UCSD Center for fMRI

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UCSD Center for Functional MRI

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TBD

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Previous Seminar Materials

2.1 Previous Seminars

2.1.1 An Introduction to BIDS: Data Organization for Transparency and Reproducibility in Neuroimaging Research

Speaker: Amanda Bischoff-Grethe

Date: November 14th, 2018

`Intro to BIDS_Bischoff-Grethe`

CHAPTER 3

Imaging Protocol Documentation

3.1 CFMRI Imaging Protocol Documentation

3.1.1 CFMRI Multiband Protocol #1

Protocol Location and Receiver Coil Info

The ABCD protocol requires the use of the Nova Medical 32 channel head coil

The ABCD protocol can be found on both the 3T West and 3T East scanners under: * Adult >Template-> C_CFMRI_ABCD_Scan_Session1_v22

Pre-Scan Preparation

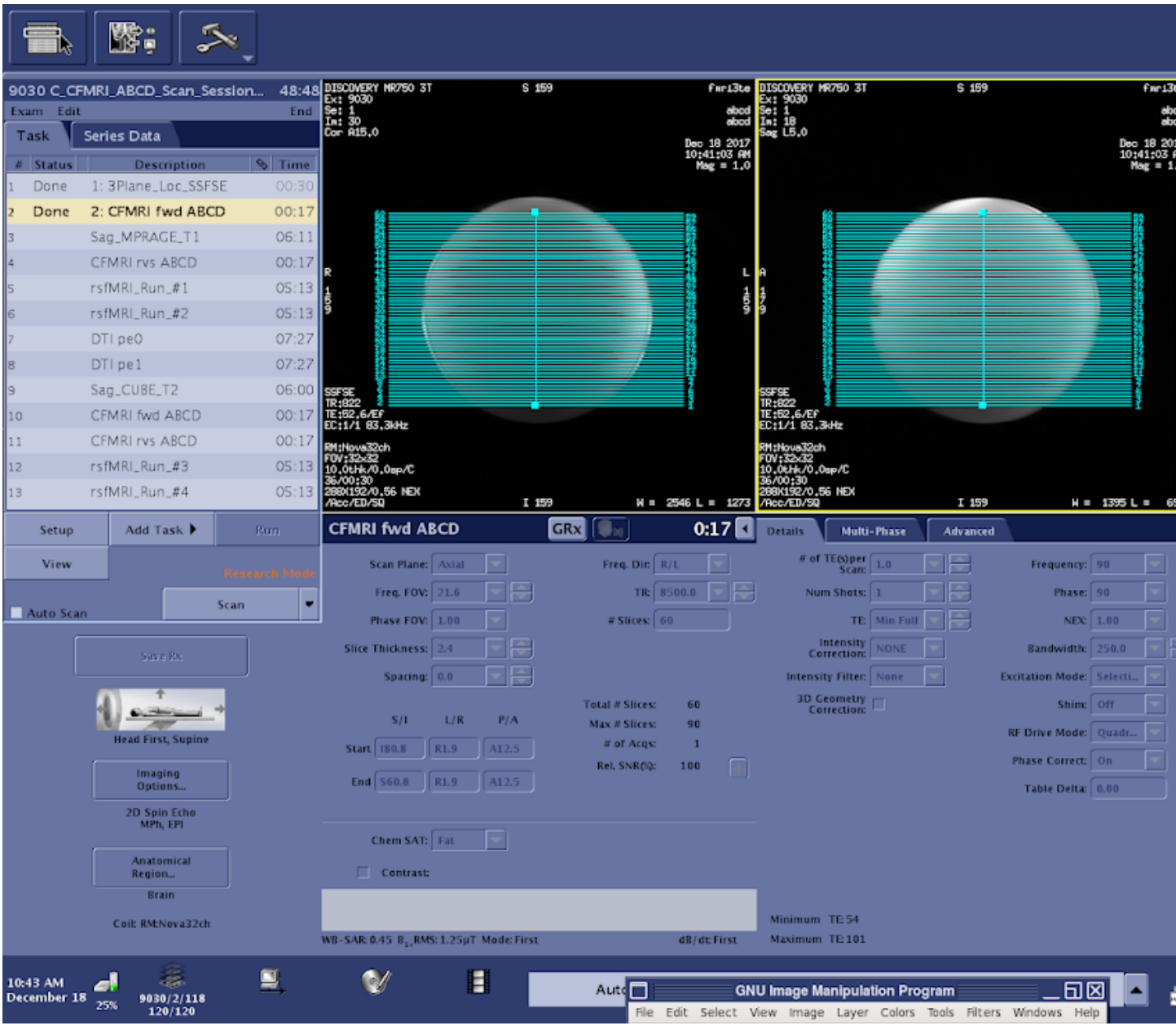
- Place the 32channel coil on the scanner table and plug it in
- Make sure the coil is recognized by the scanner by checking on the iROC monitor above the patient bed
- Setup peripheral equipment such as the projector, screen, stimulus laptop, etc.
- Setup the subject (blanket, emergency communication device, mirror, etc.) on the scanner patient bed
- Setup physiological monitoring if needed
- Register the subject and "Start Exam"

Data Acquisition: EPI & Topup Distortion Correction

CFMRI fwd ABCD (~17 sec)

- Magnetic susceptibility and geometric distortion artifacts can be addressed by acquiring two short sequences with opposite phase encoding directions (1. Forward: Anterior–>Posterior, 2. Reverse: Posterior–>Anterior), followed by preprocessing using FSL topup https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/topup

- The ABCD topup scans should have 60 slices
- The topup scans do not utilize multiband acceleration
- The number of slices you see in the Rx reflects the total acquisition coverage
- Center the slices over the desired location in the brain

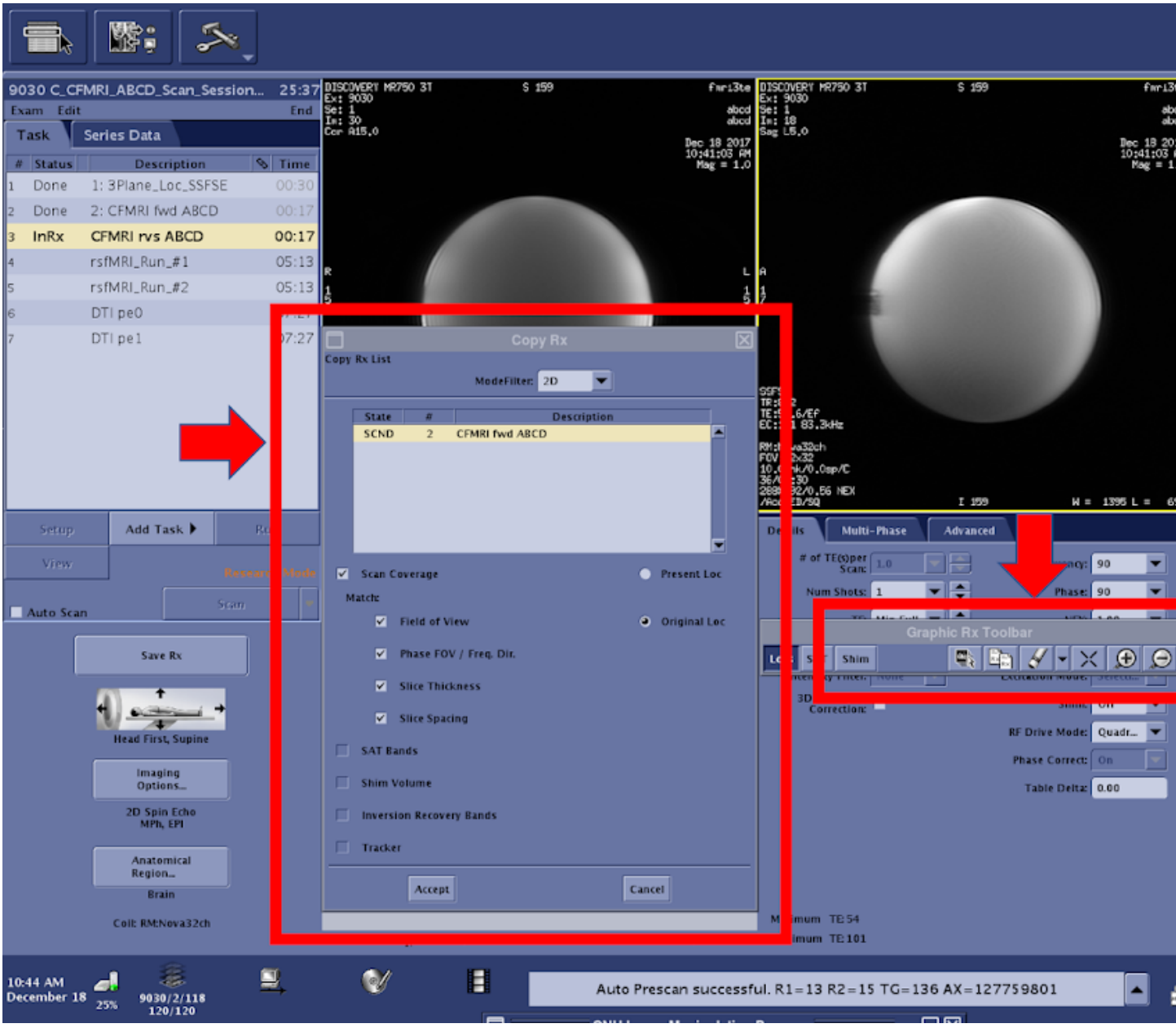


- **Save Rx–>Scan**
  - There may be a long (20 sec) pause before the topup scan begins

CFMRI rvs ABCD (~17 sec)

- To run the second (rvs) topup scan you will need to copy the Rx from the previous topup scan (fwd)

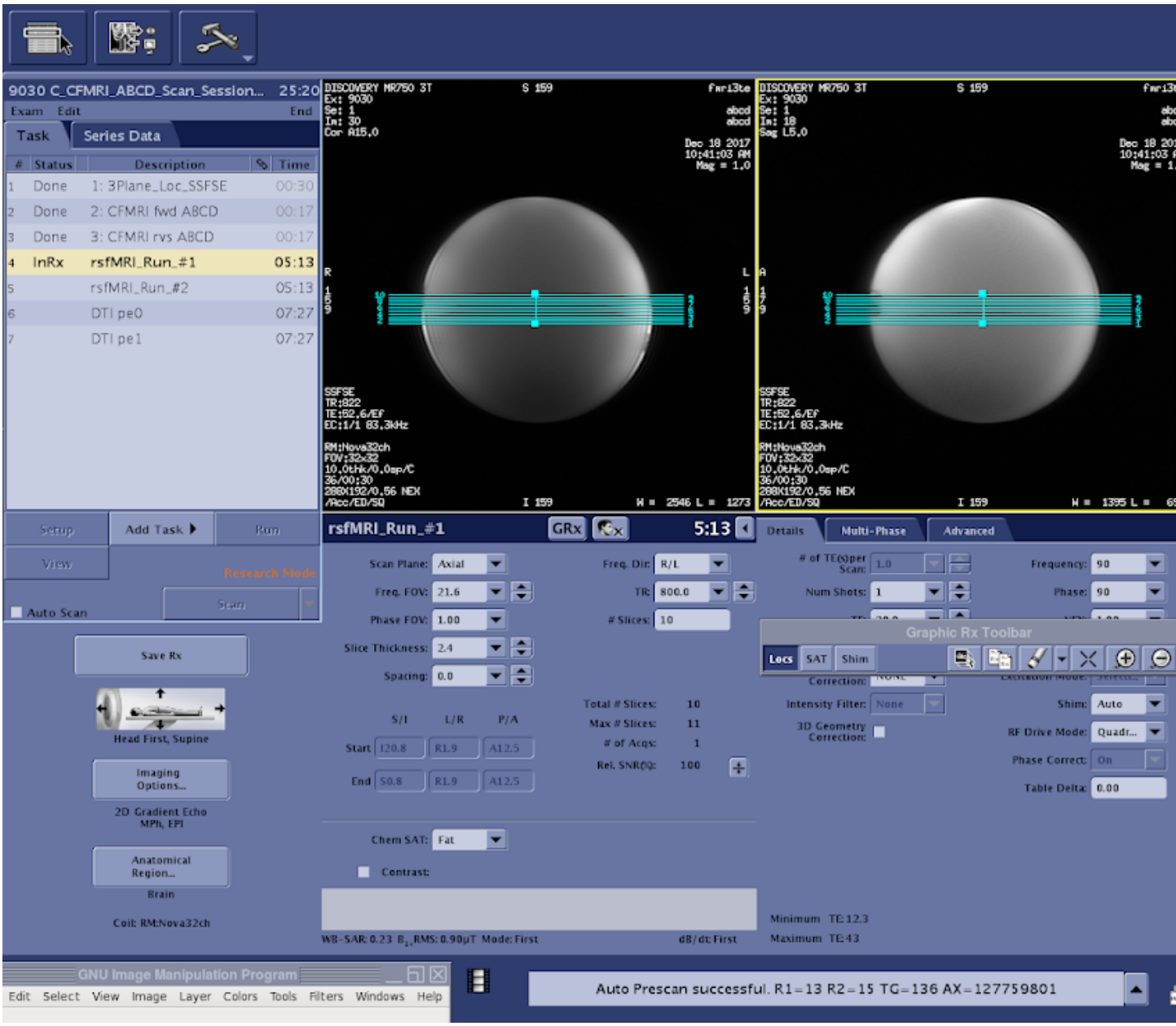
- **Use the Graphic Rx Toolbar**
  - Select the previous topup (fwd) scan Rx



