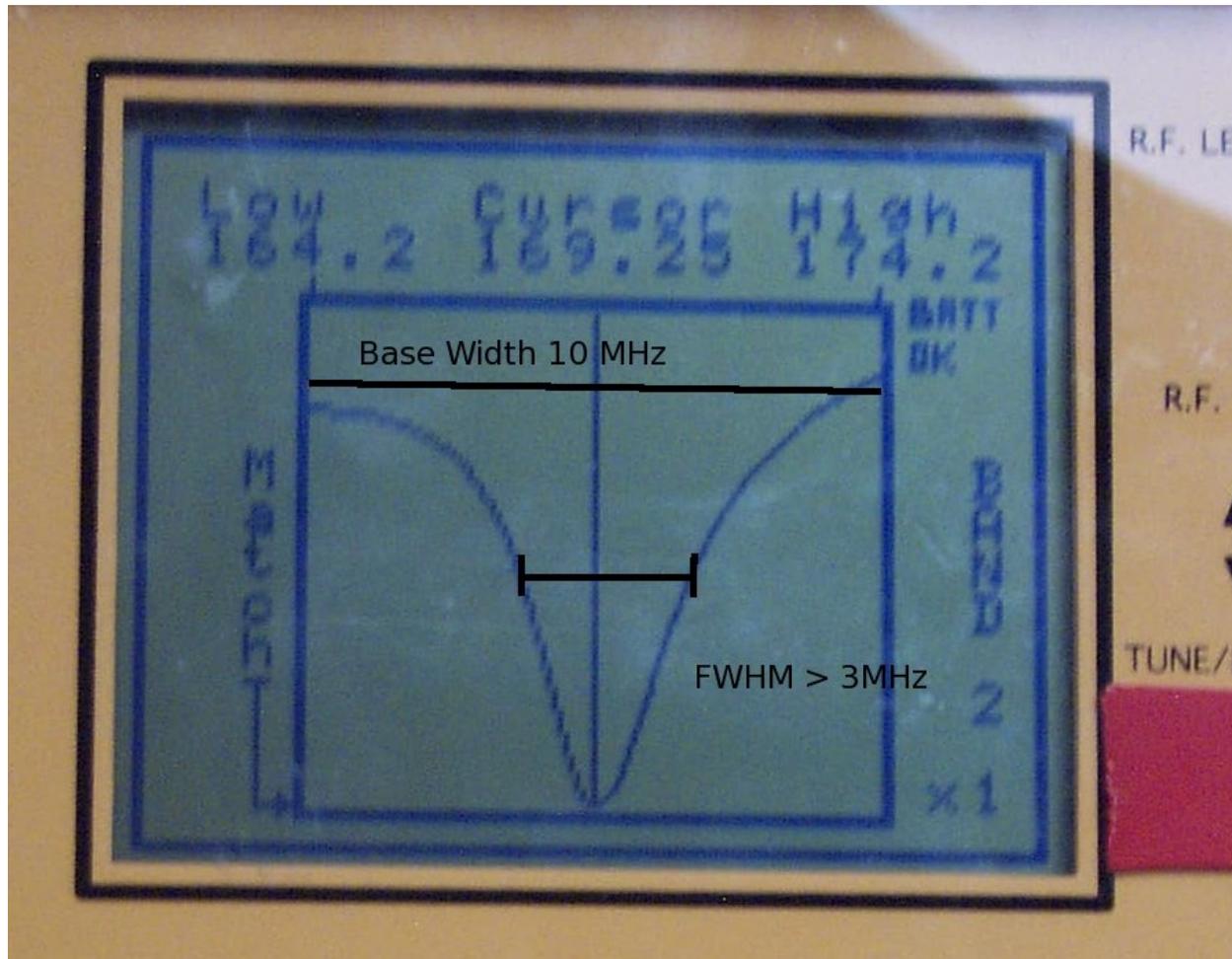


Running DJSWIFT

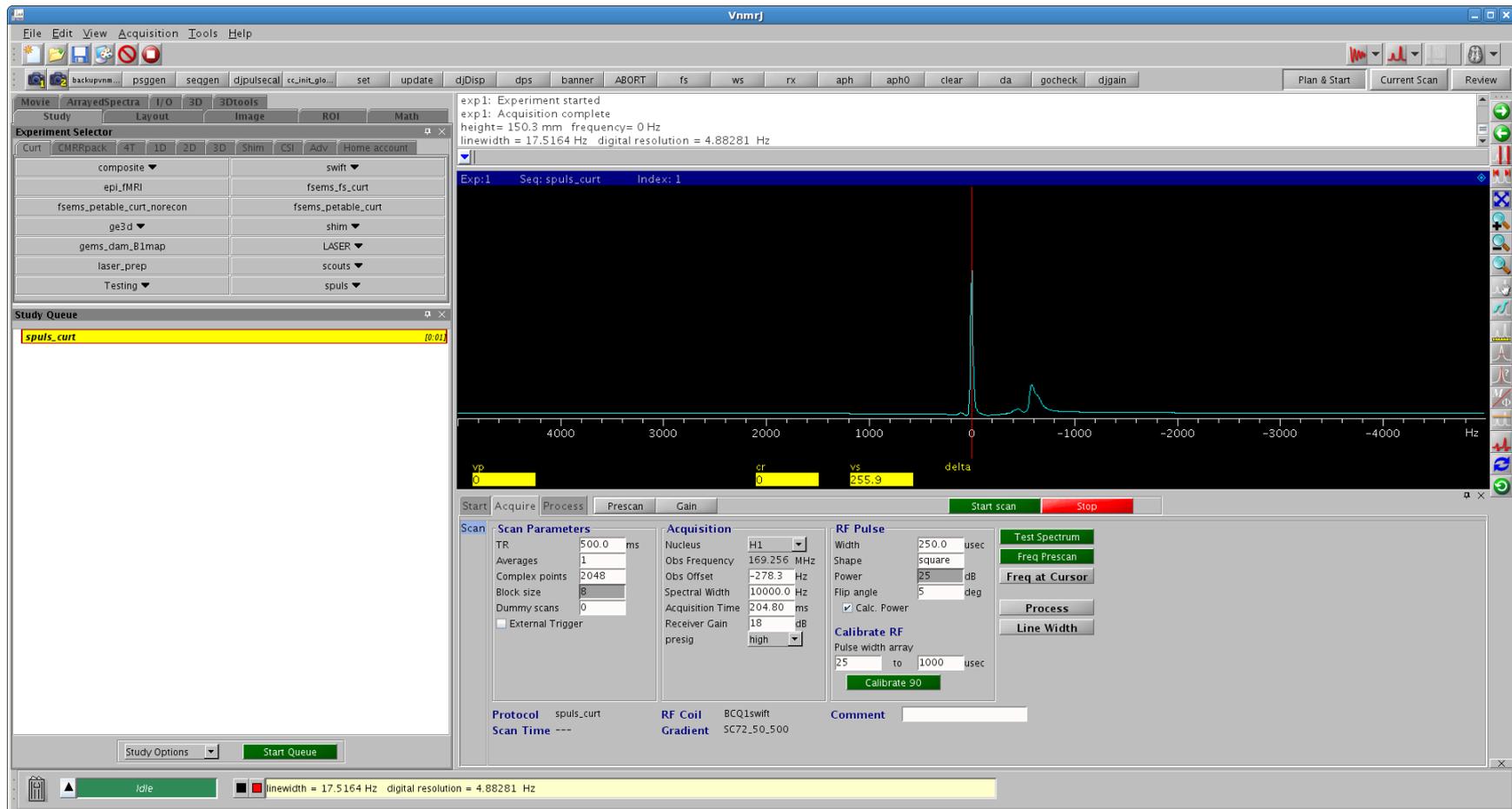
- Phase reference
- Gain check
- Acquire
- Reconstruct

Tune Coil and Sample



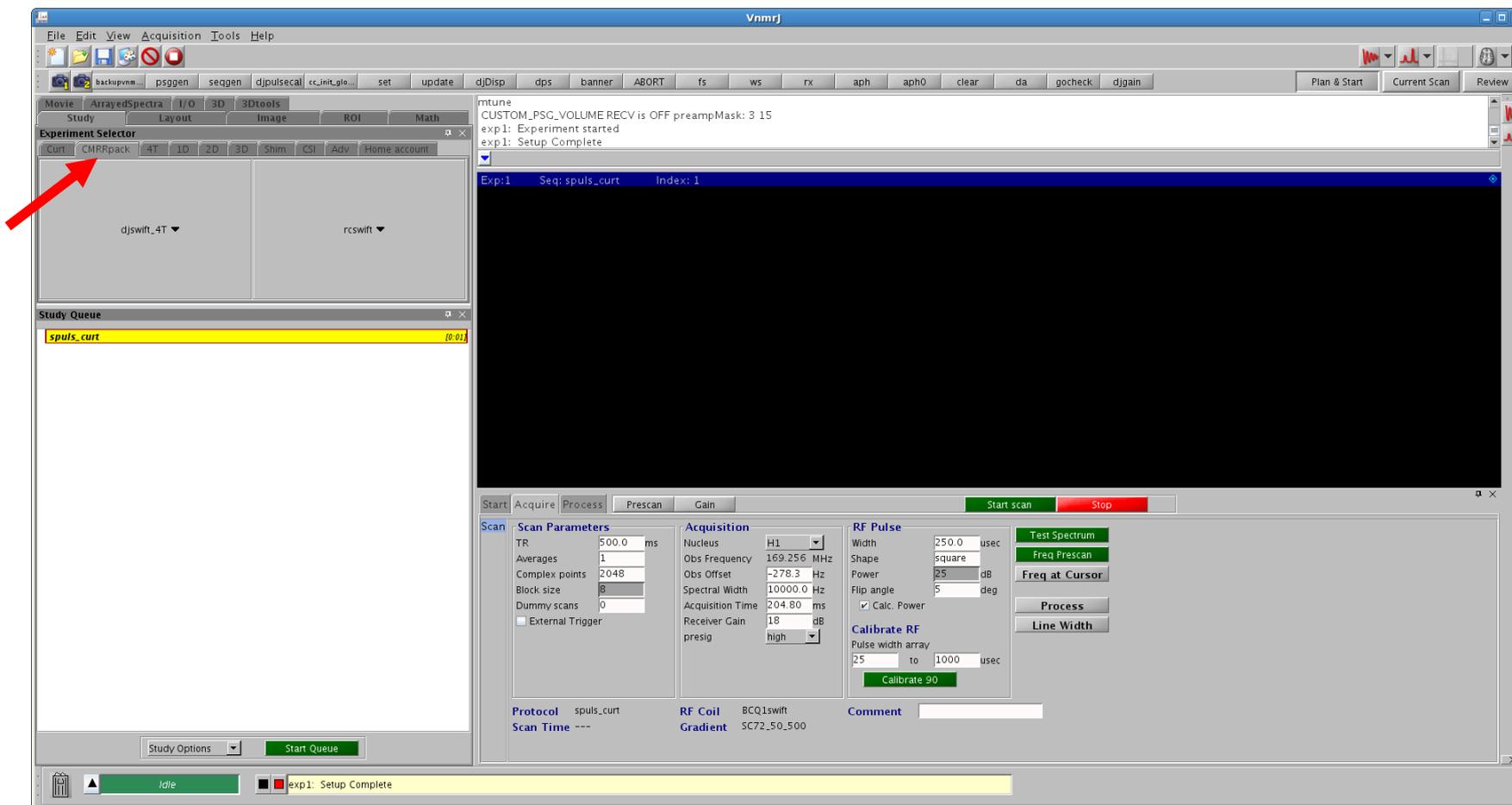
Make sure the coil and sample are set up and tuned to 3mhz or greater FWHM (full width half max) of the resonance. Here we are using a sweep generator to verify the tuning. Other options are to use a network analyzer or Vnmrj with mtune (a sweep generator mode).

Start VnmrJ



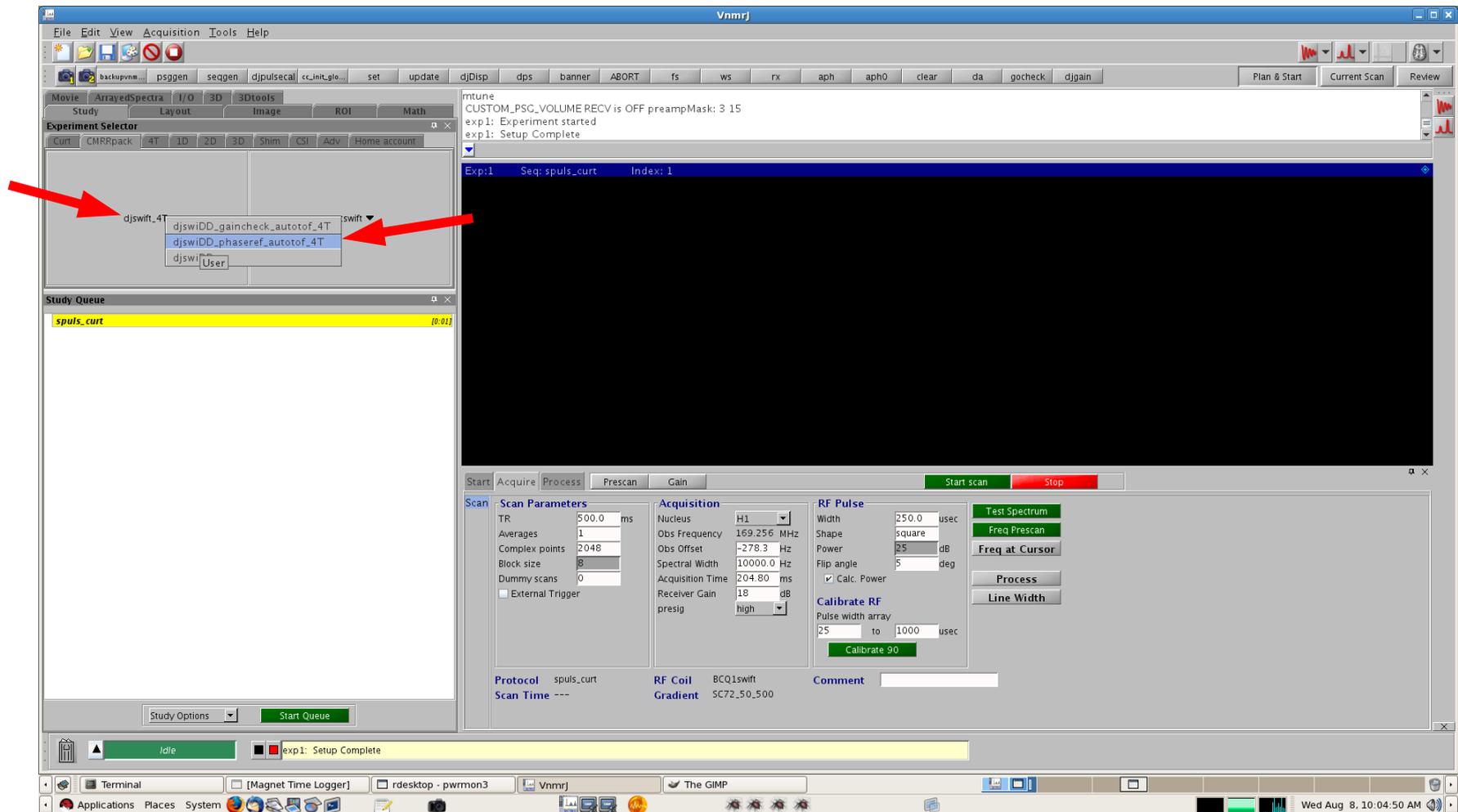
VnmrJ starts up. Verify you have a signal using SPULS or similar sequence.

Select CMRRpack in experiment selector



In the experiment selector, click on the CMRRpack tab header.

Load Phaseref sequence



Click on dswift_4T down arrow on the left side of the CMRRpack tab.
Select djswiDD_phaseref_autotof_4T from the drop down menu.

Load Phaseref sequence (con't)

The screenshot displays the Vnmrj software interface. The 'Study Queue' window is open, showing a list of studies. A red arrow points to the study 'djswiDD_phaseref_autotof_4T'. The main window shows a pulse sequence diagram for 'Exp:1 Seq: djswiDD_phaseref_autotof_4T Index: 1'. The diagram includes parameters such as tr=10.0, pw=4.0, and at=4.096. The 'Study Queue' window also shows 'spuls_curt' and 'djswiDD_phaseref_autotof_4T' (highlighted in yellow). The bottom panel shows various acquisition parameters and commands.

Study Queue:

Study Name	Modified	Unknown
spuls_curt	[0:01]	
djswiDD_phaseref_autotof_4T		(unknown)

Parameters:

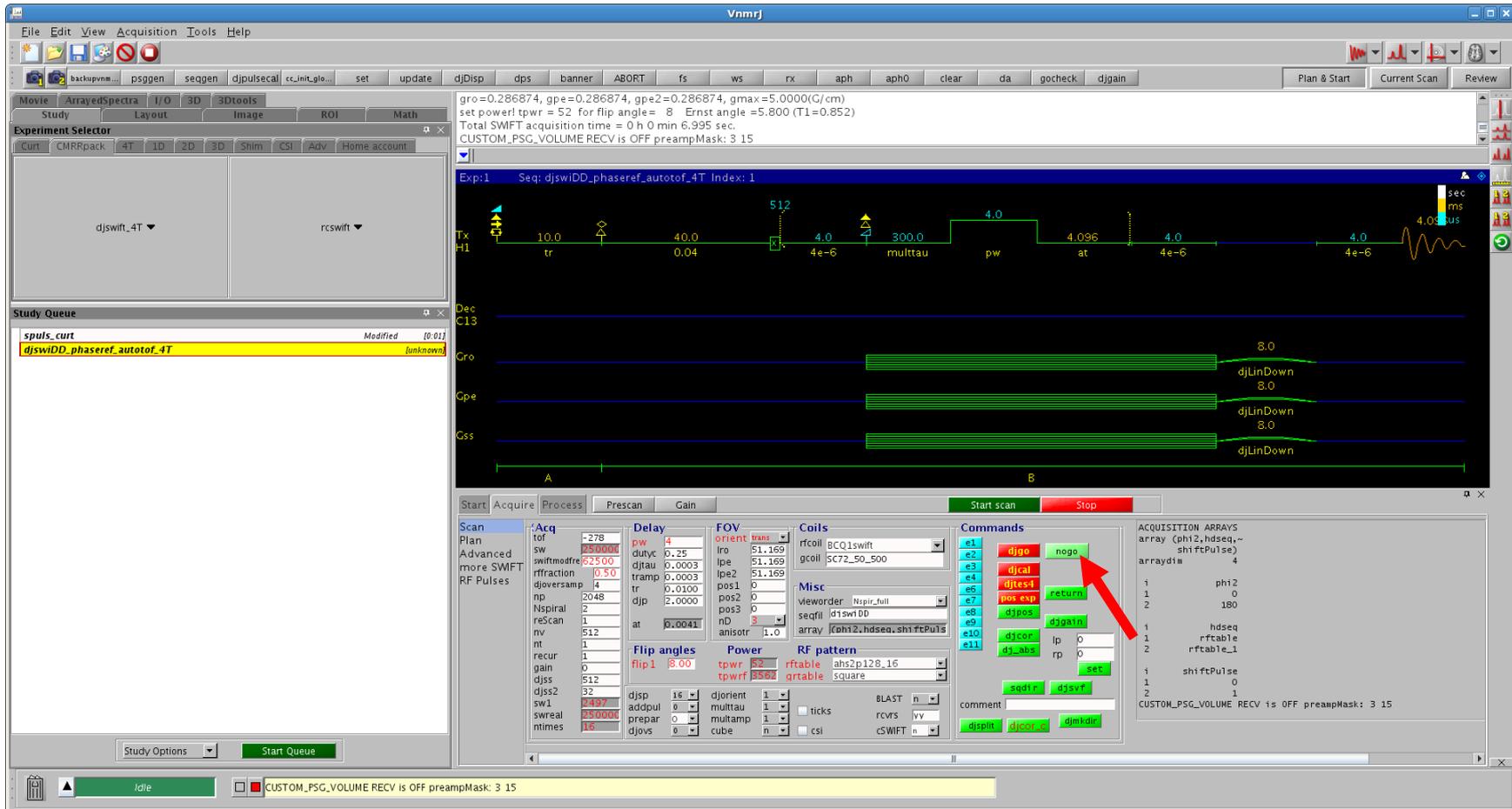
Parameter	Value
tr	10.0
pw	4.0
at	4.096
multitau	300.0
at	4.0
at	4.0

