



Manual 31
PET Procedures
ARIC-NCS III

Version 0.3 – 09/23/2021



PET Procedures Table of Contents

1	LIST OF ABBREVIATIONS	3
2	OVERVIEW	3
3	POSITRON EMISSION TOMOGRAPHY (PET).....	3
3.1	SITE QUALIFICATION.....	3
3.2	ISOTOPE ORDERS.....	4
3.3	SEQUENTIAL APPOINTMENTS	5
3.4	MEASURING WEIGHT	5
3.5	ISOTOPE INJECTION.....	5
3.6	SCANNING	6
3.7	SCAN DISCONTINUATION	6
3.8	ANONYMIZING DATA.....	6
3.9	DATA TRANSFER	7
3.10	ARCHIVE PROCEDURES.....	8
3.11	REQUEST FOR REPEAT PET SCANS	8
4	XNAT DESKTOP CLIENT USER GUIDE	8
4.1	INSTALLATIONS	8
4.2	CONNECTING XNAT DESKTOP CLIENT TO YOUR CNDA	10
4.3	UPLOADING IMAGE SESSIONS.....	12
4.4	SELECTING A PROJECT AND SUBJECT.....	12
4.5	SELECTING AN IMAGE SESSION	13
4.6	VERIFYING THE VISIT DATE	14
4.7	SELECTING SCANS TO UPLOAD	14
4.8	SPECIFYING SESSION LABEL AND OTHER VALUES.....	14
4.9	VISUAL INSPECTION OF DICOM IMAGES	14
4.10	INITIATING THE UPLOAD TRANSFER	15
4.11	MANAGING TRANSFERS	16
4.12	PAUSING AND RESUMING TRANSFERS.....	16
4.13	CANCELLING AND RESTARTING TRANSFERS.....	17
4.14	UPON COMPLETION OF UPLOAD.....	17
4.15	CLEARING COMPLETED TRANSFERS	18
5	APPENDICES	18
	APPENDIX 1. SCANNERS	18

1 LIST OF ABBREVIATIONS

ARIC	Atherosclerosis Risk in Communities
CNDA	Central Neuroimaging Data Archive
DICOM	Digital Imaging and Communications in Medicine
IRB	Institutional Review Board
IVF	PET Imaging Visit form
MRI	Magnetic Resonance Imaging
NCS	Neurocognitive Study
PET	Positron Emission Tomography
PRE	PET Recruitment and Eligibility form
WashU	Washington University at St. Louis

2 OVERVIEW

This manual of operations describes positron emission tomography (PET) procedures pertinent to PET technologists working on the Atherosclerosis Risk in Communities Neurocognitive Study (ARIC-NCS). Details about the procedures performed by field staff are described in ARIC Manual 34 (MRI and PET Procedures).

PET procedures are conducted utilizing standardized protocols. These protocols will be identical across participants. All PET technologists must be fully familiar with this manual of procedures, be trained and certified in the appropriate protocols, and remain standardized throughout data collection. Mastery of the procedures described in this manual is required so that patterns in the ARIC data can reflect differences between participants and their characteristics as opposed to differences between technicians or field centers.

3 POSITRON EMISSION TOMOGRAPHY (PET)

3.1 SITE QUALIFICATION

Prior to scanning any participant, each PET site will be visited (in-person or via remote visit) by Dr. Arman Rahmim or another designee to ensure that the site meets the necessary qualifications.

The Coordinating Center and PET reading center will track the PET technologist(s) performance throughout this study on the following: protocol violations (changing parameters), incomplete data, failure to send images to PET reading center in a timely manner, too much motion and incorrect or incomplete labeling of the transferred images. Similarly, if participants complain about interactions with PET staff, this will be tracked and remediated. If the Coordinating Center, PI, or PET reading center identify any of these problems throughout this study, they will require the PET Tech to become re-trained/re-certified and site investigators will be notified.

3.2 ISOTOPE ORDERS

Each site will be responsible for placing isotope orders with PETNET. The University of Mississippi Medical Center is the keeper of the funds; therefore, all invoices will be sent to Tonya L. Beauchamp (via TLBeauchamp@umc.edu) for payment. The invoices on record will be documented as shown in the following tables.

Table 1a. Forsyth Invoice Documentation

Scan Site	136118
Customer	35282
Party Site	156391
STATUS	A
PRIMARY NAME	PETNet-Raleigh/Durhm
CUSTNAME1	UNIVERSITY OF MISSISSIPPI MEDICAL CENTER
SHIP TO	JH NIH RESEARCH-WAKE FOREST-AMYVID
ADDRESS1	JH NIH RESEARCH-WAKE FOREST SCHOOL OF MEDICINE
ADDRESS2	ONE MEDICAL CTR BLVD
CITY	Winston Salem
STATE	NC
ZIP	27157

Table 1b. Jackson Invoice Documentation

Scan Site	136911
Customer	35282
Party Site	156386
STATUS	A
PRIMARY NAME	PETNet - New Orleans
CUSTNAME1	UNIVERSITY OF MISSISSIPPI MEDICAL CENTER
SHIP TO	JH NIH RESEARCH-UMMC-AMYVID
ADDRESS1	JH NIH RESEARCH-UNIV OF MISS MED CTR
ADDRESS2	350 W WOODROW WILSON
CITY	Jackson
STATE	MS
ZIP	39213

Table 1c. Washington County Invoice Documentation

Scan Site	136928
Customer	35282
Party Site	156387
STATUS	A
PRIMARY NAME	PETNet - Philadelphia
CUSTNAME1	UNIVERSITY OF MISSISSIPPI MEDICAL CENTER
SHIP TO	JH NIH RESEARCH-HAGERSTOWN IMAG-AMYVID
ADDRESS1	JH NIH RESEARCH-HAGERSTOWN IMAGING

ADDRESS2	11236 ROBINWOOD DR STE 106
CITY	Hagerstown
STATE	MD
ZIP	21742

3.3 SEQUENTIAL APPOINTMENTS

Field staff are encouraged to schedule 2 to 4 PET scans in a row since this is more cost efficient for transporting the PET isotope. A potential timetable for completing back-to-back PET scans with two participants is provided below.

