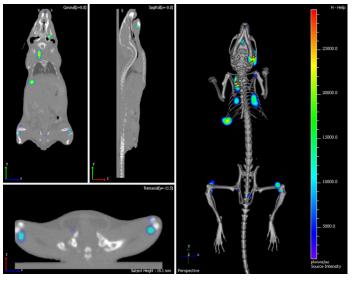
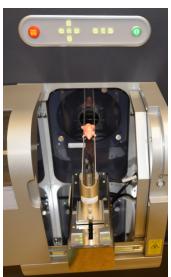


# Quantum GX2 microCT Imaging System April 2018









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### 1 Welcome

**About This Manual** 

What's New in the Quantum GX2 microCT Imaging System on page 2

Quantum GX2 microCT Help on page 3

Additional Important Documentation on page 3

Contact Information on page 4

#### 1.1 About This Manual

Welcome to the *Quantum GX2 microCT Imaging System Manual*. The Quantum GX2 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 GX2 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 GX2 4.0 Software	For image acquisition, data analysis, reconstruction, and post-processing. Factory-installed on the imaging system workstation.
Quantum GX2 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 GX2 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 GX2 microCT Imaging System
- Obtain and view CT images

Please read this manual carefully before using the Quantum GX2 microCT Imaging System to obtain safe, optimum performance, and a maximum service life from the imaging system.

### 1.2 What's New in the Quantum GX2 microCT Imaging System

Table 1.1 lists the new or improved features for the Quantum GX2 microCT Imaging System.

Table 1.1 Quantum GX2 microCT Imaging System New or Improved Features

Item	Description	See Page
Computer and software	■ Larger local storage with 2 TB hard drive.	
	■ Improved graphics card – NVIDIA GeForce GTX 1080.	
	■ Support for Windows 10.	
Data management	Move image data to a different sample and study.	34
	■ Delete image data (requires Administrator privileges).	34
Gating	More robust cardiac gating	
	Respiratory rate displayed (breaths per minute) during gated scan setup.	53
18mm FOV	Smaller FOV for high resolution imaging of ex vivo samples.	
86mm FOV	Wider FOV for additional application support. Entire rat lungs can be imaged using this FOV in a one second scan.	
Changeable X-ray filters	Choose between 6 filters to optimize imaging protocols.	64
High speed scan	High speed scan times as fast as 3.9 seconds.	

Table 1.1 Quantum GX2 microCT Imaging System New or Improved Features (continued)

Item	Description	See Page
Work with data offline	Ouantum GX Image Analysis Software for working with image data offline on a workstation not connected to the imaging system.  • View 2D image data and 3D reconstructions.  • Post-acquisition processing of gated image data  • Post-acquisition reconstruction of slices or subvolume at higher resolution.	37
Estimated radiation dosage	Control panel displays the estimated radiation dosage (mGy) based on the acquisition settings.	27
Reconstruction improvements	<ul> <li>Subvolume and slice reconstructions for subjects that contain metal.</li> <li>Improved accuracy of grayscale values.</li> </ul>	
Viewer	<ul> <li>View Z-axis maximum intensity projection (MIP) in the 2D viewer.</li> <li>Additional 3D filters (EDGE and BONE) for enhanced visualization.</li> </ul>	71
3D Viewer	"Artistic mode" display generates 3D renderings of the image using factory installed colormaps.	72

### 1.3 Quantum GX2 microCT Help

You can view a tooltip about a software button function by putting the mouse cursor over the button.

### **1.4 Additional Important Documentation**

Table 1.2 lists other important documentation related to the use of the Quantum GX2 microCT Imaging System.

Table 1.2 Documentation for the Quantum GX2 microCT Imaging System

Document Name	Description	Part No.
Safe Operating and Emergency Procedures for the Operation of the Quantum GX2 microCT Cabinet X-Ray System	Provides detailed instructions on the safety features, operating procedures, and emergency procedures for the Quantum GX2 microCT Imaging System.	CLS150200
Mouse Imaging Shuttle Instructions	Explains how to install and use the optional Mouse Imaging Shuttle that can be used to contain the subject during optical and CT imaging. The Mouse Imaging Shuttle enables imaging and transfer of subjects between imaging platforms without disrupting the subject position. As a result, 3D optical and 3D volumetric data can be precisely registered.	127820

### 1.5 Contact Information

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## **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 GX2 microCT lmaging System. If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.



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



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

#### Safety Symbols

Table 2.1 shows safety symbols that are found on the Quantum GX2 microCT and in this manual.

Table 2.1 Safety Symbols

Symbol	Definition
A	Warning: Hazardous voltage.
	Warning: The equipment produces X-rays when energized.
	Warning (Canada): The equipment produces X-rays when energized.

#### Instructions



WARNING! The Quantum GX2 microCT should be operated only by personnel who have been trained in radiation safety and the operation and safety instructions contained in this manual. PerkinElmer 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 GX2 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 GX2 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 GX2 microCT unless an X-ray safety survey has been performed within the last 12 months. For more information, please contact PerkinElmer 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 GX2 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 GX2 microCT, please comply with your own laboratory radiation regulations or contact PerkinElmer technical support for further assistance.

Owners and operators of the Quantum GX2 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 GX2 microCT are responsible for contacting the appropriate public health agencies for registration information that pertains to installation of the Quantum GX2

microCT. If you need assistance with this requirement, contact PerkinElmer technical support. For more details and contact information, see *Safe Operating and Emergency Procedures for the Operation of the Quantum GX2 microCT Cabinet X-Ray System*. This document was provided with the pre-installation instructions.



WARNING! A PerkinElmer employee will conduct a radiation leakage survey and safety tests when the Quantum GX2 microCT is installed. PerkinElmer 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 PerkinElmer 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 GX2 microCT**

Consider the proper environment for the components before installation of the Quantum GX2 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%.
- 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 GX2 microCT equipment. A minimum space of 4 inches (10 cm) from the flat surface of the rear panel should be provided behind the Quantum GX2 microCT to provide unobstructed air flow and access to the main power on/off switch.
- The work space is level.
- Altitude is  $\leq 2000$  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 GX2 microCT components. Sprays and liquids that come into contact with the Quantum GX2 microCT hardware may result in damage to the system or electrocution. For more details on proper care of the system, see Cleaning the Quantum GX2 microCT on page 81

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

#### **Moving the Quantum Quantum GX2 microCT**



WARNING! Only PerkinElmer employees are authorized to move the Quantum GX2 microCT Imaging System.

#### **Power Considerations**

#### **Power Sources**

The Quantum GX2 microCT is configured for the voltage requirements of the installation locality that was specified at the time of order. If the Quantum GX2 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 GX2 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 PerkinElmer technical support.

Intended to be powered by a standard wall receptacle (Overvoltage 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 GX2 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 GX2 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 GX2 microCT Imaging System.

Facilities should be adequately wired according to local building codes.



WARNING! The Quantum GX2 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 GX2 microCT Imaging System.



WARNING! The Quantum GX2 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 PerkinElmer technical support. If the Quantum GX2 microCT is damaged and requires service, unplug the Quantum Quantum GX2 microCT from the outlet and contact PerkinElmer technical support. Servicing by anyone other than an authorized PerkinElmer representative voids the warranty covering the Quantum GX2 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 GX2 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 GX2 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 PerkinElmer 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 GX2 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. PerkinElmer 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 GX2 microCT Imaging System is heavy and weighs approximately 600 kg. The imaging system has many internal motorized components that can move at any time.

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



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



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



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



WARNING! Do not attempt to remove or modify the access tube 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 the *Mouse Imaging Shuttle Instructions* (part no. 127820\_RevA) 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 GX2 microCT Imaging System before requesting service by PerkinElmer 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 GX2 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 GX2 microCT Imaging System. Do not remove the electronics tray from the imaging system or the cover from the light source module unless you are instructed by and under the supervision of a PerkinElmer technical service representative.

Do not modify the Quantum GX2 microCT Imaging System in ANY manner by making any kind of hole or aperture in the imaging system or removing any component that is part of the radiation shielding.



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



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

### 2.3 X-Ray Safety and Radiation Hazards

The Quantum GX2 microCT Imaging System produces X-rays when the X-ray function has been energized and initiated. The Quantum GX2 microCT Imaging System 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. PerkinElmer certifies the Quantum GX2 microCT Imaging System to produce not more than 0.5 millirem 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 GX2 microCT Imaging System meets all US (FDA) regulations regarding a cabinet X-ray system.

#### **Effects of Radiation**

The Quantum GX2 microCT Imaging System produces ionizing radiation in the energy range from 0 to 90 kilovolts (X-ray). While this energy can be hazardous to the human body, the shielded cabinet protects the user or others in the vicinity from any exposure above background. The user is responsible for minimizing the total X-ray exposure to the individual mouse or other animal subject as part of the total amount of time spent imaging.

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



WARNING! This product produces X-rays. Do not attempt to open the Quantum GX2 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 PerkinElmer technical support.



WARNING! Do not, for any reason, attempt to defeat the built-in safety interlocks described in *Safety Features & Safety Systems* on page 13. Operating the Quantum GX2 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 PerkinElmer technical support.

#### X-Ray Dose Limits

A sample model of PerkinElmer Quantum GX2 microCT Imaging System has been tested at maximum operating conditions. PerkinElmer 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 mrem/h.

PerkinElmer declares that the Product Quantum GX2 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 61010-1:2001 Standard (Dose limit of 0.5 mrem/h at 5 cm from the surface of the equipment under maximum operating conditions)

PerkinElmer certifies that Quantum GX2 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 GX2 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.

PerkinElmer 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.

PerkinElmer 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 PerkinElmer technician performs maintenance or service, in which case the safety survey will be conducted by PerkinElmer



WARNING! A PerkinElmer employee will conduct a radiation leakage survey and safety tests after the Quantum GX2 microCT Imaging System is serviced by PerkinElmer. PerkinElmer 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 PerkinElmer 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 GX2 microCT for Radiation Leakage on page 80 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 GX2 microCT Cabinet X-Ray System document. This document was provided as part of the pre-installation instructions and is also included on the same CD-ROM as this manual. International customers should check with their governing bodies about possible registration or other requirements.

PerkinElmer certifies that the Quantum GX2 microCT Imaging System complies with FDA regulation CFR 1020.40 after installation at the customer's site. PerkinElmer also certifies that the instrument meets all of the International regulations of the country where it is installed.

## 3 Quantum GX2 microCT Imaging System Components

Components

Door Operation on page 20

X-Ray System Control Panel on page 20

Key Selector Switch Lost Keys on page 21

Scanning System and Acquisition Computer Specifications on page 21

Environmental Requirements on page 22

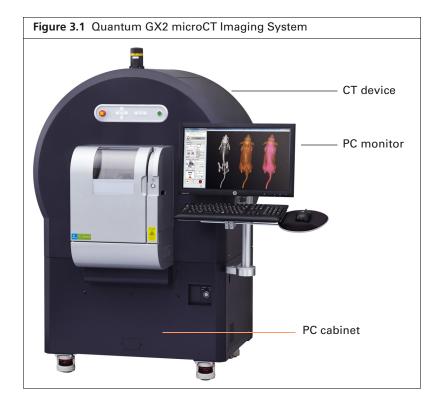
Tube Inlet on page 22

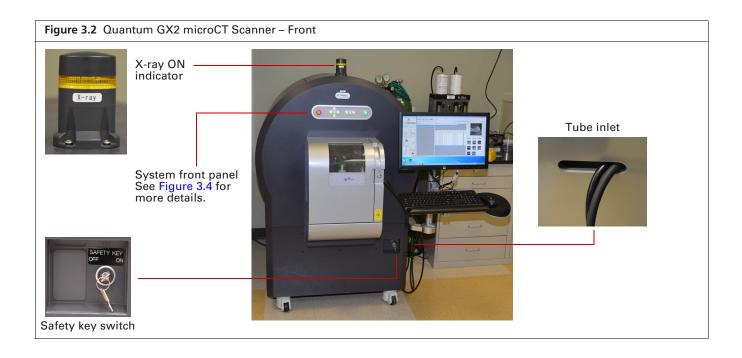
Transfer Bed and Mouse Imaging Shuttle on page 23

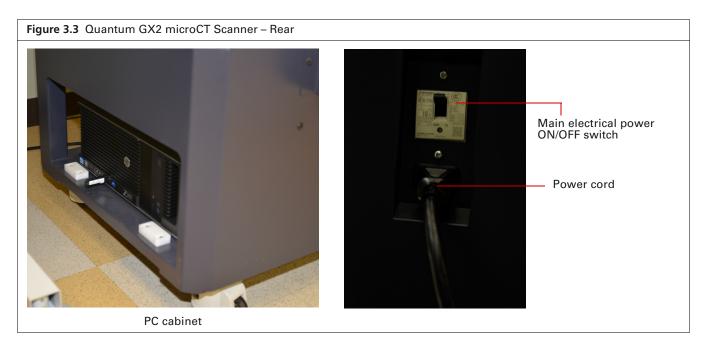
FMT Mouse Imaging Cassette on page 24

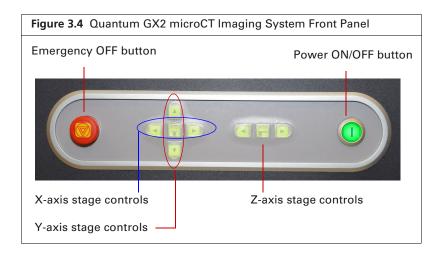
### 3.1 Components

The Quantum GX2 microCT Imaging System 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.









