



You can draw and measure angles using the Angle ROI tool. Drawing angles requires three click on the image to define the 3 points of the angle (Figure 6.74).



Figure 6.74. The Angle ROI tool.

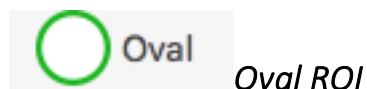


You can use the rectangle ROI tool to draw rectangles or squares and to compute their area (figure 6.75). Click on one of its corners and keep the mouse button pressed while dragging to the opposite corner. When the mouse button is released, the area, width, height, mean, standard deviation, sum, minimum value, and maximum value are displayed in a box to the side.



Figure 6.75. The Rectangle ROI tool.

If pixel dimensions are available from the DICOM file, area is given in  $\text{cm}^2$  or in  $\mu\text{m}^2$  (for values less than  $1 \text{ mm}^2$ ). Otherwise, the values are given in square pixels and pixels respectively. The rest of the statistical values are in pixels.



You can draw ellipse on an image and to compute its area. Click and hold on the image where you want the center point of the ellipse and drag the mouse away from the center to define the size and eccentricity of your ellipse. When you release the mouse button, the ROI is validated and information on its area, mean, standard deviation, sum, minimum value and maximum value are displayed (Figure 6.76). If pixel dimensions are available from the DICOM file, area is given in  $\text{cm}^2$  or in  $\mu\text{m}^2$  (for values less than  $1 \text{ mm}^2$ ). Otherwise, the values are given in square pixels and pixels respectively. The rest of the statistical values are in pixels.

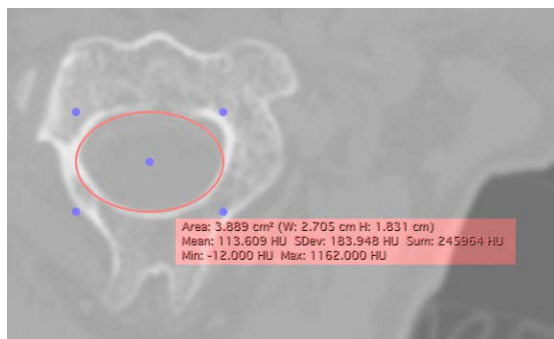
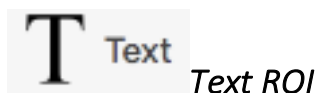


Figure 6.76. The Oval ROI tool.



You can add text annotations to an image by clicking anywhere on an image; the text label will be centered at this location. To edit the text, simply double click and enter the information in the popup window. The ROI Info Panel will also allow you to change the size (thickness), color, and opacity of the text.

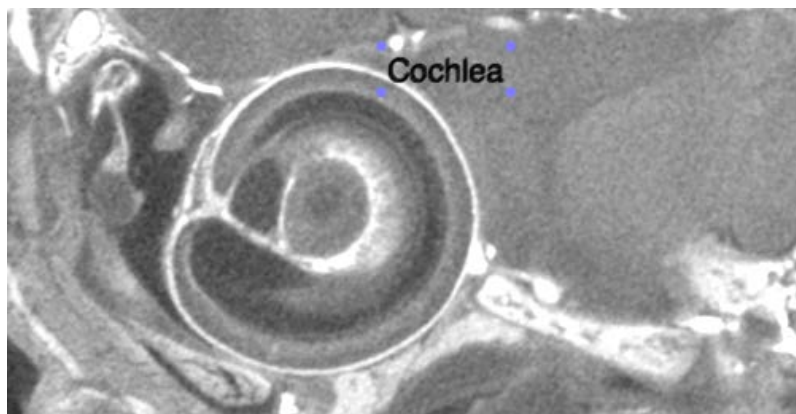
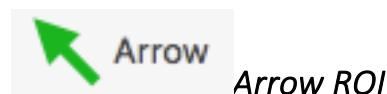


Figure 6.77. The Text tool.