Table 2. Potential Timetable for PET Scans with Two Participants

Procedure	Time	
	Participant #1	Participant #2
Written consent (if applicable*)	1:00	1:45
Weigh participant	1:20	2:05
IV insertion, injection, then remove IV lines	1:30	2:15
Participant goes to restroom	2:10	2:55
Position participant supine on PET scanner table	2:15	3:00
Scan Acquisition (50 minutes after injection)	2:20	3:05
Scan Transition (70 minutes after injection)	2:40	3:25
Participant goes from PET scanner table to prep room	2:45	3:30
Discharge participant	2:50	3:35

*If participant has already been consented for the PET scan (if they had the MRI scan and consent first, for instance), no repeat consent is required.

Appointment cancellations require notification at least the night prior to the PET scan (amount of advance notification required varies from site to site) as well as notification of the company that makes and transports the PET isotope. The PET technologists working at each imaging facility will need to order a dose of the PET isotope in advance of each PET scan. Ideally, this will occur 5 days before the PET scan. Consequently, it is critical for field staff to inform the lead PET technologist at each imaging facility about the number of doses needed from week to week. The process for coordinating these orders will vary from site to site and should follow similar procedures and timing to those used in the ARIC-PET study.

3.4 MEASURING WEIGHT

During a scheduled appointment, the weight of the participant will be measured by field staff. Weigh the participant and record the measurement to the nearest ones digit in pounds into question 3 of the PET Imaging Visit form (IVF) form. This should be done no more than 30 minutes prior to the planned florbetapir injection, which means the measurement may need to be deferred until the PET isotope has arrived and is being prepared for injection.

3.5 ISOTOPE INJECTION

An intravenous (IV) injection of [18F]florbetapir at a dose of 10 mCi +/- 10% (370 MBq) should be performed by a PET technologist utilizing a standard sterile protocol. The isotope is injected as instructed in Avid Radiopharmaceuticals/Lilly packaging materials. Information about quantity and timing should be recorded precisely in the IVF form.

After the IV is placed and the florbetapir is injected, field center and PET staff should relocate to the waiting room or imaging room. To avoid exposure to recurrent radiation, staff should *not* remain in the same room as the participant during the waiting period.

3.6 SCANNING

a. Participant Safety and Monitoring

All sites must follow the standard participant consent protocols as approved by their local Institutional Review Board (IRB).

b. Participant Confidentiality

Each site will be responsible for anonymizing all patient specific information according to each site's own local laws and regulations. Please follow the specific instructions for participant anonymization prior to sending the images.

c. Participant Positioning

Proper participant positioning is crucial for a successful PET scan. Therefore, it is important that each participant is positioned in the same manner for every scan. Participants should be positioned comfortably and be able to remain in that position for the duration of the scan. The PET technologists will facilitate this process by closely following the standard operating procedures for patient positioning at their site.

d. Scan Acquisition

Scans will be obtained after a 50-minute uptake period of the radiotracer, florbetapir. The scan should last 20 minutes and consist of dynamic acquisition of 4 x 5 min frames. It is crucial that the participant's position is checked several times throughout the duration of the scan. Any movement during the scan should be recorded along with time of movement, and this information should be documented on the IVF form and communicated with the PET reading center. Once the scan is completed, staff will ask if the participant noticed any adverse effects. Responses will be recorded on the IVF form. The Principal Investigator should be notified about any adverse effects.

Specific scanner protocols will be resolved with the sites individually by the PET reading center.

e. Phantom Scans

A water phantom scan with ~1 mCi of F-18 should be performed every week with scheduled scans and transferred to the PET reading center to ensure spatial uniformity and quantitative accuracy across study sites.

3.7 SCAN DISCONTINUATION

If the participant experiences discomfort during the scan, every effort should be made to adjust the table, head coil, etc. to allow scan continuation. If the participant elects not to complete the scan, then the PET scan must be abandoned and the Study Coordinator must be notified.

3.8 ANONYMIZING DATA

Each site will be responsible for anonymizing all patient-specific information according to local laws and regulations. At a minimum, the following Digital Imaging and Communications in Medicine (DICOM) fields will be replaced:

Patient ID: Must be replaced with the Participant ID provided by the Coordinating Center (Site identifier (F/J/M/W; in upper case) followed by 6 digit ARIC ID, without any spaces and without any additional characters; for example: "W123456")

3.9 DATA TRANSFER

a. Transfer Setup

Scans should be transferred to each site's respective project in the CNDA. To set up a CNDA account:

1. Go to the CNDA website at cnda.wustl.edu
2. Click the "Register" link in the Login box.
3. The "New User Registration" form will display.
4. Complete the form and click the "Register" button.
5. You will receive an email with a link to verify your email address, please click link.

After an account is set up, the necessary users will be given upload access to the relevant project on the CNDA.

More detailed instructions for user registration, data upload/download and deleting erroneous data can be found in the XNAT Desktop Client User Guide in Section 4.

b. Header Information

After a scan is completed, the scans should be uploaded to the WashU CNDA using the XNAT Desktop Client. The following attributes should be included in the PET scan DICOM header:

Patient ID: "X#####"

- X = Site Identifier (F, J, M, or W)
- ##### = Study Participant ID

Radiopharmaceutical: "[18F]Florbetapir"

Radiopharmaceutical Start Time: "HHMMSS"

Radionuclide Total Dose (Bq): "#####"

Acquisition Date: "MMDDYYYY"

Acquisition Time: "HHMMSS"

It is critical that the DICOM header information be entered in the format above and without any extra characters to give key information about the isotope amount and to facilitate coregistration with MR and PET images.

c. Phantom Scans

Phantom scans should be transferred weekly to the WashU CNDA using the XNAT Desktop Client. The following attributes should be included in the phantom scan DICOM header:

Patient ID: "Phantom"

Radiopharmaceutical: "[18F]Florbetapir"

Radionuclide Total Dose (Bq): "#####"

Acquisition Date: "MMDDYYYY"

Acquisition Time: “HHMMSS”

3.10 ARCHIVE PROCEDURES

Every PET scan for the study must be archived at the imaging facility following the department’s standard local practice in addition to the data transfer to WashU immediately after the PET scan. Additional data transfers or copies may be requested by WashU in the event that a data transfer is interrupted or incomplete.

3.11 REQUEST FOR REPEAT PET SCANS

If there is a problem with delivery of the florbetapir tracer, appointments may need to be rescheduled. In the event that delivery is delayed past the scheduled injection time enough that the scan cannot be completed, the company that makes the isotope should be contacted and notified about the delayed arrival, so we are not charged for the delayed isotope.

