

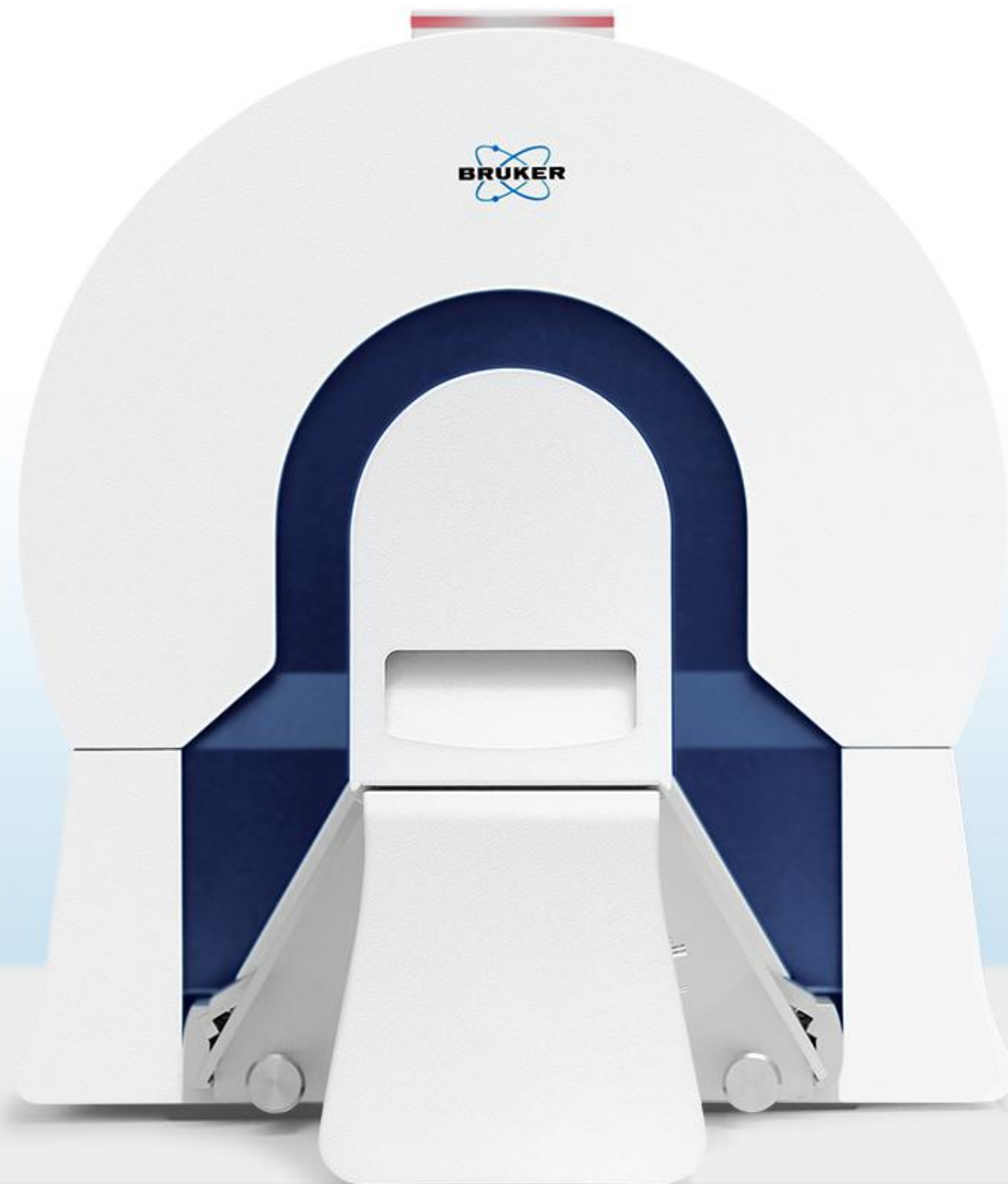
# SkyScan 1278

- Ultra Low-Dose, High Throughput  
*In-Vivo* X-Ray Microtomograph



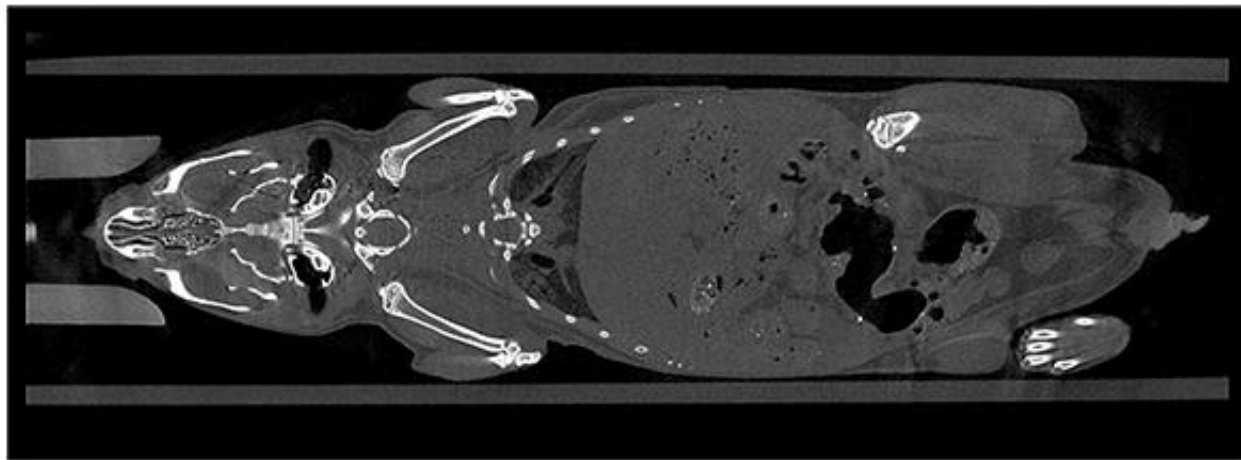
◆ **WORLD'S FASTEST LOW-DOSE HIGH RESOLUTION *IN-VIVO* MICRO-CT**

- Shortest full-body animal scan takes 7.2 seconds with typical dose less than 6mGy.
- 50  $\mu$ m nominal resolution throughout 80 mm scanning diameter and 200 mm scanning length.
- Fast and very sensitive flat-panel detector resolving dynamics of mouse heart and lungs activities even without using a contrast agent.
- Microfocus X-ray source with adjustable energy from 20 to 65kV and automatic filter changer allows optimized scanning protocol with minimized applied dose.
- Spatial beam shaper invented by **Bruker microCT** reduces dose 2-5 times without affecting reconstructed image quality.
- Integrated physiological monitoring with breathing sensor, ECG, temperature stabilization and body movement detection, provides 4D (time-resolved) cardiac and respiratory microtomography. It can deliver more than 100 measurements per second for all parameters and images.
- Easily replaceable mouse and rat cassette with anaesthetic gas mask, electrical connections to all physiological sensors can be inserted and removed by a single click.
- On-screen dose meter indicates applied dose to the animal based on information from individual analysis of X-ray images.
- Integrated touchscreen allows control of main system functions by gloved hands.
- Reconstructed image data saved in DICOM and other conventional formats such as TIFF, JPG, BMP, PNG as well as movies of 3D renderings in AVI-format.
- Results of reconstruction can be directly sent to mobile devices, such as iPad, iPhone or Android phones/tablets for volume rendered 3D viewing using supplied software.
- The system is supplied with GLP (Good Laboratory Practice) software.

