CMRRpack2

a collection of pulse sequences from the

University of Minnesota, Center for Magnetic Resonance Research (CMRR)

`Version: 2.63_package`

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Contents

Chapter 1

CMRRpack2 pulse sequence and reconstruction collection.

CMRRpack2 pulse sequence implementations and recons.

1.1 Obtaining the CMRRpack2

```
- Please contact Dr. Michael Garwood [gar@cmrr.umn.edu]
```

Chapter 2

Installation

2.1 Installation prodecure (using installer)

Obtain the self-installing archive from CMRR. In this example it is a file called "INSTALL_CMRRpack2_2.5_master-128-gd745578.run".

```
tesch 134>chmod u+x ./INSTALL_CMRRpack2_2.5_master-128-gd745578.run
tesch 135>./INSTALL_CMRRpack2_2.5_master-128-gd745578.run
Verifying archive integrity... All good.
Uncompressing CMRRpack2 2.5_master-128-gd745578.....
*************************************************************************
****  THIS IS THE CMRRpack2 PULSE SEQUENCE & RECON PACKAGE INSTALLER  ****

The install directory for running a sequence should be the
user's ~/vnmrsys/ directory.  You may select any arbitrary
directory if you are only using the reconstruction software.

The install directory will get several subdirectories, including:
 {cmrr2/ maclib/ parlib/ psglib/ psgpatch/ shapelib/ tablib/ templates/}

Any existing CMRRpack2 installation will be over-written!
(Backup files should be created of any collision files;
 nonetheless: USER BEWARE!)

Select install directory: [/lhd/home/tesch/vnmrsys]

About to extract CMRRpack2 into /lhd/home/tesch/vnmrsys ... Proceed ? [y/N]
```

Hit return here to accept the default installation location, or type in another directory. Installing in a location other than your local vnmrsys/ directory will work for recon, but obviously you wont be able to use the sequences from VnmrJ.

```
Extracting ...
Installing into /lhd/home/tesch/vnmrsys ...
Backing up /lhd/home/tesch/vnmrsys/./CMRRPACK2.version to /lhd/home/tesch/vnmrsys/./CMRRPACK2.version.cmrrpack2back

A list of installed files is in /lhd/home/tesch/vnmrsys/CMRRPACK2.contents.

Extracting documentation into /lhd/home/tesch/vnmrsys ...
Packagte documentation is availalbe in a browser at
 file:///lhd/home/tesch/vnmrsys/cmrr2/doc/html/index.html

The install has modified and made backups of these files:
/lhd/home/tesch/vnmrsys/CMRRPACK2.version.cmrrpack2back


The installer has completed, the next time VnmrJ start,
there should be a new tab called 'CMRRPack2' in the
experiment selector.
```

2.2 Installation prodecure (using sequence source)

If you're running >= VnmrJ 4, then you'll need to build both the sequence and a psglib locally for yourself.

The patches and sequence are currently tested only for 3.2, but they should work for VnmrJ 4 as well.

The following commands should be run from a shell in the account with SWIFT installed already as per the previous section. The pacth command should be repeated for each of the other patch files in ∼/vnmrsys/psgpatch/ .

```
psggen
cd ~/vnmrsys/

rm psg/psgmain.cpp
cp /vnmr/psg/psgmain.cpp psg/
patch -p0 < ~/vnmrsys/psgpatch/psgmain.cpp.patch.VnmrJ_VERSION_3.2_REVISION_A

rm psg/.....other patch files....
cp /vnmr/psg/....other patch files... psg/
patch -p0 < ~/....other patches....

psggen
seqgen rcswift
```

