Net Station Acquisition

Technical Manual

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Net Station Acquisition

Technical Manual

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EGI

dense-array EEG

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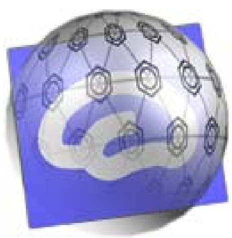
PREFACE



The Net Station icon

Net Station from Electrical Geodesics, Inc. (EGI) is a complete software package for working with electroencephalography (EEG) data. With Net Station, you can:

- acquire EEG, in conjunction with EGI's Net Amps and Neurotravel amplifiers, and dense-array Geodesic Sensor Nets (GSNs)
- perform various operations on your data, primarily for basic event-related potential (ERP) derivation
- view and navigate EEG and ERP data

Note: Net Station does not support Unicode string.

The following publications, and other technical documentation, are available as PDF files at www.egi.com/documentation.html:

- The Net Station Acquisition is the component of Net Station for acquiring EEG, in conjunction with EGI's Net Amps and Neurotravel amplifiers, and Geodesic Sensor Nets. This document, the ***Net Station Acquisition Technical Manual***, describes all Acquisition features and functions.
- The Net Station Viewer is the component of Net Station for viewing and navigating EEG and ERP data. The ***Net Station Viewer Technical Manual*** describes all Viewer features and functions.
- The Net Station Waveform Tools is the component of Net Station for performing various operations on EEG data, primarily for basic ERP derivation. The ***Net Station Waveform Tools Technical Manual*** describes all Waveform Tools features and functions.

- The ***Net Station Viewer and Waveform Tools Tutorial*** instructs you in the use of Net Station Viewer and Waveform Tools by guiding you through the analysis of a sample data set. It is not intended to be a comprehensive guide to these components, but it is a good place to start when learning about the software.
- The ***Net Station File Formats Technical Manual*** documents the objects contained in a native Net Station file, the formats of the export files, and other files associated with Net Station.
- The Geodesic Sensor Net is EGI's patented device for acquiring electrical signals from the human scalp. The ***Geodesic Sensor Net Technical Manual*** describes all GSN features and functions.
- GES hardware is all the system hardware except for the GSN. GES hardware supports the acquisition and processing of EEG data and includes an amplifier, a data-acquisition computer, a monitor, and, in most cases, a cart or travel case. The ***GES Hardware Technical Manual*** provides comprehensive descriptions of all GES hardware components and features.

These publications contain a good deal of background information on the EEG field. However, they are not intended to represent a complete primer. To get the most out of these books, you should have some background in EEG methods.

These manuals assume you are familiar with the Macintosh computer, the platform for Net Station software.

About This Manual

The *Net Station Acquisition Technical Manual* describes the acquisition of EEG data using EGI's Net Station software, Geodesic Sensor Net, and Net Amps 200, Net Amps 300, or Neurotravel amplifiers. At the present time, Net Station works only with these products.

Features

This manual is supplied as a PDF file and in printed form. The hard-copy version has been printed from the PDF so the content of both will match. The printed manual contains mostly grayscale images; the PDF contains color and grayscale images.

Manual Organization

This manual features a table of contents, list of figures, list of tables, and index, which in the PDF are all hyperlinked to the topics they reference in the publication.

The chapters fall into four main categories:

- *Introduction*
  - Chapter 1, "Acquisition Overview"
  - Chapter 2, "Introducing Net Station"
- *User-Defined Features (using the Workbench)*
  - Chapter 3, "Workbench: The Basics"
  - Chapter 4, "Workbench: Controls/Displays"
  - Chapter 5, "Workbench: Acquisition Setups"
- *Standard Features*
  - Chapter 6, "Dense Waveform Display"
  - Chapter 7, "Sessions and Session Templates"
- *Clinical Options*
  - Chapter 8, "Clinical Interface"
  - Chapter 9, "Digital Video"
  - Chapter 10, "Photic Stimulator Interface"

A number of appendixes are also include:

- Appendix A, "Software Technical Support"
- Appendix B, "Updating EGI Licenses"
- Appendix C, "Montages"
- Appendix D, "Acquisition How-To"

Conventions and Typography

In this manual:

- The terms *Net Amps* may be used in reference to features shared by both the Net Amps 200 and 300.
- The terms *Geodesic Sensor Net*, *GSN*, *HydroCel GSN*, and *sensor array* are used interchangeably.

- In general, a minimal amount of special fonts are used in this manual—*italics* for definitions or newly introduced terms, ***boldface italics*** for important concepts, and **boldface** for command paths (such as, **File > Save**).

Additional Information

Two different methods are used to convey additional information: notes and cautions.

Note: This indicates information that is helpful in understanding Net Station operations.

Caution!: *This denotes important information that, if unheeded, could hinder use of Net Station.*

Troubleshooting, Support, and Repair

- For online updates to this book, check EGI's Documentation page at www.egi.com/documentation.html.
- For Net Station EEG software support, see Appendix A, "Software Technical Support."
- To update your Net Station license, see Appendix B, "Updating EGI Licenses."

The EGI Documentation page at www.egi.com/documentation.html

chapter 1

Acquisition Overview

EGI's Net Station Acquisition software is designed for the acquisition of dense-array EEG data. This publication, the *Net Station Acquisition Technical Manual*, describes the components of Net Station Acquisition and its use.

This chapter provides an introduction to the acquisition process using Net Station, highlighting both general and specific issues.

General topics include intended use, system requirements, and Net Station acquisition, including the roles played by the sensor array, amplifier, data-acquisition computer, and Net Station.

Specific details are provided about how Net Station displays and records the EEG; the chapter closes with a reference to an acquisition how-to appendix.

Intended Use

Net Station is intended to measure and record the electrical activity of the brain. It is designed for use with adults, children, and infants.

Net Station is targeted for research and clinical applications, and for operation by trained medical and research personnel. Net Station includes functions to support the Neurotravel amplifier, European Data Format (EDF) import, FireWire digital video, and the Neurotravel PH80 photic stimulator.

System Requirements

Net Station is designed for Mac OS X 10.3 or later (10.4 is recommended), and to run on Mac G4 or later (G5 is recommended) PowerPC units, either portable or desktop. The application's minimum hardware requirements are a 1.25 GHz processor and 1 GB of RAM.

Net Station Acquisition Overview

Your system equipment can be set up in various ways. However, all configurations share a common set of core components (Figure 1-1), including at least one Geodesic Sensor Net (GSN) sensor array; one Net Amps 300, Net Amps 200, or Neurotravel amplifier; and a data-acquisition computer (DAC) running EGI's Net Station software.

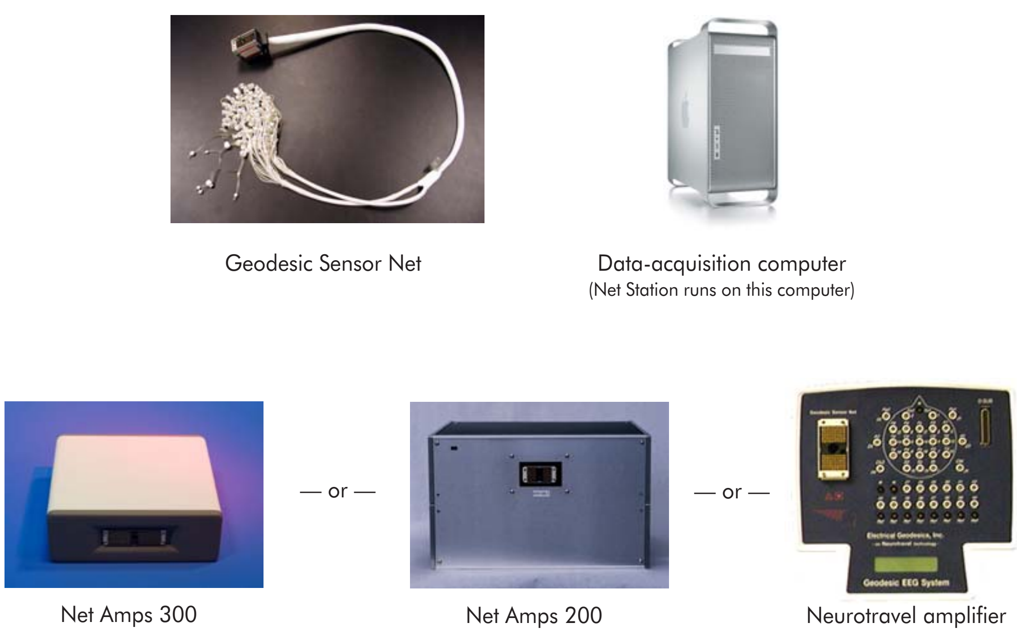


Figure 1-1. Core components

Sensor Array

During EEG recordings, subjects wear a Geodesic Sensor Net. A subject wearing a 128-channel adult-sized HydroCel GSN (HCGSN) is shown as an example in Figure 1-2.

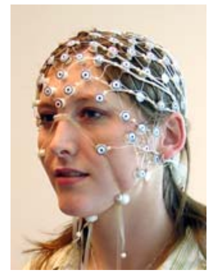


Figure 1-2. Subject wearing an HCGSN

Amplifier

A sensor array is connected to a Net Amps 300, Net Amps 200, or Neurotravel amplifier unit. The amplifier filters and measures the EEG signals that are picked up by the sensor array and samples them at millisecond intervals.

(In addition to native formats, Net Station supports the European Data Format, a standard clinical format for the exchange and storage of simultaneously recorded physical signals. Developed in 1991, EDF is well documented and a full specification of the format can be found on the web.)

The digitized samples are transferred to the DAC in real time.

DAC and Net Station

Packets of data containing digitized EEG samples are sent from the amplifier to the DAC so that the Net Station software can collect them for display and storage to disk. In Net Station, you can display EEG data in a variety of ways and record them to permanent computer files.

Net Station resides on the DAC, where it is capable of continuously collecting dense-array EEG data from the amplifier.

Caution!: *Verify that the sleep mode for the hard drive is "off." Otherwise, Net Station will freeze when the hard drive "falls asleep." Also, if your DAC is connected to a network, verify that Appletalk is "on." Otherwise, Net Station may freeze.*

A functional diagram is shown in Figure 1-3.

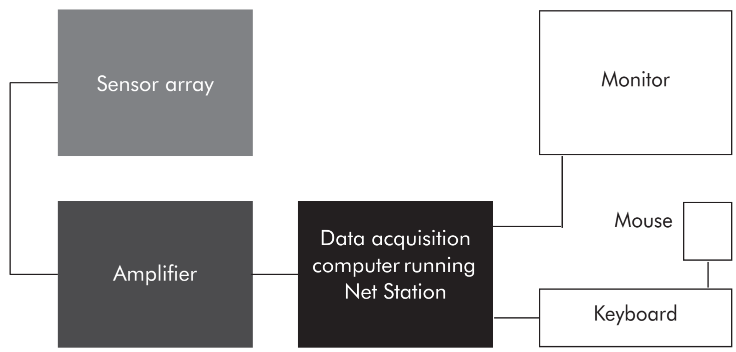


Figure 1-3. Net Station Acquisition functional block diagram

Basic Operation

Physically, the sensor array connects to the amplifier via the Hypertronics connector on the front of the amplifier. An interface cable that allows the subject to be positioned farther away from the amplifier may be used to connect the array and the amplifier. This is shown in Figure 1-4.

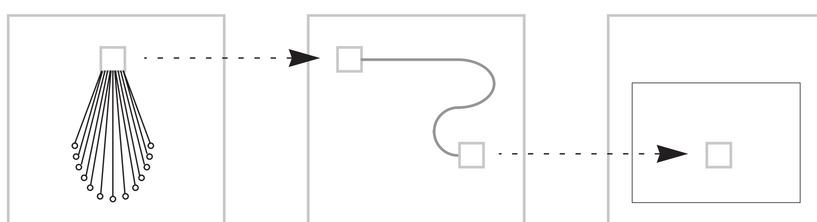


Figure 1-4. Sensor array, interface cable, amplifier

The array's sensors pick up changes in voltage originating at the surface of the subject's head (the EEG), along with a certain amount of electrical noise originating in the room environment. Electrical signals from all the sensors of the array are received simultaneously by the amplifier where they are amplified, filtered, sampled, and digitized. As quickly as the samples are acquired, they are packaged and sent to the

DAC along the Universal Serial Bus (USB) or FireWire cable that connects the amplifier and the DAC (Figure 1-5).

Figure 1-5. Amplifier–to-DAC connection diagram

Note: During acquisition, Net Station presents a warning that the disk is getting full, when only 200 MB of space remains. Later, when only 100 MB of space remains, recording automatically stops.

Display and Recording of EEG

The data of each sensor are segregated into their own channels. As the samples stream into the DAC over the USB or FireWire cable, Net Station gathers, organizes, and displays each channel's EEG data in the manner of a traditional chart recorder (Figure 1-6).

Figure 1-6. Net Station displays and records EEG waveforms

When you instruct Net Station to record the data to a file, the chart recorder display continues without interruption while the data are being written to disk.

Note: If you receive a message indicating that the USB driver is not installed, try reinstalling Net Station and restarting the computer.

Display Method

In contrast to a physical chart recorder that uses electromechanical pens to draw waveforms on a piece of moving paper, Net Station “draws” tiny dots on the computer screen called *pixels* (for *picture elements*; Figure 1-7).

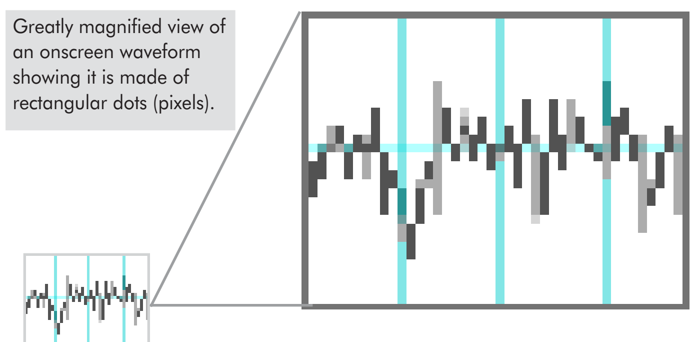


Figure 1-7. Onscreen waveforms are composed of pixels

You can achieve fine control of the display of EEG waveforms using the time and amplitude controls of Net Station’s scrollable Dense Waveform Display (DWD), shown in miniature in Figure 1-6. See Chapter 6, "Dense Waveform Display,” for details.

Recording Method

The voltage samples pass as *data packets* from the amplifier to Net Station via the bidirectional USB or FireWire cable that connects the amplifier to the DAC. Net Station records the data to disk in the form of either Recording or Session files (Figure 1-8).

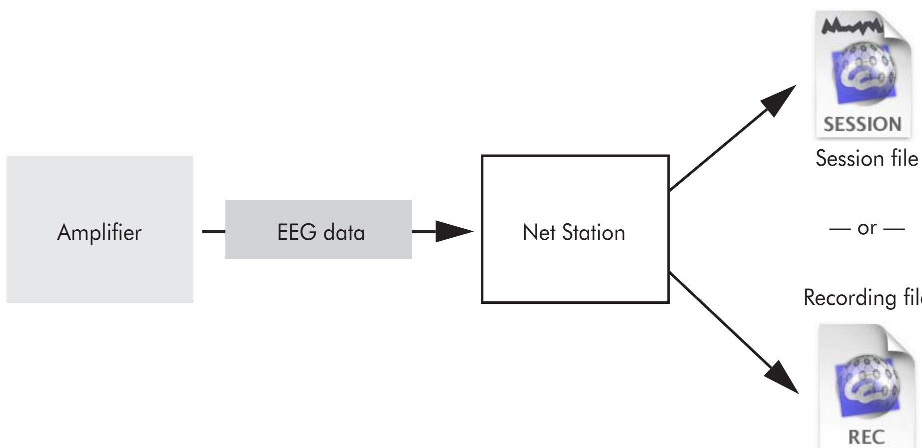


Figure 1-8. Net Station data files

Note: Because the USB or FireWire cable is bidirectional, Net Station can send queries and commands to the amplifier as well as receive data from it.

The default size limit for a Net Station EEG file is 1.8 GB. Once that limit is reached, Net Station immediately starts recording another file, with no loss of data. For more information about Net Station's continuous or multi-file recording, see "Recording Modes and File Sizes" on page 79.

High Density and Resolution

Net Station handles heavy workloads easily. Net Station's buffers can handle as many as 1,000 samples per second from your sensor array. You can observe the waveforms of each channel in groups limited only by the size of the computer monitor, even as the data are written to disk.

Data Protection

Net Station writes EEG and events to the DAC hard drive. To maximize the protection of these data after they are collected, the DAC must feature an optical drive (for example, DVD-R) that accepts high-capacity removable media. You can, and should, copy your data files from the acquisition hard drive to removable optical disks. An optical recording has a life span of decades and is immune to magnetic fields. This procedure ensures that the data cannot be lost because of hard-drive problems, and it greatly expands the data storage capacity of the system, as well.

Acquisition How-To

This manual focuses on the features and functions of Net Station Acquisition. For a step-by-step guide to acquiring EEG data and events using Net Station, see Appendix D, "Acquisition How-To."

chapter 2

Introducing Net Station

Users of Net Station Acquisition perform EEG data acquisition, monitor and control the amplifier, and store subject information and technician markup events in data files (Session or Recording) using Net Station software. This software resides on the hard drive of the data-acquisition computer and communicates with the amplifier via the USB or FireWire cable that connects the amplifier and the DAC (see Figure 1-5 on page 29).

Optionally, via Net Station, the Acquisition system can register and record external digital input (DIN) events and experimental control interface (ECI) events simultaneously with the EEG (see “Digital Input Controls” on page 91 and “Impedance Display Panel” on page 117 for details).

This chapter provides introductory material that is essential and/or helpful for understanding and realizing the full capabilities of the software and lays the foundation for the detailed material in the rest of the manual. Topics include the Mac OS X environment, how to launch Net Station, and the Net Station Distribution (that is, the files and folders that are installed on the DAC).

You should study the Distribution to become familiar with the names and locations of the example files that are part of the Net Station Distribution, and the default files and folders that form a vital part of the Acquisition system’s functionality. The chapter finishes by introducing the Workbench, Acquisition Setups, and Workbench devices.

This chapter, with few exceptions, assumes that you are familiar with the Mac OS and its basic operation. If you need help using the mouse, choosing from menus, or working in the Finder or with Mac OS control panels, please consult the User’s Guide that came with your Macintosh computer, or the online Apple guide that is accessible by choosing **Help > Mac Help**.

Before using Net Station Acquisition to acquire subject EEG, read the following, in sequence:

- Chapter 2, "Introducing Net Station”
- Chapter 3, "Workbench: The Basics”
- Chapter 4, "Workbench: Controls/Displays”
- Chapter 5, "Workbench: Acquisition Setups”
- Chapter 6, "Dense Waveform Display”
- Chapter 7, "Sessions and Session Templates”
- Appendix D, "Acquisition How-To”

If you are using Net Station for clinical applications, then also read:

- Chapter 8, "Clinical Interface”
- Chapter 9, "Digital Video”
- Chapter 10, "Photic Stimulator Interface”

Net Station Under OS X

Net Station operates slightly differently under Macintosh OS X than it did under the previous operating system. Notable differences include the Documents folder, font smoothing, and highlight colors.

Documents Folder

It is important to understand that OS X has a distinct Documents folder for each user.

This folder is located in the user's home directory under OS X. This documents folder (~/Documents [the tilde denotes the current user's home directory]) is entirely separate from the OS 9 documents folder (/Documents) located at the root level of the hard drive.

Net Station 3.0 used the OS 9 documents folder to store the Net Station User Data folder. Net Station 4.0 and later use the OS X documents folder to store the Net Station User Data folders. These are not the same location, and so Net Station 3.0 and Net Station 4.0 do not share tool specifications or settings. In addition, separate user accounts under OS X also do not share specifications or settings.

This has the potential for creating confusion for someone who is new to OS X, or who has been running Net Station 3.0 and is now running Net Station 4.0 or later on the same machine. If you are missing specifications, tools, or recordings, check which documents folder you are accessing.

Font Smoothing

For Net Station controls and text labels to be clearly readable under OS X, choose **Apple > System Preferences**, click on the Appearance icon in the Personal section, and in the Appearance window make sure that "Turn off text smoothing" is set to "for font sizes 8 and smaller." If this is set to 9, 10, or 12, Net Station labels may be difficult to read.

Highlight Colors

The default OS X highlight color may be too light for easily readable displays in Net Station. If this is true, choose **Apple > System Preferences**, click the Appearance icon in the Personal section, and choose a darker color from the Highlight Color pop-up menu in the Appearance window. The pop-up menu's "other" option enables you to create your own highlight color using a color wheel.

Net Station Distribution

As a part of the Net Station installation process, a number of files are placed on the hard drive of the system DAC. Collectively, these files are called the *Net Station Distribution*.

Note: This chapter uses the terms directory *and* folder *interchangeably and assumes basic familiarity with Mac OS configured as a single user.*

Mac Desktop Items

The hard drive where Net Station is installed is named “Data Acquisition.” Its icon (Figure 2-1) is situated in the top-right corner of the desktop. The Net Station icon is located on the Dock in Macintosh OS X. Clicking on the icon launches Net Station.

Figure 2-1. Desktop and Dock icons of the Distribution

__Caution!:__ Files and folders that are part of the Distribution should not be moved, renamed, or deleted. Doing so could adversely affect the operation of Net Station. For the same reason, the directory structure of the Distribution should not be altered except where indicated in the text of this chapter.

Root Directory

Double-clicking on the data-acquisition hard drive opens a window that shows its root directory structure (Figure 2-2).

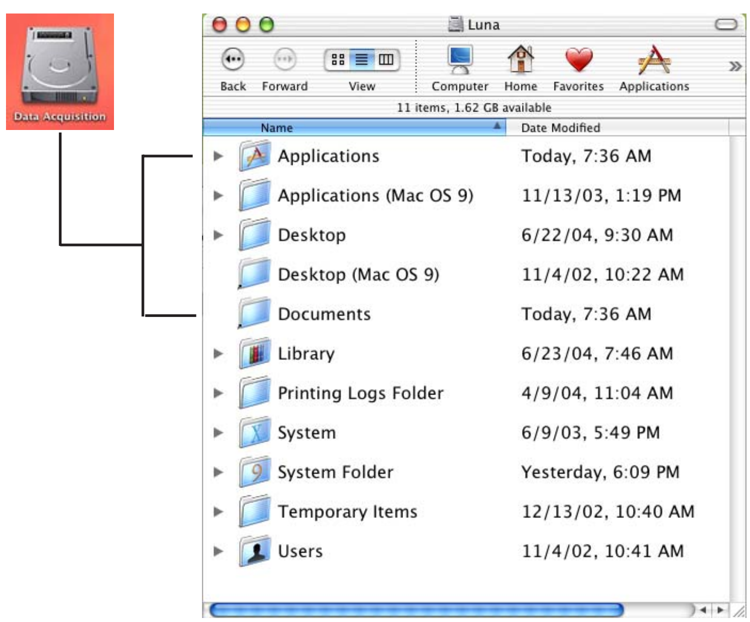


Figure 2-2. Root directory structure of data-acquisition hard drive

The exact contents of the root may include more files and folders than those shown in the figure, but the essential ones are shown. The important folders to notice are Applications and Documents. These two folders contain parts of the Distribution and are also essential components of the Mac OS installation. You can add or delete your own folders and files at any time.

Net Station Folder

Inside the Applications folder is the Net Station folder. As shown in Figure 2-3, the Net Station folder encloses the Net Station Application Program Package.

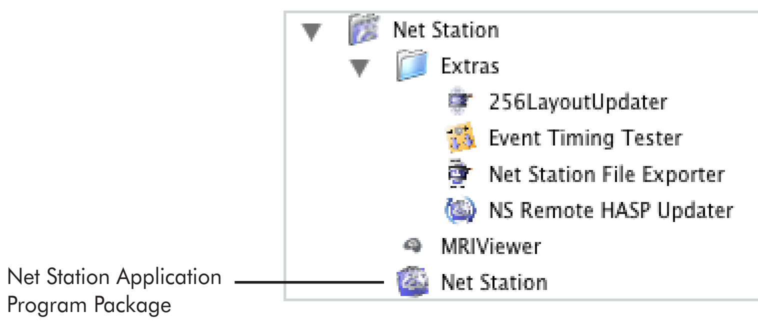


Figure 2-3. Inside the Net Station folder

Also in the Net Station folder is the Extras folder.

Caution!: *Do not move, rename, or delete the Net Station folder or its contents. Changing any of the folders, except the Extras folder (described later in this section), may result in data loss or corruption.*

Net Station Application Program Package

The Net Station icon is actually a package (that is, a folder disguised as an application icon). Remember not to move, rename, or delete any item that is enclosed in the Net Station Application Program Package, or Net Station may exhibit unexpected behavior, possibly including data corruption.

Extras Folder

Auxiliary applications are distributed with Net Station in the Extras folder. You can move such applications out of the Extras folder without adversely affecting Net Station. The Net Station File Exporter, described in the next paragraph, is one such auxiliary application.

Net Station File Exporter

The Net Station File Exporter is a droplet application. You can launch the Net Station File Exporter only by dragging files onto its icon. If a Net Station Recording or Session file is dragged onto it, the data of the file will be exported as a simple-binary data file. See the Read Me documentation file supplied with the File Exporter in the Extras folder to learn about the simple-binary format. (The *Net Station File Formats Technical Manual* also describes the File Exporter.)

⌘

Command key

Another function of the File Exporter is to extract diagnostic and calibration information from an EEG data file. Dragging a Net Station Recording or Session file onto the Exporter while holding down the Command key causes the gains, zeros, impedances, and history stored in the file to be written to separate text files. These output files have the extensions.GAIN, ZERO, .IMP, and .HIST.

For information on how channel gains and zeros are measured, and the formula for converting channel A/D values to microvolts, see “Calibration” in Chapter 5, “Amplifiers,” in the *GES Hardware Technical Manual*.

Documents Folder

The Documents folder is a default component of Mac OS.

During Net Station installation, a Net Station User Data folder is installed in the Documents folder. The Net Station User Data folder and its contents—the Acquisition Setups, Session, Support, and Template folders (Figure 2-4)—are part of the Net Station Distribution and are described in this section.

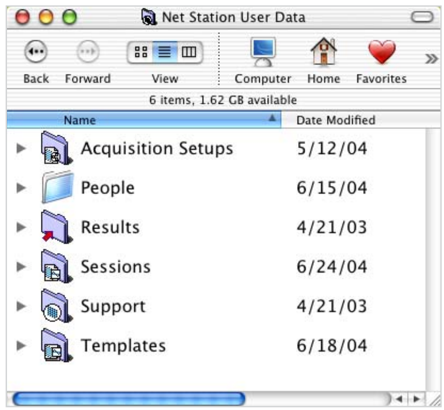


Figure 2-4. Net Station User Data folder

Caution!: *As with the Net Station folder, do not move, rename, or delete the Net Station User Data folder, its subfolders, or any of its contents. The one exception is the Resource Database, which you* ***must*** *move out of the Net Station folder if you reinstall the application, but wish to keep your montages, event sets, and so forth (“Support Folder” on page 40 describes the database further).*

(See “Net Station Under OS X” on page 34 for the different document folders used in OS 9 and OS X.)

Acquisition Setups Folder

The Acquisition Setups folder stores Acquisition Setups. When you save new, editable Acquisition Setups, Net Station routes them to this folder by default. Directly after installation of Net Station, the Acquisition Setups folder is empty.

Note: Session Templates require an embedded Acquisition Setup (see “The Embedded Acquisition Setup” on page 159). When you create a new Session Template, Net Station looks for available Acquisition Setups in the Acquisition Setups folder.

Sessions Folder

The Sessions folder is the destination for saved Net Station Session files. Such files are native Net Station EEG data files that are initiated when you pick a Session Template and use it to acquire new EEG data (see Chapter 7, "Sessions and Session Templates”).

Support Folder

The Support folder holds the Resource Database, an automatically generated file that stores user information needed by Net Station. The Resource Database contains:

- topographic map compositions
- montages
- filters
- event sets and user events
- keyboard mapping
- people (global unique identifiers)
- fields

Over time, Net Station adds and removes information from the Resource Database. If the Resource Database is moved, renamed, or deleted, *Net Station creates a new one* and places it in the Support folder, but as a consequence the information in the old Resource Database is no longer be available to Net Station.

You should regularly back up your Resource Database, saving the Resource Database backup files as a protection against the database being deleted inadvertently.

Templates Folder

Like the Acquisition Setups folder, the Templates folder is for your convenience. When you create custom Session Templates, Net Station puts them in this folder automatically as soon as they are saved.

Net Station looks for Session Templates in this folder when you initiate a new session. It lists the names of any templates it finds, along with the names of its default, preconfigured Session Templates. You choose from the list (see Figure 7-1 on page 158). The names of Net Station's default Session Templates are: ***Clinical Neurotravel Session, NA 200 Clinical Session, NA 200 Exp. Control Template, NA 200 Simple Session Template, NA 200 Typical Session Template, NA 300 Clinical Session, NA 300 Exp. Control Template, NA 300 Simple Session Template,*** and ***NA 300 Typical Session Template***.

When creating a new Session Template, choose a name that does not match one of the names of the default templates, to prevent duplicate names appearing in the list of Session Templates.

Remember not to move, rename, or delete this directory, otherwise Net Station will not be able to find user-created templates.

Workbench and Devices

Net Station's Workbench is a facility for designing and saving data-acquisition configurations. You preserve Workbench configurations by saving them to computer files called *Acquisition Setups*. You can initiate EEG data collection directly from the Workbench or from a saved Acquisition Setup. Nine default Acquisition Setups are provided for embedding into Session Templates; you cannot directly acquire EEG using these default setups.

Typically, Net Station users will choose a Session Template for performing data acquisition. An Acquisition Setup is embedded in each Session Template (Chapter 7, "Sessions and Session Templates").

For your convenience, the Distribution includes nine preconfigured Session Templates for data acquisition (these contain the nine default Acquisition Setups mentioned earlier). If these preconfigured templates match your needs, it may be unnecessary to use the Workbench at all. Still, the following sections should be studied and understood as background for the remainder of the manual, which covers a number of topics related to data acquisition using Net Station.

Workbench Fundamentals

In an electronics laboratory, hardware often consists of modular devices on a workbench, interconnected with cables. Such devices have their own controls, displays, and functionality. When a new device becomes available, it is added to the workbench collection with minimal consequence to the other devices.

Net Station's Workbench (Figure 2-5) emulates a real-world, physical workbench where devices can be placed and connected together. On the computer screen, the workbench surface is represented by a grid of rectangles called *cells*. You can place a single device into each cell and connect the devices using virtual cables.

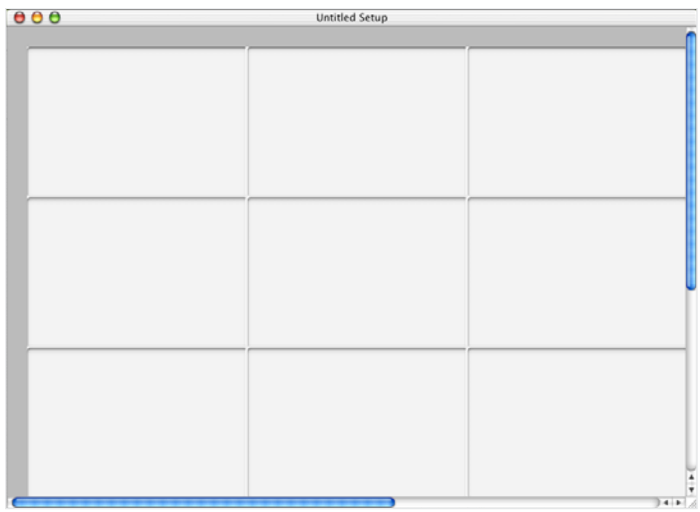


Figure 2-5. The Workbench

Devices

Chapter 4, "Workbench: Controls/Displays,"covers each device in detail. In general, however, the following rules apply to Workbench configurations:

- Each device has a particular function (Figure 2-6).
- Each device—except the Net Amps USB, Net Amps 300, Neurotravel USB, and Digital Video devices—has both input (left side of the device) and output jacks.

- You cable together devices by creating connections (cables) from the output jack of one device to the input jacks of other devices.
- EEG and digital input data from the amplifier are made available to the Workbench via the Net Amps USB, Net Amps 300, or the Neurotravel USB device.

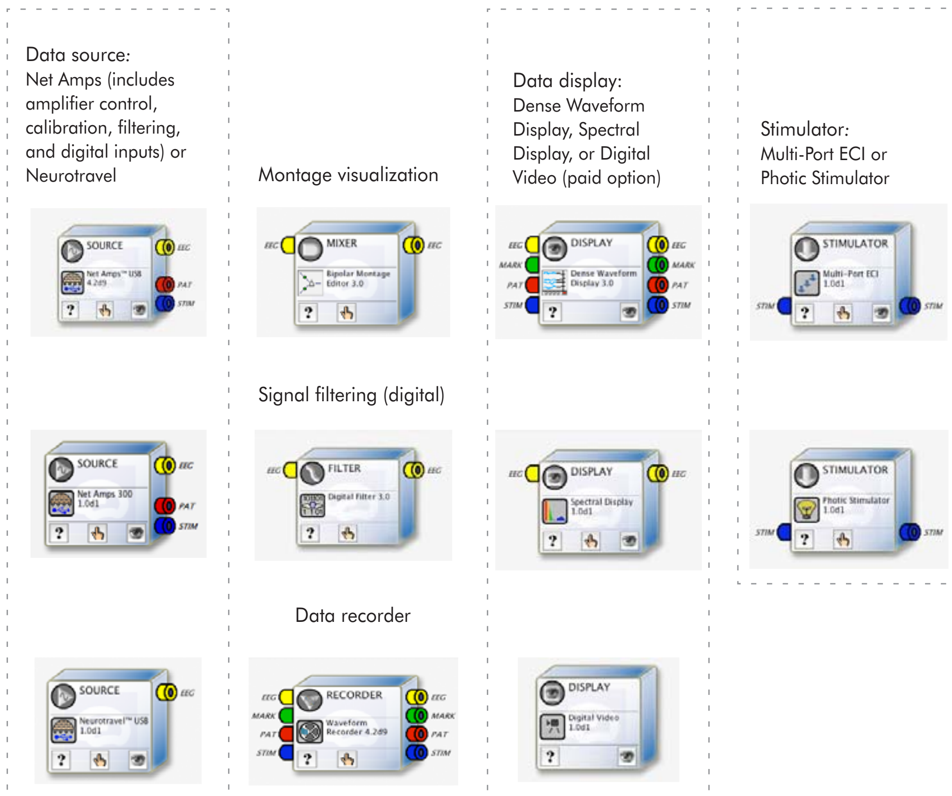


Figure 2-6. Workbench devices

Net Station's Workbench interface extends the metaphor of a real-world workbench by providing access to display and control panels that are linked to the functions of the devices.

For example, after connecting the Digital Filter device in an appropriate way (Figure 5-15 on page 142), click the control panel button (the "finger" icon) on the Digital Filter device to deploy its control panel (Figure 2-7). Then use the control panel to set filter parameters and turn the filter on and off.

You can start with simple configurations and add more devices to create more complicated setups.

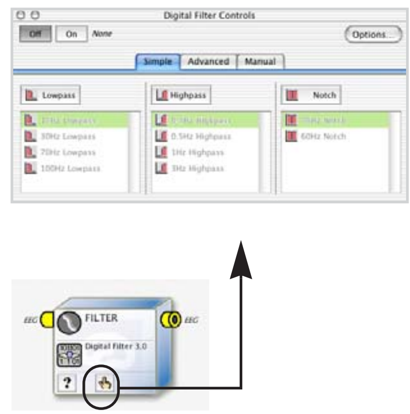


Figure 2-7. Example of deploying a control panel

Acquisition Setups

An Acquisition Setup stores a Workbench configuration including device placements and connectivities, display and control panel settings, and window positions and sizes. There are two types of Acquisition Setups: default, and saved.

Net Station provides nine default Acquisition Setups that are already embedded in the nine default Session Templates provided.

The default Acquisition Templates and their corresponding default Session Templates are:

- Simple Net Amps 200 Acq Setup and NA 200 Simple Session Template
- Simple Net Amps 300 Acq Setup and NA 300 Simple Session Template
- Typical Net Amps 200 Acq Setup and NA 200 Typical Session Template
- Typical Net Amps 300 Acq Setup and NA 300 Typical Session Template
- Exp. Control Net Amps 200 Setup and NA 200 Exp. Control Template
- Exp. Control Net Amps 300 Setup and NA 300 Exp. Control Template
- Clinical Net Amps 200 Acq Setup and NA 200 Clinical Session
- Clinical Net Amps 300 Acq Setup and NA 300 Clinical Session
- Clinical Neurotravel Acq Setup and Clinical Neurotravel Session

Because the default Acquisition Setups are designed to be embedded into a Session Template, you cannot acquire data directly with them or edit their Workbench configurations.

Saved Acquisition Setup files, however, are editable documents that you create with their own particular device layout and configuration. Adding and removing devices is one aspect of editing an Acquisition Setup. Another is modifying the positions and settings of display and control panels.

If you modify the Workbench configuration of a saved Acquisition Setup, Net Station asks you if you want to save the changes when the Setup file is closed. However, if you modify only window positions or panel settings, then Net Station autosaves them without asking, when the Setup file is closed.

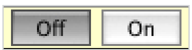
Acquiring Data

Of the two types of Acquisition Setups, you can acquire data *directly* only with a saved Acquisition Setup. To acquire data based on a default Acquisition Setup, you must use a Session Template that contains the chosen default setup (see Chapter 7, “Sessions and Session Templates”).

Opening a saved Acquisition Setup automatically launches Net Station and loads the Workbench configuration the setup contains. If the setup is valid, turning the Workbench “on” initiates EEG data acquisition.

For example Acquisition Setups, see “Default Acquisition Setups” on page 95, which describes the nine default Acquisition Setups included with the Distribution.

Caution!: *When creating a Net Station file—(1) Assign a subject. An empty subject field can cause problems later during the Combine Files or Statistic Extraction processes. (2) Create file names that vary within the first 22 characters. When exporting data to text files, Net Station truncates file names longer than 22 characters; if truncated file names are identical, they may overwrite each other.*



Look for the Workbench Off and On buttons in the upper-right corner of the Workbench window.

Workbench Off and On

Once the Workbench contains a source device, you can switch on the Workbench and data will stream from the source device into connected downstream devices. When the Workbench is “off,” it is in a dormant state in terms of its ability to bring a data stream into Net Station, but devices can be added or removed. You cannot add or remove devices or modify connections when the Workbench is “on.”

Stop and Record buttons are located on the Waveform Recorder device control panel.

Recording On and Off

With a Waveform Recorder connected downstream of a source device, as in Figure 2-7, and the Workbench on, clicking the Record button on the control panel of the Waveform Recorder device initiates recording to disk.

Note: When the Workbench is off, the Record button is dimmed (disabled).

chapter 3

WORKBENCH: THE BASICS

The Workbench allows you to design your own data-acquisition routines, which are *saved Acquisition Setups*. If the supplied Session Templates meet your needs, the Workbench and Acquisition Setups may be unnecessary. However, familiarity with their features and capabilities is useful, and custom-designed setups may ultimately prove helpful to achieving your lab's particular goals.

The Workbench is a powerful tool, with many features, and is discussed in three separate chapters.

This chapter, Chapter 3, introduces you to the Workbench and describes:

- Acquisition status panel
- Workbench menus
- devices, in general
- device buttons
- device panels
- Devices palette
- placing and connecting devices

Chapter 4, "Workbench: Controls/Displays," describes the specific controls of the Workbench; and Chapter 5, "Workbench: Acquisition Setups," describes the default Acquisition Setups and how to create your own.

Acquisition Status Panel

To open the Workbench, launch Net Station, and in the Customize section of the start-up window, click the Acquisition Setup button.

Above the Workbench is the Net Station menu bar associated with the Workbench, and attached to the lower margin of the menu bar is the yellow Acquisition status panel (Figure 3-1).

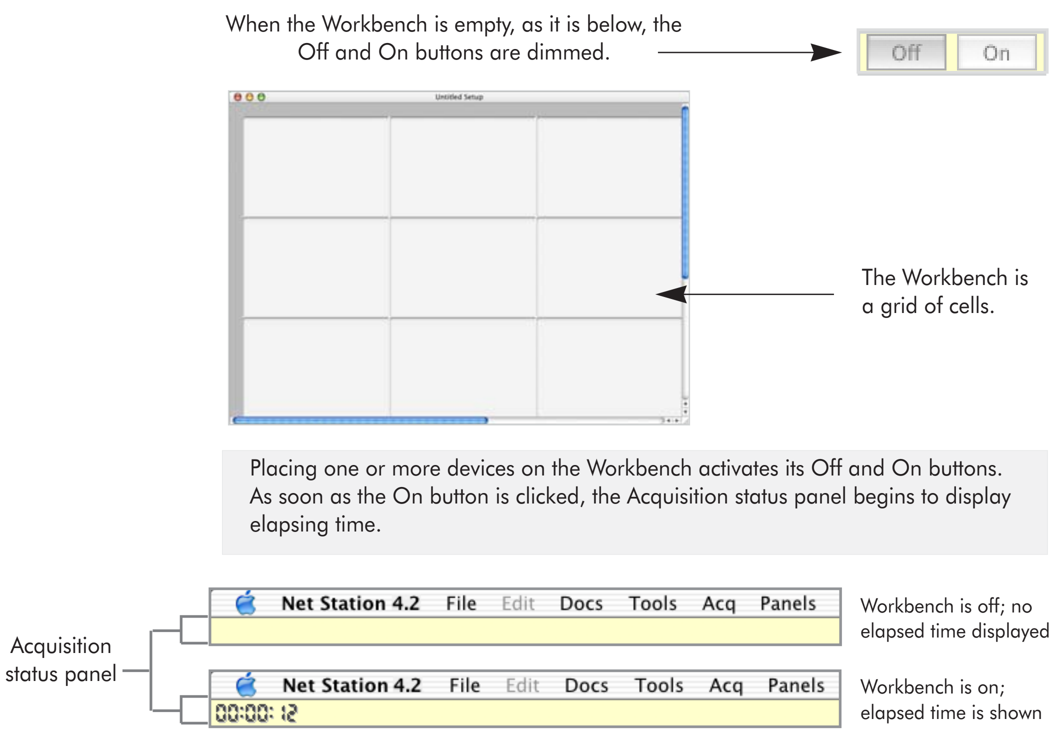


Figure 3-1. Menus and Acquisition status panel

Note: Deploying the Dense Waveform Display (Chapter 6) causes additional menus to appear on the menu bar (see "Dense Waveform Display Menu Bar" on page 51).

Notice that the right side of the Acquisition status panel contains two buttons for turning the Workbench on and off. You can also turn the Workbench on or off by using the Acq menu (see "Acq" on page 54).

The behavior of the Workbench depends on its on or off status, as shown in Table 3-1.

Table 3-1. Workbench rules

Workbench devices function only when the Workbench is **on**.
Data recordings can be made only with the Workbench **on**.
Devices can be added, removed, or configured only when the Workbench is **off**.

The Record menu is not available when the Workbench is off (see Figure 3-1).

On the left side of the Acquisition status panel is the elapsed time display, showing the time that has passed since the Workbench was last turned on, in hours:minutes:seconds (Figure 3-2).

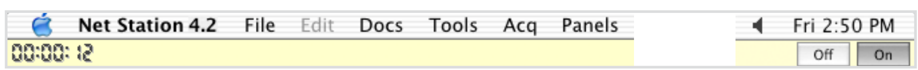


Figure 3-2. Acquisition status panel with Workbench on

Note: When you use a Session Template to conduct EEG and event data acquisition, the Off and On buttons that accompany the Workbench are replaced by the Session Info and Close Session buttons. The elapsed time display is the same. See Chapter 7, "Sessions and Session Templates," for details.

Menus

The menus presented in the Net Station menu bar are subject to change, depending on what part of the application is being used.

Workbench Menu Bar

The menus connected with Workbench operations (Figure 3-3) are displayed only when the Workbench is being used. The Record menu is available only when the Workbench is on and disappears when the Workbench is off.

Figure 3-3. Menu bar, when the Workbench is on

The Acq menu is available only when the Workbench is being used but is displayed whether the Workbench is on or off.

Session Menu Bar

The Session menu bar is shown in Figure 3-4. The Record menu is always available during a Session because initiating a Session automatically turns the Workbench on.

Figure 3-4. Session menu bar

Dense Waveform Display Menu Bar

When the Dense Waveform Display is the frontmost window onscreen, the menu bar includes associated menus (Figure 3-5).

Workbench menu bar when the Dense Waveform Display is frontmost

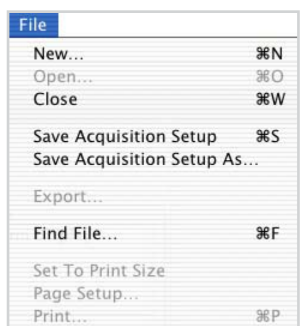
Session menu bar when the Dense Waveform Display is frontmost

Figure 3-5. Dense Waveform Display menu bar

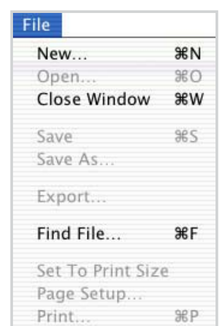
File

The commands available in the File menu depend on what part of Net Station is being used, as shown in Figure 3-6.

Sidebar



Workbench



Ongoing session

Figure 3-6. File menu

- *New*: opens the Select Session Template window with a list of choices for creating a new document (Figure 3-7). Each choice opens the Enter Session Information window, for inputting information about the subject/patient, experiment/exam, and so forth.

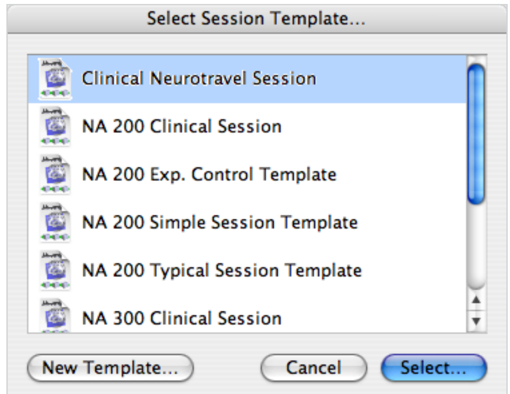


Figure 3-7. File > New opens the Select Session Template window

- *Open*: opens an “open file” dialog. Note that if an Acquisition Setup is already open, the “open file” dialog will not display Acquisition Setup files.
- *Close/Close Window*: closes either the current Acquisition Setup, with autosaving, or the frontmost Dense Waveform Display window if one or more Dense Waveform Displays are deployed.

  This command and its corresponding default keyboard shortcut, z-W, have no effect on palettes, which must be closed by clicking their close buttons.

- *Save Acquisition Setup*: saves the current Acquisition Setup. If the current Acquisition Setup has not been saved previously, a dialog prompts for a name and location. This command is not available when a session is under way.
- *Save Acquisition Setup As*: saves a copy of the current Acquisition Setup document.
- *Page Setup*: not available in this version of Net Station.
- *Print*: not available in this version of Net Station.

Edit

The Edit menu (Figure 3-8) operates on selected (highlighted) text or alphanumeric fields. Some commands also operate on a Workbench cell. When a field has not been selected, the command operates on the field where the cursor has been placed.

Figure 3-8.
Edit menu

- *Undo*: not available.
- *Cut*: removes the selection and puts a copy of it on the Clipboard.
- *Copy*: copies to the Clipboard the contents of a selection.
- *Paste*: pastes the contents of the Clipboard to a selected field.
- *Clear*: irreversibly deletes the contents of a selected field or Workbench cell.
- *Select All*: selects (highlights) all the text in any field where the cursor is placed or where a partial or full selection of text is active.
- *Unselect All*: not available.

Docs

The Docs menu (Figure 3-9) allows you to organize your screen space.

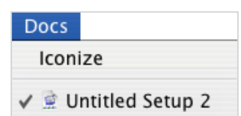


Figure 3-9. Docs menu

- *Iconize*: reduces the current Net Station window to an icon and places it in the Dock to save screen space. (You can also click the yellow Minimize button in the top-left corner of the Net Station file window.)
- <*Filename*>. returns the Net Station file to its previous size onscreen. (You can also click the file icon in the Dock).

Acq

This menu (Figure 3-10) is called *Acq* for *data acquisition*. It is available only when the Workbench is being used. The devices it presents match those of the Devices palette (see "Devices Palette" on page 65).

- *Turn On/Off Workbench*: activates/deactivates the Workbench devices. You can also turn the Workbench on or off by using the buttons on the right side of the Acquisition Status panel just below the menu bar (Figure 3-1).

  You can change a Workbench configuration only when the Workbench is off.

- *Hide Device Palette/Show Device Palette*: toggles visibility of the Devices palette.
- *Devices*: selecting a device places it in the currently selected Workbench cell.

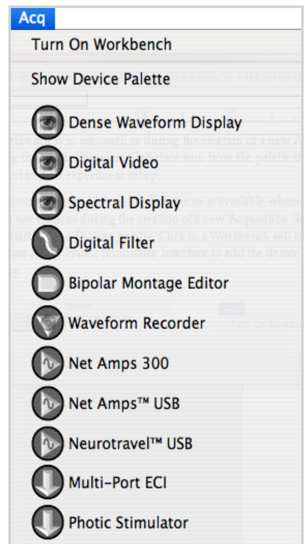


Figure 3-10. Acq menu

Panels

The Panels menu (Figure 3-11) provides access to the control and display panels associated with devices that belong to the current Workbench configuration (when using the Workbench) or that are part of an active Session Template.

The menu displays the devices alphabetically. Beneath each device name are its associated control and display panels.

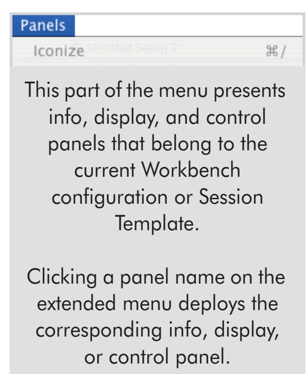


Figure 3-11. Panels menu

Opening and Closing Panels

Device buttons

Open a panel by selecting it from the list. Close it by clicking its close button. Panels are also available through the buttons on the device itself.

- *Iconize*: any panel can be reversibly minimized to icon form and placed on the Dock by choosing **Panels > Iconize**. Clicking a minimized panel restores it to the screen in its full size. Iconizing control panels makes them readily available while reducing the amount of screen space that they occupy.

  You can also minimize the panel by: (1) clicking the yellow button in the top-left corner of the panel window; (2) double-clicking anywhere on the panel's title bar; or (3) pressing Command-/.

Record

The Record menu (Figure 3-12) does not appear in the menu bar unless a Waveform Recorder Device is a part of the Workbench configuration and the Workbench is on.

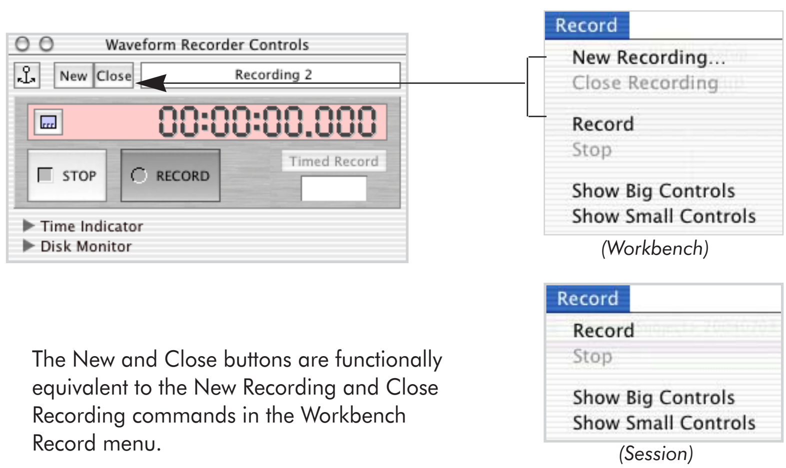


Figure 3-12. Record menu, Workbench, and Session variants

When you use a Session Template to initiate a new session, the Record menu is always present but does not contain the New Recording and Close Recording commands. This is because the Session Template automatically handles the naming and closing of the file.

Each Record menu command is described in the following paragraphs.

- *New Recording*: deploys the New Recording window (Figure 3-13) to create and name a new Recording file.

  New Recording does not initiate recording; it only creates and names the file. Use Record (Figure 3-14) to start recording.

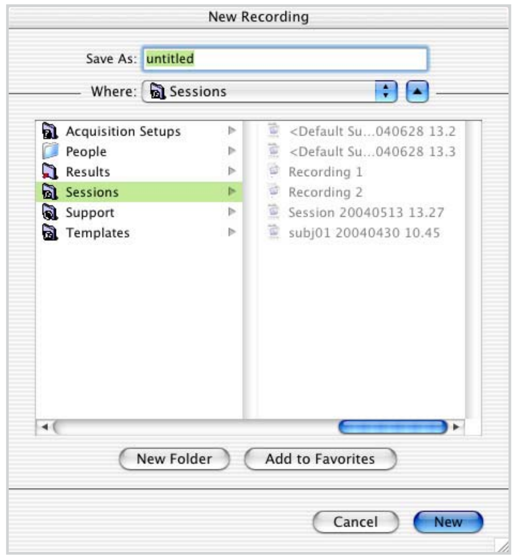


Figure 3-13. New Recording window

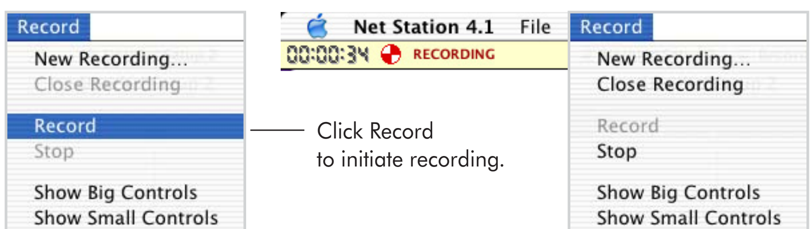


Figure 3-14. Clicking Record initiates Workbench recording

- *Close Recording*: terminates recording and closes the Recording file.
- *Record*: starts recording. Functionally equivalent to the Record button (see Figure 3-15).
- *Stop*: stops recording. Functionally equivalent to the Stop button (see Figure 3-15).

- *Show Big/Small Controls*: toggles between normal-sized and small Waveform Recorder Controls panel. Functionally equivalent to the anchor button (see Figure 3-15).

Figure 3-15. Big controls and small controls

Display

The Display menu is used to manage multiple Dense Waveform Display panels (Figure 3-16). It becomes available when at least one Dense Waveform Display (see Chapter 6) is deployed on the Workbench or in a session.

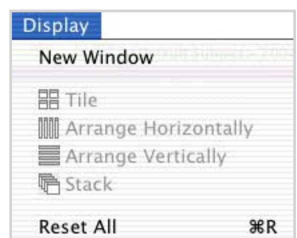


Figure 3-16. Display menu

Multiple Dense Waveform Display Devices

The Workbench allows multiple DWD devices, each of which can have up to four Dense Waveform Display windows.

- *New Window*: opens a new window for the frontmost Dense Waveform Display, up to four windows per Workbench device.
- *Tile, Arrange, Stack*: rearranges the windows of the frontmost Dense Waveform Display in the indicated arrangement.
- *Reset All*: causes the sweep lines of the frontmost Dense Waveform Display to reset to the leftmost position.

Time

The Dense Waveform Display's Time menu duplicates the functionality of the Time pop-up menu (see "Scale Control Strip" on page 149) and controls the rate at which Net Station displays EEG waveforms.

Time menu settings persist in Acquisition Setups. Opening an Acquisition Setup restores the last setting used in that setup. Opening a Session Template restores the settings of its embedded Acquisition Setup (see "The Embedded Acquisition Setup" on page 159).

You can modify Time menu settings at any time, even during recording. The settings apply only to the way the data are displayed; changes to the Time menu do not affect the data recorded to disk.

Figure 3-17 displays the Time menu.

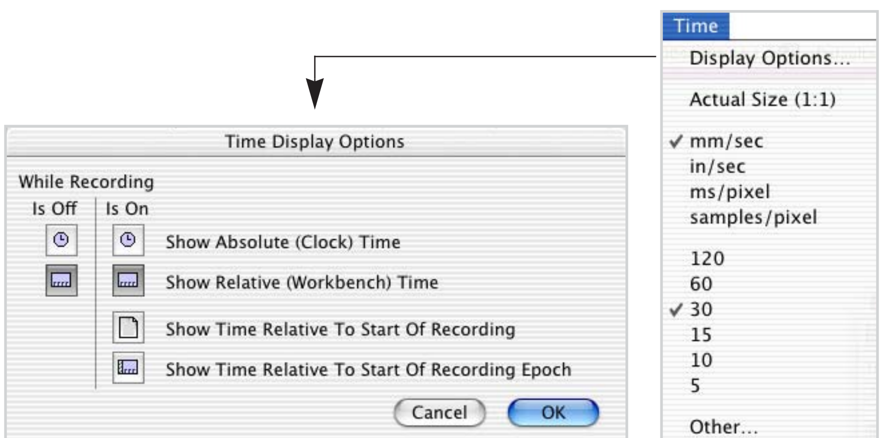


Figure 3-17. Time menu (default settings)

Following are brief descriptions of the menu items:

- *Display Options*: deploys the Time Display Options window.
- *Actual Size (1/1)*: sets the waveform display to 1 sample/pixel.
- *mm/sec* and *in/sec*: sets units based upon screen distance.
- *ms/pixel* and *samples/pixel*: sets units based upon screen pixels (see "Display Method" on page 30).

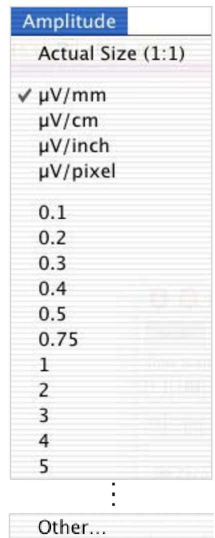
- *(preset values)*: configures time scale to common presets.
- *Other*: allows entry of custom values for time scale.

Amplitude

The Dense Waveform Display's Amplitude menu (Figure 3-18) commands duplicate those of the Amplitude pop-up menu (see "Scale Control Strip" on page 149).

Amplitude settings control the amount of vertical displacement each waveform occupies in the waveform display area of the Dense Waveform Display.

Like the Time menu, the Amplitude menu settings persist in Acquisition Setups. Opening an Acquisition Setup restores the last setting used in that setup. Opening a Session Template restores the settings of its embedded Acquisition Setup (see "The Embedded Acquisition Setup" on page 159).



This is a shortened version of the menu. The values continue, in varying increments, to 200.

Figure 3-18. Amplitude menu

You can modify Amplitude menu settings at any time, even during recording. The settings apply only to the way the data are displayed; settings made with the Amplitude menu do not affect the data recorded to disk.

The Amplitude menu commands are:

- *Actual Size (1:1)*: sets display to 1 µV/pixel.
- *µV/mm* and *µV/cm* and *µV/inch*: sets units based upon screen distance.
- *µV/pixel*: sets units based upon screen pixels ("Display Method" on page 30).
- *(preset values)*: configures amplitude scale to common presets.
- *Other*: entry of custom values for amplitude scale.

Events

Using Net Station's Dense Waveform Display (see Chapter 6), EEG technicians and experimenters can enter "mark-up" events into an EEG recording. The events are called "mark-up" events after the practice of manually marking the paper chart recording to indicate the locations of significant occurrences in the EEG.

The Events menu (Figure 3-19) is one way to enter mark-up events into a recording. It displays preset events and their corresponding keyboard shortcuts. While a recording is in process, choosing one of the presets from the menu causes the preset event to be entered into the marks event track of the recording.

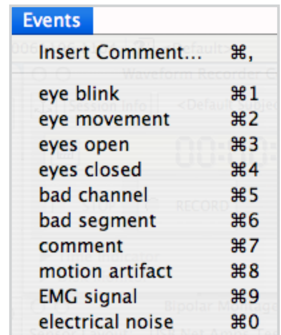


Figure 3-19. Events menu

The buttons on the Events control strip of the Dense Waveform Display perform the same function.

The display of mark-up events in the Dense Waveform Display and the use of the Events control strip are covered on page 150.

Devices in General

Net Station provides six classes of Workbench devices for configuring acquisition (Table 3-2).

Table 3-2. Device class descriptions

Device class	Provides...
Display	Windows and controls for viewing waveform and event data and for entering events.
Filter	Controls for choosing and setting parameters for digital waveform filters.
Mixer	Windows and controls for mixing multiple channels into a single channel.
Recorder	Controls for starting, stopping, and pausing recording.
Source	Controls for choosing the manner in which EEG and digital input event data are acquired.
Stimulus/Response	Controls for configuring how stimulus presentation and subject responses are handled.

On the face of the device icon, the device's class is shown along with the device's name and version number. Using the Dense Waveform Display device as an example, Figure 3-20 demonstrates that:

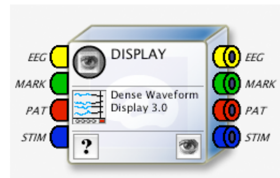


Figure 3-20. Example device

- A device has an input and output side, except for a couple of exceptions (Source devices have only outputs, and the Digital Video device in the Display class has no input or outputs; this is discussed in Chapter 9).
- A device's class is indicated by a class icon unique to the class, and the device itself carries an icon that is unique to the device.
- A device has buttons on its face for deploying various info, display, and control panels. (Not all devices have all three; notice that the Dense Waveform Display has only info and display buttons.)

Core Devices

Workbench configurations need a Source, a Display, and a Recorder device, hence the following Net Station devices are termed, respectively, *core* devices:

- Net Amps USB, Net Amps 300, or Neurotravel USB
- Dense Waveform Display
- Waveform Recorder

A basic Workbench configuration consisting of only the three core devices is shown in Figure 3-21. This is actually the configuration used in the default Primitive Acquisition Setup (for details, see page 132).

Source Display Recorder

Figure 3-21. Three core devices in a Workbench configuration

Cables and Jacks

Devices have from zero to four input and output jacks. Inputs are located on the left, outputs on the right (Figure 3-22). When you configure devices on the Workbench, you drag from the output jack of one device to the input of another and thus create a connecting cable (see "Placing and Connecting Devices" on page 66).

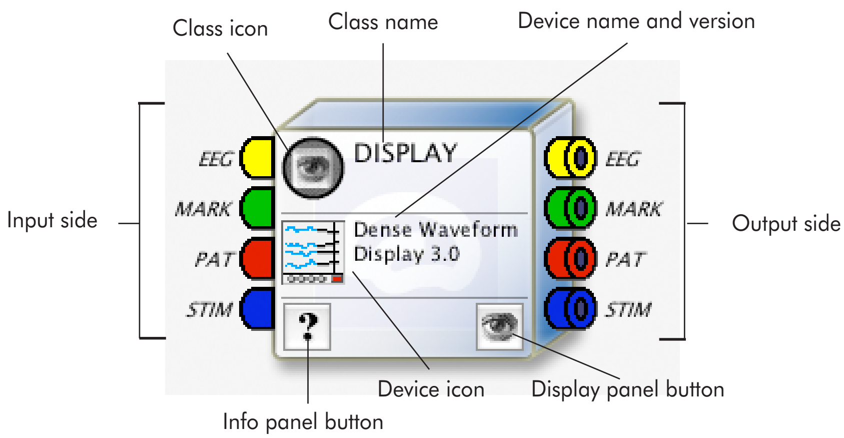


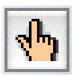
Figure 3-22. Dense Waveform Display device with parts labeled

Jacks are labeled and color-coded to match the four types of cables. The four jack types are:

- *EEG*: Waveform I/O; colored yellow. The yellow cable carries waveform data and all the necessary information to display such data, including sampling rate, montage, filter, gain, scale, and source device calibration information.
- *MARK*: Event marking I/O; colored green. The green cable carries information about user-generated events (for example, technician markups that are made in the Dense Waveform Display; see Chapter 6).
- *PAT*: Auto Pattern I/O; colored red. The red cable carries computer-generated events (for example, pattern recognition results).
- *STIM*: Stimuli I/O; colored blue. The blue cable carries events that originate at the Net Amps DIN port and those sent to Net Station by an experiment control computer (for example, with E-Prime).

Device Buttons

Info panel button: All devices have an information panel button identified by a question mark. Clicking this button opens a panel that contains basic information about the device. See “Info Panels for All Devices” on page 72.



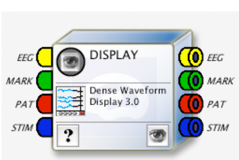
Control panel button: Labeled with a pointing hand or “finger,” the control panel button deploys floating, device-specific windows that feature a variety of control elements.

Display panel button: The “eye” indicates a button that deploys device-specific windows containing a variety of data display elements. Some display panels have buttons for initiating measurements, such as the Net Amps USB Device Display Panels (page 102).

Device Panels

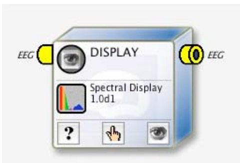
Table 3-3 describes the Net Station devices, in the order that they appear in the Devices palette (Figure 3-23).

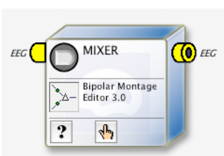
Table 3-3. Panel references

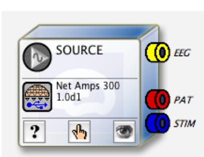


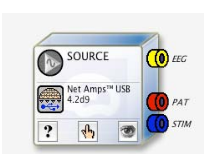
Device	Panels
Dense Waveform Display EEG waveform viewer with controls for altering the rate, scale, and appearance of dense array EEG. Input device for technician markup events.	Dense Waveform Display Info Dense Waveform Display
Digital Video FireWire digital video synchronized with the EEG waveforms	Digital Filter Info Digital Filter Controls

Table 3-3. Panel references (Continued)



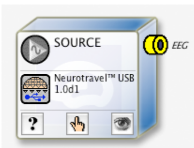






Device	Panels
Spectral Display Near-real-time display of spectral data. Takes same data shown in the Dense Waveform Display (montage and reference information) as the data input.	Spectral Display Info Spectral Display Controls Panel: *Settings for controlling the amount of spectral data shown in the Spectral Display* Spectral Display Display Panels: *Spectral Display of data in Grid, Topo Plot, or Topo Map views*
Digital Filter IIR filter with user-customizable settings. Use only for visualization of data, not recording.	Digital Filter Info Digital Filter Controls
Bipolar Montage Editor Channel-grouping, mixing, and rereferencing tool. Rearranges how channels are displayed.	Bipolar Montage Editor Info Montage Controls
Waveform Recorder Writes EEG and event data to a Session or Recording file.	Waveform Recorder Info Waveform Recorder Controls
Net Amps 300 The control and data interface to the Net Amps 300 amplifier. When the Workbench is “on,” it conveys live data and events to devices connected to it.	Net Amps 300 Info Net Amps 300 Control Panels: *Net Amps 300, Advanced Net Amps Controls, Digital Input Controls, Amp Diagnostics* Net Amps 300 Display Panels: *Gains, Zeros, Noise, Impedance*
Net Amps USB The control and data interface to the Net Amps 200 amplifier. When the Workbench is “on,” it conveys live data and events to devices connected to it.	Net Amps USB Info Net Amps USB Control Panels: *Net Amps Controls, Advanced Net Amps Controls, Digital Input Controls, Amp Diagnostics* Net Amps USB Display Panels: *Gains, Zeros, Noise, Impedance*

Table 3-3. Panel references (Continued)



Device	Panels
Neurotravel USB The control and data interface to the Neurotravel amplifier. When the Workbench is “on,” it conveys live data and events to devices connected to it.	Neurotravel USB Info Neurotravel USB Control Panels: *Sampling Rate* Neurotravel USB Display Panels: *Impedance*
Multi-Port Experimental Control Interface Transports stimulus and user response events from the ECC to other Workbench devices.	Multi-Port ECI Info Multi-Port ECI Display
Photic Stimulator Transports photic-stimulator events from the photic stimulator to other Workbench devices.	Photic Stimulator Info Photic Stimulator Display

Devices Palette

Devices can be placed on the Workbench via the Devices palette (Figure 3-23) or from the Acq menu (“Acq” on page 54). "Placing and Connecting Devices" on page 66 describes how to access the Devices palette and drag devices from the palette to the Workbench.

For now, note that on the palette, the icon on the left is the class icon. The device icon is next to it, followed by the device name. Beneath the name is the device class name. The devices on the palette are always sorted by class name, the same sort order used for Table 3-3.

Figure 3-23. Devices palette

Placing and Connecting Devices

You place devices on the Workbench and link them together with cables to create a Workbench configuration. Devices can be moved onto the Workbench only when the Workbench is off. Cables convey data from one device to another.

Create cables by using the mouse to drag from one jack (either input or output) to another (Figure 3-24). Inputs connect to outputs, and vice versa. The Workbench interface automatically rejects connections that are disallowed. If a connection is allowed, it is valid.

Note: Not every possible Workbench configuration will produce your expected result; if you experience difficulties with a Workbench configuration, contact Technical Support (Appendix A).

More than one output cable can be attached to a device so that the device's data can stream into more than one device simultaneously. Also, some devices accept multiple input cables.

How to Place Devices on the Workbench

Launch Net Station to open the start-up window. In the Customize section, click the Acquisition Setup button. The Workbench, Acquisition status panel, Workbench menu bar, and Devices palette appear.

The Workbench is a grid of rectangles. Each rectangle is called a *cell*. You can place a single device into each cell.

Drag a Net Amps USB, Net Amps 300, or a Neurotravel USB device from the Devices palette to a Workbench cell. The result should resemble frame 1 in Figure 3-24.

Use the Acq menu to place a Dense Waveform Display device into the cell that adjoins the Net Amps USB, Net Amps 300, or Neurotravel USB cell on the right. Do this by first single-clicking the cell to the right of the one that holds the amplifier device, which causes the cell to be highlighted. Choose Dense Waveform Display from the Acq menu (see frame 2 of Figure 3-24).

How to Cable Together Two Devices

Connect the EEG output jack of the amplifier device to the EEG input jack of the Dense Waveform Display by placing the cursor over the output jack of the Net Amps USB, Net Amps 300, or Neurotravel USB device (frame 3 of Figure 3-24), then dragging to the right until the cursor is over the input jack of the Dense Waveform Display device. Release the mouse button to complete the connection (frame 4 of Figure 3-24).

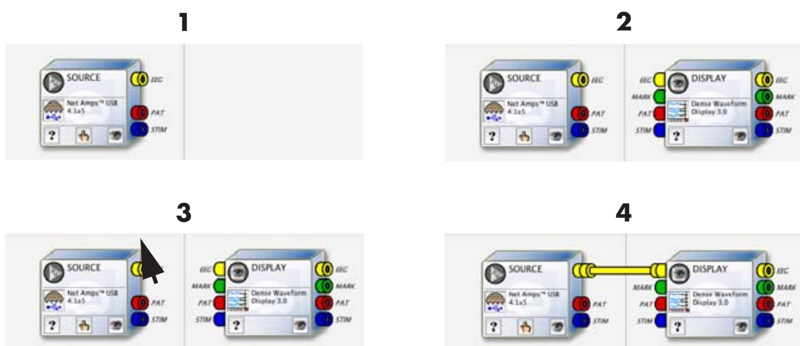


Figure 3-24. Cabling two devices together

When two or more devices must be cabled to the same output jack, you must drag *from* the downstream device *to* the upstream device, or you will not be able to make the one-to-many connection.

Spectral Display Device

The Spectral Display device contains only EEG inputs and outputs because it shows frequency information for EEG data and does not display user or experimental events as the Dense Waveform Display does. However, similar to the Dense Waveform Device, you can have more than one Spectral Display device on your Workbench.

To add the Spectral Display device to an Acquisition Setup, you can place it anywhere on the Workbench. If you wish to view spectral data with filters, montages, and other devices applied, then place the Spectral Display device downstream of those devices. During review, you have the option of viewing spectral data with or without viewer transformations applied. For more information, see the *Net Station Viewer Technical Manual*.

Figure 3-25 shows a sample Workbench configuration. During acquisition using this setup, one Spectral Display presents the unprocessed data, another Spectral Display shows filtered and rereferenced data, the Dense Waveform Display also shows the processed data, and the Waveform Recorder device records the unprocessed data and the user and experiment events.

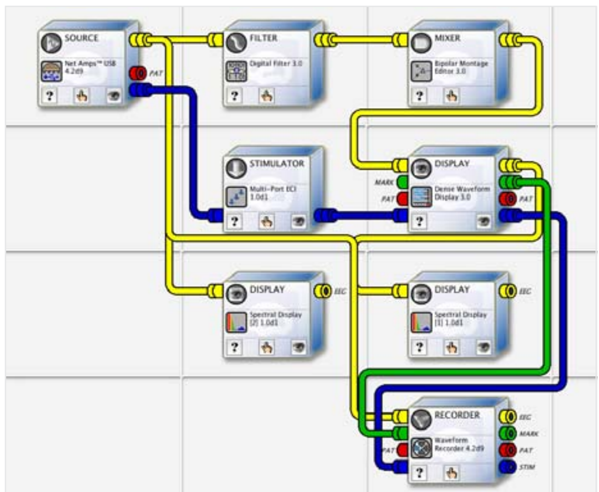


Figure 3-25. Sample Workbench configuration with multiple Spectral Display devices

Optional Digital Video Device

The Digital Video device has no inputs or outputs because it is an auxiliary device that is automatically linked to the Waveform Recorder. Add it to the Workbench without connecting cables to or from it, and save the Acquisition Setup. During recording, it automatically receives the start and stop recording commands from the Waveform Recorder device. See Chapter 9 for more information.

chapter 4

Workbench: Controls/Displays

The Workbench offers a number of devices and panels to help you create the Acquisition Setup you need. The core devices are Source, Display, and Recorder; once you have these connected, add other devices and configure them as desired.

This chapter starts with an overview of the five core devices: Net Amps USB and 300, Neurotravel USB, Dense Waveform Display, and Waveform Recorder.

The chapter then describes in detail the panels for *all* the devices. These panels include:

- info panels
- control panels (for example, file size, Net Amps calibration, digital inputs)
- display panels (amplifier and GSN noise tests, electrolyte bridge detection, and so on)

Overview of the Core Devices

This section briefly describes the five core devices: Net Amps USB and 300, Neurotravel USB, Dense Waveform Display, and Waveform Recorder.