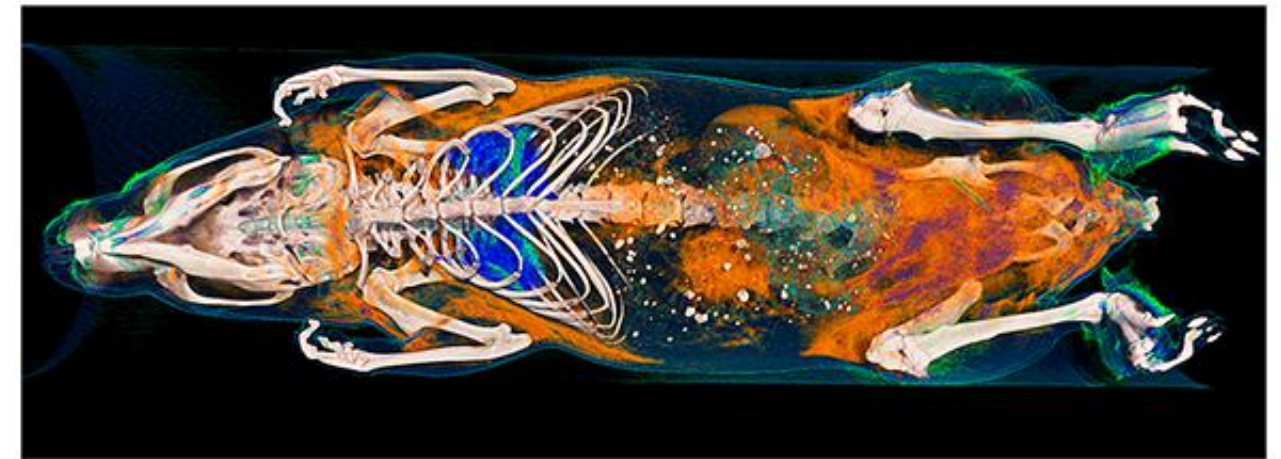




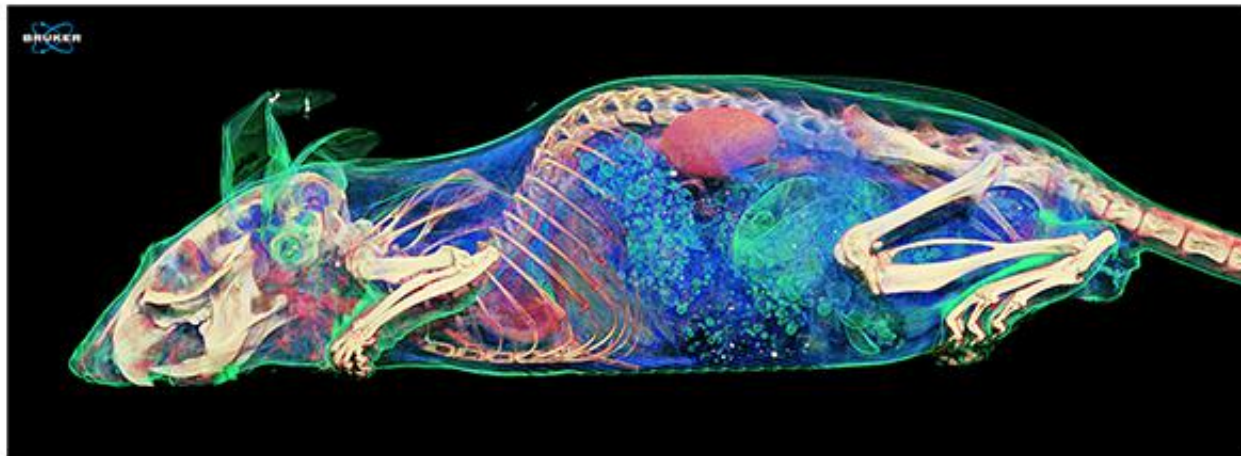
● Best results in any application



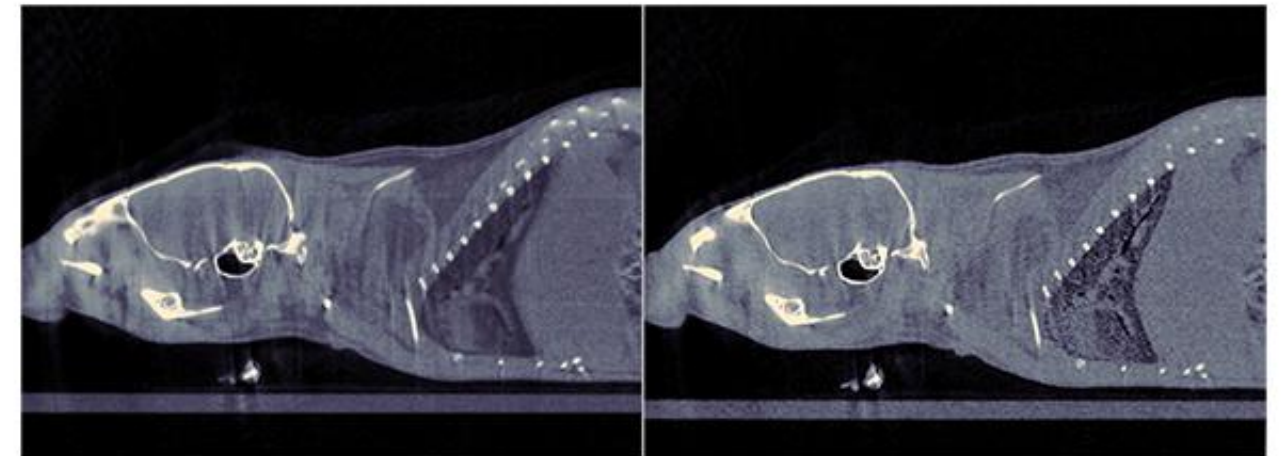
**FULL BODY MOUSE SCAN** A reconstructed coronal virtual slice through a mouse body. No contrast agent. Scanning protocol: 65kV, Al 1mm filter, 50µm isotropic pixel size, 680x680x1732 pixels.



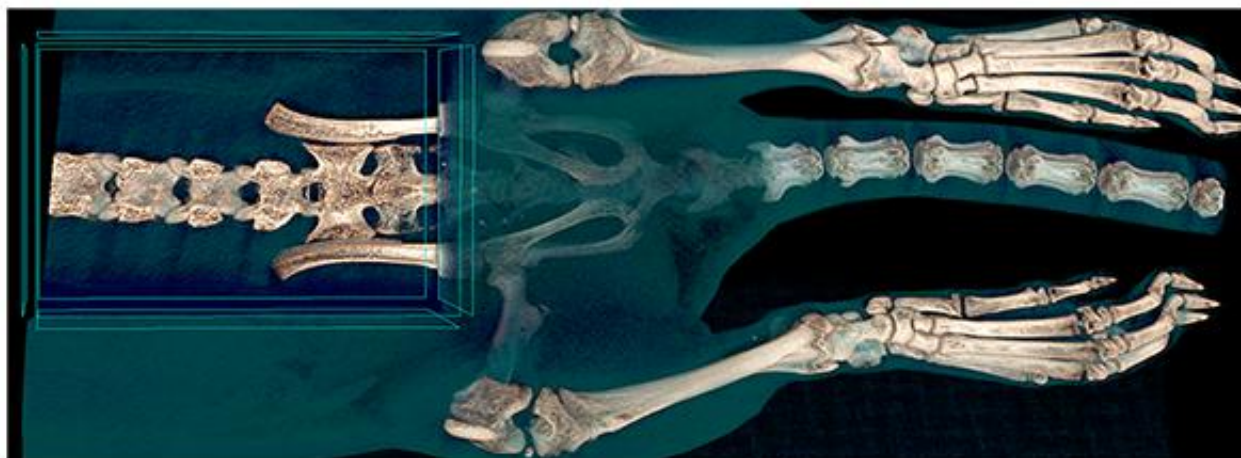
**FAT DISTRIBUTION ANALYSIS** Volume rendering of the distribution of fat shown in orange inside the mouse body. No contrast