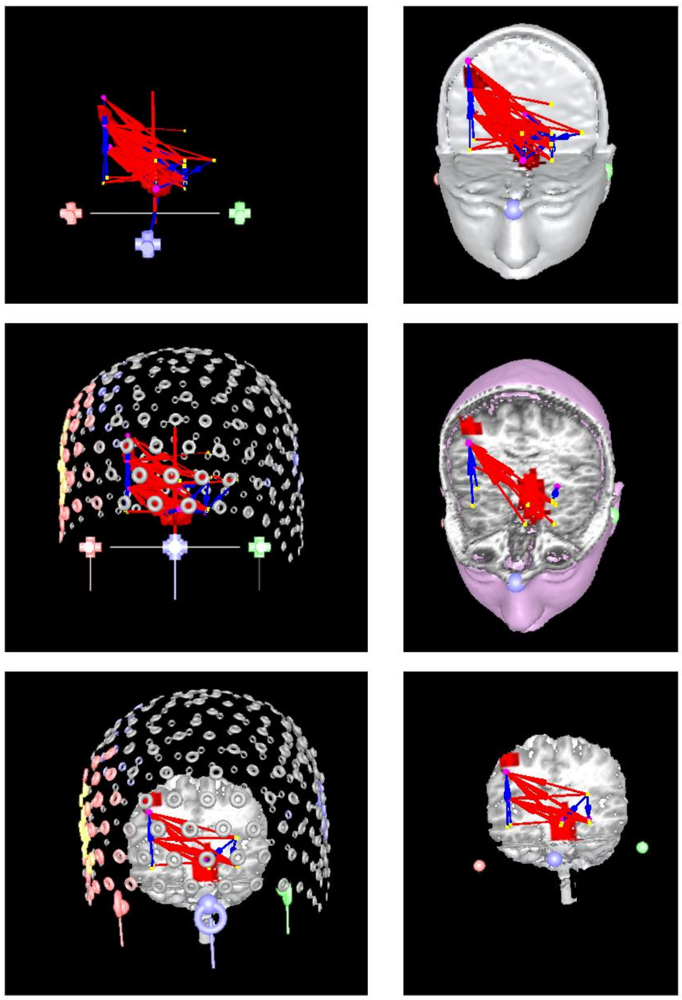
MSI 3D Viewer

Software Guide



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Thank you.

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Warnings and Cautions

This software supports functional images, structural images and neural networks. Functional image data include magnetoencephalography (MEG) and electroencephalography (EEG) data. Structural image data include magnetic resonance imaging (MRI) and computed tomography (CT). Though MEG and EEG waveforms appear similar, they have different unit in amplitude. If the MEG and EEG data recorded simultaneously, their time unit or temporal resolution is typically the same.

Neural network data are typically computed with MEG/EEG source data. The unit, strength and time-frequency parameters may vary different computing methods and source data.

If you use MSI 3D Viewer to convert a DICOM (Digital Imaging and Communications in Medicine) series containing oblique slices with a slice plane that is not orthogonal to the scan direction, the result will be a distorted image. The severity of distortion will depend on the angle of the oblique scan. Such a distorted image should not be used for analysis.

There are a set of source localization algorithms in the program. Each source localization algorithm has been designed and tested for specific reasons. To ensure the quality and visibility, all source localization algorithms will generate a volumetric source image, which can be considered as a image with millions of “dipoles” or multi-value-voxel, which is significantly different from the conventional magnetic source imaging (MSI) or equivalent current dipoles.

The accuracy of the structural images (MRI/CT) may also affect the MEG results if the conventional magnetic source imaging (MSI) is used. If MRI/CT is distorted, the combination of MEG/MRI/CT will be low-quality. In addition, multiple local sphere, head model or other structural constrained source localization my internally use the MRI/CT images. Any analysis based on those distorted images may yield unexpected or poor results.

The co-registration is only as good as how closely the lipid markers correspond to the placement of the head localization coils during an MEG collection, and how accurate the head coil locations are relative to the sensors. Please See the Head Localization Guide for more details on head coil localization methods and accuracies. In addition, if the MRI contains any distortions which may distort the locations of the lipid markers, the co-registration of the MEG data results and the MR image may also be compromised.

For source localizations on the surface of the brain, there is little or no difference in results between the MSI 3D Viewer shape data extraction methods (“cortical hull”, “head” and others). However, for deep sources (e.g., those located in the hippocampus or inferior temporal lobes), the cortical hull extraction method results in source localizations that more closely approximate the true model. This method is the default selection in the MSI 3D Viewer software.

The accuracy of the multiple local spheres head model used for the mathematical analysis of MEG data is dependent on the accuracy of the MRI itself. If MR images are poor (i.e., distorted), the shape data created in MSI 3D Viewer and the resulting multiple local spheres model created by the local spheres application will likewise be inaccurate. Any analysis based on this multiple local spheres model may yield poor results.

It is a good idea to use input data generated by MEG Processor software when processing and analyzing data. For example, the multiple local spheres model created by the local spheres model in MSI 3D Viewer has only been tested and validated using shape data files generated by MEG Processor. Use of other software to generate input files for MSI 3D Viewer is at the discretion of the user.

When the source volume is not overlay correctly on an MRI, it is possible due to the source localization methods, MR images and/or co-registration errors. The following warnings and cautions appear in this guide. Please ensure you are aware of all the operations and interpretations.

Preface

This guide describes the operation of the MSI 3D Viewer. The MSI 3D Viewer is one of the core windows for integration of MEG/EEG and MRI/CT. Critically, it provide key functions for integrate MEG/EEG sources and neural network with structural data. It is used as the primary tool to view 3D structural and functional activity/activation or abnormality for academic or clinical purposes. The MSI 3D Viewer provides graphic user interface (GUI) for access other function. In other words, it is also often used to launch other windows such source manager, MRI/CT manager and neural network manager.

The MSI 3D Viewer application allows you to manipulate an isotropic volumetric image data that can be co-registered with 3D coordinate system. In addition, it allows for co-registering neural network data to 3D coordinate system. You can view source images and neural network connection for in one 3D coordinate system.

Intended Audience

This guide is intended for persons responsible for analyzing MEG/EEG sources, MRI/CT structures and neural networks in 3D. The guide assumes the reader is familiar with standard MEG/EEG procedures, MRI/CT data analysis and neural network analysis. In addition, this guide assumes the reader is familiar with the Windows operating systems.

> MSI 3D Viewer supports up to 6 fiducial points (head shape matching is discussed in other model). To co-register two image datasets, at least three fiducial points are necessary. If the fiducial markers are being imported from an external program, the same unaltered MRI used to compute the fiducial points must be loaded into MSI 3D Viewer. Any alterations to the image that change the image data, such as re-coregistration or orthogonalization, must be performed after the fiducial markers are loaded.

References

This document assumes familiarity with many terms related to computer operations and physiology. There is also wide use of acronyms.

Document Structure

Documents are generally provided in both Microsoft Word® format and Adobe® Acrobat® PDF (Portable Document Format). All editions are distributed on Flash Driver, CD or websites with the related software, and include bookmarks and hyperlinks to assist navigating the document. Please feel free to send your critiques, corrections, suggestions and comments to: BrainX@live.com.

Conventions

Numeric: Numeric values are generally presented in decimal but in special circumstances may also be expressed in hexadecimal or binary. Hexadecimal values are shown with a prefix of 0x, in the form 0x3D. Binary values are shown with a prefix of 0b, in the form 0b00111101. Otherwise, values are presumed decimal.

Units: Units of measure are given in metric. Where measure is provided in imperial units, they are typically shown in parenthesis after the metric units. Magnetic signal strength is given in Teslas (T), the SI unit of flux density (or field intensity) for magnetic fields, also known as the magnetic induction. Typical signal strengths in MEG measurements are in the order of pT (picoteslas = 10^{-12}) or fT (femtoteslas = 10^{-15}).

MSI 3D Viewer supports more than one structural datasets. For example, MSI Studio may overlap source data onto the brain, white matter, gray matter or the entire head. If you have more one MRI/CT data, which can be produced by segmentation, associated with MSI 3D Viewer, ensure that you select the intended one.

MSI 3D Viewer also supports more than one functional datasets. For example, MSI Viewer may overlap source data for somatosensory, motor, auditory and visual stimulation on to the brain. If you have more one MEG/EEG source data associated with MSI 3D Viewer, ensure that you select the intended one.

Changes from Previous Releases

If you used the software before, please read the ReadMeFirst.doc or ReadMeFirst.pdf file for late changes that did not make it into this manual and for a list of new functions or options, changes, additions, bug fixes, and known bugs for the application. You can open this file from the main window's Help -> New Features menu.

Overview

This chapter describes the various graphical elements that make up MSI 3D Viewer and defines the coordinate systems used throughout the software applications.

MEG Sensors and/or EEG Electrodes

MSI 3D Viewer can visualize the MEG sensors and/or EEG electrodes (sensor). The sensor array can be coregistered with other imaging data with fiducial points. In addition, the sensor can color-encode the amplitude of MEG/EEG data, which provides the capability to visualize the spatial distribution of MEG/EEG data at sensor space.

The MSI 3D Viewer MEG/EEG data also retain information regarding the fiducial landmarks such that any three-dimensional location with respect to the MEG/EEG coordinate system can be automatically co-registered with the corresponding coil location in the sensor-array. The fiducial points in 3D Viewer are typically showed as tori with a short tail.

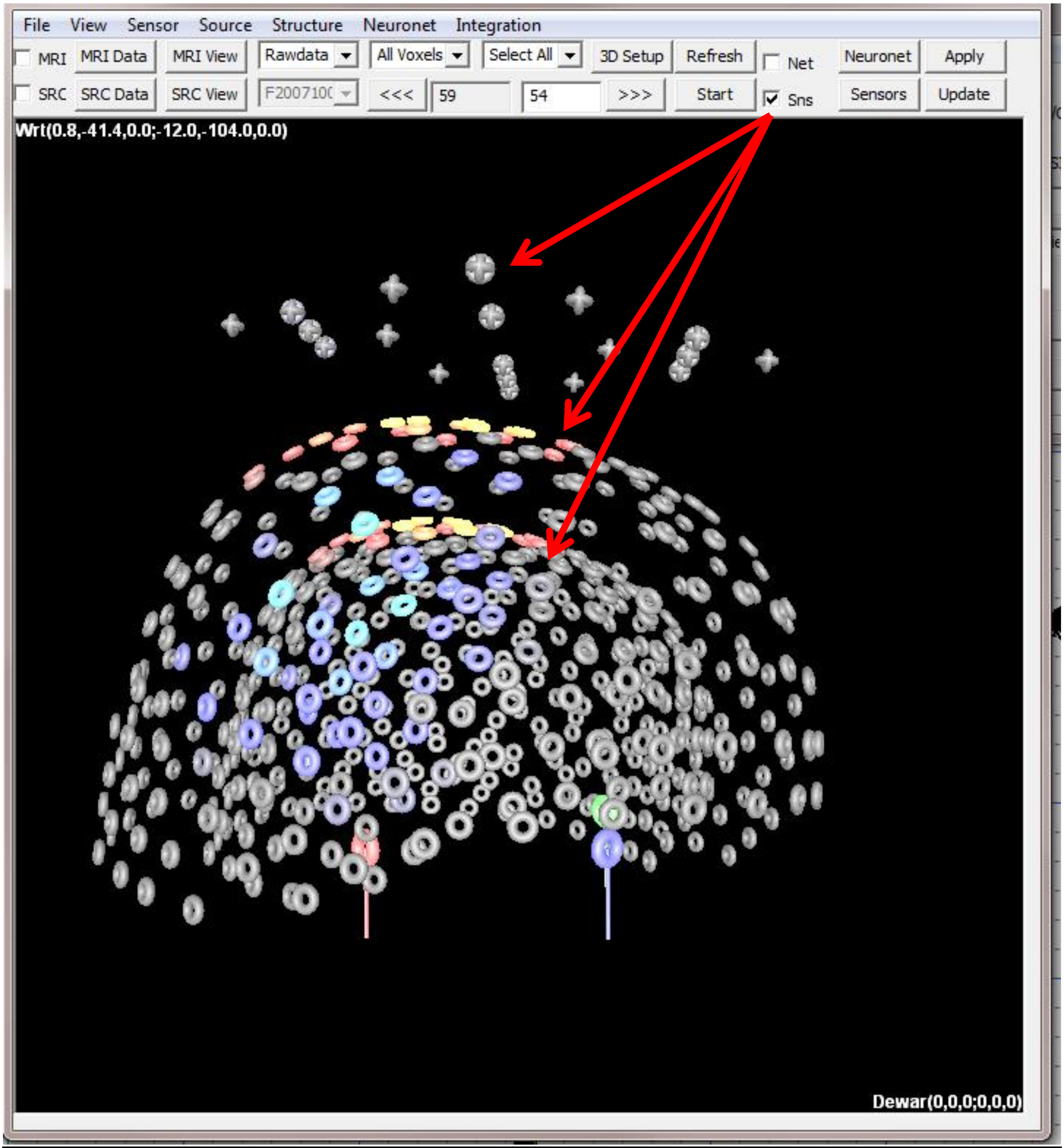

Figure 1. Main Window of Magnetic Source Imaging (MSI) 3D Viewer.

Structural Data (MRI/CT)

MSI 3D Viewer creates and uses its own format for reading and viewing volumetric structural and functional images. It has a set of build-in functions to import a variety of files such as DICOM file, CTF MRI files. These files should consist of a three-dimensional volumetric image that is typically created by interpolating an original set of "3D" or "volumetric" MRI/CT data to provide an "isotropic" (equal dimensioned voxel) dataset with known dimensions. The resulting dataset contains a width x height x depth (e.g. 256 x 256 x 256) volumetric (3D) MRI/CT plus additional information. The width, height and depth do not have to be equal in the new version of MSI 3D Viewer (since 2009).

