Electrode Identifier and Electrode Survey

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Monica Volz – Relevant Financial Relationships

- Speakers' Bureau, consultant, and/or advisory board member for Medtronic and Boston Scientific.

All relevant financial relationships have been mitigated

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Poll #1

- I use Brainsense technology (Electrode Identifier & Electrode Survey) as a tool to guide me for initial programmings:
  - A: 0-25% of the time
  - B: 26-50% of the time
  - C: 51-75% of the time
  - D: 76-100% of the time
  - E: I have never used Brainsense technology

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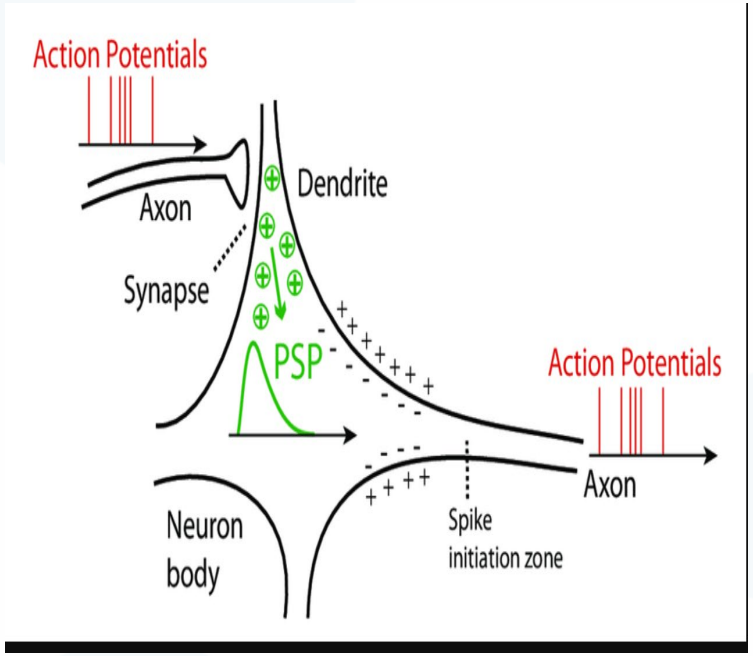
Local field potentials

- Local Field Potentials (LFPs), are the signals measured by electrodes in the brain. They are generated by:
  - Postsynaptic potentials (PSPs): the change in the electrical voltage when one neuron communicates with another.
  - Temporal-spatial summation: Individual PSPs are minuscule. The LFP signal is the combined (summed) effect of thousands of these PSPs happening at roughly the same time (temporally) and in the same general location around the recording electrode (spatially).
  - Local neuronal population: The summation involves the electrical activity of a small group of neurons immediately surrounding the electrode, not the activity of single, isolated neurons or the whole brain.
- The signal an electrode records (the LFP) primarily reflects the average, synchronized electrical activity of the surrounding neurons as they receive and process information from other parts of the brain.



N. Maling, C. McIntyre, Local Field Potential Analysis for Closed-Loop Neuromodulation, pgs.67-79, Closed Loop Neuroscience. http://dx.doi.org/10.1016/B978-0-12-802452-2.00005-6

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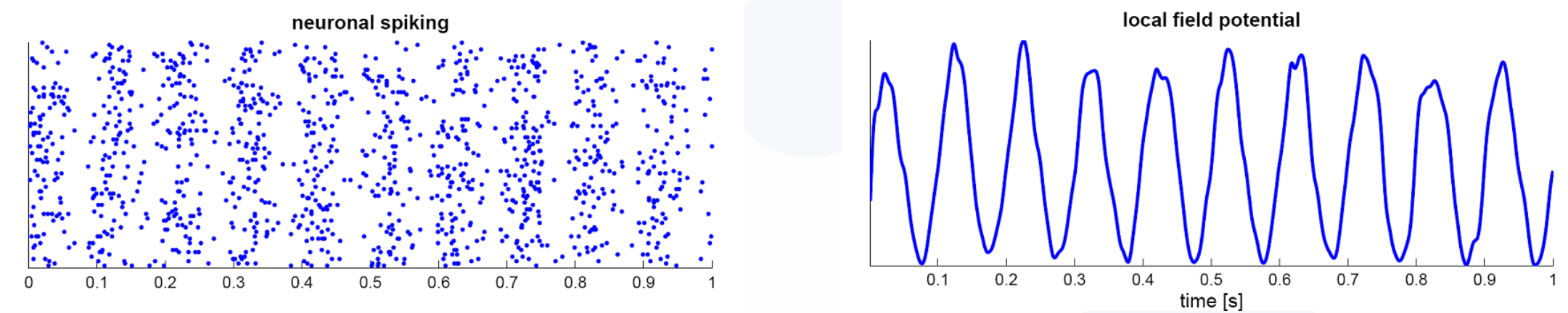
Local field potentials

- LFPs mainly represent the temporal–spatial summation of post synaptic potentials from the local neuronal population surrounding an electrode.
- Simulation of neural oscillations at 10 Hz. The panel on the left shows spiking of individual neurons (with each dot representing an individual action potential within the population of neurons), and the panel on the right is the local field potential reflecting their summed activity.



Think of PSPs as individual heartbeats (depolarization/hyperpolarization), and LFPs as the EKG (electrocardiogram) showing the combined electrical rhythm of the whole heart muscle.

https://commons.wikimedia.org/wiki/File:SimulationNeuralOscillations.png

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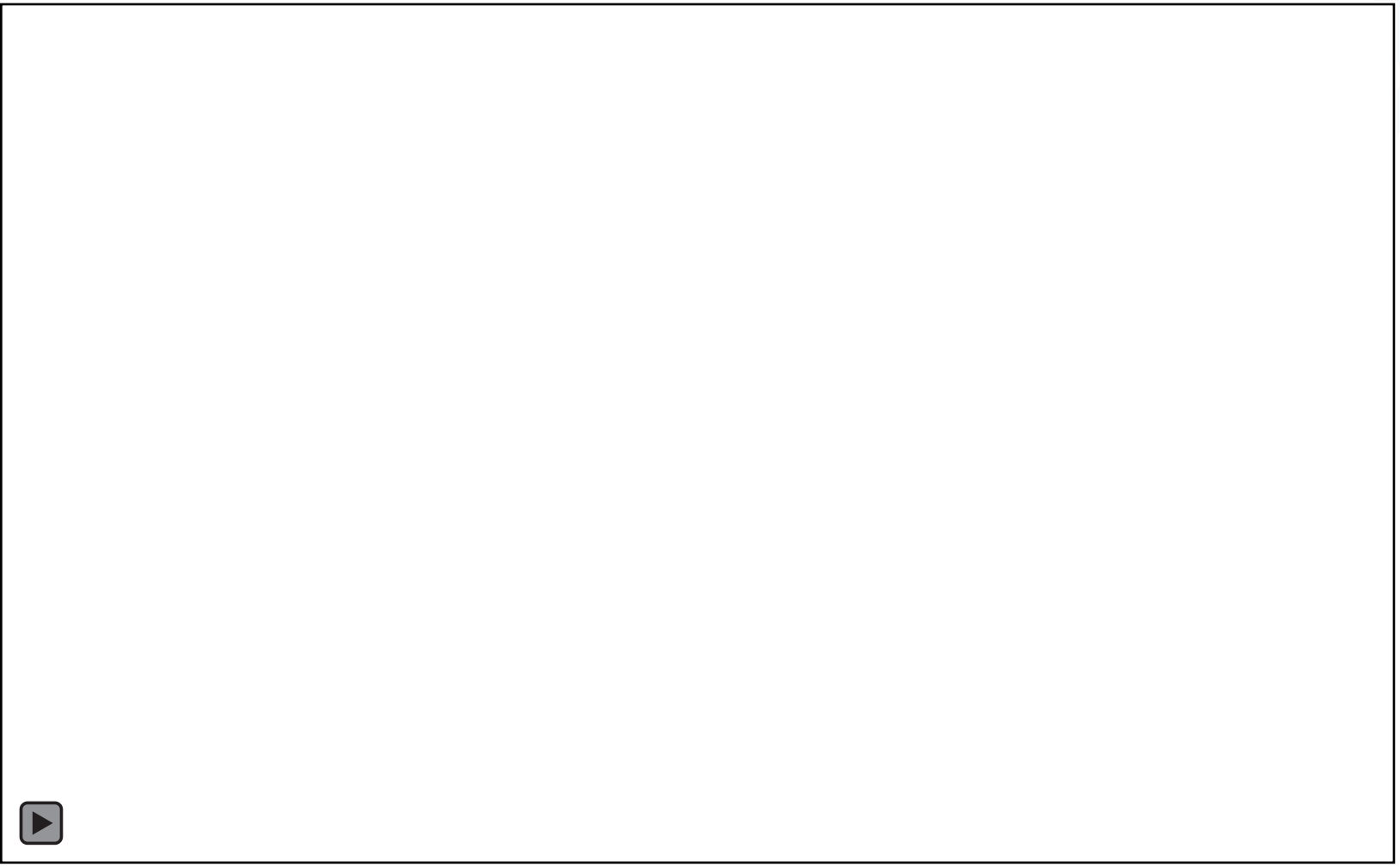
Signal Analysis



Frequency band	Frequency range (Hz)†
Delta	0-3
Theta	4-7
Alpha	8-12
Beta	13-30
Gamma	31-200
High Frequency	>200

Used with permission of Ro'ee Gilron, Rune Labs

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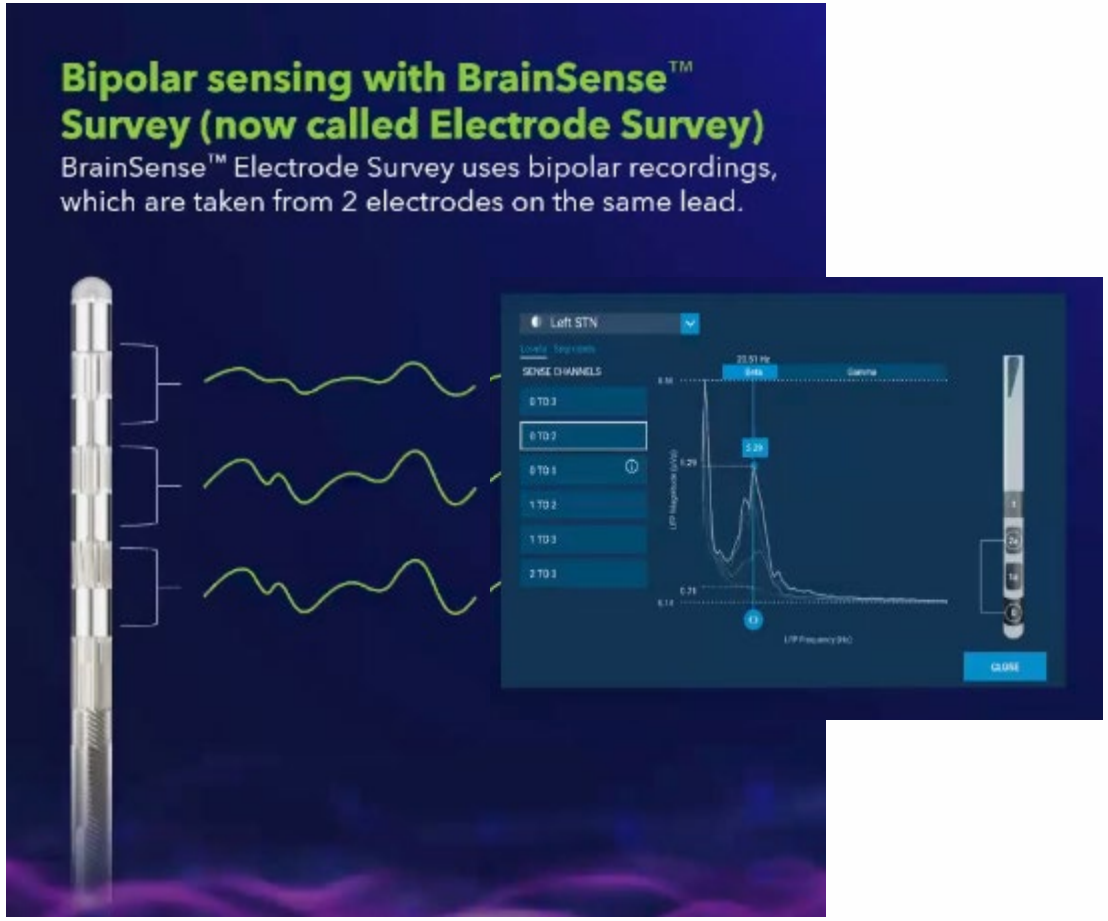
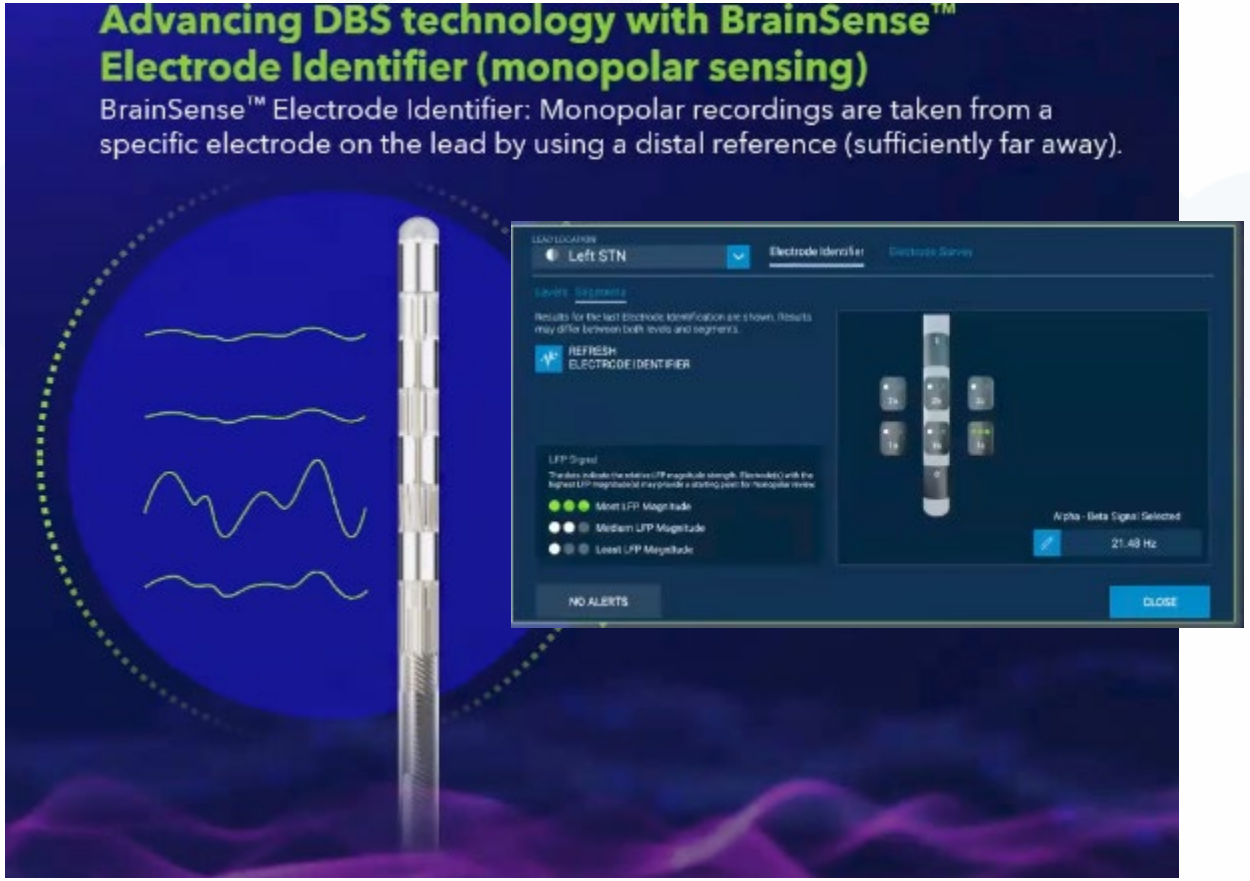
Electrode Survey & Electrode Identifier





