Installation and Orientation 4.5

The Neuroscan Systems

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SCAN 4.5 - Vol. I

Installation and Orientation: The Neuroscan Systems

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1.1 Contact Information

For Technical Support...

If you have any questions or problems, please contact Technical Support through any of the following routes.

If you live outside the USA or Canada, and purchased your system through one of our international distributors, please contact the **distributor** first, especially if your system is under warranty.

In all other cases, please use **techsup@neuroscan.com**, or see the other Support options on our web site (*http://www.neuroscan.com*).

Or, if you live in the USA or Canada, please call **1-877-717-3975**. International callers should use **1-704-749-3200**.

For Sales related questions, please contact your local distributor, or contact us at **sales@neuroscan.com**.

Note
The e-mail addresses for Neuroscan Sales and Technical Support have changed. Please use sales@neuroscan.com and techsup@neuroscan.com for e-mail, rather than neuro.com.

1.2 The Neuroscan Systems

The Neuroscan Systems

Roadmap for New Users

Where do I begin? Users new to the family of Neuroscan products may be overwhelmed by the sheer volume of functionality and the supporting documentation. The guide below was developed to help you locate the various places in the documentation that are useful for introducing new users to the various SCAN programs. These are the introductory sections or tutorials; the complete details are found in the various user manuals.

Initial Introduction to SCAN and Stim^2

The best initial introduction the SCAN and Stim^2 systems is in the "Getting Started" and "Example of a Simple Paradigm" sections below. These were designed to illustrate how to create and present stimuli from Stim^2, configure ACQUIRE for acquisition, and perform some of the analysis options.

More Detailed Introduction to Acquisition and Analysis

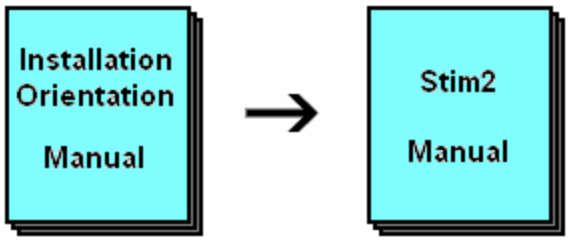
The SCAN Tutorials manual explains in more detail, through several examples, how to configure ACQUIRE for various types of acquisition and paradigms. Demo data files are supplied that are similar to what would have been created, had you actually acquired the data. Then most of the examples have more demonstrations of analysis techniques.

Acquisition

Analysis

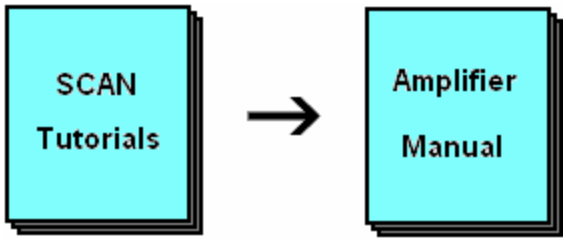
More Detailed Introduction to Stim^2

After the initial introduction found in the two sections mentioned above, there are more Stim^2 examples in the "Quick Introduction" section in the Stim^2 user manual. Additionally, most of the Stim^2 modules have demo setup files that let you see how the modules function.



Introduction to Amplifier Configuration

The *SynAmps*, *SynAmps*^{2}, *SynAmps RT*, *SynAmps Wireless*, and *NuAmps* amplifiers are software configured. The SCAN Tutorials manual describes much of the general configuration options. Those that are specific to each amplifier are otherwise described in the respective amplifier manuals.



Introduction to 3DSpaceDx

The 3DSpaceDx program is used primarily for digitizing the electrode positions and functional landmarks. These are used in PCA/ICA analyses, and in source reconstruction (SOURCE and CURRY). There are tutorials at the beginning of the 3DSpaceDx manual that guide you through its basic operation. Examples for using the output electrode and landmark position files are found in the PCA/ICA (Toolbox manual), SOURCE, and CURRY manuals.

Introduction to the Waveboard

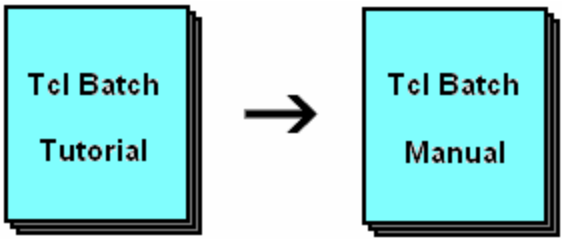
The Waveboard is an ancillary program to SCAN for displaying waveform data in ways not possible within SCAN. There is a Waveboard Tutorial at the beginning of the Waveboard manual. The Waveboard manual is Appendix A in the EDIT manual.

Introduction to Linear Derivation Files (LDR files)

As you go through the SCAN programs and documentation, you will encounter Linear Derivation, or LDR files. These are simple matrix files that are used to modify your data files in several ways. LDR files can be created and modified in the Montage Editor. Much of the Montage Editor manual is devoted to LDR files, including a general introduction. The Montage Editor document is found at the end of the EDIT manual (Appendix B).

Introduction to Batch Processing

Batch files are used primarily to automate the offline analyses, but may be used online as well to control acquisition. These are program files you create (they are largely created for you) using the Tcl Batch Editor. See the Tcl Batch Tutorial for an initial introduction (exists as a .pdf file only in the ...*Scan4.5**Pdf* folder). More detailed examples are presented throughout the Tcl Batch manual. If you install the Demo Data (option during the SCAN software installation), you will also find numerous sample batch files in the *...\Scan Data\Batch Examples* folder.

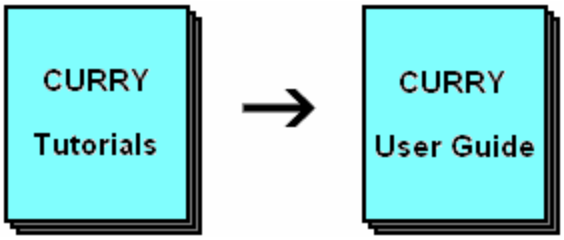


Introduction to Source Localization Using SOURCE

There are two versions of SOURCE. The first (V2) is contained within SCAN, and the second (V5) is a stand-alone program. In SOURCE V2, there is a "Quick Introduction to SOURCE" section in the user manual, followed by several example data sets. In SOURCE V5, there is a "SOURCE Tutorial" section, followed by several examples.

Introduction to Source Localization Using CURRY

There are two manuals for CURRY. The first covers the installation, and the remainder of the document contains the CURRY Tutorials. This is the document you should go through first before trying to use CURRY. Complete details are in the CURRY User Guide.



Additional Documentation

Toolbox. The Toolbox is a collection of add-in programs for SCAN (online and offline). These include online and offline Blink Reduction, offline EKG Noise Reduction, Principle and Independent Component Analyses (PCA/ICA), exporting files to Excel, and interfacing with MATLAB. The Toolbox manual details all of the Toolbox features.

MagLink RT. The MagLink RT System is used to record and analyze EEG from within the MR chamber. It contains artifact reduction options that are not found in the regular SCAN software. The features that are specific to MagLink RT are found in the MagLink RT manual.

1.3 PC Requirements

PC's are constantly evolving and becoming more powerful. Operating systems change and new versions are released every few years. The computer demands for recordings made in the MR chamber are greater than other recordings. The capabilities in the SCAN, Stim^2 and CURRY software evolve over time, and these may affect the PC specifications. For these reasons, any list of requirements may be out of date months from when it is created. SCAN and Stim^2 PCs should be obtained from Neuroscan, where we can ensure that they will function properly. PCs dedicated to CURRY (and SOURCE) may be purchased separately; contact techsup@neuroscan.com for the latest requirements.

1.4 Installation and Orientation

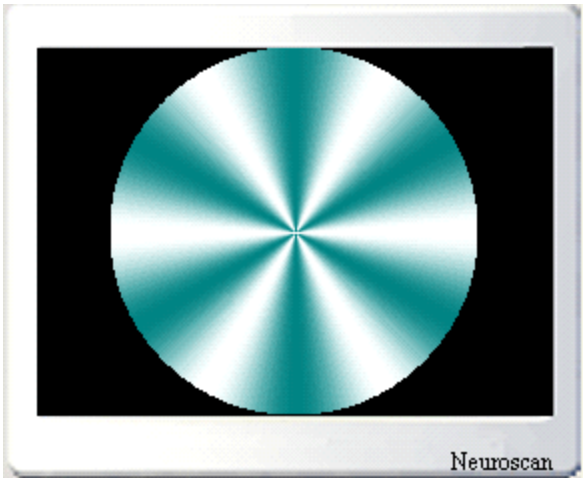
The purposes of this introduction are (1) to familiarize you with the basic equipment components of the Neuroscan systems, (2) provide installation directions, (3) to give an overview of the software modules and their functions, and (4) take you step by step through the setups for a sample study. Some of this information (3 and 4) is a simplified version of that presented in the various manuals. It is not meant to replace the need for you to acquaint yourself with the information in the manuals; rather, it is intended to provide a quick introduction to the system.

We believe that the Neuroscan systems are the best systems available in terms of *flexibility* in data acquisition and analysis, as well as the *reliability* of the data that is obtained. Hand-in-hand with the increased flexibility and reliability is increased *complexity* . We realize that first time users are eager to "get up and running", and that wading through several manuals beforehand is probably the last thing that you want to do or will do. The large variety of options available with the complete Neuroscan systems, however, necessitates lengthy documentation. As a partial compromise, we have developed these pages to familiarize you with the more prominent aspects of the hardware and software in the Neuroscan systems.

1.4.1 The Basic System Components

Most electrophysiological systems are comprised of three main components: stimulus presentation, signal amplification and digitization, and data acquisition and analysis.

I. *Stimulus presentation unit*. Neuroscan provides Stim^2 as a flexible unit for stimulus presentation, although we can interface with other stimulation software.



Stim^2, Audio System, and Response Pad

II. *Signal amplification and digitization*. The bioelectric signals that are recorded from the surface of the body are small, in terms of voltage, and require considerable amplification on the order of, for example, 20,000 times (non-*SynAmps* systems). Neuroscan will supply *SynAmps*, *SynAmps*^{2}, *SynAmps RT*, *NuAmps, or SynAmps Wireless* for amplification.

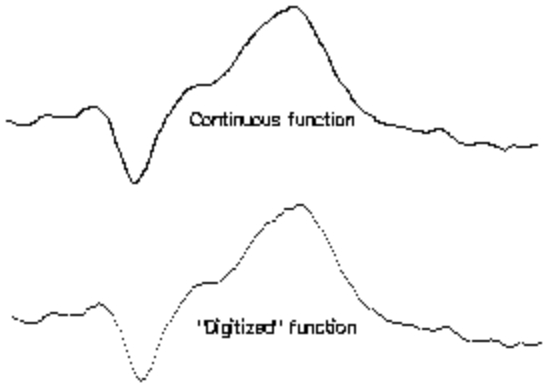
SynAmps

NuAmps

SynAmps^2

SynAmps Wireless

EEG activity from the head is *analog,* that is, in the form of a continuous, oscillating function. The analog output must first be *digitized*, or converted to a digital format that the PC can recognize and process. The analog-to-digital, or A-to-D, or A/D, conversion essentially consists of converting the continuous, oscillating function to a series of discrete points that approximate the original function. Each point may be expressed as an ordered pair of numbers (x,y), where x is voltage (positive or negative), and y is time (usually milliseconds before or after a defined zero point, such as the point of stimulation). An A/D card accomplishes the A/D conversion. This function resides within the amplifier units.



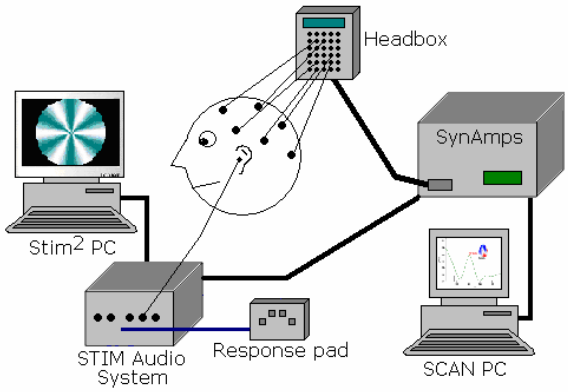
III. *Data acquisition and analysis*. The digitized signals are received by the SCAN system.

SCAN PC and SynAmps

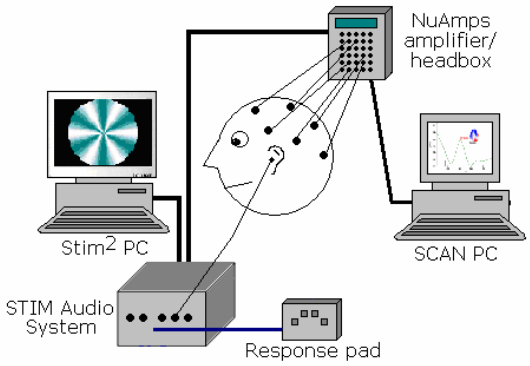
Recordings may be stored in several formats, depending on your needs. If desired, the entire raw data file may be stored for offline analysis. The analysis options typically consist of artifact removal or minimization, averaging, statistical comparisons, graphic display of the results, and so forth.

Common Configurations

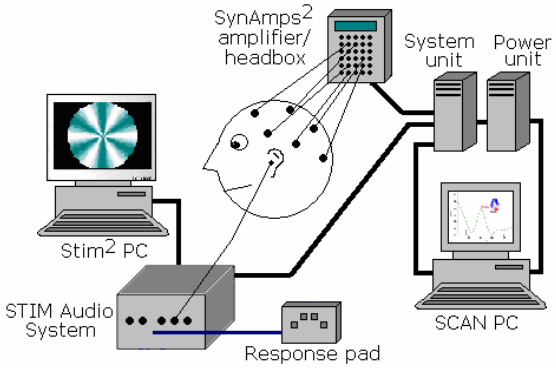
The following diagrams illustrate the most common configurations of systems. The first shows the configuration with the SCAN and Stim^2 systems, with a *SynAmps*. The second shows SCAN and Stim^2 with *NuAmps* (the amplifiers and headbox are in the same unit). The third shows SCAN and Stim^2 with *SynAmps^2* (the amplifiers and headbox are also in the same unit).



Stim2 and SCAN with SynAmps



Stim2 and SCAN with NuAmps



Stim2 and SCAN with SynAmps2

Some Do's and Don'ts - these are a few of the more common initial mistakes that users have been prone to make.

General

Do make the SCAN computer a dedicated unit, limited to acquisition and analysis. If you are connected to the internet, and have programs such as e-mail, instant messaging, auto-updating, virus scanning, etc. running in the background, you run the risk of interrupting acquisition and losing data. LAN connections generally do not cause problems, unless there is activity during acquisition. Avoid installing extraneous software to the SCAN PC.

Don't try to save data to an external drive or across a network during acquisition. The devices will not be able to keep up, and you will likely get a "buffer overrun" error.

Do make sure that you have the power cords of all components of the system plugged into the isolation transformer (or *SynAmps*^{2} Power Unit).

Do make sure that the room in which you will be obtaining the recordings has been inspected by a qualified electrician ***before*** you begin collecting data from subjects. All outlets should be grounded, and an electrician should verify that the ground is a true earth ground. If you are using more that one wall plug, the electrician should verify that these have a common ground. ***Failure to use this equipment in an electrically safe environment could put the subjects at risk for physical injury.*** A faulty ground may introduce 50 or 60Hz line noise.

Do read the parts of the manuals that pertain to your applications. Tutorials and other examples have been included at several places in the manuals. Reading these is the quickest way to become familiar with the more common capabilities of the system. While the tutorials in ACQUIRE may include specific modalities, such as SEPs, ABRs, etc., the procedural information has any number of other applications (i.e., read them all).

Do make pilot recordings and perform all analyses before you start collecting actual data to make sure that you will be able to analyze the data in the way you desire.

Do make a copy of all the data you collect. Work with a copy and save the original version.

SynAmps (original)

Don't connect any other device that is connected to the subject (such as some form of psychophysiological transducer) to the *SynAmps* amplifiers (unless you have a specially modified *SynAmps*). Contact the Neuroscan Technical Support regarding other devices that you wish to connect.

Do let the *SynAmps*(s) boot fully to SN1 (SN2, SN3, etc.) before turning on the SCAN PC.

Don't turn the *SynAmps* amplifiers OFF and then ON too quickly. Wait at least 20 seconds after turning *SynAmps* OFF before turning the unit back ON. Turning the amplifiers ON too soon could damage the unit, necessitating its return to Neuroscan for repair.

Don't unplug the *SynAmps* headbox from the *SynAmps* if the unit is ON.

Don't unplug the SCSI cable unless both the *SynAmps* and the PC are OFF. The SCSI card may be damaged. The only things that may be connected and disconnected safely while the units are ON are the jumpers, the shorting plug for the head box, and the electrodes or electrode cap.

Don't short unused jacks to GROUND on the *SynAmps* headbox (could create increased electrical noise) - short unused channels to REF. (Unused jacks should be shorted to ground for bench testing; see the *SynAmps* manual Appendices).

SynAmps^2

Do turn off the System Unit and SCAN computer whenever you are connecting or changing the USB cable or headboxes (**do not "hot swap" the headboxes or USB cable**, as this can damage the System Unit or headboxes). **Use the thumbscrew connections** to attach the cables securely, so they do not become disconnected when the system is on.

Do use a *USB 2.0* port on the SCAN computer. If you have USB ports on the front and back of the computer, use one on the back (they usually have more reliable communication with the motherboard). Make sure it is a USB 2.0 port. To verify, turn the System Unit off. Go into the Device Manager on the SCAN computer, and expand the USB port list. Turn on the System Unit, and you should see it being found in the Device Manager, with a USB 2.0 port indication.

Stim or Stim^2

Don't use SOUND stimuli in excess of 90dB unless you have tested for loudness first (to avoid injury to the ears and/or headphones). It is best to start with lower dB levels and gradually increase them.

1.4.2 Hardware Installation Guide

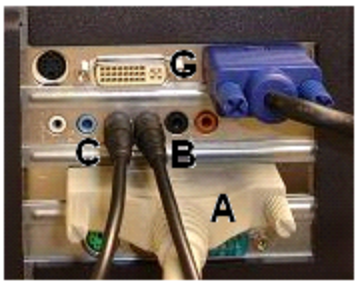
Stim^2 Hardware and Software Installation

Directions for the Stim^2 hardware and software installation are found in the beginning of the Stim^2 manual and are not repeated here. If you have the original version of STIM, and need directions for re-installation, please see your older version of this manual (or contact Technical Support).

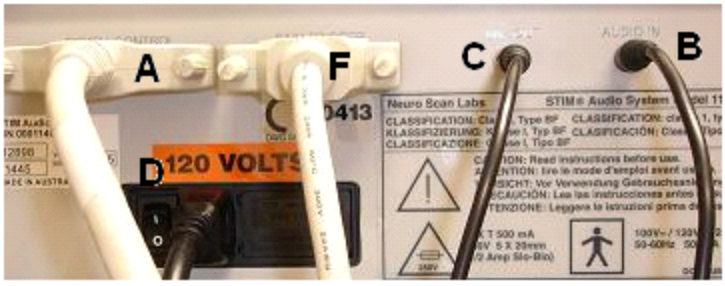
Installation Updates

The following information does not appear in the current *Stim^2* installation instructions.

The SoundBlaster audio board that we have installed in your Stim computer periodically changes. Currently, there is a row of six mini-phone jacks on the exposed part of the board. Rather than text labels, they now have symbols. When connecting the two small cables from the board to the Audio Unit, you'll have to look carefully at the symbols to determine the correct jacks. The one with the microphone symbol is the **Mic In** jack (**C** in the figure) - be sure the symbol is referring to that jack, and not the one next to it (it is sometimes not clear which symbol goes with which jack). The **Line 1 Out** jack is the one next to it (**B** in the figure). Connect the other ends of the cables into the labeled jacks in the Audio Unit.



back of STIM PC



back of STIM Audio System

The monitor connection cable to the video board we have installed in your computer will likely not fit (see **G** in the figure). Along with the monitor is a box with assorted cables and connectors. Find the one that adapts the monitor connector to the video board connector, and use it. **A**, in the figure, is the connection between the I/O board in the computer and the Audio Unit - it can only connect one way. (**F** is the stim-to-scan cable).

Isolation Transformer (or Power Unit)

With all new *Stim^2* and *NuAmps* systems you will receive an Isolation Transformer (small, white, heavy unit). With *SynAmps^2*, the Power Unit serves the same function. All Neuroscan equipment, and any other devices connected to the Neuroscan equipment, should be plugged into the transformer(s). The transformer(s) should be plugged into the wall receptacle. It is permissible to plug a power strip into the transformer to allow enough

sockets for all the power cords. However, **DO NOT EXCEED THE AMPERAGE SHOWN ON THE TRANSFORMER**. If the amperage is exceeded it is possible to blow out the fuse in the transformer, or to cause internal damage to the transformer. If you do not know how to compute the amperage of your devices, please contact Technical Support.

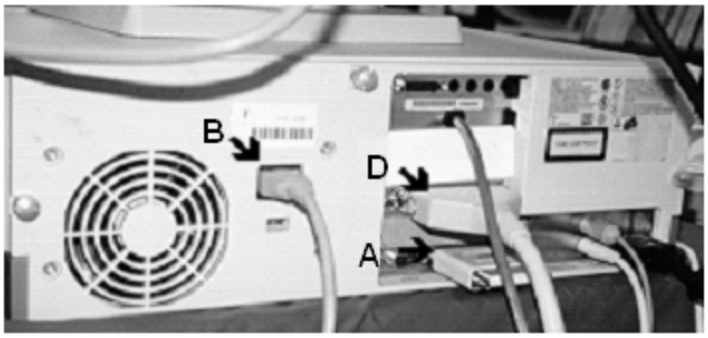
DO NOT USE THE TRANSFORMER POWER SWITCH OR ANY ATTACHED POWER STRIP SWITCHES TO TURN ON THE NEUROSCAN COMPONENTS. Turn the components on individually using their own power switches. This is to avoid the amperage pull on the transformer encountered when most devices are powered up. If the amperage is exceeded it is possible to blow out the fuse in the transformer, or to cause internal damage to the transformer.

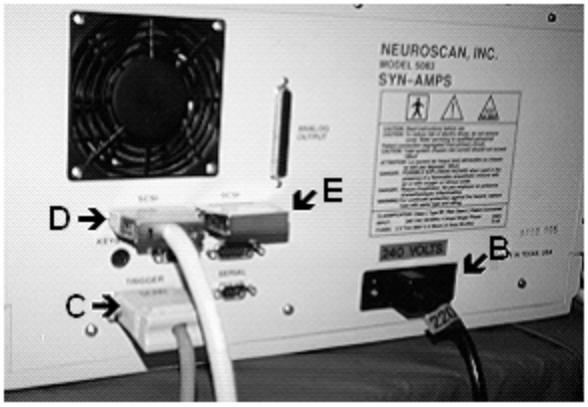
DO NOT PLUG OTHER DEVICES NOT USED WITH THE NEUROSCAN SYSTEM INTO THE TRANSFORMER.

If you add components to your original Neuroscan system, **DO NOT PLUG THEM INTO THE TRANSFORMER** without determining their additive amperage. If you have any questions, please contact Technical Support.

SCAN Hardware Installation

SCAN PC, with a SYNAMPS. If you are reinstalling a *SynAmps*, you will need to install the SCSI Host Adapter card for the SCAN PC (actual card will vary over time). This is the card that communicates with the *SynAmps*. Turn the SCAN PC off, ground yourself to discharge any static electricity, and install the card securely in a free PCI slot. With the *SynAmps* off, connect the SCSI cable between the *SynAmps* and the SCSI card, using the SCSI2 to SCSI2 cable (see also the *SynAmps* manual for more details regarding the *SynAmps*). Plug the SCSI terminator into the free SCSI connector on the back of the *SynAmps* - it does not matter which connector has the terminator and which has the SCSI cable. *If you have more than one SynAmps, refer to the SynAmps manual for additional connections between the SynAmps*. If you have STIM or Stim^2, plug the STIM-to-SCAN cable (SCAN end) into the Trigger connector on the back of the *SynAmps*. Connect the head box to the head box cable, and the other end of the head box cable to the front of the *SynAmps*. The various cable connections are shown in the figures below. Turn the *SynAmps* on and let it boot to SN1. If it displays SCSI instead of SN1, that is OK. Then turn the SCAN PC on.





SCAN PC

SynAmps

A. Software key (or "dongle"). Newer ones attach to the USB port.

B. Power cable

C. STIM-to-SCAN cable from the STIM Audio System to the back of the *SynAmps*.

D. SCSI cable from back of *SynAmps* to the SCSI controller card in the SCAN PC (the picture shows an older Adaptec with a SCSI1 connector - current ones have a SCSI2 connector, as on the *SynAmps*).

E. SCSI terminator (must be installed on open connector; either connector may be used for the SCSI connector and terminator).

For SynAmps users: always make sure the SynAmps(s) are turned ON and that SN1 (and SN2, SN3, etc.) appears BEFORE you boot the SCAN PC.

Installing the SCSI driver. SCSI adapter cards may change pending availability, and the installation of their software may vary. The Adaptec 2930CU is the current version being used. You will need to install the driver for it. For Windows 2000, the correct driver is **w2ksynamp.sys**. It may or may not be included with the version of Windows you have, but you will receive an Adaptec floppy disk or CD with the driver included.

To install the driver, go first into the Device Manager. For 2000, go to the Control Panel, then click the System icon. Select Hardware, and then see the Device

Manager.

In the Device Manager, see the "SCSI controllers" line. Under it you should see the Adaptec SCSI adapter. Highlight that line, and then click the Properties button. Then select the "Drivers" tab, and click the "Update Drivers" button. Follow the directions, and let Windows search for the best driver. If necessary, direct the search to the Adaptec floppy or CD, and verify that the **w2ksynamp.sys** file has been selected (for 2000). Windows should find, register, and install the correct driver.

Alternatively, when you reboot the computer after installing the Adaptec card, you may get a message saying that the new hardware was found, and asking if you want to install the software for it. Say yes and follow the directions, directing the search to the Adaptec floppy, if needed.

SCAN PC, with SynAmps^2. If you purchased *SynAmps^2* amplifiers, please follow the instructions in the *SynAmps^2* manual for the hardware installation. The installation of the SCAN software is the same as that described below. WITH NEW INSTALLATIONS, INSTALL THE SOFTWARE **BEFORE** YOU TURN ON THE *SYNAMPS^2*.

SCAN PC, with NuAmps. If you purchased *NuAmps* amplifiers, please follow the instructions in the *NuAmps* manual for the hardware installation. The installation of the SCAN software is the same as that described below.

SCAN PC, with SynAmps Wireless. If you purchased *SynAmps Wireless* amplifiers, please follow the instructions in the *SynAmps Wireless User Guide* for the hardware installation and network configuration. The installation of the SCAN software is the same as that described below.

Video Camera. The Video Camera option allows you to superimpose the EEG data (in map form) on the view seen from the camera. You need to install the camera's software and verify that it is functioning first. Then, when you run the *Amplifier Install* program (**Start → All Programs → Scan4.5 → Amplifier Install**), you have the option

to enable the 

. Be sure you select the correct amplifiers, then click **OK** and **Finished**. (Make sure ACQUIRE and EDIT are closed whenever you run the *Amplifier Install* program). (Refer to the ACQUIRE and EDIT manuals for more details).

1.4.3 SCAN 4.5 Software Installation

If you are installing Scan 4.5 on a computer with no prior versions of Scan, just insert the CD and follow the steps indicated. If you have an earlier version of Scan on your computer, uninstall it before installing Scan 4.5. Scan 4.5 is a complete installation, not a patch. The installation program creates a series of subdirectories, programs the registry, and copies necessary files to appropriate directories. Failure to use the provided installation program will result in unpredictable results in the operation of the program.

Note
If you are installing the system as a **new** system, be sure to install the Scan software **before** you connect and turn on the amplifiers (so that the drivers will be found).

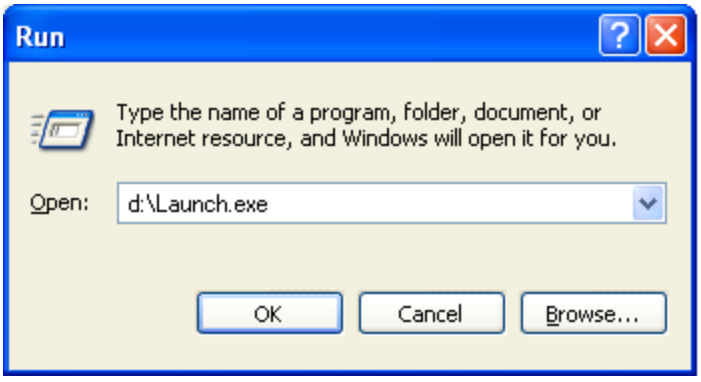
The Installation is largely automatic. SCAN 4.5 runs under **Windows XP Professional, 32 bit** and **Vista**. (The XP Home version is discouraged, although it may function fully aside from the networking option). **You must install SCAN 4.5 when logged on with full Administrator rights**. There is a single installation for all systems: XP and Vista, Scan and MagLink RT, and SynAmps Wireless. Select the proper system in the **Setup Type** dialog screen (see Step 6 below).

If you have a MagLink RT system, your dongle (software lock) will activate the MagLink RT version of the software.

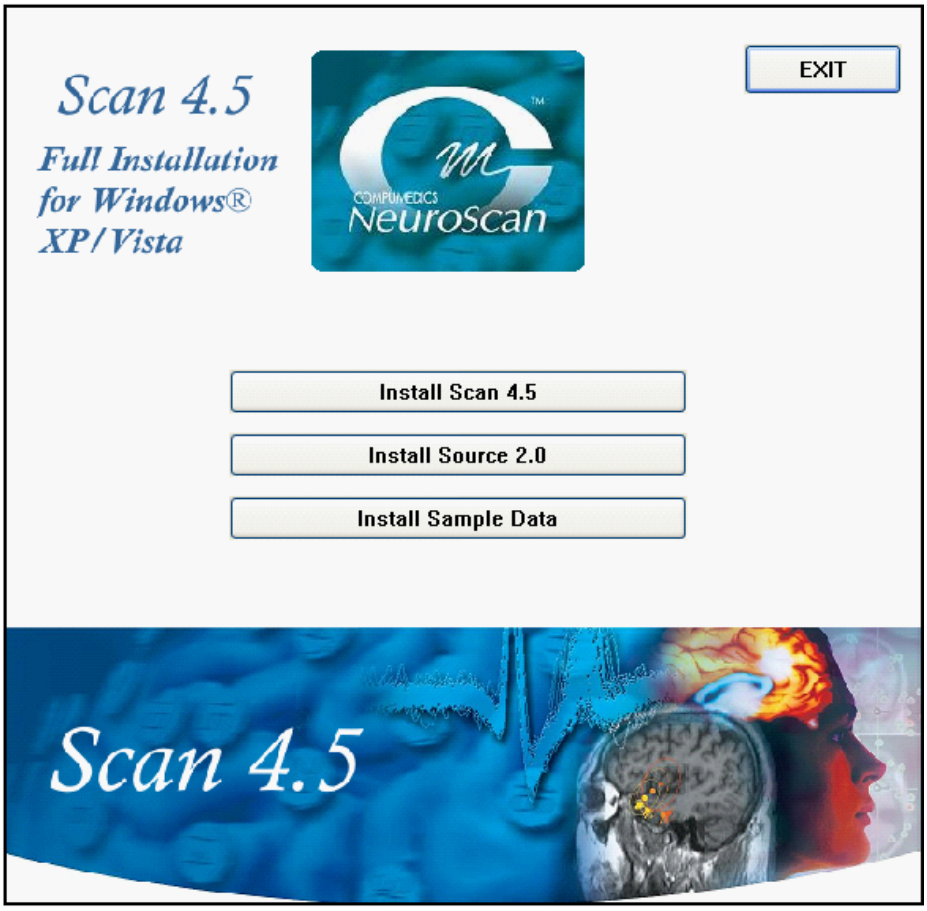
Follow these steps to install SCAN 4.5:

1. If the installation process does not begin automatically after you insert the CD, click on the **Start** 

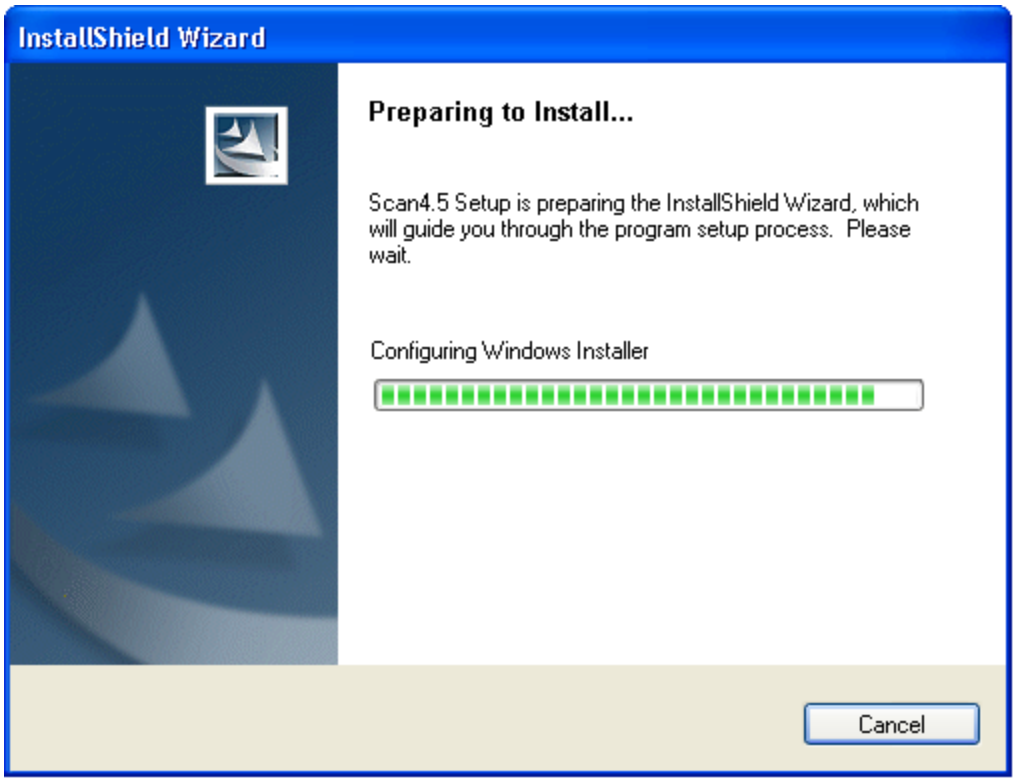
button of Windows. Click on the **Run** option of the task bar, and enter **D:\Launch.exe** for CDROM media (or whatever drive your CD/DVD is mapped to).



