Caliper LifeSciences

System Manual

Quantum FX µCT

PN 128059_Rev00

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1 Welcome

1.1 Introduction

The Quantum FX µCT is a high-speed CT system used for small animal X-ray imaging. It uses a high cone beam X-ray source and a flat panel X-ray detector to produce high resolution 3D images of mouse bone structure and surrounding soft tissue. It incorporates a fast processing board on the PC which provides a 45 second reconstruction speed with 512 slices of CT images. This system manual explains the system components, applicable user warnings, hazard notices, and the care and maintenance of the instrument (Figure 1.1).

Figure 1.1 Quantum FX µCT instrument

The Quantum FX µCT is an integrated imaging system that includes:

- The module for X-ray imaging.
- The Quantum FX Software for automated image acquisition, post-processing, and data analysis.
- A Windows®-based computer system for data acquisition and analysis.

This manual explains how to operate and maintain the equipment, and provides guidelines for obtaining CT images. Before using the Quantum FX µCT, please read this manual carefully to obtain safe, optimum performance and a maximum service life from the instrument.

For instructions on using the acquisition software, please see the *Quantum FX* µCT *Software User's Manual*.

If you have questions regarding this manual or the Quantum FX µCT, please contact Caliper technical support.

1.2 Caliper Technical Support

Telephone:	1.877.522.2447 (US)
	1.508.435.9500
E-mail:	tech.support@caliperLS.com
Fax:	1.508.435.3439

2 Important Safety Instructions

2.1 Safety Information

This manual provides safety information in the following formats:

CAUTION

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 instrument. 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 FX µCT. If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

WARNING

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

VOLTAGE

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

2.2 Safety Symbols

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

Table 2.1 Safety symbols

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

2.3 Instructions

WARNING

WARNING! The Quantum FX µCT should be operated only by personnel who have been trained in radiation safety and the operation and safety instructions contained in this manual. Caliper 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 FX µCT. 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 FX µCT.

2.4 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 & Radiation Hazards*, page 15. DO NOT operate the Quantum FX µCT unless an X-ray safety survey has been performed within the last 12 months. For more information, please contact Caliper technical support.

An X-ray safety survey must be performed when the instrument is installed or after it has been moved. A survey is also to be performed when the Quantum FX µCT 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

WARNING! For radiation survey of the Quantum FX µCT, please comply with your own laboratory radiation regulations or contact Caliper technical support for further assistance.

Owners and operators of the Quantum FX µCT 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 instrument. Equipment registration may be required immediately or within 30 days of acquiring the equipment.

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

WARNING

WARNING! A Caliper employee will conduct a radiation leakage survey and safety tests when the Quantum FX µCT is installed. Caliper 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 Caliper employee survey the installation before operating the instrument.

WARNING

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 tube 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.

2.5 Environmental Considerations for the System Components

Locating the Quantum FX µCT

Before the Quantum FX µCT is installed, consider the proper environment for the components.

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.
- No open flame is present.
- There is sufficient space behind the Quantum FX µCT equipment. A minimum space of four inches from the flat surface of the rear panel should be provided behind the Quantum FX µCT to provide unobstructed air flow and access to the main power on/off switch.
- The work space is level.

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 & Moisture

VOLTAGE

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.

2.6 Cleaning or Moving the System Components

Cleaning/Liquid Entry

VOLTAGE

VOLTAGE! Do not use liquid or aerosol cleaners and never spill liquid of any kind on any of the Quantum FX µCT components. Sprays and liquids that come into contact with the Quantum FX µCT hardware may result in damage to the system or electrocution. For more details on proper care of the system, see *Cleaning the Quantum FX µCT*, page 34.

Moving the Quantum FX µCT

WARNING

WARNING! Only Caliper employees are authorized to move the Quantum FX µCT instrument.

2.7 Power Considerations

Power Sources

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

VOLTAGE

VOLTAGE! The Quantum FX µCT can operate at multiple voltages (100-240 VAC); 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 Caliper technical support.

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.

Lightning & Power Line Surges

The Quantum FX µCT 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 FX µCT 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

WARNING! Do not overload wall outlets, extension cords, or integral convenience receptacles as this can result in a risk of fire or electric shock. For more details on the power requirements of the Quantum FX µCT system, see Chapter 6, page 25.

Facilities should be adequately wired according to local building codes.

WARNING

WARNING! The Quantum FX µCT 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

WARNING! Portable and mobile RF communications equipment can affect the Quantum FX µCT system.

WARNING

WARNING! The Quantum FX µCTsystem 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.

2.8 Servicing

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

2.9 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 FX µCT in ANY manner by making any kind of hole or aperture in the instrument or removing any component of the radiation shielding.

3 Warnings

3.1 Electrical Safety

VOLTAGE

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

CAUTION

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.

3.2 X-Ray Safety

WARNING

WARNING! This equipment produces X-rays when energized.

