Bruker SkyScan X-ray Microscopes For Materials Science

SS1272

SS1273

SS1275

SS2214

Bruker USA Headquarters – Madison, WI

SkyScan X-ray Microscopes
Bruker At A Glance

History

1960	**Bruker** was founded by **Prof. Günther Laukien.** The growing start-up was located in the backyard of a Karlsruhe residence.
1969	World's first **FT-NMR spectrometer** that enabled broadband proton decoupling
1980	Foundation of Bruker-Franzen Analytik, adding **mass spectrometers** to the portfolio
1990	Foundation of Bruker Saxonia in Leipzig, dedicated to **ion mobility spectrometry**
1997	Bruker acquires the **analytical X-ray** division of Siemens AG
2001	Bruker Daltonics – first division to be listed on the **NASDAQ** – followed by Bruker AXS in 2002
2008	**Merger** of all Bruker corporate units completed with the final addition of Bruker BioSpin, the magnetic resonance division
2010	Bruker acquires Veeco's **scanning probe microscopy** and **optical industrial metrology** scientific instruments business
2012	Bruker acquires SkyScan N.V., a leading provider of **micro-CT systems for 3D X-ray imaging** in materials research & preclinical studies

Bruker Physik AG
First operational facility
Karlsruhe, Germany

Bruker Corporation
Headquarter
Billerica, Massachusetts, USA

SkyScan X-ray Microscopes
SkyScan At A Glance

- **XRM / Micro-CT scanner manufacturer – est. 1996 (SkyScan)**
  - **Headquarters in Kontich, Belgium**
  - **Life science and material science**
  - **Hardware and software**

- **Since 2012 part of Bruker group**
  - **Worldwide supplier of analytical equipment**
  - **6000 employees**

SkyScan X-ray Microscopes
Bruker USA

Bruker AXS LLC USA

- **Sales, Service & Training Center Headquarters**
- **XRM Demo Lab**
- **1 SkyScan 1275 & 1 SkyScan 2214**
- **1 XRM Scientist; Direct Ties To Kontich, Belgium**

Supporting the countries:
USA, Puerto Rico, U.S. Virgin Islands, Canada

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Sales = 2
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5465 East Cheryl Parkway
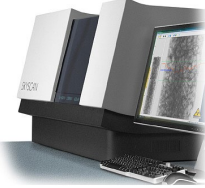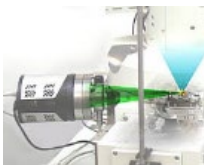Madison, WI 53711-5373, USA

SkyScan X-ray Microscopes
SkyScan XRM Evolution

1997 SkyScan 1072

2001 SkyScan 1076

2005 SkyScan 1172, 1178, 2011

2007 SkyScan 1174

2008 SkyScan 1173 SEM-CT

2010 SkyScan 1176

2011 SkyScan 2140

2013 SkyScan 1272 CCD

2014 SkyScan 1278, 2211

2016 SkyScan 1275, 1276

SkyScan X-ray Microscopes
SkyScan Current Models

2016 — SkyScan 1275
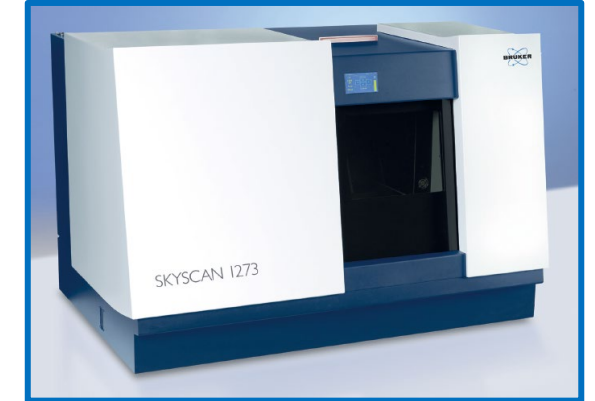
2018 — SkyScan 2214

2019 — SkyScan 1273

2022 — SkyScan 1272 CMOS

SkyScan X-ray Microscopes
SkyScan Current Models

BRUKER

Cone-Beam Geometry

When X-rays pass through an object the intensity is reduced by absorption proportional to the average atomic number along the trajectory.

In traditional radiography the resulting projection image visualizes the intensity reduction inside a 3D object as a 2D projection.

By taking projection images at many different rotation angles the full 3D information can be slice-wise retrieved through a mathematical process called backprojection. Computed tomography enables the reconstruction of the complete 3D volume.

All SkyScans Use A Cone-Beam Geometry

3D X-ray Microscopy (3D XRM)

Detector

Sample

X-ray tube
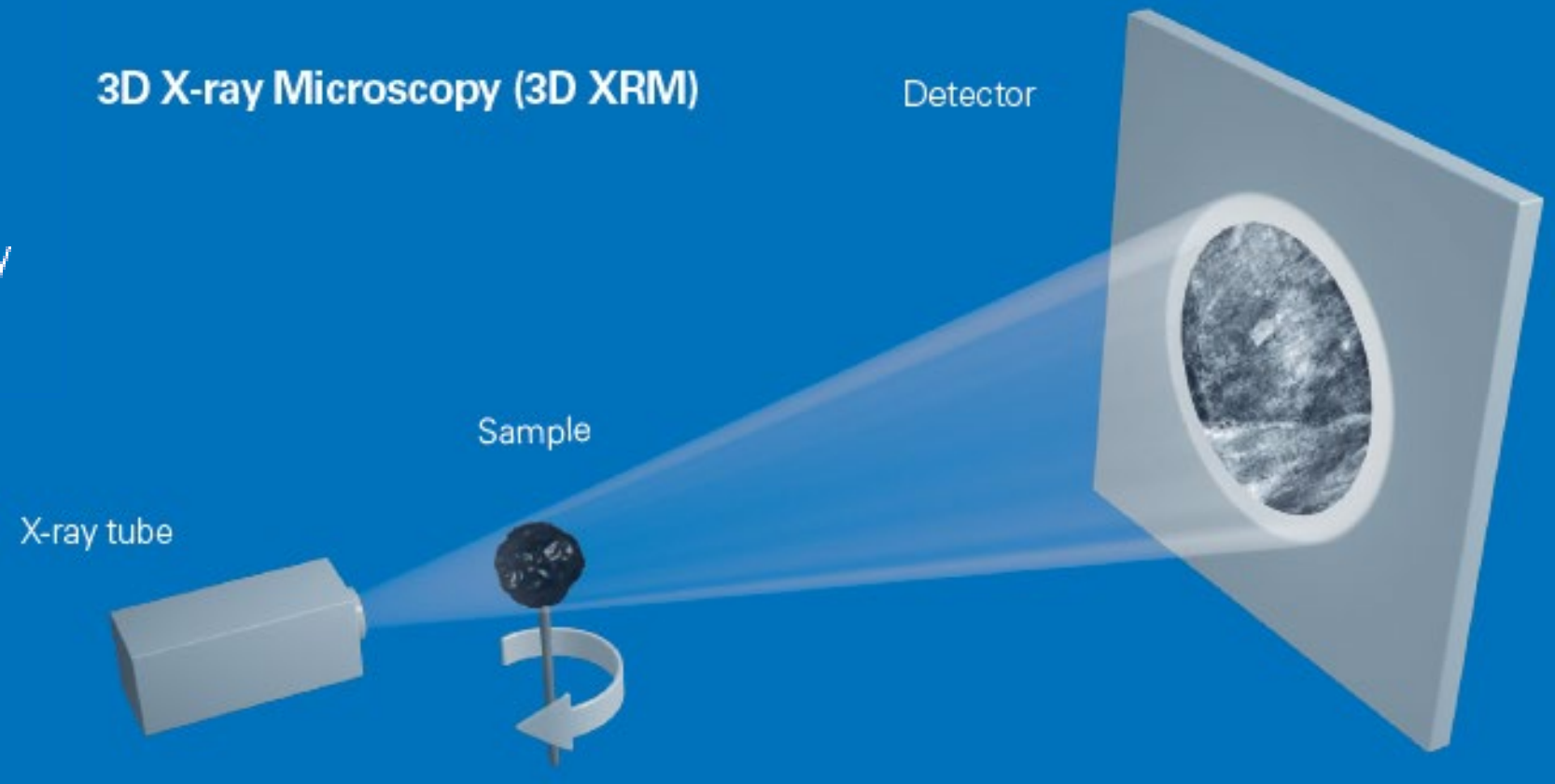
SkyScan X-ray Microscopes
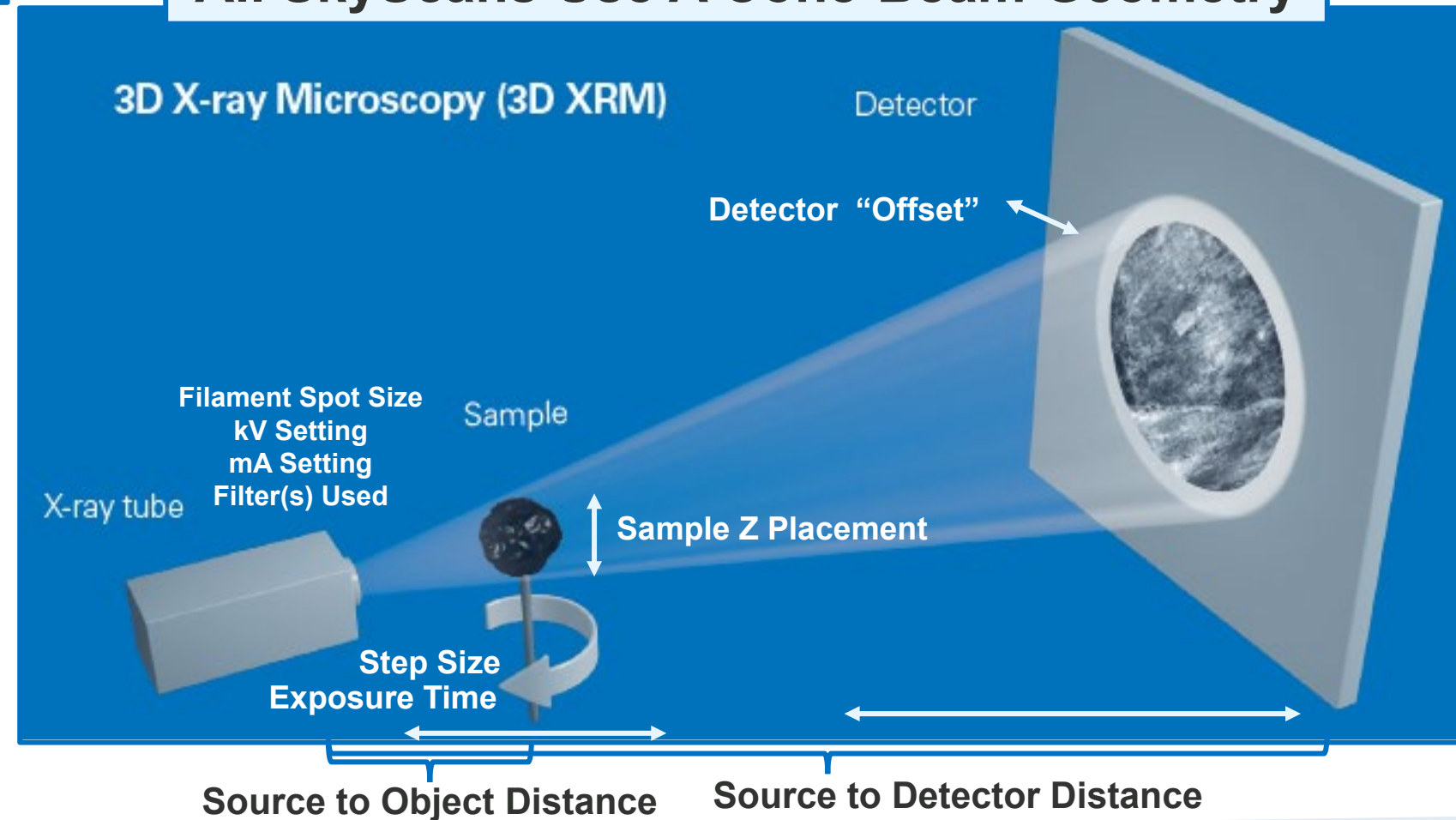## SkyScan Current Models

Cone-Beam Geometry

Potentially Adjustable Experimental Parameters

- **Source Spot Size**
- **Source kV & mA (Power W)**
- **Filter(s) In X-ray Beam**
- **Sample Rotation Step Size**
- **Sample Exposure Time**
- **Sample Z Placement**
- **SOD & SDD**
- **Detector Choice (Fixed Or Software Selectable)**
- **Detector Offset**

All SkyScans Use A Cone-Beam Geometry

3D X-ray Microscopy (3D XRM)

Detector

Detector "Offset"

Filament Spot Size
kV Setting
mA Setting
Filter(s) Used

Sample

Sample Z Placement

X-ray tube

Step Size
Exposure Time

Source to Object Distance

Source to Detector Distance

SkyScan X-ray Microscopes
Performance Characteristics

Cone-Beam Geometry

SOD
Source to Object Distance

SDD
Source to Detector Distance
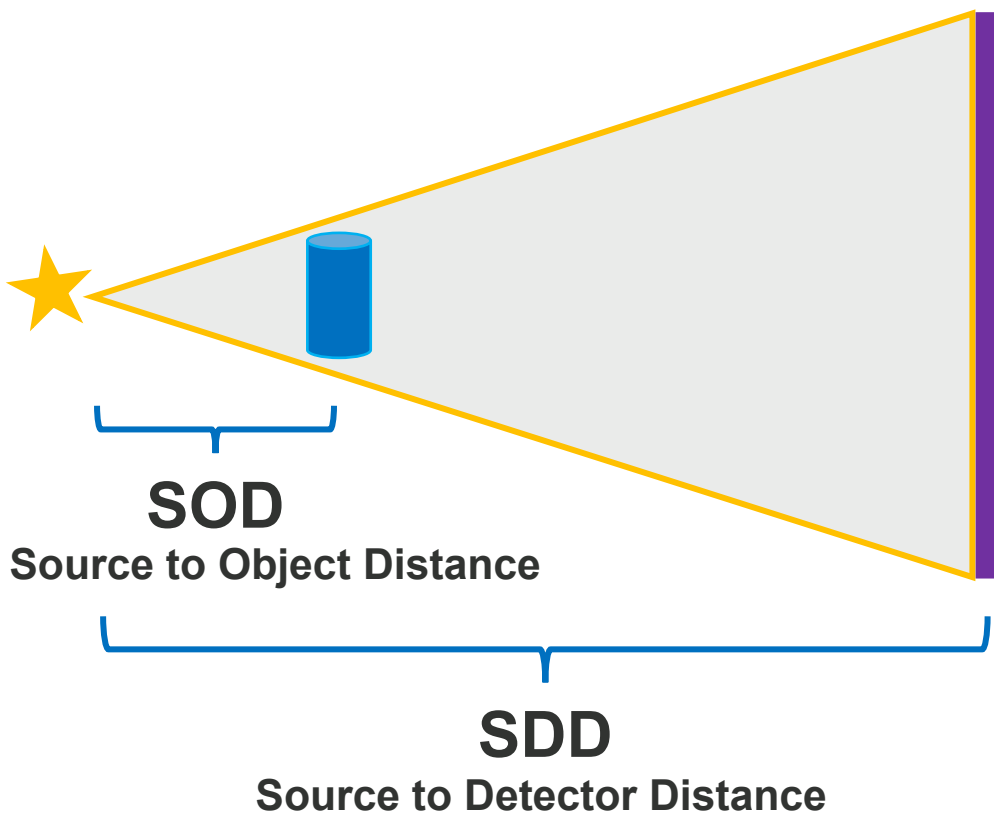
- Magnification = SDD / SOD
- Voxel Size = (Detector Pitch) / Magnification

- Example:
  - Detector Pitch (pixel size) = 18 μm
  - SOD = 10 mm
  - SDD = 300 mm
  - Magnification = 30X
  - Voxel Size = 0.6 μm

Voxel Size is the size of a voxel in a reconstructed dataset
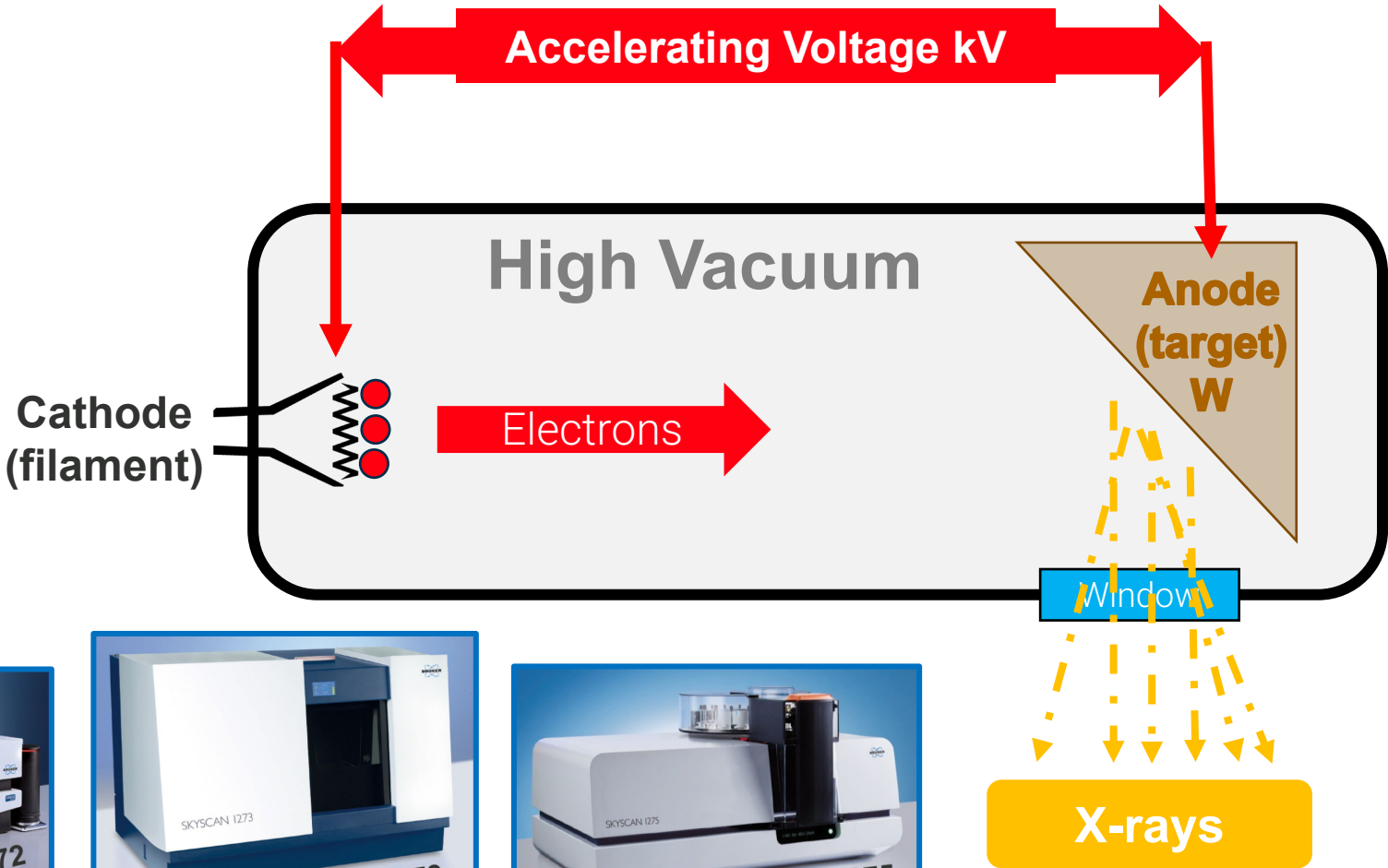
All SkyScans Use A Cone-Beam Geometry

SkyScan X-ray Microscopes Performance Characteristics

Sealed X-ray Source

- **Reflection Type Design**
- **Spot Size 4 - 5 μm**

Used In All SkyScan Benchtops
- **SkyScan 1272**
- **SkyScan 1273**
- **SkyScan 1275**

Accelerating Voltage kV

High Vacuum

Anode (target) W

Cathode (filament)

Electrons

Window

X-rays

SS1272

SS1273

SS1275

SkyScan X-ray Microscopes Performance Characteristics

Open X-ray Source

- **Transmission Type Design**
- **Smallest Spot Size 0.4 μm**

Accelerating Voltage kV

High Vacuum

Cathode (filament)

Electrons

Anode (W target)

X-rays

Window

SS2214

- **Replaceable Filaments**
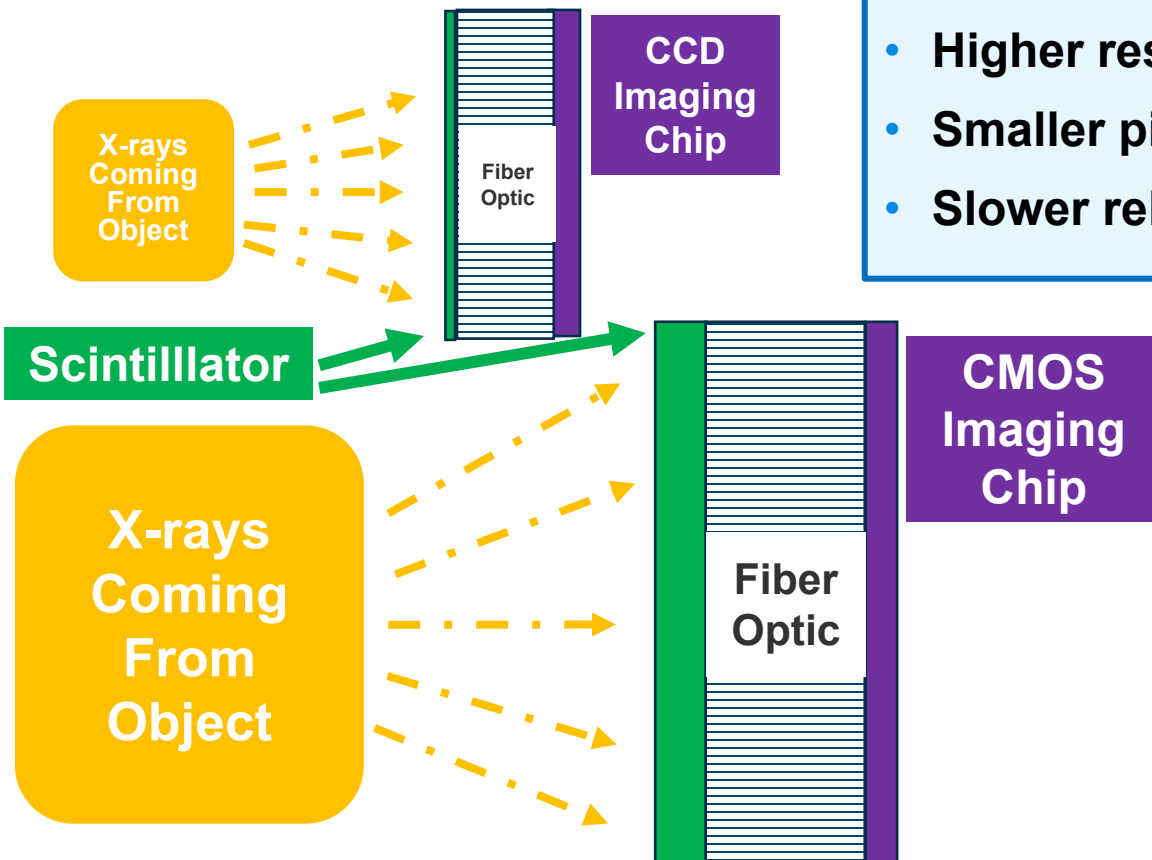- **Pre-Aligned W, 20 – 160 kV**
- **Pre-Aligned LaB$_6$ 20 – 100 kV**

Used Only In Floor Standing SkyScan 2214
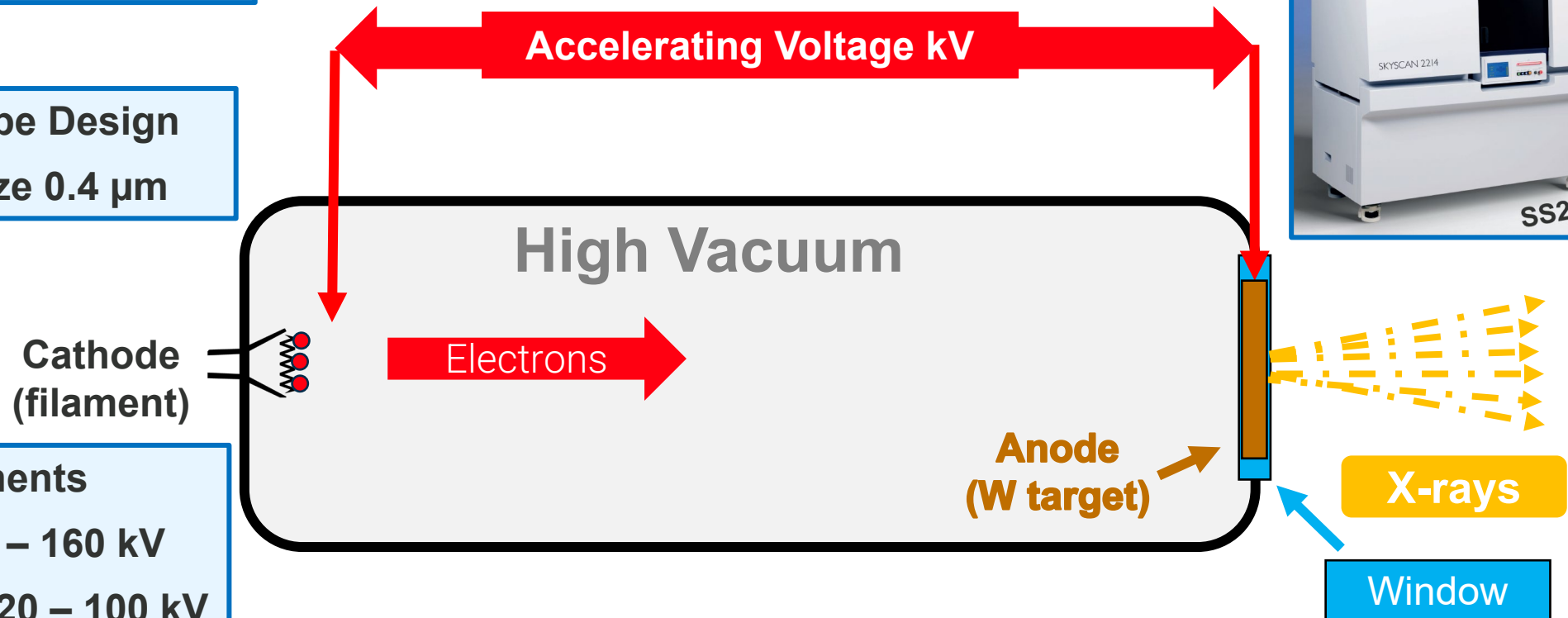
SkyScan X-ray Microscopes Performance Characteristics

Detectors, CCD & CMOS

X-rays Coming From Object

Fiber Optic

CCD Imaging Chip

Scintilllator

X-rays Coming From Object

Fiber Optic

CMOS Imaging Chip

CCD Detector

- Smaller active area
- Higher resolution
- Smaller pixels (4.5-18 µm)
- Slower relative to CMOS

sCMOS Detector

Scientific CMOS Detector

- Best of both worlds
- Higher resolution
- Smaller pixel (9 µm)
- Fast like regular CMOS

CMOS Detector

- Larger active area
- Lower resolution
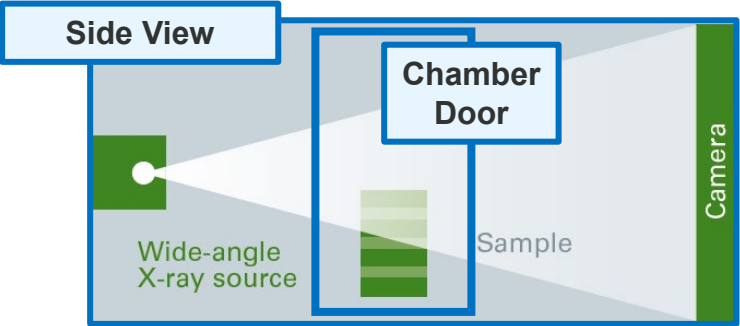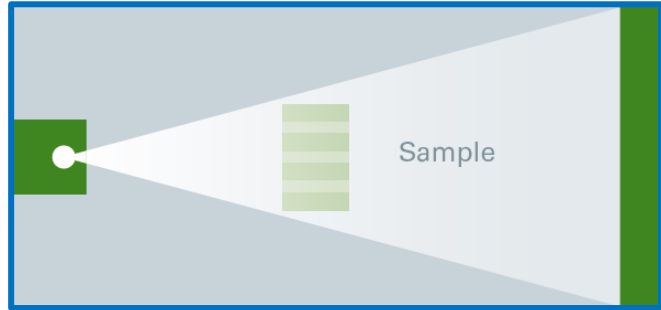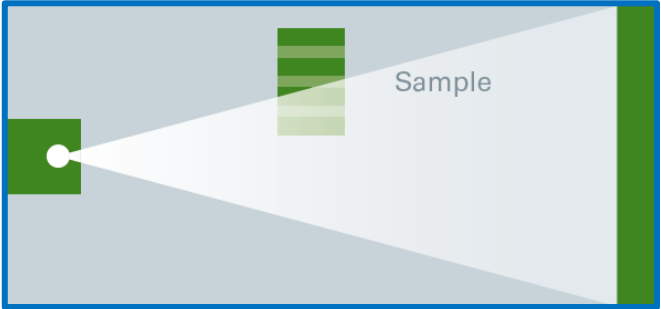- Larger pixels (75-100 µm)
- Faster relative to CCD

SkyScan X-ray Microscopes Performance Characteristics

Helical Scanning

Improves Image Quality For Planar Structures Perpendicular To The Sample Scanning Rotational Axis

Included With
- SkyScan 1273
- SkyScan 1275
- SkyScan 2214

Sample

Sample

Side View

Chamber Door

Camera

Wide-angle X-ray source

Sample

Rotating & moving along the rotation axis during the scan

SS1273

SS1275

SS2214

SkyScan X-ray Microscopes Performance Characteristics

Image Slices

HART Plus

X-rays From Source

High Aspect Ratio Tomography Plus

Included With
- SkyScan 1273
- SkyScan 2214

Top-Down View

HART Plus Variable Rotation Step

Chamber Door

Insufficient Resolution

Standard Fixed Rotation Step

Oversampled

Small Fixed Rotation Step

SS1273

SS2214
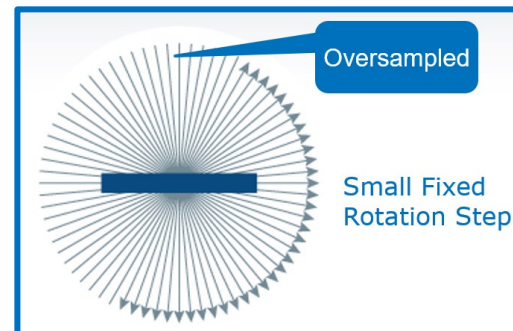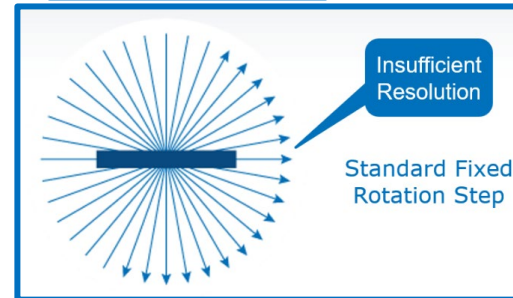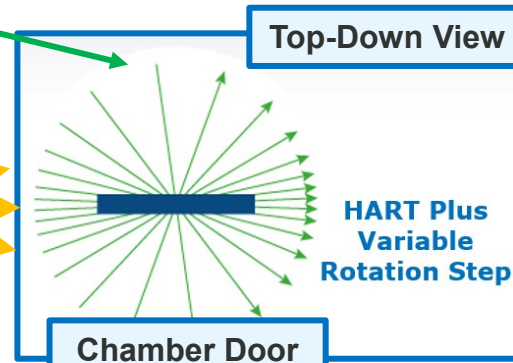
HART Plus

- **Variable rotation step enables up to 4x faster scanning with great resolution**
- **NRECON2 detects HART Plus mode & automatically selects the optimized reconstruction algorithms**

SkyScan X-ray Microscopes
Performance Characteristics

Variable SOD & SDD
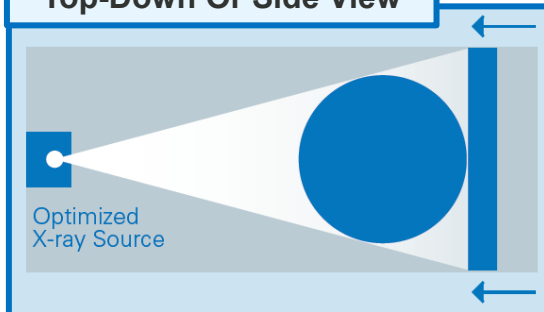
Magnification = SDD/SOD

Optimized Conditions
- Highest Intensities
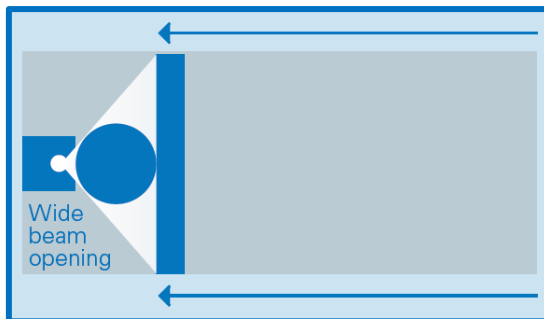- Best Magnification
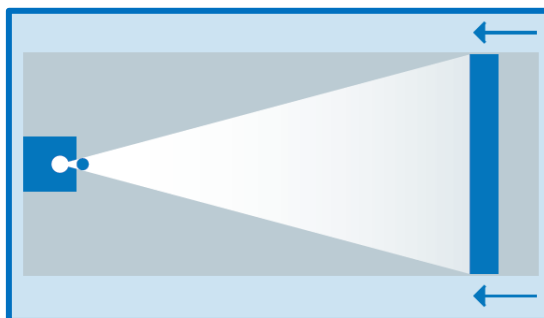- Shortest Measurement Times

Included With
- SkyScan 1272
- SkyScan 2214

Top-Down Or Side View

Optimized X-ray Source

Large sample with low magnification

SS1272

Wide beam opening

Medium-size sample with medium magnification

SS2214

Small sample with high magnification

SkyScan X-ray Microscopes Performance Characteristics

Sample Changer Option

Fully Automatic

- Status Display Of All 16 Samples
- All Types Of Samples In The Same Tray
- Automatic Or User Selected Measurement Parameters

Available With

- SkyScan 1272
- SkyScan 1275

Easy installation – quickly mounts on top of the SkyScan

Change samples at any time, without interrupting an ongoing scan

Up to 16 samples

A random combination of large & small samples possible

SS1272

SS1275

SkyScan X-ray Microscopes Performance Characteristics

Stage Options
- Cooling
- Heating
- Materials Testing

Available With
- SkyScan 1272
- SkyScan 1273
- SkyScan 1275
- SkyScan 2214

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.

+ 85 °C To -40 °C

SS1273

SS1272

SS1275

SS2214
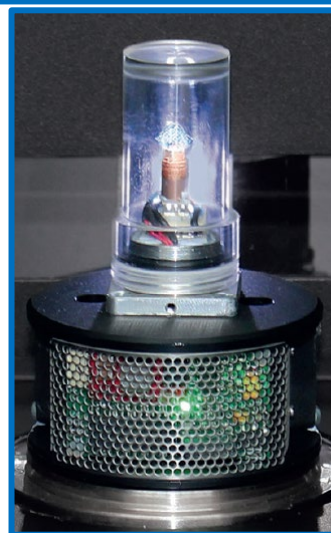
SkyScan X-ray Microscopes Performance Characteristics
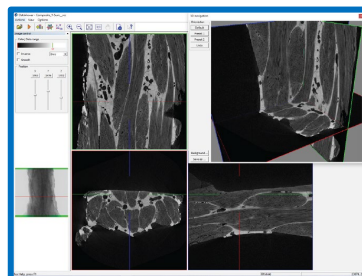
3D.SUITE Software

NRECON2

Reconstruction with NRECON readily transforms the 2D projection images into 3D volumes thanks to the supersonic GPU acceleration, no matter how large the image size. Advanced phase retrieval algorithms can reveal features that would remain hidden when using only standard absorption contrast.

Included With
- **SkyScan 1272**
- **SkyScan 1273**
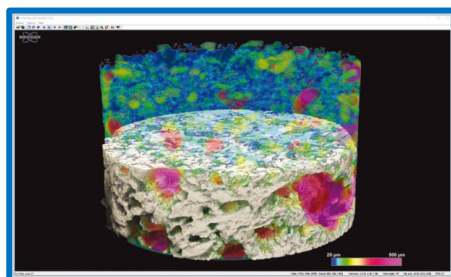- **SkyScan 1275**
- **SkyScan 2214**

3D Inspection with DATAVIEWER

- Display reconstructed results as slice-by-slice movies or three orthogonal projections
- Smoothing, linear and non-linear grey scale transformations, color coding
- Differential image analysis between samples
- Exactly align multiple scans through image registration

3D Visualization with CTVOX and CTVOL

- Volume rendering to display reconstructed results as a realistic 3D object
- Create animated movies flying around or through the object
- Produce cut-away views
- Adjust coloring and transparency
- Export surface rendered models in STL format to 3D printers or to 3D CAD software
- Modelling using mobile devices

3D Image analysis with CTAN

- Handles large data sets with ease
- Open/closed porosity
- Thickness and separation
- Fiber orientation
- Density analysis
- 3D distances and angles
- Extensive tool set for region-of-interest selection
- Various thresholding methods, morphological operations, and filtering algorithms
- Color coding of local orientation, thickness and separation
- Automated batch analysis

SkyScan X-ray Microscopes
Performance Characteristics

Genius-Mode

1. Moving to the **Best-Scan-Geometry™**

2. Finding the **Best-X-ray-Energy-Window™**

3. Starting with the **Best-Scan-Conditions™**

Variable SOD & SDD

Thanks to SKYSCAN 1272 CMOS' movable camera and its extra large X-ray beam opening, Genius-Mode finds the Best-Scan-Geometry – as compact as possible with the largest magnification – automatically. **1**

To find the perfect X-ray energy window, SKYSCAN 1272 CMOS automatically checks which of the six filters and X-ray energy best fits the sample's density in order to achieve the optimal image contrast. **2**

Fully Automated

Simply load the sample changer, select "Auto" protocol, and then let the system take care of the rest! All scan settings are defined using Genius-Mode. Feel confident that your work is being done – anytime – with system-generated reports emailed directly to your inbox, including a link to access data remotely.