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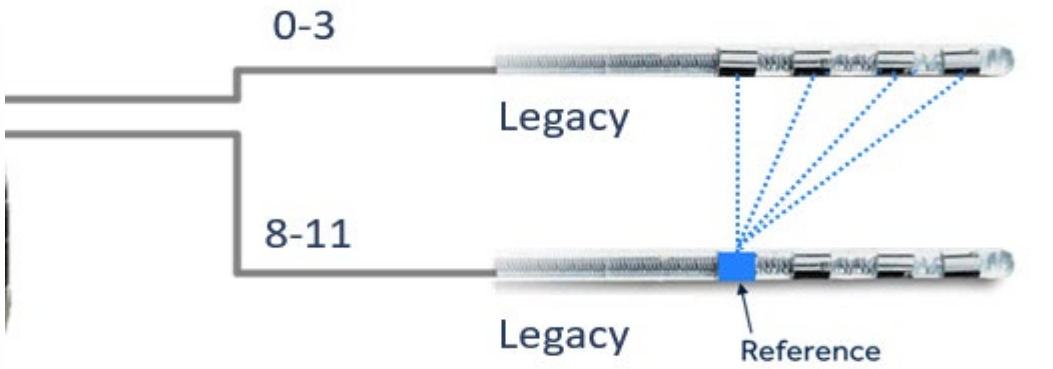
Electrode Survey

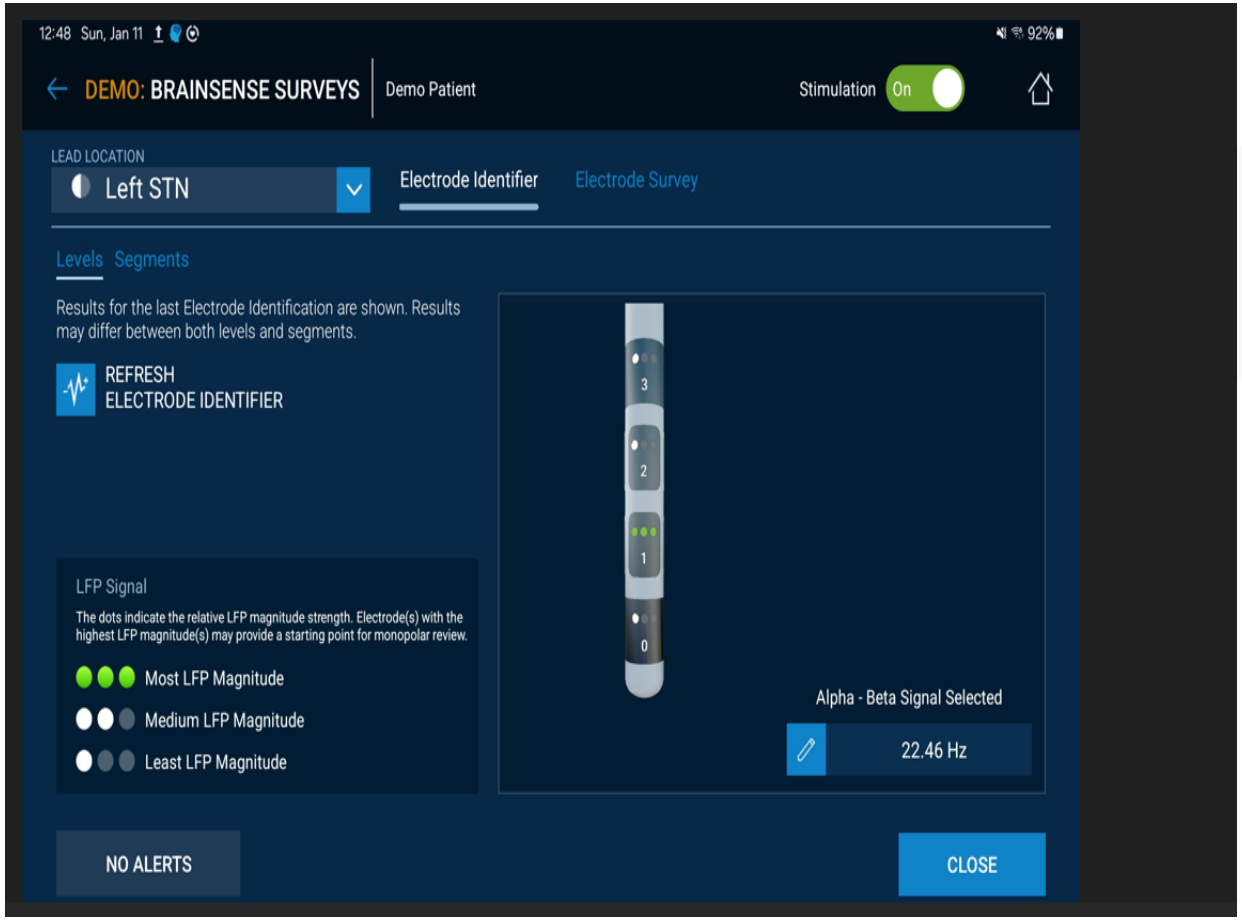
Electrode Identifier – Algorithm Design

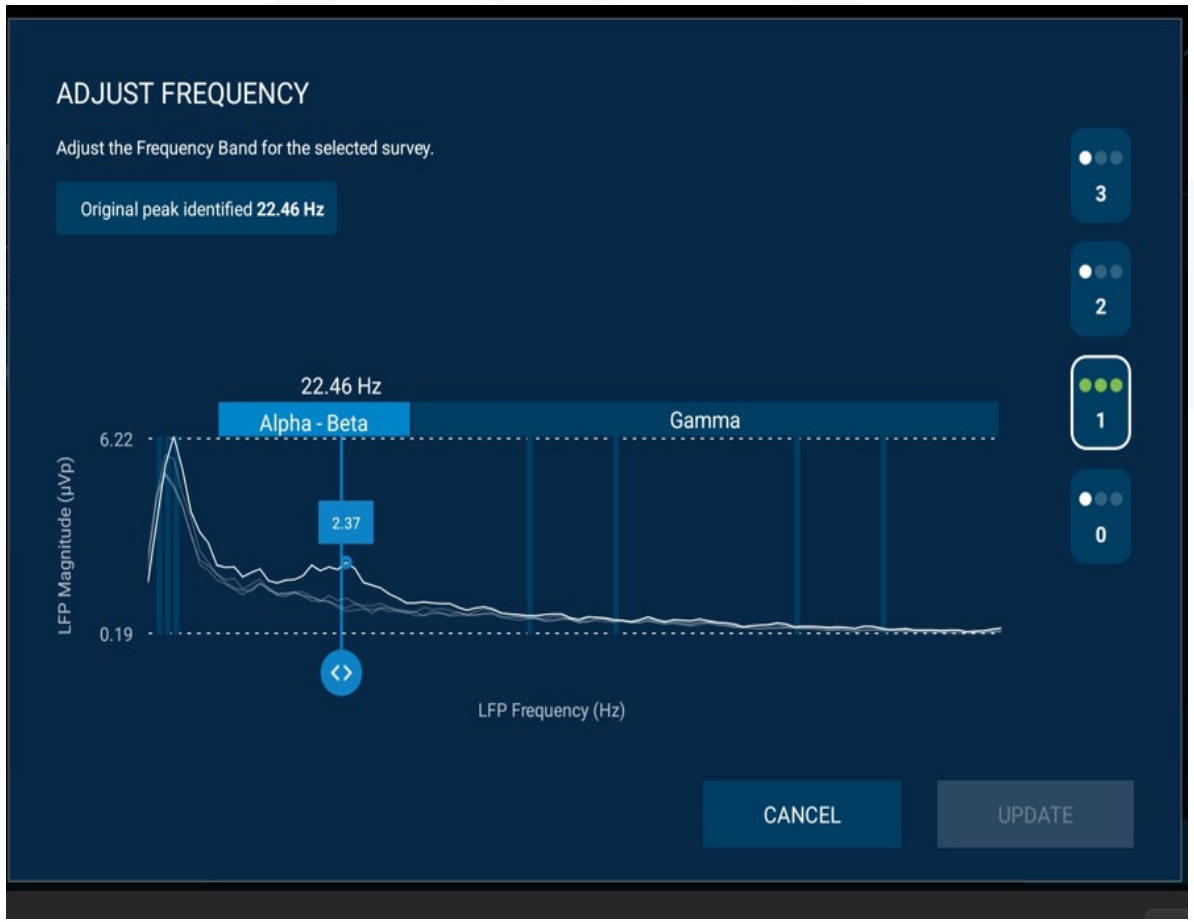
Configuration:

- For patients with **two** implanted DBS leads, in one **dual-channel** device
- Reference electrode is automatically set to proximal (top) ring electrode of second lead (cannot be changed)
- Normal operational impedances required
- No Adaptors Allowed



Electrode Identifier





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Poll #2

- The LFP frequency range that correlates most to symptoms of rigidity, stiffness, and bradykinesia is:
  - A: Theta (4-7 Hz)
  - B: Alpha (8-12 Hz)
  - C: Beta (13-30 Hz)
  - D: Gamma (> 30 Hz)
  - E: Not sure

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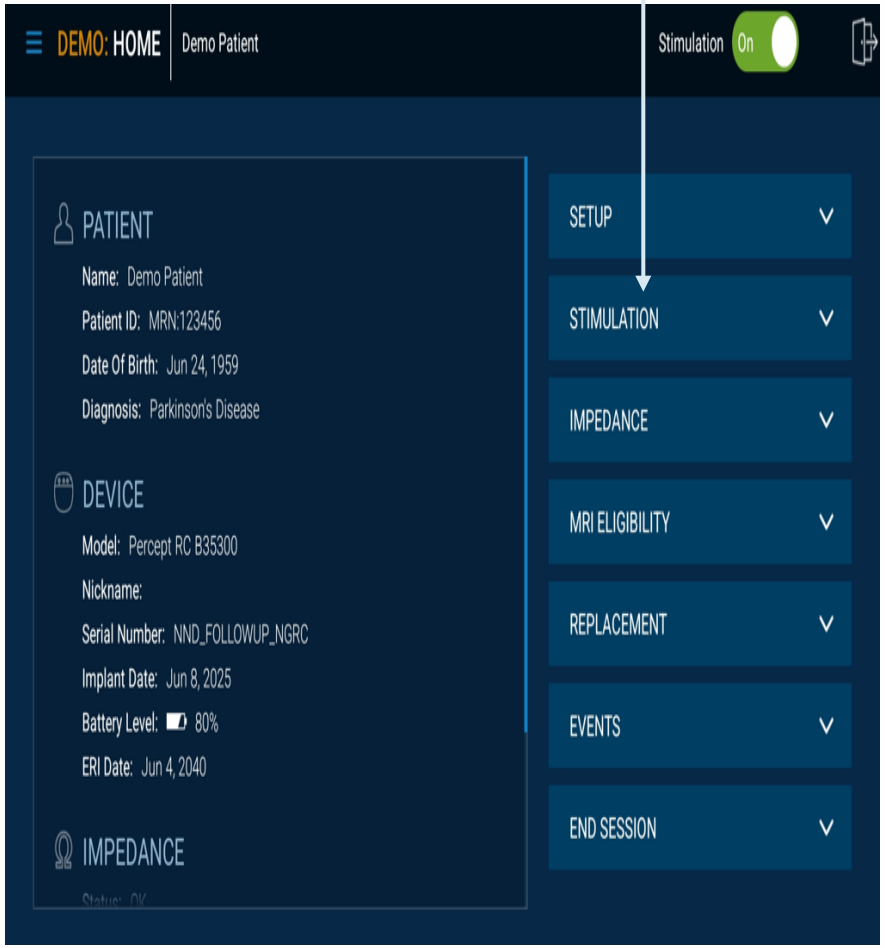
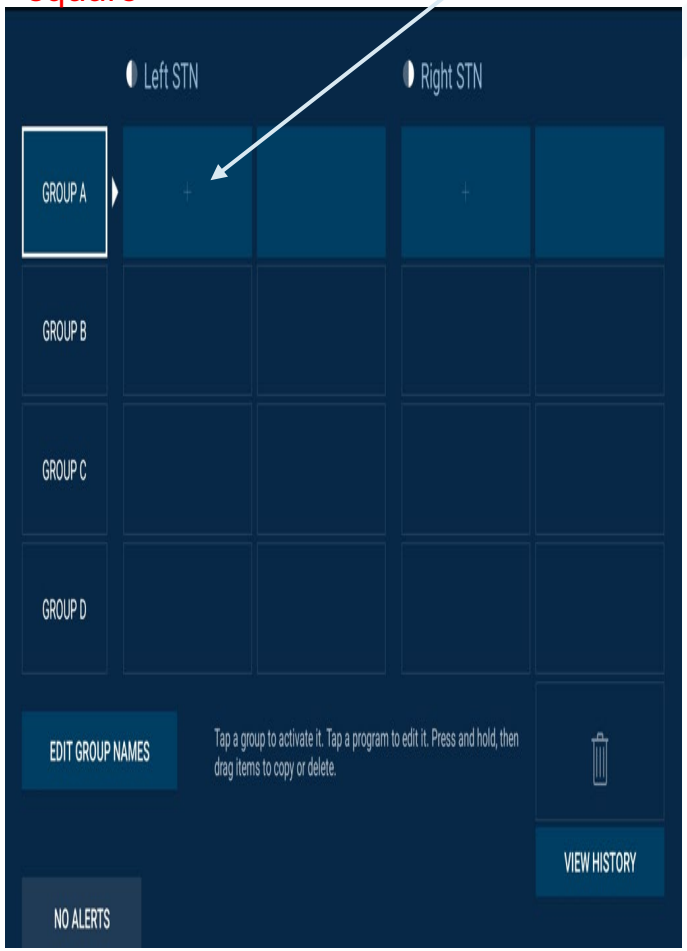
Initial Programming: Electrode Identifier (EI)

