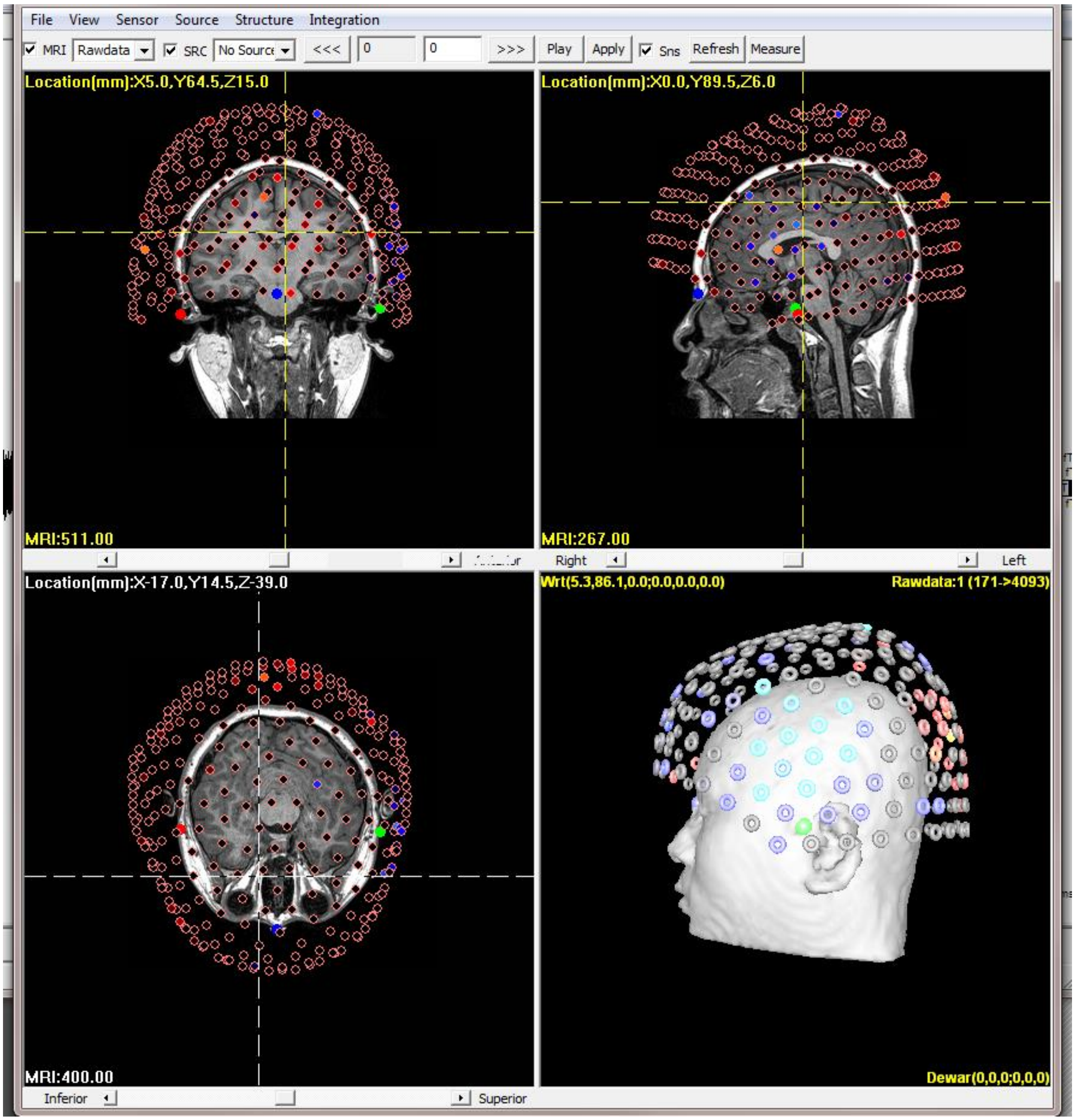
Magnetic Source Imaging (MSI) Studio

MSI Studio Guide



DISCLAIMER

Sending Your Comments and Critiques: We'd like to hear from you. Your comments and suggestions for improving this document are welcome and appreciated. Please e-mail your feedback to MEG_Processor@live.com

Thank you.

Contents

Warnings and Cautions

This software supports both functional and structural images. 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.

If you use MSI Studio 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 Studio shape data extraction methods (“cortical hull”, “head” and others). However, for deep sources (e.g., those located in the hypocampus 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 Studio 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 Studio 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

Studio has only been tested and validated using shape data files generated by MEG Processor. Use of other software to generate input files for MSI Studio 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 Studio. The MSI Studio is one of the core windows for integration of MEG/EEG and MRI/CT. It is used as the primary tool to view structural and functional activity/activation or abnormality for academic or clinical purposes. Importantly, the MSI Studio provides graphic user interface (GUI) for access other function. In other words, it is also often used to launch other windows such as source localization.

The MSI Studio application allows you to manipulate an isotropic volumetric image data that can be co-registered with 3D coordinate system. You can view source images for superimposition onto individual MRI/CT slices. This program can also be used to generate a set of sphere models for source analysis.

Intended Audience

This guide is intended for persons responsible for co-registering source images with volumetric MRI/CT data and/or generating "best-fit" sphere models. The guide assumes the reader is familiar with standard MEG/EEG procedures and is familiar with the Windows operating systems.

> MSI Studio supports up to 6 fiducial points (head shape matching is discussed in other model). To co-register two image dataset, 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 Studio. 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: MEG_Processor@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 Studio 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 Studio, ensure that you select the intended one.

MSI Studio also supports more than one functional datasets. For example, MSI Studio 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 Studio, ensure that you select the intended one.

Changes from Previous Releases

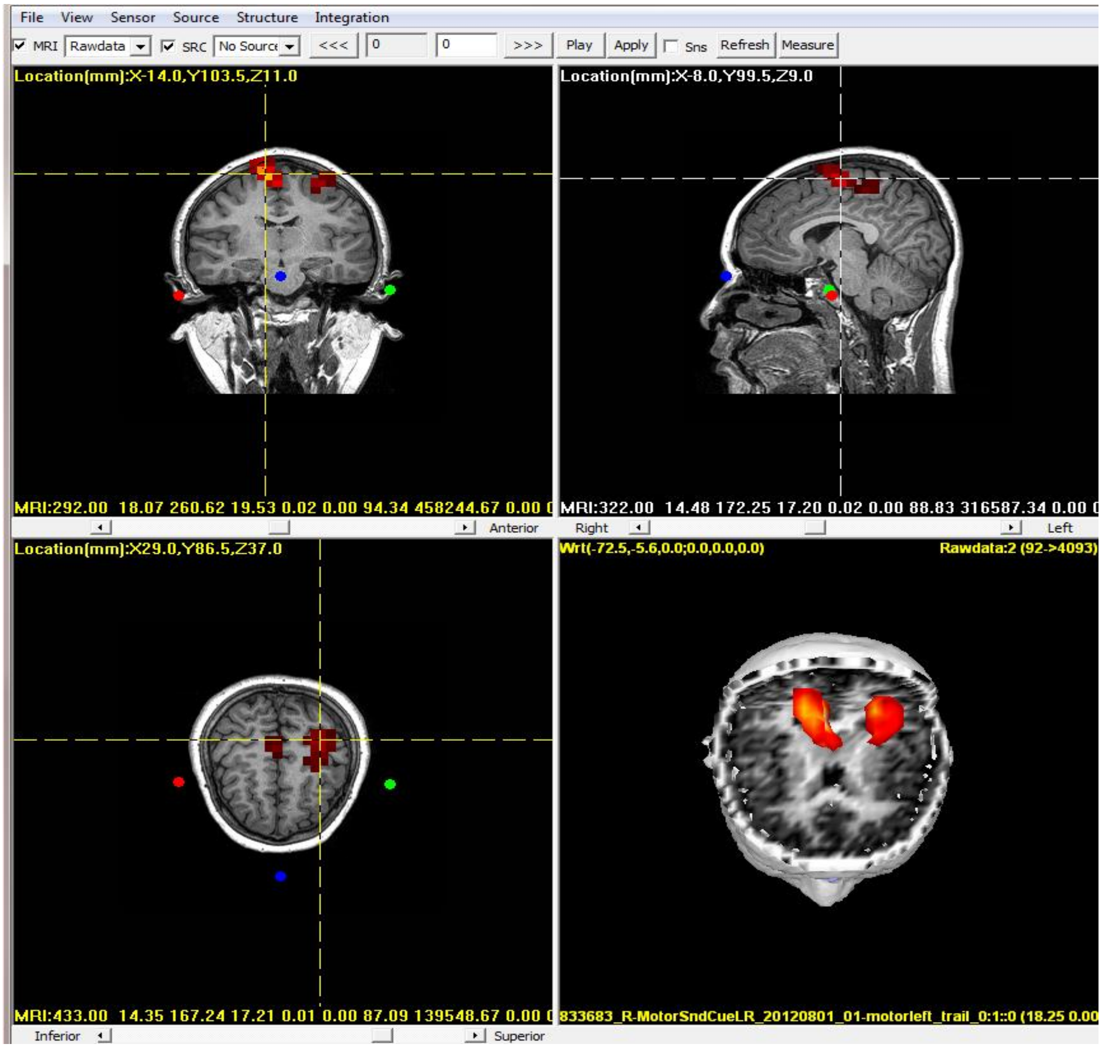
If you used the software before, please read the ReadMeFirst.doc file for late changes that did not make it into this manual and for a list of new functions or options, changes, additions, bug fixes, and known bugs for the application. You can open this file from the main window's Help > New Features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

Overview

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

Structural Data (MRI/CT)

MSI Studio 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 Studio (since 2009).



The MSI Studio 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 Studio, 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.

MRI/CT 2D Viewers

The main window in MSI Studio displays the volumetric MR/CT image in three orthogonal orientations. These orientations are the coronal, axial, and sagittal views. A slice from each view is shown in the figure below.

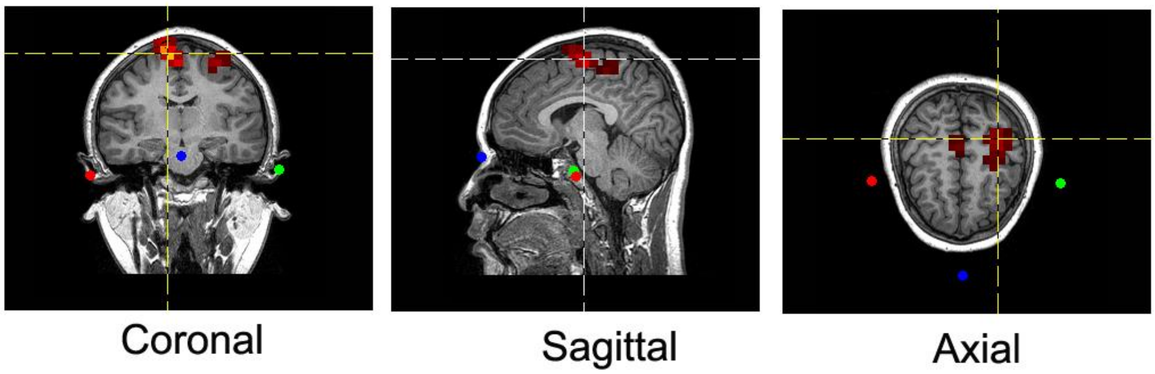


Figure 2. MSI Studio 2D Viewers. Coronal, Sagittal and Axial views. The two lines indicate the selection of the mouse.

