

Measure

Introduction page 529

Measure Module Interface page 530

Menu page 531

Measurement Tools page 533

Other Measure Module Interface Areas page 534

1-D Measurement Tools page 536

Sample Point(s) page 536

Sample Line(s) page 541

Making Line Measurements using Sample Line(s) page 545

Making FWHM Line Measurements using Sample Line(s) page 547

Generating Line Profiles using Sample Line(s) page 549

Making Line Measurements on the 3D Rendering using Sample Line(s) page 551

Sample Trace(s) page 552

Sample Border(s) page 554

Sample Angle(s) page 557

Sample Two Lines page 559

Sample Perpendicular Lines page 561

2-D Measurement Tools page 563

- Sample 2-D Rectangle page 563
- Sample 2-D Oval page 570
- Sample 2-D Closed Trace page 572
- Selected Region page 574
- Selected Object page 576
- Enabled Objects page 578
- Entire Image page 585

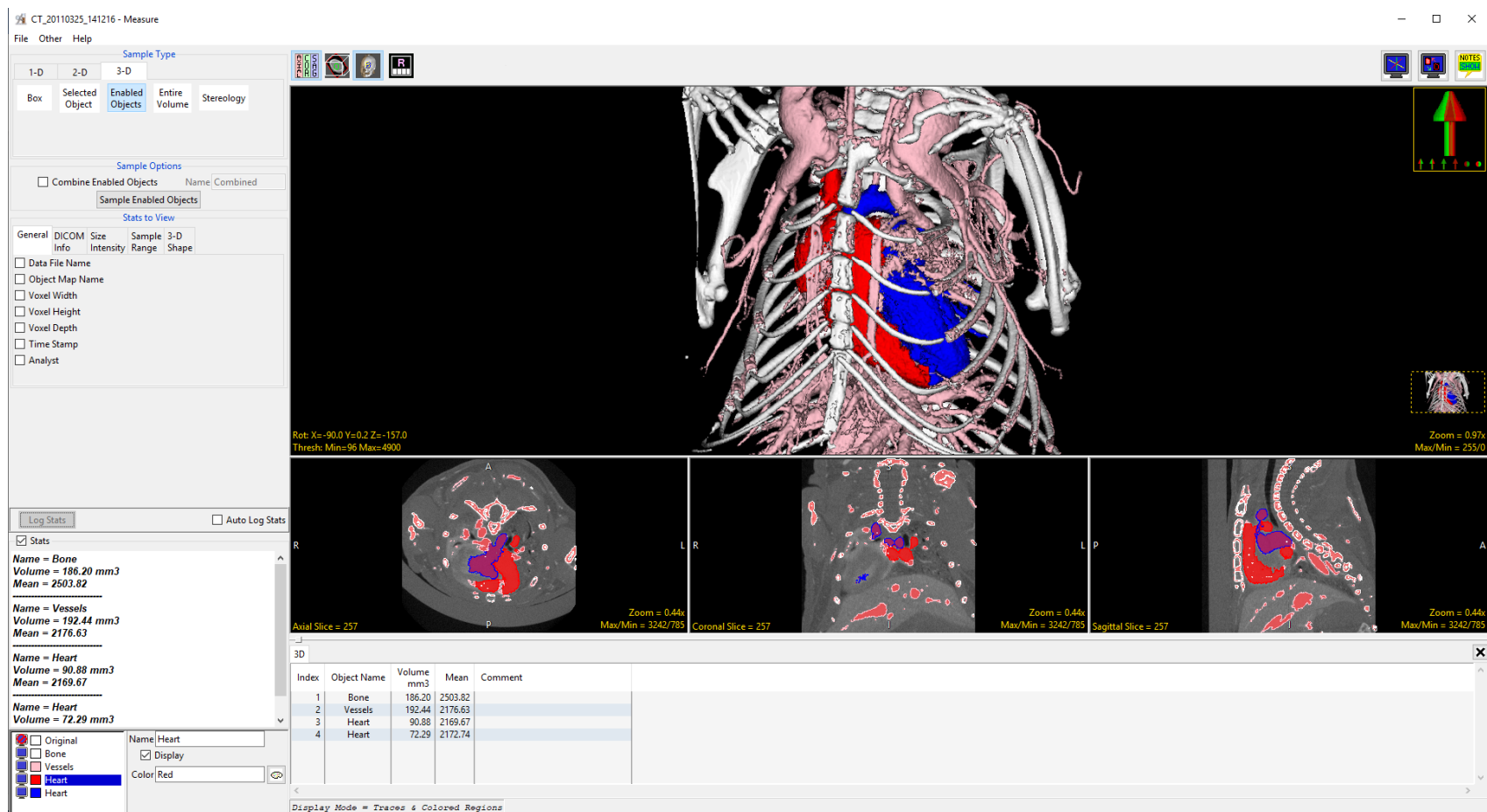
3-D Measurement Tools page 589

- Box page 589
- Selected Object page 593
- Enabled Objects page 596
- Entire Volume page 601
- Stereology page 607
- Sampling 4D Multivolumes using 3D Tools page 609

Introduction

The Analyze Measure module provides access to an array of measurement tools that allow users to sample their image data.

1D measurement tools are available for sampling and logging 3D positions of points, making line intensity and distances measures, or making angle measurements. 2D measurements tools allow users to interactively defined rectilinear or elliptical regions, sample freehanded traces of regions of interest, or sample regions or objects on images. Finally, 3D measurements tools allow users to sample loaded object maps to return spatial size measures, signal intensity information, or 3D shape characteristics.





Measure Module Interface

The measure module is divided into several areas: 1) the menu, 2) measurement tools, 3) stats display, 4) stats log, 5) the object control window, 6) display controls, 7) tools, 8) orthogonal image display, and 9) the rendering window. Each of these areas are now described.

Stats

Name = Soft tissue
Maximum = 30452.890625
Minimum = 17303.0
Area = 100155.84 mm²
Volume = 5007.79 mm³
Mean = 22556.27
St. Dev. = 1398.12
Sum = 903656991848.74
Entropy = 17.50

Name = Lungs
Maximum = 21637.5546875
Minimum = 7418.33349609375
Area = 11312.08 mm²

Index	Object Name	Maximum	Minimum	Area mm ²	Volume mm ³	Mean	St. Dev.	Sum	Entropy	Comment
1	Soft tissue	30452.890625	17303.0	100155.84	5007.79	22556.27	1398.12	903656991848.74	17.50	
2	Lungs	21637.5546875	7418.33349609375	11312.08	565.60	13869.03	1431.04	62755034431.03	15.32	
3	Bone	65405.33203125	30453.0	2752.86	137.64	40110.96	6484.85	44167939436.44	13.90	
4	airspace	25010.775390625	16039.22265625	958.87	47.94	19778.80	1732.30	7586099496.95	12.85	

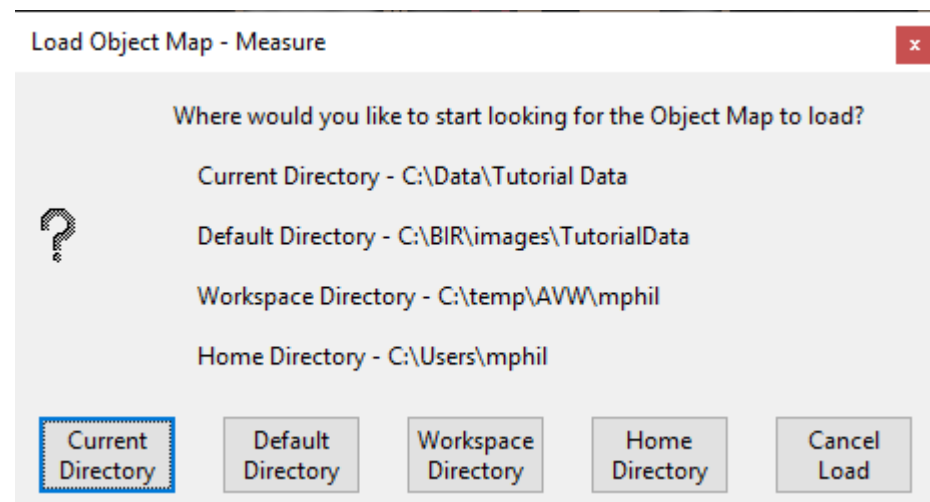


Menu

The Menu provides access to the File, Options and Help menus.

File: The File menu allows users to load and save object maps for the loaded data set. The File options include:

- **Input/Output Ports:** Displays a Volume area at the bottom of the Segment module window. This area facilitates the dragging and dropping of image data into the module and the loading of a related image data set, see Dual Input Segmentation for additional information.
- **Load Object Map:** When selected opens a Load Object Map window allowing users to navigate to, select and load an object map file. The following options are available:
 - **Current Directory:** Takes user to the current directory, the current directory is set by right-clicking in the main Analyze 14.0 window and then choosing Current Directory from the menu. See section 1. Analyze Basics for additional information.
 - **Workspace Directory:** Takes user to the current Workspace directory.
 - **Home Directory:** Takes user to the user's Home directory.
 - **Cancel Load:** Cancels the load of the object map.
- **Unload Object Map:** Unloads the current object map
- **Exit:** Closes the module





Menu (continued)

Other: The other menu provides access to additional module options and configuration of the tools area.

- **Options:** When selected opens the Options menu providing access to Module configuration options, including:
 - **Intensities Linked:** Allows users to enable or disable linked intensity adjustment. When linked any adjustment an images intensity display will be applied to all grayscale slices displayed. When disabled image intensities can be adjusted individually.
 - **Fast Object Rendering:** Enables/Disabled Fast Object Rendering.
 - **Show Cursor Coordinates:** Allows users to Enable/Disable the display of the linked cursor coordinates and voxel grayscale value displayed in the lower left-hand corner of the display window.
 - **Auto Note Update:** Allows the Auto Note Update option to be enabled or disabled.
 - **Auto Cursor Link:** Allows the Auto Cursor Link option to be enabled or disabled.
 - **Remember Layout:** When enabled the module will remember changes made to the layout and will open with this layout in the future. When disabled the module will open with the default layout.
 - **Decimal Places:** The Decimal Places options allows users to set the number of decimal places reported for measurements. By default the number of decimal places is set to 2.
 - **Threads:** Allows users to specify the number of threads used in a multi-threaded rendering process. By default, the number of threads is set to the number of processors on the system.
- **PowerBar Editor:** When selected opens the PowerBar editor allowing users to add additional shortcut buttons to the tools area of the Measure window. Add or remove the following shortcut buttons form the tools area: 1) Exit, 2) Options, 3) Input/Output, 4) Load Object Map, 5) PowerBar Editor, 6) Set Note Stat, 7) Toggle Cursor Link, 8) Toggle Region Display, and 9) Unload Object Map.
- **Help:** The Help menu provides users with quick access to help resources including:
 - **About:** View version, system and environment information.
 - **Users Guide:** Opens the Analyze 14.0 User's Guide.
 - **Get Help:** Opens the AnalyzeDirect Support Page.



Measurement Tools

The measurement tools options are grouped into three tabs under Sample Type. These are:

1-D: The 1-D tab provides access to the following measurement tools:

- Sample Point(s)
- Sample Line(s)
- Sample Trace(s)
- Sample Border(s)
- Sample Angle(s)
- Sample Two Lines
- Sample Perpendicular Lines

3-D: The 3-D tab provides access to the following measurement options:

- Box
- Selected Objects
- Enabled Objects
- Entire Volume
- Stereology

2-D: The 2-D tab provides access to the following sampling options:

- Sample 2-D Rectangle
- Sample 2-D Oval
- Sample 2-D Closed Trace
- Selected Region
- Selected Object
- Enabled Object
- Entire Image

These three tabs provide access to all of the measurement tools in Measure. The measurement tools within each tab will be discussed in the Measurement Tools section of this guide.



Other Measure Module Interface Areas

Stats Display

The stats display area reports the select measurements. Measurements cannot be saved from this area (see Stats Log for saving out measurements), however, measurements can be copied and pasted from this area.

Stats Log

When the Auto Log Stats option is checked the Stats Log reporting the selected measurements will be displayed below the main image display area. The following right mouse menu options are available:

- **Save Log:** Allows users to save the log file as a .csv file.
- **Clear Log:** Clears all measurements from the current log file.
- **Dismiss Log:** Closes the log file.
- **Remove Last Entry:** Allows users to delete the last entry in the stats log.

Object Control Window

The Measure object controls window allows users to enable and disable the display of objects within the current object map. It also allows users to edit object properties including name, color, and opacity.

Display Controls

The Display Control tools allow users to control and customize the layout of the Measure display area. For further information on these tools please refer to the Image Display, Controls and Customization section of this User's Guide.



Other Measure Module Interface Areas (continued)

Tools

The Tools options provide access to the Toggle Cursor Link, Toggle Region Display and the Set Note State tools. For further information on these tools please refer to the Image Display, Controls and Customization section of this User's Guide.

Orthogonal Image Display

The orthogonal slice display windows provide an interactive 2D review tool of the slice data in the axial, coronal and sagittal planes. For more information about the slice display windows, refer to the Display section of this User's Guide.

The Rendering Window

The render window provides an interactive 3D display of the segmented image data. For more information about the render window, refer to the Display section of this User's Guide.



1-D Measurement Tools

1D measurements include points, lines, trace, angles, borders distances, intersecting lines, and perpendicular lines. Coordinates, signal values, linear distances, line profiles and angles can all be generated using Measure. Full Width Half Max (FWHM) parameters can also be set to control sampling. Note 1-D measurements (apart from Sample Border(s)) can be made on image data with or without a loaded object map. The 1-D tab provides access to the following measurement tools:

- Sample Point(s)
- Sample Line(s)
- Sample Trace(s)
- Sample Border(s)
- Sample Angles
- Sample Two Lines
- Sample Perpendicular Lines

Sample Point(s)

The Sample Point(s) tool allows users to select points on the 2D image data or 3D rendering. The tool will report the coordinates and intensity value of the selected point. The following options are available:

Sample Options: Provides users with access to the following point sampling options:

- **Name:** Allows users to assign a name to the selected point when reported to the log file.
- **Persistent:** When selected prevents previously selected points for being cleared from the image.
- **Clear:** Clears all points from the image.

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

- **General:** Allows users to report information about the image data set including:
 - **Data File Name:** Reports the data set name to the stats log.
 - **Object Map Name:** Reports the object map name to the stats file.
 - **Voxel Width:** Reports the voxel width to the stats file.
 - **Voxel Height:** Reports the voxel height to the stats file.
 - **Voxel Depth:** Reports the voxel depth to the stats file.



Sample Point(s) (continued)

Stats to View > General (continued):

- **Time Stamp:** Reports the date and time of sampling to the stats file.
- **Analyst:** Reports the current user logged into the system to the stats file.
- **DICOM Info:** Only applicable for DICOM image data, allows users to report:
 - **Patient Name:** Reports the patient name to the stats log.
 - **Patient ID:** Reports the patient ID to the stats log.
 - **Birth Date:** Reports the patient's date of birth to the stats log.
 - **Gender:** Reports the patient's gender to the stats log.
 - **Weight:** Reports the patient's weight to the stats log.
 - **Study ID:** Reports the study ID to the stats log.
 - **Study Date:** Reports the study date name to the stats log.
 - **Study Time:** Reports the study time to the stats log.
 - **Study Description:** Reports the study description to the stats log.
 - **Series Number:** Reports the series number to the stats log.
 - **Series Description:** Reports the series description to the stats log.
 - **Accession Number:** Reports the accession number to the stats log.
 - **Modality:** Reports the modality to the stats log.
- **Points:** Provides users with the option to report the following point related information and measurements:
 - **Orient:** Reports the orientation the point was logged in. Options include; Axial, Coronal, Sagittal, Rendering, and Oblique.
 - **Name:** Reports the name.
 - **Object:** Reports the object the point was logged on (if an object map is loaded).
 - **Point Location:** Reports the X, Y, Z location of the point.
 - **Intensity Value:** Reports the greyscale intensity value of the point.

Sample Type

1-D 2-D 3-D

Points

Sample Options

Name: None

☐ Persistent

Clear

Stats to View

General DICOM Info Points Lines Traces FWHM Angles Two Lines Perp Lines

☒ Orient

☒ Name

☒ Object

☒ Point Location

☒ Intensity Value



Sampling Points using Sample Point(s)

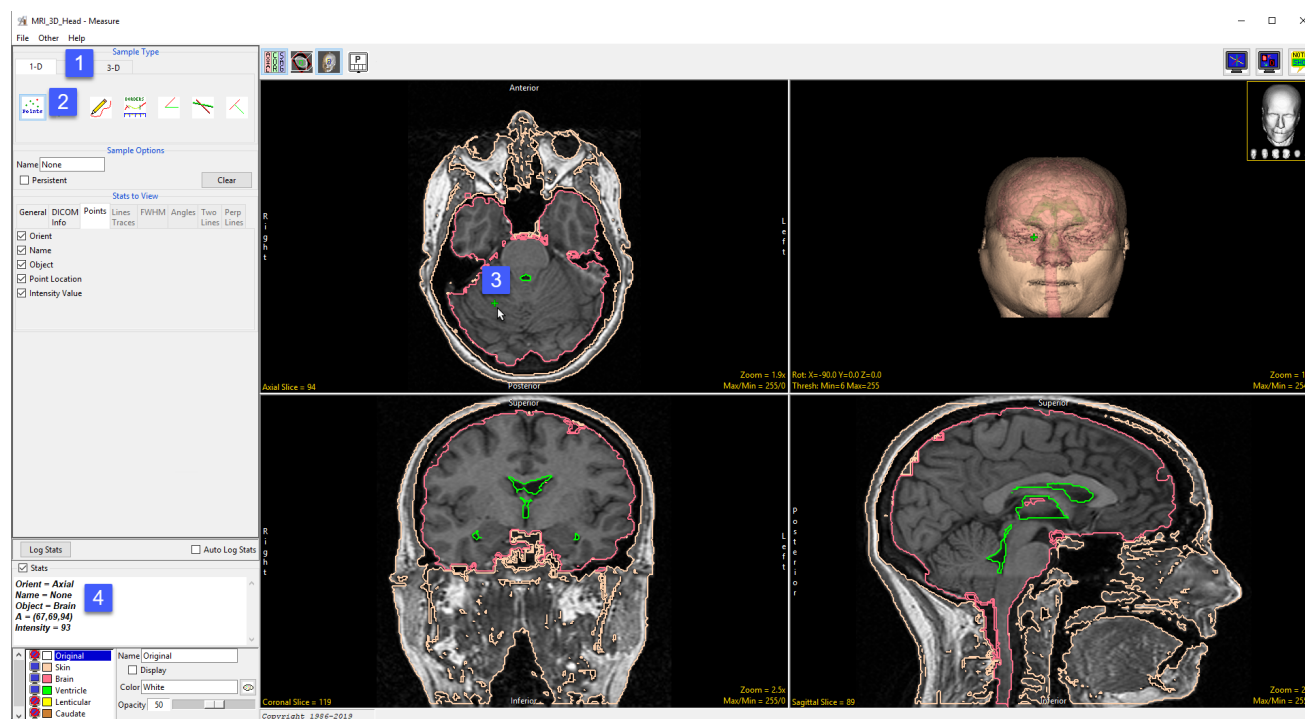
The Sample Point(s) tool can be used to sample landmarks for morphological applications.

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

To sample points, do the following:

- Open Input/Output and load MRI_3D_Head.avw into Analyze.
- Select MRI_3D_Head and open Measure.
- Select File > Load Object Maps and load MRI_3D_Head.obj.
- Select the 1D Sample Type [1] and choose Points [2].
- Click on the brain in the axial orientation [3] to set a point.

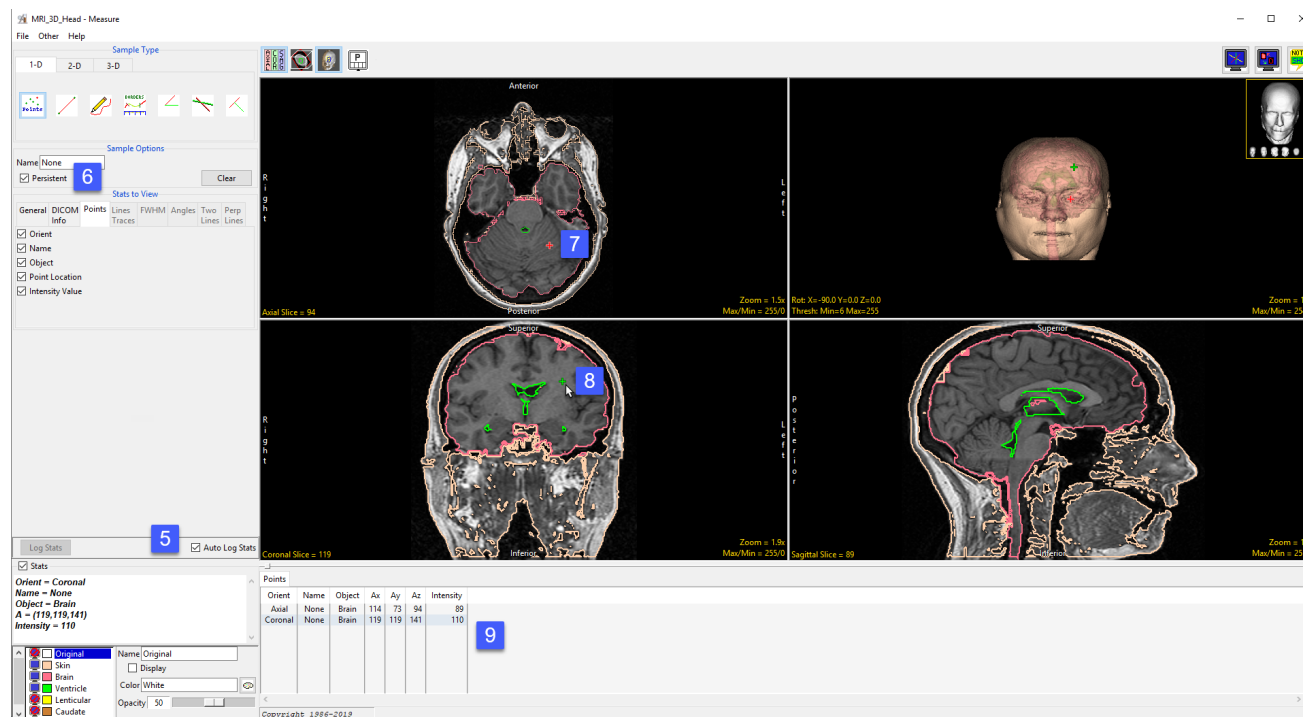
Note that the coordinates and intensity of the point will be reported in the Stats review area [4].





Sampling Points using Sample Point(s) (continued)

- Check the Auto Log Stats option [5]. Each point selected will now be saved to a measurement log.
- Check the Persistent checkbox [6]. This will prevent points from being cleared from the display when a new point is selected.
- Set a new point in the axial orientation [7] and set another point in the coronal orientation [8]. The current point will display as green, while previous points will change to red.
- The coordinates and intensity values will be reported in the log [9].



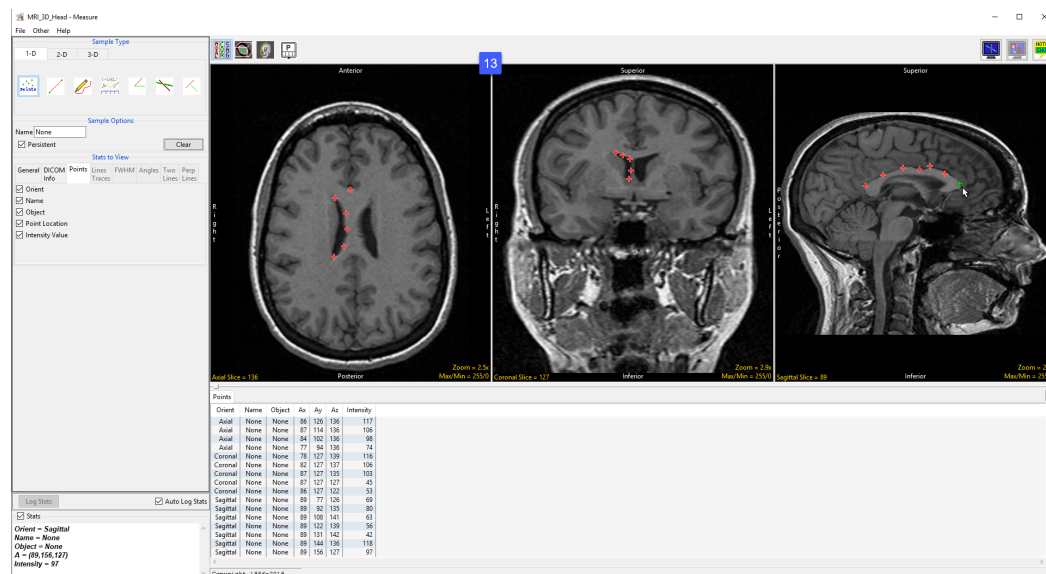


Sampling Points using Sample Point(s) (continued)

- Set several new points in the sagittal orientation [10] and on the rendering [11].
- Right click on the log to save as a .CSV file [12].



Note that point sampling does not require an object map to be loaded [13].



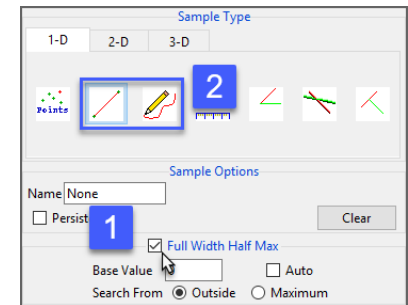


Sample Line(s)

The Sample Line(s) tool allows users to define a line on a 2D image or a 3D rendering. The tool will report distance measurements, line intensity profile and the coordinates of the line end points. The following configuration options are available:

Sample Options: Provides users with access to the following line sampling options:

- **Name:** Allows users to assign a name to the defined lines when reported to the log file.
- **Persistent:** When selected prevents previously defined lines for being cleared from the image.
- **Clear:** Clears all lines from the image.



Full Width Half Max: The Full Width Half Max (FWHM) option can be enabled [1] for the Sample Line(s) and Sample Trace(s) tool [2].