4 XNAT DESKTOP CLIENT USER GUIDE

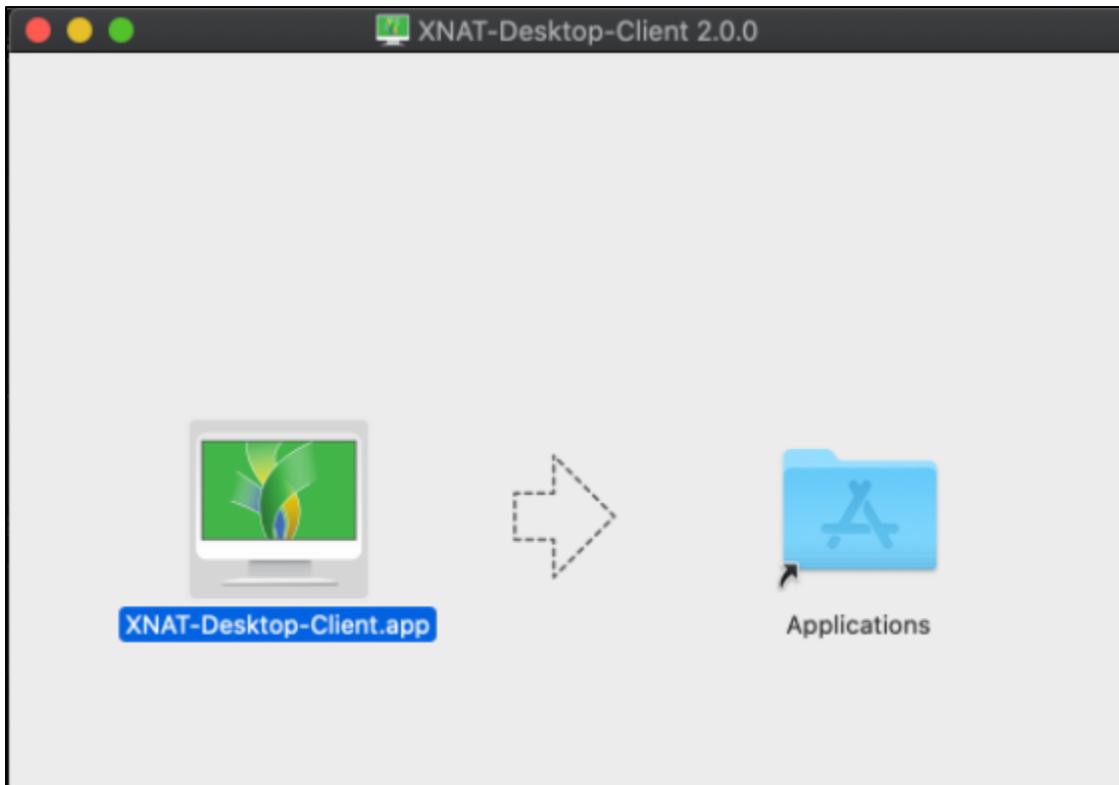
4.1 INSTALLATIONS

The XNAT Desktop Client is available for use on modern Mac, Windows, and Linux operating systems, though the installation methods and requirements differ for each system.

a. Mac OS Installations

The XNAT Desktop Client for Mac OS includes an embedded Java Runtime Environment. There have been known issues accessing this bundled resource in virtualized Mac environments, so we strongly recommend only installing the client on a native Mac OS.

Installation is very straightforward.



1. Download the .DMG file from download.xnat.org/desktop-client
2. Open the .DMG file and drag the app into your Applications folder
3. Open the application for the first time
4. If you get a security warning when trying to launch this application, open **System Preferences > Security > General**. You should see a message about this app and the option to "Open Anyway".

b. Windows OS Installations

The XNAT Desktop Client for Windows includes an embedded Java Runtime Environment. There have been known issues accessing this bundled resource in virtualized Windows environments, so we strongly recommend only installing the client on a native Windows OS.

Installation is very straightforward.



1. Download the .exe file from download.xnat.org/desktop-client
2. Open the .exe file, which launches the one-step installer

Installing the application will install file-handling support for all your browsers so that image session download requests from the XNAT web app will open in your desktop client.

c. Linux Installations

 Linux users must have a compatible JRE installed in order to use the XNAT Desktop Client.

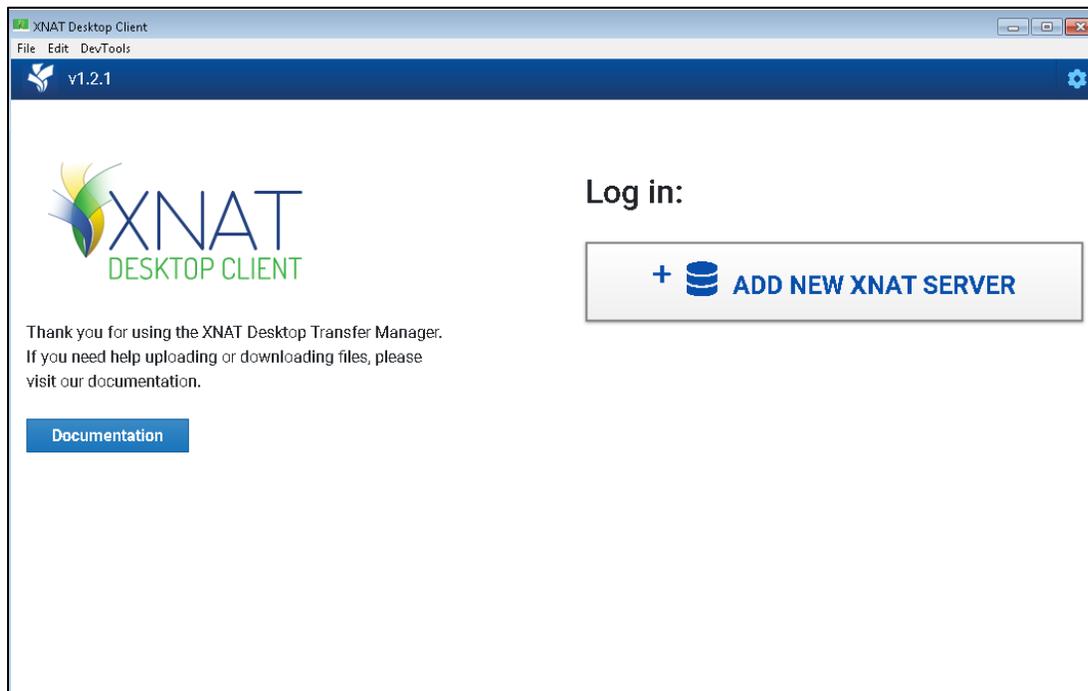
The XNAT Desktop Client for Linux is distributed as an AppImage, which is an executable application that does not need a separate installation step. For more on working with AppImage files, see: <https://docs.appimage.org/user-guide/faq.html#question-how-do-i-run-an-appimage>

