

3D X-RAY MICROSCOPY

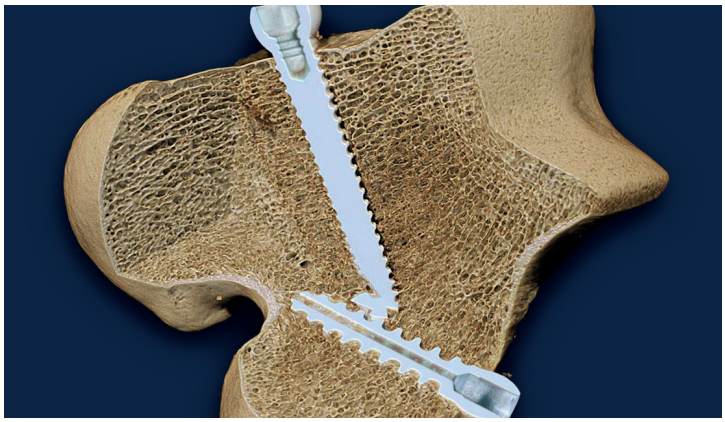
SKYSCAN 1273

High Capacity 3D X-ray Microscopy

Innovation with Integrity

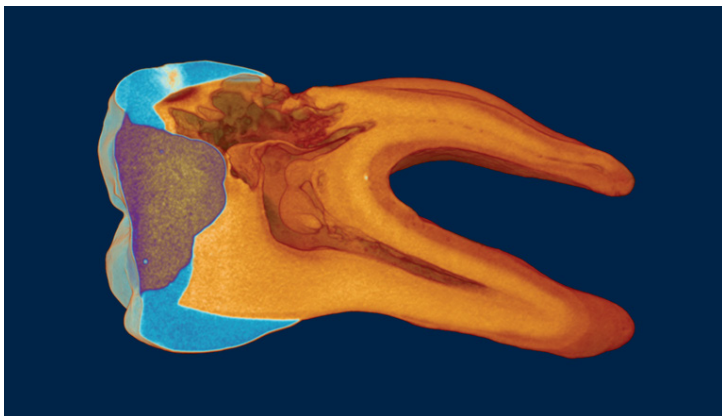
Osteology

3D volume rendering of a sheep bone, 60 mm in size, with 2 titanium implants, 5 mm in diameter. The model is partially cut to show the internal bone structures and osteointegration of the implants.



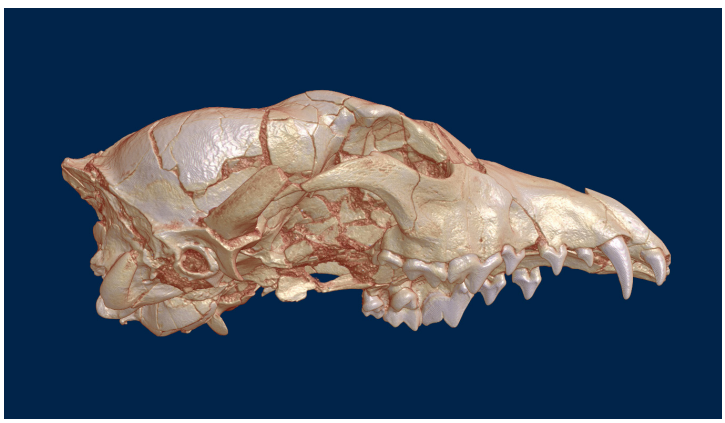
Dentistry

3D volume rendering of a human molar, scanned at 15 µm voxel size.



