SAN DIEGO STATE
UNIVERSITY

KinetiCor: MR Motion Tracking System

Template Pulse Sequences

Copy the appropriate pulse sequence to your directory tree. Do not make changes to the templates.

- Location: *Dot Cockpit -> Default -> Customer Sequences -> Default*
  - xpace_ep2d_bold
    - fMRI (T2*)
  - xpace_ep2d_diff
    - Diffusion - DTI
  - xpace_gre
    - Gradient Echo (T1)
  - xpace_gre_cal
    - Gradient Echo for calibration (Testing Only)
  - xpace_tfl
    - Turbo Flash
    - Can be set for MPRAGE
  - xpace_tse
    - Turbo Spin Echo
    - Echo can be set for FLAR sequence
  - xpace_tse_vfl
    - Turbo Spin Echo with variable flip angle (SPACE)

Pulse Sequence Parameters

In the *Dot Cockpit* edit the protocol to suit your research needs (i.e., TR, TE, FOV…). For the KinetiCor motion correction settings navigate to *Step Properties -> Protocol Parameters -> Sequence -> Special* and input the following settings (See **Fig. 1**).

The *XPace* tab serves as a KinetiCor developer kit panel for camera calibration and will appear on some pulse sequence templates. No changes need to be made to this tab when utilizing the KinetiCor system for motion correction.
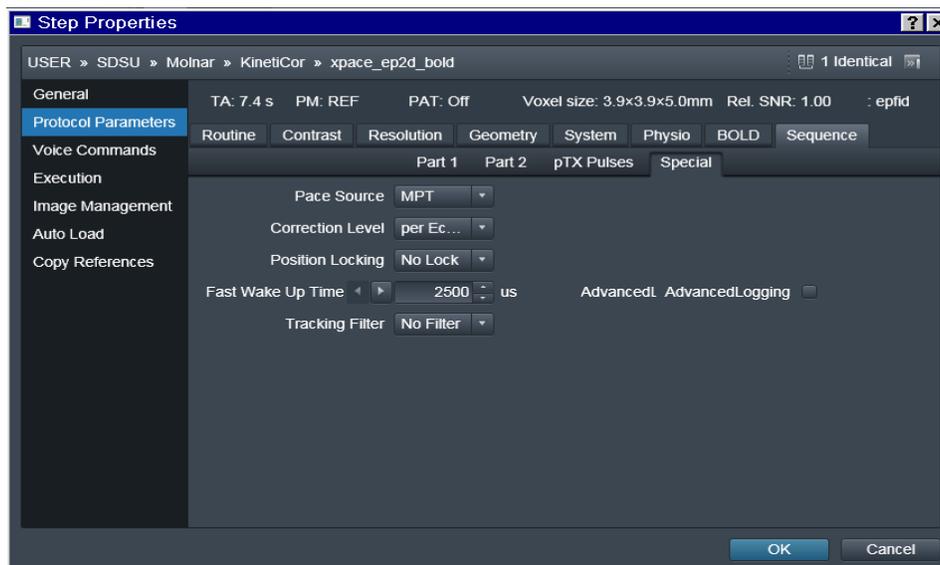

Fig. 1. Step Properties for the xpace_ep2d_bold pulse sequence template

fMRI (T2*) Sequence (xpace_ep2d_bold)

- **Pace Source**: *MPT*
- **Correction Level**: *per Echo Train*
- **Position Locking**: *No Lock*
    - The other options (*Use Current* & *Create New*) are generally for testing/development purposes only. They allow you to align the head to a reference position via Kineticor. You will have to run a localized scan (i.e., localizer-3sag) with XPACE on and set to *Create New*.
- **Fast Wake Up Time**: *2500*
- **Slow Wake Up Time**: *200000*
- **Advanced Logging**: Unchecked
- **XPace Trace Level**: *1*
    - Used for debugging; Can range from 1 -10 and adjusts the amount of information output to the MR log file. Access log file via Run -> logviewer
- **Tracking Filter**: *No Filter*

Structural MRI (T1) Sequence (xpace_gre)

Pace Source	*MPT*
Correction Level	*per Line*
Position Locking	*No Lock*
Fast Wake Up Time	*2500*
Slow Wake Up Time	*200000*
XPace Trace Level	*1*
Tracking Filter	*No Filter*
Reject Mode	Unchecked
RF Elongation	*100*
Advanced Logging	Unchecked
Retrospective Correction	Unchecked
Disable Phase Encoding	Unchecked
Use Phase Patch	Unchecked

