11.0 PURPOSE:

The GE HealthCare eXplore Locus SP MicroCT scanner is used in conjunction with the MS console to scan, acquire, and reconstruct specimens for in-depth three-dimensional analysis. A series of several hundred, 2D x-ray image projections, captured at regularly spaced view angles around the object, during the acquisition process are reconstructed into a single 3D volume by the MS console using GE eXplore software.

2.0 SCOPE:

This document outlines a typical scanning procedure that is applicable only to scans performed by the MS scanner. The laboratory area where the scans are performed will vary between a Containment Level 1 or Containment Level 2 laboratory depending on the specimen being scanned. Analysis methods and techniques on full-resolution reconstructed regions of interest will not be outlined.

3.0 RESPONSIBILITIES:

- Users who have received training from qualified individuals may operate the scanner and are responsible for performing image acquisition, adjustment and reconstruction.
- If necessary, trained personnel execute procedures related to animal preparation and decontamination of the area in compliance with local policies from *The University of Western Ontario Council for Animal Care (UCAC)*.
- The REQUIRED safety courses to be taken include:
    - X-Ray (with a TLD badge)
    - Biohazard
    - WHMIS
    - General lab safety
- UWO Health and Safety Website:
    - http://www.uwo.ca/humanresources/facultystaff/h_and_s/training/training_idx.htm

4.0 DEFINITIONS:

Acquisition – The process of acquiring CT images. i.e. scanning; or the data from one scan

ADU – Analog-to-Digital Units – Arbitrarily-scaled units arising from the digitization of an analog signal which need to be calibrated to have physical meaning. Eg. The voxel values in a CT scan can be calibrated into Hounsfield Units (HU), also called CT Numbers, which represent different biological tissue densities.

Center of Rotation – The vertical axis of the reconstructed three-dimensional volume, measured in pixels. The correct choice of this reconstruction parameter is critical to a proper, artefact-free 3D reconstruction. Artefacts in Parker weighted (180 + x-ray cone angle) manifest in the 3D reconstruction as “letter-C” shaped objects. Full 360 acquistion artefacts manifest as blurry circular regions.

Operator – A trained individual qualified to work with the scanner.

Reconstruction – The process of converting many 2D projections taken during the same scan into a single 3D volume.

"MS" scanner – GEHC Locus SP MicroCT Scanner. This scanner is designed for high-resolution CT of small objects or *ex-vivo* specimens.

MS console – The computer located beside the MS scanner that acquires and reconstructs the scanned images. The MS scanner is directly connected to this console. It is capable of µCT scans with voxel sizes of ~10-50 µm, and very long scans with low noise of 40-70 HU.

ROI – Region of Interest

Specimen – The object that is being imaged.

5.0 REFERENCES

- GE Healthcare eXplore Locus SP User Manual
- Kevex Tube Operation Manual

6.0 EQUIPMENT:

- GEHC eXplore Locus SP MicroCT Scanner
- MS Console

7.0 PROCEDURES:

All references to programs related to GE software can be found under the following directory: Start → Program Files → GE Medical Systems → eXplore utilities.

INCEASE or DECREASE the TUBE VOLTAGE & CURRENT, over a minimum 30-60 SECOND TIME PERIOD. DO NOT ADJUST VOLTAGE & CURRENT TO FULL POWER FROM STANDBY QUICKLY.
BE ALERT TO ARCING WHEN RUNNING SOURCE UP TO FULL POWER. ARCING CAN CAUSE X-RAY TUBE FAILURE. IF ARCING IS OBSERVED (audible ticking sound), then see SECTION 7.2.5.1. for tube warmup and conditioning.

7.1 PRELIMINARY PROCEDURE: X-RAY ACQUISITION

7.1.0. Write methods section for relevant journal manuscript.

7.1.1. Decide what protocol will be used for scanning the specimen.

7.1.2. Refer to the SOP that complies with the specimen being scanned for preparation and handling procedures.

Table 1: Object SOP's

Object	SOP
Living rat/mouse	Animal Handling for MicroCT
Non-living rat/mouse	Non-living rat/mouse

Rat/mouse ligament	Rat/mouse ligament
Phantom	Phantom

*****IF SCANNER IS ALREADY ON AND WARMED UP TO DEFAULT SETTINGS (50 kVp, 20 µA, GO TO 7.3.*****

7.2 SYSTEM START UP & WARMUP

7.2.1. Set the temperature controller unit (Series 800, Alpha Omega Instruments) at 12.88, using the arrows. The green digits represent the temperature set point; red digits represent the actual temperature of the tube (see Figure 1).

7.2.2. Log in (Windows login screen).

- User: Administrator
- Password: EvS8899

Figure 1: Series 800 Temperature Controller

7.2.3. Green power indication lights on the black x-ray control unit (GE Medical Systems CM-8X) will indicate if the scanner is ON* (standby). Turn on the CM-8X using the key if the green lights are not on:

7.2.3.1. Turn the key located in the black CM-8X control unit below the MS scanner ¼ turn counter-clockwise. At this point you will not be able to remove the key.

7.2.3.2. The green power indication lights should turn on. If system is OFF upon arrival, a longer warm-up is required. A 12 hr. scan will require a 30-60min warm-up. *Should always be left ON @ 50-51 kVp, 20 µA to prevent tube from becoming gassy and causing electrical arcing (see Figure 2).

Figure 2: CM-8X

7.2.4. Manually warm up the system.

7.2.4.1. Set up the CM-8X to the desired scan parameters (tube current and voltage) and let it sit for 5-10 minutes. See section 7.2.4.2. for detailed instructions, or if the x-ray tube has been off.

7.2.4.2. Manual System Warm-Up (from the Kevex X-Ray Tube PX55-925EA Operation Manual):

CONDITIONING

An periodic conditioning (or run-up procedure) is required to ensure safe operation, maintain the warranty and help prolong the life of the source. Increasing the target voltage in steps allows the source to become high voltage "conditioned", which prevents arcing and damage to the source. When operating a new source or one that has been idle for more than two days, begin with the target voltage and tube current controls set at their minimum values, and take 10 to 15 minutes to run the source up to full power. At each step in the run-up schedule below, first increase the beam voltage and then the current, waiting at least the minimum time before proceeding to the next step.