Commands:

Command	Value
e1	djgo
e2	djcal
e3	djtesf
e4	pos exp
e5	return
e6	djpos
e7	djgain
e8	djcor
e9	lp
e10	dj_abc
e11	rp

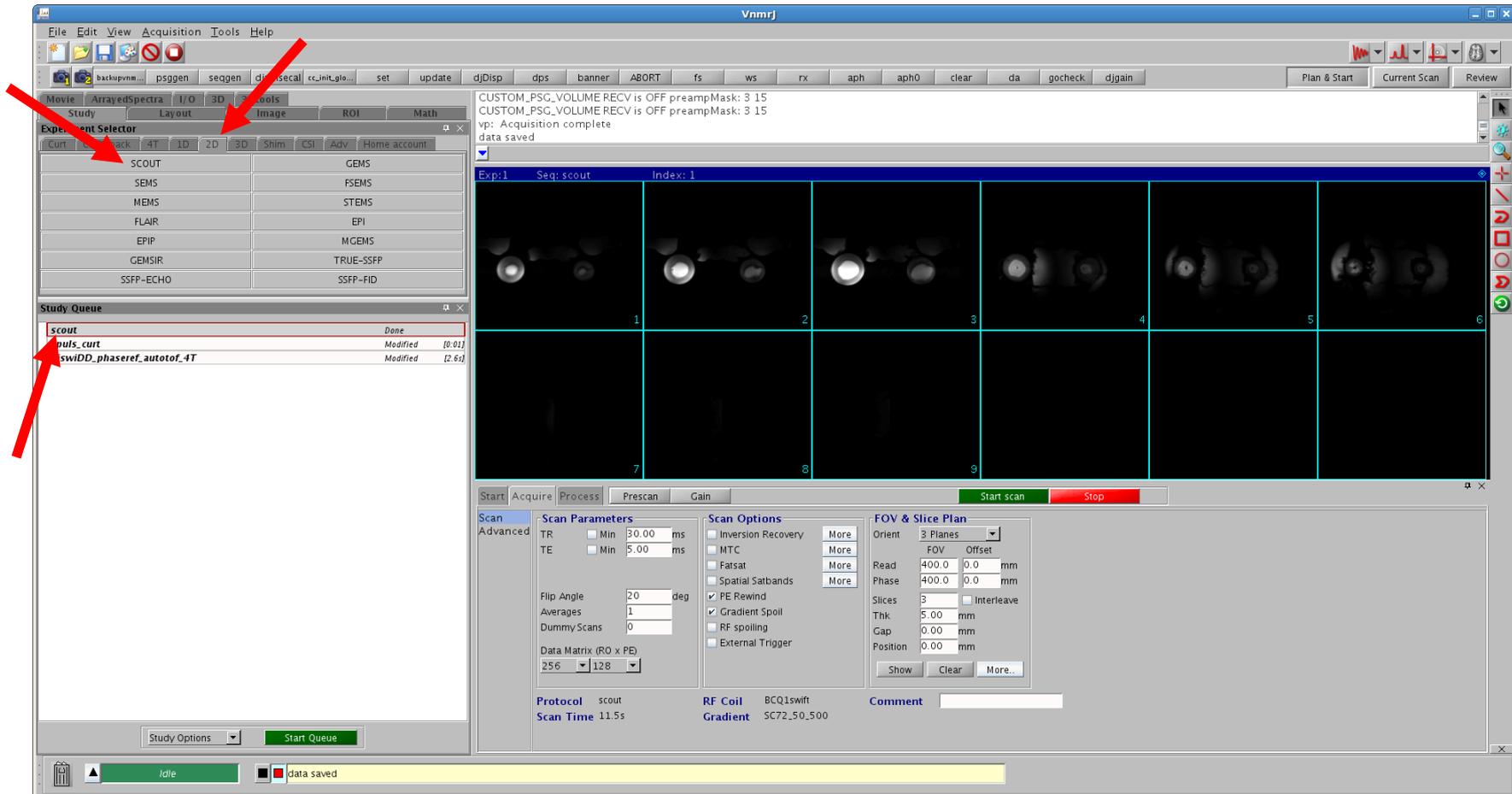
In the study queue menu below, double-click on djswiDD_phaseref_autotof_4T study. This will load the SWIFT panel and pulse sequence.

Compute tablib tables with “nogo”



Click on the nogo button. This computes tables in vnmrsys/tablib needed for the sequence to run. If you update parameters such as LRO or LPE, a nogo is needed to see the recomputed tables and parameter changes before running. A nogo is also done as part of Start Scan.

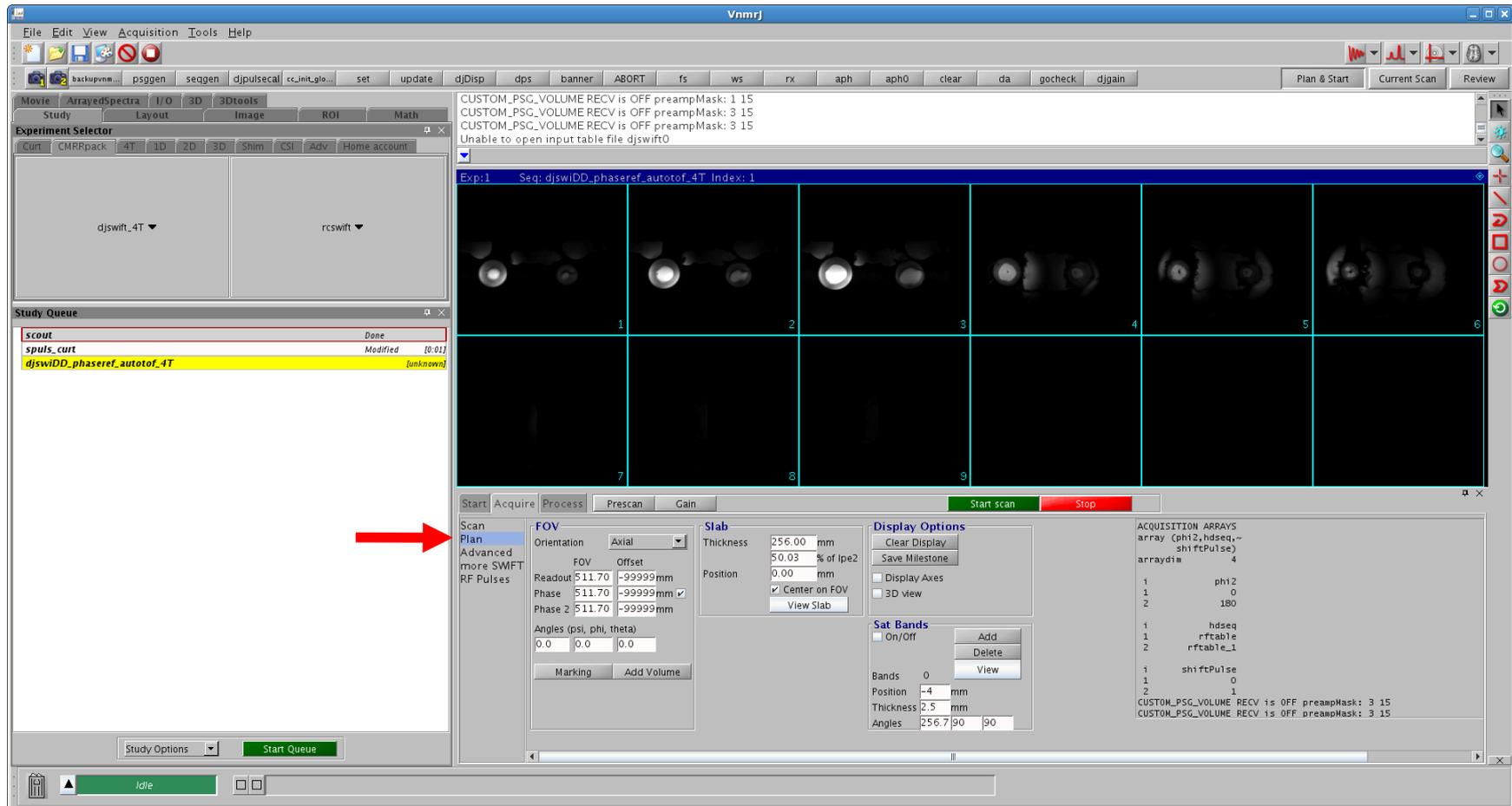
Do a SCOUT scan for planning



Make a scout scan for planning the SWIFT field of view. One way to do this is to use the SCOUT sequence. Click on the 2D tabheader in the experiment selector and choose the SCOUT sequence. Clicking on SCOUT adds it to the study queue below. Double click on SCOUT to load this sequence.

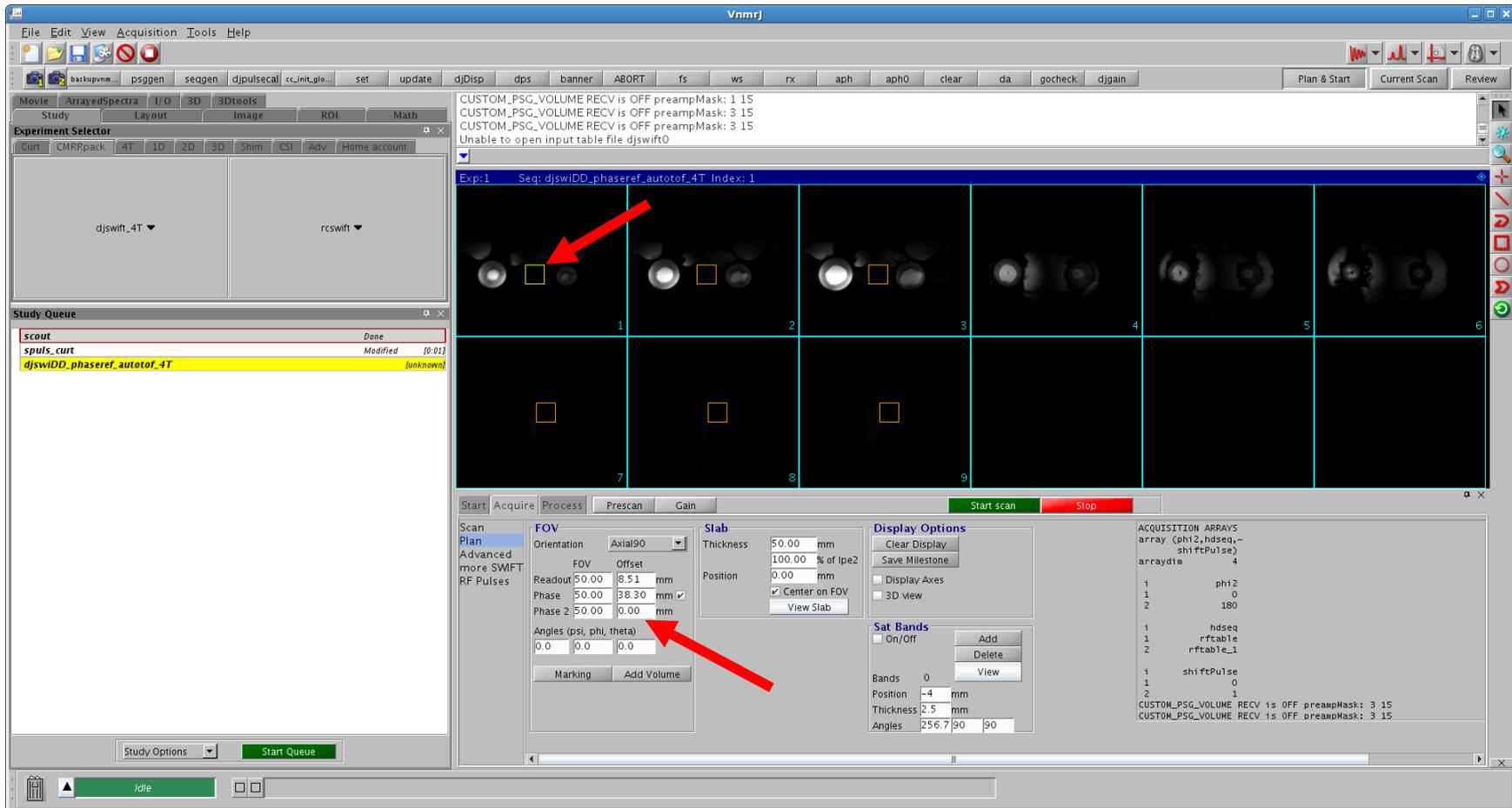
After the scout scan, double click on the SCOUT entry in the study queue to load the scout slices in the Plan & Start viewport.

Switch to the Plan subpanel



Click on the word Plan on the left side to bring up the Plan subpanel. This is very similar to the Agilent planning panel.

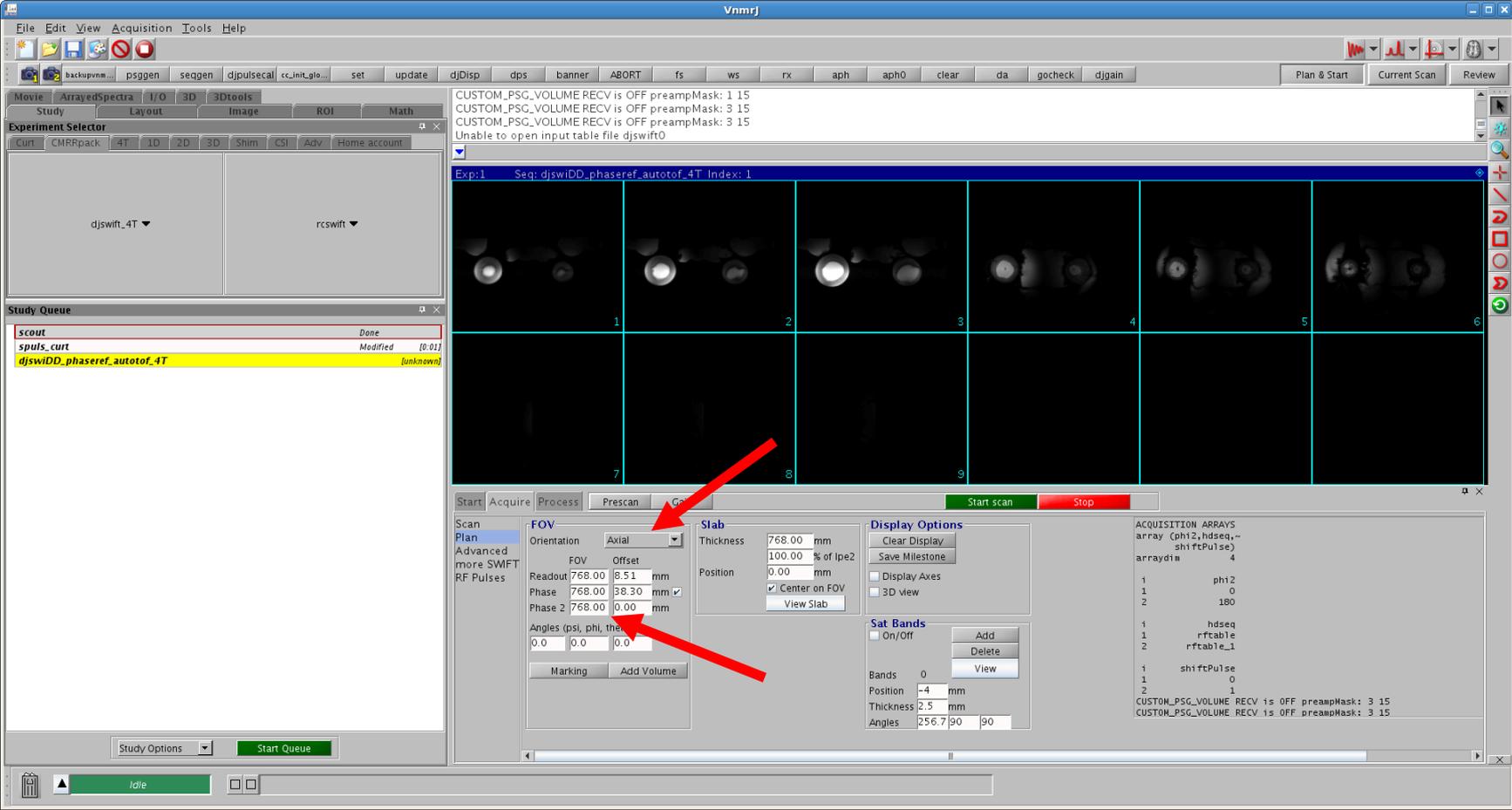
Choose your FOV



Change entries in the FOV section. Make a small field of view (example 50, 50, 50, offset 0, 0, 0) and choose Axial90 orientation to update the Plan & Start window with the small FOV at isocenter.

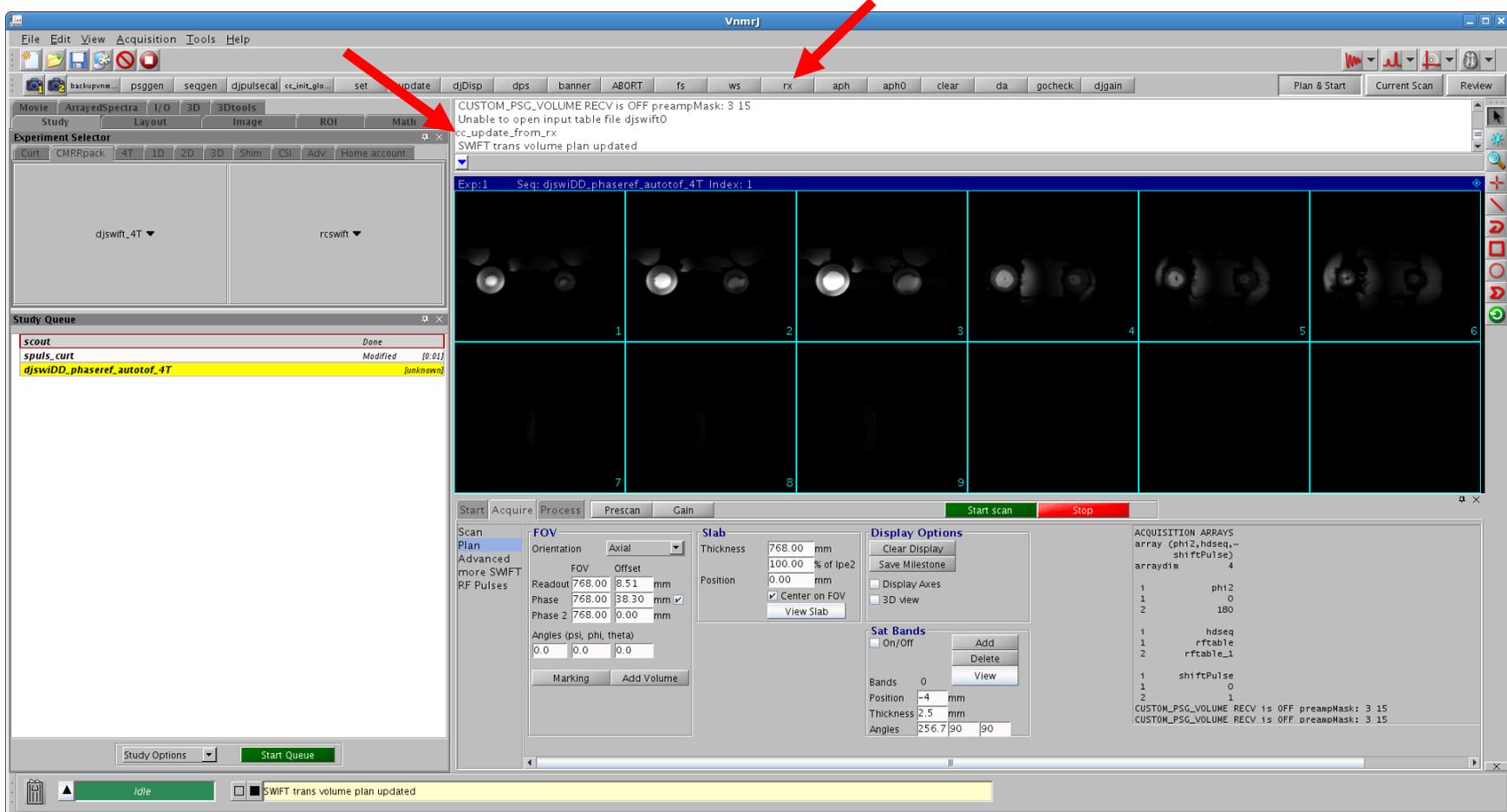
Drag the small FOV rectangle to the center of your desired phaseref field of view.

