USER MANUAL

Quantum™ GX3 microCT Imaging System

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For Research Use Only. Not for use in diagnostic procedures.

CE

Quantum™ GX3 microCT Imaging System

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Contents

1 Welcome

1.1 About This Manual

Welcome to the *Quantum GX3 microCT Imaging System Manual*. The Quantum GX3 microCT Imaging System is a high-speed CT system used for small animal X-ray imaging.

The imaging system is a low-dose X-ray micro-computed tomography scanner. The scanner acquires high-quality slice images which are rendered for 3D visualization. The system is appropriate for preclinical longitudinal studies of small animals.

The imaging system uses a cone beam X-ray source and a flat panel X-ray detector to produce high resolution 3D images of small animal bone structure and surrounding soft tissue.

Figure 1.1 Quantum GX3 microCT Imaging System

The Quantum GX3 microCT Imaging System is an integrated imaging system that includes:

- A module for X-ray imaging.
- A Windows®-based computer workstation for data acquisition and analysis.
- Software:

Name	Description
Quantum GX3 Software	For image acquisition, data analysis, reconstruction, and post-processing. Factory-installed on the imaging system workstation.
Quantum GX3 Image Analysis Software	Enables post-acquisition analysis of raw image data, reconstruction, and display of CT images. For use on an analysis only workstation which is not connected to the imaging system.
Quantum GX3 Viewer Pack Software	CT image display only. For use on a laptop or desktop computer.

This manual explains how to:

- Operate and maintain the Quantum GX3 microCT Imaging System
- Obtain and view CT images

Read this manual carefully before using the Quantum GX3 microCT Imaging System to obtain safe, optimum performance, and a maximum service life from the imaging system.

1.2 Quantum GX3 microCT Help

Tooltips are available throughout the application and provide more information on the function of buttons. You can view a tooltip by hovering the pointer over the button, usually with a mouse.

1.3 Additional Important Documentation

Table 1.1 lists other important documentation related to the use of the Quantum GX3 microCT Imaging System.

Table 1.1 Documentation for the Quantum GX3 microCT Imaging System

Document Name	Description	Part No.
Safe Operating and Emergency Procedures for the Operation of the Quantum GX3 microCT Cabinet X-Ray System	Provides detailed instructions on the safety features, operating procedures, and emergency procedures for the Quantum GX3 microCT Imaging System.	CLS159310
Mouse Imaging Shuttle Instructions	Explains how to install and use the optional Mouse Imaging Shuttle that can be used to contain the subject during optical and CT imaging. The Mouse Imaging Shuttle enables imaging and transfer of subjects between imaging platforms without disrupting the subject position. As a result, 3D optical and 3D volumetric data can be precisely registered.	127820

1.4 Contact Information

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2 Safety, Warnings, and Radiation Hazards

2.1 Important Safety Information

This manual provides safety information in the following formats:

CAUTION: A caution note indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury and/or mechanical damage. It is also used to alert you to unsafe practices. It reminds you that all safety instructions should be read and understood before installation, operation, maintenance, or repair of this imaging system. When you see this symbol, pay particular attention to the safety information presented. Observance of safety precautions will help avoid actions that could damage or adversely affect the performance of the Quantum GX3 microCT Imaging System. If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

WARNING! Used when an action or condition may potentially cause serious personal injury or loss of life. Mechanical damage may also result.

VOLTAGE! Provides safety information about high voltage or risk of electric shock.

Safety Symbols

Table 2.1 shows safety symbols that are found on the Quantum GX3 microCT and in this manual.

Table 2.1 Safety Symbols

Symbol	Definition
	Hazardous voltage; risk of electric shock. (IEC 60417-6042) Tension dangereuse; risque de blessure par électrocution.
	Caution: X-Rays ON. (ISO 361:1975) ATTENTION: Les rayons x sur
	CAUTION: X-RAYS. (C.R.C., c. 1370) ATTENTION: RAYONS X.

Table 2.1 Safety Symbols (continued)

Symbol	Definition
	CE compliance mark. Marque de conformité CE.
	Korean Certification Mark. Marque coréenne de certification.
	WEEE symbol (EN50419:2005). Do not dispose of as unsorted municipal waste. See the Revvity website (www.revvity.com) for more information.

Instructions

WARNING! The Quantum GX3 microCT should be operated only by personnel who have been trained in radiation safety and the operation and safety instructions contained in this manual. Revvity also recommends that personnel who operate the equipment, or are close proximity to the equipment, use a radiation film badge or other type of appropriate personal dosimeter

Read Instructions

Read and understand all the safety and operating instructions before you install, operate, or perform maintenance on the Quantum GX3 microCT. Make sure that you fully understand the following safety instructions, warnings, and disclaimers before proceeding to the rest of the manual.

Retain Instructions

Retain the safety and operating instructions for future reference.

Follow Instructions

Follow all operating and handling instructions. Failure to follow operating or handling instructions may void any warranty covering this product.

Heed Warnings

Abide by all warnings on the product and in the operating instructions. Failure to adhere to warnings or safety precautions may void any warranty covering the Quantum GX3 microCT.

X-Ray Safety & Hazards: Regulations

This equipment produces X-rays when energized. Before operating the equipment, read and understand the specific information in *X-Ray Safety and Radiation Hazards* on page 12. DO NOT operate the Quantum GX3 microCT unless an X-ray safety survey has been performed within the last 12 months. For more information, contact Revvity technical support.

An X-ray safety survey must be performed when the imaging system is installed or after it has been moved. A survey is also to be performed when the Quantum GX3 microCT has undergone any form of service in which the access panels have been opened, the safety interlocks have been adjusted, or any of the shielding has been removed and re-installed.

After servicing, if the safety interlocks are not operating properly or if the X-ray shielding is not properly re-installed, serious injury can result when operating the system. Conducting an X-ray safety survey is the only way to confirm proper shielding and interlock operation.

WARNING! For radiation survey of the Quantum GX3 microCT, comply with your own laboratory radiation regulations or contact Revvity technical support for further assistance.

Owners and operators of the Quantum GX3 microCT are responsible for complying with all regulations in the country where the equipment is operated. This includes all local, state, and federal regulations. In some states of the US, it may be necessary to register radiation sources with the governing state and/or local public health agencies before operating the imaging system. Equipment registration may be required immediately or within 30 days of acquiring the equipment.

Owners and operators of the Quantum GX3 microCT are responsible for contacting the appropriate public health agencies for registration information that pertains to installation of the Quantum GX3 microCT. If you need assistance with this requirement, contact Revvity technical support. For more details and contact information, see the *Safe Operating and Emergency Procedures for the Operation of the Quantum GX3 microCT Cabinet X-Ray System* document provided as part of the preinstallation instructions.

WARNING! A Revvity employee will conduct a radiation leakage survey and safety tests when the Quantum GX3 microCT is installed. Revvity employees are trained in radiation safety. However, check with your local radiation control authority to determine the specific radiation survey requirements at your facility. If necessary, have a qualified expert other than a Revvity employee survey the installation before operating the imaging system.

WARNING! Confirm that X-ray generation is stopped or active in at least two ways. These may include X-ray generation display on the control screen, tube voltage display, and tub current display, as well as the X-ray generation pilot lamp. Ensure that the alarm equipment is used to inform the surroundings when X-rays are being generated.

Environmental Considerations for the System Components

Locating the Quantum GX3 microCT

Consider the proper environment for the components before installation of the Quantum GX3 microCT.

Install the equipment in an environment where:

- The temperature does not fluctuate widely and is maintained between 15-25° C (59-77° F).
- The humidity does not exceed 80% (non-condensing).
- No strong electric or magnetic fields exist.
- No vibrations are present.
- No corrosive gases are present.
- High amounts of dust are not present (Pollution Degree 2).
- No open flame is present.
- There is sufficient space behind the Quantum GX3 microCT equipment. A minimum space of 4 inches (10 cm) from the flat surface of the rear panel should be provided behind the Quantum GX3 microCT to provide unobstructed air flow and access to the main power on/off switch.
- The work space is level.
- Altitude is ≤ 2000 meters.

Heat

The system should be situated away from heat sources such as open flames, radiators, heat registers, stoves, and other heat-generating electrical equipment.

Water and Moisture

VOLTAGE! Do not use this product near water (for example, near a sink or wet room) due to risk of electric shock, electrical damage, and/or equipment failure.

Cleaning or Moving the System Components

Cleaning/Liquid Entry

VOLTAGE! Do not use liquid or aerosol cleaners and never spill liquid of any kind on any of the Quantum GX3 microCT components. Sprays and liquids that come into contact with the Quantum GX3 microCT hardware may result in damage to the system or electrocution. For more details on proper care of the system, see *Cleaning the Quantum GX3 microCT* on page 127.

Clean the exterior of the scanner by wiping with a damp, soft cloth.

Moving the Quantum Quantum GX3 microCT

WARNING! Only Revvity employees are authorized to move the Quantum GX3 microCT Imaging System.

Power Considerations

Power Sources

The Quantum GX3 microCT is configured for the voltage requirements of the installation locality that was specified at the time of order. If the Quantum GX3 microCT is moved to another area, make sure that the same voltage requirements exist.

Table 2.2 Voltage Ratings (Nominal and Max)

120Vac, 8A, 50/60HZ (108-132Vac)
208Vac, 4A, 50/60HZ (187-229Vac)
220Vac, 4A, 50/60HZ (198-242Vac)
230Vac, 4A, 50/60HZ (207-253Vac)
240Vac, 4A, 50/60HZ (216-264Vac)

WARNING! The Quantum GX3 microCT can operate at multiple voltages, such as 120V, 230V, or 240V, with the factory setting marked on the imaging system label. However, you are *not permitted* to change the input voltage to any of the system components. Several internal modifications are required for voltage change. If the operating voltage must be changed, contact Revvity technical support.

Intended to be powered by a standard wall receptacle (Over-voltage Category II).

Power Cord Protection

Power supply cords should be routed so that they are unlikely to be walked on or pinched by items placed upon or against them. Pay close attention to receptacles and to points of connection between cords and equipment.

Do not replace the power cord provided with inadequately rated nor uncertified replacement. The power cord's plug at the wall or the AC inlet at the rear of the system should remain accessible after installation, to allow disconnection of power should it be needed for safe servicing.

Lightning & Power Line Surges

The Quantum GX3 microCT is supplied with a surge protector. All components should be connected to this device to protect against electrical transient events.

Power Outages

If the Quantum GX3 microCT experiences a loss of supply power, turn off the power switch for all components and do not restart the system until reliable power has been restored.

Overloading

WARNING! Do not overload wall outlets, extension cords, or integral convenience receptacles as this can result in a risk of fire or electric shock. See *Power Sources* on page 8 for more details on the power requirements of the Quantum GX3 microCT Imaging System.

Facilities should be adequately wired according to local building codes.

WARNING! The Quantum GX3 microCT Imaging System requires special precautions regarding EMC and must be installed and put into service according to the EMC information provided in the service manual.

WARNING! Portable and mobile RF communications equipment can affect the Quantum GX3 microCT Imaging System.

WARNING! The Quantum GX3 microCT Imaging System complies with CISPR 11 group 1 Class A and may cause radio interference or may disrupt the operation of nearby equipment. It may be necessary to take mitigation measures, such as reorienting or relocating the equipment, or shielding the location.

Servicing

Refer all servicing to Revvity technical support. If the Quantum GX3 microCT is damaged and requires service, unplug the Quantum GX3 microCT from the outlet and contact Revvity technical support. Servicing by anyone other than an authorized Revvity representative voids the warranty covering the Quantum GX3 microCT.

Other Equipment

Use of any equipment other than that recommended by this manual has not been evaluated for safety and, therefore, is the sole responsibility of the user.

Do not modify the Quantum GX3 microCT in ANY manner by making any kind of hole or aperture in the imaging system or removing any component of the radiation shielding.

2.2 Warnings

Electrical Safety

VOLTAGE! DO NOT attempt to service the Quantum GX3 microCT Imaging System yourself. Although there are no voltages in excess of 24V inside the sample bore area, high voltages are present behind interlocked access panels. Contact Revvity technical support for electrical service needs.

CAUTION: Depending on environmental or use conditions, such as humidity, using the equipment without grounding may lead to electric shock. To ensure safety, securely connect the ground wire of the power cable or the ground terminal of the equipment (Class D grounding) to ground.

X-Ray Safety

WARNING! The equipment produces X-rays when energized.

WARNING! The Quantum GX3 microCT Imaging System should be operated only by personnel who have been trained in radiation safety and the operation and safety instructions contained in this manual. Revvity also recommends that personnel who operate the equipment, or are close proximity to the equipment, use a radiation film badge or other type of appropriate personal dosimeter.

Mechanical Safety

The Quantum GX3 microCT Imaging System weighs approximately 600 kg. The imaging system has many internal motorized components that can move at any time.

The X-ray flat panel detector and source located inside of the bore area are delicate parts and should not be handled with bare hands or sprayed with cleaning agents.

WARNING! If the gas hoses become caught, kinked, or disconnected, do not operate the imaging system. Over exposure to anesthesia gas may occur.

CAUTION: The bore cover and the sample bed are made of an acrylic material. To avoid damage, do not wash with organic solvents.

CAUTION: Confirm that the sample and the sample bed are not in the sample chamber during the system warm-up. If so, the detector may be damaged by overexposure, resulting in degradation of the CT image.

WARNING! Do not attempt to remove or modify the access tubing in the sample chamber. Doing so may lead to hazardous X-ray exposure.

CAUTION: Bind the tubes and cables injected into the sample chamber firmly as the damage to the tubes or cables may be caused by contact with the gantry arm.

CAUTION: The image may be degraded if the contrast medium adheres to the bore cover or sample bed. Wipe off any adherent contrast medium before it hardens and dries.

CAUTION: If gas anesthesia is to be used, the RAS-4 Anesthesia System and the Mouse Imaging Shuttle are recommended. Ensure adequate ventilation before using gas anesthesia equipment. See *Mouse Imaging Shuttle Instructions* (PN 127820) on the use of the transfer bed and Mouse Imaging Shuttle.

CAUTION: Use the attachment screws to attach the bore cover to the face plate. Loose attachment screws or incomplete attachment of the bore cover may result in damage to the bore cover during imaging.

CAUTION: To avoid system malfunction, do not shut down the computer during control software startup or quit the control software during CT imaging or live scan modes.

Chemical & Biological Safety

Normal operation may involve the use of test samples that are pathogenic, toxic, or radioactive. It is your responsibility to ensure that all necessary safety precautions are taken before such materials are used.

Dispose of all waste materials according to appropriate environmental health and safety guidelines.

It is your responsibility to decontaminate the Quantum GX3 microCT Imaging System before requesting service by Revvity technical support. Ask your laboratory safety officer to advise you about the level of containment required for your application and about the proper decontamination or sterilization procedures to follow.

Handle all infectious samples according to good laboratory procedures and methods to prevent the spread of disease.

CAUTION: Do not use this Quantum GX3 microCT Imaging System for medical purposes such as diagnosis or treatment.

Access Panels

There are no user serviceable components in the lower electronics area, or in the side and rear panels of the Quantum GX3 microCT Imaging System. Do not remove the panels unless you are instructed by and under the supervision of a Revvity service representative.

Do not modify the Quantum GX3 microCT Imaging System in ANY manner by making any kind of hole or aperture in the imaging system or removing any component that is part of the radiation shielding.

WARNING! This equipment uses a beryllium window X-ray tube. Beryllium is hazardous to the human body. Contact a professional waste disposal service to dispose of X-ray tubes. Do not mix with general consumer waste.

WARNING! The X-ray emission window of the X-ray tube contains metallic beryllium. Avoid any contact with the window with bare hands. Beryllium powder or vapor is hazardous to the human body. Avoid grinding, processing, or burning the beryllium window. Avoid wiping the window with chemicals. In case of accidental contact between your skin and the window, immediately wash the affected area with soap and water. Comply with all applicable regional rules concerning proper disposal when disposing of the X-ray tube (the unit containing the X-ray tube).

Korean EMC Registration Statement

EMC Registration is done on this equipment for business use only. The equipment may cause interference if it is used outside a lab.

This warning statement applies to a product for business use.

사용자안내문

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

※ 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

2.3 X-Ray Safety and Radiation Hazards

The instrument produces X-rays when the X-ray function has been energized and initiated. The instrument is defined by most regulatory agencies as a "Cabinet X-Ray System." A cabinet system is one that produces little or no X-ray exposure to the user and is safe to operate with the user in close proximity. Revvity certifies the Quantum GX3 microCT Imaging System to produce not more than 0.5 millroentgens per hour at a distance of 5 cm from the instrument surface. In addition, the instrument is certified to meet all international exposure requirements (typically, 0.1 millirem per hour) and other regulations for where it is sold. The Quantum GX3 microCT Imaging System meets all US (FDA) regulations regarding a cabinet X-ray system.

Effects of Radiation

The Quantum GX3 microCT Imaging System produces ionizing radiation in the energy range from 0 to 100 kilovolts (X-ray). While this energy can be hazardous to the human body, the shielded cabinet protects the user or others in the vicinity from any exposure above background. The user is responsible for minimizing the total X-ray exposure to the individual mouse or other animal subject as part of the total amount of time spent imaging.

Only individuals who have been trained to operate the equipment should be permitted to use it. In some locations, government regulations may require that the user have radiation training and be certified.

WARNING! This product produces X-rays. Do not attempt to open the Quantum GX3 microCT door when X-rays are being generated as indicated by the "X-Ray On" light on the front panel and on the computer monitor.

WARNING! Do not modify this product in ANY way. Do not drill or modify the shielding panels in ANY way. Do not operate the instrument or turn on the source unless all shielding is in place and is in good repair. Do not attempt to access the electronics compartment below the imaging chamber. Operation of the instrument in a modified condition could result in exposure to X-rays. Exposure to X-rays can cause serious bodily injury or death. Refer all servicing to Revvity technical support.

WARNING! Do not, for any reason, attempt to defeat the built-in safety interlocks described in *Safety Features & Safety Systems* on page 14. Operating the Quantum GX3 microCT Imaging System without the safety interlocks can result in exposure to X-rays. Exposure to X-rays can cause serious bodily injury or death. Refer all servicing to Revvity technical support.

X-Ray Dose Limits

A sample model of Revvity Quantum GX3 microCT Imaging System has been tested at maximum operating conditions. Revvity has determined the local X-ray dose rate at a distance of 5 cm from the surface of the equipment is less than 0.5 millroentgens/h.

Revvity declares that the Product Quantum GX3 microCT Imaging System conforms to:

- 1996/29/Euratom Directive (Dose rate of 0.5 mrem/h at 10 cm from any accessible surface under normal operating conditions)
- US CFR21 Part 1020.40 Regulation (Dose rate of 0.5 mrem/h at 5 cm outside of the external surface under maximum operating conditions) in accordance with the following standard:

  IEC 61010-1:2019 Standard (Dose limit of 0.5 mrem/h at 5 cm from the surface of the equipment under maximum operating conditions)

Revvity certifies that Quantum GX3 microCT Imaging System has achieved the objectives of:

- ICRP 60 recommendations of annual public dose limit of 100 mrem
- ICRP 103 recommendations of annual public dose limit of 100 mrem
- US OSHA workplace annual public dose limits of 100 mrem and other international public safety standards and regulations

Safety Features & Safety Systems

The Quantum GX3 microCT is enclosed within shielding that limits X-ray exposure to normal background levels. The access door to the sample chamber is provided with two safety interlocks which cut power to the X-ray source if they are interrupted. Additionally, the door is provided with a solenoid-activated lock that prevents the door from being opened during an imaging session when X-rays could be generated. For reasons discussed in the warning above, it is important not to attempt defeat of any of these safety features.

Revvity will perform at least two safety tests on every system at the time of installation:

- At the time of manufacturing
- At the user's laboratory or facility

The safety test includes, but is not limited to, an X-ray radiation leakage test.

Revvity recommends, and some local government agencies may require, an X-ray leakage safety test be performed under the following conditions:

- Every 12 months
- After a Revvity technician performs maintenance or service, in which case the safety survey will be conducted by Revvity

WARNING! A Revvity employee will conduct a radiation leakage survey and safety tests after the Quantum GX3 microCT Imaging System is serviced by Revvity. Revvity employees are trained in radiation safety. However, check with your local radiation control authority to determine the specific radiation survey requirements at your facility. It necessary, have a qualified expert other than a Revvity employee survey the installation before operating the instrument.

- After any abnormal condition that could impair any of the safety systems. For example, the door becomes difficult to open or close.

See *Surveying the Quantum GX3 microCT for Radiation Leakage* on page 126 for more information.

Regulatory Compliance

Customers in the US are directed to check with their state radiation control program director for registration requirements. For a list of U.S. state agencies and Canadian Provinces, see the ***Safe Operating and Emergency Procedures for the Operation of the Quantum GX3 microCT Cabinet X-Ray System*** document provided as part of the preinstallation instructions. International customers should check with their governing bodies about possible registration or other requirements.

Revvity certifies that the Quantum GX3 microCT Imaging System complies with FDA regulation CFR 1020.40 after installation at the customer's site. Revvity also certifies that the instrument meets all of the International regulations of the country where it is installed.

3 Components

3.1 Components

The instrument includes scanner with a movable sample holder surrounded by a rotating gantry (Figure 3.1). The gantry has an X-ray source and a flat panel detector mounted on it. The detector and slide can be moved radially to change the magnification. Multiple bore sizes are available, depending on the magnification chosen.

Figure 3.1 Quantum GX3 microCT

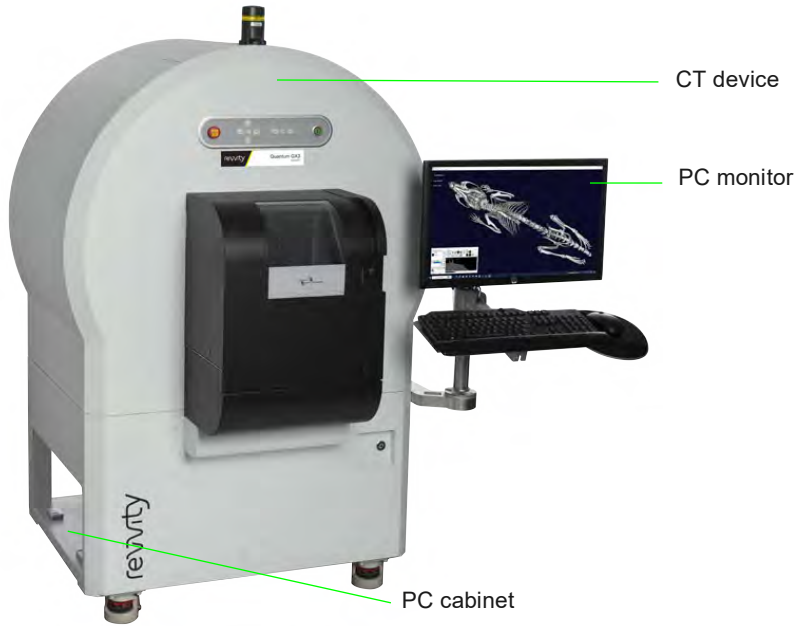


Figure 3.2 Quantum GX3 microCT Scanner – Front

X-ray ON indicator

System front panel
See Figure 3.4 for more details.

Tubing inlet

Safety key switch

Figure 3.3 Quantum GX3 microCT Scanner – Rear

PC cabinet

Main electrical power ON/OFF switch

Power cord

Figure 3.4 Quantum GX3 microCT Front Panel

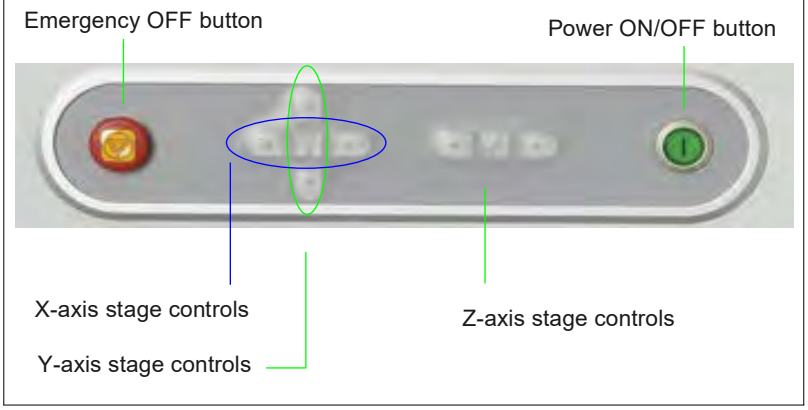


Figure 3.5 Quantum GX3 microCT Sample Chamber

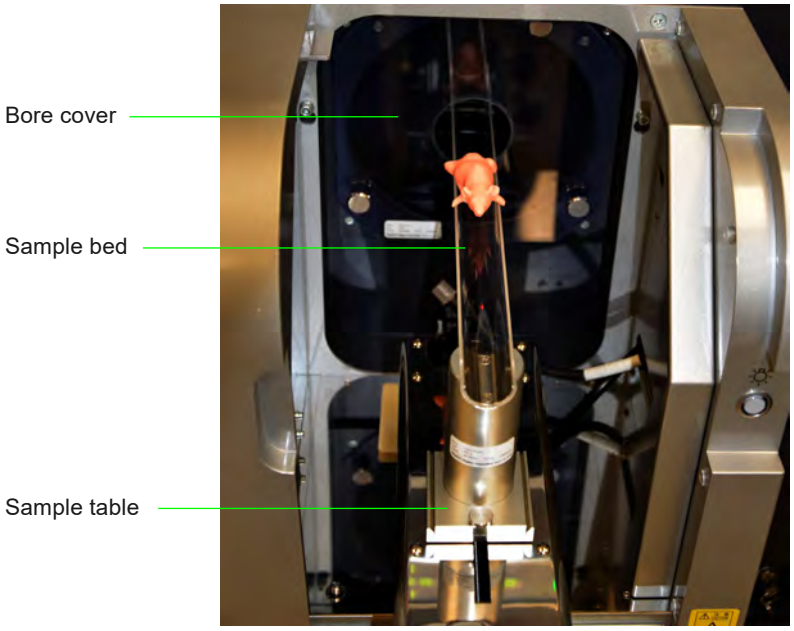


Table 3.1 Standard Accessories

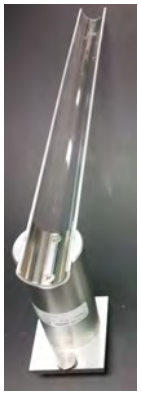
Item	Photo
Mouse bed	
Rat bed	
8mm FOV bore cover and bed	
18mm FOV bore cover and bed	

Table 3.1 Standard Accessories (continued)

Item	Photo
86mm FOV bore cover and bed	
Changeable X-ray filters	

Al 0.5mm		• Low contrast sample (ex. in-vitro brain)
Al 1.0mm		• Soft tissue scanning (ex fat analysis)
Al 0.5mm + Cu0.06mm		• General CT scanning(standard) • Same as Al 2.5mm X-ray counts
Cu 0.1mm		• BMD analysis
Cu 0.2mm		• Metal containing sample (ex. Dental implant)
Cu 1.0mm		• For FPD protection when XG warm-up

Control Panel

The Control Panel appears when the Quantum GX3 microCT software starts (Figure 3.6). See:

- Page 26 for instructions on starting the software and Control Panel details.
- Page Table 4.2 on page 28 for details on the Control Panel.

Figure 3.6 Control Panel

Table 3.2 Scan Acquisition and Display Parameters

Parameter	Description
Voltage	Variable voltage up to 100 kV.
CT	Variable current up to 200 µA.
Live	Variable current up to 5200 µA.
FOV (mm)	Acquisition – Field of view for acquisition, variable 8 - 86 mm. Reconstruction – Field of view for reconstruction, variable.
Voxel Size	Voxel size determined by the software based on the acquisition FOV and reconstruction FOV.

Table 3.2 Scan Acquisition and Display Parameters (continued)

Parameter	Description
Scan Mode	▪ Standard – A common scan configuration for low dose *in vivo* imaging. ▪ High Resolution – A scan mode that reduces image noise. ▪ High Speed, Whole Body – A scan configuration that performs multiple scans and stitches them together to increase the axial field of view. After the first scan, the bed moves into the bore and the next scan is completed. The software uses the images from all of the scans to generate the 3D reconstruction (.vox). ▪ High Speed – A scan mode that is as fast as possible to reduce dose. ▪ High Speed, Gating – A scan configuration which mitigates motion artifacts from cardiac and respiratory rhythms. **Note:** Gating is optional. ▪ Continuous – The X-ray generator and the FDP continuously rotate around the subject without interruption during the image acquisition process. ▪ Step Scan – The X-ray generator and the FPD move to a specific position, stop briefly to capture an image, and then move to the next step.
Display Settings	3D filters remove noise by combining pixels and displaying the average intensity of the selected pixels: Original – Does not apply a filter. Soft – Applies a 3 x 3 x 3 averaging filter. Smooth – Applies a 5 x 5 x 5 averaging filter.

Table 3.3 X-ray Source Specifications

Item	Description
High Voltage Potential	100 kV
Maximum Current	200 µA
Maximum Power	20 W
Anode Type	Tungsten
Window	Beryllium
Focal Size	5 – 30 µm
Filter	Changeable (see *Changing the X-Ray Filter* on page 108).

3.2 Door Operation

The instrument sample chamber door has shielding to prevent the escape of X-ray radiation and should not be tampered with or modified in any way. The door also contains part of the X-ray safety interlock system. When the door is open, the X-ray source cannot be powered on. Never try to defeat the safety interlock function by defeating its purpose or modifying the mating safety interlock. This safety interlock should be visually inspected daily for signs of malfunction.

3.3 X-Ray System Control Panel

The main ON/OFF switch that controls the electrical power to the full imaging system is on the rear of the instrument (see Figure 3.3 on page 16). Activation of this switch provides power to the imaging system, but does not permit energizing the X-ray source unless the following conditions have been met:

- The sample chamber door is completely closed and the door handle is in the completely closed position.
- The Emergency OFF switch is in the ON (out) position (Figure 3.7).

NOTE: The Emergency OFF button is not intended as a main X-ray source control and should not be used to turn the X-ray function ON or OFF on a routine basis. It should only be used in the unlikely situation where the X-ray source must be immediately turned OFF. It should be left in the ON position under normal circumstances.

- The key selector switch is turned ON.
- All access panels are secured.

The X-ray source cannot be energized from the instrument control software until these conditions have been fulfilled.

Figure 3.7 Front Panel – Emergency Stop Button

3.4 Key Selector Switch Lost Keys

X-ray safety regulations require controlled access to the instrument. The objective of this requirement is to prevent untrained and unauthorized personnel from operating the X-ray functionality of the imaging system. The key-operated switch on the imaging system fulfills this requirement when used in conjunction with the user's own written radiation safety procedures. The control of the key is typically managed by a master key person.

The key-operated switch is designed so that the key cannot be removed except in the OFF position. When the authorized user is finished using the imaging system, the key is removed from the switch. Two keys are provided with the imaging system, and it is a good practice to archive the spare key. If the keys are lost, contact Revvity technical support (see page 3).

3.5 Scanning System and Acquisition Computer Specifications

The computer contains an Intel family processor and Windows® operating system. The computer controls the instrument. A printer can be connected to the computer.

Scanning System Specifications

Scanner Item	Description
Power Requirements	100/120V, 8A, 50/60 Hz 240V, 4A, 50/60 Hz
Dimensions	155 cm W, 110 cm D, 154 cm H
Door opening dimensions	250 mm x 257 mm
Weight	530 Kg

Computer Features

- High speed Windows®-based PC
- Microsoft Windows 10 64-bit operating system
- 128GB RAM
- 512GB SSD
- 8TB hard drive
- Instrument control software
- CD-burner installed for data storage and transport
- Network ready
- 27" touch screen monitor

Computer Specifications

Item	Description
Power requirements	1.0 A at 120 V, 0.5 A at 240 V, 50-60 Hz
Dimensions (H x W x D)	17.5 x 6.75 x 18.3 in (44.45 x 17.15 x 46.48 cm)
Graphics card (2xGPUs)	NVIDIA T400 4GB or higher NVIDIA RTX4000 or higher

Computer Monitor Specifications

Computer Monitor (Flat screen)	Description		
Power requirements	0.6 A at 120 V	0.35 A at 240 V	50-60 Hz
Dimensions with stand	17.5” x 17.5” x 9”	45 cm x 45 cm x 23 cm	
Weight with stand	33 lbs	15 Kg	
Dimensions without stand	17.5” x 17.5” x 2.5”	45 cm x 37 cm x 6.5 cm	
Weight without stand	20 lbs	9 Kg	

3.6 Environmental Requirements

Environmental Requirements	Specification
Temperature	15° C to 25° C (50° F to 78° F)
Humidity	<80% non-condensing
Type of use	Indoor
Imaging chamber shelf temperature	Ambient to 37° C
Altitude rating	<2000 meters (6560 ft.)
Pollution degree	2
Installation category	II

3.7 Tubing Inlet

The Quantum GX3 microCT is equipped with a tubing inlet for use with external devices such as the RAS-4 Anesthesia System or angiographic injectors that are inserted into the sample chamber or gantry (Figure 3.8). Anesthesia tubing and manifolds for the small and medium animal beds are provided with the standard accessories kit.

Figure 3.8 Tubing Inlet

CAUTION: Bind tubes and cables together to prevent cable disconnection that can be caused by the inserted tubes or cables touching the electric table.

CAUTION: Image quality may be affected by contrast media or anesthesia on the bore cover or the sample bed. If contrast media adheres to the bore cover or sample bed, wipe it off before it hardens or dries out.

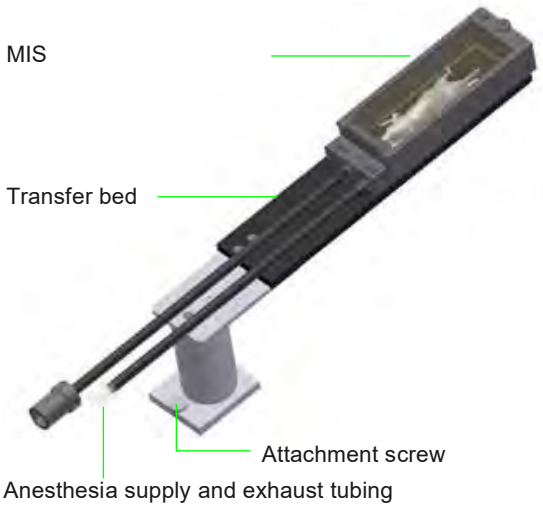
CAUTION: Scavenging is recommended when using gas anesthesia. Be aware of air ventilation requirements when using gas anesthesia.

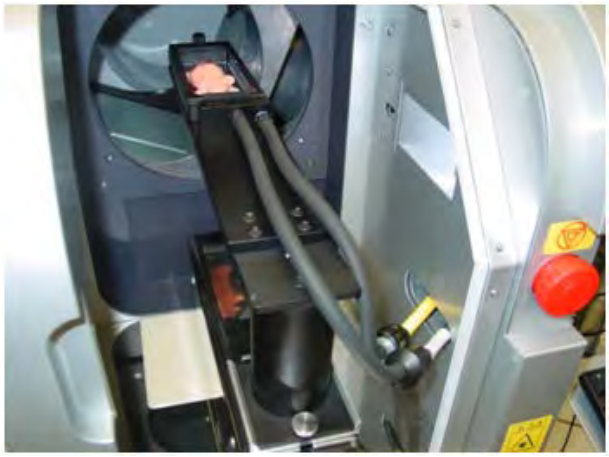
3.8 Transfer Bed and Mouse Imaging Shuttle

The transfer bed is for use with the optional Mouse Imaging Shuttle (Figure 3.9). The Mouse Imaging Shuttle (MIS) contains the subject during image acquisition on the Quantum GX3 microCT and the instrument. The MIS transports the subject between the imaging systems without disrupting the subject position so that 3D volumetric data acquired on the Quantum GX3 microCT can be precisely registered with the optical data obtained on the instrument.

The transfer bed replaces the acrylic beds supplied. A single mounting screw secures the transfer bed to the movable sample platform on the Quantum GX3 microCT scanner. The bed has an anesthesia supply and exhaust tubing attached that connects to the RAS-4 Gas Anesthesia System hoses.

Figure 3.9 Transfer Bed and Mouse Imaging Shuttle (MIS)





Transfer bed with MIS mounted in the instrument scanner

4 Getting Started

4.1 Workflow Overview

Table 4.1 presents an overview of acquiring CT data on the Quantum GX3 microCT Imaging System.

Table 4.1 Workflow Overview

Step	See
1. Start the Quantum GX3 microCT Imaging System.	Below
2. Warm up the Quantum GX3 microCT Imaging System (click the  button in the Control Panel).	page 54
3. Create and/or connect to a database.	page 26, 30
4. Create or select a sample and study where the image data (series) will be saved.	page 56
5. Set the scan configuration.	page 58
6. Place the anesthetized subject in the sample chamber and center the subject in the Xcapture window.	page 69
7. Start the CT scan.	page 73, 75, or 79
8. View and analyze the 3D reconstruction.	page 109
9. Post-processing options: ▪ Reconstruct a subvolume or slice(s). ▪ Reconstruct the sinogram (image data). **Note:** Post-processing analyses may be performed offline on a workstation not connected to the imaging system.See page 63 for required software, workstation requirements, and workstation setup.	page 84

4.2 Starting the Imaging System

1. Turn on the Quantum GX3 microCT Imaging System by pressing the green power button (default user ID – "CTadmin", default password – "ct2admin").

Figure 4.1 Quantum GX3 microCT Imaging System

2. Start the software by double-clicking the icon on the desktop.
   The Control Panel and Database window appear (Figure 4.2).
   Figure 4.2 shows an overview of the Control Panel functions.
   All image data are saved to a database. See *Working With Databases and Data* on page 31 for more details about databases.

NOTE: The user ID "CTadmin" has administrator privileges on the computer.

If you have any concerns during the startup procedure, contact Revvity technical support (see page 3) for assistance.