IMPORTANT: WHEN RUNNING A SOURCE UP TO FULL POWER, ALWAYS BE ALERT TO ANY ARCING. IF MORE THAN TWO ARCS ARE OBSERVED, DECREASE THE BEAM VOLTAGE TO THE PREVIOUS STEP. THEN WAIT AT LEAST THE MINIMUM TIME, STEP THE VOLTAGE BACK UP AND CONTINUE THE PROCEDURE, **ALWAYS BEING ALERT TO ARCING** (an audible ticking sound will be produced when an arc occurs).

RUN-UP SCHEDULE

STEP	% OF MAX kV	% OF MAX mA	MINIMUM TIME
1	20	0	1 MINUTE
2	40	10	1 MINUTE
3	60	30	2 MINUTES
4	80	50	2 MINUTES
5	90	70	3 MINUTES
6	100	100	3 MINUTES

Once the source has been fully conditioned, turning on x-rays with both the beam voltage and current set to their maximum values is possible. However, the following guidelines are best kept in mind when establishing your own operating routine.

1. If the source is to be used throughout the working day, continuous operation within specified ratings will maintain the source at its normal operating temperature and minimize warm-up drift.

2. Frequent on-off cycling to full power, is stressful to the source. This is especially true if x-rays have been off for several hours or more. In this case, it is recommended to run a short version of the run-up schedule above. For example, if x-rays have been off more than a few hours, but less than 2 days, start the source at 50% of max kV and run it up to full kV and mA over a 1 minute period.

3. Occasional arcs are inherent in x-ray equipment and should not cause alarm. However, frequent arcing which cannot be stopped by repeating this run-up procedure is indicative of a fault in the x-ray source.

4. The source is not focused below 45kV and operation with beam current below 20kV is not recommended.

*****START HERE IF THE SCANNER IS ALREADY ON AND WARMED UP TO DEFAULT SETTINGS!*****

7.3 CHANGING THE DATA DIRECTORY

7.3.1. Go to **Start → Control Panel** and run **GEHC eXplore System Controls** by double clicking the left mouse button.

7.3.2. Make sure the **Data Directory** is **"D:\eXplore_Data\"** and that the parameters are correct, according to the photo. Click **OK** (see Figure 3).

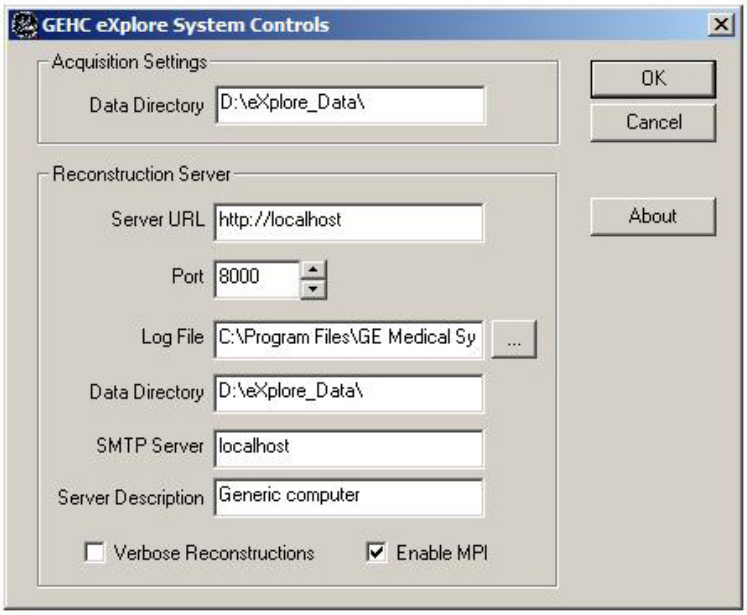

Figure 3: Data Directory

7.3.3. A window will pop up entitled "Service Successfully Restarted". Click **OK.** Close the Control Panel.

7.4 SCANNING

7.4.1. Pre-Scan Set-Up

7.4.1.1 Double click to run the **eXplore Scan Control** icon on the desktop.

7.4.1.2 Choose **Scan New Subject** or **Add to Existing Subject**.

7.4.1.3 If **Add to Existing Subject** is chosen, record the scan number that is shown: the number becomes the directory whereby the acquired images will be allocated. Click **Accept.**

7.4.1.4 If **Scan New Subject** is chosen, input what the specimen is when the **Subject Identification** window appears and click **Accept**. Next, input a descriptive name for the scan for the **Scan Description**. *Note: folder will NEVER come out what you name it.* Follow filename format: *YYYYMMDD_username_object.* Record the scan number that is shown:

the number becomes the directory whereby the acquired images will be allocated. Click **Accept.**

7.4.1.5 Select the scanning protocol from the drop down menu.

7.4.1.6 Ramp down **Tube Voltage** and **Tube Current** using the knobs (bottom left black console), gradually over a *minimum of 30-60 seconds.* Voltage should be 18 kVp and current ~0-2 µA.

