



USER MANUAL Quantum[™] GX3 microCT Imaging System



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Quantum[™] GX3 microCT Imaging System

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1 Welcome

About This Manual Quantum GX3 microCT Help on page 2 Additional Important Documentation on page 2 Contact Information on page 3

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.



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.

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

 Table 1.1
 Documentation for the Quantum GX3 microCT Imaging System

1.4 Contact Information

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Technical Support Telephone: +1 800 762 4000 (US Toll Free) +1 203 925 4602 (Worldwide) Fax: +1 203 944 4904 Email: support@revvity.com www.revvity.com/contact-us

2 Safety, Warnings, and Radiation Hazards

Important Safety Information Warnings on page 10 X-Ray Safety and Radiation Hazards on page 12

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.



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
\bigtriangledown	CAUTION: X-RAYS. (C.R.C., c. 1370) ATTENTION: RAYONS X.

Table 2.1 Safety Symbols (con	tinued)
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Symbol	Definition
	CE compliance mark.
CE	Marque de conformité CE.
	Korean Certification Mark.
Š	Marque coréenne de certification.
X	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.

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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.

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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.

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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

Components Door Operation on page 21 X-Ray System Control Panel on page 22 Key Selector Switch Lost Keys on page 22 Scanning System and Acquisition Computer Specifications on page 22 Environmental Requirements on page 24 Tubing Inlet on page 24 Transfer Bed and Mouse Imaging Shuttle on page 25

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 3.3 Quantum GX3 microCT Scanner – Rear





Table 3.1 Standard Accessories ltem Photo Mouse bed Rat bed 8mm FOV bore cover and bed 18mm FOV bore cover and bed

Item	Photo
86mm FOV bore cover and bed	to to
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

Table 3.1	Standard Accessories	(continued))
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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.



Table 3.2 Scan Acquisition and Display Parameters

Parameter	Description
Voltage	Variable voltage up to 100 kV.
СТ	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.

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 3.2 Scan Acquisition and	Display Parameters	(continued)
----------------------------------------	--------------------	-------------

Table 3.3 X-ray Source Specifications

Item	Description
High Voltage Potential	100 kV
Maximum Current	200 μΑ
Maximum Power	20 W
Anode Type	Tungsten
Window	Beryllium
Focal Size	5 – 30 µm
Filter	Changeable (see <i>Changing the X-Ray Filter</i> 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 Pan	el – Emergency Stop Button	
Emergency OFF bi	utton	
	ND 81110	
	6	

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.





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.



4 Getting Started

Workflow Overview

Starting the Imaging System on page 26

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 shutton 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). 	page 84
 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.	

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").



2. Start the software by double-clicking the **p** 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.

	U Database Tala Study Sections Helds	Descritoria de la construcción d	For non 1010 1018 (start) Inde None Inde None	D: drive space monitor bar
Winker Kitt, D Correct Luk: D Date (Initial) D U U U Total U U U Total Total Volt will Accuration: U Same family Same family Same family Same family Same family Total Same family To		See Annato. Bron G Top Die (Tan III is a soil is an Ma	Okofe	

Table 4.2 Control Panel

Item	Description	For More Details, See:
	Scanner status	Figure 7.1 on page 55
Presets: Manual 🗸	Choose a preset or custom scan configuration from this drop- down list.	Table 7.1 on page 56
Voltage (kV) 0 100 ~	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
Current (uA) 0 CT 140 ~ Live 140 ~	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)	 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. <i>Mol Imaging Biol</i> (2016). doi:10.1007/s11307-016-1026-x for information on estimated exposure dose and radiation dose. 	
FOV (mm) Acquisition: 36 V Recon: 36 V Voxel Size: 72 um	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 <i>Changing the X-Ray Filter</i> on page 108).	
Gating Technique	Click 👷 to select respiratory gating. Click ፪ 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 Scan Mode High Speed Gating 4min	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 Cortinuous Step Binning 1 Viniber of Integration 1 Viniber of Projection 250 Viniber of Projection 200 Viniber of Pro	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 <i>CT Scan Modes</i> on page 61 for additional setting information.	
Display Settings Soft	Filters for removing noise by combining pixels.	Table 3.2 on page 20
Animal Orientation / Stage Control (mm)	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).	page 69
	 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. 	
Rotation Control (degree) 90 90 Set Home pos.	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.	
·LIVE (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:
STOP	Emergency stop button. Click this button to abort acquisition and stop X-ray generation.	
	Closes the software.	

5 Working With Databases and Data

Creating a Database Connecting to a Database on page 32 Data Organization on page 33 Managing Data on page 35 Managing Databases on page 38 Working With Data Offline on page 40

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:

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


- 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
Create New Datab	ase
Database Name:	Sample
DB Location:	D:\ Browse
	Create Cancel

5.2 Connecting to a Database

- 1. Click the Connect to Database button 🚾 in the Database window.
- 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	
Connect to Database	Browse For Folder
Choose Database to Connect To: D:\Advanced Training IVIS U December Remove Entry	Computer Computer Composition Composition
Connect to Database In: D:\Advanced Training IVIS U December Browse	
Connect Cancel	OK Cancel

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.

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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**.

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To filter the data:

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

Figure	5.6 Se	electing Da	tabase	Filters											
Database File Study	Settings Help	0230627	/ = =	Search	9			Path to	Save New Dat	ia:				Free macro 3.43178/6.83178 Use Immediate Rever	.403 w
Database Study Information			Sample Information											Image Preview	
Study ID	Study	Animal Type	Sample	Sample Name	Sample Comme	nt	Date	Last	date						
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00000000026	The leg					_	_	_	_						
00000000027	Mouse hand		Series information		170.77-0			FOV	Voxel Size	1		Animal	Louis		
00000000029	Fast Scan demo		Series (D	Scan Type	Date of Scan	kV	uA	(mm)	(um)	Scan Mode	Scan Time	Orientation	Contrast		2
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			29	Normal	6/27/2023 1:39:44 PM	100	140	36	36	High Resolution	4min	42	2		
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¢	-	,	e										,		*

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 system toolbar button. Alternatively, select File \rightarrow Import File on the menu bar.
- 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 stolbar button. Alternatively, select File \rightarrow 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		
Export File		×	
Export Settings New Folder Name:	50mL Water Tube_1_20230802_142800		—— Data will be copied to this folder
New Folder Path: File Format:	D:\ DICOM(16bit, Single page) v evnoted into the folder located at "New Folder Path"" "New Folder Name"	Browse	
Inage Slice Selecti	on From To Dimited 1 - 400 OK	Cancel	

- 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).

Figur	e 5.8	Selecting	Se	ries	s Da	ta										
Series Informa	tion															
Series ID	Scan Type	Date of Scan	kV	uA	FOV (mm)	Voxel Size (um)	Scan Mode	Scan T	ime	Exposure Time (ms)	Integration Times	Total View	Animal Orientation	Contrast	Filter	X-ra
1	Stitchin	8/25/2023 11:35:00	100	120	8	8	High Resolution	1hours Omin	ı	125	32	900	<u>"M</u>		Original	Cu 0.06
2	Step	8/25/2023 11:35:02	100	120	8	8	High Resolution	1hours Omin	n	125	32	900	<u>"M</u>		Original	Cu 0.06
3	Step	8/25/2023 2:37:31 PM	100	120		Create No	u Study			125	32	900	<u>, 181</u>	-	Original	Cu 0.06
4	Step	8/25/2023 5:43:49 PM	100	120		Create New Study				125	32	900	<u>"M</u>	-	Original	Cu 0.0
5	Step	8/25/2023 8:46:36 PM	100	120		Create ive	w sample			125	32	900	<u>"M</u>	÷	Original	Cu 0.06
						Move Entr Delete Ent Set Image Configure Open Vox, Open RAV	y Ty Save Location Display Columns (Photo/Movie Data / Data folder L Calibration	a folder								
						Launch Ce	enter Adjust Tool									

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



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.