*Arrow ROI*

You can add arrows to an image by clicking and dragging the mouse. Begin at the point where you want the arrowhead and drag away the desired length.

*Closed Polygon ROI*

You can create a closed polygon with as many corners as you desire. Begin by clicking on a point on the image you would like to enclose in a polygon. Continue to click to add corners to the polygon until you have nearly enclosed it. Finish by double clicking on the last point. This creates a closed polygon with information on area, perimeter (length), mean, standard deviation, sum, and maximum and minimum values for the polygon (Figure 6.78).

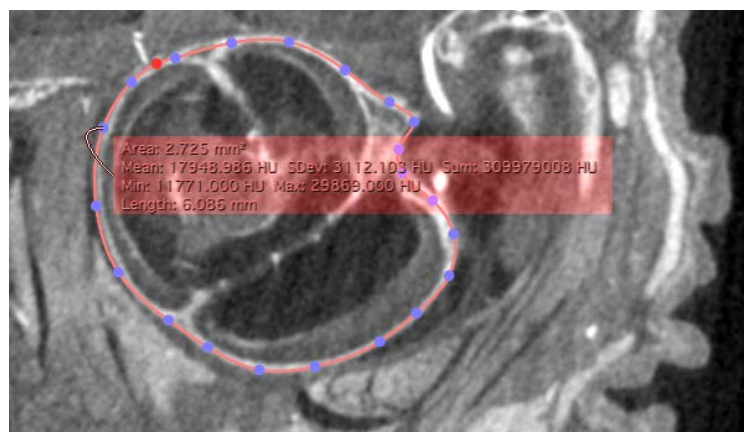
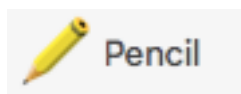


Figure 6.78. The Closed polygon tool with the statistical information displayed.

If pixel dimensions are available from the DICOM file, area is given in cm<sup>2</sup> or in μm<sup>2</sup> (for values less than 1 mm<sup>2</sup>). Length is given in cm or μm. Otherwise, the values are given in square pixels and pixels respectively. The rest of the statistical values are in pixels.

*Opened Polygon ROI*

The Opened Polygon tool is similar to the Closed Polygon tool except that the first and last points are not connected. Double clicking on the last point displays the length of the line.



### *Pencil ROI*

You can create a closed polygon with the Pencil ROI tool, however the pencil tool is used differently. With the pencil tool selected, click and hold the mouse button on the starting point and drag the mouse along a path to enclose the structure you wish to measure. Releasing the mouse button completes the ROI and brings up information such as area, perimeter length, etc. (Figure 6.79).

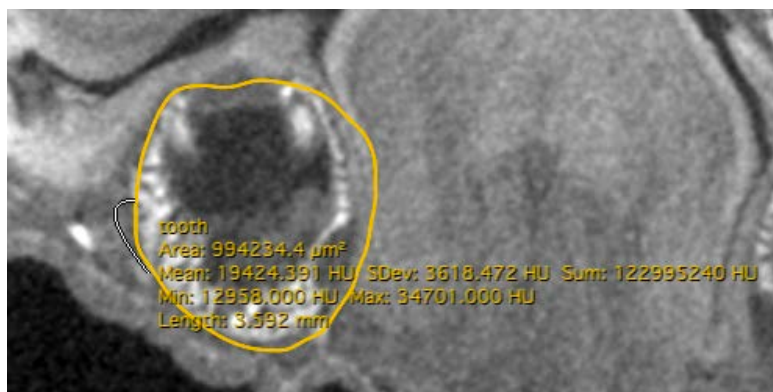
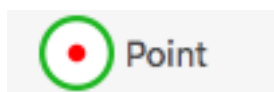


Figure 6.79. An area outlined using the pencil tool.

