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Microfocus X-Ray CT System

inspeXio SMX-225CT FPD HR

Instruction Manual

Basic Operations

Read the instruction manual thoroughly before you use the product.
Keep this instruction manual for future reference.

This Basic Operations manual describes how to start up and shut down the system and how to perform basic operations. For more detailed explanations of the CT software inspeXio64, or for more advanced operating instructions, refer to Advanced Operations Instruction Manual.

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Introduction

Read this Instruction Manual thoroughly before using this product.

Thank you for purchasing this product.

The inspeXio SMX-225CT FPD HR Basic and Advanced Operations instruction manuals are intended to help those operating or managing the equipment better understand how to properly operate and maintain the equipment.

Read the instruction manual carefully before operating the system to ensure it is operated correctly. Keep the manual stored in an accessible location for easy reference.

IMPORTANT

1. If the user or the location where this system is used changes, make sure both the Basic and Advanced Operations instruction manuals are provided to the new user or site.
2. If this manual or a product warning label is lost or damaged, immediately contact your Shimadzu representative to request a replacement.
3. To ensure safe system operation, make sure to read all safety instructions prior to using the product.
4. To ensure safe system operation, contact your Shimadzu representative if you require product installation, adjustment, or re-installation after the product is moved.
5. Operate the system within the various limits and specifications indicated in this manual. In addition, inspect the system periodically to prevent accidents and malfunctions.

   ☞ For more information about how to inspect the system, refer to 6 System Manager Inspection Items in the Advanced Operations Instruction Manual.
6. This manual does not attempt to address problems that occur randomly. For issues not covered in the instruction manuals, contact your Shimadzu representative.
7. In the system malfunctions, promptly provide the following information to your Shimadzu representative.

   •Information indicated on product label of instrument (product name, serial number, model number, date of manufacture, etc.)

   •Description of malfunction circumstances (including immediately preceding and following the problem – in as much detail as possible)

■ Notice

1. Due to product improvements, the contents of this manual are subject to change without notice.
2. Schematics, diagrams, software windows, and other illustrations in this manual represent standard specification models. Therefore, they may differ from models delivered with special-order specifications.
3. This manual has been prepared with care. However, should any errors or omissions be found, it may not be possible to correct them immediately.
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   - Microsoft® Windows® 7 Professional Edition is referred to as "Windows 7" or “Windows” in this manual.
   - This product is used in conjunction with Windows.
   - Screen images are used in accordance with Microsoft Corporation's guidelines.
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Original version is approved in English.

Indications Used in This Manual

Dangers, warnings, cautions, and notes are indicated using the following conventions:

Indication	Meaning
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or possibly death.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor to moderate injury or equipment damage.
NOTE	Emphasizes additional information that is provided to ensure the proper use of this product.

The following symbols are used in this manual:

Indication	Meaning
Prohibitions	Indicates an action that must not be performed.
Instructions	Indicates an action that must be performed.
	Indicates the location of related reference information.

Safety Instructions

To ensure safe product operation, read these important safety instructions carefully before use. Be sure to observe the precautions described below. They are important for ensuring safety.

■ Applications

⚠ WARNING

- **This system is a microfocus X-ray CT system. Do not use this system for purposes other than industrial nondestructive testing. Use for other applications can cause an accident.**
- **This equipment is not medical implements. It is X-ray equipment for an irradiation experiment and research. Therefore, it cannot be used for medical treatment or diagnosis.**

■ Installation Site Precautions

⚠ WARNING

- **Do not install the system in a location with flammable or explosive gases or liquids. This instrument is not designed to be explosion proof. Doing so may cause fire or explosion.**
- **Do not install the system in a location with corrosive gases, gases containing organic solvents, halogen compounds, or siloxanes, oil mist, or high levels of debris/dust. Doing so may prevent maintaining specified performance levels or shorten its service life.**
- **Do not operate the system in an environment where condensation may form. Doing so could cause it to malfunction.**

■ Setting Layout

⚠ WARNING

- **Do not install the system in a location other than the designated location. Doing so may prevent pressing the [EMERGENCY STOP] button rapidly.**

■ Installation Work Precautions

⚠ WARNING

Prohibitions

- **Do not place heavy items on or heating devices near power supply or communication cables/cords. Do not modify, excessively bend, or pull on the cords. Ignoring this precaution could damage the cord and cause a fire, electric shock, or malfunction. If the cord is damaged, contact Shimadzu or a Shimadzu service representative immediately.**
- **Installation in Polluted Environments**

  If installing the system in a controlled area, such as areas subject to control regulations for specific pathogens specified in the Infectious Disease or areas subject to other relevant laws, then installation in a certain level or higher controlled area may not be permitted. Also, restrictions may apply to the installation, maintenance, transfer, disposal, or other aspects of systems installed in controlled areas.

  Installation or maintenance work for systems installed in controlled areas described above may require cooperation to accomplish the following, in terms of appropriately controlling specified pathogens and ensuring the safety of service personnels.

  - Preliminary investigation by questionnaire or other means
  - Implementation of safety training for service personnels
  - Provision of safety gear
  - Decontamination of the system and the surrounding area

Instructions

- **To install, adjust, or reinstall a relocated system, contact your Shimadzu representative. Not doing so could cause injury or equipment failure. It is also important for ensuring the system functions in a stable manner. Otherwise, system safety and performance cannot be guaranteed.**
- **Implement measures to ensure that the equipment does not fall over in the event of an earthquake. If the equipment falls over, it could cause injury.**
- **Power supply voltage requirements are indicated on the nameplate located on the right side of the system. Connect the product to a power supply that complies with the indicated requirements. Connecting the product to a noncompliant power supply may result in fire or electric shock. If the power supply voltage is unstable or if the power capacity is insufficient, specified performance levels may not be achieved. Also, calculate the power capacity required by the whole system to provide an appropriate power supply.**
- **Be sure the system is grounded. Not doing so could cause electric shock in the event of a malfunction or short circuit. It is also important for ensuring the system functions in a stable manner.**
- **Be careful of the gaps between system components during installation. Not doing so could cause pinched fingers or other injuries.**
- **Connect the control computer and optional equipment to a common ground. Not doing so could disrupt communication between instruments or cause a malfunction.**
- **To relocate the system, contact your Shimadzu representative.**

■ Work / Operating Precautions

⚠ WARNING

Prohibitions

- **Do not measure explosive, ignitable, or flammable substances or place them in the system. Doing so could ignite the substance and cause a fire.**

Instructions

- **If water, organic solvent, or other liquid is spilled on the instrument, wipe it off immediately. Not doing so could cause instrument failure/malfunction.**
- **Be sure to back up data stored on the control computer hard drive. Not doing so could result in losing valuable data in the event of an unexpected accident.**
- **If the power is shut OFF, wait at least 10 seconds before switching the power ON again. Not doing so could cause instrument failure/malfunction.**

■ Maintenance and Inspection

⚠ CAUTION

Prohibitions

- **Never remove the main cover. Doing so could cause injury or equipment failure. The main cover does not need to be removed for normal maintenance inspections or servicing. If repairs requiring the removal of the main cover are necessary, contact your Shimadzu representative.**

⚠ WARNING

Instructions

- **The system manager should periodically inspect the items indicated in 6.2 System Manager Inspection Items in the Advanced Operations Instruction Manual. For all other inspection items, periodically contact your Shimadzu representative. Note that the Shimadzu service personnel may need to shut off the circuit breaker at the on-site power supply service panel or disconnect the main power supply cable.**
- **Disconnect the power cord from the power outlet before inspecting or servicing the instrument or replacing parts. Not doing so could cause an accident from electric shock or short circuit.**
- **Replace parts only with those specified in the instruction manual. Using any other parts could result in part damage that prevents the instrument from functioning properly.**
- **Inspection and Maintenance Work at Contaminated Environments**
  If radioactive substances, microbial substances, or biologically active substances were used in the equipment, then the customer must have a certified contractor decontaminate the equipment according to applicable law before the service personnel can start inspection or repair work. Please provide individual certificates of decontamination (such as declaration statements or certificates of analysis).

■ Repair, System Disassembly and Modification

⚠ WARNING

Prohibitions

To avoid possible injury or death, never attempt the following.

- Do NOT disassemble or modify the X-ray generator.
- Do NOT open the control board cover.
- Do NOT disassemble or modify the X-ray Detector.
- Do NOT disassemble or modify the instrument.

Doing so could cause an accident from electric shock or short circuit. It could also cause injury or equipment failure.

For repairs, contact Shimadzu service provider or Shimadzu. Not doing so could cause a fire, electrical shock, or injury.

■ Laws and Regulations

⚠ WARNING

Instructions

Use this system in compliance with all related laws and regulations.
Observe all laws and regulations for X-ray equipment that apply in the country where the system is used.

■ Preventing X-Ray Exposure

⚠ WARNING

Prohibitions

X-rays are harmful to humans and require particular caution. Pay special attention to the following when using the system and make them a habit.

- **Never open the sliding door and maintenance door while emitting X-rays. Confirm that X-rays are not being emitted before opening the sliding door and maintenance door.**
- **Never modify or alter the sliding door interlock circuits (such as shorting the sensor switch).**
- **Never modify the system. The safety and performance cannot be guaranteed if the system has been modified.**

Instructions

- **Make sure the shield box door is completely closed before emitting X-rays.**
- **Make sure the lead glass in the sliding door is not scratched, cracked, or broken before using the system.**
- **Make sure the sliding door interlock circuits are functioning properly before using the system.**
- **Periodically measure the X-ray leakage (rate), as necessary, to make sure it is less than specified by regulations (1 µSv/h). Contact your Shimadzu representative to measure the X-ray leakage (rate).**
- **During X-ray irradiation, check that the X-ray indicator lamp is lit.**

■ Inspecting Halogen Compounds

⚠ WARNING

Prohibitions

Do not inspect certain halogen compounds, such as polyvinyl chloride (PVC). Some halogen compounds can generate toxic or corrosive gases when exposed to X-rays. These gases are harmful to humans and may also adversely affect the system.

■ Preventing Pinching Fingers

⚠ CAUTION

Instructions

The sliding door is very heavy and generates considerable inertia when opened or closed. Open and close the door gently to avoid pinching hands or fingers.

■ Caring for FRP Items

⚠ CAUTION

Clean the fiberglass reinforced plastic outer covers by applying a small amount of mild detergent to a dry clean cloth and lightly wiping. Do not use organic solvents such as acetone, benzine, or paint thinner, as they may discolor or deform the plastic.

■ Caring for Lead Glass

⚠ WARNING

- **Broken or cracked lead glass could cause X-ray leakage. Make sure there are no cracks, breakage, or other damage before use.**

⚠ CAUTION

The lead glass in the sliding door is more prone to clouding than regular glass and requires the following precautions.

- **If the lead glass is touched with bare fingers or hands, wipe off any sweat or oil immediately with a dry cloth. If left without cleaning, the sweat or oils will permanently adhere to the surface.**
- **Clean the lead glass using a dry clean cloth. Do not use a wet cloth.**
- **If using a dry clean cloth is not sufficient to clean the lead glass, apply a small amount of alcohol or glass cleaner to a dry clean cloth and wipe lightly. Then wipe it again with a dry clean cloth.**

■ Intake and exhaust port of the Cooling Water Unit

⚠ CAUTION

Do not place anything close to Intake and exhaust port of the cooling water unit. Because can not be cool the X-ray tube, there is a possibility that life is shortened.

■ Using Lead

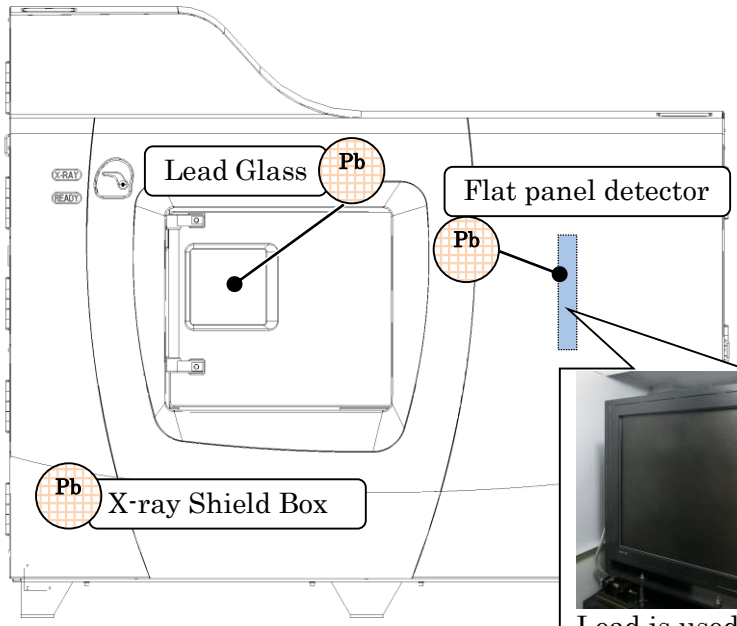
⚠ CAUTION

This system contains lead in the locations indicated below.
Use particular care when handling or disposing of the relevant parts.

Instructions

Pb Indicates a location where lead is used. These include the following.

- Flat panel detector (to block unwanted X-rays)
- X-ray shield box
- Lead glass (in the sliding door)



Lead is used to protect the Flat panel detector circuit.
Although the surface is covered with sheet metal, be careful that samples, jigs, or other objects do not hit this part.

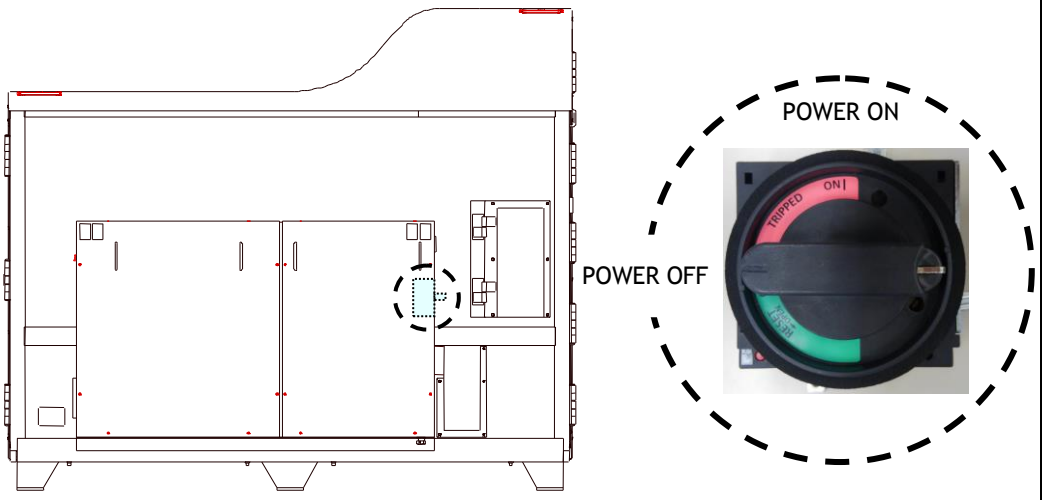
■ In Case of Emergency

⚠ WARNING

Instructions

In the event of a malfunction or other problem, such as if an unusual odor or smoke is observed, immediately shut off power supply to the system by switching the POWER circuit breaker OFF in the on-site power supply service panel. Pressing the emergency stop switch shuts off power to the X-ray generator, CT stage, and other components, but does not shut off power supply to the system control circuits.

Then inspect the system before using it again and, if necessary, contact your Shimadzu representative.



Installation Conditions

Before installation or using system it should be complied with the following conditions.

(1) Operating Environment Conditions

Ambient temperature :15℃ to 30℃

Temperature fluctuations :Temperature changes must be less than 5°C in 1 hour

Ambient humidity : 35% to 70%

* No condensation

*When operating environment conditions exceed the above ranges, stop operation of the instrument and turbomolecular pump. Continued operation may adversely affect the life of the turbomolecular pump.

(2) Storage Conditions

Ambient temperature :0℃ to 40℃

Ambient humidity :10% to 90%

* No condensation

(3) The floor must be flat (within ±5mm of the entire length of the instrument installation surface) and stable, and free of tilting, vibration and impacts.

(4) Floor vibration (frequency) must be within the values indicated in the following table.

Frequency	Acceleration [cm/sec^2]
2 Hz to 6 Hz	1.421
6 Hz to 10 Hz	0.394
10 Hz to 20 Hz	0.750
20 Hz to 90 Hz	0.473
90 Hz to 2000 Hz	1.119

* Installing the system where floor vibration exceeds the above values may adversely affect CT images.

(5) Do not locate the system where it could be adversely affected by air containing dust, salt, sulfur, oil mist, corrosive gases.

(6) Install the system away from open flames.

(7) Install the system where it will not be splashed with water.

(8) Install the system in a well-ventilated location free from direct sunlight.

(9) Install the system in a location not subject to radio waves that exceed adversely affect the system, or to magnetic fields other than the geomagnetic field.

(10) Install the system indoors.

Warranty

Shimadzu provides the following warranty for this product.

1. Period

Please contact your Shimadzu representative for information about the period of this warranty.

2. Description

If a product/part failure occurs for reasons attributable to Shimadzu during the warranty period, Shimadzu will repair or replace the product/part free of charge. However, in the case of products which are usually available on the market only for a short time, such as personal computers and their peripherals/parts, Shimadzu may not be able to provide identical replacement products.

3. Limitation of Liability

(1) In no event shall Shimadzu be liable for any lost revenue, profit, or data, or indirect, consequential, incidental, or punitive damages.
(2) In no event shall Shimadzu be liable for any damages incurred based on compensation paid to a third party.
(3) In no event shall Shimadzu's liability exceed the amount paid for the product.

4. Periodic Maintenance Inspections

This product is designed for seven years of use, provided it is periodically inspected and maintained. To continue using the system after seven years, please have a seventh-year inspection, in addition to regular maintenance and inspections, performed by Shimadzu or an authorized Shimadzu service provider. Not performing this seventh-year inspection could result in malfunction or equipment failure.

5. Exceptions

Failures caused by the following are excluded from the warranty, even if they occur during the warranty period.

(1) Improper product handling
(2) Installation, relocation, maintenance, repairs, or modifications performed by parties other than Shimadzu or Shimadzu designated companies
(3) Product use in combination with hardware or software other than that designated by Shimadzu
(4) Computer viruses leading to device failures and damage to data and software, including the product's basic software
(5) Power failures, including power outages and sudden voltage drops, leading to device failures and damage to data and software, including the product's basic software
(6) Turning OFF the product without following the proper shutdown procedure leading to device failures and damage to data and software, including the product's basic software
(7) Reasons unrelated to the product itself
(8) Product use in harsh environments, such as those subject to high temperature or humidity, corrosive or explosive gases, strong vibrations, or magnetic fields other than the geomagnetic field.
(9) Fires, earthquakes, or any other act of nature, contamination by radioactive or hazardous substances, or any other force majeure event, including wars, riots, and crimes
(10) System malfunctions due to wear of consumable items, such as X-ray generator unit filaments

(11) Stabilized power supply malfunctions
(12) Instrument malfunctions due to remodeling for the unique safety requirements of a country
(13) Consumable items
Note: Recording media such as CD-ROMs are considered consumable items. With respect to nonconformities that arise within one year of acceptance inspection due to design, manufacture and materials, the vendor shall replace or repair parts free of charge.

6. Special Warranty Items

The warranty period of FPD is one year. Due to the characteristics of FPDs and their manufacturing process, defective pixels can neither be completely eliminated nor prevented from increasing in number. The warranty standards for defective pixels are as follows.
Increases in the number of defective pixels after shipment are not subject to repair free of charge if they fall within the warranty standards noted below.

Defect Type	Allowable Range
Line	
Defect line	20
Cluster	
Class 7 or higher cluster	0
Class 6 cluster	10
Class 5 cluster	100
Class 4 cluster	115
Total pixel defect count	10000

*A "cluster" refers to a group of adjacent pixel defects. The cluster class indicates the number of defective pixels within the eight pixels adjacent to a defective pixel.

*The total pixel defect count refers to the total number of defective pixels, including line and cluster defects.

* If a warranty or other such document is supplied with the system, or a separate contract containing warranty provisions has been signed, the stipulations indicated in those documents shall apply.

* Separate warranty periods shall be stipulated for items such as custom specification parts.

After-Sales Service and Availability of Replacement Parts

■ After-Sales Service

⚠ CAUTION

If any problem occurs with this product, perform an inspection and take appropriate corrective action as described in 7 Troubleshooting in the Basic Operations Instruction Manual. If the problem persists, or the symptoms are not covered in the troubleshooting section, contact your Shimadzu representative.

■ Replacement Parts Availability

⚠ CAUTION

Replacement parts for this product will be available for a period of seven (7) years after the product is discontinued. Thereafter, such parts may cease to be available.

Note, however, that the availability of parts not manufactured by Shimadzu shall be determined by the relevant manufacturers.

Disposal of the System

■ Disposal of the System

⚠ CAUTION

Dispose of the inspeXio SMX-225CT FPD HR (Including cooling water,etc) and its accessories in compliance with the applicable laws in the country where it is used.

If this system is disposed of inappropriately, the environment could be contaminated by substances in its parts.

Precautions for Using the X-ray System

To ensure a long system service life, be sure to observe the following precautions.

1. Observe the following precautions when installing or storing the system.
   - Place the system indoors, in a level well-ventilated location where it is not exposed to an ignition source, water, direct sunlight, vibration, or impacts.
   - Do not locate the system where it could be adversely affected by air containing moisture, dust, salt, sulfur, oil mist, explosive gases, or other factors.
   - Operate the system in a location with ambient temperature within the range 15℃ to 30℃.
   - Store the system in a location with ambient temperature within the range 0℃ to 40℃.
   - Age the X-ray generator monthly, even if the system is not being used or is in storage. Not aging the X-ray generator regularly could shorten its service life.

2. Confirm the following before installing and operating the system.
   - The main power supply meets the specified requirements for frequency, voltage, and allowable current.
   - The main power supply has no sudden voltage fluctuations.
   - The system is grounded properly as specified.
   - All cables are connected properly.
   - No radio waves harmful to this system and no magnetism other than that of the earth.

3. Confirm the following when operating the system.
   - Be sure X-ray emissions are OFF before leaving the system unattended.
   - If any error or other abnormality occurs, immediately stop operating the system.

4. Confirm the following after operating the system.
   - Always disconnect cables and power cords carefully by gripping the connector. Disconnecting cables by pulling on the cord portion, or otherwise applying undue forces on the connectors, can damage the cord and cause fire, electric shock, or malfunction.
   - Keep the system clean to prevent problems the next time it is used.

5. If a malfunction or other problem occurs, contact your Shimadzu representative to arrange service as soon as possible. Contact your Shimadzu representative if a warning label peels off, as well.

■ Safety Mechanisms

⚠ CAUTION

Instructions

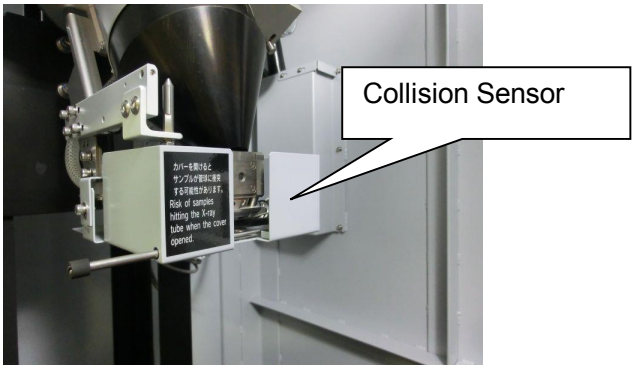
To ensure a safe service life, the system includes the following safety mechanisms. If any of the safety mechanisms is triggered, immediately stop operating the system and eliminate the cause.

1. **Interlock Circuits**

   The system is equipped with interlock circuits that immediately stops X-ray emissions and CT stage movement if the sliding door is opened.

2. **Collision Sensor**

   The system is equipped with a collision sensor around the X-ray tube. If a sample or sample setting jig hits the collision sensor, it immediately stops CT stage movement to minimize damage to the X-ray tube or CT stage.



3. **Software Limit Functions**

   The software includes a feature that, by specifying the sample diameter, allows restricting CT stage movement to a limited area to prevent samples from hitting the X-ray tube. It also limits X and Y-axis movement to within 50 mm of the center of stage rotation.

4. **Aging Completion and Tube Voltage Monitoring Function**

   X-rays can be emitted indefinitely if tube voltage is set to 160 kV or less, but for tube voltage settings above 160 kV, X-rays can be emitted only if the last aging process was completed within the last 48 hours or if the last X-ray emission occurred within the last 8 hours.

5. **Filament Replacement Reminder Function**

   This feature monitors the elapsed time since the filament was last replaced and the high voltage cables were last greased and displays a maintenance reminder message after 200 hours of X-ray emissions since the filament was replaced or after 6 months has elapsed since the high voltage cables were greased.

■ Precautions Regarding the Control Computer

⚠ CAUTION

Prohibitions

Always observe the following precautions. Not doing so may cause the CT software inspeXio64 and optional software (such as Image-Pro Analyzer and VGStudio) to malfunction.

1. **Do NOT change any operating system settings, such as display properties, computer power management, or screen saver settings.**
2. **Do NOT install any software other than the pre-installed software or install new hardware.**
3. **Do NOT update Internet Explorer, Media Player, or other software included with Windows. Do NOT install or update Windows extensions, such as DirectX or DirectMedia. Do NOT install or update such software via the Internet as well.**
4. **Do NOT change the screen theme.**
   Factory Settings
   Theme: Windows7 Basic
5. **Do NOT perform any printing processes while the CT software is processing images. Do NOT start optional software, or perform edit or save operations while the CT software is processing images.**
6. **Never move, delete, or rename any of the following folders or files they contain. Doing so could cause the system to malfunction.**
   - **C:＼Windows**
   - **C:＼IPANA70**
   - **C:＼Program Files**
   - **D:＼inspeXio**
7. **The CT software can be operated only by users designated (by a person with administrator rights) when the system was installed.**
8. **Do NOT change the task bar height.**
9. **Do NOT install any image processing software other than optional Image-Pro Analyzer and VGStudio.**

NOTE

System Manager

Password-controlled functions are provided in this system.
The system manager is the only person who knows these passwords.
Only the System Manager can disclose the password.

NOTE

Software Data Entry Rules

Numbers, letters, and other characters entered in CT software inspeXio64 edit boxes must comply with the following rules.

1. Numerical Entry Rules

Number Type	Entry Format	Entry Example
Positive Numbers	%%%%	1234
Negative Numbers	-%%%%	-1234
Positive Real Numbers Greater Than or Equal To 1.0	%%.%%%	12.345
Positive Real Numbers Less Than 1.0	0.%%%	0.123
Negative Real Numbers Less Than or Equal To -1.0	-%%.%%%	-12.345
Negative Real Numbers Greater Than -1.0	-0.%%%	-0.123

2. Character Entry Rules

Character Type	Entry Rules	Character String Length
Comments	Any character	Max 300 single-byte
Folder Names, Series Names, File Names	Any character except the invalid characters listed below: Invalid Characters Single-byte space \ / : , . * ? “ | < > %	Max 64 single-byte

NOTE

System Power Supply

This system has a power supply line consisting of two systems, a 200 V AC system for the X-ray generator and a 100 V AC system for all other components (such as the CT stage and Flat panel detector). The following table shows the power supply status to the X-ray generator and rest of the system for various switch configurations. Note that the following does not apply to the control computer, which has a separate 100 V AC power supply line.

Status	X-ray generator Power Status 200 V AC	System Internal Power Status 100 V AC
On-site power supply service panel is OFF.	OFF	OFF
Main system circuit breaker is OFF.	OFF	OFF
The [EMERGENCY STOP] button on the operation box is depressed.	OFF	OFF
Power switch on back side of X-ray control box is OFF.	OFF	ON
[OFF] button (orange) is depressed on front panel of X-ray control box.	OFF	ON
The [OPERATE] switch on the main operation box is turned to [OFF].	ON However, X-rays cannot be emitted, because the interlock circuit is open.	OFF
Key switch on front panel of X-ray control box is turned to [OFF].	ON However, X-rays cannot be emitted, because the interlock circuit is open.	ON
Sliding door (on shield box) is open.	ON However, X-rays cannot be emitted, because the interlock circuit is open.	ON However, the CT stage cannot be moved, because the interlock circuit is open.

Restoring the System After an Error Shutdown

If an error shutdown occurs, use the following procedure to restore the system.

1. If the [EMERGENCY STOP] button on the operation box was pressed.

(1) Close the CT software. (If the software cannot be closed, go to Step 2.)

(2) Turn the [OPERATE] key switch counterclockwise to the [OFF] position.

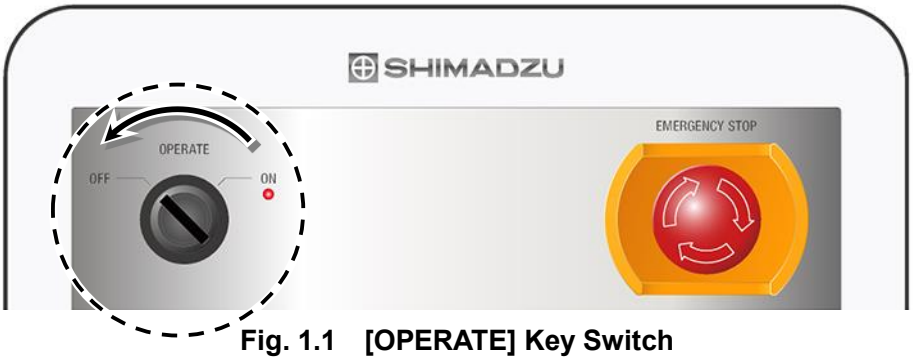


Fig. 1.1 [OPERATE] Key Switch

(3) Eliminate the cause that resulted in pressing the [EMERGENCY STOP] button.

(4) Release the [EMERGENCY STOP] button from its depressed state by turning the button clockwise.

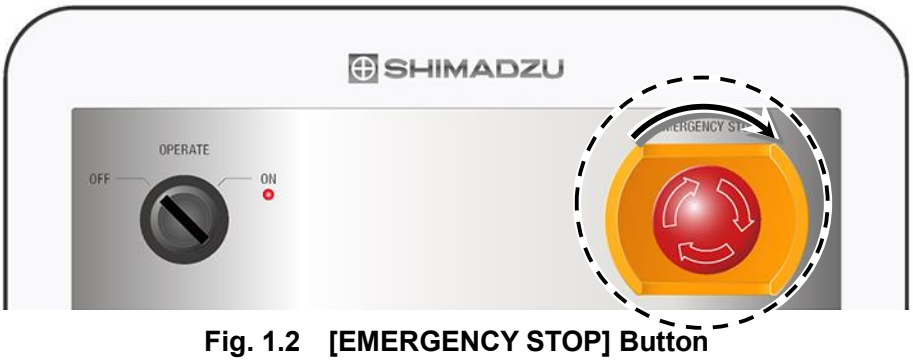


Fig. 1.2 [EMERGENCY STOP] Button

(5) Confirm that the power switch on X-ray control box is turning on, and push the [ON] button (green) on the front panel of X-ray control box(MTT controller) to start the vacuum pump (diaphragm pump and turbo molecular pump).

Fig. 1.3 X-ray Control Box (MTT controller)

(6) After waiting for about 10 seconds with the [OPERATE] key switch in the [OFF] position, turn the switch clockwise to [ON].
(7) Restart the CT software. However, if the CT software does not shut down normally, hold the control computer power button down until the power shuts off. Press the power button again to restart the control computer, then restart the CT software.

2. If the Main Power Supply Shuts Off

(1) Shut down the system according to 3.6 Shutting Down the System.
(2) Remove the reason for the stoppage of the primary power supply.
(3) Wait about 10 seconds after shutting down the system, then restart the system according to 3.2 Starting Up the System.

3. If the Main Power Supply Voltage Drops Momentarily Due to Lightning or Other Cause

(1) Shut down the system according to 3.6 Shutting Down the System.
(2) Use an electrical tester to confirm that the main power supply has returned to normal.
(3) Wait about 10 seconds after shutting down the system, then restart the system according to3.2 Starting Up the System.

4. If the Control Computer Freezes

(1) Hold the control computer power button down until the power shuts off.
(2) Turn the [OPERATE] key switch counterclockwise to the [OFF] position.

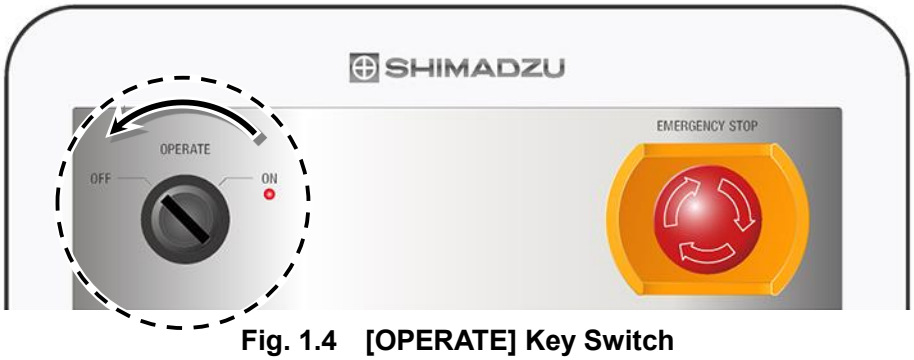


Fig. 1.4 [OPERATE] Key Switch

(3) After waiting for about 10 seconds with the [OPERATE] key switch in the [OFF] position, turn the switch clockwise to [ON].
(4) Switch on the control computer power and restart the CT software.

NOTE

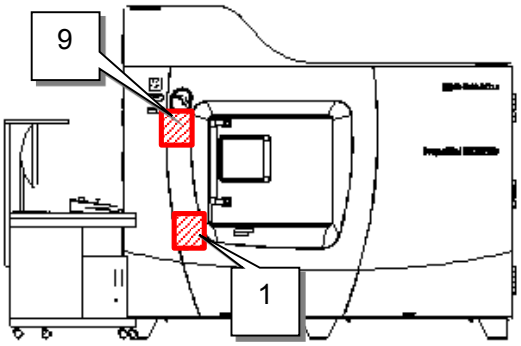
Launching the Software

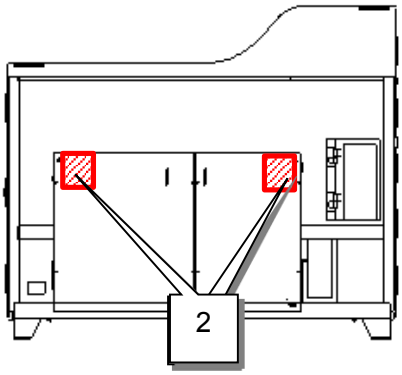
It may require several minutes after switching the [OPERATE] switch and control computer ON before communication is established between the control computer and instrument. Therefore, if an error message is displayed when the software is launched, wait a few minutes before restarting the software.

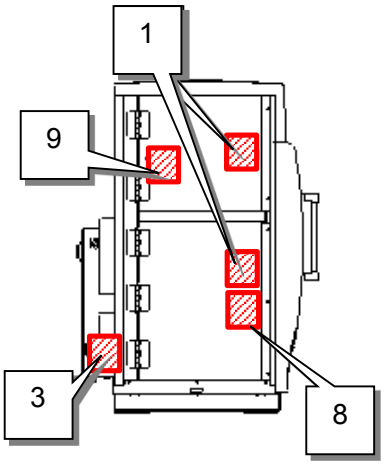
Warning Labels

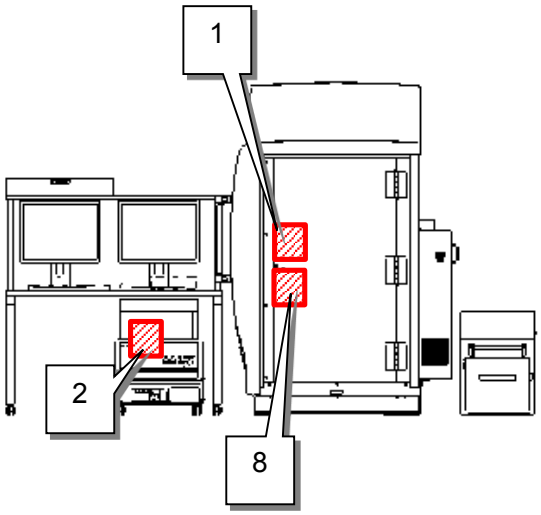
In order to ensure safe system operation, warning labels are attached at places requiring particular attention. **Be sure to thoroughly understand the content of all labels before operating the system.**

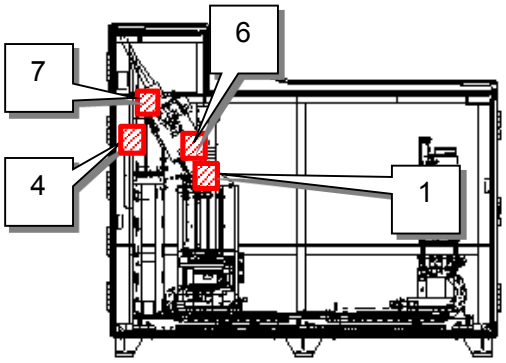
If any of these labels are lost or damaged, order replacements from your Shimadzu representative and attach them in the appropriate positions.

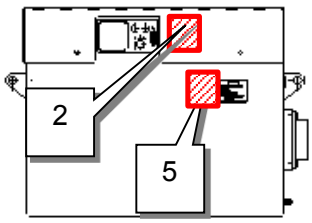


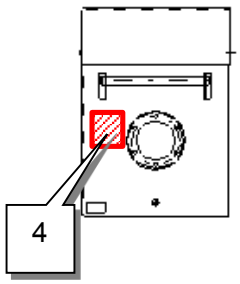












Warning Labels

No.	Caution Text	Label	Part Number
1	X線注意 被ばくするおそれがあります。 安全保護装置を解除しないでください。 X-RADIATION To reduce the risk of exposure to X-ray radiation, do not release interlocks. 小心 X 射线 辐射危险, 禁止解除安全保护装置。		037-72999-15 037-72999-16
2	感電注意 カバーを開けるときは電源を切ってください。 フィールドエンジニア以外はカバーを取り外さないでください。 HAZARDOUS VOLTAGE Turn off the power supply before opening this cover. DO NOT remove cover. Refer servicing to qualified personnel. 当心触电 打开保护面板前必须切断电源。 严禁擅自取下保护面板。如有异常，请联系售后服务工程师。		037-72999-04
3	感電注意 サービス作業をおこなうときは電源を切ってください。 HAZARDOUS VOLTAGE Turn off the power supply before servicing. 当心触电 维修服务时, 必须切断电源。		037-72999-04
4	高電圧注意 高電圧ケーブルを抜いた後は、アース線の先端を高電圧ケーブルの先端に接触させてください。 HIGH-VOLTAGE HAZARD After removing the high voltage cable, touch the ground wire's tip to the high voltage cable's tip. 注意高压 拔下高压电缆后，需将地线前端触碰高压电缆的前端。		037-72999-03 037-72999-04

No.	Caution Text	Label	Part Number
5	火気注意 引火性の絶縁油を使用しています。火気を近づけないでください。 RISK OF FIRE Keep unit away from heat, sparks or flame. Unit uses flammable insulating oil. 注意烟火 因为使用易燃性绝缘油，所以必须远离火源。		037-72999-10
6	高電圧注意 フィラメント交換後、フォーカスカップを必ず接地してから作業を行ってください。 ELECTRIC SHOCK HAZARD Ground focus cup before replacing filament. 注意高压 更换灯丝后，必须先将焦距杯接地再进行作业。		037-72999-04
7	高温注意 ターボ分子ポンプは動作中高温になっています。手を触れないでください。 CAUTION HOT DO NOT touch. The turbo molecular pump is hot during operation. 注意高温 涡轮分子泵运行中为高温状态。禁止用手触碰。		037-72999-12

Caution Labels

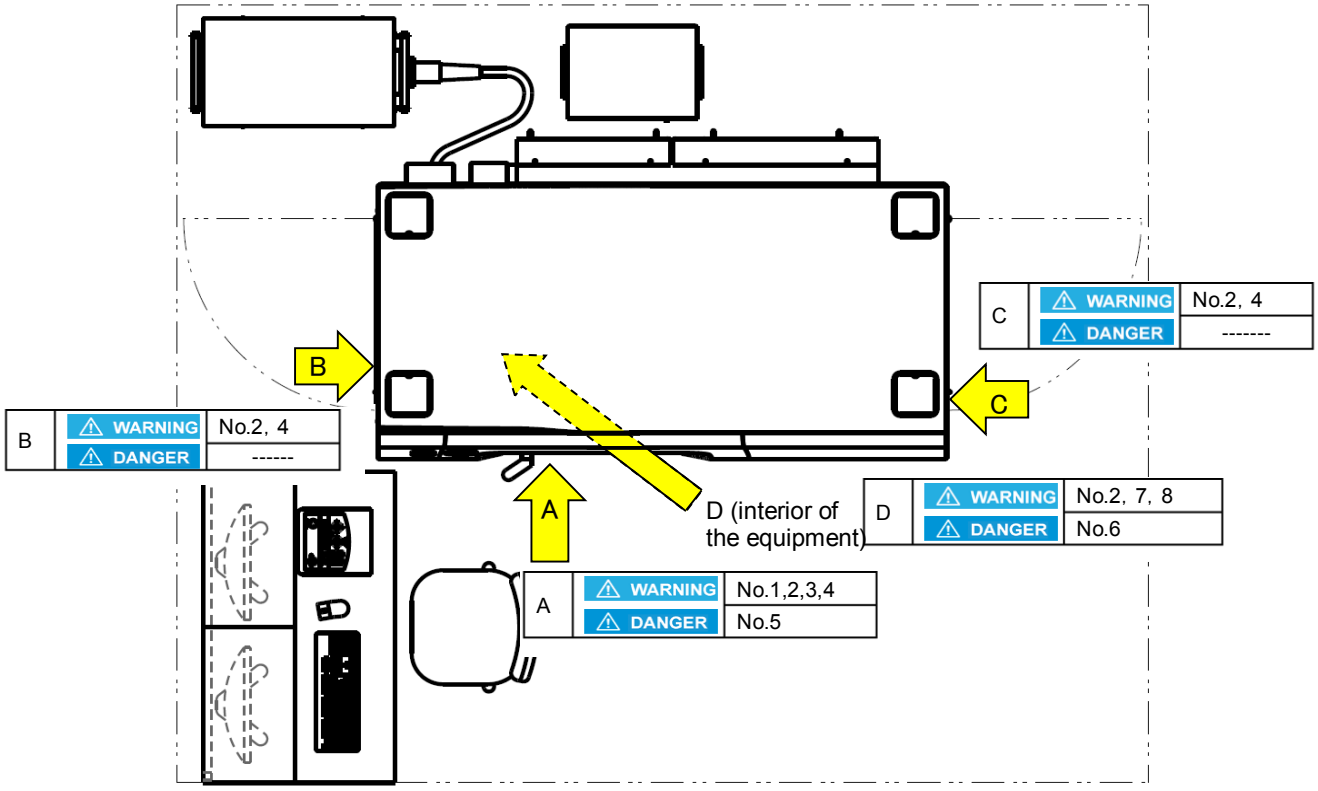
No.	Caution Text	Label	Part Number
8	フィールドエンジニア以外は扉を開けないでください。 手や指をはさまれないように注意してください。 DO NOT open the door. Refer servicing to qualified personnel. Be careful not to pinch your hand or finger. 严禁擅自开门。如有异常，请联系售后服务工程师。 请勿夹到手或手指。		037-72999-02
9	手や指をはさまれないように注意してください。 Be careful not to pinch your hand or finger. 请勿夹到手或手指。		037-72999-02

Residual Risk Information

A residual risk indicates a risk that could not be reduced or eliminated in the process of design and manufacture. Check the risk locations in "Residual Risk Map", and take the relevant protective measures described in "List of Residual Risks".