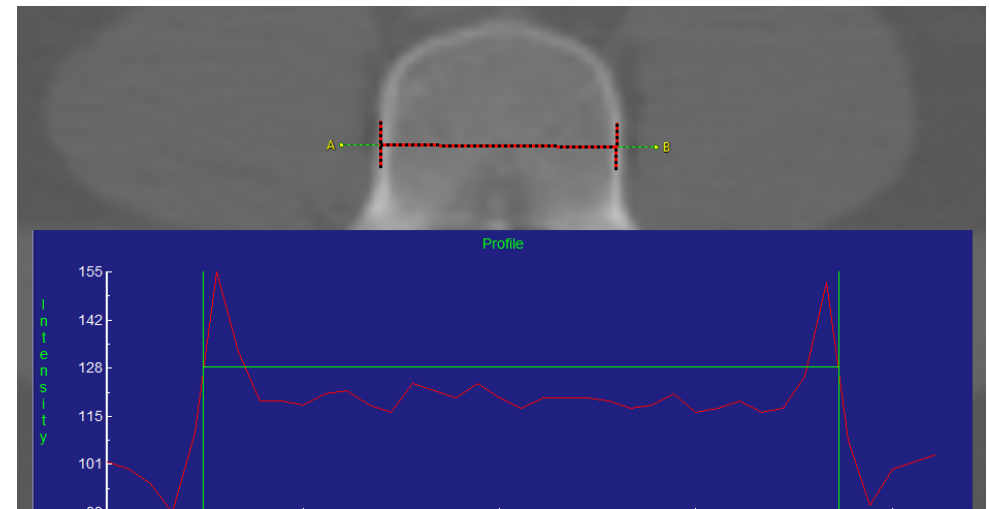
Once enabled, Measure will automatically log FWHM distance measurements [3] for defined lines [4] and traces.



Sample Line(s) Options (continued)

Full Width Half Max (continued):

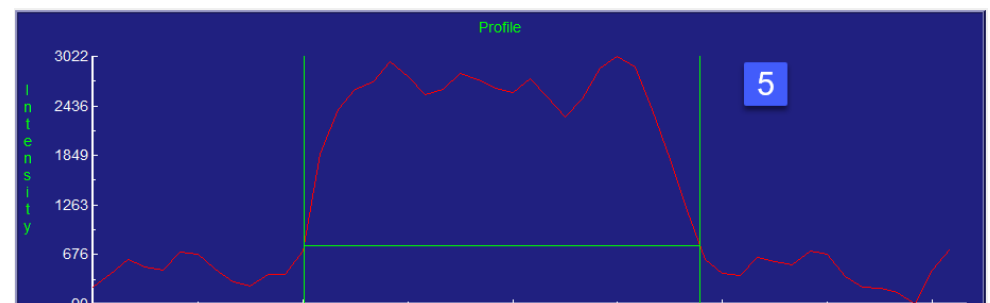
- **Base Value:** Allows users to specify the value used in the FWHM calculation.
- **Auto:** When enabled, the base value is automatically calculated by computing the mean of the nine-point neighborhoods around each endpoint of the line or trace
- **Search from:** Allows users to specify the search mode for FWHM measurement. The following options are available:
 - **Outside:** Specifies that search begins at the ends of the profiles.
 - **Maximum:** Specifies that search begins at the maximum value and proceeds to both the left and right for the two half max values.



The Full Width Half Max

To find the FWHM of the line profile [5] (the calculation of pixel intensities along straight lines and freehand traces on the images), the 'Half Max' value is first computed using the formula:

$$\text{Half Max} = ((\text{Maximum Value} - \text{Base Value})/2 + \text{Base Value})$$





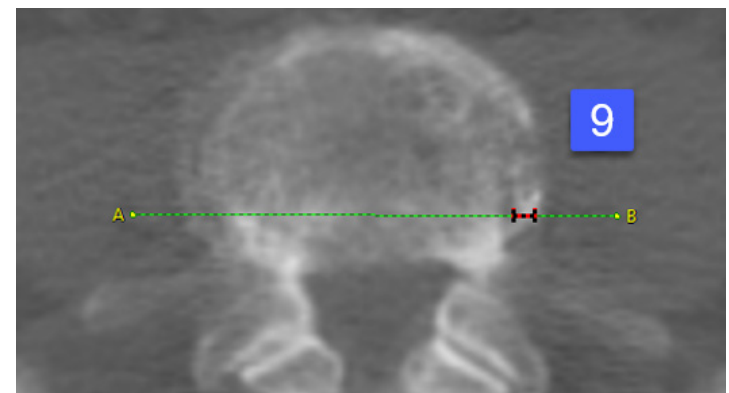
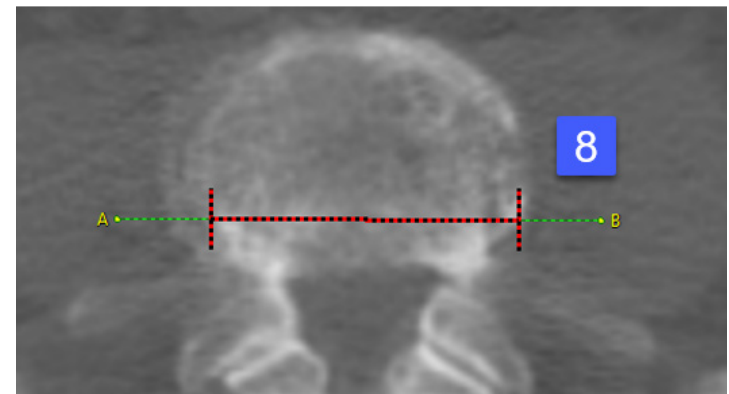
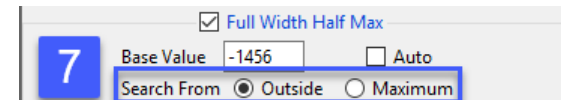
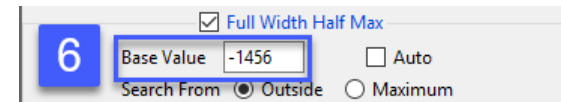
Sample Line(s) Options (continued)

Full Width Half Max (continued):

The 'Maximum Value' is the maximum intensity value of the line profile. The 'Base Value' is defined under the Full Width Half Max options [6]. The Base Value can be set to a specified value, or it can be set dynamically using the 'Auto' option. When the Auto option is selected, the Base Value is set to the mean intensity value of the nine-point neighborhoods surrounding each endpoint of the line. Once the Half Max value is known, Measure will search the line profile to see where that value is first crossed over on either side of the line maximum. The direction from which the module searches the line profile for the Half Max is determined by the 'Search From' option in under the Full Width Half Max options [7].

If the Search From option is set to 'Outside', then Measure will search for where the line intensity values cross over the Half Max value beginning at the outside of the profile and moving inwards. In this example, the FWHM will be defined by the closest voxel to either endpoint of the line with an intensity value greater than the Half Max value [8].

If Search From is set to 'Maximum', then Measure will search for where the line intensity values cross over the Half Max value beginning at the profile Maximum and moving outwards (to the right and left). In this example, the FWHM ends up being defined by the voxels closest to the line Maximum that have an intensity value less than the Half Max [9]. Once the FWHM of the line has been defined, Measure will compute the FWHM distance by taking the distance between the voxels on either side of the FWHM weighted by their relative value to the true Half Max value.





Sample Line(s) Options (continued)

Stats to View

General: Allows reporting of general data parameters in the stats log file. See Sample Point(s) > Stats to View > General for full description.

DICOM Info: Allows reporting of DICOM tag information. See Sample Point(s) > Stats to View > DICOM Info for full description.

Line Traces:

- **Orient:** Reports the orientation the line was defined in. Options include; Axial, Coronal, Sagittal, Rendering, and Oblique.
- **Name:** Reports the name.
- **End Point Locations:** Reports the X, Y, Z location of each line end point (A and B).
- **Maximum:** Reports the maximum voxel intensity value along the line.
- **Minimum:** Reports the minimum voxel intensity value along the line.
- **Mean:** Reports the mean intensity value for the voxels along the line.
- **Standard Deviation:** Reports the standard deviation.
- **Endpoint Distance:** The Endpoint Distance (or Distance as reports in the stats display) reports the linear distance from end point A to end point B. Note, even if this option is unchecked it will still be reported to the stats display area and stats log.
- **Curved Distance:** Reports the curvilinear distance between the endpoints. The curvilinear distance is an approximation based on the distance between the two 3-D surface endpoints.
- **Surface Distance:** The Surface Distance is only available for lines defined on the rendering. This option reports the surface distance of the line. The defined line is projected onto surface of the rendering and measured.
- **Profile:** Displays the line profile plot.

FWHM:

- **Half Max:** Reports the half max intensity value.
- **Half Max Location:** Reports the X, Y, Z location of both half max locations.
- **Maximum:** Reports the maximum voxel intensity value along the line.
- **Base Value:** Reports the Base Value.
- **Distance:** Reports the FWHM distance.



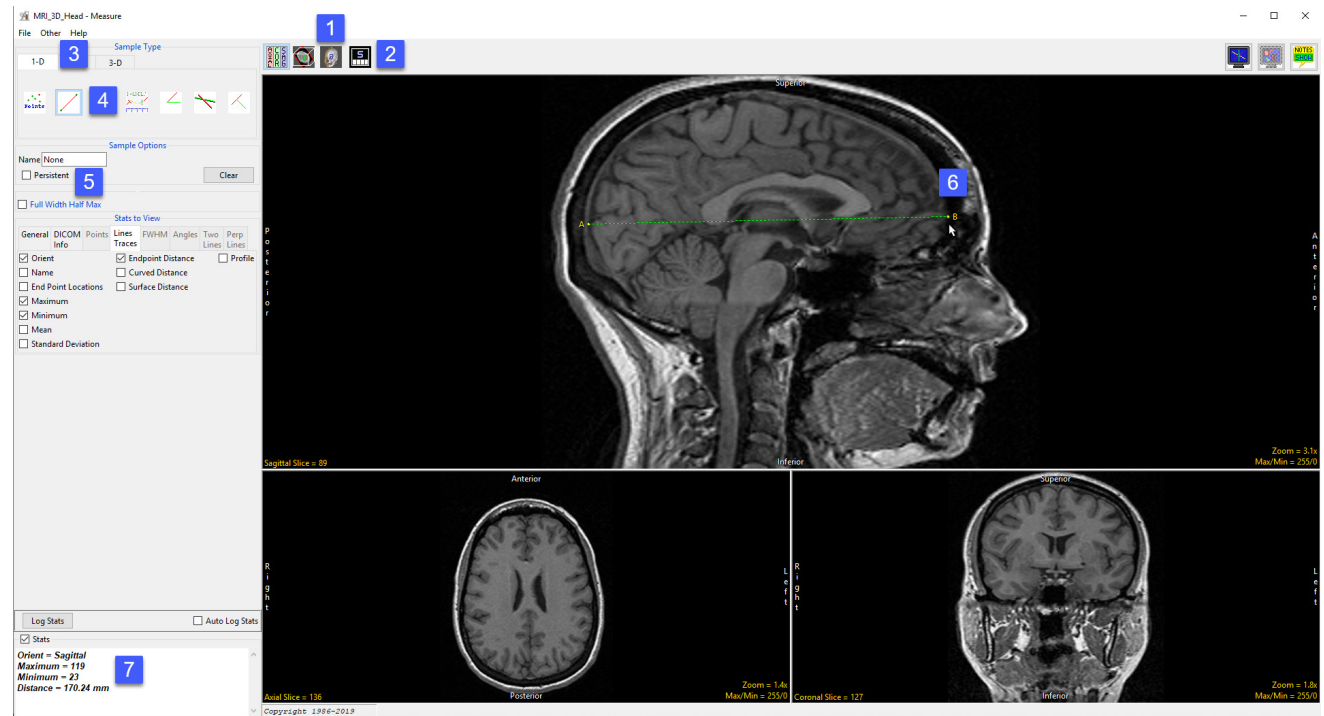
Making Line Measurements using Sample Line(s)

Here we use the Sample Line(s) tool to make line measurements.

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

To make a line measurement, do the following:

- Open Input/Output and load MRI_3D_Head.avw into Analyze.
- Select MRI_3D_Head and open Measure.
- Switch the display of the Rendering off [1] and set the primary display to Sagittal [2].
- Select the 1D Sample Type [3] and choose the Line tool [4].
- If checked (enabled), uncheck Full Width Half Max [5].
- Define a line on a sagittal slice. [6] To draw a line position the cursor on the image and press the left mouse button to begin drawing. Release the button to end the line.
- The coordinates for the line endpoints (A and B) and the line distance are reported in the Stats review area [7].





Making Line Measurements using Sample Line(s) (continued)

- Press Clear [8] to reset.
- Check the Persistent [9] and Auto Log Stats checkboxes [10].
- Define several lines on the sagittal slice [11].
- The coordinates for the line endpoints (A and B) and the line distances are reported in the log [12]. Right click to save the log as a .CSV file.

The screenshot displays the MRI_3D_Head - Measure software interface. The main window shows a sagittal brain slice with several red line measurements drawn across it. The interface includes a left sidebar with various measurement tools and options, a top menu bar, and a bottom status bar. The 'Sample Options' panel on the left shows the 'Persistent' checkbox checked (labeled 9) and the 'Clear' button (labeled 8). The 'Stats to View' panel shows the 'Orient' checkbox checked (labeled 10). The 'Log Stats' panel at the bottom left shows the 'Stats' checkbox checked (labeled 10) and the 'Auto Log Stats' checkbox checked (labeled 10). The 'Lines' table at the bottom right (labeled 12) lists the measurements:

Index	Orient	Maximum	Minimum	Endpoint Distance
1	Sagittal	104	35	55.45
2	Sagittal	99	30	46.32
3	Sagittal	108	37	36.60
4	Sagittal	82	35	33.37
5	Sagittal	92	32	33.95

The status bar at the bottom left shows the following information:

Orient = Sagittal
Maximum = 92
Minimum = 32
Distance = 33.95 mm

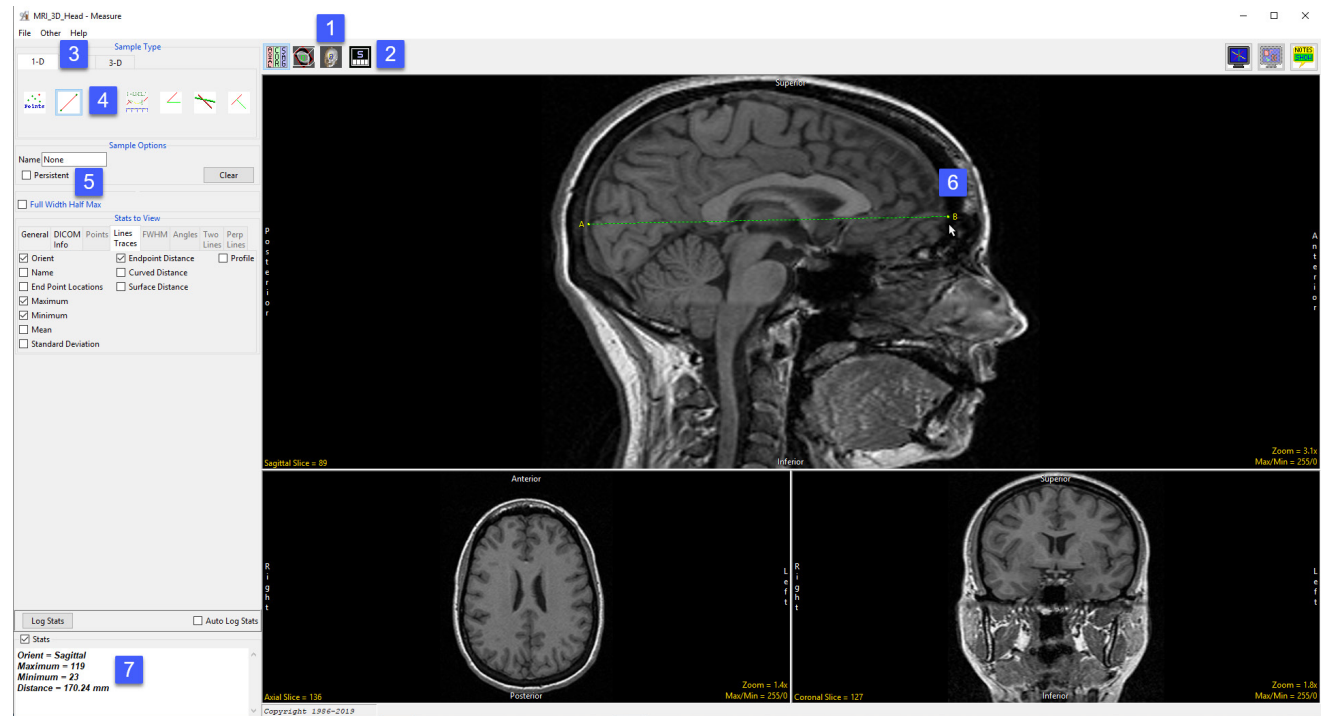


Generating Line Profiles using Sample Line(s)

The Sample Line(s) tool allows users to sample and plot pixel intensity values for a defined line.

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

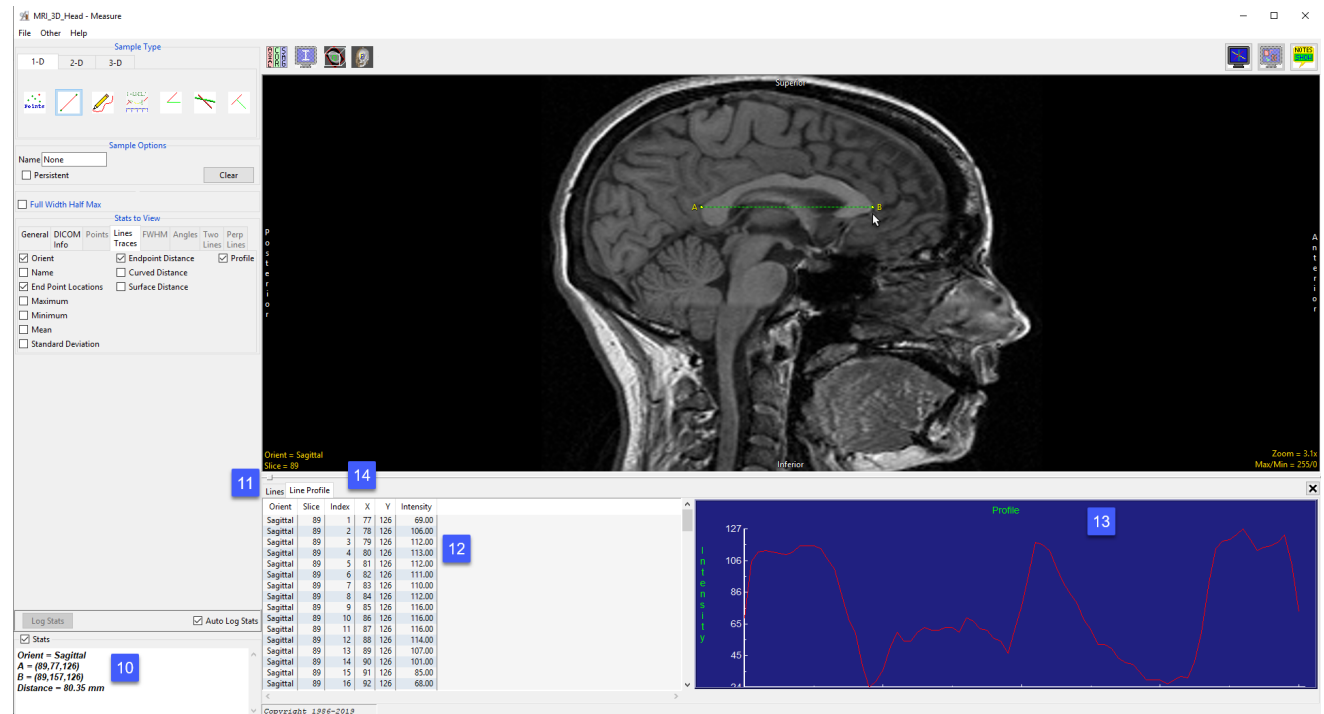
- Open Input/Output and load MRI_3D_Head.avw into Analyze.
- Select MRI_3D_Head and open Measure.
- Switch the display of the Rendering off [1] and toggle the display of all orientations off [2].
- Use the Orient option to switch to Sagittal [3].
- Select the 1D Sample Type [4]. Choose the Line tool [5].
- If enabled (checked), uncheck Full Width Half Max [6].
- Check the Profile option [7] and the Auto Log Stats checkbox [8].
- Define a line on a sagittal slice to measure the posterior to anterior distance of the corpus callosum [9].





Generating Line Profiles using Sample Line(s) (continued)

- The coordinates for the line endpoints (A and B) and the line distance are reported in the Stats review area [10] and in the Lines tab [11].
- The intensity profile of the defined line is logged [12] and plotted [13] in the Line Profile tab [14].





Making FWHM Line Measurements using Sample Line(s)

The Sample Line(s) tool allows for measurement of FWHM (Full-Width, Half-Max) distance on a line that crosses a structure of sufficient contrast to produce edges which cross the half-max value, which represents half the difference between the minimum and maximum intensity values along the line. FWHM measurements can be useful when trying to make exact measurements on a structure when placing the end points accurately is difficult.

Download the VH_Abdomen.avw data set from analyzedirect.com/data to follow along.

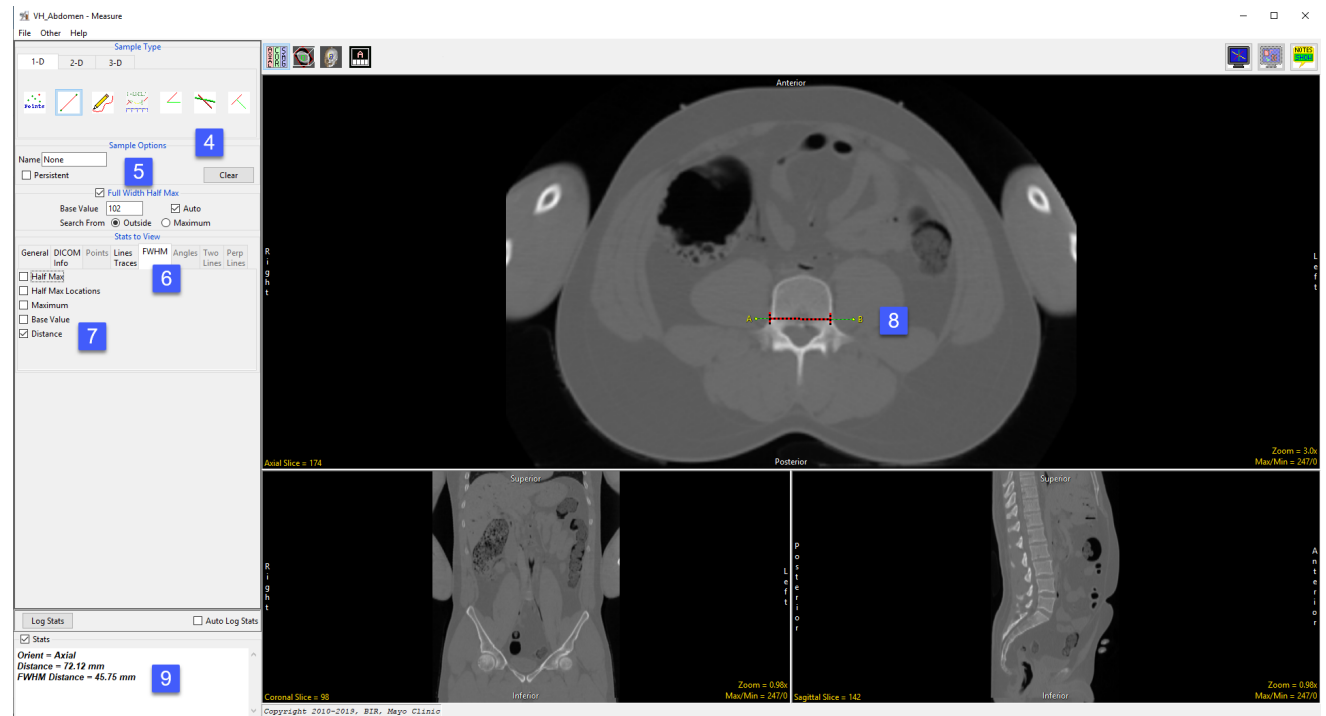


- Open Input/Output and load VH_Abdomen.avw into Analyze. Select VH_Abdomen and open Measure.
- Select the Sample Line(s) tool [1] from 1-D Sample Type.
- Define a line in the axial orientation to measure the distance from the right side of the vertebral body to the left side [2].
- Note the distance [3].



Making FWHM Line Measurements using Sample Line(s) (continued)

- Placing the endpoints, point A and point B, exactly in the correct location to obtain an accurate measurement can be difficult.
- Click Clear [4] to reset the line.
- Check the Full Width Half Max checkbox [5] and check the Auto option to have the tool calculate the FWHM Base Value.
- Select the FWHM Stats to View tab [6] and make sure Distance [7] is selected, this will report the FWHM Distance in the stats display.



- In the axial orientation, define a line across the vertebral body, however, this time do not place the endpoints of the line exactly on each side of the vertebral body [8]. Note that the FWHM is overlaid in red on the line.
- Note the distance measurement in the stats display [9]. Even if the same distance measurements as before were obtained, FWHM is a quicker and easier method than trying to accurately place endpoints.

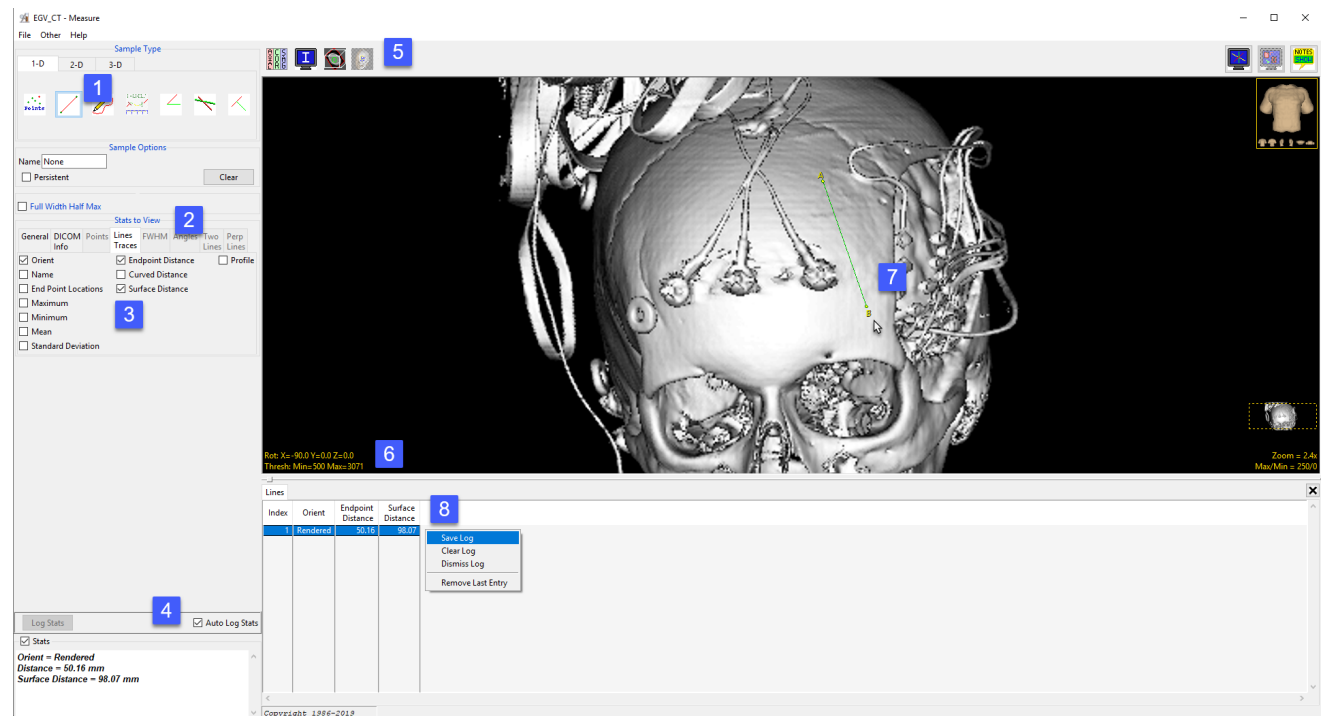


Making Line Measurements on the 3D Rendering using Sample Line(s)

Like the Sample Points tool, the Sample Line(s) tool can also be used to make measurements on the 3D rendering.