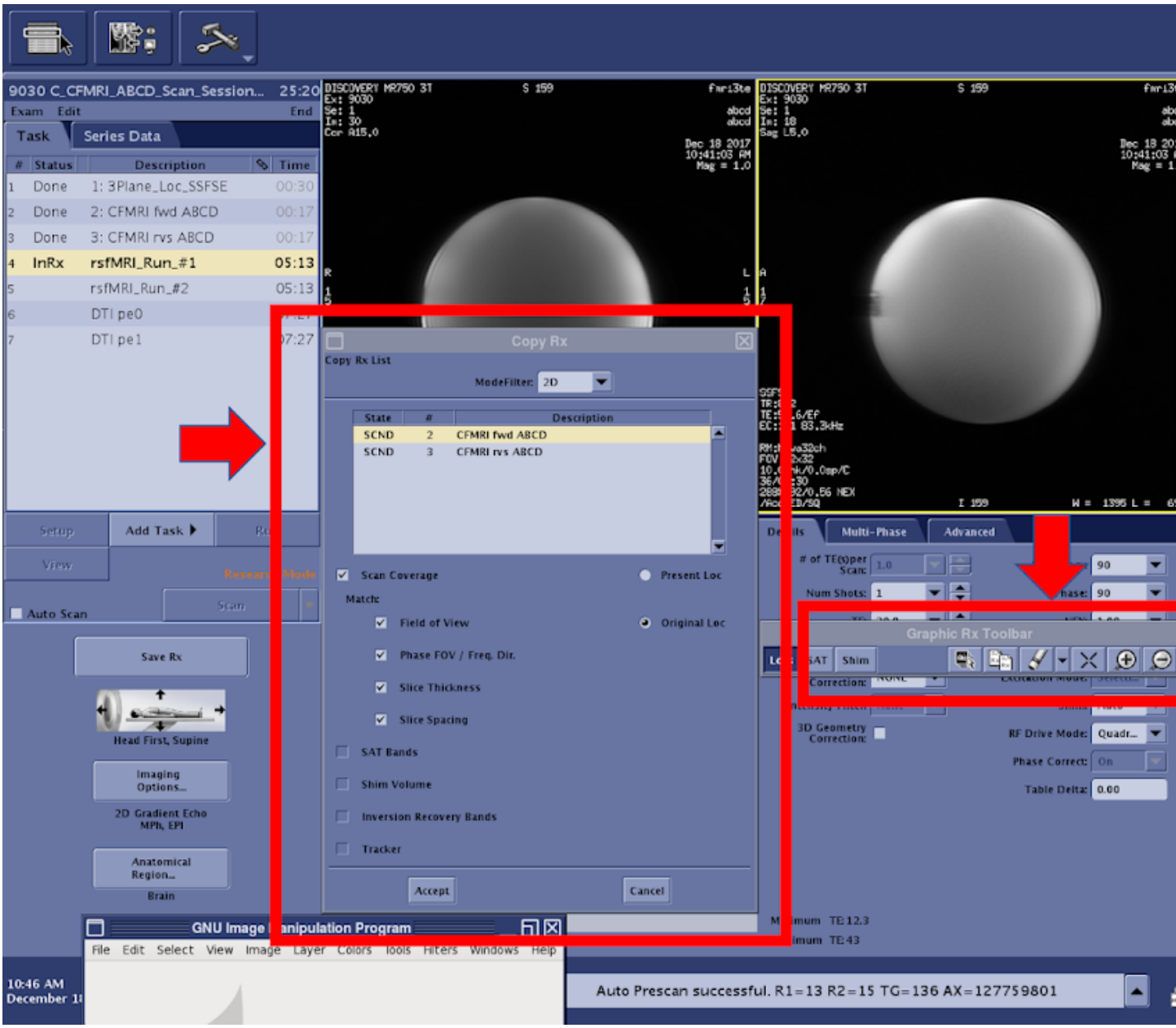
- Save Rx–>Scan

rsfMRI_Run_#(1-4) (~5.5 min each)

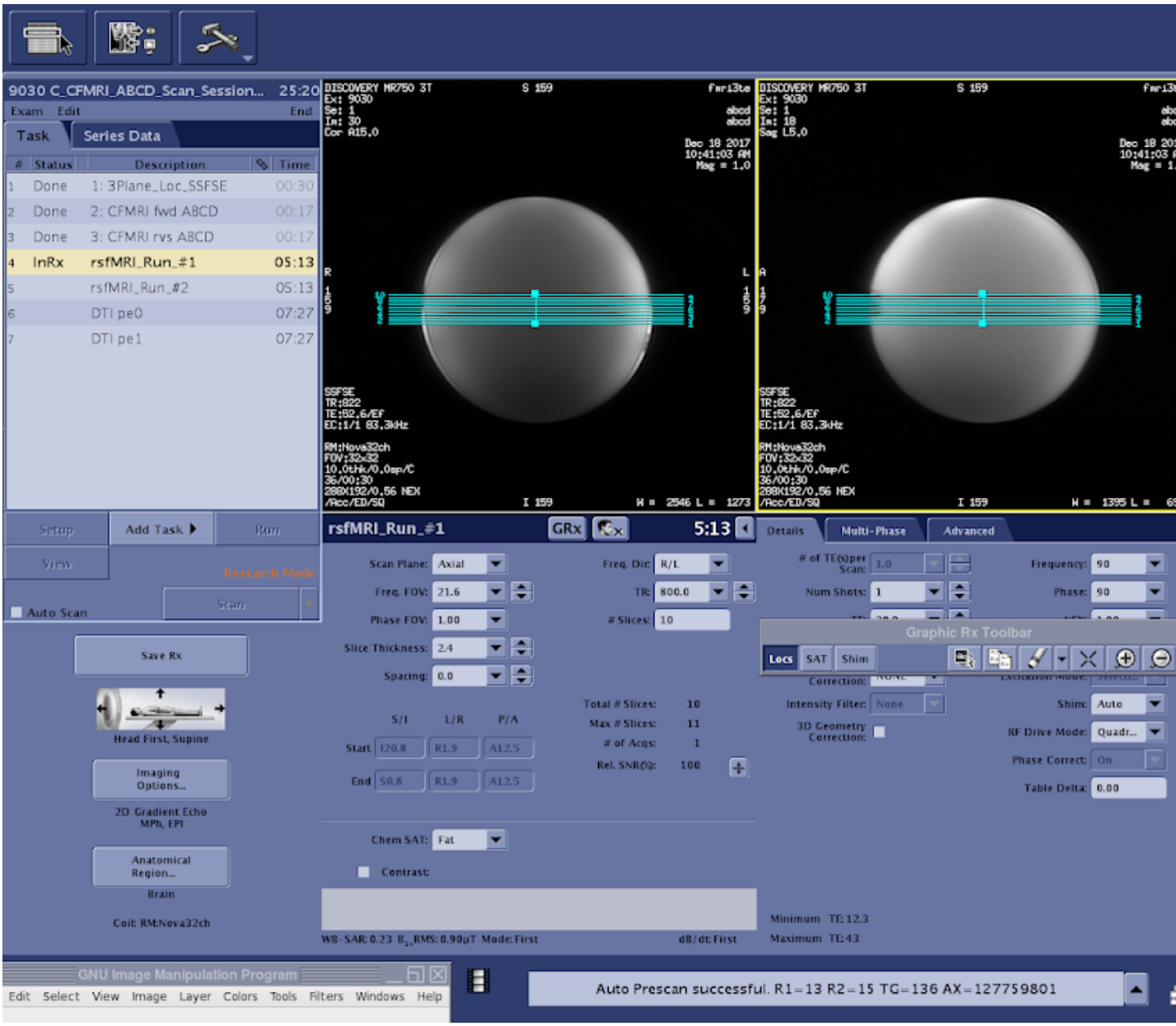
- The multiband ABCD fMRI sequence acquires 60 total slices using a multiband factor of 6.
- Using the current GE MR750 software available on CFMRI scanners, only 10 of the 60 slices are visible during the final Rx setup phase



- Erase the default Rx (10 visible slices) and copy the full (60 slice) Rx from the CFMRI fwd ABCD series



- Copying this Rx will keep the location consistent across topup and fMRI scans, which is critical for the success of your imaging session
- After the slice coverage is successfully copied from the topup scan, reduce the number of visible slices to the original parameter setting (10 slices)
- **The duration of your fMRI scan can be adjusted using Phases per Location on the console (Multi-Phase tab)**
  - The total scan time for your scan is calculated by TR x number of Phases per Location
  - **IMPORTANT: The first 2 x Multiband Factor (2 x 6 (ABCD MB factor) = 12) reps will not be included in your f**
    - 12 reps x 1000 ms (TR) = 9.6 seconds of data not included in the final dataset
    - The timing of your stimulus presentation must be designed with this in mind

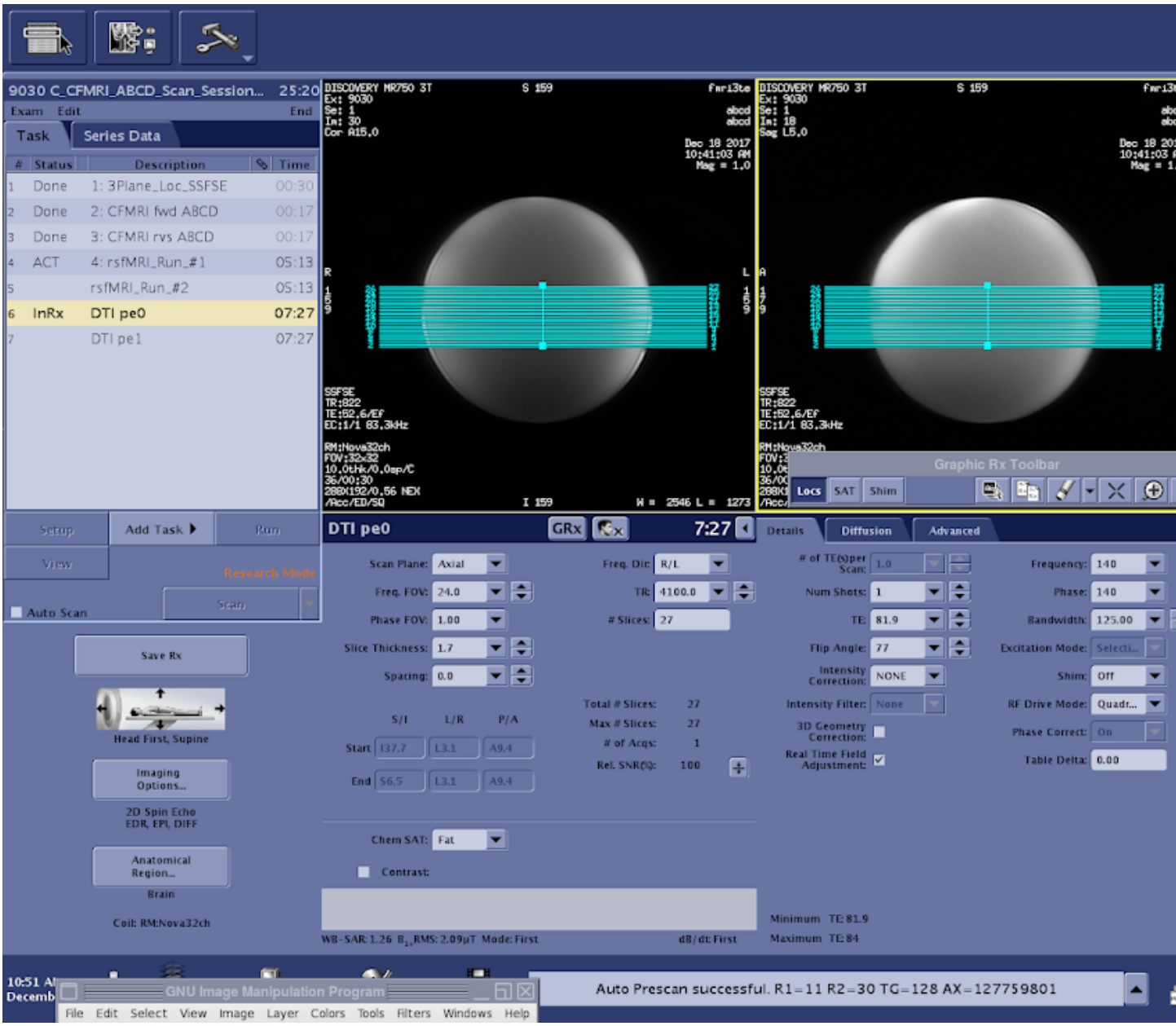


- **When you are ready to save the Rx, check the scan time to ensure it is an accurate reflection of the expected acquisition tir**
  - Save Rx–>Scan

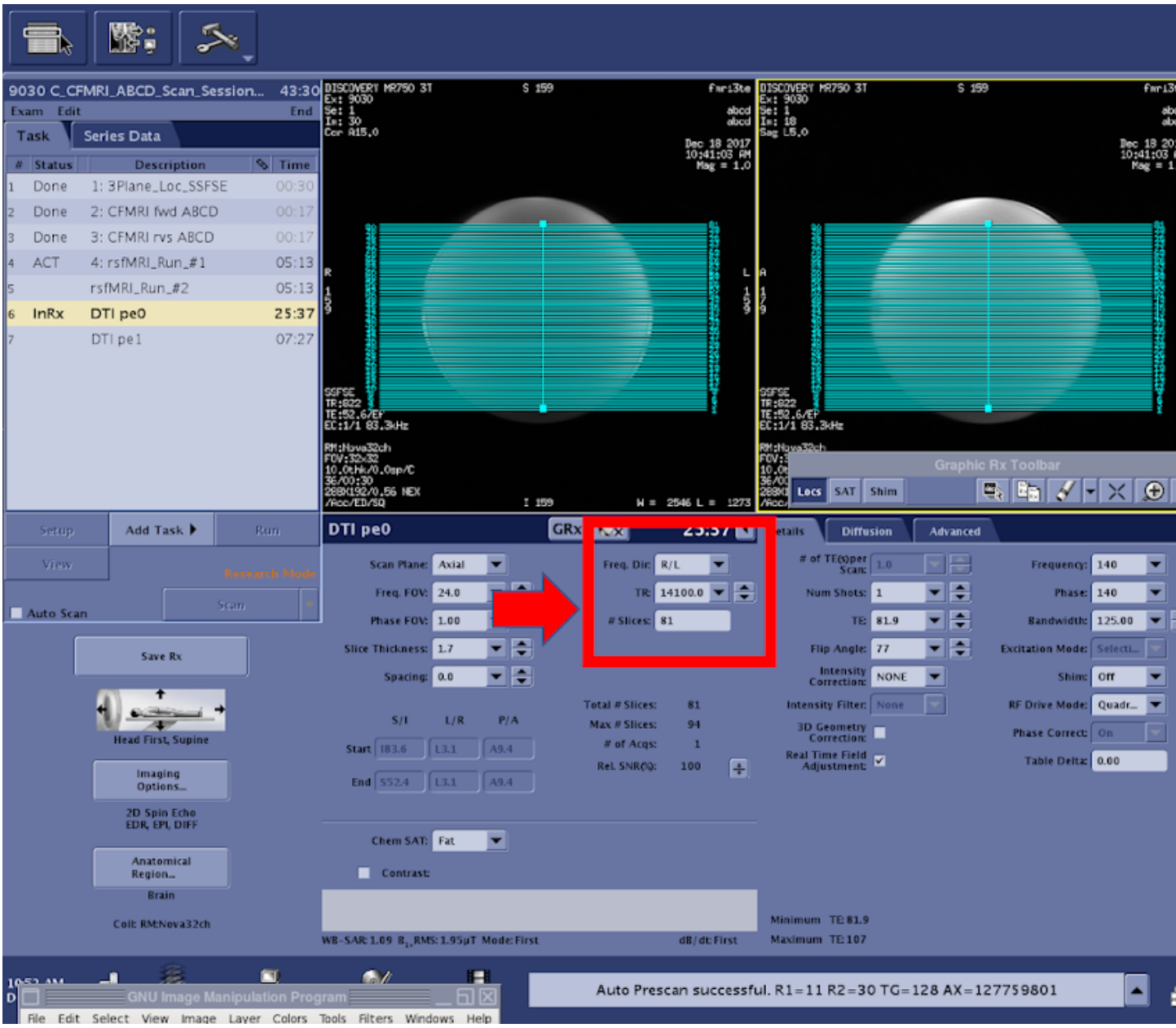
Data Acquisition: Diffusion Tensor Imaging (DTI)

DTI pe0 (7:27)