Included With
- SkyScan 1272 **1** **2** **3**
- SkyScan 1273 **2** **3**

The SKYSCAN 1272 CMOS operating in Genius-Mode selects the best exposure time and rotation step automatically. **3**

SkyScan X-ray Microscopes
Performance Characteristics


Press once to start Push-Button-CT

Automated reconstruction & 3D visualization

SS1275

Ultimate simplicity with Push-Button-CT™

Just insert a sample, manually or automatically, and get a complete 3D volume without any further interaction. Push-Button-CT includes everything: automatic sample size detection, sample scanning, 3D reconstruction, and 3D volume rendering. Combine it with a sample changer and SKYSCAN 1275 even works 24/7.

Included With
- **SkyScan 1275**
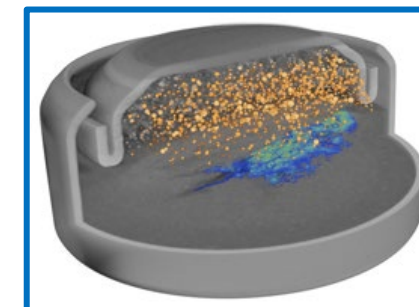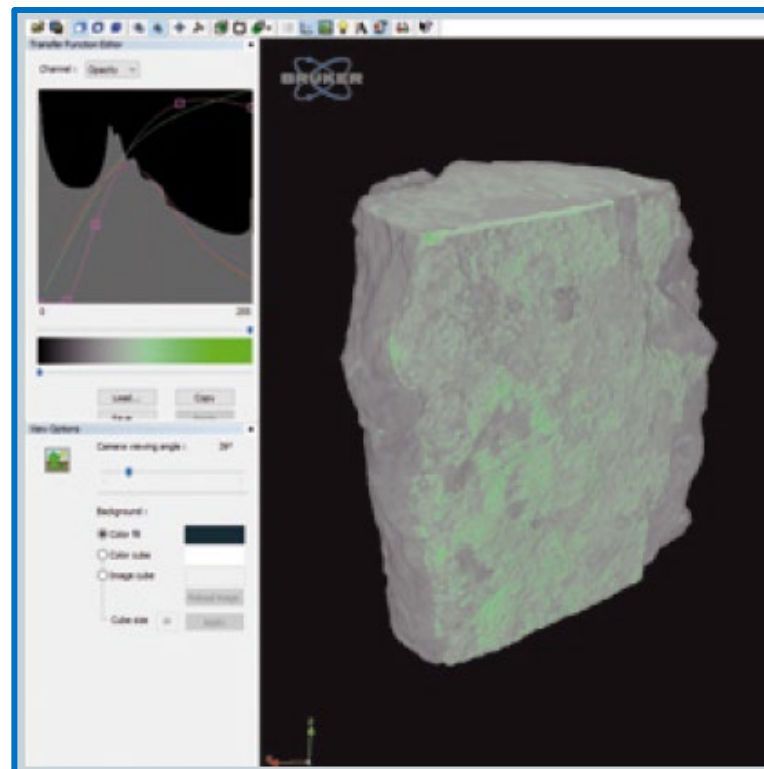
SkyScan X-ray Microscopes Performance Characteristics

Detector Choice Software Selectable

SkyScan Model & Detector	Minimum Voxel Size
SS2214 CCD1	<0.06 µ
SS2214 CCD2	<0.12 µ
SS2214 CCD3	<0.25 µ
SS2214 CMOS FP	<1.2 µ

Included With
- SkyScan 2214

SkyScan X-ray Microscopes
Performance Characteristics

SS1272

Technical Data	
X-ray Source	40 – 100 kV, up to 10 W
X-ray Detector	16 Megapixel sCMOS camera 4 096 x 4 096 pixels
Reconstructed Slice Format	Up to 11 200 x 11 200 pixels
Resolution	Voxel size < 0.45 micron 3D spatial resolution < 5 micron
Max. Object Dimensions	Up to ∅ 75 mm Up to height 80 mm

System Dimensions (W x H x D)	116 cm x 52 cm x 33 cm, 150 kg 116 cm x 52 cm x 44 cm, 155 kg (with sample changer)
Power supply	100 – 240 VAC, 50 – 60 Hz, 3 A

Front

Right

116 cm

52 cm

44 cm

33 cm

SKYSCAN 1272

Sample changer

150 kg

5 kg

SkyScan X-ray Microscopes
Performance Characteristics

SS1273

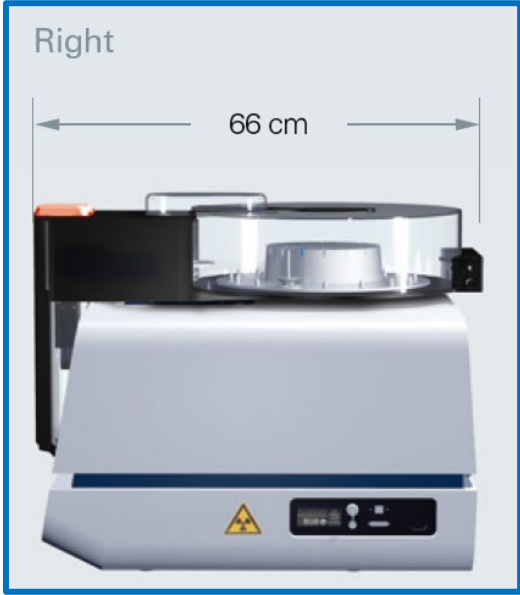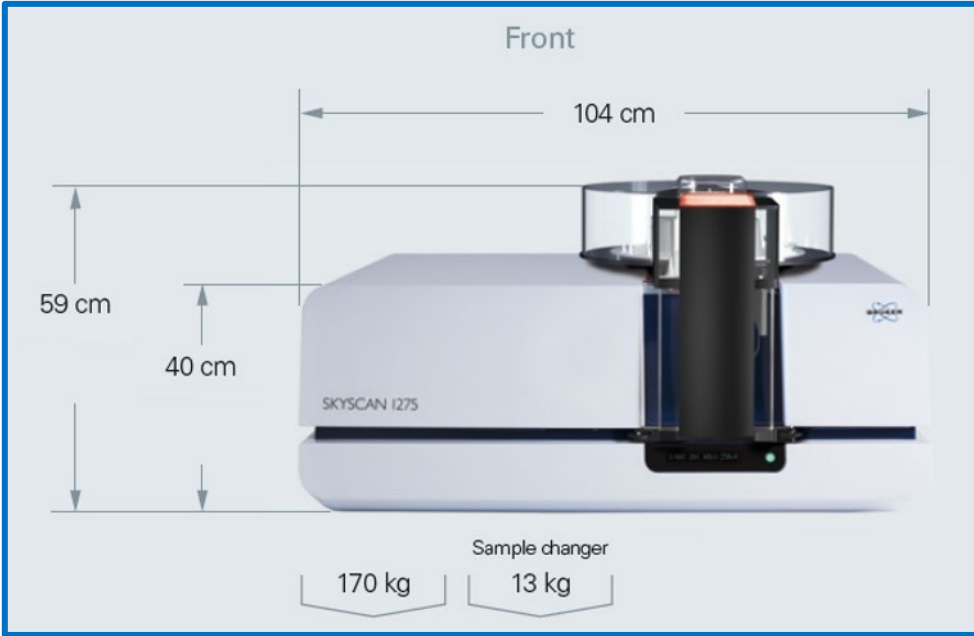| Technical Data	
X-ray Source	40…130 kV, up to 39 W
X-ray Detector	6 Megapixel CMOS flat-panel detector 3072 x 1944 pixels
Reconstructed Slice Format	Up to 4800 x 4800 pixels
Resolution	Voxel size < 3 µm 3D spatial resolution < 5 µm
Max. Object Dimensions	Up to 300 mm in diameter and 500 mm in length Up to 20 kg
Max. Scanned Volume	Up to 250 mm in diameter and 250 mm in length

System Dimensions (W x H x D)	1250 mm x 815 mm x 820 mm 400 kg
Power supply	100 – 240 VAC, 50 – 60 Hz, 3 A

1250 mm

815 mm

SKYSCAN 1273

400 kg

820 mm

SkyScan X-ray Microscopes
Performance Characteristics

SS1275

	Specification
X-ray source	20 – 100 kV, 10 W < 5 µm spot size at 4 W
Nominal resolution (pixel size at maximum magnification)	< 4 µm
X-ray camera	3 MP 1,944 x 1,536 px active pixel CMOS flat panel
Reconstructed volume (after round trajectory scan)	up to 1,944 x 1,944 x 1,160 px
Sample size	SKYSCAN 1275 Max. height 120 mm, max. Ø 96 mm

Dimensions (W x D x H)	SKYSCAN 1275 104 cm x 66 cm x 40 cm 104 cm x 66 cm x 59 cm, with sample changer

Front

104 cm

59 cm

40 cm

SKYSCAN 1275

Sample changer

170 kg   13 kg

Right

66 cm

SkyScan X-ray Microscopes
Performance Characteristics

SS2214

Technical Data

X-ray Source	Open (pumped) type with diamond window 20-160 kV, **16 W max.**
X-ray Detector(s)	6 Mp active pixel flat-panel 11 Mp large format cooled CCD 11 Mp mid format cooled CCD 8 Mp hi-res cooled CCD
Image Formats	Up to 8000 x 8000 x 2300 pixels after a single scan
Spatial Resolution	60 nm smallest pixel size, <500 nm low-contrast resolution (10% MTF)
Positioning Accuracy	<50 nm for rotation, anti-vibration granite platform with pneumatic leveling
Maximum Object Size	300 mm in diameter (140 mm scanning size), 400 mm in length, maximum object weight 25 kg
Radiation Safety	<1 μSv/h at any place of the instrument surface

System Dimensions

1800 mm

950 mm

1680 mm

SKYSCAN 2214

1500 kg

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Attributes

- **Sealed X-ray Source**
- **Scientific CMOS Detector**
- **Variable SOD & SDD**
- **Sample Changer Option**
- **Genius-Mode Operation**
  1 **2** **3**
- **3D.Suite Software With 25 User License**
- **Detector Choice Fixed**

Clean Image Scan Technology

Plug'n Analyze

No Water Supply

Single-phase Power

Small Footprint

SKYSCAN 1272

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Its state-of-art 16 megapixel scientific CMOS X-ray detector provides high-contrast images with superior resolution. The extended detector field of view and enhanced sensitivity for X-rays result in up to two times faster scan speed. The extraordinary native resolution of up to 11 200 x 11 200 pixels per slice allows zooming into any part of the 3D volume without rescanning the sample. The new **Clean Image™** scan mode significantly reduces typical CT artefacts right from the start, thus providing great quality images without cumbersome a posteriori corrections.

FFP2 mask, color-coded fiber orientation

Polymers & Composites

- Resolve fine structural details
- Assess the microstructural architecture
- Evaluate local fiber orientation, fiber-to-fiber distance and density
- Investigate microstructural changes under tensile or compressive load
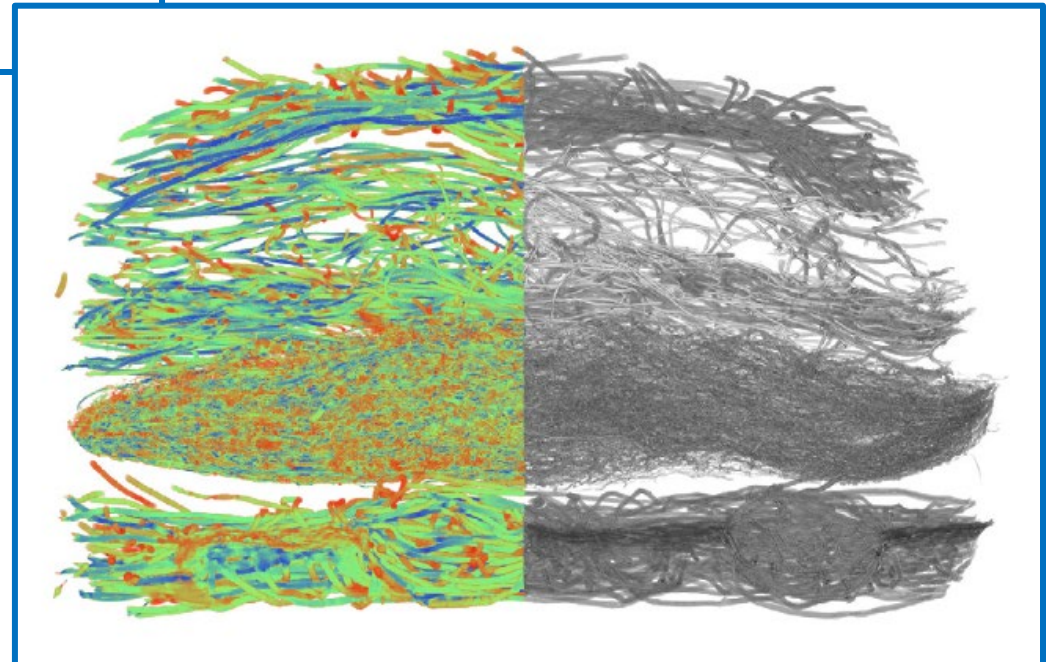
SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Pharmaceuticals & Packaging

- Measure coating thickness and distribution of API's
- Check mechanical properties and defects
- Investigate pharmaceutical packaging up to a size of 7 cm x 7 cm x 8 cm
- Monitor and control the quality of metal and plastic components

Pharmaceutical tablet, color-coded coating thickness and visualization of pore distribution (blue)
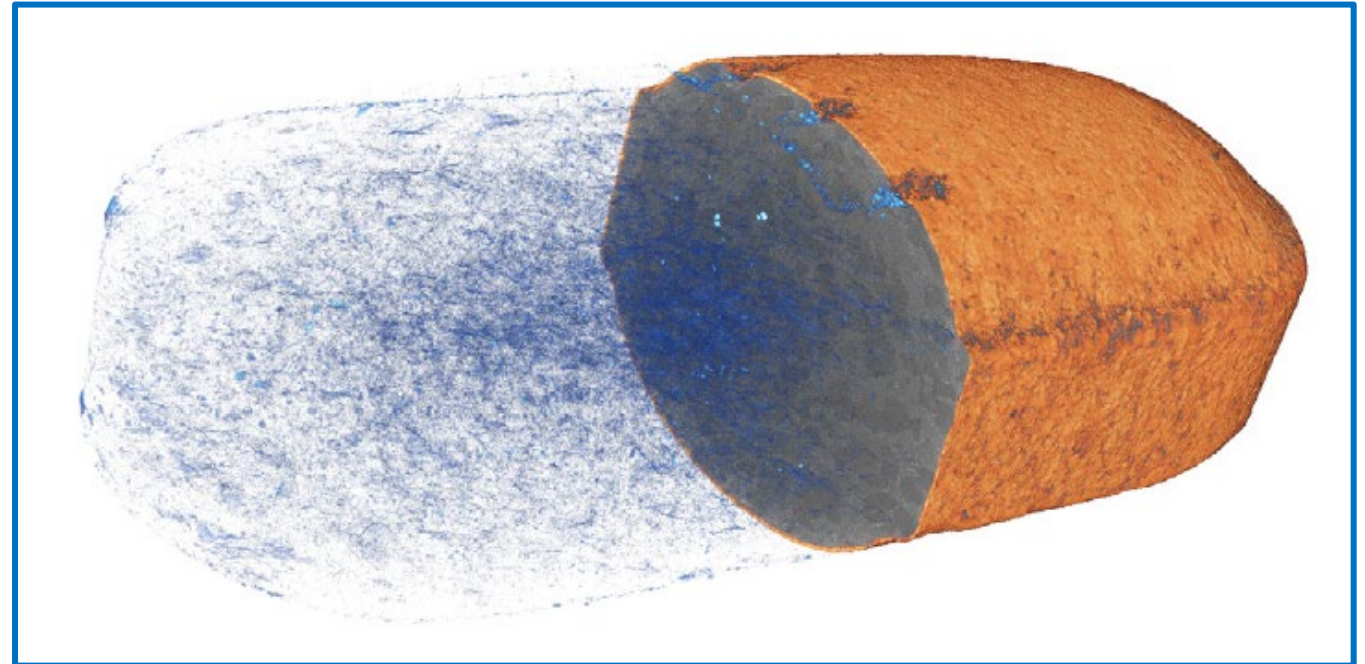
SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Food

- Assess the microstructural architecture
- Evaluate porosity and wall thickness
- Investigate food packaging up to a size of 7 cm x 7 cm x 8 cm
- Investigate microstructural changes under non-ambient conditions

Deep fried chips, showing distribution of oil-filled pores (red) and unfilled pores (blue)
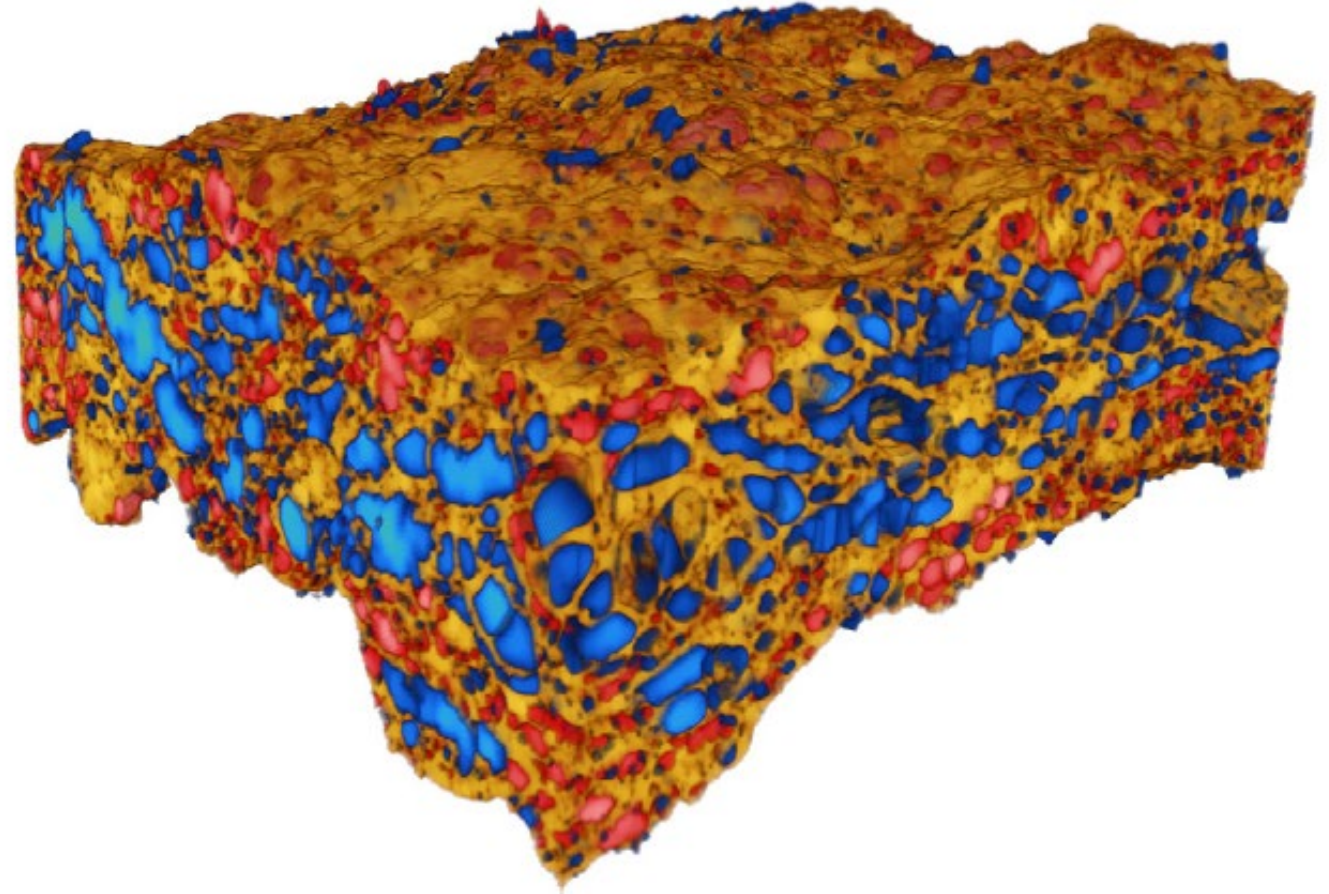
SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Other Materials

- Quantify porosity, pore network, and local thickness in 3D
- Apply in-situ analysis of mechanical properties and dynamic processes
- Detect inhomogeneities and deviations in the printing process
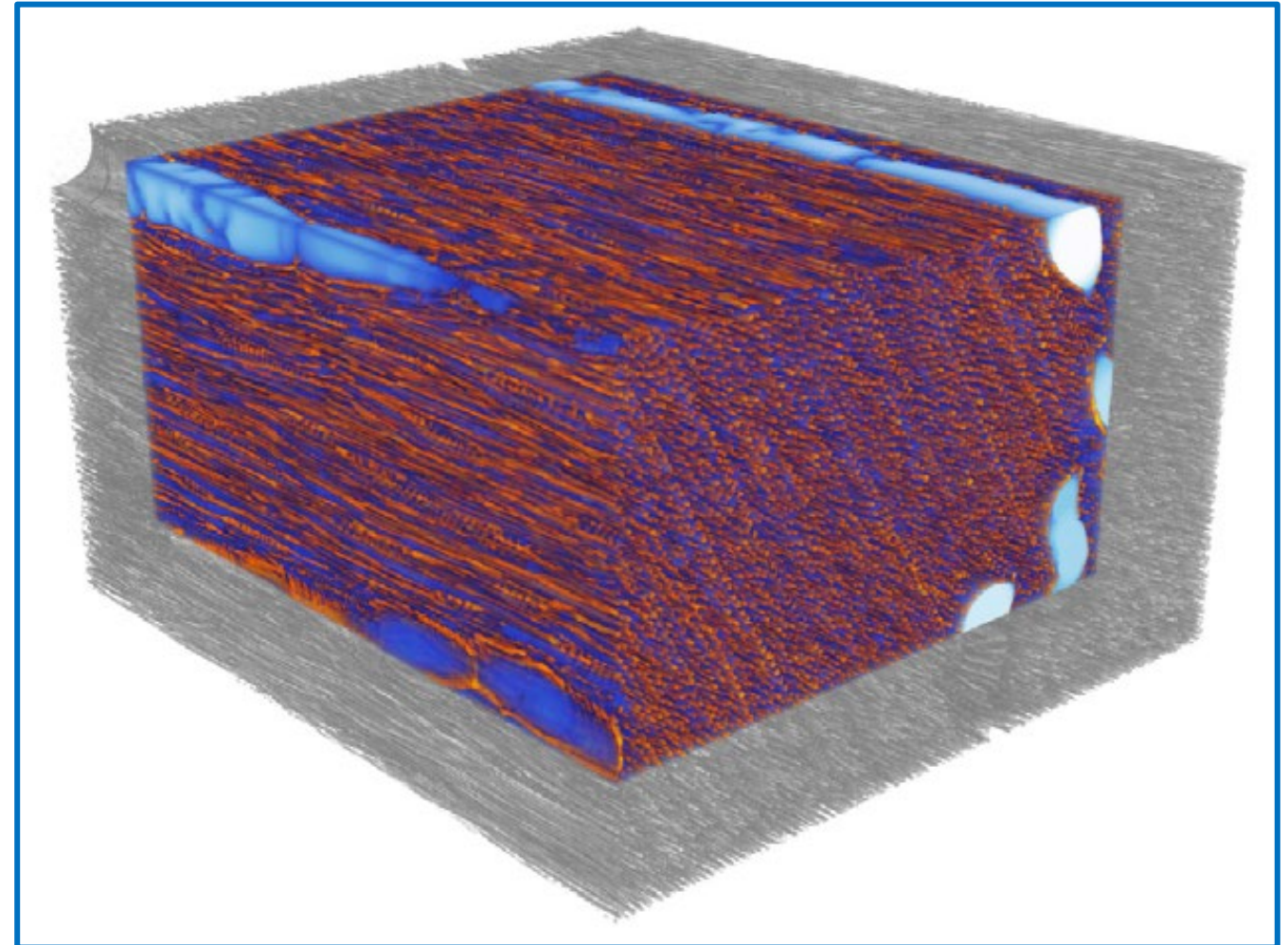
Hartwood, color-coded structure thickness (red) and separation (blue) distribution

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Projection image of an open Ti structure made with additive manufacturing. The complete structure fits in the field of view of the CMOS detector (blue), whereas the smaller field of view of the CCD detector (red) would require an oversize scan.

**Performance Comparison
SkyScan 1272 CCD
versus
SkyScan 1272 CMOS Edition**

The SKYSCAN 1272 CMOS operating in Genius-Mode selects the best exposure time and rotation step automatically.
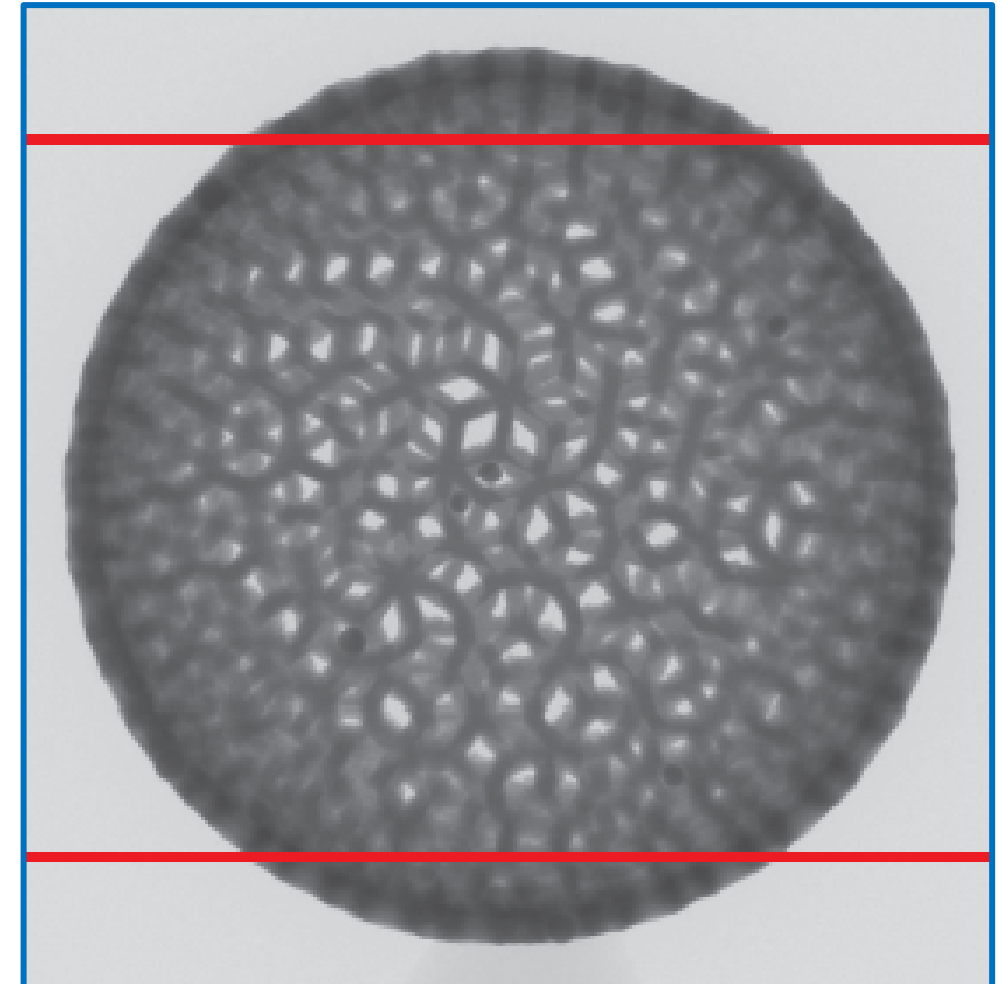
SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Several factors affect the true 3D spatial resolution: the focal spot size of the X-ray source, the acquisition geometry, the overall system stability, the mechanical accuracy of the rotation axis, as well as the reconstruction algorithms. The 3D spatial resolution is determined with special phantom structures after reconstruction. The SKYSCAN 1272 CMOS easily resolves better than 4 μm in both directions.

4 Micron

pattern of 1 to 10 μm structures

QRM — A PTW COMPANY

QRM-MicroCT-Barpattern-NANO

MicroCT Bar Pattern NANO Phantom

BarPattern NANO V2 - Redesigned Chip

Section 2

section	line thickness (μm)	linepairs / mm	points (μm)
A	2, 4, 6, 8, 10 (tilt 90°)	250 - 50	
B			2, 4, 6, 8, 10
C			2, 3, 4, 5
D	1, 2, 3, 4, 5	500 - 100	

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Genius-Mode

2. Finding the Best-X-ray-Energy-Window™

To find the perfect X-ray energy window, SKYSCAN 1272 CMOS automatically checks which of the ==six filters== and X-ray energy best fits the sample's density in order to achieve the optimal image contrast. **2**

Filter Settings

None, 0.25 mm Al, 0.5 mm Al, 1.0 mm Al, 0.5 mm Al + 0.038 mm Cu, 0.25 mm Cu
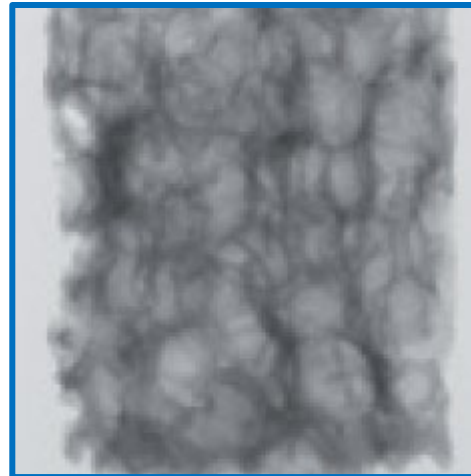
80 kV, Al 1 mm

Selected "Best Conditions" For High Magnification Image
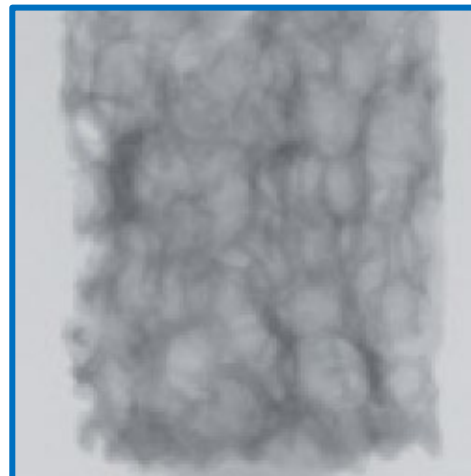
100 kV, Cu 0.25 mm

Selected "Best Conditions" For Low Magnification Image

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

SKYSCAN 1272 CMOS with sample changer can be operated in three ways:

Easy installation – just mount the sample changer on top of the scanner

Fully automatic

Simply load the sample changer, select "Auto" protocol, and then let the system take care of the rest! All scan settings are defined using Genius-Mode. Feel confident that your work is being done – anytime – with system-generated reports emailed directly to your inbox, including a link to access data remotely.

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

SKYSCAN 1272 CMOS with sample changer can be operated in three ways:

Change samples at any time, without interrupting an ongoing scan

User selected

Want more control? Individually adjust scan parameters for one, some, or all samples. Once all "Manual" protocols are defined, simply press "Start" to initiate the full batch.

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

SKYSCAN 1272 CMOS with sample changer can be operated in three ways:

Prior selection

Streamline the workflow using the "Previous" command to apply the last settings. Because the sample changer operates outside the shielded X-ray chamber, new samples can be easily placed without interrupting the scanning process.

Autodetection of new samples and status LEDs for every scan: ready, running, done

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

Fully Automated
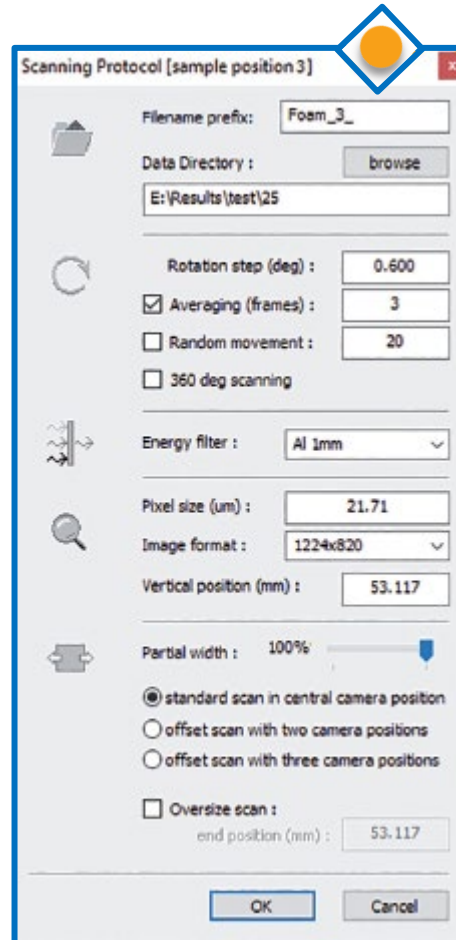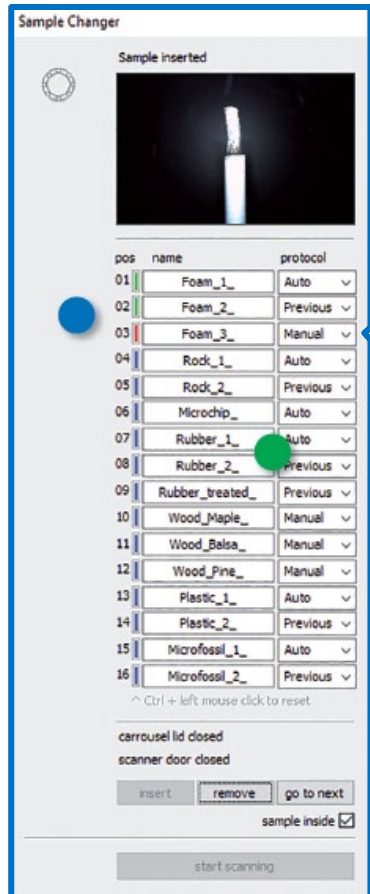
- 🔵 **Status display of all 16 positions**

- 🟢 **All types of samples in the same tray**
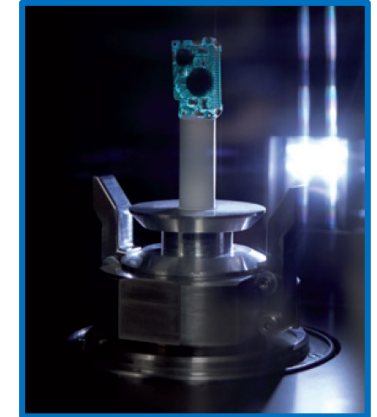
The optional automatic sample changer for SKYSCAN 1272 CMOS ==can handle up to 16 samples with different sizes (25 mm maximum object diameter, 40 mm maximum object length) and materials.== Four sizes of object mounts are supplied with the changer (16 pcs each size) that allow scanning of small samples at high magnification and large samples with a big field of view.

The sample changer is located outside the shielded area and all scanned samples can be removed or replaced at any time without interrupting the scanning process.

SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

3D.SUITE – a perfect match for SKYSCAN 1272 CMOS

Intuitive, simple, yet powerful – our 3D.SUITE software that comes with every SKYSCAN 1272 CMOS is designed to inspire finding out what's inside. With the help of Genius Mode, even a novice user can intuitively start scanning right away. Genius Mode automatically moves detector and sample to the optimum scan geometry, selects the appropriate filter and X-ray energy to achieve best image contrast, and optimizes exposure time and rotation step for efficient scanning.

Reconstruction with NRECON readily transforms the 2D projection images into 3D volumes thanks to the supersonic GPU acceleration, no matter how large the image size. Advanced phase retrieval algorithms can reveal features that would remain hidden when using only standard absorption contrast.