Expand your FOV



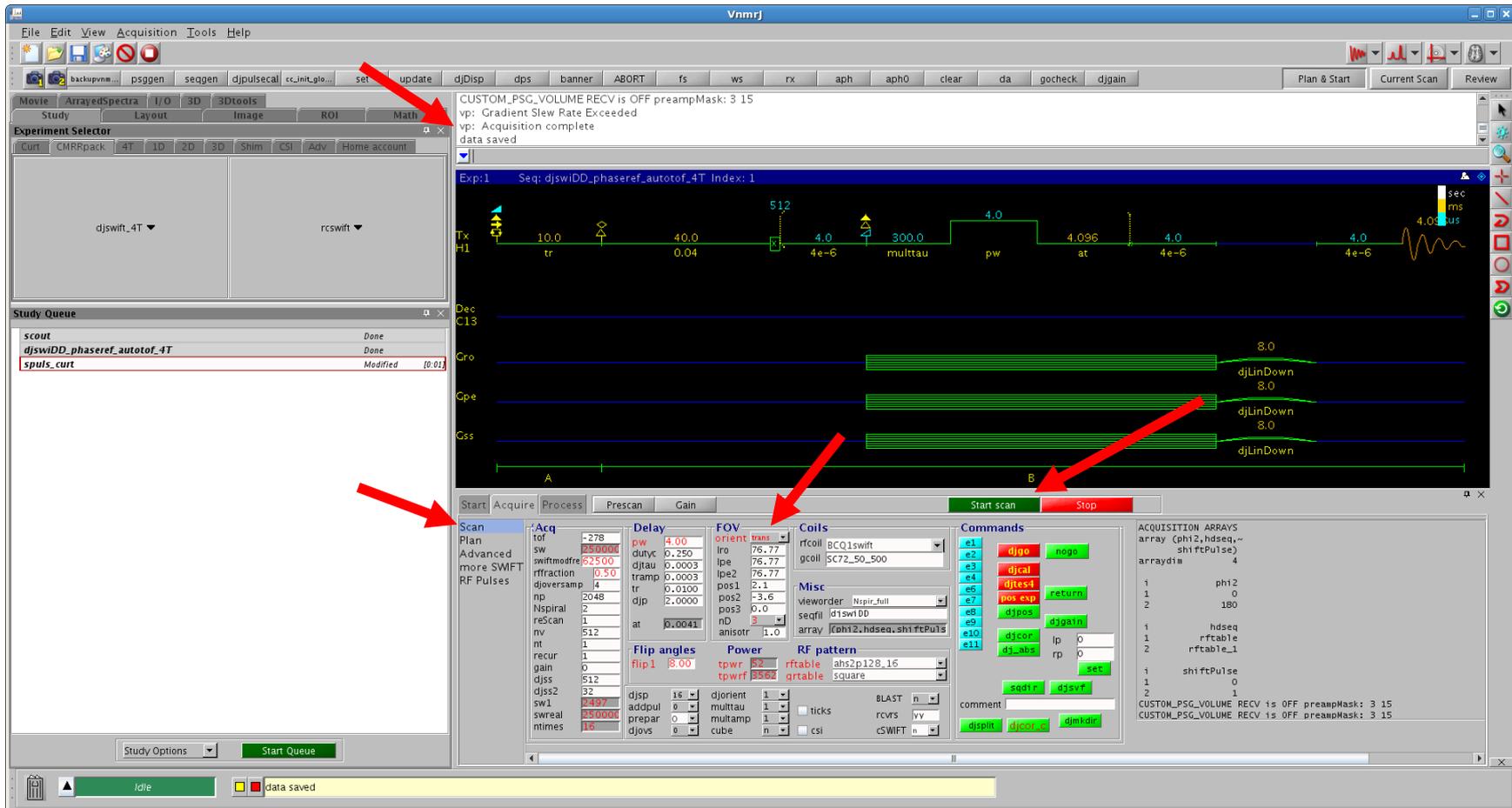
Enter values for the FOV large enough so that it is at least twice as large as the largest dimension of the object. The FOV rectangle may not be visible after this if it is larger than your original scout image. Change to back the Axial orientation.

Update FOV parameters POS1, POS2, POS3



In the command window, type "cc_update_from_rx" to invoke the macro. This will transfer the offset values to the POS1, POS2, POS3 values on the Scan page FOV section. (We have this macro hooked to a toolbar button called "rx".) If successful, the macro will respond "SWIFT trans volume plan updated".

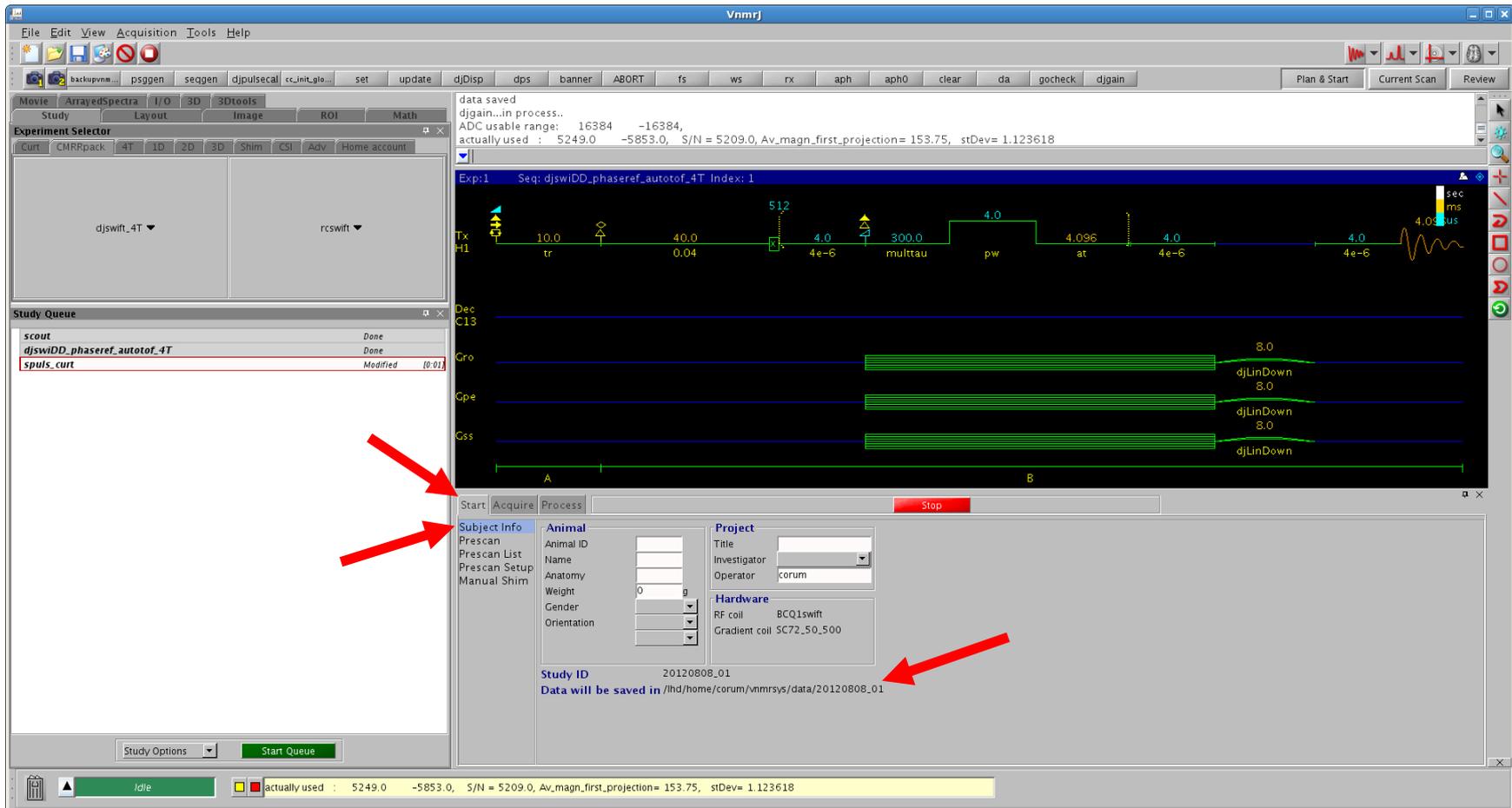
Acquire for Phaseref



Switch back to the Scan page. Notice that the FOV and POS1, 2, 3, values have been updated, but note that the values on this panel are displayed in cm rather than mm.

Now hit Start Scan (green) to acquire the phase reference. You will see "acquisition complete" and "data saved" messages. The SWIFT sequence is now displayed in the viewing area.

Note location of data folder



You can find the name of the data directory on the Start tab Subject Info page, next to Data will be saved in...

Start grid3p3 on remote system

Now open a remote session to run the grid3p3 Labview executable. It is preferred to run this Labview executable remotely because of the memory and CPU required. We use VNC to do this. Another option is ssh (forwarding X-windows with the -Y or -X options).

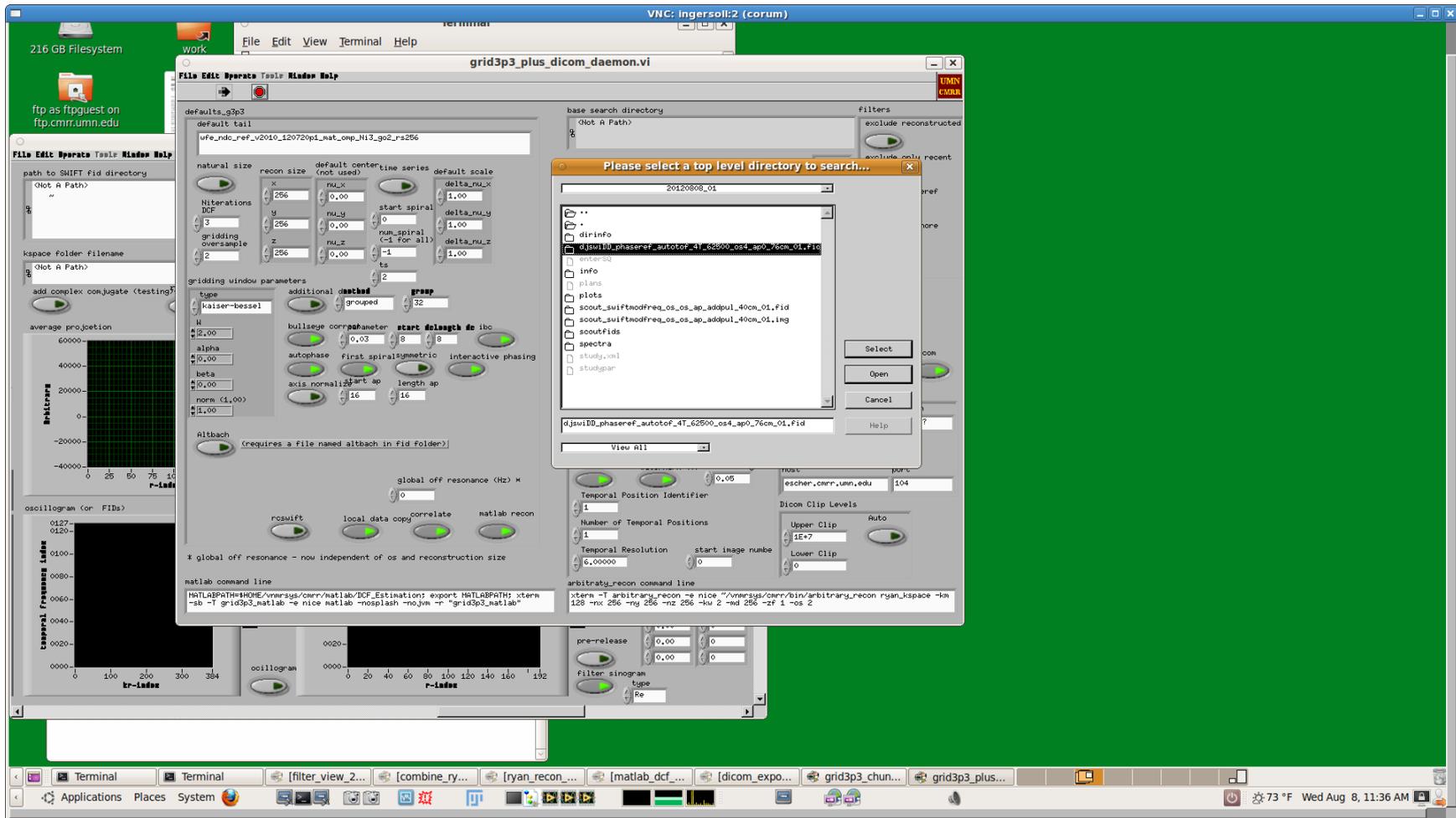
On the remote system, open a terminal window and run the program. You will have installed grid3p3 on the remote system under a vnmrsys/cmrr directory.

In our case, we have a shared directory over NFS and are running the executable installed on the console. The shared NFS directory also allows the executable to access the data that was just acquired.

```
cd  
cd vnmrsys/cmrr/bin  
./grid3p3_plus_dicom_daemon
```

A number of windows will first open and then be hidden. You will see the file selection dialog.

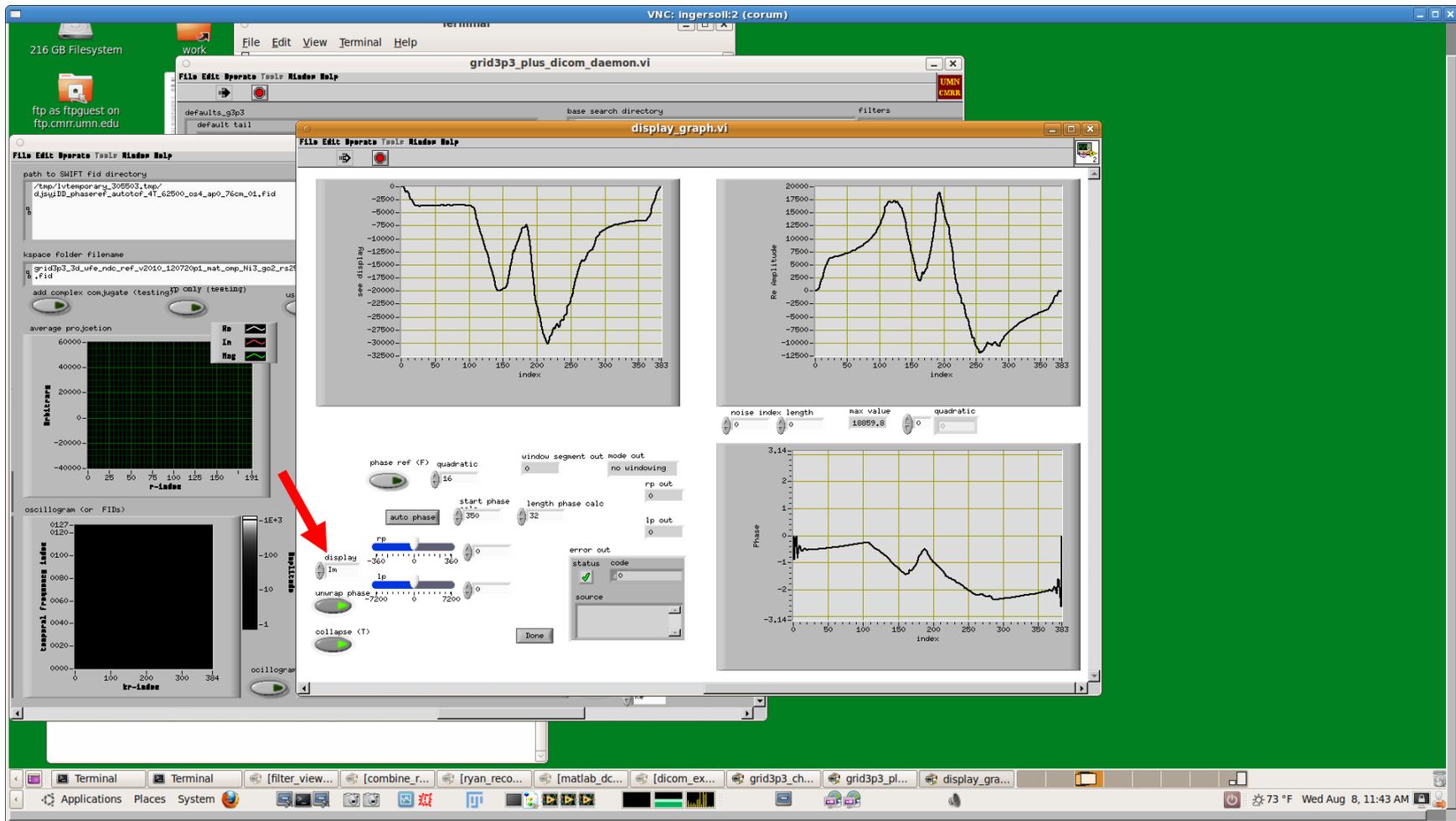
Open the Phaseref fid



The default directory opened is vnmrsys/data. Select the study folder just created. Double click on the study folder, then select the fid file for the phaseref and click Select. In this case it was data/20120808_01/djswDD_phaseref_autotof_4T_62500_os4_ap0_76cm_01.fid

Parts of the fid directory name may be replaced with automatic values (which is customizable via Vnmrj file save data setup dialog).