Step 1: Home Screen - Tap “STIMULATION” tab



Step 2: “Groups” Screen - Tap Left STN square



Step 3: Programming Screen – For EI tap icon in left corner

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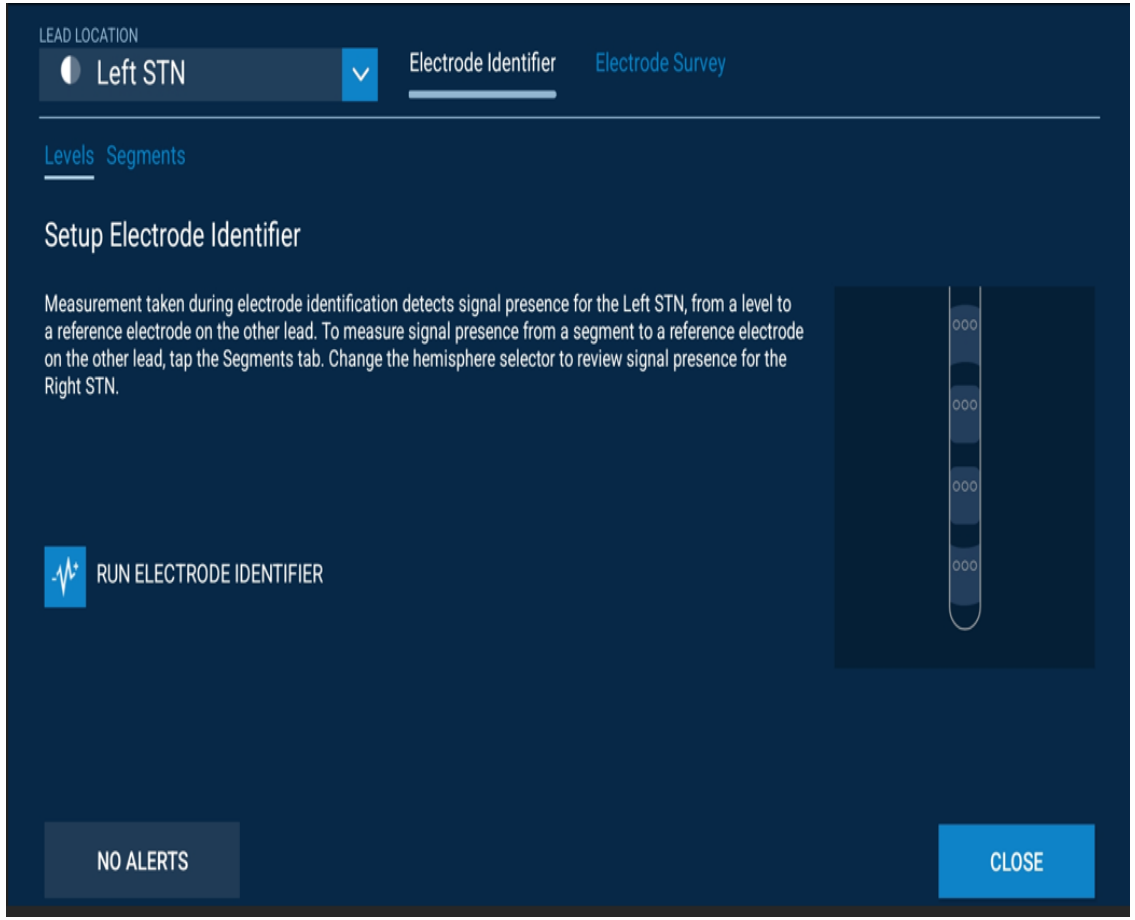
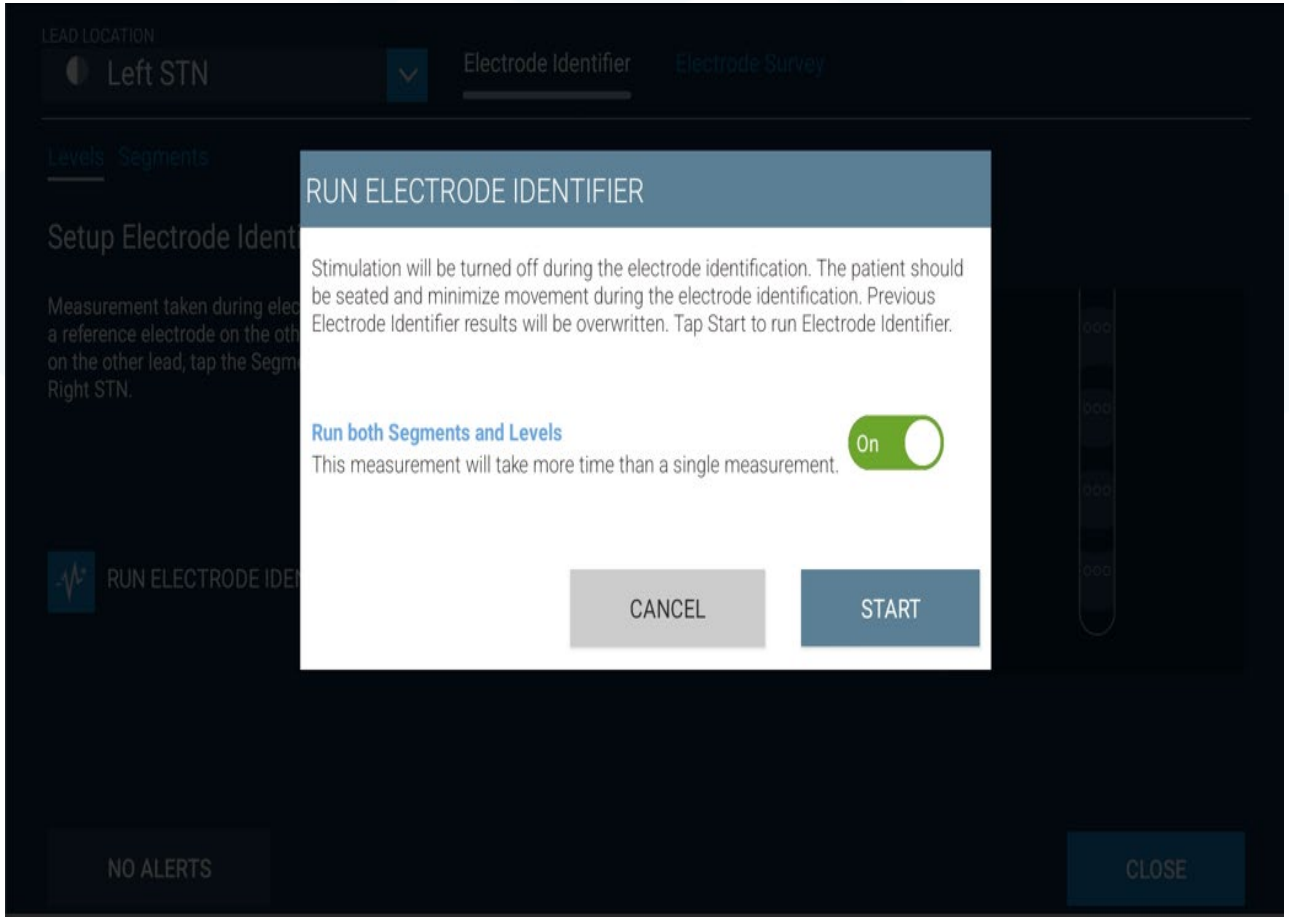
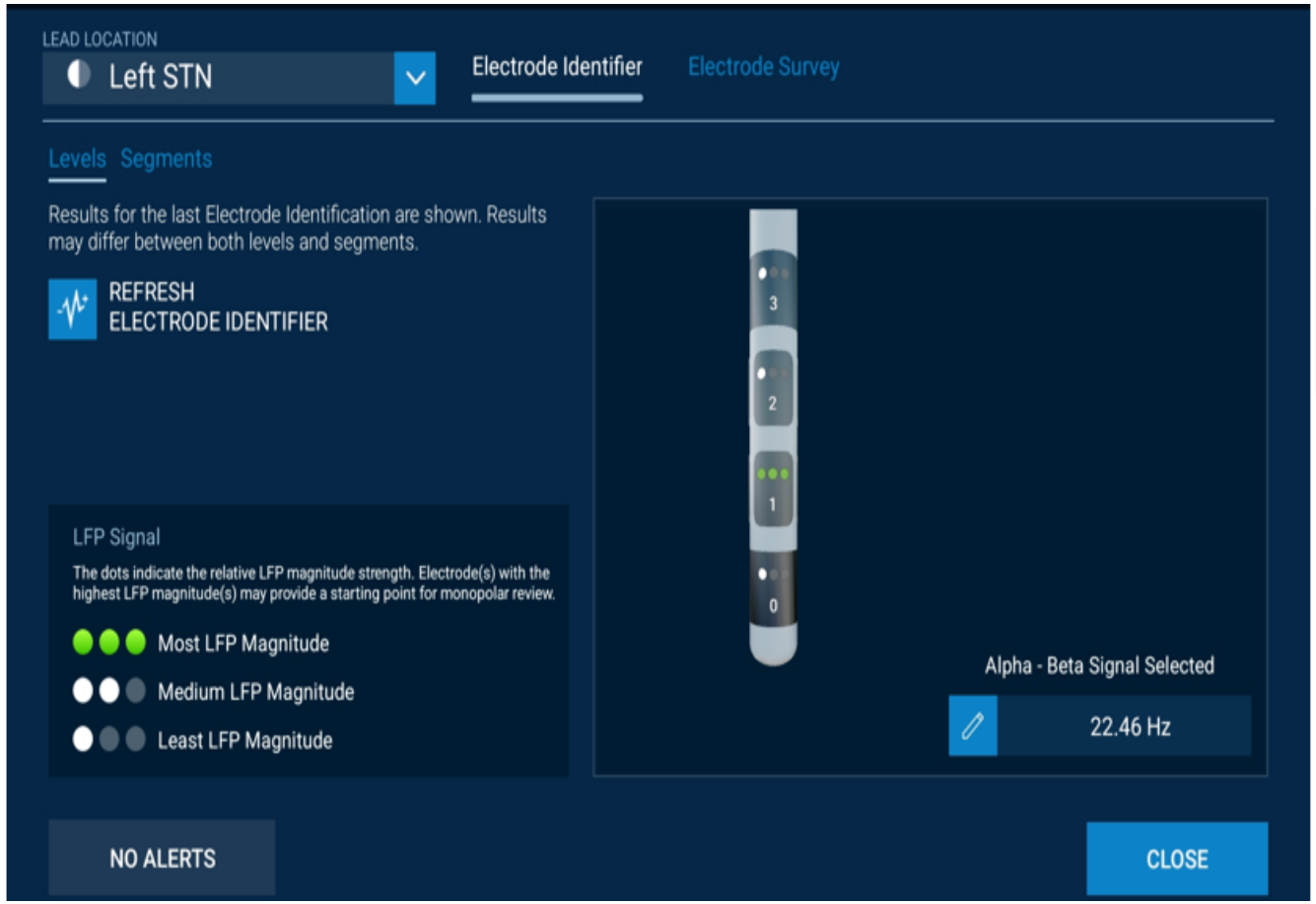
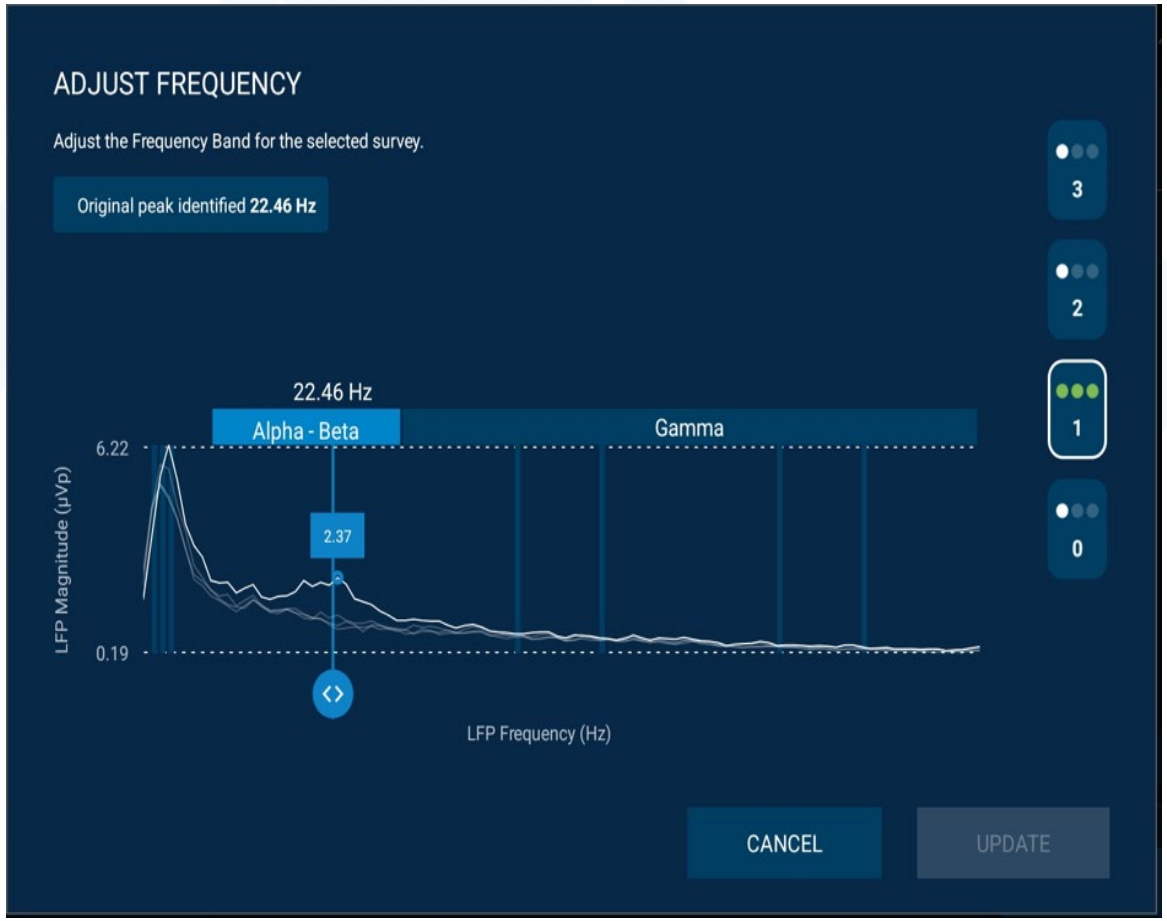
Initial Programming: EI





Initial Programming: EI (LEVELS)





