Volume Graphics

Solutions about Voxels
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APPLICATION SOFTWARE FOR VISUALIZATION AND DOCUMENTATION OF INDUSTRIAL COMPUTER TOMOGRAPHY/VOXEL DATA

REFERENCE MANUAL

2.0

myVGL
Release 2.0

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1 WELCOME

Thank you for choosing *Volume Graphics* products. This document is the main manual of *myVGL2.0* and contains a reference guide to the options, menus and dialogs as well as a guide to further resources such as instructions for (un)installation and maintenance and help/support options.

All documentation is part of the product, please read it carefully. Make sure to have the complete documentation available throughout the lifetime of this product. In case of change of ownership (as far as compliant with the terms and conditions) make sure to provide the new user with the full installation package including all supplementary material. Updating your software installation might include a new documentation version or additional material. Please make sure to always use matching versions of both product and supplementary materials.

About this product

myVGL is a software package for the visualization and documentation of voxel data projects (.vgl files) created in *VGStudio MAX 2.0* or *VGStudio 2.0*. It is used in a variety of application areas such as industrial CT, medical research, life sciences, and many other.

Feature	Description
Product name	myVGL
Release	2.0
Scope of delivery	Installation package (download or CD-ROM), platform-specific as ordered, online documentation and supplementary material such as sample data

TABLE 1-1: PRODUCT DETAILS

Before first usage

The installation instructions will tell you how to install *myVGL2.0*.

Preparations/Warnings

Working with voxel data requires considerable system resources. Shut down all other applications using large amounts of main memory or processor power before launching ***myVGL***.

Your work with ***myVGL*** might be subject to legal restrictions or company-specific conditions. Contact your supervisors for details.

Additional information

This manual is part of the documentation of ***myVGL***. Refer to the installation directory of ***myVGL*** to browse the documentation.

Related documents:

If you are looking for...	**... refer to:**
Installation instructions	*<documents in installation directory>*
Tutorials	*<documents in installation directory>*

TABLE 1-2: AVAILABLE DOCUMENTATION

If you are interested in more extensive functionality than the one offered by ***myVGL***, you have the chance to evaluate our other products, ***VGStudio 2.0*** or ***VGStudio MAX 2.0***:

www.volumegraphics.com/products/evaluation/form.html

For further questions about our product portfolio, please contact

sales@volumegraphics.com

Conventions used in the documentation

Throughout the documentation, you will find the following conventions:

- Main menus and tools have their own chapter.
- Cross-references like “see chapter...” are linked, click the link to follow it.
- Menu entries, labels, etc. are highlighted with a sans-serif font and blue color.

2 WORKSPACE

The workspace of ***myVGL2.0*** is divided into several workspace windows with which you inspect and manipulate the objects you are visualizing. Access the tools you need for your tasks from the Icon bars or the Tooldocks (see *Tooldocks* on page 2-9 and *Icon bars* on page 2-9).

Resize the different workspace windows by moving the mouse cursor over their respective window borders. The cursor will change to a resize cursor indicating by its shape the directions in which you can drag it to resize the workspace window.

Clicking inside a workspace window will mark it as currently selected workspace window. This is indicated by the blue frame around the selected workspace window.

Each workspace window is decorated with a set of controls allowing you to modify the content or the behavior of a workspace window. For an overview of the available controls see Table 2-1: *Workspace Window Controls* on page 2-1.

Option	Icon	Description
Toggle fullscreen state		Toggle fullscreen state of respective window
Focus selected object		Focus on selected object
Reset zoom		Resets zoom of 2D window
Zoom in		Zoom into 2D window
Zoom out		Zoom out of 2D window
Lock slice position		Locks the slice position.
Set brightness		Set the Level/Window (aka Brightness/Contrast) values for the 2D windows
Original display mode		Select original color mode to display the slice image in its original, brightness and contrast settings.
Color mode/ Color and Opacity mode		Switch between Color mode and Color and Opacity mode.

TABLE 2-1: WORKSPACE WINDOW CONTROLS

Option	Icon	Description
Create/replace clipping plane		Create/replace a clipping plane based on the current slice view.
4/2/1 pixels per ray		Specify the amount of downsampling in the 3D window.
Freeze rendering		Enable/disable the rendering process.
Center and Focus camera		Centers the selected objects and makes them fully visible.

TABLE 2-1: WORKSPACE WINDOW CONTROLS

3D Window

The 3D window shows the result image of the rendering process. Specify rendering parameters for voxel data sets with the Volume Rendering tool (see *Volume Rendering tool* on page -1). Specify rendering parameters for polygonal models with the Polygon Rendering tool (see chapter *Polygon Rendering tool*).

The coordinate system tripod in the lower left corner of the 3D window indicates the orientation of the currently chosen coordinate system. Select a coordinate system from the Coordinate system icon bar to change the currently selected coordinate system.

Object selection

If you select an object in the Scene Tree (and it is chosen to be visible by activating the checkbox in front of it), the corners of a box surrounding it will be shown in the 3D window. Most of these corners will be bright red if you are in the Rotate mode and bright green if you are in Move mode. The lines that are not in that respective color represent the x (dark red), y (dark green) and z (blue) axes of the object's coordinate system.

Tips and tricks You can also select an object by double-clicking onto it in the 3D window with the left mouse button. By holding down <*Ctrl*> while doing so you, you can select multiple objects. Double-Click the background to deselect all objects.

Move / Rotate mode

There are two basic modes for the 3D window: The Rotate mode and the Move mode. Choose a mode by clicking the respective icon in the icon bar  , by choosing the respective entry from the Object menu or by using the <*Ctrl*>+<*Shift*>+*R* / <*Ctrl*>+<*Shift*>+*M* shortcuts.

Tips and tricks You can also switch between the Rotate mode and the Move mode by double-clicking into the 3D window with the middle mouse button.

MOVE MODE

When in Move mode, drag the selected object by using the left mouse button. To move the object in smaller steps, hold <*Ctrl*> while doing so.

Hold down the middle mouse button and move the mouse up or down to zoom into or out of the scene.

Tips and tricks If you want to zoom in on a specific point of the object, position the mouse pointer over it, hold <*Ctrl*> and rotate the mouse wheel.

Hold down <*Shift*> in Move mode to move the object along either the vertical or horizontal direction of the 3D window image plane.

ROTATE MODE

When in the Rotate mode, left-click the selected object, hold it and move the mouse to rotate the object into the respective direction. To rotate the object in smaller steps, hold <*Ctrl*> while doing so.

Hold down the middle mouse button and move the mouse up / down to rotate the object clockwise / counter-clockwise.

Hold down <*Shift*> in Rotate mode to rotate the object along either the vertical or horizontal direction of the 3D window image plane.

An object will always be rotated around its center: see *Center* in chapter *Transform tool* on page 14-2.

Warning An object can only be transformed (i.e. moved/rotated) within the scene if it is *unlocked* in the Scene Tree. If it is *locked*, you will transform the camera instead. If there is only one object visible, you might not notice a difference between the two cases, but it becomes important when there are multiple objects involved, when you perform measurements or when you are in the Scene coordinate system.

You can also transform objects through keyboard input: See chapter *Transform tool*.

Preview

The Preview factor is a reduction factor by which the rendering of voxel data sets is reduced while manipulating a scene. Higher reduction factors

will lead to a smoother interaction. This is especially helpful on computers with a low overall performance.

4 / 2 / 1 pixels per ray

Specify if you want to render every 16th, every 4th or every pixel. The former option leads to the fastest rendering, the latter to the most accurate.

Freeze rendering

Click this button to stop rendering of your object. This can be useful if you want to make changes to your data without showing the results in the 3D window after each step.

Center and focus camera

Click this button to center the currently selected object and make it become fully visible within the 3D window.

Toggle fullscreen state

Toggle the fullscreen mode of this window.

Tips and tricks You can also use the *F11 key* to toggle the fullscreen mode.

Context menu of 3D window

Right-click anywhere in the 3D window to access its context menu.

Annotations

In this submenu, you can Minimize, Maximize or automatically Arrange annotations. You can also Configure the settings for this.

Freeze rendering

Stops the rendering process.

Tripod/Box > Show tripod

Toggles the display of the coordinate system tripod.

Tripod/Box > Show box

Toggles the display of the grid box of the coordinate system with tick marks.

Tripod/Box > Configure

Brings up the preference dialog for the coordinate system display.

Clipping > Create clipping plane

Creates a clipping plane, see *Clipping plane* on page 13-1

Clipping > Create clipping box

Creates a clipping box, see *Clipping box* on page 13-2

Clipping > Create aligned clipping box

Creates an aligned clipping box, see *Aligned clipping box* on page 13-2

Text overlay > Default / Preset

Either select the Default text overlay preset or a user defined text overlay preset.

Text overlay > Configure ...

Shows the Configure text overlay dialog see chapter *Text Overlay Editor*

Background color

Displays a dialog window in which you can choose whether you want the background of the 3D window to be a single color, a horizontal or a vertical gradient and lets you pick the respective color(s).

Reset

Resets all transformations applied to the selected object.

Copy to clipboard

Copy a screenshot of the 3D window to the clipboard.

Properties

Displays information about the selected object. For more information, please refer to *Properties* on page 12-4 in chapter *Scene Tree tool*

2D Windows

The 2D windows show slices of the currently visible objects as seen from the Front (along the y-axis), Top (along the z-axis), respectively Right (along the x-axis) of the current coordinate system.

Voxel data is shown in gray values, whereas polygonal models, ROIs and selections are displayed as colored outlines in the 2D windows.

You can scroll through sections in a certain direction by scrolling the mouse wheel while the mouse pointer is in the respective window or by changing the value in the text box in the lower left corner of the 2D window.

Use the scroll bars below and on the right hand side of each 2D window to move the content of the window.

Tips and tricks Using the middle mouse button, you can also drag the slice view around in the window.

Focus selected object

By clicking this button, you can center the slice view of the selected object in the 2D window.

Reset zoom

Use this button to reset the zoom of the 2D window.

Zoom in / out

Use these buttons to zoom into or out of the respective 2D window.

Tips and tricks If you want to zoom in on a specific point of the object, position the mouse pointer over it, hold <Ctrl> and rotate the mouse wheel.

Lock slice position

Locks the slice position for this 2D window. That means that for example moving the Navigation cursor will not cause this 2D window to switch to the respective slice. However, it is possible to modify the slice position deliberately by entering a value in slice position spin box.

Set brightness

This feature can be enabled/disabled in the Preferences: see *General* in chapter *Edit menu* on page 4-2

Click this button, if you are in Original display mode or Color mode. The Level/Window settings are set for a selected object in the 2D view.