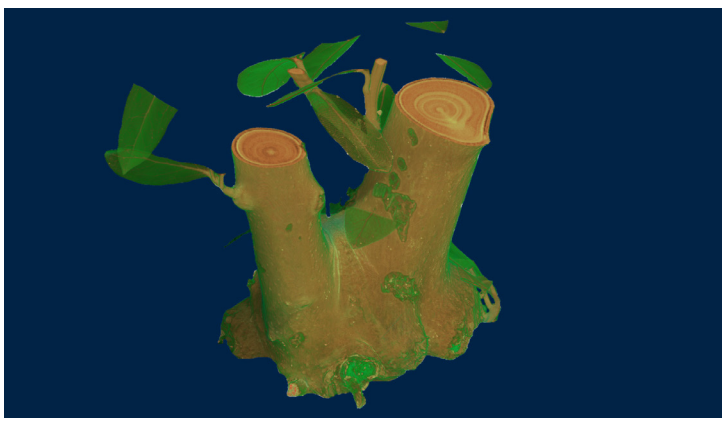
Paleontology

3D volume rendering of a prehistoric wolf skull, 72 µm voxel size. Courtesy of Katarina Harvati, Faculty of Mathematics and Natural Sciences, University of Tübingen.



Botany

3D volume rendering of a small tree, scanned without removing from the flowerpot, 25 µm voxel size.





SKYSCAN 1273 – High-Capacity 3D X-ray Microscopy



The SKYSCAN 1273 is the next-generation benchtop 3D X-ray microscope based on micro computed tomography (Micro-CT), a non-destructive imaging technology pioneered by Bruker. The SKYSCAN 1273 sets a new standard for non-destructive testing (NDT) with benchtop instruments, providing a performance previously only achieved by floor standing systems. Samples with up to 500 mm length, 300 mm diameter, and a maximum weight of 20 kg can be inspected. The combination of a higher-energy X-ray source running at higher power and a large format flat-panel detector with ultimate sensitivity and readout speed provides excellent image quality in just a few seconds.

SKYSCAN 1273 – Plug'n Analyze™
the internal structure of your sample

3D X-ray Microscopy – Non-destructive Imaging of the Internal Structure

Seeing is believing. That's why microscopy is commonly used for materials characterization. Conventional microscopy uses light or an electron beam to directly image a sample by refocusing the radiation passing through the sample. Alternative microscopy techniques, such as Atomic Force Microscopy (AFM), use other sensors to probe the sample surface. They all provide detailed and local 2D images of surface or near-surface structures or properties.

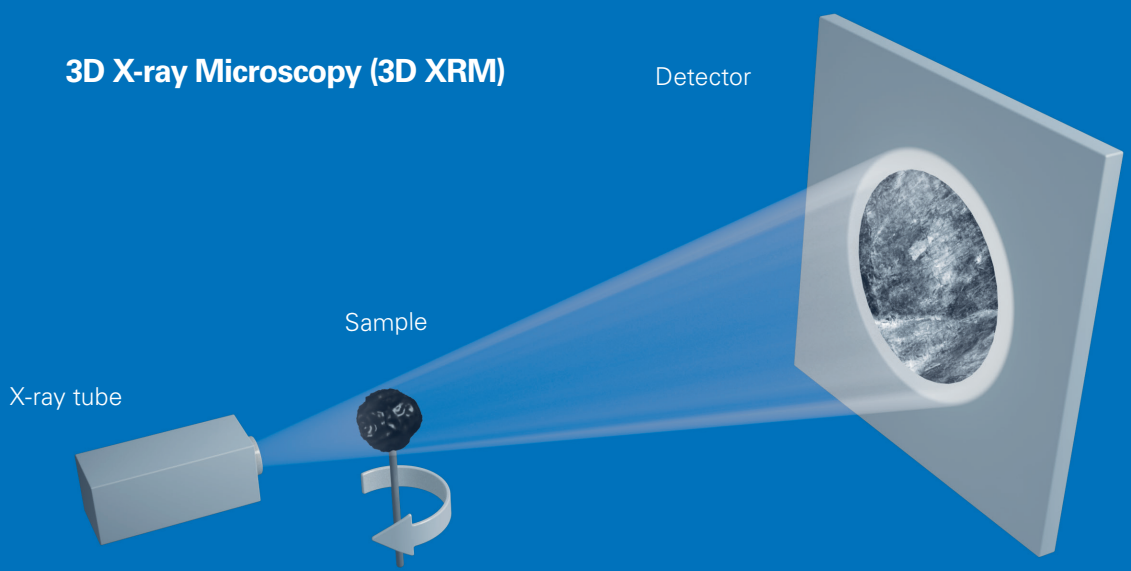
But wouldn't it be great if you could also …

… image the 3D internal structure?
… measure your whole sample at once?
… start right away?