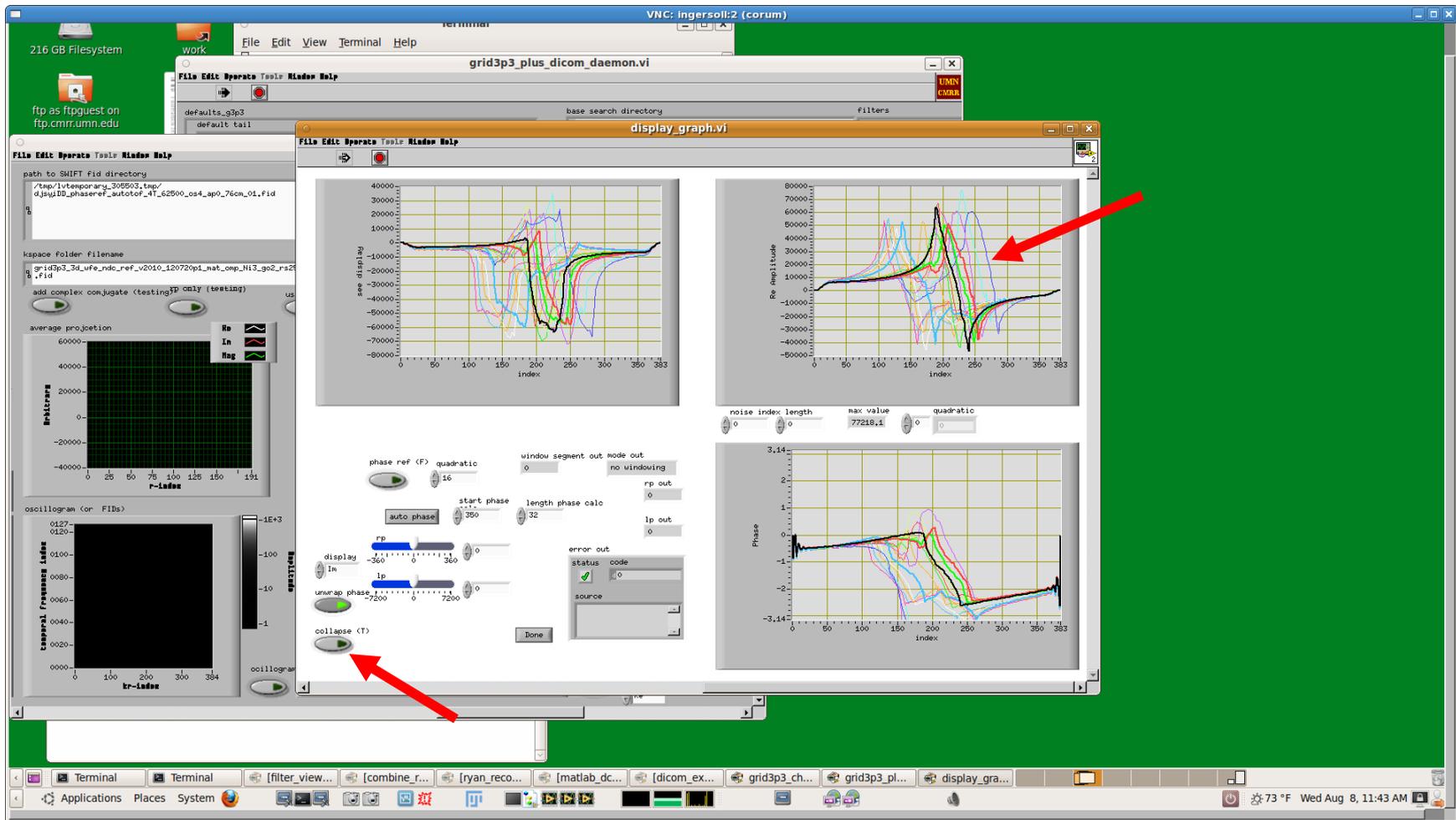
grid3p3 displays the average projections



The window `display_graph.vi` will open. The upper left shows imaginary (by default), the upper right shows the real, and the lower right shows the phase of the average projection.

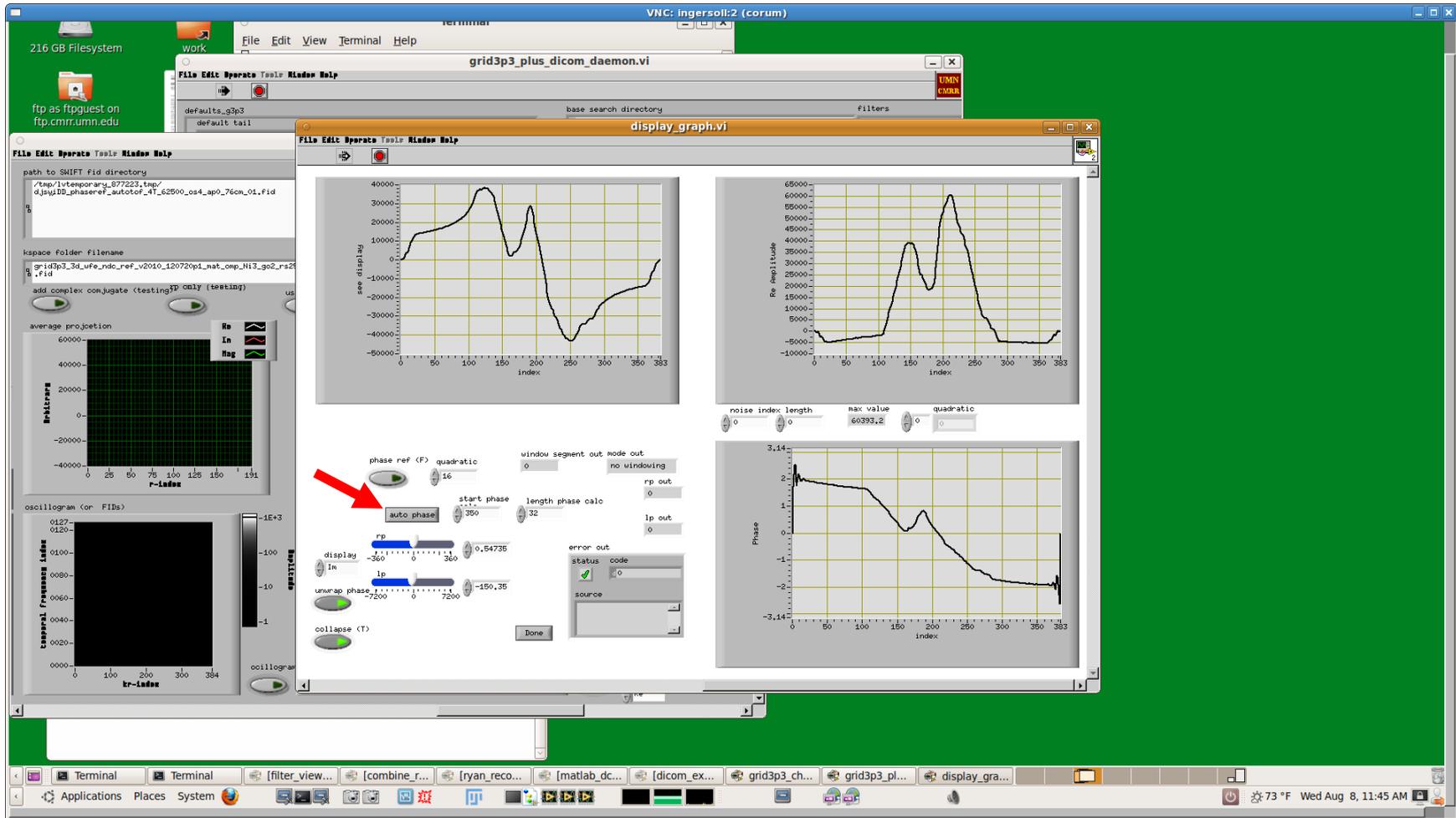
You can change what the upper left graph shows by using the display menu on the left. By default it shows the imaginary component. The average projection is an average of all the available data.

grid3p3 projection option - Collapse



You can display more detail by clicking on the Collapse button. With collapse on, the average is displayed (single line). With collapse off, a number of individual projections are displayed.

grid3p3 auto phase



Click on the auto phase button. The program will recalculate the phase and redisplay the average projections and phase graphs. Under ideal conditions (no coil ringdown, no short T2 background, and homogenous/uniform B1), this is all that is needed. The auto phase works from the average projection (the "collapsed" line).

grid3p3 phase adjustments

The default values used for the auto phase are displayed next to the auto phase button. The value in start phase calc and length phase calc are used to calculate the phase when you click auto phase. The default value of "350" should work well. If these values are out of range of your data, you may get "not a number" or other errors. Adjust these as needed to fit your data.

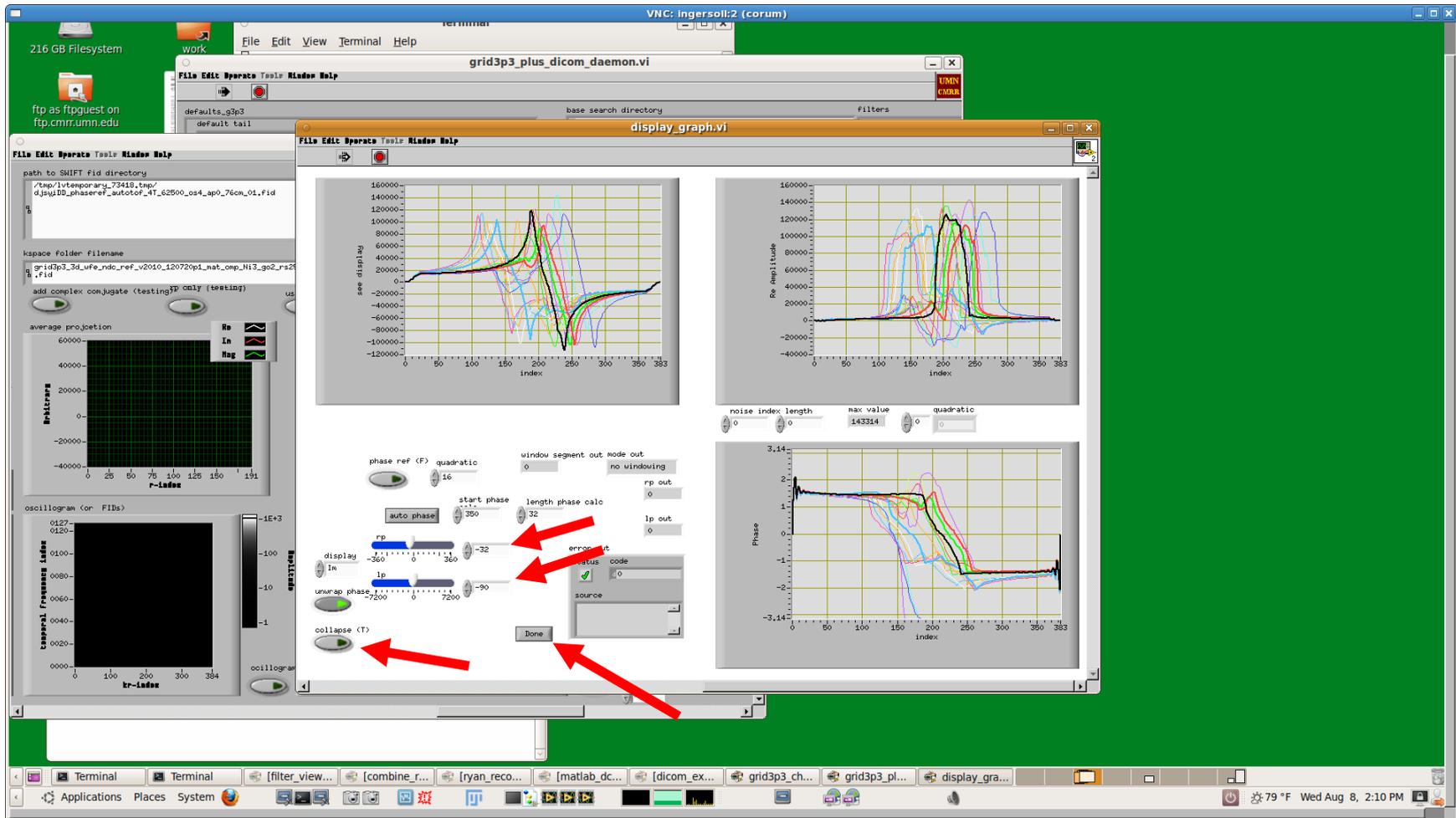
To further fine tune the phasing, there are two phase parameters to adjust, lp and rp. For this sequence, an lp value of "-90" works well. A rp value will depend on your coil, cabling, etc. In our case, a value of "-31" or "-32" results in an average projection in the real display with a desirable characteristic shape.

The desired graph shape has the property that data related to the object is displayed in the middle of the graph and is surrounded by a relatively symmetric baseline. The slope change from the baseline to the object part of the graph will be roughly symmetrical on both sides of the object. You can tune the shape by changing the values of lp and rp.

To change the values of lp and rp, you can enter values into the text boxes, use the up and down arrows, or use the sliders. Changing these values will automatically recalculate the phase and redisplay.

Clicking auto phase will return to the default calculation.

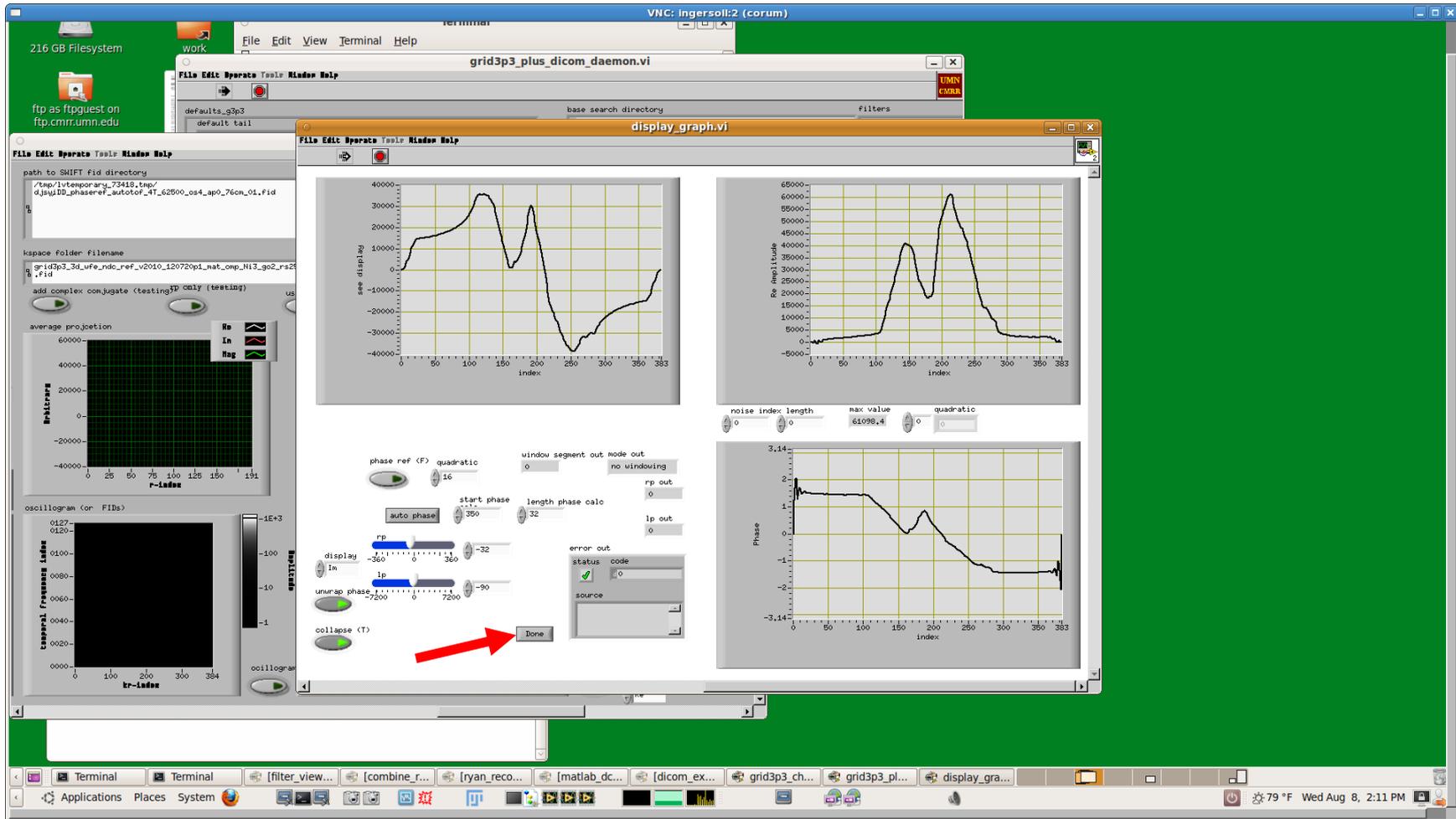
grid3p3 phase adjustments (con't)



You might also want to click on the collapse button (turn off collapse) to display additional projections, and watch the black line in the graph as you tune the phase parameters.

Once you have finished tuning the phase, click on the Done button.

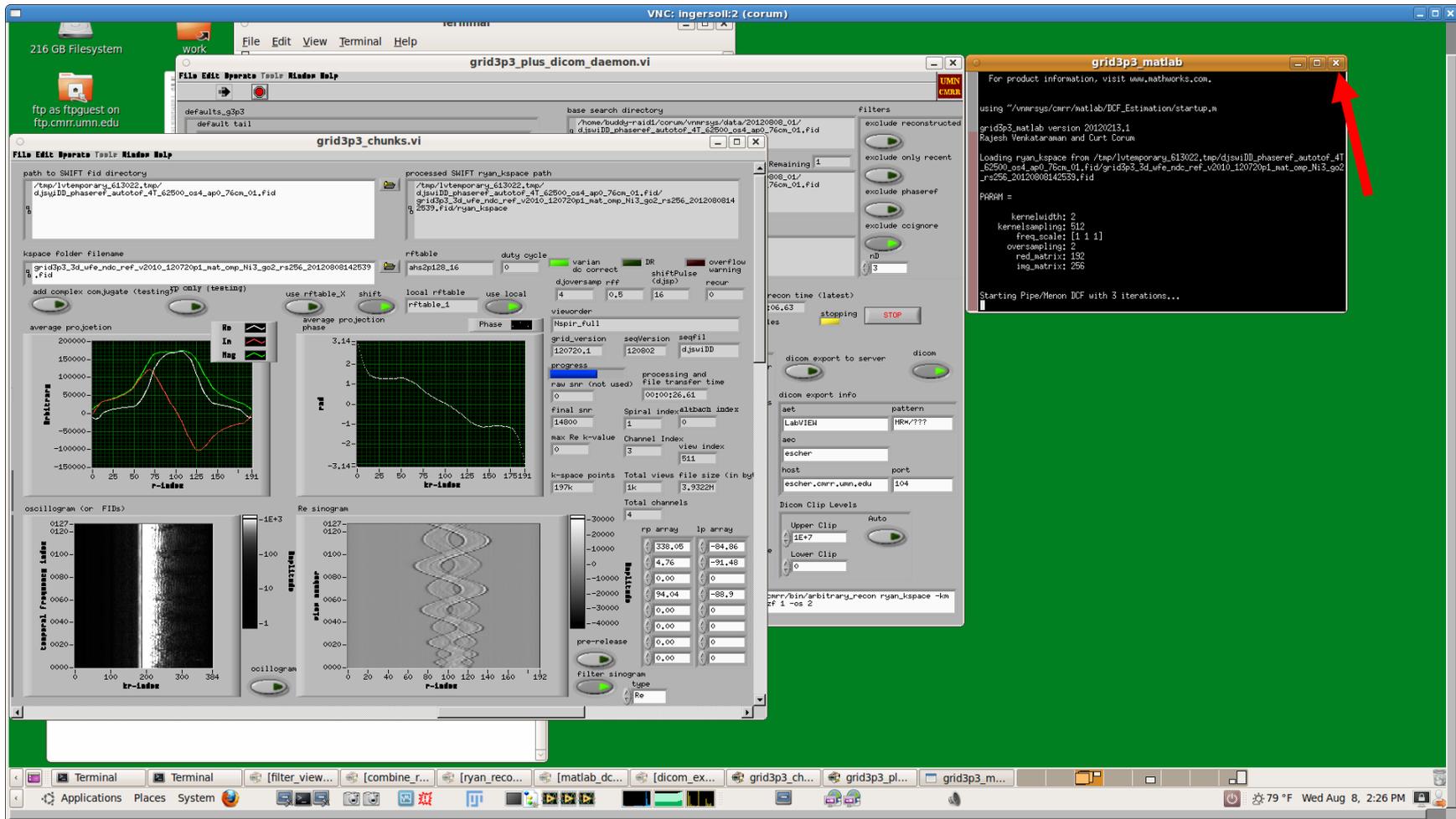
grid3p3 Phase tuning additional channels



If you have multi-channel data, additional `display_graph.vi` windows will appear, one at a time. (The channel number will not appear.) You can tune the phase for each channel individually. Ordinarily, the `lp` parameter will remain the same, and the `rp` will need to be adjusted.