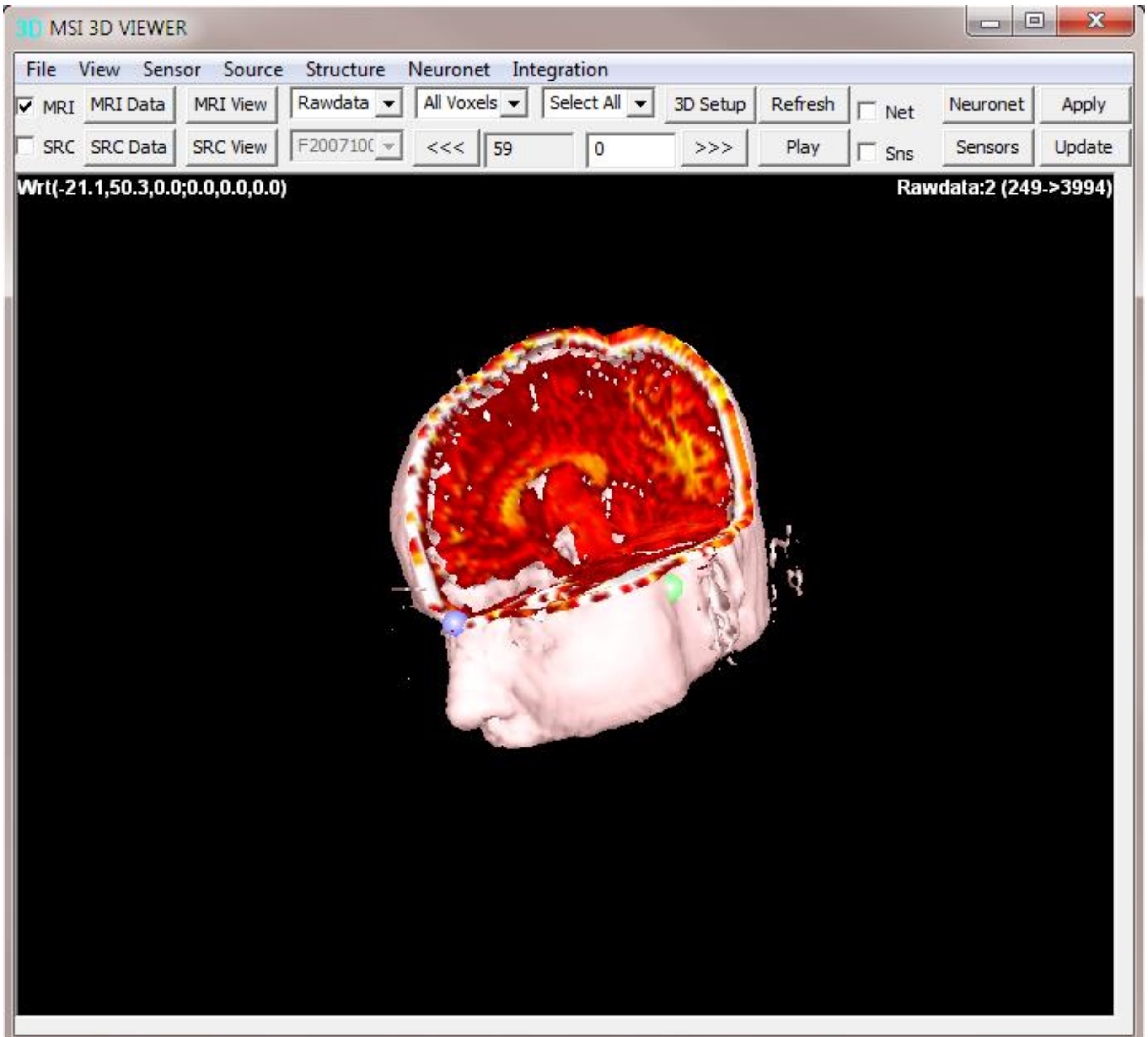

Figure 2. Main Window of Magnetic Source Imaging (MSI) 3D Viewer.

The MSI 3D Viewer structural data also retain information regarding the fiducial landmarks such that any three-dimensional location with respect to the MEG/EEG coordinate system can be automatically co-registered with the corresponding voxel location in the MRI.

Please note that the co-registration of MRI/CT and MEG/EEG requires the fiducial points. If the MRI/CT data does not have three fiducial points, you may set the fiducial points with MSI Studio. Otherwise, the source location in the MRI/CT images may not correct.

In MSI 3D Viewer, three fiducial points, left and right pre-auricular points and nasion, are typically used. To simplify the usage, right is typically marked as red, left is typically marked as green and nasion is typically marked as blue.

MSI 3D Viewer and MSI Studio

From functionality point of view, MSI 3D Viewer is similar to the MSI Studio's 3D view panel. However, the MSI 3D Viewer is a standalone window and has much more powerful functions. In MEG Processor, the MSI 3D Viewer and the MSI Studio's 3D view panel is internally linked. By double clicking the 3D view panel in MSI Studio, the standalone MSI 3D Viewer will pop-up, which allows better visualization of MEG/EEG, source, structural data and neural networks in one 3D coordinate system.

The main window in MSI 3D Viewer can display the volumetric MR/CT image alone or integrated with other image data in one 3D Viewer. The data information is shown in the four corners.

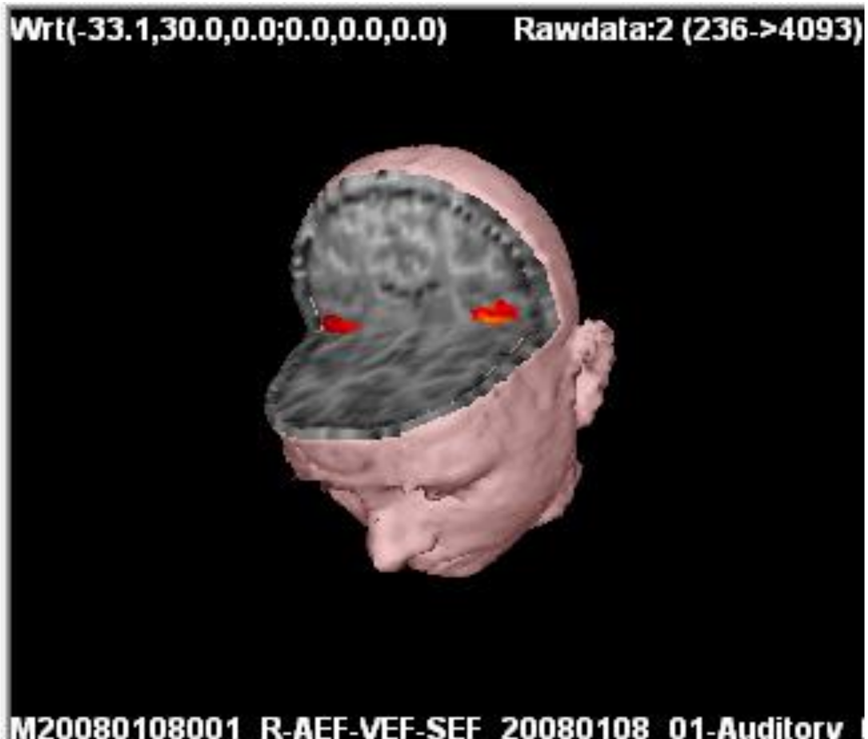

Figure 2. MSI Studio 3D Viewer. The four corners of the viewer shows the information about the data.

Properties of the MRI/CT

The MR/CT images in MSI 3D Viewer may vary slightly according the source files. However, all images have the following properties:

- The MRI/CT is isotropic, i.e., slices are equally spaced in an orientation.
- Voxels on the MRI/CT may be defined either in the MEG/EEG head coordinate system or in the MRI/CT coordinate system.

For example, if the MRI data are from CTF MEG system, the images have the following properties

- Each view contains 256 slices.
- The MRI is isotropic, i.e., slices are equally spaced in all orientations.
- Each slice is identified by its slice number and orientation (coronal, axial, or sagittal).
- The MR image is displayed in grey scale.

Manipulating the MRI/CT

MSI 3D Viewer provides various functions that change the display of the MR/CT image. In some cases, these changes can be saved as a new MRI data file. The MRI may be manipulated in the following ways:

1. The MR/CT image can be show/hide for better viewing sensors/sources.

2. Brightness and contrast are adjustable in the image.
3. Fiducial markers can turn on and off.
4. The thresholded black-and-white image can be displayed.

Displaying the Slices

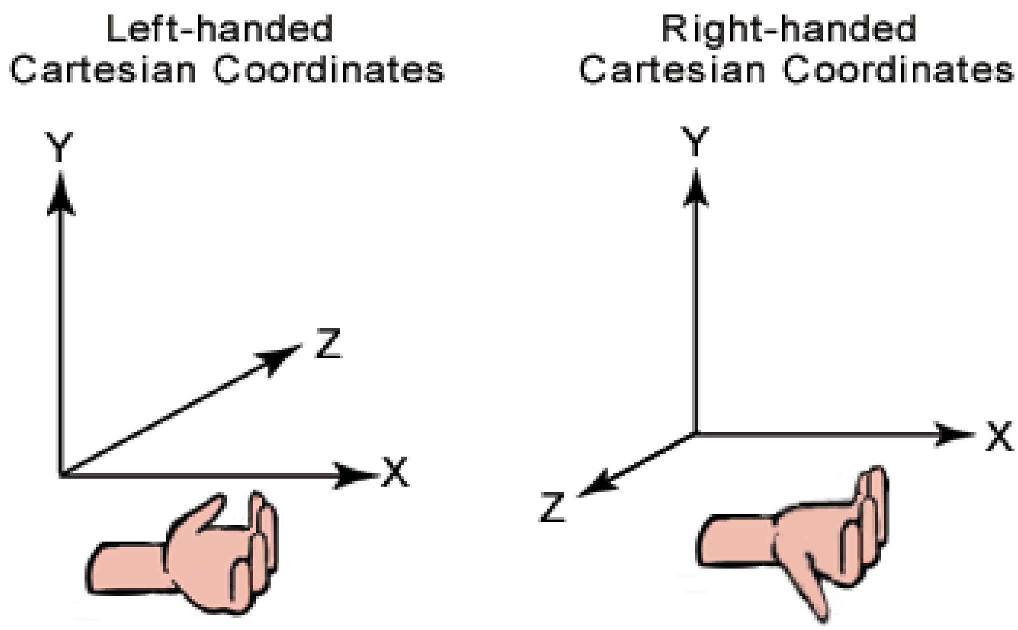

Figure 3. MSI 3D Viewer uses a left-handed coordinate system (Direct 3D), which is different from the right-handed coordinate system (OpenGL). Although left-handed and right-handed coordinates are the most common systems, there is a variety of other coordinate systems used in 3D software. For example, it is not unusual for 3D modeling applications to use a coordinate system in which the y-axis points toward or away from the viewer, and the z-axis points up.

MRI/CT 3D Coordinate System

The MRI/CT coordinate system, shown in Figure 4 is defined by the orthogonal viewing directions typically used in radiology — sagittal, coronal (also termed frontal), and axial (also termed horizontal).

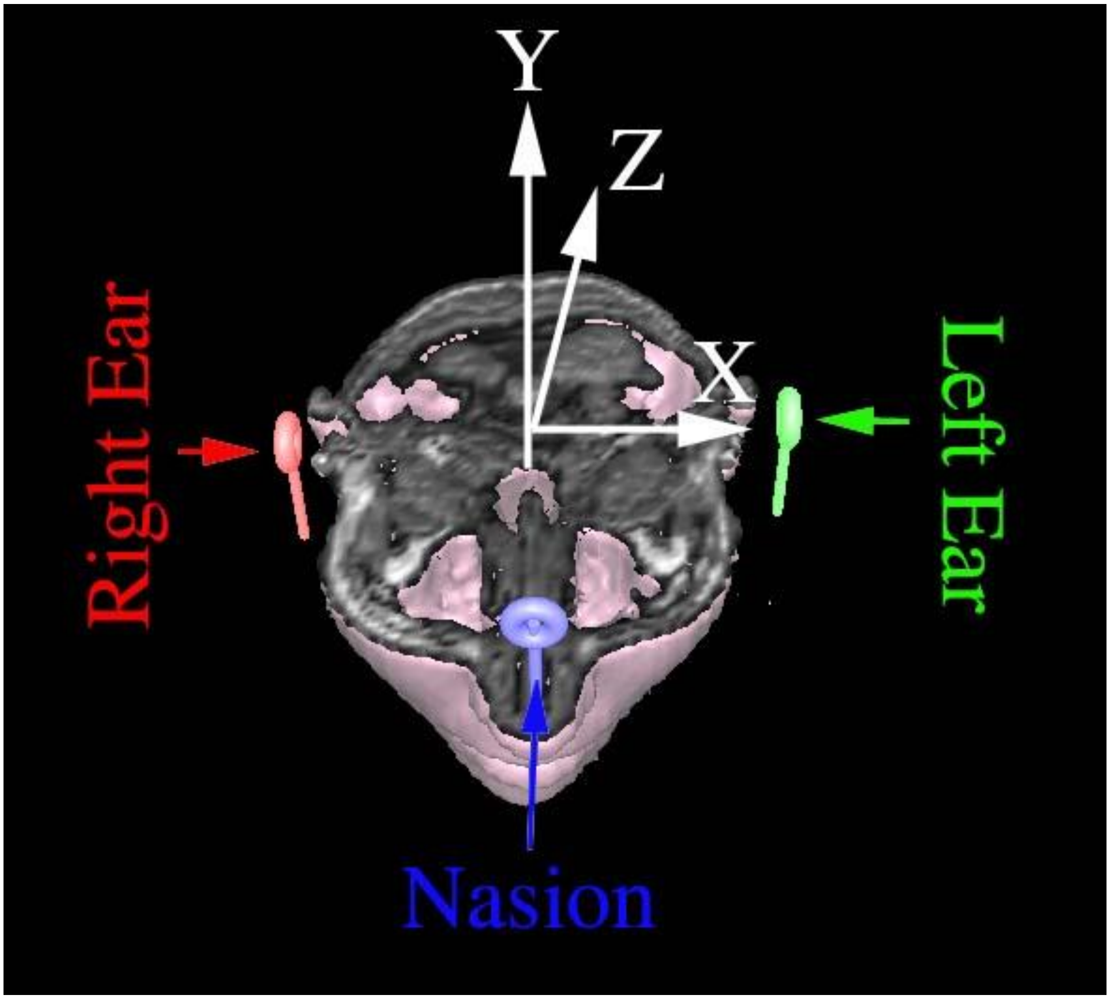

Figure 4. MSI 3D Viewers uses a left-handed coordinate system (Direct 3D), which is different from the right-handed coordinate system (OpenGL). In MSI Studio, right fiducial point is always red, left fiducial point is always green and the nasion is always blue.

MSI 3D Viewer uses these cardinal directions as axes in an internal coordinate system where sagittal = X', coronal = Z', and axial = Y', forming an additional left-handed coordinate system which is translated and rotated with respect to the head coordinate system, and which has its origin at the upper left anterior corner of the volume .