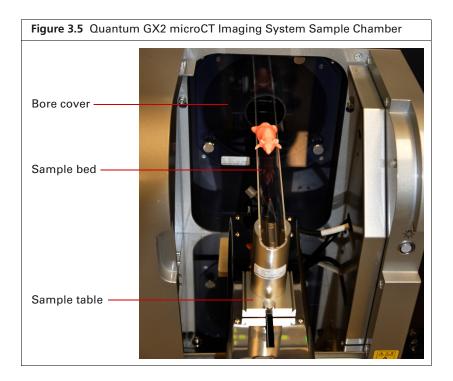


 Table 3.1
 Standard Accessories

Item	Photo
Mouse bed	
Rat bed	
Small bore cover	
Large bore cover	
18mm FOV bore cover and bed	No photo available.
86mm FOV bore cover and bed	No photo available.
Changeable X-ray filters	No photo available.

#### **Control Panel**

The Control Panel appears when the Quantum GX2 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 27 for details on the Control Panel.



Table 3.2 Scan Acquisition and Display Parameters

Parameter	Description	
Voltage	Variable voltage up to 90 kV.	
СТ	Variable current up to 200 μA.	
Live	Variable current up to 500 μA.	
FOV (mm)	Acquisition – Field of view for acquisition, variable 18 - 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.	
Scan Mode	<ul> <li>Standard – A common scan configuration for low dose in vivo imaging.</li> <li>High Resolution – A scan mode that reduces image noise.</li> <li>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</li> </ul>	
	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).	
	<ul> <li>High Speed – A scan mode that is as fast as possible to reduce dose.</li> </ul>	
	<ul> <li>High Speed, Gating – A scan configuration which mitigates motion artifacts from cardiac and respiratory rhythms. Note: Gating is optional.</li> </ul>	
	Note: See Table 6.2 on page 44 for details on Preset Scan Configurations.	
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.	

Item **Description** High Voltage Potential 90 kV Maximum Current 200 µA Maximum Power 8 W Anode Type Tungsten Window Beryllium Focal Size  $5-30 \mu m$ Changeable (see Imaging With Different X-Filter Ray Filters, page 64).

Table 3.3 X-ray Source Specifications

### 3.2 Door Operation

The Quantum GX2 microCT 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 Quantum GX2 microCT (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 Quantum GX2 microCT Imaging System control software until these conditions have been fulfilled.



### 3.4 Key Selector Switch Lost Keys

X-ray safety regulations require controlled access to the Quantum GX2 microCT Imaging System. 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 PerkinElmer technical support (see page 4).

### 3.5 Scanning System and Acquisition Computer Specifications

The computer contains an Intel family processor and Windows® operating system. The computer controls the Quantum GX2 microCT Imaging System. 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	138 cm W, 106 cm D, 130 cm H
Door opening dimensions	250 mm x 257 mm
Weight	489 Kg

### **Computer Features**

- High speed Windows®-based PC
- Microsoft Windows 10 64-bit operating system
- 16GB RAM
- 2TB hard drive
- Quantum GX2 microCT Imaging System control software
- CD-burner installed for data storage and transport
- Network ready
- 21.5" flat screen monitor
- Microsoft Office installed

### **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	NVIDIA GeForce GTX 1080

### **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	

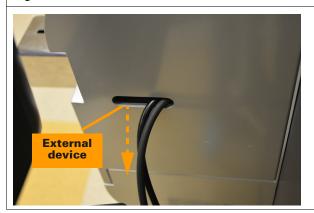
### 3.6 Environmental Requirements

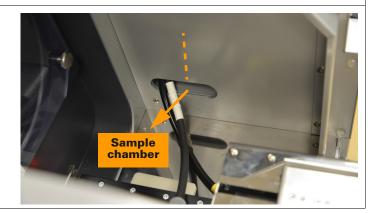
Environmental Requirements	Specification
Temperature	15° C to 25° C (50° F to 78° F)
Humidity	0% to 80% non-condensing
Type of use	Indoor
Imaging chamber shelf temperature	Ambient to 37° C
Altitude rating	<2000 meters (6560 ft.)
Pollution degree	2
Installation category	II

### 3.7 Tube Inlet

The Quantum GX2 microCT Imaging System is equipped with a tube inlet for use with external devices such as the RAS-4 Anesthesia System or angiographic injectors that are inserted into the sample chamber or gantry (Figure 3.8). Anesthesia tubing and manifolds for the small and medium animal beds are provided with the standard accessories kit.

Figure 3.8 Tube Inlet







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



CAUTION: Image quality may be affected by contrast media or anesthesia on the bore cover or the sample bed. If contrast media or anesthesia 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 GX2 microCT Imaging System and the IVIS<br/>
Spectrum Imaging System. The MIS transports the subject between the imaging systems without disrupting the subject position so that 3D volumetric data acquired on the Quantum GX2 microCT Imaging System can be precisely registered with the optical data obtained on the IVIS Spectrum Imaging System.

The transfer bed replaces the acrylic beds supplied. A single mounting screw secures the transfer bed to the movable sample platform on the Quantum GX2 microCT Imaging System scanner. The bed has an anesthesia supply and exhaust tube attached that connects to the XGI-8 Gas Anesthesia System hoses.

Mouse Imaging Shuttle

Mouse Imaging Shuttle

(MIS)

Transfer bed

Attachment screw

Anesthesia supply and exhaust hoses

Transfer bed with MIS mounted in the Quantum GX2 microCT Imaging System scanner

### 3.9 FMT Mouse Imaging Cassette

An optional adapter provides compatibility with the FMT mouse imaging cassette (Figure 3.10). The FMT Mouse Imaging Cassette contains the subject during image acquisition on the Quantum GX2 microCT Imaging System and the FMT Imaging System. The cassette enables transport between the imaging systems without disrupting subject position so that 3D volumetric data acquired on the Quantum GX2 microCT can be precisely registered with the optical data.





FMT Mouse Imaging Cassette Adapter



Adapter with FMT Mouse Imaging Cassette mounted in the Quantum GX2 microCT Imaging System scanner

## **4** Getting Started

Workflow Overview
Starting the Imaging System

### **4.1 Workflow Overview**

Table 4.1 presents an overview of acquiring CT data on the Quantum GX2 microCT Imaging System.

Table 4.1 Workflow Overview

Step	See Page
1. Start the Quantum GX2 microCT Imaging System.	See below
2. Warm up the Quantum GX2 microCT Imaging System (click the panel).	40
3. Create and/or connect to a database.	29, 30
4. Create or select a sample and study where the image data (series) will be saved.	41
5. Set the scan conditions.	43
<b>6.</b> Place the anesthetized subject in the sample chamber and center the subject in the Xcapture window.	47
7. Start the CT scan.	51, 52, or 55
8. View and analyze the 3D reconstruction.	65
<ul> <li>9. Post-processing options:</li> <li>Reconstruct a subvolume or slice(s).</li> <li>Reconstruct the sinogram (image data).</li> </ul>	58
<b>Note:</b> 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 GX2 microCT Imaging System by pressing the green power button (default user ID – "CTadmin", default password – "ct2admin").



2. Start the software by double-clicking the F 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 Chapter 5 on page 29 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, please contact PerkinElmer technical support (see page 4) for assistance.

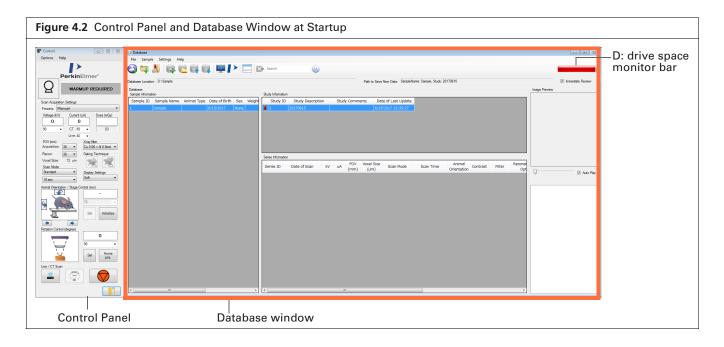


Table 4.2 Control Panel

Item	Description	For More Details, See:
WARMUP REQUIRED	Scanner status	Figure 6.1 on page 40
Presets: Manual	Choose a preset or custom scan configuration from this drop-down list.	Table 6.2 on page 44
Voltage (kV)  0  90	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 45
Current (uA)  O  CT 88   Live 40   ▼	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.	Acquisition in Fluoroscopy Mode on page 62
Dose (mGy)	Displays the scheduled X-ray dose per unit time during a CT or fluoroscopy scan.  CT scan – Estimated exposure dose calculated from the actual irradiation time.*  Fluoroscopy scan – Estimated radiation dose, updated every second.  Dose for a CT scan using that particular mode. This number changes based on the scan mode settings.  *See Meganck, J.A. and Liu, B. Mol Imaging Biol (2016). doi:10.1007/s11307-016-1026-x for information on estimated exposure dose and radiation dose.	
FOV (mm) Acquisition: 36 Recon: 36 Voxel Size: 72 um  X-ray filter selection	Acquisition – Field of view options: 86, 72, 36 or 18 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.  Drop-down menu that is used to indicate which filter has been manually placed in the instrument (see Imaging With Different X-Ray Filters, page 64).	Table 6.2 on page 44 for more information on scan modes.
Gating Technique	Click to select respiratory gating.  Click to select cardiac gating.	page 52 page 55
Scan Mode High Speed   Gating 4min  ▼	Available scan modes: Standard, High Speed, or High Resolution.  Scan times vary with the scan mode (see Table 6.2 on page 44).	Table 3.2 on page 19
Display Settings Soft ▼	Filters for removing noise by combining pixels.	Table 3.2 on page 19

Table 4.2 Control Panel (continued)

Item	Description	For More Details, See:
Animal Orientation / Stage Control (mm)  - 70  Set Initialize	Use the and arrows to set the subject orientation.  Initialize – Moves the sample bed to the "0" position and initiates manual control of the sample bed.  - Actual z-axis position of the sample bed (into or out of the bore). Position information is available after you click Initialize).  - To move the sample bed in/out of the bore, select a distance (mm) from the drop-down list or enter a value, and click Set.  - Click to move the bed in or out of the bore.	page 47
Rotation Control (degree)  0  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 <b>Set</b> .  Click <b>Home pos</b> . to return the gantry to 0 degree rotation.	
<u> </u>	Click to begin X-ray tube warm-up. The Warm-Up button changes to the Live Mode button of after X-ray tube warm-up is complete.	
<u>`</u> `	Click this button to view the subject in real time.  Starts a scan.	
	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 30

Data Organization on page 31

Managing Data on page 33

Managing Databases on page 35

System Administrator Login/Logout on page 37

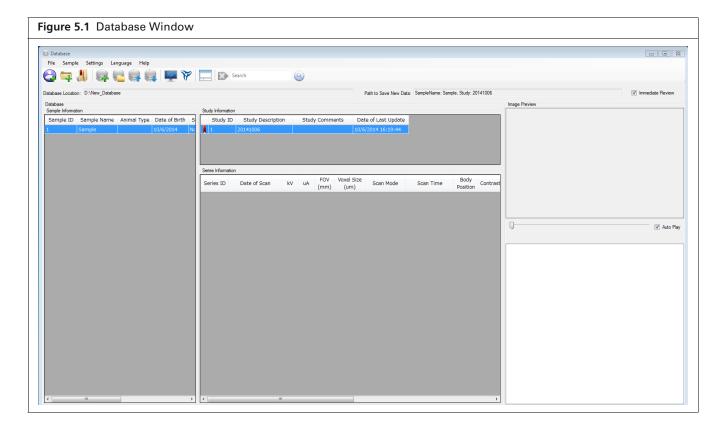
Working With Data Offline on page 37

### **5.1 Creating a Database**

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

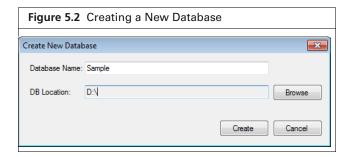
#### To create a database:

1. Open the Database window by starting the Quantum GX2 microCT software (click the **pr** icon on the desktop (Figure 5.1).