 $\overline{\mathbb{Q}}$

	eleting	Data	а										
udy Information	Sample Inform	ation											
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	0	Normal	8/3/2023 8:27:13 AM	100	120	26	72 High Res	dution 4min	400		Original	Cu 0.06+AL0.5	
	0	Normal	9/3/2023 9:31:40 AM	100	120	20	72 11011100	41111	440		Original	Cu 0.05+AL0.5	
	10	Normal	8/3/2023 8:31:40 AM	100	120	30	Create New Study	_		-	Original	CU 0.06+Al 0.5	-
	10	Normal	8/3/2023 8:36:08 AM	100	120	30	Create New Sample		And a second second	-	Original	CU 0.06+AI 0.5	-
	11	Normal	8/3/2023 8:40:36 AM	100	120	36	Update Metadata		and the second s	-	Original	Cu 0.06+AI 0.5	-
	12	Normal	8/3/2023 8:45:03 AM	100	120	36	Advance Frances		and the second s	-	Original	Cu 0.06+AI 0.5	-
	113	Normal	8/3/2023 8:49:31 AM	100	120	- 14	NOVE Entry		6 million				
				100		30	Delete Entry			-	Original	Cu 0.06+Al 0.5	
	14	Normal	8/3/2023 8:53:58 AM	100	120	36	Delete Entry			-	Original Original	Cu 0.06+Al 0.5 Cu 0.06+Al 0.5	-
	14	Normal Normal	8/3/2023 8:53:58 AM 8/3/2023 8:58:26 AM	100	120 120	36	Delete Entry Set Image Save Loca	tion		-	Original Original Original	Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5	-
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	14 15 16 17 18	Normal Normal Normal Normal	8/3/2023 8:53:58 AM 8/3/2023 8:58:26 AM 8/3/2023 9:04:42 AM 8/3/2023 11:15:48 AM 8/3/2023 11:20:49 AM	100 100 100 100 100	120 120 120 200 200	36 36 36 36	Delete Entry Set Image Save Loca Configure Display C Open Vox/Photo/M	tion olumns ovie Data folder		- - - - -	Original Original Original Original Original	Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5	-
	14 15 16 17 18 19	Normal Normal Normal Normal Normal	8/3/2023 8:53:58 AM 8/3/2023 8:58:26 AM 8/3/2023 9:04:42 AM 8/3/2023 11:15:48 AM 8/3/2023 11:20:49 AM 8/3/2023 11:25:17 AM	100 100 100 100 100 100	120 120 120 200 200 200	36 36 36 36 36 30	Configure Display C Open Vox/Photo/M Open RAW Data fold	tion olumns ovie Data folder ler		• • • • • •	Original Original Original Original Original Original	Cu 0.06+Al 0.5 Cu 0.05+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5	- - - - -
	14 15 16 17 18 19 24	Normal Normal Normal Normal Normal Normal	8/3/2023 8:53:58 AM 8/3/2023 8:58:26 AM 8/3/2023 9:04:42 AM 8/3/2023 11:15:48 AM 8/3/2023 11:20:49 AM 8/3/2023 11:25:17 AM 9/22/2023 4:43:30 PM	100 100 100 100 100 100 100 90	120 120 200 200 200 100	36 36 36 36 36 36 36	Delete Entry Set Image Save Loca Configure Display C Open Vox/Photo/M Open RAW Data fold Launch HU Calibrat	tion olumns ovie Data folder er		- - - - - -	Original Original Original Original Original Original Original 3D-Soft	Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Al 0.5mm	- - - - -
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	14 15 16 17 18 19 24 25 26 27	Normal Normal Normal Normal Normal Normal Normal Normal	8/3/2023 8:53:58 AM 8/3/2023 8:58:26 AM 8/3/2023 9:04:42 AM 8/3/2023 11:15:48 AM 8/3/2023 11:15:48 AM 8/3/2023 11:20:49 AM 8/3/2023 11:20:49 AM 9/22/2023 4:55:32 PM 9/22/2023 5:04:37 PM 9/22/2023 5:04:37 PM	100 100 100 100 100 100 100 100 100 90 90 90 100	120 120 200 200 200 100 100 100	36 36 36 36 36 36 36 36 86	Delete Entry Set Image Save Loca Configure Display C Open Vox/Photo/M Open RAW Data fold Launch HU Calibrat Launch HU Calibrat 22 High Spe- 167 High Spe-	tion olumns ovie Data folder ler on st Tool st Tool 3.9sec d 3.9sec	a a a a a a a a a a a a a a a a a a a	- - - - - - - -	Original Original Original Original Original Original 3D-Soft 3D-Soft 3D-Soft	Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Cu 0.06+Al 0.5 Al 0.5mm Al 0.5mm Al 0.5mm	- - - - - - - - - - - - - -
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	14 15 16 17 18 19 24 25 26 27 28 29	Normal Normal Normal Normal Normal Normal Normal Normal Normal Normal	9/2/2023 8:53 58 AM 8/3/2023 8:58 26 AM 8/3/2023 9:04:42 AM 8/3/2023 11:15:148 AM 8/3/2023 11:20:49 AM 8/3/2023 11:20:49 AM 9/22/2023 4:330 PM 9/22/2023 4:53:23 PM 9/22/2023 5:08:46 PM 9/22/2023 5:10:30 PM 9/22/2023 5:11:55 PM	100 100 100 100 100 100 90 90 90 100 100	120 120 200 200 100 100 100 100 100	36 36 36 36 36 36 36 86 86 36	Move Entry Delete Entry Set Image Save Locc Configure Display C Open Vox/Photo/M Open RAW Data fol Launch HU Calibrat Launch HU Calibrat Launch Center Adju 72 High Spee 167 High Spee 167 High Spee 72 High Spee	tion olumns ovic Data folder ler on st Tool st		- - - - - - - - - - - - - - - - - - -	Original Original Original Original Original Original 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft	Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 AI 0.5mm AI 0.5mm AI 0.5mm AI 0.5mm	- - - - - - - - - - - - - - - - - - -
	14 15 16 17 18 19 24 25 26 27 28 29 30	Normal Normal Normal Normal Normal Normal Normal Normal Normal Normal	8/3/2023 8:53 58 AM 8/3/2023 8:58:26 AM 8/3/2023 9:04:42 AM 8/3/2023 11:15-148 AM 8/3/2023 11:25-17 AM 9/22/2023 11:25-17 AM 9/22/2023 4:55:33 PM 9/22/2023 5:06:36 PM 9/22/2023 5:10:30 PM 9/22/2023 5:11:35 PM 9/22/2023 5:11:35 PM	100 100 100 100 100 100 90 90 90 100 100	120 120 200 200 100 100 100 100 100 100	36 36 36 36 36 36 86 86 36 36	Move Entry Delete Entry Set Image Save Lock Configure Display C Open Vox/Photo/M Open RAW Data fold Launch HU Calibrat Launch HU Calibrat Launch Center Adju 72 High Spee 167 High Spee 72 High Spee 72 High Spee 72 High Spee 72 High Spee	tion ovie Data folder fer st Tool sd 3.9sec d 3.9sec d 3.9sec d 3.9sec d 3.9sec d 3.9sec d 3.9sec		- - - - - - - - - - - - - - - - - - -	Original Original Original Original Original Original 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft	Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 AI 0.5mm AI 0.5mm AI 0.5mm AI 0.5mm AI 0.5mm	- - - - - - - - - - - - - - - - - - -
	14 15 16 17 18 19 24 25 26 27 28 29 30 31	Normal Normal Normal Normal Normal Normal Normal Normal Normal Normal Normal	9/2/2023 6:53:58 AM 9/3/2023 6:52 6 AM 9/3/2023 1:52 65 AM 9/3/2023 1:15:48 AM 9/3/2023 1:12:47 AM 9/3/2023 1:12:17 AM 9/2/2023 4:43:30 PM 9/2/2023 5:04:43:30 PM 9/2/2023 5:04:37 PM 9/2/2023 5:04:37 PM 9/2/2023 5:10:55 PM 9/2/2023 5:15:55 PM 9/2/2023 5:15:55 PM	100 100 100 100 100 100 90 90 100 100 10	120 120 200 200 100 100 100 100 100 100	36 36 36 36 36 36 36 86 86 86 36 36 36	Delete Entry Delete Entry Configure Display C Open Vox/Photo/M Open RAW Dats fold Launch HU Calibrat Launch Center Adju 72 High Spe- 167 High Spe- 167 High Spe- 72 High Spe-	tion solutions oburns voir Data folder ler on st Tool sd 3.9sec sd 3.9sec sd 3.9sec sd 3.9sec sd 3.9sec		- - - - - - - - - - - - - - - - - - -	Original Original Original Original Original Original 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft 3D-Soft	Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 Cu 0.06+AI 0.5 AI 0.5mm AI 0.5mm AI 0.5mm AI 0.5mm AI 0.5mm AI 0.5mm	- - - - - - - - - - - - - - - - - - -
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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	
Caution		\times
	The CT_RawData folder is now full. To save new acquisition data, raw data must be deleted from (D:) drive. Click[Yes] to automatically delete the oldest raw data or click[No] to manually select raw data to delete from the CT_RawData folder.	
	<u>Y</u> es <u>N</u> o	

