



# SKYSCAN 2214

- High-Resolution Multiscale Nanotomograph

# SKYSCAN 2214 – High-Resolution, Multiscale Nanotomograph

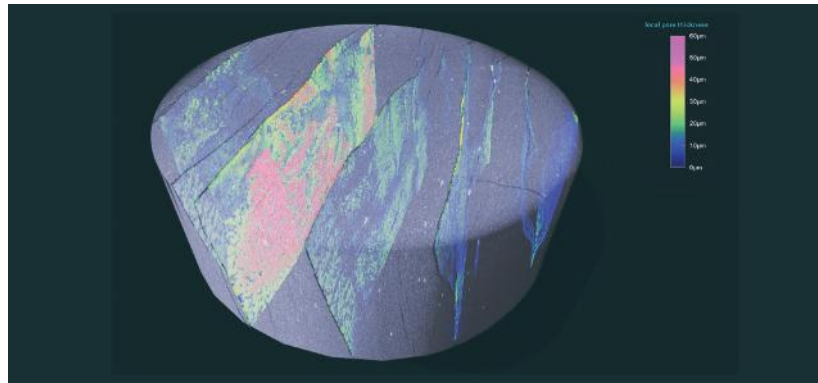
The SKYSCAN 2214 is the latest nanotomograph by Bruker, a pioneer of microCT technology. The SKYSCAN 2214 offers X-ray microscopy at exceptional resolution with an unparalleled user experience. Utilizing the latest technologies in each of the components make the SKYSCAN 2214 the most complete and versatile system on the market.

- Multipurpose system for samples up to 300 mm in diameter and resolutions down to 60 nm pixel size.
- Unique X-ray source with <500 nm focal spot size.
- Innovative modular design with up to 4 different, field-upgradeable detectors for ultimate flexibility.
- InstaRecon® – the world's fastest 3D reconstruction.
- Distortion-free, exact reconstruction algorithm for helical scanning.
- Almost maintenance-free system, reducing downtime and cost of ownership.



## Geology, Oil & Gas Exploration

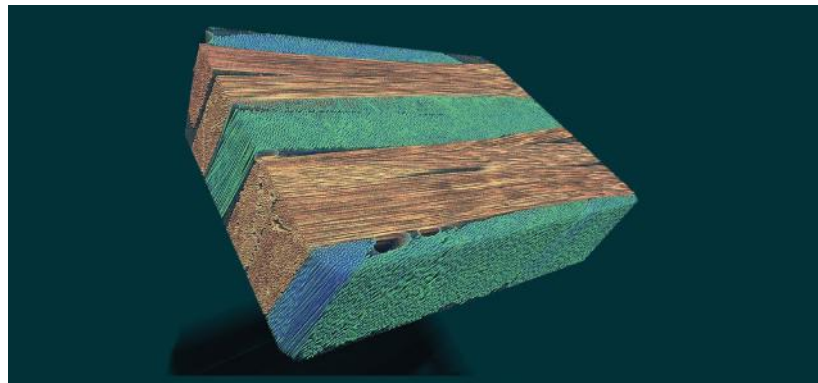
- High-resolution imaging of conventional and unconventional reservoirs
- Measure pore size and permeability, grain size, and shape
- Calculate distribution of mineral phases
- Analyze dynamic processes



Shale scanned at 6.2 µm voxel size.  
Volume rendered 3D model with color coded local structure separation.

## Polymers & Composites

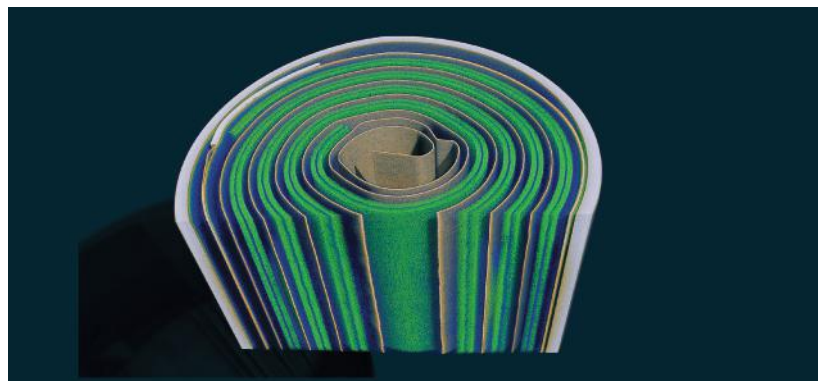
- Resolve fine structures with true 3D resolution <500 nm
- Assess microstructural architecture and porosity
- Quantify defects, local fiber orientation and thickness



CFRP scanned at 600 nm voxel size.  
Volume rendered 3D model with color coded local fiber orientation.

## Batteries & Energy Storage

- Non-destructive 3D imaging of batteries and fuel cells
- Quantify defects
- Anode and cathode structural analysis
- Dynamic experiments monitoring structural changes over time



Lithium-ion battery scanned at 900 nm voxel size.  
Volume rendered 3D model.

## Life Sciences

- Resolve structures with true submicron resolution, e.g. soft tissues, bone osteocytes and dentinal tubules
- Artefact-free imaging of osteointegration of biomaterials and high density implants
- High-resolution characterization of biological samples, e.g. plants and insects



Mouse lungs scanned at 3 µm voxel size.  
Volume rendered 3D model.

