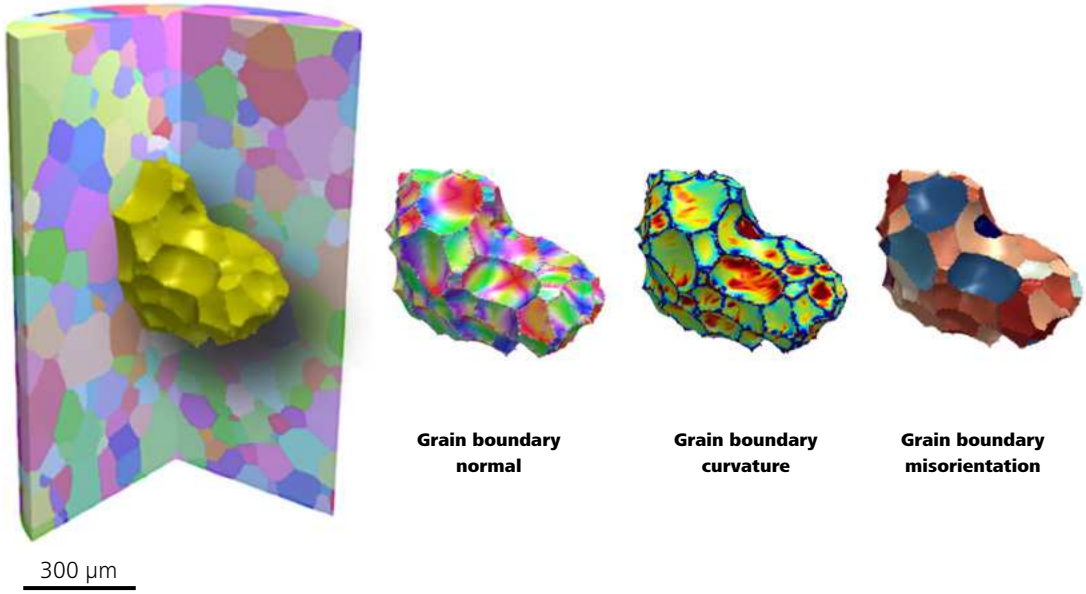
# Your Insight into the Technology Behind It



**ZEISS LabDCT Pro – Unlocking Crystallographic Information in Your Lab**

With the LabDCT Pro option exclusively available on Xradia 630 and 620 Versa, ZEISS brings you the first-ever ever laboratory-based diffraction contrast tomography imaging module. This unique grain imaging analytical technology enables non-destructive mapping of orientation and microstructure in 3D. No longer confined to conventional 2D metallographic investigations, direct visualization of 3D crystallographic grain orientation opens up a new dimension in the characterization of polycrystalline materials like metal alloys, geomaterials, ceramics, or pharmaceuticals.

- LabDCT Pro enables comprehensive 3D microstructure analysis from large volume, large grain statistics down to local individual grain boundary analysis including parameters like misorientation and curvature. Investigate microstructural evolution with 4D imaging experiments, tracking grain boundary mobility and grain growth processes. Bring the capabilities of synchrotron experiments to your lab, with routine access enabling prolonged time-dependent studies across days, weeks or even months—well suited to corrosion, creep, or fatigue studies.
- Routinely and non-destructively acquire data (including grain size, morphology, orientation) on large volumes at fast acquisition times. Stitch multiple LabDCT scans to generate very large grain statistics essential for validating and improving numerical grain models.
- Combine 3D crystallographic information with 3D microstructural features such as defects or precipitates you have observed in absorption or phase tomography. Combine modalities to understand structure-property relationships between grains, voids, inclusions, and other morphological details.
- LabDCT Pro now supports specimens with crystal structures from high cubic symmetry to systems with lower symmetry such as monoclinic materials.




*Armco iron sample with abnormal grain growth. Sample courtesy of Prof. Burton R. Patterson, University of Florida, US.*

# Your Insight into the Technology Behind It



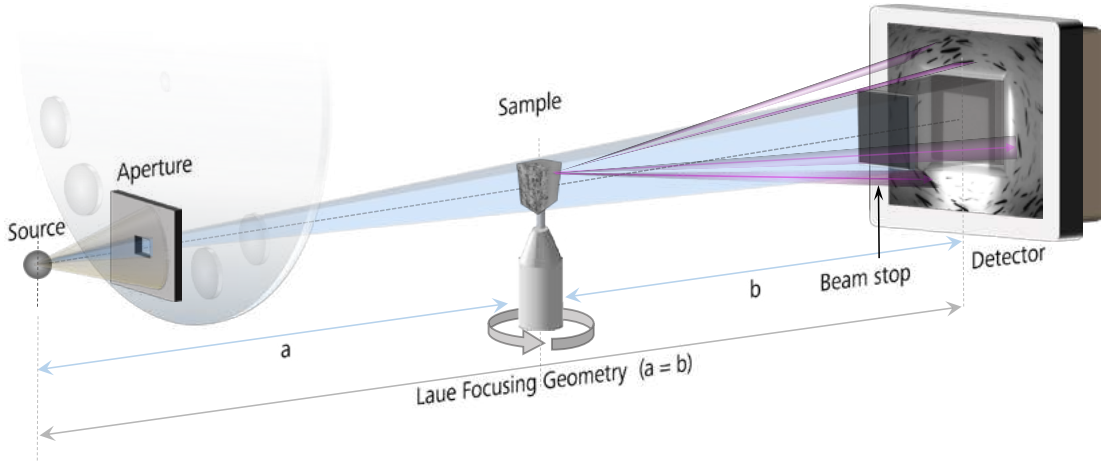
**ZEISS LabDCT Pro – How it Works**

LabDCT Pro option on Xradia 630 and 620 Versa is a fully integrated analytical module. 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. A beamstop is added to the set-up to block out the direct beam and to enhance the contrast of the diffraction signal. 3D crystallographic information (e.g., grain size, morphology, position and orientation) is reconstructed using GrainMapper3D software.

**LabDCT Pro Advanced Imaging Module**

- Dedicated hardware: apertures, beamstop
- Integrated acquisition with Scout-and-Scan
- GrainMapper3D advanced and interactive crystallographic reconstruction software
- Dedicated high performance workstation

*$Al_4Cu$ alloy showing absorption and grain information. Courtesy of Prof. Masakazu Kobayashi, Toyohashi University of Technology, Japan.*




*Schematic of the LabDCT setup.*

# Your Insight into the Technology Behind It



### ZEISS Advanced Reconstruction Toolbox

ZEISS Advanced Reconstruction Toolbox (ART) is an innovative platform through which you can continuously access state-of-the-art reconstruction technologies from ZEISS to enrich your research and increase the return on investment of your 3D XRM.

These unique offerings leverage AI and a deep understanding of both X-ray physics and customer applications to solve some of the hardest imaging challenges in new and innovative ways. These optional modules are workstation-based solutions that provide easy access and usability.

### ZEISS DeepScout

ZEISS DeepScout uses high-resolution 3D microscopy datasets as training data for lower resolution, larger field of view datasets and upscales the larger volume data using a neural network model. ZEISS DeepScout, developed through continued algorithmic innovation enabled by the unique AI infrastructure from ZEISS, employs the unique Scout-and-Zoom capability to acquire richer information at higher resolution, including interior tomographies for large samples.

Now you can take your large overview scan, feed it through through the ZEISS DeepScout reconstruction algorithm, and get resolution that approaches the resolution of a Zoom scan, but over a much larger field of view. At its core, ZEISS DeepScout relies on the ability to generate multiscale, spatially registered datasets and uses that ability to train neural networks to improve the reconstruction.

New capabilities, fueled by deep learning, mitigate the traditional trade-off between field of view and resolution.

### ZEISS DeepRecon

The first commercially available deep learning reconstruction technology enables you to increase throughput by up to 10× without sacrificing novel RaaD. Alternatively, keep the same number of projections and enhance the image quality further. ZEISS DeepRecon uniquely harvests the hidden opportunities in big data generated by your XRM and provides significant AI-driven speed or image quality improvement.

ZEISS offers DeepRecon technology in two forms
1) ZEISS DeepRecon Pro
2) ZEISS DeepRecon Custom – both leveraging AI to provide unprecedented image quality with unparalleled speed.

| | **FDK**<br>Standard Analytical Reconstruction | **OptiRecon**<br>Iterative Reconstruction | **DeepRecon Pro** | **DeepScout**<br>AI (Deep-Learning) based Reconstruction |
|---|---|---|---|---|
| **Throughput** | 1× | up to 4× | up to 10× | up to 100× |
| **Image Quality*** | Standard | Better | Best | Unprecedented over LVOV, FVOV** |
| **Ease-of-use** | Minimal | Requires parameter optimization | One-click setup | Simple setup<br>Familiar Scout-and-Zoom, user-friendly NavX |

* Image quality refers to the contrast-to-noise ratio and the relative performance of reconstruction technologies is shown.
** Large volume of view and full volume of view.

# Your Insight into the Technology Behind It



**ZEISS DeepRecon**

ZEISS DeepRecon Pro is an innovative AI-based technology bringing superior throughput and image quality benefits across a wide range of applications. ZEISS DeepRecon Pro is applicable to both unique samples as well as semi-repetitive and repetitive workflows. Customers can now self-train new machine learning network models on-site with an extremely easy-to-use interface. The one-click workflow of ZEISS DeepRecon Pro eliminates the need for a machine learning expert and can be seamlessly operated by even a novice user. ZEISS DeepRecon Custom is targeted specifically for repetitive workflow applications to further boost XRM performance beyond ZEISS DeepRecon Pro. Customers can closely collaborate with ZEISS to develop custom-created network models that precisely fit their repetitive application needs. ZEISS DeepScout and ZEISS DeepRecon Pro are offered as part of the AI Supercharger package for the Advanced Reconstruction Toolbox.

**ZEISS PhaseEvolve**

ZEISS PhaseEvolve is a patent-pending post-processing reconstruction algorithm that enhances the image contrast by revealing material contrast uniquely inherent to X-ray microscopy, which can often be obscured by phase effects in low-medium density samples or high resolution datasets. Perform more accurate quantitative analysis with improved contrast and segmentation of your results.

**ZEISS Materials Aware Reconstruction Solution (MARS)**

MARS is a reconstruction algorithm that is aware of the constituents within a reconstruction. A challenge in X-ray reconstruction in a lab setting is that imaging with a polychromatic source creates different X-ray energies to generate a phenomenon called beam hardening. This effect is particularly challenging when your material is very dense and embedded in a relatively less dense material. MARS tells the reconstruction system how to compensate for the effect of extreme beam hardening in the regions between very dense objects.

This is important in applications like biomaterials, where you might be looking at implants next to bone or tissue. Or electronics where extremely dense solder balls appear next to other less dense materials on a printed circuit board, generating strong artifacts. MARS reconstructs your images to compensate for these effects.

ZEISS PhaseEvolve and MARS form the Artifact Reduction package of ART.

**ZEISS OptiRecon**

A fast and efficient algorithm-based technology that delivers iterative reconstruction from your desktop, allowing you to achieve up to 4× faster scan times or enhanced image quality with equivalent throughput.

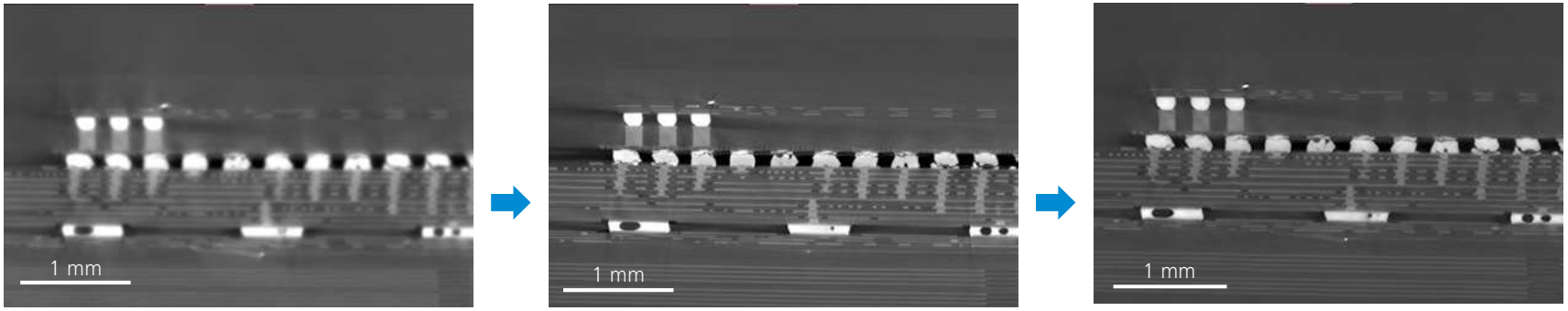
ZEISS OptiRecon is an economical solution offering superior interior tomography or throughput on a broad class of samples.

ZEISS OptiRecon bonds with ZEISS DeepRecon to create the Recon package of ART.

# Your Insight into the Technology Behind It

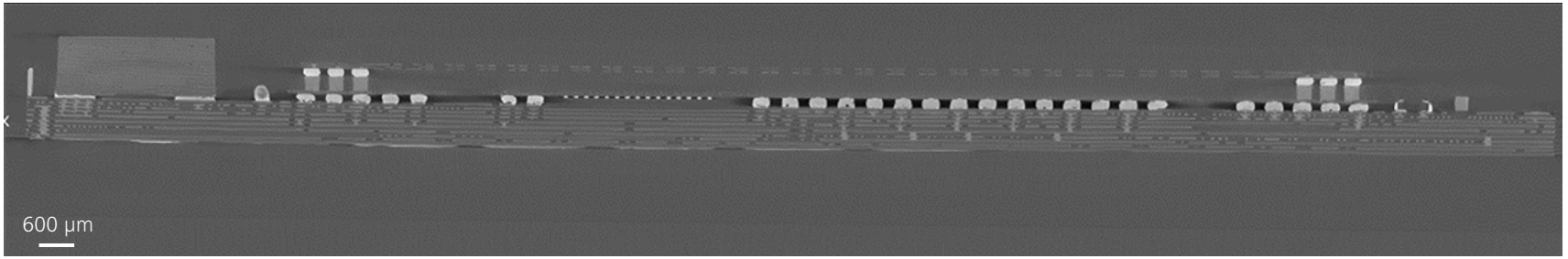


## ZEISS DeepScout




*Low resolution* *High resolution* *ZEISS DeepScout*

*ZEISS DeepScout enables high resolution everywhere in a large FOV volume with no need for numerous high-resolution scans. The DeepScout example shown above took only 3 hours in data acquisition, achieving the large and high-resolution volume that would require at least 81 hours with standard data acquisition. The DeepScout images clearly show fatigue solder cracks in a commercial A12 smartphone control board, with the image quality comparable to the actual high-resolution scan.*

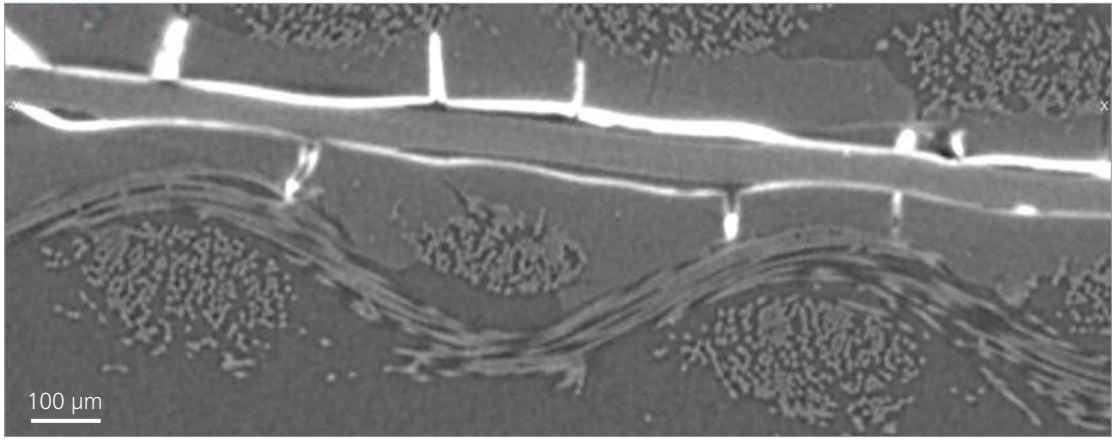



*The single full field of view DeepScout scan was generated in 1.6 hours. A single high-resolution scan took 2.5 hours. It would require 27 scans, or 67.5 hours, to achieve the same volume of data as the DeepScout scan.*