Chapter 3

Intro

Chapter 4

SWIFT

4.1 Getting Started with SWIFT

4.1.1 SWIFT Scan Panel

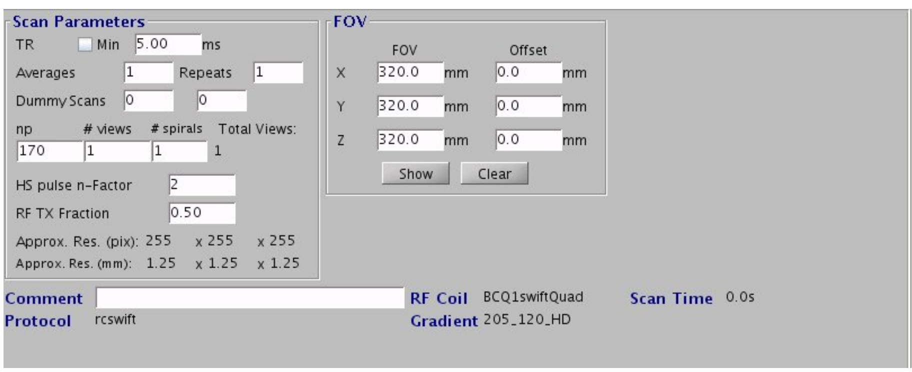

Figure 4.1: SWIFT Scan Panel

- TR Min (checkbox) - when set, the sequence always uses the smallest possible TR
- TR (value) - when TR_min is not checked, force this to be the TR. If this is too small, the sequence may not run.
- Dummy Scans (1) - Number of non-acquisition steady-state setup TRs before acquisition.
- Dummy Scans (2) - Number of non-acquisition steady-state setup TRs between spirals.
- np - Approximate image pixel count
- # views - Number of spokes per sphere / frame / spiral
- # spirals - Number of spirals per image
- Repeats - [untested]
- HS pulse n-factor - "N-factor" in hyperbolic secant excitation pulse
- RF TX fraction - Fraction of the readout during which RF is interleaved
- FOV - Field of view.

4.1.2 SWIFT Advanced Panel

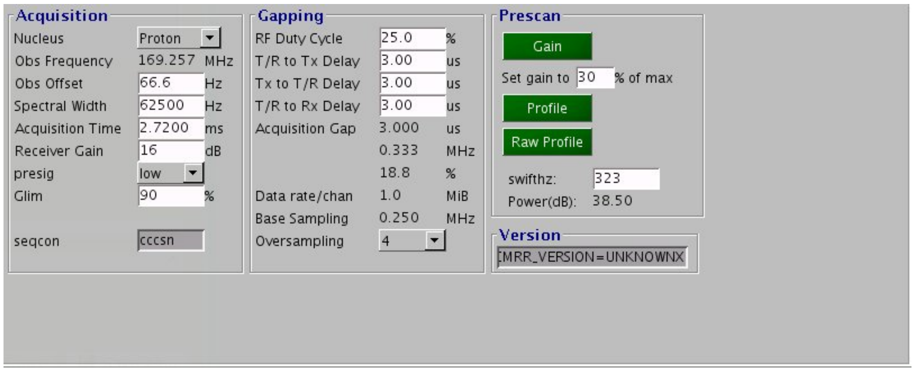

Figure 4.2: SWIFT Advanced Panel

- Spectral Width - bandwidth across FOV
- Receiver Gain - Receiver gain. Might be useful in case of low signal.
- RF Duty Cycle - % of gap used for RF excitation.
- T/R to TX delay - homorof1
- Tx to T/R delay - homorof2
- T/R to Rx delay - homorof3
- Oversampling - the receive readout is performed at (Spectral Width $*$ Oversampling). Actual parameter is *os*.

4.1.3 SWIFT RF Panel

Figure 4.3: SWIFT RF Panel

- Flip Angle - the flip angle in degrees each HS pulse should achieve. This value is converted to a power in Hz, and then finally into a dB value for the RF amplifier. The conversion requires a correct entry in pulsecal for the current *rfcoil*.
- T1 estimate - this is just a utility for the user to estimate the Ernst angle. It does not affect the pulse sequence at all.

4.1.4 SWIFT Timing Parameter Setup

SWIFT is difficult to initially setup. This is an attempt at simplifying the setup procedure. The rapid switching between transmit and receive usually needs some timing setup for any given setup. Some steps to find the correct gap timing:

- Start with a *normal* sample with a lot of signal.
- Tune your coil and get some normal images using a non-SWIFT scout sequence.
- First optimize a *single* SWIFT pulse-acquire using the "Raw profile" button in the SWIFT Advanced Panel .
- Start with a high level of oversampling (*os* = 64 or 128) and slow *sw* (=32 kHz).
- Start with a low tip angle ∼1-2 degrees so as to limit the RF power in case homorof2 isnt set well.
- Increase FA to 5-6 deg when you are comfortable with your homorof2 setting. SWIFT RF Panel.
- Set *ssc* and *ssc2* values to 0 (they need to be set back when making an image). SWIFT Scan Panel.
- Start with conservative safe values of homorof1,2,3 maybe (3us,3us,0.1us) YMMV.
- Set homorof1 to a reasonable value for your system.
- Calculate a safe small value of homorof2, or reduce homorof2 slowly to find the start of the ring-down signal.
- Use the "Raw profile" button to inspect a single readout, zoom in to see 2-5 gaps at a time.
- Increase homorof3 until raw signal contains no ring-down.
- For imaging, reduce *os* to maybe 12 (or 4 or 8) maybe try increasing *sw*, etc...
- Data errors from VnmrJ can sometimes be mitigated by forcing a longer TR. SWIFT Scan Panel

