ELECTRODE GRID VISUALIZATION

Using Analyze

AnalyzeDirect

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Introduction

Implantation of subdural electrodes is an invasive procedure for the recording of intercranial EEG (iEEG). In order for researchers to properly interpret the data and understand the relationship between signal, electrode position and underlying brain anatomy, it is essential for the three-dimensional location of the electrodes to be known.

Effective 3D representation of multimodal information provides researchers with the necessary synergistic image, displaying grid electrodes from a post-implantation computed tomography (CT) scan with the underlying brain anatomy from a pre-implantation magnetic resonance imaging (MRI) scan, required for such applications. Analyze provides a fast methodology to achieve these important visualizations.

Co-Registration of Pre-Implantation MRI to the Post-Implantation CT

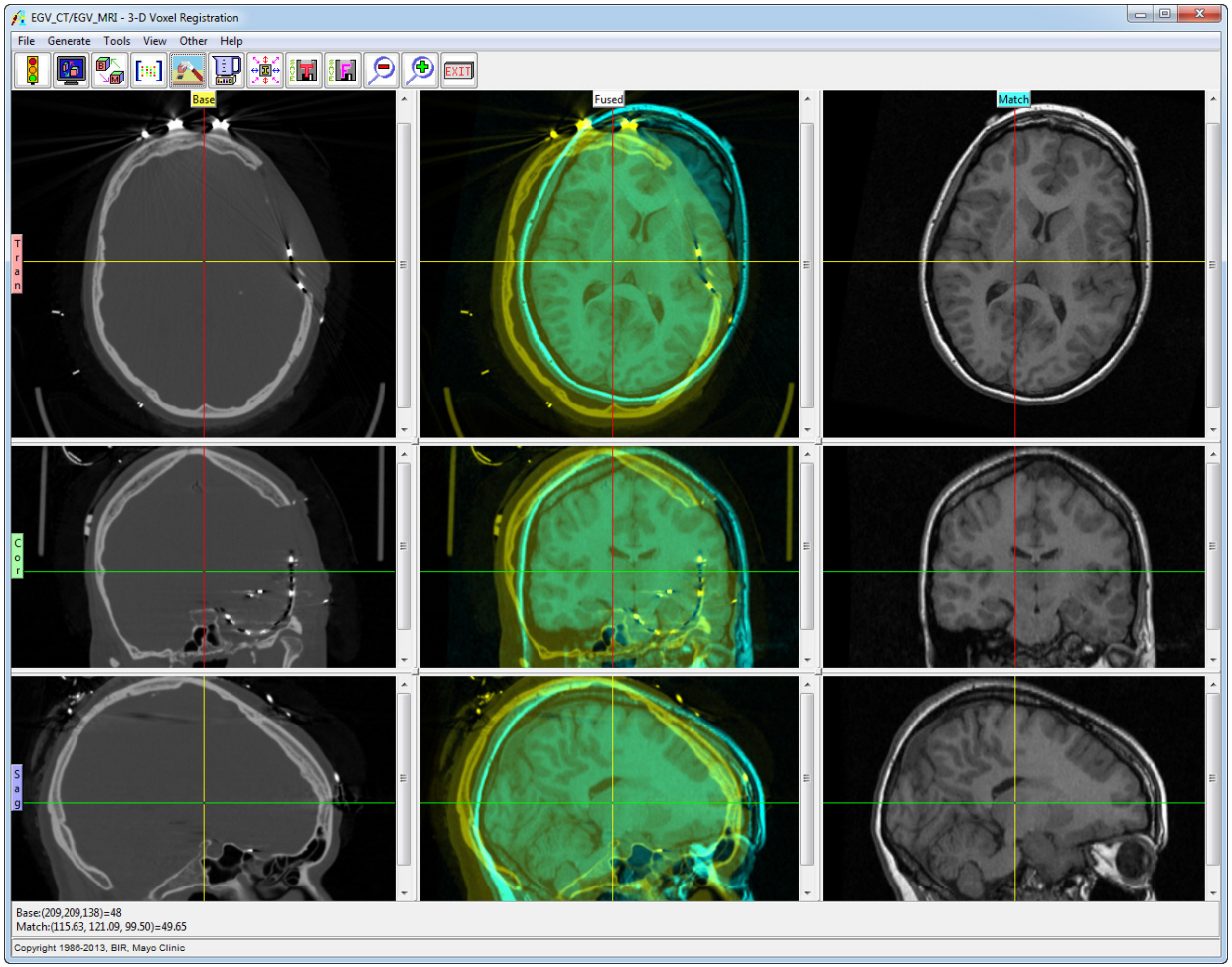
The co-registration of pre-implantation MRI to post-implantation CT (or MRI if available) facilitates electrode imaging and visualization of brain anatomy. With co-registration the two scans are aligned to a common coordinate system; in this case the pre-implantation MRI is aligned and transformed to the post-implantation CT. Once co-registration is complete key information can be extracted from each scan and visualized in a single frame of reference.