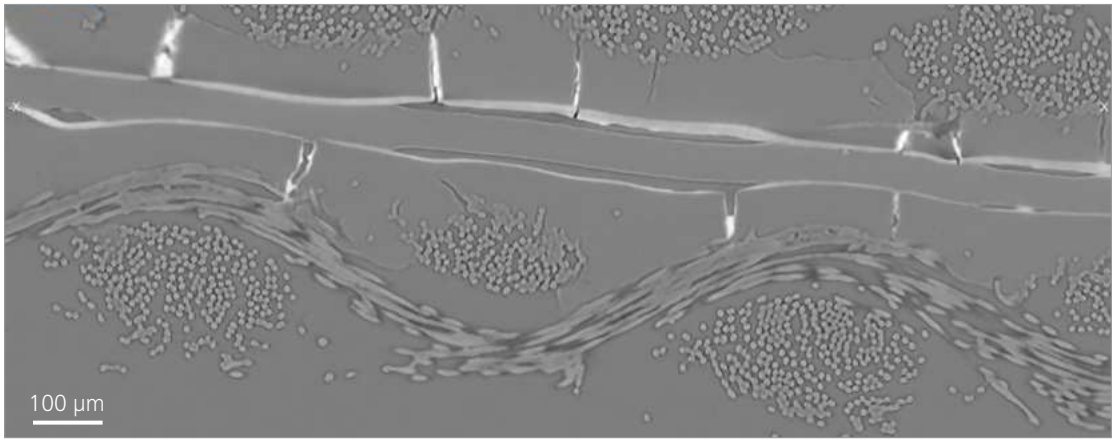
# Your Insight into the Technology Behind It



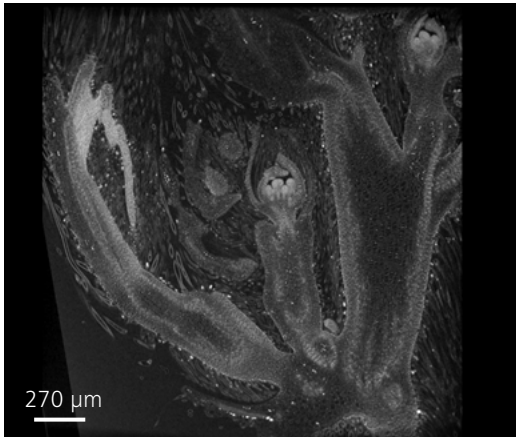
**ZEISS DeepScout**



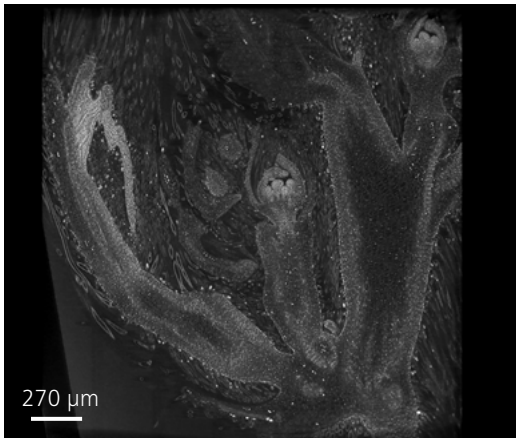

*Polymer electrolyte fuel cell (PEFC) membrane electrode assembly imaged without ZEISS DeepScout.*




*ZEISS DeepScout: Acquire high resolution data across entire sample image for a clear view of critical microstructural features that influence water formation and fuel cell performance.*




*Without ZEISS DeepScout*

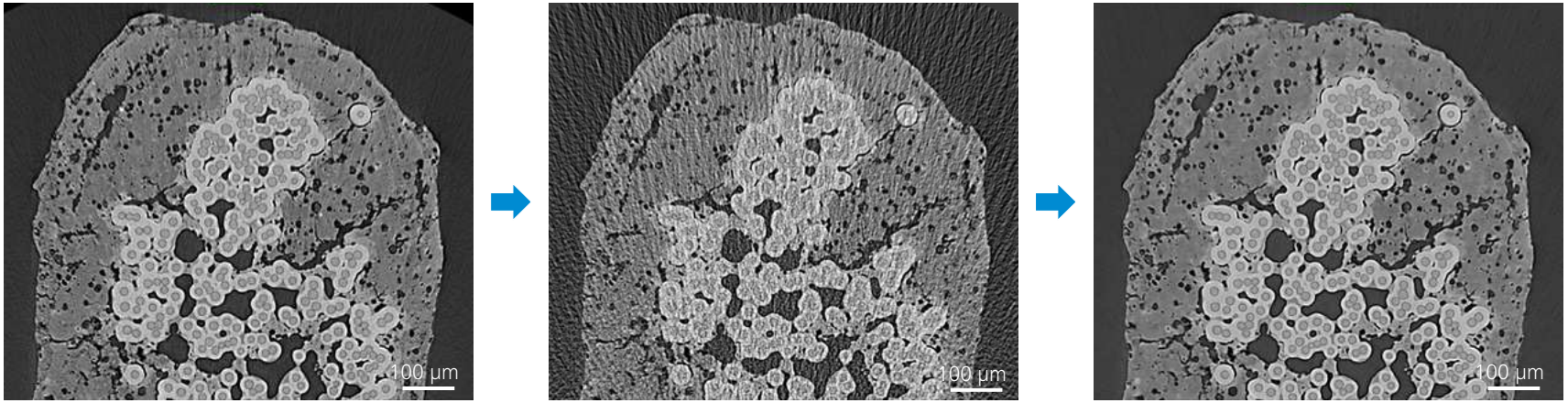



*ZEISS DeepScout: Soybean flower. Sample courtesy of Keith Duncan, Donal Danforth Plant Science Center .*

# Your Insight into the Technology Behind It



## ZEISS DeepRecon Pro

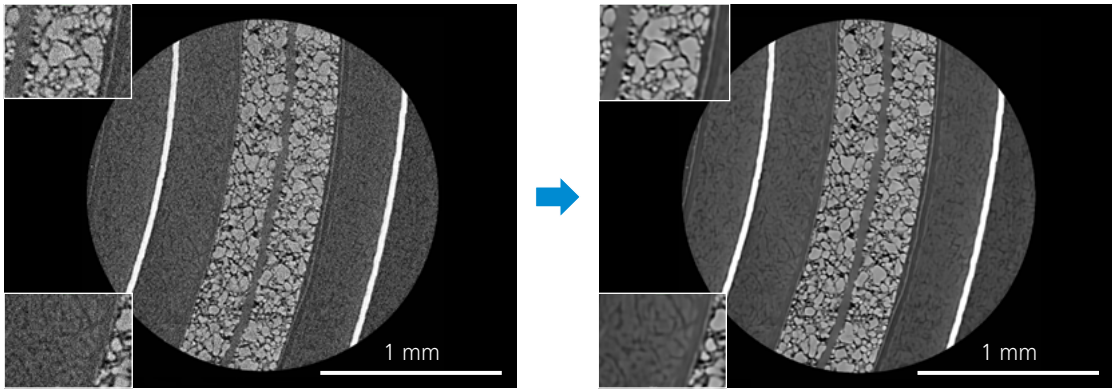



*Standard reconstruction (FDK): Scan time 9 hrs (3001 projections)*

*Standard reconstruction (FDK): Scan time 53 mins (301 projections)*

*ZEISS DeepRecon Pro: Scan time 53 mins (301 projections)*

*ZEISS DeepRecon Pro used for throughput improvement for Ceramic Matrix Composite (CMC) sample, achieving 10× throughput improvement without sacrificing image quality. This would allow for much higher temporal resolution for* in situ *studies.*




*Standard Reconstruction (FDK)*

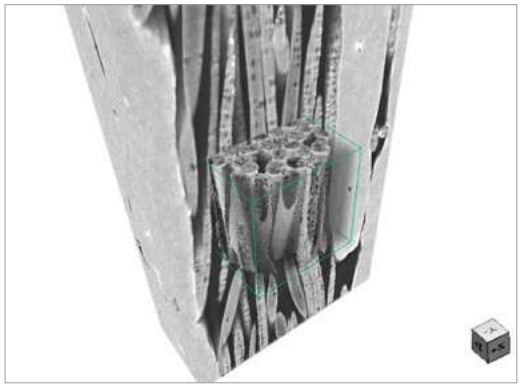
*ZEISS DeepRecon Pro*

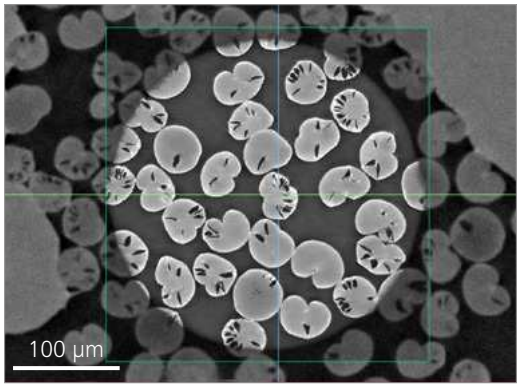
*ZEISS DeepRecon Pro used for image quality improvement for a smartwatch battery. ZEISS DeepRecon Pro both improves the clarity of cathode grains and polymer separator. It also allows for the recovery of features otherwise obscured by image noise, such as the electrolyte saturated anode.*

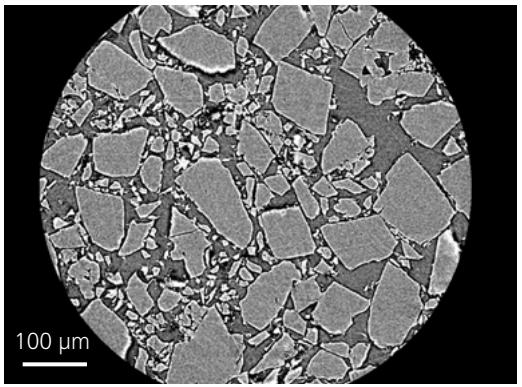
# Your Insight into the Technology Behind It



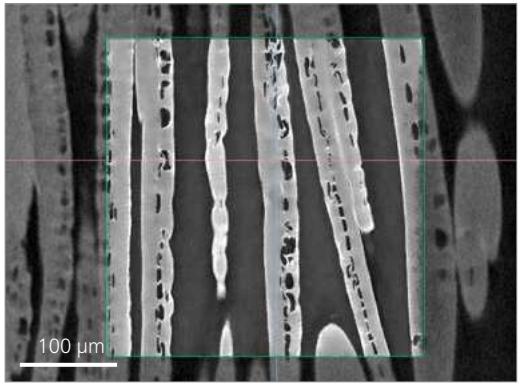
**ZEISS PhaseEvolve**

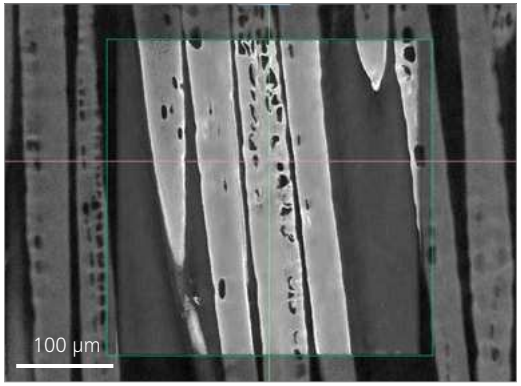




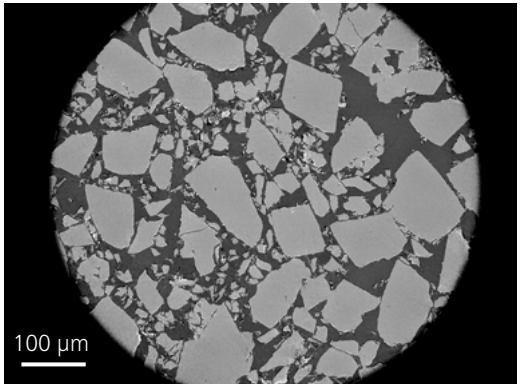




*Standard reconstruction*




*Rayon fibers were imaged at 1.5 µm/voxel resolution and processed using ZEISS PhaseEvolve revealing the large distribution of radial porosity along the length of the fibers. Sample courtesy Dr. Sherry Mayo & Dr. David Fox, CSIRO, Australia.*

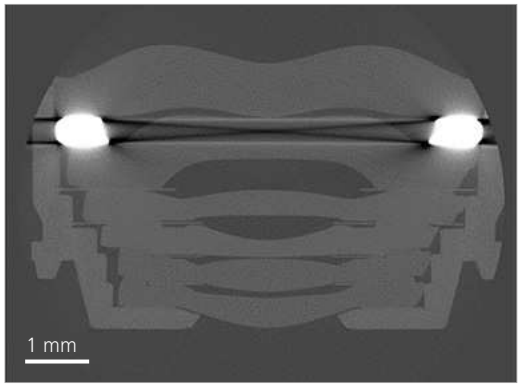



*ZEISS PhaseEvolve applied to a pharmaceutical powder sample. High resolution or low kV imaging can result in inherent material contrast being obscured by phase contrast artifacts. ZEISS PhaseEvolve effectively removes phase fringes to enhance image contrast and improve segmentation results. Sample courtesy of Dr. Parmesh Gajjar, TEVA Pharmaceuticals, UK.*

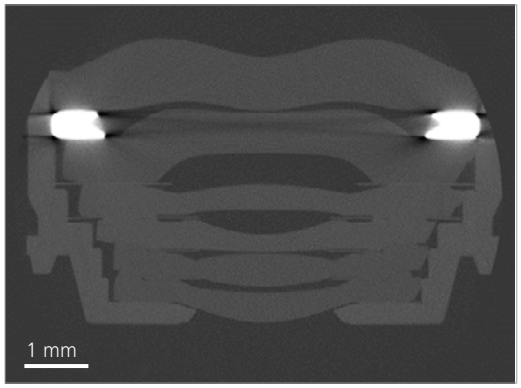
# Your Insight into the Technology Behind It



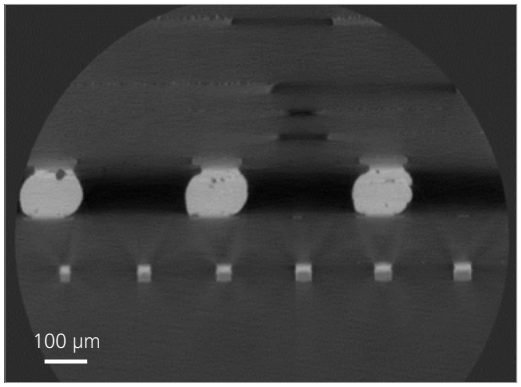
**ZEISS Material Aware Reconstruction Solution (MARS) for Reducing Beam Hardening**