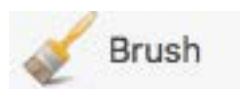


### *Point ROI*

The Point ROI tool allows to get data on single pixels in an image. Clicking on a point in the image brings up a box that displays the pixel value, along with its 2D (x, y) and 3D (x, y, z) positions in pixels (Figure 6.80). 2D positions are given in pixels and 3D positions are given in mm. Note that Point ROIs will also be visible on the 3D Volume Rendering, 3D Surface Rendering tools (see the specific sections for more details).



Figure 6.80. The point ROI tool.

***Brush ROI***

The brush ROI tool allows you to paint a region on the image by clicking and dragging the mouse with the button held down. When the region has been painted, simply release the mouse button. When you first select the brush tool a popup window appears (Figure 6.81) which allows you to adjust the size of the brush for more precision. Clicking on the erase button in the popup tool converts the brush to an eraser and allows you to remove regions you previously painted. Double clicking on the brushed region brings up the ROI info panel which allows you to name the region, change the brush color, modify the opacity among other options (Figure 6.82).

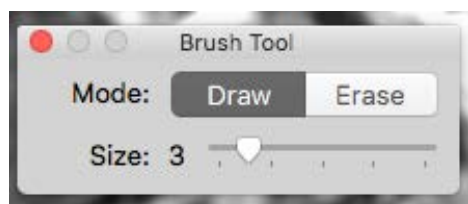


Figure 6.81. The Brush tool popup window.

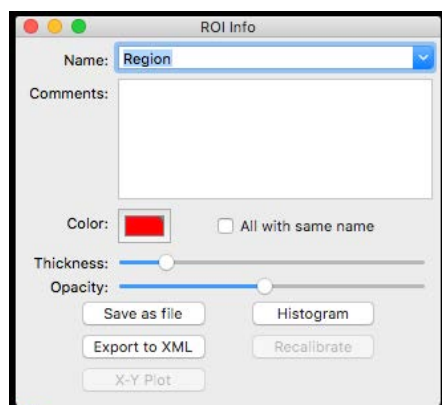
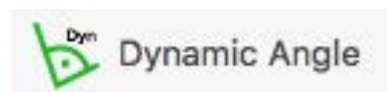


Figure 6.82. The ROI info panel.

Unlike other ROI tools, the brush ROI cannot be resized or rotated. It is attached to its underlying pixels. Completed brush ROIs also display information on area, mean, standard deviation, sum, and maximum and minimum pixel values. If pixel dimensions are available from the DICOM file, area is given in  $\text{cm}^2$  or in  $\mu\text{m}^2$  (for values less than  $1 \text{ mm}^2$ ), or in square pixels. The rest of the statistical values are in pixels.

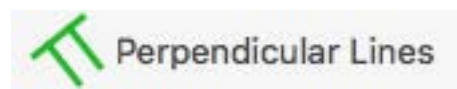
***Axis ROI***

The mean axis is calculated and displayed based on four points.



### *Dynamic Angle ROI*

The Dynamic angle tool calculates the angle between two lines. Each line is defined by two points (the first two points define line 1 and the last two points define line 2). The angle between those lines is displayed in an info box along with its opposite angle. The sum of these two angles is equal to 360 degrees.



### *Perpendicular Lines ROI*

The Perpendicular Lines ROI generates three lines, A, B, and C. Lines B and C are parallel to each other and orthogonal to line A (figure 6.83). Each line terminates in a small dot, which you can grab with the mouse and move. An info box provides information of the length of each line as well as the length between lines B and C in cm.



Figure 6.83. The perpendicular lines ROI.



### *Repulsor Tool*

Although the Repulsor tool is found at the bottom of the ROI tools list, it does not create an ROI. Instead, it is used to modify the shape of existing ROIs on an image. The Repulsor only works with the Length, Opened Polygon, Closed Polygon and Pencil ROIs.