agent. Scanning protocol: 60kV, Al 0.5mm filter, 50µm isotropic pixels.



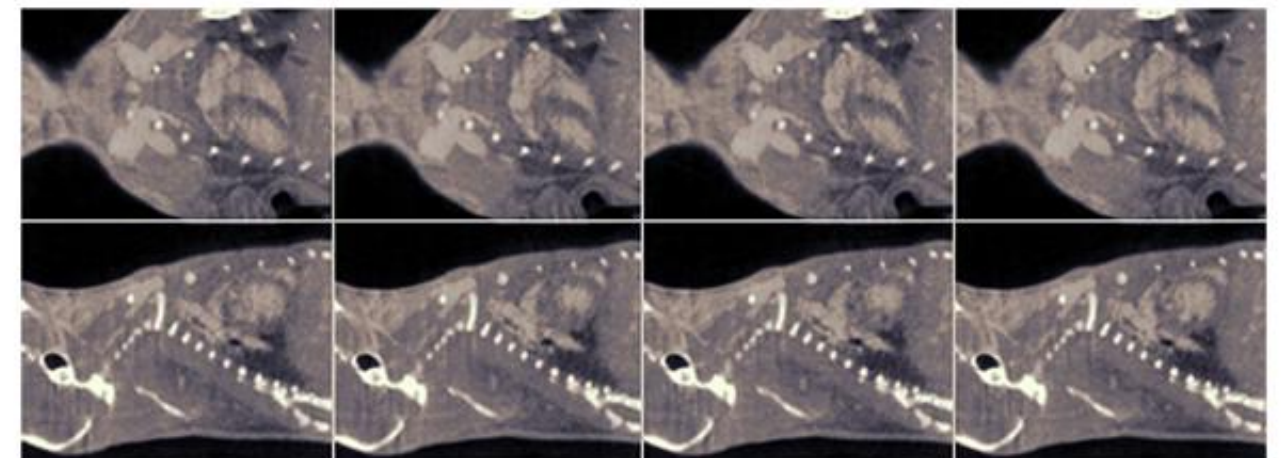
**USING CONTRAST AGENT** Volume rendering from a full body mouse scan with contrast agent injection. Scanning protocol: 65kV, "low dose" filter, 50µm isotropic pixel size, 860x860x1944 pixels



**SCANNING OF MOUSE LUNGS** Two identical sagittal slices reconstructed without synchronization with breathing (left) and by 4D sorting using time marks from breathing sensor (right). No contrast agent.