Automatic Registration

From the Analyze workspace select the CT and MRI.

Open the **Register > 3D Voxel Registration** module.

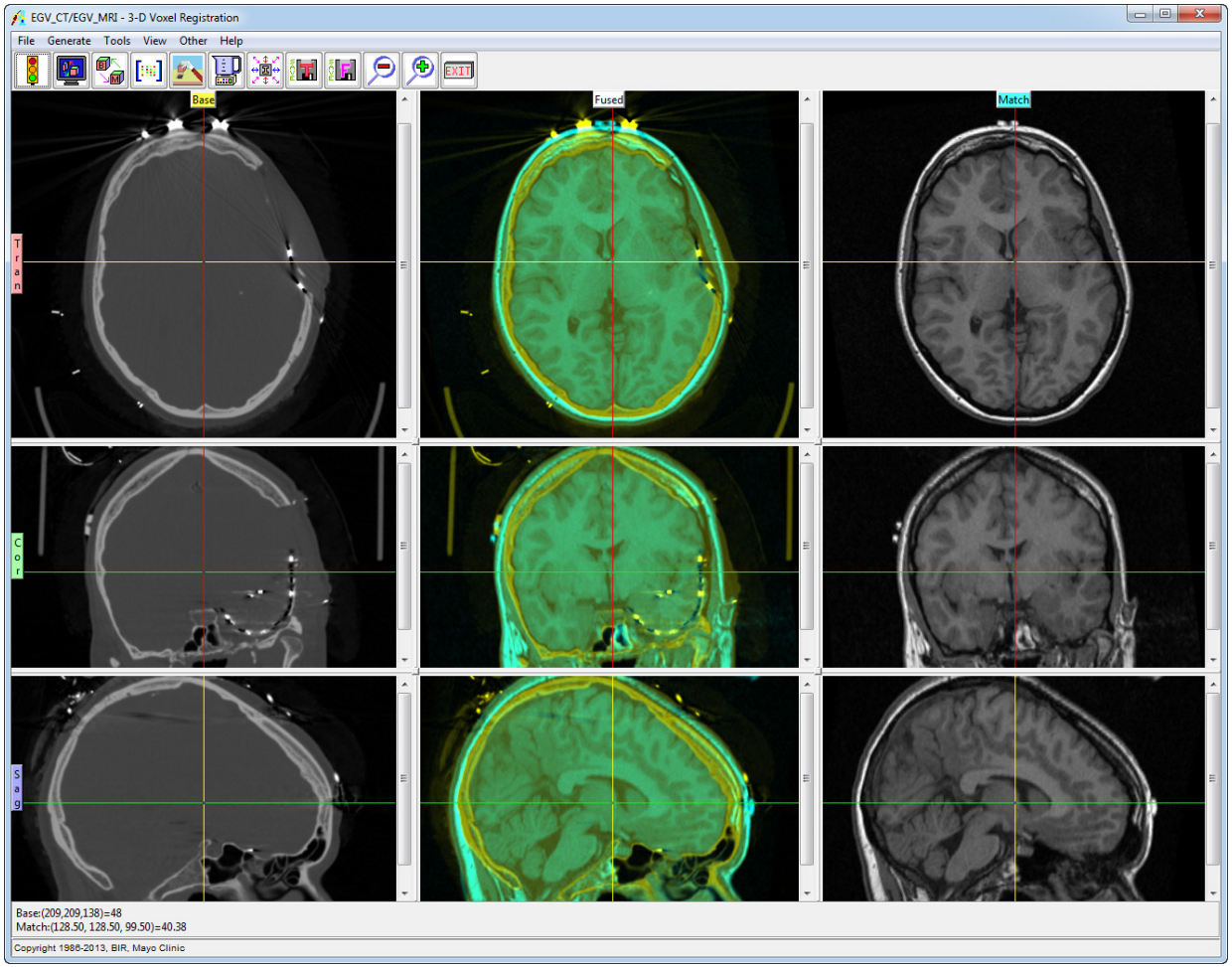
To help with visual evaluation of the registered grayscale data, select **Generate > Blend** and select a Blend Type.