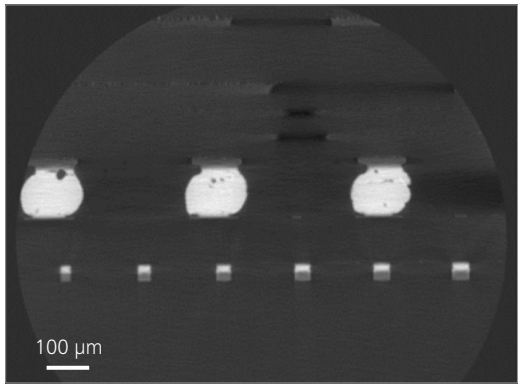

*Without ZEISS MARS*



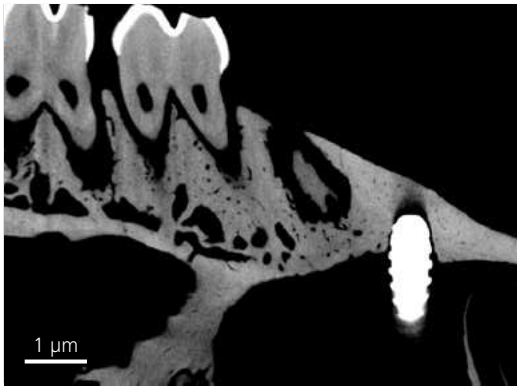

*Camera module image using ZEISS MARS.*



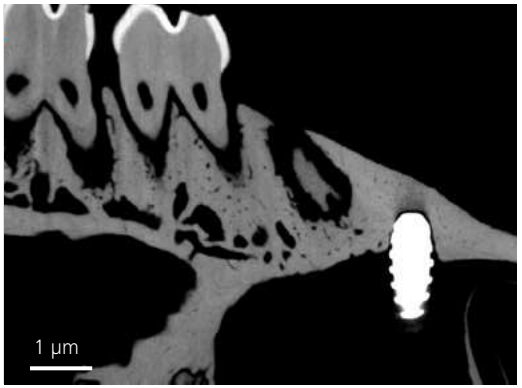

*Without ZEISS MARS*




*Semiconductor package image using ZEISS MARS.*




*Without ZEISS MARS*

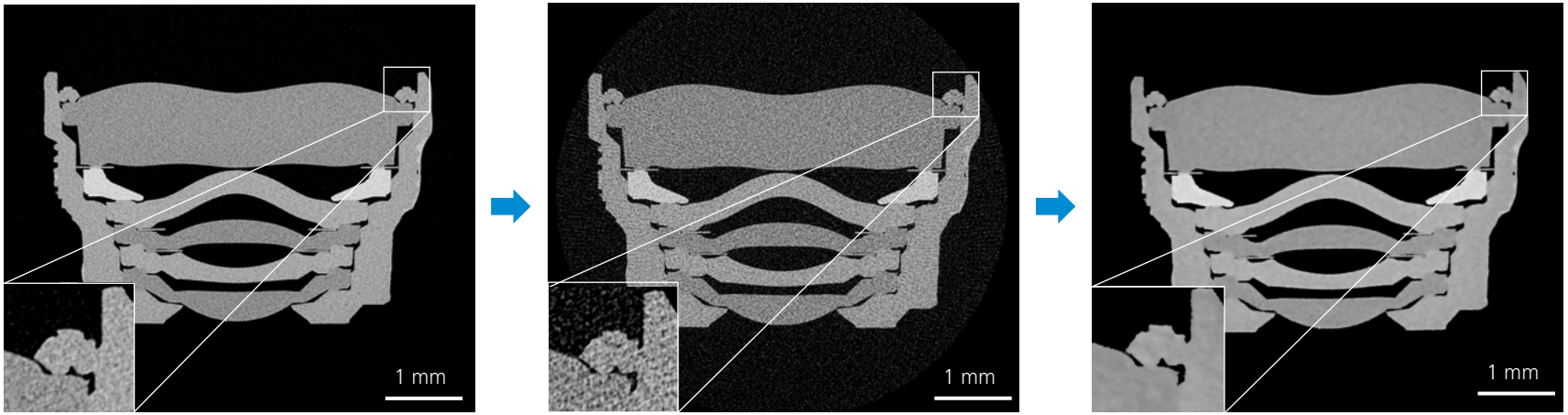



*Biomedical implant image using ZEISS MARS.*

# Your Insight into the Technology Behind It



**ZEISS OptiRecon**




*Standard reconstruction: Scan time 90 minutes (1200 projections)*

*Standard reconstruction: Scan time 22 minutes (300 projections)*

*OptiRecon: Scan time 22 minutes (300 projections)*

*Observe the performance of ZEISS OptiRecon in a workflow performed on an electronics sample. Analyze integration issues in a smart phone camera lens, now 4× faster using ZEISS OptiRecon.*

# Your Insight into the Technology Behind It



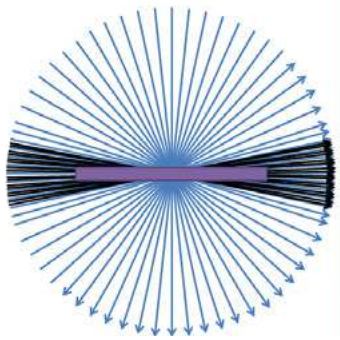
**Achieve Higher Throughput – Obtain Faster Time to Results**

In addition to faster tomography scans due to higher X-ray flux and advanced reconstruction technologies, the innovative High Aspect Ratio Tomography (HART) mode, exclusive to the ZEISS Xradia 630 and 620 Versa, provides you with further throughput advantages for your flat samples such as semiconductor packages and boards. HART enables you to space projections variably so that you collect fewer projections along the broad side of a flat sample and more along the thin side. A wealth of 3D data is provided by these closely-spaced long views versus less densely-spaced short views, maximizing information density during acquisition.

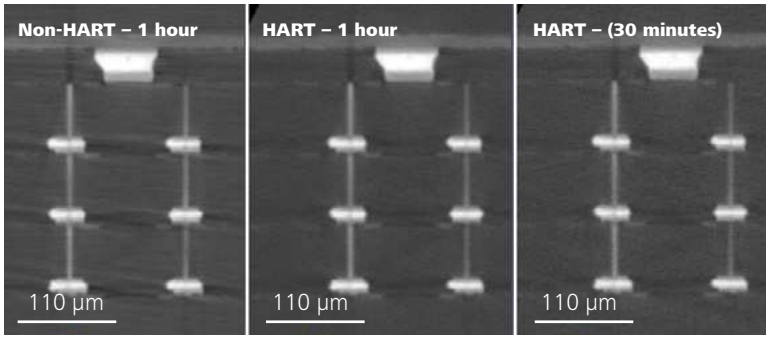
You can also tune HART to emphasize higher throughput or better image quality, thereby potentially accelerating image acquisition speed by 2×. This faster acquisition mode is in addition to a powerful dual GPU workstation that accelerates image reconstruction time by up to 40%. Add the optional flat panel extension (FPX) to achieve higher throughput (2-5×) on very large samples (up to 10×).

**Challenging Sample Imaging Made Easier**

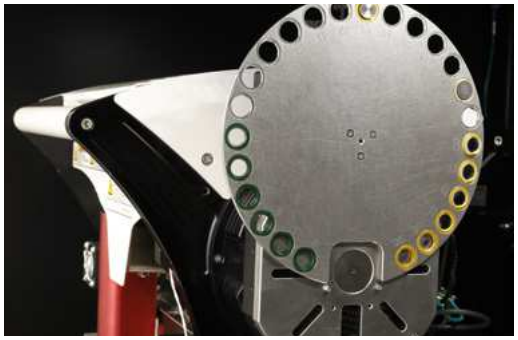
Researchers commonly use source filters to tune the X-ray energy spectrum and every ZEISS Xradia 630 Versa comes with a standard set of 13 filters. ZEISS Xradia 630 Versa system features Automated Filter Changer (AFC), which improves ease of use for seamlessly changing filters without manual intervention. In addition to the standard range of filters, you will find 11 additional filter slots on the AFC to allow you to use custom source filters, such as filters composed of different materials or thicknesses. The AFC houses these filters and allows your selection to be programmed and recorded for each workflow with NavX. When you don't need a source filter at all, there is a convenient cut-out on the AFC to allow your samples to move even closer to the source for higher throughput.



*HART projection spacing and density optimized for feature-rich short side.*




*DRAM chip: Non-HART (left) vs. HART (middle) shows better image quality at the same imaging time. Non-HART (left) vs. HART (right) shows same image quality in half the scan time. HART can be tuned to emphasize either better image quality or higher throughput.*



*The Automated Filter Changer (AFC) exclusive to the ZEISS Xradia 630 Versa offers 13 standard filters with room for 11 custom filters.*

# Your Insight into the Technology Behind It



**Flexibly Image Larger Samples**

Wide Field Mode (WFM) is used to stitch projections horizontally to form an extended lateral field of view. This technique can provide you with either higher voxel density (nearly 2×) for a given field of view or a wide lateral field of view to provide 3× larger 3D volume for large samples.

All ZEISS Xradia Versa systems are capable of WFM with 0.4× objective. In addition, ZEISS Xradia 630 Versa system features WFM with 4× objective.

Combining WFM with the existing Vertical Stitching feature, which joins separate tomographies vertically into a taller single tomography, enables you to image large samples that are both wider and taller than the standard field of view.

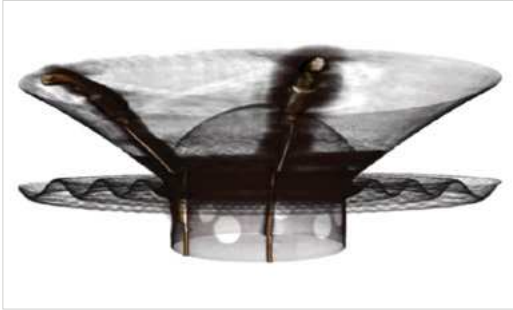
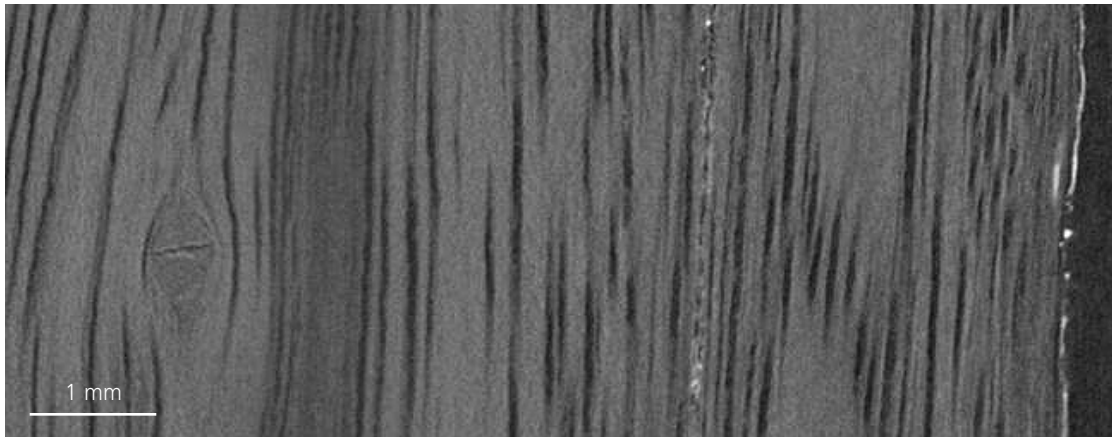


*Image large samples with Wide Field Mode such as this 6" stereo speaker.*




*Achieve higher resolution (2× voxel) in standard field of view mode.*

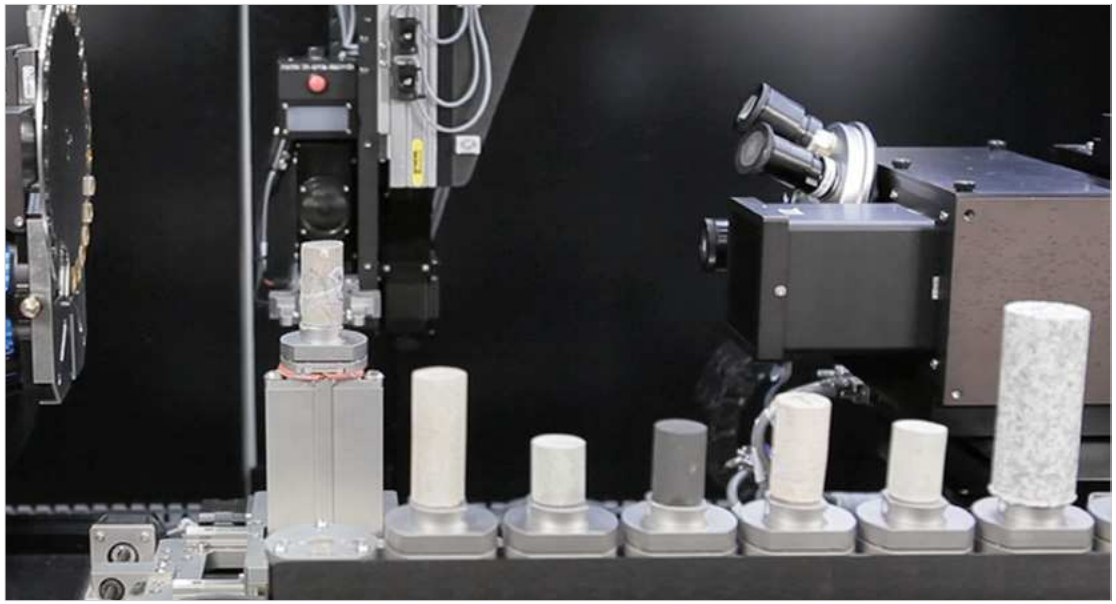
# Your Insight into the Technology Behind It



**Increase Your Sample Handling Efficiency**

Maximize your instrument's utilization by minimizing user intervention with the optional Autoloader available for all instruments in the ZEISS Xradia Versa series of sub-micron 3D X-ray microscopes. Reduce the frequency of user interaction and increase productivity by enabling multiple jobs to run. Load up to 14 sample stations which can support up to 70 samples, queue, and allow to run all day, or off-shift.

The software provides you with the flexibility to re-order, cancel and stop the queue to insert a high priority sample at any time. An e-mail/text notification feature in the NavX user interface provides timely updates on queue progress. Autoloader also enables a workflow solution for high volume repetitive scanning of like samples.



*Autoloader option enables you to program up to 70 samples at a time to run sequentially.*

# Your Insight into the Technology Behind It



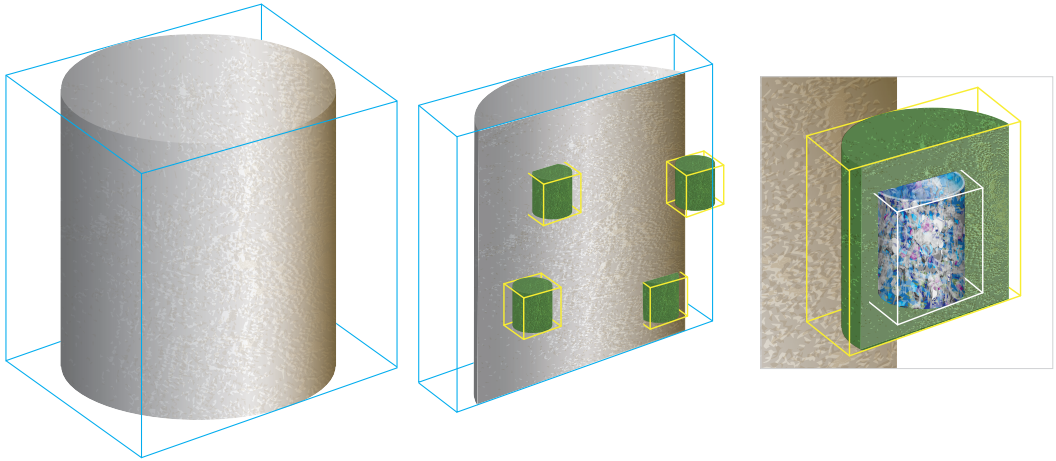
**Image Even Larger Samples with High Throughput**

ZEISS Flat Panel Extension (FPX) delivers large-sample, high throughput scanning with ZEISS best-in-class image quality. FPX enhances imaging flexibility and creates workflow efficiencies with an all-in-one system for industrial and academic research.

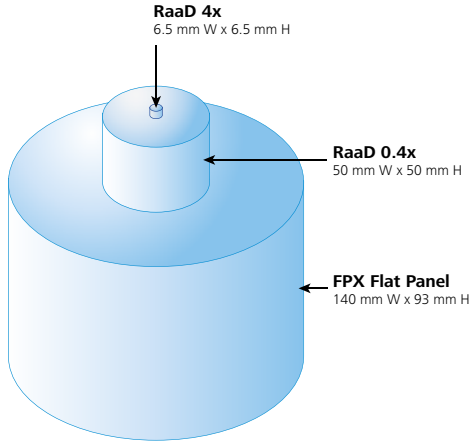
Scout-and-Zoom is a unique capability of ZEISS X-ray microscopes that leverages FPX to perform a low resolution, large field of view, "scout", scan, and identify interior regions for higher resolution "Zoom" scans on a variety of different sample types. The Volume Scout workflow streamlines this process within NavX.

This powerful technique is achieved only by the Versa dual magnification microscope objectives that enable Resolution at a Distance (RaaD) and can be used to accurately identify regions of interest in several applications such as imaging a specific region of trabecular bone inside an intact bone, a particular solder bump in the interior of a large semiconductor package, or a specific area of cracks or voids in a composite sample.

Now, advanced reconstruction technologies, such as ZEISS OptiRecon and ZEISS DeepRecon Pro, can improve the image quality of challenging "Zoom" scans without increasing image acquisition time, while ZEISS DeepScout improves the "Scout" scan, providing resolution at FOV.



*Scout-and-Zoom capability enables large sample imaging at high throughput and subsequent high resolution sub-sampling.*




*Comparison of reconstructions of single FOV volumes performed with different objectives.*

| FPX Specifications | |
|---|---|
| Flat Panel Detector Array | 3072 px × 1944 px |
| Single FOV | 140 mm diameter |
| | 93 mm height |
| Maximum field of view with automated stitching | 140 mm diameter |
| | 165 mm height |

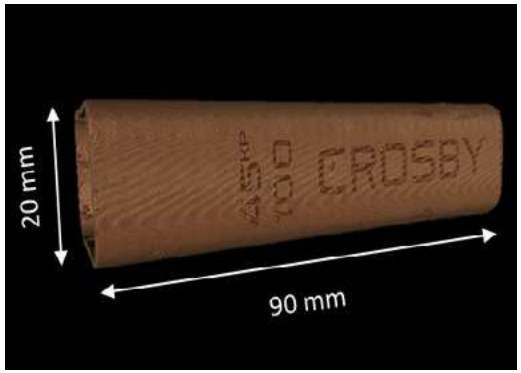
# Your Insight into the Technology Behind It



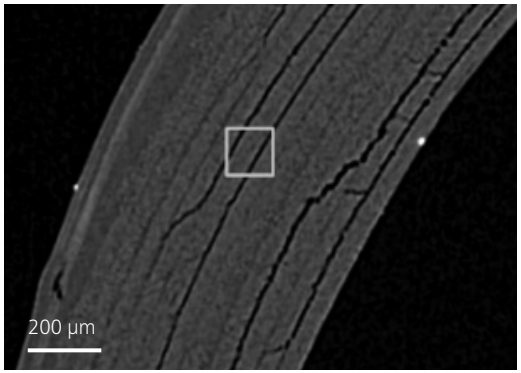
**Large Object Volume Scout Workflows with FPX**

Three-stage Scout-and-Zoom workflow. Rapidly scan large field of view with FPX and then zoom to regions of interest with RaaD objectives.