# SKYSCAN 2214 – State-of-the-Art Nanotomograph With Unrivalled Versatility



SKYSCAN 2214 multiscale X-ray nanotomograph





**Large chamber for mounting big samples and optional sample stages**



**Easy operation using the embedded touchscreen**



**Comprehensive system status indicators**

## Multiscale X-ray nanotomograph

SKYSCAN 2214 is a multiscale X-ray nanotomograph with a unique X-ray source and detector geometry that generates sharper images with outstanding precision. The SKYSCAN 2214 offers unprecedented, ultra-high resolution for larger fields of view in larger objects. This makes nano-CT practical and truly useful for industrial and academic research.

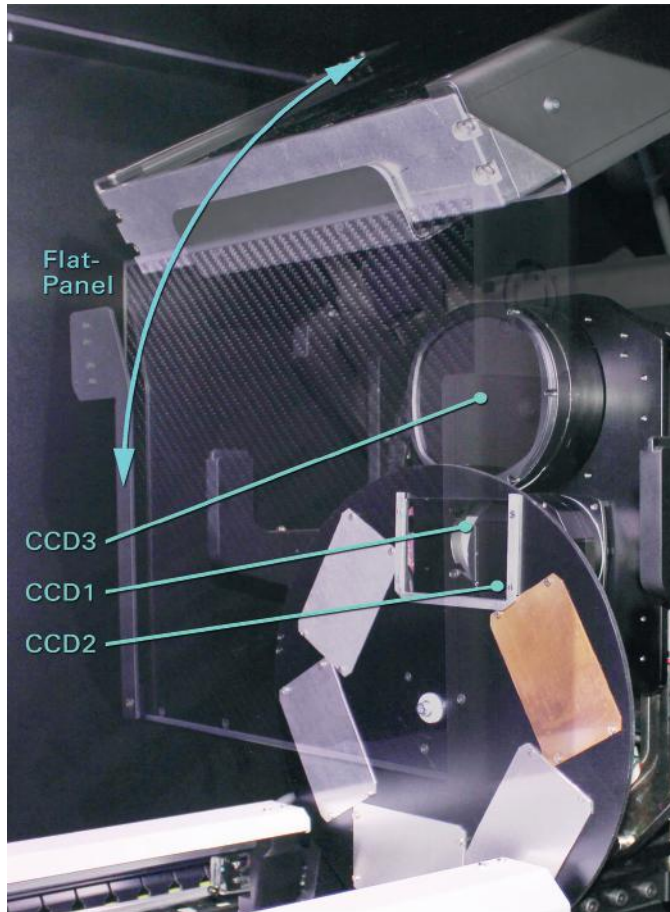
## Ultimate flexibility

The SKYSCAN 2214 features an innovative, modular design, accommodating up to four detectors. This guarantees the best image quality, for whatever sample and application. This supreme flexibility offers the scanning of a wide variety of sample types and sizes in one instrument, reducing the need for multiple, different CT systems. All detectors are field-upgradeable for cost-effective expansion of the SKYSCAN 2214, in order to accommodate changing analytical requirements.

## Ultra-high submicron resolution

The SKYSCAN 2214 pushes the boundaries for measuring larger objects at ultra-high resolution. Its uniquely large field of view allows for the analysis of objects up to 300 mm in size. For objects up to 12 mm in size, it provides better than 500 nanometer true 3D resolution. The achievable voxel size is 60 nanometer.

# Advanced Key Components for Uncompromised Image Quality



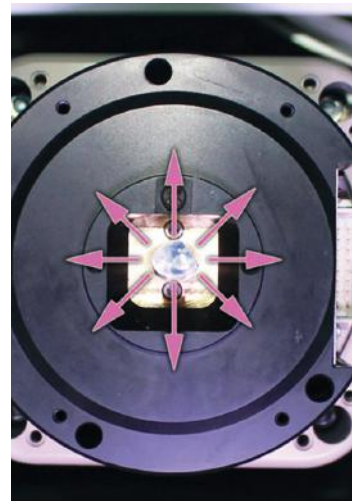
## Detectors

The SKYSCAN 2214 can be equipped with up to four X-ray cameras for ultimate flexibility: three CCD cameras with different resolution and field of view and one large-area flat panel detector. All cameras can be selected with a single mouse click. The different CCD cameras can be retro-fitted at any point of time during the system's lifetime. All three CCDs can take images in the central beam position and in two offset positions to double the field of view. The images in the two offset positions are automatically stitched together with compensation of the shifts and possible intensity differences.



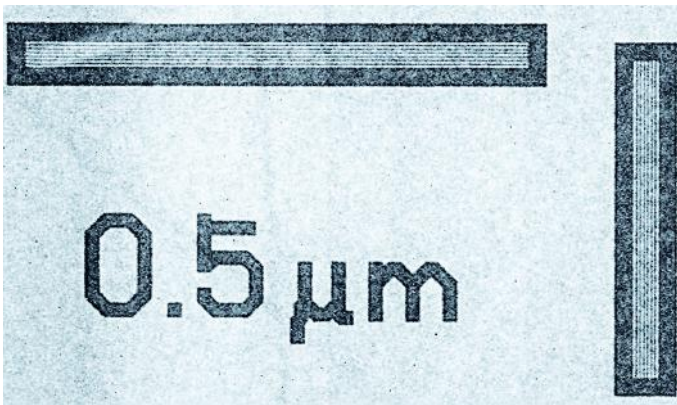
## Source

The SKYSCAN 2214 uses a latest generation open-type X-ray source. The source offers true spatial resolution below 500 nm, an X-ray energy up to 160 kV and source power up to 13 W. The source is practically maintenance-free with an extremely easy pre-aligned filament replacement procedure.