The images show a reconstructed slice through chips. When potato slices are deep fried, oil preferentially fills pores at the surface. With standard absorption contrast (left) it can be challenging to discern between oil-filled and unfilled pores. Applying a phase retrieval algorithm significantly enhances contrast (right).
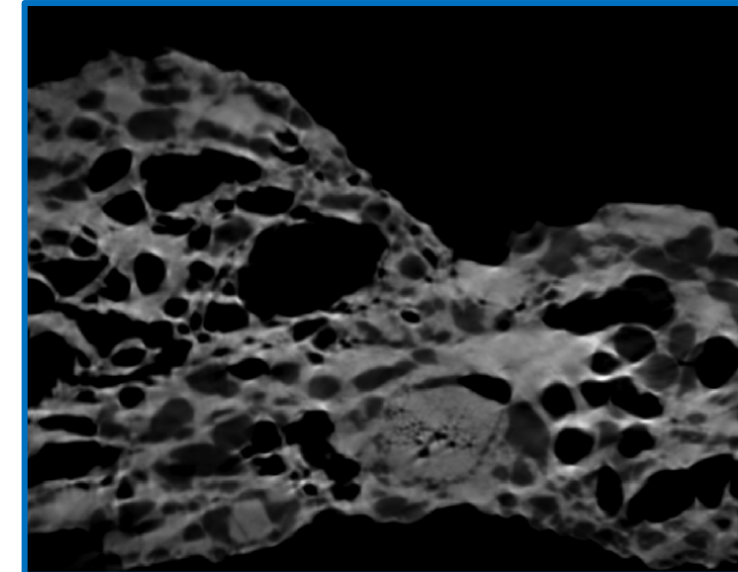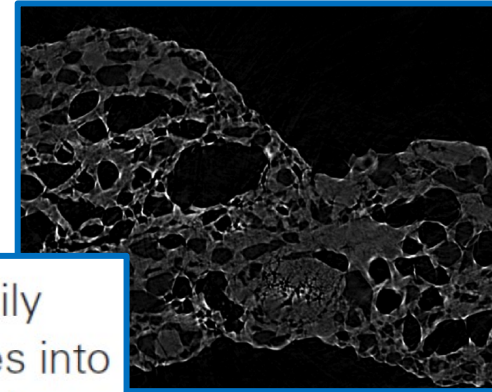
SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

SS1272

BRUKER

3D Inspection with DATAVIEWER

3 orthogonal projections through a CFRP composite

- Display reconstructed results as slice-by-slice movies or three orthogonal projections
- Smoothing, linear and non-linear grey scale transformations, color coding
- Differential image analysis between samples
- Exactly align multiple scans through image registration

Carbon Fiber

Reinforced Polymer
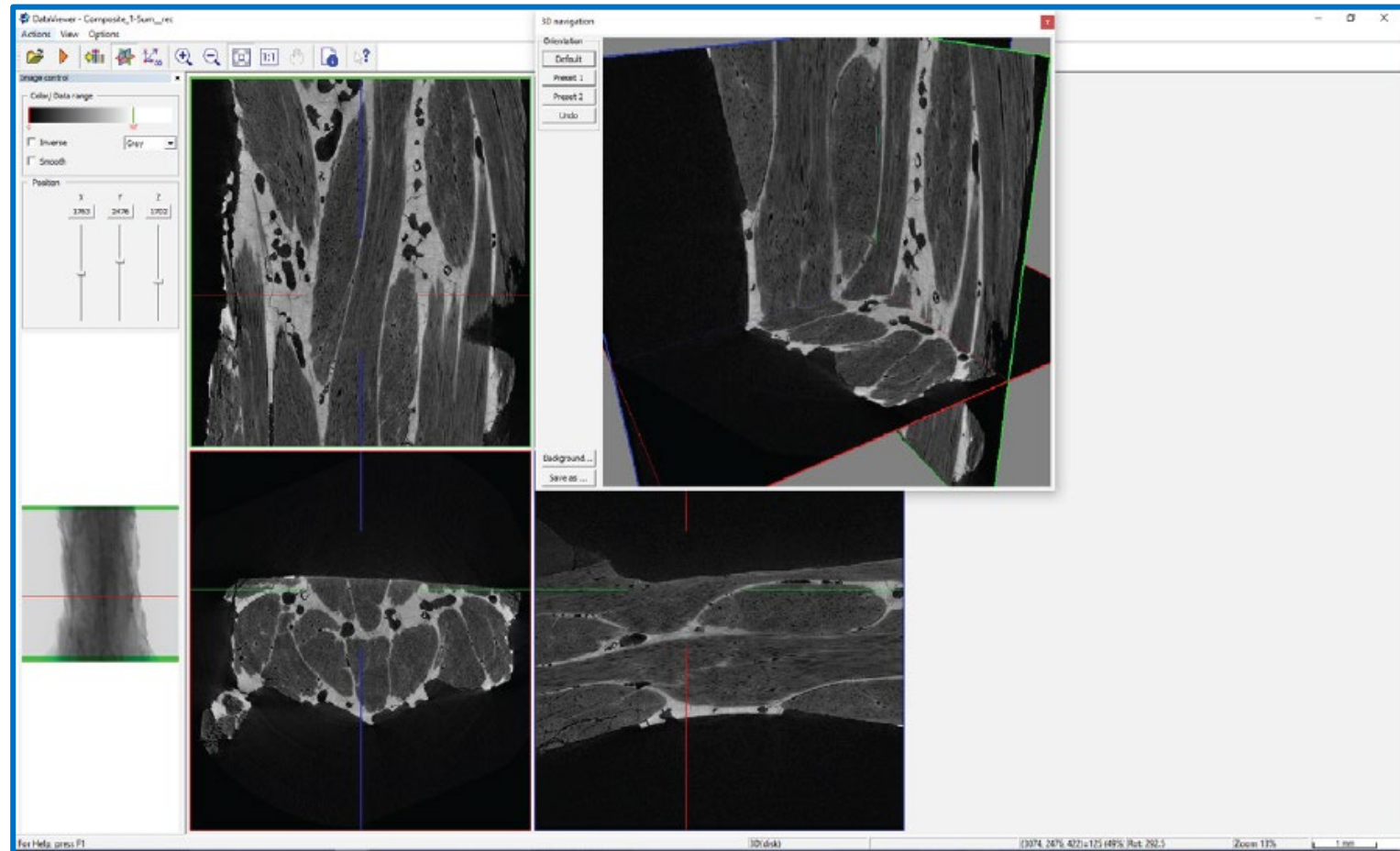
SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

3D Visualization with CTVOX and CTVOL

3D rendered volume of a hazelnut chocolate bonbon

- Volume rendering to display reconstructed results as a realistic 3D object
- Create animated movies flying around or through the object
- Produce cut-away views
- Adjust coloring and transparency
- Export surface rendered models in STL format to 3D printers or to 3D CAD software
- Modelling using mobile devices
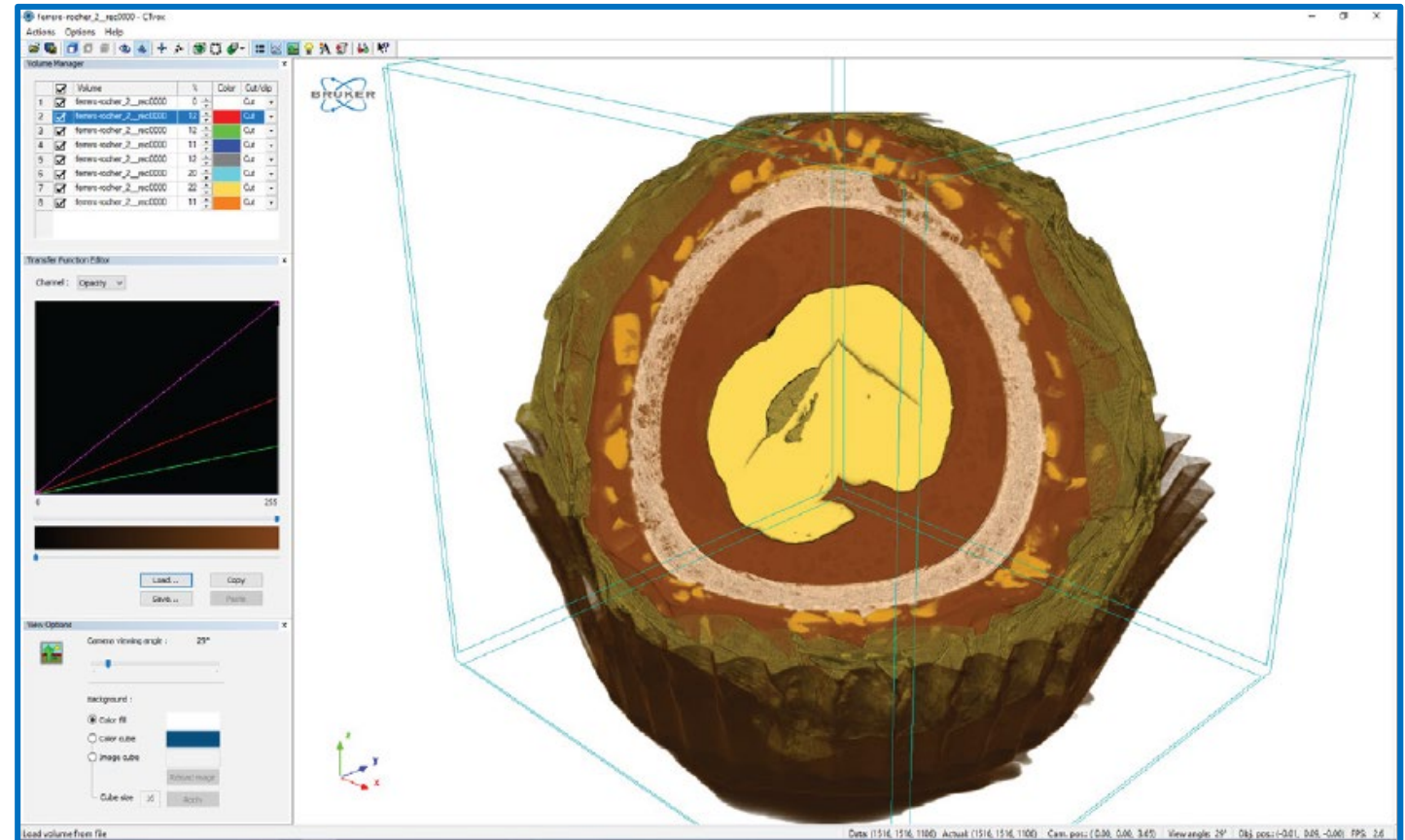
SkyScan X-ray Microscopes
SkyScan 1272 CMOS Edition

3D Image analysis with CTAN

- Handles large data sets with ease
- Open/closed porosity
- Thickness and separation
- Fiber orientation
- Density analysis
- 3D distances and angles
- Extensive tool set for region-of-interest selection
- Various thresholding methods, morphological operations, and filtering algorithms
- Color coding of local orientation, thickness and separation
- Automated batch analysis

Morphometry analysis of a coal sample

SkyScan X-ray Microscopes Performance Characteristics

SS1272

SS1272

Technical Data	
X-ray Source	40 – 100 kV, up to 10 W
X-ray Detector	16 Megapixel sCMOS camera 4 096 x 4 096 pixels
Reconstructed Slice Format	Up to 11 200 x 11 200 pixels
Resolution	Voxel size < 0.45 micron 3D spatial resolution < 5 micron
Max. Object Dimensions	Up to ∅ 75 mm Up to height 80 mm

System Dimensions (W x H x D)	116 cm x 52 cm x 33 cm, 150 kg
	116 cm x 52 cm x 44 cm, 155 kg (with sample changer)
Power supply	100 – 240 VAC, 50 – 60 Hz, 3 A

Front

Right

116 cm

52 cm

44 cm

33 cm

150 kg

Sample changer
5 kg

SkyScan X-ray Microscopes
SkyScan 1273

Attributes

- **Sealed X-ray Source**
- **CMOS Detector**
- **Variable SOD**
- **Helical Scanning**
- **HART Plus Scanning**
- **Genius-Mode Operation**
  - **2** **3**
- **3D.Suite Software With 25 User License**
- **Detector Choice Fixed**
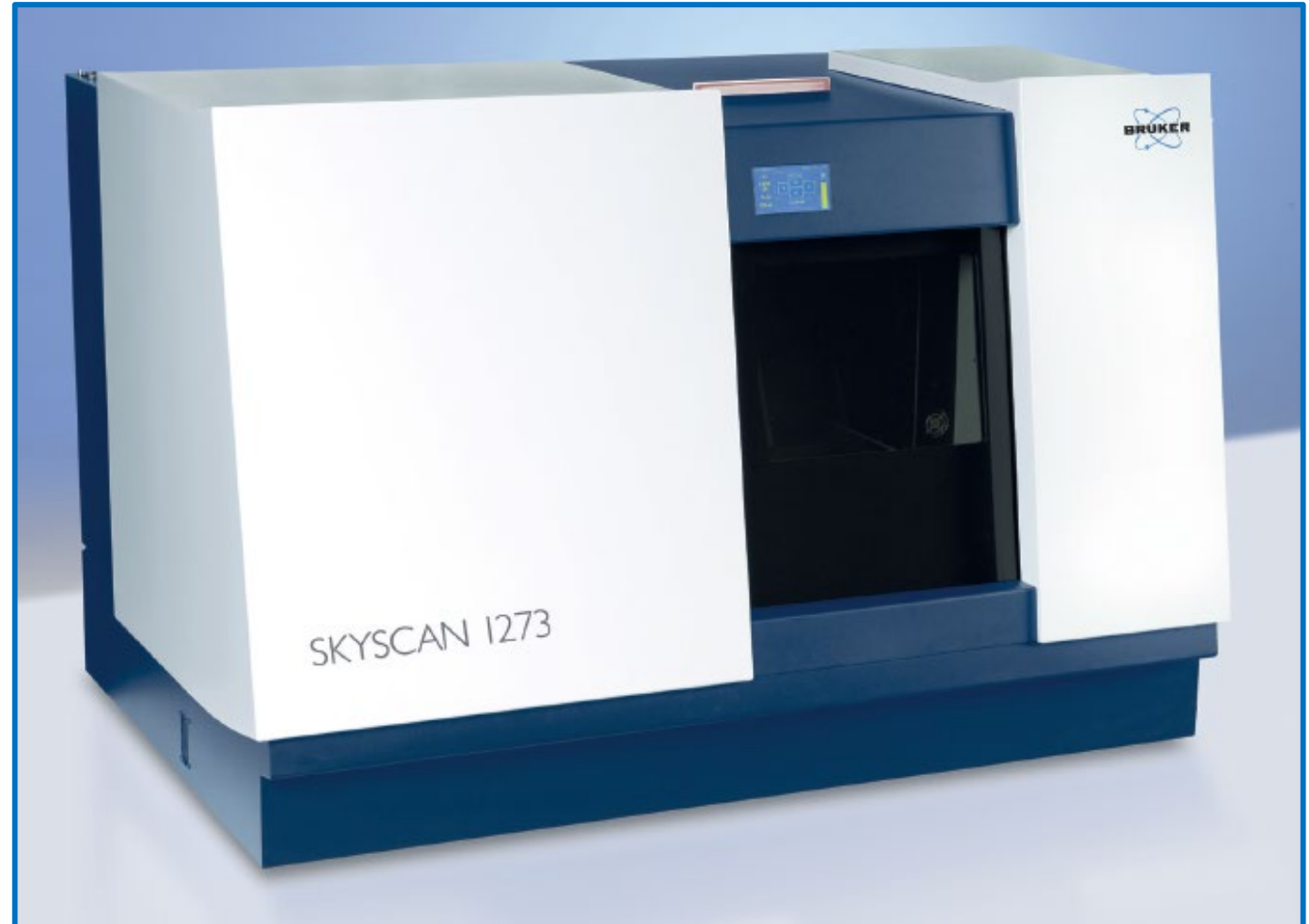
Plug'n Analyze

No Water Supply

Single-phase Power

Small Footprint

SkyScan X-ray Microscopes
SkyScan 1273

SS1273

Large chamber for mounting big samples and optional sample stages
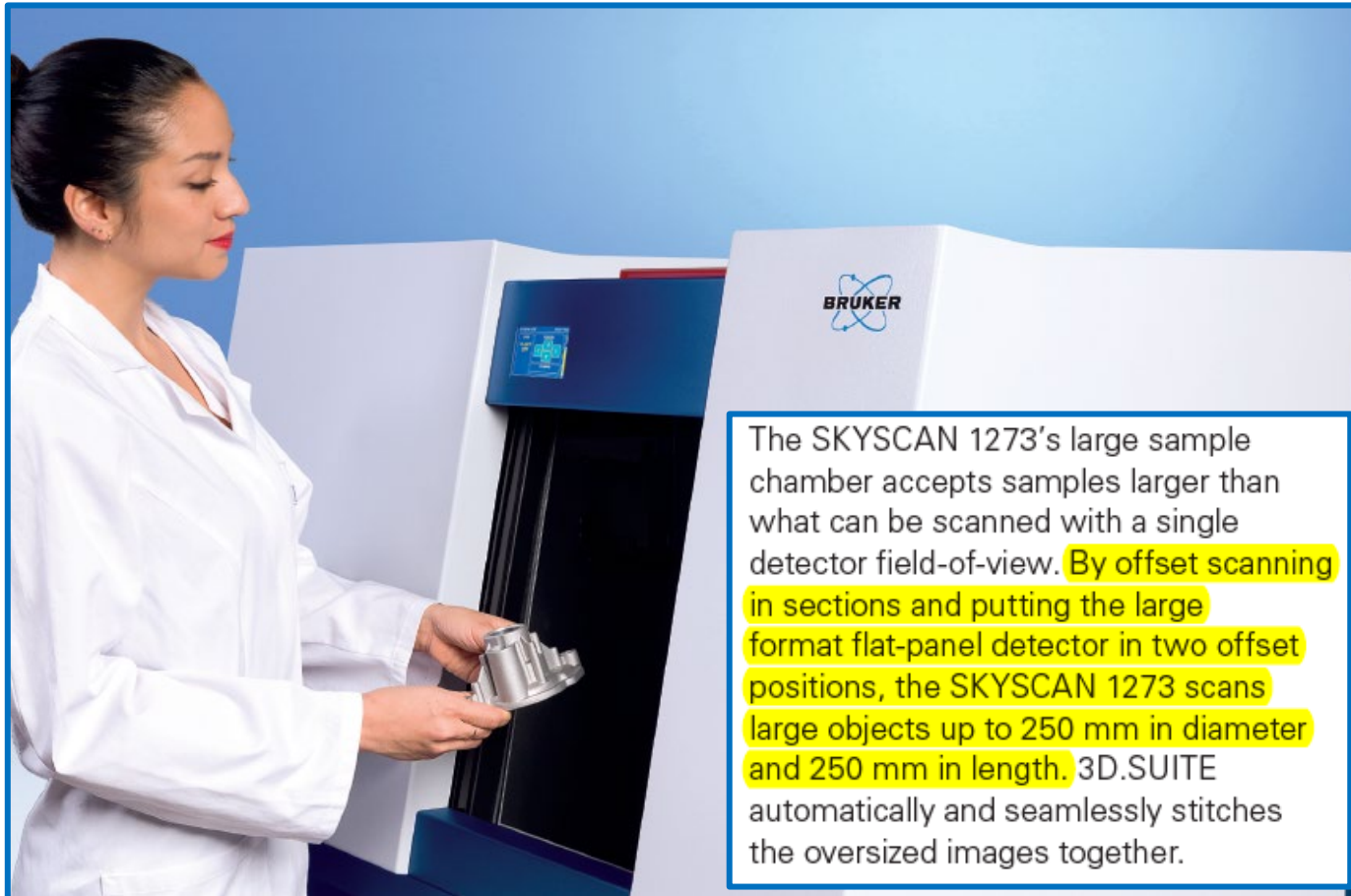
The SKYSCAN 1273's large sample chamber accepts samples larger than what can be scanned with a single detector field-of-view. By offset scanning in sections and putting the large format flat-panel detector in two offset positions, the SKYSCAN 1273 scans large objects up to 250 mm in diameter and 250 mm in length. 3D.SUITE automatically and seamlessly stitches the oversized images together.
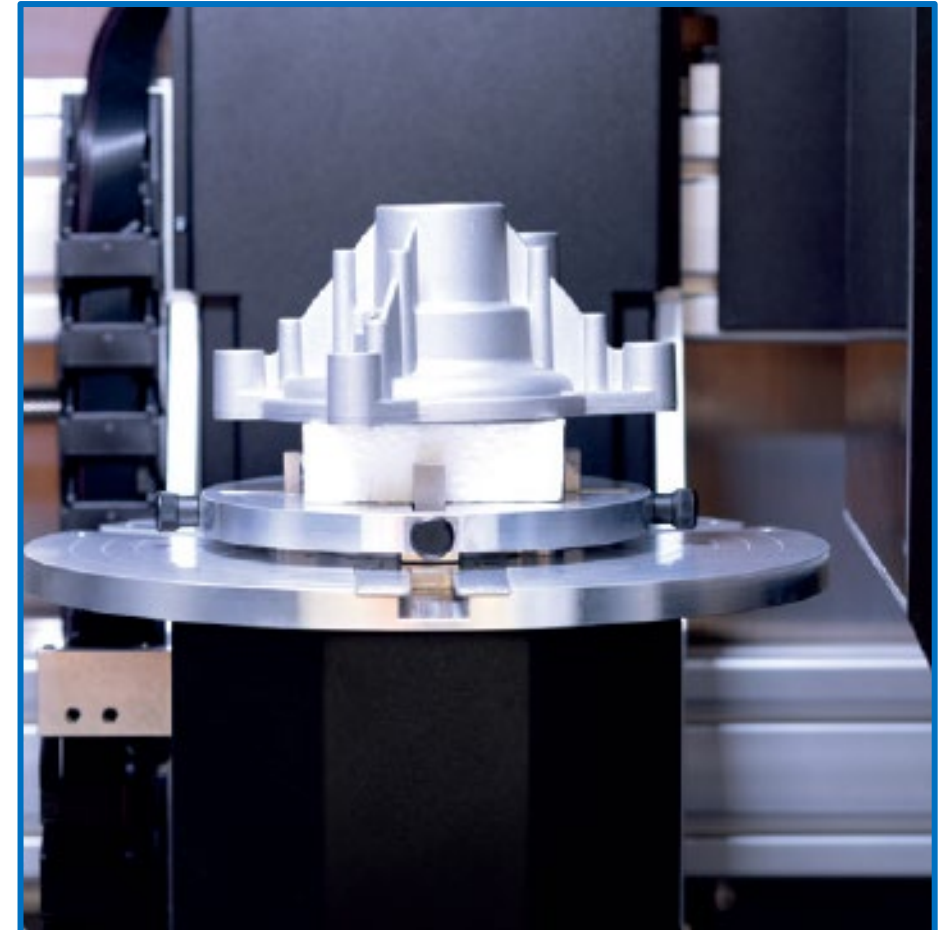
SkyScan X-ray Microscopes
SkyScan 1273

Embedded touch screen and lead glass door enable easy operation while observing the object

8-Position Filter Changer For Automatic Selection Of The Optimum Energy Setting

Intuitive, simple, yet powerful – the 3D.SUITE software that comes with every SKYSCAN 1273 is designed to inspire finding out what's inside. With the help of Genius Mode, even a novice user can intuitively start scanning right away. It helps optimize the scan conditions by choosing the appropriate filter and X-ray energy to achieve optimal image contrast, and by selecting the optimum exposure time and rotation step for efficient scanning.
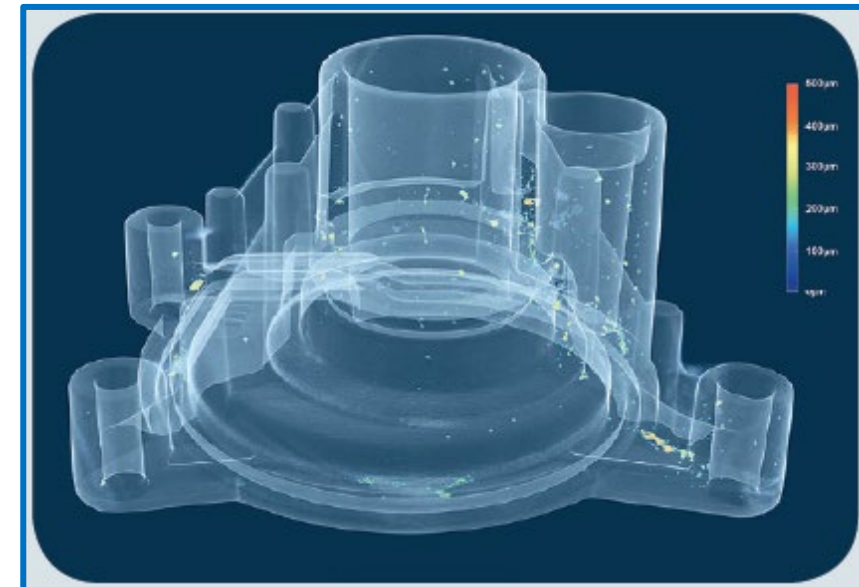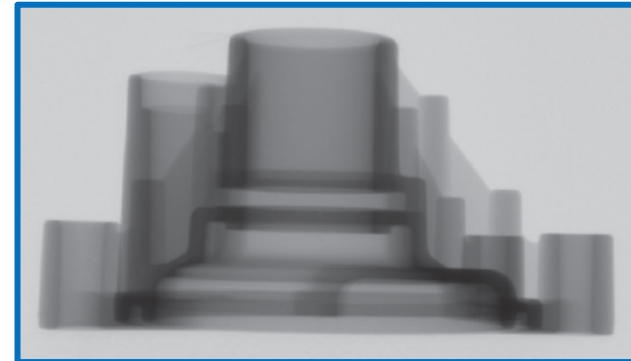
SkyScan X-ray Microscopes
SkyScan 1273

3D volume rendered 200 mm long carbonate drill core, at 13 μm isotropic resolution.
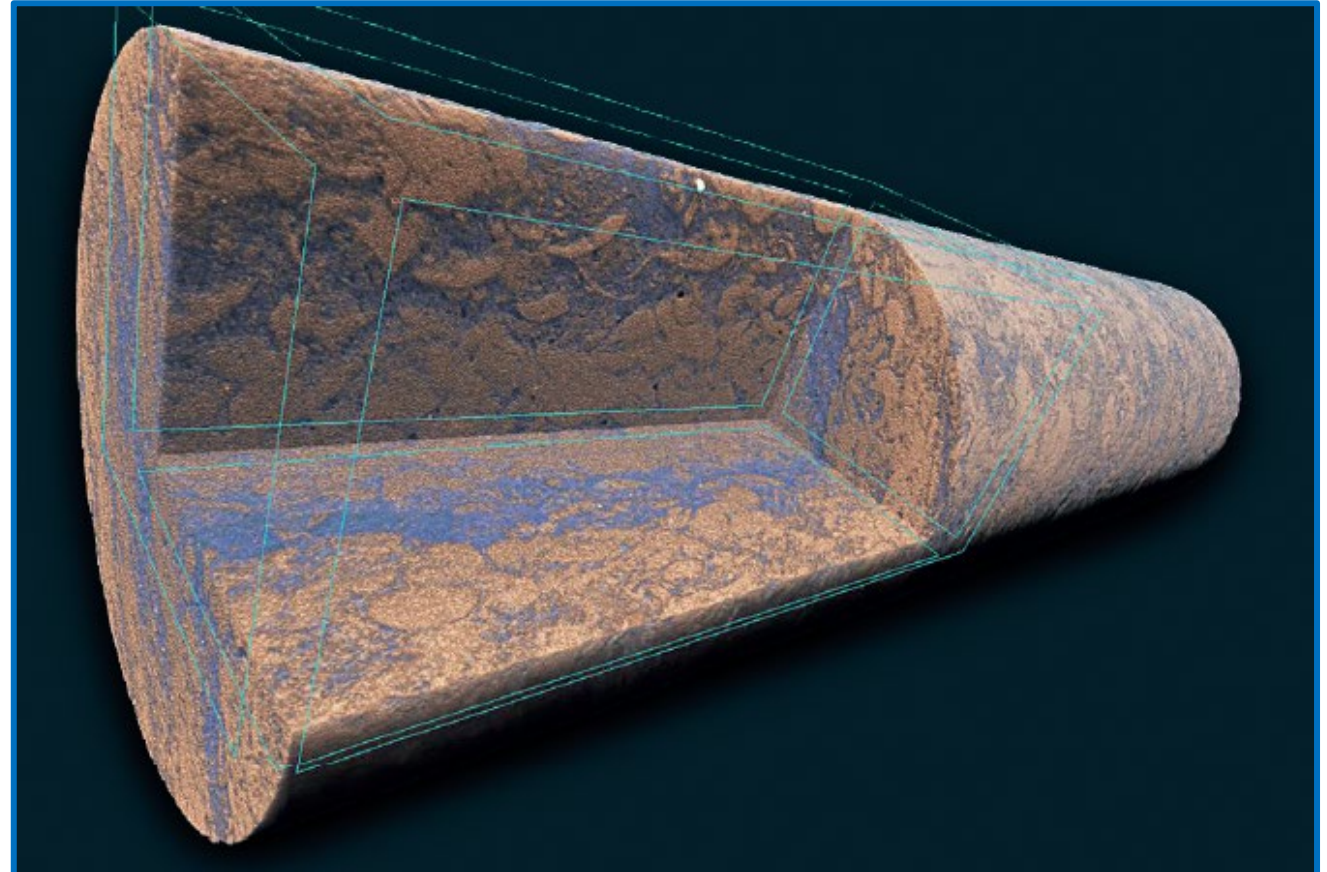
SkyScan X-ray Microscopes
SkyScan 1273

Several factors affect the true 3D spatial resolution: the focal spot size of the X-ray source, the acquisition geometry, the overall system stability, the mechanical accuracy of the rotation axis, as well as the reconstruction algorithms. The 3D spatial resolution is determined with special phantom structures after reconstruction. The SKYSCAN 1273 easily resolves better than 5 μm in both directions.

5 Micron

19 mm

3 mm

3 mm

5.2 mm

pattern of 1 to 10 μm structures

QRM
A PTW COMPANY

QRM-MicroCT-Barpattern-NANO

MicroCT Bar Pattern NANO Phantom

BarPattern NANO V2 - Redesigned Chip

Section 2

section	line thickness (μm)	linepairs / mm	points (μm)
A	2, 4, 6, 8, 10 (tilt 90°)	250 - 50	
B			2, 4, 6, 8, 10
C			2, 3, 4, 5
D	1, 2, 3, 4, 5	500 - 100	

SkyScan X-ray Microscopes
SkyScan 1273

3D volume rendered additive manufactured part, at 34 μm isotropic resolution.
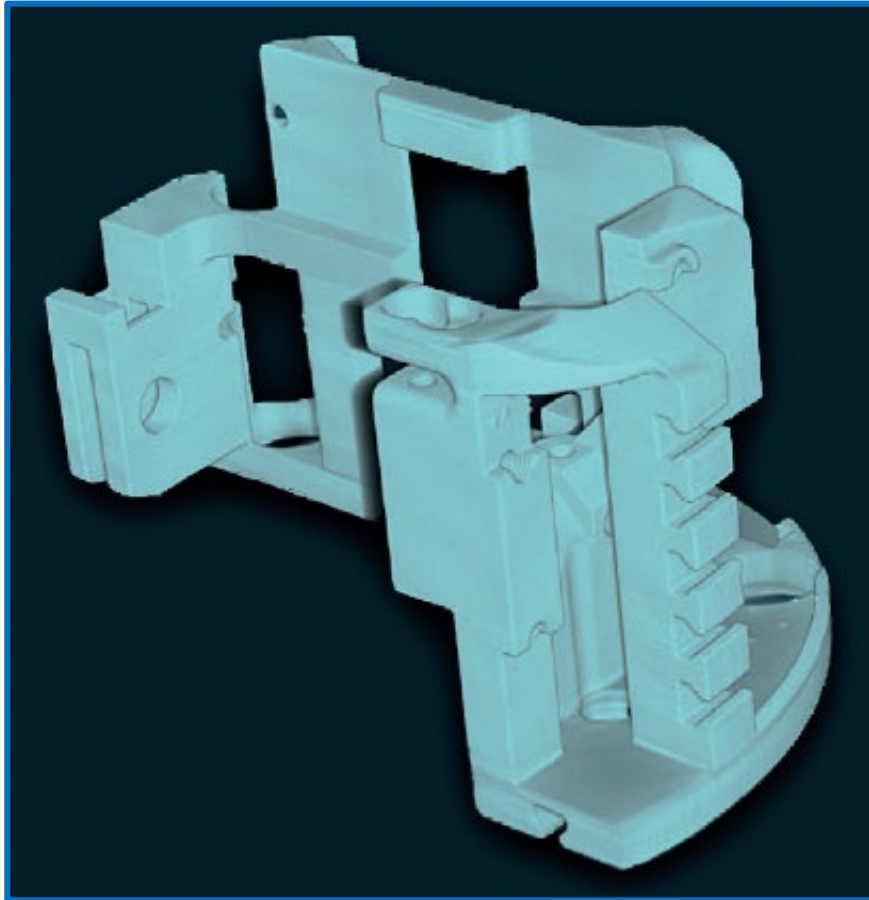
3D volume rendered epipen, at 50 μm isotropic resolution.
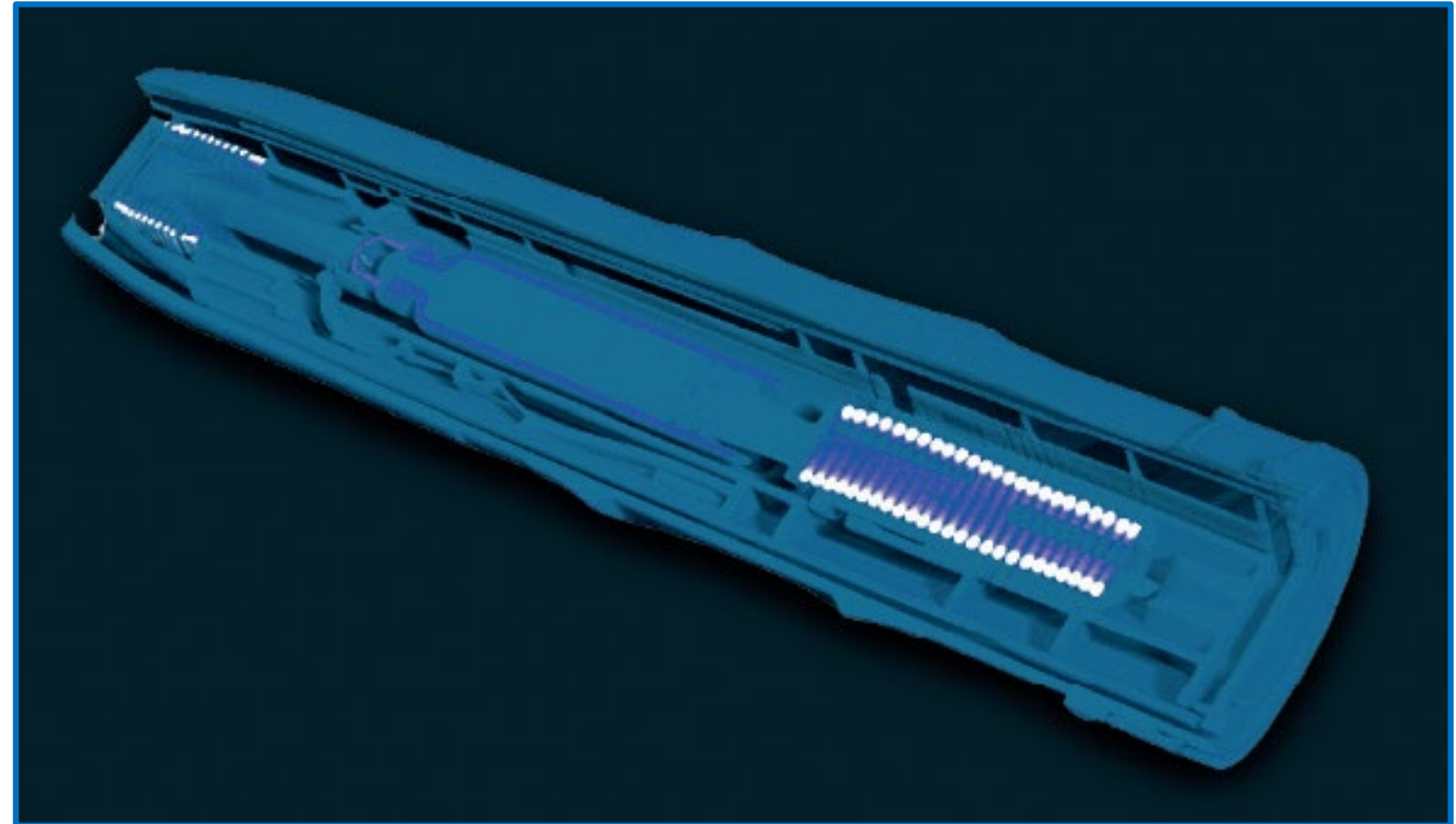
SkyScan X-ray Microscopes
SkyScan 1273

Sheep bone 60 mm in size with 2 titanium implants, 5 mm in diameter.

Other Materials

- Artefact-free imaging of osteo-integration of biomaterials and high density implants
- Imaging and analysis of various samples for forensics and palaeontology
- Classification and structural analysis in zoologic and botanic research

SkyScan X-ray Microscopes
SkyScan 1273

HART Plus

High aspect ratio

Conventional scanning strategies fall short on samples with high aspect ratio. A fixed angular step is either optimized for the short or for the long sample side. This results in very long scan times or in loss of resolution and consequent decrease in image quality.

High Aspect Ratio Tomography PLUS (HART PLUS) ensures optimum scan conditions at every rotation angle using a scanning strategy with continuously variable angular steps. As a result, planar objects are scanned 4 times faster than with a standard scan strategy at the same resolution. 3D.SUITE automatically selects the optimized reconstruction algorithms.

13 min scanning time

45 min scanning time

13 min scanning time

(a) Fixed rotation step optimized for the long side of the object results in artifacts due to lack of resolution along the short side.
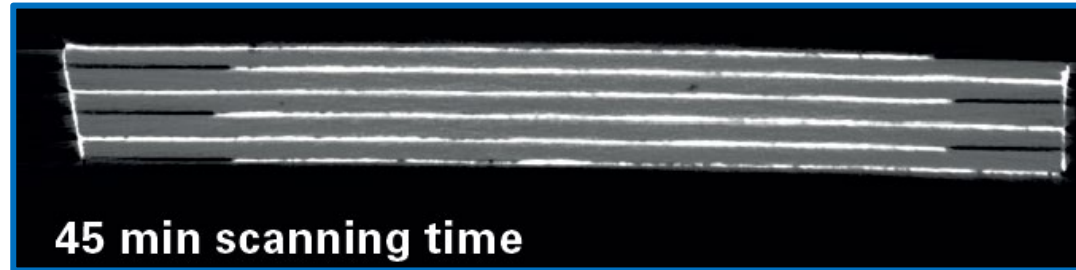
(b) Fixed rotation step optimized for the short side of the object results in an artifact-free image, but with long scanning time.
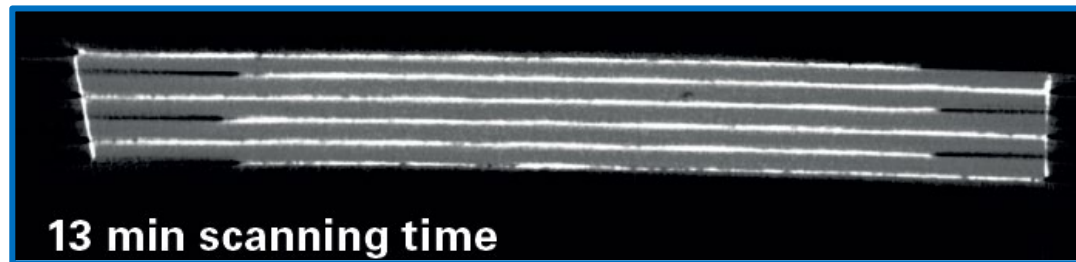
(c) HART PLUS results in an artifact-free image as in (b), but 3 to 4 times faster.