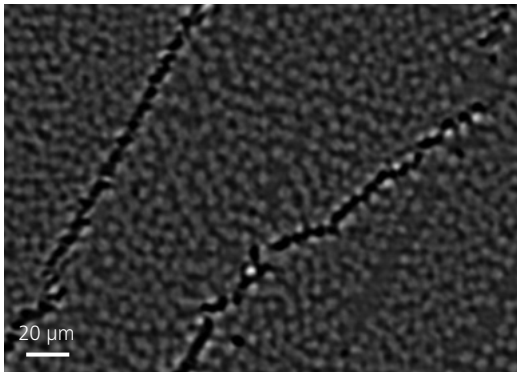
**FPX**




**0.4×**



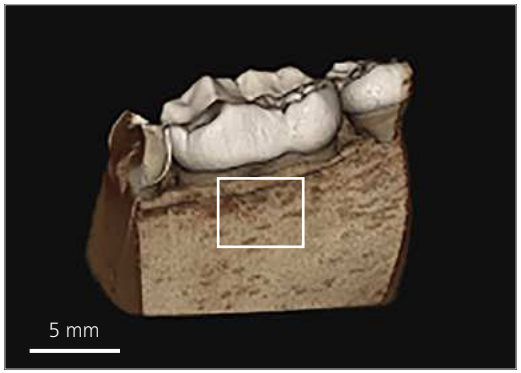

**4×**



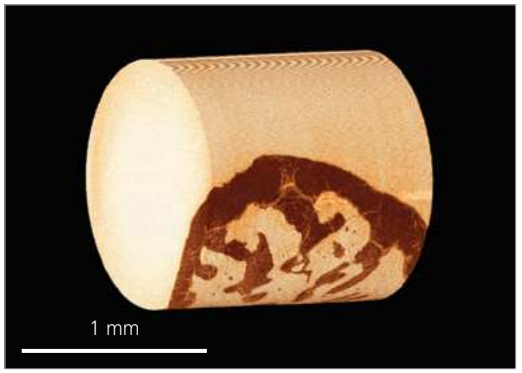

*Sample set: Hockey stick fiber reinforced composite.*

**FPX**


**0.4×**




**4×**




*Sample set: Bear jaw, 15 cm long.*

# Your Insight into the Technology Behind It

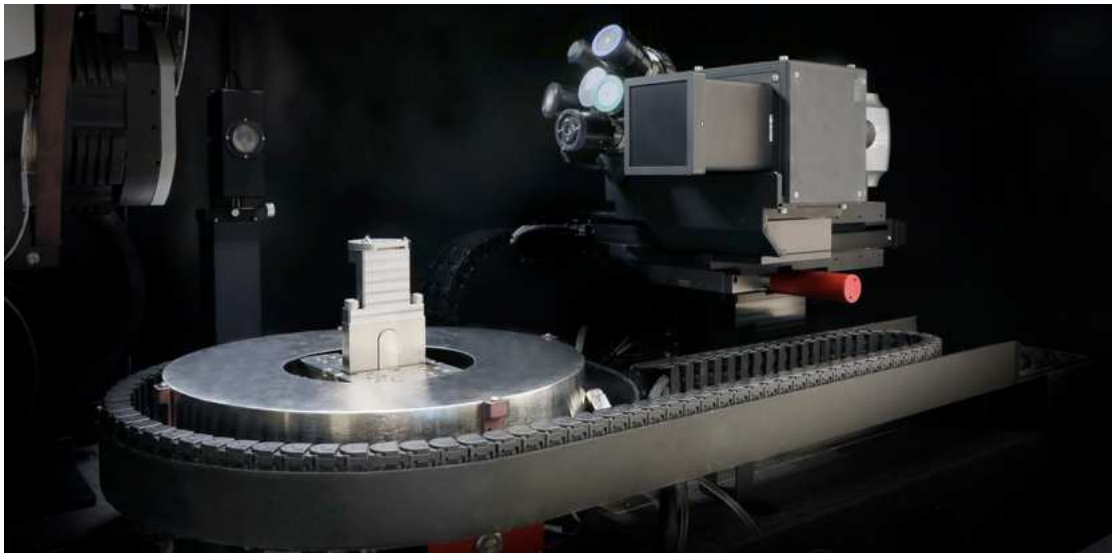


## Enhance Your Experimental Possibilities by Adding the *In Situ* Interface Kit to Your XRM

Continuing to push the limits for scientific advancement, ZEISS Xradia Versa solutions have evolved to provide you with the industry's premier 3D imaging solution for the widest variety of *in situ* rigs, from high pressure flow cells to tension, compression and thermal stages. ZEISS X-ray microscopes uniquely enable the most advanced *in situ* experiments.

These studies require samples to be further away from the X-ray source to accommodate various types of *in situ* rigs. On traditional microCT systems, this significantly limits the resolution achievable for your samples. ZEISS XRM are uniquely equipped with dual-stage magnification architecture with RaaD technology that enables the highest resolution for *in situ* imaging. You can add the optional *In Situ* Interface Kit to all Xradia Versa instruments.

Contents include a mechanical integration kit, a robust cabling guide and other facilities (feedthroughs) along with recipe-based software that simplifies your operation from within the Scout-and-Scan user interface. Experience the highest level of stability, flexibility and controlled integration of such *in situ* devices on the Xradia Versa, which benefit from an optical architecture that doesn't compromise resolution in variable environmental conditions.



*ZEISS SmartShield virtually wraps your sample to protect it, the source, and the objectives.*

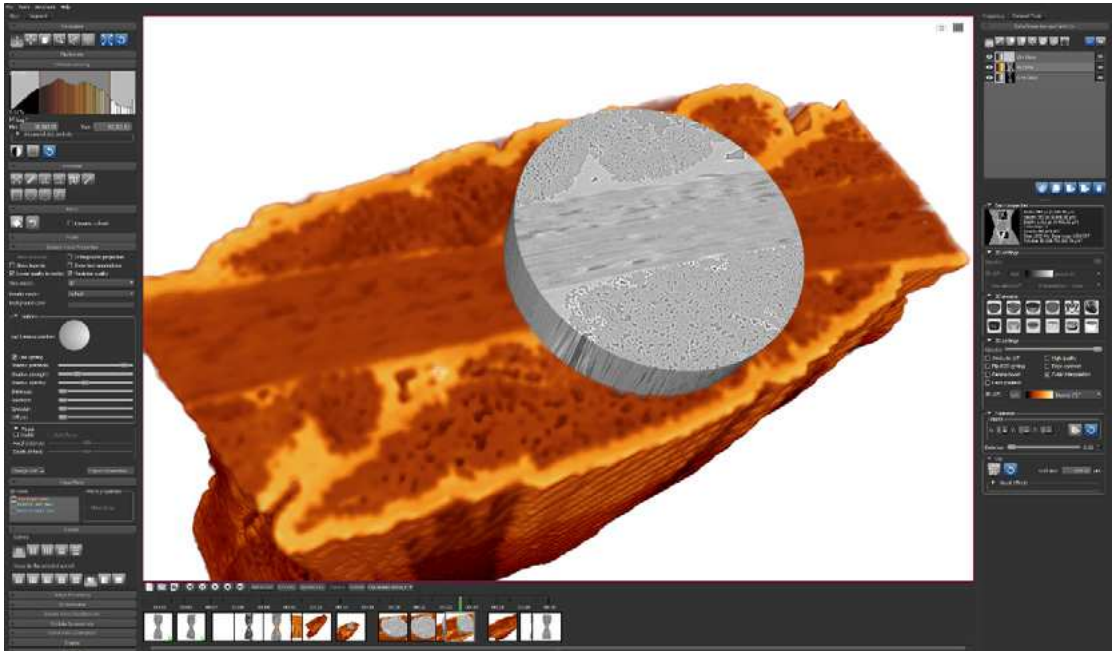

*Tensile testing of a steel laser weld under increasing load. The data reveal a crack initiating and propagating from a rough surface imperfection, as well as the elongation of internal voids. Sample courtesy of Sandia National Laboratories.*

# Your Insight into the Technology Behind It



**Dragonfly Pro – Your Visual Pathway to Quantitative Answers**

Dragonfly Pro is advanced 3D visualization and analysis software from Object Research Systems (ORS). It is offered exclusively by ZEISS for processing XRM, SEM, and FIB-SEM data. Combining advanced image processing algorithms and state-of-the-art volume rendering, Dragonfly Pro enables high definition exploration and powerful quantitative analysis of your data. Dragonfly Pro is distinguished by its ease of use, best-in-class image segmentation toolkit, and endless extensibility. Import your multi-scale, multi-microscope image studies, and you'll discover that Dragonfly Pro is the most advanced correlative imaging platform available. Integrated with a suite of image processing tools for 2D and 3D image registration, resampling, and more, Dragonfly Pro's cutting-edge image filters will make imaging artifacts disappear.



*Tailor tools that are optimal to your workflow: choose plug-ins that allow you to control registration, map differences, and customize appearance. Ceramic matrix composite, imaged on a ZEISS Xradia Versa microscope. Sample courtesy of Dr. David Marshall, University of Colorado, US.*

Your visual results will let your images speak for themselves. Capture and share insightful screenshots—as still images or 2D animations—or turn to Dragonfly Pro's 3D Movie Maker for effortless high-impact 3D animations.

Dragonfly Pro's integrated machine learning engine solves segmentation of even the most challenging samples, while interactive painting and contouring tools make curation and fine edits a breeze. Record your workflows and replay them as needed or in batch. Even write custom Python code to drive the software to highly-customized and robust solutions.

Simple to use, but delivering the quantitative answers and visual impressions you demand, Dragonfly Pro will accelerate your 2D/3D data productivity.

**Key User Benefits:**

- Ease of use
- Image segmentation
- Multi-modal (XRM, SEM, FIB-SEM)
- Scripting robust and batching workflows
- Multi-scale
- Quantitative Analysis
- Movies

# Your Insight into the Technology Behind It



**Python API for Your Custom Use Case**

The ZEISS XRM Python API provides additional capability to interact with the Versa X-ray microscopes. There are three different APIs that can be used in Python scripts to interact with the microscope for different use cases.

- The Basic API module provides methods to interact with the microscope, such as moving motors and changing objectives.
- The Recipe API module contains functions that can modify and run recipes to acquire data.
- The Basic Data Set API module can be used to read the data generated by an acquisition or reconstruction.

With the seamless integration of Python API into the control system, you can expand instrument control capabilities and enhance the productivity and quality of your research.

# Your Insight into the Technology Behind It



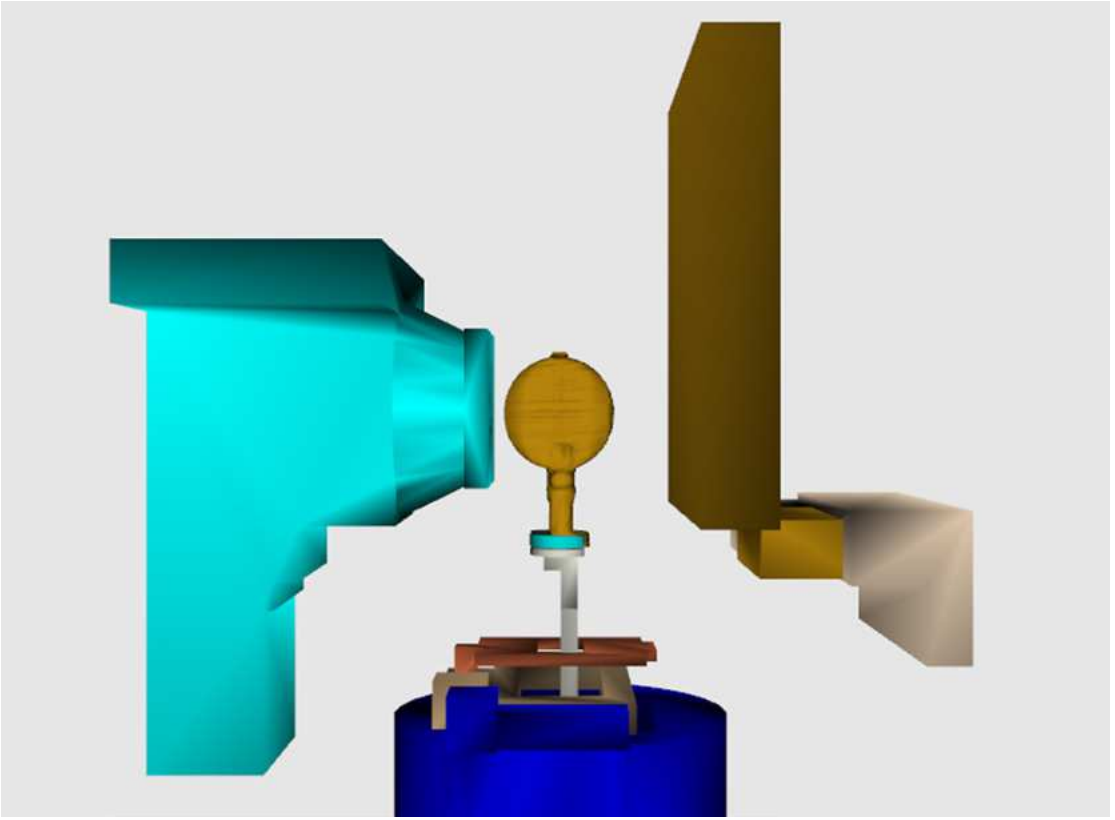
**ZEISS SmartShield – Protect Your Sample and Optimize Experiment Setup**

ZEISS SmartShield protects your sample and your microscope, working within ZEISS NavX control system. It wraps a digital envelope around your sample with an easy click of a button. This automated solution allows you to confidently bring your sample even closer to the source and detector. With ZEISS SmartShield, new and advanced users alike can experience an elegant sample setup workflow and efficient navigation of the Versa system along with enhanced guidance specific to their sample geometry.

Use ZEISS SmartShield Lite for sample protection of highly transparent, reflective, and flat samples, or samples smaller than 1 mm in diameter.