Click the to register the MRI to the CT.

After registration is complete, evaluate the fused images in the middle column. (**File > Save Transformed > Analyze Workspace.)**

Exit the module.



Segmentation of Electrodes from the Post-Implantation CT

To create the 3D visualization of the grid electrodes with the underlying brain anatomy, the structures of interest must be extracted from each scan.

For this segmentation application we are interested in isolating the voxels representing the electrodes from the remaining voxels in the CT scan.

Separating dense metal electrode implants from surrounding tissue can be achieved rapidly by setting a global threshold that includes the grayscale values of the target electrodes, effectively isolating these voxels into an object of interest.

Some manual clean-up maybe necessary to remove non-electrode voxels, such as leads, which are not required for the visualization.

Electrode Segmentation

Select the CT from the Analyze workspace and then select **Segment > Volume Edit**.

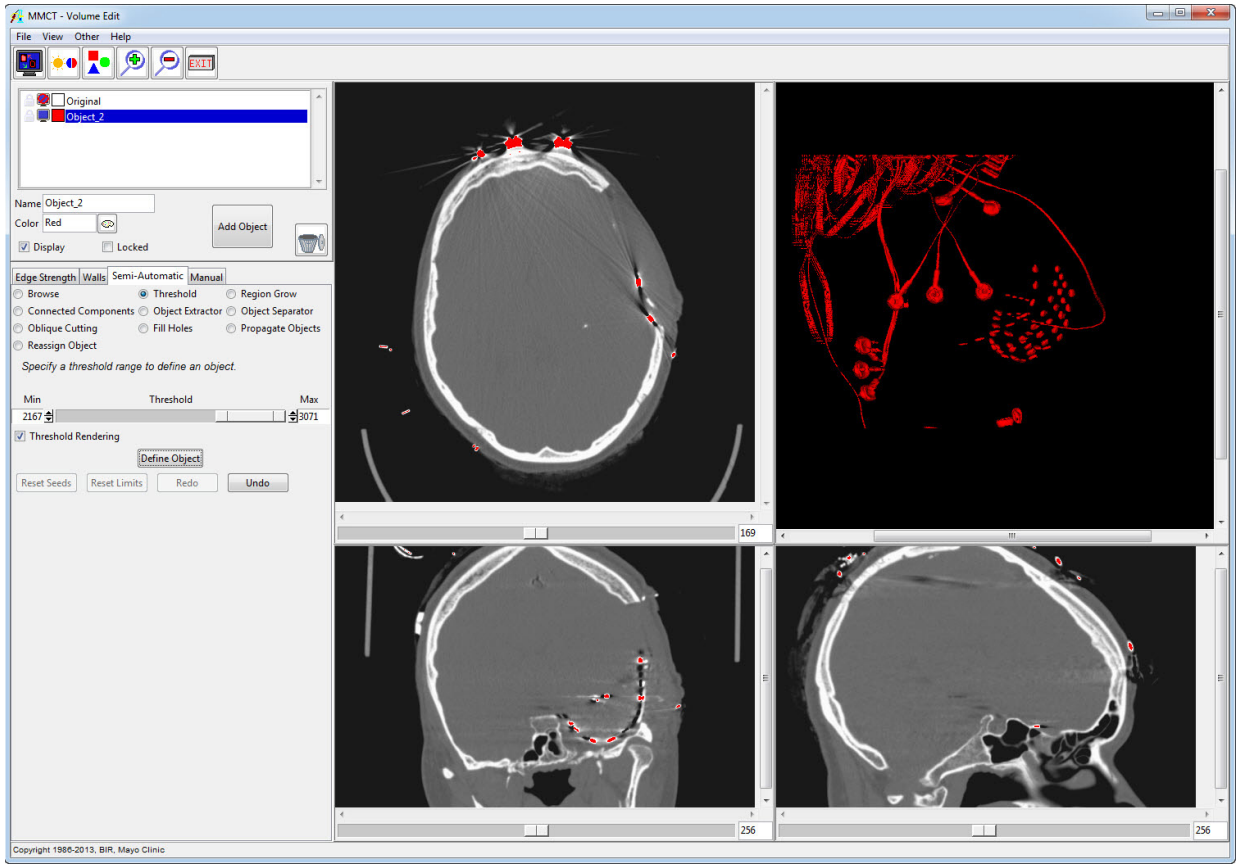
Select the **Semi-Automatic** tab and choose the **Threshold** option.