Upon defining the landmark or "fiducial" locations set by the placement of the head localization coils, an internal representation of the MEG head coordinate system is defined using the same convention as that of the MEG acquisition software described above. This information, combined with the voxel resolution in each direction, is used to construct an internal transformation matrix (T) to automatically convert any three-dimensional location in the MEG head coordinate system to any voxel location in the MRI. Thus, a point P(x, y, z) specified in the MEG head coordinate system (see Figure 3) can be converted to the MRI voxel P'(x', y', z') by multiplication.

MEG/EEG 3D Coordinate System

The MEG/EEG head coordinate system used by this software is a left-handed coordinate system based on the location of the nasion, left ear, and right ear head positioning coils determined when localization is performed during acquisition. Since there is no standardized coordinate system for MEG/EEG, the coordinate system in varies among MEG/EEG systems from different manufacturers. Understandably, the software converts all the kinds of coordinate systems to the left-handed coordinate system as shown in Figure 3. These coil locations are used to form the head-based coordinate system shown in Figure 4. For example, in CTF MEG system, when localization is performed during acquisition, the position of the gradiometer sensors is automatically converted to this coordinate system and stored with the data. The origin of the head coordinate system is defined as the mid-point of the line connecting the left and right ear coil locations. The x-axis is formed from the vector pointing from this origin to the nasion coil location. The positive y-axis is then determined as the vector pointing from the origin to the left ear coil location. If necessary, this vector is slightly rotated about the origin toward or away from the x-axis to make it exactly orthogonal to the nasion vector. The z-axis is defined as the normal to the resulting x-y plane pointing in the upward (superior) direction. When CTF MEG data are imported by this software, this software will automatically read all those information and converts the CTF coordinate system to the left-handed coordinate system.

Superimposed Objects/Items

A useful feature of MSI 3D Viewer is the ability to import graphical representations of various MEG/EEG data interpretations or analysis. These are co-registered and superimposed on the MRI/CT. As well, graphical markers can be defined or imported, then viewed on the MRI.

In addition to MRI/CT data, the following graphical objects may be co-registered in one 3D coordinate system:

- Fiducial points
- Head localization coils
- Shape data points
- Source volume
- Virtual Sensor Locations
- Best-fit sphere
- Dipoles
- Markers
- Neural networks

These objects/items share the following common properties:

1. They do not alter the MRI/CT data, but are instead graphical integration.
2. They are stored internally and separately in the program.
3. They may be manipulated simultaneously or independently depending on the function. For example, when you set the fiducial points of MRI/CT, it only changes the fiducial points of

MRI/CT. However, when you click the co-registration function, it uses both MRI/CT and MEG/EEG fiducial points to change both MRI/CT and MEG/EEG data.

4. Each object is optional and does not need to be defined to view the MRI/CT data. However, default values are always present for best-fit sphere and the fiducial points.
5. Any combination of these objects may exist together (from none to all).
6. They can all be displayed in color.
7. With the exception of the fiducial points, these objects are defined in the MEG/EEG head coordinate system. Since the colors in fiducial points have special meanings, the colors in fiducial points are purposely fixed.

The sections that follow describe each of these graphical objects in detail.

Fiducial Points

Fiducial points are also called fiduciary points. In this menu, we typically refer them as fiducial points. The nasion, left ear, and right ear landmarks are collectively called the fiducial points and together form a coordinate system defined relative to the subject's head. The section "MEG/EEG Head Coordinate System" describes this coordinate system in detail.

In the example MRI shown in Figure 4 on previous page, the landmarks are identified with the placement of lipid markers. The center of each lipid marker is defined in MSI 3D Viewer as a fiducial point using the Set Fiducial command.

If lipid or some other physical markers were not placed on the fiducial landmarks during the recording of the MRI/CT data, the location of the fiducial landmarks must be determined by locating the closest slices which best correspond to the locations of the head localization coils. The accuracy of the resulting fiducial points depends on the operator's experience. Alternatively, the head localization coils may be digitized before or after an MEG/EEG recording session while the coils are still on the subject's head along with the subject's head shape. You may have software that co-registers the MRI/CT with these digitized points to derive the voxel locations of the head coils. These results may be imported into MSI 3D Viewer using the Fiducial Markers Dialog. Digital photos are also useful for checking the accuracy of fiducial points.

When MEG/EEG data are collected, the head localization coils are placed on the same three landmarks and the sensor locations are defined relative to these landmarks. Hence, source results that are derived from MEG/EEG data and the MRI/CT can be described in a common head coordinate system by co-registering the MRI/CT coordinate system with the MEG/EEG head coordinate system through the definition of the three fiducial points on the MRI. The fiducial points can be defined in MSI 3D Viewer.

The co-registration is only as good as how closely the lipid markers correspond to the placement of the head localization coils during an MEG/EEG collection, and how accurate the head coil locations are relative to the sensors.   In addition, if the MRI/CT contains any distortions which may distort the locations of the lipid markers, the co-registration of the MEG/EEG data results and the MR/CT image may also be compromised.

Fiducial Points Properties

Fiducial points have the following properties:

1. They are defined in the three-fiducial coordinate system.
2. They have position coordinates defined in units of millimeters.
3. The nasion fiducial point is displayed with a blue ball/torus/cube/cross, the left ear fiducial point with a green ball/torus/cube/cross, and the right ear fiducial point with a red ball/torus/cube/cross.
4. MEG/EEG fiducial points are tori with a short-tail
5. MRI/CT fiducial points are balls
6. Source fiducial points are cubes
7. Neural network fiducial points are cross signals.

> The color coding in MSI corresponds to the color coding used on the head coils. Nasion = blue, Left Ear = green, and Right Ear = Red.

Head Localization Coil Positions

The position of each head localization coil is displayed in the MSI 3D Viewer as a hollow circle in the slice in which it occurs. Head localization coils have the same color as their corresponding fiducial point.

You cannot directly jump to the location of the head coils using the “GOTO” controls in the main window. However, whenever an MRI/CT fiducial marker is displayed, the corresponding head coil marker will also be displayed, even when it is not on the current slice in the view. This allows you to visually judge the consistency of co-registration. A head coil marker and corresponding MRI/CT fiducial marker are coincident if and only if they coincide (i.e., appear aligned) in all three views. For example, it is possible for a fiducial marker and corresponding head coil marker to appear aligned from one view’s perspective, but not from another’s. For each fiducial marker, it is therefore necessary to check co-registration in each of the Coronal, Sagittal, and Axial views. When the head localization coil and fiducial marker are displayed together, the fiducial marker shows as a solid point within the hollow circle along with its descriptive label. See the green “Left Ear” label, fiducial point, and localization coil circle in Figure 6 for an example. If the head localization coil is displayed in a different slice from the fiducial point, only the hollow circle displays along with the appropriate label (“LE”, “RE”, or “NA”).

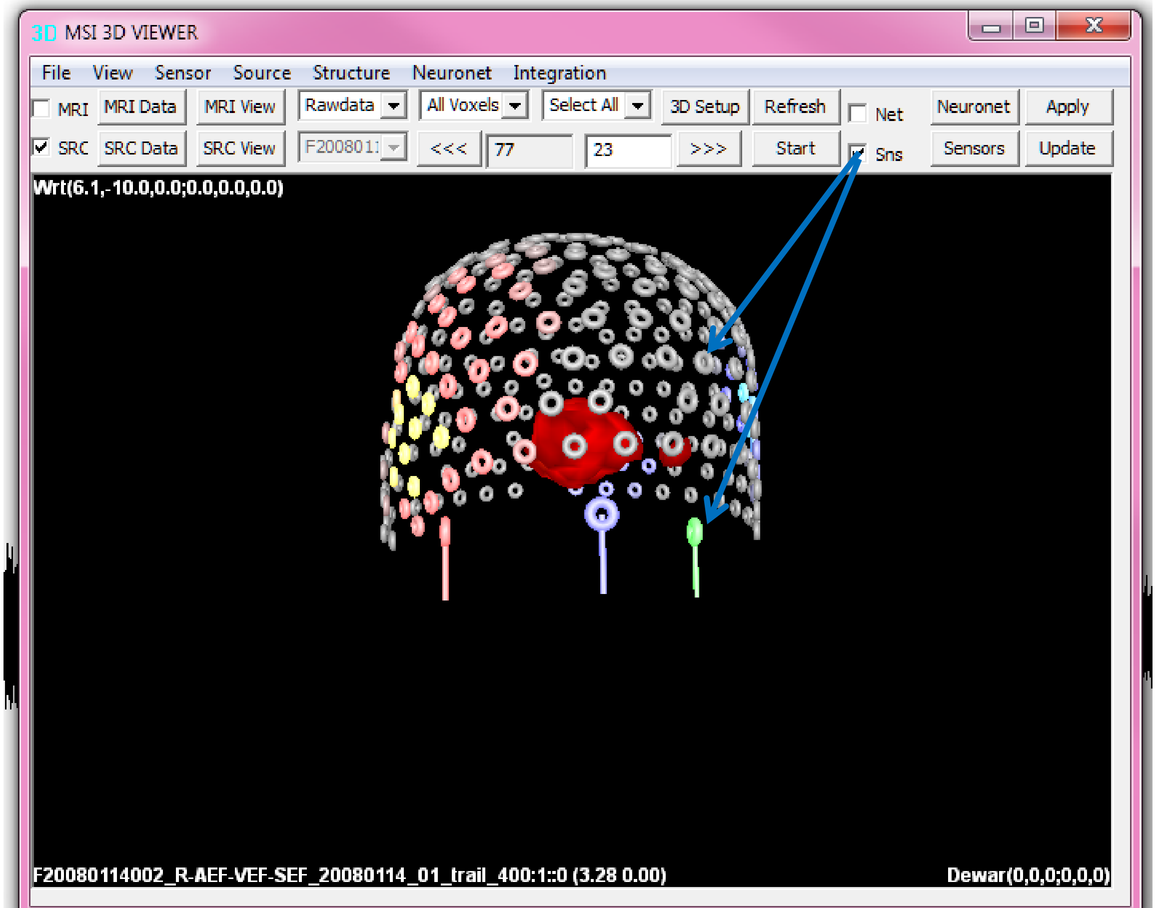

Figure.7. MEG/EEG fiducial points are shown as small tori with a line in MSI 3D viewer. The 3D objects are similar to the real coils used in the MEG recordings.

Source Volume

Source volumes cannot be created in MSI 3D Viewer, but are instead computed using source localization module or software then transferred or loaded into MSI 3D Viewer. Source volumes cannot be edited or saved using MSI 3D Viewer, either. However, peaks may be marked and the brightness, transparency, and level of detail are adjustable. A source volume is a colored volumetric image produced by source localization software.

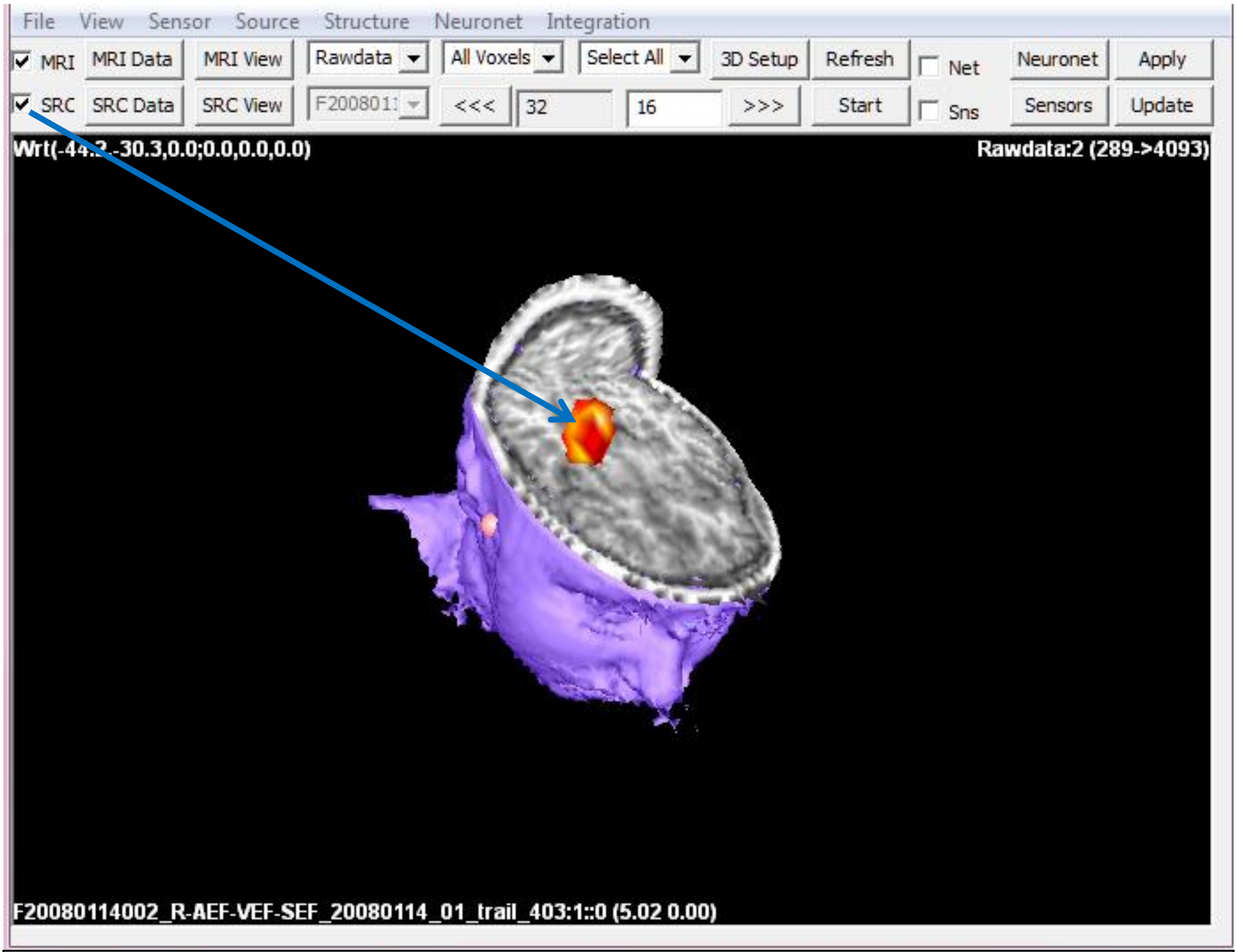

Figure.7. MEG/EEG fiducial points are shown as small tori with a line in MSI 3D viewer. The 3D objects are similar to the real coils used in the MEG recordings.