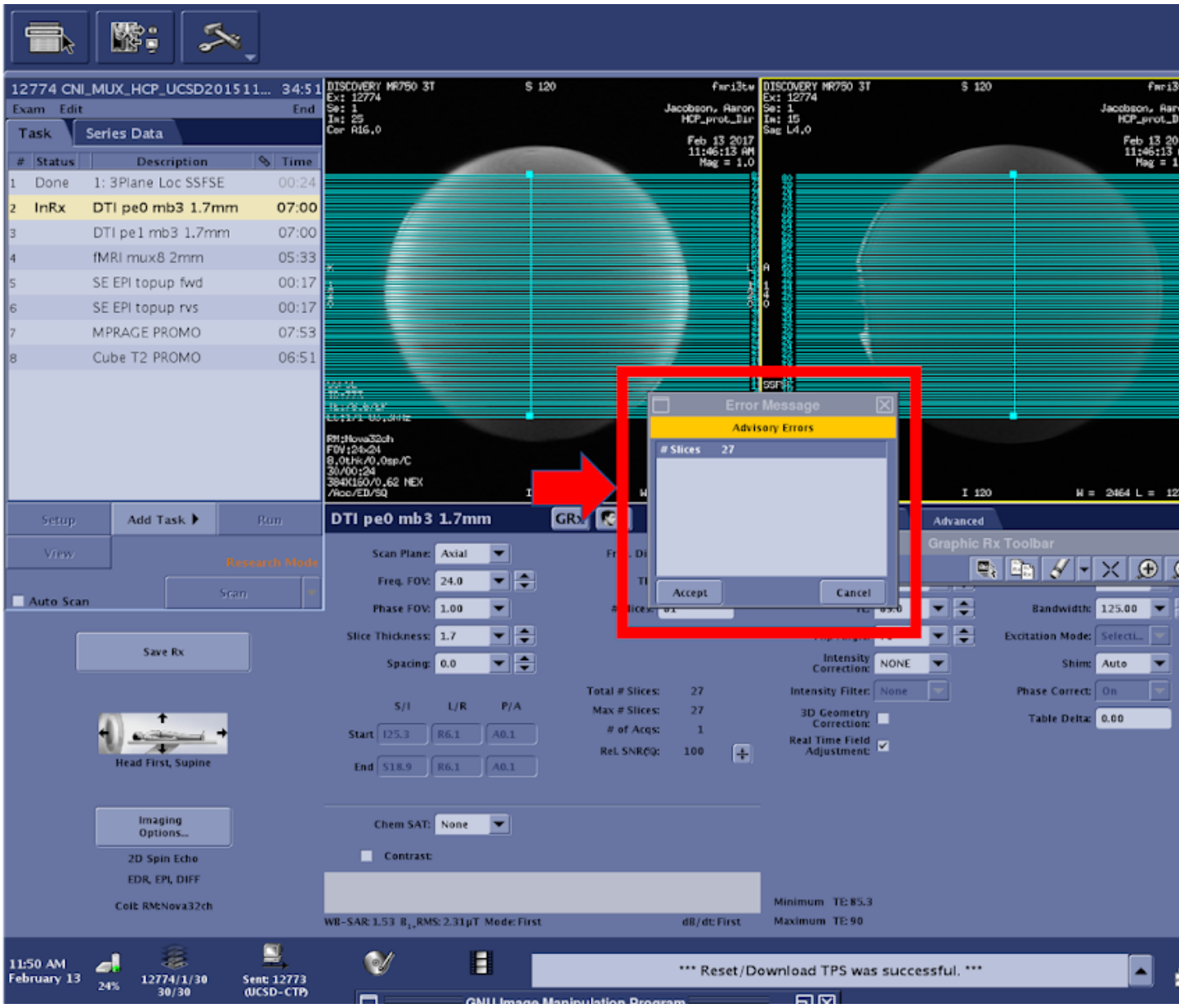
- The multiband ABCD DTI sequence acquires 81 total slices using a multiband factor of 3
- Using the current GE MR750 software only 27 of the 81 slices are visible during the final Rx setup phase



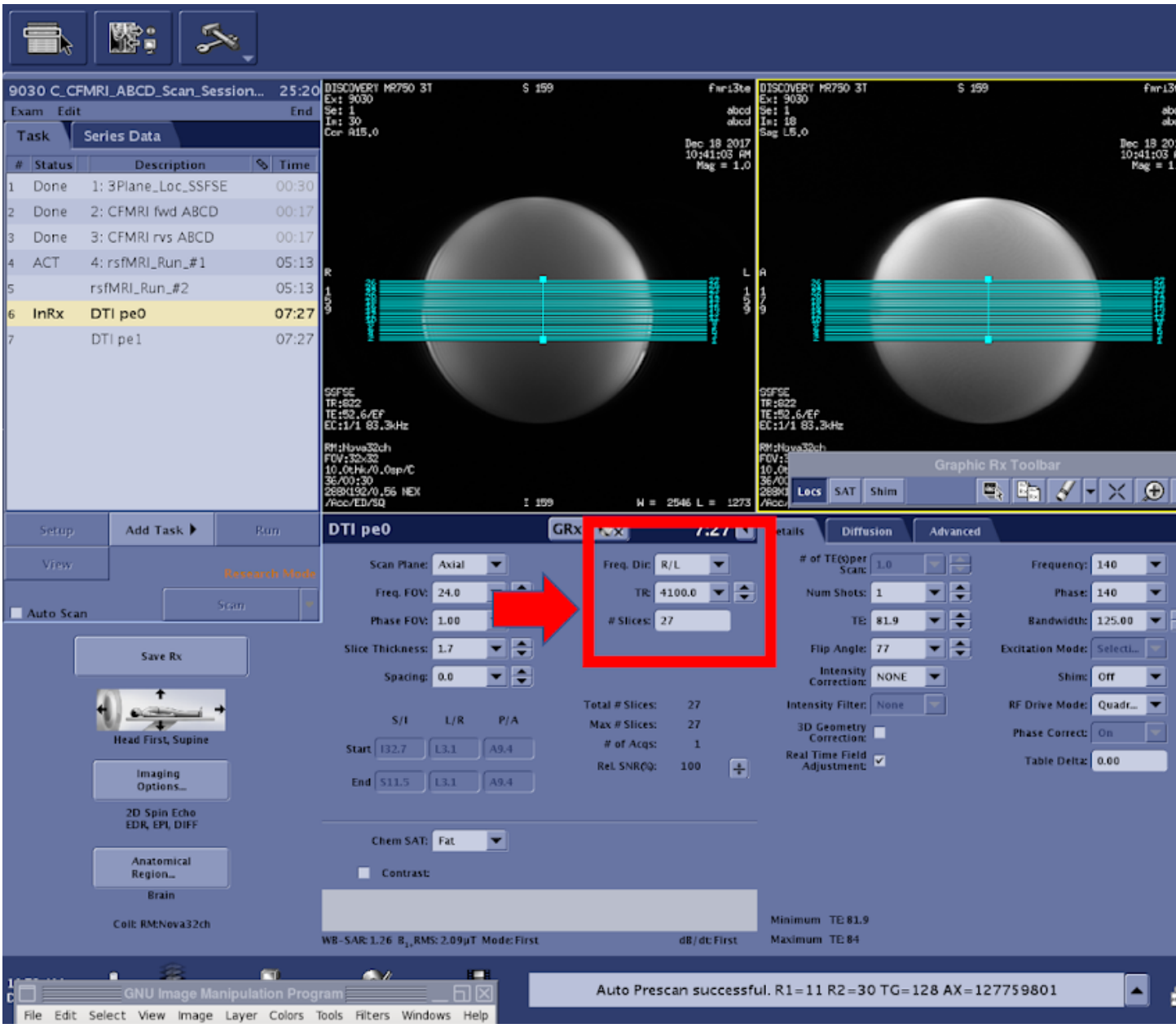
- It is easier to set the Rx and ensure proper anatomical coverage if you can see all of the slices that you will acquire
- This will require temporarily setting the number of slices to 81
- Before changing the number of slices to 81 (total number of slices collected) you must increase the TR dramatically to account for the length of time required to image a larger number of slices (ex: from 4,100 ms to 1,4100 ms)



- Increase TR (4,100 –> 14,100)
- **Set the number of slices to 81 (total number of slices collected)**
  - If you do not change the TR before editing the number of slices you will receive an advisory error indicating that you have exceeded the maximum number of slices that can be acquired within the current TR
- Center the slices over the desired coverage area of the brain
- Return # of slices to the original value (27)
- **Change TR back to 4,100 ms**
  - If you do not return the number of slices to 27 before editing the TR you will receive an advisory error indicating that you have exceeded the maximum number of slices that can be acquired within the current TR



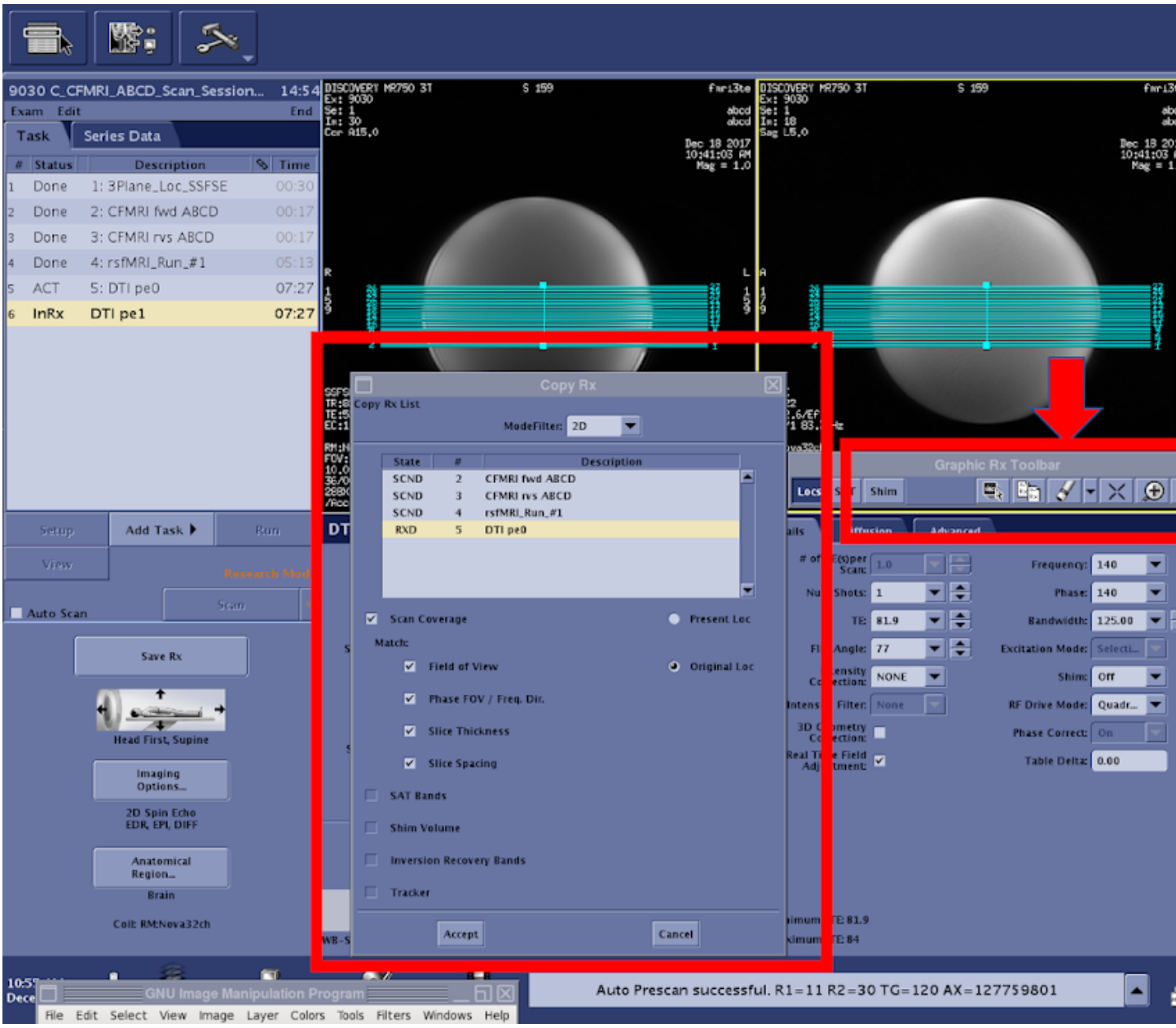
- If the scan time has returned to normal (7:27), you are ready to begin



DTI Distortion Correction Acquisition Option #1:

DTI pe1 (7:27)

- To run the second (pe1) DTI scan you will need to copy the Rx from the previous DTI scan
- Use the Graphic Rx Toolbar



- Select the previous DTI scan Rx
- Save Rx–>Scan

DTI Distortion Correction Acquisition Option #2:

DTI_fieldmap (pe1) (~0:50)

- **The official ABCD protocol uses an Rx matched, 50 second, reverse phase encoded DTI acquisition to perform distortion c**
  - Pros: Reduces total scan session time by ~6 min
  - Cons: All resulting diffusion analyses are based on one ~7 minute acquisition

- The process of running the DTI_fieldmap is identical to the instructions above (DTI pe1)

3.1.2 CFMRI Multiband Protocol #2

Protocol Location and Receiver Coil Info

The CFMRI Multiband Protocol #2 (HCP Lifespan Based) requires the use of the Nova Medical 32 channel head coil

The MB Protocol #2 can be found on both the 3T West and 3T East scanners under: * Adult >Template-> C_CFMRI_HCP_LIFESPAN

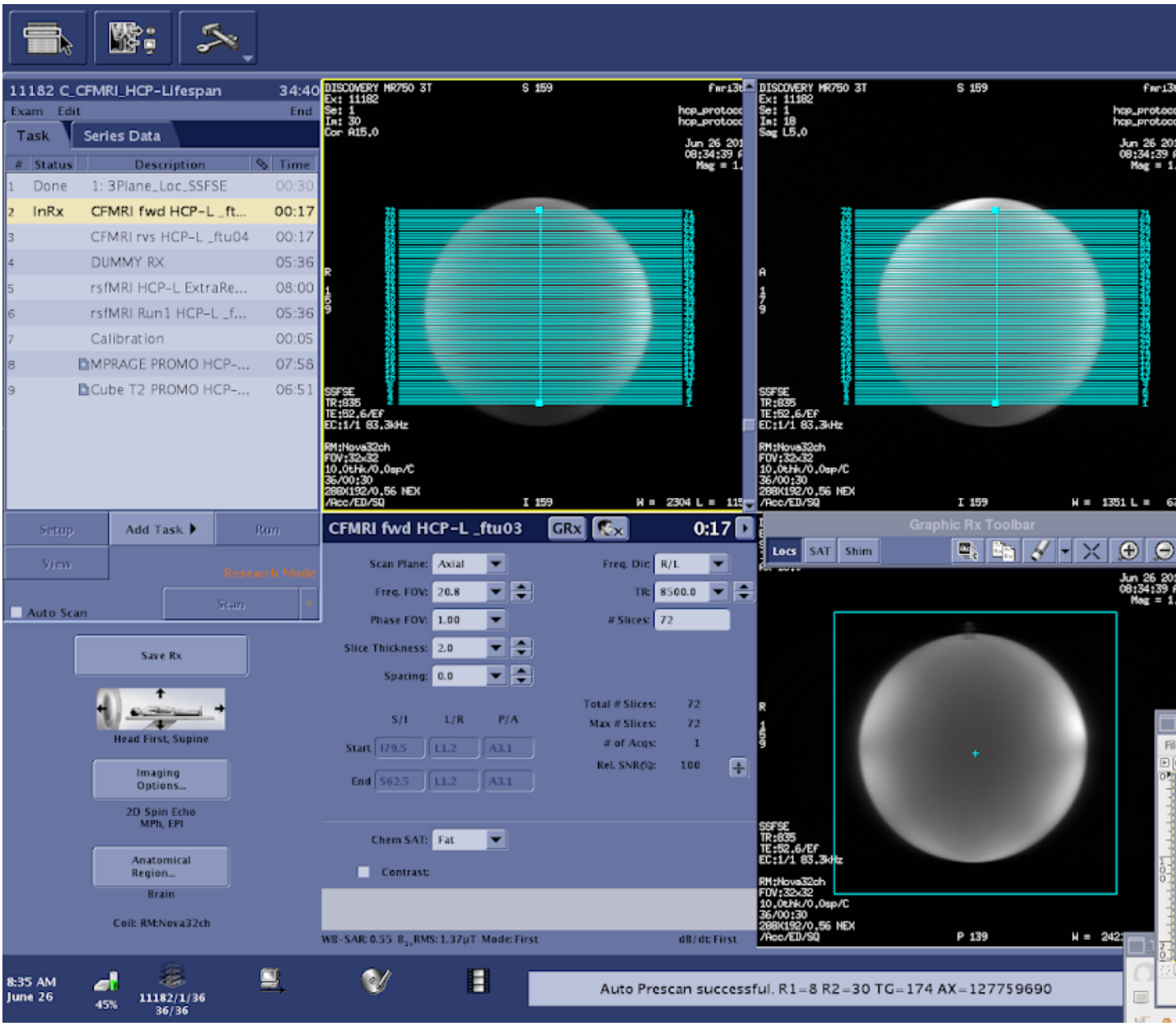
Pre-Scan Preparation

- Place the 32channel coil on the scanner table and plug it in
- Make sure the coil is recognized by the scanner by checking on the iROC monitor above the patient bed
- Setup peripheral equipment such as the projector, screen, stimulus laptop, etc.
- Setup the subject (blanket, emergency communication device, mirror, etc.) on the scanner patient bed
- Setup physiological monitoring if needed
- Register the subject and "Start Exam"