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 \rightarrow 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		
Save Database As	×	Browse For Folder
Database Name:		La companya de la company
DB Location: D:\	Browse	Desktop Desktop Distries
		🖻 🧟 CT admin 🖉 🌉 Computer
	Save Cancel	▷ 📆 System (C:) ▷ 📷 Data (D:)
		▷ dd DVD RW Drive (E:)
		Make New Folder OK Cancel

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
Advanced Search Settings X
String to Find
Select Search Columns
Sample Name Study Comments
Animal Type Series Description
Sample Comments
Study Description
Select Search Options
☑ Search by Date
Dates: 1/ 1/2023 • - 9/2023 • •
Date of Creation Date of Scan
Date of Last Update
Search Cancel

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 \rightarrow 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.

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 ≥16GBNVIDIA 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

Table 5.1 Workstation Requirements for ViewerPack and ImageAnalysis Software

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.



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.

 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.

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

		1 m 1 m							Cold In
Computer	 Data (D:) RigekuApplicationData 	 RmCT2 + 		• 47	Employed Ret.	P G + Compute	r » Data (D:) » RigalouApplicationData » RmCT	2 > CT_RevOrte >	• + Storn CL_
irganize + 🙀 Open	Include in library • Share with	Burn New folder		15	+ []	Drganize 🔹 🎲 Open	Include in library . Share with . Bu	ny New Folder	\$* E
Eworites	Name	Date modified	Type	Size		Favorites	Filefolder	Fletskier	
Desktop	30Viewer BackUp	2013/11/02.7-38 2015/06/22.17-92	File Felder File Felder			Desktop	CR_20170214_130736	CR_28120214_115741 The Telder	
Recent Places	CalibrationData	2016/09/16 14:58 2014/11/14 14:52	File folder File folder			Recent Places	CR_20170214_314015	CR_20120214_105615	
a ribranes	DR	2013/12/07/11/07	Filefalder			Comme	AT ALART CARD		
Computer	Log	2017/02/20 9 40 2013/12/17 10:34	File folder File folder			Computer	CR_20120214_304726 File folder	CR_20120203_111358 File felder	
👝 Data (D) 👝 Local Disk (E)	L Recon	2015/07/28 9:06 2014/03/04 5 11	File fälder File földer			Data (D:)	CR_20170117_141017 Fila folder	CR_20170116_095031 Sile/Folder	
Bata2 (F) HDPC-UT (G) ATLAS 6006 (H)	 Temponey Viewer CellurationDatazip 	2015/08/21 13:55 2013/10/25 10 18 2014/11/06 11:58	File folder File folder Compressed (filep)	131.KB		Deta2 (F) HDPC-UT (G;) ATLAS 6006 (H)	CR_20120116_094347 Tile folder	CR_281.70116_094039 Electoide	
Network						Network	CR_20120116_093751 File folder	CR_20120116_093552 Elefrider	
							CR_2012/01106_093215 Tille Folder	CR_20170110_105322	
							CR_20170110_103507 Filefolder	CR_28120110_101714	
							CR 20120106 174123	CR 20,20105 173046	

5.7 System Administrator Login/Logout

- **1.** Open the Database window.
- 2. Select **Settings** \rightarrow **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 Log	gin as Administrato	r
Login as Adminis	trator	×
0	Password	
	Login	Cancel

6 Hounsfield Unit Calibration

Introduction

Check the Scan Conditions and Indicators Before Calibration on page 45 Set Gain Calibration on page 46 Other Gain Calibration Features on page 48 HU Calibration Water Phantom on page 50 HU Calibration Procedure on page 51

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** \rightarrow **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.

HU C	alibration Settin	gs			- 🗆	×	
u 0.06	+AI 0.5 None	AI 0.5	5mm Al 1.0mm Cu 0.1mm Cu 0.2mm				
FOV	ScanMode	kV	HU Calibration File		Calibration Date	^	
86	High Resolution	100	100kV_FOV86_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/13 09:51:27		
86	High Speed	100	100kV_FOV86_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/13 09:23:56		
86	Standard	100	100kV_FOV86_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/13 09:28:09		
72	High Resolution	100	100kV_FOV72_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/03 13:37:37		
72	High Speed	100	100kV_FOV72_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/03 12:58:02		
72	Standard	100	100kV_FOV72_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/03 13:05:31		
70	High Resolution	100	100kV_FOV70_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
70	High Speed	100	100kV_FOV70_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing		found." means the sc
70	Standard	100	100kV_FOV70_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		configuration has not
60	High Resolution	100	100kV_FOV60_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing		been HU calibrated
60	High Speed	100	100kV_FOV60_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
60	Standard	100	100kV_FOV60_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
45	High Resolution	100	100kV_FOV45_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
45	High Speed	100	100kV_FOV45_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
45	Standard	100	100kV_FOV45_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
36	High Resolution	100	100kV_FOV36_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/03 12:32:46		
36	High Speed	100	100kV_FOV36_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/06 09:26:09		
36	Standard	100	100kV_FOV36_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	~	2023/07/13 10:58:48		
25	High Resolution	100	100kV_FOV25_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
25	High Speed	100	100kV_FOV25_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing		
25	High Speed	90	90kV_FOV25_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	~	Nothing		
05	a	100			N. 41.	¥	

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.