Download the EG_CT.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load EG_CT.avw into Analyze. Select EG_CT and open Measure.
- Select the Sample Line(s) tool [1] from 1-D Sample Type.
- From Stats to View select the Line Traces tab [2].



- Ensure that both the Endpoint Distance and Surface Distance options are selected [3] and check Auto Log Stats [4].
- Use the Display control tools [5] to enable the display of the rendered image and switch off the display of the slice data.
- To view the skull, double-click on the yellow Thresh text in the lower left-hand corner and set the minimum value to 500 [6]. The skull will be displayed. Define a line on the skull [7].
- Note that both the straight line and surface distance have been reported to the stats log [8]. Note the difference in the measurements. Right-click to save the log.



Sample Trace(s)

The Sample Trace(s) tool provides all the functionality of the Sample Line(s) tool, while allowing the user to define a freehand trace. Available options are as follows:

Sample Options: Provides users with access to the following trace sampling options:

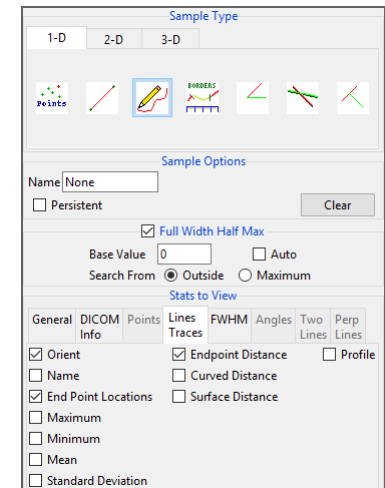
- **Name:** Allows users to assign a name to the defined trace when reported to the log file.
- **Persistent:** When selected prevents previously defined traces for being cleared from the image.
- **Clear:** Clears all traces from the image.

Full Width Half Max: The Full Width Half Max (FWHM) option can be enabled for the Sample Line(s) and Sample Trace(s) tool. For additional information refer to the FWHM description under Sample Line(s) tool.

- **Base Value:** Allows users to specify the value used in the FWHM calculation.
- **Auto:** When enabled, the base value is automatically calculated by computing the mean of the nine-point neighborhoods around each endpoint of the line or trace
- **Search from:** Allows users to specify the search mode for FWHM measurement. The following options are available:
 - **Outside:** Specifies that search begins at the ends of the profiles.
 - **Maximum:** Specifies that search begins at the maximum value and proceeds to the left and right for the two half max values.

Stats to View

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See the DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.
- **Lines Traces:** Allows users to report an array of information about the trace. See Lines Trace under Sample Lines(s) > Stats to View above for a full description of available options.
- **FWHM:** Allows report an array of information for Full Width Half Max measurements. See FWHM under Sample Lines(s) > Stats to View above for a full description of available options.



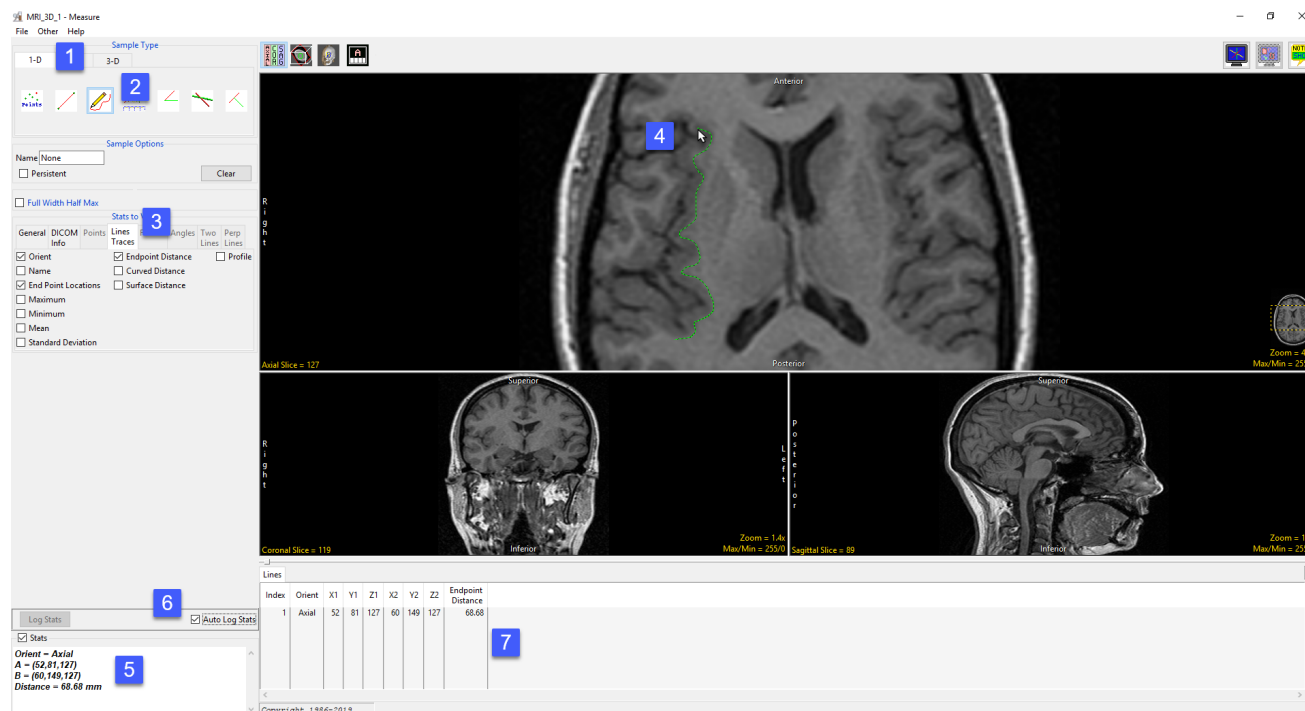


Making Freehand Trace Measurements using Sample Trace(s)

Here we use the Sample Trace(s) tool to make freehand trace measurements.

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select the 1-D Sample Type [1] and choose Sample Trace(s) [2].
- Check any of the measurements required from the Lines Traces tab [3].
- Define a freehand trace on the data [4].
- The measurements selected will be returned to the Stats review area [5] once tracing is completed.
- If the Auto Log Stats [6] checkbox is selected, the measurements will be added to the Lines log [7] which can be saved as a .CSV file.





Sample Border(s)

The Sample Border(s) tool enables the measurement of a portion of an object's border. Note that an object map must be loaded in order to utilize this tool. The following user configuration options are available:

Sample Options: Provides users with access to the following border sampling option:

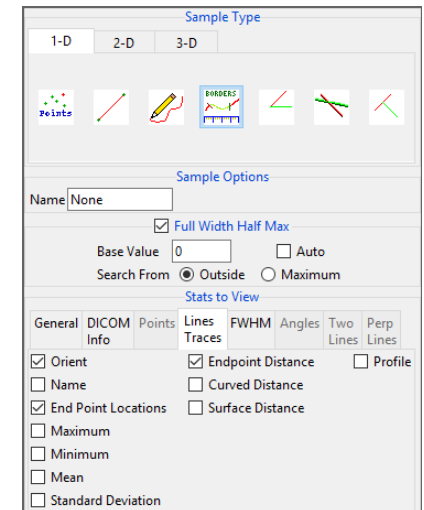
- **Name:** Allows users to assign a name to the region of the border being measured when reported to the log file.

Full Width Half Max: The Full Width Half Max option can be enabled for Sample Border(s), Sample Line(s) and Sample Trace(s) tool. For additional information refer to the FWHM description under Sample Line(s).

- **Base Value:** Allows users to specify the value used in the FWHM calculation.
- **Auto:** When enabled, the base value is automatically calculated by computing the mean of the nine-point neighborhoods around each endpoint of the line or trace
- **Search from:** Allows users to specify the search mode for FWHM measurement. The following options are available:
 - **Outside:** Specifies that search begins at the ends of the profiles.
 - **Maximum:** Specifies that search begins at the maximum value and proceeds to the left and right for the two half max values.

Stats to View

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See the DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.
- **Lines Traces:** Allows users to report an array of information about the trace. See Lines Trace under Sample Lines(s) > Stats to View above for a full description of available options.
- **FWHM:** Allows report an array of information for Full Width Half Max measurements. See FWHM under Sample Lines(s) > Stats to View above for a full description of available options.

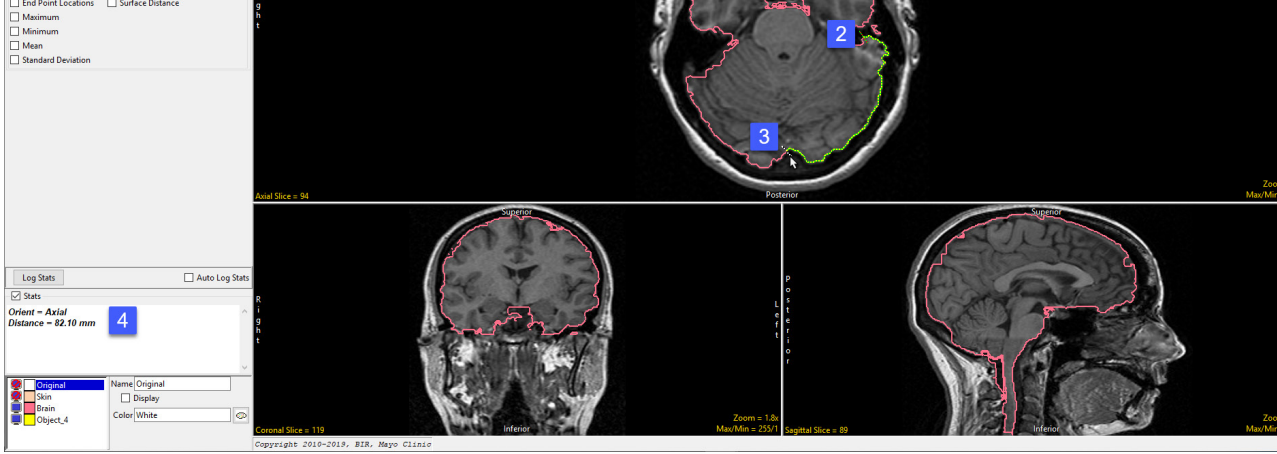




Making Border Measurements using Sample Border(s)

Here we use the Sample Border(s) tool to make border measurements.

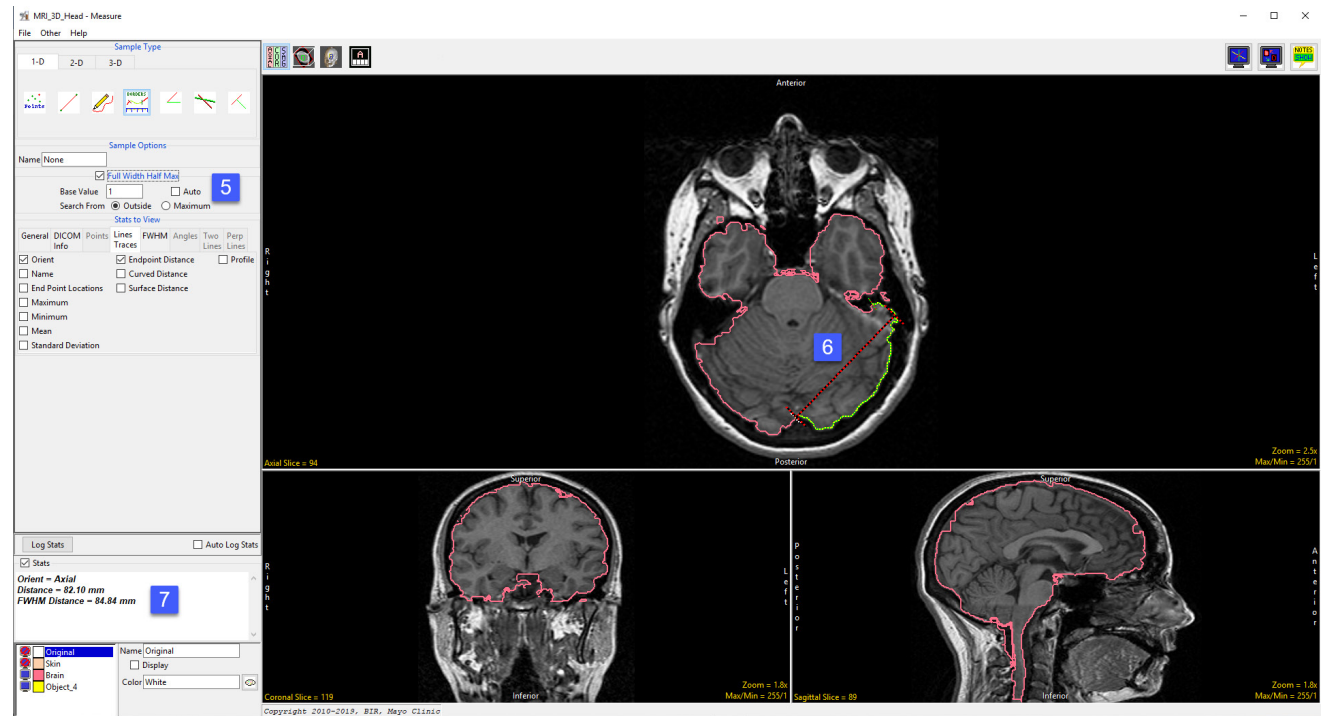
Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
 - Select File > Load Object Map and load the MRI_3D_Head.obj file.
 - Select the Sample Border(s) tool [1] from 1-D Sample Type.
- 
- To measure a length of an object border, move the cursor over the border and click to set the starting point [2] move the cursor to the where you wish to measure and click to set the end point [3].
 - The distance measurement along the border will be reported in the stats display [4].



Making Border Measurements using Sample Border(s) (continued)

- To enable FWHM check the Full Width Half Max checkbox [5].
- Note that the FWHM is overlaid in red on the image display [6].
- The FWHM Distance will be reported in the stats display area [7]. If the FWHM distance is not displayed select the FWHM tab from Stats to View and select check the Distance option.





Sample Angle(s)

The Sample Angle(s) tool allows users to make distance measurements between points and angle measurements between defined lines. The following options are available:

Sample Options: Provides users with access to the following angle sampling options:

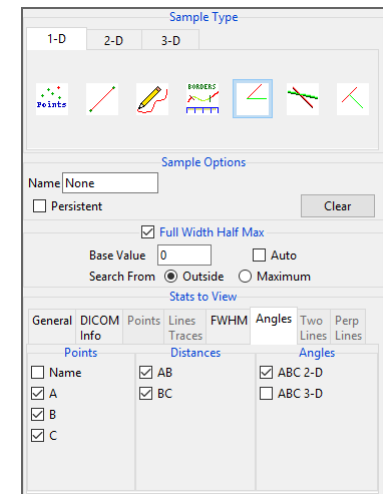
- **Name:** Allows users to assign a name to the defined angle when reported to the log file.
- **Persistent:** When selected prevents previously defined angles for being cleared from the image.
- **Clear:** Clears all angles from the image.

Stats to View

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See the DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.

Angles: The following angle measurement options are available:

- **Points:** Provides users with the option to report the following point related information and measurements:
 - **Name:** Reports the name entered in the Sample Options area for the angle measurement.
 - **A:** Reports the X, Y, Z coordinate location for point A of the angle measurement.
 - **B:** Reports the X, Y, Z coordinate location for point B of the angle measurement.
 - **C:** Reports the X, Y, Z coordinate location for point B of the angle measurement.
- **Distances:** Provides users with the option to report the following distance measurements:
 - **AB:** Reports the distance between point A and point B.
 - **BC:** Reports the distance between point B and point C.
- **Angles:** Provides users with the option to report the following angle measurements:
 - **ABC 2-D:** Reports the 2D angle measurement.
 - **ABC 3-D:** Reports the 3D angle measurement.



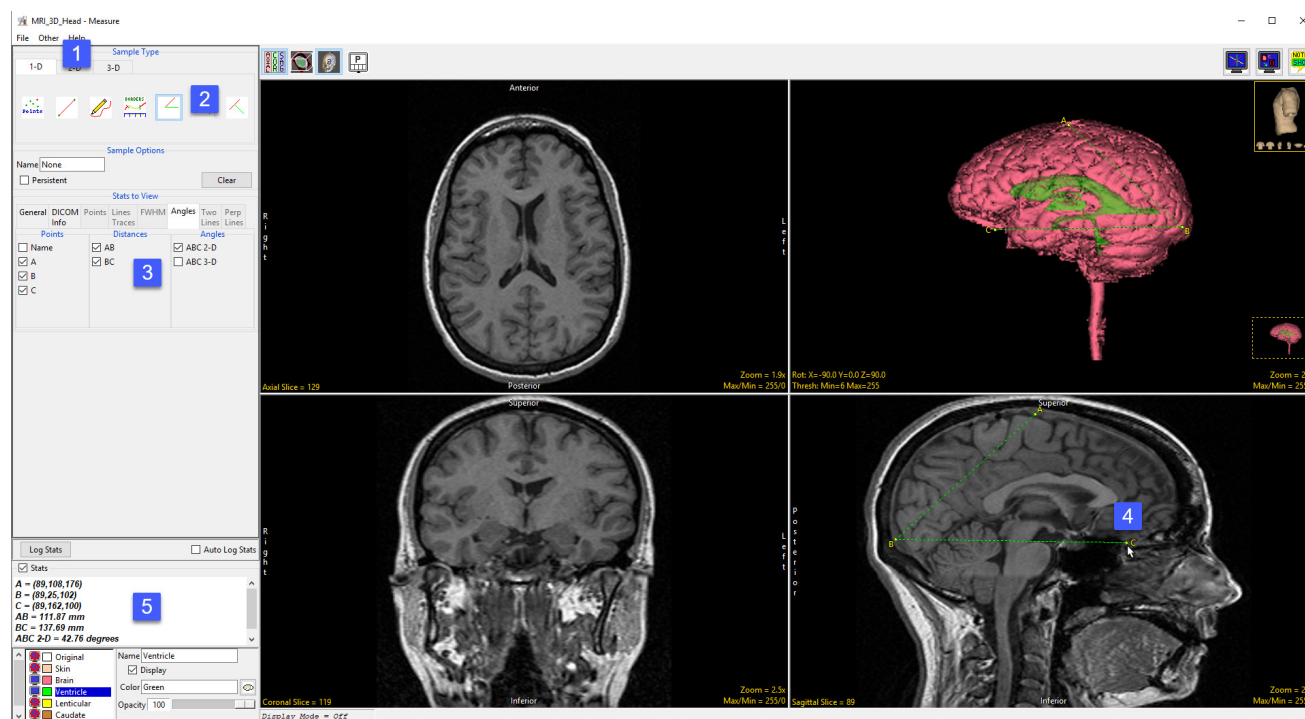


Making Angle Measurements using Sample Angle(s)

Here we use the Sample Angle(s) tool to make angle measurements.

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj file.
- Select the 1D Sample Type [1]. Choose the Angles tool [2].
- Check the Points, Distances, and Angles to be reported [3].
- Define the angles on any of the 2D slices or the 3D rendering [4].
- The selected measurements will be reported in the Stats review area [5].





Sample Two Lines

The Sample Two Lines tool provides users with an interactive tool for making point, distance, and angle measurements. The tool is useful for applications such as measuring midline shift in stroke CT images.

Sample Options: Provides users with access to the following sampling options:

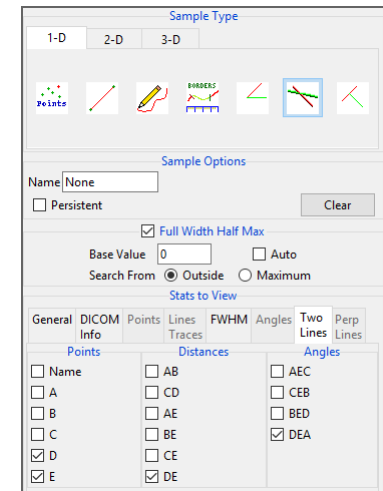
- **Name:** Assigns a name to the defined set of two-line measurements when reported to the log file.
- **Persistent:** Prevents previously defined two-line measurements for being cleared from the image.
- **Clear:** Clears all measurements from the image.

Stats to View

- **General:** Allows reporting of general data parameters in the stats log file. See General under Sample Point(s) > Stats to View.
- **DICOM Info:** Allows users to report DICOM tag information. See the DICOM Info under Sample Point(s) > Stats to View.

Two Lines:

- **Points:** Provides users with the option to report the following point related information and measurements:
 - **Name:** Reports the name entered in the Sample Options area for the two lines measurement.
 - **A:** Reports the X, Y, Z coordinate location for point A of the two line(s) tool.
 - **B:** Reports the X, Y, Z coordinate location for point B of the two line(s) tool.
 - **C:** Reports the X, Y, Z coordinate location for point C of the two line(s) tool.
 - **D:** Reports the X, Y, Z coordinate location for point D of the two line(s) tool.
 - **E:** Reports the X, Y, Z coordinate location for point E of the two line(s) tool.
- **Distances:** Provides users with the option to report the following distance measurements:
 - **AB:** Reports the distance between point A and point B.
 - **BE:** Reports the distance between point B and point E.
 - **CD:** Reports the distance between point C and point D.
 - **CE:** Reports the distance between point C and point E.
 - **AE:** Reports the distance between point A and point E.
 - **DE:** Reports the distance between point D and point E.
- **Angles:** Provides users with the option to report the following angle measurements:
 - **AEC:** Reports the 2D angle measurement for points A-E-C.
 - **BED:** Reports the 2D angle measurement for points B-E-D.
 - **CEB:** Reports the 2D angle measurement for points C-E-B.
 - **DEA:** Reports the 2D angle measurement for points D-E-A.

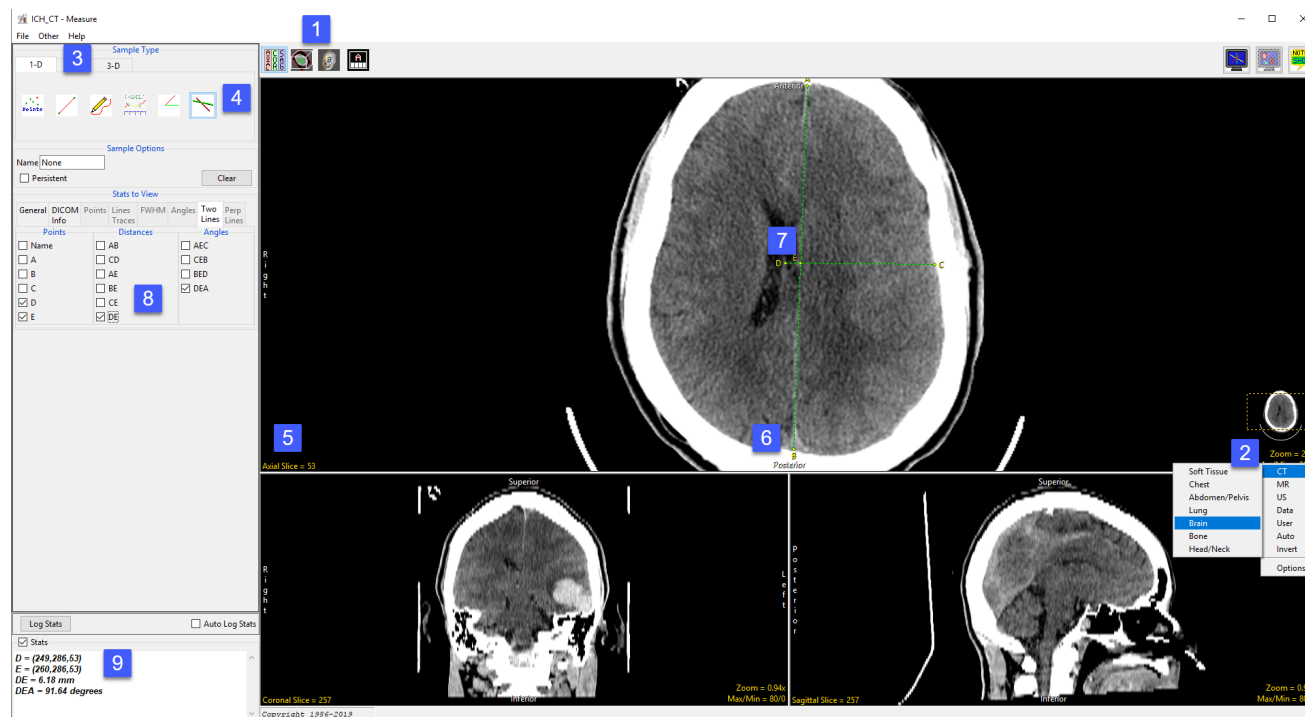




Making Measurements using Sample Two Lines

Download the ICH_CT.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load ICH_CT.avw into Analyze. Select ICH_CT and open Measure.
- Use the display configuration tools to display the 3 ortho sections making axial view the primary [1].
- Right click on the Max/Min option and select CT > Brain. This will provide a better display of the brain structure in the CT data [2]. Select the 1D [3] Sample Type and choose Sample Two Lines [4].
- To measure the displacement of the septum pellucidum from the midline at the level of the foramen of Monroe, find a suitable axial slice to make the measurement on. [5]
- Click on the image to set the first point, A, and drag the end point of the first line, B, to the desired location. This is the midline [6]. Once the midline is set, the next line will automatically appear. To define the second line, move point D perpendicular to the midline of the septum pellucidum. [7] Point C may need adjusting to make the second line perpendicular to the first.
- Check the Points, Distances, and any Angles you want to measure. [8] In this example, the midline shift measurement is between point D and point E. Reviewing angle DEA will confirm whether the second line is perpendicular to the first. The angle should be 90 degrees.
- Measurements will be reported in the Stats review area. [9]





Sample Perpendicular Lines

The Sample Perpendicular Lines tools allows users to make point and distance measurements perpendicular to a defined line (points A and B).