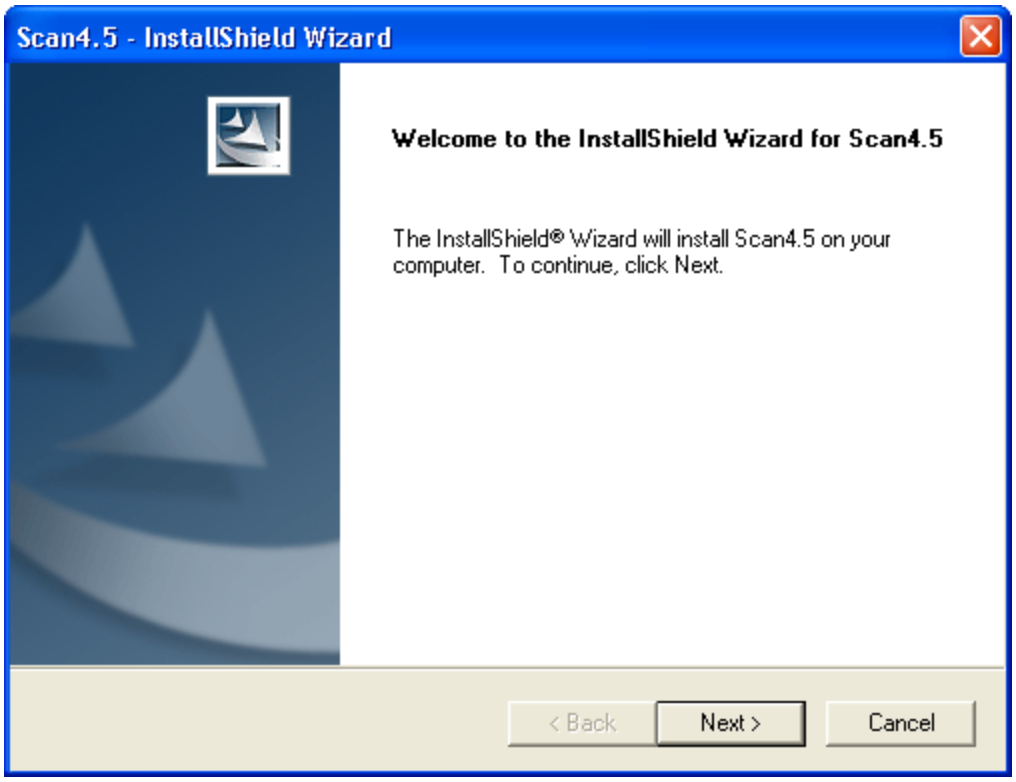
Click **OK**, and the SCAN 4.5 initial screen will appear. You have the choice to install the SCAN software, the Source 2.0 software (separate license required), or the Sample Data.



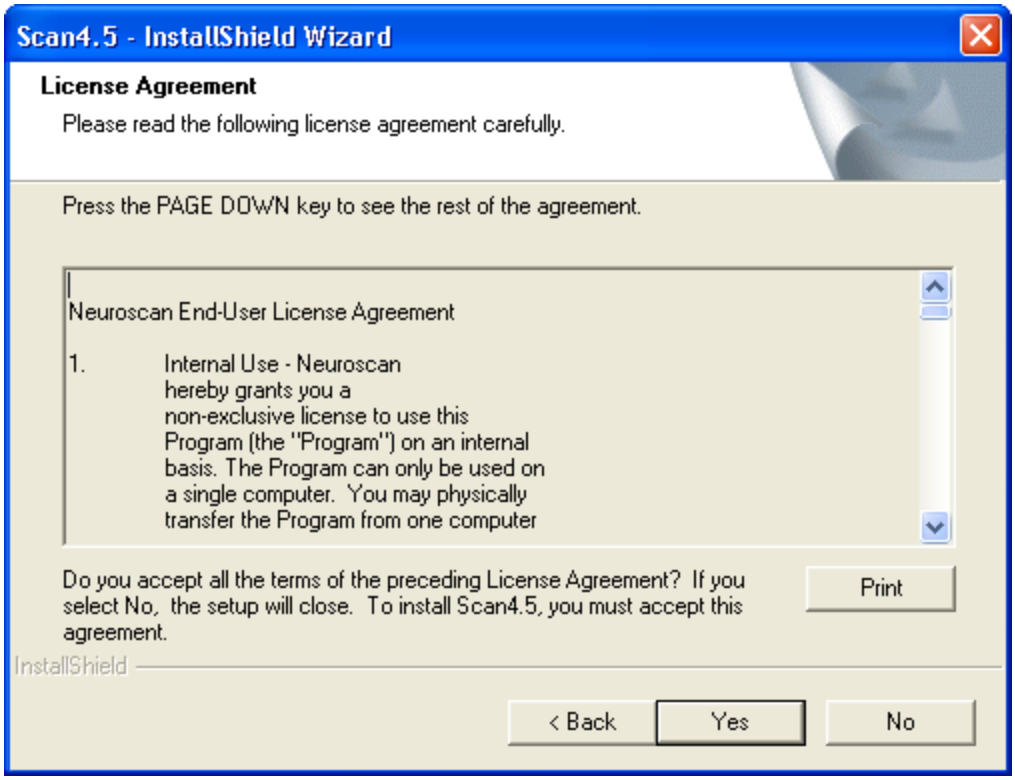
2. Click the Install SCAN 4.5 button to install the Scan software. The InstallShield Wizard will appear and prepare your computer for installation.



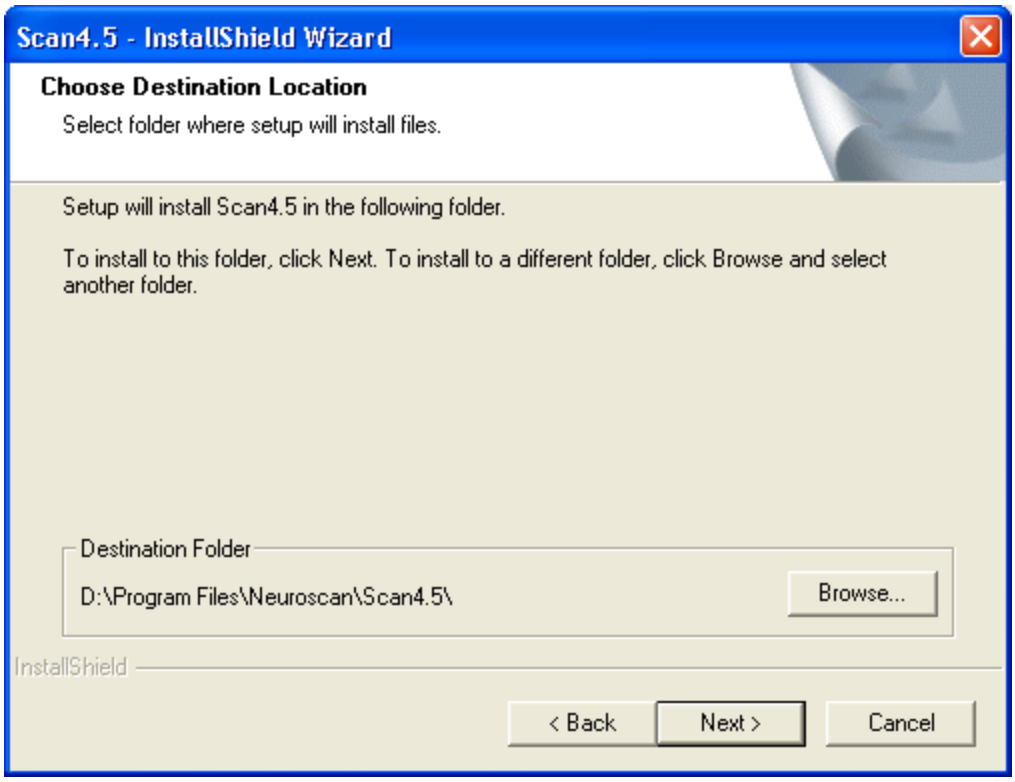
3. The InstallShield Wizard screen will appear after a few moments. Click on the **Next** button.



4. You will then see the Software License Agreement. Read it, and if you agree, click **Yes** to continue. If not, click **No** to exit the setup.



5. Next, the destination directory of SCAN 4.5 will be determined. Under normal circumstances this will be the default *c:\Program Files\Neuroscan\Scan4.5* folder. However, it is possible to install into a different directory using the Browse button.



If you already have SCAN 4.5 installed, you should uninstall it via Windows software before reinstalling it in a different directory (do not just move the files to a different directory). Click on the **Next** button again and you will see the Setup Type screen.

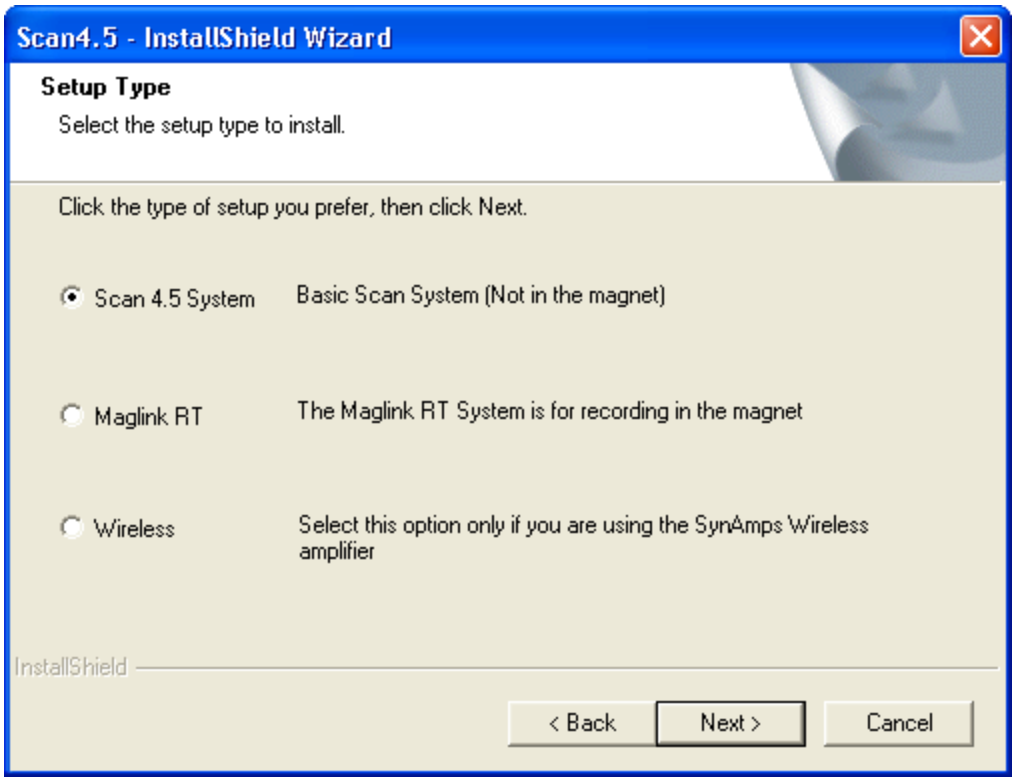
6. From the Setup Type screen, select the option that matches the system you have.

   Select **Scan 4.5 System** if you have the basic Scan system, with *SynAmps* (original, *SynAmps2*, or *SynAmps RT*), and you are not recording in the magnet (i.e., you do not have a MagLink System).

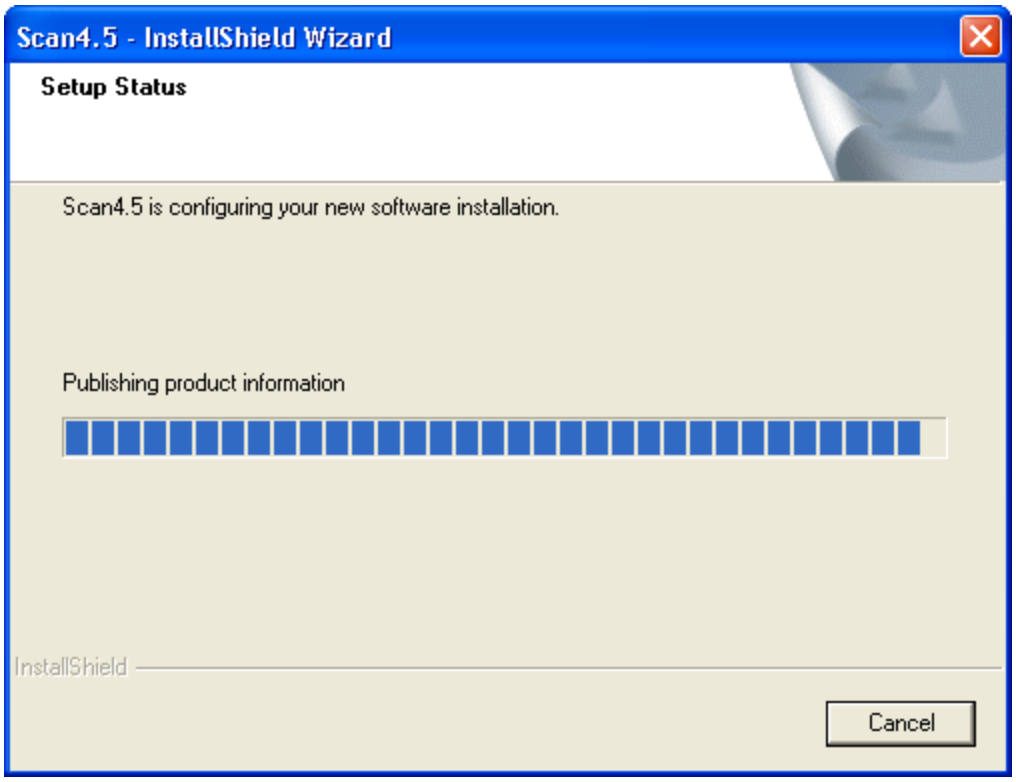
   Select **MagLink RT** if you have a MagLink RT System (for recording in the magnet).

   Select the **Wireless** option only if you have the *SynAmps Wireless* amplifier.

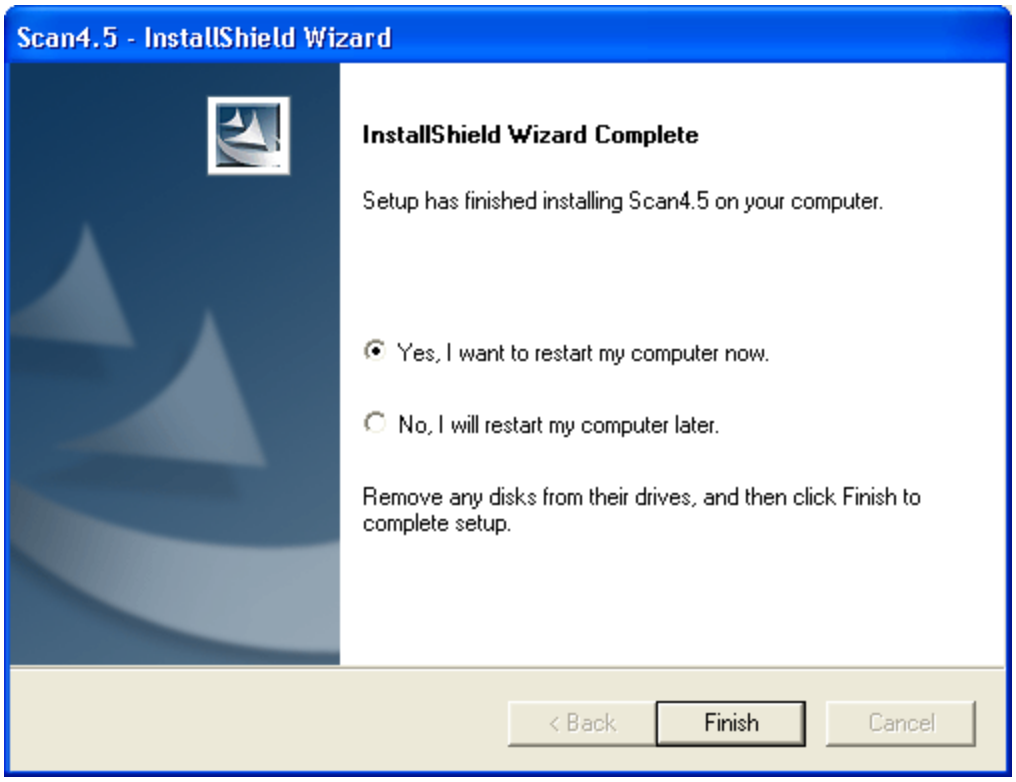
   Then click **Next**.



7. Shortly, you will see a progress indicator showing which files are being decompressed and copied.

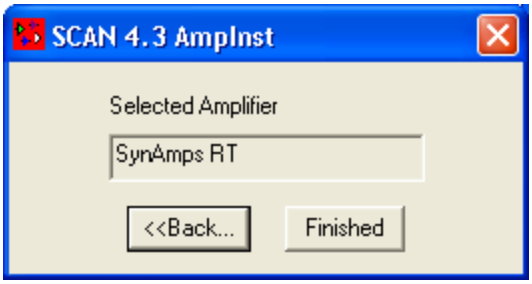


8. You will need to restart your computer at this point (or later if need be).



9. When the computer has rebooted, go to **Start** → **All Programs** → **Neuroscan** → **Scan4.5** and select **Amplifier Install**. You will then see the "Select an amplifier" screen. Highlight the amplifier that you are using. (For ease in future access, you may wish to create a shortcut from the Desktop to the Amplifier Install program). Enable ☑ Video Camera if you want to superimpose the EEG data on the view from the camera (this is not an option for simultaneous video and EEG recording).

10. You will see a confirmation screen to verify the selection you made. Click **Finish** to complete the installation, or **Back** to make any changes.



11. Rerun **Launch.exe**, as described above in Step 1, if you wish to install the additional components.

Source. The Source 2.0 software is separate from SCAN and must be purchased separately. You can install the software, but it will not run until you reprogram your dongle for Source. Click the Install Source 2.0 button to install the Source 2.0 software. The installation is very similar to the above steps.

Example Data. You will likely want to install the Example Data. Click the Install Sample Data button, and the installation will be very similar to the one above. It will take a few minutes to install all of the demo data files.

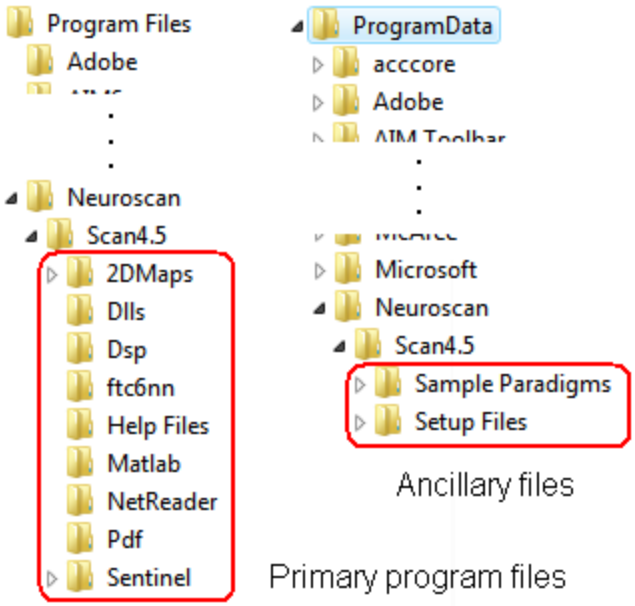
Exit. Click the EXIT button to leave the SCAN 4.5 installation.

Installation of the Sentinel drivers

If this is the initial installation of Scan 4.5, you will then see a series of steps for installing the Sentinel drivers. These are the drivers used to read the dongle, or software lock. This is the small USB device (appears similar to a thumb drive) that connects to a USB port. This is the license; the software will not run without it. Install the Sentinel drivers, as directed.

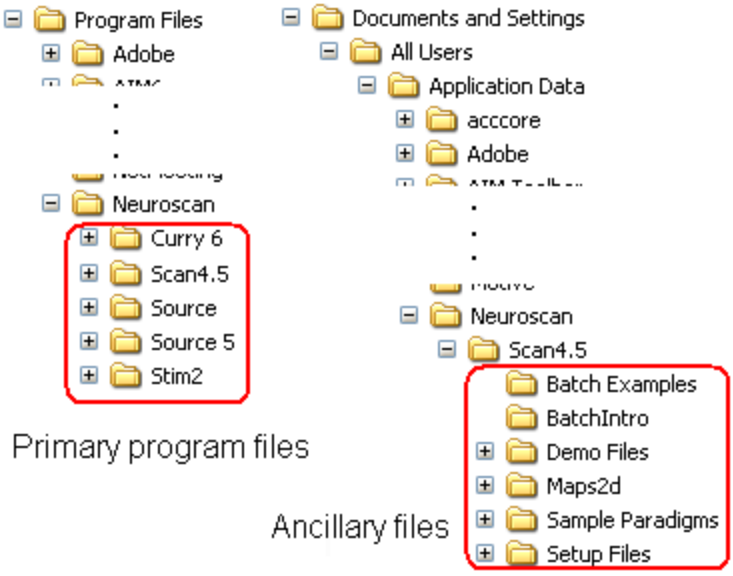
XP and Vista Installation of Folders

Because of certain constraints specific to Vista, some of the installed folders and files appear in the *c:**ProgramData**\Neuroscan\Scan4.5* folder, rather than under *...**Program Files**\Neuroscan...* These include the *Sample Paradigms* and *Setup Files* folders. The main program files are installed under *...\Program Files...*, as usual. The **Scan Data** demo files are installed in the root.



Vista Installation

In the **XP** version of the installation, folders are created in the following locations shown below.



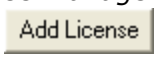
XP Installation

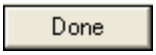
1.4.4 License Manager

In order to run SCAN 4.5 you must have a properly programmed software lock, or "dongle", connected to your computer's parallel or USB port. If you are a brand new user, you will have received the dongle with the system, and it will be preprogrammed with a license. If

you already have a dongle for your SCAN system, it will *not* need to be reprogrammed in order to run SCAN 4.5 (the 4.3 license is sufficient).

If you should need to reprogram your dongle, you will need a new License Number and Password. To obtain one, you first need to find the serial number of the dongle. In either ACQUIRE or EDIT, select **Help** → **About ACQUIRE** (or **About EDIT**). The serial number is displayed. Or, run the *License Manager* program (**Start** → **All Programs** → **Neuroscan** → **Scan4.5** → **License Manager**), and the serial number is displayed. The License Manager allows you to upgrade your software lock to accommodate new software or a software upgrade. Then contact techsup@neuroscan.com.

You will receive a License Number and Password in return. Run the *License Manager* program as described above, and enter the new information. Then click 

. You should see a message saying the process was successful. Then click 

. You can now access the software.

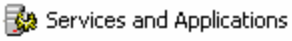
Incidentally, SCAN checks for the dongle periodically. You cannot start SCAN on one computer, then remove the dongle and use it to run SCAN on a second computer. The first one will not continue to function without the dongle.

If you have installed everything and you then see a message saying that there is no valid license when you start the program, close any open windows and remove the dongle. Connect it to a different USB port, and start the program again. The dongle should then be found.

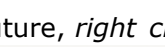
Running SCAN and CURRY or SOURCE 5 at the same time

You can run SCAN and CURRY or SOURCE 5 at the same time, even if you have more than one dongle. If you cannot run the programs at the same time, or if you find that you have to wait a couple of minutes between closing SCAN and starting CURRY (before the dongle is found), you need to *disable the SuperProServer*. To do this, click the 

button, then *right click* on 

. Select **Manage**, expand 

, and click **Services**. The Services will appear on the right. Scroll down to 

. Click 

(upper left area). To prevent the service from starting automatically in the future, *right click* on 

and select **Properties**. Set **Startup type** to 

, and click **OK**. You will then be able to run CURRY and SCAN at the same time.

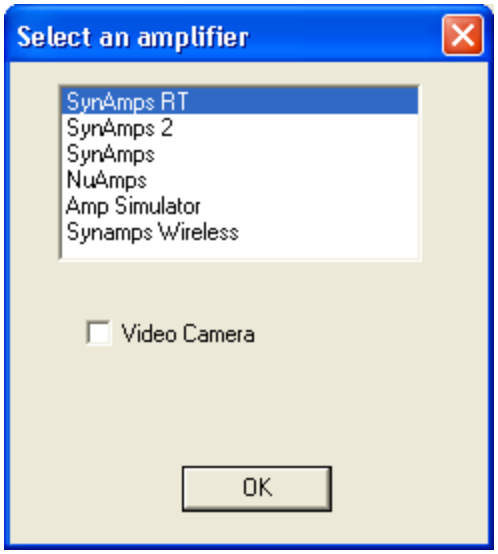
1.4.5 Amplifier Software Installation

Some additional information concerning your amplifiers must be entered prior to acquiring data. The Installation program will lead you directly to the AMPINST (Ampinstall) program, or you can come back to it at a later time and run it as a stand-alone program.

If you have not already *installed* your amplifiers, you should do so at this point. Go to the Scan4.5 folder and double click on the 

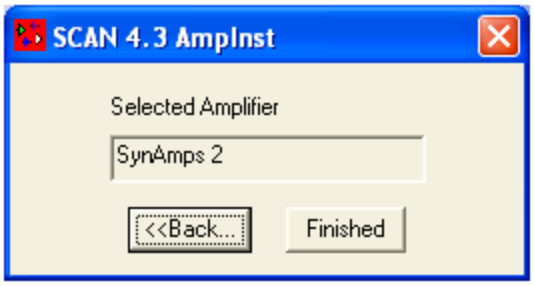
program, or go to **Start** → **All**

Programs → **Scan4.5** and select the *Amplifier Install* program. The **Select an amplifier** window will appear asking which amplifiers you wish to install.



Enable the **Video Camera** option if you have a camera installed and functioning on your computer. Highlight your selections and click **OK**. A confirmation screen will appear. You have the choice to go **Back** and reselect the amplifiers, or else click **Finished** to complete the process.

The program takes a fraction of a second to run; it is creating or modifying some registry files. If you wish to change the amplifiers, rerun AmpInstall with the new selection.

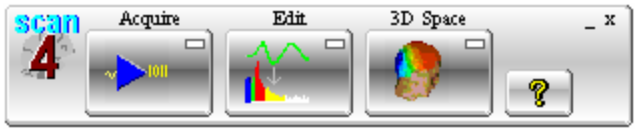


As part of your initial installation, your amplifier settings should be entered in ACQUIRE. The settings will vary depending on which amplifier is installed. This is described in more detail below.

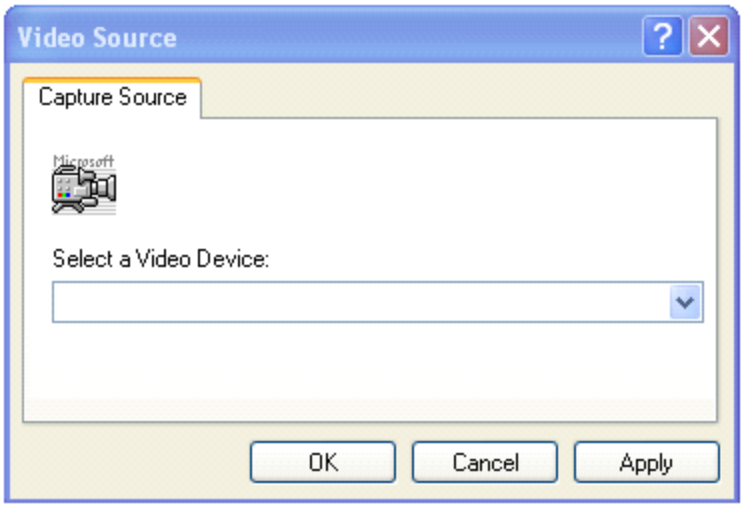
The software lock provided with the CD should be connected to a USB 2.0 port on your computer (older dongles connect to the parallel port, LPT1).

Double-click the SCAN 4.5 icon 

, and then click on the ACQUIRE icon  from the Program Launcher to start the ACQUIRE program.

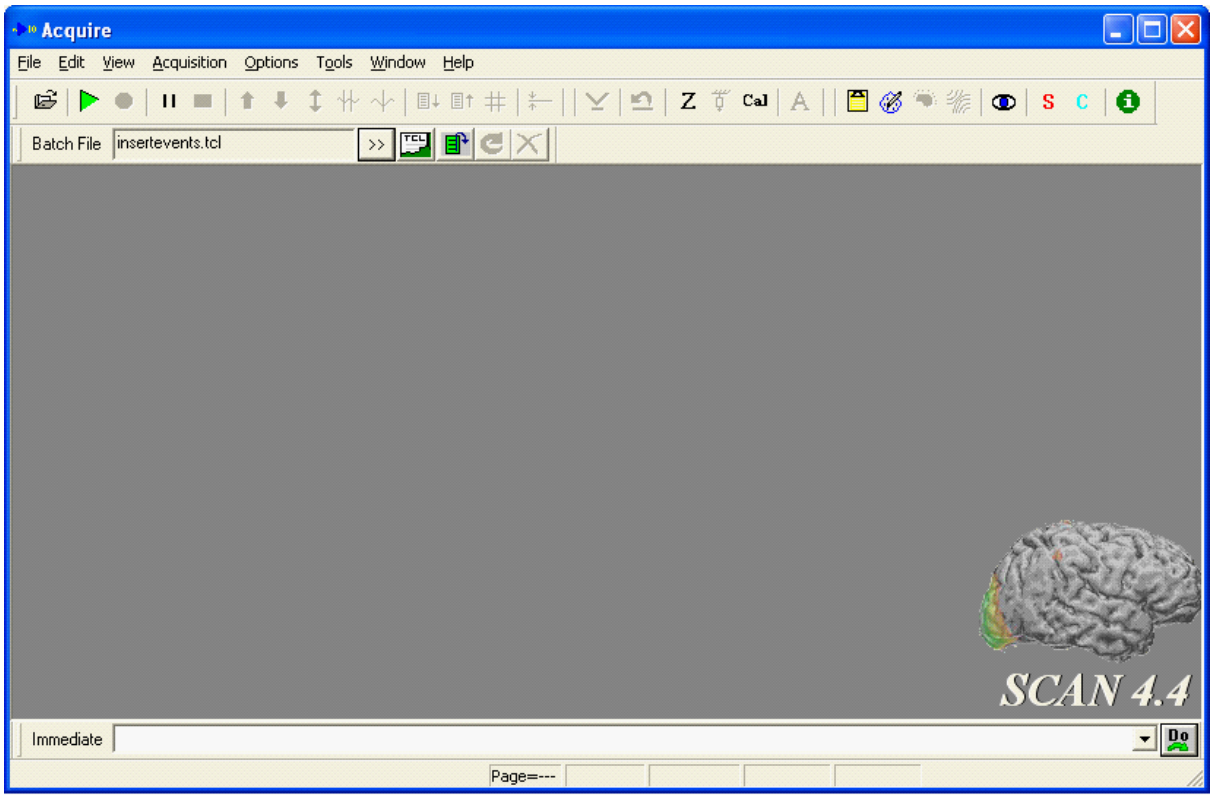


If you have the **Video Camera** option enabled, the following display will appear the first time you start ACQUIRE or EDIT.

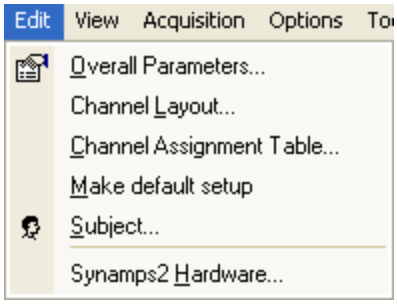


Select the **Video Source** from the pull-down list, then click Apply and **OK**.

The Main screen will appear.

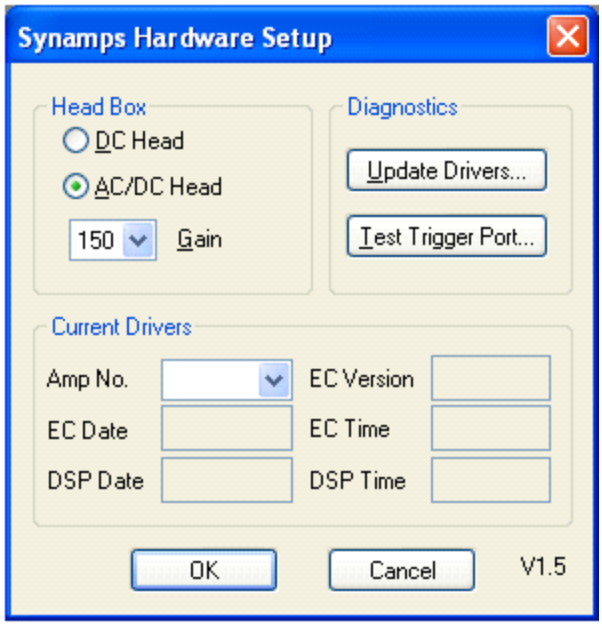


Continuing with the Amplifier Software Installation, in ACQUIRE, click **Edit**, and at the bottom of the menu list you should see the amplifiers specific for your system, as described above (i.e., **SynAmps2 Hardware**, etc.).