7.4.1.7 Toggle the **X-Ray** switch **OFF.**

7.4.2. Selecting an X-Ray Tube Filter

7.4.2.1. Open the top hatch of the scanner (see Figure 4).

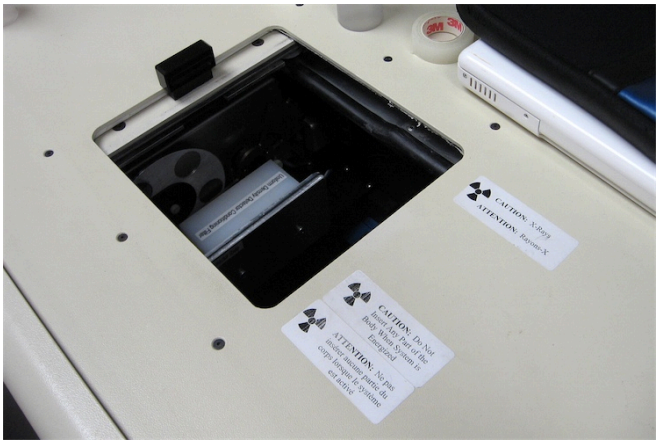

Figure 4: Top Hatch of MS Scanner

7.4.2.2. Lift the "Uniform Density Detector Conditioning Filter" and take it out (see Figure 5).

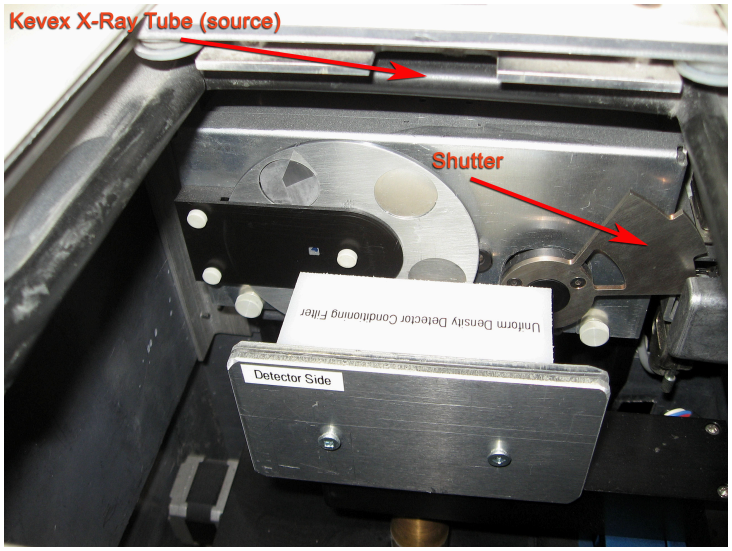

Figure 5: Inside the MS Scanner

7.4.2.3. See the **Filter Wheel Specifications** in the chart below:
Choose a filter in the hatch by turning the silver wheel (see Figure 6). The Filter # will show in the window. #4 is the default filter.

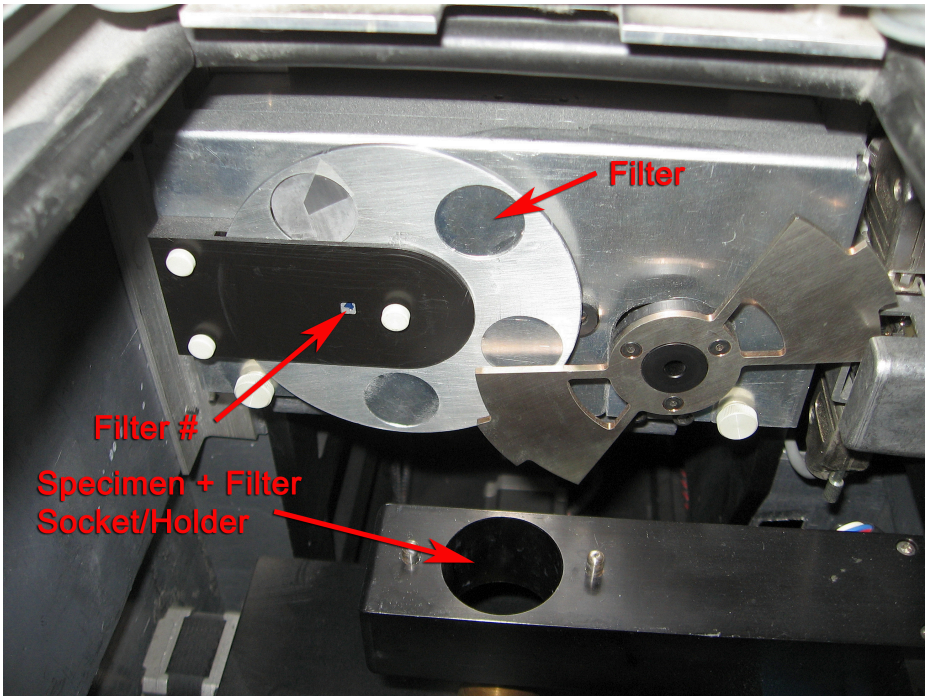

Figure 6: Filter Selector & Specimen Socket

Table 2: Filter Specifications

Filter number	Material and Thickness
1	Al (0.254 mm) plus Cu (0.254 mm)
2	Er (0.050 mm)
3	Al (0.254 mm)
4	Al (0.508 mm)
5	Al (1.016 mm)

- Note: the filter wheel currently has a 0.05 (50 µm) thick Erbium filter in place in Filter number 2; this spot is normally empty. (The foil is 0.025 mm thick; the filter wheel spot should have two layers in place to total 0.050 mm).

7.4.3. Inserting and Positioning Specimen

7.4.3.1. Choose an appropriate specimen holder, for the size of the specimen (see Figure 7).

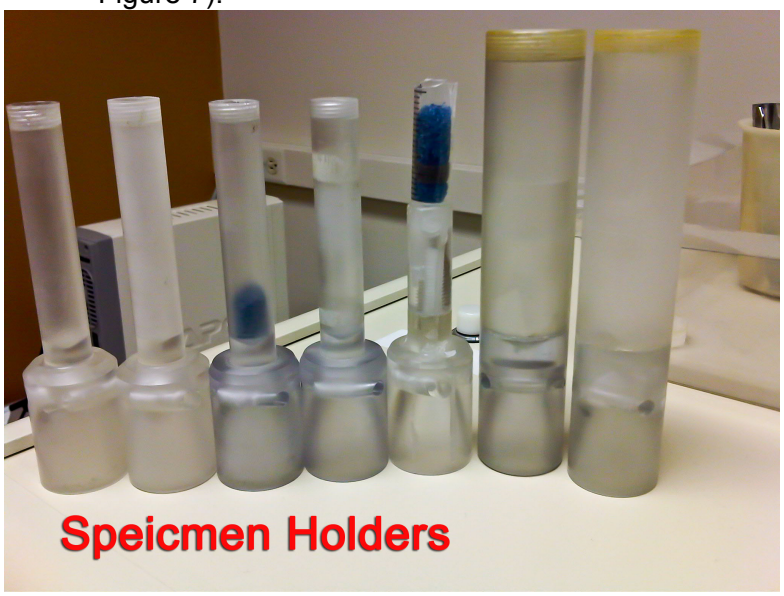

Figure 7: Specimen Holders (different sizes)