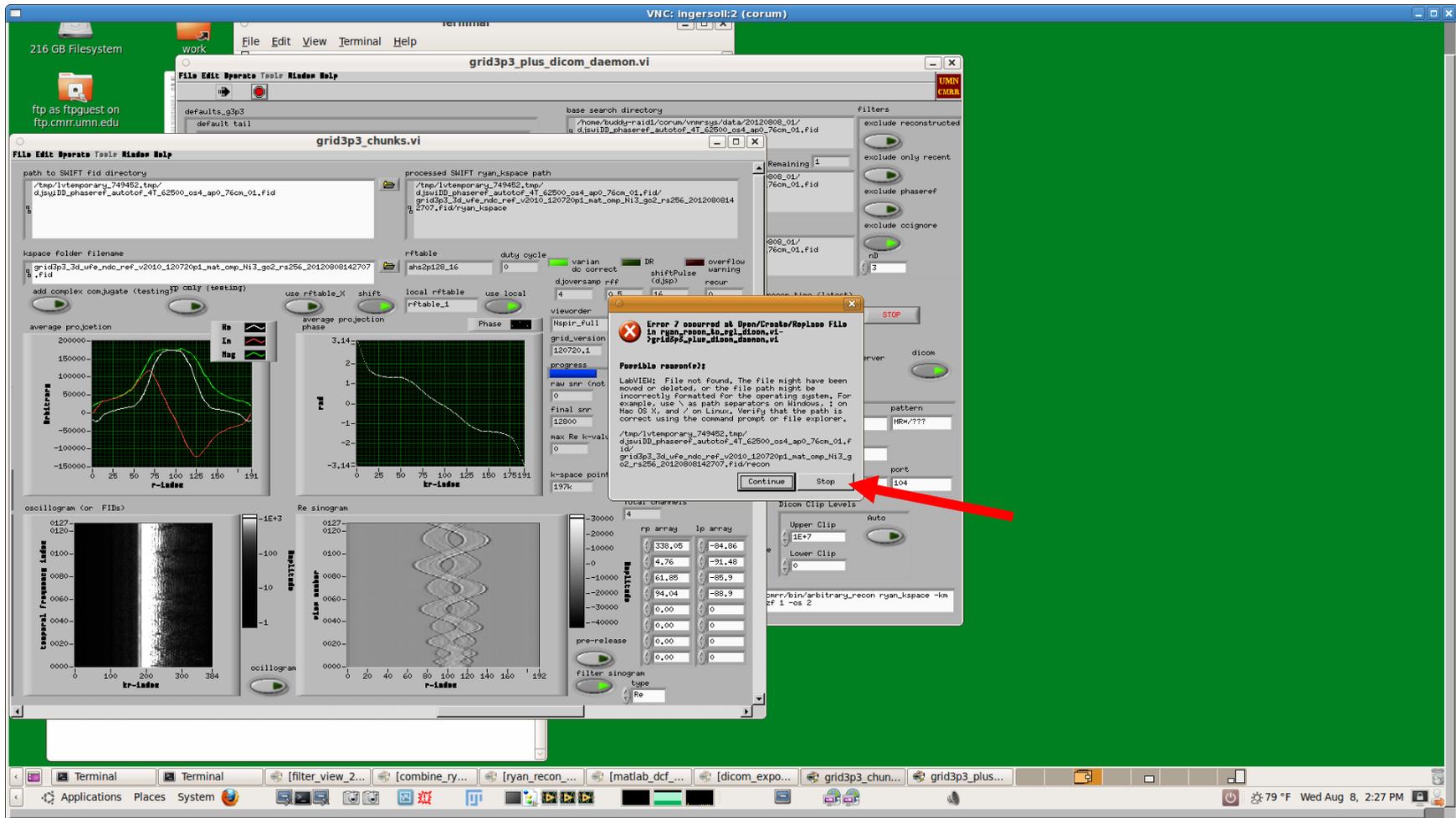
Continue to adjust the phase and click `Done` for each channel until the phase is tuned for each channel.

grid3p3 Cancel reconstruction during phase tuning



At this point, grid3p3_matlab window will open and a reconstruction will start. This is not useful during phase tuning, and should be canceled.

grid3p3 Cancel reconstruction during phase tuning (con't)



To cancel this reconstruction, close the grid3p3_matlab window by clicking in the upper right corner. Labview may display an error window when you do this. Click on "Stop" button in the Labview error window if this happens.

grid3p3 Phase values set

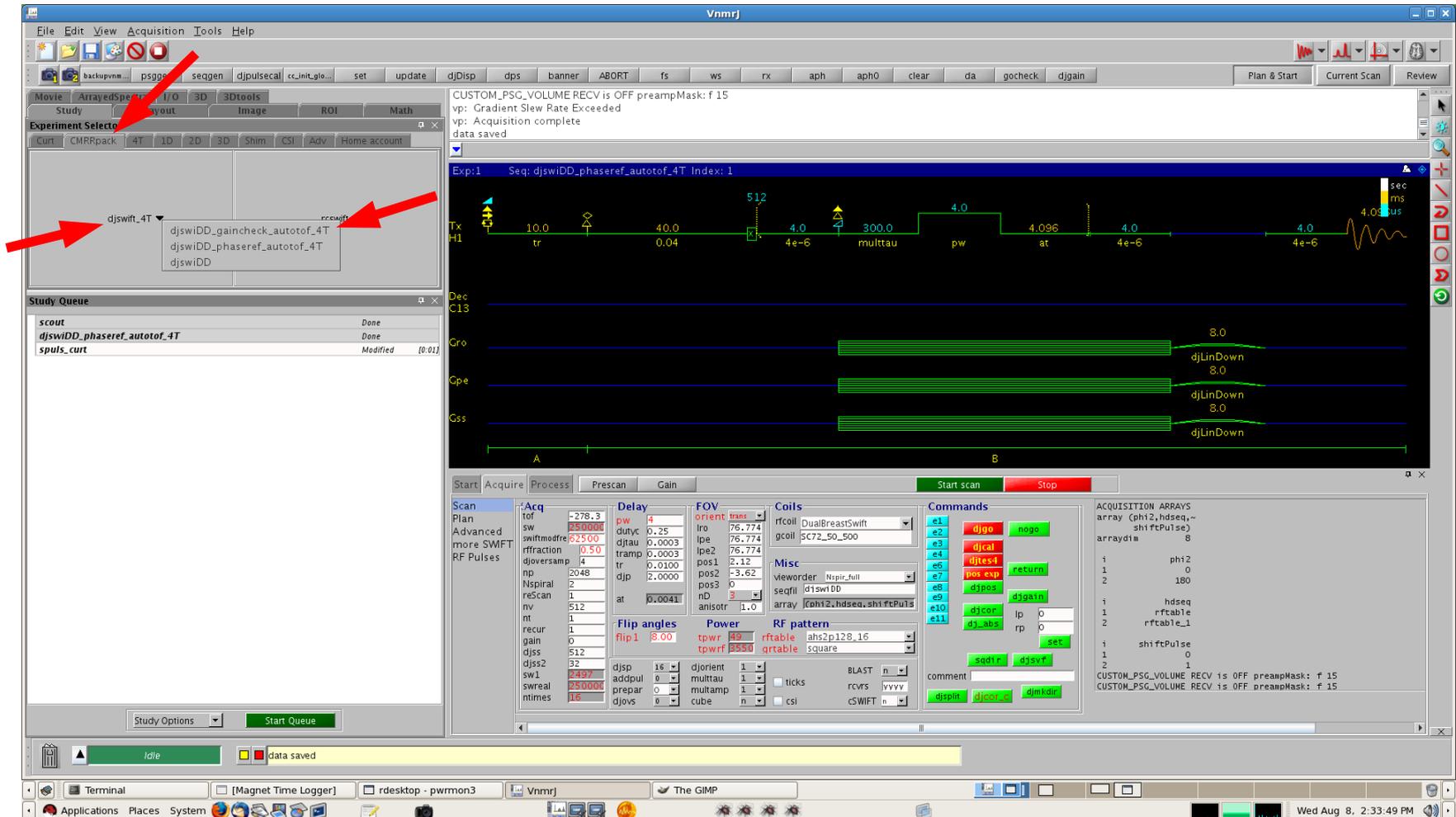
The screenshot shows a Linux desktop environment with several windows open. The primary window is `grid3p3_chunks.vi`, which displays various plots and a table of phase values. The table in the lower right corner of the window is as follows:

rp array	lp array
338.08	-84.86
4.76	-91.48
61.85	-88.9
94.04	-88.9
0.00	0
0.00	0
0.00	0
0.00	0
0.00	0
0.00	0

A red arrow points to this table. The window also displays several plots, including an average projection plot, a phase plot, an oscillogram (or FIDs) plot, and a Re sinogram plot. The desktop environment includes a terminal window and a taskbar at the bottom showing the date and time as Wednesday, August 8, 2:32 PM.

At this point, you have set good phase values in rp array and lp array. These are displayed in the lower right corner of the `grid3p3_chunks.vi` window.

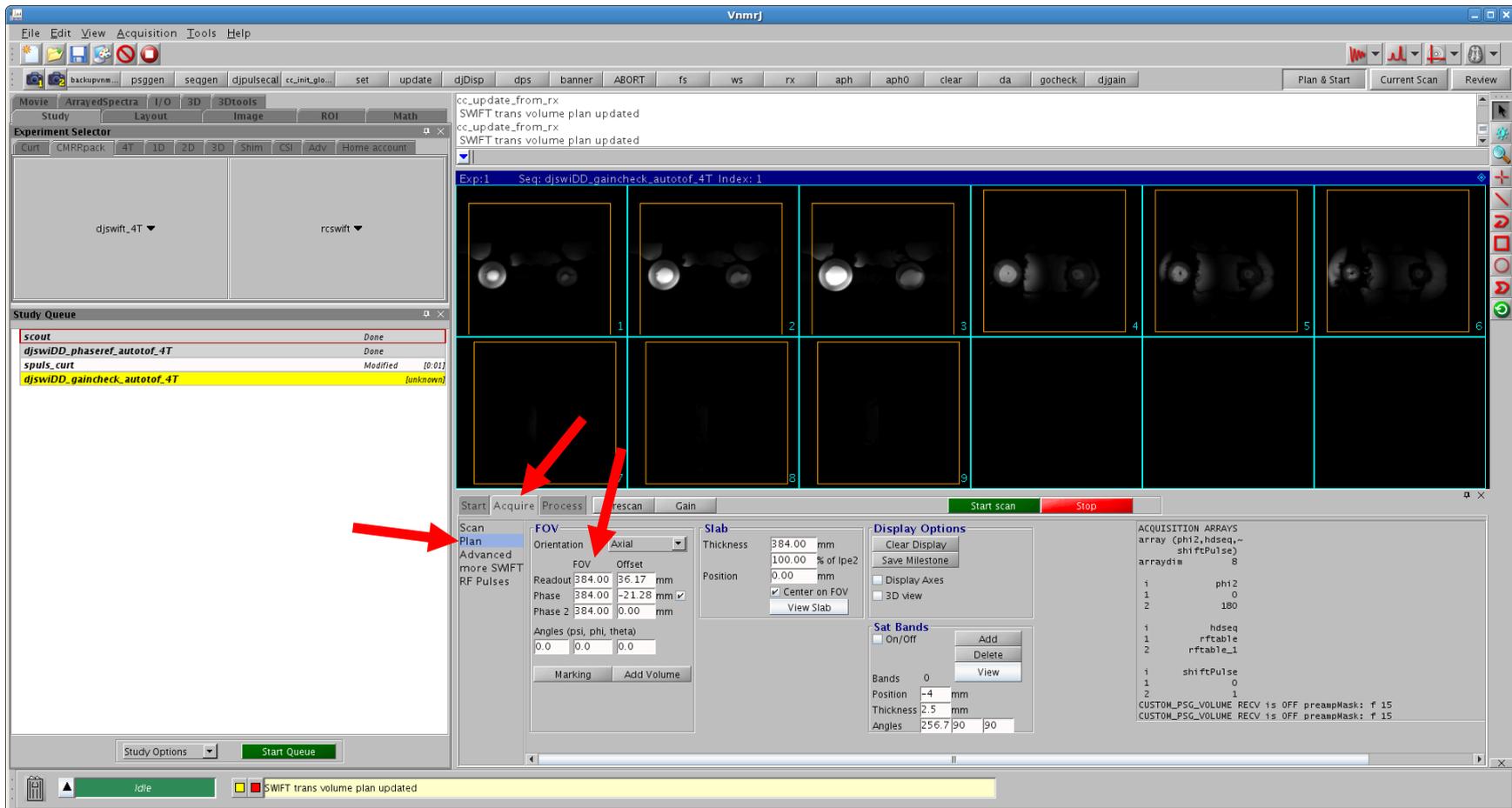
Load gaincheck sequence



Return to the Vnmrj window. In the experiment selector, choose the CMRRpack tab. On that tab, click on the djswiDD_gaincheck_autotof_4T down arrow on the left and select the djswiDD_gaincheck_autotof_4T option from the dropdown menu to load it into the study queue.

Double-click djswiDD_gaincheck_autotof_4T in the study queue to load the gaincheck protocol.

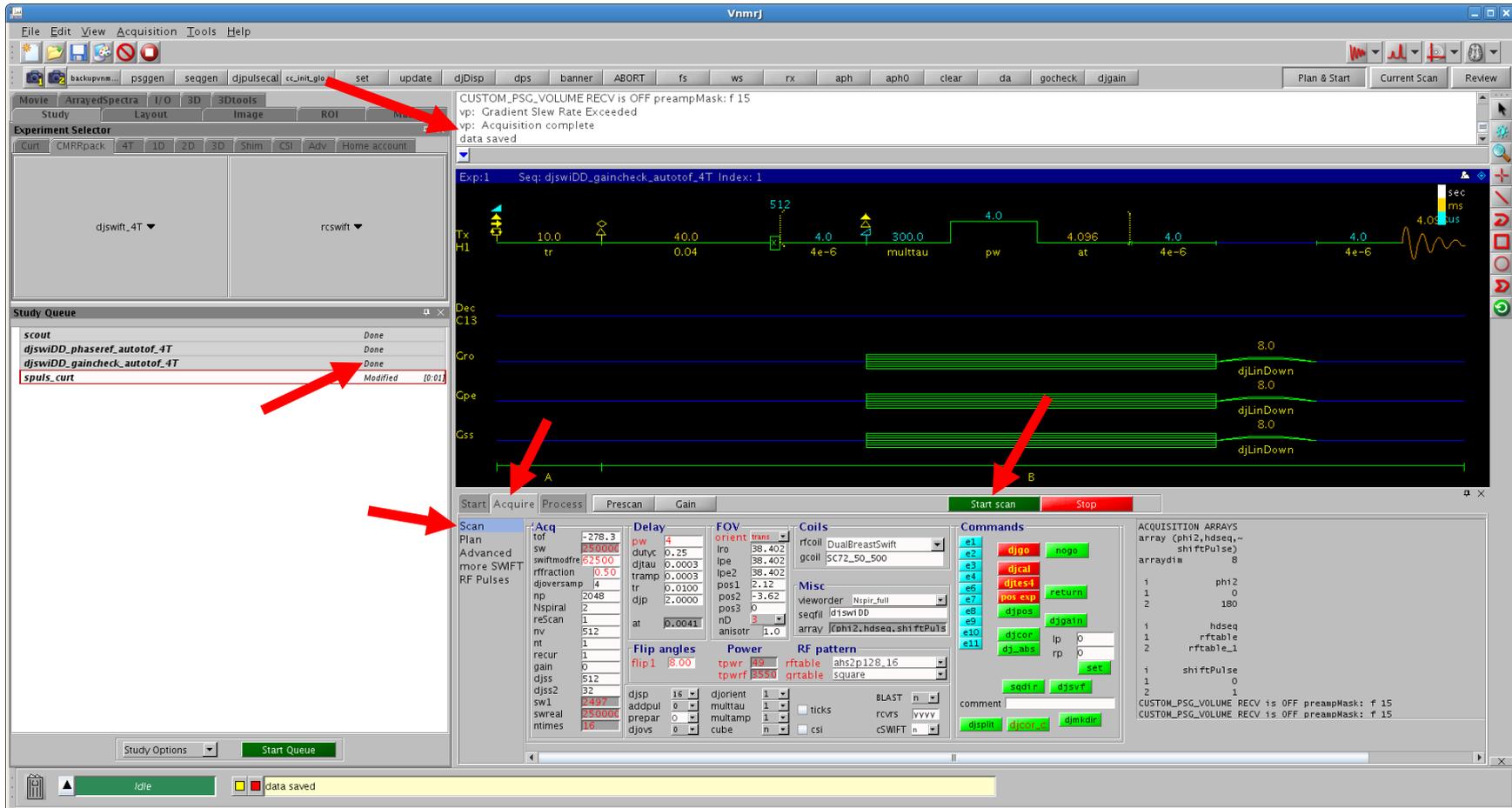
Set gaincheck FOV



Click on the Acquire, Plan page and adjust the FOV parameters again to your desired field of view that includes all the object signal. Previously the phaseref was set to a larger FOV. Here the gaincheck will have a smaller FOV.

You should set the flip angle flip1 to the desired value before adjusting the gain.