SynAmps

If you have a *SynAmps* system, select the *SynAmps Hardware* option, and a dialog box will appear. Indicate the appropriate settings for your system (the information must match your *SynAmps*):



Head Gain. Select either 30 or 150x gain (*SynAmps* since approximately 1994 are 150x, unless specially ordered).

AC/DC. Indicate whether the *SynAmps* is DC only, or AC/DC (*SynAmps* since approximately 1994 are AC/DC, unless specially ordered).

If your computer and amplifiers are communicating correctly, you will see information in all of the Current Drivers fields. If the fields are blank, please refer to the ACQUIRE manual for a description of the *Diagnostics* and *Current Drivers* sections for troubleshooting.

For SynAmps users: always make sure the SynAmps(s) are turned ON and that SN1 (and SN2, SN3, etc.) appears BEFORE you boot your PC.

SynAmps^2 or SynAmps RT

The installation of *SynAmps*^{2} or *SynAmps RT* is contained in their manuals. Operational details specific to *SynAmps*^{2} or *SynAmps RT* are described in their manuals. Details in common with other systems are described in the ACQUIRE manual.

NuAmps

The installation of *NuAmps* is contained in the *NuAmps* manual. Operational details specific to *NuAmps* are described in the *NuAmps* manual. Details in common with other systems are described in the ACQUIRE manual.

See also the section at the end of the ACQUIRE manual for a summary of the differences in the ACQUIRE software according to the amplifiers you have installed.

SynAmps Wireless

The installation and network configuration for the *SynAmps Wireless* amplifiers is contained in the *SynAmps Wireless User Guide*. Operational details specific to *SynAmps Wireless* are described in the *SynAmps Wireless* manual. Details in common with other systems are described in the *ACQUIRE* manual.

See also the section at the end of the ACQUIRE manual for a summary of the differences in the ACQUIRE software according to the amplifiers you have installed.

This concludes the SCAN Software Installation procedure.

1.4.6 3D Digitizer

If you have purchased a 3D Digitizer for inputting three dimensional head shapes for the 3DSpaceDx program, please complete the following installation steps. This information is repeated in the beginning of the 3DSpaceDx manual.

1.4.6.1 Hardware Installation

3DSpaceDx supports only the Polhemus FASTRAK™ device. Described below are the specific interface concerns related to the 3DSpaceDx program. The user is referred to the accompanying 3DSpaceDx manual for all other hardware concerns. Familiarization with this manual and the operation of the device is required before proceeding with the steps listed below.

CAUTION - All Polhemus devices are sensitive to electrostatic discharge (ESD). Be sure to take precautions when following the instructions listed below. Power should not be applied to the device until all connections and all switch settings have been completed.

1. Attach the serial communication cable. A 10 foot serial communication cable is provided. One end of the cable should be plugged into serial communications port COM1 or COM2. The other end should be plugged into the 9 pin connector labeled RS-232 on the digitization unit.

2. Attach the transmitter. The transmitter is a plastic cube, roughly 2" on all sides, with a long cable and connector attached. With the power off, plug in and firmly screw the transmitter cable into the connector labeled **transmitter.** The transmitter should be attached to the head of an aluminum tripod, supplied with the system.

3. Attach the stylus. The digitizing stylus is a pen-like device with a long cable and connector attached. Plug in and firmly screw the stylus cable into the connector labeled **Receiver ONE.** The stylus must at all times occupy the first receiver position. Other positions will result in erroneous data.

4. Attach the power cable. Make sure the power switch on the back panel of the digitizer is in the off position. Remove the power cable from the transformer and plug the circular DIN type connector into the connector labeled **POWER** on the back of the device. Now plug in the power cable into the back of the transformer and the other end into the power socket.

CAUTION - Never plug the DIN connector into the device with power applied to the transformer. Damage to the device may occur!

5. Attach the 3 additional receivers. Attach the three additional receivers. These receivers are used to form a reference plane on the head or object to be digitized. If the device was purchased directly from Neuroscan, the cables will be tied together to form a harness. Plug these receivers in **TWO**, **THREE,** and **FOUR**.

6. Check the serial communication parameters on the 3DSpace device. The 3DSpace system should be set for 57.6 Kilobaud, 1 stop bit, no parity. The appropriate switch settings can be found in the user manual of the device. Lower baud rates are acceptable. The appropriate changes should be made on the switches, within Windows (e.g., from the Device Manager), and in the 3DSpaceDx software (see below). *NOTE: Power to the digitizer should be shut OFF whenever you make switch changes.*

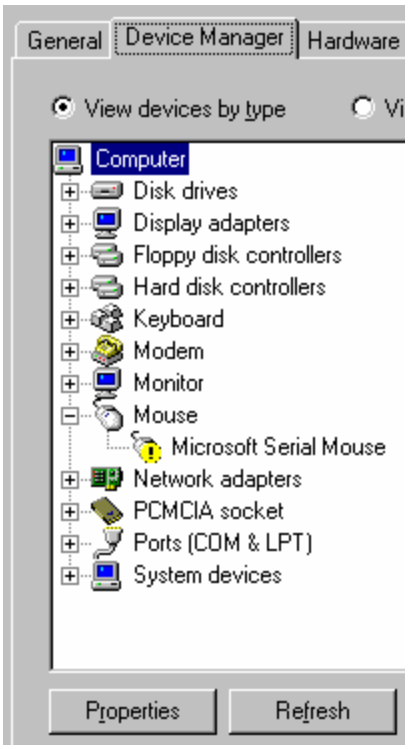
1.4.6.2 Software Installation

1. Check the serial communication parameters on the host computer. It may be necessary to configure the serial port to the 57.6 K baud rate required by the digitizer.

To check and or change the baud rate to these settings click on the 

button and select the **Settings** options and then the **Control Panel** folder. (The following is for Windows 2000; XP will be similar).

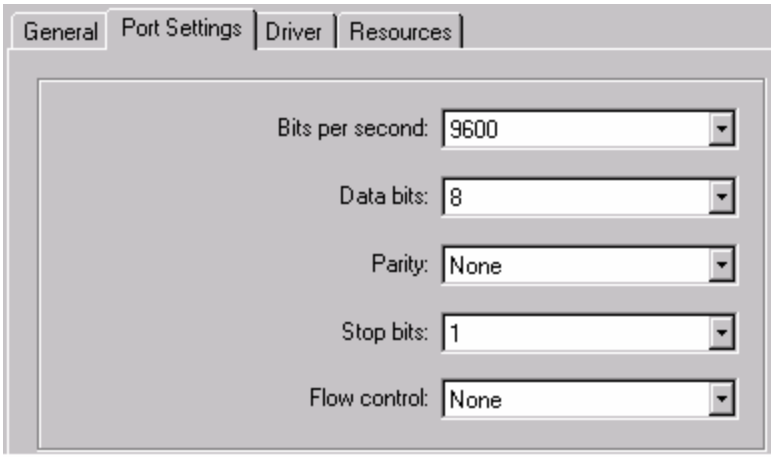
Double click on the and the **System Properties** screen will appear. Click the **Hardware** tab. Click on the **Device Manager** button, and a list of the installed devices will appear.



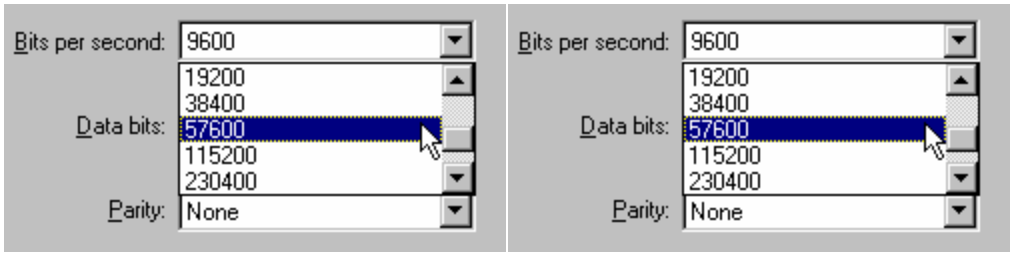
Double click on the Ports icon

and a device tree will expand to show the installed ports.

Double click on Communications Port (COM1 or COM2) and the Communications Port properties page will appear. In this example the baud rate of the system is set to 9600.



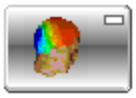
To change the settings, click on the 'pull-down' arrow located to the right of the number. A list box will appear. Select 57600 and click on the OK button to modify the communications values.

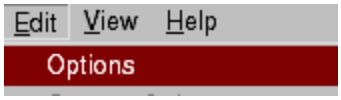


The Communication Properties dialog box will disappear and the System Properties dialog box will reappear. Click on the OK button to close this dialog box.

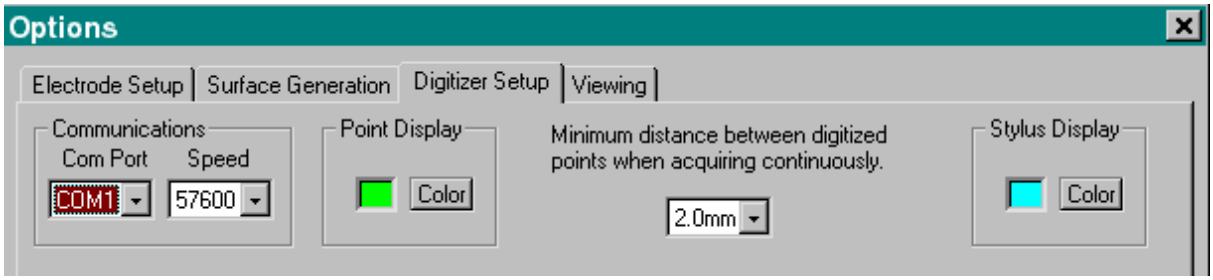
The host computer is now configured for 57K baud transmission rates.

2. Check that the number of receivers for your digitization unit is set correctly. If you purchased the FASTRAK digitizer from Neuroscan, the number of receivers should already be set to **four**. The settings switches on the front of the unit should all be On (down). Three of the receivers (receivers 2-4) are used to form a reference plane and the position of the stylus (receiver 1) is computed relative to this plane. Consult the FASTRAK manual to set the number of receivers to four.

3. 3DSpaceDx installation. The last steps are to enter the necessary settings within 3DSpaceDx. Click on the 3DSpaceDx icon  from the Program Launcher, and the main 3DSpaceDx screen will appear.

Click on the Edit menu item and select the Options menu item. 

The Options window will appear. Click the Digitizer Setup tab, and see the following screen.



Under the Communications section, select the Com Port and Speed (BAUD rate) to match the settings on the digitizer. The remaining options are described in the 3DSpaceDx manual.

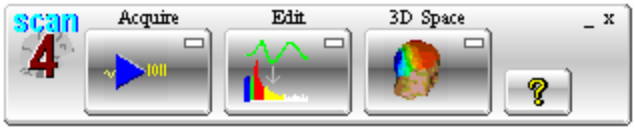
This completes the installation of the 3D Digitizer.

1.5 SCAN and Stim2 Software Modules

The SCAN and Stim^2 software packages each consist of several modules, or programs. The SCAN 4.5 system is divided primarily into two modules: ACQUIRE (for acquisition of data) and EDIT (for analysis of data). The Stim^2 system consists of modules for presenting individual neuropsychological tasks, intended for application in EEG and evoked potential recording paradigms, as well as utility programs for creating your own auditory stimuli and converting visual stimuli. Many of the modules are self-contained, preset programs (with some variable parameters), although the Gentask module allows you to create your own stimulus presentation sequence.

SCAN system

The SCAN programs are accessed from the Program Launcher. First, double-click the SCAN 4 icon, and then see the Program Launcher. Note that a green dot appears on the Program Launcher when that program has been started. This is just a convenience to let you see what programs you have already opened. Please refer to the respective manuals for complete details for each of the programs.



ACQUIRE module. The ACQUIRE module is used for recording EEG and EP data. It records the data primarily in three formats - continuous stream (appears as scrolling EEG-like record), discrete epochs (stores series of discrete EP epochs), and averaged files. There are advantages and disadvantages to each acquisition type. In most

instances you will want to take advantage of SCAN's ability to record the entire raw data file (continuous mode) - as opposed to storing only the *epochs* or *averaged* EP data. This allows you to perform any number of offline analyses, while still having access to the original data.

EDIT module. The EDIT module is used for transforming the data files in a number of ways, including offline filtering, re-referencing, baseline correction, editing the recordings for eye movement and other types of artifact, and manual review of individual sweeps. Spectral analysis (forward and backward FFT), coherence, mean frequency, global field power and filtering are among the types of analyses that may be calculated offline. 2D and 3D Mapping and 2D Cartooning are options in the EDIT program.

NETWORK ACQUIRE module (no longer accessed from the Program Launcher). Beginning in SCAN 4.3, the Network version of ACQUIRE is part of the ACQUIRE program. It allows you to run the acquisition program from a remote computer. (You must have licenses for both computers to use Network ACQUIRE). Details are found in the ACQUIRE manual.

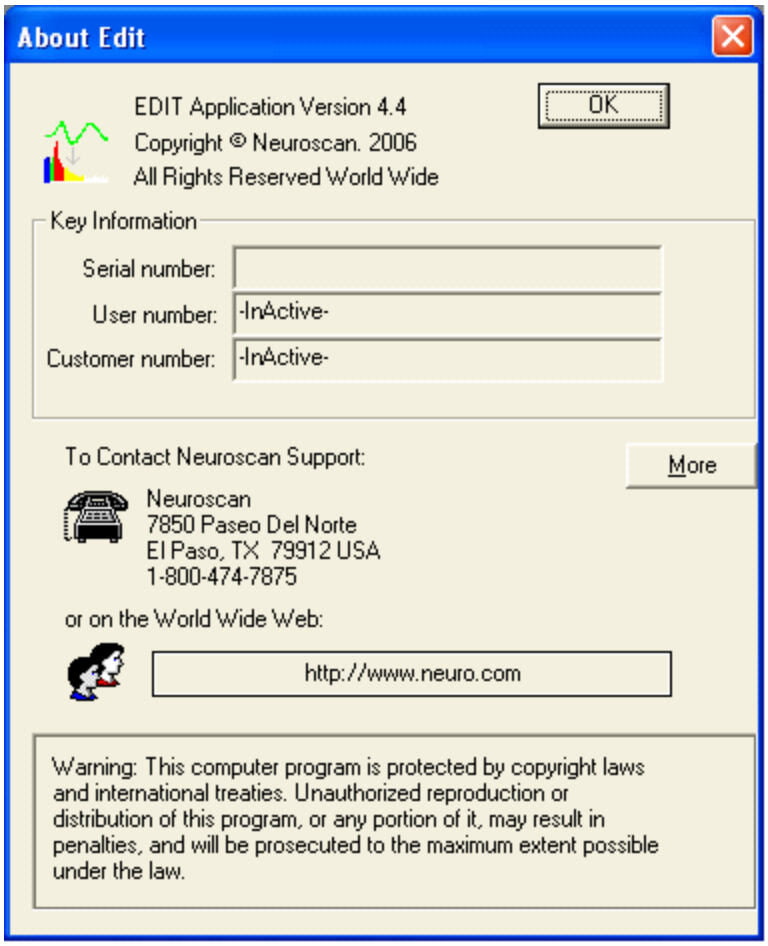
3DSpaceDx module. The 3DSpaceDx module allows you to digitize the subject's head shape and electrode positions, and create 3DD files containing the information for use in ACQUIRE, EDIT, SOURCE and CURRY.

MAPGEN module. The MAPGEN module is used for creating and modifying the two-dimensional map files used in EDIT. MAPGEN is accessed under Tools in ACQUIRE and EDIT.

AMPINST program. AMPINST.exe (ampinstall) installs the appropriate SCSI controller or USB driver files, etc., and must be run after the initial SCAN 4.5installation. You can instead install the amplifier simulator, which is useful for setup file testing. The *AMPINST.exe* program may be found in the Scan4.5 folder, and may be run by double-clicking it from the Explorer. For convenience, you can create a shortcut to it from the Desktop.

WAVEBOARD program. The Waveboard is a program that is useful for displaying multiple waveforms from multiple files, and measuring points and differences between points on the waveforms. It is accessed from the Waveboard icon  in ACQUIRE or EDIT.

Version Information. Click the "About" section of the Program Launcher  to access information about the current version of SCAN 4.5. The serial number (blank in the figure) is the number of your dongle (hardware lock in the parallel or USB port).



Stim^2 System

The Stim^2 System contains preprogrammed neuropsychological tasks, including a Naming task, the Stroop test, the Wisconsin Card Sorting test, Categories, Finger Tapping, a Spatial Memory task, and others. These may be used as stand alone neuropsychological tasks, or in combination with EEG or evoked potential recordings. More typical EP presentation protocols may be found in Contrast (VEP pattern reversal) and Audcpt (auditory resting and P300 EP recordings). In Gentask, users may create an almost unlimited variety of stimulation paradigms that might include, for example, stimuli that you create or import from other sources, and cross-modality stimulation. The Sound Editor and Image Converter modules were designed to create or import various auditory and visual stimuli.

1.6 Getting Started...

To help you get up and running as fast as possible, we have summarized the basic steps that need to be completed before you put the electrodes on. As you are aware, the Neuroscan system is not a "turn key" system. It has been designed for researchers who have a fairly clear idea what they want to do, without the constraints of hardware or programming limitations. In order to have that flexibility, it is necessary for you to tell the system exactly what you want it to do. We have made the interactive process as straightforward as possible, but it will take some time for you to tailor the system for your

own particular needs. There are some basic steps that will apply in most situations:

Basic EEG recording...

Setup file. Assuming that the hardware and software have been installed correctly, the typical first step on the SCAN side is to create a setup file in ACQUIRE. The steps are described in more detail in the SCAN Tutorials manual. In essence, the setup file configures the SCAN PC to record from a specified number of channels, label the channels, store the data in a specified format (Acquisition Type), set digitization rates, set filter levels, set automatic artifact rejection criteria, set the duration of the recording epoch, and so forth. The SCAN PC must be configured to your system and needs prior to data acquisition.

MAPGEN file. If you plan on displaying your data in the form of color 2D topographical maps, you may need to create a map "template", again, tailored to your specific number of channels and electrode positions. Standard 10-20 system labels are recognized and mapped automatically. Commonly needed MAP files are included with the system; MAPGEN is used to modify these as needed, or to create your own MAP files.

Basic Evoked Potential recording....

Setup file. In creating the Setup file, you should give some consideration to the *Acquisition Type*, mentioned above. You can record the Eps in a scrolling, "continuous" format, in which all of the data are saved, including the activity between the epochs. In other words, if you present stimuli every 2 seconds, and define the epoch to have a one second post-stimulus duration, the full 2 seconds will be recorded. The advantage is that you can reanalyze the data offline any number of times, with redefinition of the pre- and post-stimulus time points. You can also record stimulus *and response* event markers that can be used for creating over-lapping epochs, or to perform response averaging. The primary disadvantage is that the size of the data files can get very large (although this is becoming less of a concern as improvements in data storage devices occur and as hard drive capacity increases).

With the "epoched" acquisition type, only the recording epochs that you define are stored. If you are certain that you will never want to reanalyze your data using some other epoch span, or if you will not analyze the data according to the response, and if storage space is an issue, then the epoched mode may be appropriate. Realize, however, that some Transforms in EDIT require a continuous file type. For example, you can only merge the Stim^2 behavioral data file (containing Accuracy and Latency information) with a Continuous type file in EDIT. If possible, you should always record in Continuous Mode.

In general, routine EEG recordings and more complex evoked potential paradigm recordings work best with the continuous mode; simpler evoked potential recordings work well with either continuous or epoched mode. This is, however, one decision that should be considered carefully when creating your final Setup file(s). We recommend that continuous mode be used whenever possible.

Presentation of stimuli. You have a great deal of freedom with regard to the presentation of auditory or visual stimuli with Stim^2. While you might find a default

file that will let you perform a simple auditory P300, for example, it is worth the time to set up your own stimulus presentation file(s). Through the process, you will see the range of possibilities that exists with the Stim^2 system. With a simple auditory P300, you create configuration files in which you specify the pitch of the tones, their duration, their loudness, left/right or both ears, the interstimulus interval, whether a response is required, and so forth. While it does take a little extra time to set the system to do what you want, you will gain a more complete understanding of the options available with the system.

Gentask is an extremely powerful program for stimulus presentation. In Gentask, you create a *sequence file* in which you define the sequence of stimulation - one stimulus at a time. For each consecutive stimulus, you specify the type (auditory or visual, or a mix of the two), duration, position on the monitor (visual), decibel level (auditory), etc., and you can present nearly any type of auditory or visual stimuli that you create (see Gentask in the Stim^2 manual for details). In the sample recording below we will create a sequence file.

Triggering. Lastly, you will need to specify triggering information. Whether you use Stim^2 or some other stimulus presentation unit, the basic procedures are similar. Signals are sent from the stimulus presentation unit to start the acquisition of EP epochs, as well as to signify stimulus and response events in the continuous recording. The events are specified with "type codes" that you designate. For example, in a typical P300 recording, the frequently presented stimuli might be given a type code of 10, and the rare stimuli might be coded as 20. Similarly, a response with the left button of the mouse is coded as 1, and the right button response is coded as 2. Stimulus type codes are used with both continuous and epoch-based recording; response event codes are possible with continuous recordings only.

Setting up the triggering and event codes may be fairly straightforward, or rather complex, depending on the complexity of your recording paradigm, and type of stimulus presentation device. This can sometimes be confusing for users who are new to computerized recordings of EEG and Eps. Triggering is well documented in the manuals, and the setup is easily accomplished with a fundamental understanding of the logical processes involved. Please refer to Appendix A for interface options and details.

Once you have set up the stimulation and acquisition parts of the system, you will be ready to test it out. The best pieces of advice we can give to new users is to read the manuals, at least the tutorials initially, and be patient. Many of the questions we receive at Technical Support have answers in the manuals. Most users find that if they take their time and work with the system and with the manuals, they are able to solve many of the difficulties they encounter. In doing so, they gain a better understanding of how the system works. When you see how it works, you may get additional ideas for more creative applications. If you have problems, please contact Technical Support.

2 Example of a Simple Paradigm

The purpose of the next section is to walk you through the steps required for setting up all the files needed to run a basic study using Stim^2 and SCAN. In this example, we will design a simple study, create the stimulus files, create the sequence file for use in

Gentask, and create a setup file in ACQUIRE to record the data. The Stim^2 manual has additional examples near the beginning of the manual, and at the beginning of the Gentask section of the manual, and there are additional tutorials in the SCAN Tutorials, Tcl Batch Tutorial, and 3DSpaceDx manuals.

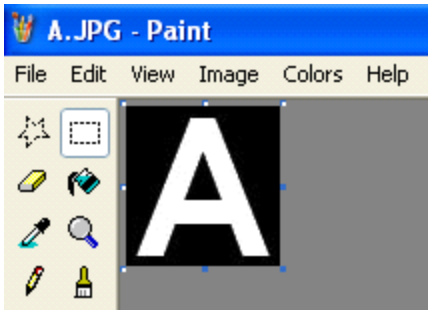
Let's say we are interested in a simple P300 study, where the stimuli are letters (A, B, C, etc.), and the "oddballs" are the vowels. The stimuli will be presented visually. The subject's task is to press the right mouse button if the letter is a vowel, A, E, I, O and U, and to press the left mouse button if the letter is a consonant.

We want to record 100ms before the stimuli, to create a prestimulus baseline, and then 2000ms after the stimuli to capture the P300 and then let it resolve to zero. We decide that the duration of the stimulus presentation will be 100ms, and that the subject has to respond within 1500ms.

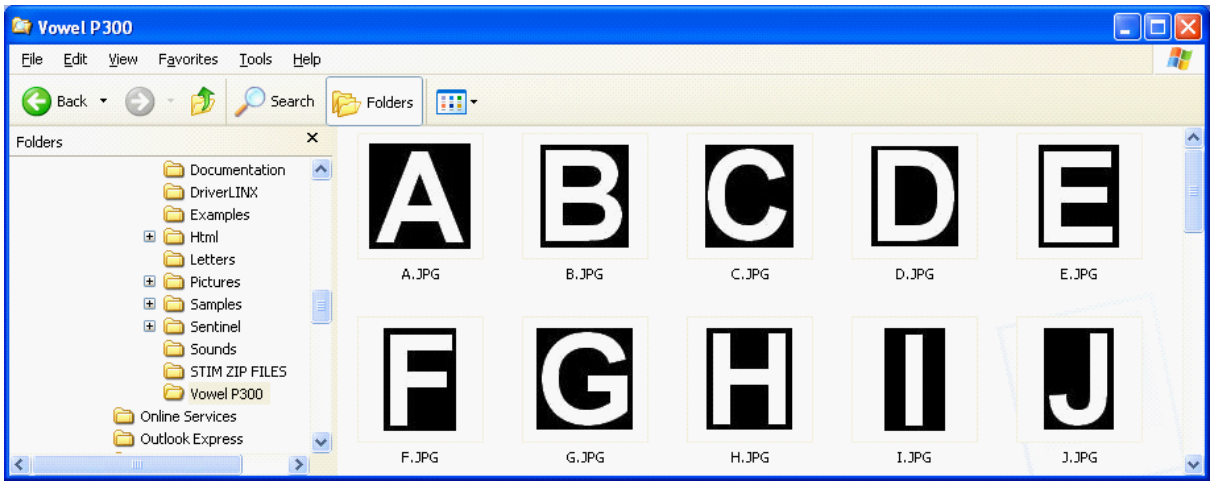
With five vowels and 21 consonants the percentage of "oddball" stimuli is 19.2%, which is in the appropriate range for a P300 paradigm. The Gentask program is the best module to use for this particular task.

Now that we have decided what we want to do, the next step is to create the stimuli. There are several ways to do this. Gentask has Mode commands called TEXT and FONT, which are used to present TXT files and to modify the attributes of the files (font, size, position, etc.). We could also use the ImageWord utility to create text stimuli. These are both described in the Stim^2 manual. A third option is to create the stimuli as graphics files. Since presenting audio and video files is the more common use of Gentask, we will use that method to illustrate the operation.

Before creating the stimuli, it is always a good idea to have a dedicated folder for the stimuli, and all other files. We will create a folder called "Vowel P300" under *\Stim2* to hold all of the files. The graphic stimuli can be created in any program capable of creating and saving graphics files - the easiest is probably Paint. We used the Arial font, bold, with 72 points. We Inverted the colors to make the letters white on a black background.



We will use a black background in Gentask, and therefore only the letters will be seen. Create the files so that the letters are centered in the image; the entire file will be positioned in Gentask. We saved the files as JPGs.



Now that the stimuli have been created, we will create an Instruction file. This is a file that is displayed to the subject just prior to the first stimulus. Create it in a text editor, such as Notepad or Wordpad, and save it as a TXT file (e.g., *instructions.txt*). The directions might appear similar to the following:

In a moment, you will see a series of letters presented one at a time: A, B, C, etc.
If the letter is a vowel (A, E, I, O and U), click the right mouse button.
If the letter is a consonant (any other letter), press the left mouse button.
Try to respond as fast as possible, but also try not to make any errors.
Please keep your eyes focused on the image in the center of the screen, and try to blink as infrequently as possible.

Note the reference to the fixation point - this is something we will include in the Gentask Parameters.

Now that the stimuli and instructions are created, we will enter the Parameters and create the sequence file in Gentask. Go into Stim^2, and then into Gentask.

We will use the Mouse as the Response Device, although we could also use the Keyboard or the STIM Response Pad. Go to **Options** → **Response Device Settings**, and make sure that the Mouse is highlighted, and that **Enable Response Output** is checked. The **Response Base Word** should be **0**. Then click **Accept**.

2.1 Creating a Gentask sequence file

All of the parameters are entered in the Gentask Parameters screen and the sequence file.

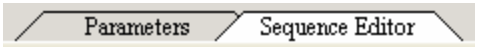
Click the yellow open file icon at the ends of each of the **Gentask Filename** and **Output Filename** fields, and enter "Vowel P300" for the file names. You may be asked if you want to save whatever *.gen file that may be loaded. Click No to not save the file. Select the Instructions file that you created for the **Instruction Filename** field. For convenience, save all of the files to the same folder containing the stimuli.

Gentask Filename	C:\Program Files\Neuroscan\Sti...\Vowel P300.gen
Output Filename	C:\Program Files\Neuroscan\Sti...\Vowel P300.html
Sequence Filename	
Instruction Filename	C:\Program Files\Neuroscan\Stim...\instructions.txt

We will not use the Feedback or Background sound files in this example.

Enter the values as displayed for the remaining parameters. Display Counter is a trial counter that can be displayed on the screen (toggle No). Select the black Background. Enter 100 (ms) for the Minimum Response Time (responses faster than this are assumed to be too fast for a genuine response, and are ignored). The program will automatically adjust the value to the nearest video refresh rate (106.67 in this case). Enable Stop Points is used only for diagnostic reasons (Disable it). Select a Fixation Type from the pull-down list, and select a color for it. The X- and Y-Positions are used to place the Fixation Point on the screen (0,0 centers it). The Fixation Radius is used to size the Fixation Point (enter 5 to make it smaller).

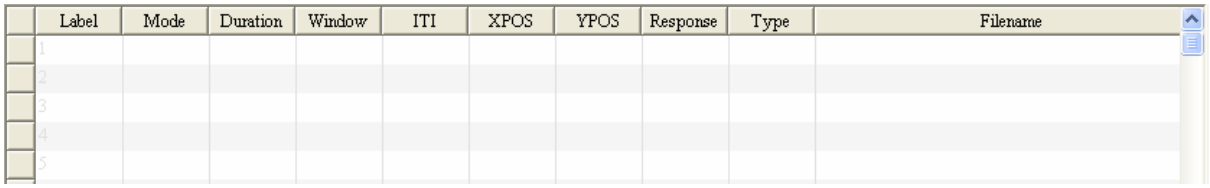
Display Counter	No
Background Color	
Minimum Response Time	106.67
Enable Stop Points	Disable
Fixation Type	Plus
Fixation Color	
Fixation X-Position	0
Fixation Y-Position	0
Fixation Radius	5

Now go to the Sequence editor 

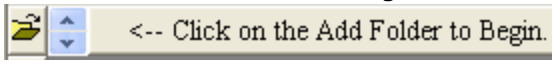
.

The sequence file will be empty unless you have already opened a different sequence file.

If the sequence file is not empty, click the  icon (upper left area), and you will see a message saying you will be asked for a new sequence file name - click OK. Then you will be asked if you want to save any changes to the existing sequence file. Click Yes or No depending on whether you want to save any changes you have made. Then you will see the Save As utility screen to enter a file name for the new sequence file you are creating (enter Vowel P300.seq). The sequence file should now be empty.

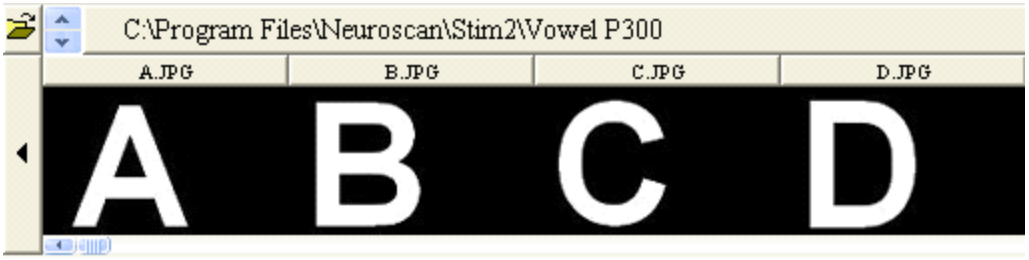


There are 10 columns in the sequence file (Label, Mode, Duration,...). These are described completely in the Gentask section of the Stim^2 manual. Some columns have multiple uses. For now, we will focus on the commands needed for this study.

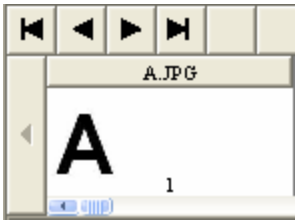
The next step is to open the file that contains the stimuli we will be using. Click the open file icon in the lower left part of the display 

, and use the 

option to select the folder in which you placed the letter stimuli. The letters will appear on the bottom row.



Now, "grab, drag, and drop" the *A.jpg* file onto the monitor on the display. You will see three changes: the monitor will show the stimulus, the row at the top of the screen will show the stimulus, and the first line will be created in the sequence file.

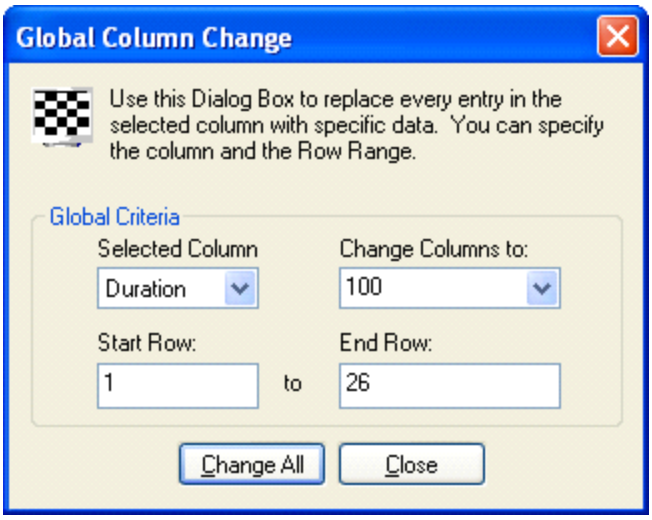


Label	Mode	Duration	Window	ITI	XPOS	YPOS	Response	Type	
	IMAGE	26.67	0.00	53.33	-54	52	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\A.JPG

Then repeat the grab and drop process for the remaining files. Do them in alphabetical order; we will randomize them shortly. Don't worry about centering the stimuli on the screen - we will do that shortly as well. You should now have 26 IMAGE lines in the sequence file.