A window appears in which you can specify the Level/Window (i.e. Brightness/Contrast) values for the 2D windows.
Click the button to reset the Level/Window values for the selected object. Click the button to disable Brightness/Contrast rendering completely (The brightness button is shown crossed-out). Click the button to accept the Level/Window values and close the settings window.

Tips and tricks You can also hold down the left mouse button over a 2D window and move it vertically to modify the Level values and horizontally for the Window values.

Original display mode

Toggle between displaying the slice images in their original brightness, contrast and color settings and showing them in the settings specified in Display mode.

Color mode / Color and Opacity mode

Choose which of the user-defined Volume Rendering settings you want the 2D windows to display: only the colors or the colors *and the opacity* settings.

Create clipping plane

Click this button create a clipping plane aligned to the view represented by the selected 2D window. Use this to orientate yourself within the 3D window or to show the interior of the object at the current slice position.

Toggle fullscreen state

Toggle the fullscreen mode of this window.

Tips and tricks You can also use the *F11 key* to do so.

Context menu of 2D window

If you right-click anywhere in the 2D window, you can access its context menu.

Zoom > Zoom in/out

Zooms into or out of the 2D window.

Zoom > Fit object to window

By clicking this button, you can center the slice view of the selected object in the 2D window.

Zoom > Fit scene to window

By clicking this button, you can center the slice view of the whole scene in the 2D window.

Zoom > Reset

Resets the zoom settings.

Coordinate system

Here you can specify a reference coordinate system for the respective 2D window. Other 2D windows will not be affected by this choice. Select Fol-

low global coordinate system to reference the coordinate system active in the Coordinate system icon bar.

Display mode

Choose if you want the display of the 2D windows in *original* settings, overlaid with *colors* defined in the Volume Rendering Tool or overlaid with both *colors and opacity* settings defined in the Volume Rendering Tool. See *Display mode* on page 9-3 in chapter *Window menu*.

Slice step width

Here, you can define the step width to be used when scrolling through slices in the 2D views. It is only active when you are not in a “Grid of ...” coordinate system.

Level/Window mode

Here you can toggle the Set Brightness window. For further information please see *Set brightness* on page 2-6.

Background

Set the background color of the 2D windows here.

Annotations

In this submenu, you can Minimize, Maximize or automatically Arrange annotations. You can also Configure the settings for this.

Text overlay

Here you can toggle the display of text information (Show text overlay), choose from different Text Overlay presets and Configure those presets.

Clipping > Create clipping plane

see *Create clipping plane* on page 2-7

Interpolation mode

Here you can choose if you want ***myVGL2.0*** to always (On) interpolate between voxels, never (Off) or decide automatically when to do so.

Tripod overlay > Show tripod

Toggles the display of the coordinate system tripod.

Tripod overlay > Configure

Shows the preference dialog for the coordinate system display.

Reset

Resets all transformations applied to the selected object.

Copy to clipboard

Copy a screenshot of the active window to the clipboard.

Properties

Displays information about the selected object. For more information, please refer to *Properties* in chapter *Scene Tree tool* on page 12-4.

Tooldocks

The Tooldock, per default on the right hand side of the workspace, is used to dock tools. You can minimize the tools, close them or have them free floating over the workspace by clicking the respective icons in their upper right corner. You can arrange the tools in an arbitrary order by dragging & dropping non-minimized tools.

You can open further tool docks below or on the left hand side of the workspace by simply dragging & dropping tools there.

Due to their format, most tools can only be put in vertical tooldocks.

You can resize tooldocks or hide them completely by clicking the border between them and the workspace and moving them into the desired direction.

Icon bars

The icon docks are used to dock icon bars. Icon bars consist of one or more icons that represent shortcuts to functions most of which are otherwise accessible via the menus. You can distribute icon bars in icon docks. Per default, there is only one icon dock at the top of the workspace. You can however open further icon docks below, on the left or right hand side of the workspace: Simply drag and drop an icon bar there.

By right-clicking an icon dock, you can choose which icon bars should be visible and which not by checking or unchecking the boxes in front of them.

Tips and tricks Once you are done organizing the icon bars, you can right-click the respective icon docks and choose Line up to align the icon bars without gaps.

Display unit

In the icon dock you can find the Display unit toolbar. You can use this to select the unit in which to display length, area and volume values. Set additional parameters about units via Edit > Preferences.

3

FILE MENU

The File menu of ***myVGL2.0*** provides basic features for loading projects as well as for saving images or image stacks. Thus the File menu allows you to handle the two basic file types: object files and project files (and folders).

- **Object files**
  These files contain voxel data representing your real object, basically the output of the CT-scanner (after scanning and reconstruction) or some other device, or contain other data representing your real object, such as polygons.

  The number of files per object varies. You might have *one* file containing the whole object (volume file formats) or an *image stack* (e.g., bitmaps or tiffs) where each file represents one slice of the scanned object. Scanner settings and additional information might be included in the data files or in separate files.

- **Project files (and folders)**
  .vgl files contain basic information on the project including references to the object files and supplementary files belonging to the project. For supplementary files a project folder will be created as a subdirectory of the directory in which you saved the .vgl file.

Warning A .vgl file must always be accompanied by the project folder and the file(s) containing the object(s). You cannot open a .vgl file without the associated project folder, and you cannot load an object into the scene without the files containing the object data.

.vgl files and project folders replace the .vgi files of earlier versions of ***myVGL*** containing the *scene*.

The project will include references to all imported objects, modifications such as rotation, opacity settings and analysis results. Items in the Scene Tree (see chapter *Scene Tree tool*) like light sources or measurement features are saved as well as the layout of the 3D and 2D windows.

A scene can contain one or multiple objects. You can work with only one project at a time.

See Table 3-1: *File menu options* for a list of File menu options, to be described in the following. Menu entries currently not available are dis-

abled and displayed in gray (e.g., saving is only possible after loading a project or an object).

Option	Icon	Description
New		Create a new project
Open...		Open a complete scene (or a single volume)
Save image(s)...		Save selected views (e.g., slice views) as images (several format options)
Save AVI/ image stack		Save selected visible items of the scene into an image stack or .avi file
Print image(s)...		Print selected views (e.g., slice views) as images
Quit		Exit the application

TABLE 3-1: FILE MENU OPTIONS

New

Choose this option if you want to exit the current project and create a new empty scene. You would typically proceed by opening a project or a scene.

Open...

Opens a project saved in a .vgl file (or scene saved in a .vgi file). You can either open the file including the analyses, material settings etc., or load just a single volume from the file. If you open a .vgl file (or a .vgi file), make sure the project directory and object file(s) are available as well.

.vgl files are used for projects in ***myVGL2.0***, but you can also read scenes from .vgi files which were used by previous versions of ***myVGL***.

Throughout the entire open process, defaults will be set to the values you specified in the last process or, where applicable, to information automatically retrieved from the files (such as resolution which is included in some file formats).

Tips and tricks

During the whole open process, ***myVGL*** will scan the data file(s) (e.g., to provide you with default values and a preview). Copy the files to your local harddisk to speed up the process as well as to avoid problems caused by networking or CD/DVD drive lags.

A sophisticated import wizard will lead you through the open process (see *Open options* on page 3-3) of volume data.

If the wizard has gathered enough information about the volume to be imported, it can display the Memory needed to load the data based on the specifications so far and the Memory available on your system. If the memory needed exceeds the memory available, the field will be highlighted in red. Reduce the amount of data by mapping to a “smaller” data type, by applying a region of interest or a skip factor.

Warning Although you can load and display an object if the memory available is larger than the memory needed, analysis tasks require additional memory.

These options will be available during the open process and are explained below (see *Open options* on page 3-3) in the sections for the respective dialogs. The memory values will be updated continuously.

Open options

Depending on the file(s) you want to open and the options you specified so far, the ***myVGL*** import wizard will show you a series of dialogs. The dialogs and their options are explained below. Note that you will only see the dialogs relevant to your object.

Tips and tricks After selecting a file , you can see the content of that file in the preview window on the left hand side of the import wizard.

OPEN PROJECT

This option will open the complete file, including analyses, material settings, reference objects etc.

IMPORT SINGLE VOLUME

This option loads a single volume from the file, either completely or using a specified region of interest (ROI).

LOAD SCENE

You can apply the Resolution reduction (skip) option to be able to load a very large object into a low capacity system.

Warning Applying a skip factor will reduce the resolution of the voxel data and thus lead to significantly less accurate analysis results.

Specify the number of voxels to be skipped in the respective direction. A skip rate of 0 applies no skipping. A skip rate of 1 for one axis will load

only every other slice so that the memory needed is reduced by half. A skip rate of 5 will skip 5 slices, load one slice, then again skip 5 slices etc.

You can also reduce the memory needed by specifying the analyses you want to load. The Included analyses list shows all analyses of the project as well as the memory needed to load them. Deactivate the Load? checkbox for all analyses you don't want to load.

FILE SELECTION

Choose the volume you want to open from the list.

LOAD AS...

Several parameters determine how the data shall be loaded. For example, the type of data loaded can be different from the type stored on disk. The dialog will show you only the parameters applicable to your data.

Specify the voxel size in the resolution part of the dialog. Some data formats provide this information automatically. In this case the input field will be disabled and show the given numbers, you can correct/modify those numbers if you activate the Override resolution checkbox.

If the data has significant differences (e.g., factor 3 or more) in voxel size for x, y, and z, the resulting pictures will show elongated steps in the respective dimension. In order to improve the visual appearance, you can activate the Force isotropic resampling checkbox. myVGL will then interpolate intermediate slices.

You can import data sets with varying slice distances. If the object has been scanned with small slice distances but in certain areas only, the resolution has wide differences. In this case you would probably not want to resample the data set. Use the option No slice interpolation beyond... . Slice distances larger than the number specified will not be padded with interpolated slices.

Warning Forcing isotropic resampling might change analysis results. Use this option only if you want to optimize the visual presentation of the data for creating screenshots, avi files etc.

Use the Data range mapping area to specify the interval of original gray values to be imported and the interval they shall be mapped to. This interval must not exceed the number of gray values of the data type (to be specified in the same dialog). Voxels with gray values outside the interval will also be imported, but with assigned gray values inside the interval. The assigned gray value depends on the mapping specified, see Table 3-3: *Gray value*

handling on page 3-6. As an alternative, you can specify the intervals in the histogram.

Click the Histogram button to open another window showing the gray values and their numbers of occurrences. For details, see *Histogram (Import)* on page 3-7.

