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Revision 2

GE HEALTHCARE
eXplore CT 120 User Guide

http://www.gehealthcare.com

Revision History

Revision History		
Effective Date	**Revision**	**Nature of Change**
Aug 27 2008	0	Draft
Oct 16, 2008	1	CT 80 references deleted, typos corrected, system diagrams changed, x-ray tube voltage corrected to 120 kVP, ROI description improved, trash can description improved
Nov 28, 2008	2	Added CT Scout to Glossary. Other minor changes

Before You Begin

This Guide documents GE's eXplore CT 120. It is only intended for use by qualified personnel who have received training on its operation by GE. No part of the eXplore CT 120 may be used in a manner not specified by the manufacturer.

This Guide is periodically updated. Please ensure you are using the most current version by checking the Common Documentation Library (CDL) at:

http://apps.gehealthcare.com/servlet/ClientServlet?REQ=Enter%2bDocumentation%2bLibrary

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Chapter 1
Safety & Regulatory Information

Section 1.1 Introduction

This chapter explains important safety information about your GE Healthcare eXplore CT 120. Please read it carefully before working with the machine. Pay special attention to the section on radiation safety.

1.1.1 Intended Use

This device is designed and intended for use by those operating the device for research purposes only. It is not intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease in humans or animals.

1.1.2 Compliance

GE Healthcare eXplore Series CT scanners are compliant with the United States Radiation Control for Health and Safety Act (Title 21, Code of Federal Regulations, Subchapter J) as they pertain to Cabinet X-Ray Systems (21 CFR 1020.40), FDA Report accession number 0212737-0, and Canadian RED Regulations C.R.C., c. 1370.

This product is also CSA (Canadian Standards Association) certified for both the U.S. and Canadian markets, to the applicable American and Canadian standards for safety and performance.

Certificate #/Project #: 1840634

Master Contract: 219225

Date Issued: 2007/01/08

Installation Category II, Pollution Degree 2

1.1.3 Contacting GE Healthcare

Toll Free:	1-800-526-3593
Email:	PCIServiceEngineering@ge.com
Website:	http://gehealthcare.com/preclinical_imaging
Mail:	GE Healthcare 1-1510 Woodcock Street London, ON, Canada N6H 5S1

When contacting GE Healthcare, please provide the following:

- System serial number
- Table computer log files - found in C:\Inukshuk\Logs
- CT computer log files - found in C:\Program Files\GEHC\Logs and C:\Inukshuk\Logs
- SPECT computer log files - found in C:\Program Files\GEHC\Logs and C:\Inukshuk\Logs
- Console computer log files - found in /var/log/GEHC.

1.1.4 Product Description

The eXplore CT 120 is a pre-clinical x-ray Computed Tomography (CT) scanner for small animals. The eXplore CT 120 hardware and software platform is optimized for small animals in pre-clinical and research applications.

Section 1.2 Safety Warnings

1.2.1 Standard Hazard Icons

Several different graphical icons (symbols) are used to make you aware of specific types of hazards that could possibly cause harm.

ELECTRICAL

MECHANICAL

RADIATION

LASER

HEAT

PINCH

Some others make you aware of specific procedures that should be followed.

AVOID STATIC ELECTRICITY

TAG AND LOCK OUT

WEAR EYE PROTECTION

1.2.2 IMPORTANT! X-RAY PROTECTION

DANGER

X-ray equipment, if not properly used, may cause injury. Accordingly the instructions herein contained should be thoroughly read and understood before you attempt to place this equipment in operation. The General Electric Company, Medical Systems Division, will be glad to assist and cooperate in placing this equipment in use. It is important that everyone having anything to do with x-radiation be fully acquainted with the recommendations of the National Council on Radiation Protection and Measurements as published in NCRP Reports available from NCRP Publications, 7910 Woodmont Ave., Bethesda, MD 20814, and of the International commission on Radiation Protection, and take adequate steps to ensure protection against injury.

RADIATION SAFEGUARDS

The GE eXplore CT 120 utilizes a radiation emitting x-ray source and complies with US and Canadian cabinet x-ray standards (as detailed above) which allow the system to be safely operated without additional x-ray shielding. The x-ray tube, using a rotating anode, has a maximum tube potential of 120kVP and a tube current of 125mA.

The source and scanning area is completely shielded during X-ray operation. The system is manufactured with redundant mechanical and electronic safety systems that prevent X-ray output any time the scanning door is opened. X-rays cannot be generated at anytime during access to the specimen bed or scanning area. The X-ray tube power may only be switched on from the acquisition computer console. X-rays may only be generated if the scanner door is closed and the X-ray Reset button has been reset. Radiation measurements are taken from the scanner at the time of manufacture to confirm that the maximum exposure level 2 cm from any accessible surface is less than or equal to 0.5 mR/h.

1.2.3 Operating Recommendations

The CT 120 system may only be operated by users who have received training from qualified individuals. Prior to or upon installation of the unit, the facility health and safety or radiation officer must be notified of the presence of the scanning equipment. The user must follow all rules and regulations which govern the use of this class of radiation emitting equipment at the facility in which the unit operates. This may include:

- Use of radiation monitoring devices
- The display of additional radiation markings or labels on the equipment or the area of use
- Additional x-ray safety training for users as required by the facility
- Registration of the system with local/state/provincial et. al. authorities that govern radiation protection for non-human use.

Users must not remove or modify any labels or markings which identify the unit as a radiation emitting device. Users must not tamper with or modify any electronic or mechanical systems within the scanner as this may change the functionality of the system and will void the system warranty. If the system has been modified or damaged in any way, the use of the scanner must be discontinued and GE Healthcare contacted immediately.

1.2.4 Moving Parts

CAUTION

To prevent pinching or crushing, keep your hands away from the edge of the moving table top/cradle and its surrounding equipment, or between the table base and the table's side panels.

To prevent pinching or crushing, watch the equipment at all time during table movement.

If unwanted motion occurs or motion does not stop, press one of the Emergency Stop buttons.

1.2.5 Electrical Safety

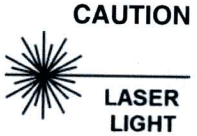
CAUTION

This unit is powered via a Power Panel. To avoid electric shock, disconnect the input power to the CT 120 before servicing.

1.2.6 Laser Safety

CAUTION

The laser beam can cause eye injury.



The lasers can be turned off from the Tableside Controller. Always take care to avoid looking into the laser beam.

1.2.7 Maintenance & Cleaning Instructions

The device does not require any customer performed maintenance other than cleaning as described below. All other maintenance must be performed by trained and qualified technicians.

CLEANING INSTRUCTIONS

The device should be located in a clean, low dust, laboratory environment. Typically, no cleaning should be required other than removing excess dust from the exterior of the device and control units.

The device can be cleaned by wiping it with a soft cloth, which can be lightly dampened with water as required.

WARNING ***DO NOT under any circumstances use domestic or industrial cleaning products and DO NOT spray any liquid, including water, onto any surface of the control units, scanner or into the interior of the scanner.***

CLEAN EQUIPMENT (BIO HAZARD)

CAUTION **Blood Bourne Pathogens Procedure**

Before any equipment is serviced or returned to GEMS, the following criteria must be met:

- Equipment used in a clinical or laboratory setting must be clean and free of any blood and other infectious substances.
- *Customers are responsible for the sanitary condition of the equipment.* The suggested equipment clean-up procedure for cleaning any fluids or matter discovered inside the equipment is as follows:
  - Wear personal protective equipment.
  - Wear proper Nitrile gloves.
  - Before cleanup take note of any sharp corners or objects that could cut the gloves. If gloves tear, remove, wash hands thoroughly and re-glove.
  - Use cloth or paper towels along with cleaner, taking care not to splash the material.
  - Sanitize the area using common bleach diluted 10:1 or a product listed under Approved Cleaning Products below. Clean any tools that came in contact with a body fluid.
  - Since viruses require moisture to remain active, dry the entire area using a heat gun or hair dryer.
  - When confident the area is clean and dry, place used cleaning materials in a red biohazard bag.
  - Remove gloves, turning them inside out, and put gloves in the biohazard plastic bag. Seal and give the bag to appropriate personnel for proper disposal.

Approved Cleaning Products:

- Common household bleach - dilute 10:1
- Fullsan 128 Neutral Germicidal Detergent - dilute 1 oz to 1 gal Fuller Brush Company: phone number 1-800-438-5537
- Wavecide 6 Disinfectant Spray - use full strength Edwards Medical: phone number 1-800-837-7000

DECOMMISSIONING EQUIPMENT

Waste Electrical and Electronic Equipment (WEEE)

ENG This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.

FRA Ce symbole indique que les déchets relatifs aux équipements électriques et électroniques ne doivent pas être jetés comme les ordures ménagères non-triées mais doivent être collectés séparément. Contactez un représentant agréé du fabricant pour obtenir des informations sur la mise au rebut de votre équipement.

GER Dieses Symbol kennzeichnet elektrische und elektronische Geräte, die nicht mit dem gewöhnlichen, unsortierten Hausmüll entsorgt werden dürfen, sondern separat gesammelt werden müssen. Bitte eine autorisierte Vertretung des Herstellers kontaktieren, um Informationen hinsichtlich der Entsorgung des Gerätes zu erhalten.

ITA Questo simbolo indica che i rifiuti derivanti da apparecchiature elettriche ed elettroniche non devono essere smaltiti come rifiuti municipali indifferenziati e devono invece essere raccolti separatamente. Per informazioni relative alle modalità di smantellamento delle apparecchiature fuori uso, contattare un rappresentante autoriuato del fabbricante.

SPA Este símbolo indica que el equipo eléctrico y electrónico no debe desecharse con 10s residuos domésticos y debe tratarse por separado. Contacte con el representante local del fabricante para obtener más informacion sobre la forma de desechar el equipo.

SWE Denna symbol anger att elektriska och elektroniska utrustningar inte får avyttras som osorterat kommunalt avfall och måste samlas in separat. Var god kontakta en auktoriserad tillverkarrepresentant för information angående avyttring av utrustningen.

1.2.8 Access and Installation

GE Healthcare-trained installation professionals will install this device for you. DO NOT under any circumstances attempt to install or activate the device prior to the installation provided by GE Healthcare.

Chapter 2
CT Basics

Section 2.1 CT Scanning Basics

This chapter introduces the concepts of CT imaging. This chapter contains

- The terminology used throughout the Guide
- Basic concepts to help you understand CT imaging
- The fundamentals of CT image creation

2.1.1 Glossary

The following contains a glossary of terminology used in this Guide that may be unfamiliar to some users.

acquisition	Acquisition is the process of acquiring CT images, i.e. scanning.
ADUs	When x-ray particles hit the detector screen, the intensity of those particles is measured and converted to a number. This number is given in Arbitrary Digital Units. The ADU values form the data set, which is used in the calculation of the reconstructed volume.
axial	Parallel to the z-axis; in the direction of the z-axis. See *trans-axial.*
beam hardening	Beam hardening occurs when the x-ray beam passes through dense material. The dense material acts in the same way as a filter, and removes low voltage photons from the x-ray beam. Beam hardening takes the form of a "cupping" artefact, where the centre of a solid object appears less dense than the edges.
binning	Binning is a process of grouping pixels together into a single data unit. The pixel values are added to form the new value.
calibration object	An object with known attenuation properties that is scanned at the same time as a specimen. Using a calibration object allows you to calibrate the Hounsfield scale correctly.
center of rotation	The z-axis of the reconstructed three-dimensional volume.
cradle	The apparatus that holds a specimen for scanning.
CT	Computed Tomography - a means of acquiring x-ray transmission measurements through an object for the purpose of reconstructing a tomographic image of the animal's anatomy.

CT value	ADUs are converted to CT values during the reconstruction process. ADUs are units used only by the eXplore CT system. CT values, given in Hounsfield units, are a standard scale in CT imaging. By calibrating the CT values in Hounsfield units, you can communicate meaningful data about the attenuation properties of a specimen.
CT Scout	A CT scan showing the entire field of view from the top and one side. This allows a region of interest (ROI) to be defined before executing a final CT scan.
current	Current refers to the intensity, or amount, of photons in an x-ray beam.
DICOM	Digital Imaging and COmmunications in Medicine.
fan angle	The angle of the fan beam.
fan beam	This is the x-ray beam. It is actually in the shape of a cone, but when it is represented in two dimensions it is in the shape of a fan.
FBP	Filtered Back-Projection.
filtering	The process of removing photons of low energy from the x-ray beam. Filtering does not remove all low voltage photons, but it reduces them to a statistically insignificant number. The resulting beam is less easily attenuated than the original, and is less susceptible to beam hardening.
FOV	Field Of View.
gantry	An assembly that includes both the x-ray tube and the detector.
HU	Hounsfield Units.
keV	kilo electron Volts.
kV	kiloVolts
level	The Level setting determines which CT value gets mapped to 50% brightness.
mA	milli Amps.
PDU	Power Distribution Unit.
pixel	A pixel is a picture element. It is a single piece of data in a two-dimensional image.
reconstruction	Reconstruction is the process of converting many single projections taken during the same scan into a single three-dimensional volume.
resolution	Resolution refers to the minimum size of a structure that can be distinguished in a CT image.
ROI	Region Of Interest.

sagittal	Pertaining to the sagittal suture, the midline of the skull. In an animal-centric coordinate system, pertains to vertical plane bisecting the animal. By shorthand convention, it is usually taken to be the Y-Z plane in the scanner coordinate system.
scan	A scan is a series of projections taken of a single specimen. Each scan belongs to only one subject.
SNR	Signal-to-Noise Ratio. Signal is useful data, and noise is non-useful data. An important consideration in imaging is balancing the ratio between signal and noise.
specimen	A specimen or animal is what you scan.
trans-axial	A plane that is normal to the z-axis; a line or direction that is perpendicular to the z-axis.
VOI	Volume of Interest.
voltage	Voltage refers to the potential difference between the cathode and the anode. An x-ray beam with high energy is created when the potential difference is high.
voxel	A voxel is a volume element. It is a single piece of data in a three-dimensional image.
window	The Window setting determines how many of the values in the dataset get mapped from 0 to 255 (black to white).

Section 2.2 Definitions of Basic Concepts

The following sections describe some basic concepts related to creating a projection of a specimen using x-rays.