Label	Mode	Duration	Window	ITI	XPOS	YPOS	Response	Type	
20	IMAGE	26.67	0.00	53.33	-36	182	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\T.JPG
21	IMAGE	26.67	0.00	53.33	-32	-1	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\U.JPG
22	IMAGE	26.67	0.00	53.33	-60	-9	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\V.JPG
23	IMAGE	26.67	0.00	53.33	5	158	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\W.JPG
24	IMAGE	26.67	0.00	53.33	-29	54	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\X.JPG
25	IMAGE	26.67	0.00	53.33	-33	83	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\Y.JPG
26	IMAGE	26.67	0.00	53.33	-6	29	0	0	C:\Program Files\Neuroscan\Stim2\Vowel P300\Z.JPG

The Label fields are used to define lines for loops, subroutines, etc. - leave them blank for now. The IMAGE Mode is used to present graphics files. Duration is the amount of time that each stimulus will stay on the screen. The minimum Duration is displayed by default (two video refreshes). We want the Duration to be 100ms. You could change each cell manually, but it is much easier to use the **Global Column Change** option under **Edit**. Click the Duration cell on the last line in the sequence file, and then select Global Column Change. By clicking in the Duration column first, Duration will automatically be the Selected Column. By clicking the last line in the sequence, the End Row will automatically be 26. So now just enter 100 for the Change Columns to field, and enter 1 for the Start Row. Then click Change All. The program will automatically adjust this to your computer's nearest video refresh rate (the true duration is 106.67 in this case).



Window is the Maximum Response Time. The subject must respond prior to this time (and after the Minimum Response Time you set in the Parameters section). Change the Selected Column to Window (in the Global Column Change screen), and enter 1500 (ms) in the Change Columns to field. Click Change All and all of the Windows cells will read 1500 (or the nearest video refresh rate - 1506.67 in this case)

ITI is the Intertrial Interval. This is the time from the beginning of the current stimulus to the beginning of the next one. We said we wanted the stimuli to be presented every 2000ms, so select the ITI column and enter 2000. Click Change All to change all of the ITI cells to 2000ms. XPOS and YPOS are used to position the stimuli on the screen. Change all of the XPOS and YPOS cells to 0 for each to center the stimuli on the screen.

The Response column is used to specify the correct response that is expected for this particular stimulus. A 1 means the left mouse button, and a 2 means the right mouse button. This of course depends on whether the stimulus file is a vowel or a consonant. For now, change all of the Response cells to 1. Type is the stimulus trigger type code that will be sent to SCAN. We will use type 10's for the consonants, and 20's for the vowels. Change them all to 10 for now. Then close the Global Column Change dialog box.

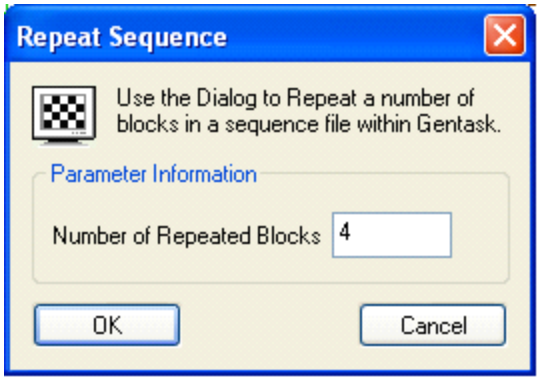
Go through the list of stimuli and change the Response cell for the vowels to 2, and the Type cells for the vowels to 20. The sequence file should now appear as follows (shown in part).

Label	Mode	Duration	Window	ITI	XPOS	YPOS	Response	Type	
1	IMAGE	106.67	1506.67	2000.00	0	0	2	20	C:\Program Files\Neuroscan\Stim2\Vowel P300\A.JPG
2	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\B.JPG
3	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\C.JPG
4	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\D.JPG
5	IMAGE	106.67	1506.67	2000.00	0	0	2	20	C:\Program Files\Neuroscan\Stim2\Vowel P300\E.JPG
6	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\F.JPG
7	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\G.JPG
8	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\H.JPG
9	IMAGE	106.67	1506.67	2000.00	0	0	2	20	C:\Program Files\Neuroscan\Stim2\Vowel P300\I.JPG
10	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\J.JPG

We now have one block of 26, non-randomized stimuli. If you were to run the sequence file now, you would see the 26 letters presented one at a time, in alphabetical order. We

need to increase the number of times each file is presented, and we want to randomize all of the lines. You could drag-and-drop the files many more times, selecting them randomly, until you get a file with a few hundred lines. Fortunately, there are easier ways to do this. We will copy the block of 26 lines 4 more times, giving a total of 130 lines. Then we will randomize all of the lines, and lastly set the sequence of 130 lines to be repeated. This assumes that the subject will not recognize that the sequence is repeating after every 130 lines - a fairly safe assumption.

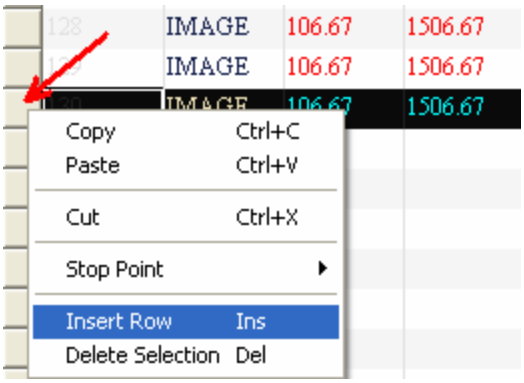
To copy the existing block, go to **Transforms**, **Repeat Block**, and enter 4 for the Number of Repeated Blocks, then click OK. The sequence file is now 130 lines long.



The next step is to randomize the entire sequence file. We first need to highlight all of the lines in the sequence file. Click the far left cell on the first line to highlight that line. Then, using either the mouse wheel, or the sliding bar at the far right of the display, got to the end of the sequence file. Click again in the far left cell, only hold down the Shift key on the keyboard when you click the mouse (Shift+left mouse). This will highlight the entire file. Go to **Transforms**, and select **Random Sample w/o Replacement**. The lines will then be randomized. If you do not like the sequence that was created, repeat the process.

IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\L.JPG
IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\Y.JPG
IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\Q.JPG
IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\F.JPG
IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\P.JPG
IMAGE	106.67	1506.67	2000.00	0	0	2	20	C:\Program Files\Neuroscan\Stim2\Vowel P300\I.JPG
IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\D.JPG

Now, we said we would repeat this sequence of 130 lines rather than create a very long sequence file. All we need to do is add a GOTO line at the end of the sequence, telling the program to go back to the beginning. Go to the last line in the file, and click the box to the left of the Label field (see the red arrow) to highlight the entire line, then right click in the same box, and select the Insert Row option. This lets you add a line after the last line. On the new line, under Mode, select GOTO. Under Duration, enter "Start". Now go to the very first line in the sequence (click Ctrl+Home), and enter "Start" in the Label field. Now the sequence file will run indefinitely. We can stop it manually by clicking the Esc button. (We could also have the program repeat the sequence X number of time by using a Counter).



The beginning and end of the final sequence file appear as follows:

Label	Mode	Duration	Window	ITI	XPOS	YPOS	Response	Type	
Start	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\W.JPG
2	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\F.JPG
3	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\H.JPG
128	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\X.JPG
129	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\P.JPG
130	IMAGE	106.67	1506.67	2000.00	0	0	1	10	C:\Program Files\Neuroscan\Stim2\Vowel P300\P.JPG
131	GOTO	Start	0	0	0	0	0	0	0

Save the sequence file by clicking the icon. Say Yes when asked if you want to save the changes to the sequence file. Run the sequence file by clicking the button. The stimuli files will load, and you will then see the Instructions appear. Click Enter to run the task.

When the task is completed (when you click the Esc key), you will be returned to Gentask. Go to the Parameters screen, and the results will be displayed in the upper right field. Click the icon for the Output Filename field to see the results in the Internet Browser.

Gentask Filename	C:\Program Files\Neuroscan\Stim2\Vowel P300\Vowel P300.gen
Output Filename	C:\Program Files\Neuroscan\Stim2\Vowel P300\Vowel P300.html
Sequence Filename	C:\Program Files\Neuroscan\Stim2\Vowel P300\Vowel P300.seq

There is a Stim and a Resp line for each trial. The Trials column is numbered consecutively because it lists all of the events in the file - stimulus and response. On the Stim lines, the Response column shows which button was clicked (0 = no response; 1 = left mouse; 2 = right mouse). Type is the *stimulus* trigger type code sent to SCAN. The Correct column shows whether the response was correct or not (0 = incorrect; 1 = correct; no responses are scored as 0). Latency is the time from the presentation of the stimulus to the button press. If no response has been made, the Latency will be the ITI. The Resp lines show the *response* type code that was sent to SCAN. Notice how we differentiated the stimulus (10 and 20) and the response (1 and 2) type codes so there would be no confusion in SCAN (see the Stim^2 manual for more details).

Trial	Response	Type	Correct	Latency (ms)	Stim/Resp
1	1	10	1	232	Stim
2	0	1	0	0	Resp
3	1	10	1	232	Stim
4	0	1	0	0	Resp
5	2	20	1	241	Stim
6	0	2	0	0	Resp
7	1	10	1	258	Stim
8	0	1	0	0	Resp
9	1	10	1	290	Stim
10	0	1	0	0	Resp

Now that we have the stimuli created, and the Gentask files to present them, the next step is to create a setup file in ACQUIRE to record the EEG.

2.2 Creating an ACQUIRE setup file

On the SCAN PC, start the **ACQUIRE** program. To acquire data, you must first select an existing "setup" file, or create a new one (**.ast* extensions). Setup files contain a considerable amount of information, and you would typically use the same setup file for all data recorded in a study. The setup file contains, for example, the number of EEG channels and their labels, the acquisition parameters (sampling rate, gain, filter settings, online average parameters, etc.), and additional settings. Once created, the setup files can be saved so you do not have to create them again.

With higher density recordings, you will likely be using an electrode cap, and we supply setup files for the caps we offer. It is generally best to use one of the provided setup files, making minor modifications to it as needed. You can, however, create setup files from scratch. In this example, we will use an existing setup file for 68 channels. Existing setup files may be found in the *C:\Documents and Settings\All users\Application Data\Neuroscan\Scan4.5\Setup Files* folder, with subfolders for *SynAmps*, *SynAmps*^{2}, *NuAmps* and *Synamps Wireless* (for Vista, the files are in the *C:\ProgramData\Neuroscan\Scan4.5\Setup Files* folder). ***SynAmps*^{2} and *SynAmps RT* are considered the same amplifiers in ACQUIRE (there is no distinction between them)** .

For this example, go to **File** → **Load Setup** (or click the  icon), and select the *Synamps2 Quik-Cap64.ast* setup file. You can see the loaded setup file in the lower right hand corner, on the Status Bar 

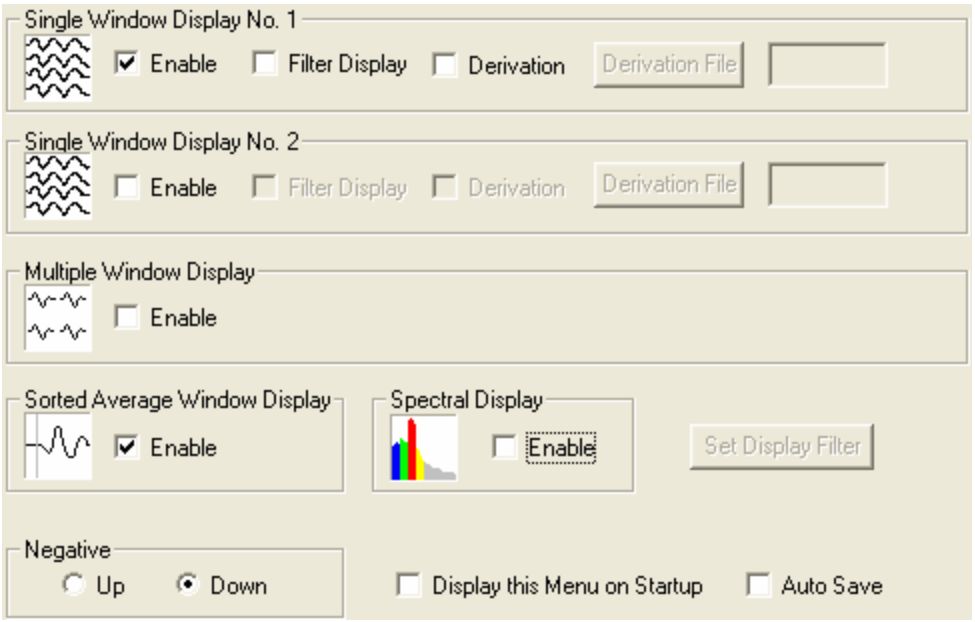
.

Then go to **Edit** → **Overall Parameters** and click the **Startup** tab.

 **Note**
If you have *SynAmps* or *NuAmps*, you will see slight variations in some of the options. See

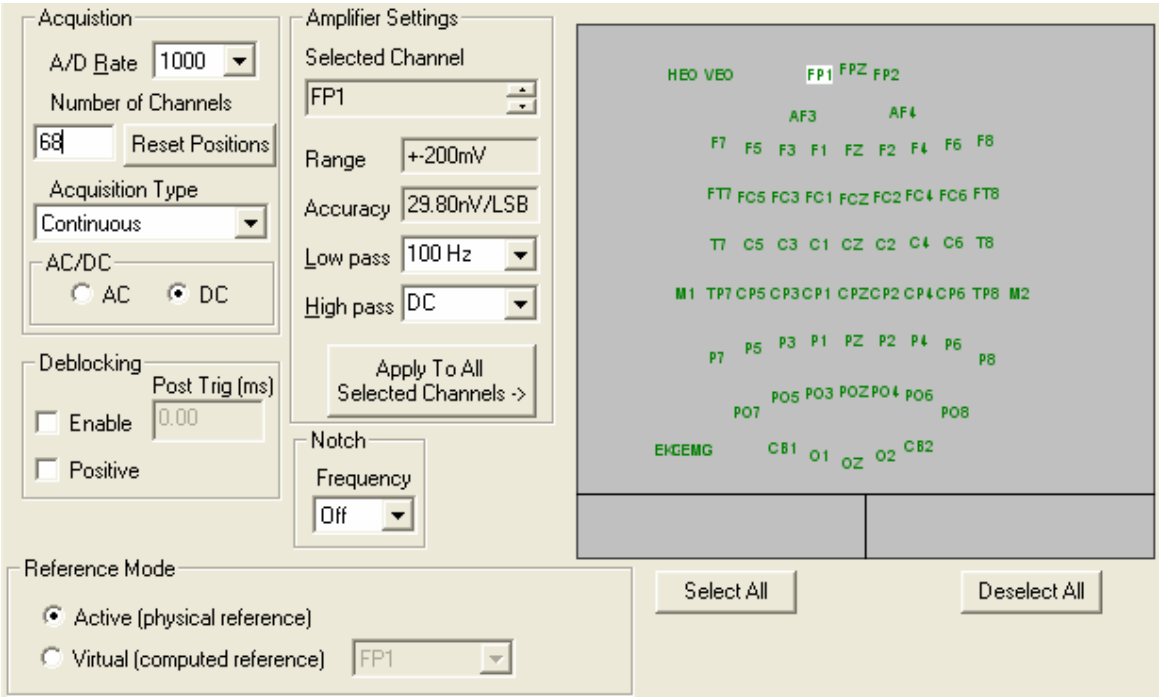
the *SynAmps* or *NuAmps* manuals for options that are specific to them, and see the section at the end of the ACQUIRE manual for a summary of the differences.

Startup. The **Startup** screen is used to select the type(s) of displays that you will see during data acquisition, as well as for some online filtering and other online options. For this example, enable **Single Window Display No. 1**. The **Sorted Average Window Display** is enabled automatically when you enable the online average field in the Sorting display, described below (enable it now, if desired). If you have a preference for whether **Negative** voltage is displayed up or down on the y-axis, select your choice. Leave the other options disabled.



Then click the **Amplifiers (SN2)** tab.

Amplifiers (SN2). The first decision is what AD rate to use. This is the sampling or digitization rate (how often the continuous signal is sampled). You can also think of this as temporal, or x-axis resolution. If you have epochs from 0-1000ms, and an AD rate of 1000Hz, you will have data points every 1ms, or a 1ms resolution. If you are interested in very fast frequencies, such as ABRs or EMG activity, you will want a fast AD rate. The general rule of thumb is: you should 5x oversample the highest frequency of interest. If all you cared about was alpha, you could, theoretically, use an AD rate of 50 (100 is the lowest option). Another point to consider is that as you double the AD rate, you are also doubling the file size. For the basic evoked potential recordings in this demonstration, an AD rate of **1000** will easily give the temporal resolution we need, yet not result in needlessly large data files.



The number of channels for this setup file is **68** (leave that for this example). There are four acquisition types, or modes. For this demonstration, select **Continuous**. This will record the entire data stream, and we can create epochs offline. Continuous is the preferred acquisition mode because of the increased offline flexibility it allows. If you have a *SynAmps* or *SynAmps*^{2}, select **DC** mode. Leave the 60Hz (or 50Hz) **Notch** filter disabled.

The Amplifier Settings section lets you set individual Filter parameters for all or selected channels. For filter settings we recommend recording with as wide a band pass as possible. You can always digitally refilter the data offline. Depending on your particular interests you may wish to filter out faster or slower frequencies that are of no interest and serve only to obscure the online frequencies of interest. Note that there is a relationship between the AD rate and the highest available Low Pass filter. The program imposes a 5x oversampling rate. For example, if you have an AD rate of 500, the highest available low pass filter setting is 100Hz. If the AD rate is 1000, the highest low pass filter is 200Hz, and so on. For this example, if you have a *SynAmps*^{2}, select a Low Pass of **100**Hz and a High Pass of **DC**Hz.

The montage display allows you to apply the Filter settings to individual channels (*SynAmps* and *SynAmps*^{2} only). For this example, we'll leave the settings the same for all channels. Make sure that the labels are all green in the montage display (click the 

button, if needed). Then click the 

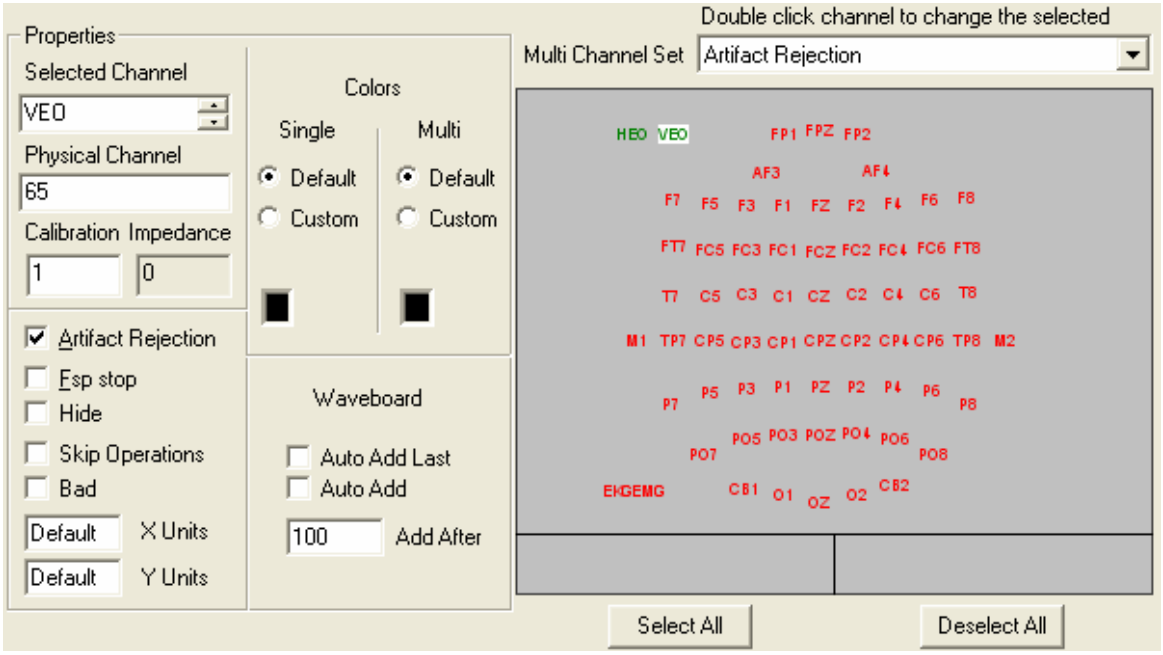
button to apply the changes to all channels (the channels in green will be affected).

If you have a *SynAmps* system, you may set the *Gain* and Filter settings individually for each channel. If you have *SynAmps*^{2} or *NuAmps*, the Gain is fixed, but you can set the filter settings individually for each channel. With a *SynAmps*, the next decision is what Gain to use. Gain will determine two things: the Range of acceptable input

signals (how large signals can be before amplifier saturation occurs), and the voltage, or y-axis resolution, or Accuracy. These two factors are inversely related. The greater the Range, the lower the voltage resolution. There are about 65000 discrete points (16 bits) that are available for measuring voltages. If these are spread over a wide range, there is a greater distance between points, and therefore a lower resolution. If the points are concentrated in a narrow range, there is a smaller distance between points - finer resolution. Thus, there is a trade-off between range and resolution. For conventional EP and EEG recordings, a Gain of 500-1000 is a good compromise (select *1000* for this example).

With *SynAmps*^{2}, there is no Gain setting. The Gain is fixed, but differs between AC and DC modes. In AC mode the Gain is approximately 2010, and in DC mode it is approximately 10. With *NuAmps*, there is a single Gain setting of 19. Both *SynAmps*^{2} and *NuAmps* have such large dynamic ranges it is not necessary to specify the Gain.

Channel Attributes. Now, click the **Channel Attributes** tab. These fields are used to set a variety of attributes for some or all of the channels. For example, you can relabel the channels, set specific ones to be Artifact Rejection channels, change the color of the waveform for specific channels, and so forth. For this example, let's set the **Artifact Rejection** channels. Artifact Rejection works as follows, and is essentially the same in both online and offline operations. Channels are designated for artifact monitoring. Voltage threshold values are entered. If the voltage in one of the designated artifact channels exceeds the threshold, the sweep is rejected. Since we elected not to use the online Artifact Rejection for the sorted averages, there will be no online artifact rejection (artifact rejection does not apply to the continuous file we will be storing). Artifact Rejection can be performed offline after you epoch the continuous file. If the artifact electrodes are selected in the setup, that information will be carried with the data file, and you will not have to designate the electrodes later.



Typically, the VEOG and HEOG channels are the artifact rejection channels, but other

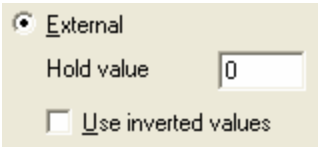
ones may be used depending on your particular needs. Make sure that the **Multi Channel Set** field is displaying Artifact Rejection: 

. The channels in the montage display are all Deselected by default. Double-click the VEO and HEO channels to Select them. They will turn green and the 

field will be Enabled. You can identify Artifact Channels in the data file - online or offline - by the asterisk that will appear after the electrode label 

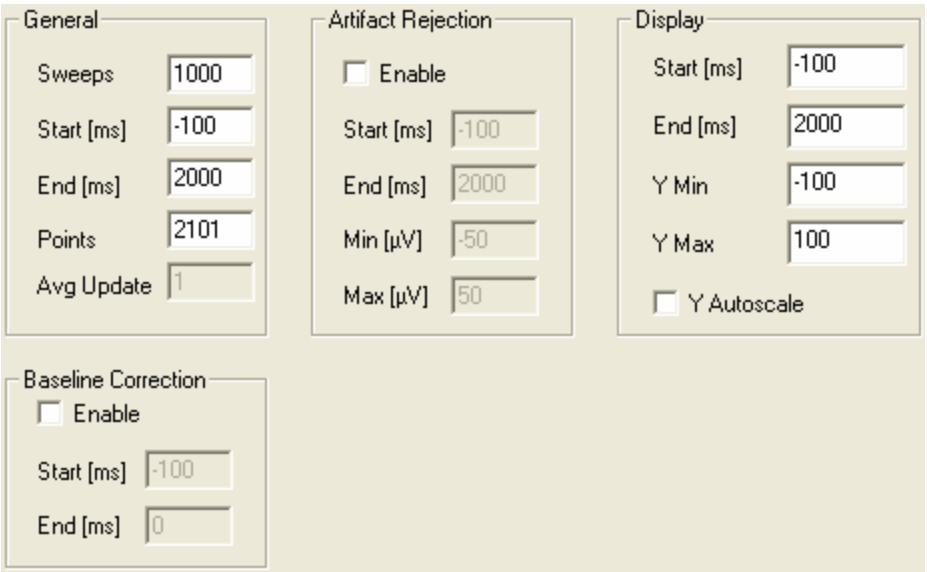
.

These channels are now designated Artifact Rejection channels.

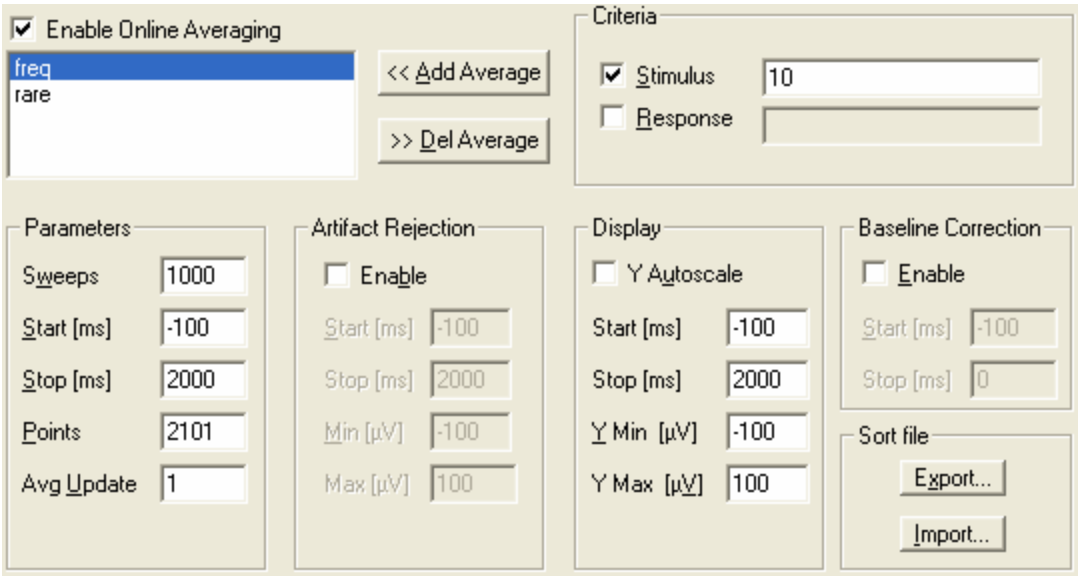


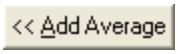
Triggers. Now click the **Triggers** tab. With a Stim^2 system, select **External,** a **Hold value** of 0, and do not enable **Use inverted values**. For other stimulus presentation systems, whether you **Use inverted values** depends on several things, and there is no simple way to determine what the setting should be for every possible equipment configuration. The best thing to do is to try it without inverting the triggers, and, if you do not see any triggers during acquisition, then try it again with inverted values (see also Appendices A and B).

Epochs. Next, expand the **Epochs** panel. In continuous mode the epochs settings have no direct effect. However, the settings that are entered here are carried over when you do the epoching offline. Therefore, it will save some steps later to enter the information here. **Sweeps** has no effect in continuous mode (enter *1000*). At the beginning of this example, we said that the eventual sweeps will range from **-100** (100ms pre-stimulus) to **2000**ms. Enter those values for the **Start** and **End** points. The **Points** value will be calculated automatically (**2101**, with an AD rate of 1000). Leave the **Artifact Rejection** and **Baseline Correction** *off* (unchecked) for this example, and use the **Display** values that appear.

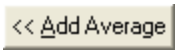


Sorting. It might be useful to display the "rare" and "frequent" Eps online as they develop to insure that we are obtaining good responses. Click the **Sorting** tab, and Enable the **Enable Averaging** field.



Click the 

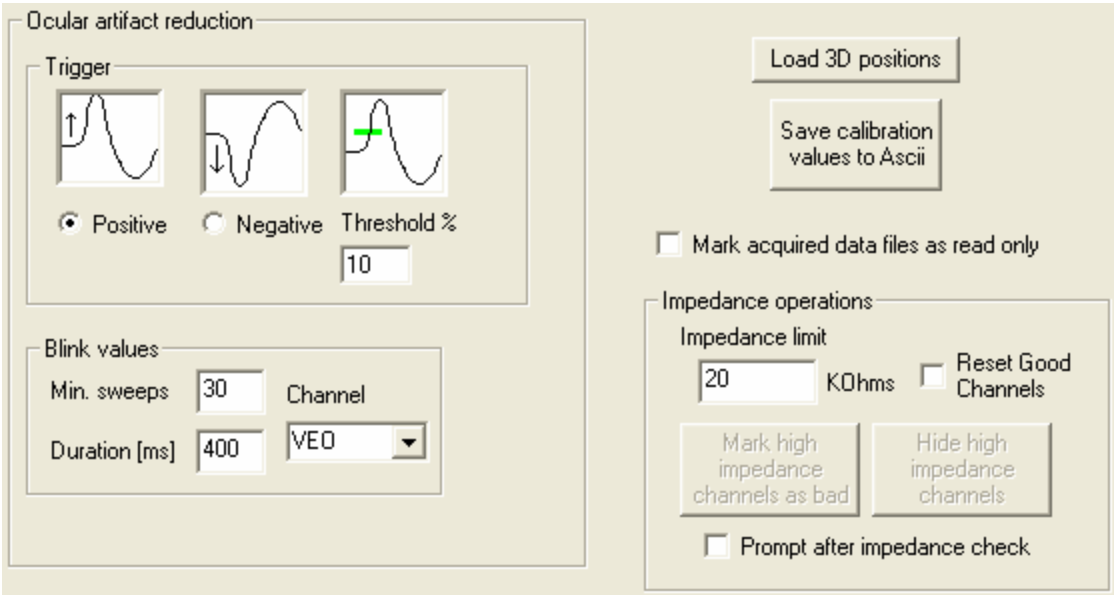
button, and the Save File utility will appear. Enter a file name for the responses to the consonant stimuli (call it *freq*). Enable the **Stimulus** field and enter **10** - the type code we set in the sequence file for the consonant stimuli.

Click the 

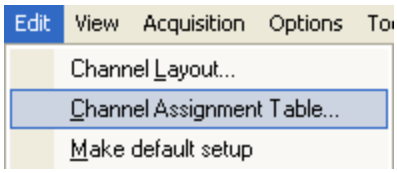
button again, and enter a file name for the responses to the vowel stimuli (call it *rare*). Enter **20** in the Stimulus field (as specified in the Gentask sequence file). Set the remaining settings as desired. By highlighting the "freq" and "rare" file names, you can see the settings for each average file.

Under **Parameters**, verify that **Sweeps** is **1000**, **Start** is **-100**, **Stop** is **2000**, and **Points** is **2101**. **Avg Update** lets you set how often the online average wave form display gets updated. To update with every stimulus, enter **1**. Leave the remaining fields off (not enabled).

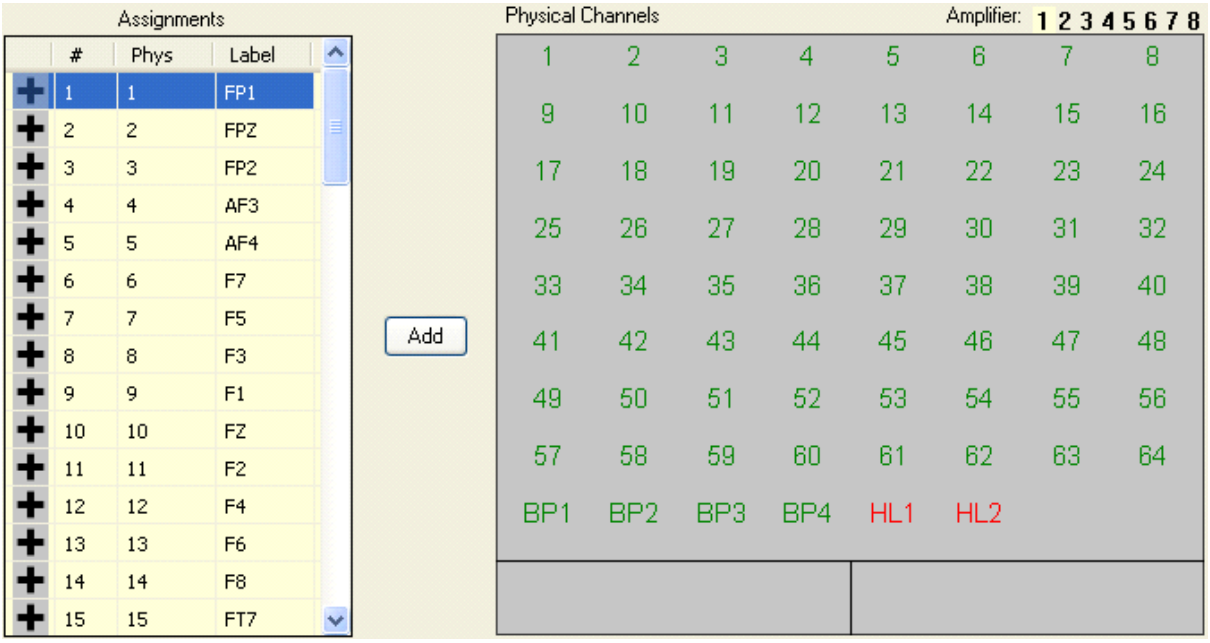
Miscellaneous. The miscellaneous tab lets you enter several settings that may be useful. Entering settings in the setup file means you do not have to reenter the settings for each file when you analyze them in EDIT.