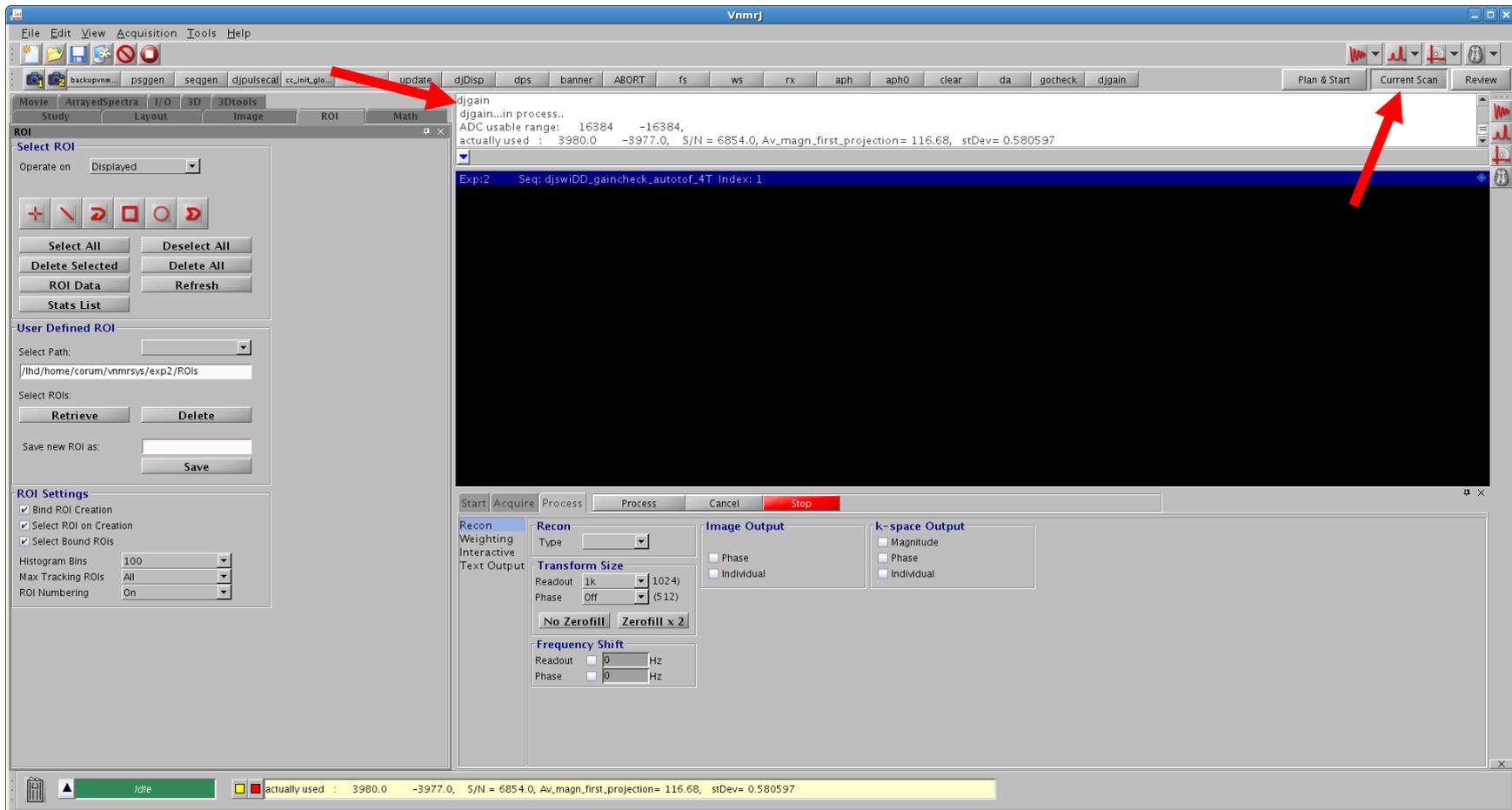
Acquire first gaincheck



At this point, return to the Acquire, Scan page and click Start Scan (green).

You will see acquisition complete, data saved in the command window. In the study queue, you will see gaincheck... Done.

Run djgain macro to check data range



Now click on the Current Scan button in the upper right (next to Plan & Start) to switch to the current scan viewport. In the command window, type "djgain".

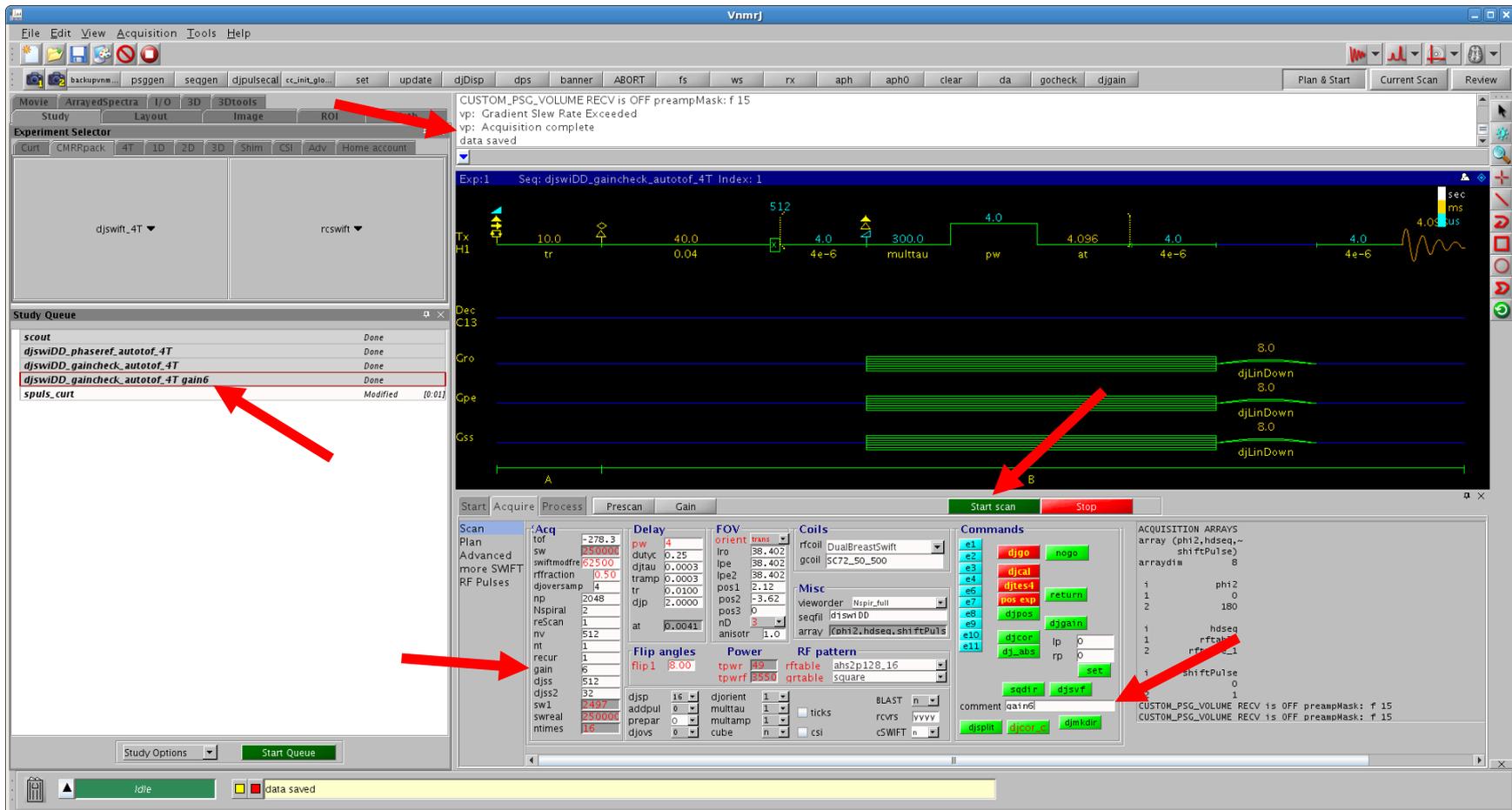
Adjusting the gain

The screenshot displays the Vnmrj software interface. At the top, the 'djgain' process is running, showing 'actually used' values: 3983.0 (real) and -3982.0 (imaginary), with S/N = 6911.0 and Av_magn_first_projection = 116.59. The central plot area shows a pulse sequence with parameters like tr=10.0, pw=4.0, and at=4.096. The 'Scan' page at the bottom has a 'Gain' section with a value of 0.0. Red arrows highlight the 'djgain' status bar, the 'Study Queue', and the 'Gain' section.

The first djgain is run using a gain value of "0". This value is on the Acquire,Scan page on the middle left side. djgain will display its results with "actually used" values. These are real, imaginary values in A/D units. A valid target value for the real component of "actually used" is about 5000-9000 with an optimal value of about 8000.

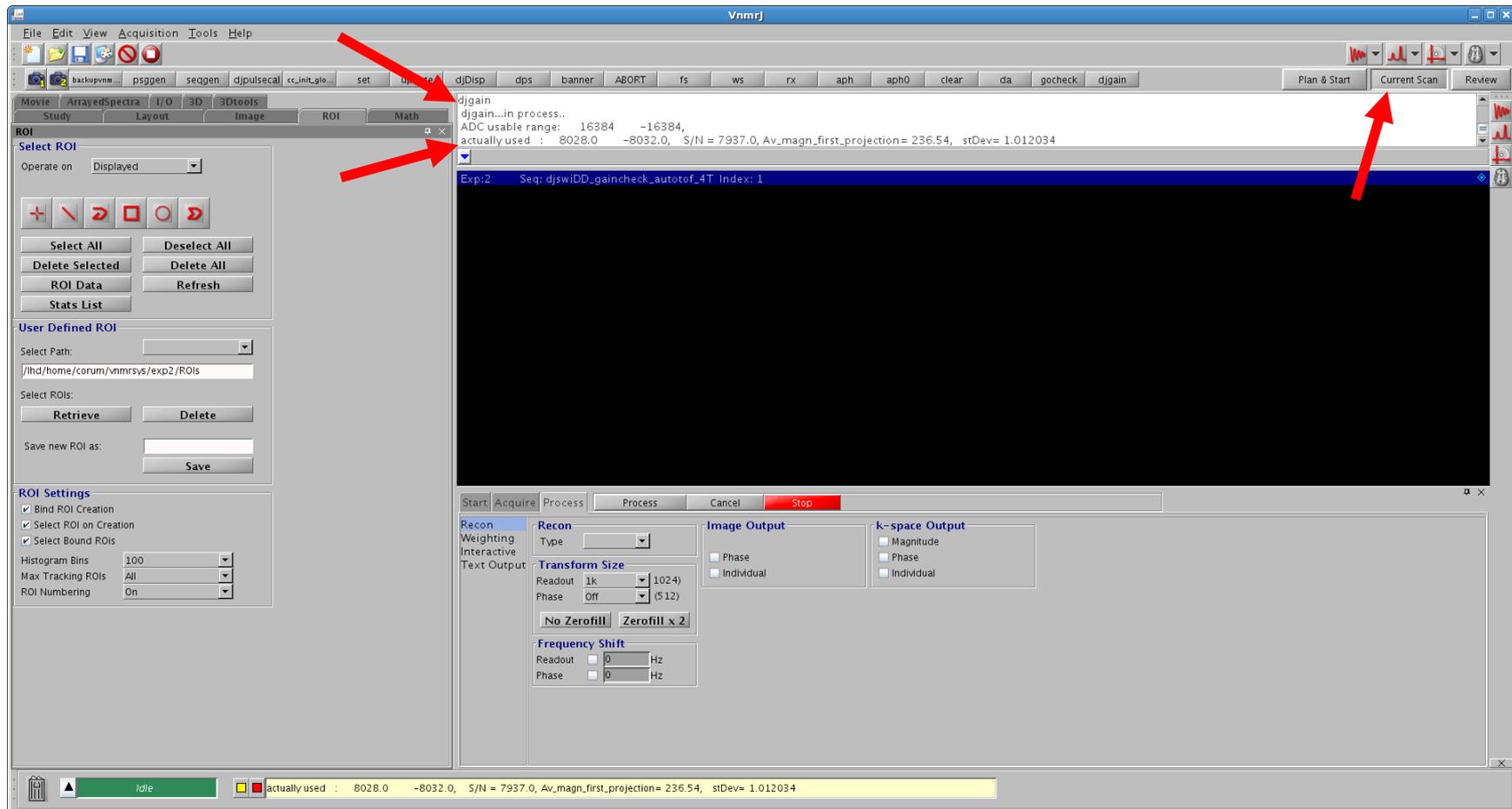
To adjust this value, change the gain value on the Acquire,Scan page. The gain value affects the "actually used" values in a logarithmic fashion. Increasing the gain value by "6" should adjust the "actually used" values by 2x, while increasing the gain value by "20" should adjust those values by 10x.

Rechecking the gain – comment and reacquire



You may want to add a comment in the comment field in the Commands area to note this change. Here we add the comment "gain6". Once you have adjusted the gain value, click on Start Scan (green). You will see another study entered into the study queue with your comment (in this case "gain6"). When complete, you will again see Data saved, gaincheck done in the messages window.

Rechecking the gain – check data ranges



After reacquiring, return to the Current Scan window, type "djgain" in the command window, and observe the change in "actually used" A/D values. Repeat as needed to achieve "actually used" values near 8000.

Load SWIFT sequence

The screenshot shows the Vnmrj software interface. In the 'Experiment Selector' window, the 'CMRRPack' tab is active, and 'djswiDD' is selected in the dropdown menu. The 'Study Queue' window shows the sequence 'djswiDD_gaincheck_autotof_4T gain6' selected. The main window displays a timing diagram for the sequence and various acquisition parameters.

Timing diagram parameters:

- 10.0 tr
- 40.0 0.04
- 512
- 4.0 4e-6
- 300.0 multtau
- 4.0 pw
- 4.096 at
- 4.0 4e-6
- 4.0 4e-6

Study Queue:

Sequence Name	Status
scout	Done
djswiDD_phaserref_autotof_4T	Done
djswiDD_gaincheck_autotof_4T	Done
djswiDD_gaincheck_autotof_4T gain6	Done
spuls_curt	Modified [0.01]

Acquisition Parameters:

Parameter	Value
tof	-278
sw	25000
swiftmodfr	0.50
rffraction	0.50
djoversamp	4
np	2048
Nspirals	2
resScan	1
nt	1
recur	1
gain	6
djss	512
djss2	32
sw1	25000
swreal	25000
ntimes	16

Commands:

- e1 array (phi2,hdseq,shiftpulse)
- e2 arraydia 8
- e3 i 1 phi2 0
- e4 i 2 180
- e5 i hdseq 1
- e6 i rftable 2
- e7 rftable_1
- e8 shiftPulse 1
- e9 i 0
- e10 i 1
- e11 i 2

In the experiment selector, on the CMRRPACK tab, click on the djswiDD down arrow on the left and select the djswiDD option from the dropdown menu to load it into the study queue. Then double-click djswiDD in the study queue to load the SWIFT protocol.

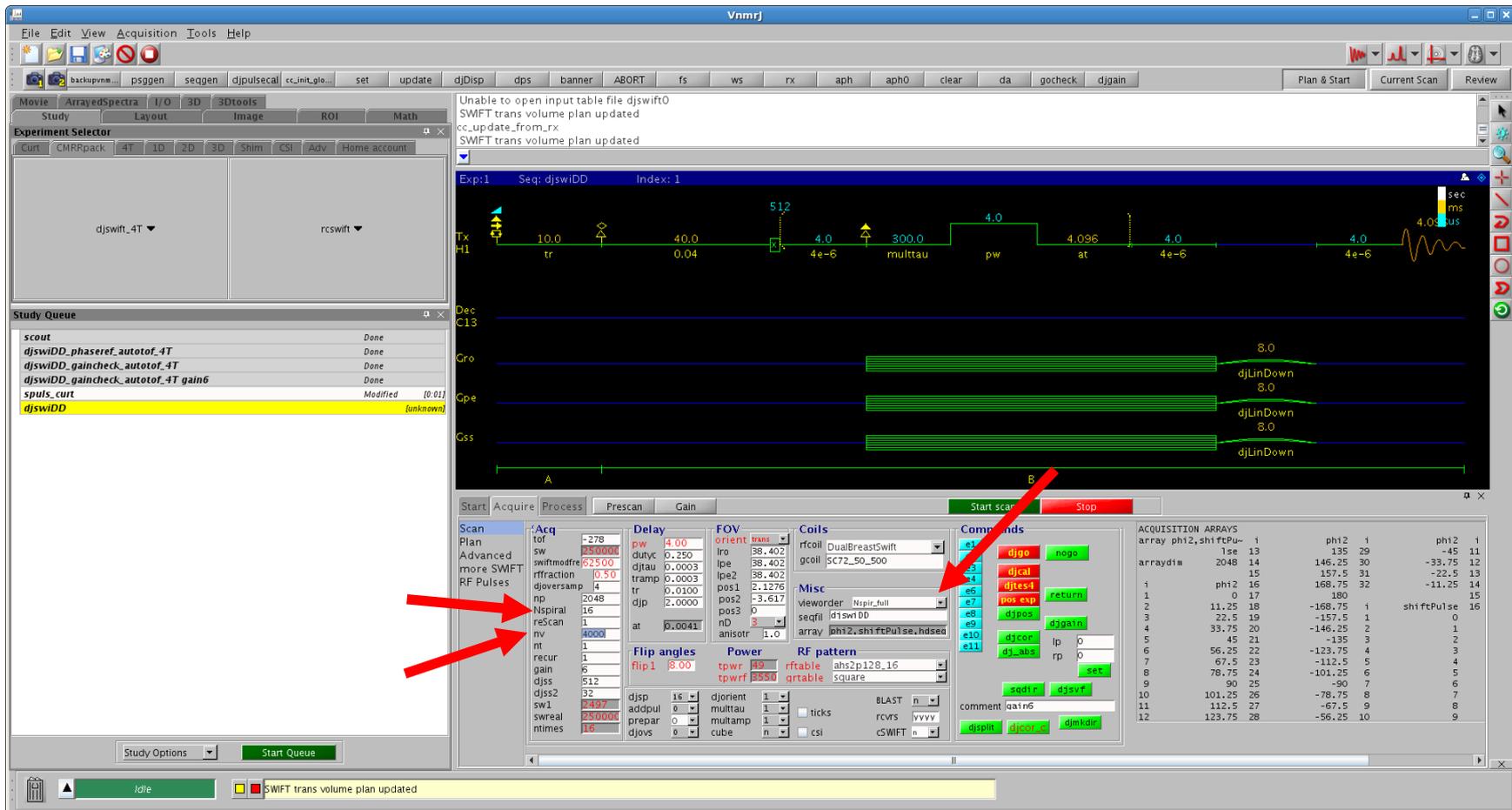
Copy volume plan, flip angle, and gain from gaincheck

The screenshot shows the Vnmrj software interface. The 'Study Queue' on the left lists several protocols, with 'djswidd' highlighted in yellow. The 'Experiment Selector' on the right shows the 'cc_update_from_rx' macro selected. The 'Parameter Settings' at the bottom are divided into several sections: 'Scan Plan', 'Delay', 'FOV', 'Coils', 'Misc', 'RF pattern', 'Flip angles', and 'Power'. The 'Flip angles' section shows 'flip1' set to 8.00. The 'Power' section shows 'tpwr' set to 3550. The 'Commands' section on the right contains a list of acquisition arrays and their parameters.

Right click on the gaincheck protocol in the study queue and choose Copy Volume Plan as before. Run the `cc_update_from_rx` macro to update the POS1, POS2, POS3 fields.

Fill in the flip angle `flip1` and the gain value you arrived at during the gaincheck. Optionally enter the same comment in the comment field.

Select SWIFT view order



At this point, select the view order under the Misc section. Full view order "Nspir_full" is recommended for static high-resolution scans, while Halton view order "view_halton_nav64nosub_512_512_16_xx" is recommended for dynamic scans.

If you use full view order, also adjust Nspir in the Acq section to the number of spirals desired and Nv to the number of views per spiral desired. The total number of views will be $Nv * Nspir$. For Halton view orders, Nv and Nspir are read from tables.

Acquire SWIFT data

Click on Start Scan (green). The estimated time length of the scan is reported in the messages window and depends on the number of views selected.