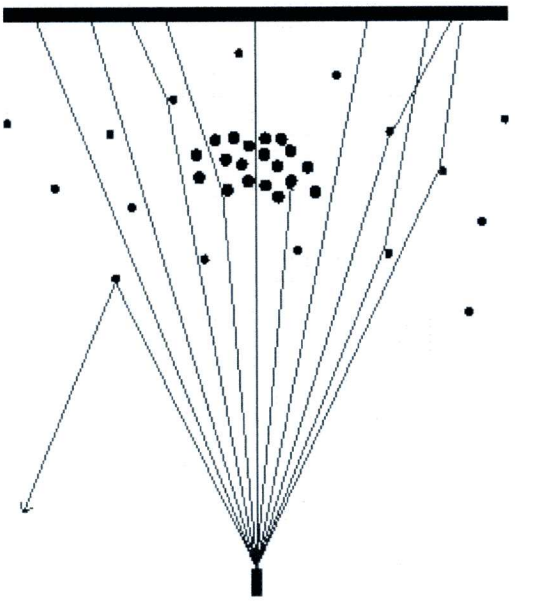
It describes some concepts that will help you to understand the choices that are available to you when you set up and perform a scan.

2.2.1 Attenuation

The attenuation coefficient can be understood as the x-ray

stopping power of an object.

When x-rays pass through an object, the object attenuates the beam. This means that the beam of x-rays is reduced in intensity as individual photons are absorbed or scattered by the object. The process is similar to the way that light passes through a translucent object. If light is shone through glass, most of the light comes through to the other side. Very little is absorbed or scattered by glass. If light is shone through thick fabric, only a small amount of light will come through. The rest will be reflected back, absorbed, or scattered.



Particles in the specimen in the surrounding medium can deflect x-rays. Notice how some x-rays pass through the particles directly, some are deflected slightly, and some are deflected considerably.

Different materials have different **attenuation properties**. Bone, a dense material, has a high attenuation coefficient. X-rays will lose a great deal of intensity when they pass through bone. Fat, a low density material, has a low attenuation coefficient. X-rays will not lose much intensity when they pass through fat.

Attenuation varies directly with the atomic weight of the substance being subjected to x-rays. The atomic weight is generally related to material density.

2.2.2 Scatter

The x-ray beam, the specimen, and even the air surrounding the specimen all consist of particles. These particles interact in a manner similar to billiard balls on a table. The x-ray particles are moving in a straight line, and the object particles fixed in position. When the x-rays go towards the object, some of the x-ray particles miss and pass through empty space, some of them hit object particles and are deflected slightly, and some of them hit object particles and bounce back. The x-ray particles that pass through are detected. The particles that hit and are deflected are also detected, but they are a form of noise that we call *scatter*.

Every projection contains a small amount of scatter noise.

Section 2.3 CT Image Creation Basics

The basic concepts behind digital imaging are introduced below. Understanding these concepts will help you to make useful choices when you are setting up scans and reconstructing volumes.

It is important to understand that both the projection that is created with the GE eXplore CT 120 and the reconstructed volume that is created using Reconstruction **are representations** of the structure that the x-ray beam passed through. It is therefore important that you understand how both projections and reconstructions are created, so that you can choose the optimal settings.

2.3.1 Analog vs. Digital

One difference between a CT scanner and a conventional clinical x-ray machine is the detector. A clinical x-ray setup uses a film screen as a detector. The x-rays pass through the object, hit the film, and create a projection. Each photon that hits the film causes an effect on that film. The degree of exposure of the film is directly related to the sum of the energies of the x-rays that hit the film at that point. The projection created on film is a photo-chemical representation of the object, and the brightness of the film can have a continuous range of values.

In digital image creation, each photon hits a detector, which is divided into discrete receptor units. It is useful to think of each unit as a sort of bucket which slowly becomes filled with the photons emitted by the x-ray tube. The energy of the photons in each of these buckets is measured, and a numerical value is assigned to that energy. Because of the inability of the computer equipment to deal with a continuous range of values, the values are digitized. The projection that is created is a representation of the object as numerical data.

2.3.2 ADUs, CT Number, and Hounsfield Units

When the first projections are created, the values of the pixels are given in ADUs. ADU stands for Arbitrary Digital Units, and it is a scale that is particular to the eXplore CT system. The same material may be given a different ADU value in a different scan, because the scale is particular to each scan and changes depending on the materials scanned and on the strength and intensity of the x-ray beam.

When a volume is first reconstructed, the ADUs are converted to CT values. The CT value is a number that represents the attenuation coefficient of a particular voxel in the reconstruction. CT values should be given in Hounsfield units (HU), but the Hounsfield scale has specific known values for air and water, and the scale must be calibrated properly, using actual air and water (or equivalents) in a specific scan as reference points.

2.3.3 The Hounsfield Scale

- Air is -1000 HU
- Water is 0 HU
- Fat is approximately -150 HU
- Compact bone is approximately 3000-4000 HU
- Ethyl alcohol is -700 HU

Until the scale is properly calibrated, the CT numbers are not given in HU.

2.3.4 Pixels and Voxels

A **pixel** is a **pic**ture **el**ement. It is a single element in a two-dimensional image. Images are made up of an array of individual pixels. Each pixel has a numerical value. In MicroView, each pixel is represented by a shade of gray.

A **voxel** is a **vo**lume **el**ement. It is a single element in a three-dimensional image. As with pixels, each voxel has a numerical value. In MicroView, each voxel is represented by a shade of gray on the screen.

2.3.5 Resolution

The resolution of an image refers to the smallest structure that can be discretely represented. If the resolution of an image is 25 microns (µm), then any structure smaller than 25 µm will not be distinguishable.

It is important to note that resolution and pixel/voxel size are separate. Pixel/voxel size is defined as the amount of space represented by each pixel or voxel. Resolution is limited by pixel size, but many factors will cause resolution to be larger than pixel/voxel size.

Factors that affect resolution include the pixel/voxel size, the signal-to-noise ratio, the immobility of the subject during scanning, and the x-ray tube properties.

2.3.6 Signal-to-Noise Ratio (SNR)

Signal is useful information, and noise is non-useful information. In general, the SNR can be positively affected by choosing a higher binning setting, using a filter, and performing some frame averaging.

With digital imaging, considerable control is given to the user to affect the SNR.

To understand how the SNR in the CT system is affected by scanning parameters, let the number of x-ray photons collected by each detector pixel for an image be **n**. Signal strength in the image increases linearly with **n**, while noise in the image generally increases with the square root of **n**. Therefore, in order to increase the SNR by a factor of two, **n** must be increased by a factor of four. This can be accomplished by increasing the binning by a factor of two in each direction (e.g., from 2x2 to 4x4), by averaging four frames together, or by increasing the current by a factor of four, although this latter technique is generally not feasible.

2.3.7 Binning

Binning is a process of adding the values of neighboring pixels together to produce a new pixel in a reduced-resolution image.

Binning is sometimes called *pixel ganging*. Using this technique improves the signal-to-noise ratio. In general, noise is scattered evenly throughout an image, but signal is concentrated in specific areas. By adding pixel values together, the effect of noise on the pixel values is reduced, and the effect of signal is increased.

5	2
8	4

The value of this 2 x 2 bin is 19.

In the above example, the bin mode 2x2 is chosen. In the case of a 2x2 bin, 4 pixels are ganged together and considered as a unit ("2 x 2" refers to the dimensions of the matrix).

The CT numbers of the 4 pixels in the illustration to the right are 5, 2, 8, and 4. In 1x1 mode, 4 pieces of data would be stored. In the 2x2 mode shown, only one piece of data, the sum of the 4 pixels, is stored. The values of the 4 pixels are added together (not averaged) and this sum is recorded as a single piece of data. The value of the 2x2 matrix shown is 19.

2.3.8 Frame Averaging

Frame averaging is a process whereby several frames are averaged into a single file. The effect is similar to that of a film camera when a long shutter interval is used in combination with slow film.

Frame averaging is one method for improving the SNR. In general, noise is scattered evenly throughout an image, but signal is concentrated in specific areas. By increasing the total number of photons used to create a single view, a more reliable image is created.

Chapter 3
The eXplore CT 120 System

This chapter describes the individual hardware and software components of the GE eXplore CT 120, and briefly explains the purpose of each.

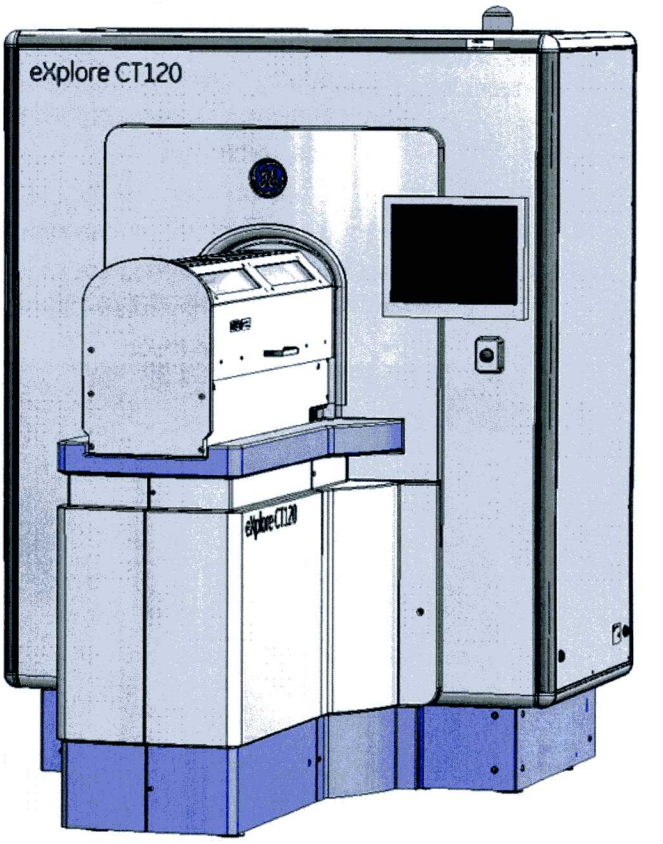
Section 3.1 Hardware

OVERVIEW

The **eXplore CT 120** is a pre-clinical x-ray Computed Tomography (CT) scanner for small animals. It is designed specifically for routine and high quality scanning for a number of applications.

The CT 120 utilizes a large Field Of View (FOV) and cone beam reconstruction. This provides high throughput, non-invasive, high resolution, isotropic imaging where users may precisely identify the location of an abnormality related to the surrounding anatomical structure.

The system can perform prospectively-gated respiratory and cardiac imaging and has shielded ports for ventilation tubing, anesthetic gases, or monitoring hardware. In addition, the scanner is fully shielded for laboratory use.



KEY SCANNING FEATURES

- Acquisition time: typically 1 to 15 minutes for entire volume, depending on scan protocol
- CT data may be acquired with full 360° or half scan
- Pre-configured & user-defined protocol selections
- Live Fluoroscopic viewing for animal positioning
- Large field of view
- Scout view imaging
- Prospective cardiac and respiratory gating.

ACQUISITION MODES

The system supports the following acquisition modes:

- Static planar imaging with or without table motion (acquires a 2 dimensional image from one projection angle),
- Dynamic planar imaging (observe the motion of a radioactive tracer through the body through the acquisition of a series of planar images of the specimen over time).

CT PARAMETER CONTROLS

The CT system provides the operator with control of the following parameters:

- X-ray tube voltage and current

  The voltage, measured in kVp, controls the energy of X-ray beam. The current, measured in micro/milli Amperes (uA/mA), controls the intensity of the x-ray beam.
- Exposure time

  Exposure time is the amount of time that the camera will be exposed to the x-rays
- Number of views

  The number of views represents the number of projections which will be acquired during the scan.
- Angle of increment

  The value represents the increment measured by degrees between one view and the next.
- Scan technique
  - Short scan

    The gantry rotates approximately 200 degrees.
  - Full scan

    The gantry rotates through an entire 360 degree rotation
- Detector bin mode

  The system provides detector bin modes of 1x1, 2x2 and 4x4.

Gated acquisition is used when the imaging of interest involves a periodic process such as cardiac and/or respiratory motion. The start of each period is defined by an incoming trigger. The CT system supports the gating triggering from:

- ECG triggers
- Respiratory triggers.

3.1.1 CT 120 System Components

CT'S ROTATING GANTRY

The CT scanner assembly consists of an x-ray generator and tube, and an x-ray detector with data acquisition electronics. The CT 120's CT scanner's x-ray tube has 120 kV maximum tube voltage. It comes with complete system shielding with interlocks suitable for lab use.

X-RAY GENERATOR

The 120kV maximum tube voltage system comes with an X-Ray Generator that is positioned beside the CT 120 table. The X-Ray Generator supplies electric power to the X-ray tube; a key function of which is the rectification of line voltage to produce a smooth direct current voltage to the X-ray tube.

SPECIMEN TABLE & CRADLE

The computer-controlled, motorized scanning table provides precise specimen positioning features, including live fluoroscopic viewing (2-D image) through the operator console.

The table is designed to support tubing management, animal physiological monitor leads, and animal life supporting systems such as a heated bed. It comes with 2 carbon fiber animal cradles:

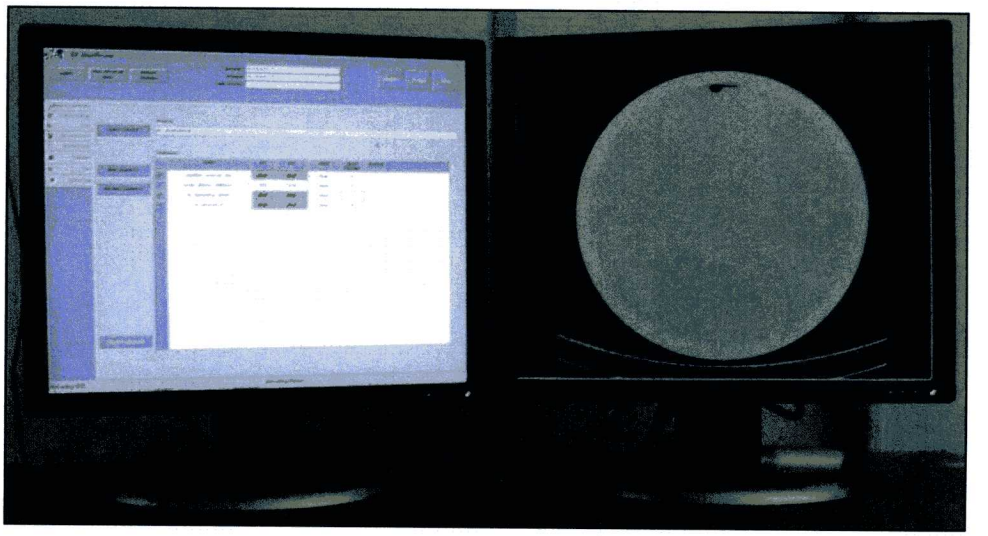
- Rat: 75 mm width
- Mouse: 25 mm width.

TABLESIDE CONTROLLER

User controlled table motion (versus automated motion driven by the system) is available via the Tableside Controller. The Tableside Controller is the touch screen panel mounted above the Table. This interface is used to set and position the specimen cradle.