**What ZEISS SmartShield Offers:**

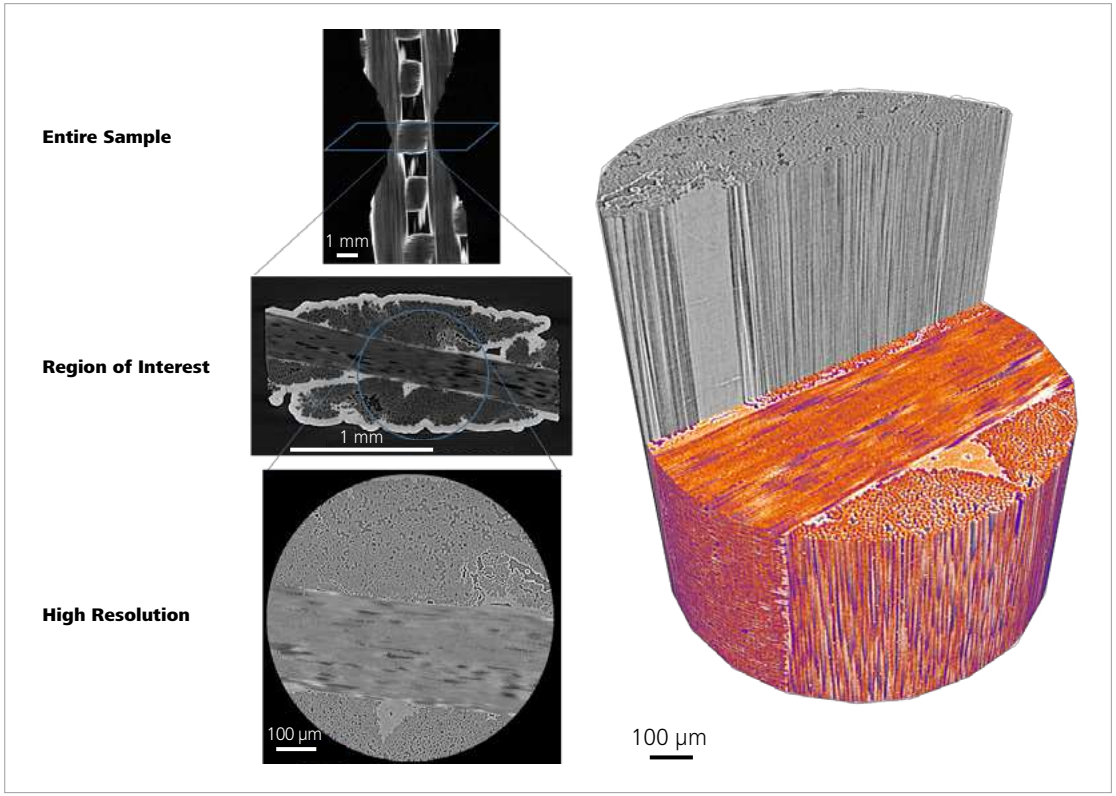
- Fully integrated rapid envelope creation within NavX
- 3D awareness for sample and instrument safety
- Enhanced operator efficiency during setup



*Graphical user interface guiding your SmartShield workflow.*

# ZEISS X-ray Microscopy at Work: Materials Research






*A dogbone-shaped ceramic matrix composite (CMC) sample, used for* in situ *mechanical testing. Using the Scout-and-Zoom workflow, the sample can be imaged non-destructively at multiple levels of magnification to identify, target, and study changes in local structure at high resolution. Sample courtesy of Dr. David Marshall, University of Colorado, US.*

### Typical Tasks and Applications

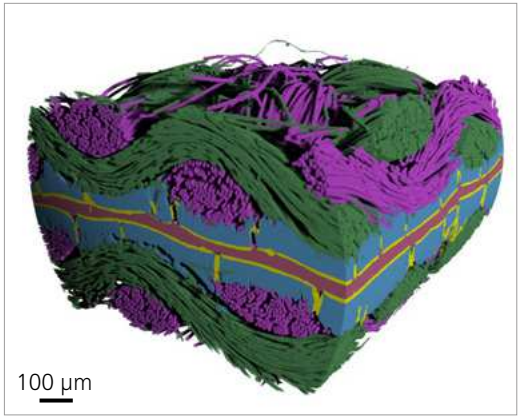
- Characterize three-dimensional structure
- Observe failure mechanisms, degradation phenomena, and internal defects
- Investigate properties at multiple length scales
- Quantify microstructural evolution
- Perform *in situ* and 4D (time dependent studies) to understand the impact of heating, cooling, desiccation, wetting, tension, compression, imbibition, drainage and other simulated environmental studies

### ZEISS Xradia 600-series Versa Benefits

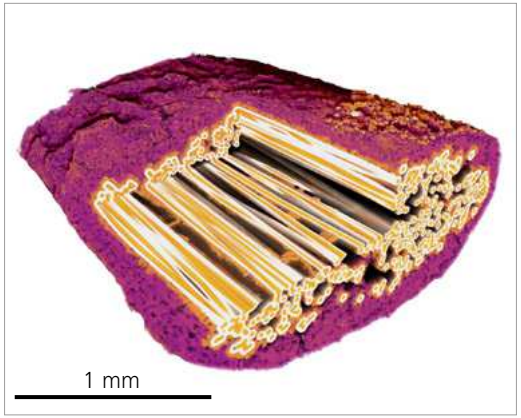
- Non-destructive views into deeply buried microstructures that may be unobservable with 2D surface imaging; compositional contrast for studying low Z or "near Z" elements and other difficult-to-discern materials
- Ability to maintain resolution at a distance for non-destructive *in situ* imaging experiments
- Fast, efficient Scout-and-Zoom technology further enhanced with FPX to look at very large samples on a macro scale to determine regions of interest for high resolution imaging
- Faster throughput provides more sample runs for better data and increased sample statistics
- For academic shared-use facilities, faster scans enable more users and improved instrument utilization

# ZEISS X-ray Microscopy at Work: Materials Research

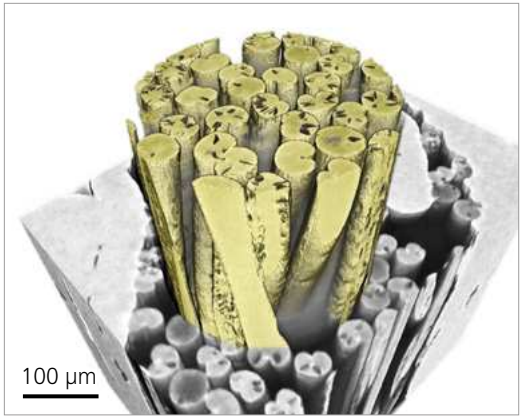




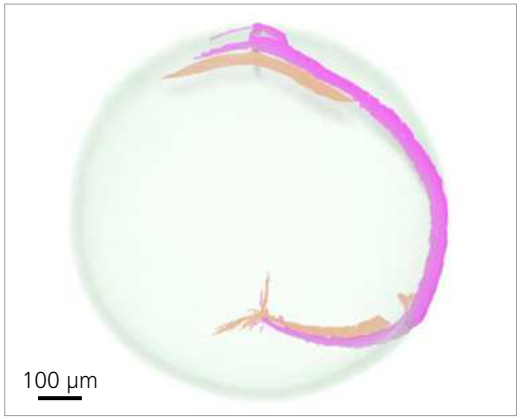

*Segmented 3D volume of a polymer electrolyte fuel cell membrane electrode assembly. Gas diffusion layer fiber weaves are visible in green and magenta, microporous layer in blue, catalyst in yellow, and electrolyte membrane in red.*



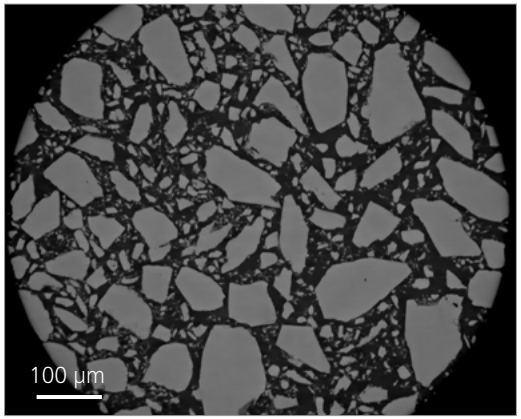

*3D rendering of a ceramic matrix composite sample with the interior coated fibers visible in orange and white in the cutaway and the protective ceramic coating layer in magenta. Sample courtesy of Dr. David Marshall, CU Boulder, CO, US.*




*3D rendering of a bundle of Rayon polymer fibers that have been imaged in propagation phase contrast mode on the ZEISS Xradia Versa X-ray microscope. The yellow rendered volume shows an interior tomography collected at a high resolution and processed using ZEISS PhaseEvolve to enhance the microvoids.*



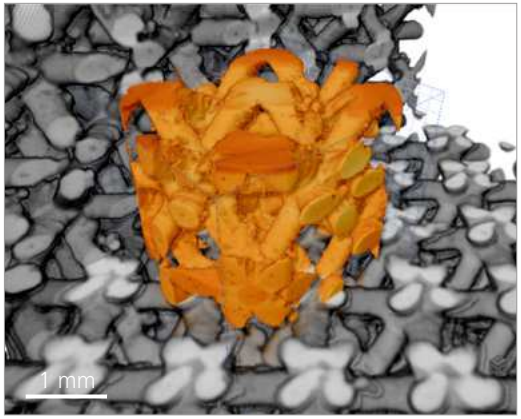

*3D rendering of a surrogate TRISO (tristructural isotropic) fuel particle with cracks through the outer SiC and pyrolytic carbon layers highlighted in orange and magenta. Sample courtesy of Dr. Peter Hosemann, UC Berkeley, CA, US.*



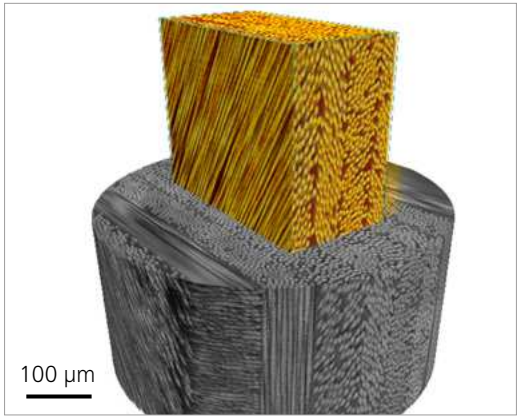

*2D virtual slice of a powder blend containing both lactose (larger particles) and pharmaceutical API particles (API here stands for "active pharmaceutical ingredients"; finer particles 1-5 µm). Processing with ZEISS PhaseEvolve enables segmentation and quantitative analysis of the particle distribution. Sample courtesy of Dr. Parmesh Gajjar, TEVA Pharmaceuticals, UK.*

# ZEISS X-ray Microscopy at Work: Materials Research

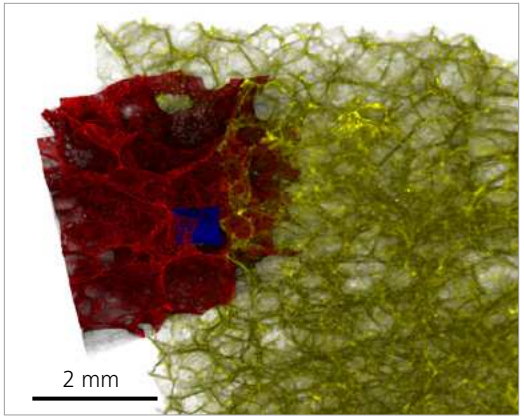




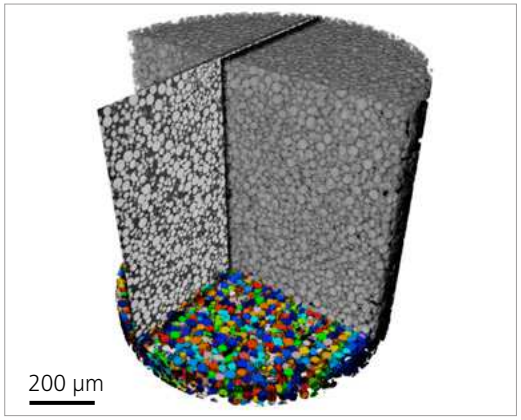

*Additive manufactured lattice structure. Sample courtesy of Kavan Hazeli, Mechanical and Aerospace Engineering, The University of Alabama, Huntsville, US.*



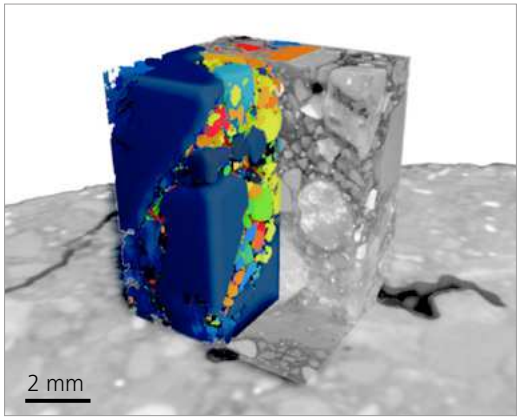

*Carbon fiber reinforced polymer composite.*




*Porous glass foam insulation imaged at multiple length scales. Sample courtesy of M.B. Østergaard, Dr. R.R. Petersen and Prof. Y. Yue (Aalborg University, DK), and Dr. J. König (Jozef Stefan Institute, Slovenia).*



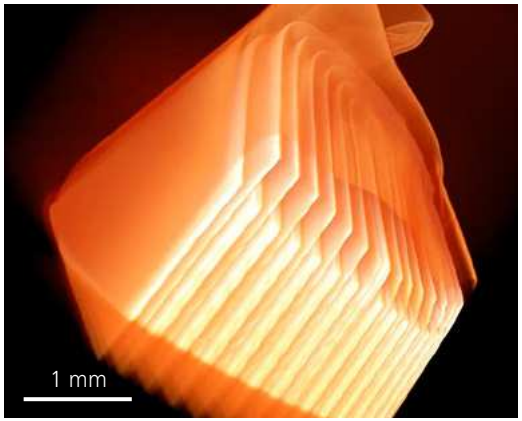

*Ti-6Al-4V feedstock powder for additive manufacturing.*



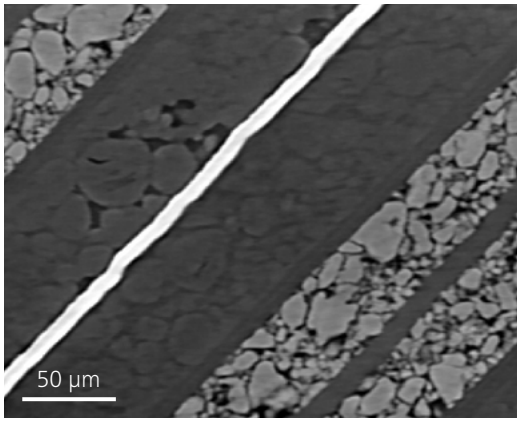

*Localized high resolution tomography and segmentation of multiple phases in concrete.*

# ZEISS X-ray Microscopy at Work: Lithium Ion Batteries

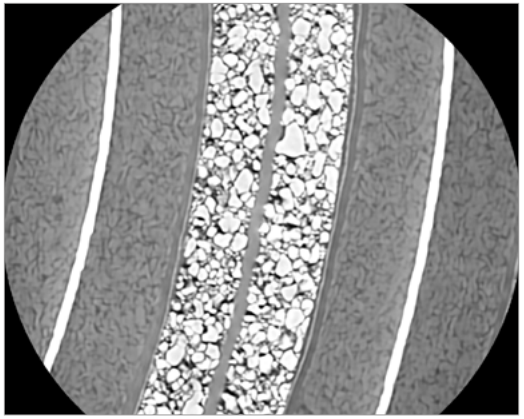





*Small pouch cell: 0.4× overview scan; 4× Resolution at a Distance.*




*2D Virtual slice. Interior region imaged at 80 kV with 40X-Prime detector and reconstructed with DeepRecon Pro. Fine particles and cracks are visible in both the high density cathode particles and the low density graphite anode particles.*



*2D virtual slice from a small pouch cell battery reconstructed using DeepRecon Pro. Features like the cathode particles, anode particles, polymer separator membrane, and metal current collector foils are visible across the electrode stack.*

### Typical Tasks and Applications

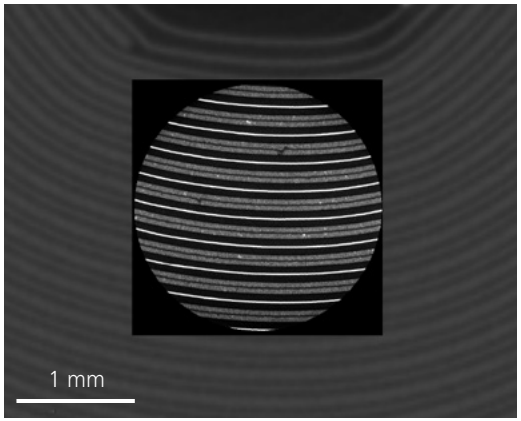
- Recipe development and supply chain control: Inspection of intact samples for effective supplier control, revealing changes in recipe or cost savings that may affect performance or longevity
- Safety and quality inspection: Identification of debris, particle formation, burrs at the electrical contact or damage to the polymer separator
- Lifetime and aging effect: Longitudinal studies of aging effects

### ZEISS Xradia 600-series Versa Benefits

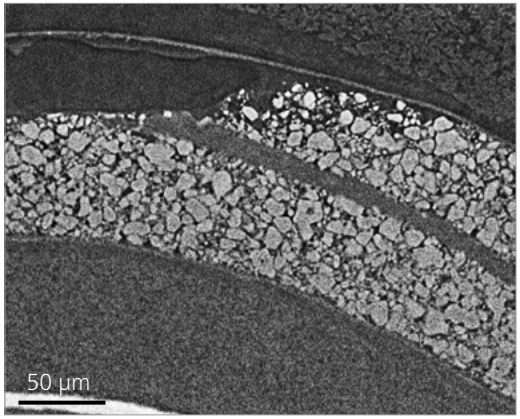
- Resolution at a Distance allows intact pouch and cylindrical cells to be imaged at high resolution—enabling longitudinal studies of aging effects, across hundreds of charge cycles.
- No other tool can look into an intact battery with such fidelity.
- Scout-and-Zoom enables a region of interest to be identified for a high resolution investigation.
- High resolution scan times are dramatically reduced with the 600-series.
- ZEISS DeepScout offers for high resolution interior tomographies of larger samples.