The Data range mapping determines the range of gray values *used* for your object, i.e. it specifies the *maximum* number of different gray values available for your object. The size of the data range is always smaller than or equal to the numbers of gray values in the data type. For details on the data types, please refer to Table 3-2: *Data types*.

Data type	Description
unsigned 8 bit / signed 8 bit	8 bit code one gray value, each bit has either value 0 or value 1. Consequently, $2^8 = 256$ different gray values are possible Gray values from 0 to 255 (unsigned) or -128 to 127 (signed)
unsigned 16 bit / signed 16 bit	$2^{16} = 65\,536$ different gray values. Gray values from 0 to 65 535 (unsigned) or -32 768 to 32 767 (signed)
unsigned 32 bit / signed 32 bit	More than one million different gray values. Gray values from 0 to 1 048 575 (unsigned) or -524 288 to 524 287 (signed)
32 bit float	Effective gray value dynamics 32 bit float, 3D rendering as 16 bit
rgb8	8 bit per RGB component color images for a total of 24bit color.

TABLE 3-2: DATA TYPES

Warning Objects with 32 bit signed/unsigned data have an effective data range of 20 bit for all rendering procedures (full data range for analysis procedures).

Choosing a lower data type (i.e., a data type with a lower number of gray values) than the type in which your files are available may reduce accuracy because your object will be described by a lower number of gray values. In contrast, it is not possible to increase accuracy by selecting a higher data type.

Tips and tricks Loading floating data requires a lot of main memory. If your scanner has 32 bit float as output and your system is not capable of dealing with this amount of data, choose a data type mapping (e.g., 16 bit unsigned).

Select an option to determine how values outside the interval shall be handled. As a default, gray values below the lower interval limit will be set to the value of the lower interval limit, gray values higher than the upper interval limit will be set to the value of the upper interval limit. This is the option Ramp. The options are listed in Table 3-3: *Gray value handling*.

Option	Shape	Lower gray values will be set to:	Higher gray values will be set to:
Ramp		lower interval limit	upper interval limit
Inverse Ramp		upper interval limit	lower interval limit
Sawtooth		lower interval limit	lower interval limit
Inverse Sawtooth		lower interval limit	lower interval limit

TABLE 3-3: GRAY VALUE HANDLING

You can use this option to invert the data. If your data has low gray values for material and high gray values for air so that you would see black material and white air, apply the Inverse Ramp to see white material and a black background.

Click the Preview button for 2D previews of your object. The preview is also available in the following steps. For details, see *Preview (Import)* on page 3-8.

ROI AND SKIP SELECTION

This dialog offers options to reduce the memory needed to load the object.

The scanned object will usually be surrounded by air. Reducing (but not eliminating) the surrounding air by applying a Region of Interest (ROI) reduces the memory needed. Only the slices from Min to Max (in x, y, and z direction) will be imported. Use the Preview for graphically supported ROI specification (see *Preview (Import)* on page 3-8 and *How to define a ROI graphically in the preview* on page 3-9).

Warning Do not apply a ROI directly on the object's surface or even cutting into the object. This would destroy the partial volume effect and thus cause imprecise measurement results. Make sure to import the object including some surrounding air.

If your object is surrounded by a large number of background (air) voxels, applying a ROI reduces the memory needed very efficiently without nega-

tive effects on the quality. In other cases you might have to apply the Skip option to be able to load a very large object into a low capacity system.

Warning Applying a skip factor will reduce the resolution of the voxel data and thus lead to significantly less accurate analysis results.

Specify the number of voxels to be skipped in the respective direction. A skip rate of 0 applies no skipping. A skip rate of 1 for one axis will load only every other slice so that the memory needed is reduced by half. A skip rate of 5 will skip 5 slices, load one slice, then again skip 5 slices etc.

MANIPULATION

You can swap or mirror axes in order to display the object in a preferred or real-world orientation.

Mirror axes will mirror the object along the chosen axis or axes (e.g., activating the checkbox for the x-axis will place the voxel with the highest value for x at the origin of the x-axis). You can choose more than one axis to mirror.

Swap axes will change the axes in the coordinate system so that instead of xyz, the coordinates will be interpreted in the chosen sequence (e.g., choosing xzy instead of xyz will keep the position on the x-axis but change the y coordinate to z and vice versa. The result is a rotation by 90° around the x-axis followed by a mirroring along the y-axis).

Histogram (Import)

Click the Histogram button in the Load as dialog to open another window. The Histogram tab displays the number of occurrences of each gray value in the object as a diagram. The gray values of the object's voxels are given on the axis of abscissae. The number of voxels with each gray value are given on the axis of ordinates. The dark gray area in the background of the diagram shows the number of occurrences of each gray value.

The histogram contains two vertical red lines, initially positioned at the very left and the very right of the diagram. Each red line is labeled with two numbers, the first indicating the gray value at the current position of the line, the second shows how many voxels in the object are of this gray value.

You can move the red lines by left-clicking them. Shift them left or right while holding the left mouse button pressed. Shifting a line to a new position will adapt the value in the Data range mapping area of the Load as dialog and vice versa. You can also change the ramp type in the Load as dialog while the Histogram is displayed.

Use either of the methods to define an interval of significant gray values, i.e., the interval in which there is a high probability of gray values varying in accordance with a variation of the material. A typical histogram has one peak for each material in the data set plus one peak for the air. Make sure not to cut out any of those peaks. Always keep the air peak, myVGL needs surrounding air for the interpretation of the partial volume effect which is the basis for analysis results.

The Calibration tab allows you to perform a gray value calibration within the import process. Here you can dynamically select material and background gray values and assign them to destination gray values. Select either the Define background button or the Define material button. Move your mouse cursor over the preview window. Hold down the left mouse button and move the mouse to create a selection rectangle. The area inside the rectangle is considered for either background or material selection. By pressing the Apply button the acquired values are applied to the data range mapping on the Load as dialog.

Preview (Import)

The Preview button is available in a number of import dialogs. Click this button for 2D previews and projections of your object in order to:

- **Control the parameters specified so far**
  If you only see black and white stripes or a grainy image, check the data type and/or size specified earlier.
- **Define a Region of Interest (ROI)**
  Modify the ROI settings by adapting the blue frame in the slice preview or one of the projections. For detailed instructions, see *How to define a ROI graphically in the preview* on page 3-9. You can also modify the settings in the dialog ROI and Skip selection (see *ROI and Skip selection* on page 3-6).

Click the tabs to select one of the views. The following views are available:

1 **Slice Preview (top/right/front)**

The main area of the Preview tab shows a single slice of your object. Specify the slice number in the lower left input field by using either the number keys, arrow keys or the mouse.

Choose the axis along which to slice by clicking the buttons:

- Button T for top perspective
- Button R for right perspective
- Button F for front perspective

You can enhance the contrast automatically:

- Button C for auto contrast

By default, the preview will be rendered taking into account the data range settings (see *Histogram (Import)* on page 3-7). Activating auto contrast will analyze the data set and apply a ramp mapping to the data range covered by the voxels in the current slice.

2 **Projection preview (top/right/front)**

Click the Top projection tab for a projection along the z-axis. All xy-planes of your object will be projected into one 2D view.

Click the Right projection tab for a projection along the x-axis. All yz-planes of your object will be projected into one 2D view.

Click the Front projection tab for a projection along the y-axis. All xz-planes of your object will be projected into one 2D view.

Save image(s)...

Captures your current workspace area into an image. The Views area displays the currently available workspace windows. By clicking the checkbox beside each entry you can select the window to be taken into account for the final image. The Preview area shows the screenshot so far.

The Decorations area contains options for displaying additional information within the screenshot. By choosing the option show logo in headline you can define a custom logo that will appear above the headline specified inside the headline text field. By selecting show legend, the current slice position, the

HOW TO DEFINE A ROI GRAPHICALLY IN THE PREVIEW

If the scanned area contains a lot of background, importing the full data set would result in unnecessarily high memory consumption. To reduce memory load, define a Region of Interest (ROI) to be imported.

A ROI defined during import is always a cuboid. The maximum size for a ROI is the size of the scanned area.

You can define a ROI based on numerical input in a dialog (see *ROI and Skip selection* on page 3-6) or graphically in the preview (see *Preview (Import)* on page 3-8). Here, the graphical approach will be explained.

In any of the four preview tabs (slice preview, top/right/front projection), use the mouse to resize or move the blue frame surrounding the scanned area. If the blue frame is not visible, use the +/- buttons and the scrollbars to adjust the view.

Resizing Left-click a corner or an edge of the blue frame surrounding the scanned area and draw the mouse pointer.

Moving Left-click into the area surrounded by the blue frame and draw the mouse pointer. You can only move the frame if the ROI is smaller than the scanned area.

Any modifications are always valid for all slices along the chosen axis.

The ROI should preferably be controlled in the projection views to ensure the full extent of the object is visible. Modifying the ROI in a single slice might accidentally cut off protruding parts of your object visible only in other slices.

current coordinate system and the window type will be attached below the image for the respective window.

The Overlays area gives you the option to enable/disable graphical overlays like analyses results, reference objects, the isosurface and measurements. This does not influence the objects in your scene. Disabling for example the measurements will only disable them within the screenshot.

Within the Custom image size area you can specify an image size differing from the suggested one. Image width and height can be coupled to keep a reasonable aspect ratio for the image. The dpi value controls the size of handles, fonts and other display-relative elements. You can use it to save images at higher resolutions and still retain the proportions of these elements.

Tips and tricks

If you select only one window within the Views area, you can change the image width and height parameters independently from each other by clicking the lock/unlock button to the right of the width/height input fields.

Supported formats:

- **Bitmap (*.bmp)**
- **JPEG (*.jpg)**
- **JPEG2000 (*.jp2)**
- **Portable Pixmap (*.ppm)**
- **Tiff (*.tif)**

Save AVI/image stack ...

Saves the slices of one of the 2D views into an AVI movie or an image stack.

Select the 2D view to specify the orientation. The images will be created parallel to this view.

Select Display mode to specify the coloring of the resulting image (for details on display modes see *Display mode* in chapter *Window menu* on page 9-3).

The Overlays area gives you the option of enabling/disabling graphical overlays like analyses results, reference objects, the isosurface and measurements. This does not influence the objects in your scene. Disabling for example the measurements will only disable them within the screenshot.

Define the resulting Image size (in pixels). By clicking on the button to the right of the width/height parameters you can specify whether the image

size should be scaled uniformly or not. If uniform scaling is activated, changing the width will change the height of the image in proportion to the width (and vice versa). A larger image size leads to a better resolution.