Figure 4.2 Control Panel and Database Window at Startup

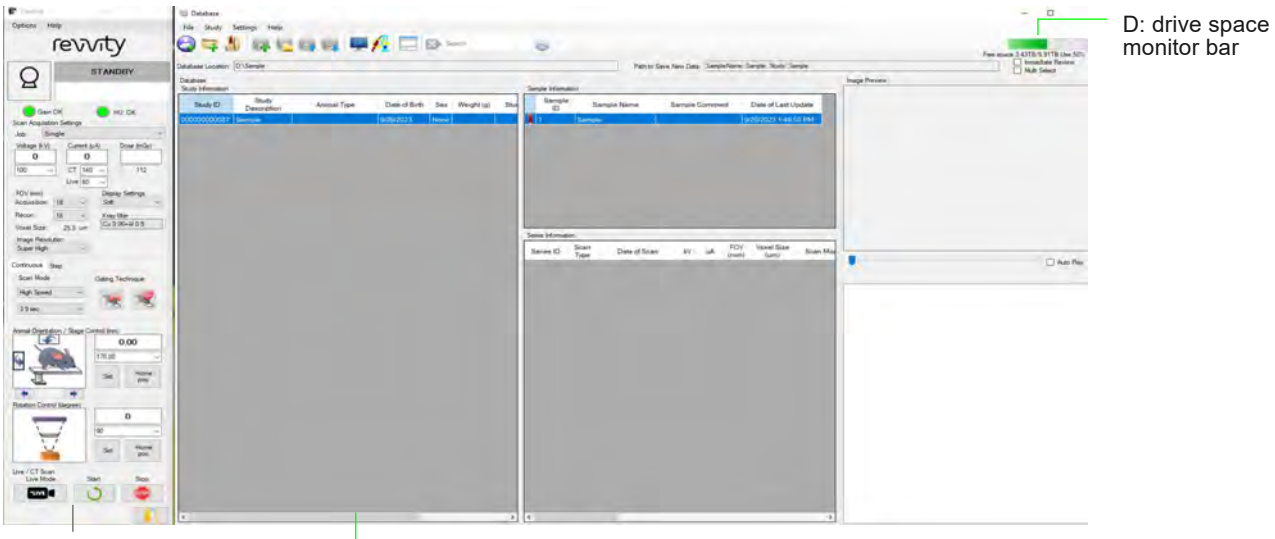


Table 4.2 Control Panel

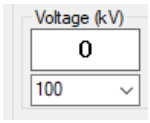
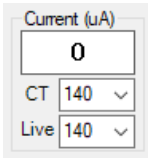
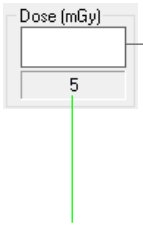
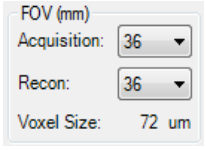
Item	Description	For More Details, See:
	Scanner status	Figure 7.1 on page 55
	Choose a preset or custom scan configuration from this drop-down list.	Table 7.1 on page 56
	Actual voltage of the X-ray tube during a scan (top). To edit the voltage for a scan, enter a value in the lower field or make a section from the drop-down list.	page 58
	Actual current of the X-ray tube (top). CT – The current setting for a scan. Live – The current setting for a fluoroscopy/Live Mode scan.	*Advanced Image Reconstruction Settings* on page 86
Dose (mGy)	 Displays the scheduled X-ray dose per unit time during a CT or fluoroscopy scan. CT scan – Estimated exposure dose calculated from the actual irradiation time.* Fluoroscopy scan – Estimated radiation dose, updated every second. Dose for a CT scan using that particular mode. This number changes based on the scan mode settings. *See Meganck, J.A. and Liu, B. *Mol Imaging Biol* (2016). doi:10.1007/s11307-016-1026-x for information on estimated exposure dose and radiation dose.	
	Acquisition – Field of view options: 86, 72, 36, 18 or 8 mm. **Note:** 36 mm is only available with the small bore cover. Recon – The reconstruction field of view. Voxel size – Voxel size determined by the software based on the acquisition FOV and reconstruction FOV.	Table 7.1 on page 56 for more information on scan modes.
X-ray Filter Selection	Drop-down menu that is used to indicate which filter has been manually placed in the instrument (see *Changing the X-Ray Filter* on page 108).	
	Click  to select respiratory gating. Click  to select cardiac gating.	page 75 page 79
Image Resolution	Low: 512x512x400 Medium: 1024x1024x800 High: 2864x2864x2272	

Table 4.2 Control Panel (continued)

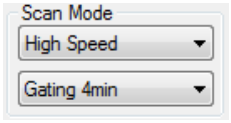
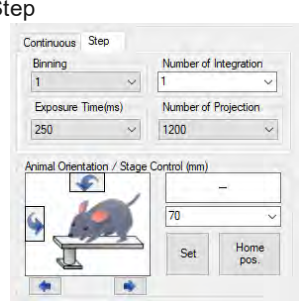
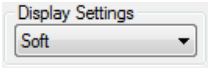
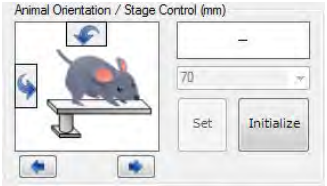
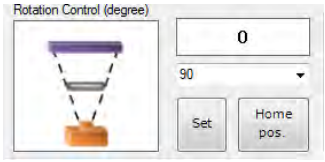
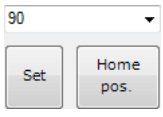
Item	Description	For More Details, See:
Scan Modes: Continuous 	Continuous - The X-ray generator and the FDP continuously rotate around the subject without interruption during the image acquisition process. Available scan modes: Standard, High Speed, or High Resolution. Scan times vary with the scan mode (see Table 7.1 on page 56).	Table 3.2 on page 20
Step 	Step Scan - The X-ray generator and the FPD move to a specific position, stop briefly to capture an image, and then move to the next step. Step Scan is a fully configurable mode allowing for the highest resolution image. Refer to section *CT Scan Modes* on page 61 for additional setting information.	
	Filters for removing noise by combining pixels.	Table 3.2 on page 20
	Use the and arrows to set the subject orientation. **Initialize** – Moves the sample bed to the “0”position and initiates manual control of the sample bed. – Actual z-axis position of the sample bed (into or out of the bore). Position information is available after you click **Initialize**). – To move the sample bed in/out of the bore, select a distance (mm) from the drop-down list or enter a value, and click **Set**. – Click to move the bed in or out of the bore.	page 69
	 Shows the current gantry position and degree of rotation, 0 degrees in this example.  To manually rotate the gantry before scanning, select the degrees of rotation or enter a value, and click **Set**. Click **Home pos**. to return the gantry to 0 degree rotation.	
	Click to begin X-ray tube warm-up. The Warm-Up button changes to the Live Mode button after X-ray tube warm-up is complete.	
	Click this button to view the subject in real time.	
	Starts a scan.	

Table 4.2 Control Panel (continued)

Item	Description	For More Details, See:
	Emergency stop button. Click this button to abort acquisition and stop X-ray generation.	
	Closes the software.	

5 Working With Databases and Data

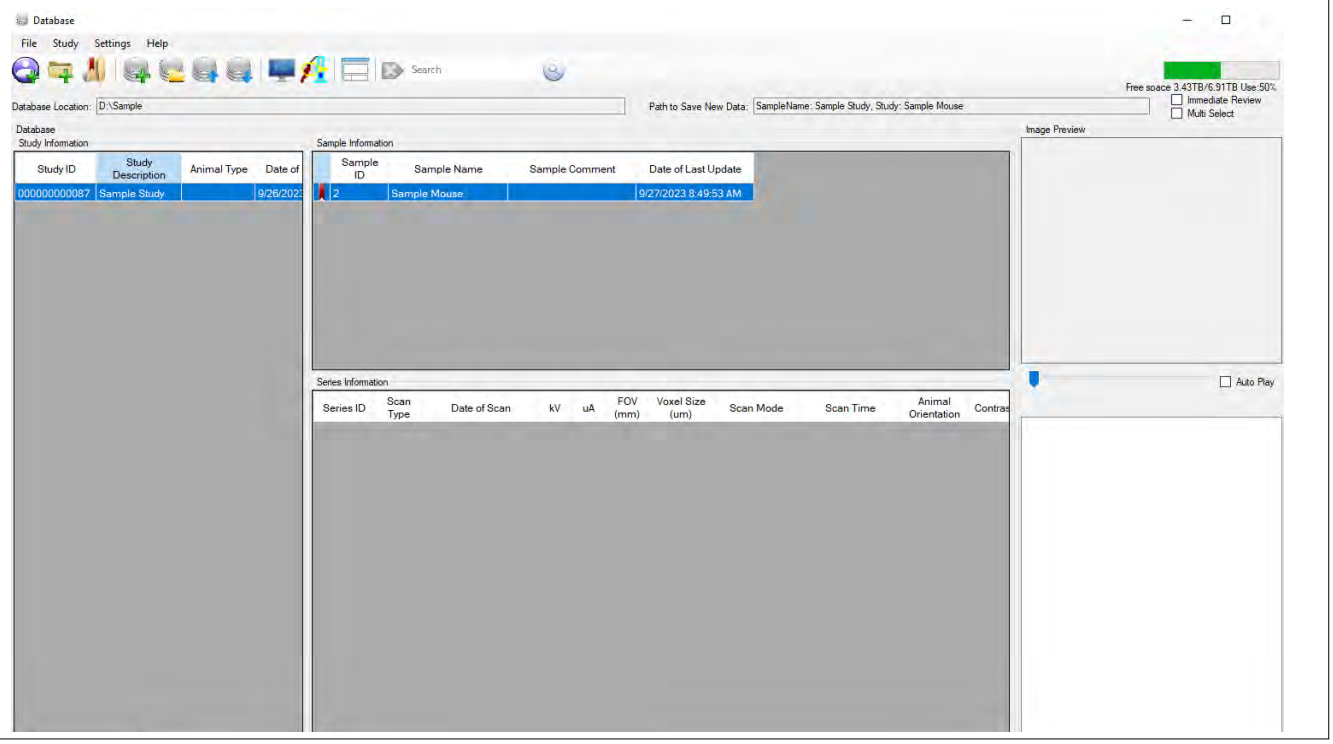
5.1 Creating a Database

All image data (*series*) are saved to a local database. Each scan is stored in the folder D:\Data and the raw acquisition data are stored in Computer\Data (D:)*. The database facilitates interacting with and managing data sets.

To create a database:

1. Open the Database window by starting the Quantum GX3 microCT software (click the  icon on the desktop (Figure 5.1).

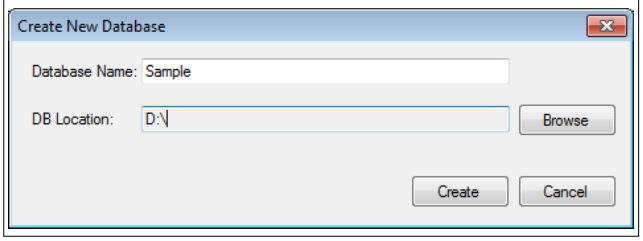
Figure 5.1 Opening the Database Window



2. Click the New Database button in the Database window. Alternatively, select **File** → **New Database** on the menu bar.
3. In the dialog box that appears:
   a. Enter a name for the new database (Figure 5.2).
   b. Click **Browse**, and in the dialog box that appears, navigate to the drive where the database will be saved and click **OK**.
   c. Click **Create**.

The new database will appear in the Database window.

Figure 5.2 Creating a New Database

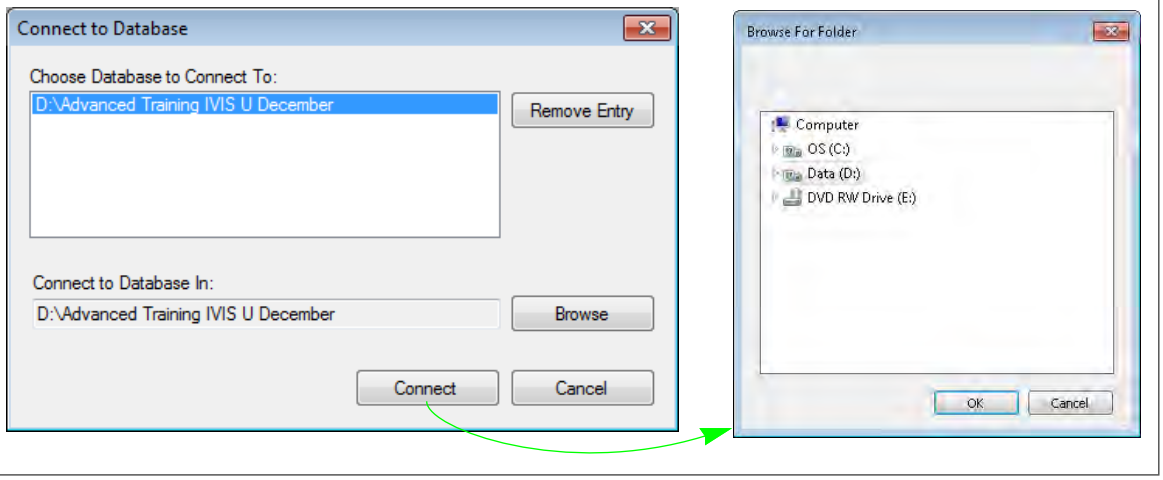


5.2 Connecting to a Database

1. Click the Connect to Database button in the Database window.
2. If the database name is listed the dialog box that appears, double-click the name. Alternatively, select the database name and click **Connect** (Figure 5.3).

   If the database name is not listed in the dialog box:
   a. Click **Browse**
   b. Select a database in the dialog box that appears and click **OK**.
   c. Click **Connect**.

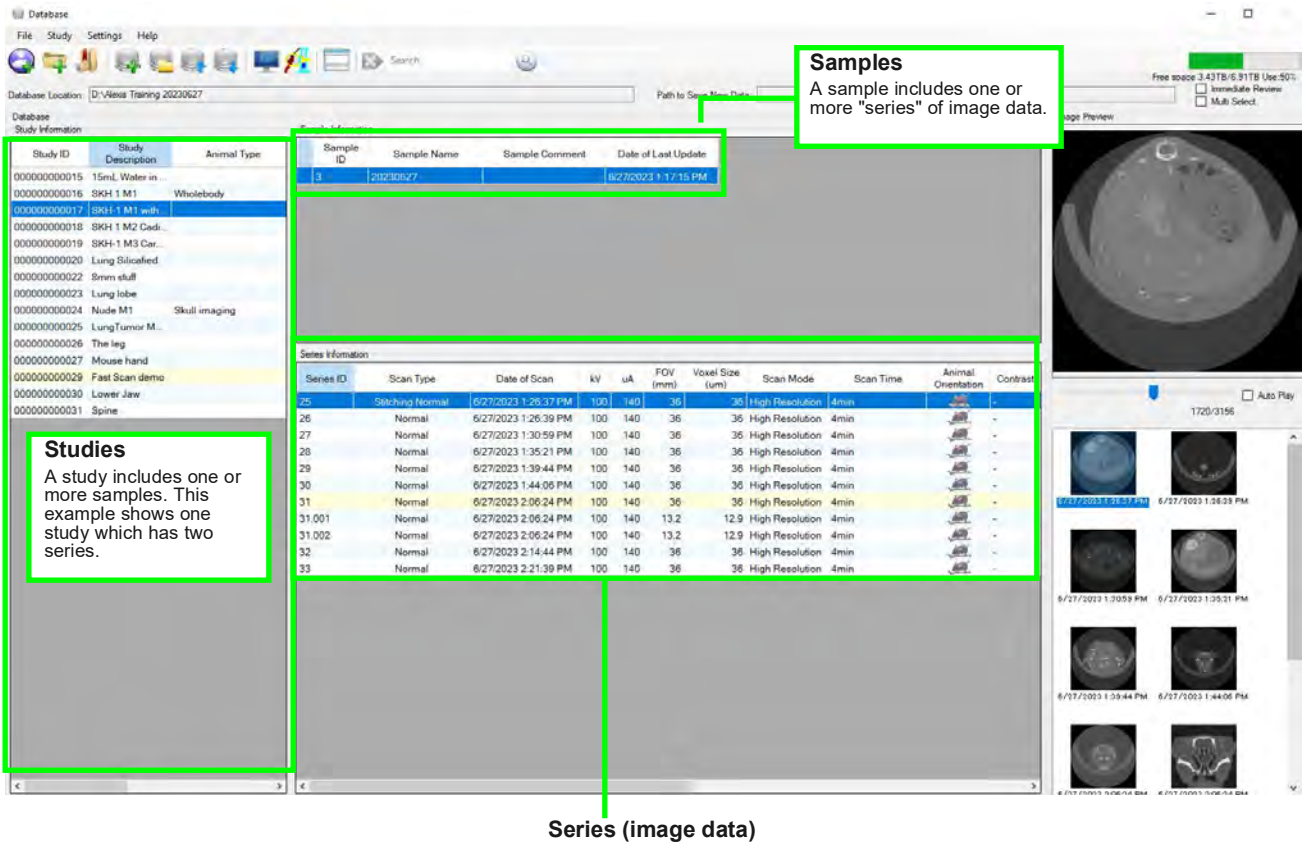
Figure 5.3 Connecting to a Database



5.3 Data Organization

The image data (series) in a database are associated with a study and a sample (Figure 5.4). A study may include multiple samples, and a sample may include one or more series.

Figure 5.4 Database Organization - Studies and Samples



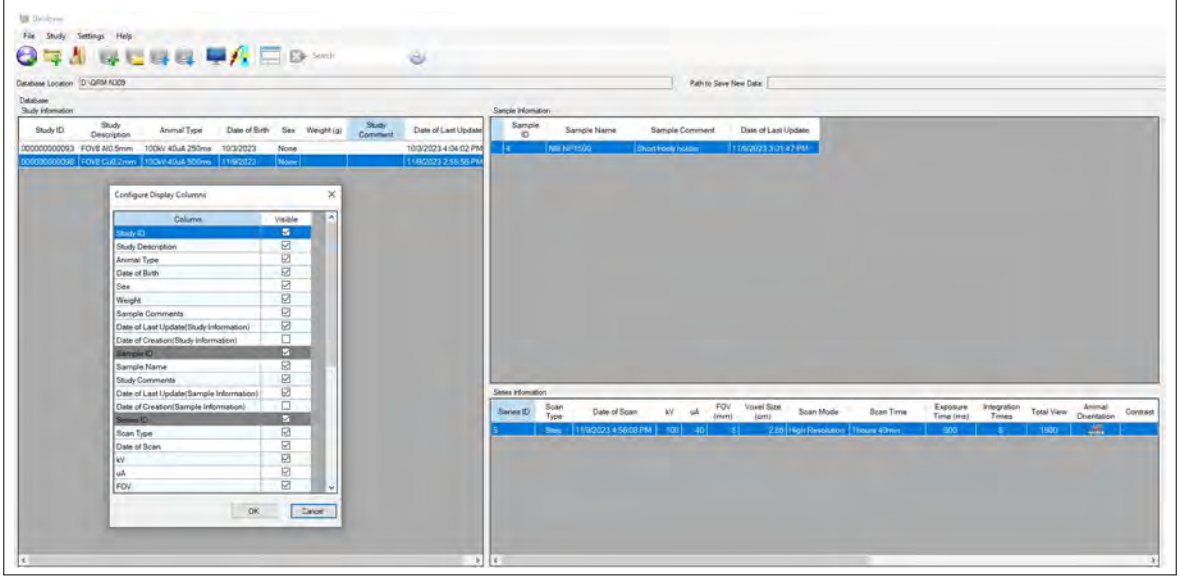
Customizing the Database View

You can select particular columns and data to display in the Database window.

To hide/show columns:

1. Right-click a column header in the Database window (Figure 5.5).
2. Select **Configure Display Columns** on the shortcut menu that appears.
3. In the dialog box that appears, remove or add a check mark next to a column name that you want hide or show. Click **OK**.

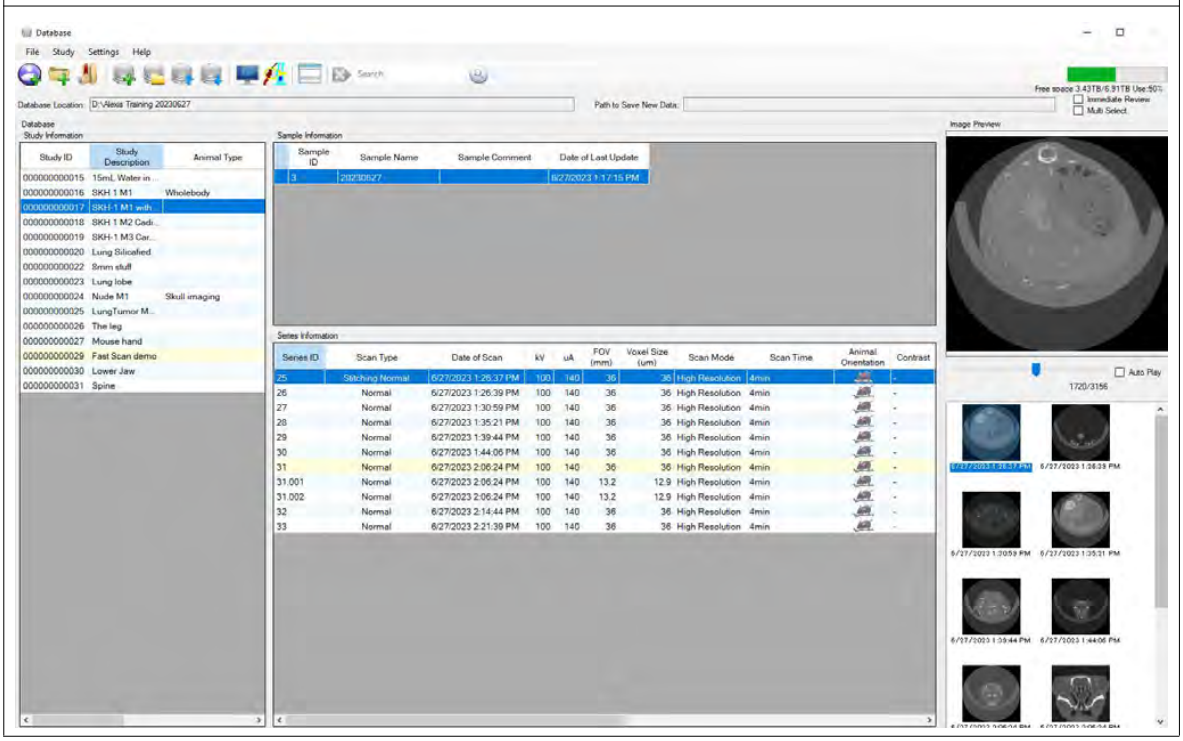
Figure 5.5 Selecting Database Columns



To filter the data:

Select a filter from the Name, Study, and/or Series drop-down list (Figure 5.6).

Figure 5.6 Selecting Database Filters



5.4 Managing Data

Reconstructed image data (*.vox) can be imported between databases or exported from the database to another location such as the desktop.

Importing Data

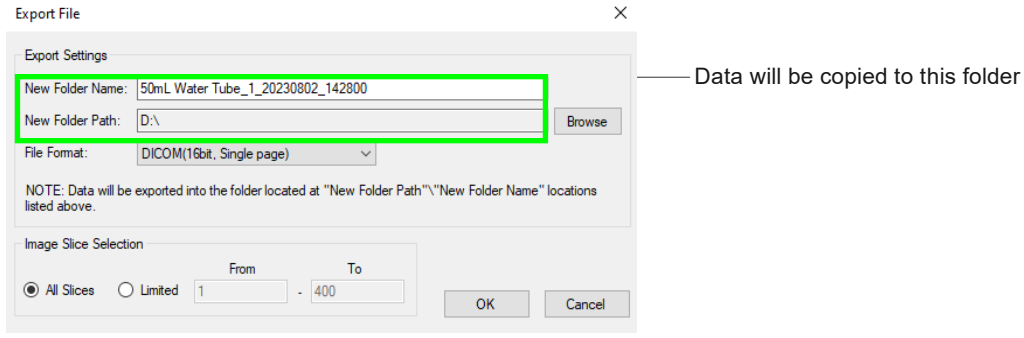
1. Select a save location (study and sample) for the data in the Database window. See *Select a Save Location* on page 56 for instructions on selecting a save location.
2. Click the toolbar button. Alternatively, select **File** → **Import File** on the menu bar.
3. Select the data (*.vox) for import in the dialog box that appears and click **Open**.

   The imported series appears in the Database window. The original data name is listed in the Series Description.

Exporting Data

1. Select the series for export in the Database window.
2. Click the toolbar button. Alternatively, select **File** → **Export File** on the menu bar.
3. In the dialog box that appears (Figure 5.7), confirm the default name or enter a different name for the new folder where the data will be copied.

Figure 5.7 Export File Dialog Box



4. To change the folder path, click **Browse** and select a location in the dialog box that appears.
5. Select a file format from the drop-down list.

File Format	Description
CT image with a SimpleViewer	Exports the 3D reconstruction (.vox) along with the SimpleViewer. See page 112 for more details on the Viewer.
DICOM (16bit, Single page) Tiff (16, Multi page) JPEG Bitmap PNG	Exports individual slices in a file formats common for medical imaging. Exporting to DICOM format creates a folder of .dcm files, one file per slice. Exporting to Tiff format creates a single file which includes all of the slices.
AVI	Exports the selected images in a video file format.

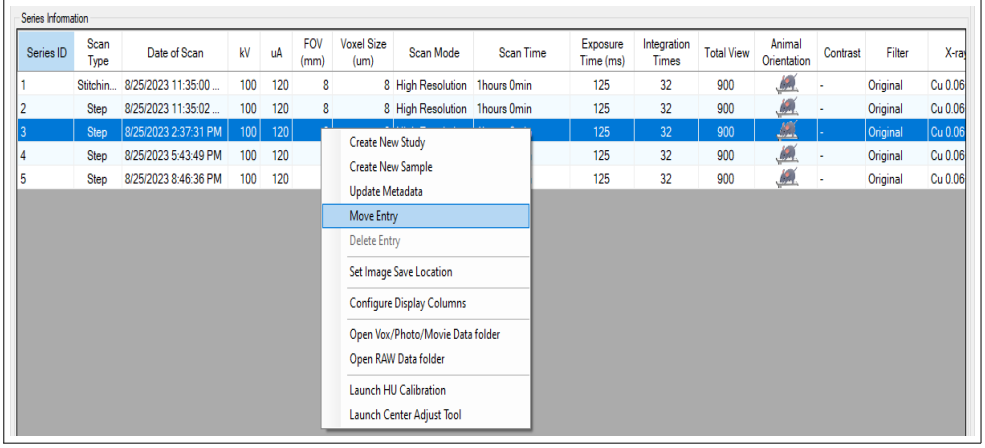
6. To export only a subset of the slices contained in an image, choose the “Limited” option and enter a range of slice numbers. Click **OK**.

Moving Data

You can move a series to a different study and sample.

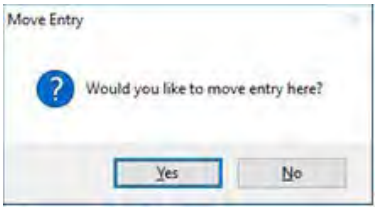
1. In the database window, right-click the row of the series that you want to move and select **Move Entry** from the drop-down menu (Figure 5.8).

Figure 5.8 Selecting Series Data



2. Click the destination study and sample.
3. Click **Yes** in the prompt that appears (Figure 5.9).

Figure 5.9 Move Entry Prompt



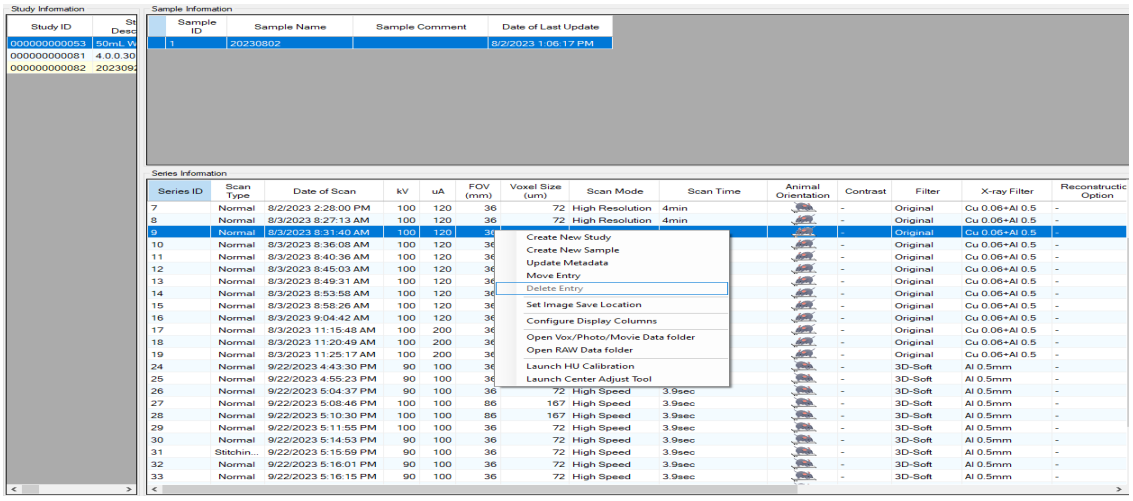
Deleting Data

NOTE: Only the system administrator can delete data. See *Working With Data Offline* on page 40 for instructions on system administrator login/logout.

CAUTION: Deleting data removes all reconstructed and raw images from the system. The images cannot be recovered once the delete process is initiated.

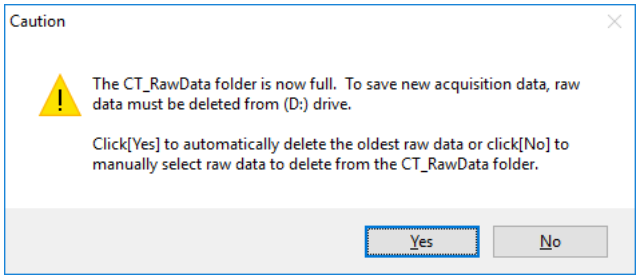
1. Select a study, sample, or series in the Database window.
2. Right-click the row and select **Delete Data** on the shortcut menu.
3. Click **Yes** in the confirmation message that appears.

Figure 5.10 Deleting Data



NOTE: When the “CT_RawData” folder is full, a caution dialog box appears (Figure 5.11). Click “Yes” to automatically delete the oldest raw data. Click “No” to manually select raw data from the folder.

Figure 5.11 Data Cleaner Warning



5.5 Managing Databases

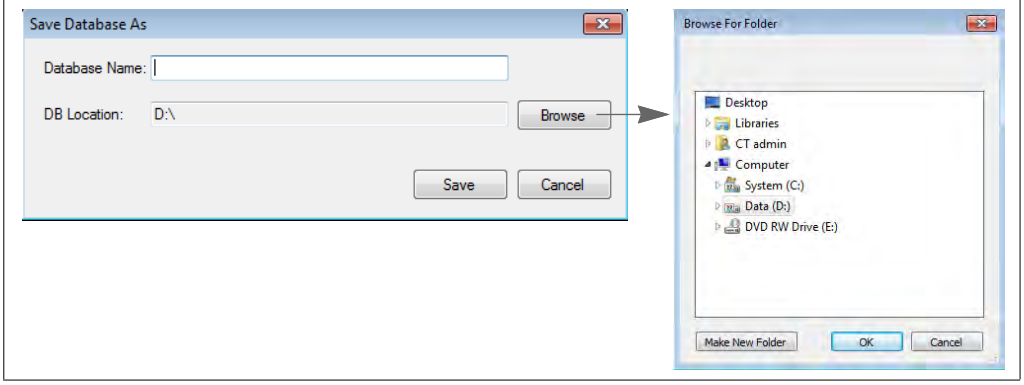
Copy a Database

Copying a database provides a convenient way to share data.

NOTE: Only the system administrator can copy a database. See *Working With Data Offline* on page 40 for instructions on system administrator login/logout.

1. Connect to the database that you want to copy. (See *Connecting to a Database* on page 32 for details on connecting to a database.)
2. Select **File** → **Save Database as** on the menu bar.
3. Enter a name for the new database in the dialog box that appears.
4. To change the save location:
   a. Click **Ref (**Figure 5.12).
   b. Select a folder in the dialog box that appears, and click **OK**.
5. Click **Save**.

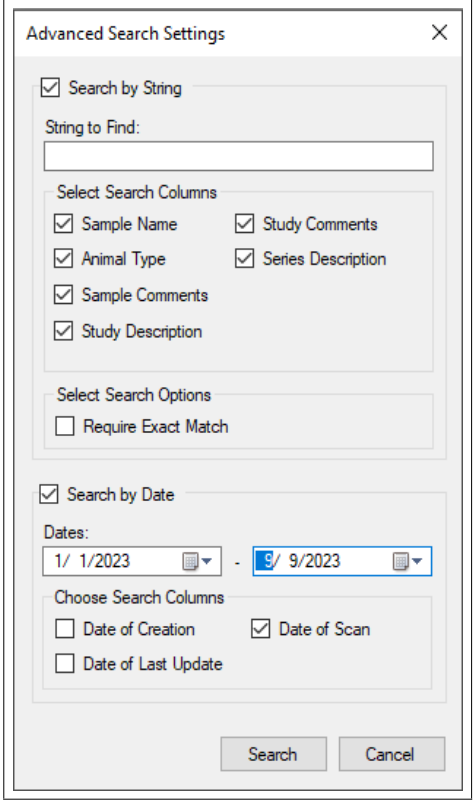
Figure 5.12 Copying a Database



Search a Database

1. Click the toolbar button.
2. Enter a text string, choose the search options, and click **Search**.

Figure 5.13 Database Search Parameters



Delete a Database

NOTE: Only the system administrator can delete a database (includes the associated studies and series), study (includes the associated series), or series only. See *Working With Data Offline* on page 40 for instructions on system administrator login/logout. Do not delete a database using Windows Explorer.

CAUTION: Deleting a database removes all reconstructed and raw images from the system. The images cannot be recovered once the delete process is initiated.

1. Connect to the database that you want to delete:
   a. Click the Connect to Database button in the Database window.
   b. Select the database in the dialog box that appears.
2. Select **File** → **Delete Database** on the menu bar.
3. Click **OK** In the confirmation messages that appears.

5.6 Working With Data Offline

Two different software packages are available for working with data offline.

- Quantum GX Viewer Pack Software – Display only software for viewing image data and reconstructed microCT images.
- Quantum GX Image Analysis Software – Analysis and display software that enables you to reconstruct and view microCT images.

Workstation Requirements

Table 5.1 lists the workstation requirements for the software.

Table 5.1 Workstation Requirements for ViewerPack and ImageAnalysis Software

Item	Workstation Requirement	
	QuantumGX ViewerPack	**QuantumGX ImageAnalysis**
OS	Windows® 10, 64-bit Home Edition or higher	Windows 7 Professional 64-bit or Windows 10 Professional 64-bit
CPU	Intel® Core i7 or i9, 2.0GHz or higher	Intel® Core i7 or i9, 3.0GHz or higher
Memory	4GB minimum	128GB minimum
Hard drive	System drive (C drive) – 1GB or more free space	▪ System drive (C drive) – 1GB or more free space Data drive (D drive) – This drive is required for storage of raw image data. The drive should be formatted with a file system capable of handling single files larger than 10GB (e.g. NTFS) and have sufficient storage (at least 1TB is recommended).
Graphics board	▪ OpenGL2.0 or later ▪ Graphic memory ≥4GB	▪ Graphic memory ≥16GB ▪ NVIDIA Quadro RTX4000 or later.
USB port	One or more USB 3.0 ports. **Note:** USB port for keyboard, mouse, and one extra port required).	One or more USB 3.0 ports. **Note:** USB port for keyboard, mouse, and one extra port required).
Monitor resolution	1920 x 1080 minimum	1920 x 1080 minimum

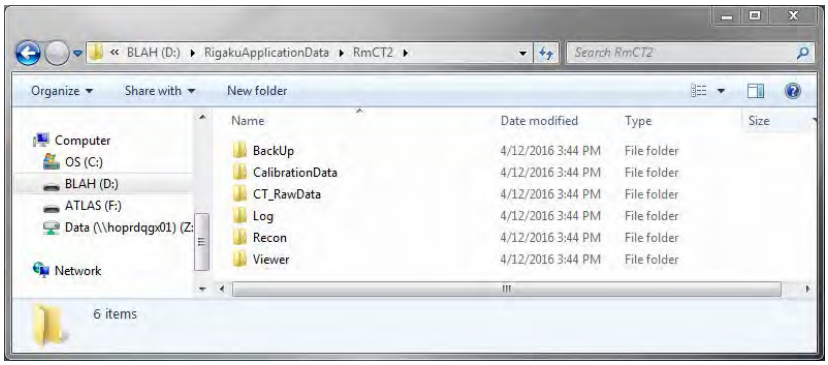
Workstation Setup

NOTE: A hard drive labeled as "D:" is required and can be created as a partition on another hard drive if necessary.

1. Manually create the folder "D:\RigakuApplicationData".
2. Install the Quantum GX Analysis Software on the analysis workstation using the software installer.
3. Launch the database.

This creates a folder structure on the D: drive that matches the imaging system D: drive (Figure 5.14). Quantum GX Analysis Software only supports subvolume reconstructions using folder hierarchies that match what is on the imaging system workstation.

Figure 5.14 Folder Structure on the Analysis Workstation



4. Copy a database from the imaging system or data archive to an external medium, for example a USB external hard drive. See *Copy a Database* on page 38 for instructions.

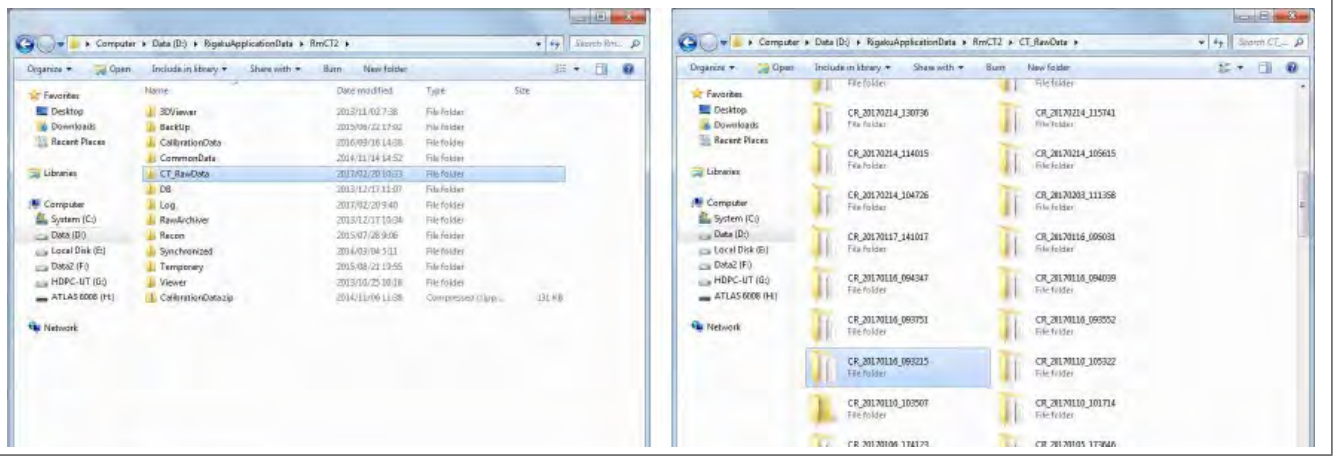
NOTE: Quantum GX Analysis Software only analyzes image data on the local workstation.

5. Go to "Data (D:)\RigakuApplicationData\RmCT2\CT_RawData" on the imaging system. Select and copy the raw data folder(s) of interest to an external medium. Each folder name includes the date and time of a scan (CR_YearMonthDay_HourMinuteSecond) (Figure 5.15).

NOTE: Be sure to copy the data folder and its contents, not just the raw data. Otherwise the workstation will not be able to process the data.