WARNING

WARNING! The Quantum FX µCT should be operated only by personnel who have been trained in radiation safety and the operation and safety instructions contained in this manual. Caliper 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.

3.3 Mechanical Safety

The Quantum FX µCT is heavy and weighs 470 kg. The Quantum FX µCT 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

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

CAUTION

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

CAUTION

CAUTION! Slide the sample bed completely into the gantry when closing the door of the sample chamber. Closing the door without sliding the bed all the way into the gantry may result in contact with the slide rail, potentially misaligning the sample stage attachment.

CAUTION

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.

DANGER

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

CAUTION

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

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

CAUTION

CAUTION! If gas anesthesia is to be used, the XGI-8 Gas Anesthesia System and the Mouse Imaging Shuttle are recommended. Ensure adequate ventilation before using gas anesthesia equipment. See page 31 for more details on the use of the transfer bed and Mouse Imaging Shuttle.

CAUTION

CAUTION! Use the attachment screws to attach the bore cover to the gantry arm. Loose attachment screws or incomplete attachment of the bore cover may result in damage to the bore cover during imaging.

CAUTION

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.

3.4 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 FX µCT before requesting service by Caliper 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

CAUTION! Do not use this system for medical purposes such as diagnosis or treatment.

3.5 Access Panels

There are no user serviceable components in the lower electronics area, or in the side and rear panels of the Quantum FX µCT. Do not remove the electronics tray from the Quantum FX µCT or the cover from the light source module unless you are instructed by and under the supervision of a Caliper technical service representative.

Do not modify the Quantum FX µCT in ANY manner by making any kind of hole or aperture in the instrument or removing any component that is part of the radiation shielding.

WARNING

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

WARNING CONCERNING BERYLLIUM INJURY! 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).

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4 Legal Notices

4.1 Limited Warranty

Caliper Life Sciences, Inc. ("Caliper") provides the following limited warranty for each new Quantum FX µCT ("System") as follows ("Limited Warranty"):

i. This Limited Warranty for the System extends to the original purchaser ("Customer") for a period of one (1) year following installation of the System, and is not assignable or transferable to any successor.

ii. During the Limited Warranty, Caliper will repair or replace, at Caliper's sole option, any defective parts if such repair or replacement is needed because of System malfunction or failure to confirm to published specifications during normal usage in accordance with the instructions in this manual. Repairs and replacements under the Limited Warranty will be made at Caliper's expense. Caliper's limit of liability under the Limited Warranty shall be the purchase price of the Imaging System. Caliper 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 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 Caliper.

b. Caliper was not advised in writing by the Customer of the alleged defect or malfunction of the System within the earlier to occur of ten (10) days after the expiration of the Limited Warranty period, or 15 days after becoming aware of the defect or malfunction.

c. If Customer moves the System from its installed location to another location without Caliper's technical assistance, then any damage to the System due to such movement shall not be covered under the initial warranty or any extended warranty, and Licensee shall pay Caliper's standard service rates for repair of such damage.

iv. If a problem develops during the Limited Warranty, the Customer shall contact Caliper technical support for assistance.

v. THE FOREGOING LIMITED WARRANTY IS THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. CALIPER 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 ARISING FROM BREACH OF THE WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, STRICT TORT, OR ANY OTHER LEGAL OR EQUITABLE THEORY, EVEN IF CALIPER KNEW OF THE LIKELIHOOD OF SUCH DAMAGES. CALIPER SHALL NOT BE LIABLE FOR DELAY IN

RENDERING SERVICE UNDER THE LIMITED WARRANTY, OR LOSS OF USE DURING THE PERIOD THAT THE SYSTEM IS BEING REPAIRED.

vi. 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.

vii. This Limited Warranty shall be governed by the laws of the State of California, U.S.A., excluding its conflicts of laws principles and excluding the United Nations Convention on Contracts for the International Sale of Goods.

4.2 Trademarks

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

5 X-Ray Safety & Radiation Hazards

5.1 Introduction

The Quantum FX µCT produces X-rays when the X-ray function has been energized and initiated. The Quantum FX µCT 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. Caliper certifies the Quantum FX µCT 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 FX µCT meets all US (FDA) regulations regarding a cabinet X-ray system.

5.2 Effects of Radiation

The Quantum FX µCT 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

WARNING! This product produces X-rays. Do not attempt to open the Quantum FX µCT 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

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 Caliper technical support.

WARNING

WARNING! Do not, for any reason, attempt to defeat the built-in safety interlocks described in *Safety Features & Safety Systems*, page 16. Operating the Quantum FX µCT 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 Caliper technical support.

5.3 X-Ray Dose Limits

A sample of Caliper Model Quantum FX µCT has been tested at maximum operating conditions. Caliper has determined the local X-ray dose rate at a distance of 5 cm from the surface of the equipment is less than 1.0 µSv/h.