■ Residual Risk Map

The "Mechanical Location" and "No." indicated below are in accordance with those in "List of Residual Risks". For details, see "List of Residual Risks".



■ List of Residual Risks

The "No." and "Mechanical Location" indicated below are in accordance with those in "Residual Risk Map". Be sure to check the actual "Mechanical Location" referring to "Residual Risk Map".

Furthermore, read through and understand the content in "Reference" to take appropriate protective measures.

No.	Operation Phase	Operation	Required Qualification/ Education	Location	Description	Protective Measure taken by machine user	Reference
1	Preparation Operation	Pre-operation check	Qualified person received training to use the instrument	A	⚠ WARNING Exposure to X-ray radiation leaking due to scratch or crack on lead glass.	· If the lead glass is scratched, cracked, or otherwise damaged, click the [Out of Order] button in the startup inspection wizard to stop the wizard.	Basic P. 31
						· Please request Shimadzu Services representative the implementation of the periodic inspection, make sure the X-ray leakage (rate) is less than specified by regulations (1μSv/h).	Advanced P. 280
2	Preparation Operation	Pre-operation check	Qualified person received training to use the instrument	A、B、C、D	⚠ WARNING Exposure to X-ray radiation leaking due to abnormality on the interlock circuit.	· Please request Shimadzu Services representative the implementation of the periodic inspection.	Advanced P. 280
3				A		· As a pre-operational inspection routine, always confirm that the sliding door interlock circuits are functioning properly.	Basic P. 33
4	Preparation Operation	Operation with irradiating X-rays.	Qualified person received training to use the instrument	A、B、C	⚠ WARNING Exposure to X-ray radiation leaking.	· Please request Shimadzu Services representative the implementation of the periodic inspection, make sure the X-ray leakage (rate) is less than specified by regulations (1μSv/h).	Advanced P. 280
5	Preparation Operation Maintenance	· Setting or replacing samples · Replacing the filament · Cleaning the vacuum chamber · Rotating the target	Qualified person received training to control the instrument or to use the instrument	A	⚠ CAUTION The hands (fingers) are pinched between the sliding door and the machine body due to the inertial force of the sliding door.	· The door safety lock mechanism is provided to prevent pinching fingers, hands, or other items.	Basic P. 34
6	Maintenance	· Replacing the filament · Greasing up high-voltage cable · Cleaning the vacuum chamber · Rotating the target · Replenishment of cooling water	Qualified person received training to control the instrument	D	⚠ CAUTION The equipment is damaged. Get an electric shock.	· Only a system manager who has received special training is allowed to perform the tasks described in 6 chapter.	Advanced P. 203

No.	Operation Phase	Operation	Required Qualification/ Education	Location	Description	Protective Measure taken by machine user	Reference
7	Maintenance	Replacing the filament	Qualified person received training to control the instrument	D	⚠ WARNING Touching high-voltage charging unit causes an electric shock.	・Definitely turn the power of X-ray generator off.	Advanced P. 235
8	Maintenance	Replacing the filament	Qualified person received training to control the instrument	D	⚠ WARNING Contacting the focus cup first causes an electric shock.	・To prevent electric shock during this step, first bring the Phillips screwdriver into contact with the X-ray vacuum chamber and then allow the screwdriver to contact the focus cup from the side in a sliding motion.	Advanced P. 235

Content of Instruction Manuals

Instruction manuals for this system include the following.

Document Name	Document No.	Description
Basic Operations	349-01352	Be sure to read this manual. It describes how to perform basic operations and provides precautions for using the system properly. It also describes how to maintain and troubleshoot the system.
Advanced Operations	349-01353	Describes how to use specific CT software inspeXio64 features and how to perform periodic maintenance and inspection procedures, to be performed by the user's system manager.

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Contents

1 Overview and Features

1.1 Overview

This instrument is a micro focus X-ray CT system, which is used to observe the internal structure of a measurement target without destroying it. It includes microfocus X-ray generator, Flat panel detector, and high-precision stage, and can be used for X-ray fluoroscopic inspection and CT scanning.

1.2 Features

1. Large Flat Panel Detector

The system includes a large flat panel detector with a wide dynamic range that provides a broad field-of-view with sharp high-contrast cross-section images.

2. Advanced High Performance HPCinspeXio Computing System

Due to advancements in the high performance computing system, the system is able to quickly process the huge amounts of data output from the large flat panel detector.
By performing data acquisition and reconstruction computation processes concurrently, the system is able to display results immediately after data acquisition.

3. Includes Proprietary Microfocus X-ray generator Designed by Shimadzu

The system includes proprietary microfocus X-ray generator designed in-house by Shimadzu, which allows obtaining sharp images with minimal blur, even at high magnification rates. Software is used to switch X-ray emissions ON/OFF and specify tube voltage and current settings.

4. 3D Data Display Function

The high performance 3D display software (MPR display function) includes a function for displaying CT scan regions. This allows confirming, in real time, the region inside the sample currently being CT scanned.

5. Calibration-Free

Samples can be CT-scanned by simply placing them on the CT stage and pressing the start button.

6. Recommended Scanning Function

This function enables quick and easy CT scanning without having to configure any complicated CT scanning parameter settings. Simply select the sample material, the CT image resolution and contrast levels and then the system will automatically optimize the CT scanning parameter settings accordingly.

7. Center Adjustment Function

The center adjustment function can correct image blur caused by a shift in the center position during high-magnification CT scanning, with corrections made while viewing the images after CT scanning.

8. Acquisition Data Smoothing Function

The acquisition data smoothing function improves the S/N ratio of CT images by applying a sophisticated smoothing process to acquired data. This enables analyzing even finely detailed and complicated internal structures with high image quality.

9. Multi-Rotation Function

The multi-rotation function improves the S/N ratio of CT images by integrating multiple sets of acquired data. This means that even samples that previously resulted in inadequate contrast can now be analyzed with high image quality.

10. DICOM Conversion Function

This enables converting image data to the DICOM format, which is the world standard for medical imaging.

11. Maximum Sample Size of 400 mm (dia.) by 300 mm (H)

By the ample-sized shield box and the CT stage, samples up to 400 mm in diameter and 300 mm in height (including jig to secure sample) can be placed in the system. Also, the stroke of the XY stage on the rotation stage is 100 mm long, adapting various sample size positioning.

12. CT Scan Auto-Positioning Function

The system incorporates an intuitive CT scan auto-positioning function that uses an exterior camera.

13. X-Ray Parameter Auto-Setup Function

The optimum X-ray parameters according to the sample's X-ray transmittance can be set automatically.

14. Innovative Design

The external appearance of the system, operation box, and software GUI have been designed to enable intuitive operation.

15. Design for Ample Safety

- X-ray leakage (rate) to outside the system is less than 1μSv/h.
- A sliding door finger-pinch preventive mechanism (door safety lock) is provided.
- A collision sensor is provided as standard on the X-ray tube.

16. Image-Pro Analyzer Advanced 2D Image Processing Software (Optional)

Image-Pro Analyzer, sophisticated 2D image processing software, is optional. Image-Pro Analyzer is linked to CT software inspeXio64, allowing any image to be sent from inspeXio64 to Image-Pro Analyzer for a variety of image processing functions, such as measuring dimensions.

17. VGStudio Advanced 3D Image Processing Software / VGStudio MAX (Optional)

VGStudio / VGStudio MAX, sophisticated 3D imaging software, is optional. VGStudio / VGStudio MAX is linked to the CT software inspeXio64, allowing any image to be sent from inspeXio64 to VGStudio / VGStudio MAX and displayed in three dimensions.

2 Part Names and Functions

2.1 Main X-ray CT Unit

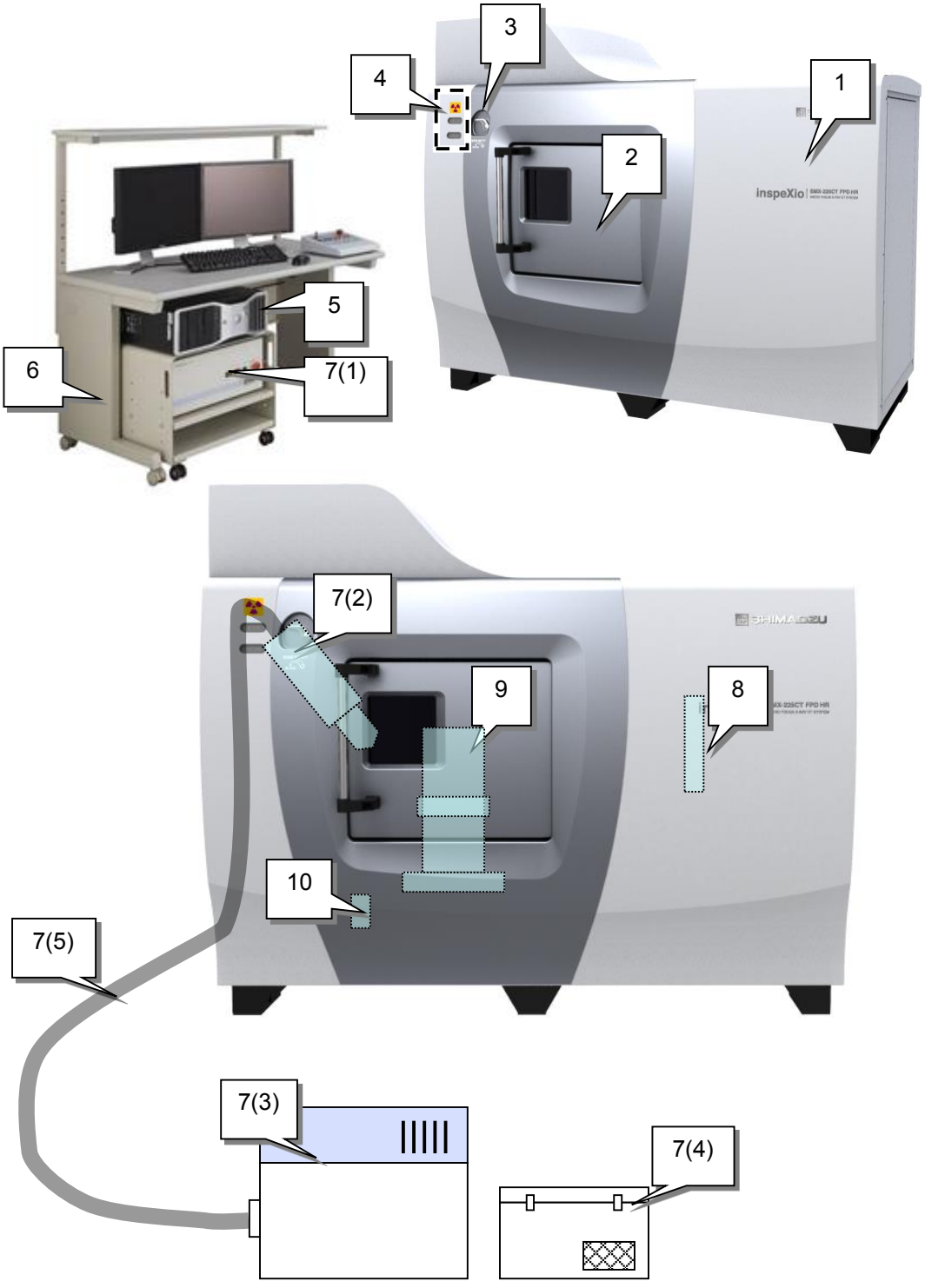


Fig. 2.1 The device configuration diagram

No.	Name	Description
1	Shield Box	The shield box has a protective structure that adequately blocks X-rays. It has a panel design, consisting of a formed steel frame, with iron and lead panels. The outer covers, covering the front and top of the shield box, are made of fiberglass reinforced plastic.
2	Sliding Door	This door is used to move samples in and out of the shield box. It includes a lead-glass window that allows viewing inside the box.
3	Door Safety Lock	This safety mechanism protects against pinching fingers in the sliding door. To close the door, turn the door safety lock counterclockwise with the left hand and grip the door handle with the right hand and gently slide it to the left.
4	[X-RAY] Indicator Lamp [READY] Indicator Lamp	These lamps indicate the X-ray output status. The [X-RAY] indicator illuminates red while X-rays are being emitted. The [READY] indicator illuminates green when the interlock circuit is completed.
5	Control Computer	The computer used to control the system.
6	Operation Desk	Monitors, keyboard, mouse and operation box are all placed on this desk.
7	Microfocus X-ray generator	The X-ray generator generates the X-rays. This equipment consists of the five items below. (1) X-ray Control Box (MTT controller): Located on the operation desk (2) X-ray Tube: Located inside the X-ray shield box (3) High Voltage Transformer: Located beside the X-ray shield box (4) Cooling Water Unit: Located beside the X-ray shield box (5) High Voltage Cable: Connects the X-ray tube to the high voltage transformer
8	Flat Panel Detector	X-rays detector used to detect the X-rays which entered. The X-rays which entered are changed into visible light bright enough. The changed visible light is sent to a control computer.
9	CT Stage	A precision stage used to move measurement samples to the desired position or rotate it for CT scanning.
10	Main Power Supply Circuit Breaker	The main power supply circuit breaker is located on the side of the control board, at the rear of the shield box. Switching it OFF, shuts off power to all units, except the control computer.

⚠ WARNING

Prohibitions

Do NOT Enter the Instrument

Do not enter the instrument. Have a Shimadzu service representative perform instrument maintenance and inspection work.

2.1.1 X-ray Tube

X-rays are generated by using high voltage to accelerate electrons in a vacuum and collide them against a metal surface called a target. The wavelength and intensity of generated X-rays is determined by the number of electrons per unit time (= tube current) and acceleration voltage (= tube voltage).

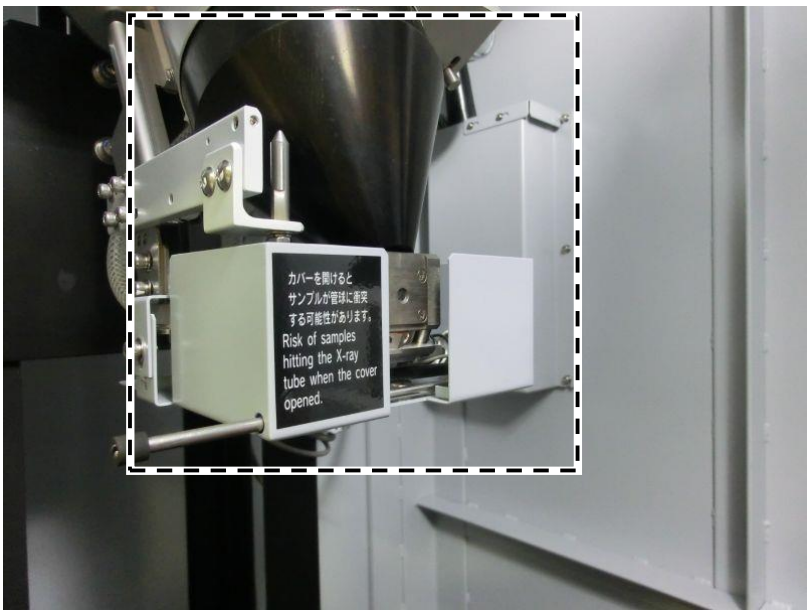


Fig. 2.2 X-ray Tube

2.1.2 Collision Sensor

The X-ray tube is equipped with a collision sensor around it. If a sample or sample setting jig hits the collision sensor, it immediately stops CT stage movement to minimize damage to the X-ray tube or CT stage.

A collision sensor cover is located in front of the collision sensor, which can be opened or closed using a knob.

Fig. 2.3 Collision Sensor

When the collision sensor cover is opened, software limiting functions are disabled. So it can close the sample to the X-ray tube.

(a) Cover Is Opened

(b) Cover Is Closed

Fig. 2.4 Collision Sensor Cover

⚠ CAUTION

Instructions

Collision Sensor Cover

When the collision sensor cover is opened, software limiting functions are disabled. Therefore, samples can be moved closer to the X-ray tube to increase magnification rates even higher. However, this requires particular caution and taking full responsibility for opening the collision sensor cover. Because there is a possibility that the CT stage will collide with the X-ray tube, be careful to avoid their collision.

2.1.3 Flat Panel Detector(FPD)

This equipment carries the flat panel detector (FPD) as Flat panel detector.

By this FPD, X-rays are efficiently changed into visible light, and it takes into a control computer.

A lead panel is prepared in the front and side of a flat panel detector, and the electronic circuit portion of a flat panel detector is protected from exposure of X-ray.

Fig. 2.5 Flat Panel Detector

NOTE

Stability of the Flat Panel Detector

After turning ON the key switch, the flat panel detector is in the warm-up period for about 60 minutes, and the luminosity value may be changed until the temperature of the flat panel detector is stabilized.

Although acquisition of fluoroscopic images, CT images and calibration data is possible also during the warm-up period, fluoroscopic images, CT images, and calibration data may be affected.

When fluoroscopic images, CT images and calibration data which is not affected by the luminosity change is required, please wait to acquire the images for 60 minutes after the ON key switch.

NOTE

Image Persistence

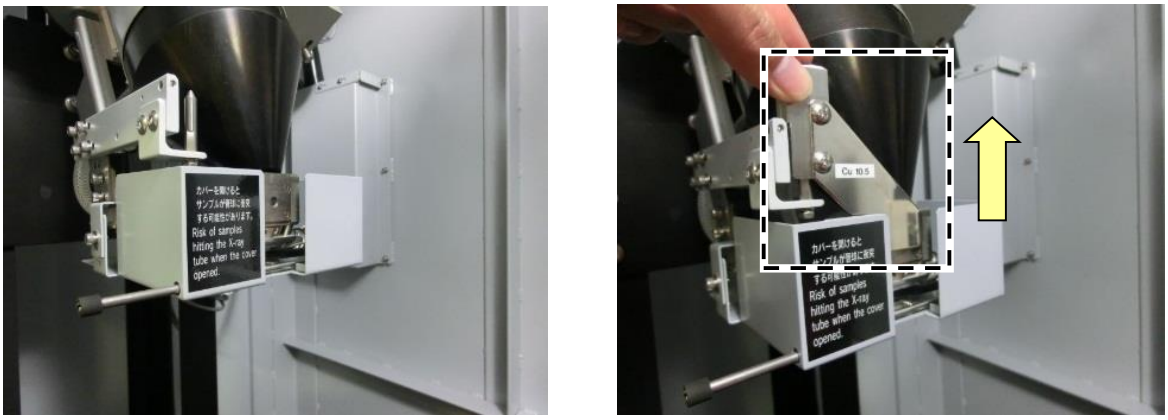
Due to the characteristics of the light receiving area of the flat panel detector, image persistence can sometimes occur after data acquisition.

It can be particularly prominent after scanning high-contrast samples, but image persistence dissipates with time and is not a malfunction.

2.1.4 Metal Filter

A metal filter is used to allow increasing tube voltage for samples through which X-rays penetrate relatively poorly. Using a metal filter allows obtaining adequate X-ray penetration in the sample area and inhibiting saturation from air pockets, even after tube voltage is increased. There are three types of metal filters provided, 0.5 mm, 1.0 mm, and 2.0 mm thick, which can be selected according to tube voltage and sample conditions.

To replace a metal filter, hold the knob of the metal filter and lift it.



(a) Metal Filter Is Removed **(b) Metal Filter Is Attached**

Fig. 2.6 Using a Metal Filter

NOTE

Tarnish of the Metal filter

It is not unusual that the exposure of X-ray irradiation might tarnish the position of the Metal filter in use

2.1.5 Manipulator

The manipulator primarily serves two functions.
One is to rotate or translate the CT stage, which is used to rotate or move the CT stage during CT scanning, position samples, or change the magnification rate.
The other is to move the Flat panel detector, which is used to change the magnification rate or switch between scan modes (normal or offset).

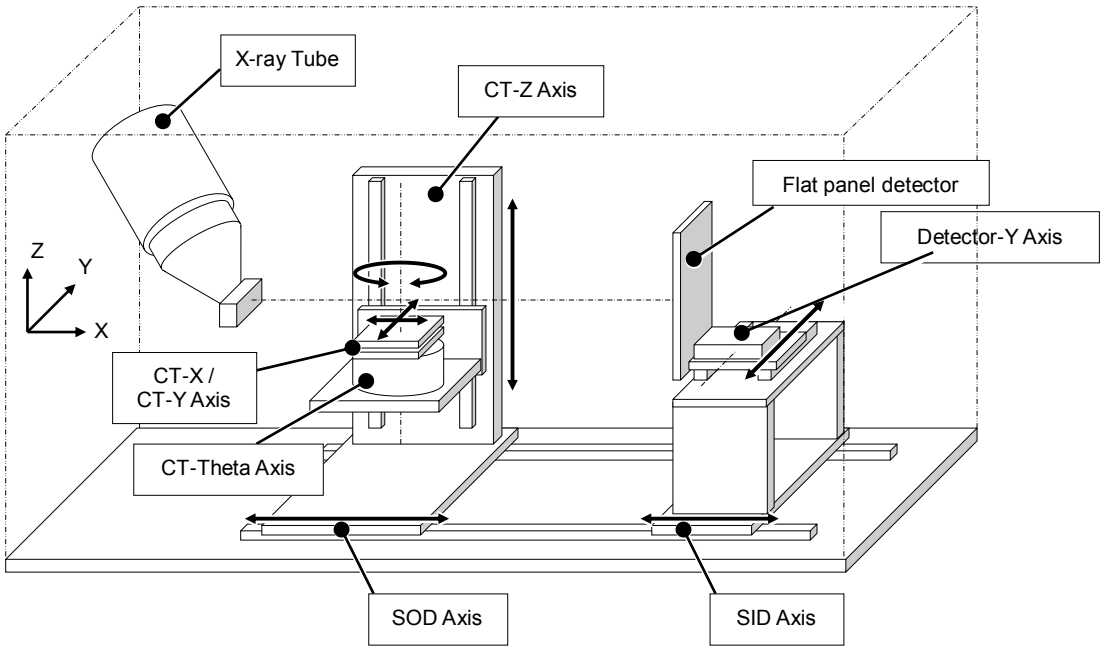


Fig. 2.7 Manipulator Diagram

Name	Description
SOD Axis	The SOD (=Source to Object Distance) axis is used to change the distance between the focal point and sample. The sample is moved in the X-axis direction to change the magnification rate. Moving it closer to the X-ray tube increases the magnification rate and moving it closer to the Flat panel detector increases the field of view.
CT-Z Axis	The sample is raised or lowered along this axis. It is used to move the target area to be scanned into the field of view.
CT-Theta Axis	The sample is rotated around this axis. During CT scans, the CT stage is rotated to collect projection data from various directions and reconstruct the CT image.
CT-X / CT-Y Axis	These are perpendicular axes located above the CT-Theta axis. Since the CT image is centered around the CT-Theta axis, these axes are used to align the area of the sample to be scanned with the center of rotation.
SID Axis	The SID (=Source to Image Distance) axis is used to change the distance between the focal point and detector. The Flat panel detector is moved in the X-axis direction to change the magnification rate. Moving it closer to the tube reduces magnification, but increases detection sensitivity. Moving it farther from the tube increases magnification, but reduces detection sensitivity.
Detector-Y Axis	This axis is used to move the Flat panel detector in the Y-axis direction. Normally, the rotation center is aligned with the Flat panel detector center, but moving the detector in the Y-direction allows shifting the rotation center toward the edge of the detector. Center shifting is typically used in offset scanning, which obtains offset data by shifting the rotation center toward the edge of the detector.

2.2 Operation Box

The operation box allows performing operations such as switching the system power ON/OFF, moving the CT stage, or starting CT scans.

⚠ CAUTION

Prohibitions

Caring For the Operation Box

Do NOT let the operation box fall off the desk. Do NOT use a pen or other pointed object to push the buttons. If the membrane switch surface becomes dirty, clean it by applying a mild detergent to a soft cloth and lightly wiping. Never use acetone, benzene, paint thinner, or other harsh solvents, which can discolor or deform the plastic.

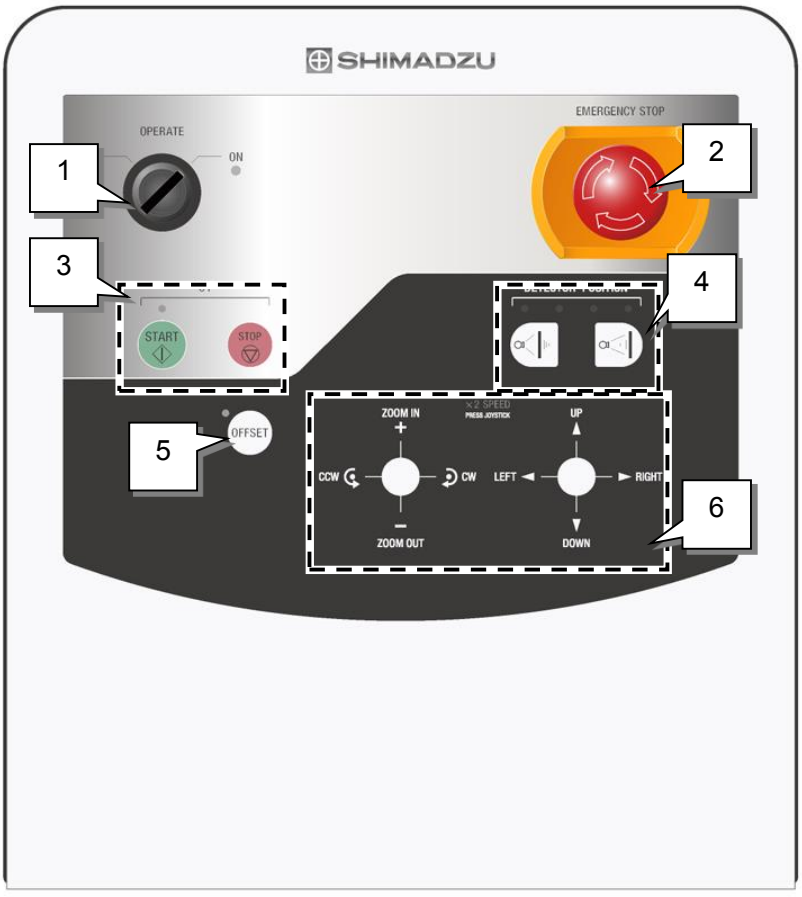


Fig. 2.8 Operation Box

No.	Name	Description
1	[OPERATE] Key Switch	This is the operation key switch for the system. Switching it OFF, shuts off power to all units, except the control computer. The [OPERATE] key can only be removed in the [OFF] position.
2	[EMERGENCY STOP] Button	When pressed, the [EMERGENCY STOP] button shuts off power to all units except the control computer and remains depressed. To reset the button, turn it clockwise. ☞For more about how to restore the system, see Restoring the System After an Error Shutdown (page xxi).
3	[CT] START/STOP Buttons	Pressing the [START] button starts CT scanning and pressing the [STOP] button stops CT scanning.
4	Detector Position Mode Buttons	Moves the SID axis. Switches the SID between two modes, either 800 or 1200 mm.
5	[OFFSET] ON/OFF Button	Switches between CT scan modes (normal or offset scan). Select the offset mode to scan a larger area and normal mode to increase magnification. The LED indicator illuminates when the offset scan mode is selected. ☞ For more about normal and offset scan modes, see 9.3 Normal and Offset Scanning.
6	Axis Drive Joystick Buttons [X2 SPEED] Indicator Lamp	These buttons are used to operate the CT-Z axis, XY-axes, SOD axis, and CT-Theta axis. [ZOOM IN] / [ZOOM OUT]: Controls movement on the SOD axis. [CCW] / [CW] : Controls movement on the CT-Theta axis. [UP] / [DOWN] : Controls movement on the CT-Z axis. [LEFT] / [RIGHT] : Controls movement on the XY axis. Joystick Down : Switches X2 SPEED mode ON/OFF each time it is tilted downward. The [X2 SPEED] indicator illuminates when the X2 SPEED mode is ON. The CT stage can also be moved by moving the mouse pointer on the CT software inspeXio64 live image.

⚠ CAUTION

Prohibitions

Do not Operate the Mouse during the Joystick Operation

Unexpected stage movement may occur.

Press the [EMERGENCY STOP] button immediately when unexpected stage movement occurs.

2.3 Power Supply Switch and [EMERGENCY STOP] Button

2.3.1 Main Power Supply Circuit Breaker

The main power supply circuit breaker is located on the side of the control board, at the rear of the shield box. If the system will not be used for an extended period, such as before the weekend or holidays, switch the main power supply circuit breaker OFF, as described in 3.6 Shutting Down the System.

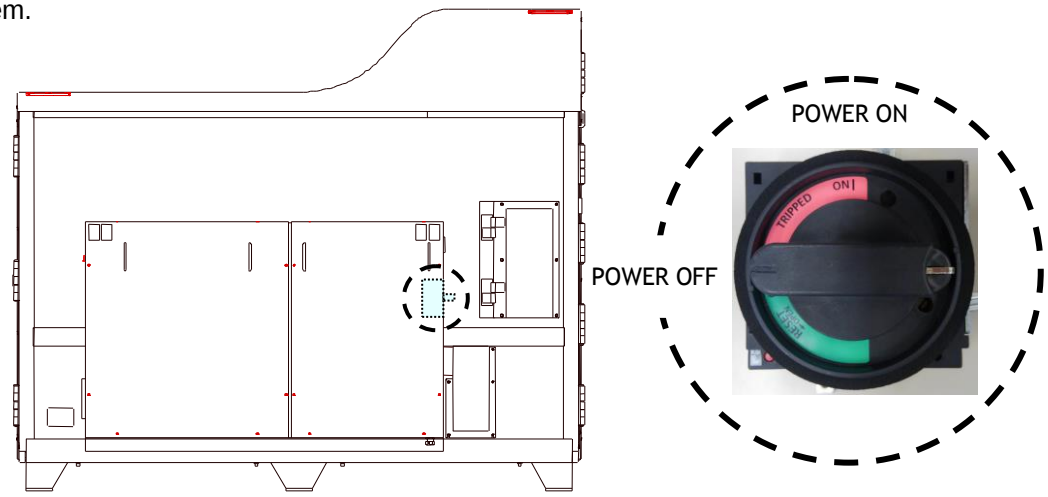


Fig. 2.9 Main Power Supply Circuit Breaker

2.3.2 [OPERATE] Key Switch

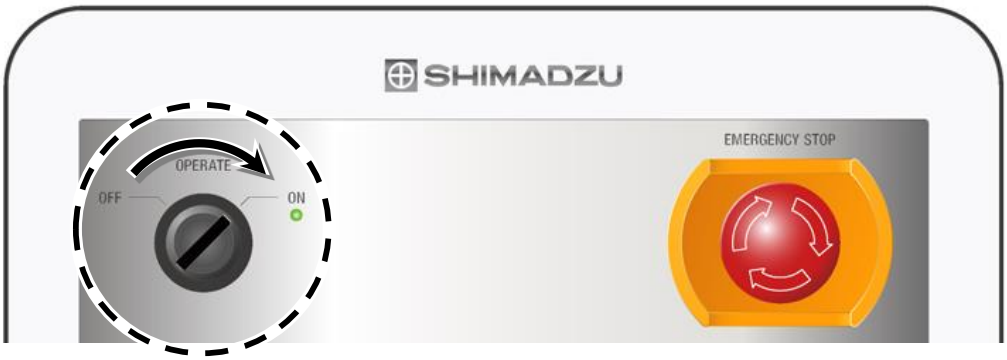


Fig. 2.10 [OPERATE] Key Switch

The [OPERATE] key switch is located on the upper left of the operation box. To operate the system, insert the OPERATE key into the key hole and turn the [OPERATE] key switch clockwise to [ON].

To stop operating the system, turn the [OPERATE] key switch to [OFF] by turning the OPERATE key counterclockwise, then pull it out.

Store the OPERATE key carefully so that it does not get lost or damaged.

2.3.3 [EMERGENCY STOP] Button

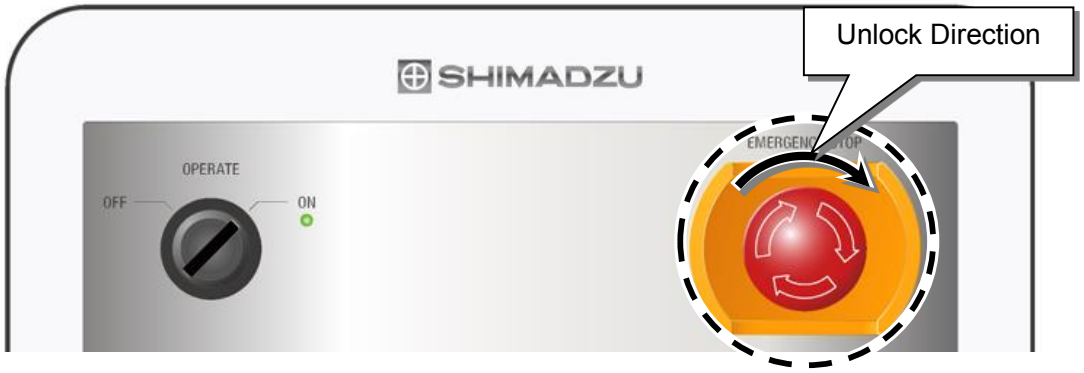


Fig. 2.11 [EMERGENCY STOP] Button

The [EMERGENCY STOP] button is located on the upper right of the operation box.

Pressing the [EMERGENCY STOP] button immediately shuts off X-ray generator and stops CT stage movement.

To restart the system after the [EMERGENCY STOP] button is depressed, eliminate the cause and unlock the [EMERGENCY STOP] button by turning it clockwise, and confirm that the power switch on X-ray control box, then restart the CT software inspeXio64.

☞ For more about how to restore the system, see Restoring the System After an Error Shutdown (page xxi).

⚠ CAUTION

Prohibitions

EMERGENCY STOP Switch

Pressing the [EMERGENCY STOP] button immediately shuts off X-ray generator and shuts off the vacuum pumps (diaphragm pump and turbo molecular pump).
Do not press the [EMERGENCY STOP] button indiscriminately.

2.4 X-ray Control Box (MTT Controller)

The X-ray control box (MTT controller) is the controller used to generate X-rays.

The control box allows switching the X-ray generator ON/OFF or verifying the X-ray radiation time.

(a) Rear Panel **(b) Front Panel**

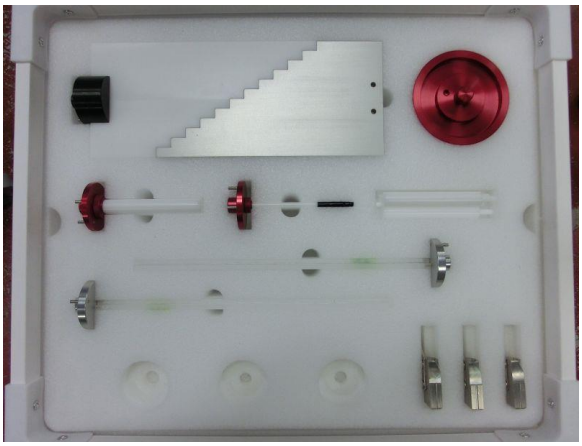
Fig. 2.12 X-ray Control Box

No.	Name	Description
1	Main Power Switch	This is the main power supply switch for the control box (MTT controller).
2	[ON] Button	Starts X-ray control. The LED indicator illuminates green when the X-ray controller is operating.
3	[OFF] Button	Ends X-ray control.
4	[KEY] Switch	This is the key switch for the control box (MTT controller) interlock. X-rays cannot be emitted if the [KEY] switch is [OFF].
5	[RUN TIME] Display	Displays the number of hours the control box (MTT controller) power has been ON.
6	[RADIATION] Display	Displays the X-ray radiation time.

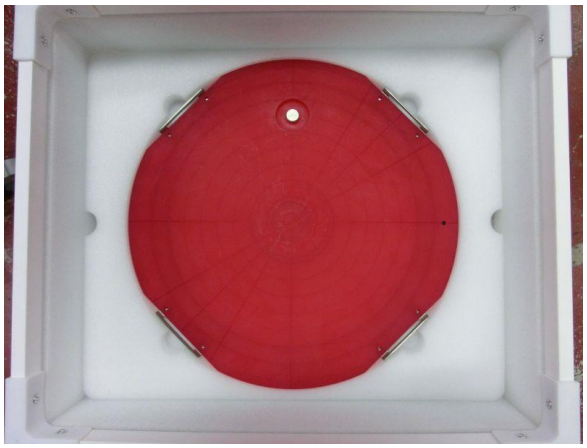
2.5 CT Accessory Storage Box

The CT accessory storage box included with the X-ray CT System contains sample setting jigs, phantoms used for calibration functions, BHC phantoms, and metal filters, which are placed in front of the Flat panel detector.

☞ For more about the calibration functions, refer to 2.13 Instrument Settings Area in the Advanced Operations Instruction Manual.

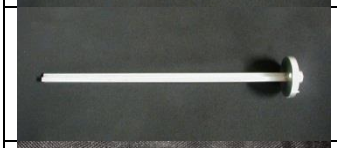
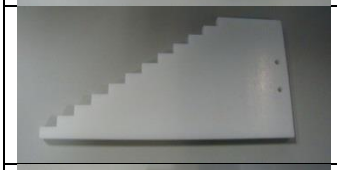


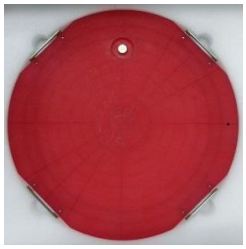
(a) CT Accessory Storage Box (upper tray)



(b) CT Accessory Storage Box (lower tray)

Fig. 2.13 CT Accessory Storage Box

Level	Item	Description
Upper Tray		Center Calibration Phantom(100 μm) Phantom used to calibrate the center of rotation. Used for large magnification.
		Center Calibration Phantom(150μm) Phantom used to calibrate the center of rotation. Used for low magnification.
		Sample Setting Jig (small) Used to set up samples. This is ideal for small samples.
		Sample Setting Jigs (small) - 3 spares Used to replace damaged small sample setting jigs.
		Sample Setting Jig (medium) Used to set up samples. Ideal for samples too large for the small sample setting jig.
		Sample Setting Jigs (medium) - 2 spares Used to replace damaged medium sample setting jigs.
		Sample Setting Jig (large) Used to set up large samples.
		BHC Phantom, Aluminum (2.7 g/cm^3) Used by securing it to the BHC phantom mounting base. Used when creating BHC data.
		BHC Phantom, Polyacetal (1.35 g/cm^3) Used by securing it to the BHC phantom mounting base. Used when creating BHC data.
		BHC Phantom Mounting Base Used to secure the BHC phantom. Used when creating BHC data.
		Resolution Phantom Phantom used to make adjustments at the factory and during installation. Used such as to evaluate resolution when replacing filaments.

Level	Item	Description
Lower Tray		Metal (copper) Filters (0.5 mm, 1.0 mm, 2.0 mm) Used when scanning samples that are relatively difficult to penetrate with X-rays, to prevent saturation associated with high tube voltage levels. The metal filter thickness is selected according to the tube voltage level and sample parameters.
		Sample Setting Jig (extra-large) The size of this sample setting jig is dia. 400 mm. Used to set up large samples.