7.4.3.2. Put the specimen in the specimen holder.

7.4.3.3. Place the specimen holder with the specimen into the gantry socket in the hatch, until it clicks into place.

7.4.3.4. Place the Uniform Density Compensating filter (clear acrylic “water bath”) on top (see Figure 8 & 9).

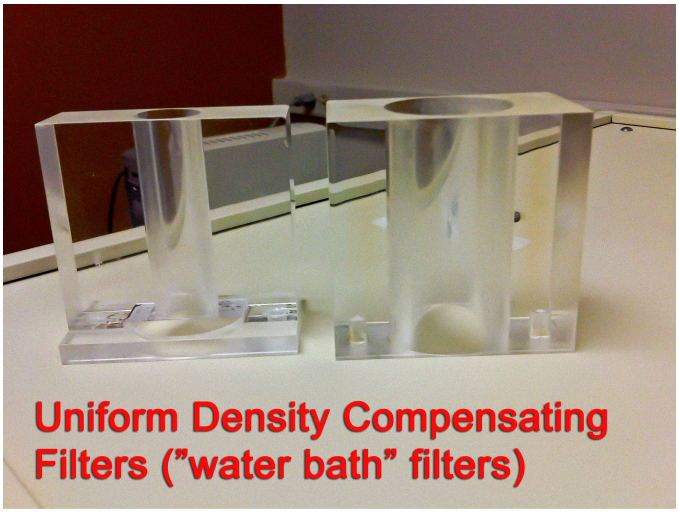

Figure 8: Uniform Density Compensating Filters.

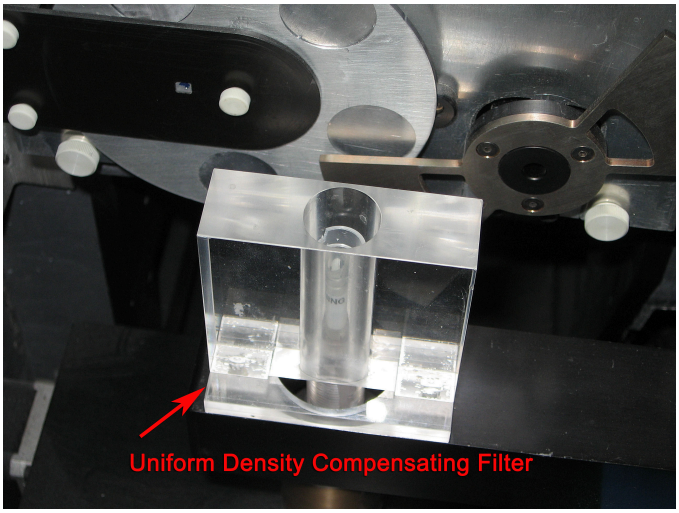

Figure 9: Sample with the sample holder and a water bath on top.

7.4.3.5. Close the hatch FULLY. A click/clunk should be heard.

7.4.3.6. Toggle **X-Ray ON** on the CM-8X. Press the square RED **Reset** button. A "screech" sound is heard.

7.4.3.7. Adjust the **Tube Voltage** and **Tube Current** settings according to the desired scan protocol values, using the knobs (bottom left black console), gradually over a *minimum of 30-60 seconds*. **Let the X-Ray warm up for 5-10 minutes!!**

7.4.3.8. Click **Fluoro** in the Scan Control window to view the position of the specimen. "Homing the Elevation Stage" window will appear in about 1-2 min.

7.4.3.9. Ignore "Add Specimen" window (click **OK**). It may take a few minutes. On the top right of the Desktop, **"Tube Status" & X-RAY STATUS ON** will be seen.

7.4.3.10. A new window with a "Live" fluoro image of the sample should be seen.

7.4.3.11. If the sample is not visible in the Live Flouro image window, locate the specimen by repositioning the stage as follows in steps 7.4.3.11-7.4.3.14.