Tracking Markers

Four KinetiCor cameras inside the bore track the location of the markers in space and adjust the gradients during a scan to correct for participant movement. The two types of markers available at the Center work in exactly the same way and utilize the same tiles yet one is a little smaller and may be better suited for kids or individuals will smaller noses (See **Fig 2**.). In addition, we have a sheet of individual *Type I* tiles for use if you only want to use one tile for tracking. The markers are designed for one time use however they can be reused by researchers during piloting or if a participant returns for a second/follow-up scan.
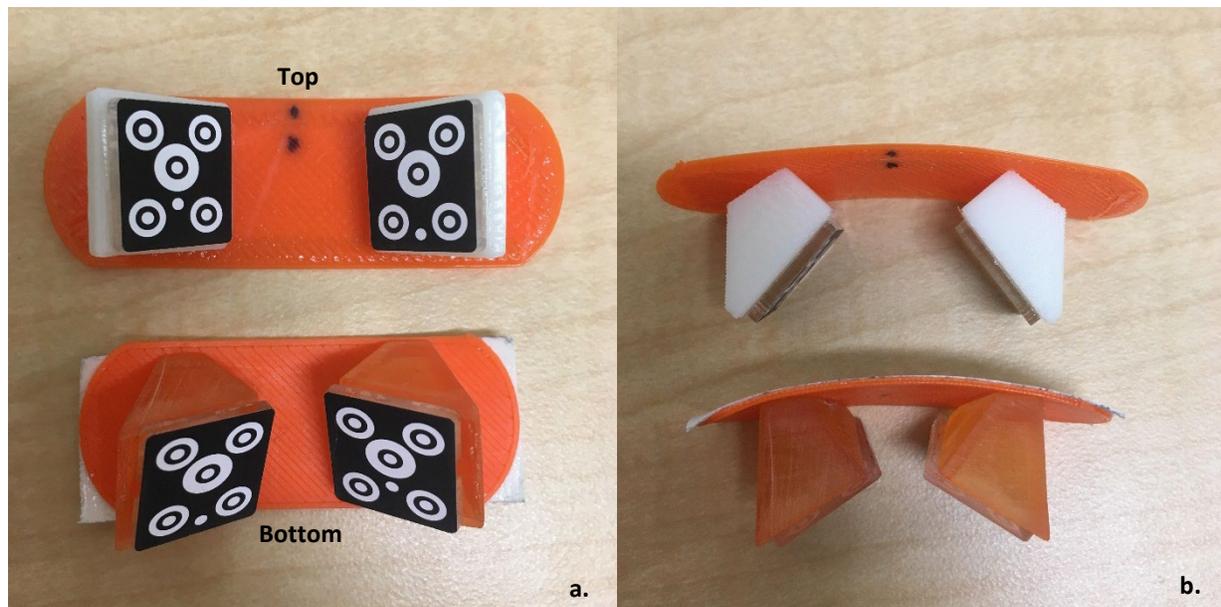

Fig 2. Two versions of the Tracking Markers available for use. When applying the markers, the top should be pointed toward the eyebrows and the bottom should be pointed toward the tip of the nose. **a)** The top and bottom of the markers are identified. The tiles themselves are slightly angled down toward the tip of the nose initially but when applied will fan out for easier detection by the KinetiCor Cameras. **b)** A top down view of the markers.

Application

1. Gently wipe the bridge of the nose with alcohol and wait for skin to dry
2. Remove white backing on marker to expose adhesive
3. Position the markers on the bridge of the nose, securing snuggly along the sides of the nose. When positioned correctly the small white dots located on the tiles will be on the bottom of the marker.

Tiles

Tile *Type I* is required to initiate motion tracking; *Type II* serves as a backup in case *Type I* drifts out of range of the cameras. When attaching only one tile to a participant you must use *Type I*. Avoid touching the top the tiles and transferring oil to the surface. Any imperfections or artifacts on the surface of the tile may add error into the motion tracking corrections

- **Type I** : distinguished by a dot close to the center ellipse (See **Fig. 3**)
- **Type II** : distinguished by a dot close to the edge of the tile

Fig 3. Tile Type I (left) and Tile Type II (Right)