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.



Check ca	libration status			*
	The calibration status scan as it is?	corresponds to the fol	llowing. Do ye	ou want to
4	- HU calibration file ex	pired		
Det	ails	(Continue	Cancel

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

Options Help	
Job Scan Settings	
Ring Reduction Settings	
HU Calibration Settings	
Gain Calibration	
Fov Settings	
Service Menu	
Login/Logout	

- 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.
- 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 unselect 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		
🖳 Gain Calibration		- 🗆 ×
Cu 0.06+AI 0.5		
Select conditions		
Scan Mode	ScanMode	kV uA
High Speed(Bin4)	High Resolution	100 100
Standard(Bin2)	High Resolution	100 200
High Resolution(Bin1)	High Resolution-1000ms	100 100
	High Resolution-1000ms	100 200
	High Resolution-125ms	100 100
	High Resolution-125ms	100 200
Unselect	High Resolution-200ms	100 100
All voltage select	High Resolution-200ms	100 200
	High Resolution-250ms	100 100
All voltage unselect	High Resolution-250ms	100 200
	High Resolution-500ms	100 100
	High Resolution-500ms	100 200
	right toodiation ocomo	100 200
	Two or more currents(uA) are rea	quired for one voltage.
Add Delete		
Initial value	Execute	Close
Initial value Edit		

- 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 Procee	ed with Gain Calibration
	Caution: Gain Calibration $ imes$
	Caution: X-rays will be Produced When Energized. Would you like to proceed? If you would like to, remove all objects from the chamber and CLOSE the door. (MID=1084)
	<u>Y</u> es <u>N</u> o

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

Figure 6.8 Gain C	Calibration Complete			
	ScanMode	kV	uA	Gain Calibration X
	High Resolution	90	45	Gain Calibration Completed.
	High Resolution	90	88	(MID=1003)
	Standard	90	45	
	Standard	90	88	ОК

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						
🛃 Gain Calibration				- 0	\times	
Cu 0.06+AI 0.5						
Select conditions Scan Mode High Speed(Bin4)	ScanMode Standard	kV 80	uA 120		^	
 ✓ Standard(Bin2) ✓ High Resolution(Bin1) 	Standard High Resolution	80 90	200 40		L	
Voltage (kV)	High Resolution High Resolution	90 90	70 100			
Unselect	Standard Standard	90 90	50 120		L	
All voltage select	Standard High Resolution	90 100	200 40		L	
	High Resolution High Resolution	100 100	60 80			
	Standard Standard	100 100	50 120			
	Standard	100	200	red for one volta	~	
Add Delete	o or more culterits		i o roqui	i co for one voltay	,	
Initial value Edit	Execute			Close		

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

Figure 6.10 Adding Gain Calibration Item						
	GainCalibrationItemAdd ×					
	Scan Mode 🛛 High Speed 🔍 🗸					
	Voltage (kV)					
	uA					
	Add Cancel					

• 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					
	Confirm delete	×			
	Delete selected line? Line: 9 (MID=1952)				
	OK Cancel				

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

Figure 6.12 Initial Value Overwrite		
Loading	the specified value Load specified value file into the currently selected filter. Is it	×
_	OK? (MID=1954)	
	OK Cancel	

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

Figure 6.13 Editing Tube \	/alue	
	GainCalibrationItemEdit	
	Scan Mode Standard	
	Voltage (kV) 100	
	uA 20	
	Edit Cancel	

Ŵ

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).





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.



2. Click Add.

HU C	alibration Settin	gs			_	
u 0.06	+AI 0.5 None	AI 0.9	5mm Al 1.0mm Cu 0.1mm Cu 0.2mm			
FOV	ScanMode	kV	HU Calibration File		Calibration Date	^
86	High Resolution	100	100kV_FOV86_High Resolution_Cu 0.06+Al 0.5_HUCAL.PRM	\sim	2023/07/13 09:51:27	
86	High Speed	100	100kV_FOV86_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/13 09:23:56	
86	Standard	100	100kV_FOV86_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/13 09:28:09	
72	High Resolution	100	100kV_FOV72_High Resolution_Cu 0.06+Al 0.5_HUCAL.PRM	\sim	2023/07/03 13:37:37	
72	High Speed	100	100kV_FOV72_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/03 12:58:02	
72	Standard	100	100kV_FOV72_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/03 13:05:31	
70	High Resolution	100	100kV_FOV70_High Resolution_Cu 0.06+Al 0.5_HUCAL.PRM	\sim	Nothing	
70	High Speed	100	100kV_FOV70_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
70	Standard	100	100kV_FOV70_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
50	High Resolution	100	100kV_FOV60_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
50	High Speed	100	100kV_FOV60_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
50	Standard	100	100kV_FOV60_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
45	High Resolution	100	100kV_FOV45_High Resolution_Cu 0.06+Al 0.5_HUCAL.PRM	\sim	Nothing	
45	High Speed	100	100kV_FOV45_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
45	Standard	100	100kV_FOV45_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
36	High Resolution	100	100kV_FOV36_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/03 12:32:46	
36	High Speed	100	100kV_FOV36_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/06 09:26:09	
36	Standard	100	100kV_FOV36_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/13 10:58:48	
25	High Resolution	100	100kV_FOV25_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
25	High Speed	100	100kV_FOV25_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
25	High Speed	90	90kV_FOV25_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
-	o	100	100LV FOURT OF LL LC ARC ALAS HUGAL DOM		NL IL 1	×

- 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	
Н	IUCallibrationItemAdd ×	
	X-ray Filter Cu 0.06+AI 0.5 FOV 36 V 60 kV ScanMode Standard V	
	Add Cancel	

6. Select HU Calibration Settings.

Figure 6.19 Hl	J Calibration Setting	S
F	Options Help	
	Job Scan Settings Ring Reduction Settings	5
	HU Calibration Settings	
	Gain Calibration Fov Settings Service Menu	

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

🕒 ни с	alibration Settin	gs			-	×
0.000						
Cu 0.06	HOLD None	AI 0.3	omm Al I.Omm Cu O.Imm Cu O.2mm			
FOV	ScanMode	kV	HU Calibration File		Calibration Date	^
86	High Resolution	100	100kV_FOV86_High Resolution_Cu 0.06+Al 0.5_HUCAL.PRM	\sim	2023/07/13 09:51:27	
86	High Speed	100	100kV_FOV86_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/13 09:23:56	
86	Standard	100	100kV_FOV86_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/13 09:28:09	
72	High Resolution	100	100kV_FOV72_High Resolution_Cu 0.06+Al 0.5_HUCAL.PRM	\sim	2023/07/03 13:37:37	
72	High Speed	100	100kV_FOV72_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/03 12:58:02	
72	Standard	100	100kV_FOV72_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/03 13:05:31	
70	High Resolution	100	100kV_FOV70_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
70	High Speed	100	100kV_FOV70_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
70	Standard	100	100kV_FOV70_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
60	High Resolution	100	100kV_FOV60_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
60	High Speed	100	100kV_FOV60_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
60	Standard	100	100kV_FOV60_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
45	High Resolution	100	100kV_FOV45_High Resolution_Cu 0.06+Al 0.5_HUCAL.PRM	\sim	Nothing	
45	High Speed	100	100kV_FOV45_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
45	Standard	100	100kV_FOV45_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
36	High Resolution	100	100kV_FOV36_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/03 12:32:46	
36	High Speed	100	100kV_FOV36_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/06 09:26:09	
36	Standard	100	100kV_FOV36_Standard_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	2023/07/13 10:58:48	
25	High Resolution	100	100kV_FOV25_High Resolution_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
25	High Speed	100	100kV_FOV25_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
25	High Speed	90	90kV_FOV25_High Speed_Cu 0.06+AI 0.5_HUCAL.PRM	\sim	Nothing	
05	a	100			AL 41 C	¥