- 2. Click the New Database button in the Database window. Alternatively, select  $File \rightarrow New$  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.

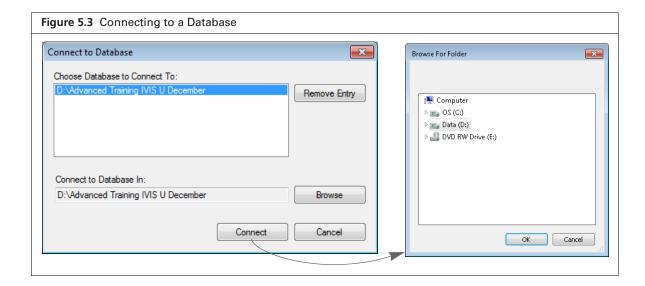


### **5.2 Connecting to a Database**

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

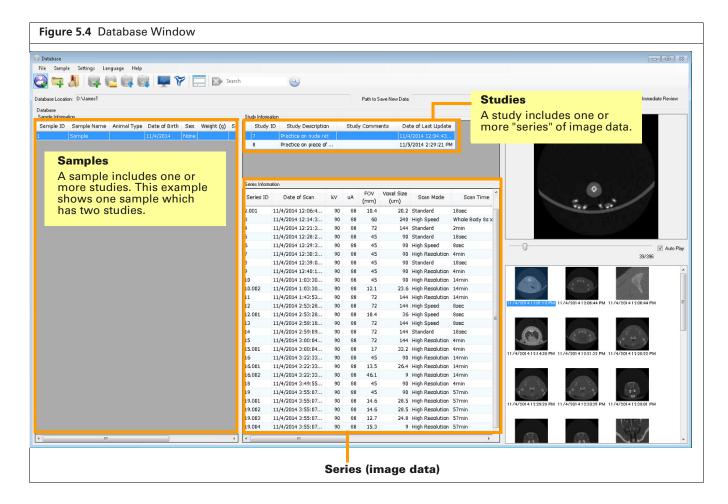
If the database name is not listed in the dialog box:

- a. Click Browse
- **b.** Select a database in the dialog box that appears and click **OK**.
- c. Click Connect.



### **5.3 Data Organization**

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

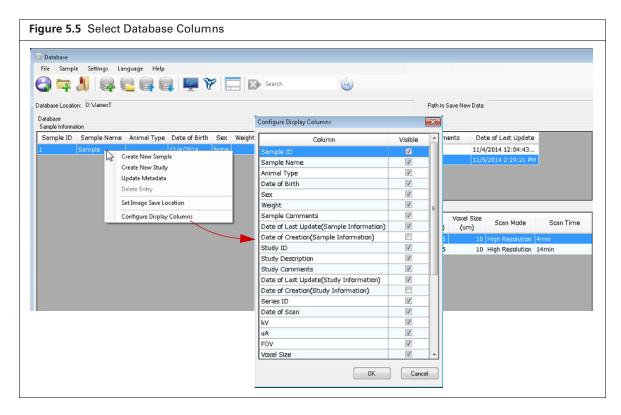


#### **Customizing the Database View**

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

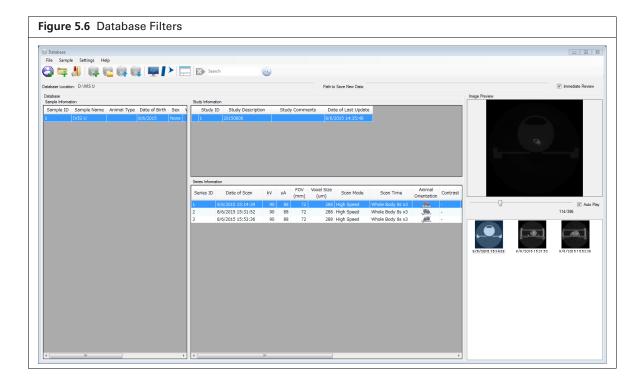
#### To hide/show columns:

- **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**.



#### To filter the data:

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



# **5.4 Managing Data**

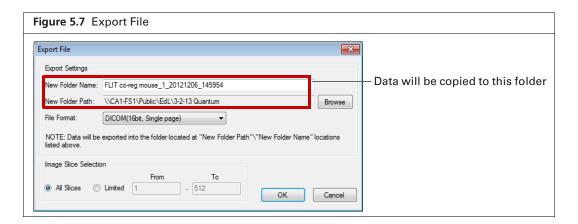
Reconstructed image data (\*.vox) can be imported between databases or exported from the database to another location such as the desktop.

### **Importing Data**

- **1.** Select a save location (sample and study) for the data in the Database window. See page 41 for instructions on selecting a save location.
- **2.** Click the  $\blacksquare$  toolbar button. Alternatively, select **File**  $\rightarrow$  **Import File** on the menu bar.
- **3.** Select the data (\*.vox) for import in the dialog box that appears and click **Open**. The imported series appears in the Database window. The original data name is listed in the Series Description.

#### **Exporting Data**

- **1.** Select the series for export in the Database window.
- **2.** Click the  $\bowtie$  toolbar 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.



- **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.

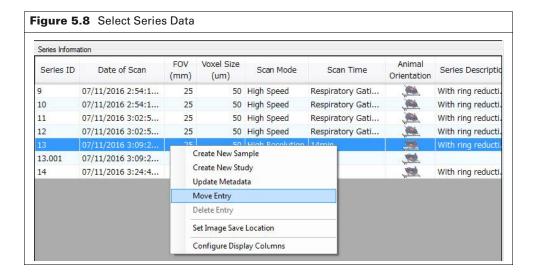
File Format	Description
CT image with a SimpleViewer	Exports the 3D reconstruction (.vox) along with the SimpleViewer. See page 68 for more details on the Viewer.
DICOM (16bit, Single page) Tiff (16, Multi page) JPEG Bitmap PNG	Exports individual slices in a file formats common for medical imaging. Exporting 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 sample and study.

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).



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



#### **Deleting Data**



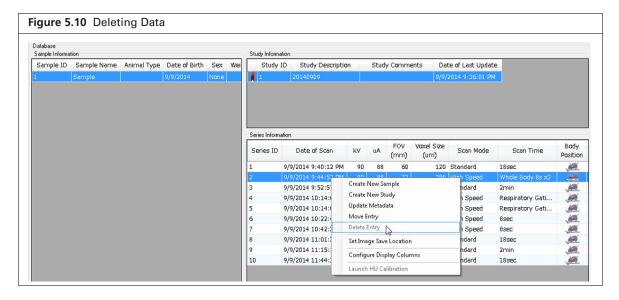
**NOTE:** Only the system administrator can delete data. See page 37 for instructions on system administrator login/logout.



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 sample, study, 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.



# **5.5 Managing Databases**

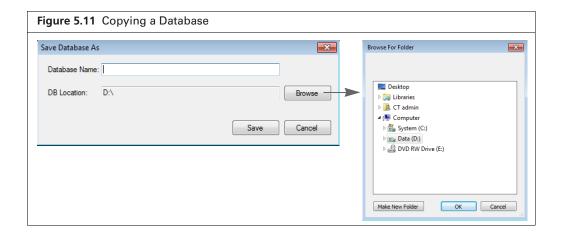
### Copy a Database

Copying a database provides a convenient way to share data.



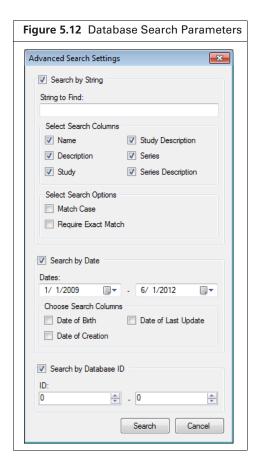
**NOTE:** Only the system administrator can copy a database. See page 37 for instructions on system administrator login/logout.

- **1.** Connect to the database that you want to copy. (See page 30 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 5.11).
  - **b.** Select a folder in the dialog box that appears, and click **OK**.
- 5. Click Save.



#### Search a Database

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



#### **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 page 37 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 System Administrator Login/Logout

- **1.** Select **Settings**  $\rightarrow$  **Login/Logout** as Administrator on the menu bar.
- **2.** Enter the administrator password in the dialog box that appears. The default password is *ct2admin*.
- 3. Click Login (or Logout if logging out).



# **5.7 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**

Ensure that the offline workstation meets the requirements in Table 5.1.

Table 5.1 Workstation Requirements for Offline Analyses

Requirement	Software			
	Quantum GX Viewer Pack	Quantum GX Image Analysis		
Operating system	Windows® 7 or 10 32-bit or 64-bit Home Edition or higher	Windows 7 Professional 64-bit or Windows10 Professional 64-bit		
CPU	Intel® Core i5 or i7 2.0GHz or higher	Intel Core i5 or i7 3.0GHz or higher		
Memory	4GB minimum	16GB minimum		
Hard disc	System drive (C drive) – 1GB or more free space	<ul> <li>System drive (C drive) – 1GB or more free space</li> </ul>		
		■ 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).		

Table 5.1 Workstation Requirements for Offline Analyses (continued)

Requirement	Soft	ware
Graphics card		The following graphics cards are supported:  NVidia GeForce GTX 680, 2048MB GDDR5
		<ul> <li>NVidia GeForce GTX 770, 2GB GDDR5</li> </ul>
		<ul> <li>NVidia GeForce GTX 980, 4096 MB, 256 bit GDDR5 (for example, EVGA GeForce GTX 980 4GB GAMING, Silent Cooling Graphics Card 04G- P4-2980-KR)</li> </ul>
Graphics board	OpenGL2.0 or later, graphic memory of 1GB or more	<ul> <li>NVIDIA GeForce GTX680 or later or</li> <li>Quadro K2000 or later</li> <li>Graphic memory 1.5GB or more</li> <li>Driver Ver.378.49 or later (GeForce type) or</li> <li>Driver Ver.376.62 or later (Quadro type)</li> </ul>
USB port	One or more USB2.0 ports.	One or more USB2.0 ports.
	<b>Note:</b> USB port for keyboard, mouse and one extra port required.	<b>Note:</b> USB port for keyboard, mouse and one extra port required.
Monitor resolution	1920 × 1080 or more	1920 × 1080 or more
D drive		Drive with sufficient storage (at least 1TB is recommended) that is formatted with a file system capable of handling single files larger than 10GB (e.g. NTFS)
RAM		16GB

# **Workstation Setup**



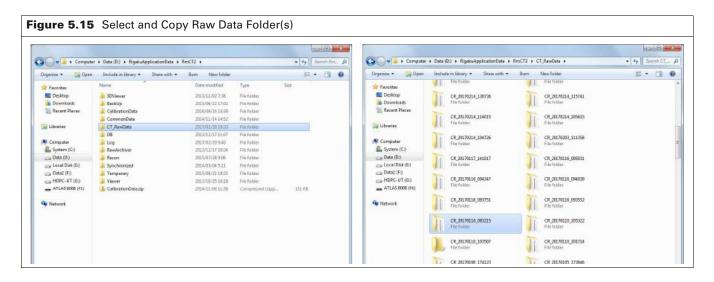
**NOTE:** A hard drive labeled as "D:" is required and can be created as a partition on another hard drive if necessary.