Assuming you have an appropriate ROI on an image, select the repulsor tool and click on the image while holding down the mouse button. The repulsor is a pulsing yellow circle. Note that when clicking close to the ROI, the radius of the Repulsor appears small and when clicking far from the ROI, the radius is large. With your mouse button still held down, drag your repulsor circle toward the ROI. The repulsor re-shapes the ROI border. Releasing the mouse button causes the repulsor circle to disappear, but clicking again on a new location brings the repulsor tool back. ROIs that are not currently selected will not be affected by the repulsor tool (use the

Selector tool to select ROIs). Note that you can also position the repulsor inside a closed polygon and push the border from within.

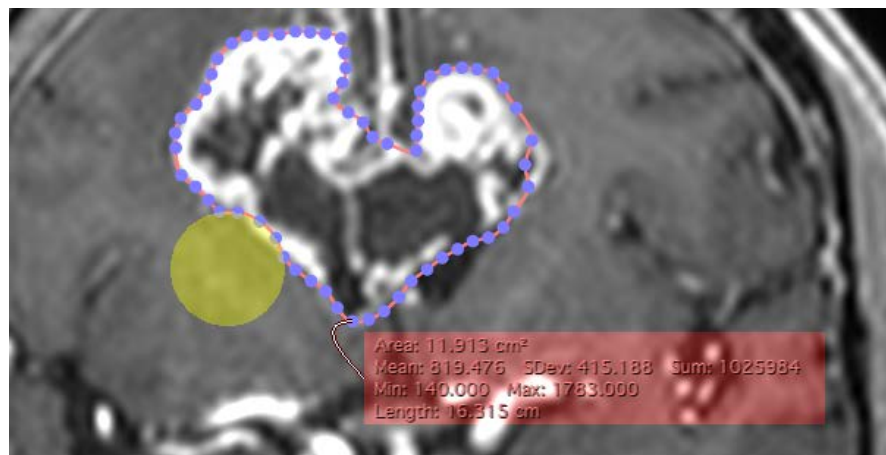
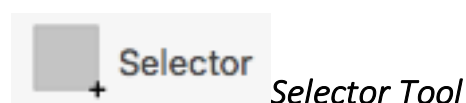


Figure 6.84 The Repulsor tool modifying a Polygon ROI created with the Pencil ROI tool. The ROI info box is shown in the lower right.



The Selector tool is a special tool that does not create ROIs. As its name implies, the Selector allows you to select ROIs by clicking on an ROI, or by clicking and dragging the mouse to create a selection rectangle. All ROIs within, or partially within, the selection area will be selected.

### *ROI Info Box*

Horos displays an info box next to each ROI containing several statistics, such as area, length, etc. The kind of statistics depends on the type of the ROI. For example, the closed polygon shown in Figure 6.84 has an info box displaying area, mean, sdev, sum, min, max, and length. Clicking on an info box will select its ROI.

If you have a large number of ROIs, each with an info box, it can sometimes obscure important parts of the image. You have two options (available from the ROI menu) to handle this problem in Horos:

*Display Info Only when ROI Selected* hides all info boxes except for the selected ROI.

*Display Name Only* hides the statistics in the info boxes reducing their sizes.



### ROI Info Panel

You can modify certain parameters of a selected ROI using the ROI info panel (Figure 6.82). You can name the ROI, create associated comments, re-color the ROI using the standard Max OS color picker, change the thickness of the ROI border, and change the opacity from opaque to almost transparent.

The buttons on the bottom of the ROI info panel also allows you to:

- *Save as file* - export the ROI in a proprietary .roi file for archiving, sharing, etc.
- *Export to XML* - export the ROI as an XML file for archiving, sharing, and statistical processing with third party software.
- *X-Y Plot* - display the plot of the pixels intensities along the line. This option is only available for length ROIs.
- *Histogram* - display the pixels intensities within the ROI as a histogram. You can adjust the bin width for the histogram bars in the popup window (Figure 6.85).
- *Recalibrate* - recalibrate the pixels size using a known length. This option is only available for length ROIs.