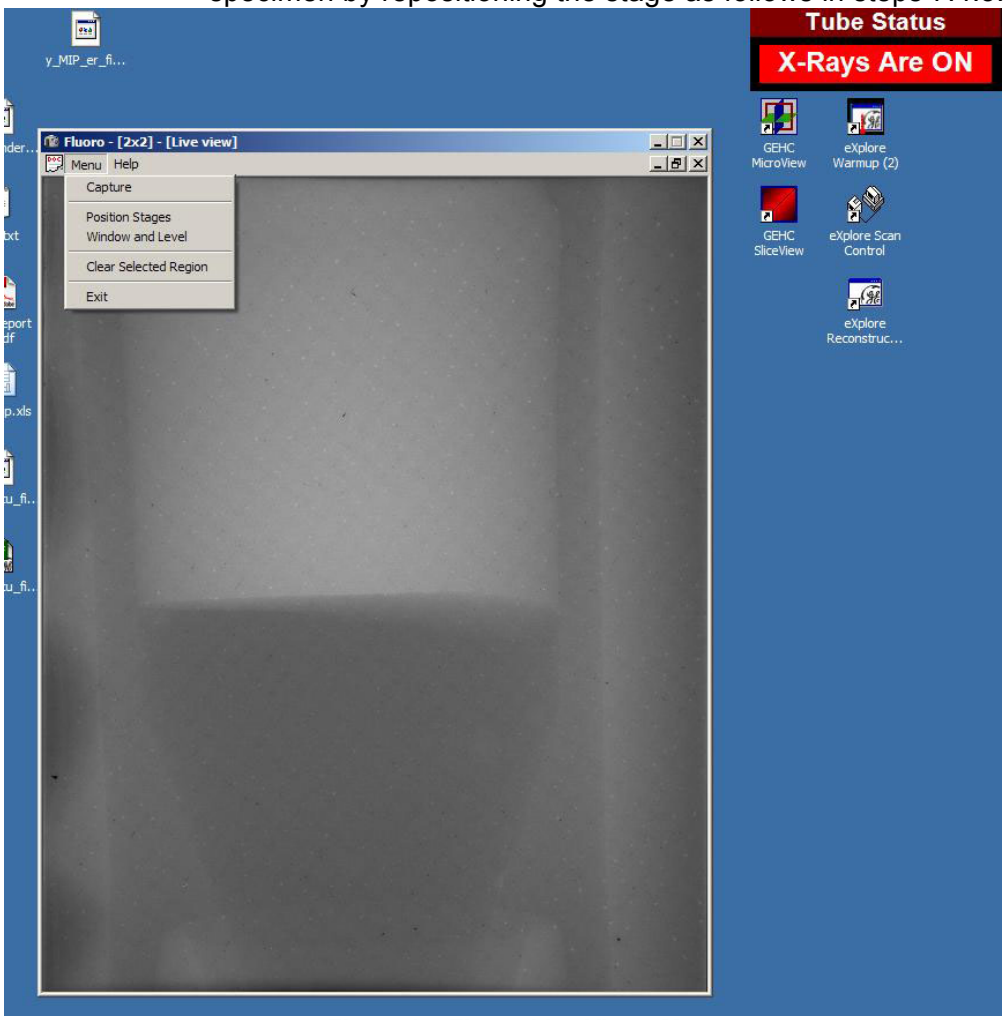

Figure 10: Fluoro Live View - Menu

7.4.3.12 Click **Menu→Window and Level**. Adjust accordingly. Avoid the bottom and left hand side due to detector delamination in that region. Click **OK.**

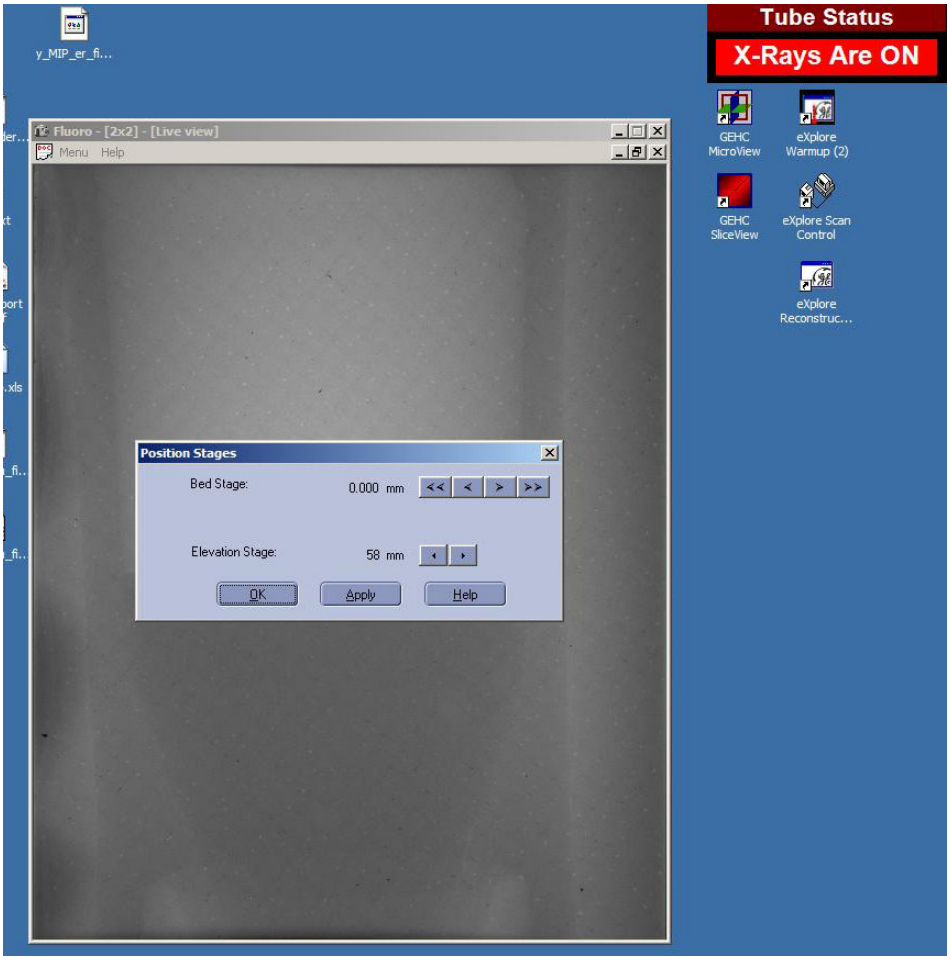

Figure 11: Positioning stages

7.4.3.13. Click **Menu→Position Stages** (see figure 10). Move **"Elevation Stage"** in the **Position Stages** window to center the sample vertically (up and down) in the fluoro image. Click the Left or Right arrows to raise or lower sample. Click **Apply** to view change in elevation position. When the desired sample position has been achieved, click **OK** (see figure 11). Close the Fluoro window.

STEPS 7.4.3.14 – 7.4.3.20 are for Fluoro Image Troubleshooting

7.4.3.14. IF the specimen image **DOES NOT** appear during fluoro, the shutter service may have to be restarted:

7.4.3.15. Go to **Start, My Computer, Control Panel, Administrative Tools, Services, GEHC eXplore Shutter Server.**

7.4.3.16. Click on **Start Service** (in upper left corner) to restart the shutter. Retry fluoro and positioning steps again (step 7.4.3.8. – 7.4.3.13). Continue to 7.4.4. if this is successful.

7.4.3.17. IF there is STILL NO FLUORO IMAGE, ramp down **Tube Voltage** and **Tube Current** using the knobs (bottom left black console), gradually over a *minimum of 30-60 seconds*. Voltage should be 18 kVp and current ~0-2 µA .

7.4.3.18. Toggle **X-Ray** toggle to **OFF** position, turn **OFF** CM-8X controller by twisting the key. Let it sit for a few minutes.

7.4.3.19. Restart the CM-8X by twisting the key, then toggling the **X-Ray** to the **ON** position. Ramp up the **Tube Voltage** and **Tube Current** settings according to the desired scan protocol values, using the knobs (bottom left black console), gradually over a *minimum of 30-60 seconds*. Let the X-Ray warm up for 5-10 minutes.

7.4.3.20. Retry steps 7.4.3.8 - 7.4.3.13 to obtain a fluoro image.

7.4.4. Collecting Bright/Dark Fields

7.4.4.1. In Scan Control window, click the **Scan Bright and Dark First** check box.

7.4.4.2. GEHC eXplore Scan Control window opens, stating that the x-ray must be warm. Click **OK.**

7.4.4.3. Ramp down the **Tube Voltage** and **Tube Current** gradually over a *minimum of 30-60 seconds.* The voltage should be approximately 18 kVa and the current ~0-2 µA.