6. Copy the raw data folder(s) from the external medium to "D:\RigakuApplicationData\RmCT2\CT_RawData" on the analysis workstation.

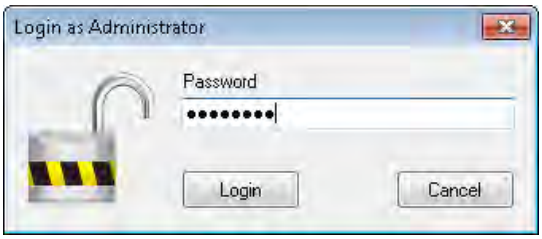
Figure 5.15 Selecting and Copying Raw Data Folder(s)



5.7 System Administrator Login/Logout

1. Open the Database window.
2. Select **Settings** → **Login/Logout** as Administrator on the menu bar.
3. Enter the administrator password in the dialog box that appears.
   The default password is *ct2admin*.
4. Click **Login** (or **Logout** if logging out).

Figure 5.16 Login as Administrator



6 Hounsfield Unit Calibration

6.1 Introduction

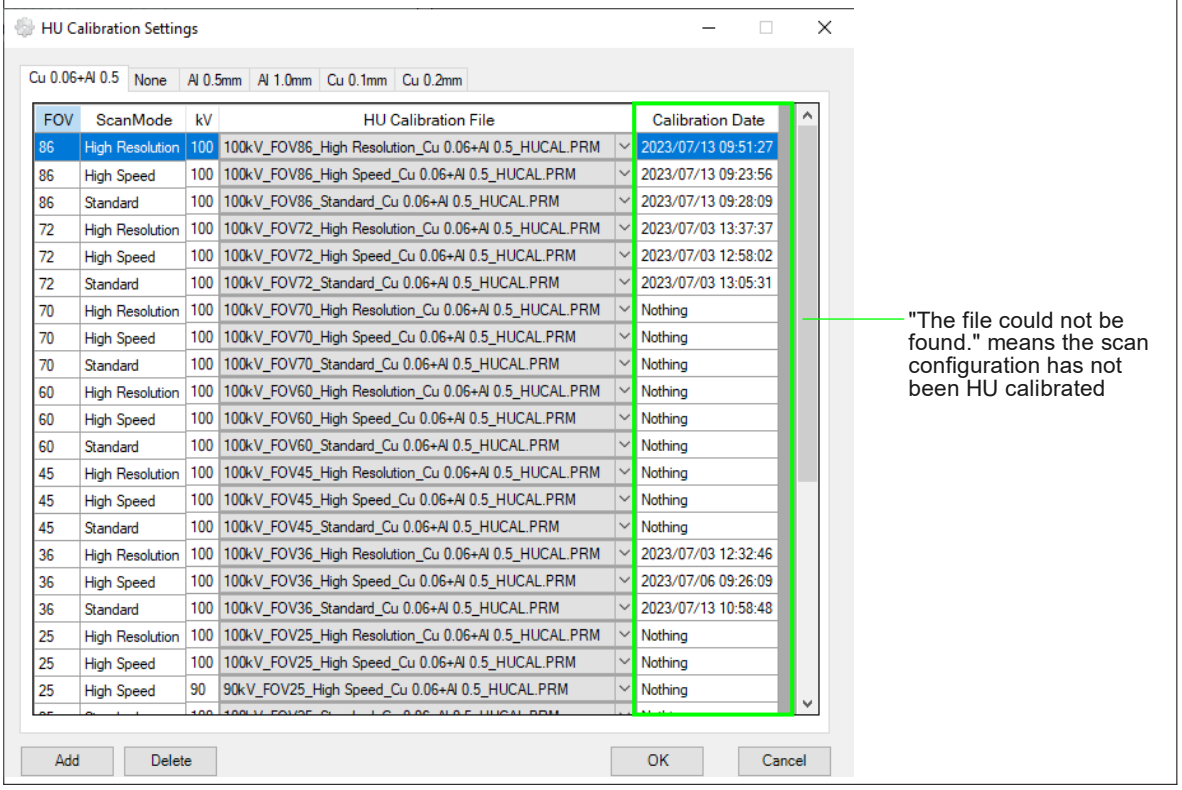
The Hounsfield Unit (HU) characterizes the radio density of computed tomography (CT) images. HU is a dimensionless value which is proportional to X-ray attenuation. The HU scale is defined as a two point scale with air = -1000 and water = 0. Values for all other materials are either interpolated or extrapolated. X-ray attenuation in air or water is related to X-ray beam energies. Therefore, changing the peak X-ray tube voltage, X-ray filter, or FOV affects the HU scale.

The instrument enables you to calibrate HU values for air and water at a particular scan configuration. The calibrated HU values will be saved to the system, allowing you to apply a specific HU scale to future scans.

HU calibration is recommended prior to all scans. Otherwise, image grayscale values may not be accurate. The Revvity service engineer will calibrate the present scan configurations during installation of the instrument.

Select **Options** → **HU Calibration Settings** in the Control Panel to view available HU calibration files (Figure 6.1). If the Calibration Date column contains "The file could not be found", it means the HU calibration procedure has not been performed for that scan mode.

Figure 6.1 HU Calibration Settings



HU Calibration

It is important for you to confirm whether the scanning parameters you want to use have a HU calibration file (and associated Gain calibration file). Gain calibration and HU calibration can now be performed for each filter and each tube voltage, so be sure to calibrate under the conditions you want to scan before scanning. **By performing calibration, your scan contains calibrated values (-1000 HU for air and 0 HU for water).**

If calibrations have not been done, the CT scan can still be performed, but:

- The closest HU calibration file will be used based on voltage value and filter type. If no alternative HU calibration file is found, default values will be used.
- The closest Gain calibration file will be used based on voltage value, scan mode and filter type. If no alternative Gain calibration file is found, a message appears as scanning is not possible until the Gain calibration is performed.

The 100kV HU calibration files cannot be deleted as these are the default files for all other scanning conditions

When performing a HU Calibration of 2864x2864x2272 (Super High Resolution) image you must save two HU Calibration files with different filenames e.g. "Low Image Resolution" and "High Image Resolution" so you can distinguish between the two calibration files.

Gain Calibration

Gain calibration refers to the calibration of a combination of kV and uA settings and is essential to correct for the nonuniform response of individual pixels of a flat panel detector (FPD) to X-ray exposure. A general gain calibration involves acquiring a flood field image and generating a gain map.

6.2 Check the Scan Conditions and Indicators Before Calibration

In Quantum GX3 software, a traffic-light type indicator appears in the Control panel to indicate the status of the Gain and HU calibration files needed to conduct the selected scanning parameters.

Figure 6.2 Gain and HU Calibration Status

Before you perform your scan, check the display to know whether your scan will be calibrated or not.

There are three types of colored icons which indicate the following:

- The unit of expiration for each Gain/HU file is in days (120).
- If the status of a calibration file is Green (OK), the calibration was performed within 120 days.
- If the status of a calibration file is Yellow (Caution), it is nearly 120 days old.
- If the status of a calibration file is Red (NG), it is more than 120 days old.

If there are multiple conditions in Job Scan the results of checking all scan conditions appear. The importance level is:

- (1) Green - calibrated
- (2) Yellow - older calibration date
- (3) Red - uncalibrated condition

If you try to perform a Live Mode or a CT scan in spite of the traffic light (Yellow or Red) a status message appears.

- Click **Continue** to continue scanning, or click **Cancel** to cancel scanning.
- Click **Details** to see the condition number and details of the problem, which can be used as reference when performing calibration.

Figure 6.3 Calibration Status Message, File Replaced

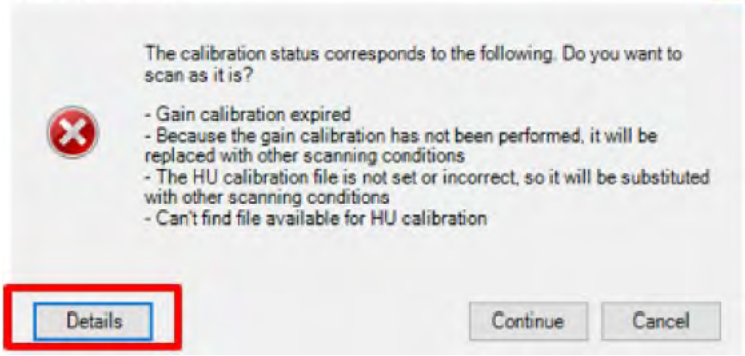
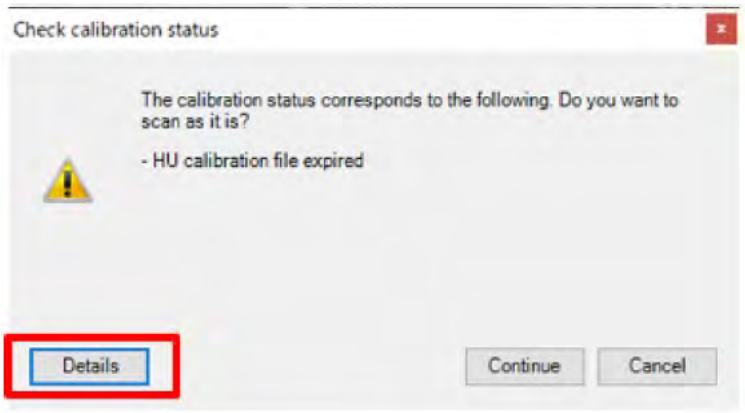


Figure 6.4 Calibration Status Message, File Expired



6.3 Set Gain Calibration

For each Gain calibration you can adjust:

- the scan mode it will apply to
- the voltage (kV) to correspond to each uA value
- the filter selection

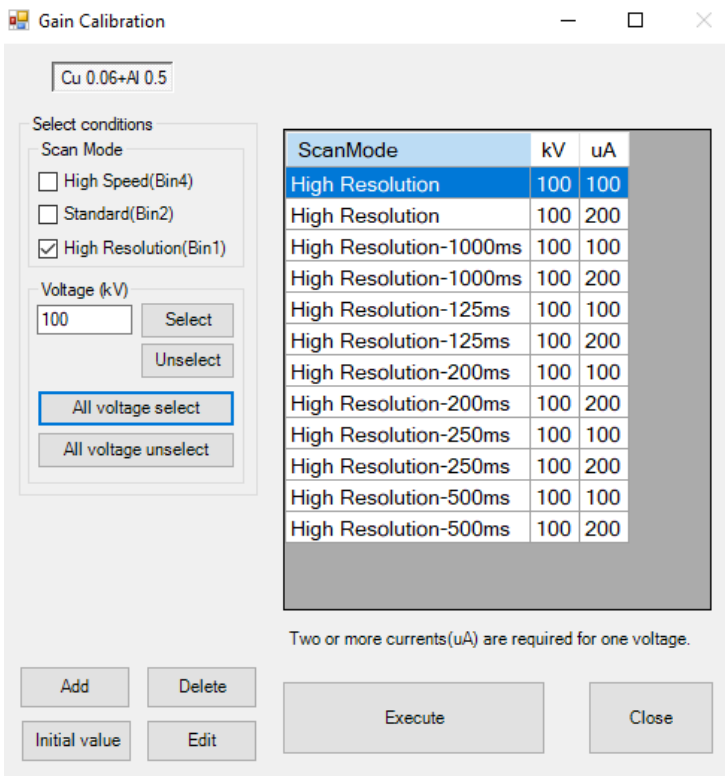
Select the condition for gain calibration. Set the conditions according to the filter tab to be used. The set conditions are saved and reflected in the settings from the next time.

1. Go to **Control Panel** -> **Options** -> **Gain Calibration**

Figure 6.5 Gain Calibration

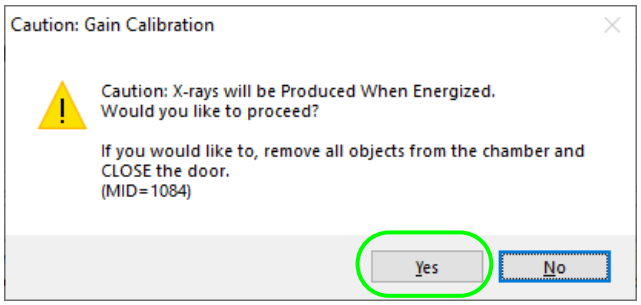
2. Set the conditions for the Gain calibration table under **Select Conditions.**
   Only the calibration settings in the table are executed, and the Gain calibration table values are saved and displayed in the table when you return to the Gain calibration window.
3. Choose a **Scan mode** to calibrate such as High Speed, Standard, or High Resolution.
4. Choose a **Filter** such as Cu 0.06mm +Al 0.5 mm, None, Al 0.5 mm, Al 1.0 mm, Cu 0.1 mm or Cu 0.2 mm.
5. Choose the **Voltages** (kV) corresponding to each uA value up to a maximum of 20 W.
   - For voltages <100 kV, select two points for the range of corresponding uA values such as a Gain calibration of 70 kV + 100 uA and 70 kV + 200 uA.
   - **Select** - selects the voltage value entered in the text box. This changes the table on the right (following figure), to parse out only the calibrations for that voltage (if they exist).
   - **Unselect** - deselects the voltage value selected with the select button. It cannot be used when all items are selected.
   - **All voltage select** - selects all existing voltage values.
   - **All voltage unselec**t - deselects all voltage conditions currently selected.
6. Choose other Gain Calibration features as necessary, such as Add, Delete, Initial Value, and Edit. See the following section for details about these features.

Figure 6.6 Voltage in Gain Calibration



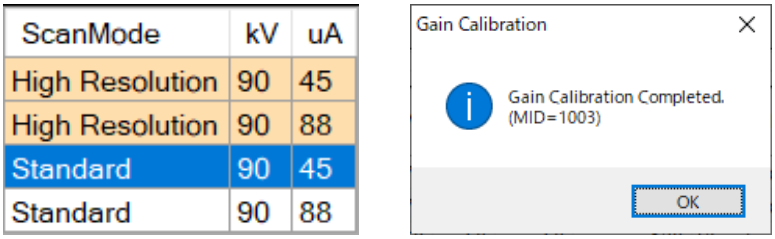
7. Ensure only the clean bore cover is inside the scanner.
8. Check the displayed table and click **Execute**.
9. Click **Yes**. Gain Calibration starts.

Figure 6.7 Proceed with Gain Calibration



The color of the completed line changes, and a message appear when complete.

Figure 6.8 Gain Calibration Complete

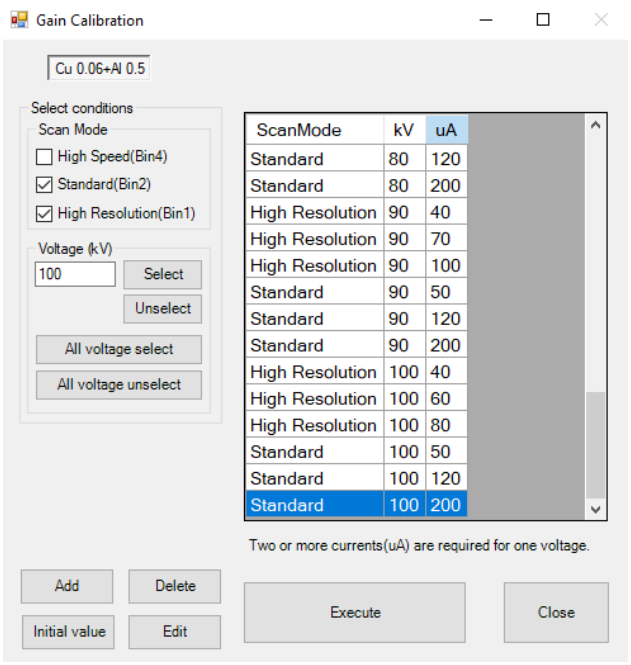


10. Click OK then close the Gain calibration window.

6.4 Other Gain Calibration Features

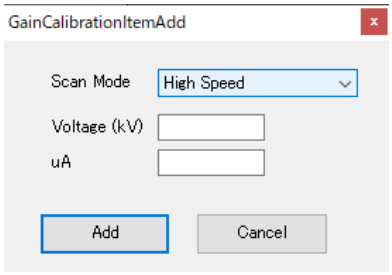
You can choose other features in the Gain Calibration window.

Figure 6.9 Other Features in Gain Calibration



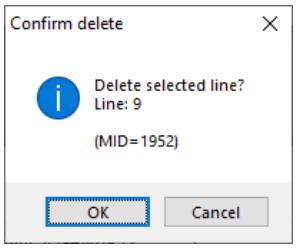
- Click *Add* to set the scan mode, tube voltage and tube current, and add one condition candidate.

Figure 6.10 Adding Gain Calibration Item



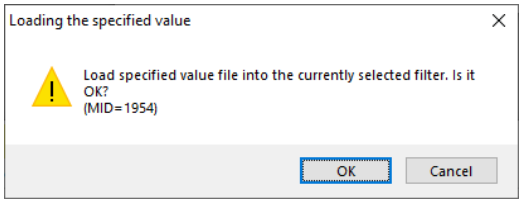
- Click *Delete* to delete the row selected in the condition table to be executed. You may select more than one row.

Figure 6.11 Deleting Row from Condition Table



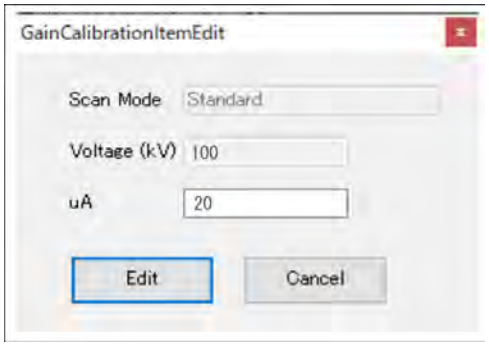
- Click *Initial value* to overwrite the condition candidates created by the selected filter with the default values.

Figure 6.12 Initial Value Overwrite



- Click *Edit* to edit the tube current value of the currently selected line. You cannot select multiple lines.

Figure 6.13 Editing Tube Value



6.5 HU Calibration Water Phantom

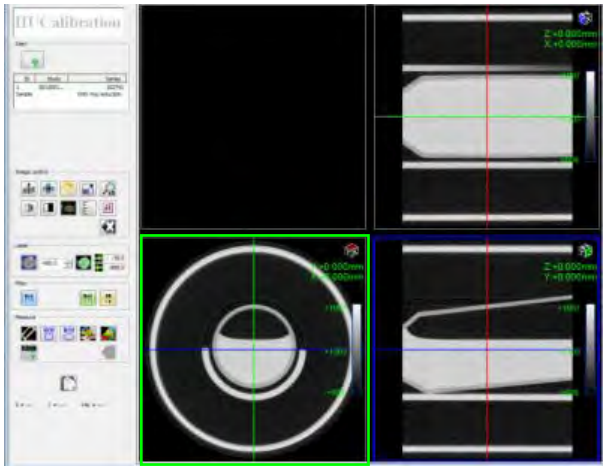
The HU calibration procedure uses a water phantom which is made by adding water to a conical tube or microtube (Figure 6.14).

Select a tube size that is close to the size of the subject you will be imaging. If there is a small Teflon® rod attached to the tube cap, remove and discard the rod. Fill the tube about half full with water and tightly cap.

NOTE: Ensure that the entire cross section of the phantom image is visible in the FOV (Figure 6.15).

Figure 6.14 Example HU Calibration Water Phantoms

Figure 6.15 Example Phantom Image



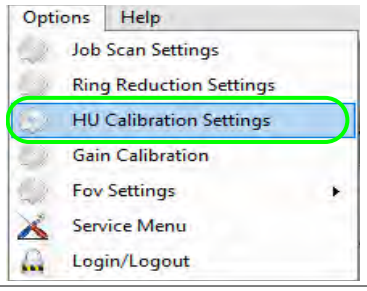
The entire cross section should be visible in the FOV

6.6 HU Calibration Procedure

Set other HU calibration voltages in addition to 50, 70, and 100 kV, when you add or delete calibration conditions. Use the calibration file created in the previous section.

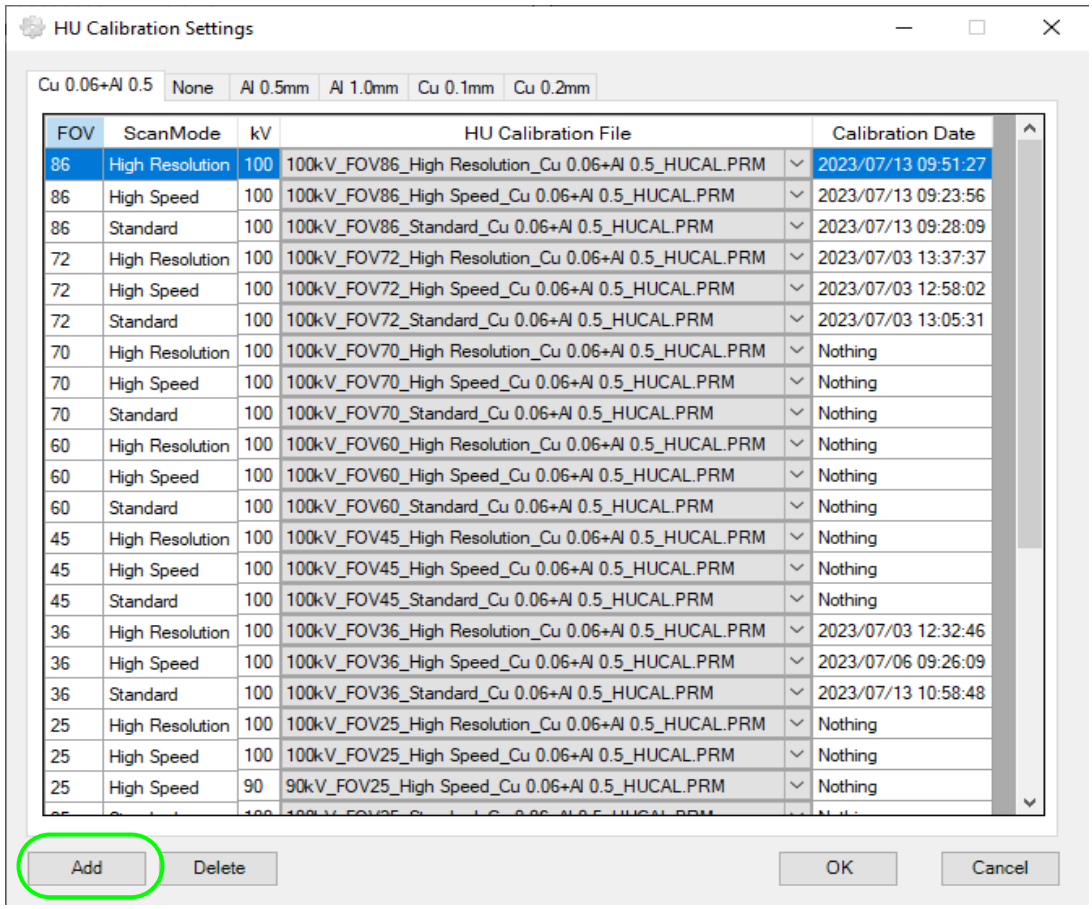
1. Select **HU Calibration Settings.**

Figure 6.16 HU Calibration



2. Click **Add**.

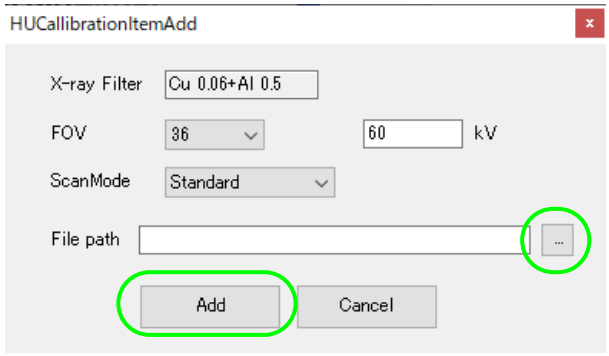
Figure 6.17 Adding Calibration Condition



3. Set the conditions you want to add.
4. Select a file with the 3-dots button to locate the HU file in HU calibration folder.

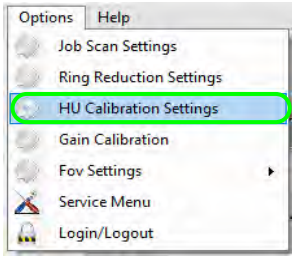
5. Click **Add.**

Figure 6.18 Setting Calibration Item



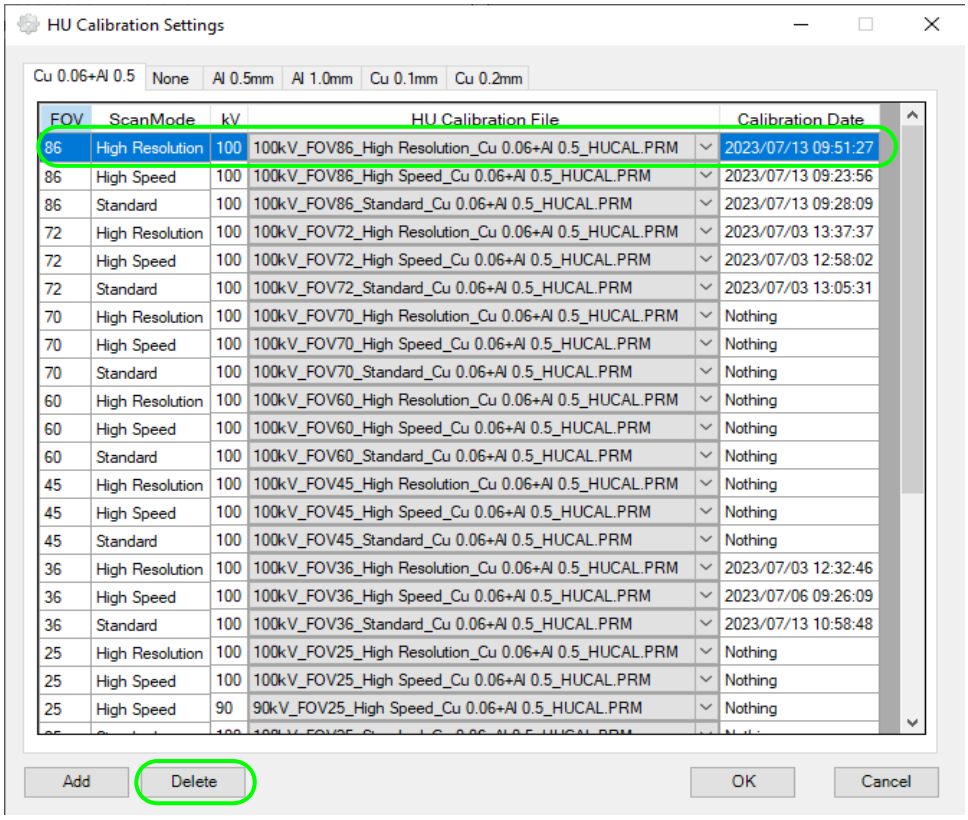
6. Select **HU Calibration Settings.**

Figure 6.19 HU Calibration Settings



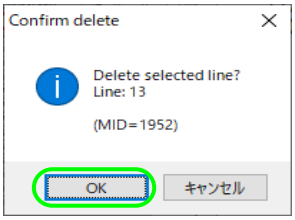
7. Click an item on the list and then click **Delete**.

Figure 6.20 Deleting Calibration Condition



8. Click **Ok**. The item is removed from the list.

Figure 6.21 Confirmation of Deletion



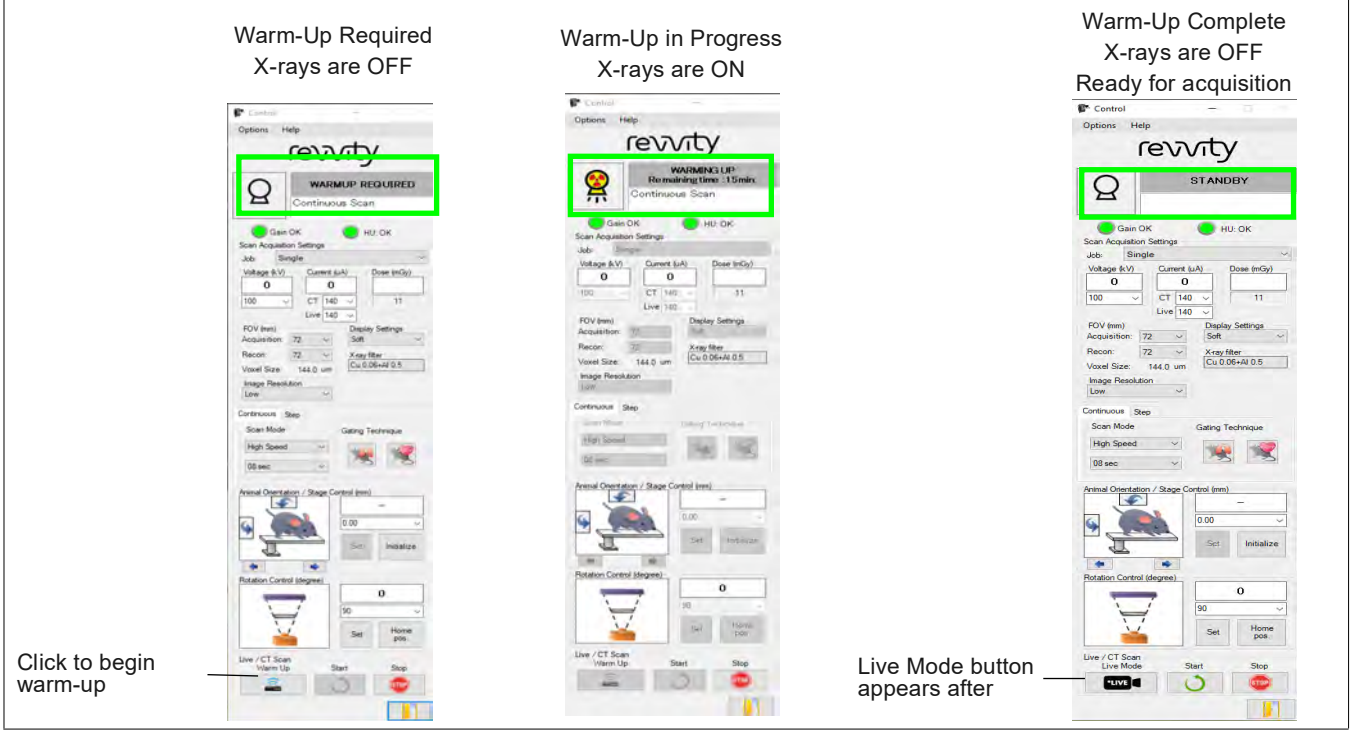
7 Image Acquisition

7.1 Imaging System Warm-Up

NOTE: If the imaging system is not turned on, see *Starting the Imaging System* on page 26 for instructions.

Check the Control Panel to see if the imaging system requires warm-up (Figure 7.1). If the Control Panel is not open, click the icon on the desktop.

Figure 7.1 Control Panel



To warm-up the imaging system:

1. Confirm that the sample chamber is empty (no subject or sample bed is inside the sample chamber).
2. Close the imaging system door.

NOTE: The Quantum GX3 microCT Imaging System does not generate X-rays unless the door is properly closed and the safety interlock is engaged. There is an audible “click” when the safety interlock properly engages as the door is closed.

3. Click the Warm-up button in the Control Panel. Click **OK** in the warning message that appears (Figure 7.2).

   The X-ray tube begins the warm-up process and generates X-rays. The time required for warm-up depends on how long it has been since the imaging system was last used (Table 7.1). X-ray tube status changes to “STANDBY” when warm-up is completed (Figure 7.1).

CAUTION: Do not open the imaging system door when X-rays are being produced (the Control Panel displays “XRAY ON” and the X-ray indicator is flashing). Opening the door terminates the X-rays and aborts the warm-up process.

Figure 7.2 Warm-Up Warning Message

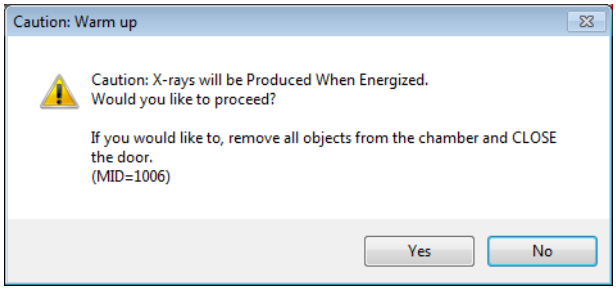


Table 7.1 Estimated Time Required for Warm-Up

Duration of Imaging System Disuse	Approximate Time Required for Warm-Up
8 hours to 1 month	15 minutes
1 – 3 months	40 minutes
More than 3 months	2 hours

7.2 Select a Save Location

All image data (series) are saved to a database where the data are organized by sample and study (sample:study:series). See *Data Organization* on page 33 for more details on data organization. Before image acquisition, select a database and specify the sample and study where the series will be saved. You can save a series to a new or existing sample and a new or existing study within the sample.

NOTE: The selected database drive must have at least 30GB free disk space available. If this requirement is not met, the scan will not proceed.

Set the Save Location:

1. Connect to a database or create a new database. (See *Connecting to a Database* on page 32 for details).
2. Follow the instructions in Table 7.2 to select a study and sample for the series.

Table 7.2 Setting the Save Location in the Database Window

To Save the Series to a:	Do One of the Following:
New study and sample	Click the toolbar button. or Right-click the Database window and select **New Study** on the shortcut menu. or Select **Study** → **New Study** on the menu bar.

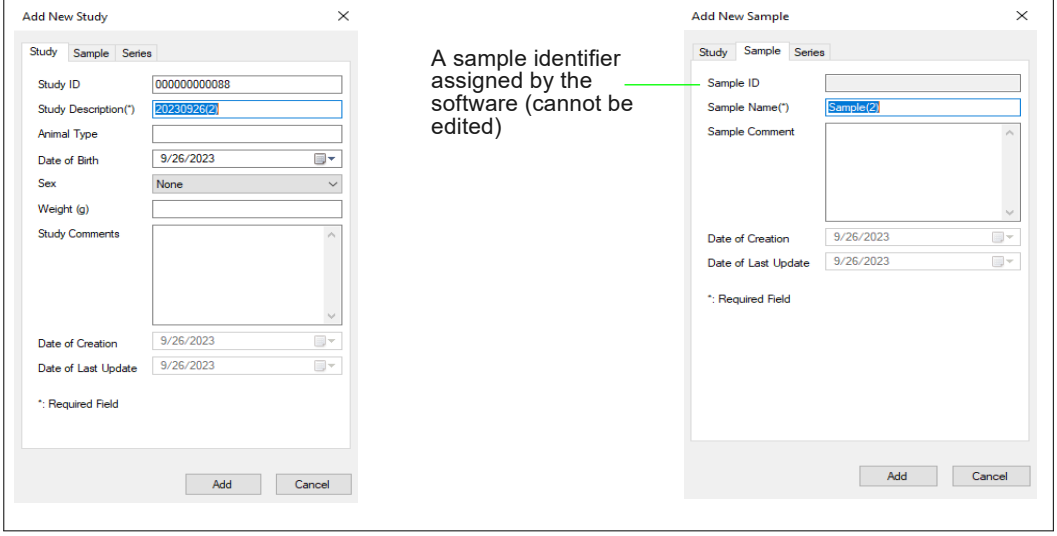
Table 7.2 Setting the Save Location in the Database Window (continued)

To Save the Series to a:	Do One of the Following:
Existing study and new sample	Select the study row and click the toolbar button. or Right-click the study row and select **New Sample** on the shortcut menu. or Select the study row and select **Study** → **New Sample** on the menu bar.
Existing study and existing sample	Select the sample row and click the toolbar button. or Right-click the sample row and select **Set Series Save Location** on the shortcut menu.

3. Enter the study and/or sample information in the dialog box that appears. Click **Add**. For example, edit the default study name and enter a description of the study.

NOTE: Depending on the method used to select the save location, the Add Study or Add Sample dialog box may not automatically appear. To display them, right-click a selected study or sample in the Database window and choose **Update Data** from the shortcut menu.

Figure 7.3 Entering Information About a New Study and/or New Sample

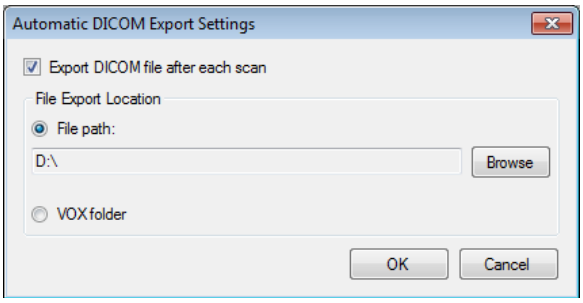


7.3 Set Up Automatic Image Export

After acquisition, DICOM images can be automatically exported to a user-selected location.

1. Select Setting **Automatic** → **DICOM Export Settings** in the Database window.
2. Put a check mark next to "Export DICOM file after each scan" in the dialog box that appears.
3. Choose the File path or VOX folder option and click **Browse** to select a folder. Click **OK**.

Figure 7.4 Automatic DICOM Export Settings



7.4 Set the Custom Scan Configuration

Set the scan configurations by choosing a:

- Job scan configuration or set custom scan parameter values in the Control Panel.

NOTE: Confirm that the scan configuration you want to use has an HU calibration file (see *Introduction* on page 43 for more details). If there is no HU calibration file, it is recommended that you perform HU calibration before performing a scan. Otherwise, grayscale values may not be accurate. See *Hounsfield Unit Calibration* on page 43 for instructions on HU calibration.

- Gating option if performing a gated CT scan.

There are two ways to set a custom scan configuration:

- Edit the scan parameters in the Control Panel (see below). These changes will not be saved to the system.

  or

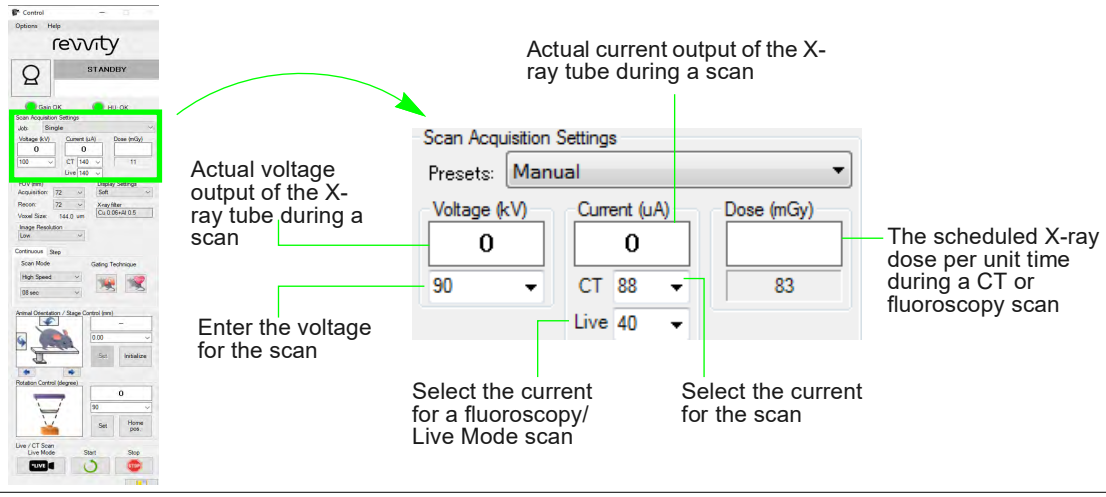
- Create and save a scan configuration in the Menu Settings table (see *Edit a Job Scan* on page 62). The custom scan configuration will be available in the Menu drop-down list of the Control Panel.