Source Volume Properties

A source volume has the following properties:

1. The size of the volume is variable
2. The size and resolution of source volume depend on the settings during the source computations.
3. The image is displayed in color — blue for negative values and red for positive values.
4. Voxels and ranges are defined in the MEG head coordinate system.

Neural Network

Neural network cannot be created in MSI 3D Viewer, but are instead computed using volumetric image for coherent sources (VICS) module or software then transferred or loaded into MSI 3D Viewer. Neural network cannot be edited or saved using MSI 3D Viewer, either. However, links may be threshold-selected and the number of links for showing is adjustable.

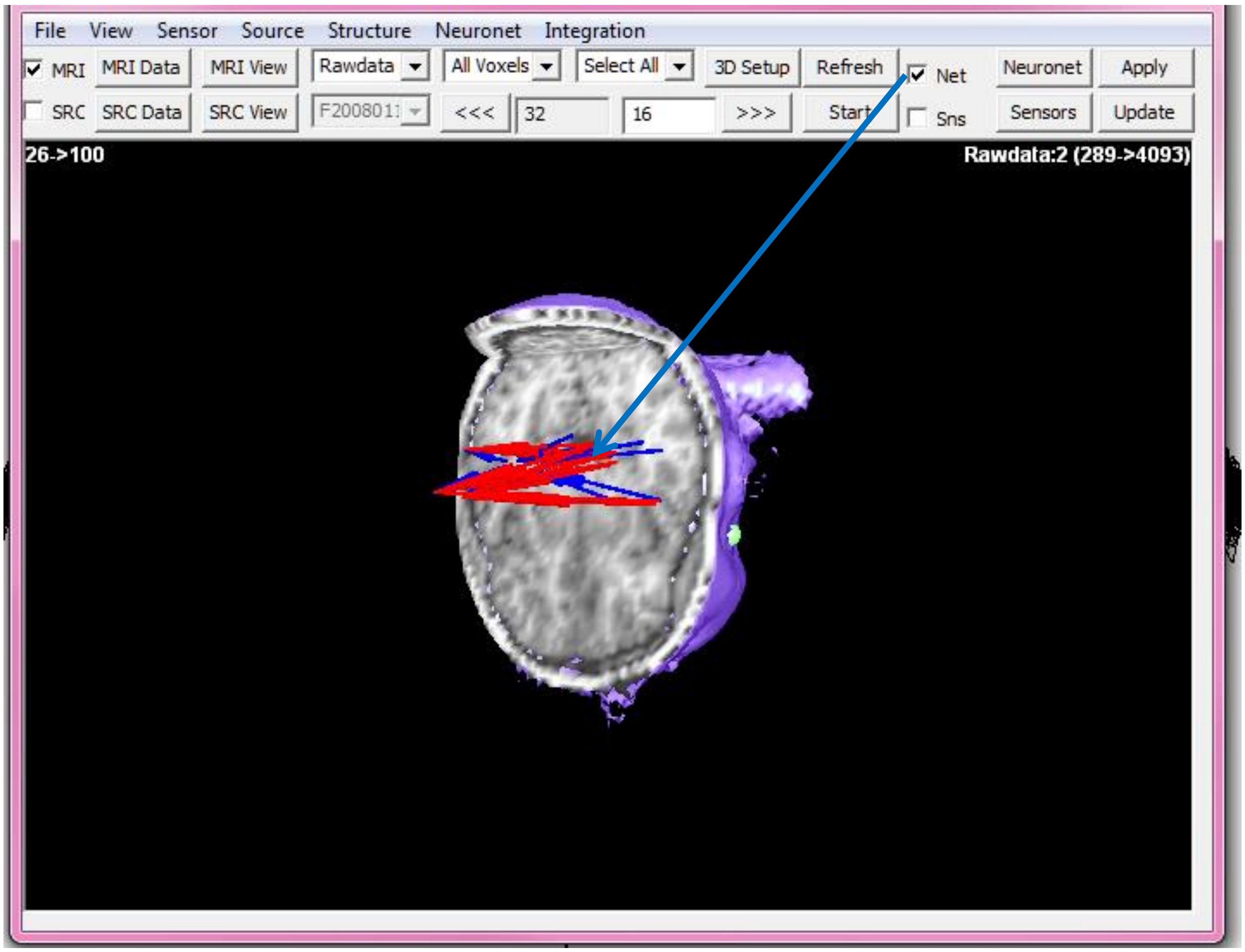

Figure.7. MEG/EEG fiducial points are shown as small tori with a line in MSI 3D viewer. The 3D objects are similar to the real coils used in the MEG recordings.

Neural Network Properties

A neural network has the following properties:

1. All links of the neural network have the same size of time-window;
2. The unit of all the links in a neural network is the same;
3. The time-delay for all the links in a neural network is the same.
4. The total number of links and the unit depends on the settings of for the computing.

Using MSI 3D Viewer

MSI 3D Viewer is functional module which can be launched within a program like MEG Processor and MSI Studio. Specifically, MSI 3D Viewer is a dynamic-link library (DLL). DLL is an executable file that acts as a shared library of functions. Dynamic linking provides a way for a process to call a function that is not part of its executable code. The executable code for the function is located in a DLL, which contains one or more functions that are compiled, linked, and stored separately from the processes that use them. DLLs also facilitate the sharing of data and resources. Multiple applications can simultaneously access the contents of a single copy of a DLL in memory. For example, when you drop a MRI file on to MEG Processor, the MRI data can be displayed in MSI 3D Viewer right away.

Main Window GUI Guide

The MSI 3D Viewer main window is shown in Figure 10. It is the principle window used to manipulate MEG/EEG sensor or electrodes, MRI/CT images, MEG/EEG source images as well as neural networks.

The GUI in the main window may vary slightly among different version of the MSI 3D Viewer due to its differences in functionality and complex. Consequently, the information displayed in the windows may also vary slightly among the versions of the software.

Cursors

The cursor changes with the work modes, such as rotating, zooming and moving all the 3D objects. By paying attention to the cursor, you may complete a “complicated task” easily. For example, you may show the “3D Selector” of MRI/CT data to cut the “brain” in many ways.

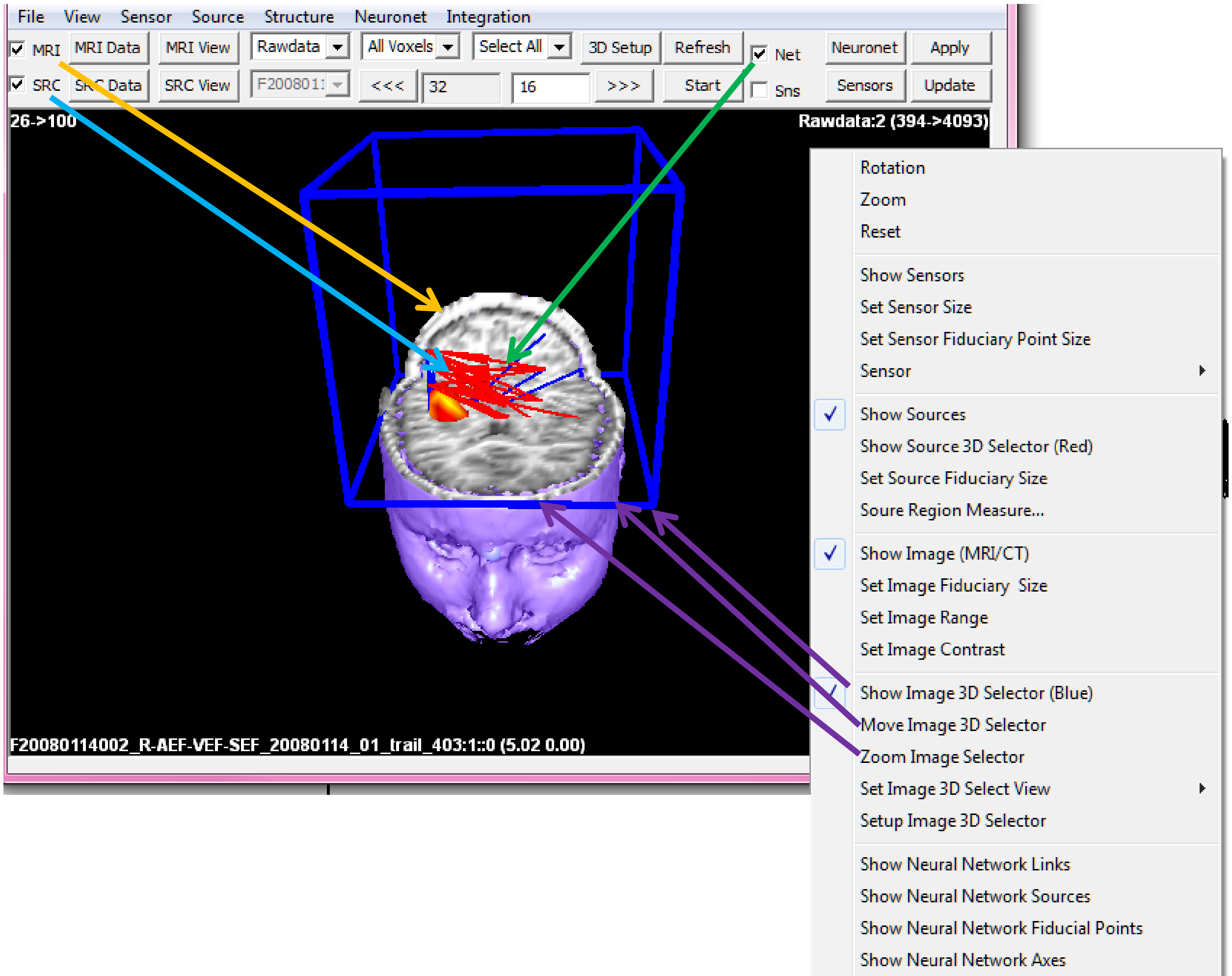

Figure 11. The graphic user interface (GUI) of the main window in MSI 3D Viewer.

Popup Menu in 3D Viewer

When an MEG/EEG, Source images and/or MRI/CT data have been loaded into MSI 3D Viewer, you may manipulate various display features for a specific view and set certain image parameters via a Popup menu. Clicking the right mouse button when the cursor is positioned over one of the image windows displays the menu. The Popup menu options are described in Figure 12.

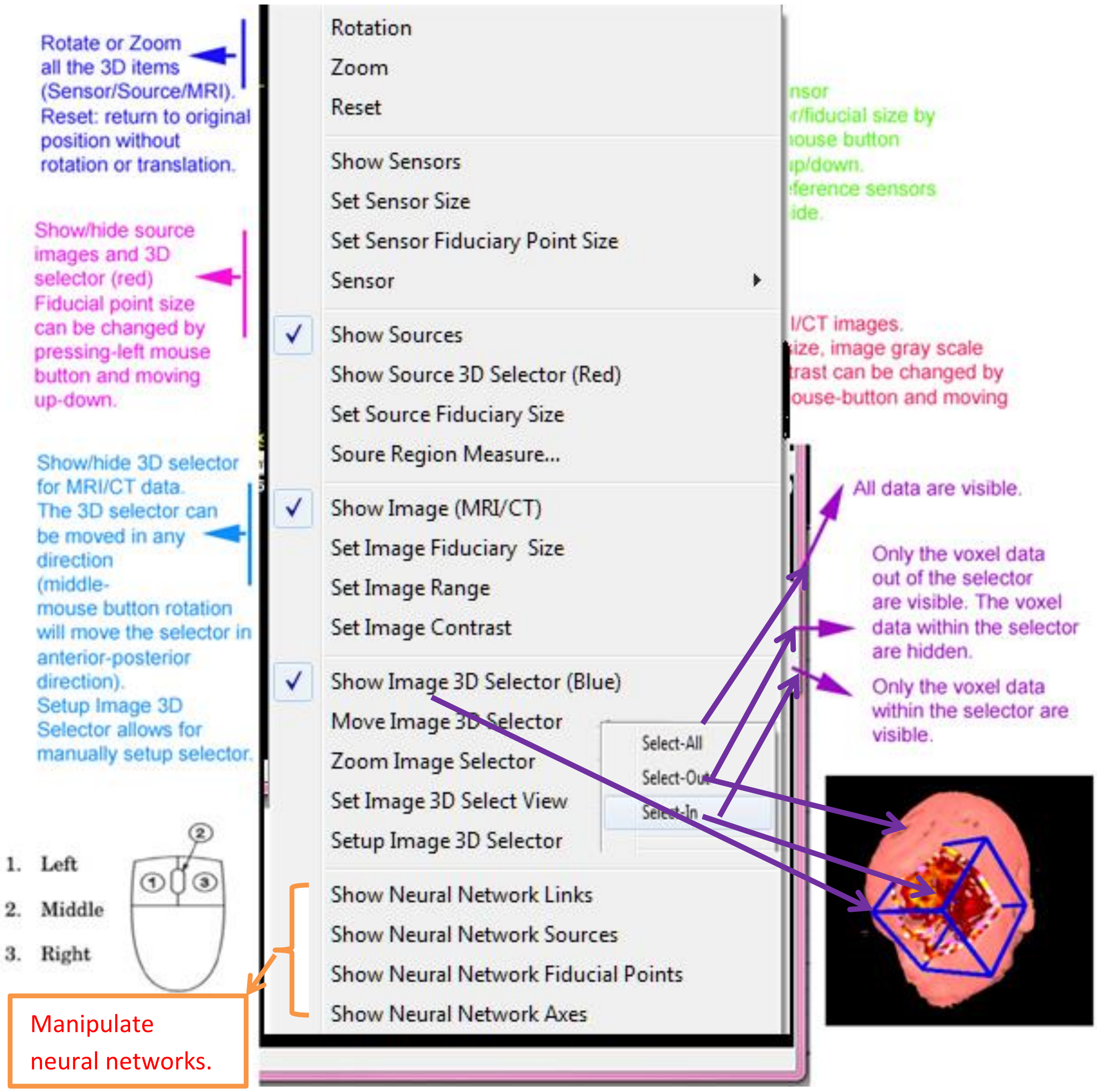

Figure 13. Popup-menu in 3D Viewer.

Navigation GUI Controls

The MSI 3D Viewer main window contains GUI controls for navigating the MEG sensor/EEG electrodes, MRI/CT images, MEG/EEG sources and neural network links.

