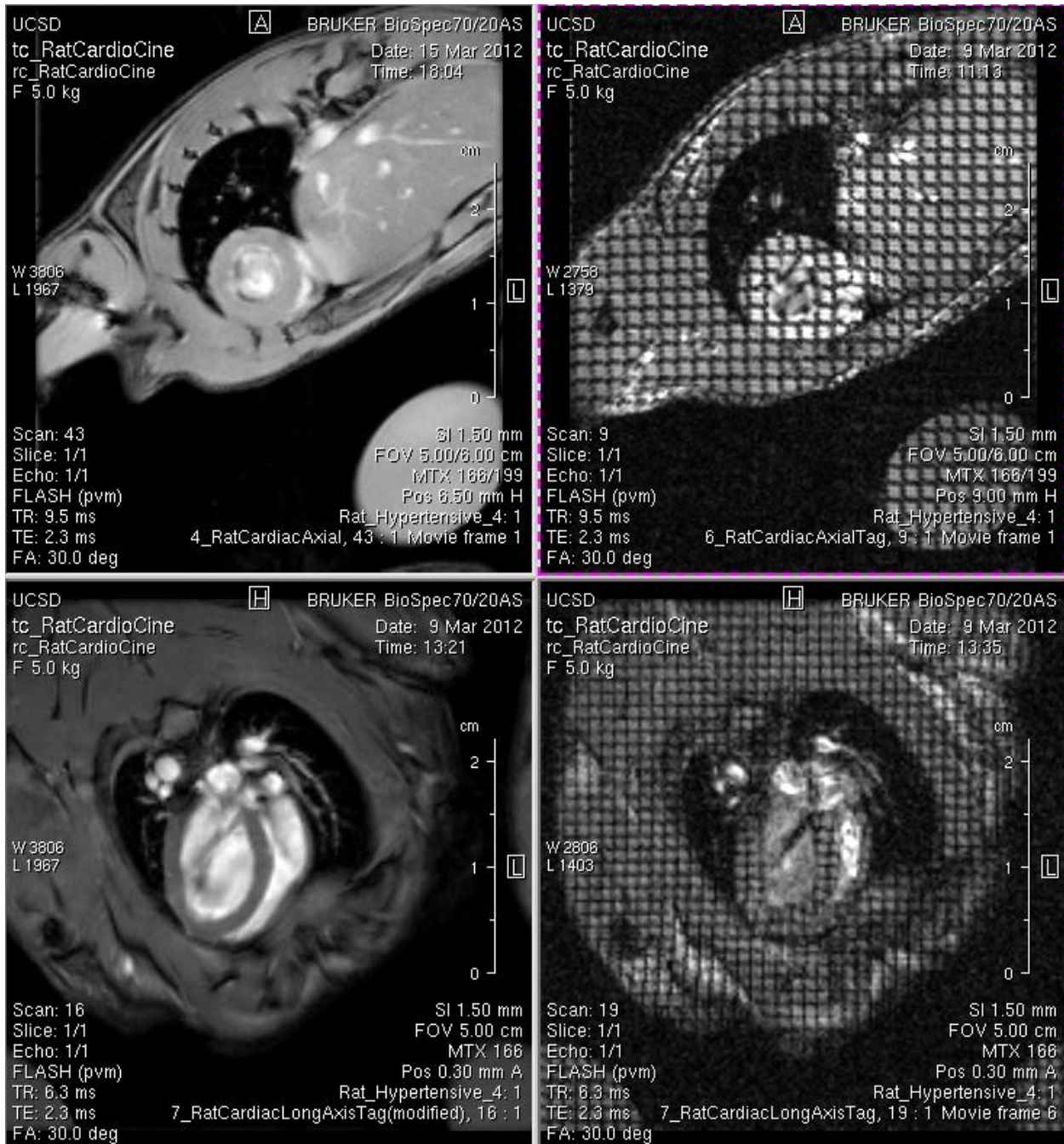# Protocol: Rat Cardiac CINE with Tagging

Purpose

- Basic cardiac movies with 12 frames per cycle.
- Measurement of endocardial motion and deformation using a grid that moves with the tissue.