Data Acquisition: EPI & Topup Distortion Correction

CFMRI fwd HCP-L (~17 sec)

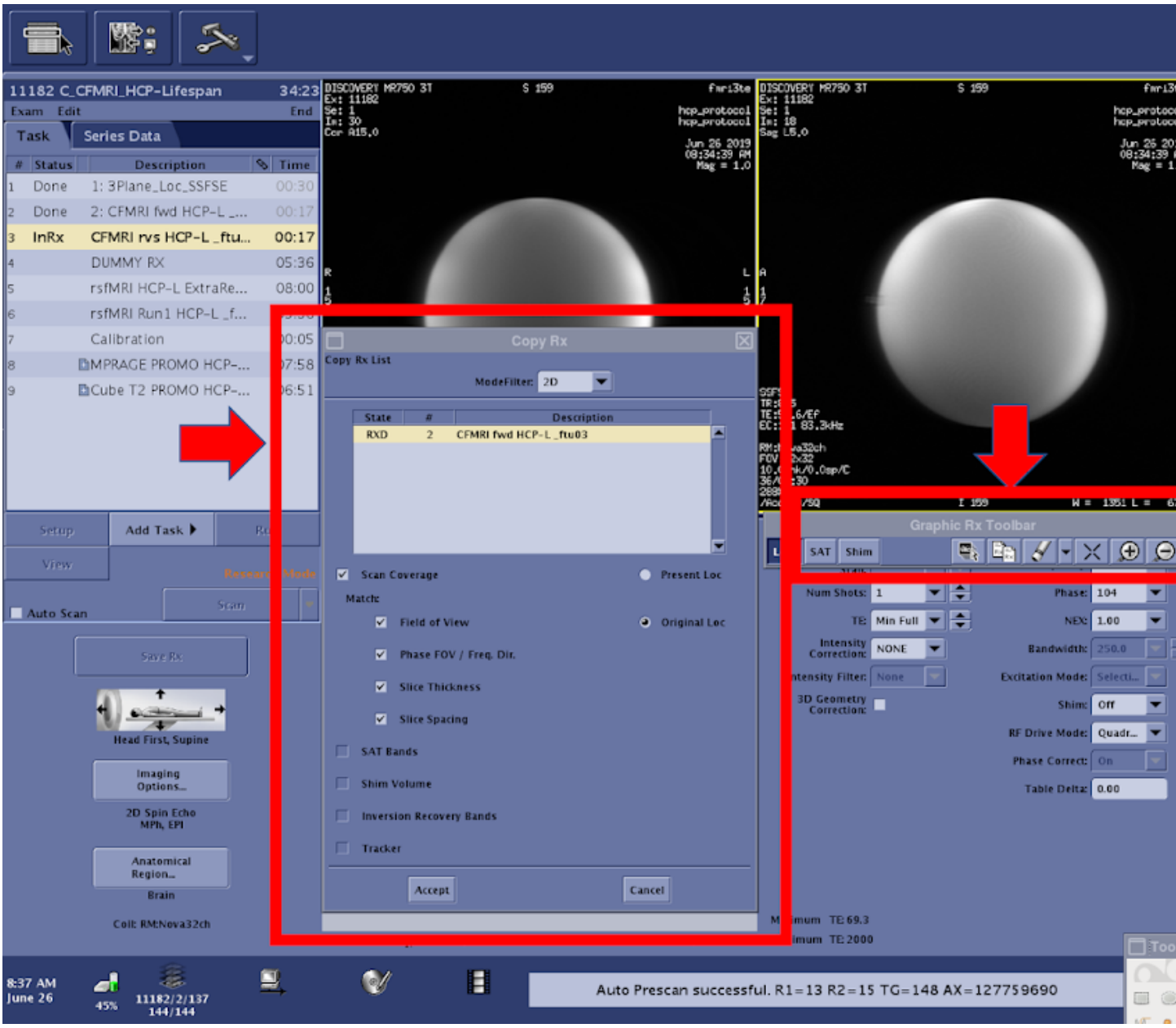
- Magnetic susceptibility and geometric distortion artifacts can be addressed by acquiring two short sequences with opposite phase encoding directions (1. Forward: Anterior–>Posterior, 2. Reverse: Posterior–>Anterior), followed by preprocessing using FSL topup https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/topup
- The HCP-L topup scans should have 72 slices
- The topup scans do not utilize multiband acceleration
- The number of slices you see in the Rx reflects the total acquisition coverage
- Center the slices over the desired location in the brain



- **Save Rx–>Scan**
  - There may be a long (20 sec) pause before the topup scan begins

CFMRI rvs HCP-L (~17 sec)

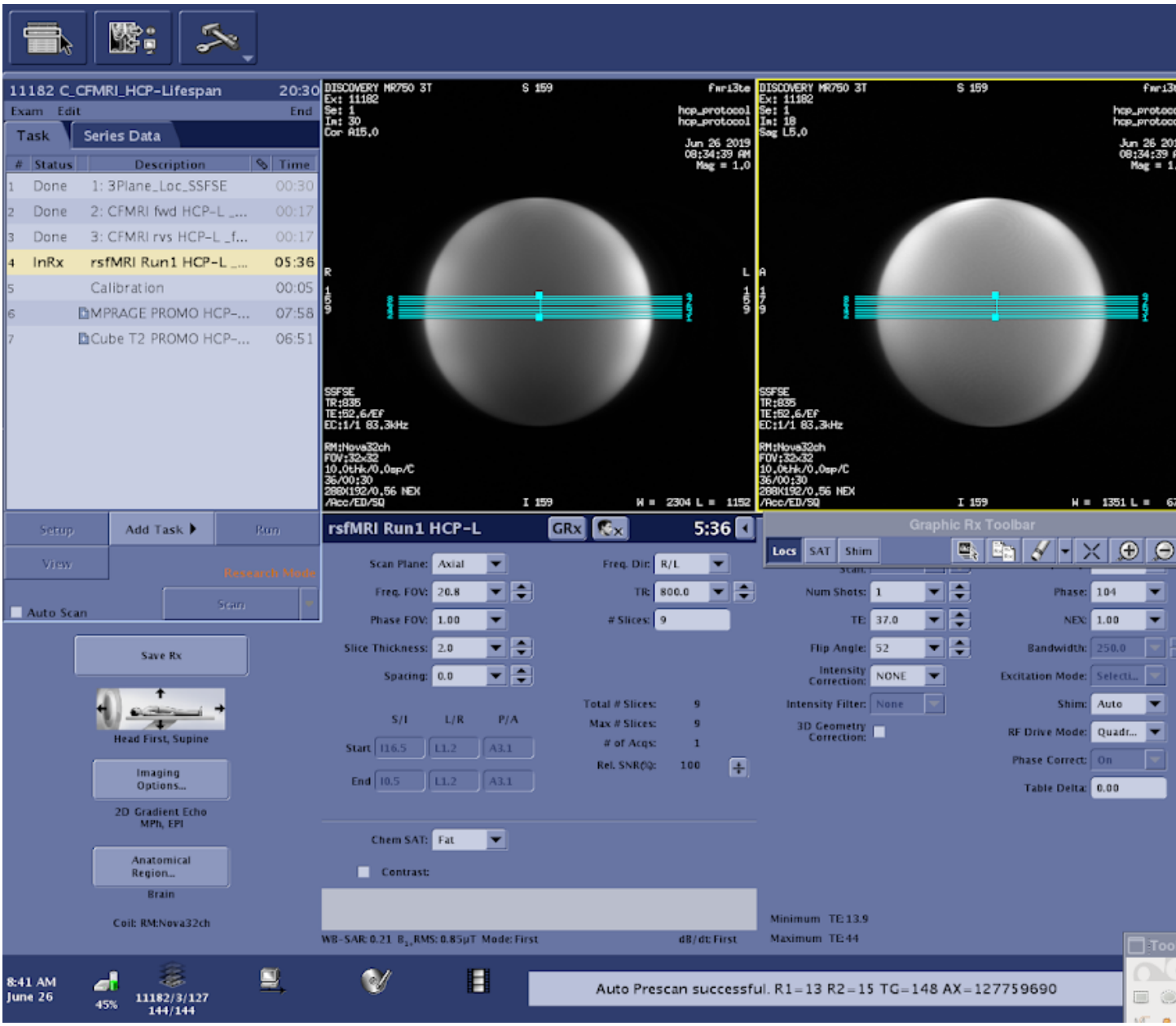
- To run the second (rvs) topup scan you will need to copy the Rx from the previous topup scan (fwd)
- **Use the Graphic Rx Toolbar**
  - Select the previous topup (fwd) scan Rx



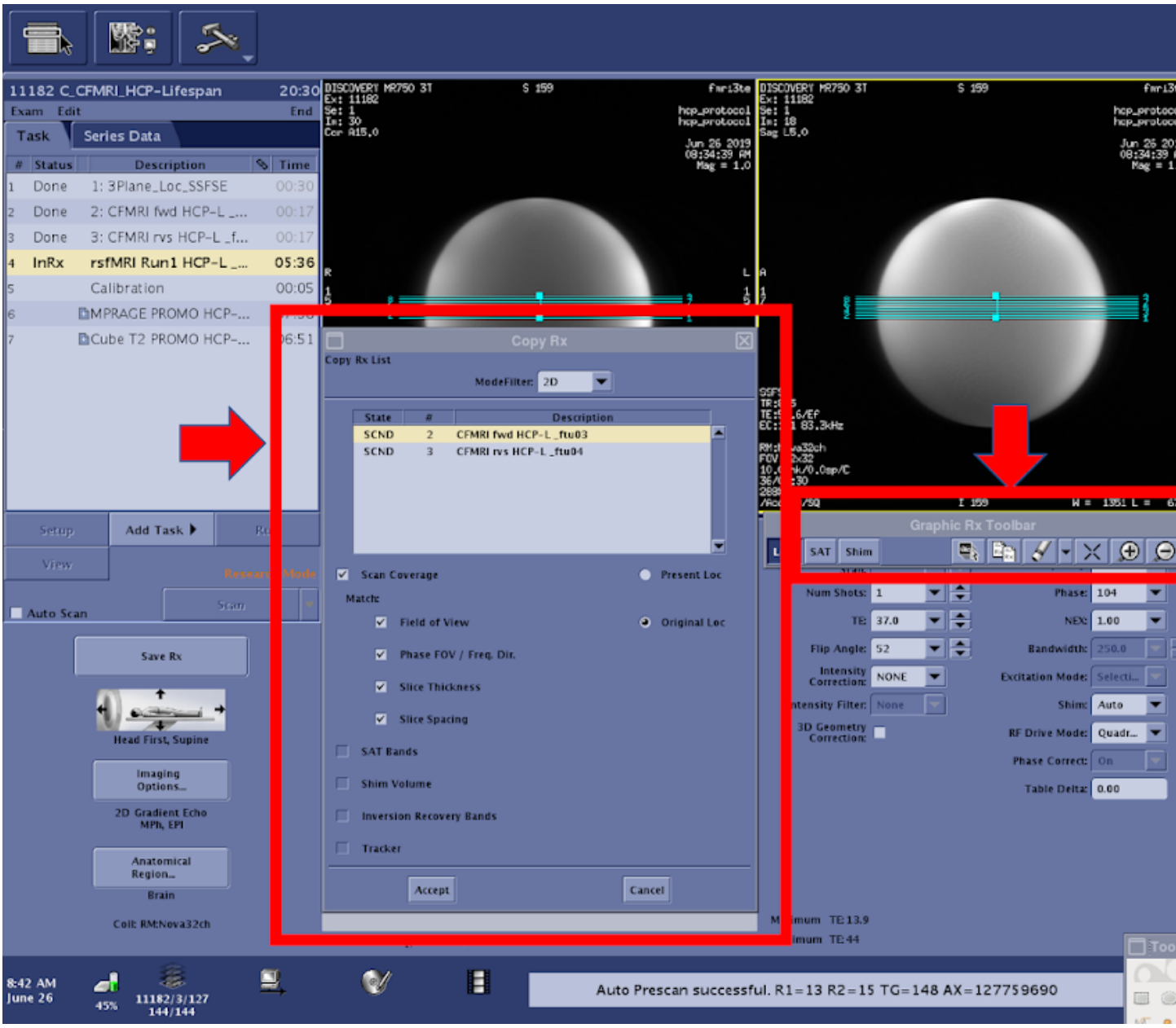
- Save Rx–>Scan

rsfMRI_Run_#(1-4) HCP-L (~5.5 min each)

