

Neural Response Imaging (NRI) is a valuable tool used by clinicians to obtain an objective measurement of the electrically-evoked compound action potential (eCAP) which can assist with intra-operative testing and post-operative cochlear implant programming. This guide provides the basic information needed to get started with performing NRI in Target CI.

## FITTING HARDWARE

NRI can be performed in Target CI fitting software using a Marvel CI sound processor and either the Noahlink Wireless or CPI-3 programming interface.

## PERFORMING NRI MEASUREMENTS

### 1. OPEN TARGET CI

### 2. ACCESS THE CLIENT FILE AND OPEN A FITTING SESSION

#### For a New client:

- Select *New client*. Enter the client details<sup>1</sup> and *Save*.
- Select *New session* to open a new fitting session.

#### For an Existing client:

- Search and select the client's file; then select *Open Session*<sup>2</sup>.

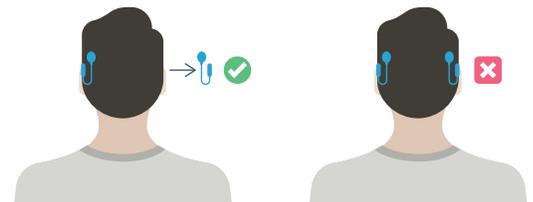
### 3. CONNECT TO THE HEARING INSTRUMENT

- Connect to the hearing instrument via Noahlink Wireless or CPI-3.
- If using the Noahlink Wireless, ensure that a fully charged rechargeable battery is used. Remove and re-attach the battery to put the sound processor into pairing mode. Select the *Connect* button within the 3-minute pairing window.
- Verify the side for which the device is intended to be used.
- Once device connection is successful, *Close* to proceed.



### 4. CONNECT TO THE INTERNAL DEVICE

- Place the headpiece on the recipient's head to achieve lock with the implant.
- For a new client, create a new implant record.
- Remove the contralateral sound processor<sup>3</sup> prior to running NRI (if applicable). Otherwise, excessive noise will be observed in the NRI tracing.



### 5. REVIEW IMPEDANCES

- Under *Client*, access the *Impedance* tab to review impedances and run conditioning, if desired.
- Only run NRI on electrodes with normal impedances<sup>4</sup>.

### 6. ACCESS NEURAL RESPONSE IMAGING (NRI)

- Under *Client*, access the *NRI* tab to measure NRI<sup>5</sup>.
- Select *New measurement* to open the NRI measurement window.



1. Always enter the client's Date of birth so that the appropriate default settings can be applied.

2. Open session should be used at all follow-up visits to allow access to past impedance and NRI data.

3. It is okay for the recipient to wear contralateral hearing aid during NRI measurements.

4. Do not perform NRI on extra-cochlear, shorted, open, or out of compliance electrodes.

5. Due to probable impedance changes after surgery, it is best to re-run NRI in the clinic prior to creating new maps for the recipient instead of using NRI data collected in the OR.

### 7. DETERMINE ELECTRODES TO MEASURE

- To add/remove electrodes, select the stimulating electrode(s) in the NRI window
- Use keyboard shortcuts to select more than one electrode at a time.

Electrode	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
300																
225																

- Hold the *Ctrl* key while selecting channels in the data grid to measure multiple electrodes.
- Use the *Ctrl+A* keys to select all electrodes for NRI measurement.

### 8. ADJUST NRI SETTINGS

- Set High and Low CU values for electrode(s) to be measured.
  - Behavioral M-Levels can be used as a guide to establish initial low and high CU values.
  - A minimum range of 150 – 200 CU should be considered where the low CU value results in one or two responses within the noise floor.
- Choose number of *Data points*, as appropriate.
  - Target CI will populate 5 data points by default; however more can be added, as needed.
  - Unmeasured data points are indicated by an open circle. Filled data points indicate a completed measurement.
- Choose the appropriate *Stim Level Ordering*.
  - Select *Low to High* for use in the clinic.
  - Select *High to Low* for use in the operating room.
- Consider using the following settings as a starting guide for measuring NRI:

#### FOR USE IN OPERATING ROOM

- Low CU = 150
- High CU = 400
- Data points = 5
- Stim Level Ordering = High to Low

#### FOR POST-OPERATIVE USE (ADULTS)

- Low CU = 100
- High CU = 300
- Data points = 5
- Stim Level Ordering = Low to High

#### FOR POST-OPERATIVE USE (PEDIATRICS)

- Low CU = 50
- High CU = 250
- Data points = 5
- Stim Level Ordering = Low to High

### 9. SELECT START

- NRI will continue to conduct measurements until all data points have been obtained.
- When measuring NRI post-operatively, monitor the recipient for signs of discomfort while NRI is running to ensure stimulus levels are not exceeding the recipient's comfort levels.
- Press *Pause* or the *Space bar* to stop running a measurement at any time.