HART Plus Variable Rotation Step

The pictures above show reconstructed cross sections through a ceramic capacitor with different scan strategies.
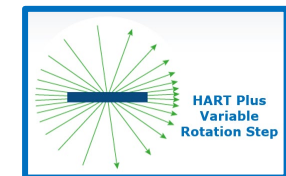
SkyScan X-ray Microscopes
SkyScan 1273

3D Inspection with DATAVIEWER

- Display reconstructed results as slice-by-slice movies or three orthogonal projections
- Smoothing, linear and non-linear grey scale transformations, color coding
- Differential image analysis between samples

3 orthogonal projections through a concrete sample
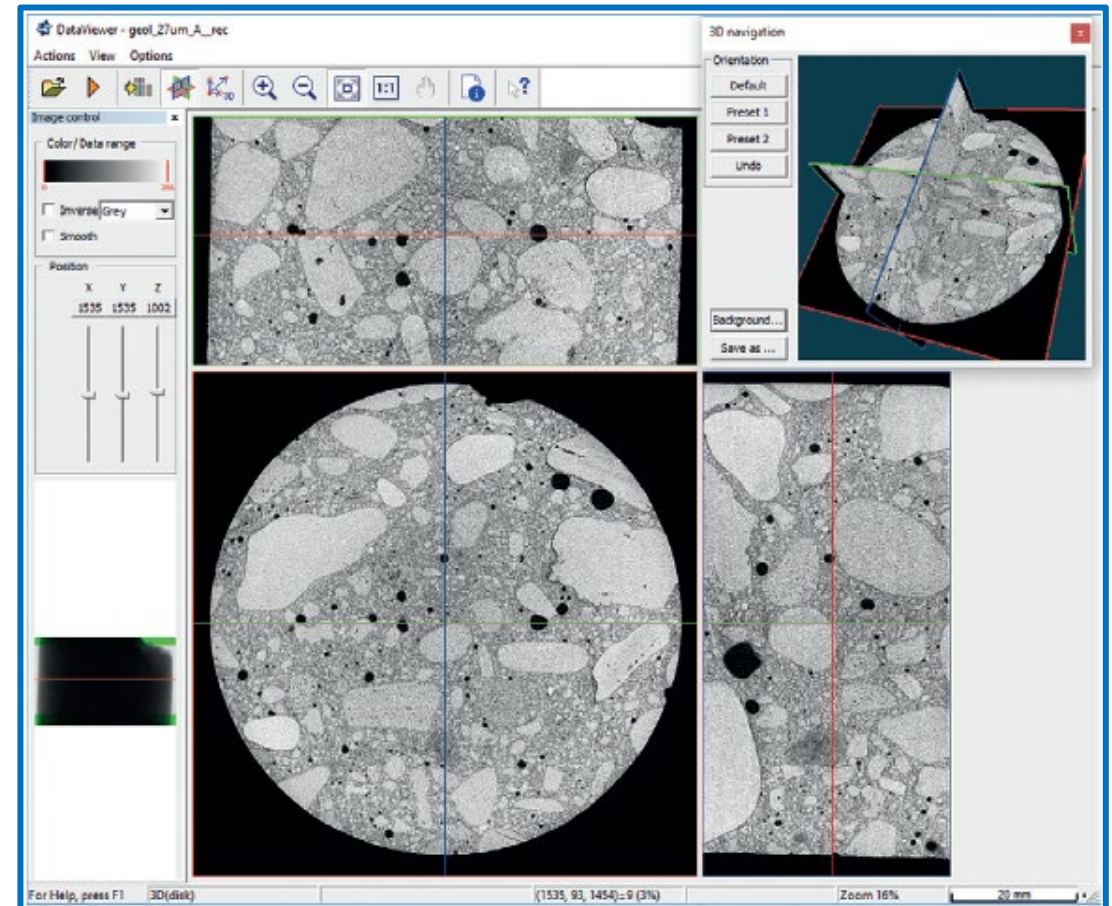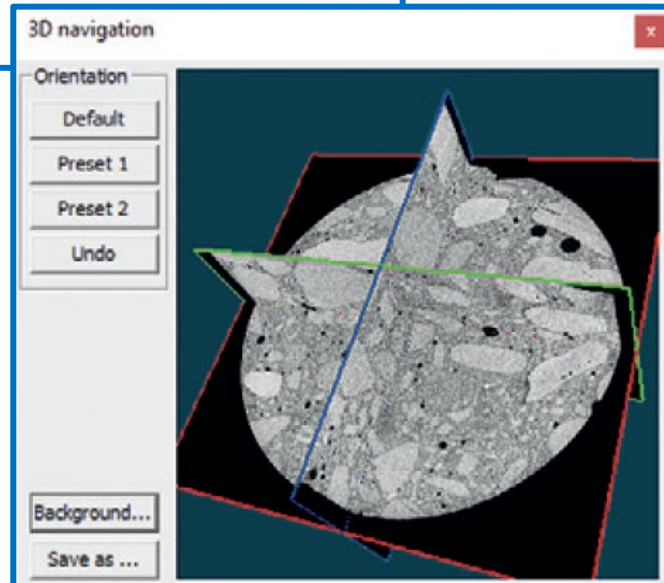
SkyScan X-ray Microscopes
SkyScan 1273

3D Visualization with CTVOX and CTVOL

- Volume rendering to display reconstructed results as a realistic 3D object
- Create animated movies flying around or through the object
- Produce cut-away views
- Adjust coloring and transparency
- Export surface rendered models in STL format to 3D printers, or to 3D CAD software
- Modelling using mobile devices

3D rendered volume of a small stepper motor
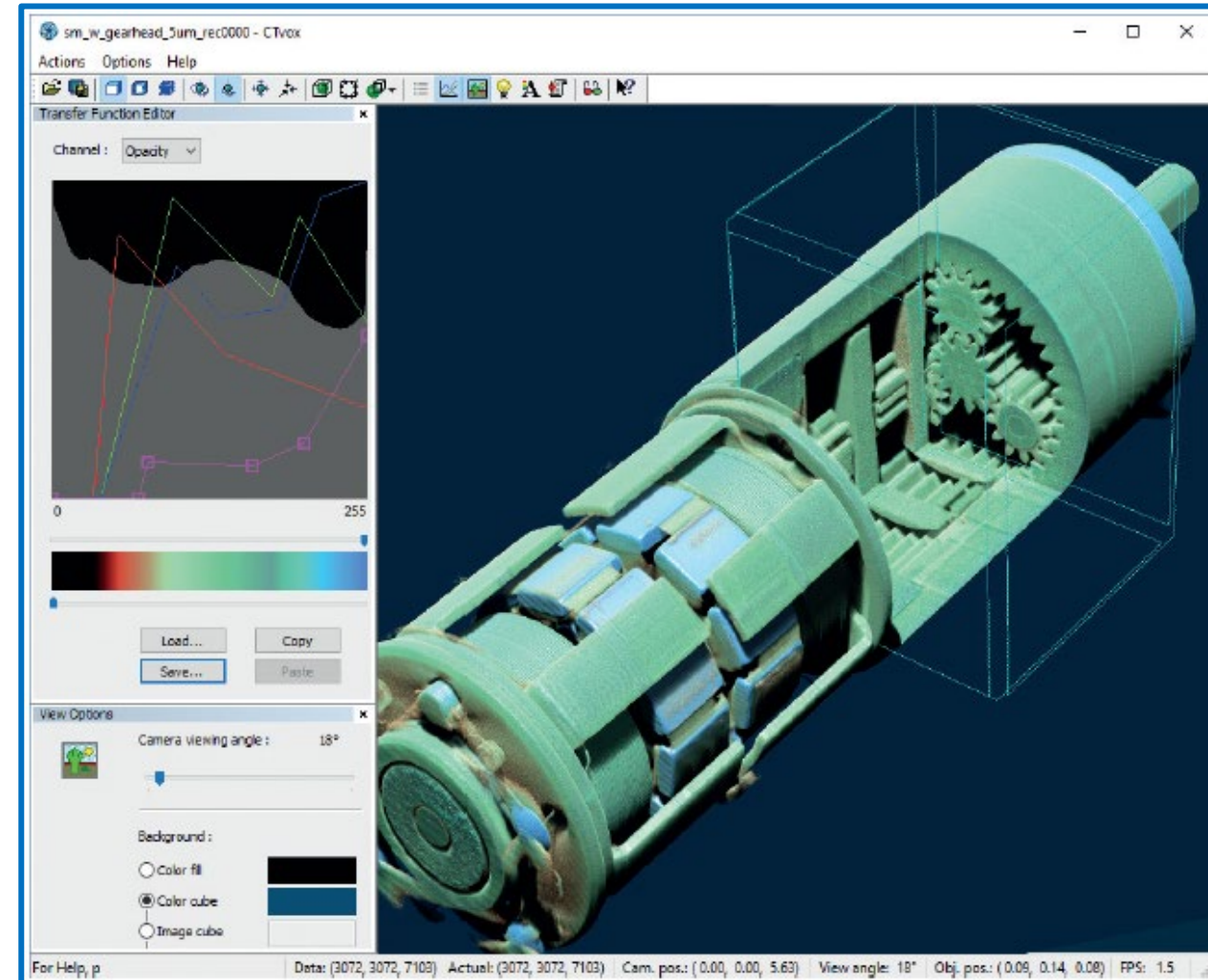
SkyScan X-ray Microscopes
SkyScan 1273

3D Image analysis with CTAN

- Handles large data sets with ease
- Density analysis
- Open/closed porosity
- 3D distances and angles
- Thickness and separation
- Extensive tool set for region-of-interest selection
- Various thresholding methods, morphological operations, and filtering algorithms
- Color coding of local orientation, thickness and separation
- Automated batch analysis
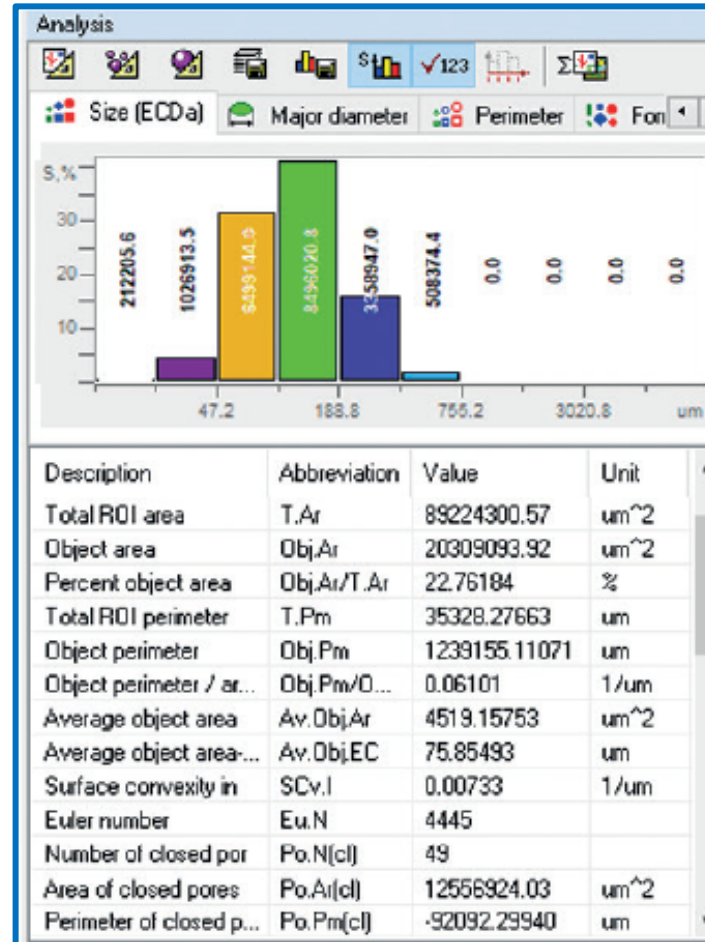
Porosity analysis of a tree slice

SkyScan X-ray Microscopes Performance Characteristics

SS1273

Technical Data

Technical Data	
X-ray Source	40…130 kV, up to 39 W
X-ray Detector	6 Megapixel CMOS flat-panel detector 3072 x 1944 pixels
Reconstructed Slice Format	Up to 4800 x 4800 pixels
Resolution	Voxel size < 3 µm 3D spatial resolution < 5 µm
Max. Object Dimensions	Up to 300 mm in diameter and 500 mm in length Up to 20 kg
Max. Scanned Volume	Up to 250 mm in diameter and 250 mm in length

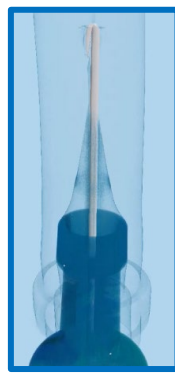|	
System Dimensions (W x H x D)	1250 mm x 815 mm x 820 mm 400 kg
Power supply	100 – 240 VAC, 50 – 60 Hz, 3 A

1250 mm

815 mm

820 mm

SKYSCAN 1273

400 kg

SkyScan X-ray Microscopes
SkyScan 1275

Attributes

- **Sealed X-ray Source**
- **CMOS Detector**
- **Variable SOD**
- **Helical Scanning**
- **Sample Changer Option**
- **Push-Button-CT**
- **3D.Suite Software With 25 User License**
- **Detector Choice Fixed**

Plug'n Analyze

No Water Supply

Single-phase Power

Small Footprint

SkyScan X-ray Microscopes
SkyScan 1275

Automotive & Electronics

- Detect defects in metal parts

- Evaluate connections non-destructively

- Analyze manufactured components automatically

- Operate the system at-line

Orthogonal slices and volume render of a large capacitor.
25 μm voxel size, 100 kV, 1 mm Cu filter, 1,944 x 1,944 x 6,000 px – 40 mm sample diameter
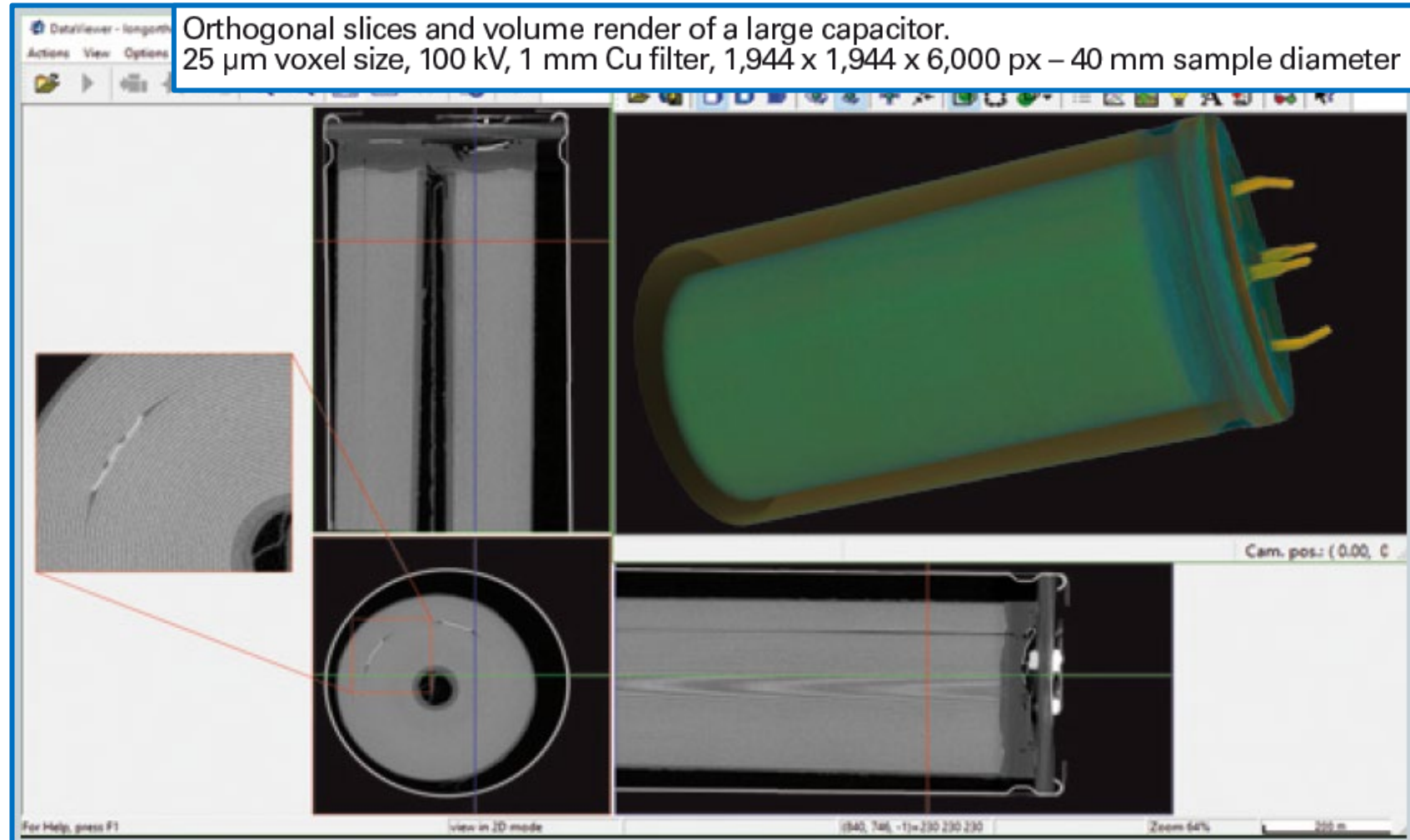
SkyScan X-ray Microscopes
SkyScan 1275

- Individual characteristics of features can be quantified

- In this case the individual sizes of the dense particles were measured

- The results indicate the equivalent sphere diameter of the particles
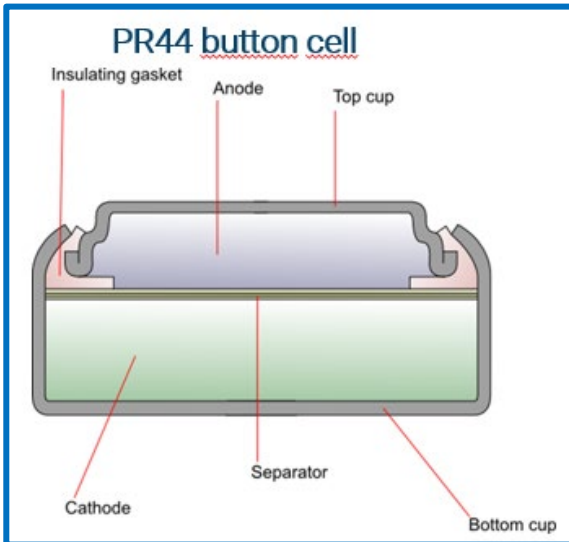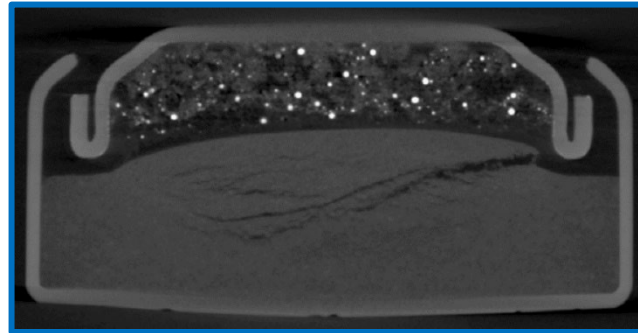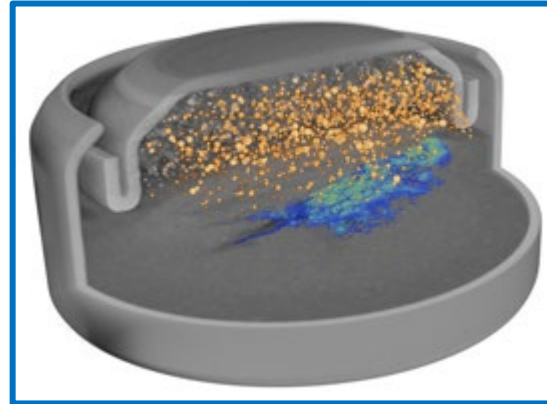
PR44 button cell

- Button cell scanned with SKYSCAN 1275

  - Voxel resolution 8 µm

  - Scan time 1h 21min

Equivalent Sphere Diameter

0.22mm
0.20mm
0.15mm
0.10mm
0.05mm
0.00mm
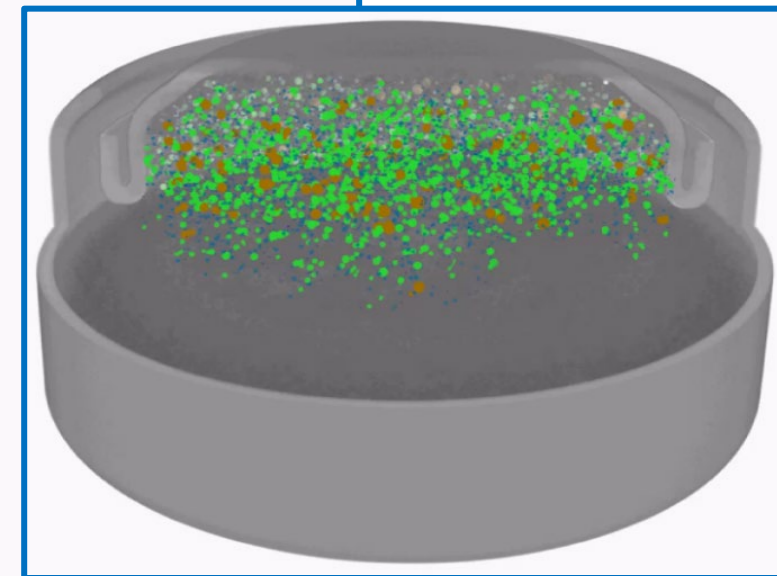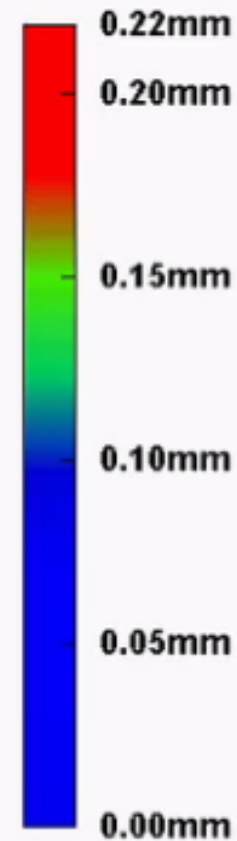
SkyScan X-ray Microscopes
SkyScan 1275

Helical (Spiral) Trajectories

Helical Scan Of Battery Results In Distortion-Free Reconstruction Of Image, With No Artifacts
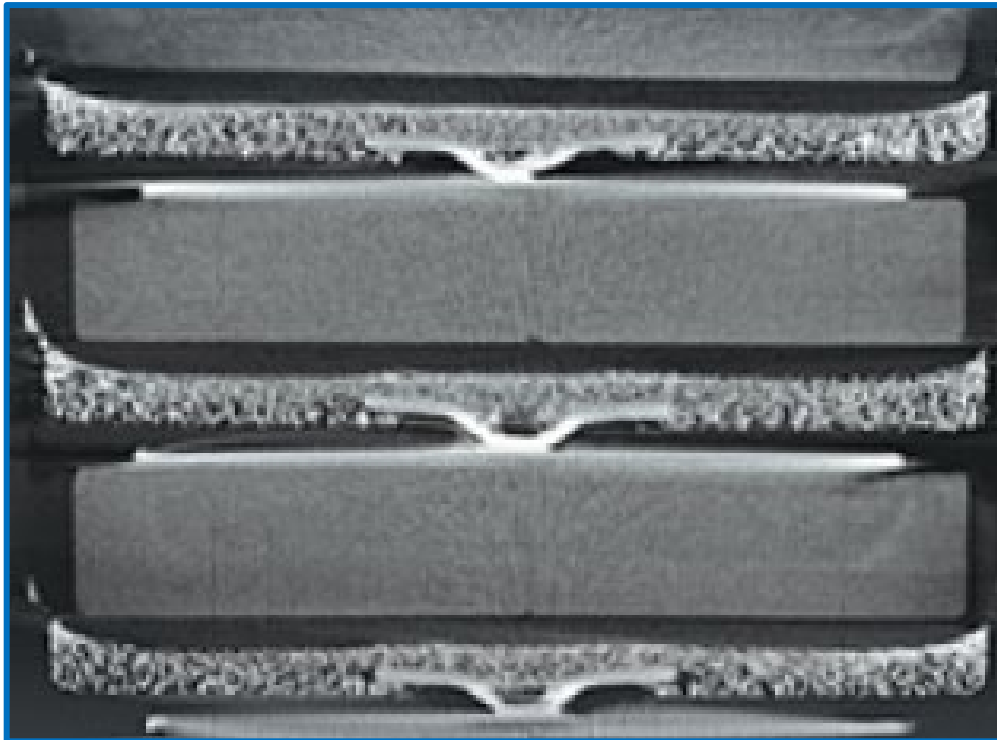
Helical Scan Of Defrise Phantom Results In Distortion-Free Reconstruction Of Image, With No Artifacts

SkyScan X-ray Microscopes
SkyScan 1275

NRECON
GPU-accelerated reconstruction for round and spiral trajectories

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

CTVOX
Realistic visualization by volume rendering

CTVOL
Built-in surface rendering

CTAN
2D/3D image analysis & processing

3D.SUITE Software
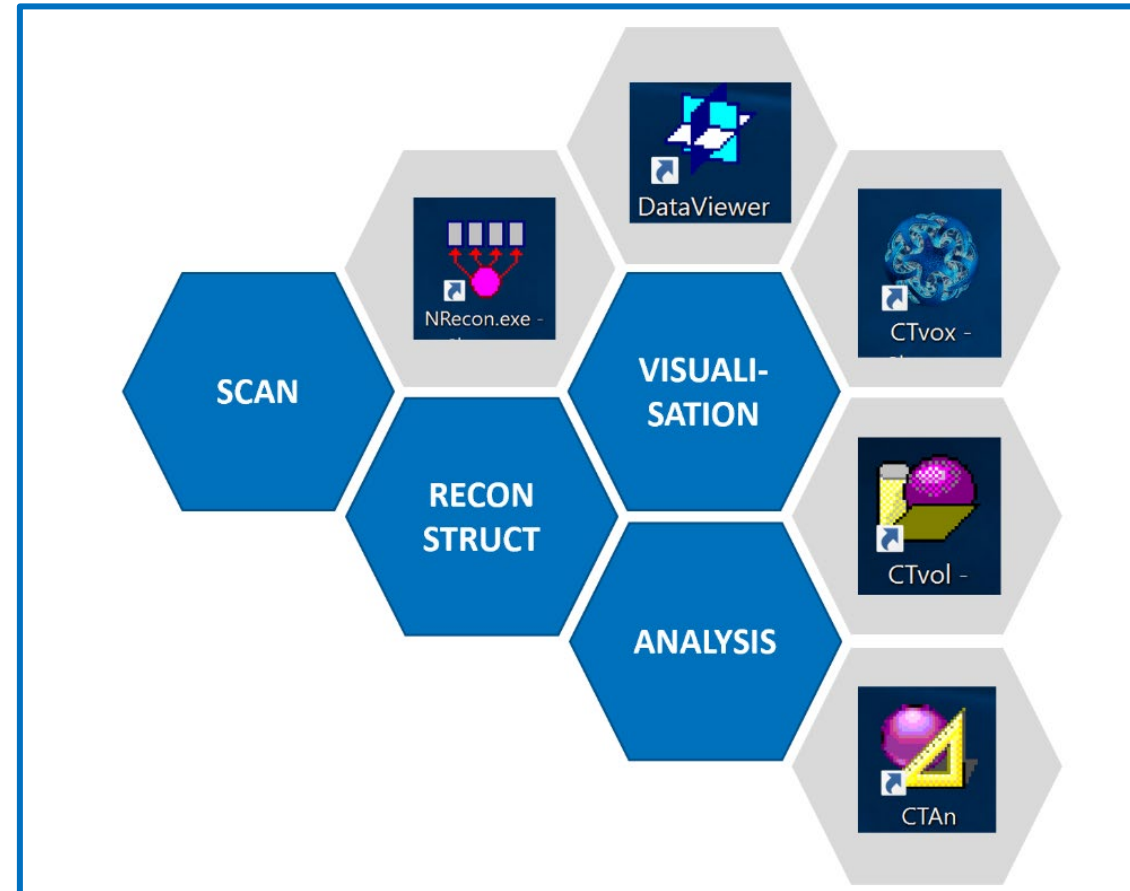
SkyScan X-ray Microscopes
SkyScan 1275

Pharmaceuticals & Packaging

- Measure coating thickness and distribution of active ingredients

- Measure external and internal dimensions and detect defects

- Implement high-throughput scanning of medical devices

- Investigate pharmaceutical packaging up to a size of 10 cm x 10 cm x 10 cm

- Monitor and control the quality of metal and plastic components

3D reconstruction of a syringe with a cap
8 μm voxel size, 70 kV, 1 mm Al filter, 1,944 x 1,944 x 3,980 pixels – 6 mm sample size
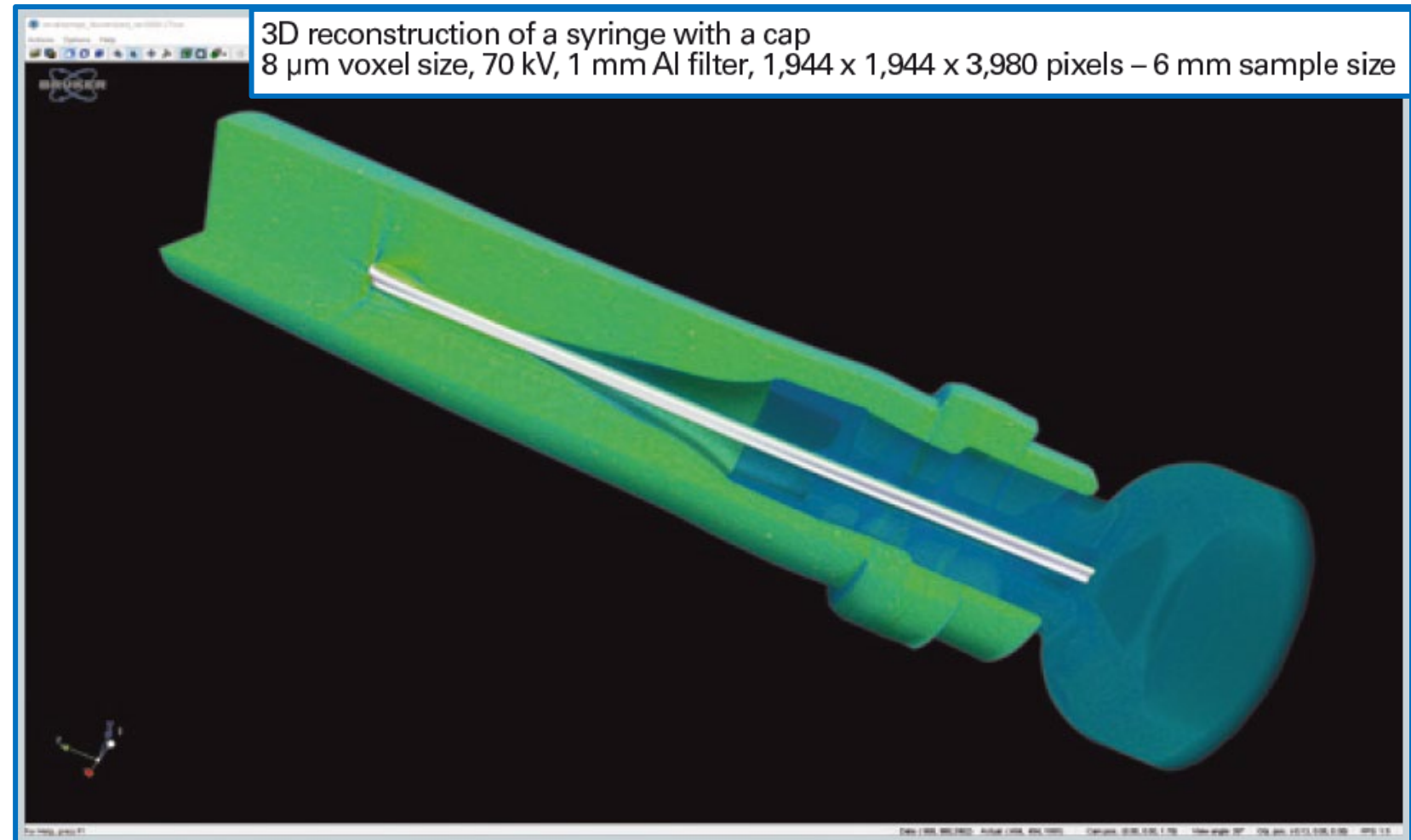
SkyScan X-ray Microscopes
SkyScan 1275

SS1275

Syringes scanned using SKYSCAN 1275 – 8 - 10 μm voxel size
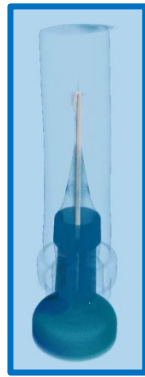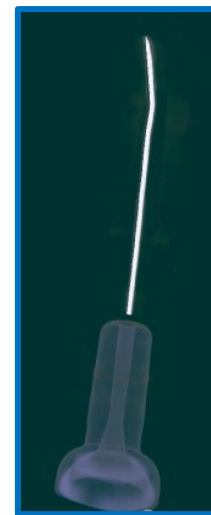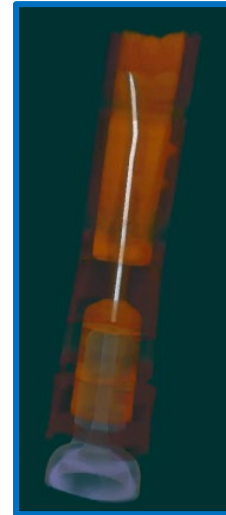
Glass vial scanned using
SKYSCAN 1275
10 μm voxel size
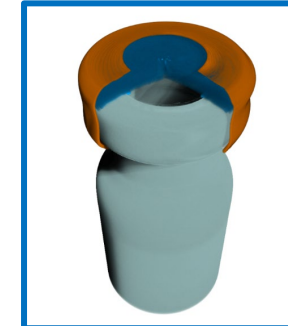
SkyScan X-ray Microscopes
SkyScan 1275

The internal components of an inhaler
scanned in just 100 seconds
40 μm pixel size, 100 kV, 1 mm Cu filter,
972 x 972 x 768 px – 38 mm sample diameter

Video Image

- Sample inspection with live optical camera

- Allows positioning of the sample for the highest resolution
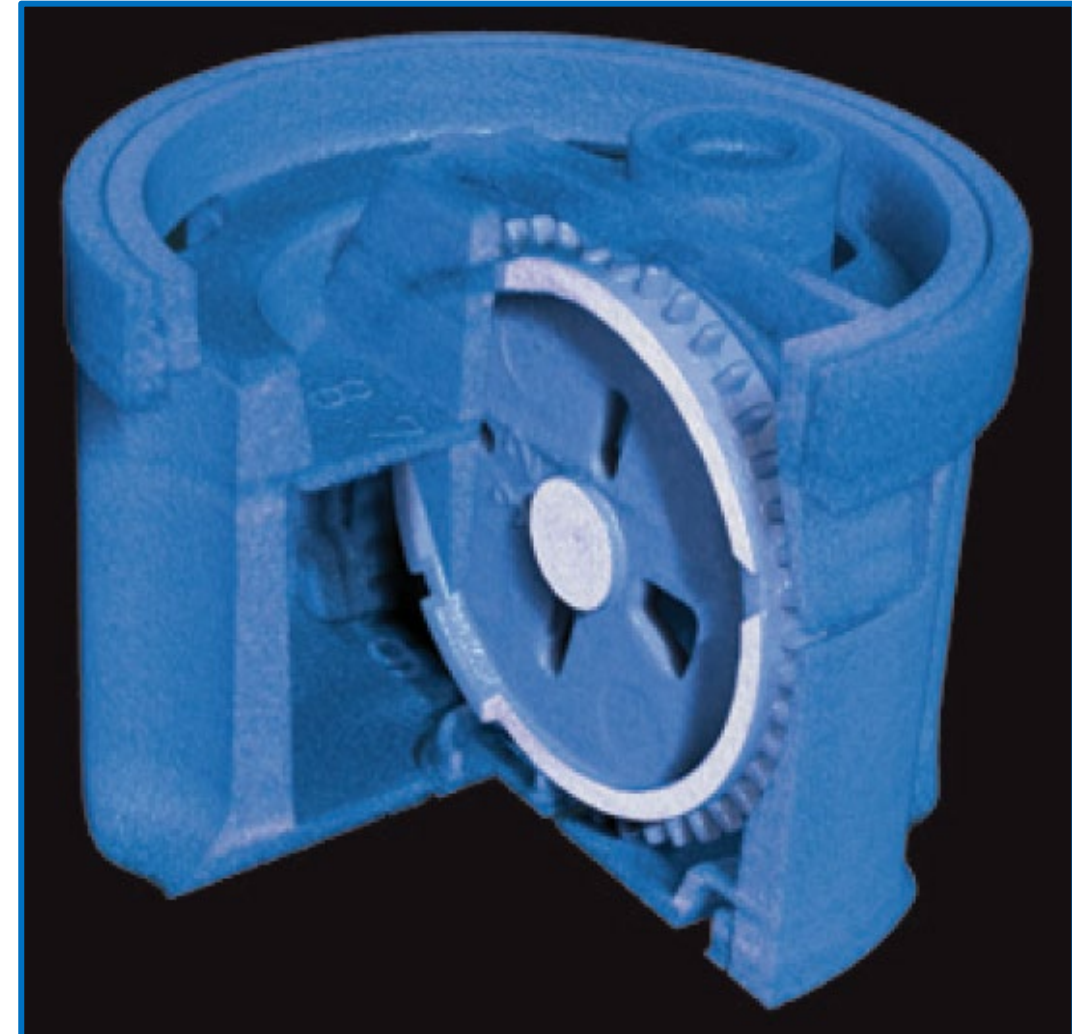
SkyScan X-ray Microscopes
SkyScan 1275

Good Laboratory Practice (GLP)

The SKYSCAN 1275 systems are supplied with a GLP module, which allows administration of user rights and implementing the necessary data protection according to GLP requirements. Three levels of access can be granted: standard users, advanced users and supervisors.

When the GLP module is activated, the control software duplicates every scan logfile, with all scan parameters and system settings, in an encrypted copy that cannot be directly accessed or modified. When necessary, encrypted logfiles can be restored to text for QA audit, to ensure the secure storage and traceability of critical scan information and allow reproduction of any scan.