1. Download the AppImage file from download.xnat.org/desktop-client
2. Make the AppImage file executable
3. Run the AppImage file

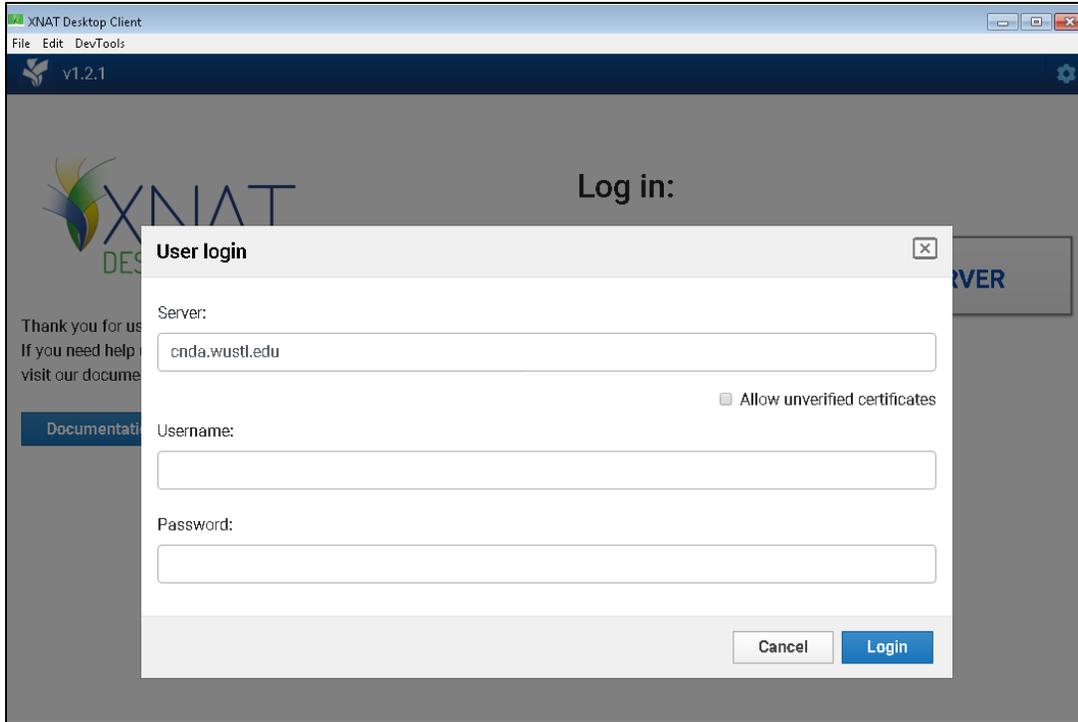
Running the application for the first time will install file-handling support for all your browsers so that image session download requests from the XNAT web app will open in your desktop client.

4.2 CONNECTING XNAT DESKTOP CLIENT TO YOUR CNDA

The first time you open the XNAT Desktop Client, you'll be prompted to add the CNDA server address to log into.

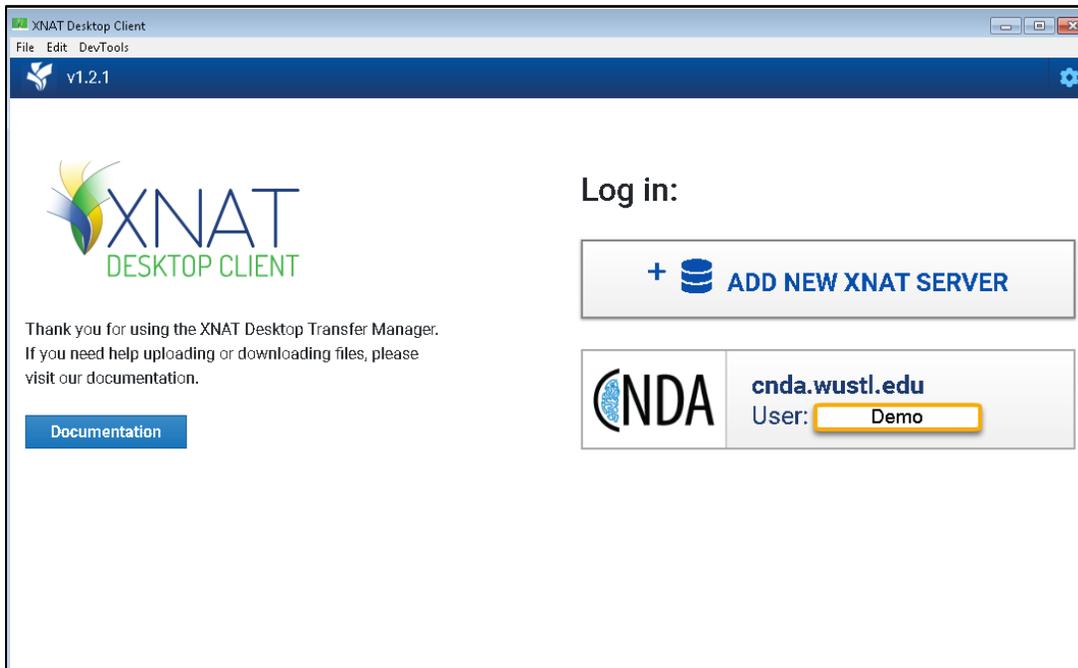


Clicking on “Add New XNAT Server” will allow you to set a server (enter `cnda.wustl.edu`), username and password (same as what you use on CNDA). **Note: You do not need to specify the http / https protocol. The application will detect this for you.**