Net Amps USB and 300 Devices

The Net Amps USB and 300 devices provides software control of the Net Amps 200 and 300 amplifiers. Data being collected by the real-world amplifier are brought into Net Station via the output jacks of the Net Amps USB or 300 device.

If the system is collecting EEG, other Workbench devices can access the EEG when their input EEG jacks are hooked up to the output jack of the Net Amps USB or 300 device.

Net Amps 200 and 300 support the following features:

- digital inputs (DINs)
- automatic amplifier calibration
- automatic impedance measurement
- automatic noise measurement
- electrolyte bridge detection
- analog signal filtering

These features are accessible through the Net Amps USB or 300 device control and display panels. The panels for the two devices are nearly identical and are described in the same sections. Descriptions of the Net Amps USB and 300 device control panels begin on page 85. Descriptions of the Net Amps USB and 300 device display panels begin on page 109.

Neurotravel USB Device

The Neurotravel amplifier works the same way as the Net Amps 200. It collects real-time data and sends them to Net Station by way of a USB cable connected to the DAC.

As with the Net Amps USB device, other Workbench devices can access the EEG collected by the Neurotravel amplifier. When creating the Acquisition Setup, just connect the output jack of the Neurotravel USB device to the input EEG jack of the desired devices.

However, the Neurotravel amplifier is a 32-channel clinical unit and, consequently, has fewer features than either the Net Amps 200 or 300 amplifier.

The Neurotravel amplifier contains no digital inputs connector, no hardware support for electrolyte bridge detection, and no user controls for setting the analog signal filter (hardware filter). The filter is set to 0.016–141.0 Hz, bandpass, and cannot be changed. The amplifier requires no calibration or noise tests, but does run a calibration test signal. Impedances can be measured but not stored.

The Neurotravel filter, calibration signal, and impedance features are viewable in the Neurotravel USB device control and display panels. Descriptions of the Neurotravel USB device control panels begin on page 101. Descriptions of the Neurotravel USB device display panels begin on page 126.

Dense Waveform Display Device

The Dense Waveform Display device (Figure 4-1) is used for viewing EEG waveforms and event tracks. In addition, it is an input interface for technician markup events that can be entered and recorded along with the EEG in the Dense Waveform Display MARK event track.

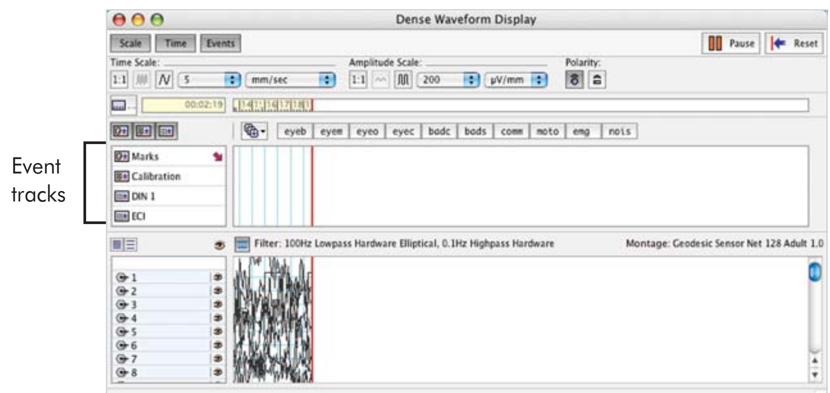


Figure 4-1. Example Dense Waveform Display

EEG and DINs are correctly set up for display by the Workbench configuration shown in Figure 3-21 on page 61. The EEG and STIM cables are both connected from the source device to the Dense Waveform Display.

The Dense Waveform Display display panel is briefly described, beginning on page 109. Because the Dense Waveform Display is such a major part of Net Station, an entire chapter is also devoted to it; see Chapter 6.

Waveform Recorder Device

Recording EEG to disk is accomplished by cabling EEG data on the Workbench to the Waveform Recorder device. The Workbench configuration in Figure 3-21 shows that the EEG data cable coming out of the Net Amps USB device does not need to connect directly to the input of the Waveform Recorder. The data can “pass through” another device on their way to the recorder. In this case, they pass through the Dense Waveform Display.

In the Workbench configuration shown in Figure 3-21, DIN events are conveyed to the recorder by connecting the STIM output of the source device to the Dense Waveform Display and hooking the STIM output of the Dense Waveform Display to the recorder’s STIM input. DIN events will be recorded along with the EEG. No time delay is introduced by the Dense Waveform Display device being connected between the source and recorder devices.

The Dense Waveform Display device provides an interface for entering technician mark events into a recording. For these events to be registered in a recording, the MARK input of the Waveform Recorder device is connected to the MARK output of the Dense Waveform Display (as in Figure 3-21).

A description of the Waveform Recorder device control panel begins on page 78.

Info Control Display

Device Panels for All Devices

In most cases, device panels are deployable via device buttons (see “Device Buttons” on page 63) and optionally by menu commands that Net Station installs in the Panels menu (see “Panels” on page 54), depending on which devices are part of the active Acquisition Setup. An exception are the Net Amps USB and 300 devices. Some of the control and display panels for this device are available only from the Panels menu.

Info Panels for All Devices

Each device has an info panel, which you can view by clicking the info panel button on the device (Figure 4-2).

The info panel contains general information about the device, including version number. Figure 4-3 shows the info panels for all the devices.

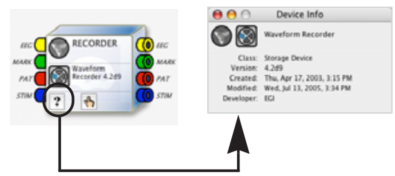


Figure 4-2. A device info panel

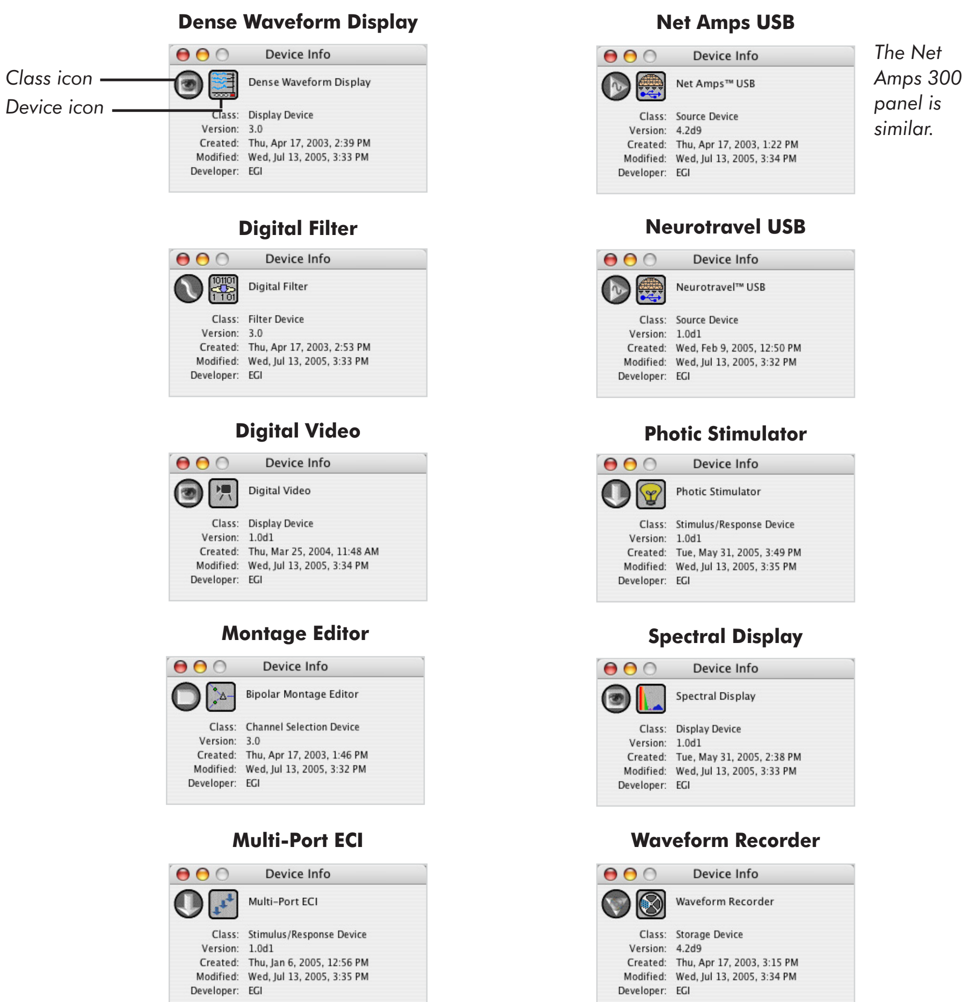


Figure 4-3. Info panels for all the devices

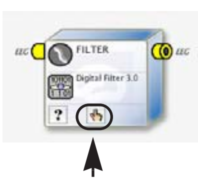
Control Panels for All Relevant Devices

Not all devices have control panel buttons.

Those devices that *do* contain control panel buttons are:

- Digital Filter
- Montage Editor
- Waveform Recorder
- Net Amps USB
- Net Amps 300
- Neurotravel USB
- Multi-Port ECI
- Photic Stimulator
- Spectral Display

This section describes each control panel in detail.



Digital Filter Control Panel

To open the Digital Filter controls panel (Figure 4-4):

- click on the control panel button on the Digital Filter device or
- choose **Panels > Digital Filter Controls**.

Caution!: *See page 77 for a caution against placing this Filter device in a configuration that would result in digitally filtered data being recorded.*

Control Panel Description and Usage

You customize a Digital Filter device's effect by choosing to activate one, two, or all three of the available filter effects:

- lowpass
- highpass
- notch

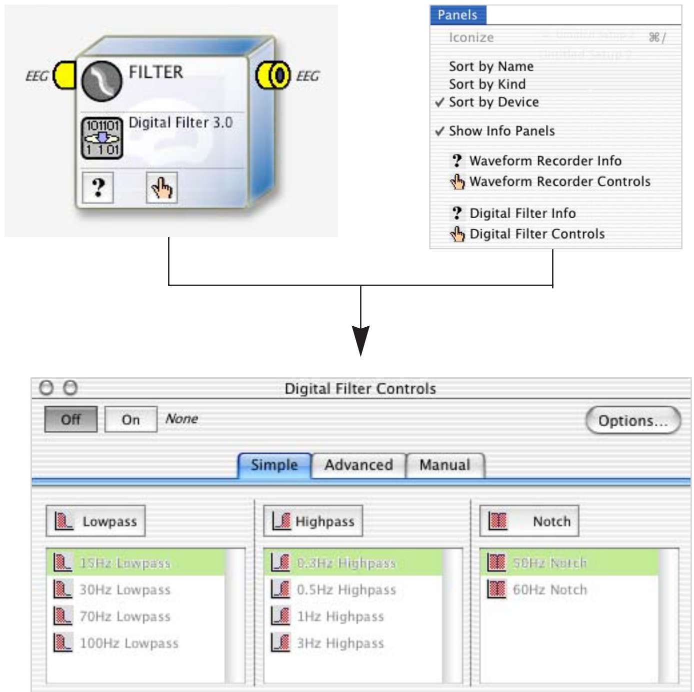


Figure 4-4. Digital Filter Controls

Activate lowpass digital filtering by toggling the Lowpass button to its "on" position (Figure 4-5) and clicking one of the available presets below the button. The selected preset is highlighted. The Highpass and Notch toggle buttons work exactly the same way.

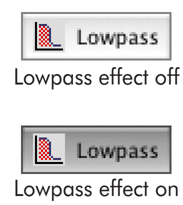


Figure 4-5. Effect of toggling the Lowpass button

The presets of a given list are mutually exclusive choices, but the Lowpass, Highpass, and Notch buttons can be set in any combination.

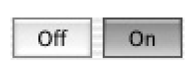


Figure 4-6. Appearance of buttons when filter is on

When a Digital Filter device's input is connected to an EEG cable carrying EEG, the output jack of the Digital Filter device produces filtered EEG according to the activated preset effects—***but only if the Digital Filter device has been turned on.*** In the top-left portion of the control panel are two buttons you use to turn the Digital Filter device off and on. These buttons indicate by their appearance (Figure 4-6) the current state of the device. When it is on, the filter produces an effect that is a combination of your selections (see example in the following "Filter Types" section). When the Digital Filter device is off, data pass through it unchanged.

Filter Types

Some filtering terminology:

- *Lowpass filters*: pass low frequencies and attenuate high frequencies.
- *Highpass filters*: pass high frequencies and attenuate low frequencies.
- *Notch filters*: are set to attenuate a single frequency, for example, 50 Hz or 60 Hz, with sharply limited attenuation of frequencies above and below the target frequency.
- *Bandpass and bandstop filters*: are shorthand ways to describe a combination of lowpass and highpass filters. Bandpass filters attenuate frequencies on either side of a band, allowing the band to pass unattenuated. Bandstop filters attenuate frequencies above a certain frequency and below a higher frequency, so that only frequencies not in the band are allowed to pass unattenuated. A notch filter is a kind of bandstop filter, one with a particularly sharp profile.

  For example, you can choose a 1–100 Hz bandpass filter by picking a 100-Hz lowpass filter and a 1-Hz highpass filter. Next to the On button a label will appear, describing the filter that has been built.

Clicking the close button of the control panel or choosing **File > Close Window** causes the control panel to disappear, but the filter is still active as long as the Workbench is on and the panel was closed with its On button selected.

Multiple Digital Filter devices can be used in a Workbench setup, each with its own parameters.

IIR Filtering

Net Station offers IIR filtering using the Digital Filter device. IIR filtering is rapid, but an IIR filter lacks linear phase response (the amount a filter shifts each frequency component in time).

Linear phase response is necessary to obtain a filtered signal with no distortion. The inherent distortion of IIR filtering disqualifies it for use in transforming data, but it is adequate for data visualization. IIR filtering is very useful, for example, for observing real-time waveforms with 60-Hz environmental noise (common in the United States) filtered out.

Net Station presents a Caution message whenever you cable together a Workbench configuration that has a recorder device downstream of the Digital Filter device (Figure 4-7). You are free to click the OK button in the Caution dialog and accept the configuration, but see the Caution message below.

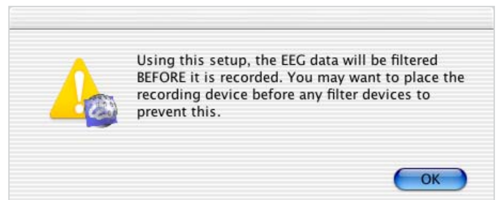
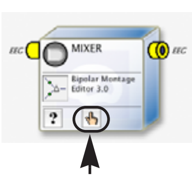


Figure 4-7. Recording of IIR-filtered data is inadvisable

Caution!: *Connecting an active Digital Filter ahead of and in series with the Waveform Recorder device results in filtration of the data being recorded. IIR filters are not appropriate for this purpose. Do not connect a Digital Filter device in such a way that the data are acted upon by the filter before they are recorded.*

Montage Editor Control Panel



The term *montage* refers to a specific way of defining sensor data visualization.

To open the Montage controls panel (Figure 4-8):

- click on the control panel button of the Bipolar Montage Editor device or
- choose **Panels > Montage Controls**.

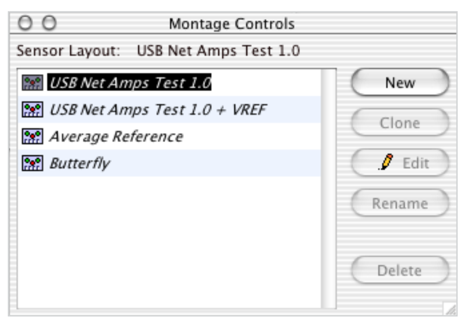


Figure 4-8. Montage controls panel (Workbench on)

When the Workbench is off, the montage list is not displayed in the panel. When the Workbench is on, single or multiple montages will be listed.

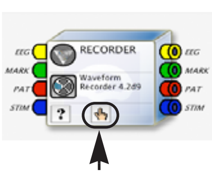
Net Station includes preconfigured montages for Geodesic EEG Systems. The ones that match the channel count of the Geodesic Sensor Net being used will appear in the list if a Net is connected to the system. If a Net is not connected, only default channel-count montages are listed.

Rereferencing the signals of all the sensors of a Net to a reference consisting of the mean signal of all the sensors is called *average referencing*. An average reference montage appropriate to the connected Net's sensor density is included in the montage list.

You can choose other available default montages from the list. Clicking the "eye" icon to the left of any montage label in the Montage controls panel moves the "eye" icon to the selected montage, and the EEG channels being displayed in the Dense Waveform Display (Chapter 6) will immediately reflect the newly selected montage.

Note: Applying a montage does not alter the data being recorded; it only modifies the way the data are displayed onscreen.

Sensor maps showing the architecture of the default listed montages for EGI's 32-, 64-, 128-, and 256-channel Nets are given in Appendix C, "Montages," which includes a table indicating the referencing scheme for each montage.



Waveform Recorder Control Panel

The job of the Waveform Recorder device is to take the data coming in to its inputs and write them to Net Station Recording and Session files (see "Recording Modes and File Sizes" on page 79).

With the Workbench, you take control of recording via the Waveform Recorder controls panel (Figure 4-9), which you can open by:

- clicking the control panels button on the Waveform Recorder device or
- choosing **Panels > Waveform Recorder Controls**.

The Waveform Recorder Controls panel features tape-recorder–style Stop and Record buttons. You toggle between two sizes of the control panel using its "anchor" button. The minimized or "small controls" version of the control panel is not movable and anchors to the bottom of the screen. The "large controls" version can be repositioned anywhere on the screen by dragging.

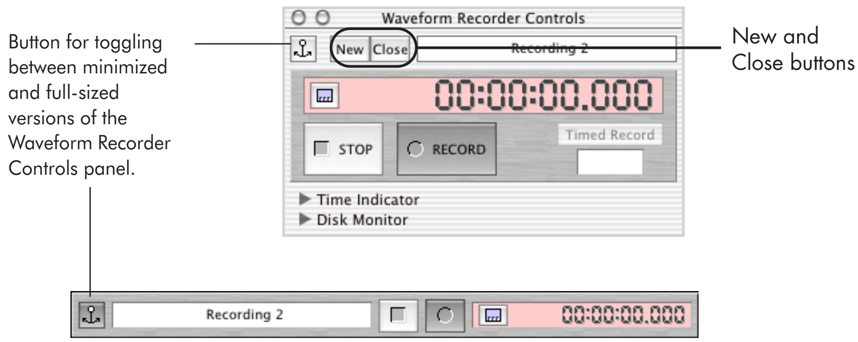


Figure 4-9. Waveform Recorder Controls (Workbench off)

When recording a Session file using a Session Template, the Waveform Recorder Controls panel is identical to its Workbench version except for the New and Close buttons being replaced by a Session Info button (Figure 4-10). The anchor and other buttons work the same way.

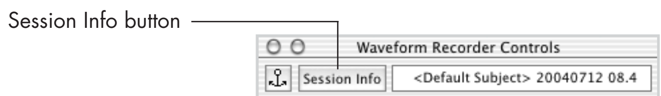


Figure 4-10. Waveform Recorder Controls detail (Session)

Recording icon

Session icon

Recording Modes and File Sizes

Net Station writes two EEG data file types during acquisition:

- Net Station Recording (created using an Acquisition Setup)
- Net Station Session (created using a Session Template, clinical or research)

Both file types have a default file-size limit of 1.8 GB. You can change the file size by choosing **Net Station > Preferences** and typing in a value from 100 to 1,800 MB in the Recording File Segments section at the bottom of the window (Figure 4-11).

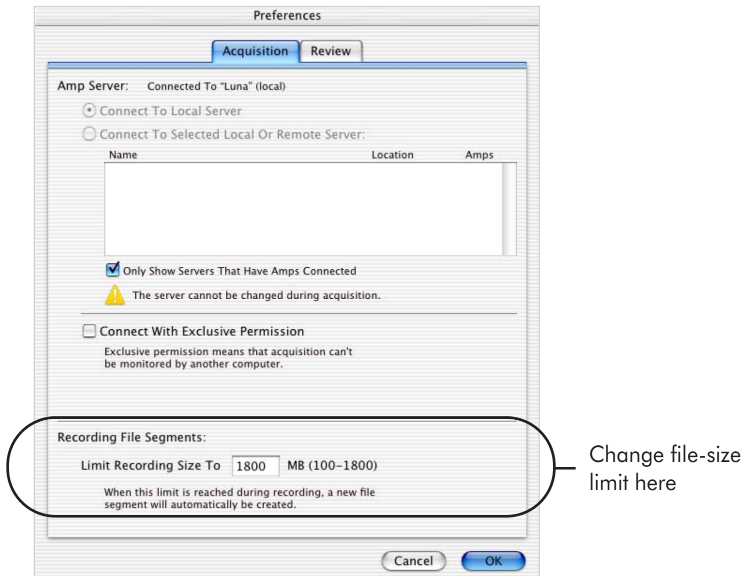


Figure 4-11. File-size limit

During acquisition, Net Station stops recording if the file-size limit is reached, and immediately starts recording a new file, providing continuous recording with no loss of data. The automatic file-naming convention is 00_<filename>, 01_<filename>, and so on.

Note: For long acquisition sessions resulting in multiple files, we recommend creating a file folder for storing each session's files. This prevents the overwriting of identically named files from different sessions.

To review the recorded data in the Viewer, open any of the Session files for that recording. A message automatically displays, indicating that other files are associated with that file (Figure 4-12).

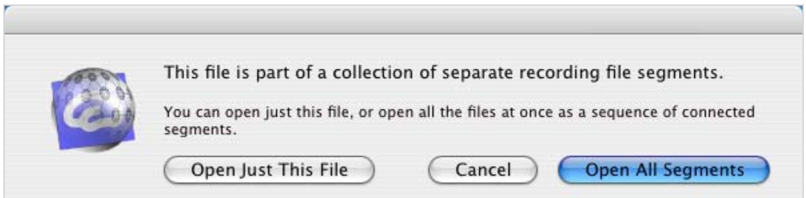
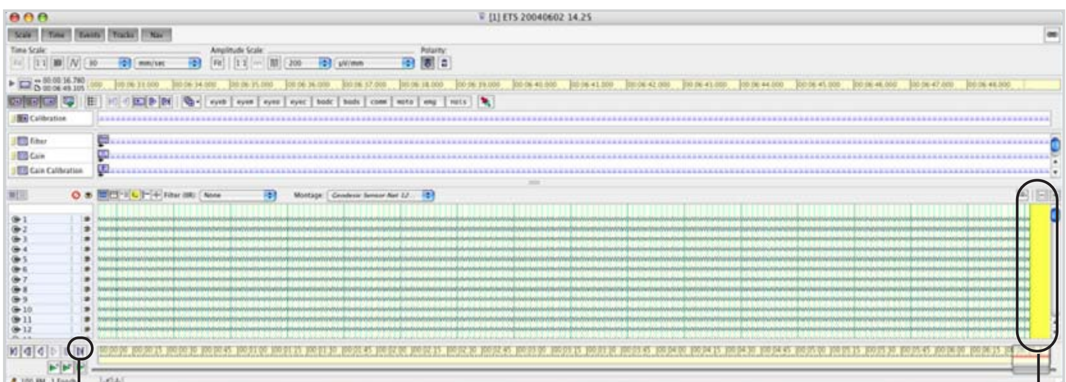
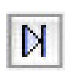


Figure 4-12. Additional-file message

Click Open All Segments, which will automatically open the first file of the recording. When you navigate to the end of that file, a thick yellow vertical bar indicates that the data are continued in another file. Click the Go To End navigation button (Figure 4-13) to open the next file in the data session automatically. When you navigate to the end of the last file in the recording, the Go To End button is dimmed, indicating the end of the recorded data.



The Go To End button is active, indicating that the recording contains more data. Click this button to open the next file in the recording automatically.



The thick yellow bar indicates that the data continue to another file.

Figure 4-13. The first file in a multifile recording

Net Station Recording File

You create Net Station Recording files by using the Workbench environment. As soon as you click the Record button of the Waveform Recorder Controls panel, Net Station starts writing a file. The elapsed time area of the panel changes from yellow to pink and the elapsed time counter begins (Figure 4-14).

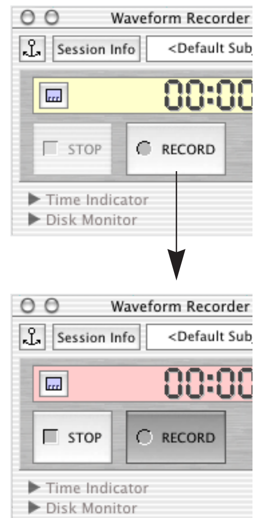


Figure 4-14. Click the Record button

Clicking the Stop button suspends recording but does not close the Recording file. Clicking the Record button after Stop reinitiates recording to the same file, appending additional data to it.

When you click the Close button in the control panel, the Recording file closes and cannot be overwritten or appended to. You can initiate a new Recording file by clicking Record.

Toggling Record and Close creates successive recording files that are autonamed in the series, "Recording 1," "Recording 2," and so forth. The default destination of these files is the Sessions folder (see page 40 for details).

Clicking the New button invokes the appearance of a file-naming and destination window. Typing a file name overrides the default autonaming scheme.

Recording files can contain multiple epochs of EEG. As noted earlier, the Stop button halts recording without closing the file. Clicking the Record button appends data to the file until you click the Stop button again. In this way, the resulting Recording file will contain a sequence of multiple epochs delineated by epoch boundaries.

Net Station Session File

You use a Session Template to initiate Session files. When a new session is initiated, the Waveform Recorder Controls panel becomes available on the Panels menu after you click the Begin Session button in the New Session panel.

Record and Stop buttons work the same way in a session as they do when you are using the Workbench (see earlier) and allow you to create multiepoch files.

Figure 4-15. Session Info and Close Session buttons

Close the Session file by clicking the Close Session button (Figure 4-15), which occupies the right side of the Acquisition status panel when a session is under way.

During a session, the Close Session button performs the same function as the Close button on the Waveform Recorder Controls panel when you are using the Workbench.

For an example Session, see Chapter 7, “Sessions and Session Templates.”

Time Indicator and Disk Monitor

Figure 4-16 shows how the Waveform Recorder Controls panel might appear during Workbench recording. The two disclosure triangles independently toggle the deployment of the Time Indicator and Disk Monitor subpanels.

The Time Indicator subpanel works just like the Elapsed Time area. During recording and at pauses during recording, it reports the passage of time using a chosen time mode (see the next section, "Time-Mode Buttons").

The Disk Monitor shows how much space or recording time is left on the disk to which the recording is being made.

Note: It is safe to toggle the buttons of the Disk Monitor subpanel during recording. This has no effect on the data being recorded.

Time-Mode Buttons

With its two time-mode buttons (see Figure 4-16), the Waveform Recorder Controls panel allows you to monitor elapsed time in more than one format simultaneously. Net Station’s time modes are shown in Table 4-1. You can select Absolute, Relative, or Epoch mode by toggling a time-mode button. Toggling the time-mode buttons is permitted during recording and does not affect the data being recorded.

Recording Time mode is not one of the options; it is available only in the Dense Waveform Display.

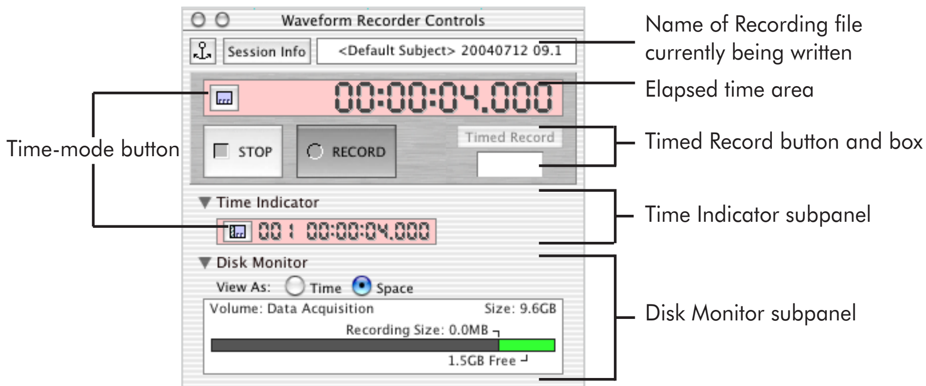
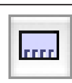
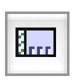
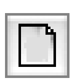


Figure 4-16. Expanded Waveform Recorder Controls panel

The time-mode buttons do not acquire a “pushed-in” appearance, but the symbol displayed on the face of such buttons always reports the time mode that is in effect (see Table 4-1).

Table 4-1. Time modes

Symbol	Time mode	Time reckoning scheme
	**Absolute** (Clock)	980105/18:39:11 date (yymmdd)/hour:minute:second
	**Relative** (Workbench)	00:03:22 hour:minute:second
	**Epoch**	[3]00:08:23 [epoch number]hour:minute:second
	**Recording**	00:05:59 hour:minute:second

Timed Record

The button and field labeled "Timed Record button and box" in Figure 4-16 provide a means for stopping a recording after a set period of time, with the default time equal to 20 seconds. This feature is useful when a series of epochs needs to be generated, each with exactly the same duration.

When the Timed Record button is initially pushed in, the box displays the default set time of 20 seconds, and the box becomes editable (Figure 4-17). Editing is performed by selecting each digit individually and typing over it to create a new set time, which will persist until edited again.

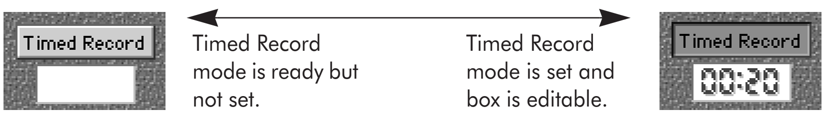
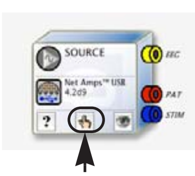
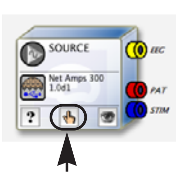


Figure 4-17. Using the Timed Record feature

Whenever the Timed Record box is displaying a set time, clicking the Record button on the Waveform Recorder Controls panel causes timed recording to begin. As soon as recording begins, the Timed Record box becomes a countdown display, ticking off the seconds until the new epoch is finished being recorded. The box then reverts back to displaying the duration that was last set.





Net Amps USB and 300 Control Panels

Unlike other Net Station devices, the Net Amps USB and 300 devices have multiple control panels:

- *Net Amps Controls*: to open, click on the control panel button on the Net Amps USB or 300 device or choose **Panels > Net Amps Controls**.
- *Digital Input Controls*: to open, choose **Panels > Digital Input Controls**.
- *Amp Diagnostics*: to open, choose **Panels > Amp Diagnostics**.

The Net Amps USB contains a fourth panel (Figure 4-18):

- *Advanced Net Amps Controls*: to open, choose **Panels > Advanced Net Amps Controls**.

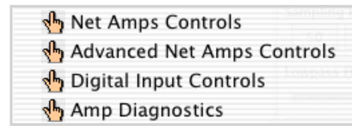


Figure 4-18. Net Amps USB Control panels (Panels menu)

Net Amps Controls

When the Net Amps USB or 300 device is a part of a Workbench configuration, the Panels menu displays its four or three control panels as shown in Figure 4-18. Chief among these panels is the Net Amps Controls panel, which gives access to and control over the Net Amps sampling rate, multifunctional amplifier calibration sequence, and impedance measurement interface.

The Net Amps USB Controls panel also contains controls for a lowpass hardware filter; the Net Amps 300 Controls panel does not.

To open this panel (Figure 4-19):

- click the control panel button on the Net Amps USB or 300 device or
- choose **Panels > Net Amps Controls**.

The panel consists of the notification area, Sampling Rate buttons, Lowpass Hardware Filter slider (for Net Amps USB only), Calibrate Amplifier button, and Measure Net Impedance button.

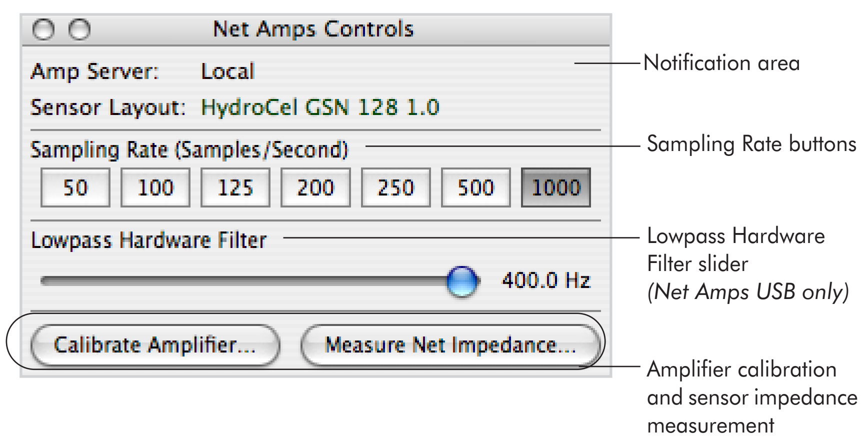


Figure 4-19. Net Amps Controls (default settings)

Notification Area

The notification area delivers information about the status of Net Station's USB or FireWire connection to the Net Amps. For example, if Net Station detects that an amplifier is not connected, it displays the message shown in Figure 4-19: <unknown - no amps connected>.

Sampling Rate Settings

Net Station defaults to collecting EEG at 250 samples per second, but you can click a Sampling Rate button to change this, even during recording. However, changing sampling rates during recording can complicate subsequent data analysis.

When recording begins, the initial sampling rate setting is stored in the Sampling Rate track of the Recording or Session file. Any subsequent sampling rate changes that you may make during recording are also registered in the Sampling Rate track with the time of their occurrence.

Lowpass Hardware Filtering Settings for the Net Amps

Net Amps 200 electronics perform lowpass analog filtering before digitization. Controls for setting the lowpass cut-off frequency are on both the Net Amps Controls panel and Advanced Net Amps Controls panel (see page 85).

The default cut-off frequency is close to the Nyquist frequency, subject to the setting of the Auto Set to Nyquist checkbox on the Advanced Net Amps Controls panel.

Note: See "Antialiasing and Lowpass Filtering" in Chapter 5, "Amplifiers," in the GES Hardware Technical Manual, *if you are considering setting the lowpass cutoff below the Nyquist frequency, which generally is not recommended.*

The Net Amps 300 also performs lowpass analog filtering, but it sets the cut-off frequency automatically, based on the sampling rate chosen. No filter controls are included in the Net Amps 300 Control panel.

Amplifier Calibration

Assuming the physical components of the system are connected and switched on, the amplifier is calibrated using the Net Amps Controls panel of the Net Amps USB or 300 device (Figure 4-19). Such calibrations can be automated using an appropriate Session Template (see “Automatic Amplifier Calibration” on page 168). Likewise, sensor impedances (“Net Noise Display Panel” on page 117) and noise (“Noise Display Panel” on page 114) can be measured and stored in a retrievable way.

To initiate an amplifier zero and gain measurement manually, click the Calibrate Amplifier button. See “Calibration” in Chapter 5, “Amplifiers,” in the *GES Hardware Technical Manual* for complete coverage of this topic, including:

- amplifier calibration process
- gains and zeros

You will see the Measuring Zeros progress bar (Figure 4-20) after clicking the Calibrate Amplifier button. Zeros calibration is performed first, followed by gains calibration. You can cancel both gains and zeros calibration by clicking the Cancel button on the Measuring Zeros progress bar at any time while zeros are being measured. Once the Measuring Gains progress bar appears, you can cancel only the gains measurement.

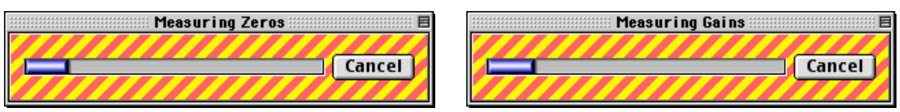


Figure 4-20. Calibration progress bars

Net Station stores gains and zeros measurement sets in Amplifier History files that are sequestered in the Net Station Package file. To review past measurements of gains and zeros, use the Gains display panel and Zeros display panel (see coverage, beginning on page 113).

Net Station checks for out-of-range values for gains and zeros and issues a message if any channel exhibits an out-of-range value. A channel gain is in-bounds if it is between 50% and 150% of its nominal value. A channel zero is specified to be in-bounds if it is between –100 μV and +100 μV. If an out-of-range condition occurs, follow the instructions presented by the Net Station message.

Note: The Gains display panel and Zeros display panel (page 113) also present buttons for initiating gains and zeros measurements, and when used in tandem they duplicate the functionality of the Calibrate Amplifier button. The Calibrate Amplifier button always *performs zeros calibration first, then gains calibration. When using the display panels to initiate calibration, the order of these measurements is unimportant.*

Sensor Impedance Measurements

A sensor array must be plugged into the system for impedances to be measured. Attempting to measure impedances without an array connected, or disconnecting an array during an impedance measurement, will generate an error message.

Net Station begins to measure the contact impedance at each sensor location when you click the Measure Net Impedance button on the Net Amps Controls panel. You can also initiate sensor impedance measurement by clicking the Measure button on the Impedance display panel (see "Impedance Display Panel" on page 120). In both cases, the result is the same: the Impedance Measurement window (Figure 4-57) opens and a sensor impedance measurement begins (for details, see page 121).

A progress bar at the bottom of the Impedance Measurement window is active during the time this window is frontmost on the screen. Net Station performs a scanning operation and reports on it via the progress bar. As soon as Net Station has scanned all the sensors of the array, it updates the window with the latest impedance values, showing them as a list and refreshing the color-coding of the sensor layout. EGI's standard recommendation for scalp impedances is 50 KΩ.

Net Station repeats this cycle until you click the Close or Save & Close button.

Note: Impedance values are not saved to the file unless data are recorded after measuring impedances. Merely clicking the Save & Close button will not save the impedance values.

Advanced Net Amps Controls (Net Amps USB)

Unlike the Net Amps 300, the Net Amps USB contains an Advanced Net Amps Controls panel. You open that panel (Figure 4-21) by choosing **Panels > Advanced Net Amps Controls**.

The panel consists of the Lowpass Hardware Filtering controls and the Highpass Hardware Filtering controls.

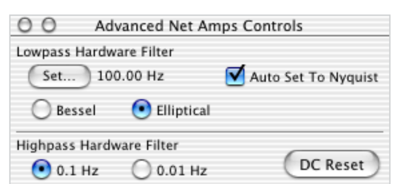


Figure 4-21. Advanced Net Amps Controls panel (default settings); available for Net Amps USB only

Lowpass Hardware Filtering

A choice of Bessel or elliptical (the default) lowpass hardware filtering and an Auto Set to Nyquist checkbox are provided in the upper subpanel. See "Antialiasing and Lowpass Filtering" in Chapter 5, "Amplifiers," in the *GES Hardware Technical Manual* for a discussion of filter types.

Highpass Hardware Filtering

The lower subpanel of the Advanced Net Amps Controls panel is where you can choose the cut-off frequency for the Net Amps highpass filter, with a 0.1 Hz cutoff being the default. Before changing the default, you should study and understand the rationale and theory behind highpass hardware filtering in "Highpass Filtering" in Chapter 5, "Amplifiers," in the *GES Hardware Technical Manual*.

Digital Input Controls

The digital inputs connector (DIN port) on the back panel of the Net Amps 200 and 300 brings in external digital input (DIN) events into your recording. Net Station converts inputs to events based on user-definable rules.

Setting up digital inputs is accomplished through the Net Amps USB or 300 device's Digital Inputs Controls panel. Its STIM output jack is a source for DIN events when the amplifier is configured for receiving digital inputs.

The Digital Input Controls panel allows you to configure how external digital input events are captured by Net Station via the Net Amps.

To open this panel, choose **Panels > Digital Input Controls**.

Background for Using Digital Input Controls

Every Net Amps 200 amplifier has a 9-pin (DB-9) connector (the DIN port) on its rear panel for connection of external devices such as the EGI response pad or external circuitry. The Net Amps 300 amplifier has two 12-pin connectors (two DIN ports), but the current version of Net Station is capable of supporting only 8 inputs.

Net Station monitors the DIN port for external events. The Dense Waveform Display shows real-time DIN events in its tracks area in synch with EEG acquisition.

Depending on the Net Amps 200 serial number, you can monitor as many as four or eight external signals simultaneously through pins 1–4 or 1–9 of the DB-9 connector. With the Net Amps 300, you can monitor as many as eight external signals.

When digital input events are being monitored and recorded along with EEG, they are synchronized with the EEG, with millisecond accuracy.

Note: For Net Amps 200 models with serial numbers 20040135 and later, the pins are 1–9, and for Net Amps with earlier serial numbers, the pins are 1–4; for all Net Amps 200 models, pin 5 is ground. If you are unsure about how many DIN channels your amplifier has (for example, if the number of DIN channels on your amp was specially upgraded), contact support@egi.com.

You may not need or want Net Station to monitor pins 1–4 or 1–9 of the Net Amps' connector. This capability is configurable using the Digital Inputs Controls panel (see page 92).

Mapping Pin Numbers to Net Station Digital Input Events

Because you can toggle a total of four (or eight pins) on the connector independently, a maximum of $2^4 = 16$ (or $2^8 = 256$) event states are possible. Each event state corresponds to a digital input channel.

Net Station maps the DIN port into the four (or eight) bits corresponding to a binary number (Figure 4-22) such that each combination of events corresponds to a number between 0 and 15 (or 0 and 255). Hence, the digital input channels recognized by Net Station can be numbered from 1 to 14 (or 1 to 254), with the remaining event state (no events on any pins) being undesignated as a channel because it is the absence of any digital input.

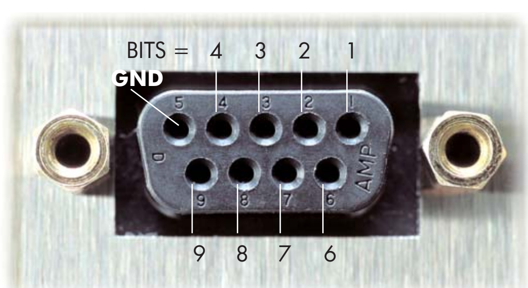


Figure 4-22. DIN port pin numbers map to bits

Acquisition Setup Connections

The STIM jack of the Net Amps USB or 300 device is a spigot for digital input events that are captured at the DIN port by the physical Net Amps 200 or 300 (Figure 4-23).

DIN events will not be recorded unless a STIM cable is connected in a manner that allows flow from the Net Amps USB or 300 device to the Waveform Recorder. The events will not be visible in the Event track of the Dense Waveform Display unless the STIM cable is connected so that DIN events can flow into the Dense Waveform Display device STIM input jack.

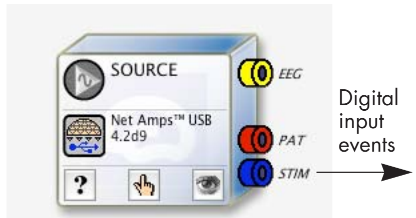


Figure 4-23. Connect STIM to deliver digital input data to downstream device

Physical Connections

"DIN Port" in Chapter 5, "Amplifiers," of the *GES Hardware Technical Manual* provides details on connecting external signals to the DIN port of the Net Amps.

Verify that the Workbench is "off" before attaching devices (for example, an AV tester) to the DIN port, otherwise you may receive an error message.

Digital Input Controls Panel

After you connect an EGI response pad or similar device to the Net Amps' DIN port, you must invoke the Digital Input Controls panel in Net Station and make settings that are appropriate to the input device and how the events are going to be displayed and recorded.

The basic appearance of the panel is shown in Figure 4-24, which indicates how clicking the disclosure triangle either reveals or hides the tabpanel where you make your settings.

Note: The controls of the Digital Input Controls panel are dimmed and unavailable when the Workbench is on. To use the controls, first turn the Workbench off.

Source Tabpanel

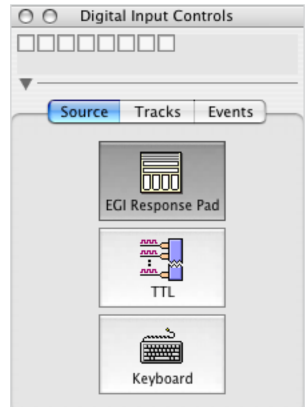
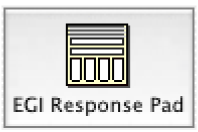


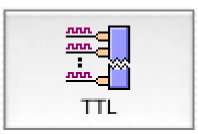
Figure 4-24. Digital Input Controls panel, with Source tabpanel selected

Use the Source tabpanel to choose the mechanism for capturing external events (Figure 4-24). The EGI Response Pad button is the default.

If no external devices are linked to the connector, Net Station ignores the settings of the Digital Input Controls panel, unless you have chosen to designate the keyboard for digital input.



Set the EGI Response Pad button when an EGI response pad is linked to the Digital Inputs connector on the back of the Net Amps. (The EGI response pad connects only to the Net Amps amplifier.)



Set the TTL button when a custom-designed circuit for generating external events has been linked to the Net Amps digital inputs connector. Such a circuit must be able to put TTL-level signals on the DIN port pins. The external circuitry should hold a DIN port pin at ground when not generating events. To generate an event, the circuitry should put a positive TTL-level voltage on the pin momentarily or for a period of time. Such events will be recognized by Net Station appropriately if TTL has been set in the Source tabpanel.

Set the Keyboard button for demonstration purposes only. DIN events will be generated when keyboard buttons are pressed, but without millisecond accuracy.

Tracks Tabpanel

Net Station provides a maximum of eight tracks for registering and recording digital input events. The Tracks tabpanel shown in Figure 4-25 exhibits Net Station's default naming scheme for the tracks (DIN 1–DIN 8). You can edit the text boxes next to the track numbers to rename the tracks. After an Acquisition Setup is saved, your track names will persist in the Net Station interface and in the recorded files.

Events Tabpanel

Use the Events tabpanel (Figure 4-25) to set up which digital input channels should be monitored by Net Station.

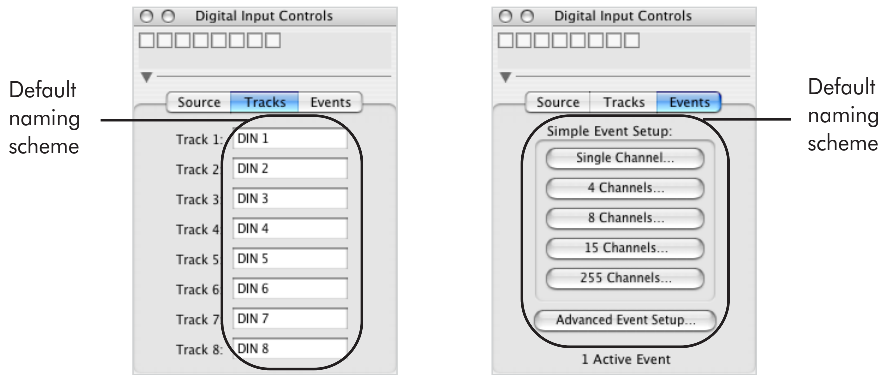


Figure 4-25. Tracks and Events tabpanels

The controls on this panel consist of preset buttons and the Advanced Event Setup button.

Eight pins on the digital inputs connector can receive external events, but not all the pins may need to be monitored. For example, a single response pad has only four keys that are linked to pins 1–4 of the connector. The Events tabpanel permits you to configure the monitoring of digital inputs in a way that is appropriate for your work. With the response pad, this would most likely be the 4 Channels preset.

Notice in Figure 4-25 that the bottom of the tabpanel contains the words “1 Active Event.” This is a visual feedback feature for users, indicating which of the digital input configurations is in effect.

Advanced Event Setup

The Advanced Event Setup button opens the Advanced Event Setup panel. An example setup is presented in Figure 4-26. Digital inputs are configured for recording events occurring on any combination of four (or eight) pins. The total number of possible pin combinations is $4^2 = 16$ (or $4^8 = 256$). (The Advanced Event Setup shows 255 channels, with the 256th corresponding to “no events.”)

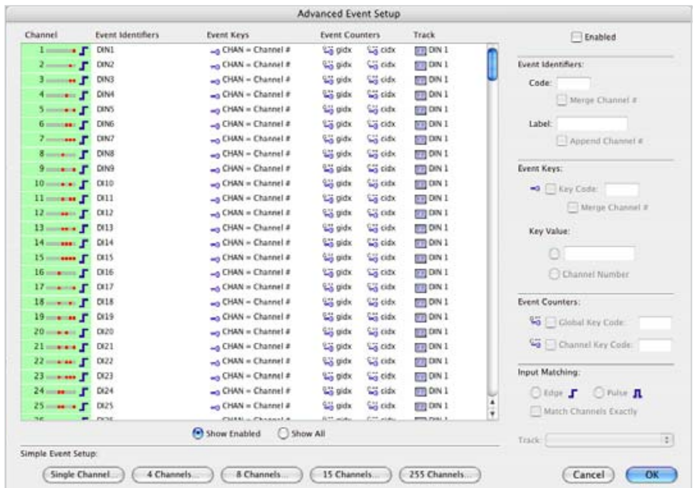


Figure 4-26. Advanced Event Setup

Each digital event channel has a label number with a graphical representation of its binary code next to it. The binary code corresponds to events occurring on the pins of the connector.

Clicking a channel selects and highlights it. Select noncontiguous channels by clicking on them while pressing the Command key. Select multiple contiguous channels by dragging across them.

Selecting a channel (Figure 4-27) activates the subpanels to the right of the channel display area.

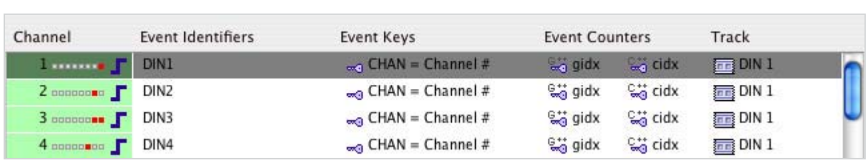


Figure 4-27. Channel 1 after being selected

The Event Identifiers subpanel contains a code and/or label that will then be associated with the selected channel(s). Figure 4-28 shows the Event Identifiers subpanel with the default values displayed. Note that the Enabled checkbox is selected by default. This means that Net Station will look for events on the selected channel. Toggling the Enabled box off causes the channel to be ignored by Net Station.

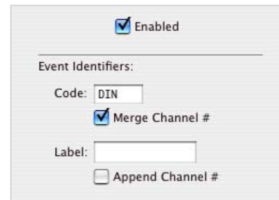


Figure 4-28. Event Identifiers subpanel

Figure 4-29 shows an example of how text entered in the Event Identifiers subpanel propagates to the selected channel in the channel list.

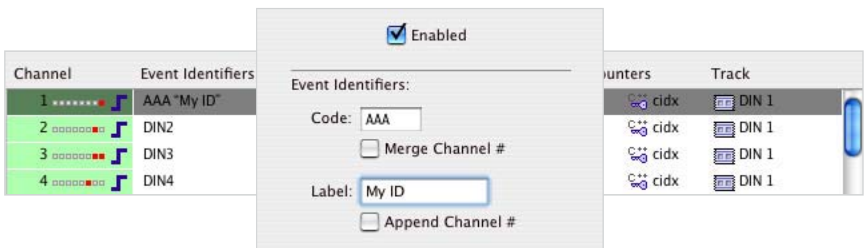


Figure 4-29. Editing code and label of a channel

But *only after the OK button has been clicked* do the user's code and label become associated with the selected channel (Figure 4-30).

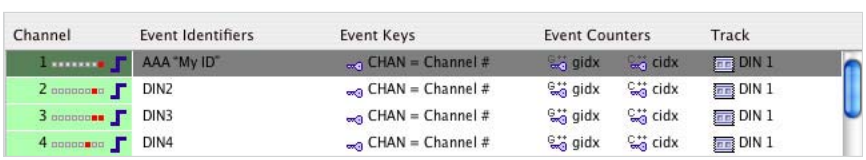


Figure 4-30. After you have clicked OK, the code and label are set

DIN Event Structure

A DIN event always has an associated Event Identifier Code and Label. The Code must have a value, but the Label can be blank. Net Station puts the default value, "DIN" in the Code area, but leaves the Label area blank.

All DIN events also have a key list (Figure 4-31), which may be empty or contain from one to three key-value pairs:

- KeyCode : Value
- Global Key Code : Value
- Channel Key Code : Value

The key list of a DIN event has all three by default, shown by the boxes associated with the key-list items being checked (Figure 4-32).

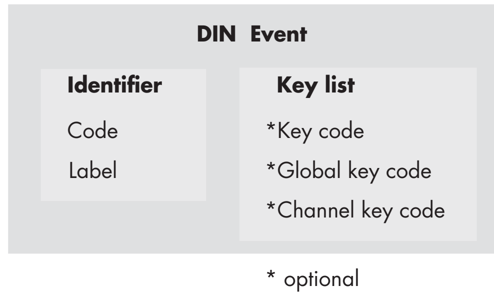


Figure 4-31. Anatomy of DIN event

Event Keys

The default key code is "CHAN" (Figure 4-32), but you can rename it, if desired. The default value for the key code is the DIN channel number, but it too may be changed (in the Key Value subpanel).

Event Counters

Net Station counts DIN events as they are received at the DIN port. The Global Key Code item of the key list holds a count of all DIN events that have been received. The Channel Key Code item holds a count of all DIN events of the channel to which the DIN belongs.

Figure 4-32. Keys and counters

Input Matching

The lower-right corner of the Advanced Event Setup panel contains the Input Matching and Track controls (Figure 4-33).

Figure 4-33. Edge vs. pulse

Selecting the Edge button causes Net Station to register a single event when it detects a switch has changed its state from open to closed or closed to open, or when the TTL state of the pin has changed from positive to zero or zero to positive volts. When the electrical condition of the pin returns to its prior state, Net Station becomes ready once again to register a single event when and if the pin changes state again. In other words, when Edge is selected, Net Station registers the occurrence but not the duration of digital input events.

Selecting Pulse means that Net Station registers an event when it detects a change of state, and keeps registering events until the pin changes state. In this way, both the occurrence and the duration (number of samples that are acquired while the pin was in its change of state) are registered by Net Station.

The Input Matching default is Edge. You can mix and match if you wish, setting some channels to Edge and others to Pulse.

The Match Channels Exactly checkbox determines what sequence of inputs gets registered as a DIN event:

- *If checked*: an event is registered if the sequence of inputs received at the DIN port *exactly* matches the digital event channel's binary code (see page 95).
- *If unchecked*: an event is registered if the sequence of inputs received at the DIN port only *contains* the digital event channel's binary code (see page 95).

Assigning Digital Inputs to Net Station Event Tracks

DIN events are recorded into one or more tracks. In the Dense Waveform Display, events can be viewed in the Tracks area and matched to the EEG waveforms that were occurring at the times the events were recorded (see "Tracks Area" on page 151).

Note: Net Station's eight event tracks for recording DINs have default names, DIN 1 to DIN 8 (Figure 4-34). As described in "Tracks Tabpanel" on page 93, you can rename the event tracks Net Station uses to register digital input events. The following section assumes that the event tracks have not been renamed.

A channel's events are assigned by default to a particular event track (Table 4-2).

Table 4-2. Default channels to tracks assignments

Preset	Default event track(s)
Single Channel	DIN 1
4 Channels	DIN 1–DIN 4
8 Channels	DIN 1–DIN 8
15 Channels	all DIN 1
255 Channels	all DIN 1

Especially in the case of the 15- and 255-channel presets, you may find it useful to reassign channels to event tracks that differ from the defaults. After you select a channel in the Advanced Event Setup panel, the Track assignment pop-up menu (Figure 4-34) is deployed and an event track selected. The channel display area updates to show the new assignment, but you must click the OK button for the setting to be made. If you plan to make a number of reassignments, it is best to enter all or groups of them at one time before clicking the OK button because the button closes the Advanced Event Setup panel.

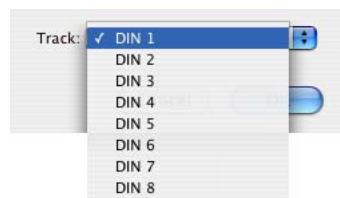


Figure 4-34. Track pop-up menu

Simple Event Setup Subpanel

The lowermost portion of the Advanced Event Setup panel contains the Simple Event Setup subpanel (Figure 4-35), with selections that match the choices on the Tracks tabpanel.

Figure 4-35. Simple Event Setup subpanel

The Simple Event Setup subpanel provides a convenient way to set Edge vs. Pulse, Code, and Event Keys for a given preset, or to reset all channels of a preset to the default settings. The Setup Inputs panel that appears when you click the 8 Channels Presets button is shown in Figure 4-36.

Figure 4-36. Example Setup Inputs panel

Using Digital Inputs

When digital inputs are enabled and the Digital Input Controls panel is onscreen, the top part of the panel becomes a display device that registers events as they occur (see Figure 4-37). The event channels are indicated visually, with hexadecimal labels, and with corresponding decimal labels at the same time.

Even as the digital input events are displayed in this manner, the Dense Waveform Display is registering the DINs in its Tracks area, as explained in Chapter 6, "Dense Waveform Display."

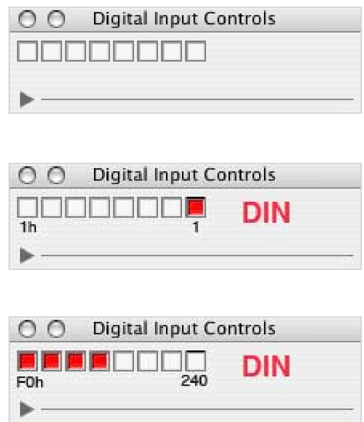
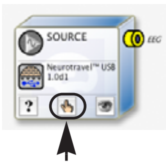


Figure 4-37. Digital inputs display

Amp Diagnostics

The Amp Diagnostics panel is for the use of EGI technicians and is not covered in this manual. To make changes to this panel, contact EGI Technical Support (Appendix A, "Software Technical Support").



Neurotravel USB Control Panel

Unlike the Net Amps, the Neurotravel amplifier is designed solely for clinical settings. Consequently, the Neurotravel USB device is simpler in functionality and appearance than the Net Amps USB device.

The Neurotravel USB control panel contains the same top features as the Net Amps USB device control panel—notification area, and sampling rate buttons—but omits the bottom features—filtering and calibration (Figure 4-38). The filtering and calibration values are fixed and cannot be modified by the user.

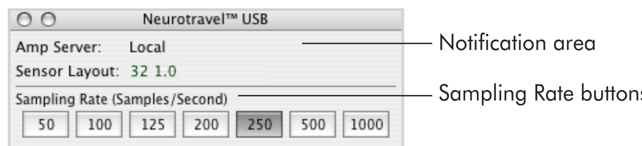


Figure 4-38. Neurotravel USB control panel

To open the Neurotravel USB control panel:

- click on the control panel button on the Neurotravel USB device or
- choose **Panels > Neurotravel USB**.

The panel consists of the notification area and Sampling Rate buttons.

Notification Area

The notification area delivers information about the status of Net Station's USB connection to the Neurotravel amplifier. For example, if Net Station detects that the Amp Server is not connected to a local server or that a Neurotravel amplifier is not connected to one of the DAC's USB ports, it displays the following message: Can't connect with local server, and <unknown - no amps connected>.

Sampling Rate Settings

As with Net Amps, Net Station defaults to collecting EEG at 250 samples per second with the Neurotravel amplifier. You can click a Sampling Rate button to change this, even during recording; however, doing so can complicate subsequent data analysis.

When recording begins, the initial sampling rate setting is stored in the Sampling Rate track of the Recording or Session file. Any subsequent sampling rate changes that you may make during recording are also registered in the Sampling Rate track with the time of their occurrence.

Sensor Impedance Measurements

As with the Net Amps, the Neurotravel amplifier requires that a sensor array be plugged into the system for impedances to be measured. Attempting to measure impedances without an array connected, or disconnecting an array during an impedance measurement, will generate an error message.

The Impedance Measurement feature allows you to verify that good contact exists between the electrodes and the scalp before you record EEG data.

To check the impedances, choose **Panels > Impedance History** to open the Impedance History window (Figure 4-39).

Click to open the Impedance Measurement window

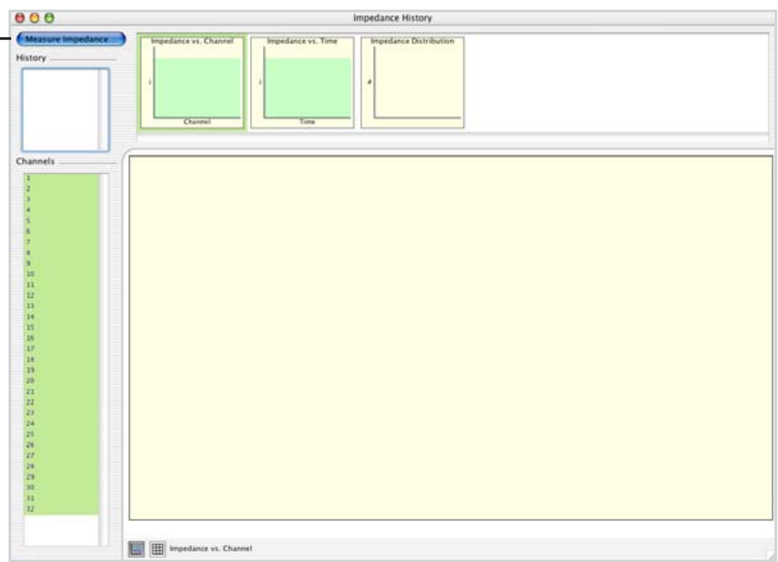


Figure 4-39. Impedance Measurement window for Neurotravel USB device

The Impedance History window contains windows for graphing the impedance values. These windows are blank until you click the Measure Impedance button, which opens the Impedance Measurement window (Figure 4-40) and initiates impedance checking.

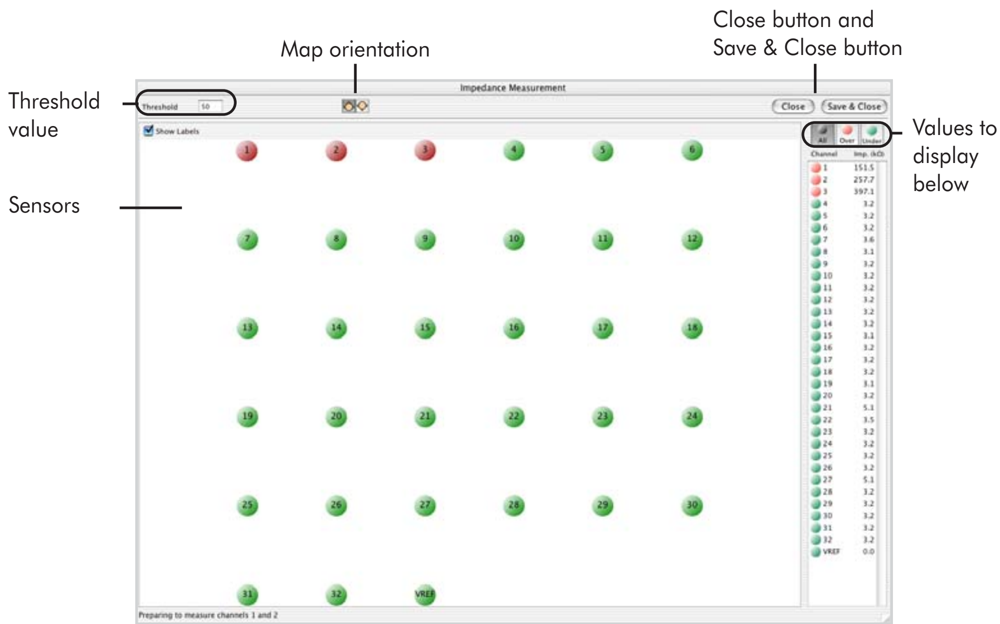


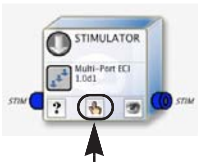
Figure 4-40. Impedance Measurement window for Neurotravel USB device

The Impedance Measurement window contains controls for setting the measurement threshold, and for specifying whether to display all values or just those above or below the threshold. This window is described in detail in “Impedance Measurement Window” on page 121.

The impedance feature continuously scans the electrodes, while you adjust the electrodes to improve contact. As soon as Net Station has scanned all the sensors in the array, it updates the window with the latest impedance values, showing them as a list and refreshing the color-coding of the sensor layout (red electrodes exceed the impedance threshold; green electrodes fall below or meet the threshold).

Net Station repeats this cycle until you click the Close or Save & Close button. The Close button dismisses the window without saving the values; the Save & Close button saves the values to the file before dismissing the window and graphs them in the Impedance History window.

When you review the file later, and choose **Panels > Impedance**, the Impedance History window graphs the saved impedance values according to your preferences (see “Impedance Display Panel” on page 120 for more details).



Multi-Port ECI Control Panel

Net Station's Multi-Port Experimental Control Interface (ECI) device allows serial communication or TCP/IP communication between the experiment control device and the DAC. The device is called "multi-port" because more than one port can be selected, enabling more than one stimulus-presentation tool to be used.

The Multi-Port ECI device must be a part of a Workbench setup, Acquisition Setup, or Session Template for experiment control with ECI to function. The STIM output of the Multi-Port ECI device must be connected such that the messages it generates can be received by the Dense Waveform Display and Waveform Recorder devices (see Figure 5-5 in Chapter 5, "Workbench: Acquisition Setups," for an example that uses the Net Station default Experimental Control Setup).

To open the Multi-Port ECI control panel:

- click the control button on the Multi-Port ECI device, or
- choose **Panels > Multi-Port ECI**

The panel consists of the IP address, TCP/IP port information, Configure button, and Log button (Figure 4-41).

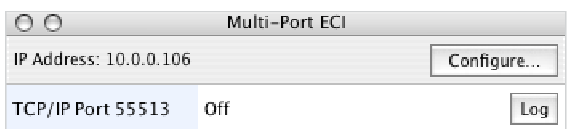


Figure 4-41. Multi-Port ECI control panel

IP Address

The IP address provides networking information required by the experiment control computer for experiment control using TCP/IP communication. For more information, see Chapter 7, "Experiment Control," in the *GES Hardware Technical Manual*.

TCP/IP Port Information

The TCP/IP port information indicates which port is open for TCP/IP communication between the experiment control device and the DAC. The default is port 55513.

Configure Button

Click the Configure button to open the Multi-Port ECI Configuration window (Figure 4-42). In this window, you can change the serial port or TCP/IP port settings.

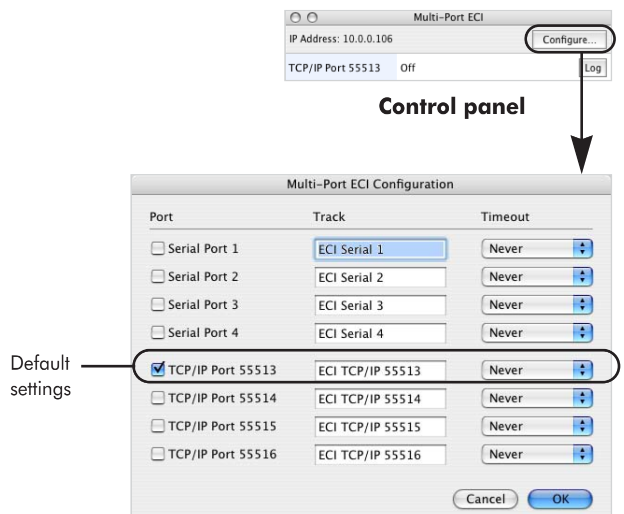


Figure 4-42. Multi-Port ECI Configuration window

The Timeout pop-up menu enables the user to specify whether to terminate the connection in case of failure of the computer or process interaction. If termination is chosen, the Timeout pop-up menu monitors the interactions, and if no activity occurs for the set period of time (the options are 30 seconds, 1 minute, 5 minutes, or 30 minutes), then the connection is terminated.

Log Button

Click the Log button to open the Session Log (Figure 4-43). The Session Log, which is also the display panel, allows you to monitor ECI events. For more information, see “Multi-Port ECI Display Panel” on page 127.

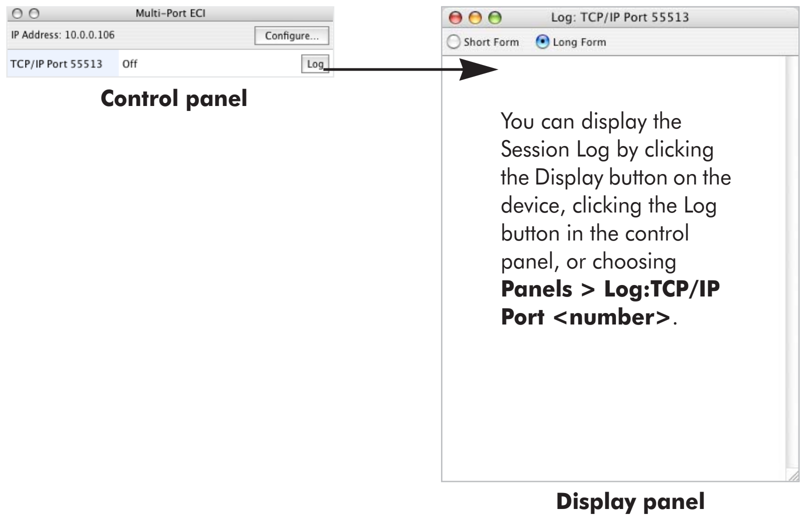


Figure 4-43. Session Log (aka display panel)

Photic Stimulator Control Panel

A photic stimulator flashes a light at a frequency that evokes predictable brain activity in a patient during an exam. The device typically consists of a flash unit that is triggered either by an external source or by a software program that provides a trigger pulse for the recording apparatus.

The Photic Stimulator control panel allows you to create photic-stimulation protocols to control the frequency and the duration of such flashes through the software.

To open the Photic Stimulator control panel:

- click on the control panel button the Photic Stimulator device or
- choose **Panels > Photic Stimulator Controls**.

The control panel (Figure 4-44) consists of controls for setting the number of flashes per interval, total duration of flashes, duration of rest interval following flashes, and number of times the sequence is run. The panel also displays a flash/rest graph, to indicate the ratio of flashes to rest for each interval.

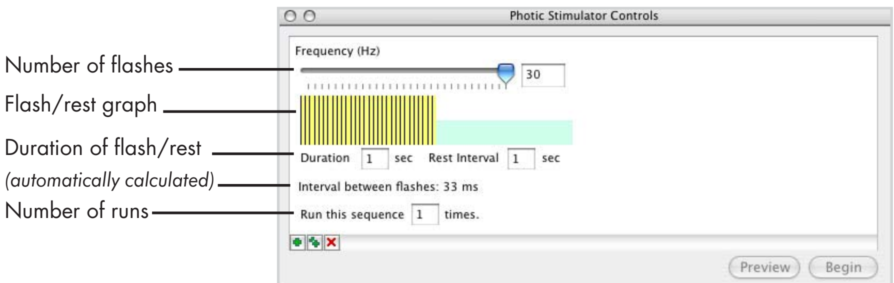
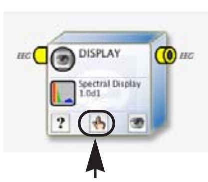


Figure 4-44. Photic Stimulator control panel

Many users may not need photic stimulation as part of their EEG acquisition sessions. Consequently, its features are described in a separate chapter (Chapter 10, "Photic Stimulator Interface").



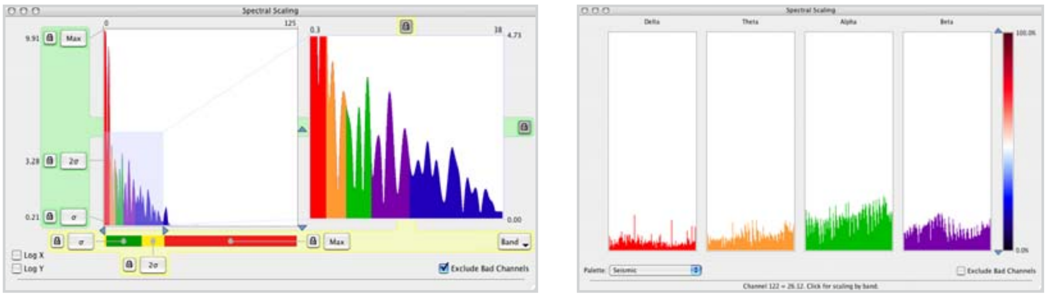
Spectral Display Control Panel

Spectral Display shows the frequencies present in each window of EEG data and their relative strengths, in amplitude or power, for each channel. You can view the spectral information as user-definable frequency bands (delta, theta, alpha, and beta are the defaults) in Grid, Topo Plot, or Topo Map view.

The Spectral Scaling window/control panel allows you to control the power and frequency ranges of the spectral data shown in the Spectral Display. To open the control panel:

- click on the control panels button on the Spectral Display device or
- choose **Panels > Spectral Scaling**.

The control panel varies in appearance, depending on the view (Figure 4-45).



Grid and Topo Plot View controls

Topo Map View controls

Figure 4-45. Spectral Display control panel for Grid and Topo Plot (left) and Topo Map (right)

The controls for Spectral Display during acquisition and review are the same, and for conciseness are discussed in the *Net Station Viewer Technical Manual*, rather than this manual, because Spectral Display is primarily a viewing tool.

Display Panels for All Relevant Devices

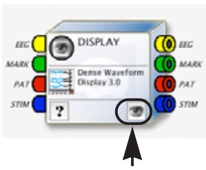
Not every device has a display panel.

Those devices that *do* contain control panel buttons are:

- Dense Waveform Display
- Digital Video
- Net Amps USB
- Net Amps 300
- Neurotravel USB
- Multi-Port ECI
- Spectral Display

This section describes each control panel in detail.

DWD Display Panel



To open the Dense Waveform Display display panel (Figure 4-46):

- click the display panel button on the Dense Waveform Display device or
- choose **Panels > Dense Waveform Display**.

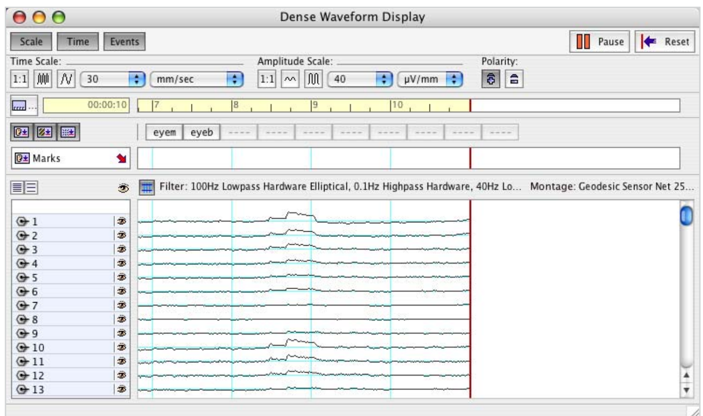


Figure 4-46. Example Dense Waveform Display panel

When the Dense Waveform Display is deployed, the menu bar will present additional menus, shown on page 51 and described in “Menus” on page 50.