All without the need for extensive sample preparation that may alter or destroy your sample?

With X-rays you can!

3D X-ray Microscopy (3D XRM)



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

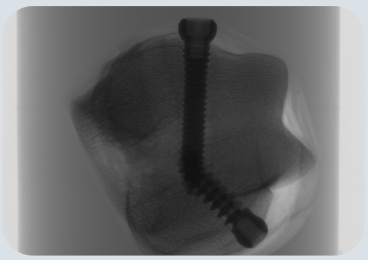
In traditional radiography the resulting projection image visualizes the intensity reduction inside a 3D object as a 2D projection.

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 thus enables the reconstruction of the complete 3D volume.

P

Position
the object at the appropriate magnification



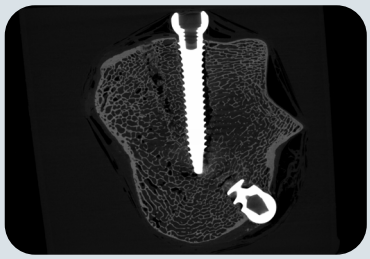


S

Scan
2D projection images at different rotation stepts

R

Reconstruct
the 3D object volume



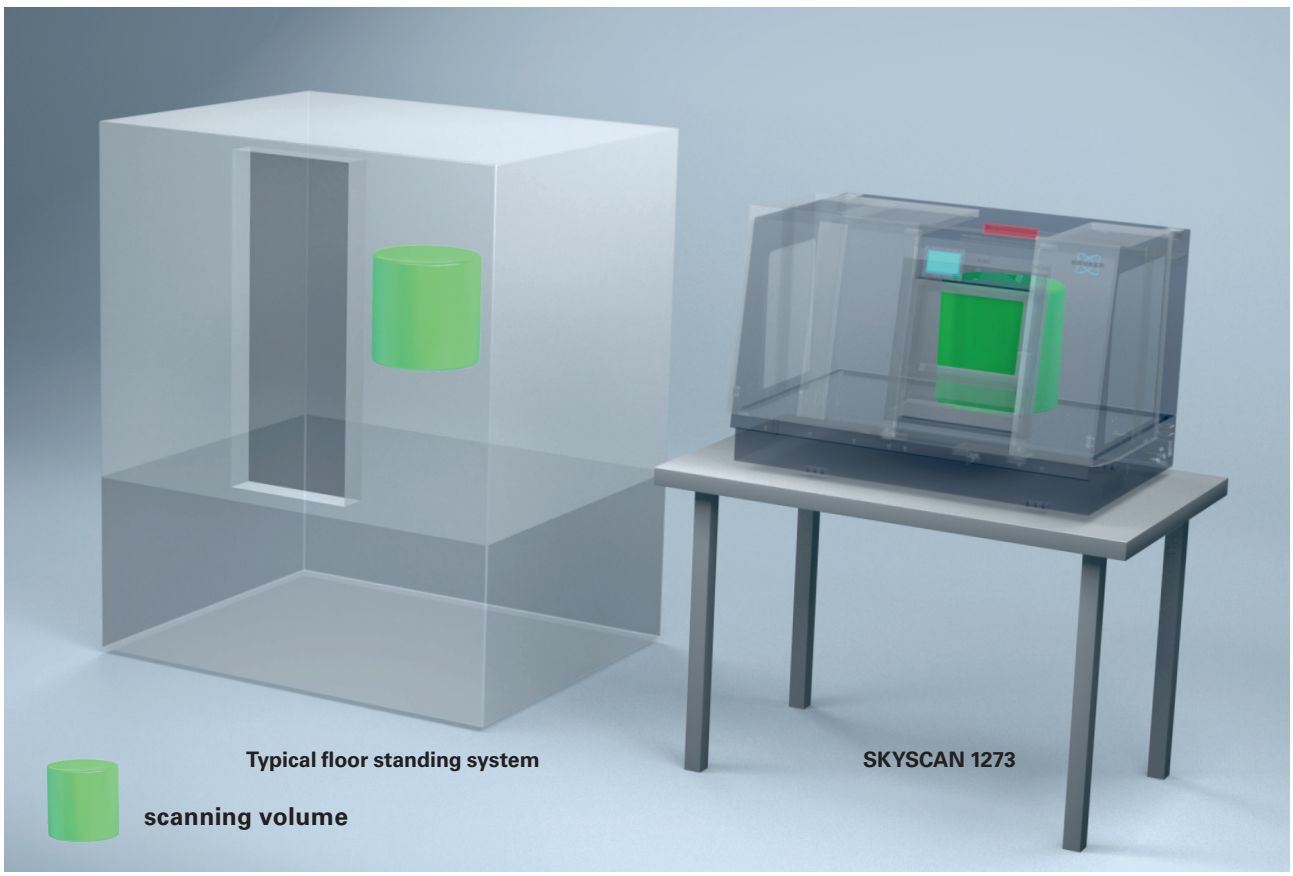


A

Analyze
the 3D structure

3D X-ray Microscopy – a guided workflow in 4 simple steps

SKYSCAN 1273 – Plug'n Analyze™



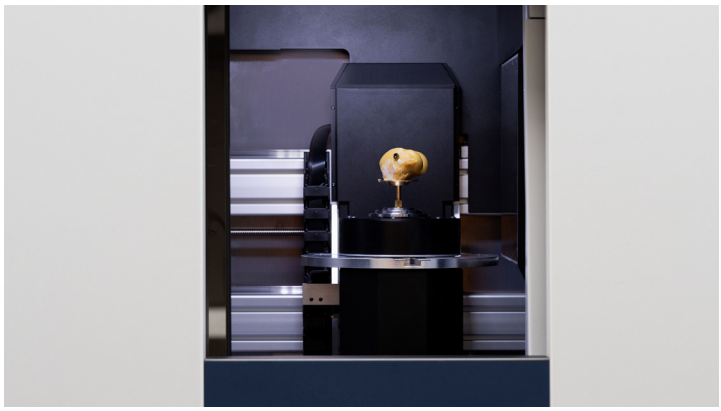
Our SKYSCAN 1273 is a real space sensation. Its benchtop cabinet fits XL-size samples up to 500 mm in height and 300 mm in diameter. Such large samples would typically require a floor standing system. Clever sample mounts enable precise sample positioning, regardless of their size.

Best-in-class components turn the SKYSCAN 1273 into a real power pack. The higher-energy X-ray source running at higher power (130 kV, 39 W) provides abundant X-ray intensity for fast scanning even on large or dense samples. The high sensitivity flat-panel detector achieves very high contrast in the accumulated images thanks to the large dynamic range. That combined with the detector's large 6 megapixel format and fast readout speed provides excellent image quality in a stunningly short cycle time of less than 15 seconds, ideal for time-resolved 3D X-ray microscopy. Even on large samples the cycle time will typically be only minutes.

This top performance comes with low cost of ownership. In contrast to floor standing systems the benchtop SKYSCAN 1273 does not demand a lot of expensive lab space. A simple domestic power plug is all you need to start running the instrument, no water chiller or additional compressor. There are no further hidden costs as the industry-grade sealed X-ray source is maintenance-free.