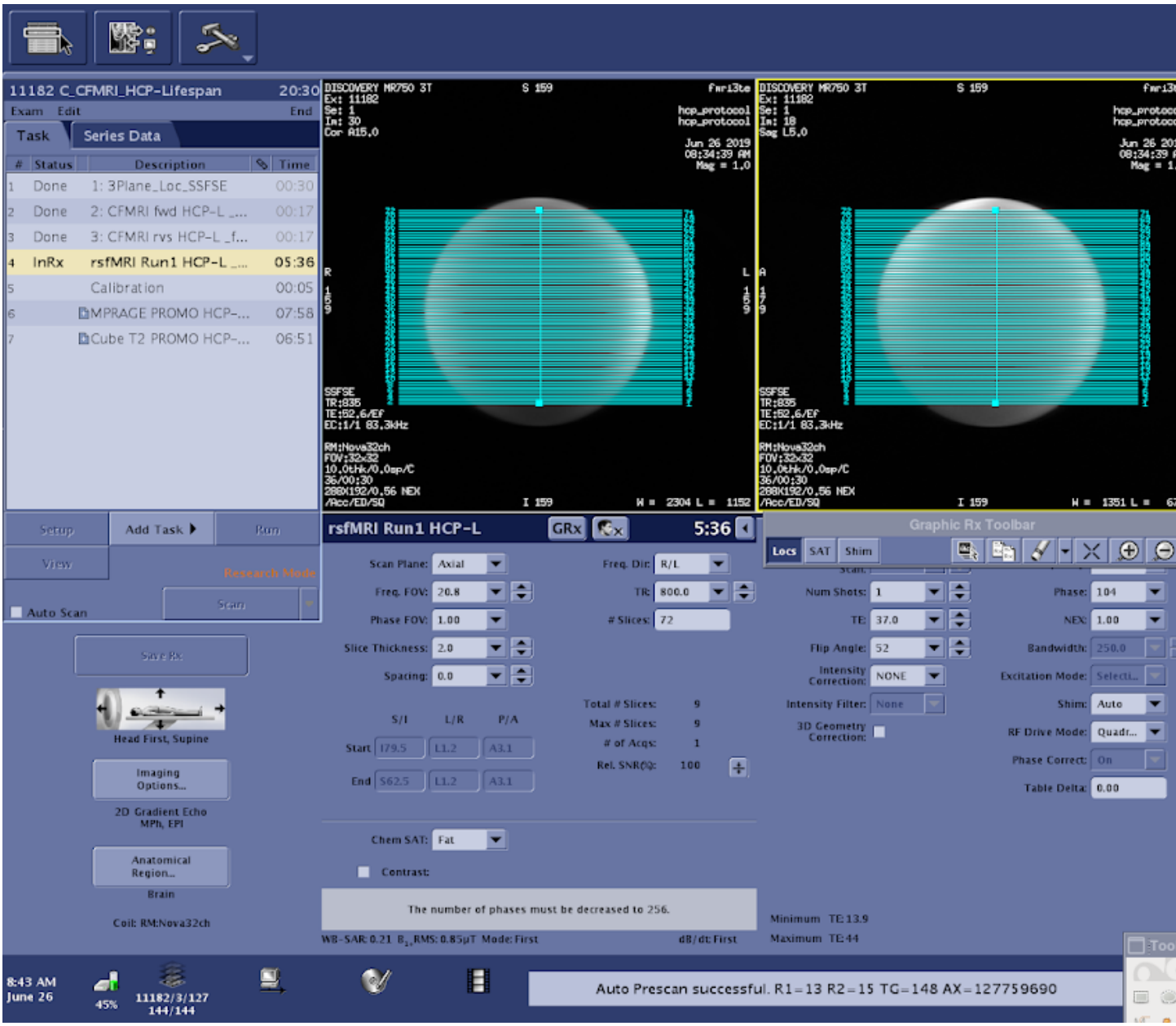
- The multiband ABCD fMRI sequence acquires 72 total slices using a multiband factor of 6.
- Using the current GE MR750 software available on CFMRI scanners, only 9 of the 72 slices are visible during the final Rx setup phase



- Erase the default Rx (9 visible slices) and copy the full (72 slice) Rx from the CFMRI fwd ABCD series

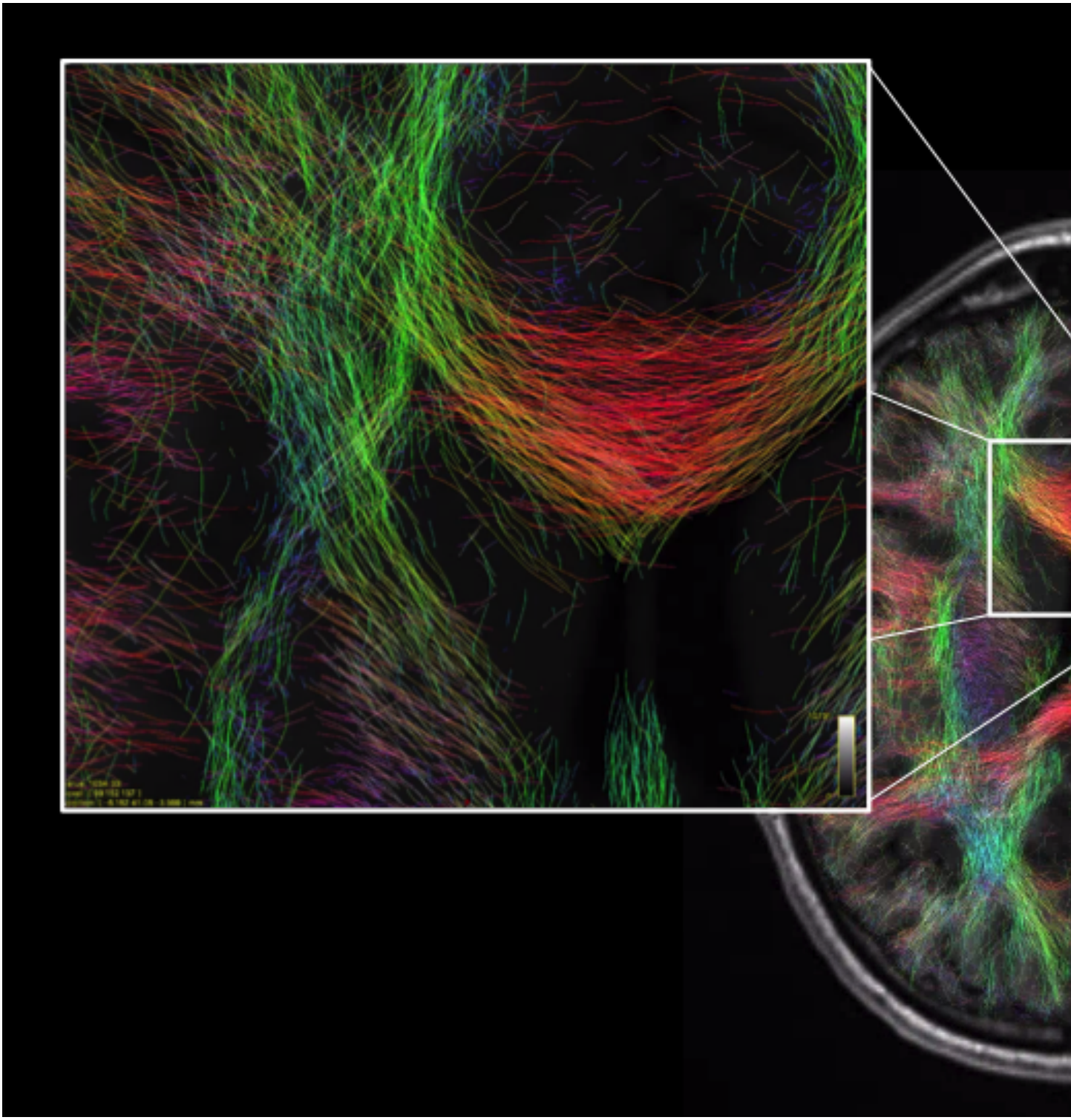


- Copying this Rx will keep the location consistent across topup and fMRI scans, which is critical for the success of your imaging session
- After the slice coverage is successfully copied from the topup scan, reduce the number of visible slices to the original parameter setting (10 slices)
- **The duration of your fMRI scan can be adjusted using Phases per Location on the console (Multi-Phase tab)**
  - The total scan time for your scan is calculated by TR x number of Phases per Location
  - IMPORTANT: The first 2 x Multiband Factor (2 x 6 (ABCD MB factor) = 12) reps will not be included in your final dataset * 12 reps x 1000 ms (TR) = 9.6 seconds of data not included in the final dataset * The timing of your stimulus presentation must be designed with this in mind



- When you are ready to save the Rx, check the scan time to ensure it is an accurate reflection of the expected acquisition time (TR x Phases per location) * Save Rx–>Scan

3.1.3 Diffusion Tensor Imaging User Guide



Introduction

CFMRI supports the following 3 non-multiband DTI protocols

	Protocol #1	Protocol #2
Number of Scans	1 DTI scan	2 DTI scans
Typical Scan Time	3-10 min	6-20 min
Resolution	2x2x2 mm	2x2x2 mm
Pros	Only 1 scan is required. Short scan time	Optimal distortion correction. Ability to use ASSET
Cons	Will not work with ASSET, which leads to reduced slice coverage per unit time	Scan time is doubled due to the requirement for two separate scans
Recommendation to Use	Use for simple protocol setup and acquisition	Dest to use when scan time is not a limiting factor and the best distortion correction results are desired
*Note	# of DTI slices must be even for all t	

Protocol #1

Description

Protocol #1 consists of DTI acquisition: "DTI-TOPUP"

- By default Protocol 1 acquires two T2 (or b=0) images at the beginning of the scan
- The first T2 image uses reversed phase encoding direction, whereas the second T2 image and the subsequent diffusion weighted images use forward phase encoding direction
- Due to the requirement of opposite phase encoding directions, the number of T2 images must be 2 or greater.

Location of the Protocol

Adult -> Templates -> DTI_TOPUP The protocol is available on both 3T West and 3T East scanners.

Parameters

- User should adjust b value and number of directions to fit study needs
- Other parameters to customize include: FOV, slice thickness, number of slices (must be even), TR, and matrix size.

Advanced Options

The following CVs are set under the advanced tab and can be customized as needed:

CV1: pepolar = 2 or 3 (do not set to 0 or 1)

- The pepolar parameter controls the phase encoding direction, i.e. pepolar = 2 corresponds to forward phase encoding, whereas pepolar = 3 corresponds to reverse phase encoding
- In a typically MRI setup, forward phase encoding causes compression of the frontal lobe and stretching of the occipital lobe; whereas reverse phase encoding causes stretching of the frontal lobe and compression of the occipital lobe
- Since stretching is easier to correct than compression, one could choose this parameter accordingly for the specific areas of brain being studied

CV2: rhmethod = 1

- prevent interpolation to 256 in the reconstructed images)

CV4: ssgr fat suppression = 1

- reverses spin echo refusing gradient polarity to better suppress fat signal

Shim Settings and Scan Instructions

Shim is set to Auto. After saving Rx, press Scan to start.

Protocol #2

Description

Protocol 2 consists of two DTI acquisitions: ” DTI-fwd” & “DTI-rvs”

- The DTI-fwd scan acquires data in forward phase encoding direction, whereas the DTI-rvs scan acquires data with reversed phase encoding direction
- All parameters must match between the two scans except the phase encoding direction
- This protocol is also available with ASSET option ON.

Location of the Protocol

Adult -> Templates -> DTI_TOPUP The protocol is available on both 3T West and 3T East scanners.

Parameters

- User should set the number of T2 images, the number of diffusion directions and b value as desired
- The same parameters must be applied to both scans
- Other parameters to customize include: * FOV * Slice thickness * Number of slices (must be even) * TR * Matrix size
- The same parameters must be applied to both scans

Advanced Options

The following CVs are set under the advanced tab and can be customized as needed:

- CV2: rhmethod = 1 * Prevent interpolation to 256 in the reconstructed images
- CV4: ssgr fat suppression = 1 * Reverses spin echo refusing gradient polarity to reduce remaining fat signal

Shim Settings and Scan Instructions

The order of the two scans can be swapped. However, the first scan can have shim set to Auto and the second scan must have the shim set to OFF.

For each scan, save Rx and press Scan.

Protocol #2

Description

Protocol 3 consists of three DTI acquisitions: ” DTI”, “DTI_cal_fwd” & “DTI_cal_rvs”

- The first two scans of this protocol are calibration scans with forward and reversed phase encoding directions respectively * They are used to estimate the field map, which is then applied to the DTI scan to correct distortions
- The subsequent DTI can be any DTI scan (i.e, either GE standard DTI or the DTI supplied with this protocol)
- The only requirement is that the Rx info must match among all three scans, e.g. FOV, slice thickness, number of slices and matrix size
- This protocol is also available with ASSET option ON

Location of the Protocol

Adult -> Templates -> DTI_TOPUP The protocol is available on both 3T West and 3T East scanners.

Parameters

For the two calibration scans, user may customize: * FOV * Slice thickness * Number of slices (must be even) * TR * Matrix size Please keep in mind that Rx information must match the DTI scan.

For the DTI, user should set: * Number of T2 images * The number of diffusion directions * b value.

Other parameters to customize include: * FOV * Slice thickness * Number of slices (must be even) * TR * Matrix size

Remember that the Rx info of the DTI scan must match the Rx info of the calibration scans

Advanced Options

User should not change any advanced options in the calibrations scans.

For the DTI scan, if you are using the GE standard DTI, no change should be made in the advanced tab

If you are using the DTI supplied with this protocol, the following CVs under the advanced tab can be customized as needed:

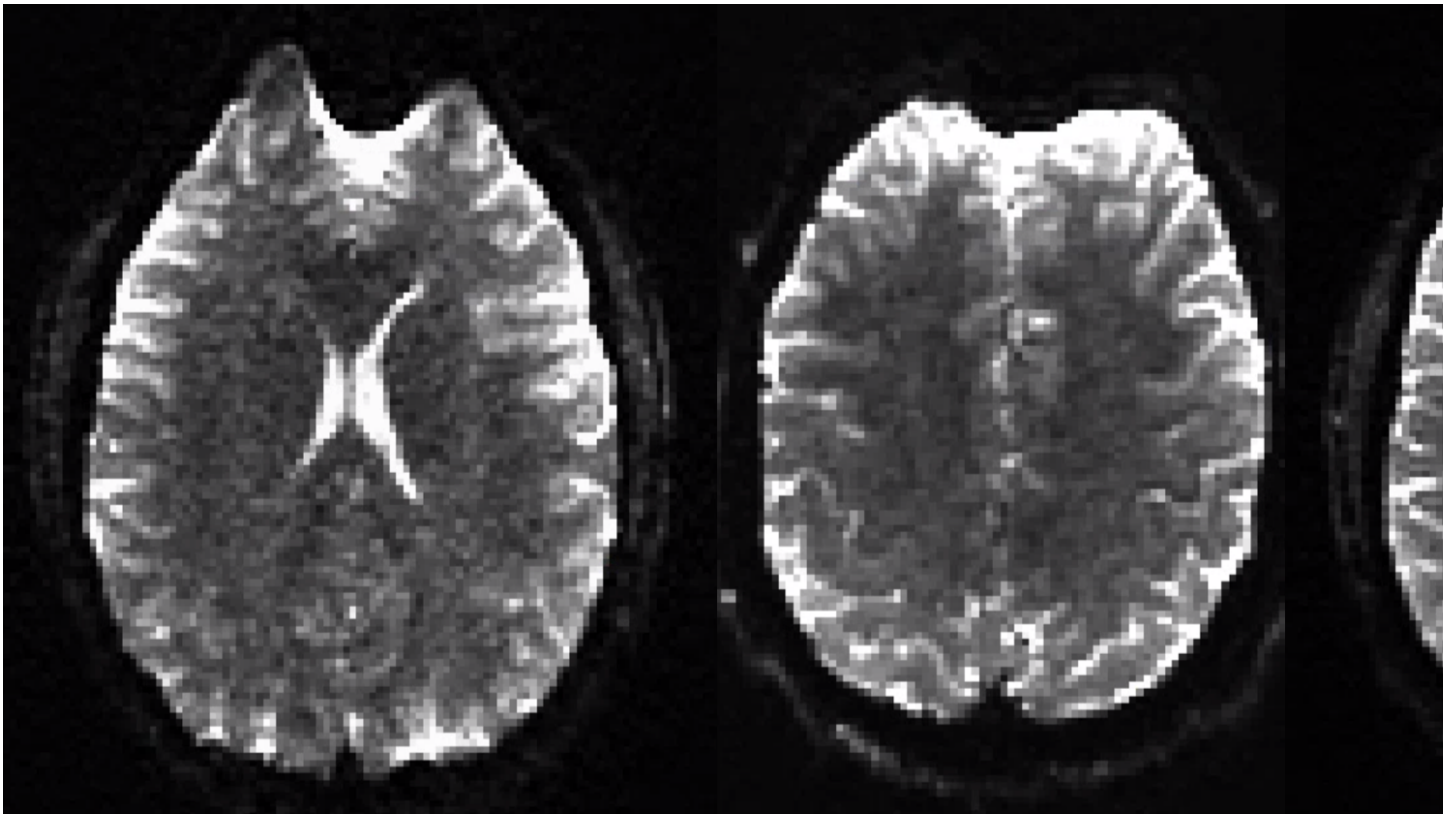
- CV1: pepolar = 0 or 1 (do not set to 2 or 3) * The pepolar parameter controls the phase encoding direction, i.e. pepolar = 0 corresponds to forward phase encoding, whereas pepolar = 1 corresponds to reverse phase encoding * In a typically MRI setup, forward phase encoding causes compression of the frontal lobe and stretching of the occipital lobe; whereas reverse phase encoding causes stretching of the frontal lobe and compression of the occipital lobe * Since stretching is easier to correct than compression, one could choose this parameter accordingly for the specific areas of brain being studied
- CV2: rhmethod = 1 * To prevent interpolation in the reconstructed images
- CV4: ssgr fat suppression = 1 * Reverse spin echo refusing gradient polarity to reduce remaining fat signal

Shim Settings and Scan Instructions

The order of the two scans can be swapped. However, the first scan can have shim set to Auto and the second scan must have the shim set to OFF.