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

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

Figure 5.14 Folder Structure on the Analysis Workstation ▼ 4 Search RmCT2 O Share with ▼ New folder -**(2)** Name Date modified Type ↓ Computer BackUp 4/12/2016 3:44 PM File folder OS (C:) CalibrationData 4/12/2016 3:44 PM File folder BLAH (D:) CT RawData 4/12/2016 3:44 PM File folder ATLAS (F:) 📗 Log 4/12/2016 3:44 PM File folder P Data (\\hoprdqgx01) (Z: Recon 4/12/2016 3:44 PM File folder Viewer 4/12/2016 3:44 PM File folder 6 items

- **4.** Copy a database from the imaging system or data archive to an external medium, for example a USB external hard drive. See page 35 for instructions.
  - NOTE: Quantum GX Analysis Software only analyzes image data on the local workstation.
- **5.** Go to "Data (D:)\RigakuApplicationData\RmCT2\CT\_RawData" on the imaging system. Select and copy the raw data folder(s) of interest to an external medium. Each folder name includes the date and time of a scan (CR\_YearMonthDay\_HourMinuteSecond) (Figure 5.15).
  - **NOTE:** Be sure to copy the data folder and its contents, not just the raw data. Otherwise the workstation will not be able to process the data.
- **6.** Copy the raw data folder(s) from the external medium to "D:\RigakuApplicationData\RmCT2\CT\_RawData" on the analysis workstation.



# **6** Image Acquisition

**Imaging System Warm-Up** 

Select a Save Location on page 41

Set Up Automatic Image Export on page 43

Set the Scan Conditions on page 43

Place a Subject in the Sample Chamber on page 47

CT Scan Without Gating on page 51

CT Scan With Respiratory Gating on page 52

CT Scan With Cardiac Gating on page 55

Reconstructing a Subvolume or Slice on page 58

Acquisition in Fluoroscopy Mode on page 62

Ring Reduction on page 63

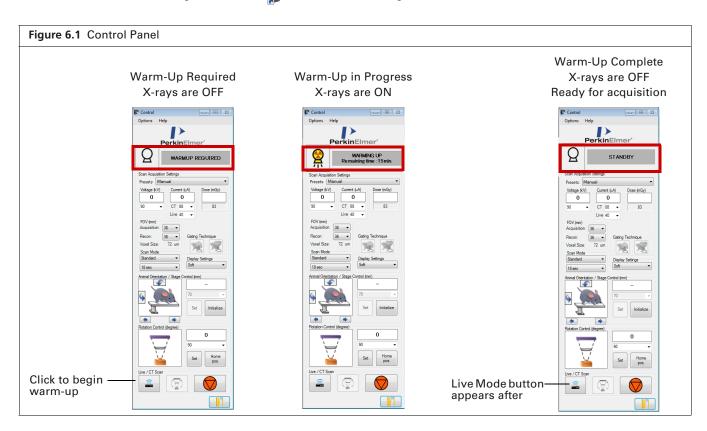
Imaging With Different X-Ray Filters on page 64

# **6.1 Imaging System Warm-Up**



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

Check the Control Panel to see if the imaging system requires warm-up (Figure 6.1). If the Control Panel is not open, click the recommendation on the desktop.



#### 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 GX2 microCT Imaging System does not generate X-rays unless the door is properly closed and the safety interlock is engaged. There is an audible "click" when the safety interlock properly engages as the door is closed.

**3.** Click the Warm-up button in the Control Panel. Click **OK** in the warning message that appears (Figure 6.2).

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 6.1). X-ray tube status changes to "STANDBY" when warm-up is completed (Figure 6.1).



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

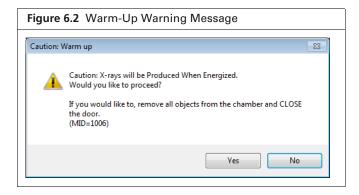


Table 6.1 Estimated Time Required for Warm-Up

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

#### 6.2 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 page 31 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 10GB 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 Managing Databases page 9 for details).
- **2.** Follow the instructions in Table 6.1 to select a sample and study for the series.

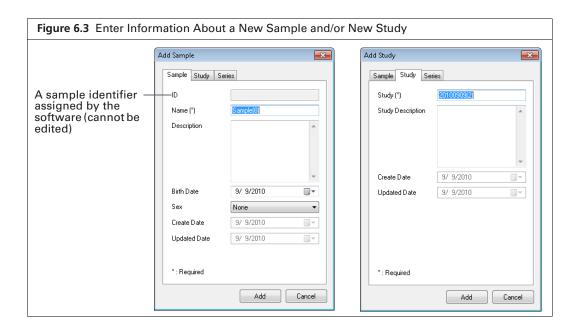
Table 6.1 Setting the Save Location in the Database window

To Save the Series to a:	Do One of the Following:
New sample and new study	Click the 🕞 toolbar button.
	or
	Right-click the Database window and select <b>New Sample</b> on the shortcut menu.
	or
	Select <b>Sample</b> $\rightarrow$ <b>New Sample</b> on the menu bar.
Existing sample and new study	Select the sample row and click the 🦺 toolbar button.
	or
	Right-click the sample row and select New Study on the shortcut
	menu.
	or
	Select the sample row and select <b>Sample</b> $\rightarrow$ <b>New Study</b> on the
	menu bar.
Existing sample and existing	Select the study row and click the 🦊 toolbar button.
study	or
	Right-click the study row and select <b>Set Series Save Location</b> on the shortcut menu.

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



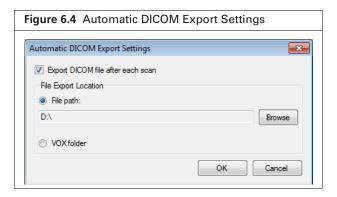
**NOTE:** Depending on the method used to select the save location, the Add Sample or Add Study dialog box may not automatically appear. To display them, right-click a selected sample or study in the Database window and choose **Update Data** from the shortcut menu.



# **6.3 Set Up Automatic Image Export**

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

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



### 6.4 Set the Scan Conditions

Set the scan conditions by choosing a:

- Preset scan condition or specify custom scan parameter conditions in the Control Panel.
- Gating option if performing a gated CT scan.

#### **Preset Scan Conditions**

1. Select a preset or custom scan setting from the Presets drop-down list (Figure 6.5).



**NOTE:** Custom scan settings saved to the system are also available in the Preset drop-down list. See page 45 for instructions on creating custom scan settings.

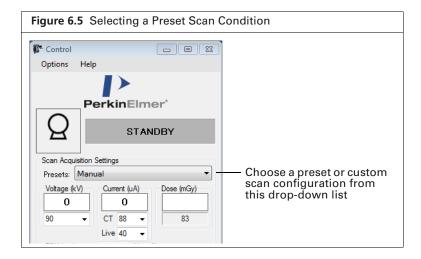


Table 6.2 Preset Scan Configurations

See Table 3.2 on page 19 for a description of the scan parameters.

Note: FOV 45, 60 and 72 can be used with the small or large bore. FOV 25 and 36 can only be used with the small bore.

No.	Menu Name	kV	CT µA	Live µA	Acquisition FOV (mm)	Recon FOV (mm)	Scan Mode	Scan Time	Display Settings
1	FOV72 High Speed, 8sec	90	88	40	72	72	High Speed	08 sec	Soft
2	FOV72 Standard, 18sec	90	88	40	72	72	Standard	18 sec	Soft
3	FOV72 Standard, 2min	90	88	40	72	72	Standard	02 min	Soft
4	FOV72 High Resolution, 4min	90	88	40	72	72	High Resolution	04 min	Off
5	FOV72 High Resolution, 14min	90	88	40	72	72	High Resolution	14 min	Off
6	FOV60 High Speed, 8sec	90	88	40	72	60	High Speed	08 sec	Soft
7	FOV60 Standard, 18sec	90	88	40	72	60	Standard	18 sec	Soft
8	FOV60 Standard, 2min	90	88	40	72	60	Standard	02 min	Soft
9	FOV60 High Resolution, 4min	90	88	40	72	60	High Resolution	04 min	Off
10	FOV60 High Resolution, 14min	90	88	40	72	60	High Resolution	14 min	Off
11	FOV45 High Speed, 8sec	90	88	40	72	45	High Speed	08 sec	Soft
12	FOV45 Standard, 18sec	90	88	40	72	45	Standard	18 sec	Soft
13	FOV45 Standard, 2min	90	88	40	72	45	Standard	02 min	Soft
14	FOV45 High Resolution, 4min	90	88	40	72	45	High Resolution	04 min	Off
15	FOV45 High Resolution, 14min	90	88	40	72	45	High Resolution	14 min	Off
16	FOV36 High Speed, 8sec	90	88	40	36	36	High Speed	08 sec	Soft
17	FOV36 Standard, 18sec	90	88	40	36	36	Standard	18 sec	Soft
18	FOV36 Standard, 2min	90	88	40	36	36	Standard	02 min	Soft
19	FOV36 High Resolution, 4min	90	88	40	36	36	High Resolution	04 min	Off

Table 6.2 Preset Scan Configurations (continued)

See Table 3.2 on page 19 for a description of the scan parameters.

Note: FOV 45, 60 and 72 can be used with the small or large bore. FOV 25 and 36 can only be used with the small bore.

No.	Menu Name	kV	<b>CT</b> μ <b>A</b>	Live µA	Acquisition FOV (mm)	Recon FOV (mm)	Scan Mode	Scan Time	Display Settings
20	FOV36 High Resolution, 14min	90	88	40	36	36	High Resolution	14 min	Off
21	FOV25 High Speed, 8sec	90	88	40	36	25	High Speed	08 sec	Soft
22	FOV25 Standard, 18sec	90	88	40	36	25	Standard	18 sec	Soft
23	FOV25 Standard, 2min	90	88	40	36	25	Standard	02 min	Soft
24	FOV25 High Resolution, 4min	90	88	40	36	25	High Resolution	04 min	Off
25	FOV25 High Resolution, 14min	90	88	40	36	25	High Resolution	14 min	Off
26	FOV72 High speed, whole body	90	88	40	72	72	High Speed	Whole Body 8 sec x 3	Off
27	FOV 60 High speed, whole body	90	88	40	72	60	High Speed	Whole Body 8 sec x 3	Off

#### **Custom Scan Conditions**

There are two ways to set custom scan conditions:

• 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 condition in the Menu Settings table (see page 46). The custom scan condition will be available in the Menu drop-down list of the Control Panel

#### To edit scan parameters in the Control Panel:

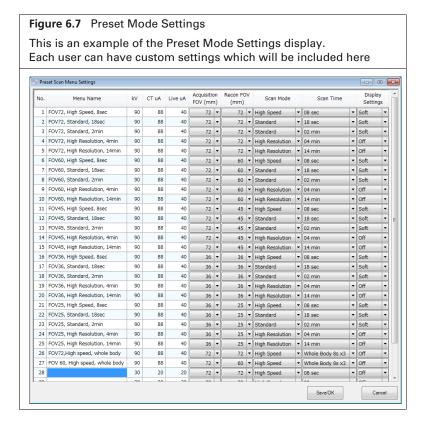
- 1. Select "Manual" from the Menu drop-down list.
- **2.** Enter a custom voltage and current in the Control Panel (Figure 6.6).
- **3.** Select FOV and Scan Mode. See Table 3.2 on page 19 for more details on these parameters.

Figure 6.6 Setting Custom Scan Conditions See Table 4.2 on page 27 for more details on these parameters. - B X Options Help |> PerkinElmer' Actual current output of the STANDBY X-ray tube during a scan Scan Acquisition Settings 0 0 CT 88 Actual voltage Presets: Manual output of the X-ray tube during a scan Voltage (kV) Current (uA) Dose (mGy) The scheduled X-ray 0 0 Voxel Size dose per unit time Scan Mode during a CT or 90 CT 88 83 18 sec fluoroscopy scan Live 40 Enter the voltage for the scan Select the current Select the current for a fluoroscopy/ for the scan Live Mode scan

#### To create a custom scan condition:

Create a custom scan condition by editing an existing scan condition or creating a new scan condition.