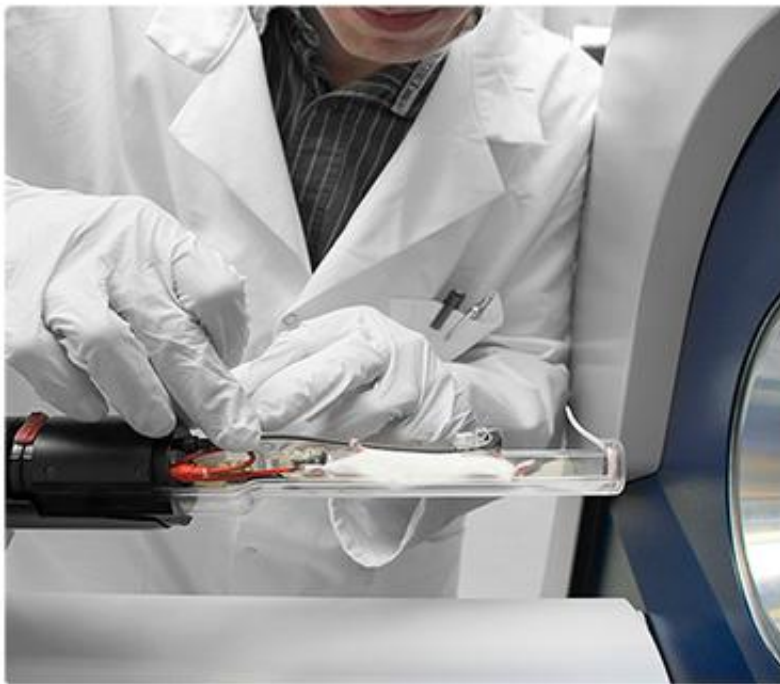
**SPINE MICROSTRUCTURE** Volume rendering with virtual opening of the spine of a rat. Scanning protocol: 65kV, "low dose" filter, 50µm isotropic pixel size, 992x992x1566 pixels



**TIME-RESOLVED HEART BEAT** Coronal (top) and sagittal (bottom) reconstructed slices from four phases of the cardiac cycle. 4D scanning using contrast agent with data sorting according to ECG time marks.



## ● Animal Handling



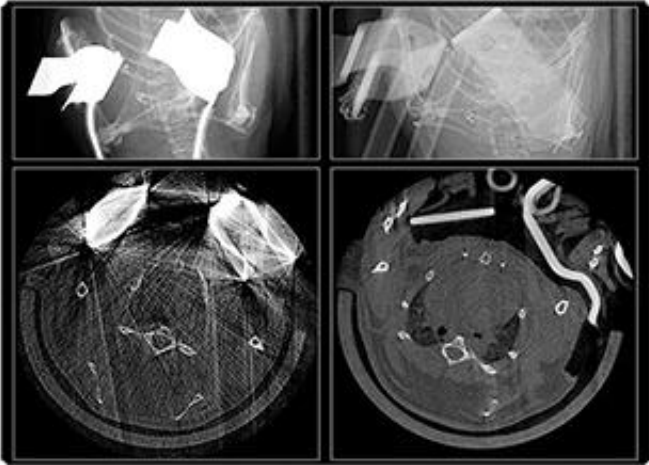
### MOUSE AND RAT CASSETTES

The SkyScan 1278 system is supplied with exchangeable animal cassettes that can be used in all Bruker *in-vivo* imaging instruments such as MRI, micro-PET, micro-SPECT, bio-luminescence, bio-fluorescence, etc. to collect multimodal information. It allows co-registration of functional and morphological information from the same animal.

The cassettes are equipped with face mask and tubes for anaesthetic gas as well as with connectors for ECG electrodes and a temperature sensor. All tubes and contacts are combined to a single connector, which can be attached to or detached from the animal transport system by simple turn of a small slider. To prevent leakage of anaesthetic gas, corresponding connections have valves which stay closed if the animal cassette is disconnected from the animal transport system.

### ALL-CARBON ECG ELECTRODES

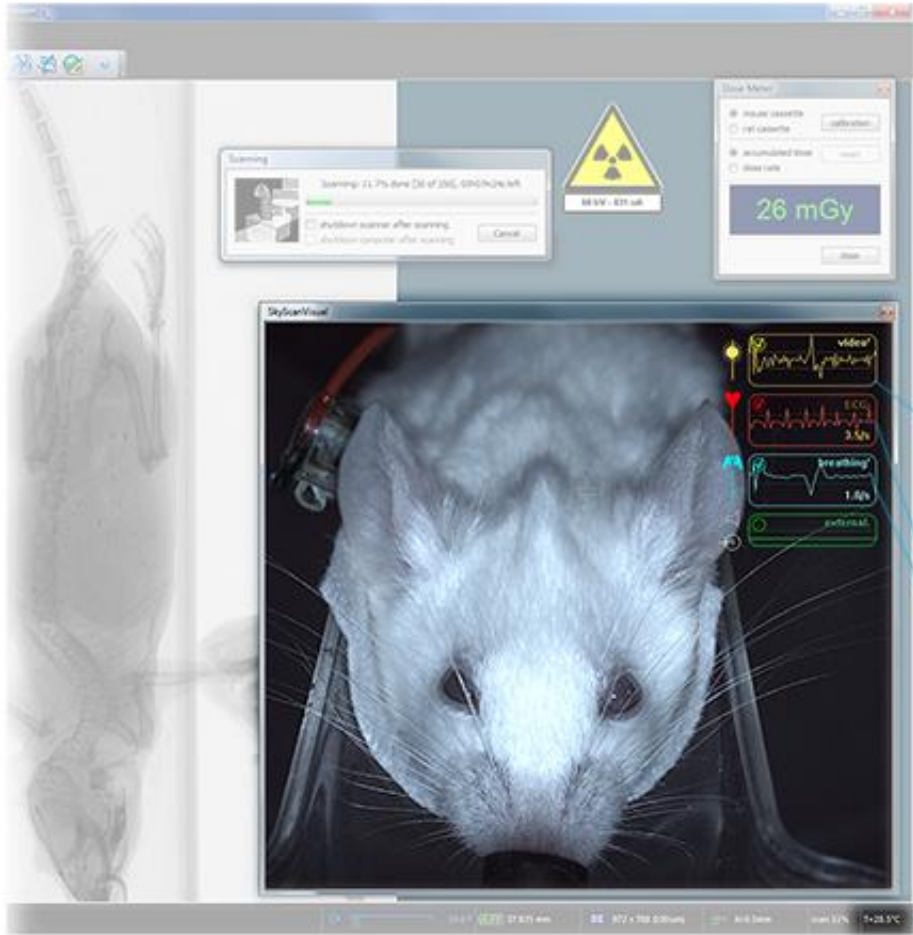
The animal cassettes include special cables and clip electrodes to detect ECG signals by a sensitive amplifier integrated in the physiological monitoring sub-system. The ECG connections use ECG wiring and electrodes specially developed by **Bruker microCT** which contain no metal parts. The wires and electrodes employ advanced carbon-fiber conductive parts with X-ray absorption similar to that of animal tissues for uncompromised image quality.