OPERATOR CONSOLE

All scan acquisition and analysis functions are controlled from the Operator Console. The Operator Console consists of 2 LCD display monitors and a host computer.



3.1.2 Optional Components

PCI ANALYSIS WORKSTATION

A PCI analysis workstation is available for user's applications (separate from the Console) The functionality on the PCI analysis workstation includes the following:

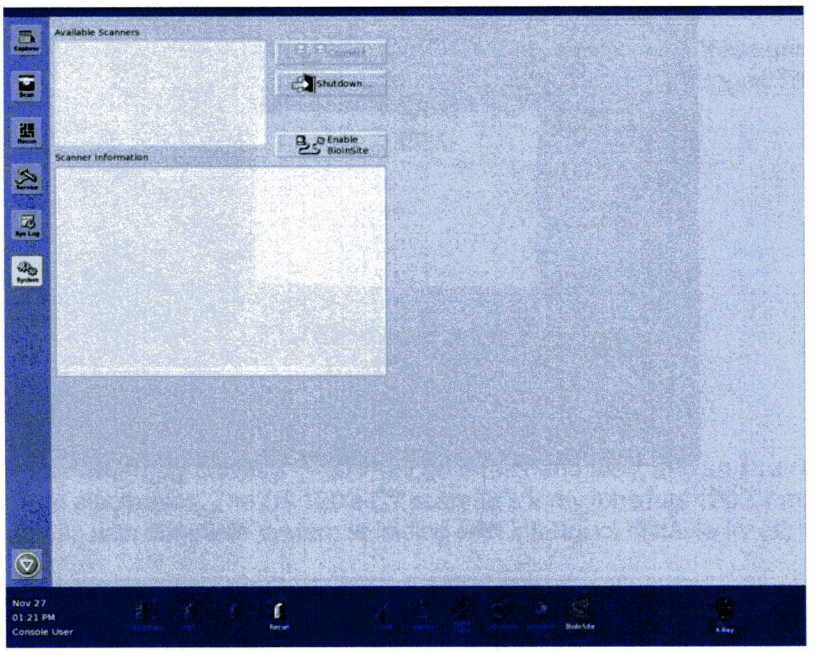
- Registration/fusion display
- Region of interest (ROI)/volume of interest (VOI) analysis
- Segmentation analysis
- Oblique image reformatting
- Volume rendering
- Input/Output (I/O) of DICOM
- Image post-reconstruction filtering such as Gauss.

Both monitors display the Host Console Interface. Use the left monitor to operate the control functions. The right monitor acts primarily as a "viewer" displaying data output, images, etc.

Section 3.2 Software

The following describes the software components of the GE eXplore CT 120 system needed to control the scanners, acquire projections, reconstruct and view the results.

3.2.1 Host Console Interface



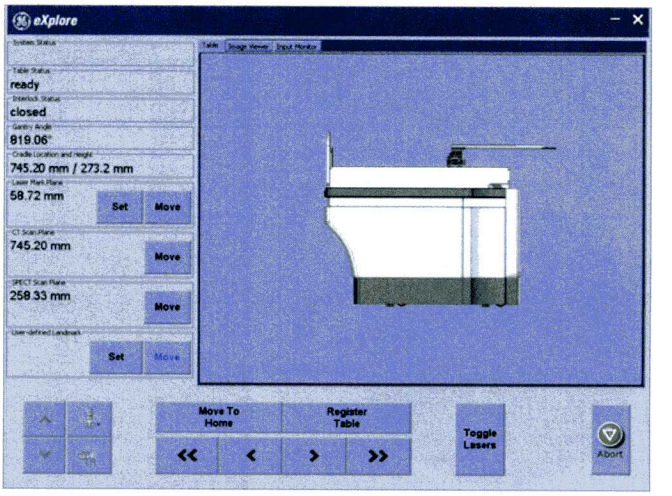
The Host Console Interface is used to:

- Login
- Manage your Projects, exams & specimens
- Design and manage your Protocols & Sequences
- Perform scans using the CT scanner
- Perform reconstructions

  Reconstruction is used to reconstruct three-dimensional volumes from a series of two-dimensional projections. It converts all the single-projection files that are created during the scanning phase (acquisition), it corrects errors and irregularities in the data, and it reconstructs the data into a three-dimensional volume.
- Launch eXplore MicroView
- Archive data and restore data
- Transfer data to (optional) PCI Analysis Workstation
- Logoff and shutdown the system.

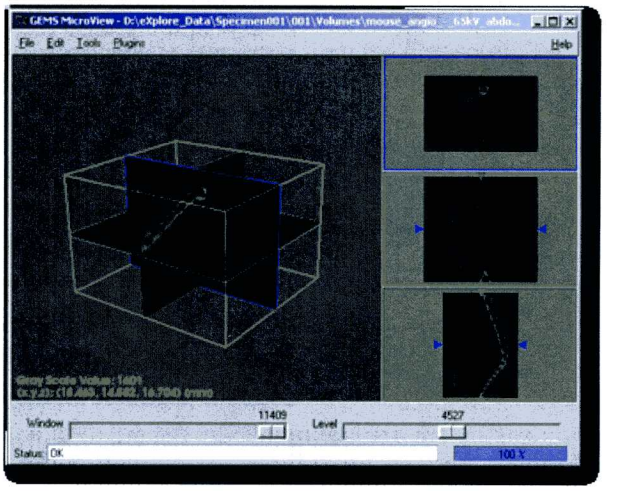
3.2.2 Tableside Controller

The Tableside Controller is the touch screen monitor positioned on the front of the Gantry, just above the Table. This interface is used to control the positioning of the specimen cradle, set landmarks, and turn on/off the alignment lasers.



3.2.3 eXplore MicroView

eXplore MicroView is the open source viewing application available from GE Healthcare. eXplore MicroView can display files of single projections that were created during the acquisition phase, and it can also view the three-dimensional volume or the transverse slices that were created during the reconstruction phase.



eXplore MicroView has many features that are discussed at length in the full *eXplore MicroView Software User Guide*, available from GE Healthcare. The *eXplore CT 120 User Guide* will discuss only the features of eXplore MicroView that allow the user to view slices and view three-dimensional reconstructed volumes.

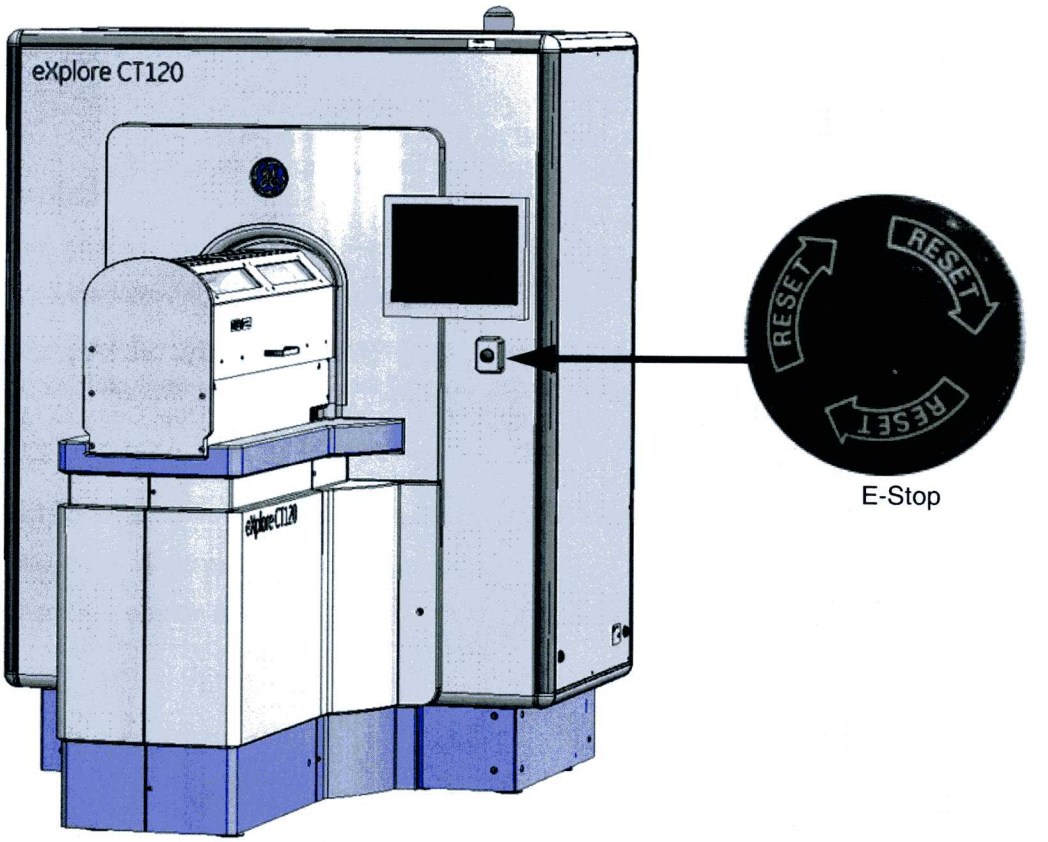
Chapter 4
Pre-Scan Preparation

Section 4.1 Using the System Safely

4.1.1 Emergency Stop Buttons

An **Emergency Stop** (E-Stop) button is found on the front right side of the CT Gantry. As well, the **Abort** button on the Tableside Controller acts in the same manner as the Emergency Stop button.

Use the Emergency Stop (or Abort button on the Tableside Controller) to immediately stop all scanner activity and abort a scan in the case of an emergency. All power to the CT 120 system is shut off.



E-Stop

AFTER PRESSING THE EMERGENCY STOP BUTTON

Once the **Emergency Stop** button is pressed, the user must ensure that the button is in the "out" position before restarting scanner. This is done by turning the **Emergency Stop** button to the right until it pops out. Once reset, the scanner may be restarted by turning the key on the side of the specimen table.

4.1.2 Safety Interlocks

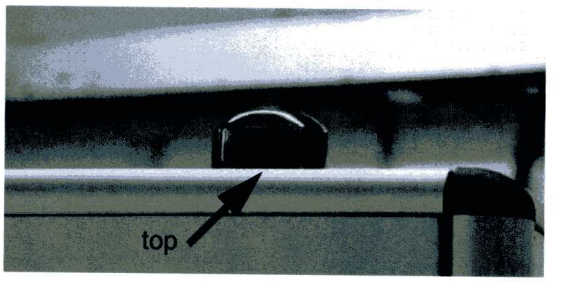
For safety purposes, the CT 120 system comes with interlocks. An interlock is a device that, once tripped, precludes radiation exposure by preventing x-rays from firing. The interlocks on the CT 120 ensure that the specimen table cover is both closed and is in its forward position over the cradle *before* x-rays fire.

Each time an interlock is tripped (i.e. the specimen table cover is opened or the cover is moved from its forward position), the user must return the cover to its proper position and then press the **X-Ray Enable** button next to the keyboard (which resets the Interlocks.)

The X-Ray Enable button appears bright yellow any time the interlocks are tripped.

4.1.3 X-Rays ON Warning Lights

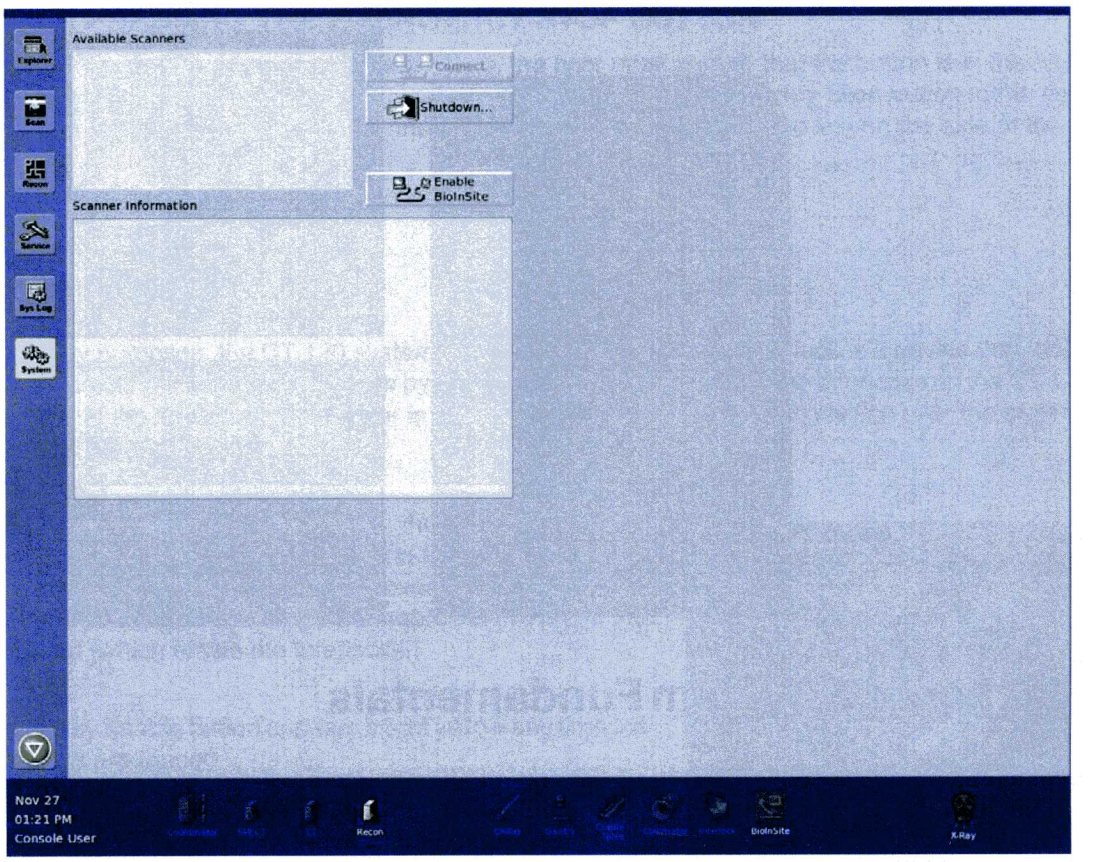
CT 120 has three x-ray ON warning lights. When x-rays are firing, these lights appear bright red. One light appears at the top cover of the CT scanner, another is located on the back cover of the system, and the other is commonly located near the Host Console Interface (although it may be mounted in another location such as outside the door to the scanning room).



Section 4.2 System Fundamentals

4.2.1 Login

1. If needed, power up the eXplore CT 120: on the side of the table, turn the system "key" clockwise, then press the green **Start** button next to the key (if the key is pulled out, x-rays can not fire).
2. Turn on the Host Console.
3. Type the following Username (using lower case): **vct**
4. Type the following Password (using lower case): **vct**
5. Click on the **GE icon** to launch the Host Console Interface. The System screen is presented. Choices on the left of the screen are displayed (and will reflect the options available to the user).
6. Highlight the desired scanner in the Available Scanners window.
7. Click on the **Connect** button.
8. Check the system buttons at the bottom of the screen (see Topic 4.2.3).