The Boundary option allows you to define an additional offset applied to the original image. It does not change the image size, instead it enables you to zoom into or out of the current viewport.

The Stack settings specify the number of slices and the slice distance in the given unit. The stack settings apply to the complete data set in the current orientation. Modifying the number of slices will recalculate the slice distance and vice versa:

$$\text{distance} \times (\text{number of slices} - 1) = \text{height of complete data set}$$

The Slice range parameters specify the part of the slices to be exported. The slices will be resampled, applying the stack settings such that one of the slices will be positioned at the start value. The end value specifies the upper boundary of the slices. The first slice to be exported is defined by the start value, the second slice is at position (start value + slice distance).

You can also set the start and end values by navigating to the desired position in the Preview and clicking the s for start or e for end. If the end slice has a lower value than the start slice, the values will be swapped.

Modifying the Slice range will change the number of slices but not the slice distance. The number of slices and distance parameters specify how fine the data should be sampled within the given Slice range.

Supported formats:

- **Bitmap (*.bmp)**
- **JPEG (*.jpg)**
- **JPEG2000 (*.jp2)**
- **Portable Pixmap (*.ppm)**
- **Tiff (*.tif)**
- **AVI movie (*.avi)**

Print image(s)...

Send a snapshot of the current workspace for documentation purposes to a printer. Select the 2D/3D views to be included into the image. Configure the image by adding Decorations (logo, legend, headline). Your company logo can be included if you activate show logo in headline. Specify a company logo file by clicking the icon next to the field. This will open a file dialog. Add Overlays as needed (analyses, reference objects, measurements, isosurface). See also *Save image(s)... on page 3-9*.

Quit

Close the application.

4

EDIT MENU

Through the Edit menu of myVGL you can access the undo/redo and cut/copy/paste functions. The menu also enables you to edit general application settings.

Table 4-1: *Edit menu options* lists the menu entries with a brief description. They will be explained in detail later in this chapter.

Option	Icon	Description
Undo		Undo the latest action/command
Redo		Redo the latest action/command
Clear undo queue		Delete all entries stored in the undo queue
Delete		Remove the currently selected object(s) from the scene (with partial buffering, see Undo/Redo)
Preferences... *(+ dialogs)*		Set general application parameters and options

TABLE 4-1: EDIT MENU OPTIONS

Undo / Redo

Most actions can be undone (and then redone to reestablish the situation before undo). Actions which change the underlying data or otherwise require a lot of memory (e.g., filtering) may not be available for undo/redo.

The amount of memory allocated for the undo queue can be set by editing the Preferences as described later in this chapter (see *Preferences* on page 4-2). Should the last issued command require more storage space within the undo queue than currently available, then myVGL will start erasing entries in the queue beginning with the oldest command in the queue and proceed chronologically until enough storage space becomes available. If a command requires more space than is available for the undo queue, then the command will not be stored and the current command history is erased.

If you think you might want to undo an action which requires a lot of memory, save desired images or image stacks prior to the action.

Clear undo queue

The command history of the current ***myVGL2.0*** session is stored in the undo queue. Clear undo queue will erase the accumulated command history. The command history will be erased automatically if an action requires more memory than is available to the undo queue.

Delete

Deletes the selected object(s) from the scene. The object(s) can be (partially) restored using Edit > Undo. Analysis results (e.g., from a wall thickness analysis) are not restored.

Preferences

Set general application parameters and options according to your preferences. These settings apply to ***myVGL*** in general and not only to a specific project.

You can save these settings as presets in order to load them at a later time. Presets can also be deleted, exported and imported.

General

GENERAL

- Dump core file
  Specify if a core dump should be executed if the program terminated unexpectedly.
- Print / Save image(s)
  Specify if changes in the Save image(s) dialogue should be saved.
- Undo
  Specify how much memory can be used by the Undo function.
- Rendering settings for imported data
  Specify which rendering algorithm and if shadows are to be used by default.
- Slice window
  If you choose Medical mode, the slices in the 2D window showing the xy-plane are looked upon from the Bottom instead from the Top. This only becomes effective if the window is in one of the standard layouts.

  The Level/Window mode checkbox determines whether the ◑ Set brightness button is available in the slice views.

- Icon theme
  Specify if you want large or small icons.
- Hardware renderer
  In this section you see the Graphics Card that is used by the Hardware renderer and you can determine how much of its memory can be used for rendering.
- Application user interface
  Specify if once message boxes should be displayed again after checking the “never show again” checkbox.

ANNOTATION ARRANGEMENT

In this section you can determine the behaviour of the Annotations > Arrange function. The Allow overlap setting specifies, which objects may be concealed by the annotations: The Object only, the Colortable only, Both or None.

The Strategy parameter determines where the annotations should be positioned: At the Window border or Around the object.

The Alignment X / Y settings determine how annotations of non-uniform size should be positioned with respect to each other.

The Center parameter specifies if the distribution of the annotations should be determined by the center of the Object, of the Window or Automatically.

The Margin values determine how much space should be between annotations, and the Border values determine how far away from the window border the annotations should stay. For both parameters, the first setting determines the x value and the second setting the y value.

The Grid snap checkbox determines if the annotations snap to a grid when you shift them manually. If activated, you can determine the grid spacing by the Grid snap step setting and the grid origin by the Grid snap offset setting. For both parameters, the first setting determines the x value and the second setting the y value.

If the number of visible annotations in a window increases above the Max. visible annotations parameter, all annotations are hidden.

COORDINATE SYSTEM DISPLAY

- Box
  Here you can specify the look of the coordinate system box: You can modify the font, color, outline, alignment and style of the labels. Furthermore, you can specify if you want to show the box frame, ticks, labels, grid and background. You can also extend the box by a certain distance in each direction.

The color of the box background, box frame, ticks and grid can also be specified.

- Tripod

  Here you can specify the color of the tripod axes.

SNAP FRAME

Here you can set the default mode of the snap frame. Furthermore, you can define its size, either in pixels (Display relative mode) or in physical units (e.g. mm; Scene relative mode).

TEXTOVERLAY

Here you can define the look of the text overlay: You can set the font size, color and type and specify the distance to the border of the 2D/3D window (Cell border). If you click the Configure button, the Text Overlay Editor will open (see chapter *Text Overlay Editor*).

UNIT

Here you can define with which precision a Length, Area, Volume, Angle, Time or Storage value should be displayed. You can do so by setting the number of decimal places or the respective absolute precision value.

Slice elements

ISOSURFACE

Here you can define the look of the isosurface line in the 2D windows, both for selected and unselected volumes.

REGION OF INTEREST

Here you can define the look of the ROIs line in the 2D windows, both for selected and unselected volumes.

Analysis

COORDINATE MEASUREMENT

- Features

  In the General section you can specify the size and type of Feature handles. Furthermore, you can decide if handles should Snap to a grid with a specified Grid distance. You can also define the font type, color, size and outline for feature descriptions here.

  In the Color, selected instrument section you can determine the look of Features that belong to a selected instrument: You can specify the color and

width of the respective Subsidiary lines, Handles, the selected Feature itself and unselected features belonging to the same selected instrument (Feature). Each subsection allows you to set a specific style for items in the slice plane, behind the slice plane and in front of the slice plane.

Similarly, you can determine the look of Features that do not belong to a selected instrument in the Color, unselected instrument section.

- Instruments

  In the General section you can specify the length of Instrument handles. Furthermore, you can decide if Indicator annotations should be visible in all slices. Also, you can set the size of the Navigation cursor here.

  In the Color, selected section you can determine the look of Instruments with features, instruments without features (Instruments) and their Handles. Each subsection allows you to set a specific style for items in the slice plane, behind the slice plane and in front of the slice plane.

  Similarly, you can determine the look of unselected Instruments in the Color, unselected section.

- Reference objects

  In the General subsection of both the 2D and 3D display settings sections, you can define how points are displayed in the respective windows. This includes both fit points and auxiliary points , for example the center pionts of cylinders. Furthermore, you can decide if you want to display annotations for selected reference objects in 2D or 3D windows. In the 3D display settings, you can also set the Reference object grid spacing and if you want Shaded reference objects (only applies if Fill mode in the Color subsection is set to On).

  In the Fitpoint colorbar subsection of both the 2D and 3D display settings sections, you can define how the Fitpoint colorbar is displayed in the respective windows: You can set its visibility, width, length, font style and title (Caption).

  In the Color subsection of both the 2D and 3D display settings sections, you can define the look of Selected, Highlighted and Unselected Reference Objects. Highlighted Reference Objects are those that belong to a selected feature. In the 2D display settings section, you can set a specific style for items in the slice plane, behind the slice plane and in front of the slice plane.

DEFECT DETECTION

- 2D display settings

  In the Annotations section you can define the size of the annotation cursor in the 2D windows, whether a newly created annotation should be minimized

or maximized (Default annotation size) and whether the annotations should be visible in all slices or just at their cursor position.

In the Colorbar section you can define whether you want the result colorbar displayed in the 2D windows and how you want it to look there: You can define its width, length, position and font style.

- 3D display settings

  In the Annotations section you can define the size of the annotation cursor in the 3D window and whether a newly created annotation should be minimized or maximized (Default annotation size).

  In the Colorbar section you can define whether you want the result colorbar displayed in the 3D window and how you want it to look there: You can define its width, length, position and font style.

NOMINAL/ACTUAL COMPARISON

- 2D display settings

  In the Annotations section you can define the size of the annotation cursor in the 2D windows, whether a newly created annotation should be minimized or maximized (Default annotation size) and whether the annotations should be visible in all slices or just at their cursor position.

  In the Colorbar section you can define whether you want the result colorbar displayed in the 2D windows and how you want it to look there: You can define its width, length, position and font style.

  In the Isosurface section you can define if you want the isosurface in the 2D windows colored according to the local variance value, if you want additionally Haired lines whose length corresponds to the respective variance value or no color coding at all (No line). You can define the width of the colored line. For Haired lines, you can also specify the distance between hairs and the multiplication factor between the variance value and hair length (Hair scale factor).

- 3D display settings

  In the Annotations section you can define the size of the annotation cursor in the 3D window and whether a newly created annotation should be minimized or maximized (Default annotation size). The Cursor color follows overlay checkbox determines whether the 3D cursors should be colored according to their variance or not.

  In the Colorbar section you can define whether you want the result colorbar displayed in the 3D window and how you want it to look there: You can define its width, length, position and font style.

WALL THICKNESS

- 2D display settings

  In the Annotations section you can define the size of the annotation cursor in the 2D windows, whether a newly created annotation should be minimized or maximized (Default annotation size) and whether the annotations should be visible in all slices or just at their cursor position.