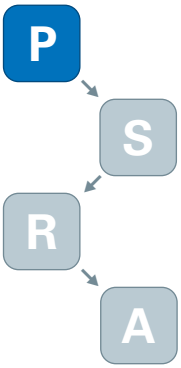
Embedded touch screen and lead glass door enable easy operation while observing the object



Large chamber for mounting big samples and optional sample stages



Non-ambient (up to +85°C, down to 40°C below ambient) and mechanical stages (up to 4400 N) for time-resolved 3D microscopy





Plug'n Analyze



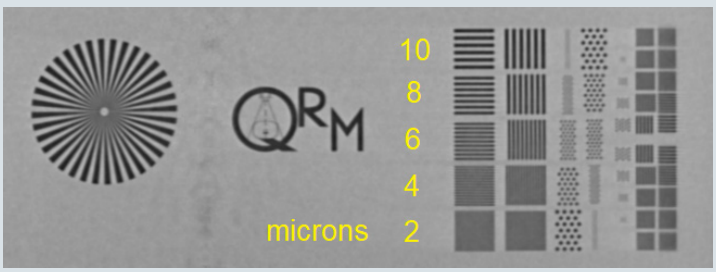
No Water Supply



Single-phase Power



Small Footprint



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 6 µm in both directions.

SKYSCAN 1273 – Data Quality and Efficiency through Intelligence

Some sample types are challenging for efficient scanning or for getting high image quality due to their particular geometry. Not with the SKYSCAN 1273!

XL size

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 thanks to patented* algorithms correcting for the Heel effect.

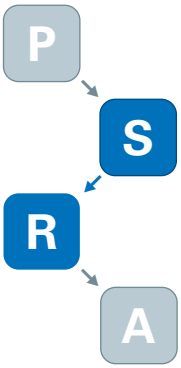
Planar structures

The cone-beam geometry used in most X-ray imaging systems causes artifacts for planar structures perpendicular to the rotation axis. These appear as streaks after reconstruction. The SKYSCAN 1273 prevents such artifacts through helical scanning combined with exact reconstruction algorithms. In helical scanning the sample follows a spiral trajectory during the data acquisition. Only special algorithms as those licensed by Bruker ensure exact, artifact-free reconstruction of the whole object volume.

* Patent EP 4 177 595 A1



Left: standard round scanning strategy with Feldkamp reconstruction results in streak artifacts for planar structures perpendicular to the rotation axis (indicated by the red arrows).
Right: helical scanning strategy with exact reconstruction results in artifact-free images