Note: *The **Enable BioInSite** button is used when servicing the system. It allows GE technicians to connect to the system remotely for diagnostic purposes.*

4.2.2 Logoff

To logoff:

1. Click **System** on the left of the screen.
2. Do one of the following:
   - click on the **Disconnect** button to disconnect the Host Console Interface from the current scanner (but keep the Host Console Interface running)
   - if the Host Console Interface is already disconnected from the scanner, clicking on the **Shutdown...** button will only shut down the Host Console Interface
   - If the Host Console Interface is connected to the scanner, clicking on the **Shutdown...** button shuts down the scanner (all the computers) and the Console program.

4.2.3 Screen Icons & Abort Button

COMMUNICATION ICONS

The icons appearing at the bottom of the screen communicate the current states of various system components. Generally:

- Dark gray (grayed-out) indicates "in-active" or "not connected"
- Bright gray indicates the component is working correctly or "connected".
- Red icon plus a bouncing stop sign indicates an error
- Yellow warning sign indicates a warning
- Green rotating cog indicates that system is busy.

System Coordinator:

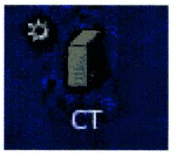
This icon appears bright gray when all system components are correctly communicating with each other. It will appear green with a rotating cog when the system is busy (i.e., starting up, scanning, etc.). It will appear disabled (dark gray) should connections be interrupted.

SPECT Subsystem:

This icon is not applicable to the eXplore CT 120 (disabled).

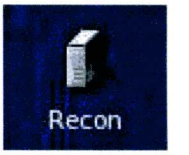
CT Subsystem:

This icon appears bright gray when the system is communicating with all facets of the CT subsystem. It will appear green with a rotating cog when the system is busy. If a red bouncing stop sign appears, there is an error/state that will not allow the scan to proceed (i.e., interlock open). It will appear disabled (dark gray) if the connection to the CT subsystem is interrupted.



Recon Engine:

This button appears bright gray when the system is able to communicate with the default Reconstruction server. It will appear dark gray if the Reconstruction server is not available.



Chiller:

This icon is not applicable to the eXplore CT 120 (disabled).

Gantry:

This button appears bright gray if the CT Gantry is idle, green if it is busy, and red with a bouncing stop sign if the CT Gantry encounters an error. Dark gray means the CT subsystem is disconnected.

Cradle/Table:

Appears dark gray if the table is not properly set up or registered. It appears red with a bouncing stop sign if the table's cradle conflicts with the installed collimator.

Collimator:

This icon is not applicable to the eXplore CT 120 (disabled)..

Interlock:

If the Interlock icon appears red with a bouncing stop sign, the specimen table cover on the unit is not properly in place for a CT scan. The cover must be closed and in its forward position, and the X-Ray Enable button pressed in order to release the Interlock and enable the x-rays.

BioInSite:

Appears green when connecting, and bright gray when connected to the service.

XRay:

Appears dark gray when no x-rays are firing. It appears bright yellow when x-rays are firing.

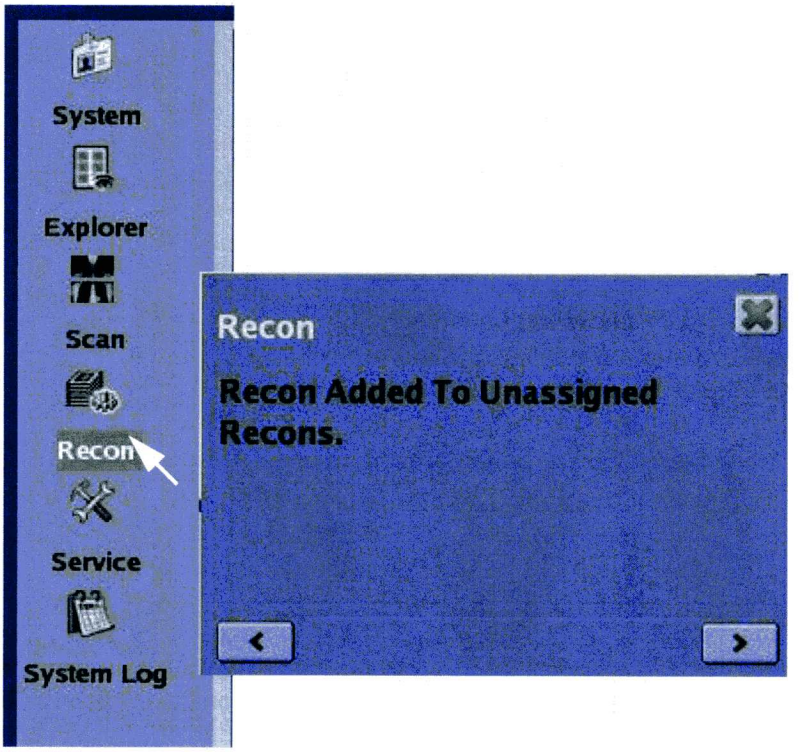
ABORT

Clicking on the Abort icon immediately stops all system activity (e.g. scans, reconstructions, table movement, etc.).

4.2.4 Message Pop-Ups

A pop-up window automatically appears to communicate various messages pertaining to a particular module or system. This pop-up appears on any screen, in the bottom right corner, when an appropriate message or status needs to be conveyed. The box disappears if the user clicks anywhere outside the pop-up, or after a 5 second delay.

This pop-up may also appear when the user moves the cursor over a module name to the left of the screen (if a message exists pertaining to that module). In the example below, the user has passed the cursor over **Recon**.



Left and right arrows appearing at the bottom of the pop-up indicate more messages exist. Use the arrows to cycle through the messages.

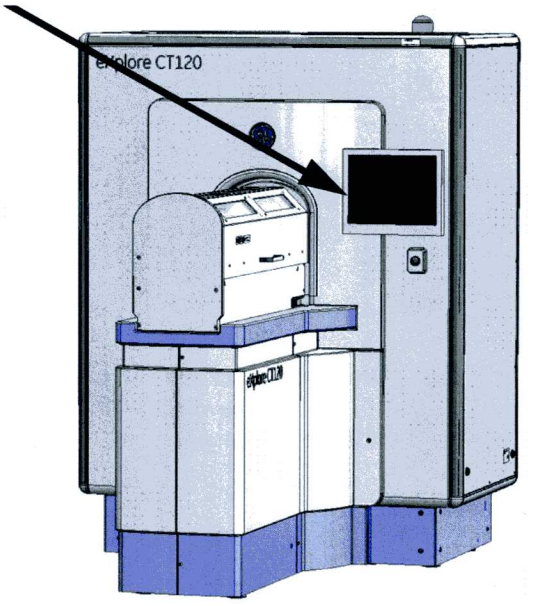
To remove the message, simply click on the **X** in the top right corner of the pop-up.

If the title of the message pop-up changes colour when the cursor passes over it, the user may click on the title to jump to that particular module.

Section 4.3 Working with the Tableside Controller

The Tableside Controller is the touch screen panel mounted above the table. This interface is used to set and position the specimen cradle via "landmarks". The user must "register" the table each time the CT 120 is powered up.

Once the table is registered, the Tableside Controller is used to precisely position or align the specimen to the imaging regions.



Understanding Landmarks

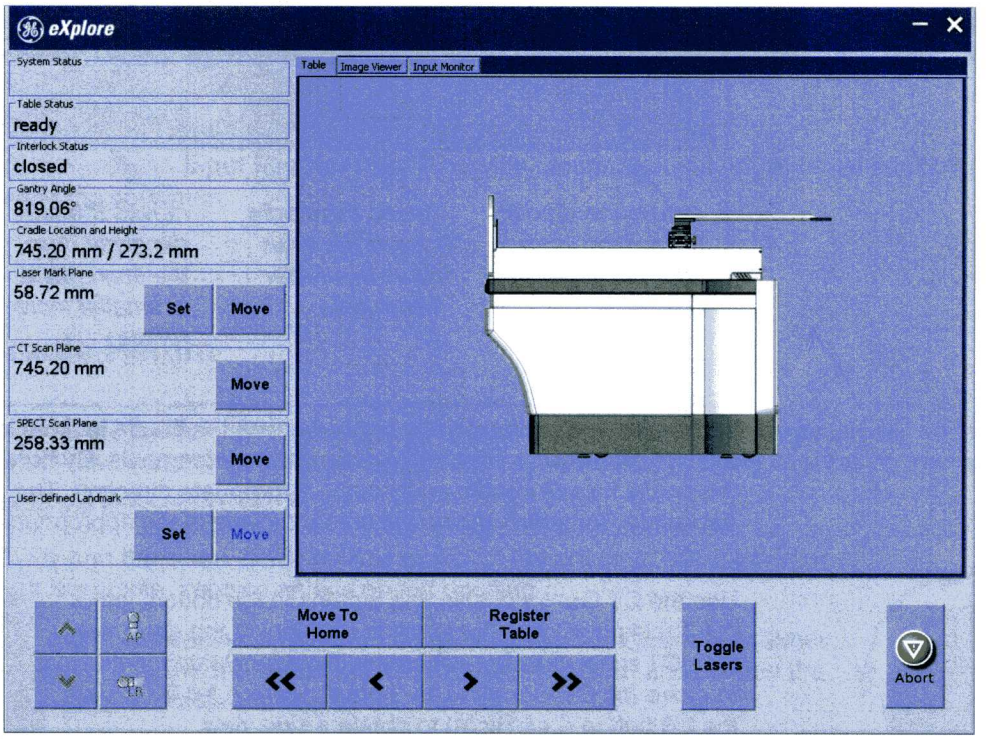
By positioning the specimen under the alignment lasers at a region of interest and pressing Set, the system records 2 landmarks:

- *Laser Mark Plane*: the distance the table must travel from its home position in order to position the region of interest on the laser mark plane (alignment lasers).
- *CT Scan Plane*: the distance the table must travel from its home position in order for the region of interest to be properly positioned on the CT scan plane.

Another landmark may also be recorded. This is a *User-defined Landmark* which may be used for a purposes other than scanning (e.g. a convenient position to which the cradle moves when there is a need to interact with the specimen)

4.3.1 Register the Table

When the CT 120 is powered up for the fist time, the word *Starting* appears in the Tableside Controller. Once the starting sequence is complete, the Tableside Controller appears as follows.



The user must register the Table each time the CT 120 is powered up. A scan may not be performed until the Table is registered.

At the Tableside Controller:

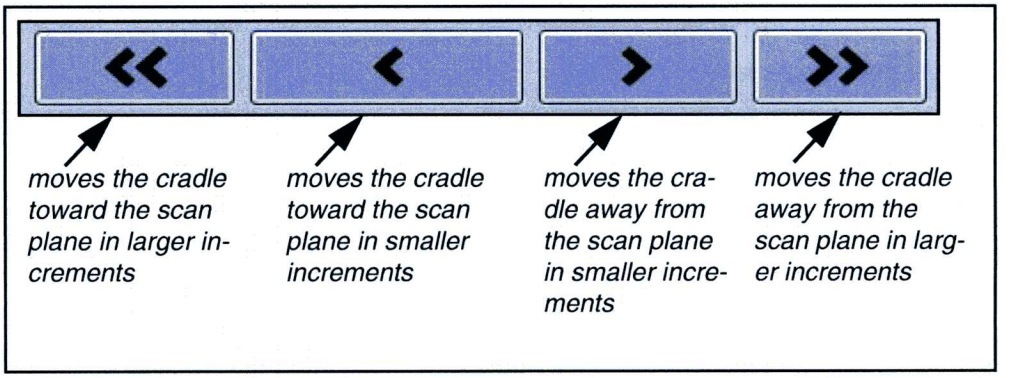
1. Press the **Register Table** button.
2. Wait a few seconds for the table to register. The word "Registered" will appear under Table Status and the Cradle Location and Height displays the position of the specimen cradle.

4.3.2 Position the Specimen for Scanning

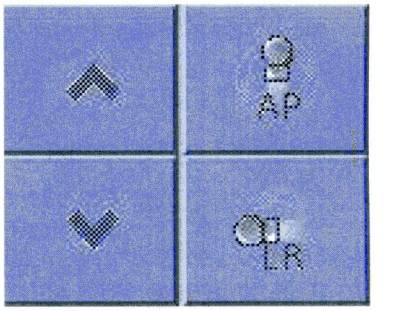
WARNING ***No equipment such as a pump or ventilator may be placed on the table or cradle. The equipment's vibration may affect image quality. Should this equipment be required, an ancillary cart may be positioned beside the table.***

1. Position the specimen on the specimen cradle and leave the specimen table cover open.
2. Press the **Toggle Lasers** button to turn on the alignment lasers.
3. At the Tableside Controller, ensure the **Table** tab is selected in the top right of the screen.

4. Use the following to move the table until the specimen is positioned at the region of interest:



Tapping once on the double arrows moves the cradle in 5mm increments. Tapping once on the single arrows moves the cradle in .1mm increments. By **holding down** any of the arrows, the cradle moves continuously in the appropriate direction. The graphic image on the Tableside Controller shows the cradle moving in the appropriate direction.



Use the CT Gantry positioning buttons in the bottom left of the Tableside Controller to aid in positioning the specimen for a CT scan. Use the **AP** button (Anterior/Posterior view) to move the CT Gantry to its "home" position (-0.00°). Use the **LR** button (Left/Right) to obtain a side view.

Use the **Up** arrow to rotate the CT Gantry counter clockwise. Use the **Down** arrow to rotate the CT Gantry clockwise.
Tapping once on an arrow rotates the CT Gantry in 1° increments. By **holding down** the arrows, however, the Gantry rotates continuously in the appropriate direction until the button is released.

5. Once the specimen is properly positioned, click on the **Set** button under *Laser Mark Plane*. Using the lasers as the reference point, this landmark gives the specimen cradle a predefined distance it must travel (in mm) to the CT scan plane once scanning is to begin.

   Alternatively, the user may move the table to a desired position and press the **Set** button under *User-defined Landmark*.

6. Press **Toggle Lasers** again to turn the lasers off.

Note: *Use the **Move to Home** button to move the table to its outermost position (away from the scan plane).* Use the various **Move** buttons to move the cradle to the appropriate scan plane e.g. Laser Mark Plane, CT Scan Plane, etc.

7. Close the specimen table cover and move the cradle to its forward position.

IMAGE VIEWER TAB

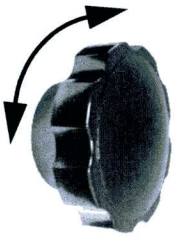
The **Image Viewer** tab on the Tableside Controller is a CT tool used to control the positioning of your specimen using fluoroscopy. This tool, however, only becomes available once *Fluoro Mode* is selected in the Scan module. See the next chapter for details.