7.4.4.4. Toggle X-Ray toggle **OFF**.

7.4.4.5. Open the hatch and remove the Uniform Density Compensating filter, the sample and its holder. Put the Uniform Density Compensating filter (clear acrylic, “water bath”) in. Close the hatch fully until a click/clunk is heard.

7.4.4.6. Turn the X-Ray toggle **ON,** and press the **X-RAY RESET** button. Ramp up the **Tube Voltage** and **Tube Current** settings to the scan protocol using the knobs (bottom left black console), gradually over a *minimum of 30-60 seconds*.

7.4.4.7. Click **START, My Computer, Data (D:), explore_Data.** Look for the scan folder that corresponds to the date on which you scanned (the recorded scan# from 7.4.1.2. & 7.4.1.3.). Double click to open the folder – it should contain a **Description.txt.** Leave this window open on the desktop.

7.4.4.8. Return to the GEHC eXplore Scan Control screen (the scan folder should still be open from step 7.4.4.7.). Click **Start Scan**.

7.4.4.9. Click **OK** when the window regarding removing the specimen (which should already be done) appears.

7.4.4.10. Click **OK** when done. Press **F5** approximately a couple times per second repeatedly, with the eXplore directory window selected and open until the desired bright field file is seen (*bright.vff*) (see Figure 12).

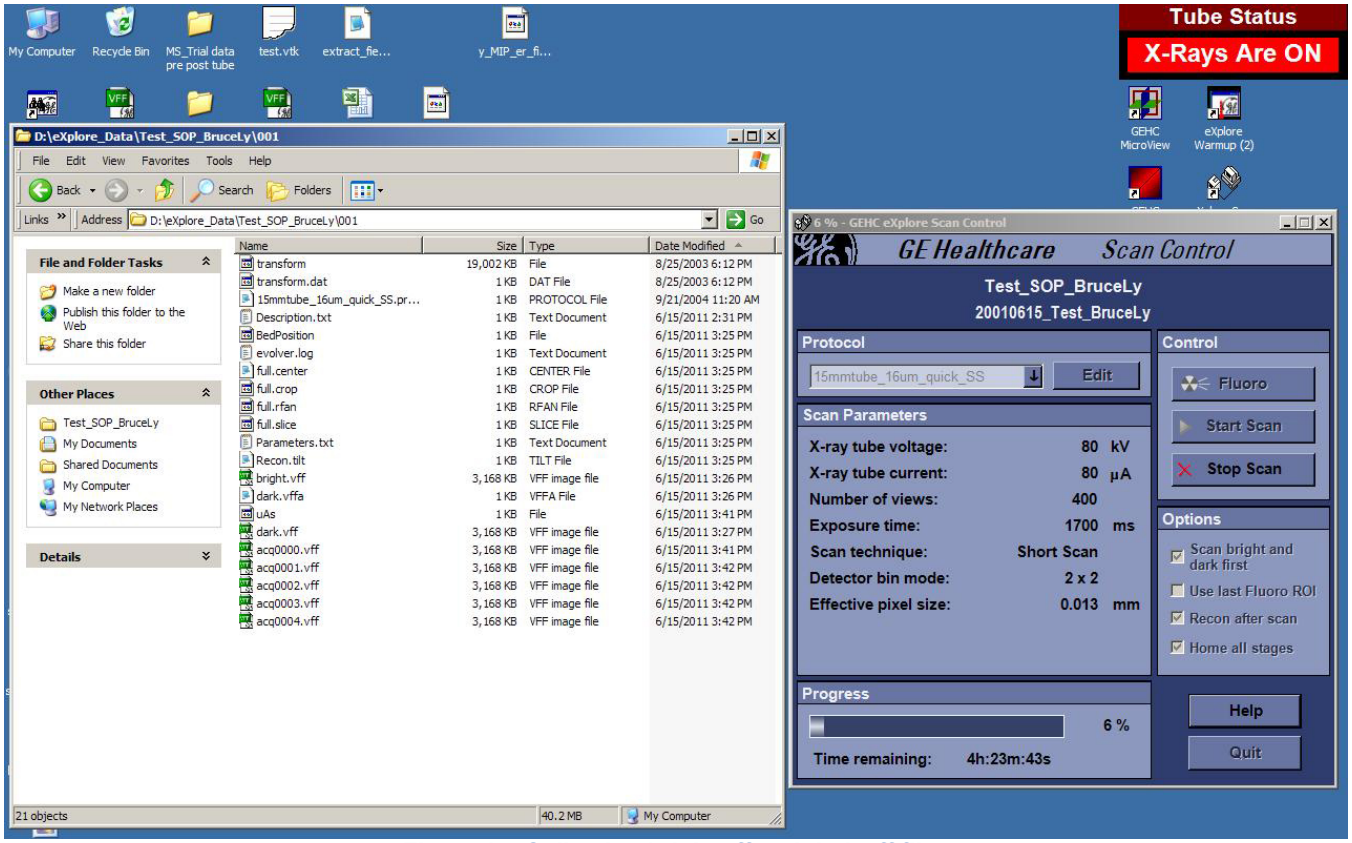

Figure 12: Collecting bright.vff and dark.vff files

7.4.4.11. Ramp down **Tube Voltage** and **Tube Current** gradually over a *minimum of 5 seconds.* The voltage should be approximately 18 kVa and the current ~0-2 µA. IMMEDIATELY toggle the X-Ray **OFF.**

7.4.4.12. Press **F5** repeatedly again with the eXplore directory window selected and open until the **GEHC Evolver** window appears, and the desired darkfield file is seen (*dark.vff*, see Figure 12). Don't click **OK**.

7.4.4.13. Open the hatch and put the sample into the holder with the Uniform Density Compensating filter back into slot. Close the hatch fully.

7.4.4.14. Turn X-Ray toggle **ON.** Press **X-RAY RESET**. Ramp up the **Tube Voltage** and **Tube Current** gradually over a *minimum of 30-60 seconds* to the desired scan protocol values. Click **OK** in the **GEHC Evolver** window.

7.4.4.15. On the top right of the Desktop, **"Tube Status" & X-RAY STATUS ON** will be seen. The scan acquisition will be complete when all of the projection images (acq0000.vff to acqNNNN.vff) are in the Data Directory.