## Stage

The high-precision object stage of the SKYSCAN 2214 supports objects up to 300 mm diameter and 25 kg in weight. The air-bearing rotation motor allows precise rotation of objects at very high accuracy, and the integrated micro-positioning stage guarantees a perfect sample alignment.



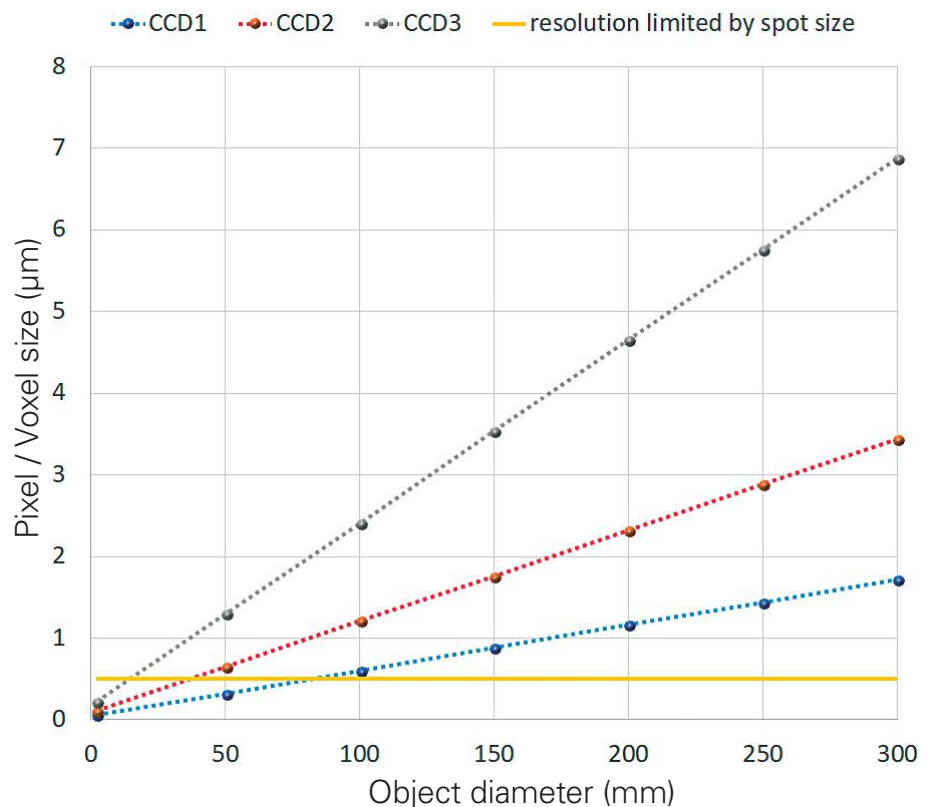
**JIMA resolution chart imaged by the SKYSCAN 2214 proving 500 nm structures are clearly resolved**

## High performance X-ray source

The SKYSCAN 2214 has an open-type (pumped) nanofocus X-ray source with diamond window. It produces an X-ray beam with peak energy from 20 kV to 160 kV and is supplied with two types of cathodes. The tungsten (W) cathodes operate in the full range of accelerating voltages up to 160 kV and provide a spot size down to 800 nm. The lanthanum hexaboride ( $\text{LaB}_6$ ) cathodes can be used for accelerating voltages from 20 kV to 100 kV and provide a spot size of the X-ray beam smaller than 500 nm to achieve the highest resolution in imaging and 3D reconstruction. The JIMA resolution pattern indicates that 500 nm structures can be easily resolved. For long-term stability of the focal spot size and position of the emission point, the X-ray source is equipped with a liquid cooling system which contains a re-circulator providing precise temperature stability of the cooling fluid.

## High magnification for small and large objects

Using CCD detectors with small pixel size allows extension of high-resolution imaging and 3D reconstruction to large objects. The built-in detector flexibility enables adjusting the field of view and spatial resolution according to the object size and density. An advanced reconstruction from a volume of interest provides scanning of a selected part of a large object with high resolution without compromising image quality. Additionally, the field of view can be increased horizontally and vertically by using offset camera positions and vertical object movement.





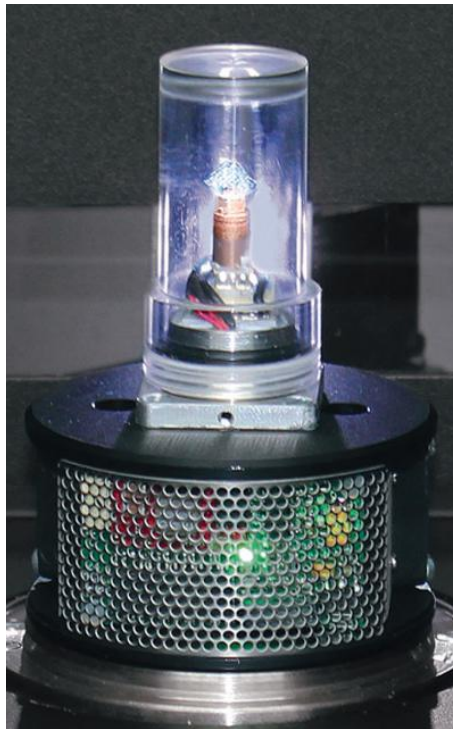
# Large Sample Chamber to Accommodate Big Samples and Optional Stages

The SKYSCAN 2214 has a large and easily accessible sample chamber to allow scanning of big objects as well as mounting of optional stages. On top plenty of space is available for peripheral equipment.



