**Panoramic ECAP Data Collection Procedure**

The guidelines set out the procedure for collecting Panoramic ECAP (PECAP) data using Cochlear Corporation Cochlear Implant Devices. It is the responsibility of the tester to ensure that all stimulation parameters are safe and comfortable for the patient.

***Pre-Testing Note*:** if the testing computer goes to sleep during PECAP data collection for a significant portion of time, the Custom Sound EP software will also go to sleep, and there may not be a way to re-start the PECAP sequence from where it left off.

*Required Software and Hardware:*

1. Custom Sound EP (including Trans Impedance Matrix (TIM) Feature)

***Note****: tested using versions 5.0 and 5.2*

1. MATLAB

***Note****: tested on MATLAB 2018a*

1. CP910 or CP1000 processor

***Note****: Tested with CP910 / N6 platform only (TIM does not work on CP810)*

*Outline of Operations:*

1. In Custom Sound EP
   1. Measure Impedances
   2. Find Most Comfortable Levels (MCL) for all electrodes included in the patients most recent MAP (the goal here is to achieve as close to uniform loudness across the electrode array as possible)
      1. Using the Stimulate-Only feature, set the Artefact Cancellation method to Forward Masking, the Interphase Gap to 8 µs, the Phase Duration to 25 µs, the Masker Offset to 0 (the software default is generally 10), the frame rate to 80 Hz, and adjust any other settings to match the intended ECAP recording parameters.

***Note****: It may be most optimal to adjust the phase duration to match the parameters used in the patient’s MAP (i.e. 37 or 50 µs)*

* + 1. Start at a low current units and increase in steps of 6, 4, and 2 until MCL is achieved. See Garcia *et al* (2021) for details of the recommended procedure.
    2. It is recommended that loudness ratings of 4 (medium soft), 5 (medium), and 6 (Most Comfortable Level / MCL) be recorded during the process of determining MCL so that if compliance is reached before the patient achieves the MCL for any electrodes, a loudness rating of 4 or 5 can be used for all electrodes in order to maintain uniform loudness across the array.
  1. Select 1 or 2 electrodes for which a clear ECAP can be seen at MCL in the Stimulate-Only feature display. Run the optimization routine for gain and delay settings. Determine the gain and delay settings that result in the clearest ECAP waveform with a high amplitude.

1. In MATLAB
   1. Run **pecap\_daq.m** script to generate Custom Sound EP input csv files
   2. Using the electrodes, MCL levels, gain, delay, and any other settings as inputs to the function, ensure electrodes, CU levels, and other recording parameters are as desired
   3. The script will generate two .csv files, one for loudness verification along the length of the array, and one for executing the PECAP sequence. Both are in the format to be imported into Custom Sound EP

***Note****: If the filename specified already exists, the pecap\_daq() function will print out an error indicating it was unable to complete the file-generation process and will not overwrite the previously-existing file.*

* 1. There are comments within the MATLAB function file to explain the inputs required to run it

***Note****: the input ‘half’ can be set to 1 in order to generate a data acquisition file with half the PECAP matrix. This is known as ‘mediumCAP’ and will take approximately 25 minutes to collect using the recommended parameters. For a full 22x22 matrix that will take approximately 45 minutes to collect, omit this input or set it to 0.*

1. In Custom Sound EP
   1. In the Advanced NRT menu, import the .csv files generated by the MATLAB script
   2. Run the SUBJECTN\_verification.csv NRT sequence to confirm that all electrode current levels are comfortable for the subject
      1. For faster test time, check the box in the pop-up window that says “Don’t show this dialog anymore” so that all the items in the NRT sequence run one after the other.
      2. This sequence will run 50 sweeps for each electrode along the diagonal of the probe/masker matrix
   3. Collect Trans-Impedance Matrix (TIM) data
      1. Collect the TIM at the default settings. This should be recorded at 25 µs (this is usually labeled as T6)
      2. If time permits, collect the complex TIM data additionally at timepoints of 0, 6, 34, 40 and 58 µs (usually labeled as T1/T2/T8/T9/T13)
      3. The TIM data can alternatively be collected at the end of the session, after PECAP
   4. Run the full PECAP SUBJECTN.csv NRT sequence
      1. Check the box in the pop-up window that says “Don’t show this dialog anymore” so that all the items in the NRT sequence run one after the other. This will reduce the test time.
   5. Save data from PECAP NRT sequence, and from TIM data collection
      1. Confirm that data is being saved in **.xlsx** form, and **not in .csv** form!

***Note****:* ***This is absolutely crucial****. If the file is saved in .csv form, none of the recorded ECAP data will be maintained, as it is stored in secondary tabs that will not be saved in a .csv file format, and the data cannot be retrieved.*

# References

Garcia, C., Goehring, T., Turner, R. E., Deeks, J. M., Brochier, T., Rughooputh, T., . . . Carlyon, R. P. (2021, March). The Panoramic ECAP Method: estimating patient-specific patterns of current spread and neural health in cochlear implant users. *Journal of the Association for Research in Otolaryngology*, 1-23. doi:10.1007/s10162-021-00795-2