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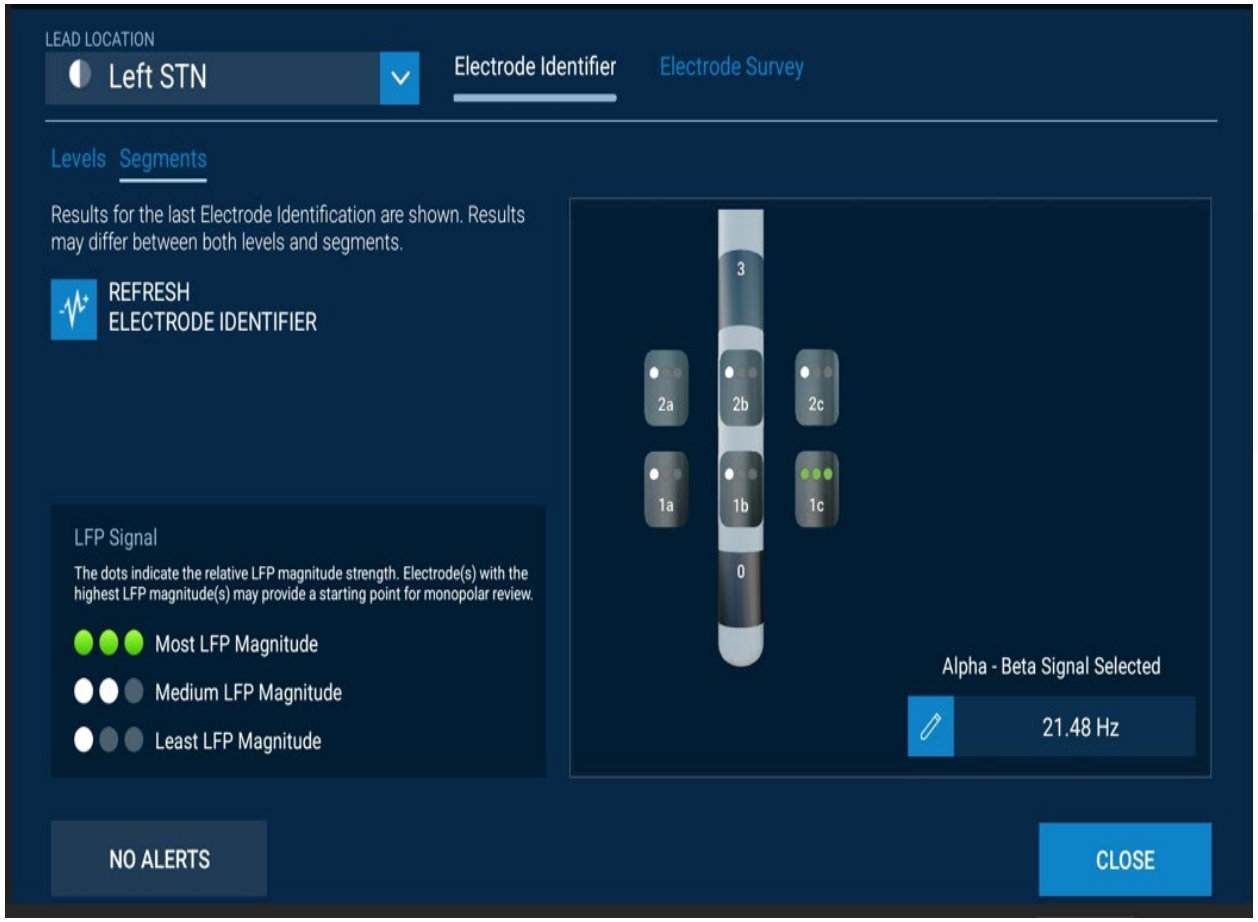
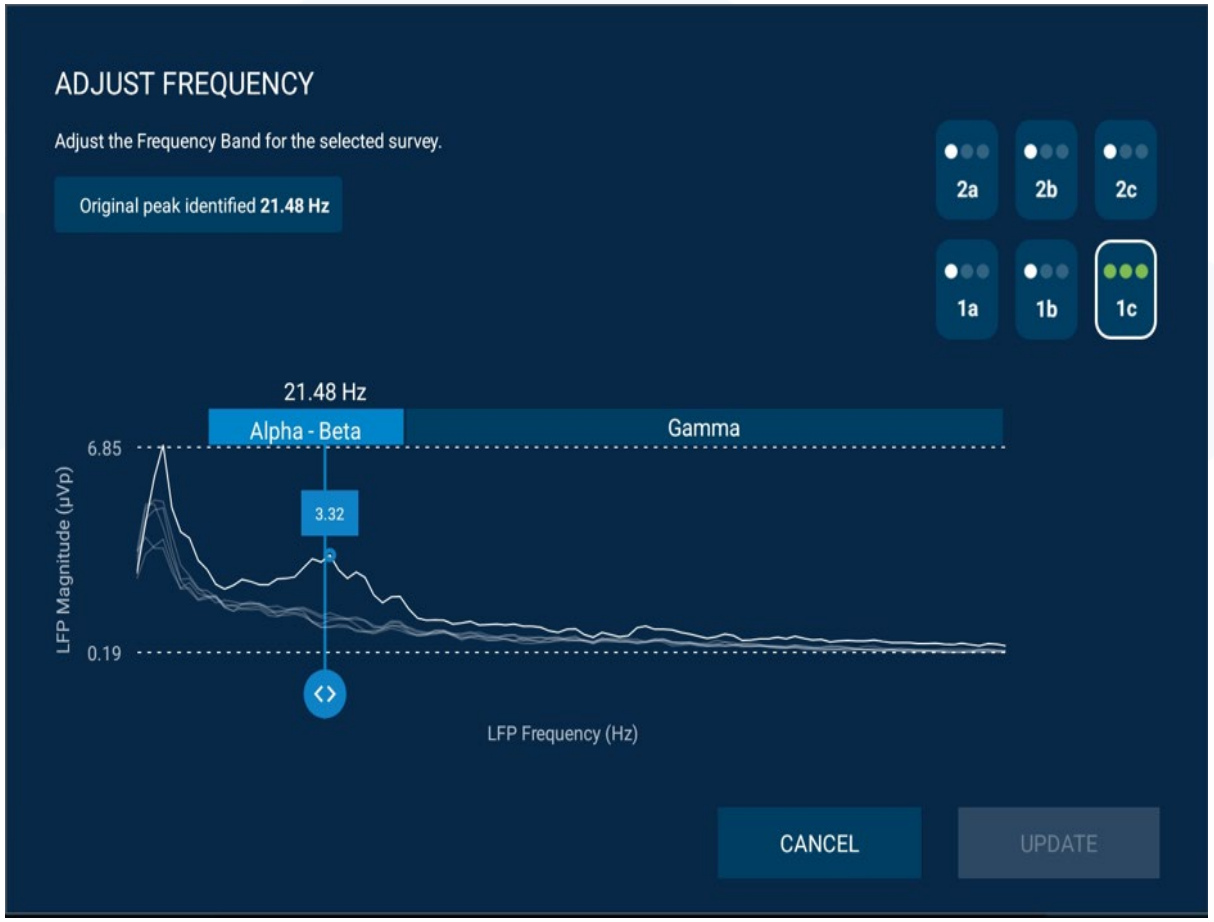
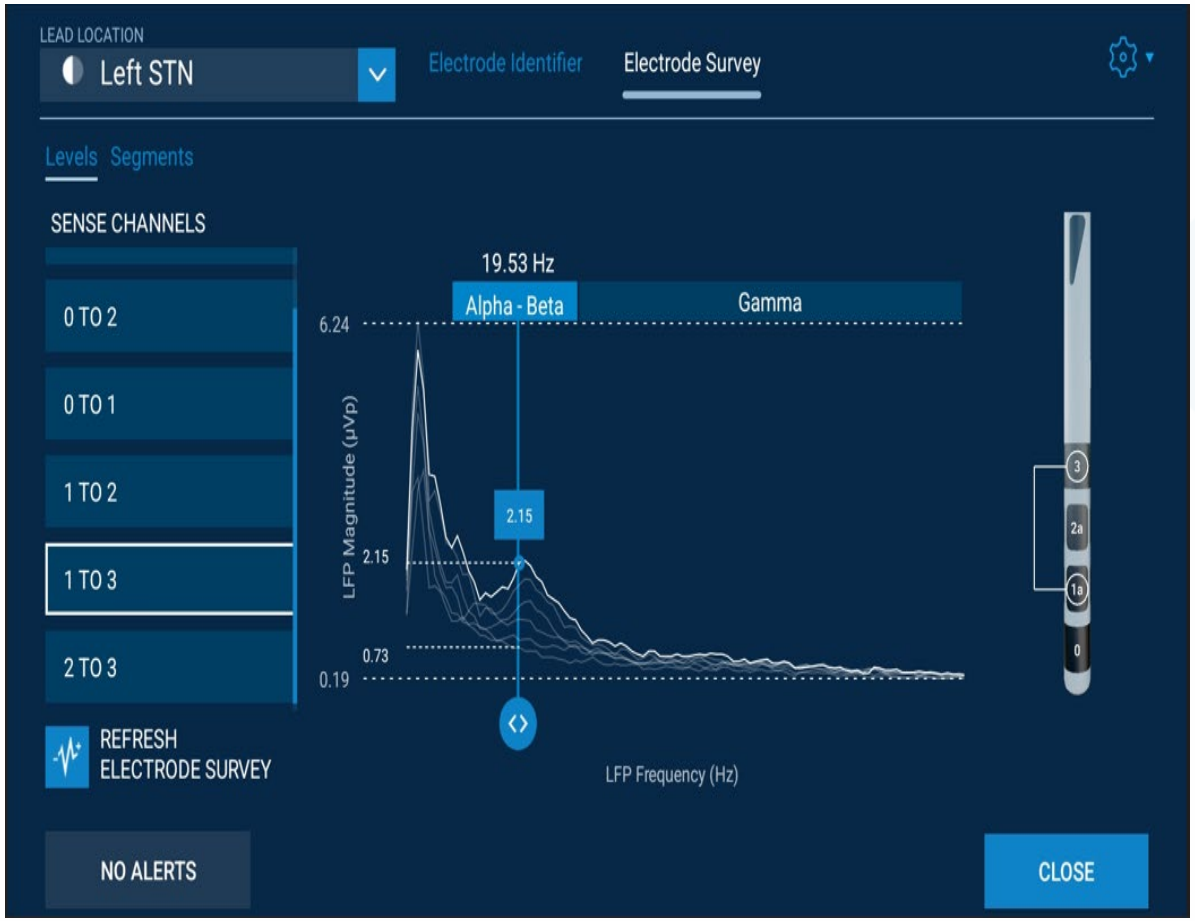
Initial Programming: EI (SEGMENTS)



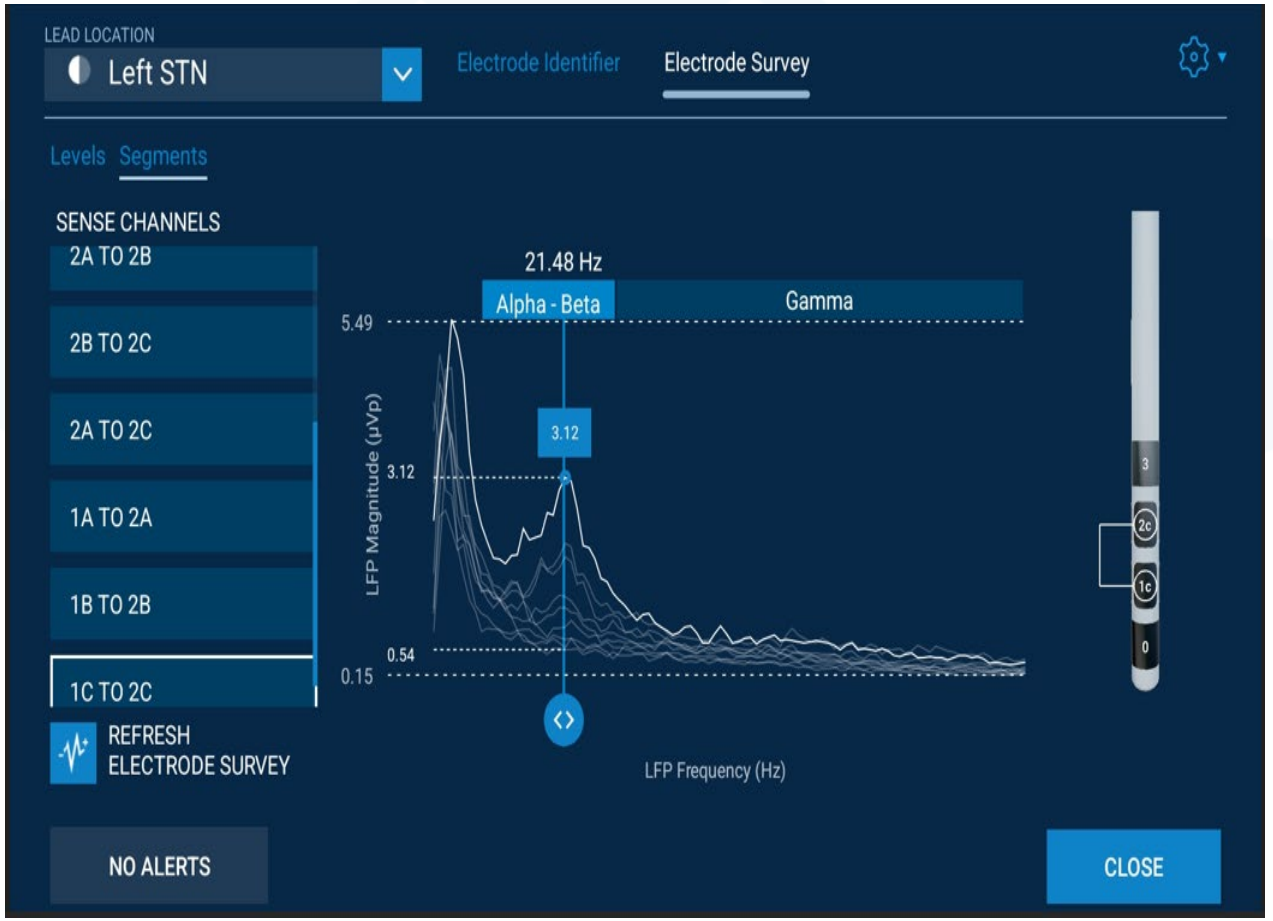


Electrode Survey: Levels & Segments

Levels

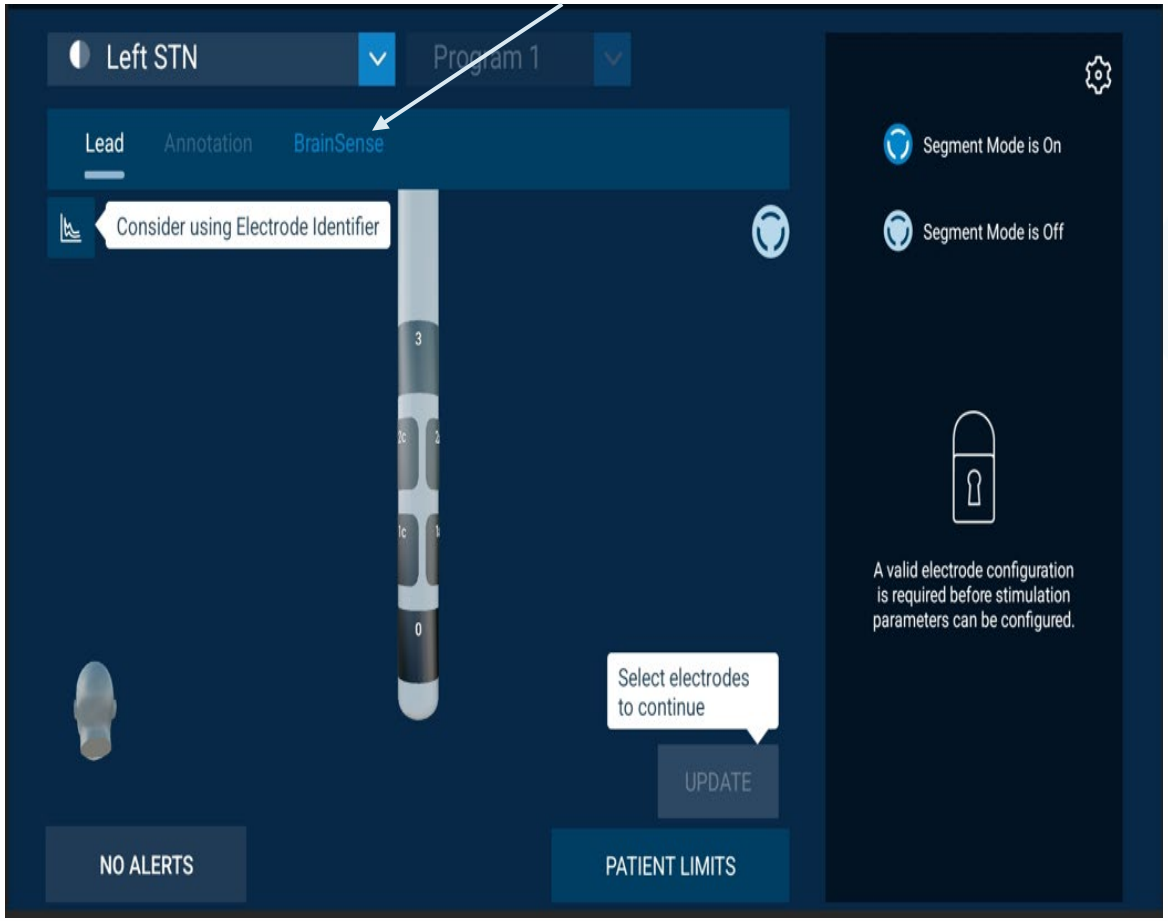


Segments

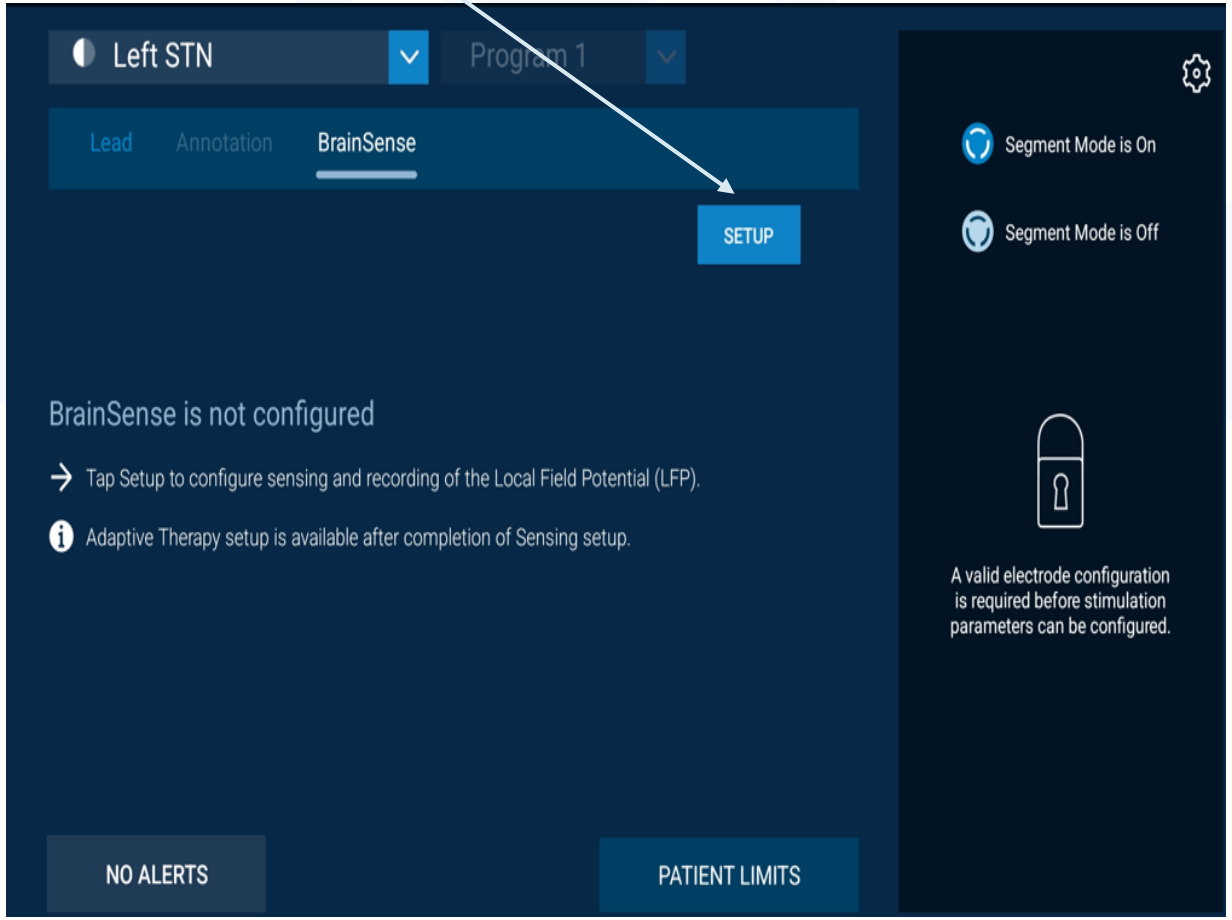


BrainSense Setup

Step 1: Programming screen – tap “BrainSense”