In future releases the **Input Monitor** tab will provide feedback about any external equipment attached to the specimen.

4.3.3 Change Cradle Height

The height of the cradle may need adjustment. Ideally, the cradle should be positioned so it moves directly into the *centre* of the CT opening. To centre the cradle by raising or lowering the height:

1. Open the specimen table cover.
2. Slowly turn the fluted, silver knob underneath the cradle to either lower or raise the cradle, keeping an eye on the opening.
3. Look at the Tableside Controller's **Table Status** field. If the cradle is either too high or too low, the status will read "motion disabled" and provide the reason why the table is disabled.
4. Continue to slowly turn the knob until the cradle appears to be centred in relation to the opening, and the Table Status field reads "Ready".



WHAT'S NEXT?

Use the **Scan** module (described in Chapter 5) to set up and run your CT scans, and reconstructions. Here you choose the protocol (that tells the system on how an exam is carried out), and assign sequences (which define how to collect a series of images). More than one series may be added to a sequence, as needed. A standard reconstruction is added to each CT Sequence but reconstruction parameters may be adjusted and new reconstructions added using this module. Additionally, the user may pin point a ROI (Region Of Interest) prior to scanning and reconstructing, by running a Scout.

Use the **Explorer** module (described in Chapter 6) to manage your all your project data (e.g. view, delete, backup, restore, etc.). You may also use the Explorer module to send various series to the Reconstruction module if you wish to change various reconstruction parameters.

Use the **Reconstruction** module (described in Chapter 7) to view information about your reconstruction jobs. Use this module to manage your reconstructions separately, fine tune adjustments prior to reconstruction, and reconstruct various series that were set up in the Scan module.

Chapter 5
The Scan Module

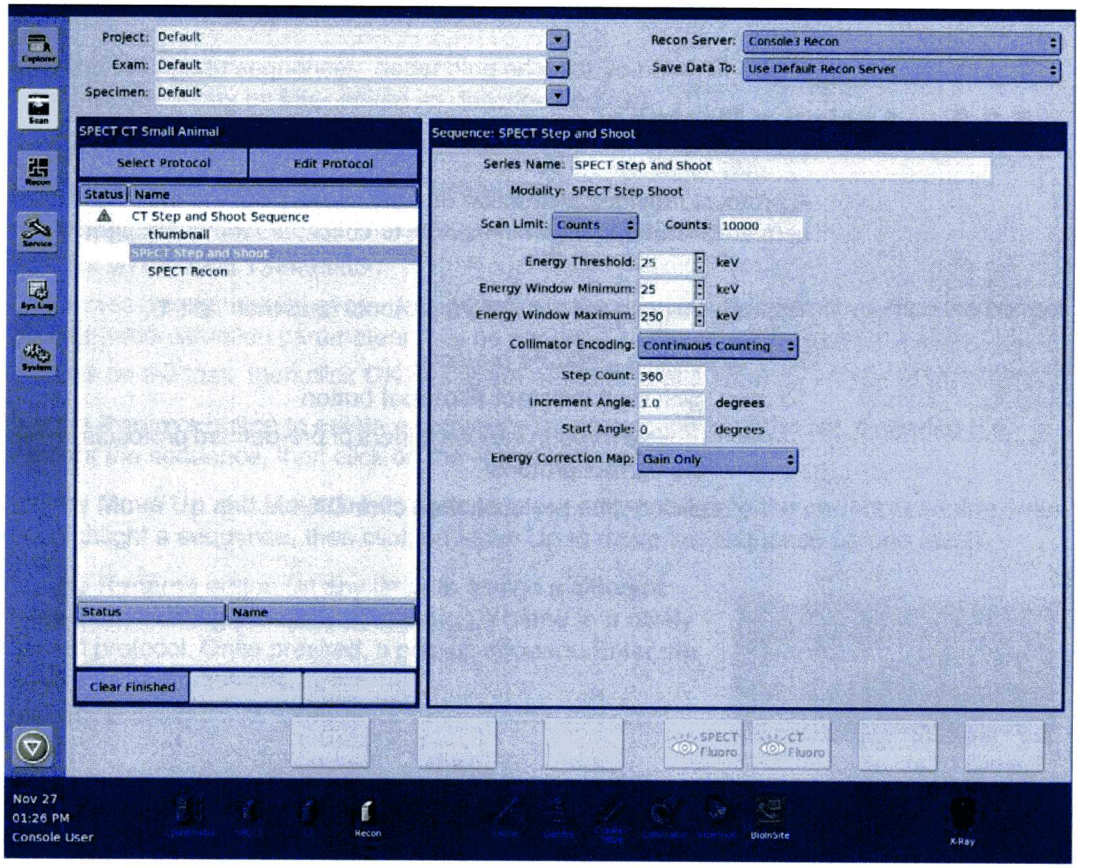
Section 5.1 Understanding the Scan Module

5.1.1 Overview

The Scan module is a flexible tool that is used to set up and run scans and reconstructions. Scans are labelled according to the Project they are associated with, the applicable Exam within the Project (since Projects may have multiple Exams), the particular Specimen used, and the type of Protocol - which tells the system how to conduct the Exam. Each Protocol consists of one or more Sequence (which defines how to collect a series of images).

Each sequence is automatically assigned a standard reconstruction (thumbnail) but reconstruction parameters may be adjusted and additional reconstructions added, if desired.

In addition, the user chooses a server on which to run the reconstruction(s). The resulting data may be sent to that server, or to a different data source.



Note: A SPECT sequence is shown for convenience only. SPECT is not available on the eXplore CT 120.

Section 5.2 Using the Scan Module

The information below describes how to use the Scan module. Initially, the Project Exam, and Specimen fields are set to "default".

5.2.1 Identify the Fundamentals

1. Click **Scan** on the left side of the screen.
2. Enter a new or existing name in the **Project** field.
3. Enter a new or existing name in the **Exam** field.
4. Enter a name in the **Specimen** field that identifies the animal to be scanned.
5. Click on **Recon Server** and choose the reconstruction server that is to be used to reconstruct the scans. This default may be changed later for individual scans.
6. Click on **Save Data To** and indicate where the data is to be sent. If you choose *Use Default Recon Server*, the data will be sent to the server you selected in step 5.

5.2.2 Assign a Protocol

A protocol provides instruction on how to carry out the exam and it consists of one or more sequences. Sequences define how to collect a series of images.

The user may select a standard protocol (and then edit it).

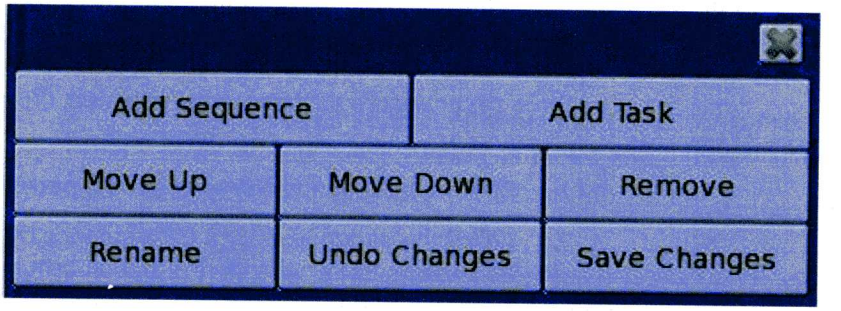
7. To select a standard protocol:
   - click on the **Select Protocol** button
   - browse through various folders of pre-defined protocols in the pop-up window until you find the correct protocol
   - click on the protocol, then click **OK**.

5.2.3 Edit a Protocol

The Edit Protocol button is used to edit an existing protocol (from the previous step), or create a new protocol.

8. Click on the **Edit Protocol** button.

   Additional buttons will appear on the bottom left of the screen.

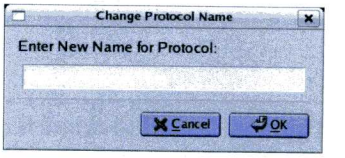


9. Add sequences:
   - click on the **Add Sequence** button
   - browse through the list of pre-defined sequences in the pop-up window until you find the correct sequence, click on the sequence, then click **OK** (sequences are added one at a time)

Note: *A standard reconstruction is automatically added to each selected sequence.*

   - continue to add sequences, depending on what you wish to accomplish (sequence parameters may be later edited as described below).

10. Add additional reconstruction(s) to a sequence:
    - click on the sequence to which you wish to add a reconstruction
    - click on the **Add Task** button
    - Browse through the list of pre-defined tasks in the pop-up window until you find the correct one (reconstruction parameters may be adjusted as described below)
    - click on the task, then click **OK** (tasks are added one at a time)
11. Use the **Remove** button to delete a sequence/reconstruction from the list, if needed (i.e. highlight the sequence, then click on the Remove button)
12. Use the **Move Up** and **Move Down** buttons to put sequences into the correct scanning order (i.e. highlight a sequence, then click on Move Up to move the sequence up one level).
13. Use the **Rename** button (at any time) to assign a different name to an existing protocol, or to assign a name to a newly created protocol. Once pressed, a pop-up appears. Enter the new name and press **OK**.

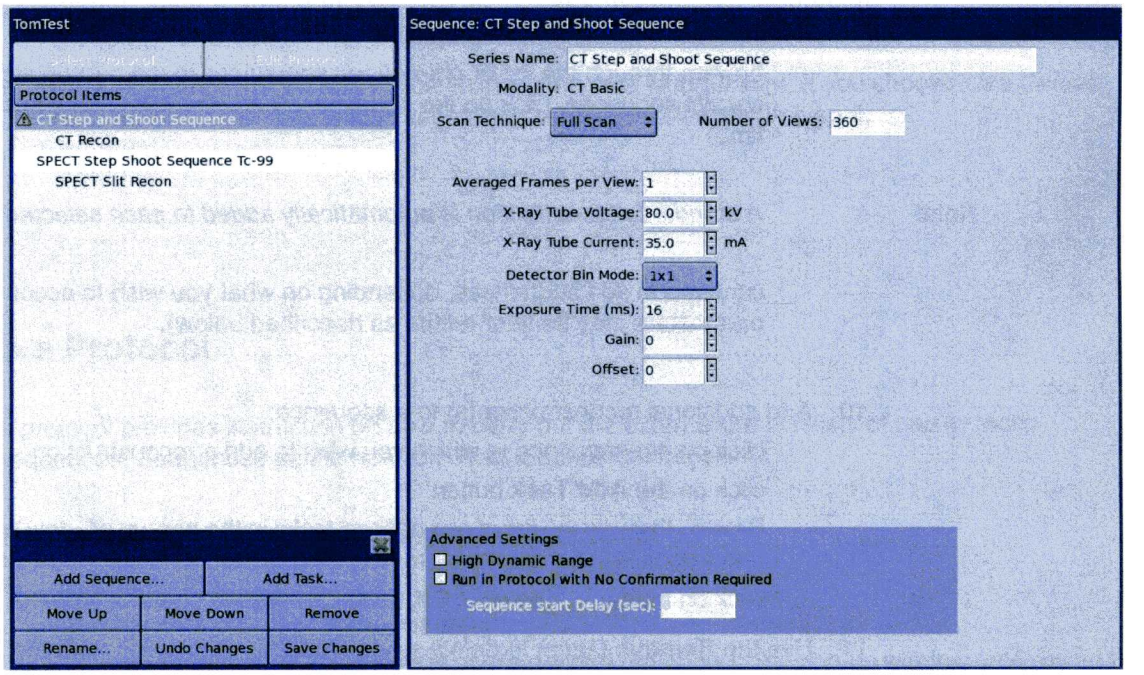


14. Once sequences and reconstructions are added to the protocol list, use the following steps to adjust any of the following:
    - CT sequence parameters
    - CT reconstruction parameters.

ADJUST CT SEQUENCE PARAMETERS (IF DESIRED)

Once the protocol's sequences are selected, CT sequences may be adjusted as follows.

1. Click on a sequence and examine the parameters that appear on the right side of the screen.
2. Adjust the parameters for a CT sequence by adjusting the following fields. Adjustments to these fields do not change the default sequence - changes are only applied to this particular Exam.



Field	Definition
Series Name	Leave the default or assign a name to this series.

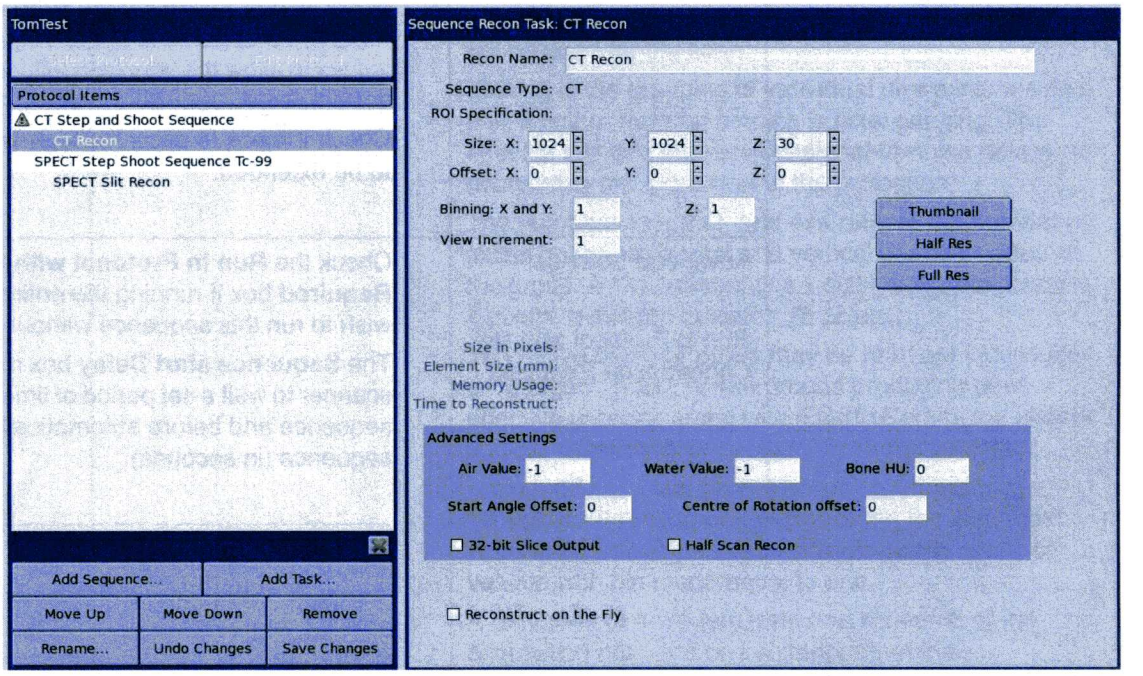
Field	Definition
Scan Technique	The Scan Technique is the gantry's degree of rotation. Choose either: Full Scan - a full rotation (e.g. 360°) Short Scan - a half rotation (e.g. 180°) Custom - enter a custom rotation The selected **Scan Technique** must be accompanied by the equivalent **Number of Views** and corresponding **Increment Angle**.
Number of Views Increment Angle	These fields correspond to the type of **Scan Technique** selected. The **Number of Views** equals the number of projections which will be acquired during the scan. The **Increment Angle** represents the increment (measured in degrees) between one image and the next. The higher the number, the fewer the slices. A Full Scan (one full rotation) may equal a Number of Views of 360 and an Increment Angle of 1, or a Number of Views of 180 and an Increment Angle of 2, etc. A Half Scan could equal a Number of Views of 200 and an Increment Angle or 1, or a Number of Views of 100 and an Increment Angle of 2, etc.
Averaged Frames per View	Each averaged projection is made up of a number of projections from the same rotation angle. The **Averaged Frames per View** represents the number of projections which are averaged on a per pixel basis to produce a single projection. When a value of 1 is chosen, the final VFF file will have one image taken per angle (i.e. no averaging is done). If you type 2, two images are taken per angle; these two images are then averaged into a single projection (VFF file). Averaging projections improves the signal-to-noise ratio (SNR).
X-Ray Tube Voltage (kV)	Enter the voltage or potential that is delivered during the sequence. Use the up or down arrows to increase or decrease the kV (the system keeps the kV within an acceptable range).