MRI/CT 3D Viewer

The main window in MSI Studio displays the volumetric MR/CT image in one 3D Viewer. The data information is shown in the four corners.

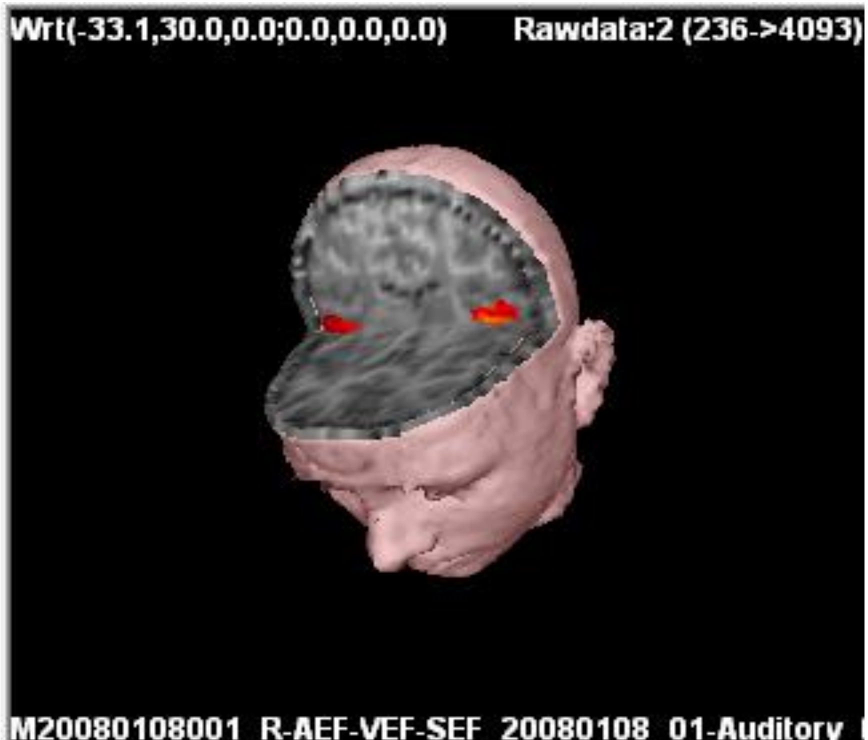


Figure 2. MSI Studio 3D Viewer. The left-up corner shows the location and orientations of all objects. The right-up corner shows the structural data name (ID number if multiple structural data are available). The button left shows source data name.

Properties of the MRI/CT

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

Each slice is identified by its slice number and orientation (coronal, axial, or sagittal).

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 Studio 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. The voxel value and coordinates of MR/CT image can be measured by a mouse clicking
3. The MR image may be viewed in either neurological or radiological orientation.
4. The MR image may be viewed with colors inverted.
5. Brightness and contrast are adjustable in the image.
6. Voxels can be marked onto the MRI when it is converted to DICOM format.
7. Fiducial markers can turn on and off.
8. The thresholded black-and-white image can be displayed.

Displaying the Slices

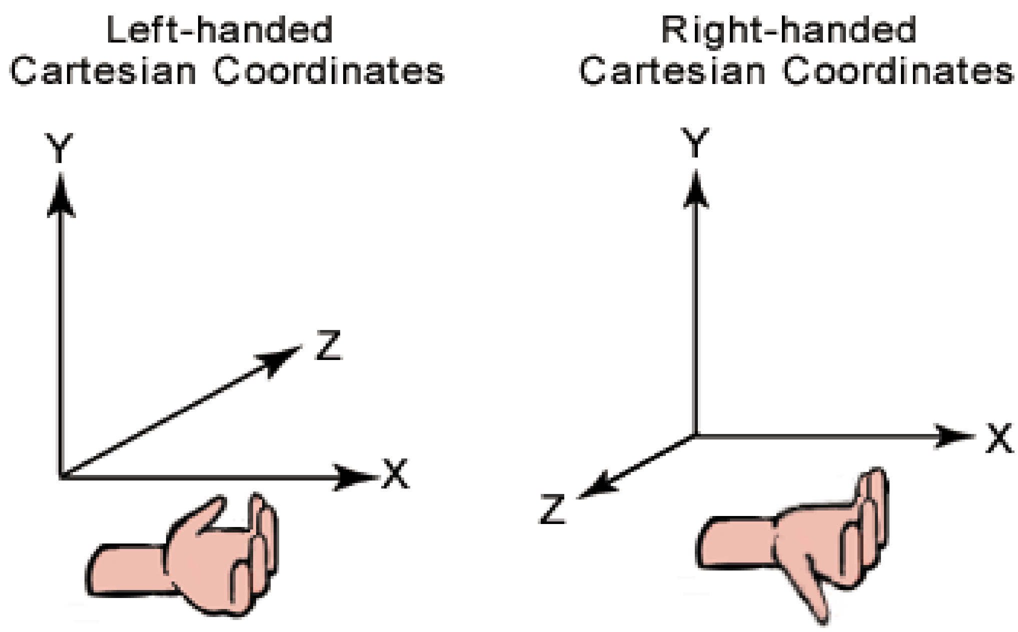


Figure 4. MSI Studio uses a left-handed coordinate system (Direct 3D), which is different from the right-handed coordinate system (OpenGL). Although left-handed and right-handed coordinates are the most common systems, there is a variety of other coordinate systems used in 3D software. For example, it 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.

Any three unrelated orthogonal slices can be displayed by clicking the slider bar below each image. Click until the desired slice number appears for each view.

1. You can also display the three intersecting slices of any 3D point.
2. If the point is one of the fiducial markers or the sphere origin, click the corresponding toggle button in the main window.
3. If the point is a dipole, selecting the dipole displays the three intersecting slices where the dipole is located.
4. If the point is a marker, selecting the marker displays the three corresponding intersecting slices.
5. If you want to locate the slices for a point displayed on one of the three views, enable Lock views to cursors, and then click the mouse on the point of interest. The other two views change to the slices that intersect this point.

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).

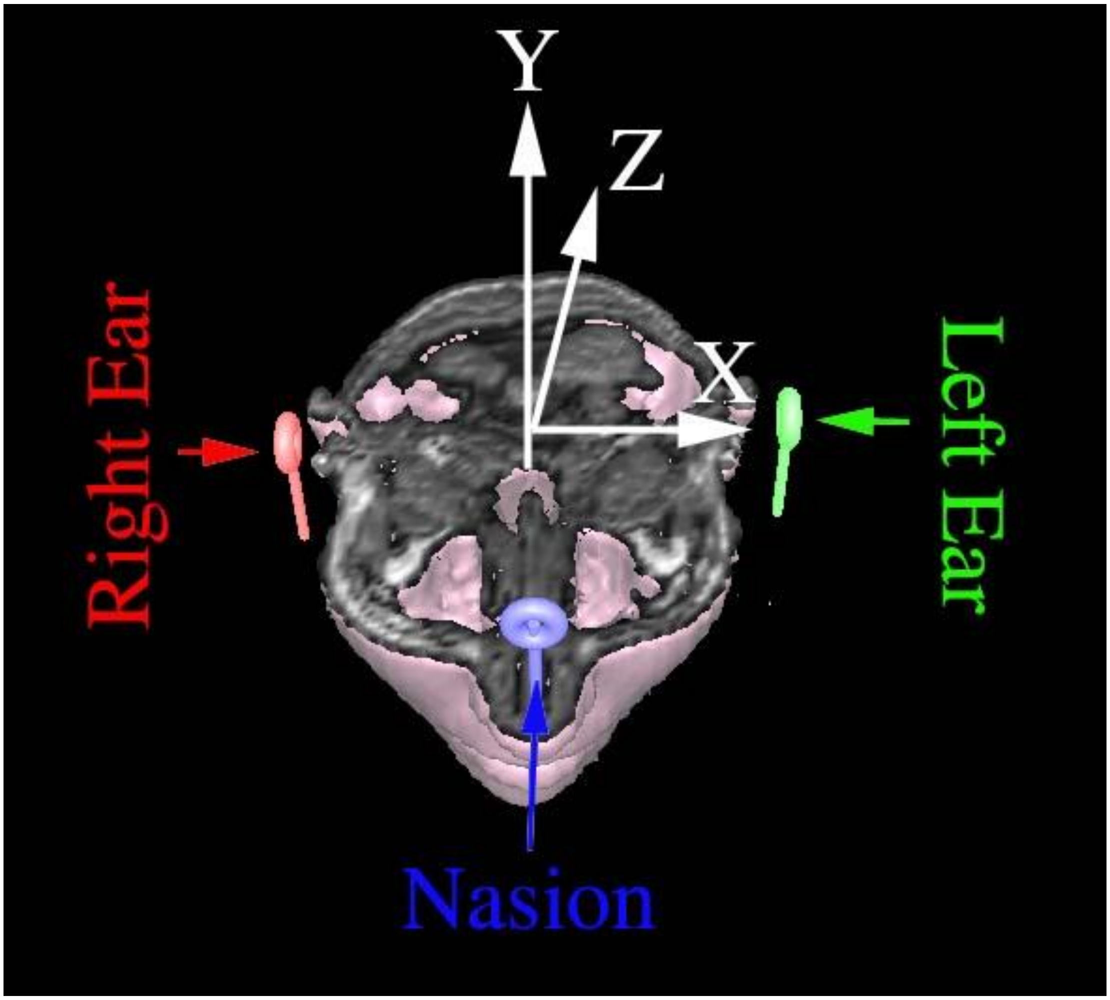


Figure 5. MSI Studio uses a left-handed coordinate system (Direct 3D), which is different from the right-handed coordinate system (OpenGL). In MSI Studio, right fiducial point is always red, left fiducial point is always green and the nasion is always blue.

MSI Studio 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 Studio 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.

The following graphical objects may be superimposed on the MR image:

1. Fiducial points
2. Head localization coils
3. Shape data points
4. Source volume
5. Virtual Sensor Locations
6. Best-fit sphere
7. Dipoles
8. Markers

These objects/items share the following common properties:

1. They do not alter the MR image data, but are instead graphical objects overlaid on the MR image.
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 are displayed in color, while the MRI/CT is displayed in grey scale.
7. With the exception of the fiducial points, these objects are defined in the MEG head coordinate system.

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 Studio 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 Studio 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 Studio.