Because the Dense Waveform Display is such a major part of Net Station, an entire chapter is also devoted to it; see Chapter 6.

Digital Video Display Panel

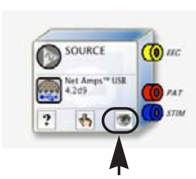
To open the Digital Video display panel (Figure 4-46):

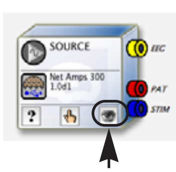
- click the display panel button on the Digital Video device or
- choose **Panels > Video**.

Figure 4-47. Digital Video display panel

The Digital Video display window contains controls for setting resolution, compression, adjustment, and source.

Many users may not need digital video as part of their EEG acquisition sessions. Consequently, its features are described in a separate chapter (see Chapter 9, "Digital Video”).





Net Amps USB or 300 Display Panels

Gains, zeros, noise, and impedance diagnostic measurements are made in response to user requests. Each type of measurement has a corresponding Net Amps USB or 300 display panel:

- Gains
- Zeros
- Noise
- Net Noise
- Impedance
- Electrolyte Bridges

Note: The Impedance Display panel is associated with an Impedance Measurement panel that displays a sensor layout. The other five display panels have no such associated sensor layout panel.

After obtaining one of these diagnostic measurements, Net Station stores the results and displays the channel-by-channel values in the display panel. Each of the diagnostic panels has the same user-customizable architecture, as described in the following sections of this chapter.

Opening the Display Panels

Not all the Net Amps USB or 300 display panels open up the same way:

- *Gains and Zeros*: to open both panels open simultaneously, click the display panel button on the Net Amps device.
- *Gains*: to open, choose **Panels > Gains**.
- *Zeros*: to open, choose **Panels > Zeros**.
- *Noise*: to open, choose **Panels > Noise**.
- *Net Noise*: to open, choose **Panels > Net Noise**.
- *Impedance*: to open, choose **Panels > Impedance**.
- *Electrolyte Bridges*: to open, choose **Panels > Electrolyte Bridges**.

Each display panel can be iconized to save screen space by choosing **Panels > Iconize**, or via the keyboard shortcut, z-\. Note, however, that palettes have priority to any window they float over with respect to the Iconize command. To iconize a display panel, it may be necessary to first iconize any palettes, then iconize the display panel. You can return the palettes to normal size by double-clicking on their icons.

Organization and Function of Display Panels

Each of the six panels has a similar layout, as shown in Figure 4-48.

The following are brief descriptions of the numbered items from Figure 4-48.

1. ***Insets area***. Presents plots of the current measurement set.

2. ***Measure button***. In each of the six display panels, clicking this button tells Net Station to initiate a new set of measurements, obtaining a new measurement for each channel. When you use this button to initiate an impedance measurement or electrolyte bridge detection, the Impedance Measurement or Electrolyte Bridges window is displayed.

3. ***History area***. Displays a list, by date, of all measurement sets. Each element in the list constitutes an entry that Net Station has stored in an Amplifier History file. Selecting an entry from the list triggers all displays in the panel to update, showing the measurements for that History entry.

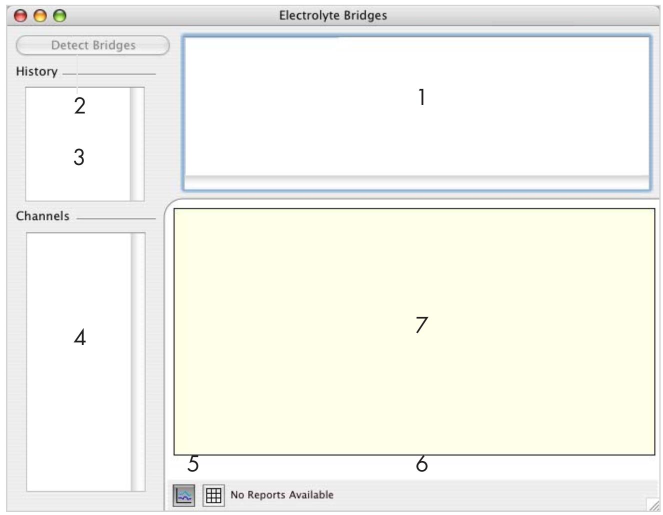


Figure 4-48. Generic Net Amps display panel

4. Channel list. In this list, the values of a selected measurement set are shown as channel number/value pairs, sorted by channel number. Selecting a channel or group of channels in the list causes the graphic plots to display that selection.

5. Display buttons. The left button activates a graphical display of the selected measurement, the right button a spreadsheet-style display. When both buttons are pushed in, the main area splits to present both the graphical and spreadsheet-style displays.

6. Statistics area. Displays the mean, median, and variance of the selected measurement. This area is blank when there are no measurements to select or when none are selected.

7. Main area. Responds to the settings of the display buttons (5).

Gains and Zeros Display Panels

The gains and zeros display panels provide access to measurement sets performed during Net Amps calibrations.

You can perform a gains or zeros measurement at any time, but are advised to do so *without* a Geodesic Sensor Net connected to the system. If the Calibrate Amplifier checkbox in the Create New Session Template window is selected when a Session Template is saved, both measurements will be made automatically whenever a new Session is initiated.

For the Gains display panel, the example in Figure 4-49 shows a History area that contains two entries, with the lower entry selected. Selecting the top entry would cause all the plots in the Gains display panel to update, showing the measurement set data for the newly selected History entry. In this example panel, the Insets area contains three user-selectable plots. Whichever plot is currently selected will be repeated at higher resolution in the main area of the panel.

The Zeros display panel works the same way.

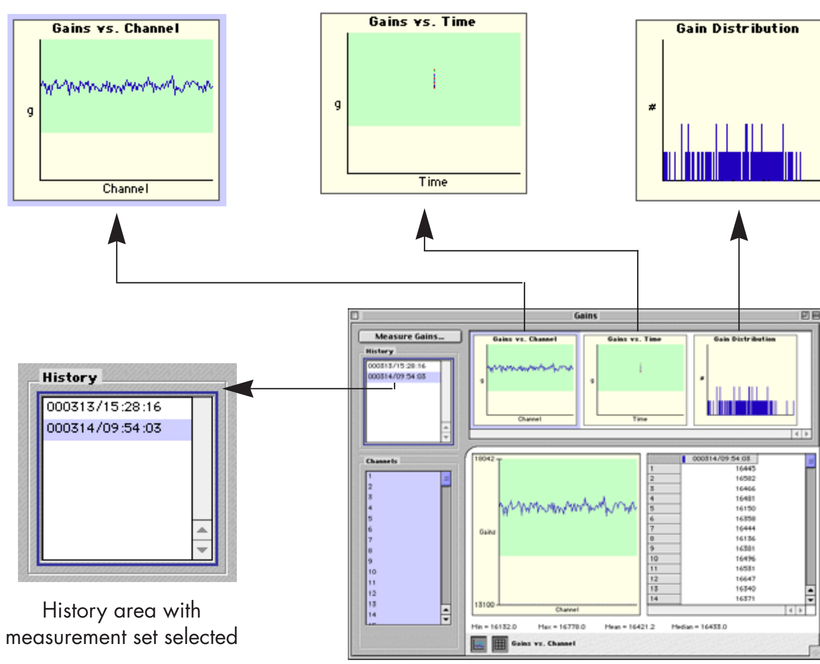


Figure 4-49. History area and insets of the Gains display panel

Noise Display Panel

Noise is any component of a signal that does not contain useful information. Net Station gives users a view of how amplifier noise is affecting the signals that Net Station is acquiring, on a channel-by-channel basis, and allows storing of previously acquired noise profiles.

When Net Station conducts a channel-by-channel noise measurement, the Net Amps front-panel Hypertronics receptacle is internally disconnected from the Net Amps circuitry. This means that the noise being measured does not include components that may be picked up by the interface cable or the sensor array.

Noise that is part of an EEG signal has a number of sources. Some noise originates in the electronics of the amplifier. Problematic noise originates from the environment in which the Net Amps is operating and contaminates the EEG signals by being acquired along with the EEG. The Noise display panel provides a window into the noise levels and noise characteristics of a given environment.

Note: When the noise test is run from the Noise display panel, the lowpass hardware filter cut-off frequency is automatically set to 400 Hz. (The waveforms may display an increase in noise in the DWD during the test because of the higher throughput of noise in the frequencies that are typically attenuated during data acquisition.) After the test, the filter returns to its previous setting.

In a relatively low-noise environment, the Noise display panel would look similar to the one shown in Figure 4-50. The plot in the main area of the panel shows graphically the microvolt RMS noise values for each channel, and the table view shows the same information. Although the amount of noise on each channel is not uniform, all microvolt RMS noise values are within the green portion of the chart. As the vertical scale of the chart indicates, this means that all channels have noise values below 1.0 μV RMS. The exact noise values are shown in the table next to the plot.

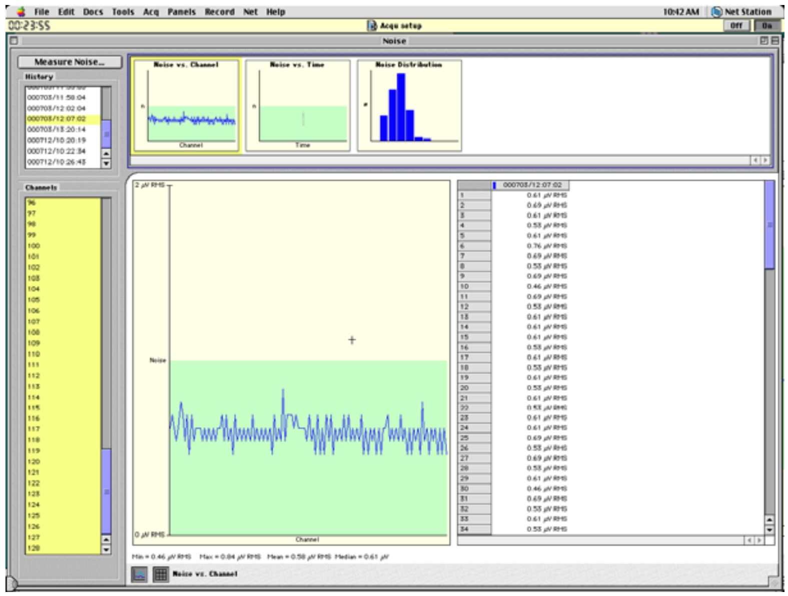


Figure 4-50. Noise measurement in a low-noise environment

Clicking the Noise Distribution inset (Figure 4-51) fills the chart display with an enlarged view of the Noise Distribution histogram and presents the same information in an adjoining table (Figure 4-52).

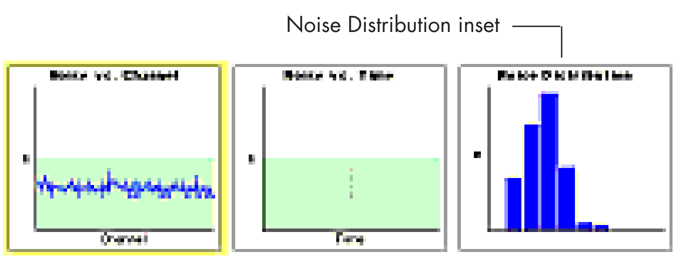


Figure 4-51. Noise panel insets

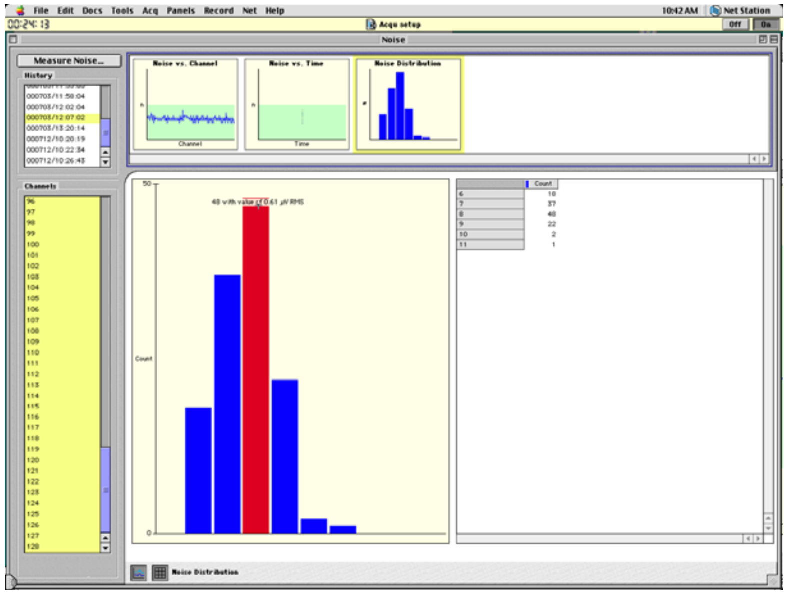


Figure 4-52. Noise Distribution histogram

As you move the cursor over the bars of the histogram, the bar under the cursor changes color and the precise noise value it is associated with appears at the top of the bar. The Noise vs. Time inset plot operates similarly.

In a noisier environment, the Noise display panel would look more like the one shown in Figure 4-53. Taking note of the vertical scaling of the chart, which ranges from 0 to 4.0 μV RMS, you see that the channel noise is mostly at levels above the amplifier specification of 1.0 μV RMS but still below 4.0 μV RMS. This is indicative of noise being picked up from the environment, combined with intrinsic amplifier noise.

As the Noise Distribution histogram in Figure 4-53 reveals, the levels of noise affecting the channels can display modality. This information can be useful in troubleshooting.

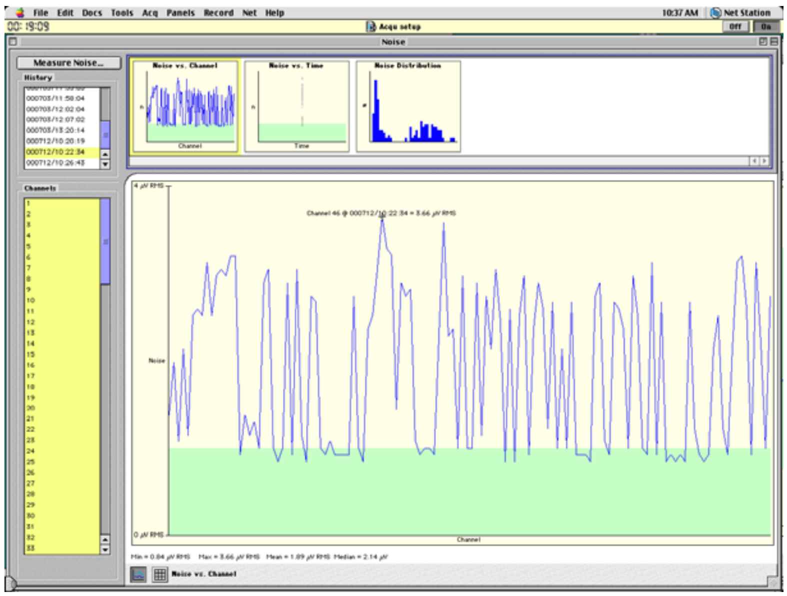


Figure 4-53. Noise panel in a noisier environment

Net Noise Display Panel

The Net Noise feature allows you to measure the amount of noise present in a Geodesic Sensor Net, highlighting individual electrodes that may require replacement. The feature works the same way as the amplifier noise measurement, except that the inputs to the amplifier are not grounded, which allows signals on the Geodesic Sensor Net to pass through to Net Station.

It is unnecessary to perform a Net Noise test regularly. It is a diagnostic tool to use if the following circumstances arise:

- Your lab log indicates that specific electrodes may be “noisy.”
- During analysis, you notice an electrode that is “bad” when the Geodesic Sensor Net is used with different subjects.
- You suspect the ambient noise in the room is high.

To perform the Net Noise test:

1 Prepare a container of fresh electrolyte (see the instructions given in “Preparing the Electrolyte Formulation” in Chapter 6 of the *Geodesic Sensor Net Technical Manual*), but ***omit any shampoo***.

2 Soak the Geodesic Sensor Net, which is connected to the amplifier, in the electrolyte solution for five minutes to saturate the sponges thoroughly; after 2.5 minutes, push the Net below the surface with your hand to ensure that the sponges are sufficiently hydrated.

Caution!: *The total submersion time for the Geodesic Sensor Net—including soaking time and test time—should not exceed 15 minutes. Prolonged exposure to a saline-based solution may weaken the Net's elastomer.*

3 With the sponges still submerged, plug the Geodesic Sensor Net's Hypertronics connector into the articulated arm (which is connected to the amplifier). (If you are using a 128-channel system, you could alternately plug the connector directly into the Net Amps unit.)

4 Start Net Station, click the Session button in the New section of the start-up window, choose a Session Template, and click the Begin Session button to initiate acquisition.

5 As the signals are displayed onscreen, choose **Panels > Net Noise**, and click the Measure Net Noise button in the Net Noise window (Figure 4-54); a progress bar appears during the measurement.

Click to measure the noise in a Geodesic Sensor Net.

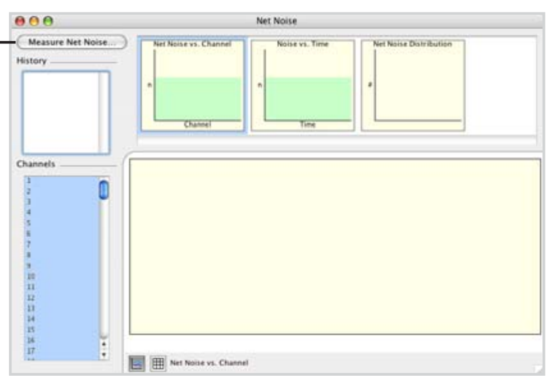


Figure 4-54. Net Noise window

6 When the measurement is complete, the results are graphed in the Net Noise window (Figure 4-55).

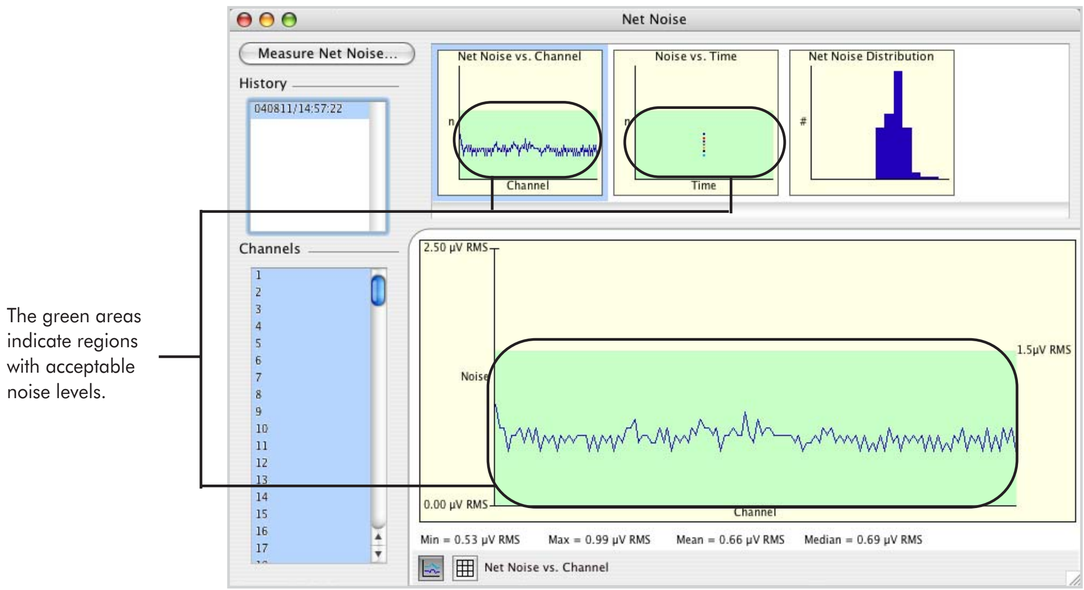


Figure 4-55. Net Noise results

View the results, and adjust as needed:

- *All values within the green area*: no bad electrodes.
- *Some values outside the green area*: check that the corresponding electrodes are submerged and hydrated; if they are not, return to Step 2.
- *Spikes*: bad electrodes; if using a GSN 200, replace the electrodes following the instructions given in Chapter 9 in the *Geodesic Sensor Net Technical Manual*. If using a HCGSN, contact support@egi.com.
- *Many or all values outside the green area, but no major spikes*: check the equipment around the amplifier and the Geodesic Sensor Net; they may be producing environmental noise. (Also check equipment on neighboring floors.)

7 After conducting the test, rinse the Geodesic Sensor Net, following the instructions given in “Rinsing” in Chapter 7 of the *Geodesic Sensor Net Technical Manual*.

Impedance Display Panel

Under Net Station supervision, the Net Amps 200 and 300 drive certain sensors with a precision 20 Hz, 400 μV peak-to-peak sine wave signal. This level of voltage is above the level of EEG but still results in extremely small current flows across the scalp.

Net Station measures the voltage at an undriven, passive sensor and calculates the contact impedance.

Sensor impedance measurement sets are displayed and graphed in the Impedance display panel. You can initiate a new impedance measurement by:

- clicking the Measure Impedances button in the Impedance display panel (see example panel shown in Figure 4-56) or
- clicking the Measure Net Impedances button in the Net Amps controls panel (see Figure 4-19 on page 86).

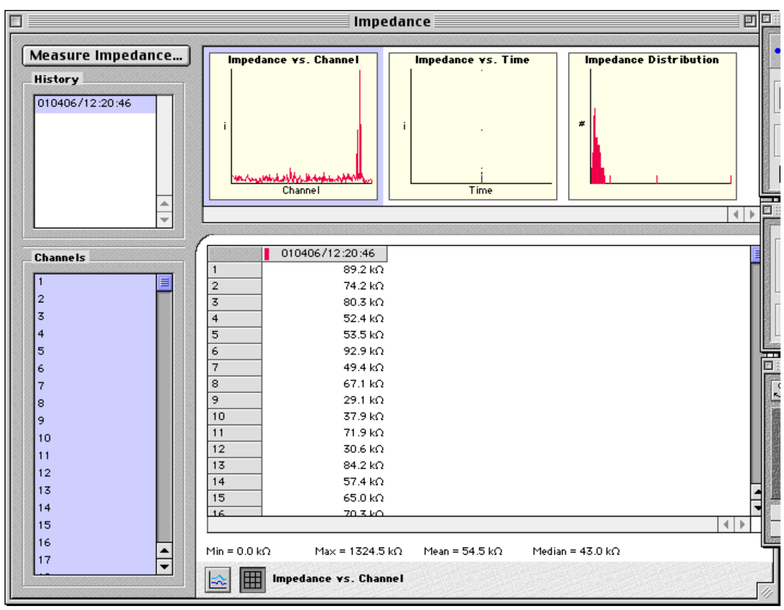


Figure 4-56. Example Impedance display panel

Initiating a new impedance measurement opens the Impedance Measurement window, described in detail in the next section.

Impedance Measurement Window

When the Impedance Measurement window (Figure 4-57) opens, Net Station initiates a measurement of the contact impedance of each sensor. After performing a complete set of measurements, Net Station updates the impedance values displayed in a list on the right side of the window. The process repeats until the window is closed.

The Impedance Measurement window's layout matches the sensor array being used. In the display, sensors that have measured impedance values exceeding the Threshold setting are colored *red*, and sensors at or below the Threshold setting are colored *green* (see the next paragraph, "Impedance Measurement Window Controls").

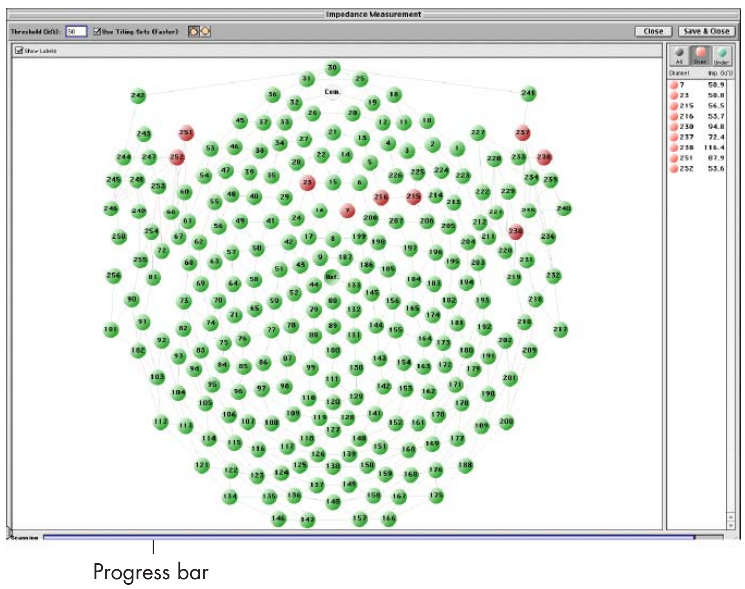


Figure 4-57. Example Impedance Measurement window

Impedance Measurement Window Controls

The All, Over, and Under buttons (Figure 4-58) and the user-editable Threshold text box work in the following way:

- *All*: the list of impedance values displayed includes all the sensors of the Net.
- *Over*: the only sensor impedances displayed are those that exceed the Threshold.
- *Under*: only those values under the Threshold are listed.

Figure 4-58. All, Over, and Under buttons

EGI's standard recommendation for scalp impedances is 50 KΩ.

Next to the Threshold box is a checkbox that controls the speed and method of the impedance measurement. With the checkbox unselected, Net Station measures impedances one at a time. This method is most precise, but very slow. With the checkbox selected, Net Station measures impedances for several channels at once, speeding up the measurement process but sacrificing accuracy by reporting impedances slightly (10–15%) too high.

The pair of orientation buttons (Figure 4-58) changes the orientation of the sensor layout.

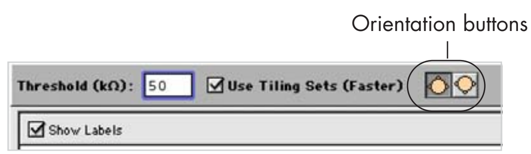


Figure 4-59. Orientation buttons

The Show Labels checkbox hides or displays channel names.

To halt the impedance measurement process, use either the Close or Save & Close buttons (Figure 4-58). Save & Close appends the most recent complete scan to the impedance measurement sets in the History area of the Impedance Display panel (see page 117).

Note: Impedance values are not saved to the file unless data are recorded after measuring impedances. Merely clicking the Save & Close button will not save the impedance values.

Electrolyte Bridge Display Panel

The electrolyte bridge detection feature is specific to the Net Amps USB and 300 devices. It detects salt bridges between neighboring electrodes, and indicates their positions with thick red lines in a sensor layout display.

Background

Bridges can be caused by one of two factors: (1) electrodes physically touching each other or (2) electrodes not making contact with the scalp but sitting on a mat of hair, thus allowing a continuous bridge to exist between them.

Net Station's electrolyte bridge detection algorithm knows all the pairs of neighboring electrodes for all the Net models. The detection feature scans the sensor array for 10 seconds, measures the A/D value for each electrode, and subtracts the A/D values of each electrode pair to yield a difference wave for that 10-second interval.

To compute the variance of the difference wave and produce a single value, the detection feature then applies the following formula:

$$S^2 = \Sigma\,(X_1 - \overline{X})^2 \;/\; n - 1$$

where S^2 is the sample variance squared, X_1 is the score for the first point in the sample, $\overline{X}$ is the sample mean, and n –1 is the sample size.

If a bridge exists between two neighboring electrodes, the signal will be very similar and the difference of the signal will exhibit little variance. You define the threshold level in the interface, and the software indicates pairs exceeding that level with red lines (Figure 4-60).

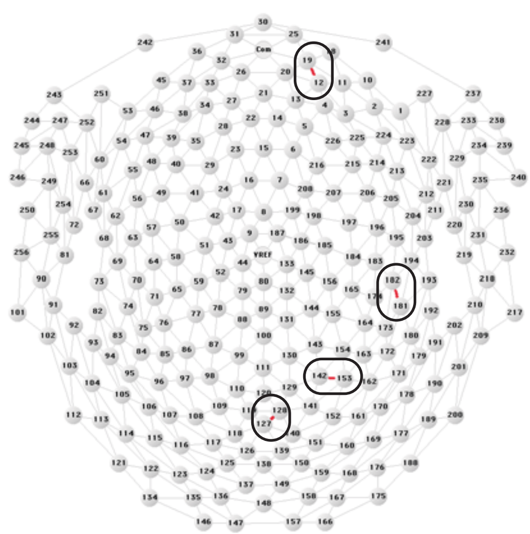


Figure 4-60. Four bridged electrode pairs

Interface

The electrolyte bridge detection and the impedance measurement features are similar in that both scan the electrodes in the sensor array continuously, allowing you to adjust the electrodes by hand and view the effect in Net Station.

For consistency, the window for detecting electrolyte bridges resembles that for impedance measurement, even though not all the features are used. The main feature is the Detect Bridge button.

Unlike the Impedance Measurement window, however, electrolyte bridge detection does not save graphs or values to the Session file.

Instructions

To detect bridges:

1. Before recording EEG data, choose **Panels > Electrolyte Bridges** to open a window that allows initiation of the bridge-detection algorithm.

Note: The window resembles the impedance measurement window for consistency; however, the panes remain empty because the sample values from the bridge-detection algorithm cannot be graphed in this manner.

2. In the Electrolyte Bridges window (Figure 4-61), click the Detect Bridges button.

Click to begin detecting bridges.

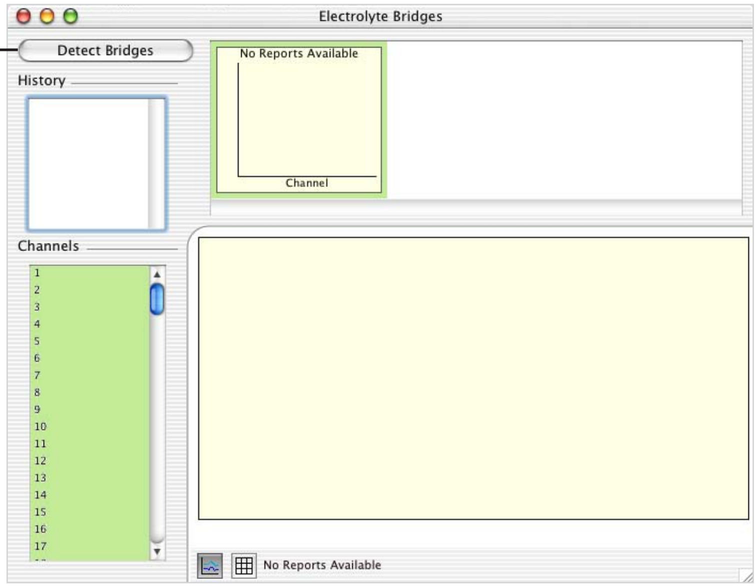


Figure 4-61. Electrolyte Bridges window

3 A sensor layout window opens, similar to the window used to measure impedances (see "Impedance Measurement Window" on page 121 for a detailed description).

4 Set the threshold and other values as desired, and allow the software to scan the electrodes; bridges will be indicated by thick red lines connecting the bridged sensors (Figure 4-62).

Note: We recommend a threshold of 4 μV^2 for adults. However, it is a good idea to experiment with this number yourself.

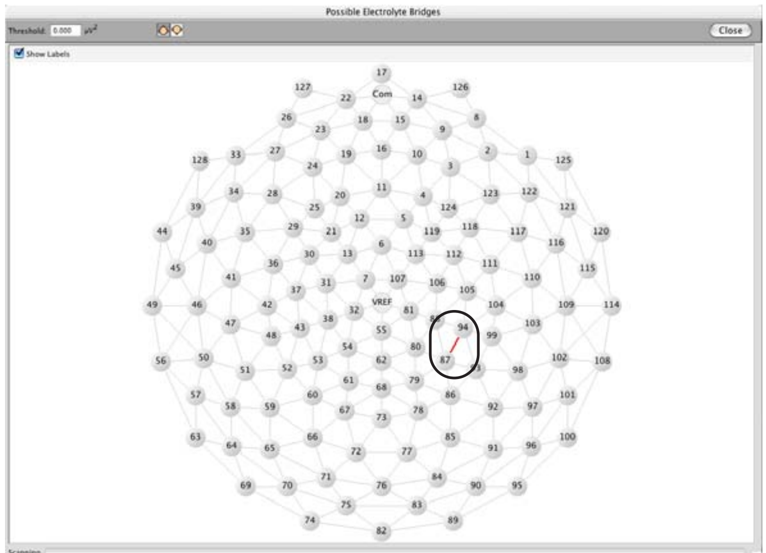


Figure 4-62. Electrolyte bridge results, with a bridge indicated between electrodes 94 and 87

5 Adjust the sensors, and allow the software to scan and update the layout.

6 Continue adjusting the sensors, as needed; when satisfied, close the window.

Neurotravel USB Display Panel

The Neurotravel USB display panel is similar to the Net Amps USB display panel in that it makes impedance diagnostic measurements in response to user requests (it does not, however measure gains, zeros, or noise).

To open the Neurotravel USB display panel:

- click the display panel button on the Neurotravel USB device or
- choose **Panels > Impedance History**.

After obtaining this diagnostic measurement, Net Station stores the results and displays the channel-by-channel values in the display panel.

Impedance Display Panel

The Impedance display panel shows and graphs impedance measurement sets (Figure 4-63). This window is nearly identical to the Impedance window for the Net Amps USB device; for more details, see page 120.

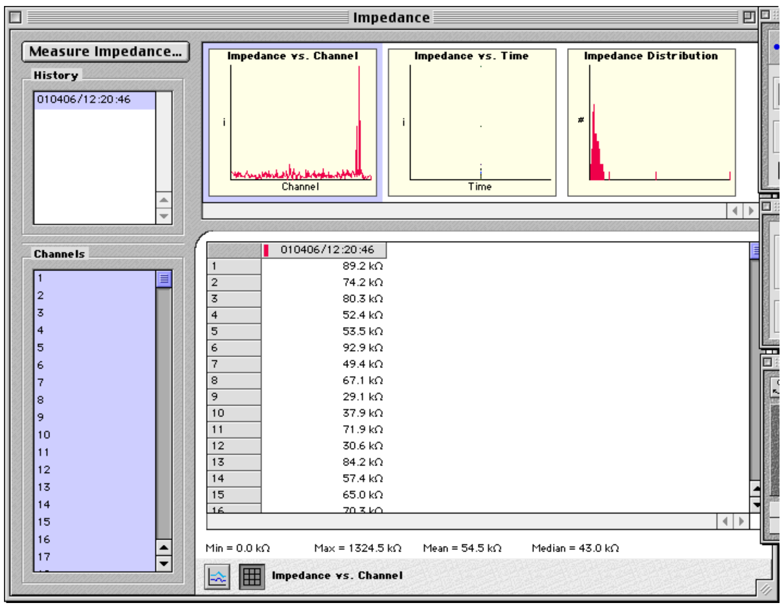
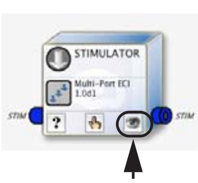


Figure 4-63. Example Impedance display panel

You can initiate a new impedance measurement from this display panel by clicking the Measure Impedance button (see example panel shown in Figure 4-63).

Initiating a new impedance measurement opens the Impedance Measurement window. This window is nearly identical to the Impedance Measurement window for the Net Amps USB device; for more details, page 121.

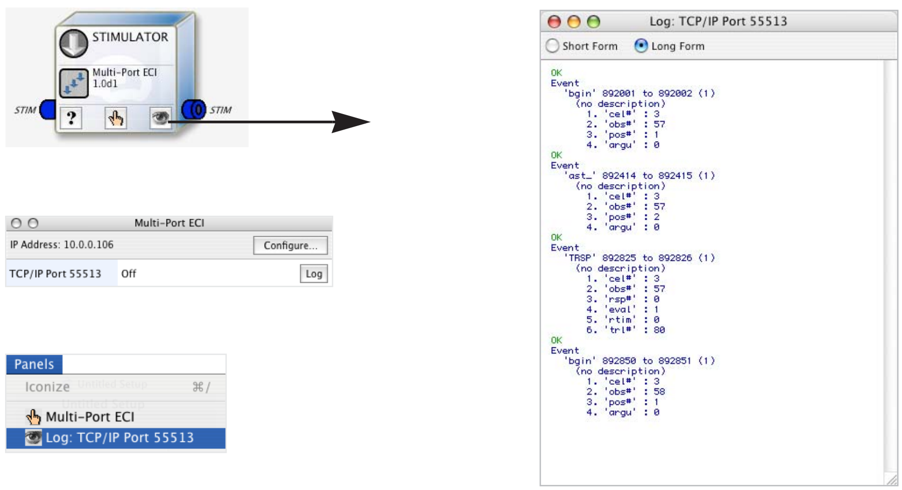


Multi-Port ECI Display Panel

When the Multi-Port ECI device is part of a Workbench configuration, saved Acquisition Setup, or Session Template, the Multi-Port ECI display panel (also known as the *Session Log*) is available for viewing ECI events.

To open the Multi-Port ECI display panel (Figure 4-64):

- click the display panel button on the Multi-Port ECI device,
- choose **Panels > Log: TCP/IP Port <number>** (55513 is the default), or
- click the Log button in the control panel.



You can display the Session Log by:
- clicking the display button on the device
- clicking the Log button in the control panel
- choosing **Panels > Log: TCP/IP Port 55513**

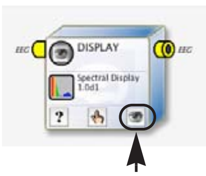
Display panel

Figure 4-64. Opening the display panel (aka Session Log)

For an example Acquisition Setup containing a Multi-Port ECI device, see "Default Experimental Control Setups" on page 137.

You can monitor ECI events using both the ECI track in the Dense Waveform Display and the Session Log at the same time, but the Session Log offers more detail, as the example in Figure 4-64 indicates. However, when many events are occurring during short durations of time, the Session Log may not display all the information with enough time for you to completely read it. The Session Log attempts to keep up with the events in real time.

For configuration details, see Chapter 7, “Experiment Control,” in the *GES Hardware Technical Manual*.



Spectral Display Panel

To display near-real-time spectral information during acquisition, Net Station performs an FFT on successive data windows of an EEG file, with the length of the data window specified by the user. This section briefly covers the display panel and the controls for specifying the data-window size.

To open the Spectral Display display panel:

- click the display panel button on the Spectral Display device or
- choose **Panels > Spectral Display**.

The Spectral Display display panel presents the spectral data in Grid, Topo Plot, or Topo Map views (Figure 4-65). During acquisition or review, the display updates as FFTs are performed on different data windows.

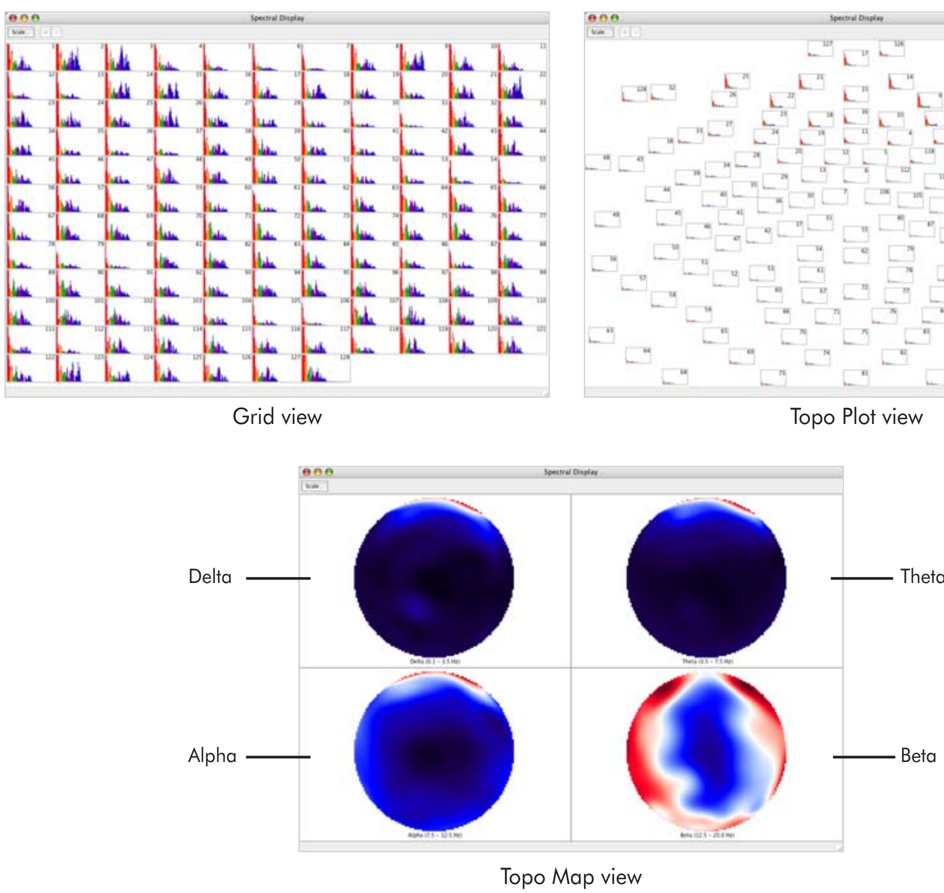


Figure 4-65. Spectral Display of 128-channel data in Grid, Topo Plot, and Topo Map views

The display controls for Spectral Display during acquisition and review are nearly identical, and for conciseness are discussed in the *Net Station Viewer Technical Manual*, rather than this manual, because Spectral Display is primarily a viewing tool.

The only difference in controls is in the “FFT” section of the Spectral Viewer Options window. During acquisition, the FFT process is automatic: an FFT is performed on successive data windows as EEG data are being acquired. During review, the FFT process requires user intervention: an FFT is performed on user-selected windows of the recorded data.

To open the Spectral Viewer Options window, choose **View > Options** when a spectral display window is foremost.

Figure 4-66 shows the Spectral Viewer Options window for acquisition.

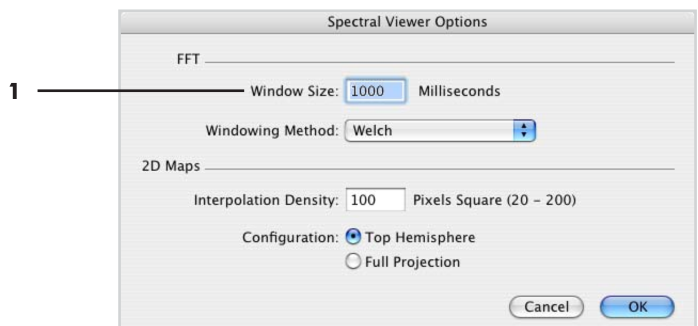


Figure 4-66. Spectral Viewer Options window for acquisition

The following is a brief description of the numbered item from Figure 4-66. The other items are described in the *Net Station Viewer Technical Manual*.

1. Window Size text box. Enables you to type in a value for the length of the data window on which to perform an FFT. The size range is from 10 to 60,000 milliseconds (1 minute).

chapter 5

WORKBENCH: ACQUISITION SETUPS

An Acquisition Setup is a means for saving a particular Workbench configuration along with its device control and display panel settings (see “Acquisition Setups” on page 44).

You can use any of the nine default Acquisition Setups provided by Net Station, or you can create your own Acquisition Setups (see page 138) for data acquisition using the Workbench and for embedding Session Templates.

The default setups are called:

- Simple Net Amps 200 Acq Setup
- Simple Net Amps 300 Acq Setup
- Typical Net Amps 200 Acq Setup
- Typical Net Amps 300 Acq Setup
- Exp. Control Net Amps 200 Setup
- Exp. Control Net Amps 300 Setup
- Clinical Net Amps 200 Acq Setup
- Clinical Net Amps 300 Acq Setup
- Clinical Neurotravel Acq Setup

Their purpose is to ensure consistent Workbench configurations in Session Templates. To that end, they differ from user-created Acquisition Setups in several ways:

- You cannot use the default setups to acquire data themselves via the Workbench; you use them to create Session Templates (page 144), which then acquire the data. The names of the default setups are displayed in the Select Session Template window (see Figure 7-8 on page 165) and in the Create New Session Template window (see Figure 7-4 on page 161).
- You cannot double-click on the default setups to open them; they are not editable.
- You cannot view the default setups’ Workbench configurations.

To facilitate your understanding of Net Station, this chapter describes the default Acquisition Setups, their Workbench configurations, and panel deployment schemes. It also discusses how to create and save your own Acquisition Setups using the Workbench.

Default Acquisition Setups

Default Simple Acquisition Setups

Simple Workbench Configuration

The Simple Net Amps 200 Acq Setup uses a Workbench configuration consisting of the Net Amps USB, Dense Waveform Display, and Waveform Recorder connected in series as shown in Figure 5-1.

Figure 5-1. Workbench configuration of the Simple Net Amps 200 Acq Setup

The Workbench configuration of the Simple Net Amps 300 Acq Setup is identical, except the Net Amps 300 device is used in place of the Net Amps USB.

For details about these devices, see “Core Devices” on page 61.

In this setup, the EEG cables pass through the Display and are connected to the Recorder. Recorder and Display could be transposed with no change in the way the EEG data are recorded; however, this transposition would mean that user markups made in the Display device would not propagate to the recording because the Display would be downstream of the Recorder device.

Note: If user mark-up events are going to be part of a recording, always be sure that in the Workbench configuration there is a MARK cable connecting the output of the Display device to the input of the Recorder device.

Simple Panel Deployment

Whenever you create an Acquisition Setup, which panels are open and their positions in the Net Station window are preserved with the file.

For example, during the design of Net Station when the Simple Net Amps 200 Acq Setup was saved, the Net Amps and Waveform Recorder panels were open but the Dense Waveform Display was not deployed. Consequently, when the setup is opened, the position of the panels is preserved, but the Display does not appear automatically (Figure 5-2). You can select it from the Panels menu or via the display button on its corresponding Workbench device.

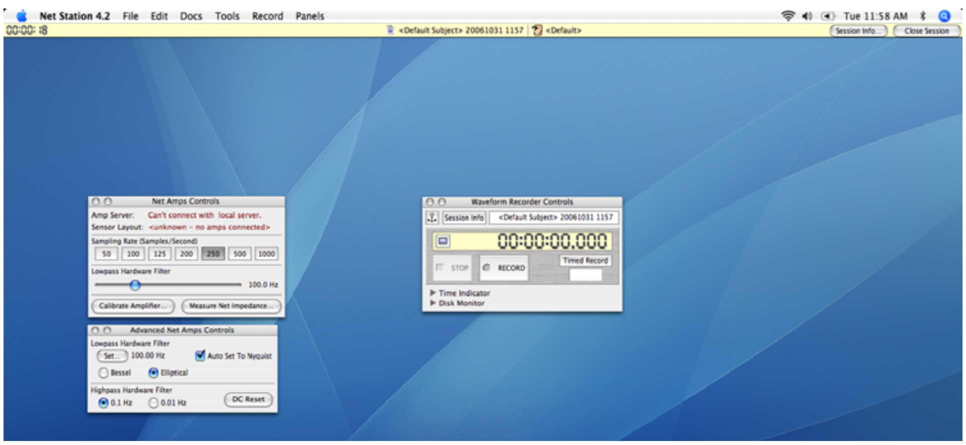


Figure 5-2. Panel deployment of the Simple Net Amps 200 Acq Setup

When the Simple Net Amps 300 Acq Setup was saved, the Net Amps panel (note: the Net Amps 300 contains no Advanced Net Amps panel), Waveform Recorder panel, and Dense Waveform Display were deployed. The Net Amps and Waveform Recorder control panels were moved to the right, to allow the waveforms in the Dense Waveform Display to be observed (Figure 5-3).

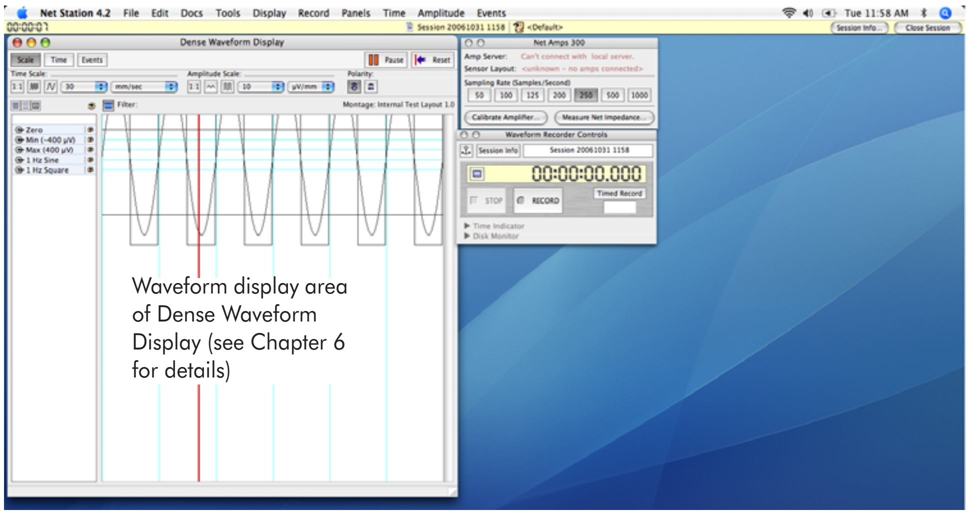


Figure 5-3. Panel deployment of the Simple Net Amps 300 Acq Setup

Default Typical Acquisition Setups

Typical Workbench Configuration

In the Typical Net Amps 200 Acq Setup and Typical Net Amps 300 Acq Setup, a Digital Filter and a Montage Editor have been included in the Workbench configuration. EEG data are connected both directly to the Waveform Recorder and to the Digital Filter.

Figure 5-4 shows the Workbench configuration of the Typical Net Amps 200 Acq Setup. The Workbench configuration of the Typical Net Amps 300 Acq Setup is identical, except the Net Amps 300 device is used in place of the Net Amps USB.

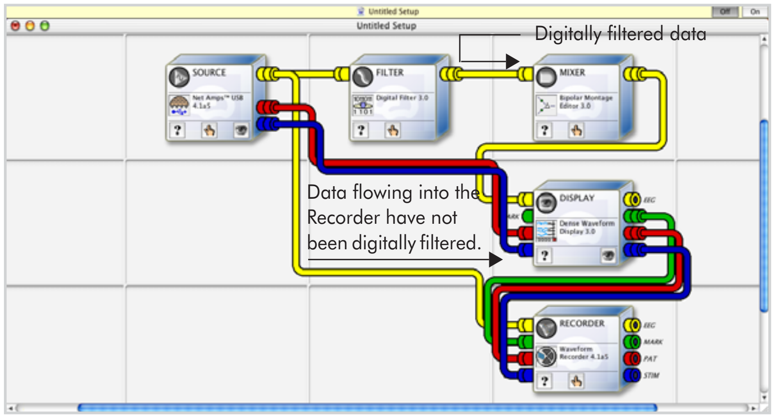


Figure 5-4. Workbench configuration of the Typical Net Amps 200 Acq Setup

This arrangement ensures that the data that enter the Recorder will not be modified by digital filtering, yet filtered data can be visualized using the Dense Waveform Display.

Typical Panel Deployment

During the design of Net Station when the Typical Net Amps 200 Acq Setup (Figure 5-5) was saved, its control panels were moved to the right side of the window, to allow the waveforms in the Dense Waveform Display to be observed. The Montage Editor control panel was minimized and moved to the Dock; it can be accessed by clicking its icon or by choosing it from the Panels menu.

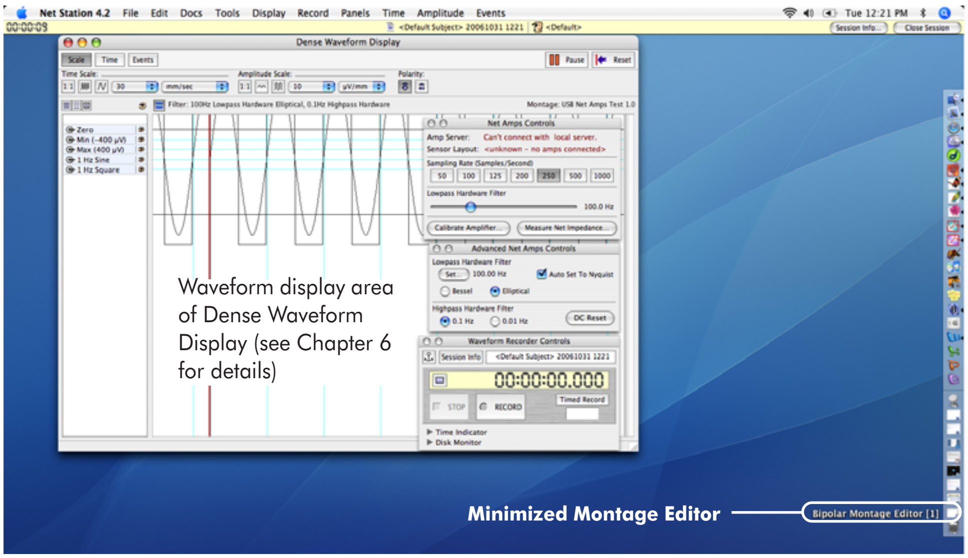


Figure 5-5. Panel deployment of the Typical Net Amps 200 Acq Setup

When the Typical Net Amps 300 Acq Setup was saved, none of its panels was minimized or moved to the right of the Dense Waveform Display (Figure 5-6).

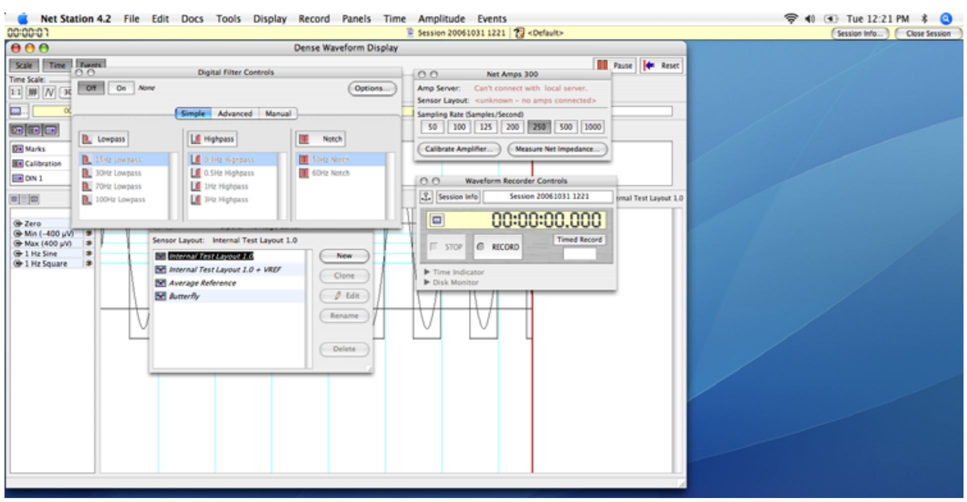


Figure 5-6. Panel deployment of the Typical Net Amps 300 Acq Setup

Default Experimental Control Setups

Experimental Workbench Configuration

The default Exp. Control Net Amps 200 Setup (Figure 5-7) is identical to the Typical Net Amps 200 Setup, save for the addition of the Multi-Port ECI device and its connection via the STIM cable. The Workbench configuration of the Exp. Control Net Amps 300 Setup is identical, except the Net Amps 300 device is used in place of the Net Amps USB.

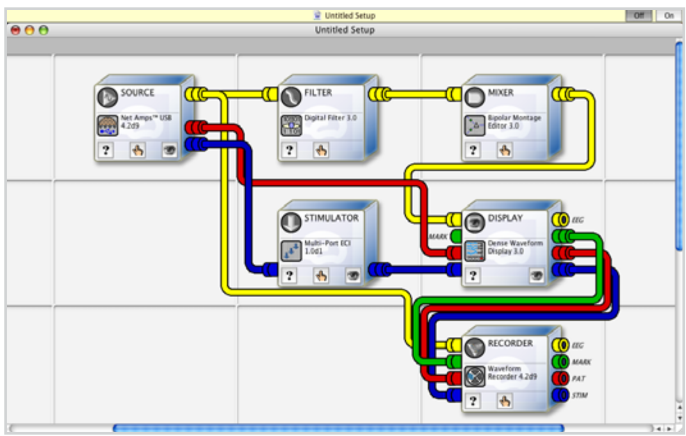


Figure 5-7. Workbench configuration of the Exp. Control Net Amps 200 Setup

Experimental Panel Deployment

The panel deployment scheme for the Exp. Control Net Amps 200 Setup is the same as that of the Typical Net Amps 200 Setup, except for the inclusion of Experimental Control Status and Montage Editor windows (Figure 5-8).

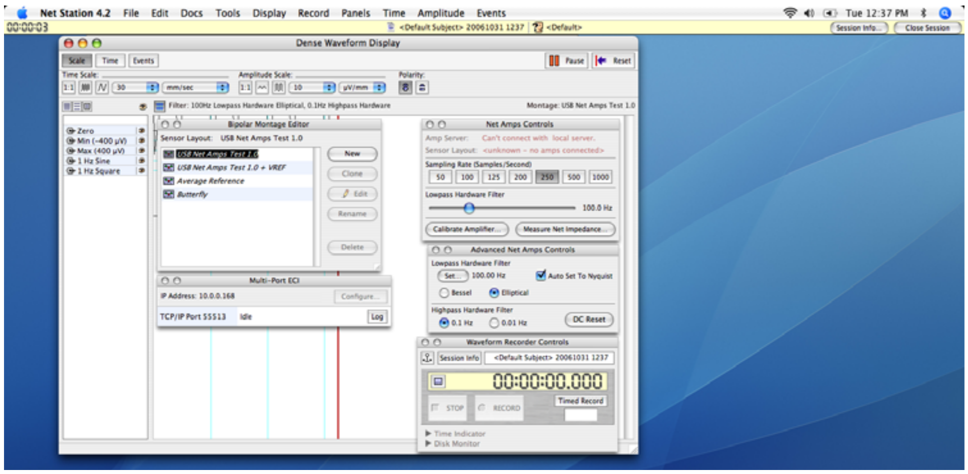


Figure 5-8. Panel deployment of the Exp. Control Net Amps 200 Setup

The panel deployment scheme for the Exp. Control Net Amps 300 Setup is identical to that of the Exp. Control Net Amps 200 Setup, except it contains no Advanced Net Amps panel.

Default Clinical Net Amps Setups

Clinical Net Amps Workbench Configuration

The default Clinical Net Amps 200 Setup uses the same components as those in the Typical Net Amps 200 Acq Setup, but connects them slightly differently. In this setup, the Montage Editor comes before the Digital Filter, and the PAT and STIM cables connect directly from the Net Amps USB to both the Waveform Recorder and the Dense Waveform Display (Figure 5-9). The Workbench configuration of the Clinical Net Amps 300 Setup is identical, except the Net Amps 300 device is used in place of the Net Amps USB.

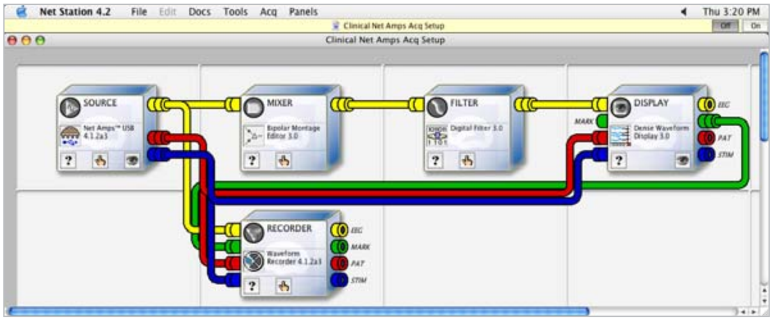


Figure 5-9. Workbench configuration of the Clinical Net Amps 200Setup

Clinical Net Amps Panel Deployment

When the Clinical Net Amps 200 Setup (Figure 5-10) was saved, its control panels were moved to the right side of the window, for unobstructed viewing of the waveforms in the Dense Waveform Display. The panel deployment scheme for the Clinical Net Amps 300 Setup is identical.

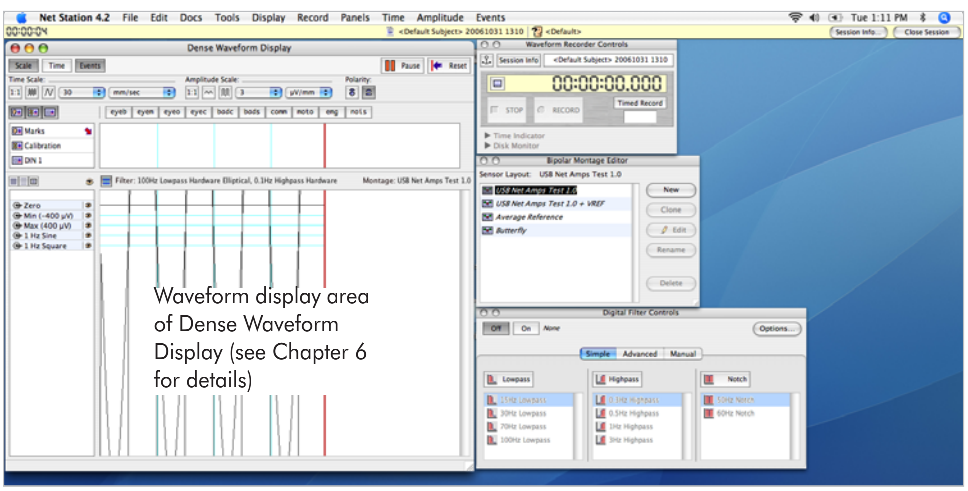


Figure 5-10. Panel deployment of the Clinical Net Amps 200 Setup

Default Clinical Neurotravel Setup

Clinical Neurotravel Workbench Configuration

The default Clinical Neurotravel Acq Setup is identical to the default Clinical Net Amps 200 Setup, except it replaces the Net Amps USB device with the Neurotravel USB device and contains no STIM connections (Figure 5-11).

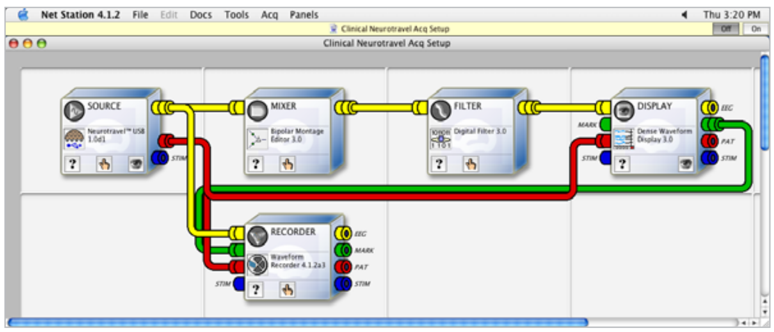


Figure 5-11. Workbench configuration of the Clinical Neurotravel Acq Setup

Clinical Neurotravel Panel Deployment

When the Clinical Neurotravel Acq Setup (Figure 5-5) is deployed, its control panels are to the right side of the window, for a clear view of the Dense Waveform Display.

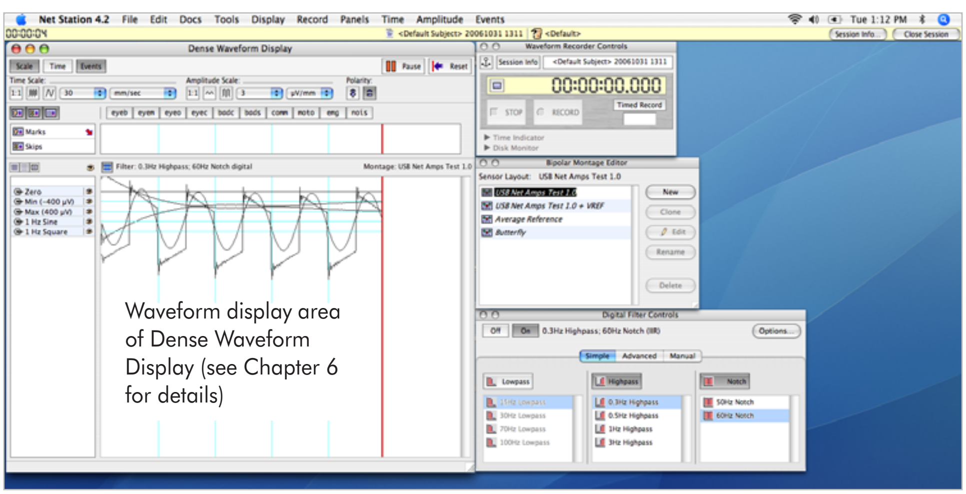


Figure 5-12. Panel deployment of the Typical Clinical Neurotravel Setup

Creating New Acquisition Setups

You can create your own Acquisition Setup files by opening the Workbench, configuring devices, making panel settings, and then saving their creation to disk. The editable files that result from this process are saved by Net Station to the Acquisition Setups folder by default (see “Acquisition Setups Folder” on page 39). The destination folder can be overridden in the Save dialog—clicking the Navigate button (Figure 5-13) provides a file navigation window.

Figure 5-13. Default Save dialog for saving Acquisition Setups

Constructing an Acquisition Setup involves placing and connecting devices on the Workbench (see “Placing and Connecting Devices” on page 66), deciding which panels to deploy, then saving the setup as an Acquisition Setup file (see “File” on page 51).

Configuration Examples

The examples in this section demonstrate features of Workbench configurations that you should be aware of if you choose to design your own Acquisition Setups.

Bypassing the Display

Figure 5-14 shows a Workbench configuration that is identical to the default Simple Net Amps 200 Acq Setup, but in which the STIM cable has been reconfigured to bypass the Display device. There is no particular reason to do this except to illustrate a point: In this setup, any digital input events captured by the Net Amps USB device will be recorded by the Waveform Recorder, but will not be displayed in the Dense Waveform Display. In this situation, the digital input tracks in the Display would remain blank even though the events would be written to the data file.

Figure 5-14. Recording but not displaying digital inputs

Note: PAT and STIM connections have been omitted from the following dual Display configurations for the purpose of illustration.

Correctly Connecting the Filter

The next example configuration demonstrates one way to properly connect the Digital Filter device. As discussed in “Digital Filter Controls” on page 74, the IIR filter of the real-time Digital Filter device is not appropriate for transforming data, only for visualizing it. It follows that it is not correct to connect a Digital Filter ahead of the Recorder device. In the configuration of Figure 5-15, the Filter device is not connected in series with the Recorder.

Also demonstrated in Figure 5-15 is the way that more than one Display device can occupy the same configuration. Clicking the display buttons on both devices results in two Dense Waveform Displays opening, one for each device. Users can resize and position the two display windows next to each other onscreen, then manipulate the Digital Filter controls. In so doing, the effect of the IIR filter will be immediately observed in DWD[1] and can be compared with the unfiltered data viewable in DWD[2].

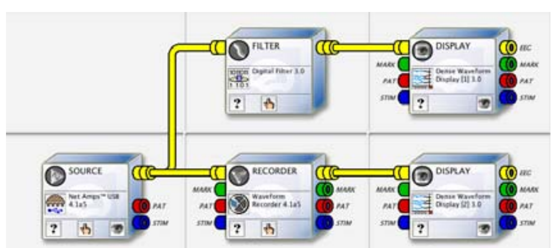


Figure 5-15. Correct connection of filter device, no events

Incorrectly Connecting the MARK Cable

It might be imagined that user mark events could be implemented in this configuration by connecting the MARK jack on the output side of DWD[2] to the MARK jack on the input side of the Recorder (Figure 5-16), but this is an invalid configuration.

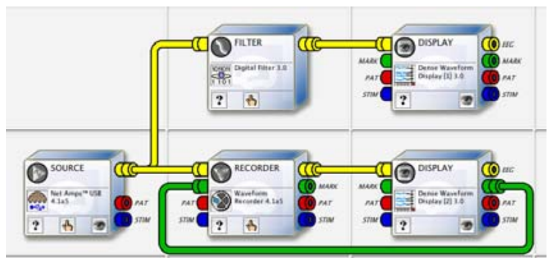


Figure 5-16. Example of a cable loop (invalid configuration)

It is invalid because it contains a cable loop. The same device cannot both receive input from a device and send output to the same device, which is exactly what the DWD[2] device is doing. It is receiving input from the Recorder device and also attempting to send mark events to the same Recorder device.

Correctly Connecting the MARK Cable

A different way to bring user mark events into the recording is implemented with the configuration shown in Figure 5-17. It does not violate the looping rule and it works.

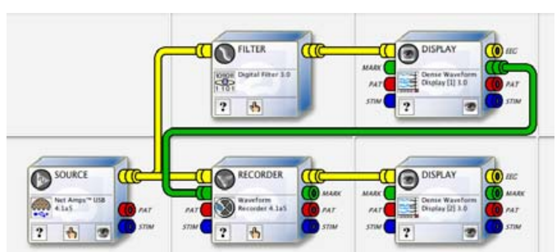


Figure 5-17. A correct dual-DWD configuration with mark events

A simpler way to implement this functionality is shown in Figure 5-18, where the positions of DWD[2] and the Recorder have been transposed.

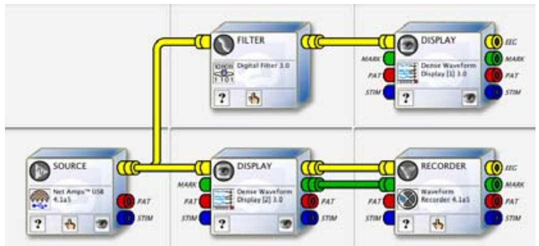


Figure 5-18. Reconfiguring for a simpler configuration

Session Templates Use Acquisition Setups

As shown in Figure 7-3 on page 160, Acquisition Setups are embedded in Session Templates. In particular, the default setups are always available for embedding in a new Session Template. User-created setups will also be available, so long as they are saved to the appropriate location and contain the required devices.

Note: Workbench configurations that do not contain a Source device, or lack either the Dense Waveform Display device or Waveform Recorder device can be saved in Acquisition Setup files, just like any other configuration. However, Net Station will not display such files in the Create New Session Template window. Such setups cannot be embedded in a Session Template because Net Station regards them as fundamentally incomplete.

Because creating a Session Template does not involve the Workbench, it is not covered in this chapter. Instead, Chapter 7 describes Session Templates and how Acquisition Setups are a part of every Session Template (see page 159 for an example of how to embed an Acquisition Setup in a Session Template, and page 161 for how to create a Session Template and how to use it to acquire data).

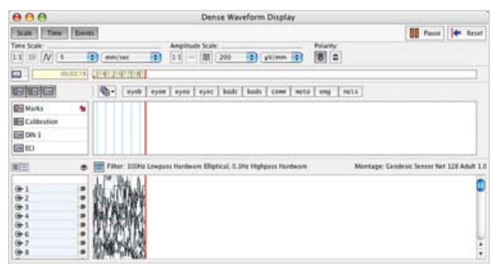
Final Note

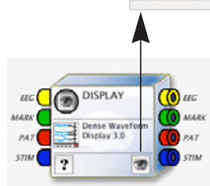
Remember that with an Acquisition Setup, screen locations of the *control* and *display panels* and their minimized states in the Dock are remembered by Net Station. A reopened Acquisition Setup file will contain devices and device panels in the state they were in when the file was closed.

chapter 6

DENSE WAVEFORM DISPLAY

The Dense Waveform Display (Figure 6-1) provides a way to view real-time EEG waveforms and events. In addition, the Dense Waveform Display is an input interface for technician mark-up events that can be entered and recorded along with the EEG.





When using the Workbench, click the Display button on the Dense Waveform Display device to make the Dense Waveform Display appear.

When conducting a session, choose the Dense Waveform Display from the Panels menu.

Figure 6-1. Invoking the Dense Waveform Display

Main Components

See Figure 6-2 for the structure of the Dense Waveform Display. See the sections following the figure and its numbered list for a part-by-part treatment of Dense Waveform Display functionality.

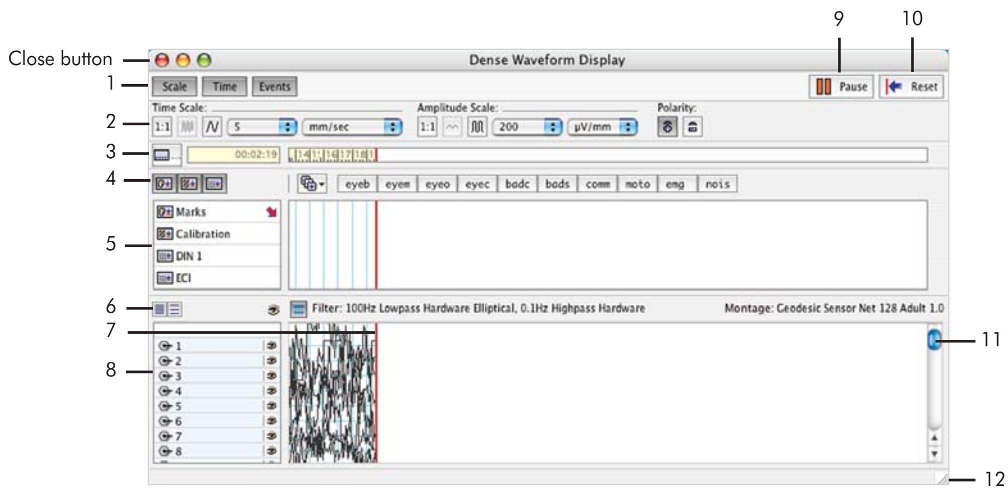


Figure 6-2. Example Dense Waveform Display

The following are labels for the numbered items in Figure 6-2.

1. ***Upper control strip***
2. ***Scale control strip***
3. ***Time control strip***
4. ***Events control strip***
5. ***Tracks area***
6. ***Waveform Options control strip***
7. ***Sweep line***
8. ***Channel tiles***
9. ***Pause button***
10. ***Reset button***
11. ***Scroll bar***
12. ***Size box*** (resize the Dense Waveform Display by dragging)

Menus and Acquisition Status Panel

When the Dense Waveform Display is frontmost, menus that are specific to its functions are available in Net Station's menu bar. For coverage of these Dense Waveform Display–specific menus, see "Dense Waveform Display Menu Bar" on page 85.

The Dense Waveform Display also includes pop-up menus (Figure 6-3). This type of menu occurs on the Scale control strip (see page 149). To open a pop-up menu, position the cursor over it and press the mouse button.

Figure 6-3. Pop-up menus

The Acquisition status panel is always present just below the main menus (see page 169 for coverage of the Acquisition status panel when using a Session Template; see page 39 for the Acquisition status panel when doing Workbench recording).