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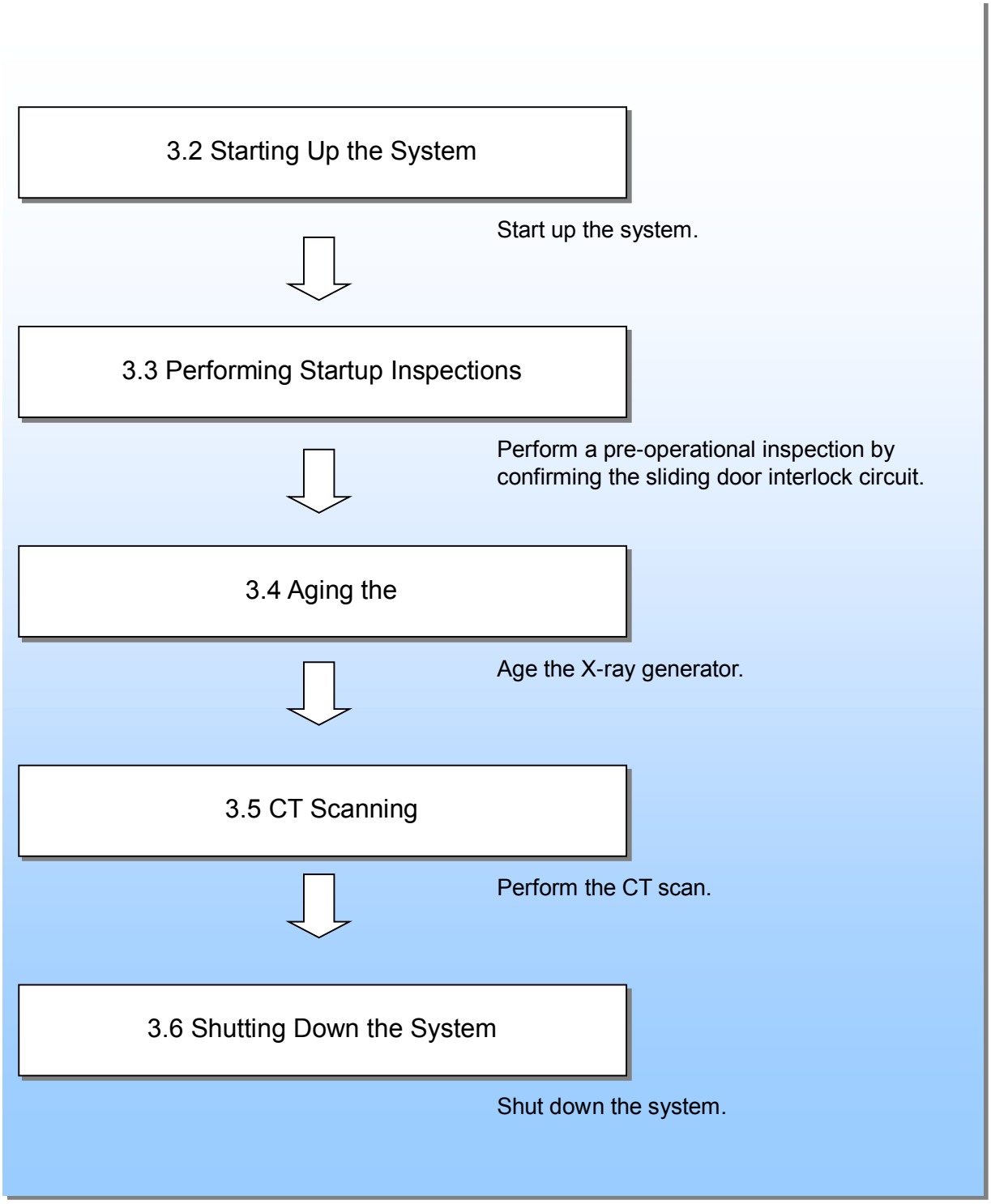
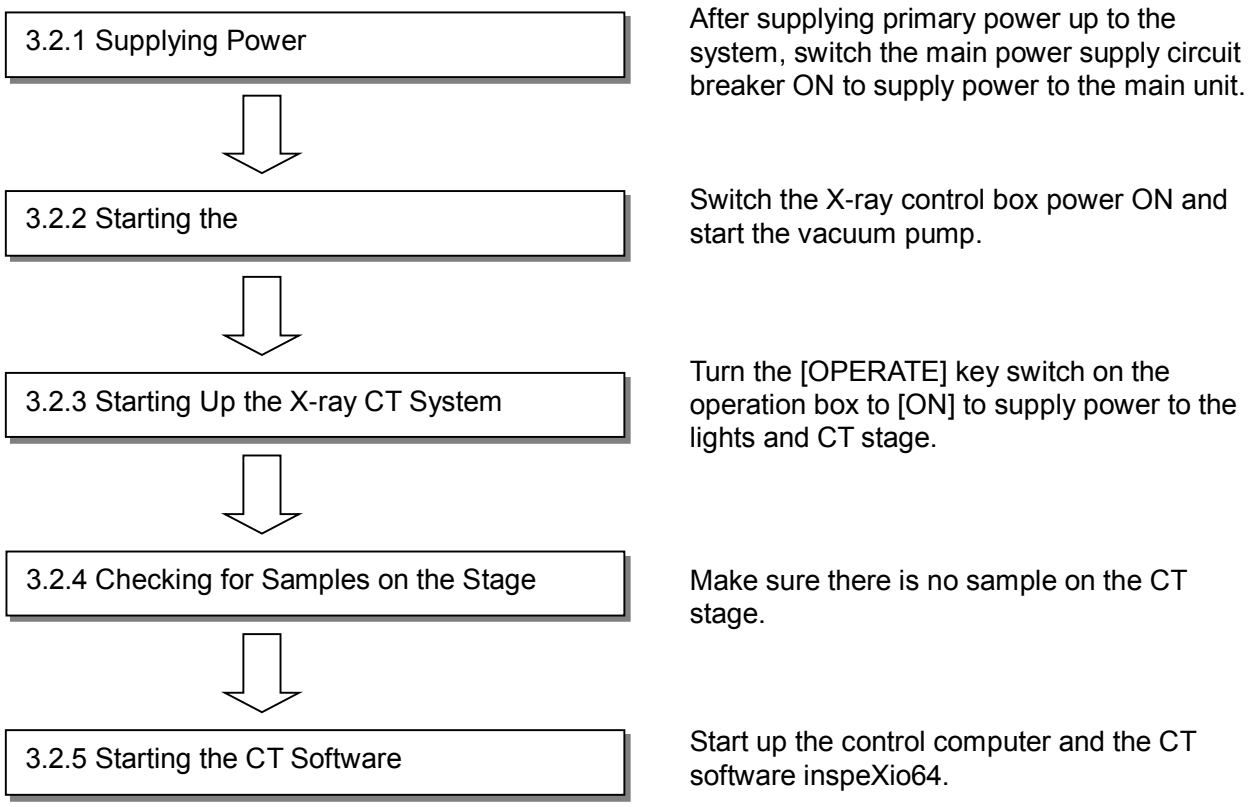
3 Operating the X-ray CT System

3.1 Basic Operating Procedure



3.2 Starting Up the System



⚠ CAUTION

Instructions

Operating the System Intermittently

If operating the system intermittently (without a long period of disuse), start up the system beginning with 3.2.3 Starting Up the X-ray CT System. If starting the system after installation or an extended period of disuse, start up the system beginning with 3.2.1 Supplying Power.

Age the X-ray generator monthly, even if the system is not being used or is in storage. Not aging the X-ray generator regularly could shorten its service life.

3.2.1 Supplying Power

Supply the primary power.

Power Supply: Single-phase 200 ±20 V, 3 kVA (50/60 Hz) and 100-120 VAC, 1kVA (50/60Hz)*

Ground: 100 Ohm max. ground resistance

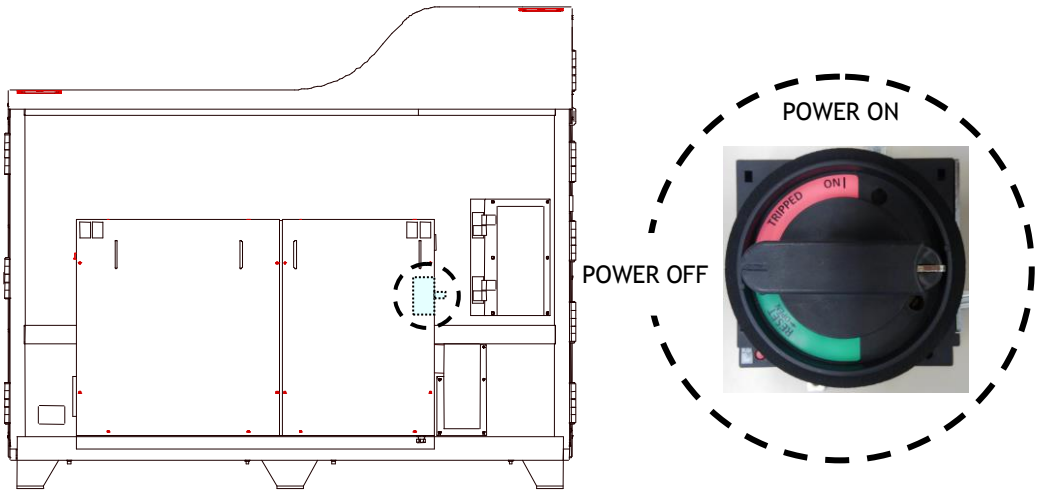


Fig. 3.1 Switching Main Power Supply Circuit Breaker OFF

1) Switch the circuit breaker OFF in the on-site power supply service panel.
2) Confirm that the [OPERATE] key switch on the operation box is in the [OFF] position.
3) Confirm that the main power supply circuit breaker located on the side of the control board, at the rear of the shield box is in the [OFF] position.
4) Connect the power cable, provided with the X-ray system, properly to the output terminal of the circuit breaker in the on-site power supply service panel.
5) Switch the circuit breaker ON in the on-site power supply service panel.
6) Switch the main power supply circuit breaker ON.

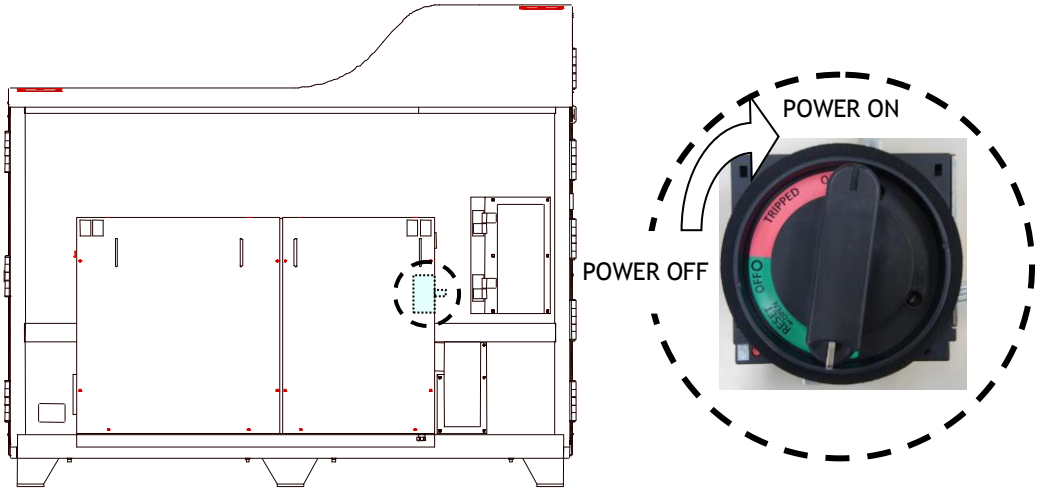


Fig. 3.2 Switching Main Power Supply Circuit Breaker ON

NOTE

Before Switching the Main Power Supply Circuit Breaker ON

Before switching the main power supply circuit breaker ON, confirm that the [EMERGENCY STOP] button on the operation box is not locked in the depressed position. Power is not supplied to the system if the button is depressed, even if the main power supply circuit breaker is switched ON.

3.2.2 Starting the X-ray generator

Set up the X-ray generator according to the procedure below.

1. Switch ON the power switch located on the back of the X-ray control box (MTT controller).

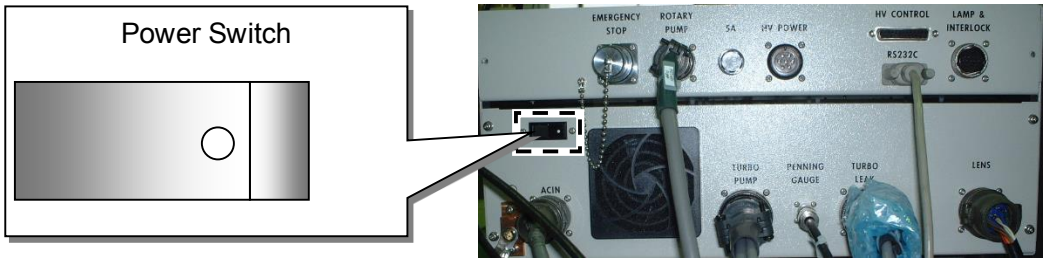


Fig. 3.3 Power Switch on Back of X-ray Control Box (MTT controller)

2. Turn ON the key switch located on the front panel of the X-ray control box (MTT controller).

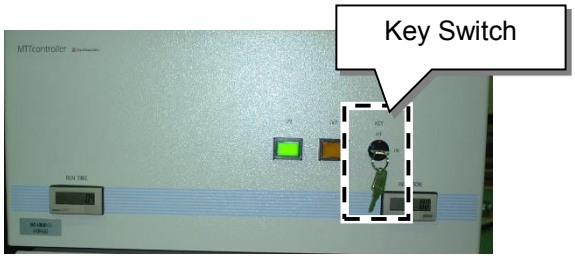


Fig. 3.4 Key Switch on Front of X-ray Control Box

3. Loosen the fastener screws and open the maintenance door, located on the left upper of the shield box.

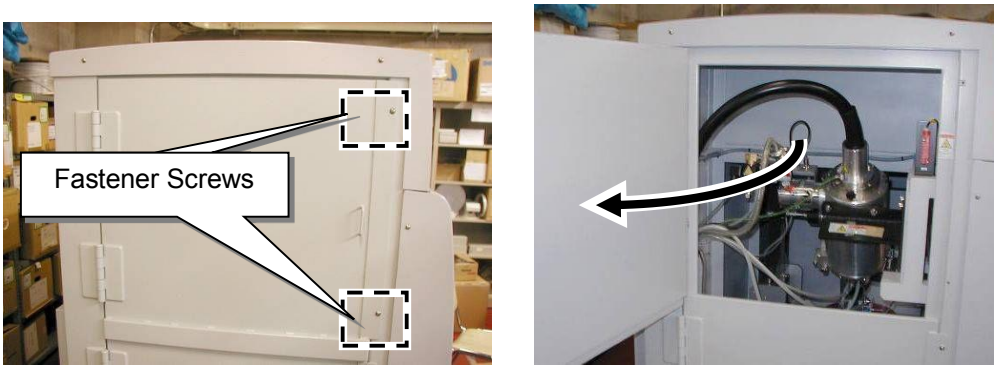


Fig. 3.5 Maintenance Door on Left Upper of Shield Box

4. Tighten the valve of turbo molecular pump in turning clockwise.

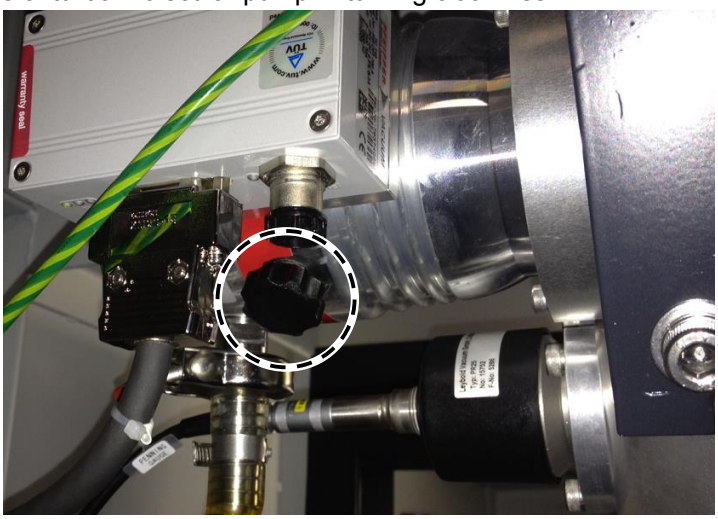


Fig. 3.6 Tighten Vent Valve

5. Push the [ON] button (green) on the front panel of the X-ray control box (MTT controller) to start the vacuum pumps (diaphragm pump and turbo molecular pump).

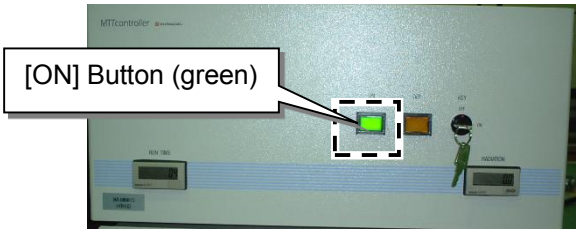


Fig. 3.7 [ON] Button on Front of X-ray Control Box

6. Close the maintenance door located on the left upper of the shield box, and tighten the fastener screws.

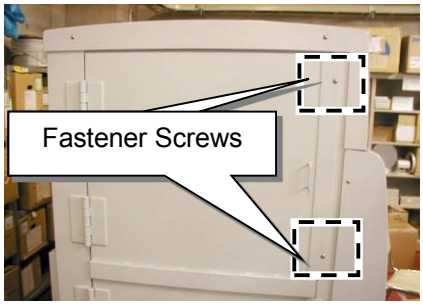


Fig. 3.8 Maintenance Door on Left Upper of Shield Box

⚠ CAUTION

Prohibitions

Ambient Temperature of Turbo Molecular Pump

The specified ambient temperature of the turbo molecular pump during operation is 15℃ to 30℃. If the ambient temperature exceeds this range, do NOT start turbo molecular pump operation. Furthermore, if the ambient temperature exceeds this range at any point during turbo molecular pump operation, immediately stop the vacuum pumps by pressing the [OFF] button (orange) located on the front of the X-ray control box.

3.2.3 Starting Up the X-ray CT System

The [OPERATE] key switch is located on the upper left of the operation box.

To start operating the system, insert the key into the key hole and turn it clockwise to [ON].

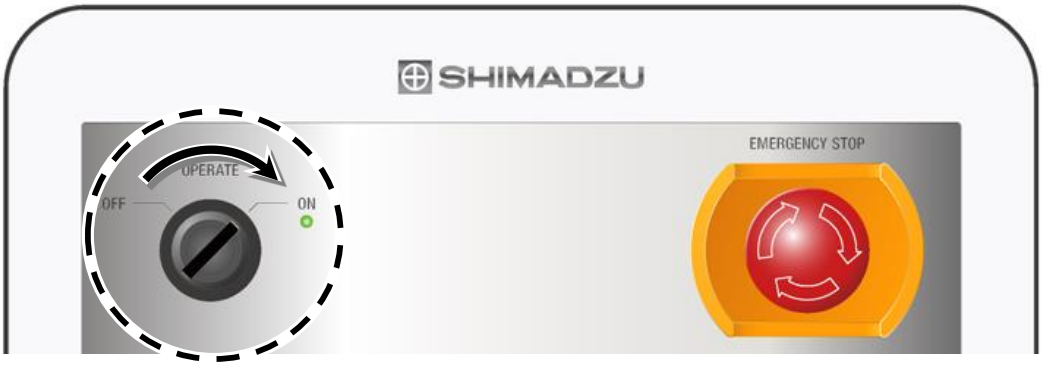


Fig. 3.9 [OPERATE] Key Switch

NOTE

Before Switching the Main Power Supply Circuit Breaker ON

Before switching the main power supply circuit breaker ON, confirm that the [EMERGENCY STOP] button on the operation box is not locked in the depressed position. Power is not supplied to the system if the button is depressed, even if the main power supply circuit breaker is switched ON.

3.2.4 Checking for Samples on the Stage

The CT stage is initialized during CT software inspeXio64 startup.

CT stage initialization consists of moving the CT stage to the reference position for each axis (home position), each time the CT software inspeXio64 is started. This ensures each CT stage axis is positioned accurately.

Leaving a large sample on the stage during CT stage initialization could damage the sample or instrument.

Make sure nothing is on the CT stage before starting CT software inspeXio64.

⚠ CAUTION

Instructions

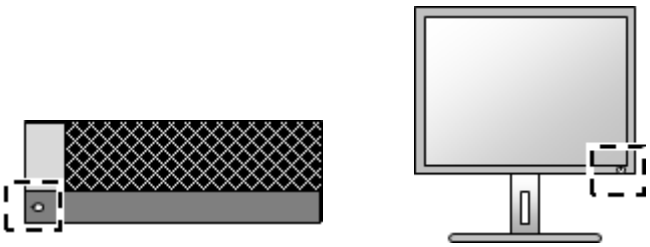
Damage to Samples or X-ray System

Always make sure nothing is on the CT stage before starting CT software inspeXio64. Leaving a large sample on the stage during CT stage initialization could damage the sample or instrument.

3.2.5 Starting the CT Software

Start up the CT software inspeXio64 according to the following procedure.

1. Switch the control computer and monitors power ON.



(a) **Control Computer** **(b) Monitor**

Fig. 3.10 Control Computer and Monitors

After a brief delay, the control computer will start up automatically.

2. Once the operating system is running, double-click the  (inspeXio64) icon on the desktop to open the CT software inspeXio64.

(1) The opening screen is displayed.

Fig. 3.11 Opening Screen

(2) The [Start Evacuation System] window is displayed. When the turbo molecular pump exceeds a specified rotation speed, the [Start Evacuation System] window disappears.

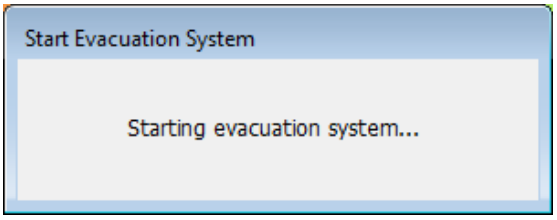


Fig. 3.12 [Start Evacuation System] Window

(3) The startup inspection wizard starts. Perform the startup inspection by following the wizard instructions.

☞ For more details regarding the startup inspection, see 3.3 Performing Startup Inspections.

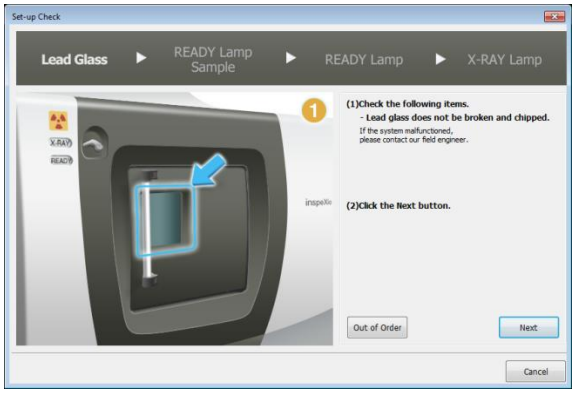


Fig. 3.13 [Set-up Check] Wizard Window for Checking the Lead Glass

(4) An X-ray control area appears in the upper right part of the screen.

Fig. 3.14 X-ray Control Area

(5) The CT stage initialization routine starts. An [Initializing Stage] window is displayed during stage initialization. Clicking the [Cancel] button in the [Initializing Stage] window during CT stage initialization cancels the CT stage initialization process.

If CT stage initialization is canceled, close and restart the CT software inspeXio64.

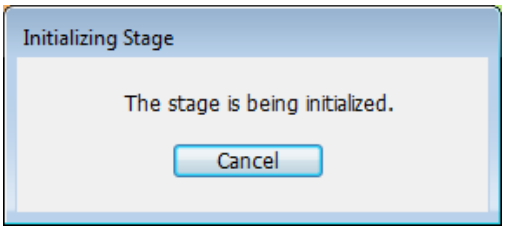


Fig. 3.15 [Initializing Stage] Window

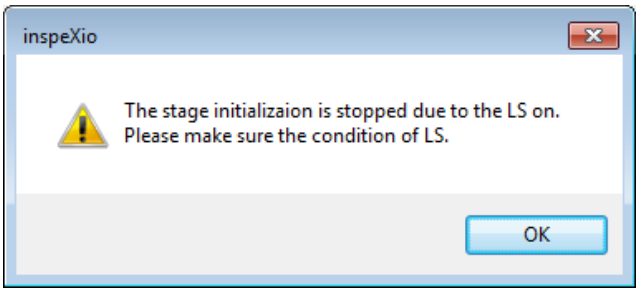
⚠ CAUTION

Instructions

Initializing the Stage and LS Status for Respective Axes

Each axis is equipped with a limit sensor (LS) in both the positive and negative directions to detect movement past respective limits. Before initializing the stage, the system checks the limit sensors for all axes and displays the following message and stops stage initialization if any of the sensors is tripped.

If the following message is displayed, promptly contact your Shimadzu representative.



NOTE

Time Required to Launch CT Software

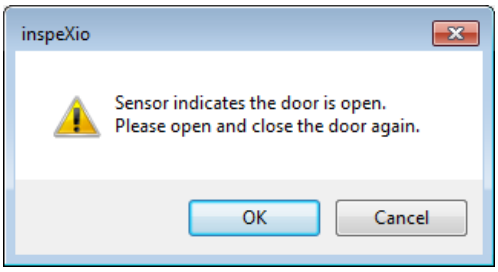
The time required for startup, from when the control computer power is switched ON until the inspeXio64 [Main] window appears, will vary depending on various computer settings and performance, but typically is about 2 minutes.

NOTE

Stage Initialization and Sliding Door Position

The stage cannot be initialized if the sliding door is opened. Make sure the sliding door is closed before starting the CT software inspeXio64.

If the sliding door is opened during stage initialization, initialization is stopped for safety reasons and a message appears. If this occurs, wait about 1 second before closing the sliding door and click the [OK] button. Then, initialization will resume.



(6) Once the CT stage has been successfully initialized, the CT software inspeXio64 [Main] window opens.

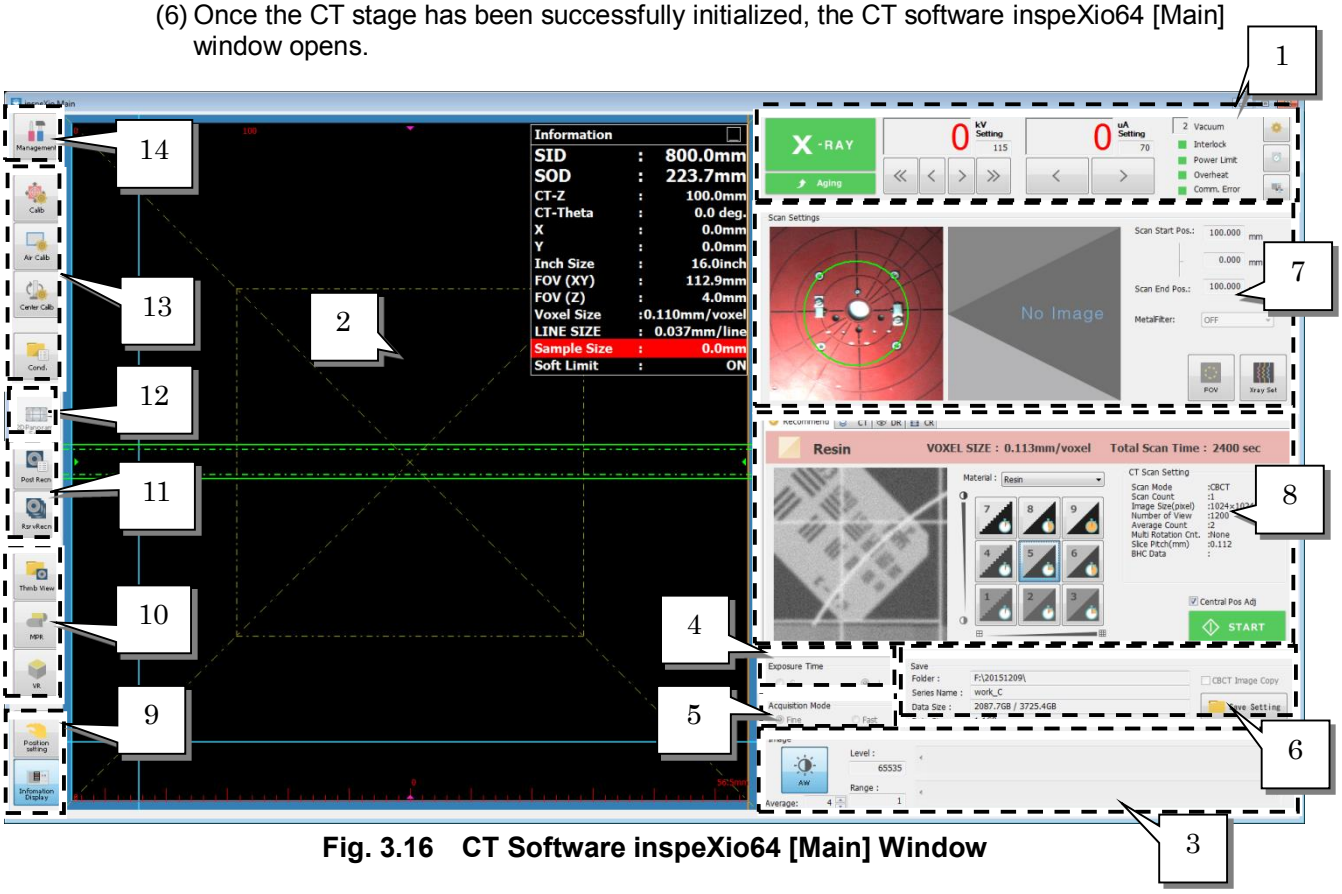


Fig. 3.16 CT Software inspeXio64 [Main] Window

No.	Item	Description
1	X-ray Control Area	Used to control the X-ray generator.
2	Live Image Display Area	Used for viewing live images, for moving the CT stage by left-clicking on the live image, and for displaying instrument information.
3	Live Image Quality Settings Area	Used to specify image quality settings for the live image.
4	Exposure Time Setting Area	Used to select the exposure time of the Flat panel detector.
5	Acquisition Mode Settings Area	Used to specify acquisition mode settings for the flat panel detector.
6	Save Settings Area	Used to specify settings for saving image files.
7	Scan Settings Area	Used to automatically position the CT stage and set X-ray parameters during CT scanning.
8	Scanning Parameter Settings Area	Used to switch between [CT], [DR], and [CR] tabs and specify various scan parameters.
9	Other Settings Area	Used to switch between various information displayed on the live image and control stage movements.
10	Image Display Area	Used to display resulting scan, MPR, and VR images.
11	Reconstruction Area	Used to change parameters and recalculate previously collected data.
12	2D Panorama Scan Setting Area	Used to specify 2D panorama scan settings.
13	Instrument Settings Area	Used to save/load instrument parameters and perform various calibration processes.
14	System Management Area	Used to specify system management settings. Note: No one except your system manager should click this button.

3.3 Performing Startup Inspections

Confirm that the system functions properly by performing a startup inspection according to the following procedure.

1. When the software is launched, a startup inspection wizard starts up.
2. Inspect the lead glass for any scratches or cracks. If nothing unusual is discovered, click the [Next] button.

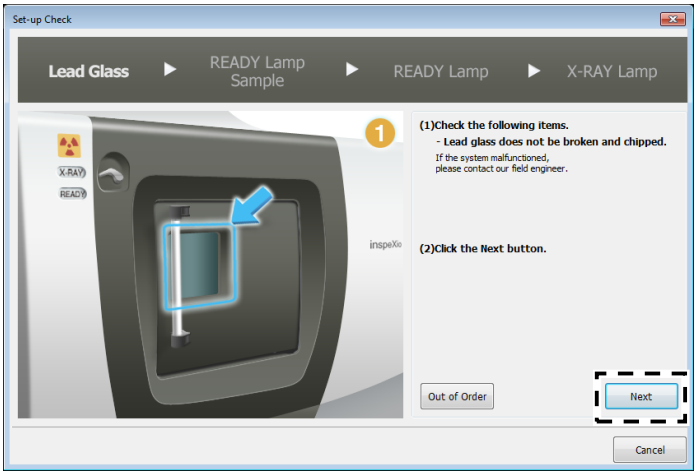


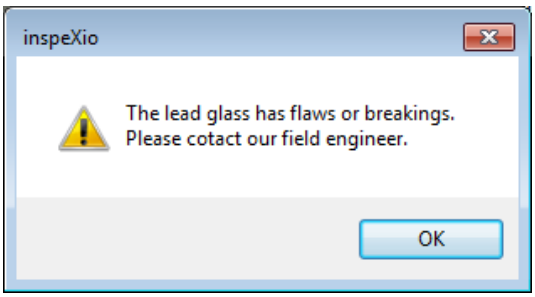
Fig. 3.17 [Set-up Check] Window for Checking the Lead Glass

⚠ WARNING

Instructions

Problems with Lead Glass

If the lead glass is scratched, cracked, or otherwise damaged, click the Out of Order [Out of Order] button in the startup inspection wizard to stop the wizard. If the wizard is stopped, the following message appears and the X-ray control area is not launched. Scratched or cracked lead glass could cause X-ray leakage. Therefore, promptly contact your Shimadzu representative.



3. Confirm that the [READY] lamp is not illuminated and whether or not a sample is present.

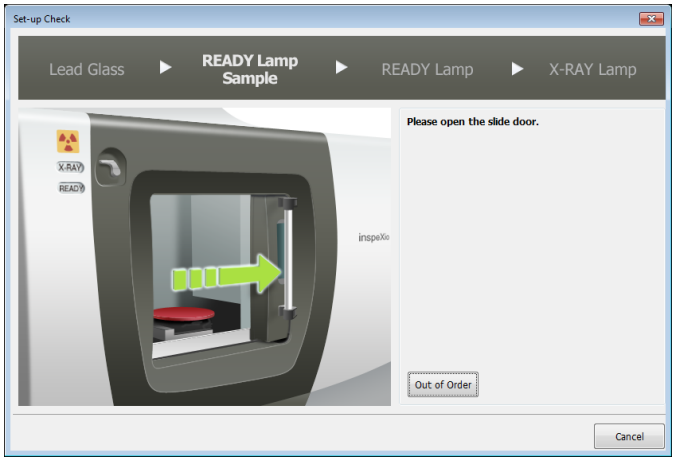


Fig. 3.18 [Set-up Check] Wizard Window for Checking the [READY] Lamp and Sample

> **NOTE**
>
> **If the Sliding Door is Open**
>
> This wizard window does not appear if the sliding door is already open, but that is normal.

4. Grip the sliding door handle and open the sliding door.

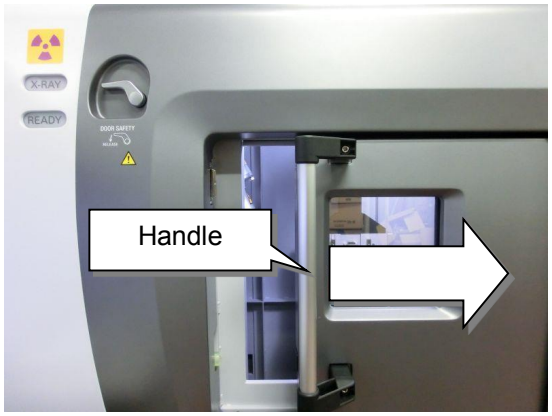


Fig. 3.19 Opening the Sliding Door

5. When the sliding door is opened, the wizard alternates between displaying the following windows. Confirm the following.

- The [READY] lamp is not illuminated
- There is no sample on the CT stage

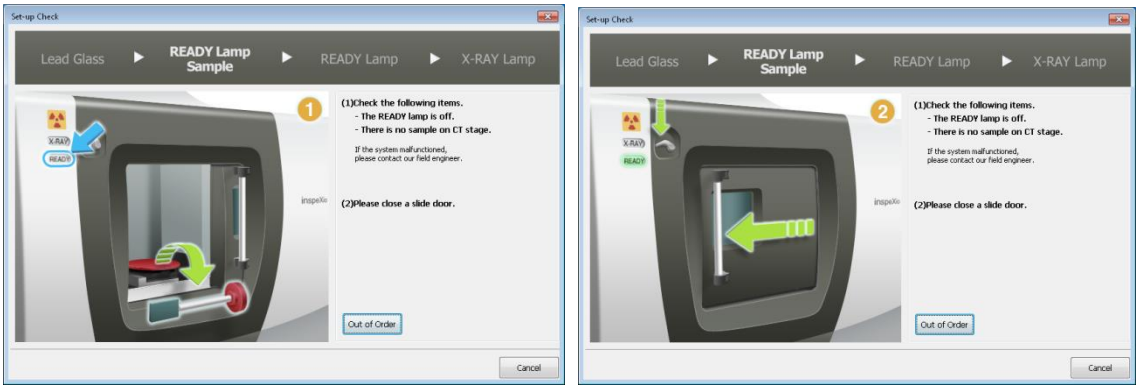


Fig. 3.20 [Set-up Check] Wizard Window for Checking the [READY] Lamp and Sample

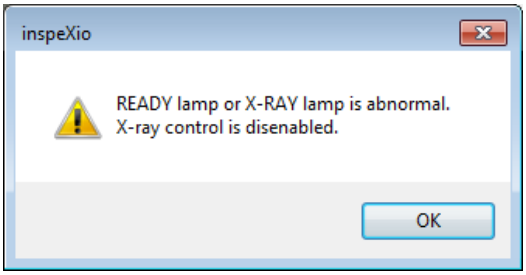
⚠ WARNING

Instructions

[READY] Lamp Error

Confirm that the [READY] lamp is not illuminated. If the [READY] lamp is illuminated, click the Out of Order [Out of Order] button in the startup inspection wizard to stop the wizard. If the wizard is stopped, the following message appears and the X-ray control area is not launched.

The status of interlocks cannot be verified if the [READY] lamp is not functioning properly. Therefore, promptly contact your Shimadzu representative.



6. Close the sliding door and confirm that the [READY] lamp is illuminated.Close the sliding door by turning the door safety lock counterclockwise with the left hand and gripping the door handle with the right hand and gently sliding the door to the left.

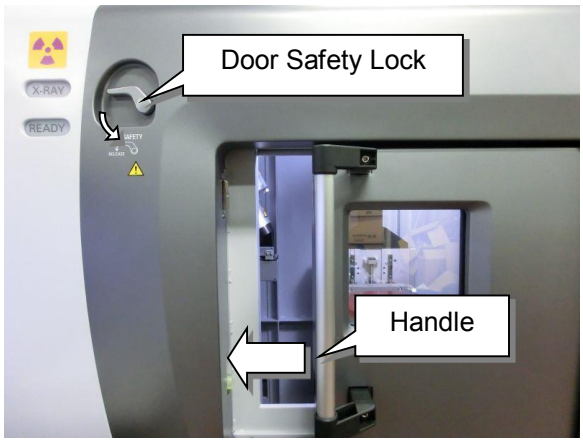


Fig. 3.21 Closing the Sliding Door

⚠ CAUTION

Instructions

Door Safety Lock

The sliding door is very heavy and generates considerable inertia when opened or closed. The door safety lock mechanism is provided to prevent pinching fingers, hands, or other items.

NOTE

Checking the MTT Controller Key Switch

Turn the MTT controller key switch ON before starting the software. If the key switch for the MTT control is not ON, then the [READY Lamp and Sample] window, used for startup inspection, cannot be closed, even the [READY] lamp is illuminated.

7. When the sliding door is closed, the wizard displays the following window. Confirm the following.

• The [READY] lamp is illuminated

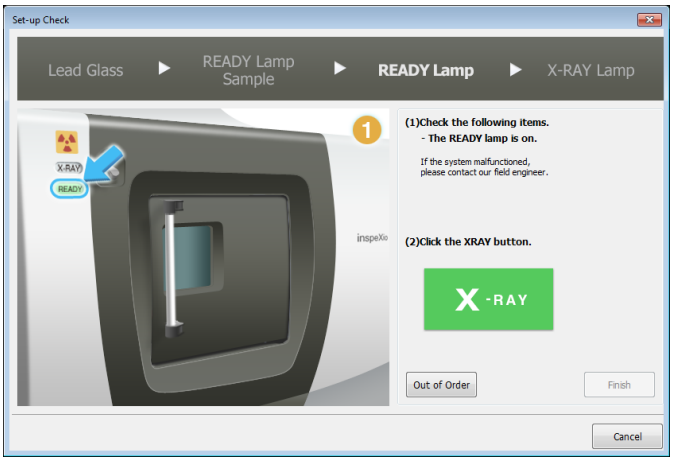


Fig. 3.22 [Set-up Check] Wizard Window for Checking the [READY] Lamp

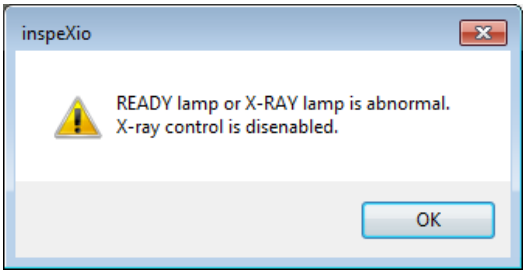
⚠ WARNING

Instructions

[READY] Lamp Error

Confirm that the [READY] lamp is illuminated. If the [READY] lamp is not illuminated or otherwise not functioning properly, click the Out of Order [Out of Order] button in the startup inspection wizard to stop the wizard. If the wizard is stopped, the following message appears and the X-ray control area is not launched.

The status of interlocks cannot be verified if the [READY] lamp is not functioning properly. Therefore, promptly contact your Shimadzu representative.



8. Emit X-rays and confirm that the [X-RAY] lamp illuminates.

Click the [X-RAY] button in the startup inspection wizard to emit X-rays.

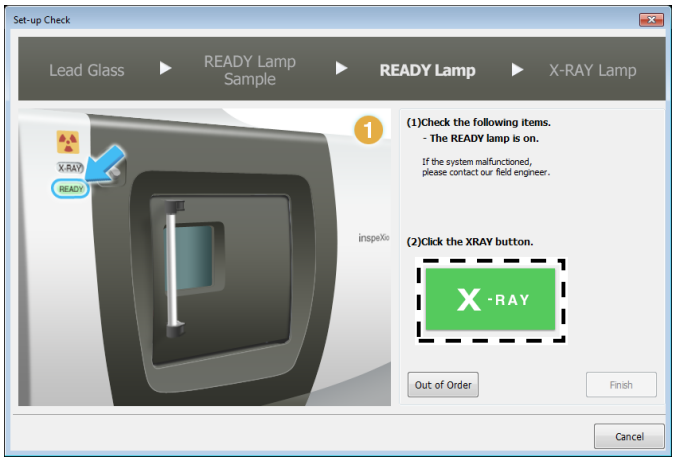


Fig. 3.23 [Set-up Check] Wizard Window for Checking the [X-RAY] Lamp

9. When X-rays are emitted, the wizard displays the following window. Confirm the following. The [X-RAY] button in the startup inspection wizard appears red while X-rays are being emitted.

• The [X-RAY] lamp is illuminated

If everything is normal, click the [Finish] button and close the startup inspection wizard.

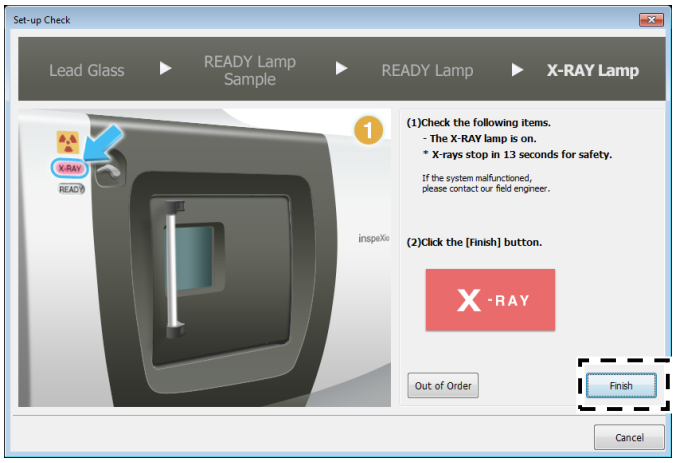


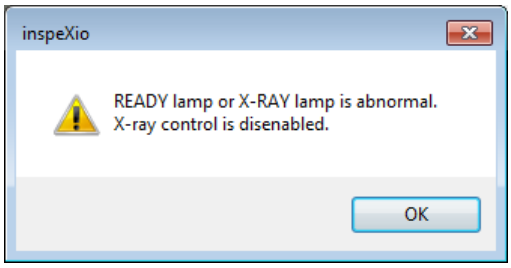
Fig. 3.24 [Set-up Check] Wizard Window for Checking the [X-RAY] Lamp

⚠ CAUTION

Instructions

[X-RAY] Lamp Error

Confirm that the [X-RAY] lamp is illuminated while X-rays are emitted. If the [X-RAY] lamp is not illuminated or otherwise not functioning properly, click the Out of Order [Out of Order] button in the startup inspection wizard to stop the wizard. If the wizard is stopped, the following message appears and the X-ray control area is not launched. The X-ray emission status cannot be verified if the [X-RAY] lamp is not functioning properly. Therefore, promptly contact your Shimadzu representative.



10. When X-rays are emitted, the wizard displays the following window. Confirm the following. The [X-RAY] button in the startup inspection wizard appears red while X-rays are being emitted.

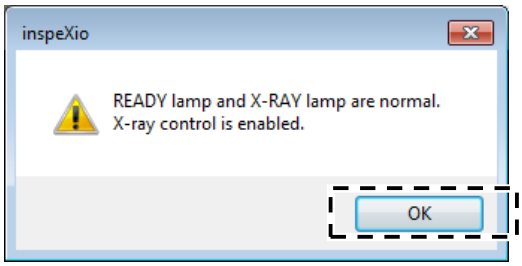


Fig. 3.25 Startup Inspection Finished Message

⚠ WARNING

Instructions

X-Ray Exposure Hazard

As a pre-operational inspection routine, always confirm that the sliding door interlock circuits are functioning properly. If the interlock circuits are not functioning properly, there is a risk of X-ray leakage and exposure. If this is the case, immediately stop using the system and contact your Shimadzu representative.