SkyScan X-ray Microscopes
SkyScan 1275

BRUKER

SS1275

Geology, Oil & Gas

- Measure pore network properties, grain size, and shape

- Calculate distribution of mineral phases in 3D

- Digitize a 3D volume of precious samples, e.g. archeological finds

- Analyze dynamic processes

3D reconstruction of the internal microstructure of a carbonate, volume rendering with top half virtually removed overlapped with color map of local pore sizes
20 μm voxel size, 80 kV, 1 mm Al filter, 1,944 x 1,944 x 2,925 px – 35 mm sample size
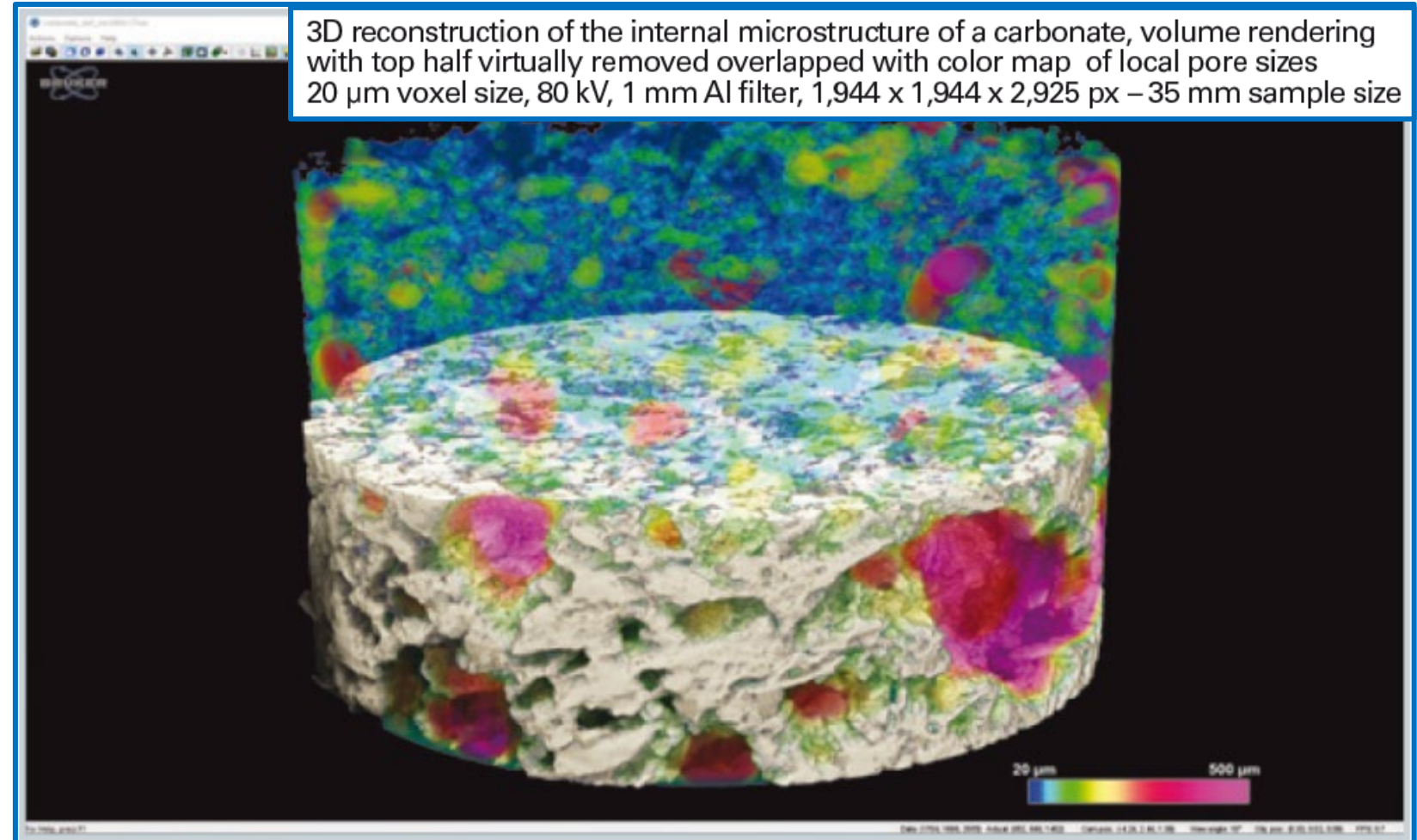
SkyScan X-ray Microscopes
SkyScan 1275

Automated stitching of multiple
circular scans of a sandstone microplug
5 µm voxel size, 80 kV, 1 mm Al filter,
1,944 x 1,944 x 6,000 px – 5 mm sample diameter
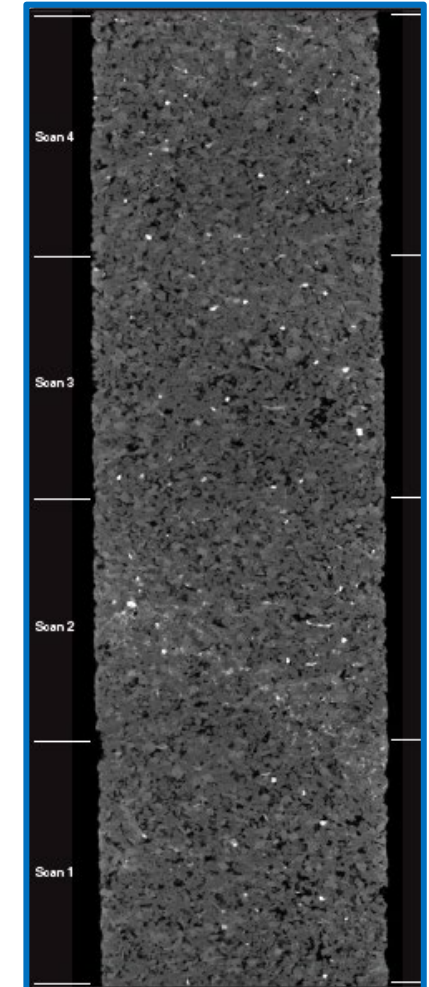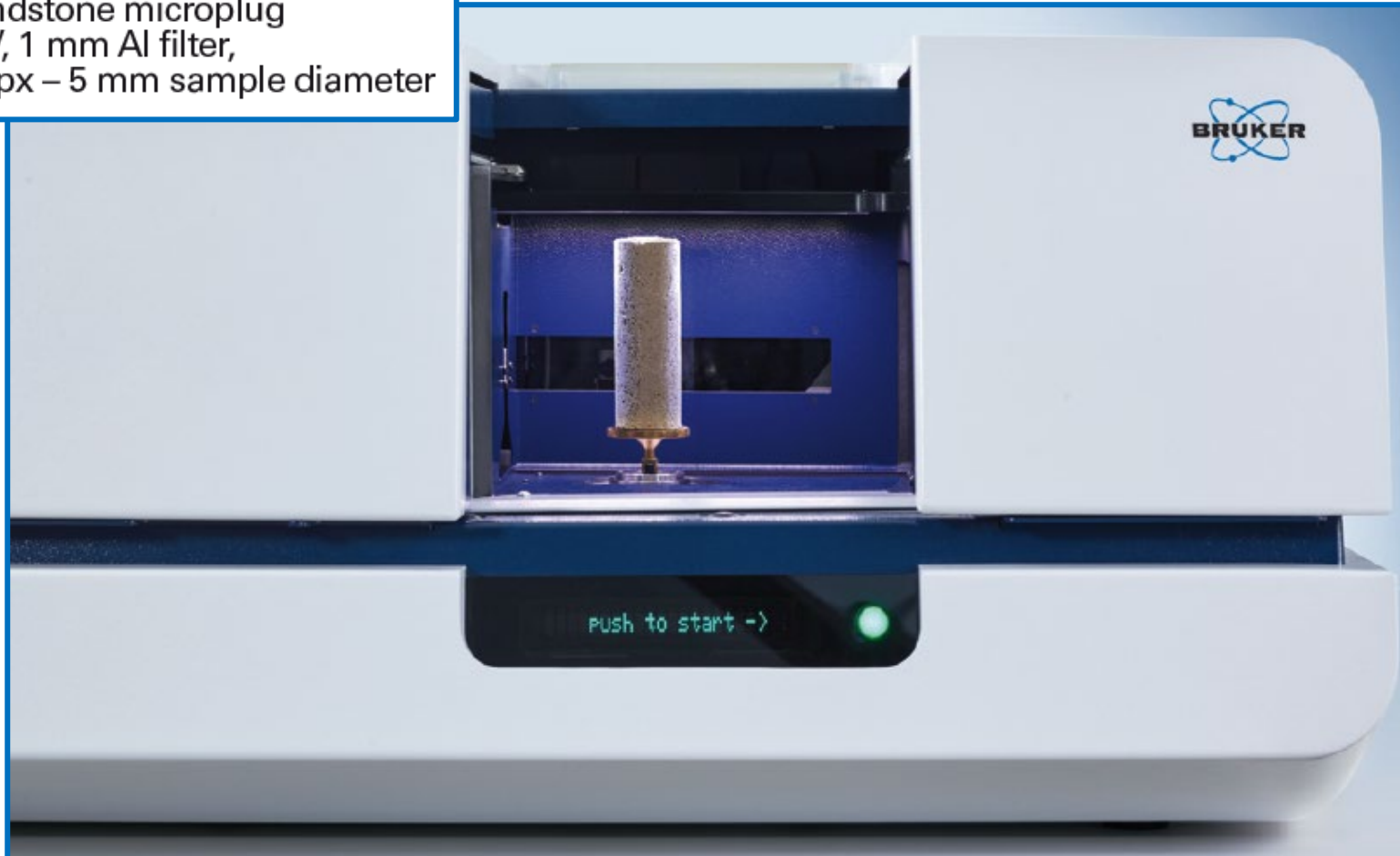
SkyScan X-ray Microscopes
SkyScan 1275

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

Three orthogonal slices through a concrete core in DATAVIEWER

SkyScan X-ray Microscopes
SkyScan 1275

Volume rendered concrete sample
showing color-coded pore size distribution in CTVOX
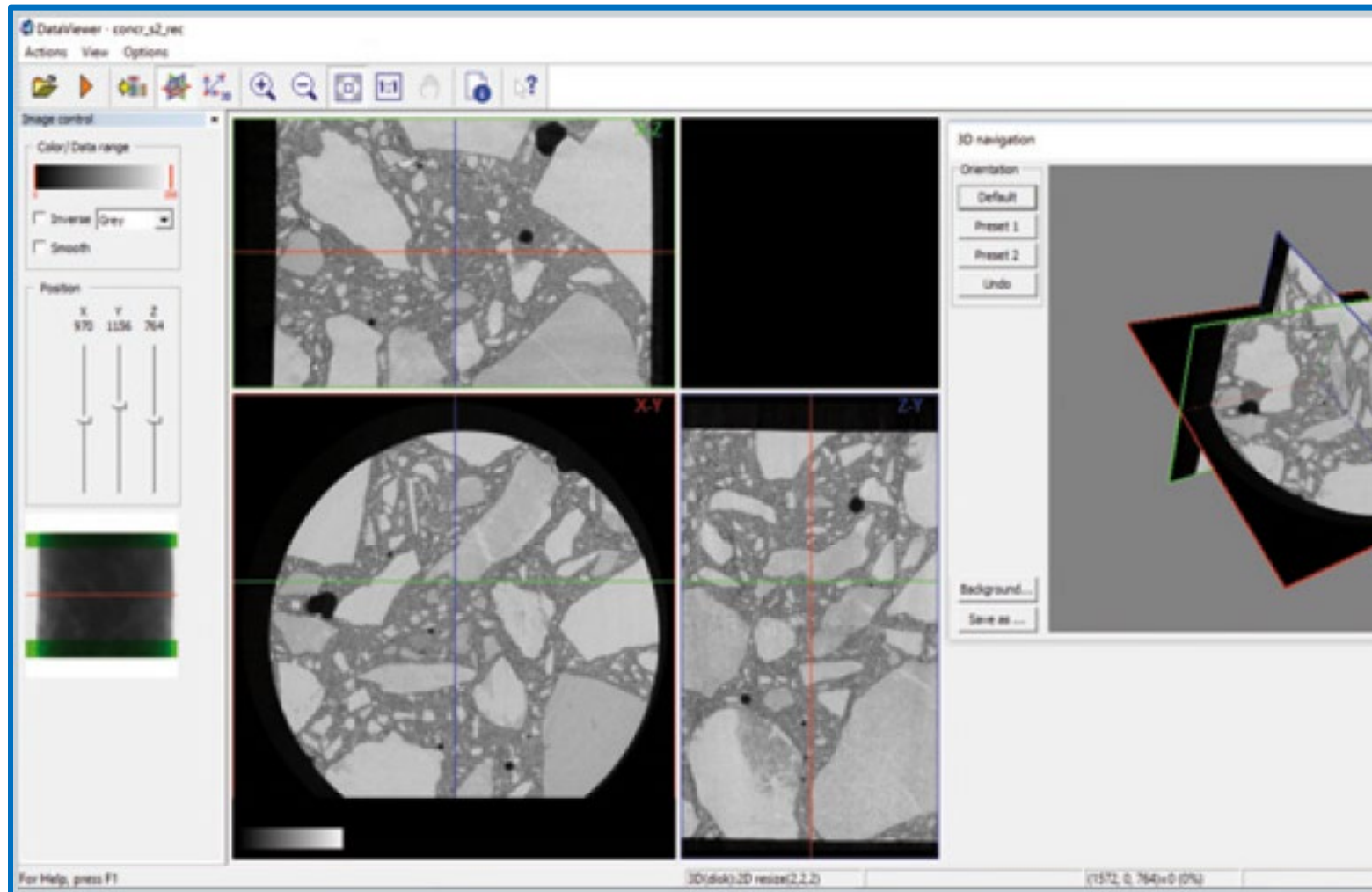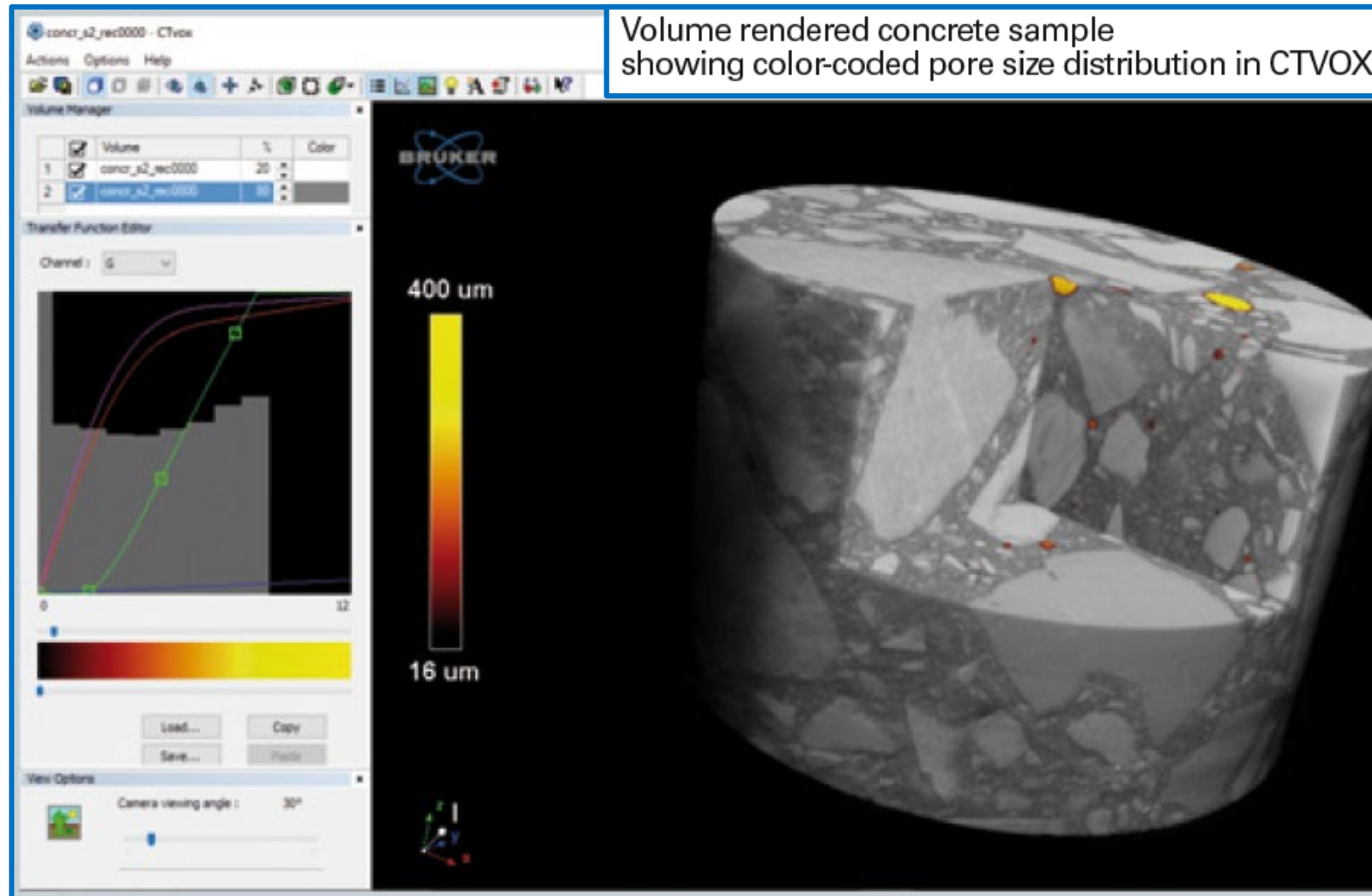
SkyScan X-ray Microscopes
SkyScan 1275

CTVOL
Built-in surface rendering

Surface rendered model of concrete binder and aggregate in CTVOL

SkyScan X-ray Microscopes
SkyScan 1275

Individual analysis of aggregate particles in concrete using CTAN

SkyScan X-ray Microscopes
SkyScan 1275

High Throughput & 4D CT

- Add time, force or temperature as a fourth dimension to 3D studies

- Apply in-situ mechanical tests with compression and tensile stages

- Visualize fluid flow, crystallization, dissolution and other processes in porous media

- Measure samples in non-ambient conditions

Volume render of salt crust on a Bentheim sandstone.
5 µm voxel size, 80 kV, 1 mm Al filter, 1,944 x 1,944 x 1,536 px – 6 mm sample diameter
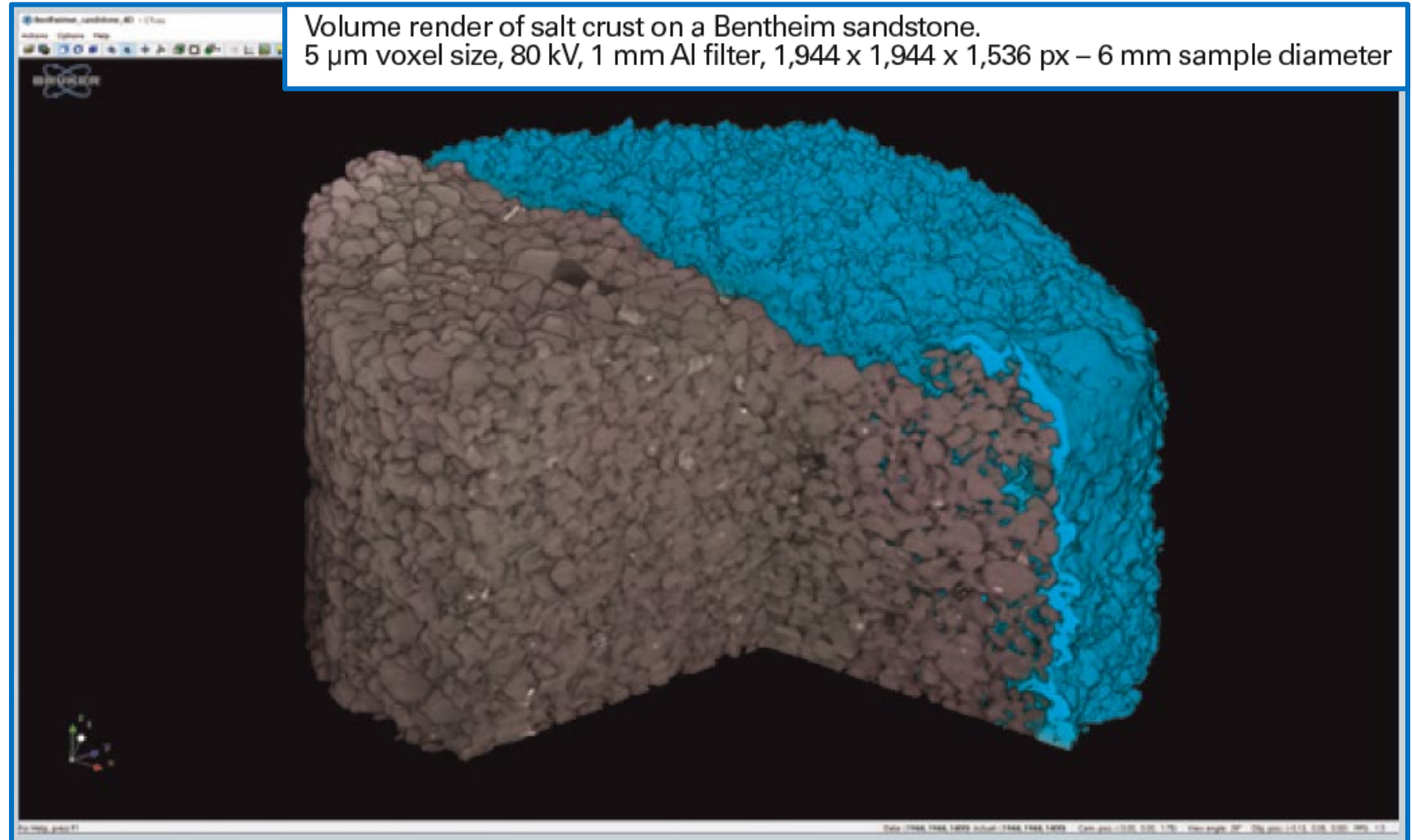
SkyScan X-ray Microscopes
SkyScan 1275

Time-resolved 4D CT
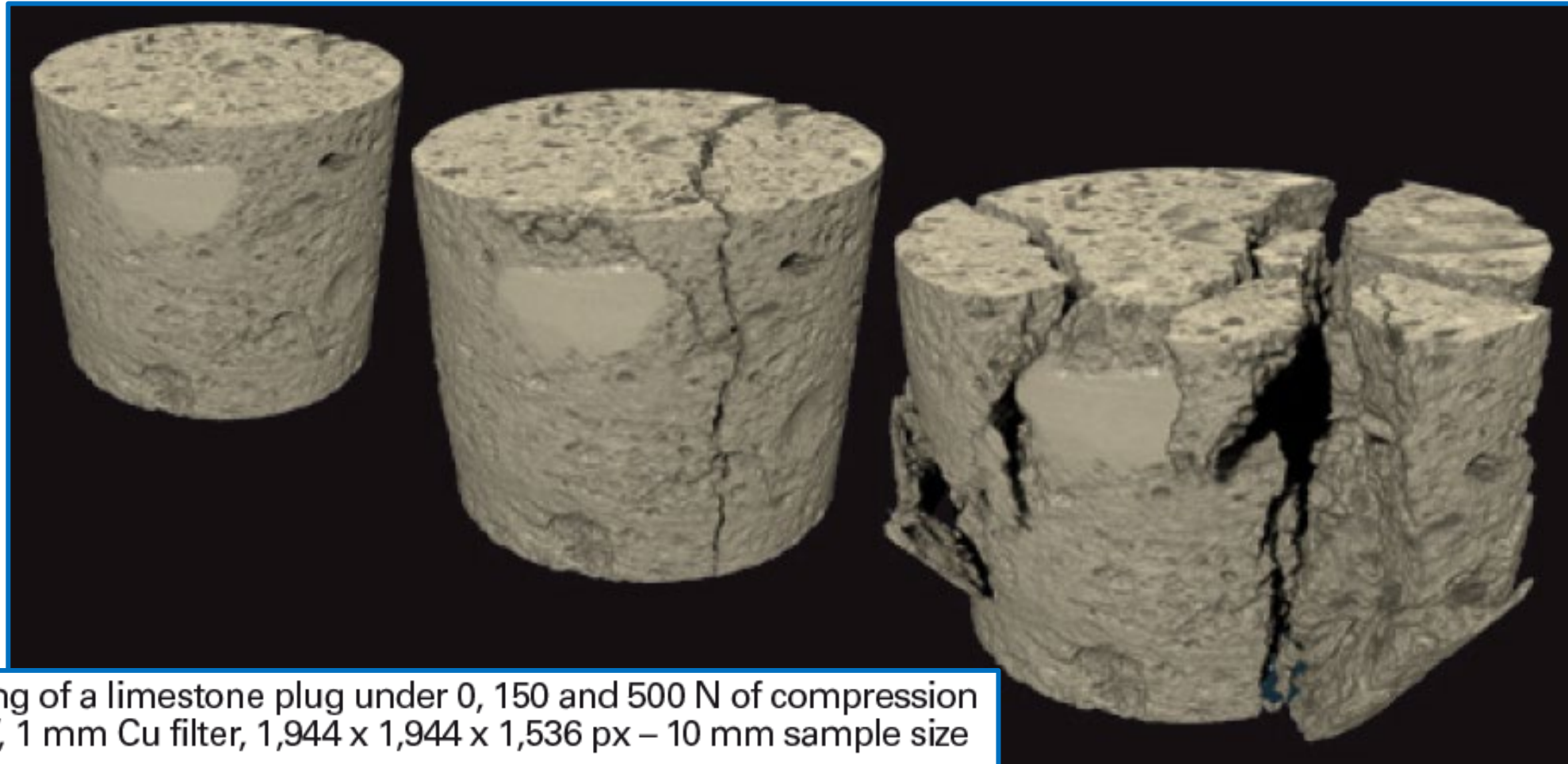
In-situ mechanical testing of a limestone plug under 0, 150 and 500 N of compression
12 μm pixel size, 100 kV, 1 mm Cu filter, 1,944 x 1,944 x 1,536 px – 10 mm sample size

SkyScan X-ray Microscopes
SkyScan 1275

Metrology

For metrology purposes, the SKYSCAN 1275 can be factory calibrated to achieve very high measurement accuracy. Using several specially developed phantoms, measured exactly using independent scans, the system's calibration parameters are carefully adjusted. This way, the scanner can be used for metrological analysis, both on the outside and on the inside of the sample.

3D registration between a reference and a produced part (left) and a color-coded map of measured deviations (right)
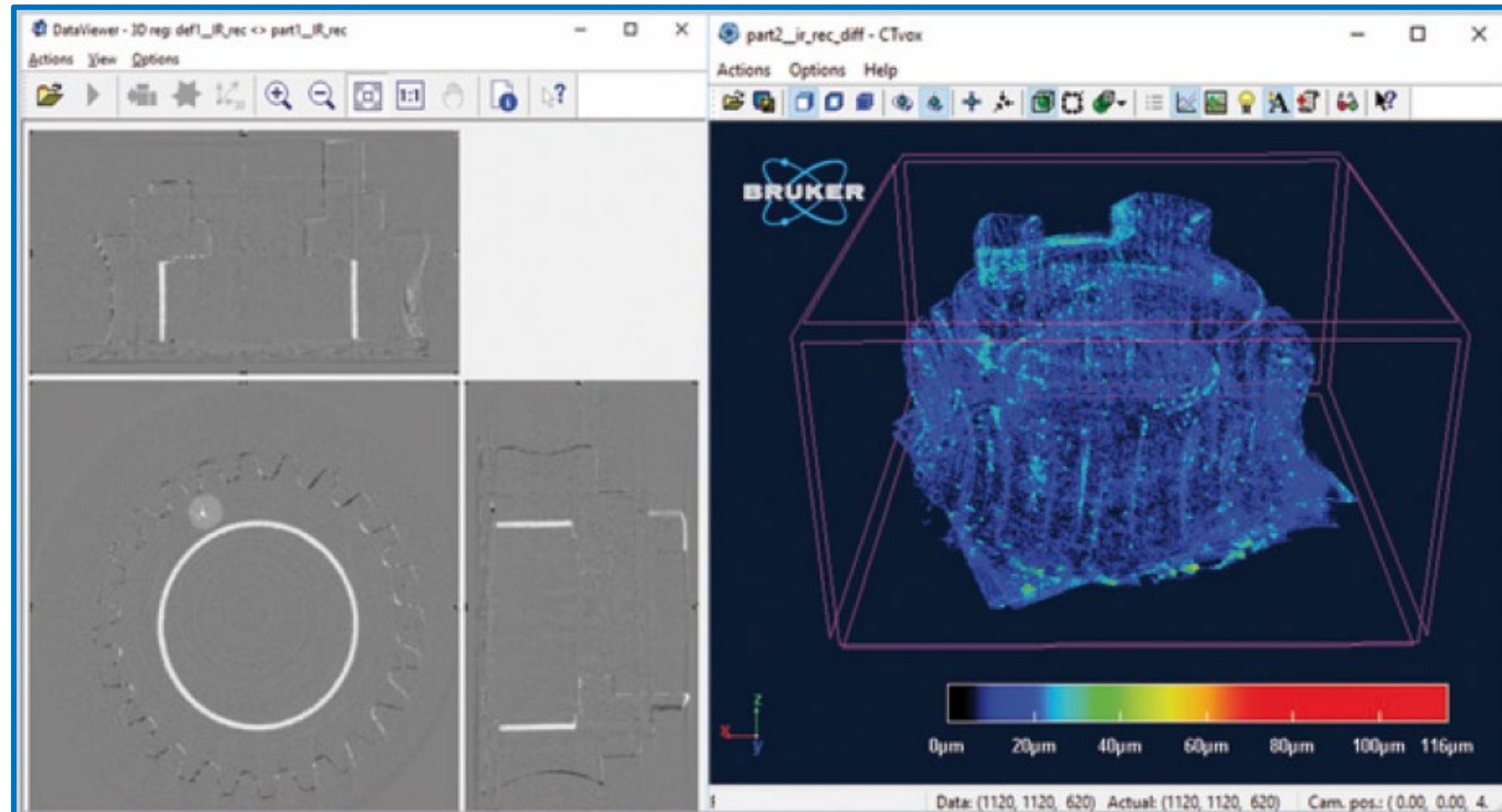
SkyScan X-ray Microscopes
SkyScan 1275

High image quality across all sample sizes

By using geometric magnification, the SKYSCAN 1275 reaches resolutions below 4 µm on small samples, and also scans large or dense samples at high quality. The efficient flat-panel camera ensures fast acquisition of images with a very high signal-to-noise ratio. Long, oversized samples of up to 12 cm in height can be scanned in sections, which are seamlessly and automatically stitched together.
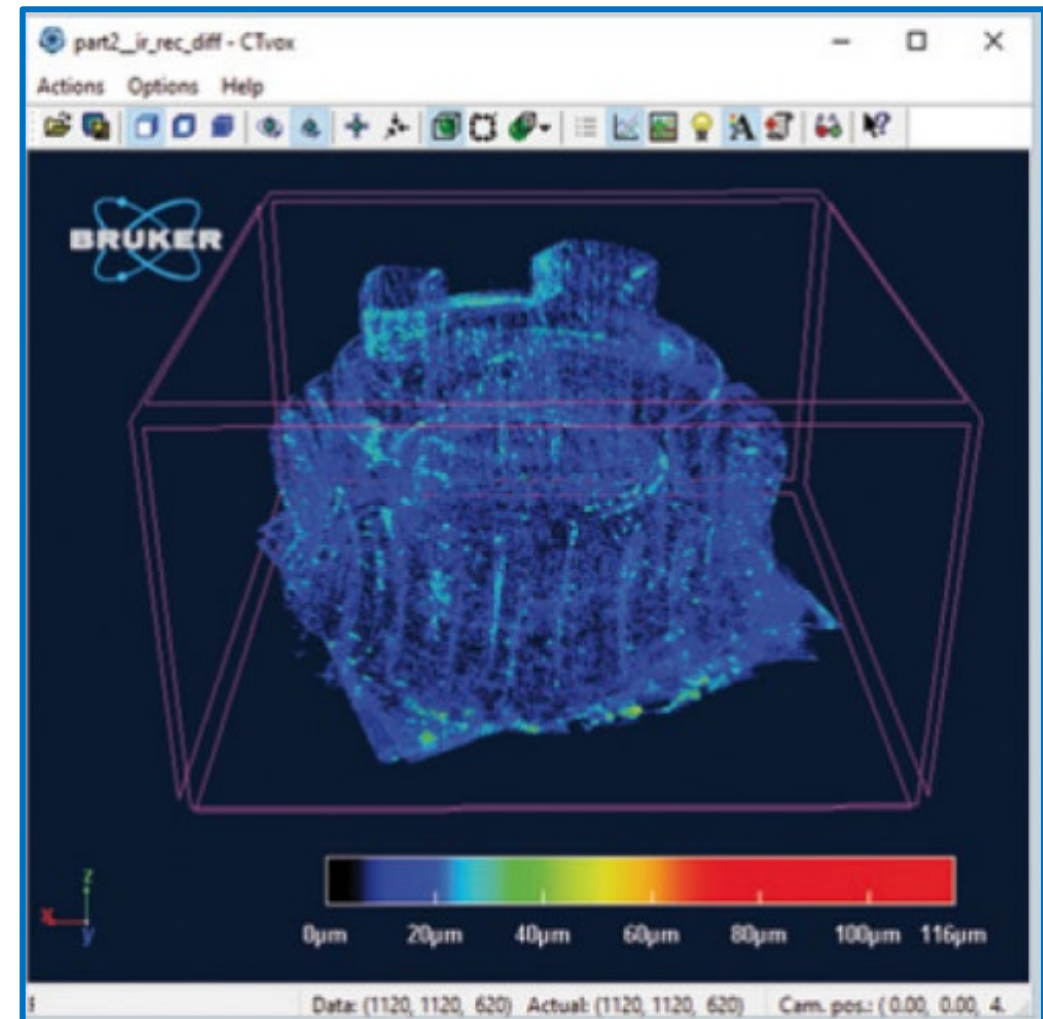
SkyScan X-ray Microscopes
SkyScan 1275

Ultimate simplicity with Push-Button-CT™

Press once to start Push-Button-CT

No sample preparation needed

SkyScan X-ray Microscopes
SkyScan 1275

Automated reconstruction & 3D visualization

Just insert a sample, manually or automatically, and get a complete 3D volume without any further interaction. Push-Button-CT includes everything: automatic sample size detection, sample scanning, 3D reconstruction, and 3D volume rendering. Combine it with a sample changer and SKYSCAN 1275 even works 24/7.
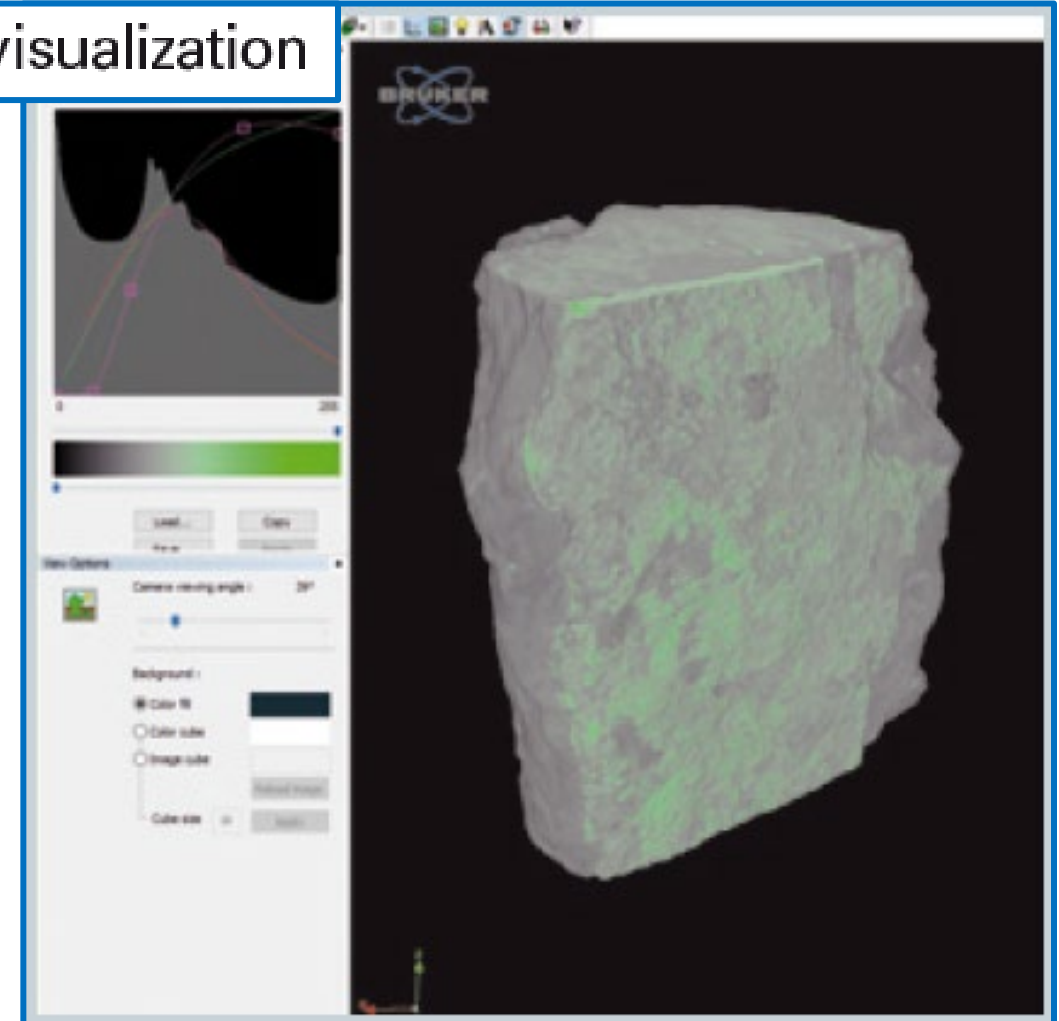
SkyScan X-ray Microscopes
SkyScan 1275

Up to 16 samples with a maximum diameter of 45 mm
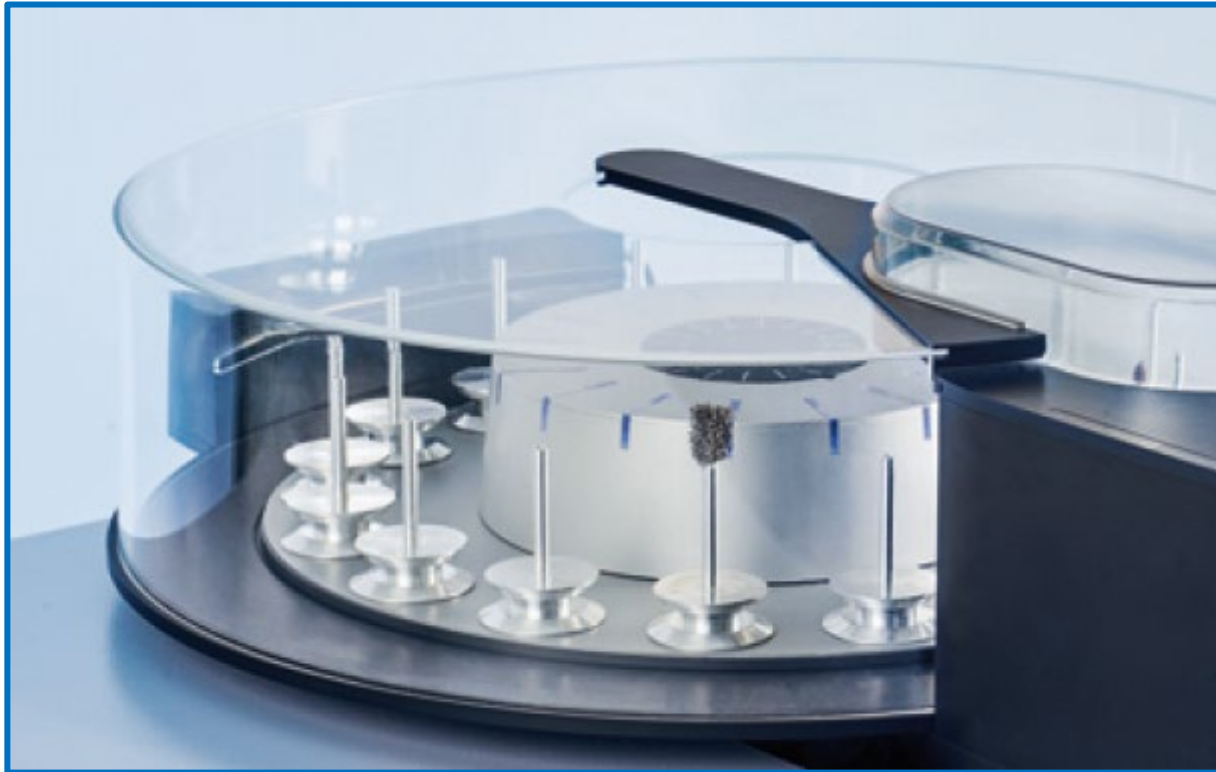
Up to 8 large samples (96 mm) or a random combination of large and small samples

SkyScan X-ray Microscopes
SkyScan 1275

Change samples at any time without interrupting an ongoing scan

Autodetection of new samples and status LEDs for every scan: ready, running, done
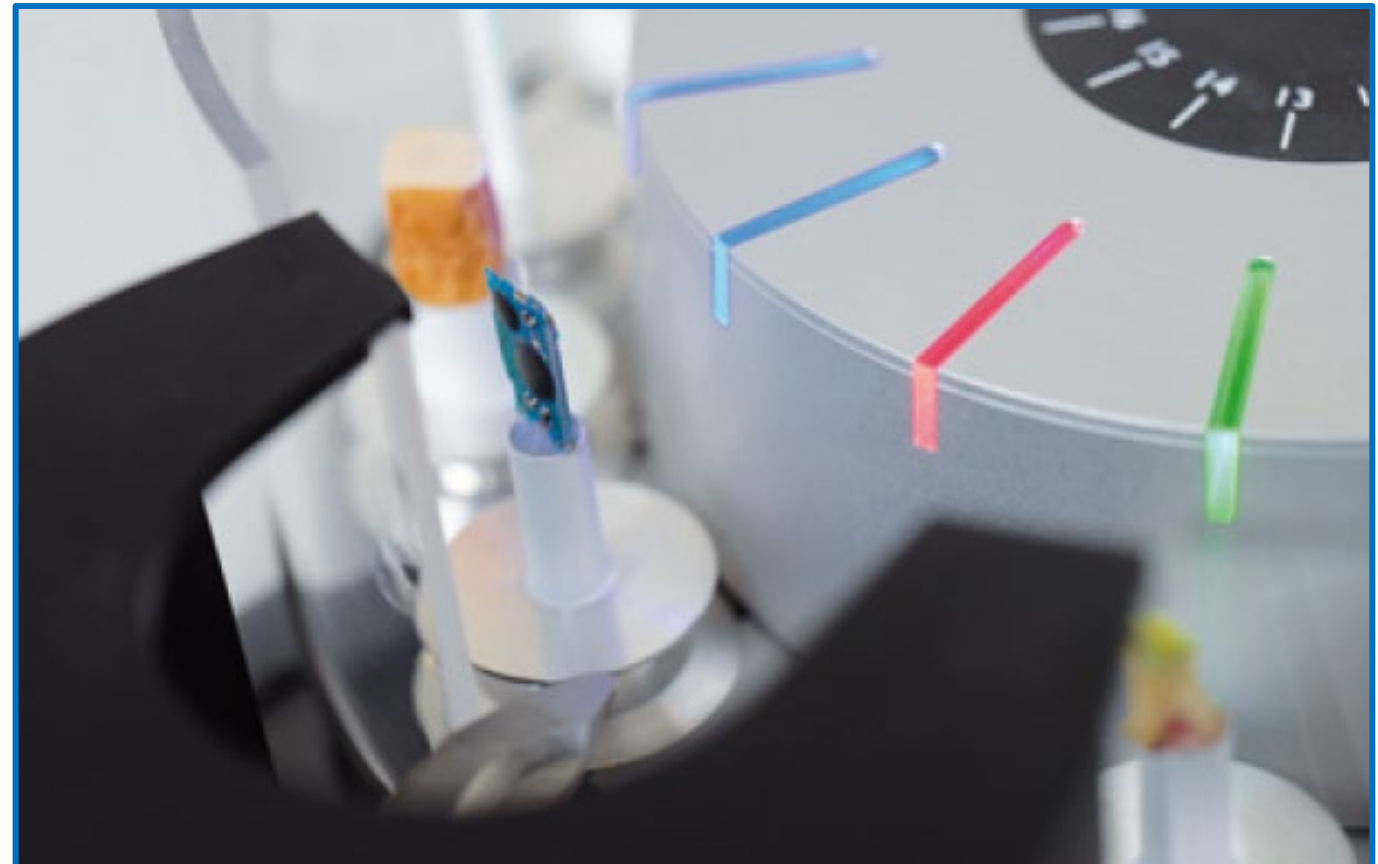
SkyScan X-ray Microscopes
SkyScan 1275

Sample changer window

Scanning protocol window

1 Status display of all 16 positions

2 Automatic or user-selected parameters

3 Scan samples with the previous protocol

1) Fully automatic
Simply load the sample changer, select "Auto" protocol with your predefined Push-Button-CT sequence, and then let the SKYSCAN 1275 take care of the rest! All scan, processing and visualization settings are predefined in your Push-Button-CT sequence. Feel confident that your work is being done – all day, all night, or over the weekend – with system-generated reports emailed directly to your inbox, including a link to access data remotely.