Upper Control Strip

The upper control strip contains two groups of buttons: Scale, Time, and Events (left side of strip); and Pause and Reset (right side).

Scale, Time, and Events Buttons

Various functional areas of the Dense Waveform Display can be either hidden or displayed using the Scale, Time, and Events buttons (Figure 6-4) on the left side of the upper control strip. Toggling these buttons has no effect on the settings of their corresponding functional areas, only on visibility.

Figure 6-4. Scale, Time, and Events buttons

Figure 6-2 shows the Scale control strip, Time control strip, Events control strip, and Tracks area in their visible states. The corresponding buttons on the upper control strip have a “pushed-in” appearance to indicate that visibility is set for all of them.

Note: The Events button toggles the visibility of both the Events control strip and the Tracks area.

Pause and Reset Buttons

On the right side of the upper control strip are the Pause and Reset buttons.

Figure 6-5. Pause and Reset buttons

Toggle the Pause button to halt the sweep line (page 153)—momentarily freezing the scene in the waveform area—or to restart the sweep line from a paused state. The Pause button works with recording on or off. Elapsing time on the Acquisition status panel continues to update during a pause.

The Pause button does not halt recording or prevent the entry of technician mark events; it only freezes the real-time display of waveforms.

After you resume the display of waveforms, a pause line (Figure 6-6) will be visible in the Dense Waveform Display in the position where the pause took place. It indicates a discontinuity in the displayed data.

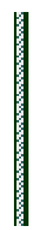


Figure 6-6. Pause line

Technician mark-up events can be entered during the paused state and will become a part of the data file if recording is on. Such events will not be placed in the recording at the point of the pause, but rather at the time in the recording when you clicked the mark event button.

Note: Mark-up events entered during a pause do not show up in the marks track during real-time display. However, they are entered in the recording. Also, the size box and scroll bar cannot be used during a pause without erasing the waveform area. Data and events being recorded are not affected, and normal sweeping is restored when the Pause button is toggled off.

Click the Reset button to cause the sweep line to relocate to the leftmost part of the waveform display area and recommence sweeping from that position.

Buttons affect only the display window to which they belong. To reset all multiple Dense Waveform Display sweep lines in a single operation, choose **Display > Reset All** (see page 92).

Scale Control Strip

The Scale control strip (Figure 6-7) contains controls for customizing the way that waveforms appear in the Dense Waveform Display waveform area. (The controls provided by the Scale control strip are also available via menus [see “Time” on page 92 and “Amplitude” on page 93].)

To display the Scale control strip, click the Scale button on the upper control strip.

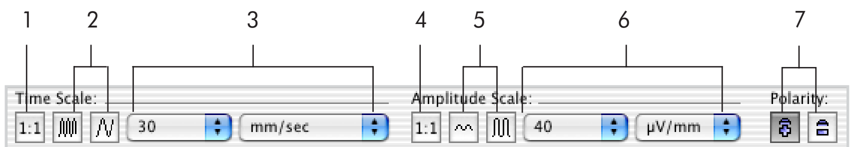


Figure 6-7. Scale control strip

The following are brief descriptions of the numbered items from Figure 6-7.

1. Time Scale 1:1 button. Sets the waveform display to 1 sample per pixel on the horizontal (X) axis of the screen.

2. Time Scale Decrease/Increase buttons. Change the time scale (left button decreases, right button increases) incrementally.

3. Time Scale pop-up menus. Set the value and units for the horizontal axis.

4. Amplitude Scale 1:1 button. Sets the waveform display to 1 μV/pixel on the vertical (Y) axis of the screen.

5. Amplitude Scale Decrease/Increase buttons. Resize the waveform amplitudes (left button decreases, right button increases) incrementally.

6. Amplitude Scale pop-up menus. Set the value and units for the vertical axis.

7. Polarity buttons. Toggle between *displaying* the waveforms with positive up or positive down. Data being recorded are unaffected.

Whatever settings are in effect apply to all waveforms of the Dense Waveform Display.

Time Control Strip

The Time control strip (Figure 6-8) features a time-mode button that opens the Time Display Options panel. Setting the time display options is covered in “Time” on page 92, which includes a picture (Figure 3-65) of the Time Display Options panel.

The Time Menu Display Options command from the Time menu duplicates the functionality of the time-mode button.

Elapsed time (in one of four time modes; see Table 3-4 on page 58) is displayed in the box to the right of the time-mode button.

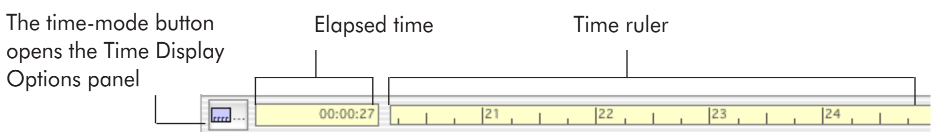


Figure 6-8. Time control strip

Time Ruler

The sweep line (Figure 6-2, label 7) passes through the time ruler portion of the Time control strip in synch with its passage through the waveform area, indicating the time of the current sample.

Events Control Strip

The left side of the Events control strip (Figure 6-9) features three toggle buttons for hiding or displaying their corresponding tracks: Marks, Calibration, and DIN/ECI (see “Tracks Area” on page 151).

Figure 6-9. Events control strip

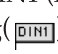
The rest of this control strip contains a series of buttons for adding user mark-up events to a recording. Clicking a button causes a corresponding user mark-up event to be added to the file at that point in the recording. The mark-up event is displayed in the Tracks area in the form of a flag bearing the name of the mark-up event.

Note: The default Acquisition Setups use Workbench configurations that are designed to capture user mark-up events to the recording and to the Dense Waveform Display, but it is possible to construct Workbench configurations where mark-up events will not be recorded or not displayed, or both. Refer to the examples in “Default Acquisition Setups” on page 95.

Tracks Area

The sweep line passes through the Tracks area (Figure 6-10) in synch with its passage through the waveform area and time ruler. Each track is labeled according to the type of event it can store and display. For example, if you are using a Session Template that automatically performs calibration, you will see calibration events registering in the Calibration track when the session begins.

Figure 6-10. Tracks area with Events control strip

By using the Digital Inputs Controls panel (see page 63), you can specify up to eight DIN tracks and customize the DIN track labels. The Net Station default is to have all DIN events record to the track labeled DIN1 (Figure 6-10). A DIN event registering in the track has the form of a miniature flag().

ECI events display in the ECI track when experimental control is being used. When you click a button in the Events control strip, a new mark event appears in the form of a flag in the Marks track, and a corresponding event appears in the recording. For an example, see the rightmost portion of the Tracks area in Figure 6-2, where a “Comment” flag is visible in the Marks track. In this instance, the user clicked the “comm” button to produce the Comment event.

The button labels are abbreviations for various phenomena that you will encounter while recording EEG. The abbreviations are decoded in Table 6-1.

Table 6-1. Mark-up events

Button label	Mark-up event type
eyeb	eye-blink artifact
eyem	eye-movement artifact
badc	bad channel
bads	bad segment
comm	comment
moto	motion artifact
emg	electromuscular artifact
noise	noise artifact

The Events menu duplicates the functionality of the buttons and adds a special Insert Comment command that deploys a Comment text window. You can type a comment into this window; when you click the Insert button in the window, a Comment event will be registered into the Marks track at the then-current position of the sweep line.

Note: Net Station registers and records events in real time with millisecond accuracy, and their placement in the tracks vis-a-vis the time ruler is precise. But the moment the event flag appears in a track of the Dense Waveform Display may not always precisely match the moment the event was generated in real time. This imprecision applies only to the real-time display of the event flags, not to the recording of the events and their position with respect to the time ruler in the Dense Waveform Display.

Waveform Options Control Strip

The Waveform Options control strip is always deployed (Figure 6-11).

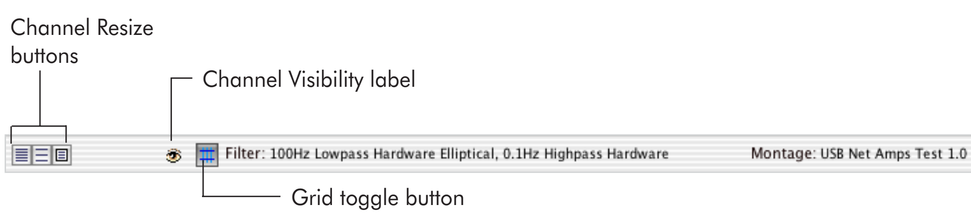


Figure 6-11. Waveform Options control strip

This control strip carries buttons for changing channel spacing and toggling the waveform area grid on and off. You can also change the channel spacing by dragging the boundary of a channel tile (see page 154).

Note: The rightmost of the three Channel Resize buttons will not be available if the channels in the current montage are so numerous that all of them cannot fit in the window.

The "eye" icon is the Channel Visibility label indicating the column of visibility buttons on the channel tiles (see page 154).

Also displayed in the Waveform Options control strip are:

- the current hardware filters in effect, with their cut-off frequencies
- the name of the current montage

Note: If an ellipsis (...) appears in the filter or montage notifications, it means that there is not enough room to display a complete notification. Moving the cursor over the notification causes the complete text to be momentarily displayed.

Sweep Line

The red line moving from left to right in the waveform area of the Dense Waveform Display window is the sweep line. It traverses the time ruler (page 150) and Tracks area (page 151) in synch with its traversal of the waveform area, and it indicates the current time, event, and sample.

Sweep Line Interruption

Under some circumstances, the sweep line pauses momentarily while data are being written to disk, then resumes sweeping. This interruption in sweeping is not a cause for concern.

Channel Tiles

The channel tiles are always visible on the left side of the Dense Waveform Display. Each channel tile is labeled with a channel name and carries a signal originating from one of the sensors of the Geodesic Sensor Net. Different sensor layouts have different numbering/naming schemes and Nets are available with differing densities, so the tile labels may differ from the example (Figure 6-12).

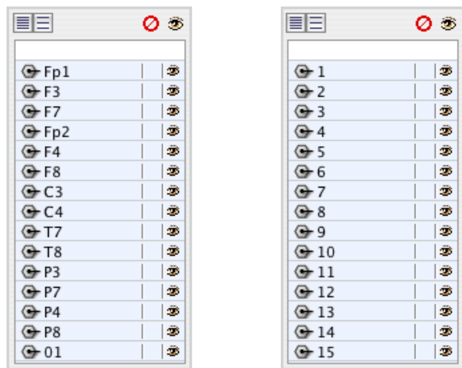


Figure 6-12. Numbered channel tile label example

Visibility button

Clicking the Visibility button on a channel tile toggles between hiding and displaying the waveform of that channel.

Clicking a channel tile outside the Channel Visibility button causes the waveform of that channel to be displayed in red. Use this to differentiate overlapping waveforms. Toggle a selected channel tile to return the waveform to its default color. Multiple channel tiles can be toggled to display their waveforms in red.

Resizing Channel Tiles

You can resize channel tiles to their minimum and maximum heights by using the Channel Resize buttons (see "Waveform Options Control Strip" on page 152). You can set channel tiles to heights intermediate between maximum and minimum by dragging. Bring the cursor over the boundary of any of the channel tiles and the cursor changes into the resize cursor. Dragging the resized cursor causes all the channel tiles to resize.

Size Box

Use the window size box to change, by dragging, the size of the entire Dense Waveform Display window.

Waveform Area

EEG waveforms are displayed in the waveform area. Use the controls on the Scale control strip (page 149) to customize how the waveforms are displayed. Use the scroll bar on the right side of the Dense Waveform Display to browse the waveform area when the window is so small, or the channel spacing so large, that not all the channels will fit in the window.

chapter 7

SESSIONS AND SESSION TEMPLATES

This chapter describes *sessions* and *Session Templates*, and explains their connection to one another.

Net Station Session

A Net Station session is an EEG data-acquisition procedure that requires the use of a Session Template. The result of such a session is a Session file containing a recording of dense-array EEG along with (optionally) user mark-up events and external digital input events that occurred simultaneously with the EEG. In addition, the Session file can store along with the EEG and events a wide range of metadata such as subject name and subject traits.

Session Templates contain embedded Acquisition Setups and may also contain editable metadata fields. Depending on how the Session Template was configured, a session can include automatic amplifier calibration and impedance measurements, and automated naming of the output Session file. The idea is to make the EEG data acquisition process as streamlined, repeatable, and automatic as possible.

Net Station comes with a number of default Session Templates based on the default Acquisition Setups described in “Default Acquisition Setups” on page 95.

Once created, a Session Template cannot be edited. You can conduct repeated data-acquisition sessions that always have the same parameters, by using a Session Template.

The flowchart in Figure 7-1 shows the basic process of starting a new session using a Session Template. For details, see “How to Use A Session Template” on page 165.

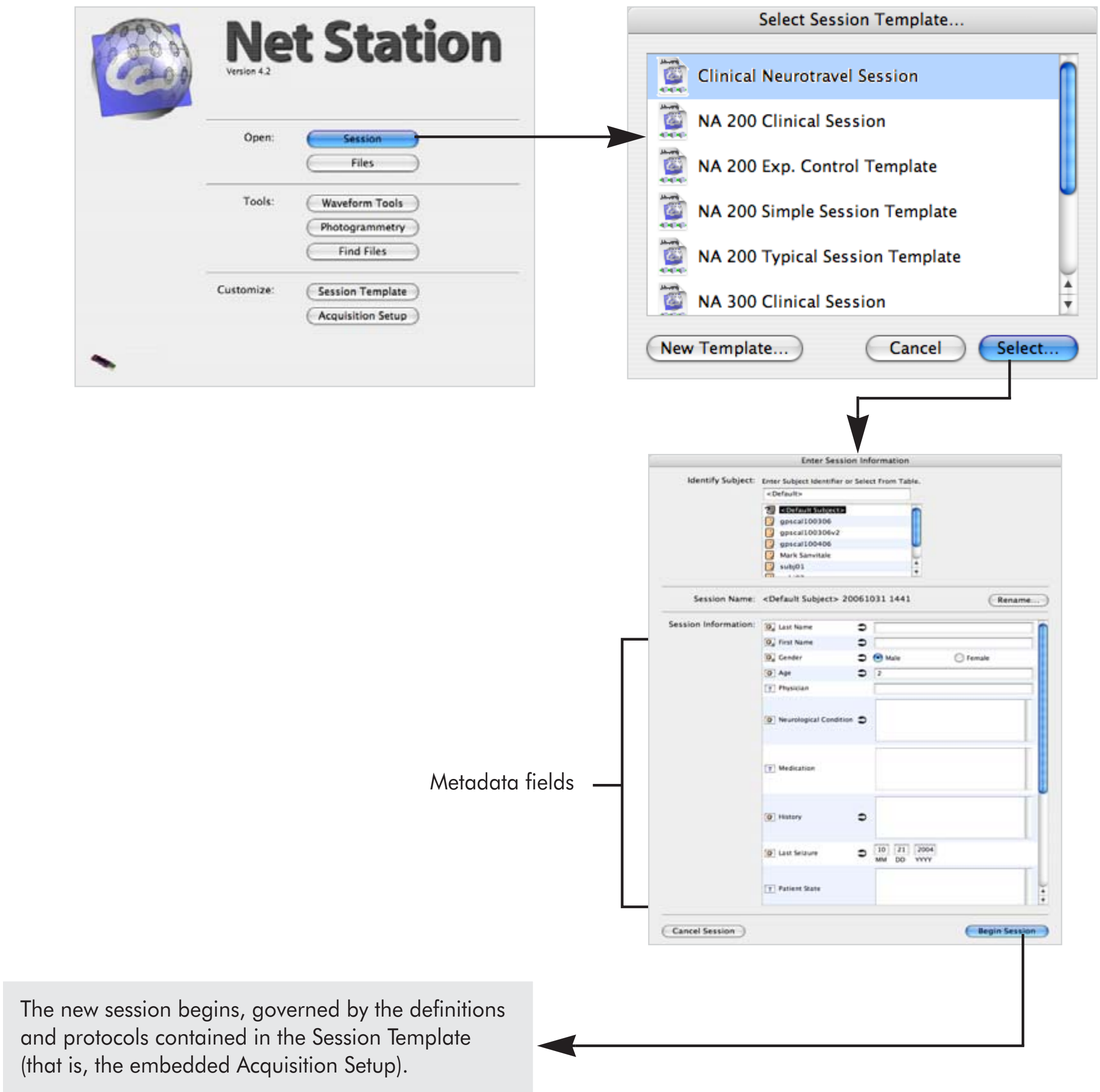


Figure 7-1. Flowchart for initiating a session

Session Template Components

A Session Template has some required and some optional components (see Figure 7-2, "Anatomy of a Session Template").

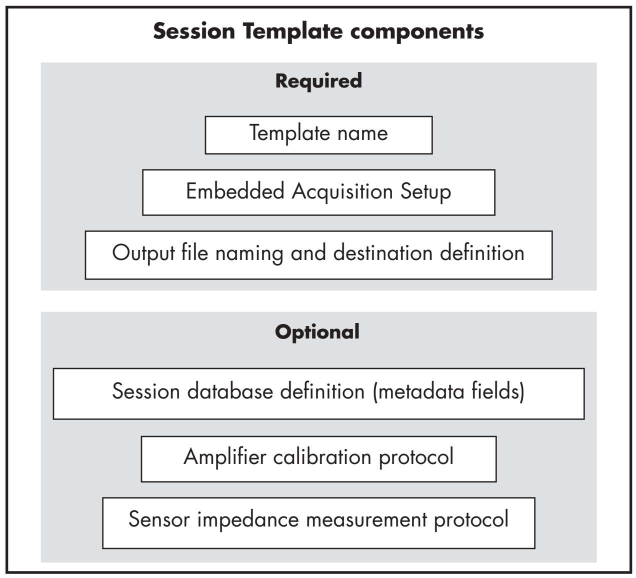


Figure 7-2. Anatomy of a Session Template

Name

The Session Template name is simply the file name in the Finder and can be altered later.

The Embedded Acquisition Setup

When a Session Template is created (see "How to Create a Session Template" on page 161), a particular Acquisition Setup is copied into it. This process is called *embedding* the Acquisition Setup. The original Acquisition Setup is not altered by this process and remains an editable document. But the *copy* that becomes part of the Session Template is no longer editable (Figure 7-3).

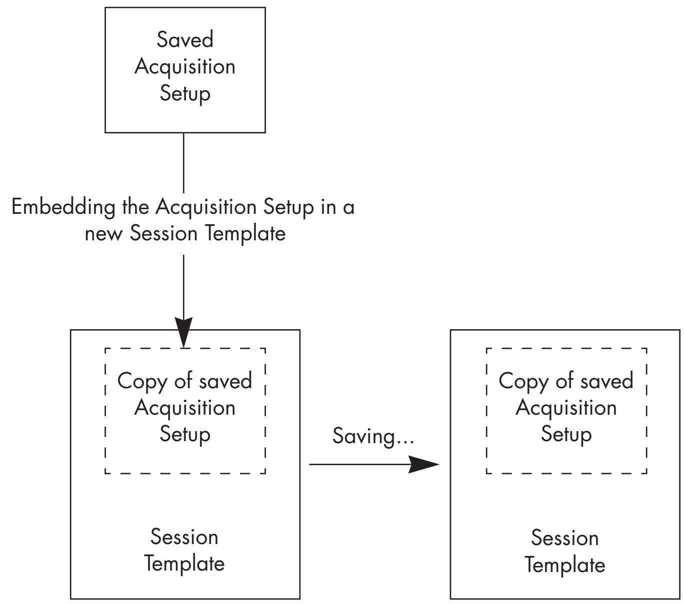


Figure 7-3. Embedding an Acquisition Setup in a Session Template

Output File Naming and Destination Definition

Session files generated during a session must be named and placed in a destination folder. When the Session Template is created, automatic naming and destination conventions are specified. The file name and destination are governed by the specification of the template, although you can override the specification later during the initiation of the session.

Metadata Fields

A Session Template may optionally include metadata fields. The default Session Templates include a built-in set of metadata fields. You can create your own templates with preexisting metadata fields or create and incorporate new fields. The fields and the metadata they contain become part of the Session file when it is saved.

Information can be entered into fields during a session, but the presence or absence of fields cannot be changed.

Other Session Template Options

Two additional options are available when defining a Session Template. When either of these options is chosen, Net Station automatically performs the specified operations during startup of the session:

- amplifier calibration (gains and zeros measurement)—***if the Source device is the Net Amps USB or Net Amps 300***
- sensor impedance measurement

After Net Station completes the operations, if any were specified, the session is then governed by the embedded Acquisition Setup and your interaction with it.

Note: Sensor impedance measurements can be collected only with a Geodesic Sensor Net attached to the system.

How to Create a Session Template

To begin, launch Net Station and click the Session Template button in the Customize section of the start-up window. This opens the Create New Session Template window (Figure 7-4).

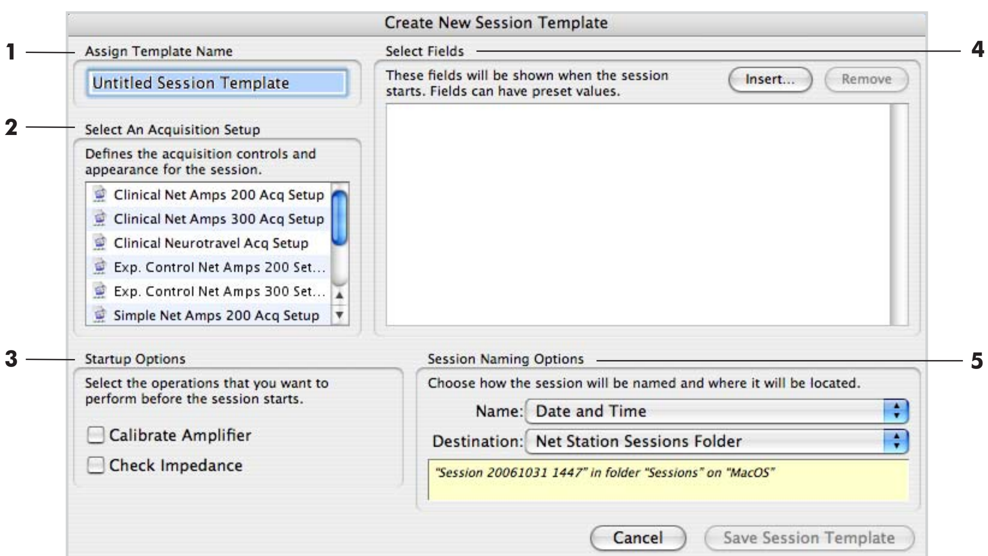


Figure 7-4. Create New Session Template window

The Create New Session Template window is divided into five areas. Refer to the figure as you read the next sections, to go over a step-by-step description of how to create a template.

1. Choose a template name. The Save Session Template button will not activate if the field is empty.

2. Click the name of the Acquisition Setup to be embedded (copied) into the Session Template.

3. Choose which operations to perform at the start of the session:

   ◦ *Calibrate Amplifier* ***(for Net Amps USB or 300 device only)***: measures the gains and zeros for each of the individual amplifier channels. For the most accurate measure of amplifier characteristics, you should not connect the Geodesic Sensor Net during these measurements, because it can interfere with calibration.

   ◦ *Check Impedance:* initiates measurement of impedance at each sensor. To check for sensors that might be in poor contact with the subject's scalp, apply the Net to the subject before initiating the impedance check.

4. Select the metadata fields to include with each session. This area is initially blank and can remain so if you do not want to include metadata fields in a session. Whatever fields are added here will appear at the start of the session, prompting you to input metadata.

   Click the Insert button to deploy the Insert Fields window (Figure 7-5). Choosing fields in the Insert Fields window and clicking Insert will add them to the Session Template.

5. Select session-naming and destination options. The text box beneath the Destination pop-up menu shows the resulting name and destination.

After completing these steps, click the Save Session Template button. See Figure 7-7 on page 164 for an example of a completed Session Template.

Insert Fields Window

Add metadata fields to a Session Template by selecting a field in the Insert Fields window (Figure 7-5) and clicking the Insert button at the bottom of the window. The standard fields are not editable, but you can create custom fields that can be edited.

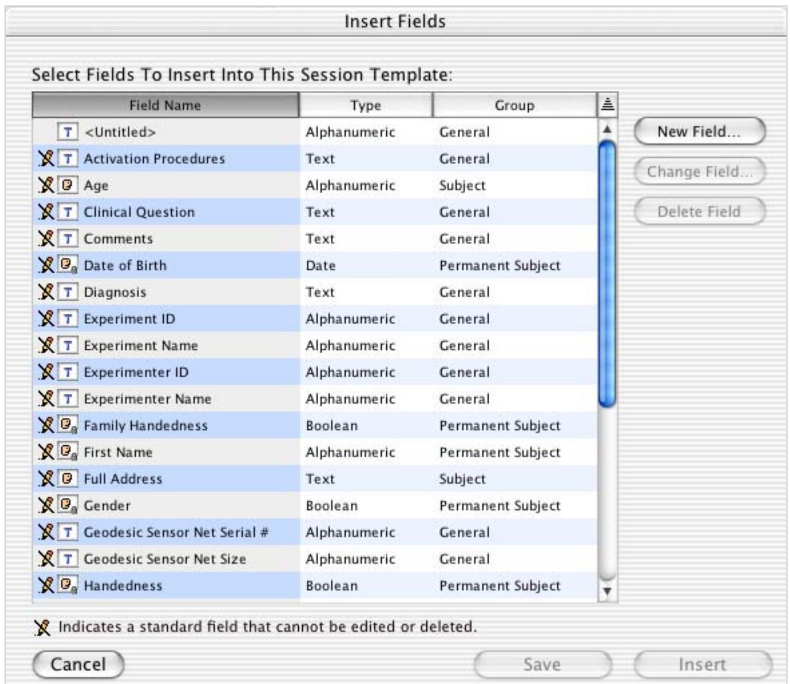


Figure 7-5. Insert Fields window

To add a custom field, click the New Field button. This produces the Create New Field window (Figure 7-6), with a text box for entering the field name. Specify the field type using the Field Type pop-up menu (Figure 7-6), which defaults to Alphanumeric.

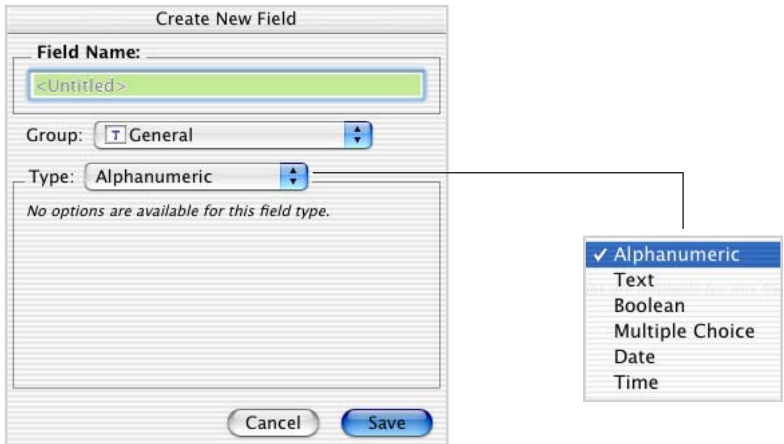


Figure 7-6. Create New Field window with Field Type pop-up menu

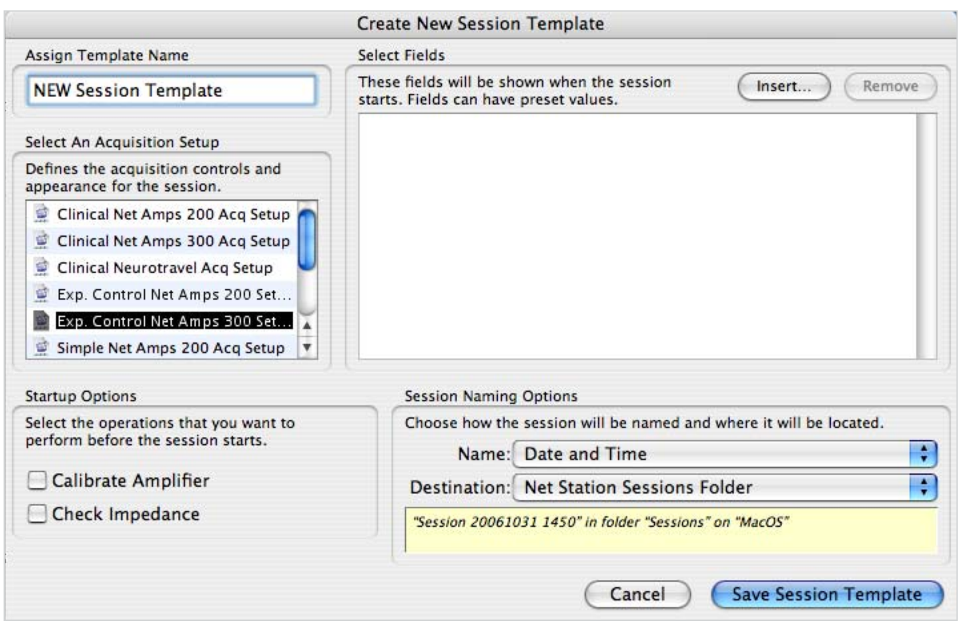


Figure 7-7. Example of a completed Session Template

How to Use A Session Template

To begin a session, click the Session button in the Open section of the Net Station start-up window. The Select Session Template window opens, offering a choice of Session Templates (Figure 7-8). Any user-created templates located in the Templates folder (see page 40 for information about this folder) will be listed, in addition to the default templates.

The default templates will always appear first in the list, sorted alphabetically. User templates in the Templates folder will be listed next. User templates can have the same names as the default templates, but this is not a wise way to name your custom templates.

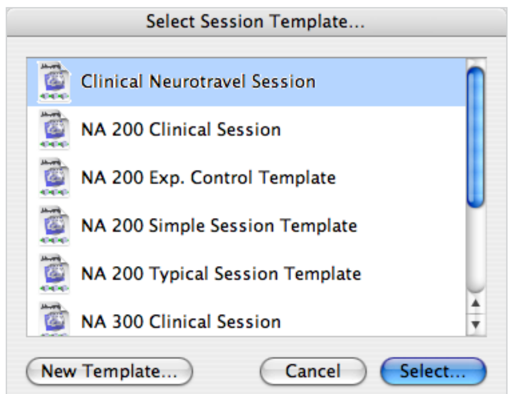


Figure 7-8. Select Session Template window with Clinical Neurotravel Session selected

There are three ways to choose one of the available Session Templates from the Select Session Template window:

- Double-click a Session Template list item
- Single-click a Session Template list item, then click the Select button
- Single-click a Session Template list item, then press the Return key on the keyboard

All three ways have the same result—opening the Enter Session Information window (see “Session Information,” the next section).

Note: You can double-click user-created templates directly in the Finder to begin a session, whether Net Station has already been launched or not. If Net Station is inactive when you double-click a Session Template, Net Station will automatically launch and the Session Information window will open. Using this method of initiating a session bypasses the Select Session Template window.

Session Information

After you pick a Session Template, the Enter Session Information window appears, displaying in its Session Information subpanel the metadata fields and buttons that were specified when the template was originally created. You can enter session information at this point, or do so later in the session. Whatever metadata are entered will automatically become a permanent part of the Session file after it has been saved. Figure 7-9 shows the Enter Session Information window defined in the default NA 300 Exp. Control Template.

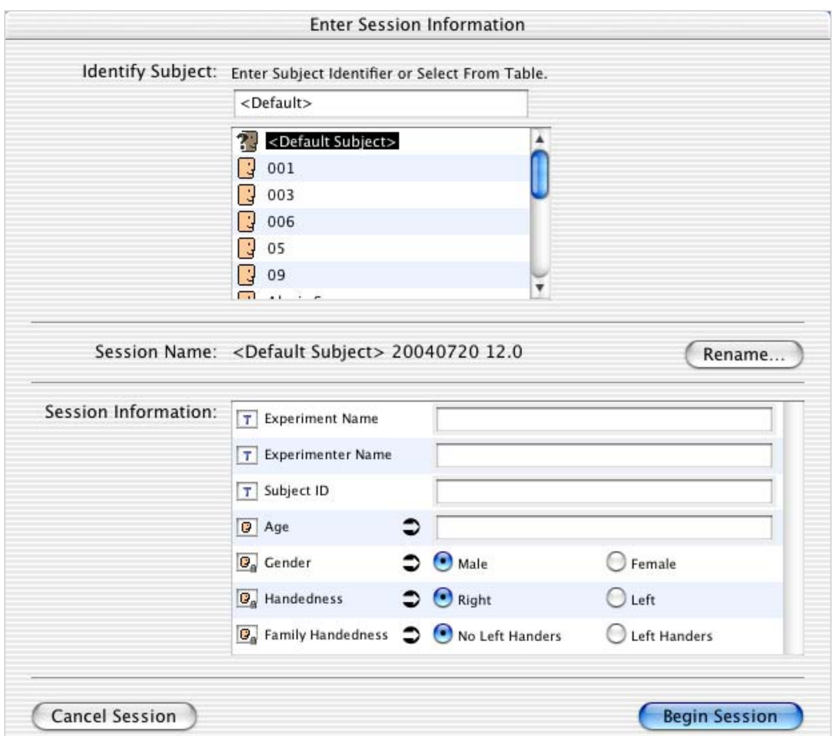


Figure 7-9. Enter Session Information window included with the default templates

Identify Subject Subpanel

Subject identifiers do not store metadata; they are simply labels. If subject identifiers have been created in previous sessions, they will appear in the Identify Subject subpanel of the Enter Session Information window. Net Station stores previously created subject identifiers in its Resource Database (see "Support Folder" on page 40).

New subject identifiers are created by typing into the box to the left of the list.

Session File Naming and Destination Scheme

When you create a new Session Template, you can choose from two autonaming schemes (for details, see page 162). In the case of the default Typical Session Template, the option was set to automatically name the Session file using the subject name and current date and time.

The middle of the Enter Session Information window (Figure 7-9) displays the name that will be applied automatically to the Session file when you close the session and save the file. This particular scheme constructs the session name by appending a date and time code to the user-chosen subject identifier (or the default, if there are no others). The date-time code is of the form: yyyymmdd hour.minute.

Note that you can click the Begin Session button at any time during this part of the setup for a session, but once you click the Begin Session button, you cannot change the file name and destination folder. The Session file can always be renamed and moved using the Finder after the session.

You can override the template's built-in naming scheme, destination setting, or both using the Rename Session window, described in the following paragraphs.

If you click the Rename Session button in the Enter Session Information window, a window is displayed for overriding the default session name (Figure 7-10). You can navigate to a destination folder as well as enter a new name for the session. With the navigation feature, you can override the Session Template's destination scheme, which is also defined when the template is saved.

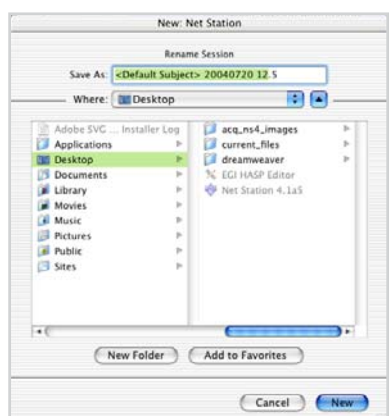


Figure 7-10. Rename Session window

Click the New button in the Rename Session window to save the new name and destination and return to the Enter Session Information window, or click the Cancel button to accept the built-in naming scheme. Once you click the New button, the destination that was displayed in the window becomes the new destination, overriding the Session Template's built-in specification.

If you have renamed the session, the new name will appear in the middle of the Enter Session Information window.

Automatic Amplifier Calibration

With the default NA 200 Typical Session Template and the default NA 300 Typical Session Template (which use the Net Amps USB and Net Amps 300, respectively, as their Source device), automatic amplifier calibration is performed. The gains and zeros progress bars come up in tandem (Figure 7-11).

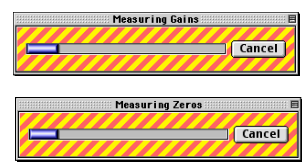


Figure 7-11. During amplifier calibration

Note: For the most accurate measurement of amplifier gains and zeros during calibration, do not connect a Geodesic Sensor Net.

When the measurement of gains and zeros is finished, the progress bars disappear from the screen.

Impedance Measurement

If you create a Session Template with the Check Impedance checkbox selected (see page 162), impedance measurement is automatically performed when you initiate the session. If not, you must manually initiate impedance measurement (Figure 7-12).

Before a sensor impedance measurement begins, connect a Geodesic Sensor Net to the amplifier and apply the Net to the subject.

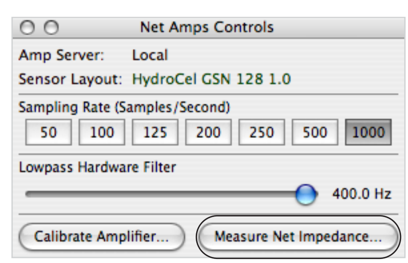


Figure 7-12. Click the Measure Net Impedance buttons

If an impedance measurement is initiated without a Geodesic Sensor Net connected, Net Station issues an error. Otherwise, the Impedance Measurement window appears, displaying a sensor layout that matches the layout of the attached sensor array (see Figure 7-13).

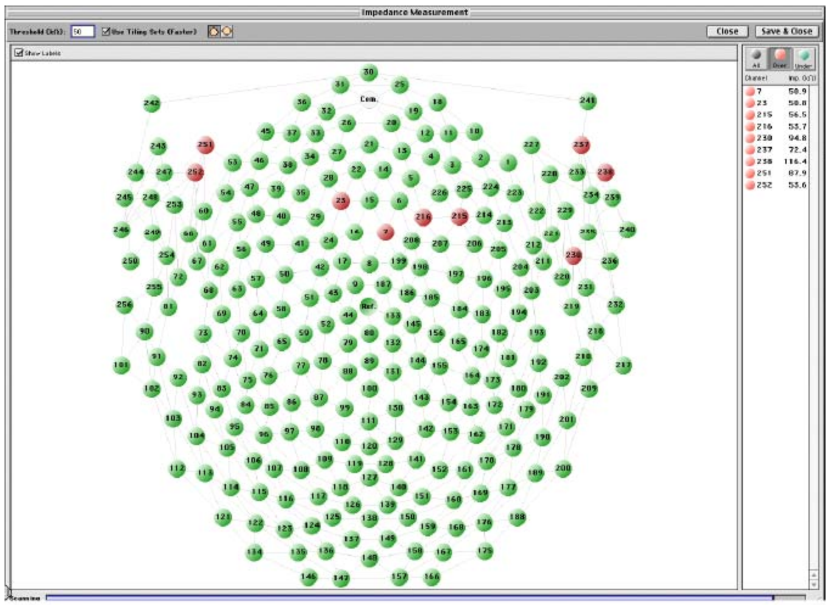


Figure 7-13. Impedance Measurement window (EGI's 256-channel GSN 200)

Adjust sensors so that impedances are acceptable, then click the Save & Close button to save the current measurement set (see "Impedance Measurement Window" on page 82).

Recording EEG

Click the Record button on the Waveform Recorder Controls panel and note that the Acquisition status panel displays an indicator that recording is in progress.

Click the Stop button to end the epoch of EEG being recorded. Click Record again to begin a new epoch.

Closing the Session

Clicking the Close Session button ends the recording and closes the Session file, naming and placing the file in a directory per the Session Template specification (or the user override, if any).

chapter 8

CLINICAL INTERFACE

The optional Clinical Interface is designed to provide the full functionality of Net Station to clinicians and physicians. In the Clinical Interface, voltage values are plotted negative up and positive down by default. The Clinical Interface also offers the following clinically oriented features:

- a simplified start-up screen
- automated Session Templates
- patient records
- the Review window, a patient-oriented interface for locating and reviewing exams
- printing of patient and exam information with EEG data

This chapter describes the interface windows, buttons, and controls, and the main clinical features.

Accessing the Clinical Interface

The Clinical Interface is an adjunct to the research interface; the two cannot operate simultaneously.

If you purchased a complete clinical Geodesic EEG System, the computer is configured to operate in clinical mode automatically.

If you are upgrading your software to enable the clinical features, contact support@egi.com to upgrade your license.

Interface Appearance

The start-up window of the Clinical Interface contains three buttons: Acquire, Review, and Analyze (Figure 8-1).

Figure 8-1. Clinical Interface start-up window

- *Acquire*: opens the Select Session Template window or the Acquisition Session window, depending on the Sessions setting in the Preferences window (see page 178). Acquiring data using the Clinical Interface is discussed in "Acquiring Exams" on page 179. For full details about acquisition, see relevant chapters in this manual, the *Net Station Acquisition Technical Manual*.
- *Review*: opens the Review window, for locating exams for review. Reviewing data using the Clinical Interface is discussed in "Reviewing Exams" on page 183. For full details about the review tools, see the *Net Station Viewer Technical Manual*.
- *Analyze*: opens the Waveform Tools tool specification editor. Analyzing data using the Clinical Interface is discussed in "Analyzing Exams" on page 185. For full details about the Waveform Tools, see the *Net Station Waveform Tools Technical Manual*.

Menu Bar

The Clinical Interface contains a simple menu bar (Figure 8-2).

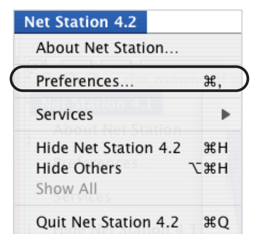
Figure 8-2. Net Station clinical menu bar

Apple

The Apple menu contains standard Mac OS items for operating the system.

Net Station

The Net Station menu contains standard commands for operating Net Station. The most important is Preferences:



- *Preferences*: allows you to set up exam (file) size, viewer preferences, cover page content, and Session Template usage (see "Clinical Preferences" on page 175).

File

The File menu contains standard commands for working with Net Station files. The most important is New:

- *New*: allows you to create a new Acquisition Setup to embed into a new Session Template (shortcut: Command-N). The start-up window does not offer this capability. (To make a new Session Template, see the "Note" on page 180.)

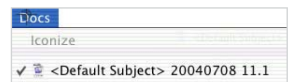
Edit

The Edit menu is available only if a window is open; the only command available is Clear.

- *Clear*: clears selected items from a list.

Docs

The Docs menu allows you to view selected exams during review and acquisition.



- *Iconize*: unavailable. The Clinical Interface does not allow minimization of exam windows.
- <*Filename*>: switches between the windows of selected exams during review mode, and opens the selected exam's Session Info window during acquisition mode.

Tools

The Tools menu offers advanced features for processing data. These commands are described fully in the Menus chapter of the *Net Station Viewer Technical Manual*.

Clinical Preferences

Before running any EEG exams, set up the Net Station Preferences. To open the Preferences window, choose **Net Station > Preferences**.

The window contains four panes: Acquisition, Review, Printing and Sessions (Figure 8-3).

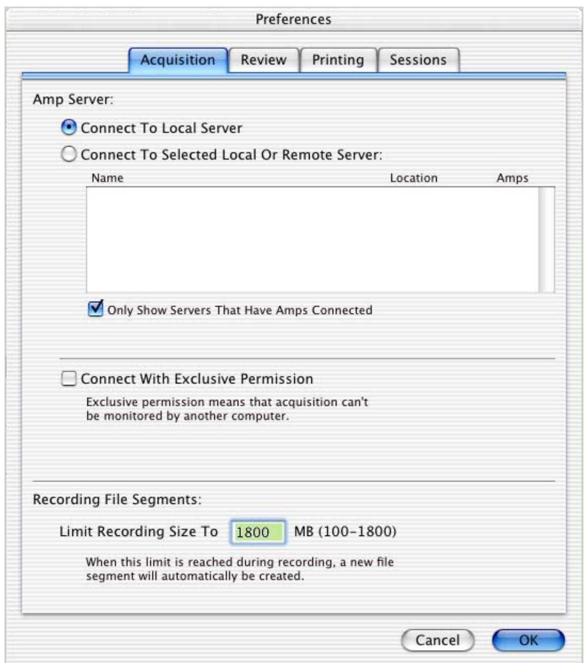


Figure 8-3. Net Station Preferences window, with the Acquisition pane frontmost

Acquisition Pane

The Acquisition pane allows you to set up the connection permissions and the maximum size of the exams.

The Amp Server section contains controls for permitting local-area network access to your amplifier. More information about this feature is provided in the *Amp Server Getting Started Guide (draft)*.

For information about exam (file) sizes, see "Recording Modes and File Sizes" on page 79 of this manual.

Review Pane

The Review pane allows you to customize your review display in terms of color, screen aliasing, topographic map precision, calibration, and events (Figure 8-4). More information about these controls are provided in the *Net Station Viewer Technical Manual*.

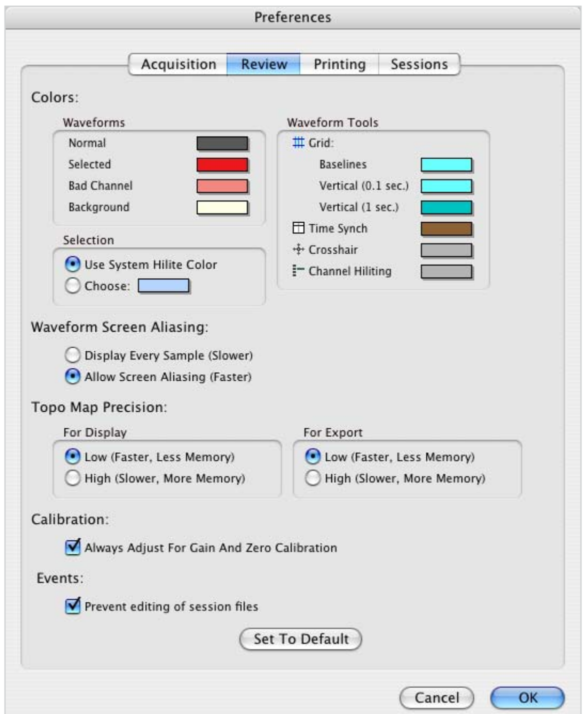


Figure 8-4. Review pane of the Net Station Preferences

Printing Pane

The Printing pane allows you to set up as many as two cover pages to print with a patient's EEG exam. The cover pages contain information related to the exam and the patient (Figure 8-5).

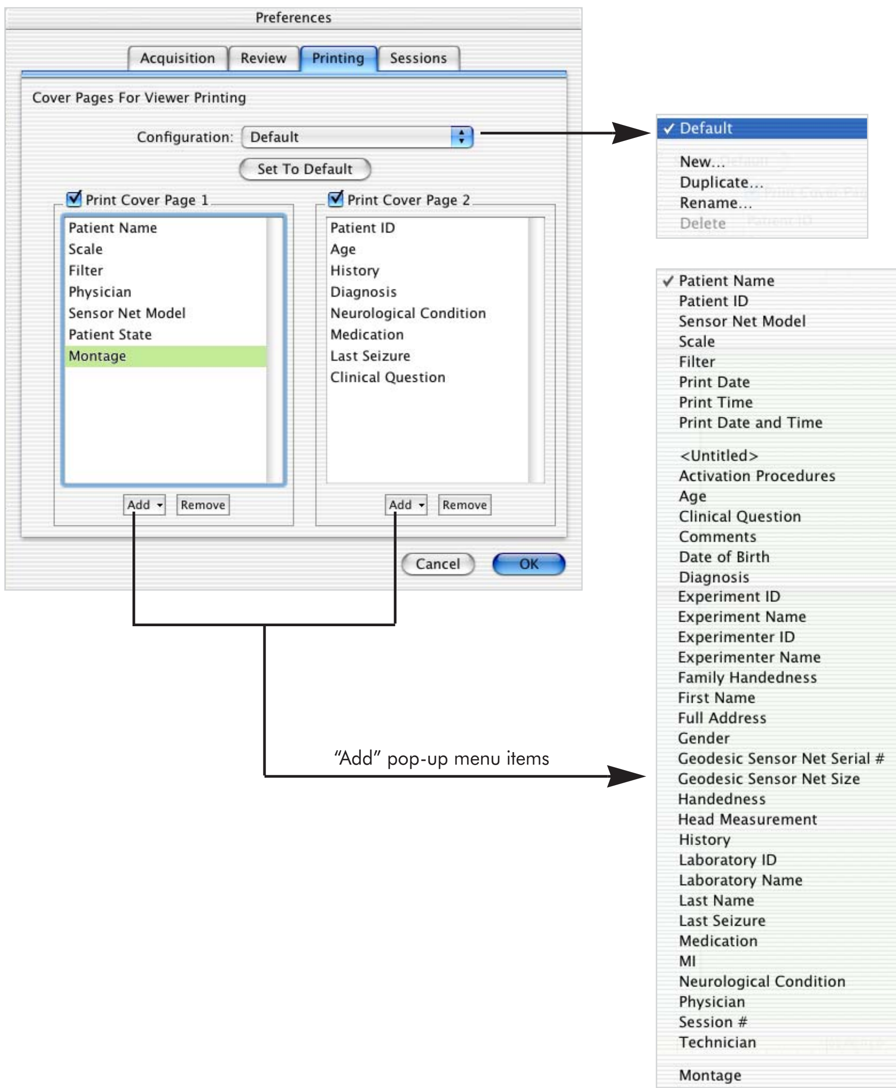


Figure 8-5. Printing pane with "Configuration" and "Add" pop-up menus

The “Configuration” pop-up menu allows you to choose or duplicate default cover pages, or to create new cover pages populated with information selected from the “Add” pop-up menu items.

The “Add” pop-up menus are active only when their corresponding “print cover page” checkboxes are selected (see Figure 8-5 on page 177).

The first cover page contains information identifying the subject and exam (such as patient name, filter settings, Geodesic Sensor Net used). The second page contains information provided by the referring physician (patient ID, medical history, diagnosis, medication, and so forth).

For additional information, see “Printing Patient or Exam Information” on page 185.

Sessions Pane

The Sessions pane (Figure 8-6) allows you to set up the EEG exam format that appears when EEG acquisition is initiated.

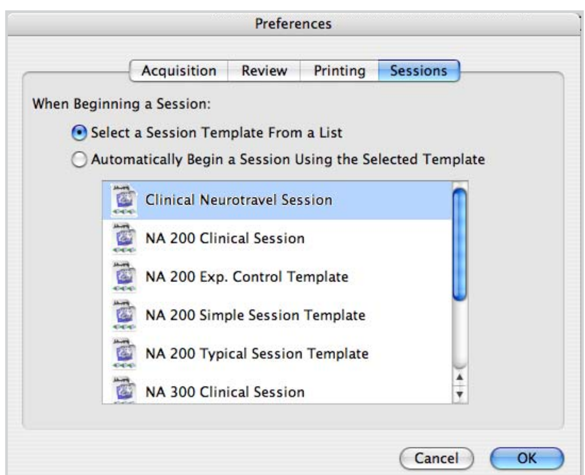


Figure 8-6. Sessions pane of the Net Station Preferences

- *“Select a Session Template” button*: If this button is selected, the Select Session Template window appears when you click the Acquire button in the start-up window, allowing you to use different setups for individual exams.

- *“Automatically Begin” button*: If this button is selected, the Acquisition Session window appears when you click the Acquire button in the start-up window. The chosen Session Template is automatically set up to acquire EEG data, ensuring that the same setup is used for each exam.

For more information about Session Templates, see Chapter 7, "Sessions and Session Templates.”

For more information about acquiring EEG in Net Station’s clinical mode, see “Acquiring Exams,” in the next section.

Acquiring Exams

The EEG exams recorded using the Clinical Interface are based on Net Station’s Session Templates. Before acquiring EEG data, make sure that the default Session Templates meet your needs. Otherwise, create and save new Session Templates. For more information, see Chapter 7, "Sessions and Session Templates.”

Acquiring exams consists of initiating acquisition, supplying patient information, and acquiring EEG data using the Dense Waveform Display. When you create a patient record, you must at least enter the patient’s name and assign a unique identifier to the patient—the Patient ID—which allows Net Station to correctly link the EEG files to the corresponding patient.

This section provides step-by-step instructions and an illustration of the acquisition process.

Note: For long acquisition sessions resulting in multiple files, we recommend creating a file folder for storing each session’s files. This prevents the overwriting of identically named files from different sessions.

Acquisition Instructions

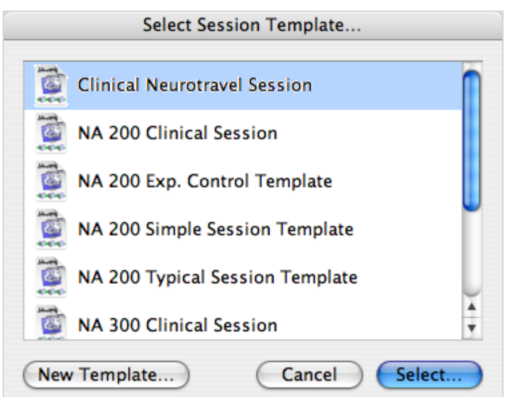
To acquire EEG data:

1 Click the Acquire button in the start-up window.

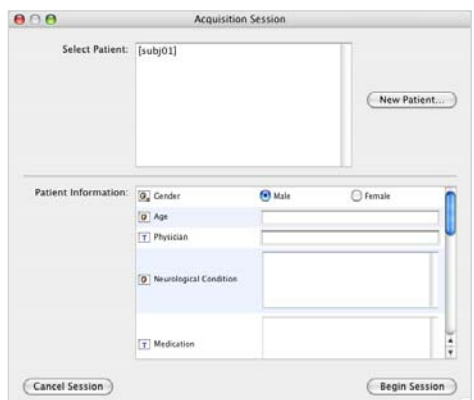
- If the “Select a Session Template” button is selected in the Sessions pane of the Preferences window (see page 178), the Select Session Template window will appear (Figure 8-7, left). After you click the Select button in the Select Session Template window, the Acquisition Session window will appear.

Note: If the Select Session Template window does not contain the template required, click the New Template button to create a template based on the Acquisition Setups available. If the list of Acquisition Setups does not include the correct setup, click Cancel, choose **File > New** *to create and save a new setup; and click the New Template button in the Select Session Template window to create the desired template.*

- If the “Automatically Begin” button is selected in the Sessions pane of the Preferences window (see page 178), the Acquisition Session window will appear (Figure 8-7, right).



If the “Select a Session Template” button is selected in your Preferences, this window appears after you click the Acquire button.



If the “Automatically Begin” button is selected in your Preferences, this window appears after you click the Acquire button.

Figure 8-7. Acquisition windows: Select Session Template and Acquisition Session

2 Select a patient from the patient list at the top of the Acquisition Session window. If you must create a new-patient record:

   ° Click the New Patient button to open the New Patient window (Figure 8-8).
   ° Fill in the information in the New Patient window and click OK to return to the Acquisition Session window.

Note: The Patient ID box requires a unique patient identifier up to 15 characters in length (no colons).

The minimum requirements for a new-patient record are the patient ID and patient name.

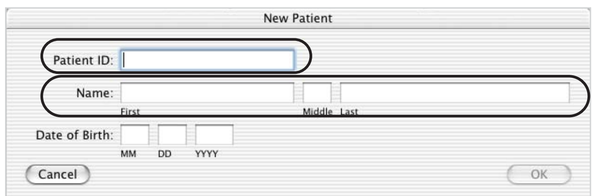


Figure 8-8. New Patient window

   ° Complete the Patient Information section of the Acquisition Session window.

3 When ready, click the Begin Session button in the Acquisition Session window to display the Dense Waveform Display and begin acquiring data.

4 Click the Record button in the Waveform Recorder controls panel to begin recording, and click the Stop button to stop.

5 Click the Close Session button in the top-right corner of the Dense Waveform Display to save the exam and to return to the start-up window.

Recording without Complete Patient Information

If you must run the EEG exam immediately, *at the very least* fill in the following information:

- patient's first name
- patient's last name
- patient ID

Later, locate the exam and complete the rest of the patient information.

Acquisition Ilustration

Click the Acquire button in the start-up window to open the Acquisition Session window.

Optional: Select a Session Template and proceed to the Acquisition Session window.

Select a patient from the Acquisition Session window.

Optional: Create a new-patient record and return to the Acquisition Session window to complete the patient information.

Click the Begin Session button.

Acquire and record data, which are displayed in the Dense Waveform Display.

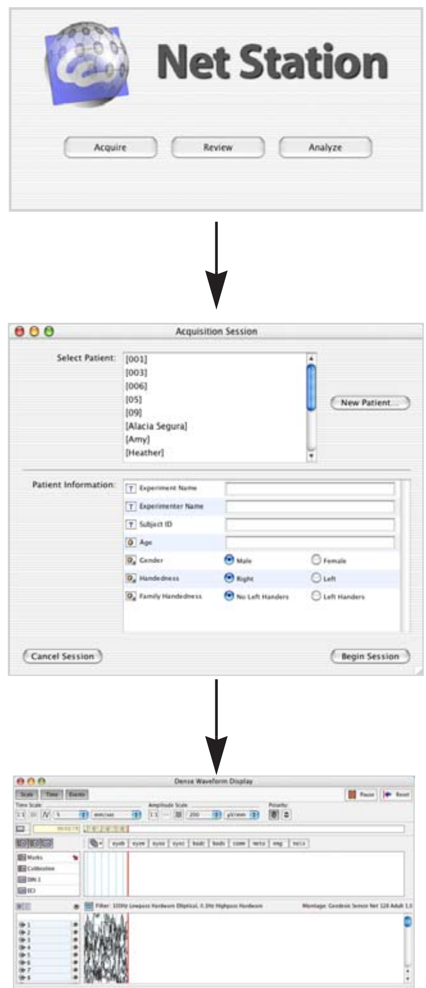


Figure 8-9. An illustration of the clinical acquisition process

Reviewing Exams

Reviewing exams consists of locating the exams using the patient-oriented interface and opening them in the Viewer. For more information about Net Station's review capabilities, see the *Net Station Viewer Technical Manual*.

Note: The Clinical Interface plots voltage values with negative up and positive down by default.

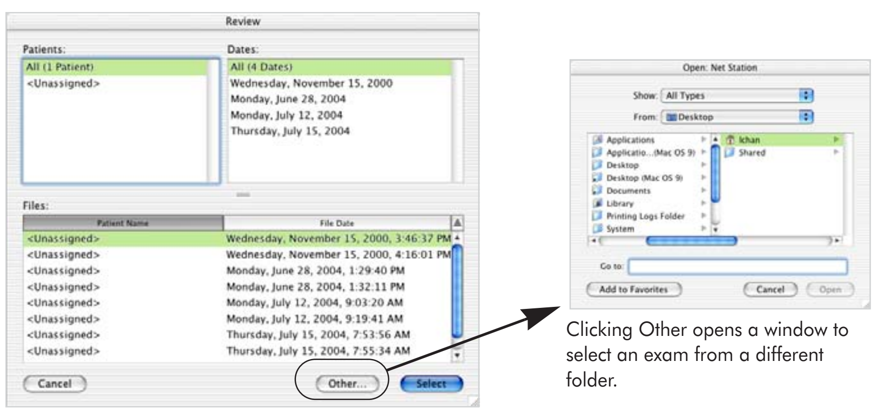
Note: Files recorded in Research mode and viewed using the Clinical Interface will contain references to "subjects," rather than "patients."

Review Instructions

To review exams:

1. Click the Review button in the start-up window to open the Review window, which allows you to view Session exams sorted by patient or date.

2. In the Review window (Figure 8-10, left), click on an item (or Command-click to select more than one item) in the Patient pane on the left, in the Date pane on the right, or in both panes; the File pane at the bottom will display only the exams for the selected patient(s) or date(s).



The window displays exams for selected patients and/or dates.

Figure 8-10. Review windows: main window and exam-selection window

The default destination for Net Station Session exams is the Documents folder in the user's home directory (see "Net Station Under OS X" on page 34 of this manual for more information). To view an exam saved elsewhere, click the Other button in the Review window, which opens an exam-selection window (Figure 8-10 on page 183, right).

3 To open an exam, double-click on its name in the Files pane or select its name in the pane and click the Select button.

Event Labels

If you are viewing an exam with events, all the events are displayed as labels in the data-display area of the Viewer when using Chart view (Figure 8-11). This allows quick review of the data, especially if the event track-display area near the top of the Viewer is not visible.

To view only certain event labels, choose **Events > Filter Events** to select which events to display. (For more information, see Chapter 15, "Viewing Events," in the *Net Station Viewer Technical Manual*.)

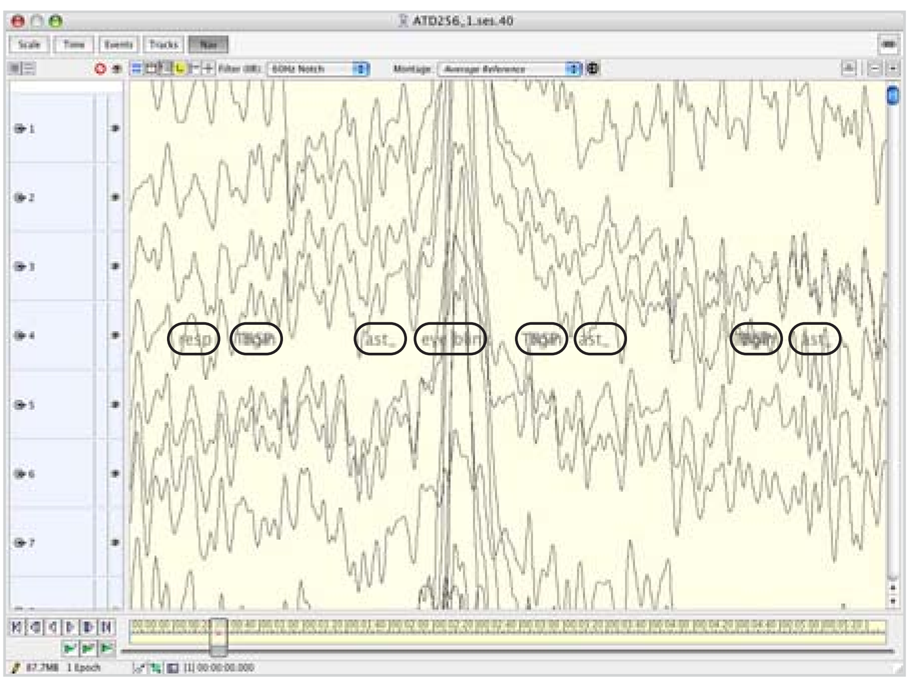


Figure 8-11. Event labels in the data-display area in Chart View

Printing Patient or Exam Information

The Clinical Interface allows you to print as many as two cover pages containing information about the patient, exam, or diagnosis.

To print only the cover pages, open the exam in the Viewer and choose **File > Print Cover Pages**.

To print the cover pages with the EEG data, either choose **File > Print Window** to print the entire exam, or select a portion of data by highlighting it in the waveform area and choosing **File > Print Selection**.

For details about setting up the cover pages, see “Printing Pane” on page 177. For information about printing the EEG data, see the printing chapter in the *Net Station Viewer Technical Manual*.

Analyzing Exams

Analyzing exams consists of applying a Waveform Tool to a selected Session file. For more information about Net Station’s analysis capabilities, see the *Net Station Waveform Tools Technical Manual*.

Analysis Instructions

To analyze exams:

1. Click the Analyze button in the start-up window to open the Waveform Tools window (Figure 8-12 on page 186).
2. Click the Add button in the Waveform Tools window and select the exam.
3. Click Filter List to select a defined Waveform Tool specification or click Create to define a new Waveform Tool specification.

4 Click the Run button to run the tool on the exam (see the *Net Station Waveform Tools Technical Manual* for full details).

Figure 8-12. Waveform Tool window

chapter 9

Digital Video

Net Station's Digital Video option provides full support for any FireWire (IEEE-1394) DV-compliant digital camera. This capability enables you to record and review video of a patient or subject that is synchronized with his or her recorded EEG data. The result is an ability to link EEG events to physical movements performed by the subject or patient during acquisition, which is essential for clinical behavioral studies in areas such as sleep.

This chapter discusses how to add video capability to EEG acquisition, acquire EEG with video, and review an EEG–video file.

Video Acquisition Setup

To acquire video synchronized with EEG, you must first create an Acquisition Setup that includes the Digital Video device in its Workbench configuration (Figure 9-1). As shown in the example in Figure 9-1, the Digital Video device contains no input or output ports; placing it on the Workbench automatically activates Net Station's video capabilities.

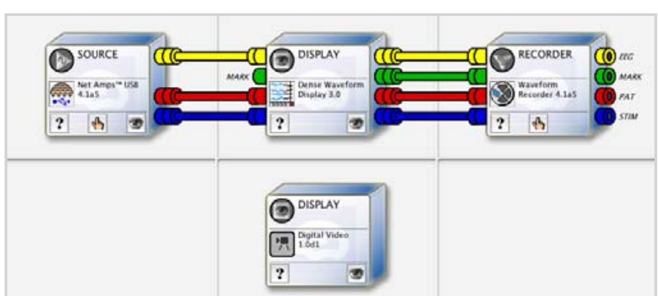


Figure 9-1. Primitive Acquisition Setup with video capability

The Digital Video device contains no ports because it is automatically linked to the Waveform Recorder; whenever you click the Waveform Recorder's Record or Stop button, you trigger the Digital Video device to start or stop recording.

Acquisition Setups retain the positions of open control and display panels when saved. When designing your video Acquisition Setup, make sure that the following, at least, are displayed:

- Video display (choose **Panels > Video**)
- Dense Waveform Display
- Waveform Recorder controls

When finished designing your video Acquisition Setup, save it and create a Session Template (see Chapter 5, "Workbench: Acquisition Setups," and Chapter 7, "Sessions and Session Templates," for more information).

Video Acquisition

To acquire video–EEG data:

1 Make sure that the camera is properly connected and is on.

Note: The camera must be on before you initiate acquisition. If you acquire EEG before switching on the camera, stop acquisition, switch on the camera, and restart acquisition.

2 Start Net Station, click the New button in the start-up window, and select the video Session Template.

3 Enter the Session information and click the Begin Session button to initiate acquisition and to view the draggable Digital Video display floating on top of the Dense Waveform Display, as shown in Figure 9-2 (if the template is not set up to display the video display automatically, choose **Panels > Video**).

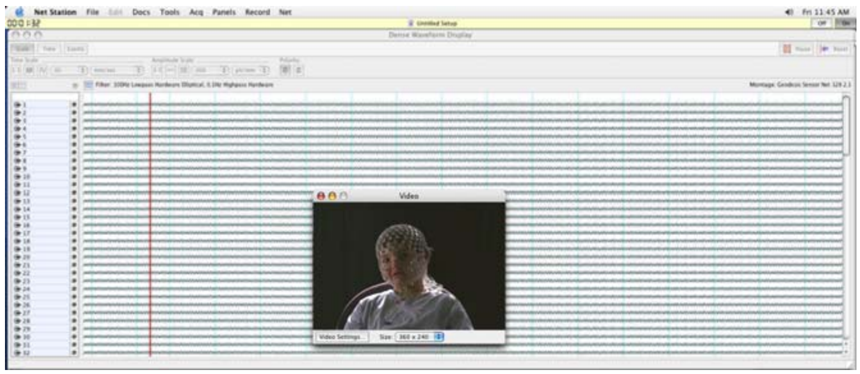


Figure 9-2. Digital Video display floating over the Dense Waveform Display

4 Net Station’s default video format is .mov, normal quality, 640 x 480 resolution. From the Size and Quality pop-up menus, you can set up the digital video according to your preferences. (The camera used as an example in Figure 9-3 is the Apple iSight; other cameras will have different windows for establishing the video settings.)

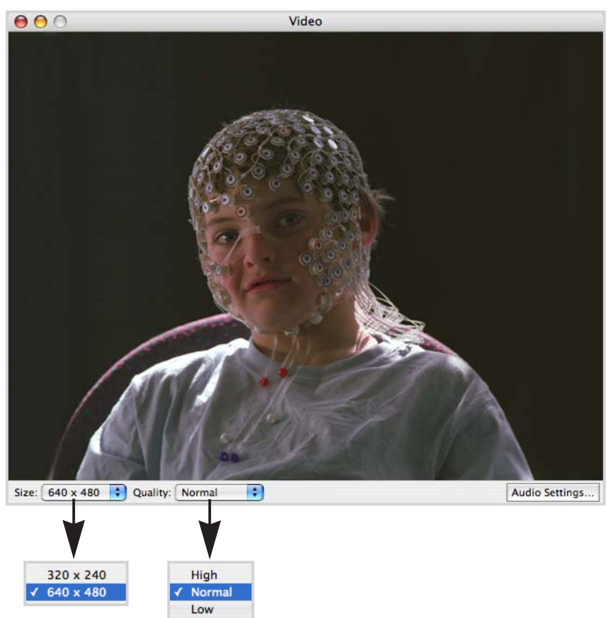


Figure 9-3. Video display settings

5 Click the Record button in the Waveform Recorder controls to begin saving EEG data and video to disk.

Video Review

Net Station creates a companion video file when you create a video–EEG recording and saves it in the same folder as the EEG file. The video file is automatically named <filename>.mov (Figure 9-4).

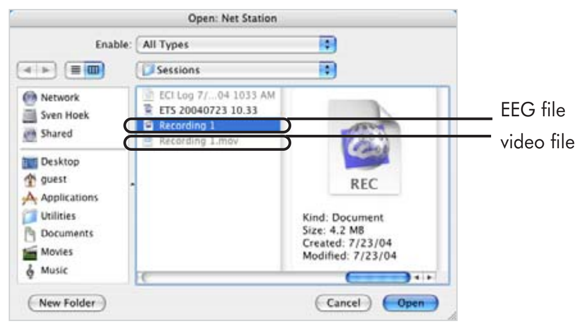


Figure 9-4. The sample EEG file is saved with its companion video file

Video is typically recorded and played back at a maximum of 30 frames per second, depending on the video settings established during acquisition. Because EEG is typically acquired at a much faster rate (for example, 1,000 samples per second), when you review your video–EEG file, the video will appear slow in comparison. To rectify this, adjust your EEG scale to a slower rate (for example 15–30 milliseconds per pixel). Net Station will map each sample to the nearest frame.

To view an EEG–video file:

1 Open the EEG file and choose **View > Video** to open the video window of the companion video file (the video window shows only the image and contains no controls).

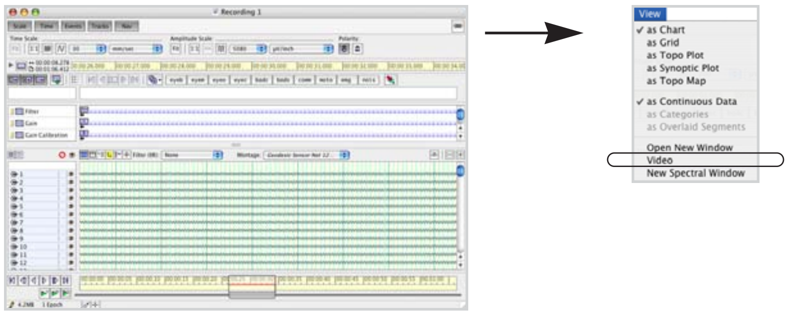


Figure 9-5. Open the video window so it floats over the data display in the Viewer

2 Click the Time Synch toggle in the data-display control strip of the Viewer to display the Time Synch line in the EEG data display. (The Time Synch represents a single sample in the EEG display and is used to align views of multiple windows.)

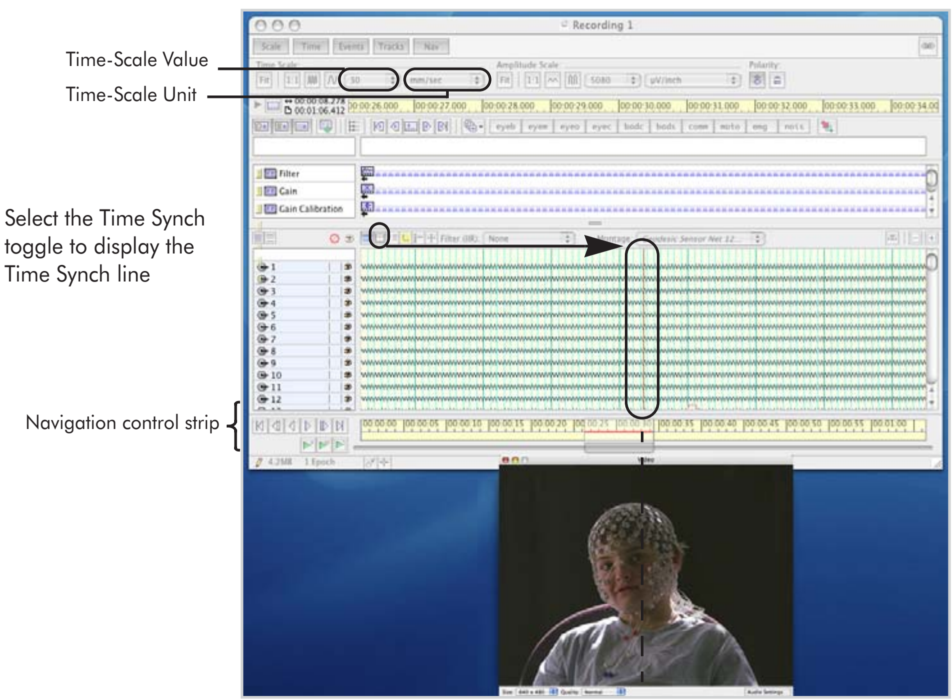


Figure 9-6. The Time Synch is synchronized with the video frame

3 Adjust the rate of the EEG display so it corresponds more closely to the rate of the video recording, by choosing items from the Time-Scale Value and Time-Scale Unit pop-up menus in the Scale control strip of the Viewer.

4 Navigate through the linked EEG and video using the buttons in the Navigation control strip, inserting events into the EEG file based on the subject's or patient's action shown in the video window. The events and the actions are linked to the same timepoint. (The event labels, however, do not appear in the video window.)

5 When finished with the EEG review:

- Save the entire EEG and video files by choosing **File > Save** or pressing Command-S.

- Or save a portion of the EEG and the video corresponding to that segment by highlighting the EEG in the data-display area and choosing **File > Save Selection**.

Video–EEG Archive

To archive a video–EEG file, you must save both the EEG file and its companion video file. Saving one without the other will allow you to view only the EEG or the video of an acquisition session.

chapter 10

Photic Stimulator Interface

A photic stimulator flashes a light at a frequency that evokes predictable brain activity in a patient during an exam. The device typically consists of a flash unit that is triggered either by an external source or by a software program that provides a trigger pulse for the recording apparatus.

Net Station's Photic Stimulator Interface allows you to create photic-stimulation protocols to control the frequency and the duration of such flashes through the software. The Photic Stimulator Interface is a Workbench device, in the same Stimulus/Response class as the Multi-Port ECI.

With Net Station, automatic operation is the only option. You cannot manually trigger the photic stimulator during acquisition.