For each scan, save Rx and press Scan.

DTI TOPUP Distortion Correction



Required Software

We provide a C-Shell script "processtopup" for processing the data acquired with the above protocols.Processtopup first prepares the GE dicom data and converts it into NIFTI format and then calls the TOPUP tool from FSL to unwarp the distortion. More information on the FSL TOPUP tool is available at the FSLwiki website (http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/topup).

1. Processtopup (http://fmri.ucsd.edu/download/processtopup)
2. AFNI (http://afni.nimh.nih.gov/afni/)
3. FSL version 5.0 or above (http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/)

- Environment Variable FSLOUTPUTTYPE must be set to NIFTI_GZ
- Environment Variable FSLDIR must be set and point to the FSL installation folder
- The acquired DTI data must have an even number of slices (requirement of the FSL TOPUP tool) * If the number of slices is odd, processtopup will remove the last slice from the data

Usage

processtopup -dsnum <num of DTI dir> -d1 <data dir> [-d2 <data dir> -d3 <data dir> <options>] -o <outstem>"

Required Inputs

-dsnum <number of DTI data directories, 1, 2 or 3>

if -dsnum 1 -d1 <DTI data dir>

if -dsnum 2 -d1 <DTI_fwd data dir> -d2 <DTI_rvs data dir>

if -dsum 3 -d1 <Cal1_dir> -d2 <Cal2_dir>" -d3 <DTI data dir>

Note: The -d1 and -d3 inputs must have the same phase encoding direction;

-o <unwarpped filename stem>"

Optional Inputs

-tmpdir : specify tmp dir name -nocleanup : disables removal of temporary files

Output

<outstem> - unwarpped volume filename stem

Examples

Protocol 1: >>processtopup -dsnum 1 -d1 dti_dir -o myoutput

Protocol 2: >> processtopup -dsnum 2 -d1 dti_fwd -d2 dti_rvs -o myoutput

Protocol 3: >> processtopup -dsnum 3 -d1 cal_fwd -d2 cal_rvs -d3 dti_fwd -o myoutput

For questions about this manual, please contact Aaron Jacobson (ajacobson@ucsd.edu)

3.1.4 Arterial Spin Labeling User Guide

Background

- At CFMRI, we strive to provide the state-of-the-art arterial spin labeling (ASL) protocols for a quick and robust measure of whole brain cerebral blood flow (CBF).
- As of May 1, 2015, we have updated our existing ASL protocols to ensure that the scan parameters are in compliance with those recommended by the ISMRM Perfusion Study Group1.
- In addition to the standard acquisition parameters, we now provide two additional subsets of parameters optimized for pediatric and geriatric populations.
- The scans for each protocol are also more streamlined, making them easier to execute and less prone to operator error.
- For questions about the ASL protocols, please contact Conan Chen (coc004@ucsd.edu).

ASL FAQs

- What is ASL?
- What types of ASL protocols are available at CFMRI?
- What is new as of the May 1, 2015 update?
- Where do I find the updated CFMRI ASL protocols?
- How do I transfer data acquired from the scanner?
- How do I process data once the data are acquired?
- Between FAIR and PCASL, which one should I use?

- Between 2D PCASL and 3D PCASL, which one should I use?
- What are the standard scan and labeling parameters for each protocol?
- Is there an ASL protocol I can use for functional studies?
- What other ASL techniques are out there?

What is ASL?

Healthy brain function is critically dependent on well-regulated CBF for the delivery of oxygen and glucose. Regional alterations in CBF have been observed in a wide range of health conditions, including acute and chronic cerebrovascular disease (e.g. stroke, transient ischemic attacks), Alzheimer's disease, mild cognitive impairment, epilepsy, HIV-related cognitive impairment, multiple sclerosis, depression, schizophrenia, post-traumatic stress disorder, traumatic brain injury, obsessive-compulsive disorder, and vascular dementia. Over the past decade, ASL has emerged as a robust and non-invasive method for acquiring regional CBF maps. Because of its non-invasive nature and ease of use, a growing number of research and clinical sites are now using ASL.

What types of ASL are available at CFMRI?

We provide both FAIR2 and Pseudocontinuous ASL1 (PCASL) protocols.

What is new in ASL at CFMRI?

1. In addition to the existing CFMRI 2D PCASL, we now support GE 3DASL.
2. The CSF scan is now part of the ASL scan and thus is no longer needed as a separate acquisition (no need to remember to run manual prescan!).
3. Introduced a 10-minute 2D PCASL protocol with background suppression optimized for measurements of whole brain white matter CBF3.
4. Introduced a single-click multi-TI transit delay mapping protocol (PCASL) that provides a whole brain T1 map, transit delay map, and a quantified CBF map in 15 minutes4.
5. After the ASL/CSF scan, a MATLAB script is automatically invoked and the quantified CBF map is displayed on screen to provide immediate feedback on data quality.
6. In order to account for variance in transit delays among different study groups, acquisition parameters have been optimized for each (see below).

2D PCASL			
Groups	**Labeling Duration**	**Post Labeling Delay**	**Comments**
Standard	1800 ms	1800 ms	Recommended for healthy adults
Pediatrics	1800 ms	1500 ms	Recommended for children less th
Geriatrics	1800 ms	2000 ms	For healthy adults > 70 y. Also for
White Matter	1900 ms	1900 ms	Use background suppression to ir pulses 1570 ms and 350 ms prior
2D FAIR			
Groups	**Tag Width/Gap**	**TI1/TI2**	**PLD (TI2-TI1)**
Standard	15 cm/1 cm	800 ms/1800 ms	1000 ms
Pediatrics < 15 yr	10 cm/1 cm	600 ms/1600 ms	1000 ms

Where do I find the updated CFMRI ASL protocols?

The latest ASL protocols are available both on the 3TW and 3TE scanners under

- Adult–>Templates–> * C_ASL_2DFAIR * C_ASL_2DPCASL * C_ASL_3DPCASL

Note: Individual scans under each protocol can be selected and imported into your own protocol.

For each of the protocols selected, users will find a note associated with the ASL scan (see red box in the figure above) that describes how to prescribe the imaging volume

How to see the Protocol Note:

- Set up a patient and select an ASL protocol

- Select a desired ASL series in the Work Flow Manger List Window by a single mouse click on the series and then click on Set Up.
- The note will appear directly on the scan prescription page at the right bottom corner (see Figure below).

Below are the screenshots of the note for each protocol.

2D PCASL Protocol Coverage

Protocol Notes for Edit Protocol

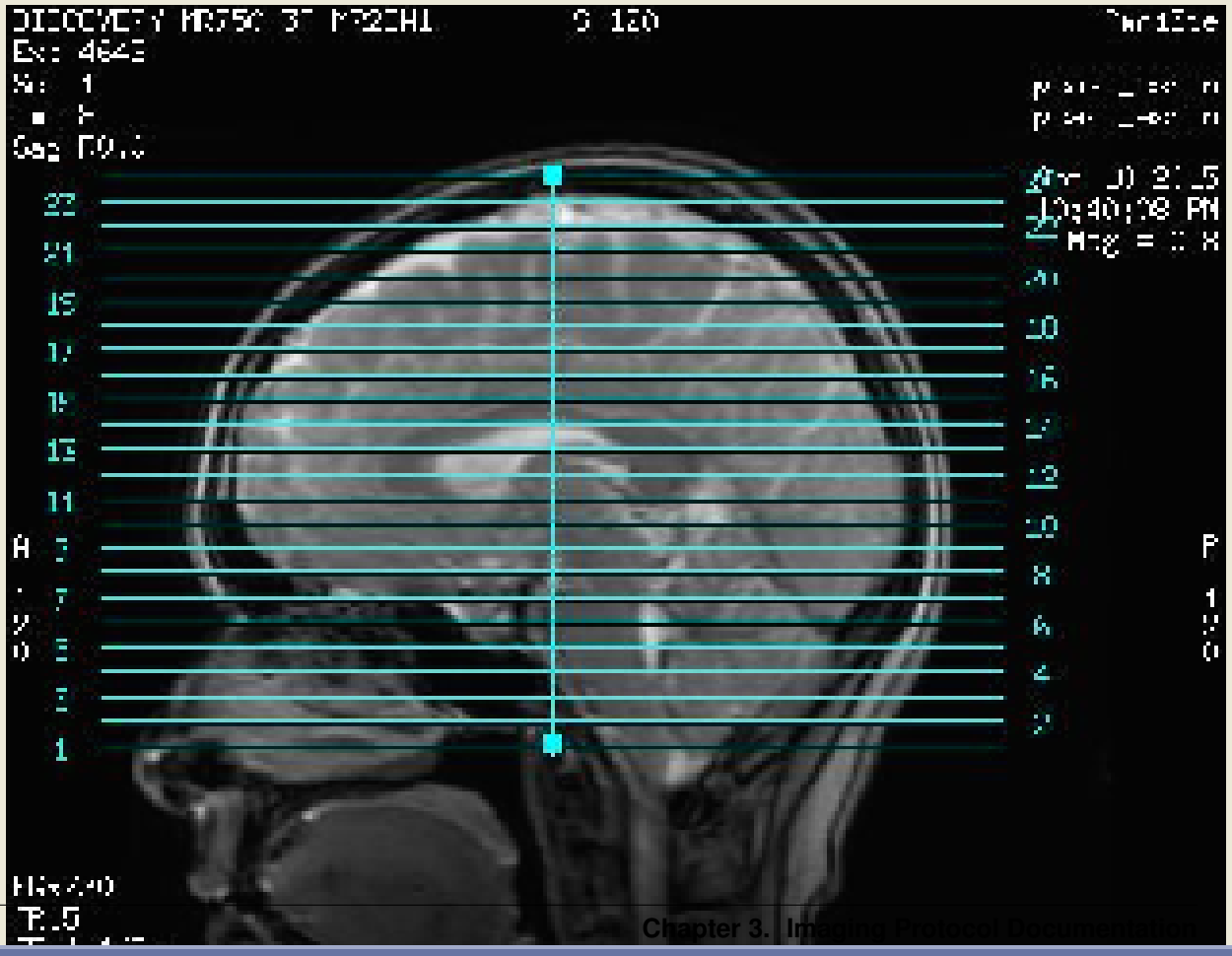
Medium

Operator Instructions

1. Make sure that the bottom of RX is matched to the b
cerebellum.

See figure below for illustration.

2. Save Rx and Scan.



3D PCASL Protocol Coverage

Protocol Notes for Edit Protocol

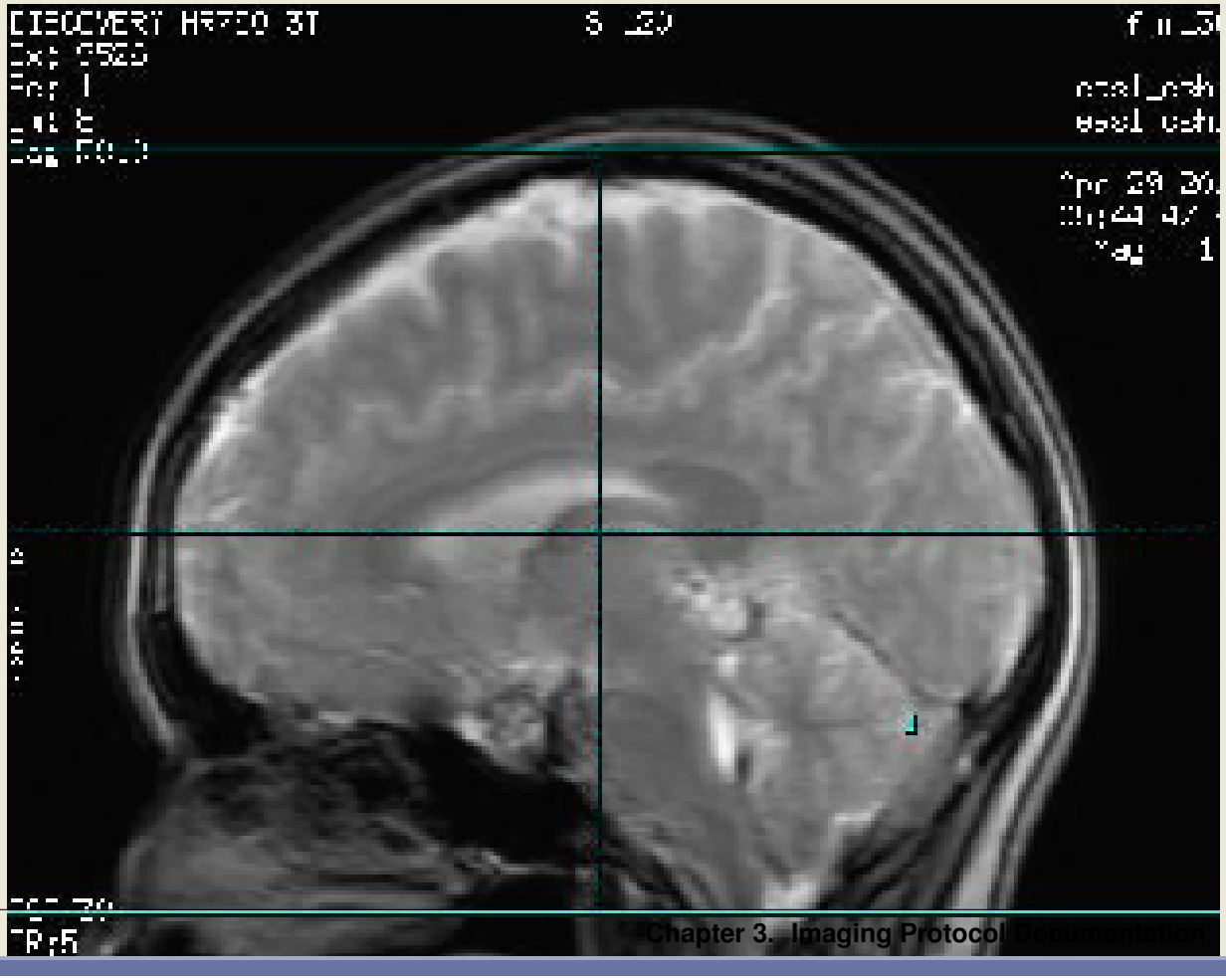
Medium

Operator Instructions

1. Make sure that the bottom of RX is matched to the b
cerebebellum.

See figure below for illustration.