NOTE

Interlock Circuits

It is normal for the [X-RAY] button in the X-ray control area to take one or two seconds to turn green after the sliding door is closed.

In some cases, the [X-RAY] button in the X-ray control area will remain gray even after closing the sliding door. If opening and gently closing the door again solves the problem, this is normal.

3.4 Aging the X-ray generator

The CT software inspeXio64 determines the tube voltage output permitted based on the last time the previous aging process was finished and the specified voltage setting. If aging was finished within the last 24 hours, then X-ray output can be freely selected within the aging range.

However, if more than 24 hours have elapsed since aging was last finished, the monitor value is displayed in red, to indicate a warning. If more than 48 hours have elapsed and the voltage setting is over 161 kV, then a message appears reminding the user to perform aging and X-ray output is limited to 160 kV.

However, if more than 24 hours have elapsed since aging was finished, the monitor value is displayed in red to indicate a warning. If a voltage setting of over 160 kV is specified more than 48 hours after aging is finished or 8 hours after X-rays were last emitted, then a message appears reminding the user to perform aging and X-ray output is limited to 160 kV.

X-ray output at 160 kV or less is possible even after more than 48 hours since aging was last finished, but to ensure X-ray generator performance is maximized, perform aging before each time the system is used, even if the voltage setting is below 160 kV.

Age the X-ray generator monthly, even if the system is not being used or is in storage. Not aging the X-ray generator regularly could shorten its service life.

Period Since Last Aging Was Finished	Below 160 kV or Voltage When Last Finished Aging		Over 160 kV or Voltage When Last Finished Aging	
	Monitor Value Display Color	X-Ray Emission	Monitor Value Display Color	X-Ray Emission
0 to 24 hrs	Black	Yes	Black	Yes
24 to 48 hrs	Red	Yes	Red	Yes
Over 48 hrs	Red	Yes	Red	No

3.4.1 Aging Cycle

Aging is required if more than 24 hours have elapsed since aging was last finished. The aging cycle is set automatically based on when the last aging was finished and the voltage setting, as shown in the table below.

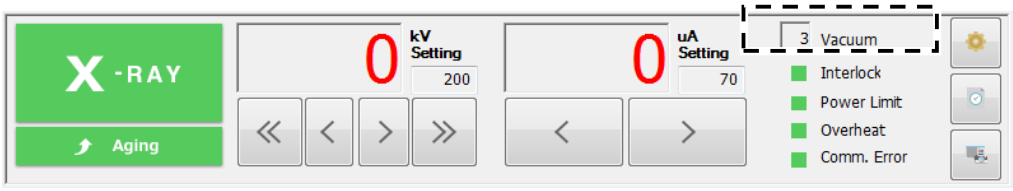
Period Since Last Aging Was Finished	Voltage Setting (kV)							
	1	2	3	4	5	6	7	8
24 hours to 3 days	165	185	205	225	--	--	--	--
4 to 7 days	145	165	185	205	225	--	--	--
7 to 30 days	125	145	165	185	205	225	--	--
Over 30 days or since filament was replaced	85	105	125	145	165	185	205	225

⚠ CAUTION

Prohibitions

Vacuum Gauge Output

Do NOT perform aging until the indicated vacuum gauge output value is 15 or less. Aging the X-ray generator when the vacuum gauge output is over 15 can cause an electrical discharge accident or cause the X-ray generator to malfunction. Use the vacuum gauge output display to confirm the vacuum gauge output value.



3.4.2 Aging the X-ray generator

Age the X-ray generator according to the procedure below.

1. In the X-ray control area, specify the maximum tube voltage to be used that day.

Based on the time the previous aging finished and the voltage setting, the software determines whether or not aging is necessary. If necessary, the values in the [kV] and [μA] monitor displays are shown in red.

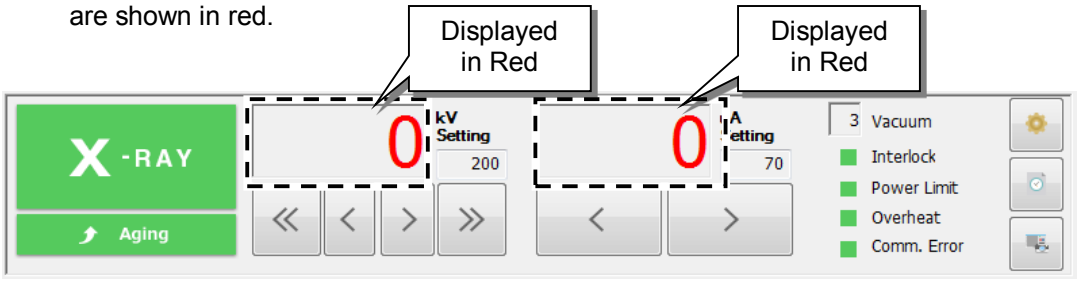


Fig. 3.26 Tube Voltage / Tube Current Monitor Values Displayed in Red

2. Make sure the sliding door is completely closed.

3. Clicking the [Aging] button opens the [Automatic Aging] window below.

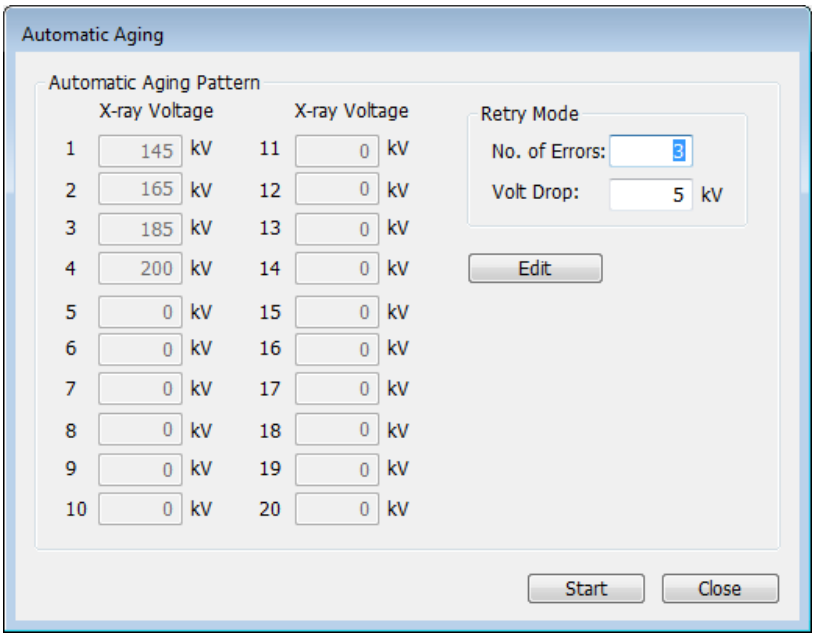


Fig. 3.27 [Automatic Aging] Window

4. The [Automatic Aging] window displays the optimal aging cycle (list of kV setting values), based on the voltage value and time when the previous aging finished.

Click [Start] to start the aging.

(1) X-ray radiation begins, and the voltage is gradually increased from zero to the value for each voltage setting in the aging cycle.

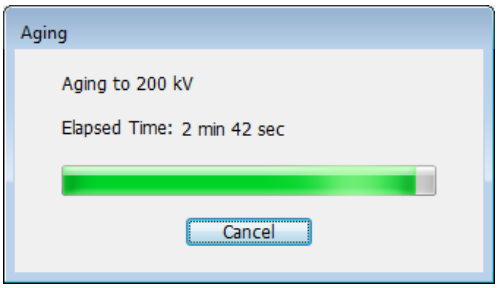


Fig. 3.28 [Aging] Window

(2) The [Aging] Finished window appears.

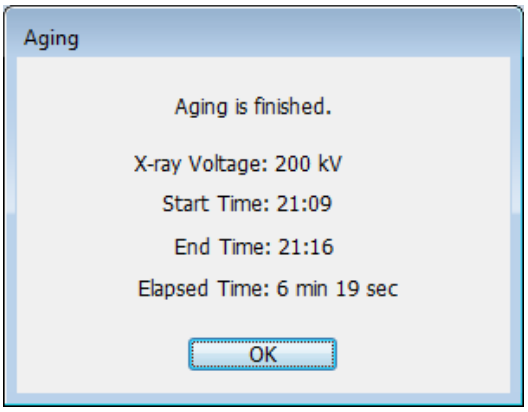


Fig. 3.29 [Aging] Finished Window

NOTE

kV/µA Monitor Value Display During Aging

The kV/µA monitor values may fluctuate during aging. This is due to the micro discharge inside the tube and is normal.

NOTE

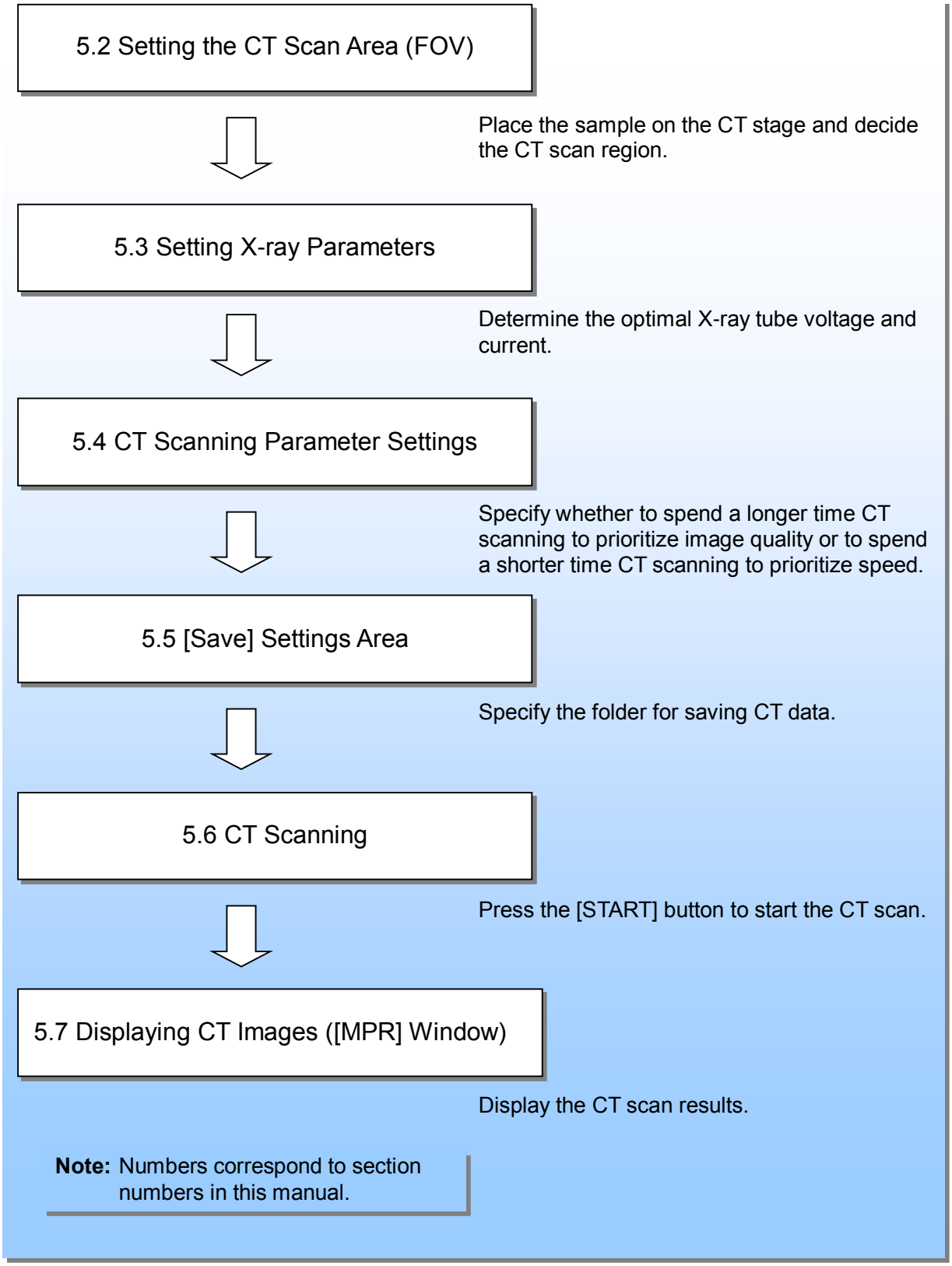
Bursting Sound From High-Voltage Transformer

In rare cases, a bursting sound may be emitted from the high voltage transformer during aging. This is due to air bubbles in the insulating oil bursting from electrical discharges inside the high voltage transformer and is normal. If this occurs, temporarily stop aging, then resume aging again.

3.5 CT Scanning

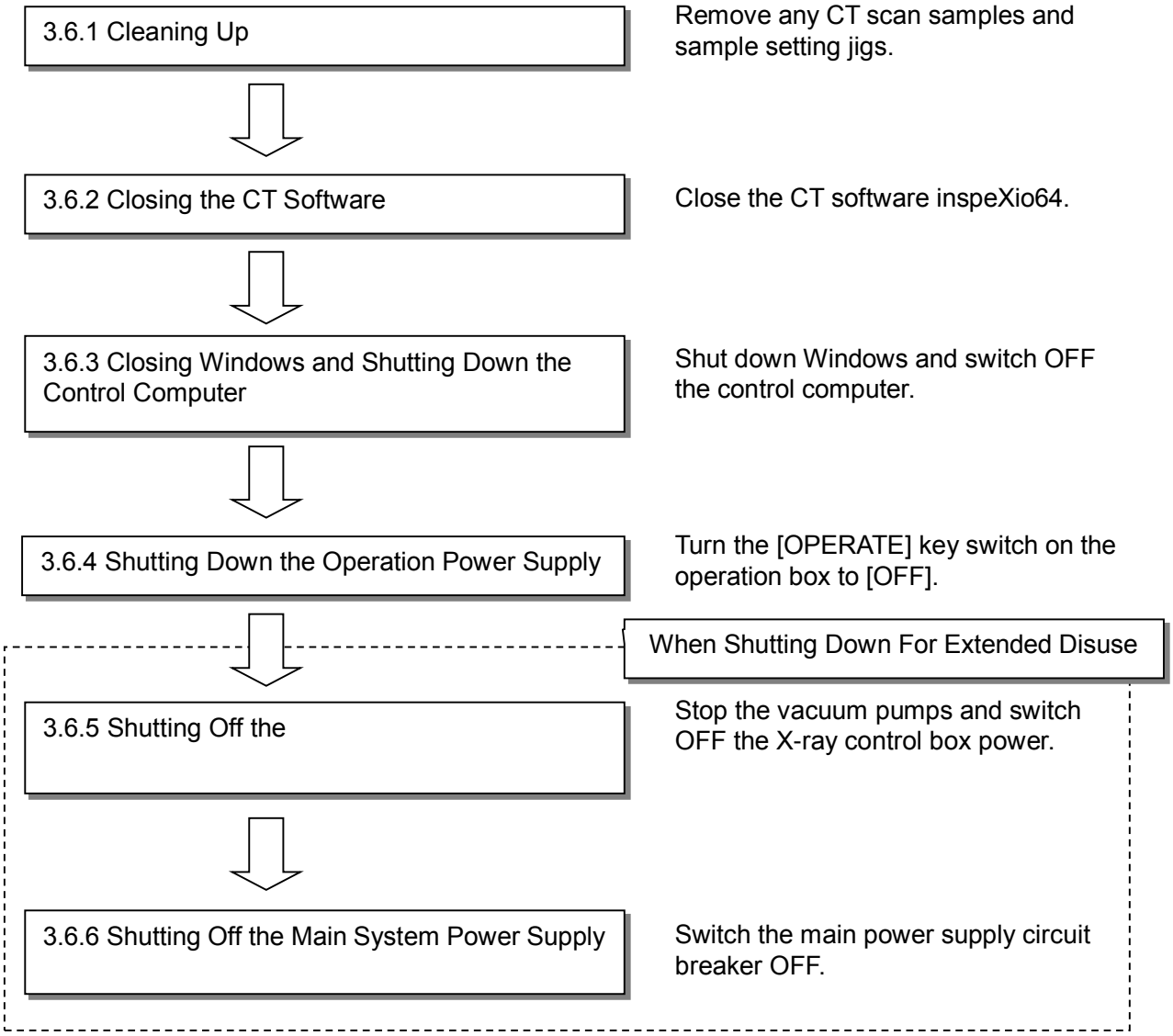
The basic process flow for performing CT scans is described below.

☞ For more details about CT scanning, see 5 CT Operations.



3.6 Shutting Down the System

Shut down the system according to the process flow summarized below.



⚠ CAUTION

Instructions

Operating the System Intermittently

If the system will be operated intermittently (without long periods of disuse), shut down the system according to the procedure described up to 3.6.4 Shutting down the Operation Power Supply. If the system will not be used for an extended period, shut down the system according to the procedure described up to 3.6.6 Shutting Off the Main System Power Supply.

Age the X-ray generator monthly, even if the system is not being used or is in storage. Not aging the X-ray generator regularly could shorten its service life.

3.6.1 Cleaning Up

Remove any CT scan samples and sample setting jigs.

3.6.2 Closing the CT Software

Close the CT software inspeXio64 by clicking the (close) icon in the upper right corner of the inspeXio64 [Main] window.

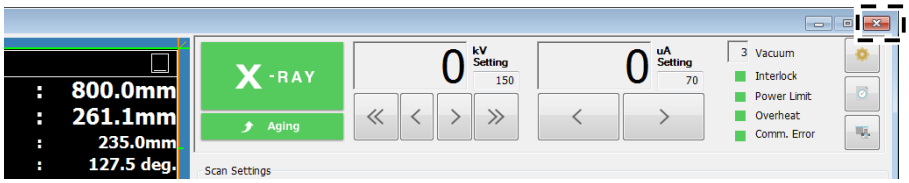


Fig. 3.30 Closing the Software

3.6.3 Closing Windows and Shutting Down the Control Computer

Shut down the control computer as described in the procedure below.

1. Click the button to display the [Start] menu, then click [Shut down].

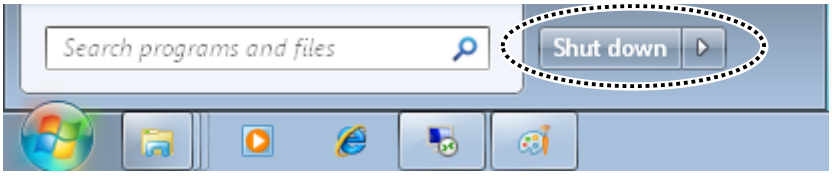


Fig. 3.31 Start Menu

After a brief delay, the control computer automatically shuts down and the power is switched OFF.

3.6.4 Shutting Down the Operation Power Supply

To stop operating the system, turn the OPERATE key counterclockwise, to [OFF], then pull the OPERATE key out.

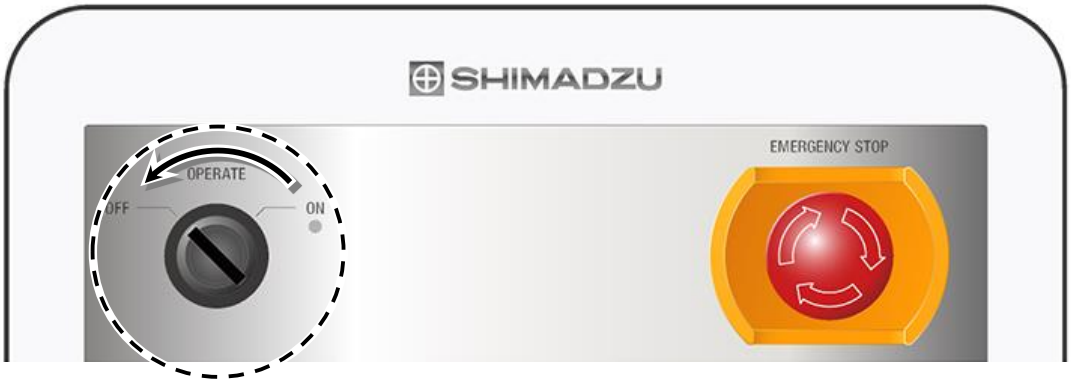


Fig. 3.32 [OPERATE] Key Switch

⚠ CAUTION

Instructions

[OPERATE] Key

Store the OPERATE key carefully so that it does not become lost or damaged.

3.6.5 Shutting Off the X-ray generator

Shut off the X-ray generator according to the procedure described below.

1. Loosen the fastener screws and open the maintenance door, located on the left upper of the shield box.

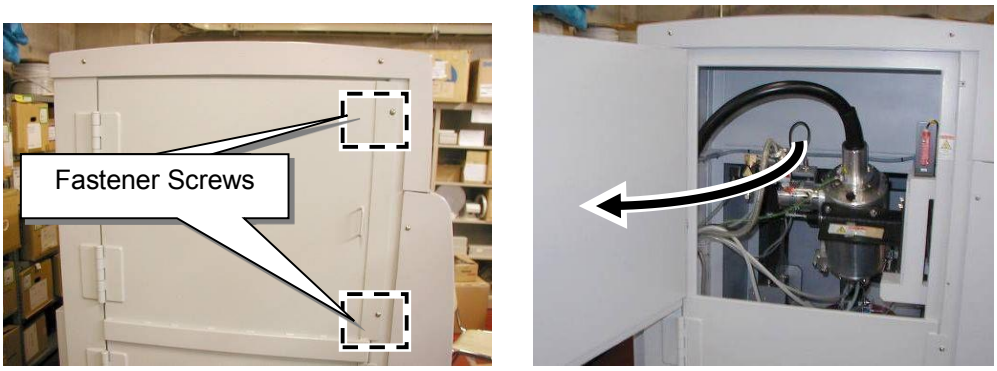


Fig. 3.33 Maintenance Door on Left Upper of Shield Box

2. Push the [OFF] button (orange) on the front panel of the X-ray control box (MTT controller) to shut off the vacuum pumps (diaphragm pump and turbo molecular pump).

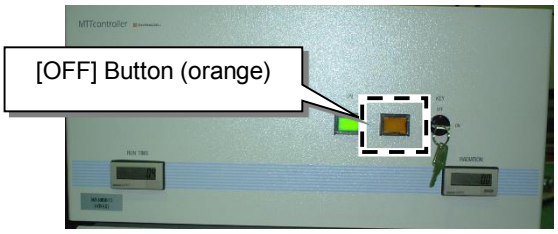


Fig. 3.34 [OFF] Button on Front of X-ray Control Box

3. After 3 minutes, Loosen the vent valve of turbo molecular pump in turning counterclockwise once. Then the X-ray tube is discharged to atmosphere.

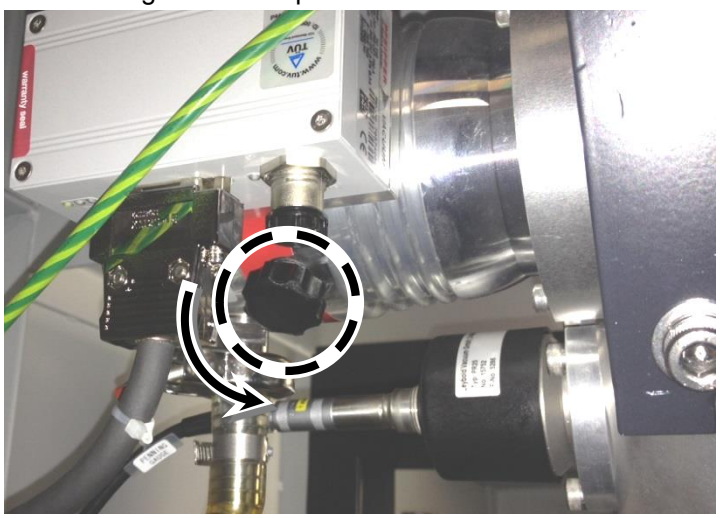


Fig. 3.35 Loosen the Vent Valve

4. Turn the key switch on the front panel of the X-ray control box (MTT controller) to [OFF]. Store the OPERATE key carefully so that it does not become lost or damaged.

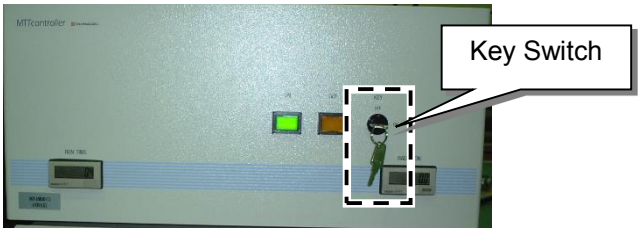


Fig. 3.36 Key Switch on Front of X-Ray Control Box

5. Switch OFF the power switch located on the back of the X-ray control box (MTT controller).

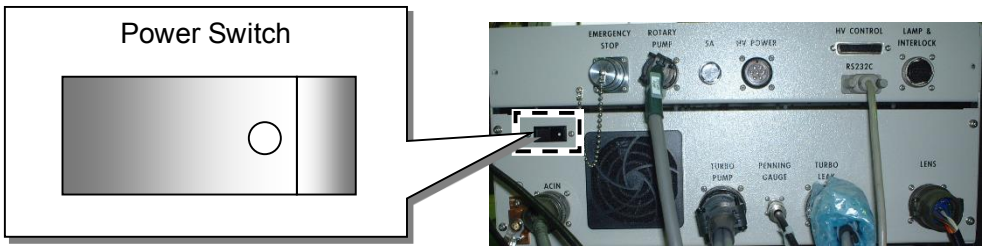


Fig. 3.37 Power Switch on Back of X-ray Control Box (MTT controller)

6. Close the maintenance door located on the left upper of the shield box, and tighten the fastener screws.

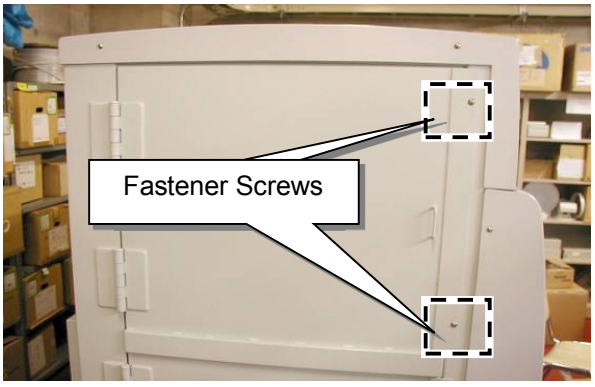


Fig. 3.38 Maintenance Door on Left Upper of Shield Box

3.6.6 Shutting Off the Main System Power Supply

1. Switch the main power supply circuit breaker OFF.

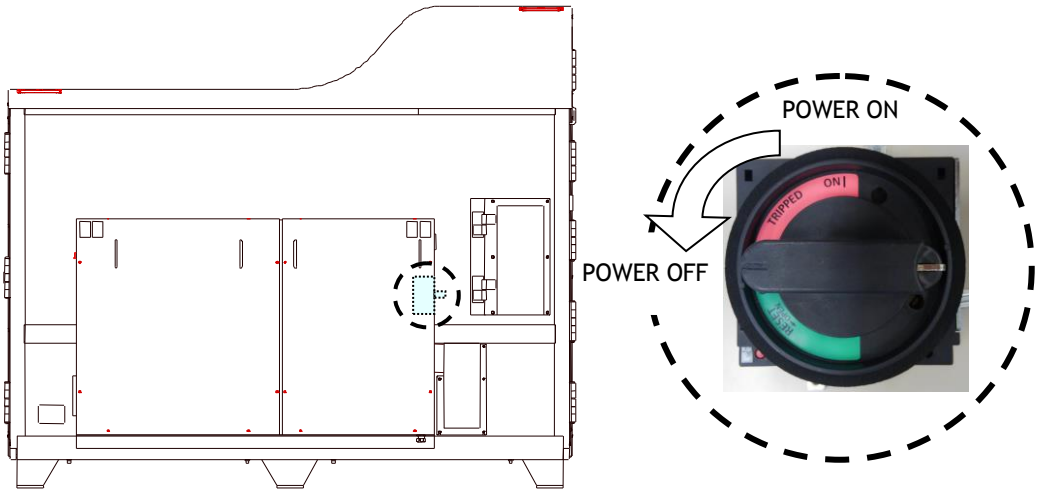


Fig. 3.39 Main Power Supply Circuit Breaker (OFF)

2. Switch the circuit breaker OFF in the on-site power supply service panel.

4 X-ray Control Area

4.1 X-ray control area

The X-ray control area is used to switch X-ray emissions ON/OFF, age the X-ray generator, and specify X-ray output settings.

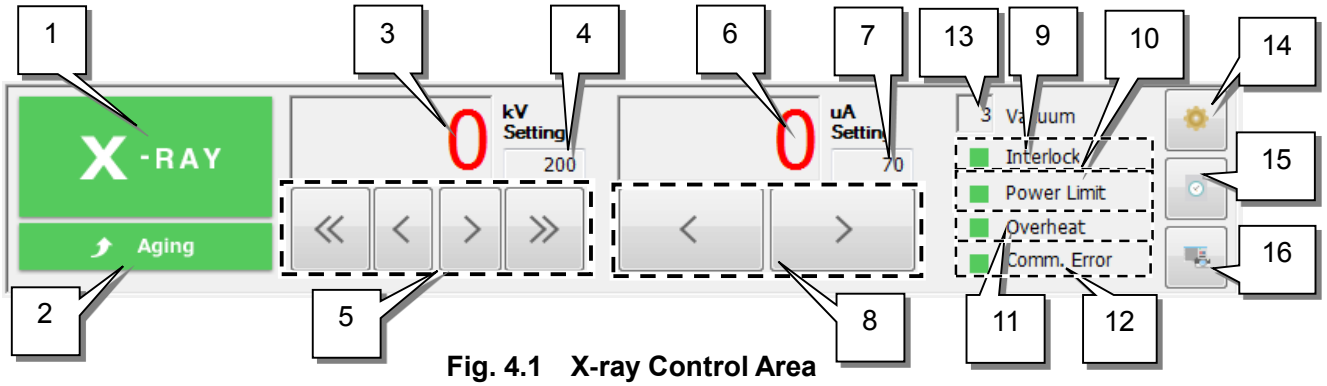


Fig. 4.1 X-ray Control Area

No.	Item	Description
1	[X-RAY] Button	Switches X-ray emissions ON/OFF. This button changes color depending on instrument conditions, as indicated below.
		X-ray Emission is ON: Red
		X-ray Status is "Pre-WARNING": Yellow
		X-ray Emission is OFF
		Interlock Circuit Closed: Green
		Interlock Circuit Open: Gray
2	[Aging] Button	Displays the [Automatic Aging] window. This button changes color depending on instrument conditions, as indicated below.
		Aging is ON: Red
		Aging is OFF
		Interlock Circuit Closed: Green
		Interlock Circuit Open: Gray
3	Voltage Monitor Value Display	Displays the voltage monitor value during X-ray emission. The software confirms the last time aging was finished for the voltage setting value and, if more than 24 hours have elapsed, displays the value in red.
4	Voltage Setting Display	Indicates the voltage setting. Due to wattage limits, voltage and current settings are restricted to values whose product is 135 watts or less.
5	Voltage Setting Buttons	Changes the voltage setting. Clicking the double-arrow buttons changes the setting by 10-kV increments. The single-arrow buttons change the setting by 1-kV increments.
6	Current Monitor Value	Displays the current monitor value during X-ray emission.

No.	Item	Description	
	Display	The software confirms the last time aging was finished for the voltage setting value and, if more than 24 hours have elapsed, displays the value in red.	
7	Current Setting Value Display	Indicates the current setting. Due to wattage limits, voltage and current settings are restricted to values whose product is 135 watts or less.	
8	Current Setting Buttons	Changes the current setting. Clicking the arrow buttons changes the setting by 10-μA increments.	
9	[Interlock] Indicator	Indicates the status of the interlock circuit. The indicator changes color depending on instrument conditions, as indicated below.	
		Interlock Circuit Closed	Green
		Interlock Circuit Open	Red
10	[Power Limit] Indicator	Indicates electrical discharge inside X-ray tube and other power limit generation status. The indicator changes color depending on the status of the X-ray generator, as indicated below. * Even if this indicator turns ON, it is not a breakdown.	
		Normal	Green
		When power limit is reached	Red
11	[Overheat] Indicator	Indicates if overheating has occurred. An overheat signal is detected whenever the amount of water circulating through the cooling water unit falls below a specified value or the temperature inside the X-ray tube exceeds a specified value. The indicator changes color depending on the status of the X-ray generator, as indicated below.	
		Normal	Green
		Overheated	Red
12	[Comm. Error] Indicator	Indicates if a communication error has occurred. The indicator changes color depending on the status of the X-ray generator, as indicated below.	
		Normal	Green
		Communication Error	Red
13	[Vacuum] Value Display	Indicates the vacuum gauge output of the X-ray tube. X-Ray can be emitted when the degree of vacuum reaches or falls below 40.	
14	X-ray generator Information Button	Displays the [X-ray Generator Information] window. Except for the user's system manager, do not click this icon.	
15	Elapsed Time Display Button	Displays the [X-ray Maintenance Schedule] window.	
16	Screen Capture Button	Captures screenshots of the CT software inspeXio64 [Main] and [MPR] windows. It transfers captured images to optional Image-Pro Analyzer software, if installed.	

4.2 [X-RAY] Button

As shown in Fig. 4.1 above, clicking the [X-RAY] button generates X-rays based on the voltage and current settings specified using buttons in (5) and (8) of the X-ray control area.

If the interlock circuit is not complete, such as if sliding door is open, the [X-RAY] button appears gray and no X-rays are emitted even if the [X-RAY] button is clicked. The [X-RAY] button is gray in the following cases.

- The [OPERATE] key switch on the operation box is set to [OFF].
- The [EMERGENCY STOP] button on the operation box is depressed.
- The key switch on the front panel of the X-ray control box (MTT controller) is set to [OFF].
- The sliding door and maintenance door on the shield box are not completely closed.
- The interlock confirmation indicator is illuminated.

NOTE

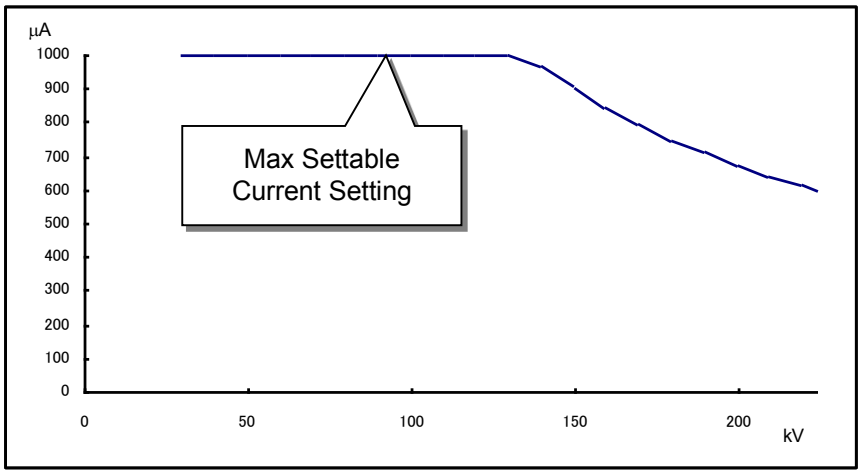
Voltage and Current Monitor Values

The voltage and current values shown in the monitor displays may differ slightly from the their respective setting values, but this is normal.

NOTE

Wattage Limits

Due to wattage limits, voltage and current settings are restricted to values whose product is 135 watts or less. Therefore, the maximum settable current setting varies depending on each voltage setting, as shown below.



NOTE

About Cooling Water

Clicking [X-RAY] button and X-ray is irradiated or during warming up, the cooling water runs into the X-ray tube.

And, after stopping X-ray and warming up is suspended/completed, the circulating of cooling water continued for 10 minutes.

NOTE

How to Restore System After Overheating

If an overheat signal is detected and X-ray emission is forced to shut off, wait for 30 minutes. If the overheat signal is still detected when resuming X-ray emissions after 30 minutes, then consult your system manager.

Have the system manager verify that the ambient temperature is between 15 and 30℃ and the filter inside the cooling water tank is not clogged before contacting a Shimadzu service representative.

NOTE

Pre-WARNING Time

The time it takes until X-rays are generated after clicking the [X-RAY] button is referred to as "Pre-WARNING" time. During that time the [X-RAY] button will appear yellow. This Pre-WARNING time is factory-set to 1 second before shipping.

NOTE

TMP Stopping

If the TMP is stopped running during running, the diaphragm pump is stopped at the same time, the X-ray tube is open to the atmosphere.

In addition, if the TMP does not rotate normally despite 5 minutes after starting vacuuming, the TMP and the diaphragm pump will be stopped to avoid the breakdown of X-ray tube. In this case, the frontal panel of the X-ray controller is maintained “ON (green)”. So, firstly, push the 【OFF】(orange) button, then push 【ON】(green) button to restore this system.

If it is not restored, contact us.

4.3 [Screen Capture] Button

As shown in Fig. 4.1 above, clicking the [Screen Capture] button (16) of the X-ray control area saves a file of captured CT software inspeXio64 [Main] and [MPR] window images.

NOTE

Naming Rules for Screen-Captured Files

- Captured Images of inspeXio64 [Main] Window:

  Save to Folder: “D:＼inspeXio＼screenshot”

  Saved File Name: YYYYMMDDHHMMSS.jpg

(where "YYYY" indicates year, "MM" month, "DD" day, "HH" hours, "MM" minutes, and "SS" seconds)

- Captured Images of [MPR] Window:

  Save to Folder: [MPR] data load folder.

  Saved File Name: %%%%.jpg (numbered in series)

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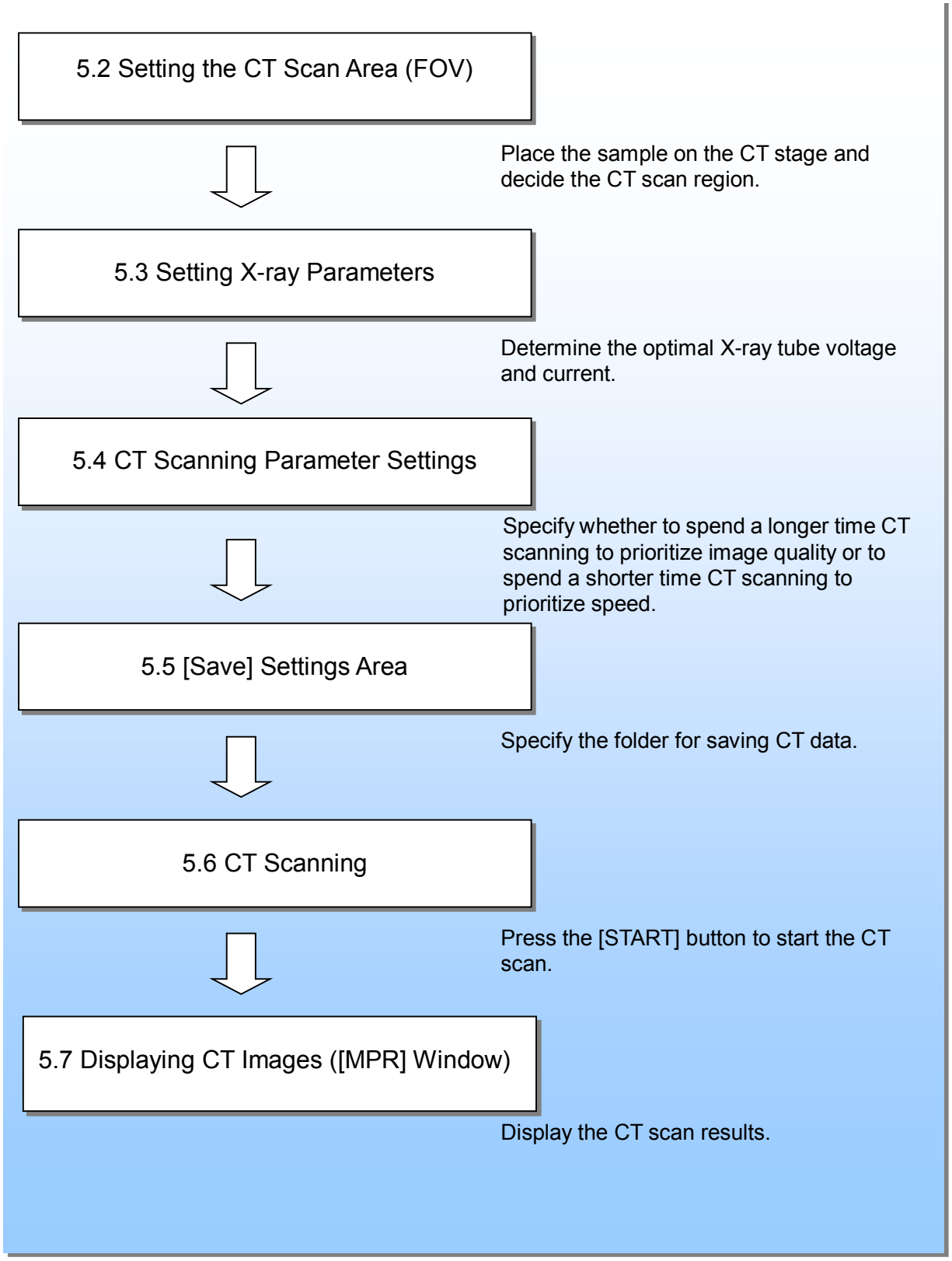
5 CT Operations

5.1 Overview of CT Scanning Process

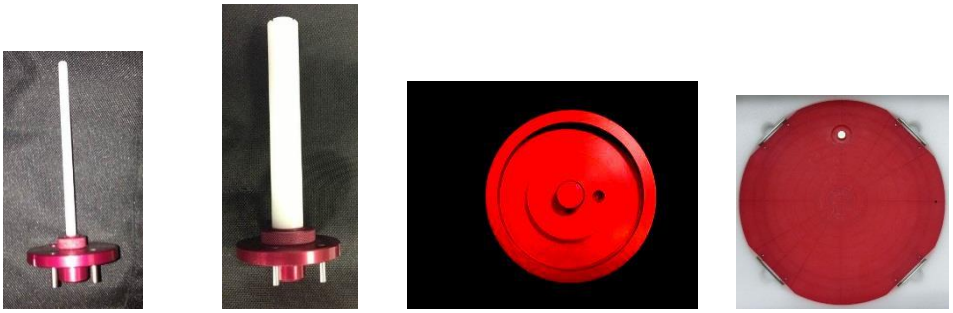


5.2 Setting the CT Scan Area (FOV)

5.2.1 Placing Samples on the Stage

Place the sample on the CT stage according to the following procedure.

1. Of the four sample setting jigs provided, select the one best suited to the sample.



Sample Setting Jig (small) | **Sample Setting Jig(medium)** | **Sample Setting Jig(large)** | **Sample Setting Jig(extra-large)**

Fig. 5.1 Types of Sample Setting Jigs

2. Securely attach the sample using the provided oil clay, double-sided tape, or other means, to prevent the sample from moving when the CT stage is rotated.
Oil clay and double-sided tape are provided as accessories for the X-ray generator.