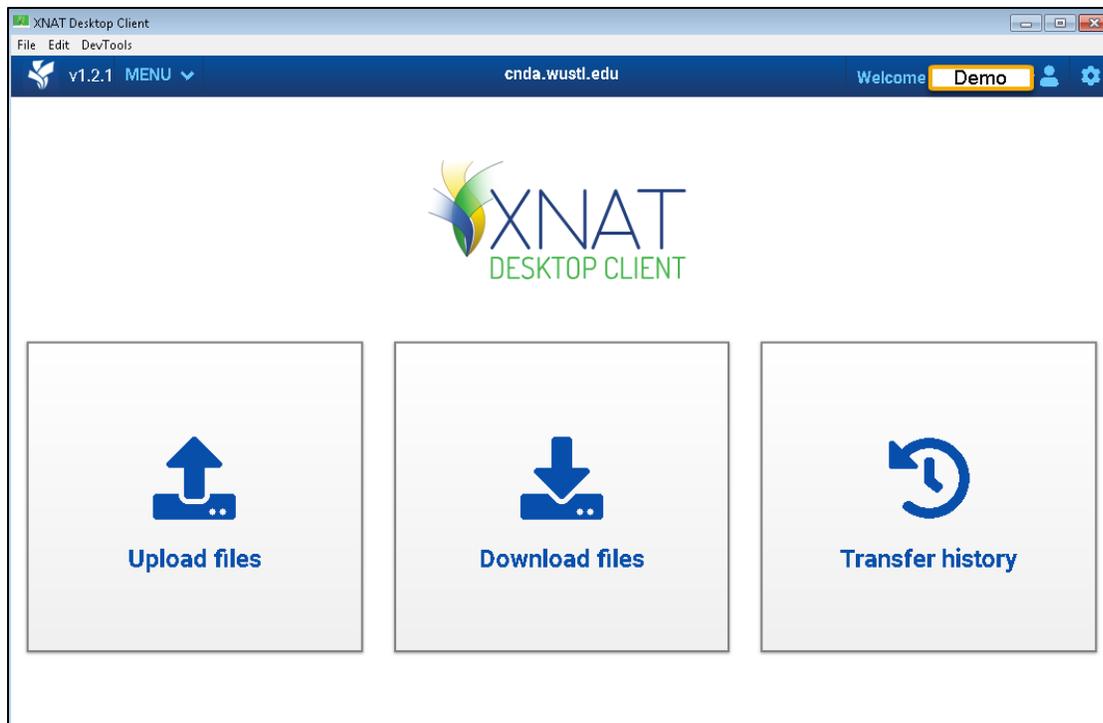
Once you have successfully logged in, the Desktop Client saves your username and server information to make it easy to log in again in the future.

Note: Your password is never saved, it is only used to log in.



You can manage the saved server logins in your Desktop Client settings by clicking the “Settings” gear icon in the top-right corner of the UI and clicking on the “Connections Settings” tab.

Once you are successfully logged in to CNDA server, you’ll see that you have two activities necessary for upload sites: Upload files and Transfer history.



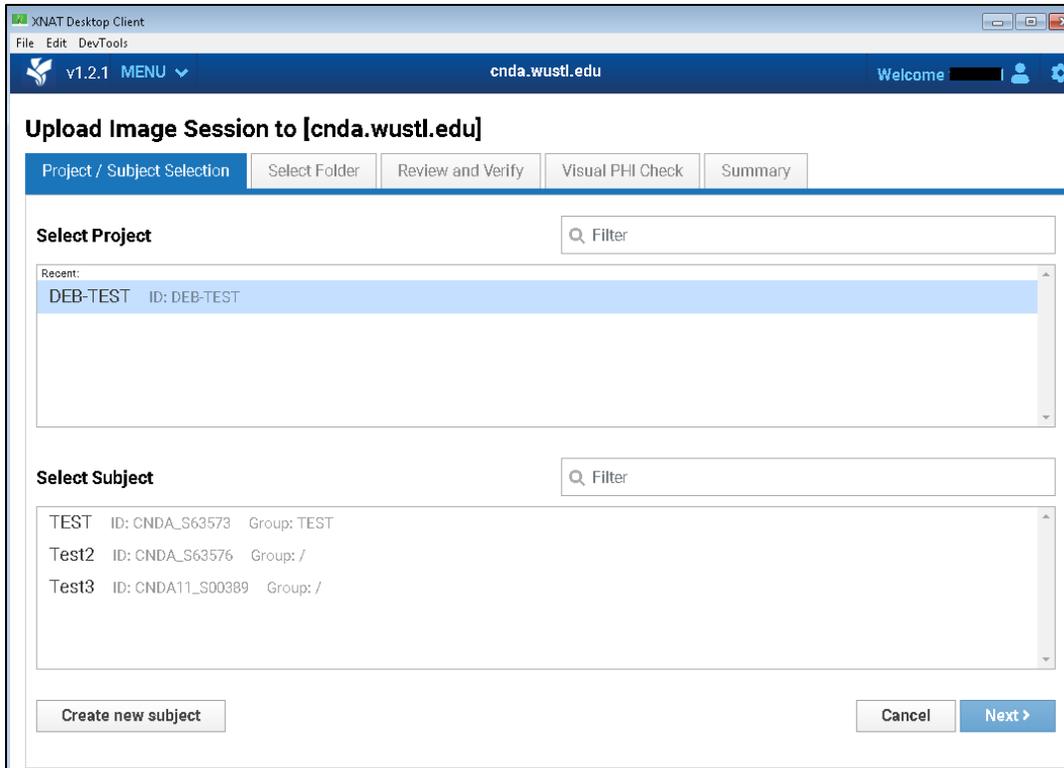
4.3 UPLOADING IMAGE SESSIONS

With an authenticated CNDA connection, you can select image sessions to upload. Click "Upload Files" to get started.

4.4 SELECTING A PROJECT AND SUBJECT

The Desktop Client will display a list of projects that you have permission to upload image session files to. This permission is given to project members. If you do not see the correct project in this listing, contact that project owner or contact the CNDA Help Desk (cnda-help@wustl.edu).