Step 2: tap BrainSense “SETUP”



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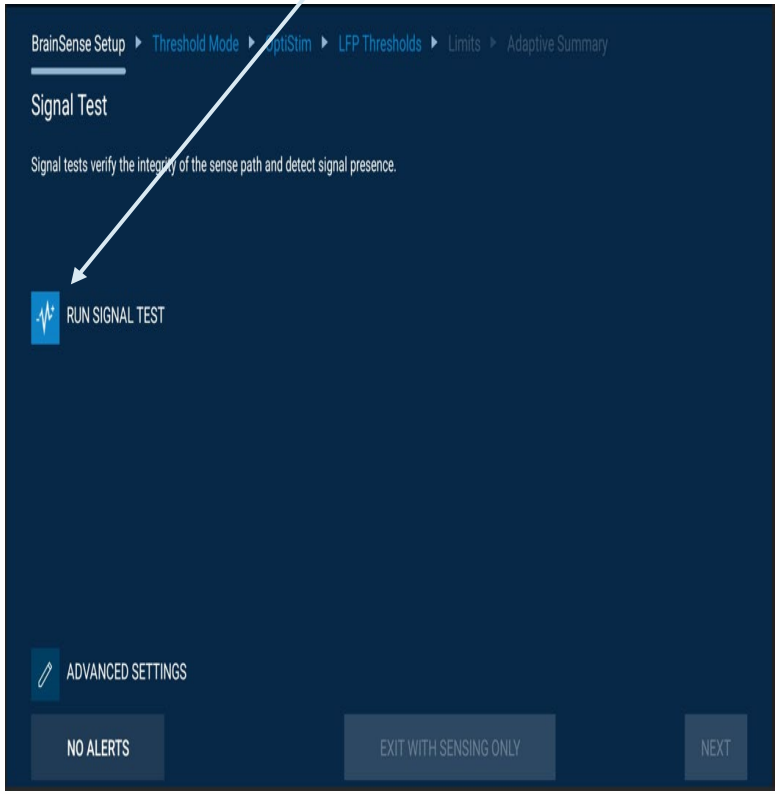
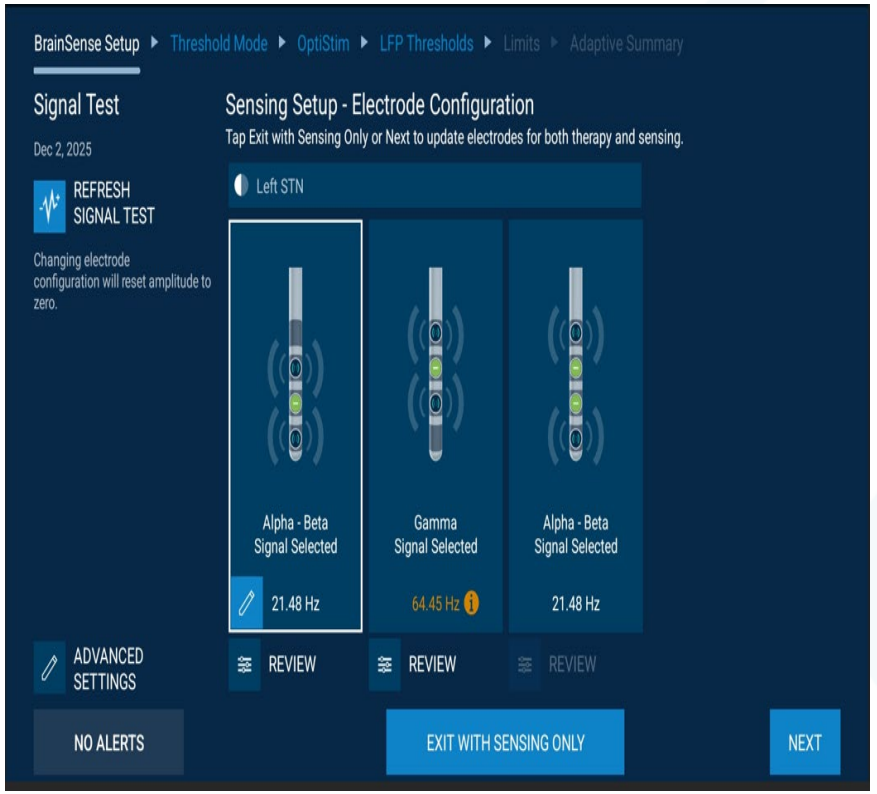
Brainsense Signal Test

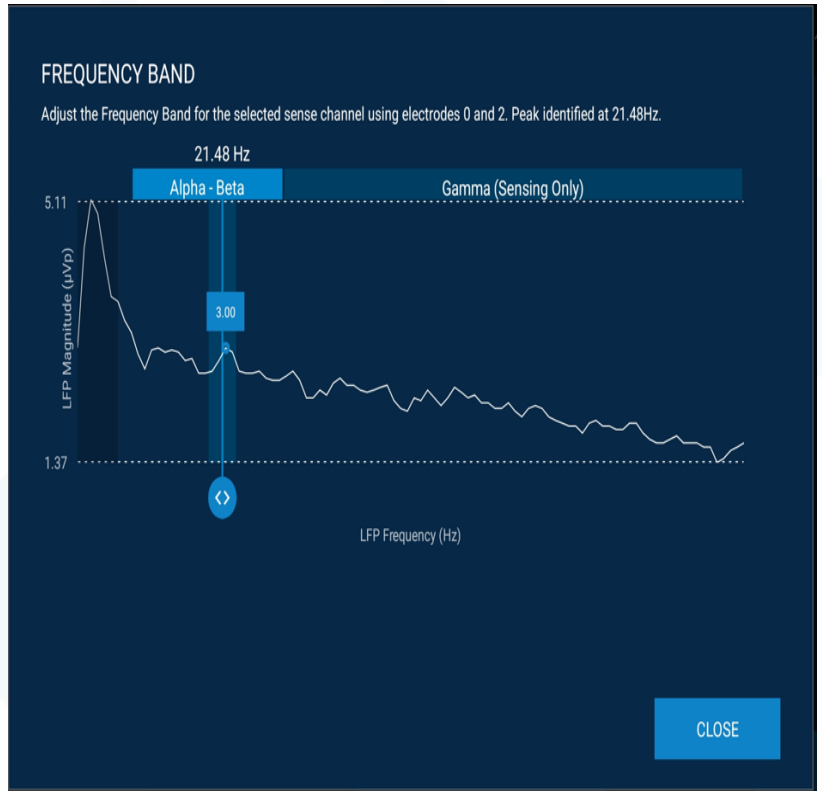
Step 1: Run Signal Test



Step 2: Select Electrode Configuration



Step 3: Select/Adjust Frequency Band



After selecting frequency, for streaming, tap “Exit With Sensing Only”

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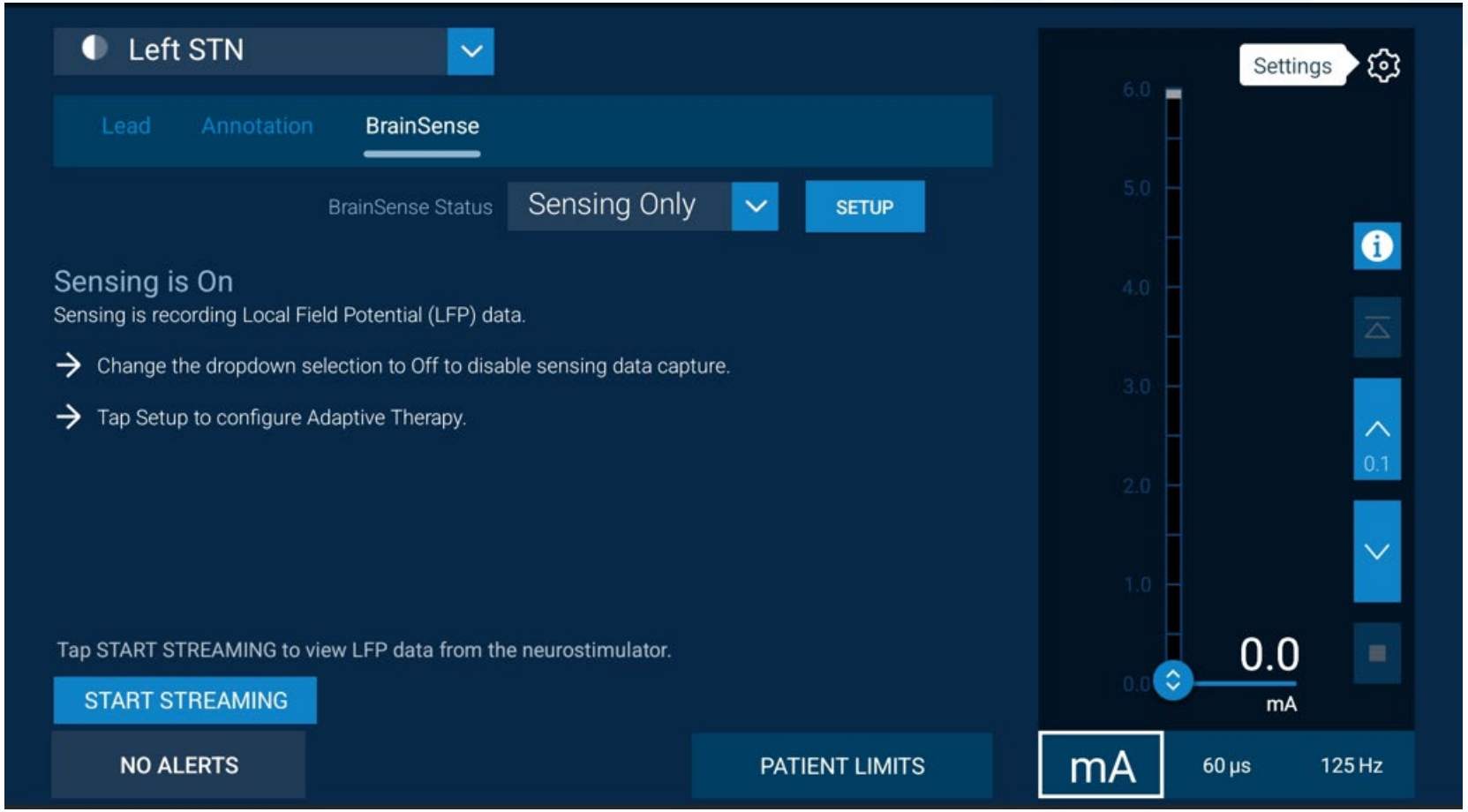
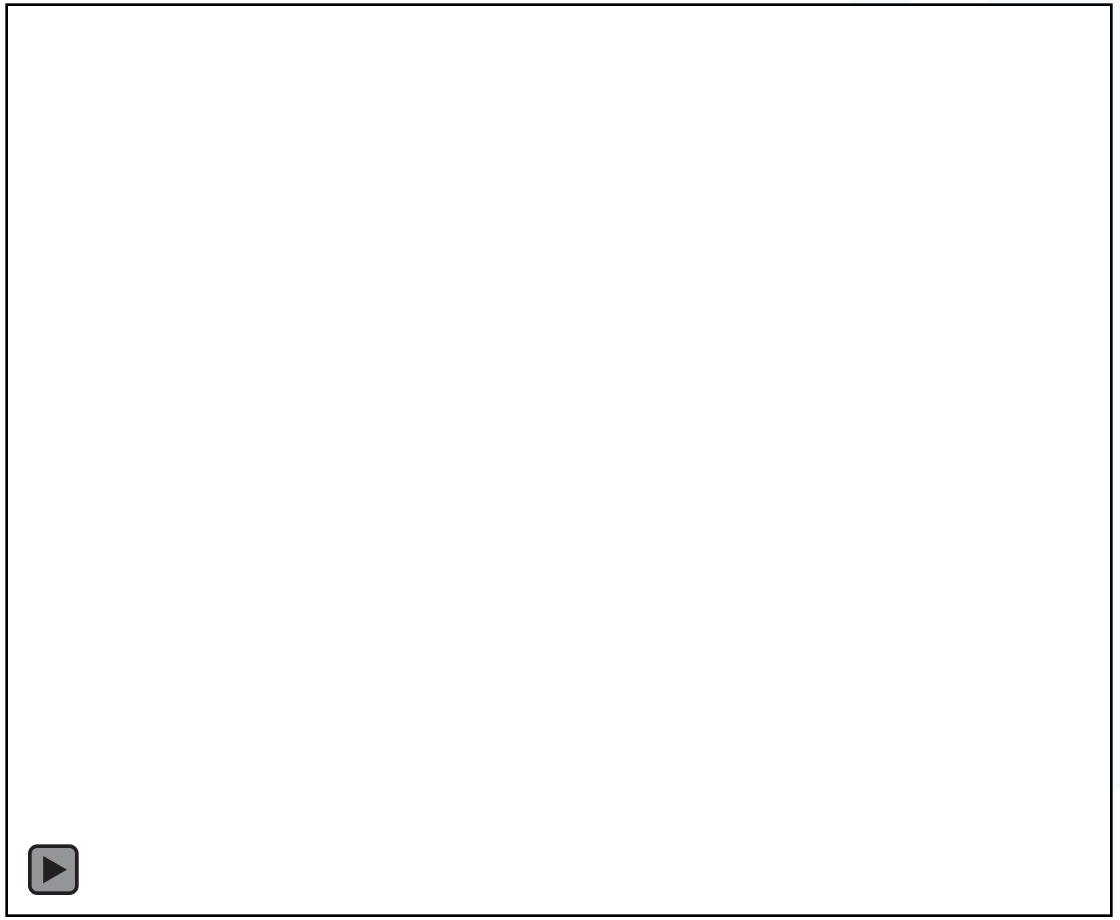
BrainSense Streaming



BrainSense Streaming



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Case Study: Initial Programming Using BrainSense Technology

- 66 yo male with Parkinson's disease since ~ 2012
- Primary concerns at on/off preop evaluation:
  - Mobility/gait
  - Wearing off
  - Bradykinesia
- PD meds pre DBS:
  - Carbidopa/levodopa 25/100: ~ 2 tabs every 2 hours; total 12.5 tabs/day
  - Entacapone 100 mg: 1 tab 6x/day
- ON/OFF preop eval:
  - OFF meds: 35
  - ON meds: 14
  - 60% improvement ON meds
- Bilateral STN DBS surgery September 2025