NOTE: Perform HU calibration for a custom scan configuration before acquiring an image. Otherwise, grayscale values may not be accurate. See *Hounsfield Unit Calibration* on page 43 for instructions.

To edit scan parameters in the Control Panel:

1. Select "Single" from the Menu drop-down list.
2. Enter a custom voltage and current in the Control Panel (Figure 7.5).
3. Select FOV and Scan Mode. See Table 3.2 on page 20 for more details on these parameters.

Figure 7.5 Setting a Custom Scan Configuration
See Table 4.2 on page 28 for more details on these parameters.



7.5 About Job Scan Features

Now you can create and save a scan in single or multiple segments for any combination of:

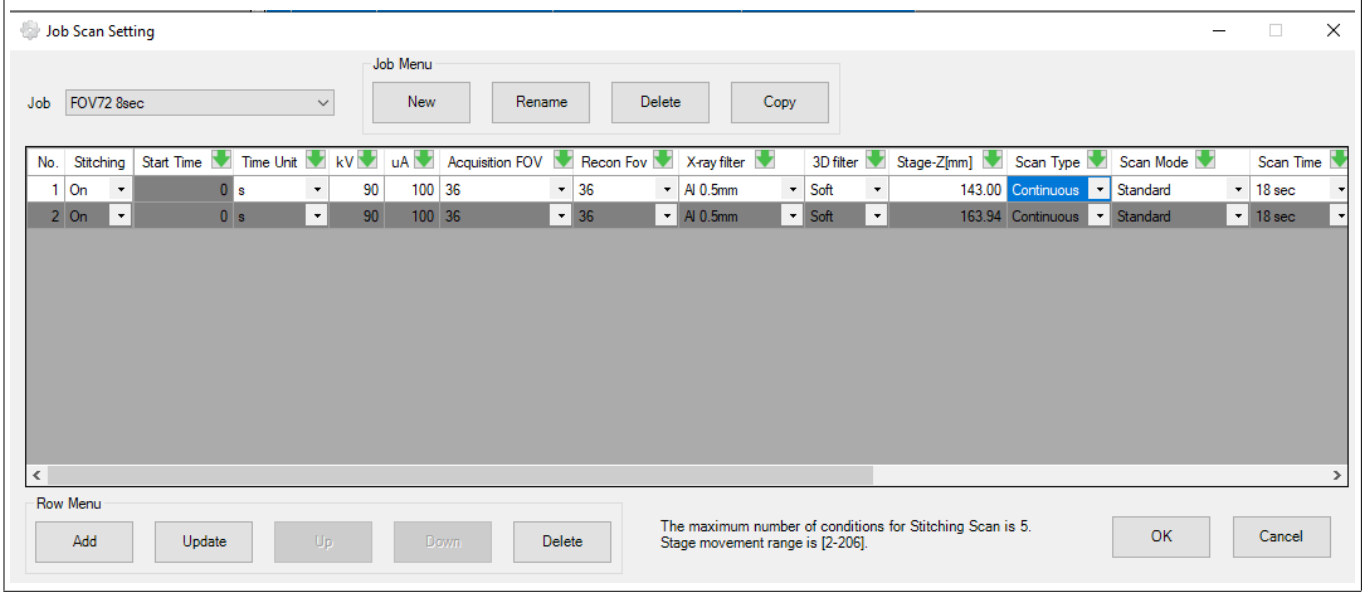
- kV
- uA
- FOV (acquisition and recon)
- X-ray Filter
- Scan Mode and Time
- Stage (Z) positions

You may use Job Scan to freely create whole body scans for each Scan Time. In addition, you can move the Z-axis position for each or create a Job Scan that includes a different scanning time, thus expanding the range of scanning.

Table 7.3 Job Scan Features

Scan Mode	Reconstructed FOV Size (mm)	Depth (mm)	Minimum Pixel Size (µm)
High Speed 3.9 sec., 8 sec	8 18 5/10/25/36 45/60/72 70/86	5 11 5/9/21/22 39/46/43 54/50	11.5 25.8 51.6 103.1 119.9
Standard 18 sec., 2 min.	8 18 5/10/25/36 45/60/72 70/86	5 11 5/9/21/22 39/46/43 54/50	5.7 12.9 25.8 51.5 59.9
High resolution 4 minutes, 16 minutes, 60 minutes	8 18 5/10/25/36 45/60/72 70/86	5 11 5/9/21/22 39/46/43 54/50	2.9 6.4 12.9 25.7 29.9

Figure 7.6 Using Job Scan



Job scan settings include:

- Select a job to edit.
- Create a new job; rename, delete, or copy an existing job.
- Edit rows with options to add, update, delete, and move up/down in job content area.

After you start a Job Scan you cannot edit the scan settings in the Control Panel, you must edit the settings in Job Scan.

Acquisition FOV and X-ray Filter can only be set in the first row and are automatically copied to subsequent rows and scans.

Gated scans cannot be performed in Job Scan.

To set your scan conditions manually, go to the Job Scan menu on the Control Panel, and choose Single. This is the same as Manual in Presets. See the previous section.

You may also use Stitching (multiple scan segments). Stitching is automatically turned on and up to five scans are set. This is equivalent to the “WholeBodyScan”, 3 x18 sec. With this setting, the stage moves from the Z position 2 mm to 94 mm. (Z position range is 2 mm to 206 mm.)

If you need an Autoscan license to edit the Job Scan stitching, contact technical support: www.revvity.com/contact-us

7.6 CT Scan Modes

The Quantum GX3 can capture images using *Continuous* or *Step Scan* modes.

If *Continuous* mode is selected, the X-ray generator and flat panel detector (FPD) rotate continuously around the stage without interruption during the image acquisition process. During the scan, the X-ray generator emits a continuous X-ray beam as the gantry rotates around the subject and the FDP continuously captures the transmitted X-rays. Continuous mode allows for faster scan times and minimizes radiation exposure to the subject.

If *Step Scan* mode is selected, the X-ray generator and FPD move to a user-defined number of steps and then pauses to capture a static image before moving to the next step. Step Scan mode provides the highest resolution quality with reduced noise and artifact, but has longer acquisition times and results in higher radiation doses. Step Scan mode is recommended for ex-vivo imaging where high-quality images are required.

Figure 7.7 Continuous/Step Selection Settings

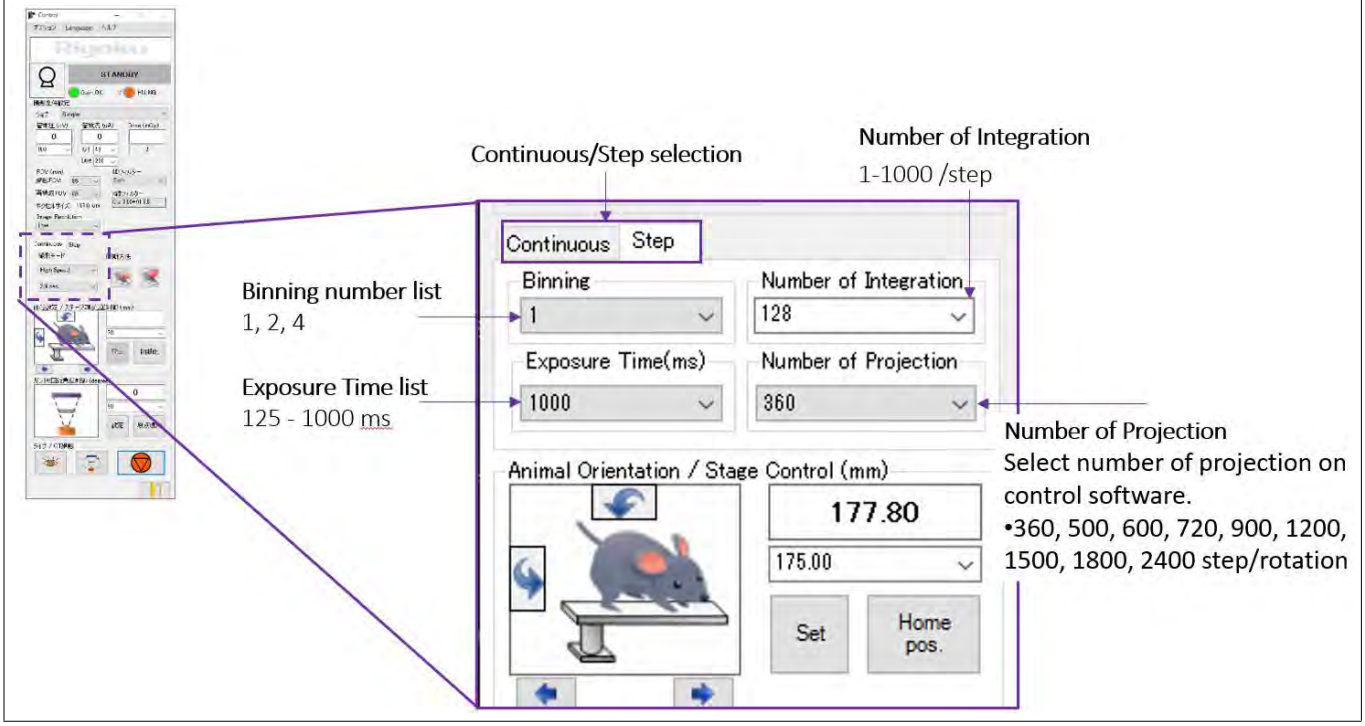


Table 7.4 Step Scan Settings

Step Scan Settings	Description
Binning Number	Binning settings of 1, 2, and 4, where Binning 1 provides the highest resolution, but increases acquisition time.
Exposure Time	Exposure from 125 – 1000ms, where longer image time provides higher image quality and increased acquisition time.
Number of Integration	Integration steps from 1 – 1000 provide more images at each step but increase acquisition time and file size.
Number of Projection	Select 360, 500, 600, 720, 900, 1200, 1500, 1800, or 2400 projections/steps in the scan. Increasing the number of projections provides higher quality images and longer acquisition times.

7.7 Perform CT Job Scans

Before selecting a Job Scan attach the appropriate bore cover for your FOV.

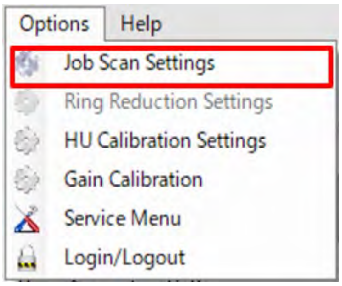
With a Job Scan you may also:

- Create a New Job Scan
- Edit the Job Scan
- Edit the Stitching for a Job Scan
- Change the Size Recon Matrix

Create a New Continuous or Step Scan Mode Job Scan

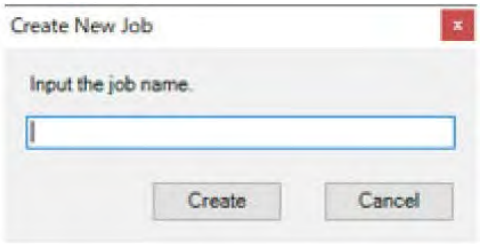
1. Go to Options -> Job Scan Settings -> New.

Figure 7.8 Creating a New Job Scan



2. Enter the scan name and click Create.
   Example: 8sx5 if it is a series of five 8s scans.

Figure 7.9 Entering Job Scan Name



Edit a Job Scan

To edit an existing job scan, Select the Job name from the drop-down menu.

- Copy Job - Copies the currently selected Job Scan. Select or enter the copy destination Job name and press the Copy button (see the following table).
- Delete Job - Deletes the currently selected Job Scan. Click Delete and then click Delete again on the confirmation (see the following table).
- Rename Job - Changes the name of the currently selected Job Scan. Click Rename and enter the new Job name (see the following table).

To set the conditions for Job Scan, use the Row Menu buttons in the table in the center of the Job Scan settings window and press the OK button to save. The options in Row Menu are:

- Add - Adds a scan to the Job Scan (e.g., press this 4 times to create a 5 x Y Job scan). Note that pressing Add will automatically set Stitching to On.
- Update - Updates any scan settings changes for the Job scan.
- Up/Down - Moves the rows (scans) in the Job scan to different positions.
- Delete - Deletes a scan from the Job scan sequence.
- Stitching - Automatically turns On after a row is added and allows up to five scans.
- Stage Z (mm) - The stage moves in the Z position from 2-94 mm (range is 2-206 mm).

Table 7.5 Conditions for a Continuous Job Scan

Settings	Description
Stitching	Select whether to combine CT images or not. On Z-axis position is automatically determined according to the FOV setting for each scan in the job. Scans each part of a sample multiple times and allows obtaining overall image by combining the CT images in the job. Off Obtains a separate image for each entered condition in job.
Start Time	Set the time until the start of the next scan. For sequential scan, set time interval until the start of the next scan. If scan number is set to one, this setting is disabled.
X-ray Voltage (kV)	Set the tube voltage. (Same as the **Voltage (kV)** in the Control window.)
X-ray Current (uA)	Set the tube current. (Same as the **Current (uA)** in the Control window)
Acquisition FOV	Set Acquisition FOV.
Recon FOV	Set FOV. (Same as the **Recon FOV** in the **Control** window)
3D Filter	Select a 3D filter to apply.
Stage-Z (mm)	Set the position of the stage in the front - back direction for scan.
Scan Mode	Select a scan mode for Continuous scan.
Scan Time	Select the scan time for Continuous scan.

Table 7.6 Conditions for a Step Job Scan

Settings	Description
Stitching	Select whether to combine CT images or not. On Z-axis position is automatically determined according to the FOV setting for each scan in the job. Scans each part of a sample multiple times and allows obtaining overall image by combining the CT images in the job. Off Obtains a separate image for each entered condition in job.

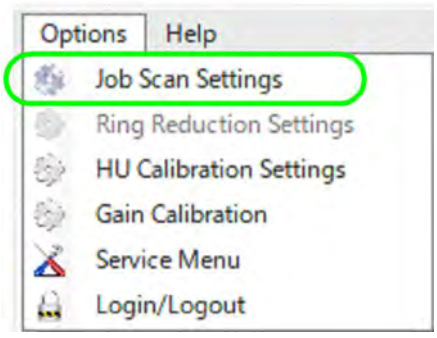
Table 7.6 Conditions for a Step Job Scan (continued)

Settings	Description
Start Time	Set the time until the start of the next scan. For sequential scan, set time interval until the start of the next scan. If scan number is set to one, this setting is disabled.
X-ray Voltage (kV)	Set the tube voltage. (Same as the **Voltage (kV)** in the Control window.)
X-ray Current (uA)	Set the tube current. (Same as the **Current (uA)** in the Control window)
Acquisition FOV	Set Acquisition FOV.
Recon FOV	Set FOV. (Same as the **Recon FOV** in the **Control** window)
3D Filter	Select a 3D filter to apply.
Stage-Z (mm)	Set the position of the stage in the front - back direction for scan.
Scan Mode	Select a scan mode for Continuous scan.
Scan Time	Select the scan time for Continuous scan.
Binning	Pixel binning of 1, 2, or 4 (Lowest bin value provides the highest resolution.)
Exposure Time	Exposure time from 125 -1000 ms. Low exposure time provides higher speed, but lower resolution.
Num of Integration	1 – 1000 integration exposures at each step. Lower integration provides higher speed but greater noise.
Num of Projections	360 – 2400 steps per rotation. 360 equals one full rotation and provides the highest speed but greater noise and artifacts.
Image Resolution	Low: 512x512x400 High: 1024x1024x800 Super High: 2864x2864x2272

To edit a job with Job Scan and stitching:

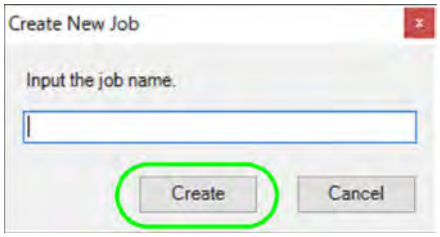
1. Select **Job Scan Settings.**

Figure 7.10 Job Scan Settings



2. Go to **Job Menu** -> **New** -> type **Job Name** -> **Create**.

Figure 7.11 Creating New Job



3. Use the **Row Menu** buttons to arrange each condition.

Figure 7.12 Job Scan Arrangement

4. Double-click **Add** to set stitching.

Figure 7.13 Stitching Settings

No.	Stitching	Start Time	Time Unit	kV	uA	Acquisition FOV	Recon Fov	X-ray filter	3D filter	Stage-Z[mm]	Scan Type	Scan Mode	Scan Time
1	On	0	s	50	100	8	8	Al 0.5mm	Soft	185.00	Step	High Resolution	04 min
2	On	0	s	50	100	8	8	Al 0.5mm	Soft	189.71	Step	High Resolution	04 min
3	On	0	s	50	100	8	8	Al 0.5mm	Soft	194.42	Step	High Resolution	04 min
4	On	0	s	50	100	8	8	Al 0.5mm	Soft	199.13	Step	High Resolution	04 min

No.	Stitching	3D filter	Stage-Z[mm]	Scan Type	Scan Mode	Scan Time	Binning	Exposure Time[ms]	Num of Integration	Num of Projection	Image Resolution
1	On	Soft	185.00	Step	High Resolution	04 min	1	500	8	360	High
2	On	Soft	189.71	Step	High Resolution	04 min	1	500	8	360	High
3	On	Soft	194.42	Step	High Resolution	04 min	1	500	8	360	High
4	On	Soft	199.13	Step	High Resolution	04 min	1	500	8	360	High

5. Click **OK**.

Start a Job Scan

1. Go to the Control Panel -> choose a job where Presets used to be.
   Confirm that HU and Gain Calibration traffic light indicators are Green for HU calibrations.
   See *Check the Scan Conditions and Indicators Before Calibration* on page 45 for details.

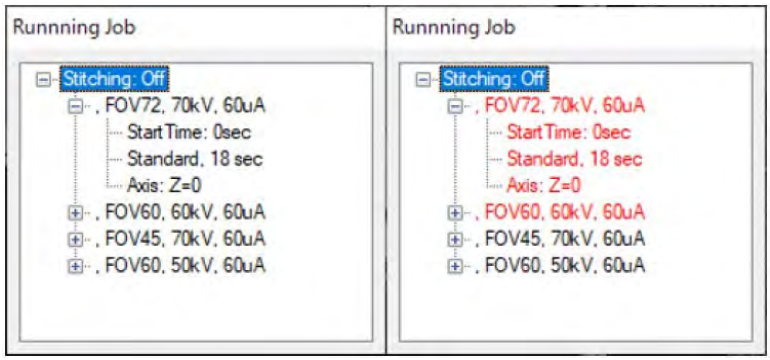
Figure 7.14 Starting Job Scan

2. Click the Start CT scan button to run the Job scan.

During scanning, if there are two or more scans, the Job Scan confirmation window appears. Each component of the Job Scan appears in a tree structure. Click [+] to view the scan conditions.

After a scan is completed, the scan conditions text appears red.

Figure 7.15 Job Scan Conditions

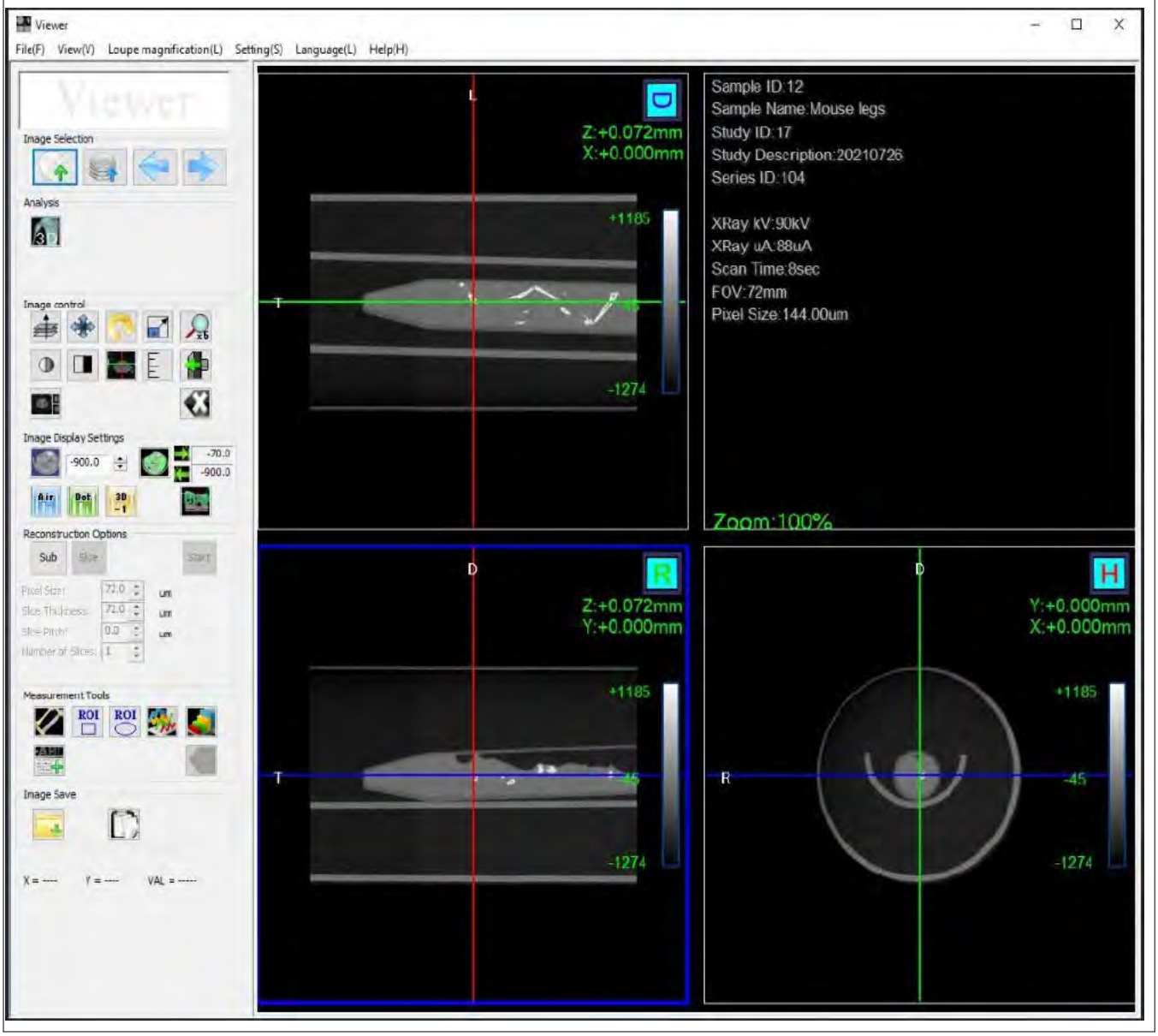


After each scan is completed, it is automatically reconstructed and appears in the AutoViewer, which becomes enabled.

When all scans are completed the stitching process automatically begins.

After the Job Scan is stitched the final stitched scan appears in the AutoViewer, if enabled. See the following figure.

Figure 7.16 Viewing Final Stitched Scan in AutoViewer



Edit the Stitching for a Job Scan

If you need an Autoscan license to edit the Job Scan stitching, contact technical support: www.revvity.com/contact-us

If you do not have the Autoscan license then go to Job Scan and set the Stitching scan condition to On. In the Database, after the scans are stitched and the final image is created, the individual scans are deleted (Scan Type = Stitching).

If you do have the Autoscan license then:

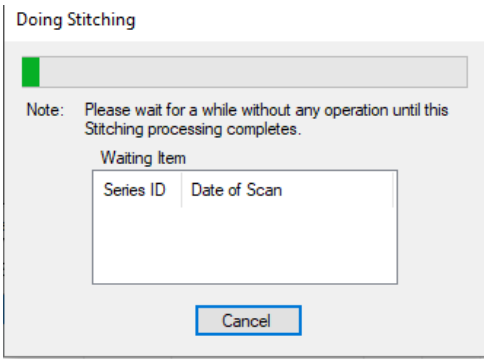
- In the Database, the Scan Type column indicates what the scan is:
  Stitching Normal = the resultant stitched scan
  Normal = each component or stitch of the Job Scan, one for each row you created.

Figure 7.17 Database Scan Type Column - Normal

Series ID	Scan Type	Date of Scan	kV	uA
16	Normal	6/27/2023 10:56:59 ...	100	140
17	Normal	6/27/2023 11:03:24 ...	100	140
18	Normal	6/27/2023 11:03:24 ...	100	140
19	Stitching Normal	6/27/2023 11:15:45 ...	100	140
20	Normal	6/27/2023 11:15:47 ...	100	140
21	Normal	6/27/2023 11:20:08 ...	100	140
22	Normal	6/27/2023 11:24:30 ...	100	140
23	Normal	6/27/2023 11:28:52 ...	100	140
24	Normal	6/27/2023 11:33:15 ...	100	140

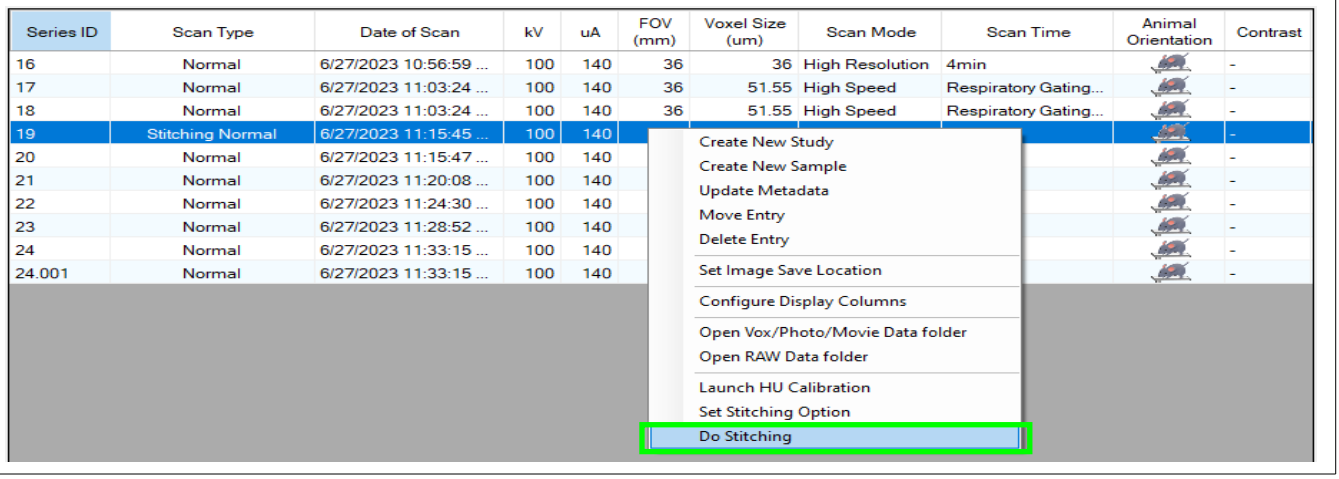
- For Stitching Scan Types, after the last image reconstruction is completed, the Stitching Process is automatically activated and Normal scans are not deleted.
- For scans acquired under High CT Image Resolution, the image file size is large, so the Stitching Process takes longer.

Figure 7.18 Stitching Scan Conditions - Processing



You can redo the stitching for your stitched scan. Go to the database -> right-click on the scan in the database -> Do Stitching.

Figure 7.19 Do Stitching



7.8 Place a Subject in the Sample Chamber

The imaging system is ready to acquire images after warm-up is complete. (See *Imaging System Warm-Up* on page 54 for more details on imaging system warm-up.) Place a subject in the sample chamber after you choose the scan settings.

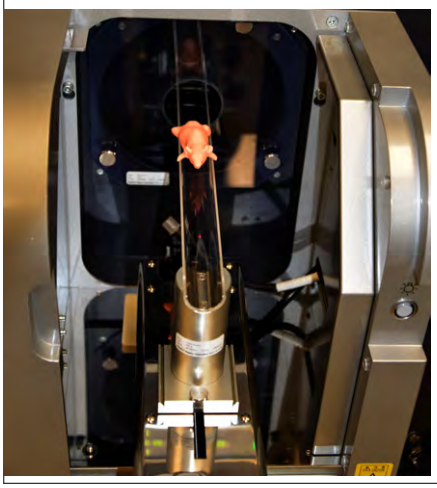
1. Install an appropriate bore cover:

Bore Name	Diameter (mm)	For Use With FOV
Sample Φ8mm	8	8, 18
Sample Φ18mm	18	18, 36
Small	70	36, 60, 72
Medium	120	72, 86
Large	170	72

2. Manually slide the sample bed to the out-limit position (Figure 7.20). Alternatively, press the stage control buttons on the instrument front panel to move the sample bed.

CAUTION: If the small bore cover is installed, watch through the viewing window of the sample chamber when using the motor control buttons on the front panel to move the bed to make sure that the bed does not hit the bore cover.

Figure 7.20 Sample Bed at Out-Limit Position



3. Place the anesthetized subject on the sample bed.
   If using the Mouse Imaging Shuttle, place the shuttle with the anesthetized subject on the sample bed. If needed, connect the gas anesthesia tubing. See ***Mouse Imaging Shuttle Instructions*** (PN 127820) for details on the Mouse Imaging Shuttle.
4. Push the sample table into the bore and slide the imaging system door closed so that the interlock properly engages.
5. Set the body orientation using the  or  arrows in the Control Panel. (Figure 7.21).

Figure 7.21 Body Orientation

Head first, prone (HFP) | Feet first, prone (FFP) | Head first, supine (HFS) | Feet first, supine (FFS)

6. Turn on Live Mode by clicking the  button in the Control Panel.
   The Xcapture window appears and shows the subject in real time (Figure 7.22).

NOTE: Only the image data inside the bounding box are used to reconstruct the 3D volume.

WARNING! If using the small bore cover with the mouse bed, watch through the front viewing window when moving the bed right or left using the Stage X-axis control buttons on the front panel (Figure 7.23). Make sure the bed does not hit the bore cover.

Figure 7.22 Xcapture Window
Respiratory gating is selected in this example.

7. Click “Initialize” in the Control Panel and move the sample bed into the bore using one of the following methods.
   - Z-axis controls on the front panel of the imaging system (Figure 7.23) – Press and hold the Fast button while you press the Z-axis left or right arrow.
   - Use the stage control arrows in the Control Panel (Figure 7.24).
   - Move the sample bed a specific distance by entering a distance (mm) and click **Set** (Figure 7.24).

Figure 7.23 Quantum GX3 microCT Imaging System Front Panel

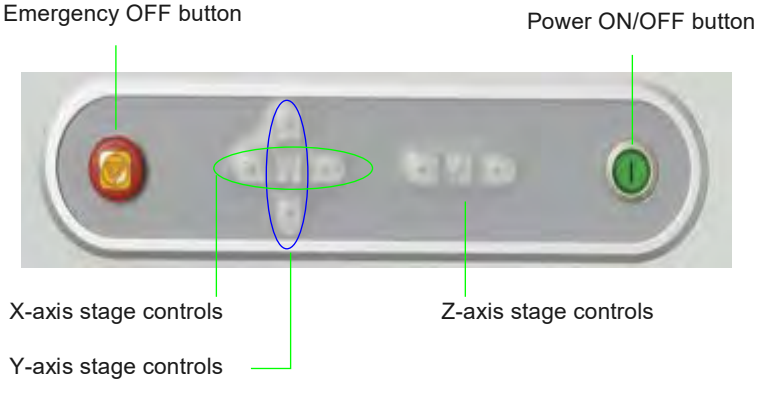
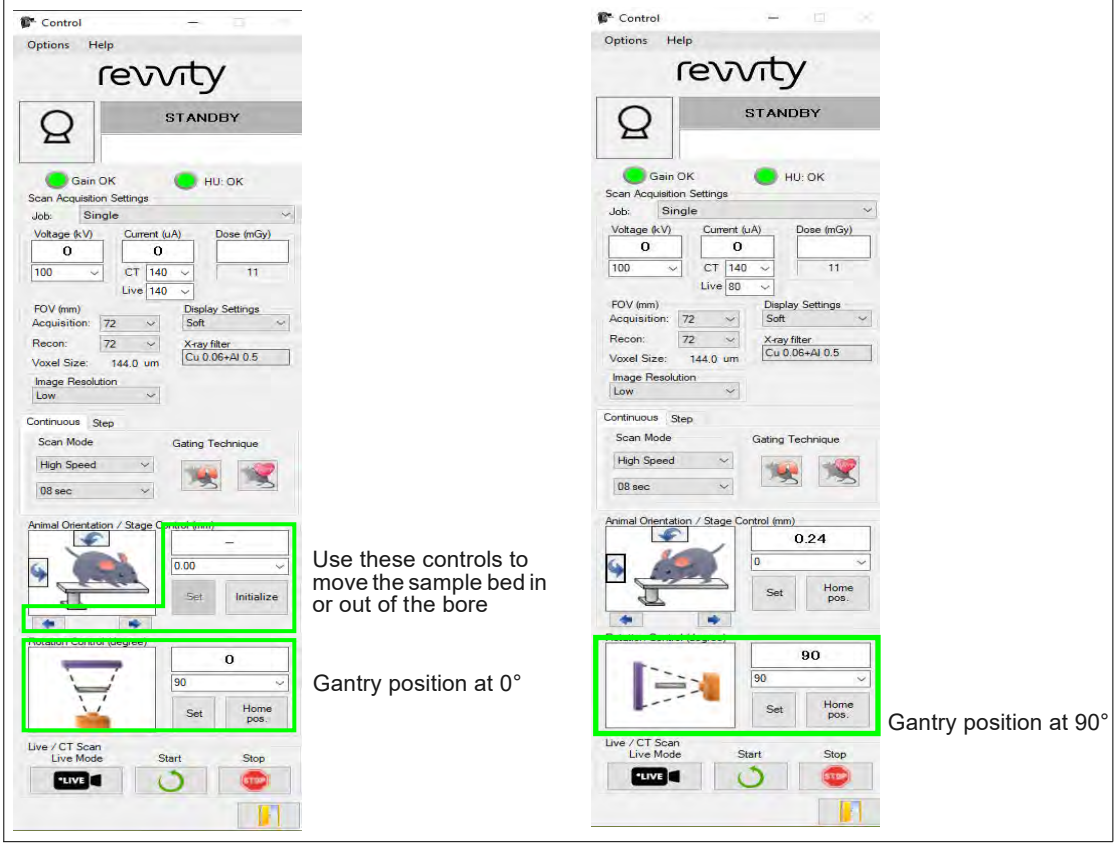


Figure 7.24 Control Panel



8. Check the subject position in the Xcapture window at the 0° gantry position:
   a. Select "0" from the Rotation Control drop-down list.
   b. Click **Set** (Figure 7.24).
   c. If necessary, use the stage X-axis controls on the imaging system front panel to center the subject in the Xcapture window (Figure 7.24).
9. Check the subject position in the Xcapture window at the 90° gantry position:
   a. Select "90" from the Rotation Control drop-down list and click **Set** (Figure 7.24).
   b. If necessary, use the stage Y-axis controls on the imaging system front panel to center the subject in the Xcapture window (Figure 7.23).
10. Click the LIVE button to turn off Live Mode and close the Xcapture window.

NOTE: Live Mode automatically times out after 150 seconds.

7.9 CT Scan Without Gating

IMPORTANT: If you need to abort acquisition and stop X-ray generation, click the emergency stop button in the Control Panel.

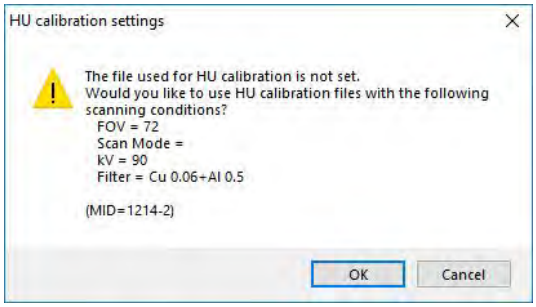
1. Confirm that the scan configuration has an HU calibration file. See *HU Calibration Settings* on page 44 for more information.

   If there is no HU calibration file, it is recommended that you calibrate the scan configuration. Otherwise, the image grayscale values may not be accurate. See *Hounsfield Unit Calibration* on page 43 for instructions on HU calibration.

2. Click the CT Scan button to begin the scan.

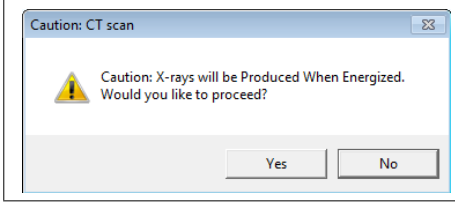
   If there is no HU calibration file, the system will inform you before the scan starts (Figure 7.25). Click **Cancel** in the message and perform HU calibration for the scan configuration before proceeding with the scan. See *Hounsfield Unit Calibration* on page 43 for instructions.

Figure 7.25 System Message
No HU calibration settings for the scan configuration.



If there is an HU calibration file for the scan configuration, a scan confirmation message appears (Figure 7.26).

Figure 7.26 CT Scan Confirmation Message



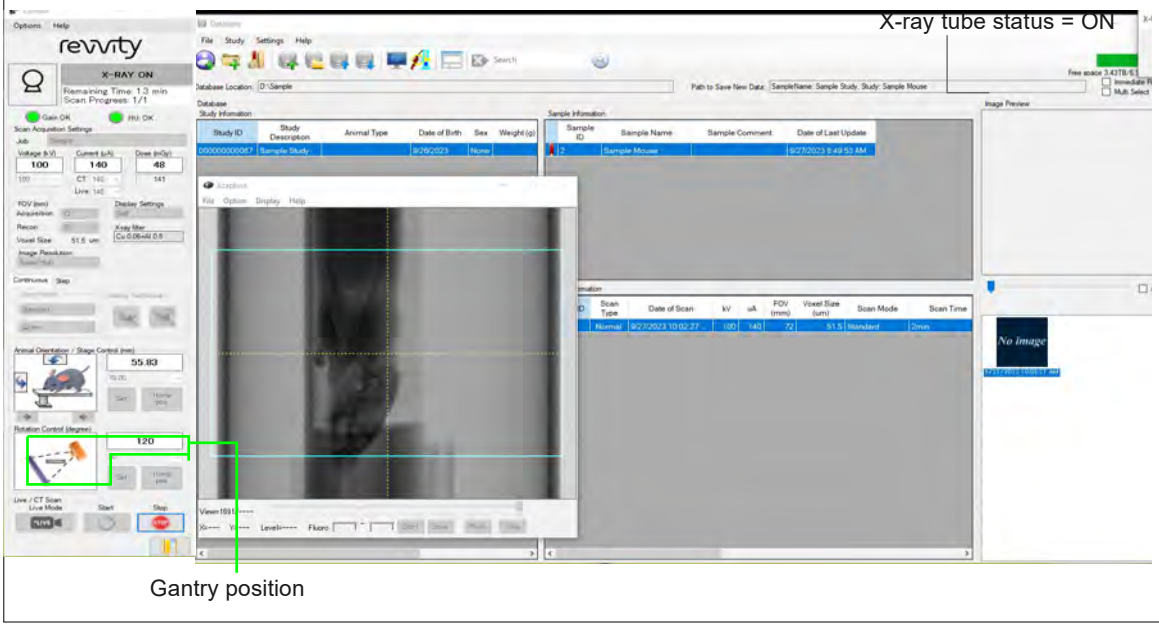
3. Click **Yes** in the confirmation message (Figure 7.26).