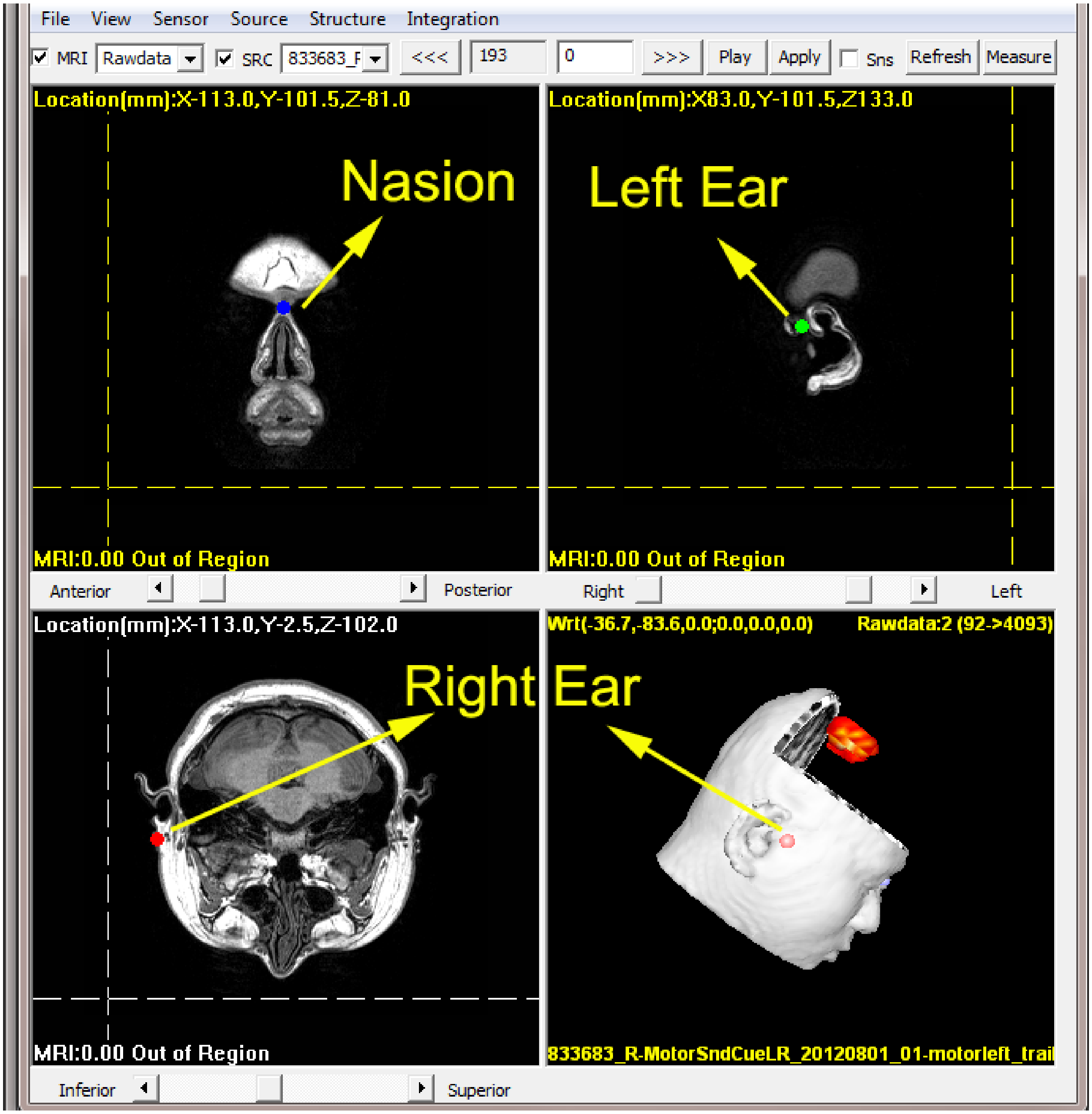


Figure 6. Structural Fiducial Points (MRI/CT), which are typically shown as filled circles in 2D and small balls in 3D viewers.

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 points coordinate system.
2. They have position coordinates defined in units of voxels, slice numbers and location in millimeters.
3. The nasion fiducial point is displayed with a blue dot/circle/square, the left ear fiducial point with a green dot/circle/square, and the right ear fiducial point with a red dot/circle/square.

> 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 Studio 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”).

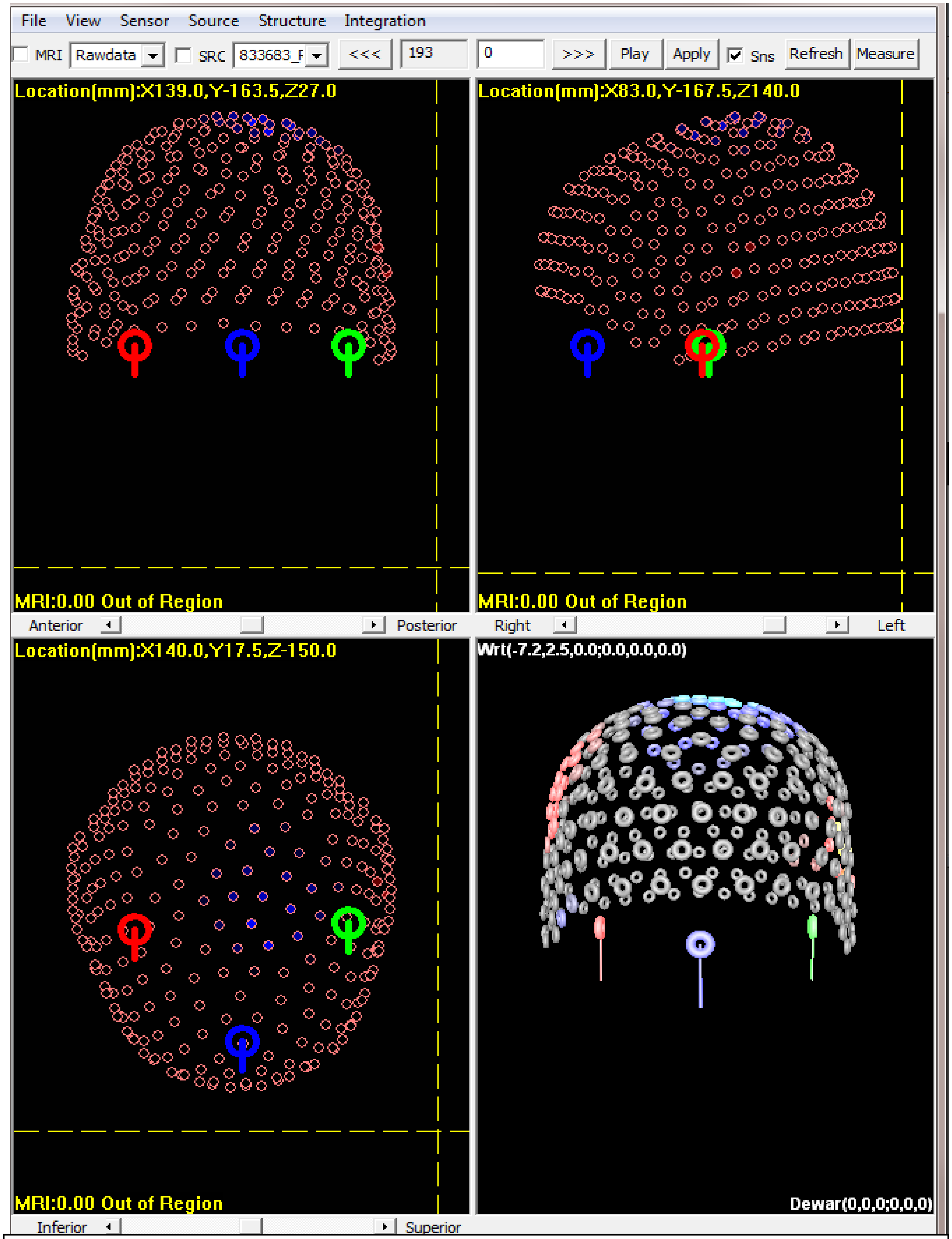


Figure.7. MEG/EEG fiducial points, which are typically shown as empty circles (or hollow circles) with a line in 2D and small torus with a line in 3D viewers.

Head Localization Coil Properties

The nasion head localization coil position is displayed with a hollow blue circle and a line, the left ear head localization coil position with a hollow green circle and a line, and the right ear head localization coil position with a hollow red circle and a line.

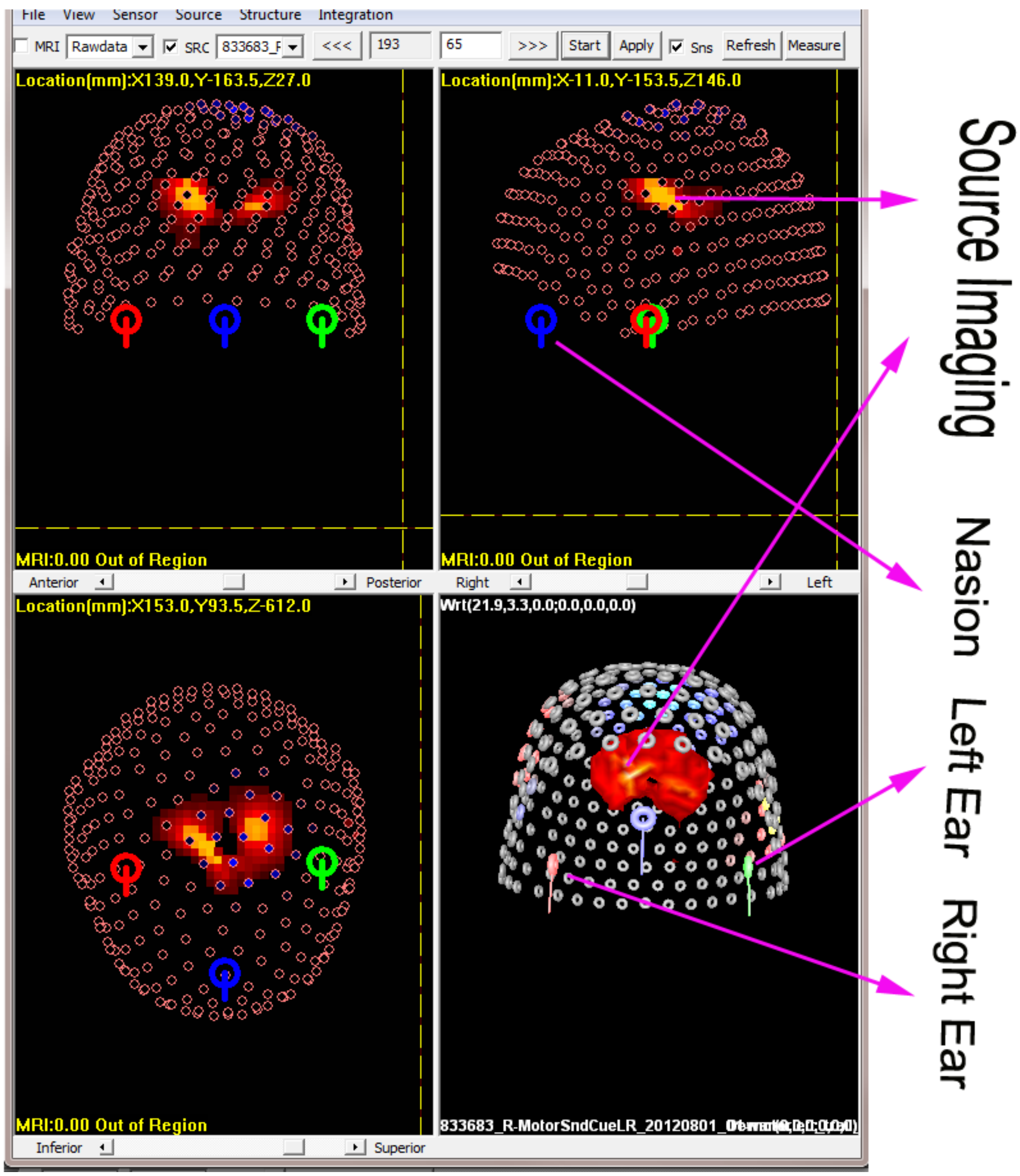


Figure 8. MEG/EEG source imaging without MRI data.