### 10. NRI ANALYSIS

**NRI measurement**

Electrode	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
High <sub>CU</sub>	0	0	0	0	0	0	0	0	250	0	0	0	0	0	0	0
Low <sub>CU</sub>	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0
Data points	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0
Record on	3	4	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Z <sub>KC2</sub>	9.3	5.6	6.8	8.1	7.5	6.0	9.6	8.1	9.6	8.3	6.9	5.5	6.4	6.1	5.8	5.5
tNRI <sub>CU</sub>									79							

**RECORDING**  
Start

**DATA POINT**  
Skip to next data point  
Skip to next electrode

**SETTINGS**  
Stim level ordering: Low to high  
Averages per data point: 32  
Simulated dataset: 1  
Recording gain: 300  
Stimulation sequence: Cathodic first

**EP Growth Function – Regression Analysis**  
(with 1-2 data points in the noise floor and more than 3 measured data points above the noise floor)

Noise floor < 20µV

tNRI value

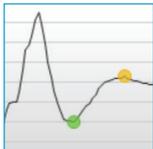
Responses

- Response @ 138 CU  
EP: 264 µV
- Response @ 175 CU  
EP: 369 µV
- Response @ 213 CU  
EP: 643 µV
- Response @ 250 CU  
EP: 752 µV

Good waveform morphology

Save Save and close Cancel

#### GOOD RESPONSE



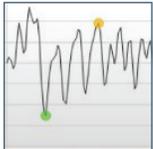
- It is important to obtain 1-2 data points within the noise floor and a minimum of 3-4 data points rising from the noise floor for an accurate calculation of tNRI.
- Confirm accuracy of selected N1 and P2 peaks for each waveform. N1 and P2 latencies will remain stable with increased stimulation levels.

#### NO RESPONSE



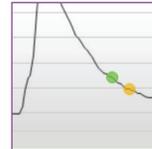
- If there is no visible response:
- Increase the stimulation level (up to levels of compliance), while monitoring recipient for comfort.
  - Use a different recording electrode to measure the NRI response.

#### NOISY RESPONSE



- If waveform tracing appears noisy:
- For bilateral recipients, confirm that the contralateral processor is removed.
  - Increase the number of Averages per data point.

#### RESPONSE WITH ARTIFACT



- If artifact is present, use a different recording electrode to measure the NRI response

- Verifying correct tNRI values prior to saving and closing the session will ensure correct tNRI values are calculated.
- To repeat measurements in future sessions, use the copy setting function, as shown below.

1/26/2021 11:43 AM

86	88	89	85	88	84	85	74
----	----	----	----	----	----	----	----

Copy

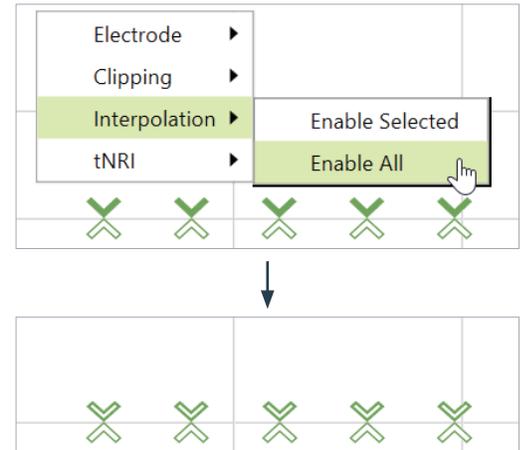
### 11. SAVE NRI MEASUREMENT

- Save and close the NRI measurement.

## FITTING GUIDE

### 1. CREATE A MAP USING NRI DATA

- Access the *Fitting* tab to begin the fitting process.
- In the *Mapping* tab, right-click on any channel and select *Interpolation*; then, *Enable all*. All markers will change to unfilled or open arrows.
- On channels with measured tNRI, set M-Levels to tNRI values.
- Confirm *Live Speech* as the stimulation mode.
- Globally reduce the M-Levels slightly to ensure recipient comfort and *Start stimulation*.
- Gradually increase M-Levels to find recipient's most comfortable level (level 6 on the loudness scale).
- Consider loudness balancing across each electrode.
- Verify settings (i.e. Ling Sounds, soundfield detection, etc.).



### 2. FINALIZE THE FITTING SESSION

- Continue with fitting process by managing program settings in *Fine Tuning Tab*.
- *Save and close* the fitting session.

## NEURAL RESPONSE IMAGING (NRI) RESOURCES

- Koch, D. B., Overstreet, E.H. (2003). Neural Response Imaging: Measuring Auditory-Nerve Responses from the Cochlear with the HiResolution™ Bionics Ear System. Advanced Bionics White Paper.
- He, S., Teagle, H., Buchman, C. (2017). The Electrically Evoked Compound Action Potential: From Laboratory to Clinic. *Frontiers in Neuroscience*, Volume 11, Article 339.
- Hughes, M., Audiology Online. *Fundamentals of Clinical ECAP Measures in Cochlear Implants Part 2: Measurement Techniques and Tips*.