   X-rays are energized as indicated by the blinking voltage icon and the imaging system status box (Figure 7.27). The Xcapture window opens, then gantry rotation and image acquisition begin.

   3D reconstruction automatically proceeds after acquisition is complete.

   The AutoViewer displays the 3D reconstruction (Figure 7.28). See *Viewing a Z-Axis Slice* on page 115 for more information on viewing 3D reconstructions.

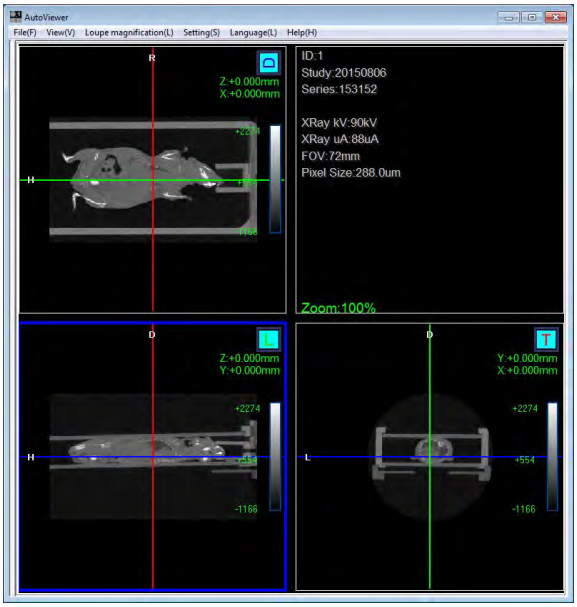
Figure 7.27 Control Panel and Xcapture Window During a Scan



4. Remove the subject from the sample chamber after the Quantum GX3 microCT is in Standby mode.

CAUTION: Do not remove or change the bore cover until the Quantum GX3 microCT is in standby mode and the CT scan button becomes available.

Figure 7.28 AutoViewer Window



If the AutoViewer does not automatically appear, confirm that the AutoView option is selected in the Database window.

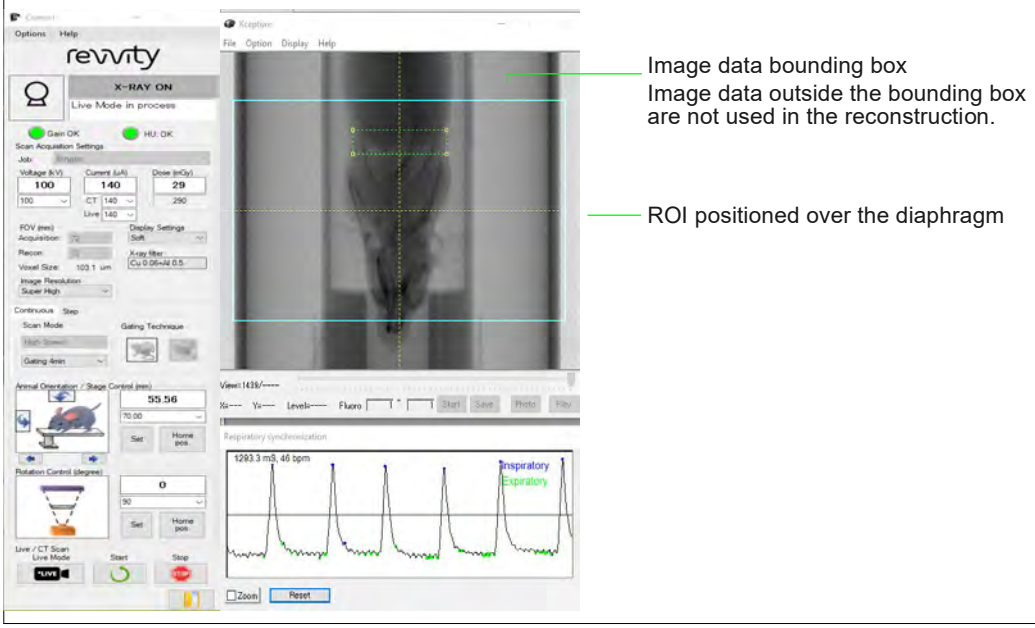
NOTE: A subvolume or slice(s) of a 3D reconstruction can be reconstructed at higher resolution (smaller pixel size). See *Reconstructing a Subvolume or Slice* on page 82 for more details.

7.10 CT Scan With Respiratory Gating

IMPORTANT: If you need to abort acquisition and stop X-ray generation, click the emergency stop button in the Control Panel.

1. Confirm that the scan configuration has an HU calibration file. See *HU Calibration Settings* on page 44 for more information.
   If there is no HU calibration file, it is recommended that you calibrate the scan configuration. Otherwise, the image grayscale values may not be accurate. See *Hounsfield Unit Calibration* on page 43 for instructions on HU calibration.
2. Click the respiratory gating button .
3. Turn on Live Mode by clicking the button in the Control Panel.
   The Xcapture window appears and shows the subject in real time (Figure 7.29).
4. Adjust the ROI dimensions in the Xcapture window so that the ROI is positioned over the diaphragm.
5. Rotate the gantry 90°. Ensure that the subject is within the field of view and the ROI is correctly positioned over the diaphragm.
6. Rotate the gantry back to 0° position.

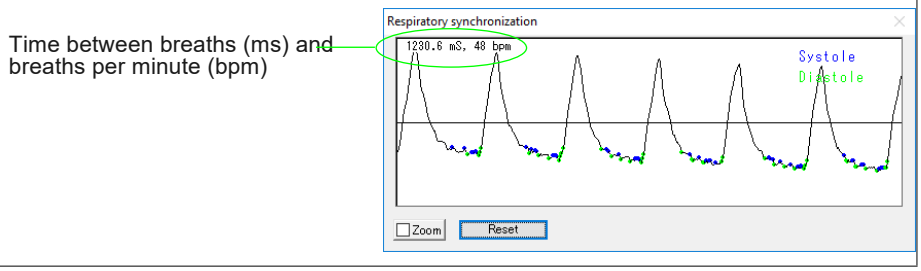
Figure 7.29 Xcapture Window
Respiratory gating is selected in this example.



7. Check the respiratory signal trace in the Respiratory Synchronization window (Figure 7.30).

Trace spikes represent diaphragm movements. Wait for the breath rate to stabilize with longer than 1000 ms ±1 sec between breaths.

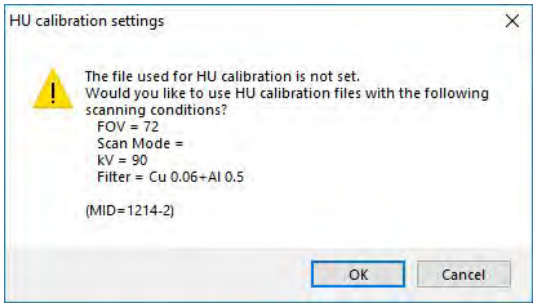
Figure 7.30 Respiratory Synchronization



8. Click the CT Scan button to begin the scan.

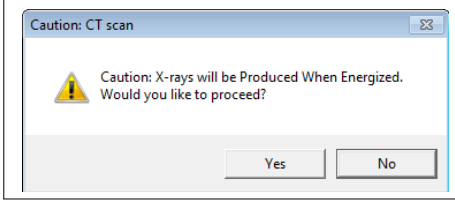
   If there is no HU calibration file, the system will inform you before the scan starts (Figure 7.31). Click **Cancel** in the message and perform HU calibration for the scan configuration before proceeding with the scan. See *Hounsfield Unit Calibration* on page 43 for instructions.

Figure 7.31 System Message
No HU calibration settings for the scan configuration.



If there is an HU calibration file for the scan configuration, a scan confirmation message appears (Figure 7.32).

Figure 7.32 CT Scan Confirmation Message



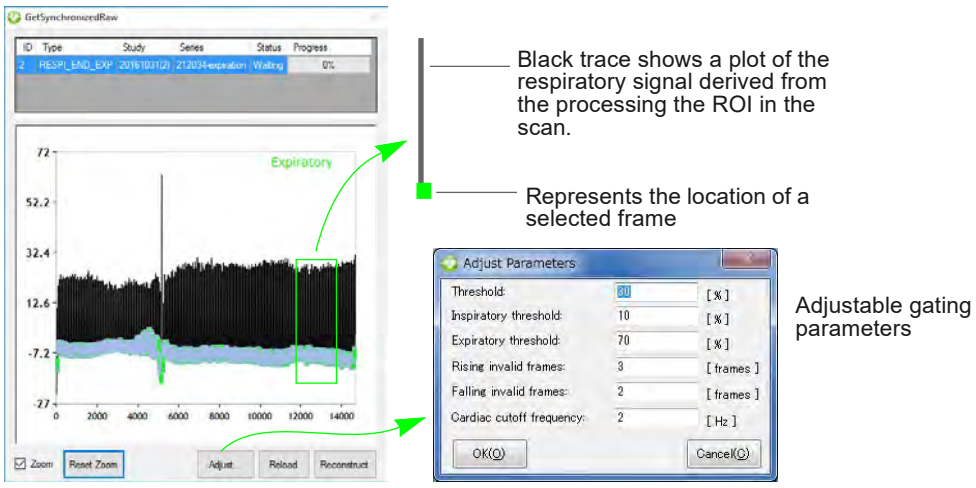
9. Click **Yes** in the confirmation message (Figure 7.32).

   X-rays are energized as indicated by the blinking voltage icon and the imaging system status box (Figure 7.27 on page 74). The Xcapture window opens, then gantry rotation and image acquisition begin.

10. Review the raw data in the GetSynchronizedRaw window (Figure 7.33). To magnify the view, choose the Zoom option an use the left mouse button.

    The goal is to obtain green squares with Y-axis values that are as uniform as possible.

Figure 7.33 GetSynchronizedRaw Window – Respiratory Gating



11. If you want to filter the data:
    a. Click **Adjust** (Figure 7.33).
    b. Enter a new Threshold value (%) in the dialog box that appears and click **OK**. See Table 7.7 on page 77 for more details on gating parameters.

> **NOTE:** If the Threshold value excludes too much data, a good 3D reconstruction will not be produced.

    c. Click **Reload** and review the data.
    If you want to filter the data again, repeat step a to step c.

> **NOTE:** Gating parameter values cannot be edited after the data are reconstructed.

    d. Click **Reconstruct** when you are satisfied with the data.

The 3D reconstruction proceeds. The AutoViewer displays the 3D reconstruction (Figure 7.28). See *Viewing a Z-Axis Slice* on page 115 for more information on viewing 3D reconstructions.

Table 7.7 Gating Parameters

Parameter	Gating Type	Description
Threshold	Respiratory	The threshold applied to the entire waveform to separate the baseline from the peaks. This allows for an initial separation of the relaxed state of the diaphragm (baseline) from the inspiration/ expiration phases of diaphragm motion (peak).
Inspiratory threshold	Respiratory	A secondary threshold that further refines point selection above the initial threshold. Reducing this threshold reduces the number of points on the waveform selected as 'end inspiration' points. This can help identify the transition point in diaphragm motion between the inspiration and expiration phases. However, fewer points may also lead to a noisier image reconstruction.

Table 7.7 Gating Parameters (continued)

Parameter	Gating Type	Description
Expiratory threshold	Respiratory	A secondary threshold that further refines point selection below the initial threshold. Reducing this threshold reduces the number of points on the waveform selected as 'end expiration' points. This can help refine selection of the resting phase from the inspiration/expiration phases.
Rising invalid frames	Respiratory	The number of frames to ignore on the rising (inspiration) side of the peak.
Falling invalid frames	Respiratory	The number of frames to ignore on the falling (expiration) side of the peak.
Cardiac Cutoff Frequency	Cardiac	Frequency (Hz) that is used to separate the cardiac portions of the waveform from background signals. Frequencies above this value are considered part of the cardiac signal. This is related to the heart rate (for example, 300 beats per minute = 5 Hz).

7.11 CT Scan With Cardiac Gating

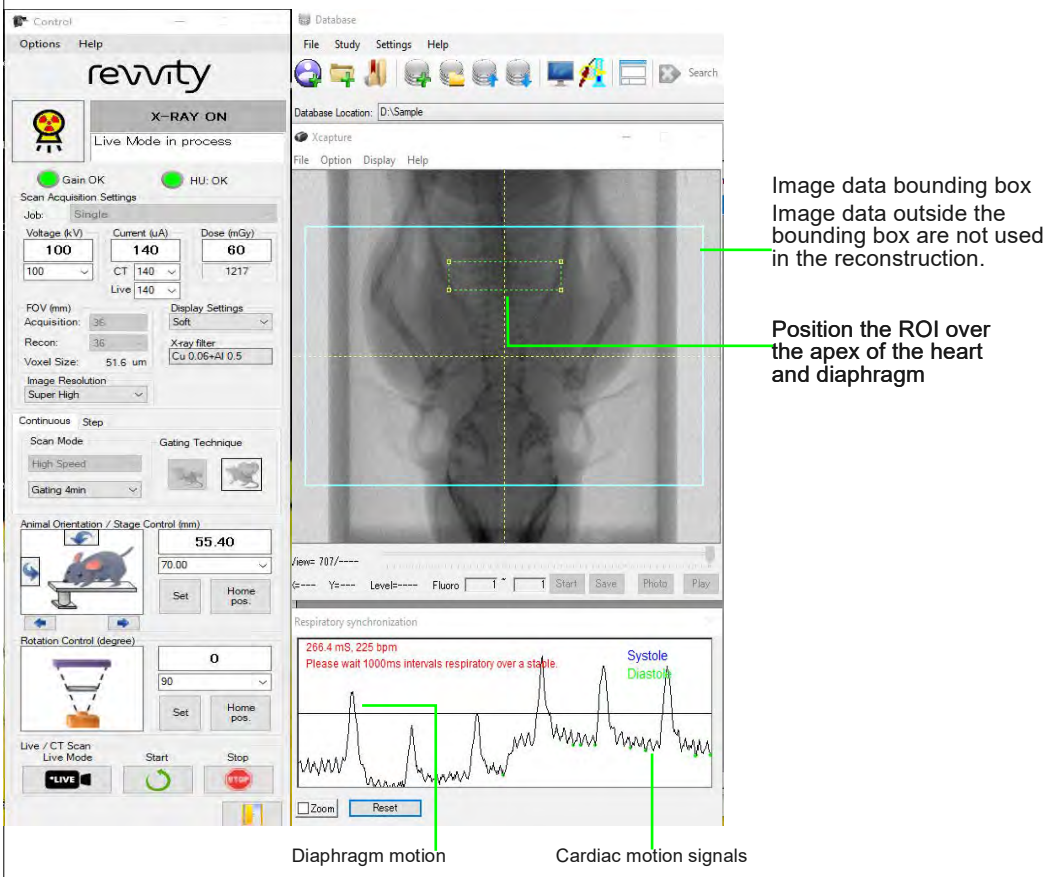
IMPORTANT: If you need to abort acquisition and stop X-ray generation, click the emergency stop button in the Control Panel.

1. Confirm that the scan configuration has an HU calibration file. See page 44 for more information.

   If there is no HU calibration file, it is recommended that you calibrate the scan configuration. Otherwise, the image grayscale values may not be accurate. See *Hounsfield Unit Calibration* on page 43 for instructions on HU calibration.
2. Click the cardiac gating button.
3. Turn on Live Mode by clicking the button in the Control Panel.

   The Xcapture window appears and shows the subject in real time (Figure 7.29).

Figure 7.34 Xcapture Window

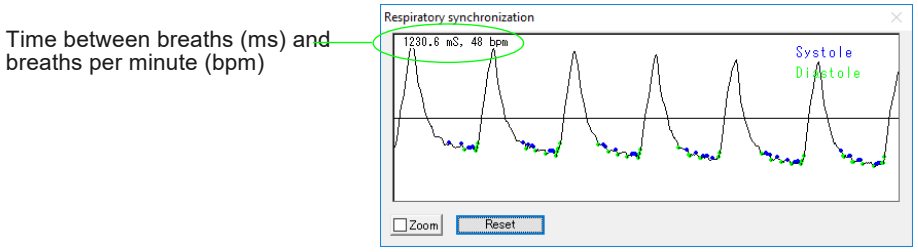


4. In the Xcapture window, adjust the ROI dimensions to position it over the apex of the heart and diaphragm.
5. Rotate the gantry 90°. Ensure that the subject is within the filed of view and the ROI is correctly positioned.
6. Rotate the gantry back to 0° position.
7. Check the respiratory and cardiac signal trace in the Respiratory synchronization window (Figure 7.35).

The large trace spikes represent diaphragm movement. The smaller spikes in between represent cardiac movement. Ensure that the cardiac signal is as visible as possible (Figure 7.35). It may be possible to improve the signal visibility by adjusting the ROI position.

Wait for the breath rate to stabilize with longer than 1000 ms ±1 sec between breaths.

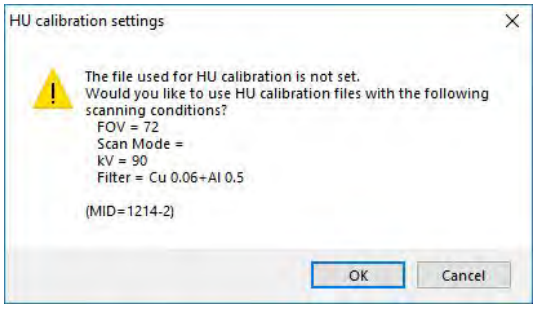
Figure 7.35 Respiratory Synchronization



8. Click the CT Scan button to begin the scan.

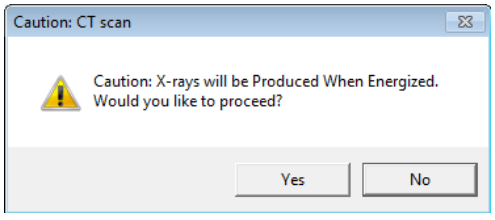
   If there is no HU calibration file, the system will inform you before the scan starts (Figure 7.36). Click **Cancel** in the message and perform HU calibration for the scan configuration before proceeding with the scan. See *Hounsfield Unit Calibration* on page 43 for instructions.

Figure 7.36 System Message
No HU calibration settings for the scan configuration.



If there is an HU calibration file for the scan configuration, a scan confirmation message appears (Figure 7.37).

Figure 7.37 CT Scan Confirmation Message

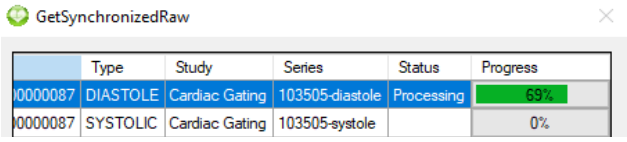


9. Click **Yes** in the confirmation message that appears (Figure 7.37).

   X-rays are energized as indicated by the blinking voltage icon and the imaging system status box (Figure 7.27). The Xcapture window opens, then gantry rotation and image acquisition begin.

Progress indicators for image processing appear (Figure 7.38). The AutoViewer displays the 3D reconstruction (Figure 7.28) after processing is complete. See *Viewing a Z-Axis Slice* on page 115 for more information on viewing 3D reconstructions.

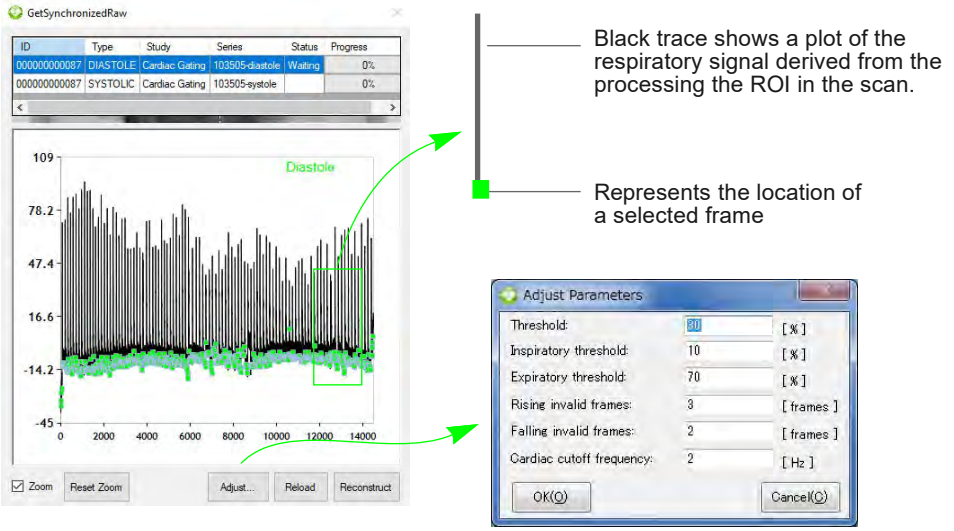
Figure 7.38 Processing Progress for Images Corresponding to Diastolic and Systolic Phases of the Cardiac Cycle



10. Review the raw data in the GetSynchronizedRaw window (Figure 7.39). To magnify the view, choose the Zoom option and use the left mouse button.

    The goal is to obtain green squares with Y-axis values that are as uniform as possible.

Figure 7.39 GetSynchronizedRaw Window – Cardiac Gating



11. If you want to filter the data:

    a. Click **Adjust** (Figure 7.39).

    b. Enter new values for Lower Breath (%) and/or Cardiac Cutoff Frequency (Hz) in the dialog box that appears and click **OK**. See Table 7.7 on page 77 for more details on gating parameters.

> **NOTE:** If the gating parameter values exclude too much data, a good 3D reconstruction will not be produced.

    c. Click **Reload** and review the data. If you want to filter the data again, repeat step a to step c.

> **NOTE:** Gating parameter values cannot be edited after the data are reconstructed.

    d. Click **Reconstruct** when you are satisfied with the data.

    The 3D reconstruction proceeds. The AutoViewer displays the 3D reconstruction (Figure 7.28). See *Viewing a Z-Axis Slice* on page 115 for more information on viewing 3D reconstructions.

7.12 Reconstructing a Subvolume or Slice

Subvolume Reconstruction

NOTE: If you will be performing subvolume reconstruction offline, ensure that the workstation meets the requirements in Table 5.1 on page 40. Set up and copy image data to the workstation following the instructions on *Workstation Setup* on page 38.

1. Load the data (by double-clicking on a thumbnail or series row in the Database window) and click Sub.
   An ROI appears on the images in the Viewer (Figure 7.40).
2. Move and resize the ROI so that it outlines the image data for reconstruction.
3. Click Start.
   A reconstruction progress indicator appears and the AutoViewer displays the CT image when reconstruction is complete. The image is added to the database (for example, if the series ID is "12", subvolume reconstructions will be named consecutively as 12.001, 12.002, and so on).
   The Sub/Slice Region window shows the reconstructed subvolume within the context of the original image (Figure 7.41).

Figure 7.40 Selecting Image Data for Reconstruction

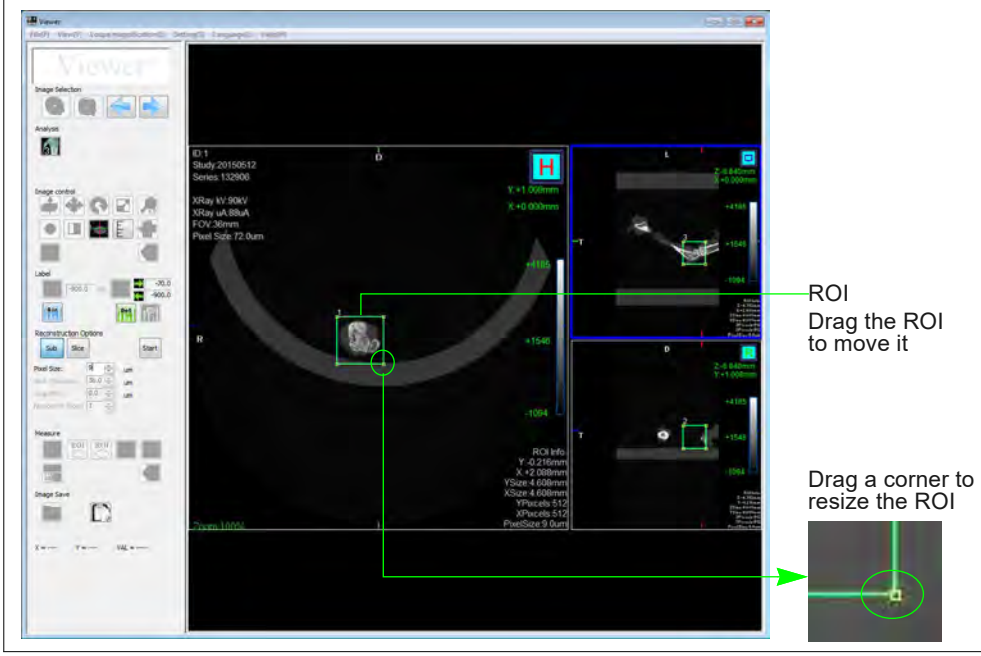
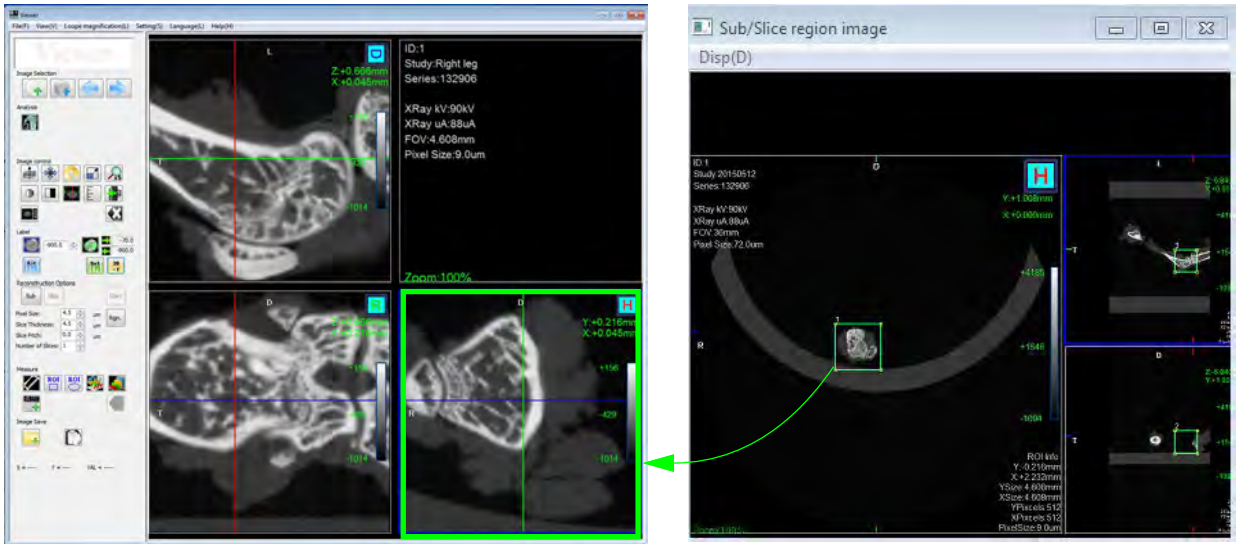


Figure 7.41 Reconstructed Subvolume

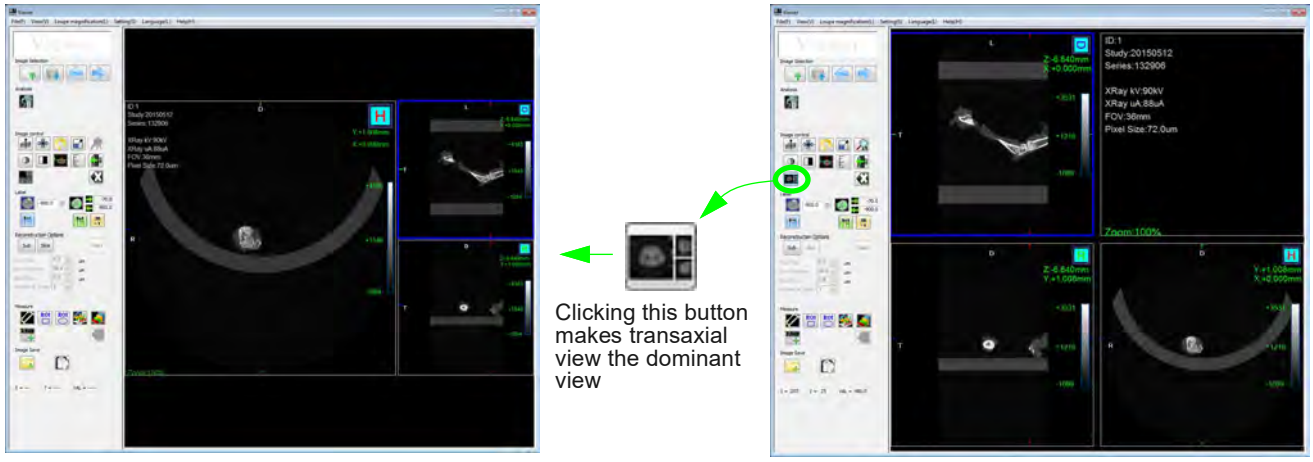


Slice(s) Reconstruction

NOTE: If you will be performing slice reconstruction offline, ensure that the workstation meets the requirements listed in Table 5.1 on page 38. Set up and copy image data to the workstation following the instructions on *Workstation Setup* on page 38.

1. Load the data (double-click a thumbnail or series row in the Database window).
2. Click the  button.
   The transaxial view becomes the main view (Figure 7.40).

Figure 7.42 Changing to Transaxial View



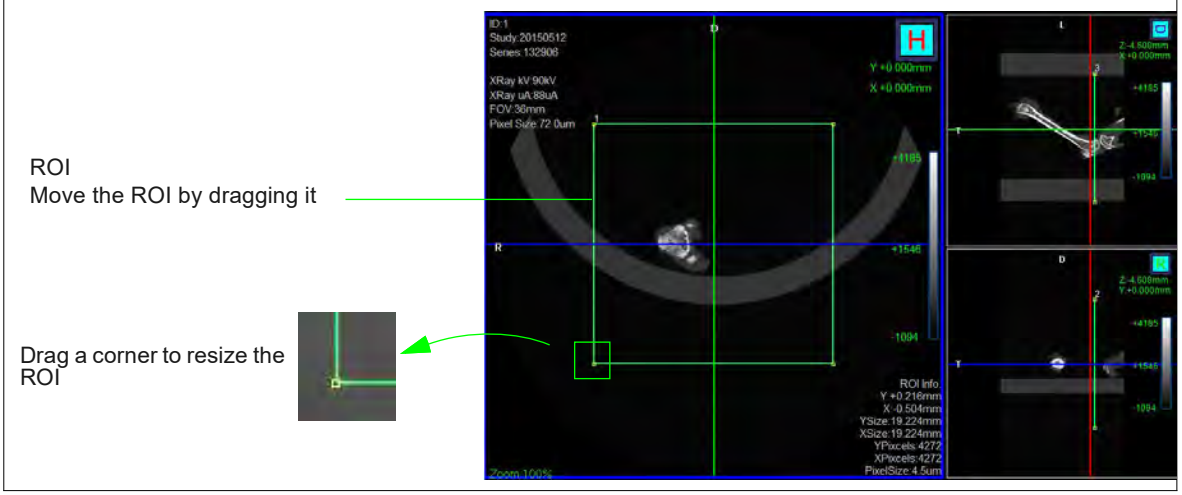
3. Choose a slice by doing either of the following:
   - Click the  button and scroll through the slices using the mouse scroll wheel.

- Drag the red crosshair (Figure 7.43).

Figure 7.43 Selecting a Slice Using the Crosshair

4. Click the Slice button.
   An ROI appears on the image (Figure 7.59). ROI size and position can be adjusted to select a portion of the slice for reconstruction.

Figure 7.44 ROI on Image



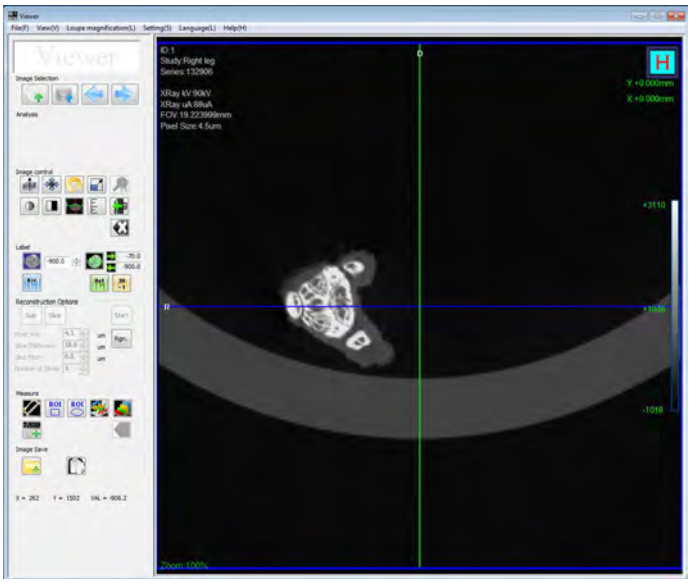
5. Confirm the defaults or enter new values for slice thickness, slice pitch (distance between slices), number of slices to reconstruct.
6. Click the Start button.

A reconstruction progress indicator appears and the AutoViewer displays the CT image when reconstruction is complete. The image is added to the database (for example, if the series ID is "12", slice reconstructions will be named consecutively as 12.001, 12.002, and so on).

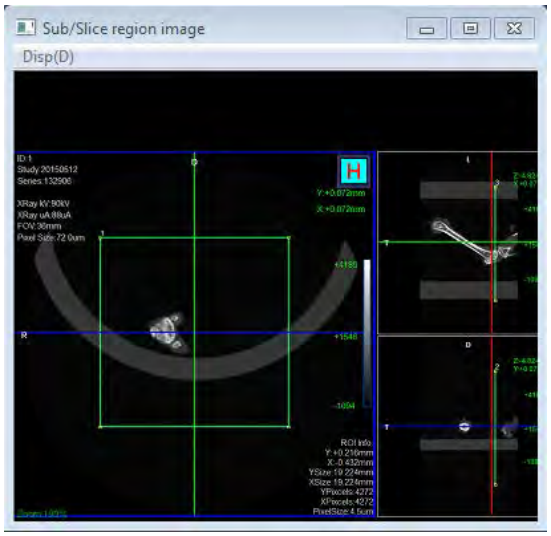
The Sub/Slice Region window shows the reconstructed slice(s) within the context of the original image (Figure 7.45).

Figure 7.45 Sub/Slice Region Window

Reconstructed slice



Original image with ROI and selected slice



7.13 Using the Center Adjustment Tool

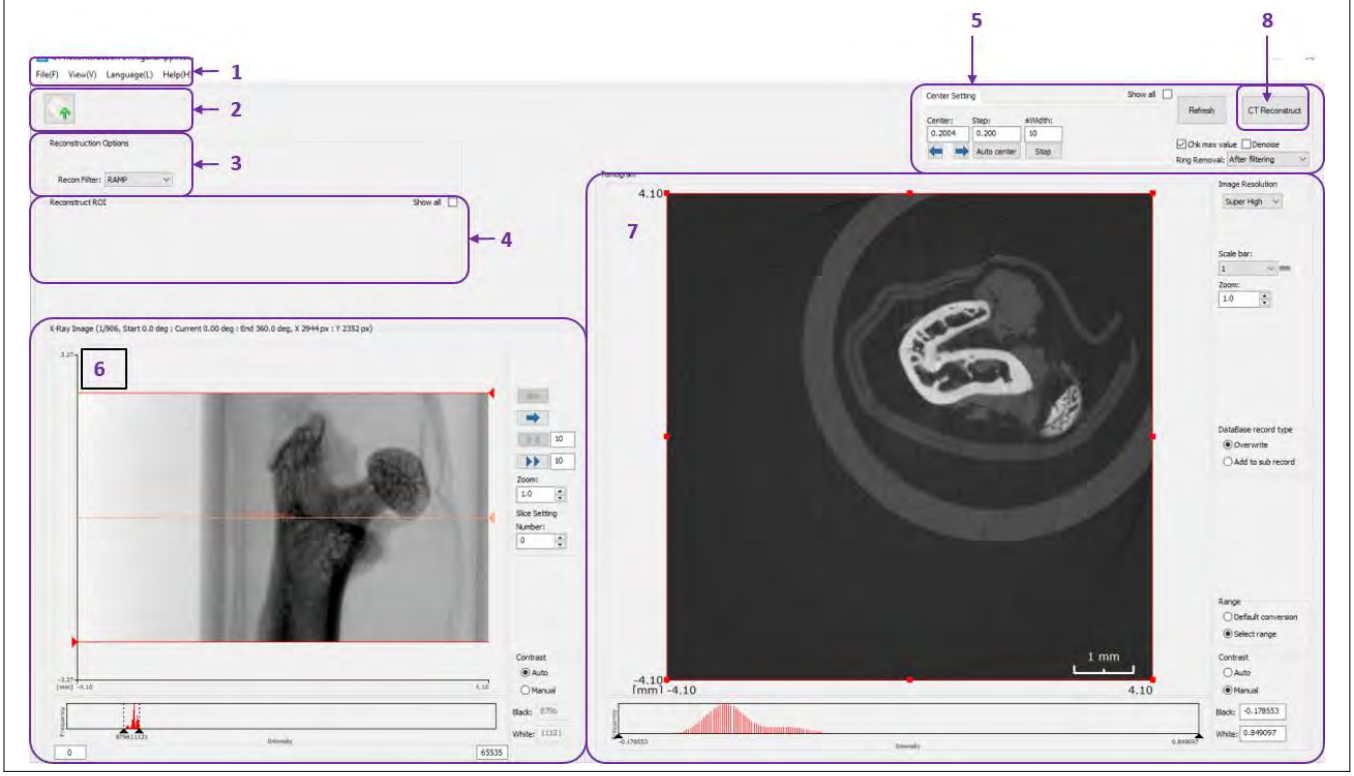
Advanced Image Reconstruction Settings

CT reconstruction is performed by using the center adjustment tool to reduce rings, denoise, correct the misalignment between the center of the rotation axis and the center of the X-ray detector, specify the reconstruction range and set the angle, and change the reconstruction filter and image resolution.

NOTE: If the center of rotation (center value) correction is performed properly and the tomographic image is formed, it is possible to perform reconstruction and check the CT image even if the other settings remain at the initial values.