Acquisition Setup

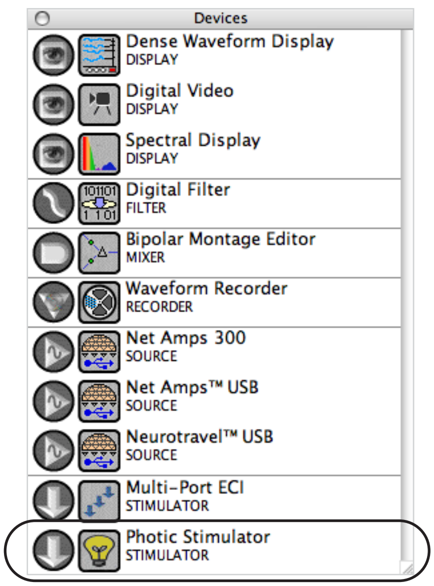
Any photic-stimulation protocol created in Net Station must be saved in an Acquisition Setup. In other words, the steps are:

1. Add the Photic Stimulator Interface device to an Acquisition Setup.
2. Create a photic-stimulation protocol in Net Station.
3. Name and save the setup.

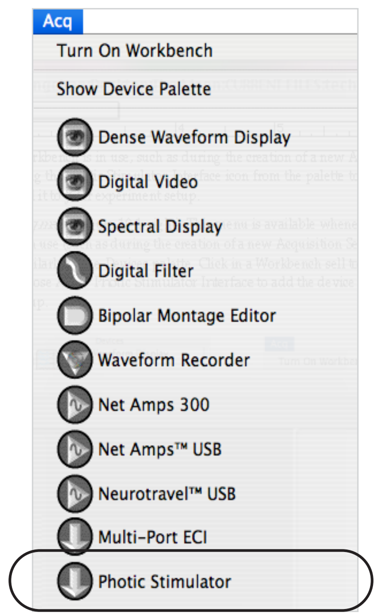
You can access the Acquisition Setup just before the exam.

To add the Photic Stimulator Interface device to your setup, you have two options:

- *Devices palette* (Figure 10-1, left): This palette is available whenever the Workbench is in use, such as during the creation of a new Acquisition Setup. Drag the Photic Stimulator Interface icon from the palette to the Workbench to add it to your experiment setup.
- *Acq menu* (Figure 10-1, right): This menu is available whenever the Workbench is in use (such as during the creation of a new Acquisition Setup), and functions similarly to the Devices palette. Click in a Workbench cell to select it, and choose **Acq > Photic Stimulator Interface** to add the device to your experiment setup.



Devices palette



Acq menu

Figure 10-1. The Photic Stimulator device icon in the Devices palette (left) and the Acq menu (right)

The photic-stimulation setup should allow the experiment events to be both displayed and recorded. The STIM cable runs from the Source through the Stimulator and into the Recorder, while another STIM cable runs from the Stimulator into the Display (Figure 10-2).

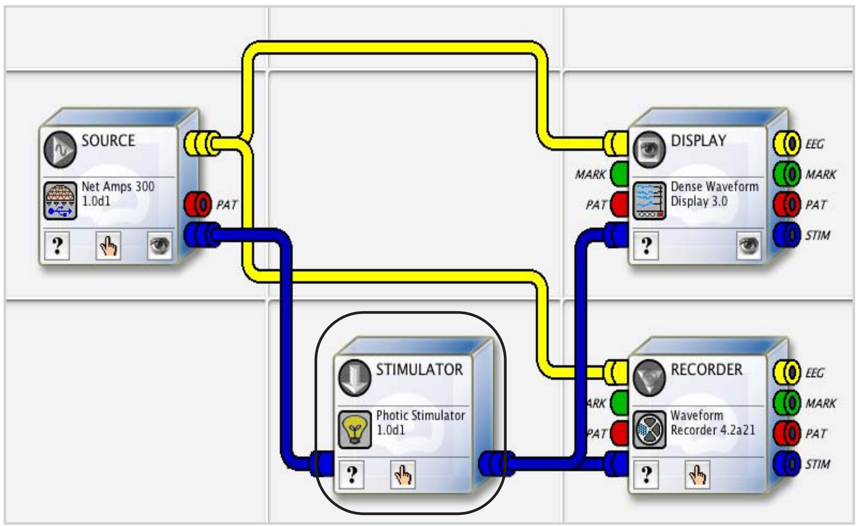


Figure 10-2. An example Acquisition Setup with a photic stimulator added

Creating a Protocol

To create an automatic photic-stimulation protocol, you must first create a *flash interval*, use that to create a *step*, and string together a number of steps to create the *protocol*. The following paragraphs describe these terms further.

A *flash interval* is defined by three factors:

- the number of flashes,
- the total duration of the flashes, and
- the duration of the rest interval following the flashes.

A *step* defines the number of times the defined flash interval runs (Figure 10-3).

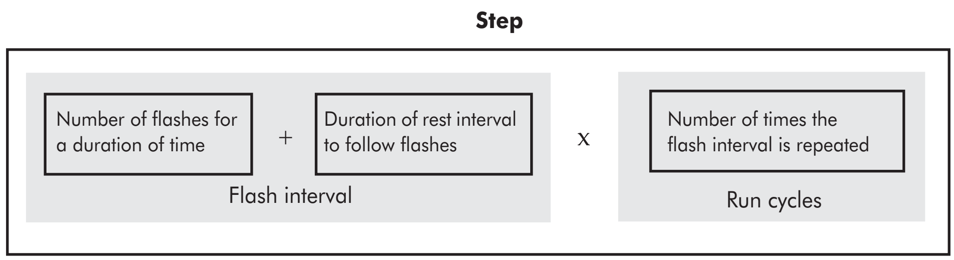


Figure 10-3. Creating a step in a protocol

A sequence of steps make up a *protocol*.

The Photic Stimulator Controls window enables you to build a photic-stimulation protocol in an Acquisition Setup. In this window, you can create a flash interval and steps, and then string the steps together.

A protocol can consist of as many steps as you desire. The Photic Stimulator Controls window shows only two steps at a time, oriented horizontally, but you can use the scroll bar at the bottom of the Photic Stimulator Controls window to view the remaining steps.

Choose **Panels > Photic Stimulator Interface** to open the Photic Stimulator Controls window (Figure 10-4).

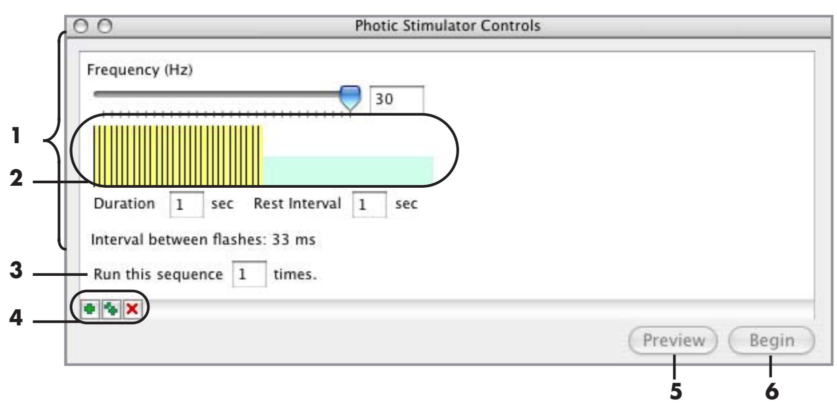


Figure 10-4. Photic Stimulator Controls window

The following are brief descriptions of the numbered items from Figure 10-4.

1. ***Flash-interval settings***. Provide a variety of ways to set up the flash interval:

   - *frequency in Hz*: manually type in a value from 1 to 30, or use the slider
   - *total duration of flashes (in seconds)*: manually type in a value
   - *rest interval following flashes (in seconds)*: manually type in a value
   - *interval between individual flashes*: automatically calculated by Net Station

2. ***Flash/rest graph***. Visually represents the flash-to–rest interval ratio, for the flash interval. Useful if you prefer to use the slider to set the pulse frequency.

3. ***Run cycle***. Allows you to set the number of times the flash interval is run before proceeding to the next protocol step.

4. ***Protocol-step controls***. Enable you to:

New

   - Create a new flash-interval window that will appear after the last step. The “new” button is always available.

Copy

   - Copy the selected flash interval. The duplicated interval will appear after the last step. The “copy” button is available only when a step is selected.

Delete

   - Delete the selected flash interval. The selected interval will be deleted and the steps following it will move up in order. The “delete” button is available only when a step is selected.

Note: You cannot drag the steps into the correct order; you must create the steps in the desired sequence and delete those that are incorrectly placed.

5. ***Preview button***. Allows you to view the photic-stimulation events inserted into the Dense Waveform Display. Use to review the Acquisition Setup settings.

6. ***Begin button***. Allows you to start the photic stimulator and view the photic-stimulation events inserted into the Dense Waveform Display. Use after initiating recording of the acquisition data.

To create a protocol:

1 Define a step by setting values for:

- number of flashes (frequency),
- total duration of flashes,
- duration of rest interval following flashes, and
- number of run cycles.

2 Click the “new” button to create a new step, or select the first step and click the “copy” button to duplicate it.

3 Define the second step.

4 Create a new step, or select and copy an existing step.

5 Once you have defined all the steps, click the Preview button, and, when satisfied, close the Photic Stimulator Controls window.

Acquiring Data

To acquire data with photic-stimulation events:

1 Click the Session button in the “Open” section of the Net Station start-up window.

2 Select the correct Session Template in the Select Session Template window, and click the Select button.

3 Fill in the subject information and click the Begin Session button in the Enter Session Information window. (See Figure 10-5.)

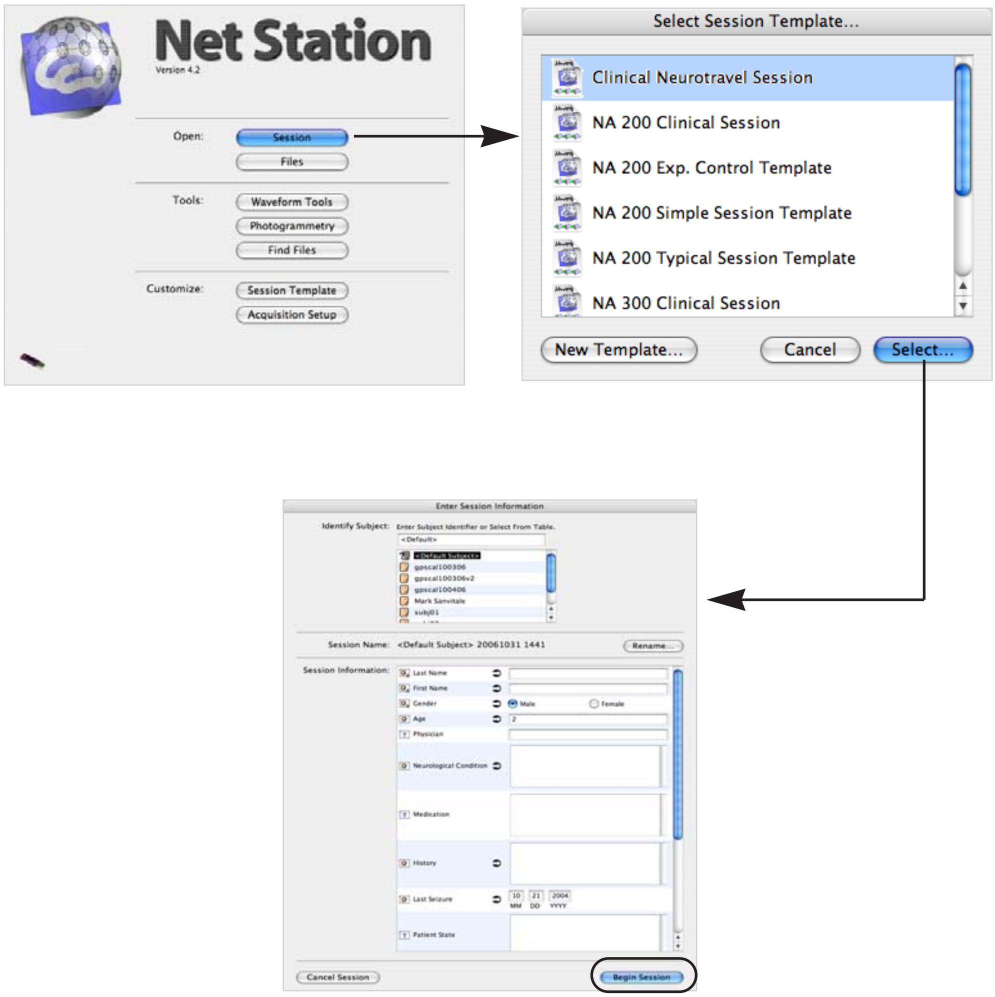


Figure 10-5. Starting an acquisition session

This opens the Dense Waveform Display, which shows the acquisition signals and the control windows for devices such as the amplifier and the photic stimulator (if the Photic Stimulator Controls window is *not* displayed, choose **Panels > Photic Stimulator Controls**).

4 If the displayed control windows are correct, click the Record button in the Waveform Recorder Device control window to begin recording data to disk.

5 Click the Begin button in the Photic Stimulator Controls window to start the photic stimulator and to insert these events into the event track.

appendix A

SOFTWARE TECHNICAL SUPPORT

Before Contacting EGI

Please check the Contents on page v and the Index on page 295 for coverage of your issue or question. You can also perform an electronic search using Find or Search in the PDF version of this manual posted on the Documents page of the EGI website (www.egi.com/documentation.html).

In addition, the Support page of the EGI website (www.egi.com/support.html) may have the information you need.

If you need more help, EGI recommends the following:

• ***Try to isolate the problem***. Is your problem well defined and repeatable?

• ***Document the problem.*** Carefully record and organize the details gleaned from the above step and report the problem to EGI.

Contacting EGI

EGI Support web page	www.egi.com/support.html
Email support	support@egi.com
Sales information	info@egi.com
Telephone	+541-687-7962
Fax	+541-687-7963
Address	Electrical Geodesics, Inc. 1600 Millrace Drive Suite 307 Eugene, OR 97403 USA

appendix B

UPDATING EGI LICENSES

HASP key

EGI protects its software from unauthorized use by encoding licensing data in HASP keys. If you have purchased a complete EGI Geodesic EEG System, the HASP key is attached to the system cart handle. If you have purchased only the Net Station software, the key is included in the software installation package.

A HASP key is a small hardware device (sometimes called a *dongle*) that you plug into a computer's USB port. The information in the HASP key tells Net Station whether you are allowed to use the software.

All authorized Net Station users have a HASP key. To update your EGI license, *do not send EGI the actual hardware key*. Instead, you will need to generate a computer file from the HASP key and email the file to EGI, which will update the licensing information in the file and email it back to you. Use the edited HASP file to update your software. (See Figure B-1.)

Figure B-2 lists some points to keep in mind before you begin the HASP key–updating process. Step-by-step instructions for updating EGI licenses follow the tips.

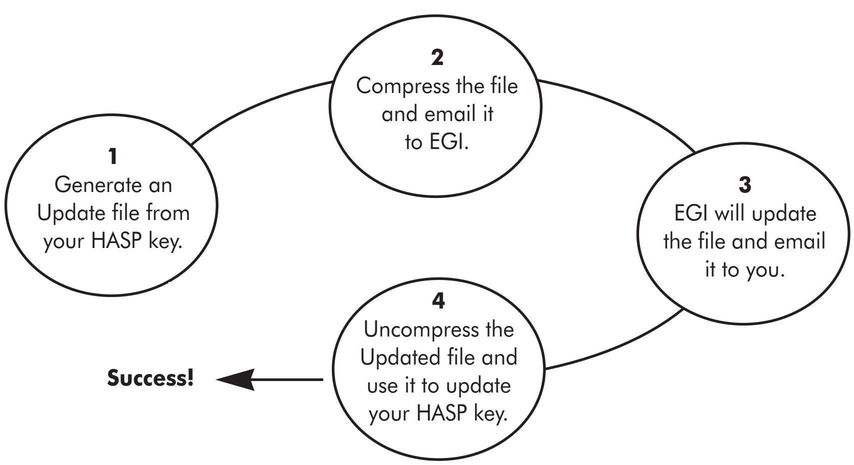
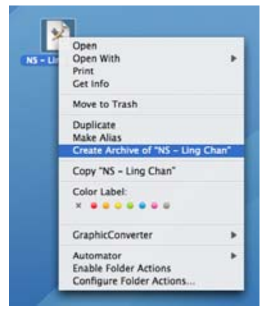


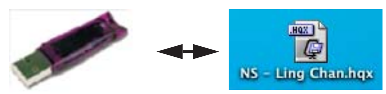
Figure B-1. Overview of the license-updating process

Tips on Updating EGI Licenses

File compression. Before emailing your Update file to EGI, compress the file (by Control-clicking on the file and choosing "Create Archive of <filename>" from the pop-up menu) to safeguard against file corruption during the email process.



Unique HASPs. Updated HASP files are unique to their individual HASP keys. The HASP key that created the Update file must be plugged in when the Updated file from EGI is applied to update the license. *Note: You may have multiple HASP keys with the same name, followed by a number. The number of the HASP key* ***must*** *match the number of the Update file when updating.*



HASP names. To determine which HASP key is which, launch Net Station. The name of the HASP key is in the bottom-left of the Net Station start-up screen. Quit Net Station, launch the Updater application, and apply the ***corresponding*** HASP file.

File organization. Avoid duplicate Update files. After emailing your Update file to EGI, delete it from your computer. Likewise, after applying the Updated file from EGI to your HASP key, delete the file.

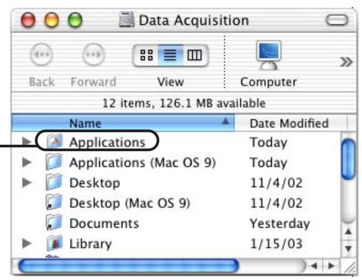
Figure B-2. HASP-updating tips

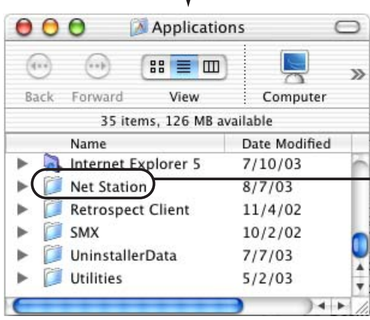
Opening the Updater Application

1 Quit Net Station, if necessary.

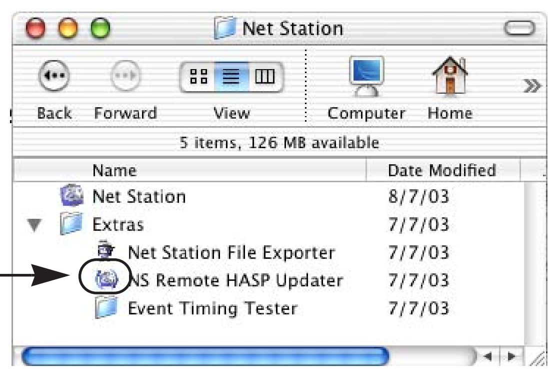
2 Insert the HASP key into the USB port at the side of your keyboard or at the back of your computer. A light should illuminate within the key.

3 On your hard drive, open the Applications folder.





4 Open the Net Station install folder in the Applications folder.



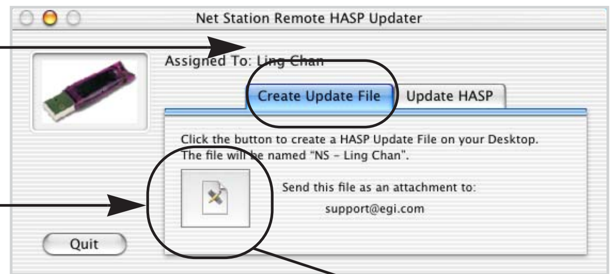
5 Open the Extras folder and double-click on the NS Remote HASP Updater icon to launch the application and open the Updater dialog.

Figure B-3. Open the HASP Updater application

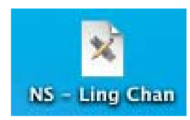
Generating the Update File

1 Make sure that the Create Update File tab is frontmost in the Updater dialog.

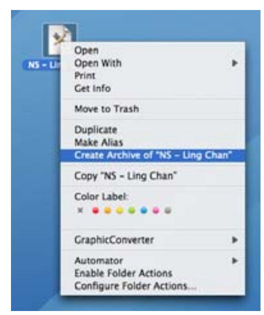
2 Click the HASP file button.



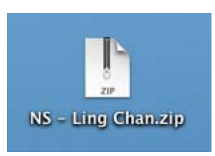
3 The Update dialog will automatically close, and an Update file will appear on your Desktop with the filename "NS – xxxx," where xxxx is the license holder's name. If you have more than one HASP, the number of the HASP will be appended (e.g., NS - Ling Chan, NS - Ling Chan 1).



4 Compress the file by Control-clicking on the file and choosing Create Archive of "<filename>" from the pop-up menu. This will ensure that your file is not corrupted in transit. Note that this operation **must** be performed on a Macintosh computer, not a PC.



5 Email the compressed file to support@egi.com and include in the email message your name, the license holder's name (if you are not the licensee), your organization, and a ***description of what must be updated***. For best results, email the file from the Macintosh computer that generated it. Or, you can copy the file to a Mac HFS-formatted removable drive, transfer it to another Mac, and email it. Do not email it from a PC.



6 Delete the HASP Update file and any previous compressed copies from your Desktop.

7 EGI will modify the file, updating your license, and email it back to you, typically within two to three days.

Figure B-4. Create the HASP Update file, compress it, and email it to EGI

Applying an Updated File

1 Save to the Desktop the Updated file from EGI, uncompressing it if needed.

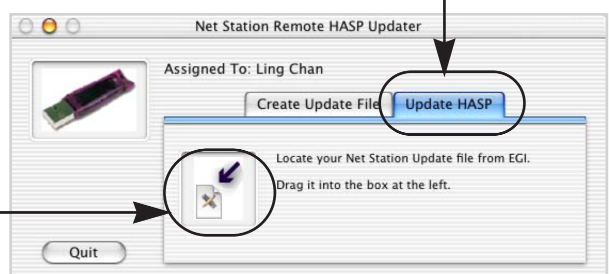
2 Quit Net Station, if necessary.

3 Insert the ***corresponding*** HASP key into the USB port at the side of your keyboard or at the back of your computer. A light should illuminate within the key.

4 Open the Net Station install folder in the Applications folder on your hard drive.

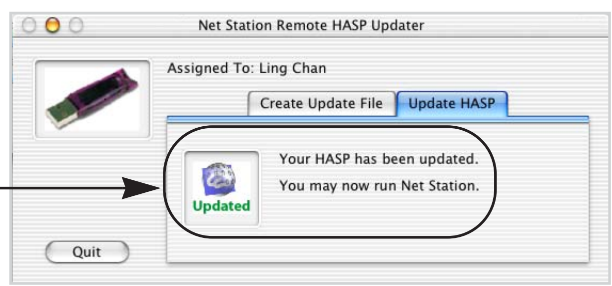
5 Double-click on the NS Remote HASP Updater icon, which will open the Updater dialog.

6 Make sure that the Update HASP tab is frontmost in the Updater dialog.



7 Drag the Updated file into the Update box.

8 A dialog will appear, with a message indicating a successful update.



9 Delete the Updated file and any compressed copies from your Desktop.

Figure B-5. Apply the Updated file from EGI to the corresponding HASP

Questions

Contact EGI at support@egi.com with any questions regarding this document and the issues discussed.

appendix C

Montages

The following tables list the current adult Net Station default montages, their referencing schemes, and page locations for sensor map views. Net Station contains other default montages (earlier GSN versions, infant and toddler models, and so on); please contact support@egi.com for more information.

A montage affects the *display* of EEG waveforms, not the way they are recorded. In a number of cases, the sensor maps indicate which sensors' data are displayed in the Dense Waveform Display, and which are not, for a given montage.

For how to apply a montage during data acquisition, see the "Montage Controls" section in Chapter 4.

Table C-1, Table C-2, and Table C-3 list the montages for the 256-, 128-, and 64-channel GSN 200 models, respectively. Table C-4, Table C-5, Table C-6, and Table C-7 lists the montages for the 256-, 128-, 64-, and 32-channel HCGSNs.

Table C-1. 256-channel GSN 200 montages

Montage	Referencing scheme	Figure on page
GSN 256 Adult 2.1	vertex	N/A
Average Reference	average of all sensors	Figure C-1, page 212
10-10	average of all sensors	Figure C-8, page 219
10-10 All Sensors	average of all sensors	Figure C-15, page 226
10-20	average of all sensors	Figure C-22, page 233
Double Banana	bipolar	Figure C-29, page 240
Eyes	vertex	Figure C-36, page 247
Left Mastoid Reference	sensor 93	Figure C-43, page 254
Linked Mastoid Reference	sensors 93 and 191	Figure C-50, page 261
Right Mastoid Reference	sensor 191	Figure C-57, page 268

Table C-2. 128-channel GSN 200 montages

Montage	Referencing scheme	Figure on page
GSN 128 Adult 1.0	vertex	N/A
Average Reference	average of all sensors	Figure C-2, page 213
10-10	average of all sensors	Figure C-9, page 220
10-10 All Sensors	average of all sensors	Figure C-16, page 227
10-20	average of all sensors	Figure C-23, page 234
Double Banana	bipolar	Figure C-30, page 241
Eyes	vertex	Figure C-37, page 248
Left Mastoid Reference	sensor 57	Figure C-44, page 255
Linked Mastoid Reference	sensors 57 & 101	Figure C-51, page 262
Right Mastoid Reference	sensor 101	Figure C-58, page 269

Table C-3. 64-channel GSN 200 montages

Montage	Referencing scheme	Figure on page
GSN 64 Adult 2.0	vertex	N/A
Average Reference	average of all sensors	Figure C-3, page 214
10-10	average of all sensors	Figure C-10, page 221
10-10 All Sensors	average of all sensors	Figure C-17, page 228
10-20	average of all sensors	Figure C-24, page 235
Double Banana	bipolar	Figure C-31, page 242
Eyes	vertex	Figure C-38, page 249
Left Mastoid Reference	sensor 26	Figure C-45, page 256
Linked Mastoid Reference	sensors 26 and 51	Figure C-52, page 263
Right Mastoid Reference	sensor 51	Figure C-59, page 270

Table C-4. 256-channel HydroCel GSN montages

Montage	Referencing scheme	Figure on page
HydroCel GSN 256 1.0	vertex	N/A
Average Reference	average of all sensors	Figure C-4, page 215
10-10	average of all sensors	Figure C-11, page 222
10-10 All Sensors	average of all sensors	Figure C-18, page 229
10-20	average of all sensors	Figure C-25, page 236
Double Banana	bipolar	Figure C-32, page 243
Eyes	vertex	Figure C-39, page 250
Left Mastoid Reference	sensor 94	Figure C-46, page 257
Linked Mastoid Reference	sensors 94 and 190	Figure C-53, page 264
Right Mastoid Reference	sensor 190	Figure C-60, page 271

Table C-5. 128-channel HydroCel GSN montages

Montage	Referencing scheme	Figure on page
HydroCel GSN 128 1.0	vertex	N/A
Average Reference	average of all sensors	Figure C-5, page 216
10-10	average of all sensors	Figure C-12, page 223
10-10 All Sensors	average of all sensors	Figure C-19, page 230
10-20	average of all sensors	Figure C-26, page 237
Double Banana	bipolar	Figure C-33, page 244
Eyes	vertex	Figure C-40, page 251
Left Mastoid Reference	sensor 57	Figure C-47, page 258
Linked Mastoid Reference	sensors 57 and 100	Figure C-54, page 265
Right Mastoid Reference	sensor 100	Figure C-61, page 272

Table C-6. 64-channel HydroCel GSN montages

Montage	Referencing scheme	Figure on page
HydroCel GSN 64 1.0	vertex	N/A
Average Reference	average of all sensors	Figure C-6, page 217
10-10	average of all sensors	Figure C-13, page 224
10-10 All Sensors	average of all sensors	Figure C-20, page 231
10-20	average of all sensors	Figure C-27, page 238
Double Banana	bipolar	Figure C-34, page 245
Eyes	vertex	Figure C-41, page 252
Left Mastoid Reference	sensor 29	Figure C-48, page 259
Linked Mastoid Reference	sensors 29 and 47	Figure C-55, page 266
Right Mastoid Reference	sensor 47	Figure C-62, page 273

Table C-7. 32-channel HydroCel GSN montages

Montage	Referencing scheme	Figure on page
HydroCel GSN 32 1.0	vertex	N/A
Average Reference	average of all sensors	Figure C-7, page 218
10-10	average of all sensors	Figure C-14, page 225
10-10 All Sensors	average of all sensors	Figure C-21, page 232
10-20	average of all sensors	Figure C-28, page 239
Double Banana	bipolar	Figure C-35, page 246
Eyes	vertex	Figure C-42, page 253
Left Mastoid Reference	sensor 23	Figure C-49, page 260
Linked Mastoid Reference	sensors 23 and 24	Figure C-56, page 267
Right Mastoid Reference	sensor 24	Figure C-63, page 274

Average Reference Montage

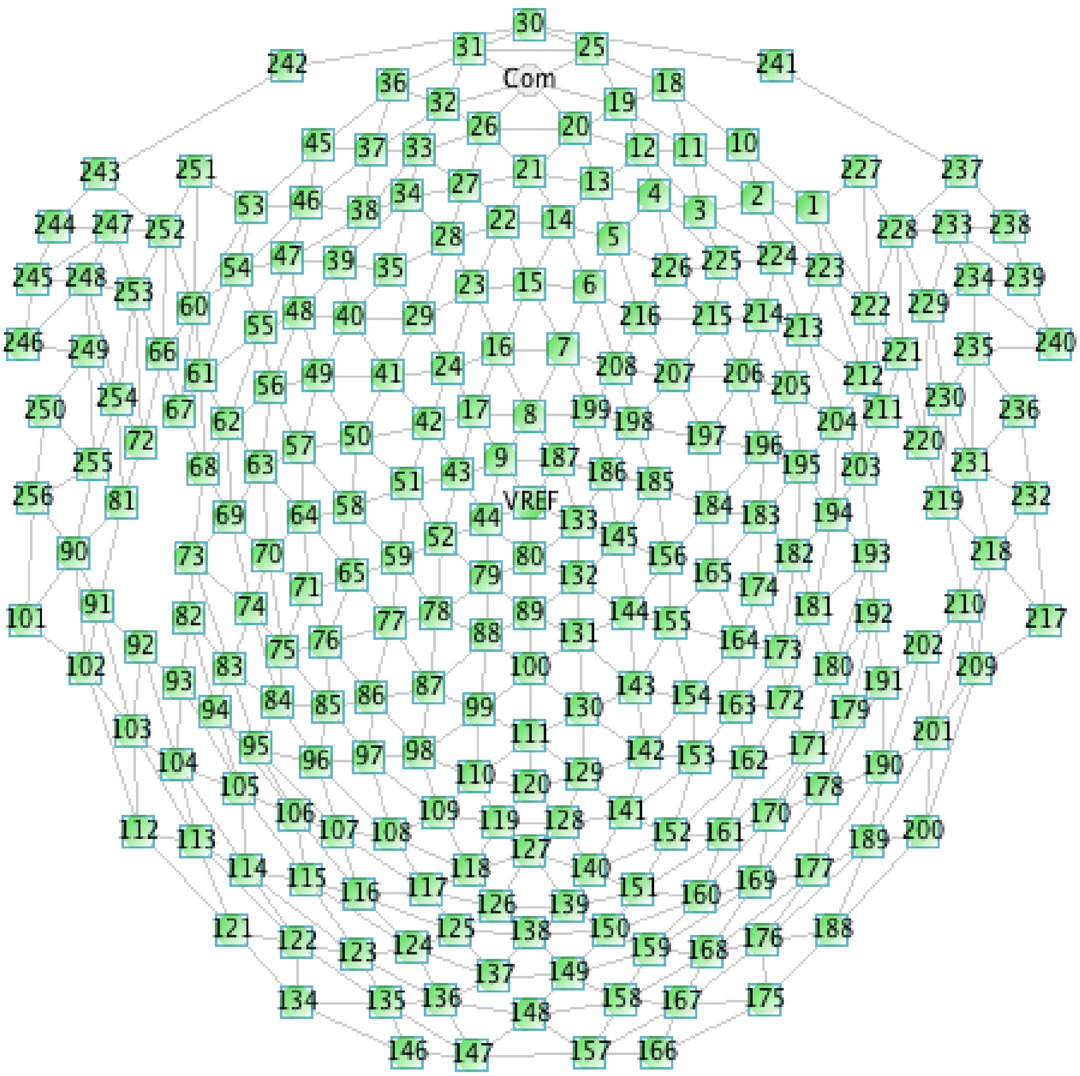


Figure C-1. Average Reference (256-channel GSN 200 adult 2.1)

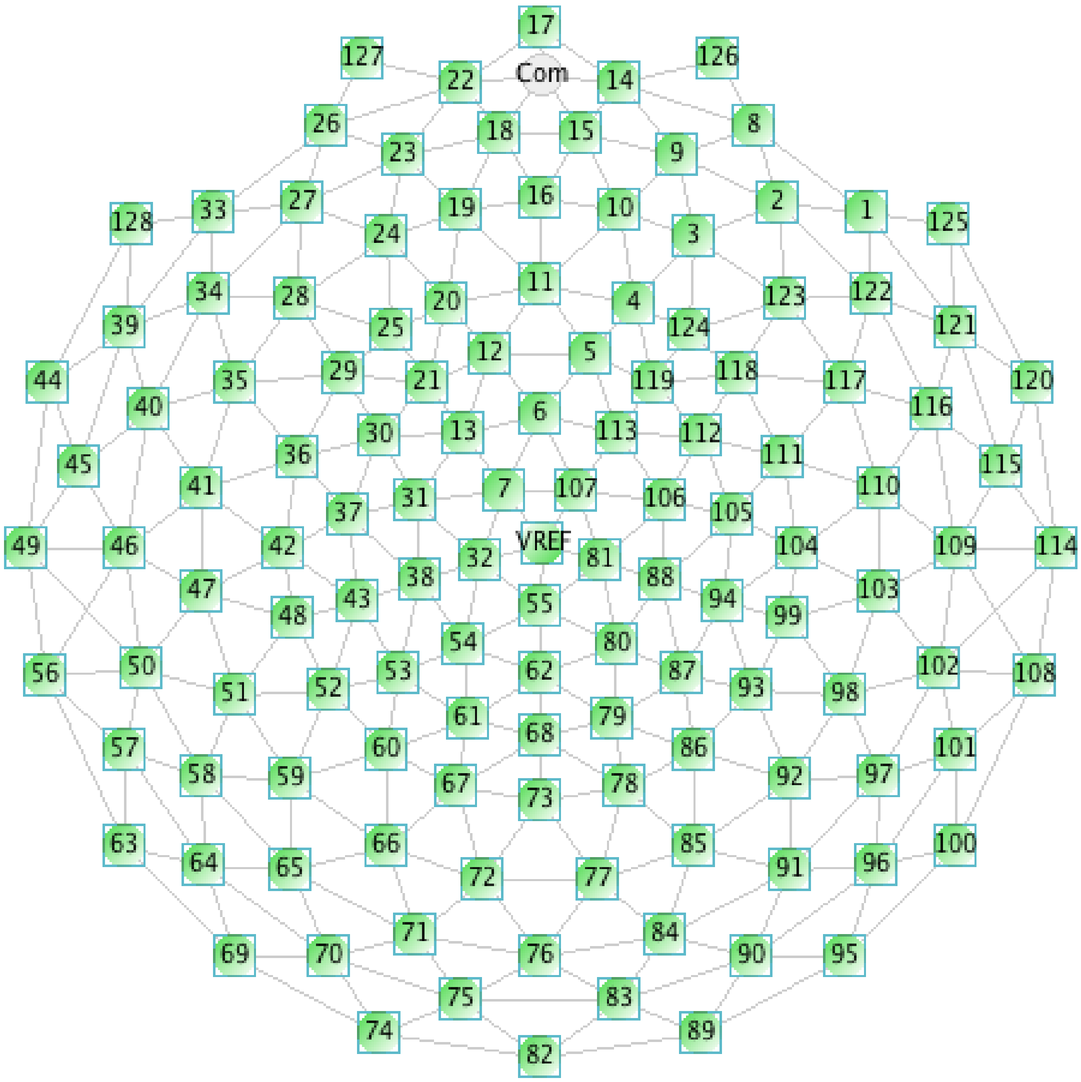


Figure C-2. Average Reference (128-channel GSN 200 adult 2.1)

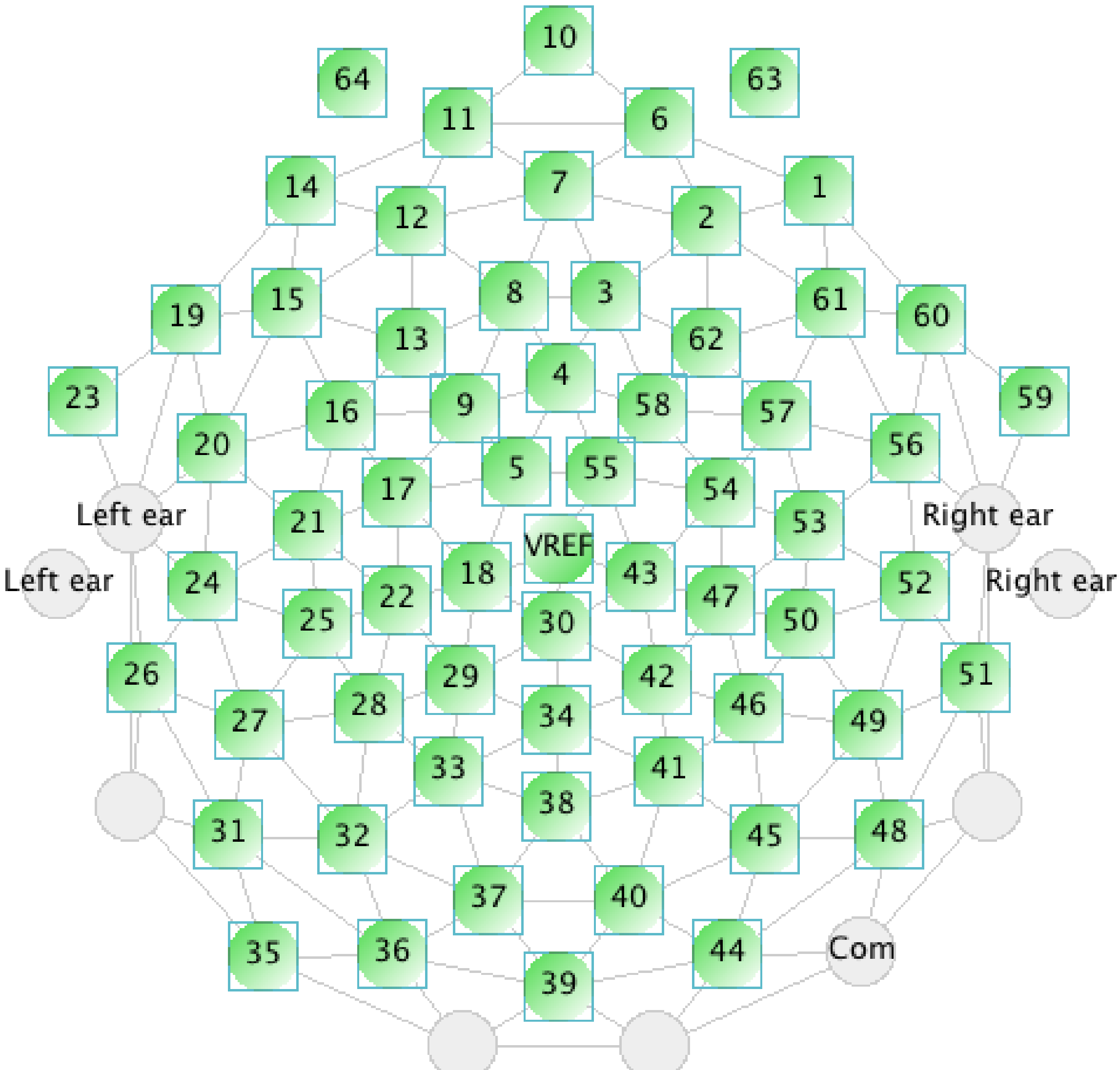


Figure C-3. Average Reference (64-channel GSN 200 adult 2.0)

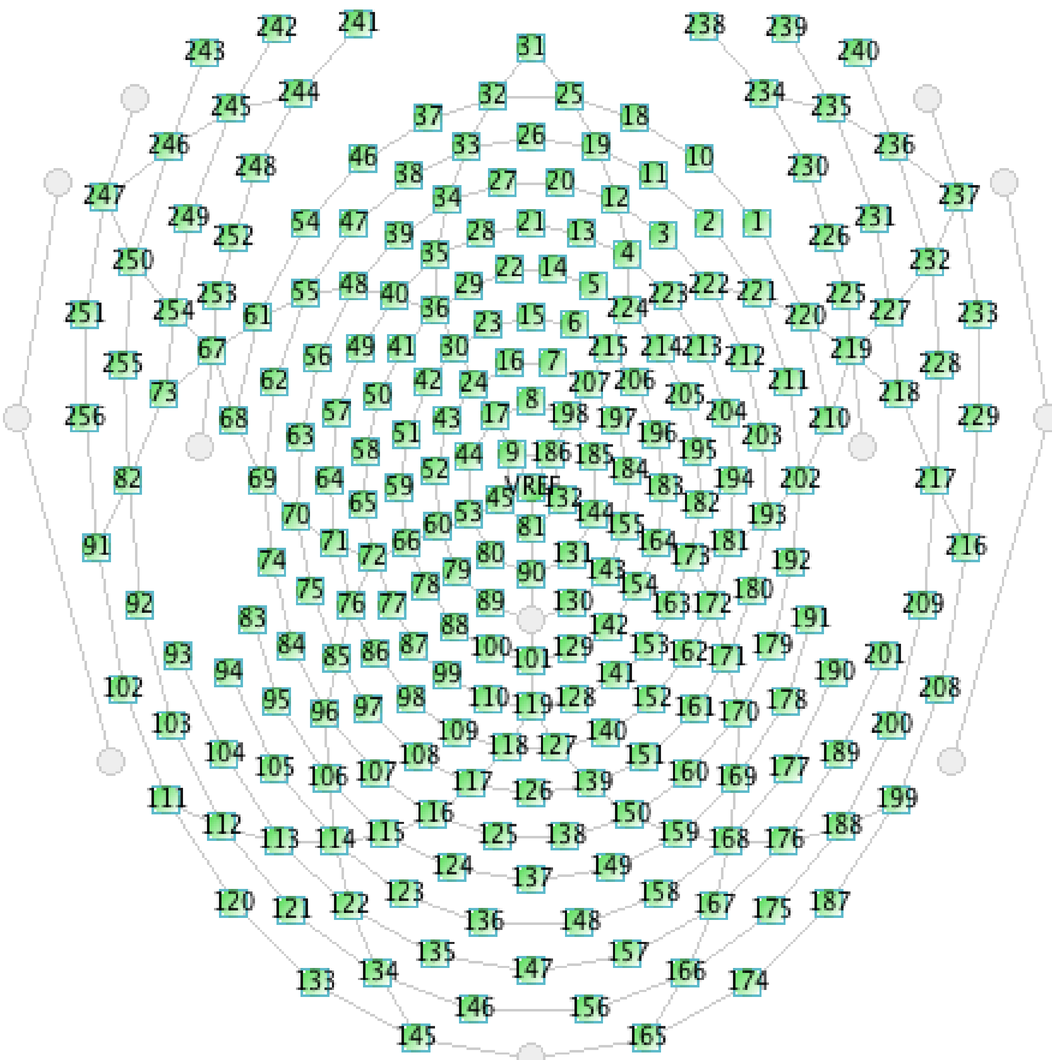


Figure C-4. Average Reference (256-channel HCGSN adult 1.0)

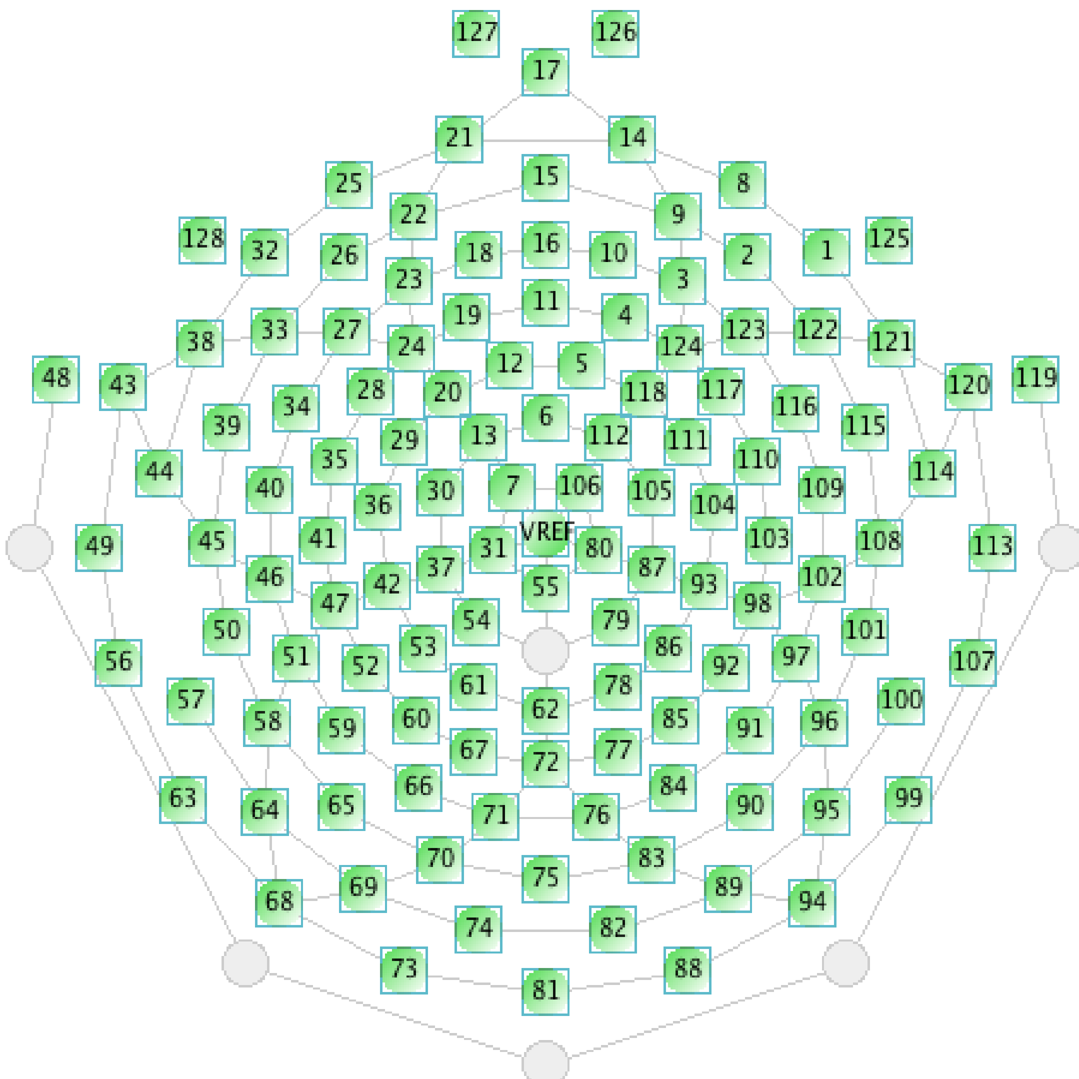


Figure C-5. Average Reference (128-channel HCGSN adult 1.0)

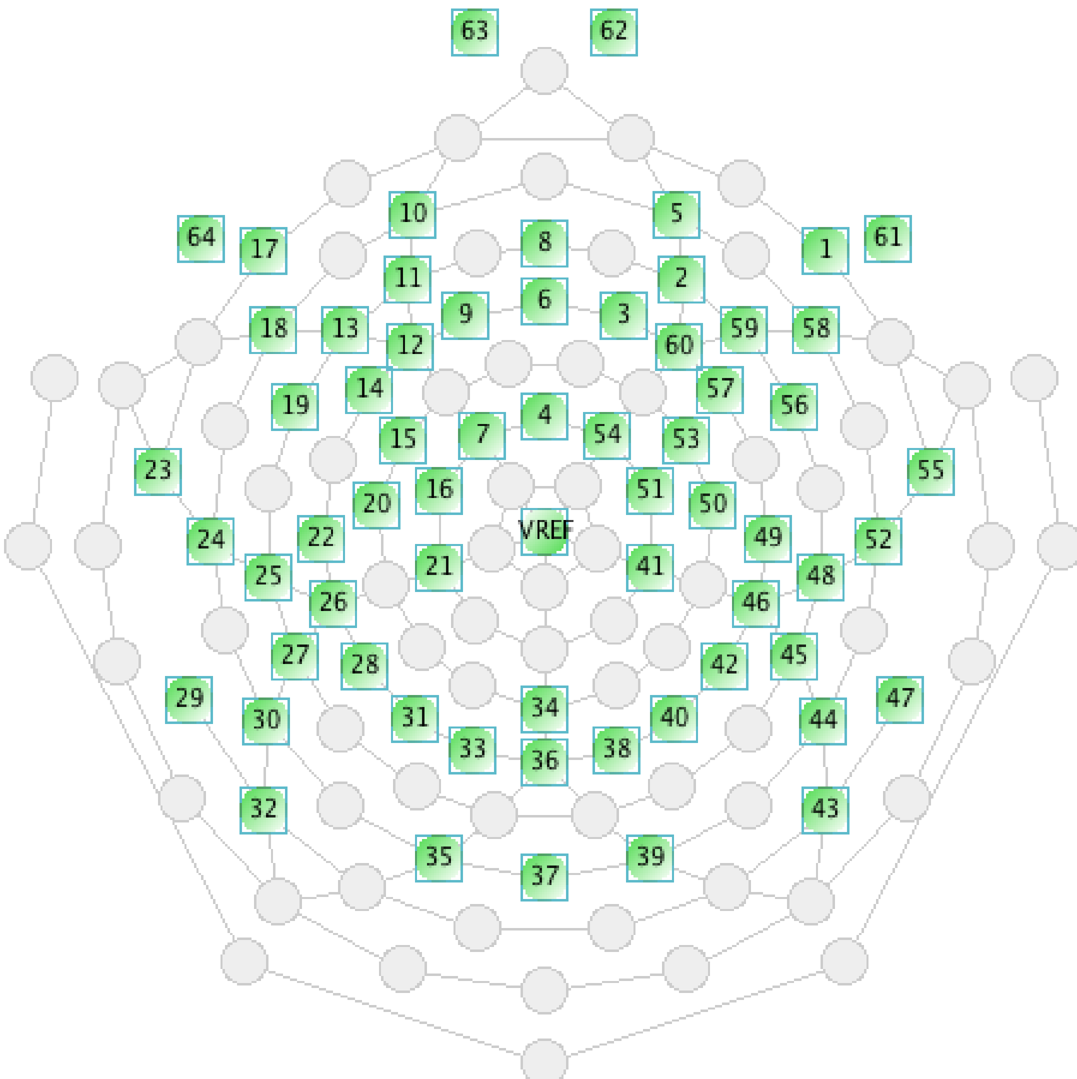


Figure C-6. Average Reference (64-channel HCGSN adult 1.0)

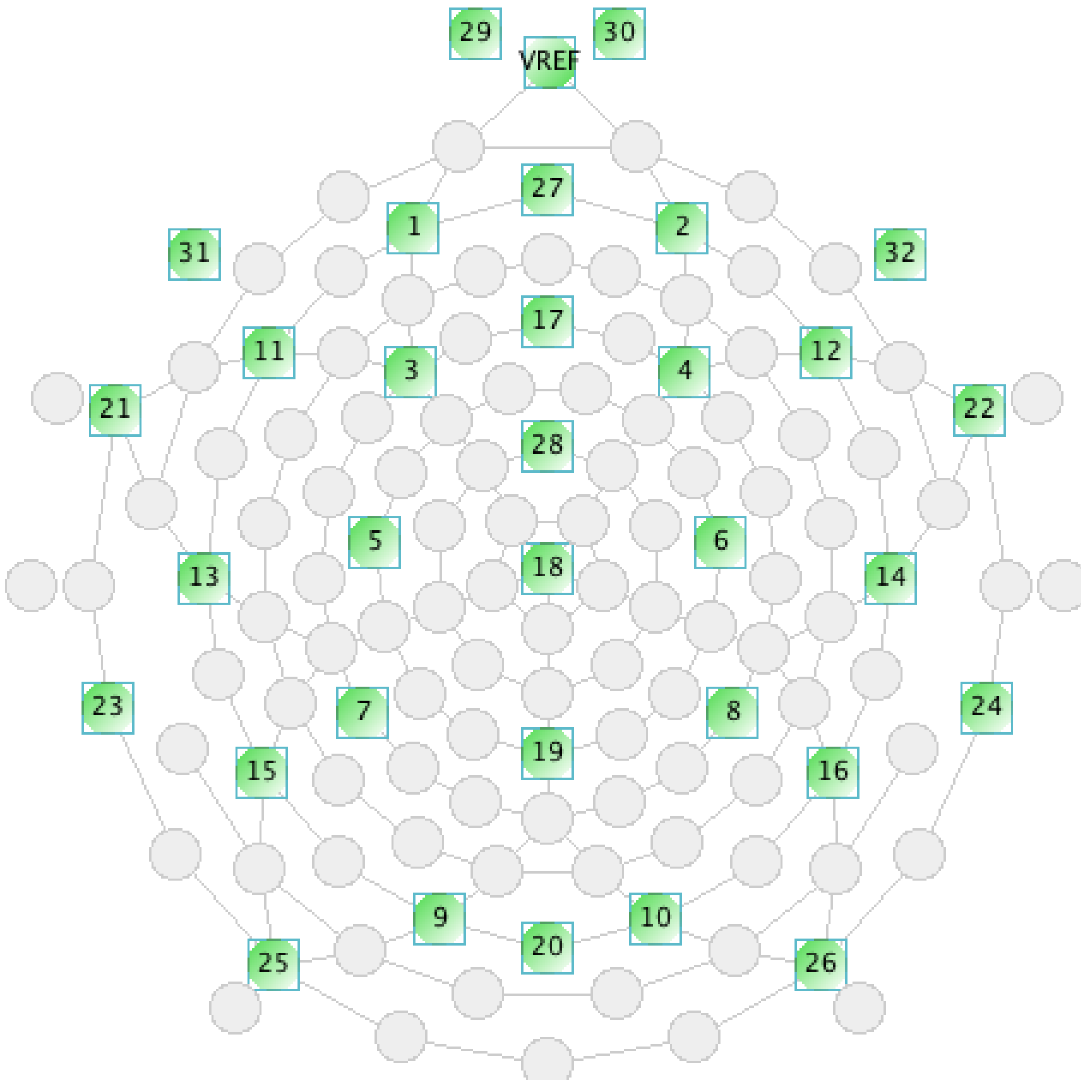


Figure C-7. Average Reference (32-channel HCGSN adult 1.0)

10-10 Montage

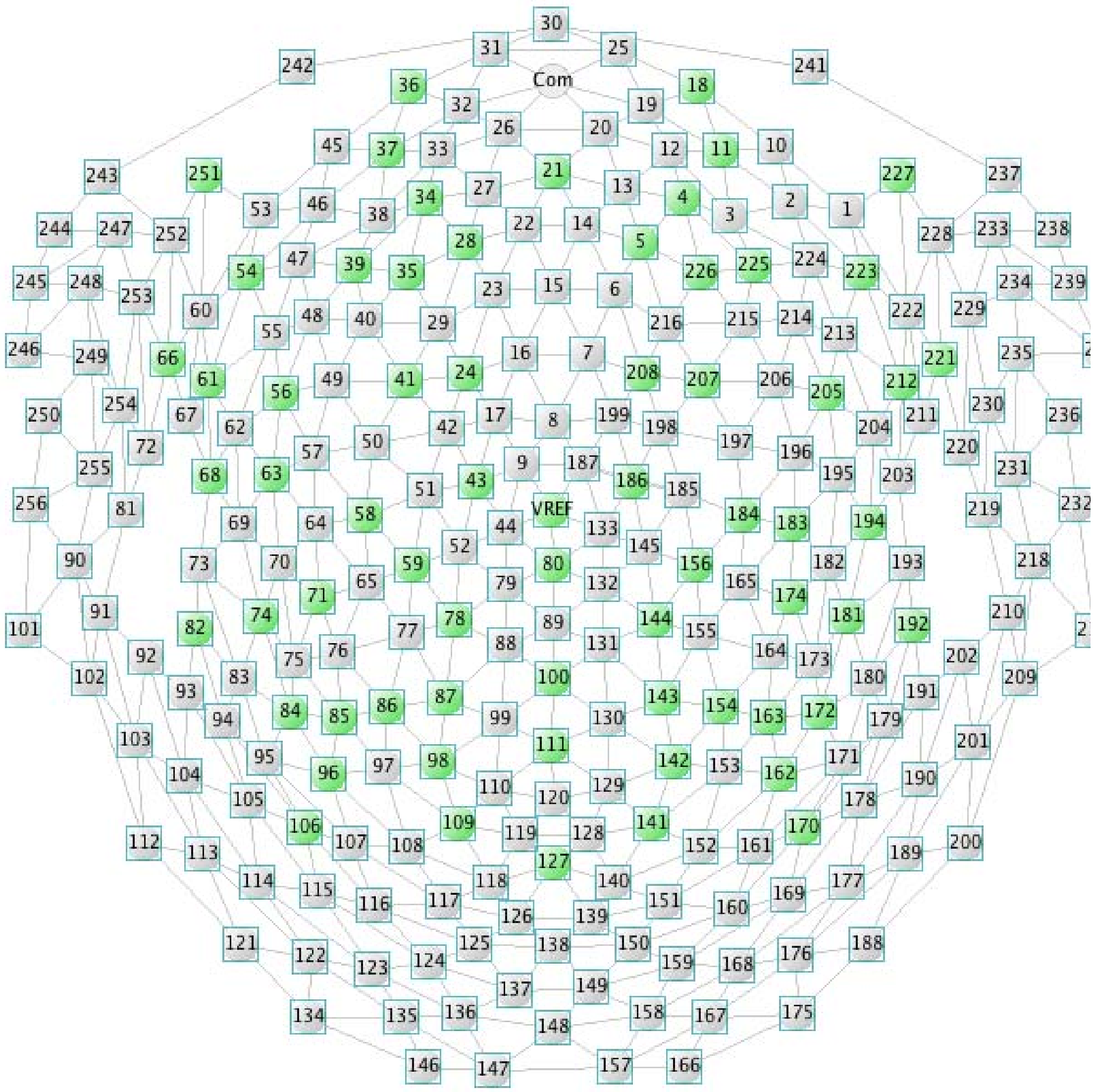


Figure C-8. 10-10 (256-channel GSN 200 adult 2.1)

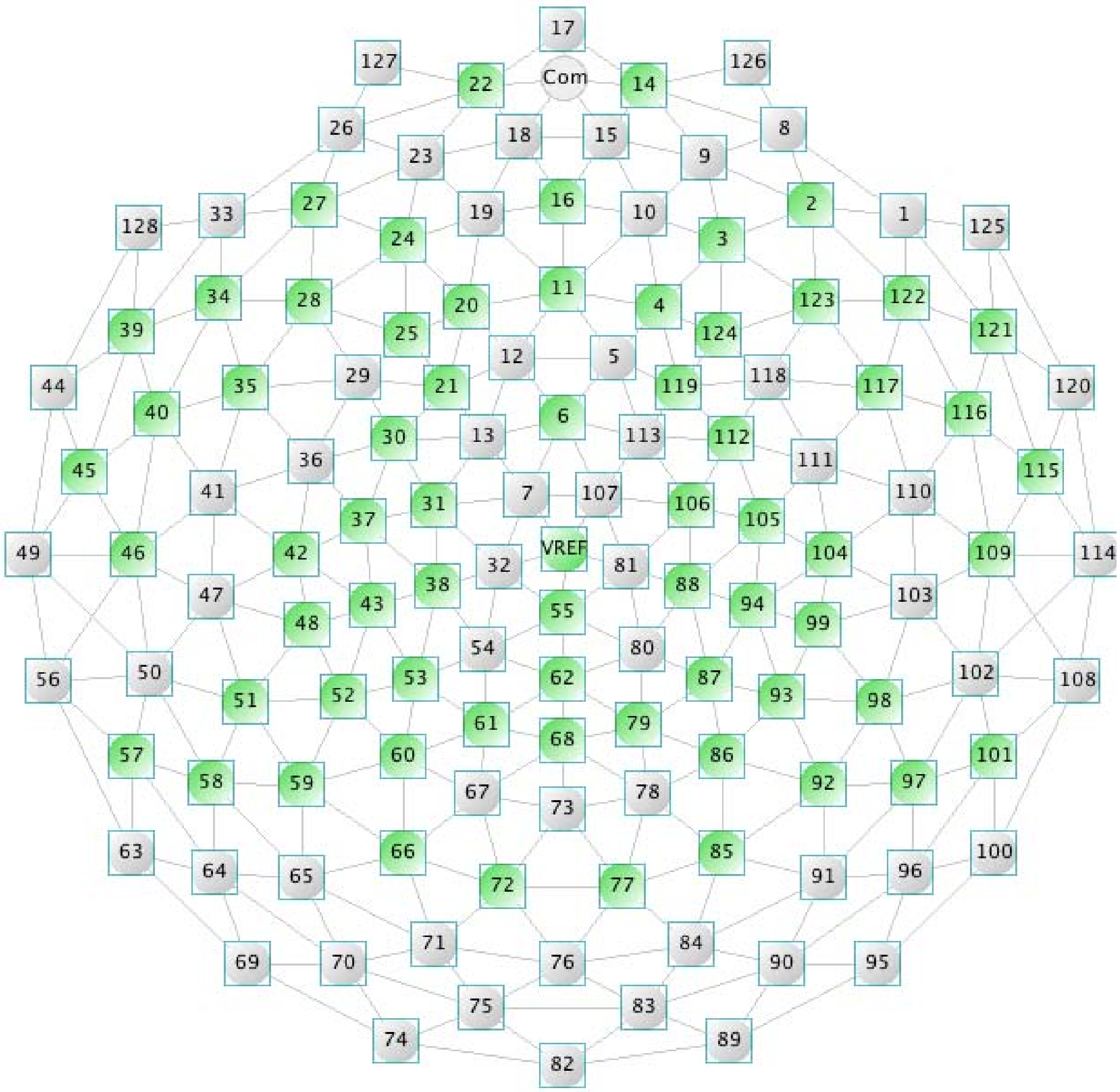


Figure C-9. 10-10 (128-channel GSN 200 adult 2.1)

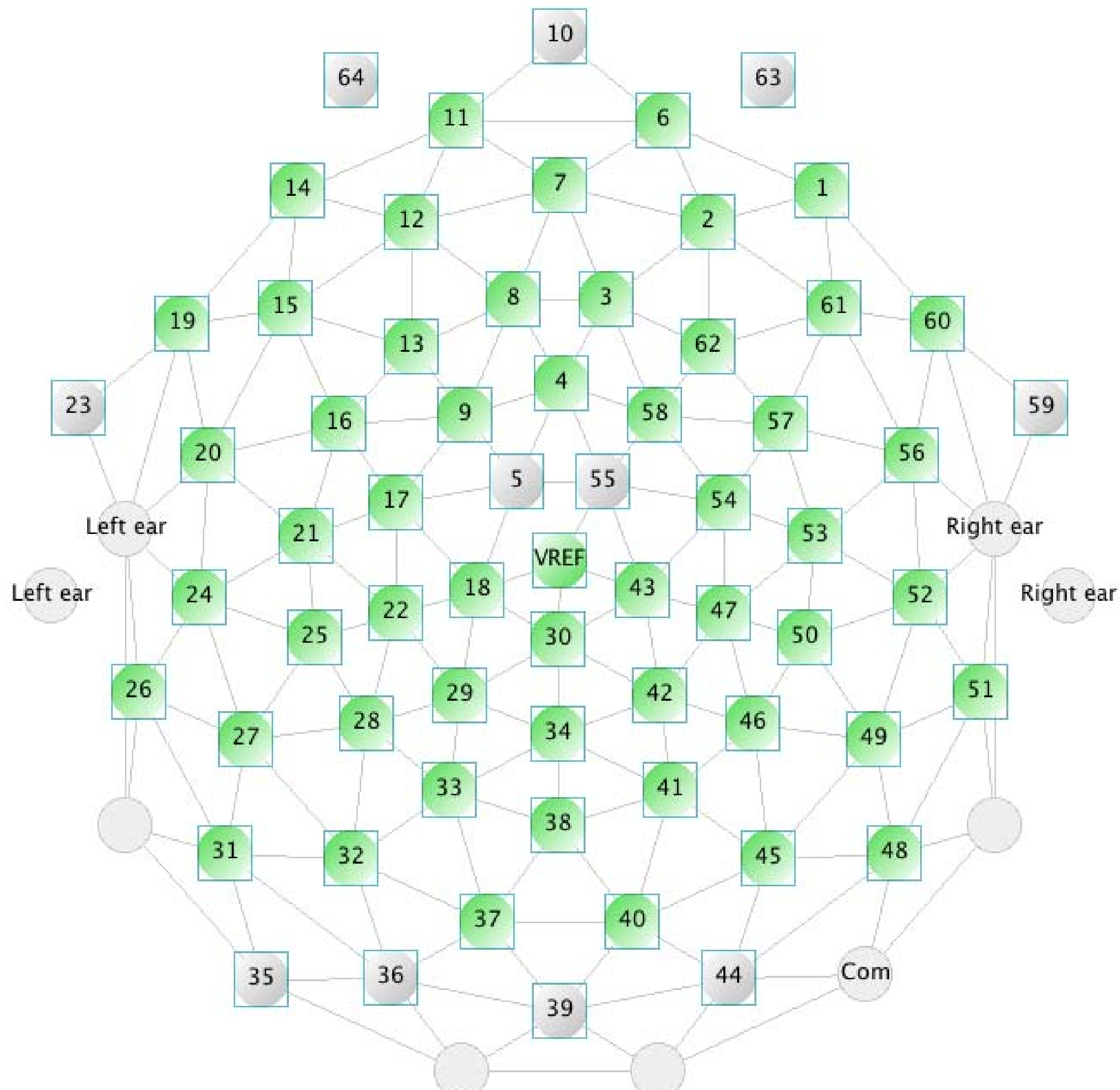


Figure C-10. 10-10 (64-channel GSN 200 adult 2.0)

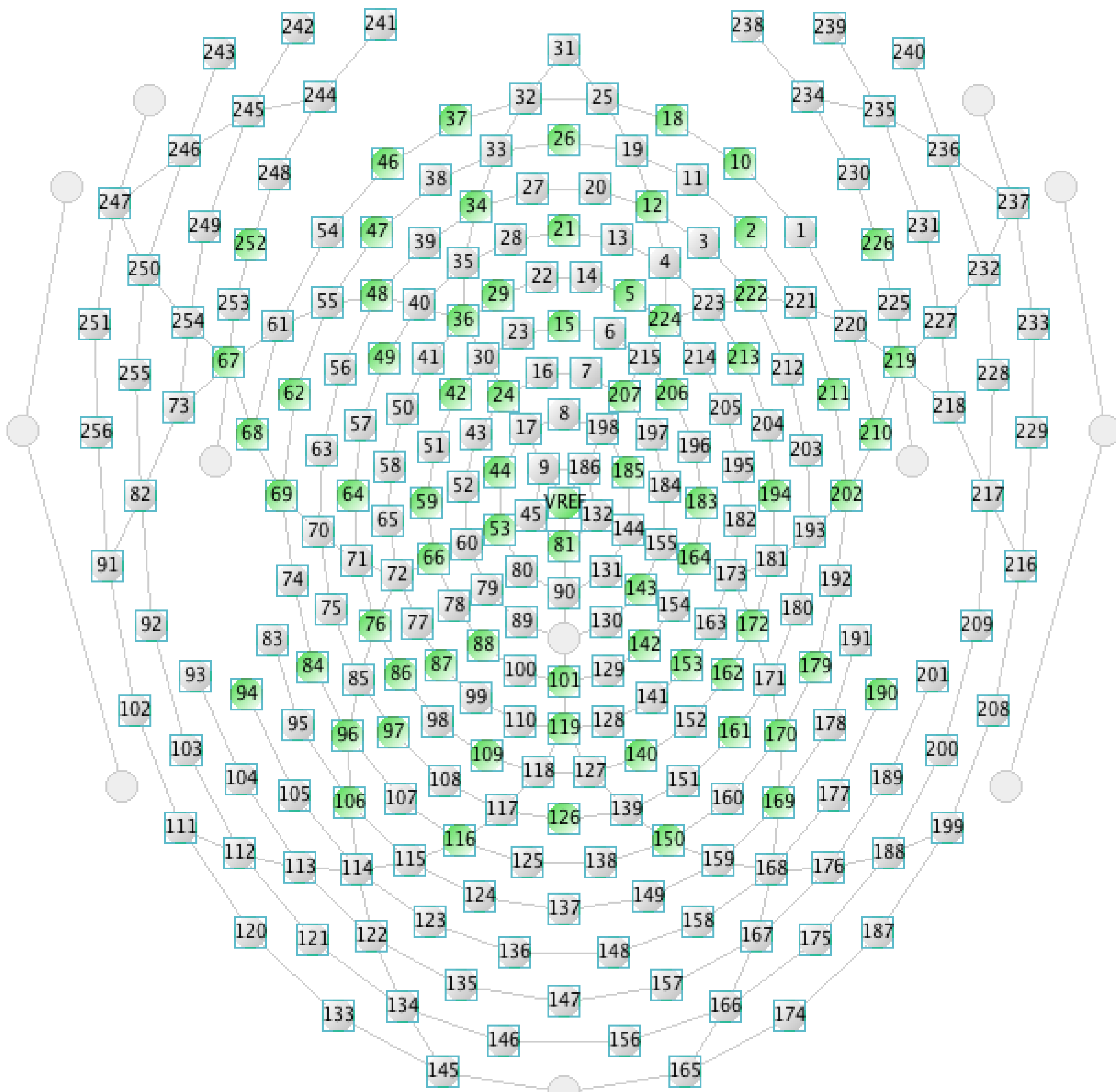


Figure C-11. 10-10 (256-channel HCGSN adult 1.0)

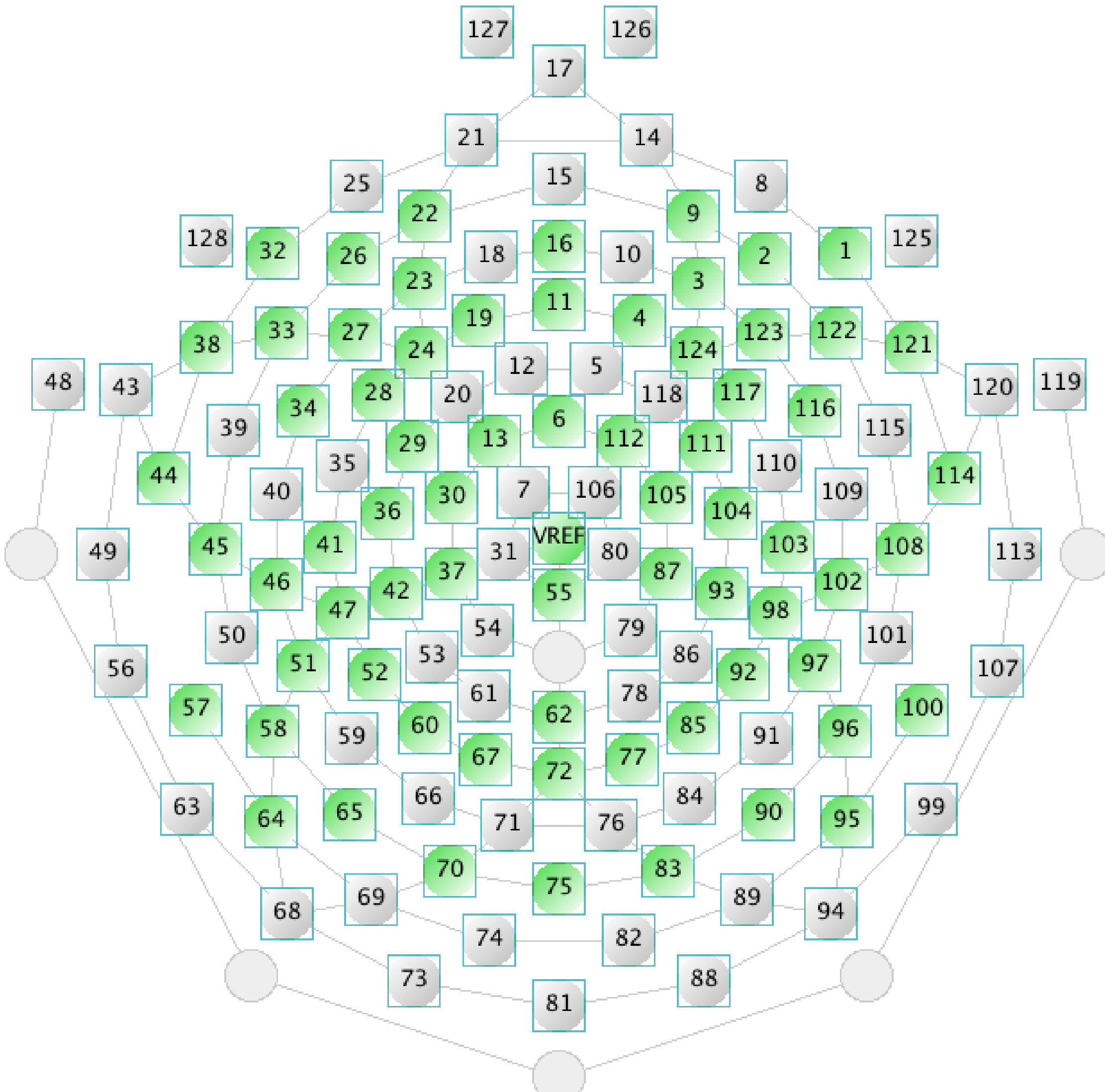


Figure C-12. 10-10 (128-channel HCGSN adult 1.0)