Using the slider adjust the threshold minimum and maximum until only the voxels representing the electrode array are visible.

Click **Define Objects**, these voxels will be assigned to an object.

To isolate the electrodes from the leads, select the Manual tab**.**

Click the **Add Object** button and rename the new object to Electrodes.

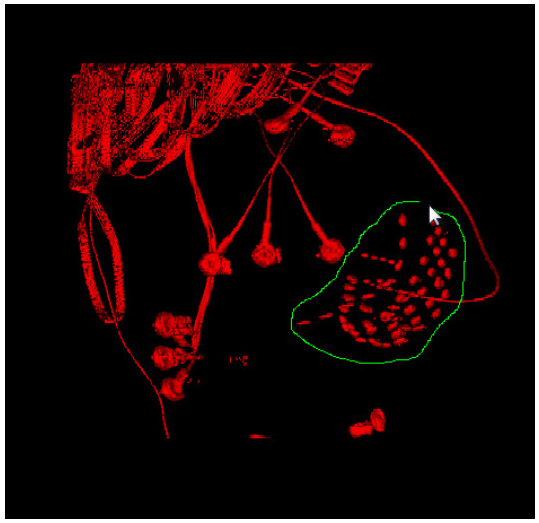


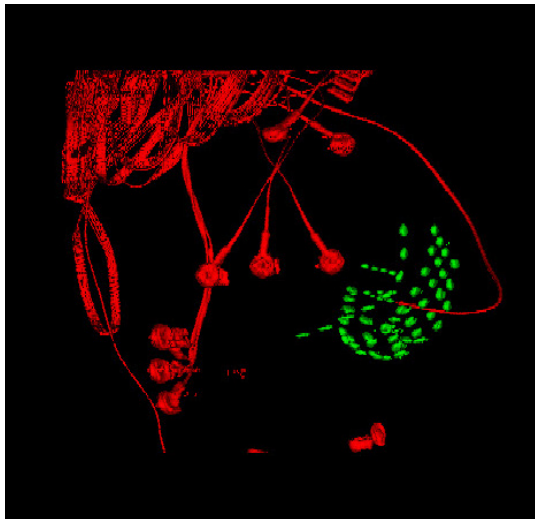
Select the Trace tool.

On the 3D rendering in the upper right window, trace around the electrodes. All voxels within the trace will be reassigned to the Electrodes object.

Select **File > Save Object Map** to save your work.

Exit the module.





Segmentation of the Brain from Pre-Implantation MRI

The next step towards creating the combined visualization is the segmentation of the brain. The brain parenchyma can be rapidly isolated from the MRI scan using the object extractor routine in Analyze.

Object extractor provides a semi-automatic segmentation strategy for rapid segmentation of target objects. A seed location is set in the brain, followed by a threshold range that encompasses the grayscale voxels that represent the brain. The segmentation routine then uses a combination or region growing and morphological erosion and dilation to isolate the brain as a single 3D object of interest.