## Material testing stages

The Bruker material testing stages are designed to perform compression experiments up to 4400 N and tensile experiments up to 440 N. All stages automatically communicate through the system's rotation stage, without the need of any cable connections. Using the supplied software, scheduled scanning experiments can be set up.



## Cooling / Heating stage

Bruker's heating and cooling stages can reach temperatures of up to 80 °C or 25 °C below ambient temperature. Just like the other stages, no extra connections are needed, and there is an automatic recognition of the stage. Using the material testing stages, samples can be examined under non-ambient conditions, to evaluate the effect of temperature on the sample's microstructure.



## Deben stage

The SKYSCAN 2214 is fully compatible with stages from DEBEN. With the included adapter, the DEBEN stage can be simply placed onto the rotation stage of the SKYSCAN 2214, which is then powered and controlled through the slip rings. No additional wires need to be connected from outside the system.



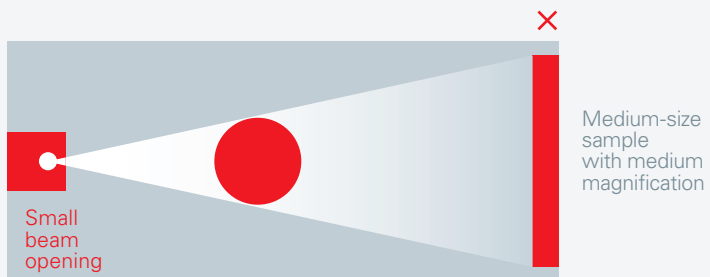
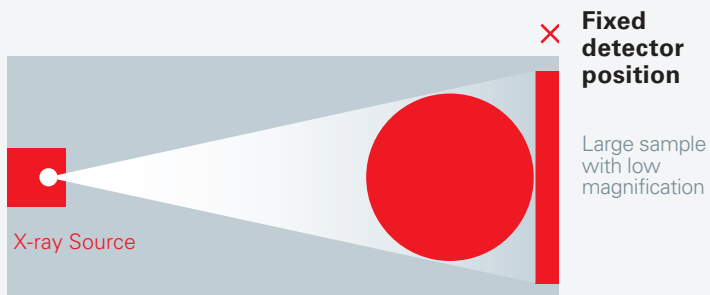
## Conventional Systems with Fixed Camera Position

**Fixed Position, Less Intensity, Less Speed**

**No**

Variable Camera Position

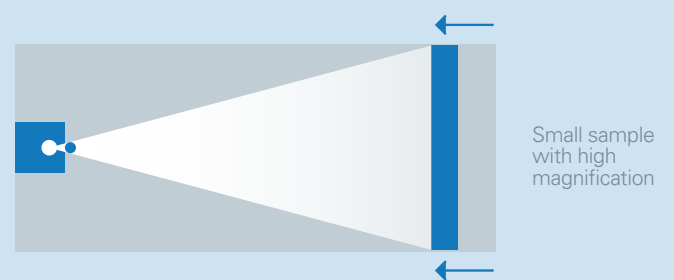
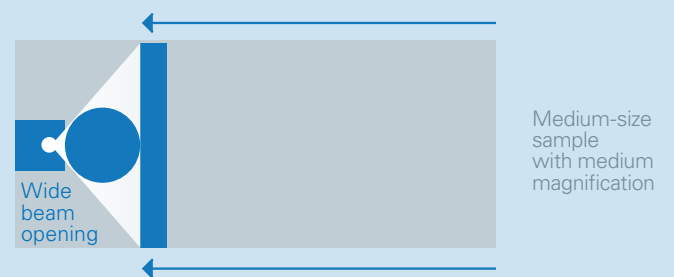
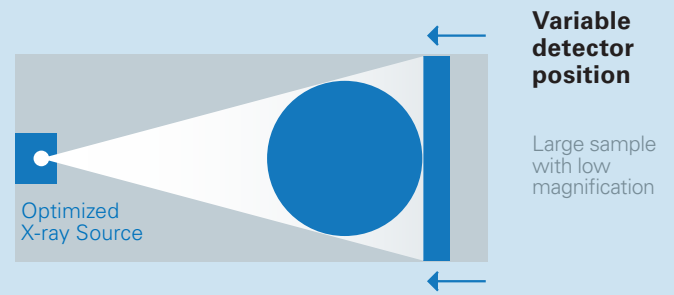
**Yes**



Conventional fixed camera systems are limited to one scanning speed, regardless of the sample size or magnification.