Display Controls

The display controls in the main window are shown below:

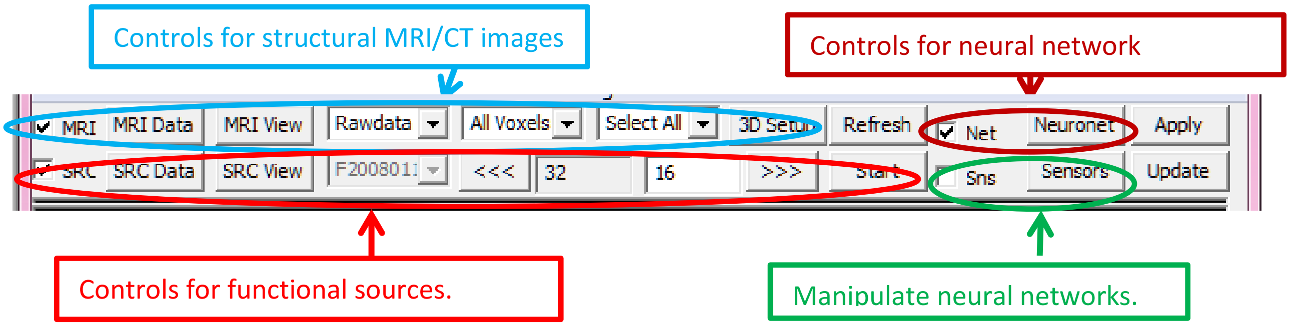

Figure 15. Display Controls in MSI Studio.

MRI/CT Display
The "MRI" check box and the closest combo box define if the MRI/CT data will be showed and which MRI/CT data component(s) will be showed.

Neural Network Display
The "Net" check box and the closest button ("Net") define if the neural network data will be showed and which neural network links will be showed.

Source Display
The "SRC" check box and the closest combo box define if the source (SRC) data will be showed and which source data component(s) will be showed.

Sensor/Electrodes
The "Sns" check box and the closest button ("Sensors") define if the MEG sensor or EEG electrodes (SRC) will be showed and how the sensors/electrodes will be showed.

Refresh
This button will refresh the 3D viewers. If the window size has been changed, "refresh" will re-calculate the window size and then render all 3D objects accordingly.

Apply
You may also manually type a number and click "Apply" to show specific slice.
Sensor Display

Update
Launch the source analysis window. Of note, click on the 2D viewer will measure the voxel values of the point, which is currently selected with two-select line in the 2D viewers.

Dynamic Source Imaging
If there is more than one time-slice in the source images, the source images can be showed one-by-one or be animated as a movie. The "Start" button will start the animation.

Dynamic Neural Network

If there is more than one time-slice in the neural network, the neural network can be showed one-by-one or be animated as a movie. Clicking the “Neuronet” button will show a window for animation.

Brightness

Adjusts the grey scale brightness to improve the visibility of the original image.

Contrast

Adjusts the grey scale contrast to improve the black/white contrast in the original image

Source Virtual Sensor Controls

The source data contain the definitions of source virtual sensors. When source virtual sensors are computed, source virtual sensor controls are available in the main window.

Source Peak Controls

When a source image is computed, source peak controls are available in the main window. Use the source peak controls to control the number of colors displayed on the source image overlay, to mark peaks in the computed source image, and to locate, edit, and delete the peaks that are currently defined.

Thresholding the Source Image

The horizontal scroll bar located above each color gradient allows you to control the number of colors displayed on the source image overlay. The location of the slider bar along the color gradient defines the threshold. By moving the slider bar away from 0, the image voxels representing values smaller than the threshold are not displayed. In this way, only key features represented by large absolute values are visible on the source image overlay, allowing the MRI/CT to be more visible. Between these color gradient controls and the Transparency setting in the Color Settings dialog, you can adjust the source image to display both the MRI and source volume effectively.

Selecting a Source Peak Marker

Selecting a Source Peak Marker by Number

Type the desired source peak marker number in the source Peak text edit field. The total number of source peak markers set is displayed to the right of this edit field. To execute the change, press <Enter>. The marker becomes the active marker and the slices containing the marker are displayed in the three views.

Selecting Source Peak Markers Sequentially

Click < or > to sequentially view each source peak marker in the list. The marker number field updates to show the current selection.

Source Peak

Text edit field to set the active source peak marker.

<<

Selects the previous source peak marker in the list. This marker becomes the active marker and is displayed on the corresponding three slices.

>>

Selects the next source peak marker in the list. This marker becomes the active marker and is displayed on the corresponding three intersecting slices.

Editing a Source Peak Marker

Click Edit to display the following dialog. Use this dialog to edit the active marker.

Mark Peaks Button

Click the Mark Peaks button to add 3D markers at the source data maxima using the parameters set in the source Settings dialog.

Marker Controls

The marker controls are shown in the dialog below:

Markers you have added to the MR image using Set Marker from the Popup menu will display here.

Selecting a Marker

Selecting a Marker by Marker Number

Type the desired marker number in the Marker text edit field. The total number of markers set is displayed to the right of this edit field. To execute the change, press <Enter>. The marker becomes the active marker and the slices containing the marker are displayed in the three views.

Hide Source Volume Overlay

This option shows/hides the source volume overlay on the MRI/CT views in the main window.

WARNINGS Display Options

Show all markers

Displays all markers on current slices regardless of their three-dimensional location. Otherwise, displays only the markers relevant to the current slices.

Show marker labels

Displays the marker labels.

Show all points

Displays all the shape data points regardless of their three-dimensional location.

Show fiducial mismatch regardless of tolerance

Displays fiducial mismatch messages at the bottom of the MRI/CT views in the main window. If selected, the amount of fiducial mismatch is always shown, even when below tolerance. If unselected, fiducial mismatch only shows when it is above tolerance (i.e., as a red warning).

Show head motion regardless of tolerance

Displays head motion messages at the bottom of the MRI views in the main window. If selected, the maximum head motion is always shown, even when below tolerance. If unselected, head motion only shows when it is above tolerance (i.e., as a red warning).

Color Options

This menu option displays the following dialog:

MSI 3D Viewer displays MR/CT images in black and white and source overlays in color. Use this dialog to change the color palettes of these displays.

Grey Scale Settings

These settings define the grey scale palette of the MR/CT image.

Levels

Text edit field to set the number of shades of grey in the palette. A minimum of two levels (black and white) and a maximum of 256 levels may be set.

Invert

Reverses the grey scale color table so that black is mapped to white and white to black.

Data Range

Shows the possible range of data values in the MRI file, where the minimum “0” is black and the maximum “4509” is white.

Display Clipping Value

Displays the clipping value, or cutoff point, at which

MSI 3D Viewer displays MRI data as white in the main window views. The clipping value is automatically calculated based on the Display variables. You can change the clipping value manually for this session by entering a new value or moving the histogram slider bar (see below). Manipulating the clipping value allows you to bypass “noise” by lightening or darkening the image. The MRI views in the main window display the results immediately so you can see the effect of your change. To revert the clipping value to its original setting, click the Recalculate button (see below).

Note that changing the clipping value in this dialog only applies to the current session. It does not change the Display variables in the configuration file. The next time the MRI/CT file is loaded, the clipping value will be automatically recalculated based on the variables in this file.

Histogram and Slider Bar

The histogram displays the frequency distribution of data values in the MR image. The slider bar is another way to change the clipping value manually for the session.

When you move the slider bar, the Display Clipping Value setting changes, and vice versa. The main window views also display the results of the new setting.

Display Clipping Value Calculation Settings

Shows the current values in the configuration file for the Display variables. You can change these settings manually by entering new values and clicking the Recalculate button. This will calculate a new clipping value based on your changes. (Note that this does not modify the actual variables in the configuration file. The next time the MRI is loaded; these fields will once more display the values from the file.)

Recalculate

Recalculates the clipping value based on the values in the fields.

The algorithm for calculating the clipping value

Based on the values is as follows:

1 Calculate the frequency distribution histogram using the data range in the MRI/CT data

2 Start calculations from the maximum data value and proceed to the minimum value (0).

3 Use the Length value as the length interval for the first calculation step.

4 Sum the number of data values falling into the current length interval and check if it is larger than the Limit value.

5 If it is larger, use the lower limit of the current length interval as the clipping value.

6 If it is smaller, define the next length interval as follows: (a) use the lower limit of the previous length interval as the upper limit; (b) subtract (previous length interval + Length) from the upper limit to calculate the lower limit. (With each iteration, the length interval increases by one Length.)

7 Repeat the last three steps until the clipping value is determined.

Color Scale Settings

These settings define the color palette of SAM overlays. The default color scale defines shades of blue for negative values and shades of red for positive values. The larger the absolute numerical value of the voxel, the darker the shade used.

Color Scale Levels

Text edit field to set the number of colors in the color palette. A minimum of two and a maximum of 64 may be used. If only one polarity is represented in the image, only shades of one color (red for positive and blue for negative) are set for the color levels.

Color Scale

Sets the color scale to any of the predefined color-plate.

Transparency

Sets the transparency of the colour overlay image. A setting of 1 displays an opaque image and a setting of 100 displays a transparent image (i.e., no image).

Invert

Reverses the mapping for the colour table so that the lightest colours are mapped to the darkest and the darkest to the lightest. The larger the absolute numerical value of the voxel, the lighter the shade used.

Fiducial Points

Use this dialog to inspect and modify the fiducial markers.

The existing fiducial markers are displayed in units of voxels (or equivalently the slice numbers of the sagittal, coronal, and axial slices) for the current MRI. New values can be entered in the editable fields. The fiducial markers may also be imported by clicking the Read File button and selecting a *.fid file to open.

This dialog is used mainly for importing fiducial markers that have been determined by an external program, rather than for defining them from MSI 3D Viewer. Units of voxels (equivalent to slice number), which are universal and absolute units, are required to ensure that the location of the fiducial markers are interpreted in the same way between the external program and MSI 3D Viewer. To define fiducial markers within MSI 3D Viewer, use the Set Fiducial command from the Popup menu of the main window.

Fiducial Marker Coordinate Fields

Nasion

Text edit fields to set the sagittal, coronal, and axial slice numbers (or voxels) at which the position of the nasion is located.

Left Ear

Text edit fields to set the sagittal, coronal, and axial slice numbers (or voxels) at which the position of the left ear is located.

Right Ear

Text edit fields to set the sagittal, coronal, and axial slice numbers (or voxels) at which the position of the right ear is located.

File Menu

The File menu provides actions for exiting the program.

View Menu

Since the View menu deals with the display or showing of MEG sensors, functional and structural data, the functions in the menu typically do not change the data. Instead, the functions in this Menu change how the data will be presented. Some functions in this Menu can also be found in the Pop-up Menu for convenience; those functions are described in the Pop-up Menu section.

Refresh

This menu will refresh the 3D viewers. If the window size has been changed, “refresh” will re-calculate the window size and then render all 3D objects accordingly.

Autofit

This menu re-calculates the window size, and then renders all 3D objects accordingly. It is to automatically fit all 3D objects in a given window.

Rotate, Zoom and Move

The three menus operate on the 3D “world” that means the all the 3D objects will be rotated, zoomed (move away or close to the viewer) and moved (up-down, left-right).

Show/Hide Information

The “Show Information” menu can display or hide the information provided in the corners of the viewer.

Background Color

The color used for the background for showing all the 3D objects.

Setup Render States

The menu changes the 3D rendering states of Direct 3D and OpenGL. This function is designed for experienced users only. Any changes in this menu will affect all the 3D rendering.

Show Render Cursor

It shows/hides the display of cursor during the rendering of 3D objects. It is useful for rendering a huge amount of data because it gives some clues of the rendering status.

Show Tool Tips

This function is designed for new users. When mouse move over to a button or window, it will show a pop-up message or hint about the functions and/or usages of the button or window.

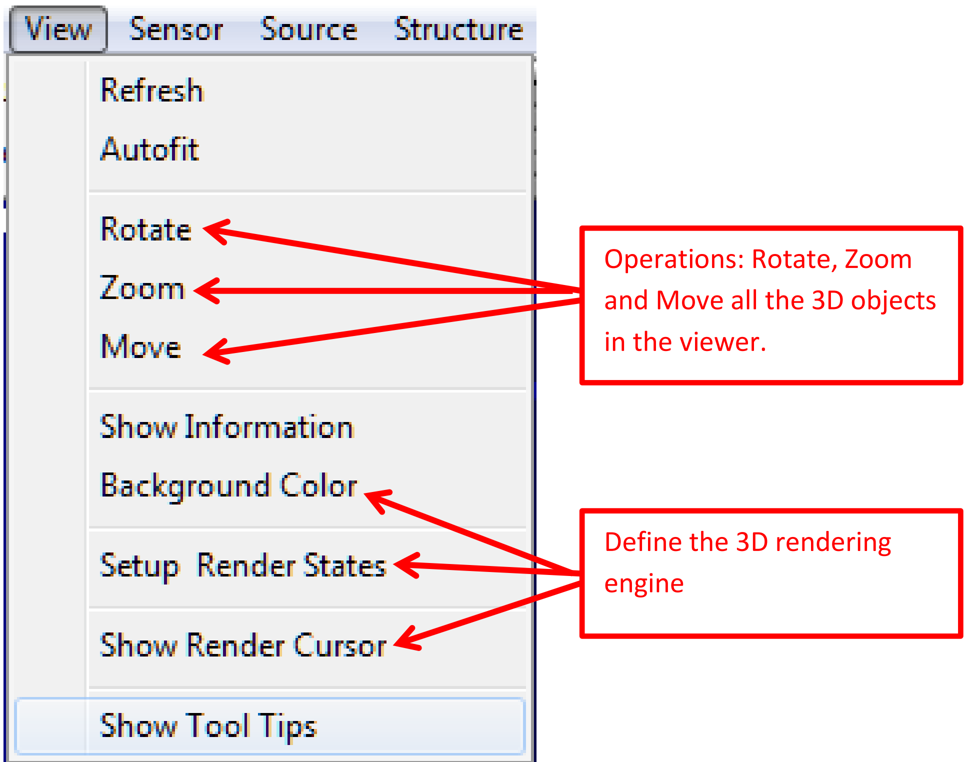

Figure 16. View Menu for manipulating the display of Sensor/electrodes, sources, MRI/CT images and neural networks.

Sensor Menu

As indicated by its name, the Sensor Menu provides functions dealing with the display of MEG sensors or EEG electrodes. The functions in the menu are also straight forward.

Show Sensors

Show/hide MEG Sensor or EEG electrodes on 2D and 3D viewers. If this function is disabled, many other functions (e.g. Show Sensor Active") are automatically disabled.