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



7 Image Acquisition

Imaging System Warm-Up Select a Save Location on page 56 Set Up Automatic Image Export on page 58 Set the Custom Scan Configuration on page 58 About Job Scan Features on page 59 CT Scan Modes on page 61 Perform CT Job Scans on page 62 Place a Subject in the Sample Chamber on page 69 CT Scan Without Gating on page 73 CT Scan With Respiratory Gating on page 75 CT Scan With Cardiac Gating on page 79 Reconstructing a Subvolume or Slice on page 82 Using the Center Adjustment Tool on page 86 Acquisition in Fluoroscopy Mode on page 86 Ring Reduction on page 107 Changing the X-Ray Filter on page 108

7.1 Imaging System Warm-Up

 $\overline{\mathbb{W}}$

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 **p** icon on the desktop.

Figure 7.1 Control	ol Panel			
	Warm-Up Required X-rays are OFF	Warm-Up in Progress X-rays are ON		Warm-Up Complete X-rays are OFF Ready for acquisition
		Contents Coptions FEVVILY WARMENS LP Recommissing times - 15 mins		Cevrity
	Centificación Scient Gan OK Son Academia Scient Job Bingle Water Sky Coner Sky Coner stray	Continuous Scan Continuous Scan Contin		Gain OK Soan Acquitation Settings Job (Smight V) Votagie kV) Doment Luk) Dome (mGy)
	100 v CT 100 111 POV Ivest Loving Station Total Station 100 Records 72 v State Station v Nexed for Station Total Station Classifier Classifier Classifier Versition Table Station Classifier Classifier Classifier Classifier	FOV brinit Accusations 20 Process 20 Vacal Size 142 process 20 Vacal S		100 CT 11 100 Live [140 11 POV (mm) Deploy Settings Settings Acquation: 72 Settings Culo Set All 0.5 Nexon: 72 Kray filter Vacional Settings Vacionalization: 14.0 um Culo Set All 0.5 Image Resolution: Low Vacionalization:
	Currences Sage Scare Midde Hight Scare Rese Rese Arend Overstation / Stopp Current (sm)	Contenues Sage		Continuous Step Scon Mode Gating Technique 19g Speed V IVIII IIII IIIII IIIIIIIIIIIIIIIII
	Batelon Correl Magnel	COC		Botation Control Magness
Click to begin warm-up	Iver (c) See Verm (b) See See See See	Line / CF Steep Viteor Up Steet Steep	Live Mode button	Uve /CT Scan Live Mode Stat Step

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 an 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 of is flashing). Opening the door terminates the X-rays and aborts the warm-up process.

Figure 7	7.2 Warm-Up Warning Message
<u>^</u>	Caution: X-rays will be Produced When Energized. Would you like to proceed? If you would like to, remove all objects from the chamber and CLOSE the door. (MID=1006)
	Yes No

 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.

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 \rightarrow New Study on the menu bar.

Table 7.2 Setting the Save Location in the Database Window

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 <u></u> toolbar button.
	or
	Right-click the study row and select New Sample on the shortcut
	menu.
	or
	Select the study row and select $\textbf{Study} \rightarrow \textbf{New Sample}$ 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.

d New Study		×		Add New Sample		
udy Sample Serie	ts.		A sample identifier	Study Sample Serie	s	
Study ID Study Description(*)	00000000088 20230926(2)		assigned by the software (cannot be edited)	Sample ID Sample Name(*)	Sample(2)	
Date of Birth	9/26/2023		,	Sample Comment		
Sex Weight (g)	None	~				
Study Comments		^		Date of Creation	9/26/2023	
				Date of Last Update	9/26/2023	
	0.00.0000	×		*: Required Field		
Date of Creation	9/26/2023					
Date of Last Update	3/26/2023					
: Required Field						

7.3 Set Up Automatic Image Export

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

- 1. Select Setting Automatic \rightarrow 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 Ex	kport Settings
Automatic DICOM Export Settings	
Export DICOM file after each scan	
File Export Location	
File path:	
D:\	Browse
O VOX folder	
	OK Cancel

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.



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	8	5	11.5
	18	11	25.8
20.000 8.000	5/10/25/36	5/9/21/22	51.6
3.9 sec., 8 sec	45/60/72	39/46/43	103.1
	70/86	54/50	119.9
Standard	8	5	5.7
	18	11	12.9
10 0	5/10/25/36	5/9/21/22	25.8
18 sec., 2 min.	45/60/72	39/46/43	51.5
	70/86	54/50	59.9
High resolution	8	5	2.9
	18	11	6.4
1 minutos 16 minutos 60 minutos	5/10/25/36	5/9/21/22	12.9
4 minutes, 16 minutes, 60 minutes	45/60/72	39/46/43	25.7
	70/86	54/50	29.9

Figure 7.6 Using Job Scan			
💮 Job Scan Setting			– 🗆 X
Job FOV72 8sec V	Job Menu New Rename [Delete Copy	
No. Stitching Start Time 💌 Time Unit 💌 kV	👤 uA 🖤 Acquisition FOV 👤 Recon Fov	v 🛃 X-ray filter 🛃 3D filter 🛃 Stage-Z[mm]	🛃 Scan Type 🚺 Scan Mode 🛃 🛛 Scan Time 🛡
1 On • 0 s •	90 100 36 - 36	 ✓ AI 0.5mm ✓ Soft ✓ 143. 	00 Continuous 🔹 Standard 🔹 18 sec 💌
2 On • 0 s •	90 100 36 • 36	▲ Al 0.5mm ▲ Soft ▲ 163.	94 Continuous 💌 Standard 💌 18 sec 💌
۲			>
Row Menu Add Update Up	Down Delete	The maximum number of conditions for Stitching Sc Stage movement range is [2-206].	an is 5. OK Cancel

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.



 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 Ne	ew Job Scan
Opt	ions Help
(\$F	Job Scan Settings
9	Ring Reduction Settings
6)	HU Calibration Settings
6)	Gain Calibration
X	Service Menu
A	Login/Logout

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

3	Create New Job		×	
	local the lab series			
	input the job name.			
	l			
		reate	Cancel	

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).

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 7.5 Conditions for a Continuous Job 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.

Ор	tions	Help	
一些	Job S	Scan Settings	
1	Ring	Reduction Se	ettings
34	HUC	Calibration Set	ttings
34	Gain	Calibration	
X	Servi	ice Menu	
10	Logi	n/Logout	

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

Figure 7.11	Creating New Job
	Create New Job
	Input the job name.