You open the ROI info panel by either double clicking on the ROI, by selecting ROI Info from the ROI tab in the 2D Viewer menu, or by the keyboard shortcut  $\text{⌘} I$ .

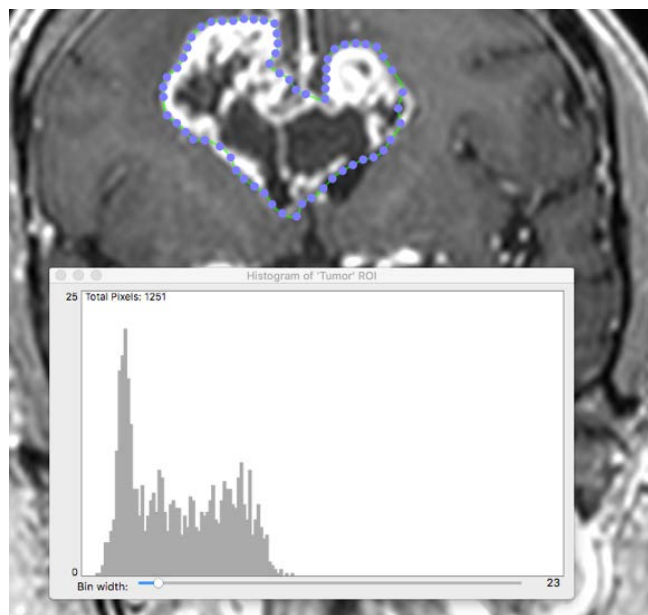


Figure 6.85. The histogram option within the ROI info panel. Note that you can adjust bin width using the slider at the bottom of the histogram window.



### *ROI naming*

Each newly created ROI will be given a name in an incremental fashion. For example, length ROIs will be labelled measurement 1, measurement 2, etc. You can turn off automatic naming in the Viewer Preferences (sec. 2.2.1.3) by checking the New ROIs are unnamed box. In this case, Horos will not display their names in their ROI info boxes. Point, text and brush ROIs use different naming convention.

- New Point ROIs are always named Point 1, Point 2, Point 3, etc. with an incremental counter.
- New text ROIs are always named Double-Click to edit.
- New brush ROIs are always named Region.

The ROI menu at the top of the 2D Viewer offers two naming functions: ROI Rename and Set Default ROI Name. ROI Rename brings up a small popup window that allows you to assign a new name to all ROIs in the current image or all ROIs in the current series or all selected ROIs. The Set Default ROI Name also brings up a small popup window allowing you to set a new default name for all ROIs created subsequently (or to restore the default name).

### *ROI selection*

There are several ways to select an ROI. You can select a single ROI by setting the mouse tool to any of the ROI tools (i.e. closed polygon, brush, pencil, etc.) and then clicking on the ROI. The ROI anchor points will change to blue dots, indicating that this ROI is selected. Alternatively, you can use the Selector tool to select ROIs.

With one ROI already selected you can select additional ROIs by holding down the shift key on the keyboard and clicking on a new ROI. You can also select all ROIs in the current series by using the Select All ROIs in this Series option from the ROI menu in the 2D Viewer. Click anywhere on the current image with an ROI tool selected to deselect ROIs on this image. To deselect all ROIs in the series, choose Deselect All ROIs in this Series from the ROI menu.

### *ROI deletion*

You can delete a selected ROI by pressing the delete or backspace keys on the keyboard. Alternatively, you delete all ROIs in the series using the Delete All ROIs in this Series option from the ROI menu in the 2D Viewer.

### *ROI Spline Rendering*

You can achieve a smoother border for an ROI using spline interpolation. This is available for the Opened Polygons, Closed Polygons and the Pencil ROIs only (Figure 6.86). You can turn on and off spline interpolation in Viewers Preferences.