  In the Colorbar section you can define whether you want the result colorbar displayed in the 2D windows and how you want it to look there: You can define its width, length, position and font style.

- 3D display settings

  In the Annotations section you can define the size of the annotation cursor in the 3D window and whether a newly created annotation should be minimized or maximized (Default annotation size).

  In the Colorbar section you can define whether you want the result colorbar displayed in the 3D window and how you want it to look there: You can define its width, length, position and font style.

5 INSTRUMENTS MENU

You can perform various measurements like distances, gray values, angles and more on your data with the utilities available in the Instruments menu of myVGL. Each new instrument will be accompanied by an annotation containing the respective measured value(s) and represented by an entry in the Scene Tree (see chapter *Scene Tree tool*).

Warning For useful results, the object must have been calibrated.

Measurement instruments are visible in the 2D views and—unless hidden by opaque material—in the 3D view. See Table 5-1: *Instruments menu options* for an overview.

Option	Icon	Description
Indicator		Left-click to create a new indicator to measure gray value and position of a single voxel
Distance instrument		Left-click and draw with the mouse to measure a distance
Angle instrument		Left-click to create a new angle instrument
Polyline instrument		Left-click to create a new polyline instrument
Caliper instrument		Left-click and draw with the mouse to measure a distance rectangular to a surface
Activate navigation cursor		Left-click while pressing the <*Ctrl*>-key to position the navigation cursor, left-click and drag to move it
Snap modes		Choose a mode from the submenu to determine the snapping behavior when setting points or handles

TABLE 5-1: INSTRUMENTS MENU OPTIONS

General

Handling of instruments

To *create* a new instrument, choose one of the options in the Instruments menu and click with the mouse into a slice window. The polyline instru-

ment, the indicator and the navigation cursor can also be positioned in the 3D window.

To *modify* an instrument, select it in a slice window, 3D window (polyline instrument, indicator and navigation cursor only) or Scene Tree (see chapter *Scene Tree tool*) and resize it with the left mouse button: Click one of its handles to drag it, click onto the instrument's base line to move the whole instrument.

Warning In the 3D window, instruments are manipulated differently than in the 2D windows:
In the 3D window, double-click instruments with the left mouse button to select them, and hold <*Ctrl*> while left-clicking to create new points (polyline instrument) or set it to another point (indicator and navigation cursor).
In the 2D windows, a single left-click is sufficient for both actions.

Selecting an instrument in 2D or 3D will change the slice display such that all 2D views display the slices in which the instrument is located.

Display of instruments

An instrument is always displayed in the 2D views, whether or not the current slice is the slice the instrument is located in. The way the instrument is displayed is subject to its position relative to the current slice. You can modify the display properties in the preferences (see *Preferences* in chapter *Edit menu* on page 4-2). The default settings are as follows.

- **Display of punctiform measurement instruments**
  Indicator and navigation cursor are displayed in
  - red if located in the *current* slice,
  - green if located in a *higher* slice,
  - white if located in a *lower* slice.
- **Display of linear measurement instruments**
  - If a measurement line is located in the *current* slice, it will be displayed as a solid green line with red handles. The handles will only be displayed in the slice in which they are located.
  - If a measurement line is located in a *lower* slice, it will be displayed as a solid green line without handles.
  - If a measurement line is located in a *higher* slice, it will be displayed as a dashed green line without handles.

This also applies for parts of the line. If a line runs diagonally through the object, the upper part of it will be displayed dashed and the lower part solid.

Tips and tricks

For the linear measurement instruments, you can view the gray value profile along the measurement line (see chapter *Window menu*) or perform a dimensioning (see chapter *Measurements menu*).

Annotations

Specify the positioning of the instrument's annotation in the view. Move your mouse over the annotation and click on the small button appearing above the upper right corner of the annotation to switch between the following modes:

- A **(**Automatic positioning **mode)**
  Places the annotation automatically, thereby avoiding intersections between the annotation line and the instrument line. This option is only available for Distance and Caliper instruments.
- F **(**Fixed positioning **mode)**
  Places the annotation at a fixed position in the respective 2D window.
- R **(**Relative positioning **mode)**
  Places the annotation at a position relative to the instrument.

For advanced measurement features, coordinate measuring and coordinate system options see chapter *Measurements menu*.

Indicator

The indicator is a 3D cross-hair that points to a single voxel. Its annotation contains the gray value of the voxel and its x/y/z coordinates in units of the selected coordinate system. If the coordinate system is the grid of the object, the position will be given in voxels.

Distance instrument

Use this tool to measure a distance between two points. If you want to measure e.g. the material thickness, activate the snap option as explained above (see *Annotations* on page 5-3) so that the handles of the distance instrument are automatically positioned on the material boundary.

The handles of the distance instrument can be dragged using the left mouse button. Hold down <*Shift*+*Ctrl*> while doing so to leave the direction of the distance instrument unchanged (other than changes of 45°).

If you hold <*Shift*> while dragging a handle, its movement is restricted to the horizontal or vertical direction in the respective 2D window.

The whole distance instrument can be moved by dragging the line between the handles (using the left mouse button).

To measure another distance with the *same* distance instrument, simply draw at a new position. Select another object or deselect the instrument in the Scene Tree to stop modifying this distance instrument.

To measure another distance with an *additional* distance instrument, choose this menu entry again.

Angle instrument

Use this tool to measure the angle between two edges. The angle instrument consists of two lines, each with two handles.

You can drag the handles with the left mouse button. By doing so you define the angle between the two lines which is displayed within the annotation of to the angle instrument.

If you hold <*Shift+Ctrl*> while dragging a handle, the direction of the corresponding line is locked and will only change in steps of 45°.

If you hold <*Shift*> while dragging a handle, its movement is restricted to the horizontal or vertical direction in the respective 2D window.

The whole angle instrument can be moved by dragging one of the green lines between the handles (using the left mouse button).

Polyline instrument

Use this tool to measure the outline of an arbitrary shape by fitting a polyline to that shape. Click the left mouse button to create control points for the polyline instrument. The new points are added to the start or the end of the polyline, depending on whether the cursor is nearer to the current start or end point, respectively. The start and end point are distinguished from the other points by their different display. Each successive line segment adds to the total length. Insert a point between two existing points using the middle mouse button. Remove a point by clicking it with the middle mouse button.

Manipulate the polyline instrument in the 3D view by holding down <*Ctrl*> during the respective mouse clicks. To move an existing point of a selected polyline instrument no modifier key is needed. Double click the polyline instrument with the left mouse button to select it.

Choose the polyline type from the floating toolbar:

- Linear connects the points with straight lines.
- CatmullRom connects the points by a Catmull-Rom-Spline. Modify the Slope factor to increase or decrease the curvature of the. A Slope factor of *0.0* leads to the same result as a Linear polyline.

The annotation shows the distance measured along the polyline.

Caliper instrument

Like the distance instrument, the caliper instrument is used to measure distances. The caliper can be regarded as a distance instrument enhanced by a additional line at each end. The additional lines are in a fixed right angle to the distance measurement line. Use the additional line to position one end of the distance measurement line rectangular to a surface. Then position the other end of the distance measurement line, e.g. onto the opposite surface, to measure the distance.

If you hold <*Shift*+*Ctrl*> while dragging a handle, the direction of the corresponding line is locked and will only change in steps of 45°.

If you hold <*Shift*> while dragging a handle, its movement is restricted to the horizontal or vertical direction in the respective 2D window.

If you change the coordinate system, the additional lines of the caliper will not be displayed. They become visible again if you switch back to the coordinate system in which they have been created.

Activate navigation cursor

The navigation cursor allows easy navigation in the scene: Hold <*Ctrl*> and left-click a point in any (2D or 3D) window to position the navigation cursor there. The position specified this way will be shown in the other 3 windows; 2D windows will update their slice index to do so. Use the left mouse button to drag the navigation cursor around. Hold <*Ctrl*> and left-click somewhere to set the cursor to a new position.

Tips and tricks

If you are interested in a specific point located on the surface of the object, position the navigation cursor on this point by <*Ctrl*>-clicking it in 3D. All 2D windows will display the slices for this point so that you can investigate it further.

If another instrument is selected, the navigation cursor can be brought back to focus in the 3D window by <*Ctrl*>-clicking somewhere within it.

Snap

Activate one of the snap options from the pull down menu to automatically snap the points/handles you set for the measurement instruments. The snap works both for volume and geometry objects in the 2D view. If a volume object has been calibrated, the calibrated isosurface can be used for snapping.
Activate this option to display a square capture frame. The point snaps inside this capture frame. Define the snapping area inside the preferences (see *Preferences* in chapter *Edit menu* on page 4-2).
Disable this option to set the points/handles exactly where you click.
Enable an arbitrary snapping mode for geometry objects to snap onto their surface.

Use one of the following snap options from the pull down menu for the instruments in the 2D view:

Snap modes > Min

 Snaps to the lowest gray value in the snap area.

Snap modes > Max

 Snaps to the highest gray value in the snap area.

Snap modes > Gradient

 Snaps to the position with the largest gray value difference in the snap area.

Snap modes > Nearest

 Snaps to the nearest isosurface created by the calibration in the snap area. If there is no calibration present, this modes works like the snap mode Local.

Snap modes > Local

 Performs a temporary, local calibration within the snap range and snaps to the resulting temporary isosurface.

6 OBJECT MENU

The Object menu of myVGL allows you to manipulate the objects in the scene (like voxel objects or polygon models, but also clipping planes etc.).

See Table 6-1: *Object menu options* for an overview.

Option	Icon	Description
Rotate		Enables rotating the object in 3D.
Move		Enables moving the object in 3D.
Create clipping plane		Creates a clipping plane for the selected object.
Create aligned clipping box		Creates an aligned clipping box for the selected object.
Create clipping box		Creates a clipping box for the selected object.
Properties		Displays object properties.

TABLE 6-1: OBJECT MENU OPTIONS

Rotate / Move

Toggle between rotate mode and move mode for the selected object(s) in the 3D window. The current mode can be identified by the color of the bounding box of the object in the 3D window: A red bounding box indicates rotate mode, a green bounding box indicates move mode.

For more details please refer to *Move / Rotate mode* in chapter *Workspace* on page 2-2.

Clipping

Either create a clipping plane, a clipping box or an aligned clipping box for the selected object(s). For more information about clipping objects, please refer to chapter *Clipping tool*.

Properties

Displays information about the selected object. For more information, please refer to *Properties* in chapter *Scene Tree tool* on page 12-4.