Caliper declares that the Product Quantum FX µCT system conforms to:

1. 1996/29/Euratom Directive (Dose rate of 1 µSv/h at 10 cm from any accessible surface under normal operating conditions)
2. 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)

Caliper certifies that Quantum FX µCT system has achieved the objectives of:

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

5.4 Safety Features & Safety Systems

The Quantum FX µCT 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.

Caliper 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.

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

WARNING

WARNING! A Caliper employee will conduct a radiation leakage survey and safety tests after the Quantum FX µCT is serviced by Caliper. Caliper 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 Caliper 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.

For more information, see *Conducting the X-Ray Radiation Survey*, page 33.

5.5 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 FX µCT 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.

Caliper certifies that the Quantum FX µCT meets the Japanese standard JAIMAS0101-2001 with respect to X-ray containment. Caliper certifies that the Quantum FX µCT complies with FDA regulation CFR 1020.40 after installation at the customer's site. Caliper also certifies that the instrument meets all of the International regulations of the country where it is installed.

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6 Quantum FX µCT Components & Specifications

6.1 Quantum FX µCT System Components

The Quantum FX µCT is a CT imaging system that consists of a moveable sample holder surrounded by a rotating gantry. 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. Two bore sizes are available depending on the magnification chosen: 70 or 200 mm.

Figure 6.1 Quantum FX µCT Instrument System

Figure 6.2 Standard Accessories

Figure 6.3 Quantum FX µCT System Components

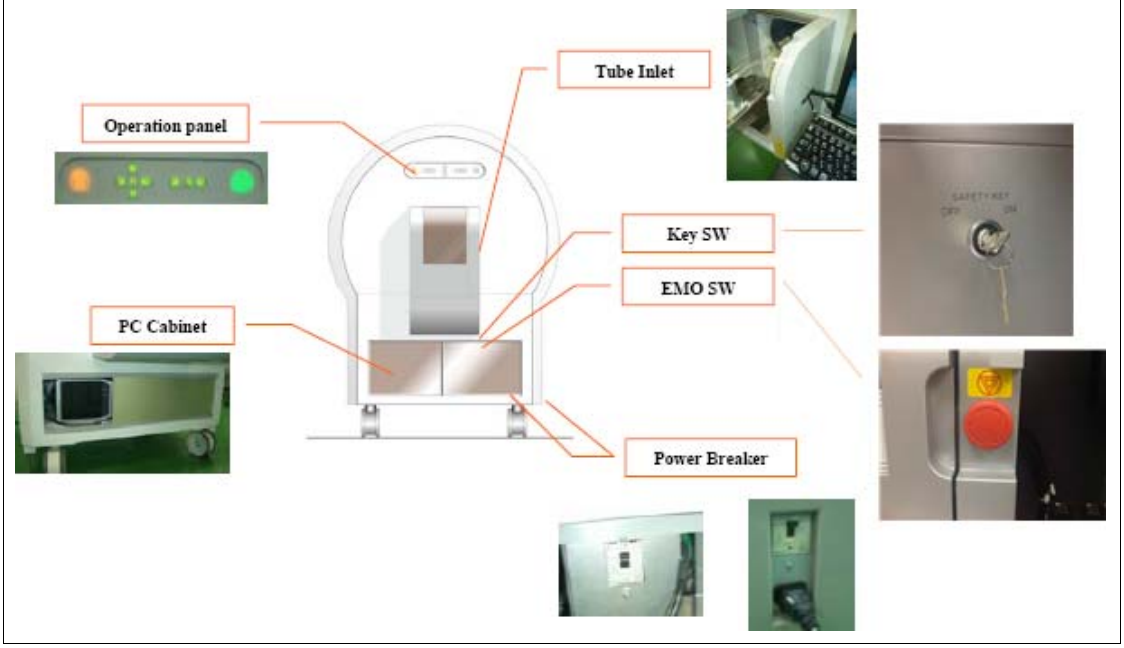


Figure 6.4 Quantum FX µCT Front Panel

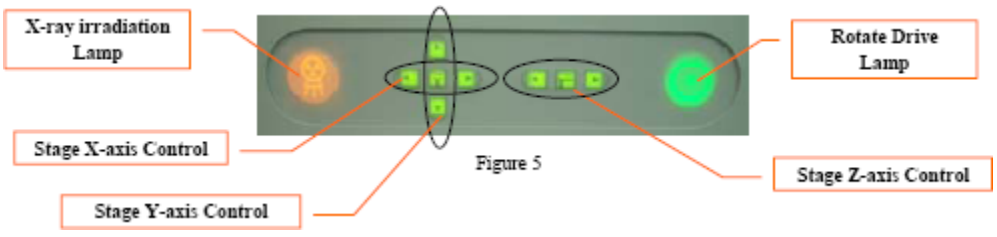


Figure 6.5 Quantum FX µCT Sample Chamber

6.2 Placing Samples in the Sample Chamber

1. Select the appropriate bore cover for the sample.

   Standard bore —193 mm inner diameter

   High resolution—65 mm inner diameter

2. Select a bore cover.
3. Manually slide the sample bed to the out-limit position (Figure 6.6). Alternatively, press the stage control buttons on the instrument front panel to move the sample bed.