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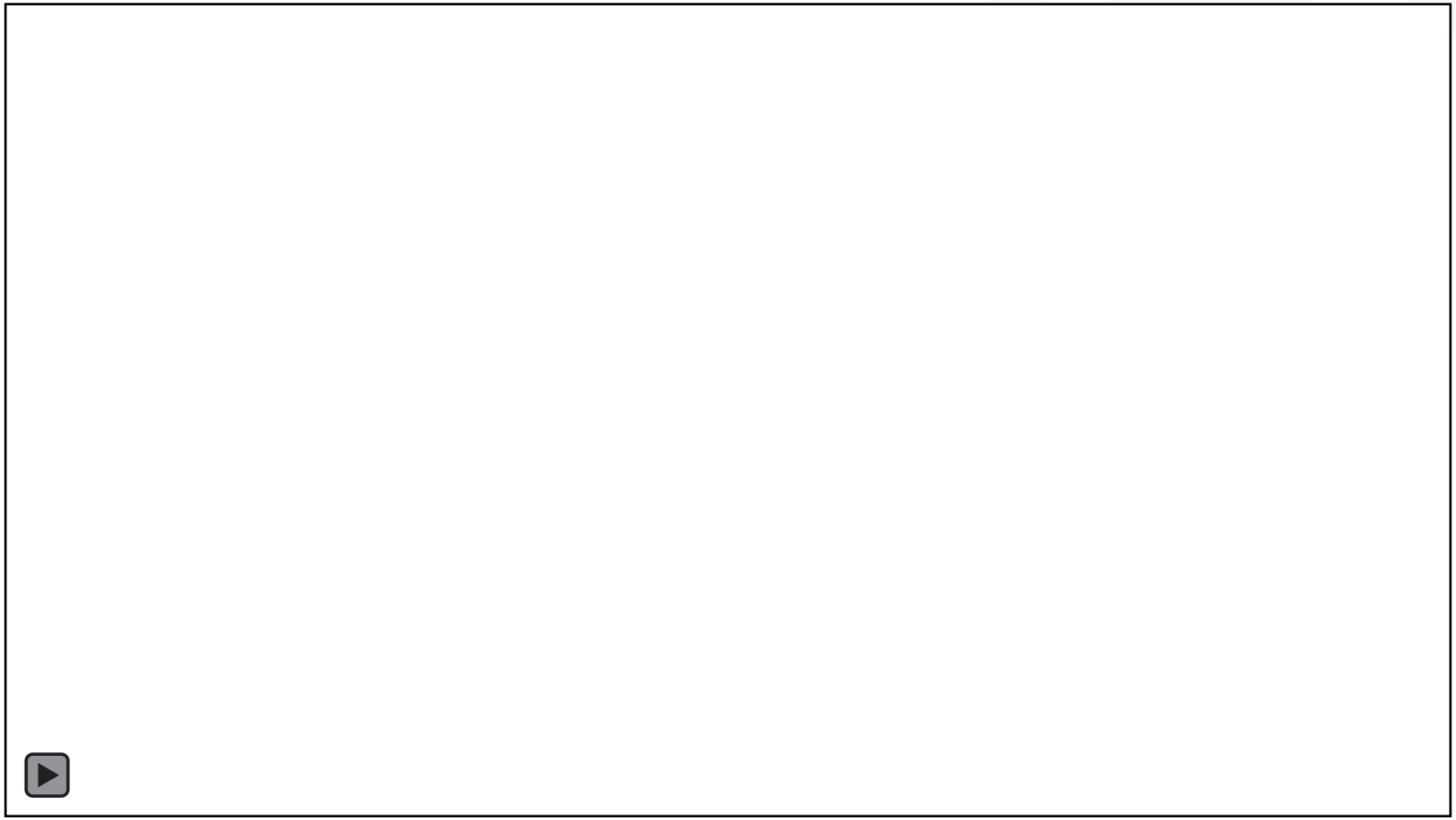
Preop video: Walking OFF meds



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Initial Programming: Timeline Data (Pre DBS Activation)

September 13th

September 16th

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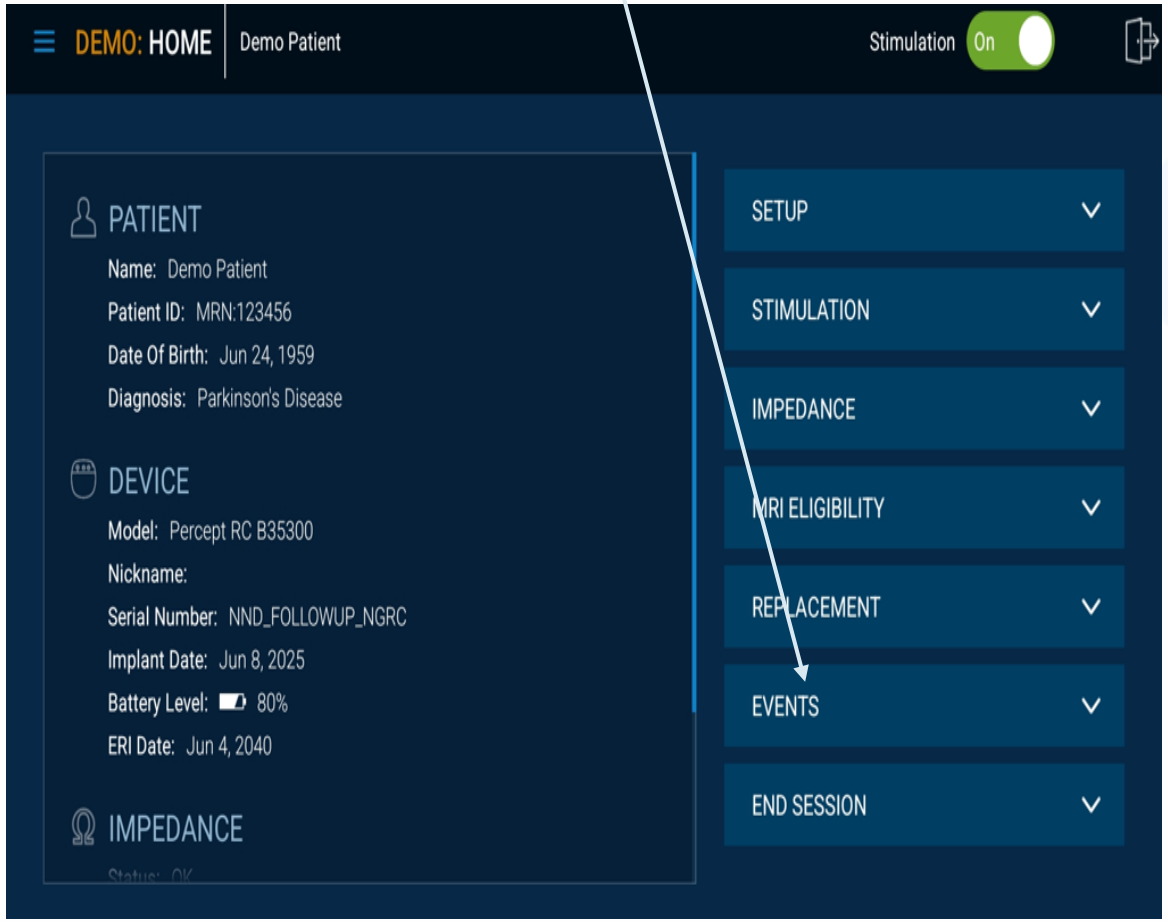
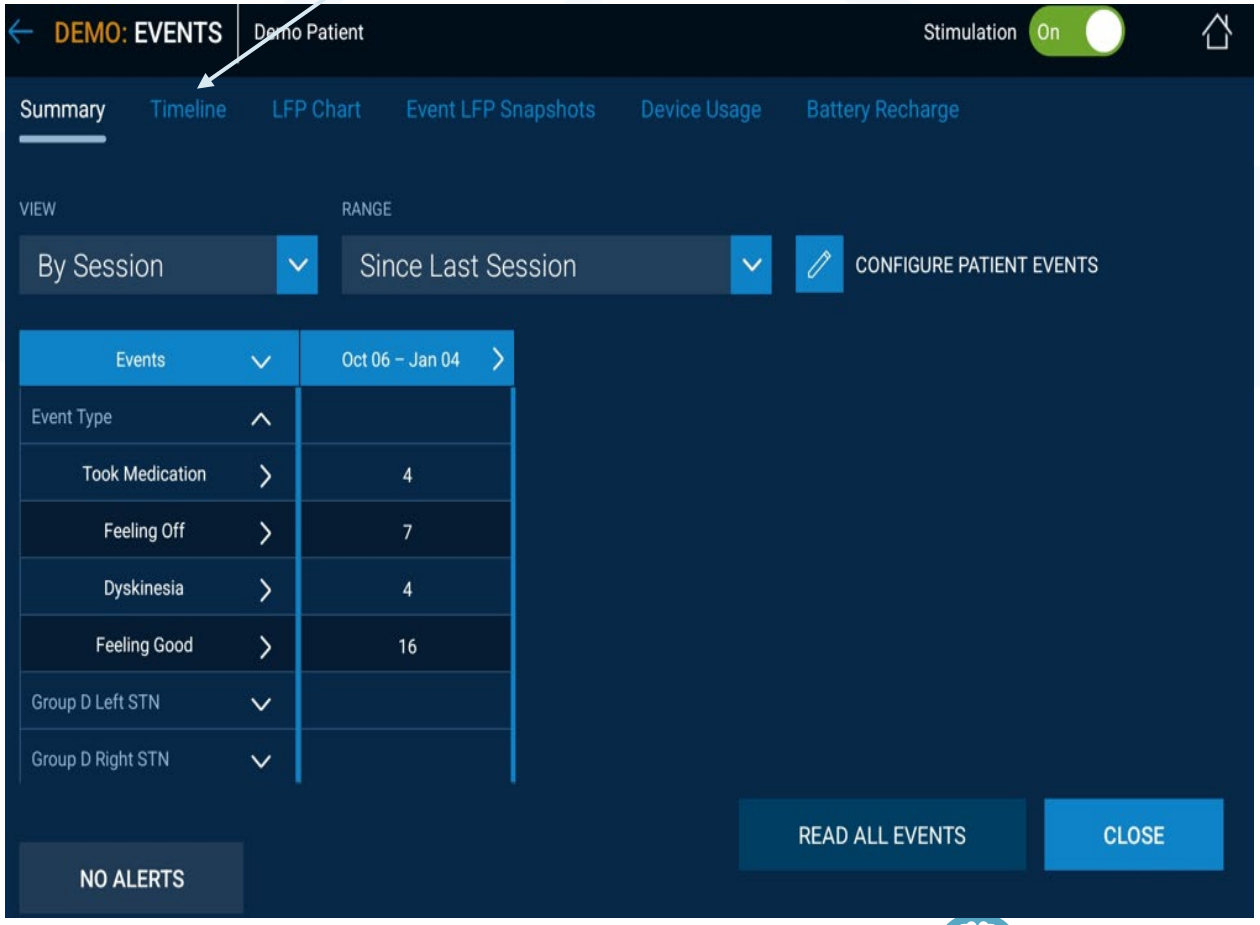
Accessing Timeline Data