Select Options → Preset Modes on the Control Panel menu bar
 The Menu Settings table appears (Figure 6.7). It lists the available scan conditions and their parameter settings.



- 2. To set scan conditions:
  - a. Enter a name (under the "Menu Name" column header).
  - **b.** Enter values for kV, CT  $\mu$ A, and Live  $\mu$ A.
  - **c.** Make a selection from the FOV and Scan Mode drop-down lists.
  - d. Click Save/OK.

The scan condition appears in the Menu drop-down list in the Control Panel.

- **3.** To edit an existing scan condition:
  - **a.** Double-click a table cell and enter a new value.
  - **b.** Select a new value from a parameter drop-down list.
  - c. Click Save/OK.

The changes are saved to the system.

**4.** Select the scan condition from the Menu drop-down list in the Control Panel.

# 6.5 Place a Subject in the Sample Chamber

The imaging system is ready to acquire images after warm-up is complete. (See page 40 for more details on imaging system warm-up.)

**1.** Install an appropriate bore cover:

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

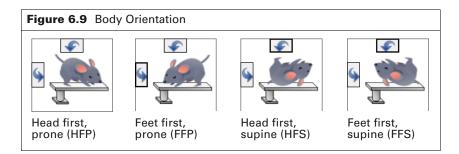
2. Manually slide the sample bed to the out-limit position (Figure 6.8). Alternatively, press the stage control buttons on the instrument front panel to move the sample bed.



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

Figure 6.8 Sample Bed at Out-Limit Position

- **3.** Place the anesthetized subject on the sample bed. If using the Mouse Imaging Shuttle, place the shuttle with the anesthetized subject on the sample bed. If needed, connect the gas anesthesia tubing. See the *Mouse Imaging Shuttle Instructions* (part no. 127820) for details on the Mouse Imaging Shuttle.
- **4.** Push the sample table into the bore and slide the imaging system door closed so that the interlock properly engages.
- **5.** Set the body orientation using the or arrows in the Control Panel. (Figure 6.9).



**6.** Turn on Live Mode by clicking the button in the Control Panel. The Xcapture window appears and shows the subject in real time (Figure 6.10).



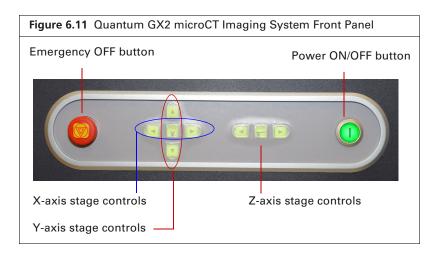
NOTE: Only the image data inside the bounding box are used to reconstruct the 3D volume.

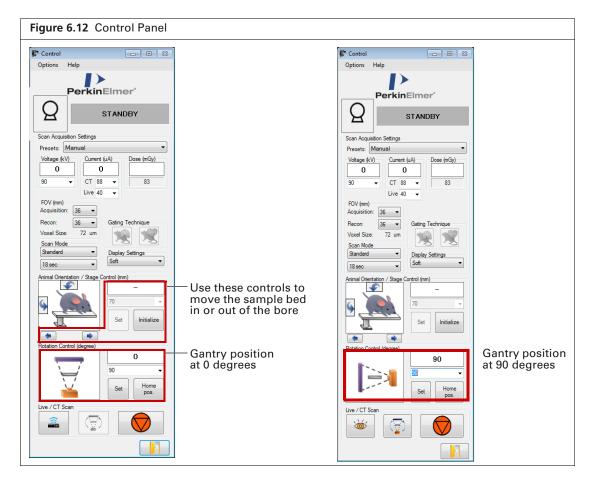


WARNING! If using the small bore cover with the mouse bed, watch through the front viewing window when moving the bed right or left using the Stage X-axis control buttons on the front panel (Figure 6.11). Make sure the bed does not hit the bore cover.

Figure 6.10 Xcapture Window Respiratory gating is selected in this example. Xcapture File Options Display Help Image data bounding box Image data outside the bounding box are not used in the reconstruction. Gating bounding box positioned around the diaphragm View= 1/533 Movie Photo Play X=--- Y=---

- **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 6.11) 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 6.12).
  - Move the sample bed a specific distance by entering a distance (mm) and click Set (Figure 6.12).





- **8.** Check the subject position in the Xcapture window at the 0 degree gantry position:
  - a. Select "0" from the Rotation Control drop-down list.
  - **b.** Click **Set** (Figure 6.12).
  - **c.** If necessary, use the stage X-axis controls on the imaging system front panel to center the subject in the Xcapture window (Figure 6.12).
- **9.** Check the subject position in the Xcapture window at the 90 degree gantry position:
  - **a.** Select "90" from the Rotation Control drop-down list and click **Set** (Figure 6.12).
  - **b.** If necessary, use the stage Y-axis controls on the imaging system front panel to center the subject in the Xcapture window (Figure 6.11).
- **10.** Click the button to turn off Live Mode and close the Xcapture window.



NOTE: Live Mode automatically times out after 150 seconds.

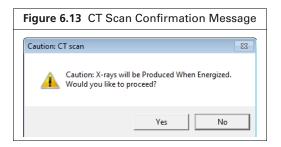
# 6.6 CT Scan Without Gating

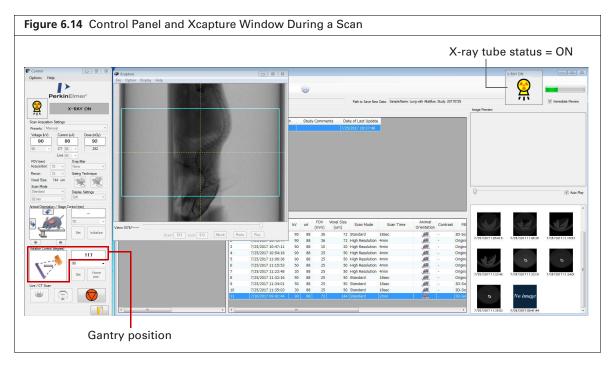
- IMPORTANT: If you need to abort acquisition and stop X-ray generation, click the emergency stop button in the Control Panel.
- 1. Click the CT Scan button ( to begin the scan.
- 2. Click Yes in the confirmation message that appears (Figure 6.13).

X-rays are energized as indicated by the blinking voltage icon and the imaging system status box (Figure 6.14). 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 6.15). See Chapter 7 on page 71 for more information on viewing 3D reconstructions.





**3.** Remove the subject from the sample chamber after the Quantum GX2 microCT is in Standby mode.



CAUTION: Do not remove or change the bore cover until the Quantum GX2 microCT is in standby mode and the CT scan button ( becomes available.

Figure 6.15 AutoViewer

| Figure 6.15 AutoViewer does not automatically appear, confirm that the AutoView option is selected in the Database window.



**NOTE:** A subvolume or slice(s) of a 3D reconstruction can be reconstructed at higher resolution (smaller pixel size). See page 58 for more details.

# **6.7 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.** Click the respiratory gating button **1.**
- 2. Turn on Live Mode by clicking the button in the Control Panel.

  The Xcapture window appears and shows the subject in real time (Figure 6.16).
- **3.** Adjust the ROI dimensions in the Xcapture window so that the ROI is positioned over the diaphragm.
- **4.** Rotate the gantry 90 degrees. Ensure that the subject is within the field of view and the ROI is correctly positioned over the diaphragm.
- **5.** Rotate the gantry back to 0 degree position.

Figure 6.16 Xcapture Window

Respiratory gating is selected in this example.

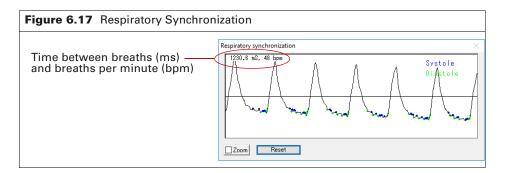
| Figure 6.16 Xcapture Window
| Respiratory gating is selected in this example.

| Figure 6.16 Xcapture Window
| Respiratory gating is selected in this example.

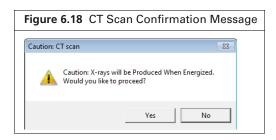
| Image data bounding box Image data outside the bounding box are not used in the reconstruction.

| ROI positioned over the diaphragm | Roise | Roise

**6.** Check the respiratory signal trace in the Respiratory Synchronization window (Figure 6.17). Trace spikes represent diaphragm movements. Wait for the breath rate to stabilize with longer than 1000 ms ±1 sec between breaths.

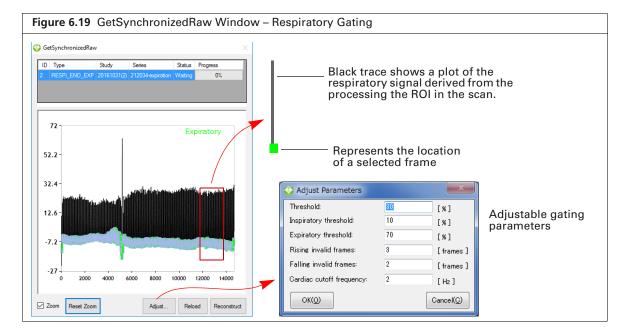


- 7. Click the CT Scan button to begin the scan and click Yes in the confirmation message that appears (Figure 6.13).
  - X-rays are energized as indicated by the blinking voltage icon and the imaging system status box (Figure 6.14). The Xcapture window opens, then gantry rotation and image acquisition begin.



**8.** Review the raw data in the GetSynchronizedRaw window (Figure 6.19). 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.



- **9.** If you want to filter the data:
  - a. Click Adjust (Figure 6.19).
  - **b.** Enter a new Threshold value (%) in the dialog box that appears and click **OK**. See Table 6.3 on page 55 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 6.15). See Chapter 7 on page 71 for more information on viewing 3D reconstructions.

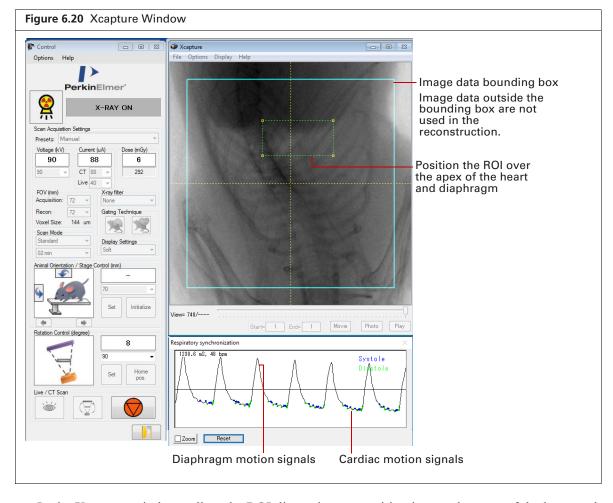
Table 6.3 Gating Parameters

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

# **6.8 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. Click the cardiac gating button.
- 2. Turn on Live Mode by clicking the button in the Control Panel.

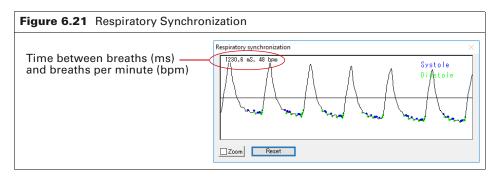
  The Xcapture window appears and shows the subject in real time (Figure 6.16).



- **3.** In the Xcapture window, adjust the ROI dimensions to position it over the apex of the heart and diaphragm.
- **4.** Rotate the gantry 90 degrees. Ensure that the subject is within the filed of view and the ROI is correctly positioned.
- **5.** Rotate the gantry back to 0 degree position.
- **6.** Check the respiratory and cardiac signal trace in the Respiratory synchronization window (Figure 6.21).

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 6.21). It may be possible to improve the signal visibility by adjusting the ROI position.

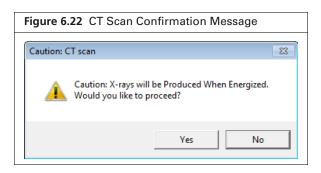
Wait for the breath rate to stabilize with longer than 1000 ms  $\pm 1$  sec between breaths.