Show Sensor Active

Show the amplitude of waveform data on the sensor with colors. When the selection of the cursor on the waveform changes; the color on the sensor will also change. It is actively reflecting the amplitude of the waveform at the current cursor position.

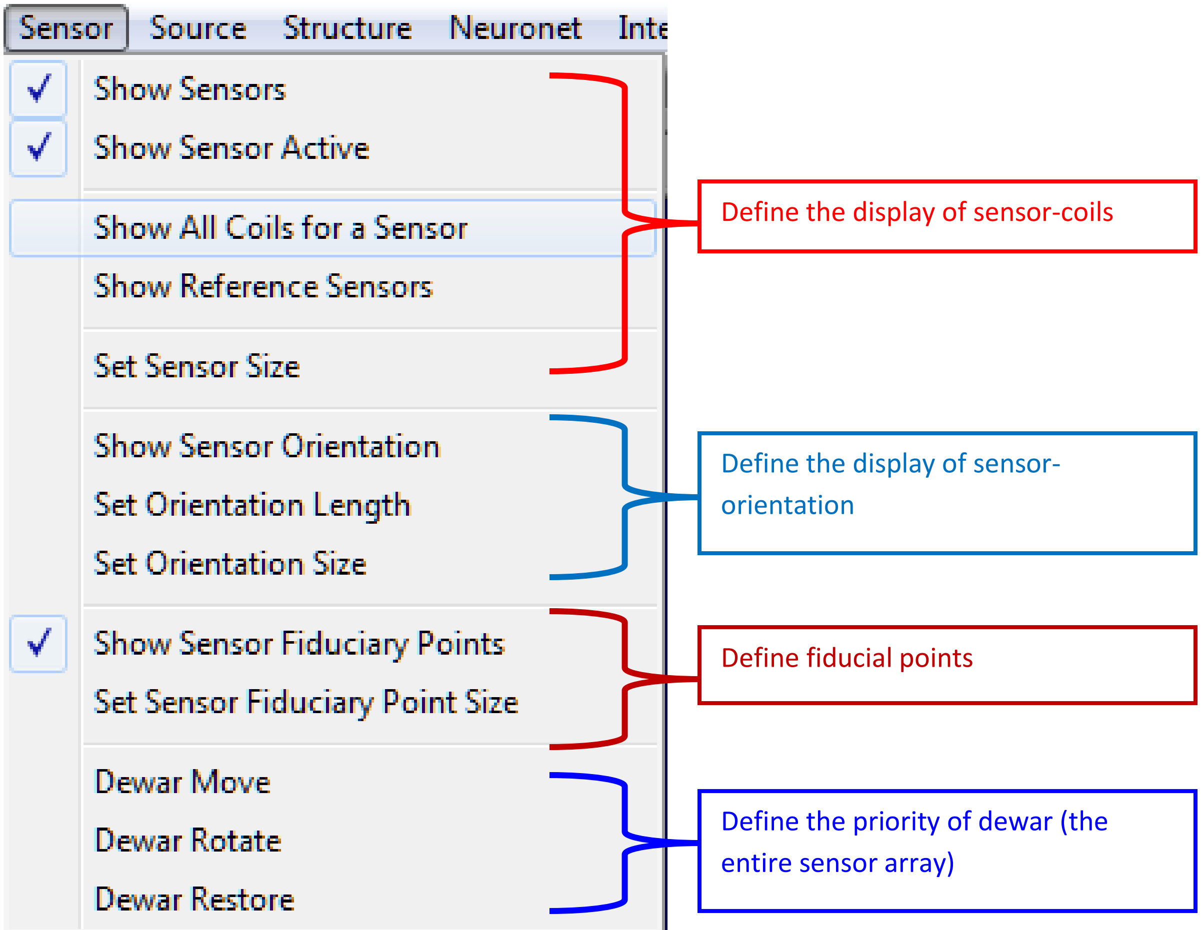

Figure 17. Sensor Menu for manipulating the display of MEG sensors or EEG electrods.

Shall All Coils for a Sensor

A MEG sensor is typically composed with more than one coil. By default, the MSI 3D Viewer only shows the first coil for a MEG sensor. The first coil in a sensor is typically the closest sensor to the nearby brain. By selecting this menu, the software will show/hide all coils or just show one coil for sensors.

Show Reference Sensor

Modern MEG systems typically have reference sensors specifically designed for detecting environmental noise. By selecting this menu, the software will show/hide reference sensors.

Set Sensor Size

By selecting this menu, you can change the size of the sensors (coils) by press-left-button and moving mouse up-down. In addition, in this working mode, you may rotate the middle mouse to change the size of sensors.

Show Sensor Orientation

Show/hide the orientation of sensor, which is important for MEG data but not EEG because MEG sensors are sensitive to tangential oriented signals. However, for demonstration purposes, it is not necessary to show the orientation.

Set Sensor Orientation Length and Set Orientation Size

Set the sensor orientation length and size by pressing-left mouse button and moving up and down. To get better results, the "Show Sensors" function must be turn on.

Show Sensor Fiducial Points

Show/hide the sensor fiducial points that were typically determined during MEG recordings. If this function is disabled, the Sensor Fiducial 2D Overlap and the Sensor Fiducial Size were automatically disabled.

Set Sensor Fiduciary Point Size

Set the sensor fiducial size by pressing-left mouse button and moving up and down. To get better results, the "Show Sensors Fiducial Points" function must be turn on.

Dewar Move, Rotate and Restore

Since the rotate and co-registration of MRI/CT data may reduce the quality of structural imaging, you may rotate and move the sensor-array (dewar) to register with MRI/CT using fiducial points. Understandably, the source localization of MEG/EEG data will use the rotate/moved coordinate system. Consequently, the three functions in the Menus are designed for experienced users only.

Source Menu

As indicated by its name, the Source Menu deals with MEG/EEG source data or functional source images. The functions in the menu are also straight forward.

Show Source

Show/hide MEG/EEG sources on 3D viewers. If this function is disabled, some other functions (e.g. Show Source Current") are automatically disabled.

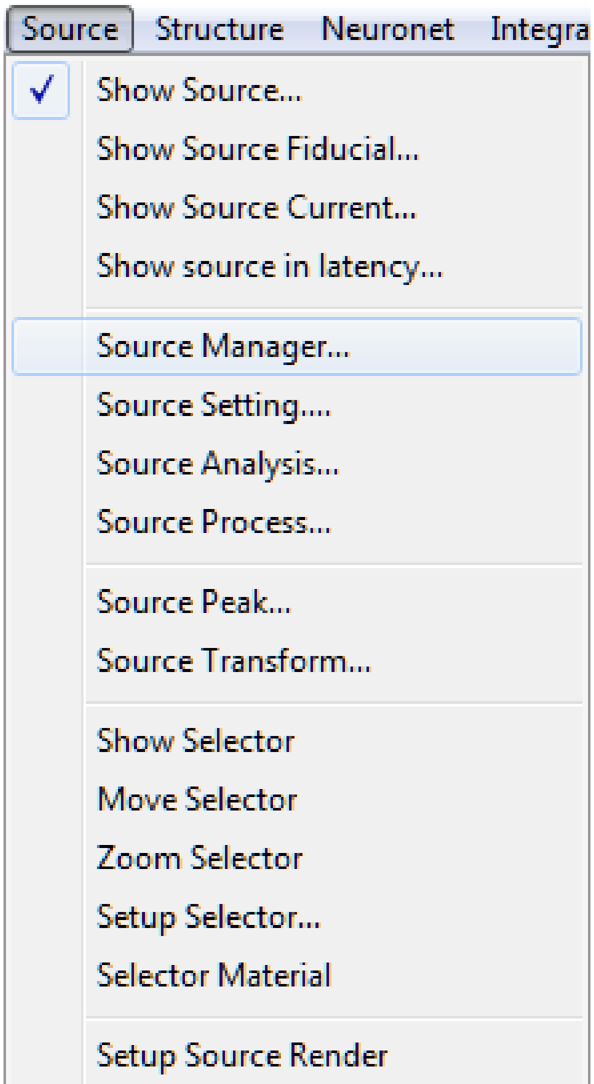

Figure 18. Source Menu for manipulating MEG/EEG source data.

Show Source Fiducial
Show/hide source fiducial points on 3D viewers.

Show Source Current
Show the source data currently selected in source manager. MSI 3D Viewer can show more than one source datasets at once. It is typically applied to 3D Viewer with one-unique color plate (or bar) for each dataset. For example, multi-frequency analyses may generate multi-source images. Each source image may unique color to show the spatial distributions of a frequency.

Show Source in latency
Show source data in a selected latency range in 3D Viewers. This function is typically linked to the waveform window so that the correlation between source data and the waveform can be better

understood. In other words, this function shows the source data in the latency currently selected in the waveform viewer. Of note, this function only works if the source data have multi-time slices and the time slices are in the latency of the selection in the waveform viewers.

Source Manager
Launch the window for managing source data. MSI 3D Viewer can theoretically support more than hundreds of sources which are practically limited by a computer's memory. You may delete, rename and edit the source data in Source Manager.

Source Settings
Launch the window for the settings for displaying source data. Since MSI 3D Viewer supports multiple source images, the Window of Source Settings deals with the currently selected dataset in the Source Manager. Noteworthy, each point in volumetric source data has multiple values. The meaning of each value depends on the source localization algorithms. You may needs to choose the right one for your study.

Source Analysis
Launch the window for analyzing the voxel values of source data. Since MSI 3D Viewer supports multiple source images, the analysis window deals with the currently selected dataset in the Source Manager. Of notes, each point at volumetric source data has multiple values. The meaning of each value depends on the source localization algorithms. You may needs to choose the right one for your study.

Source Process
This menu launches the window for source process, which is designed to process the source images when the data have already been scanned or localized. This is relative to the source data processing during source scanning or source localizing. This function is designed for advanced users only.

Source Peak
Launch the window for analyzing the peaks of source images, which typically represent the highest or lowest value in several areas. Since MSI 3D Viewer supports multiple source images, the analysis window deals with the currently selected dataset in the Source Manager. Of notes, each point at volumetric source data has multiple values. The meaning of each value depends on the source localization algorithms. You may needs to choose the right one for your study.

Source Transform
Launch the window for transforming the entire source images. This function is designed for advanced users only, which involves different coordinate systems.

Show Source Selector
Show/hide the selector for source image. By the default, the selector for source data is red.

Move Source Selector
Move the selector for source image in 3D space.

Zoom Source Selector
By pressing the left-mouse button and move up-down, this function makes the source selector bigger or smaller. The change of the size of the selector indicates the change of the selected region.

Setup Source Selector
By clicking this menu, a dialog will show up to allow users to setup all the parameters for the selector. This function is very useful for selecting some parts of source images for analysis. This function is designed for advanced users only.

Source Selector Material
By the default, the selector for source data is red. You may change the material to other color with fancy features.

Structure Menu

The structure menu provides access to manipulate the structural images such as MRI and CT data. MSI 3D Viewer has intuitive GUI for easy to identify and measure the functional/structural changes as well as their correlations in 3D space.

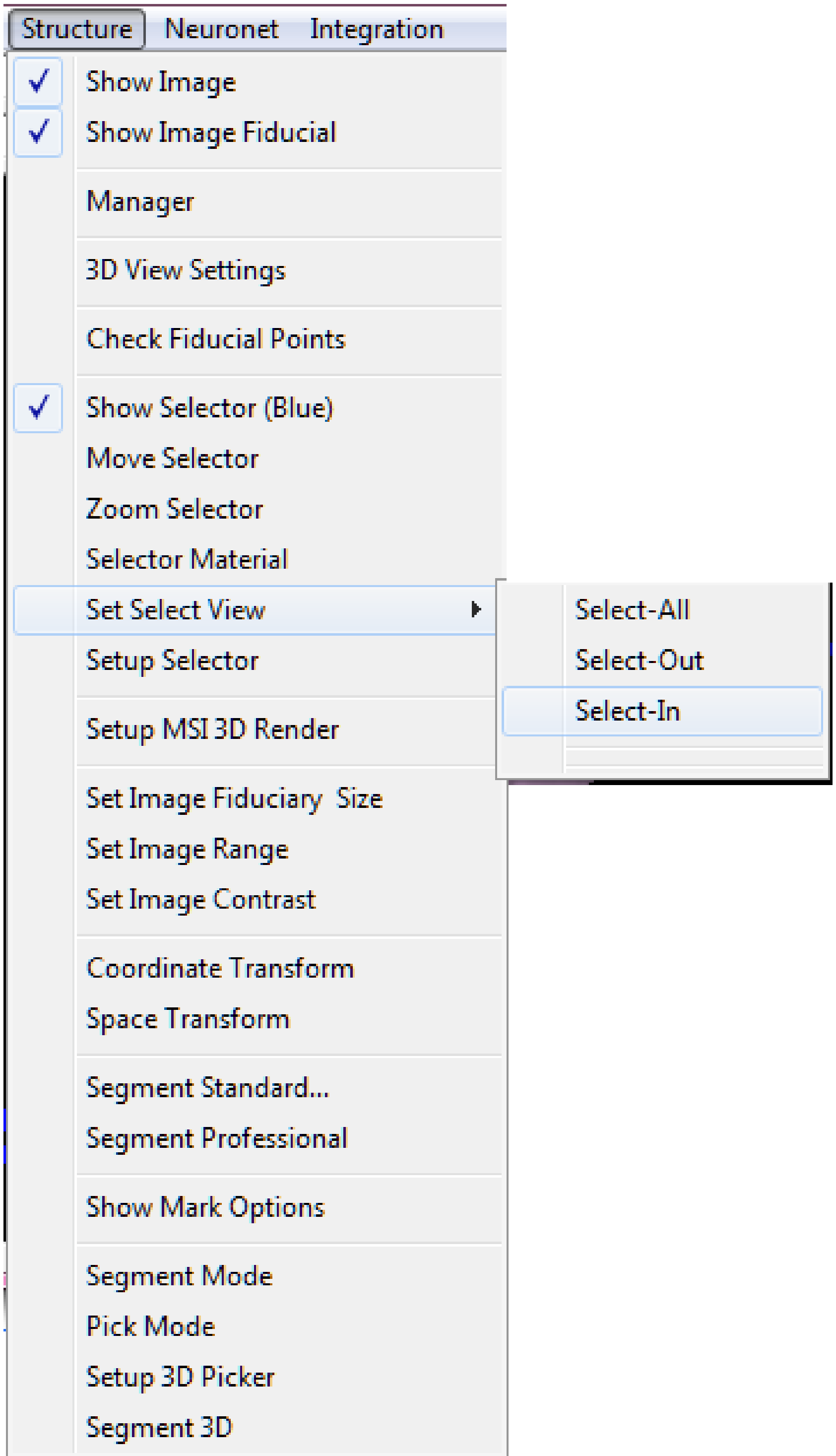

Figure 19. Structure Menu for manipulating volumetric MRI/CT data.