If you want to improve image quality by making various corrections, or if you want to reduce volume data capacity after reconstruction, make the following detailed settings.

Figure 7.46 Center Adjustment Tool Window



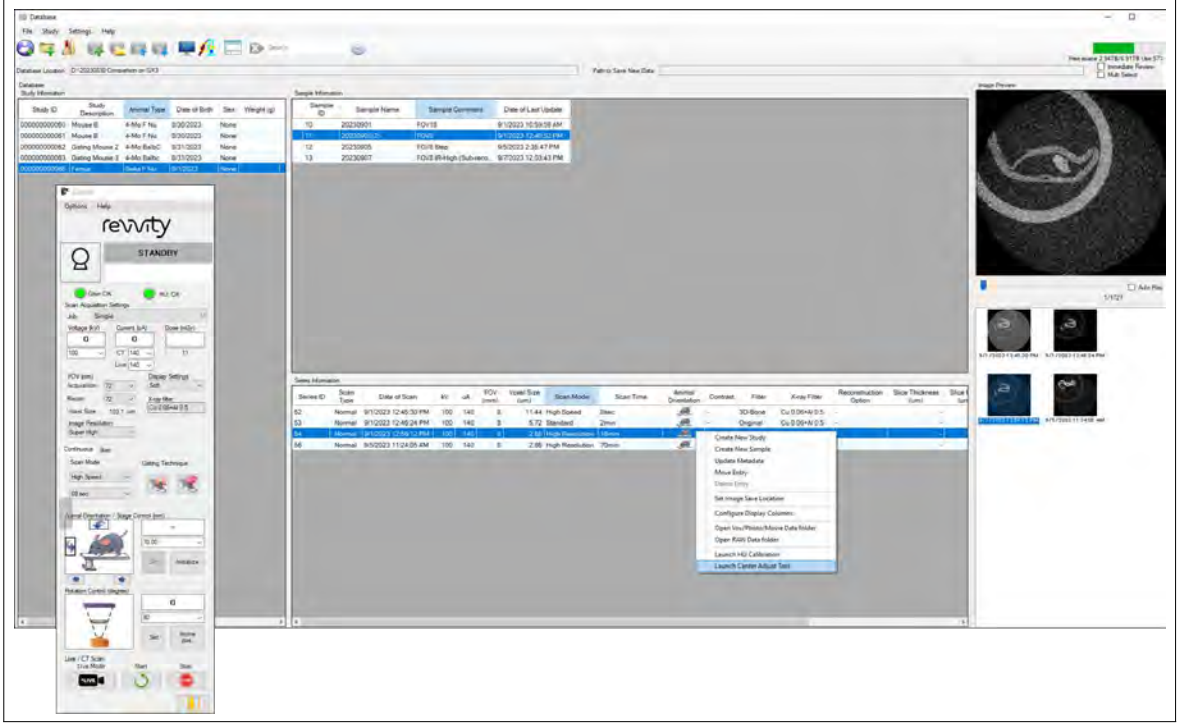
1	Menu bar	Various menus are displayed.
2	Reconfiguration Settings File Processing Area	Reads the reconstruction settings file and saves or deletes the reconstruction preset.
3	Reconstruction Options Area	Set up a reconstruction filter.
4	Reconstruction range setting area	If you tick the Show All checkbox, the range you want to reconfigure will be displayed.
5	Reconfiguration settings area	

6	Perspective image area	The fluoroscopic image used for CT image reconstruction is displayed. You can change the faults displayed in the constituent tomographic image area and set the reconstruction range.
7	Reconstructed tomographic area	A single tomographic image reconstructed using the fluoroscopic image of 1 is displayed. Specify the output data range, adjust the contrast of the image, and specify the luminance value range for the reconstruction. Always select [Select range] option.
8	CT Reconstruction Execute button	Reconstruct CT image.

The activation of the center adjustment tool at the end of a CT scan depends on the reconstruction settings in the Control window. If you want to start the center adjustment tool manually, select the relevant data in the Database window and start it.

NOTE: To start the Center Adjustment Tool manually, right-click the series name for which you want to perform CT reconstruction in the Database window, and then click Launch Center Adjustment Tool from the context menu.

Figure 7.47 Center Adjustment Tool Drop-down

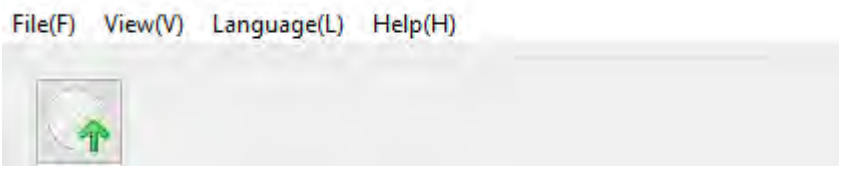


Menu Bar

Menu	Submenus and Functions
File	Image Import: Select a parameter file and load a perspective image. VOX Output Priority: Outputs the VOX file as volume data. RAW+XML priority: Outputs Raw and XML file. Exit: Exit the Center Adjustment Tool.
View	Slice number: The number indicates the position of the slice of the reconstructed tomographic image to be displayed. Slice position: The slice position of the displayed reconstructed tomographic image is expressed in the distance (mm) from the center of the captured image.
Language	English: Switches the window notation to English. Japanese: Switch the window notation to Japanese.
Help	Version Information Display: Displays the version information of the Center Adjustment Tool.

Reconfiguration Settings File Processing Area

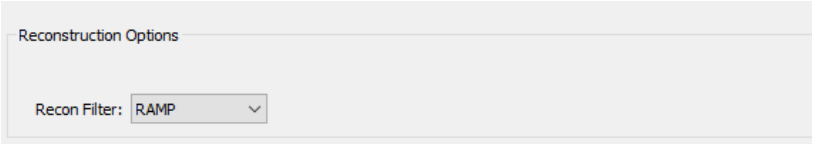
Figure 7.48 Loading Parameter Files

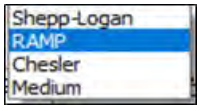


1	Icon for loading parameter files	Click to manually select the parameter file for the data you want to reconstruct and load the data.

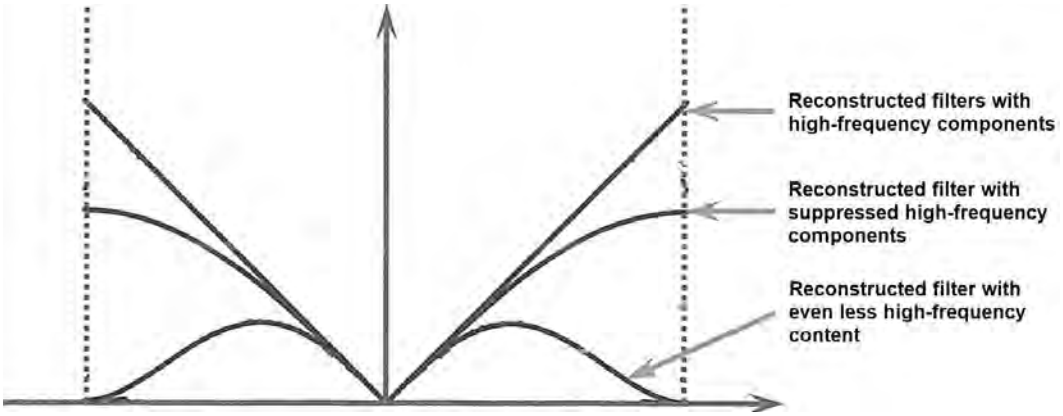
Reconstruction Options Area

Figure 7.49 Setting Reconstruction Options



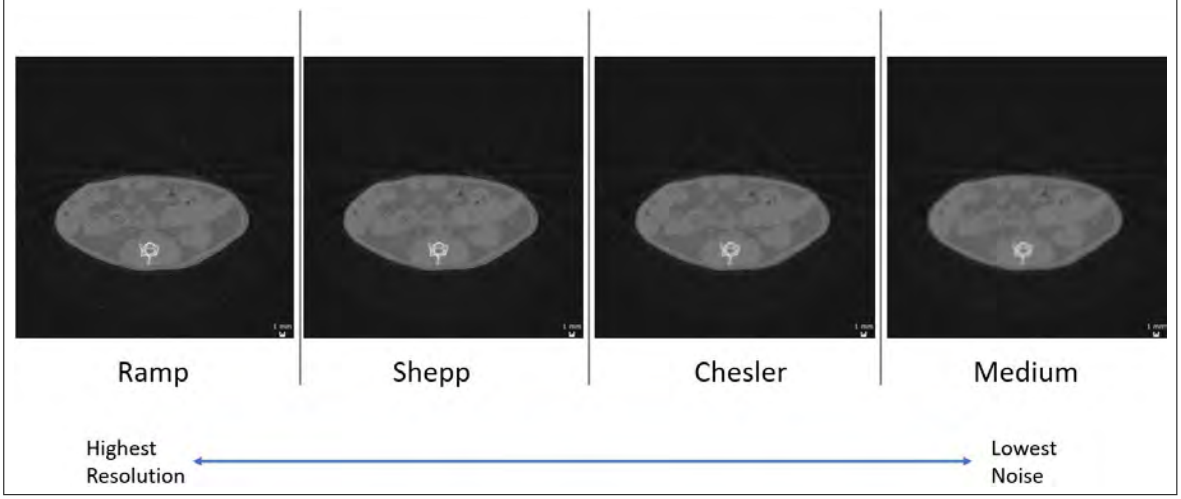
1	Reconstruct filter box	Determines the type of reconstruction filtering to perform on the projected image. You can select the following four filters in the pull-down box. 

NOTE: By changing the reconstruction filter, you can reconstruct using a low-noise projected image with suppressed high-frequency content. The effect of suppressing high-frequency components increases in the order of RAMP, Shepp-Loga, Medium, or Chesler. On the other hand, RAMP contains high-frequency components, which enhance the edges and reconstruct images with good spatial resolution.



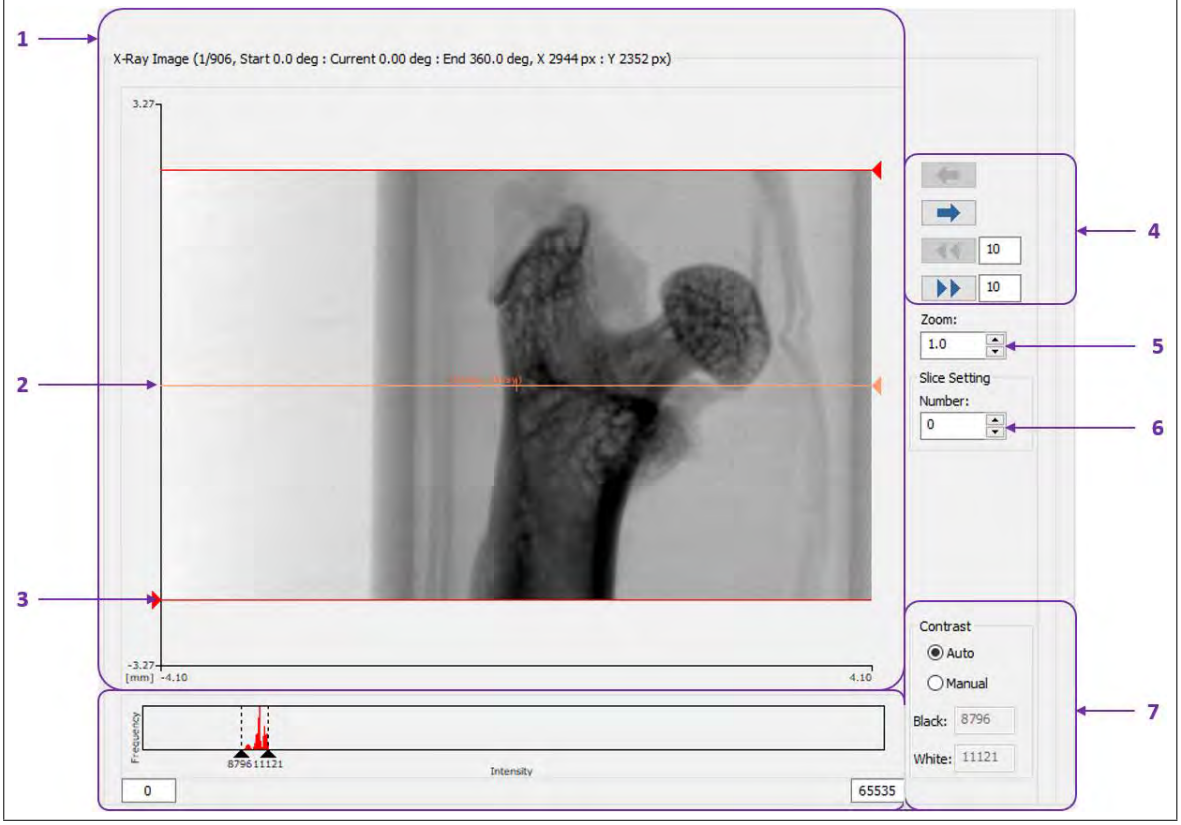
Schematic diagram of various reconstruction filters of the type that suppresses high-frequency component.

Figure 7.50 Reconstructed tomographic image when processed with each reconstruction filter



Perspective Image Area

Figure 7.51 Perspective Image Display Area

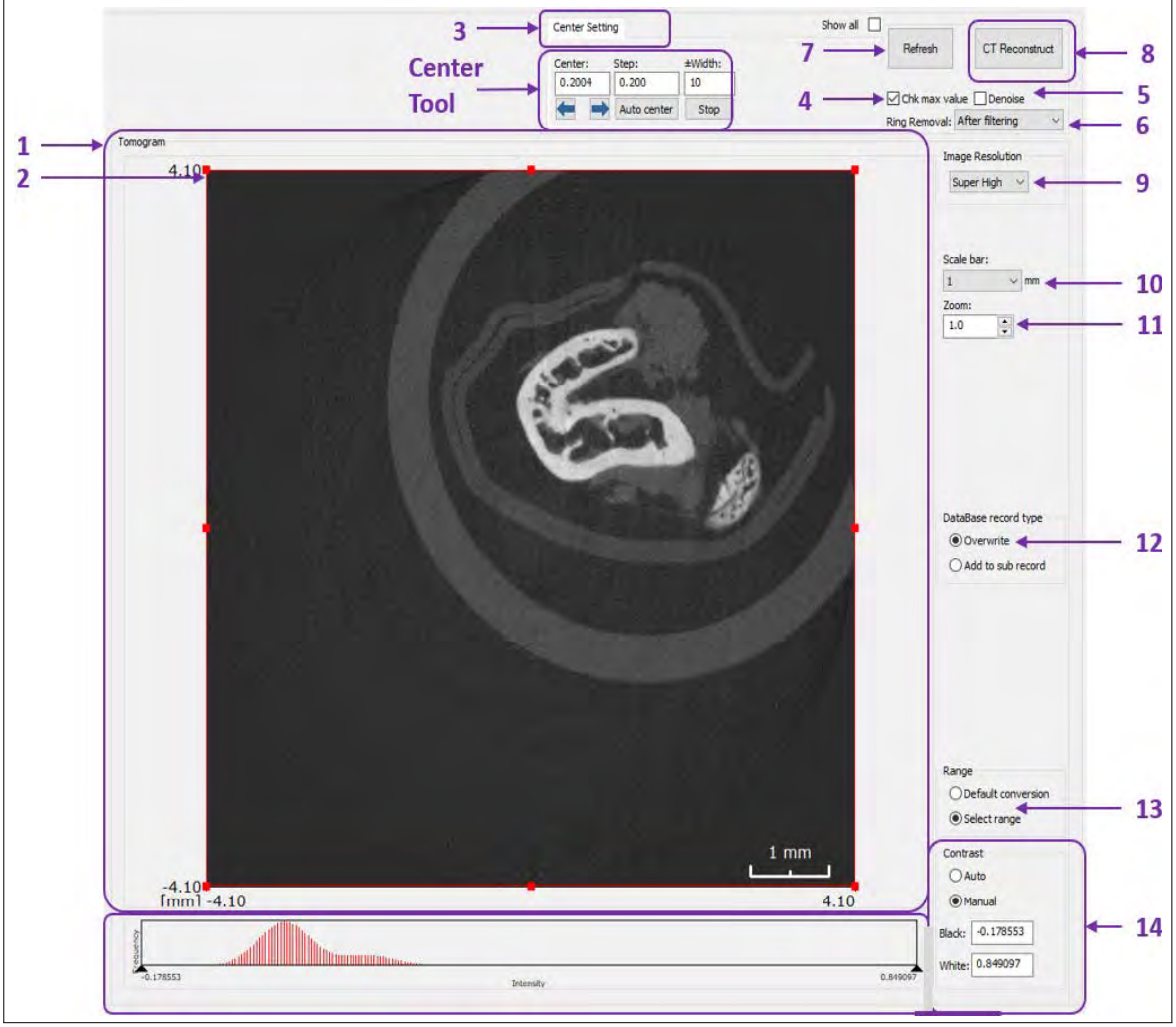


1	Perspective image display area	At the top of the area, the number of the currently displayed perspective image (# image/total number), the start and end angles, and the current angle are displayed.
2	Display the position of the reconstructed tomographic image	Represents the location of the tomographic image to be displayed in the reconstructed tomographic area. You can drag the marker button up or down to change the position of the tomographic image you want to display.
3	Reconstruct Scoping Bar	Indicates the position of the upper and lower positions of the range in which the image is to be reconstructed. You can drag the marker button up or down to change the area to be reconfigured.
4	Perspective image forward/rewind settings	Forward or rewind perspective images one at a time or a specified number.

5	Magnification setting box	Enlarges the image to the specified magnification.
6	Slice settings box	Indicates the position of the marker button in 2 and is displayed as [number] or [mm]. It is also possible to enter a numerical value directly for the position.
7	Contrast adjustment area	Adjust the contrast of the perspective image. If you want to automatically adjust the contrast, select Automatic. If you want to make manual adjustments, select Manual, and then enter the desired brightness value in the Black/White boxes. Alternatively, you can adjust the contrast by dragging the marker button ▲ on the histogram and moving it left or right. You can also enter a number (0~65535) in the box below the histogram to specify the display range.

Reconstruction Settings Area, Reconstruction Tomographic Image Area

Figure 7.52 Reconstruction Settings Area



1	Reconstructed tomographic area	A reconstructed tomographic image is displayed at the location where the ◀ marker button is located in the perspective image area.
2	Reconfiguration scope settings	Moves Surround the displayed reconstructed tomographic ■ image in the image to specify the area to be reconstructed.
3	Center of Rotation Correction Tab	Change the [Increment] and [Amplitude] to find the correct rotation center position. [Center] indicates the current center of rotation position (pixels).
4	Maximum value search settings	When Auto Center is performed, the maximum value of the Total Variation (TV) obtained as a result of the calculation process is set to be the most appropriate center value. If the check box is unchecked, the minimum value of the TV will be the center value. If you want to use the data of the half scan or offset scan to perform Auto Center, clear the check box.
5	Noise reduction settings	The perspective image is treated with a median filter and a Gaussian filter to remove noise.
6	Ring Mitigation Settings	Select either Before Filtering or After Filtering. [Filtering] applies to the perspective image, and [Filtering] applies to the reconstructed, filtered projection image, and [Filtering] performs ring mitigation processing on the reconstructed-filtered projection image.
7	Redraw button	Update to the set correction processing value, and display the reconstructed tomographic image processed with the updated value.
8	CT reconstruction button	Start CT image reconstruction.
9	Image Resolution Settings	Displays the image resolution settings in the Control window. You can also change the settings before reconfiguring.
10	Tick Marks	You can change the length of the tick marks.
11	Magnification setting	Enlarge the reconstructed tomographic image. You can move it by dragging.
12	Database storage method settings	It is used to save volume data that has been reconstructed under different conditions. Add to Child Record] to recompose the data, it will be saved as separate volume data in the Database. [Overwrite] If you check and recompose, the volume data that has already been recomposed will be overwritten. If you want to reconstruct the captured data for stitching, be sure to select Overwrite to reconstruct it.
13	Output data range setting	Specifies the luminance value range for outputting reconstructed tomographic images. [Default value conversion] is signed by performing a certain calculation operation16. The bits are reconstructed, and the specified range is reconstructed in the histogram with unsigned 16 bits, and the reconstructed image is output. When performing [CT value calibration] with our Viewer, be sure to reconstruct with [Default Value Conversion].
14	Contrast Adjustment	Adjust the contrast of the reconstructed tomographic image. If you want to make manual adjustments, select Manual, and then enter the desired brightness value in the Black/White boxes. Alternatively, you can adjust the contrast by dragging the marker button ▲ on the histogram and moving it left or right.

NOTE: This software removes the virtual image that occurs with linear hardening (beam hardening). However, the effect depends on each sample.

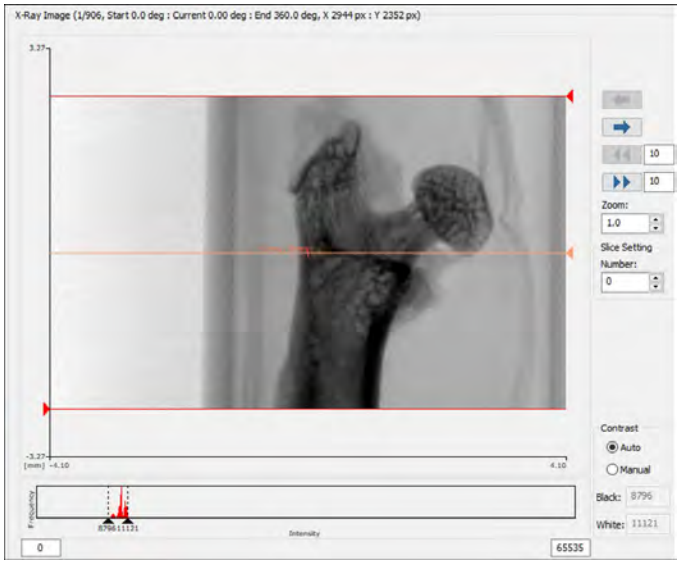
Rotation Center Position (Center Value) Correction

When reconstructing a fluoroscopic image to create a CT image, the correction value (center value (detector misalignment)) that the image forms is determined by the following procedure.

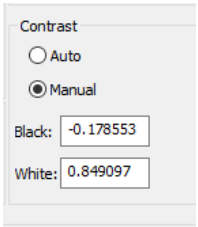
NOTE: This correction can be done in two ways: manually and automatically. Depending on the size of the deviation, use it properly while checking the image.

1. If necessary, use the Magnification Setting Box to zoom in on the image with the magnification changed, and adjust the brightness value with the Contrast Adjustment.

Figure 7.53 Reconstructed Tomographic Image after Image Enlargement and Brightness Value Adjustment

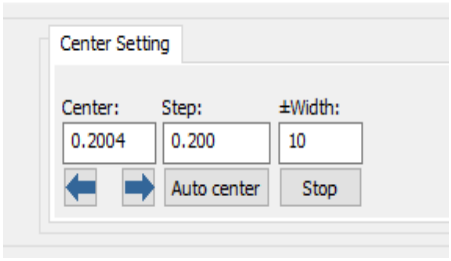


NOTE: When you adjust the brightness value, the selection of the [Contrast Adjustment] option button switches to [Manual]. If you want to reset the brightness value, check [Auto] to return to the initial value.

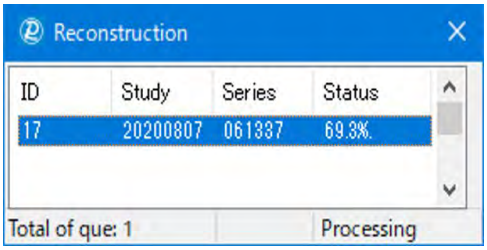


2. Enter an appropriate value (e.g., 5 or -5: pixels in pixels) in the Center text box in reconstruction settings area, and then click the Redraw button to observe the change in the image.

a. When the ⬅ or ➡ button is pressed, the number is [notch] pixels specified in the pixel will change.

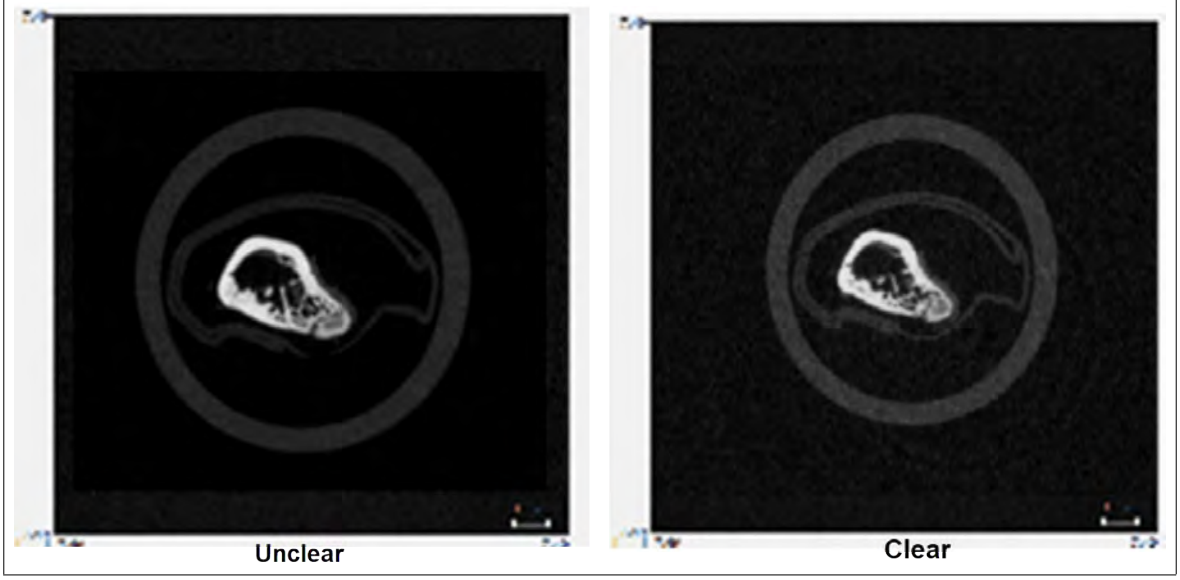


b. When you press the [Redraw] button, the following dialog box is displayed in the lower-left corner of the monitor, and the tomographic image reconstruction begins. After the reconstruction is complete, the image of the reconstructed tomographic area is updated.



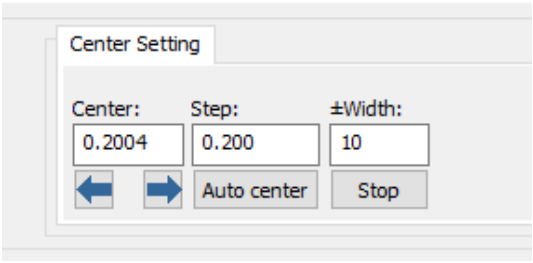
c. If the Center value is incorrect, you will not get a clear image. Until a clear image is obtained, repeat Steps 1 and 2 above.

Figure 7.54 Unclear and Clear Reconstruction Images



3. Click the [Auto Center] button to auto-compensate.
   a. Set the center to an initial value (for example, 0).
   b. In Increments, set the interval between searching for the center value (for example, 1).
   c. In Amplitude, set the range in which you want to find the center value (for example, 10).

d. Click the [Auto Center] button to move the center position in the above range (-10~+10), display the reconstructed images in the tomographic image area in order, and display the most appropriate center position in the specified range.



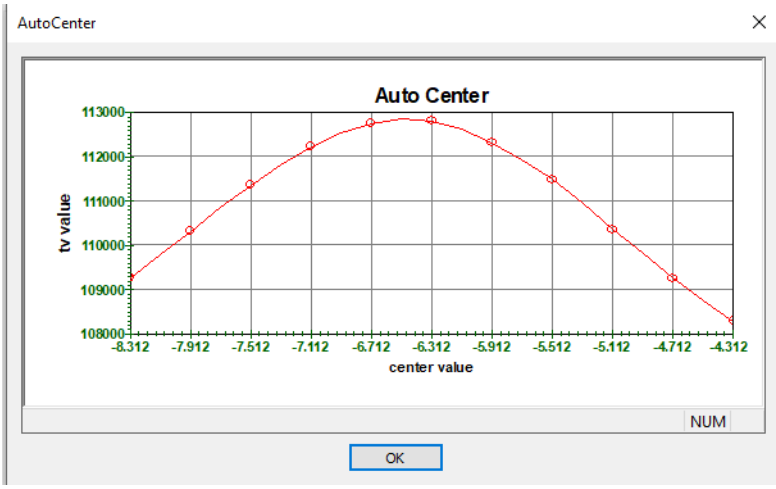
NOTE: If the image is too misaligned and the [Center] value is judged to be inappropriate, make adjustments such as changing the initial value of [Center] or increasing the range of [Increments], and then click [Auto Center]. Start by coarse [Increments] (e.g., 1) and then finely adjust (e.g., 0.1).

If the deviation is outside the range of [Amplitude], manually correct the [Center] value by referring to step 2.

NOTE: You can enter up to 20 amplitudes.

NOTE: In the case of half scan and offset scan, clear the check box for maximum value search. In that case, Auto Center will look for the lowest value of the TV value.

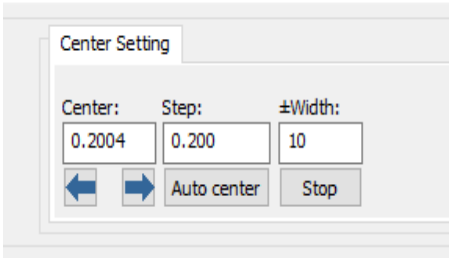
NOTE: If you click the [Auto Center] button to perform automatic correction, the [Auto Center] graph will be displayed. Giving the maximum value of the Total Variation (TV) value is the most appropriate center value. The following is an example of an Auto Center Chart.



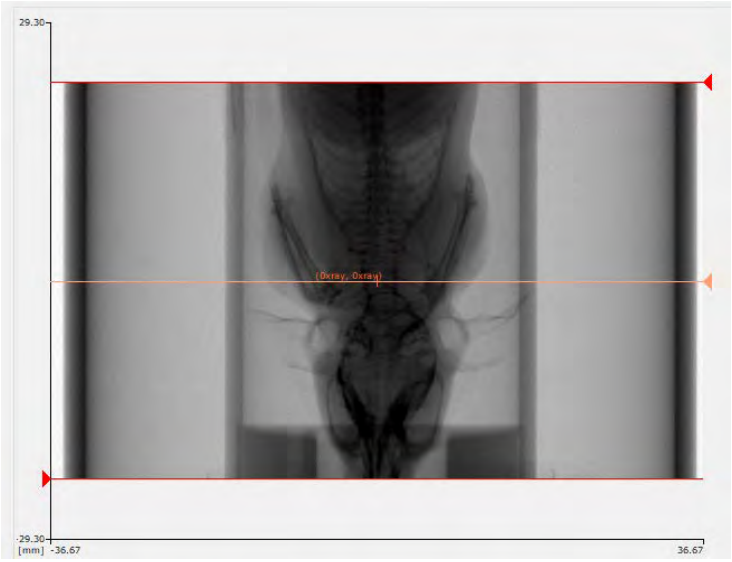
Perform Other Settings and Reconfigurations

Perform reconstruction by using settings other than rotation center position (center value) correction.

1. Specify the image resolution.
   Select the desired image resolution in the pull-down box.

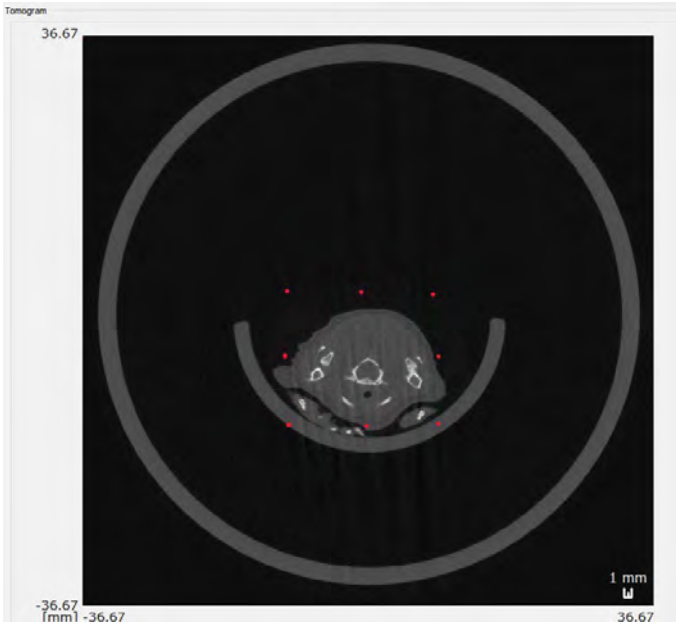


2. Specify the reconstruction filter.
   While reviewing the tomographic image, select the desired reconstruction filter (Ramp, Shepp, Chesler and Medium).
3. Specify whether or not to set noise reduction and whether to use ring reduction processing.
   While reviewing the tomographic image, select the desired treatment.
4. Specify the reconfiguration range.
   a. Drag the slice bar (orange line) displayed in the X-ray perspective image to the position you want to display.
   b. Drag the upper (red) and lower lines (red line) of the X-ray fluoroscopic image reconstruction range bars to set the Z-axis to be reconstructed.

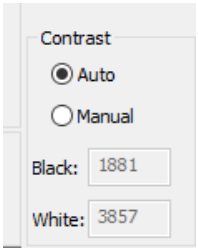


   Adjust the contrast of the CT reconstruction image. Drag the marker button ▲ in the contrast adjustment area to the left or right to set the maximum and minimum contrast values. You can also enter a number directly in the [Black] or [White] box.

c. Drag the reconstruction area (red frame) of the reconstructed tomographic image to set the X and Y axis ranges to be CT reconstructed. Specify the reconstruction range after setting the magnification back to 1x.

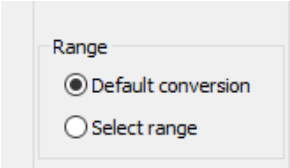


NOTE: When you adjust the brightness value, the selection of the [Contrast Adjustment] option button switches to [Manual]. If you want to reset the brightness value, check [Auto] to return to the initial value.



5. Specify the range of luminance values for outputting CT reconstruction tomographic images.

   Specifies the luminance value range for outputting reconstructed tomographic images. [Default Value Conversion] performs a signed 16-bit reconstruction by performing a certain calculation process, and [Specified Range] reconstructs the specified range in the histogram with an unsigned 16-bit and outputs the reconstructed image. When performing [CT value calibration] with our Viewer, be sure to reconstruct with [Default Value Conversion].

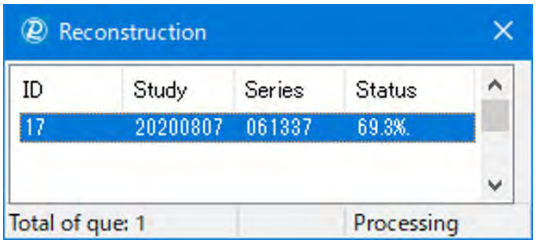


.

NOTE: Preferred Selection: If you select [Default Value Conversion] in the output data range, the [CT Value Calibration] function is used, and the luminance value is calculated by performing a certain calculation process. The [CT Value Calibration] function calculates the luminance value of one standard (uniform material) based on the luminance value of another material. Since the luminance value of the standard sample can be kept almost constant even when the state of the X-ray generator or X-ray detector changes, the luminance value of the data taken at different times can be compared, and image analysis using almost the same luminance value is possible. However, there are some limitations to the reconfiguration settings.

If you select [Specified Range] for the output data range, the luminance value is calculated in the specified contrast range. When comparing multiple samples, it is possible to compare the luminance values of multiple samples by always setting a constant contrast range, and image analysis using it is possible. However, since the calculation process is not performed based on the luminance value of the standard sample, the luminance value will also change if the state of the X-ray generator or X-ray detector changes.

6. Click the [CT Reconstruction] button to perform the CT reconstruction. The following dialog box will appear in the lower left corner of the monitor, and image reconstruction will begin.

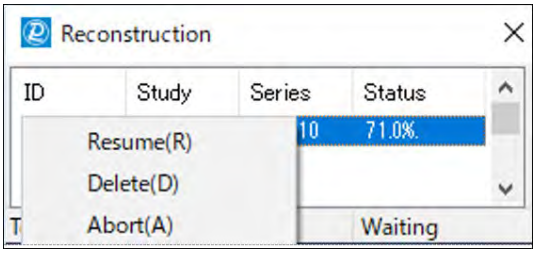


NOTE: In the Reconstruction dialog box, you can right-click the data being reconstructed to do the following:

- Resume If an error occurs in the reconstruction process, abort the process.

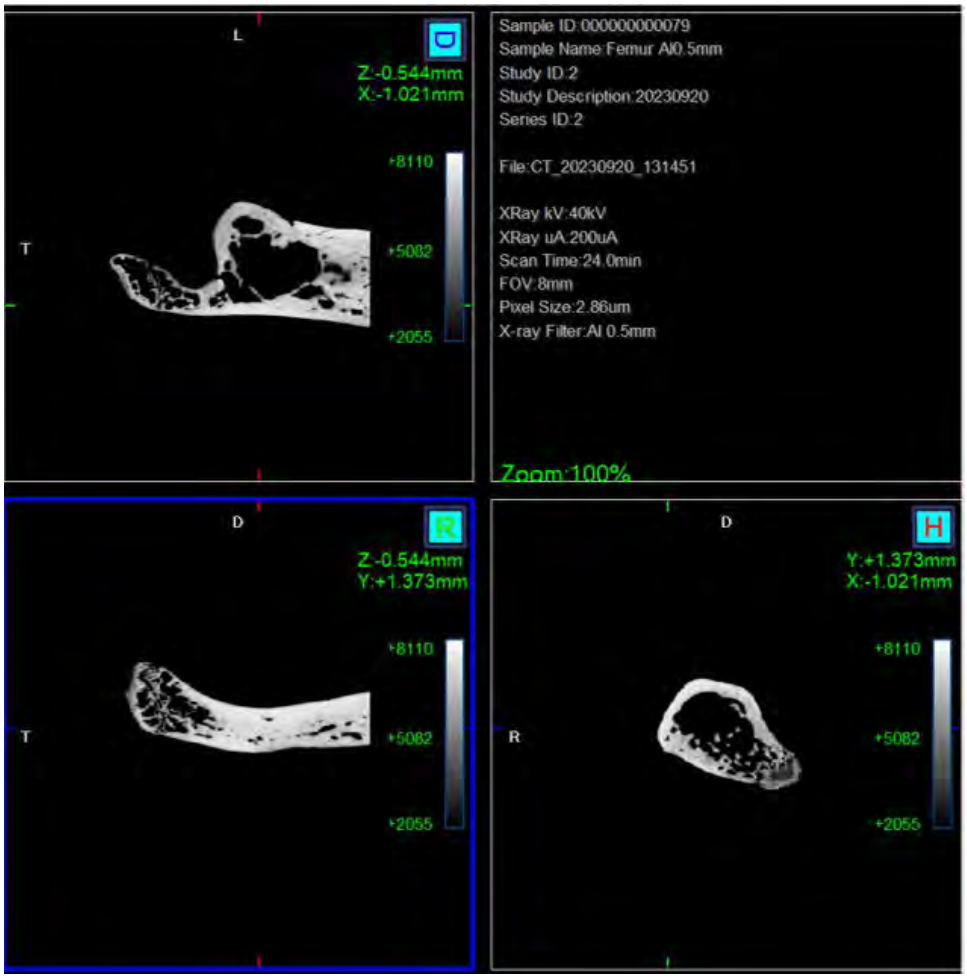
- [Delete] If an error occurs in the reconfiguration process, abort the process and delete the process.