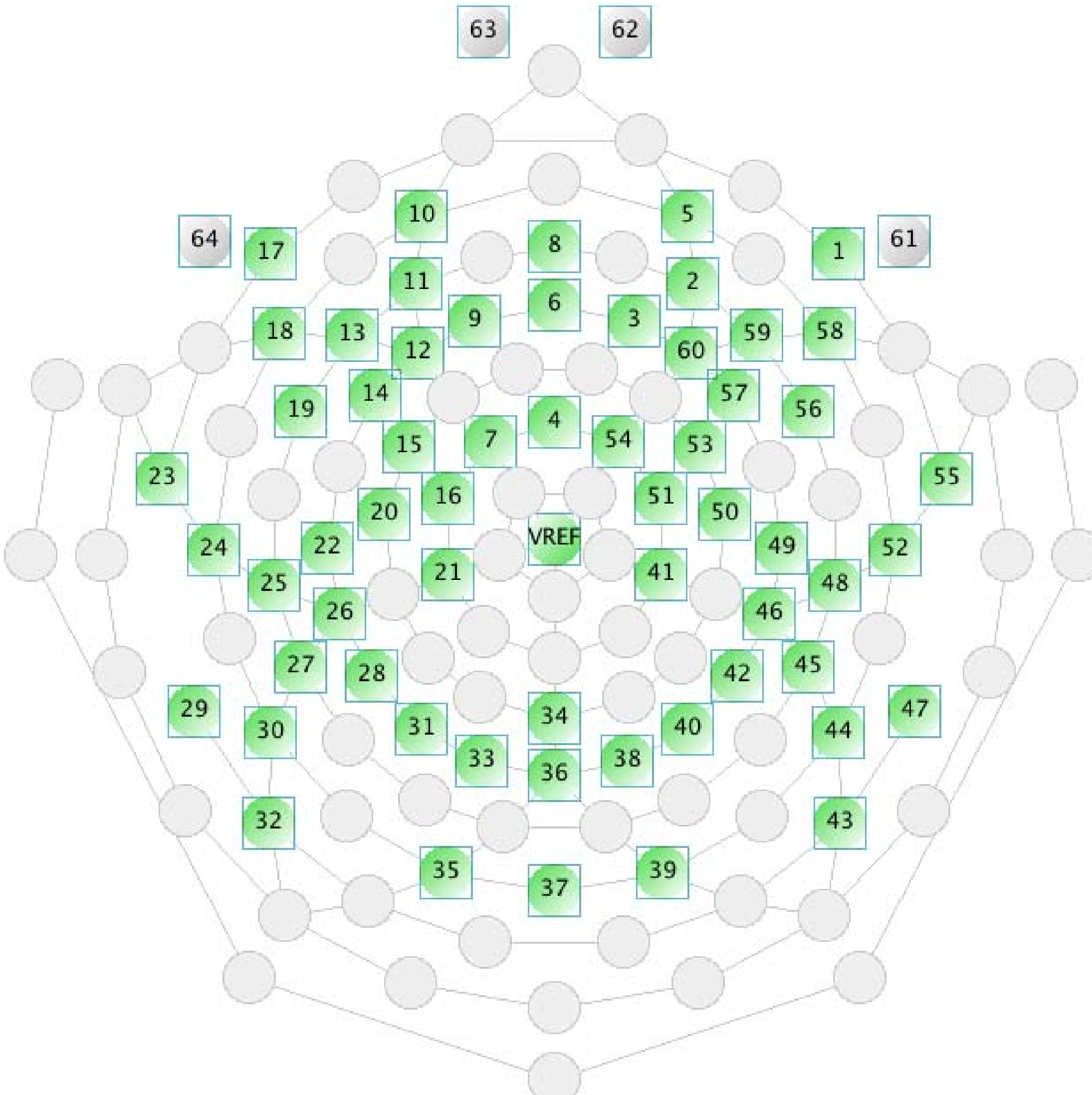


Figure C-13. 10-10 (64-channel HCGSN adult 1.0)

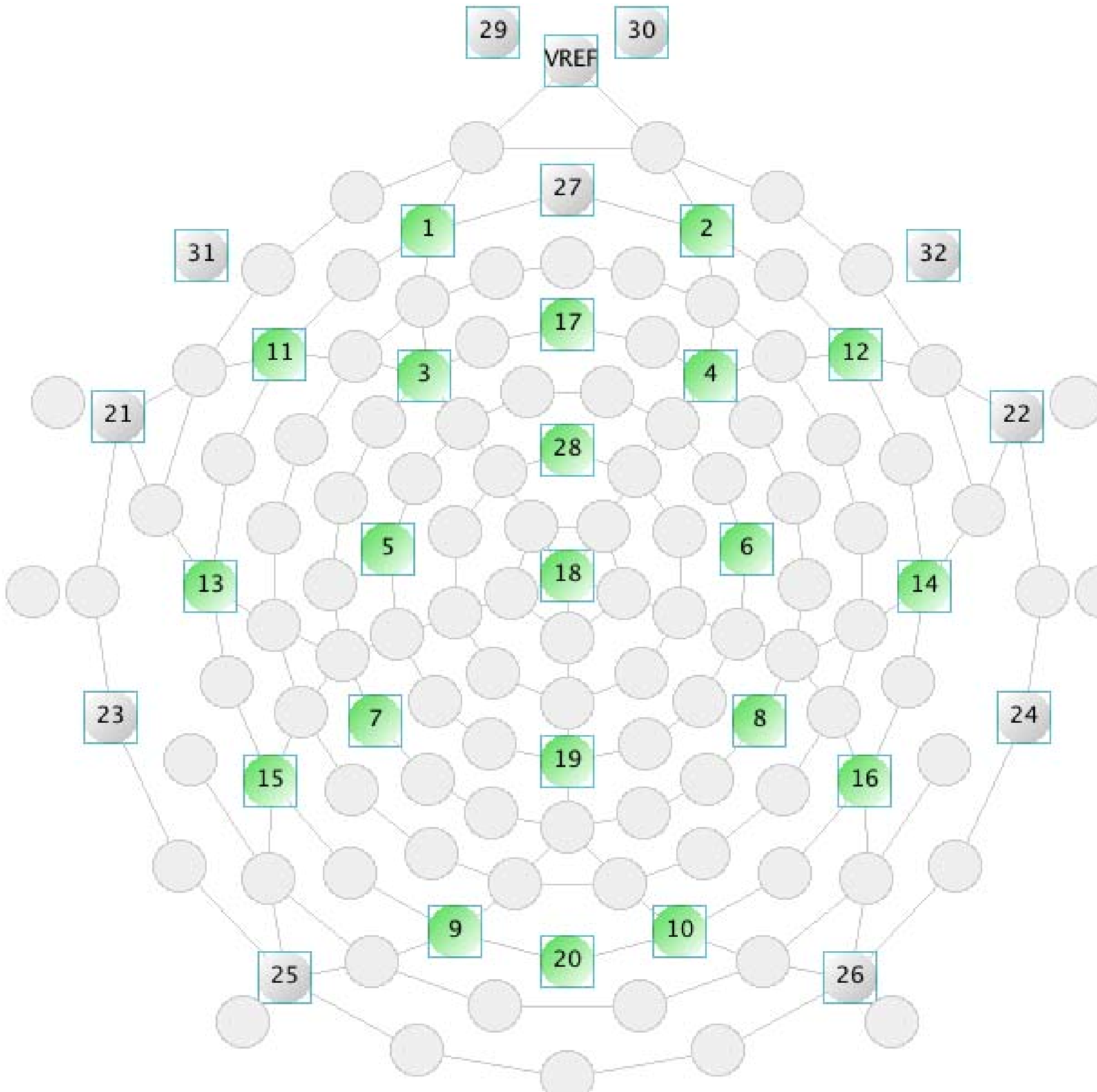


Figure C-14. 10-10 (32-channel HCGSN adult 1.0)

10-10 All Sensors Montage

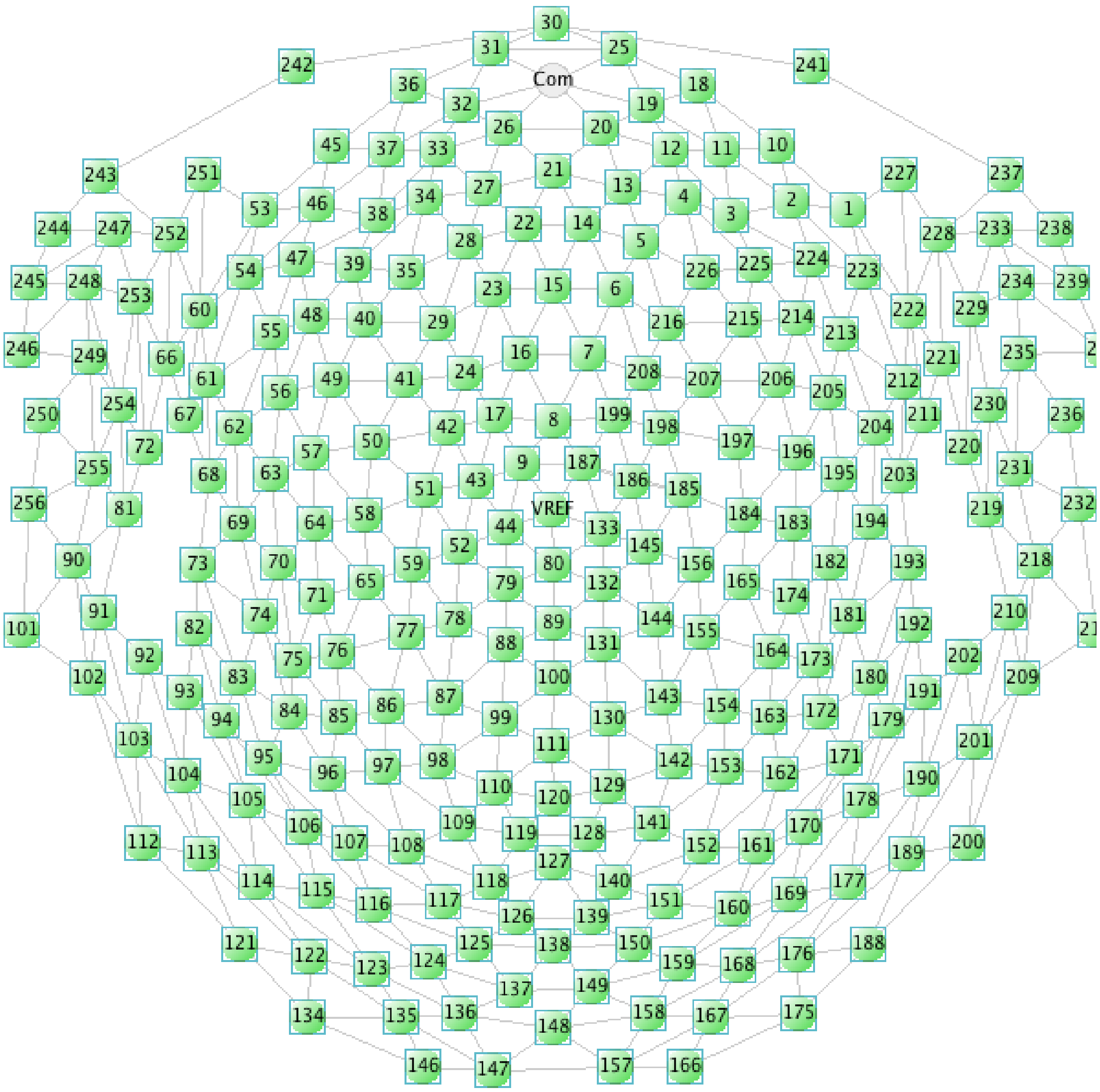


Figure C-15. 10-10 All Sensors (256-channel GSN 200 adult 2.1)

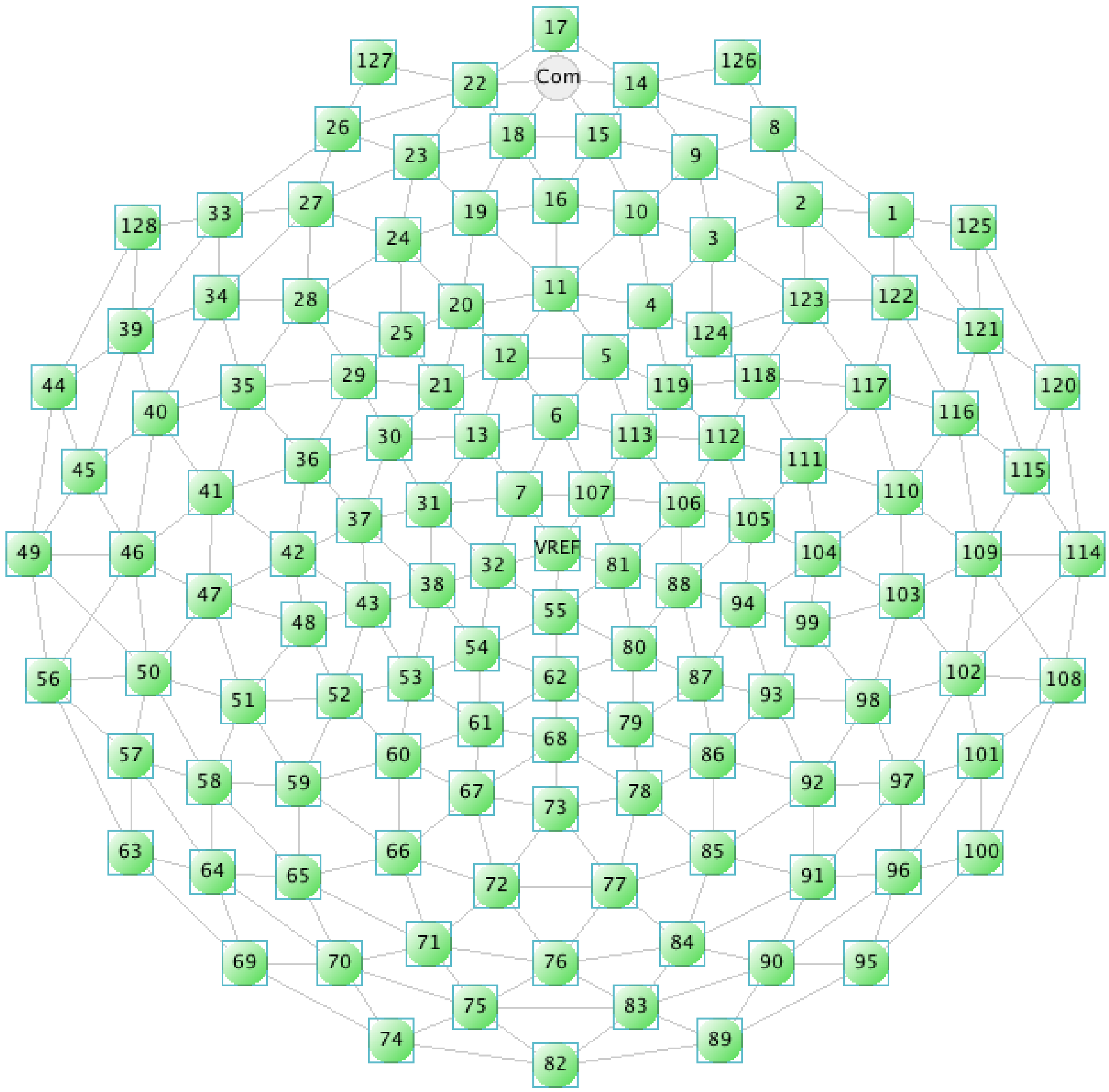


Figure C-16. 10-10 All Sensors (128-channel GSN 200 adult 2.1)

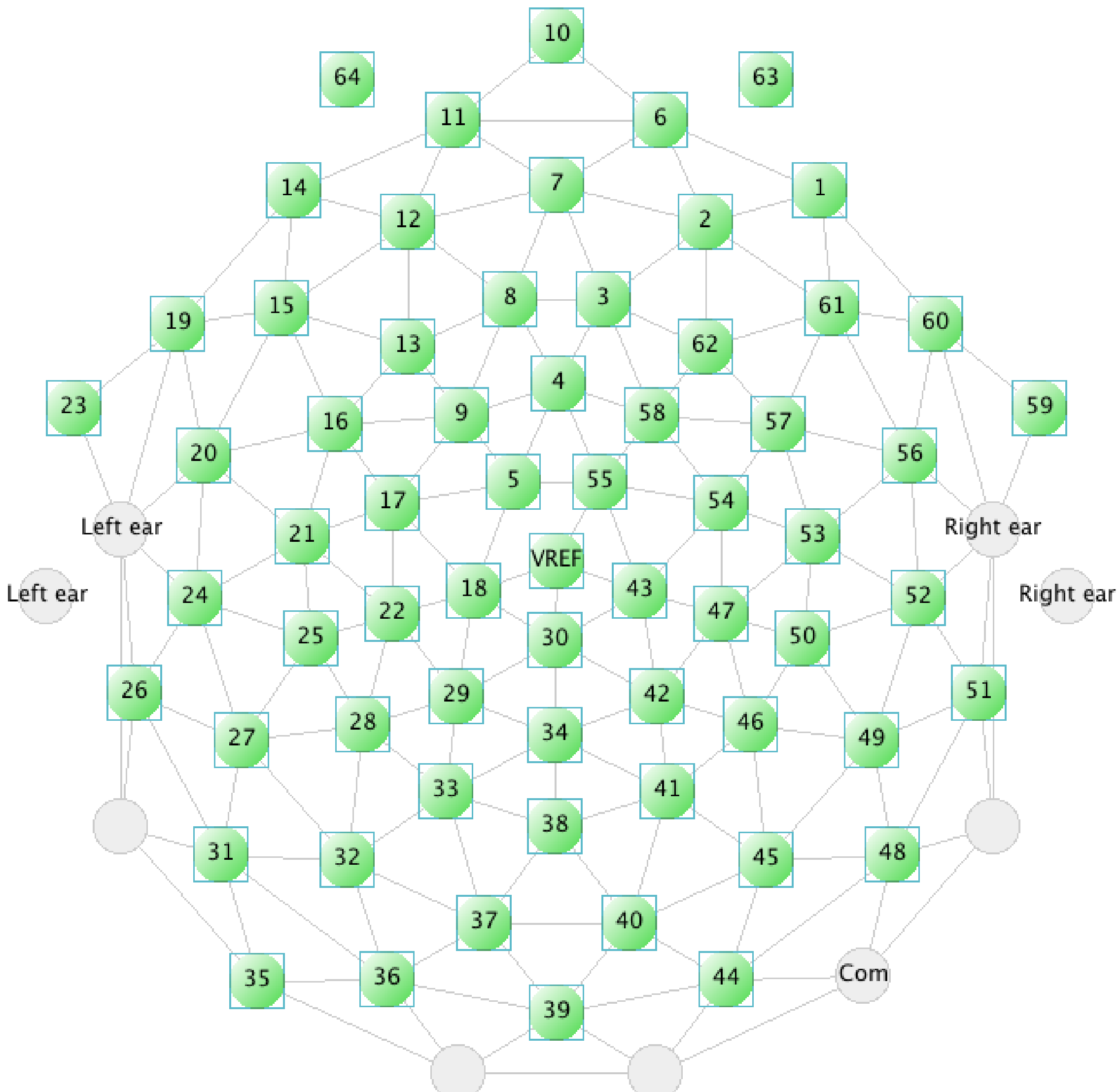


Figure C-17. 10-10 All Sensors (64-channel GSN 200 adult 2.0)

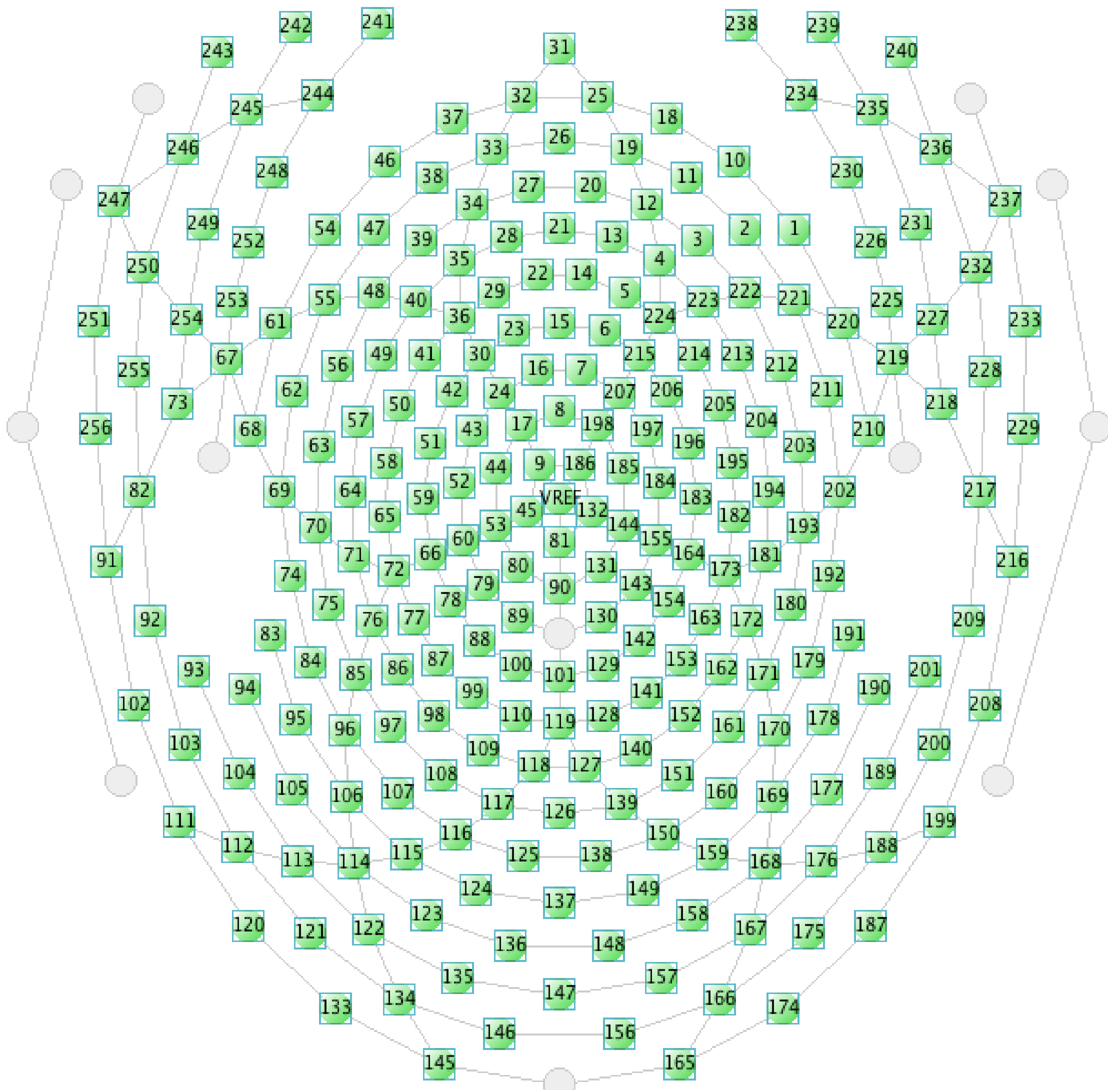


Figure C-18. 10-10 All Sensors (256-channel HCGSN adult 1.0)

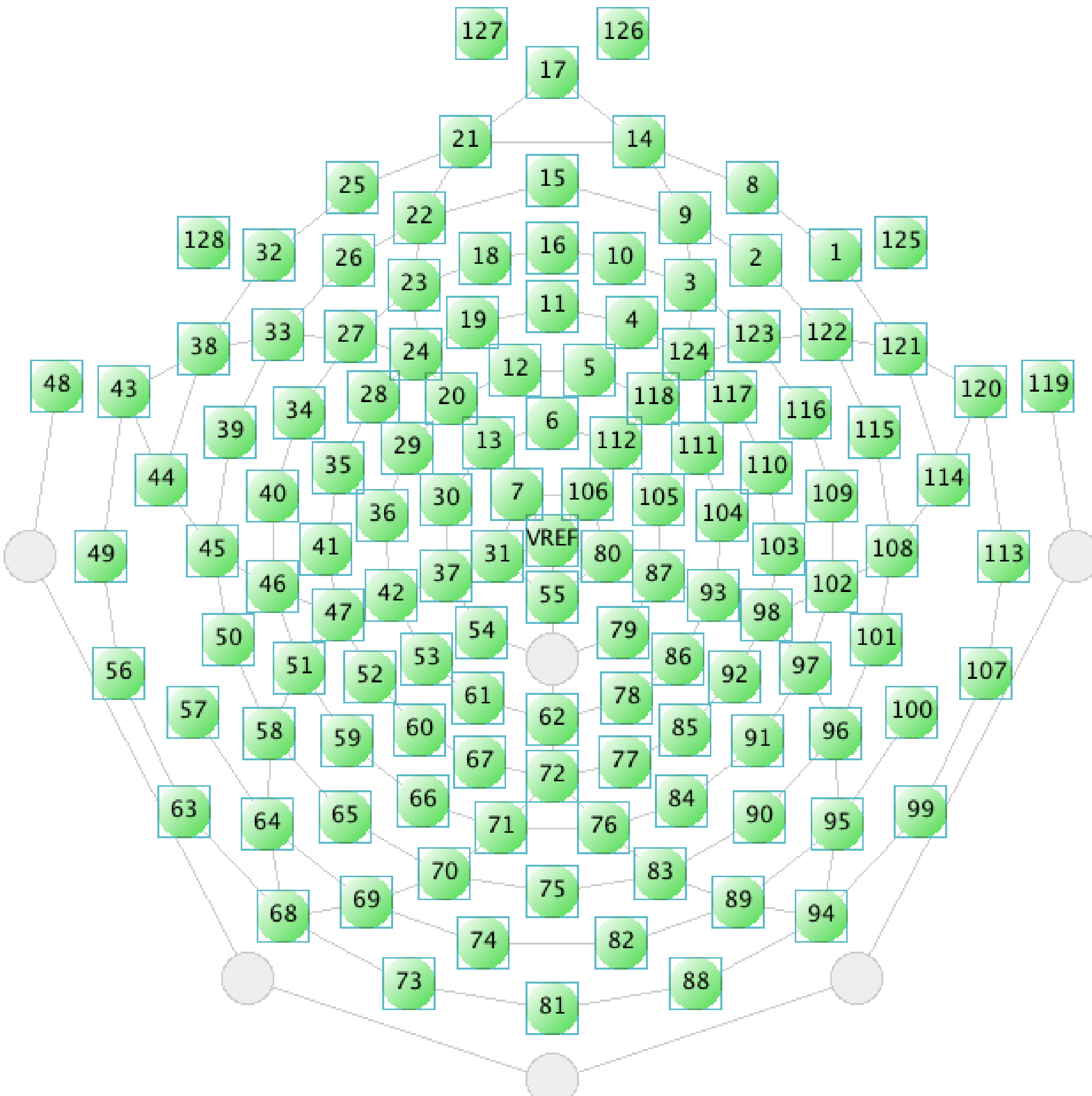


Figure C-19. 10-10 All Sensors (128-channel HCGSN adult 1.0)

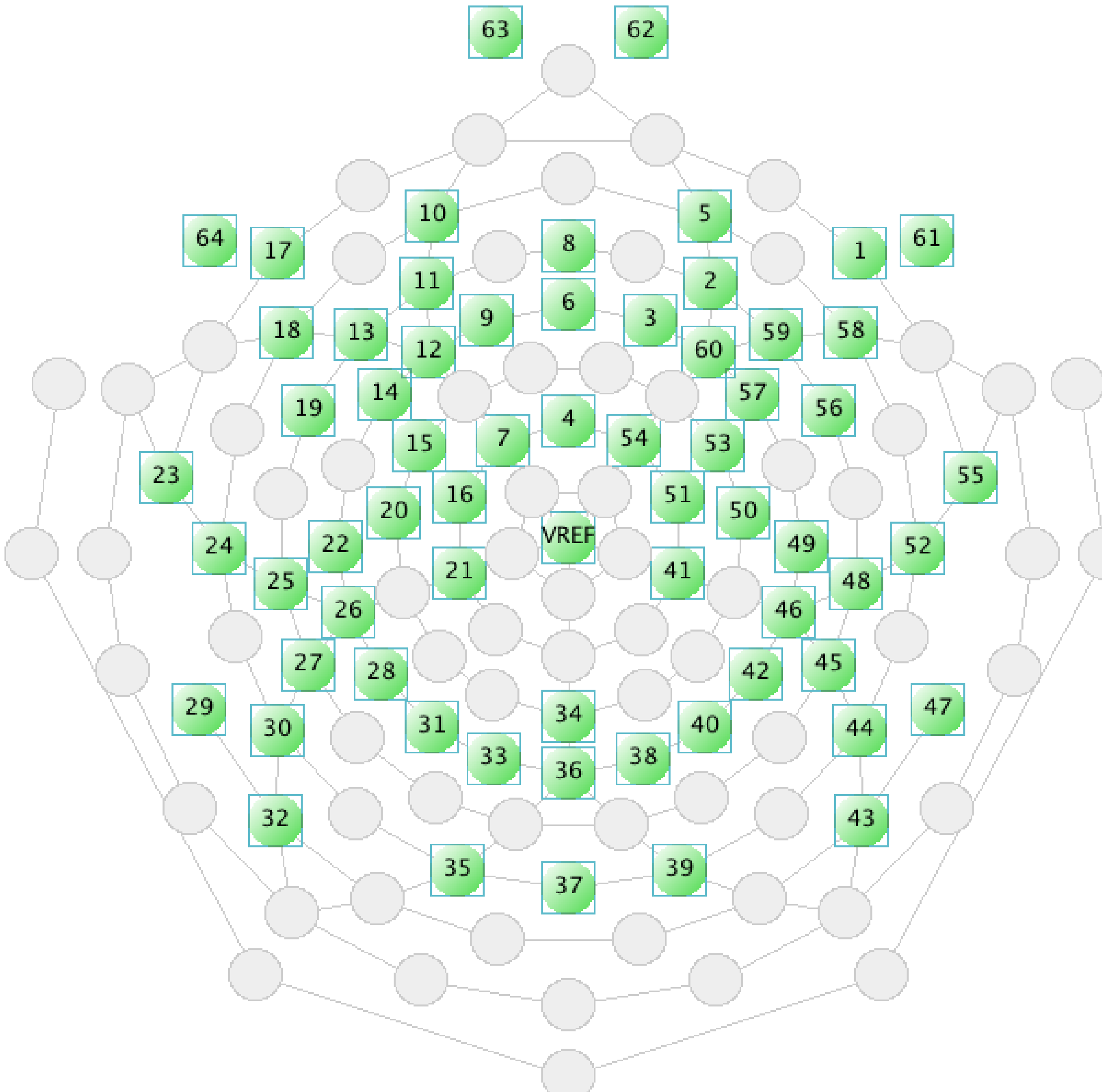


Figure C-20. 10-10 All Sensors (64-channel HCGSN adult 1.0)

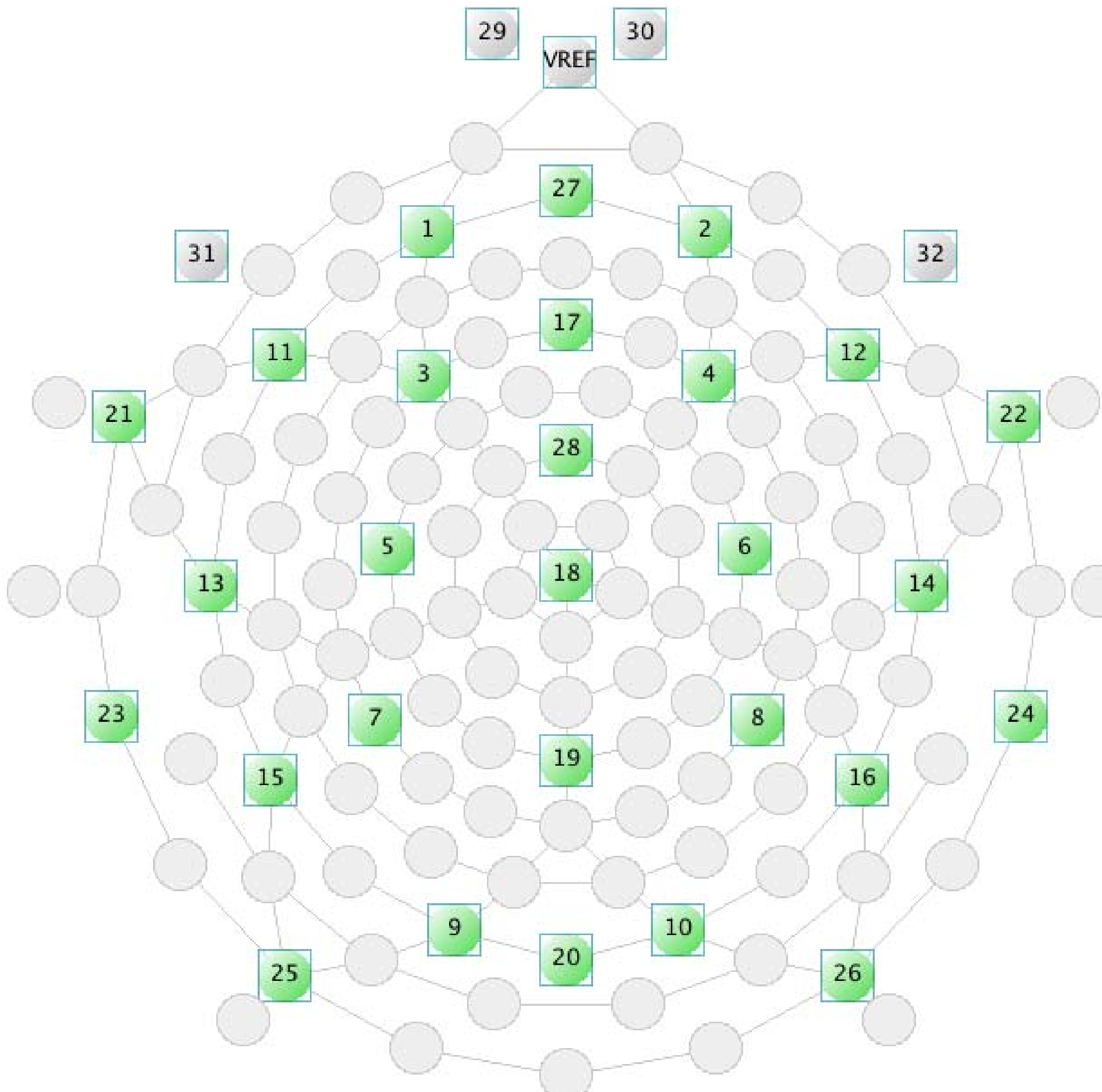


Figure C-21. 10-10 All Sensors (32-channel HCGSN adult 1.0)

10-20 Montage

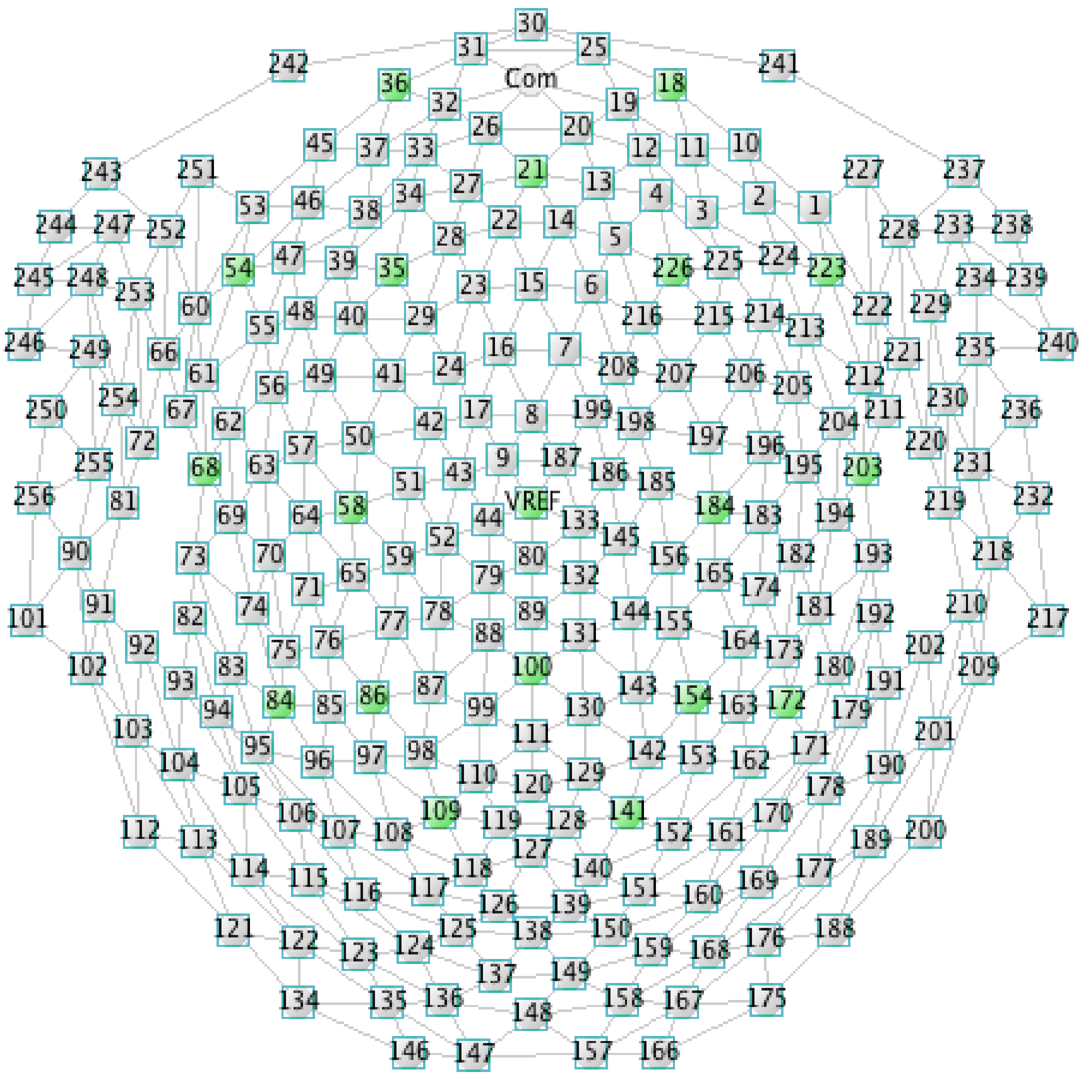


Figure C-22. 10-20 (256-channel GSN 200 adult 2.1)

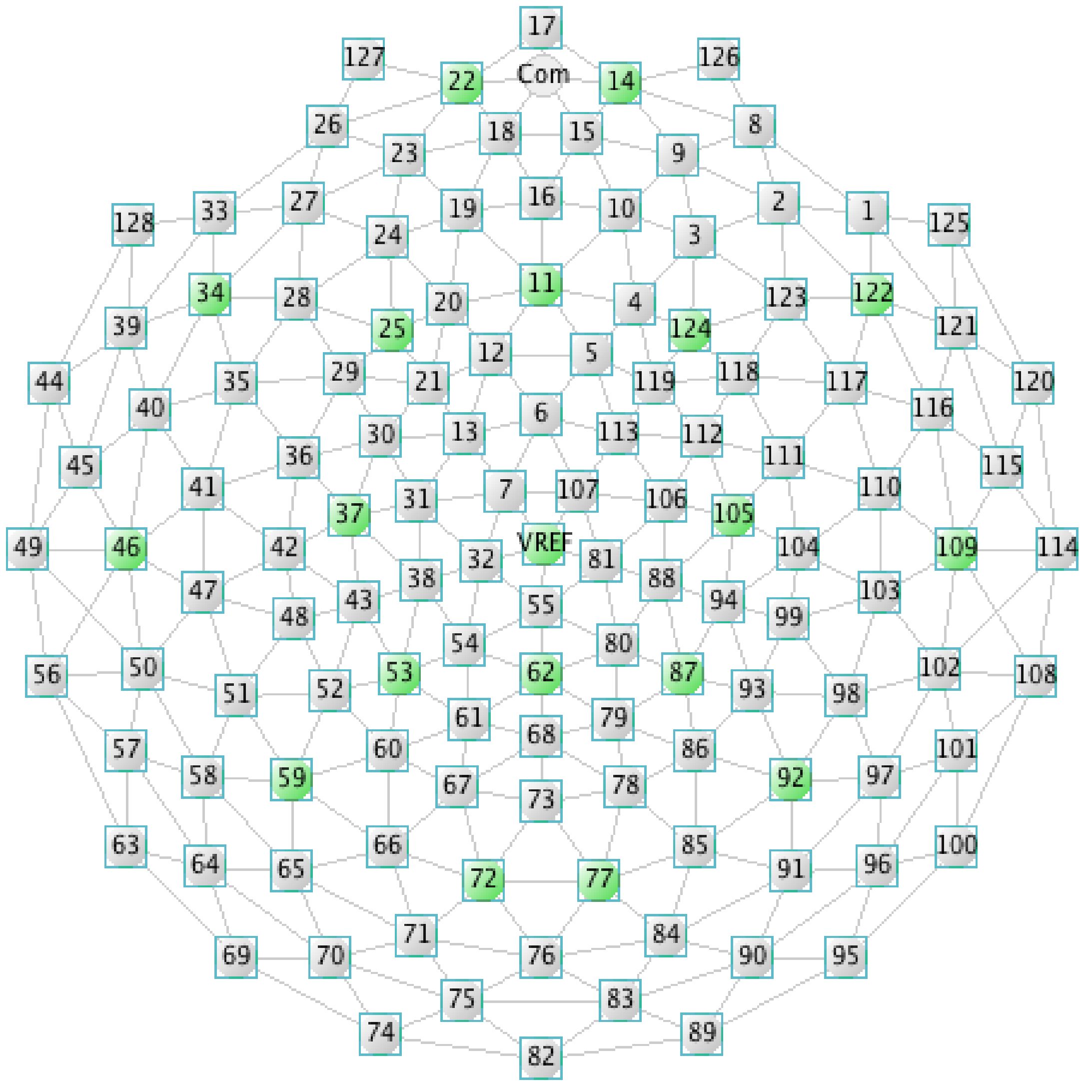


Figure C-23. 10-20 (128-channel GSN 200 adult 2.1)

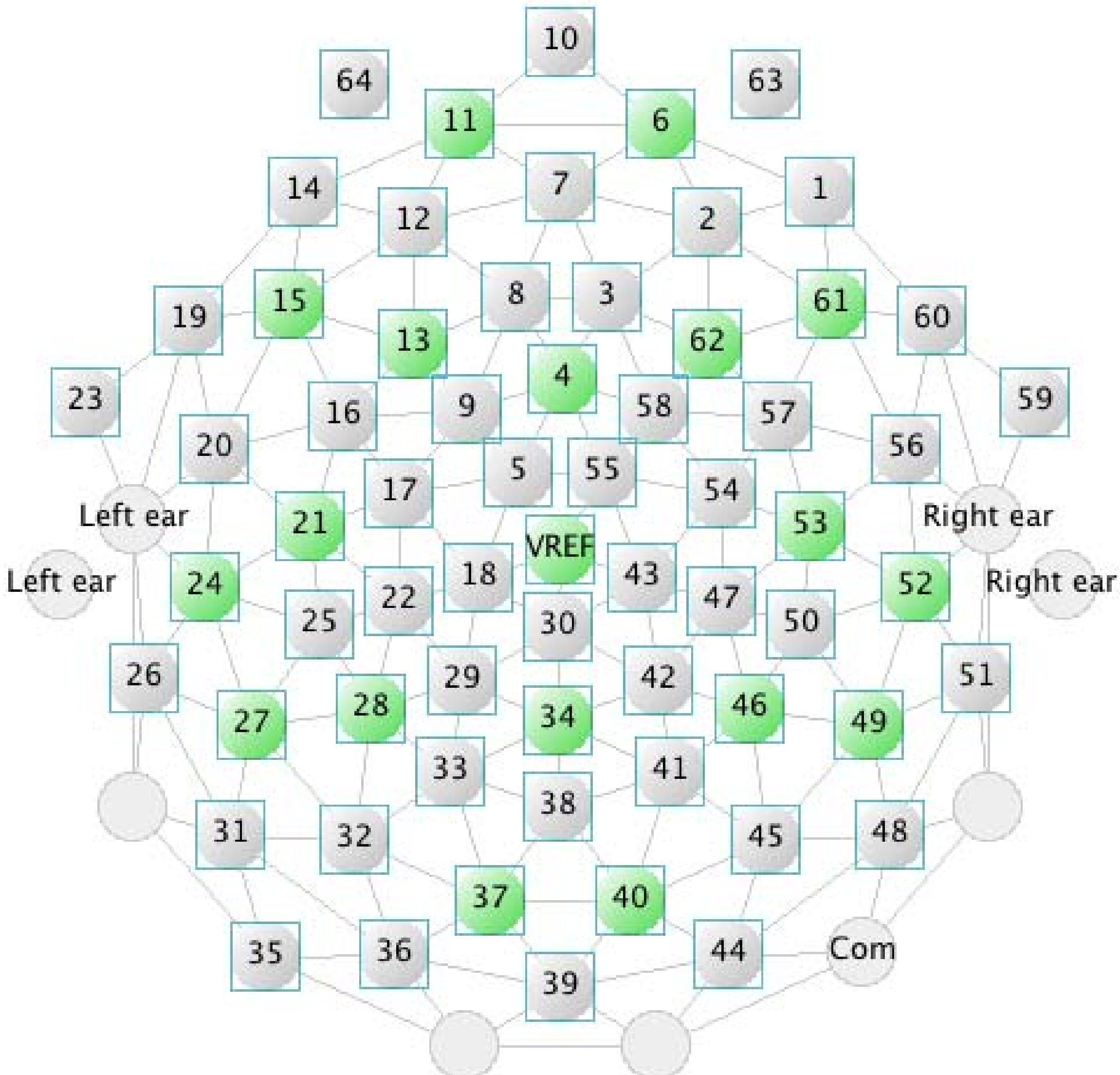


Figure C-24. 10-20 (64-channel GSN 200 adult 2.0)

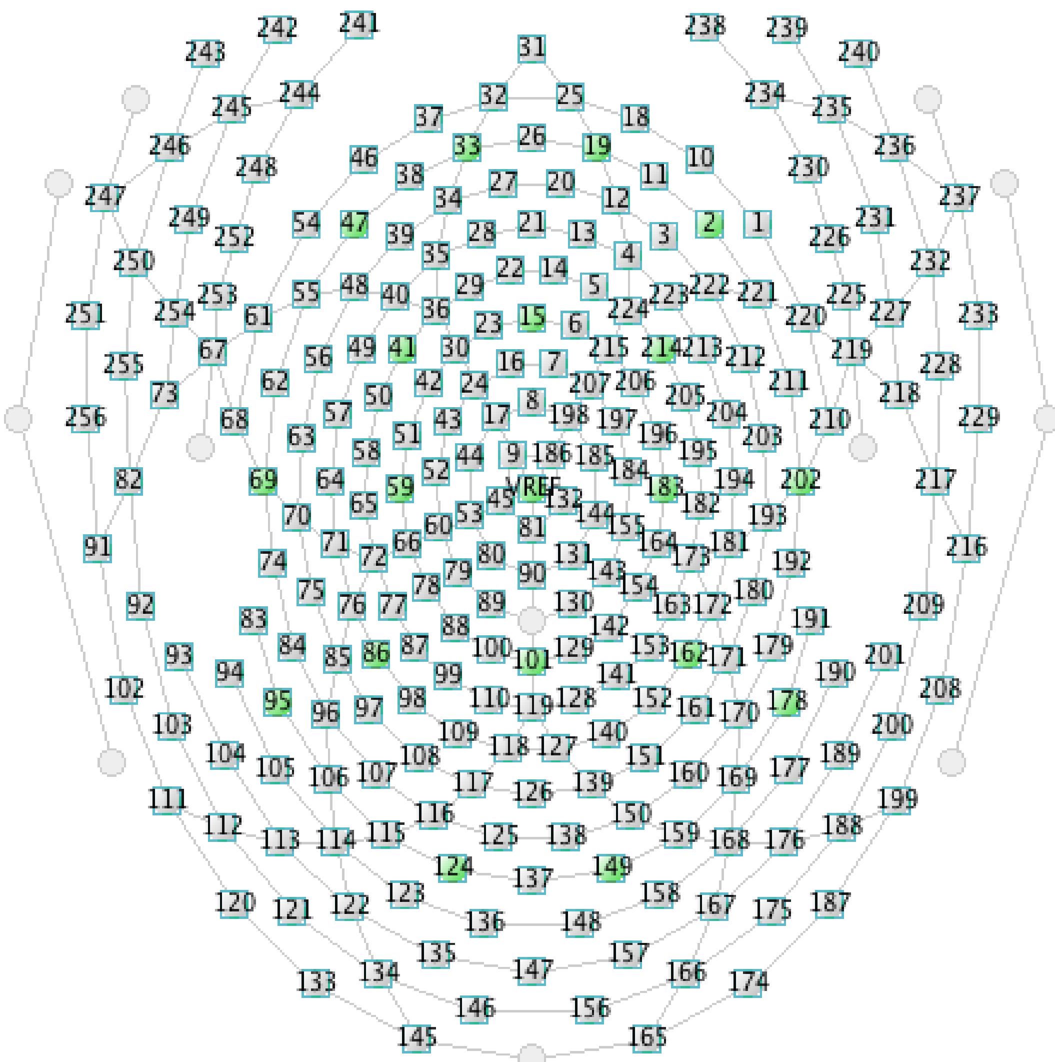


Figure C-25. 10-20 (256-channel HCGSN adult 1.0)

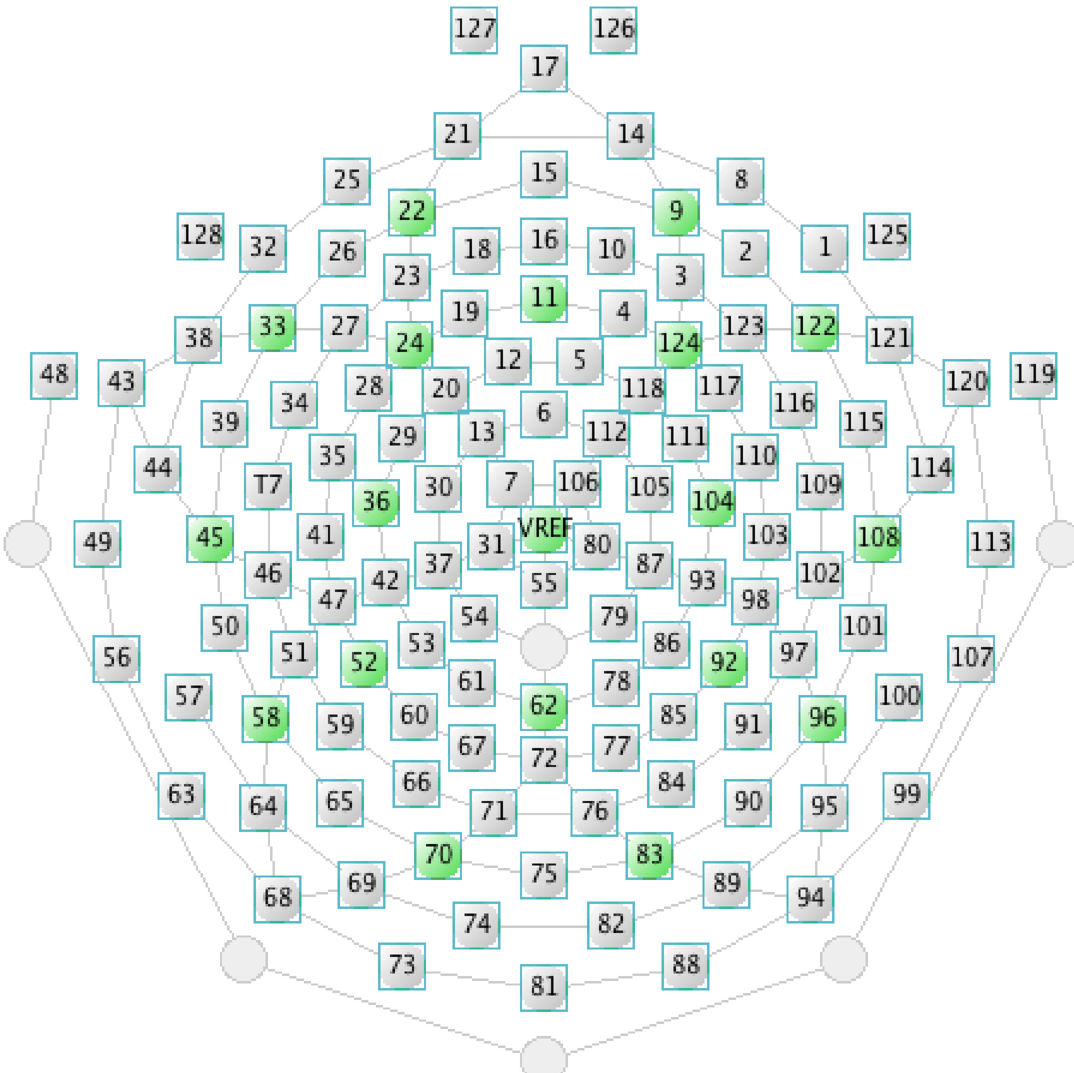


Figure C-26. 10-20 (128-channel HCGSN adult 1.0)

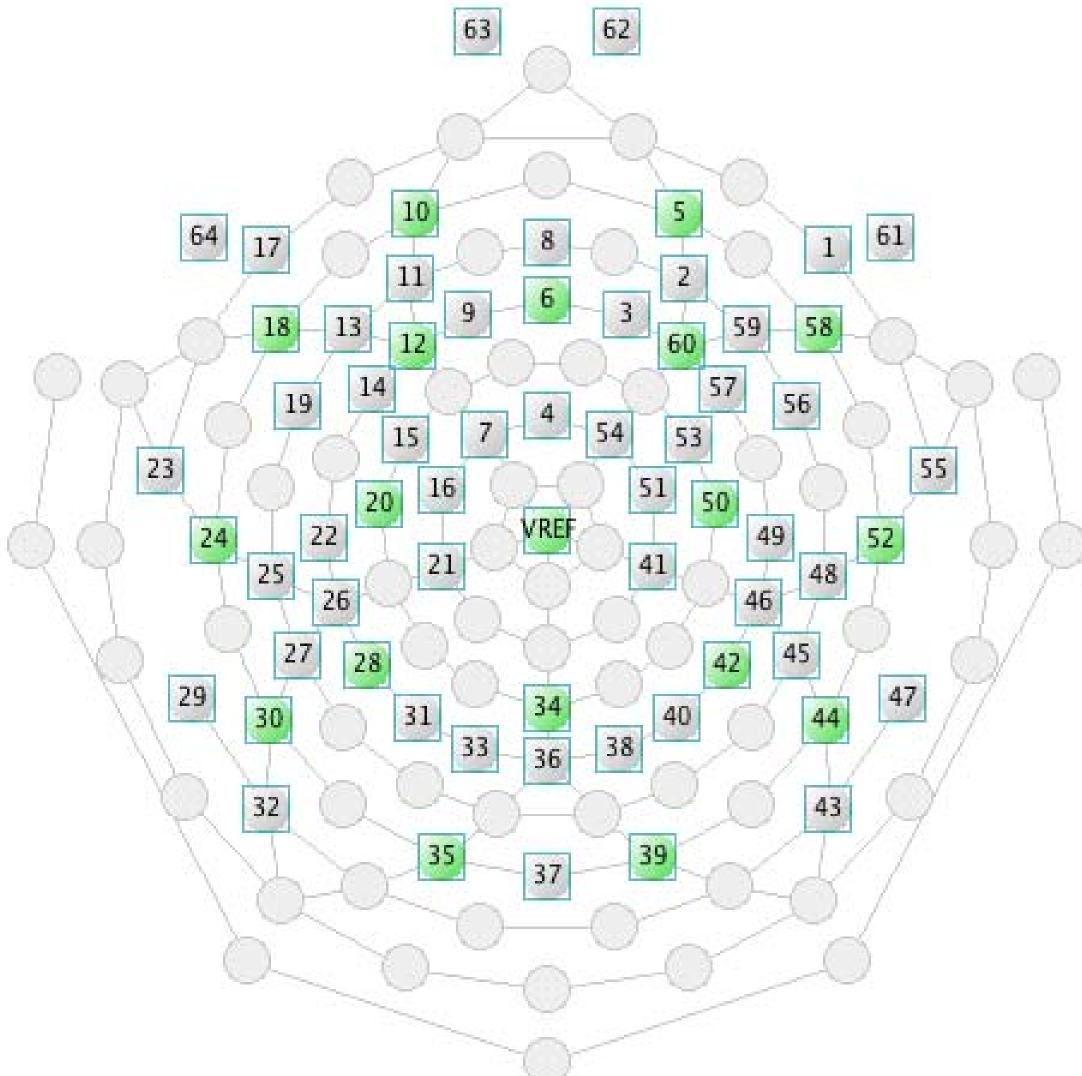


Figure C-27. 10-20 (64-channel HCGSN adult 1.0)

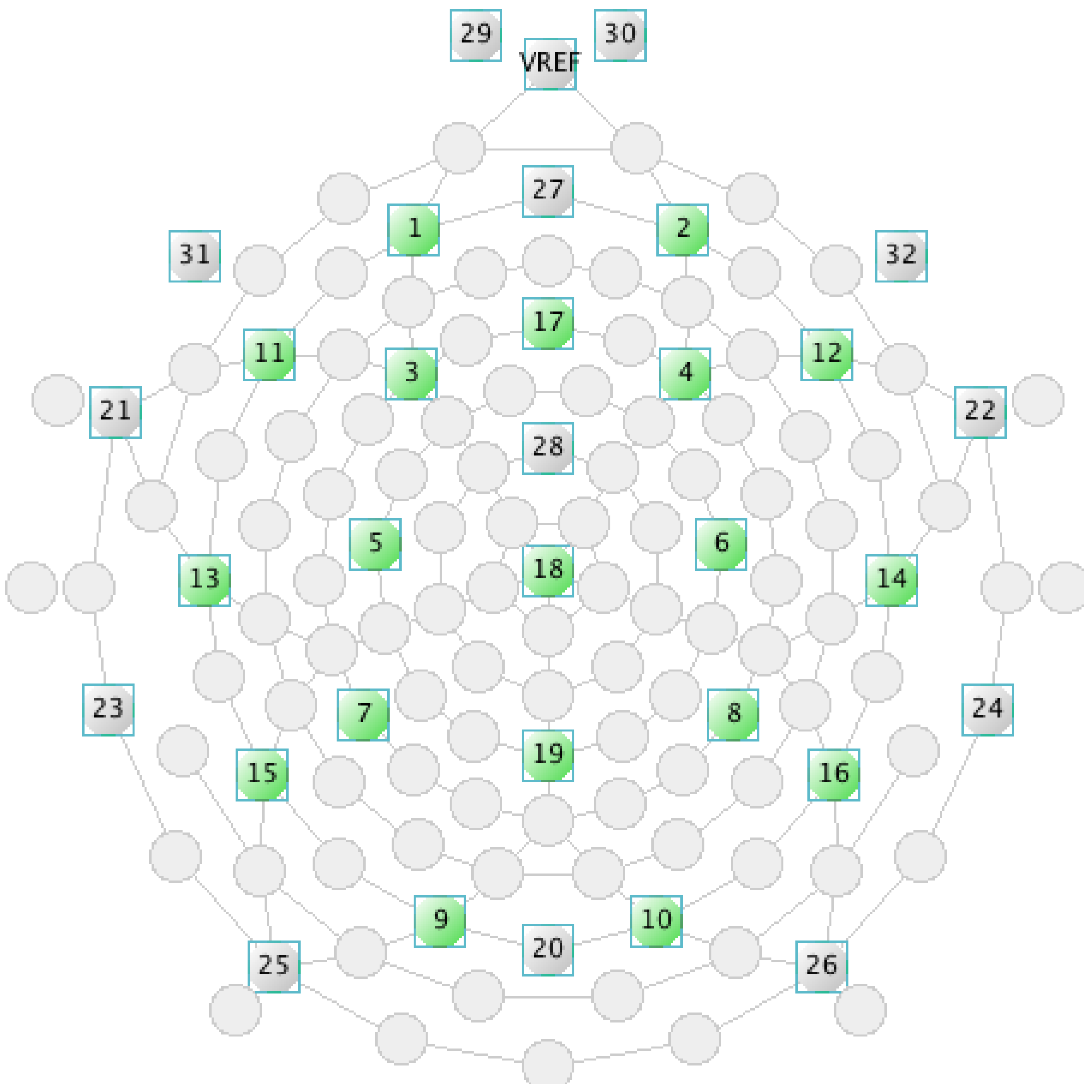


Figure C-28. 10-20 (32-channel HCGSN adult 1.0)

Double Banana Montage

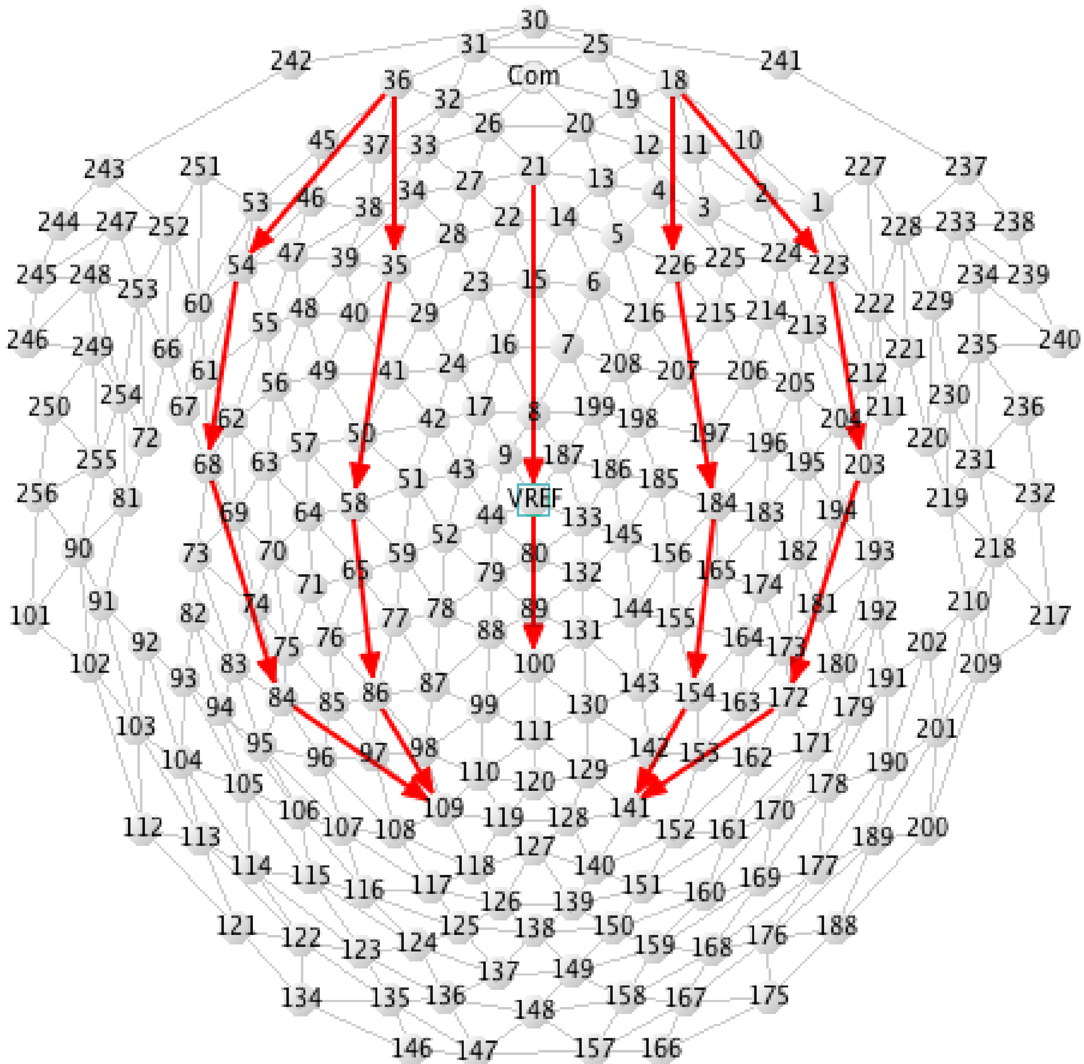


Figure C-29. Double Banana (256-channel GSN 200 adult 2.1)

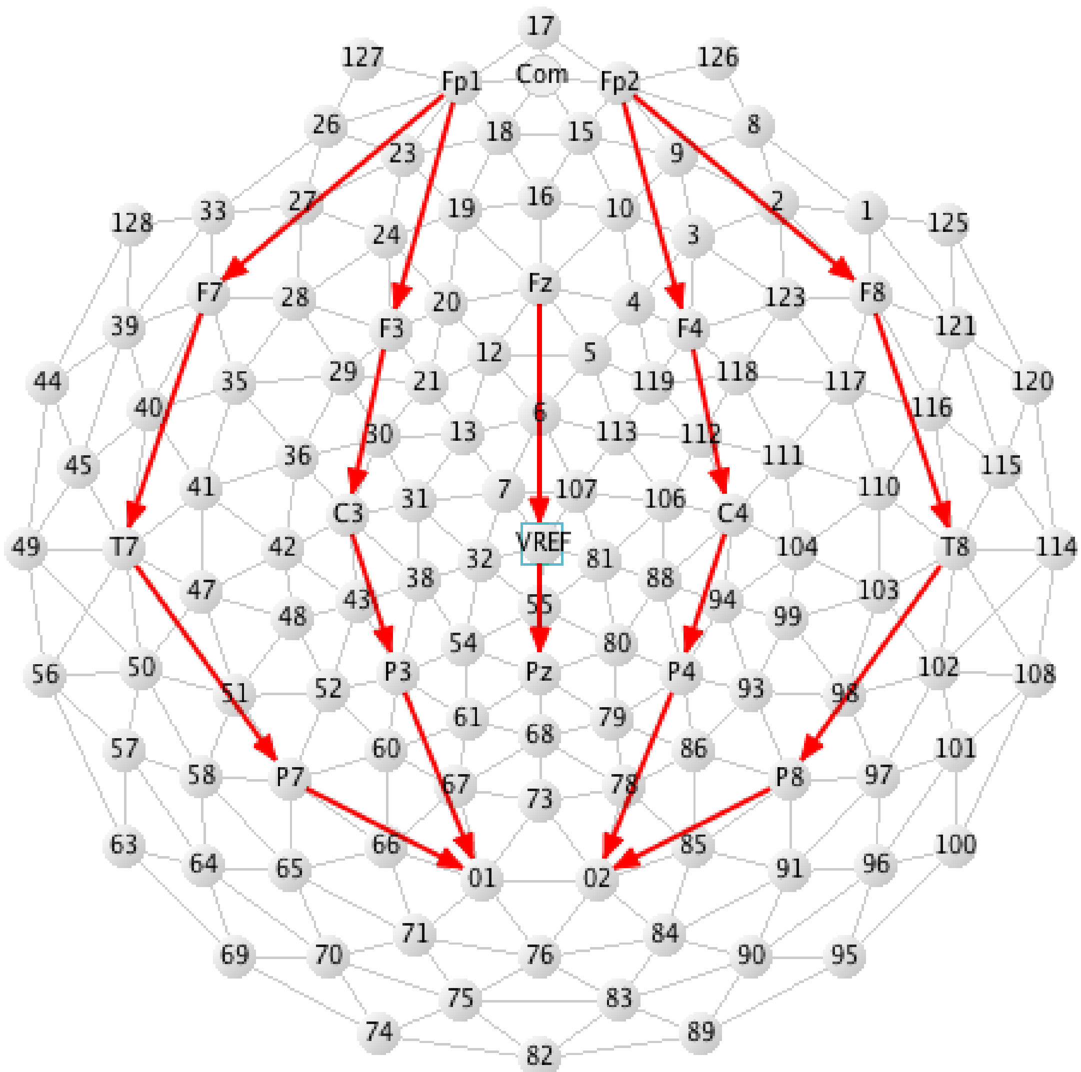


Figure C-30. Double Banana (128-channel GSN 200 adult 2.1)

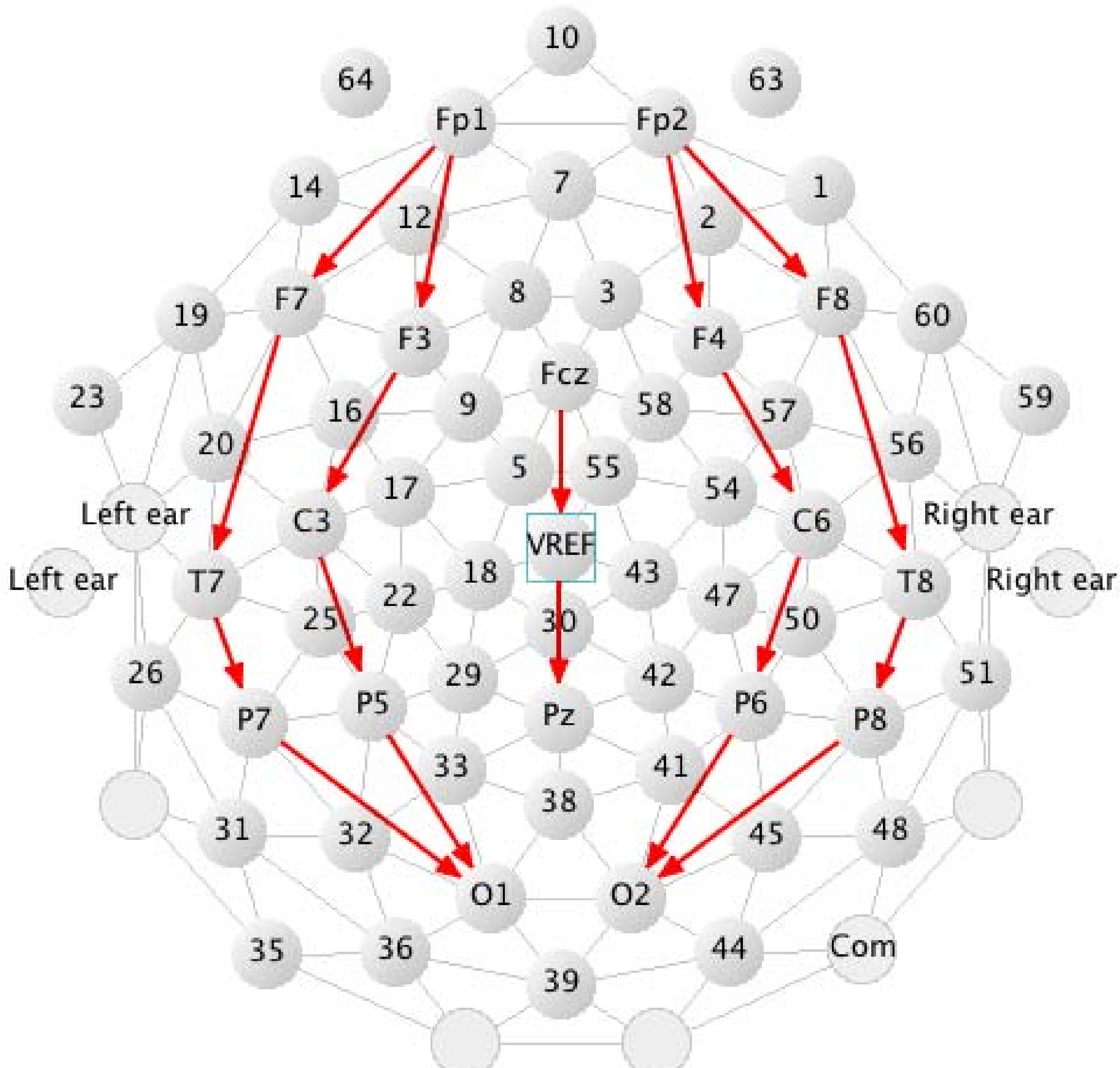


Figure C-31. Double Banana (64-channel GSN 200 adult 2.0)

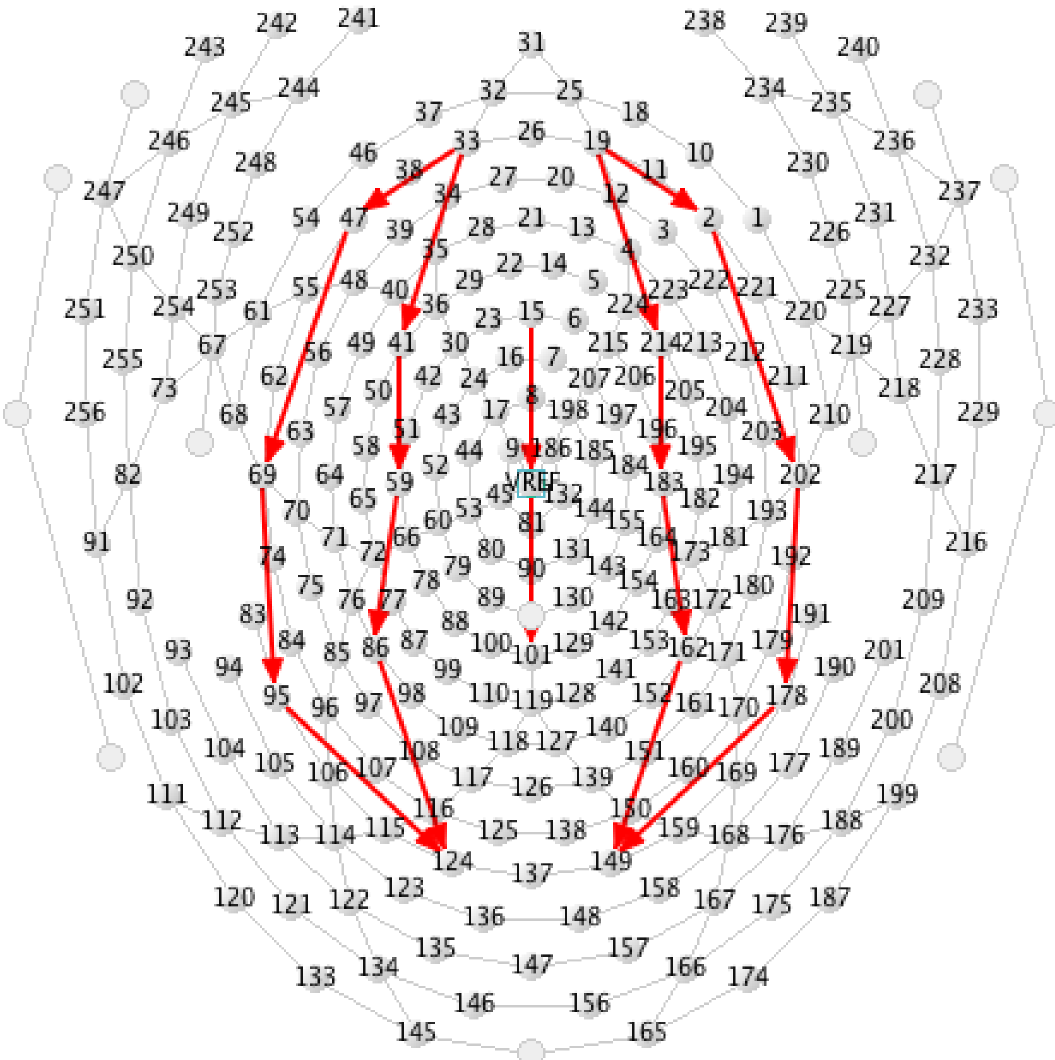


Figure C-32. Double Banana (256-channel HCGSN adult 1.0)