Source Volume

A source volume is a false-colored volumetric image produced by source localization software. An example source volume is shown below.

Source volumes cannot be created in MSI Studio, but are instead computed using source localization module or software then transferred or loaded into MSI Studio. Source volumes cannot be edited or saved using MSI Studio, either. However, peaks may be marked and the brightness, transparency, and level of detail are adjustable.

Source Volume Properties

A SAM volume has the following properties:

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

Dipoles

A dipole, or equivalent current dipole, is a model used to represent certain neurological activities.2 Dipoles are created and modeled using the MEG/EEG System source modeling programs, and the resulting dipole locations can be superimposed on the subject's MRI/CT using MSI Studio. The figure below shows how dipoles are displayed in MSI Studio. Dipoles cannot be created in MSI Studio. They are loaded from a dipole file. However, you can save a dipole file in MSI Studio, because it is possible to edit the dipole parameters and combine the dipole files. The Dipoles window in MSI Studio provides a means of viewing and sorting the dipoles in a spreadsheet format.

Dipole Properties

Dipoles have the following properties:

1. Each dipole has a position and orientation. Displaying the orientation is optional.
2. A dipole has a magnitude.
3. A dipole has a color, shape, size, and label.
4. A dipole has an associated error and latency information if it is the result of a dipole fit.
5. A dipole may be categorized as good or bad.
6. The dipole parameters are defined in the MEG head coordinate system.
7. An optional error volume may also exist for any dipole.

Dipole Error Volume

When performing an analysis of clinical data, regardless of which software programs are used, ensure that you review the "goodness-of-fit" and "confidence volume" for the data results. If the error is unusually high, it is recommended that you repeat the measurement. If an error volume for a dipole was computed in MEG Processor, the confidence ellipsoid is displayed surrounding the dipole.

MEG Best-fit Sphere

A spherical conductor with concentrically uniform conductivity is one type of conductor model used in the MEG Processor dipole source modeling programs. The best-fit sphere is the sphere which best approximates the subject's head shape. An example of a best-fit sphere is shown in the diagram below. Although it is also possible to define the best-fit sphere in MEG Processor, MSI Studio is better suited to create the sphere because it allows you to position the sphere relative to the physical features of the MRI. The best-fit sphere is saved in the head model file as well as the dipole file. The sphere's parameters can also be loaded from these files. For more information on the best-fit sphere, see the Source Scan Guide.

EEG Spherical Shell Modeling

Both MEG and EEG source modeling require a best-fit sphere to be defined, ideally using the subject's MRI as a guide. Only one conducting shell exists for MEG because the conductivities are not part of the magnetic field equations. For EEG, the conductivities are part of the electric field equations, and up to four concentrically spherical conductivities may be specified in the EEG System's source modeling programs. However, MSI Studio only displays a single sphere and a single shell. When a dipole file is loaded with EEG sphere information, only the smallest shell is displayed. This shell usually represents the brain layer. To define the best-fit spherical shells for EEG using MSI Studio, determine the smallest shell location and radius, then load the results into MEG Processor to define the additional three shells.

Best-fit Sphere Properties

The best-fit sphere has the following properties:

1. It has position coordinates and a radius.
2. Its conductivity is assumed to be concentrically uniform, and for EEG, four spherically concentric conductivities may be defined.
3. It is defined in the EEG head coordinate system.

Using MSI Studio

MSI Studio is functional module which can be launched within a program like MEG Processor. Specifically, MSI Studio 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 Studio right away.

Co-registering Using Fiducial Landmarks

After creating a structural data set from the original data files, the location of the fiducial landmarks used in the head localization software must be defined for correct “co-registration” between the head coordinate system and the MRI/CT coordinate system. This is achieved by moving the cursor to each of these locations, using the Set Fiducial option in the popup menu, then selecting the appropriate fiducial point submenu (Nasion, Left Ear, Right Ear) corresponding to the individual head localization coils used during MEG acquisition.

This procedure, which must be done for all three coil locations, may be repeated as many times as necessary from any view, including the “Zoomed” view to improve viewing detailed structures in the images.

When you quit MSI Studio, you may save your changes by clicking the Save button

Creating a Best-fit Sphere Head Model

MSI Studio can be used to create a “best-fit” single sphere based on the anatomy of the patient’s head for the purpose of source modeling routines.

When creating a volumetric structural file, a default sphere is created with a specific origin in the MEG/EEG head coordinate system as well as a default radius. Use the main window’s Popup menu and select Show Sphere to make this sphere visible.

If you are viewing a slice that does not intersect the sphere origin, you will see the sphere surface that intersects that slice, but no origin marker will appear in the image. However, if you click the Sphere Origin menu for the sphere, all views will be updated to the slice numbers that contain the sphere origin, which is shown as a square box. Alternatively, you can scan through the slices until the origin appears.

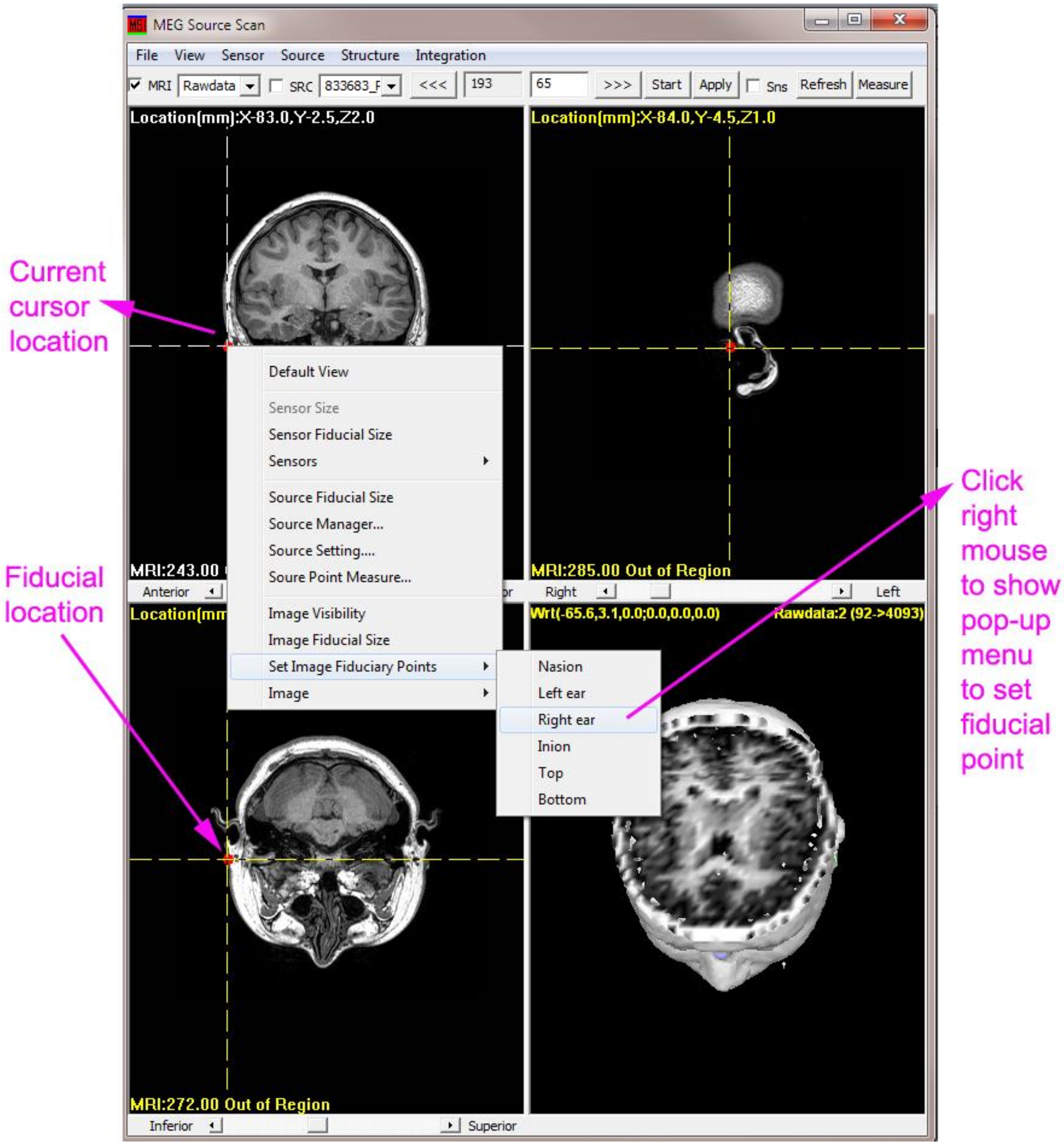


Figure 9. Setting Fiducial Point (e.g. right ear). Top: Using popup menu (right mouse button) to select Set Fiducial -> Right Ear submenu after cursor has been positioned over desired location (identified by lipid marker in patient's MRI). Bottom: After releasing mouse button, resulting location of fiducial point is marked by colour-coded dot.

Extracting Shape Data

A source analysis cannot be performed on the data until shape data for the patient are created. The shape data can be extracted from the MRI/CT using two methods — the cortical hull (brain) extraction method and the head (scalp) extraction method.

Using 3D Markers

The program allows you to insert three-dimensional “3D Markers” anywhere in the volumetric image. To use the Popup menu in the main window, select Set Marker to insert a marker at the current cursor location. The marker is shown as a small, yellow, filled circle with a numerical label indicating its order in the list of all existing markers. Delete Marker in the Popup menu deletes the currently selected marker that is shown in green. Clear Markers deletes all markers. Stepping through the entered markers using the marker’s buttons changes the currently selected marker and switches the current slice in each view to the one containing that marker.

Multiple local spheres

As of Release 2006, it is no longer necessary to define a best-fit single sphere or save the head model. The source modeling functions in MEG Processor have the capability of employing a multiple local spheres head model that is typically computed using the shape data.

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

Displaying Dipoles

You can use MSI Studio to import the three-dimensional location of dipole sources produced by the MEG System’s source modeling software to superimpose them on the MR/CT image. (This assumes that MRI-MEG co-registration has already been performed. Importing dipoles allows the output files of the source modeling program to be read directly into this program for display on the MRI/CT data. You can load multiple dipole files, and will be given the option of discarding the previously entered dipoles when opening a subsequent dipole file. If the previous entries are not discarded, the dipoles are added to the list of current entries. This program has no limit to the number of dipoles that can be loaded. After loading a dipole file, the dipole is shown as a small filled circle, square, or triangle with a “tail” indicating its direction vector. The dipole is selected using the scroll buttons shown in the figure. The dipole strength is reflected in the length of the tail. The List button can be used to select more than one dipole at a time. The option Current slice only shows all selected dipoles that lie within the currently viewed slice.

Latency values displayed in Waveform viewer will automatically be sent to MSI Studio. If the Synchronization option is enabled in the Tools Menu, the appropriate dipole will be automatically selected based on a match in latency between the two windows.