7

RESULT MENU

Through the Results menu of myVGL you can access results of advanced analysis features. With myVGL, you can view the results of, but not perform, an analysis.

See Table 7-1: *Results menu options* for an overview.

Option	Icon	Description
Defect detection		Open the results of a Defect detection analysis.
Nominal/Actual comparison		Open the results of a Nominal/Actual comparison.
Wall thickness		Open the results of a Wall thickness analysis.
CM reporting		Open the results of Coordinate measurements.

TABLE 7-1: RESULTS MENU OPTIONS

Nominal/Actual comparison

Visualizes the variations between the calibrated surface of a voxel object and the surface of a polygon model.

See chapter *Nominal/actual comparison module* for details.

Wall thickness

Visualizes the material thickness of a voxel object.

See chapter *Wall thickness module* for details.

Defect detection

Visualizes the material defects of a voxel object.

See chapter *Defect detection module* for details.

CM Reporting

Visualizes the material defects of a voxel object.

See chapter *Measurements menu* for details.

8 TOOLS MENU

Activate various tools by checking their entry in the Tools menu of myVGL.

See Table 8-1: *Tools menu options* for an overview.

Option	Icon	
Volume Rendering		define opacity, intensity and color mappings for volume objects
Scene Tree		access and control elements (and their subelements) in the scene, this includes camera and light sources, volume objects and surface models, measurement features, clipping planes, and others
Clipping		control the clipping plane
Polygon Rendering		specify the rendering of surface models
Transform		access and control the transformation properties of volume objects and surface models, these include the position, rotation, resolution and center of an object
Light		access and control the properties of light sources in the scene, these include the type (e.g., spot light source), color, shadow, and others
Camera		access and control the properties of the camera, these include its position and focal point, the rendering mode and others

TABLE 8-1: TOOLS MENU OPTIONS

Check a tool to activate it. An activated tool will be displayed either in one of the tool docks or as a floating tool. It might be minimized to its title bar or maximized. Position and size of the tool depends on its status before it was deactivated.

Uncheck a tool to deactivate it. You can reactivate the tool at any time.

Deactivating a tool via the Tools menu is equivalent to closing the tool via the corresponding icon in its title bar.

For details on the tools, refer to the respective chapters.

9

WINDOW MENU

Choose and/or modify the overall layout of views in myVGL. This includes the 3D and 2D views to be displayed, their size and arrangement as well as display of rulers and text overlays.

See Table 9-1: *Window menu options* on page 9-1 for an overview.

Option	Icon	Description
Slices Left		Applies a standard two column layout with three slice views and a large 3D view. The slice views are arranged top to bottom in the left column.
Slices Right		Applies a standard two column layout with three slice views and a large 3D view. The slice views are arranged top to bottom in the right column.
Slices Below		Applies a standard two row layout with three slice views and a large 3D view. The slice views are arranged left to right below the 3D view.
Quad		Applies a standard two by two layout with three slice views and a 3D view, where each view of the quad is of the same size.
Background		Select the Background color for the selected 2D window.
Coordinate system		Select a reference coordinate system for the respective 2D window.
Zoom		Controls the zoom setting of the selected 2D view.
Ruler		Activate to display rulers in the slice views.
Display Mode		Changes the Display Mode (data representation) of the 2D views.
Annotations		Rearranges and configures annotations

TABLE 9-1: WINDOW MENU OPTIONS

Option	Icon	Description
Level/Window mode		Toggles the 2D view Level/Window (Contrast/brightness) mode.
Slice step width		Defines step width to be used for navigation in 2D view (if not in “Grid” coordinate system).
Text overlay editor		Configures text overlays for slice views and/or 3D view

TABLE 9-1: WINDOW MENU OPTIONS

Slices Left/Right/Below

Select one of the window layouts with a larger 3D view and apply it to your current workspace.

Quad

Select this layout to apply a standard two by two layout with three slice views and a 3D view.

Background

Specify the background color of the 2D windows here.

Coordinate System

Here you can specify a reference coordinate system for the selected 2D window. Other 2D windows will not be affected by this choice. Select Follow global coordinate system to reference the coordinate system active in the Coordinate system iconbar.

Zoom

You can zoom in or out, fit an object or a scene to the window or reset to the original zoom factor.

Ruler

Select this option to toggle the ruler at the borders of each 2D window.

Display mode

The Display mode determines the way by which the slice images in the 2D views are rendered.

Original

Displays the slice images using their original color, brightness and contrast.

Color

Displays the slice images using their original brightness and contrast, but applies the color setting from the Volume Rendering tool. Also displays the contour of the calibrated surface.

Color and Opacity

Displays the slice images using the brightness, contrast and color settings of the Volume Rendering tool. Also displays the contour of the calibrated surface.

Annotations

Select Arrange, Minimize, Maximize to modify the display of the currently visible annotations.

Refer to e.g. *Annotations* in chapter *Nominal/actual comparison module* on page 20-6 for instructions on how to create an annotation.

Level/Window mode

Launches the Level/Window (contrast/brightness) tool. This can be used to change the displayed Level/Window of the volumetric data independent of the Volume Render settings. The chosen settings are taken into account in all the Display Mode settings.

Slice step width

Here, you can define the step width to be used when scrolling through slices in the 2D views. It is only active when one is not in a “Grid of ...” coordinate system.

Text overlay

Launches the Text Overlay Editor for the 2D and 3D windows. Via this tool additional information such as slice position and company logos can con-

figured and rendered on top of the 2D and 3D views. For further details see chapter *Text Overlay Editor*.

10

Help Menu

The Help menu of ***myVGL2.0*** provides information about the software and provides access to the manual.

Option	Icon	Description
About		Display product information
Show manual		Displays the reference manual

TABLE 10-1: HELP MENU OPTIONS

About

Displays product information including the version (release) and build number.

Always provide version and build number when requesting support or reporting a bug.

Show manual

Displays this reference manual.

11 VOLUME RENDERING TOOL

Volume objects can be visualized with various rendering techniques by myVGL2.0. The Volume Rendering tool allows to manipulate the look of volume objects or parts of them in various ways: You can choose a color for each object, apply user-defined transfer functions to its opacity, set its overall transparency, and pick a rendering algorithm.

Preset selection

If you choose one of the default or user defined settings most changes in the tool are overwritten and lost. The red flag next to a preset name indicates that changes were made to it.

To save your own presets choose Save preset from the right pull down menu.

To save and load the settings into or from a file choose Export preset or Import preset.

When saving, you can choose if you want to save an Absolute Preset, i.e. a preset that maps properties to absolute grayvalues. If the checkbox is not activated, properties are saved relative to the histogram length.

You can choose between the following predefined presets:

- Ramp sets a ramp from left bottom to right top in the Opacity manipulation area, sets the colors to white and causes the object to be rendered as a volume.
  The result is a gray shaded volume object. Low gray values have high transparency and are shown with low intensity. High gray values have high opacity and are shown with high intensity.
- Inverse Ramp sets a ramp from left top to right bottom in the Opacity manipulation area, sets the colors to white and causes the object to be rendered as a volume.
  The result is a gray shaded volume object. Low gray values have high opacity and are shown with high intensity. High gray values have high transparency and are shown with low intensity.
- Components sets the opacity to maximum for all gray values, sets a color gradient for Ambient and causes the object to be rendered as a volume.
  The result is a completely colored object. Every gray value has another

color. This is a good setting to visually detect the components of the object. Use the aligned clipping box to look into the object.

- Isosurface Transparent sets the colors to white and causes the object's surface(s) to be rendered transparently. The threshold of the iso surface is shown as a red vertical line in the Opacity manipulation area. Change it with the mouse interactively.

Opacity manipulation area

In this area you see a histogram of the selected object and can specify the opacity of its voxels depending on their gray value using the opacity transfer function. The opacity transfer function is represented by the gray line plotted over the histogram. It can be manipulated as described in the following.

Manipulation of the opacity transfer function

Set handles by clicking with the middle mouse to define supporting points of the transfer function. The transfer function is linearly interpolated between the supporting points.
You can move handles or whole sections of the opacity transfer function by dragging them with the left mouse button.
Delete handles by middle-clicking them or by right-clicking them and choosing Delete handle from the context menu.
Move the mouse over the handle to see its gray value followed by its assigned opacity value.
Choose Reset opacity curve > from the context menu and the respective sub menu entry to set the transfer function to Default (Ramp), Full transparent or Full opaque.
Choose Copy opacity curve from the context menu and Paste opacity curve to copy the curve into the area of another object.

Warning The opacity transfer function has no effect on the 3D window when the isosurface renderer is chosen. You can however still see the effects in the 2D window when you set them to Color and Opcacity mode.

Gray value histogram and zoom

Click into the background of the histogram with the left mouse to show its zoom level and gray value range. Move the mouse now up or down to change the zoom.
Use the  icon or  - icon to reduce or enlarge the section of the gray values.
Choose Histogram > Disable histogram to disable the histogram in the background.

Tips and tricks Dock the tool window out from the tool bar and resize the window horizontally as large as possible to see the histogram in more detail if you have an object with thousands of gray values.

Intervals

Use the intervals to disable or enable a gray value range. If an interval is disabled the opacity is set to zero for its gray value range.
Per default you work always in the *Interval 1*. Move the mouse to the right or left border of the area, hold down the left mouse and move into the middle of the area to create an additional interval. Move the blue boundary line of the interval to scale both the opacity and color transfer function. Click with the left mouse onto the name of the interval to change it.

The context menu allows various options:
Choose New interval > At left side to divide up the existing interval into two intervals on the actual mouse position with the new interval on the left side.
Choose Delete interval > Expand left neighbor to delete the interval on the actual mouse position and merge the freed region with left interval.
Choose Disable or Enable interval to disable or enable the interval on the actual mouse position.
Define the surface of the selected object by moving the red vertical line with the mouse. This sets the gray value at which the isosurface renderer displays the surface of the object.

Tips and tricks If the object was calibrated you have to click the small cal icon on the right to unlock the vertical line if you want to set the surface by hand.

Appearance

Define the color transfer functions, overall transparency and some isosurface specifics here.
The color and intensity defines how much of the light is reflected from the object's volume or surface.

Ambient

Specify the properties of the Ambient component of light reflected from the selected object here. See *Color and Intensity* in chapter *Light tool* on page 16-3 for details on the different light components.

Set handles by clicking with the middle mouse to define supporting points of the transfer function. This defines a mapping between the gray value of the object and the color. The transfer function is linearly interpolated between the supporting points.