Figure 6.6 Sample Bed at the Out-Limit Position

4. Place the sample on the sample bed.
5. Move the sample or the sample stage so that the measurement site is located on the center line.
6. The center line (dashed-dotted line) and the FOV range for each magnification are printed on the sample bed. Adjust the sample position so that the measurement site is in the FOV range.
7. Manually slide or use the stage control buttons on the instrument front panel to move the sample bed into the gantry.
8. Close the sample chamber door.

6.3 Control Software Panel

1. Log on to the Quantum FX µCT workstation (enter user ID: "CTadmin", password: "ct2admin").

   The control panel appears (Figure 6.7).

Figure 6.7 Control Panel Functions

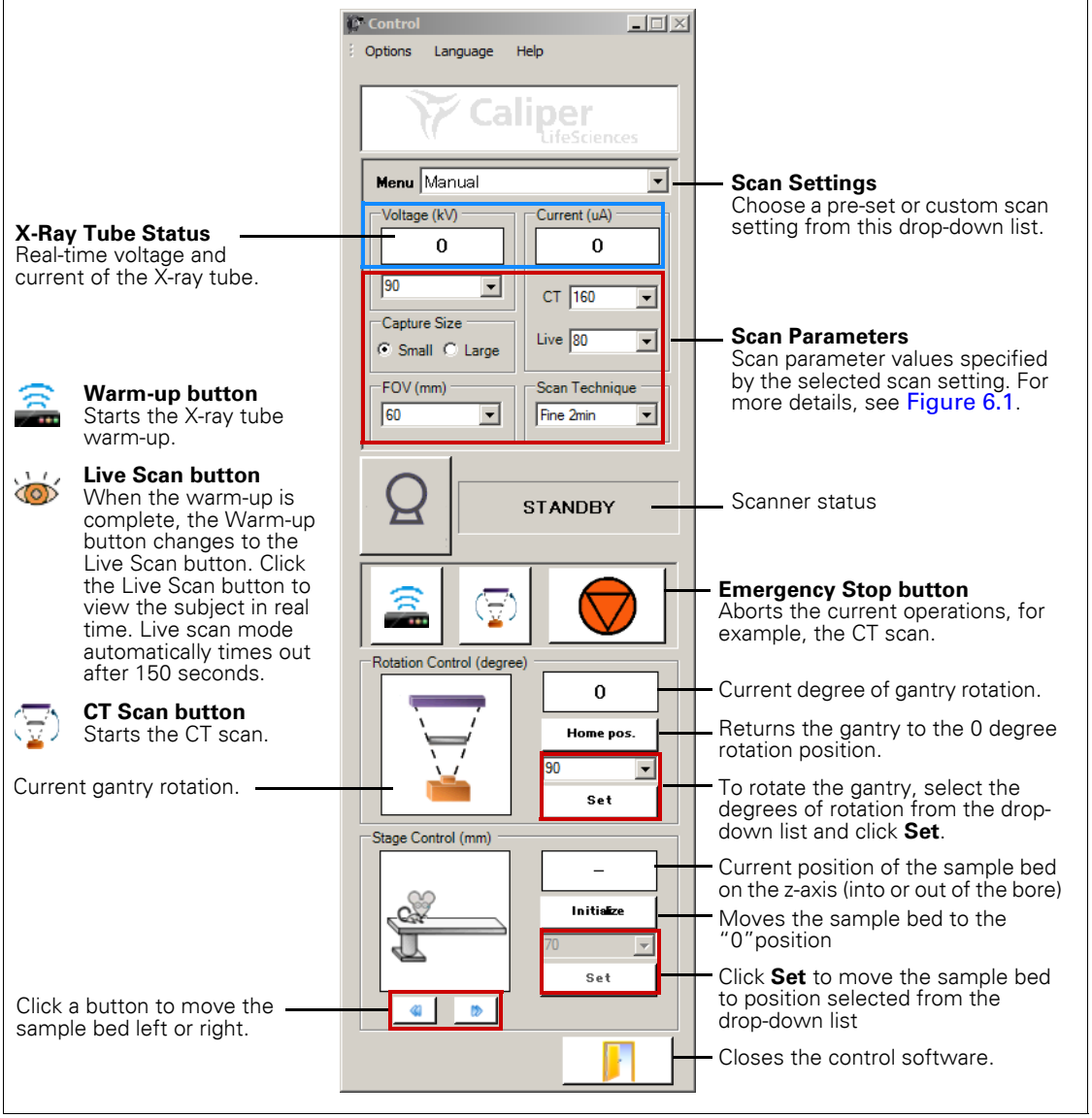


Table 6.1 Scan Parameters

Scan Parameter	Description
Voltage	Variable voltage up to 90 kV
CT	Variable current up to 200 µA
Capture Size for Live Mode Viewing	Small or Large
Live	Variable current
FOV (mm)	Variable 10 - 73 mm