Dipole cluster and volumetric source

MSI Studio can automatically handle Dipole cluster as well as volumetric source imaging.

As of Release 2004, it is no longer necessary to show dipoles or dipole clusters. The source modeling functions in MEG Processor have the capability of generating multi-items for each voxel in volumetric source images. In other words, each voxel in the volumetric source image may contain the dipole information such as location, orientation, dipole moment and latency. Consequently, dipole modeling and dipole displaying will be obsolete. We keep some functions for back compatible.

Displaying volumetric source images (or Source Image)

MSI Studio can also be used to import and display color-coded "volumetric source images" produced by source localization or source scan software.

Once the volumetric source images are computed by source localization function, the source volumetric images are then available for this MSI Studio to superimpose source images on individual 2D MRI/CT slices in the three views as well as 3D MRI/CT. The MR/CT and MEG images' axes are aligned automatically as described in "Co-registering Using Fiducial Landmarks". In 2D viewers, for source images with higher or lower resolution than the original MR/CT image, the source slice coinciding or closest to the currently viewed slice is displayed.

A false-color scale is enabled for the display of the volumetric source image intensity in each slice. The current maximum intensity level can be adjusted in the Maximum field. The data range of the intensities that are to be displayed can be specified by moving the slider bars to apply a threshold to each color scale. This allows you to view only a range of amplitudes between the threshold setting and the current maximum value to mask out low-amplitude levels in the image. Note that the source image in Figure 9 shows the display of both positive and negative color scales (e.g., for the display of differential images). For source images that contain only positive values (e.g., current density images), only the positive (red) color scale is enabled.

In addition, the Transparency slider and other options can be changed by accessing the Color Options dialog through MSI Studio main window. This dialog can be used to make the MR/CT image visible through the source image overlay image using spatial dithering.

The source voxel intensities can be analyzed for peaks that can then be marked on the SAM display by using the Mark Peaks option. Only values exceeding an Absolute Threshold will be analyzed and a Minimum Separation in centimeters between the identified peaks can be enforced.

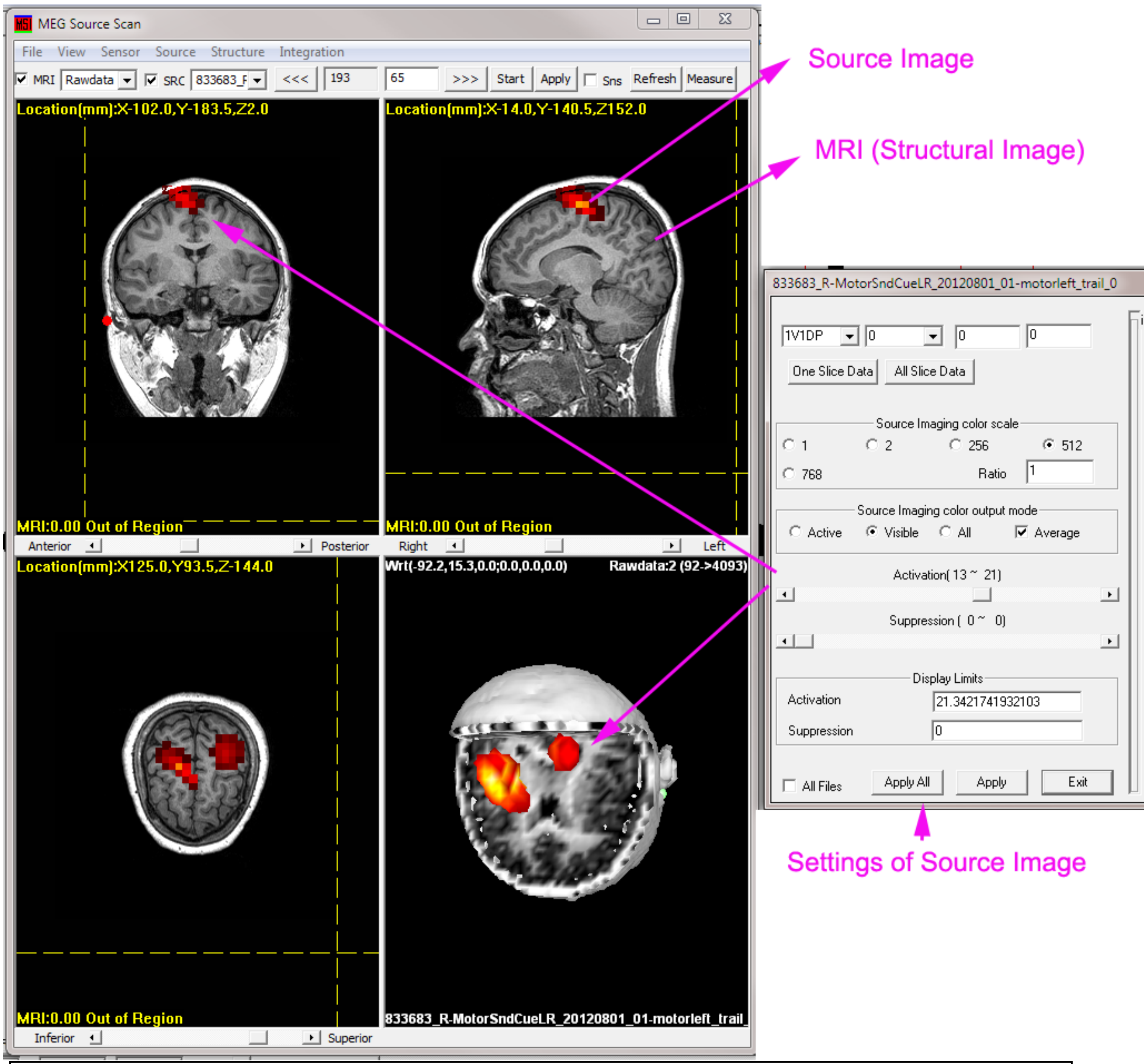


Figure. 10. Volumetric Source Image overlapped on MRI. The combination of MEG Source Image and MRI is also called Magnetic Source Imaging (MSI). In this manual, volumetric source image can be generated by MEG/EEG, the structural image can be MRI/CT.

Head Motion Information

When source analysis has been performed on data containing Continuous Head Localization (CHL) information, the maximum head motion that occurred in the analyzed data is displayed at the bottom of an MRI view if the information is loaded and the current slice in the view contains one or more sources. This head motion value is the maximum head movement that occurred in the data (that were selected for source analysis), relative to the default head position saved with the dataset during head localization. If there are multiple dipoles in the view, the head motion is the greatest amount for the entire source displayed.

If the head motion is within the specified tolerance (set before the data are recorded and saved with the data), it is displayed in white at the bottom of the view. When source analysis has been performed on non-CHL data, only source data name will be showed.

Fiducial Mismatch Information

When source data are available, the degree of mismatch between the fiducial points in the MRI/CT and source fiducial points in the data is displayed at the bottom of a 2D view. The mismatch value is the maximum of the distances between each MRI/CT fiducial point and its corresponding head coil. The default tolerance is 5 mm. If the mismatch is within tolerance, it is displayed in white. If the fiducial mismatch exceeds the specified tolerance, a warning message is displayed in red.

Main Window GUI Guide

The MSI Studio main window is shown in Figure 10. It is the principle window used to manipulate MEG/EEG sensor or electrodes, MRI/CT images, and MEG/EEG source images.

2D Views

The three 2D views in the main window display the coronal, sagittal, and axial orientations of the volumetric MR/CT image one slice at a time. The slider bars beneath each view allow you to page through the slices. You can also display the three intersecting slices of any 3D point using various main window controls. See “Displaying the Slices” for details.

3D Views

The 3D viewer in the main window display he volumetric functional sources and MR/CT data in 3D. MSI Studio currently supports both Direct3D and OpenGL. By default, the program uses Direct3D rendering engines. You may rotate, move and cut the 3D objects to show the region of interest (ROI).

The GUI in the main window may vary slightly among different version of the MSI Studio 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

When source data are available, the degree of mismatch between the fiducial points in the MRI/CT and

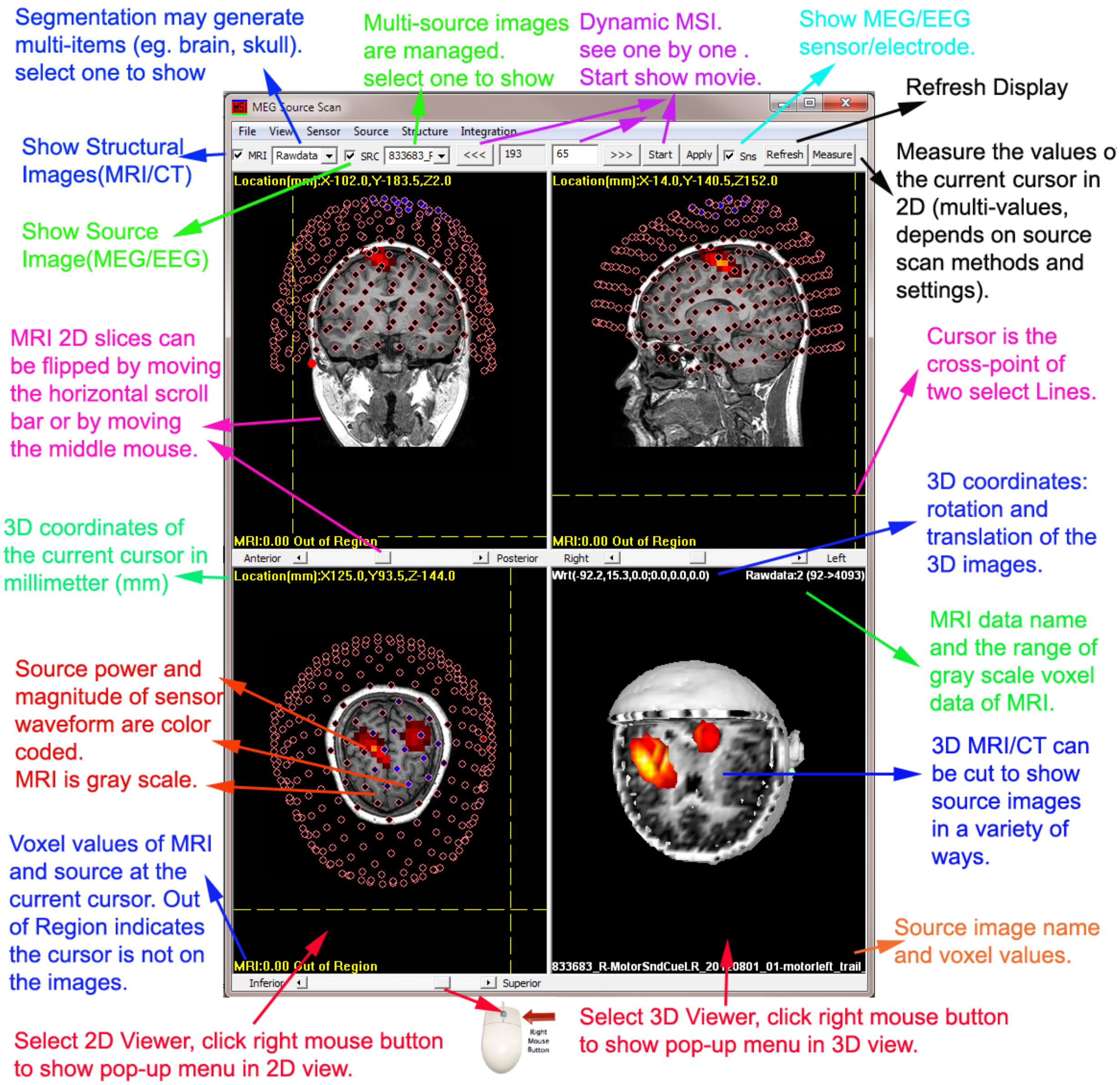


Figure 11. The graphic user interface (GUI) of the main window in MSI Studio.