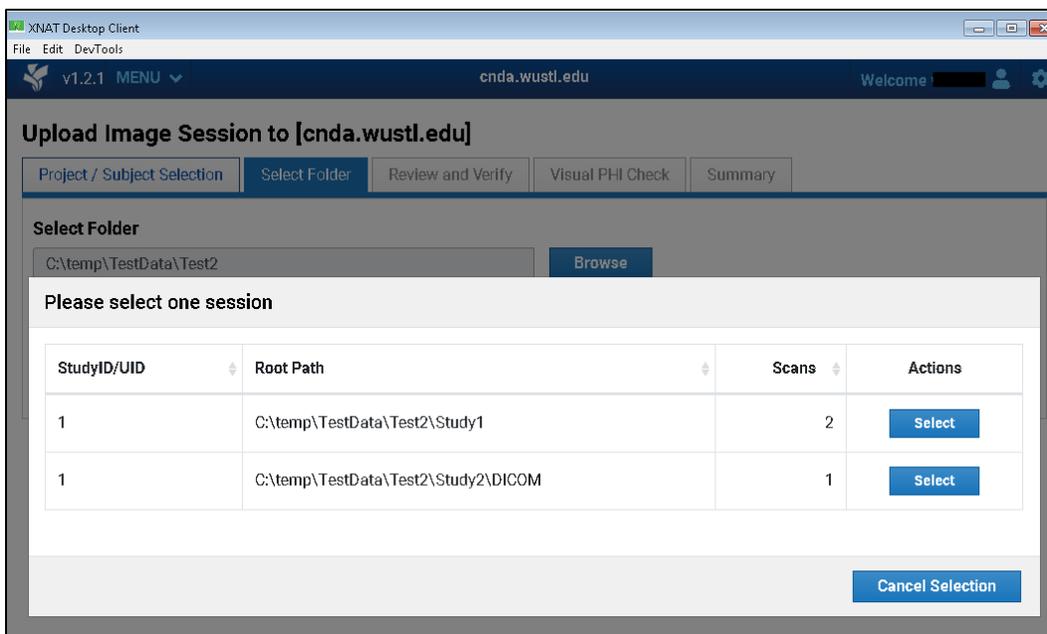
Once you select a project, the Desktop Client will display a list of subjects in that project that you can upload your image session to. You can select one of these or create a new subject.



4.5 SELECTING AN IMAGE SESSION

After selecting a project and subject to upload to, you will be prompted to select a folder on your desktop that contains one or more DICOM image sessions. Select the folder that has your image session in it.

If you select a folder that contains more than one session, you will be prompted to pick one of those sessions before continuing.



4.6 VERIFYING THE VISIT DATE

☑ This step may or may not be required depending on your XNAT's configuration, or the configuration of the project you are uploading to.

You may need to enter the visit date of the image session that you are uploading, before proceeding. This is an error-prevention measure, to ensure that users don't inadvertently upload the wrong session to a given project.

4.7 SELECTING SCANS TO UPLOAD

By default, all scans in the image session will be selected to upload. You can select a subset of these scans to upload if you like.

The screenshot shows the XNAT Desktop Client interface. The title bar reads 'XNAT Desktop Client' and the window title is 'cnda.wustl.edu'. The main window has a navigation bar with tabs: 'Project / Subject Selection', 'Select Folder', 'Review and Verify' (active), 'Visual PHI Check', and 'Summary'. Below the navigation bar, there are input fields for 'Project' (DEB-TEST), 'Subject' (Test2), and 'Experiment Label (Session)' (Test2_MR_1). A note below the session label states: 'This field has been auto-populated. If you specify a session label that matches a session already in this project, XNAT will attempt to merge selected scans into the existing session'. Below this is a section titled 'Confirm The Scans To Be Uploaded' with a note: 'Note: Unchecked scans will not be uploaded'. A table lists the scans to be uploaded:

<input checked="" type="checkbox"/>	Series Number	Series Description	Modality	File Count	Size (bytes)
<input checked="" type="checkbox"/>	1	localizer	MR	3	441 kB
<input checked="" type="checkbox"/>	2	MPRAGE GRAPPA2	MR	3	573 kB

Below the table is a 'Session Summary' section with the following details: Study ID: 1, Accession: undefined, Description: MR_Test, Date: 2012-01-10 16:15:35, Modality: MR, 2 scans in 6 files (0.97MB). At the bottom right, there are 'Cancel', '< Prev', and 'Next >' buttons.

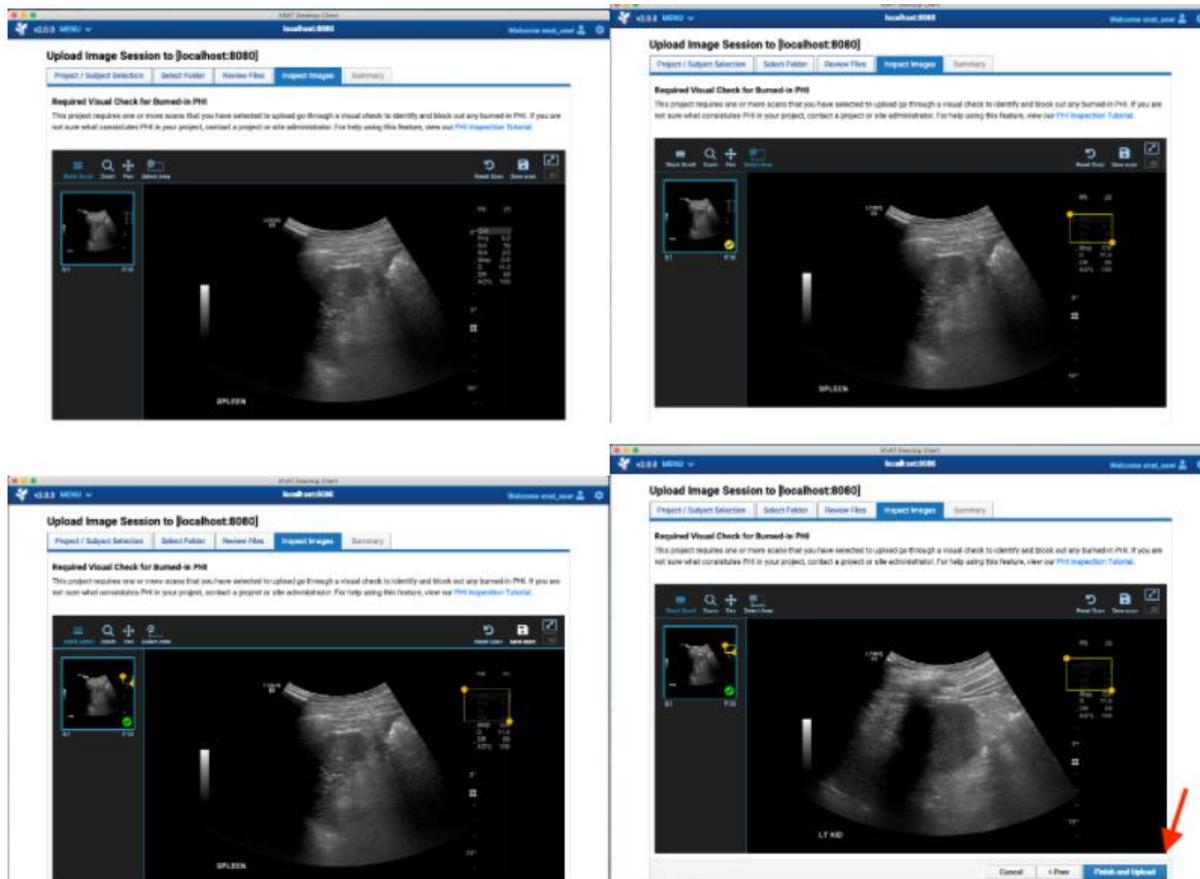
4.8 SPECIFYING SESSION LABEL AND OTHER VALUES

The Desktop Client will auto-generate a session label, based on the subject label and other variables. You can override this label if you like.