The SWIFT timing for a single gap looks like this:

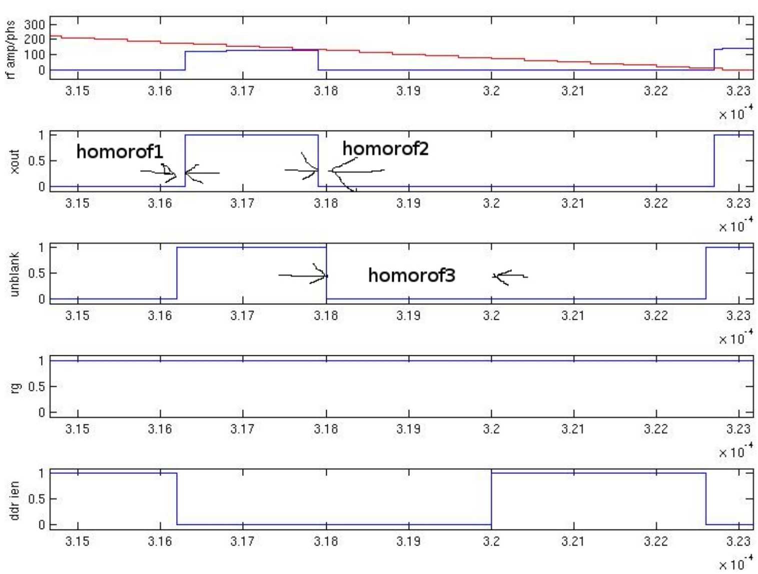

Figure 4.4: SWIFT Gap Timing

Spikes at the beginning of the sampling period indicate that the homorof3 (and possibly homorof2) is too short. Spikes at the end of the sampling period indicate a mis-set *alfa*, if that happens, try setting different values of alfa roughly between 2 and 15. *alfa* is an internal timing parameter (us) for VnmrJ, the correct value may vary depending on your system.

High levels of oversampling aren't necessary for imaging, but can be very helpful for debugging what is going on with the receive data in regards to the ring-down signal. Oversampling significantly increases the amount of data that is sent back to the console. For actual imaging, an oversampling of 8-12 is probably sufficient.

The raw recorded data from a full SWIFT acquisition looks like this:

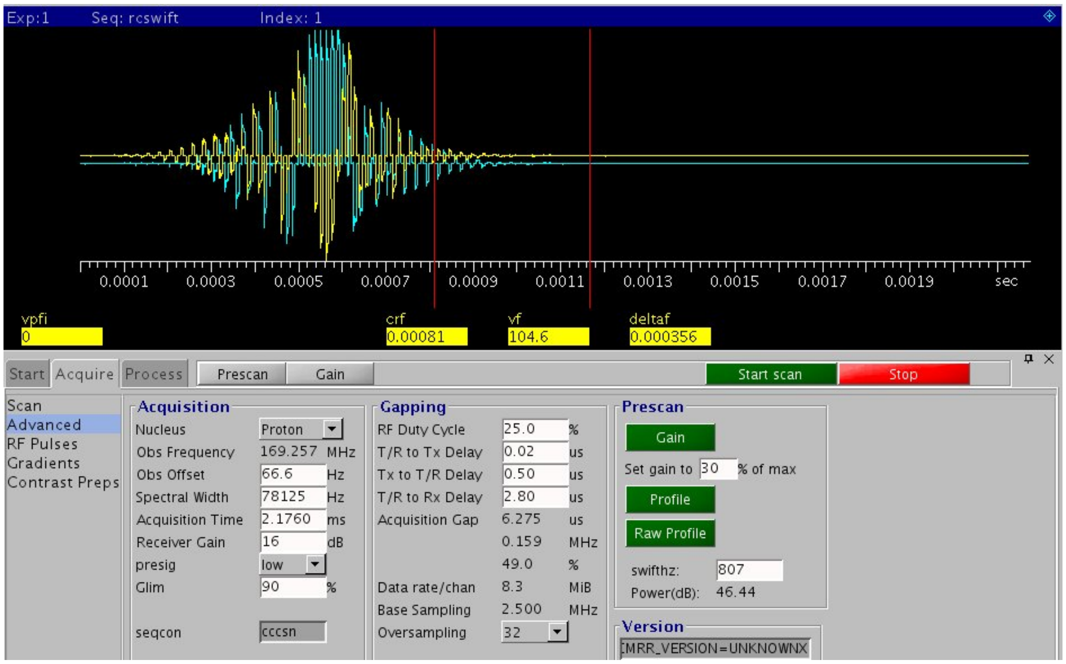

Figure 4.5: Raw Gapped data, rffraction=0.5

In VnmrJ, looking at the same data zoomed in - this pulse shows a pretty good signal, there is a small amount of ring-down at the beginning of the IEN window, evident from the little high-blips at the beginning of some sampled periods.