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

e 7.12 Job 9	Scan Arrangen	nent		
Row Menu				
Add	Update	Up	Down	Delete

4. Double-click Add to set stitching.

	Fig	ure	7.1	3 Stitc	hin	g Settir	ngs	5																		
Γ	No.	Stitch	ning	Start Time		Time Unit	V	kV 🖤	uA 🚺	Acquisition FOV	♥	Recon Fov	➡	X-ray	filter		3D filter	2	Stage-Z[mm] 🛃	Scan Ty	pe 🛡	Scan Mode	•		Scan Time	
	1	On	•		0	s	•	50	100	8	•	8	•	AI 0.5	İmm	-	Soft	•	185.00	Step	•	High Resolu	ution	•	04 min	•
	2	On	•		0	s	•	50	100	8	•	8	•	AI 0.5	İmm	-	Soft	•	189.71	Step	-	High Resolu	ution	•	04 min	•
	3	On	•		0	s	•	50	100	8	•	8	•	AI 0.5	mm	-	Soft	-	194.42	Step	-	High Resolu	ution	•	04 min	-
	4	On	•		0	s	•	50	100	8	-	8	•	AI 0.5	mm	•	Soft	•	199.13	Step	-	High Resolu	ution	•	04 min	
																				-						
ſ		0.1		00.65		~ 7										_										
[No.	Stite	hing	3D filter		Stage-Z[mm	n] 【	Sca	n Type 【	Scan Mode		Scan Tin	ne 🛾	Bin	nning	Expos	ure Time[ms]		Num of Integra	tion 👤	Num o	of Projection		Image	Resolution	
	No.	Stite	hing.	3D filter Soft	•	Stage-Z[mm	n]	Sca 0 Step	n Type 【	Scan Mode High Resolution	>	Scan Tin • 04 min	ne	Bin	nning	Exposi 500	ure Time[ms]		Num of Integra	tion 👤	Num o 360	of Projection	•	lmage High	Resolution	•
	No. 1 2	Stite On On	hing •	3D filter Soft Soft	•	Stage-Z[mm 1	n] 【 185.0	Sca 0 Step 1 Step	n Type 【	Scan Mode High Resolution	ו ז ו	Scan Tin • 04 min • 04 min	ne	Bin • 1 • 1	nning •	Exposi 500 500	ure Time[ms]	•	Num of Integra	tion 💽	Num o 360 360	of Projection	•	lmage High High	Resolution	•
	No. 1 2 3	Stite On On On	hing • •	3D filter Soft Soft Soft	• • •	Stage-Z[mm 1 1	n] 【 185.0 189.7 194.4	Sca Step Step Step	n Type	Scan Mode High Resolution High Resolution High Resolution	ו ו ו	Scan Tin O4 min O4 min O4 min	ne	 Bin 1 1 1 	nning •	Exposi 500 500	ure Time[ms	- -	Num of Integra	tion 👤	Num o 360 360 360	of Projection	• • •	lmage High High High	Resolution	•
	No. 1 2 3 4	Stite On On On On	thing • • •	3D filter Soft Soft Soft Soft Soft	• • •	Stage-Z[mm 1 1 1	n] 【 185.0 189.7 194.4 199.1	Sca 0 Step 1 Step 2 Step 3 Step	n Type	Scan Mode High Resolution High Resolution High Resolution High Resolution High Resolution	1 1 1	Scan Tin • 04 min • 04 min • 04 min • 04 min	ne I	Bir 1 1 1 1 1 1 1	nning • • •	Exposit 500 500 500 500	ure Time[ms]	•	Num of Integra 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	tion 💽	Num o 360 360 360 360	of Projection	• • •	lmage High High High High	Resolution	* * *

5. Click OK.

Start a Job Scan

 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 Starti	ng Job Scan	
Scan Ac	quisition Settings	
Job:	JobTest	~

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.

Runnning Job	Runnning Job
	Statching: Off. □-, FOV72, 70kV, 60uA □-, StartTime: 0sec Standard, 18 sec Axis: Z=0 □-, FOV60, 60kV, 60uA □-, FOV45, 70kV, 60uA □-, FOV60, 50kV, 60uA

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.


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.



- 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 Sca	n Conditions - Processing
Doing S	titching
Note:	Please wait for a while without any operation until this Stitching processing completes. Waiting Item
	Series ID Date of Scan
	Cancel

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									
Series ID	Scan Type	Date of Scan	kV	uA	FOV (mm)	Voxel Size (um)	Scan Mode	Scan Time	Animal Orientation	Contrast
16	Normal	6/27/2023 10:56:59	100	140	36	36	High Resolution	4min		-
17	Normal	6/27/2023 11:03:24	100	140	36	51.55	High Speed	Respiratory Gating		-
18	Normal	6/27/2023 11:03:24	100	140	36	51.55	High Speed	Respiratory Gating		-
19	Stitching Normal	6/27/2023 11:15:45	100	140		Create Naw S	l Marada a		<u>. 1991.</u>	-
20	Normal	6/27/2023 11:15:47	100	140		Create New 3	, and a second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second se			-
21	Normal	6/27/2023 11:20:08	100	140		Create New 3	ampie			-
22	Normal	6/27/2023 11:24:30	100	140		Update Metadata Move Entry				-
23	Normal	6/27/2023 11:28:52	100	140						-
24	Normal	6/27/2023 11:33:15	100	140		Delete Entry				-
24.001	Normal	6/27/2023 11:33:15	100	140		Set Image Save Location			-	
						Configure Di	splay Columns			
						Open Vox/Ph	oto/Movie Data fo	lder		
						Open RAW D	ata folder			
						Launch HU C	alibration			
						Set Stitching	Option			
						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.

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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 \int or \int arrows in the Control Panel. (Figure 7.21).



 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.



- 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 7.24 Control Panel		
Control	-	Control → □ Options Help
revvity		revvity
Q STANDBY	1	Q STANDBY
Gain OK HU: OK Scan Acquistion Settings Job: Single Voltage (kV) Current (uA) Dose (mGy)		Gain OK HU: OK Scan Acquidation Settings Job: Job: Single Voltage & V) Current (uA)
0 0 100 CT 140 11 Live 140 Display Settings Acquisition: 72 Soft ~		O O 100 CT 140 11 Live 80 V 11 FOV (mm) Display Settings Acquisition: 72 Soft
Recon: 72 V Voxel Size: 144.0 um Image Resolution Low V		Recon: 72 Voxel Size: 144,0 um Image Resolution Low X-say filter Cu 0 05+Al 0.5 Low Cu 0 05+Al 0.5 Cu 0 05+Al
Continuous Step Scan Mode Gating Technique High Speed 08 sec		Continuous Step Scan Mode Gating Technique High Speed ~ 08 sec ~
Animal Otiertation / Stage Control immi 0.00 ~ Set Initialize	Use these controls to move the sample bed in or out of the bore	Animal Offertation / Stage Control (mm) 0.24 0 Set Home pos.
Set Home pos.	Gantry position at 0°	90 90 Set Home pos. Gantry position at 90°
Live / CT Scan Live Mode Start Stop		Live / CT Scan Live Mode Start Stop

- 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 **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.

U calib	ration settings	×
4	The file used for HU calibration is not set. Would you like to use HU calibration files with the following scanning conditions? FOV = 72 Scan Mode = kV = 90 Filter = Cu 0.06+AI 0.5 (MID=1214-2)	

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			
Caution: CT scan	8		
Caution: X-rays wil Would you like to p	l be Produced When Energized. proceed?		
	Yes No		

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.