# ZEISS X-ray Microscopy at Work: Lithium Ion Batteries

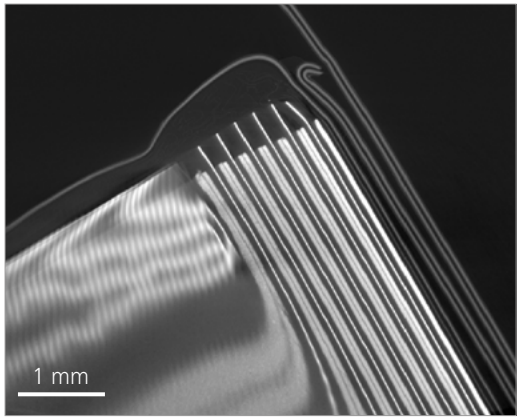




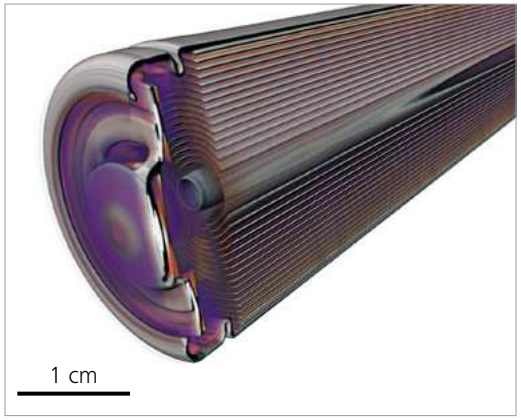

*Aging effects within an intact 18650 lithium ion battery.*




*Small pouch cell (80 kV)* – in situ *microstructure, aging effect at cathode grain level, separator layer.*



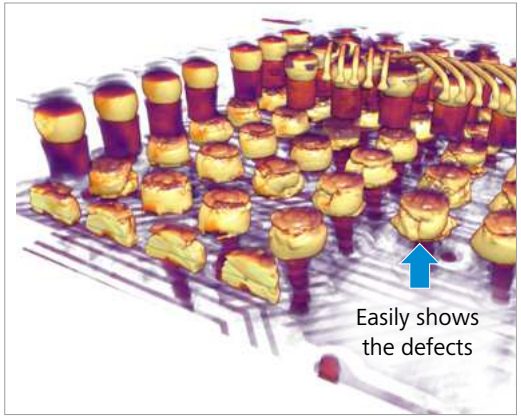

*Large pouch cell (120 kV)*
*Failure analysis, swelling, wetting, electrolyte gas evolution.*

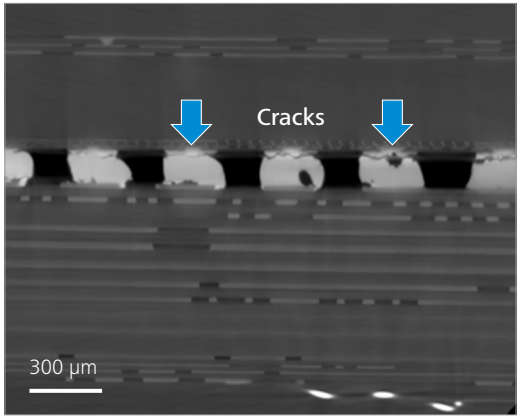



*Intact cylinder cell (160 kV) – welding burrs, metallic inclusions, folds and kinks in conductive layers.*

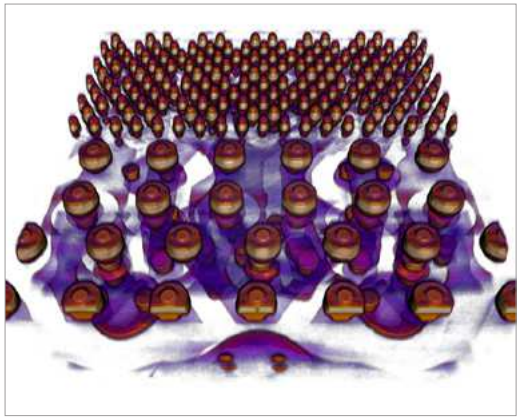
# ZEISS X-ray Microscopy at Work: Electronics and Semiconductor Packaging

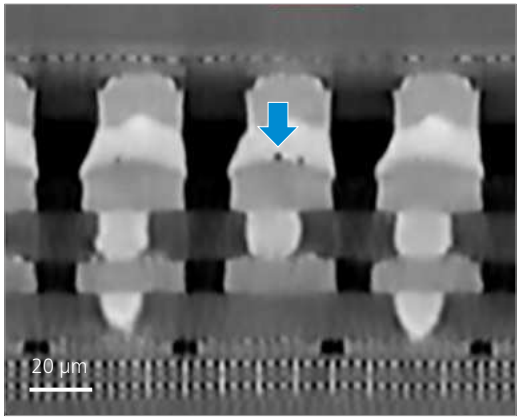





*Non-destructive visualization and characterization of solder fatigue cracks in a thermal cycled smartphone A12 control board at 2.5 µm voxel resolution.*






*Left: Package interconnects visualized in a 22x26 mm embedded multi-die interconnect bridge (EMIB) package.*
*Right: Virtual cross-section of 30 µm diameter microbumps of the EMIB package, acquired at 0.32 µm/voxel with a 40X-P objective lens.*

### Typical Tasks and Applications

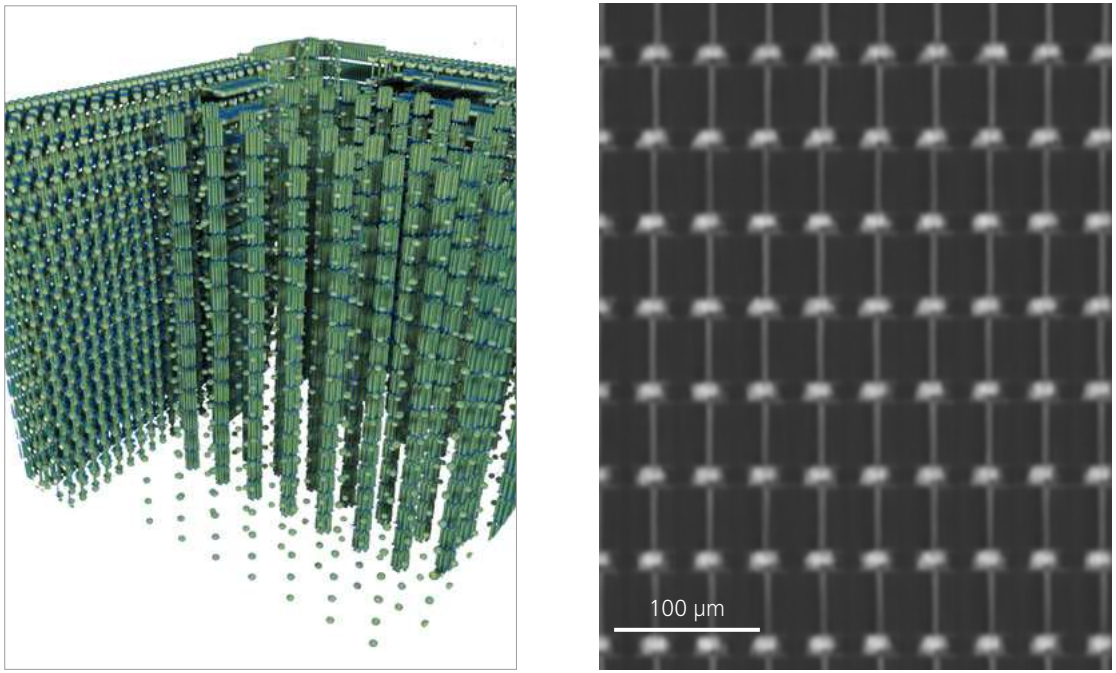
- Perform structural and failure analysis for process development, yield improvement and reliability test of advanced semiconductor packages, including 2.5/3D and heterogeneously integrated packages.
- Image and analyze IC (integrated circuit) package layouts, circuit interconnects and printed circuit boards for competitive analysis, patent infringement and cybersecurity.

### ZEISS Xradia 630-series Versa Benefits

- Non-destructively image advanced semiconductor packages and internal defects with the groundbreaking resolution improvement and scan speed comparable to physical cross-sectioning.
- The redesigned intuitive NavX user interface improves operation efficiency for all levels of users with built-in mental models and streamlined workflows.
- Faster throughput at large field of view (FOV) enables faster time-to-results for identifying failures and root causes, allowing more sample runs to aid packaging development, competitive analysis, and cybersecurity applications.

# ZEISS X-ray Microscopy at Work: Electronics and Semiconductor Packaging

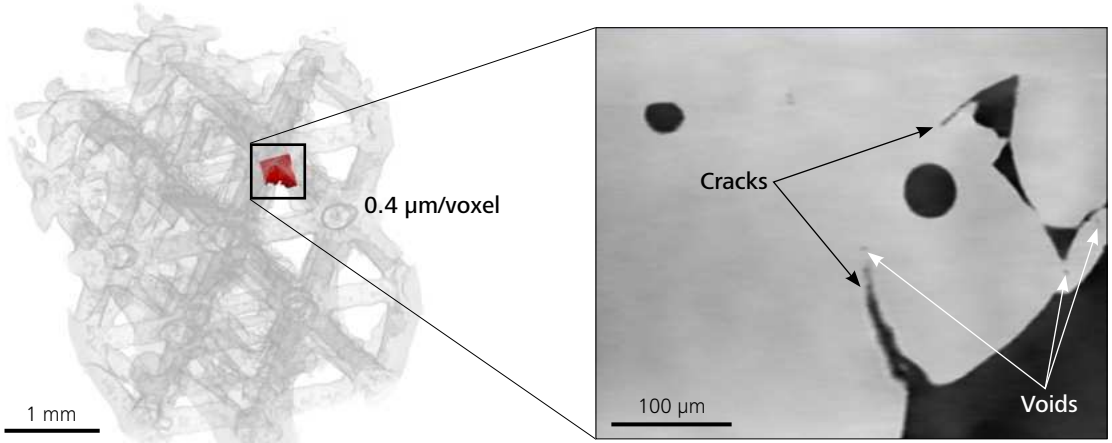




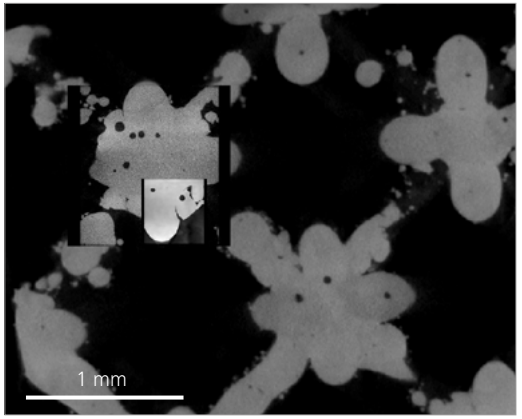

*Left: 15-layer DRAM (dynamic random access memory) package imaged at 1.4 µm voxel resolution. Right: Virtual cross-section of microbumps with 15 µm bond line thickness.*

# ZEISS X-ray Microscopy at Work: Additive Manufacturing






*3D rendering of an additively manufactured Inconel lattice structure at multiple scales. Full 5 mm sample is imaged at 5 µm/voxel and then targeted defect zone imaged at 140 kV with 40×-Prime detector at 0.4 µm/voxel and reconstructed with ZEISS DeepRecon Pro. Cracks and voids are visible in the high resolution image that are not visible at lower resolutions.*




*2D virtual slice of an additively manufactured Inconel lattice structure at multiple scales. Full sample is imaged at 5 µm/voxel, single node imaged with 4× detector at 1 µm/voxel, and then targeted defect zone imaged at 140 kV with 40×-Prime detector at 0.4 µm/voxel and reconstructed with ZEISS DeepRecon Pro.*

### Typical Tasks and Applications

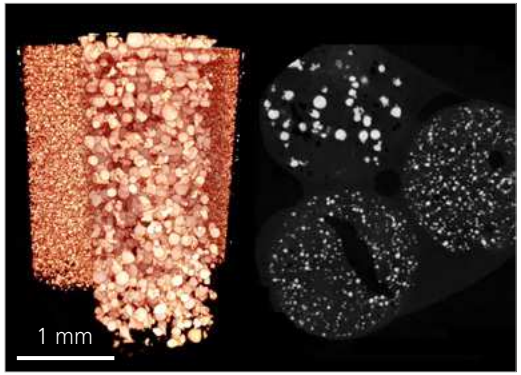
- Detailed shape, size, and volume distribution analysis of particles in Additive Manufacturing (AM) powder bed to determine proper process parameters
- High-resolution, non-destructive imaging for microstructural analysis of AM parts
- 3D imaging for comparison with the nominal CAD representation
- Detection of unmelted particles, high-Z inclusions, and voids
- Surface roughness analysis of inner structures that cannot be accessed by other methods

### ZEISS Xradia 600-series Versa Benefits

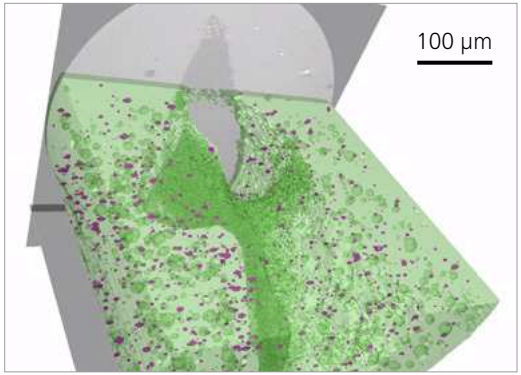
- Scout-and-Zoom technology enables fast access to inner structures without the need for any sample manipulation.
- Faster throughput allows quality inspection along the AM process chain.
- Class-leading sub-micron resolution enables detailed analysis of both process parameters and material characteristics.

# ZEISS X-ray Microscopy at Work: Additive Manufacturing



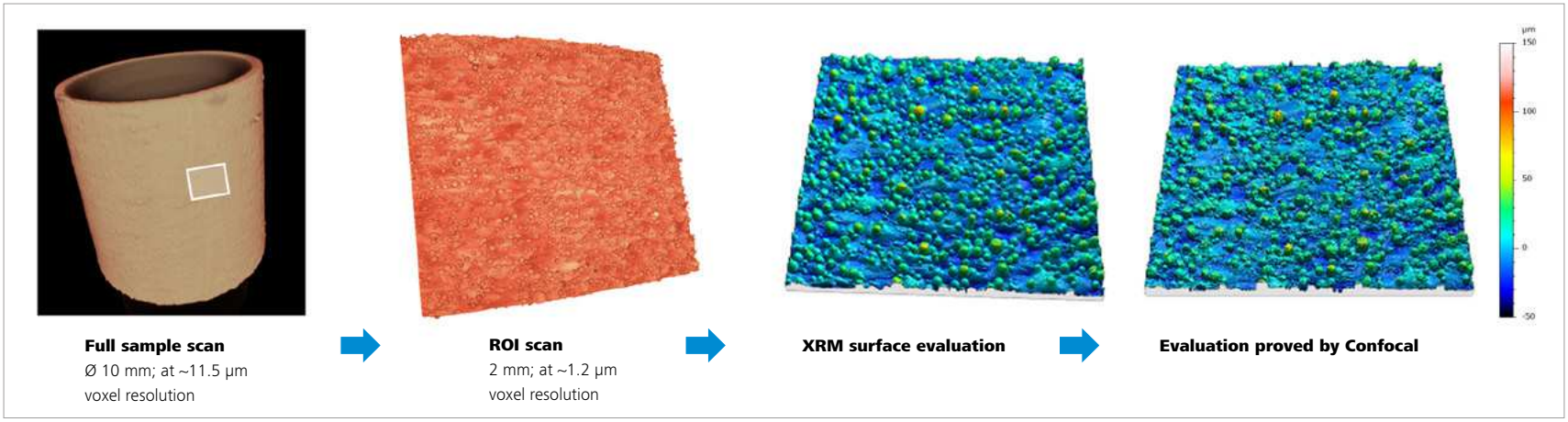



*Imaging of different A205 AM powder qualities at 3.9 µm voxel resolution.*




*Inner structure of an AM aluminum gear wheel; 3 µm voxel resolution imaging is used to see unmelted particles, high-Z inclusions, and small voids. Sample courtesy of Timo Bernthaler, University of Aalen, Germany.*


*Comprehensive characterization of an AM aluminum gear wheel reveals inclusions, pores, and deviation of dimensions relative to the CAD model. Sample courtesy of Timo Bernthaler, University of Aalen, Germany.*

