

TUS-MRS Study Protocol – “Offline” TUS

Before the participant arrives:

1. Ensure you have a copy of the Study Visit Log. Check which TUS site to target for this session.
2. Set up the Brainsight system:
 - 2.1. Turn on Brainsight system and Vicra camera.
 - 2.2. Position the participant chair in the camera Field of View (FOV).
 - 2.3. Attach subject tracker (ST-1287) to the Brainsight goggles.
 - 2.4. Load participant’s Brainsight project, select new online session and select target.
3. Calibrate the transducer:
 - 3.1. Attach the tracker adapter to the base of the transducer.
 - 3.2. Attach the Brainsight tracker (CT-922) to the transducer tracker adapter.
 - 3.3. Press the transducer holder onto the Brainsight Calibration Block (CB-1371).
 - 3.4. Place the transducer face down onto the holder on the Calibration Block.
 - 3.5. Place the Calibration Block in the camera’s FOV and calibrate the transducer.
 - 3.6. Remove the Brainsight tracker adapter with the tracker attached – ***do not move the tracker relative to the adapter or you will need to re-calibrate.***
4. Prepare the transducer and gel pad:
 - 4.1. Prepare a bowl of clean warm water.
 - 4.2. Cut the gel pad with the cookie cutter (70 mm ring for 64 mm diameter transducer) – *Ensure this is a clean cut. Jagged edges may result in trapped bubbles.*
 - 4.3. Add ultrasound gel to the surface of the transducer, rub this around the transducer face to ensure the whole surface is covered.
 - 4.4. Attach the water bladder ring to the transducer, spread gel around sides of ring.
 - 4.5. Start to insert the cut gel pad (smaller side facing transducer) into the water bladder ring, while immersing the transducer in water – *be very careful not to break the gel pad!*
 - 4.6. Gently massage the gel pad to remove bubbles.
 - 4.7. Remove from the water bowl and check there are no bubbles between the transducer face and the gel pad.
 - 4.8. Reattach the Brainsight tracker adapter and tracker.
5. Prepare the TPO and trolley:
 - 5.1. Ensure the correct matching network is connected to the TPO.
 - 5.2. Connect the RF Watt Meter (if using) to Channel 1 of the TPO and corresponding matching network. Use the long(/short?) cable.
 - 5.3. Connect the transducer to the matching network.
 - 5.4. Plug the TPO, RF Watt Meter and other equipment (e.g. laptop) on the TUS trolley into the power extension cord board – turn on power, TPO box and RF Watt Meter (if using).
 - 5.5. Run the MATLAB script to program the TPO pulse parameters.

After the participant arrives:

1. Register participant at MRI
 - 1.1. Check MR safety/fill in form if not already done.
 - 1.2. Ensure 32-ch head coil is attached and ready
 - 1.3. Ensure participant has no metal and will be ready to enter scanner (e.g. check toilet etc.) immediately after TUS.
 - 1.4. Register participant on MRI.
 - 1.5. Load scanning protocol (either dACC or PCC).
 - 1.6. Brief participant about what will happen (TUS, followed by MRI – “During the MRI you don’t have to do anything, just relax and try to keep your head very still. The whole scan will take around 50 minutes. We will check with you in between scans to see if you are OK. There is a squeazy bell in case you need to stop the scan and speak to us.””)

2. Prepare participant for TUS stimulation:
 - 2.1. Ask the participant to sit back in the chair and get comfortable.
 - 2.2. Give participant goggles with Brainsight subject tracker attached to put on.
 - 2.3. Give participant bone conducting headphones (if using).
 - 2.4. Check that the participant, fiducials, and transducer are within the camera FOV.
 - 2.5. Part hair and spread some ultrasound gel on the scalp area where transducer will be placed.

3. Perform neuronavigation using Brainsight:
 - 3.1. In online session mode, go through registration process.
 - 3.2. Ask participant to stay very still for the Subject Registration, and not to move the goggles after registration is performed.
 - 3.3. Sample participant’s fiducial markers and check that the distance errors are acceptable.
 - 3.4. Place transducer to within 0.5 mm of target.
 - 3.5. Check distance from transducer face to target – program TPO to use this focal distance.

4. Apply TUS:
 - 4.1. Check pulse protocol, power, and focal distance again.
 - 4.2. Ensure that transducer is still within 0.5mm of the target, ask participant to stay relaxed and be very still for the next 1.5 minutes. *Ensure that you are comfortable holding the transducer in place for the next 1.5 minutes!*
 - 4.3. Ask assistant to press the button to deliver TUS pulses (and play auditory mask if using).
 - 4.4. Take note of the time the stimulation starts.**
 - 4.5. Check periodically if participant is still OK during stimulation.
 - 4.6. Take note of the time that stimulation ends & start stopwatch.

5. Post TUS:
 - 5.1. Check that participant is OK.
 - 5.2. Move to MRI scanner, repeat briefing: “During the MRI you don’t have to do anything, just relax and try to keep your head very still. The whole scan will take around 50 minutes. We will check with you in between scans to see if you are OK. There is a squeazy bell in case you need to stop the scan and speak to us.”

At the MRI scanner:

1. Starting the scan:
 - 1.1. Ask radiographer to help set participant up in the MRI.
 - 1.2. Once participant is inside, check they are OK to proceed, remind them to keep still.
 - 1.3. Start scanning.

2. During the scan:
 - 2.1. T1w MRI:
 - 2.1.1. Align box edge with brainstem, make sure that the whole head is within box.
 - 2.2. fmap and fMRI 1:
 - 2.2.1. AC-PC alignment should be automatic – just need to check that this is OK.
 - 2.2.2. If you see the box asking for Automatic or Manual alignment, choose Manual.
 - 2.2.3. Take note of fMRI 1 start time.
 - 2.3. MRS:
 - 2.3.1. During fMRI, do T1 planning reconstructions.
 - 2.3.2. Place voxel where you need it on the FA calib scan.
 - 2.3.3. Copy parameters to 1st MRS scan.
 - 2.3.4. During FA calib scan, take note of maximum deg and voltage
 - 2.3.5. Set Voltage for 1st MRS scan – this should adjust for all others.
 - 2.3.6. Place voxel for 2nd MRS scan.
 - 2.3.7. Take note of FWHM for each MRS scan.
 - 2.3.8. Take note of time of MRS 1 and MRS 2.
 - 2.4. fMRI 2:
 - 2.4.1. Take note of fMRI 2 start time.

3. At the end of scan:
 - 3.1. Take participant out, thank them, pay them, send them on their way.
 - 3.2. Transfer data: select scans, Transfer > Send To > PUDicomCloud
 - 3.3. Save MRS data:
 - 3.3.1. Open Spectroscopy (under Applications)
 - 3.3.2. Select and drag scan into box. Export to offline.
 - 3.3.3. Create new folder in MRSpectroRawData: <subjid>_ses-<label>_tus-<active voxel>_<date>
 - 3.3.4. Save MRS data: ses-<label>_echo-<index>_vox-<label>[_type-<label>]_megapress.rda
 - 3.3.5. Transfer to one of the disks attached to the scanner (usually H:\ or J:\). Transfer data to OneDrive using computer to the left of scanner (so that no USB sticks or removable drives are used other than the one at the scanner).

4. Back in Stimulation Lab: unplug, clean, and put everything away.