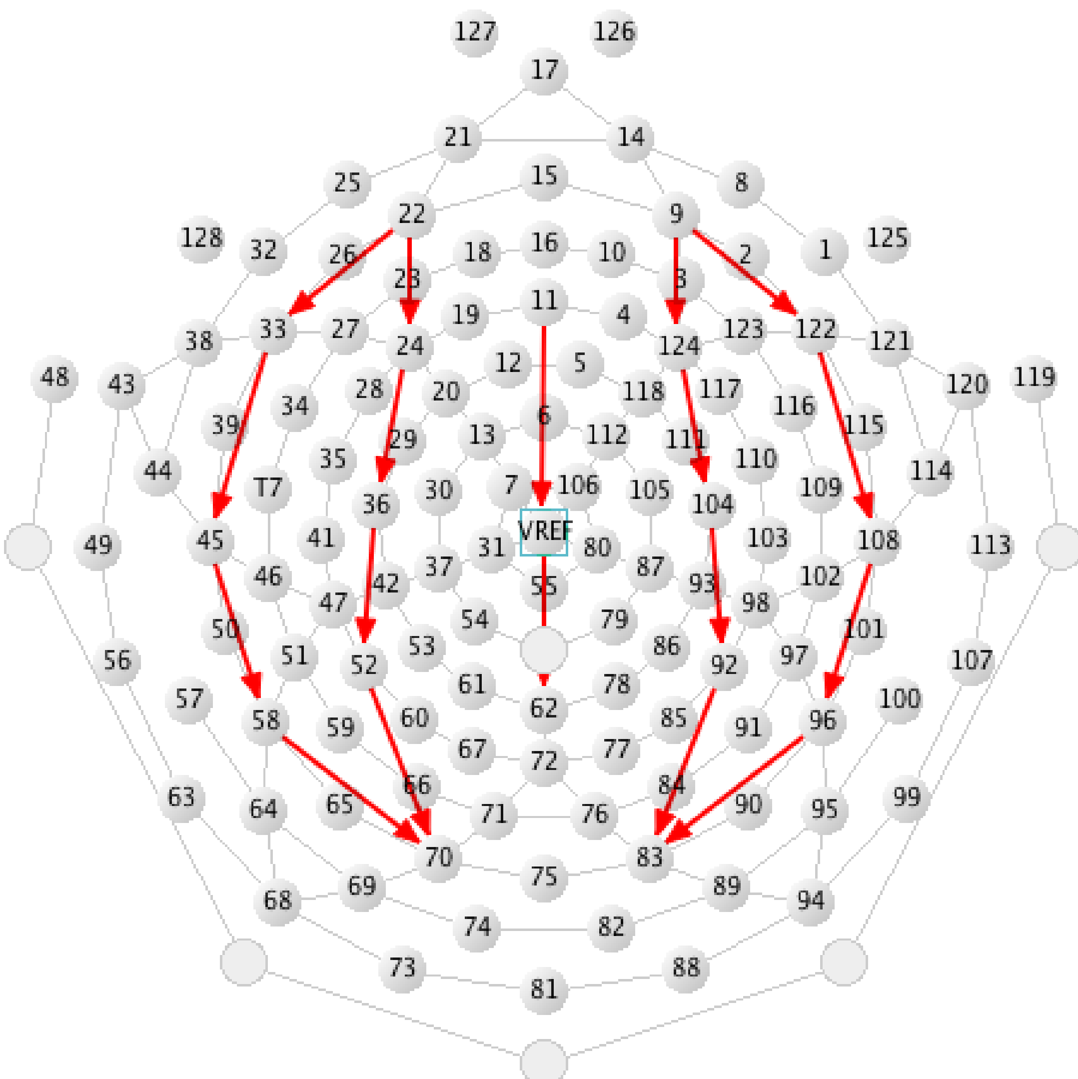


Figure C-33. Double Banana (128-channel HCGSN adult 1.0)

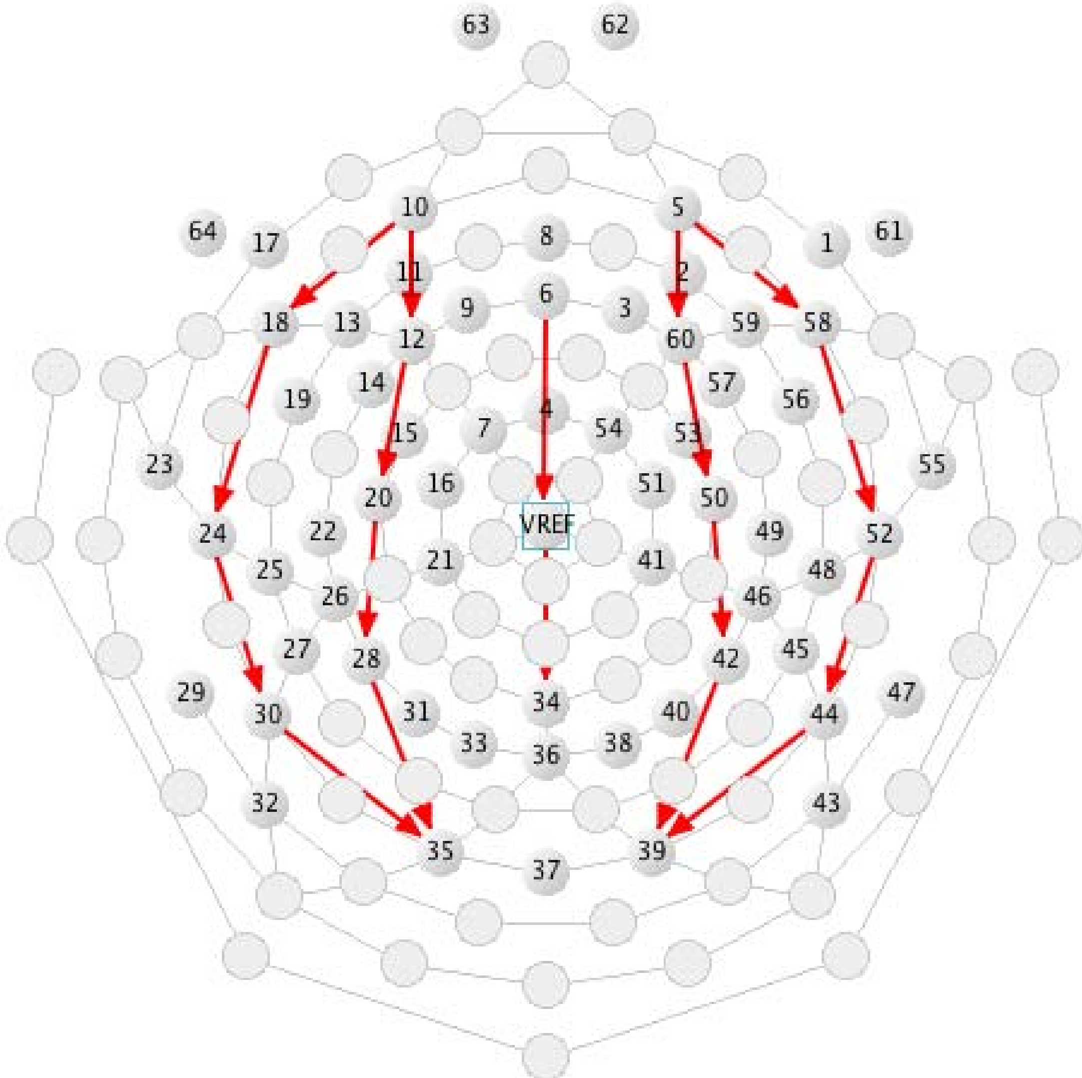


Figure C-34. Double Banana (64-channel HCGSN adult 1.0)

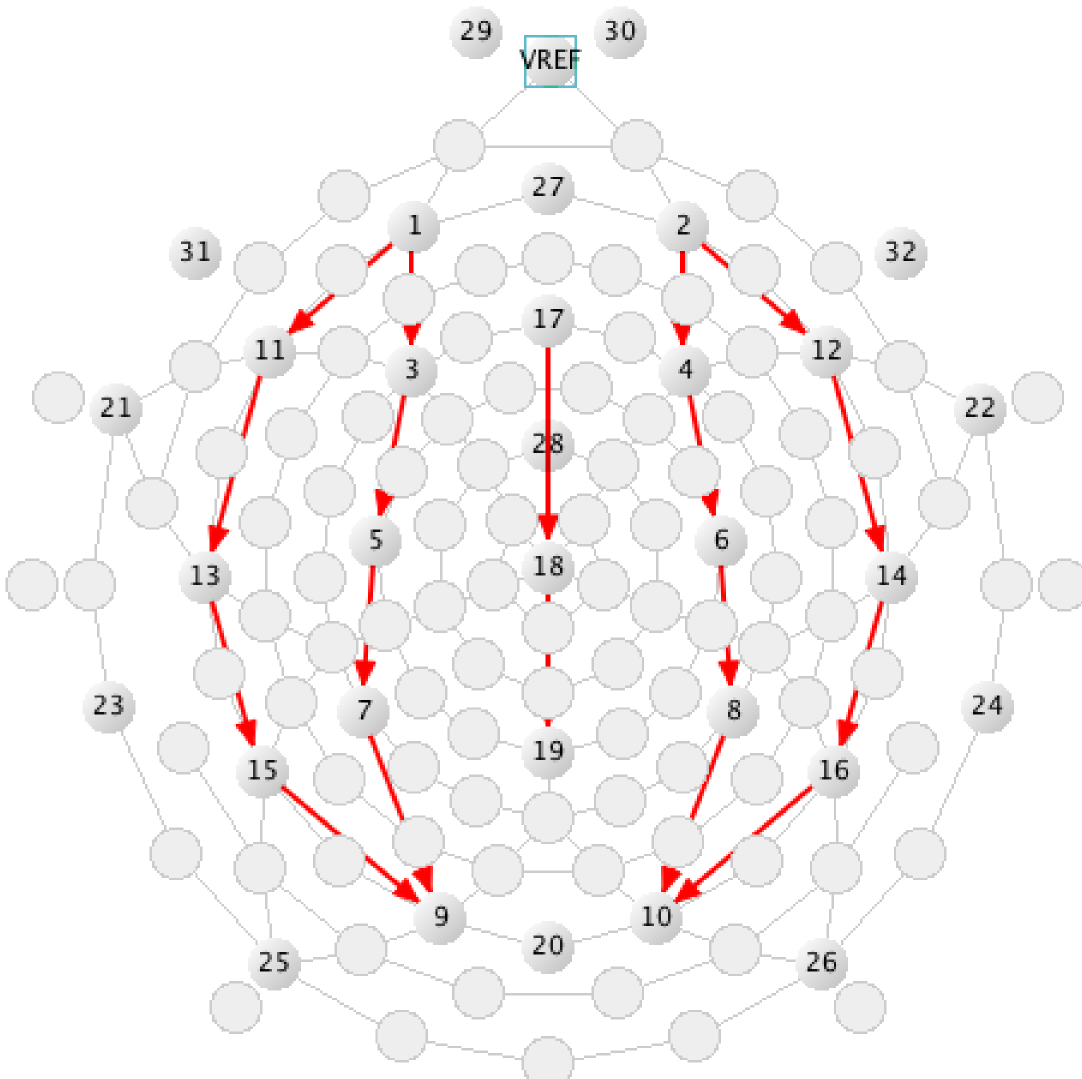


Figure C-35. Double Banana (32-channel HCGSN adult 1.0)

Eyes Montage

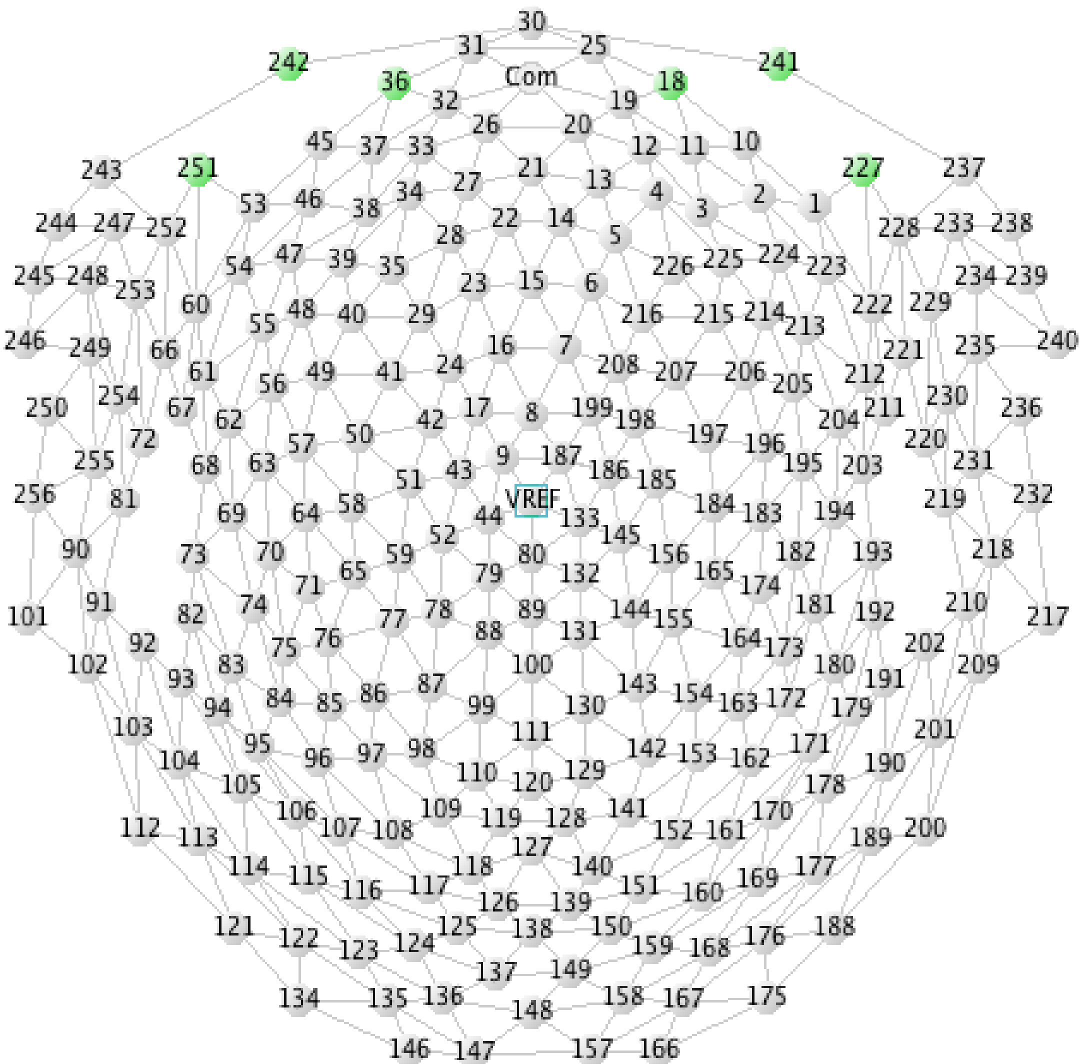


Figure C-36. Eyes (256-channel GSN 200 adult 2.1)

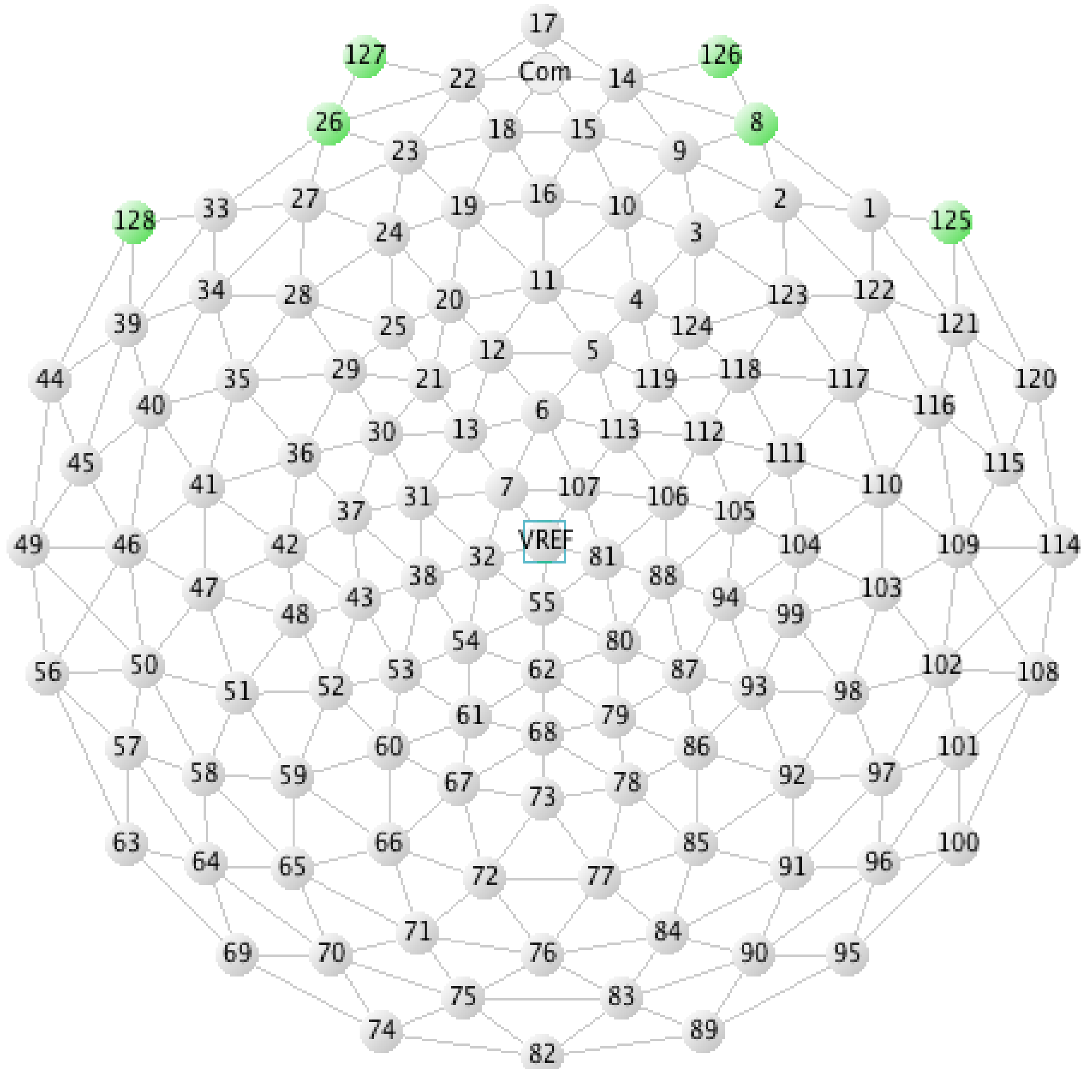


Figure C-37. Eyes (128-channel GSN 200 adult 2.1)

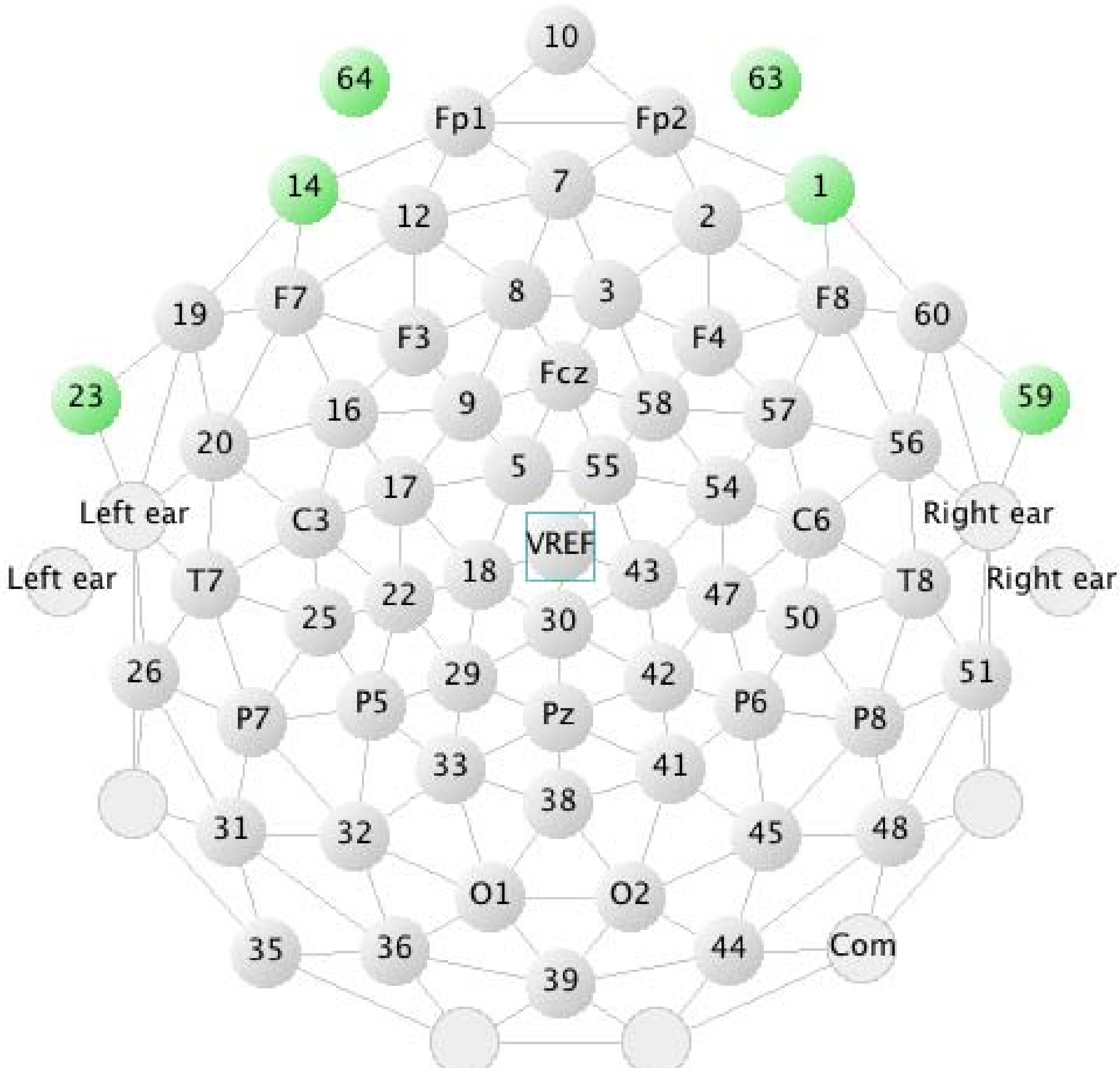


Figure C-38. Eyes (64-channel GSN 200 adult 2.0)

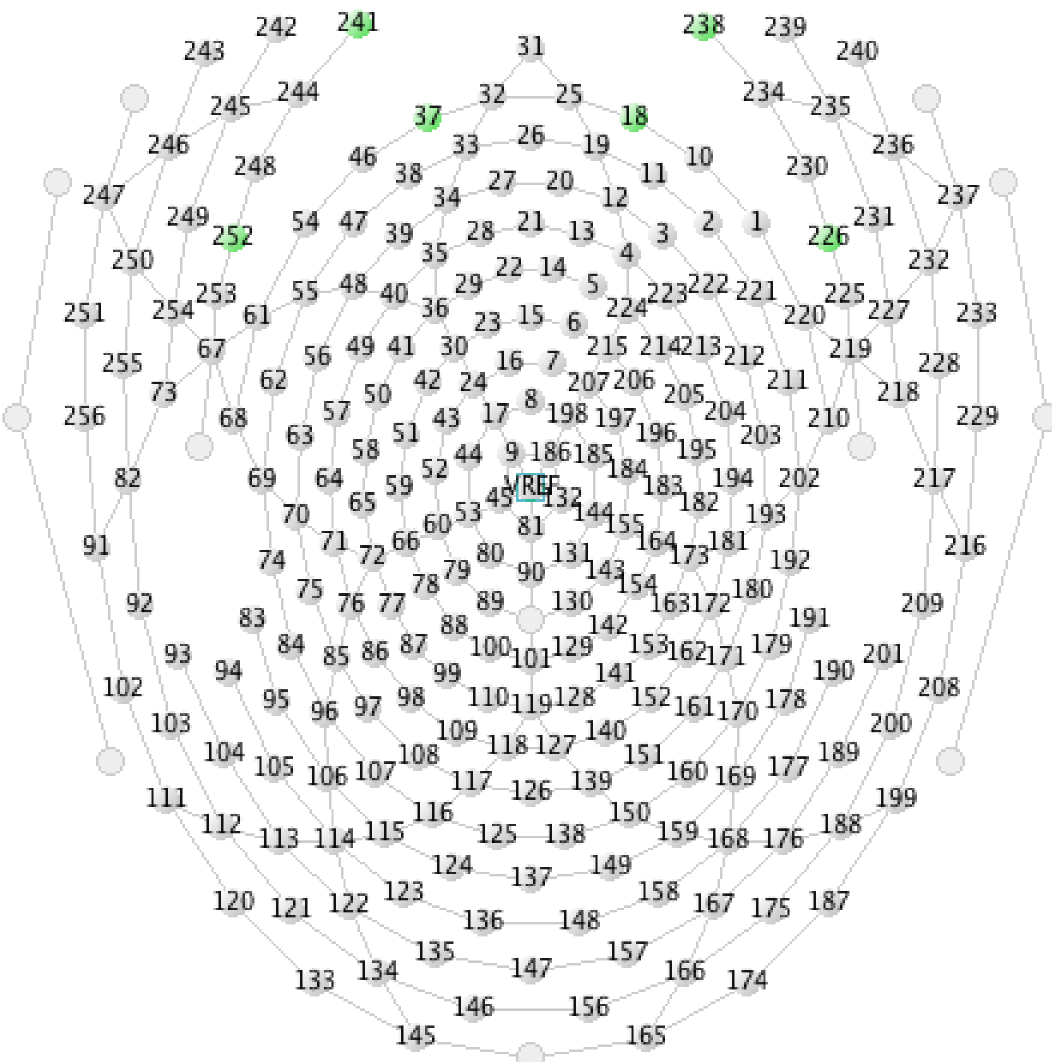


Figure C-39. Eyes (256-channel HCGSN adult 1.0)

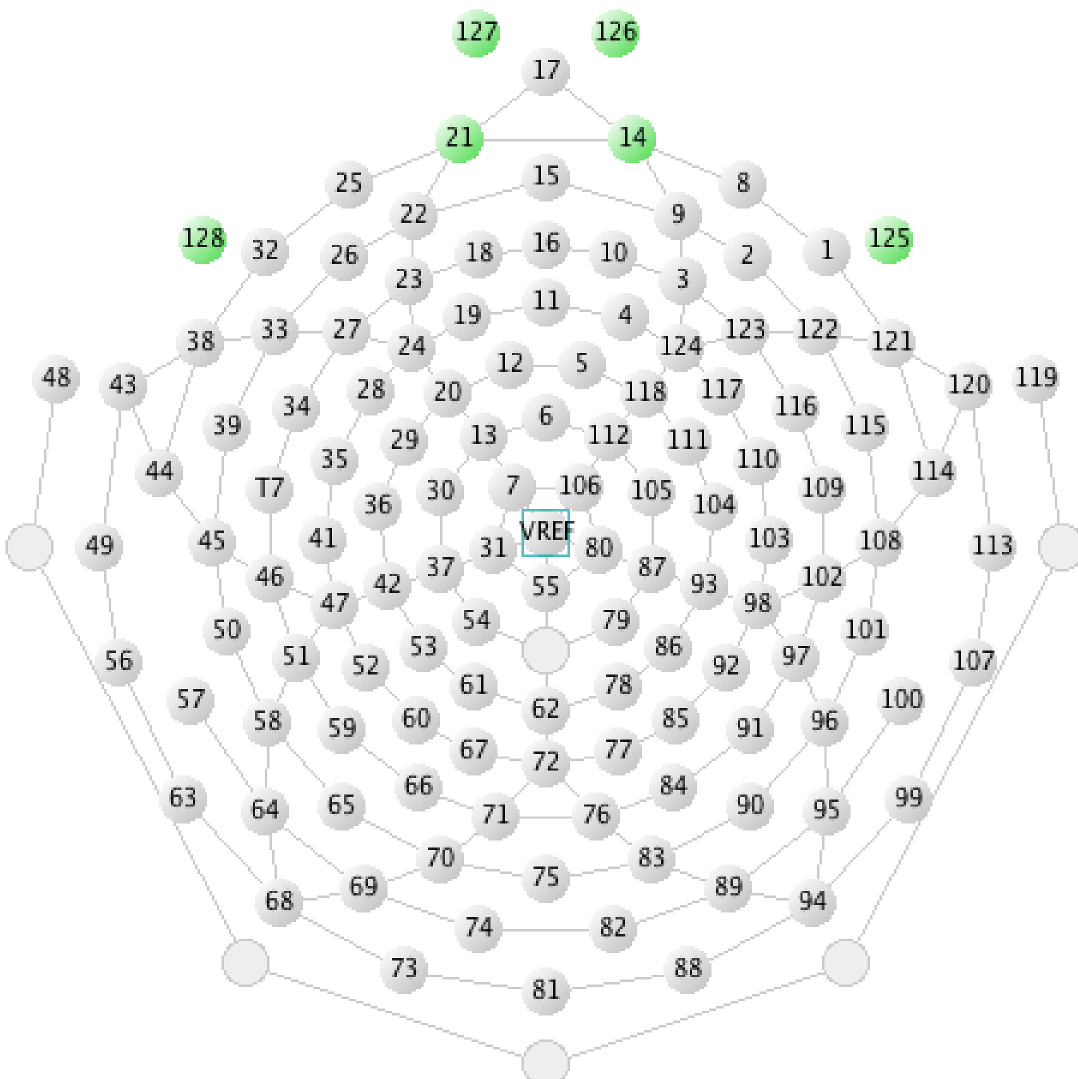


Figure C-40. Eyes (128-channel HCGSN adult 1.0)

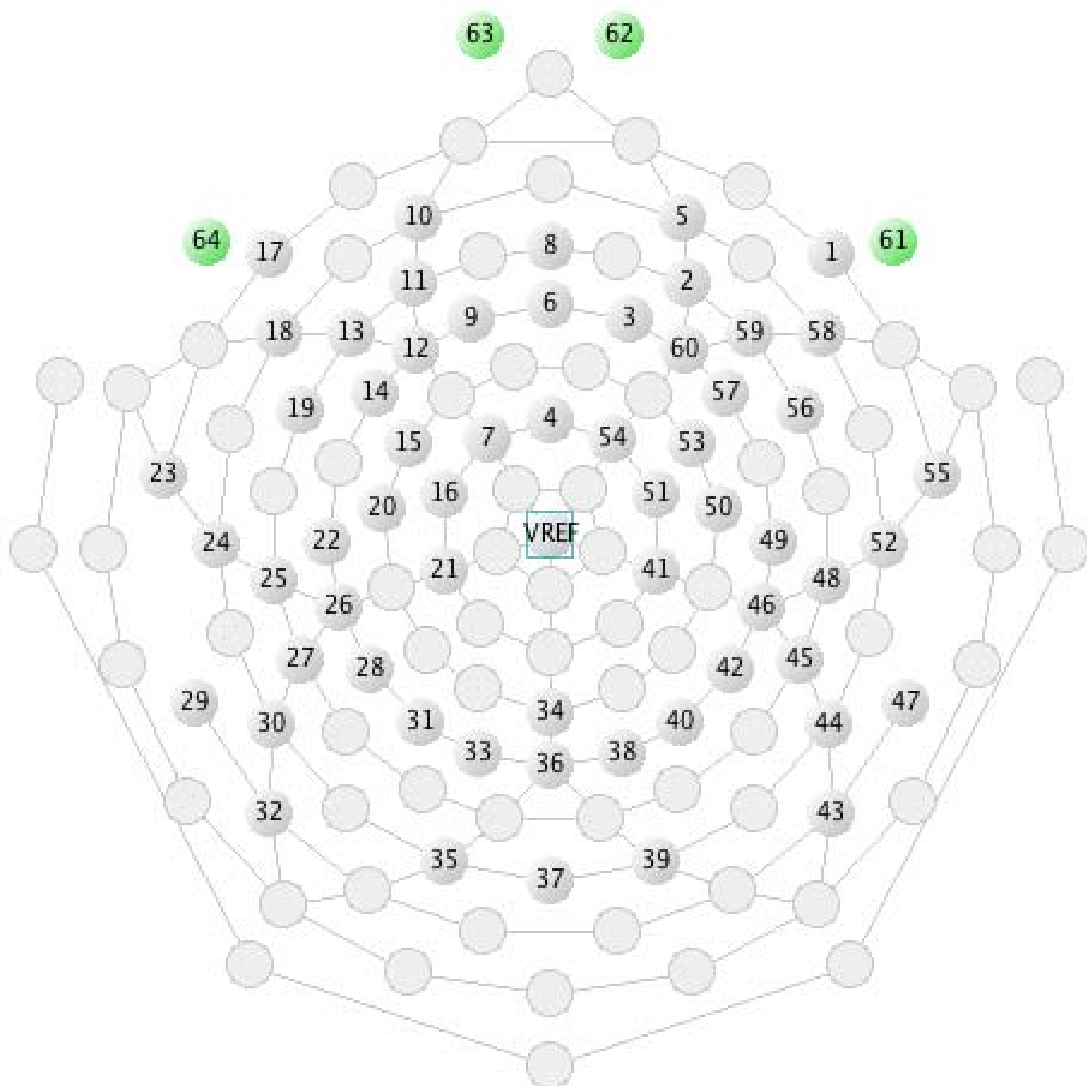


Figure C-41. Eyes (64-channel HCGSN adult 1.0)

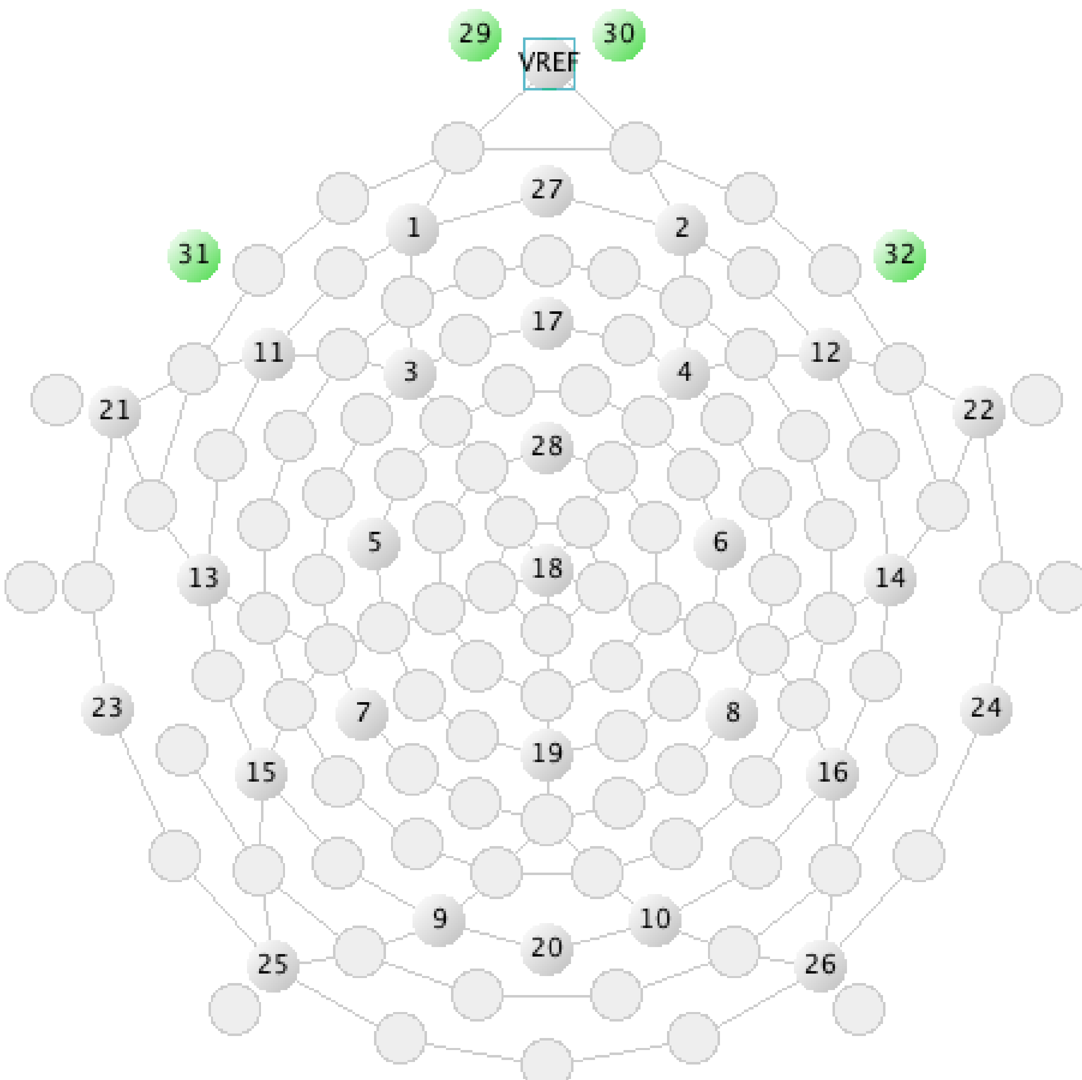


Figure C-42. Eyes (32-channel HCGSN adult 1.0)

Left-Mastoid Reference Montage

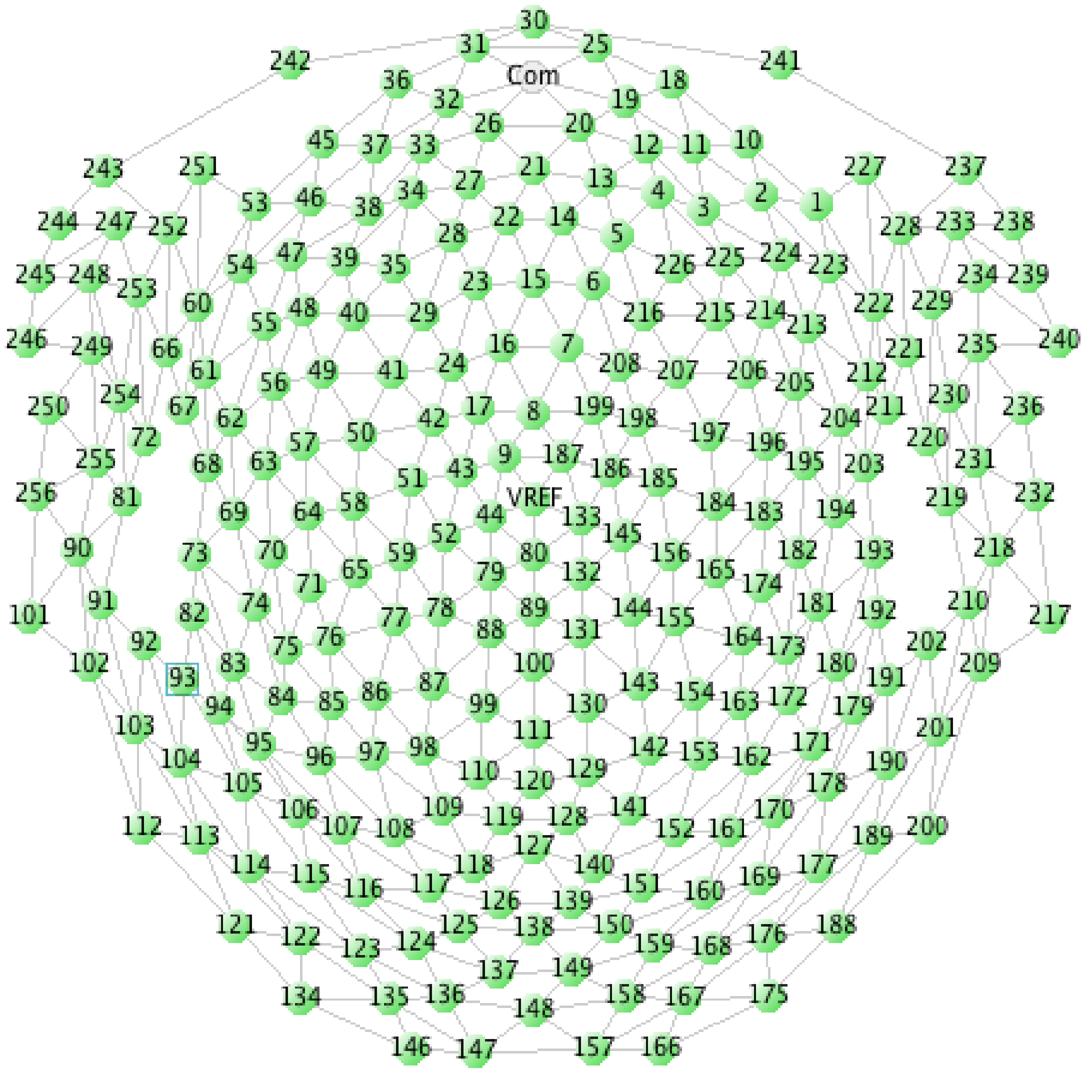


Figure C-43. Left-Mastoid Reference (256-channel GSN 200 adult 2.1)

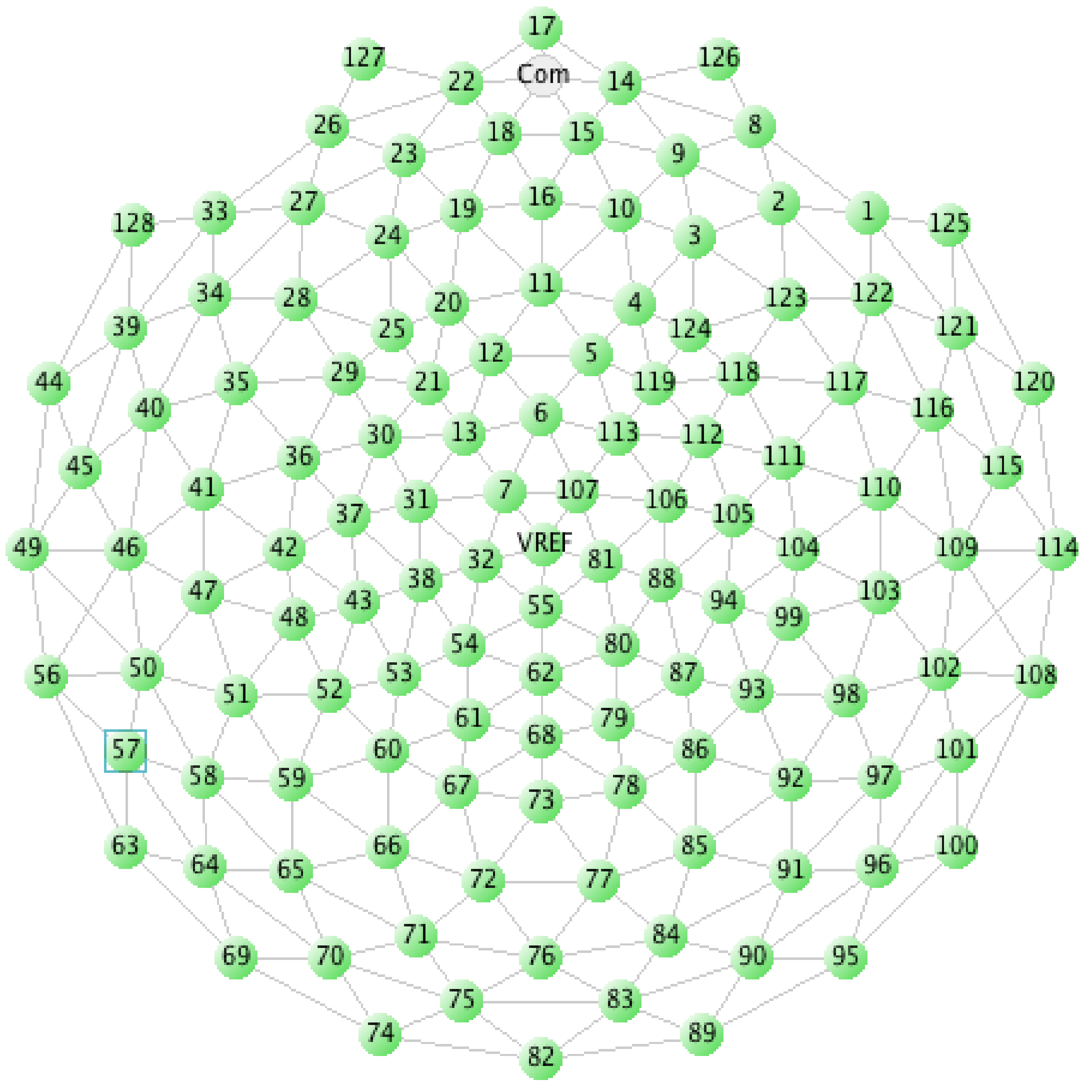


Figure C-44. Left-Mastoid Reference (128-channel GSN 200 adult 2.1)

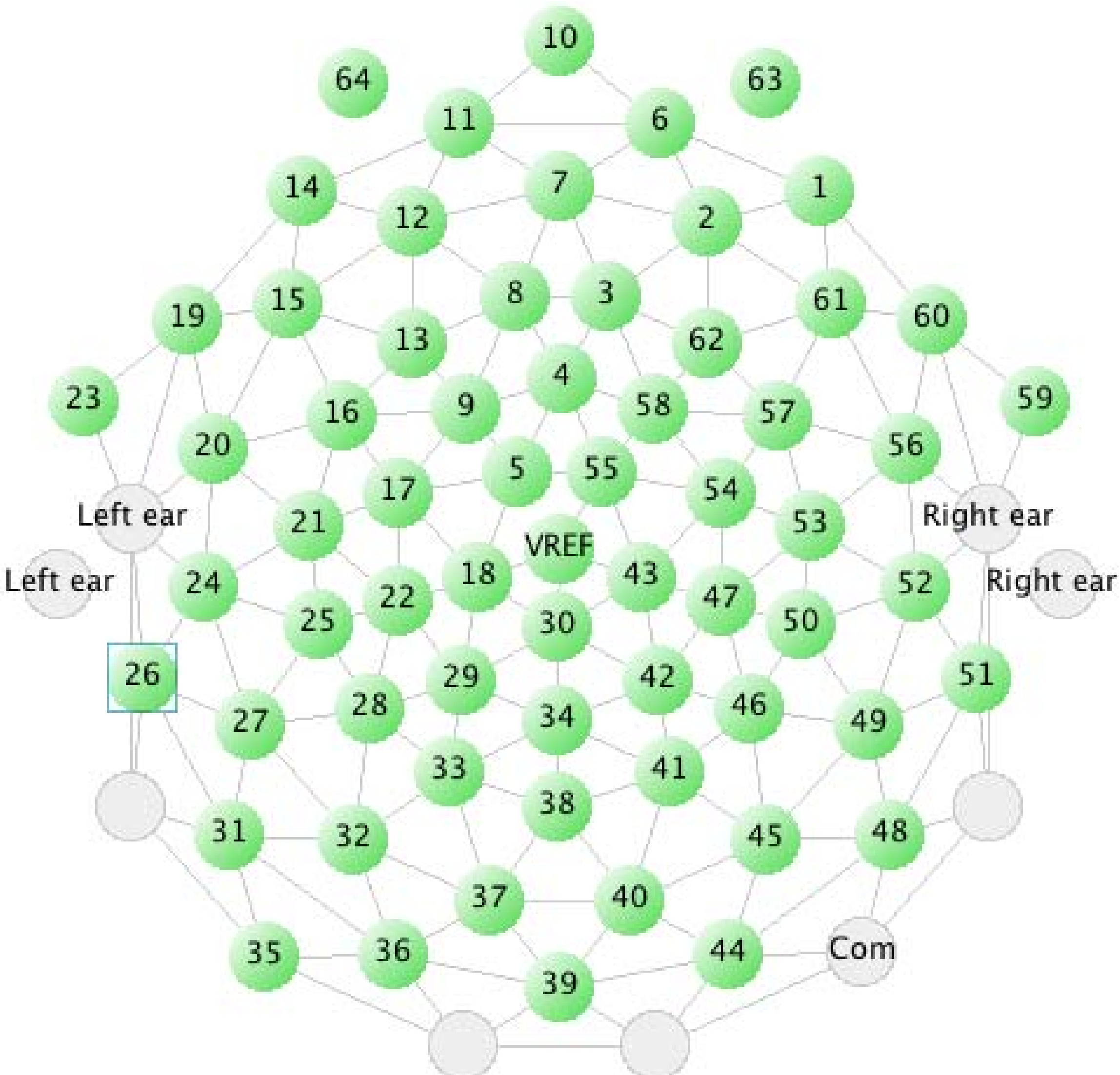


Figure C-45. Left-Mastoid Reference (64-channel GSN 200 adult 2.0)

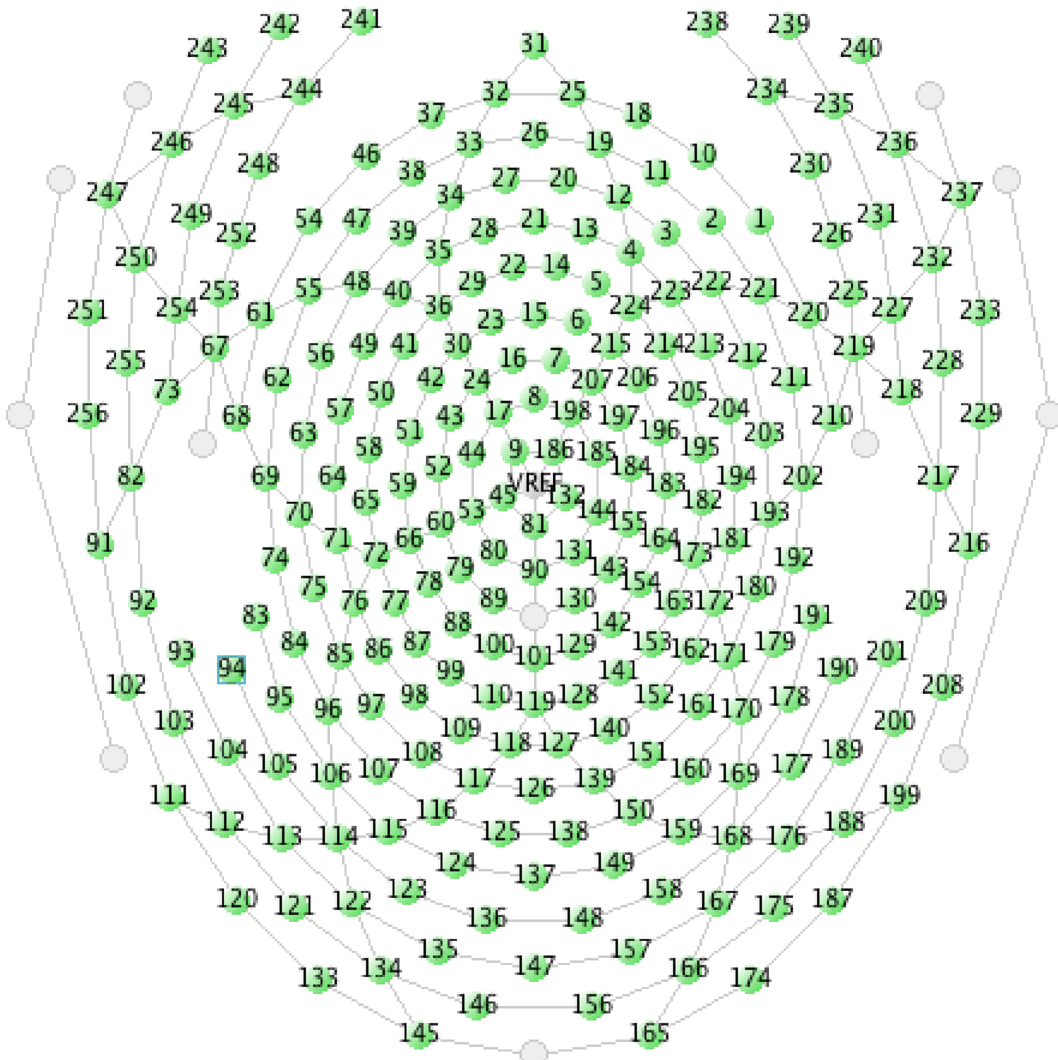


Figure C-46. Left-Mastoid Reference (256-channel HCGSN adult 1.0)

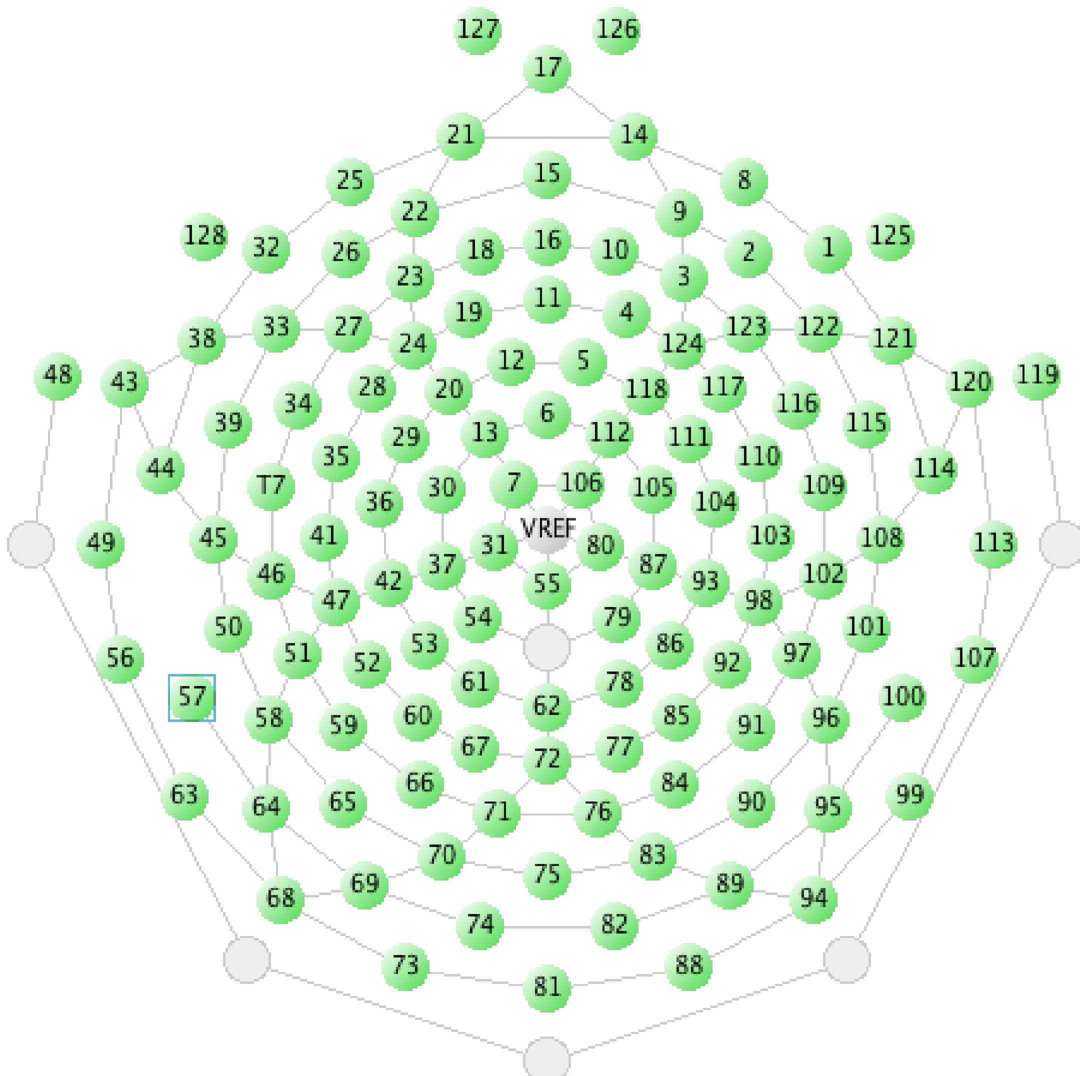


Figure C-47. Left-Mastoid Reference (128-channel HCGSN adult 1.0)

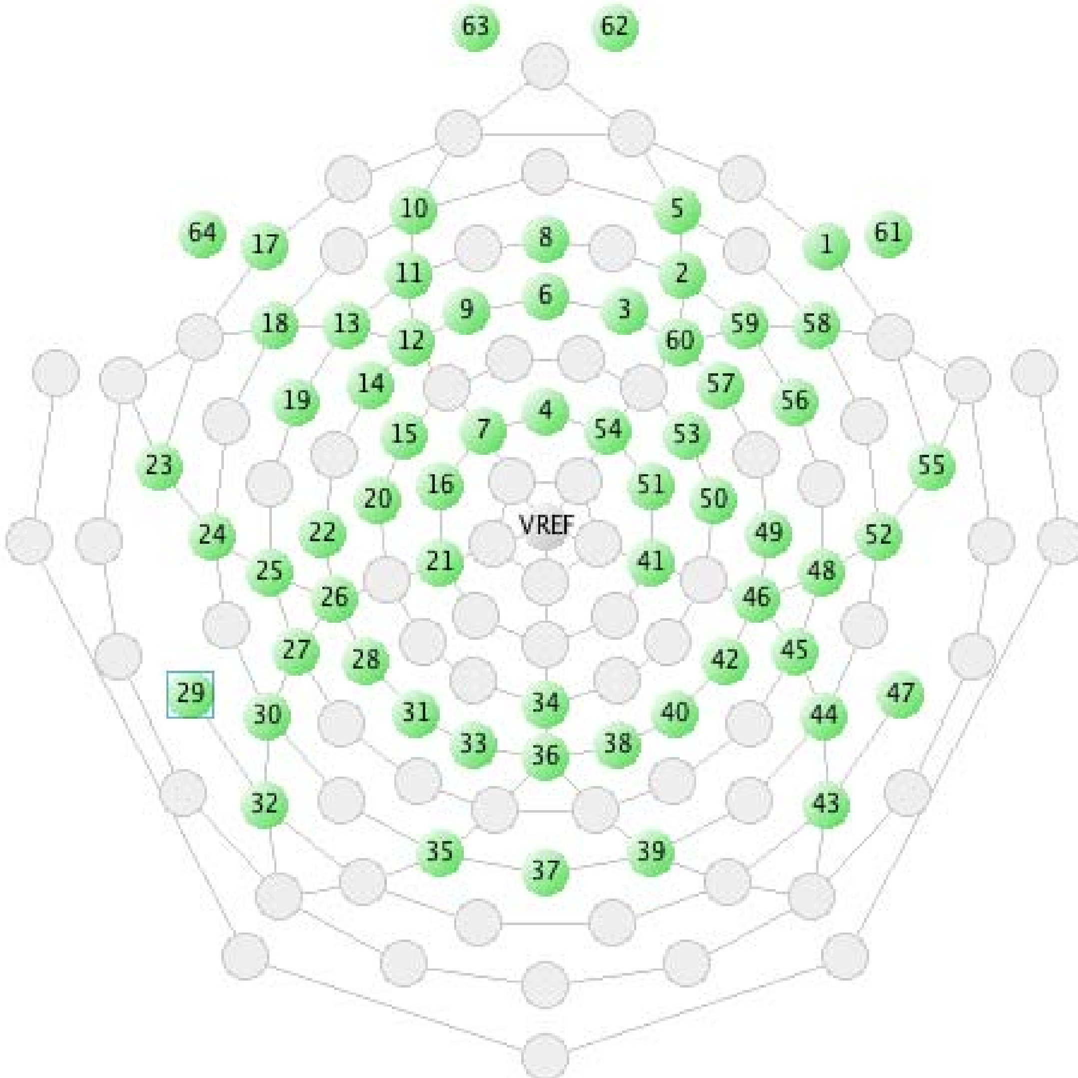


Figure C-48. Left-Mastoid Reference (64-channel HCGSN adult 1.0)

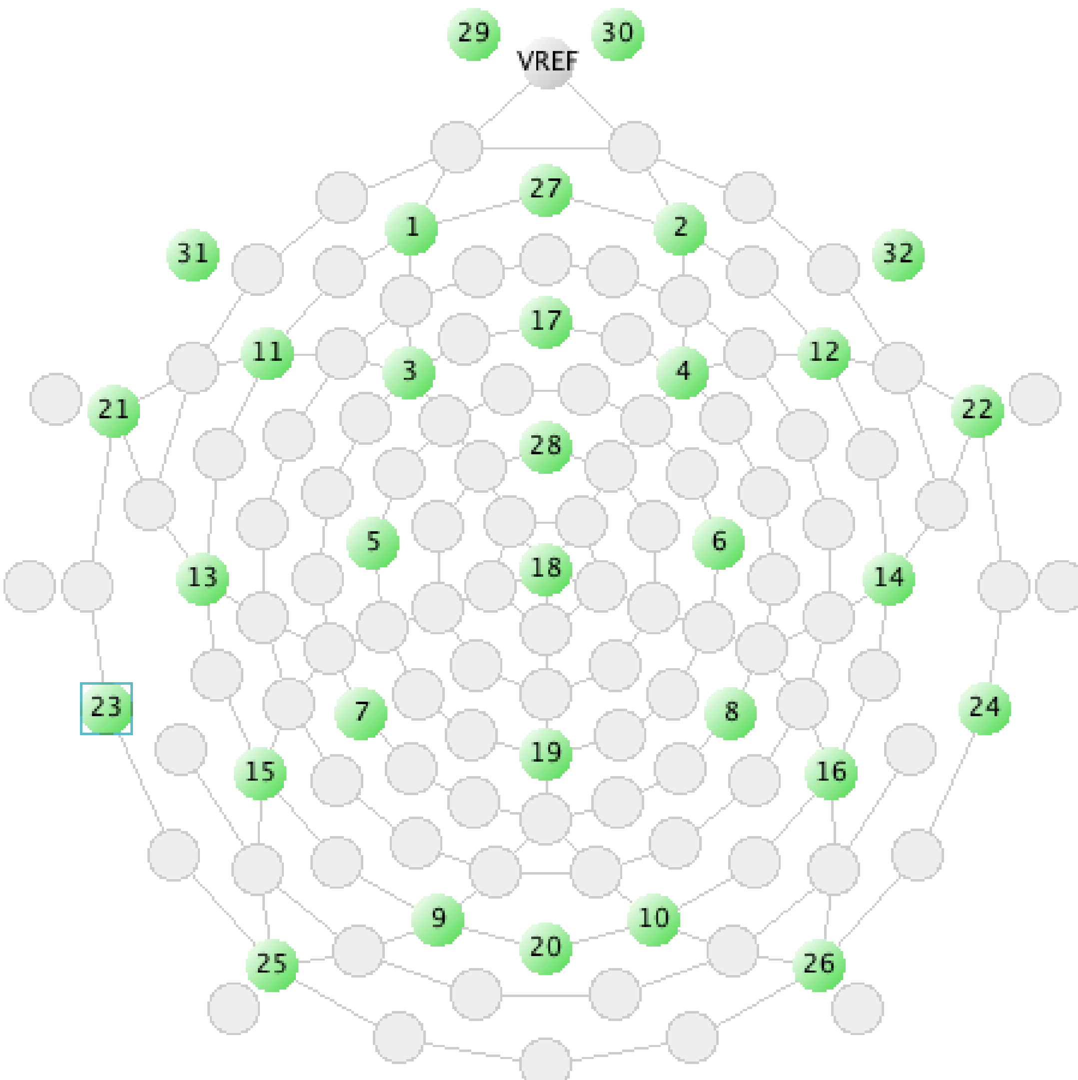


Figure C-49. Left-Mastoid Reference (32-channel HCGSN adult 1.0)

Linked-Mastoid Reference Montage

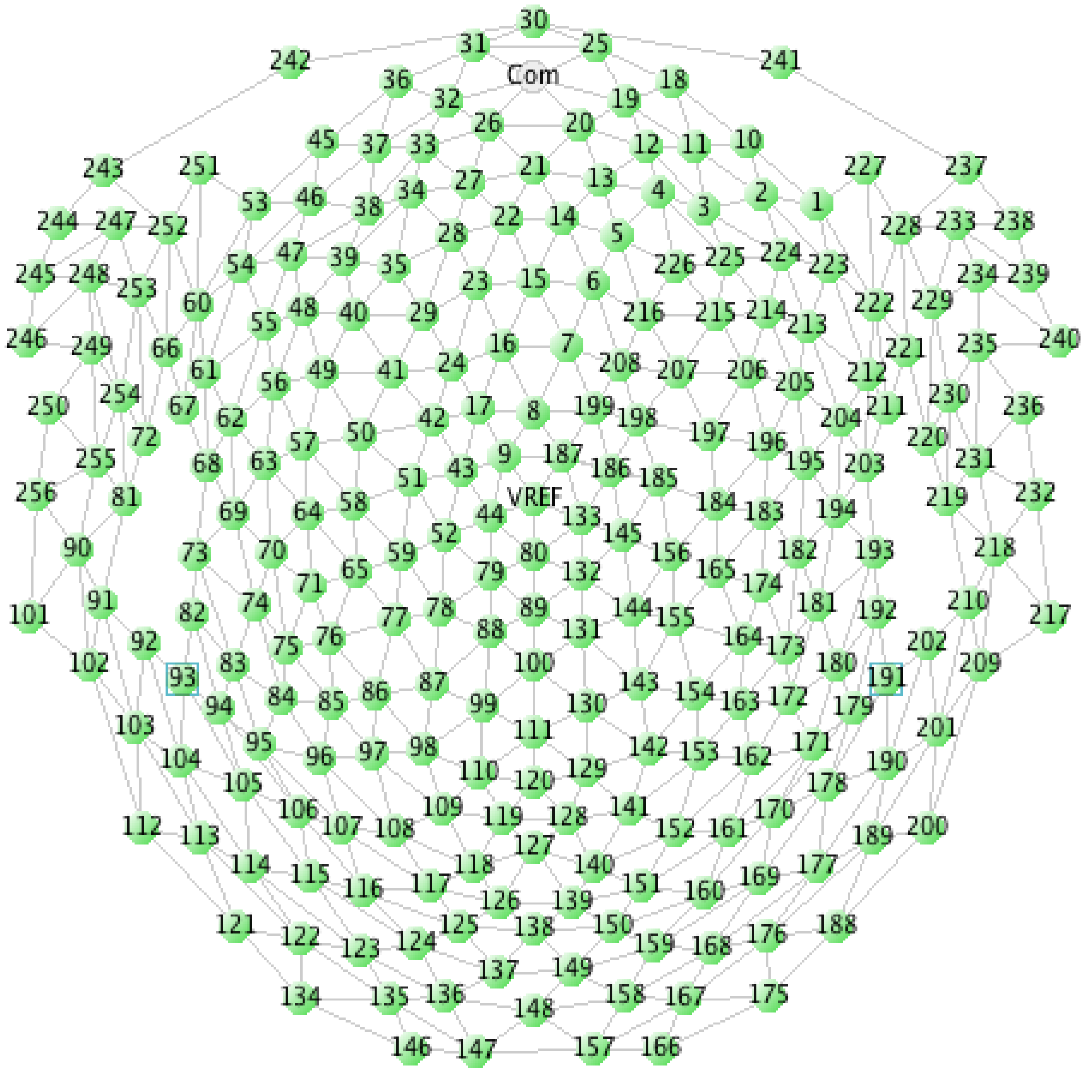


Figure C-50. Linked-Mastoid Reference (256-channel GSN 200 adult 2.1)

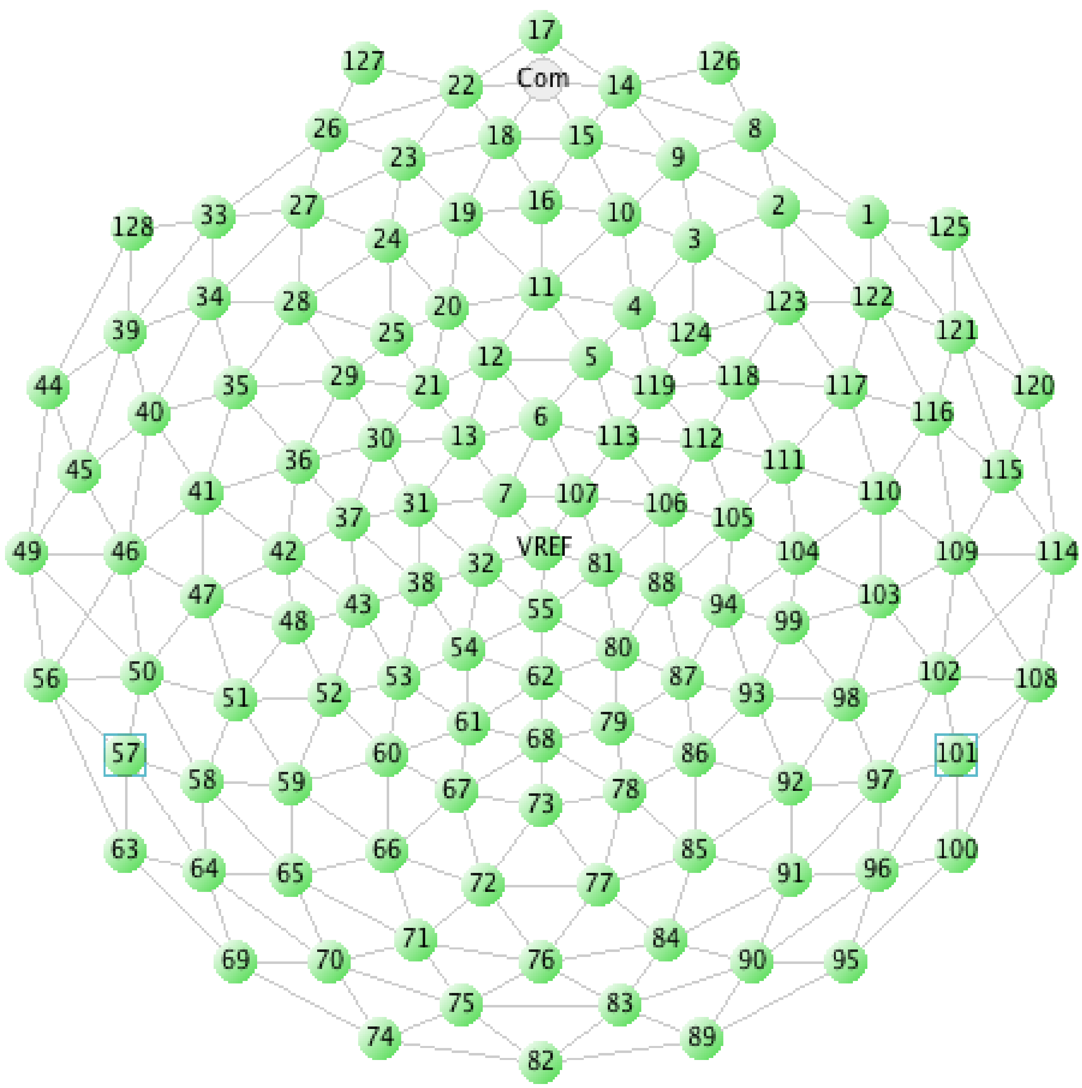


Figure C-51. Linked-Mastoid Reference (128-channel GSN 200 adult 2.1)

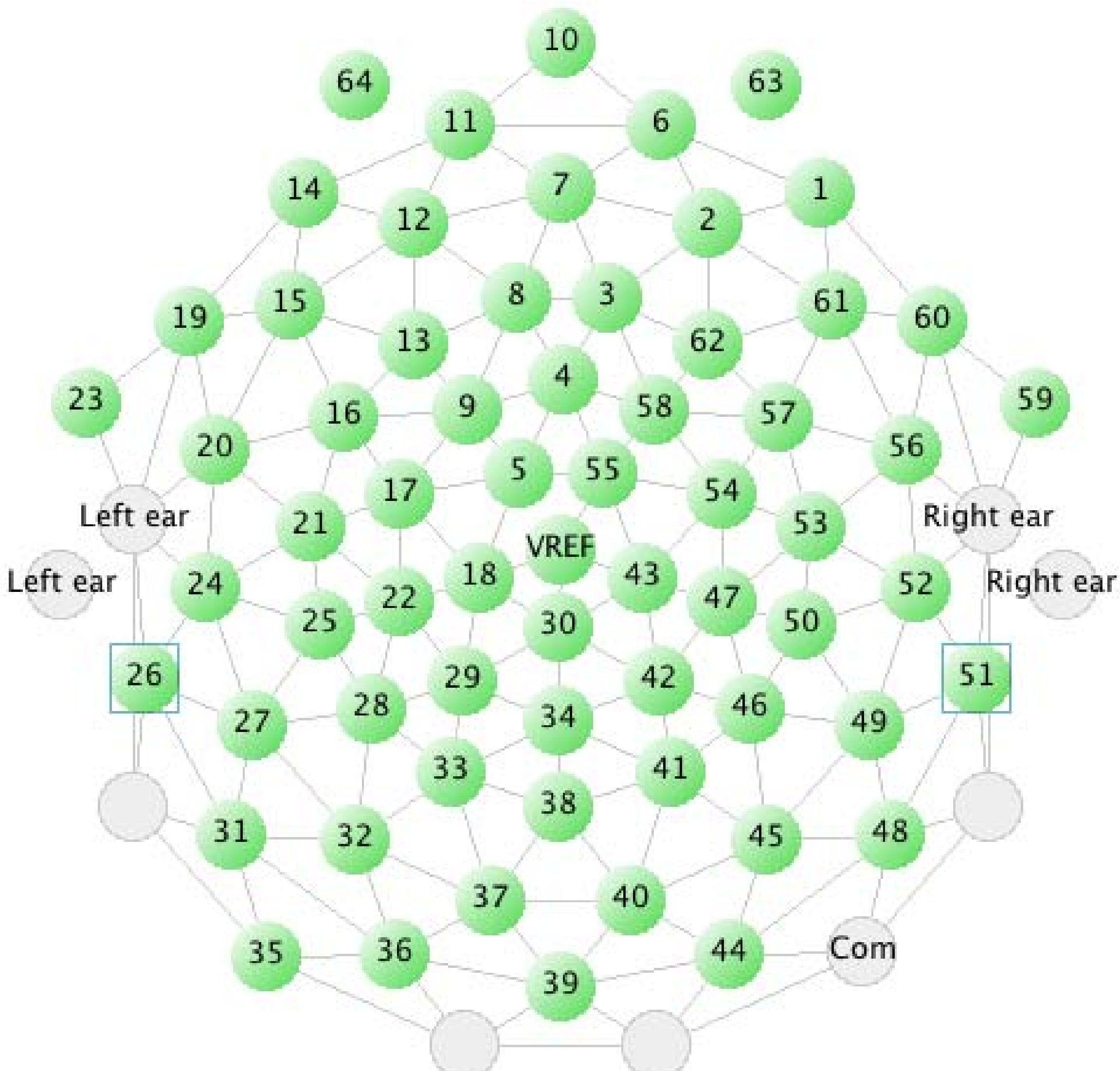


Figure C-52. Linked-Mastoid Reference (64-channel GSN 200 adult 2.0)