## SKYSCAN 2214 with Best-Scan-Geometry™

**Best Position, Best Intensity, Best Speed**



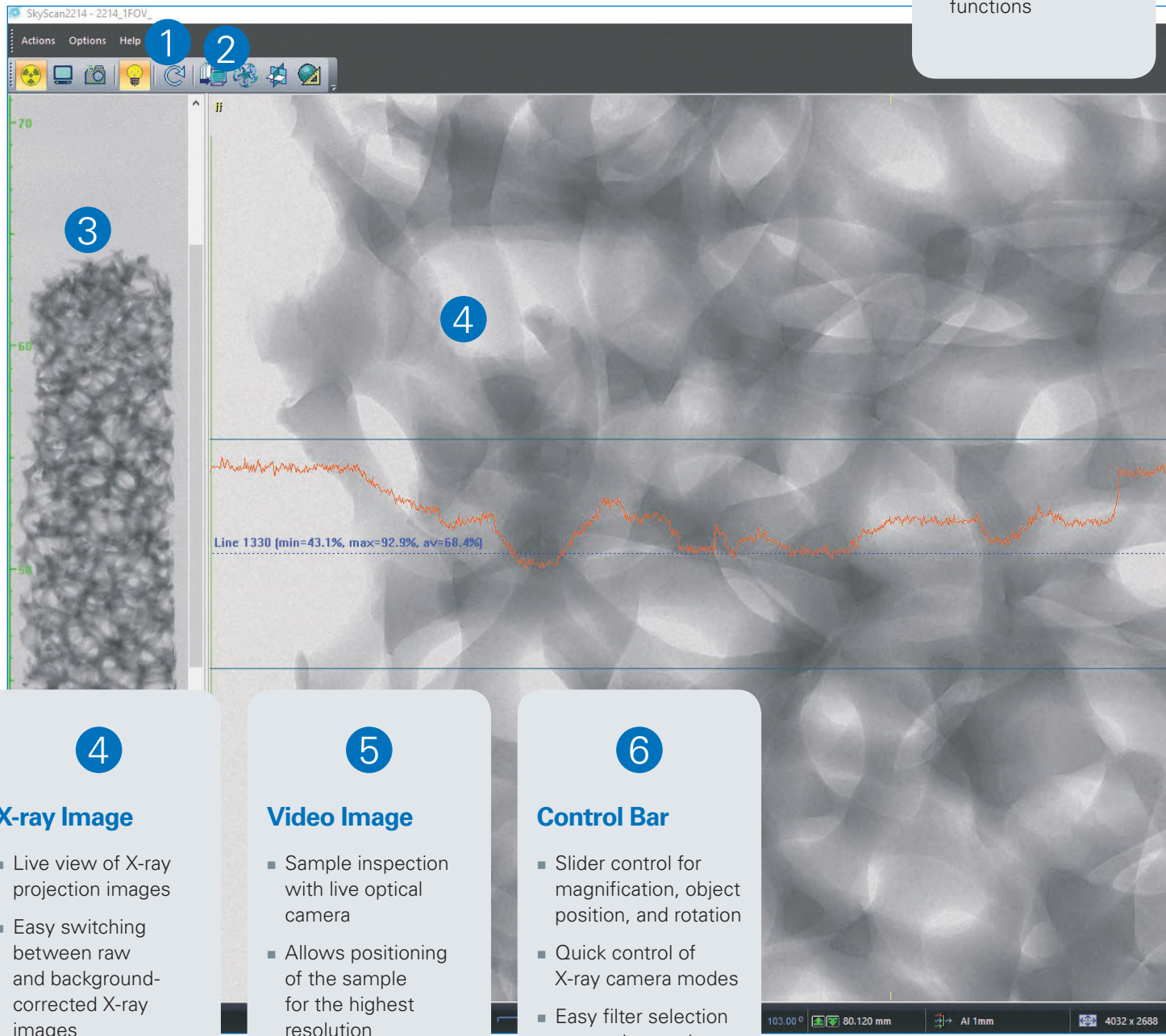
Moving both the sample and the CCD camera as close as possible to the source increases the measured intensity dramatically. That's why SKYSCAN 2214 scans faster than conventional systems.

# SKYSCAN 2214 Software Suite Means Ease-of-Use **Plus** Enjoy-your-Work

1

## Menu

- Simple, uncluttered menu for scanner control
- HELP database for additional information about features and functions



4

## X-ray Image

- Live view of X-ray projection images
- Easy switching between raw and background-corrected X-ray images
- Direct dimensional measurements

5

## Video Image

- Sample inspection with live optical camera
- Allows positioning of the sample for the highest resolution

6

## Control Bar

- Slider control for magnification, object position, and rotation
- Quick control of X-ray camera modes
- Easy filter selection to match sample attenuation