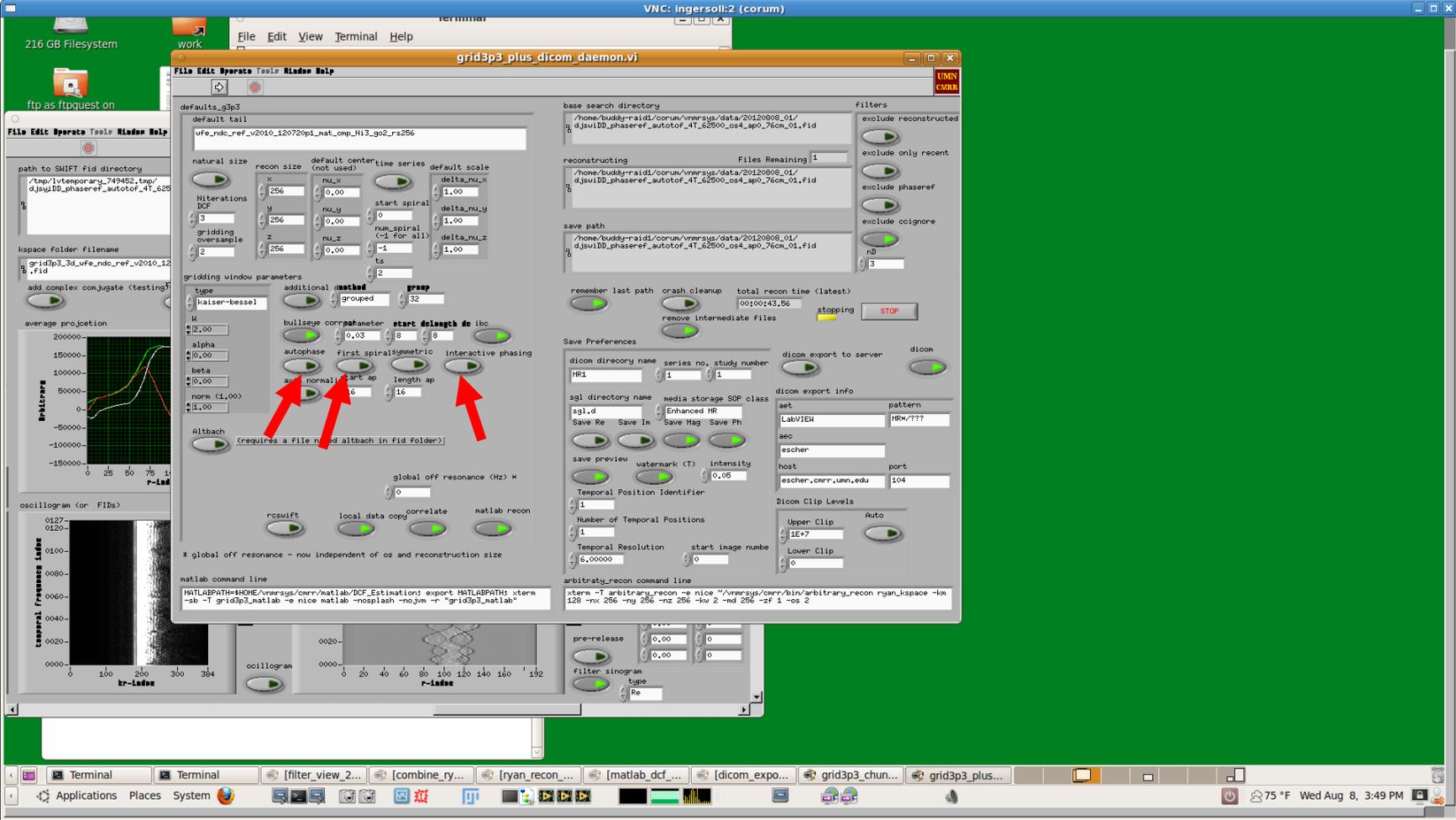
At the end of the sequence you will again see Acquisition complete, data saved in the messages window.

Afterwards, or even during the sequence, you can run "djgain" from the Current Scan window in the command window to verify the values you have.

Note that receiver overflow LED on the Agilent/Varian monitor channel monitor may not be valid for SWIFT. (If it lights up, you can ignore it.) Use djgain values to determine receiver overflow instead.

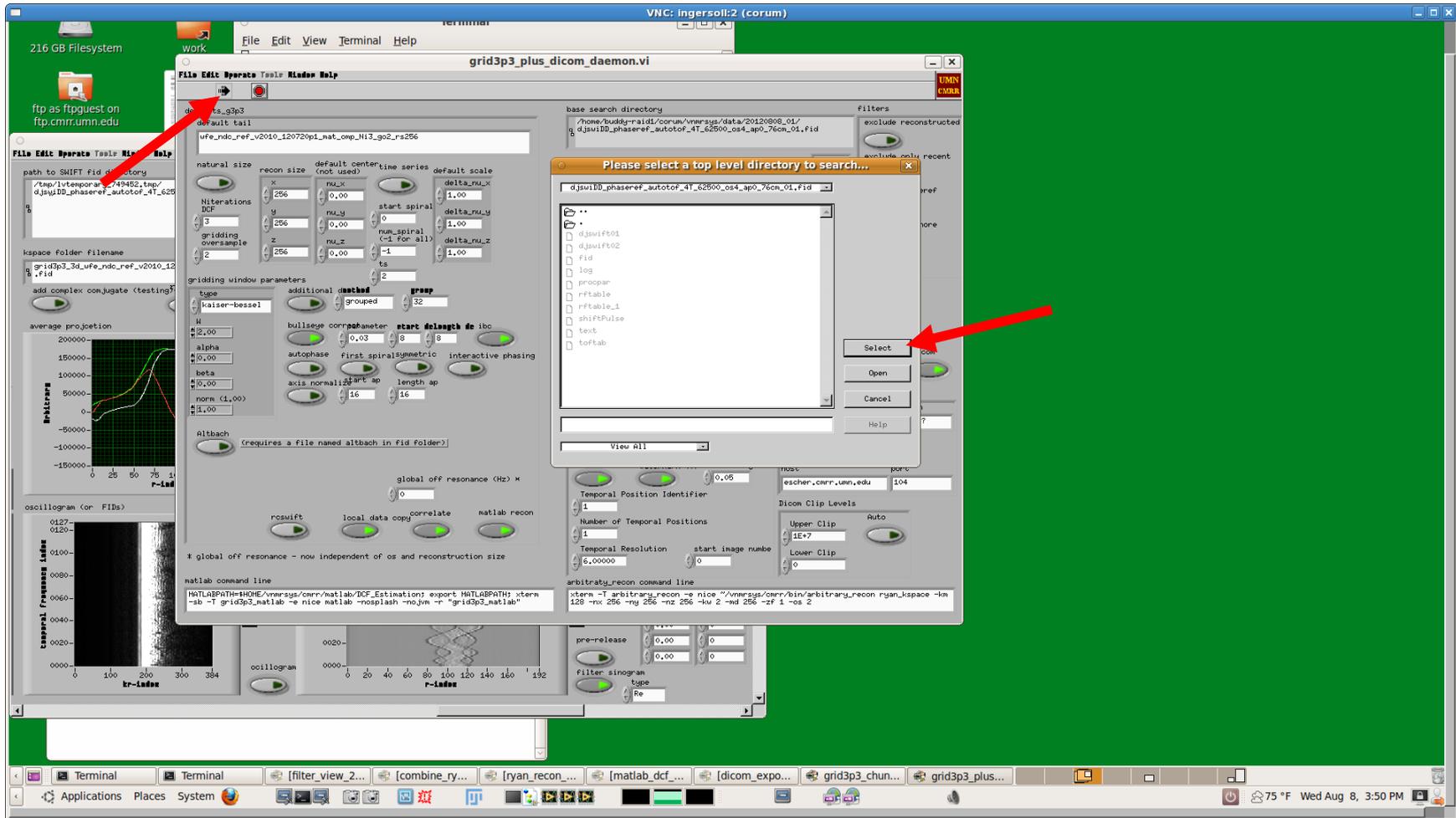
Now return to the grid3p3_plus_dicom_daemon executable window.

grid3p3 autophasing off



In the middle of the left side of the main window, click on the autophase, first spiral, and interactive phasing buttons to turn them off.

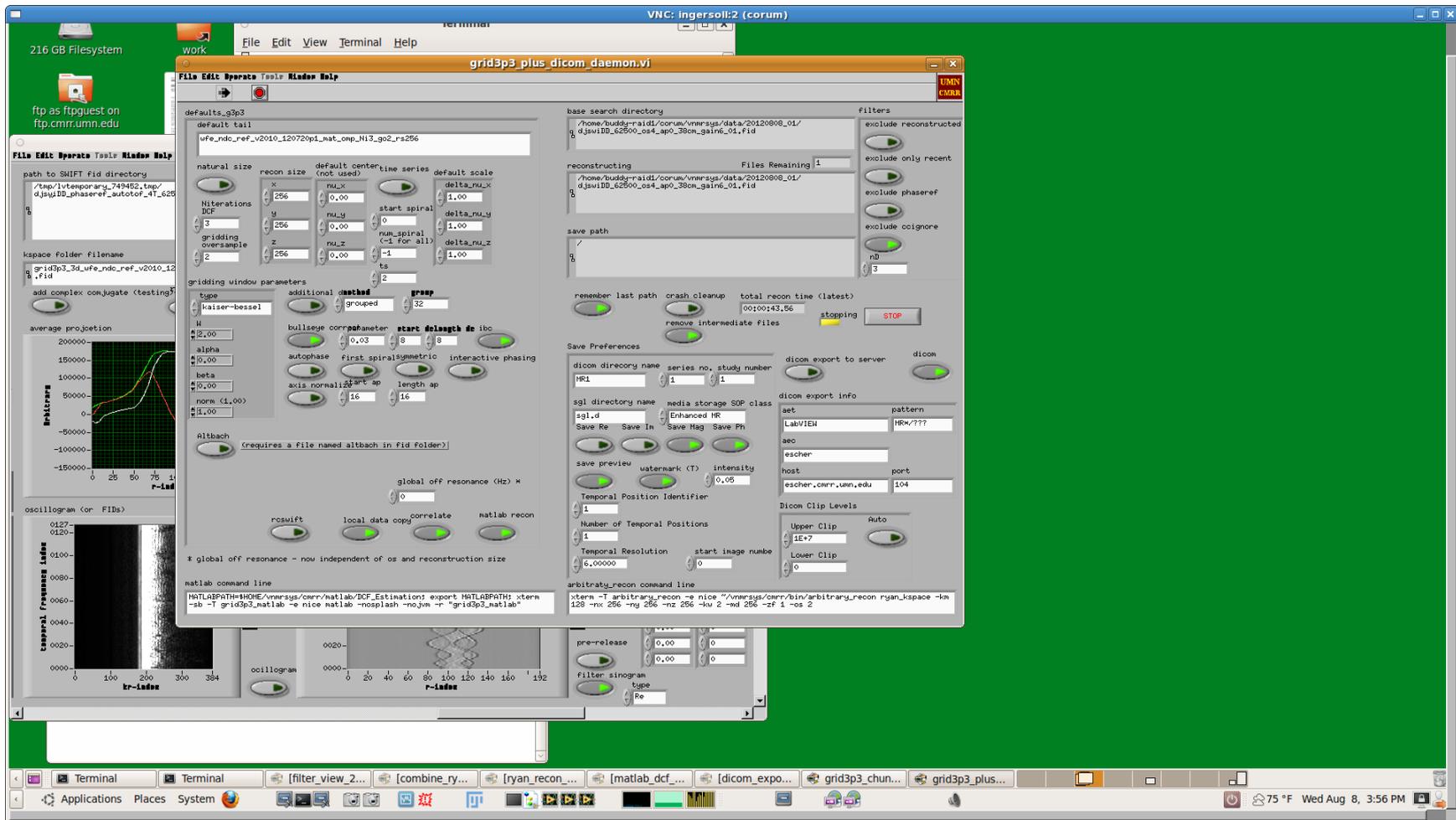
grid3p3 load SWIFT data



Now click on the Run button (right arrow on the upper LEFT side of the toolbar).

This will bring up the file dialog so you can load the data that you just acquired. It will open up in the directory where you last loaded data (in this case, the phaseref folder).

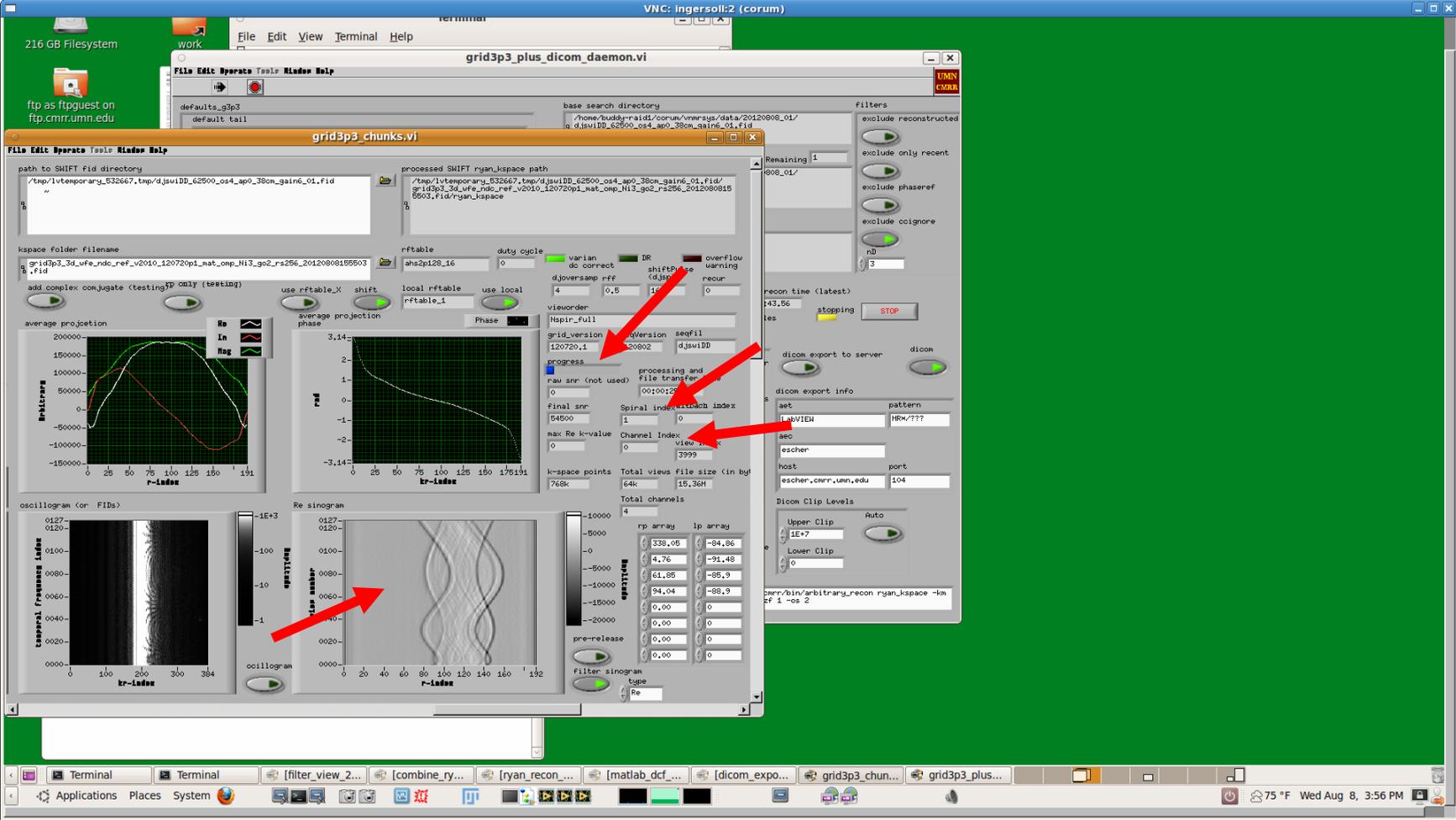
grid3p3 open SWIFT fid



First navigate back up one level to the parent folder. Now select the djswiDD fid folder to reconstruct. The name is dependent on your Vnmrj configuration. Click on Select (not off Open, Open will open that directory).

Data will load... this may take a moment or two. When loaded, the grid3p3_chunks.vi window will come to the front.

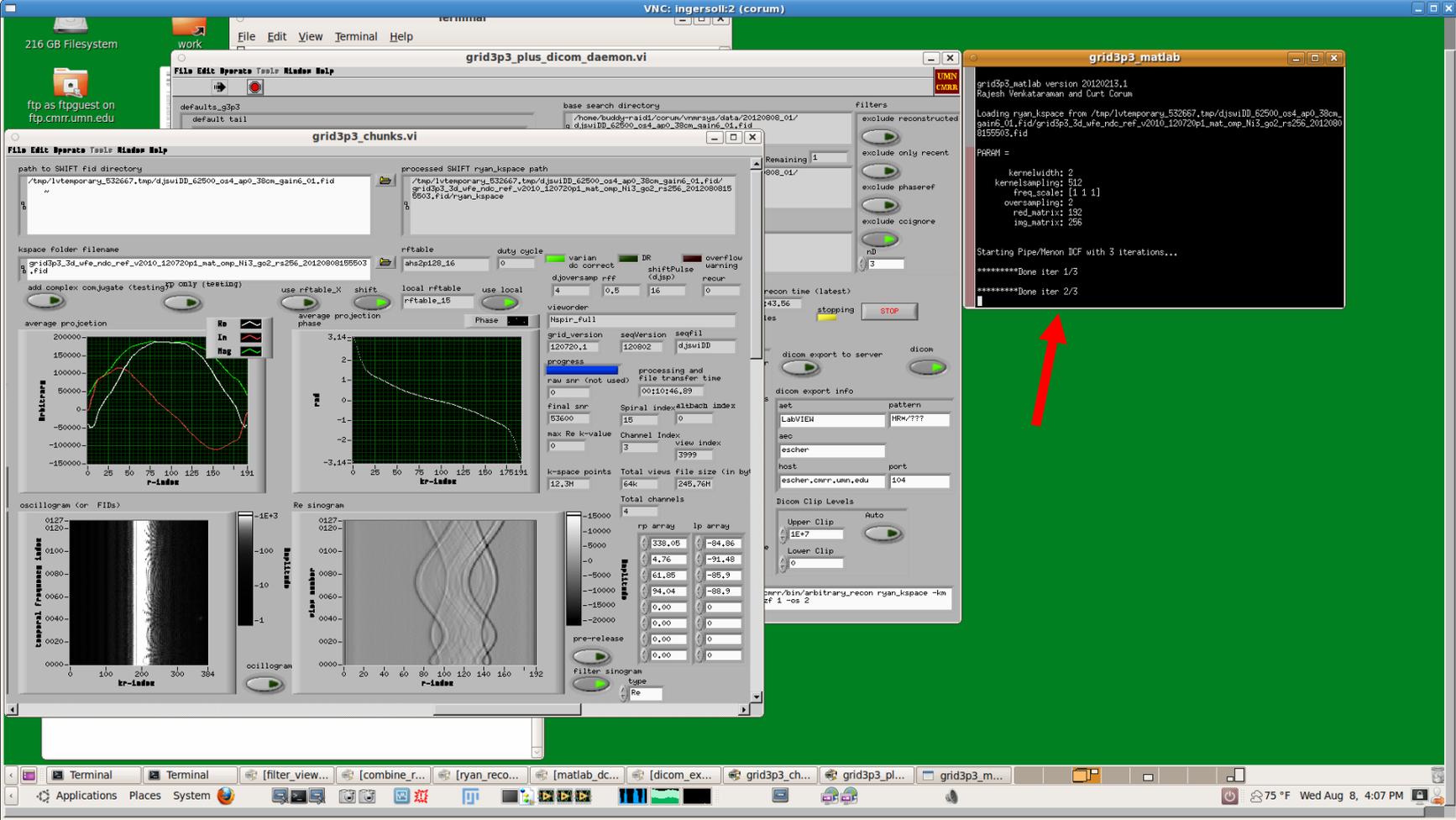
grid3p3 correlation



When grid3p3_chunks.vi comes to the front, it will still be processing the first spiral. You will see the sinogram update when the first spiral is done.