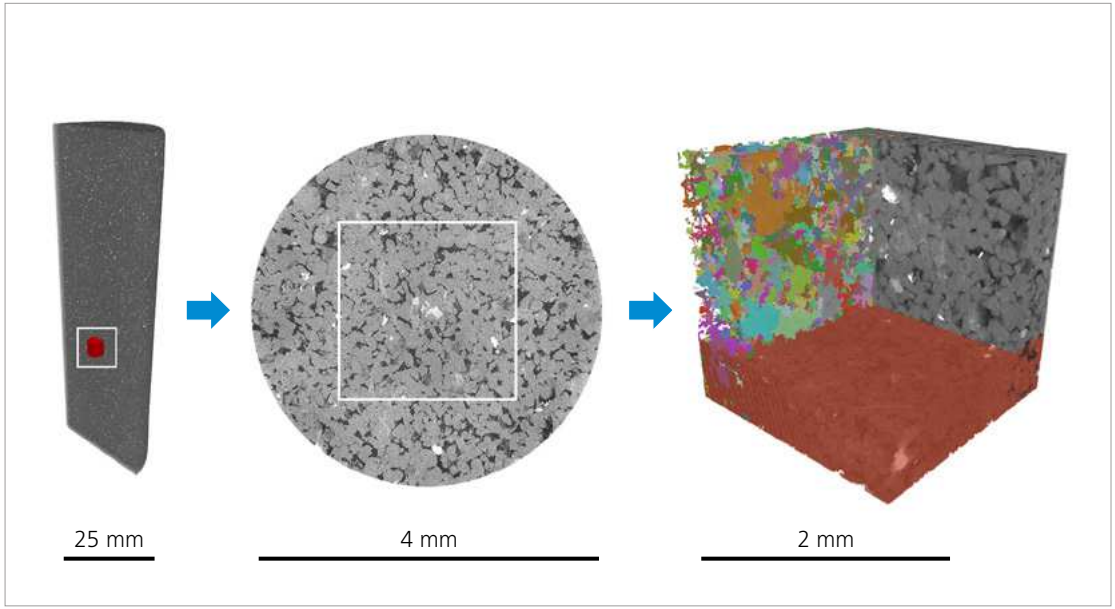



*ISO 25178 surface roughness evaluation of a Ti-6Al-4V test sample. Results are very similar between XRM and ZEISS Smartproof 5 confocal microscope. Test part supplied by LZN and Liebherr, Germany.*

# ZEISS X-ray Microscopy at Work: Raw Materials

### Typical Tasks and Applications

- Perform multiscale pore structural and fluid flow analysis
- Directly measure fluid flow at the pore scale using *in situ* flow equipment
- Analyze crystal structures using ZEISS LabDCT Pro
- Particle analysis with full 3D reconstruction
- Advance mining processes: analyze tailings to maximize mining efforts, conduct thermodynamic leaching studies, perform QA/QC analysis of mining products such as iron ore pellets
- Understand grain orientations in steel and other metals



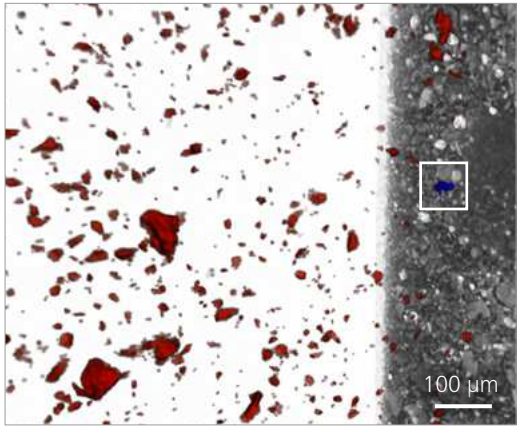

*Multiscale non-invasive characterization of sandstone core, showing macroscopic imaging, high quality non-invasive interior tomography, and integrated pore scale analytical investigation (showing pore separation).*

### ZEISS Xradia 600-series Versa Benefits

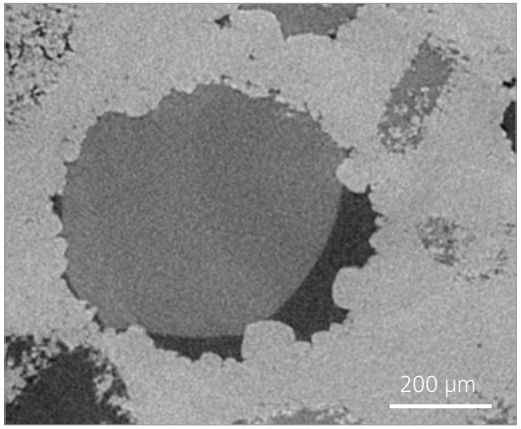
- The most accurate 3D nanoscale support for digital rock simulations, *in situ* multiphase fluid flow studies, 3D mineralogy, and laboratory-based diffraction contrast tomography (ZEISS LabDCT Pro).
- Multiscale imaging, characterization and modeling of large (4" core) samples at high throughput.
- Higher throughput equals faster run times, reducing bottleneck for pre- and post-studies.
- Higher quality data for better simulations.
- Higher power allows for high signal/noise diffraction patterns to be produced even from imperfect or low symmetry crystals.
- Combine the power of ZEISS Xradia 630 Versa with Mineralogic 3D for mineral identification, mineral liberation studies, non-destructive imaging of precious samples, CT automated quantitative mineralogy.

# ZEISS X-ray Microscopy at Work: Raw Materials

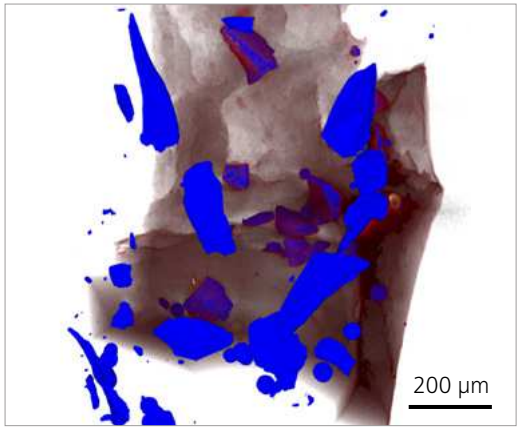




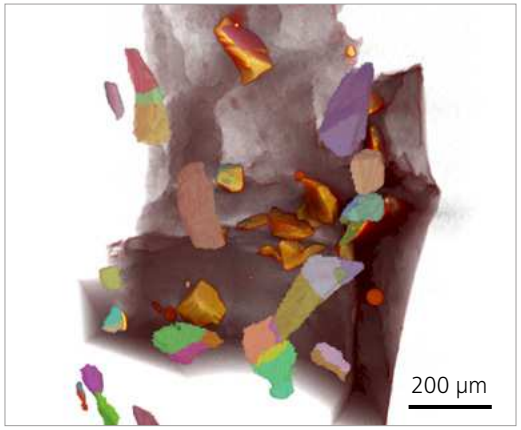

*Individual gold grain identified from population of ~26,000 pyrite grains.*




In situ *contact angle measurement of the oil (darkest phase) – brine (intermediate phase) – calcite (lightest phase) system.*



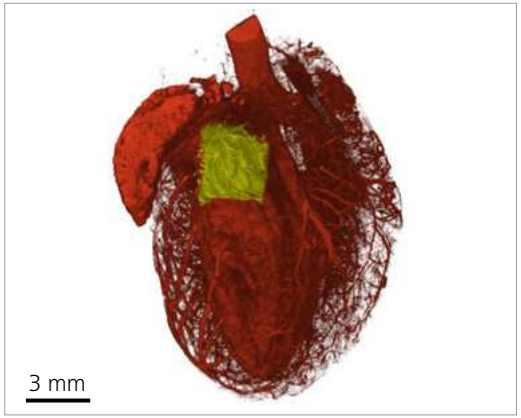

*Traditional absorption contrast image of disaggregated olivine.*

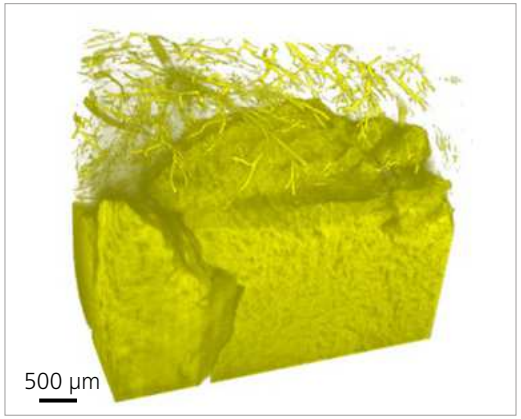



*Individual sub-crystals identified using ZEISS LabDCT on disaggregated olivine.*

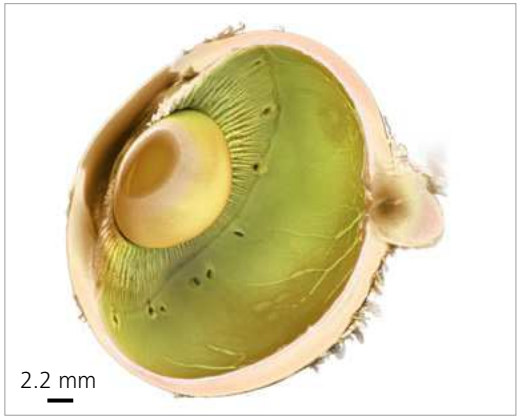
# ZEISS X-ray Microscopy at Work: Life Sciences






*High resolution and contrast X-ray microscope imaging of organs such as the heart provides valuable insights into tissue structure and allows comparisons like differences between disease states or genetic models. The sample is a rat heart (control animal) imaged at two different resolutions to reveal internal vascular structure which has been contrast enhanced. 3D reconstructions using Dragonfly Pro are shown of both the lower resolution and higher resolution scan regions. During the entire imaging process, the heart was embedded in low melting point agarose in a falcon tube to keep it still and hydrated. Sample courtesy of the University of Radboud, NL.*




*Research into eye health provides understanding and insights that lead to the development of therapeutics to treat eye diseases and conditions. This pig eye has been imaged whole to reveal the internal components of the eye in order to better understand the biology. Data courtesy of Prof Rachel Williams, Dr. Brendan Geraghty, Dr. Victoria Kearns, Valentin Pied and Dr. Julia Behnsen, University of Liverpool, UK. Image rendered using Drishti.*

### Typical Tasks and Applications

It is always a challenge to study the details of biological samples without losing the context of the larger specimen. X-ray microscopy allows high contrast, high resolution 3D imaging of your delicate biological samples including mineralized and soft tissues, individual organs and organoids, plant tissues and more. Study inside your specimen histologically, without destroying your sample with dissection, down to a cellular level.

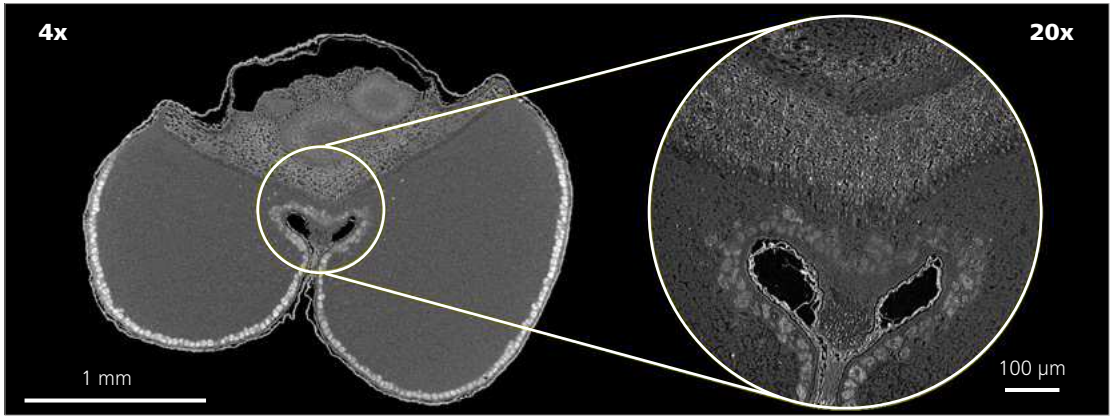
Xradia 630 Versa is particularly suitable when the highest resolution and best image quality is required.

### ZEISS Xradia 600-series Versa Benefits

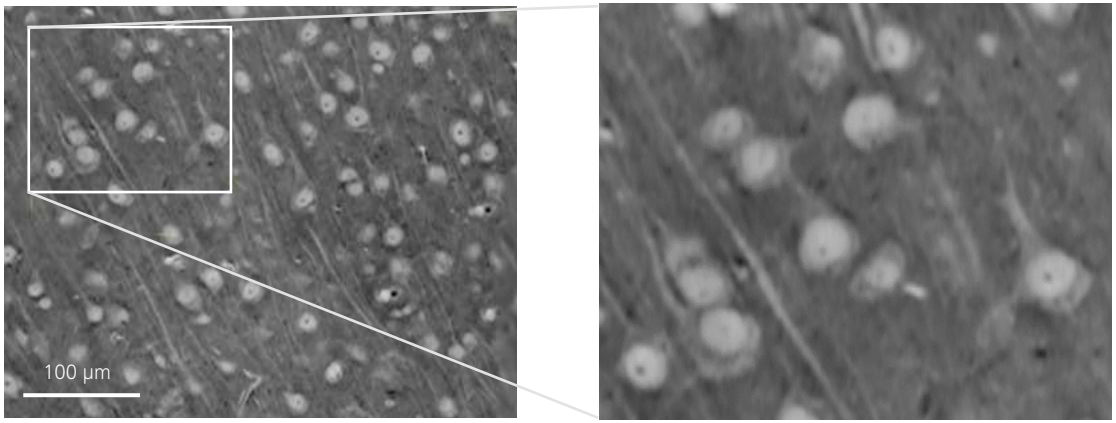
- Whole samples can be imaged at multiple lengthscales with high resolution at a distance (RaaD). Intact specimens like bones, organs, plants or tissue biopsies can be studied without any compromises in resolution.
- Large sample volumes can be imaged and processed using DeepScout to generate previously unreachable high-resolution overviews.
- High-contrast images acquired with Xradia 630 Versa enable the identification of structures of interest for subsequent fail-proof segmentation or precise localization for higher resolution acquisition using electron microscopy.

# ZEISS X-ray Microscopy at Work: Life Sciences

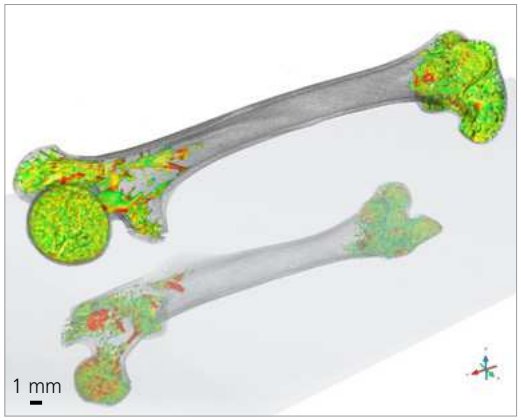





*Seeds are solid and compact structures, and their inside is difficult to image without physically dissecting the sample. Using XRM the internal structure can be revealed non-destructively so the seed can remain whole. The image shows a 3D reconstruction and virtual cross sections through a wheat grain that was imaged at two different magnifications to reveal the internal structure down to cellular resolution. Courtesy of Kim Findlay, John Innes Centre, Norwich, UK.*



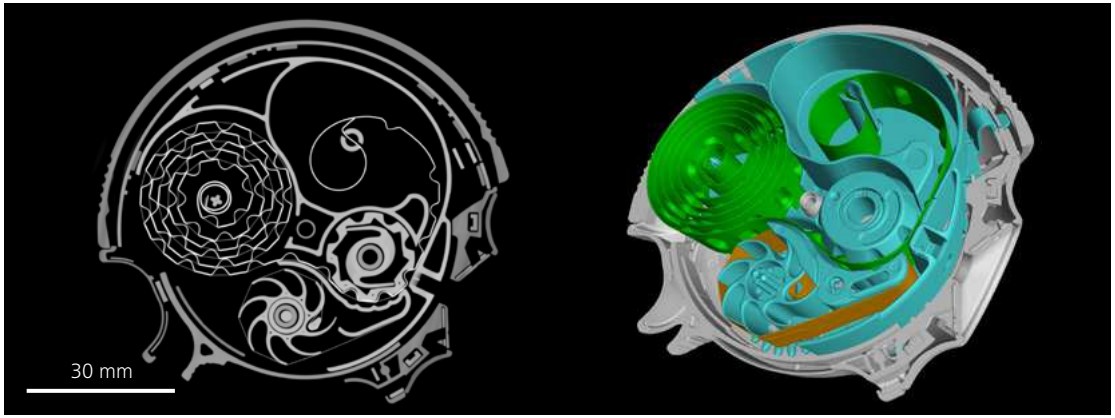

*Soft tissue specimens like brain can be imaged using XRM to generate 3D structural maps that provide context for other investigative approaches, such as light microscopy or electron microscopy. The sample is a single slice from a 3D dataset of a mouse brain imaged with the 40×-P objective of the ZEISS Xradia Versa 630 XRM and reconstructed using ZEISS DeepRecon. An inverted LUT has been applied. Sample courtesy of Dr. Kevin Boergens, the University of Illinois at Chicago, US.*