Operation

When Motion Correction (MOCO) is running, numbers (I or II) will appear in the inner corners of the display screen when the markers are placed within view of the camera (See **Fig. 4**). When the system is using one of the tile types for real time tracking a white box will appear around the number. Before you begin the scan, ensure the tile *Type I* is visible by at least two cameras and the tile identifiers are surrounded by a white border. Connecting directly to the KinetiCor system via the network is not necessary for motion correction to start. However, if MOCO is not automatically detecting the tiles, three options are available:
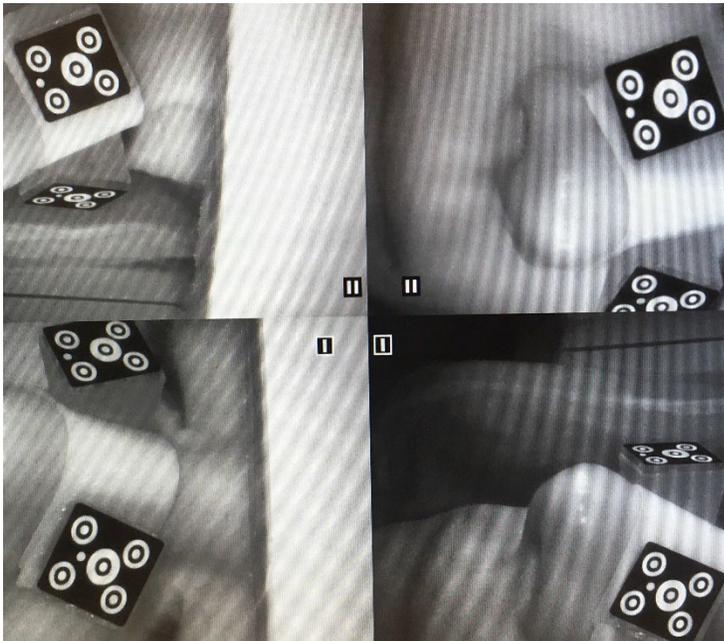

> **NOTE:** If you choose to run a manual session of MOCO via **moco.sh**, the automatic detection software will not resume upon closing the terminal window. Please remember to reactivate the automatic MOCO system for the next research team.
>
> Run either:
> - **mocoservice.sh**
> - **reset.sh**

Fig 4. View of the markers from monitor in the MRI control room. Identifiers (I & II) in the center inform the technician which tile is visible to the cameras and if it is being used for active motion correction (surrounded by a white box).

If MOCO is not automatically detecting the tiles, three options are available:

- o Power cycle the system located in the equipment room.
- o Open a terminal on the MRI Console -> **ssh** into KinetiCor system -> run **reset.sh** to rest the system -> close terminal
- o Connect to the KinetiCor system directly and run **reset.sh**

Connecting to the KinetiCor System

- o Connect directly to console via the KinetiCor ethernet cable
- o Configure your computer to Kineticor IP Address:
  - *Settings -> Network -> Change Adapter Options*
  - Right click the local area connection and select *Properties*
  - Highlight *Internet Protocol Version 4 (TCP/IPv4)* and select *Properties*
  - Assign static IP Address information (IP: 192.168.2.114; submask: 255.255.0.0)
- o Open a terminal on local computer and **ssh** into Kineticor
- o Upon logging in you will be located in **/root**.

- o Third party SSH/SFTP clients to allow easier navigation and file transfer via a GUI

- MobaXterm (Windows) - https://mobaxterm.mobatek.ne
- WinSCP (Windows) - https://winscp.net/eng/index.php
- File Zilla4 (MAC; Windows) - https://filezilla-project.org/

Log Files

o To generate a motion tracking log file for each pulse sequence in your protocol list you must run separate **moco.sh** sessions. If you manually start a MOCO session and leave it running across your entire scanning session it will generate one large Log file.

1. Connect laptop to Kineticor system via ethernet
2. Run **moco.sh** in the terminal
3. Run MRI pulse sequence
4. Before next pulse sequence terminate **moco.sh** application (Ctl+C) and restart it.
5. Repeat steps 2 thru 4 until you reach the end of your protocol list
6. When you are done scanning. Terminate **moco.sh** and run **mocoservice.sh**.
7. Disconnect from the Kineticor system

o Take note of each Log file ID associated with your run
o Log files are located at **/app/logfile** on the KinetiCor system
o Select the appropriate *OutputCoordinates.txt* file and transfer via **scp**, **sftp**, or an ftp client.

NOTE: Monthly purges of the Log files will occur due to the limited 16gb memory

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Addition Notes &Troubleshooting

o If the SSH/SFTP command does not allow you access to the system due to an expired key
- Run **ssh -keygen -R 192.168.2.6**
o Do not terminate or run **moco.sh** in the middle of a scan.