- Abort Stops the currently running reconfiguration process and deletes the process.



7. When the CT reconstruction process is complete, select the [AutoViewer. The reconstructed CT image is displayed in the window.

Figure 7.55 Viewing Reconstructed CT Image in AutoViewer



Reconstruction using CT Value Calibration

[CT value calibration] is a process that calculates the luminance value of another material based on the luminance value of one standard sample (uniform material) so the luminance value can be compared between multiple samples. Since the luminance value of the standard sample can be kept almost constant even when the state of the X-ray generator or detector changes, the luminance value of data taken at different times can be compared, and image analysis using almost the same luminance value is possible. This also makes it easier to interpret the image analysis results using the luminance values.

In order to perform [CT value calibration], it is necessary to match the imaging conditions (tube voltage, tube current, FOV, image resolution, etc.) and select [Default value conversion] for the output data range.

NOTE: CT value is a type of luminance value that voxels have, and is mainly used in medical CT. This CT value is taken with water and air as standard samples, and the luminance value of the air is calibrated to "-1000" and the luminance value of the water is "0".

1. Click [Settings] - [CT Value Calibration] in the Viewer, and the [CT Rate Enable] check box is [off] Verify that it is.

NOTE: If the check box is On, the horizontal axis of the histogram of the volume data is CT No., and if the check box is Unchecked, the horizontal axis of the histogram of the volume data is Gray Value.

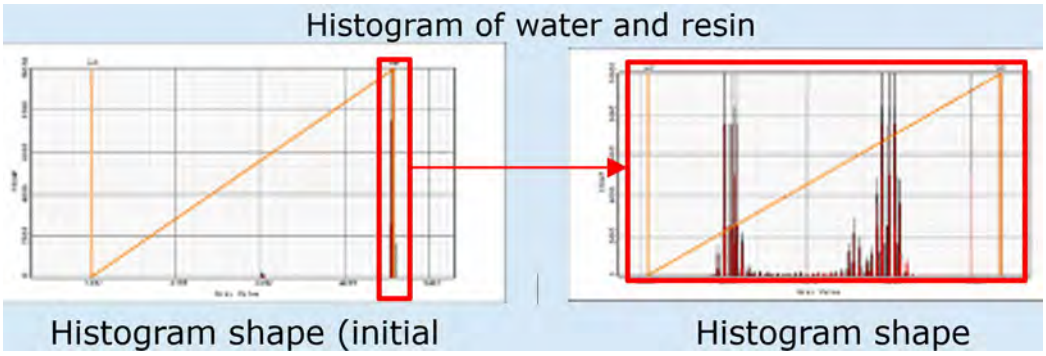
- CT Rate Enable is turned on.

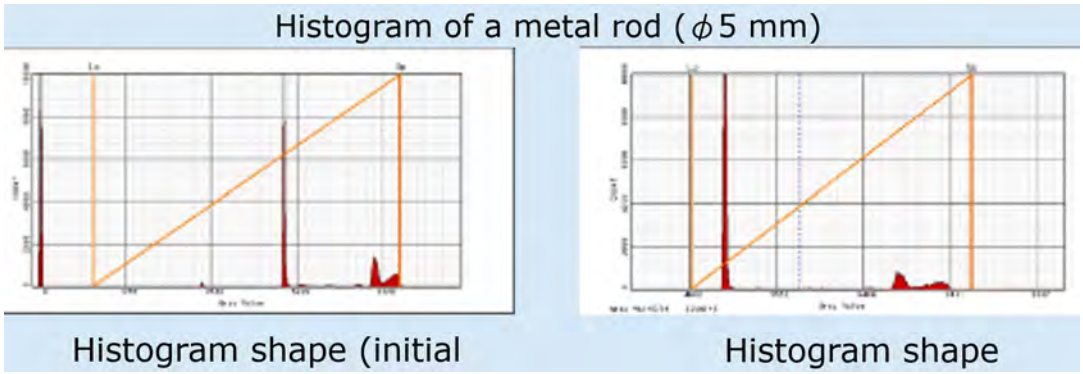
- CT Rate Enable is turned off.

2. Take a picture of a standard sample.
   Since the luminance value of the standard is used as a reference, the standard is made of a uniform material.
3. Perform reconstruction and perform CT value calibration in the viewer.

NOTE: The reconstruction must be performed by [Default Value Conversion]. Even if [Contrast Adjustment] is set to [Manual], the brightness value after reconstruction is the same as when it was set to [Auto].

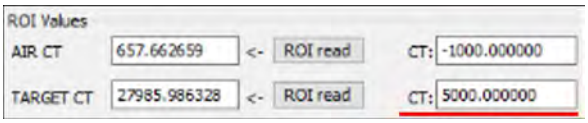
NOTE: If you reconstruct data with linear hardening correction using [Default Value Conversion], the histogram of the volume data may be wrong. This is especially true for samples with small sample densities. In this case, [CT Value Calibration] cannot be performed. When performing linear curing correction on the captured data of a low-density sample and performing image analysis with the luminance values aligned to a certain extent, be sure to perform reconstruction in the specified range.



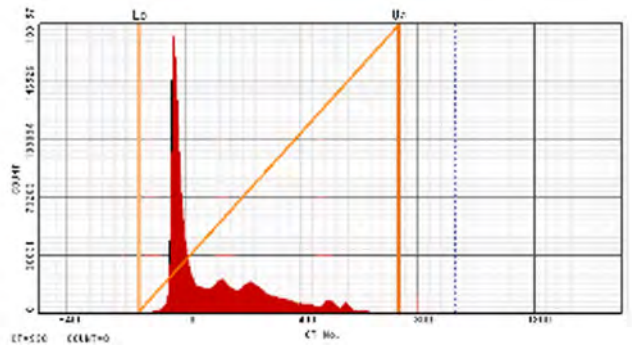


NOTE: If the value of [CT value] of [TARGET CT] is large when calibrating the CT value, the histogram range of the volume data will be wider.

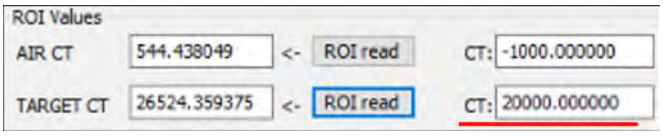
- When the value of [CT] is entered as "5000"



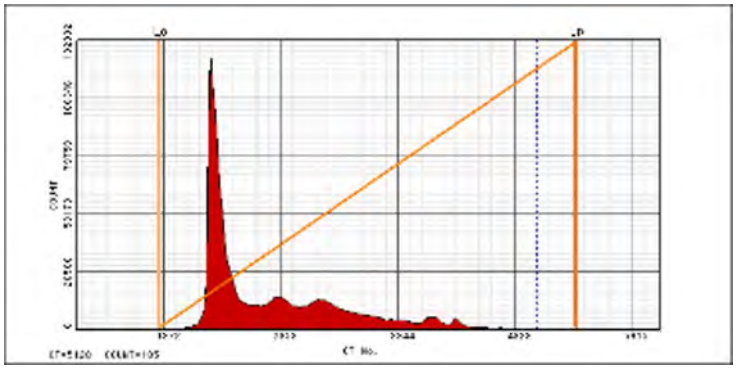
The histogram range of the volume data is reduced.



- When the value of [CT] is entered as "200000"



The histogram range of the volume data is wider.



NOTE: If you perform a reconstruction in [Specify Range], the [CT Value Calibration] button in the viewer is grayed out and CT value calibration cannot be performed.

4. The actual sample is photographed and reconstructed.

The imaging and reconstruction conditions are set the same as for the standard sample.

NOTE: The calibration information from the CT value calibration performed on the standard sample is also reflected in the next reconstruction.

This assumes that the [CT Rate Enable] check box in the viewer is "checked".

5. The reconstructed volume data is read by a viewer or analysis software and used for image analysis.
   The imaging and reconstruction conditions are set the same as for the standard sample.

NOTE: The calibration information from the CT value calibration performed on the standard sample is also reflected in the next reconstruction.

This assumes that the [CT Rate Enable] check box in the viewer is selected.

NOTE: When converting volume data to digitalicom data using Database, the converted luminance value will not be the CT value unless the [CT Rate Enable] check box in the viewer is "selected". This is also the case when using [Automatic ICOM Export Settings].

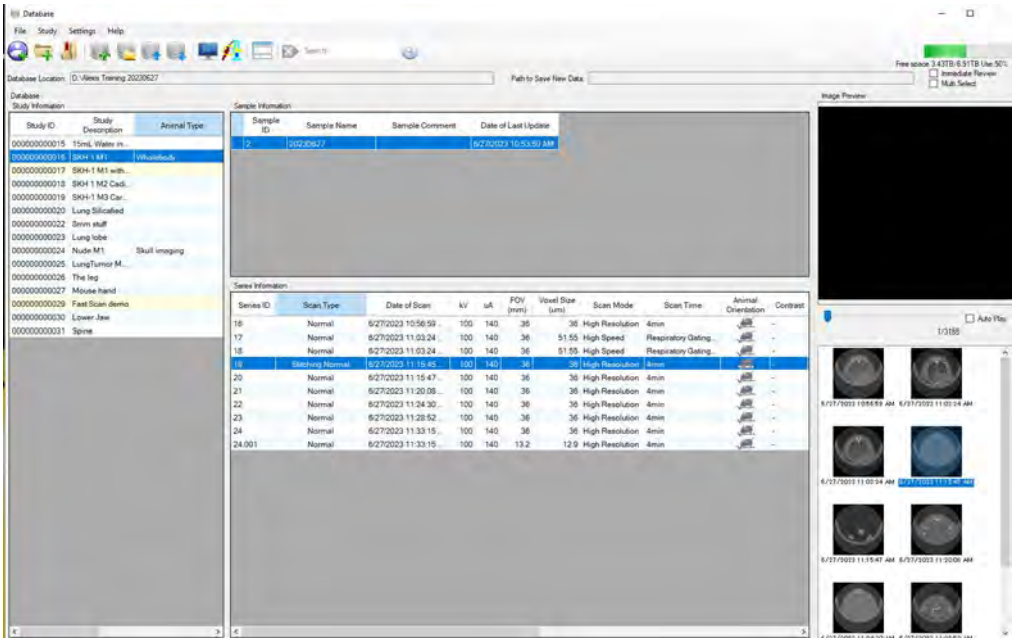
NOTE: If you want to reset the state in the CT value calibration process, make sure that [CT Rate Enable] is set to "Off" in the viewer, and perform the reconstruction with "Default Value Conversion" with [Linear Curing Correction] off. After that, the CT value calibration process is performed again.

Image Analysis using the Center Adjustment Tool

By using the image analysis software Viewer, you can display and measure images. This section describes the procedure for starting the Viewer and displaying CT images.

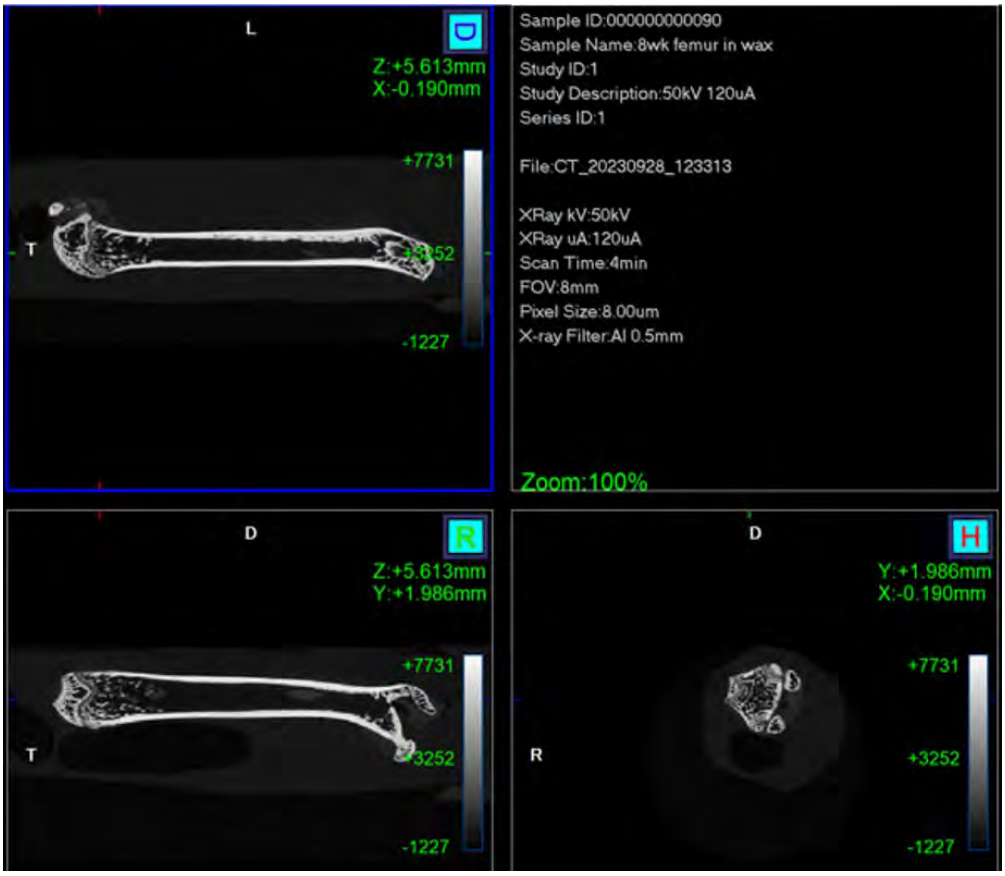
1. In the Database window, do one of the following:
   - ViewerDouble-click the series 1 row corresponding to CT image you want to display in.
   - ViewerDouble-click the thumbnail of CT image you want to display in.
   - ViewerWith the series 1 row corresponding to CT image you want to display in the  Launching Viewer).

Figure 7.56 Database Window



2. The Viewer starts and the CT image is displayed in the Viewer window.

Figure 7.57 Reconstructed CT Image



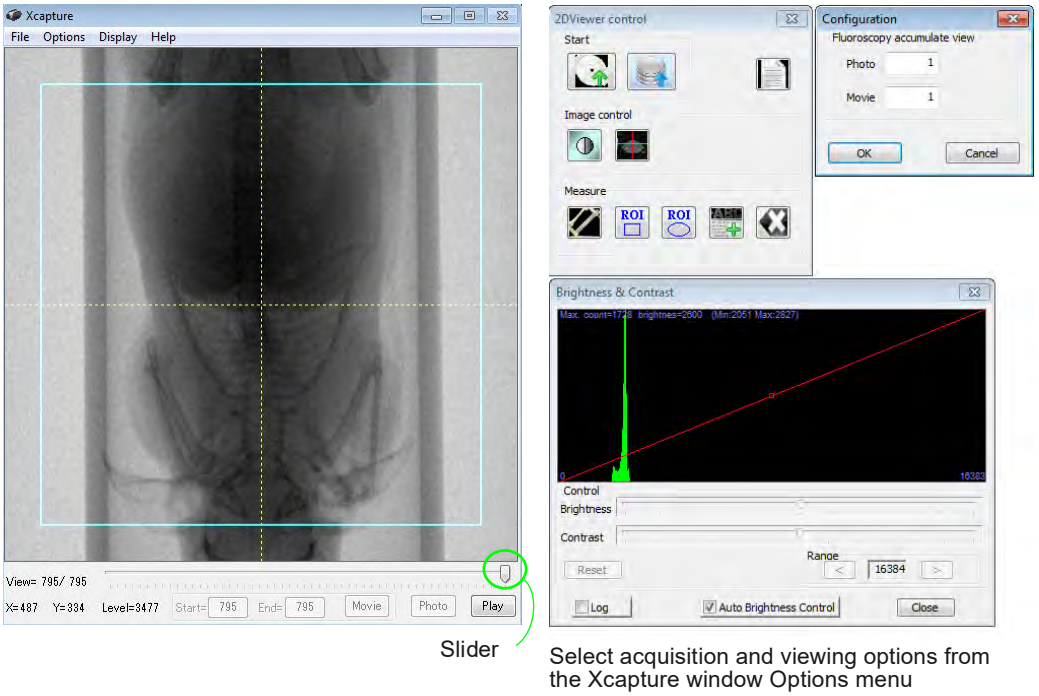
CAUTION: When shooting with the [Image resolution] setting set to [Super High], Sub volume reconstruction cannot be performed. If you set the [Image resolution] setting to [High] or [Low] and you shoot with the image resolution set to [High] or [Low], you cannot perform sub-volume reconstruction if you specify the reconstruction range. The Sub button does not display the correct image.

7.14 Acquisition and Fluoroscopy Mode

In fluoroscopy mode, a range of user-selected frames can be viewed as a movie (scrolling through 2D images) and stored in the image database.

1. Confirm the current save location or select a new save location (see *Select a Save Location* on page 56 for details).
2. Put the subject in the sample chamber and set the scan configuration. See *Place a Subject in the Sample Chamber* on page 69 and *Set the Custom Scan Configuration* on page 58 for more details.
3. In the X-Capture window, move the slider to the first frame of the movie and click **Start** (Figure 7.58).
4. Click **Play** to scroll through the selected frames.
5. Click **Save** to save the frames as a video in the current save location.

Figure 7.58 Xcapture Window and Options for Acquisition and Viewing



Saving an Image

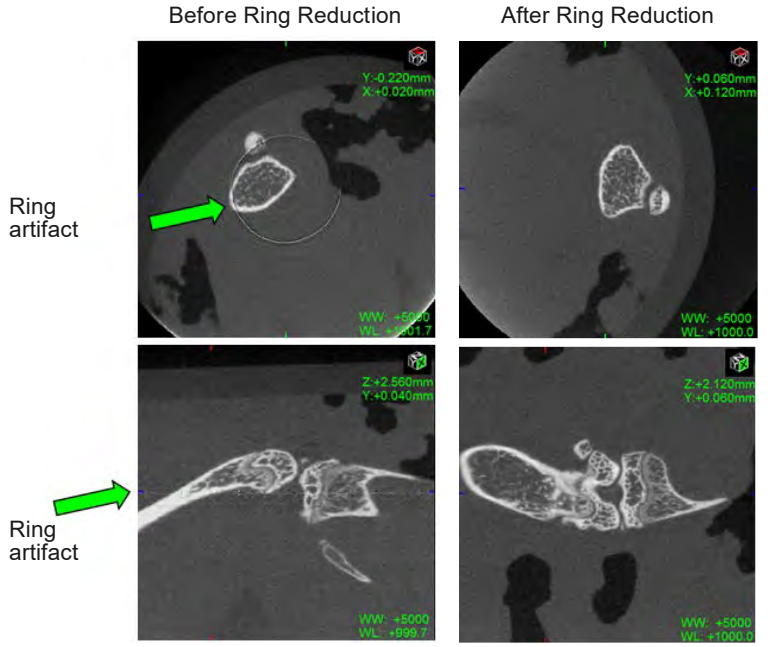
A single frame in the Xcapture window can be saved as a "snapshot" and stored in the database.

1. Select a frame using the slider in the Xcapture window.
2. Click **Photo**.
   This saves the snapshot to the current save location.

7.15 Ring Reduction

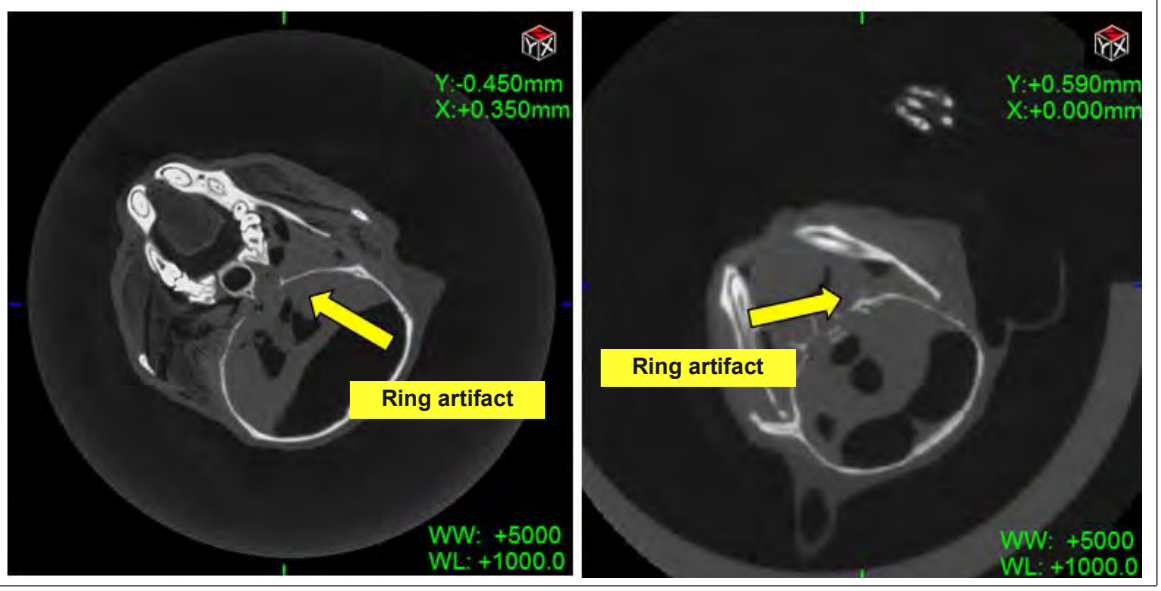
The ring reduction algorithm helps reduce image artifacts and is turned on by default. Figure 7.59 shows example images of before and after ring reduction.

Figure 7.59 Images With Example Ring Artifacts



Sometimes ring reduction may result in image artifacts (Figure 7.60). The artifacts are usually minor. However, if they are unacceptable, you can turn off ring reduction and repeat the acquisition.

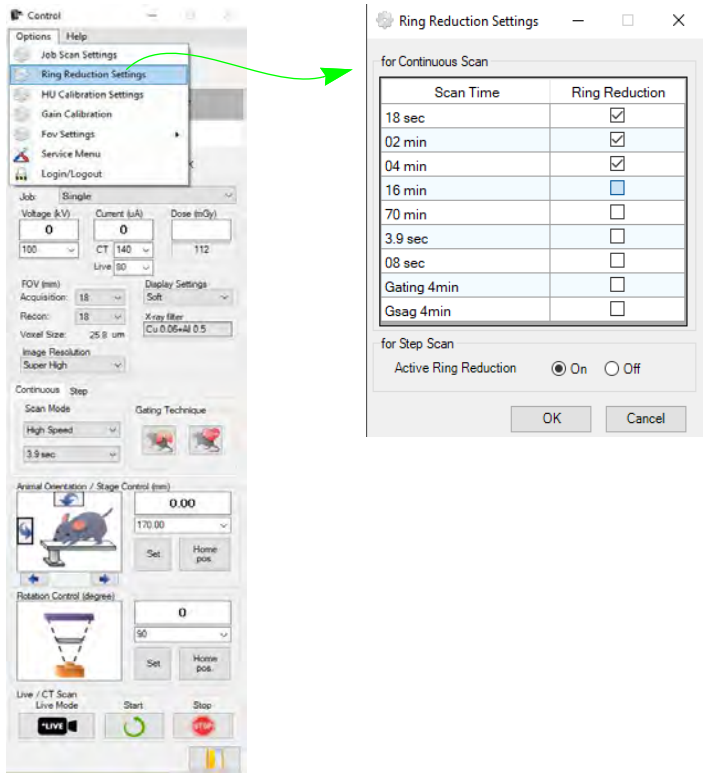
Figure 7.60 Example Image Artifacts Resulting From Ring Reduction



To turn off ring reduction:

1. Select **Options** → **Ring Reduction Settings** in the Control Panel (Figure 7.61).
2. Remove the check mark next to the scan technique that was used during acquisition and click **OK**.

Figure 7.61 Turning Off Ring Reduction



7.16 Changing the X-Ray Filter

The Quantum GX3 microCT comes with five changeable X-ray filters which allow you to optimize imaging protocols.

To change the X-ray filter:

1. Select the filter from the control panel.
2. Remove the imaging bore cover.
3. Manually change the filter in the filter chamber inside the Quantum GX3 microCT imaging bore.
4. Replace the bore cover and set up the imaging scan.

8 Viewing Images

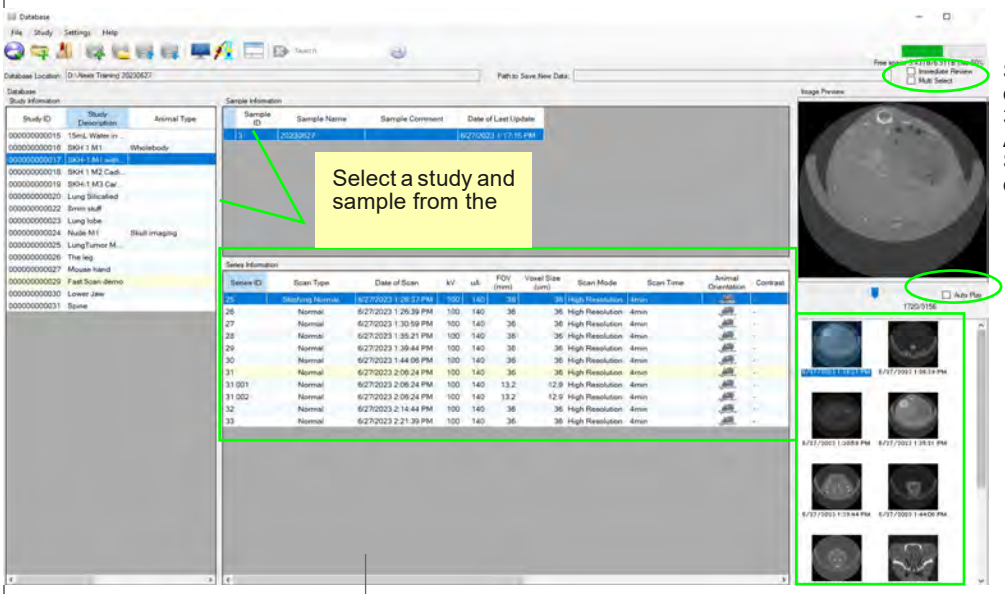
8.1 Previewing Data

The Database window provides previews of 3D reconstructions.

Table 8.1 Previewing Data in the Database Window

Select:	To Preview:
Sample	The series from all studies under the sample (Figure 8.1).
Study	All series in the study.
Series	Series

Figure 8.1 Previewing Data in the Database Window



View the data using one of the CT viewers (Table 8.2).

Table 8.2 CT Viewers

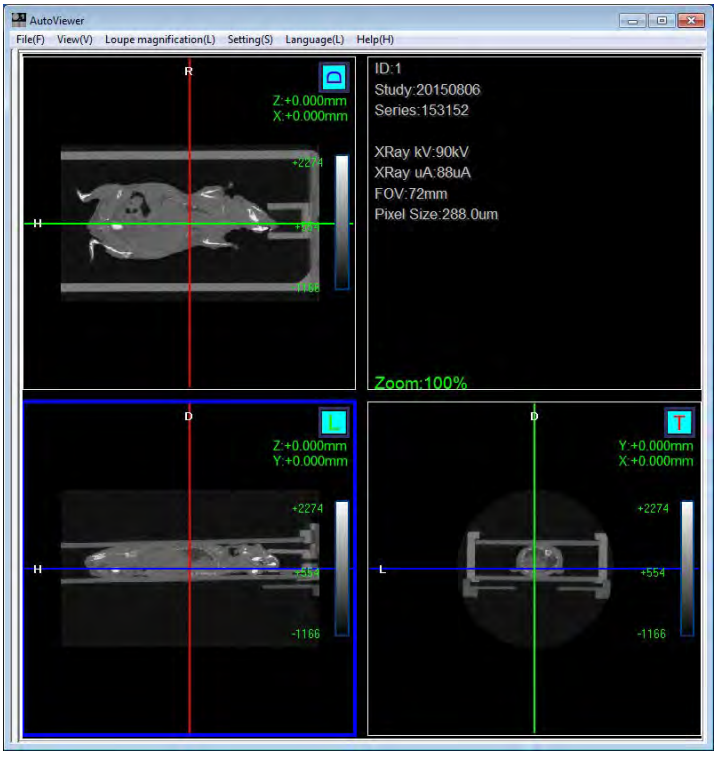
Viewer Name	Description	See
AutoViewer	The AutoViewer automatically appears after a scan and 3D reconstruction are completed. The AutoViewer enables you to: ▪ View 2D images (slices) in the x, y, or z-planes. ▪ Select other image data (.vox) for viewing. ▪ Print the current AutoViewer display.	Below
Viewer	Displays 2D image data. Double-click a series in the Database window to open the data in the Viewer. Alternatively, select a series and click the Run Viewer toolbar button . Use this viewer to visualize the 3D anatomical planes and perform basic 2D measurements.	page 112
3D Viewer	Enables rendering of a 3D reconstruction (classifying the data).	page 115

NOTE: 2D image data and 3D reconstructions can be viewed offline on a workstation not connected to the imaging system. See *Working With Data Offline* on page 40.

8.2 AutoViewer

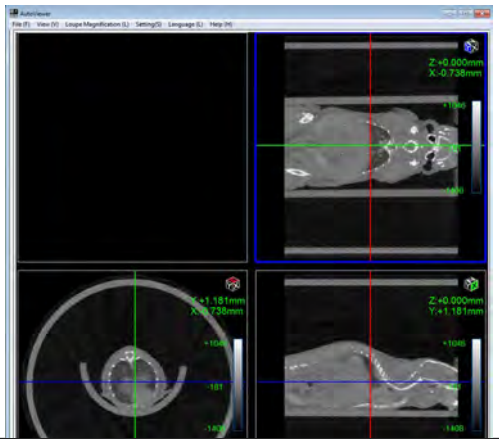
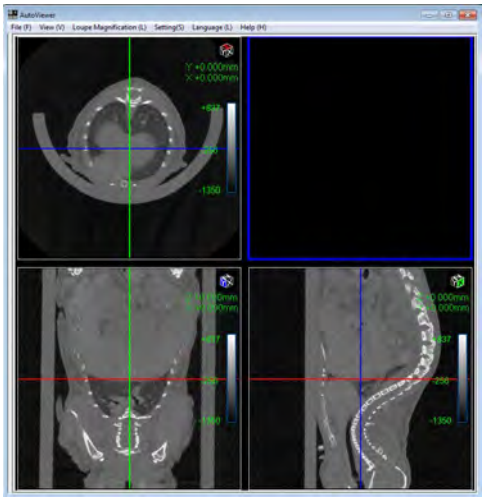
NOTE: If the AutoViewer does not automatically appear after reconstruction, confirm that the Immediate Review option is selected in the Database window (Figure 8.1).

Figure 8.2 AutoViewer Window



Drag the crosshairs to select a slice location in the x, y, and z-axis planes. Alternatively, use the middle mouse button to scroll through the slices within a viewing plane.

Table 8.3 AutoViewer Menu Commands

Menu Command	Description
File → Import	Opens a dialog box that enables you to select another .vox file for viewing.
File → Print	Opens a dialog box that enables you to print the current AutoViewer display.
Setting → CT number adjustment	Opens a dialog box that enables you to calibrate the Hounsfield Unit scale.
Setting → System Configuration	Choose this option to view the function key associations for quickly changing the window and level settings for image viewing.
View → Status Bar	Choose this option to show the x, y-coordinates of the mouse arrow in the AutoViewer window as well as the opacity value ("VAL").
View → Horizontal View	Displays the x and y-axis views in a vertical orientation. 
View → Vertical View	Displays the x and y-axis views in a horizontal orientation. 

8.3 Viewer and SimpleViewer

The Viewer provides tools for 2D image display and analysis.

NOTE: If you will be viewing 2D images offline, ensure that the workstation meets the requirements in Table 5.1 on page 40. Set up and copy image data to the workstation following the instructions on page 38.

To open data in the Viewer, double-click a thumbnail or series row in the Database window. Multiple series can be open in the Viewer at the same time.

Figure 8.3 Viewer Window

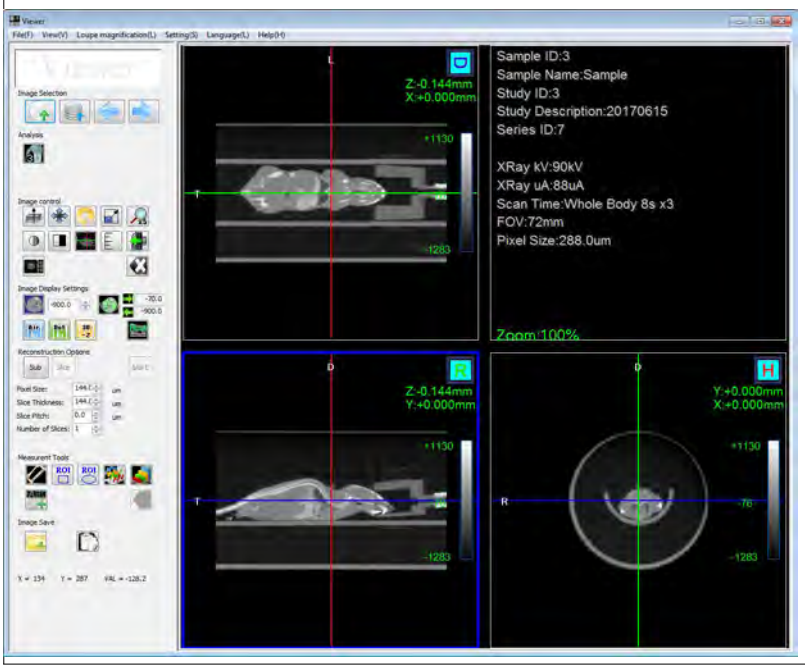


Table 8.4 Viewer Window

Item		Description
Image Selection		Click to import other CT data (*.vox) into the Viewer.
		Opens the Database window.
		Switches between images in the database.
		Click to open the next database image in the same instance of the Viewer.
		Click to open the previous database image in the same instance of the Viewer.
Analysis		Opens the optional 3D Viewer.
Image Control		Scrolls through slice images in a windowpane using the mouse wheel.
		Translates the slice image in the windowpane.
		Rotates the slice image (within a plane).
		Scales the slice image.

Table 8.4 Viewer Window (continued)

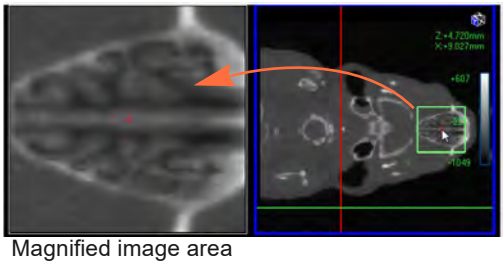
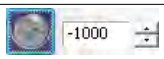
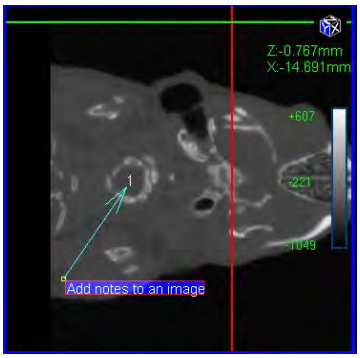
Item	Description
Image Control	Magnifies a selected area of the slice image. Right-click to select a different magnification (2x, 5x, or 10x). Alternatively, click the button the to change magnification.
	 Area within the bounding box is magnified. Magnified image area
	Changes the window and level settings to change the image display. Use the keyboard up or down arrows. Alternatively, press and hold the mouse button while you drag the mouse up or down in a windowpane.
	Reverses the gray scale color table. Click the button again to return to the default gray scale color table.
	Show or hide the x and y-axis crosshairs.
	Show or hide a scale bar in the windowpanes.
	Toggles between a horizontal or vertical slice orientation.
	Makes the transaxial view the main view in the Viewer.
	Resets to the default slice view or the default display if the image has been rotated, translated, or scaled
Image Display Settings	 Click the button to turn the mask off or on. Masks all voxels with gray scale value below the threshold value entered in the field.
	 Specifies a range of grayscale values for image display. Modify the range by editing the values in the fields. Click the button to turn the feature off or on.
	When a mask is applied using the button (generates a purple mask), click the button to mask additional voxels at the edges of the mask. This can help sharpen visualization at edges such as around the animal skin.
	When a mask is applied using the button (generates a green mask), click the button to remove single pixel noise from the thresholded mask.
	Enables you to select a 3D filter that removes noise by combining pixels and displaying the average intensity of the selected pixels: EDGE – Enhancement filter that sharpen edges in the image and improves visualization of small features. BONE – Enhancement filter that sharpens edges around high contrast objects such as bone. ORIGINAL – Does not apply a filter. SOFT – Applies a 3 x 3 x 3 averaging filter. SMOOTH – Applies a 5 x 5 x 5 averaging filter.
	Click to select options for viewing a Z-axis slice. See *Viewing a Z-Axis Slice* on page 115 for more details.

Table 8.4 Viewer Window (continued)

Item		Description
Reconstruction Options		Places an ROI on an image that will be used to select the image data for reconstruction.
		Places an ROI on an image that will be used to select the image data for reconstruction Pixel Size – Pixel dimensions. Slice Thickness – Voxel dimensions. Slice Pitch – Distance between slices. Number of Slices – The number of slices to reconstruct
		Starts the reconstruction.
Measurement Tools		Click and drag to draw a measurement cursor on an image. Right-click a measurement cursor to delete the selected cursor or all cursors.
		Draws a rectangular ROI on an image. Right-click an ROI to delete the selected ROI or all ROIs.
		Draws a circular ROI on an image.
		Displays a line graph of pixel intensities along a line segment drawn on an image. 1. Select a slice view. 2. Click the  button. The Line Profile window appears. 3. Press and hold the mouse button while drawing a line segment on the image. The Line Profile graph shows the pixel intensities along the line segment. 4. Drag either end of the line segment to resize or reposition the line segment. The graph is automatically updated. 5. Click the  button again to turn off and close the line profile graph.
		Opens a dialog box that enables you to insert a comment on an image. To add a comment to an image: 1. Select a slice view. 2. Click the  button. 3. Enter text and click **OK** in the dialog box that appears. 4. To resize or reposition the arrow, drag the arrow tip or the arrow end. To move the arrow, drag the entire arrow. 5. To delete a comment or all comments, right-click a comment and select a delete option from the shortcut menu. 
Image Save		Opens a Save As dialog box that enables export of the 3D reconstruction (.vox).
		Copies the image to the system clipboard.
	X =	Cross hair location in the X-plane.
	Y =	Cross hair location in the Y-plane.
	VAL=	Grayscale value at the crosshair location.