2

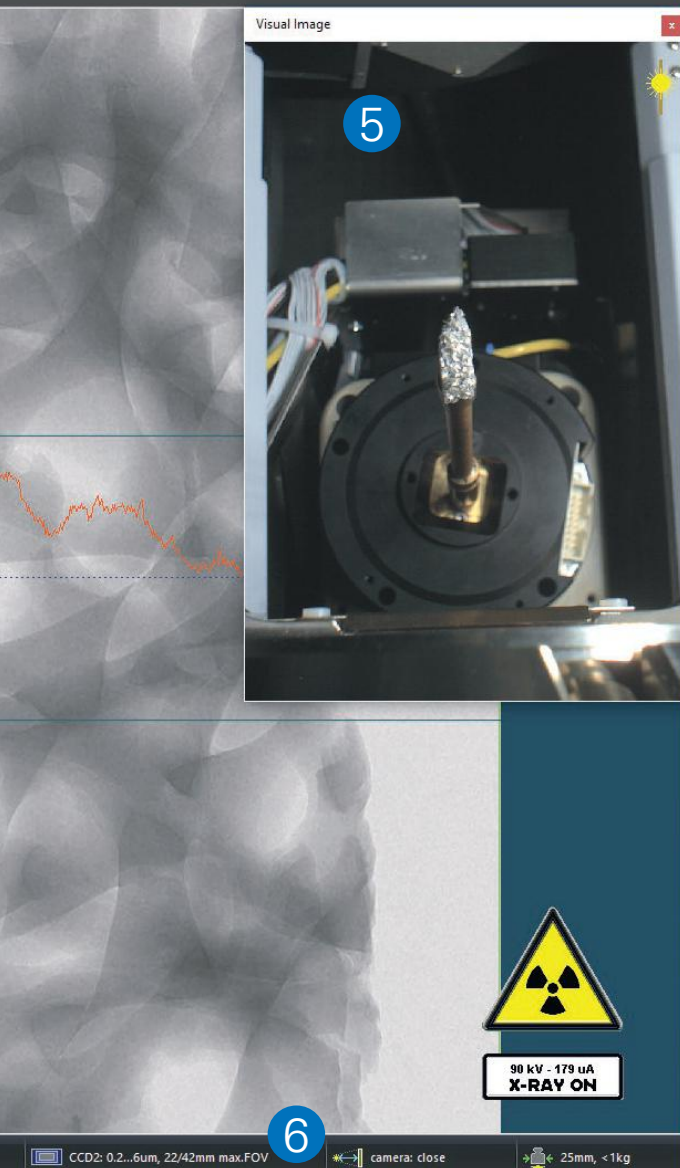
## Toolbar

- Natural left-to-right scanning workflow using clearly labeled icons
- Quick links to entire SKYSCAN software suite

3

## Scout View

- Full-length overview of entire sample
- Automatic stitching of oversized images
- Just click and drag at different vertical positions for batch scanning



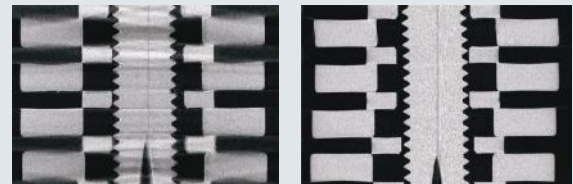
Overview of the SKYSCAN 2214 control software window

## Control software

Intuitive, simple, yet powerful – the SKYSCAN 2214 control software is designed to inspire finding out what's inside. The whole screen, including all menus and icons, is laid out in a straightforward, left-to-right manner that even a first-time user will find it intuitive enough to start scanning right away.

## Good Laboratory Practice (GLP)

The SKYSCAN 2214 systems are supplied with a GLP module, which allows administration of user rights in 3 levels and implementation of the necessary data protection according to GLP requirements.



Vertical virtual slice through a reconstructed Defrise phantom using circular (left) and helical (right) trajectories

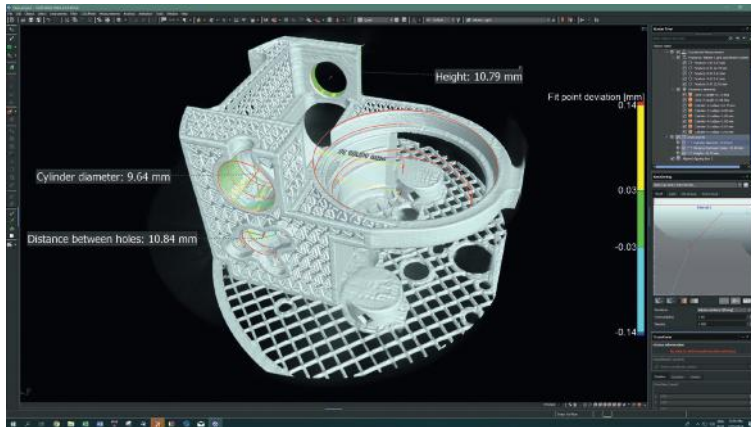
## Helical scanning: distortion-free, exact reconstruction

The cone-beam geometry of microCT systems can cause artefacts when reconstructing horizontal structures in a sample. The SKYSCAN 2214 prevents such artefacts through helical scanning, where the sample follows a spiral trajectory during the acquisition phase. Using helical scanning and GPU-accelerated reconstruction, the SKYSCAN 2214 scans and reconstructs a sample absolutely distortion-free. It can also measure long samples continuously, in one single scan.



## Metrology

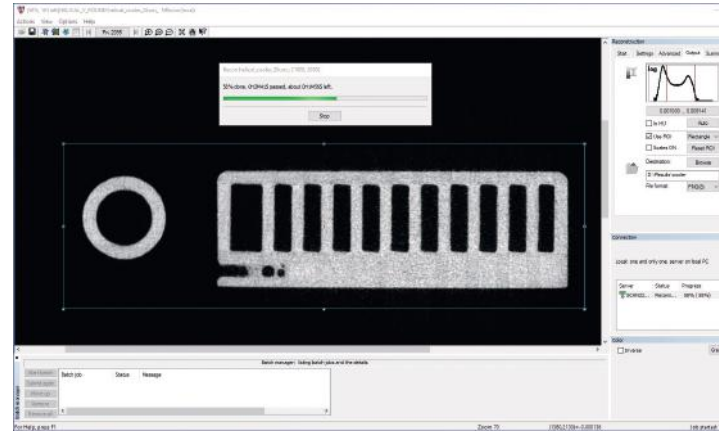
The SKYSCAN 2214 can be factory calibrated to achieve very high measurement accuracy. This way, the scanner can be used for metrological analysis, both on the outside and on the inside of the sample. The results from the SkyScan 2214 can be directly imported by Volume Graphics software VGSTUDIO MAX or VGMETROLOGY for geometric dimensioning, tolerancing, comparison to 3D CAD design and other metrological measurements.