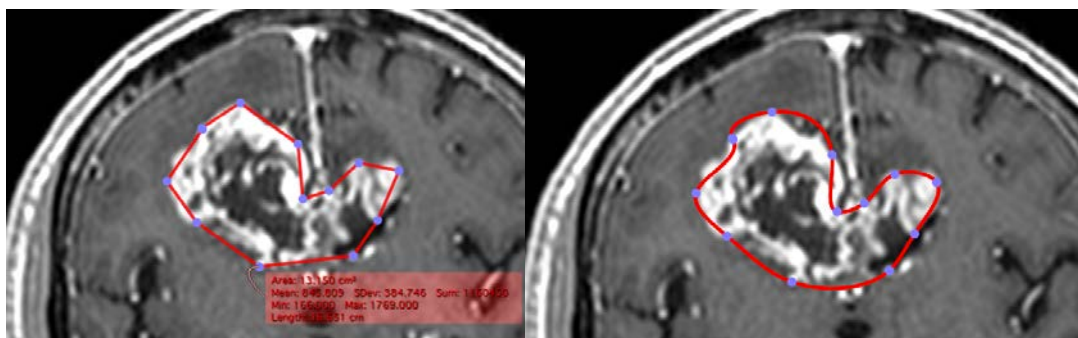


Figure 6.86. The ROI on the left is without spline interpolation and the image on the right uses spline interpolation for the same ROI.

### 3D ROIs and Volume

Horos can also create 3D ROIs from multiple 2D ROIs. For example, Figure 6.87 shows one of 18 ROIs outlining a brain tumor in a series. Clicking on the Compute Volume option in the ROI menu of the 2D Viewer reveals a popup window (Figure 6.88) showing the entire tumor rendered as a rotatable volume.

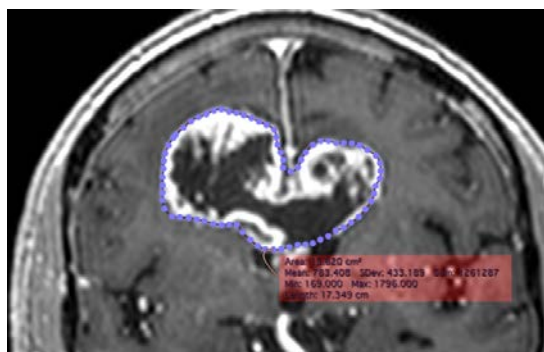


Figure 6.87. The ROI of a brain tumor.

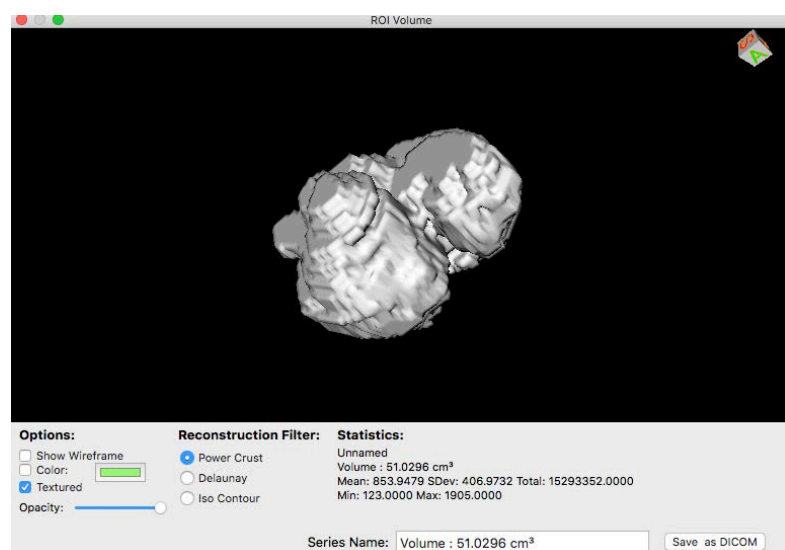


Figure 6.88. The Compute Volume popup window displaying a 3D volume for the tumor ROIs in Fig. 6.87.