Rat Cardiac CINE Protocol – "C_RatCardiacCINE"

Type	Scan Name	In-plane res, slice thickness	Fov	Scan time
Localizer (for animal positioning)	*1_RatCardiacTripilot*	625 µm x625 µm, 2.0 mm	8cmx8cm	1 min
Localizer (for selecting anatomical planes)	*2_RatCardiacCoronal*	500 µm x400 µm, 1.5 mm	4.31cmx4.86cm	4 min w/ECG 6 min w/ECG+resp
Localizer for Long Axis Sagittal	*3_RatCardiacSagittal*	258 µm x349 µm, 1.0 mm	3.3cmx4.47cm	4 min w/ECG 6 min w/ECG+resp
Short Axis CINE	*4_RatCardiacAxial*	300 µm x300 µm, 1.5 mm	5cmx6cm	15 min
Long Axis CINE	*5_RatCardiacLongAxis*	300 µm x300 µm, 1.5 mm	5cmx6cm	15 min
Short Axis with grid overlay	*6_RatCardiacShortAxisTag*	300 µm x 300 µm, 1.5 mm	5cm x 6 cm	15 min
Short Axis CINE with grid overlay	*7_RatCardiacShortAxisTag*	300 µm x 300 µm, 1.5 mm	5cmx5cm	15 min

Protocol Steps

1. **Set up the physio equipment**. Follow the instructions below and the operator manual. You will need ECG, respiratory and temperature monitoring.
2. **Set up the RF Coil**. Use Coil A, at 72mm inside diameter, 1000W Quad Transceiver coil.
3. **Prepare the animal and physio equipment.** See the "Positioning" section below.
4. **Protocol directory.** The protocols can be loaded from the directory named "Cardiac." When you create a study, choose "Cardiac" as the default directory.
5. **Acquire a tripilot reference**: Use *1_RatCardiacTripilot* to provide initial reference images.
6. **Acquire a coronal reference:** Prescribe a coronal slice using *2_RatCardiacCoronal* with the gated tripilot for a reference and acquire.
7. **Aquire a sagittal reference**: Load the protocol *3_RatCardiacSagittal*. Load the reference image from step 2 and prescribe a sagittal long axis slice. Adjust the angle of the prescription to align the heart with the image frame and acquire an image. If necessary, clone this scan and repeat.
8. **Collect a short axis slice:** Load the protocol *4_RatCardiacAxial* and use either the sagittal or coronal reference images to prescribe a single short axis slice. Acquire the image.
9. **Collect a long axis slice**: Load *5_RatCardiacLongAxis* with a short axis reference image. Position the long axis slice and acquire.
10. **Collect a slice with tagging**: Protocols that include SPAMM tagging (grid on the myocardium) are indicated by the word "*Tag*" in the protocol title. Otherwise, they are equivalent to their counterparts without tagging.

Positioning

Animal Bed

Use the sliding sample bed and a tooth bar. With the distance from the front of the sample bed to the tip of tooth bar equal to 10 cm, the rear of the sample bed sled should be at 28.5 cm to center the heart at isocenter.

Water Phantom

Place a 15 mL tube containing water and sealed with a screw top and parafilm under the rat to provide a strong signal for setting the reference gain. This tube should remain in place throughout the scan.

Physiological Gating

Anesthesia

Anesthesia should be regulated carefully to bring the heart period to about 180-200 ms and the breathing rate to about 40 bpm. In this case, it is possible to acquire 16 move frames through the cardiac cycle. If the cardiac cycle is shorter, fewer movie frames can be acquired.

ECG and Respiratory Gating
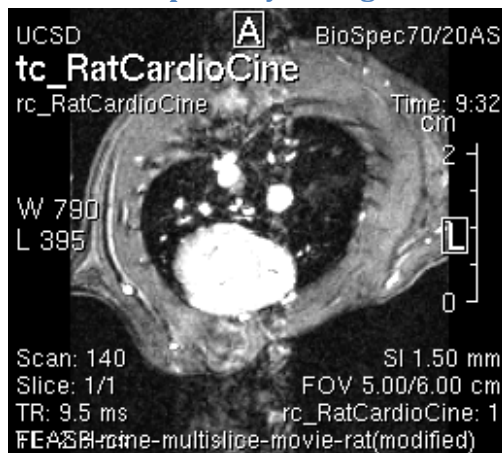
Rat cardiac CINE image. Note that the motion artifacts lie in a vertical stripe above and below the nearby large arteries. This shows up clearly by changing the windowing of the image. Excess motion artifacts will degrade, often decreasing contrast at the exterior boundary of the myocardium.