**Metrological analysis of a 3D printed metal part by Volume Graphics software**

## NRECON

2D projection images are transformed into 3D volumes by the reconstruction software NRECON. Typical CT artefacts, such as beam hardening, ring artefacts and misalignment, are easily corrected. SKYSCAN 2214 is supplied with InstaRecon® – the fastest reconstruction software available – exclusively offered by Bruker. InstaRecon® provides results up to 100 times faster than conventional reconstruction engines, operating on a single computer.

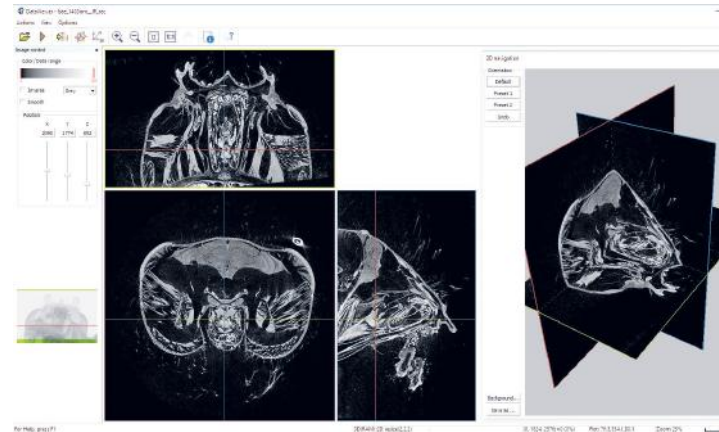


**Reconstruction of a 3D printed cooler element in NRECON**

## DATAVIEWER

### Slice-by-slice inspection of 3D volumes and 2D/3D image registration

DATAVIEWER allows inspection of the reconstructed volume using orthogonal slices in any direction. Objects can be rotated, repositioned, and resliced using their new orientation for more convenient visualization and saving of more efficient subvolumes. The software includes intuitive tools for measurement of 3D distances. 2D and 3D image registration enables the exact alignment of multiple scans of the same sample, acquired at different times.

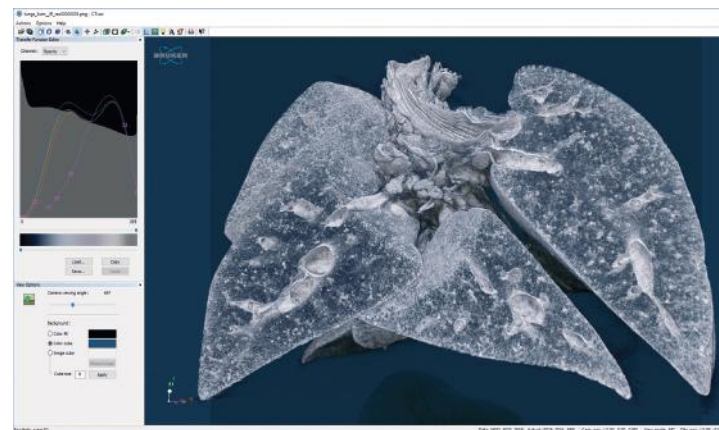


**Three orthogonal slices through a bee head in DATAVIEWER**

## CTVOX

### Realistic visualization by volume rendering

CTVOX is an easy-to-use volume rendering package that provides precise control of visualization parameters, ensuring a realistic representation of all types of samples. CTVOX offers intuitive manipulation of the point-of-view, virtual slicing through objects, and full control of light, shadow, and surface properties. Creating attractive cover images and impressive movies has never been so easy.