Table 6.1 Scan Parameters (continued)

Scan Parameter	Description
Scan Technique	Standard or Fine for all FOV
	Dynamic Sync for 60 and 73 mm

Table 6.2 X-ray source specifications

Item	Description
High Voltage Potential	90 kV
Maximum Current	200 µA
Anode Type	Tungsten
Window	Beryllium
Spot Size	50 µm
Cone Angle	30 degrees
Field of View	Variable, up to 2.3 cm
Filter	Aluminum,100 µm
	Copper, 60 µm
	Acrylic, 2 mm

6.4 X-Ray System Control Panel

The front panel located under the door of the imaging chamber has two switches and two indicator lights associated with the X-ray function of the instrument. The main ON/OFF switch that controls the electrical power to the full instrument is on the rear of the Quantum FX µCT. Activation of this switch provides power to the instrument, but does not permit energizing the X-ray source unless the following conditions have been met:

1. The sample chamber door is completely closed and the door handle is in the completely locked position.
2. The Emergency OFF switch is in the ON (out) position. See the note below.
3. The key selector switch is turned ON.
4. All access panels are secured.

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

NOTE

The Emergency OFF switch 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. Under normal circumstances, it should be left in the ON position and left as is.

Figure 6.8 Emergency Stop button on the Quantum FX µCT Front Panel

6.5 Key Selector Switch & Lost Keys

X-ray safety regulations require controlled access to the Quantum FX µCT. The objective of this requirement is to prevent untrained and unauthorized personnel from operating the X-ray functionality of the instrument. The key-operated switch on the Quantum FX µCT 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 switch is designed so that the key cannot be removed except in the OFF position. When the authorized user is finished using the instrument, the key is removed from the switch. Two keys are provided with the instrument, and it is a good practice to archive the spare key. If the keys are lost, contact Caliper technical support.

6.6 System Scanning System Specifications and Acquisition Computer

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

Scanning System Specifications

Scanner Item	Description
Power requirements	100/120V, 8A, 50/60 Hz 240V, 4A, 50/60 Hz
Dimensions	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 family operating system
- Quantum FX µCT control software

- CD-burner installed for data storage and transport
- Network ready
- 20" high-resolution flat screen monitor for image viewing
- Microsoft® Office installed

Computer Specifications

Computer	Description		
Power requirements	1.0 A at 120 V	0.5 A at 240 V	50-60 Hz
Dimensions	15.75″ x 17″ x 4.75″	40 cm x 44 cm x 12 cm	
Weight	22 lbs	10 Kg	

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	

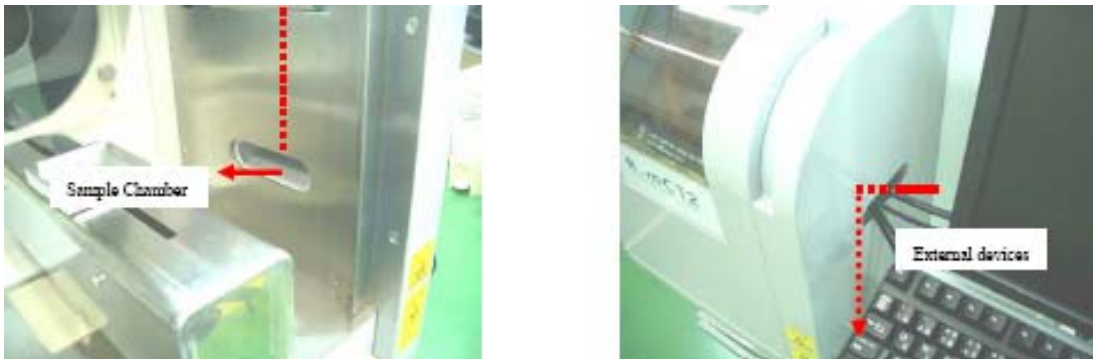
6.7 Environmental Requirements

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

6.8 Procedures for Using the Tube Inlet

The Quantum FX µCT is equipped with a tube inlet for use with external devices such as the XGI-8 Anesthesia System or angiographic injectors that are inserted into the sample chamber or gantry (Figure 6.9). Tubing for the transfer bed is included (for more details, see page 31).

Figure 6.9 Tube Inlet



CAUTION

CAUTION! Cable disconnection may be caused by the inserted tubes or cables touching the electric table. Bind the rubes and cables together.