2. Save Rx and Scan.



FAIR Protocol Coverage

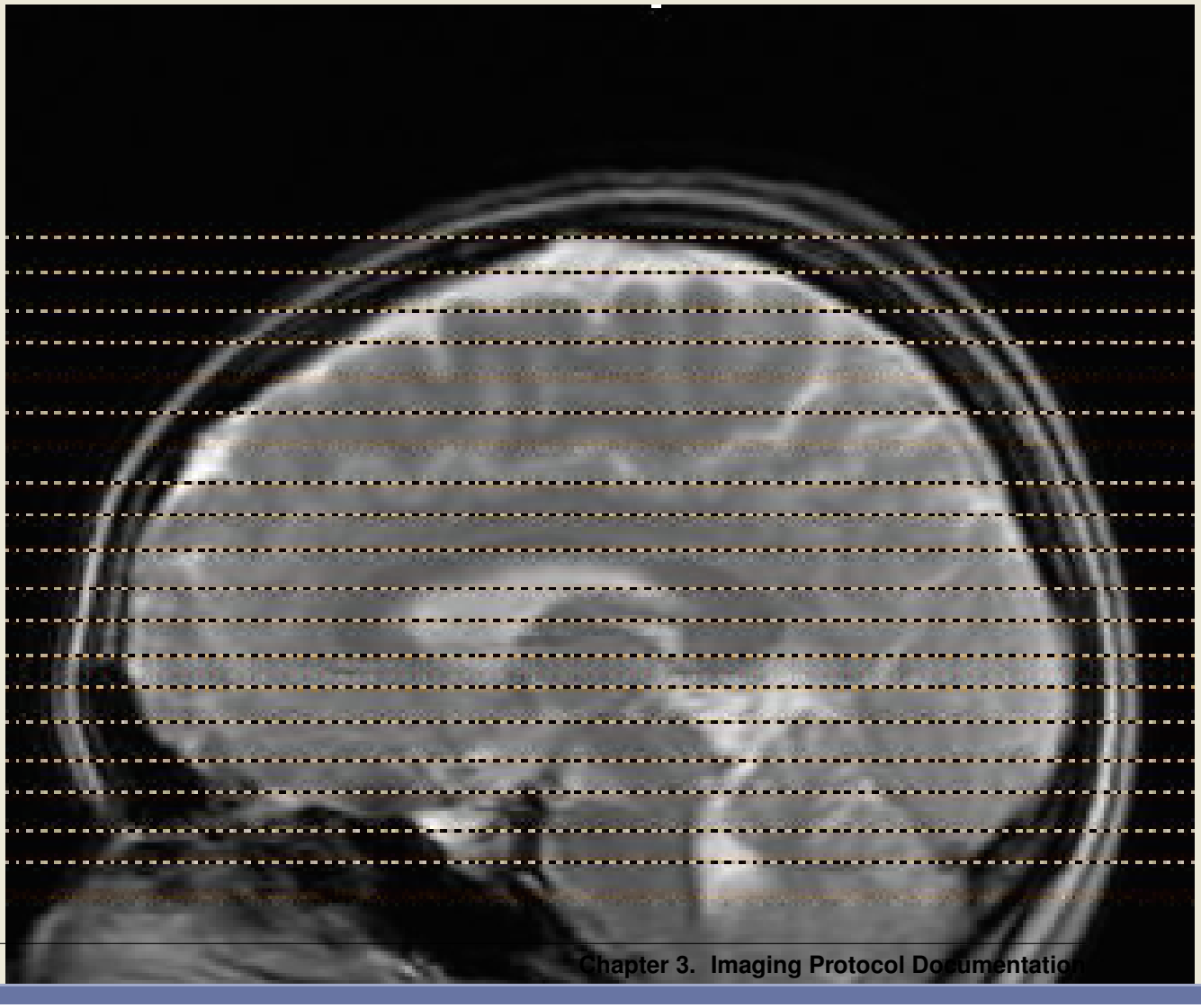
Protocol Notes for Edit Protocol

Medium

Operator Instructions

1. Position slices as high as possible while still coverin
See figure below for illustration.

2. Save Rx and scan.



Note: The prescription instruction for the FAIR protocol is different from that of the PCASL protocols!

N.B. If you erase the default graphic prescription preloaded with the protocol, make sure to position the first line of the graphic tool from the bottom and add slices toward the top. For ASL, the slices must be acquired from bottom to top for proper quantification. Do not place the first line of the graphic tool at the top and extend slices toward the bottom of the head!

How do I transfer data acquired from the scanner?

For all protocols other than GE 3DPCASL, the scanner outputs images in GE Pfile format (e.g. P34816.7).

To locate and transfer Pfiles to another server, see example below:

```
{sdc@fmri3tw}[107] cd /usr/g/mrraw/
Directory: /usr/g/mrraw
{sdc@fmri3tw}[108] ls -ltr P*
-rwxrwxr-x 1 sdc informix 135423580 2015-05-07 12:17 P31232.7*
-rwxrwxr-x 1 sdc informix   6873036 2015-05-07 12:18 P31744.7*
-rwxrwxr-x 1 sdc informix   7047403 2015-05-07 12:19 P32256.7*
-rwxrwxr-x 1 sdc informix 123723044 2015-05-07 16:07 P34816.7*
-rwxrwxr-x 1 sdc informix 270457395 2015-05-07 16:13 P35328.7*
-rwxrwxr-x 1 sdc informix   8070354 2015-05-07 16:14 P35840.7*
{sdc@fmri3tw}[110] scp -p P34816.7 marybirn@fmriserver.ucsd.edu:~/data/subjectfolder
##################################################################
#        UC San Diego - Center for Functional MRI                #
#                Authorized access only!                         #
# Disconnect IMMEDIATELY if you are not an authorized user!!! #
#         All actions Will be monitored and recorded             #
##################################################################
marybirn@fmriserver.ucsd.edu's password:
```

Your Pfiles

If you have several Pfiles to transfer, it may be easier to use the pcopy.pl script that allows you to transfer files in batch.

Example of how the script can be used is shown below.

```
{sdc@fmri3tw}[107] pcopy.pl

This program will allow you to copy P files within the last 24 hours with a time range.
Usage: pcopy.pl
       [options]
       -s [fmriserver]  server name
       -d [ ]           directory name if created on server



Example:  pcopy.pl -s fmriserver -d norm040104 <10:00:00> <18:30:00> pywong
Please email problems to pywong.edu
{sdc@fmri3tw}[108] pcopy.pl -s fmriserver -d subject1folder 16:05 16:15 marybirn
Servername = fmriserver
Directory name = subject1folder
P35328.7 Thu May  7 16:13:23 2015
P34816.7 Thu May  7 16:07:42 2015
P35840.7 Thu May  7 16:14:15 2015
Are you sure you want to copy the files listed above? <yes> or <no>
yes
mycommand = scp -p /usr/g/mrraw/P35328.7 /usr/g/mrraw/P34816.7 /usr/g/mrraw/P35840.7   marybirn@fmri
##############################################################
#        UC San Diego - Center for Functional MRI            #
#                Authorized access only!                     #
# Disconnect IMMEDIATELY if you are not an authorized user!!! #
#         All actions Will be monitored and recorded         #
##############################################################
marybirn@fmriserver.ucsd.edu's password:
```

Choose time range here for batch transfer

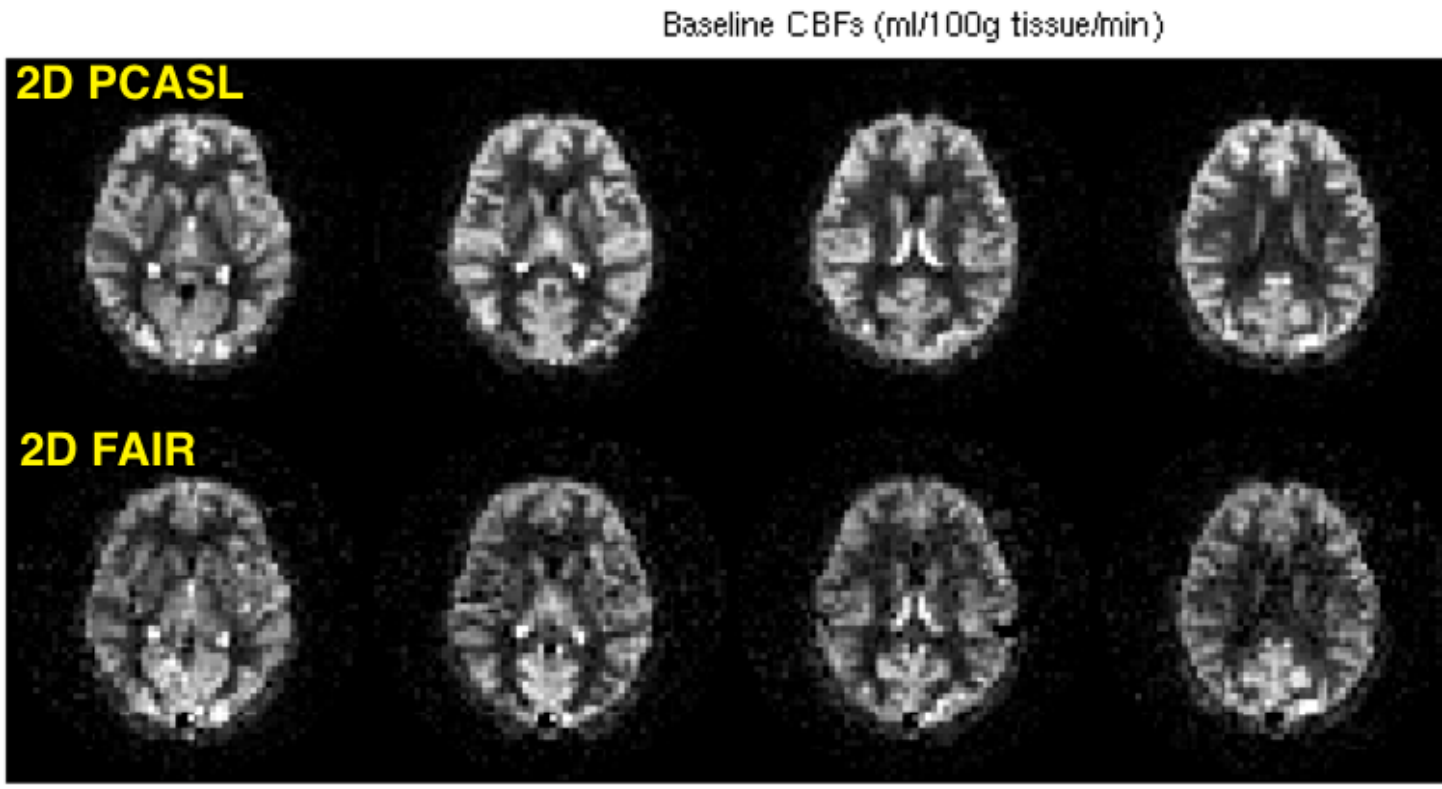
For 3DPCASL, T1 structural, and field map scans, data are stored in DICOM format.

Refer to this link for instructions on how to move DICOM files from the scanner to another server.

Between FAIR and PCASL, which one should I use?

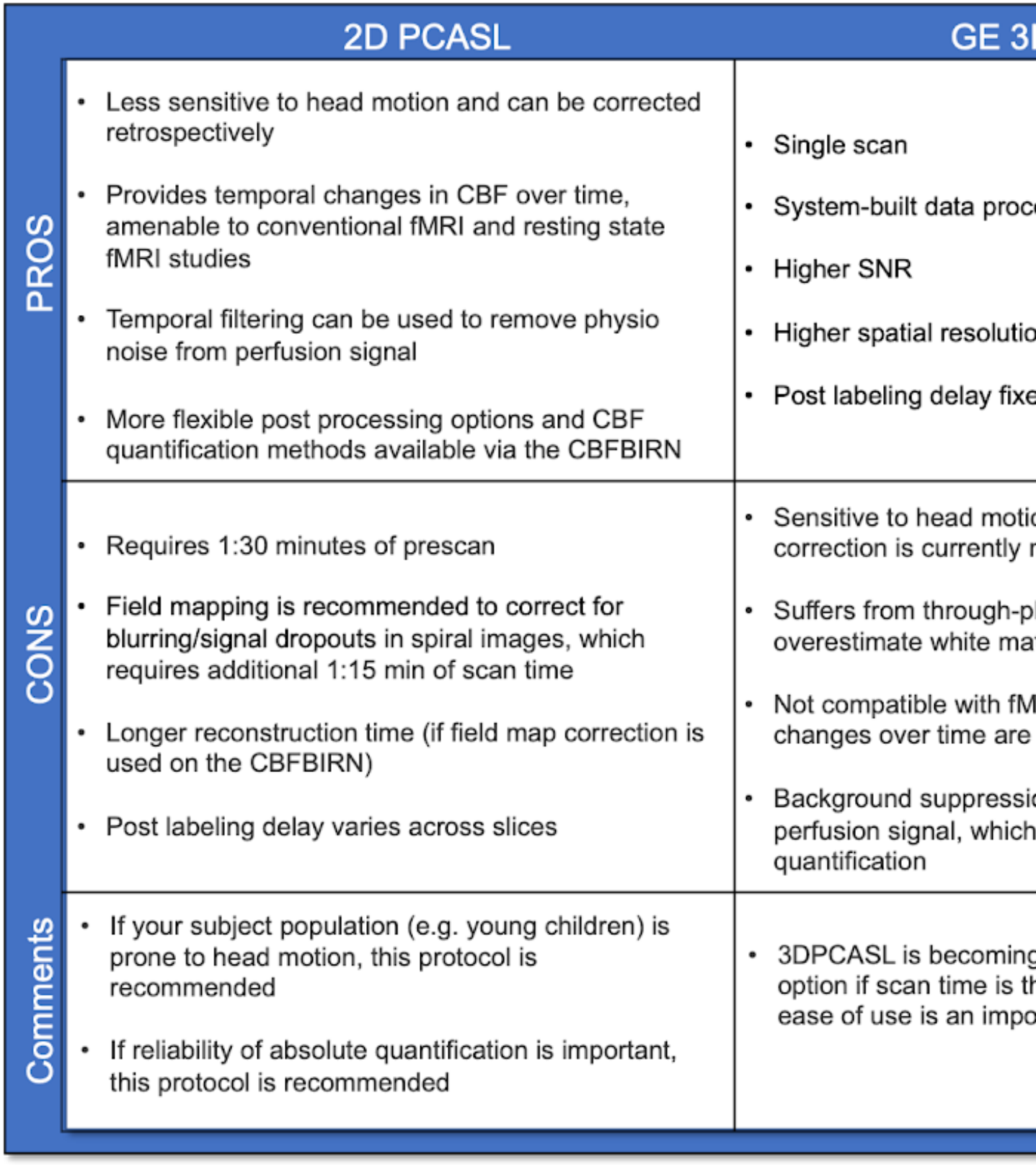
PCASL is a newer technique that provides several advantages over FAIR. Unless you have an ongoing ASL study using the FAIR protocol, we currently recommend all new users to choose the PCASL protocols.