Shadow projections (top) and reconstructed slices (bottom) through a mouse body with attached metal electrodes (left) and carbon electrodes developed by Bruker microCT (right).



## ● Integrated Physiological Monitoring



### PHYSIOLOGICAL MONITORING

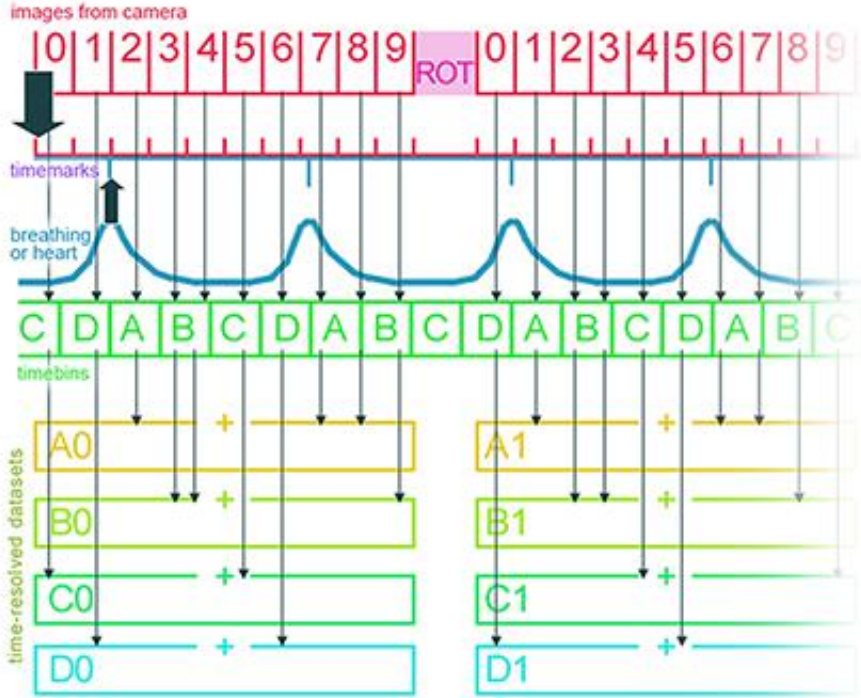
The physiological monitoring sub-system includes video monitoring of an animal with real-time movement detection, ECG and breathing detection, and temperature stabilization. A 5 megapixel colour TV-camera is mounted above the animal bed and equipped with white LED illumination to produce a real-time image of the animal during the scan. The software analyses the video stream from a user-selected area of the image, which the operator can position on a part of the animal body where breathing movement is visible. These movements are converted into a movement waveform to provide breathing timemarks for time-resolved micro-CT reconstruction.

The face mask on the animal bed is connected to an air/gas flow sensor for direct breathing detection. The ECG electrodes in the animal cassette are connected to a sensitive ECG amplifier. Both breathing and ECG signals are digitized, sent to computer and displayed as real-time profiles on-screen. An operator can select individual gain and threshold for each signal to optimise generation of timemarks. The monitoring also includes temperature stabilization by heated airflow, which maintains the scanned animal at a selected temperature, to prevent cooling of the animal under anaesthesia.

### 4D TIME-RESOLVED MICROTOMOGRAPHY

Physiological monitoring creates reference time-marks for time-resolved reconstruction of heart and lung dynamics, invented by **Bruker microCT**. In this scanning mode, multiple projection images taken at each gantry angular position are sorted post-scan into breathing or heart time bins using recorded physiological monitoring timemarks. Such sorting creates pseudo-static sets of projections, which are reconstructed as separate datasets and produce 3D sets of results corresponding to different phases of the cardiac or respiratory cycle.

Our visualization program loads all reconstructed datasets and allows scrolling in XYZ dimension across the reconstructed volume as well as in the time-dimension to demonstrate dynamics of heart or lung movements in sharp reconstructed images minimally affected by movement artifacts. Because all acquired data are sorted after the acquisition process, respiratory and cardiac cycles can be visualized by sorting according to timemarks from physiological monitoring without rescanning the animal.





## Simple control, enjoyable experience

### TOUCHSCREEN CONTROL

The user interface of the SkyScan 1278 system is simple and intuitive. The instrument can be controlled from the computer screen and also from the embedded force-sensitive touchscreen, which can be operated by gloved hands. The touchscreen allows selection of scanning protocol, adjusting animal bed position and control of imaging and scanning. Where multiple animal scans are started from the touchscreen, the software will automatically save acquired data to separate subfolders with incrementally assigned folder names and dataset file prefixes.

Full flexibility of scanner functionality is achieved by a straightforward standard Microsoft Windows user interface on the control workstation. It allows flexible adjustment of all X-ray source and detector settings as well as control of all scanning parameters. Any particular set of all instrument settings can be saved as a user configuration, allowing reload of all settings by one click for future scans.



### VARIABLE X-RAY ENERGY, FILTERS AND BEAM SHAPER FOR LOW-DOSE SCANNING

The SkyScan 1278 uses an X-ray source with adjustable energy and power. In combination with a motorized four-position filter changer it provides optimal scanning protocols for *in-vivo* studies taking into account size of animals, scanning site, gating and dose requirements. One of the positions in the filter changer is occupied by a so-called "low-dose" filter, which is a unique X-ray beam shaper invented by **Bruker microCT** (patent pending). It creates variable filtering conditions across the scanning area and reduces dose to the animal 2-5 times without compromising image quality of the reconstructed results.



### ON-SCREEN REAL-TIME DOSE METER

The SkyScan 1278 control software includes a real-time on-screen dose meter. It indicates an estimation of the dose absorbed by animal body during scanning. The measurement is based on the absorption calculations from X-ray images of the part of the animal irradiated by X-rays during scanning cross-calibrated with electronic dosimeter measurements.