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.



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.

- Turn on Live Mode by clicking the work 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.
- Figure 7.29 Xcapture Window Respiratory gating is selected in this example. Image data bounding box Image data outside the bounding box are not used in the reconstruction. ROI positioned over the diaphragm
- **6.** Rotate the gantry back to 0° position.

 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 \pm 1 sec between breaths.



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.

IU calib	ration settings	×
A	The file used for HU calibration is not set. Would you like to use HU calibration files v scanning conditions? FOV = 72 Scan Mode = kV = 90 Filter = Cu 0.06+AI 0.5 (MID=1214-2)	vith the following

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				
Caution: CT scan	X			
Caution: X-rays wi Would you like to	ill be Produced When Energized. proceed?			
	Yes No			

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.



- **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.

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

Table 7.7	Gating Parameters	(continued))
	outing r urunnotoro		

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 **met** button in the Control Panel.

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

Figure 7.34 Xcapture Win	dow	
Poptions Help	Database File Study Settings Help The Study Settings Help	
X-RAY ON Live Mode in process Gain OK HU: OK Gain OK HU: OK Scan Acquisition Settings Job Job Single Voltage KV Current (AA) 100 CT 140 100 CT 140 CO 140 CT 140 Coverst (AA) Dose (mGy) 100 CT 140 CV 140 CT 140 Coverst (AA) Dose (mGy) Acquisition: Stat Stat Stat Vace Size: 51 5 un Contraction: Stat Stat Coulde-AI 0.5 Image Resolution: Stat Stat Coulde-AI 0.5 Image Resolution: Stat Stat Mode Gating Technique High Speed Stat Stat Hone Stat Hone Stat Hone Stat Hone Stat Hone Stat Stap Uve / CT Scan Start Live Mode	Database Location: Display Hep Received To Display Hep	Image data bounding box Image data outside the bounding box are not used in the reconstruction. Position the ROI over the apex of the heart and diaphragm

- **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.



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.

U calib	ration settings	×
<u>^</u>	The file used for HU calibration is not set. Would you like to use HU calibration files with scanning conditions? FOV = 72 Scan Mode = kV = 90 Filter = Cu 0.06+AI 0.5 (MID=1214-2)	the following

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		
Caution: CT scan	83	
Caution: X-rays will be Produced When Energized. Would you like to proceed?		
Yes No		

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.

F a	Figure 7.38 Processing Progress for Images Corresponding to Diastolic and Systolic Phases of the Cardiac Cycle						
	GetSynchronizedRaw						
	Type Study Series Status Progress					1	
10000087 DIASTOLE Cardiac Gating 103505-diastole Processing 📕				69%]		
	0000087	SYSTOLIC	Cardiac Gating	103505-systole		0%]

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.



- **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.



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.
- Load the data (by double-clicking on a thumbnail or series row in the Database window) and click .

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).





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 E button.

The transaxial view becomes the main view (Figure 7.40).



- **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).



4. Click the silce 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.



- 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).



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.



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.



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						
File	e(F) V	/iew(V)	Language(L)	Help(H)		
	-					

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

Reconstruction Options Area

Figure 7.49 Setting Reconstruction Options		
	Reconstruction Options	
	Recon Filter: RAMP V	



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.



Perspective Image 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.
		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 \blacktriangle 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



1	Reconstructed tomographic area	A reconstructed tomographic image is displayed at the location where the </th
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.
1 0	Tick Marks	You can change the length of the tick marks.
1 1	Magnification setting	Enlarge the reconstructed tomographic image. You can move it by dragging.
1 2	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.
		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].
1 4	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 a on the histogram and moving it left or right.

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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.



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.

Contra	ast
OA	uto
٥M	anual
Black:	-0.178553
White:	0.849097

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 muses or muses button is pressed, the number is [notch] pixels specified in the pixel will change.

Center Setti	ng	
Center: 0.2004	Step: 0.200	±Width:
← →	Auto center	Stop

 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.

@ Rec	construction			×
ID	Study	Series	Status	^
17	20200807	061337	69.3%.	
				~
Total of	que: 1		Processing	-

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.



- 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.

Center Settin	ng	
Center: 0.2004	Step: 0.200	±Width:
← →	Auto center	Stop

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.

Center Settin	Ig	
Center:	Step:	±Width:
	Auto center	Stop

- 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 \blacktriangle 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.

9 4	ыаск:	1001
18813857 Intensity	White:	3857
0 65535		

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].

Range
Default conversion
○ Select range
○ Select range

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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.

 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.

(2) Re	construction			×
ID	Study	Series	Status	^
17	20200807	061337	69.3%.	H
				v
lotal of	que: 1		Processing	

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.

Ø R	econstruction				×
ID	Study	Serie	es	Status	^
	Resume(R)		10	71.0%.	
	Delete(D)				~
T	Abort(A)			Waiting	

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



Reconstruction using CT Value Calibration

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[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.

Clinumber adjustment		
NOX Settings	ASS .	CT Rule Brake
	Facana	ARCT MARGING & MILLION CO. MILLION
	Sec.4	TANCET CT 1221 372835 . RCI read CT: 20030.000030
		OPENESSAN ONSTANDARD - DORONALE OPENESSAN
	Dears	OK CANEL

- **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.

17456 26872	40398	53744	\$7180
- Va (+62273 COUNT+0	Gray Value		

- CT Rate Enable is turned off.

82.48	16695	25048	22180	41738	
T+19162 COUNTAL	1842	CT No.			

- 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.



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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"

ROI Values		_		
AIR CT	657.662659	<-	ROI read	CT: -1000.000000
TARGET CT	27985.986328	<-	ROI read	CT: 5000.000000

The histogram range of the volume data is reduced.



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

ROI Values				
AIR CT	544.438049	<-	ROI read	CT: -1000.000000
TARGET CT	26524.359375	<-	ROI read	CT: 20000.000000