Popup Menu in 2D Viewers

When an MEG/EEG, Source images and/or MRI/CT data have been loaded into MSI Studio, you may 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

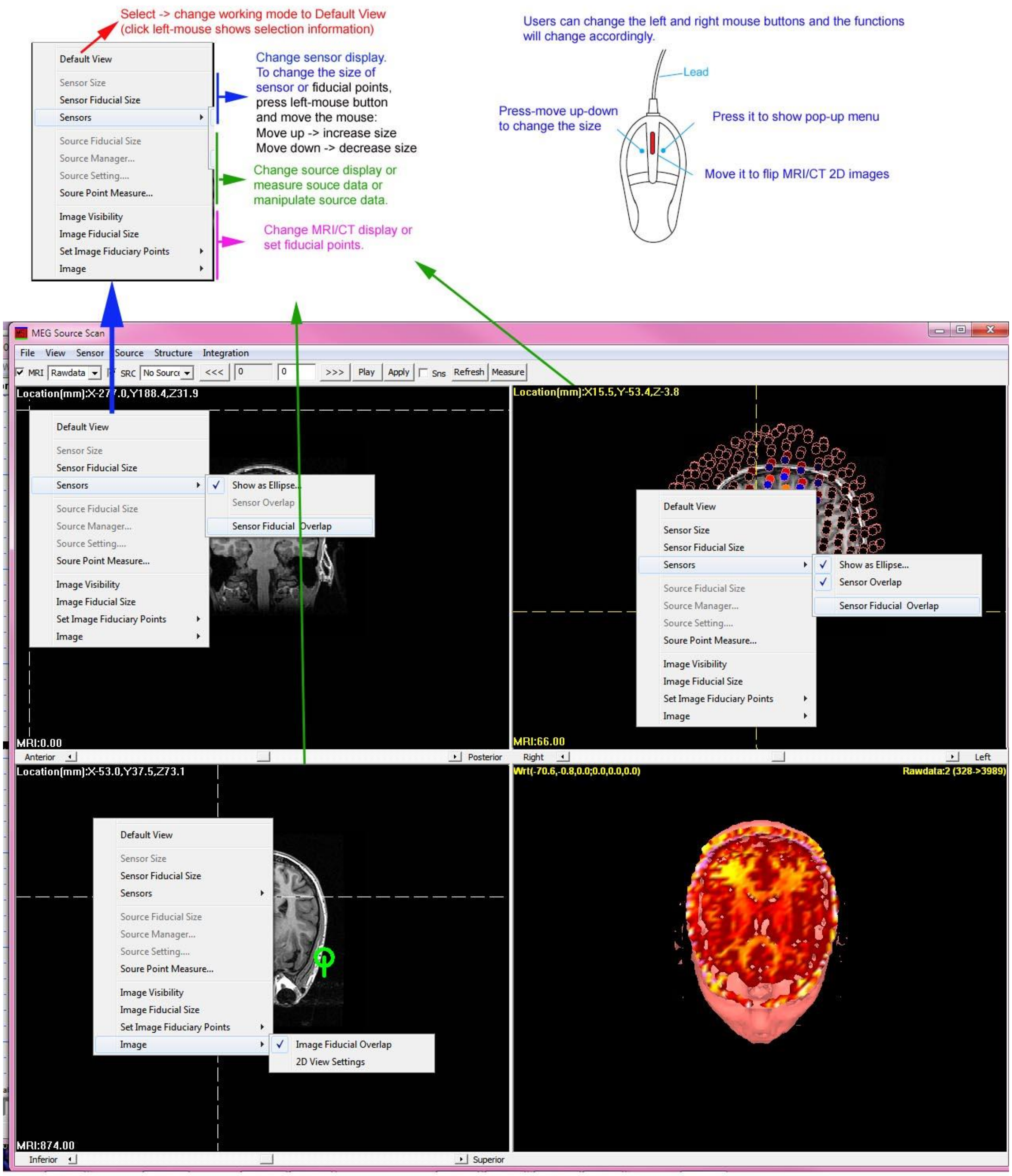


Figure 12. Popup menu and the use the menu functions.

described in Figure 11. Many of the actions define landmarks on the MRI/CT and require you to locate a point on the three 2D views to label. Use the cursor to locate the point you want to label.

Popup Menu in 3D Viewer

When an MEG/EEG, Source images and/or MRI/CT data have been loaded into MSI Studio, 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.

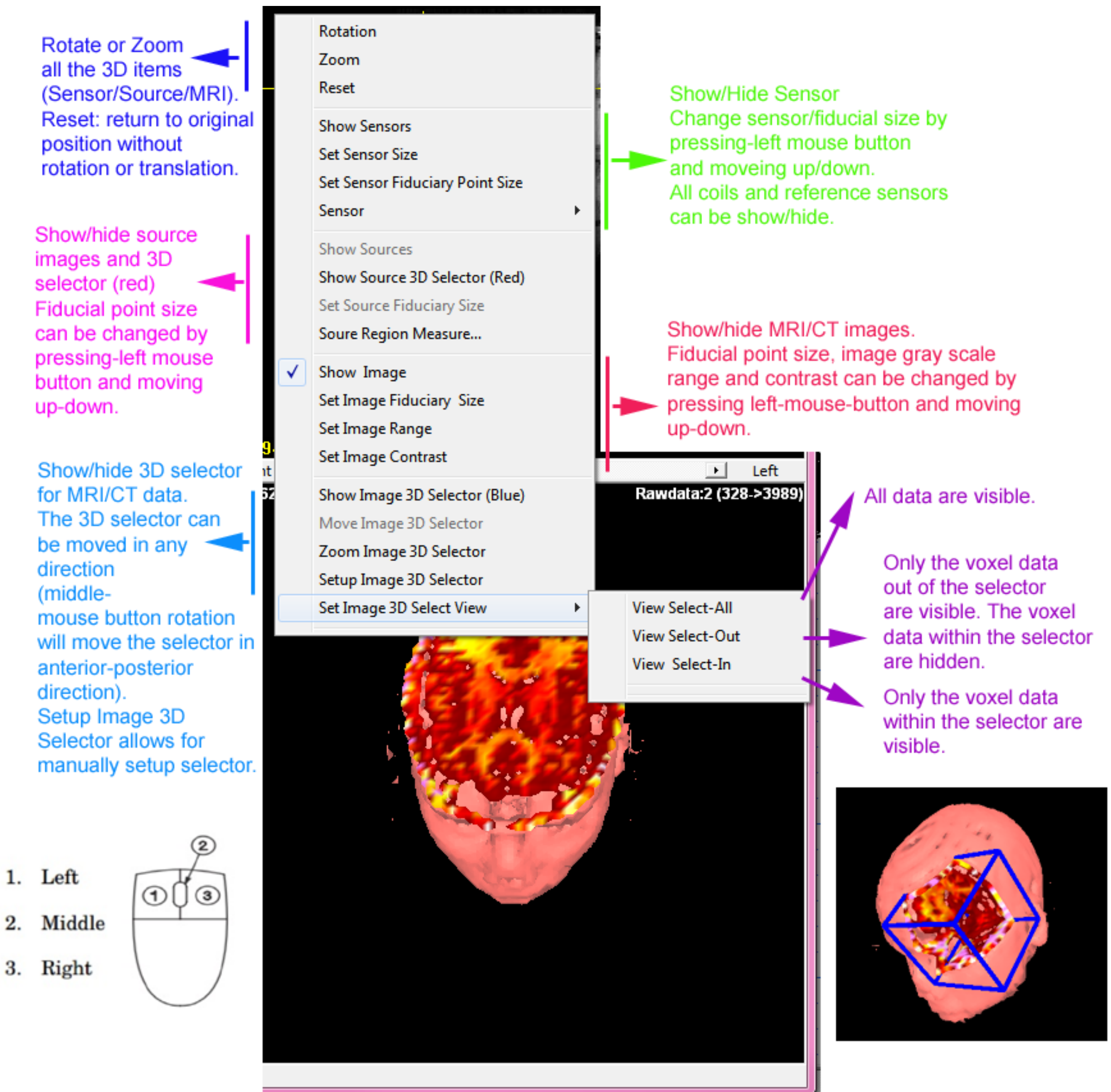


Figure 13. Popup-menu in 3D Viewer.

Set Fiducial

When pop-up menu is displayed, choose the Set Fiducial submenu and then select one of the three choices defines the current cursor position as the selected fiducial landmark. See "Co-registering Using Fiducial Landmarks" for details.