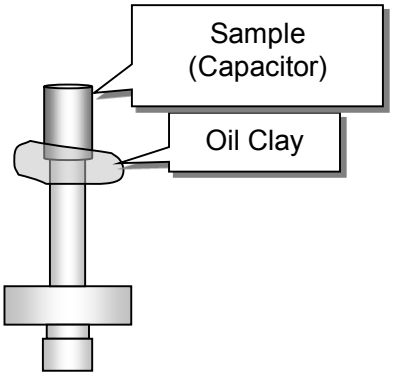


Fig. 5.2 Example of Securing Sample With Oil Clay

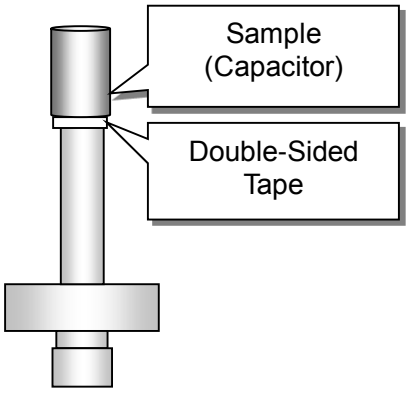
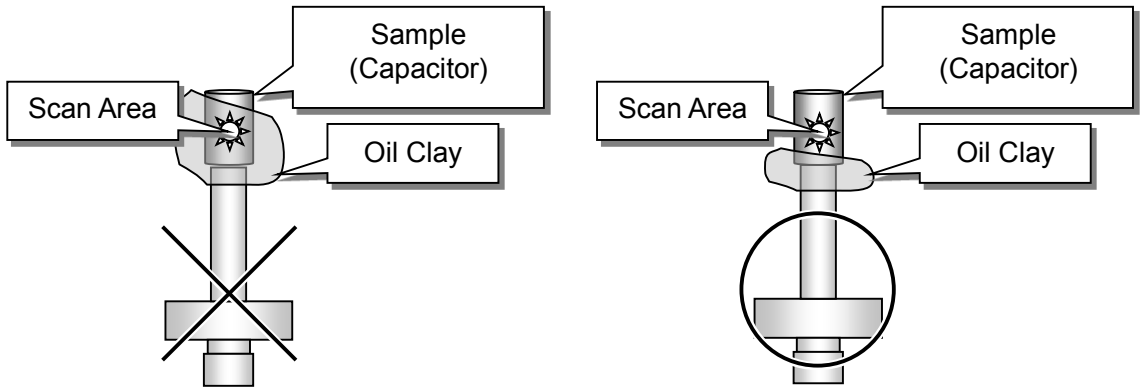


Fig. 5.3 Example of Securing Sample With Double-Sided Tape

NOTE

Securing Samples With Oil Clay

When securing samples with clay, make sure none of the clay obscures the target area for CT scanning. If samples with relatively low density are scanned with clay obscuring the area to be scanned, it will result in reduced CT image quality.



3. Insert the sample setting jig into the hole in the center of the stage.

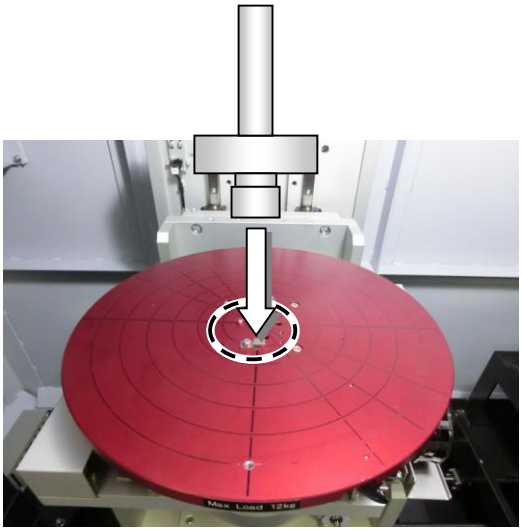


Fig. 5.4 Inserting the Sample Setting Jig

Insert the jig gently, while making sure of the following.

- The positioning pins on top of the CT stage align with the corresponding holes in the sample setting jig.
- The sample setting jig type identifier pin aligns with the corresponding hole on the CT stage.
- The tip of the plungers from each rotation stopper block is in contact with the groove on the side of the sample setting jig.

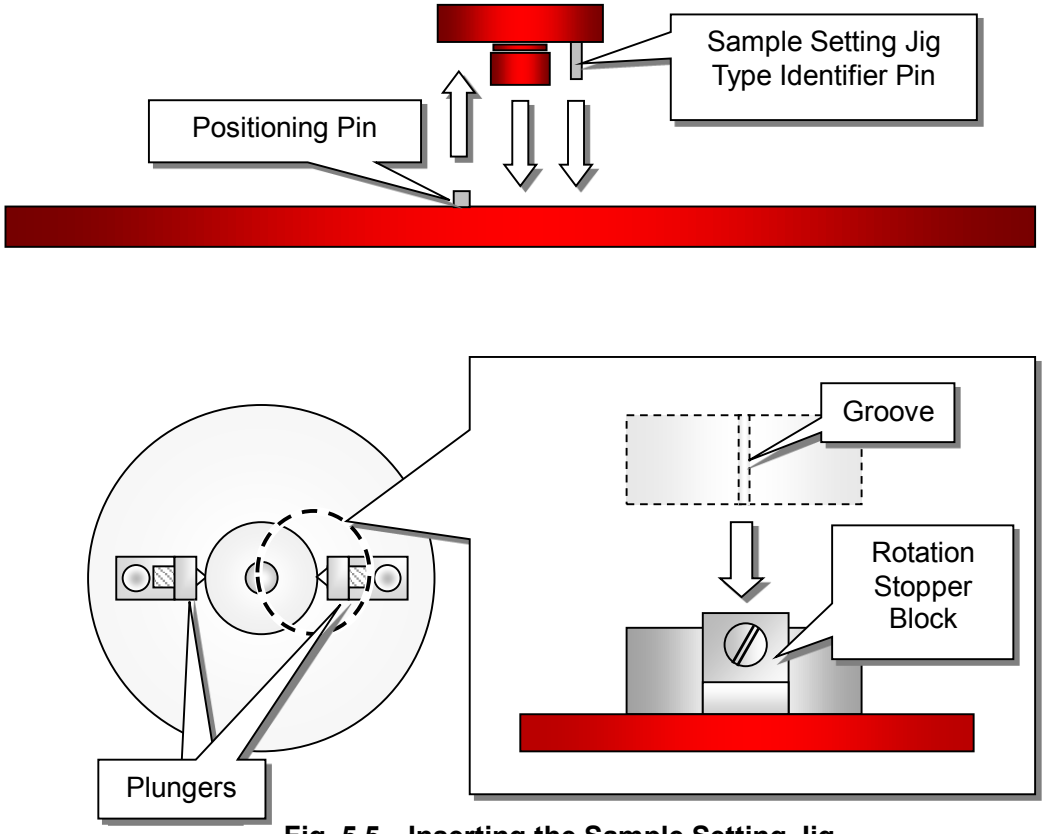


Fig. 5.5 Inserting the Sample Setting Jig

⚠ CAUTION

Prohibitions

Damaging the Sample Setting Jig Type Identifier Pin

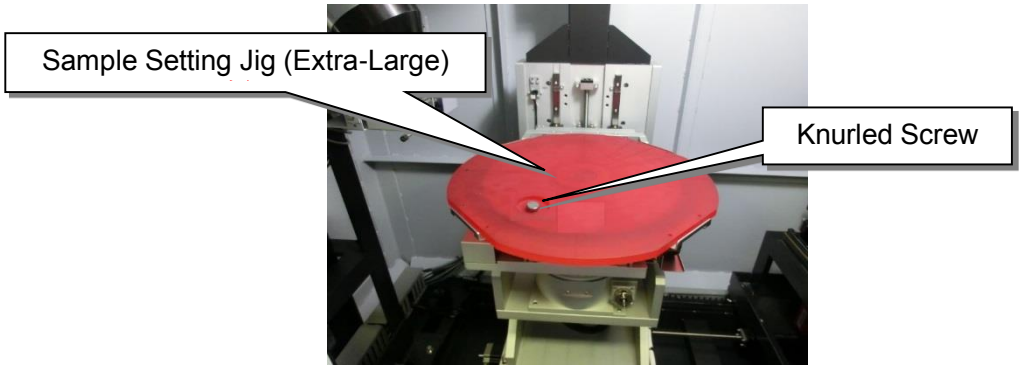
Sample setting jig type identifier pins are used to determine collision criteria parameters for CT stage software limits.

Do NOT use a jig if the type identifier pin has been damaged. The CT stage software limits will not function properly without it.

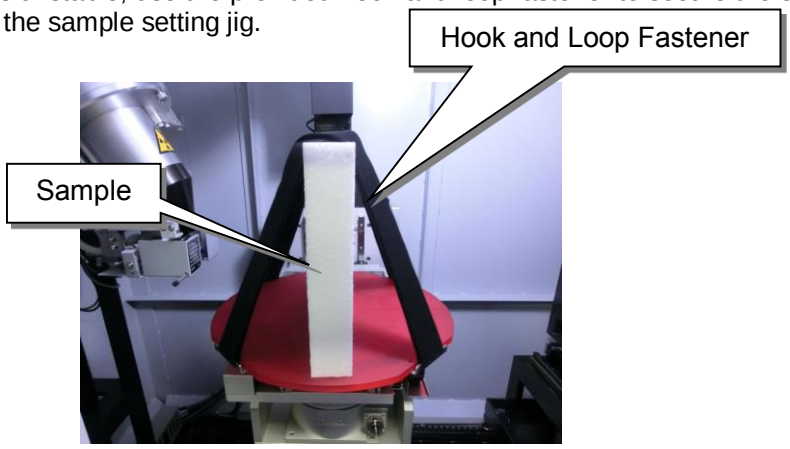
NOTE

Using the Sample Setting Jig (Extra-Large)

The sample setting jig (extra-large) is placed on top of the CT stage and fastened with a knurled screw.



If the sample is unstable, use the provided hook and loop fastener to secure the sample to the edge of the sample setting jig.

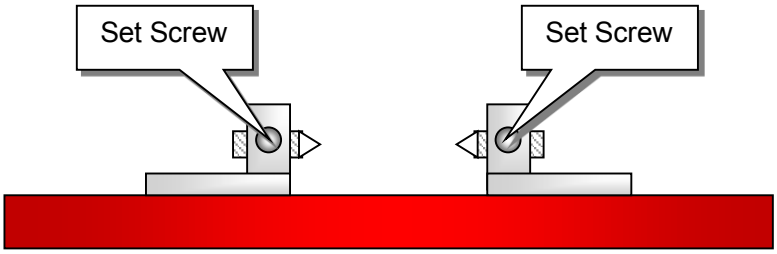


NOTE

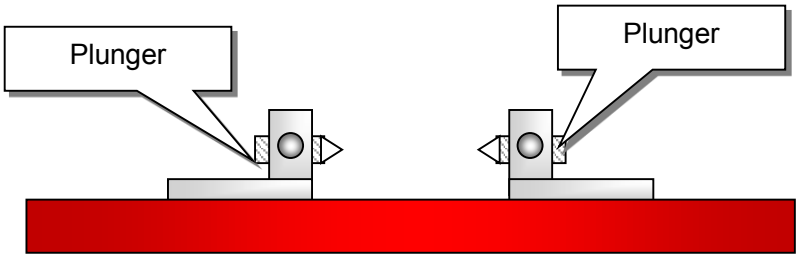
How To Adjust the Rotation Stopper Blocks

The rotation stopper blocks are devices that secure the sides of the sample setting jig to keep it from moving on the CT stage during CT scans. Contact between the ball plungers on the rotation stopper blocks and the sample setting jig is preadjusted at the factory before shipping, but can be readjusted as follows.

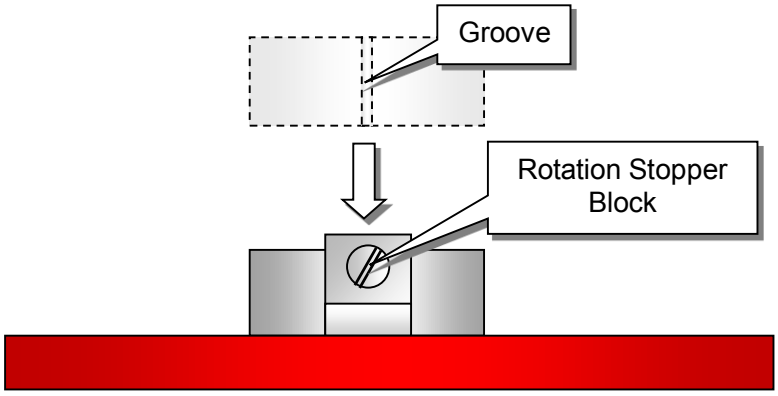
1. Loosen the plunger set screws on the rotation stopper blocks by turning them counterclockwise.



2. Loosen the plungers on the rotation stopper blocks by turning them counterclockwise.



3. Align the tips of the rotation stopper block plungers with the grooves on the sides of the sample setting jig and place the jig on the CT stage.



4. Turn the plungers on the rotation stopper blocks clockwise until the plungers contact the grooves on the sides of the sample setting jig.

5. Tighten the plunger set screws on the rotation stopper blocks by turning them clockwise.

5.2.2 Displaying Live Images

To display a live image, gently close the sliding door, click the [X-RAY] button in the X-ray control area. This irradiates the sample with X-rays and displays a real-time X-ray fluoroscopic image in the live image display area.

The image quality of the live image can be adjusted in the live image quality settings area, located in the lower left part of the CT software inspeXio64 [Main] window. Clicking [AW] (Auto Window) measures the brightness of the entire window in real time, then automatically adjusts the brightness level and display range settings appropriately.

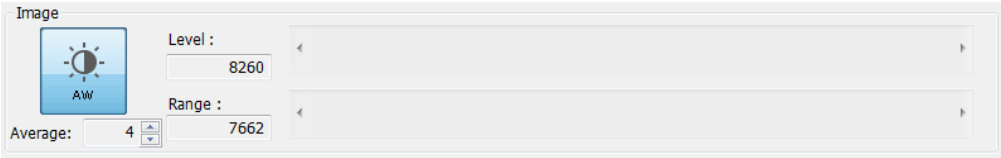
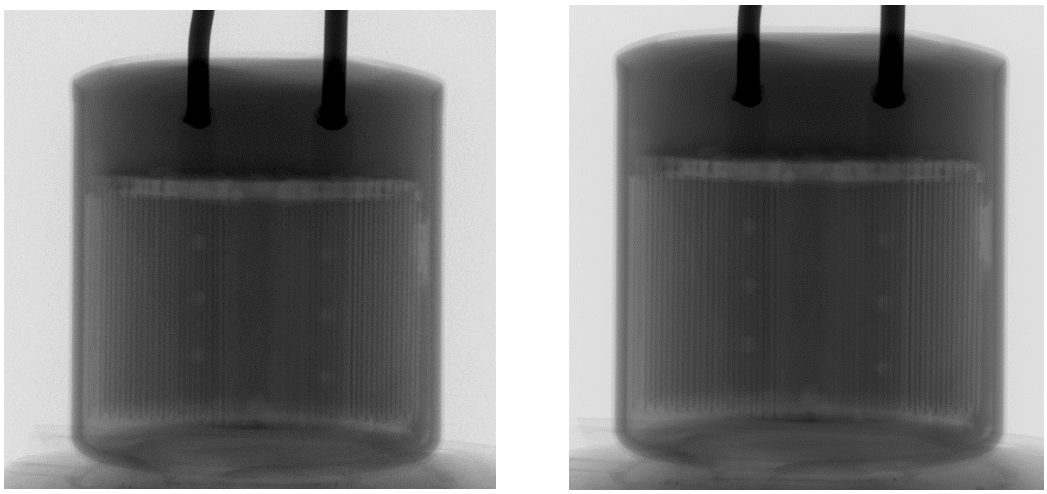


Fig. 5.6 Live Image Quality Settings Area

The image quality of the live image can be improved using average count.

Increasing the average count improves the image quality.



Average Count = 1 Average Count = 8

Fig. 5.7 Examples of Live Images ([Average Count])

5.2.3 Exposure Time Setting Area

This is used to set the exposure time for the Flat panel detector.

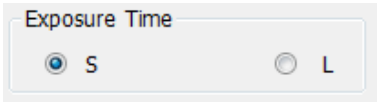


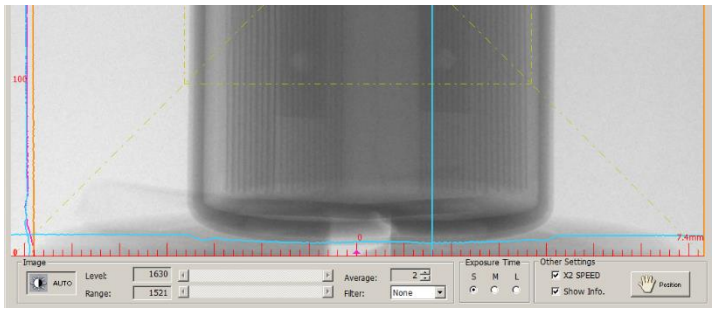
Fig. 5.8 [Exposure Time] Settings Area

The [Exposure Time] setting configures the exposure time at the Flat panel detector when single frame live images are acquired.

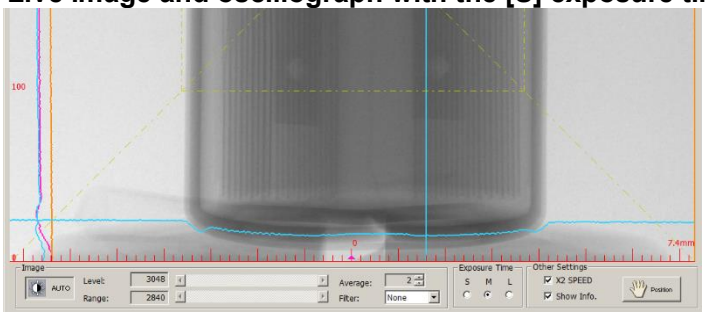
The setting can be configured to two levels: [S] and [L]. A short exposure time shortens the time during which fluoroscopic image data accumulates at the Flat panel detector. Accordingly, both the brightness value and the oscillograph will be lowered.

If the exposure time is lengthened, more fluoroscopic image data can accumulate at the Flat panel detector, which means that the brightness and the oscillograph will be raised, and a high contrast image will be obtained. However, the single frame acquisition time will be lengthened.

The relationship between the exposure time and the oscillograph under the same X-ray conditions is as follows.



(a) Live image and oscillograph with the [S] exposure time



(b) Live image and oscillograph with the [L] exposure time

Fig. 5.9 Typical Live Image Displays (Exposure Time Settings)

5.2.4 Setting the Acquisition Mode

Specify the Flat panel detector acquisition mode as follows.

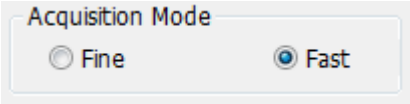
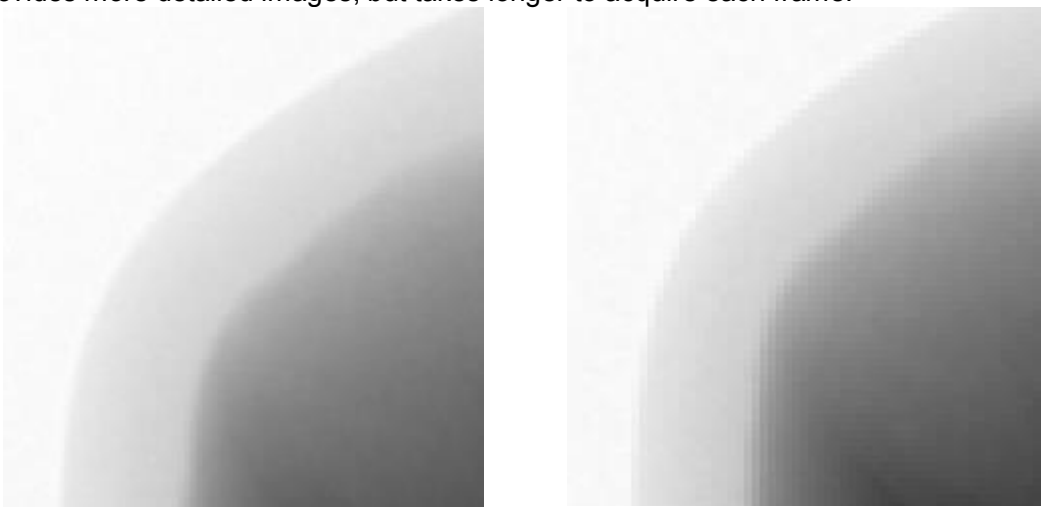


Fig. 5.10 Acquisition Mode Settings Area

The [Acquisition Mode] settings area specifies the input resolution and frame rate for the Flat panel detector.
Two levels are available, either [Fine] or [Fast], where the [Fine] mode results in 3000 * 3000 pixel resolution, but at a slower frame rate, whereas the [Fast] mode results in only 1000 * 1000 pixel resolution, but at a faster frame rate. In combination, the [Acquisition Mode] and [Exposure Time] settings result in the following frame rates.

Frame Rate Setting Value		Acquisition Mode	
		Fine	Fast
Exposure Time	Short	4.0 fps	18.0 fps
	Long	1.0 fps	4.5 fps

Setting [Acquisition Mode] to [Fine] improves the Flat panel detector input resolution, which provides more detailed images, but takes longer to acquire each frame.



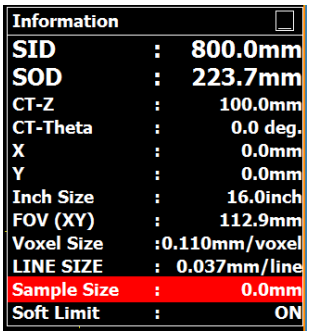
(a) Fluoroscopic Image with [Acquisition Mode] Set to [Fine] (b) Fluoroscopic Image with [Acquisition Mode] Set to [Fast]

Fig. 5.11 Enlarged View of Fluoroscopic Image ([Acquisition Mode] Settings)

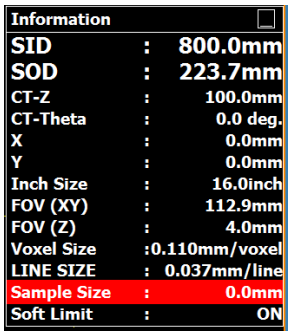
5.2.5 Displaying the [Information] Sub-Window

Select the [Show Information] checkbox to display the [Information] sub-window.

Fig. 5.12 Other Settings Area



(a) Scan Mode 1 = 2DCT



(b) Scan Mode 2 = CBCT

Fig. 5.13 [Information] Sub-window

Item	Description	
SID	Distance from X-ray focal point (source) to front of Flat panel detector	
SOD	Distance from X-ray focal point to rotation center of CT stage	
CT-Z	Height of CT stage on CT-Z axis	
CT-Theta	Angle of CT stage on CT-Theta axis	
X	Position of CT stage on X axis	
Y	Position of CT stage on Y axis	
INCH SIZE	Size of selected Flat panel detector in inches	
FOV (XY)	Size of CT scan region on X and Y axes	
FOV (Z)	Size of CT scan region on CT-Z axis This only appears if [CBCT] is selected in Scan Mode 1.	
VOXEL SIZE	Dimension of one voxel in CT image.	
LINE SIZE	Dimension of one line in fluoroscopic image.	
SAMPLE SIZE	Diameter of sample or sample setting jig, color coded according to status of settings in CT software inspeXio64, as describe below	
	Black if sample diameter is specified for [FOV] setting ☞ See 5.2.8 Determining the CT Scan Region (FOV)	Black Background
	Yellow if automatically obtained from diameter of small sample setting jig, medium sample setting jig, or rotation center calibration phantom	Yellow Background
	Red if using the large sample setting jig or no sample setting jig	Red Background
SOFT LIMIT	Indicates status of software limits ON/OFF setting, color coded according to status of settings in CT software inspeXio64, as describe below. ☞ For more information about soft limit settings, refer to the Advanced Operations Instruction Manual	
	Black when software limit setting is ON	Black Background
	Red when software limit setting is OFF	Red Background

5.2.6 Moving the CT Stage

There are two ways to move the CT stage. One is to click on the live image and the other is to use the operation box.

5.2.6.1 Moving the CT Stage on the Live Image

The live image is divided into 8 regions, where whenever the mouse cursor is moved into a region the cursor automatically changes from an arrow to the cursor corresponding to that region. For example, moving the mouse cursor into the [ZOOM IN] region changes the cursor from (standard arrow pointer) to (magnifier pointer).

On the live image, move the cursor into the region corresponding to the desired direction of the desired axis for stage movement, then click the left mouse button. The CT stage will move in that direction as long as the button is held down. To stop the movement, simply release the left mouse button. In all regions, movement is slower the closer the pointer is to the center of the live image and faster the farther away it is from the center.

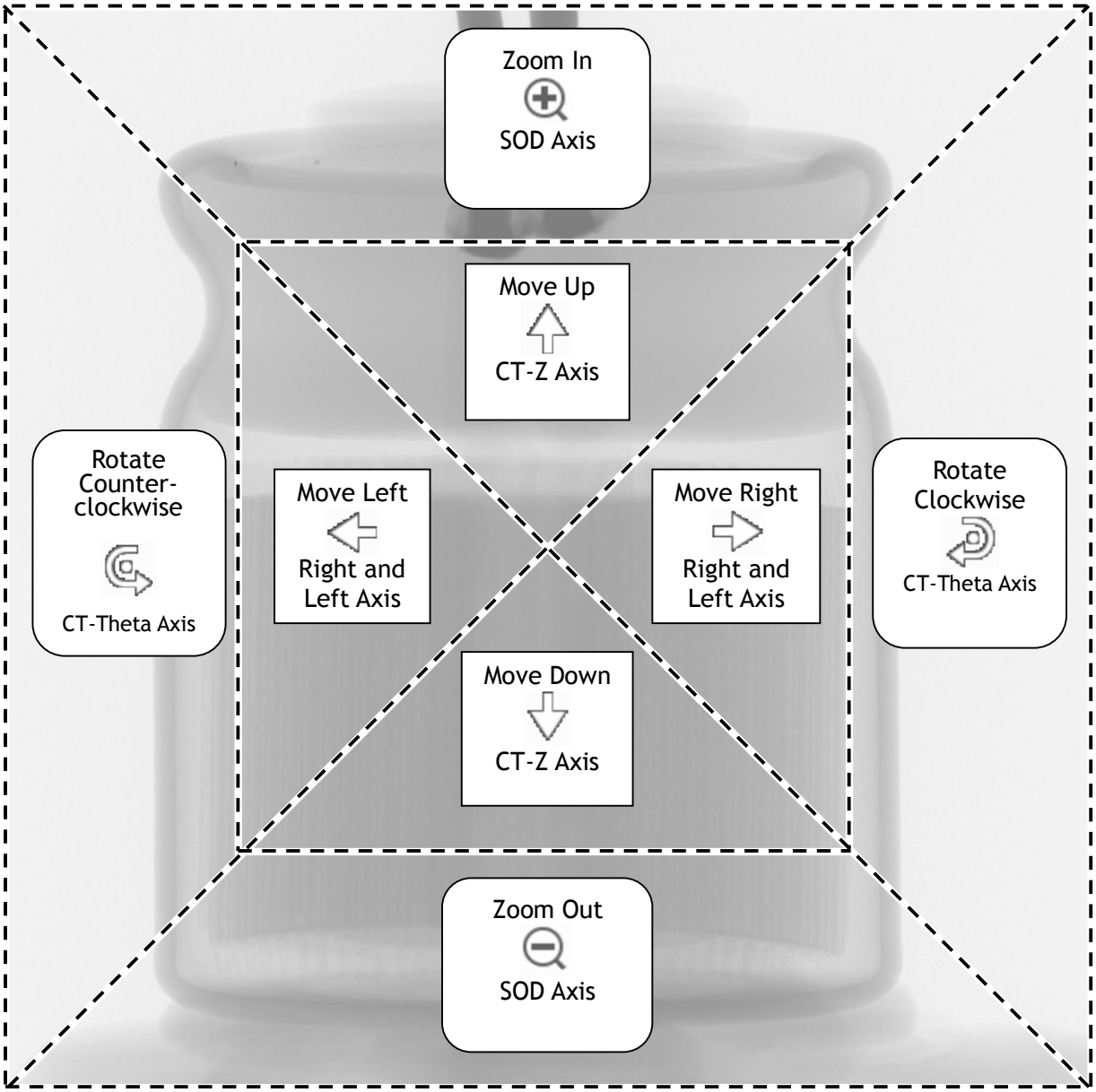


Fig. 5.14 Moving the Mouse on the Live Image [Acquired by the FPD]

Axis of Movement	Cursor	Direction of Movement	Live Image
SOD Axis		CT stage moves toward X-ray tube	Sample appears larger
		CT stage moves toward Flat panel detector	Sample appears smaller
CT-Theta Axis		CT stage rotates counterclockwise	Sample rotates
		CT stage rotates clockwise	Sample rotates
CT-Z Axis		CT stage moves upward	Sample moves upward
		CT stage moves downward	Sample moves downward
Right and Left Axis		CT stage moves left	Sample moves to the left
		CT stage moves right	Sample moves to the right

⚠ CAUTION

Instructions

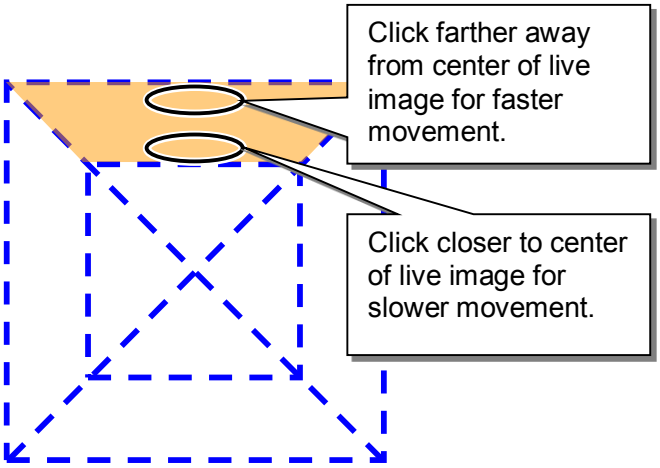
Damage to Samples or X-ray System

When viewing the live image to move the CT stage, keep confirming the SOD value in the live image display area's [Information] sub-window, or the exterior camera image to make sure the sample or sample setting jig does not collide with the X-ray tube.

NOTE

Low Speed Movement

To move the CT stage slowly, click near the center of the corresponding live image region.

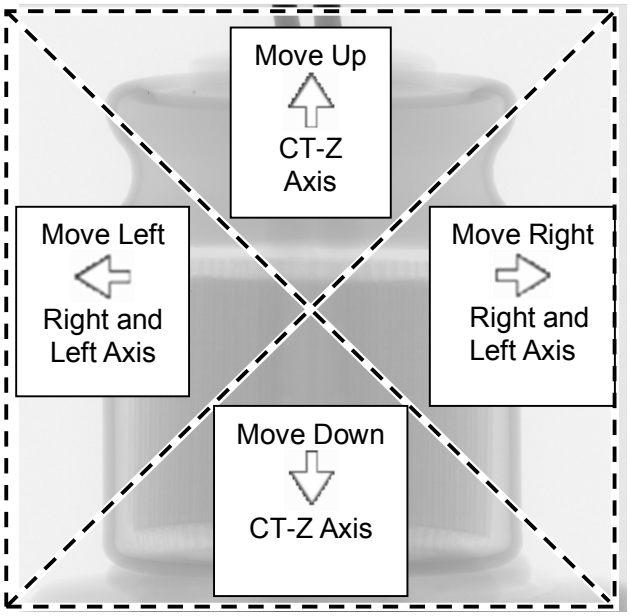


NOTE

Changing the Number of Live Image Regions

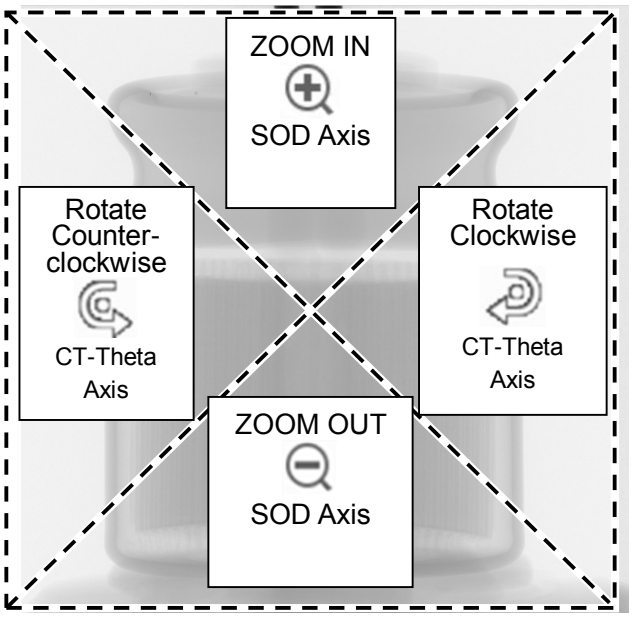
Live images are normally divided into 8 operation regions, but the number of regions can be changed from 8 to 4 as long as the [Ctrl] or [Shift] key is held down.

1. Pressing the [Ctrl] Key



The live image is divided into 4 regions, to allow using the entire live image for movement on the CT-Z, left and right(X and Y) axes.

2. Pressing the [Shift] Key



The live image is divided into 4 regions, to allow using the entire live image for movement on the CT-Theta and SOD axes.

5.2.6.2 Moving the CT Stage Using the Operation Box

The CT stage can be moved using the joystick on the lower right area of the operation box, similar to the mouse control of the live image regions. Moving the joystick moves the CT stage in the direction of the corresponding axis until it is released. Releasing the joystick stops the stage movement. Pushing the joystick in a perpendicular direction switches between regular and double-speed modes. The [X2 SPEED] lamp illuminates on the operation box when in the double-speed mode.

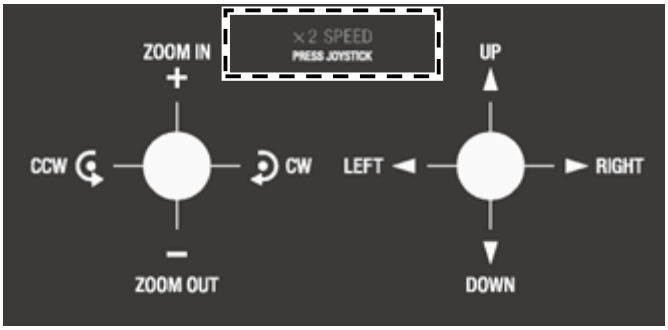


Fig. 5.15 Joystick Buttons (Operation Box)

Axis of Movement	Symbol	Direction of Movement	Live Image
SOD Axis	+	CT stage moves toward X-ray tube	Sample appears larger
	−	CT stage moves toward Flat panel detector	Sample appears smaller
CT-Theta Axis		CT stage rotates counterclockwise	Sample rotates
		CT stage rotates clockwise	Sample rotates
CT-Z Axis		CT stage moves upward	Sample moves upward
		CT stage moves downward	Sample moves downward
Right and Left Axis		CT stage moves away from operator	Sample moves to the left
		CT stage moves toward operator	Sample moves to the right
All Axes	X2 SPEED	Pushing the joystick buttons down in the perpendicular direction illuminates the [X2 SPEED] lamp. Pushing it again switches the LED OFF. While the [X2 SPEED] lamp is illuminated, movement speed is approximately doubled for each axis. However, in case double the speed exceeds the maximal speed, each axis moves at the maximal speed.	

NOTE

Connection Between CT Stage Movement Speed and Magnification

Whether moving the stage by clicking on the live image or using the operation box, CT stage movement speed depends on the magnification rate, for all axes except CT-Theta. Movement is faster for lower magnification rates and slower for high magnification rates, so that the movement speed appears approximately constant on the live image.

⚠ CAUTION

Prohibitions

Do not Operate the Mouse during the Joystick Operation

Unexpected stage movement may occur.

Press the [EMERGENCY STOP] button immediately when unexpected stage movement occurs.

5.2.7 Changing the SID

Magnification can be increased or decreased by changing the SID setting. Increasing the SID setting increases the magnification rate. The CT image S/N ratio can be improved by decreasing the SID setting.

Press the (left arrow) or (right arrow) button to switch between any of the two SID modes (800 or 1200 mm). Pressing either button causes the LED for the SID mode currently selected to illuminate.

Fig. 5.16 SID Mode Buttons (Operation Box)

NOTE

SID and X-ray Parameters

If the SID is changed, X-ray parameters are automatically set to produce a live image line profile of 60% to 70%, for any position.

☞ For line profile (oscilloscope display), refer to 2.2 Live Image Display Area in the Advanced Operations Instruction Manual.

5.2.8 Determining the CT Scan Region (FOV)

Determine the CT scan region according to the procedure below.

1. Click the  (FOV) button in the [Scan Settings] area, which displays a message that instructs placing the sample.

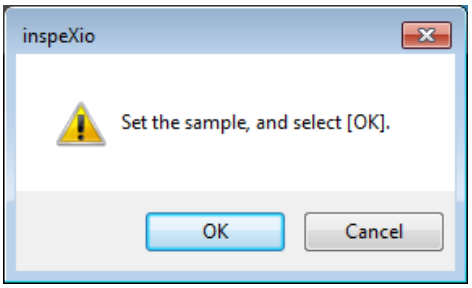


Fig. 5.17 Instruction to Place Sample

2. Place the sample on the stage and click [OK]. This displays a message confirming whether or not to initialize the stage position.

Clicking [Yes] moves the stage to the default position and displays the FOV Setting Wizard window (page 1 of 3).

Click [No] to not move the stage to the default position.

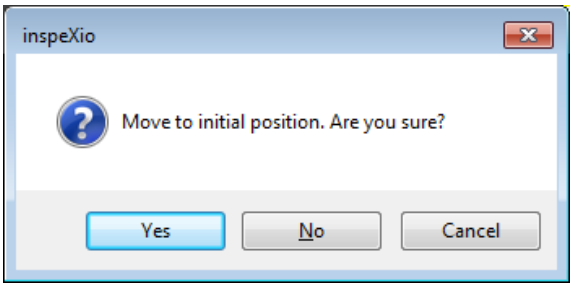


Fig. 5.18 Message Confirming Whether to Initialize Stage Position

⚠ CAUTION

Instructions

Default Position

The stage moves to specified SID-axis and SOD-axis positions to prevent the sample from hitting the tube or FPD.

Always click [Yes] to initialize the position unless the sample shape is known and safety is well established.

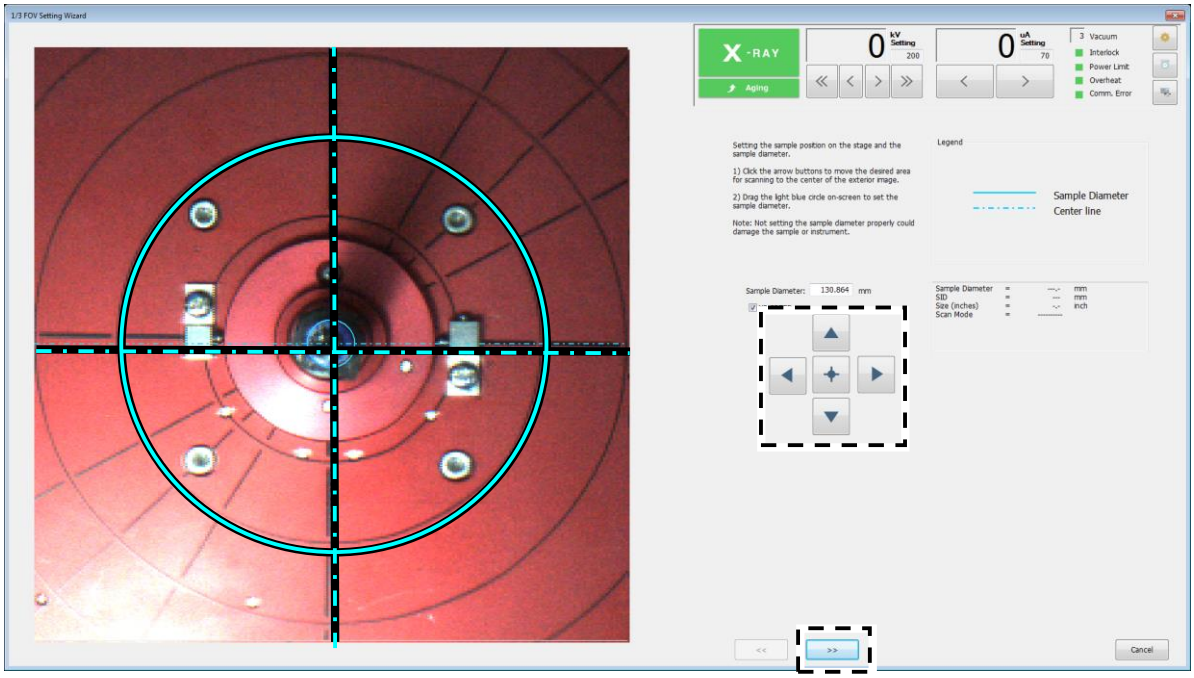


Fig. 5.19 FOV Setting Wizard Window (Page 1 of 3)

3. Click the arrow buttons on the right side of the [FOV Setting Wizard] window (page 1 of 3) to move the CT scan region to the center of the exterior image.

4. Specify the sample diameter by dragging the light blue circle that appears on the exterior image displayed on the left side of the [FOV Setting Wizard] window (page 1 of 3).

5. Click the double right arrow button at the bottom of the [FOV Setting Wizard] window (page 1 of 3) to move to the [FOV Setting Wizard] window (page 2 of 3).

⚠ CAUTION

Instructions

Setting the Sample Diameter

The sample diameter specified here is used as an impact criteria parameter for software limits. To prevent any unexpected collisions, always specify a sample diameter that is slightly larger than the actual sample.

For samples with protrusions, specify a diameter that encompasses any protrusions.