Sample Options: Provides users with access to the following sampling options:

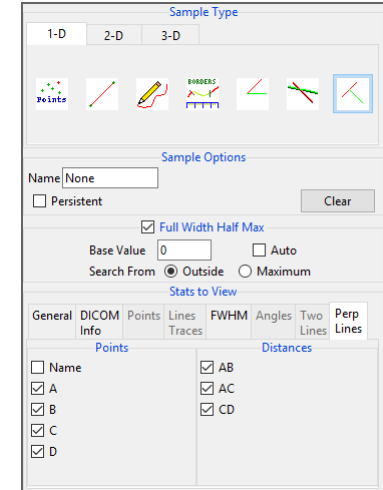
- **Name:** Assigns a name to the perpendicular line measurements when reported to the log file.
- **Persistent:** Prevents previously defined perpendicular line measurements for being cleared.
- **Clear:** Clears all perpendicular line measurements from the image.

Stats to View

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See the DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.

Perp Lines:

- **Points:** Provides users with the option to report the following point related information and measurements:
 - **Name:** Reports the name entered in the Sample Options area for the perpendicular line measurement.
 - **A:** Reports the X, Y, Z coordinate location for point A of the perpendicular line tool.
 - **B:** Reports the X, Y, Z coordinate location for point B of the perpendicular line tool.
 - **C:** Reports the X, Y, Z coordinate location for point C of the perpendicular line tool.
 - **D:** Reports the X, Y, Z coordinate location for point D of the perpendicular line tool.
- **Distances:** Provides users with the option to report the following distance measurements:
 - **AB:** Reports the distance between point A and point B.
 - **AC:** Reports the distance between point A and point C.
 - **CD:** Reports the distance between point C and point D.





Making Perpendicular Line Measurements using Sample Perpendicular Lines

The sample perpendicular lines tool is useful when making measurement perpendicular to specific landmarks in a data set. Download the CBCT.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load CBCT.avw into Analyze. Select CBCT and open Measure. Select the Sample Perpendicular Lines tool [1] from the 1-D Sample Type tab. Set the measure display so that all three orthogonal views are displayed with the Sagittal as the primary display [2].
- Adjust the Cursor Link tool in the axial [3] or coronal view to select a sagittal slice close to the mid-sagittal point. Toggle off the Cursor Link tool [4]. Enable all required Point and Distance measurements [5].
- Click on an area at the base of the skull [6] to set the first point (A) for the tool. Drag the second point (B) to an area in the nasal bone [7]. The perpendicular line (points C and D) will appear halfway between points A and B. Drag point D to the mandible [8].
- The selected measurements will be reported to the stats display area [9]. Click Log Stats to log these measurements to a stats file that can be saved to disk.





2-D Measurement Tools

The 2D sampling options in Measure allow users to derive measurements from interactively defined rectilinear or elliptical regions or from objects that exist on a specific slice. Measurement options available include spatial context measurements as well as signal value measurements, including Max/Min, mean, standard deviation, area, volume, 2D shape characteristics and more.

2D measurements include measurements tools that can be used with or without object maps, these include; rectangular region of interest sampling, oval region of interest sampling, free trace region of interest sampling, and entire image sampling. The remaining three 2-D sampling options can only be used with an object map, these are; selected regions, selected object, and enabled object.

The 2-D tab provides access to the following measurement tools:

- Sample 2-D Rectangle
- Sample 2-D Oval
- Sample 2-D Closed Trace
- Selected Region
- Selected Object
- Enabled Object
- Entire Image

Sample 2-D Rectangle

The Sample 2-D Rectangle tool enables the drawing of a rectangle on the displayed image to define a region. To define a rectangular region left click on the image and then drag the cursor until the desired size and shape rectangle has been define. The following sampling options are available.

Sample Options: Provides users with access to the following 2-D Rectangle sampling options:

- **Name:** Allows users to assign a name to the selected rectangle when reported to the log file.
- **Persistent:** When selected prevents previously defined rectangles for being cleared from the image.
- **Clear:** Clears all rectangles from the image.

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.



Sample 2-D Rectangle Options (continued)

Stats to View (continued):

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See DICOM Info under Sample Point(s) > Stats to View above for a full description.
- **Size Intensity:** Allows users to report an array of size intensity information and measurements. The following options are available:
 - **Orient:** Reports the orientation the region was defined in.
 - **Name:** Reports the name entered in the Sample Options area for the region.
 - **Slice:** Reports the slice the region was defined on.
 - **Maximum:** Reports the maximum voxel intensity in the region.
 - **Max Location:** Reports the location of the voxel with the maximum intensity value.
 - **Minimum:** Reports the minimum voxel intensity in the region.
 - **Min Location:** Reports the location of the voxel with the minimum intensity value.
 - **Number of Voxels:** Reports the number of voxels in the defined region.
 - **Area:** Reports the area of the region using the formula: $\text{Area} = \text{number of voxels} \times \text{voxel width} \times \text{voxel height}$
 - **Volume:** Reports the volume of the region using the formula: $\text{Volume} = \text{number of voxels} \times \text{voxel width} \times \text{voxel height} \times \text{voxel depth}$
 - **Mean:** Reports the mean intensity value of the voxels sampled in the region.
 - **St. Dev:** Reports the standard deviation of the sampled voxels.
 - **Sum:** Reports the sum of the intensity values of the sampled voxels.
 - **Entropy:** Reports the Shannon entropy of the sampled voxels.

The screenshot shows the 'Sample Type' dialog box. At the top, there are tabs for '1-D', '2-D', and '3-D'. Below these are icons for 'Selected Region' (a rectangle), 'Selected Object' (an oval), 'Enabled Objects' (a pencil), and 'Entire Image' (a document). The '2-D' tab is selected. Below the icons is the 'Sample Options' section, which includes a 'Name' field (set to 'None'), a 'Persistent' checkbox, and a 'Clear' button. There is also a 'Full Width Half Max' checkbox, a 'Base Value' field (set to '0'), an 'Auto' checkbox, and a 'Search From' section with 'Outside' (selected) and 'Maximum' radio buttons. At the bottom is the 'Stats to View' section, which has tabs for 'General', 'DICOM Info', 'Size Intensity', and 'Sample 2-D Shape'. The 'General' tab is selected, showing a list of checkboxes for various stats: 'Data File Name', 'Object Map Name', 'Voxel Width', 'Voxel Height', 'Voxel Depth', 'Time Stamp', and 'Analyst'.

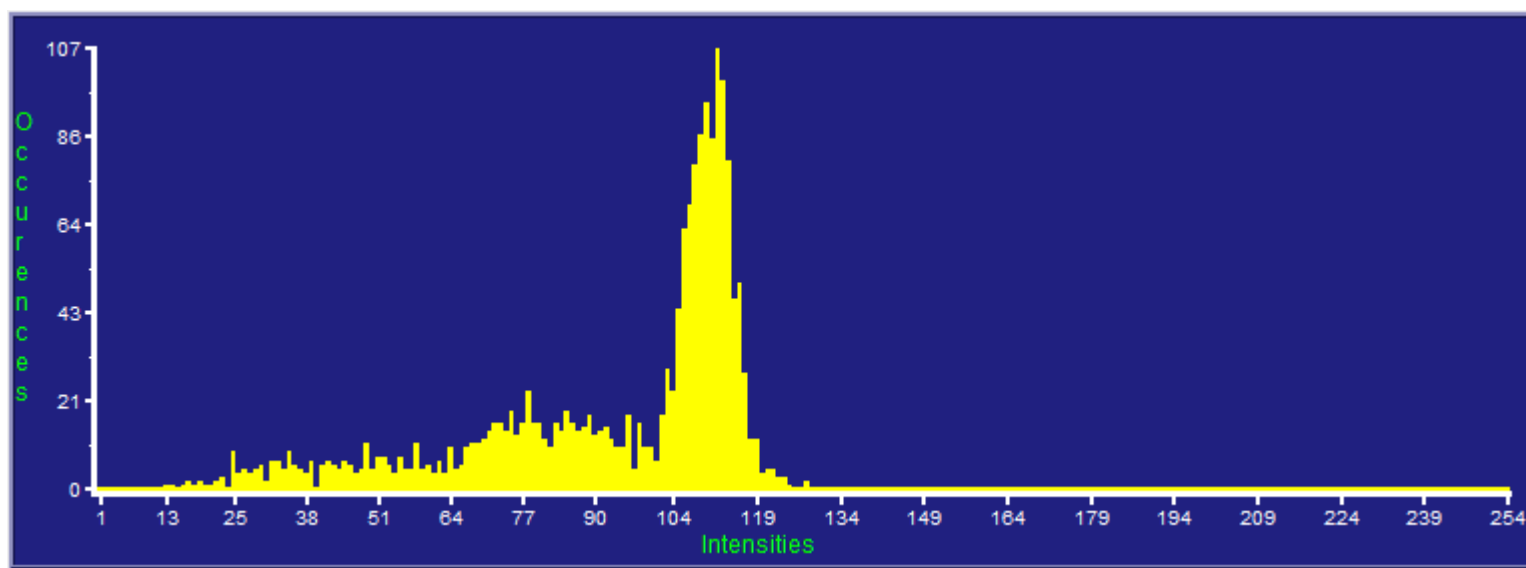


Sample 2-D Rectangle Options (continued)

Stats to View > Size Intensity (continued):

- **Histogram:** The histogram option reports plots the histogram of the region (intensities vs. occurrence) and reports relevant histogram information including:
 - **Orient:** Reports the orientation the region was defined in.
 - **Slice:** Reports the slice number the region was defined on.
 - **Object:** Reports the object or region name.
 - **Intensity:** Reports all intensity values in the region.
 - **Count:** Reports the count of the intensity in the region
 - **Histogram Mode:** Reports the Histogram Mode value.
 - **Histogram Median:** Reports the Histogram Median value.

Histogram						
Orient	Slice	Object	Intensity	Count	Histogram Mode	Histogram Median
Axial	136	Brain	1.00	0	112.00	104.00
Axial	136	Brain	2.00	0		
Axial	136	Brain	3.00	0		
Axial	136	Brain	4.00	0		
Axial	136	Brain	5.00	0		
Axial	136	Brain	6.00	0		
Axial	136	Brain	7.00	0		
Axial	136	Brain	8.00	0		
Axial	136	Brain	9.00	0		
Axial	136	Brain	10.00	0		
Axial	136	Brain	11.00	0		
Axial	136	Brain	12.00	0		
Axial	136	Brain	13.00	0		
Axial	136	Brain	14.00	0		
Axial	136	Brain	15.00	0		





Sample 2-D Rectangle Options (continued)

Stats to View > Size Intensity (continued):

- **Boundary Coordinates:** Reports the boundary (perimeter) coordinates of the region. Measurements include the following:
 - **Index:** Boundary pixel reference number.
 - **X:** Reports the X position of the boundary coordinate.
 - **Y:** Reports the Y position of the boundary coordinate.
 - **Slice:** Reports the slice position of the boundary coordinate.
 - **Orient:** Reports the orientation the sampled region is defined in.
 - **Value:** Reports the greyscale value of the boundary coordinate.
 - **Object:** Reports selected or enabled object when an object map is loaded.
 - **Border:** Reports border thickness when an object map is loaded.
- **Region Pixels:** Reports information on all pixels that make up the defined region, measurements include:
 - **Index:** Region pixel reference number.
 - **X:** Reports the X position of the pixel.
 - **Y:** Reports the Y position of the pixel.
 - **Slice:** Reports the slice position of the pixel.
 - **Orient:** Reports the orientation the sampled region is defined in.
 - **Value:** Reports the greyscale value of the pixel.
 - **Object:** Reports selected or enabled object when an object map is loaded.

Boundary Coordinates							
Index	X	Y	Slice	Orient	Value	Object	Border
1	79	10	136	Axial	45	Skin	1
2	80	11	136	Axial	89	Skin	1
3	81	11	136	Axial	87	Skin	1
4	82	11	136	Axial	88	Skin	1
5	83	11	136	Axial	89	Skin	1
6	84	11	136	Axial	83	Skin	1
7	85	11	136	Axial	82	Skin	1
8	86	10	136	Axial	45	Skin	1
9	87	10	136	Axial	55	Skin	1
10	88	10	136	Axial	63	Skin	1
11	89	10	136	Axial	65	Skin	1
12	90	10	136	Axial	67	Skin	1
13	91	10	136	Axial	71	Skin	1
14	92	10	136	Axial	73	Skin	1
15	93	10	136	Axial	70	Skin	1

Region Pixels							
Index	X	Y	Slice	Orient	Value	Object	
1	79	25	136	Axial	62	Brain	
2	80	25	136	Axial	73	Brain	
3	81	25	136	Axial	79	Brain	
4	82	25	136	Axial	82	Brain	
5	83	25	136	Axial	78	Brain	
6	84	25	136	Axial	63	Brain	
7	89	25	136	Axial	53	Brain	
8	90	25	136	Axial	78	Brain	
9	91	25	136	Axial	105	Brain	
10	94	25	136	Axial	95	Brain	
11	95	25	136	Axial	77	Brain	
12	96	25	136	Axial	53	Brain	



Sample 2-D Rectangle Options (continued)

Stats to View (continued):

- **Sample Range:** Allows users to sample voxels within the defined region based on a minimum and maximum intensity range. The following options are available.
 - **Sample Range Slider:** The sample range slider allows users to define a minimum and maximum sample range based on the image histogram. Only voxels that meet the specified criteria will be sampled.
 - **Range Min:** Set the minimum for the sampling range.
 - **Range Max:** Set the maximum for the sampling range.
 - **< Sample Min:** Reports the number of voxels with an intensity value less than the specified minimum range value.
 - **> Sample Max:** Reports the number of voxels with an intensity value greater than the specified maximum range value.
 - **>= SMin & <= SMax:** Reports the number of voxels with an intensity value equal to or greater than the sample minimum and equal to or less than the sample maximum.
 - **Mean in Range:** Reports the mean intensity value of the voxels within the specified minimum and maximum sampling range.
 - **STD in Range:** Reports the standard deviation of the sampled voxels.
 - **Sum in Range:** Reports the sum of the intensity values of the sampled voxels within the defined range.
 - **Area in Range:** Reports the area of the sampled voxels within the defined range.
 - **Volume in Range:** Reports the volume of the sampled voxels within the defined range.
 - **Brightness Area Product:** Reports the Brightness Area Product for the sampled voxels. The value is calculated from the formula: $(\text{Mean in Range} - \text{Min}) * \text{No. Pixels In Range}$.
- **2-D Shape:** All 2-D shape measurements assume the input image data will have square pixels and are in units of linear pixel-sides or square pixels as appropriate. The following options are available.
 - **MER Angle Resolution:** MER (Minimum Enclosing Rectangle) specifies the angle resolution to be used when searching for the Minimum Enclosing Rectangle.
 - **Perimeter:** Reports the perimeter of the region in pixel-sides and in calibrated voxel units.



Sample 2-D Rectangle Options (continued)

Stats to View > 2-D Shape (continued):

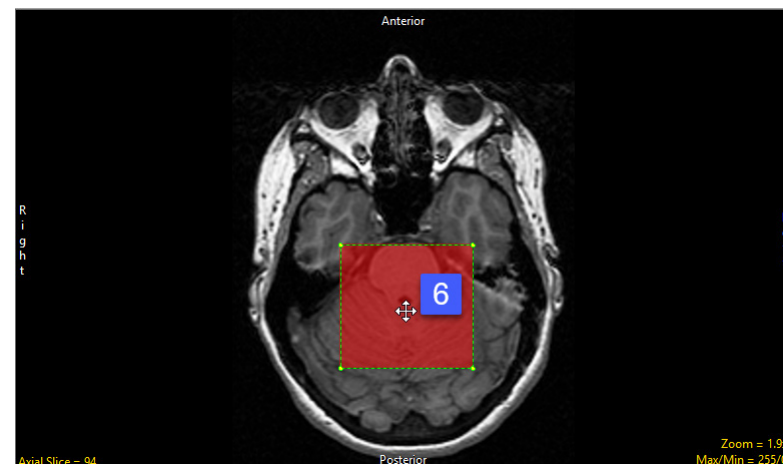
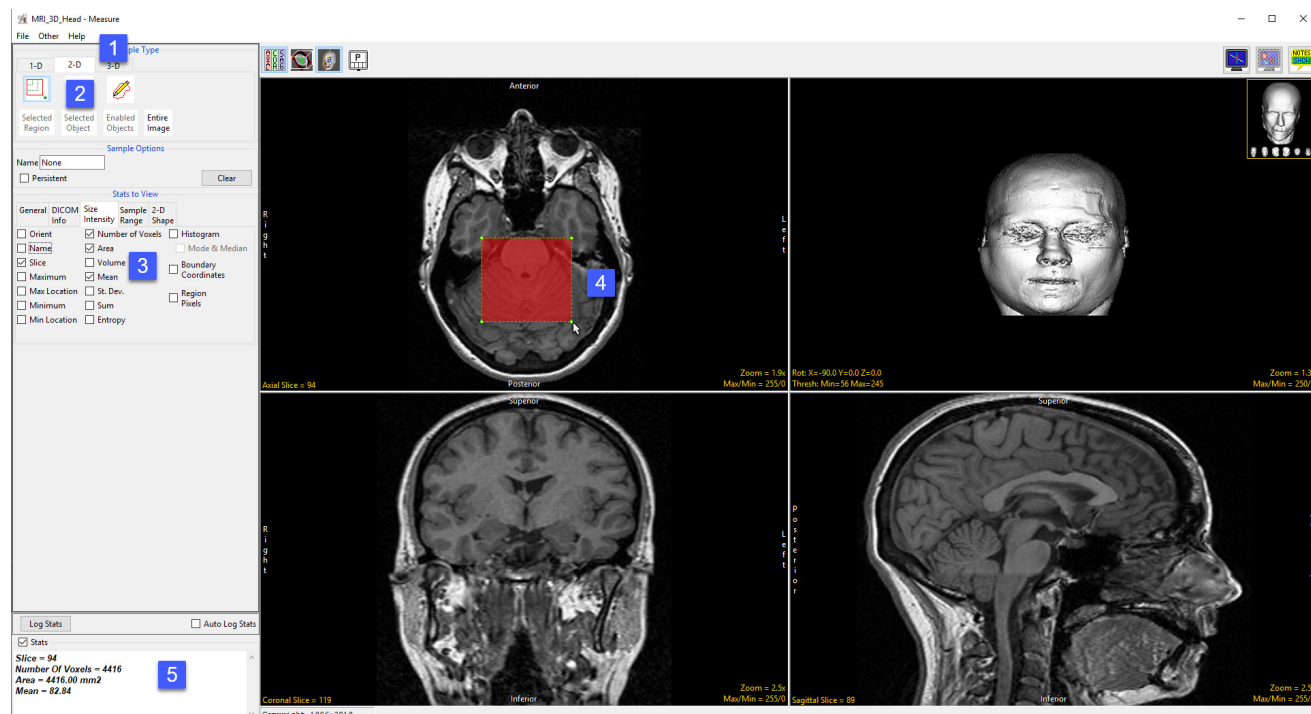
- **MER Angle:** Reports the angle of rotation in one-degree increments, at which the sides of the minimum enclosing Rectangle is parallel to the X and Y axes.
- **MER Area:** Reports the minimum enclosing rectangle.
- **MER Aspect Ratio:** Reports the short side of the minimum enclosing rectangle to the long side.
- **MER Coordinates:** Reports the coordinates of the four corners of the MER.
- **Rectangular Fit Factor:** Reports the ratio of the area of the region to the area of the minimum enclosing rectangle.
- **Circularity:** Reports the ratio of the perimeter squared of the region to the area of the region, (P^2/A). This parameter takes on a minimum value of 4π for a circle.
- **Circ./(4*Pi):** Reports the circularity value divided by 4π . This value should be 1 for a perfect circle.
- **Centroid:** Reports the center gravity for the region.
- **Surface Voxels:** For use with the rendered image only. Reports the total number of voxels counted on the surface of the defined region.
- **Surface Faces:** For use with the rendered image only. Reports the total number of exposed faces for all surface voxels.
- **Planar Area:** For use with the rendered image only. Reports the count of 2-D pixels in the user defined area.
- **Surface Area:** For use with the rendered image only. Reports an estimate of the structures surface area within the defined region, computed by examining each surface voxel found via the tracking algorithm and assigning a surface area component for each voxel based on its non-surface neighbors.



Making 2D Rectangular Measurements using Sample 2-D Rectangle

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj file. Select the 2D Sample Type [1] and choose Sample 2-D Rectangle(s) [2].
- In the Stats to View area check all required measurements [3] in the stats review area.
- Define a rectangle on the current axial slice [4].
- Selected measurements will be reported for the region in the stats review area [5]. Click Log Stats to return the stats to a log file that can be saved out of Analyze as a .csv file.
- Note, to move the rectangle, place the cursor in the center of the rectangle. When the cursor updates its shape [6] move the rectangle up, down, left, or right.





Sample 2-D Oval

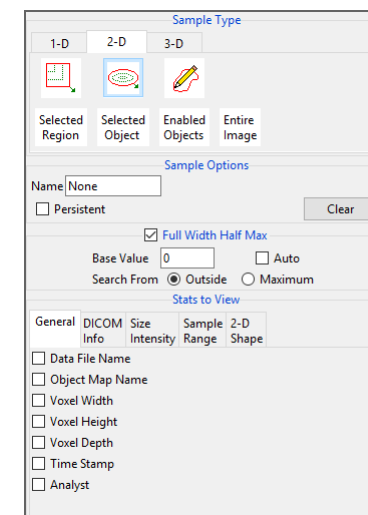
The Sample 2-D Oval tools enabled the drawing of an oval on the displayed image to define a region for sampling. To define an oval region left click on the image and then drag the cursor until the desired size and shape oval has been define. The following sampling options are available:

Sample Options: Provides users with access to the following 2-D oval sampling options:

- **Name:** Allows users to assign a name to the selected oval when reported to the log file.
- **Persistent:** Prevents previously defined ovals for being cleared from the image.
- **Clear:** Clears all ovals from the image.

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.
- **Size Intensity:** Allows users to report an array of size intensity information and measurements. Refer to the size Intensity description for Sample 2-D Rectangle for a description of all available options.
- **Sample Range:** Allows users to sample voxels within the defined region based on a minimum and maximum intensity range. Refer to the Sample Range description for Sample 2-D Rectangle for a description of all available options.
- **2-D Shape:** Allows users to report 2-D shape measurements for the defined region. Refer to the 2-D Shape description for Sample 2-D Rectangle for a description of all available options.

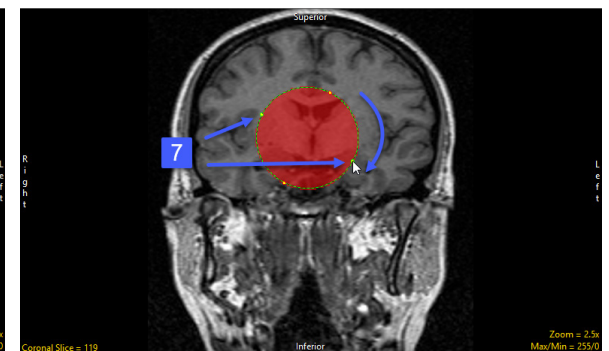
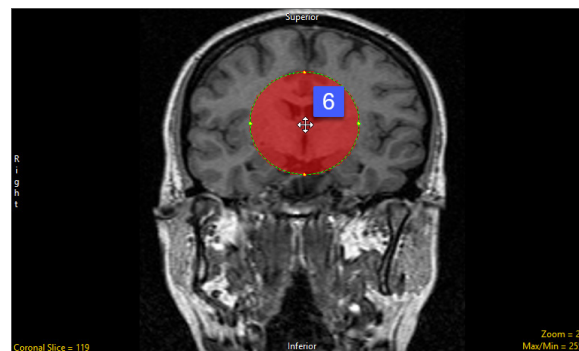
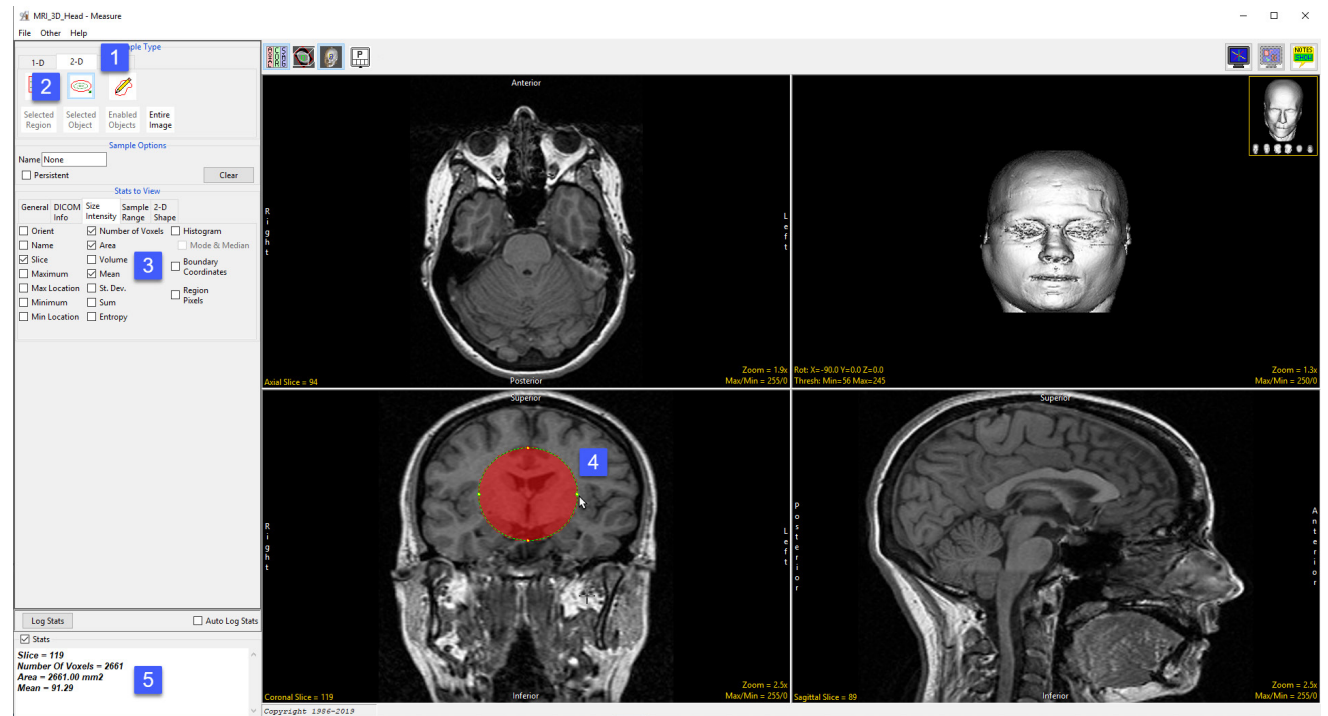




Making 2D Oval Measurements using Sample 2-D Oval

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj file. Select the 2D Sample Type [1] and choose Sample 2-D Oval(s) [2]. In the Stats to View area check all required measurements [3] in the stats review area. Define a oval on the current coronal slice [4].
- Selected measurements will be reported for the region in the stats review area [5]. Click Log Stats to return the stats to a log file that can be saved out of Analyze as a .csv file. Note, to move the oval, place the cursor in the center of the oval. When the cursor updates its shape [6] move the oval up, down, left, or right. The oval can also be rotated using the either of the two larger green control points [7].