4.9 VISUAL INSPECTION OF DICOM IMAGES

The next step allows you to review the image data and look for PHI that might be burned into the pixels. See the screen captures below for Ultrasound images that have acquisition parameters included in the image data but not actual PHI. You start by clicking on the Select Area icon in the upper left part of the display. Draw as many rectangular regions as you need to remove unwanted pixels. As you draw these, they are highlighted with orange boxes, and you will also see an orange circle in the thumbnail view to indicate you have started the process. The rectangles that you draw are applied to all images in the current series. You can use the mouse to scroll through the series to ensure that all images are properly modified; right click and

scroll through the image panel. When you are satisfied, you need to click on the "Save scan" icon. The application will turn the circle that appears on the thumbnail image to green to indicate confirmation. If there are other series, you can perform the same procedure. When you are done, select the "Finish and Upload" button at the bottom right of the screen.



You are not required to search for PHI, and you are not required to draw any rectangles on any scan. If your images do not contain PHI burned into the pixels, then select "Finish and Upload" when you see this screen and continue to the next step. In a similar manner, your session may have multiple scans. The application is designed to capture rectangular regions separately for each scan. This allows you to black out pixels in different regions of the image data on a per scan basis. Again, you might have data with PHI in some scans but not in others, and the tool gives you the flexibility to manage those scans separately.

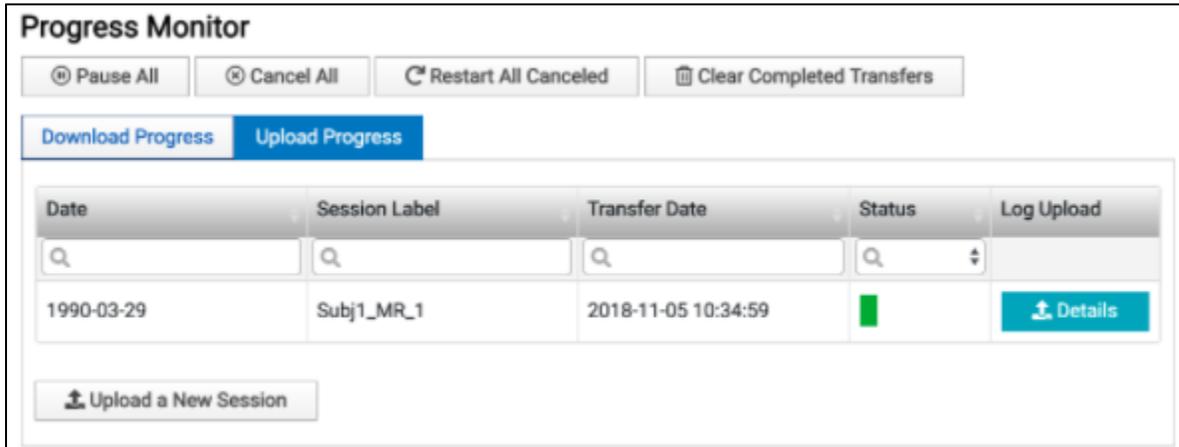
4.10 INITIATING THE UPLOAD TRANSFER

Once you start the upload, you will be taken to the transfer manager screen. You can watch the progress of the upload or start another workflow. As long as the application is running and you have an active network connection, the upload will proceed in the background. You can check on the progress of your data transfer at any time.

4.11 MANAGING TRANSFERS

The XNAT Desktop Client has a data transfer management panel for both uploads and downloads, allowing you to see the progress of the actions that you initiated. You can also pause, resume, or cancel those actions.

☑ Each transfer log is specific to the user account and XNAT instance that you are logged in with.