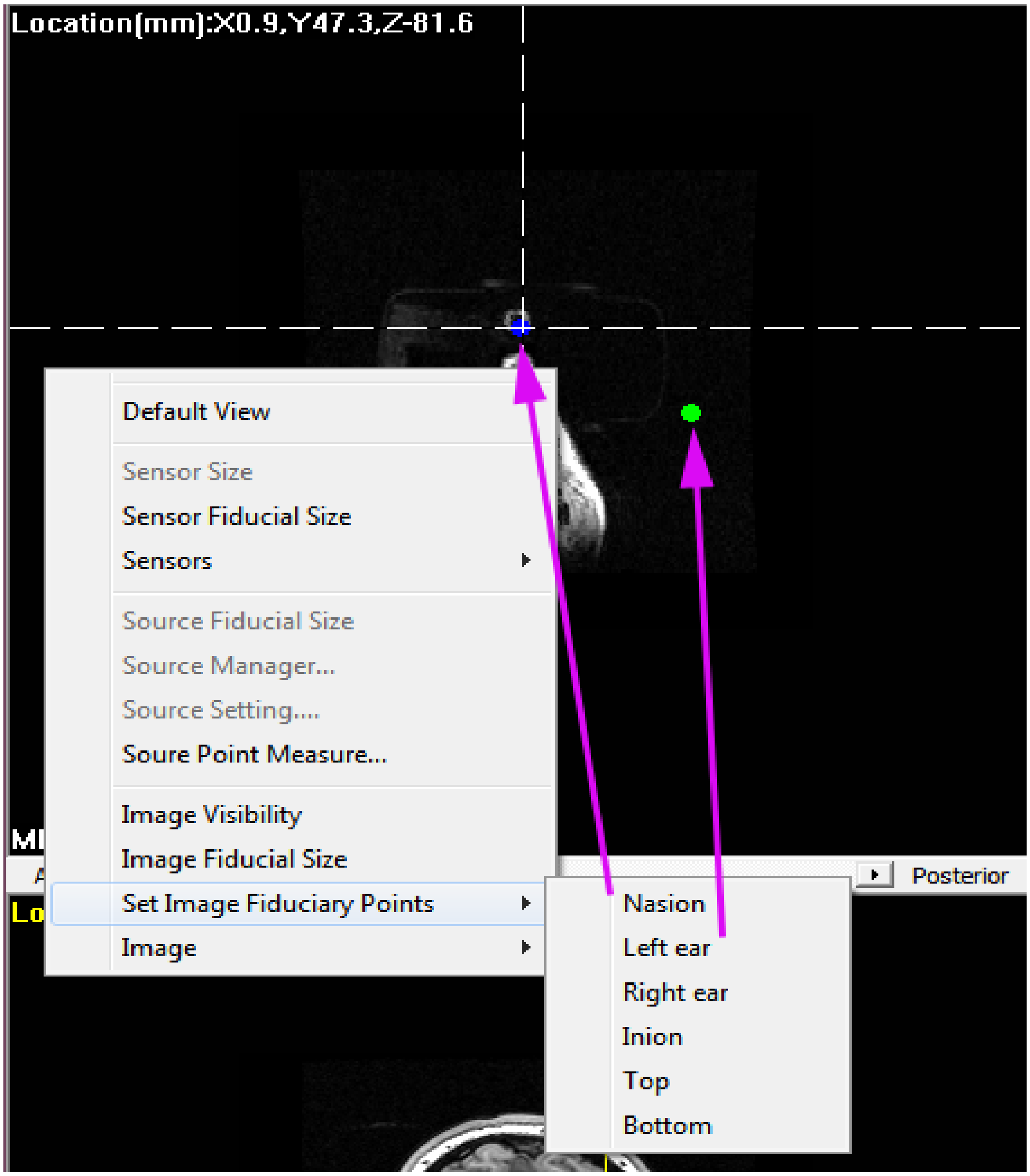


Figure 14. Popup menu and the submenu for setting of fiducial point. At least 3 points are necessary for defining a 3D coordinate system. To define a fiducial point, (1) find the marker on 2D MRI and select the point, (2) select the corresponding submenu of fiducial points. The selected point, which is indicated by the cross-point of two selection lines, will be defined a fiducial point.

Navigation GUI Controls

The MSI Studio main window contains GUI controls for navigating the MRI/CT slices as well as MEG/EEG source slices. Change the slice displayed in each 2D view individually by using the corresponding horizontal scroll bar positioned below the view, or use one of the controls described below to change all three views simultaneously to show a specific point of interest.

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.

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.

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.

Apply

You may also manually type a number and click “Apply” to show specific slice.

Sensor Display

The “Sns” check box defines if the MEG sensors or EEG electrodes will be displayed.

Refresh

This button will refresh the 2D and 3D viewers.

Measure

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.

Lock views to cursors

Locks all views to the cursor position. When the cursor is moved to a new location in one view, the slices in the other views update to reflect the current cursor position.

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 SAM Volume Overlay

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

File Menu

The File menu provides actions for opening and saving the files used by MSI Studio, importing an MRI file from and exporting it to DICOM format, and sending an MRI file to PACS. This menu also contains commands to print and get information about the MRI.

Options Menu

The Options menu provides special operations on the MRI/CT data. Select Options from the MSI Studio main window to display the following menu:

Display Options

This menu option opens the following dialog:

Use this dialog to change display setting options for dipoles, markers, shape data points, and fiducial mismatch and head motion warnings.

The development of source localization algorithms has made the Brain/Head Shape Extraction obsolete. The main reasons are (1) advanced source localization does not depends on single or multiple spheres; (2)the inner skull boundary is not important for the purposes of constraining the functional image anymore; and (3)the program can automatically extract the Brain/Head Shape if necessary.

The conclusion is based on more than one thousands of MEG datasets from 120 subjects with a 275 channels MEG system.

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 Studio 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 Studio 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.

Image Orientation

This menu option displays the following submenu:

Use this submenu to change the viewing orientation of the head between radiological and neurological. This action reverses the head direction so that the left side of the head appears on either the right or left side of the images in the coronal and axial views.

Radiological

This orientation displays the left side of the head on the right side of the image.

Neurological

This orientation displays the left side of the head on the left side of the image.

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 Studio. 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 Studio. To define fiducial markers within MSI Studio, 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.

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.

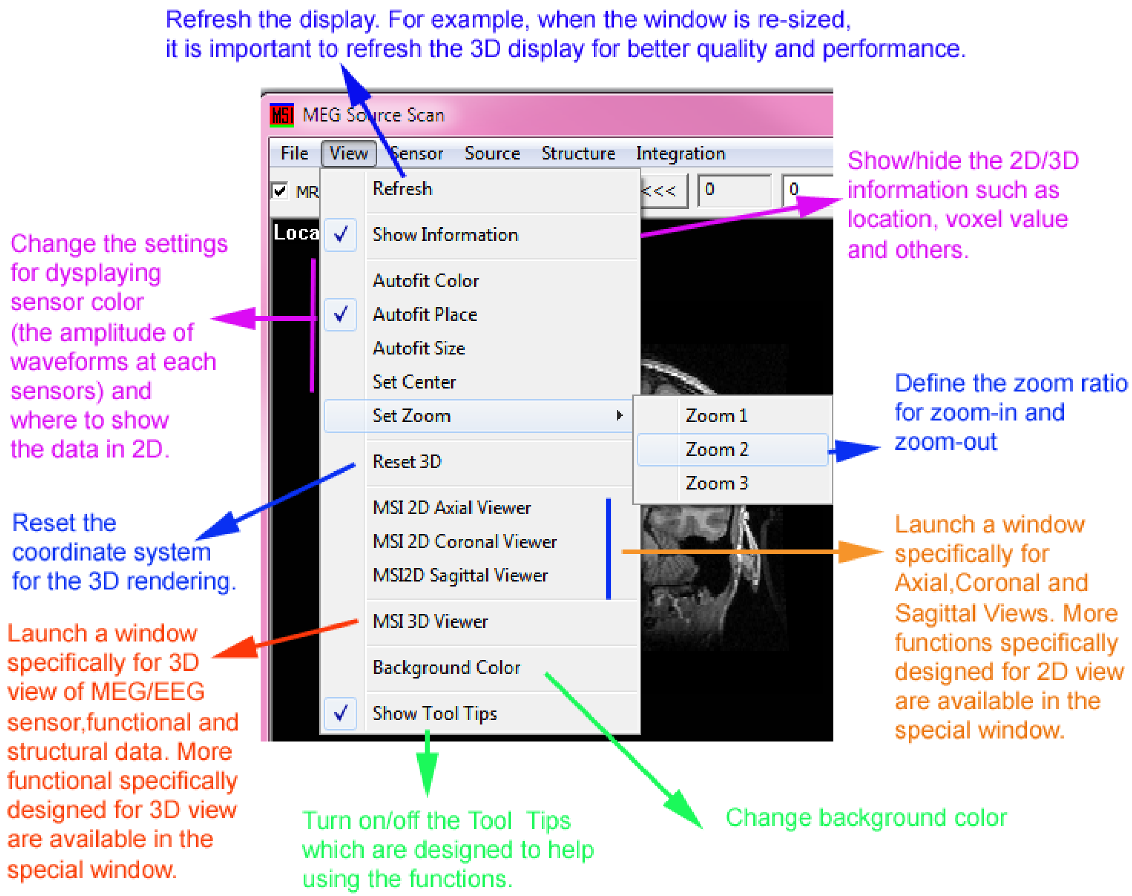


Figure 16. View Menu for manipulating the display of the functional and structural data.

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.

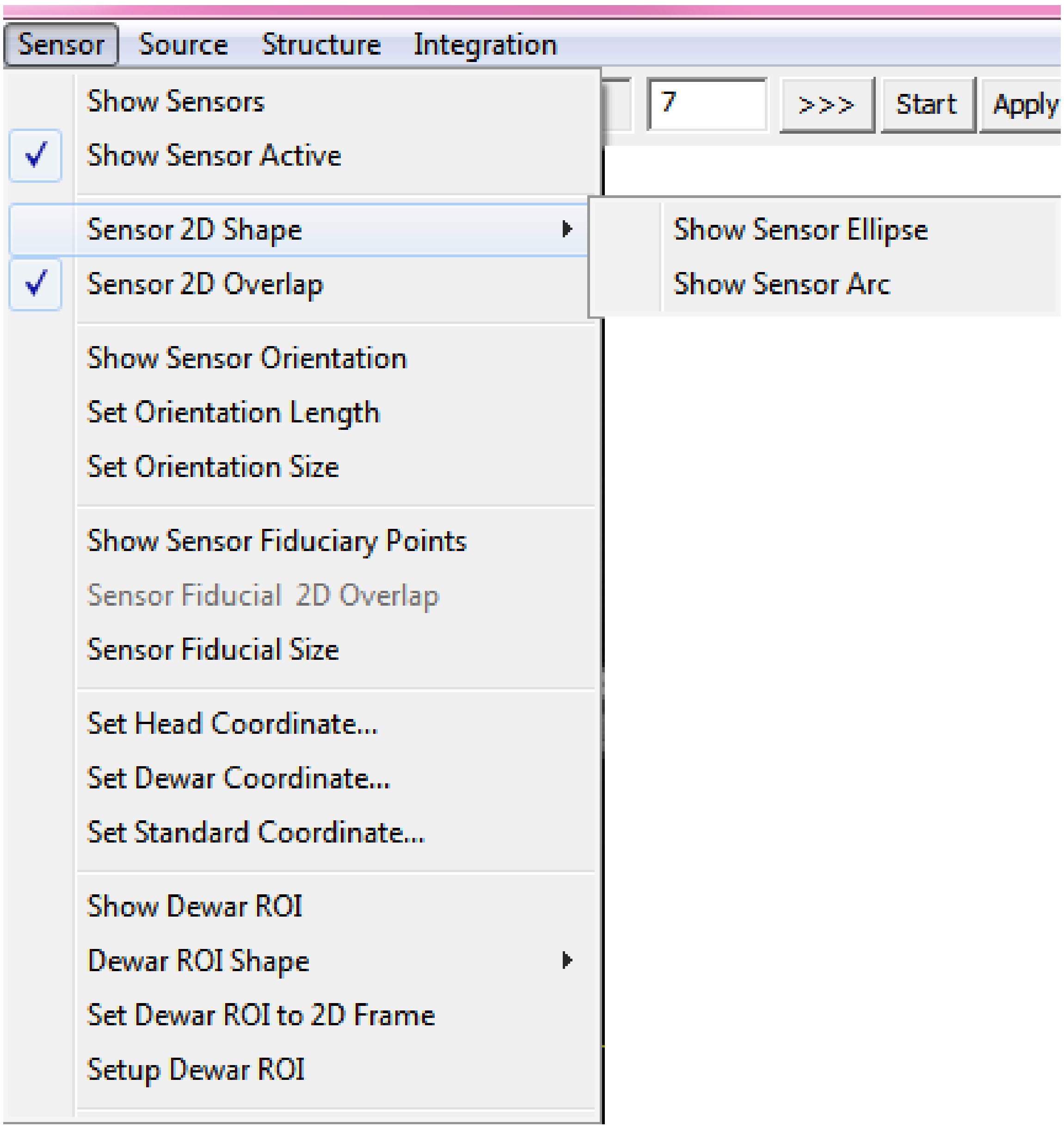


Figure 17. Sensor Menu for manipulating the display of MEG sensors or EEG electrods.