Field	Definition
X-Ray Tube Current mA	This is the current that is delivered during the sequence. Use the up or down arrows to increase or decrease the value.
Detector Bin Mode	The detector bin mode is either 1x1, 2x2, or 4x4. The detector bin mode is the pixel binning setting that will be used for the scan. Binning is the grouping of individual pixels into a single unit. Another term for binning is pixel ganging. The effect of this is to improve the signal-to-noise ratio while decreasing the resolution of the projection. The numbers 1x1, 2x2, and 4x4 refer to the number of pixels on the horizontal and vertical (x and y) sides of the group. A 1x1 bin contains 1 pixel; a 2x2 bin contains 4 pixels; a 4x4 bin contains 16 pixels. The native detector pixels may be read out individually or "ganged" in 2x2 or 4x4 groups producing new effective detector areas with 4 and 16 times the photon counts, respectively. A bin mode of 2 will generate one quarter of the acquisition data and one eighth of the reconstructed volume when compared to an equivalently scanned volume with bin mode equal to one. A bin mode of 4 will generate one sixteenth of the acquisition data and one sixty-fourth of the reconstructed volume when compared to an equivalently scanned volume with bin mode equal to one.
Exposure Time (ms)	Exposure time is the amount of time, measured in milliseconds, that the x-ray tube is activated. For the CT 120, the minimum exposure time is 14ms. For the CT 120 / 80, the minimum exposure time is 35ms. In most cases, the minimum exposure time is desirable. If the current is set to a low level, however, use a longer exposure time.
Gain Offset	**Gain** and **Offset** increase the brightness of the image using the camera electronics. Raising these values introduces more noise into the images, but raising Gain will do so more than raising the Offset value. Changing Offset is more of a shifting of values. Raising Gain is more of a scaling of values.

Field	Definition
Advanced Settings: High Dynamic Range	When something with a high atomic number (like metal, or another element higher up on the periodic table) is scanned, the value of the pixels that result from the scan can be so high that the image is incorrect. When a high dynamic range error occurs, low values may appear where high values are expected, due to a wraparound of the values. Checking the **High Dynamic Range** box adjusts the upper limit of the range of allowable ADU values to allow the very high values to be included in the correct scale. Check the box to allow the high end of the value range to be extended.
Advanced Settings: Run in Protocol with No Confirmation Required	Check the **Run in Protocol with No Confirmation Required** box if running the entire protocol and you wish to run this sequence without system confirmation. The **Sequence start Delay** box may be used to tell the scanner to wait a set period of time after running the last sequence and before automatically running this sequence (in seconds).

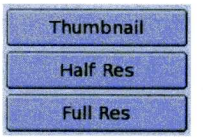
ADJUST CT RECONSTRUCTION TASK PARAMETERS (IF DESIRED)

1. Click on a CT reconstruction and examine the parameters that appear to the right of the screen.
2. Adjust the parameters for a CT reconstruction by amending the following fields. Adjustments to these fields do not change the default task, rather changes are only applied to this particular Exam.



Note: *For a **thumbnail** reconstruction, the ROI Specifications are disable (Size and Centre). A thumbnail always uses all the data to reconstruct. Additionally, the thumbnail's Recon Name cannot be changed.*

Field	Definition
Recon Name	Enter a new name for this reconstruction, or leave the default. (May not be changed for a thumbnail).

Field	Definition
ROI Specifications	To cut down on processing time and the final file size, you may designate a Region Of Interest that is smaller than the entire image. **Size** Enter the Cartesian coordinates of the boundaries of the volume to be reconstructed in pixels (the size of each dimension of the volume). The size should not be bigger than the Field Of View. **Offset** Enter the Cartesian coordinates of the exact centre location of the ROI in pixels. (May not be changed for a thumbnail).
Binning	The settings in this area determine the resolution of the *reconstructed* volume. **X and Y**: This is the size of the bins (or pixel groups) on the x-y planes. If you choose 1, no pixel binning will occur. Choosing a number higher than 1 will increase the size of voxels in the x and y dimensions and decrease the resolution by a factor equal to the bin size. **Z**: This is the size of the bins in the z dimension. If you choose 1, each slice will be 1 pixel thick. Choosing a number higher than 1 will increase the size of voxels in the z dimension (i.e. increase the slice thickness) and decrease the resolution.
View Increment	This number represents the interval between individual projections in the series that are to be used in the reconstruction. If you enter 1, every projection or image will be used. If you enter 2, every second image will be used. Choosing a view increment greater than 1 decreases the quality of the reconstructed volume but it also decreases reconstruction time.
	These buttons may be used to quickly define the bin size and view increment: **Thumbnail**: Click this to set the bin sizes to 5, and the view increment to 5. **Half Res**: Click this to set bin sizes to 2 and the view increment to 1. **Full Res**: Click this to set bin sizes to 1 and the view increment to 1.

Field	Definition
Information Display: Size in Pixels Element Size Memory Usage Time to Reconstruct	**Size in Pixels**: Displays the X, Y and Z pixel size of the reconstruction. **Element Size**: Displays the X, Y and Z pixel element size of the reconstruction in millimeters. **Memory Usage**: Displays the amount of memory this reconstruction will use. **Time to Reconstruct**: Displays an estimate of the amount of time the reconstruction will take.
Advanced Settings	**Air, Water, Bone HU** For the volume to be presented in Hounsfield units, you must calibrate the Hounsfield scale. In the Hounsfield scale, water always equals 0 HU and air always equals -1000 HU. By designating which parts of the volume image represent air and water, you specify the known points of the Hounsfield scale, which allows the rest of the scale to be determined correctly. **Start Angle Offset** This setting lets you rotate the volume around the z-axis. (Note: The z-axis of the reconstruction corresponds to the y-axis of the projections). If this text box is left blank, the volume will be reconstructed in the same orientation it was scanned in. If you enter 10, it will be rotated clockwise by ten degrees. If you enter -10, it will be rotated counter-clockwise by ten degrees. **Centre of Rotation offset** The centre of rotation is calculated by the system and in most cases this field should remain at zero. Should, however, you wish to change the automatically calculated centre of rotation, enter the offset here. **32 Bit Slice Output** If this option is selected, 32-bit slices are created in addition to the 16-bit volume that is typically created. One slice is created for every pixel included in the z-dimension. The data is saved as floating point values. This feature is used primarily for creating the 32-bit slice that is used to determine air and water values in order to calibrate the Hounsfield scale. **Half Scan Output** Use this feature if you currently running a 360 degree scan and you wish to simulate a Short Scan (220 degree) in order to perform a quicker reconstruction.

Field	Definition
Reconstruct on the Fly	Check this box if you wish to start reconstructing data immediately upon its availability from the scan (i.e. reconstruction starts before the scan is complete).

UNDO CHANGES

The **Undo Changes** button will undo any changes made to the Protocol. Once pressed, the screen will revert to settings that were in place the last time the Save Changes button was selected.

SAVE CHANGES

1. Once all data for the Project and current Exam has been created, click on the **Save Changes** button if you wish to save the protocol and have it available for future use.
2. Choose the location/directory where you wish to save the protocol.
3. Enter a file name for the Protocol.

Note: *Protocols are saved with a ".xml" file extension.*

4. Click **OK**.

WARNING ICON

A yellow warning icon may appear next to a sequence (under Status) indicating a problem may exist with the sequence parameters. Pass the mouse over the icon to display am explanatory message.

5.2.4 Warm Up the CT Scanner

1. Once the Exam is set up, use **CT Warmup** to prepare the CT detector and to warm-up the x-ray tube.

When to use this button?

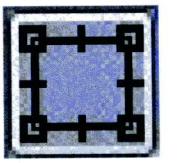
The **CT Warmup** brings the CT scanner to a certain state of preparedness. Typically it is used after a period of inactivity. Once pressed, the system determines the amount of time that has passed since the last CT scan was run, then runs a scan of the appropriate intensity to prepare the scanner.

Note: *If the **X-Ray Enable** button is on, press the X-Ray Enable (next to the keyboard) before running any scan to reset the interlocks. The X-Ray Enable must be pressed each time the specimen table cover is opened or moved back from its forward position.*

5.2.5 Use a Scout to Define the ROI

To finely tune your Region of Interest (ROI) use the **Run Scout** button. Here the system runs a CT scan and displays the entire scannable field of view in the monitor's viewer. Once displayed, the user may adjust both the size and positioning of the ROI.

1. Press the **Run Scout** button.
2. Click on the **Region Of Interest** button. A pop-up appears in the viewer listing all the sequences for this protocol.

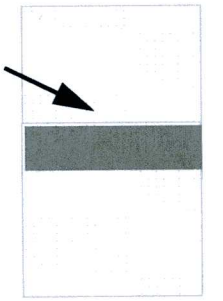


3. Place a checkmark next to the sequence that has an ROI you wish to adjust. More than one sequence may be selected.

   A transparent box appears in the viewer delineating the sequence's current ROI. The image on the right of the viewer shows a top-down view and the image on the left shows a left/right view.

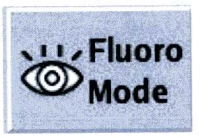
4. Drag the handles on the box's borders to increase or decrease the size of the ROI (CT sequences only). The handles operate independently. Should your ROI extend beyond the limits of the field of view, a darker shading appears indicating that 2 or more scans will run in order to obtain data for the defined ROI (and will be automatically stitched together).

   Click on the cross-hair in the centre of the box and drag the ROI to a new position. As your ROI changes, the system automatically updates the applicable sequence parameters.



5.2.6 Use Fluoroscopy for Fine Tuning

Fluoro Mode displays a real-time, fluoroscopic picture of the specimen in the both the monitor's viewer and in the Tableside Controller. Here you obtain a real-time image of the internal structures of a specimen through the use of a fluoroscope. In Fluoro, dense materials are represented by dark pixels, and less dense materials are represented as bright pixels (unlike eXplore MicroView).



USE FLUORO MODE WHILE POSITIONING A SPECIMEN

When using Fluoro Mode, you may use the table positioning buttons while viewing the fluoroscopic picture, in order to arrive at a better positioning of the cradle. Additionally, the Gantry rotation buttons may be used to achieve different perspectives of the specimen.

USE FLUORO MODE TO CONFIRM SETTINGS & FINE TUNE AN ROI

When using Fluoro Mode, you may check your protocol settings before performing a scan. It also lets you designate or fine tune a Region of Interest (ROI) which may decrease the size of the individual projection files as well as reconstruction time.

Note: *All settings specified in the protocol are in effect when Fluoro is running. If a sequence is not selected, default values are used.*

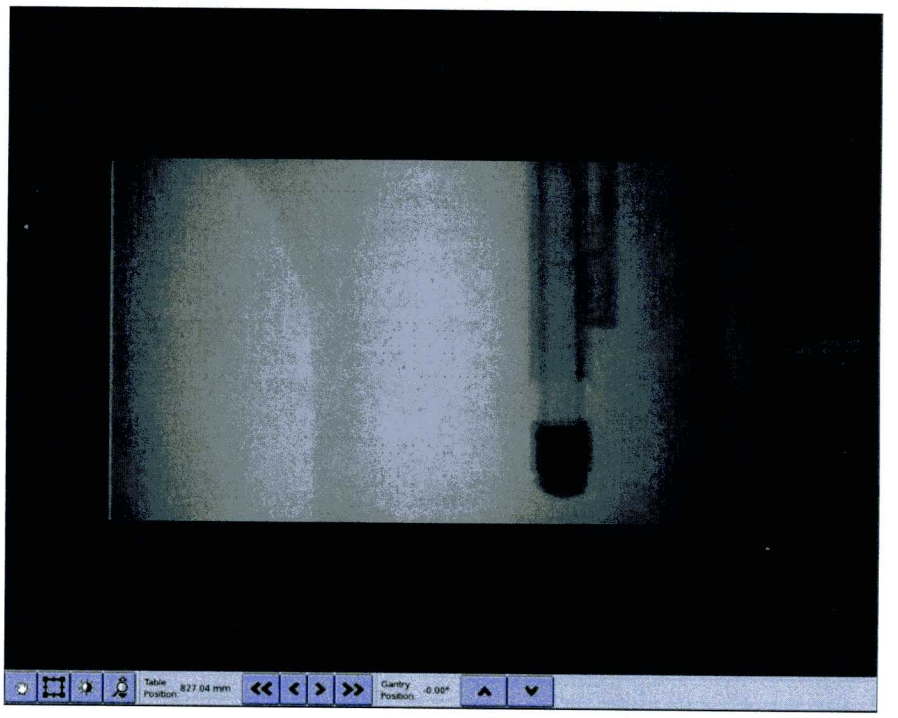
To use Fluoro:

1. Highlight a sequence.
2. Click on the **Fluoro Mode** button.

Note: *Once pressed, this button changes to **Start X-rays.***

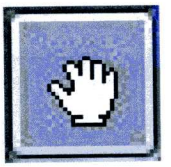
3. Press the **Start X-rays** button to start Fluoro. The fluoroscopic image may be viewed in the monitor's viewer or on the Tableside Controller.

Here is an image as it appears in the monitor's viewer:



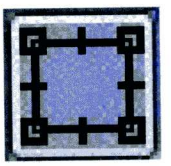
If using the Tableside Controller, click on the **Image Viewer** tab to view the fluoroscopic image.