2) User selected
Want more control? Individually adjust scan parameters for one, some, or all sixteen samples. Once all "Manual" protocols are defined, simply press "Start" to initiate the full batch.

3) Prior Selection
Streamline workflow by using the "Previous" command to assign the last settings.

Stay in charge, always. Because the sample changer operates outside the fully shielded X-ray chamber, a user can easily place a priority sample at the next position while a Push-Button-CT scan is still running.

SkyScan X-ray Microscopes
SkyScan 1275

The optional automatic sample changer has 16 positions, which can be populated by samples with different sizes and shapes. It can accept 16 samples up to 50 mm in diameter or 8 samples up to 96 mm in diameter or any mixture of large and small samples. Maximum length of the samples is 80 mm. The sample changer is located in the top of the scanner, outside the shielded area. All scanned samples can be removed or replaced at any time without interrupting of an ongoing scanning.

The sample changer contains a motorized object carrousel, a robotic arm with multiple precision drives and a microprocessor controller for monitoring the object's presence and scanning process. At every position on the object's carrousel, the scan status of the sample is indicated by a color illuminated bar: for newly installed objects waiting for scanning the bar has blue illumination, for already scanned objects the bar is green and for position reserved for returning object from the scanner the bar is red. An operator can replace scanned objects any time without interrupting the scanning. The scanning protocol for every sample can be adjusted individually. There are three possible selections of scanning protocols: manual selection, automatic selection and repeating scan parameters from the previous sample. In the case of automatic selection of scanning protocol, the control software measures the size of a sample and adjusts the optimal magnification to get it fully inside field of view.

SkyScan X-ray Microscopes Performance Characteristics

SS1275

SS1275

	Specification
X-ray source	20 – 100 kV, 10 W < 5 μm spot size at 4 W
Nominal resolution (pixel size at maximum magnification)	< 4 μm
X-ray camera	3 MP 1,944 x 1,536 px active pixel CMOS flat panel
Reconstructed volume (after round trajectory scan)	up to 1,944 x 1,944 x 1,160 px
Sample size	SKYSCAN 1275 Max. height 120 mm, max. Ø 96 mm

Dimensions (W x D x H)	SKYSCAN 1275 104 cm x 66 cm x 40 cm 104 cm x 66 cm x 59 cm, with sample changer

Front

104 cm

59 cm

40 cm

Sample changer

170 kg   13 kg

Right

66 cm

SkyScan X-ray Microscopes
SkyScan 2214

Attributes

- **Open X-ray Source**
- **CCD & CMOS Detectors**
- **Variable SOD & SDD**
- **Helical Scanning**
- **HART Plus Scanning**
- **3D.Suite Software With 25 User License**
- **Detector Choice Software Selectable**

Single-phase Power

SkyScan X-ray Microscopes
SkyScan 2214
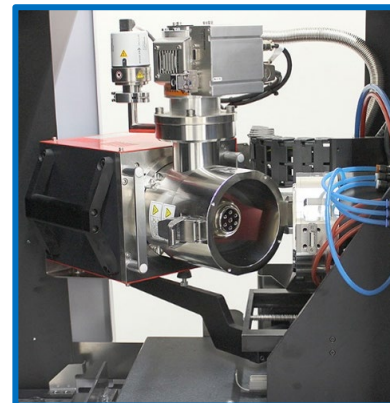
High performance X-ray source

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 (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.

SkyScan X-ray Microscopes
SkyScan 2214

SS2214

BRUKER

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.==

Comprehensive system status indicators

The X-ray source is equipped with a liquid cooling system which contains a re-circulator, providing precise temperature stability of the cooling fluid.

SkyScan X-ray Microscopes
SkyScan 2214

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.
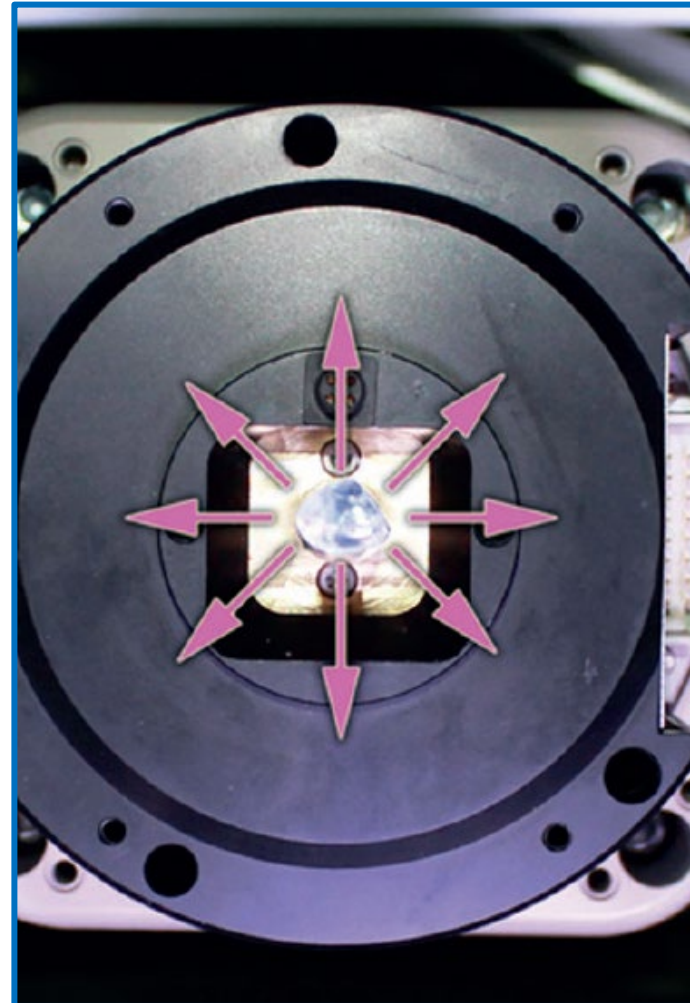
⑤

Video Image

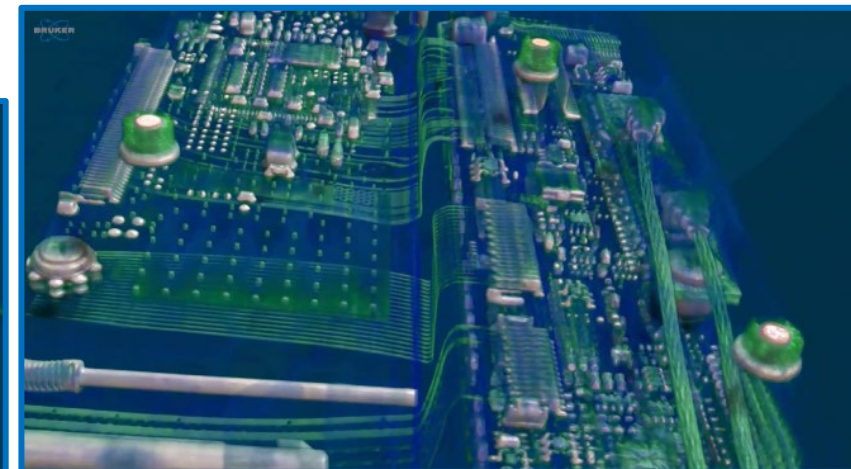- Sample inspection with live optical camera
- Allows positioning of the sample for the highest resolution

Visual Image

⑤
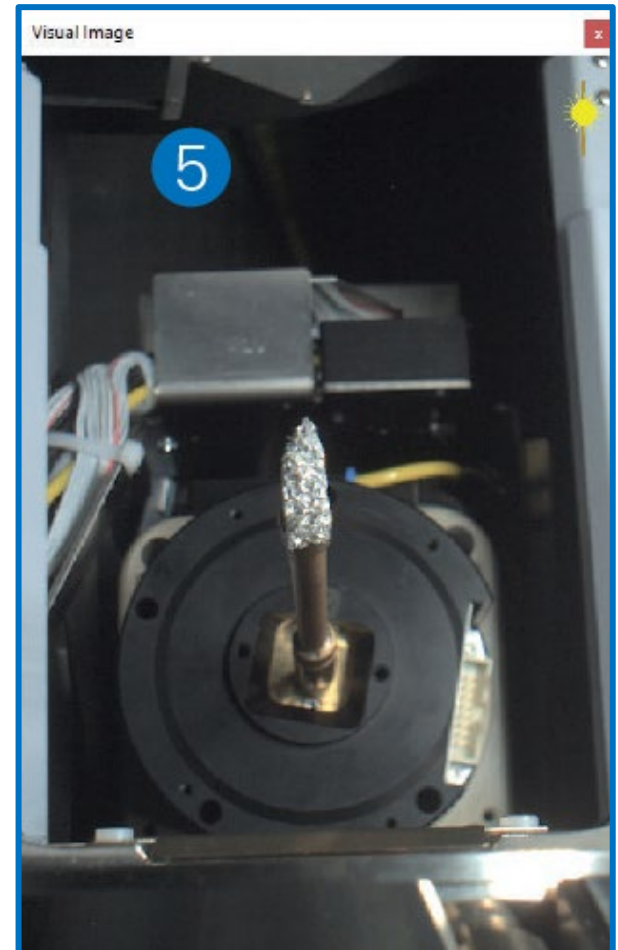
SkyScan X-ray Microscopes
SkyScan 2214

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.

- User Interchangeable Pre-Aligned Filaments
  - 20 - 160 kV with W filament
  - 20 - 100 kV with LaB_6 filament
- Spot Size / Resolution With JIMA Chart
  - 0.8 μm with W filament
  - <0.5 μm with LaB_6 filament

JIMA resolution chart imaged by the SKYSCAN 2214 proving 500 nm structures are clearly resolved
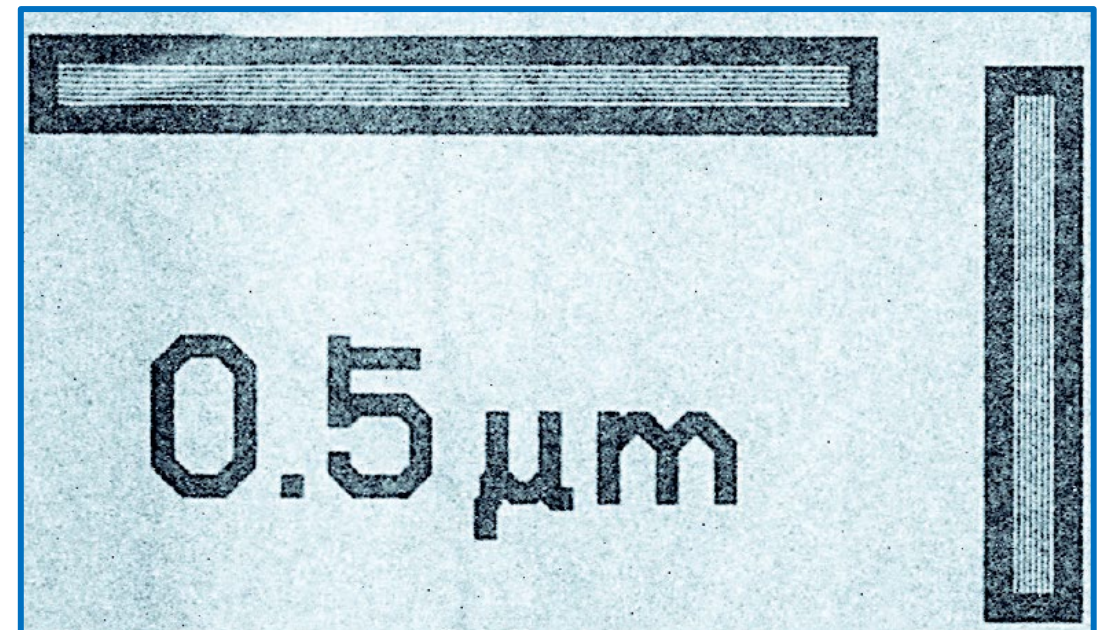
SkyScan X-ray Microscopes
SkyScan 2214

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.
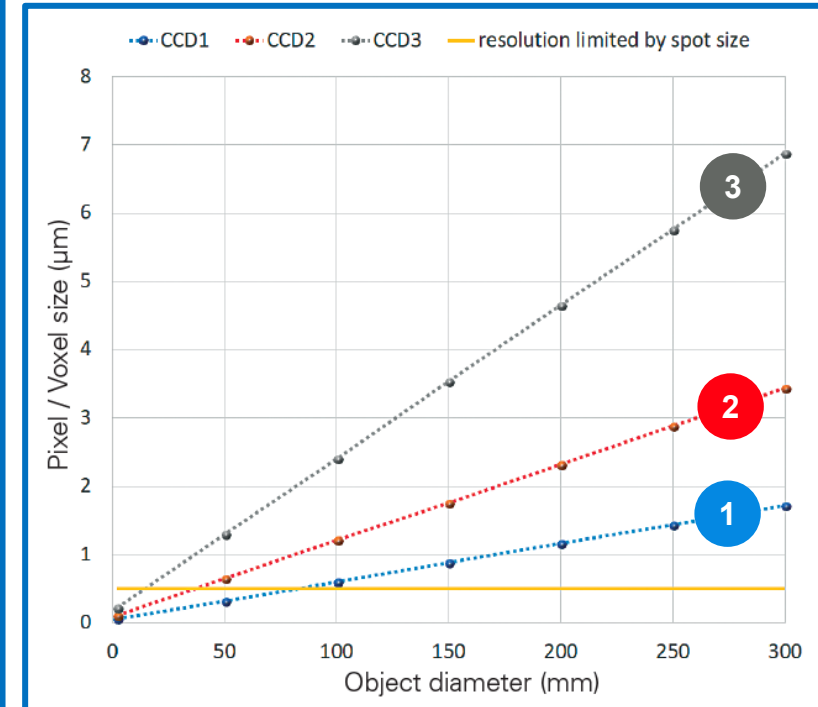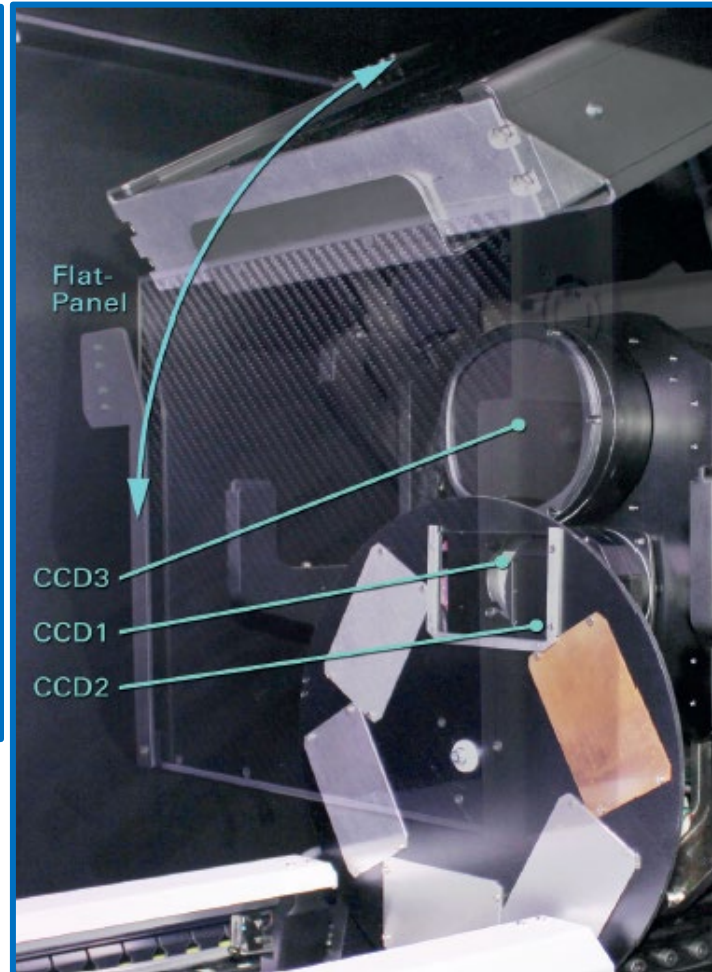
SkyScan X-ray Microscopes
SkyScan 2214

- **CCD1: For Highest Resolution**
  - **(1)** Small field of view, thin scintillator sensitive mainly for soft X-rays, can be used for small samples of organic materials, carbon-fibers, plastics, paper etc.
- **CCD2: Standard Field-Of-View, Optimal Resolution**
  - **(2)** Mid field of view, can be used for organic materials, carbon and glass fibers, plastics, light metals, such as Al and Ti.
- **CCD3: Large Field-Of-View, Bigger/Denser Objects**
  - **(3)** Large field of view with sub-micron resolution, thick scintillator sensitive to all energies, for widest range of materials and sample sizes
- **FP: Very Large Field-Of-View**
  - Large field of view, quick scanning for large objects with mid resolution in all types of materials.

- **6-Position Automatic Filter Changer; CCD Detectors**
  - No Filter, 0.25, 0.5, 1 mm Al, AlCu, Cu
- **2 Filters Manually Installed In Front of FP Detector**
  - 4 Filter Options; No Filter, Al, Cu, Al+Cu

13 inch notebook
320x220x35mm
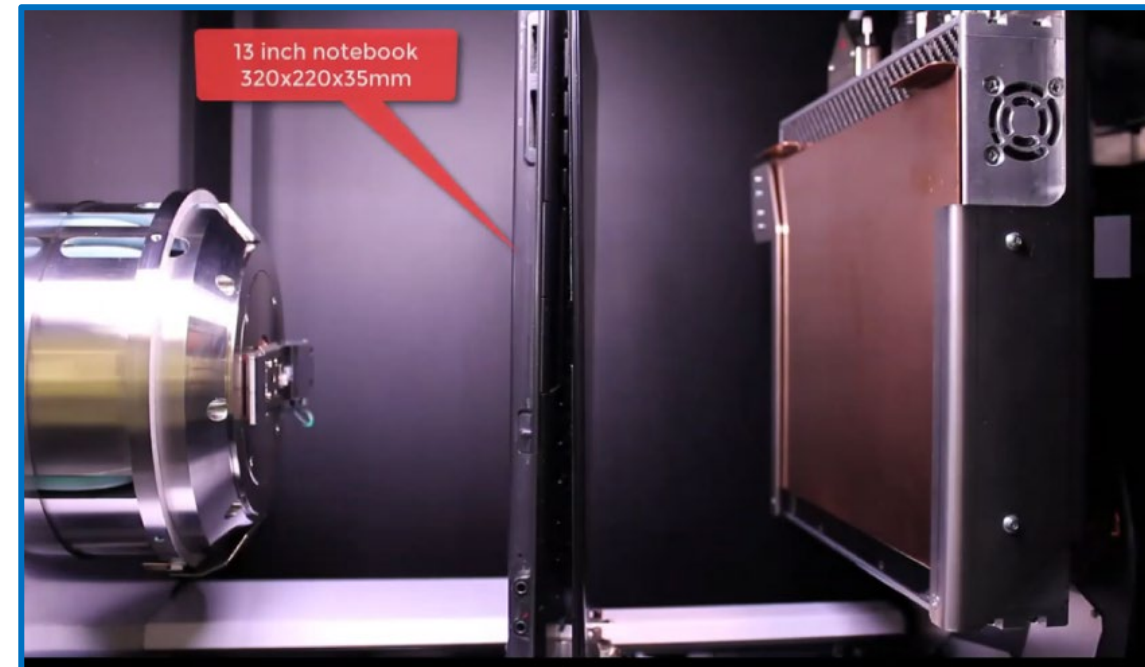
SkyScan X-ray Microscopes
SkyScan 2214
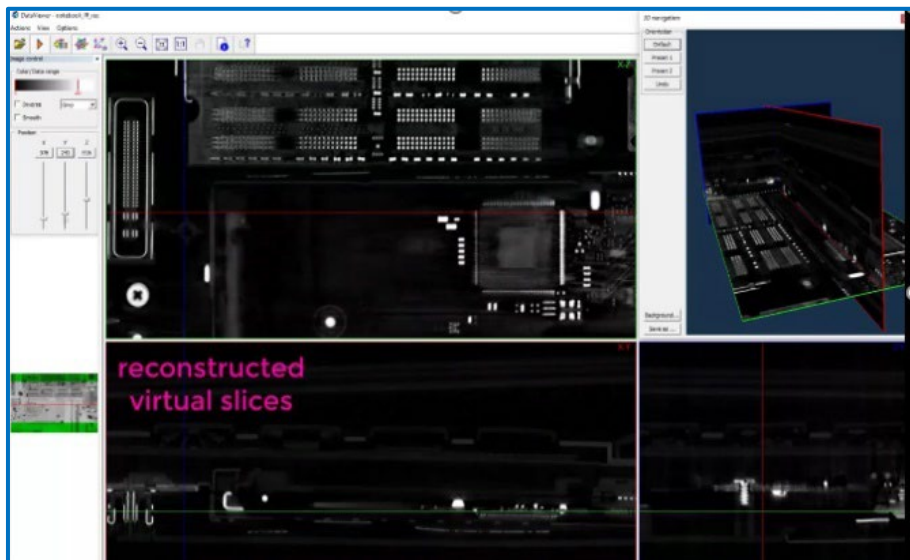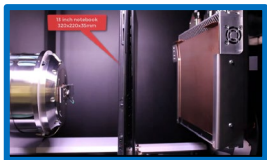
13" Notebook
FP, 34 µ res, 150 kV

Volume Rendering

reconstructed
virtual slices
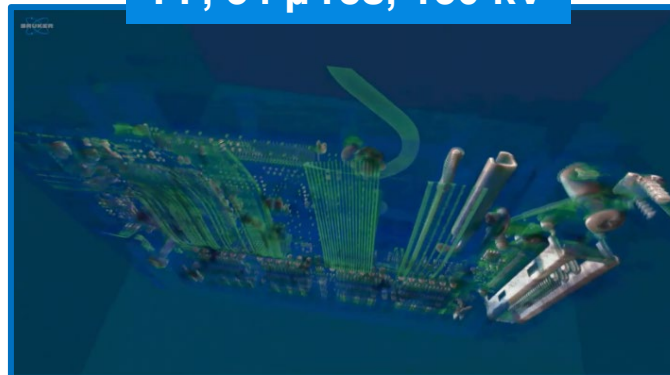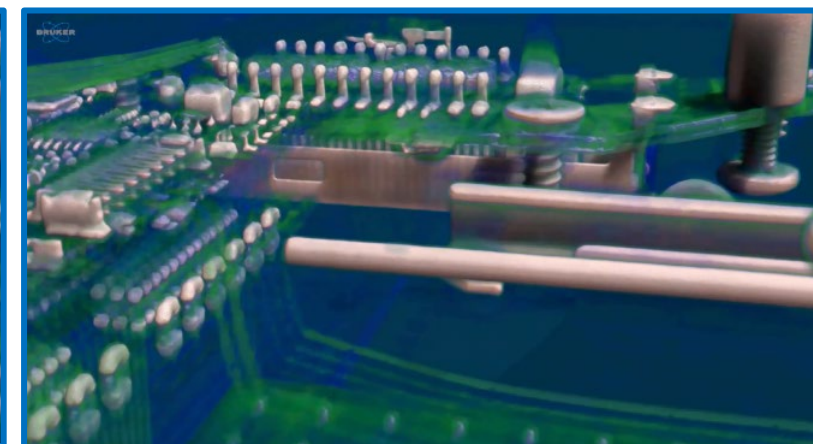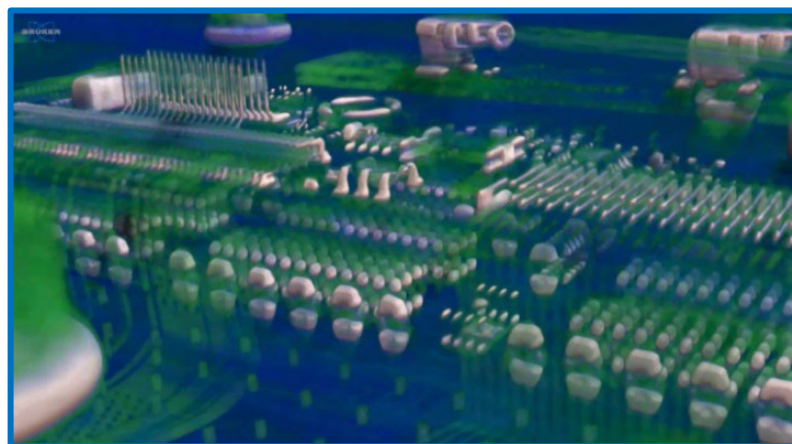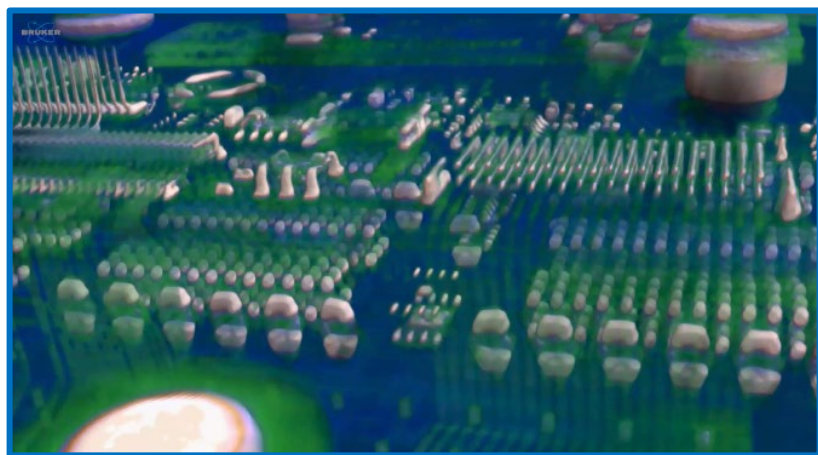
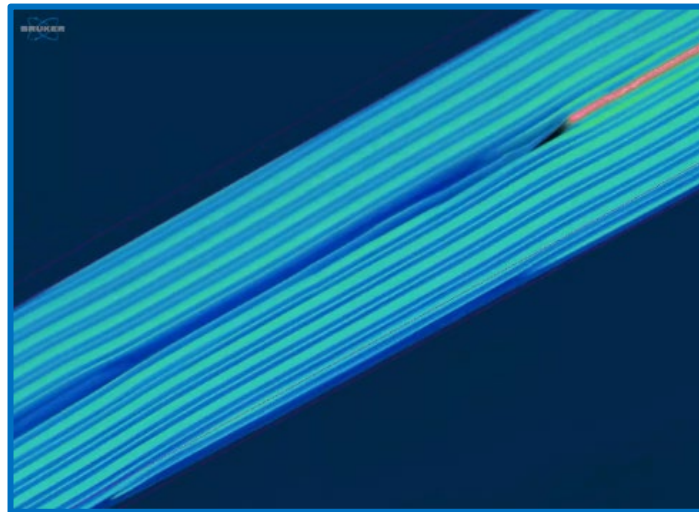# SkyScan X-ray Microscopes
SkyScan 2214

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.

- Lithium-ion battery
- 900 nm resolution, CCD3
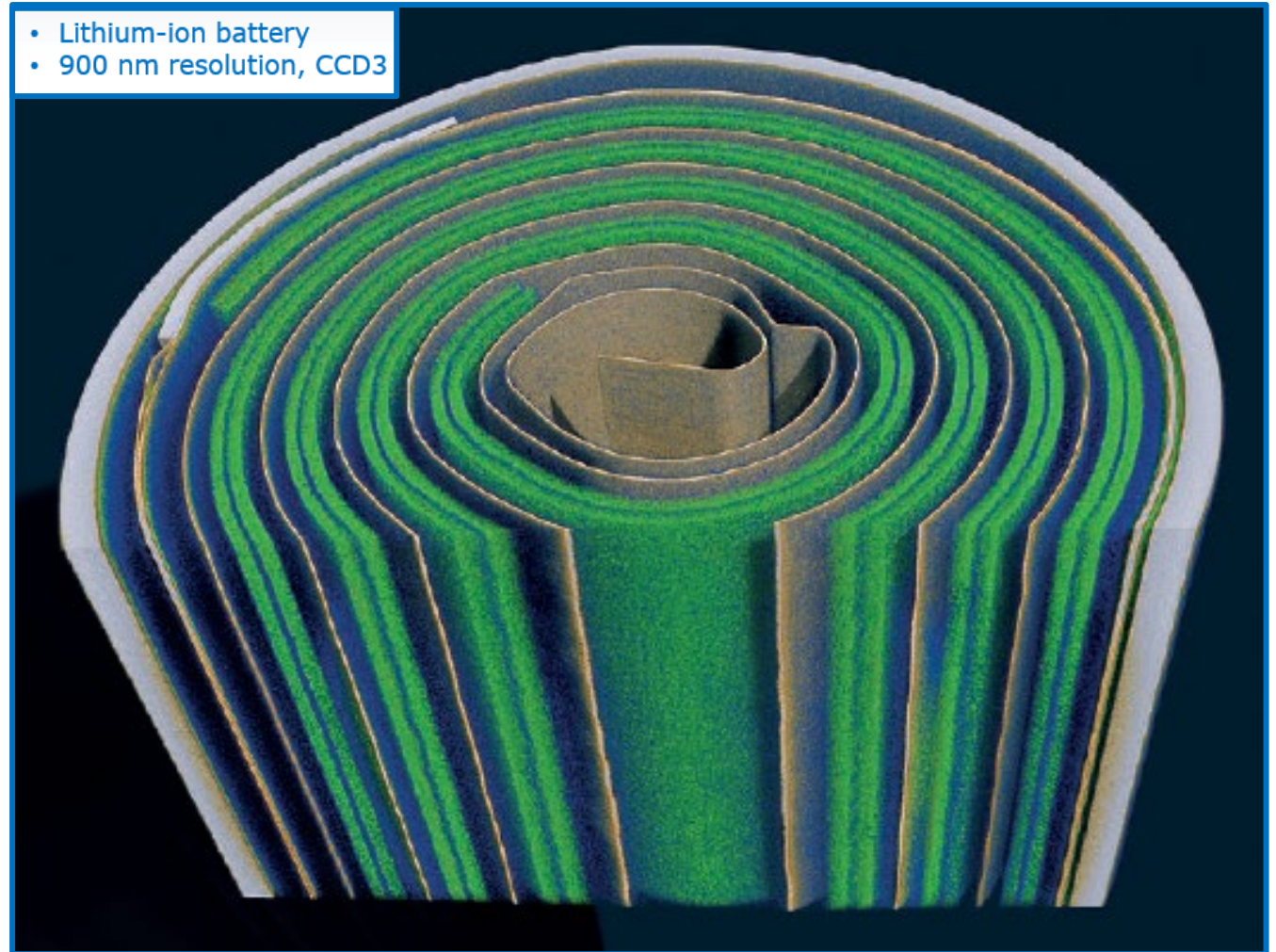
SkyScan X-ray Microscopes
SkyScan 2214

Lithium-ion battery

900 nm resolution, CCD3

900nm resolution

© 2021 Bruker
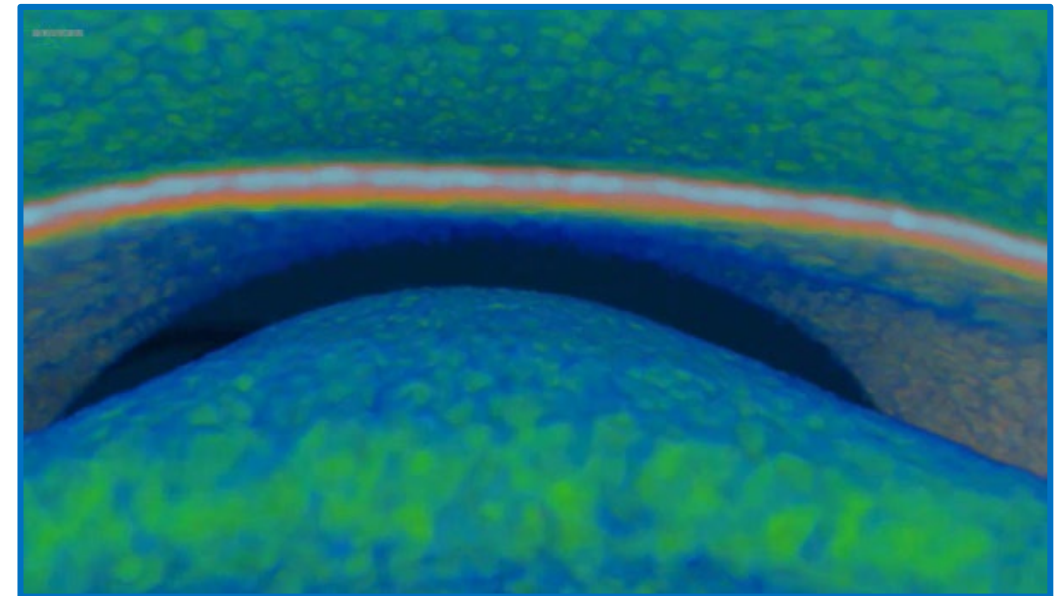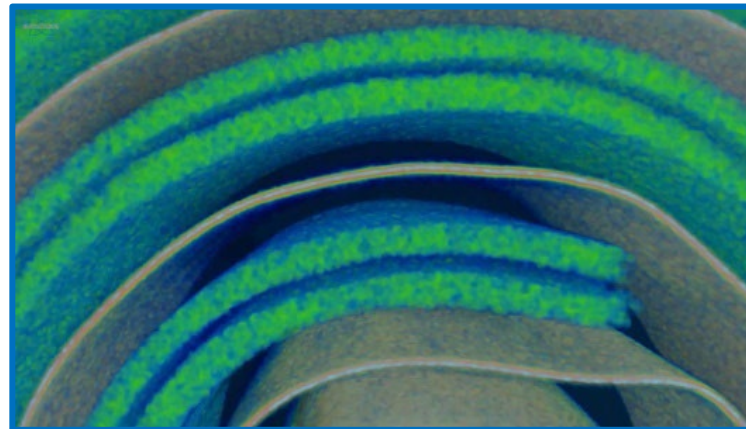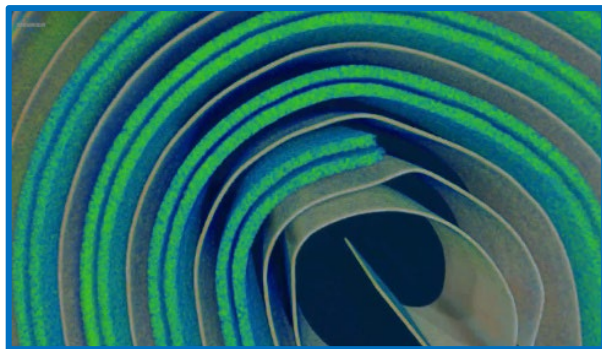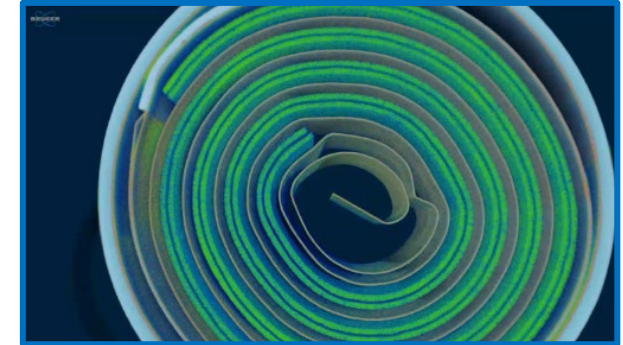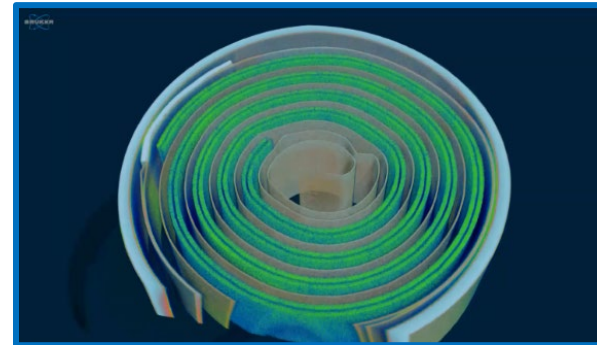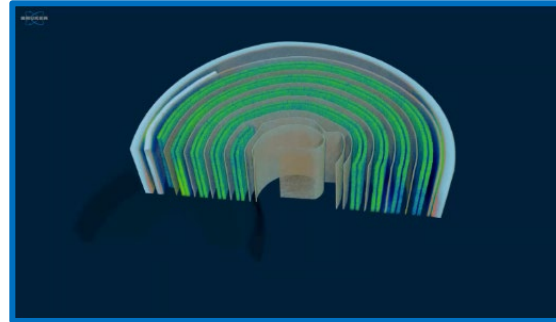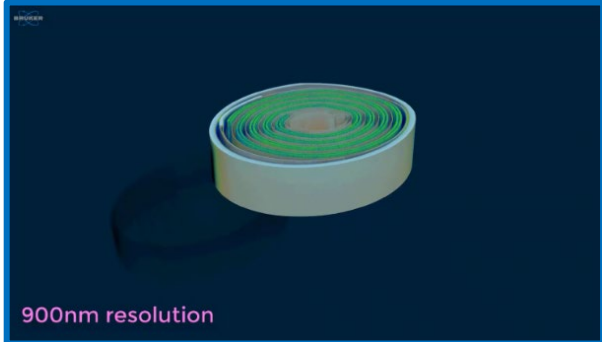
SkyScan X-ray Microscopes
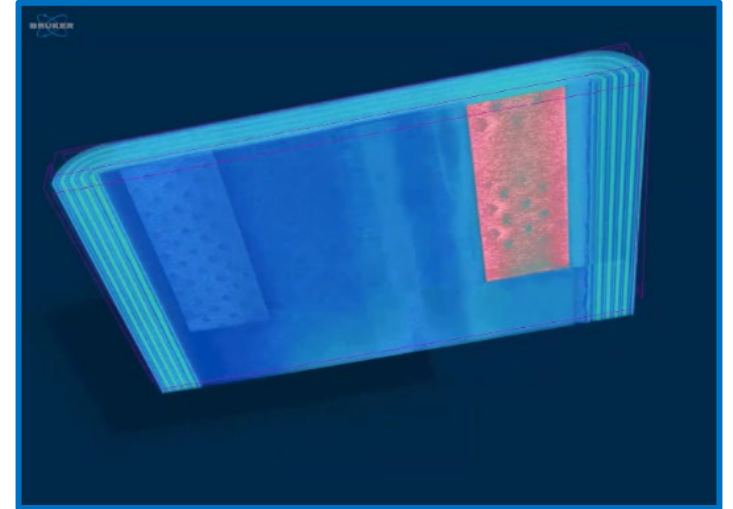## SkyScan 2214