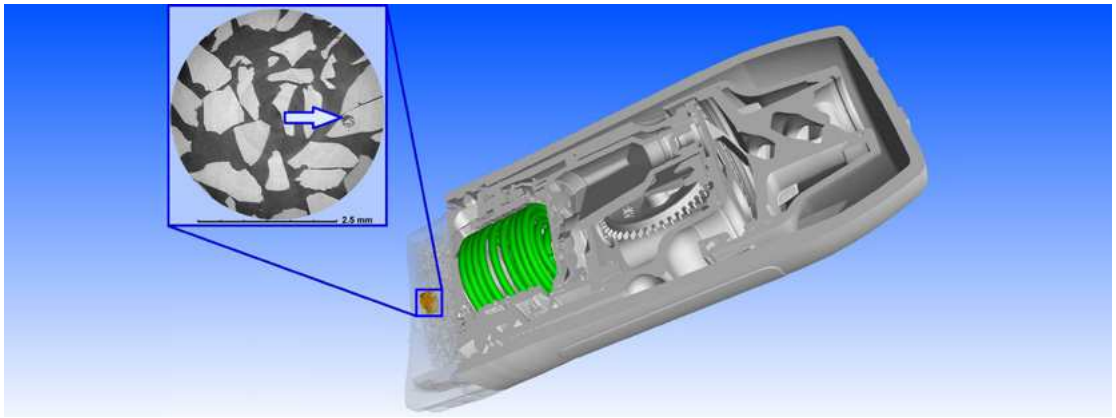

*X-ray imaging is fundamental for exploring bone morphometry to understand variations in bone health and disease. The trabecular bone of this mouse long bone has been segmented. The high resolution and contrast afforded by XRM provides the additional opportunity to use multiscale experiments to explore the hierarchical structure of bone and to combine this with* in situ *testing to simultaneously assess structural and mechanical properties. Sample courtesy of Danny Wescott, University of Texas at San Marcos, US. Rendered using ORS Dragonfly Pro Bone Analysis module.*

# ZEISS X-ray Microscopy at Work: Industrial Inspection and Quality Control






*X-ray microscopy scan of a medical device, a dry powder inhaler. A cross-sectional virtual slice of a scan obtained using a flat panel detector is shown on the left and 3D rendering on the right. The different grayscale values on the left side correspond to different density materials within the inhaler.*




*X-ray microscopy scan of a medical device showing details of inhalation powder microstructure. The clipped 3D rendering was obtained from a full scan of the device using a flat panel detector. The 2D virtual cross-sectional slice (zoom-in image) shows the complex microstructure of blends in the inhalation powder microstructure, obtained from a scan with a 4x lens.*

### Typical Tasks and Applications

- Different part components in an assembly can be non-destructively inspected for function and fit
- High-resolution imaging of manufactured parts for microstructural analysis and quality control
- 3D imaging for comparison with the nominal computer aided design (CAD) model or master part
- Manufacturing development and reverse engineering to create CAD models from 3D volume data
- Detection defects, particle inclusions, cracks, and unwanted porosity inside plastic and metal parts
- Non-destructive analysis of internal features not accessible to tactile or optical inspection methods

### ZEISS Xradia 600-series Versa Benefits

- Scout-and-Zoom technology enables fast access to part's internal features without destroying or disassembling a device
- Faster throughput allows high quality inspection of manufactured parts and assembled devices
- Class-leading sub-micron resolution enables detailed analysis of microstructures in parts and evaluation of its material characteristics

# ZEISS Xradia 630 Versa: Your Flexible Imaging Solution




**1 High Throughput X-ray Microscope**
- ZEISS Xradia 630 Versa with Resolution at a Distance (RaaD) 2.0
- Dual Scan Contrast Visualizer (DSCoVer) for materials discernment and dual energy analyses
- High Aspect Ratio Tomography (HART) for accelerated imaging and better image quality
- Optional Diffraction Contrast Tomography (LabDCT) for visualization of 3D crystallographic grain information

**2 X-ray Source**
- High power, sealed transmission source with fast activation (30 kV – 160 kV, Maximum, 25 W)

**3 Contrast-Optimized Detector System**
- Innovative dual-stage detector system offers turret of multiple objectives with different magnifications and optimized scintillators for highest contrast
- 2k × 2k pixel, noise suppressed charge-coupled detector
- Flat Panel Extension (FPX) for larger field of view, high throughput macroscopic imaging
- Optional 40X-Prime objective for up to 450 nm spatial resolution, 500 nm resolution at 160 kV

**4 System Stability for Highest Resolution**
- Granite base vibrational isolation
- Thermal environment stabilization
- Low noise detector
- Advanced proprietary stabilization mechanisms

**5 System Flexibility for a Diverse Range of Sample Sizes and Applications**
- Variable scanning geometry
- Tunable voxel sizes
- Absorption contrast mode
- Phase contrast mode
- Wide Field Mode (WFM) for increased lateral tomography volume with 0.4× and 4× objectives
- Vertical stitching for joining multiple tomographies vertically
- Optional ZEN AI Toolkit for image post-processing and segmentation using machine learning

**6 ZEISS SmartShield for Sample Protection and Setup Optimization**
- Fully integrated rapid envelope creation within NavX control system
- Sample and instrument safety in 3D
- Enhanced operator efficiency during experiment setup
- Semi-manual ZEISS SmartShield Lite for transparent, reflective samples

# ZEISS Xradia 630 Versa: Your Flexible Imaging Solution



**7 Advanced Reconstruction Toolbox with Options for Enhanced Performance**

- ZEISS DeepScout for resolution and throughput at full field of view for reconstruction that is 100x faster
- ZEISS DeepRecon Pro with AI-based reconstruction technology for up to 10× throughput or superior image quality on unique, semi-repetitive, and repetitive sample workflows
- ZEISS OptiRecon with iterative reconstruction for up to 4× throughput or enhanced image quality
- ZEISS Material-Aware Reconstruction Solution (MARS) for samples for highly attentuating samples, reducing the effects of beam hardening
- ZEISS PhaseEvolve for enhanced contrast and segmentation in low-medium density sample or high resolution imaging applications

**8 Autoloader Option**

- Maximize productivity by reducing user intervention
- Programmable handling of up to 14 sample stations
- Automated workflows for high volume, repetitive scanning
- Combined with NavX guidance enables easy access to remote data handling

**9 Sample Stage**

- Ultra-high precision 4-degrees of freedom sample stage
- 25 kg sample mass capacity

**10 X-ray Filters**

- Automated Filter Changer (AFC) with 24 filter capacity and cutout for highest throughput 'no filter' imaging
- Set of 13 filters included
- Custom filters available by special order

**11 *In Situ* and 4D Solutions**

- Resolution at a Distance (RaaD) enables superior *in situ* imaging
- Integrated *in situ* recipe control for Deben stages
- *In situ* interface kit option
- Custom *in situ* flow interface kit by special order

**12 Instrument Workstation**

- Powerful workstation with fast reconstruction
- Dual CUDA-based GPU
- Multi-core CPU
- 27" 4k display monitor

**13 NavX User Experience**

- X-ray control system developed with human-centered design principles
- Seamless and integrated guided workflows
- Visualized guidance for a wide range of parameter choices
- Integrated File Transfer Utility (FTU) for automatic transfer of data to user workstation
- Guidance for correlative workflows

**14 Software**

- Acquisition: NavX Control System
- Reconstruction: Scout-and-Scan Reconstructor
- Viewer: TXM3DViewer
- XRM Python API to expand instrument capabilities
- Output data compatible with many 3D viewers and analysis software programs
- Optional ORS Dragonfly Pro for 3D visualization and analysis

# Technical Specifications



| Imaging | ZEISS Xradia 630 Versa | ZEISS Xradia 620 Versa | ZEISS Xradia 610 Versa | ZEISS Xradia 510 Versa |
|---|---|---|---|---|
| **Spatial Resolution**[a] | 0.45 µm | 0.5 µm | 0.5 µm | 0.7 µm |
| **Resolution Performance**[b] | 0.5 µm (ZEISS Xradia Resolution Target at 160kV/LE6, equivalent to 1.3mm Al) | | | |
| **Resolution at a Distance (RaaD™)**[c] (50 mm working distance) | 0.7 µm | 1.0 µm | 1.0 µm | 1.0 µm |
| **Minimum Achievable Voxel**[d] (Voxel size at sample at maximum magnification) | 40 nm | 40 nm | 40 nm | 70 nm |

**X-ray Source**

| | | | | |
|---|---|---|---|---|
| **Architecture** | Sealed transmission, fast activation | Sealed transmission, fast activation | Sealed transmission, fast activation | Sealed transmission |
| **Voltage Range** | Spot size stable 30 – 160 kV | 30 – 160 kV | 30 – 160 kV | 30 – 160 kV |
| **Maximum Output** | 25 w | 25 w | 25 w | 10 W |

**Contrast-Optimized Detector System**

ZEISS X-ray microscopes (XRM) feature an innovative detector turret with multiple objectives at different magnifications. Each objective features optimized scintillators that deliver the highest absorption contrast details.

| | Standard | | | | Opt. | Standard | | | Optional | | Standard | | | Optional | | Standard | | | Optional | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Objectives & Detectors** | FPX | 0.4X | 4X | 20X | 40X-P | 0.4X | 4X | 20X | FPX | 40X | 0.4X | 4X | 20X | FPX | 40X | 0.4X | 4X | 20X | FPX | 40X |
| **Spatial Resolution** | 12 µm | 20 µm | 1.9 µm | 0.9 µm | 0.45 µm | 20 µm | 1.9 µm | 0.9 µm | 12 µm | 0.5 µm | 20 µm | 1.9 µm | 0.9 µm | 12 µm | 0.5 µm | 20 µm | 1.9 µm | 0.9 µm | 12 µm | 0.7 µm |
| **Max 3D Field of View (FOV)** | 140 mm | 50 mm | 6.5 mm | 1.3 mm | 645 µm | 50 mm | 6.5 mm | 1.3 mm | 140 mm | 645 µm | 50 mm | 6.5 mm | 1.3 mm | 140 mm | 645 µm | 50 mm | 6.5 mm | 1.3 mm | 140 mm | 645 µm |
| **Wide Field Mode, Max 3D FOV** | | 90 mm | 11 mm | | | 90 mm | 11 mm | | | | 90 mm | | | | | 90 mm | | | | |

**Stages**

| | |
|---|---|
| **Sample stage, load capacity** | 25 kg |
| **Sample stage travel, X,Y,Z** | 50 mm, 100 mm, 50 mm |
| **Sample stage travel, rotation** | 360° |
| **Source travel, Z direction** | 190 mm |
| **Source travel, Z direction (objectives)** | 290 mm |
| **Source travel, Z direction ( FPX detector)** | 250 mm |

a) Spatial resolution measured with ZEISS Xradia 2D resolution target, normal field mode, optional 40X Prime objective.
b) Spatial resolution measured with ZEISS Xradia 2D resolution target, normal field mode, optional 40X Prime objective, at 160kV, LE6 source filter (1.3mm Al equivalent).
c) RaaD™ working distance is defined as clearance around axis of rotation (sample radius). Resolution is measured with ZEISS Xradia 2D resolution target using 20X objective.
d) Voxel is a geometric term that contributes to but does not determine resolution and is provided here only for comparison. ZEISS specifies resolution via spatial resolution for Versa XRM, the true overall measurement of instrument resolution.
e) Z-direction is defined along the X-ray beam path.

# Technical Specifications



| Features | ZEISS Xradia 630 Versa | ZEISS Xradia 620 Versa | ZEISS Xradia 610 Versa | ZEISS Xradia 510 Versa |
|---|---|---|---|---|
| NavX User Experience with File Transfer Utility | ■ | | | |
| Scout-and-Scan™ Control System | | ■ | ■ | ■ |
| Scout-and-Zoom | Volume Scout in NavX | Manual or with DF Pro | Manual or with DF Pro | Manual or with DF Pro |
| Vertical Stitch | ■ | ■ | ■ | ■ |
| XRM Python API | ■ | ■ | ■ | ■ |
| Automated Filter Changer (AFC) | 24-filter capacity 13-standard | 24-filter capacity 12-standard | | |
| High Aspect Ratio Tomography (HART) | ■ | ■ | | |
| Dual Scan Contrast Visualizer (DSCoVer) | ■ | ■ | | |
| ZEISS LabDCT Pro for Diffraction Contrast Tomography | Optional | Optional | | |
| Wide Field Mode | 0.4× and 4× | 0.4× and 4× | 0.4× | 0.4× |
| GPU CUDA-based Reconstruction | Dual | Dual | Dual | Dual |
| ZEISS SmartShield | SmartShield, SmartShield Lite | ■ | ■ | ■ |
| ZEISS Autoloader | Optional | Optional | Optional | Optional |
| *In Situ* Interface Kit | Optional | Optional | Optional | Optional |
| ZEISS Metrology Extension (MTX) | | Optional | | |
| **Software** | | | | |
| ZEN AI Toolkit (incl. Intellesis) | Optional | Optional | Optional | Optional |
| ORS Dragonfly Pro | Optional | Optional | Optional | Optional |
| **Advanced Reconstruction Toolbox** | | | | |
| ZEISS ART AI Supercharger (DeepRecon Pro[a] + DeepScout[b]) | Optional | Optional | Optional | Optional |
| ZEISS ART Recon Package (DeepRecon Pro + OptiRecon[c]) | Optional | Optional | Optional | Optional |
| ZEISS ART Contrast Package (PhaseEvolve[d] + MARS[e]) | Optional | Optional | Optional | Optional |

a) Deep Learning reconstruction for superior throughput (up to 10X) or image quality for repetitive workflows
b) DeepScout reconstruction engine for highest resolution over large field of views
c) Iterative reconstruction for enhanced throughput (up to 4X) or image quality
d) Smart algorithm to enhance image quality by removing phase fringes
e) Material Aware Reconstruction Solution to enhance image quality by reducing beam hardening artifacts

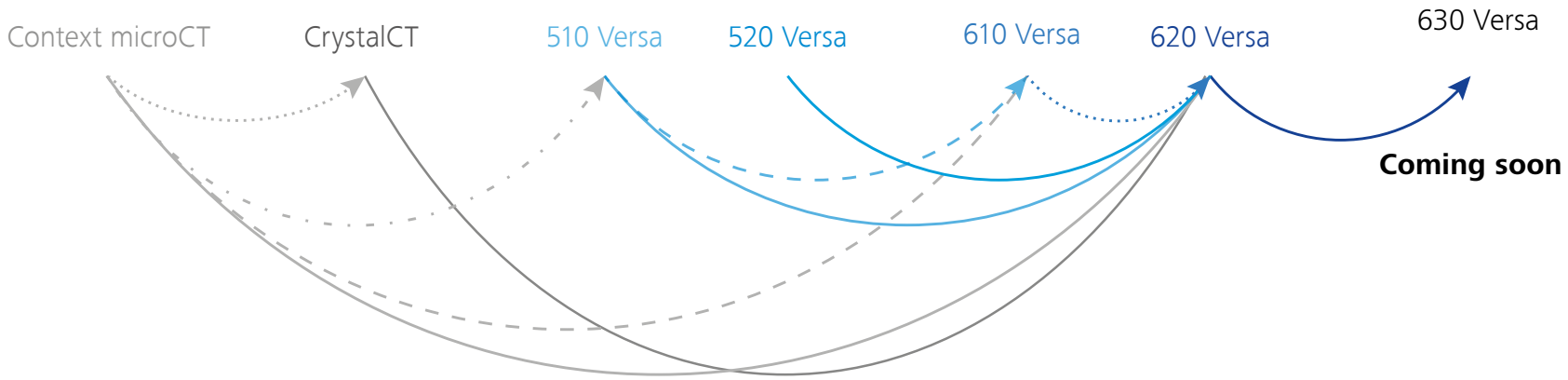
# ZEISS Customer Focus: Continuous Improvement and Upgradeability



**Protect Your Investment extends to Xradia 600-series Versa – delivering unprecedented extendibility and unrelenting support to ensure you are not left behind.**

Most ZEISS X-ray microscopes are designed to be upgradeable and extendible with future innovations and developments so that your initial investment is protected. This ensures your microscope capabilities evolve with the advancements in leading technology. This is one of the key differentiators in the 3D X-ray imaging industry.

From Xradia Context microCT, to Xradia 510/520/610/620 Versa, you can field-convert your system to the latest X-ray microscope products. In addition to instrument conversions at your facility, new modules are being continuously developed that will enhance your instrument to provide advanced capabilities such as *in situ* sample environments, unique imaging modalities, and productivity-enhancing modules. Also, periodic major software releases include important new features which are made available to existing instruments, thereby enhancing and extending the capabilities of your research.



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