Move the handles by clicking with the left mouse.
Use the right mouse on a handle and delete it by choosing Delete handle from the context menu.
Click the handle with the left mouse to see its gray value.

Choose Set handle color > to set the color for a handle. Choose Set color between handles > to set the color between handles. Choose Set interval color > to set the color for the whole interval.

Warning Set interval color > removes all handles inside the interval.

Copy the interval color by choosing Copy interval color and Paste interval color from the context menu.

Use the spinbox to set the Intensity of the color.

Diffuse

Specify the properties of the Diffuse component of light reflected from the selected object here. See *Color and Intensity* in chapter *Light tool* on page 16-3 for details on the different light components.

Set the color transfer function in the same way as done for Ambient above.

Use shared color to use exactly the same transfer function for the diffuse component as for the ambient component. Change the intensity independent from that. The old transfer function is restored if the option is deactivated.

Specular

Specify the properties of the Specular component of light reflected from the selected object here. See *Color and Intensity* in chapter *Light tool* on page 16-3 for details on the different light components.

Double click the quadratic box to choose the color for the Specular component. Use the spinbox to set the Intensity of the color.

The Shininess controls the size and brightness of the highlight of the specular component.

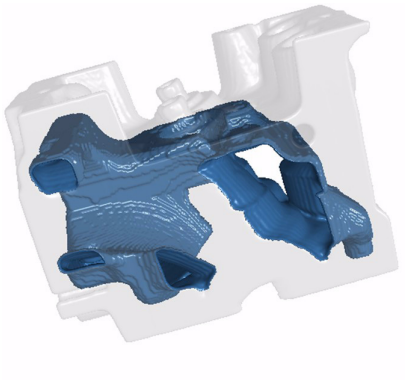
Transparency

Use the spinbox to set the overall Transparency of the selected object. This changes the intensity of the opacity in the Opacity manipulation area. The opacity is the inverse of the transparency. It is the equivalent of the Intensity of the color transfer functions Ambient and Specular.

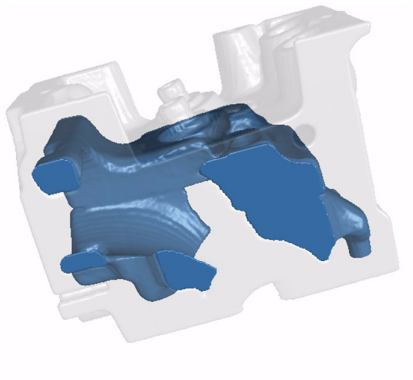
Enable Remove hidden surfaces to disable the rendering of surfaces inside the object. This has an effect only if the surfaces are transparent.

Swap

Choose Swap inner/outer areas to set inner areas to outer areas and vice versa. This is for the Isosurface renderer only. The figure below illustrates a common use of this switch.



Swap inner/outer areas off



Swap inner/outer areas on

Rendering settings

For each object in the scene, you can specify which rendering algorithm to use to display it in the 3D window (and any screenshots or movies derived from it).

Isosurface renderer

This algorithm displays the surface of the selected object as defined by the iso-level (red line in the Opacity manipulation area). It is recommended for the analysis and visualization of industrial CT data sets: This algorithm produces high quality photorealistic images at interactive speeds almost independently of the size of the data set. The most common use of the isosurface renderer is to render the object at the iso-level defined by the calibration, i.e. showing the actual calibrated surface of the object.

Volume renderer (Phong)

This algorithm is a volume rendering algorithm which emphasizes the local gradients within the voxel data. The full support of lighting sources and clipping objects makes it most suitable for animations.

Volume renderer (Scatter HQ)

This algorithm is a volume rendering algorithm. It is the “all-rounder” amongst the visualization algorithms of ***myVGL***. It is well suited for the visualization of faint gray value differences within the voxel data as well as to visualize surface structure details.

Hardware renderer (Scatter HQ)

In contrast to all other renderers, which all use the CPU (s) for rendering, the Hardware renderer uses the graphics card for direct-volume-rendering. This delivers the best rendering performance on most systems but uses the least features of the light and clipping objects. However, for data sets larger than the graphics card memory the Hardware renderer can be used as preview only, because the volume has to be downsampled and looses detail.

X-Ray

The X-ray algorithm casts one ray per display pixel into the dataset. The higher the integrated opacity of voxels along a ray, the darker the corresponding pixel.

Sum along Ray

The Sum along Ray algorithm casts one ray per display pixel into the dataset. The higher the integrated opacity of voxels along a ray, the brighter the corresponding pixel.

Maximum Projection

The Maximum intensity projection algorithm casts one ray per display pixel into the dataset. The maximum intensity of the voxels along a ray determines the gray value of the corresponding pixel.

Scatter (v1.2)

This algorithm is a volume rendering algorithm which is suited best for the visualization of transparent structures only, e.g. in computational fluid dynamics.

Scatter HQ (v1.2)

This is the standard volume rendering algorithm from ***myVGL*** 1.2. See “Volume renderer (Scatter HQ)” for more details.

Scatter Gradient (v1.2)

This algorithm is a volume rendering algorithm which emphasizes the local gradients within the voxel data. Therefore it is suited best to visualize objects with a clearly defined surface structure.

REMARKS ON RENDERERS

Some renderers are adopted from ***VGStudio Max*** 1.2: VGStudio MAX 1.2 (Scatter), VGStudio MAX 1.2 (Scatter HQ), VGStudio MAX 1.2 (Scatter HQ Gradient), VGStudio MAX 1.2 (X-Ray), VGStudio MAX 1.2 (Sum along Ray) and VGStudio MAX 1.2 (Maximum Projection). You can use those to display data that was saved in ***VGStudio Max*** 1.2 or ***VGStudio*** 1.2.

Tips and tricks Note that the VGStudio MAX 1.2 (X-Ray), VGStudio MAX 1.2 (Sum along Ray) and VGStudio MAX 1.2 (Maximum Projection) are not dedicated to old data sets only, but can be used with their full functionality in ***myVGL2.0***.

The renderers Volume renderer (Scatter HQ) and Volume renderer (Phong) are similar to VGStudio MAX 1.2 (Scatter HQ) and VGStudio MAX 1.2 (Scatter HQ Gradient) respectively, but fully support the attributes of light and clipping objects of ***myVGL2.0*** and have higher precision by nearly the same performance.

Oversampling

Set the oversampling to a factor larger than *1.0* to sample the object more precisely than one voxel distance. The higher the oversampling the slower the rendering but the better the image quality.

Normalize gradients

Switch on to normalize the gradients for lighting calculations. This is supported by the Volume renderer (Scatter HQ), Volume renderer (Phong) and the Isosurface renderer.

Limitations of specific renderers

The renderers Volume renderer (Phong) and Iso surface renderer support all attributes of the light sources and clipping objects. To be compatible to the ***myVGL*** 1.2.1 renderers the Volume renderer (Scatter HQ) does not support the specular component and behaves very similar to the VGStudio MAX 1.2 (Scatter HQ).

The VGStudio MAX 1.2 (x) renderers have some limitations:

- Only two light sources on the camera are supported. The first one is always interpreted as directional light shining frontal onto the object. The second one always is a directional light, too, and shines angular from the right side. Shadow is supported on second light source only. The specular component is not supported.
- The inversion of the clipping region of clipping boxes and the opacity setting of all clipping objects is not supported.

The Hardware renderer has the following limitations:

- Only the colors and intensities of light sources are supported.
- Neither inverting the clipping region of clipping boxes nor opacity settings of any clipping object are supported.
  Due to restrictions of OpenGL, most systems support only up to six

clipping planes. In this context, every side of a clipping box that actually clips the object counts as a separate clipping plane.

- Overlays used by the wall thickness and defect detection analysis to dye certain wall thicknesses or defects are not supported.

12 SCENE TREE TOOL

The scene in myVGL consists of all elements currently loaded. This not only includes volume objects and polygon models, but also measurement features, light sources etc. The scene is hierarchically structured: For example, a volume object is at top-level, all measurements and analysis results belonging to this object are ordered below it. This hierarchical structure is depicted in the Scene Tree. The Scene Tree tool allows you to access the elements of the scene.

Entries in the Scene Tree are preceded by an icon indicating the current locking state of this element, clicking this icon will change the state. The checkbox will toggle the visibility state. Additional access is provided by the context menu which you can open by right-clicking the entry (or entries) in question.

Entries in the Scene Tree

Click an entry in the Scene Tree to select it. Use the <*Ctrl*> key while clicking to select multiple objects.

A selected object is highlighted in the Scene Tree. In the 3D window, its bounding box is displayed.

Any object-related operations will refer to the selected object. Selecting an object in the Scene Tree is equivalent to selecting it in the 3D window. Select an object in the 3D window by double-clicking it, deselect an object by double-clicking another object or by double-clicking the background.

Tips and tricks Double-clicking a volume or polygon object in the Scene Tree will show a dialog listing all available properties of that object.

Delete

Delete a selected entry by pressing the <*Del*> key on your keyboard.

Rename

To rename a selected entry, click it or press the <*F2*> key.

Visibility

Activate the checkbox in front of an object to display it in the scene. Deactivate the checkbox if the object shall not be displayed in the 2D and 3D

views. This will change the visibility status only, all other settings will remain unchanged. If you want to toggle the visibility of multiple objects, select them and click the right mouse button to bring up the context menu. In the menu, choose the according visibility status.

Status indicators

A lock icon indicates the status of an object (not applicable for all types of objects). In ***myVGL***, the status of an object cannot be changed.

- **closed lock** 
  The object is locked in the scene. This implies that rotating the object will rotate the camera. The relative position of the object in the scene will not be changed.
- **closed lock with a red R** 
  The object has been locked in the scene after a registration.
- **open lock** 
  The object is unlocked. This implies that rotating the object will change the relative position of the object in the scene. Otherwise, the scene will remain unchanged.
- **warning sign** 
  If the basis of an analysis has changed (e.g. coordinate systems in case of a nominal/actual comparison), the analysis is marked to indicate that the results are no longer valid.