FAIR and 2D PCASL CBF maps acquired from the same subject are shown below.



Between 2D PCASL and 3DPCASL, which one should I use?

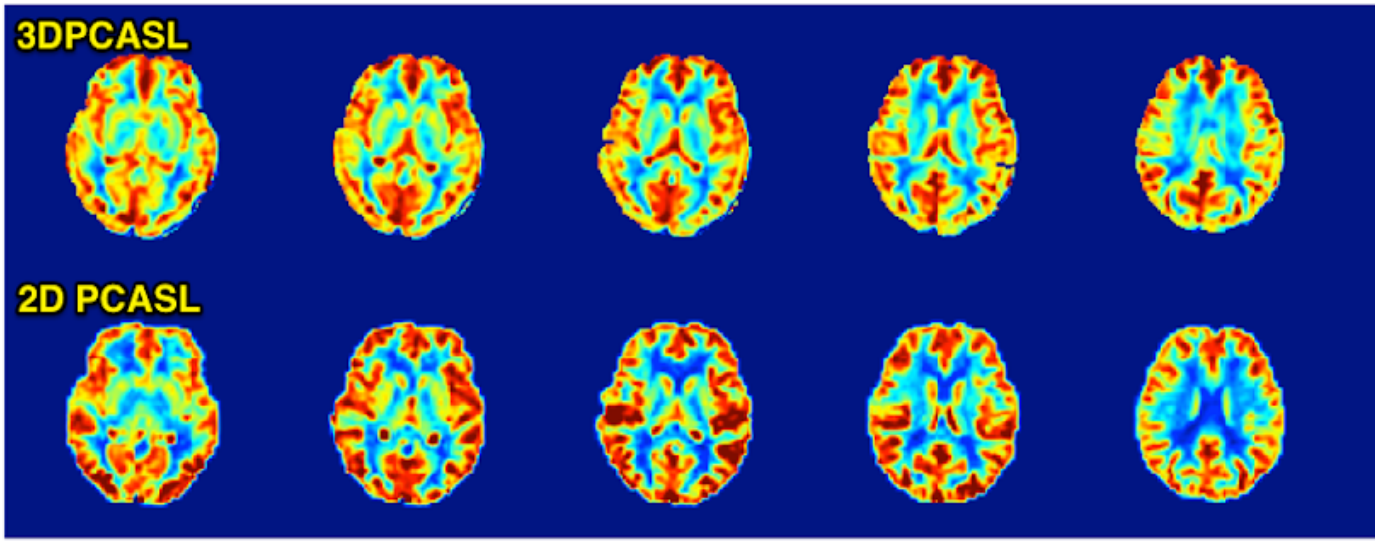
Use the table below to assess the pros and cons of each protocol.

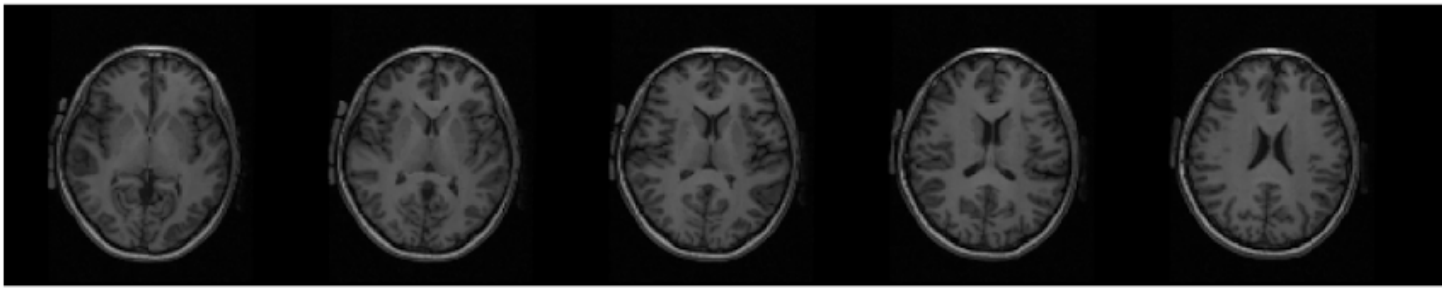


	2D PCASL	GE 3I
PROS	• Less sensitive to head motion and can be corrected retrospectively • Provides temporal changes in CBF over time, amenable to conventional fMRI and resting state fMRI studies • Temporal filtering can be used to remove physio noise from perfusion signal • More flexible post processing options and CBF quantification methods available via the CBFBIRN	• Single scan • System-built data proc • Higher SNR • Higher spatial resolutio • Post labeling delay fixe
CONS	• Requires 1:30 minutes of prescan • Field mapping is recommended to correct for blurring/signal dropouts in spiral images, which requires additional 1:15 min of scan time • Longer reconstruction time (if field map correction is used on the CBFBIRN) • Post labeling delay varies across slices	• Sensitive to head motic correction is currently r • Suffers from through-pl overestimate white ma • Not compatible with fM changes over time are • Background suppressio perfusion signal, which quantification
Comments	• If your subject population (e.g. young children) is prone to head motion, this protocol is recommended • If reliability of absolute quantification is important, this protocol is recommended	• 3DPCASL is becoming option if scan time is th ease of use is an impo

3DPCASL and 2D PCASL CBF maps acquired from the same subject are shown below.

Also shown are corresponding anatomical images.


3DPCASL
2D PCASL



What are the standard scan and labeling parameters for each protocol?

Parameters	2D	
	FAIR (QUIPPS II)	PCASL
TR	2500 ms	4300 ms
TE	3.2 ms	3.2 ms
FOV	24 cm	24 cm
# of Spirals	1 (single shot)	1 (single shot)
Points per Spiral	4872	4872
Image Matrix	64x64x20	64x64x24
Slice Thickness	6 mm	6 mm
Brain Coverage	12 cm	14.4 cm
Temporal Bolus	800 ms	1800 ms
Post Labeling Delay	1000 ms	1800 ms
Background Suppression	Optional	Optional
Scan Time	4:50 + 30-sec calibration	4:18 + 30-sec calib

Dual echo OptPCASL provides both BOLD and ASL time series simultaneously6,7,8.

If OptPCASL is used for a series of functional scans, the same scan can be used to acquire whole brain CBF in the same time it takes to use regular 2D PCASL but with improved labeling efficiency.

Please contact Conan Chen if you are interested in using the OptPCASL protocol for fMRI studies.

What other ASL techniques are out there?

We are actively involved in the development and testing of advanced ASL techniques. Some examples include velocity selective ASL9 and vascular territory imaging10.

If you are interested in using these techniques for your study, please contact Conan Chen (coc004@ucsd.edu).

References

1. Alsop et al. Recommended implementation of arterial spin-labeled perfusion MRI for clinical applications: A consensus of the ISMRM perfusion study group and the European consortium for ASL in dementia. MRM 73:102-116, 2014.
2. Wong et al. Quantifying CBF With Pulsed ASL: Technical and Pulse Sequence Factors. JMRI 22:727-731, 2005.
3. Jia et al. White Matter Perfusion Measurement using Velocity-Selective Arterial Spin Labeling – A Comparison with Pulsed ASL and Pseudo-Continuous ASL. Abstract #2702. ISMRM 2014.
4. Jia et al. Comparison of Transit Delay Sensitivity between Pseudo-Continuous ASL, Pulsed ASL and Velocity-Selective ASL. Abstract #2705. ISMRM 2014. ISMRM 2014.

5. Shin et al. The Cerebral Blood Flow Biomedical Informatics Research Network (CBFBIRN) database and analysis pipeline for arterial spin labeing MRI data. Front Neuroinform 7:21, 2012.

6. Shin et al. Pseudocontinuous Arterial Spin Labeling with Optimized Tagging Efficiency. MRM 68:1135-44, 2012.

7. Restom et al. Calibrated fMRI in the medial temporal lobe during a memory-encoding task. NeuroImage 40:1495, 2008.

8. Restom et al. Cerebral Blood Flow and BOLD Responses to a Memory Encoding Task: A Comparison Between Healthy Young and Elderly Adults. NeuroImage 37:430, 2007.

9. Wong et al. Velocity-selective arterial spin labeling. MRM 55:1334-1341, 2006.

10. Wong et al. Vessel-Encoded Arterial Spin-Labeling Using Pseudocontinuous Tagging. MRM 58:1086-1091, 2007.

CHAPTER 4

Peripheral Equipment Usage

4.1 Peripheral Equipment Usage

4.1.1 Projectors

- In each control room there are two projectors - the Lower projector and the Upper projector.
- The Lower projector is the main one used by many researchers. Tthis uses the large projection screen that stands at the end of the table. This setup is helpful if your subject is claustrophobic.
- The Upper projector is used when you want to use the projection screen that goes inside the bore.
- **Projector Power:**
  - Both projectors can be turned on with the red button on the remote. Make sure you point the remote very close to the projector you want to use or you could accidently turn both of them on.
- To turn off the projector simply press the power button on the remote twice.
- **Projector Source Selection:**
  - If you are getting a no signal error message: - Make sure the VGA cable is attached to your computer. - Press the source bottom on the remote until VGA port A is selected then press the Enter button.
- **Projector Resolution:**
  - The native max resolution of the lower projector is 1280x800 and the upper projector is 1024x768.
  - Both can be set on your computer's "System Preferences" or "Control Panel" depending on which OS you are using. Please refer to your user manual.

width 1000

width 1000

4.1.2 Button Boxes

- **The button box system at CFMRI contains the following components:**
  - Electronic Interface
  - Fiber Optic cable
- **Response Pads (2 button and 4 buttons)**
  - 2 and 4 button handhelds
- **SET UP**
  - To test the optical part of the system without a computer: -The LEDs on the side of the interface box will light when the correesponding buttons is pressed. This means that the optical part of the system is working properly.
    - Set the program switch for your specific application and handheld.
    - The program switch is on the front plate of the interface box (see picture below). The switch has a small arrow which points to a number as shown below. Use a small flat headed screw driver to turn the switch to other positions.

CHAPTER 5

Safety

5.1 Training

5.1.1 Safety Training

How do I sign up for Safety Training?

- Fill out the online registration form before the safety lecture. This information is needed to process your safety training. (link). NOTE: If you do not attend the next safety lecture you will have to register again.
- The Center schedules the Safety Training Lecture when 12 or more requests are received. The scheduled session will then be posted on the CFMRI website and notification will be distributed via CFMRI E-Updates. Please note that no individual notification will be issued..
- If you attend the safety lecture without registering, you will only be admitted if there is space. You will still need to complete the online registration forms before your training can be processed.
- After each Safety Lecture, the Webmaster will take the attendance record with the information submitted during registration and send out passwords to take the online test.
- Using the assigned password, take the online safety test. (Link: https://cfmriweb.ucsd.edu/etraining).
- We encourage everyone to attend the safety lecture even if they do not need the official training.
- You can verify your status at (https://cfmriweb.ucsd.edu/cfmri-training/check.php) the following day after you have completed the online safety test.

5.1.2 Operator Training

How do I sign up for Hands-on Operator training?

- You must have attended safety training and have passed the online safety test.
- Have your Project PI submit an on-line request (link: https://cfmriweb.ucsd.edu/operator-training). CFMRI Staff will schedule the training and contact you with dates and times.

- Complete the two 2-hours sessions. (Certificate will be awarded.)
- PI must email CFMRI (cfmri@ucsd.edu) requesting that the operator be added to their approved research project(s).
- Operators should submit the CFMRI Access Request Form (Online application) once they have been signed off by CFMRI Staff.

CHAPTER 6

Training

6.1 Safety

6.1.1 Emergency Power Shutoff

When should I use the electrical power emergency shutdown button?

- Use the emergency power shutdown button when there is a fire in or near the MRI rooms, or if there is damage to the scanner that can be prevented by shutting down the electrical power (Note: shutting down the electrical power does not remove the magnetic field).

How do I shut off the electrical power to the scanner in case of an emergency?

- You can shut down the power by pushing the red triangle button on the keyboard or on the front of the magnet next to the bore entry.
- Or you can push the red buttons behind the plasic cover on the wall inside the control room (next to the control room door) or inside the manget room (right next to the control room door). These buttons will shut down the main transformer and cut off electrical power to the entire MRI system.

What do I do after I use the emergency power shutoff?

- Please do not attempt to turn the power back on by yourself. Instead, report your use of the emergency power system to CFMRI technical staff.

6.1.2 Quenching the Scanner

What should you do if the magnet quenches?

- Do not panic.
- Prop open the door between the operator room and the hallway.
- Prop open the door to the magnet room.
- Instruct any person in the magnet room to leave immediately and help them if it is safe to do so.

- Evacuate all personnel from the area until the air is restored to normal.

When should you use the quench button? *The quench button is to be used only in the case of an emergency in which a person is injured and the only safe way to avoid further injury is to decrease the magnetic field strength of the magnet.

What happens when the quench button is pushed?

- Pushing the quench button will cause the liquid helium that cools the magnet to rapidly boil off. The quench pipe above the magnet is designed to allow the helium vent outside of the building. If the quench pipe fails, there is a danger that the magnet room will be filled with helium and that the oxygen in the room will be displaced, which could cause injury or death for anybody in the magnet room or the console room during a quench.

Why is the quench button only used in case of emergency?

- Quenching the magnet can be dangerous due to the rapid boil off of helium which creates dangerously high pressures and could displace oxygen from the room. A quench could cause permanent, irreparable damage to the magnet. If the magnet survives the quench it will have to be recharged which is very costly and time consuming.

Where is the quench button?

- The quench button is on the quench box which is mounted on the side wall inside each magnet room. Lift the spring loaded plastic cover to access the button.

6.1.3 Gauss Lines

The 5, 10 and 200 Gauss lines are marked on the floor of each magnet room. These Gauss lines serve as a reminder that you are inside a magnetic field which increases sharply as you move closer to the magnet. The 5 Gauss line (the outermost line) defines the limit beyond which ferromagnetic objects are strictly prohibited.

6.1.4 Fire Extinguisher

Where Can I Find a Magnet Safe Fire Extinguisher?

- There is a magnet safe fire extinguisher inside each magnet room next to the door. This fire extinguisher is blue and white. Please note, that the red fire extinguishers should not be taken into the magnet room at any time. Red fire extinguishers are ferromagnetic and present a serious hazard in the magnet room.

6.1.5 Safety Documentation

```
Safety Manual for Using the Scanner

Supplementary Safety Guidelines

3.0 T MRI Initial Subject Recruitment/Advance Screening Form

3.0 T MRI Pre-procedure Screening Form

3.0 T MRI Operator's Check List
```

6.2 Additional Info

6.2.1 License

This is a generic license created by Aaron Jacobson.

6.2.2 Contact

Address:

UCSD Center for Functional MRI W.M. Keck Bldg 9500 Gilman Drive La Jolla, CA 92093-0677

Phone:

858-822-0513

Fax:

858-822-0605

E-Mail:

cfmri@ucsd.edu

Directions

- Exit Interstate 5 at La Jolla Village Drive-West
- Follow sign for Gilman Drive-North
- Turn right on Osler Lane

6.2.3 Need Assistance?

For assistance with protocol usage please contact Aaron Jacobson: ajacobson@ucsd.edu

Need further help

Contact us at cfmri@ucsd.edu

CHAPTER 7

Indices and tables

- genindex
- modindex
- search