Brain Segmentation

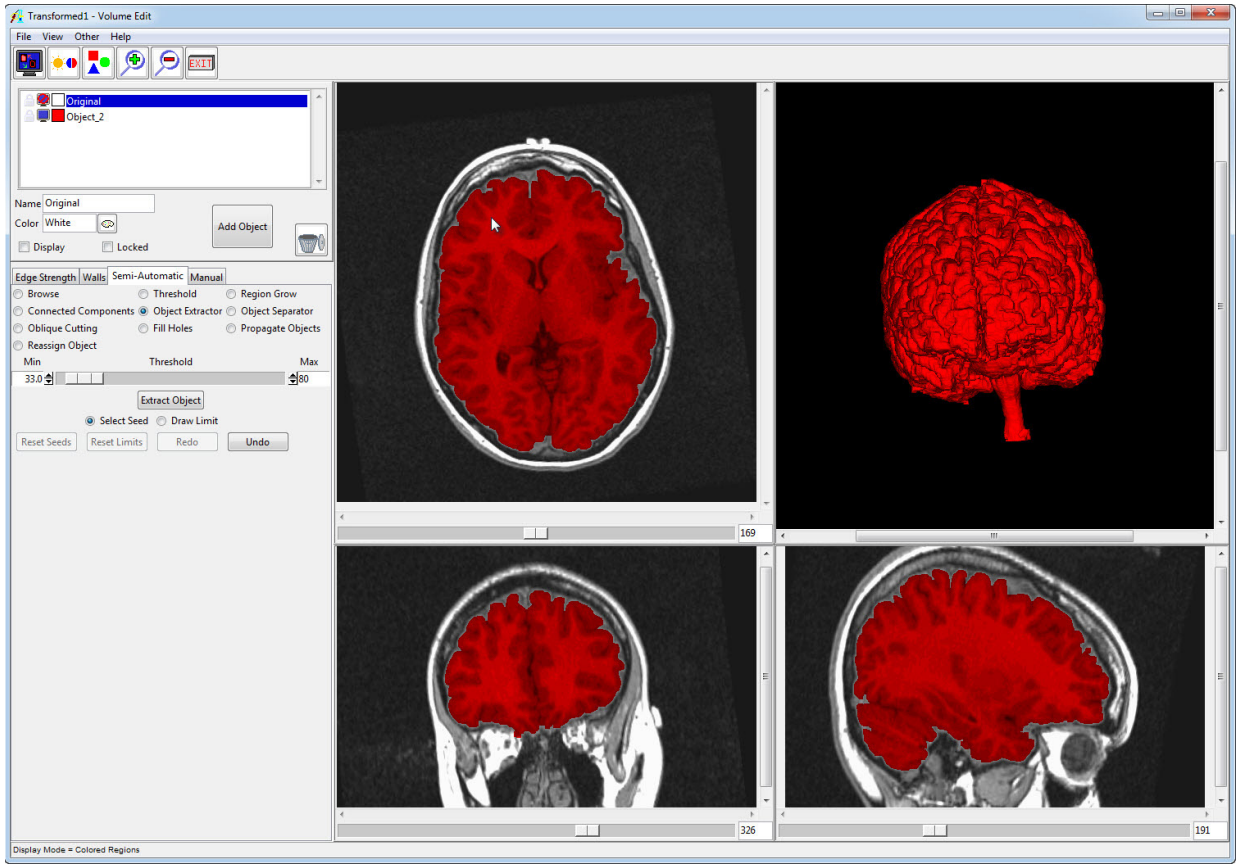
Select the transformed MRI from the Analyze workspace and then open **Segment > Volume Edit.**

Select the **Semi-Automatic** tab and choose **Object Extractor**.

Click in the brain to set a seed point.

Using the slider to adjust the threshold minimum and maximum until a red boundary grows out around the brain. Adjust the maximum so that in the binary image the voxels representing the gray and white matter remain solid but the voxels outside the brain start to dissolve.

Click **Extract Object.**



A 3D rendering of the segmented brain will be displayed in the window in the upper right.

Select **File > Save Object Map** to save your work.

Do not exit the module.

Visualization of Electrodes and Brain

The final step to creating the 3D representation of the multimodal data is to merge the objects isolated from each scan into a single frame of reference.

The resulting image display will provide researchers with a tool for in-depth review and exploration of topographical relationships between the cerebral cortex and subdural electrodes.

For better visual representation change the color of the brain object from red to pink.