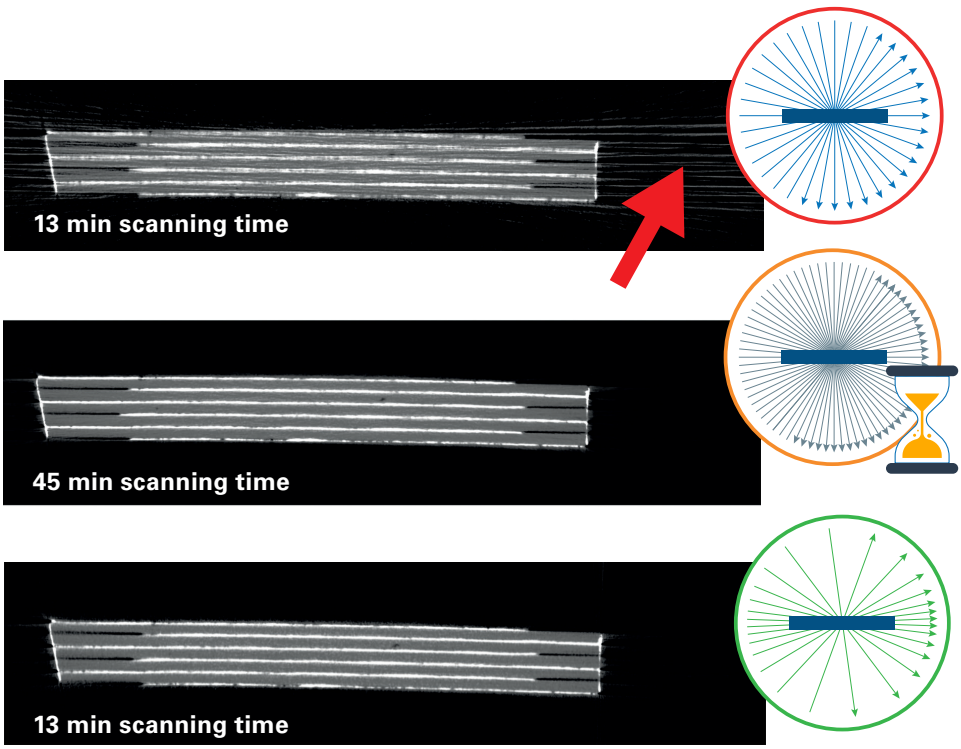


High aspect ratio

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.

SKYSCAN 1273 – the Jack of all Trades



(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.

The pictures above show reconstructed cross sections through a ceramic capacitor with different scan strategies.

SKYSCAN 1273 with 3D.SUITE – the Complete 3D XRM Solution

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.
Several special scan algorithms are included by default to ensure best image quality in the shortest time:

- helical scanning for objects with planar structures perpendicular to the rotation axis
- oversized scanning for large objects
- HART Plus scanning for high aspect ratio objects
- continuous rotation scanning for fast dynamic processes

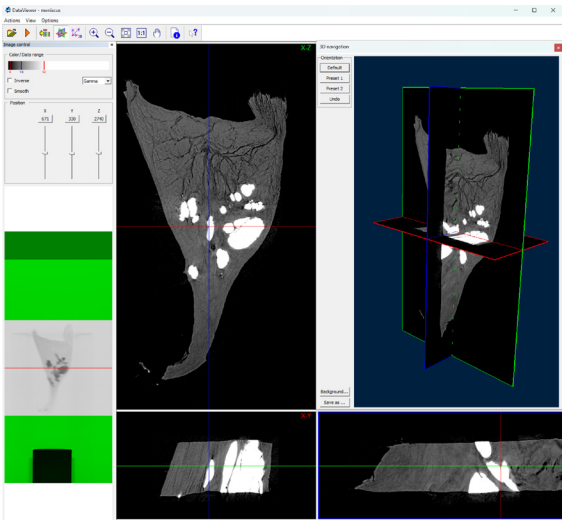
Our NRECON reconstruction software readily transforms the 2D projection images into 3D volumes thanks to the included GPU acceleration. Furthermore, NRECON includes a phase retrieval algorithm that may provide enhanced contrast and improve visualization in a range of objects.

3D.SUITE also includes all advanced software capabilities needed for 3D inspection, visualization, and analysis. So you are perfectly set up for starting with 3D X-ray microscopy.



3D Inspection with DATAVIEWER

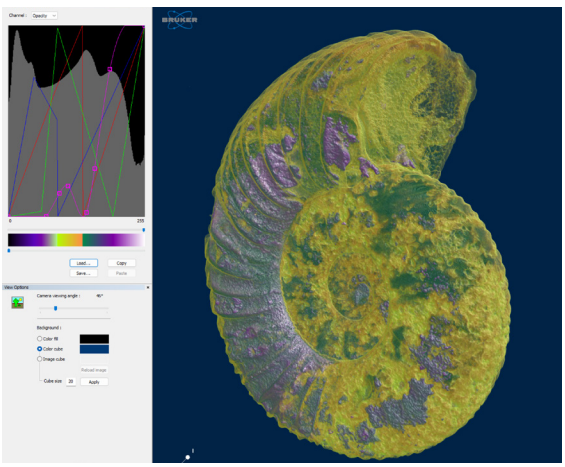
- Display reconstructed results as slice-by-slice movies or three orthogonal projections
- Smoothing, linear and non-linear grey scale transformations, color coding
- Differential image analysis between samples