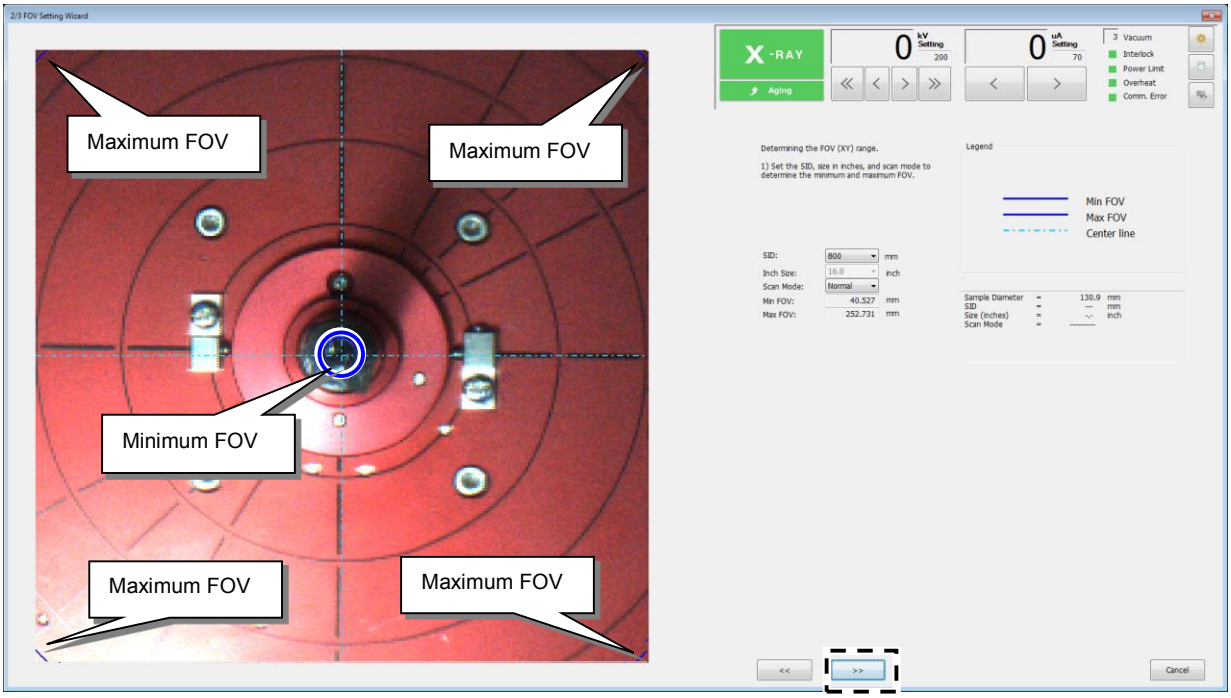


Fig. 5.20 FOV Setting Wizard Window (Page 2 of 3)

6. Select [SID] and [Scan Mode] (normal or offset) settings on the right side of the FOV Setting Wizard window (page 2 of 3). Two blue circles are then displayed according to those settings, one indicating the minimum FOV (CT scan region) and the other the maximum FOV (CT scan region).

☞ For more about normal and offset scan modes, see 9.3 Normal and Offset Scanning.

7. Click the double right arrow button at the bottom of the [FOV Setting Wizard] window (page 2 of 3) to move to the [FOV Setting Wizard] window (page 3 of 3).

NOTE

Selecting [SID] Settings

The larger the [SID] setting, the higher the voltage setting can be. Therefore, to obtain a CT scan of samples that are difficult to penetrate, such as iron, set [SID] as large as possible.

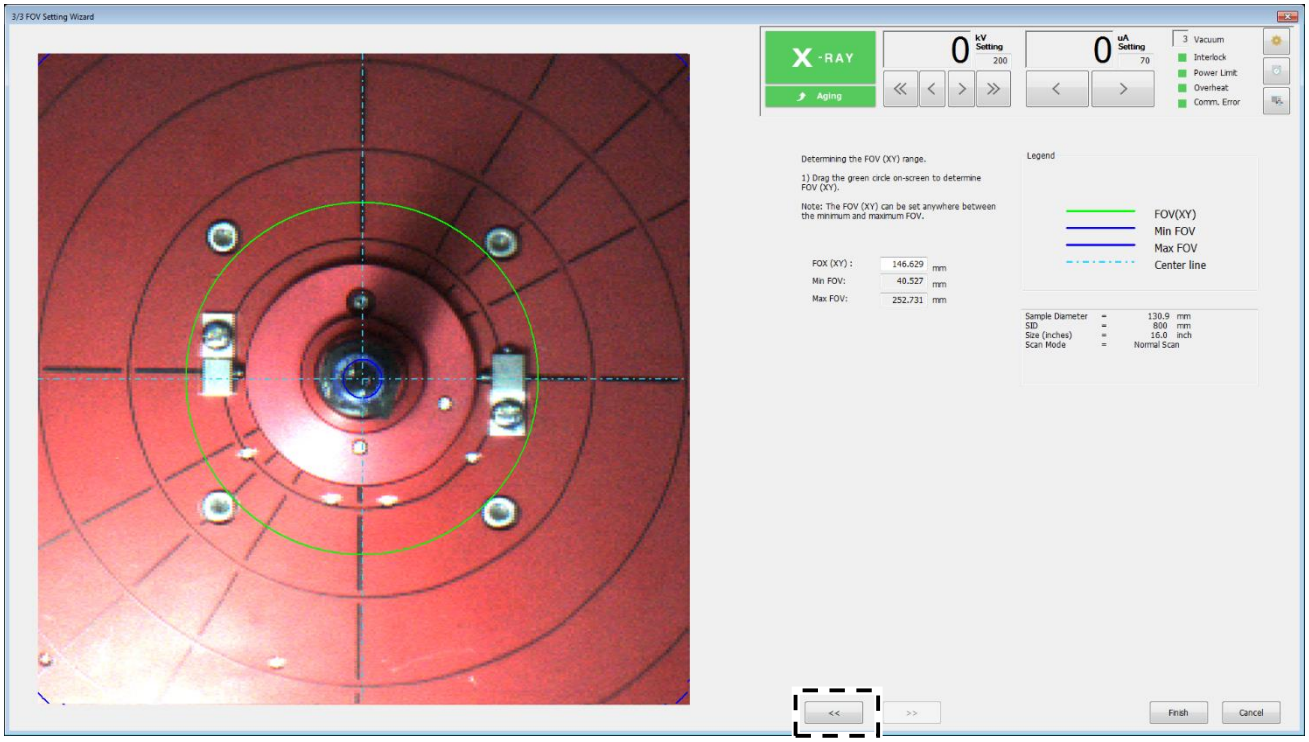


Fig. 5.21 FOV Setting Wizard Window (Page 3 of 3)

8. Specify the FOV (XY) setting by dragging the green circle that appears on the exterior image displayed on the left side of the [FOV Setting Wizard] window (page 3 of 3). The FOV (XY) can be set anywhere between the minimum and maximum FOV (XY) values determined on [FOV Setting Wizard] window (page 2 of 3).

9. Clicking the [Finish] button displays the [Moving to scan position...] window, where the SOD is calculated and each axis moves according to [SID] and [Scan Mode] (normal or offset scan) settings specified in the [FOV Setting Wizard] window (page 2 of 3), and FOV setting specified in the [FOV Setting Wizard] window (page 3 of 3).

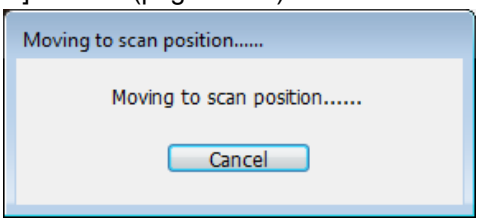


Fig. 5.22 [Moving to scan position...] Window

10. After CT stage moved at the scanning position, FOV Set up completion message will be displayed. Click【OK】button.

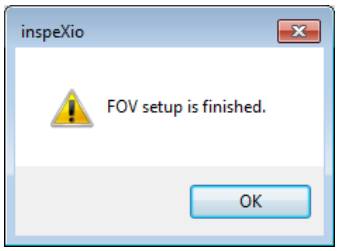


Fig. 5.23 FOV Setup Completion Message

11. Move the CT stage on the Z-axis to move the CT scan region into the field of view.

12. In the CBCT scan mode, specify the CT scan region (FOV (Z)) in the CT-Z axis direction by dragging the acquisition lines on the live image (green solid lines). Since there is a slight difference between the acquisition region lines and the CT scan region, the CT scan region is shown with a green dotted line.

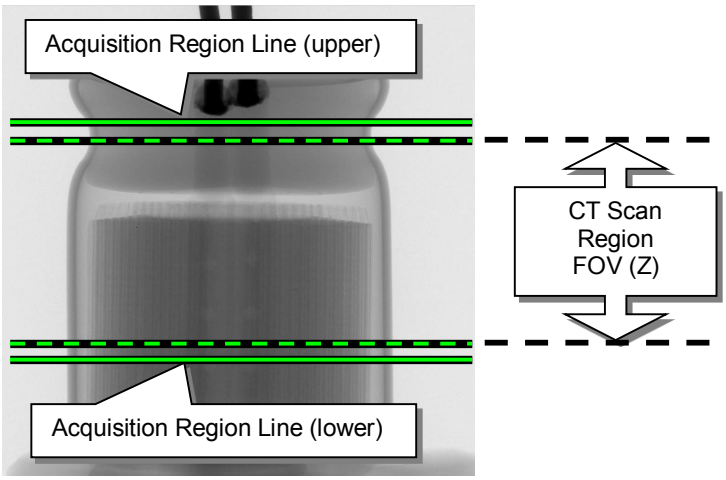


Fig. 5.24 Setting the CT Scan Region in Direction of CT-Z Axis

NOTE

FOV Setting Values

FOV settings specified in the [FOV Setting Wizard] window involve an error factor. They may result in smaller or larger values than specified.

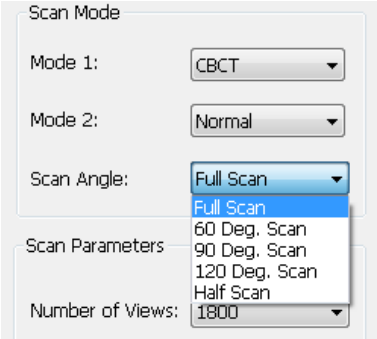
5.3 Setting X-ray Parameters

The CT software inspeXio64 automatically sets the optimal X-ray parameters (voltage and current) according to the sample being scanned.

NOTE

Setting X-ray Parameters

The X-ray parameter setup function cannot be used if [Scan Angle] is set to 60 Deg., 90 Deg., or 120 Deg. in the [Scan Mode] group box on the [CT] tab page.



☞ For CT tab, refer to 2.9.1 [CT] Tab in the Advanced Operations Instruction Manual.

Optimize CT X-ray parameters for CT scanning according to the procedure below.

1. Click the [X-RAY] button in the X-ray control area.

2. Click the  (Xray Set) button in the [Scan Settings] area. When the following CT scan confirmation message appears, confirm that the region to be scanned appears in the Live Image Display, then click [OK].

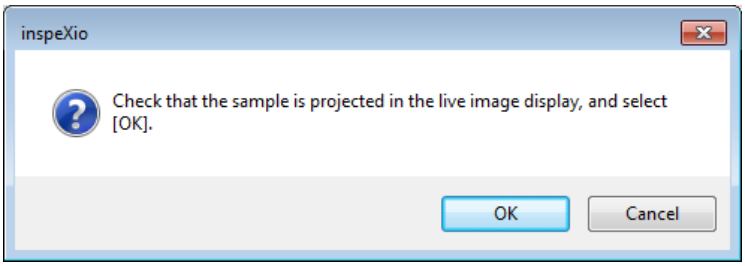


Fig. 5.25 CT Scan Confirmation Message

3. The [Obtaining X-Ray Parameters] window appears and the optimal X-ray parameters are set by measuring the X-ray transmittance at each scan angle. After rotating 180 or 360 degrees, the stage rotates to positions that need to be readjusted to set parameters.

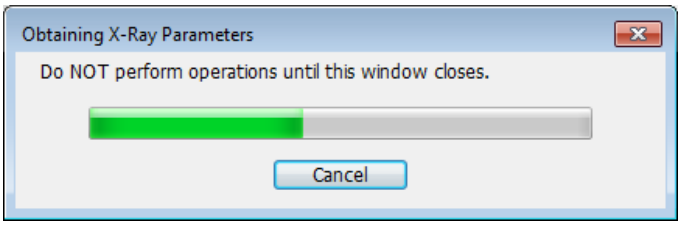


Fig. 5.26 [Obtaining X-Ray Parameters] Window

5.4 CT Scanning Parameter Settings

The following describes how to specify CT scanning parameters using the [Recommend] tab page.

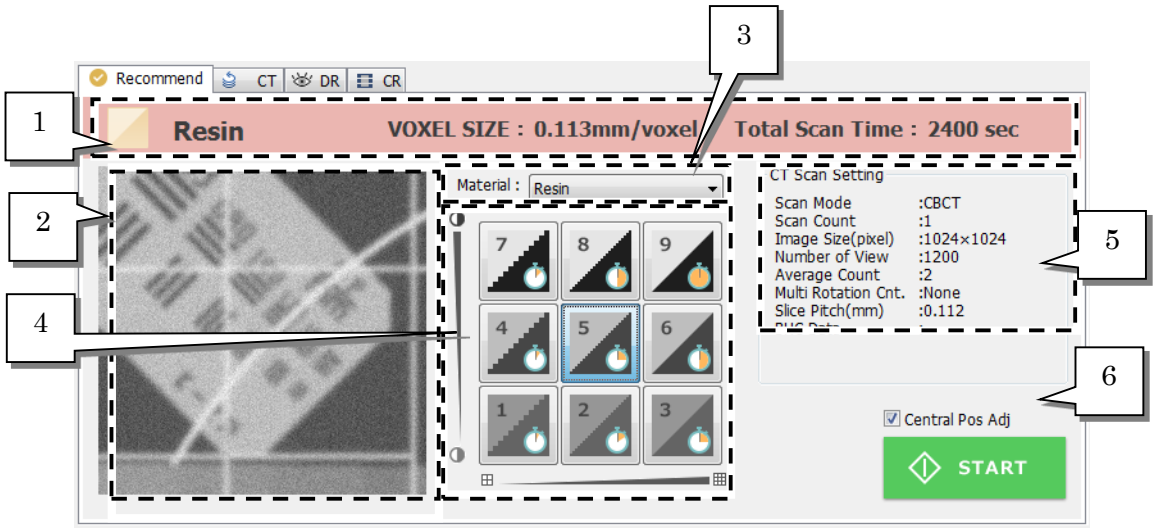


Fig. 5.27 Example of Settings Displayed on the [Recommend] Tab Page

No.	Name	Description
1	Information Display Area	Displays the sample material, voxel size, and total scan time.
2	Image Quality Display Area	Displays an example of the output image based on the selected CT scanning parameter settings. It displays variations in contrast and spatial resolution.
3	[Material] Setting Area	Selects the sample material.
4	CT Scanning Parameter Settings Area	Selects the desired parameter setting using the nine CT image quality setting buttons. The image quality varies depending on the position of the CT image quality setting button selected. The farther to the right the button is, the higher the resolution. The farther upward the button is, the higher the contrast in CT images.
5	CT Scanning Parameter Settings	Displays the CT scan parameter settings corresponding to the specified material and CT image quality settings. ☞ For center adjustment function, refer to 2.9 Scanning Parameter Settings Areas in the Advanced Operations Instruction Manual.
6	Central Pos. Adj. Setting	Specifies whether or not to use the center adjustment function.

☞ For more details about the settings specified on the [Recommend] tab page, refer to the Advanced Operations Instruction Manual.

Specify CT scanning parameter settings according to the following procedure.

1. Select the [Material] setting that most closely resembles the material used in the sample being scanned.

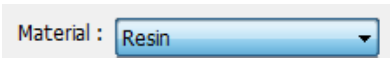


Fig. 5.28 [Material] Setting Area

2. Select CT scanning parameter settings.
The farther to the right the CT scan parameter setting button is, the higher the resolution. The farther upward the button is, the higher the contrast in CT images. To obtain a trial image, such as for positioning purposes, select the lower left CT parameter setting button.

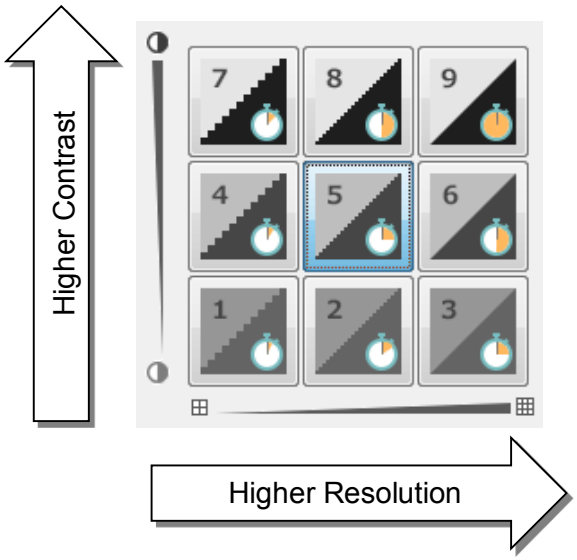


Fig. 5.29 CT Scanning Parameter Settings Area

NOTE

CT Scanning Parameter Settings

Higher resolution and/or contrast settings result in longer acquisition times. If a CT parameter setting button in the right column is selected, reconstruction can sometimes require several tens of minutes.

5.5 [Save] Settings Area

The [Save] settings area is used to specify the folder for saving CT images.

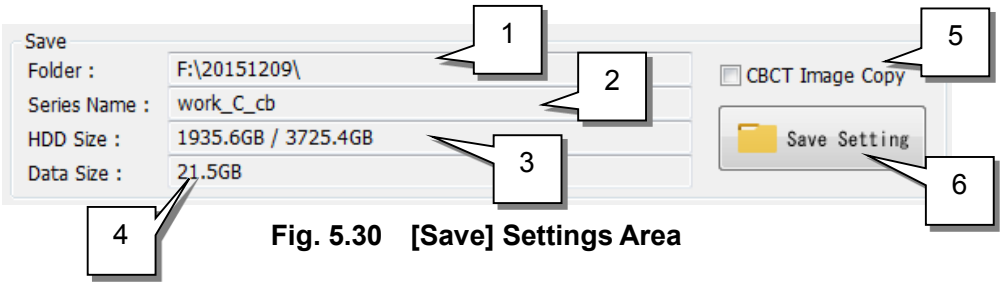


Fig. 5.30 [Save] Settings Area

No.	Settings	Description
1	Folder	Indicates the destination folder for saving CT images, which was specified in the [Select Folder] window.
2	Series Name	Displays the series name specified in the [Select Folder] window. The series name is used to automatically generate folders for saving CT imaging.
3	HDD Size	Displays the amount of free space on the hard drive versus the total hard drive capacity.
4	Data Size	Displays the amount of data being saved.
5	CBCT Image Copy	Specifies whether or not to automatically transfer images to transferred network drive. It can't be selected in case of 2DCT scan, CR scan, data accumulation and not to select transfer folder.
6	[Save Setting] Button	Displays the [Select Folder] window for changing folder settings.

NOTE

Series Names

The series name is used to automatically generate folders for saving CT imaging. Each time a CT scan is performed, the CT images are saved in a folder named in the following manner, which are automatically created in the folder specified for saving CT images.

＼series name_cb(ct)_000
＼series name_cb(ct)_001
＼series name_cb(ct)_002
…

5.5.1 [Select Folder] Window

Specify folders for saving CT images according to the following procedure.

1. Click the [Save Settng] button in the [Save] settings area to open the [Select Folder] window below.

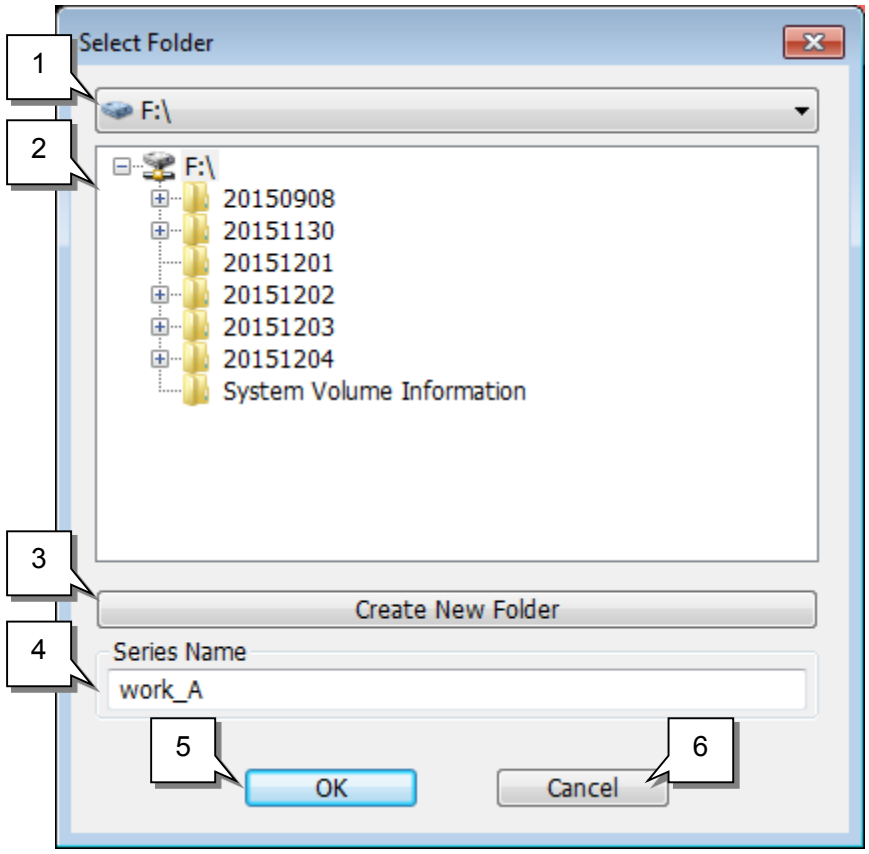


Fig. 5.31 [Select Folder] Window

No.	Settings	Description
1	Drive for Saving Data	Specifies the destination drive for saving data. Normally, selects the F: drive or G: drive. The system drive (C: drive) and D: drive cannot be selected.
2	Destination Folder Selection Area	Used to select the destination folder for saving CT images.
3	[Create New Folder] Button	Displays the [Create New Folder] window.
4	[Series Name] Box	Used to enter the series name.
5	[OK] Button	Closes the [Select Folder] window and applies the setting.
6	[Cancel] Button	Discards setting changes and closes the [Select Folder] window.

2. Specify the destination drive for saving data.

3. Select the destination folder for saving data.

To create a new folder, select the folder one level above where the new folder is to be created, then click [New Folder], which displays the [Create New Folder] window. Enter the folder name and click [OK].

Folder names may be up to 64 characters long.

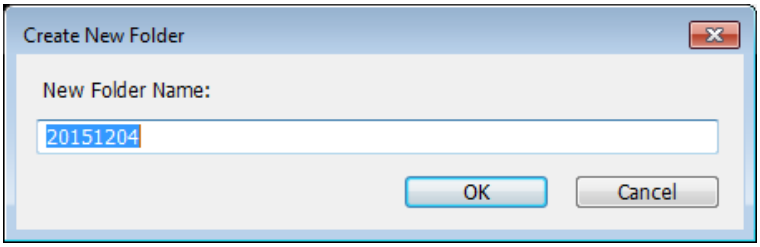


Fig. 5.32 [Create New Folder] Window

4. Enter the series name.

5. Click [OK] to close the [Select Folder] window and apply the setting.

The information entered in the [Select Folder] window now appears as the [Folder] and [Series Name] in the [Save] settings area.

5.6 CT Scanning

1. Select CT scan condition on the [Recommend] tab.

2. Press the [START] button on the operation box to start the CT scan. (In this case [CBCT Scan] selected window is not appear.) Or click the [START] button on the [Recommend] tab page to display the [CBCT Scan] window.

Fig. 5.33 [START] Button on [CT] Tab and Operation Box

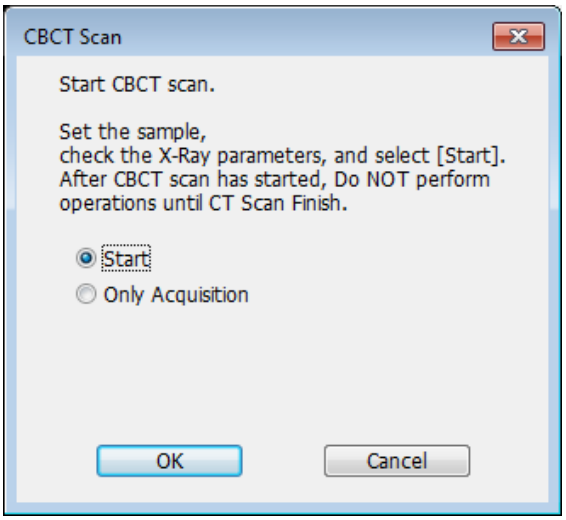


Fig. 5.34 [CBCT Scan] Selection Window

NOTE

Post-reconstruction Processing

Acquired data can be saved directly to the hard drive for CT processing later by selecting [Only Acquisition] and clicking [OK], without selecting [START] in the [CBCT Scan] window. This data is called “raw data” and its file type is “.rc0”.

Use this data to reconstruct CT data later. This function is called the "post-reconstruction function".

☞ For more about the post-reconstruction function, refer to 2.9 Reconstruction Area in the Advanced Operations Instruction Manual.

3. In the [CBCT Scan] selection window above, select [Start] or [Only Acquisition], then click [OK]. This displays the [CBCT Scan] selection window below and starts the CT scan.

To abort the scan, click [STOP] in the [CBCT Scan] selection window or press the [STOP] button on the operation box.

Fig. 5.35 Operation Box [STOP] Buttons

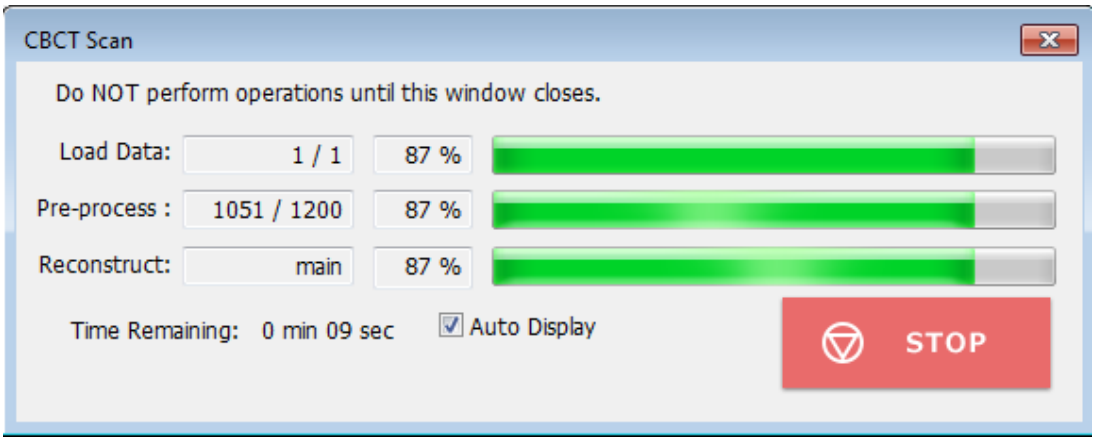


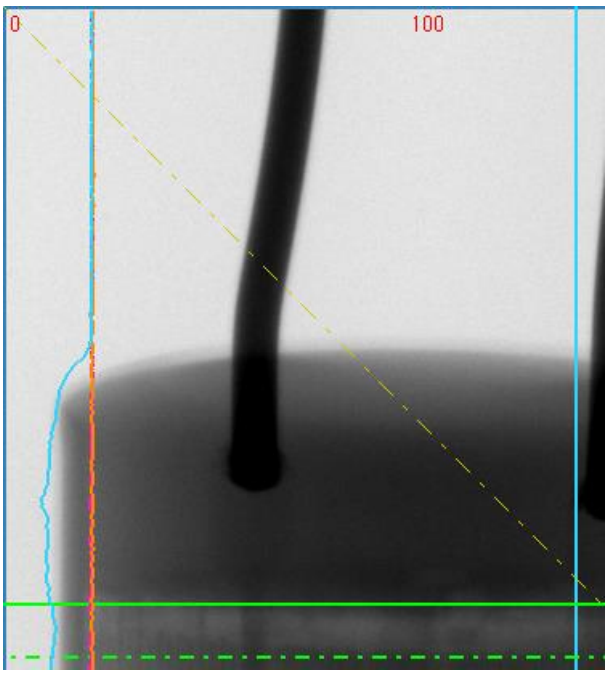
Fig. 5.36 [CBCT Scan] Window

4. If the [Auto Display] checkbox is selected in the [CBCT Scan] window, the [MPR] window is automatically opened and the CT image is displayed after all processing is finished.

NOTE

Oscilloscope Display during CT Scanning

☞ For oscilloscope display, refer to 2.2 Live Image Display Area in the Advanced Operations Instruction Manual.



Confirm that an oscilloscope display is not 100%, during CT scanning.
CT image become unusual if an oscilloscope display exceeds 100%.

NOTE

Do Not Operate Other Software during CT Scans

Do not operate other software, such as Windows Explorer or optional software, during CT scans. In particular, operating VGStudio places a large demand on the control computer, which can cause unexpected errors.

NOTE

Keep Quiet during CT Scans

Vibration during CT scans can cause CT image quality to deteriorate. Therefore, do not lean on or walk near the system.

NOTE

Air Parameters Warning Message

The CT software inspeXio64 creates air calibration tables in advance that results in optimal X-ray parameters (voltage setting, current setting), and refer them at CT scanning.

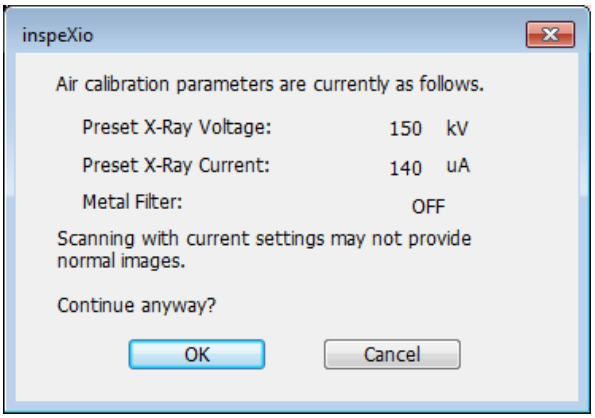
This air calibration data is referenced if [SID] / [Scan Mode] / [Metal Filter] / [Exposure Time] settings are changed when CT scanning.

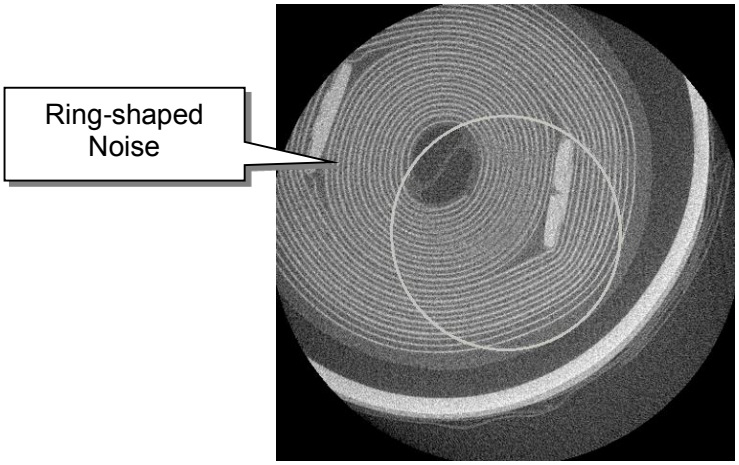
If there is no corresponding air calibration data for the changed X-ray parameters, the message below appears when the CT scan is started.

To prevent this message from appearing, reproduce the X-ray parameters shown in the message box or calibrate the air/offset before CT scanning.

Clicking [OK] in the message box and executing the CT scan can result in ring-shaped noise appearing in CT images.

If the ring-shaped noise does not disappear after air/offset calibration, then refer to Creating Detector Correction Data or Editing Detector Correction Data in 6.1 CT Software inspeXio64 [Management] Window in the Advanced Operations Instruction Manual.

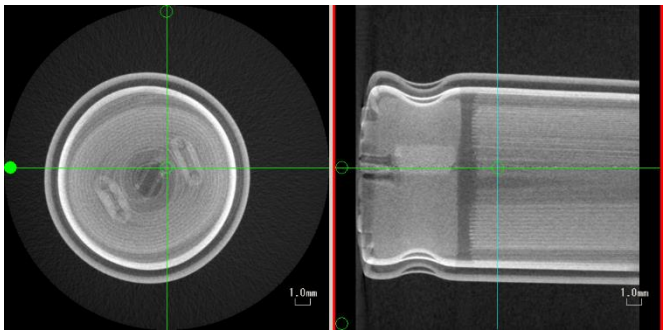




☞ For more information about air/offset calibration, refer to 2.13 Instrument Settings Area in the Advanced Operations Instruction Manual.

NOTE

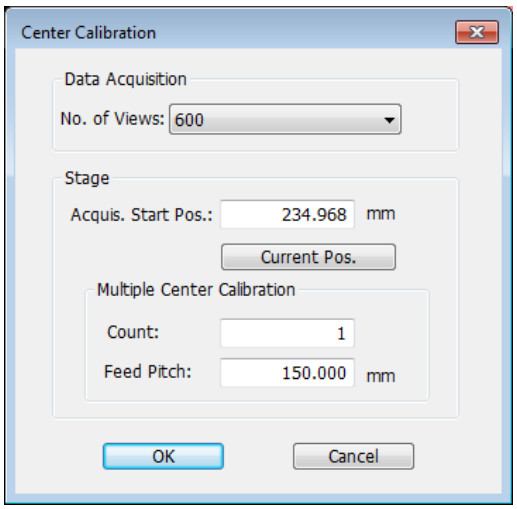
If Image Has Significant Blurring



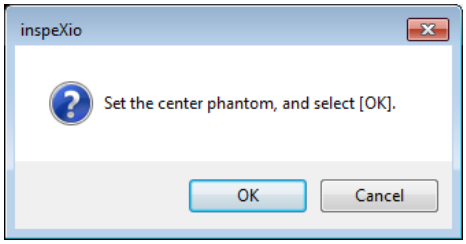
When using high magnification rates with a FOV less than 10 mm, if blurring is significant in CT images, use center adjustment function or the following procedure to calibrate the rotation center.

☞ For center adjustment function, refer to 2.9 Scanning Parameter Settings Areas in the Advanced Operations Instruction Manual.

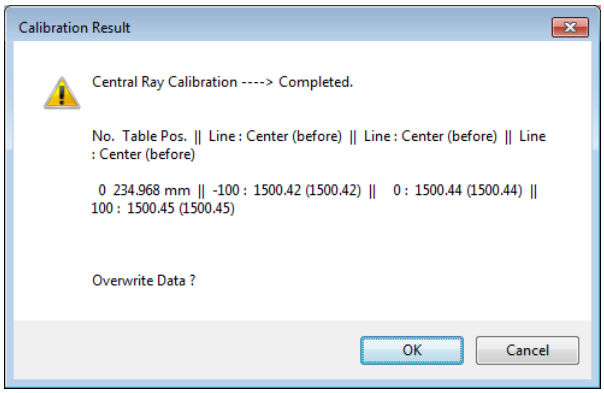
1. Open the sliding door and remove the sample setting jig.
2. Place the center axis phantom on the stage and close the sliding door.
3. Click the [Calib.] button in the instrument settings area.
4. When the [Calibration] window appears, click the [Center Calibration] button to display the [Center Calibration] window.



5. Typical parameter settings are shown in the figure. Confirm the parameter settings and click [OK].
6. Click [OK] to start the center calibration process.



7. When the center axis [Calibration Result] are displayed, click [OK] to save the calibration data.



☞ For more information about center calibration, refer to 2.13 Instrument Settings Area in the Advanced Operations Instruction Manual.

5.7 Displaying CT Images ([MPR] Window)

5.7.1 MPR Display

MPR is an acronym for multiplanar reconstruction, which is a technique for expressing data using three dimensions.

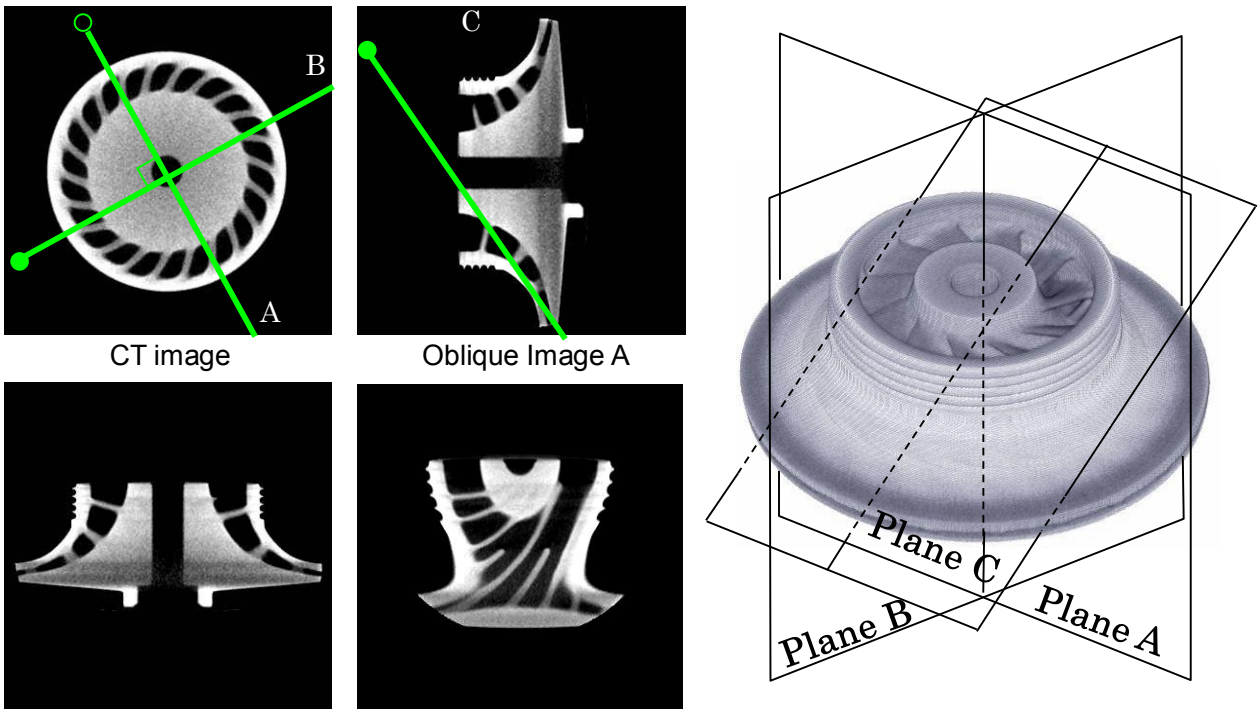


Fig. 5.37 Example of MPR Display

When 3-dimensional data, consisting of CT images stacked in the Z-direction, is bisected by two orthogonal planes (Planes A and B) the resulting cross sections are referred to as "oblique" images. Furthermore, when Plane A or B is bisected by a Plane C orthogonally to the Plane A or B, the resulting cross section is referred to as the "double-oblique" image.

In the MPR display mode, the CT image is shown in the upper left frame, the oblique image from Plane A, which is defined by Oblique Line 1, is shown in the upper right frame, the oblique image from Plane B, which is defined by Oblique Line 2, is shown in the lower left frame, and the double-oblique image is shown in the lower right frame.

5.7.2 Displaying CT Images

There are three kinds of methods used to display CT images, as described below.

1. Displaying CT Images Automatically After CT Scans

If [Auto Display] checkbox is selected in the [2DCT Scan] or [CBCT Scan] window, the [MPR] window is automatically opened and the CT image is displayed after all processing is finished.

2. Clicking the [MPR] Button to Load CT Images

Clicking the [MPR] button displays the [Load MPR Data] window. Data is loaded by specifying a folder in the folder selection pane on the lower left of the window, then clicking [OK].

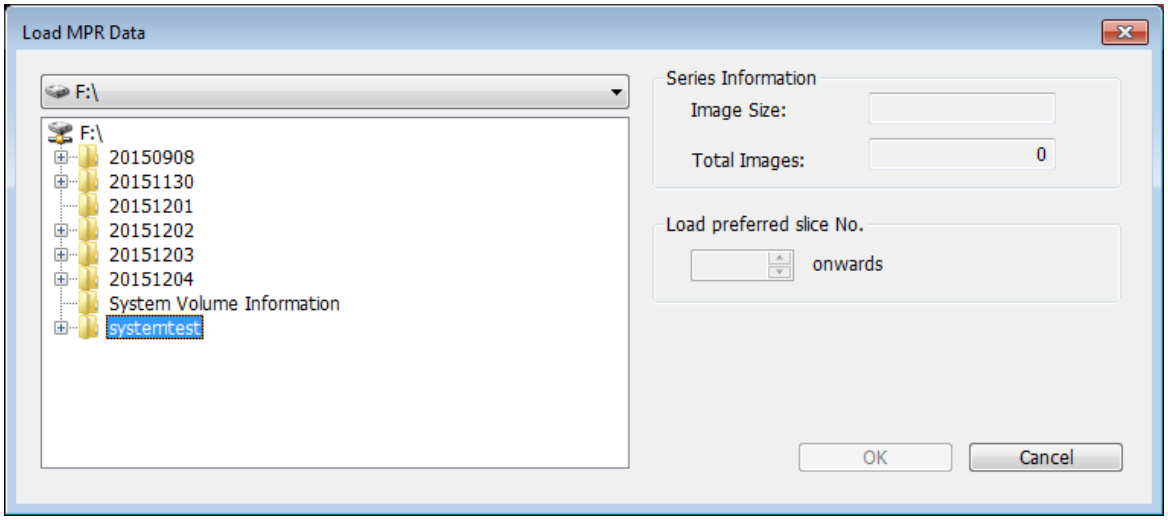


Fig. 5.38 [Load MPR Data] Window

3. Clicking the [Load] button in the [MPR] window to load CT Images

Clicking the [Load] button displays the [Load MPR Data] window. Data is loaded by specifying a folder in the folder selection pane on the lower left of the window, then clicking [OK].