Show Images

Show/hide structural images such as MRI and CT on 3D viewers. If this function is disabled, some other functions (e.g. Image 3D Visibility) are automatically disabled.

Show Image Fiducial Points
Show/hide the fiducial points of structural images on 3D viewers.

Manager
Launch the window for managing structural data. MSI 3D Viewer can theoretically support more than hundreds of structural dataset which are practically limited by a computer's memory. You may delete, rename and edit the structural data in Structural Manager.

It is important to support multiple items with a manager for several reasons. For example, a raw MRI data of the brain have skin, skull, gray matter, white mater and other tissues. We can use "segmentation" function (see the segmentation guide) to extract the brain with gray and white matter to as an independent structural item. Consequently, the relationship between functional brain activation and structural changes can be better visualized and analyzed.

3D View Settings
Launch the 3D view setting dialog for defining how the structural images will be displayed in 3D Viewers. The values in "Minimum" and "Maximum" slide bars define the range of voxels for 3D rendering. The "Lightness" and "Contrast" are used to define the "cut edge", which may show the gray scale in 3D images.

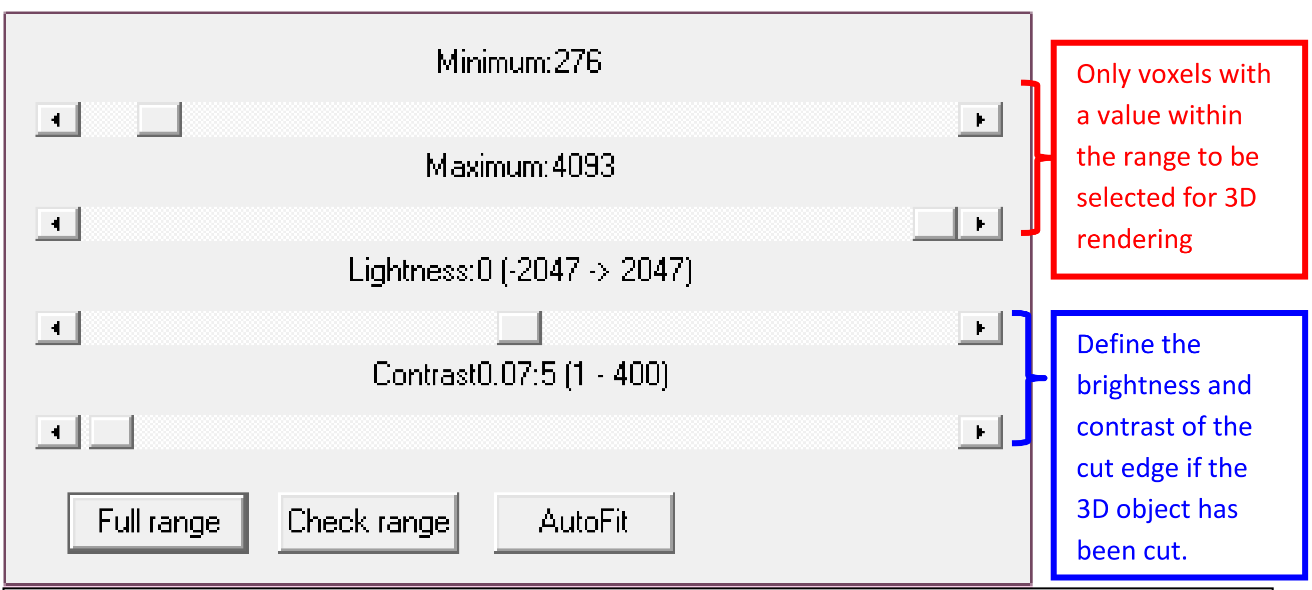

Figure 19. Settings for 3D rendering of volumetric structural MRI/CT data, which should be in gray scale.

Check Fiducial Points

This function will check the correctness and reliability based on pre-defined parameters. To appropriately co-register structural data with other 3D objects, at least three fiducial points are necessary. A fiducial marker or fiducial is an object placed in the field of view of an imaging system which appears in the image produced, for use as a point of reference or a measure. In MRI/CTdata, typically, you should be able to visually identify the fiducial marks (such as fish oil pill, specially designed marks) on the structural images.

This function will check: (1) if the left and right are correct; (2) if there are unusual distance between fiducial points.

Show 3D Selector

Show/hide the 3D Selector for the structural images. If the 3D Selector is not visible, the "Move 3D Selector" and "Zoom 3D Selector" may be automatically disabled.

Move 3D Selector

Move the 3D Selector up-down and left-right by pressing the left mouse button and moving mouse. To move the selector anterior-posteriorly, rotate the middle mouse button.

Zoom 3D Selector

Zoom-in/Zoom-out the 3D Selector by pressing the left-mouse button and moving up-down.

Set 3D Select View

The 3D Selector enables users to selectively view certain parts of the 3D objects, it can hide a selected areas.

- If the "Select-All" is selected, all the 3D objects are visible. In other words, the 3D Selector does not hide any part of the 3D objects spatially.
- If the View Select-Out is selected, only the 3D objects out of the 3D Selector are visible.
- If the View Select-In is selected, only the 3D objects in the 3D Selector are visible.

Setup 3D Selector

Launch the 3D selector window to manually setup the size and location of the 3D Selector.

To visualize the structural and functional components, this program provides three kinds of selections for precisely imaging the data of interest. If the selections are not used appropriately, you will see a "black window" without anything visible.

- Spatial Selection: a 3D selector has been designed to spatially select volumetric data. The selector provides three modes: (1) Select- all (no selection, all voxels or data are visible); (2) Select-out: voxels out of the selected region are visible; (3) Select-In: voxels within the selected region are visible. If you used the 3D selector to select all the data, and then pick the "Select-out" mode", you will see a "black window" because there is nothing to show. In this case, pick the "Select-All" option.
- Data Marks: This program provides at least three kinds of marks (red, blue and yellow) for image segmentation, voxel (pixel) label and analysis/measurement. You may selectively visualize voxels with: (1) special mark(s); and (2) voxels. If you have not mark or label any voxels and try to visualize special mark(s), you will see a "black window" because there is no mark to be visualized. In this case, pick the view "All Voxels".
- Range of Data Value: This program enables the visualization of volumetric data in certain range (from minimum value to maximum value in 3D View Control). For example, MRI/CT images typically have gray scale data in limited ranges. If you select very high or low gray scale value, you will see a "black window" because all available MRI/CT voxels are out of the selected range. In this case, please click the "Autofit" button to automatically adjust the range for visualization.

In fact, another "back window" typically appears when users hide all 3D objects or there are no 3D objects available for showing.
Please note that, this program supports MEG/EEG sensor, sources, MRI/CT images and neural networks. If you perform source scan without MRI/CT image (structural data), the program will use templates to simulate structural data. In this case, it seems the program has structural data but there is nothing visible.

Select 3D Voxels
Select what types of voxel will be showed. By default, all voxels should be showed if they meet the criteria defined by 3D View Settings. However, during data segmentation and analyses, voxels may be classified with a variety of marks. Of note, voxels in 3D images can be selected for showing. If the function is not use appropriately, you may see a "black screen" without anything.
To use this menu, choose a submenu to select the voxels to be showed.

Setup MSI 3D Render
Launch the 3D Render dialog for defining how the structural images will be rendered in 3D Viewers. The MSI 3D Render is a visualization solution for medical imaging professionals. The 3D Render is an essential tool for everyone who wants to visualize their medical data. It produces impressive, high

quality 3D images very quickly and is extremely easy to master. The 3D rendering pipeline (or engine) is now seen as the leading 3D render in its class because it has redefined the process of making 3D visualizations. It has also become an essential part of the MEG/EEG/MRI/CT toolkits.

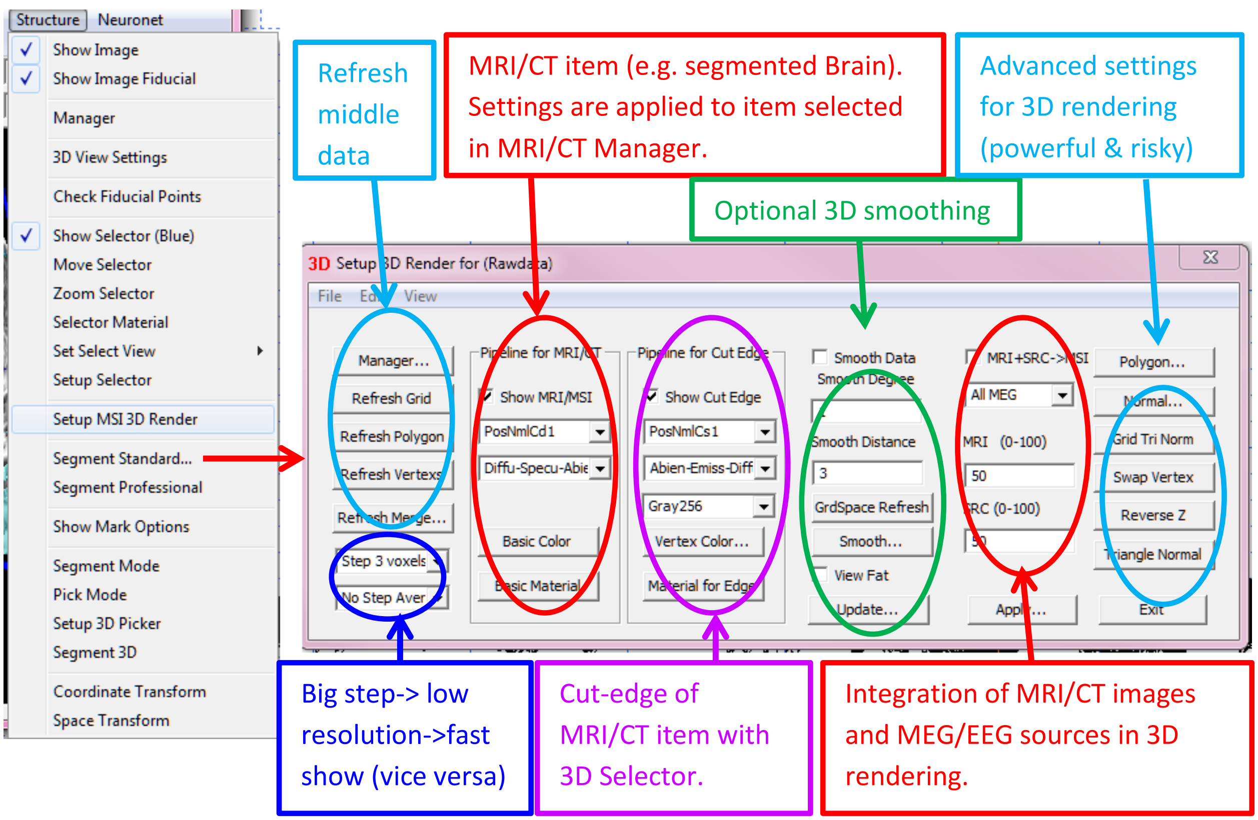

Figure 19. Settings for 3D rendering pipeline (or engine) for MRI/CT data.

MSI 3D Rendering Components

In the 3D render dialog, there are options to selectively display structural data and/or combine both structural and functional data. Since the structural images are typically MRI data and the functional sources are typically the MEG source data, the combination of both MRI and MEG is also called magnetic source imaging (MSI).

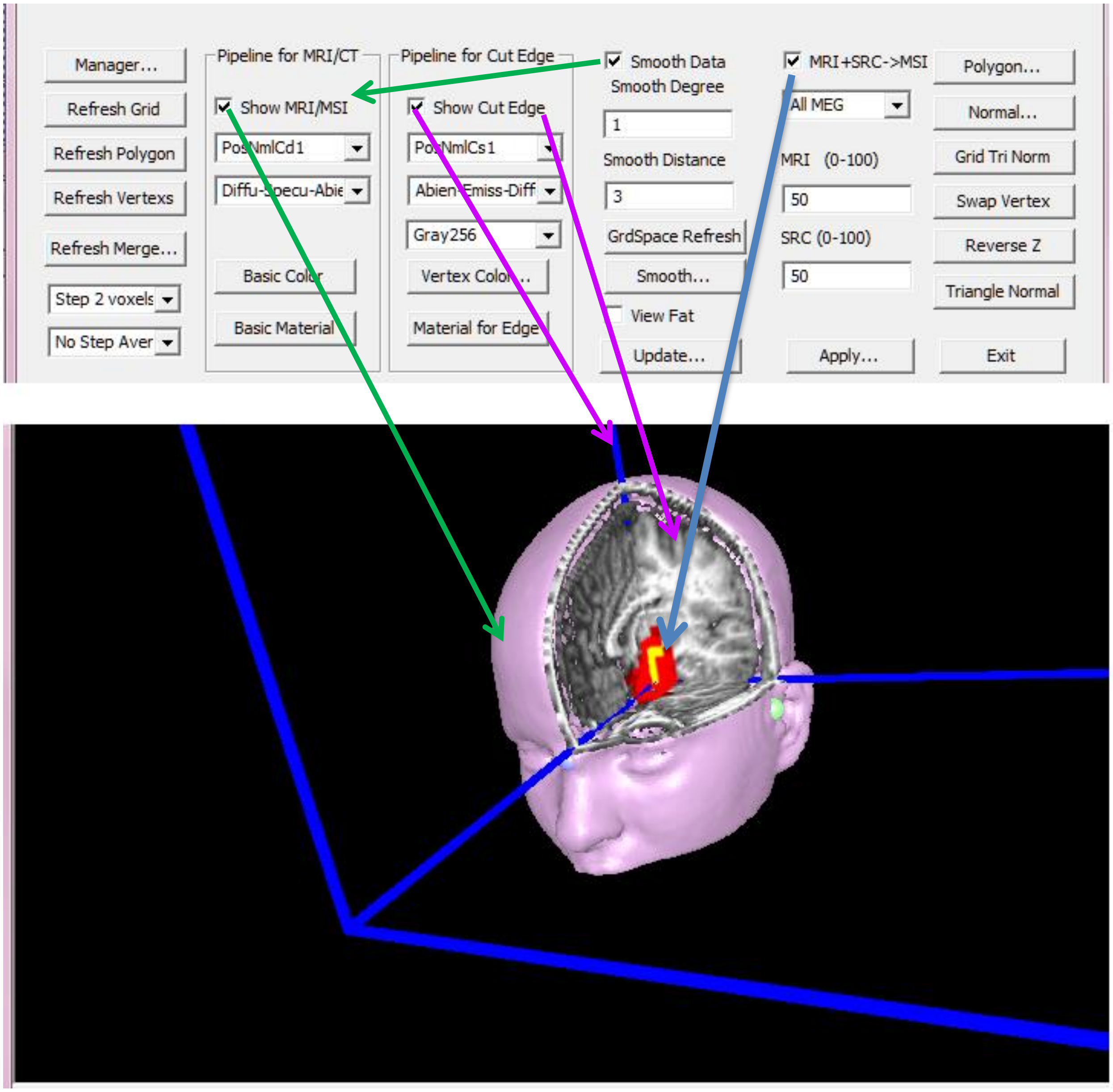

Figure 19. Settings and 3D rendering components.