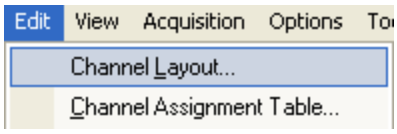


For example, you can set the Ocular Artifact Reduction parameters (for offline use), load 3D position data, save the calibration values to a text file (*SynAmps* only), set the files as Read Only, and automatically mark as Bad or Hide any channels that have unacceptable impedances. These options are all described more completely in the ACQUIRE manual.



Channel Assignments. Then go to **Edit** → **Channel Assignment Table**. This screen allows you to enter the labels for the electrode positions (FP1, FP2, etc.). If you are remapping the channels, you may set the new order using this screen (*SynAmps*; refer to the *SynAmps*, *SynAmps*^{2}, and/or ACQUIRE manuals for more details). The setup file we selected matches the 68 Channel Quik-Cap. Other setup files match other caps. The advantage of using an existing setup file is that you do not have to enter the labels for the channels. This greatly facilitates the creation of the setup files. For this example, we will leave the Channel Assignment Table as it is (click **Cancel**).

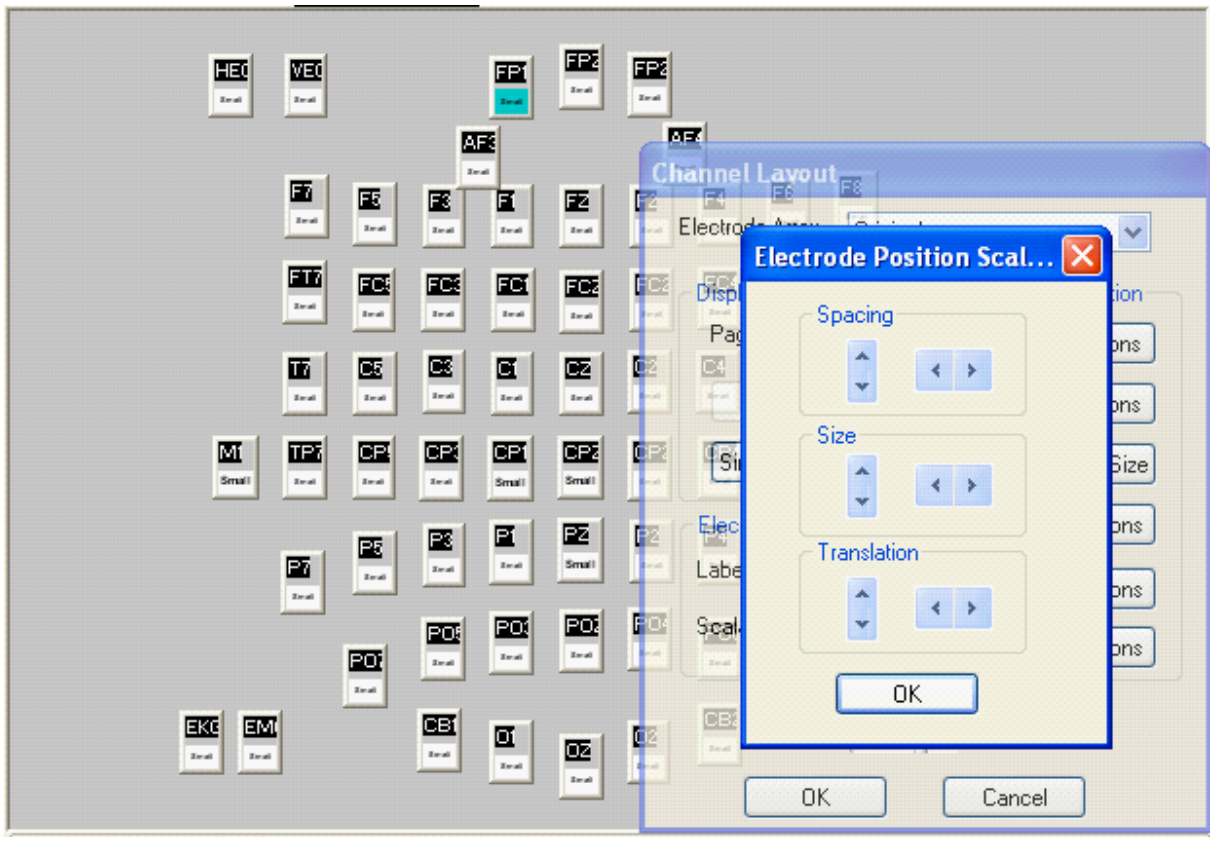


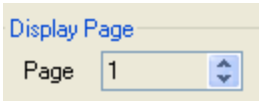


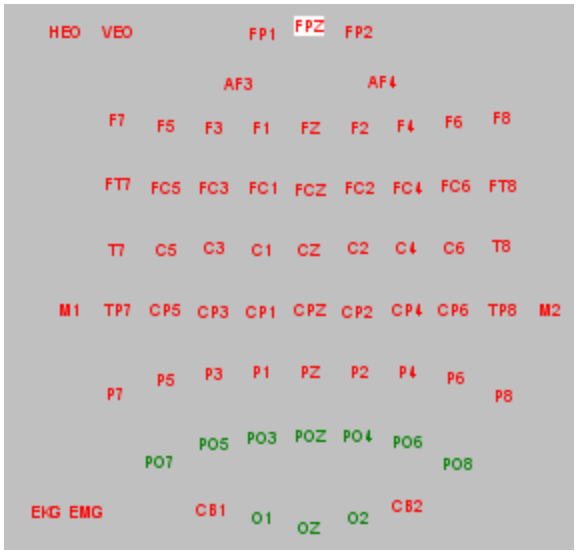
Channel Layout. Next, go to **Edit** → **Channel Layout**. This screen is used to resize and rearrange the Multiple Window displays, to create additional display pages, and to import and export the electrode positions.

For now, click the 

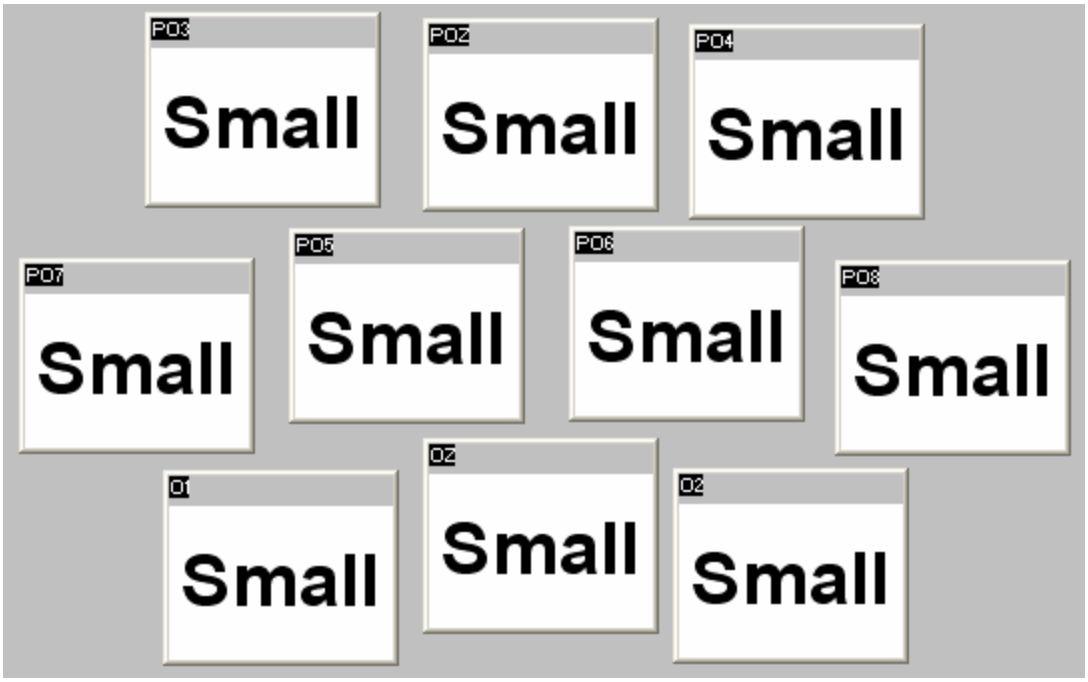
button. The buttons on the resulting display let you reposition the windows on the display and resize all the windows at the same time.



Click **OK** to close the display. If you wanted to create additional display pages, click the  up arrow to show Page 1, then click  . Select the channels you want to display. Since we are looking at VEPs in this example, we might want to show only the posterior channels.



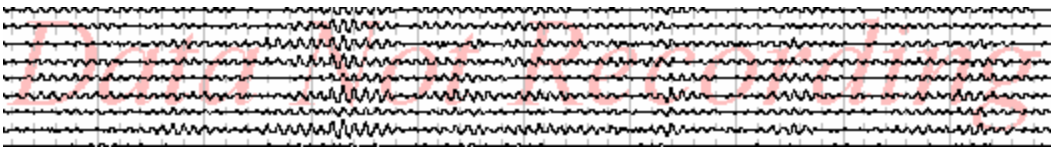
Select them and then position the windows as desired. (Click the  icons to cycle through the display pages while acquiring or reviewing the data).



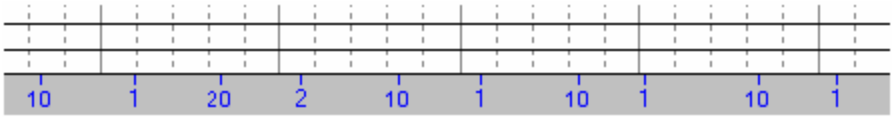
Save the setup file, if desired, using a different name (to preserve the original setup file as it was). The remaining options are described in the ACQUIRE manual.

2.3 Stimulation and acquisition

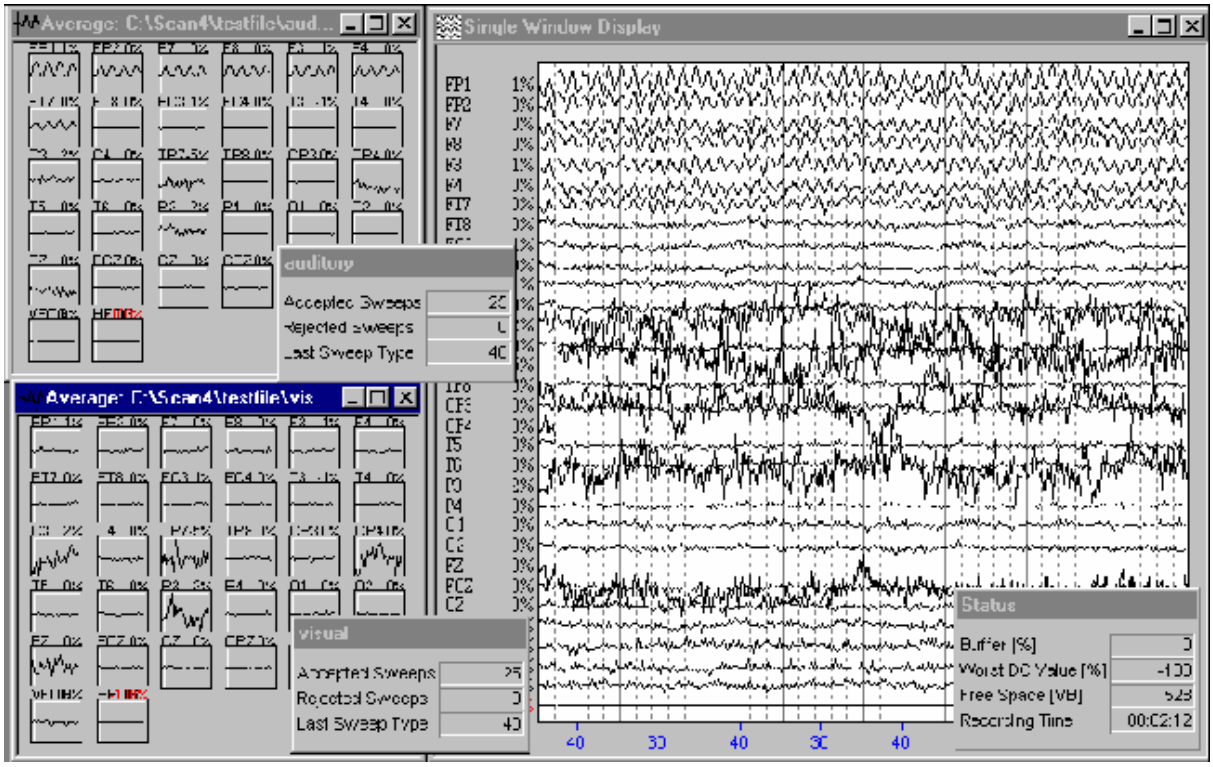
Now, we should try out what we have created so far. Always test your various setup and sequence files before trying to record from a subject. In Stim^2, set Gentask so it is ready to run the sequence file we created. Then, in ACQUIRE, click the green arrow  on the Toolbar to begin acquisition. You will be asked to enter a file name for the two sorted average *.avg* files, then the acquisition screens will appear. You will see a reminder message that the data are not being recorded - it will disappear when you begin data storage.



Resize and reposition the windows and status boxes, as desired. Click on the **Record** icon  and enter a file name for the continuous (.cnt) recording. Then press the  button in Gentask to begin stimulation. You should see the trigger type codes from Gentask appear



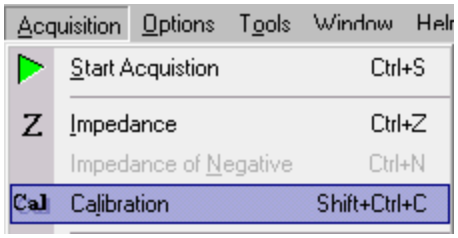
as blue numbers on the bottom of the Single Window Display in ACQUIRE. The 10's and 20's are the stimuli; the 1's and 2's are the responses. If you are using the STIM Response Pad, the responses will appear in red. The entire screen might be set to appear as:

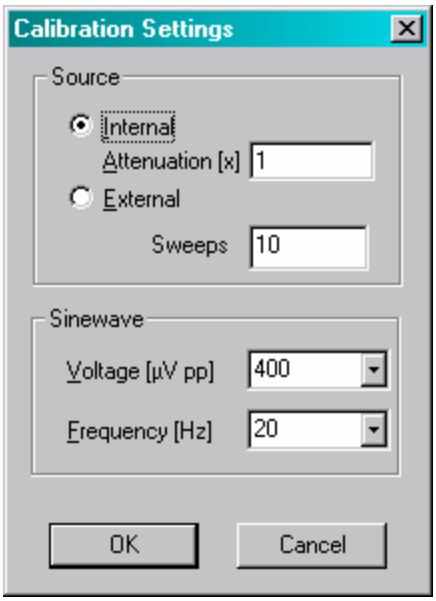


Go ahead and save the continuous file for the duration of the sequence file in Gentask (stop it using the *Esc* button).

2.4 Calibration (SynAmps only)

Before recording genuine data with *SynAmps*, you should perform an amplifier *calibration* (for more details, please see the Calibration section in the ACQUIRE manual, or the *SynAmps* manual). The current versions of *SynAmps Wireless*, *NuAmps* and *SynAmps*^{2} have no calibration option (the amplifiers are set in the factory, and no adjustments are needed). If you have a *SynAmps*, click **Acquisition** → **Calibration** (or click the Cal icon from the Toolbar).

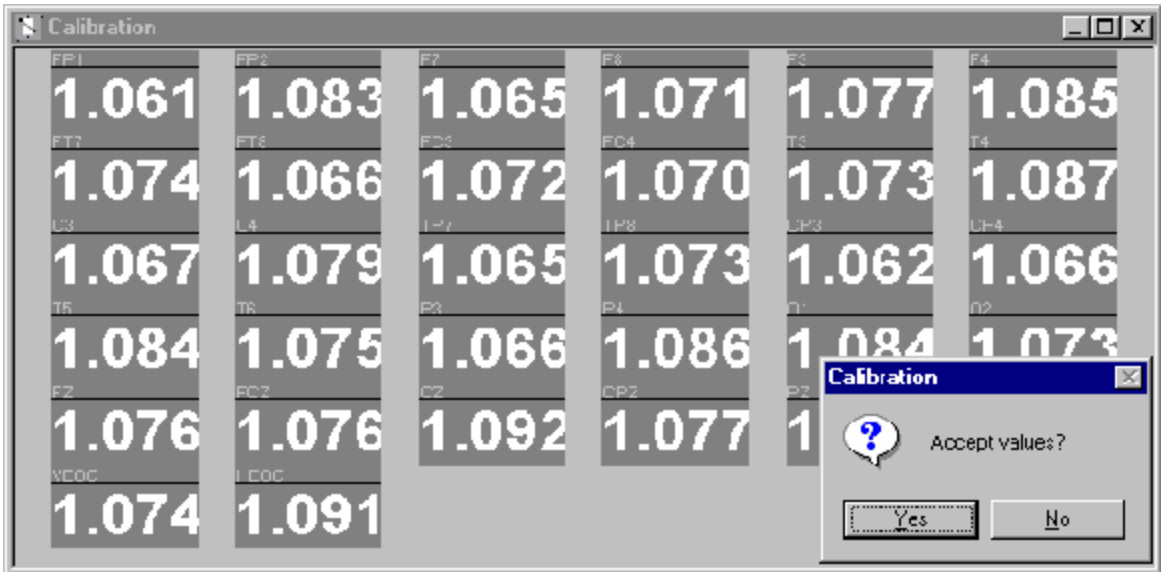




Make sure the shorting plug is in the head box, then use the default settings on the screen (Internal, Attenuation [x] 1, 10 sweeps, 400µV, and 20Hz).

The shorting plug connects into the side of the SynAmps head box, adjacent to where the head box cable to the SynAmps plugs in. Its purpose is to short all the channels together. Remove it after Calibration, or else you will see nothing but flat lines when you try to acquire data.

Click OK, and the system will pass a 20Hz sine wave through all channels. If the display shows a flat line, click the Up arrow a few times. After the 10th sweep, you will see the calibration values for all channels. These should be approximately 1.0 (with a *SynAmps*, they usually run a little higher, about 1.05 to 1.1).



Accept the values, and then ***save the setup file again*** before you start acquisition. You

must save the setup file with the Calibration values for them to be applied.

2.5 Impedance testing

If you were running a real subject, you would measure impedance first to make sure the electrodes were on securely. These steps are discussed in more detail in the ACQUIRE manual, and, if applicable, the *SynAmps* manual. With the *SynAmps*, *SynAmps*^{2} and *NuAmps* amplifiers, there are some additional considerations. These amplifiers are full range, true DC capable amplifiers, meaning that you can record signals ranging from slow DC, to fast EMG, to very fast ABR frequencies (except *NuAmps*). Because it is a true DC amplifier, you need to pay more attention to *battery potentials* that may build across electrodes (see also the "DC electrode considerations" section of the *SynAmps* manual, and the "Battery Potentials and DC Offsets...." Technical Note on the web site).

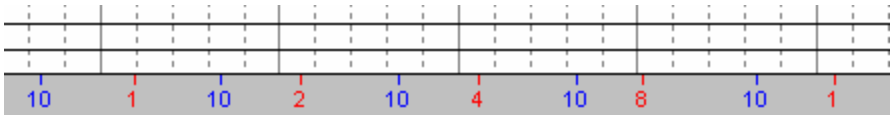
One of the common problems new users encounter is the inability to get acceptable impedances (e.g., below 5kOhms). If your impedances are high in all channels, and you are fairly certain that the reference and ground electrodes have good contact with the skin, *DO NOT KEEP DIGGING IN THE SUBJECT'S SCALP*. There may be a battery potential difference between the EEG electrodes and the reference electrode(s). This can happen if you mix metals, use different conductants, have scratched or pitted electrodes, or electrodes made of inferior quality metal. Using a DC voltage meter, measure the DC potential between electrodes. If it is too high (greater than about 18mVs), you have a problem with your electrodes that needs to be resolved before you make a recording.

Generally we suggest that before you perform the actual Impedance measurement, you monitor the signals from all channels in a Single Window Display, in DC mode. Touch up the channels that are saturated, popping, have high noise levels (50 or 60Hz), or have a high percentage of DC offset. If necessary, reduce the Gain (under **Edit → Overall Parameters**; *SynAmps only*). This increases the range, and will thereby accept signals with a greater DC offset (before saturation occurs). When all of the channels look good, with acceptable DC offsets, then do the Impedance measurement. If there is a DC problem you will see it, and thereby avoid needless discomfort to the subject from pointless scraping of the scalp. ***With SynAmps, make sure the shorting plug is OUT when you do Impedance testing.*** If it is in, all channels will be shorted, and you get essentially 0 Ohms from all electrodes.

In this demonstration we created some simple stimuli, a sequence file to control their presentation, and a setup file in ACQUIRE to record the evoked responses. If you were able to perform all of these steps, and were able to see triggers in ACQUIRE, then your system is configured correctly. One more thing to test are the responses from the STIM Response Pad.

2.6 Response Pad test

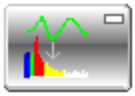
To perform a quick test of the Response Pad, start the same setup file used above. It is not necessary to be running the Gentask sequence file - just press the response pad buttons (you do, however, need to have started at least one Stim^2 task after switching the STIM box on to activate the response pad). You should see type codes of 1, 2, 4 and 8 corresponding to response pad buttons 1, 2, 3, and 4. These will appear in red at the bottom of the Single Window Display.

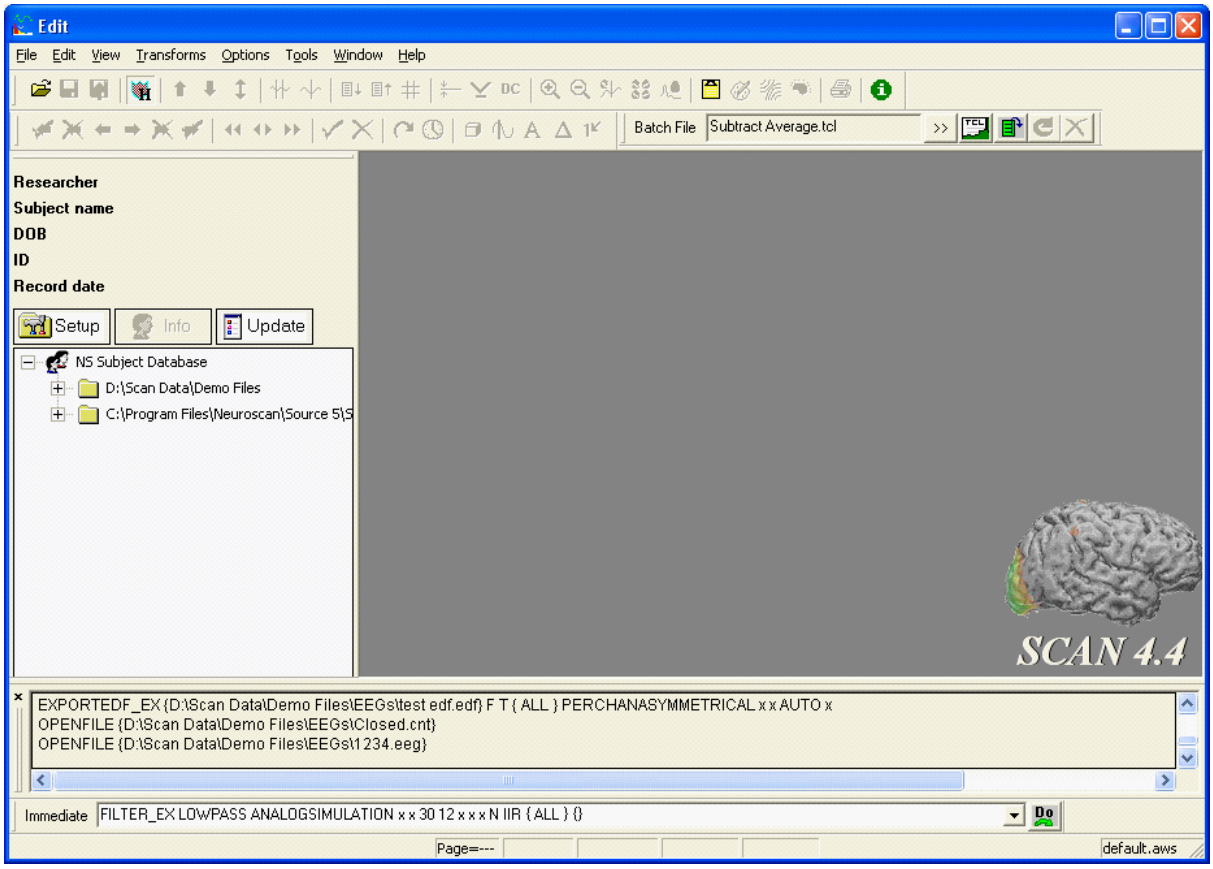


Since the Responses in the above example were made with a mouse, you should retrieve the behavioral data file from Stim^2, and merge that file with the CNT file. The behavioral data file will have the same name as the Output Filename, except it will have a DAT extension. It is stored in the same folder as the Output results file. Merge it with the CNT file in EDIT, using the "Merge task data" Transform. Merging the DAT file will convert the blue mouse responses to red STIM Response Pad responses. It will also give you access to the Accuracy and Latency data, should you wish to sort trials based on these parameters (for example, you might average only those epochs in which the subject responded correctly, within a specified latency range).

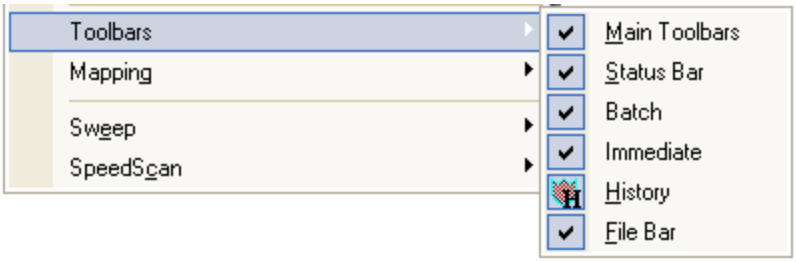
2.7 Introduction to Analysis

The Scan Tutorials will guide you through some basic analysis operations. As a preliminary introduction to the Tutorials, we will present some of the fundamental operations, options and features that are possible with the EDIT program (many of the same features are also available during acquisition in ACQUIRE).

From the Program Launcher, click the EDIT button  , and the main display will appear.



All of the possible displays are shown in the figure above. If you do not see all of them, go to (on the Main Menu Bar) **View** → **Toolbars** and enable the options. The complete descriptions of the options are found in the EDIT manual. A brief description follows.



Main Menu Bar. The Main Menu Bar - *File, Edit, View*, etc. - accesses pull-down lists of options for many of the features in EDIT.

Main Toolbars. The Main Toolbars contain icons that most quickly access many of the main features in EDIT. There are actually two Toolbars (Main Toolbar and Sweep Toolbar), and you can undock either or both and position them for easier access.

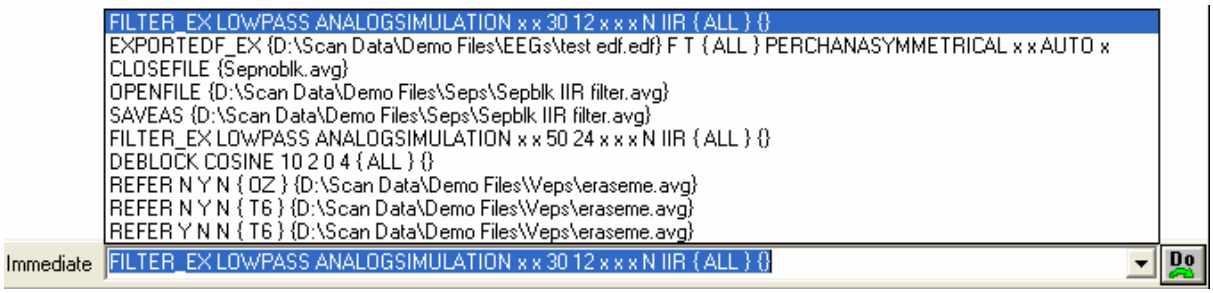
Status Bar. The Status Bar displays the Workspace file you are currently using (*.aws extension). The workspace file contains windows size and position information, as well as many display options (as set under **Options** → **Multiple** and **Single Window Settings**).

When you have retrieved a data file, and move the mouse over a waveform, you will also see time and voltage measures and the current display page in the Status Bar.

Batch toolbar. This control bar is used to retrieve Tcl Batch files you have created, to access the Tcl Batch Editor, and control the execution of your batch files.

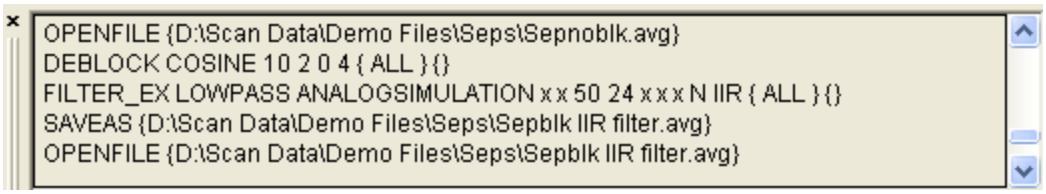
Immediate control bar. When you execute a transform, the corresponding Batch line is created automatically and appears in the Immediate field. This lets you apply the same command to any file you have retrieved in EDIT. It functions like a one-line Batch program; click the 

button to run the single command. The pull-down list contains the most recent commands that were executed.

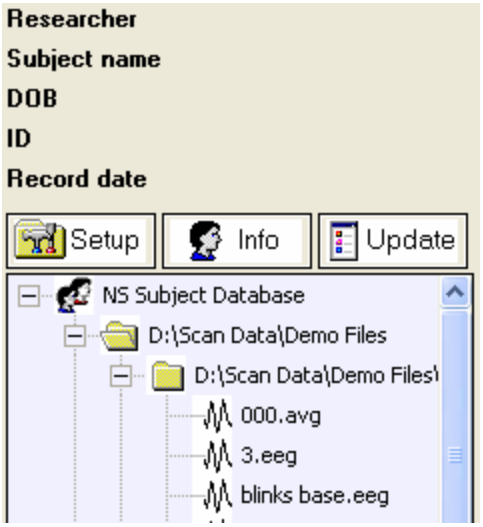


As with the History window, you can copy the commands into the Batch Editor to create batch files. Unlike the History Window, you can execute the one line command on whichever data file has the focus.

History Window. The History Window displays a chronological list of the operations that have been performed. It may be accessed also from the Toolbar icon  . This is useful for reconstructing analysis steps you have taken, plus you can copy lines from the History and paste them in the Tcl Batch Editor to facilitate batch file creation.



File Bar. The File Bar utility is useful for retrieving Neuroscan data files. Please refer to the EDIT manual for details.

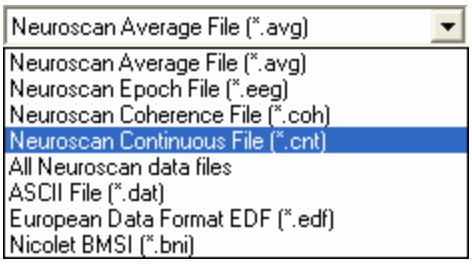


Basic Operations

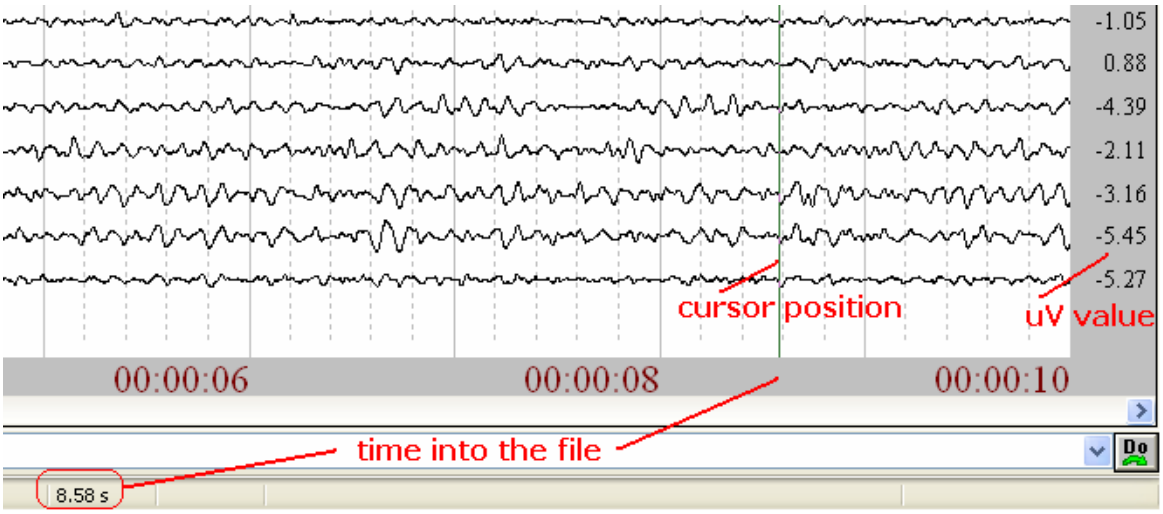
We will begin by retrieving one of the demonstration data files. Click the  icon, and then click the "Files of type" pull-down list.

Single Window Displays
The list displays the various types of files that can be opened in EDIT. Set it for

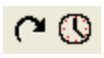
Neuroscan Continuous File (*.cnt), then go to the *C:\Documents and Settings\All users\Application Data\Neuroscan\Scan4.5\Demo Files\EEGs* folder. For Vista installations, the demo files are located in the root directory (*C:\Scan Data\Demo Files\...*). Note that there are various folders under Demo Files. These contain many data files that you may find useful. From the EEGs folder, select and retrieve the *closed.cnt* file. This is a resting, eyes closed EEG recording. You will see the data in a scrolling EEG display.



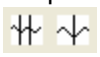
Navigation and Measurement
As you move the mouse over the waveforms, you will see the microvolt voltage for each channel on the far right. The time point in the file can be estimated from the time line at the bottom of the file, or more precisely from the Status Bar.