CAUTION

CAUTION! Image quality may be affected by contrast media or anesthesia that adheres to 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

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

7 Operating the Quantum FX µCT

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

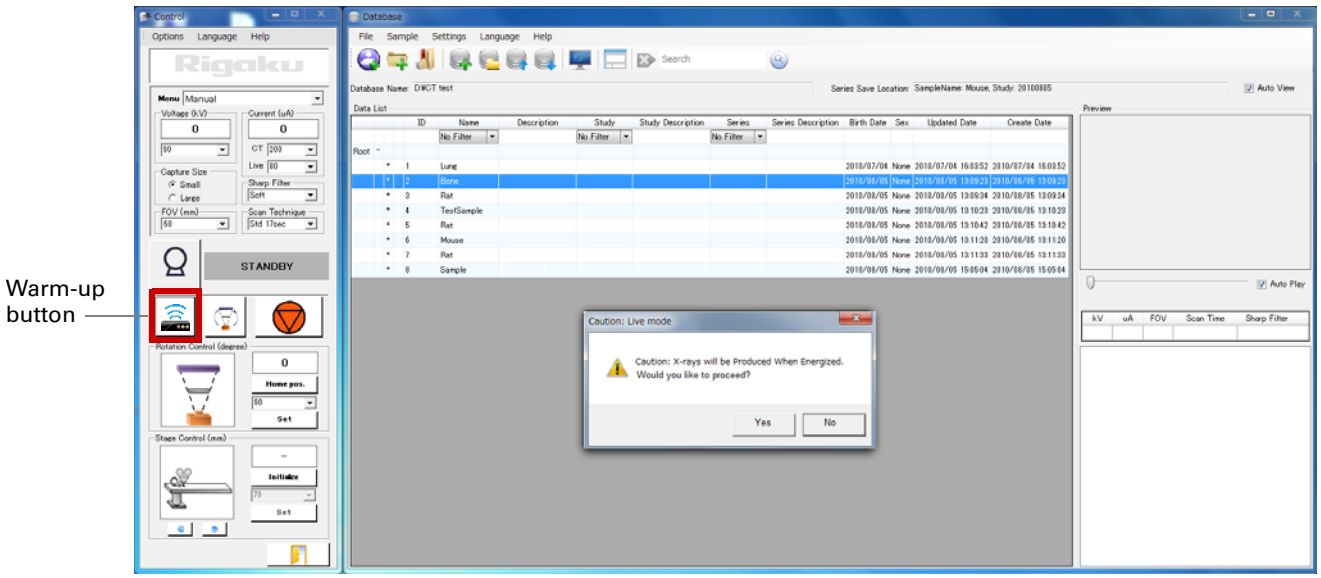
7.1 Acquiring Images On the Quantum FX µCT Scanner

NOTE

All components of the Quantum FX µCT should be left on at all times. Periodically rebooting the computer is permissible and does not affect the camera operation.

1. Log on to the Quantum FX µCT workstation (enter user ID: "CTadmin", password: "ct2admin"). The control panel and Database window appear (Figure 1).

Figure 1 Control Panel and Database Window



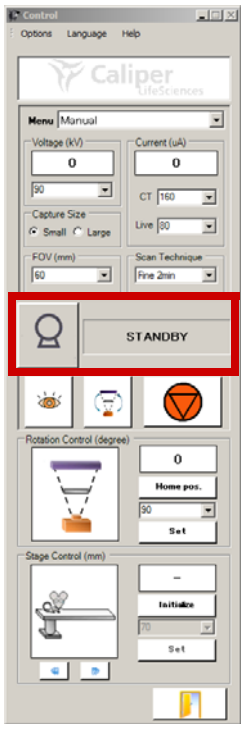
2. Confirm that the instrument door is properly closed.

NOTE

The Quantum FX µCT instrument does not generate X-rays unless the door is properly closed and the safety interlock is engaged. When sliding the door closed, you will hear an audible "click" when the safety interlock engages.

3. Click the button to begin instrument warm-up. Warm-up is completed when "STANDBY" appears in the control panel (Figure 2).

Figure 2 Control Panel—Warm Up Completed



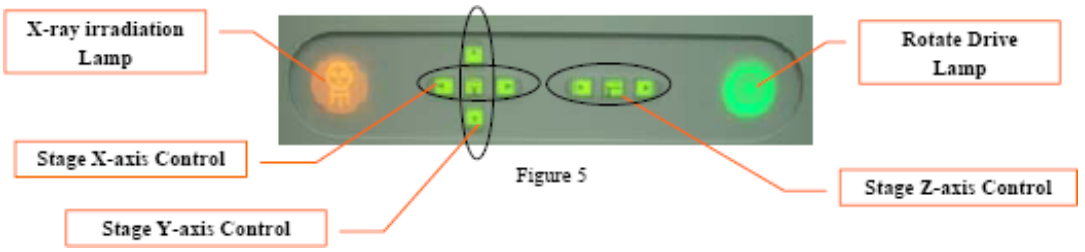
4. Specify where to save the image data (*series*). In the Database window:
   a. Connect to a database or create a new database.
   b. Select a sample or create a new sample.
   c. Select a study or create a new study.
   d. Click the button to set the location for saving data.
5. Slide open the Quantum FX µCT door and pull out the sample table.
6. Place the anesthetized subject on the sample bed. (For more details, see the *Quantum FX* µCT *System Manual*, part no. 128059_Rev0A.)