4. Check your protocol settings and refined your Region Of Interest (ROI) by using the following 4 buttons:

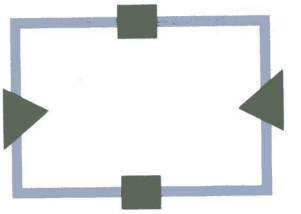


Field of View:

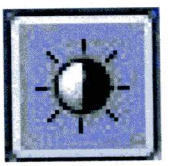
Drag this button onto the image in order to move the field of view.



Region Of Interest:



Once pressed, an ROI boundary box appears on the Fluoroscopy scan. Use the handles to change your ROI. The handles operate independently. CT parameters will change as you change the ROI. If a CT sequence has an ROI and you wish to remove it, press the **Clear ROI** button on the Scan screen.



Window & Level:

Use this button to adjust the Window and Level (similar to contrast and brightness). By adjusting the settings of the Window and Level screen in Fluoro, you can learn about the effectiveness of your voltage and current settings.

Zoom:
Use this button to zoom in or out of the scan.

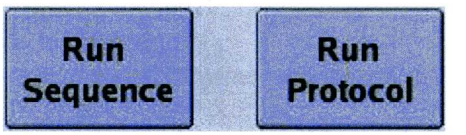
5. Use the table positioning buttons and/or the Gantry positioning buttons at the bottom of the scan to better position the specimen.

6. Use the **Stop X-rays** buttons to turn Fluoro off.

Note: *Stopping X-rays automatically sets the landmark position (i.e. the distance the cradle must travel to reach the Laser Mark Plane, and the CT Scan Plane).*

5.2.7 Start Scanning

Use one of the following buttons to start scanning.



Run Sequence

This button is used to run a single sequence, plus the tasks associated with that sequence (e.g. reconstruction). To do this:

- highlight (click on) the sequence you wish to run
- press the **Run Sequence** button.

The appropriate scanner runs the scan and then sends the scan to the reconstruction queue, and begins reconstruction according to the priority in the reconstruction queue (see the chapter Reconstruction Module).

Run Protocol

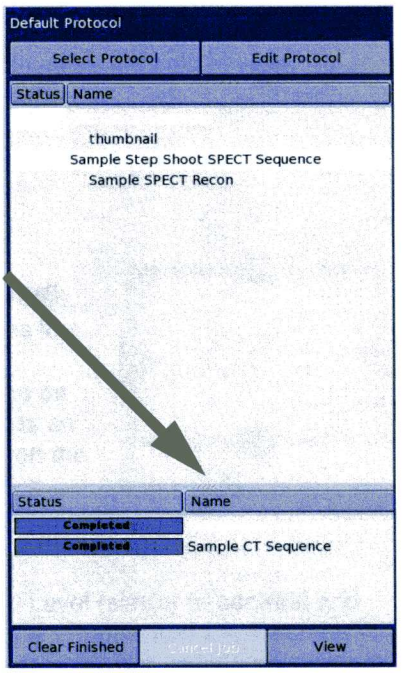
This button is used to run all the sequences and their tasks within the Protocol. Sequences are run in the order they are presented. To do this:

- press the **Run Protocol** button
- once the first sequence (see above) is run, click on the **Confirm Next Sequence** button to run the next sequence (the system highlights the next sequence and displays the sequence's parameters).
- continue clicking on **Confirm Next Sequence** until all sequences (and reconstructions) are run.

Note: *The **Gating Planner...** button will be available in a future release (disabled).*

5.2.8 Track the Progress (and Modify)

Use the progress window under the protocol list to track the progression of each item launched from this screen. Each sequence and reconstruction that is to be run is displayed here. Initially, only the Clear Finished button is enabled, but as reconstructions are completed, the user may view the results of a reconstructed volume. If the results are not satisfactory, the user may add another reconstruction to the list using this window.



To view the results of a *completed* reconstructed volume:

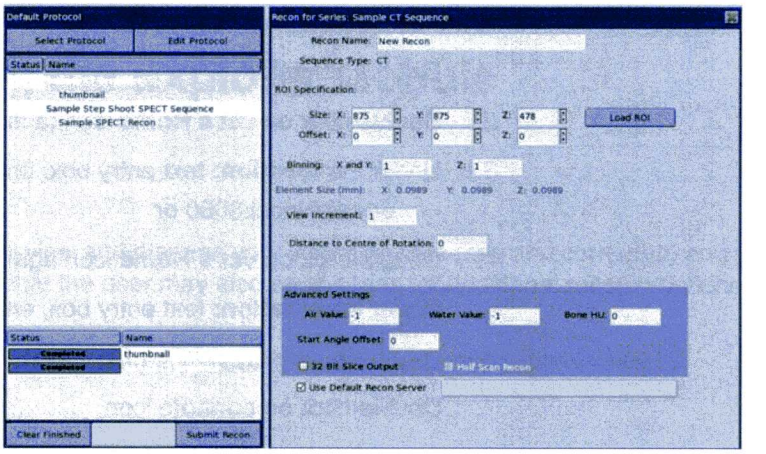
1. Click on the reconstruction's name in the progress window to enable the View button (the reconstruction's status must read *Completed*). Reconstruction parameters are displayed in read-only format.

   Note: *If you click on a Series name in the progress window. The Series parameters are displayed in read-only format.*

2. Click on the **View** button to examine the reconstructed volume in MicroView. Details on how to use the MicroView software are found in the *MicroView User Guide (2407688)*.

After examining the reconstruction, the user may choose to select a new Region Of Interest (and thus add another reconstruction to the Series). To do this:

3. Using MicroView, select and save a new Region Of Interest (ROI).
4. Returning to the Host Console, hit the **Reconstruct** button. The reconstruction parameter fields will no longer be display-only and the Reconstruct button changes to Sub Recon.
5. Give this reconstruction a new name in the **Recon Name** field.
6. Press the **Load ROI** button to download your new ROI from MicroView, and change any other applicable parameters.



7. Press the **Sub Recon** button to queue up the new reconstruction. The new reconstruction will appear at the top of the progress window with a status of "queued".
8. Click on the **X** at the top right of the parameters window to dismiss the new reconstruction parameters and return to the series parameters.

ABORT

Use the **Abort** button at any time to halt the scanning of a sequence. This button appears once the Run Sequence or Run Protocol button has been selected.

STOP RECON

Use this button to cancel a reconstruction (if you wish to cancel a scanning sequence, use the Abort button). To cancel a reconstruction, first click on the reconstruction name (the status in the progress window can not read *Competed* or *Error)*, then either:

- click the **Stop Recon** button, or
- click on the **Cancel job** button that appears in the parameter panel.

CLEAR FINISHED

Use the **Clear Finished** button when all tasks are completed.

5.2.9 Troubleshooting Scan Data Transfer

What if a scan transfer failed, but the scan completed. How do I access my data?

A specific data recovery mechanism does not yet exist, however, it is still easy to re-transfer data to the desired data source, as follows:

1. Exit the console.
2. Double-click on **vct's Home** icon (a file browser will open).
3. Under the **location:** text entry box, enter the following:
   - dav://ct.local:8080 or
4. Double-click on **vct's Home** icon again (another file browser opens).
5. Under the **location:** text entry box, enter: /media/data_disk, then click on **CT**.
6. Drag-and-drop scan folder from the remote site to the local directory.
7. Double-click on **console** icon.
8. Select **Explorer** page.
9. Re-index data source.

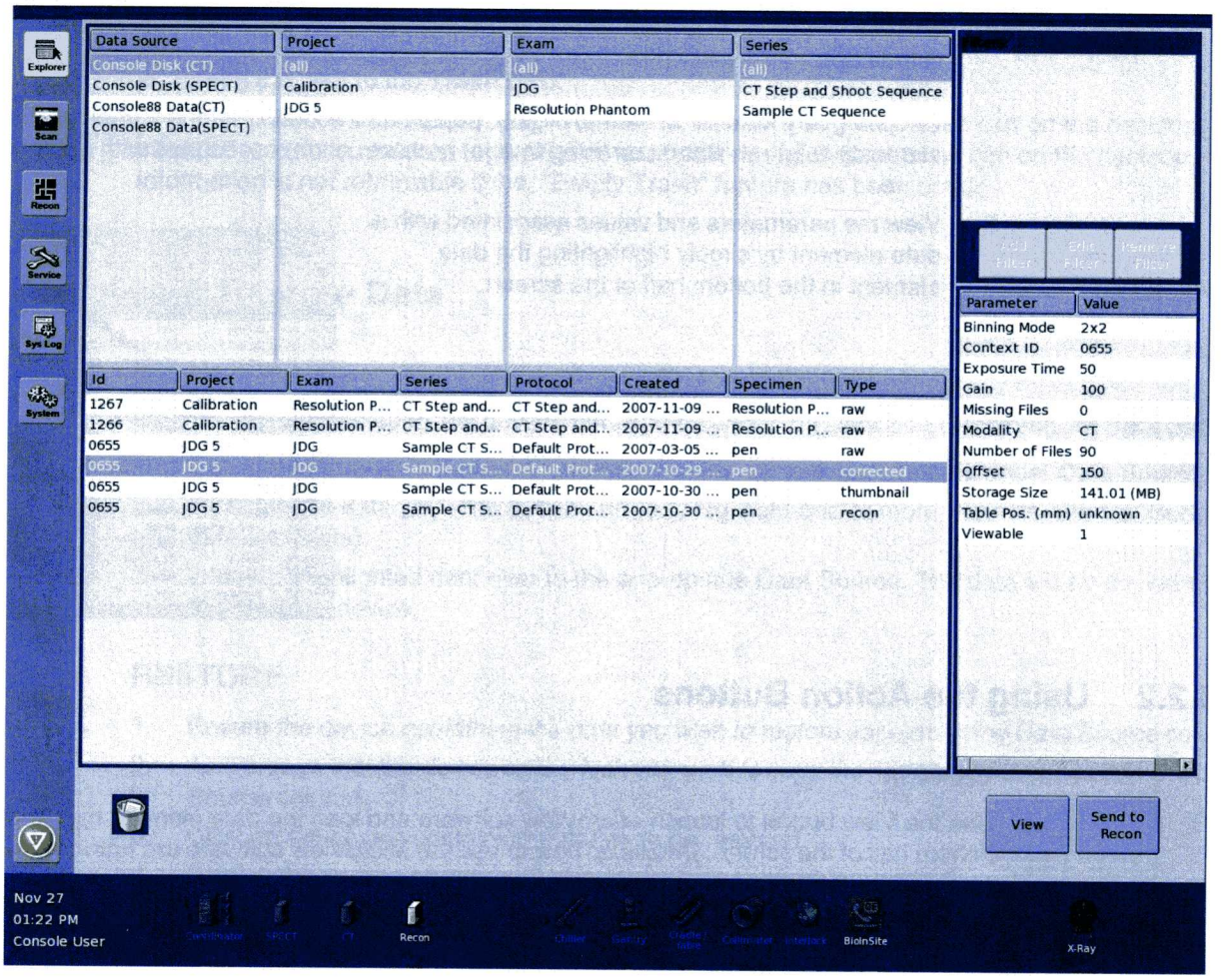
Chapter 6
The Explorer Module

Section 6.1 Understanding the Explorer Module

6.1.1 Overview

The Explorer module is used to view and manage your scanning data (raw and corrected) and your reconstruction data. It is here that the user may also send scans for additional reconstructions.

Explorer is also used to back up and restore your data, and delete any unwanted data.



Section 6.2 Using the Explorer Module

6.2.1 Display/Retrieve Data

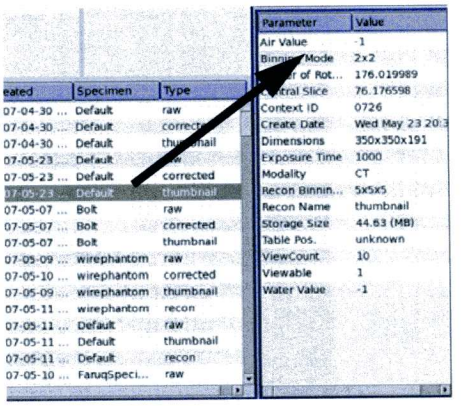
The following describes how to retrieve and view your CT 120 data.

1. Choose your **Data Source**. The Data Source column displays all the devices containing data that are connected to the system. This includes the local disk, USB drive plug ins, etc.
   - click on an individual device to display data contained only in that device (only one device may be selected).
2. Choose one or more **Projects**. This column is updated to reflect your selection under Data Source and displays all the projects located on the selected Data Source(s).

   Here you may select (all), a single project, or multiple projects.
3. Choose one or more **Exams**. This column is updated to reflect the project(s) you selected and displays all the exams that were created under the selected project(s).

   Here you may select (all), a single exam, or multiple exams.
4. Choose one or more **Series**. All the series that were created under your selected exam(s) are listed here.

   Choosing any number of series, or (all), populates the bottom of the screen with the data elements (e.g. raw data, corrected image, reconstruction) associated with each series.
5. View the parameters and values associated with a data element by simply highlighting the data element in the bottom half of the screen.



6.2.2 Using the Action Buttons

VIEW

Use the View button to launch *MicroView* software and load the data element highlighted in the bottom half of the screen. Details on how to use the MicroView software are found in the *MicroView User Guide* (2407688).

1. Highlight the data element you wish to import into MicroView.
2. Click on the **View** button.

Note: *MicroView may also be launched manually using the MicroView icon on your desktop.*

SEND TO RECON

The Send to Recon button may be used to set up a series for reconstruction.

1. Highlight the raw/corrected series element you wish to reconstruct. More than one element may be selected.
2. Click on the **Send to Recon** button.

   Once the button is pressed, the element(s) will appear in the Reconstruction Module under *Unassigned Recons*. Here the user may view the scan's raw or corrected data and make adjustments to reconstruction parameters prior to reconstruction. See the *Reconstruction Module* in Chapter 7 for information about managing your reconstructions.

TRASH CAN

Use the Trash Can button to delete data. Emptying the trash can periodically will free up disk space.

1. Highlight the data you wish to delete.
2. Drag the item to the **Trash Can**.

The Trash Can on the Explorer page moves the data to the system trash can on the desktop. Information can be restored to its original location from the system trash can on the desktop. Information is not retrievable if the "Empty Trash" feature has been used.

6.2.3 Backup & Restore Data

BACK UP

Data may be backed up to any device that appears under the Data Source column. To back up data:

1. Ensure your back up device is connected to the system and appears under Data Source.
2. Highlight the data you wish to back up (e.g. highlight one or more Projects, Exams, Series, data elements).
3. Drag the highlighted data over to the appropriate Data Source. The data will be copied on to the selected device.