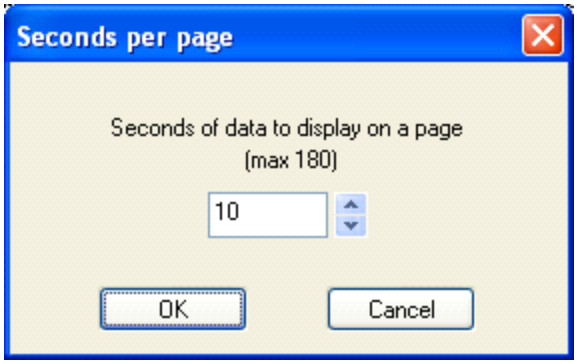


Move through the file using the mouse wheel, the arrow icons on the Toolbar  , the SpeedScan arrows on the Toolbar  , the right and left arrows on the keyboard,

or the arrows and sliding bar at the bottom of the display  . You can control the speed of SpeedScan by going to *View*, *SpeedScan*, and selecting *SpeedScan Interval*. If there is a particular event or time point in the file that you wish to jump immediately to, you can use the  buttons.

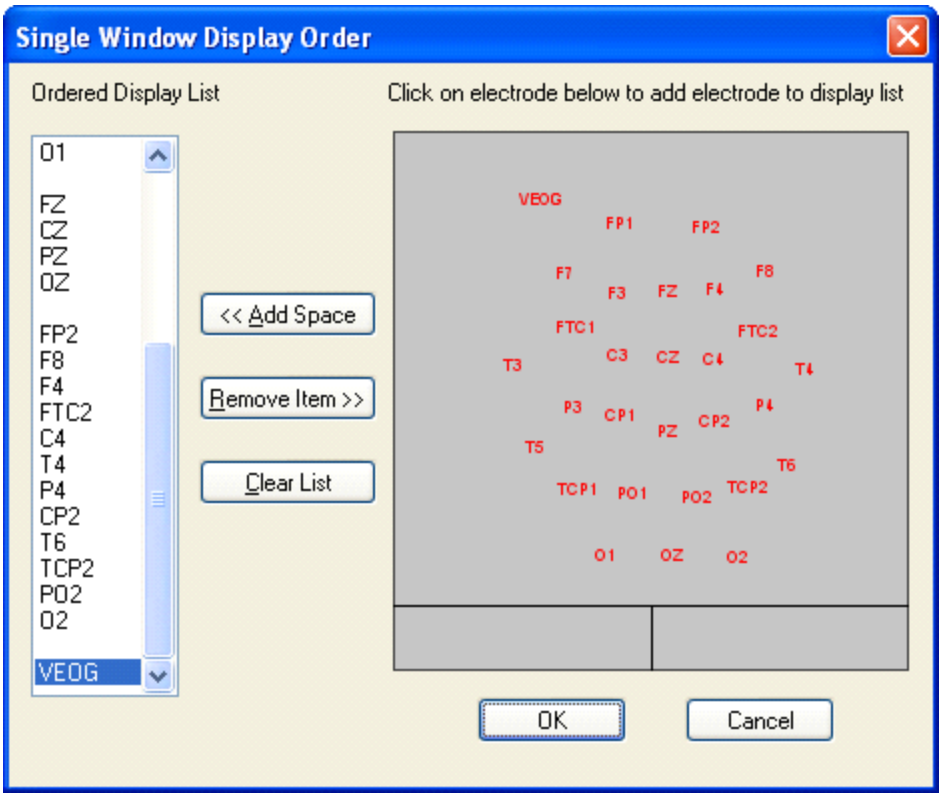
Use the  icons, the autoscale icon  , or the up and down arrow keys on the keyboard to scale the display.

The solid vertical lines in the display are one second apart; the dashed vertical lines are 200ms apart. To change the number of seconds that are displayed on the screen, click the  icons, or, right click the mouse in the data display, and select the Set seconds per page option. Enter the desired number of seconds and click ok.



Changing the Channel Order

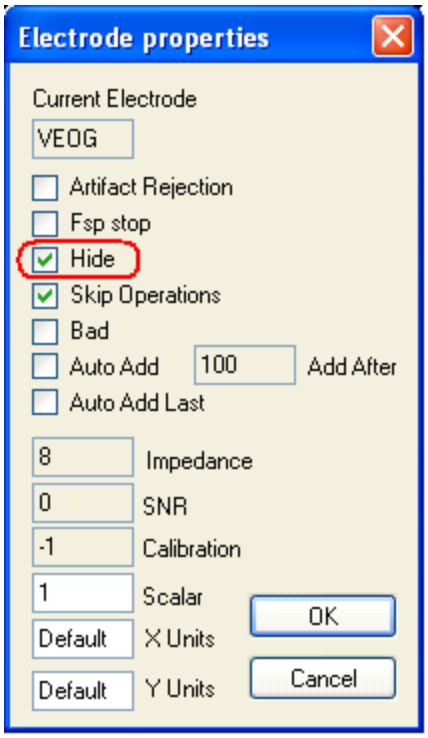
You may find that you wish to change the order of the EEG channels in the displayed file. For example, staying with the *closed.cnt* file, let's say we want to have all of the left side channels first, then the midline channels, then the right side channels. Right click in the data display and select Channel Order. To make the indicated changes, it is easiest to first click Clear List, then click on the electrode labels in the montage display, in the order you want them to appear. Select first the channels from the left side. If you like, you can click the << Add Space button after all of the left side electrodes have been added. This will place a space separation at that point. Then click the midline electrodes, and add another space. Next, click the right side electrodes, and add another space. Lastly, add the VEOG channel. The final list would look like the following.



Click OK, and the channels will be reordered.

Hiding channels
You might then decide that you do not want to display some of the channels at all, yet you do not want to delete them either. One way to do this is to create a second Display Page that contains the desired channels only, as described above in the *Channel Layout* section (in the ACQUIRE setup). An easier way is to Hide the channel(s). If we wanted to Hide the VEOG channel, for instance, just right click on the VEOG channel label on the left side of the Single Window display. You will see the Electrode Properties display. Click the Hide field, and OK. The VEOG channel is no longer displayed, although the data are still there. To restore the hidden channel, right click in the display and select 

.

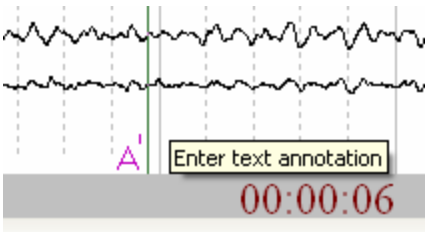


Adding Annotations and Events to the CNT file

You may encounter the need to add text annotations to the CNT file. Text can be added during acquisition or analysis. With the CNT file open, click the A button from the Main Toolbar, position the mouse where you want to add the text, and click the left mouse button. You will see the Enter Annotation display. Enter text and click OK.

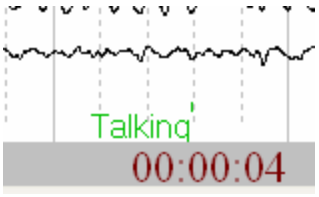
You will see an "A" added at that point in the file. Move the mouse over the "A", and a Tooltip will display the text. If you find that you are entering the same annotations over and over, you can store them in the Enter Annotation display. Enter the text,

and click Add to add the text line in the empty field shown above. In the future you can then select which annotation you want to enter by highlighting that line.

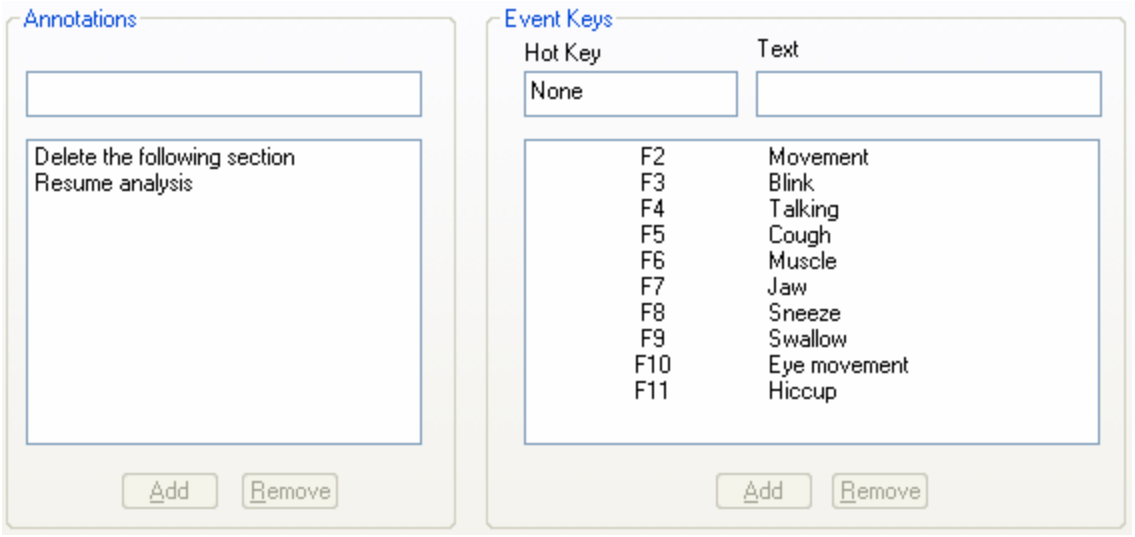


To remove annotations from the CNT file, use the Mark Block feature to define the limits around the annotations to remove, and then select Clear Annotations from the list that appears when you define the end of the block.

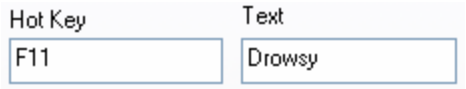
To add an event to the CNT file, click the icon from the Main Toolbar, position the mouse where you wish to add the event, and press, for example, the F4 key. Text was added to the file at that point.



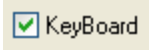
Where did the text come from? Go to the Main Menu Bar and select *Edit*, then *Overall Parameters*, and click the *Events* tab.



You will see not only the Annotations that we entered before, but also a list of Event Keys. This is an alternate place to enter Annotations, and it is where Hot Keys are defined. The text for Function Keys F2-F11 represents the "default" settings. You can change these or create new Hot Keys. For example, let's change F11 from Hiccup to Drowsy. Highlight that line, and click Remove. Now click the mouse in the Hot Key field, where it shows None, and press the F11 key on the keyboard. Move to the Text field and enter Drowsy.



Then click Add. Click OK to register the change and exit the Events display. Now position the mouse at a point in the CNT file, and click the  icon again. Press the F11 key, and you will see the Drowsy event added.

What is the difference between the Annotations and the Events that we added? There is an important distinction. The Events are actual *events* in the CNT file, like stimulus and response events. When you Epoch the CNT file (using the Epoch transform), there is an option for 

. Enabling this option will create epochs about the Keyboard events. The type codes are assigned 0-9 for Function keys F2-F11. If you create Hot Keys using other keyboard keys (such as H), the type codes will be assigned numerically after the Function keys. Annotations, on the other hand, are informational only - they are not interpreted as events in the CNT file.

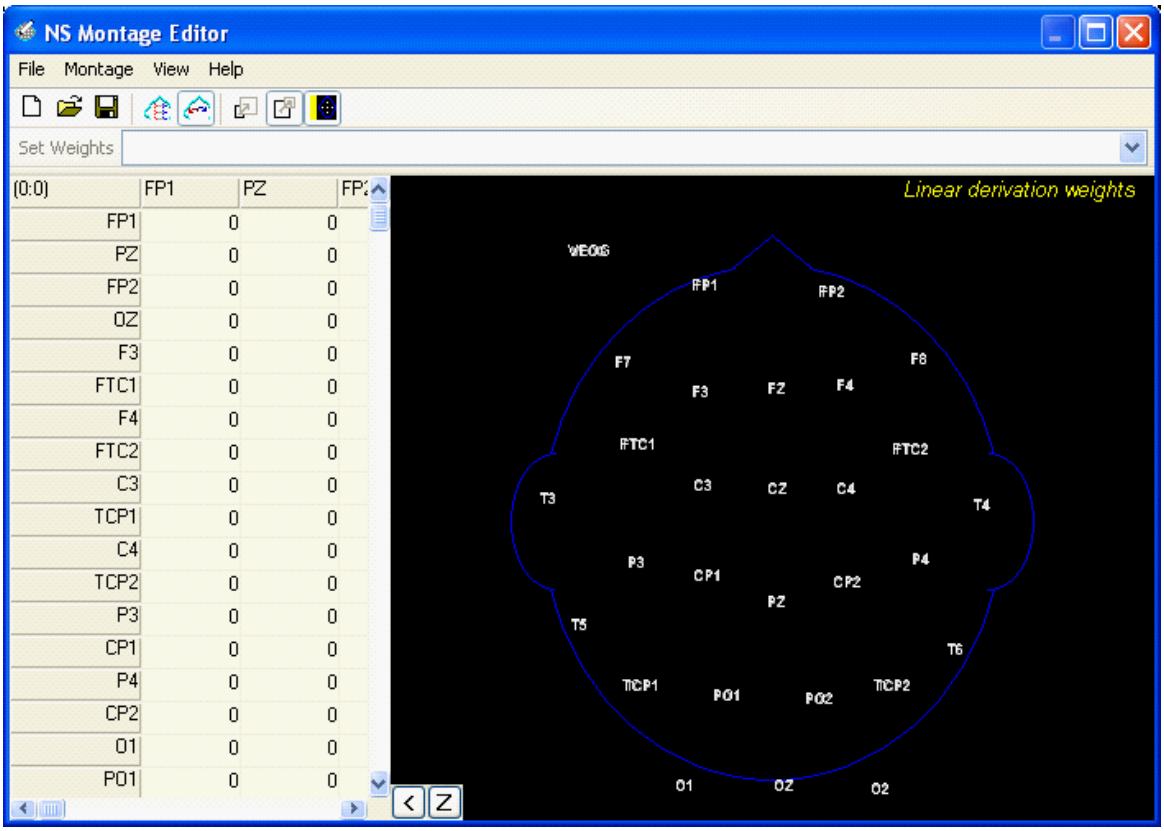
Changing montages
This particular data file was recorded with a linked-ears reference. If you wish to see the data with a Common Reference, right click in the data display, and select the 

option. To return to the original reference, right click again and select 

.

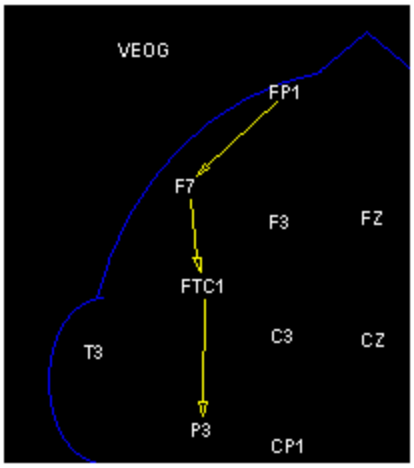
If you want a different montage, such as a bipolar montage, you will need to tell the

program which channels you want to be paired. You do that from the Montage Editor. With the *closed.cnt* file still open, click the icon, and the Montage Editor will open.



The complete details are explained in the Montage Editor appendix at the end of the EDIT manual (or the separate Montage Editor PDF file). From the Montage Editor toolbar, click the icon to enter the Bipolar EEG Montage. Then it is just a matter of dragging lines from one electrode site to another. If you want FP1-F7, drag a line from FP1 to F7; the second channel is subtracted from the first. Each line is translated into pairs on the left side of the display.

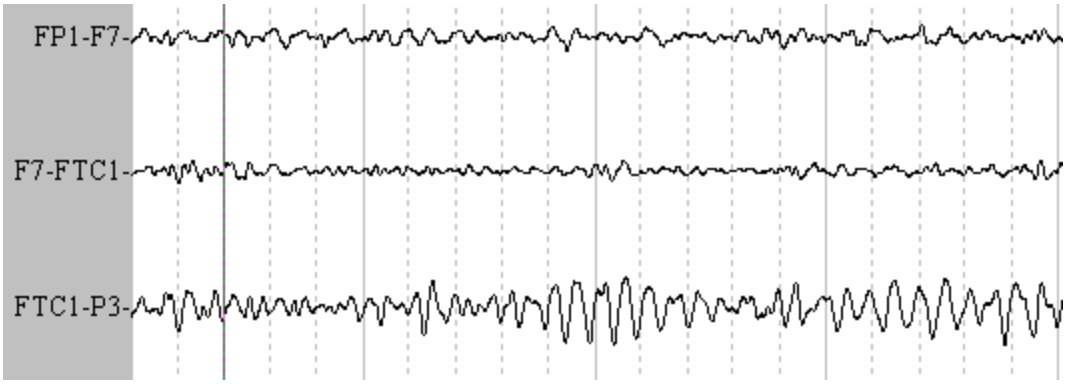
	Ch-1	Ch-2
FP1-F7	FP1	F7
F7-FTC1	F7	FTC1
FTC1-P3	FTC1	P3



If you make a mistake, right click on the bad pair on the list, and you will have the

option to delete the pair. Once you have created all of the pairs you want, click **File → Save Montage File** (or the icon), and a Save As window will appear. **From the "Save as type" pull-down list, select Linear Derivation Files (*.ldr**). Do not save the file as a Bipolar Montage File - those files have a different purpose. Enter a file name and save the file. Then close the Montage Editor.

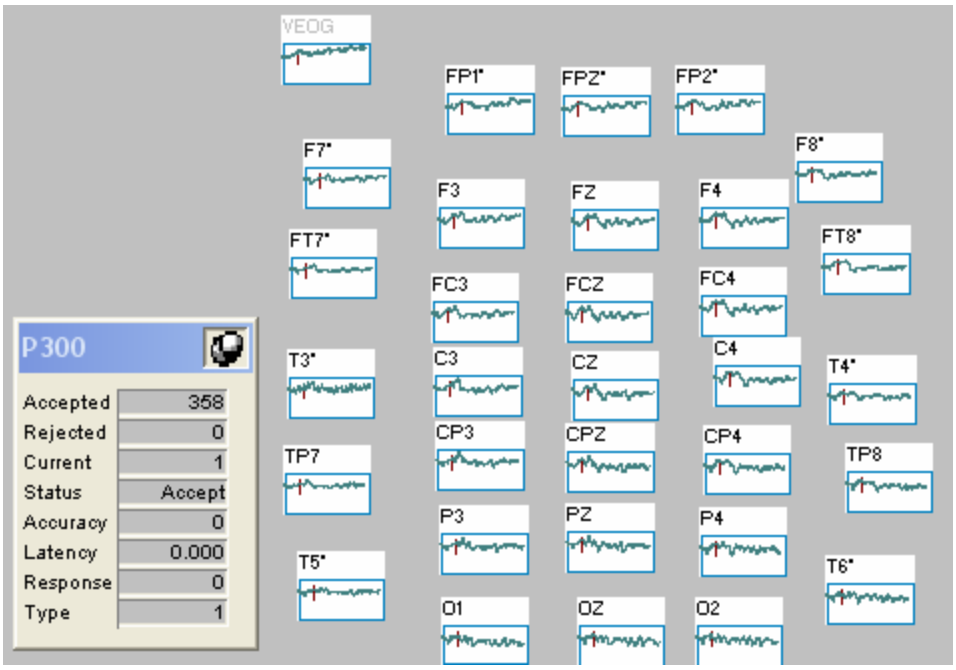
There are two ways to apply the bipolar montage we just created. One way is to apply it to the display only, and the second way is to create a new file with the bipolar montage. To apply it to the displayed file only, right click in the display, and select Add Derivation. From the Open file window, select the bipolar LDR file and click OK. The derived bipolar montage is then displayed.



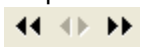
To return to the original montage, right click again and select Remove Derivation. To create a new file with the bipolar montage, select Transforms, and then Linear Derivation. From that dialog screen, select the LDR file, enter a name for the output file, and click OK. The new file will then be created. You can create multiple montage files in this way, and they can be applied to all data files having the same electrode labels.

With Multiple Window data files…

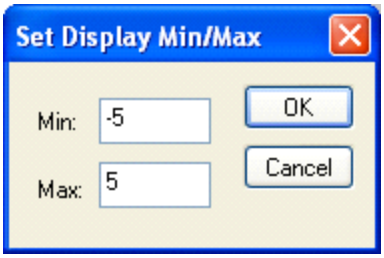
So far we have been using the *closed.cnt* file for the demonstration. Now let's look at some basic options with Multiple Window data files (EEG and AVG extensions). Open the *P300.eeg* demonstration file (...*Demo Files**P300s* folder). This file has a series of discrete epochs created around the triggers sent from STIM.



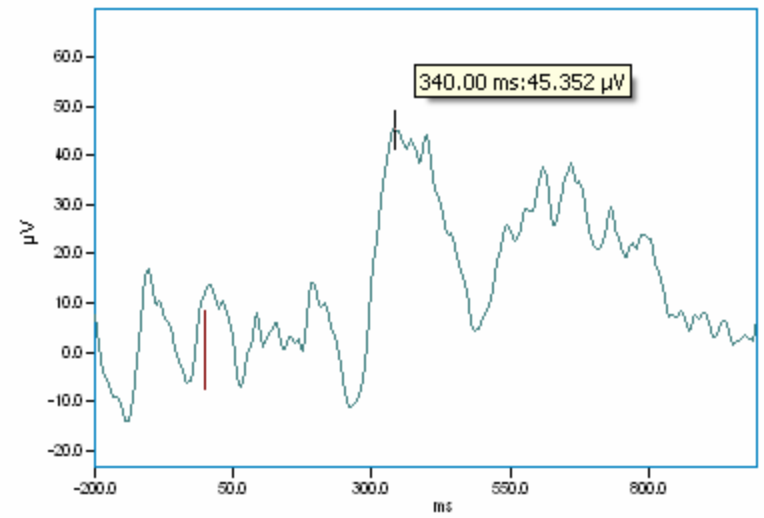
Navigation and Measurement

You can step through the file using the  icons, the Auto Scan buttons  , or the arrow keys on the keyboard. If there is a specific sweep that you wish to jump to, click the  icon. The  buttons let you know if a sweep has been rejected or not (use the buttons to accept/reject them manually).

As with CNT files, you control the scaling with the  icons, the autoscale icon  , or the up and down arrow keys on the keyboard. Additionally, you can right click between electrode displays and select the  option. From there you can enter any Min, and Max. values.

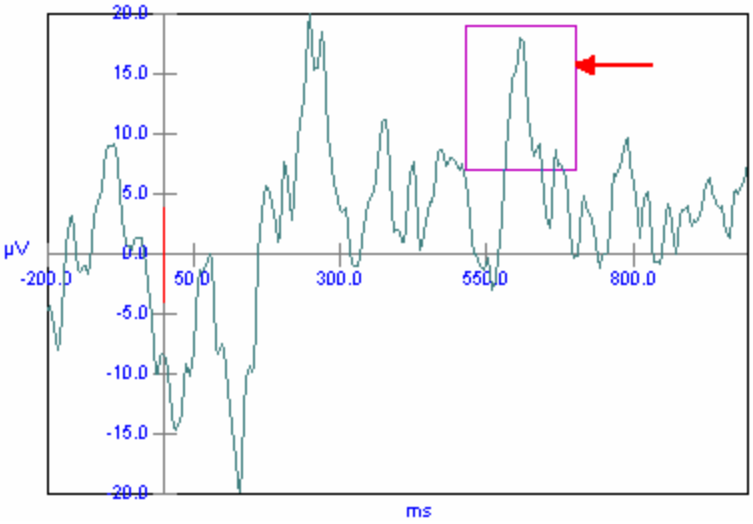


Enlarge an electrode display, and as you move the mouse over the waveform you will see a Tooltip containing the latency and amplitude for each data point. The information is displayed on the Status Bar as well  . If you do not see the Tooltip, right click inside the electrode display and click the  option.

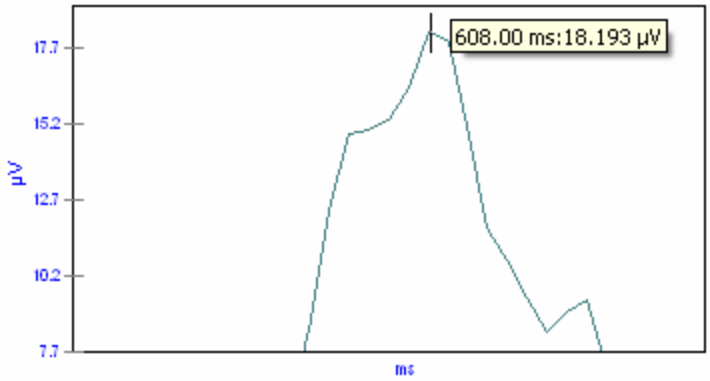


Zooming In

For very precise measurement, or to look closely at a small feature of interest, you can zoom in on an area (EEG and AVG files only). Enlarge an electrode to the full size display, then click the Zoom In icon from the Main Toolbar. Drag a box around the area of interest.



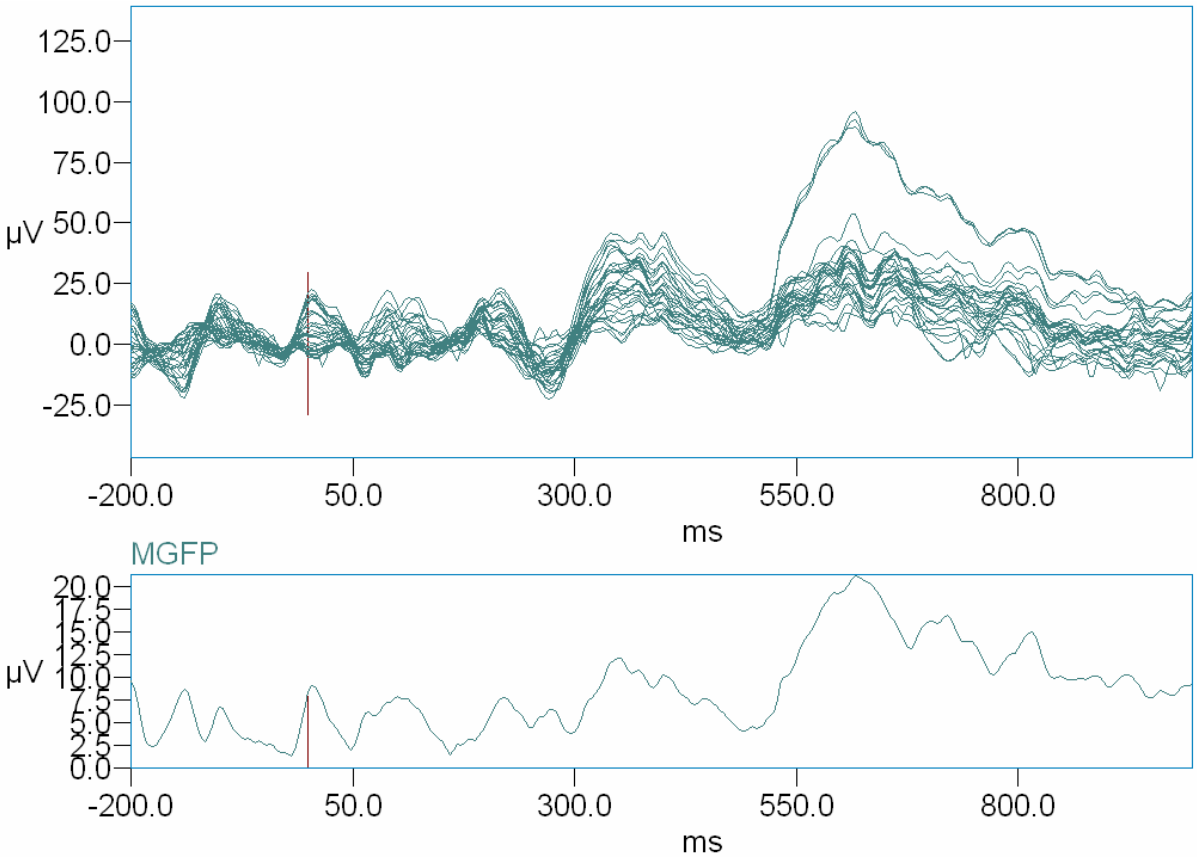
When you release the mouse button, you will see the zoomed in region. From there you can easily measure the precise data points.



Click the Zoom Out icon  to return to the original display.

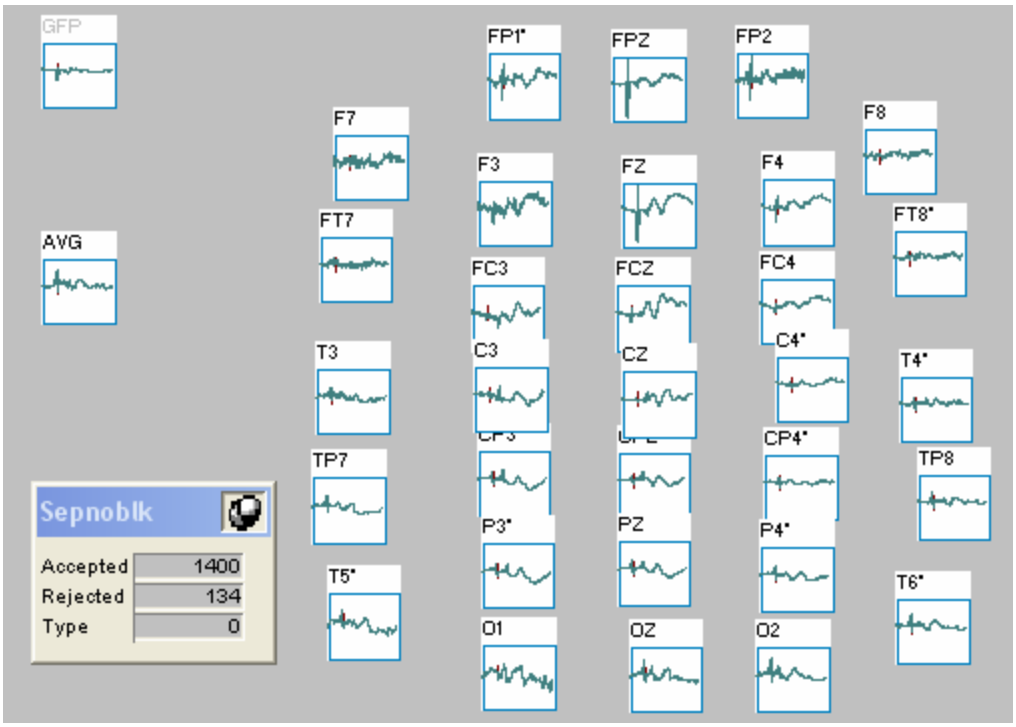
Butterfly Plots

The Butterfly Plot option will display all of the channels superimposed in one display, along with the Mean Global Field Power. Right click either inside or between electrode displays, and select Butterfly Plot. Mean Global Field Power is a composite measure of all channels, showing the time spans where greatest global energy is present.

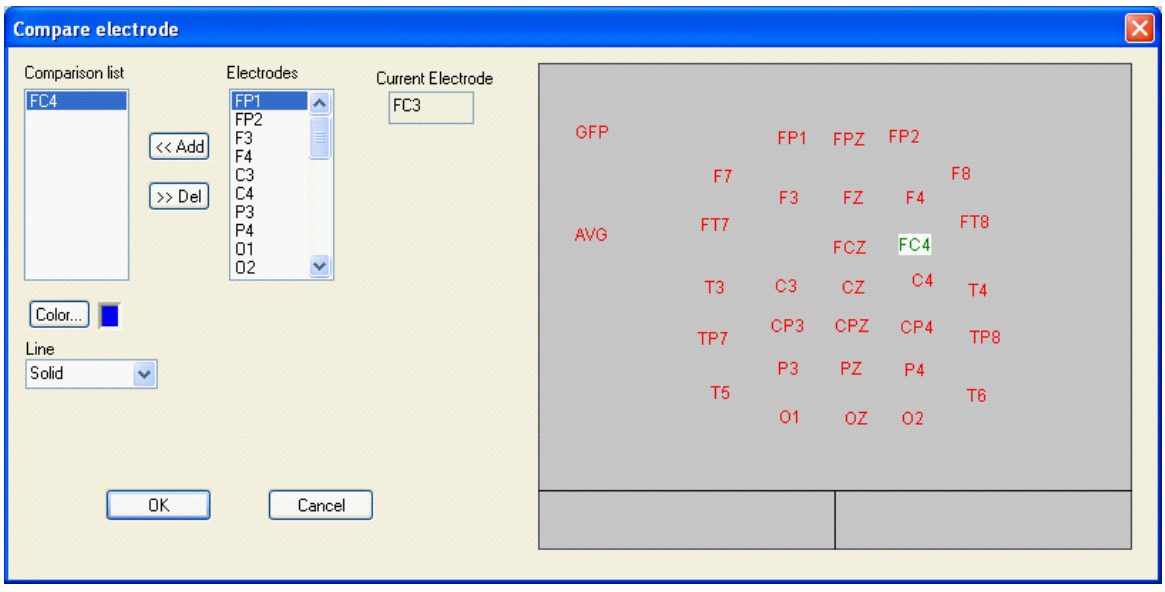


Comparing Files and Channels

Now close all open files and open the *sepnoblk.avg* file in the ...*Demo Files**Seps* folder. This is a basic SEP from right median nerve stimulation.



To see the left/right differences in the SEP, we might want to superimpose FC4 on FC3. Enlarge FC3 to mid or full-size, and right click inside the electrode display. Then select the Compare Electrode(s) option. Click the FC4 label on the montage display.