Sample 2-D Closed Trace

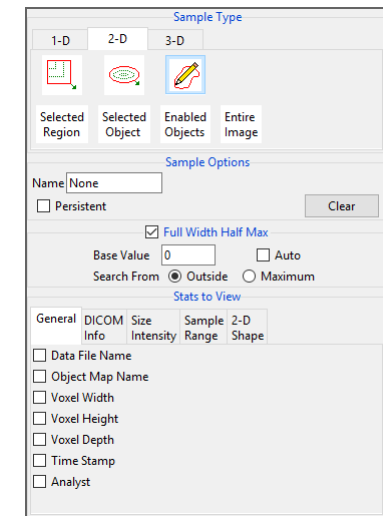
The Sample 2-D Closed Trace tools enable the drawing of a trace to define a region to sample on an image. When selected, position the cursor on the displayed slice, press and hold the left mouse button to draw a trace, release the mouse button to end the trace. The last point of the trace drawn is automatically connected to the first point of the trace. The following sampling options are available:

Sample Options: Provides users with access to the following 2-D closed trace sampling options:

- **Name:** Assigns a name to the selected closed trace when reported to the log file.
- **Persistent:** Prevents previously defined closed traces for being cleared from the image.
- **Clear:** Clears all closed traces from the image.

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.
- **Size Intensity:** Allows users to report an array of size intensity information and measurements. Refer to the size Intensity description for Sample 2-D Rectangle for a description of all available options.
- **Sample Range:** Allows users to sample voxels within the defined region based on a minimum and maximum intensity range. Refer to the Sample Range description for Sample 2-D Rectangle for a description of all available options.
- **2-D Shape:** Allows users to report 2-D shape measurements for the defined region. Refer to the 2-D Shape description for Sample 2-D Rectangle for a description of all available options.

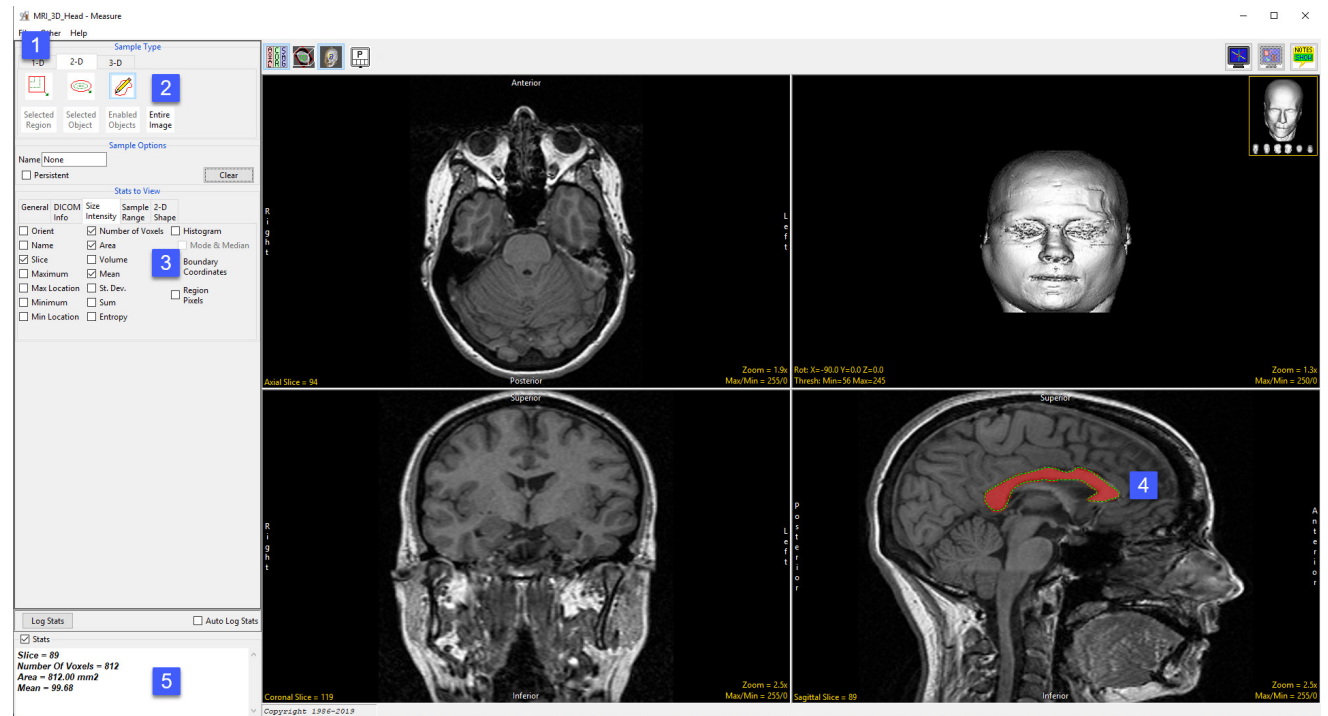




Making 2D Closed Trace Measurements using Sample 2-D Closed Trace

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj file.
- Select the 2D Sample Type [1] and choose Sample 2-D Closed Trace [2].
- In the Stats to View area check all required measurements [3] in the stats review area.
- On the current sagittal slice define a trace around the corpus callosum [4].
- Selected measurements will be reported for the region in the stats review area [5].





Selected Region

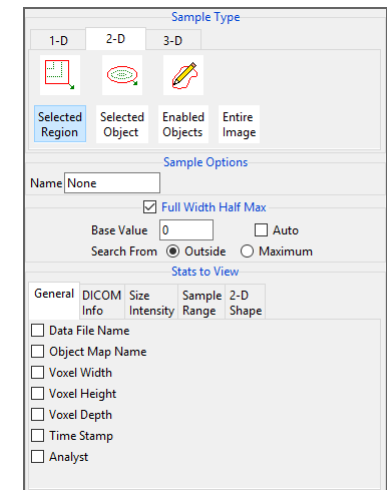
The Selected Region option allows users to sample a region of an object on a 2D slice. An object map must be loaded for this sampling option to be available.

Sample Options: Provides users with access to the following selected region options:

- **Name:** Allows users to assign a name for the selected region when reported to the log file.

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.
- **Size Intensity:** Allows users to report an array of size intensity information and measurements. Refer to the size Intensity description for Sample 2-D Rectangle for a description of all available options.
- **Sample Range:** Allows users to sample voxels within the defined region based on a minimum and maximum intensity range. Refer to the Sample Range description for Sample 2-D Rectangle for a description of all available options.
- **2-D Shape:** Allows users to report 2-D shape measurements for the defined region. Refer to the 2-D Shape description for Sample 2-D Rectangle for a description of all available options.

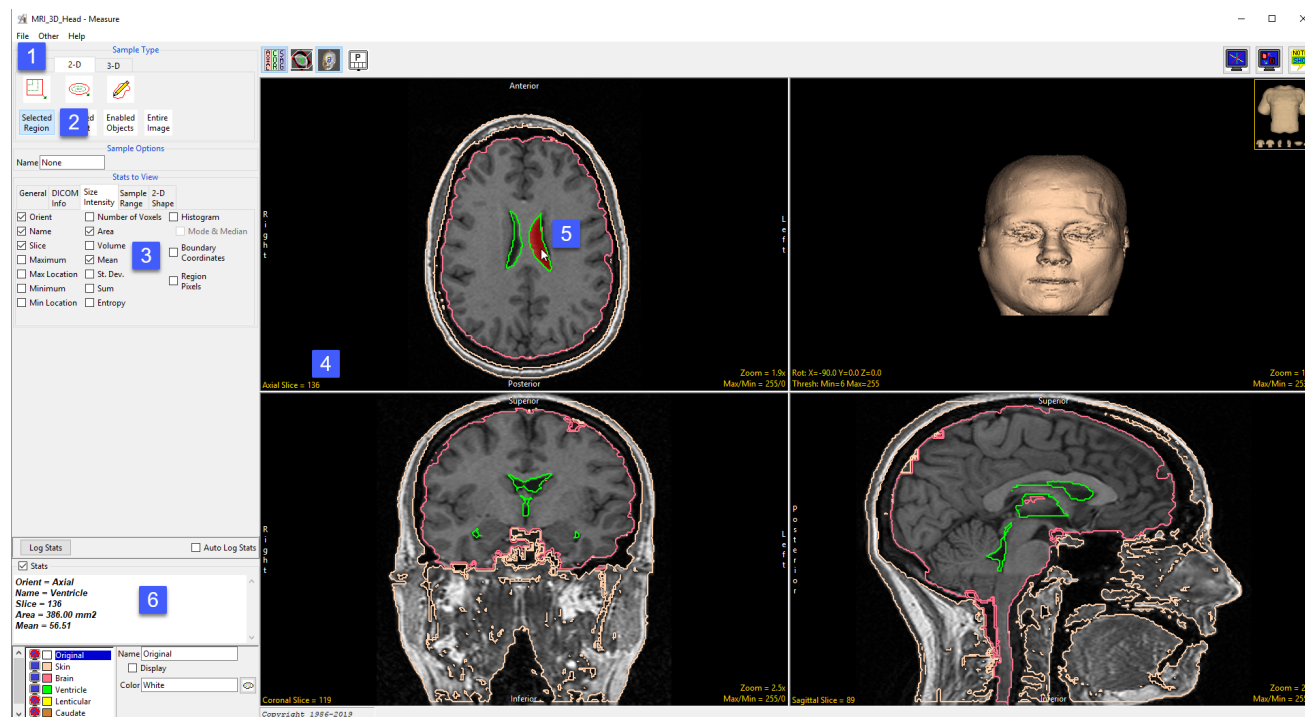




Making Measurements using Selected Region

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj file.
- Select the 2D Sample Type [1] and choose Selected Region [2].
- In the Stats to View area check all required measurements [3] in the stats review area.
- Move to axial slice 136 [4]. Click in the ventricle object on the left side to sample [5].
- Selected measurements will be reported for the region in the stats review area [6].



To sample all of the ventricle on this slice please refer to the Selected Object sampling type on the following pages.

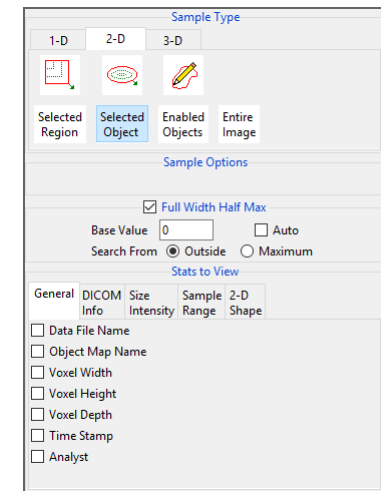


Selected Object

The Selected Object option allows users to sample an object on a 2D slice. An object map must be loaded for this sampling option to be available.

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.
- **Size Intensity:** Allows users to report an array of size intensity information and measurements. Refer to the size Intensity description for Sample 2-D Rectangle for a description of all available options.
- **Sample Range:** Allows users to sample voxels within the defined region based on a minimum and maximum intensity range. Refer to the Sample Range description for Sample 2-D Rectangle for a description of all available options.
- **2-D Shape:** Allows users to report 2-D shape measurements for the defined region. Refer to the 2-D Shape description for Sample 2-D Rectangle for a description of all available options.

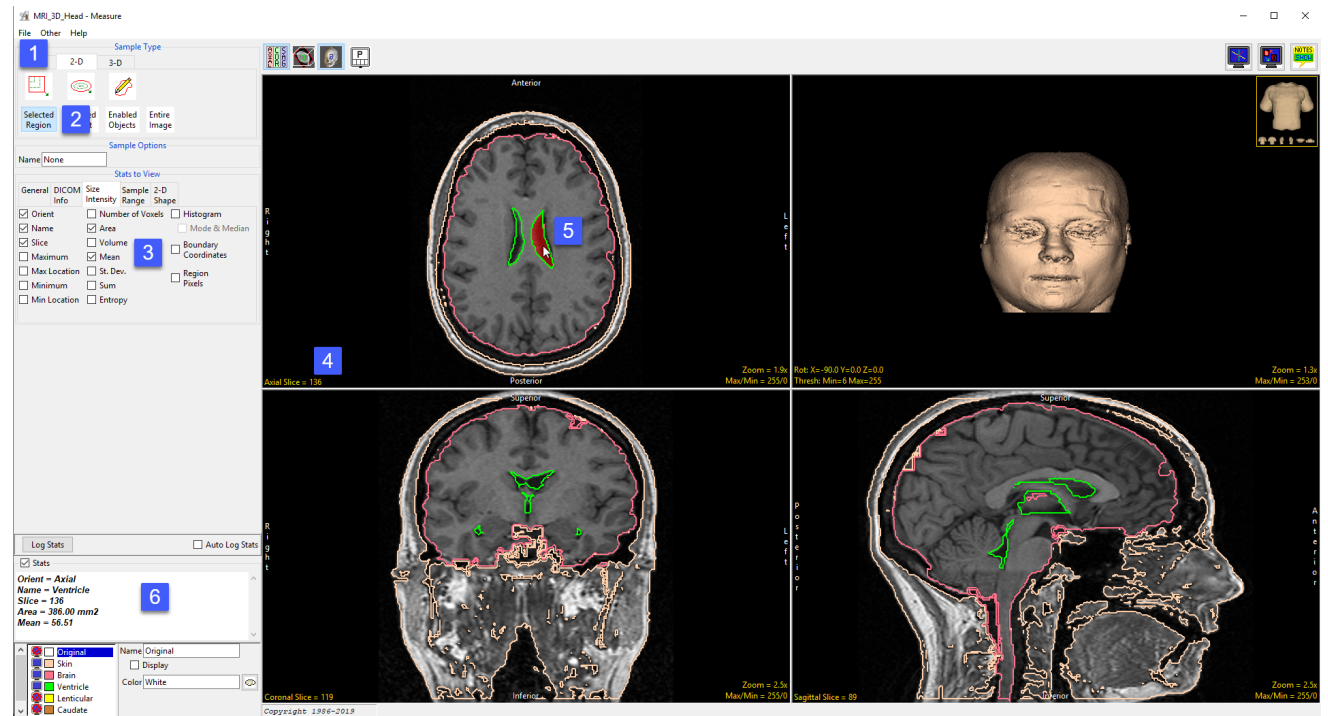




Making Measurements using Selected Object

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj file.
- Select the 2D Sample Type [1] and choose Selected Object [2].
- In the Stats to View area check all required measurements [3] in the stats review area.
- Move to axial slice 136 [4]. Click in the ventricle object on either the left or right side to sample [5]. Note that even though the two regions of the ventricle on this slice are spatially disconnected both are sampled as the sample type, selected object, will sample all voxels assigned to the selected object on the current 2D slice.
- Selected measurements will be reported for the region in the stats review area [6].



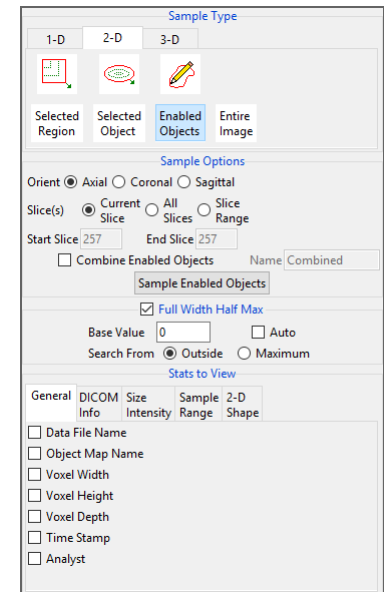


Enabled Objects

The Enabled Objects option allows sampling of all enabled objects (currently displayed) for the current slice, all slices, or a range of slices. An object map must be loaded for this option to be available.

Sample Options: Provides users the following sampling controls:

- **Orient:** Select the orientation to sample enabled objects in.
 - **Axial:** Sets the sampling orientation to axial.
 - **Coronal:** Sets the sampling orientation to coronal.
 - **Sagittal:** Sets the sampling orientation to sagittal.
 - **Slices:** Allows users to specify the slices sampled.
 - **Current Slice:** Samples the current displayed slice for the selected orientation.
 - **All Slices:** Samples all slices in the selected orientation.
 - **Slice Range:** Samples the range of samples specified using the start and end slice fields for the selected orientation.
 - **Start Slice:** Allows users to set the starting slice for sampling. Slices before the start slice will not be sampled.
 - **End Slice:** Allows users to set the ending slice for sampling. Slices after the end slice will not be sampled.
 - **Combine Objects:** Allows users to sum the measurements of the individually sampled objects.
 - **Name:** Allows users to specify a name for the combined object measurements when reported to the stats log.
 - **Sample Enabled Objects:** Initiates the sampling process.
- Stats to View:** The stats to view area allows users to enable and disable measurements and information reported to the stats log.
- **General:** Allows users to report general image data parameters in the stats log file (see General under Sample Point(s) > Stats to View.)
 - **DICOM Info:** Allows users to report DICOM tag information (see DICOM Info under Sample Point(s) > Stats to View.)
 - **Size Intensity:** Reports an array of size intensity information and measurements (see Size Intensity description for Sample 2-D Rectangle.)
 - **Sample Range:** Samples voxels within a defined region based on a min/max intensity range (see Sample 2-D Rectangle > Sample Range.)
 - **2-D Shape:** Reports 2-D shape measurements for the defined region (see Sample 2-D Rectangle > 2-D Shape.)





Sampling Objects using Enabled Objects

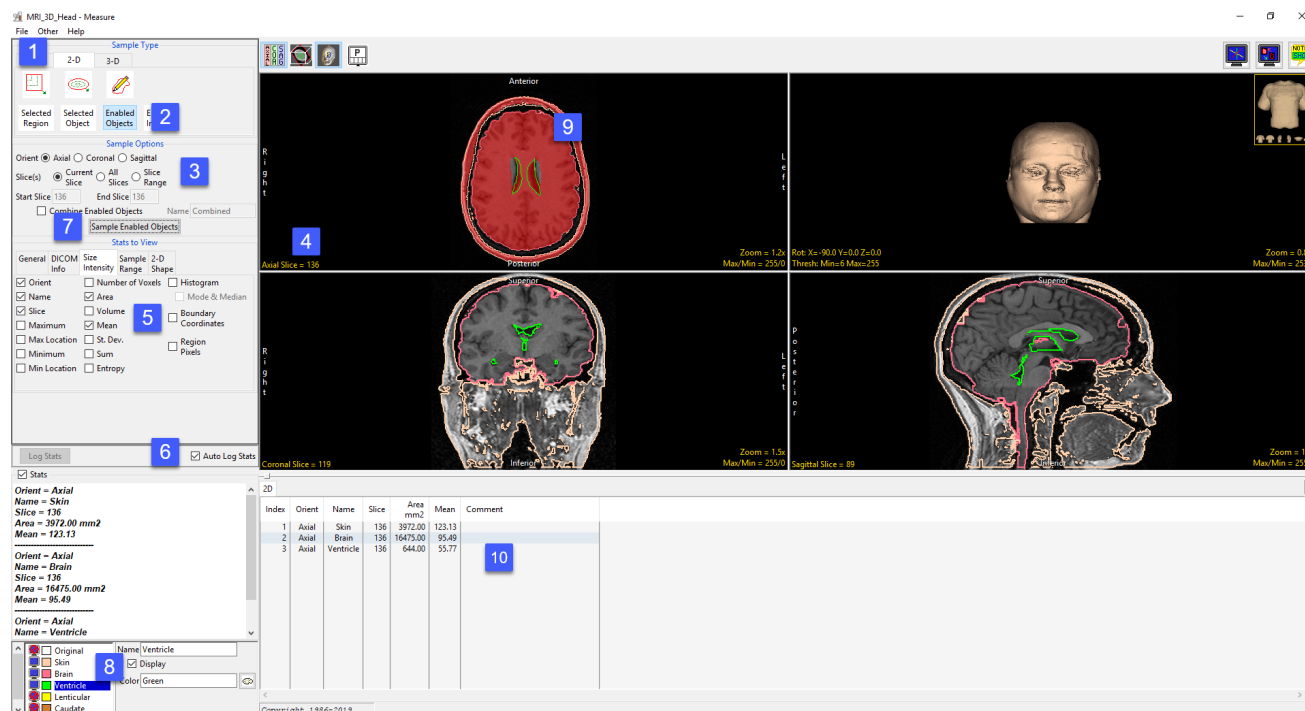
Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj file.
- Select the 2D Sample Type [1] and choose Enabled Objects [2].

Sampling the Current Slice

To sample all enabled objects for the current slice in a particular orientation, do the following:

- Leave Orient set to Axial and Slice(s) set to Current [3]. This will sample the current axial slice when Sample Enabled Objects is selected. Change the axial slice to 136 [4].
- In the Stats to View area check all the measurements [5] to be reported. Check the Auto Log option [6].
- Click the Sampled Enabled Object button [7].
- All objects currently displayed [8] will be sampled. The sampled objects are displayed for the current slice in the current orientation [9].
- The selected measurements will be returned to the stats log for the current slice [10].



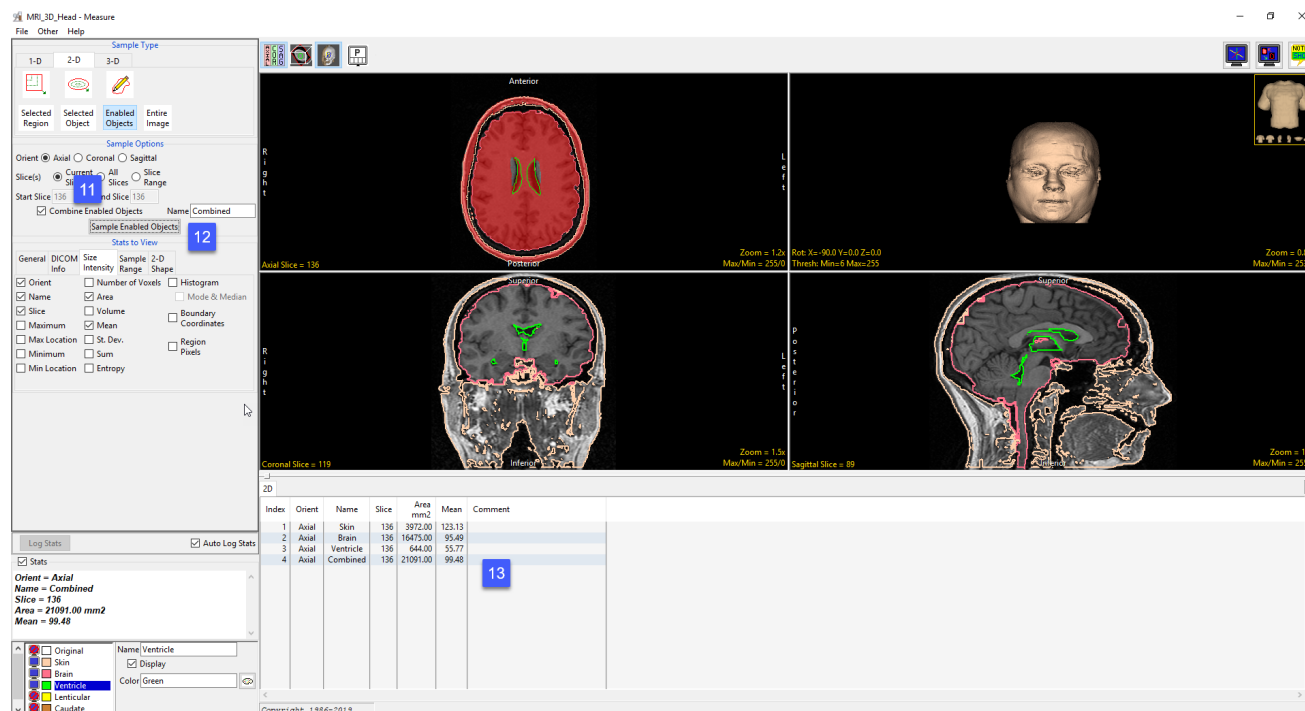


Sampling Objects using Enabled Objects (continued)

Combining Objects for the Current Slice

To return summed measurements for the enabled objects, do the following:
To return summed measurements for the enabled objects, do the following:

- Check the Combine Enabled Objects check box [11]. Leave the Name set to Combined.
- Click the Sampled Enabled Object button [12].
- All objects currently displayed will be sampled. The sampled objects are displayed in red in the current orientation. Measurements will be summed for the enabled objects (skin + brain + ventricles) and returned in a new row in the stats log [13].



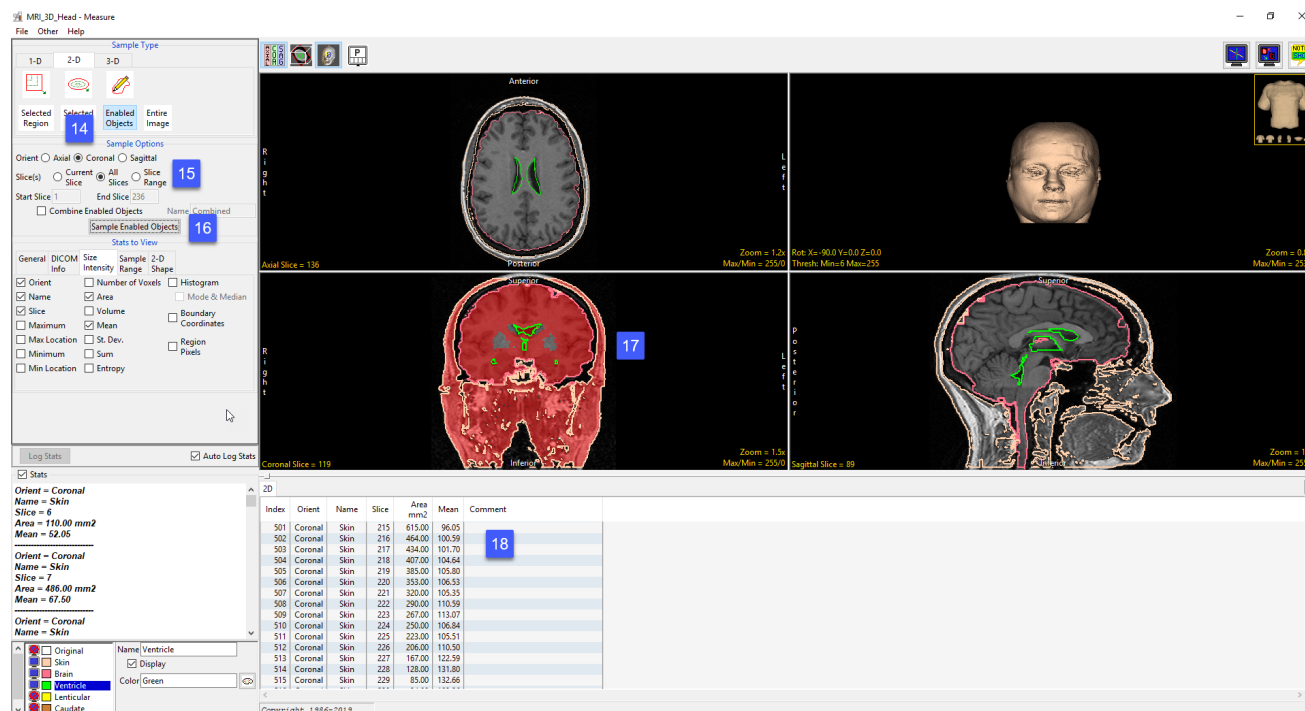


Sampling Objects using Enabled Objects (continued)

Sampling All Slices

To sample all enabled objects for all slices in a particular orientation, do the following:

- Dismiss the stats log by clicking the x in the upper right-hand corner of the stats log.
- Set the Orient to Coronal [14] and set Slice(s) set to All Slices [15], these settings will allow you to sample all slices in the coronal orientation when Sampled Enabled Object is selected.
- Click the Sampled Enabled Object button [16].
- All objects currently displayed will be sampled. The sampled objects are displayed in red in the current orientation [17].
- Measurements will be returned to the stats log for the current slice [18].