5.7.3 MPR Display Settings

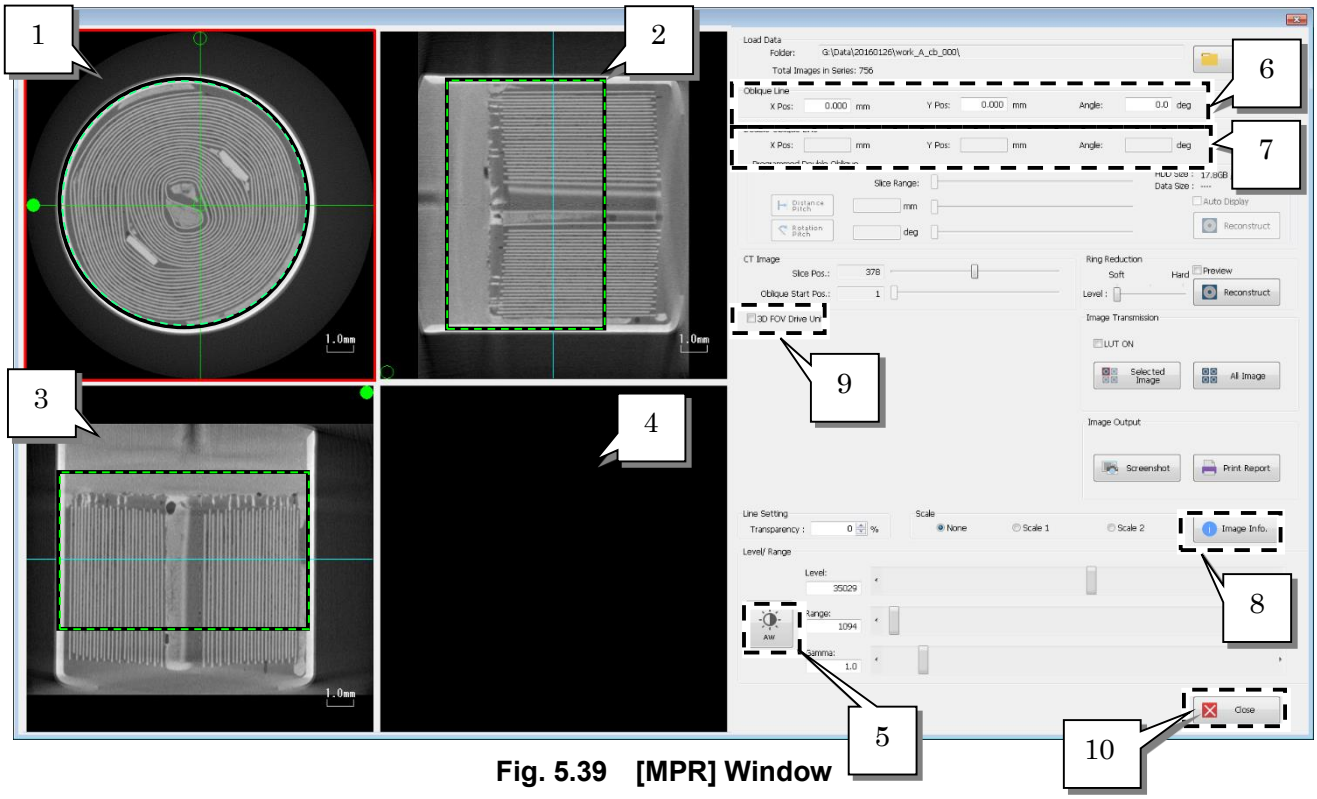


Fig. 5.39 [MPR] Window

No.	Settings	Description
1	CT Image Display Area	Displays the CT image. Oblique lines (green perpendicular lines) are overlaid on the CT image. These lines can be dragged to specify the desired oblique cross section. Oblique Line 1:open circle Oblique Line 2: filled circle
2	Oblique 1 Display Area (Upper Right Area)	Displays the oblique image of the cross section defined by Oblique Line 1 (open circle). Clicking on the Oblique 1 image displays a double-oblique line (green line) overlaid on the Oblique 1 image. This line can be dragged to specify the desired double-oblique cross section. In addition, a CT slice line (light blue line) is also shown overlaid, which can be dragged to change the slice shown in the CT image display area.
3	Oblique 2 Display Area (Lower Left Area)	Displays the oblique image of the cross section defined by Oblique Line 2 (filled circle). Clicking on the Oblique 2 image displays a double-oblique line (green line) overlaid on the Oblique 2 image. This line can be dragged to specify the desired double-oblique. In addition, a CT slice line (light blue line) is also shown overlaid, which can be dragged to change the slice shown in the CT image display area.
4	Double-Oblique Image Display Area	Displays the double-oblique image of the cross section defined by the double-oblique line.
5	[AW] (Auto Window)Button	Automatically sets the brightness level and display range for images 1 to 4 currently shown.
6	[Oblique Line] Area	Oblique lines (green perpendicular lines overlaid on CT image) are specified directly by numerical input.
7	[Double-Oblique Line] Area	The double-oblique lines (green lines overlaid on oblique images) are specified directly by numerical input.
8	[Image Info.] Button	Displays image information about the CT image currently displayed.
9	[3D FOV Drive Unit]	Selecting this checkbox enables the 3D FOV drive unit (positioning system for CT stage during CT scanning).
10	[Close] Button	Closes the [MPR] window.

Display the 3D MPR display according to the procedure below.

1. Display the CT image in the upper left frame of the [MPR] window.

Oblique lines (green perpendicular lines) are overlaid on the CT image. These lines can be dragged to specify the oblique image. If the oblique lines are grabbed near their intersection, they will translate when dragged. If grabbed on any other part of the lines, the lines will rotate.

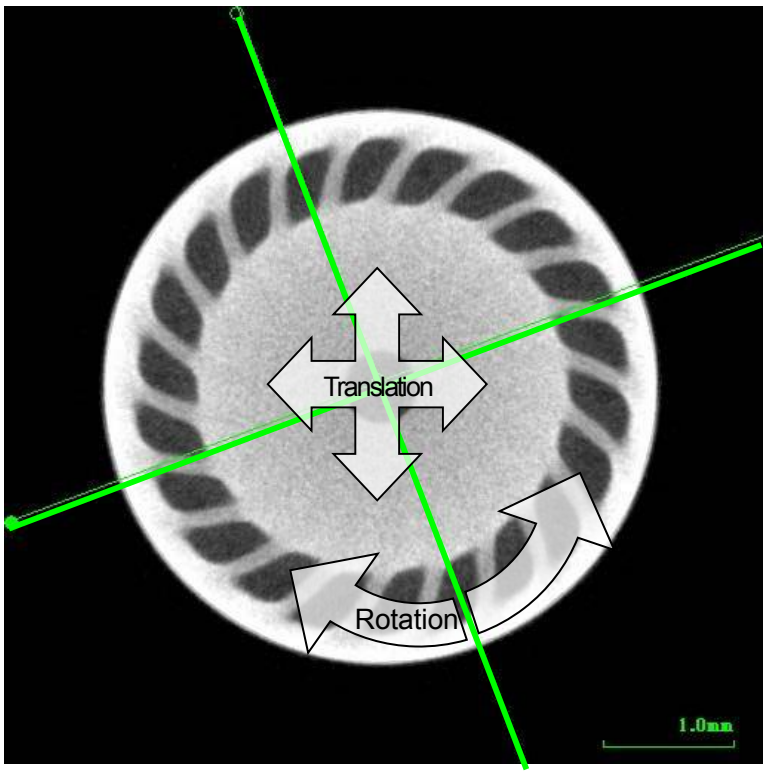


Fig. 5.40 Specifying Obliques

2. The Oblique 1 image is displayed in the upper right frame of the [MPR] window. Clicking on the upper right frame displays a double-oblique line (green line). Drag the line to specify the desired double-oblique.

Just as with the oblique lines, the double-oblique line translates if grabbed near its center point and rotates if grabbed on any other part of the line. In addition, a CT slice line (light blue line) is also shown overlaid, which can be dragged to change the slice shown in the CT image display area.

3. The Oblique 2 image is displayed in the lower left frame of the [MPR] window. Clicking on the lower left frame displays a double-oblique line (green line). Drag the line to specify the desired double-oblique.

Just as with the oblique lines, the double-oblique line translates if grabbed near its center point and rotates if grabbed on any other part of the line. In addition, a CT slice line (light blue line) is also shown overlaid, which can be dragged to change the slice shown in the CT image display area.

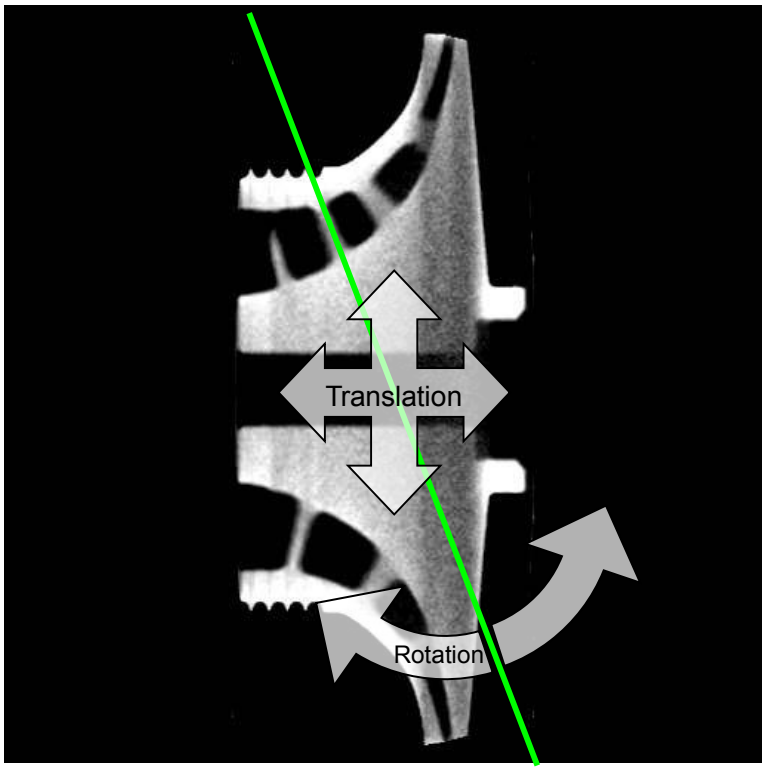


Fig. 5.41 Specifying Double-Obliques

4. The double-oblique image is displayed in the lower right frame of the [MPR] window.

5. Click the [AW] (Auto Window) button to specify the optimal brightness level.

6. In the [Oblique Line] area, the X-coordinate, Y-coordinate, and angle of rotation for the oblique lines (green perpendicular lines) are entered directly. The origin of the coordinate system is the center point of the CT image. In the rotational direction, clockwise is positive.

7. In the [Double-Oblique Line] area, the X-coordinate, Y-coordinate, and angle of rotation for the double-oblique line (green line) are entered directly. The origin of the coordinate system is the center point of the oblique image.

8. Click the [Image Info.] button to display the [Image Information] window. In the [Image Information] window, confirm the image information about the CT image currently displayed.

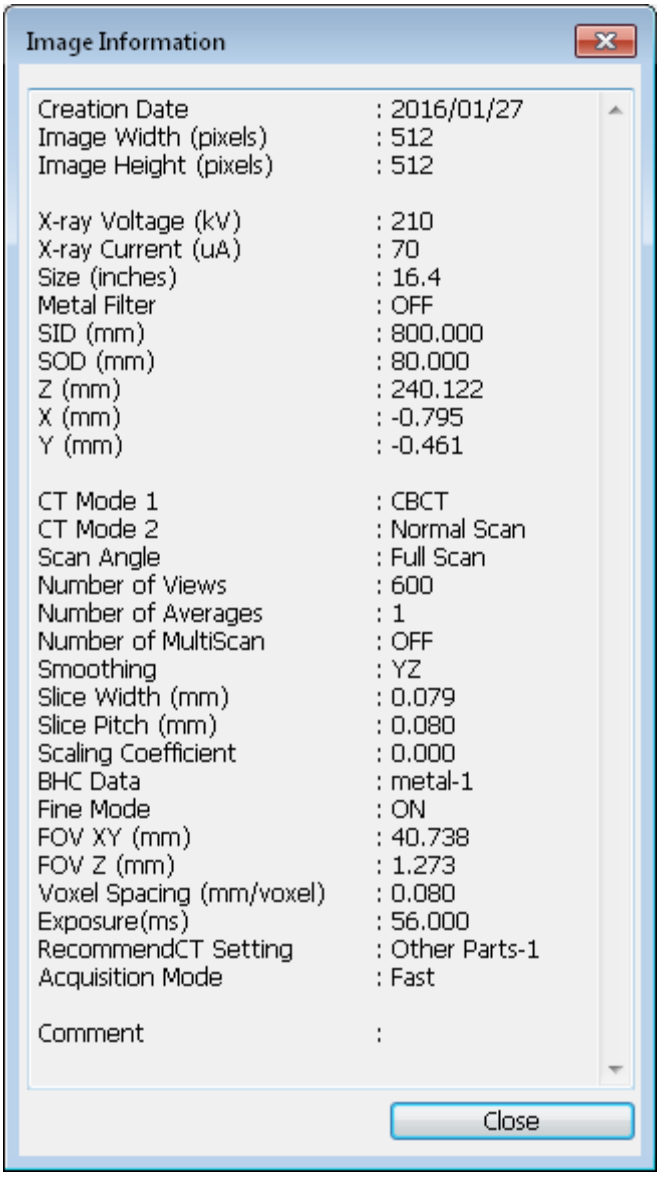


Fig. 5.42 [Image Information] Window

9. If the [3D FOV Drive Unit] checkbox is selected, the current CT scan region is indicated by a green dashed line overlaid in the [MPR] window.

5.7.4 Automatic CT Scan Positioning Function

The CT scan region for the next and subsequent scans can be specified in more detail in the [MPR] window, by operating the 3D FOV drive unit.

1. Selecting the [3D FOV Drive Unit] checkbox displays a green dashed line overlay of the current CT scan region in the [MPR] window, as shown below, and opens the [3D FOV Drive Unit] operation window.

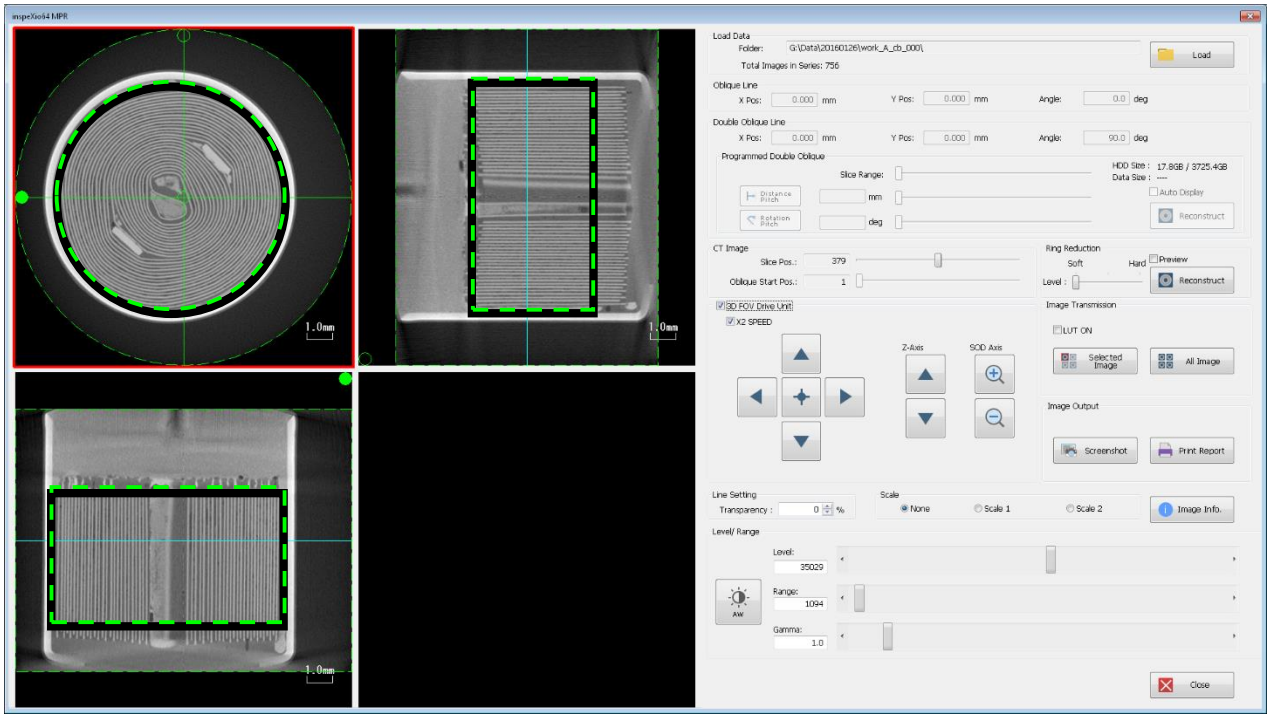


Fig. 5.43 [MPR] Window When [3D FOV Drive Unit] Checkbox is Selected

2. Click the CT stage movement buttons in the [3D FOV Drive Unit] area to respecify the CT scan region as the CT scan region is moved.

3. Clicking the CT stage movement buttons displays an overlay of the CT scan region in the [MPR] window. The CT stage then moves according to that region.

4. Click the [Close] button to close the [MPR] window and specify CT parameters on the [CT] tab page. Click the [Start] button to start the CT scan.

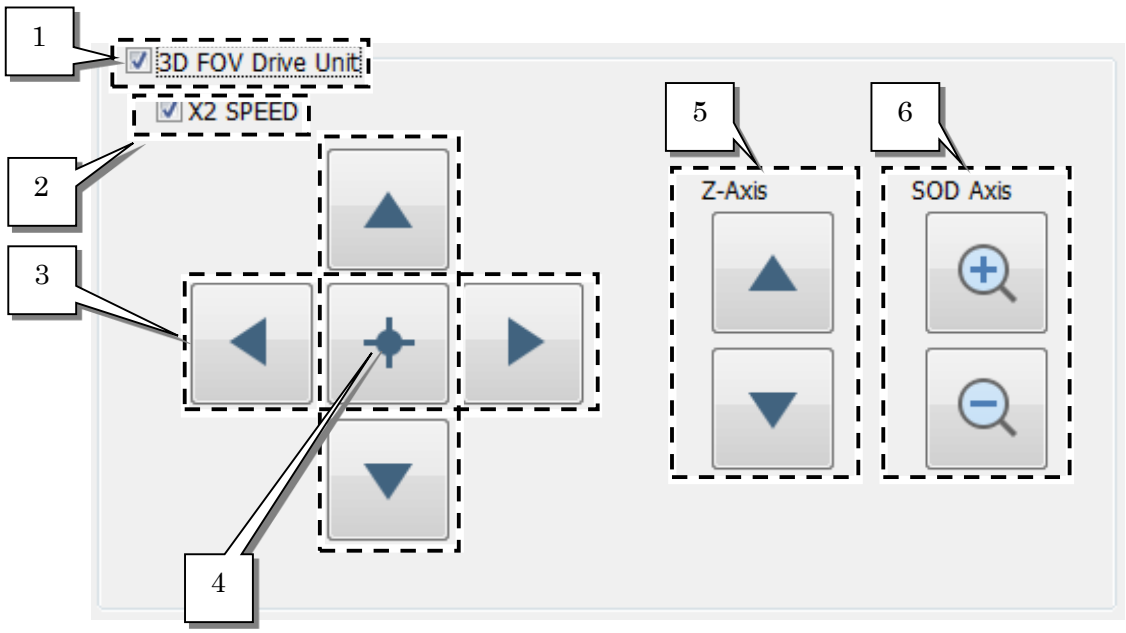


Fig. 5.44 [3D FOV Drive Unit]

No.	Settings	Description
1	3D FOV Drive Unit	Used to display a green dashed line overlay of the current CT scan region in the [MPR] window and displays the [3D FOV Drive Unit] group box.
2	X2 SPEED	Used to switch between constant speed and double speed modes.
3	X and Y-Axis Movement Buttons	Moves the CT scan region overlay in X and Y-axis directions in the [MPR] window.
4	[Home] Button	Clicking the [+] (plus) button moves the stage in the X or Y direction to align the center of the FOV circle, shown in the upper left frame (CT image), with the center of the CT image.
5	Z-Axis Movement Buttons	Moves the CT scan region overlay in the Z-axis direction in the [MPR] window.
6	SOD Axis Movement Buttons	Enlarges or reduces the CT scan region overlay shown in the [MPR] window.

NOTE

When the [3D FOV Drive Unit] Checkbox is Selected

If the [3D FOV Drive Unit] checkbox is selected, the oblique lines (green intersecting lines) cannot be translated, even if they are grabbed near their intersection.

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6 Maintenance

6.1 Routine Inspections

Inspect the following items before using the system. If any problems are discovered while inspecting any of the items, immediately stop operating the system and contact your Shimadzu service representative.

No.	Inspection Item		Description
	Location	Application	
1	X-ray Shield Box	Interlock Circuits	Confirm that the interlock circuit is functioning properly, as described in3.3 Performing Startup Inspections.
		Lead Glass	Visually confirm there are no cracks, breakage, or other damage.
		[X-RAY] Indicator Lamp	Visually confirm the entire lamp [RED] is uniformly illuminated during X-ray emission.
		[READY] Indicator Lamp	Visually confirm the entire lamp [GREEN] is uniformly illuminated when the interlock circuit is established.
		Lighting Inside Shield Box	Visually confirm that the interior lighting switches ON when the [OPERATE] key switch is turned to [ON].
2	X-ray Generator	Vacuum Gauge Output	Confirm that the vacuum gauge output value is 10 or less.
		Aging	Confirm that aging is properly completed up to the currently specified tube voltage.
		kV/μA Monitor Values	Confirm that kV/μA monitor values do not fluctuate significantly during X-ray emission.
		X-ray Emission Hours Since Filament Was Replaced	Confirm that X-ray radiation time has not exceeded 200 hours since the filament was last replaced. If more than 200 hours, ask your system manager to have the filament replaced.
		Days Since Last Greasing for Insulation	Confirm that more than 180 days have not elapsed since greasing for insulation. If more than 180 days, ask your system manager to have the cables greased.
3	CT Stage	Movement on Axes	Confirm that there are no unusual noises or vibration from any axis during CT stage movement.
4	Control Computer	Space Available on Hard Drive	Confirm the free space available on the hard drive by opening [My Computer] on the desktop, right-clicking on [Volume] for the drive where data is to be saved, and then clicking [Properties]. If there is less than 10 GB of free space, delete some unnecessary data to increase the free space available on the hard drive to over 10 GB.
		Hard Disk Drive Fragmentation Status	Click the [Start] button in Windows, then click [All Programs]-[Accessories]-[System Tools]-[Disk Defragmenter] to start the defragmentation tool. Periodically defragment the drive where data is to be saved.

NOTE

Deleting Files

After deleting files to increase free space on the hard drive, be sure to completely delete the files by right-clicking the [Recycle Bin] on the desktop and clicking [Empty the Recycle Bin].

7 Troubleshooting

If troubleshooting measures do not resolve a problem or a problem occurs that is not described below, immediately contact your Shimadzu service representative.

Type	Description of Problem	What to Check	Corrective Measures
Power Supply	System does not start even after turning the [OPERATE] key switch to [ON] on the operation box.	Is the power supply circuit breaker at the site power supply service panel or main power supply circuit breaker on the back of the unit switched OFF?	Switch the site or system power supply circuit breaker ON. ☞ See 2.3.1.
		Is the operation box cable connected with the operation box normally?	Connect an operation box cable with an operation box certainly.
		Is the [EMERGENCY STOP] button on the operation box locked in the down position?	Unlock the [EMERGENCY STOP] button on the operation box by turning the button clockwise.
Control Computer	Control computer will not start up	Refer to the manual provided with the control computer.	Refer to the manual provided with the control computer.
	Nothing appears on the monitor.	Is the control computer power switched OFF?	Switch the control computer power ON.
		Is the monitor power switched OFF?	Switch the monitor power ON.
		Is the monitor power cord or signal cable disconnected?	Connect the monitor power cord and signal cable.
		Is the control computer power cord or signal cable disconnected?	Connect the control computer power cord and signal cable.
	Software does not start.	Are the capture board, IO board, and the graphics board recognized normally?	Check what is recognized normally by the device manager.
	Data acquisition errors often occur during CT scanning.	Is the hard drive memory excessively fragmented?	Run the defragmentation function included with Windows. If defragmenting the drive does not resolve the problem, temporarily move data from the drive where data is being saved to a separate drive and then move it back.
X-ray Fluoroscopic Image	The live image remains completely black and nothing appears.	Are X-rays being emitted?	Emit X-rays. ☞ See 5.2.2.
		Is the [OPERATE] key switch on the operation box turned to [OFF]?	Turn the [OPERATE] key switch on the operation box to [ON] to restart the CT software inspeXio64.
		Is the signal cable disconnected between Flat panel detector and control computer?	Make sure the signal cable between Flat panel detector and control computer is securely connected to the image capture board in the control computer, then restart the CT software inspeXio64.
		Does the LED light in green?	Confirm that the LED of FPD lights in green.

Type	Description of Problem	What to Check	Corrective Measures
		Is the kV or μA monitor value in the X-ray control area in the CT software inspeXio64 too low?	Increase the voltage or current setting. ☞ See Chapter 4.
		Are the live image quality settings in the CT software inspeXio64 set appropriately?	Click the [AW] (Auto Window) button in the live image quality settings area in the CT software inspeXio64. ☞ See 5.2.2.
	Fluoroscopic images are blurry.	Are the X-ray focus setting values appropriate?	Adjust the focus values. ☞ Refer to 2.1 X-ray Control Area in the Advanced Operations Instruction Manual.
		Is the target rotated regularly?	Rotate the target. ☞Refer to 6.2 System Manager Inspection Items in the Advanced Operations Instruction Manual.
		Have high voltage cables been greased on a regular basis?	Contact your system manager to have the high voltage cables greased by a Shimadzu service representative. ☞Refer to 6.2 System Manager Inspection Items in the Advanced Operations Instruction Manual.
	A persistent image of the sample remains on the live image for ever.	Has the same sample been scanned in the same position for a long time?	Create an air calibration table. ☞Refer to 6.1 CT Software inspeXio64 [Management] Window in the Advanced Operations Instruction Manual.
	The exterior camera image remains black, without being updated.	Is the USB device being recognized properly?	Disconnect and reinsert the USB cable (CAMERA) for the exterior monitoring camera.
X-ray generator	The interlock indicator lamp is illuminated red, in the X-ray control area in the CT software inspeXio64.	Is the sliding door or maintenance door on the shield box open?	Securely close the sliding and maintenance doors on the shield box.
		Is the [OPERATE] key switch on the operation box turned to [OFF]?	Turn the [OPERATE] key switch on the operation box to [ON] to restart the CT software inspeXio64.
		Is the key switch on the front panel of the X-ray control box (MTT controller) in the [OFF] position?	Turn the key switch on the front panel of the X-ray control box (MTT controller) to the [ON] position. ☞ See 3.2.2.
		Is the vacuum gauge output value 41 or higher?	Verify the vacuum gauge output value. ☞ See Chapter 4.
	The [Power Limit] indicator in CT software inspeXio64 appears red during X-ray emission.	Have high voltage cables been greased on a regular basis?	Contact your system manager to grease the high voltage cables. ☞ Refer to the Advanced Operations Instruction Manual.
	The [Overheat] indicator in CT	Has the X-ray tube become too hot?	Shut off X-ray emissions and wait about 30 minutes.

Type	Description of Problem	What to Check	Corrective Measures
	software inspeXio64 appears red during X-ray emission.	Is the water level in the cooling water tank too low?	Add cooling water to the cooling water tank. ☞ Refer to the Advanced Operations Instruction Manual.
	The communication error indicator lamp is illuminated red in the X-ray control area in the CT software inspeXio64.	Is the communication cable disconnected between the X-ray control box (MTT controller) and control computer?	Make sure the communication cable between the X-ray control box (MTT controller) and control computer is securely connected to the communication port COM1 on the control computer, then restart the CT software inspeXio64. If that does not resolve the problem, the turbo molecular pump may have malfunctioned.
	X-rays are not being emitted.	Has the filament burnt out?	Contact your system manager to replace the filament. ☞ Refer to the Advanced Operations Instruction Manual.
		Has the interior of the X-ray tube become dirty/contaminated?	Contact your system manager to clean the interior of the X-ray tube . ☞ Refer to the Advanced Operations Instruction Manual 6.2.
		Is the MTT controller key switch in the [OFF] position?	Turn the MTT controller key switch to [ON].
		Is the [OPERATE] key switch on the operation box in the [OFF] position?	Turn the [OPERATE] key switch on the operation box to [ON] to restart the CT software inspeXio64.
		Is the [EMERGENCY STOP] button on the operation box pressed?	Unlock the [EMERGENCY STOP] button on the operation box and restart the CT software inspeXio64.
	Aging does not finish.	Does the vacuum gauge output display indicate 15 or higher?	Make sure the vacuum gauge output display indicates 15 or less, then repeat aging.
	The Startup inspection wizard does not proceed to the next window.	Is the MTT controller key switch in the [OFF] position?	Turn the MTT controller key switch to [ON].
X-ray CT Images	CT scan does not start.	Is the trigger cable (coaxial), between the motor controller board inside the control board and the control computer, disconnected ?	Make sure the trigger cable (EXTRG), between the motor controller board inside the control board and the control computer, is securely connected to the splitter cable for the camera signal cable.
	Problem with CT image	Does noise appear in the form of concentric circles (like Fig7.1)?	Click the [Calibration] button in the instrument settings area of the CT software inspeXio64 to perform calibrate the air settings. ☞ Refer to the Advanced Operations Instruction Manual 2.13.

Type	Description of Problem	What to Check	Corrective Measures
		Is the image blurry because of center oscillation (like Fig7.2)?	Click the [Calibration] button in the instrument settings area of the CT software inspeXio64 to calibrate the center of rotation. ☞ Refer to the Advanced Operations Instruction Manual 2.13.
		Do the defect pixels such as white dots or black dots appear on the live image?	Click the [Edit Defect Calibration Data]button in the Manager Setting window of CT software inspeXio64 to edit the defect calibration data. ☞ Refer to the Advanced Operations Instruction Manual 2.13.
		Is there a double image of the sample shape in CT images?	Make sure the sample is not moving during CT scans.
		Is the CT image brightness settings set too bright or too dark?	Select an appropriate scaling coefficient. ☞ See 5.4.
		Is the cooling fan on the back of the FPD unit stopped?	Contact your system manager to have the cooling fan replaced by a Shimadzu service representative.
CT Stage	The CT stage does not move during CT software inspeXio64 startup.	Is the [OPERATE] key switch on the operation box turned to [OFF]?	Turn the [OPERATE] key switch on the operation box to [ON] to restart the CT software inspeXio64.
		Is the communication cable (COM2) disconnected between the motor controller board inside the control board and the control computer?	Make sure the communication cable between the motor controller board inside the control board and the control computer is securely connected to the communication port COM2 on the control computer, then restart the CT software inspeXio64.
		Did the CT stage initialization process finish normally?	Restart the CT software inspeXio64.
		Isn’t the sliding door or the maintenance door open?	Confirm that the sliding door and the maintenance door are close, and the READY lamp turns on.
	A message such as "The stage is not initialized.", "A communication protocol error occurred.", or "A communication error occurred." appears in the CT software inspeXio64.	Is the communication cable (COM2) disconnected between the motor controller board inside the control board and the control computer?	Make sure the communication cable between the motor controller board inside the control board and the control computer is securely connected to the communication port COM2 on the control computer, then restart the CT software inspeXio64.
Other	A license check error appears when Image-Pro Analyzer is started.	Is the dongle key for Image-Pro Analyzer disconnected from the control computer USB port?	Insert the dongle key for Image-Pro Analyzer securely into the control computer USB port.
	A license check error appears when starting VR.	Was the license file for VGStudio copied to the correct folder on the control computer?	Copy the VGStudio license file to the prescribed folder on the control computer.

Type	Description of Problem	What to Check	Corrective Measures
		Has not it changed, such as having returned the clock display of OS in the past?	Check that the clock display of OS is normal. And check that it is dead of the battery of the mother board of a control computer.

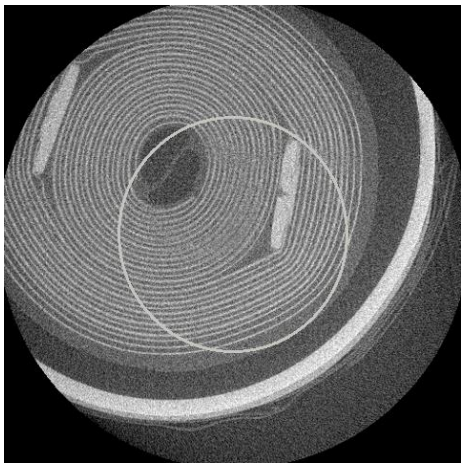

Fig. 7.1 Image with Ring-Shaped Noise

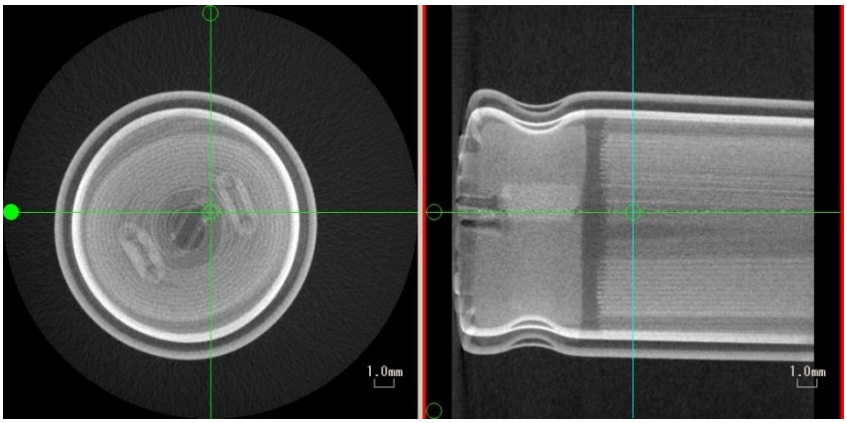

Fig. 7.2 Image with Blurry Center

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8 Consumables and Maintenance Parts List

8.1 Consumable Parts List

Table 8.1 Consumable Parts for Microfocus X-ray generator MTT-225

Part Name/Model No.	Part Number	Service life
Filament (set of 10)	S362-71225	200 hours each
O-Ring Assembly(for MTT-225)	S362-52531-40	When the necessary vacuum can no longer be maintained
Si Grease, 111 150 g (grease for high voltage cable)	S017-30831-01	As appropriate
Clean Jig for high voltage cable	S362-49525	As appropriate
Isopropyl Alcohol, S 500 g	S017-40021	As appropriate
Glanol (grease for high voltage connecter)	S362-06620	As appropriate
Grease, HIVAC-G	S017-30831-01	As appropriate
Wipers, Bemcot M3	S086-72609-02	As appropriate
Gloves, 559-2150	S086-72599-01	As appropriate
Cooling water	S362-77028-01	As appropriate

Table 8.2 Other Consumables

Part Name/Model No.	Part Number	Service life
Leon Oil Clay, S-500 g	S340-16092-01	As appropriate

8.2 Maintenance Parts List

8.2.1 Maintenance Parts

⚠ CAUTION

Instructions

Maintaining the Flat Panel Detector

The flat panel detector may need to be replaced due to malfunctions caused by deterioration of internal electrical parts over time or due to wear caused by X-ray exposure.

(1) Expected Service Life

Due to electronic part failure or other factors, the expected service life of flat panel detectors is about 7.5 years.

(2) Wear Caused by X-Ray Exposure

As the cumulative X-ray exposure on the flat panel detector increases, the probability of phenomena related to sensor deterioration increases, such as the number of defective pixels and level of image noise increasing.

Therefore, the system includes a feature for correcting defects and image noise using software. However, when the deterioration progresses to the point that the software cannot adequately correct for such phenomena, the flat panel detector must be replaced or repaired at the factory (sensor unit is replaced).

The table below shows estimated times before replacement is required, where Condition 1 represents X-ray exposure levels expected under normal operating conditions, whereas Condition 2 represents extremely high X-ray exposure levels potentially possible within specification limits.

	Condition 1	Condition 2
X-Ray Output	Tube voltage: 225 kV Tube current: Value that results in maximum dose without brightness saturation	Max. X-ray output Tube voltage: 225 kV Tube current: 600 μA
SID	1200 mm	800 mm
Instrument Operating Hours	8 hrs continuous per day, 240 days per year	
Estimated Time to Replacement	About 18,000 hrs (about 9 yrs)	About 10,000 hrs (about 5 yrs)
Remarks		Brightness saturation would occur under these conditions and prevent obtaining normal cross-section images.

SID: Source-to-Image Distance (from the X-ray focus to the flat panel detector)
Brightness saturation: Brightness that exceeds the performance limits of the flat panel detector and prevents resolving images.

The estimated service life of the flat panel detector is the shorter of (1) or (2). Under normal usage conditions, the flat panel detector should last over seven years before replacement is required.

However, the service life values indicated above are estimates and not guaranteed. Due to variability between individual units or other factors, the actual service life may be shorter than the estimates indicated above.

⚠ CAUTION

Instructions

Maintenance of High Voltage Transformer

Regarding maintenance (repair of failure) of MTT-225, in addition to replacing unit, off-site repair is also available. In this case, please request for quotation in each case.

Table 8.3 Manipulator Maintenance Parts

Part Name/Model No.	Part Number	Location Used	Service life
Flat Panel Detector, FPD-16, 8CL-H	*	Stage Y-axis	Replace when stops functioning

Note: Replacing these * parts should be performed by a Shimadzu service personnel. Contact your Shimadzu representative.

Table 8.4 X-ray generator Maintenance Parts

Part Name/Model No.	Part Number	Location Used	Service life
HV Cable	*	MTT-225 X-ray Tube	4 to 6years
Diaphragm Pump	*	MTT-225 X-ray Tube	Overhaul after 1year
Diaphragm Pump O/H (Overhaul)	*	MTT-225 X-ray Tube	Overhaul after 1.5year
TMP, Hipace80 (Turbo Molecular Pump)	*	MTT-225 X-ray Tube	Overhaul after 3 years
TMP, Hipace80 O/H (Overhaul)	*	MTT-225 X-ray Tube	Overhaul after 3 years
HIGH VOLT GENERATOR 225 ASSY	*	High-Voltage Transformer	As appropriate

Note: Replacing these * parts should be performed by a Shimadzu service personnel. Contact your Shimadzu representative.

Table 8.5 Other Maintenance Parts (Jigs, etc.)

Part Name/Model No.	Part Number	Location Used	Service life
Jig, Center Phantom 100 Assembly	S362-69629-02	Sample setting jig	Replace when damaged or bent, or when tungsten wire breaks
Jig, Center Phantom 150 Assembly	S362-69629-03	Sample setting jig	Replace when damaged or bent, or when tungsten wire breaks
Jig, Sample Setting S Shaft (5 mm dia., 115 mm length)	S362-69648	Sample setting jig	Replace when damaged and no spares remain
Sample Setting Jig Assembly (S)	S362-81395	Sample setting jig	As appropriate
Jig, Sample Setting M Shaft (15 mm dia., 115 mm length)	S362-72299	Sample setting jig	Replace when damaged and no spares remain
Sample Setting Jig Assembly (M)	S362-81399	Sample setting jig	As appropriate
Sample Setting Jig (L)	S362-71086	Sample setting jig	As appropriate
Sample Setting Jig (XL)	S362-84657	Sample setting jig	As appropriate
Resolution Phantom	S362-70835	Sample setting jig	As appropriate
Base, BHC Phantom	S362-69141	Sample setting jig	As appropriate
Aluminum, BHC Phantom	S362-69144-01	Sample setting jig	As appropriate
POM, BHC Phantom	S362-69144-02	Sample setting jig	As appropriate
Filter, t0.5	S362-84610-01	Sample setting jig	As appropriate
Filter, t1.0	S362-84610-02	Sample setting jig	As appropriate
Filter, t2.0	S362-84610-03	Sample setting jig	As appropriate
Tape, F9980Y W50 black	S362-01549-03	Sample setting jig	As appropriate

⚠ CAUTION

Maintenance of the Control Computer

It does not provide a replacement criterion for the control computer. When the control computer has failed, replacement of the control computer is required in the case the maintenance parts for the repair is not available or it can not repair with parts replacement.

In this case, please request for quotation in each case.

9 CT Operations Basic Principles

This section describes the basic principles of CT scanning operations.

9.1 X-rays and Fluoroscopic Images

Typically, the X-ray fluoroscopic images we are most familiar with are medical X-ray images.

In the case of traditional chest X-rays, the patient stands with their chest against a photographic plate and is irradiated with X-rays from behind. Then X-rays passing through the body are recorded on to a film as an image, as shown below. The recorded image is just like a projected silhouette. Since traditional X-ray images use film, they can only show still images, but the CT software inspeXio64 is able to display moving images in real time.

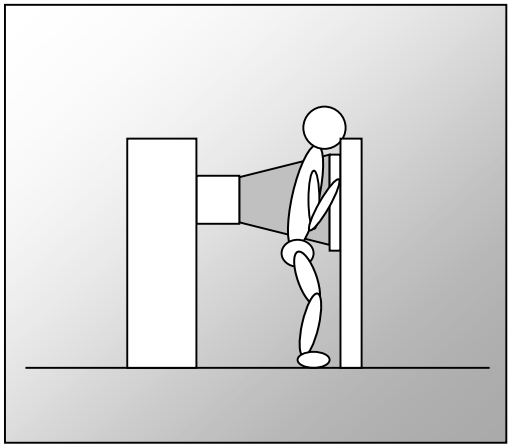


Fig. 9.1 X-ray Imaging

9.1.1 How Fluoroscopic Images Relate to Sample Characteristics

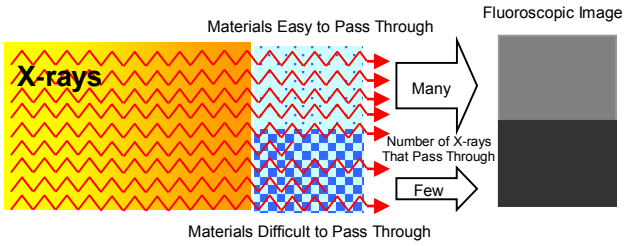
X-rays are a type of electromagnetic wave, which this inspeXio64 system generates by using a high voltage to accelerate electrons inside the X-ray tube and bombard them against a target.

Since X-rays have a short wavelength, they gradually attenuate as they pass through the object.

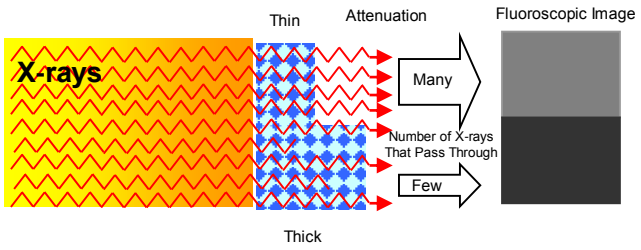
This attenuation rate varies depending on the sample material, thickness, and density, which varies the quantity of X-rays passing through the sample.

If a large quantity of X-rays pass through the sample, the fluoroscopic image will be brighter.

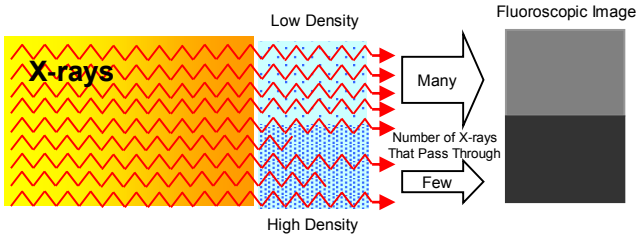
If a small quantity of X-rays pass through the sample, the fluoroscopic image will be darker.



(a) Materials That Are Easy and Difficult for X-rays to Pass Through



(b) Samples of Same Material But Different Thickness



(c) Samples of Same Material But Different Density

Fig. 9.2 How Fluoroscopic Images Relate to Sample Characteristics

9.1.2 How Fluoroscopic Images Relate to Tube Voltage and Tube Current

The intensity and quantity of X-rays is determined by the tube voltage and tube current values.

Increasing the tube voltage reduces the wavelength, which makes the X-rays harder and penetrate farther.

Increasing the tube current increases the quantity of X-rays per unit area, which makes the fluoroscopic image brighter.