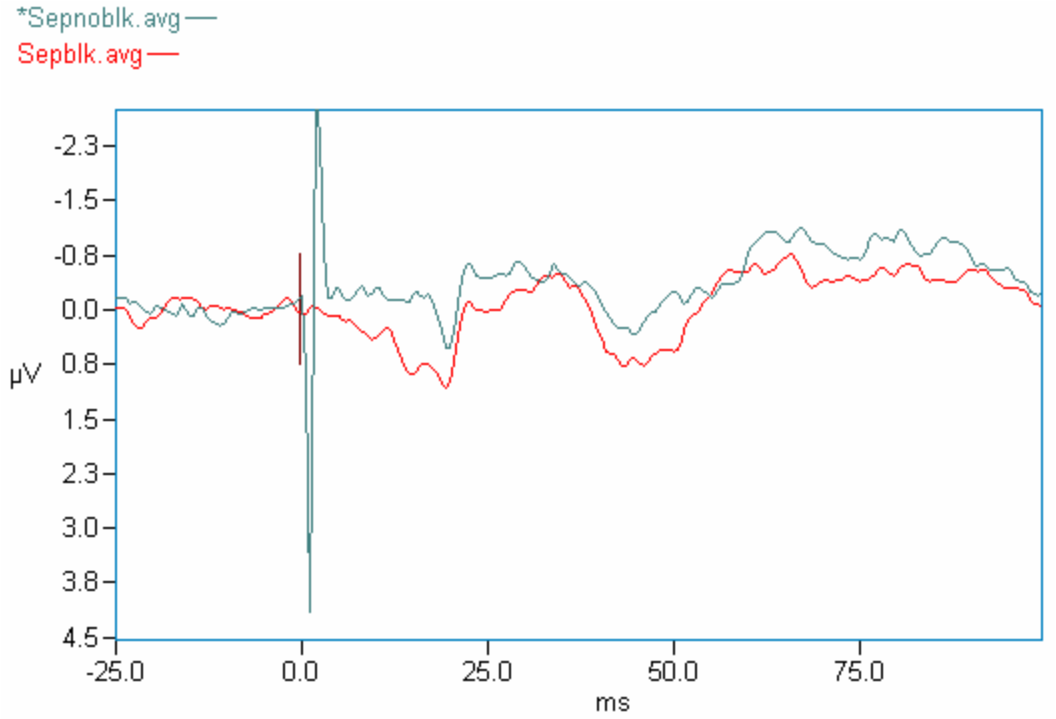
FC4 is then added to the list. Click OK and see FC4 and FC3 together. One of the issues we hear frequently involves creating graphics for publication. Many journals do not accept color graphics, or, if they do there is a significant charge. Therefore, you can change the Line style so that one waveform is dotted or dashed. Right click inside the

electrode display again, and select Compare Electrode(s) again. From the pull-down list for Line, there are various options for the line style. Even with multiple waveforms and black and white figures, you can differentiate the waveforms using different styles.

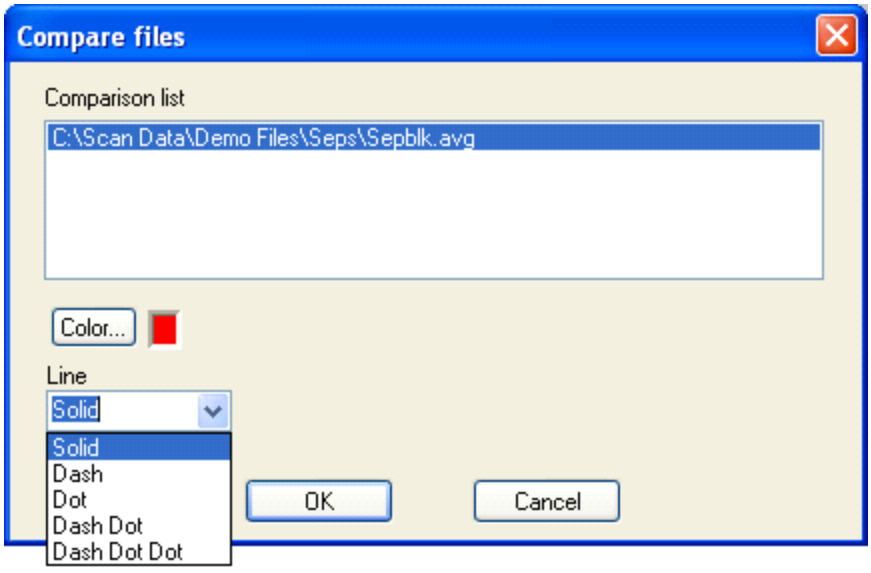
You can also select the desired color for each compared electrode.

Now go back to the Compare Electrode dialog screen and delete the compared electrode by clicking the >> Del button.

It is also possible to compare waveforms from two or more data files. With the *sepnoblk.avg* file still open, right click between electrode displays and select the Load Comparison File option. From the Select Data File window, select the *sepblk.avg* data file. Enlarge the FPZ electrode. The main difference between the two files is the presence of a large stimulus artifact from the SEP stimulator in the *sepnoblk.avg* file. (The files demonstrate the Deblocking feature of the *SynAmps* and *SynAmps*^{2} amplifiers that is used to block these kinds of artifacts).



You can have multiple compared data files. Right click between electrode displays and select the Comparison File Options option. Similar to the Compare Electrode dialog screen, the Compare Files screen lets you select the Color and Line Style for each compared file.

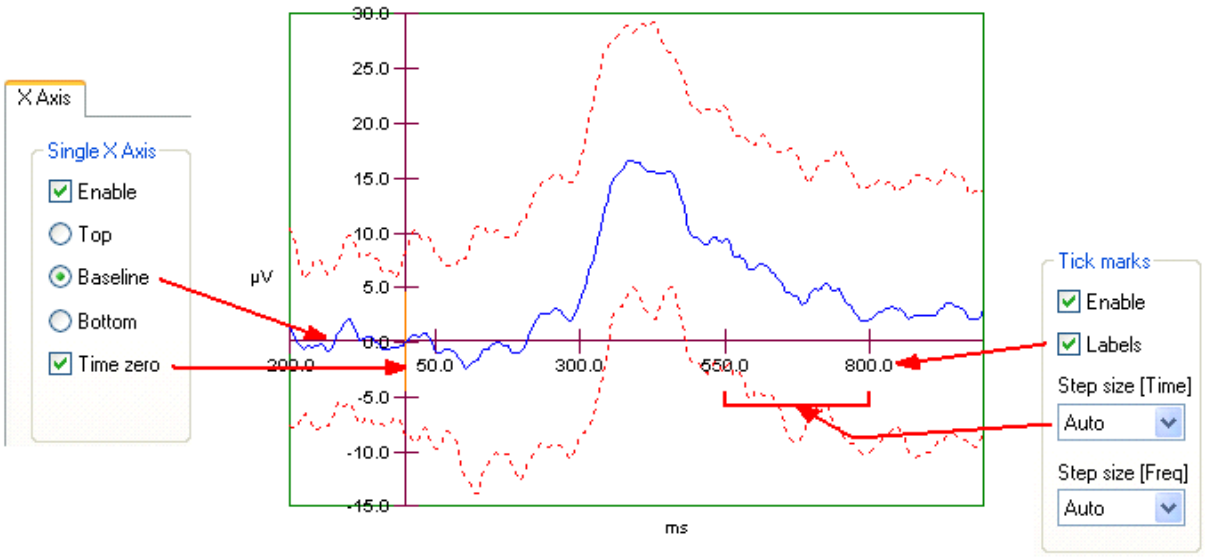


You can also send the waveforms to the Waveboard, where there are additional options for marking the waves, changing their appearance, and so forth. The right mouse accessed menu lists contain options to Send Waveforms to Waveboard. The Waveboard can be opened manually by clicking the icon on the Toolbar. See the

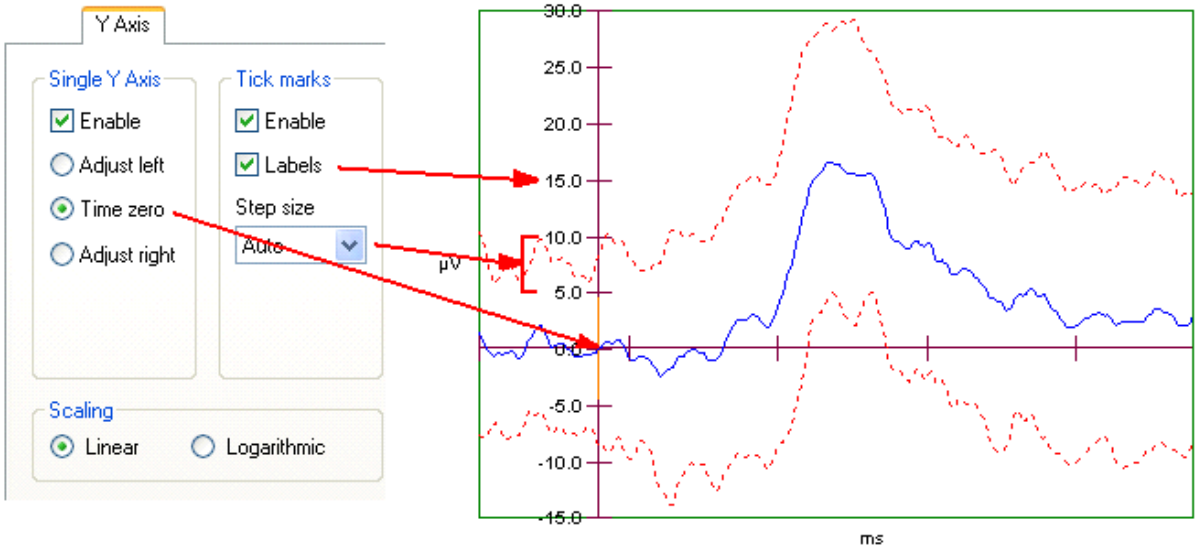
Waveboard manual attached as an Appendix to the end of the EDIT manual, or open its PDF file.

Multiple and Single Window Settings
You have probably noticed that your data displays appear differently from the ones shown above. Colors and other display parameters are controlled from the **Options** → **Multiple Window Settings** and Single Window Settings. You have great control over many aspects of the displays. Go to the **Multiple Window Settings** option, and click the X Axis tab.

The Single X Axis settings let you position the x-axis (Top, Baseline, as shown, or Bottom). If you disable it, it will not appear at all. The Time zero option will place a colored vertical line at 0ms. Tick marks are the vertical hash marks that denote the time measurements. The Labels are the numbers. You can disable the Tick marks (which also disables the Labels), or you can disable the Labels and retain the Tick marks. You can let the program set the Time or Frequency intervals between Tick marks automatically, or you can set the Time or Frequency intervals as desired.

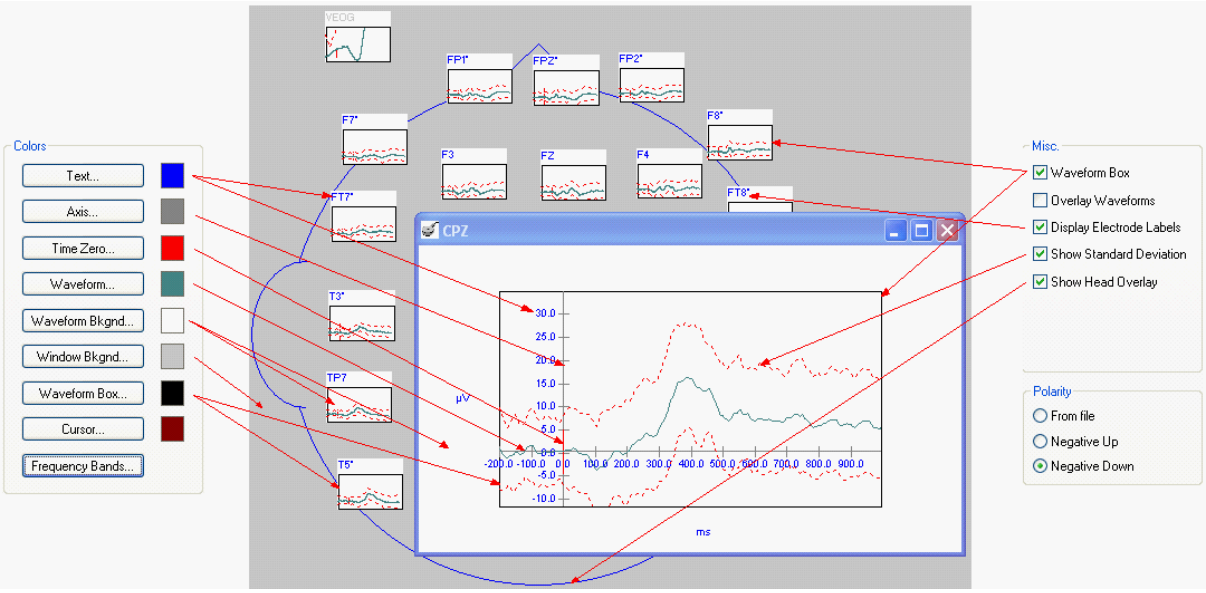


Similarly, the Y Axis tab lets you position the y-axis (far left, at Time zero, as shown, or to the far right), or you can remove it by disabling the option. Tick marks and the Labels can be displayed or removed. You can have the program determine the interval between Tick marks, or you can set the voltage interval yourself. The y-axis can be Linear, as shown, or Logarithmic.

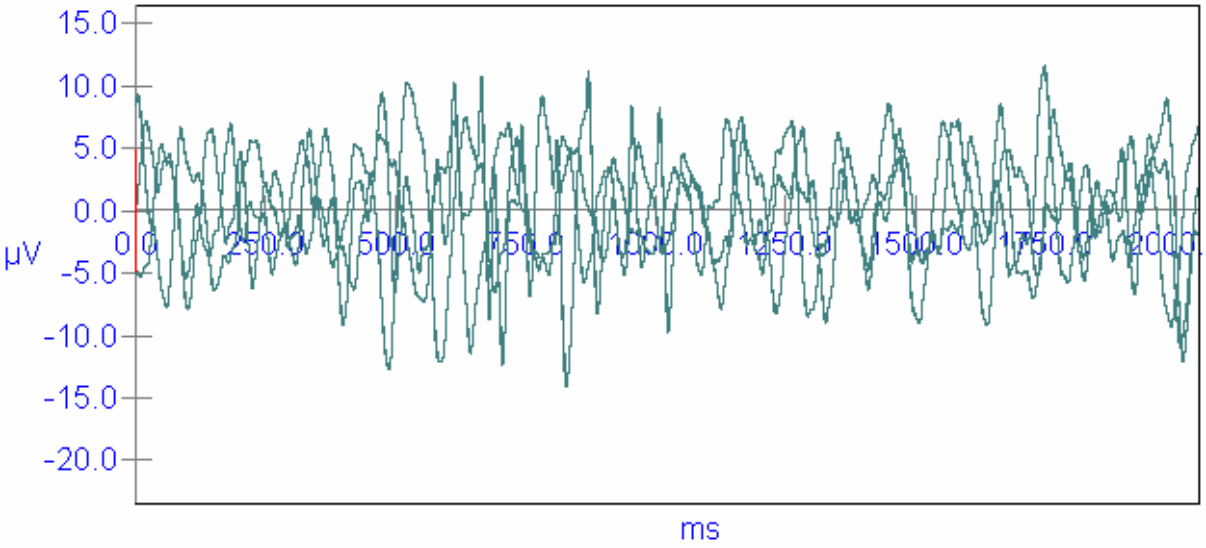


The General tab lets you set the colors for various parts of the display, as well as other miscellaneous options. The Text color determines the color of the electrode labels and text within the electrode window (scale markers and labels). The Axis color sets the X and Y axis color. Time zero sets the color of the vertical line at the zero time point. The Waveform color is applied to all waveforms. Waveform Background is the background color of the electrode windows - minimized or enlarged. Window Background is the area between the electrode windows. Waveform Box is the line around the electrode displays - minimized or enlarged. The Cursor color is seen on the vertical cursor lines when performing online mapping in ACQUIRE and in Source.

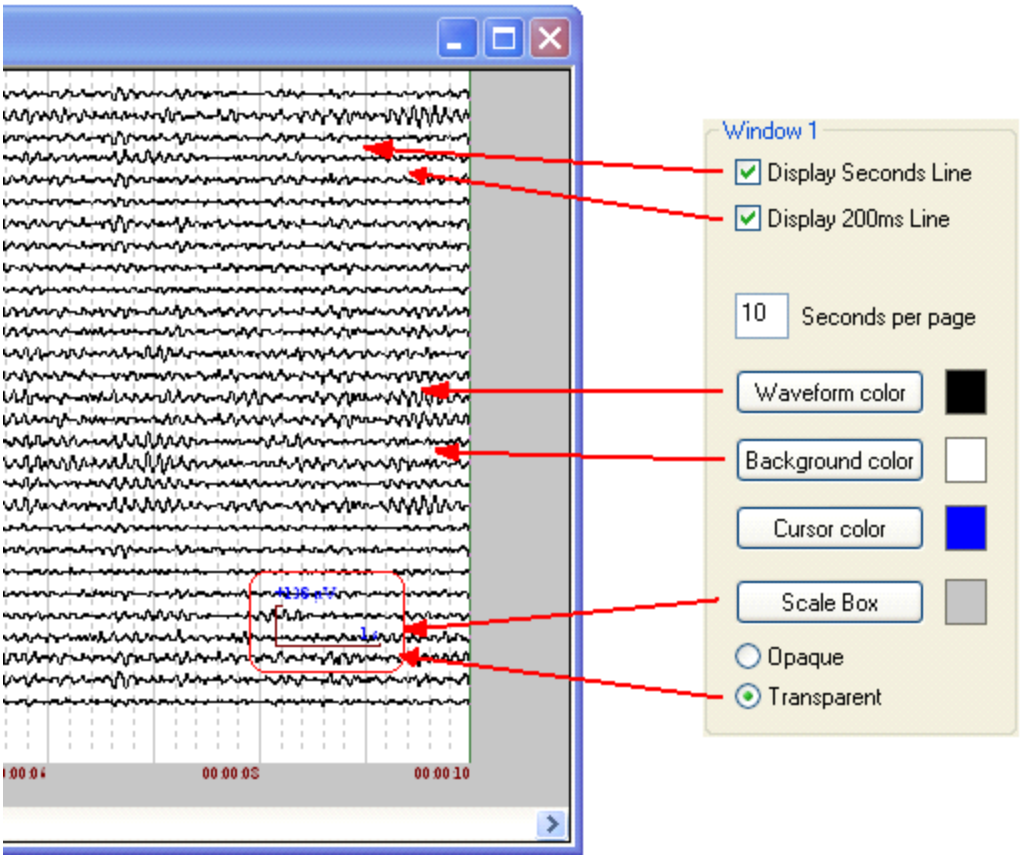
In the Misc region, the Waveform Boxes can be displayed or removed. If you enable the Overlay Waveforms option, you will see successive sweeps in an epoched file (*.eeg) superimposed on preceding sweeps (example shown below). You can display or remove the electrode labels, and you can display or remove the dashed Standard Deviation lines. The Head Display is the circular head outline, shown in blue below. The final option determines whether the displayed polarity will be based on whatever it is in the saved data file, or it can be always with the Negative values going up the y-axis, or down the y-axis.



If you enable the Overlay Waveforms option, and then step through an epoched data file, you will see a display like the following, where sweeps are superimposed on previous ones.



In the *Single Window Settings* screen (under *Options*), you have similar control of the colors and components in the display of continuous data files. You can display or remove the solid vertical lines depicting seconds, and the dashed vertical lines showing 200ms intervals. When you open a file, it will display the number of Seconds per page that you enter here. You can change this from the display, as shown above. The Waveform color is the color of the tracings; the Background color is the area behind the tracings. The Cursor color sets the color of the vertical cursor lines used in, for example, Source. The Scale Box color sets the color of the Scale Tool background. If the Scale Tool is set as Transparent, then you will not see the Scale Box color at all, as shown below. If you set it for Opaque, then you will see the Scale Box color.



After you enter the settings for the *Multiple* and *Single Window Settings*, you can save these in a Workspace file (*.aws extension). Under Options, select Save Workspace, and save the file. You can have multiple workspace files (different users may have different preferences). Or, you might have one set of settings for routine purposes, and a second set for printing or publication purposes. The currently loaded workspace file is displayed on the Status Bar My Workspace.aws. Select a new one by going to *Options*, and selecting Load Workspace. The settings you select are applied in ACQUIRE as well as in EDIT.

For Further Introductions
The information presented above introduces you to many of the basic capabilities. While we have presented these from the EDIT module, many of them will apply to ACQUIRE as well. For a more in depth introduction to the functions and operations of the SCAN software, please see the Tutorials in the following manuals. You will have received hardcopy versions of all of these (except the Tcl BATCH Tutorial), as well as PDF files that are found in the ...*Scan4.5**Pdf* folder.

- **Scan Tutorials manual**: contains tutorials for creating setup files for many types of recordings as well as acquisition options. It also contains tutorials that use demonstration files similar to those that would have been recorded had the setup files in ACQUIRE been used to obtain data files. The EDIT tutorials demonstrate typical ways for analyzing the data files.

- **3DSpaceDx manual**: contains tutorials for calibrating the system, digitizing

the electrode positions and head shape, and exporting and importing data files.

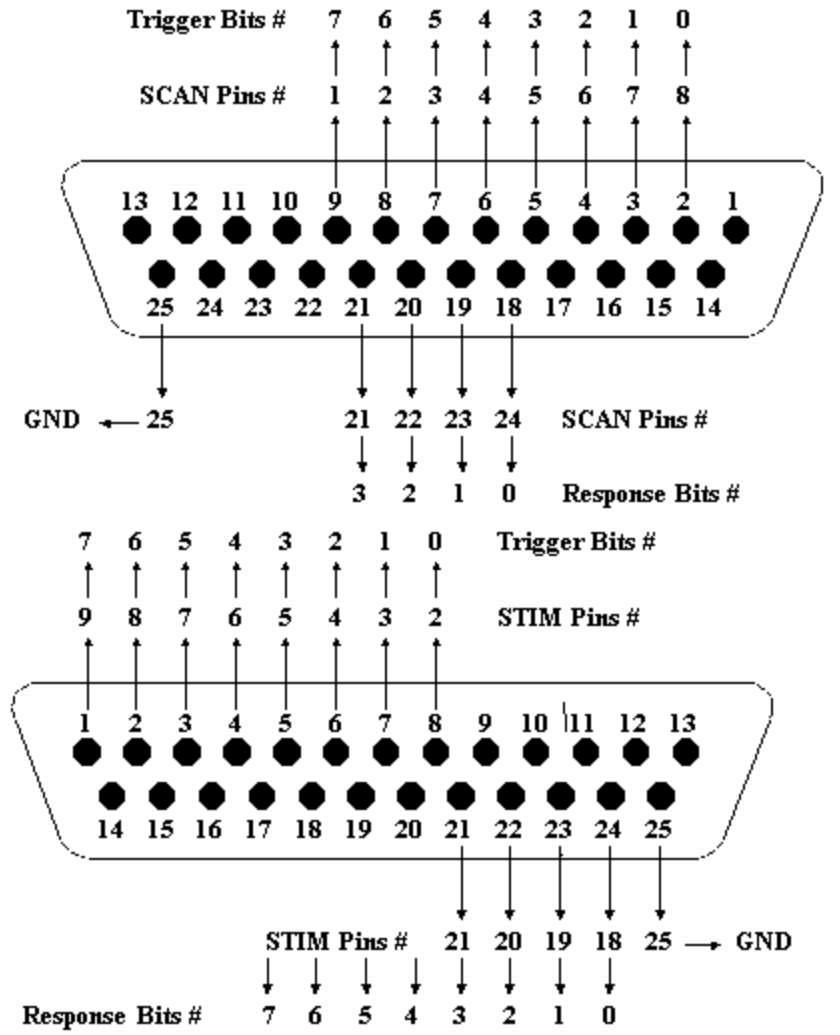
- **Tcl Batch Tutorial manual** (PDF only): contains tutorials that will introduce you to Tcl BATCH files.
- **Tcl Batch manual**: contains sample batch files and sequences throughout.
- **Waveboard manual** (Appendix to EDIT): contains a tutorial sequence demonstrating the basic operation of the Waveboard.
- **Montage Editor manual** (Appendix to EDIT): contains sequences demonstrating the operation of the Montage Editor.
- **MapGen manual**: contains sequences illustrating the basic operations for creating and modifying *.map files.
- **Stim^2 manual**: contains tutorials and examples to introduce you to the operation of the Stim^2 modules.

This concludes the overview of Basic Operations.

3 Appendix A: Trigger Port Interfacing

SCAN and Stim^2 can each be interfaced with external devices, including, for example, other stimulation devices or systems. Stim^2 can be used to trigger an external device, or it can be triggered by an external device. SCAN can be triggered by external devices or software independent from Stim^2. Any of these can be accomplished by mimicking the TTL signals sent by the Stim^2 or expected by the SCAN systems.

In a normal configuration, the method of triggering between the SCAN and Stim^2 systems is to connect the Parallel I/O ports on the back of the SCAN and Stim^2 interfaces by means of a STIM-to-SCAN cable. This cable is provided to customers who purchase Stim^2 systems. A STIM-to-SCAN cable is a grey, 25-line cable with a female connector at the end marked SCAN and a male connector at the end marked STIM. Below is a diagram of the connections within a STIM-to-SCAN cable. If you have the Software Only version of Stim^2, the **response lines have been cut**.



Back of STIM Connector **Back of SCAN Connector**

Matching Port Logic

If you are using a stimulus presentation system other than Stim^2, or the pulses sent from the MR scanner or other device, you must match the logic for stimulus and response TTL pulses. The SCAN system is expecting the following triggering convention.

Stimulus triggers. Stimulus events use positive logic TTL pulses, usually with 1-10ms duration. Positive logic means that 0V is the resting state, and 5V (at least 3.5V) is the "on", or high state.

As you can see from the diagram above (Back of STIM connector), bit 0 is carried on pin 2, bit 1 on pin 3, and so forth. When bit 0 is high, a 1 will be seen in ACQUIRE (in continuous mode). When bit 1 is high, you will see a 2. When both are high, you will see a 3. Bit 2 gives a 4, bit 4 gives an 8, bit 5 give 16, and so on, ending with a 128 trigger type code in ACQUIRE when bit 7 is high. When all bits are high you see 255 in ACQUIRE.

Response triggers. Response events use negative logic TTL pulses, usually with about a 5ms duration. Negative logic means that the resting state is at 5V, and the "on" state is 0V. The amplifiers hold the response lines at 5V when no triggers are being received.

On the back of the STIM connector the response pad lines are 21, 20, 19 and 18, carrying response bits 3, 2, 1 and 0. On the back of the SCAN connector the response pad lines are 21, 22, 23, and 24, carrying response bits 3, 2, 1 and 0.

One of the more common causes for a failure to see triggers is that the response lines have an input where the resting state is **0V**. For example, if a peripheral device is sending a *positive* logic trigger to one of the *response* lines (as is the case with scanners), that line will remain "on" most of the time. This will block other events from being registered. The signal must first be inverted to match the negative logic. Whenever you use the stimulus and/or response lines to input triggers into SCAN, you must follow the *stimulus/positive logic* and *response/negative logic* rule, or else there will be triggering problems.

The following methods of triggering are possible:

Triggering an external device with Stim^2: An external device can be triggered independently from acquisition in SCAN, or in conjunction with triggering in SCAN. The latter is more common. How you split the STIM-to-SCAN cable will determine the control you have over the device and the ACQUIRE software. Let's say you wish to trigger the devices independently, that is, you want to trigger an external device at certain time points, and you want to send triggers to ACQUIRE during the intervening time spans.

To do this you will need to split the output from the STIM-to-SCAN cable. Let's say that the other device needs only a 1-bit TTL pulse for triggering. One branch of the STIM-to-SCAN cable should go from pin 2 (on the back of the STIM connector) and GROUND (pin 25) to the external device trigger input. The remaining leads, plus GROUND, go to the *SynAmps* or P I/O-24 card, as usual. When you send a type code of 1 from STIM, the external device will read that as its trigger. Since the output from bit 0 (type code of 1) is no longer going to ACQUIRE, you cannot use a type code of 1 in STIM as a trigger for ACQUIRE. Moreover, you cannot send any odd numbered type code to ACQUIRE, because any odd number type code must use bit 0. To send triggers to

ACQUIRE only, use any even numbered type codes. If you want to send triggers to both devices at the same time, send a type code of 3 from STIM. ACQUIRE will receive it as a 2 and the other device will receive the single bit trigger.

The BYTE command in the Gentask sequence file provides another way to control triggering. This command will send out a pattern of bits from the triggering port on the back of the STIM Audio System (using the STIM-to-SCAN cable). For more information, please see the Stim^2 manual. You can specify the control byte to be sent (0-255), the duration of the pulse, and the state the port is left in after the pulse has been sent. A typical line from the sequence file might appear as:

<Label> BYTE 10 0 0 0 0 0 20 0

This will send a 10ms type code of 20 out of the triggering port. The 5th field will determine the state of the port after the duration of the pulse (refer to the Stim^2 manual for details).

Much of the time *you can use a "dummy" stimulus to control external triggering* instead of the BYTE command. For example, create a blank CUT file, and insert

<Label> CUT 100 0 1000 0 0 0 25 <dummy.jpg file>

it when you want to send a trigger. The TYPE field will let you specify the type code that is sent (e.g., 25). The duration (DUR), 100 in this example, is the duration of the stimulus presentation. The duration of the trigger pulse is set in the Programs Settings screen.

When do you use the dummy file, and when do you use the BYTE command? Some considerations are: The dummy CUT line will appear in the behavioral data file (.DAT file) in STIM; the BYTE command will not have a line in the DAT file. The BYTE command allows you to vary the duration of the trigger pulse independently from the duration you set in the Programs Settings screen. The BYTE command gives options for how you leave the port's state, depending on your needs.

The STROUT mode command in Gentask can be used to control an external device by sending a string via the serial port. You can send a string from the COM port (trigger)

<Label> STROUT 0 0 0 0 0 0 5 trigger

and a TTL trigger (5) from the trigger port (i.e., to ACQUIRE) at the same time.

The Sound Editor program can also used to trigger external devices. In the typical case a click is created with the dB set to the maximum value. The trigger output is the voltage pulse sent out the headphone jack on the STIM Audio System unit. The duration and the ISI are controlled in the Sound Editor software, as well as the number of triggers that are sent. Please refer to the Stim^2 manual for more details, and contact Neuroscan Technical Support if you encounter any problems.

Triggering STIM from an external device: STIM can receive external pulses through the phone jack where the STIM Response Pad is connected to the STIM Audio System. The idea is to mimic the signals from the Response Pad, and use the RESP field in the Gentask sequence file to register the pulses. For details about the Response Pad specifications, please refer to Appendix B in the Stim^2 manual. In Gentask, there are a couple of ways

that the responses may be registered. One way is to use the WAITFOR command. The line in the Gentask sequence file might look something like:

```
<Label>   WAITFOR   0   0   0   0   0   1   0   0
```

The Gentask sequence will wait for a pulse mimicking button 1 on the response pad.

The other way is to use the IF mode. This adds the option for conditional branching. The lines in the sequence file might look something like:

```
<Label>   IMAGE   0   wait   1000   0   0   1   10   <message.jpg file>
<Label>   IF   resp   1   1   goto   Point1   goto   Point2   0
```

"Message" might be a jpg file you create that says something like "Waiting for External Device Input". The program will display the message, send a type code of 10 to ACQUIRE (9th column), and wait (4th column) for a pulse mimicking button 1 on the response pad (8th column). The IF line translated literally means: If the response is from button 1 (literally, range of button 1 to button 1), go to line labeled Point1, which could initiate the next sequence of events. If the response is not from button 1, go to the line labeled Point2, which might end the sequence. This approach assumes you have the capability of sending more than a 1 bit trigger from the external device.

Triggering SCAN from an external device: ACQUIRE can receive triggers from an external device, such as a different stimulus presentation software package, by mimicking the expected TTL pulses. To register a type code of 1 in ACQUIRE, you would need to send the pulse to bit 0 (pin 8), and connect the GROUND pin to ground on the other device. Use the same TTL pulses as described above (duration should be at least 1ms, and up to about 10ms). Be sure to short any unused stimulus trigger pins to GROUND (to avoid possible spurious triggers). If the other stimulus package will send more than a 1-bit TTL pulse, ACQUIRE can receive more than a type code of 1 (up to 8 bits; types codes up to 255).

If you are connecting an external stimulation system to *SynAmps*/*NuAmps*, you will also need to mimic the expected inputs from the Response lines. Unlike the positive logic used with the stimulus lines (where the resting state is 0Vs), the response lines use negative logic, where the resting state is high (5Vs, or logic level of 1 in Test Trigger Port). If you are having problems getting triggers from your own stimulus system, please see the next appendix for troubleshooting tips.