   If you are using the Mouse Imaging Shuttle, place the shuttle with the anesthetized subject on the sample bed. If needed, connect the gas anesthesia tubing.

   Push the sample table into the bore and slide the instrument door closed so that the interlock is properly engaged.
7. Turn on Live Mode (click the button).

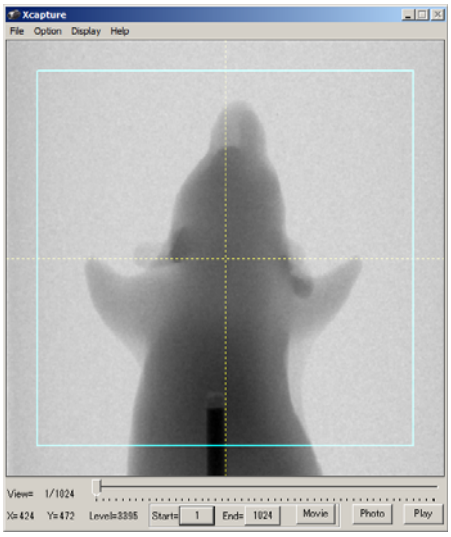
   The Xcapture window appears and shows the subject in real time.
8. Use the stage Z-axis controls on the front panel of the instrument to move the sample bed into the bore. Press and hold the Fast button + Z-axis left/right arrow (Figure 3).

Figure 3 Quantum FX µCT Front Panel



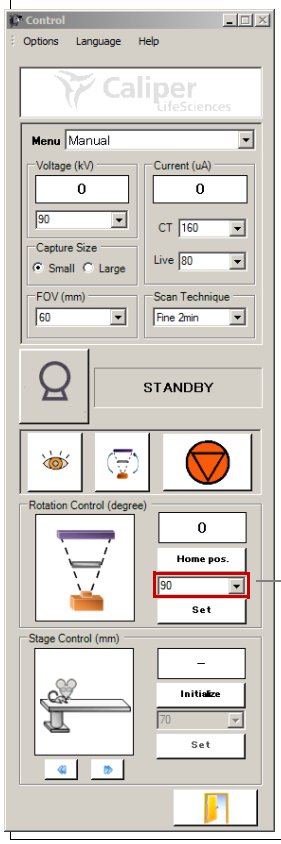
9. Check the subject position in the Xcapture window at the 0 degree gantry position. If necessary, use the stage X-axis controls on the instrument front panel to center the subject in the Xcapture window (Figure 3).

Figure 4 Xcapture Window



10. Check the subject position in the Xcapture window at the 90 degree gantry position. To do this, select "90" from the Rotation Control drop-down list and click **Set**.(Figure 5). If necessary, use the stage Y-axis controls on the instrument front panel to center the subject in the Xcapture window (Figure 3).

Figure 5 Control Panel



Rotation Control drop-down list
Gantry position set to 90 degrees.

11. If necessary, turn off Live Mode (click the button).

NOTE

Live Mode automatically times out after 150 seconds.

12. In the control panel, choose a preset acquisition or select “Manual” from the Menu drop-down list and enter the acquisition settings.
13. Click the CT Scan button .
14. After acquisition is complete, double-click the series (row) in the Database window to view the image data.

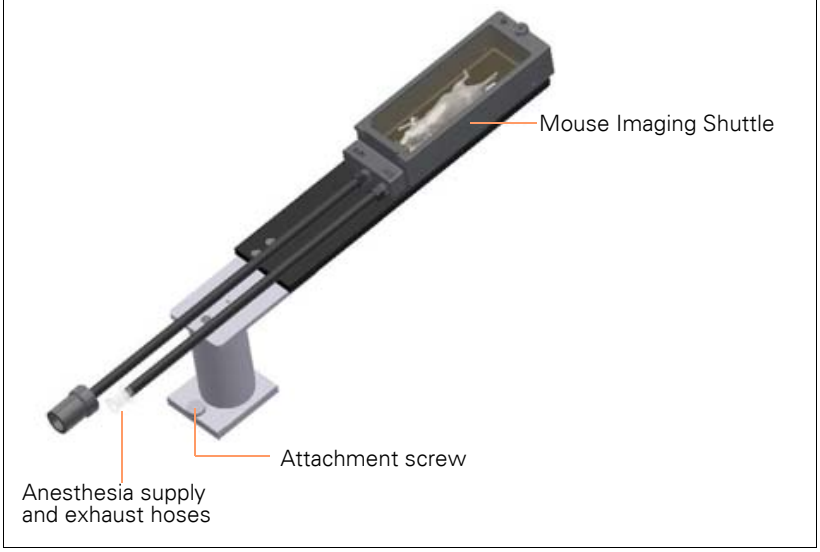
7.2 Door Operation

The Quantum FX µCT 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.