Viewing a Z-Axis Slice

1. Click the  button in the Viewer.
2. Choose viewing options in the dialog box that appears and click **OK** (Figure 8.4).
   - Thickness – 2, 4, 8, 12, or 16 slices
   - MIP Type (intensity value of each pixel along the Z-axis that will be displayed) – Max, Min, or Average intensity

Figure 8.4 Z-axis Viewing Options

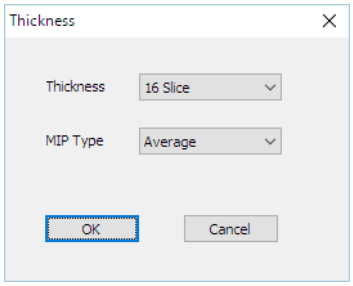


Figure 8.5 Viewer Window

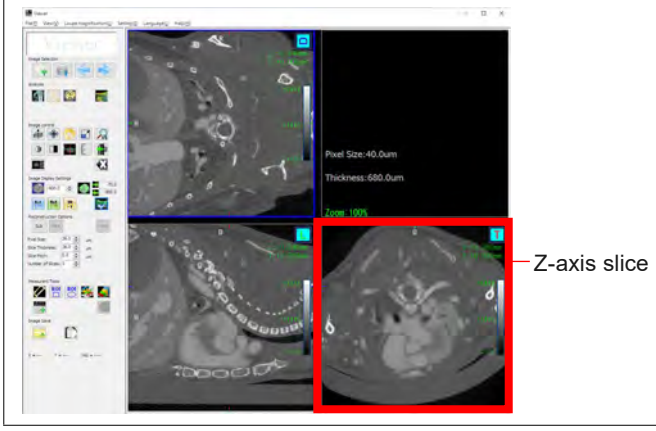
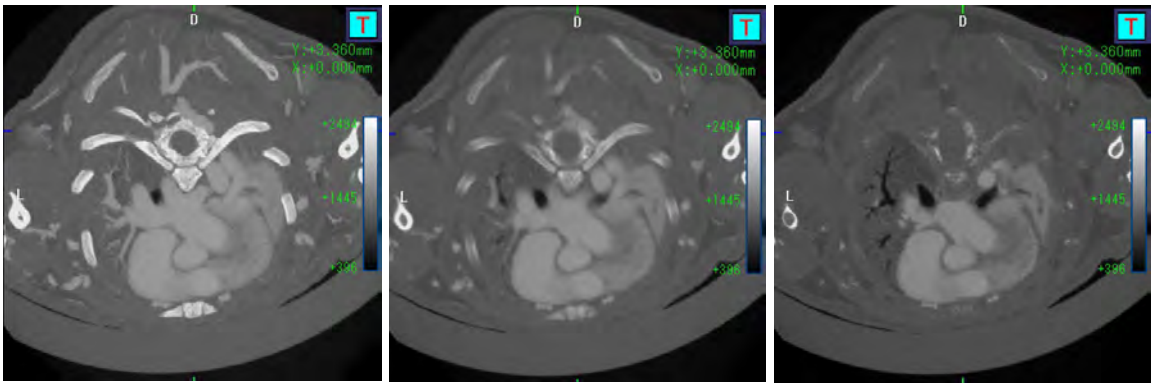


Figure 8.6 Example Z-axis Slice Images



Maximum intensity | Average intensity | Minimum intensity

8.4 3D Viewer

The 3D Viewer provides tools for rendering 3D reconstructions (classifying the image data and visualization) and viewing the 3D reconstruction from different perspectives. The volume rendering controls provide a histogram-based method for classifying the 3D reconstruction.

NOTE: If you will be viewing 3D reconstructions offline, ensure that the workstation meets the requirements in Table 5.1 on page 40. Set up and copy image data to the workstation following the instructions on page 38.

To open the 3D Viewer:

1. Double-click a thumbnail or series row in the Database window.
2. Click the  button in the Viewer that appears,

   The Volume Rendering Control Panel and 3DViewer window appears (Figure 8.7). 3DViewer has two modes:
   - Segment mode – Visualization mode that allows you to add multiple components which highlight different portions of an image.
   - Artistic mode – Visualization mode that applies a colormap to improve viewing of the grayscale data.

Figure 8.7 3DViewer and Volume Rendering Control Panel – Segment Mode

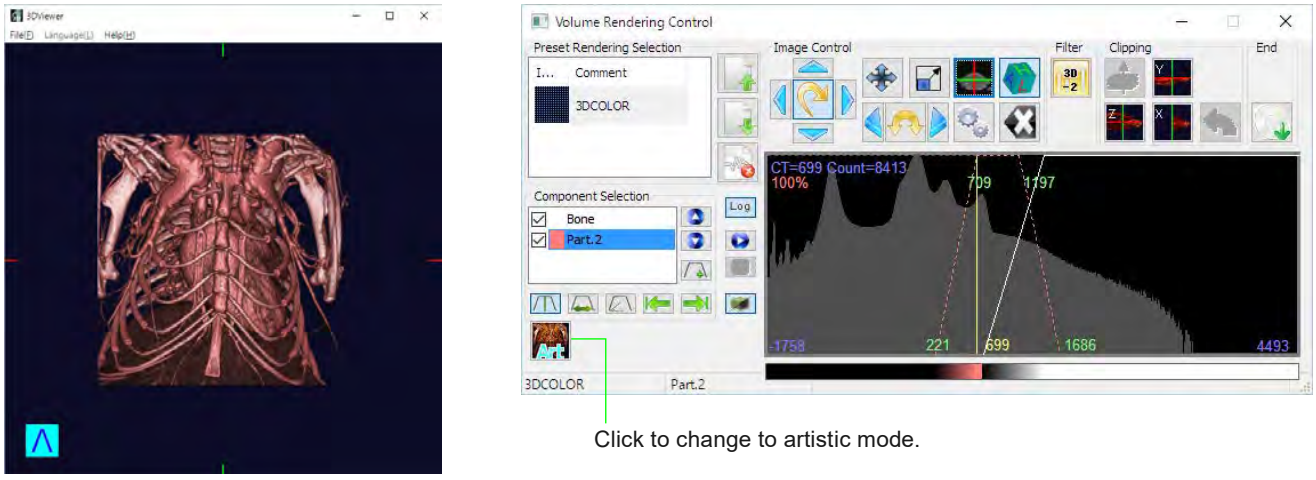


Figure 8.8 3DViewer and Volume Rendering Control Panel – Artistic Mode

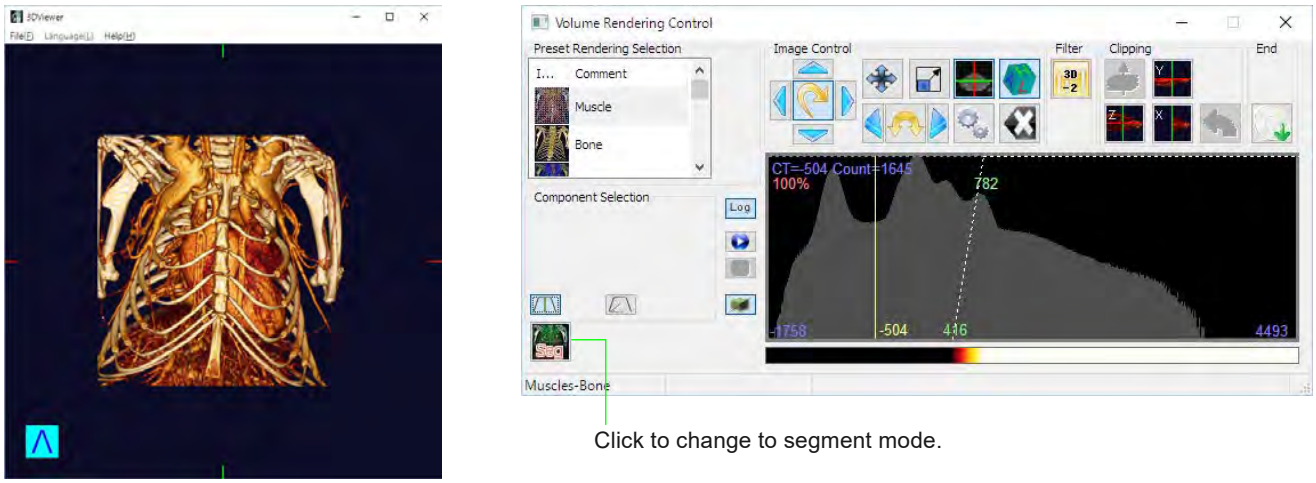


Table 8.5 Volume Rendering Controls

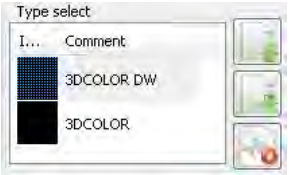
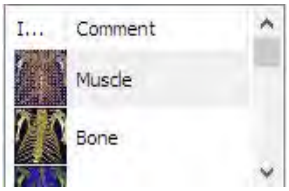
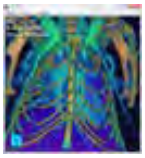
Item	Description
Preset Rendering Selection Segment Mode 	Allows you to define components using a monochromatic color table.
Preset Rendering Selection Artistic Mode 	Choose from a selection of preset color tables.  Muscle  Bone  Cardiac  Vascular Vessels and organs are blue.  Grayscale Lighter color palette than monochrome.  Rainbow  Spectrum  Perfusion For blood perfusion.  Green  Purple  Monochrome

Table 8.5 Volume Rendering Controls (continued)

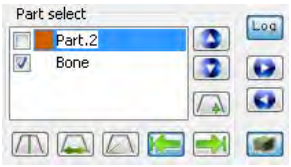
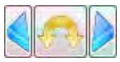
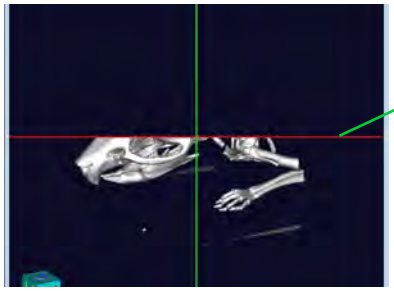
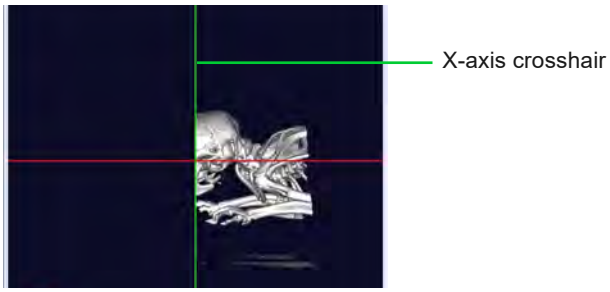
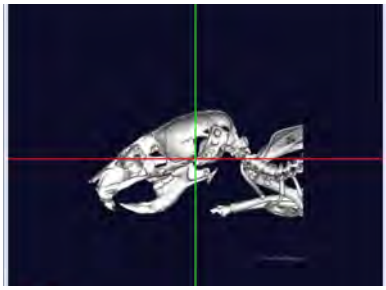
Item	Description
Component Selection 	Tools for classifying the image data. See *Classifying Image Data Using the 3D Viewer* on page 119 for more details.
	This button is available when the 3D Viewer is in artistic mode. Click to change volume rendering and controls to segment mode.
	This button is available when the 3D Viewer is in segment mode. Click to change volume rendering and controls to artistic mode.
Image Control 	Click a blue arrow to rotate the 3D reconstruction 90° about the x, y, or z-axis. To freely rotate the 3D reconstruction about the x or y-axis: 1. Click the  button. 2. In the 3DViewer, press and hold the mouse button while dragging the mouse.
	Click an arrow to rotate the 3D reconstruction about the z-axis. To freely rotate about the Z-axis: 1. Click the  arrow, then click an image. 2. Press and hold the mouse key while moving the mouse.
	Translates the slice image in the windowpane. Click the  button to return to the default view.
	Scales the slice image.
	Show or hide the x and y-axis crosshairs.
	Show or hide the perspective indicator in the 3D Viewer.
	Opens the Tool Box with controls for setting shading parameters and the level of details in static and moving images in the optional 3D Viewer. See Table 8.7 on page 123 for more details on the Tool Box.
	Resets to the default slice view or the default display if the image has been rotated, translated, or scaled.
Filter	 Allows you to select and apply a filter to improve the visibility of edges in View and 3D Viewer.
Clipping	Use these controls to “cut” and remove voxels from the 3D reconstruction.
	Hides all voxels above the y-axis crosshair. 

Table 8.5 Volume Rendering Controls (continued)

Item		Description
		Hides all voxels to the left of the x-axis crosshair. 
		Hides all voxels that are above the intersection of the x and y-axes (the axis coming out of the monitor). 
		Adds/removes voxels to the display after it has been cut using the  ,  , or  button. After the 3D reconstruction has been cut in the x, y, or z-plane, click the Slice button. To add or remove voxels from the display, click and hold the mouse button while dragging the mouse across the image.
		Undo button that reverses the “cuts” that were made (unhides the voxels). Performs the undo action in a step-by-step reverse order (the last cut is the first reversed, and so on).
End		Opens a dialog box that enables you to export the 3DViewer display to a graphic file or a movie.

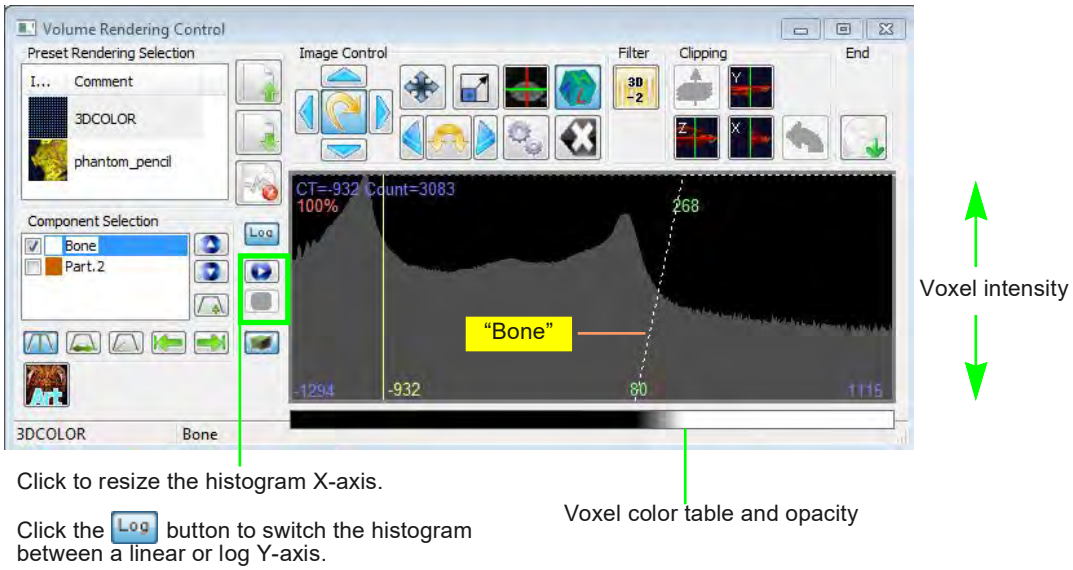
Classifying Image Data Using the 3D Viewer

The 3DViewer initially displays image data with a default air-noise boundary that identifies bone. Use the volume rendering controls to create and visualize additional intensity ranges or “parts”, for example, a particular type of soft tissue.

The histogram in the volume rendering controls represents the distribution of voxel intensities in the 3D reconstruction and their color-opacity values. The goal of classification is to set color and opacity values for different intensity ranges so that regions of the volume that are of interest appear opaque and unimportant regions are hidden (the voxels are transparent).

NOTE: This section explains how to classify data while in segment mode. The steps are the same in artistic mode.

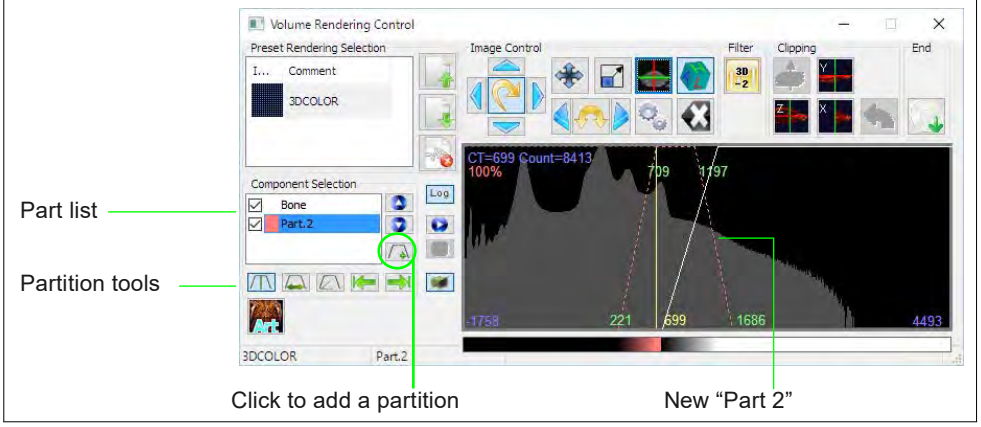
Figure 8.9 Voxel Histogram



To classify a part of the data:

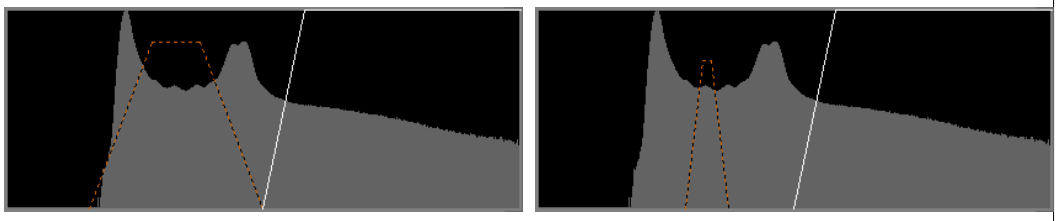
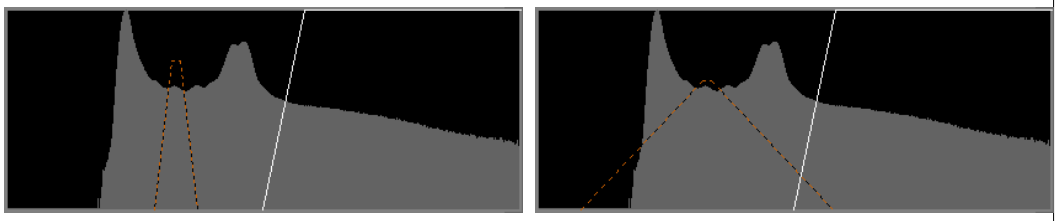
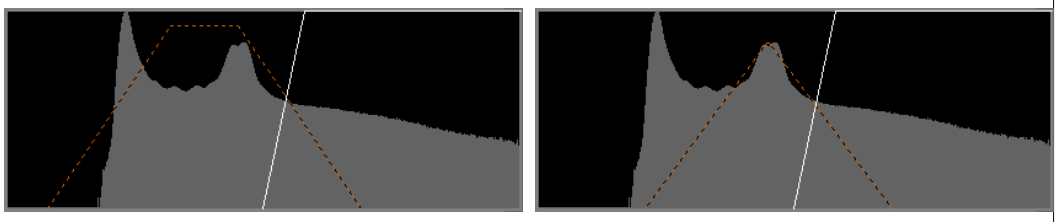
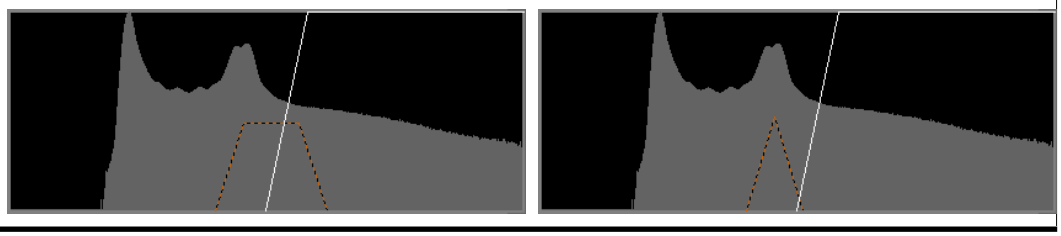
1. Click the Add Part button (Figure 8.10).
   A new partition appears in the histogram. The new part name is added to the part list.

Figure 8.10 Adding a Part to the Histogram



2. Modify the partition to visualize the tissue of interest using the tools partition tools (Table 8.6). To use a tool:
   a. Click the button, then click the histogram.
   b. Press and hold the mouse button while dragging the mouse left/right or up/down.

Table 8.6 Partition Tools

Tool	Functions
	Moves (translates) the partition up/down or left/right on the histogram.
	Adjusts the angle of the left and right portions of the partition. If the top of the partition is narrow, this can result in partition forming a point (as shown). For example: 
	Adjusts the partition height. Adjusts the width at the bottom only. For example: 
	Adjusts the partition height and moves the left side of the partition. For example: 
	Adjusts the partition height and moves the right side of the partition. For example: 

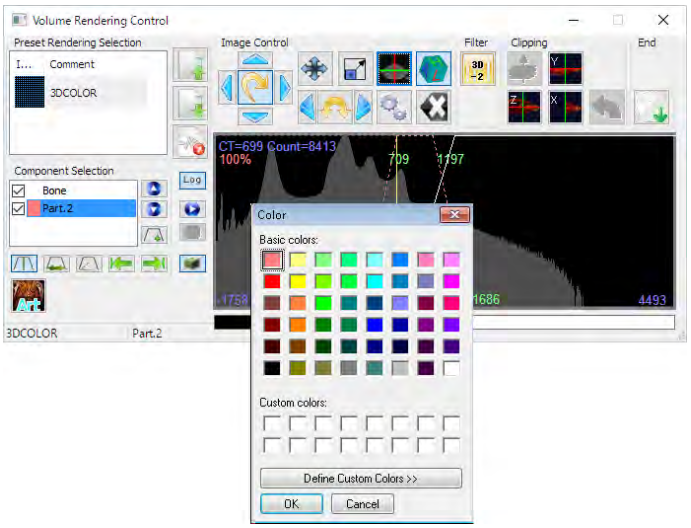
Managing Classified Data

You can edit the color table and name that are assigned to different parts of the data, and change the display order of multiple, overlapping data parts. For example, if there are two data parts that overlap, the 3DViewer displays the first part in the list on top of the second part.

To change the color table for particular data:

1. Double-click the part name and select **Color** on the shortcut menu.,
2. Select a color or define a custom color in the Color Palette that appears. Click **OK**.

Figure 8.11 Selecting a Color Table



To edit a part name:

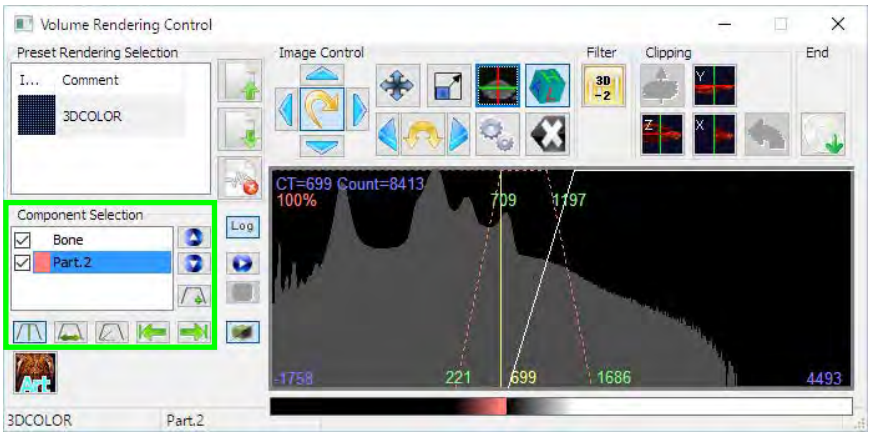
1. Double-click the part name and select **Rename** on the shortcut menu.
2. Enter a name in the dialog box that appears. Click **OK**.

To show/hide or delete parts:

1. To hide a part, remove the check mark next to the part name.
2. Put a check mark next to the name to show the part (Figure 8.12).
3. To delete a part, double-click the name and select **Delete** on the shortcut menu that appears.

Figure 8.12 Select Parts to Show or Hide

Select the parts to display in the 3DViewer



3DViewer Display Options

You can adjust the detail level and shading that is used to render the 3D reconstruction in the 3DViewer.

1. Click the  button to access the tools for setting shading and detail level.
2. Adjust the settings using the sliders.
   Changing shade settings automatically updates the 3DViewer display.

Table 8.7 Tool Box Settings

Item	Description
Shader Setting	
Ambient	Controls the intensity of the 'ambient light" that is applied to the rendering. Setting range: 0.0 to 1.0, dim to bright
Diffuse	Sets the level of "focus' of the simulated light on the rendering. Setting range: 1 = most focused, resulting in the brightest rendering; 0 = the dimmest.
Specular	Affects the lens that is used for light in the rendering. Setting range: 0 to 1.0, dim to bright.
Specular Power	Affects the "lens" used for the visual rendering. Setting range: 0 to 50. The results are dependent on the 'Specular' setting.
Level of Detail	
Still Level of Detail	Sets the quality of the visual rendering that is 'still' (not moving). Highest quality = 1.0. Decreasing this number reduces the quality of the rendering and also reduces the computational burden.
Moving Level of Detail	Sets the quality of the visual rendering during rotation, translation or zooming. The highest quality is set relative to the 'still' quality. Decreasing this number will reduce the quality of the rendering during movement and can be used to speed up reformatting of the rendering.

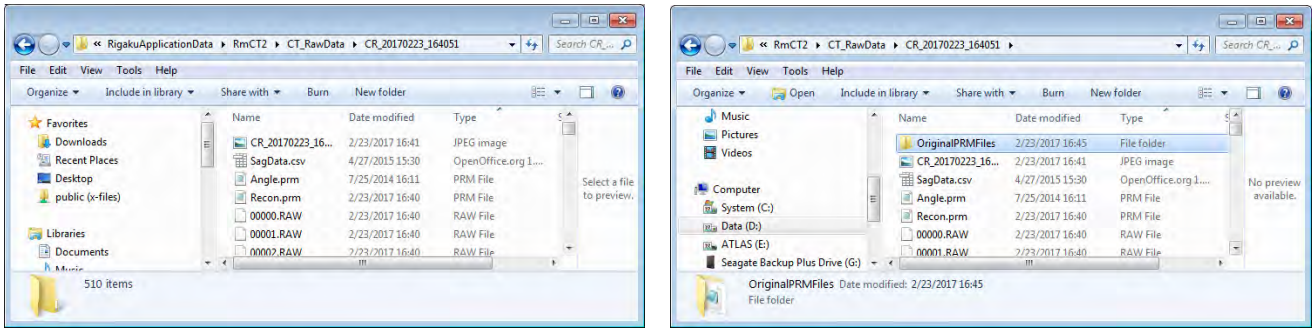
8.5 Enlarging a Reconstruction

The instrument reconstructs images into a matrix size of 512x512x512 voxels with a specific field of view (FOV). For some applications it may be helpful to enlarge the matrix size to 1024x1024x1024 voxels.

To enlarge a reconstruction:

1. Go to the folder with the scan of interest:
   "D:\RigakuApplicationData\RmCT2\CT_RawData\CR_yyyymmdd_hhmmss".
2. Create a backup of the Recon.prm file.
   The example in Figure 8.13 shows the file was copied to a folder call "OriginalPRMFiles".

Figure 8.13 Backing Up the Scan Folder



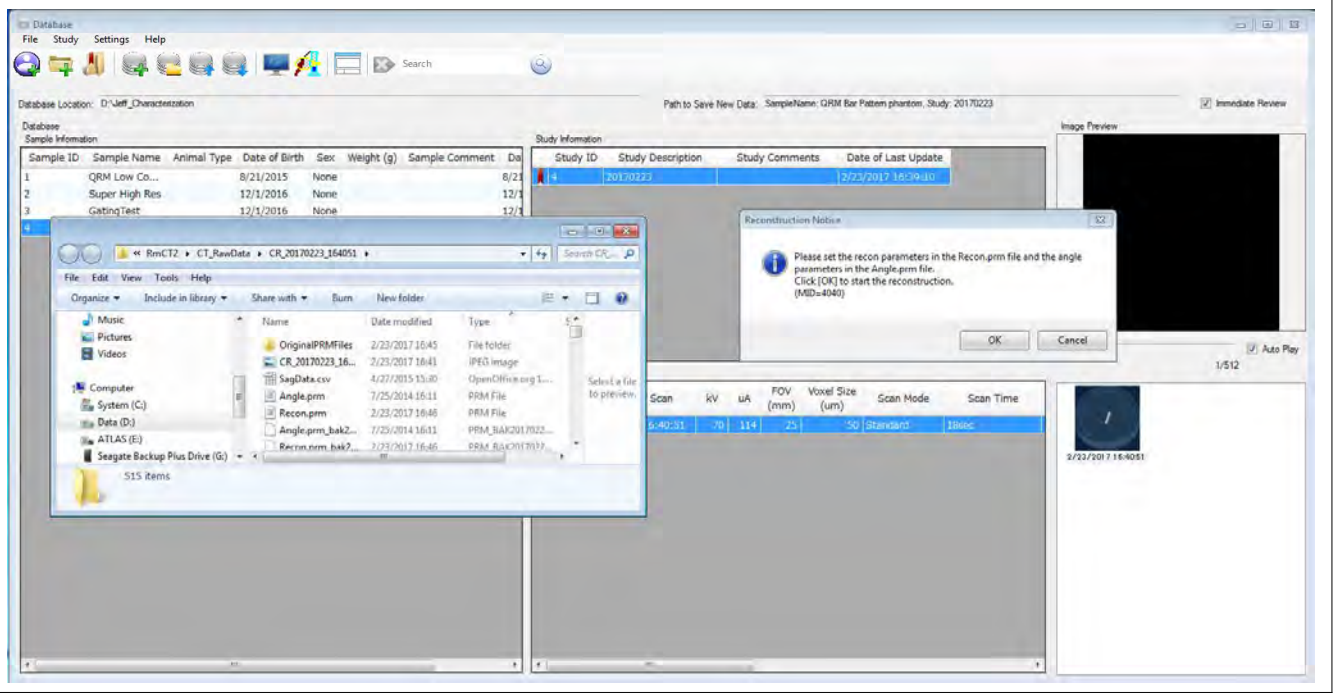
Initial folder

Folder after the backup

3. Go to the Database window. Press and hold the **Ctrl+r** keys while you right-click the image thumbnail.

   The software prompts you to edit the .prm files.

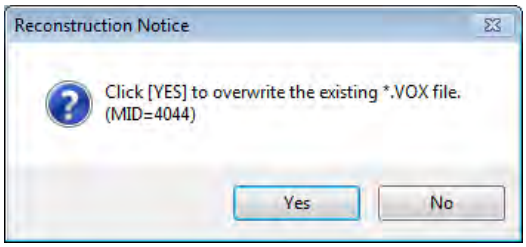
Figure 8.14 Editing the .prm Files



4. Modify the Recon.prm file using a text editor.
   a. Change the REC_NX, REC_NY and REC_NZ values 1024x1024x1024.
   b. To obtain:
      - The same FOV but a smaller voxel size, change REC_PX, REC_PY and REC_PZ to one half of their original value.
      - The same voxel size but a larger FOV, do not modify REC_PX, REC_PY and REC_PZ.
5. Click **Yes** in the dialog box that appears (Figure 8.15).

   The original reconstruction will be overwritten.

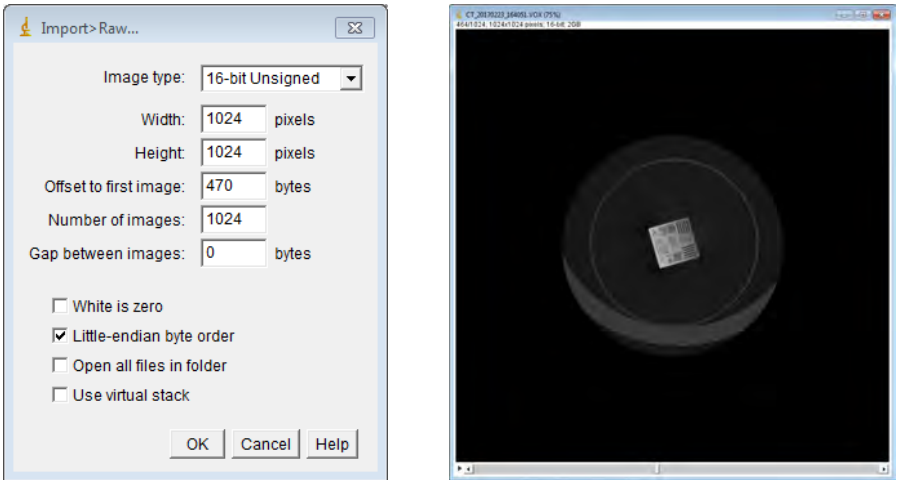
Figure 8.15 Reconstruction Modification Confirmation



6. Load the image into a third party image analysis package such as ImageJ (Figure 8.16).

NOTE: The header size is variable and will need to be calculated for raw imports.

Figure 8.16 Viewing Image Using Thirty Party Image Analysis Software



9 Care and Maintenance

9.1 Surveying the Quantum GX3 microCT for Radiation Leakage

Revvity recommends, and some local government agencies may require, an X-ray leakage safety test be performed:

- Every 12 months.
- After Revvity performs maintenance or service.
- After any abnormal condition that could impair any of the safety systems. For example, the light box door becomes difficult to open or close.

Conducting the X-Ray Radiation Survey

A radiation leakage test is a complicated matter requiring sensitive and expensive equipment. Some states or localities may require special training and certification to perform the test. Contact Revvity technical support for information regarding these tests or for scheduling a Revvity-trained person to conduct the survey as part of an overall safety check.

9.2 Maintenance & Safety Checks

NOTE: There are no user-performed maintenance procedures.

Daily/Weekly Safety Checks

Perform the following safety checks on a *daily* basis.

1. Verify that the door interlock is in good repair.
2. Verify that the key switch functions properly.
3. Verify that the "X-Ray On" indicators are functioning properly.

The following safety checks should be performed on a *weekly* basis.

1. All checks performed on a daily basis.
2. Inspect all screws holding the door shield and make sure that none are loose.

Monthly Safety Checks

Perform the following safety checks every month.

1. All safety checks performed on a daily basis.
2. Activate the "X-Ray Emergency Off" switch to verify operation.
   All indication of X-ray generation should cease when the switch is pushed in.

NOTE: X-rays will need to be generated when performing this test.

3. Reset the X-Ray Emergency Off switch by turning the red knob clockwise.
   The knob should pop out.
4. Restart X-ray generation from the instrument control software.

Annual Safety Checks

Perform the following safety checks every 12 months.

1. All safety checks that are conducted on a daily, weekly, and monthly basis.
2. A full radiation survey conducted by a qualified person.

9.3 Cleaning the Quantum GX3 microCT

Approved Cleaning Solutions

The compounds shown in Table 9.1 do not damage the internal finish of the Quantum GX3 microCT imaging chamber and are suitable for use as cleaners, if required. Do not use any solution not included in this list. In particular, avoid strong bases, bleach, or acids that may potentially damage the unit and compromise its operation.

IMPORTANT: Do not spray cleaning solutions in the sample bore. Gently wipe the bore surfaces as described on page 128.

Table 9.1 Acceptable Cleaning Solutions for the Quantum GX3 microCT Sample Bore

Cleaning Solution	Manufacturer
Cidexplus® Solution (3.4% glutaraldehyde)	Johnson & Johnson Medical
70% methyl alcohol/30% deionized water solution	
70% ethyl alcohol/30% deionized water solution	
Sporicidin® Sterilizing Solution (1.56% phenol)	Contec
Clidox-s® Disinfectant	Pharmacal Research Laboratories, Inc.

NOTE: Revvity makes no claims as to the sterility of the Quantum GX3 microCT imaging chamber after using the solutions in Table 9.1. Refer to the manufacturer's literature for information as to the applicability of the compound for the organism of interest.

It is recommended that you use a lint-free wipe, such as Scott Pure® wipe or a Kaydry EX-L® wipe to minimize the presence of particulate matter in the imaging chamber.

After saturating a lint-free wipe, clean the internal surfaces using a gentle circular motion. Use extra care when cleaning the radiolucent insert since it is a delicate assembly. Do not pour or spray the solution directly onto internal surfaces. Rinse surfaces using a wipe saturated with sterile deionized water. Do not allow puddles of water to remain on the surfaces.

Consider dedicating a Quantum GX3 microCT for immunodeficient animals to remove the risk of cross-contamination.

10 Legal Notices

10.1 Limited Warranty

Each new Quantum GX3 microCT ("System") purchased from Revvity is provided with the standard limited warranty set forth in Revvity's terms and conditions of sale available at www.revvity.com/policies.

10.2 Trademarks

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10.3 Disclaimers

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B. **Use of the System**. This manual has been developed for use by properly trained individuals only and use by individuals who have not received proper training is not advised. Any changes or modifications of the System, not expressly approved by Revvity, will void the limited warranty and any repair thereafter shall be charged to the Customer. Any movement of the System not performed by authorized personnel of Revvity may void the limited warranty. Failure to operate the system in accordance with this manual is likely to cause safety hazards, personal injury, property damage, and/or other damages.

Appendix A Troubleshooting

Issue	Possible Cause	Corrective Action
Cannot turn on the CT scanner	▪ Emergency Stop button has been pressed.	▪ Release the Emergency Stop button.
	▪ Key switch is in the OFF position (left position).	▪ Turn the key switch to the ON position (turn to the right).
	▪ The cover is open.	▪ Check to see if any of the device cover is missing and make sure that all screws are tightly fastened for all covers.

Appendix B User-Replaceable Parts

Item	Part No.
Bore Cover Large, GX	CLS143641
Bore Cover Small	CLS134993
Bed Large	CLS134994
Bed Small	CLS134995
Transfer Bed (for use with Mouse Imaging Shuttle)	127167

Appendix C System Shutdown

Revvity does not recommend power cycling the Quantum GX3 microCT (turning the system components on and off). If it is necessary to shut down the scanner for any reason, it is important to follow the procedure below.

1. Make sure that all processes are finished. Confirm that the gantry and sample bed are not moving.
2. Close the Control Panel and Database window. If prompted, save any data.
3. Turn off the computer using the standard Windows® shut down procedure.

   This also shuts down the Quantum GX3 microCT scanner.
4. Turn off the power to the other system components and power surge protection devices.

If you have any concerns during the shut down procedure, contact Revvity technical support (see page 3) for assistance.

NOTE: The Emergency Stop button is not intended as a main X-ray source control and should not be used to turn the X-ray function ON or OFF on a routine basis. It should only be used in the unlikely situation where the X-ray source must be immediately turned OFF.

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