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).
| dia Densorate | | | | | | | | | | | | - 0 |
|---------------------------------------------|--------------|-----------------------|------------------|--------------------|-----|----------|----------|----------------------|--------------------|----------------------|---------------------------|----------------------------|
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Description | Anienal Type | Sample
ID | Sample Name | Sample Comme | 1 | Date of | Lastilp | Garie _ | | | | |
| 00000000015 15mL Water in | | 2 3 | 12:0627 | | 6 | e la com | 910.5a | 1) 2.89 | | | | |
| 00000000015 SKH I MT WN | etch | and the second second | | | | | | | | | | |
| 00000000017 SKH-1 M1 with | | | | | | | | | | | | |
| 000000000018 SKH 1M2 Cad | | | | | | | | | | | | |
| 000000000020 Lung Silicafied | | | | | | | | | | | | |
| 000000000022 Smm shift | | | | | | | | | | | | |
| 000000000023 Lung lobe | | | | | | | | | | | | |
| 00000000024 Nude M1 Skul | t imaging | | | | | | | | | | | |
| 00000000025 LungTurner M | | | | | | | | | | | | |
| 00000000026 The leg | | Series Information | | | | | | | | | | |
| 00000000029 Fast Scan demo | | Series ID | Sean Tune | Date of Scan | 10 | - | FOV | Voxel Size Scan Made | Scat Time | Animal Contra | .] - | |
| 0000000000000 Lower Jaw | | Series in | | Date of Dear | | - | (mint) | (um) bosh mode | Second Frank | Orientation Contrast | | ET ANO TON |
| 000000000031 Spine | | 16 | Normal | 6/27/2023 10:56:59 | 100 | 140 | .35 | 36 High Resolution | 4min | | 171 | 1/3188 |
| | | 10 | Normal | 6/27/2023 11:03:24 | 100 | 140 | 30 | 51.55 High Speed | Respiratory Galing | 12 1 | | |
| | | 10 | Stitution Normal | 8/27/2023 11:15:45 | 100 | 140 | 36 | 35 High Resolution | Arms | | 0.28% | 1000 |
| | | 20 | Normal | 6/27/2023 11 15 47 | 100 | 140 | 36 | 38 High Resolution | 4min | | | VIUNZ |
| | | 21 | Normal | 6/27/2023 11:20:08 | 100 | 140 | 36 | 38 High Resolution | 4min | | | |
| | | 22 | Normal | 6/27/2023 11:24:30 | 100 | 140 | -30 | 38 High Resolution | Amin | | 5/27/2022 1056.59 AM 6/2 | V/3022 11 02 24 AM |
| | | 23 | Normal | 6/27/2023 11:28:52 | 100 | 140 | 36 | 36 High Resolution | Amin | A | | _ |
| | | 24 | Normal | 6/27/2023 11:33 15 | 100 | 140 | 30 | 30 High Hesolution | Arrun | | 100 | |
| | | 24.001 | Normal | 6/2//2023 11:33:10 | 100 | Dec) | 162 | 12.9 High Helolution | amin | J | NORMAN AND A | N |
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| | | | | | | | | | | | | 100 million (1990) |
| | | | | | | | | | | | | |

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





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.

Sub		Start
Pixel Size:	8.0 * u	Im

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 Acquis	ition and Viewing
Xcapture File Options Display Help	2DViewer control
	Measure ROI ROI IIII COI IIIII COI Brightness & Contrast Max. counte 1/28 Enginees=2000 (Min:2001 Max:2507)
	Control Brightness Contrast Reset I6384
X=487 Y=334 Level=3477 Start=795 End=795 Movie Photo Play	Log Auto Brightness Control Close
Silder	Select acquisition and viewing options from the Xcapture window Options menu

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.



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.



To turn off ring reduction:

- 1. Select **Options** \rightarrow **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**.

Control -	Ring Reduction Settings	- 🗆 X
ptions Help		
Job scan Settings	for Continuous Scan	
HU Calibration Settings	Scan Time	Ring Reduction
Gain Calibration	18 sec	
Fov Settings	02 min	
Service Menu	02 min	
Login/Logout	04 min	
lob: Single ~	16 min	
Voltage (kV) Current (uA) Dose (mGy)	70 min	
0 0 110	3.9 sec	
Live SD U	08 sec	
FOV (mm) Display Settings	Gating 4min	
Acquisition: 18 ··· Soft ···	Gsag 4min	
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ontinuous Step		
Scan Mode Gating Technique		OK Cancel
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ve / CT Scan		
Live mode and and		

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.
- 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

Previewing Data

AutoViewer on page 110 Viewer and SimpleViewer on page 112 3D Viewer on page 116 Enlarging a Reconstruction on page 123

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



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

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 we be 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



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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).



Table 8.3 AutoViewer Menu Commands

Menu Command	Description
$\textbf{File} \rightarrow \textbf{Import}$	Opens a dialog box that enables you to select another .vox file for viewing.
$\textbf{File} \rightarrow \textbf{Print}$	Opens a dialog box that enables you to print the current AutoViewer display.
Setting \rightarrow 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 \rightarrow 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.



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	30	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	A	Magnifies a selected area of the slice image. Right-click to select a different magnification (2x, 5x, or 10x). Alternatively, click the $\int_{\mathcal{R}}$ button the to change magnification.
		Area within the bounding box is magnified.
		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.
	E	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 for a local contract of the second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second second sec	-1000 ≟ the is button to turn the mask off or on. Masks all voxels with gray scale value below the threshold entered in the field.
		-70.0
	Speci Click	Fies a range of grayscale values for image display. Modify the range by editing the values in the fields. The substant to turn the feature off or on.
	Air	When a mask is applied using the solution (generates a purple mask), click the it button to mask additional voxels at the edges of the mask. This can help sharpen visualization at edges such as around the animal skin.
	Dot	When a mask is applied using the on button (generates a green mask), click the must button to remove single pixel noise from the thresholded mask.
	3D - 1	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 <i>Viewing a Z-Axis Slice</i> on page 115 for more details.

Table 8.4 Viewer Window (continued)

Item		Description
Reconstruction Options	Sub	Places an ROI on an image that will be used to select the image data for reconstruction.
	Slice	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
	Start	Starts the reconstruction.
Measurement Tools	\checkmark	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.
	- NY	1. Select a slice view.
		2. Click the web button.
		The Line Profile window appears.
		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 巍 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.
		 Click the button. 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.
		 To delete a comment or all comments, right-click a comment and select a delete option from the shortcut menu.
		2-0.767mm X-14 B91mm +607 222 Padd notes to an Image
Image Save		Opens a Save As dialog box that enables export of the 3D reconstruction (.vox).
	\square	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 we 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 C	ptions
Thickness	×
Thickness 16 Slice 🗸	
MIP Type Average V	
OK Cancel	





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.
- 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 8.8 3DViewer and Volume Rendering Control Panel – Artistic Mode



Table 8.5 Volume Rendering Controls



Table 0.5 Volume Rendering Controls ((continued)
Item	Description
Component Selection Part select Part.2 Bone Component Selection Component Selection Com	Tools for classifying the image data. See <i>Classifying Image Data Using the 3D Viewer</i> 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: Click the button. 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 A 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 D 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. Y-axis crosshair

Table 8.5	Volume Re	nderina C	Controls (continued
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Item	Description
	Hides all voxels to the left of the x-axis crosshair. 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 bar , bar , or bar , 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.

Table 8.5 Volume Rendering Controls (continued)

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.



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.



- 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

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.



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.



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.

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:

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

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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.

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- 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.



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 Thir	ty Party Image Analysis Software
🛓 Import>Raw	C CT.2017020 (ARCA LOG OTN) HANTESA TESATESA PROVINSI FALSE 200
Image type: 16-bit Unsigned 💌	
Width: 1024 pixels	
Height 1024 pixels	
Offset to first image: 470 bytes	
Number of images: 1024	
Gap between images: 0 bytes	
White is zero	
✓ Little-endian byte order	
Open all files in folder	
🗖 Use virtual stack	
OK Cancel Help	•

9 Care and Maintenance

Surveying the Quantum GX3 microCT for Radiation Leakage Maintenance & Safety Checks Cleaning the Quantum GX3 microCT on page 127

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

 $\overline{\mathbb{W}}$

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.
- 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.

- 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

Limited Warranty Trademarks Disclaimers

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

The names of companies and products mentioned herein may be the trademarks of their respective owners. Revvity is a registered trademark of Revvity, Inc. Apple, Macintosh, and QuickTime are registered trademarks of Apple Computer, Inc. Microsoft, PowerPoint, and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries. Intel and Pentium III is a registered trademark of Intel Corporation. Adobe and Illustrator are either registered trademarks or trademarks or trademarks or trademarks of Adobe Systems Incorporated in the United States and/or other countries.

10.3 Disclaimers

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- B. <u>Use of the System</u>. 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

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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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