Set 3D Image Fiducial Size

Change the working mode of the 3D viewer to set fiducial size: press-left mouse button and move mouse up-down to change the size. In this working mode, the fiducial point must be visible.

Set 3D Render Range

Change the working mode of the 3D viewer to set render range of voxel values: press-left mouse button and move mouse up-down to change the range. In this working mode, the 3D images must be visible.

Set 3D Render Contrast

Change the working mode of the 3D viewer to set render contrast of voxel values: press-left mouse button and move mouse up-down to change the contrast. In this working mode, the cut edge of the 3D images must be visible.

Coordinate Transform

Launch the coordinate transform window. This function is designed for experienced user only.

Space Transform

Launch the space (the distance between two voxels) transform window. This function is designed for experienced user only.

Segment Standard

The “Segment Standard” menu shows one segmentation window for data segmentation. Since segmentation of MRI/CT data is a large topic in 3D rendering and structural data analysis, please read the “Segmentation Guide” for segmentation.

Segment Professional

The “Segment Professional” menu shows three segmentation windows (coronal, axial and sagittal viewers) for data segmentation. Since segmentation of MRI/CT data is a large topic in 3D rendering and structural data analysis, please read the “Segmentation Guide” for segmentation.

Mark Options

Mark Options menu shows a window which provide GUI for checking and setting the display of marks. During MRI/CT data segmentations, MSI 3D viewer may display marked voxels only. In this working mode, the “Mark Options” is very important for visualizing the marked voxels of interest. Since segmentation of MRI/CT data is a large topic in 3D rendering and structural data analysis, please read the “Segmentation Guide” for segmentation.

Segment Mode

This menu changes the working mode of MSI 3D Viewer to segmentation; consequently, only marked voxels will be visible or displayed. You may select “View Menu->Rotate” to return to typical rotation mode and select view “All Voxels” to visualize all voxels instead of visualizing marked voxels only. Since segmentation of MRI/CT data is a large topic in 3D rendering and structural data analysis, please read the “Segmentation Guide” for segmentation.

Pick Mode

This menu changes the working mode of MSI 3D Viewer to voxel-picking, typically for segmentation. In this mode, , only picked and marked voxels will be visible or displayed. You may select “View Menu->Rotate” to return to typical rotation mode and select view “All Voxels” to visualize all voxels instead of visualizing marked voxels only. Since segmentation of MRI/CT data is a large topic in 3D rendering and structural data analysis, please read the “Segmentation Guide” for segmentation.

Setup 3D Picker

This menu shows the 3D Picker window. This window may automatically change the working mode of MSI 3D Viewer to voxel-picking, typically for segmentation. In this mode, , only picked and marked voxels will be visible or displayed. You may select “View Menu->Rotate” to return to typical rotation mode and select view “All Voxels” to visualize all voxels instead of visualizing marked voxels only. Since segmentation of MRI/CT data is a large topic in 3D rendering and structural data analysis, please read the “Segmentation Guide” for segmentation.

Segment 3D

This menu shows the 3D Segmentation window. This window may automatically change the working mode of MSI 3D Viewer to voxel-picking, typically for segmentation. In this mode, , only picked and marked voxels will be visible or displayed. You may select “View Menu->Rotate” to return to typical rotation mode and select view “All Voxels” to visualize all voxels instead of visualizing marked voxels only. Since segmentation of MRI/CT data is a large topic in 3D rendering and structural data analysis, please read the “Segmentation Guide” for segmentation.

In various segmentation working modes or got lost for any reasons, you may select “View Menu->Rotate” to return to typical rotation mode.

If you see nothing during segmentation, you may select view “All Voxels” to visualize all voxels instead of visualizing marked voxels only. This option will give you some clues about the object you are trying to segment.

Neuronet Menu

The Neuronet menu provides functions and options for MSI 3D Viewer to visualize neural network at source levels or source spaces. The connection between two sources is also called a "link" of a two-source pair.

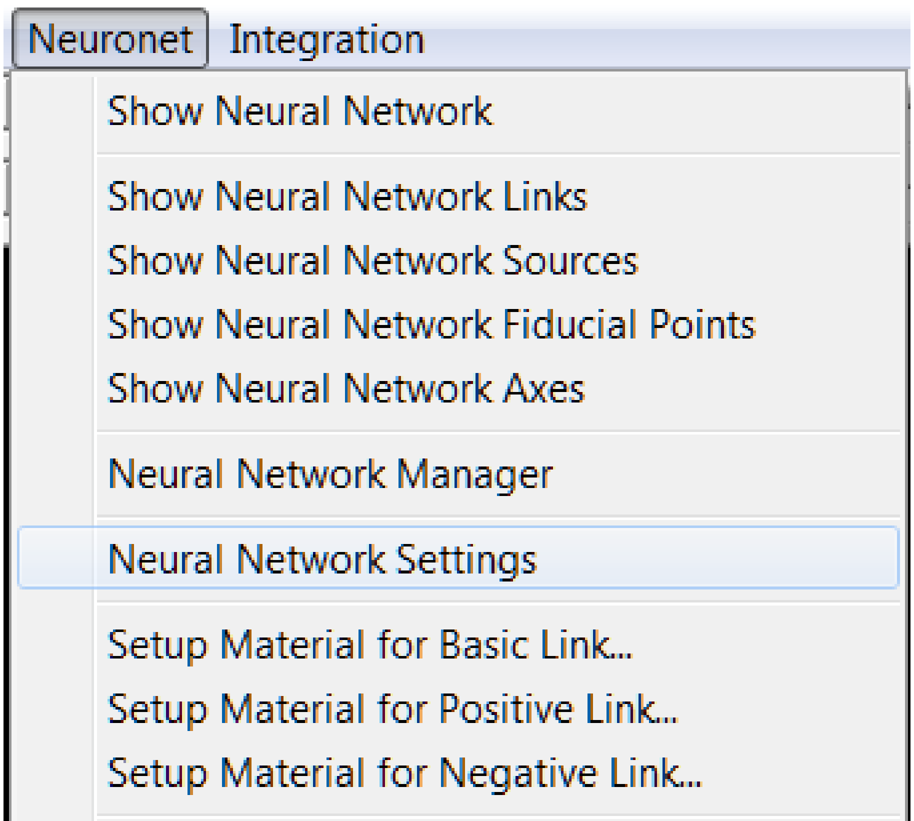

Figure 19. Settings and 3D rendering components.

Show Neural Network

This menu shows or hides the neural network data in MSI 3D Viewer. Neural network can have many connections or links. Each link can be described by two source location parameters, one strength parameter and one flow direction parameter.

Show Neural Links

This menu shows or hides the neural network links in MSI 3D Viewer. If links are hidden, the source locations can still be shown. Vice versa, the links can be shown even the source locations are hidden. This function is specifically useful if there are many links that may obscure the locations of the links.

The link can be positive (excitatory connection) or negative (inhibitory connection) link. In this program, positive correlation is typically showed in red while negative correlation is typically showed in blue.

Show Neural Network Sources

This menu shows or hides the neural network locations in MSI 3D Viewer. If links are hidden, the source locations can still be shown. Vice versa, the links can be shown even the source locations are hidden. This function is specifically useful if there are many links that may obscure the locations of the links.

If there is flow information (direction of the link or connection), yellow cubes typically represent the starting points of the sources while red balls represent the ending points of sources.

Show Neural Network Fiducial Points

This menu shows or hides the neural network fiducial points in MSI 3D Viewer. The fiducial points are 3D cross sign.

Show Neural Network Axes

This menu shows or hides the neural network axes in X (left-right), Y (bottom-up) and Z (frontal-back). The axes are represented with three lines with optional directions.

Neural Network Manager

This menu shows the window for managing the neural network data. MSI 3D Viewer can theoretically support more than hundreds of neural network dataset (each neural network may have more than thousands of links), which are practically limited by a computer’s memory. You may delete, rename and edit the neural network data in Neural Network Manager.

The neural network in this program is based on volumetric source data with or without casualty components. Consequently, the neural network is typically computed by internally analyzing the correlation of all possible sources. This function is objective, quantitative and powerful, however, it may need a lots of memory and computing resources.

This program internally support volumetric image for coherent sources. If the links are hidden, all the source locations can delineate a volumetric image.

Neural Network Settings

This menu shows the settings window for showing neural network data. Many advanced functions, such as precisely manipulating the time slice, threshold, animation, can be found in this window.

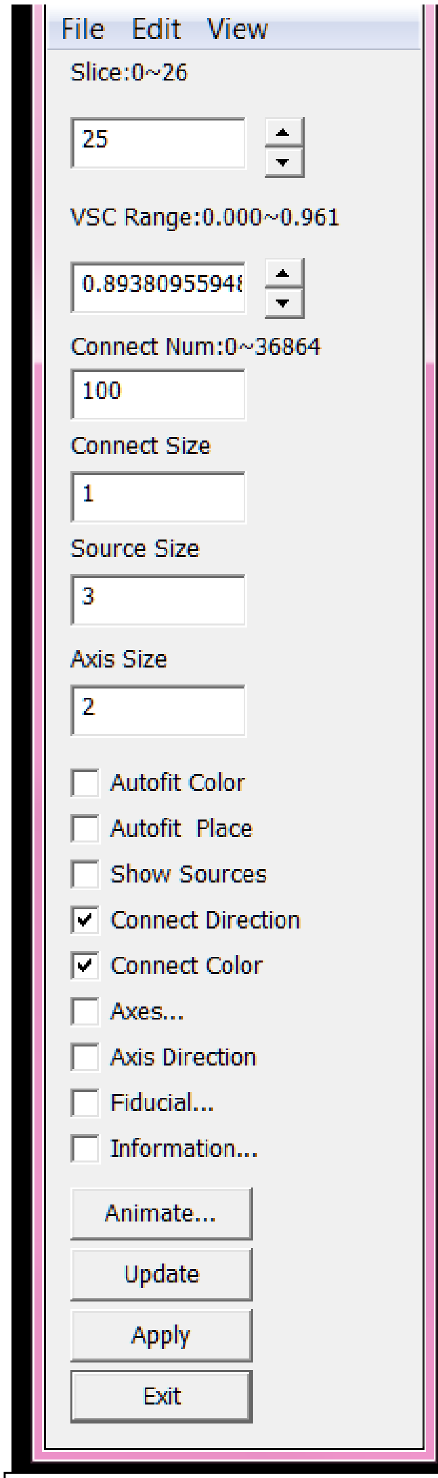

Figure 19. Structure Menu for manipulating volumetric MRI/CT data.

Setup Material for Basic Link

This menu shows the window for setting the material (such as the colors in diffuse, specular, ambient and emission) for basic link (no color, no direction information).

Setup Material for Positive Link

This menu shows the window for setting the material (such as the colors in diffuse, specular, ambient and emission) for positive link. Positive link typically represent excitatory connection. In this program, positive link is typically showed in red while negative link is typically showed in blue.

Setup Material for Negative Link

This menu shows the window for setting the material (such as the colors in diffuse, specular, ambient and emission) for negative link. Negative link typically represent inhibitory connection. In this program, negative link is typically showed in blue.

Integration Menu

The Integration menu provides functions and options for MSI 3D Viewer to integrate MEG/EEG sensor/electrodes, source data and structural data (MRI/CT) in one 3D coordinate. Select Integration from the MSI 3D Viewer main window to display the following menu:

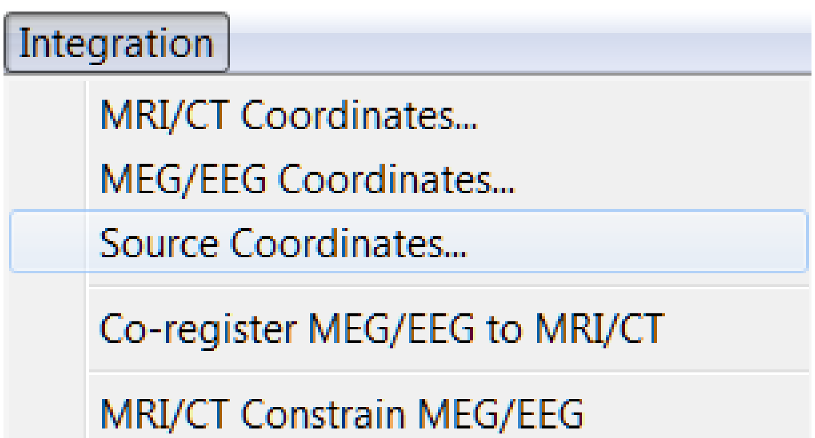

Figure 20. Integration menu for integration of all functional , structural and neural network data.

MRI/CT Coordinates

This menu option displays the window for MRI/CT Coordinate Settings. This window provides fields for setting the head center as well as the rotation.

MEG/EEG Coordinates

This menu option displays the window for MEG/EEG Coordinate Settings. This window provides fields for setting the head center as well as the rotation.

Source Coordinates

This menu option displays the window for Source Coordinate Settings. This window provides fields for setting the head center as well as the rotation.

Co-register MEG/EEG to MRI/CT

This menu option checks the fiducial points in all images and then co-register MEG/EEG to MRI/CT. The MEG/EEG data may be translated and rotated.

MRI/CT Constrain MEG/EEG

This menu option provides the capability to constrain the MEG/EEG data with structural image data.

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