Sampling Objects using Enabled Objects (continued)

Combining Objects when sampling All Slices

To return the individual object measurements summed in a single line entry in the stats log, do the following:

- Dismiss the stats log by clicking the x in the upper right-hand corner of the stats log.
- Check the Combine Enabled Objects check box [19].
- Leave the Name set to Combined [20].
- Click the Sampled Enabled Object button [21].
- All objects currently displayed will be sampled. The sampled objects are displayed in red in the current orientation. Measurements will be summed for the enabled objects and returned to the stats log for the current slice [22].

The screenshot displays the 'MRI_3D_Head - Measure' software interface. The left panel shows the 'Sample Type' section with 'Selected Object' and 'Enabled Objects' options. The 'Combine Enabled Objects' checkbox is checked [19]. The 'Name' field is set to 'Combined' [20]. The 'Sampled Enabled Object' button is highlighted [21]. The bottom panel shows a table of measurement data for the current slice.

Index	Orient	Name	Slice	Area mm ²	Mean	Comment
210	Coronal	Combined	215	615.00	96.05	
211	Coronal	Combined	216	464.00	100.59	
212	Coronal	Combined	217	434.00	101.70	
213	Coronal	Combined	218	407.00	104.64	
214	Coronal	Combined	219	385.00	105.90	
215	Coronal	Combined	220	353.00	106.53	
216	Coronal	Combined	221	320.00	105.35	
217	Coronal	Combined	222	290.00	110.59	
218	Coronal	Combined	223	267.00	113.07	
219	Coronal	Combined	224	250.00	106.64	
220	Coronal	Combined	225	223.00	105.51	
221	Coronal	Combined	226	206.00	110.50	
222	Coronal	Combined	227	167.00	122.59	
223	Coronal	Combined	228	128.00	131.80	
224	Coronal	Combined	229	85.00	132.66	
...

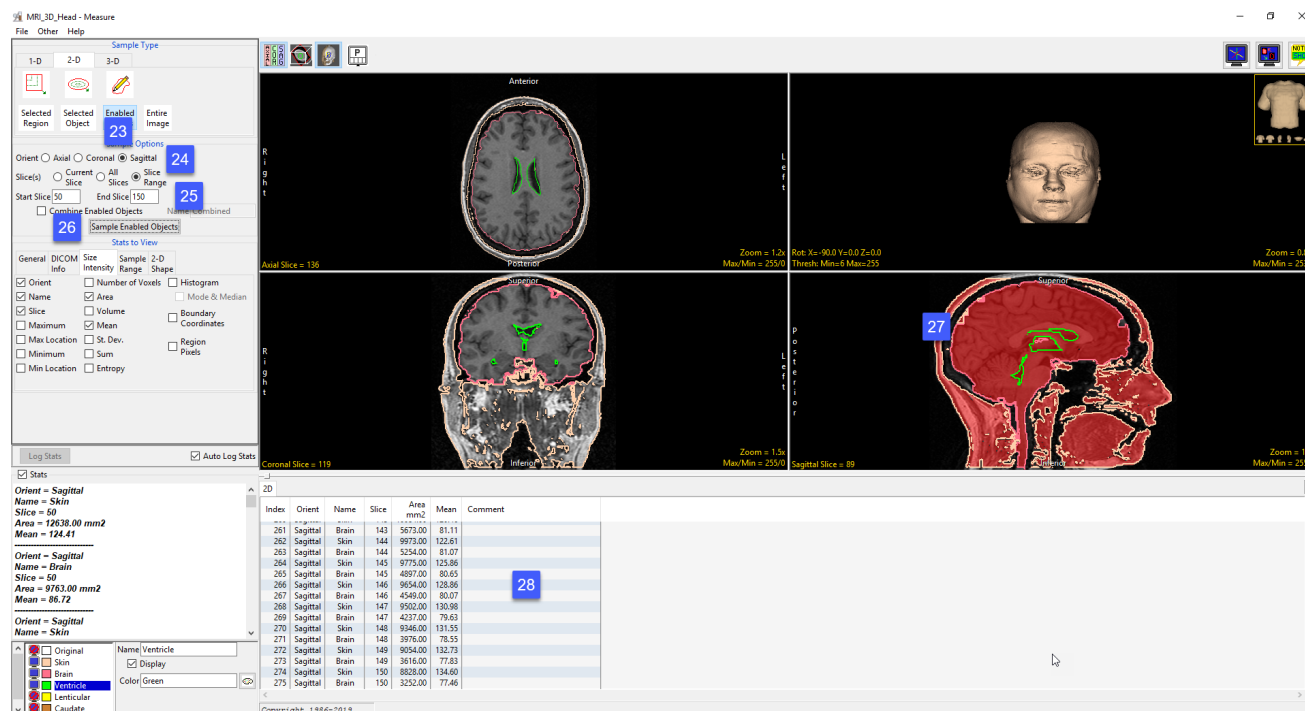


Sampling Objects using Enabled Objects (continued)

Sampling a Range of Slices

To sample a range of slices for all enabled objects in a specific orientation, do the following:

- Dismiss the previous stats log by clicking the x in the upper right-hand corner of the stats log.
- Next, uncheck the Combine Enabled Objects.
- Set the Orient to Sagittal [23] and set Slice(s) set to Slice Range [24].
- Set the Start Slice to 50 and the End Slice to 150 [25]. These settings will allow you to sample a range of slices, slice 50 to 150, in the sagittal orientation when Sampled Enabled Object is selected.
- Click the Sampled Enabled Object button [26].
- All objects currently displayed will be sampled. The sampled objects are displayed in red in the current orientation [27].
- Measurements will be returned to the stats log for the enabled objects within the specified range of slices [28].





Sampling Objects using Enabled Objects (continued)

Combining Objects when Sampling a Range of Slices

To sum the object measurements in a single line entry in the stats log for a range of slices, do the following:

- Dismiss the stats log by clicking the x in the upper right-hand corner of the stats log.
- Check the Combine Enabled Objects check box [29].
- Leave the Name set to Combined [30].
- Click the Sampled Enabled Object button [31].
- All objects currently displayed will be sampled for the range of slices specified. The sampled objects are displayed in red in the current orientation. Measurements are summed for the enabled objects and returned to the stats log [32].

The screenshot shows the 'MRI_3D_Head - Measure' application. The 'Sample Type' panel on the left has 'Combine Enabled Objects' checked (labeled 29) and 'Name' set to 'Combined' (labeled 30). The 3D views show a brain model with a red region (labeled 31). The 2D stats log at the bottom shows a table of measurements for 'Combined' objects across a range of slices (labeled 32).

Index	Orient	Name	Slice	Area mm ²	Mean	Comment
86	Sagittal	Combined	135	19290.00	105.80	
87	Sagittal	Combined	136	18902.00	104.79	
88	Sagittal	Combined	137	18620.00	103.84	
89	Sagittal	Combined	138	18309.00	103.82	
90	Sagittal	Combined	139	17975.00	103.32	
91	Sagittal	Combined	140	17490.00	102.88	
92	Sagittal	Combined	141	16928.00	103.13	
93	Sagittal	Combined	142	16387.00	104.17	
94	Sagittal	Combined	143	15757.00	106.29	
95	Sagittal	Combined	144	15227.00	108.28	
96	Sagittal	Combined	145	14672.00	110.77	
97	Sagittal	Combined	146	14203.00	113.23	
98	Sagittal	Combined	147	13738.00	115.14	
99	Sagittal	Combined	148	13322.00	115.73	
100	Sagittal	Combined	149	12670.00	117.07	

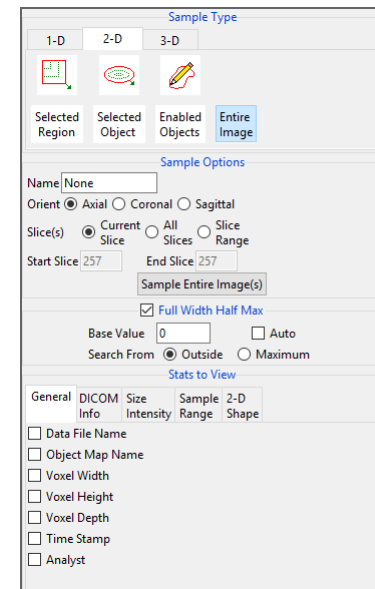


Entire Image

The Entire Image option allows users to sample measurements for the entire slice for the current slice, all slices, or a range of slices.

Sample Options: Provides users the following sampling controls:

- **Orient:** Select the orientation to sample enabled objects in.
 - **Axial:** Sets the sampling orientation to axial.
 - **Coronal:** Sets the sampling orientation to coronal.
 - **Sagittal:** Sets the sampling orientation to sagittal.
 - **Slices:** Allows users to specify the slices sampled.
 - **Current Slice:** Samples the current displayed slice for the selected orientation.
 - **All Slices:** Samples all slices in the selected orientation.
 - **Slice Range:** Samples the range of samples specified using the start and end slice fields for the selected orientation.
 - **Start Slice:** Allows users to set the starting slice for sampling. Slices before the start slice will not be sampled.
 - **End Slice:** Allows users to set the ending slice for sampling. Slices after the end slice will not be sampled.
 - **Sample Entire Image:** Initiates the sampling process.
- Stats to View:** The stats to view area allows users to enable and disable measurements and information reported to the stats log.
- **General:** Allows users to report general image data parameters in the stats log file (see General under Sample Point(s) > Stats to View.)
 - **DICOM Info:** Allows users to report DICOM tag information (see DICOM Info under Sample Point(s) > Stats to View.)
 - **Size Intensity:** Reports an array of size intensity information and measurements (see Size Intensity description for Sample 2-D Rectangle.)
 - **Sample Range:** Samples voxels within a defined region based on a min/max intensity range (see Sample 2-D Rectangle > Sample Range.)
 - **2-D Shape:** Reports 2-D shape measurements for the defined region (see Sample 2-D Rectangle > 2-D Shape.)





Sampling the Entire Image

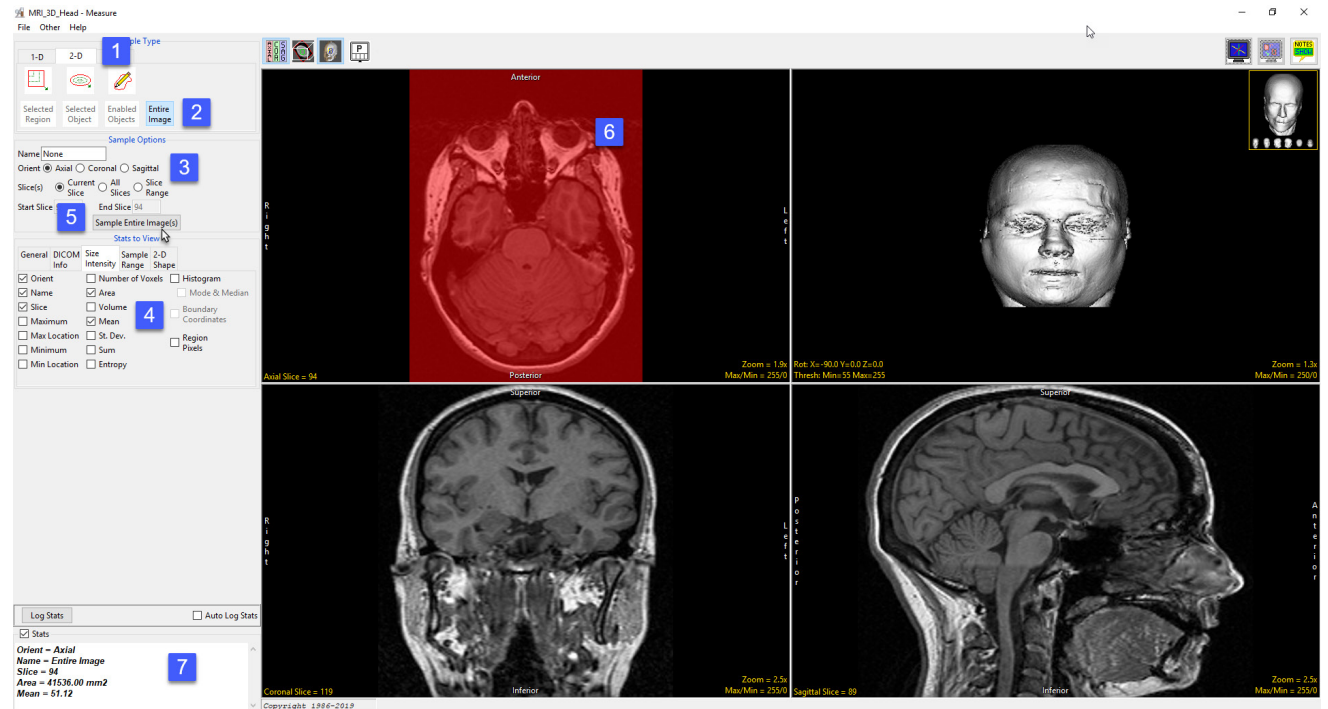
Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select the 2D Sample Type [1] and choose Entire Image [2].

Sampling the Entire Current Slice

To sample the entire current slice, do the following:

- Leave Orient set to Axial and Slice(s) set to Current Slice [3]. This will sample the current axial slice when Sample Entire Image(s) is selected.
- In the Stats to View area check all the measurements [4] you would like returned.
- Click the Sample Entire Image(s) button [5].
- The current axial image will be sampled [6].
- The selected measurements will be returned to the stats review area [7].





Sampling the Entire Image (continued)

Sampling the Entire Slice for All Slices

To sample the entire slice for all slices in the selected orientation, do the following:

- Set Orient to Coronal and then set Slice(s) to All Slices [8].
- Check the Auto Log Stats check box [9].
- Click the Sample Entire Image(s) button [10].
- All slices in the current orientation will be sampled [11].
- Measurements for each slice will be returned to the stats log [12].

The screenshot shows the 'MRI_3D_Head - Measure' application window. The 'Sample Type' panel on the left is configured as follows:

- Sample Type:** 2-D
- Selected Region:** Entire Image (indicated by a blue box with the number 8)
- Sample Options:**
 - Orientation:** Coronal (selected)
 - Slice(s):** All Slices (selected)
 - Start Slice:** 10 (indicated by a blue box with the number 10)
 - End Slice:** 236
 - Sample Entire Image(s):** (button indicated by a blue box with the number 9)
- General DICOM Info:**
 - Log Stats:** (checked, indicated by a blue box with the number 9)
 - Auto Log Stats:** (checked)

The main display area shows three views of the MRI data:

- Top View:** Axial slice 94, showing a cross-section of the head.
- Bottom Left View:** Coronal slice 119, showing a frontal view of the head (highlighted in red).
- Bottom Right View:** Sagittal slice 89, showing a side view of the head.

The 'Stats' panel at the bottom displays a table of measurements for each slice. The table has columns: Index, Orient, Name, Slice, Area mm², Mean, and Comment. The data shows measurements for slices 222 through 236, all in the Coronal orientation, with the name 'Entire Image'.

Index	Orient	Name	Slice	Area mm ²	Mean	Comment
222	Coronal	Entire Image	222	32912.00	3.80	
223	Coronal	Entire Image	223	32912.00	3.74	
224	Coronal	Entire Image	224	32912.00	3.63	
225	Coronal	Entire Image	225	32912.00	3.54	
226	Coronal	Entire Image	226	32912.00	3.45	
227	Coronal	Entire Image	227	32912.00	3.40	
228	Coronal	Entire Image	228	32912.00	3.27	
229	Coronal	Entire Image	229	32912.00	3.10	
230	Coronal	Entire Image	230	32912.00	2.89	
231	Coronal	Entire Image	231	32912.00	2.74	
232	Coronal	Entire Image	232	32912.00	2.69	
233	Coronal	Entire Image	233	32912.00	2.64	
234	Coronal	Entire Image	234	32912.00	2.58	
235	Coronal	Entire Image	235	32912.00	2.51	
236	Coronal	Entire Image	236	32912.00	2.17	



Sampling the Entire Image (continued)

Sampling the Entire Slice for a Range of Slices

To sample the entire slice for a range of slices in the selected orientation, do the following:

- Dismiss the previous stats log by clicking the x in the upper right-hand corner of the stats log.
- Next, set Orient to Sagittal and then set Slice(s) to Slice Range [13].
- Set the Start Slice to 50 and the End Slice to 150 [14]. These settings will allow you to sample a range of slices, slice 50 to 150, in the sagittal orientation.
- Click the Sample Entire Image(s) button [15].
- Only slices in the current range for the selected orientation will be sampled [16].
- Measurements will be returned to the stats log [17].

The screenshot shows the MRI_3D_Head - Measure software interface. The 'Sample Type' panel on the left is configured for '2-D' sampling. The 'Sample Options' section shows 'Orient' set to 'Sagittal' and 'Slice(s)' set to 'Range'. The 'Start Slice' is 50 and the 'End Slice' is 150. The 'Sample Entire Image(s)' button is highlighted with a blue box [15]. The main image area displays four views: Axial, Coronal, Sagittal, and a 3D surface model. The Sagittal view is highlighted with a blue box [16]. The 'Stats to View' section shows 'General' and 'DICOM' tabs. The 'Stats' log at the bottom shows the results of the sampling, with the 'Sagittal' orientation selected. The stats log is highlighted with a blue box [17].

Index	Orient	Name	Slice	Area mm2	Mean	Comment
86	Sagittal	Entire Image	135	44132.00	50.75	
87	Sagittal	Entire Image	136	44132.00	49.32	
88	Sagittal	Entire Image	137	44132.00	48.23	
89	Sagittal	Entire Image	138	44132.00	47.45	
90	Sagittal	Entire Image	139	44132.00	46.41	
91	Sagittal	Entire Image	140	44132.00	45.11	
92	Sagittal	Entire Image	141	44132.00	43.99	
93	Sagittal	Entire Image	142	44132.00	43.16	
94	Sagittal	Entire Image	143	44132.00	42.51	
95	Sagittal	Entire Image	144	44132.00	41.92	
96	Sagittal	Entire Image	145	44132.00	41.39	
97	Sagittal	Entire Image	146	44132.00	40.99	
98	Sagittal	Entire Image	147	44132.00	40.38	
99	Sagittal	Entire Image	148	44132.00	39.36	
100	Sagittal	Entire Image	149	44132.00	38.12	



3-D Measurement Tools

3D measurements are derived from the loaded object map for the data set. Spatial size, signal intensity information and 3D shape characteristics can be derived from an object or collection of objects. These options include; selected object and enabled object. The remaining three measurement options do not require an object map, these include; box, entire volume, and stereology.

The 3-D tab provides access to the following measurement tools:

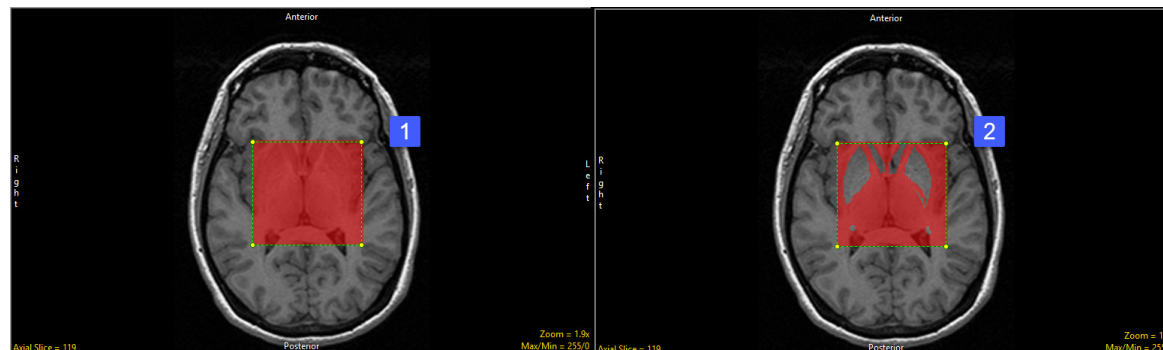
- Box
- Enabled Objects
- Stereology
- Selected Objects
- Entire Volume

Box

The Box tool enables users to interactively define and then sample a 3D box region of interest in the volume image data. The following sampling options are available.

Sample Options: Provides users with access to the following 3D Box sampling options:

- **Name:** Allows users to assign a name to the selected box when reported to the log file.
- **Sample Enabled Objects:** This option is only available when an object map is loaded. When disabled (default) all voxels within the box will be sampled [1]. When enabled only voxels that form part of enabled objects within the box will be sampled [2].





Box Options (continued)

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

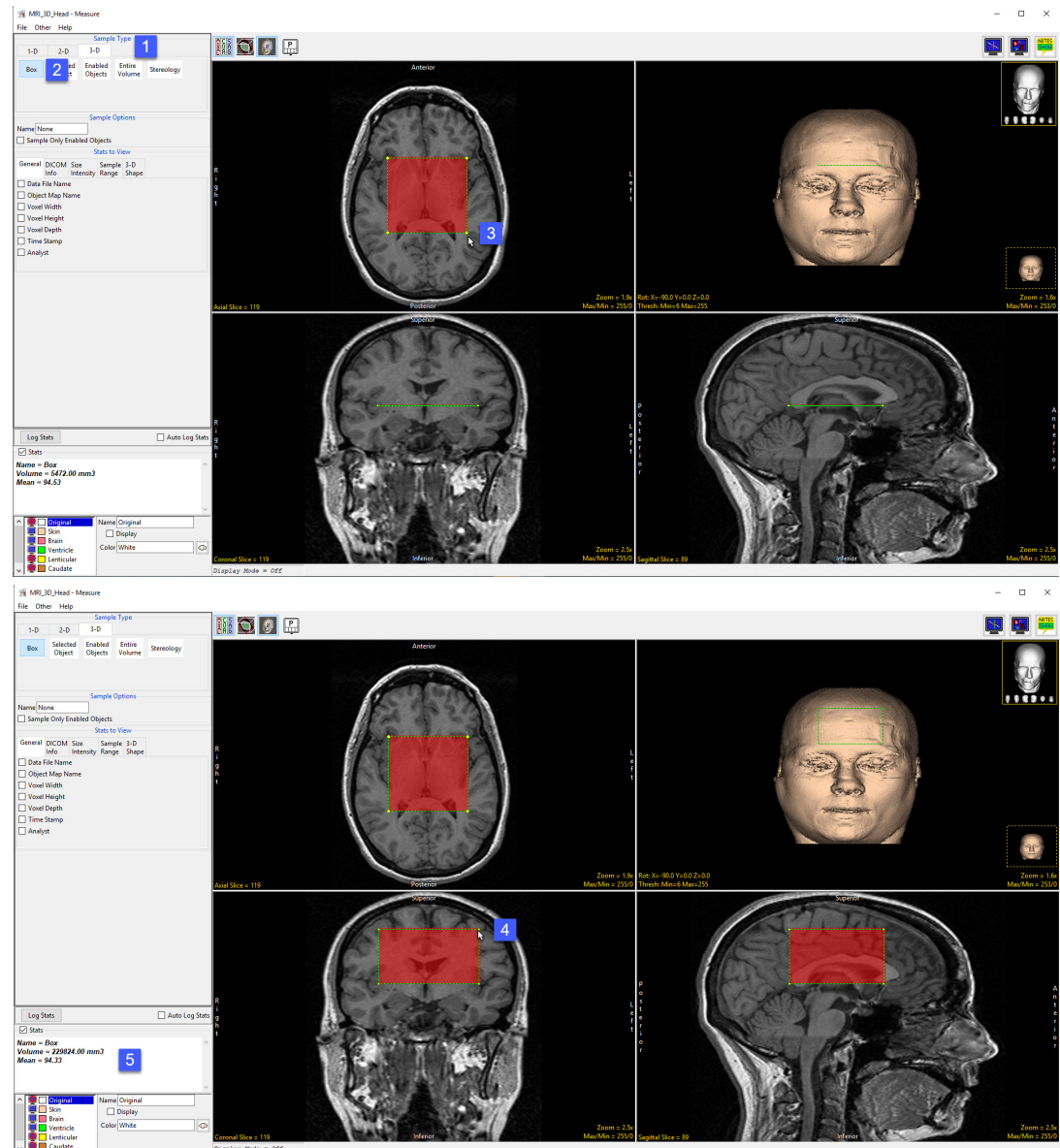
- **General:** Allows users to report general image data parameters in the stats log file. See General under Sample Point(s) > Stats to View for a full description of available options.
- **DICOM Info:** Allows users to report DICOM tag information if the data is in the DICOM format. See DICOM Info under Sample Point(s) > Stats to View above for a full description of available options.
- **Size Intensity:** Allows users to report an array of size intensity information and measurements. Refer to the size Intensity description for Sample 2-D Rectangle for a description of all available options.
- **Sample Range:** Allows users to sample voxels within the defined region based on a minimum and maximum intensity range. Refer to the Sample Range description for Sample 2-D Rectangle for a description of all available options.
- **3-D Shape:** Allow users to measure the following 3-D shape measurements:
 - **MEB Angle Resolution:** MEB (Minimum Enclosing Brick) specifies the angle resolution to be used when searching for the Minimum Enclosing Brick.
 - **Surface Area:** The surface area option reports the estimated surface area for the sampled object.
 - **MEB Angles:** The MEB Angles option reports the orientation angles of the minimum enclosing brick around the object. The angle resolution is specified in the MEB Angle Resolution option.
 - **MEB Volume:** Reports the volume of the minimum enclosing brick.
 - **MEB Coordinates:** Reports the coordinates of the eight corners of the MEB.
 - **Sphere Fit Factor:** Reports the ratio: $SA_3 / (9V^2 * 4\pi)$ where 1 equals a perfect sphere.
 - **Bick Fit Factor:** Reports the ratio: $ObjectVolume / MEB_Volume$ where 1 equals a brick shaped object.
 - **Centroid:** Reports the center gravity for the object.