3 orthogonal projections through mouse meniscus

3D Visualization with CTVOX and CTVOL

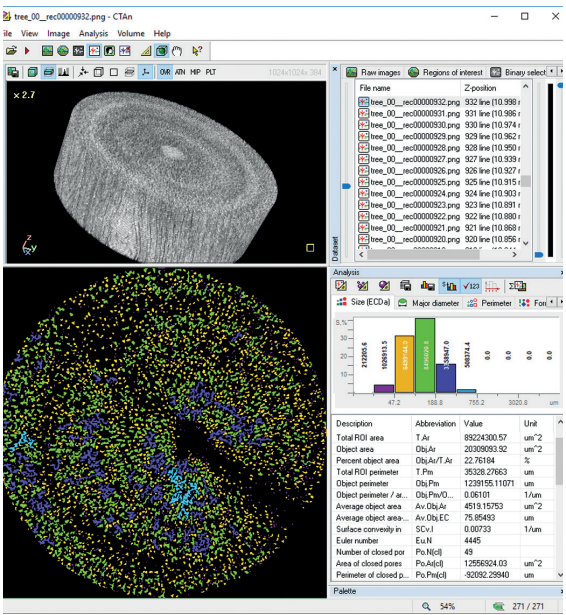
- Volume rendering to display reconstructed results as a realistic 3D object
- Create animated movies flying around or through the object
- Produce cut-away views
- Adjust coloring and transparency
- Export surface rendered models in STL format to 3D printers, or to 3D CAD software
- Modelling using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



3D rendered volume of an ammonite

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

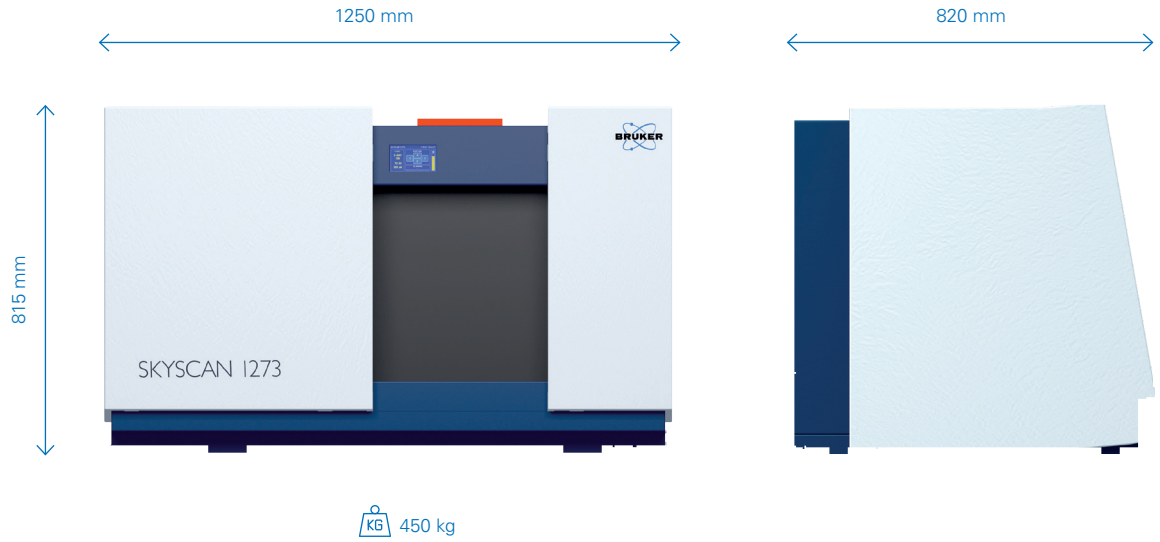


Porosity analysis of a tree slice

Technical specifications

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 < 6 µm
Maximum Object Size	Up to 300 mm in diameter and 500 mm in length Up to 20 kg
Maximum Scanned Volume	Up to 250 mm in diameter and 250 mm in length
Radiation Safety	<1 µSv/h at any place of the instrument surface

System Dimensions



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