Lithium-polymer battery

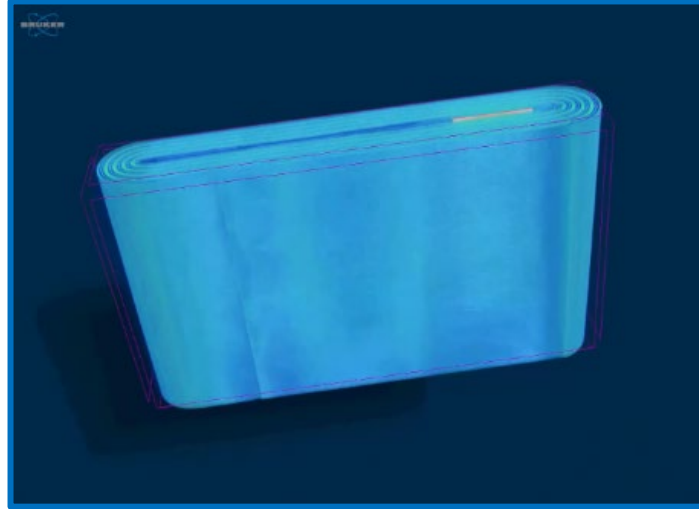3.4 µm resolution, CCD3
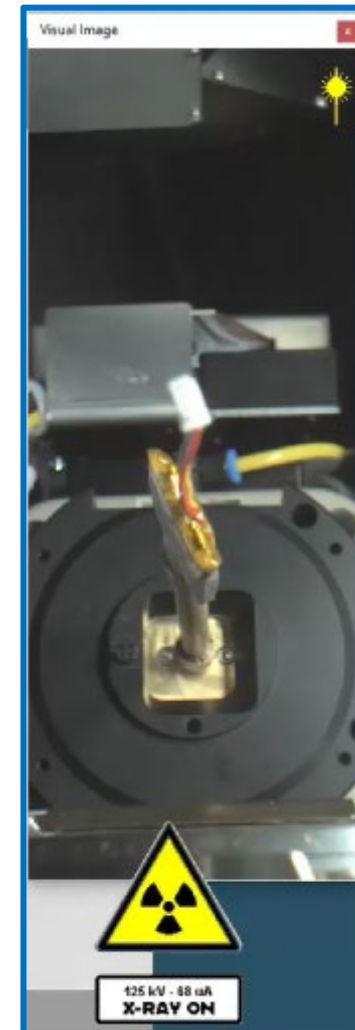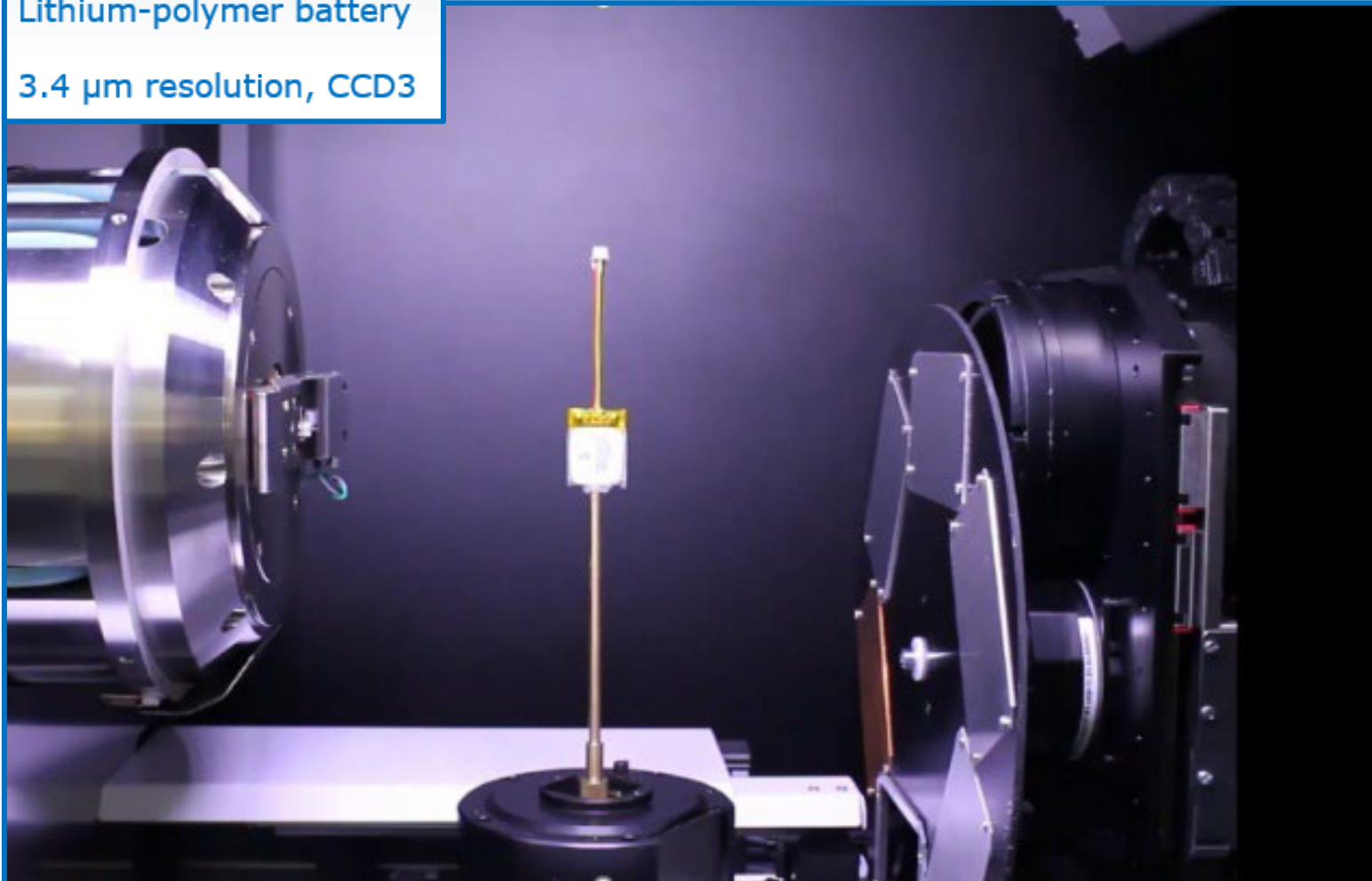
Visual Image

125 kV - 88 uA
X-RAY ON

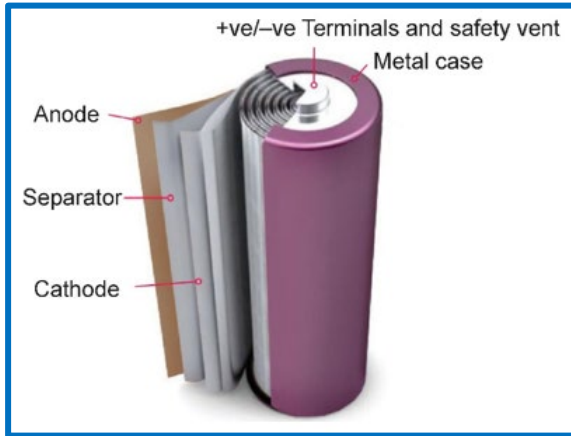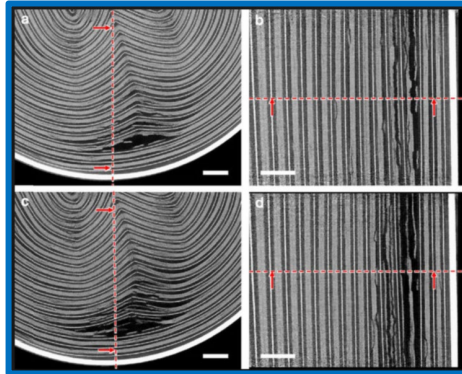# SkyScan X-ray Microscopes
SkyScan 2214

Volume Rendering
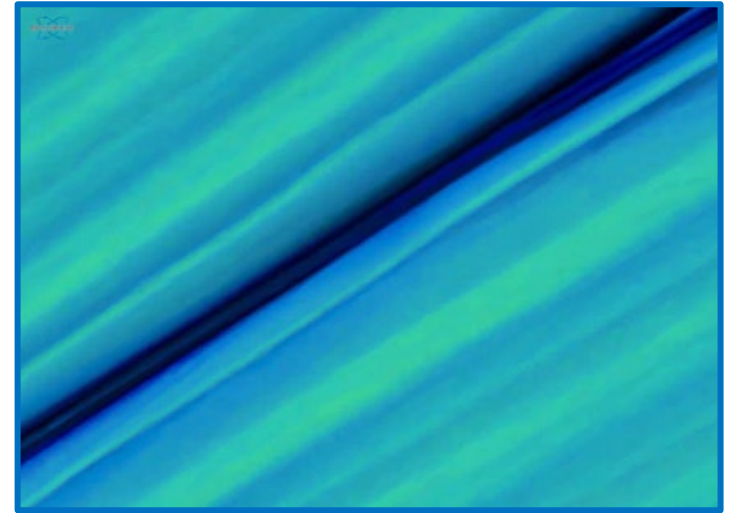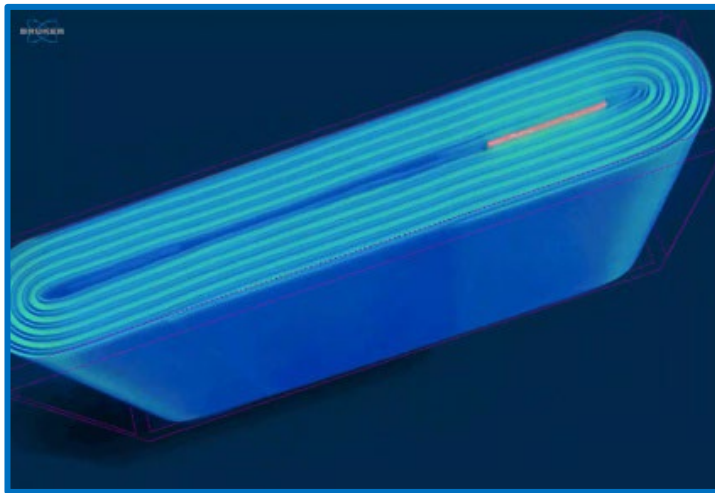
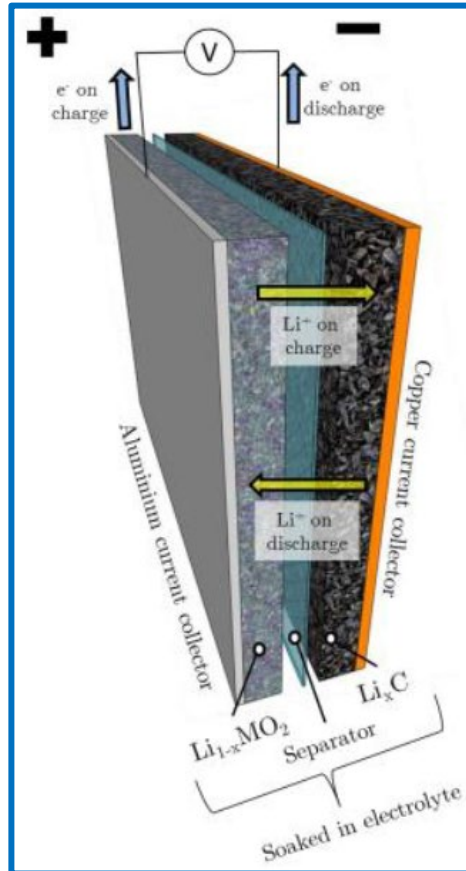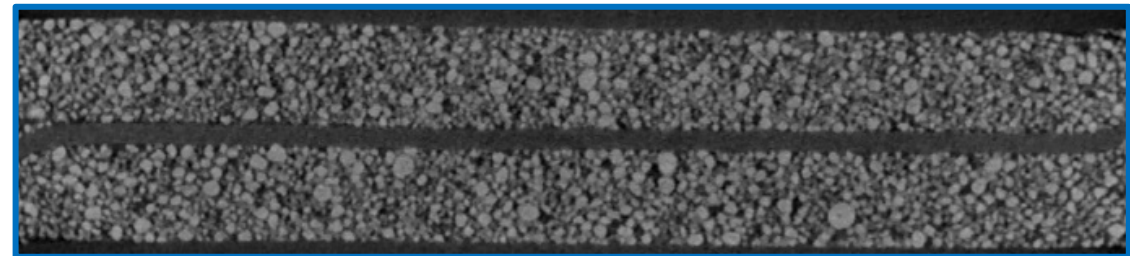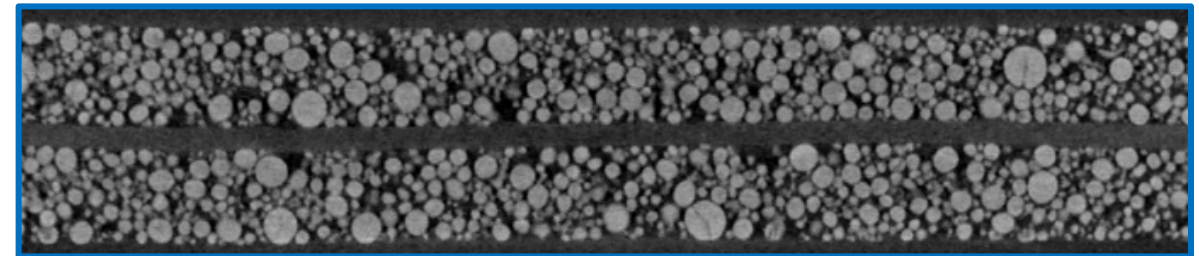# SkyScan X-ray Microscopes
SkyScan 2214

Cylindrical battery: Li-ion

Cathode foil with Aluminium layer

Production method A

Production method B

Both scans: 0.3 μm voxel size

- Imaging of Cathode / Anode – evaluation of different production methods
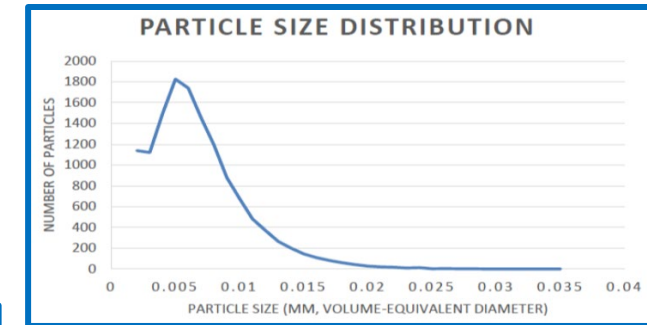
SkyScan X-ray Microscopes
SkyScan 2214

- Imaging of Cathode / Anode – highest resolution allows quantification of particle and pore sizes

E37

25 µm

P37

25 µm

0.3 µm voxel size

PARTICLE SIZE DISTRIBUTION

Pore size distribution
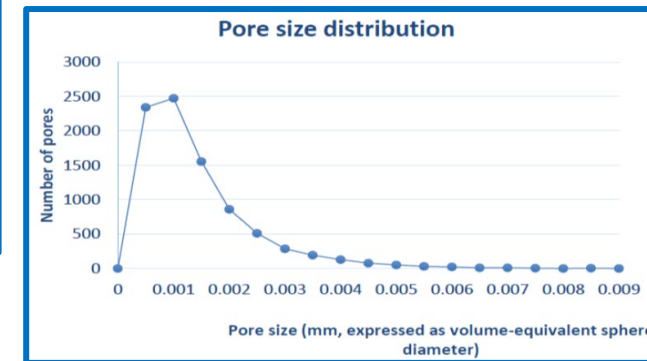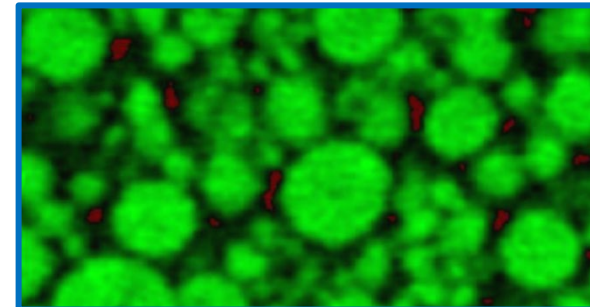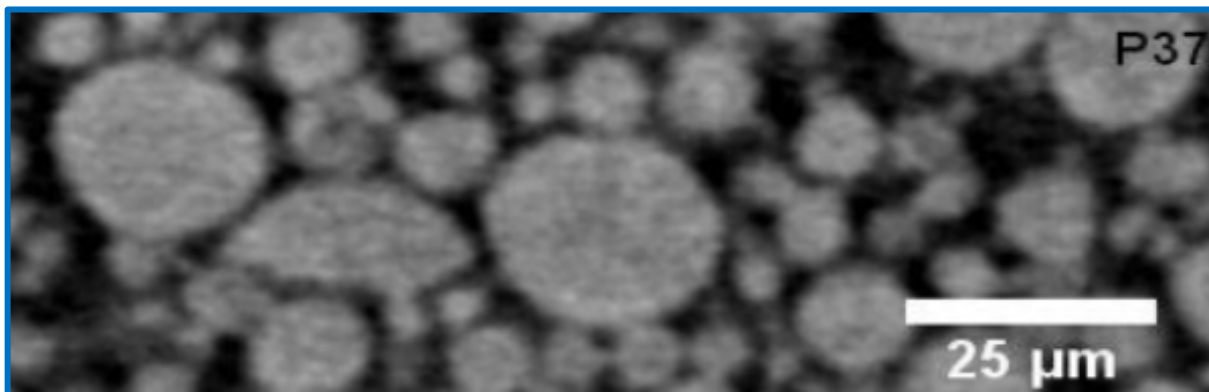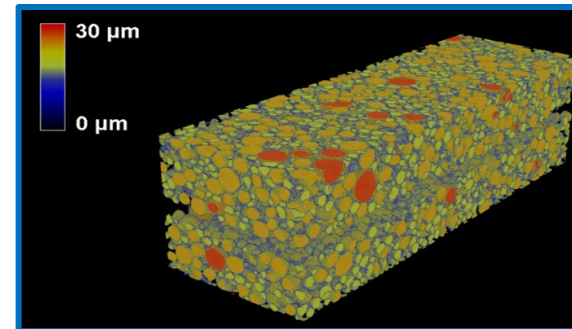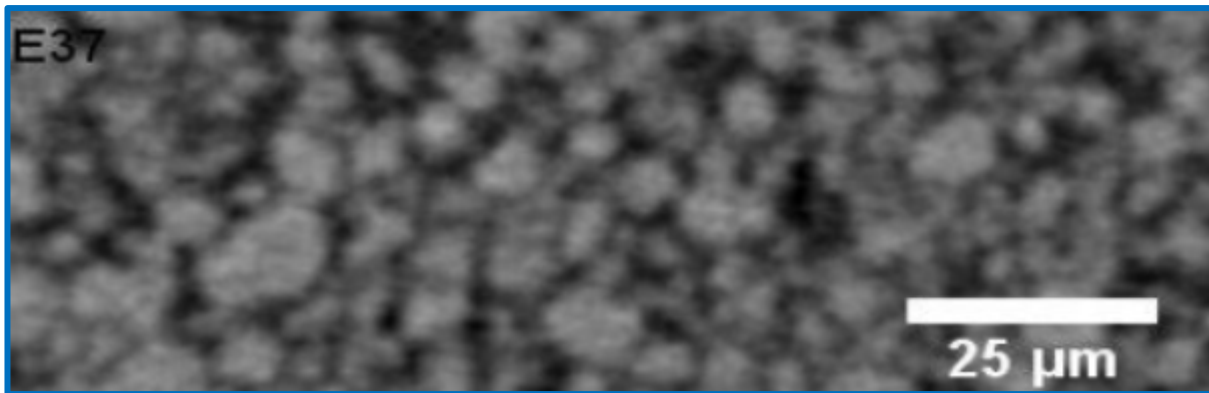
SkyScan X-ray Microscopes
SkyScan 2214

Polymers & Composites

- Resolve fine structures with true 3D resolution <500 nm

- Assess microstructural architecture and porosity

- Quantify defects, local fiber orientation and thickness

Carbon Fiber Reinforced Polymer

CFRP scanned at 600 nm voxel size.
Volume rendered 3D model with color coded local fiber orientation.
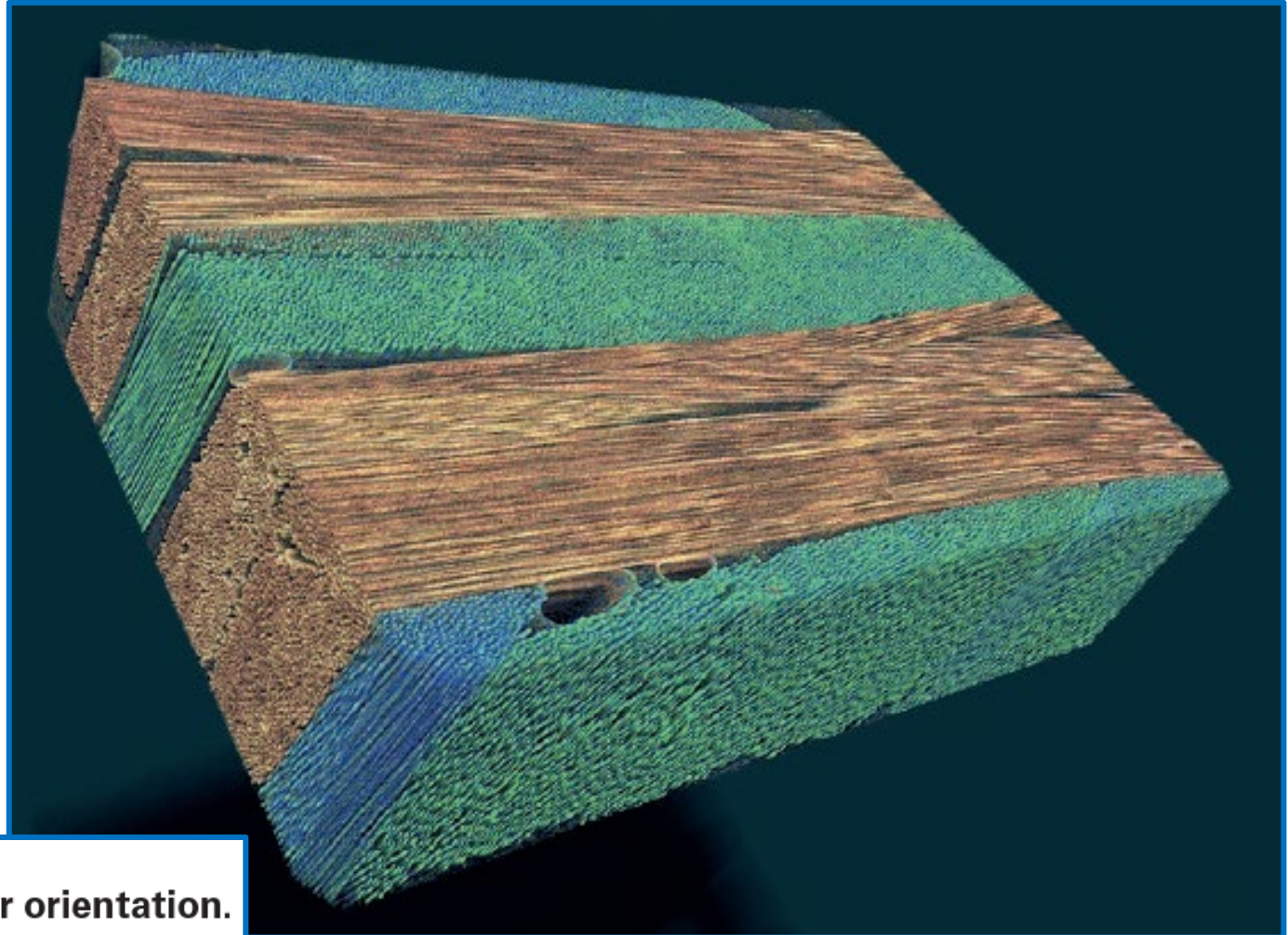
SkyScan X-ray Microscopes
SkyScan 2214

Volume Rendering

CFRP
(carbon-fiber reinforced polymer)

480 nm resolution, CCD2
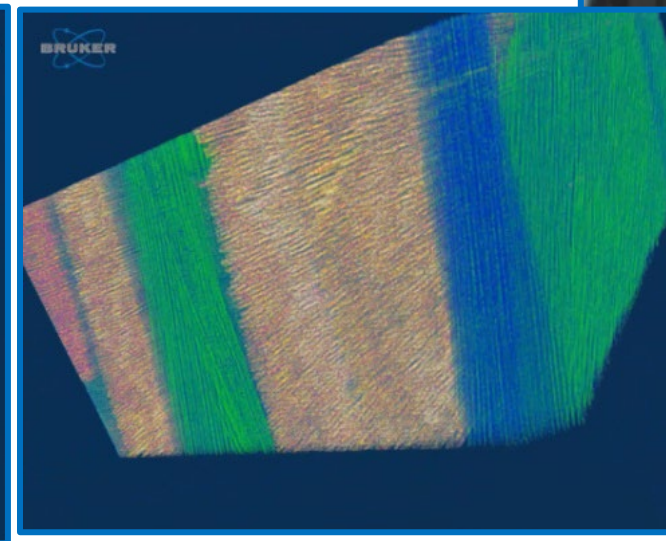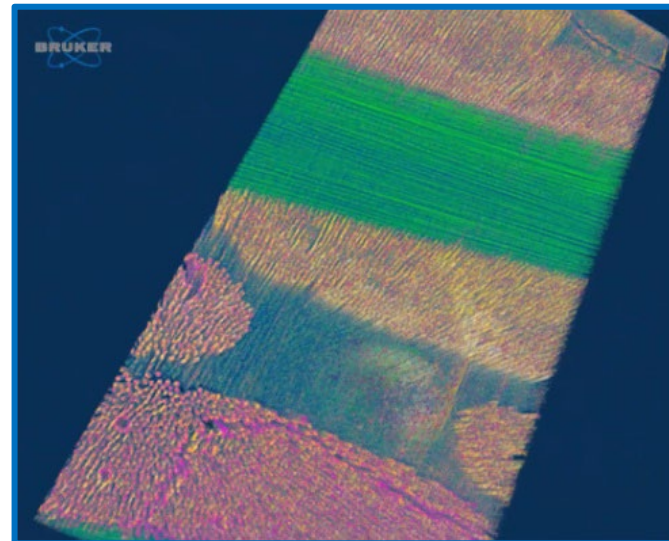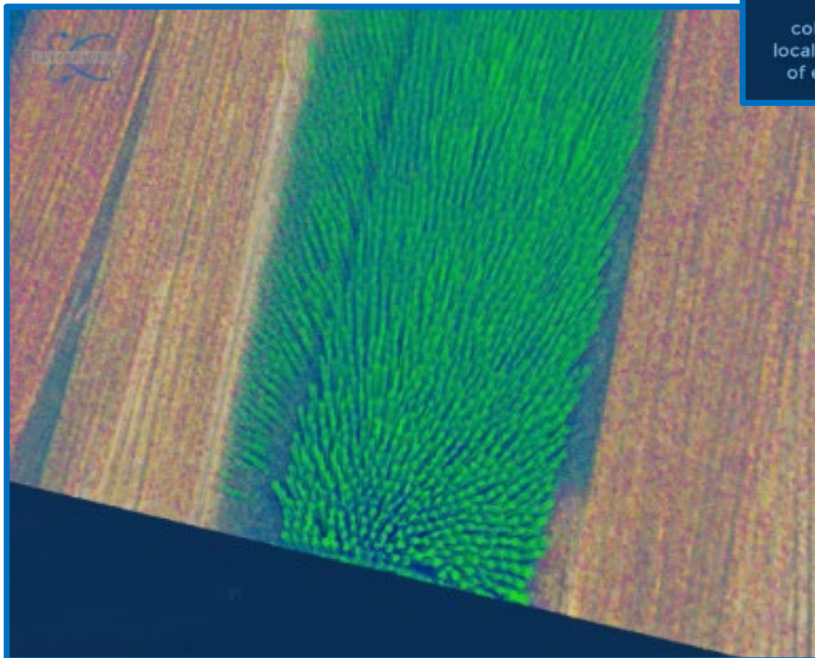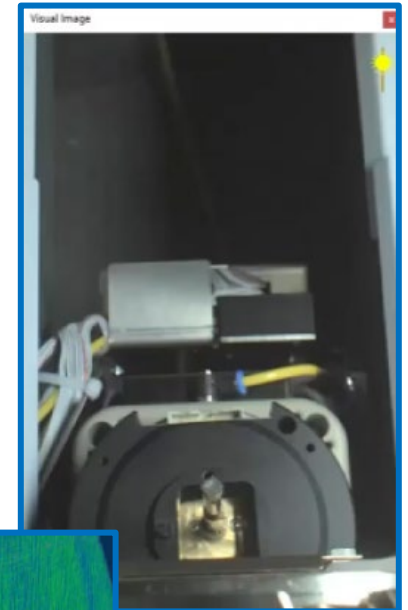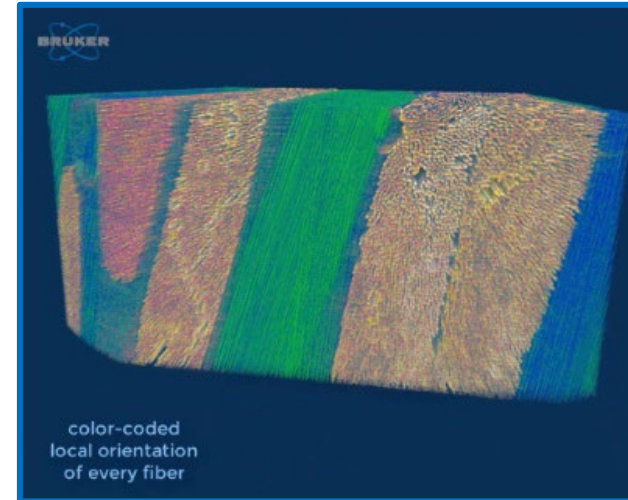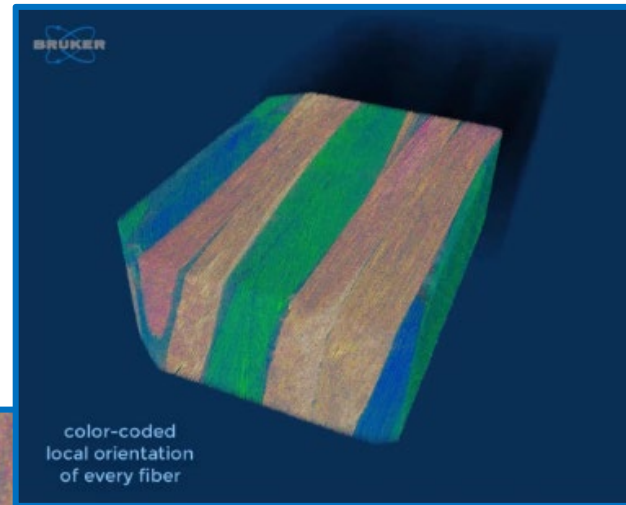
SkyScan X-ray Microscopes
SkyScan 2214

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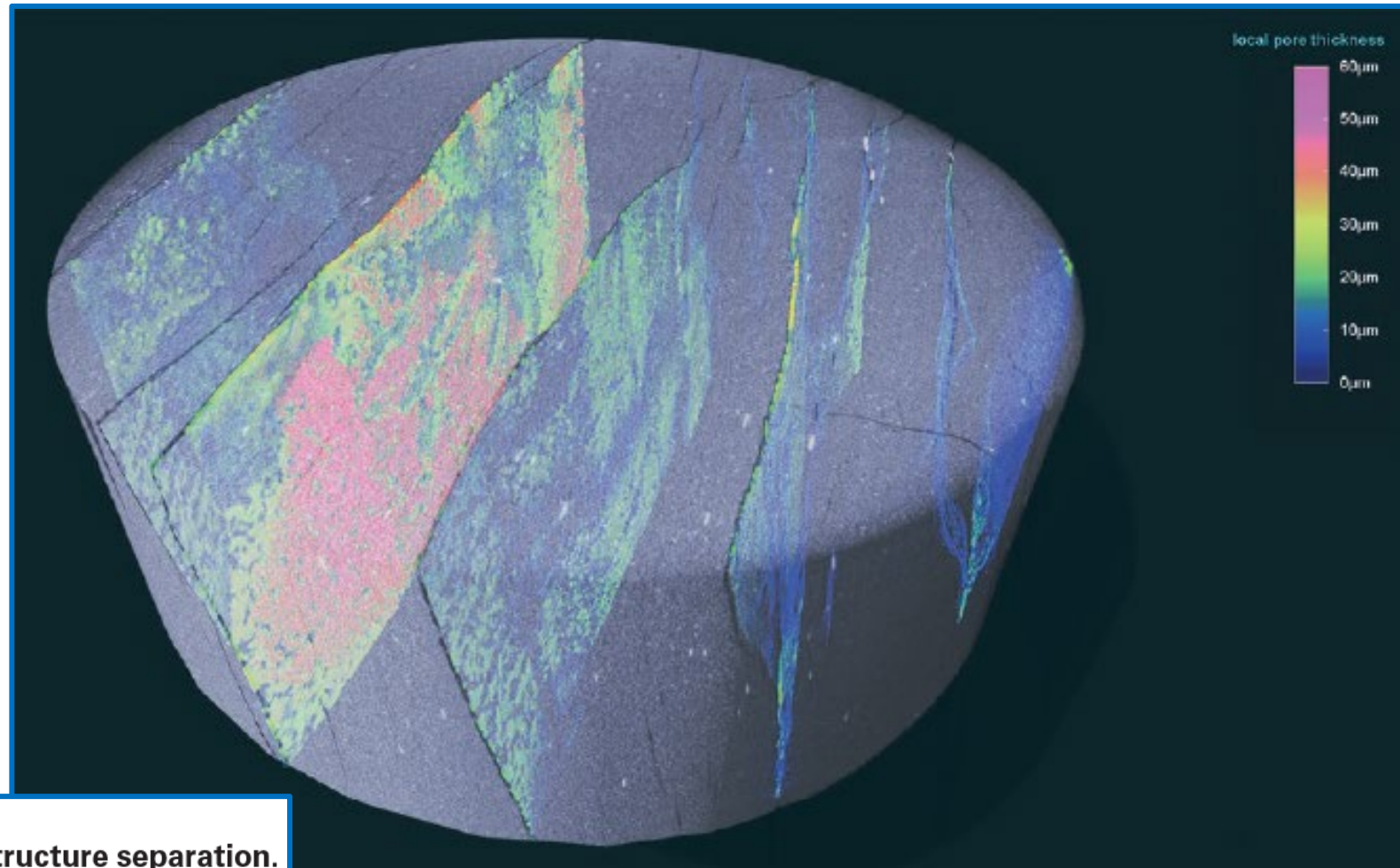
Shale scanned at 6.2 μm voxel size.
Volume rendered 3D model with color coded local structure separation.