Making Measurements using Box

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj.
- Select the 3D Sample Type [1] and choose Box [2].
- To define a box first draw a rectangular region on one of the slices, in any orientation [3].
- In either of the other two orientations left click on a corner and then drag the cursor until the desired size and shape box is define [4].
- Selected measurements will be reported for the region in the stats review area [5]. Click Log Stats to return the stats to a log file that can be saved out of Analyze as a .csv file.

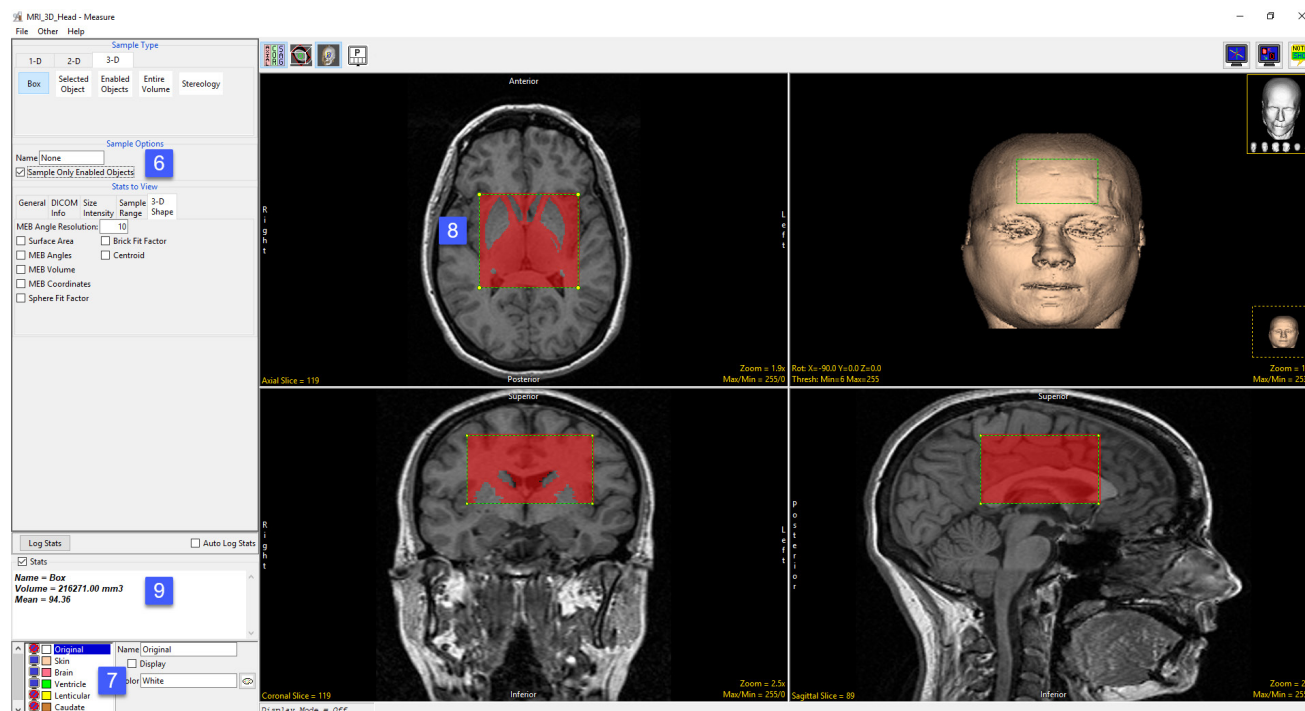




Making Measurements using Box (continued)

Making Box Measurements for Enabled Objects

- To sample only enabled objects within the box check the Sample Only Enabled Objects option [6].
- Only objects in the object list that are displayed [7] will be sampled [8].
- The stats review area will automatically update [9].





Selected Object

The Selected Object option allows users to sample an object within the 3D volume.

An object map must be loaded for this sampling option to be available. The following sampling options are available:

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

- **General:** Allows users to report general image data parameters in the stats log file (see General under Sample Point(s) > Stats to View.)
- **DICOM Info:** Allows users to report DICOM tag information (see DICOM Info under Sample Point(s) > Stats to View.)
- **Size Intensity:** Reports an array of size intensity information and measurements (see Size Intensity description for Sample 2-D Rectangle.)
- **Sample Range:** Samples voxels within a defined region based on a min/max intensity range (see Sample 2-D Rectangle > Sample Range.)
- **3-D Shape:** Allow users to sample different 3-D shape-based measurement, see the 3-D Shape description under 3-D > Box for details on each of the 3-D shape measurements available.

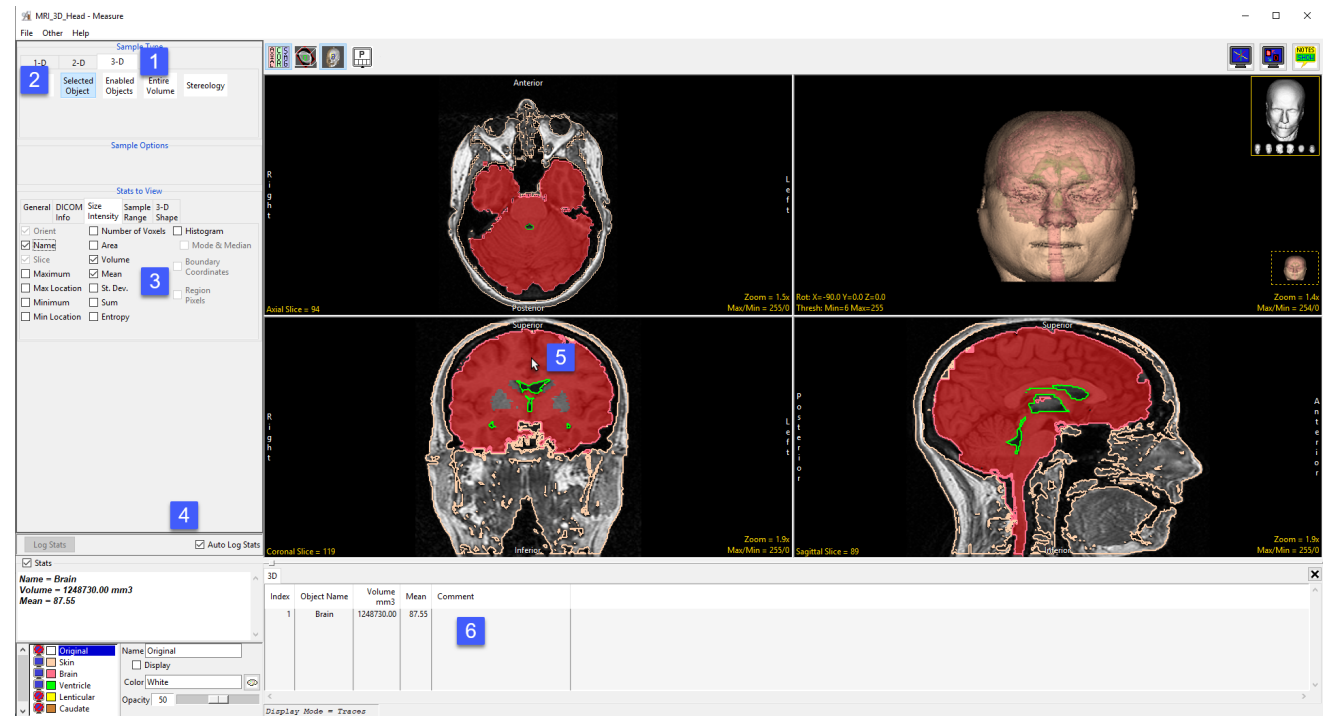
The screenshot shows the 'Sample Type' dialog box. It has three main tabs: '1-D', '2-D', and '3-D'. Under the '2-D' tab, there are four sub-tabs: 'Box', 'Selected Object', 'Enabled Objects', and 'Stereology'. The 'Selected Object' sub-tab is currently selected. Below these tabs is the 'Sample Options' section, which includes a checkbox for 'Full Width Half Max' (checked), a 'Base Value' input field (set to 0), an 'Auto' checkbox (unchecked), and a 'Search From' section with radio buttons for 'Outside' (selected) and 'Maximum' (unchecked). At the bottom is the 'Stats to View' section, which has five sub-tabs: 'General', 'DICOM Info', 'Size Intensity', 'Sample Range', and '3-D Shape'. The 'General' sub-tab is selected, showing a list of checkboxes: 'Data File Name', 'Object Map Name', 'Voxel Width', 'Voxel Height', 'Voxel Depth', 'Time Stamp', and 'Analyst'.



Making Measurements using Selected Object

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj.
- Select the 3D Sample Type [1] and choose Selected Object [2].
- In the Stats to View area check the required measurements [3] to be sampled.
- Check Auto Log Stats [4].
- Click on the brain object in any of the three orthogonal slices [5].
- Selected measurements will be reported for the region in the stats log [6]. Right click to save the log to disk as a .csv file.

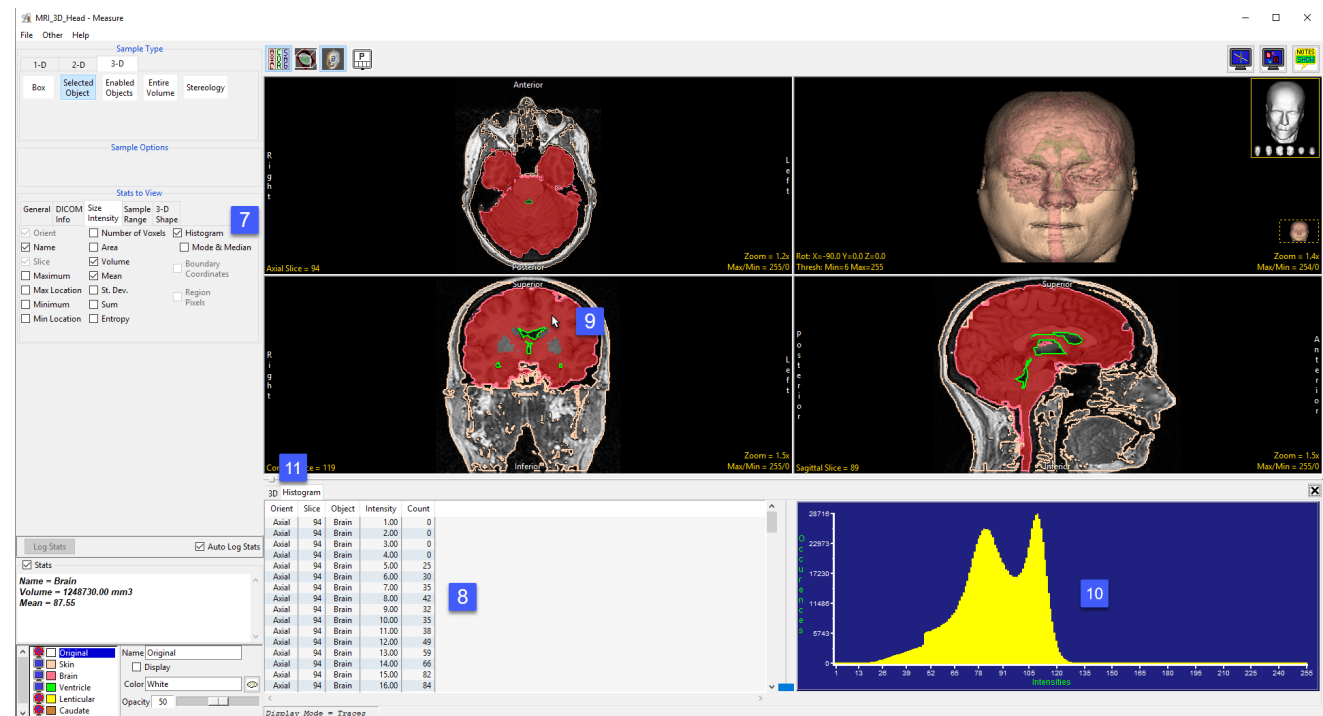




Making Measurements using Selected Object (continued)

Generating Histograms with Selected Object

- Check the Histogram checkbox [7].
- To generate the histogram statistics (intensity and count information) [8] click on the brain [9].
- The histogram for the sampled objects will be displayed below the display area [10] in a new Histogram tab [11] in front of the other statistics tabs.
- Note that objects with the view disabled can accidentally be selected and sampled when using the Selected Object tool. Be aware when selecting an object to sample.
- The histogram information can be saved as a .CSV file by right-clicking and selecting Save Log.



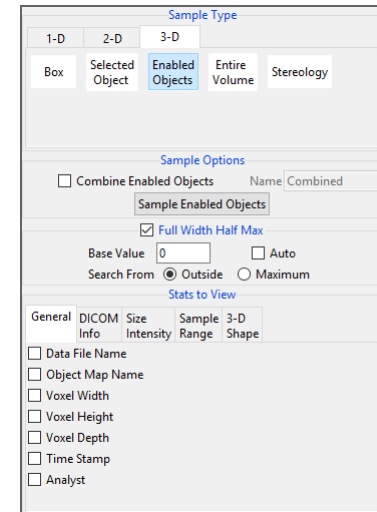


Enabled Object

The Enabled Object option allows users to sample all enabled objects (objects currently displayed) in the volume. An object map must be loaded for this sampling option to be available.

Sample Options: Provides users the following sampling controls:

- **Combine Objects:** Allows users to sum the measurements of the individually sampled objects.
 - **Name:** Allows users to specify a name for the combined object measurements when reported to the stats log.
- **Sample Enabled Objects:** Initiates the sampling process.



Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

- **General:** Allows users to report general image data parameters in the stats log file (see General under Sample Point(s) > Stats to View.)
- **DICOM Info:** Allows users to report DICOM tag information (see DICOM Info under Sample Point(s) > Stats to View.)
- **Size Intensity:** Reports an array of size intensity information and measurements (see Size Intensity description for Sample 2-D Rectangle.)
- **Sample Range:** Samples voxels within a defined region based on a min/max intensity range (see Sample 2-D Rectangle > Sample Range.)
- **3-D Shape:** Allow users to sample different 3-D shape-based measurement, see the 3-D Shape description under 3-D > Box for details on each of the 3-D shape measurements available.

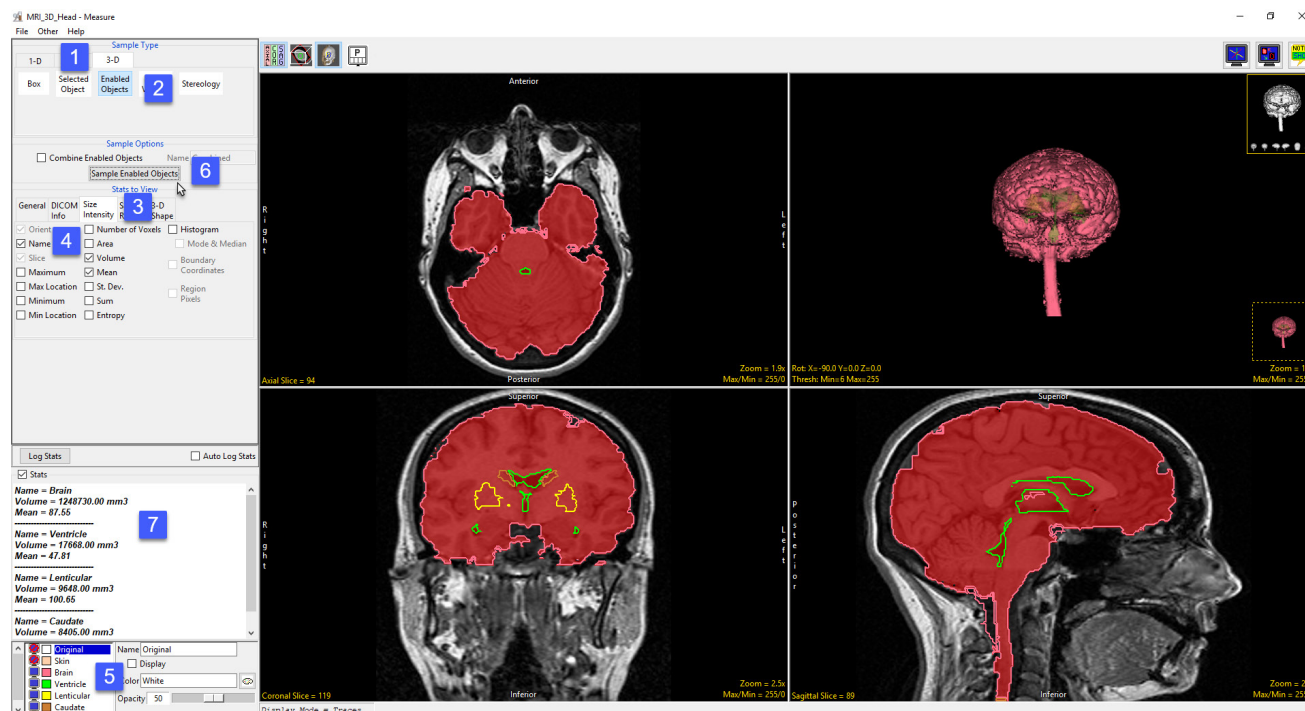


Making Measurements using Enabled Object

Sampling Enabled Objects

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze. Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj.
- Select the 3D Sample Type [1] and choose Enabled Object [2].
- Select Size Intensity [3] and make sure that Name, Volume, and Mean are checked. Uncheck Area [4].
- Switch the display of the Skin object off [5] by clicking on the monitor icon next to the object in the object list.
- Switching the display of an object off disables the object so it won't be sampled. Switch on the Lenticular and Caudate objects.
- Click Sample Enabled Objects [6]. The selected measurements for the enabled objects will be reported to the stats review area [7].

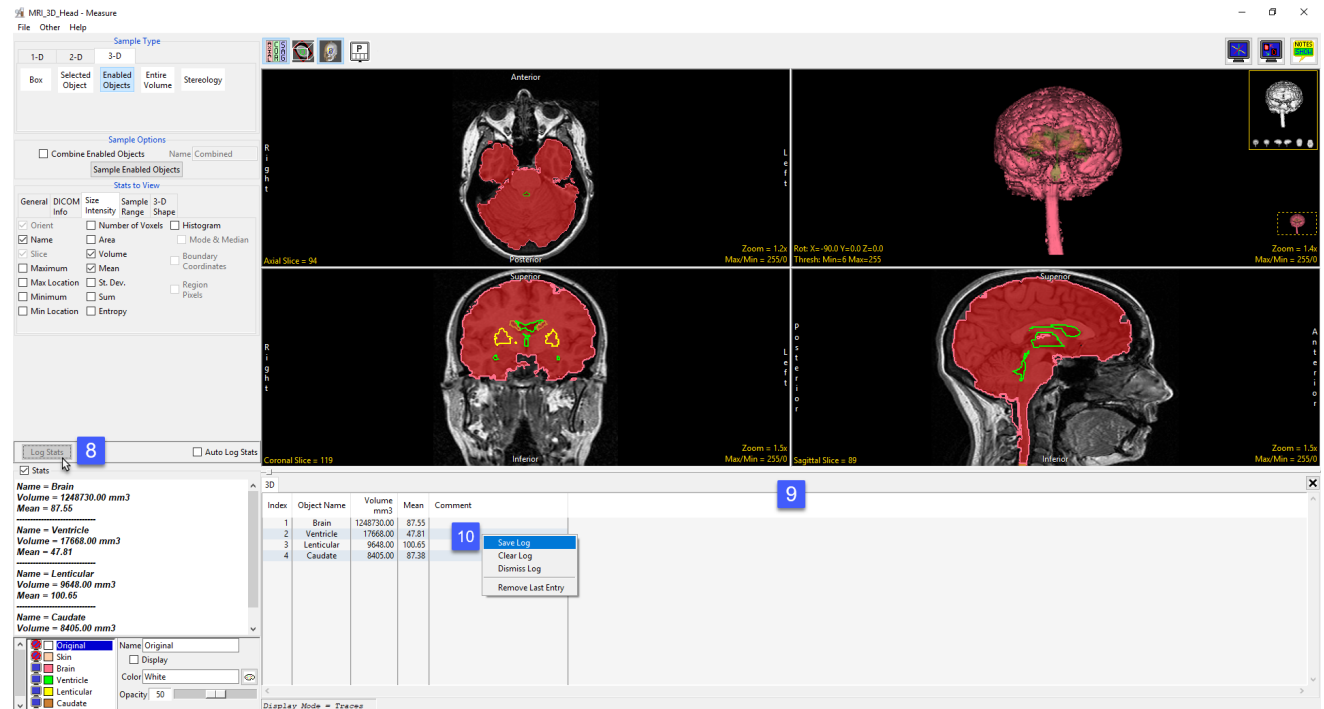




Making Measurements using Enabled Object (continued)

Sampling Enabled Objects (continued)

- To report the selected measurements to a log file that can be saved from Measure, click the Log Stats button [8]. When clicked the button will become grayed out.
- The selected measurements for the enabled objects will be reported to a file below the image display area [9].
- To save the measurements log file, right-click in this area and select Save Log [10]. The log file will be saved as a .CSV file.

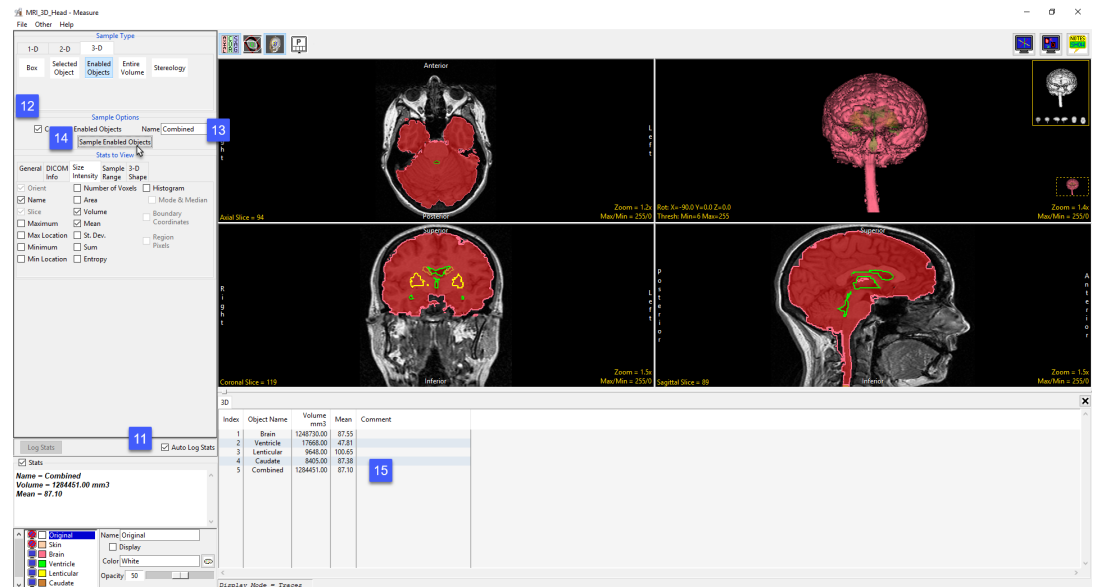




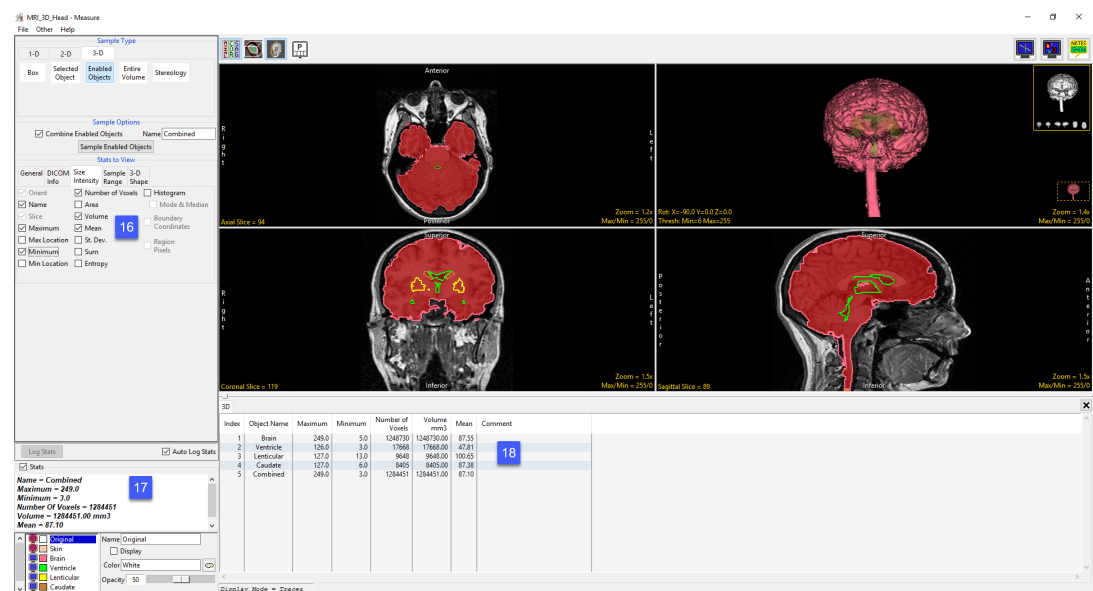
Making Measurements using Enabled Object (continued)

Using Enabled Objects to make Combined Measurements

- Check the Auto Log Stats checkbox [11].
- Next, check the Combine Enabled Objects checkbox [12].
- Name the combined result or leave the default name as Combined [13].
- Click Sample Enabled Objects [14].
- The combined measurements will be reported in the stats review area [15] and added to the log file.



- Checking additional measurement options [16] will automatically update in the stats review area with the selected measurement for the combined object [17].
- The measurements for the individual and combined objects will automatically update in the log [18].





Making Measurements using Enabled Object (continued)

Using Enabled Object to Generate a Combined Object Histogram

- Check the Histogram check box [18] and select Sample Enabled Objects [19].
- The histogram measurements will be reported [20] and the histogram plotted [21] in a new tab.





Entire Volume

The Entire Volume option allows users to sample measurements for the entire data set. The entire volume measurement option does not require an object map.

Sample Options: Provides users the following sampling controls:

- **Name:** Allows users to specify a name for the combined object measurements when reported to the stats log.

Stats to View: The stats to view area allows users to enable and disable measurements and information reported to the stats log.