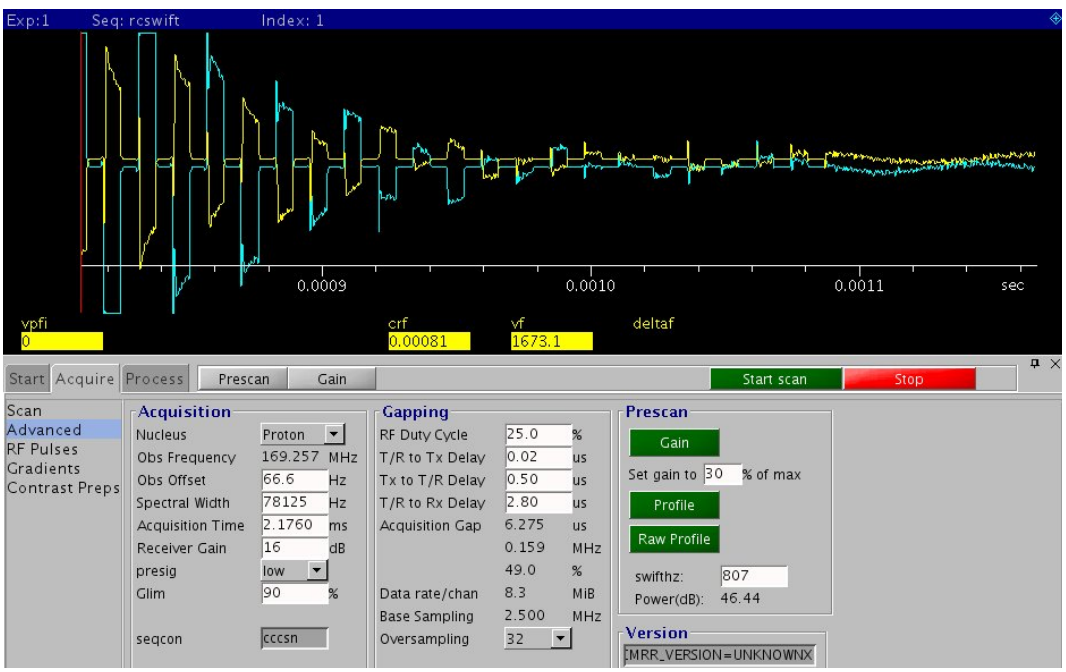

Figure 4.6: Gapped data

4.1.5 homorof1

When the receive has finished, there is a delay homorof1 between when the RF unblank signal changes and when the RF transmit starts. This is to allow slow unblank circuits to open up. Usually this parameter can be very small, around or less than 0.1 us.

4.1.6 homorof2

The RF pulse is ON when xout is high. After RF goes off, there is a delay of homorof2 until the T/R switch switches (UNBLANK and TR happen at the same time). homorof2 is critical to protecting your pre-amp from the transmit energy in the coil, *do not make it too small*. But make it as small as possible. In reality, we have never blown a pre-amp, and are not terribly careful about it, BUT in theory it IS possible.

4.1.7 homorof3

homorof3 controls when the receiver ADC is given a 'data valid' signal. homorof3 does not control any circuitry, so it is safe to use a very small value and increase it until the ring-down from the coil is no longer visible. After homorof3, the IEN signal goes high to indicate to the DDR that the data coming from the ADC is valid.

Chapter 5

Problem Resolution

5.1 Information to collect

The following information is pretty helpful when trying to debug these sequences:

- magnet strength & bore size
- phantom type
- scout image of your phantom, if available
- image showing the problem (either fid or image)
- sw, fov, tr, #views, #spirals
- type of coil & size
- screen show of the overall "Raw profile" zoomed all the way out
- screen shot of the "Raw profile" of the signal, zoomed in to see 3-10 pulse gaps, oversampled at least 32x

Chapter 6

Parameter Index

Chapter 7

Credit and Thanks

Chapter 8

References

8.1 Version ChangeLog.

Release changelog

Chapter 9

CMRR-VERSION

this is package version CMRR_VERSIONX git ident:

Id:

c797996b9601dcd5ec6d887202fc49f2c1db53db

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