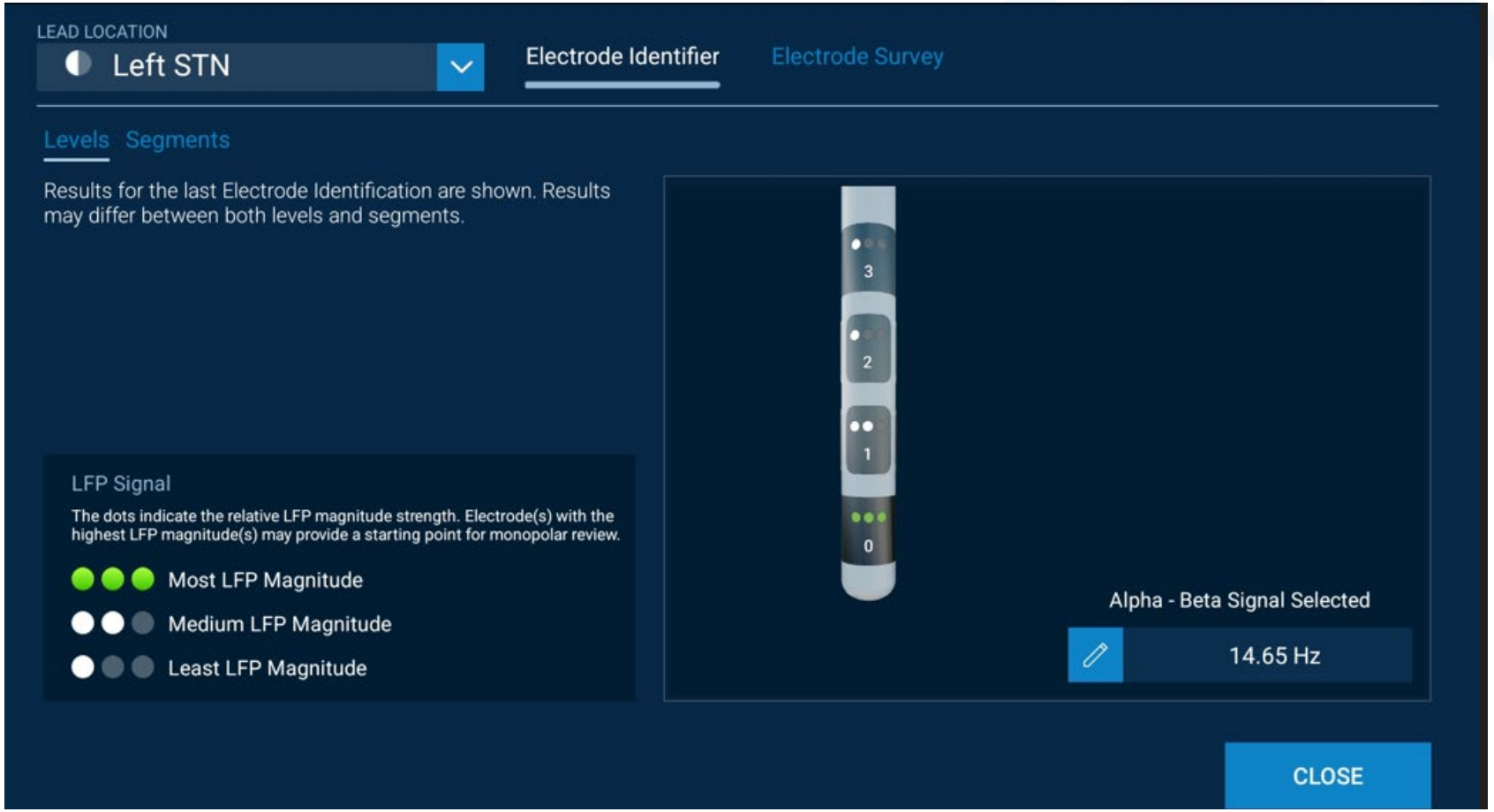
Step 1: Home Screen – Tap “EVENTS” tab



Step 2: Tap “Timeline” tab

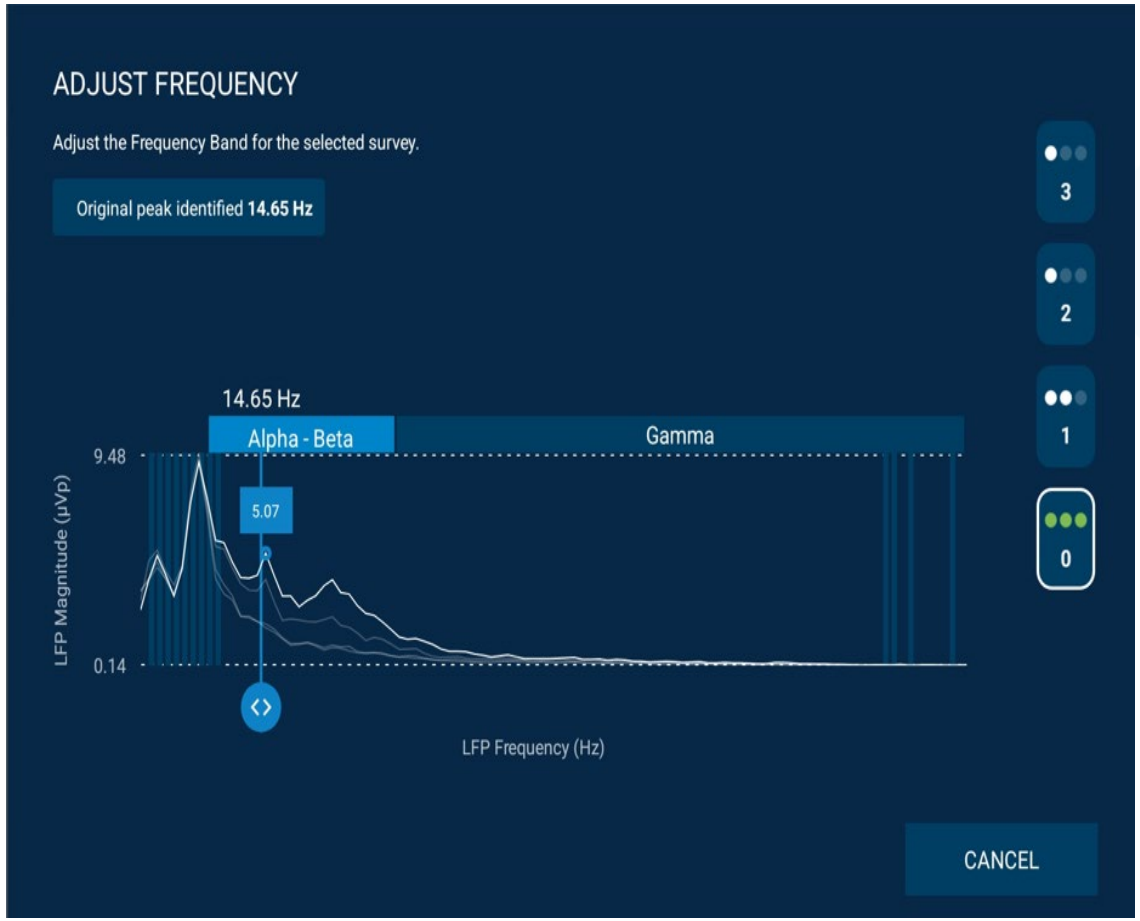


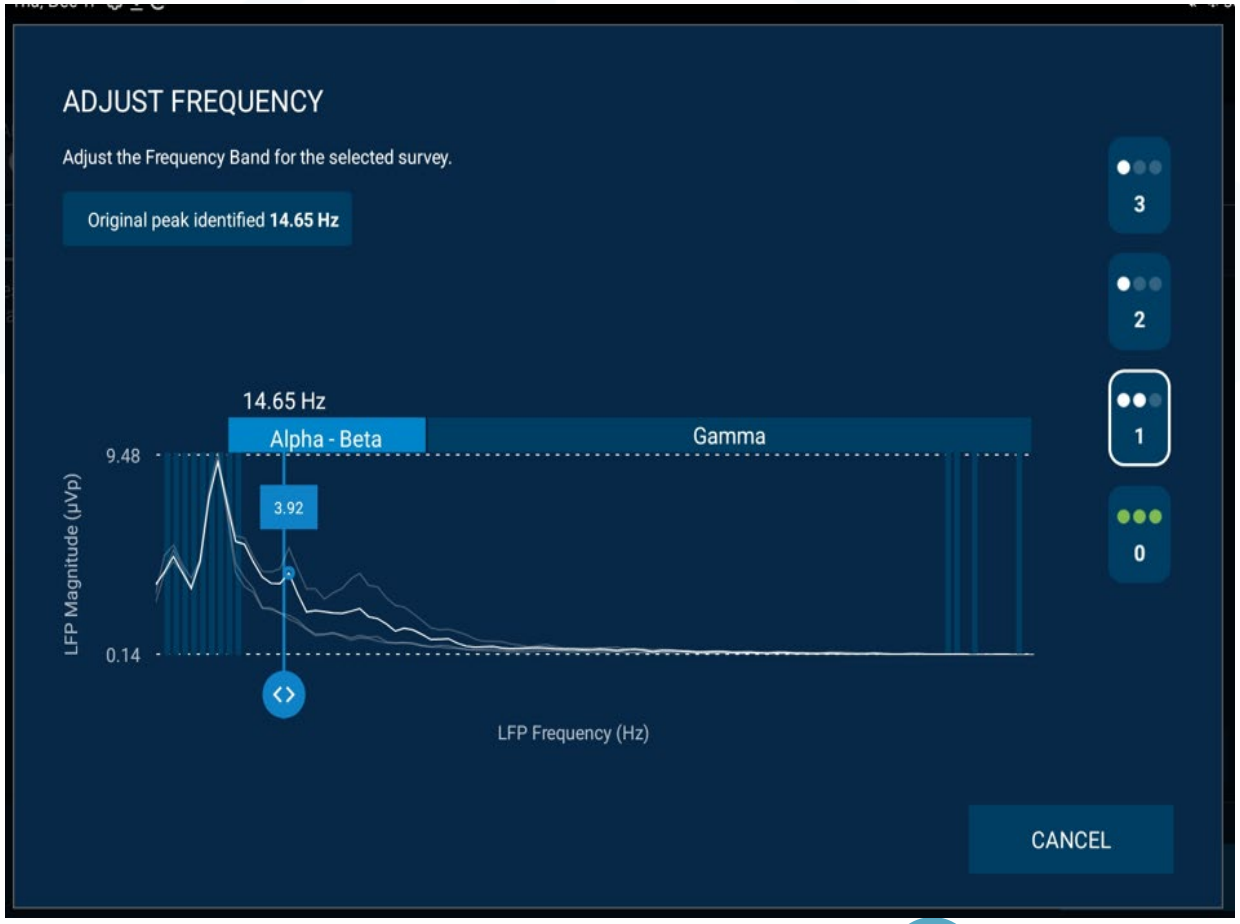
Initial Programming (Left STN): Electrode Identifier



Initial Programming (Left STN): Electrode Identifier - LEVELS

LFP magnitude should ideally be ≥ 1.20 µVp





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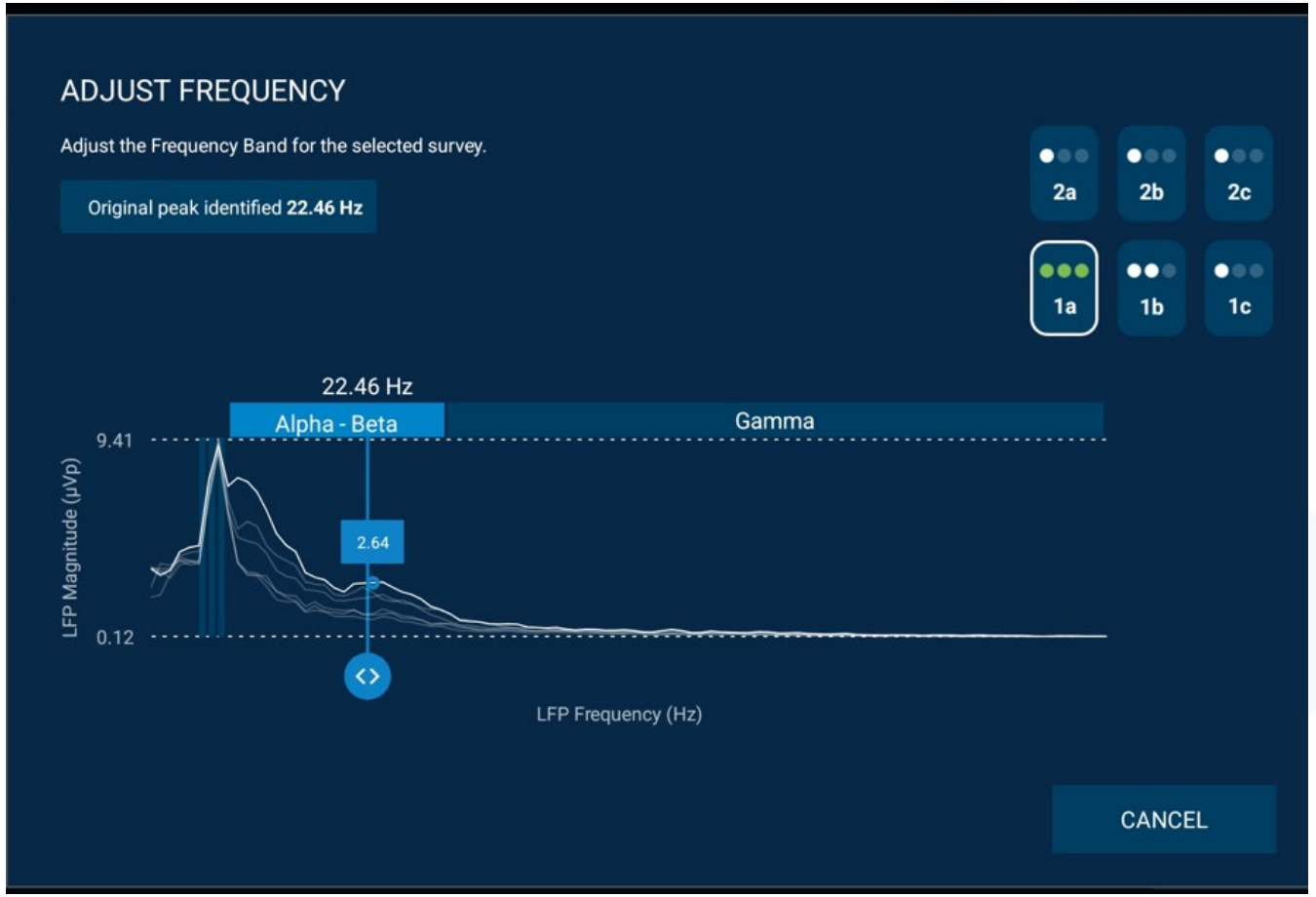
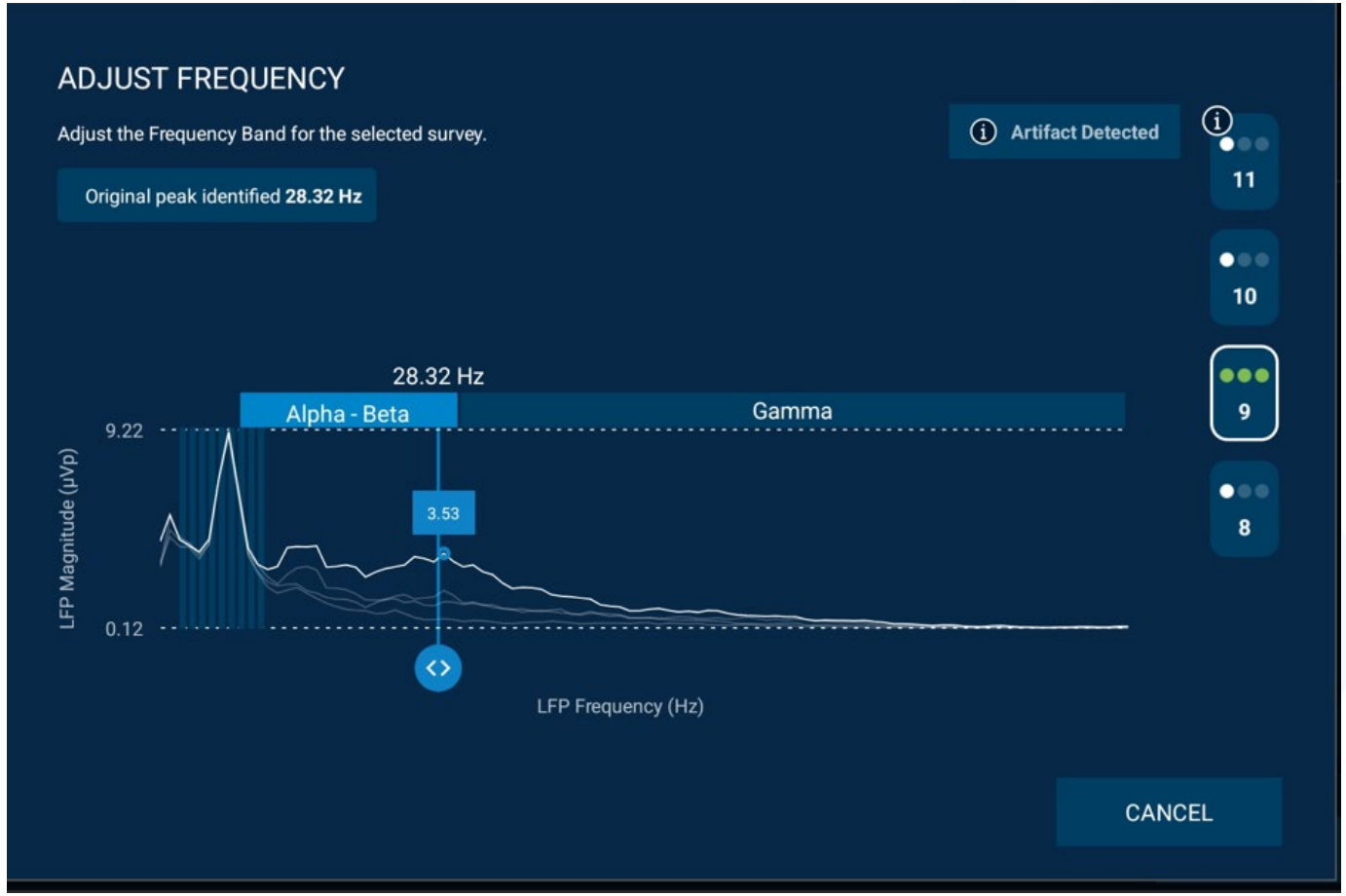
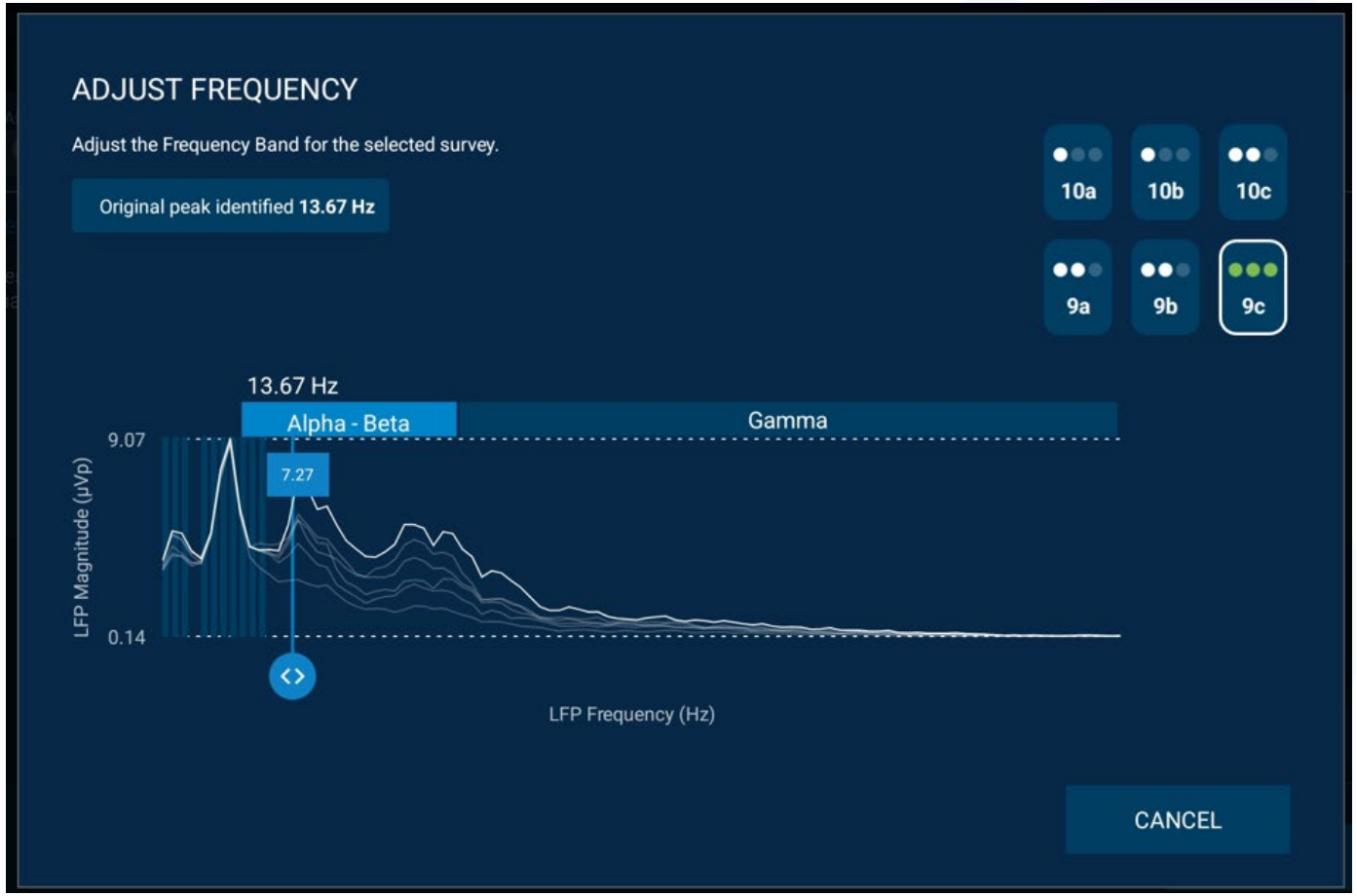
Initial Programming (Left STN): Electrode Identifier - SEGMENTS