7.4.5. Post-Scan Ramp-Down

7.4.5.1. Ramp down **Tube Voltage** and **Tube Current** gradually over a *minimum of 30-60 seconds.* Voltage should be 18 kVa and current ~0-2 µA.

7.4.5.2. Toggle the **X-Ray** switch **OFF.**

7.4.5.3. Open the top hatch of the scanner.

7.4.5.4. Take out the sample with the holder out, along with the Uniform Density Compensating filter.
7.4.5.5. Put the Uniform Density Detector Conditioning filter into the gantry socket until it clicks into place.
7.4.5.6. Close the top hatch fully.
7.4.5.7. Toggle **X-Ray ON** on the CM-8X. Press the square RED **Reset** button. A "screech" sound is heard.
7.4.5.8. Ramp up the **Tube Voltage** and **Tube Current** to the default settings (voltage 50 kVp & current 20 μA), to prevent tube from electrical arching and getting gassy.

7.5 RECONSTRUCTION

After images have been acquired from the MS scanner, the array of two-dimensional projections needs to be combined into a three-dimensional volume. The following processes are done with the eXplore Reconstruction Utility.

7.5.1 LOAD AND CORRECT SCAN IMAGES.

7.5.1.1. Run **eXplore Reconstruction Utility** (top right icon on the desktop).
7.5.1.2. Click **Load Scan** and load the log file of the scan. This log file will be found under the directory that corresponds to the scan number.
NOTE: All log files are named *evolver.log* by default.
7.5.1.3. Click **Correct** to perform the bright and dark field, & bad pixel correction. If the scan was already corrected, **Re-Correct** should appear instead of **Correct.** Click **Re-Correct** to recorrect the scan. Click **Yes** to overwrite files.

7.5.2 CENTRE OF ROTATION DETERMINATION

Note: ***Use a Parker-weighted protocol to determine the Centre Of Rotation parameter, even if the final scan uses a 360 degree protocol.***
The Centre Of Rotation parameter is simply the pixel number about which each image, in the set of projections, rotates. The determination of Centre Of Rotation should be performed with a protocol using "Parker weighting" (ie. Collecting raw data CT projections over 180 degrees + fan angle) and not from a 360 degree protocol. Centre Of Rotation image artefacts, which emanate from sharp or point-like, high-density objects, manifest as curved streaks resembling the letter "C" (or its mirror image) from Parker-weighted scans. These are much easier to recognize and correct than the circular artifact resembling the letter "O" which arise from 360 degree protocols.

7.5.2.1. In the **eXplore Reconstruction Utility,** uncheck **Mini Volume** and check **Append Job** under the **Volume Options** category.
7.5.2.2. Click **Advanced**, and input an appropriate **Centre of Rotation** (usually ~½ of the X size, under the **Subvolume Reconstruction** heading in the main window) then click **OK.**

7.5.2.3. Click **Set to Central Slice**.
7.5.2.4. Click **Full** Res**.**
7.5.2.5. Click **Advanced.** Select **32 bit Slice** (check mark).
7.5.2.6. Click **Recon** and rename using this format, with changes in bold: "cofr**centreofrotation**.vff". Example: "cofr545.00.vff".
7.5.2.7. Repeat steps 7.5.2.2.-7.5.2.4. for a range of cofr values (500-600 pixels in increments of 10 is an acceptable, default range).
7.5.2.8. Click **Job Manager** to view all jobs to be done with the set of centre of rotation values. Click **Start** to start processing.
7.5.2.9. Go to **Start**, **My Computer, Data (D:), eXplore_Data,** and find your Scan folder. The reconstructed scans will be found in the **Volumes** folder.
7.5.2.10. Right click on each cofr**centreofrotation**.vff file and open with **vffview.**
7.5.2.11. Determine what specific, smaller range of cofr (centre of rotation) values is acceptable, by examining multiple images that have the least centre of rotation artefacts (ie. no circular "C" shapes/wisps/streaks). If wisps are to the left/right, the COFR will need to be increased/decreased. Refer to Figures 13-15.

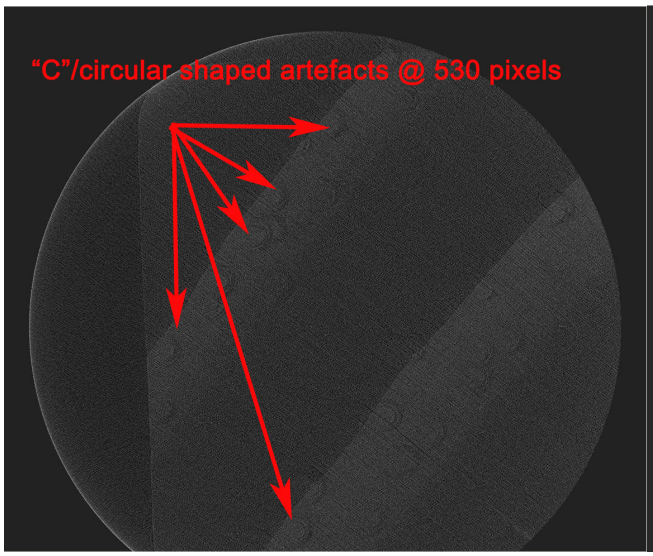

Figure 13: COFR Image of Wood at 530 pixels. Not wanted because of COFR artefacts.

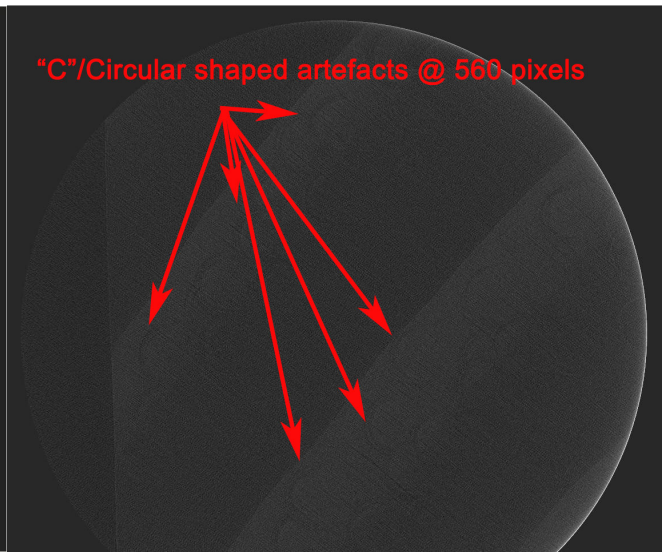

Figure 14: COFR Image of Wood at 560 pixels. Not wanted because of COFR artefacts.