To load the electrodes object segmented from the CT select **View > Objects.**

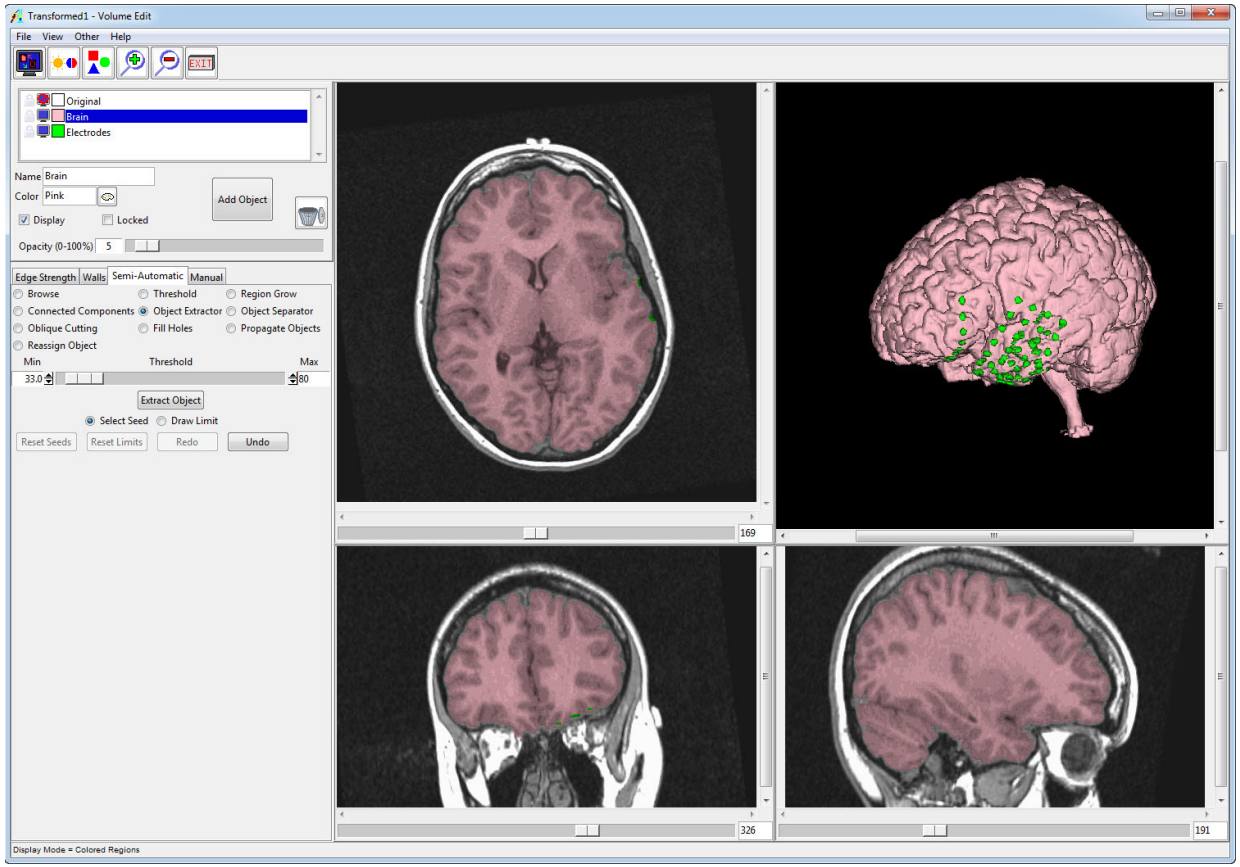
In the Objects window, click the **Load Object(s)** button.

Navigate to and select the object map containing the electrodes.

When prompted, select the electrodes from the from the list and then click **Load Selected**.

The electrodes segmented from the CT will be displayed with the brain segmented from the MRI.

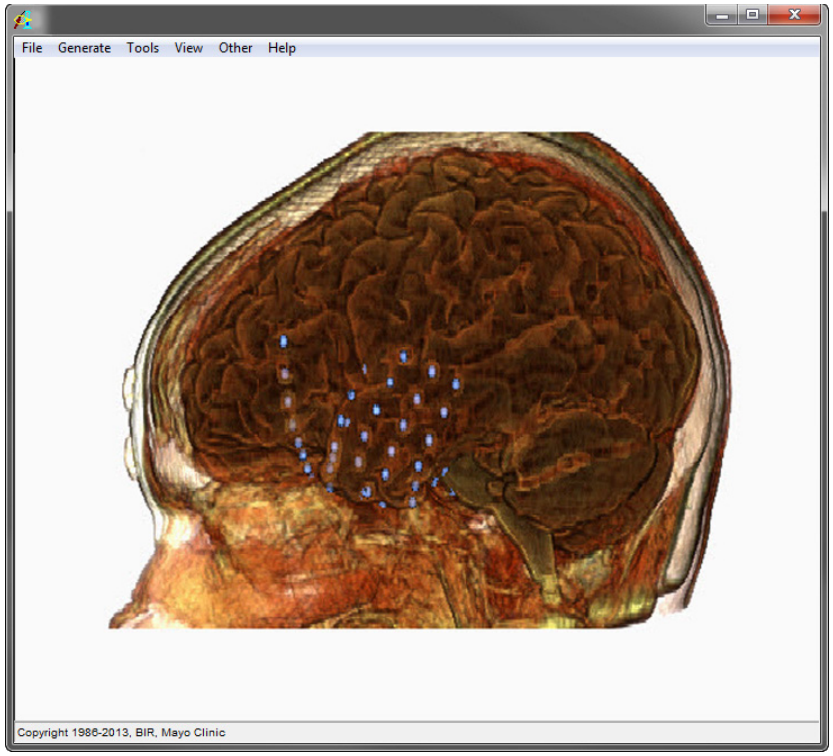
Right-click on the rendering and select **Transparency** from the menu.



Select **File > Save Object Map** to save your work.

Learn more about Analyze

Visualization and Analysis Software for Medical Imaging



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