7.3 Using the Transfer Bed and Mouse Imaging Shuttle

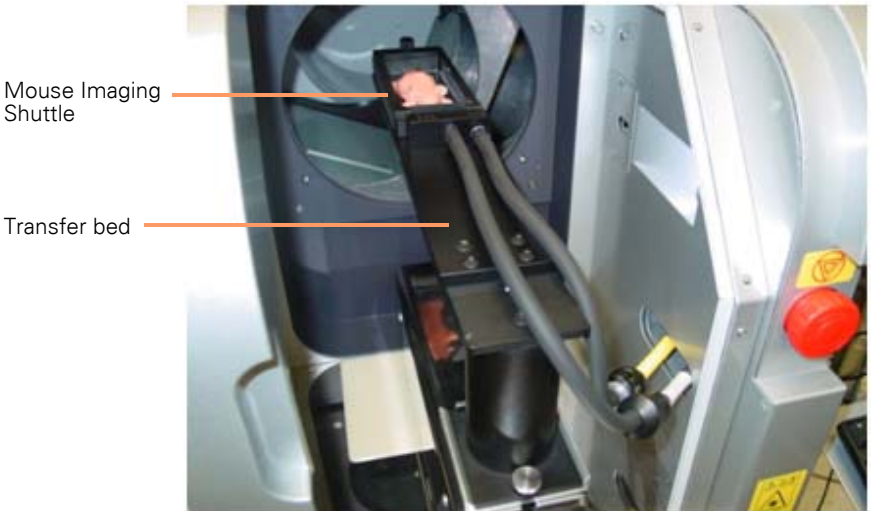
The transfer bed is for use with the optional Mouse Imaging Shuttle (Figure 7.1). The Mouse Imaging Shuttle (MIS) contains the subject during image acquisition on the Quantum FX µCT scanner and the IVIS® Spectrum Imaging System. The MIS allows the subject to be transported between the imaging systems without disrupting the subject position so that 3D volumetric data acquired on the Quantum FX µCT can be precisely registered with the optical data obtained on the IVIS Spectrum Imaging System.

Figure 7.1 Transfer Bed and Mouse Imaging Shuttle



The transfer bed replaces the acrylic bed supplied for the HX and CX modes of X-ray imaging. A single mounting screw secures the transfer bed to the movable sample platform on the Quantum FX µCT scanner. The bed has an anesthesia supply and exhaust tube attached that connects to the XGI-8 Gas Anesthesia System hoses. Figure 7.2 shows the transfer bed mounted in the Quantum FX µCT scanner.

Figure 7.2 Quantum FX µCT Scanner with Mounted Transfer Bed and Mouse Imaging Shuttle



7.4 System Shut Down Procedure

Caliper does not recommend power cycling the Quantum FX µCT (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. Close the control software and save any information of interest at the prompt.
2. Turn off the computer using the standard Windows® shut down procedure.
3. Turn off the power to the other system components and power surge protection devices.

If you have any problems during the shut down or start up procedure, please contact Caliper technical support for assistance.

NOTE

The Emergency OFF switch 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. Under normal circumstances, it should be left in the ON position and left as is.

8 Care & Maintenance

8.1 Surveying the Quantum FX µCT for Radiation Leakage

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

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

8.2 Maintenance & Safety Checks

Daily/Weekly Safety Checks

The following safety checks should be performed 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 Weekly Safety Checks

Monthly Safety Checks

The following safety checks should be performed 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 FX µCT control software.

Annual Safety Checks

The following safety checks should be performed every 12 months.

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

8.3 Cleaning the Quantum FX µCT

Approved Cleaning Solutions

The compounds shown in Table 8.1 do not damage the internal or external finish of the Quantum FX µCT 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

ALERT! Do not spray cleaning solutions in the sample bore. Gently wipe the bore surfaces as described on page 34.

Table 8.1 Acceptable cleaning solutions for the Quantum FX µCT 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

Caliper makes no claims as to the sterility of the Quantum FX µCT 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 surfaces. Rinse surfaces using a wipe saturated with sterile deionized water. Do not allow puddles of water to remain on the surfaces.

Consider dedicating an Quantum FX µCT for immunodeficient animals to remove the risk of cross-contamination.

9 Troubleshooting

Problem	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 "on" position (left position).	Turn the key switch to the right position.
	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.
Cannot move the stage using the stage control unit.	A key was pressed when the power was turned on.	The keypad control states are checked when the instrument is powered on. If any of the keys are pressed during the key check, all keys will be disabled (key check error). Turn off the scanner, make sure no keys are pressed, then turn the scanner power on.

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