We have found that setting up ECG and respiratory gating are critical in these scans. Use subcutaneous ECG leads in left and right front armpits. We have found that this produces a higher R-wave than positioning the leads in the shoulders and lower noise pickup during the scan compared to front right paw, rear left paw positioning. Be sure that leads are twisted as much as possible and are passed under the subject to the ECG monitor. The leads should be twisted along their entire length and never form a loop. Tape leads securely at multiple places along the sample bed and check for loops after insertion into the scanner. In the physio software set begin delay to 0, max width to 15 and click "hold."

A good respiratory signal is equally important for collection of artifact free images. Be sure to position the respiratory bellows between the animal and a hard surface so the respiratory signal is reliable. Set the bladder below the diaphragm. If the bladder is too high you may observe the heart beat in the respiratory signal. In the physio software set respiratory begin delay to 0 and max width to 600 ms to collect data along the plateau of the respiratory signal. The screenshot below shows at typical setup of physio equipment. Keep in mind that the respiratory and ECG signals can take 30 seconds to update after they are disturbed or changed during setup.
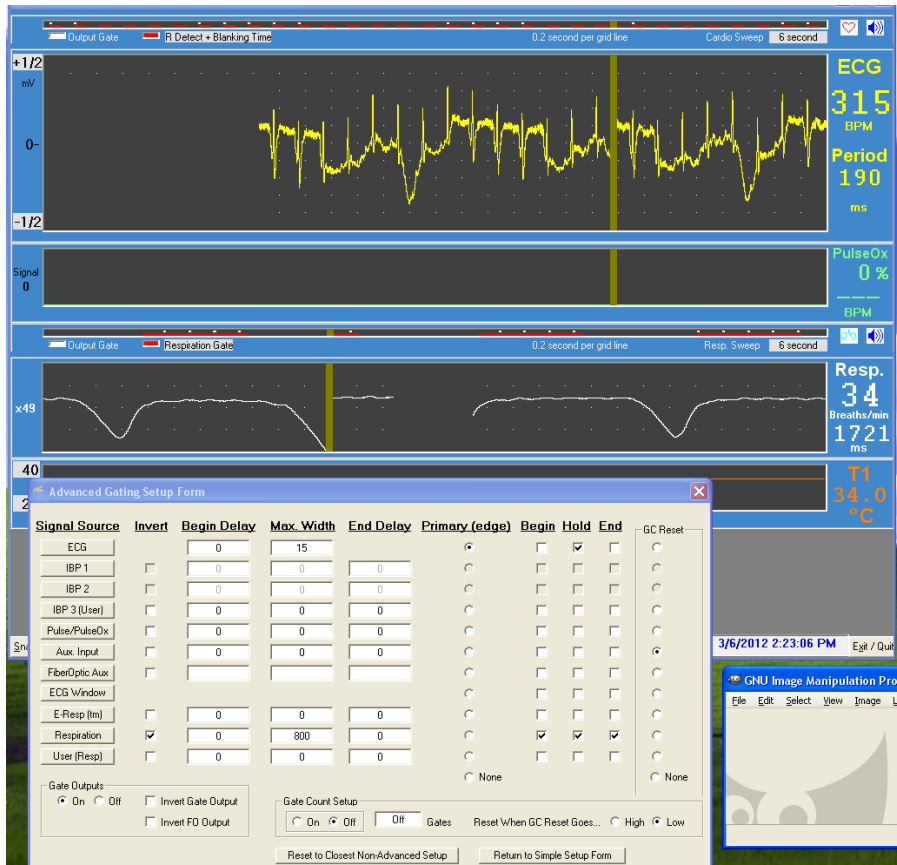
Post-Processing Support

You can convert your image series to .mov movie files using the macro MovieMaker. Alternately data is available as Bruker native format and DICOM images.

Acknowledgements

Thanks to Taylor Coe and Martin Barrio of Jeff Omen's group for excellent work in getting this protocol up and running. Reference data: rc_RatCardioCine.cU1.