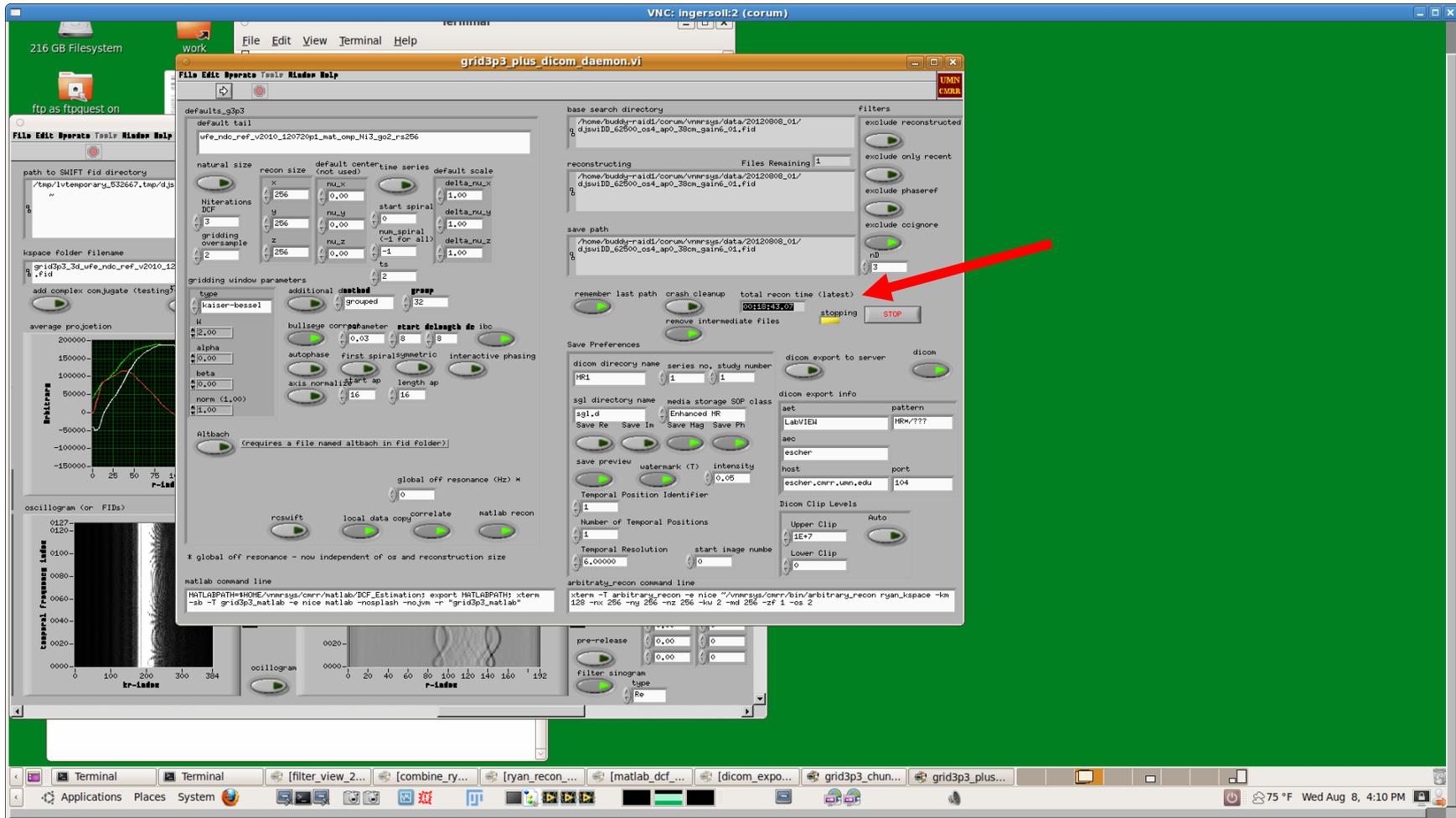
There is a blue progress bar. Also, the spiral and channel index displays will update as the correlation proceeds.

grid3p3 gridding



After the correlation, a grid3p3_matlab window will open and the gridding will begin. It will do 3 DCF iterations, forward grid, then FFT and shift, and then save the data file.

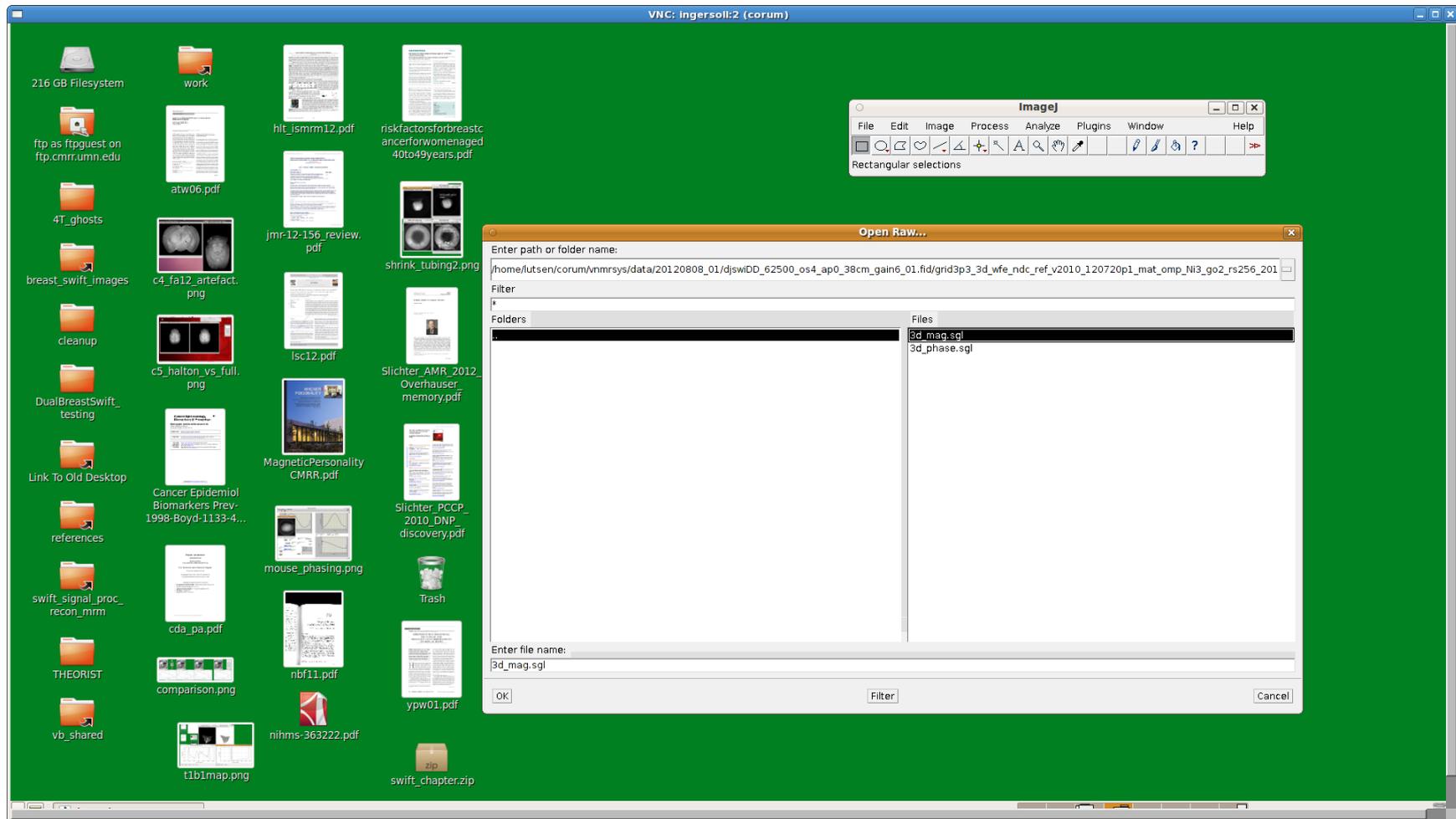
grid3p3 data conversion



The matlab window will close automatically and the data will be converted to raw and dicom formats.

Afterwards you will be able to see the total recon time taken. This depends mostly on the system performance and size of the data set.

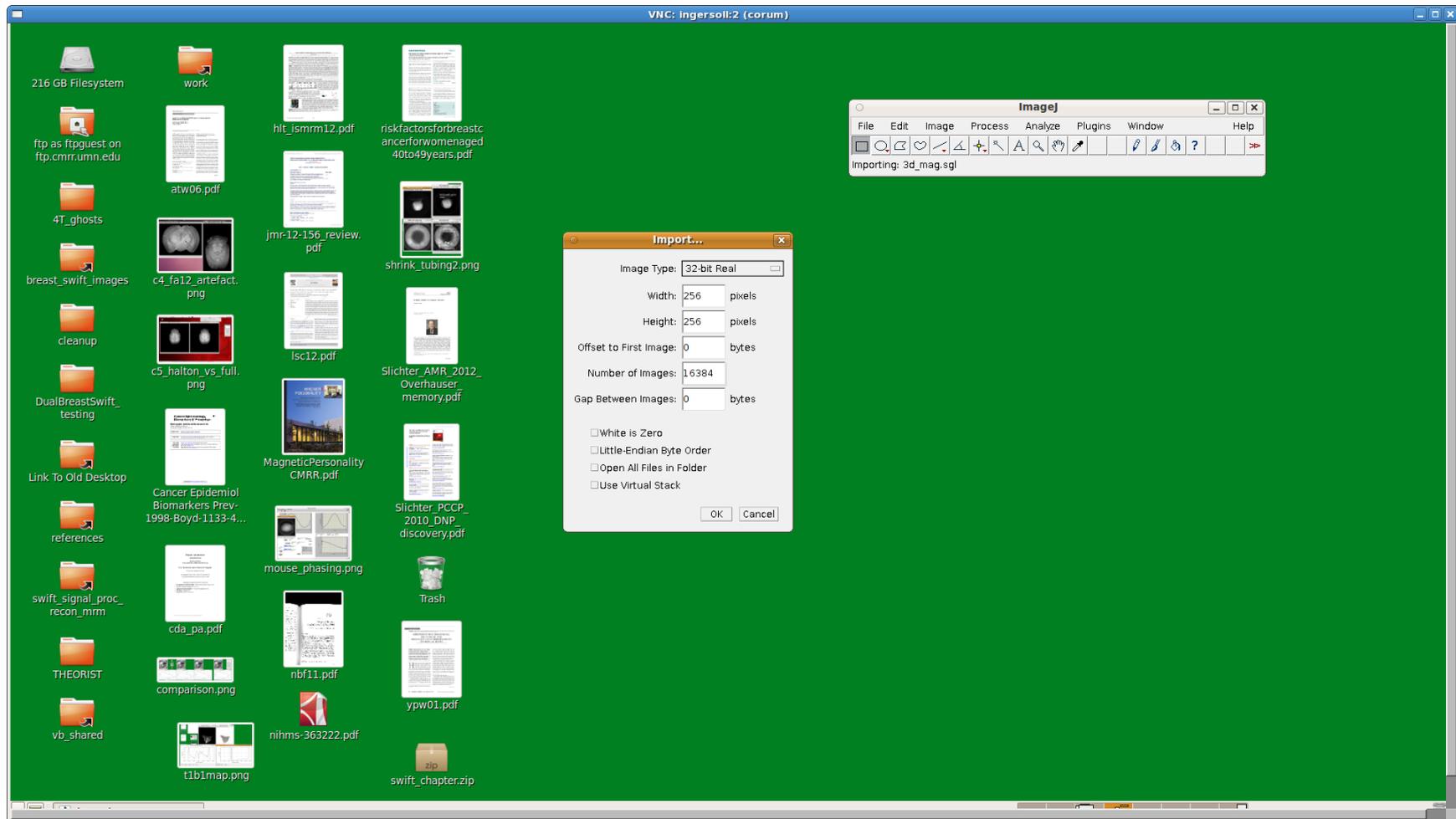
ImageJ opening raw data



You may now look at the reconstructed images with an appropriate viewing program. We use ImageJ. Another option we use is Fiji. For ImageJ, start the program (which sometimes installs under Graphics in the system Applications menu).

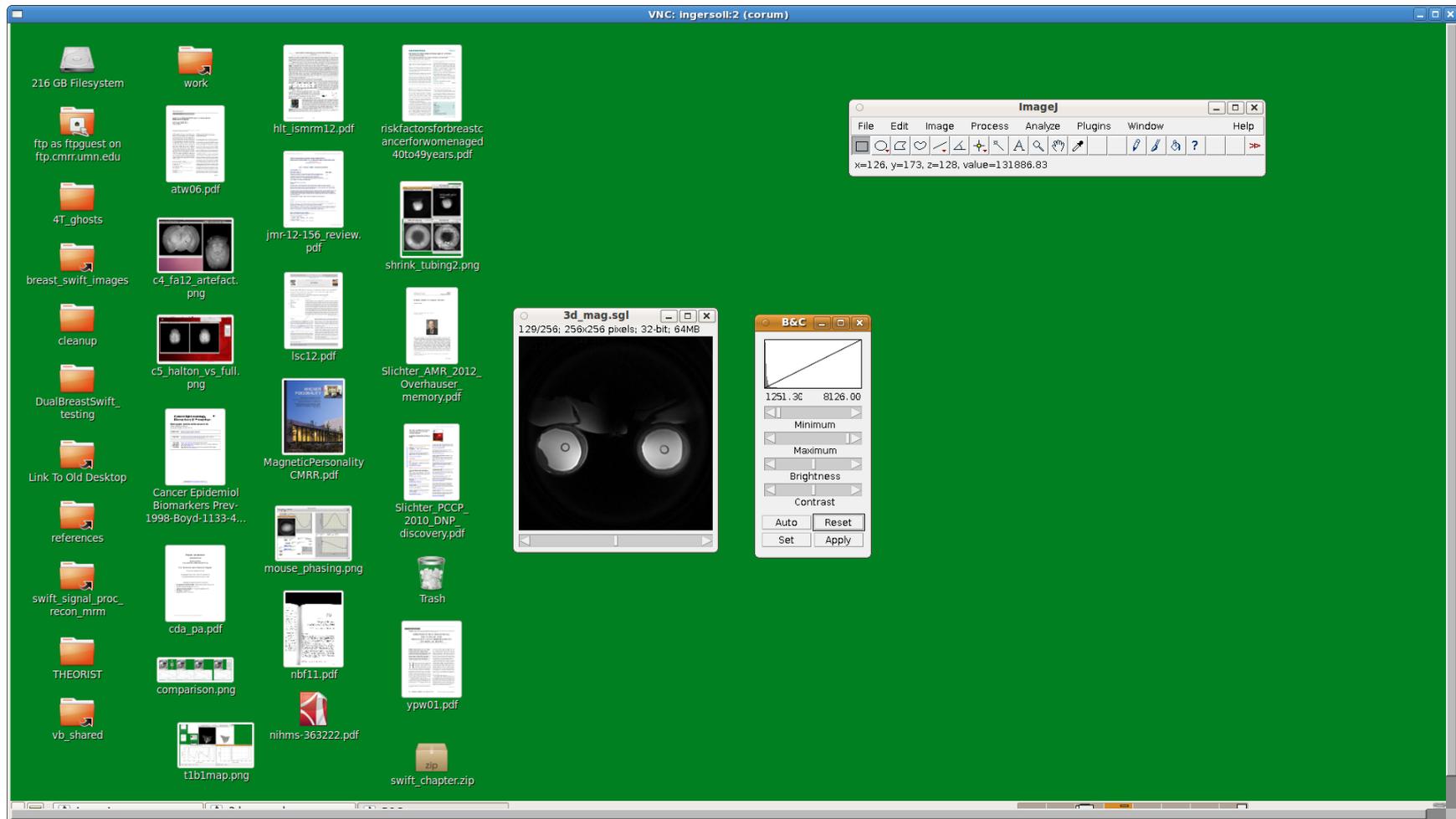
To read the raw files, click on File -> Import -> Raw and navigate to the data folder you have been using. Inside the folder, the fid folder, and the sgl.d folder, you will find a 3d_mag.sgl file.

ImageJ loading raw data



This raw data file is of type 32-bit real, 256 x 256 pixel. The number of images must be larger than the number of slices. The number of slices in the file is 256 by default.

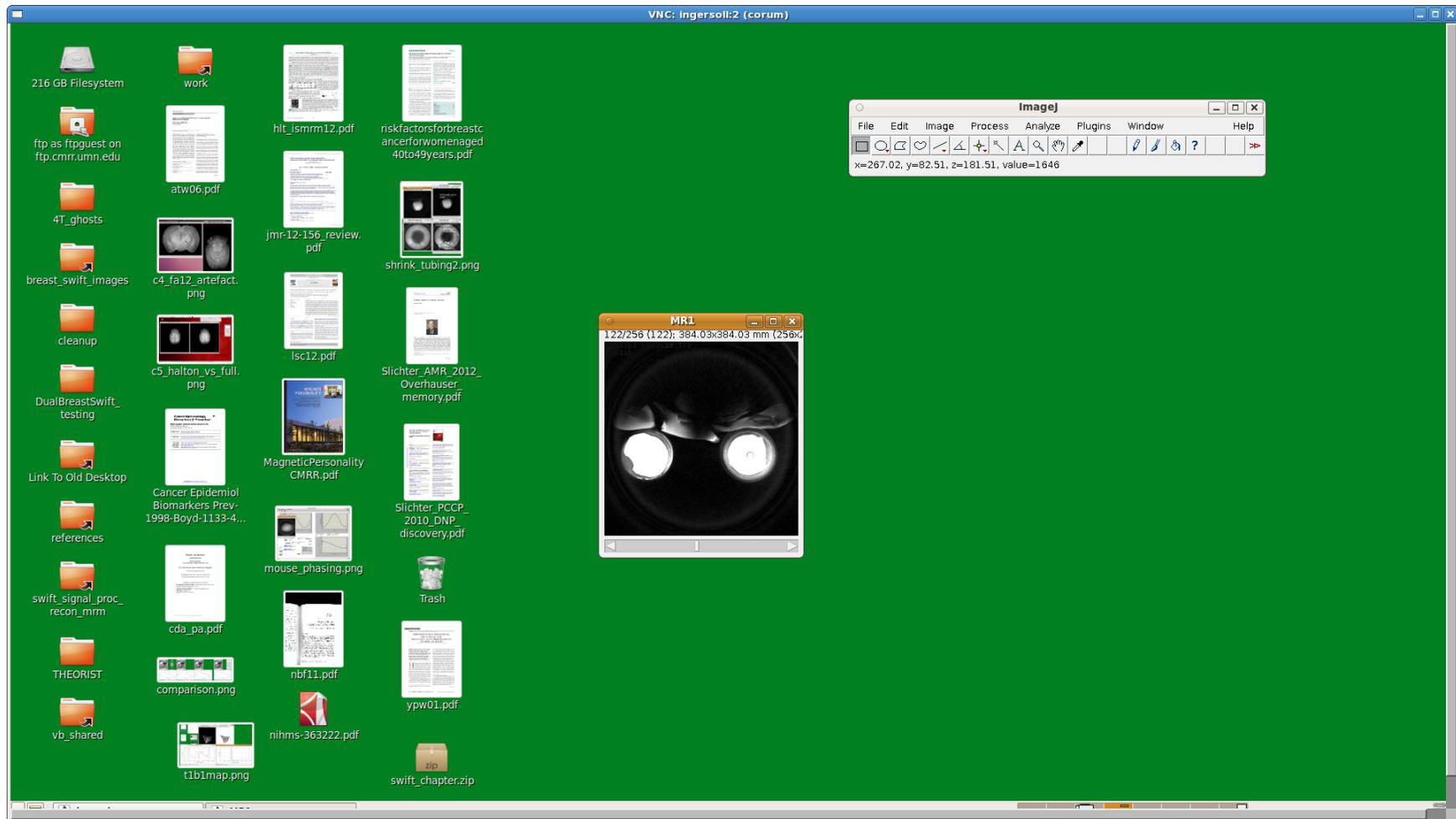
ImageJ viewing raw data



Here is an example of a displayed raw data set with ImageJ.

You can scroll to the image with signal, and then choose Image -> Adjust -> Brightness/Contrast and click Auto.

ImageJ viewing dicom data



You can also File -> Import -> Image Sequence to load the dicom file. Navigate upwards to the MR1 folder. Double click on the MR1 folder and select the 001 slice. The entire series will load. You can scroll to the image with signal and adjust the brightness and contrast as before.