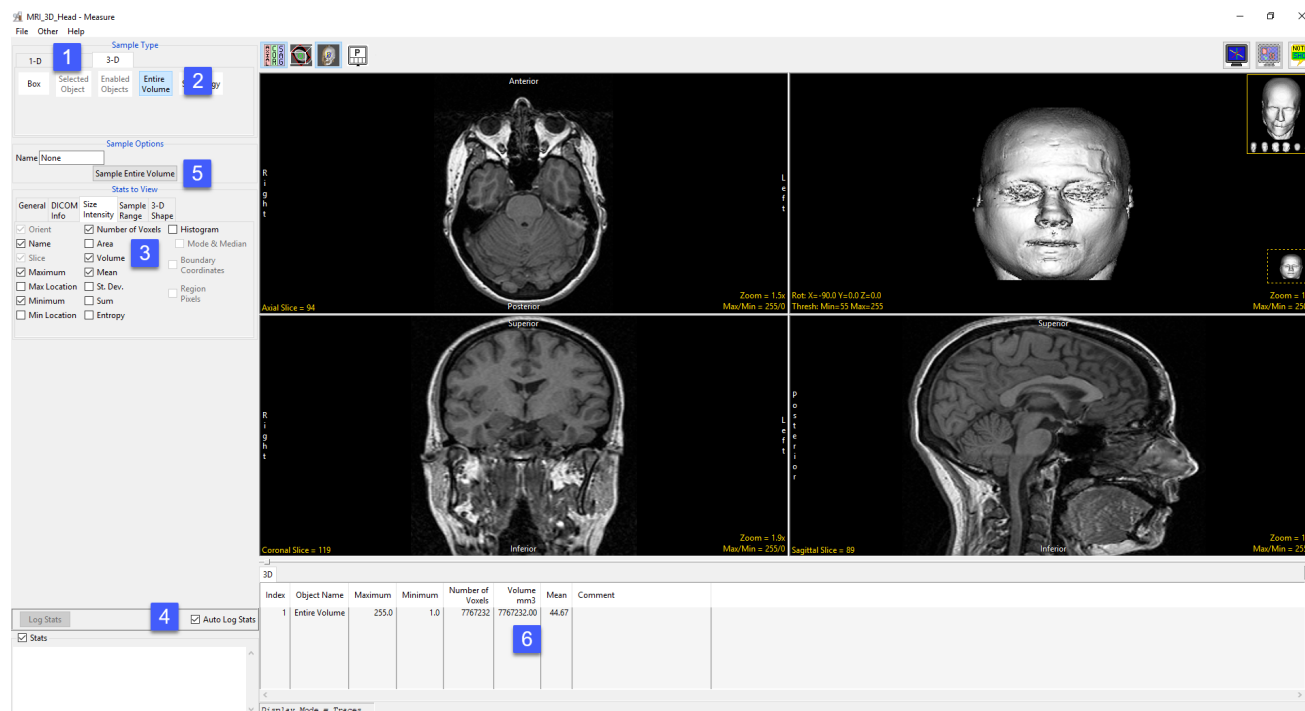
- **General:** Allows users to report general image data parameters in the stats log file (see General under Sample Point(s) > Stats to View.)
- **DICOM Info:** Allows users to report DICOM tag information (see DICOM Info under Sample Point(s) > Stats to View.)
- **Size Intensity:** Reports an array of size intensity information and measurements (see Size Intensity description for Sample 2-D Rectangle.)
- **Sample Range:** Samples voxels within a defined region based on a min/max intensity range (see Sample 2-D Rectangle > Sample Range.)
- **3-D Shape:** Allow users to sample different 3-D shape-based measurement, see the 3-D Shape description under 3-D > Box for details on each of the 3-D shape measurements available.



Sampling the Entire Data Set using Entire Volume

Download the MRI_3D_Head.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load MRI_3D_Head.avw into Analyze.
- Select MRI_3D_Head and open Measure.
- Select File > Load Object Map and load the MRI_3D_Head.obj.
- Select the 3D Sample Type [1] and choose Entire Volume [2].
- Select Size Intensity [3] and make sure that Name, Volume and Mean are checked. Uncheck Area.
- Check Auto Log Stats [4] and click Sample Entire Volume [5].
- The selected stats for the entire volume will be reported in the Stats review area [6] and log file.





Stereology

The Stereology tool estimates volume and surface area using the stereological method of point counting. This method consists of overlaying images entirely with a randomly positioned and oriented systematic array of test points and counting the number of occasions on which a point lies within the feature of interest.

Stereology Options:

- **Estimate:** Choose from the following to determine the type of estimation to conduct:
 - **Volume Only:** Specifies that only volume estimations will be made.
 - **Volume & Surface Area:** Specifies that both volume and surface area estimations will be made.
- **Orient:** Allows users to select the orientation to create the sampling grid in.

Slice:

- **Start:** Specifies the initial slice to be used for the grid. Enter the desired slice number in the text entry box.
- **Incr:** Specifies the interval of the slices used when generating the grid. Enter the desired increment in the text entry box.
- **Number:** Specifies the number of slices to be used for the grid. Enter the desired number in the text entry box.
- **Spacing:**
 - **X:** Allows users to the distance (in pixels) between grid elements in X.
 - **Y:** Allows users to the distance (in pixels) between grid elements in Y.
- **Start Position:** Choose from Random and Specified to specify whether the starting position is randomly selected or specified by the following options. When Random is selected the X Start Position, Y Start Position, and Angle text entry fields are disabled.
- **Random:** Generates a random grid.
- **Specified:**
 - **Start X:** Specifies the x position of the first grid element.
 - **Start Y:** Specifies the y position of the first grid element.
 - **Angle:** Specifies the angle used to position the grid on the image.

The screenshot shows the 'Stereology Options' dialog box. At the top, under 'Sample Type', the '3-D' tab is selected, and within it, the 'Stereology' sub-tab is active. The 'Estimate' section has 'Volume Only' selected. The 'Orient' dropdown is set to 'Axial'. The 'Slice' section shows 'Start' as 1, 'Incr' as 1, and 'Num' as 512. The 'Spacing' section shows 'X' as 10 and 'Y' as 10. The 'Start Position' section has 'Random' selected, which has disabled the 'Start X', 'Start Y', and 'Angle' fields. The 'Generate Grid' button is visible. Below this, the 'Full Width Half Max' checkbox is checked. The 'Base Value' is 0, and 'Search From' is set to 'Outside'. At the bottom, under 'Stats to View', several checkboxes are shown: 'Points' (unchecked), 'Volume' (checked), 'Coefficient of Error' (checked), 'Elliptical Error' (unchecked), 'X Intersections' (unchecked), 'Y Intersections' (unchecked), 'Z Intersections' (unchecked), 'Surface Area' (checked), and 'B/sqrt(A)' (unchecked).



Stereology Options (continued)

Stereology Options (continued):

- **B/sqrt(A):** Specifies the value used in correcting the estimation of surface area. This value is determined during the estimation of the volume.
- **Generate Grid:** Generates the grid based on the parameters entered above.

Stats to View

- **Stereology**
 - **Volume:**
 - **Points:** Reports the number of points selected.
 - **Volume:** Displays the current estimation of the specified volume.
 - **Coefficient of Error:** Specifies the current estimation of the error coefficient.
 - **Elliptical Error:** More accurate error estimate for objects which are unusually regular, close to an ellipsoidal shape.
 - **Surface Area**
 - **X Intersection**
 - **Y Intersection**
 - **Z Intersection**
 - **Surface Area:** Displays the current surface area estimation (in Surface Area mode only).
 - **B/sqrt(A):** Specifies the mean boundary length divided by the square root of the mean area of the sampled object on all the slices. This is computed in Surface Area Mode and improves Coefficient of Error Estimates.

Right click options:

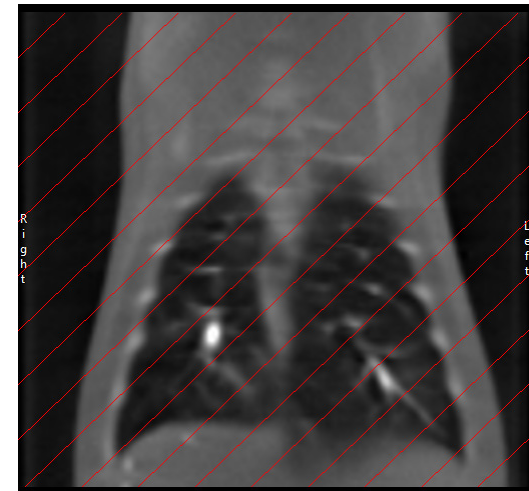
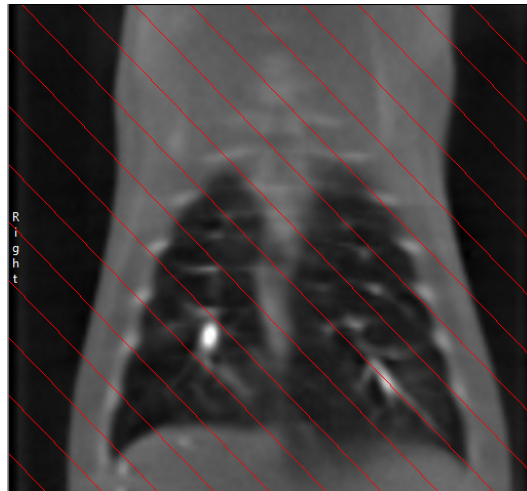
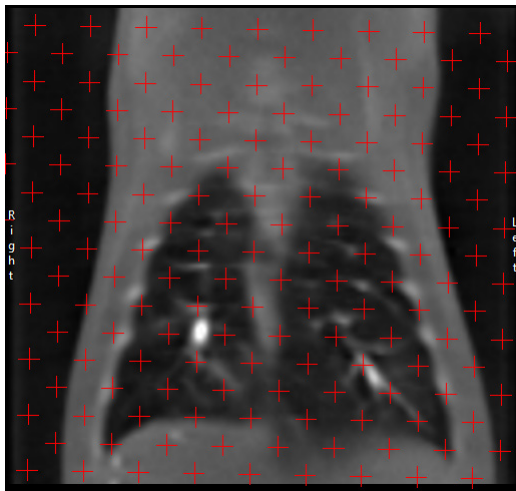
- **Copy Grid Forward:** Copies the current grid forward to the next grid slice. If points have been selected (green points) there selected state will be copied forward also.
- **Middle Button Action:** Allows users to set the action of the middle mouse button. See the Image Display, Controls and Customization section for a full description of this option.



Stereology Options (continued)

Right Click Options (continued):

- **Mouse Wheel Action:** Allows users to set the action of the middle mouse wheel. See the Image Display, Controls and Customization section for a full description of this option.
- **Copy to Clipboard:** Copies the current slice display to memory.
- **Isotropic:** Active only for anisotropic data. Allows users to toggle between an isotropic or anisotropic display of the data.
- **Show Active Slices Only:** Allow users to automatically skip non-grid slices using the + or – keys or the mouse scroll wheel.
- **Show Grid:** Toggles the display of the volume estimation grid when surface area is selected.
- **Show X Lines:** Toggles the display of the x lines for surface estimation when estimating surface area is active.
- **Show Y Lines:** Toggles the display of the y lines for surface estimation when estimating surface area is active.

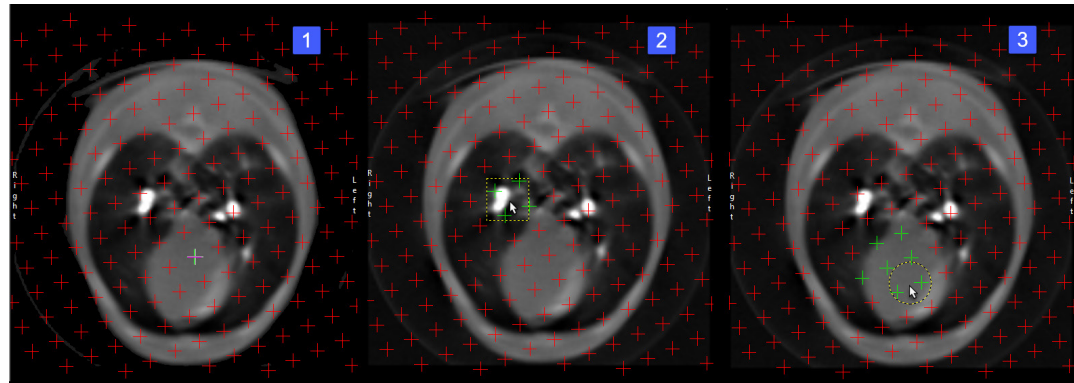




Stereology Options (continued)

Right Click Options (continued):

- **Toggle with 's' key:** When enabled allows users to toggle between Grid, X Lines, and Y Lines.
- **Stereology Cursor:** Allows users to change the shape of the cursor for selecting grid points. Users can choose from; Crosshair [1], Rectangle [2], or Oval [3].



- **Additional Cursor options:** Additional options are available for the Rectangle and Oval cursors:
 - **Rectangle Shape:** Choose from Square, Wide, or Tall.
 - **Rectangle Size:** Tiny, Small, Medium, Large, Extra Large
 - **Oval Shape:** Choose from Circular, Wide, or Tall.
 - **Oval Size:** Tiny, Small, Medium, Large, Extra Large
- **Keyboard Shortcuts:** The following keyboard shortcuts are available:
 - **S:** Toggle through the cursor options.
 - **X:** Toggle through cursor shape options.
 - **Z:** Toggle through the cursor size options.

Axis Label: Allows users to enable or disable the display of the axis labels on the perimeter of the slice display window.

Border Ruler: Enables/Disables the boarder ruler tool.

Reset: Resets all options to default.

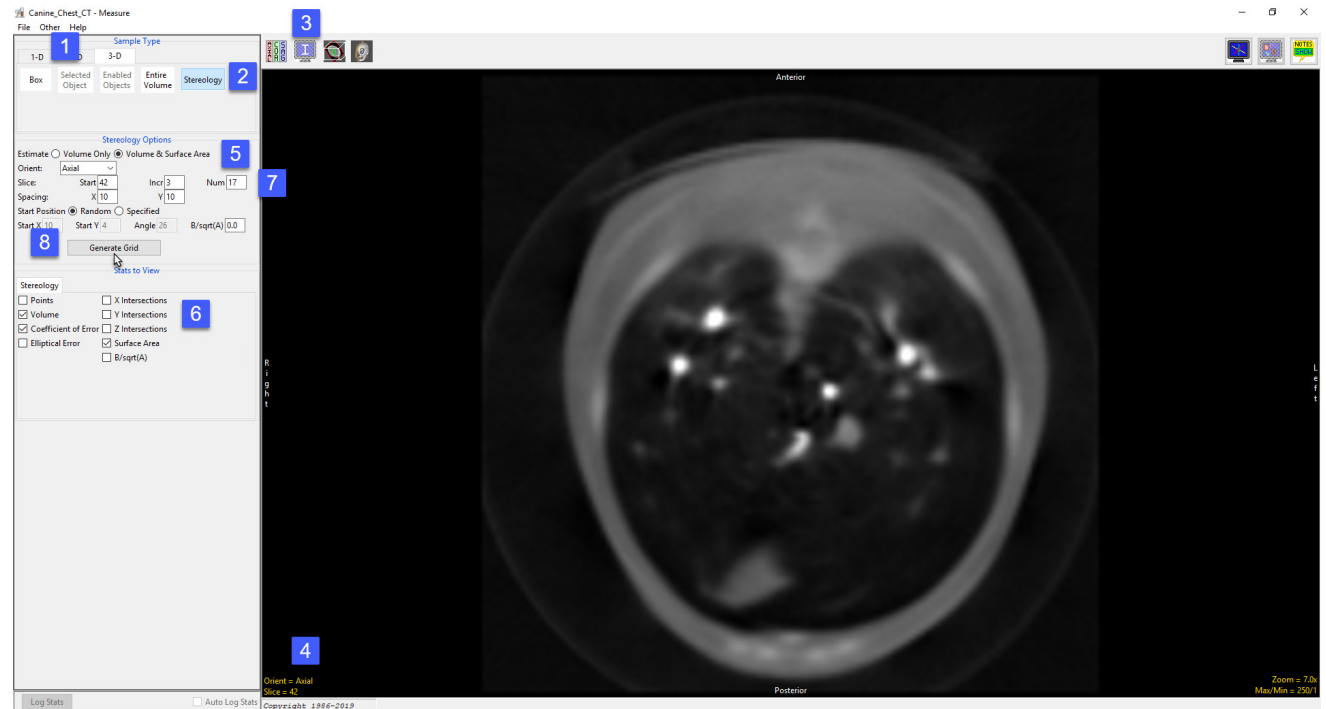


Estimating Volume using Stereology

In this example we will use Stereology to estimate the volume of the heart in a CT data set.

Download the Canine_Chest_CT.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load Canine_Chest_CT.avw into Analyze. Select Canine_Chest_CT and open Measure.
- Select the 3D Sample Type [1] and choose Stereology [2].



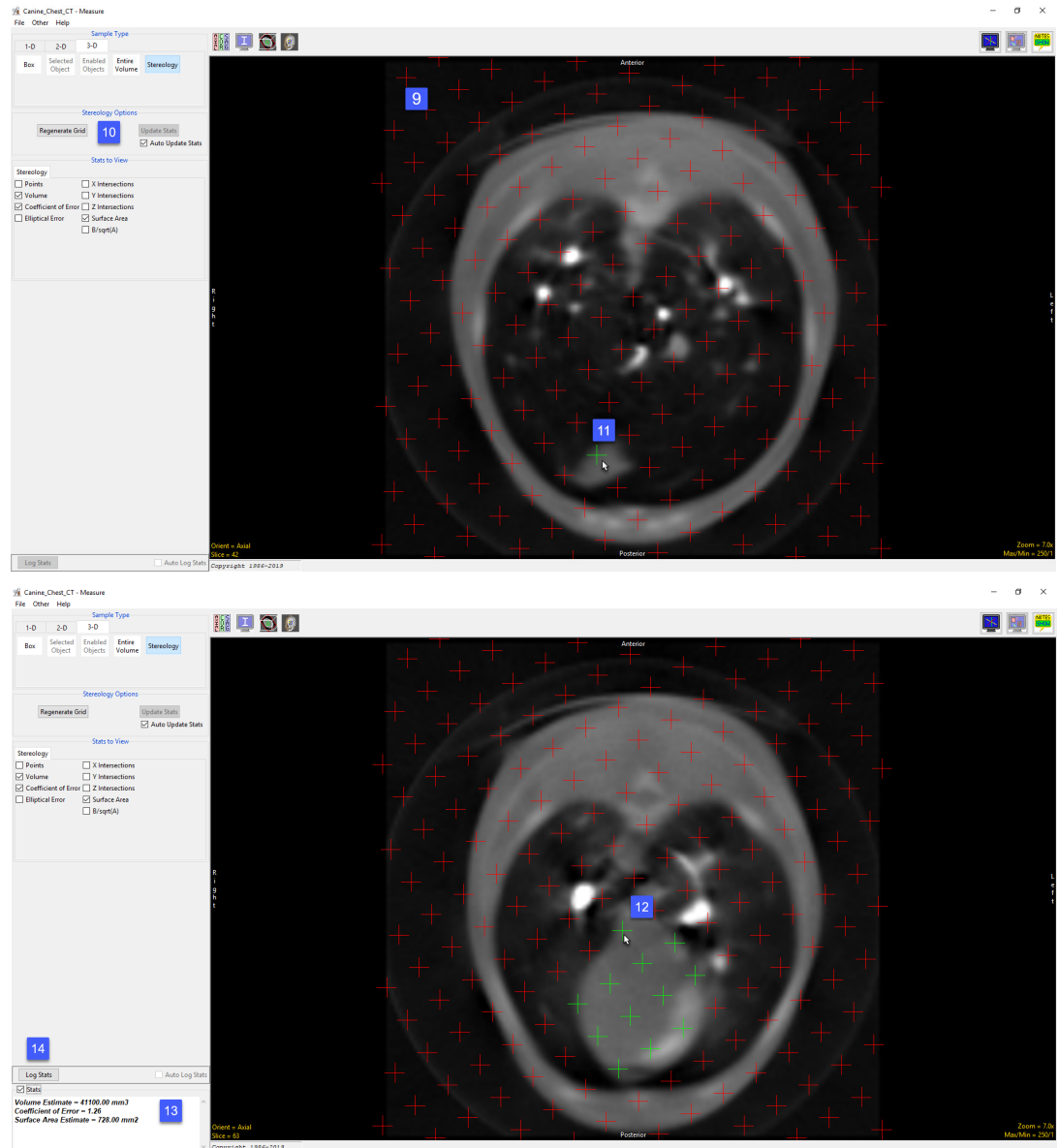
- Use the Display tools to configure the image display so that the rendering is disabled and only one orthogonal slice is displayed [3].
- Ensure the orientation is set to Axial and then move to slice 42 [4]. This is the first axial slice that the heart can be seen on.
- From Stereology Options set Estimate to Volume & Surface Area [5]. Notice that the surface area related measurement options become available in the Stats to View area [6].
- The heart first appears around axial slice 42 and remains visible until slice 94. To create a sampling grid that will encompass the heart set the Start Slice to 42. Using Stereology, it is not necessary to sample every slice, set the Grid Slide Increment to 3 and Number of Grid Slices to 17 [7].
- Click Generate Grid [8] to generate the sampling grid on the image.



Estimating Volume using Stereology (continued)

- The grid will be overlaid on the image data.[9].
- The stereology options to generate the grid will no longer be visible, however, if you need to modify or recreate the grid click the Regenerate Grid button [10] and all options will be displayed.
- Move the cursor over to the image and click on any point that falls on the heart [11]. When completed press the + key on your keyboard to move to the next grid slice and repeat.
- As you continue to move through the data selecting points [12] the stats review area [13] will update with the measurements selected.
- When sampling is complete select Log Stats to log the measurements to a stats log that can be saved to disk as a .csv file.

Note: If Stereology is to be used for research study, it is necessary to validate the process for the study application. To validate a stereologic-based estimate of volume, segmentations of the structure of interest need to be established as gold standard volume measurements to which the stereologic estimates can be compared. These gold standard test volumes also provide the opportunity to establish best grid parameters to be used for the study.



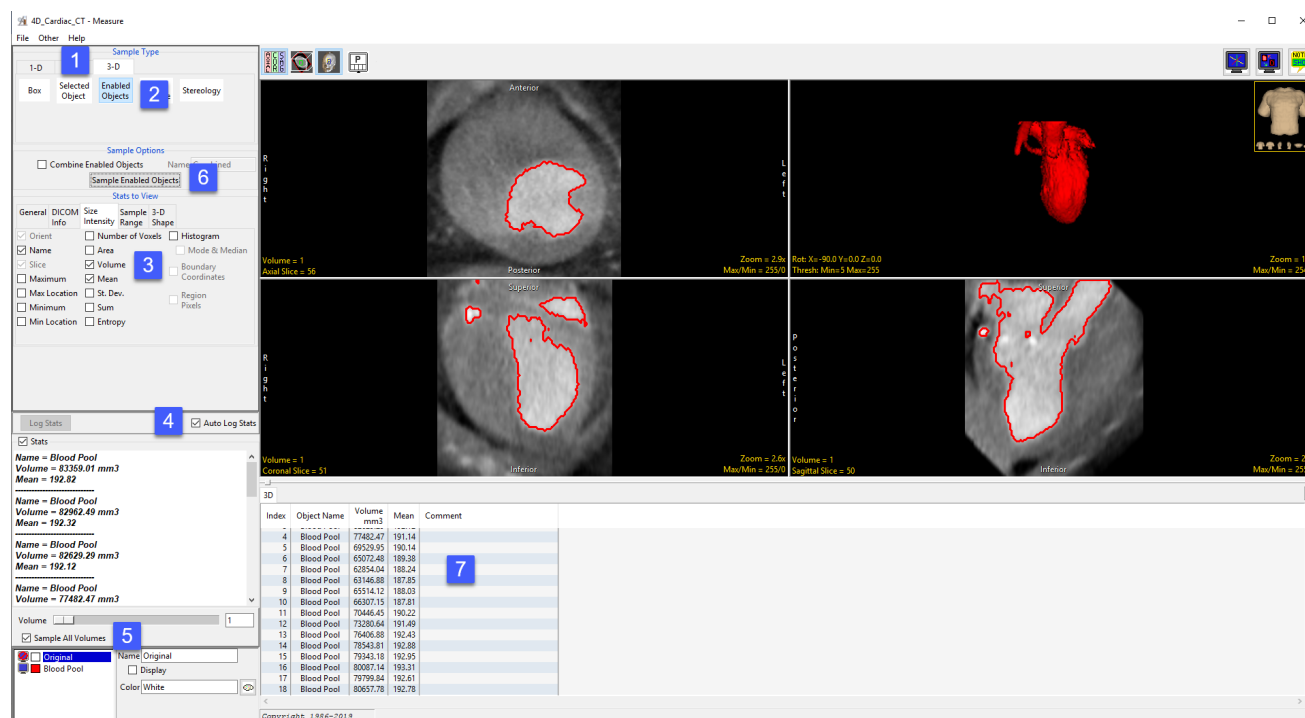


Sampling 4D Multivolumes using 3D Tools

Measure can sample 4D image data. When 4D image data is loaded into Measure a volume slider is available allowing users to selected different volumes.

Download the 4D_Cardiac_Cycle.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load 4D_Cardiac_Cycle.avw into Analyze. Select 4D_Cardiac_Cycle and open Measure.
- Select File > Load Object Map and load the 4D_Cardiac_Cycle object.
- Select the 3D Sample Type [1] and choose Enabled Objects [2].
- Select Size Intensity [3] and check Name, Volume and Mean, and uncheck Area.
- Check Auto Log Stats [4] and check Sample All Volumes [5].
- Click Sample Enabled Objects [6].
- The total volume of the blood pool for each of the 18 3D volumes in the 4D multivolume will be reported in the 3D log [7]. Right click to save the log as a .CSV file.





Sampling 4D Multivolumes using 3D Tools (continued)

Measure can also generate 4D histograms from 4D image data. When 4D image data is loaded into Measure a volume slider is available allowing users to select different volumes.

Download the 4D_Cardiac_Cycle.avw data set from analyzedirect.com/data to follow along.

- Open Input/Output and load 4D_Cardiac_Cycle.avw into Analyze. Select 4D_Cardiac_Cycle and open Measure.
- Select File > Load Object Map and load the 4D_Cardiac_Cycle object.
- Select the 3D Sample Type [1] and choose Enabled Objects [2].
- Select Size Intensity [3] and ensure that Name, Volume and Mean, and Histogram are checked [4].
- Check Auto Log Stats [5] and check Sample All Volumes [6]. Click Sample Enabled Objects [7].
- The histogram measurements will be reported [8] and the histogram plotted [9] in a new tab.
- The volume slider [10] beneath the histogram stats allows review of histograms for all 3D volumes in the 4D multivolume.