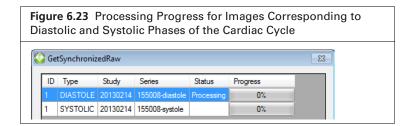
7. Click the CT Scan button to begin the scan.

8. Click Yes in the confirmation message that appears (Figure 6.13).

X-rays are energized as indicated by the blinking voltage icon and the imaging system status box (Figure 6.14). The Xcapture window opens, then gantry rotation and image acquisition begin.

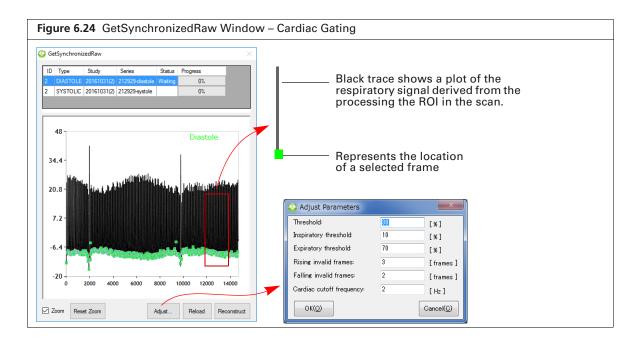


Progress indicators for image processing appear (Figure 6.23). The AutoViewer displays the 3D reconstruction (Figure 6.15) after processing is complete. See Chapter 7 on page 71 for more information on viewing 3D reconstructions.



**9.** Review the raw data in the GetSynchronizedRaw window (Figure 6.24). 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.



- **10.** If you want to filter the data:
  - a. Click Adjust (Figure 6.24).
  - **b.** Enter new values for Lower Breath (%) and/or Cardiac Cutoff Frequency (Hz) in the dialog box that appears and click **OK**. See Table 6.3 on page 55 for more details on gating parameters.



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

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



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

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

The 3D reconstruction proceeds. The AutoViewer displays the 3D reconstruction (Figure 6.15). See Chapter 7 on page 71 for more information on viewing 3D reconstructions.

# 6.9 Reconstructing a Subvolume or Slice

#### **Subvolume Reconstruction**



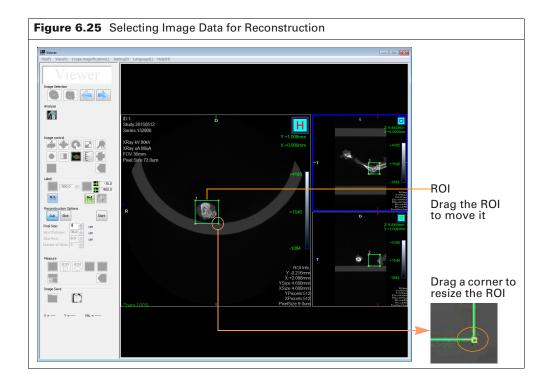
NOTE: If you will be performing subvolume reconstruction offline, ensure that the workstation meets the requirements in Table 5.1 on page 37. Set up and copy image data to the workstation following the instructions on page 38.

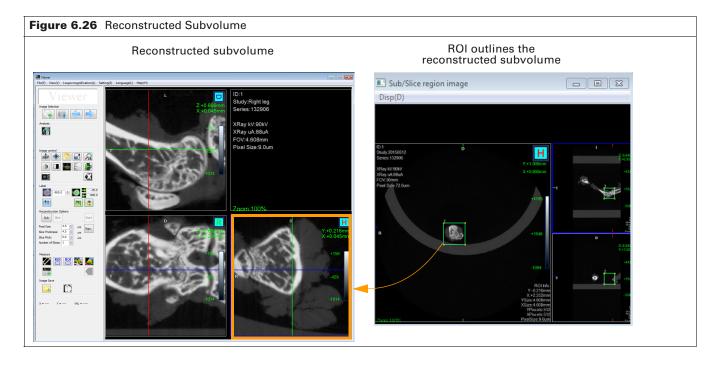
1. Load the data (double-click a thumbnail or series row in the Database window) and click An ROI on the images in the Viewer (Figure 6.25).



- 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 6.26).





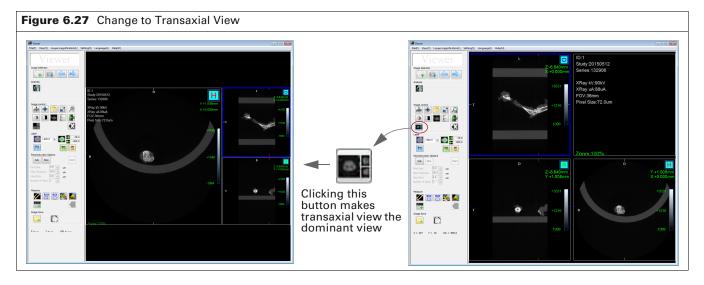
### Slice(s) Reconstruction



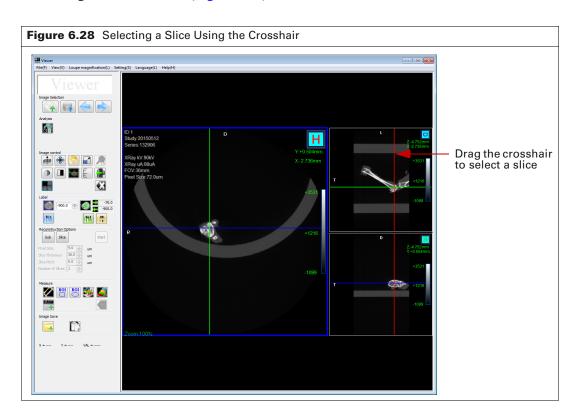
**NOTE:** If you will be performing slice reconstruction offline, ensure that the workstation meets the requirements in Table 5.1 on page 37. Set up and copy image data to the workstation following the instructions on page 38.

- 1. Load the data (double-click a thumbnail or series row in the Database window).
- 2. Click the button.

  The transaxial view becomes the main view (Figure 6.25).

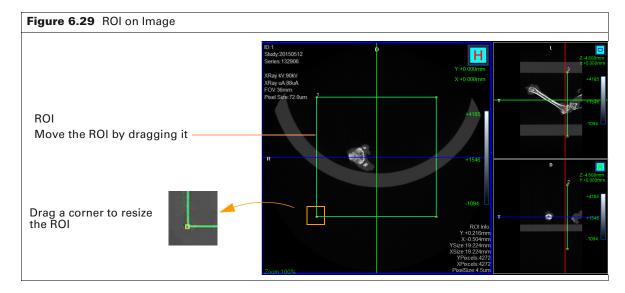


- **3.** Choose a slice by doing either of the following:
  - Click the button and scroll through the slices using the mouse scroll wheel.
  - Drag the red crosshair (Figure 6.28).



4. Click the slice button.

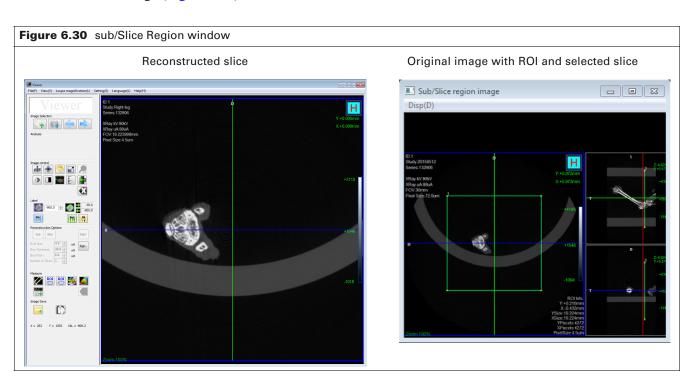
An ROI appears on the image (Figure 6.32). ROI size and position can be adjusted to select a portion of the slice for reconstruction.



- **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).

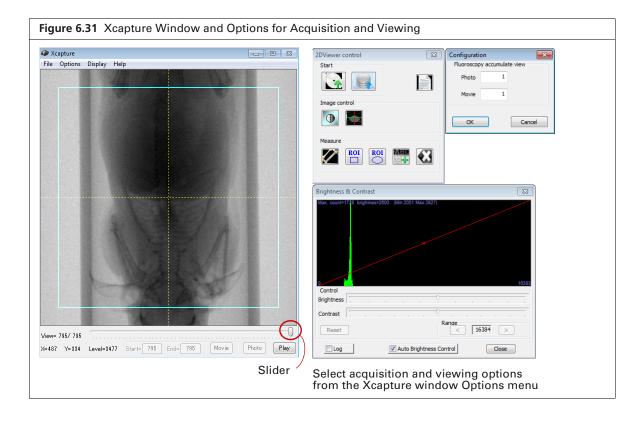
The Sub/Slice Region window shows the reconstructed slice(s) within the context of the original image (Figure 6.30).



# 6.10 Acquisition in 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 page 41 for details).
- **2.** Put the subject in the sample chamber and set the scan conditions. See *Place a Subject in the Sample Chamber* on page 47 and *Set the Scan Conditions* on page 43 for more details.
- 3. In the X-Capture window, move the slider to the first frame of the movie and click **Start** (Figure 6.31). Move the slider to the last frame of the movie and click **End**.
- **4.** Click **Play** to scroll through the selected frames.
- **5.** Click **Movie** to save the frames as a video in the current save location.



### Saving an Image

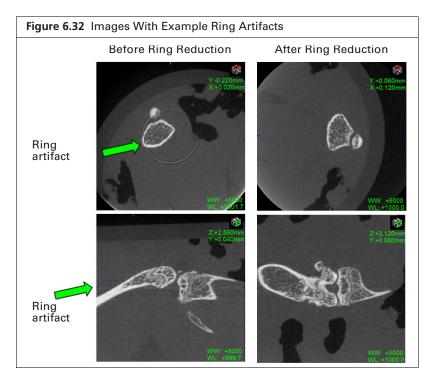
A single frame in the Xcapture window can be saved as a "snapshot" and stored in the database.

- 1. Select a frame using the slider in the Xcapture window.
- 2. Click Photo.

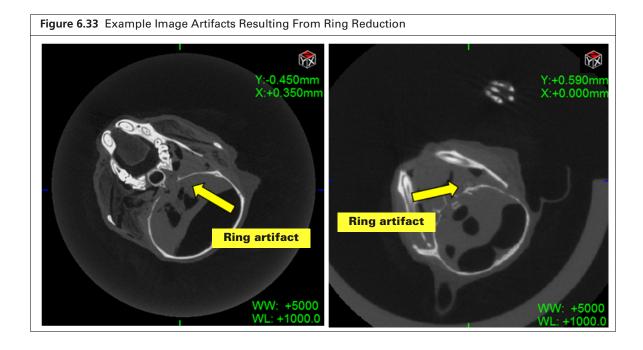
This saves the snapshot to the current save location.

# **6.11 Ring Reduction**

The ring reduction algorithm helps reduce image artifacts and is turned on by default. Figure 6.32 shows example images of before and after ring reduction.

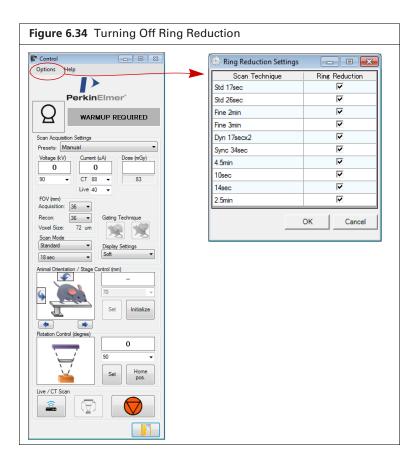


Sometimes ring reduction may result in image artifacts (Figure 6.33). The artifacts are usually minor. However, if they are unacceptable, you can turn off ring reduction and repeat the acquisition.



#### To turn off ring reduction:

- **1.** Select **Options**  $\rightarrow$  **Ring Reduction Settings** in the Control Panel (Figure 6.34).
- 2. Remove the check mark next to the scan technique that was used during acquisition and click OK.



# **6.12 Imaging With Different X-Ray Filters**

The Quantum GX2 microCT comes with five changeable X-ray filters which allow you to optimize imaging protocols.