RESTORE

1. Ensure the device *containing the data you wish to restore* appears in the Data Source column.
2. Also ensure that the device *onto which you wish to copy the restored data* appears in the Data Source column.
3. Click on the device containing the data to be restored.
4. Display the data to be restored using the procedures in Topic 6.2.1.
5. Highlight the data and drag it over to the appropriate device. The data will be copied on to the selected device.

Chapter 7
The Reconstruction Module

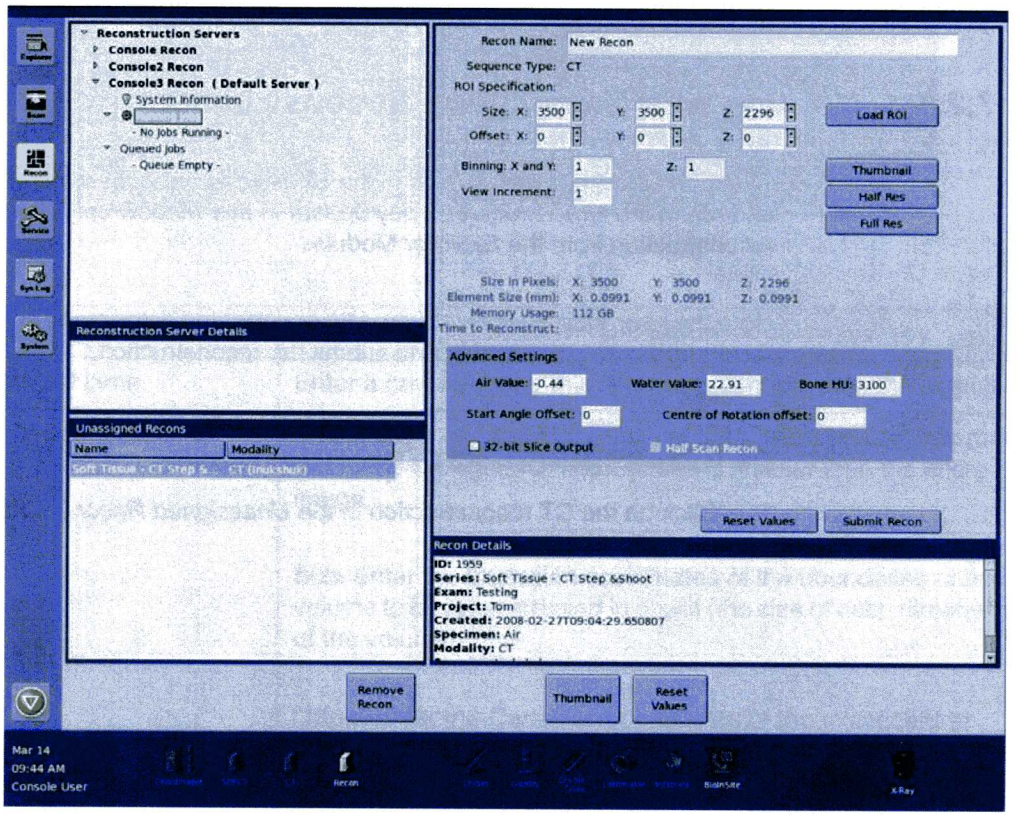
Section 7.1 Understanding the Reconstruction Module

7.1.1 Overview

Reconstruction is performed on the Host Console. The sytem displays any jobs that are currently running, plus any jobs that are queued up to run once space becomes available.

Section 7.2 Using the Reconstruction Module

Once you select the reconstruction icon, details about the current job appear.



7.2.1 View Parameters of Queued or Running Jobs

1. Highlight a job under **Queued Jobs** or under **Running Jobs**.
2. Reconstruction parameters (set up in the Scan Module) are displayed to the right of the screen. These parameters *may not be changed.*

Note: *After displaying a currently running reconstruction (under Running Jobs), the **Cancel Job** button may be used to cancel the reconstruction.*

7.2.2 Cancel/Stop Reconstruction (Cancel job)

A reconstruction may be cancelled even if it is currently running. To cancel or stop a reconstruction:

1. Click on (highlight) the reconstruction you wish to cancel under *Running Jobs*, *Queued Jobs*, or *Unassigned Recons.*
2. Click on the **Cancel job** button in the reconstruction's parameter panel.
3. Click **OK** when asked to confirm the cancellation.

7.2.3 Working with Unassigned Reconstructions

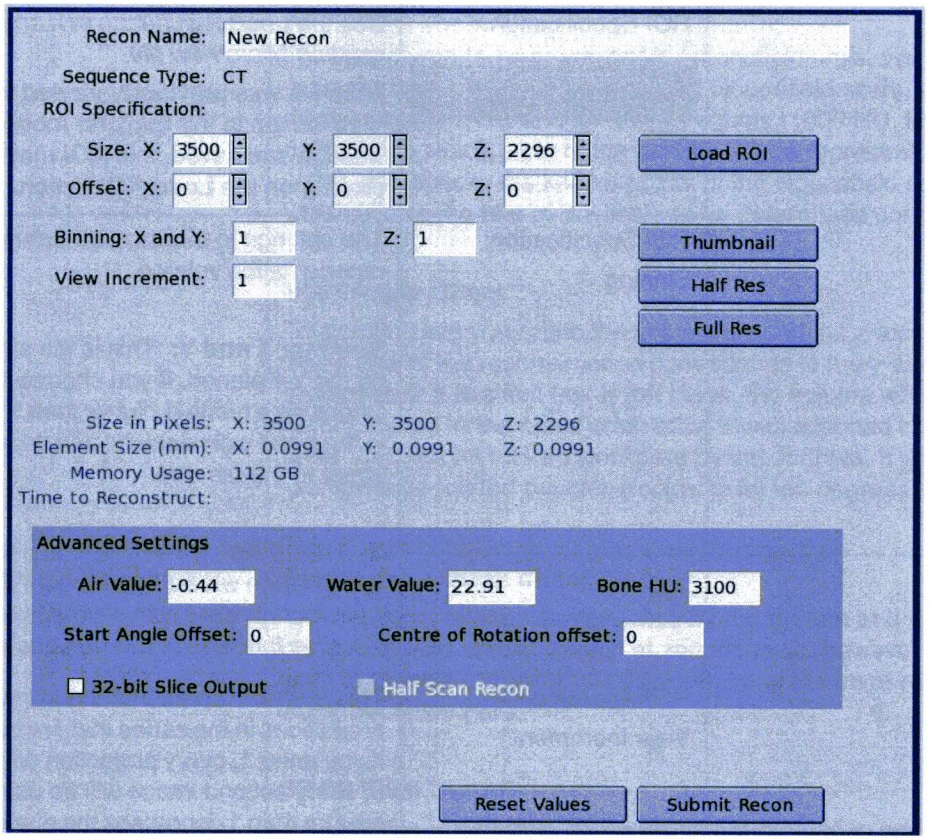
The reconstructions that appear in the *Unassigned Recons* window are completed scans (created and run in the Scan Module). They appear in this window only *after* the user has sent the scan to reconstruction from the Explorer Module.

Here the user may view the scan's raw or corrected data, make any adjustments to the reconstruction's parameters, and submit the reconstruction.

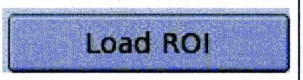
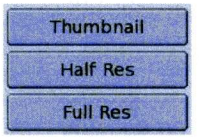
CT (UNASSIGNED) RECONSTRUCTIONS:

1. Click on the CT reconstruction in the *Unassigned Recons* window.

2. Adjust the parameters for a CT reconstruction (if desired) by amending the following fields.



Field/Button	Definition
Recon Name	Enter a new name for this reconstruction, or leave the default.
ROI Specifications	To cut down on processing time and the final file size, you may designate a Region Of Interest that is smaller than the entire image. **Size** Enter the Cartesian coordinates of the boundaries of the volume to be reconstructed in pixels (the size of each dimension of the volume). **Offset** Enter the Cartesian coordinates of the exact centre location of the ROI in pixels. (May not be changed for a thumbnail).

Field/Button	Definition
ROI Specification: 	Use the **Load ROI** button to load the ROI specifications *from an existing MicroView file.* If the file was previously viewed in MicroView (e.g. using the View button in the Explorer module) and a Region Of Interest was set and saved, this ROI may be retrieved and loaded by clicking on the **Load ROI** button.
ROI Specification: Binning	The settings in this area determine the resolution of the *reconstructed* volume. **Binning: X and Y:** This is the size of the bins (or pixel groups) on the x-y planes. If you choose 1, no pixel binning will occur. Choosing a number higher than 1 will increase the size of voxels in the x and y dimensions and decrease the resolution by a factor equal to the bin size. **Z**: This is the size of the bins in the z dimension. If you choose 1, each slice will be 1 pixel thick. Choosing a number higher than 1 will increase the size of voxels in the z dimension (i.e. increase the slice thickness) and decrease the resolution.
ROI Specification: View Increment	This number represents the interval between individual projections in the series that are to be used in the reconstruction. If you enter 1, every projection or image will be used. If you enter 2, every second image will be used. Choosing a view increment greater than 1 decreases the quality of the reconstructed volume but it also decreases reconstruction time.
	These buttons may be used to quickly define the bin size and view increment: **Thumbnail**: Click this to set the bin sizes to 5, and the view increment to 5. **Half Res**: Click this to set bin sizes to 2 and the view increment to 1. **Full Res**: Click this to set bin sizes to 1 and the view increment to 1.
Information Display: Size in Pixels Element Size Memory Usage Time to Reconstruct	**Size in Pixels**: Displays the X, Y and Z pixel size of the reconstruction. **Element Size**: Displays the X, Y and Z pixel element size of the reconstruction in millimeters. **Memory Usage**: Displays the amount of memory this reconstruction will use. **Time to Reconstruct**: Displays an estimate of the amount of time the reconstruction will take.

Field/Button	Definition
Advanced Settings	**Air, Water, Bone HU** For the volume to be presented in Hounsfield units, you must calibrate the Hounsfield scale. In the Hounsfield scale, water always equals 0 HU and air always equals -1000 HU. By designating which parts of the volume image represent air and water, you specify the known points of the Hounsfield scale, which allows the rest of the scale to be determined correctly. **Start Angle Offset** This setting lets you rotate the volume around the z-axis. (Note: The z-axis of the reconstruction corresponds to the y-axis of the projections). If this text box is left blank, the volume will be reconstructed in the same orientation it was scanned in. If you enter 10, it will be rotated clockwise by ten degrees. If you enter -10, it will be rotated counter-clockwise by ten degrees.
Advanced Settings (cont'd)	**Centre of Rotation offset** The centre of rotation is calculated by the system and in most cases this field should remain at zero. Should, however, you wish to change the automatically calculated centre of rotation, enter the offset here. **32 Bit Slice Output** If this option is selected, 32-bit slices are created in addition to the 16-bit volume that is typically created. One slice is created for every pixel included in the z-dimension. The data is saved as floating point values. This feature is used primarily for creating the 32-bit slice that is used to determine air and water values in order to calibrate the Hounsfield scale. **Half Scan Recon** Use this feature if you currently running a 360 Degree scan and you wish to simulate a Short Scan in order to perform a quicker reconstruction.

Note: Use the **Reset Values** button if you wish to return to the original settings after adjusting the above.

3. With the reconstruction highlighted in the Unassigned Recons window, click on the **Submit Recon** button. The reconstruction will be queued up and appear under the default reconstruction server.

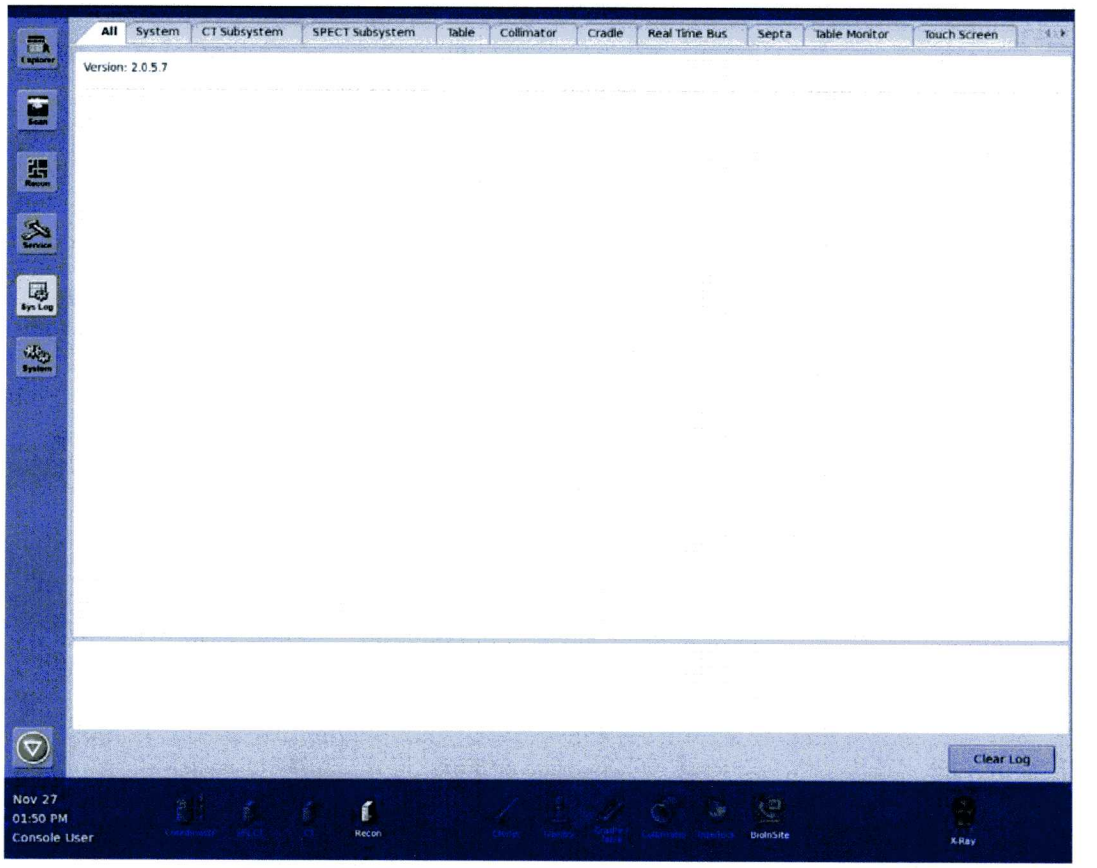
Note: *The reconstruction will still appear under Unassigned Recons, should you wish to construct multiple reconstructions.*

Chapter 8
System Log

Section 8.1 System Log

8.1.1 Overview

When troubleshooting the system, GE service technicians will often ask you to access the System Log.



The **All** tab displays all the incoming messages from the system. The other tabs display messages coming from only the system specified by the tab (e.g. the **Table** tab displays only those messages coming from the table).

Use the **Clear Log** button to clear the existing information and start logging system data at the point the window was cleared.

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