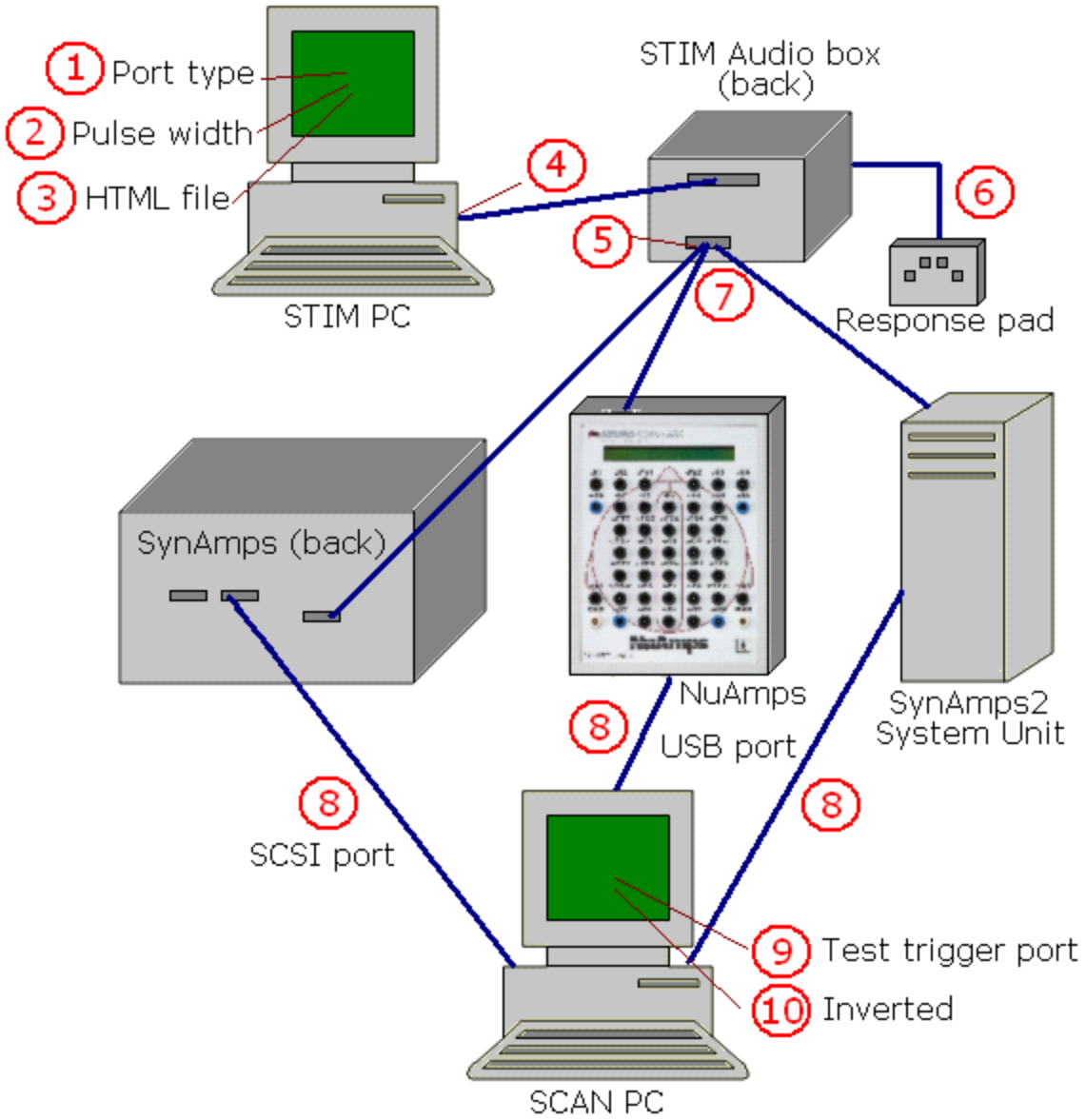
We do NOT recommend sending voltage triggers through the head box. The external mode for triggering, using voltage thresholds on a designated channel, is designed for psychophysiological activity (such as blinks, etc.). Connecting an external device creates a potential risk to the subject. **Do NOT connect any peripheral devices without contacting Technical Support first.**

4 Appendix B: Troubleshooting Triggering Problems

One of the problems that arises occasionally involves the loss of triggers seen in ACQUIRE. This can be due to errors in one or more of several settings, configurations, or connections. The following information will help determine where the problem is, and what to do to fix it. The first section shows the points where the breakdown can occur. The second section is for troubleshooting. This information is relevant to Stim^2 systems only. If you have an older STIM system, please use an earlier version of this manual.

I. Triggering Check Points

In the diagram, we start on the Stim^2 side, and point out possible sources for the loss of triggers through to the SCAN side of the system. There are no differences between *SynAmps*^{2} and *SynAmps RT* insofar as triggering is concerned.



1. **Incorrect Port Type selected**. In Stim^2, go to **Options** → **Program Settings**, and look at the **Port Type** field. The program detects automatically whether you have the STIM hardware installed, and, if so, whether the I/O board was the older ISA bus type or the newer PCI type. If you have the Software Only version, you need only to select which LPT port you will be using for triggers (the port where the STIM-to-SCAN cable is connected on the back of the PC). If you have one printer port, then LPT1 is the only choice. Make sure the option you have selected from the pull-down list is the correct one. For example, if you have the STIM Hardware, do not select an LPT port. If you have the Software Only version, and multiple parallel ports on your computer, be sure to select the one where the STIM-to-SCAN cable is connected.

2. **Too brief of a Pulse Width**. In most cases, a Pulse Width of 1ms should be long enough to be detected by SCAN. If you see only sporadic triggers, and you are using a very slow Sampling Rate in ACQUIRE (AD rate), try increasing the Pulse Width to 5-10ms (Pulse Width is found on the **Program Settings** dialog screen under **Options**).

3. **Check the HTML Results file**. After you run the task in Stim^2, check the results in the HTML results file. The Type column displays the stimulus and response Type codes that were sent to SCAN. If the type codes are not seen in that file, then they were never sent. If you are not seeing any responses in the results file, go to **Options**, and select **Response Device Settings**. Make sure the response device you are using is the one that is highlighted, and that **Enable Response Output** is checked.

4. **PI/O cable connection**. Make sure the cable is well connected to the PI/O card on the back of the STIM PC and STIM Audio system unit.

5. **STIM-to-SCAN cable connection** - STIM side. If you have the version of Stim^2 with the STIM Audio System Unit, make sure the STIM-to-SCAN cable is connected to the back of the STIM audio unit - NOT the parallel port on the back of the STIM PC. *Make sure the STIM Audio unit is turned on*. If you have the Software Only version, make sure the STIM-to-SCAN cable is connected to the parallel port on the back of the STIM computer. If you have multiple parallel ports, make sure you have the correct one selected using **Options** → **Program Settings** (see #1 above).

6. **Response Pad testing**. Testing the Response Pad is a quick way to see if triggers are being generated in the STIM side. Go to **Options** → **Program Settings**, and click the **Response pad** button. You should see a reaction for each press.

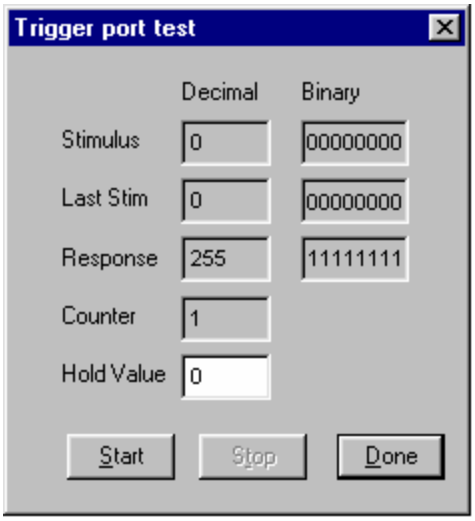
7. **STIM-to-SCAN cable connection** - SCAN side, with *SynAmps*/*SynAmps*^{2}/*NuAmps*. Make sure the SCAN side of the STIM-to-SCAN cable plugs into the trigger port on the back of the *SynAmps*, the System Unit for *SynAmps*^{2}, or the amplifiers/headbox with *NuAmps* - NOT to the parallel port on the back of the SCAN PC.

8. **SCSI/USB connection**. Make sure the SCSI cable is secure between the *SynAmps* and the SCAN PC, or the USB cable with *NuAmps* and *SynAmps*^{2}. (This is an unlikely cause of triggering problems, since there would be more significant problems on the SCAN side if the SCSI or USB was not connected).

9. **Using Test Trigger Port**. **Test trigger port** reads the values at all of the bits at the trigger input level, and it is often the most useful method for diagnosing lost

trigger problems. If you have multiple *SynAmps* / *SynAmps*^{2}, note that you select the unit that you wish to test. Test Trigger Port is run from the **SynAmps Hardware** screen in ACQUIRE (see the ACQUIRE manual for complete details). Briefly, *with the Stim*^{2} *system turned on and the STIM-to-SCAN cable connected*, go to Test trigger port, and click its Start button. The figures below are for *SynAmps*. The displays for *SynAmps*^{2} and *NuAmps* are nearly identical, and the functioning is the same. You should see:

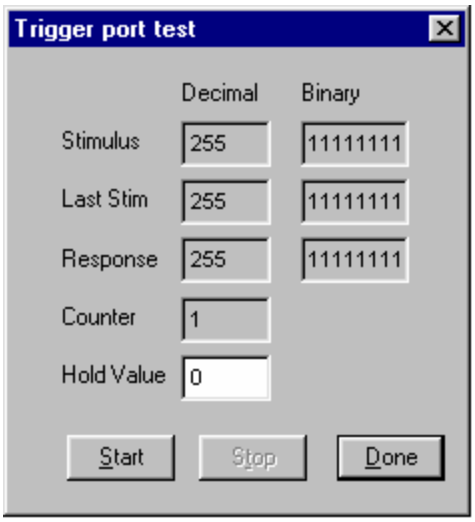
In its "resting" state, note that the Stimulus bits are at zero, and the Response bits are held high (all 1's). Summing the 8 response bits gives the 255 Decimal value. The Hold Value should be 0.



If you see, for example, one (or more) of the *stimulus* bits held high (1), that will cause all other incoming triggers to be ignored (no triggers). A workaround is to take whatever number it shows in the Stimulus field, and enter that as the Hold value. For example, if the 4th bit is stuck (8), enter 8 as the Hold value. (The events seen in ACQUIRE will be altered accordingly - this is a temporary workaround until the real problem is repaired). The cause could be a problem in the STIM box, the STIM-to-SCAN cable, or the trigger input board on the *SynAmps*.

With other stimulus systems connected, you might see all response bits at 0, or maybe the four left bits at 0. They all need to be high in the resting state. Then it is a question of whether you want to record responses or not. **If you do not want responses**, then you should not plug anything into those pins on the trigger connector in the back of the *SynAmps* (pins 17-24). The natural resting state of the *SynAmps* is high, so they will be OK. **If you do want responses**, they must use inverted logic, where the resting state is high, and the trigger pulse goes to zero. If pins 17-20 are zero, clip whatever lines are going into those pins - they are not needed for responses (but they do need to be held high).

To help isolate the cause of abnormal bits, disconnect the STIM-to-SCAN cable from the back of the *SynAmps* (and Start Test trigger port). You should see:



All of the bits should be high. If any are at zero, that points to a problem in the *SynAmps* (and a probable return for servicing). If this looks normal, connect the STIM-to-SCAN cable to the *SynAmps*, and disconnect it from the STIM box. It should still look like the picture. If it does not, there is a problem in the cable. If it still looks normal, then the problem is likely on the STIM side.

When you are testing for triggers in ACQUIRE, using the Single Window display to see the triggers in a continuous file, be sure you have NOT enabled the "Use inverted values" field in the setup file (look under **Edit** → **Overall Parameters** → **Triggers**).

10. **Disable "Use inverted values"**. With all Neuroscan amplifiers, be sure you have NOT enabled the "Use inverted values" field in the setup file - if you are using a more recent SoundBlaster STIM system (look under **Edit** → **Overall Parameters** → **Triggers**). The old LabMaster STIM system will likely need to have the "Use inverted values" option enabled. The very first few SoundBlaster systems may also need to have the field enabled.

II Troubleshooting

The most common causes of the trigger problems are due to incorrectly connecting the STIM-to-SCAN cable, mismatched port logic, or incorrect settings in the Stim^2 software. After that come problems where stimulus presentation systems other than Stim^2 are used (and usually involve the response lines). Rarely, but occasionally, there may be hardware problems in the STIM Audio System Unit (where one or more bits become "stuck").

Connecting other stimulus presentation systems to SCAN. Connecting to other stimulus systems is essentially a matter of making the other system emulate the TTL pulses from STIM, including the response lines. Test trigger port MUST look the same for the other system as it does for STIM (see #9 above). Typically, it is the response bits that cause problems. Even if they are not being used, the response lines at the port must be held high. This is most easily done by not connecting anything to the response lines. They will then be held high at the *SynAmps*/*SynAmps*^{2}/*NuAmps* port. If you want responses, you will need to invert the logic for those response lines you wish to use (so they function like STIM response lines).

Another option is to enable the "Use inverted values" field. If your STIM system uses inverted logic for the STIM triggers (resting state is at 5Vs), then you should try "Use

inverted values". In Test Trigger Port, you would see 255 in the Stimulus Decimal field, and all 1's in the resting state. Enter 255 for the Hold value, and try testing that way.

Some general testing tips. The information above is presented to show where triggering problems can occur. It does not necessarily mean that you should go through the entire list to find where the problem is.

If you contact Technical Support, you will likely be asked the following kinds of questions.

Is this our STIM system or some other system? If it is some other stimulus presentation system, then usually the best way to proceed, is to see how Test Trigger Port differs from the figures above. The problem is usually due to a less than perfect emulation of the STIM TTLs.

Is this a new STIM or Stim^2 installation? Usually trigger problems with a new system are due to connecting the STIM-to-SCAN cable to the wrong port, or selecting the wrong port in the Stim^2 software.

Was it ever working, and if so, what, if anything, changed? If the system was moved, you may have inadvertently reconnected the STIM-to-SCAN cable to the parallel port (on either the STIM or SCAN computers). Do ANY of the setup files in ANY of the STIM programs work (if so, it is a problem with the setup files for the affected program).

Do you see ANY triggers at all - even a single trigger - in ACQUIRE? This usually means that the STIM software settings are OK, and the problem may be a stuck bit in the STIM box (see #9). If it is not a STIM system, you could see a single trigger and then no more, due to an unexpected value remaining "on" at the *SynAmps*/*NuAmps* trigger port. Use Test Trigger Port to see what is wrong at the trigger port.

Still having problems? If the problem remains unclear, it is helpful to narrow the cause to the STIM side or the SCAN side. A good way to do this is to see if there are TTL triggers at the SCAN end of the STIM-to-SCAN cable. Use a meter or scope to measure the pins against ground. (See Appendix A above for pin out diagrams of the cable). You can make this easier by going into, for example, the P300 setup in AUDCPT, and then increase the pulse duration to, for example, 500ms. Then start the program. This will make it easier to see the TTL pulses.

If you can show that the correct triggers are at the end of the cable, then the problem is on the SCAN side (check Use inverted values, and use Test Trigger Port with the cable connected AND disconnected).

It does sometimes happen that the cause is a hardware problem in the STIM box, or with the *SynAmps* trigger port. Generally that means a return of the unit for repairs. In the majority of trigger related problems, however, it is not a HW problem with STIM or the amplifier units, but rather a software setting, cable connection, or imperfect emulation of the STIM TTLs.

5 Glossary

3DD file. File created by the 3DSpaceDx program that contains the digitized electrode and landmark positions. Used by PCA/ICA, SOURCE, and CURRY.

Accuracy. In this case, the least measurable voltage distance between data points (on the y-axis). The broader the dynamic range, the greater the distance between measurable points, and the higher the Accuracy value (less accurate).

A/D rate. Also AD rate, or analog to digital conversion rate. The rate at which an analog signal is digitized, or converted to digital form. Expressed in Hz. Example: an AD rate of 500Hz means the analog signal will be sampled 500 times per second, giving data points every 2ms.

Aliasing. Phenomenon that can occur when an analog signal is undersampled during digitization. Example: if undersampled, an analog wave of 1000Hz may appear as a 500Hz or 250Hz wave.

AVG file. Single sweep file created by SCAN. Typically, this will be the average of a series of sweeps in the .eeg (epoched) file.

Bad channel. In this case, a channel that has been designated as a "Bad" channel. Typically, Bad channels are those that start out well, then go bad due to a poor contact with the scalp (or other reason). You have the option to exclude Bad channels from many of the transforms in EDIT. (See also **Skip channel**).

Ballistocardiogram (BCG). Heart beat related artifact seen in MR recordings, resulting from micromovements of the body or electrode wires cutting across the lines of flux. The result is an exaggerated EKG artifact.

Band Pass Filter. Filtering in which frequencies above the High Pass and below the Low Pass cutoffs are passed (not attenuated). (See also **Band Stop Filter**).

Band Stop Filter. Filtering in which frequencies above the High Pass and below the Low Pass cutoffs are attenuated. (See also Band Pass Filter).

Batch file. User created program for automating acquisition or analysis. Refer to the Tcl Batch Tutorial and Tcl Batch Manual for more information.

Bipolar. In this case, a recording between two active electrode sites, such as, P3-P4. In essence, all EEG recordings are bipolar recordings. The difference is that monopolar recordings generally use the same reference, which may be placed on a relatively inactive site (e.g., ear lobe).

Butterfly plot. Display option that superimposes all channels in a single channel display (there is no recomputation).

Byte offset. In this case, typically the distance into a CNT file determined by the number of data points. Example: with an AD rate of 2000Hz (data points every 0.5ms), the byte offset corresponding to 5 seconds into the file would be 10000.

COH file. Single sweep file created in EDIT by the Coherence transform.

Coherence. Coherence is a frequency dependent measure of the degree of linear relatedness between two channels. Similar to a correlation, Coherence values range from 0 to 1, with 1 being perfect relatedness between the two channels.

Concatenate. Method for combining .cnt files (see the CONCATCNT command in the Tcl Batch Manual).

CNT file. Type of data file created in ACQUIRE, containing the complete EEG record without any gaps. CNT files provide the greatest flexibility for offline analysis.

DAT file. Text files created in Stim2 and SCAN. In Stim2, the .dat file contains the behavioral information about the subject's responses, and it is typically merged with the .cnt files in EDIT. Other text files created in EDIT may have a .dat extension.

DC. DC (direct current) recordings have no High Pass filtering. DC recordings are essential for recording very slow Eps, but are susceptible to drifting and offset concerns.

DC Drift. The slow drifting of a signal(s). The signal may eventually drift out of range of the amplifier, and data will be lost. Usually due to imbalance in electrodes (mixed metals, worn electrode surfaces, mixed conductance).

DC Offset. A voltage offset in the recordings (battery potential), usually due to imbalance in electrodes (mixed metals, worn electrode surfaces, mixed conductance). Clipping and saturation can occur, and data will be lost. Can occur with DC drifting.

Deblock. Originally used during acquisition with SynAmps to block stimulus artifact. There is now a transform in EDIT that will also remove brief stimulus artifacts.

Decimate. Downsampling a data file. Files with vary fast sampling rates (required for acquisition) can be downsampled to slower AD rates for easier file management and faster processing.

Dialog. In this case, the display in which the user can input parameters or make other selections. Also called screen, display screen, dialog display, etc.

Digitize. To convert an analog signal or other continuous measurement into discrete data points. The analog EEG signal is digitized during acquisition. Electrodes on the head can be digitized in 3D thus creating a file containing their discrete electrode positions.

Digitizer. In this case, the Polhemus Fastrak digitizer, used to record the electrode and landmark positions (and create a .3dd file).

Dilate. As used in SCAN, Dilate is a correction option that takes into account amplitude differences in the current sample as compared to the accumulating average artifact (as in EKG Noise Reduction). The waveform amplitude is increased or decreased to match the average.

Dongle. Also called software lock, or key. Connects to the USB port on the computer (older ones use the parallel port). Programmed to allow the SCAN or Stim^2 (other

SCAN programs) to run. The software will not run without it.

Dynamic range. The input voltage range for an amplifier. Signals exceeding the range will be clipped or lost due to amplifier saturation. The range is inversely related to Gain - the broader the Range of the amplifier, the smaller the Gain.

EDF file. European Data Format. CNT files in EDIT can be exported in EDF (16 bit, or with scaling options to reduce the 32 bit files to 16 bits).

EEG file. In SCAN, these are multiple sweep (or multiple epoch) data files. CNT files are "epoched" into .eeg files, and .eeg files are averaged to form .avg files.

Episequencing artifact. This is the very high amplitude, fast frequency artifact seen in EEG recordings during MR scanning.

Epoch. As a noun, an epoch is a single sweep of EEG data. As a verb, it means to create epochs in either a back-to-back fashion or about events in the .cnt file. The Epoch transform in EDIT is used to create an "epoched" file (.eeg), which contains successive sweeps.

ERBP. Event Related Band Power. Basically, the transform in EDIT is used to compute power spectra from sections (time intervals) of evoked potential files. The data are filtered for a frequency of interest, and power is computed for induced, evoked, or ERD/ERS (Event Related Desynchrony/Event Related Synchrony, which is approximately the sum of induced and evoked activity) activity.

ERCoh. Event Related Coherence. Transform in EDIT that is used to compute coherence within sections (time intervals) of evoked potential files. The data are filtered for a frequency of interest, and coherence is computed for induced, evoked, or both parts of the waveforms.

Event code. Same as type code. Events are marks in .cnt files to indicate the occurrence of various events in the recording: stimuli, responses, DC corrections, annotations, and function key events. Epochs can be created about the events.

Event file. Text file created by the Event File transform that lists all of the events in the .cnt file. It can also be created manually using a text editor.

Event table. The section at the end of a .cnt file that contains the event information.

Evoked phase locking. Option in the ERBP and ERCoh transforms. Each sweep in an epoched data file (where EPs were recorded) contains activity that is time-locked (phase locked) to the stimulus, and activity that is not time locked (phase locked) to the stimulus. Evoked activity is the phase locked component, which may be analyzed separately in the ERBP and ERCoh transforms.

FFT. Fast Fourier Transform. Same as power spectrum, or spectral analysis. Across a defined time interval, frequency analyses show the relative or absolute power within contiguous frequency bands (bins). Example: the results may show the amount of power (voltage) within the alpha band, during a single sweep, or averaged over all sweeps.

FIR filter. Finite Impulse Response filter. FIR is a non-recursive filter in which only

previous and current input values are included in the calculation of the new output values from the filter. FIR is therefore fundamentally phase blind to output since it does not consider the previous output in the generation of the next output. The nature of the FIR filter permits a linear, predictable phase *error* that does not occur with IIR.

Focus. In this sense, "focus" refers to the window that is highlighted. If you have multiple data windows open, and you wish to apply an operation or transform to one of them, you must click on the desired window to give it the focus (highlight it), and that is the file that will be affected.

Frequency domain. As opposed to Time domain. Frequency domain in SCAN refers to data files that show changes in amplitude across frequencies, rather than across time. FFT power spectra are in the Frequency domain. The EP waveforms are in the time domain.

Fsp. F statistic computed at a Single Point. Averaging method used traditionally with ABR (auditory brain stem responses) recordings, in which sweeps are acquired and averaged until user defined SNR (signal-to-noise ratio) criteria are met. The criterion can be the actual F statistic based on SNR comparisons, or the level of noise in the recording, or both.

Gain. Most simply, Gain is the degree to which the potential differences between two electrodes are increased (like a multiplier). There is an inverse relationship between Gain and the Dynamic Range of the amplifier (the smaller the Gain, the broader the Dynamic Range).

GFP. Global Field Power. (Same as MGFP in PCA/ICA and CURRY). Global Field Power (GFP) is a measure defined as the standard deviation across multiple channels as a function of time within a sample interval. The intention of the GFP measure is to quantify the instantaneous global activity across the spatial potential field sampled over the scalp. The result of this analysis is a waveform that represents the temporal changes in GFP. A peak of GFP at some point in time is thought to reflect a maximum (and a trough is thought represent a minimum) of the total underlying brain activity that contributes to the surface potential field. Peaks and troughs of GFP have been used to segment multichannel EEG records and to select moments of time for mapping of the potential field.

Header. In this case, the header is the part of a data file (e.g., .cnt, .dat from Stim^2, ASCII, etc.) that contains additional information beyond the actual data points (number of channels, AD rate, etc.).

HEOG. Horizontal eye movement artifact. Recorded primarily from electrodes at the sides of the eyes. Sensitive to saccadic eye movements.

High Level Inputs. Additional inputs on SynAmps^2 (and custom ordered SynAmps) that receive the (relatively high) voltage outputs from peripheral psychological devices (such as a pulse oximeter). These outputs must not be input through the regular headbox channels; they must be input through HLIs (see the amplifier manuals or ACQUIRE for details).

High Pass Filter. Frequencies higher than the selected frequency are passed, with little or no attenuation. Example: a 1Hz high pass attenuates activity below 1Hz, and

passes the faster frequencies.

Hold value. Typically 0. This is the resting bit state at the input trigger port of the amplifier for external TTL pulses (as with Stim^2 events). A trigger is registered when the hold value deviates from the value. If the Hold value was 10, any event other than a 10 (bits 2 and 4 high) would register an event.

Hotfix. This is a patch version of the software that has not been fully regression tested. SCAN 4.5 is the latest Hotfix version. All of the changes/additions were tested or retested, while the unaffected parts of the program were generally not fully retested.

ICA. Independent Component Analysis. ICA generates patterns and loadings using stricter criteria (than for PCA) for statistical independence (requires that all second order and higher correlations are zero). The generality of ICA lies in the simple principle that different physical processes tend to generate statistically independent signals. Given that scalp-recorded EEG is the summation of signals from multiple sources, ICA computes individual signals that are statistically independent, and which are therefore likely to have been generated by different physiological processes. ICA has been asserted by some to be the preferred method for use with physiological signals.

IIR filter. Infinite Impulse Response filter. IIR is a recursive filter (in essence, a filter that runs backward), which keeps track not only of previous and current input values, but also the previously calculated output values. It is therefore less prone to phase mismatches.

Impedance. The load or resistance that affects or impedes the conductance of electrical signals. Generally measured in kOhms. In impedance testing, very weak signals are sent from the amplifier, through the active electrodes, and returned to the amplifier through the ground/reference. The degree of resistance, or impedance is displayed.

Induced phase locking. Option in the ERBP and ERCoh transforms. Each sweep in an epoched data file (where EPs were recorded), contains activity that is time-locked (phase locked) to the stimulus and activity that is not time locked (phase locked) to the stimulus. Induced activity is the non-phase locked component, which may be analyzed separately in the ERBP and ERCoh transforms.

Key. In this case, key refers to the dongle, or software lock. Connects to the USB port on the computer (older ones use the parallel port). Programmed to allow the SCAN or Stim2 (other SCAN programs) to run. The software will not run without it.

Latency. Time from the zero point. For a response, the latency is the time from the presentation of the stimulus (actually, the event code for the stimulus), to the event code for the response. Otherwise, the time from zero to a component of interest in the EPs (the VEP P100 component latency is approx. 100ms from the point of stimulation).

License. License to run one or more of the Neuroscan the programs. A dongle is not the license. A license is a number obtained from NS, specific to your system, which is used to program the dongle so that it will allow access to the software.

Linear Derivation (LDR). The Linear Derivation transform enables the creation of new channels as arbitrary linear combinations of existing channels. LDR files are used extensively with the Spatial Filter, Spatial SVD, and to a lesser extent with the Ocular Artifact Reduction routine (and elsewhere). See the Linear Derivation transform and the Montage Editor appendix to the EDIT manual for details.

Linear Detrend. Transform in EDIT to remove linear drifts from waveforms. Example: HEOG is often seen as a linear drifting in the frontal channels (e.g., F7 and F8 areas). Linear detrending can be used to remove the drifting.

Low Pass Filter. Frequencies below the selected frequency are passed, with little or no attenuation. Example: a 30Hz low pass attenuates activity beyond 30Hz, and passes the slower frequencies.

MapGen. Sub-program accessed from ACQUIRE or EDIT that is used to create or modify .map files, used to display data in 2D maps. In most cases, the 2D .map files you need are supplied. If not, they can be created in MapGen (see the MapGen manual in SCAN, Vol. 1).

MGFP. Mean Global Field Power. See GFP.

Monopolar. In general, all EEG recordings are bipolar recordings, in that the electrical difference between two recording sites is measured. In monopolar recordings, the reference site is usually the same for all channels, such as a mastoid, and the site is often relatively silent (such as an ear lobe).

Multiple Window Display. Type of display in SCAN in which each EEG channel is shown in its own window. AVG, EEG, and COH files are shown in Multiple Window Displays.

Offline. In this case, not during acquisition. The EDIT program runs offline.

Online. In this case, during acquisition. The ACQUIRE program runs online.

PCA. Principle Component Analysis. PCA generates patterns and loadings that are orthogonal to each other. After the first factor is extracted (by fitting a regression line to a scatter plot), the second factor is extracted from the remaining variability, and so on until there is essentially no variance left. The resulting components are orthogonal to, or uncorrelated with each other (first order decorrelation). It has been argued that PCA may not be the most appropriate method for use with physiological data (see ICA).

Points. The actual number of data points. If a file is acquired at 500Hz, there will be 500 data points for each second, or one data point every 2ms. A file that was epoched from -100 to 1000ms, with an AD rate of 1000Hz, will have 1101 data points for each sweep (and each channel). There are 100 points before the stimulus, a point at zero, and 1000 points after the stimulus.

Power of two. An FFT, as well as coherence computation (which performs an FFT in the process), requires that there be a number of points that is a power of two (256, 512, 1024, etc.). You cannot compute an FFT on sweeps from 0 to 500ms, but you can compute it on sweeps from 0 to 512ms. Spline fitting can be used to fit data points in sweeps such that a power of two is obtained.

QRS. The principle and most easily recognized complex in an EKG recording. The QRS complex indicates ventricular contraction. (The preceding P wave indicates atrial contraction, and the subsequent T wave indicates ventricular relaxation).

Range. See Dynamic Range.

Rectify. Rectify (as in the Rectify transform) is a simple "absolute value" operation: all positive waveform values are left unchanged, and all negative waveform values are inverted to their corresponding positive values.

Refractory period. A period of time during which a certain operation is suspended. Example: in the Voltage Threshold transform, events can be added each time the voltage, in a specified channel, exceeds a threshold you set. However, voltages that meet the criterion, *during the defined Refractory Period*, will be ignored.

Rolling average. An [internal] average data file that is computed using only the N most recent number of sweeps, when N is used determined. The average is recomputed based on the N most recently detected sweeps.

Script. A user created "program" that is used to automate analysis. See also Tcl Batch files (which provide the preferred way to automate processing).

Sequence file. Used in Stim^2, most frequently in Gentask, to control stimulus presentation. In Gentask, the sequence file (.seq) is a user created "program" that controls all aspects and parameters of stimulus presentation. Some of the other Stim^2 modules use less complex sequence files.

Setup file. User created files in ACQUIRE and Stim^2 that contain all of the configuration parameters you set. Setup files are used to avoid having to manually reconfigure the system each time run a subject. You may have a number of setup files that are used for various studies that are being conducted.

Shift limit. Parameter used in the fMRI, EKG/BCG, and Correlate Peaks transforms. The value (in points, not ms) limits the range that events may be shifted in order to find the maximum correlation. It is used primarily to limit the number of correlations that are performed, but also to exclude the possible acceptance of correlations with unwanted peaks.

Shorting plug. This is a small device that connects to the cap connector on the SynAmps headbox(es). You must connect the shorting plug when performing a Calibration. With a SynAmps^2 or SynAmps RT, the shorting plug is used only as a means for inputting a test signal to all channels. NuAmps have no shorting plug.

Single Window Display. Type of display in SCAN in which all EEG channels are shown in a single window. CNT files are shown in Single Window Displays.

Skip channel. In this case, a channel that has been designated as a "Skip" channel. Typically, Skip channels are those that are known in advance to be ones that will be excluded from the analyses. These could include unused channels, artifact channels, etc. You have the option to exclude Skip channels from many of the transforms in EDIT. (See also **Bad channel**).

SNR. Signal to Noise Ratio. SNRs are used in several places in EDIT as well as SOURCE and CURRY. SNRs are an approximation of the amplitude of the signal divided by the amplitude of the noise, where there are options in how the signal and the noise are defined. The larger the ratio, the more likely the signals - the EEG or EP components - are valid.

Sorting. Sorting options are available in ACQUIRE and EDIT. Sorting allows you to select only certain stimulus, response, or other type codes, and then perform subsequent operations on the selected, or sorted, sweeps.

Spatial filter. Transform in EDIT. LDR files are created and used to construct a spatial filter that can remove unwanted activity (such as eye blinks), while retaining desired EEG activity.

Spatial SVD. Transform in EDIT. The Spatial SVD transform is equivalent to spatial PCA (principal component analysis) without rotation of components. A series of spatial components – i.e. unit magnitude channel vectors or topographies — are derived such that the first component accounts for a maximum of the temporal variability in the data; the second spatial component is orthogonal to the first and accounts for a maximum of the residual temporal variability; etc. The transform generates spatial component topographies, fraction of total variance explained by each component, and a linear derivation file for deriving component time series. It can be used to create LDR files that are then used to construct a spatial filter.

Spline fit. Transform in EDIT. Fit a new number of points to an existing waveform. Example, if you need a power of two to perform an FFT, spline fitting can fit a power of two points to your existing file. As a general rule, you should spline fit downward, not upward (e.g., 350 points should be splined down to 256, not up to 512).

Sweep. Same as an epoch. A single sweep of EEG data, generally containing a zero point for the point of stimulation, with pre- and post-stimulus intervals (back to back sweeps where there are no trigger events is another option).

TCL. Tool Command Language. The Tcl Batch commands use Tool Command Language, which is a complete programming language. Non-programmers can easily use the batch commands in EDIT; programmers can integrate more of the Tcl functionality, as desired.

Tcl Batch files. A user created "program", based on Tool Command Language, which is used to automate acquisition or analysis. Refer to the Tcl Batch Tutorial and Tcl Batch Manual for more information.

Time domain. As opposed to Frequency domain. Time domain in SCAN refers to data files that show changes in amplitude across time, rather than across frequency. The raw EP waveforms are in the Time domain. FFT power spectra are in the frequency domain.

TR Block. Time Repetition Block. Used in the fMRI Artifact Reduction transform that is included with MagLink RT Systems. A TR Block is a section of EEG during which a block of MR slices was scanned. There is usually a single trigger event at the beginning of the block, and a fixed number of slices per block.

TTL. Trigger pulses that vary between 0 and 5Vs. With positive logic, resting is 0V and the trigger is 5Vs. With negative logic, resting is 5V and the trigger is 0Vs. The frequency and duration of the pulses are user determined (as in Stim^2).

Type code. See Event code.

VEOG. Vertical eye movement artifact. Recorded primarily from electrodes above and below the eyes. Sensitive to vertical eye movements and especially eye blinks.

Zero phase shift. Type of filtering that avoids latency shifts. If filtering is done in one direction, the latencies of EP components can be increased (as with analog filtering). If filtering is done in both directions, there is no latency shift (zero phase shift).