#### To change the X-ray filter:

- **1.** Select the filter from the control panel.
- **2.** Remove the imaging bore cover.
- 3. Manually change the filter in the filter chamber inside the Quantum GX2 microCT imaging bore.
- **4.** Replace the bore cover and set up the imaging scan.

# **7** Viewing Images

Previewing Data

AutoViewer on page 66

Viewer and SimpleViewer on page 68

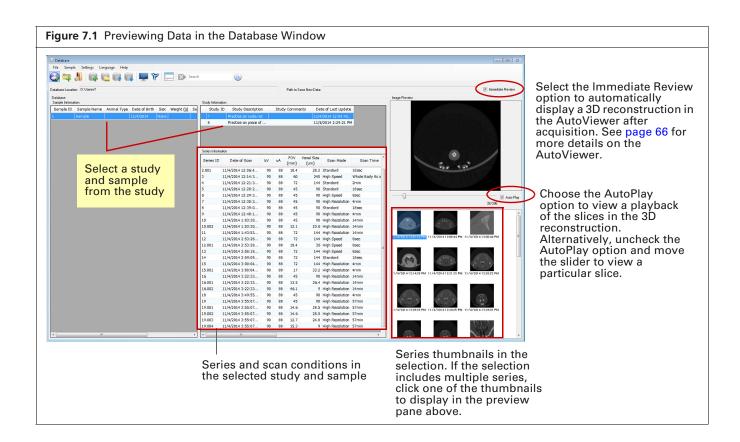
Viewing a Z-Axis Slice on page 71

# 7.1 Previewing Data

The Database window provides previews of 3D reconstructions.

Table 7.1 Previewing Data in the Database Window

Select:	To Preview:
Sample	The series from all studies under the sample (Figure 7.1).
Study	All series in the study.
Series	Series



View the data using one of the CT viewers (Table 7.2).

Table 7.2 CT Viewers

Viewer Name	Description	See Page
AutoViewer	The AutoViewer automatically appears after a scan and 3D reconstruction are completed. The AutoViewer enables you to:  • View 2D images (slices) in the x, y, or z-planes.  • Select other image data (.vox) for viewing.  • Print the current AutoViewer display.	Below
Viewer	Displays 2D image data. Double-click a series in the Database window to open the data in the Viewer. Alternatively, select a series and click the Run Viewer toolbar button . Use this viewer to visualize the 3D anatomical planes and perform basic 2D measurements.	68
3D Viewer	Enables rendering of a 3D reconstruction (classifying the data).	71



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

# 7.2 AutoViewer



**NOTE:** If the AutoViewer does not automatically appear after reconstruction, confirm that the Immediate Review option is selected in the Database window (Figure 7.1).

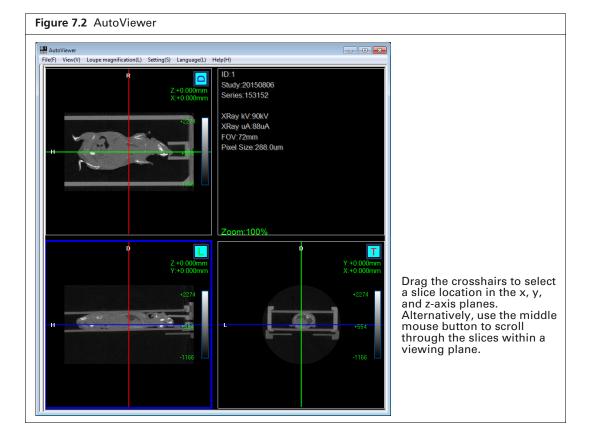
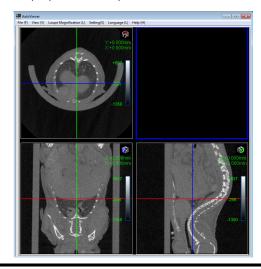


Table 7.3 AutoViewer Menu Commands

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
	Opens a dialog box that enables you to calibrate the Hounsfield Unit scale.
Setting → System Configuration	Choose this option to view the function key associations for quickly changing the window and level settings for image viewing.
View → Status Bar	Choose this option to show the x, y-coordinates of the mouse arrow in the AutoViewer window as well as the opacity value ("VAL").
$\textbf{View} \rightarrow \textbf{Horizontal View}$	Displays the x and y-axis views in a vertical orientation.
	### Autorinese  10.9 Van (1) Lings Magnifordins (3) Setting(3) Lenguage (3) Hole (14)  2.0 (0000mm)  2.0 (0000mm)  2.0 (0000mm)  2.1 (18)  3.1 (18)  4.1 (18)  4.1 (18)  5.1 (18)  5.1 (18)  5.1 (18)  6.1 (18

### $\textbf{View} \rightarrow \textbf{Vertical View}$

Displays the x and y-axis views in a horizontal orientation.



# 7.3 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 37. 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.

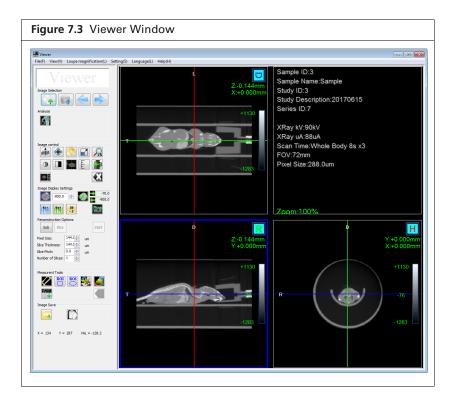


Table 7.4 Viewer Window

Item		Description
Image Selection	4	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 7.4 Viewer Window (continued)

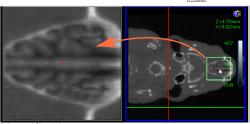
#### Item

#### Description

#### **Image Control**



Magnifies a selected area of the slice image. Right-click to select a different magnification (2x, 5x, or 10x). Alternatively, click the putton the to change magnification.



Area within the bounding box is magnified.

Magnified image area



Changes the window and level settings to change the image display. Use the keyboard up or down arrows. Alternatively, press and hold the mouse button while you drag the mouse up or down in a windowpane.



Reverses the gray scale color table. Click the button again to return to the default gray scale color table.



Show or hide the x and y-axis crosshairs.



Show or hide a scale bar in the windowpanes.



Toggles between a horizontal or vertical slice orientation.



Makes the transaxial view the main view in the Viewer.



Resets to the default slice view or the default display if the image has been rotated, translated, or scaled

#### Image Display Settings





Click the button to turn the mask off or on. Masks all voxels with gray scale value below the threshold value entered in the field.





Specifies a range of grayscale values for image display. Modify the range by editing the values in the fields. Click the button to turn the feature off or on.



When a mask is applied using the button (generates a purple mask), click the button to mask additional voxels at the edges of the mask. This can help sharpen visualization at edges such as around the animal skin.



When a mask is applied using the button (generates a green mask), click the move single pixel noise from the thresholded mask.



Enables you to select a 3D filter that removes noise by combining pixels and displaying the average intensity of the selected pixels:

EDGE – Enhancement filter that sharpen edges in the image and improves visualization of small features.

BONE – Enhancement filter that sharpens edges around high contrast objects such as bone.

ORIGINAL – Does not apply a filter. SOFT – Applies a 3 x 3 x 3 averaging filter.

SMOOTH - Applies a 5 x 5 x 5 averaging filter.



Click to select options for viewing a Z-axis slice. See page 71 for more details.

Table 7.4 Viewer Window (continued)

# Item Description

# Reconstruction Options



Places an ROI on an image that will be used to select the image data for reconstruction.



Places an ROI on an image that will be used to select the image data for reconstruction

Pixel Size – Pixel dimensions.

Slice Thickness - Voxel dimensions.

Slice Pitch - Distance between slices.

Number of Slices - The number of slices to reconstruct

Start

Starts the reconstruction.

# Measurement Tools



Click and drag to draw a measurement cursor on an image. Right-click a measurement cursor to delete the selected cursor or all cursors.



Draws a rectangular ROI on an image. Right-click an ROI to delete the selected ROI or all ROIs.



Draws a circular ROI on an image.



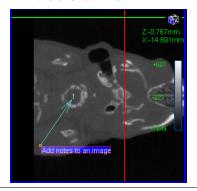
Displays a line graph of pixel intensities along a line segment drawn on an image.

- 1. Select a slice view.
- Click the button.The Line Profile window appears.
- 3. Press and hold the mouse button while drawing a line segment on the image. The Line Profile graph shows the pixel intensities along the line segment.
- 4. Drag either end of the line segment to resize or reposition the line segment. The graph is automatically updated.
- 5. Click the **M** button again to turn off and close the line profile graph.



Opens a dialog box that enables you to insert a comment on an image. To add a comment to an image:

- 1. Select a slice view.
- 2. Click the putton.
- 3. Enter text and click **OK** in the dialog box that appears.
- 4. To resize or reposition the arrow, drag the arrow tip or the arrow end. To move the arrow, drag the entire arrow.
- 5. To delete a comment or all comments, right-click a comment and select a delete option from the shortcut menu.



#### Image Save



Opens a Save As dialog box that enables export of the 3D reconstruction (.vox).

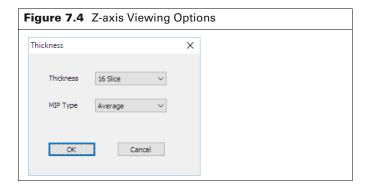


Copies the image to the system clipboard.

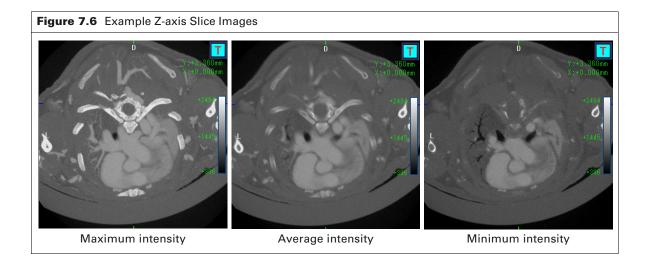
- X = Cross hair location in the X-plane.
- Y = Cross hair location in the Y-plane.
- VAL= Grayscale value at the crosshair location.

# Viewing a Z-Axis Slice

- **1.** Click the **button** in the Viewer.
- 2. Choose viewing options in the dialog box that appears and click **OK** (Figure 7.4).
  - 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







## 7.4 3D Viewer

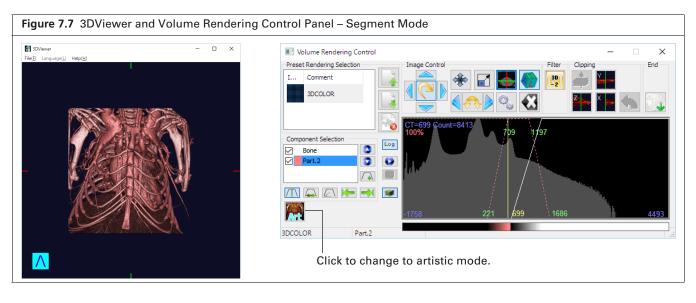
The 3D Viewer provides tools for rendering 3D reconstructions (classifying the image data and visualization) and viewing the 3D reconstruction from different perspectives. The volume rendering controls provide a histogram-based method for classifying the 3D reconstruction.

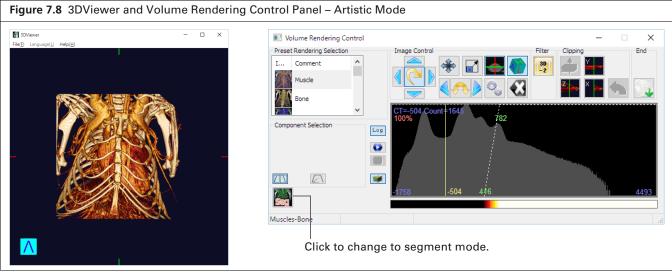


**NOTE:** If you will be viewing 3D reconstructions offline, ensure that the workstation meets the requirements in Table 5.1 on page 37. Set up and copy image data to the workstation following the instructions on page 38.

#### To open the 3D Viewer:

- 1. Double-click a thumbnail or series row in the Database window.
- 2. Click the button in the Viewer that appears,
  The Volume Rendering Control Panel and 3DViewer window appears (Figure 7.7).
  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.