Sensor 2D Shape

Show sensor in either ellipse or arch.

Sensor 2D Overlap

Show sensor located on all slices in 2D View. If it is unchecked, only sensor s at the current 2D slice view will be showed.

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.

Sensor Fiducial 2D Overlap

Show sensor fiducial points located on all slices in 2D View. If it is unchecked, only sensor fiducial points at the current 2D slice view will be showed.

Sensor Fiducial

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.

Set Head Coordinate

Show sensors at head coordinate system in 2D View. This function is designed for advanced users.

Set Dewar Coordinate…

Show sensors at Dewar Coordinate in 2D View. This function is designed for advanced users.

Set Standard Coordinate

Show sensor at standard head coordinate system in 2D View. This function is designed for advanced users.

Show Dewar ROI

Show the region of interest (ROI) of the Dewar, which can be used to scan sources without MRI/CT. This function is designed for advanced users.

Dewar ROI Shape

Show the region of interest (ROI) of the Dewar in either rectangle or sphere. This function is designed for advanced users.

Set Dewar ROI to 2D Frame
Set the frame defined by the region of interest (ROI) of the Dewar to the 2D viewer. This function is designed for advanced users.

Setup Dewar ROI
Setup the region of interest (ROI) in sensor space or at sensor level. This function is designed for advanced users.

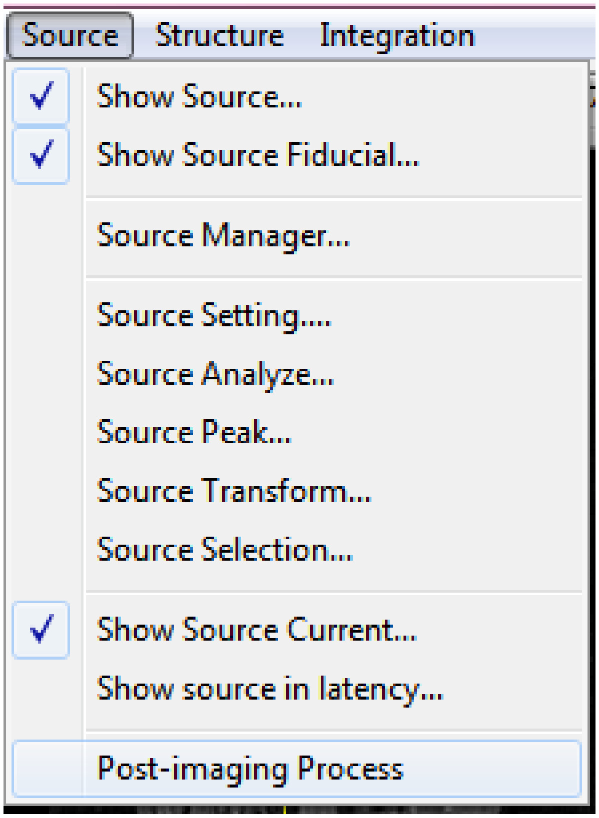


Figure 18. Source Menu for manipulating MEG/EEG source data.

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 2D and 3D viewers. If this function is disabled, some other functions (e.g. Show Source Current") are automatically disabled.

Show Source Fiducial

Show/hide source fiducial points on 2D and 3D viewers.

Show Source Fiducial
Show/hide source fiducial points on 2D and 3D viewers.

Source Manager
Launch the window for managing source data. MSI Studio 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 Studio supports multiple source images, the Window of Source Settings deals with the currently selected dataset in the Source Manager. Noteworthy, 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 Analysis
Launch the window for analyzing the voxel values of source data. Since MSI Studio 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 Peak
Launch the window for analyzing the peaks of source images, which typically represent the highest or lowest value in several areas. Since MSI Studio 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.

Source Selection
Launch the window for selecting some parts of source images for analysis. This function is designed for advanced users only.

Show Source Current
Show only the currently selected dataset in 2D and 3D Viewers.
MSI Studio 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 2D and 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.

Post-imaging Process

This menu launches the window for post-imaging 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.

Structure Menu

The structure menu provides access to manipulate the structural images such as MRI and CT data. MSI Studio has both 2D viewers and a 3D viewer for easy to identify and measure the functional/structural changes as well as their correlations.

Show Images

Show/hide structural images such as MRI and CT on 2D and 3D viewers. If this function is disabled, some other functions (e.g. Image 2D Visibility) are automatically disabled.

Show Image Fiducial Points

Show/hide the fiducial points of structural images on 2D and 3D viewers. If this function is disabled, some other functions (e.g. Show 2D Fiducial Overlap) are automatically disabled.

Manager

Launch the window for managing structural data. MSI Studio 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.

Manager

Launch the window for managing structural data. MSI Studio 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.

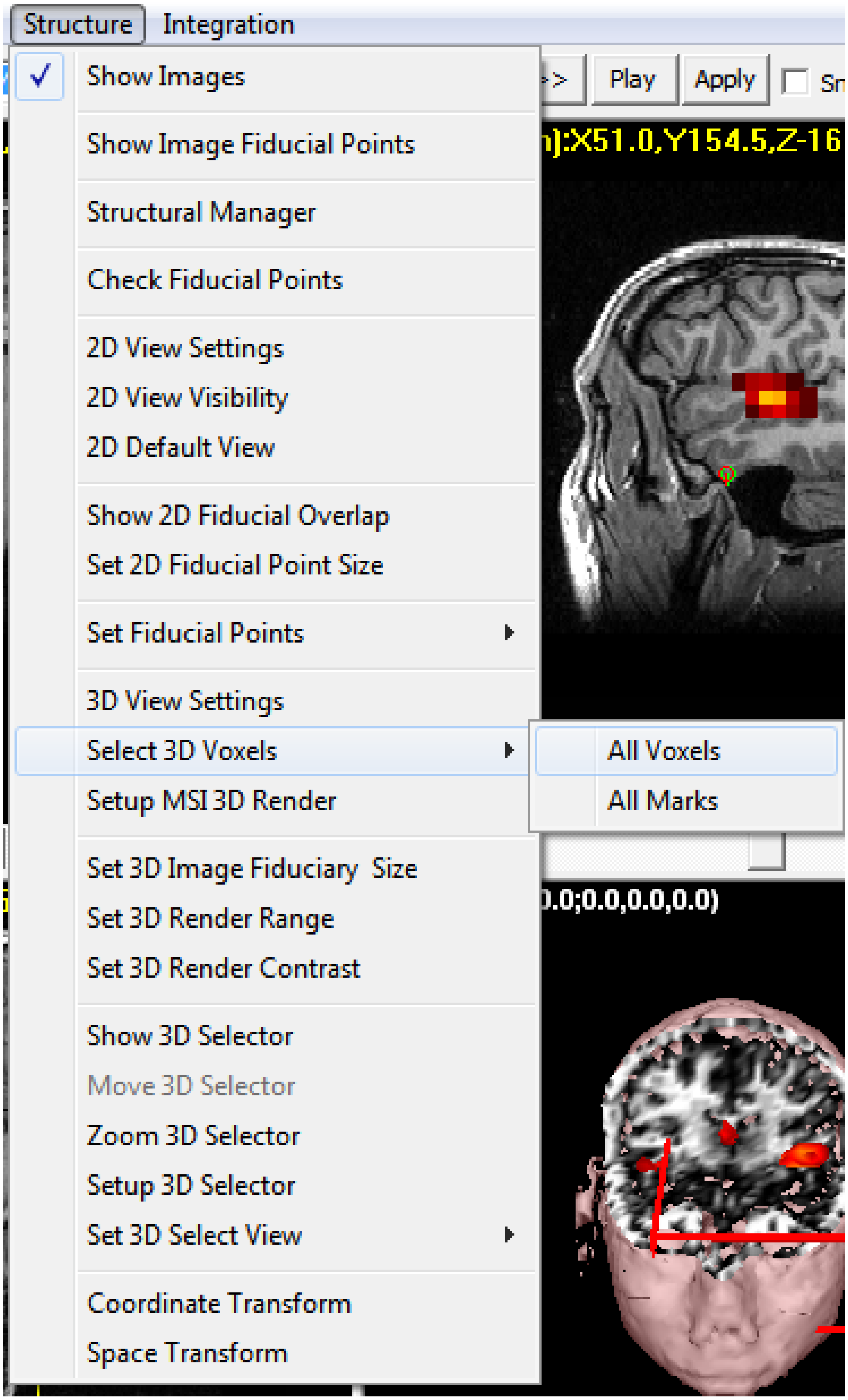


Figure 19. Structure Menu for manipulating MRI/CT data.

Check Fiducial Points

Check the fiducial points in the structural dataset. For example, checking if there is left-right reversal.

2D View Settings
Launch the 2D view setting dialog for defining how the structural images will be displayed.

2D View Visibility
Change the working mode to visibility: press-the left mouse button and move up-down-left-right to adjust the visibility.

2D Default View
Automatically adjust the visibility with the default settings.

Show 2D Fiducial Overlap
Show the fiducial points on the 2D view in all slices. If it is unchecked, the fiducial points will show only on the slices which the fiducial points are exactly localized on.

Set 2D Fiducial Point Size
Change the working mode to setting fiducial size: press-the left mouse button and move up-down to adjust the size of fiducial points.

Set Fiducial Points
The functions are similar to that in the 2D pop-up menu. To use this menu, choose the Set Fiducial submenu and then select one of the three choices defines the current cursor position as the selected fiducial landmark. See “Co-registering Using Fiducial Landmarks” for details.

Set Fiducial Points
The functions are similar to that in the 2D pop-up menu. To use this menu, choose the Set Fiducial submenu and then select one of the three choices defines the current cursor position as the selected fiducial landmark. See “Co-registering Using Fiducial Landmarks” for details.

3D View Settings
Launch the 3D view setting dialog for defining how the structural images will be displayed in 3D Viewers.

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 render 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.

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.

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.

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

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 View 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.
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.

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.

Integration Menu

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

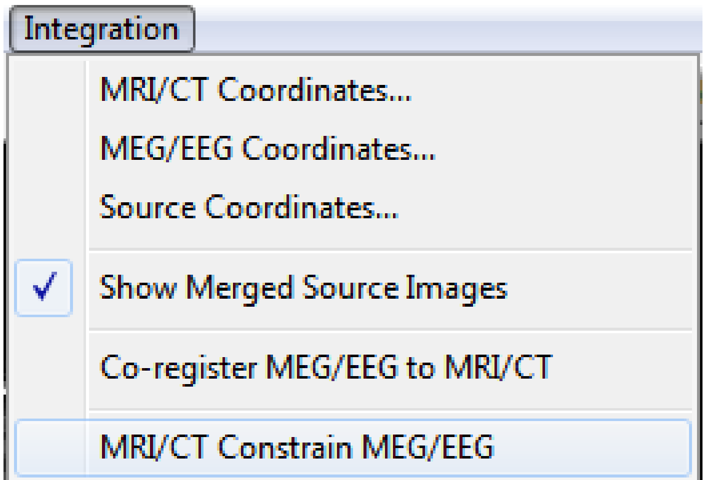


Figure 20. Integration menu for integration of all functional and structural data.

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.

Show Merged Source Images

This menu option enables the source images to be merged into the structural images to form a integrated source imaging with both structural and functional information.

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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