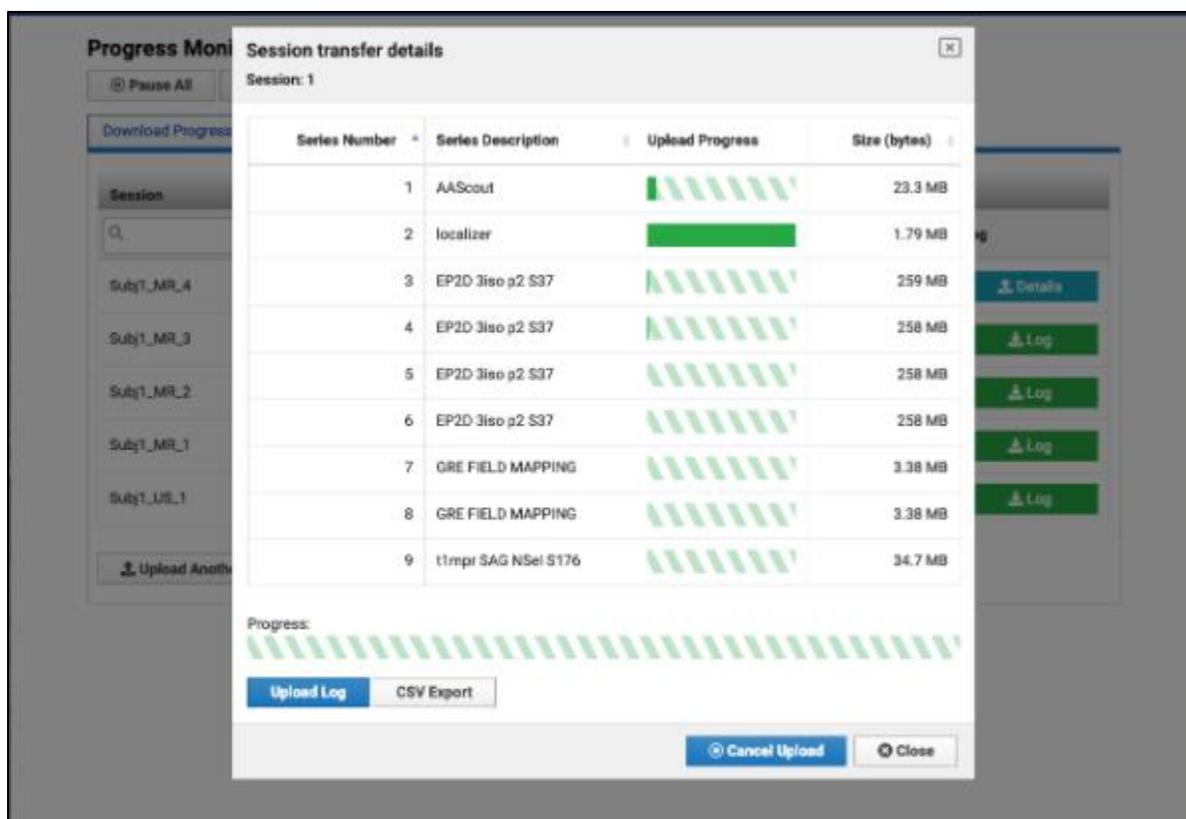


The screenshot shows the 'Progress Monitor' interface. At the top, there are four buttons: 'Pause All', 'Cancel All', 'Restart All Canceled', and 'Clear Completed Transfers'. Below these are two tabs: 'Download Progress' and 'Upload Progress', with 'Upload Progress' selected. The main area contains a table with the following columns: 'Date', 'Session Label', 'Transfer Date', 'Status', and 'Log Upload'. The table has one row of data: '1990-03-29', 'Subj1_MR_1', '2018-11-05 10:34:59', and a green status bar. A 'Details' button is next to the status bar. At the bottom, there is a button labeled 'Upload a New Session'.

Date	Session Label	Transfer Date	Status	Log Upload
1990-03-29	Subj1_MR_1	2018-11-05 10:34:59	█	Details

4.12 PAUSING AND RESUMING TRANSFERS

The Desktop Client allows you to pause and resume transfers individually if you would like to prioritize one transfer over another over limited network bandwidth or pause all transfers. Controls for affecting all transfers are located at the top of the Transfer Monitor page. Controls for affecting an individual transfer are located in the details modal for that transfer. (Click "Details" to view the modal.)

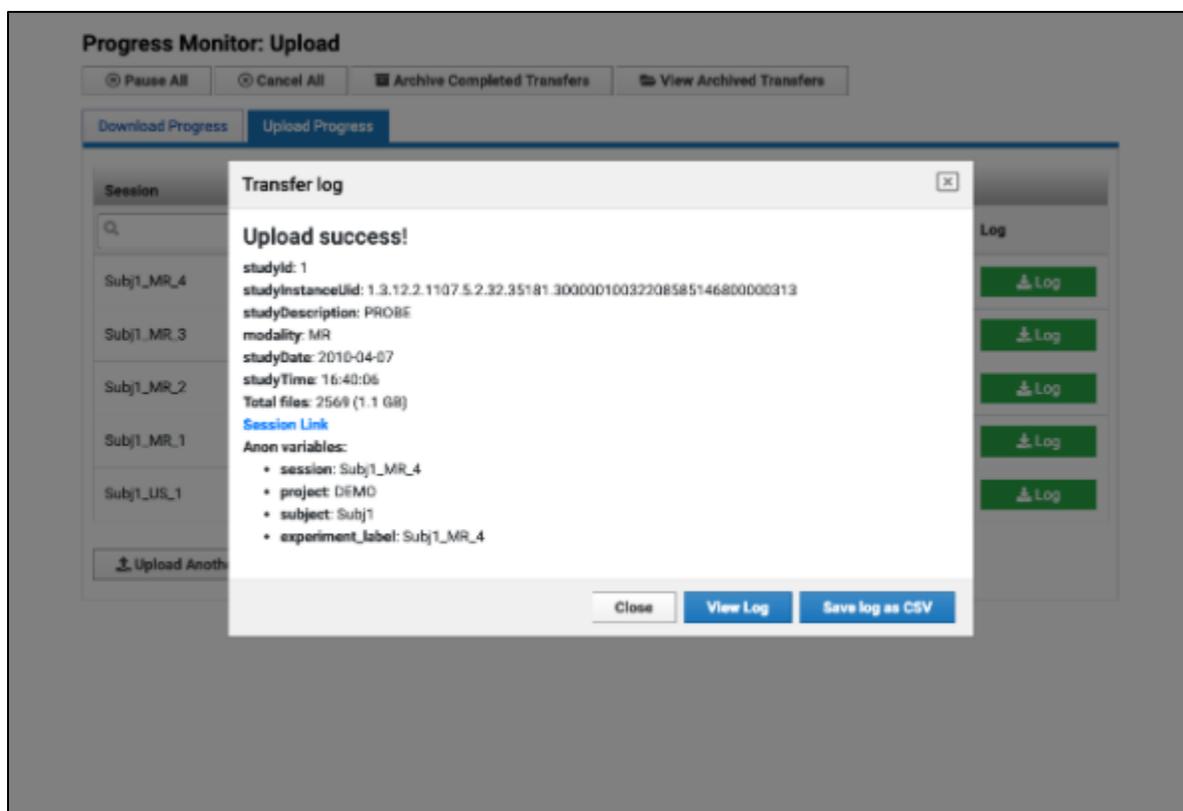


4.13 CANCELLING AND RESTARTING TRANSFERS

You can cancel a transfer if you like, and remove all canceled transfers from your queue. However, you can also restart a canceled download if you like.

4.14 UPON COMPLETION OF UPLOAD

If you had clicked on the “Details” button to observe a transfer, the application displays a dialog box when the session upload is complete. See the figure below. There are controls that allow you to view the transfer log or to store the log as a CSV file. If you did not click the “Details” button, the transfer completes and a “Log” button is available to you. Click on that button to see the same dialog box.



4.15 CLEARING COMPLETED TRANSFERS

If you want to keep a log of all your data transfers, feel free. However, if you find the long list to be unwieldy, you can clear completed transfers from this window by using the "Archive Completed Transfers" button at the top of the page. This action removes the logs from the active screen but leaves them in an archive area for you to view later.

5 APPENDICES

APPENDIX 1. SCANNERS

Site	Scanner	Reconstruction Protocol
Forsyth/Wake Forest	GE Discovery MI DR	VUE Point HD
Washington County/Hagerstown	Philips TruFlight Select PET/CT	3D-RAMLA
Jackson, MS	GE Discovery PET/CT 690	VUE Point HD