The dose meter can show accumulated dose or dose rate. The color of the dose display changes from green to yellow - orange - red to indicate increasing of accumulated dose or dose rate, to help the user limit the dose to the animal to an acceptable level.

The dose meter is calibrated for X-ray absorption in the standard mouse and rat cassettes. In this way it only measures the X-ray dose absorbed in animal body itself during scanning. The dose absorbed by the animal during a scan is documented in the scan log-file together with all scan and reconstruction settings.

## Software for reconstruction, analysis and realistic visualization

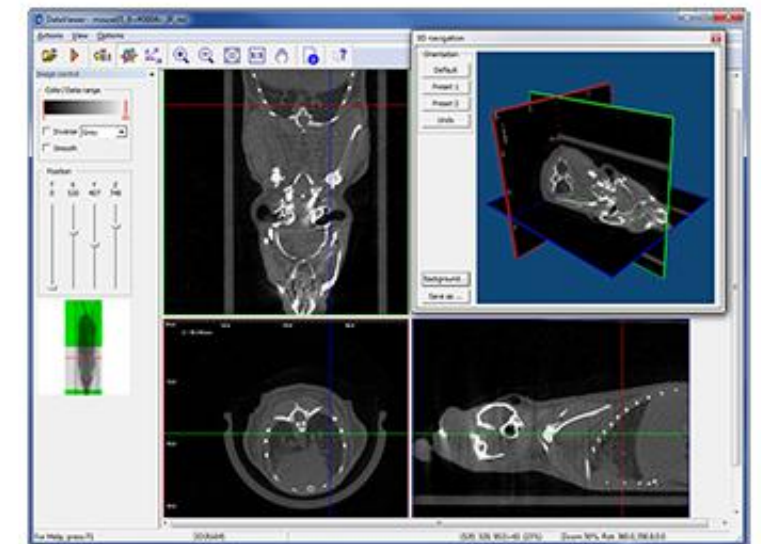
All micro-CT scanners from **Bruker microCT**, including the SkyScan 1278, are supplied with a comprehensive software suite and supported by unlimited free access to software updates available for download from the **Bruker microCT** website.

### GPU-ACCELERATED RECONSTRUCTION

The reconstruction software **NRecon** uses a unique parallelization algorithm for GPU-acceleration on single or multiple graphical processors. It supports beam-hardening correction, misalignment compensation, ring artifact removal, volume of interest reconstruction, automatic merging partial scans and many other options.

### VISUALIZATION OF RECONSTRUCTED RESULTS

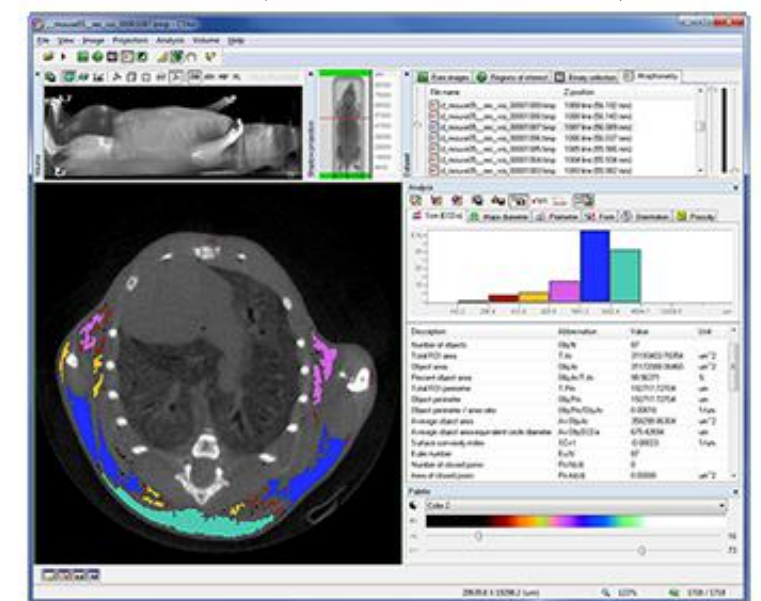
The visualization program **DataViewer** displays results as a slice-by-slice movie or as three adjacently displayed orthogonal sections, centred at any selected point. One can rotate and resample reconstructed datasets in any direction. Additional features include the 4<sup>th</sup> dimension for time-resolved cardiac and respiratory tomography. It also includes automatic 2D and 3D co-registration.



^ example of visualization of a mouse scan by **DataViewer**

### 2D / 3D IMAGE PROCESSING AND ANALYSIS

**CT-Analyser** or "CTAn" allows accurate and detailed study of micro-CT results for morphometry and densitometry. Powerful, flexible and programmable image processing tools allow a wide range of segmentation, enhancement and measurement functions for analysis inside any slice or 3D volume. Versatile volume of interest selection tools allows free hand drawing, selection of standard shapes and editing regions of interests in key slices with automatic interpolation to full volume. **CTAn** contains hundreds of embedded functions with the possibility to execute any sequence of tasks step by step, build tasklists for automated batch-analysis and execute user-created plug-ins.



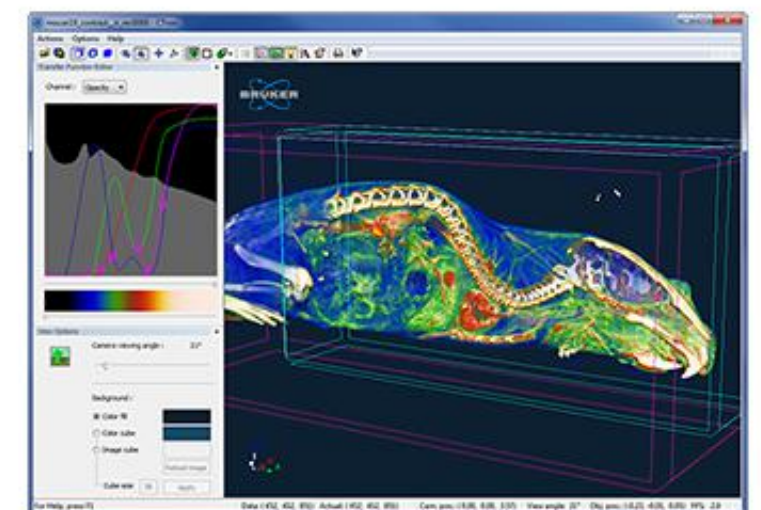
^ example of fat distribution analysis using **CTAn**

### 3D VISUALIZATION BY SURFACE RENDERING

**CT-Volume** or "CTVol" uses surface-triangulated models from **CTAn** and provides a virtual 3D viewing environment, flexible and rich in features, to give you a wide range of options for 3D presentation of microCT results. Any surface-triangulated volume can be exported in STL-format for FEA analysis or for 3D printers to create a physical copy of the scanned object.