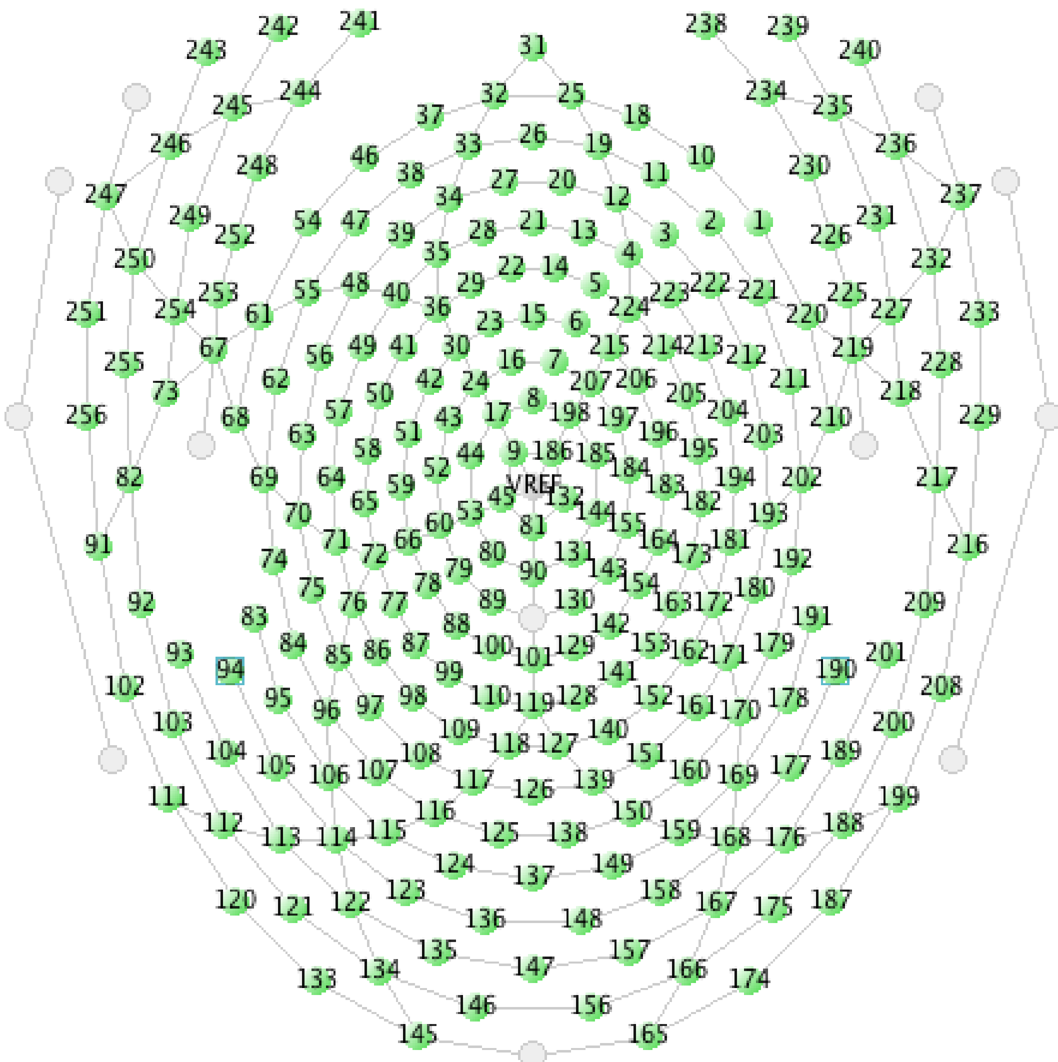


Figure C-53. Linked-Mastoid Reference (256-channel HCGSN adult 1.0)

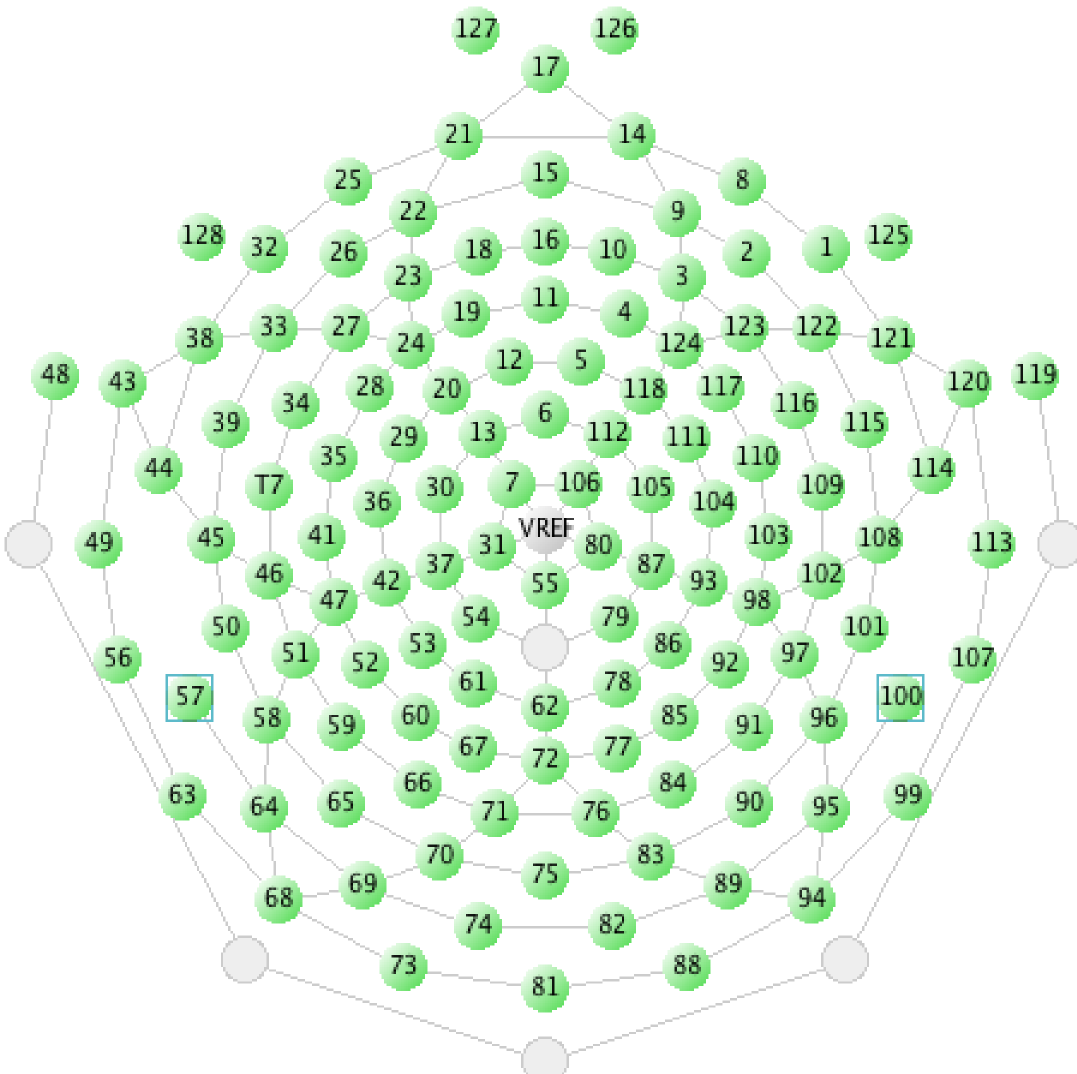


Figure C-54. Linked-Mastoid Reference (128-channel HCGSN adult 1.0)

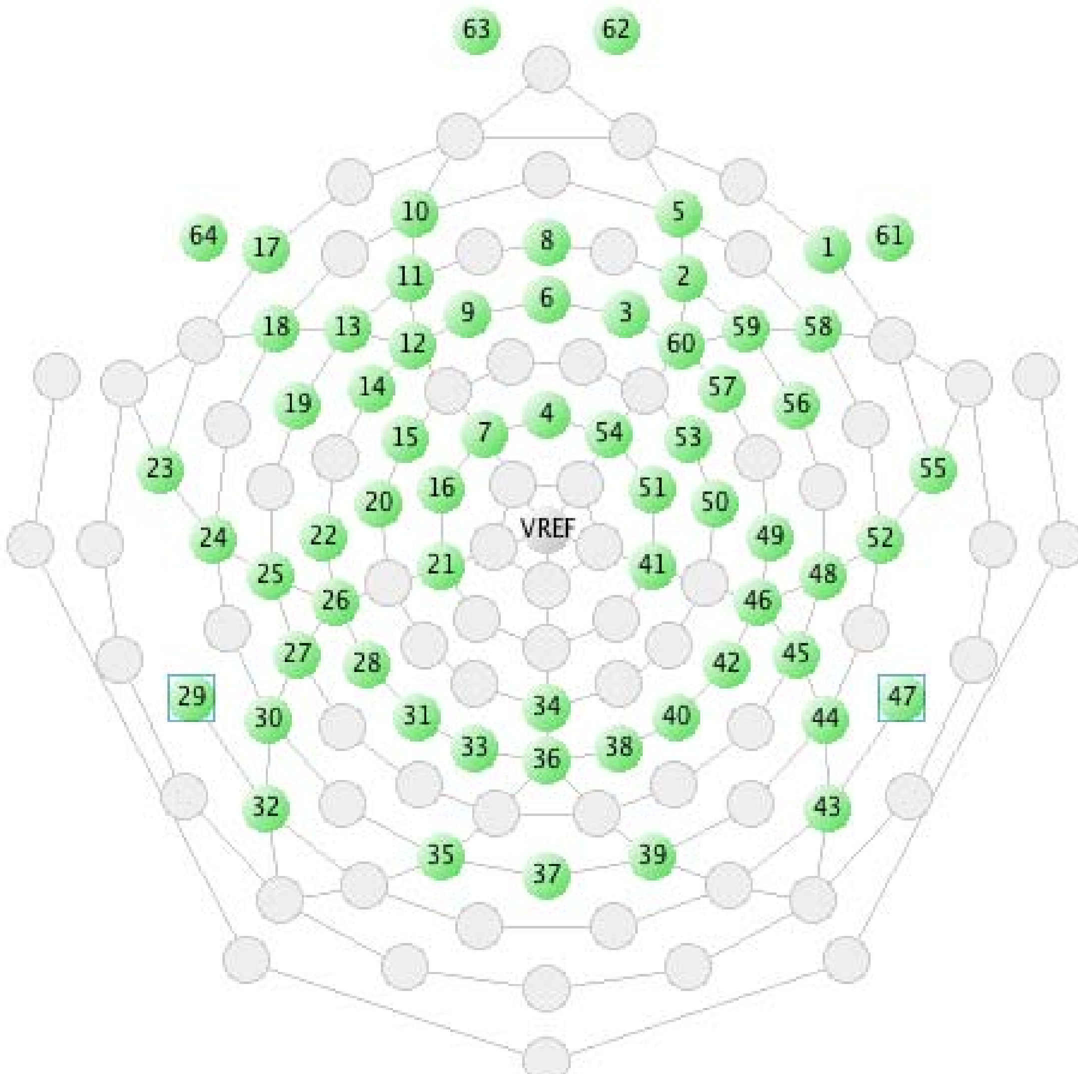


Figure C-55. Linked-Mastoid Reference (64-channel HCGSN adult 1.0)

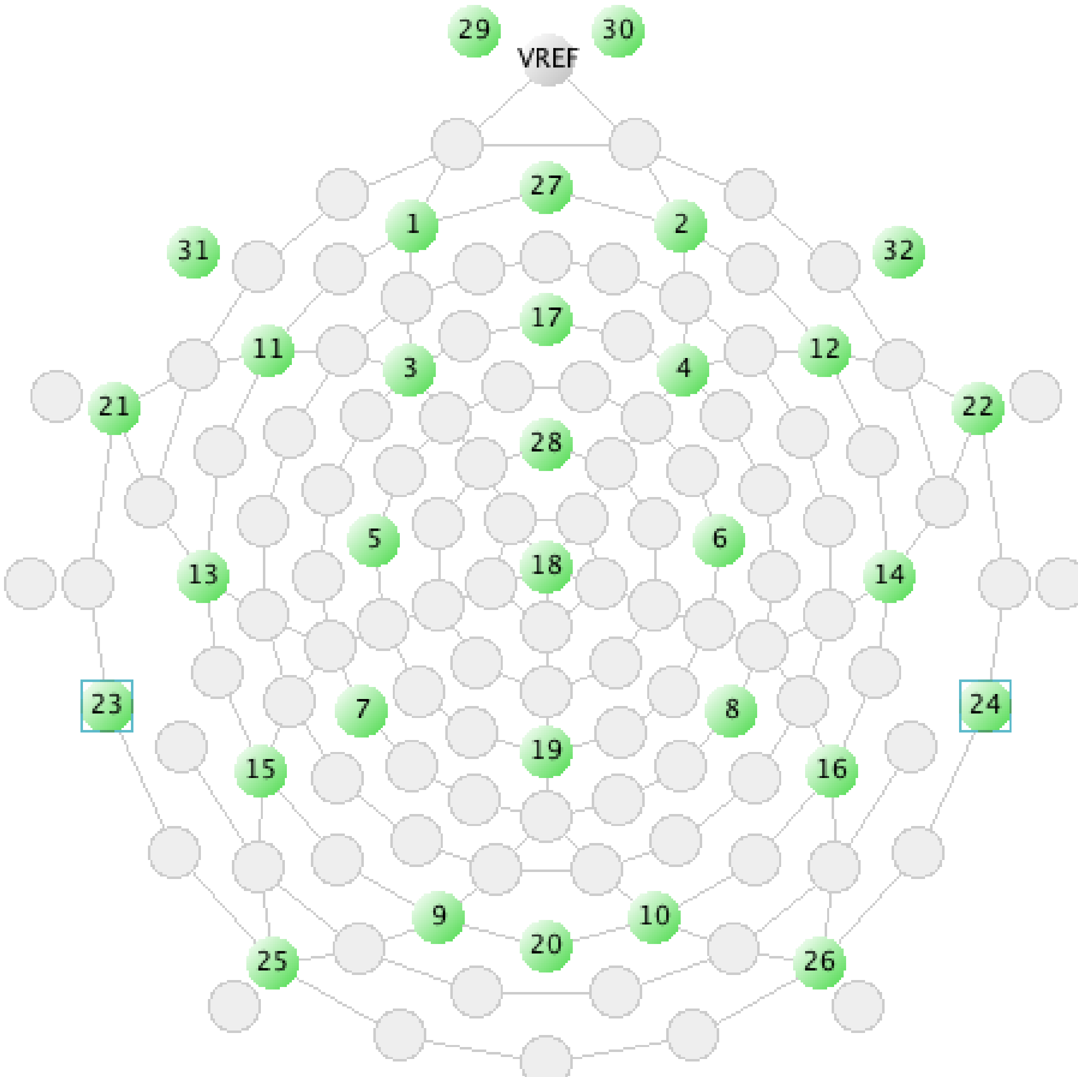


Figure C-56. Linked-Mastoid Reference (32-channel HCGSN adult 1.0)

Right-Mastoid Reference Montage

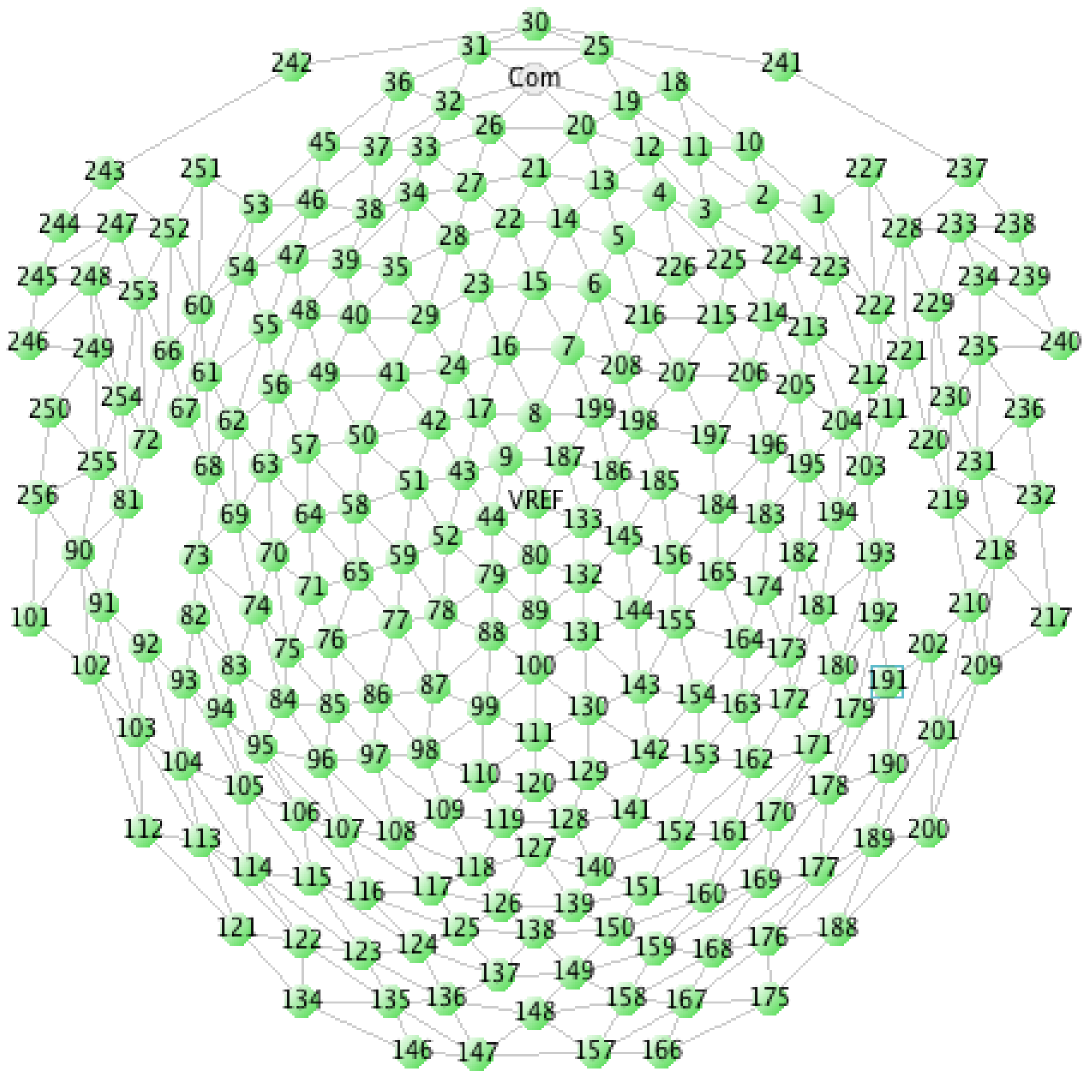


Figure C-57. Right-Mastoid Reference (256-channel GSN 200 adult 2.1)

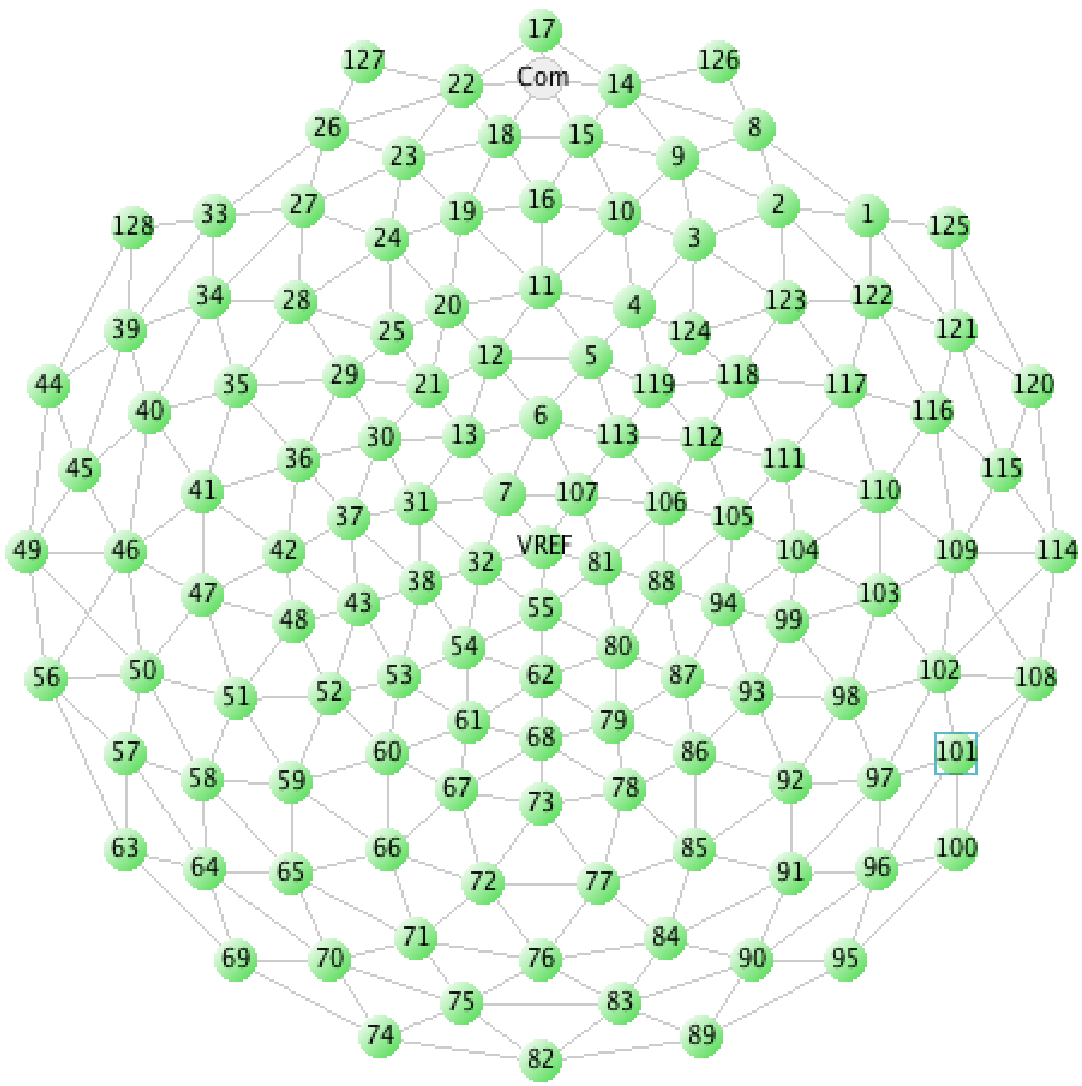


Figure C-58. Right-Mastoid Reference (128-channel GSN 200 adult 2.1)

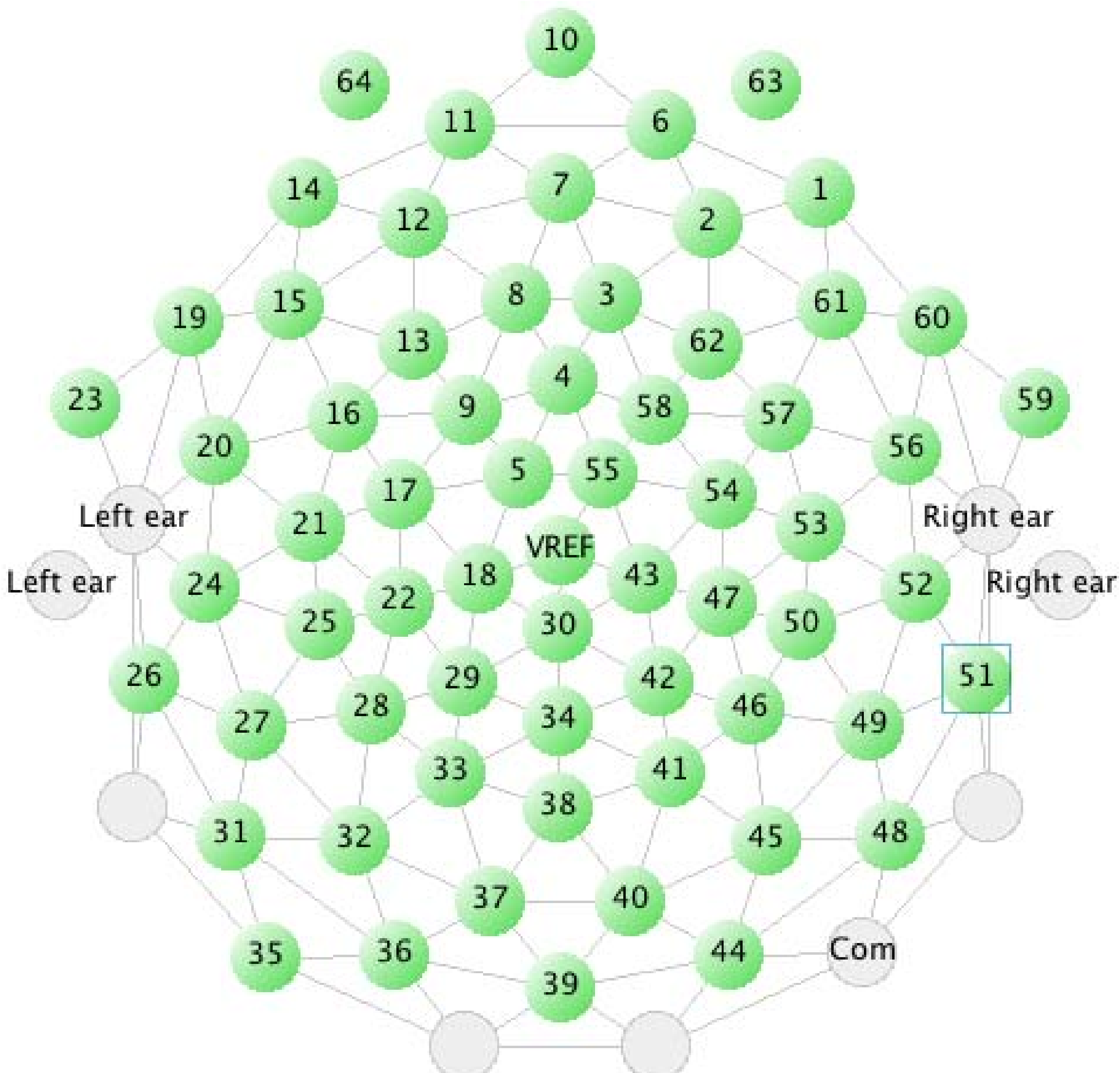


Figure C-59. Right-Mastoid Reference (64-channel GSN 200 adult 2.0)

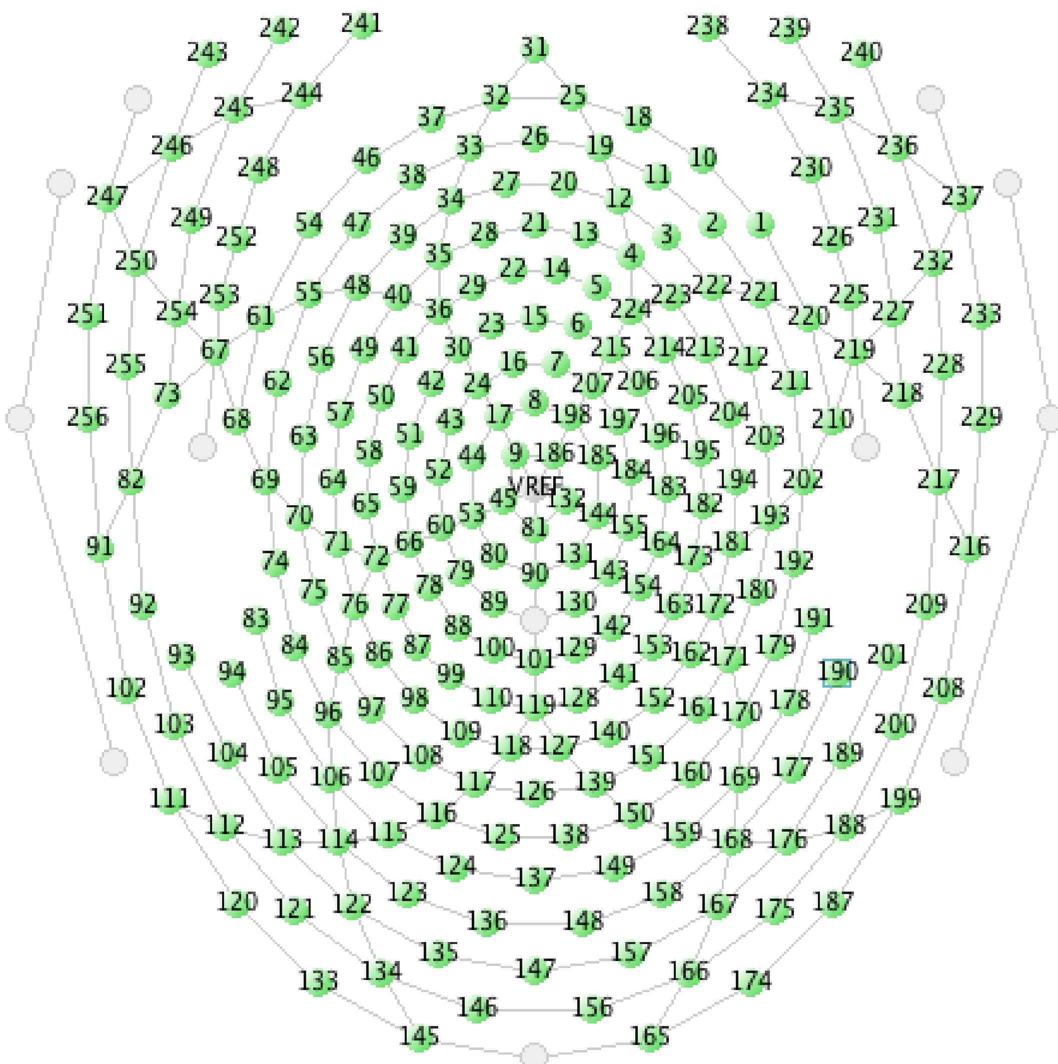


Figure C-60. Right-Mastoid Reference (256-channel HCGSN adult 1.0)

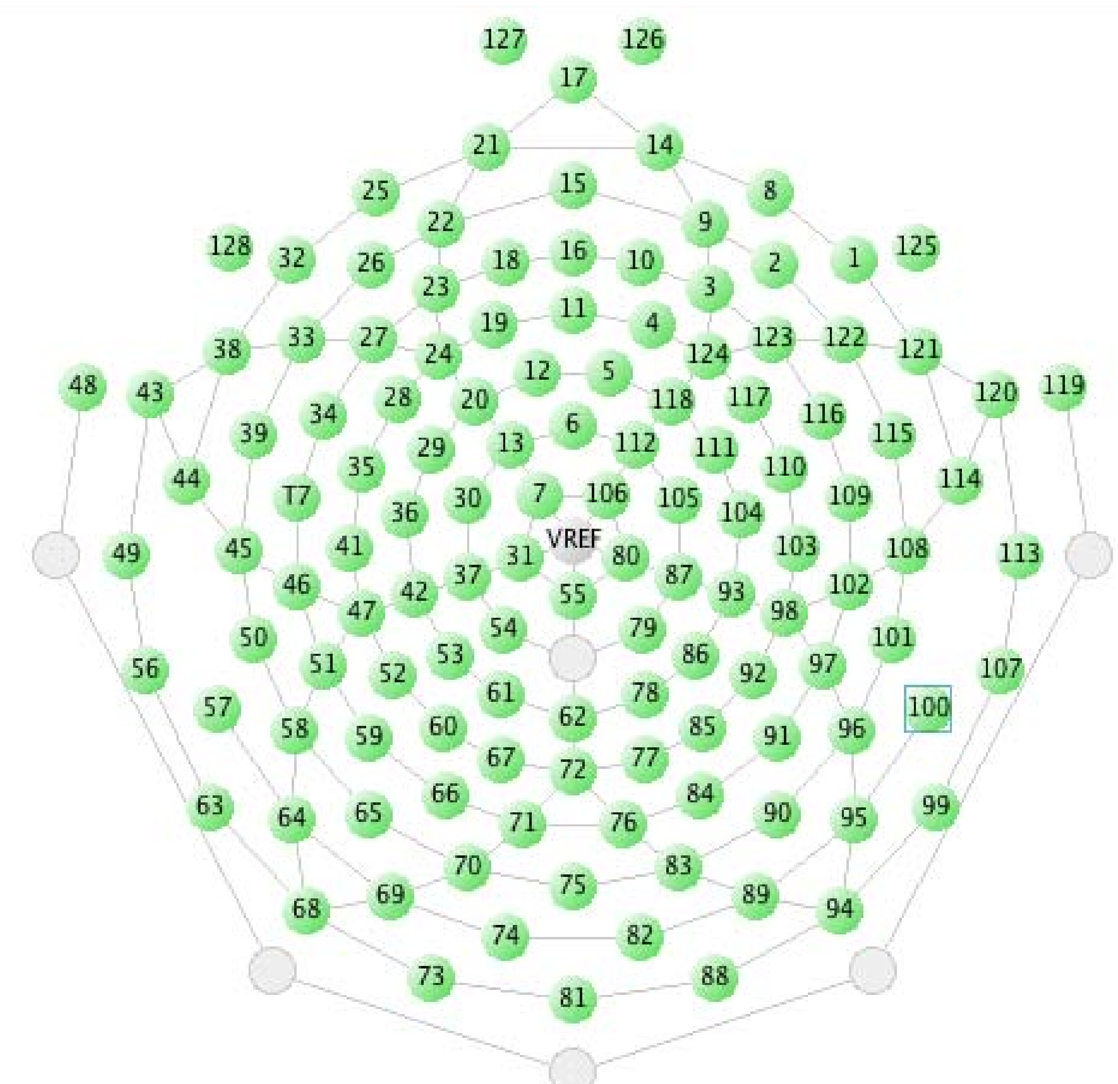


Figure C-61. Right-Mastoid Reference (128-channel HCGSN adult 1.0)

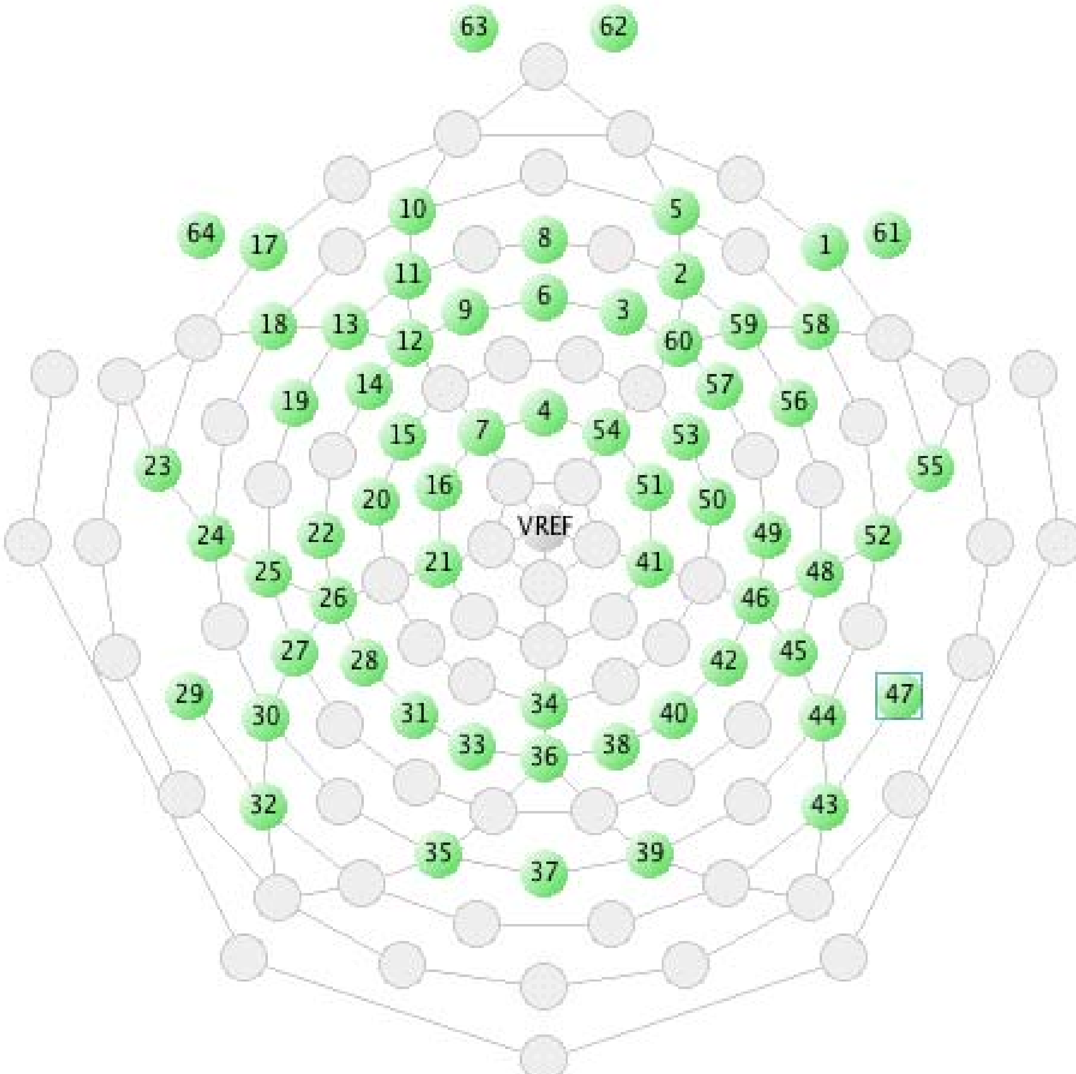


Figure C-62. Right-Mastoid Reference (64-channel HCGSN adult 1.0)

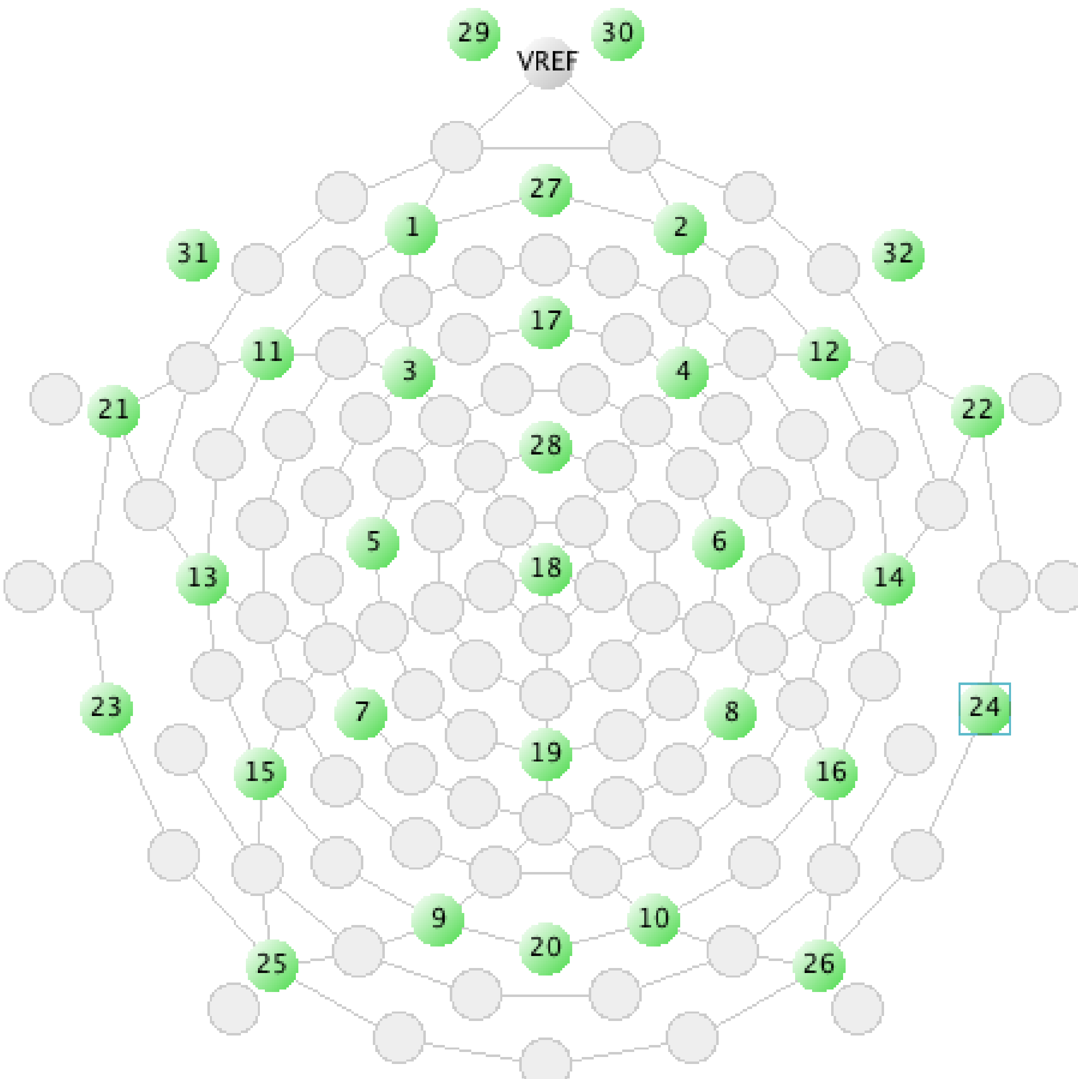


Figure C-63. Right-Mastoid Reference (32-channel HCGSN adult 1.0)

appendix D

ACQUISITION HOW-TO

This appendix provides a step-by-step guide for acquiring EEG data and events using Net Station. Use this appendix to review how to acquire data and events using EGI's Geodesic EEG System 250 and an experiment control system.

Before Acquisition

Always refer to the list to the right before your subject arrives, giving yourself enough time to procure the items you will need and have everything ready.

The System 250 components should be connected properly and Net Station should be installed on the data-acquisition computer. The experiment control computer should be running the experiment control software you have chosen, and the experiment file should be ready. Check that any cables between the data-acquisition computer and experiment control computer are securely connected.

Net application is the process of preparing electrolyte, measuring the subject's head, choosing the correct size of Geodesic Sensor Net, marking the vertex, and putting the Net on the subject. Use the EGI Net Application DVD, available from EGI Support (support@egi.com) to refresh your technique.

Acquisition List

System 250 Components:
- HydroCel GSN
- Net Amps 200
- data-acquisition computer
- articulating arm and GSN interface cable
- Net Station software

Experiment Control:
- experiment control computer
- experiment control software
- response pad (optional)

GSN Application, Rinsing, Disinfecting, and Drying:
- measuring tape
- china marker pencil
- bucket for HydroCel ES and rinse water
- bucket for disinfectant
- potassium chloride
- Johnson's baby shampoo
- warm distilled water
- clean, dry towels
- disposable plastic pipette(s)
- drying rack

Rinsing, *disinfecting*, and *drying* are performed after the Net is removed from the subject.

If you are unfamiliar with the items in the list, or need to refresh your memory, check this book, the *Net Station Acquisition Technical Manual*, and the *Geodesic Sensor Net Technical Manual* (www.egi.com/documentation.html). The manuals provide details that this "refresher" appendix excludes because of space limitations.

Note: This appendix uses the Experimental Control Template, one of the five default Session Templates included with Net Station. You will use your own template when you run your own experiment.

Acquisition Workflow

Figure D-1 illustrates the general Net Station workflow. Each step is described in detail in this section.

Net Station users can initiate EEG data acquisition using a:

- Workbench configuration (Acquisition Setup) or
- Session Template

Preconfigured templates such as the *Experimental Control Template* simplify the process of data acquisition, but achieve this in part by hiding their embedded Workbench configurations. The Workbench configuration associated with the Experimental Control Template is described in "Default

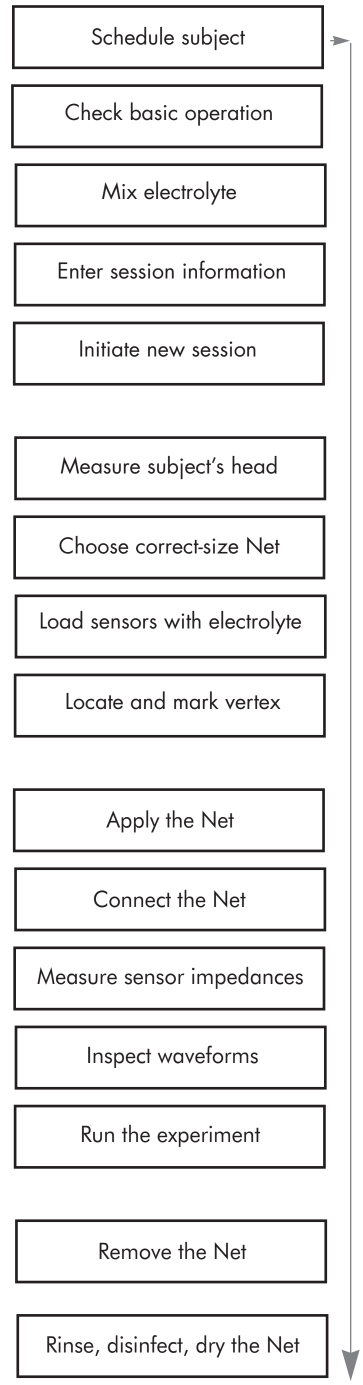


Figure D-1. Acquisition workflow

Experimental Control Setups" on page 137 for users who wish to study it, but knowledge of the configuration is not necessary for understanding the material in this appendix.

Schedule Subject

When scheduling subjects, ask them to wash their hair the day before they come to the data-acquisition session, and not to use hair-styling products. Hair should be dry for the session.

Make sure the Geodesic Sensor Nets will be dry for the upcoming session, or the sponges will not absorb the full amount of electrolyte. Have appropriate Net sizes, and extra Nets if multiple subjects are going to be run.

Check Basic Operation

Before the subject arrives, it is good to check that:

- System 250 components and experiment control computer are working properly.
- The experiment control software is sending events to Net Station.

To begin the Check of Basic Operations:

1. Open Net Station and in the Net Station start-up window, click the Session Template button in the Open section.
2. Choose Experimental Control Template and click the Select button (Figure D-2).
3. Make sure that the Geodesic Sensor Net interface cable (GSNIC) is *not* connected to the amplifier(s) during the upcoming gains and zeros measurements (calibration).

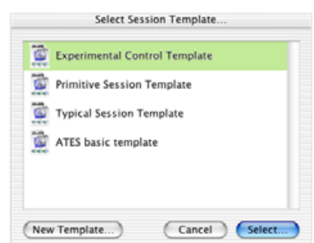


Figure D-2. Select Experimental Control Template

4. Click the Begin Session button and observe that the Ready Light illuminates on the front panel of the Net Amps. If you are setting up to collect 256-channel data, the Ready Lights of both amplifiers are illuminated.

5 At this point, amplifier calibration begins automatically, signaled by the appearance of the Measuring Zeros progress bar, followed by the Measuring Gains progress bar (Figure D-3).

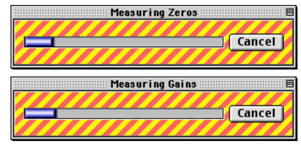


Figure D-3. Zeros and gains

6 Choose **Panels > Log: TCP/IP Port 55513** to view the Session Log, which initially will be blank.

7 Start your experiment by launching the experiment control software on the experiment control computer. Run the experiment long enough to verify that events are being logged in the Session Log window, then suspend the experiment and quit from the experiment control software (if using E-Prime, do Control-Alt-Shift on the PC keyboard).

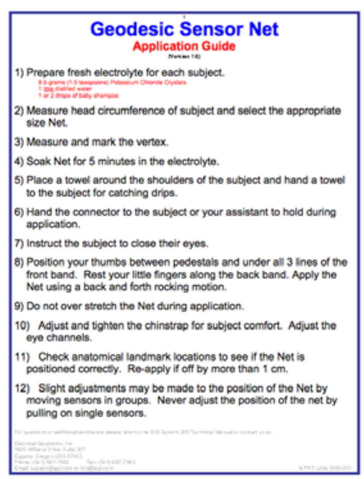
8 This completes the Check of Basic Operation. Click the Close Session button.

Prepare Electrolyte

1 Welcome your subject, describe the Geodesic Sensor Net application protocol, and explain the experiment.

2 Make the HydroCel Saline electrolyte, following the instructions on the laminated Geodesic Sensor Net Application Guide placard (Figure D-4).

Note: One (1) ***tablespoon*** *is equal to three (3)* ***teaspoons****; be careful not to confuse them.*



Geodesic Sensor Net
Application Guide

1) Prepare fresh electrolyte for each subject.
   8.5 grams (1.5 teaspoons) Potassium Chloride Crystals
   1 [illegible] distilled water
   1 or 2 drops of baby shampoo
2) Measure head circumference of subject and select the appropriate size Net.
3) Measure and mark the vertex.
4) Soak Net for 5 minutes in the electrolyte.
5) Place a towel around the shoulders of the subject and hand a towel to the subject for catching drips.
6) Hand the connector to the subject or your assistant to hold during application.
7) Instruct the subject to close their eyes.
8) Position your thumbs between pedestals and under all 3 lines of the front band. Rest your little fingers along the back band. Apply the Net using a back and forth rocking motion.
9) Do not over stretch the Net during application.
10) Adjust and tighten the chinstrap for subject comfort. Adjust the eye channels.
11) Check anatomical landmark locations to see if the Net is positioned correctly. Re-apply if off by more than 1 cm.
12) Slight adjustments may be made to the position of the Net by moving sensors in groups. Never adjust the position of the net by pulling on single sensors.

Figure D-4. Net application placard

3 Stir briefly to promote the dissolving of the potassium chloride. The ideal temperature of the electrolyte is 37 °C when you apply the Net, for the comfort of the subject.

4 Give the subject a towel to use for catching drips, and place a second towel (or two towels) over the subject's shoulders.

Enter Session Information

1 Open Net Station, if necessary, and click the Session button.

2 Choose Experimental Control Template and click the Select button.

3 Fill out the metadata fields (Figure D-5).

Figure D-5. Enter session information

Initiate New Session

1 With the GSNIC still *not* connected to the amplifier(s), click the Begin Session button and allow zero and gains measurements to proceed automatically. (You may connect the GSNIC to the amplifiers at any time *after* zeros and gains have finished.)

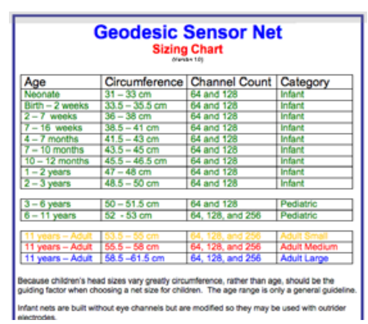
2 Begin head measurement while zeros and gains are being measured, to save time.

Measuring the Subject's Head

1 Measure the circumference of the subject's head in centimeters, using the measuring tape.

Choose Correct Size Net

1 Based on the subject's head circumference, choose a HydroCel GSN to apply to the subject's head using the laminated Geodesic Sensor Net Sizing Chart placard (Figure D-6).



Geodesic Sensor Net
Sizing Chart

Age	Circumference	Channel Count	Category
Neonate	31 – 33 cm	64 and 128	Infant
Birth – 2 weeks	33.5 – 35.5 cm	64 and 128	Infant
2 – 7 weeks	36 – 38 cm	64 and 128	Infant
7 – 16 weeks	38.5 – 41 cm	64 and 128	Infant
4 – 7 months	41.5 – 43 cm	64 and 128	Infant
7 – 10 months	43.5 – 45 cm	64 and 128	Infant
10 – 12 months	45.5 – 46.5 cm	64 and 128	Infant
1 – 2 years	47 – 48 cm	64 and 128	Infant
2 – 3 years	48.5 – 50 cm	64 and 128	Infant
3 – 6 years	50 – 51.5 cm	64 and 128	Pediatric
6 – 11 years	52 - 53 cm	64, 128, and 256	Pediatric
11 years – Adult	53.5 – 55 cm	64, 128, and 256	Adult Small
11 years – Adult	55.5 – 58 cm	64, 128, and 256	Adult Medium
11 years – Adult	58.5 –61.5 cm	64, 128, and 256	Adult Large

Because children's head sizes vary greatly circumference, rather than age, should be the guiding factor when choosing a net size for children. The age range is only a general guideline.

Infant nets are built without eye channels but are modified so they may be used with outrider electrodes.

Figure D-6. Net size placard

Load Sensors with Electrolyte; Mark Vertex

1. Dip the sensor end of the HydroCel GSN in the HydroCel Saline and soak sensors for 5 minutes.

2. Locate and mark the vertex using china marker pencil.

3. Remove the Net from electrolyte bucket and gently pat the sensors once with a clean towel to remove excess electrolyte (Figure D-7).

Figure D-7. Pat the sensors

Apply the Net

1. Give the connector to the subject or to your assistant to hold during application.

2. Place your hands gently inside the sensor array and invert the Net by stretching it slightly against the backs of your hands. Jiggle the Net so that the vertex electrode (VREF) is centered and the other electrodes are not tangled in the elastomer lines (Figure D-8).

Figure D-8. Invert the Net gently

Caution!: Do not overstretch the Net.

3. Position your fingertips along the band of the Net. With the subject's eyes close, stand in front of the subject and bring the Net down so that the vertex electrode comes down in alignment with the vertex marked on the subject's head (Figure D-9).

Figure D-9. Apply the Net on the subject's head

4 Tighten the chinstrap and adjust for subject comfort and adjust the eye channels (Figure D-10).

Figure D-10. Adjust the eye channels

5 Check anatomical landmark locations to see if the Net is positioned correctly. Reapply the Net, if the landmarks are off by more than 1 centimeter.

6 Slight adjustments may be made to the position of the Net by moving sensors in groups. ***Never adjust the position of the Net by pulling on single sensors***.

Connect the Net

1 Plug the Geodesic Sensor Net into the GSNIC and turn the locking lever on the connector to lock it in place. The GSNIC should be connected to the amplifier(s).

2 You can now measure impedances.

Note: Gains and zeros must be measured without the Net and GSNIC connected, but you already measured them.

Measure Sensor Impedances

1 Click the Measure Net Impedance button on the Net Amps Controls panel (Figure D-11), or choose **Panels > Impedance** and click the Measure button on the Impedance panel.

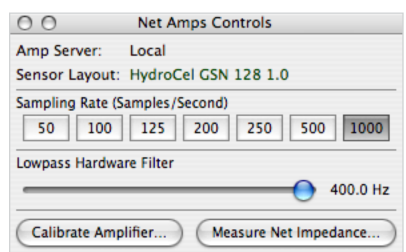


Figure D-11. Measure Net Impedance button

2 Seat each sensor on the subject's scalp by raking aside the subject's hair using the sensor, or with the help of the disposable pipette, so that the sponge makes contact with the subject's scalp. It is *very important* to push and rub the sensors strongly against the skin to get lower impedances.

3 In the Impedance Measurement window (Figure D-12), note any sensors that are not making good contact and manipulating the sensors to achieve better contact. Notice the progress bar at the bottom of the window, which begins a new scan automatically as soon as the current scan is done.

4 When impedances are satisfactory, click the Save & Close button in the Impedance Measurement window. Until you click Save & Close, impedance scanning keeps updating.

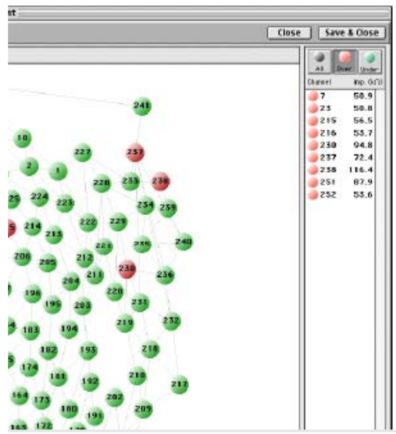


Figure D-12. Detail of the Impedance Measurement window

Caution!: *If you record EEG with the Impedance Measurement window still deployed, your EEG will be contaminated with calibration signals.*

5 Now return to the waveform display and scroll through the waveforms to look for channels that are flailing or displaying high amplitude noise because of poor contact with the scalp. Note any such sensors in a log book, to track sensor performance from session to session.

6 Adjust the eye channels, if necessary, to improve contact of sensors. Remember that Net Station's artifact detection tools use the eye channels to detect eyeblinks and eye movements.

7 If needed, add small amounts of electrolyte to sensors using a pipette. With the GSN 200, the electrolyte can be added through the small opening where the lead wire enters the pedestal (Figure D-13). It will be drawn into the sponge by capillary action. With the HCGSN, you can lift a corner of the pedestal and add electrolyte directly to the sponge.

Figure D-13. Add electrolyte through the pedestal opening

Run the Experiment

1 After making sure the subject is ready, start your experiment.

Note: For long acquisition sessions resulting in multiple files, we recommend creating a file folder for each session. This prevents the overwriting of identically named files from different sessions.

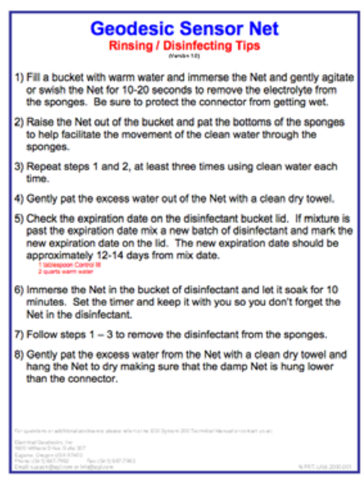
2 During the experiment, observe the waveform display to determine if any channels are displaying increasing noise levels. This indicates that during a block break it might be good to rewet some of the electrodes.

Remove the Net

1 After the experiment is finished, ask the subject to close his or her eyes while you loosen the chin strap and remove the HydroCel GSN. Check the *Geodesic Sensor Net Technical Manual* for the proper technique.

Rinse, Disinfect, Dry the Net

1 Follow the instructions on the laminated Geodesic Sensor Net Rinsing Disinfecting Tips placard that came with your system (Figure D-14).


Geodesic Sensor Net
Rinsing / Disinfecting Tips

1) Fill a bucket with warm water and immerse the Net and gently agitate or swish the Net for 10-20 seconds to remove the electrolyte from the sponges. Be sure to protect the connector from getting wet.

2) Raise the Net out of the bucket and pat the bottoms of the sponges to help facilitate the movement of the clean water through the sponges.

3) Repeat steps 1 and 2, at least three times using clean water each time.

4) Gently pat the excess water out of the Net with a clean dry towel.

5) Check the expiration date on the disinfectant bucket lid. If mixture is past the expiration date mix a new batch of disinfectant and mark the new expiration date on the lid. The new expiration date should be approximately 12-14 days from mix date.
1 tablespoon Control III
2 quarts warm water

6) Immerse the Net in the bucket of disinfectant and let it soak for 10 minutes. Set the timer and keep it with you so you don't forget the Net in the disinfectant.

7) Follow steps 1 – 3 to remove the disinfectant from the sponges.

8) Gently pat the excess water from the Net with a clean dry towel and hang the Net to dry making sure that the damp Net is hung lower than the connector.

Figure D-14. Net rinsing/ disinfecting placard

Glossary

A

Absolute Time Standard time as reckoned by the local clock in the data-acquisition computer.

Acquisition Setup file A saved Workbench configuration that preserves the control and display settings that were in effect at the time the file was saved. A setup can be multipurpose or specialized for specific acquisition needs, depending on the devices included.

A/D units The digital values reported by the Net Amps 200 and 300 amplifier after sampling and conversion of analog signals.

aliasing Distortion of the EEG signal, which occurs when the signal is digitized at a rate less than half the highest frequency present. See *Nyquist frequency*.

amp/amperage A measure of the amount of current, or number of electrons, moving across a point.

antialiasing Filtering a signal prior to digitization so that high-frequency components do not appear as false lower-frequency components. See *aliasing*.

artifact An inaccurate observation, effect, or result, especially one resulting from the technology used in scientific investigation or from experimental error.

attenuate To reduce the amplitude of an action or signal. The opposite of amplification.

autonaming A procedure used by Net Station to supply a file name automatically when the user has not specified one.

autosaving A process by which data are automatically saved to disk without requiring any action by the user.

B

bandpass filter A tuned circuit designed to pass a band of frequencies between a lower cut-off frequency (f_1) and a higher cut-off frequency (f_2). Frequencies above and below the pass band are heavily attenuated.

bandstop filter A tuned circuit designed to stop frequencies between a lower cut-off frequency (f_1) and a higher cut-off frequency (f_2) of the amplifier while passing all other frequencies.

Bessel filter An IIR filter that produces the most linear phase response of all IIR filters, with no consideration of the frequency magnitude response. Bessel filters tend to have maximally constant group delay.

C

calibration signal A signal generated internally in the Net Amps 200 and 300 for the purpose of measuring gains and impedances. This signal is a 20 Hz, 400 μV peak-to-peak sine wave.

channel Each sensor of the Geodesic Sensor Net is cabled into the Net Amps 200 and 300 amplifier where its signal is converted into a stream of digital values. Each of these streams is the data of a channel. Net Station handles channel data by storing them in track**s**, which can be recorded onto a computer disk as a file, along with event tracks containing events. In a hardware context, a channel is one of the instrumentation amplifiers inside the Net Amps 200 and 300. Channel is also the name of one of the unique combinations of bits constituting a digital input (DIN). See *DIN*.

channel gains Each amplifier channel of the Net Amps 200 and 300 has a particular gain, similar to that of the other channels but not identical. To calibrate the amplifiers for gain, the output of each channel is electronically measured while an identical calibration signal is applied to each. Recorded and stored by Net Station as A/D units, these measurements—the channel gains—provide a means for calculating a channel-specific scaling factor. The scaling factor, in turn, enables Net Station to accurately convert A/D units to microvolt data. See also *channel zeros*.

channel zeros Each amplifier channel of the Net Amps 200 and 300 has a particular response to a potential of zero volts applied to its inputs. To calibrate the amplifiers for zeros, the output of each channel is electronically measured while zero volts are applied to its inputs. Recorded and stored by Net Station as A/D units, these measurements—the channel zeros—provide a means for calculating channel-specific offset factors. The offset factors, in turn, enable Net Station to acquire microvolt data without inaccuracies from channel-by-channel variations in zero response. See also *channel gains*.

CMR See *common mode rejection*.

common An electrical point that functions in much the same way that an earth ground does, but is separated from earth ground by an isolation barrier (typically thousands of volts of isolation) in the interest of safety.

common mode rejection A measure of the attenuation of noise induced in the signal or reference lines relative to common. The ratio is typically expressed in *decibels*.

conductivity A measure of the tendency of a material to transmit electrons; the reciprocal of *impedance*.

cutoff frequency Frequency at which the power gain of an amplifier falls below 50% of maximum.

D

DAC data-acquisition computer.

dB See *decibel*.

decibel A logarithmic measure of the ratio between two values. For electrical signals, the measure is $-20 \log_{10}(A_0/A_1)$. A ratio of 1/1000, for example, corresponds to –60 dB.

dense (sensor) array Any (sensor) system that supports sufficient number of sensors to spatially sample a phenomenon adequately. For EEG recording, this generally means 64 channels or more.

deploy A term referring to when an interface panel that is initially not visible on the screen is brought into view by using a button or menu command.

device See *Net Station device*.

digital filter A computational process, or algorithm, transforming a discrete sequence of numbers (the input) into another discrete sequence of numbers (the output) having a modified frequency domain spectrum. Digital filtering can be in the form of a software routine operating on data stored in computer memory or can be implemented with dedicated digital hardware.

digital input See *DIN*.

digitization The process of putting data into digital form.

DIN A Net Amps digital input, or an event caused by a state change on one or more of the eight digital inputs on the back panel of the Net Amps 200 and 300 amplifier.

drift The change in a signal's offset over time, or the amount by which a signal's offset changes with time.

DWD Dense Waveform Display.

E

ECI See *Experimental Control Interface*.

EEG electroencephalography. The science of graphically recording the electrical activity of the brain as recorded by an electroencephalograph.

electrostatic discharge The transfer of an electrostatic charge between bodies at different electrostatic potentials (voltages), caused by direct contact or induced by an electrostatic field.

elliptical filter An IIR filter that produces the sharpest rolloff for a given number of filter taps. Elliptical filters have the poorest phase linearity of the most common IIR filter design functions. The ripple in the passband and stopband are equal with elliptic filters.

epoch When the Net Station Workbench is turned on and records EEG data, then is turned off, the EEG that has been recorded corresponds to a single epoch. Each time this occurs, a new epoch is generated. More generally, an epoch is any stretch of uninterrupted EEG or time.

Epoch Time One of the four time modes used by Net Station. Epoch Time is set to zero at the beginning of every recording epoch, and epochs are numbered starting with 1. See *Absolute Time*, *Recording Time*, and *Relative Time*.

ERP See *event-related potential*.

ESD See *electrostatic discharge*.

event A marker indicating a point of interest in an EEG recording.

event-related potential An EEG waveform elicited by a stimulus such as an auditory or visual event.

event track In Net Station, an event track is a container for events. Net Station displays event tracks and their constituent events in its waveform viewer in the form of "flags."

Experimental Control Interface Built into Net Station is a protocol for experimental control technology that uses the Experimental Control Interface device along with a messaging system.

F

filter length Refers to the number of impulse response coefficients used to approximate the corresponding FIR filter.

filter order Refers to the order of the highest-order term in the polynomial used to approximate the corresponding IIR filter.

Finder On Macintosh computers, the Finder is the program that keeps track of files and folders and displays the desktop (the working area on the screen with disk icons, a Trash icon, and so on).

FIR filter finite impulse response filter. An FIR filter calculates current output solely from the current and previous input values. This defines a class of digital filters that has only zeros on the z-plane. The key implications of this are that FIR filters are always stable and have linear phase responses (as long as the filter's coefficients are symmetrical). For a given filter order, FIR filters have a much more gradual transition region rolloff than digital IIR filters.

FireWire Apple Computer's name for the IEEE 1394 High Speed Serial Bus. It was developed by the IEEE P1394 Working Group, which consisted of members from Apple, Texas Instruments, Sony, Digital Equipment Corporation, IBM, and SGS Thomson, among others. FireWire is commonly used for connection of data storage devices and digital video cameras, and is also popular in industrial systems for machine vision and professional audio systems. It is often used in place of a USB connection because it offers faster speed and higher power-distribution capabilities, and does not require a computer host.

G

gain The amount by which a signal is amplified. A gain of 100 increases signal amplitude by 100 times.

Geodesic Sensor Net Electrical Geodesics' dense sensor array.

H

Hertz Cycles per second. Something that occurs with a frequency of 10 Hertz happens 10 times each second. Abbreviated Hz.

highpass filter A tuned circuit designed to pass all frequencies above a designated cut-off frequency. Frequencies below the cut-off frequency are rejected or attenuated.

histogram A bar graph of a frequency distribution in which the widths of the bars are proportional to the classes into which the variable has been divided and the heights of the bars are proportional to the class frequencies.

HydroCel Geodesic Sensor Net® EGI's third-generation of Geodesic Sensor Net, featuring die-cut geodesic structure, carbon-fiber electrodes with HydroCel CleanLeads® technology to minimize noise, low-profile design, and HydroCel Hydrating Skin Interface Chamber®. Commonly called the *HCGSN*. See the *Geodesic Sensor Net Technical Manual* for more information.

I

iconize In graphical user interface terms, a way to maximize screen space by reversibly causing a window to shrink down to a token that is much smaller than the window.

IIR filter infinite impulse response filter. A class of digital filters that may have both zeros and poles on the z-plane. As such, IIR filters are not guaranteed to be stable and almost always have nonlinear phase responses. For a given filter order (number of IIR feedback taps), IIR filters have a much steeper transition region rolloff than FIR filters.

impedance The alternating current equivalent of resistance, impedance is the measurement of the resistance to the flow of electricity for a particular substance. Electrode/scalp impedances affect waveform susceptibility to environmental noise.

IMR See *isolation mode rejection*.

interface cable The cable connecting the Geodesic Sensor Net to the Net Amps. The interface cable connectors are Hypertronics connectors. This cable is also known as the *Geodesic Sensor Net Interface Cable*.

isolated common See *common*.

isolation mode rejection A measure of the attenuation of ambient electrical noise common to all electrodes and common in relation to mains supply ground.

J

jack Socket or connector into which a plug may be inserted.

L

lowpass filter A tuned circuit designed to pass all frequencies below a designated cut-off frequency.

M

magnitude response The amount a filter attenuates the amplitude of each frequency component.

metadata Data about data. Examples include the name of the subject of an EEG data-acquisition session, the date of the session, the number of epochs. See *metadata field* for how Net Station keeps track of the metadata associated with an EEG Session file.

metadata field The metadata connected with a Net Station file, also called the Session information, are stored in components called *fields*. A field has a label that identifies what kind of data it holds.

montage One of several methods of combining, selecting, or arranging data from multiple sensor locations, or the result of defining one of such methods. On a given montage, a combined waveform is a derivative of the waveforms at the sensors chosen to be combined. A selection of sensors results in the display of a subset of all the sensors originally used to make a recording.

MRI Magnetic Resonance Imaging uses computer imaging of atomic response to radio waves in a magnetic field to generate imagery of tissue.

N

Net Amps 200 and 300 Electrical Geodesics' dense-array amplifiers.

Net Station Electrical Geodesics' data-acquisition software.

Net Station device A software module used in a Workbench configuration that can be saved as an Acquisition Setup file. Each device can perform a task or a closely related set of tasks. Acquisition Setups are built from devices assembled and connected together on the Workbench.

Neurotravel amplifier EGI's 32-channel clinical amplifier.

noise Unwanted electromagnetic radiation within an electrical or mechanical system.

notch filter A filter which blocks a narrow band of frequencies and passes all frequencies above and below the band.

Nyquist frequency The maximum frequency able to be characterized for a given sampling rate. The Nyquist frequency is typically taken to be 2/5 of the sampling rate, for engineering purposes. See also *antialiasing*.

O

offset With reference to waveforms, offset is a DC deviation or the amount of DC deviation from zero.

P

packetization The process of bundling information into data structures that can be sent from one hardware device to another.

passband For a filter, refers to the range of frequencies the filter will not attenuate.

passband gain For a filter, refers to the amount of a signal that is retained in the passband. For example, a passband gain of 0.1 dB would result in approximately 98.86% of the signal being retained. A passband gain of 1 dB would result in approximately 89.13% of the signal being retained.

pixel A single picture element. A pixel is a point in 2D with a single color value. The number of pixels visible on a monitor is controlled by the monitor's resolution setting.

plug Movable connector that is normally connected into a socket or jack.

port A site for passing data in and out of a computer.

R

Recording Time One of four time modes used by Net Station. Time relative to the beginning of a Net Station Session. See *Absolute Time*, *Epoch Time*, and *Relative Time*.

reference An electrical point that is treated as zero for purposes of amplifying electrical signals. The Geodesic Sensor Net has a reference electrode located at the vertex.

refresh rate The frequency, expressed in Hertz, with which each pixel on a particular monitor is updated with new information.

Relative Time One of the four Net Station time modes. Relative Time is the amount of time since the Workbench was turned on. With a session, the time since the session began. See *Absolute Time*, *Epoch Time*, and *Recording Time*.

rolloff A term used to describe the steepness, or slope, of the filter response in the transition region from the passband to the stopband.

S

sample When a continuous signal is measured by examining it at discrete moments in time, each measurement corresponds to a sample.

sampling rate The number of times per second that data are temporally sampled.

scaling factor To convert an A/D unit into its corresponding μV value, a channel-specific scaling factor is applied in the following manner: sample value in μV = (A/D Unit – channel zero) x (cal signal amplitude) / channel gain.

segment A discrete portion of EEG, especially as a product of segmentation.

sensor A device that picks up a signal being generated by something in the real world.

sensor layout Descriptive information for a particular quantity and arrangement of sensors. Includes 2D and/or 3D coordinates specifying the locations of sensors, labels (names) of sensors, and connectivity. Such information is stored in a sensor layout file.

session In Net Station, an EEG recording requiring the use of a Session Template.

session information See *metadata*.

signal A detectable, measurable quantity that can be expected to display periodicity or other forms of variation in time.

spatial sampling The process of sampling a 3D space at regular locations in a given instant of time. Compare with *temporal sampling*.

stopband Refers to the frequency range in which a signal is to be attenuated.

stopband gain For a filter, refers to the amount of the signal that is attenuated in the stopband. For example, a stopband gain of 40 dB would result in 99% of the signal being attenuated. A stopband gain of 20 dB would result in 90% of the signal being attenuated.

T

temporal sampling The process of sampling a given location at regular intervals in time. Compare with *spatial sampling*.

time base The fundamental unit of Net Station time; everything occurs in multiples of this unit. Net Station uses a millisecond time base.

toggle Each time a button is clicked, it changes the state of what it is controlling to one of two possible states and is said to toggle between the states.

track A container used to hold and separate data types (for example, EEG and events).

transition band Refers to the frequency range in which a filter is transitioning from retaining the signal to attenuating it. Typically measured in Hertz. For example, we might refer to a transition band from 10–11 Hz.

U

USB Universal Serial Bus.

V

vertex The point on an EEG subject's scalp that is closest to the top of the head. In the International 10-20 system, Cz is the vertex electrode. In the Adult 128 GSN, electrode #129 is the vertex. The point on the scalp or skull located midway between the nasion and inion and centered between the preauricular points. Also the name of the Geodesic Sensor Net sensor that corresponds to this location and that contains the reference electrode.

volt/voltage A measure of electrical force, or the tendency for electrons to move from one location to another. Voltages are measured with respect to a reference.

W

waveform Any graphical representation of a signal.

WFR Waveform Recorder device.

Workbench The Net Station equivalent of an electronics laboratory. On the Workbench, modular device are connected by data cables into Workbench configurations of differing functionality. See *Acquisition Setup file*.

Workbench Time Synonym for *Relative Time* when using the Workbench.

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