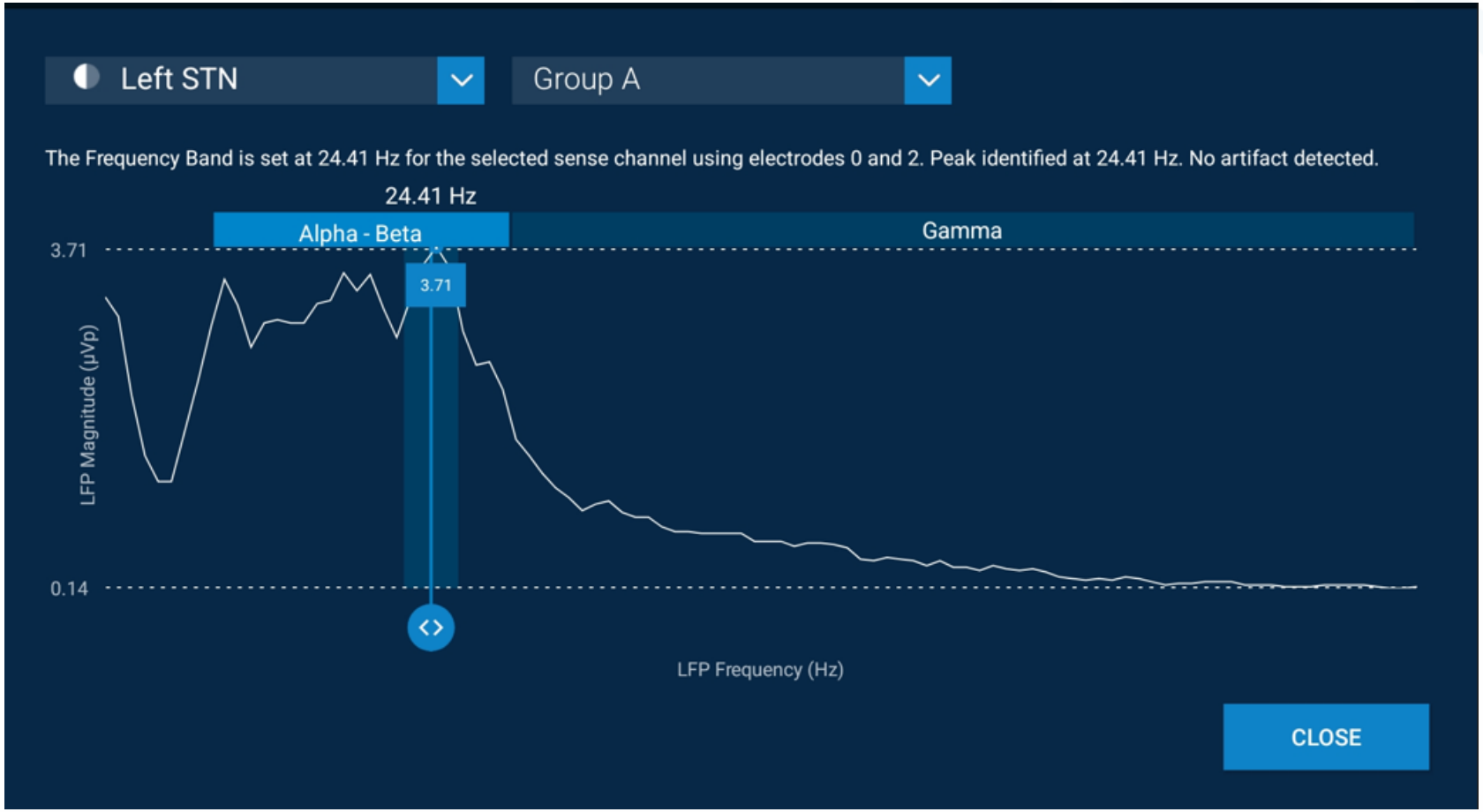
Initial Programming (Right STN): Electrode Identifier - LEVELS



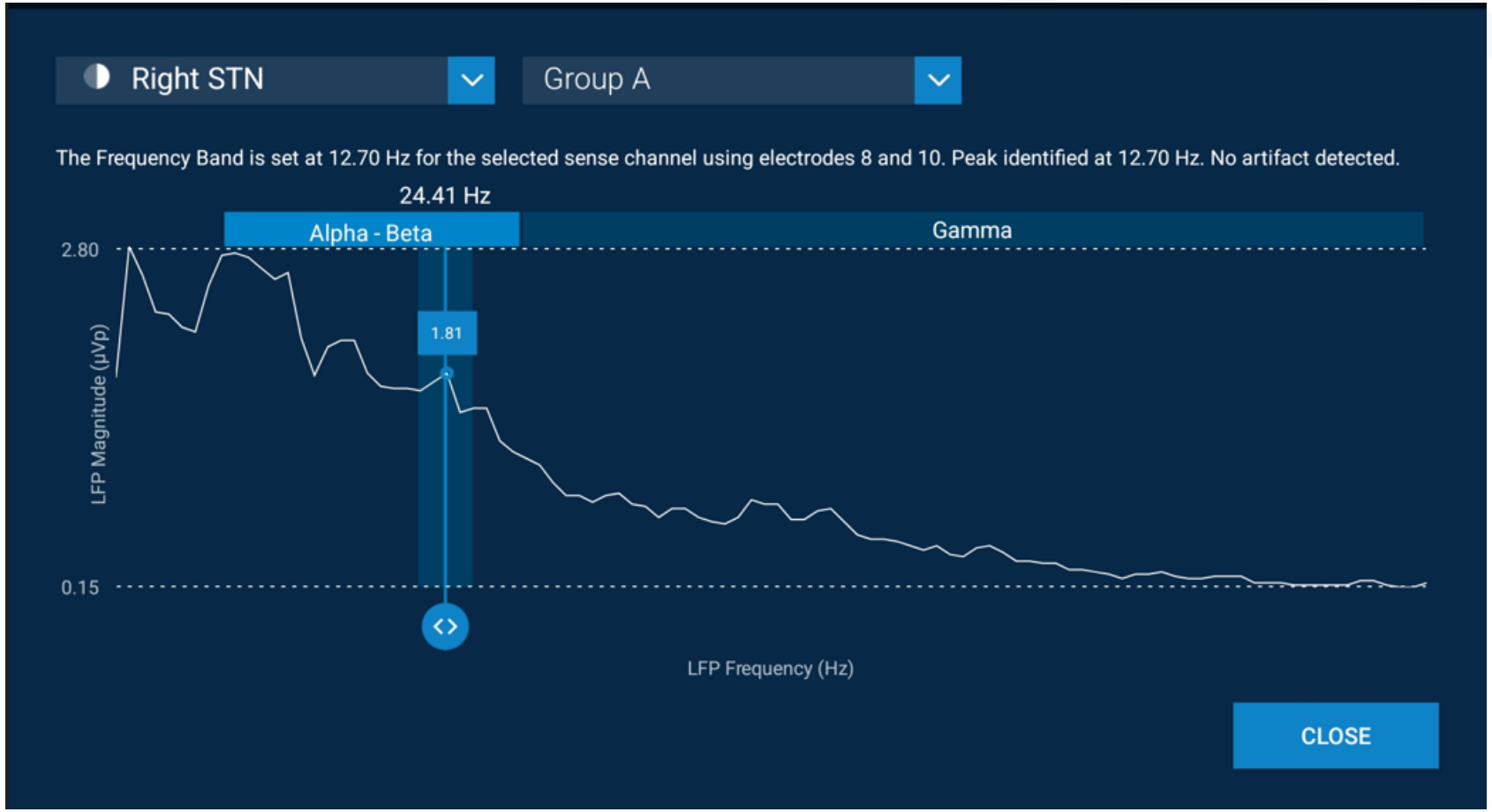
Initial Programming (Right STN): Electrode Identifier - SEGMENTS



Frequency Band Selected for left STN



Frequency Band Selected for Right STN



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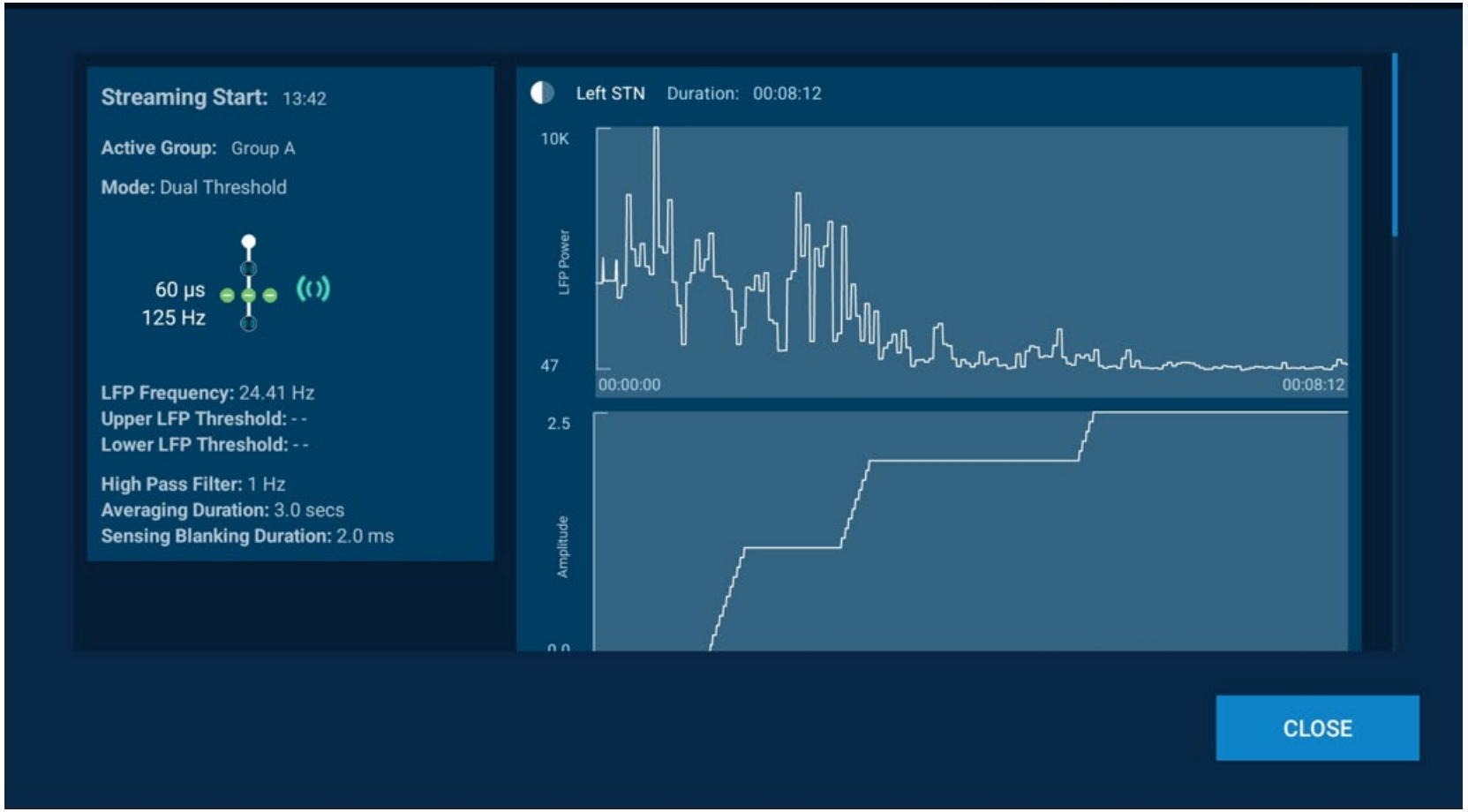
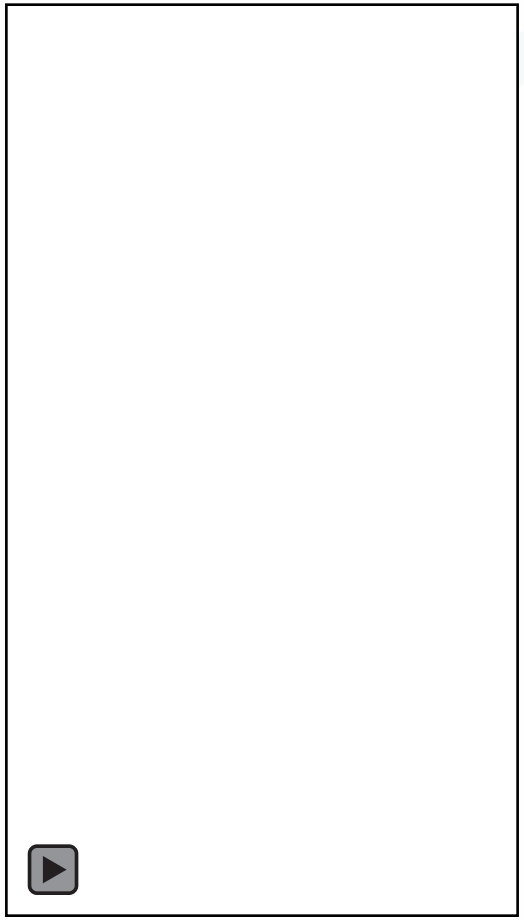
Screenshot of Brainsense Streaming: Left STN



Screenshot of Brainsense Streaming: Right STN

Video Walking: DBS ON



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Key take-aways

- Using Electrode Identifier and Electrode Survey can significantly shorten the time it takes for an initial programming. Time needed for initial programming - 45 minutes total. No monopolar review… Physiological monopolar review instead.
- BrainSense Streaming can be used in clinic to see in “real time” the effects that the stimulation has on suppressing the selected signal/FOI. (“Window into the brain”)
- Electrode Identifier, Electrode Survey and BrainSense Streaming are tools that deliver personalized insights into the patient’s symptom fluctuations which could help maximize on-time as seen on the patient Timeline.
- BrainSense provides an objective, data-driven method for monitoring brain signals that may define certain symptoms of a disease state to better inform the clinician when making programming and medication changes.
- Electrode Identifier, Electrode Survey and BrainSense Streaming is the technology needed to create the foundation for closed loop/adaptive stimulation.

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Poll #3

- I feel that Brainsense technology (Electrode Identifier, Electrode survey and Brainsense streaming) can be a useful tool for initial programming:
  - A: Yes
  - B: No
  - C: Maybe

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References

- Stanslaski S, Summers RLS, Tonder L, Tan Y, Case M, Raike RS, Morelli N, Herrington TM, Beudel M, Ostrem JL, Little S, Almeida L, Ramirez-Zamora A, Fasano A, Hassell T, Mitchell KT, Moro E, Gostkowski M, Sarangmat N, Bronte-Stewart H; ADAPT-PD Investigators. Sensing data and methodology from the Adaptive DBS Algorithm for Personalized Therapy in Parkinson's Disease (ADAPT-PD) clinical trial. NPJ Parkinsons Dis. 2024 Sep 17;10(1):174. doi: 10.1038/s41531-024-00772-5. PMID: 39289373; PMCID: PMC11408616.
- Thenaisie Y, Palmisano C, Canessa A, et al. Towards adaptive deep brain stimulation: clinical and technical notes on a novel commercial device for chronic brain sensing. *J Neural Eng*. 2021;18(4):10.1088/1741-2552/ac1d5b. Published 2021 Aug 31. doi:10.1088/1741-2552/ac1d5b.

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Thank you!

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University of California
San Francisco

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