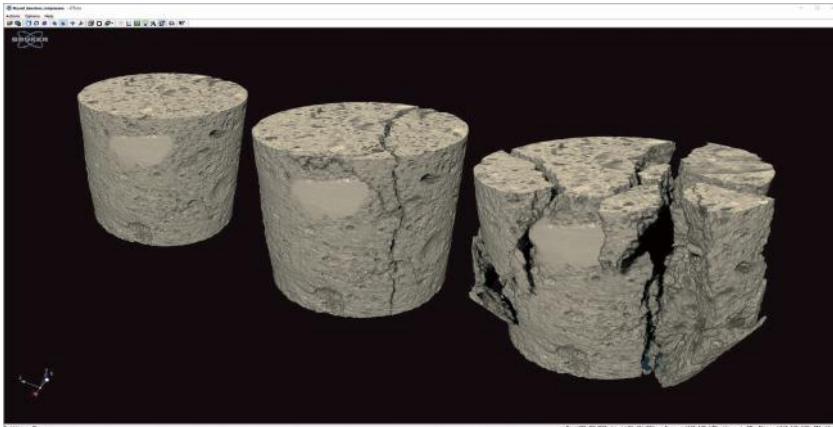


**Volume rendered mouse lungs in CTVOX**

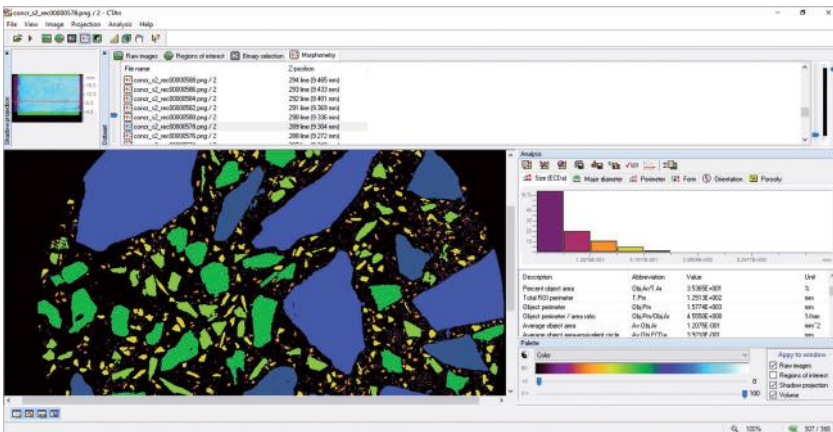


## Time-resolved 4D CT

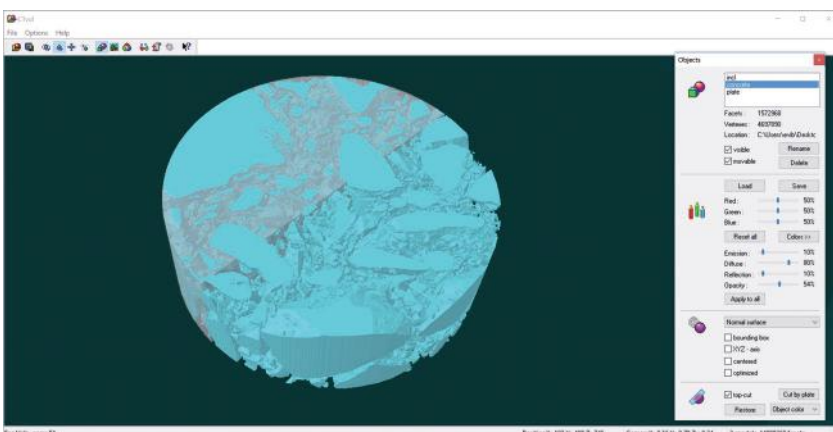
The fast scan times of the SKYSCAN 2214 make it the perfect system for time-resolved CT, also called "4D CT". Users can follow a sample's evolution by scanning it at different points in time. By using very fast scan times down to a few minutes, dynamic processes can be visualized in real time and in-situ.



In-situ mechanical testing of a limestone plug under 0 N, 150 N and 500 N of compression



Individual analysis of aggregate particles in concrete using CTAN



Surface rendered model of concrete binder and aggregate in CTVOL

## CTAN 2D/3D image analysis & processing

Built over two decades based on direct feedback from scientists all over the world, CTAN is one of the most frequently used programs for quantitative image analysis. This package includes an extensive number of tools for region-of-interest selection, image segmentation and 3D measurements. Using the comprehensive library of embedded plugins or user-customized protocols, quantifying complex microstructures such as porosity, thickness, orientation, and many other properties is an easy task. Large sets of objects can simply be studied by automated batch analysis.

## CTVOL

Surface models can be visualized in CTVOL, a flexible 3D viewing environment. Volumes can be exported in several formats, including STL, to allow 3D printing of the acquired scan data or further use in CAD and modelling programs.

# Rely on the Only One-Stop Shop for microCT and Become Part of the Bruker User Family



**Bruker microCT Academy for education and training**



**CTVOX mobile app with full functionality**



**SKYSCAN 2214 multiscale nanotomograph**

## Hardware

- Systems, sample stages, computers and monitors from one supplier
- Fully calibrated and extensively tested hardware
- Direct installation and support from certified service engineers

## Software

- Powerful 3D analysis software and realistic 3D visualization
- Dedicated mobile app with full functionality and performance
- Multiple file formats for reporting and presentation
- Fully in-house developed software

## Experts

- Direct customer support by our dedicated experts
- Full system and software training
- Scientific support for applications and analytical tasks
- Newsletter with method training notes



Bruker microCT employs a team of researchers, engineers and technicians to provide cutting-edge desktop and laboratory microCT systems. From hardware to software, all of our experts work closely together and with customers to provide the best solutions for your needs. Welcome to the only one-stop shop for X-ray microtomography.

By relying on a SKYSCAN 2214 you become part of the Bruker user family and benefit from the exchange of knowledge and experience. Bruker organizes annual microCT user meetings.

Get your CTVOX App & check out some samples!

iOS



Android



**We look forward to meeting you at our next get-together.**



**Bruker microCT User Meeting, Ghent, 2018**



## Technical Data

<b>X-ray Source</b>	Open (pumped) type with diamond window 20-160 kV, 13 W max.
<b>X-ray Detector(s)</b>	6 Mp active pixel flat-panel 11 Mp large format cooled CCD 11 Mp mid format cooled CCD 8 Mp hi-res cooled CCD
<b>Image Formats</b>	Up to 8000 x 8000 x 2300 pixels after a single scan
<b>Spatial Resolution</b>	60 nm smallest pixel size, <500 nm low-contrast resolution (10% MTF)
<b>Positioning Accuracy</b>	<50 nm for rotation, anti-vibration granite platform with pneumatic leveling
<b>Maximum Object Size</b>	300 mm in diameter (140 mm scanning size), 400 mm in length, maximum object weight 25 kg
<b>Radiation Safety</b>	<1 µSv/h at any place of the instrument surface

### System Dimensions



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