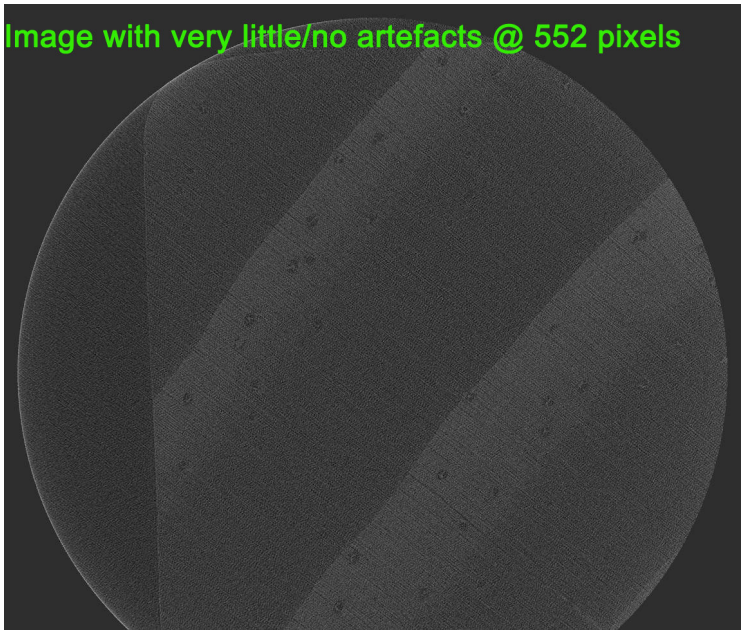

Figure 15: COFR Image of Wood at 552 pixels. This is a desired image & COFR, because there are no "C"/streak shaped artefacts.

7.5.2.12. Once a smaller range has been selected, repeat steps 7.5.2.2.-7.5.2.5, except differ the individual cofr values in smaller increments to further narrow down the exact centre of rotation (ie. 540, 545, 550, 555, 560…, then the next subset could be 545, 546, 547, 548, 549…).

7.5.2.13. Repeat steps 7.5.2.9. – 7.5.2.10. until one exact centre of rotation value is determined.

7.5.3. OBTAIN CALIBRATION VALUES

*This is done using **eXplore Reconstruction Interface**.*

7.5.3.1. Click **Advanced**.

7.5.3.2. Select **Reconstruction**.

7.5.3.3. Select **32-bit slice**.

7.5.3.4. Click Recon. eXplore MicroView is launched automatically once a reconstruction is complete.

7.5.3.5. Press ‘7’ and ‘8’ to select a rectangular region of air in the volume. Press ‘M’ to display the average ADU value of the selected region. Record the value.

7.5.3.6. Repeat step 5 to obtain the ADU values for *water* and *bone*.

7.5.3.7. Click **Advanced**.

7.5.3.8. Select **Reconstruction**.

7.5.3.9. Enter the recorded ADU values for air, water, and bone into the calibration textfields.

7.5.3.10. Click **OK**.

7.5.4. RECONSTRUCT A REGION OF INTEREST OR THE ENTIRE VOLUME

*This is done using **eXplore Reconstruction*** Inter face*.*

7.5.4.1. Check the **Mini Volume** checkbox.
7.5.4.2. Click **Thumbnail**.
7.5.4.3. Click **Recon**. eXplore MicroView is launched automatically once a reconstruction is complete.
7.5.4.4. Press 'Ctrl+7' to designate the intersection of the three planes as the first corner.
7.5.4.5. Move the three planes to define the second corner.
7.5.4.6. Press 'Ctrl+8' to designate the intersection of the three planes as the second corner.
7.5.4.7. Press 'S' to save the region coordinates.
7.5.4.8. Press **Load Crop** to load the saved coordinates. Run **Recon.** View finished thumb nail Recon images.
7.5.4.9. For Full/Half resolution scans, uncheck the **Mini-Volume** checkbox, and choose Full or Half resolution scan.
7.5.4.10. Press **Full Res** Click **Recon**. Note: this can take many hours of computational time.

7.5.5. QUEUING RECONSTRUCTION JOBS

*It is sometimes useful to queue reconstruction jobs to save time for an operator. This is done within the **eXplore Reconstruction Interface**.*

7.5.5.1. Click **Append** to place a reconstruction job into the *job queue*. Additional jobs can be queued by clicking **Append**.
7.5.5.2. Click **Job Manager** to view the job queue.

7.6 RISKS TO PERSONNEL AND PRECAUTIONS FOR RISK REDUCTION:

7.6.1. Because the MS scanner uses X-rays, avoid tampering with it.

7.7 CONTINGENCIES:

7.7.1. SLOW RECONSTRUCTIONS

If the reconstruction process is taking longer than anticipated, it may be because a local DOS box method is being used to perform the reconstruction computations. To resolve this contingency, under the eXplore Reconstruction Interface:

7.7.1.1. Click **Advanced**.
7.7.1.2. Select the **Network** tab.
7.7.1.3. Select a reconstruction server from the list.
7.7.1.4. Uncheck **Use local DOS box method**.
7.7.1.5. Click **Accept**.

7.7.2. CENTER OF ROTATION OFFSET

Occasionally the wisps will point in two opposing directions in the same image. Adjusting the value of the center of rotation will not remedy this problem. The

source of this problem is from the reconstruction software. The advised solution would be to adjust the center of rotation for the desired area of interest.

7.7.3. **SYSTEM SHUTDOWN**

This procedure should only be performed on rare occasions, such as a scheduled power outage.

7.7.3.1. Shutdown the MS console.
7.7.3.2. Turn the key in the MS scanner clockwise. You should now be able to take the key out. The green light by the power cables will be off.

8.0 REVIEWS AND REVISIONS:

This procedure shall be reviewed for compliance and effectiveness and revised as necessary.