### 3D VISUALIZATION BY VOLUME RENDERING

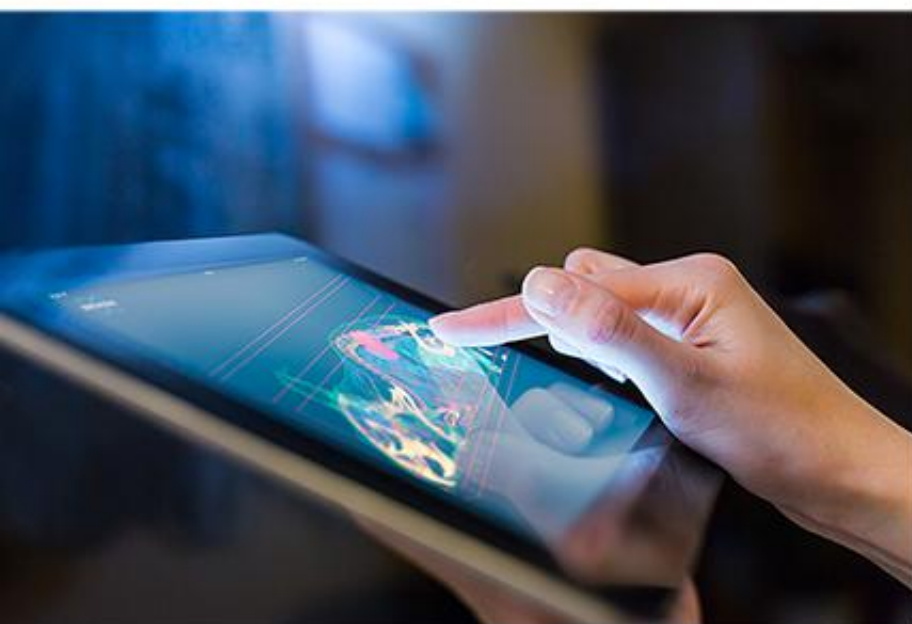
The volume rendering program **CTVox** displays a set of reconstructed slices as a realistic 3D object with intuitive navigation and manipulation of both object and camera, a flexible clipping tool to produce cut-away views and an interactive transfer function control to adjust color and transparency. The lighting and shadowing with selection of properties of the material surfaces produces fully realistic visualization. A "flight recorder" function allows fast creation of "fly around" and "fly through" animations based on simple selection of several key frames with automatic interpolation in between. Imaging possibilities include stereo viewing and displaying multiple datasets, obtained from single or different modalities.



^ volume rendering of a mouse by **CTVox** (front right part virtually removed)



## Take your results anywhere

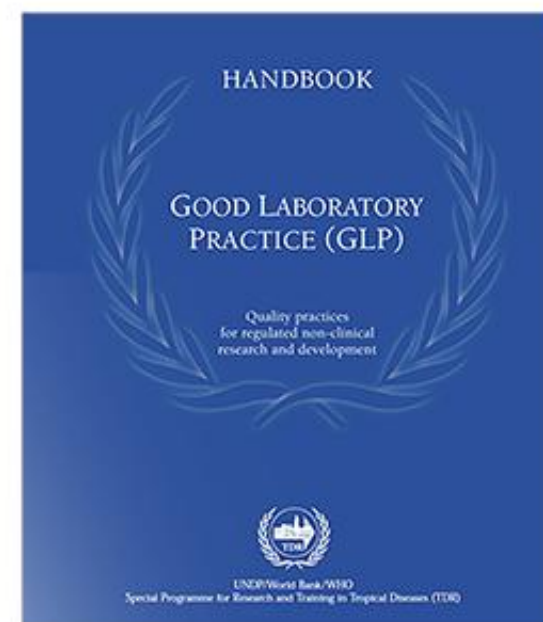


### VOLUME RENDERING FOR MOBILES

The volume rendering program supplied with the system, **CTVox**, has also its mobile versions, which can be downloaded for free from the AppStore for iPhone/iPad/iPod or from GooglePlay for Android devices. Any 3D results obtained by the system can be sent to a mobile device for realistic visualization by real-time volume rendering with 3D object manipulation, adjustments of opacity and colors, virtual cut, etc.

The results can be sent through a cable connection or wireless network. The exported rendered data and color schemes are stored in the local memory of the mobile device and do not require any connection or downloading during manipulations. A large number of reconstructed datasets can be loaded to the memory of a mobile device, allowing you to study image results while travelling, share them with colleagues and demonstrate at meetings.

## Comprehensive support and good practice for best results



### GOOD LABORATORY PRACTICE (GLP) SOFTWARE

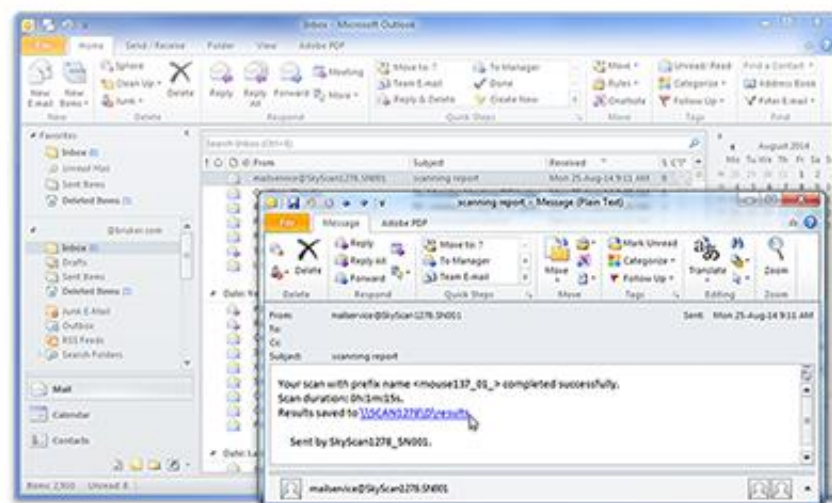
The SkyScan 1278 system is supplied with a GLP software, which when activated allows administration of user rights and implementing necessary data protection according to GLP requirements. Access to control software will be protected by a user's name - password combination. Two levels of access can be granted: standard users and advanced users. Standard user's rights allow scanning animals with saving data, reading saved results and switching scanning protocols, but do not allow erasing or modifying scanned datasets or changing scanner settings. The users with advanced access rights have access to the full functionality of the system. User passwords and access rights are managed by a single system administrator.