SkyScan X-ray Microscopes
SkyScan 2214

Shale

6.2 µm resolution, FP
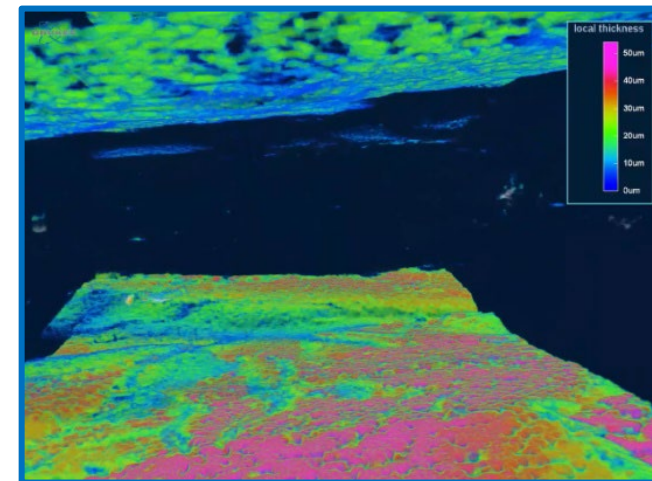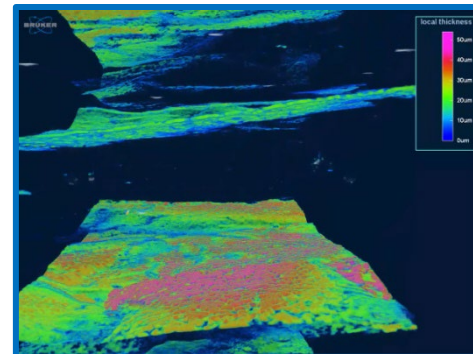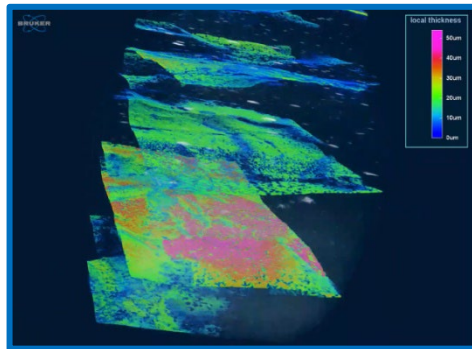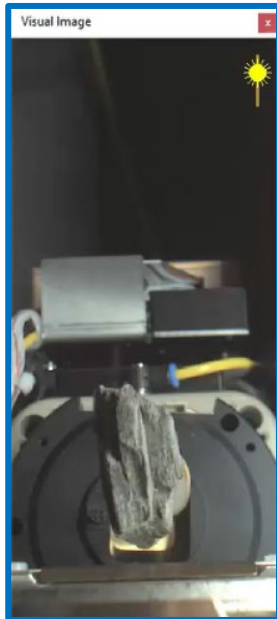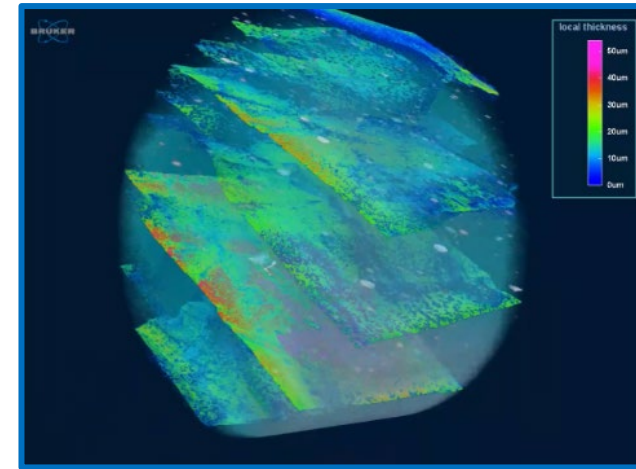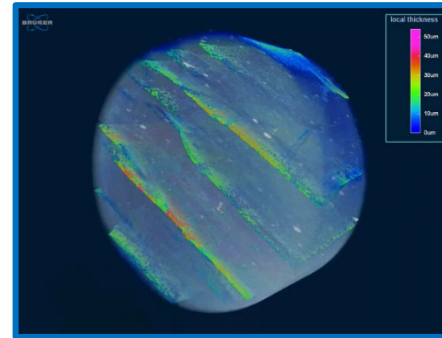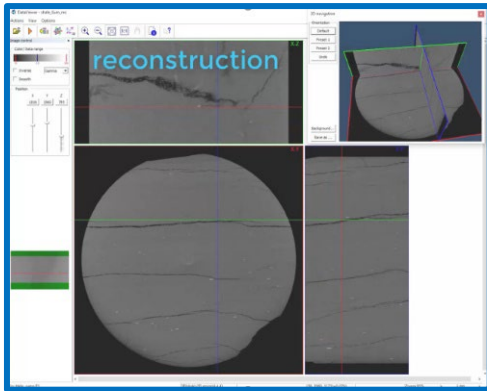
reconstruction

4 x 5.5 cm

scanning

Volume Rendering

Visual Image

SkyScan X-ray Microscopes
SkyScan 2214

Sandstone

2.2 µm resolution, CCD3
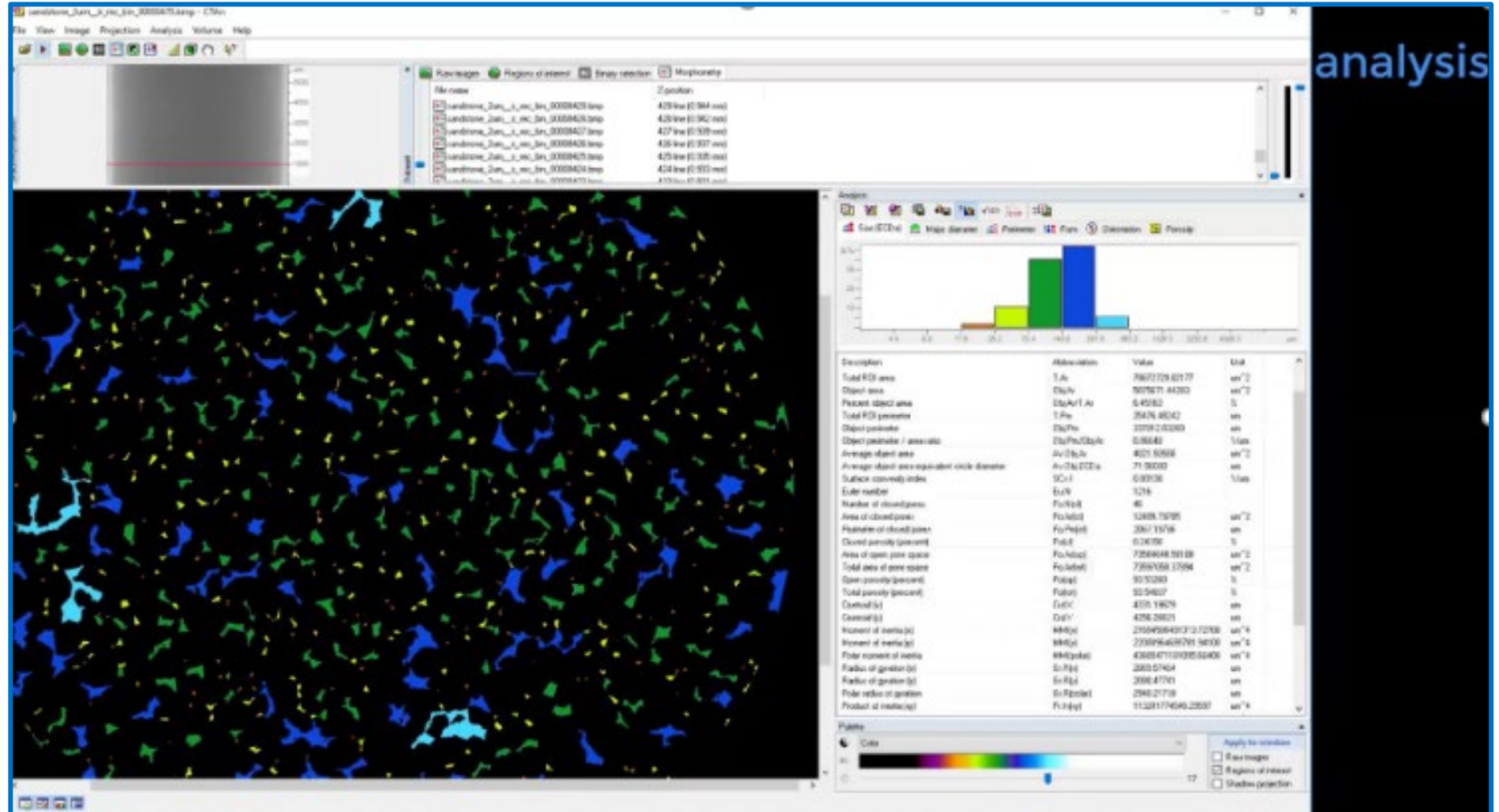
SkyScan X-ray Microscopes
SkyScan 2214

Sandstone

2.2 μm resolution, CCD3
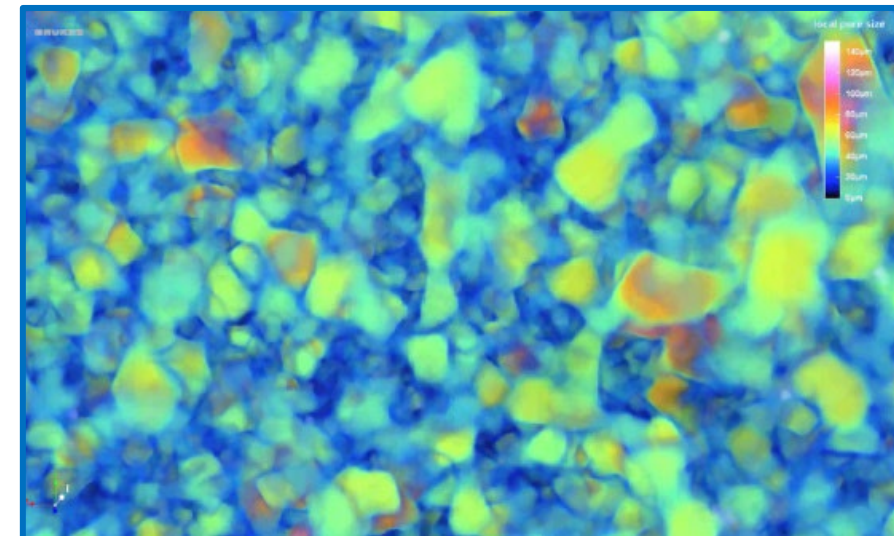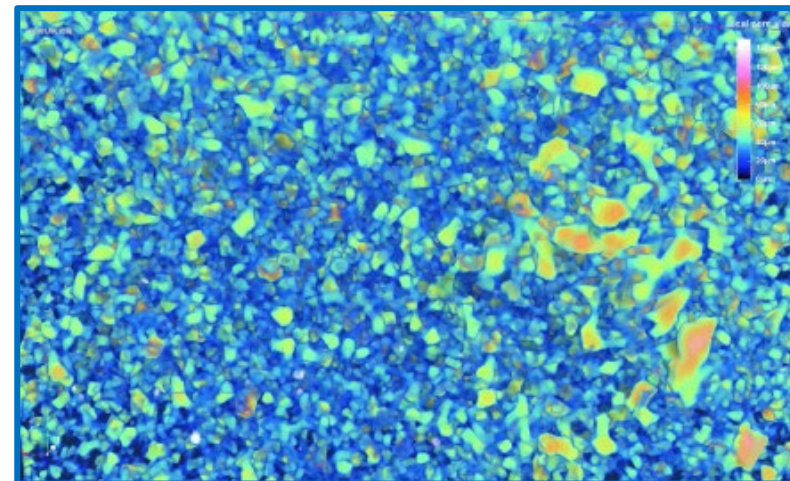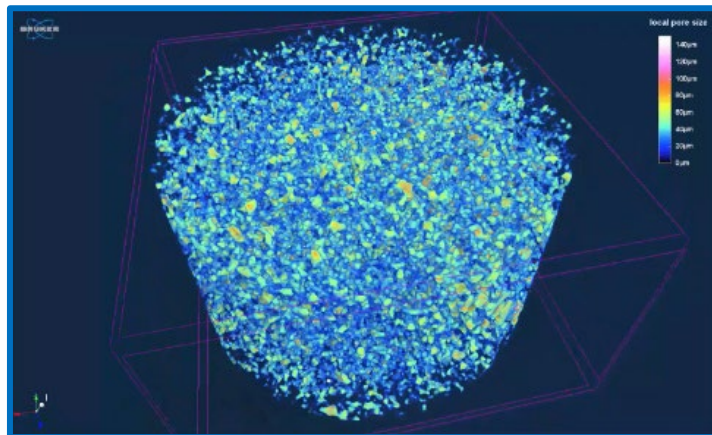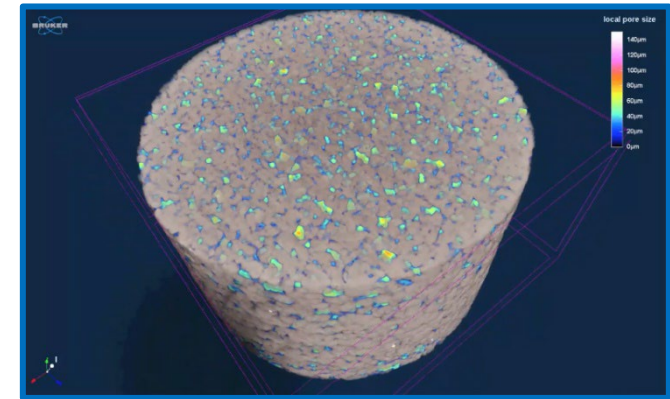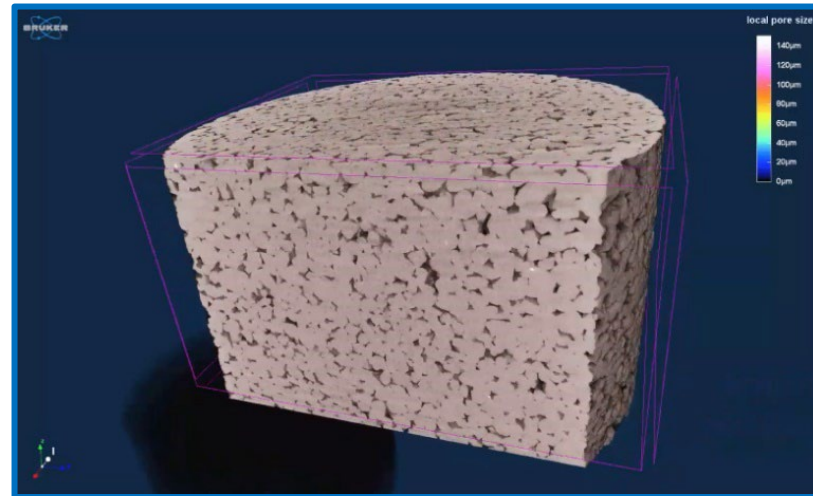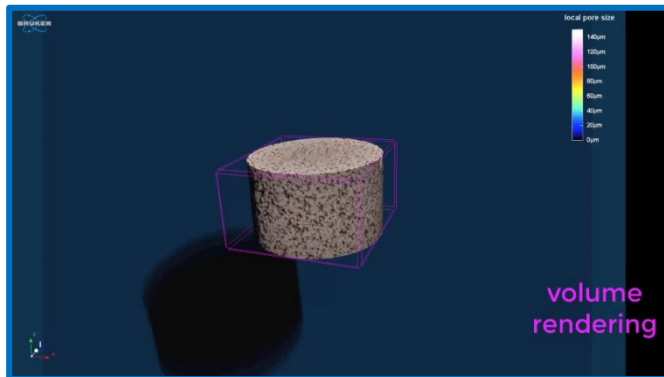
volume rendering

SkyScan X-ray Microscopes
SkyScan 2214

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.

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
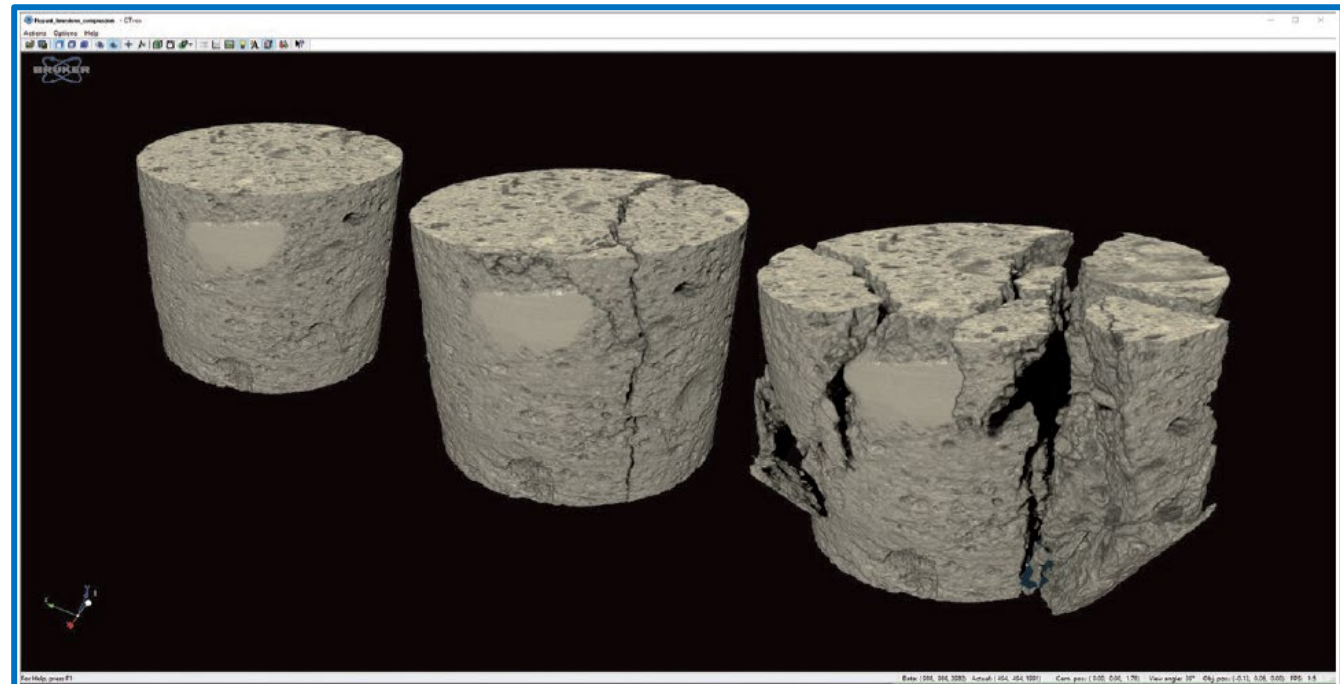
SkyScan X-ray Microscopes
SkyScan 2214

SS2214

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.

Individual analysis of aggregate particles in concrete using CTAN

SkyScan X-ray Microscopes
SkyScan 2214

SS2214

BRUKER
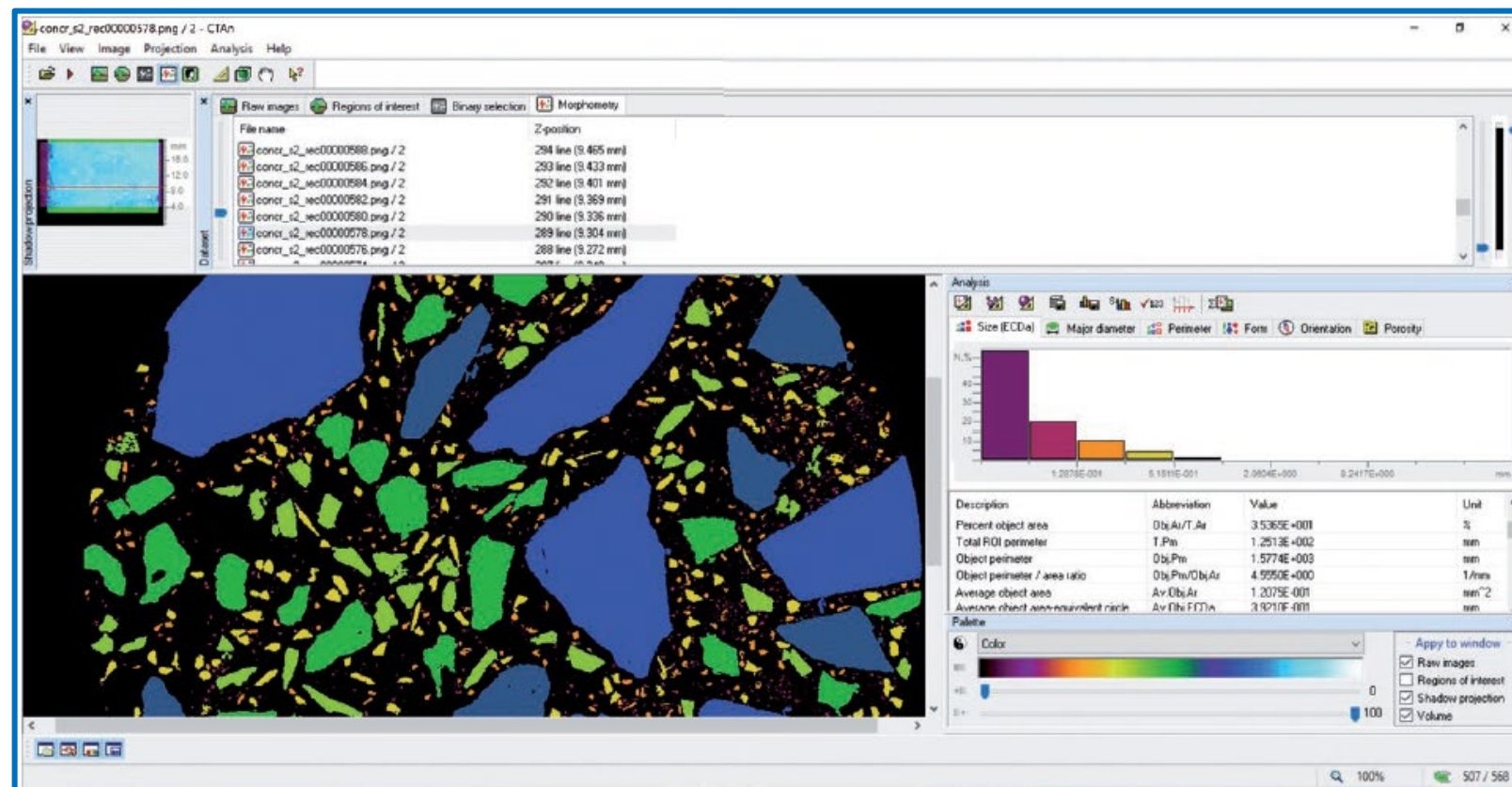
CTVOL

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.

Surface rendered model of concrete binder and aggregate in CTVOL
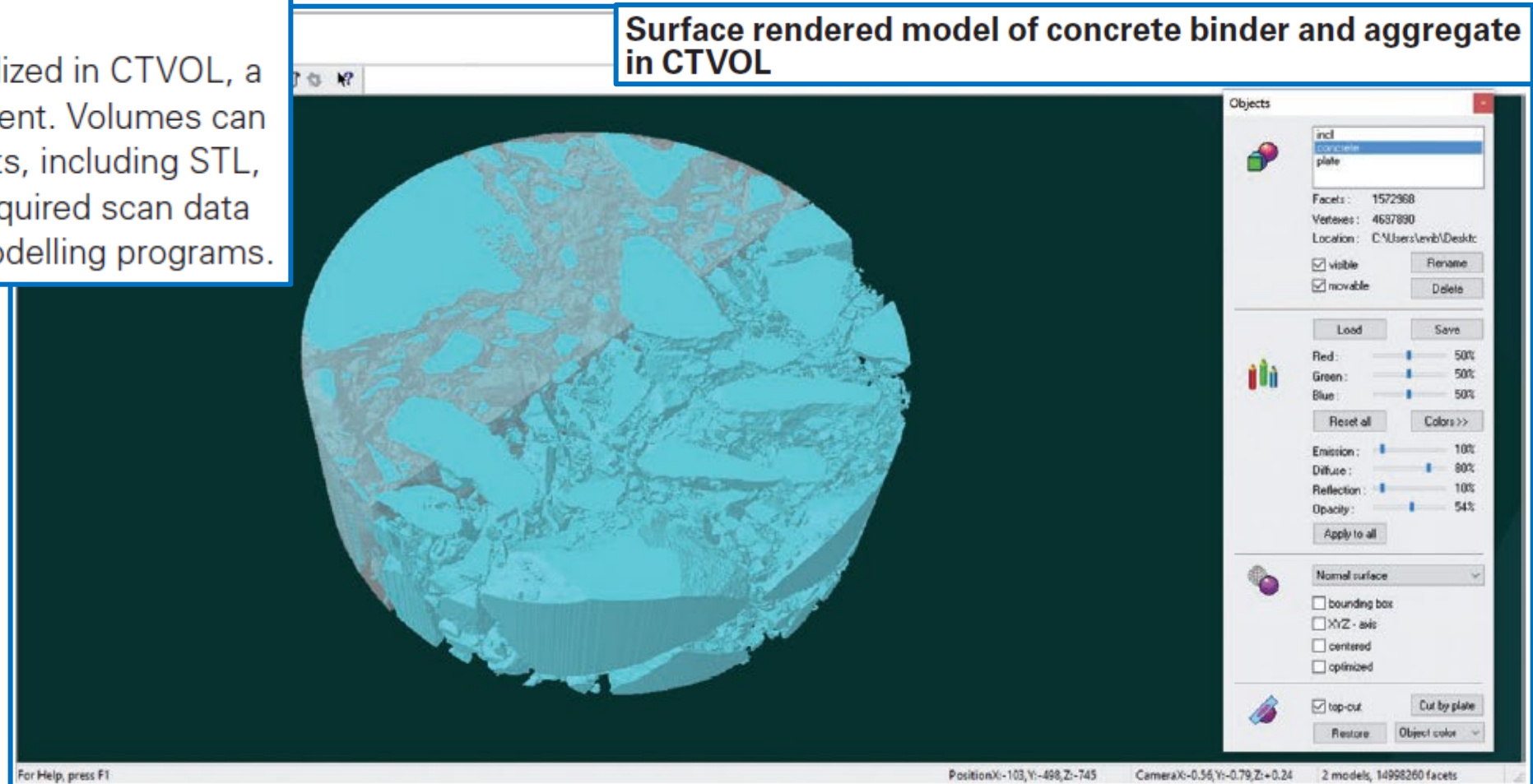
SkyScan X-ray Microscopes
SkyScan 2214

NRECON
GPU-accelerated reconstruction for round and spiral trajectories

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

CTVOX
Realistic visualization by volume rendering

CTVOL
Built-in surface rendering

CTAN
2D/3D image analysis & processing

3D.SUITE Software

SCAN
RECON STRUCT
VISUALI-SATION
ANALYSIS

DataViewer
NRecon.exe -
CTvox -
CTvol -
CTAn

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.

SkyScan X-ray Microscopes
SkyScan 2214

CTVOX
Realistic visualization by volume rendering

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

CTVOX mobile app with full functionality

SkyScan X-ray Microscopes
SkyScan 2214

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.
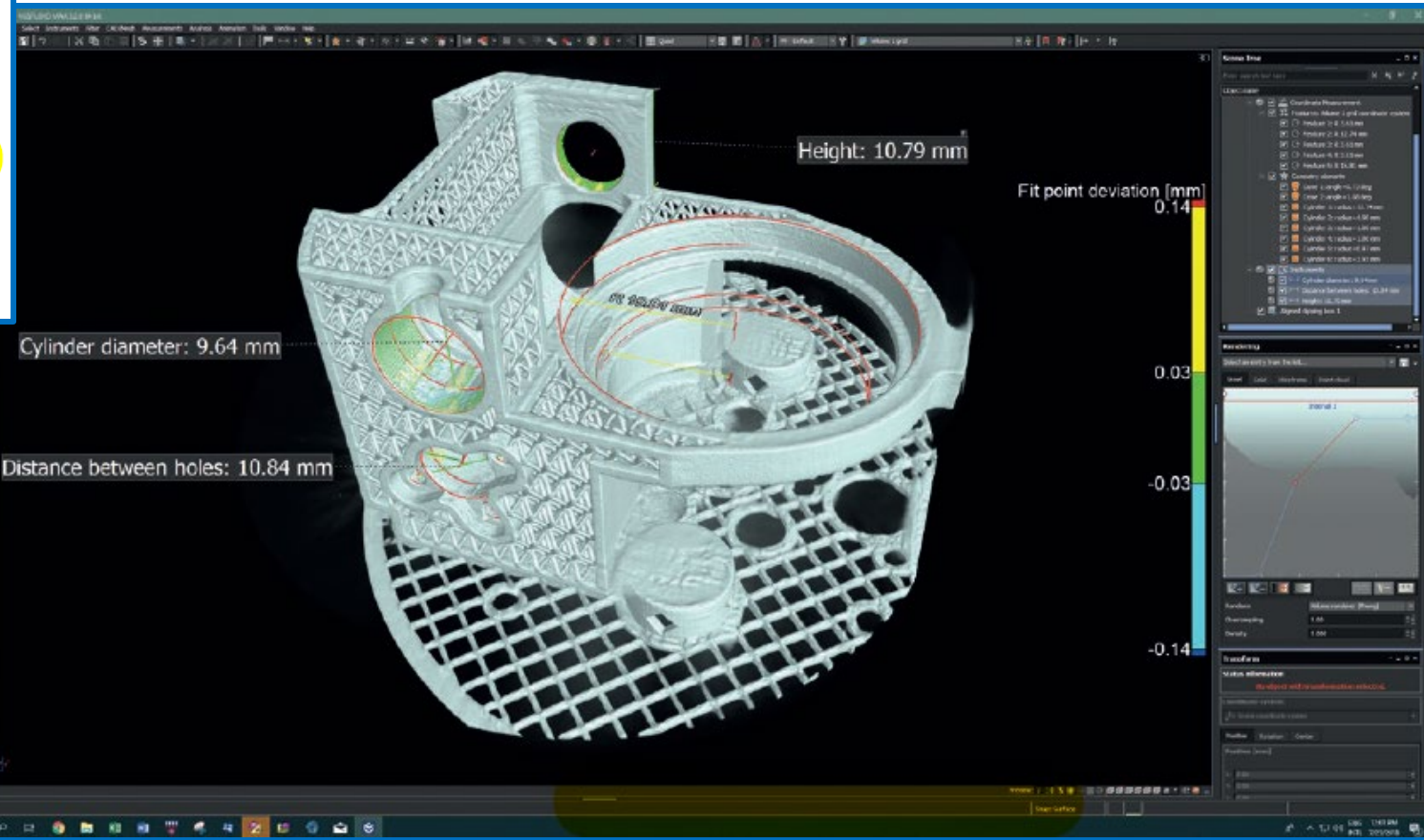
BRUKER_MICROCT   160kV 9.7W

Height: 10.79 mm

Cylinder diameter: 9.64 mm

Distance between holes: 10.84 mm

Fit point deviation [mm]
0.14
0.03
-0.03
-0.14

SkyScan X-ray Microscopes
SkyScan 2214
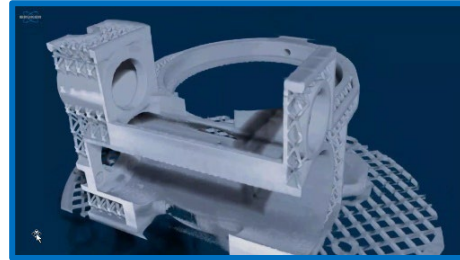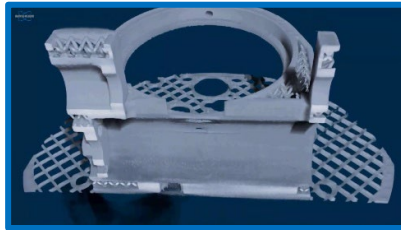
SkyScan X-ray Microscopes
SkyScan 2214

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.

In-Situ tensile/compression loadcells & Peltier stages for Micro X-ray Computed Tomography systems

A range of tensile/compression stages with loadcells from 100N to 5kN with heating cooling options and a dedicated Peltier heating/cooling stage.

CT500 500N in-situ tensile stage for μXCT applications

CT5000 5kN in-situ loadcell tensile stage for X-Ray CT applications

CT Heating and Cooling cell -20°C to +160°C for μXCT applications

https://deben.co.uk/tensile-testing/%c2%b5xct/

SkyScan X-ray Microscopes Performance Characteristics

SS2214

SS2214

Technical Data

X-ray Source	Open (pumped) type with diamond window 20-160 kV, **16 W max.**
X-ray Detector(s)	6 Mp active pixel flat-panel 11 Mp large format cooled CCD 11 Mp mid format cooled CCD 8 Mp hi-res cooled CCD
Image Formats	Up to 8000 x 8000 x 2300 pixels after a single scan
Spatial Resolution	60 nm smallest pixel size, <500 nm low-contrast resolution (10% MTF)
Positioning Accuracy	<50 nm for rotation, anti-vibration granite platform with pneumatic leveling
Maximum Object Size	300 mm in diameter (140 mm scanning size), 400 mm in length, maximum object weight 25 kg
Radiation Safety	<1 μSv/h at any place of the instrument surface

System Dimensions

1800 mm

950 mm

1680 mm

SKYSCAN 2214

1500 kg

SkyScan X-ray Microscopes Accessories: All SkyScan Models

COOLING STAGE, SKY-006308

The cooling stage allows micro-CT scanning under controlled object temperature below ambient. The cooling stage keeps an object at sub-zero temperature, down to 30-40°C below ambient. An internal microprocessor controls a solid-state cooling or heating system and measures the object temperature with <1°C accuracy.

Cooling stages are powered and controlled through a small connector at the top of the object stage. The power and control signals are connected to the static part of the scanner through special gold contact slip rings with low friction and high reliability in endless rotation.

SkyScan X-ray Microscopes Accessories: All SkyScan Models

HEATING STAGE, SKY-166941

The heating stage allows micro-CT scanning of samples under controlled object temperature above ambient.

The heating stage keeps an object at a temperature up to +85°C. An internal microprocessor controls a solid-state cooling or heating system and measures the object temperature with <1°C accuracy.

Heating stages are powered and controlled through a small connector at the top of the object stage. The power and control signals are connected to the static part of the scanner through special gold contact slip rings with low friction and high reliability in endless rotation.

SkyScan X-ray Microscopes
Accessories: All SkyScan Models

MATERIALS TESTING STAGE 44 N, SKY-016811

The material testing stage (MTS) applies controlled tension or compression symmetrically to both ends of an object. It keeps the central part in a static position allowing tomographic scanning under the force.   The software for the material testing stage works in handshake with the main control software of the scanner to perform multiple scans with selected forces applied or at predefined deformations.

The load cell is installed and calibrated in the factory.

Features:
- Compression testing
- Tensile testing
- Factory calibrated load cell for load measurement
- Factory calibrated linear displacement sensor
- Easy to use software interface

Specifications:
- Load cell maximum force: 44 N
- Displacement sensor accuracy: +/- 0.01 mm
- Load measurement accuracy: +/- 1% of the full range
- Maximum object diameter: 20 mm
- Maximum travel: 11 mm
- Max object height for compression: 24 mm
- Max object length for tensile tests: 20 mm

SkyScan X-ray Microscopes Accessories: All SkyScan Models

MATERIALS TESTING STAGE 220 N, SKY-016812

The material testing stage (MTS) applies controlled tension or compression symmetrically to both ends of an object. It keeps the central part in a static position allowing tomographic scanning under the force. The software for the material testing stage works in handshake with the main control software of the scanner to perform multiple scans with selected forces applied or at predefined deformations.

The load cell is installed and calibrated in the factory.

Features:
- Compression testing
- Tensile testing
- Factory calibrated load cell for load measurement
- Factory calibrated linear displacement sensor
- Easy to use software interface

Specifications:
- Load cell maximum force: 220 N
- Displacement sensor accuracy: +/- 0.01 mm
- Load measurement accuracy: +/- 1% of the full range
- Maximum object diameter: 20 mm
- Maximum travel: 11 mm
- Max object height for compression: 24 mm
- Max object length for tensile tests: 20 mm

SkyScan X-ray Microscopes
Accessories: All SkyScan Models

MATERIALS TESTING STAGE 440 N, SKY-016813

The material testing stage (MTS) applies controlled tension or compression symmetrically to both ends of an object. It keeps the central part in a static position allowing tomographic scanning under the force. The software for the material testing stage works in handshake with the main control software of the scanner to perform multiple scans with selected forces applied or at predefined deformations.

The load cell is installed and calibrated in the factory.

Features:
 Compression testing
 Tensile testing
 Factory calibrated load cell for load
  measurement
 Factory calibrated linear displacement
  sensor
 Easy to use software interface

Specifications:
 Load cell maximum force: 440 N
 Displacement sensor accuracy: +/- 0.01 mm
 Load measurement accuracy: +/- 1% of the full range
 Maximum object diameter: 20 mm
 Maximum travel: 11 mm
 Max object height for compression: 24 mm
 Max object length for tensile tests: 20 mm

SkyScan X-ray Microscopes
Accessories: All SkyScan Models

MATERIALS TESTING STAGE 4400 N, SKY-008773

The material testing stage (MTS) applies controlled compression from the bottom of the object. The software for the material testing stage works in handshake with the main control software of the scanner to perform multiple scans with selected forces applied or at predefined deformations.

The load cell is installed and calibrated in the factory.

Features:

- Compression testing
- Factory calibrated load cell for load measurement
- Factory calibrated linear displacement sensor
- Easy to use software interface

Specifications:

- Load cell maximum force: 4400 N
- Displacement sensor accuracy: +/- 0.01 mm
- Load measurement accuracy: +/- 1% of the full range
- Maximum object diameter: 22 mm
- Maximum travel: 5.5 mm
- Max object height: 20 mm

SkyScan X-ray Microscopes
Accessories: All SkyScan Models

MATERIALS TESTING STAGE 2200 N, SKY-016616

The material testing stage (MTS) applies controlled compression from the bottom of the object. The software for the material testing stage works in handshake with the main control software of the scanner to perform multiple scans with selected forces applied or at predefined deformations.

The load cell is installed and calibrated in the factory.

Features:
- Compression testing
- Factory calibrated load cell for load measurement
- Factory calibrated linear displacement sensor
- Easy to use software interface

Specifications:
- Load cell maximum force: 2200 N
- Displacement sensor accuracy: +/- 0.01 mm
- Load measurement accuracy: +/- 1% of the full range
- Maximum object diameter: 22 mm
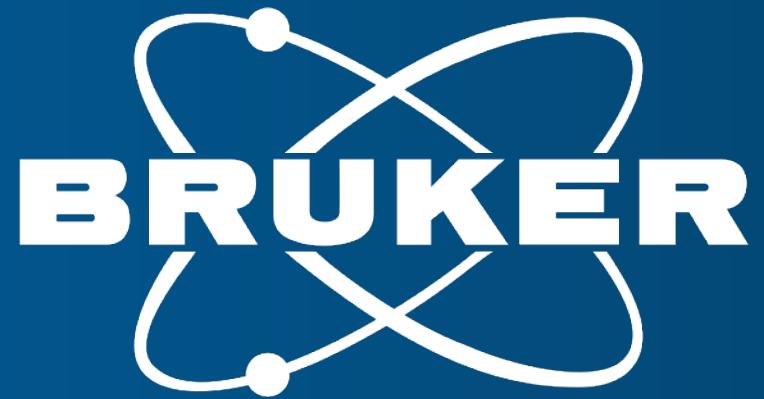- Maximum travel: 5.5 mm
- Max object height: 20 mm

Thank you!

Greg Crook, Sr. Sales Rep, XRD / XRM

e-mail greg.crook@bruker.com

Tel / Cell 949-353-7069, Orange County, CA

BRUKER

Innovation with Integrity