9.1.3 Magnifying the Fluoroscopic Image

The magnification rate is determined by the SOD and SID values, where

Magnification = SID/SOD

SOD = Source-to-Object Distance

SID = Source-to-Image Distance

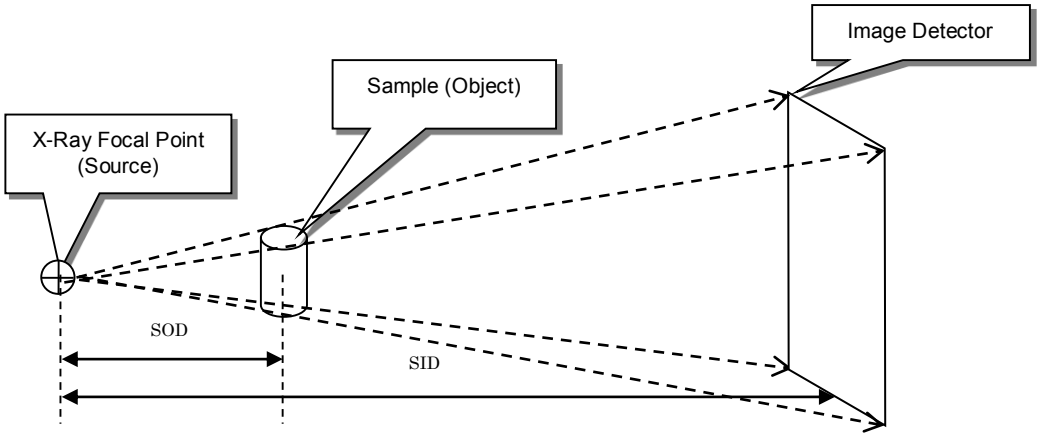


Fig. 9.3 Relationship between SID and SOD

Based on the relationship that exists between SID, SOD, and magnification rate (magnification = SID/SOD), magnification can be increased by either decreasing the SOD value or increasing the SID value.

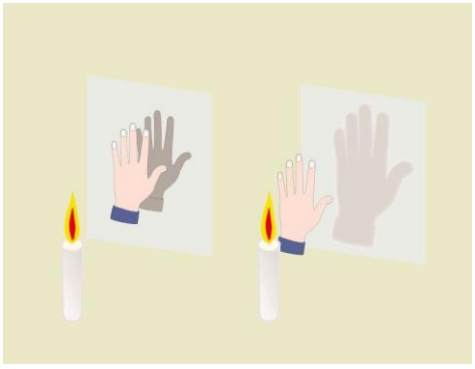


Fig. 9.4 Relationship between SID, SOD, and Magnification Rate

9.2 CT Scanning

CT is an acronym for computed tomography.

CT was originally developed for medical applications, but model inspeXio SMX-225CT FPD HR and others now use CT for industrial applications as well.

Medical CT systems typically have the patient lie down on a bed, which is passed through a gantry containing an internal X-ray tube and detector.

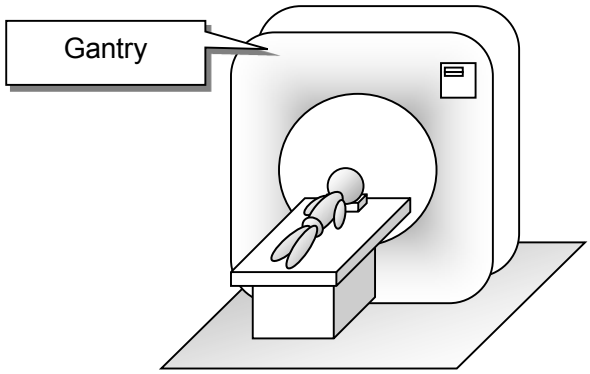


Fig. 9.5 Medical CT System

The X-ray tube and Flat panel detector inside the gantry are positioned exactly opposite from each other, as shown below. The X-ray tube and Flat panel detector are then rotated 360 degrees around the patient to collect X-ray fluoroscopic data from various angles for a particular cross section, from which a cross sectional image (CT image) of the body is calculated.

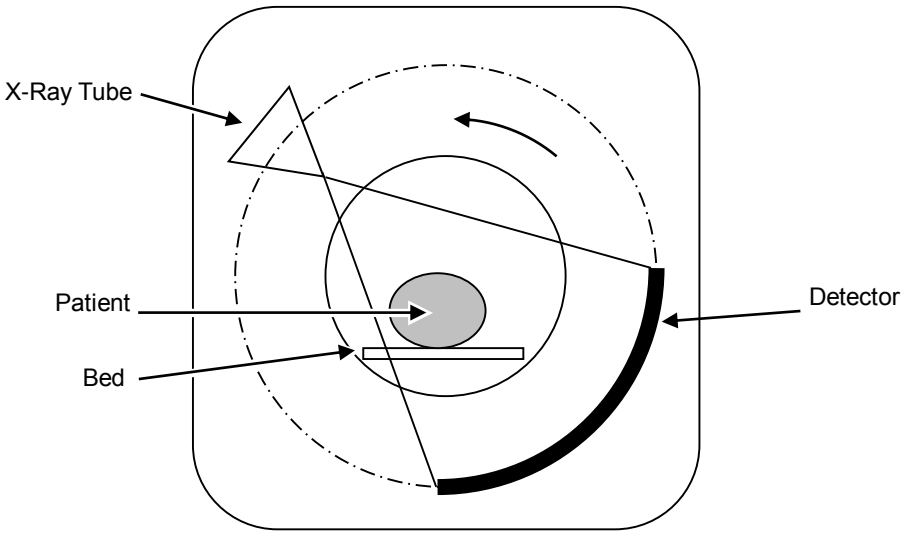


Fig. 9.6 Gantry Configuration

Unlike medical CT systems, the X-ray tube and Flat panel detector in industrial CT systems face each other in fixed positions, with the object being scanned placed in between. X-ray fluoroscopic data is collected from various angles for a particular cross section, while rotating 360 degrees, from which a cross sectional image (CT image) of the object is calculated.

With the CT stage rotated by 360 degrees during X-ray exposure, sample-related X-ray attenuation data collected by the Flat panel detector is referred to as “projection data”. Since the Flat panel detector is continuously acquiring data, different projection data can be obtained for each X-ray exposure angle.

Images obtained from reconstructing sinograms are referred to as a CT images and the method of obtaining CT images is referred to as CT scanning.

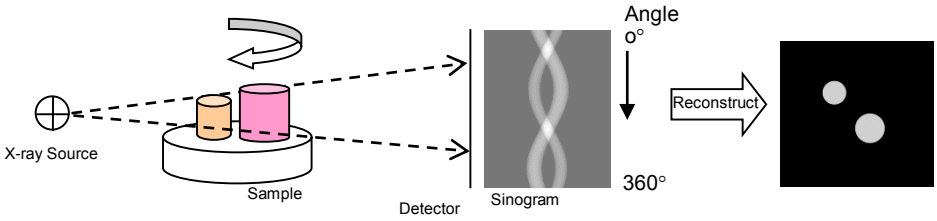
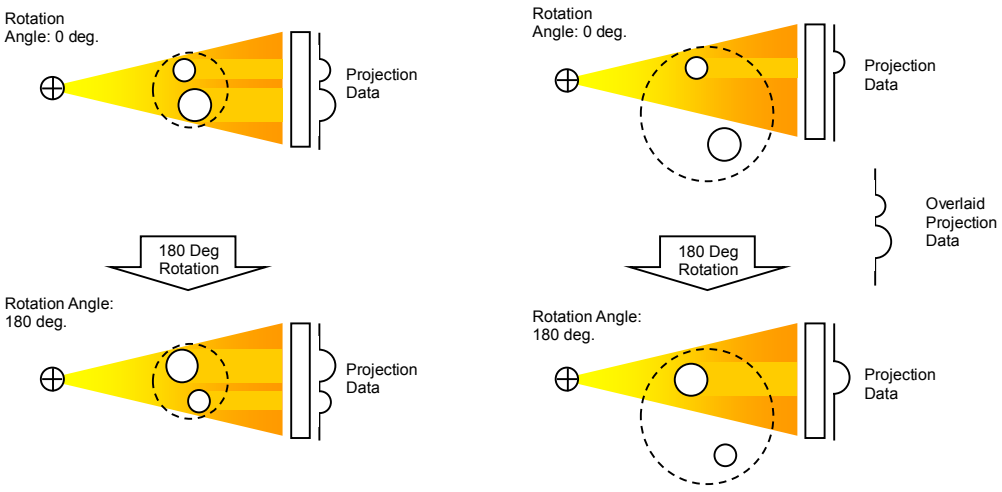


Fig. 9.7 CT Scanning

There are 2 types of CT scan methods, normal scan and offset scan. With a normal scan, the CT stage is rotated by 360 degrees, collecting 360 degrees of projection data. (See Fig. 9.8 (a).) However, like with a normal scan, if the stage's center of rotation is collinear with the X-ray source and detector centers, projection data from the half-rotation between 0 and 180 degrees is redundant with projection data obtained between 180 and 360 degrees.

This scanning configuration by using the projection data rotated by 360 degrees is referred to as normal scanning.

However, if projection data from 360 degrees is acquired with the stage center of rotation shifted away from the line connecting the source and detector centers, and the projection data obtained between 0 and 180 degrees is overlaid with projection data obtained between 180 and 360 degrees, the acquired data will be the same as projection data from normal scanning. In this way the stage center of rotation is offset, and so this scan method is referred to as “offset scanning”. (see Fig. 9.8 (b)).



(a) Normal Scan **(b) Offset Scan**

Fig. 9.8 Overview of Projection Data

9.2.1 2DCT Scanning

The CT image at the same height as the source, calculated from the sinogram, is referred to as a 2DCT scan. This inspeXio64 X-ray CT system is not only able to generate a CT image of the sample at the same height as the source, but is also able to generate a set of three simultaneous cross sectional images, which includes images from slightly above and below the source.

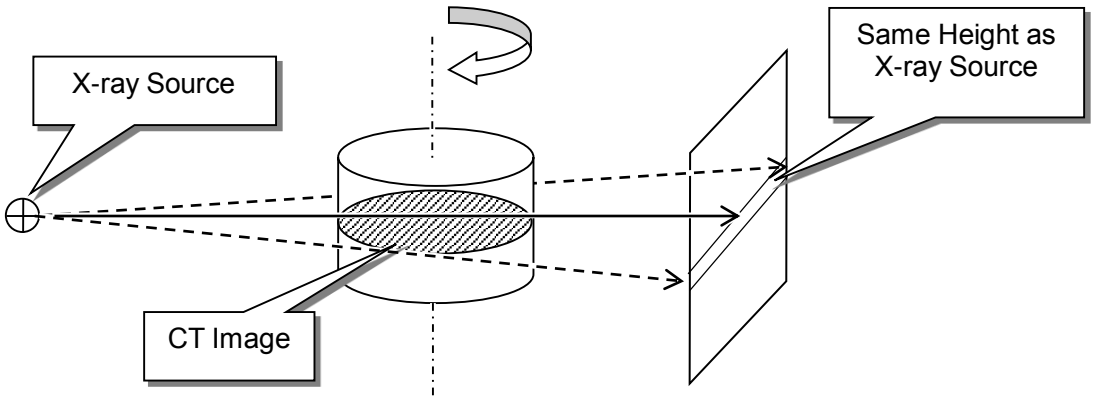


Fig. 9.9 2DCT Scanning

9.2.2 CBCT Scanning

Calculating multiple cross sectional images by simultaneously reconstructing sinograms for multiple lines worth of data acquired using an area sensor, such as I.I. or FPD, is referred to as CBCT (cone beam CT) scanning.

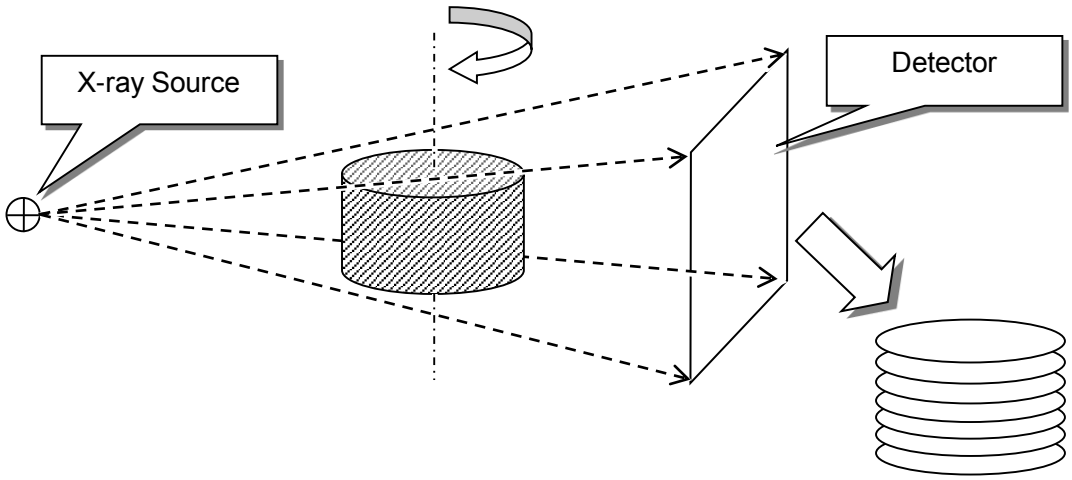


Fig. 9.10 CBCT Scanning

9.3 Normal and Offset Scanning

In general, normal scanning is used when higher magnification is desired and offset CT scanning is used when a larger scan area is desired.

9.3.1 Normal Scanning

Normal scanning is CT scanning with the CT stage rotation center positioned in-line with the source and detector centers.

The CT scan region is the area circumscribed by a circle with radius equal to the shorter of the lines extending from the rotation center of the CT stage that are perpendicular to either edge of the range irradiated with X-rays.

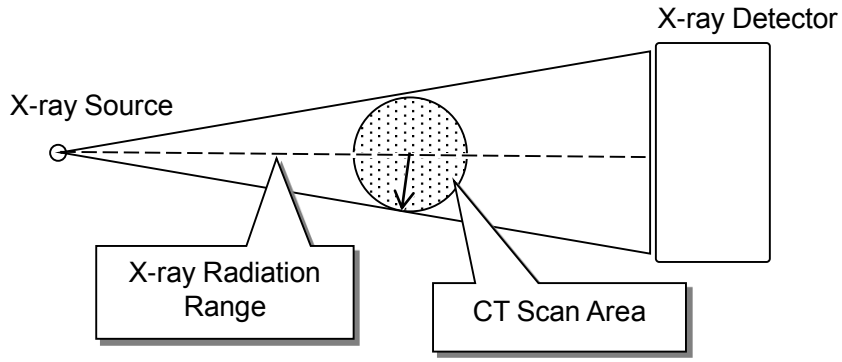


Fig. 9.11 Normal Scanning

9.3.2 Offset Scanning

Offset scanning is CT scanning with the CT stage rotation center shifted out of line with the source and detector centers.

The CT scan region is the area circumscribed by a circle with radius equal to the longer of the lines extending from the rotation center of the CT stage that are perpendicular to either edge of the range irradiated with X-rays.

While this allows scanning a larger area than normal scanning, magnification is reduced.

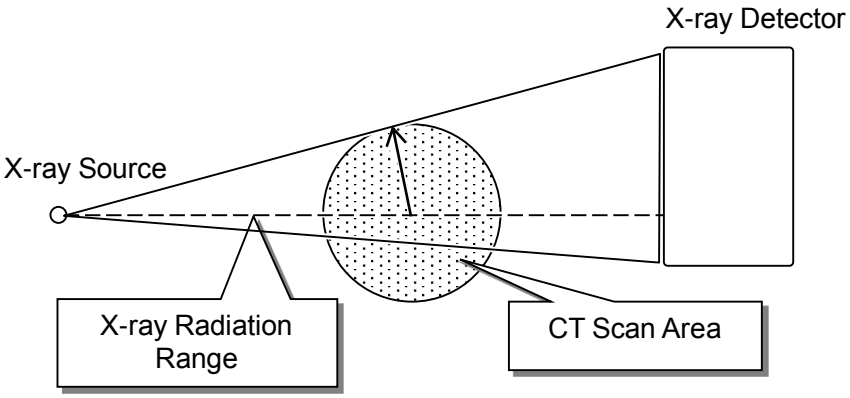


Fig. 9.12 Offset Scanning

9.4 Scan Angle

There is a possibility that the magnification rate for normal scanning can be increased by changing the CT stage angle of rotation.

9.4.1 Full Scan

The CT stage is rotated 360 degrees to collect sample projection data.

Since projection data is obtained from all angles, it allows obtaining more detailed reconstructed CT images.

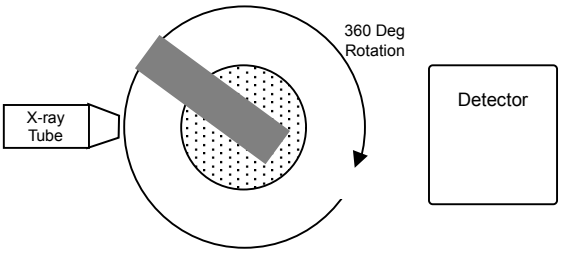


Fig. 9.13 Full Scan

9.4.2 Half Scan

The CT stage is rotated a little more than (to compensate for X-ray emission angle) 180 degrees to collect sample projection data.

The reconstructed CT image quality is not as good as the full scan image, because only half the amount of projection data was collected, but detailed images are obtained because the image is based on real data.

Since samples do not need to be fully rotated, this method is especially useful for achieving high magnification of large samples.

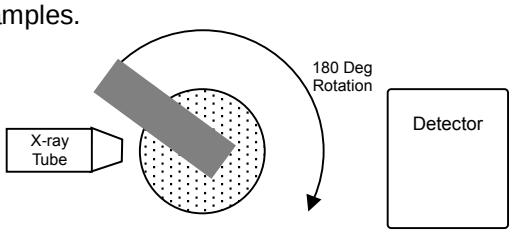


Fig. 9.14 Half Scan

9.4.3 FS Scan (limited angle scan)

The CT stage is rotated 60, 90, and 120 degrees to collect sample projection data.

CT scanning in the full-scan or half-scan modes requires keeping a certain distance between the sample and X-ray tube to prevent them from colliding, but this also prevents obtaining CT scans with higher magnification. However, though limiting the rotation angle means the collected projection data is incomplete and angle-dependent losses will occur, the FS-scan mode offers higher magnification rates by moving the sample closer to the tube and thereby reducing SOD.

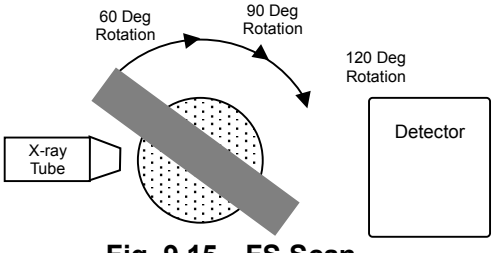


Fig. 9.15 FS Scan

9.5 CR Scanning

An X-ray fluoroscopic image with no distortion in the CT-Z direction can be obtained by acquiring a series of single-line projection data at the same height as the source, as the sample is moved vertically up the CT-Z axis. The resulting image is referred to as a CR image and the method of obtaining CR images is referred to as CR scanning.

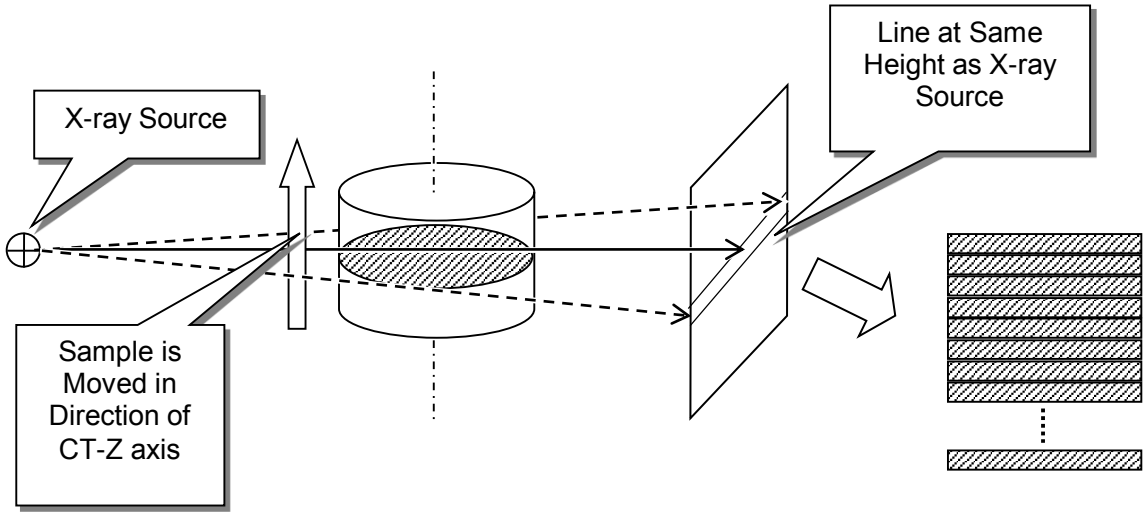


Fig. 9.16 CR Scan

9.6 CT Scanning Parameters

9.6.1 Number of Views

The number of views refers to the number of sets of data acquired as the sample is rotated 360 degrees.

The CT stage angle between adjacent sets of projection data is 360 divided by the number of views. Therefore, increasing the number of views also increases the data acquisition time and data processing time, but improves the spacial resolution of CT images.

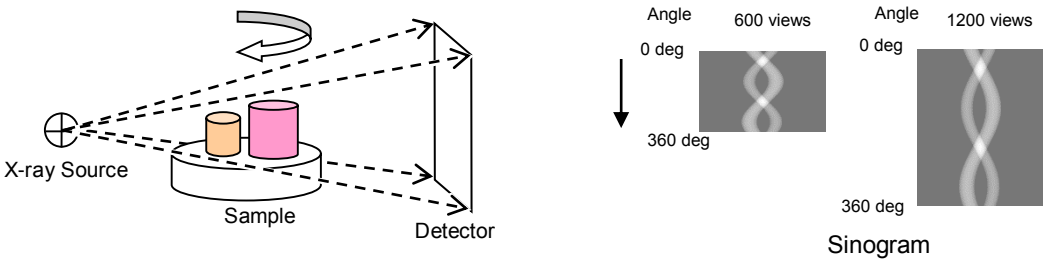


Fig. 9.17 Number of Views

9.6.2 Average Count

The average count specifies the number of times data acquired for each view is integrated.

Increasing the average count increases the time required to acquire data, but improves the S/N ratio and provides CT images with less noise.

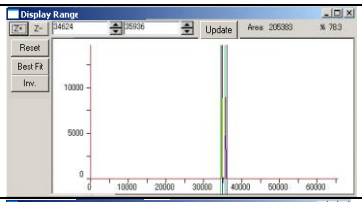
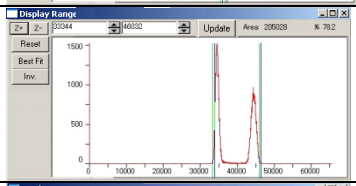
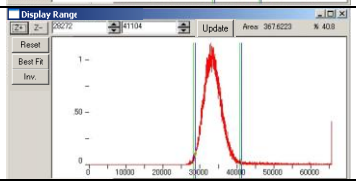
9.6.3 Scaling Coefficient

The scaling coefficient refers to the brightness conversion factor specified to optimize contrast in CT images.

In general, small scaling coefficients are specified for samples with high specific weight.

Large scaling coefficients are specified for samples with low specific weight.

Some reference scaling coefficients are listed below.

When the scaling coefficient is small	A narrow peak is formed near the center of the histogram.	
When the scaling coefficient is optimum	A large peak is formed near the center of the histogram.	
When the scaling coefficient is large	A large peak is formed near the center and a line is formed at the right edge of the histogram.	

9.6.4 Brightness Level and Display Range

Adjusting the brightness level and display range allows displaying input images with pixels of a specified brightness value enhanced.

Image signals from the CT software inspeXio64 have a 16-bit grayscale depth (65536 shades of gray between the lightest and darkest points), but Windows is limited to displaying images using 8-bit depth (256 shades). Therefore, the range of shades represented in 16-bit data must be remapped to values available in 8-bit data. Decreasing the display range increases the apparent contrast.

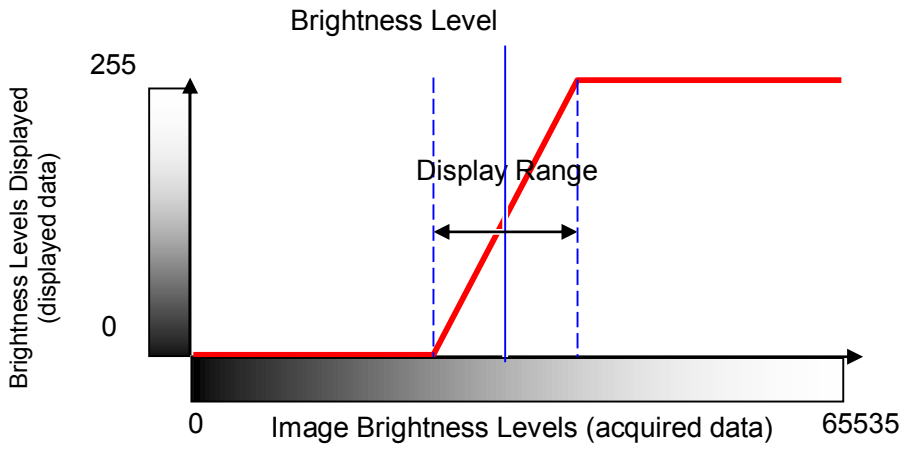


Fig. 9.18 Brightness Level and Display Range

9.6.5 Gamma Values

The function used to convert input images to output images, determined by the specified brightness level and display range values, forms a straight line.

However, this enhancement profile can be varied by specifying a gamma value for the conversion function.

Gamma values greater than 1.0 will result in dark areas appearing brighter and with less contrast.

Gamma values less than 1.0 will result in dark areas appearing darker and with more contrast.

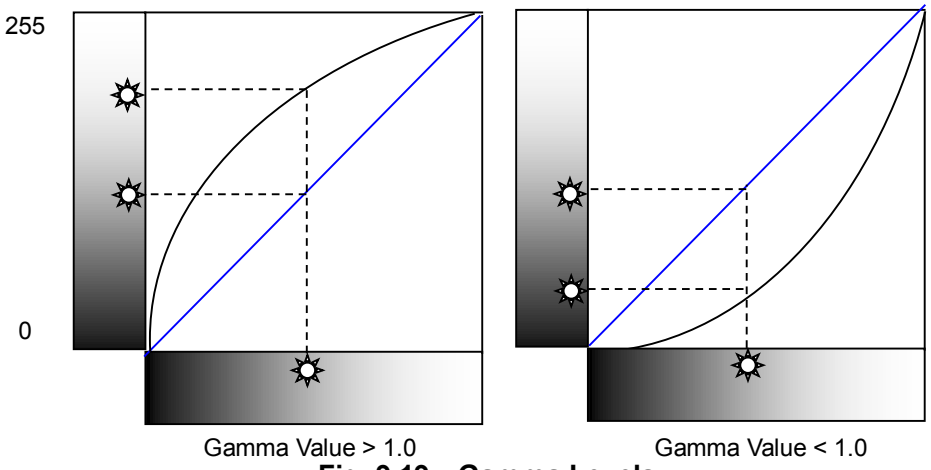


Fig. 9.19 Gamma Levels

10 Specifications

This section describes the specifications of inspeXio SMX-225CT FPD HR.

10.1 System Components

(1)	Microfocus X-ray Generator Unit	1 set
(2)	X-ray detector	1 set
(3)	X-ray Shield Box	1 set
(4)	CT Stage	1 set
(5)	Metal Filter	1 set
(6)	Operation Box	1 set
(7)	Desk/Chair	1 set
(8)	CT Processing System	1 set
(9)	Accessories	1 set
(10)	Instruction Manual	1 set
(11)	Other Accessories	1 set
(12)	Options	1 set

10.2 Main Specifications

10.2.1 Sample Applicability

(1) Max. Sample Size : 400 mm (dia.) ϕ300 mm (H)
(including jig to secure sample)

(2) Max. Sample Weight : 12 kg (including jig to secure sample)

(3) Sliding Door Opening : 500 mm (W) × 550 mm (H)

* In addition to the above-mentioned conditions, it is required for X-ray to penetrate an inspection part of a sample over all the directions using X-ray maximum output. The right result cannot be obtained when the domain which cannot penetrate X-ray is in an inspection part of a sample.

10.2.2 X-ray Generator Unit

(1) Max. Tube Voltage : 225 kV

(2) Max. Tube Current : 1000 μA

(3) Rated Output : 135 W

10.2.3 X-ray detector

(1) Detector Type : X-ray Flat Panel Detector

(2) Active Pixel Number : 3000 pixel × 3000 pixel

(3) Bit Depth : 16bits

10.2.4 CT Scan Functions

(1) Max. Field of View : Approx. 400 mm dia.
(2) Min. Field of View : Approx. 10 mm dia.
(3) Resolution : The exclusive resolution phantom must be resolvable.
*Exclusive resolution phantom : The round stick wrapped around by the film 11 μm thick and the evaporated metal film tape 3 μm thick.

10.2.5 Resolution

(1) Resolution : JIMA (Japan Inspection instruments Manufacturers' Association) RT RC-05 or RC-02 Micro chart of 4 μm is resolved.

10.2.6 Power Supplies

(1) Instrument Power Supply : Single-phase, 200V AC ±10%, 50 or 60 Hz 3kVA
* No sudden voltage fluctuations
(2) Control Computer Power Supply : Single-phase, 100V-120V AC, 50 or 60 Hz 1kVA
* No sudden voltage fluctuations
(3) Ground : 100 ohm max. ground resistance
(4) Power Cord Provided : 11 m power cord
* Only for main body

10.2.7 Size and Weight of Components

Item	Size (mm) * Excluding protrusions	Weight (kg)
Main Unit	W2,170 × D1,350 × H1,857	Approx. 3,100
High-Voltage Transformer	W727 × D417 × H583	Approx. 180
Cooling Water Unit	W530 × D360 × H324	Approx. 40
Operation Desk including monitors, keyboard, mouse, operation box	W1,200 × D700 × H1,270	Approx. 50
Sub Table including control box, control computer	W500 × D500 × H630	Approx. 60
Total		3,430

10.2.8 Paint Colors

Shimadzu standard colors are used.

White :Munsell color system 6.8PB7.9/0.8

Gray metallic :Munsell color system 4.0PB5.6/1.0

Black :Munsell color system N-2

* Standard parts, procured parts, and other parts shall be painted according to the color standards of the respective manufacturers.

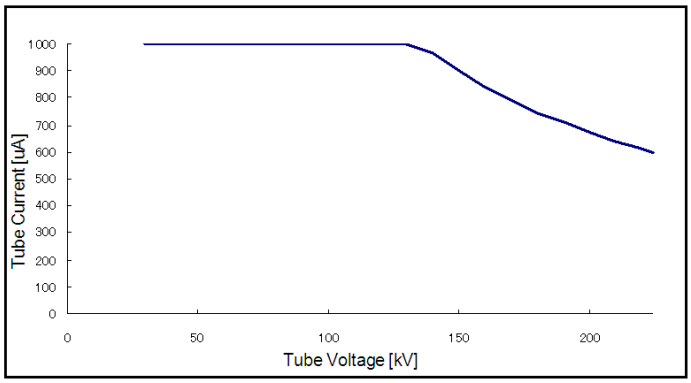
10.3 Main Specifications of Component Units

10.3.1 Microfocus X-ray Generator Unit

(1) Model : MTT-225

(2) Max. Tube Voltage : 225 kV

(3) Max. Tube Current : 1000 μA (Max. 135W)



The Setting Range of tube Current

(4) X-Ray Window : Carbon

(5) Cooling Mechanism : Water-cooled

10.3.2 Flat panel detector

(1) Detector : Flat Panel Detector

(2) Active Pixel Number : 3000 pixel × 3000 pixel

(3) Bit Depth : 16Bits

10.3.3 X-ray Shield Box

(1) X-Ray Leakage (Rate) : Max. 1 μSv/h at the exterior sides of the shield box

(2) Structure : The shield box has a panel design, consisting of a formed steel frame, with iron and lead panels.

(3) Safety Interlocks : Double interlock circuits are provided on the sliding door. X-rays can be irradiated only when these two interlock circuits are activated simultaneously. X-ray irradiation stops immediately when the sliding door is opened during X-ray irradiation. An interlock circuit is also provided on the maintenance door on the side of the shield box. X-ray irradiation stops immediately when this maintenance door is opened during X-ray irradiation.

(4) Peripheral Equipment : X-RAY and READY indicators, sliding door, interior lighting, door safety lock

10.3.4 CT Stage

(1) Max. Applicable Object Size : 400 mm dia. × 300 mm (H)
(including jig to secure sample)

(2) Max. Loading Weight : 12 kg (including jig to secure sample)

(3) Stroke and Max. Speed

Axis of Movement	Stroke	Max. Speed
CT-Z axis	300 mm	15 mm/sec
CT-Theta axis	Free rotation	20 deg/sec
CT-X axis *1	100 mm	10 mm/sec
CT-Y axis *1	100 mm	10 mm/sec
SOD axis *2	Approx. 890 mm	100 mm/sec
SID axis *3 *4	Approx. 400 mm	100 mm/sec
Detector-Y axis	Normal / Offset	----------

*1 XY axis : Movement distance is limited to 50 mm diameter range by software limits.

*2 SOD axis : Source-to-Object Distance

*3 SID axis : Source-to-Image Distance

*4 The SID setting can be switched between two levels, either 800 mm or 1200 mm.

10.3.5 Metal Filter

A metal filter can be carried in the front of a flat panel detector. A metal filter is used to increase the tube voltage used for samples for which X-rays do not penetrate very well. There are three types of metal filters provided, 0.5 mm, 1.0 mm, and 2.0 mm thick.

10.3.6 Operation Box

(1) Operation Box :1 p'ce
(2) Key Switch : Taking out the key can prevent irradiating X-ray by unauthorized people

10.3.7 Desk / Chair

(1) Desk for Control Computer (including sub-table) : 1 p'ce
(2) Chair : 1 p'ce

10.3.8 CT Processing System

< Control Computer >

(1) CPU : Intel Xeon
(2) Memory : 192 GB
(3) Hard Disk Drive : Min. 8 TB
(4) OS : Windows 7 Professional 64bit
(5) Monitor : 27" LCD screen(1920 × 1080 Pixel) × 2 units
(6) Image Storage Media : DVD Super Multi Drive
(7) LAN port : 1000Base-T (internal)
(8) Capture Board : 1 p'ce
(9) Digital I/O Board : 2 p'ces
(10) Keyboard/mouse : 1 each

* The manufacturer, model and specifications of the control computer are subject to change without notice.

*In principle, do not connect the system to the Internet or an intranet. When connecting to the Internet or an intranet, it is essential to purchase and install antivirus software. Note, however, that the "D:＼inspeXio," and data folders must not be included in virus scans. If these folders are included in virus scans, data omissions or other operation trouble might occur.

*If collect data is directly written on an external hard disk drive or a network drive, a problem may occur on this system.

< CT Software inspeXio64 >

(1) Display Language : English
(2) X-ray Control Functions : Tube voltage and tube current settings, X-ray irradiation ON/OFF
(3) Stage Control Functions
(4) Fluoroscopic Exposure Functions : Integrated, subtraction and filter processing, Continuous acquisition processing
(5) CR Scan Function
(6) Image List Display Function
(7) 3D Display Functions : MPR display functions, CT scan area display function, Programmed double-oblique function
(8) FOV Setting Function
(9) X-ray Parameter Setup Function
(10) Acquisition Mode Switching Function
(11) CT Scan Functions

1) CT scan methods :2DCT scan, CBCT scan
2) CT scan modes :Normal scan, Half scan, FS scan, Offset scan
3) 2DCT image size :512 × 512, 1024 × 1024, 2048 × 2048, 4096 × 4096
4) CBCT image size :512 × 512, 1024 × 1024, 2048 × 2048, 4096 × 4096
5) Auto-scaling coefficient setting function
6) Data acquisition time :20 secs to 60 mins
7) Calculation processing time : refer to the following table

Scan Conditions	CT Size	1024 × 1024	1024 × 1024
	No. of View	1200view	1200view
	Scan Angle	Full (360 deg)	Full (360 deg)
	No. of Slice	800 Slice	800 Slice
	Acquisition Mode	Fast	Fine
The time (sec.) that it will take to display CT images since the finish of data acquisition		5 to 10 sec.	20 to 30 sec.

8) Reserved reconstruction function
9) Post-reconstruction function
10) Multi-rotation function
11) Center adjustment function
12) Acquisition data smoothing function
13) DICOM conversion function
14) Recommended scanning function

10.3.9 Accessories

(1) Sample Setting Jig : Each 1 p'ce (extra-large, large, medium and small)
(2) Resolution Phantom : 1 p'ce
(3) Calibration Phantom
- Center Phantom :2 p'ces
- BHC Phantom :1 set (aluminum, resin)

(4) Metal Filter :3 p'ces (0.5 mm, 1 mm and 2 mm)
(5) Accessory Storage Box :1 p'ce
(6) Oil Clay for Securing Samples :1 p'ce

10.3.10 Instruction Manual

(1) Instruction Manual (Basic Operations) : 1 copy
(2) Instruction Manual (Advanced Operations) : 1 copy

10.3.11 Other Accessories

(1) Eye Bolts (M36) : 4 p'ces
(2) Eye Bolt Covers : 4 p'ces
(3) Eye Bolt Storage Box : 1 p'ce
(4) Liners (0.5 mm/1.5 mm) : 6 p'ces each

10.3.12 Options

(1) 2D Image Processing Software Image-Pro Analyzer

(1) ROI type : Linear, rectangle, ellipse, polygon, arbitrary shape supported
(2) ROI processing : Average, max., min., standard deviation, area, profile
(3) Image enlargement : 0.1 / 0.25 / 0.5 / 1 / 2 / 4 / 8 / 16X supported
(4) Size measurement : Distance, angle
(5) Printing : Image information is output in report format together with distance scale(It has a printer as an optional extra).

In addition to the functions listed above, Image-Pro Analyzer has a wide variety of 2D image processing functions.

(2) 3D Image Processing Software VGStudio

VGStudio is advanced 3D image processing software capable of volume rendering display in almost real time. The display of the 3D image can be adjusted in various ways, for example, rotated and tilted at arbitrary angles, with limited display (internal cross-section display) applied, with contrast enhanced, or with display lighting adjusted. The MIP (Maximum Intensity Projection) display function is also supported.

Do not operate other software, during operating VGStudio. The image processing cannot work correctly.

(3) 3D Image Processing Software VGStudioMAX

This is an advanced version of VGStudio, the 3D display software. VGStudioMAX features the following functions that have been added on to VGStudio:

- ROI area extraction function
- Image filter function
- Volume data positioning function
- Animation generator function
- 3D measurement function
- Various statistical processing functions
- Polygon extraction function
- STL data export function

Do not operate other software, during operating VGStudioMAX. The image processing cannot work correctly.

10.4 Layout Diagram

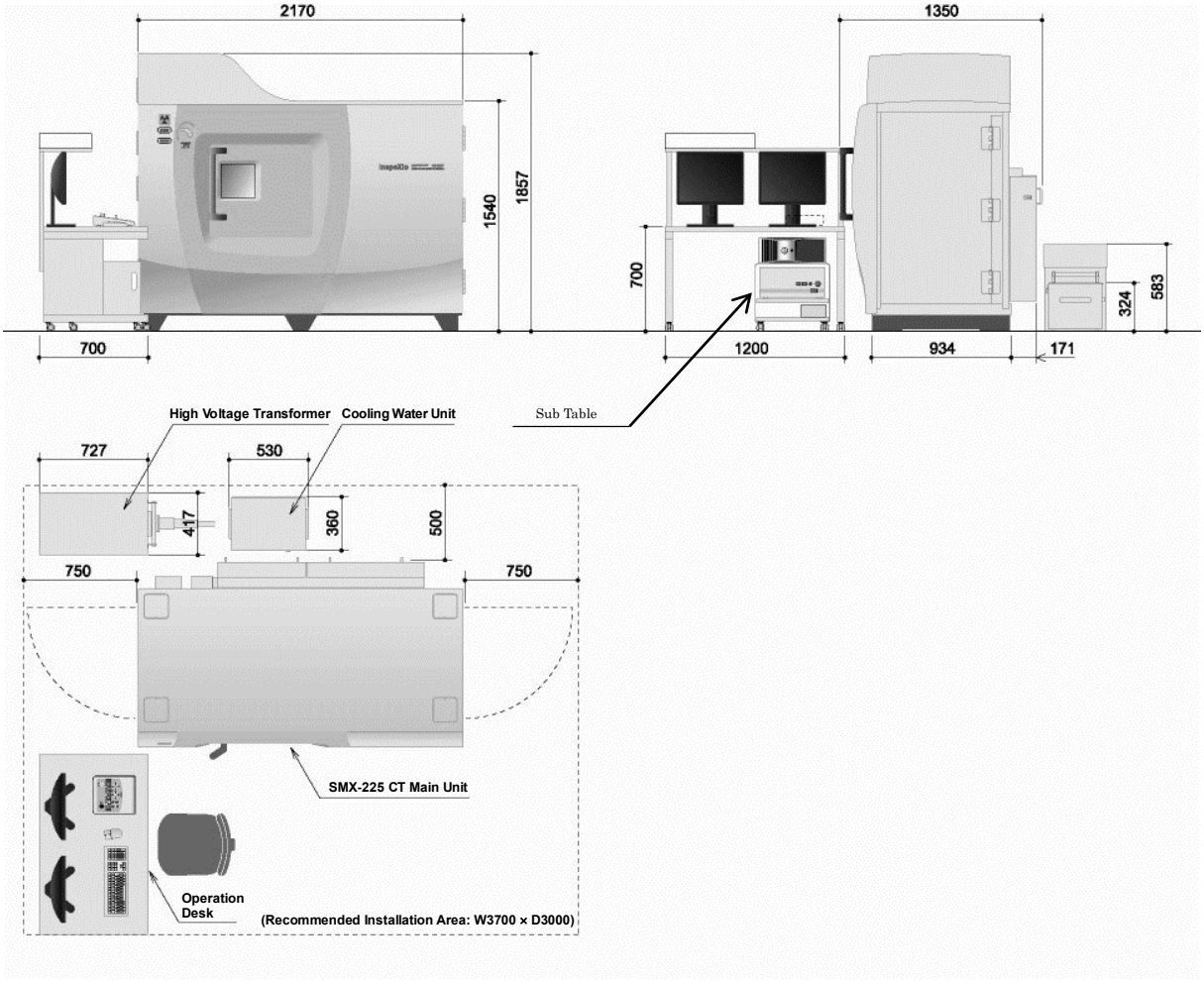


Fig. 10.1 Layout Diagram

2

A

B

C

D

E

F

H

I

L

M

N

O

P

R

S

T

V

W