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

### AUTOMATIC E-MAIL REPORTING

The SkyScan 1278 control software can send you an e-mail at the end of a scan. The e-mail includes a direct link to the data folder containing the scan results. By simply clicking this link you can open the dataset directly. If the scanning process has been interrupted, the software will also email you a report of the details.

The e-mail notification can be flexibly configured according to local security rules for IT infrastructure.



### IMAGE FORMATS FOR RESULTS

All supplied reconstruction and application software can produce and work with DICOM format (compliant with the DICOM 3 convention), which can be considered as an industry standard for medical imaging instruments. The programs can also interchange results in standard Windows-readable formats, such as BMP, JPG and TIFF for images and AVI for movie files.

If necessary, images can be converted from one format to another using the supplied **Format Converter** utility. This software can convert projection images and reconstructed slices to another format with modified size and intensity scale. It can convert separate image files or full dataset with renaming, resizing, rescaling and renumbering for combining several sets of reconstructed slices together. Another useful supplied utility named **DICOM-CT** allows the export of datasets saved as JPG, BMP or TIFF files to standard DICOM format.



### SOFTWARE UPDATES

All users of **Bruker microCT** instruments have unlimited free access to all software updates. New versions of control and application software can be downloaded from the [bruker-microct.com](http://bruker-microct.com) website. To go to the **Bruker microCT** website, just click on the link in the "About" box in the control program. Using the other link in the same "About" box, the operator can send an e-mail with questions or requests to [info@bruker-microct.com](mailto:info@bruker-microct.com).



### TRAINING COURSES, MICRO-CT ANNUAL MEETINGS, 'BRUKER MICRO-CT ACADEMY'

**Bruker microCT** offers a combination of both system and software training that covers three major topics: image acquisition, image reconstruction and data analysis/visualisation. These 5-day courses are held several times per year at Bruker microCT headquarters in Belgium. The goal is to combine the basic theoretical background of microCT with as much hands-on experience as possible. After installation of every system the new customers will receive first initial training, and later advanced training either on-site or by course attendance, at the user's choice.

**Bruker microCT** also organizes an annual MicroCT meeting in the form of a 3-day scientific conference combined with training workshops. Intensive exchange of knowledge and experience helps new and skilled users to find the way to get the best results from their microCT imaging. Invitation to the next MicroCT meeting and abstracts from presentations in the previous meetings can be found at [www.bruker-microct.com](http://www.bruker-microct.com)

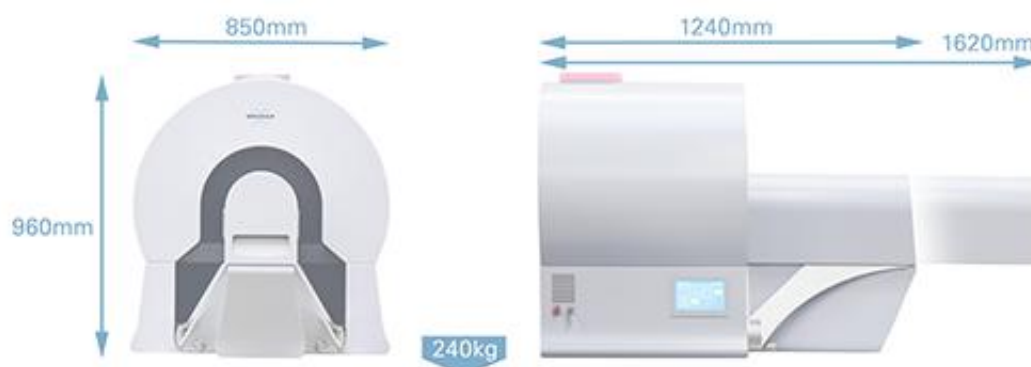


The "**Bruker microCT Academy**" is an efficient educational network for the hundreds of groups who are using SkyScan instruments. It includes a monthly newsletter with application and technical tips and keeps users updated on new methods, developments and company news. Through participation in the Academy our users gain access to a database with detailed application and technical notes and provide feedback with questions and suggestions for improvements of our instruments and software.

## TECHNICAL SPECIFICATIONS

X-ray source	20-65kV, 50W, 50µm spot size, 4-position filter changer
X-ray detector	flat-panel CMOS sensor, 1944 x 1536 pixels, 14-bit
Nominal resolution (pixel size on the object)	<52µm at any location in the scanned volume
Scanning space	80mm in diameter, 200mm in length (80mm in diameter, 80mm in length in a single scan)
Reconstructed volume (after a single scan)	up to 1536 x 1536 x 1566 pixels
Integrated physiological monitoring	real-time motion detection (5Mp colour CMOS camera), ECG, breathing detection, temperature stabilization, all signals digitized in 16bit with up to 150 samples/sec
Radiation safety	<1µSv/h at any point on the instrument surface
Dimensions, weight	850W x 1240D x 960H mm, 240kg
Power supply	100-240V AC, 50-60Hz, <150W (excluding workstation)
Control workstation:	
Processors	Dual 8-core Intel XEON
Memory (RAM)	64GB / 1866MHz
Disk space (HDD)	6TB (2 x 3TB, RAID0) + 512GB Solid State Drive
Monitor	24" UltraSharp LED LCD (1920x1200 native resolution)

Bruker microCT is continually improving its products and reserves the right to change specifications without notice.



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