## Table 7.5 Volume Rendering Controls Item **Description Preset Rendering Selection** Allows you to define components using a monochromatic color table. **Segment Mode** Type select Comment 3DCOLOR DW 3DCOLOR **Preset Rendering Selection** Choose from a selection of preset color tables. **Artistic Mode** ۸ Comment Muscle Bone Muscle Cardiac Vascular Vessels and organs are blue. Rainbow Grayscale Spectrum Perfusion Lighter color For blood palette than perfusion. monochrome. Green **Component Selection** Tools for classifying the image data. See page 76 for more details. Part select Part.2 Bone 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. Click a blue arrow to rotate the 3D reconstruction 90° about the x, y, or **Image Control** To freely rotate the 3D reconstruction about the x or y-axis: 1. Click the Putton. 2. In the 3DViewer, press and hold the mouse button while dragging the mouse.

Table 7.5 Volume Rendering Controls (continued)

# Item **Description** Click an arrow to rotate the 3D reconstruction about the z-axis. To freely rotate about the Z-axis: 1. Click the sarrow, then click an image. 2. Press and hold the mouse key while moving the mouse. Translates the slice image in the windowpane. Click the 🕻 button to return to the default view. Scales the slice image. Show or hide the x and y-axis crosshairs. Show or hide the perspective indicator in the 3D Viewer. Opens the Tool Box with controls for setting shading parameters and the level of details in static and moving images in the optional 3D Viewer. See Table 7.7 on page 79 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 3D -2 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 Hides all voxels to the left of the x-axis crosshair. X-axis crosshair

Table 7.5 Volume Rendering Controls (continued)

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

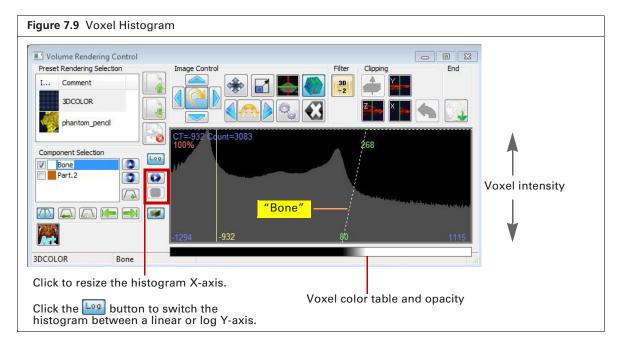
## Classifying Image Data Using the 3D Viewer

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

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

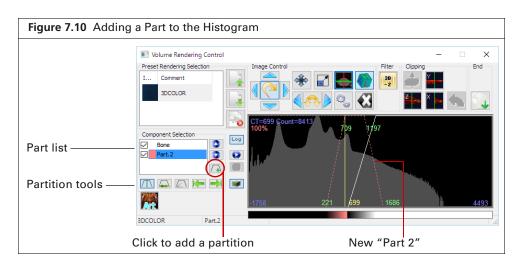


**NOTE:** This section explains how to classify data while in segment mode. The steps are the same in artistic mode.



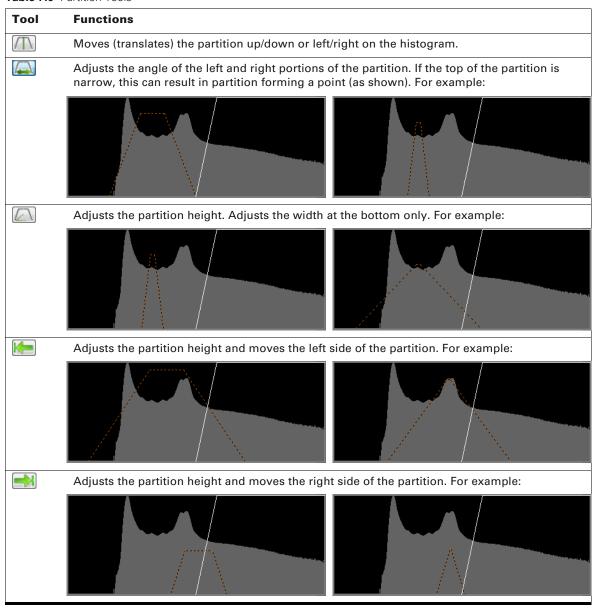
#### To classify a part of the data:

Click the Add Part button (Figure 7.10).
 A new partition appears in the histogram. The new part name is added to the part list.



- **2.** Modify the partition to visualize the tissue of interest using the tools partition tools (Table 7.6). 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 7.6 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.

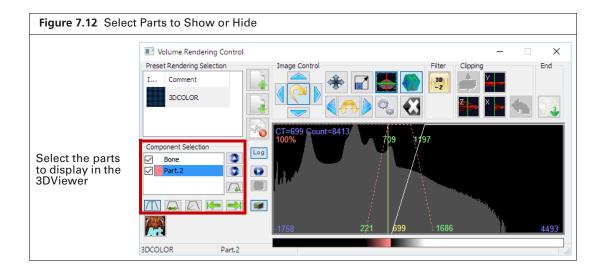


#### To edit a part name:

- 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 7.12).
- **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.

Table 7.7 Tool Box Settings

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

# **8** Care and Maintenance

Surveying the Quantum GX2 microCT for Radiation Leakage
Maintenance & Safety Checks
Cleaning the Quantum GX2 microCT on page 81

## 8.1 Surveying the Quantum GX2 microCT for Radiation Leakage

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

- Every 12 months
- After PerkinElmer 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 PerkinElmer technical support for information regarding these tests or for scheduling a PerkinElmertrained person to conduct the survey as part of an overall safety check.

# 8.2 Maintenance & Safety Checks



**NOTE:** There are no user-performed maintenance procedures.

# **Daily/Weekly Safety Checks**

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

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

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

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

### **Monthly Safety Checks**

Perform the following safety checks every month.

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



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

- **3.** Reset the X-Ray Emergency Off switch by turning the red knob clockwise. The knob should pop out.
- **4.** Restart X-ray generation from the Quantum GX2 microCT Imaging System 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.

## 8.3 Cleaning the Quantum GX2 microCT

## **Approved Cleaning Solutions**

The compounds shown in Table 8.1 do not damage the internal finish of the Quantum GX2 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 82.

Table 8.1 Acceptable cleaning solutions for the Quantum GX2 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)	Sporicidin International	
Clidox-s® Disinfectant	Pharmacal Research Laboratories, Inc.	



**NOTE:** PerkinElmer makes no claims as to the sterility of the Quantum GX2 microCT imaging chamber after using the solutions in Table 8.1. Please 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 GX2 microCT for immunodeficient animals to remove the risk of cross-contamination.

# **9** Legal Notices

Introduction
Limited Warranty
Trademarks on page 84
Disclaimers on page 85

#### 9.1 Introduction

This manual is provided to you by PerkinElmer Health Sciences, Inc. ("PEHS") on behalf of itself and its affiliates, including but not limited to, Caliper Life Sciences, Inc. ("Caliper"). PEHS and Caliper are referred to collectively throughout this manual as "PerkinElmer". Section 9.2 below provides the standard limited warranty for the System and any associated software

# 9.2 Limited Warranty

- **A.** Caliper Life Sciences, Inc. ("Caliper") provides the following limited warranty for each new Quantum GX2 microCT ("System") as follows ("Limited Warranty"):
  - i. PerkinElmer warrants that the System shall substantially conform to its published specifications existing at the time of purchase for a period of one (1) year following delivery to, and installation of, the System to the original customer, purchaser, or user ("Customer"). This Limited Warranty for the System extends only to the Customer. This Limited Warranty is not assignable or transferable to any successor, without the express written permission of PerkinElmer, which may be withheld in its sole discretion.
  - ii. During the Limited Warranty period, PerkinElmer will repair or replace, at PerkinElmer's sole option, any defective parts if such repair or replacement is needed because of System malfunction or failure during normal usage in accordance with the instructions in this manual. Repairs and replacements under the Limited Warranty will be made at PerkinElmer's expense. Parts replaced during this Limited Warranty period may be retained by PerkinElmer, at its sole option. All replacement parts will be warranted for the longer of the remaining term of the original Limited Warranty period, or for thirty (30) days from the date of replacement. PerkinElmer's limit of liability under the Limited Warranty shall be the purchase price of the System. PerkinElmer shall not be liable for any other losses or damages. These remedies are the Customer's exclusive remedies for breach of this Limited warranty.
  - **iii.** No coverage or benefits shall be provided under this Limited Warranty if any of the following conditions apply:
    - **a.** The System has been subjected to abnormal use, abnormal conditions, unauthorized modifications (e.g., unauthorized installation of hardware or software), unauthorized repair or servicing, misuse, neglect, abuse, accident, alteration, any use inconsistent with or in contradiction to the instructions in this manual, or other acts which are not the fault of PerkinElmer
    - **b.** PerkinElmer was not advised in writing by the Customer of the alleged defect or malfunction of the System within ten (10) days after the expiration of the applicable Limited Warranty period.
  - **iv.** If a problem develops during the Limited Warranty period, the Customer shall contact PerkinElmer technical support for assistance immediately following discovery of the problem.
- **B.** The following Limited Warranty provided by PerkinElmer is the sole and exclusive warranty applicable to the software provided with the System ("Software"):

- i. PerkinElmer warrants for a period of ninety (90) days that such software will conform to PerkinElmer's or the Software manufacturer's program manuals current at the time of shipment to Customer when properly installed; provided, however, that PerkinElmer does not warrant that the operation of the software will be uninterrupted or error-free. This Limited Warranty for the Software extends only to the Customer. This Limited Warranty is not assignable or transferable to any successor, without the express written permission of PerkinElmer, which may be withheld in its sole discretion.
- ii. Customer agrees that as PerkinElmer's sole liability and as Customer's sole remedy, PerkinElmer will provide services to correct documented and reproducible errors which PerkinElmer's diagnosis indicates are caused by a defect in an unaltered version of the Software; provided that Customer advises PerkinElmer of such malfunctions of the Software within ten (10) days after expiration of the applicable Limited Warranty period.
- C. THE FOREGOING LIMITED WARRANTY IS THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. PERKINELMER SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF ANTICIPATED BENEFITS OR PROFITS, LOSS OF SAVINGS OR REVENUE, PUNITIVE DAMAGES, LOSS OF USE OF THE SYSTEM OR ANY ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF ANY SUBSTITUTE EQUIPMENT OR FACILITIES, DOWNTIME, THE CLAIMS OF ANY THIRD PARTIES, INCLUDING CUSTOMERS, AND INJURY TO PROPERTY, RESULTING FROM THE PURCHASE OR USE OF THE SYSTEM OR SOFTWARE, OR ARISING FROM BREACH OF THE WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, STRICT TORT, OR ANY OTHER LEGAL OR EQUITABLE THEORY, EVEN IF PERKINELMER KNEW OF THE LIKELIHOOD OF SUCH DAMAGES. PERKINELMER SHALL NOT BE LIABLE FOR DELAY IN RENDERING SERVICE UNDER THE LIMITED WARRANTY, OR LOSS OF USE DURING THE PERIOD THAT THE SYSTEM OR SOFTWARE IS BEING REPAIRED. PERKINELMER DOES NOT REPRESENT OR WARRANT THAT THE EQUIPMENT OR SOFTWARE WILL BE FREE FROM DEFECTS, UNINTERRUPTED OR, ERROR-FREE.
- **D.** Some countries, states or provinces do not allow the exclusion or limitation of implied warranties or the limitation of incidental or consequential damages for certain products or the limitation of liability for personal injury, so the above limitations and exclusions may be limited in their application to you. When any implied warranties are not allowed to be excluded in their entirety, they will be limited to the duration of the applicable written warranty. This Limited Warranty gives you specific legal rights which may vary depending on local law.
- **E.** This Limited Warranty shall be governed by the laws of the Commonwealth of Massachusetts, U.S.A., excluding its conflicts of laws principles and excluding the United Nations Convention on Contracts for the International Sale of Goods.

#### 9.3 Trademarks

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# 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
Adapter (for use with FMT Mouse Imaging Cassette)	CLS136435

# **Appendix C** System Shutdown

PerkinElmer does not recommend power cycling the Quantum GX2 micro CT (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 GX2 micro CT 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, please contact PerkinElmer technical support (see page 4) 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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