Elements

An icon indicates the type of each object. The following types of objects are displayed in the Scene Tree:

- **volume objects** 
  top-level object, a red C in the icon indicates that the object has been calibrated, a red C+ indicates an advanced calibration
- **polygons** 
  top-level object
- **camera** 
  top-level object, only one camera per scene
- **light sources** 
  attached to top-level objects, the scene should have at least one light source
- **regions of interest**
  attached to a volume object
- **features**
  attached to a volume or polygon object

- **instruments**
  attached to a volume or polygon object
- **reference objects**
  attached to a volume or polygon object
- **wall thickness results**
  attached to a volume object or a ROI, results of wall thickness analyses
- **defect detection results**
  attached to a volume object or a ROI, results of defect detections
- **nominal/actual comparisons**
  attached to a volume object or a ROI, results of nominal/actual comparisons
- **annotations**
  attached to analyses
- **clipping objects** 
  attached to a volume or polygon object
- **groups**
  top-level object, groups of top-level objects or of lower-level objects

Menu options

Right-click an entry in the Scene Tree tool for a menu listing available options for the selected object(s). The menu will differ depending on the type of the object(s). Menu options available for the selected object type but currently not applicable will be disabled.

New >

The options in this submenu will differ depending on the type of the selected object.

GENERAL OPTIONS

- Clipping plane / Clipping box / Aligned clipping box
  Creates a clipping object of the selected type. The clipping will be applied to the selected items in the Scene Tree.

ANALYSIS AND MEASUREMENT OPTIONS

- Annotation **(defect detection / nominal/actual comparison / wall thickness)**
  Creates an annotation for the selected defect detection, nominal/actual comparison or wall thickness analysis respectively.

Import >

Import templates and apply them to the selected object.

- Indicator annotations
  Imports a template of indicator annotations containing information about their positions, names and group affiliation.

Align slices to object

- Align slices to object
  Aligns the slice views axis-parallel to a selected reference object or a selected clipping plane.

Visibility on / off

Toggle the visibility of the selected item. This menu entry corresponds to the visibility checkbox of each item but allows you to toggle the visibility of multiple items at the same time.

Delete

Deletes the selected item. Equivalent to Edit > Delete.

Rename

Renames the selected item. If multiple items are selected, this menu entry changes to Rename (multi) and leads to a dialog in which you can systematically modify the naming of multiple objects.

Reset

Resets the position and orientation of objects that are not locked to their inital state.

Properties

Displays properties of the selected volume object, polygon model or analysis object. You can also open this dialog by double-clicking an entry. Choosing the properties option on analysis objects will show the according analysis dialog. See the respective chapters for a detailed description.

For render objects the properties dialog consists of two tabs, General and File list. The general property information varies depending on the type of object (volume object or polygon model).

GENERAL PROPERTIES (VOLUME OBJECTS)

The Data info section contains information on Endianness and Datatype (for volume objects).

The overall scanned area is quantified in the Bounding box info. Note that this usually comprises the surrounding air, not only the scanned object. The bounding box is displayed in the 3D window.

The bounding box related information contains

- the Dimensions [voxel] in x, y, and z
- the Resolution on the x, y, and z axis, i.e. the size of a voxel in this axis
- the overall Voxel count in the bounding box
- the Dimensions in the scene unit (e.g. mm)

The Object info provides information on the scanned object as defined by the calibration. This includes the dimensions of the smallest possible bounding box around the object and the volume of the material (as defined by calibration) in this bounding box. If the object is not calibrated, the results will depend on the renderer (volume renderer or isosurface renderer).

GENERAL PROPERTIES (POLYGON MODELS)

The section Object info contains information on the number of vertices (Vertex count) and triangles (Triangle count) defining the polygon. The object is analyzed for Bad edges and Bad triangles.

Click the Update button if you are interested in the Surface area and the Dimensions (x, y, and z). The dimensions describe the smallest possible bounding box around this object.

Clicking Update will analyze the angles in the triangles and display the number of occurrences of the angles in a diagram.

FILE LIST

Displays a list of the files on disk containing the data of the selected object. The information refers to the data as stored in the file. Thus the volume size can vary from the volume size of the object in the scene if the object has for example been imported applying a ROI.

13 CLIPPING TOOL

Clipping objects enable you to render parts of a volumetric/polygonal object transparent independent of the Render Settings of the volumetric/polygonal object. This is done by cutting away parts of the volumetric/polygonal object using a geometric (plane or box) object.

General

Clipping objects can be created either directly from the Object menu or from the context menus of the 3D window and the Scene Tree (invoke a context menu with a right mouse click).

A clipping plane can also be created using the Scissors icon at the bottom of each of the 2D windows or from the 2D windows context menu. In this case the plane is automatically located at the slice location shown in the 2D window from which the clipping plane is created.

The transformation and scaling of a clipping object can be reset to its default values via the Reset function in the context menu.

Multiple clipping objects can be combined to achieve more complex clipping regions.

To share a clipping object between multiple volume/polygon objects, group these together and define the clipping object for the group.

Clipping plane

Defines a planar geometry for clipping. Any parts of the volumetric/polygonal object laying above the plane in the direction of its surface normal will be clipped.

Tips and tricks Use the <*Ctrl*> key in conjunction with any of the modes for finer control.

ROTATE MODE

Click and draw with the mouse:

Use the *left* mouse button to rotate the clipping plane around its origin.

The *middle* mouse button will spin the clipping plane around its origin and the viewing direction.

MOVE MODE

Click and draw with the mouse:

Use the *left* mouse button to translate the clipping plane up/down and left/right relative to the 3D view, i.e. perpendicular to the viewing direction.

The *middle* mouse button will translate the clipping plane in/out relative to the 3D view, i.e. along the viewing direction.

Clipping box

Specifies a box for clipping. Any parts of the volumetric/polygonal object outside the box will be clipped.

Pressing and holding the left mouse button over any of the yellow handles on the sides of the clipping box enables you to resize the clipping box independently of the rotation/translation mode of the 3D window. Press, hold and drag in the directions perpendicular to the side to resize the clipping box.

ROTATION MODE

Click and draw with the mouse:

Use the *left* mouse button to rotate the clipping box around its origin.

The *middle* mouse button will spin the clipping box around its origin and the viewing direction.

TRANSLATION MODE

Click and draw with the mouse:

Use the *left* mouse button to translate the clipping box up/down and left/right relative to the 3D view, i.e. perpendicular to the viewing direction.

The *middle* mouse button will translate the clipping box in/out relative to the 3D view, i.e. along the viewing direction.

Aligned clipping box

Specifies an object aligned box for clipping. Any parts of the volumetric/polygonal object outside the box will be clipped. The aligned clipping box can not be rotated or translated nor can it be scaled to be any larger that the original volumetric object on which it was defined.

A left mouse click will position the mouse over any of the yellow handles on the sides of the clipping box. Press, hold and drag in the directions perpendicular to the side to resize it.

Warning The aligned clipping box is only available for volumetric objects.

Status Information

Displays the name of the selected clipping object in green color. If no clipping object is currently selected in the Scene Tree, the text “No clipping object selected” is displayed in red and all controls are disabled.

General

This tab shows all controls applicable to all types of clipping objects.

Appearance

Activate the checkbox to invert the region used for clipping. For clipping planes, inverting the clipping region will swap the sides used for clipping. For (aligned) clipping boxes, inverting the clipping region will render anything inside the clipping box transparent.

Opacity

Controls the opacity value of the clipped region. Move the slider to modify the opacity or enter an opacity value in the edit box. The value will be clipped to the range [0;1].

The opacity setting is not available for clipped polygon objects.

Reset

Resets the rotation, translation and scaling of the selected clipping object to the default values (Opacity and inversion state are left unchanged).

Aligned Clipping box

This tab is only enabled if an aligned clipping box is selected.

Boundary

The minimum and maximum values (in voxels) of the clipping region.

Reset

Resets the boundary of the aligned clipping box to its default values which corresponds to the bounding box of the respective sample grid of the volume.

14 TRANSFORM TOOL

The Transform tool is designed to manipulate spatial properties like position and orientation, and geometric properties like center, scale and resolution for a selected object. The tool is organized into several tab pages in which you inspect and modify the specific properties.

Status information

This section displays information about the current status of the Transform tool. If a valid object is selected it‘s name is displayed in green color. A valid object is either a voxel data set, a polygonal model or a region of interest. The Status information display also gives you a hint if the transform property tool is deactivated for your current selection in the Scene Tree (e.g. No object with transformation selected).

Coordinate system

Select a coordinate system from the pull down to inspect and manipulate values relative to the selected coordinate system.

Position (Pos)

To modify the position, enter the exact position value in x, y and z coordinates. You may also use the up and down arrows to increase or reduce the values. Click the Reset button to restore the initial position.

Rotation (Rot)

Specify the rotation of an object either in Standard or Advanced mode. Switch between Standard/Advanced mode by clicking the Standard/Advanced button.

- **Standard**

  The Standard dialog provides you with an interface where you enter *incremental* rotation values for each axis. Enter the incremental rotation around the x, y, or z axis or use the up and down arrows to increase or reduce the rotation values.

- **Advanced**

  The Advanced dialog provides you with an interface where you enter *absolute* rotation values for the selected object. The absolute rotation is defined by a normalized vector in 3D space serving as rotational axis and a rotation angle around this vector.

  Enter the x, y or z coordinates to define the rotational axis or use the up and down arrows to increase or reduce the x, y or z values.

  Enter the absolute rotation angle around the rotational axis defined by the x, y and z values or use the up and down arrows to increase or reduce the rotation angle.

  Press the Reset button to reset the orientation of the selected object to its original value.

Center

Specify the center of the selected object. By default the origin of an object is at (Xmax/2, Ymax/2, Zmax/2), where Xmax, Ymax and Zmax describe the extent of the object's bounding box.

Enter the x, y or z coordinates of the desired center or use the up and down arrows to increase or reduce the x, y, or z values.

Press the Reset button to restore the default center values.

The center of an object is important for rotations, as it defines the position of the axis of rotation.

Resolution

This Option can only be applied to voxel data sets. Specify the size of a voxel by modifying the resolution values.

Warning Modifying the resolution will change the geometry of the voxel data set and therefore invalidate any existing analysis results for this voxel data set.

Press the Override button to show the Override resolution dialog. Enter the x, y or z resolution values or use the up and down arrows to increase or reduce the x, y, or z values.

15 POLYGON RENDERING TOOL

Polygon rendering is supported by **myVGL2.0**.
Supported formats (in alphabetical order):

- **Stereolithography File Format (*.stl, *.STL)**
  General Stereolithography (STL) files.
- **Stereolithography ASCII File Format(*.stl, *.STL)**
  ASCII coded Stereolithography (STL) files.
- **Stereolithography Binary File Format (*.stl, *.STL)**
  Binary coded Stereolithography (STL) files.

Polygon objects can be assigned separate materials for front and back face. In addition, polygon objects can be clipped by clipping planes or clipping boxes (see chapter *Clipping tool*) and can be illuminated by different light sources (see chapter *Light tool*).

Warning Due to restrictions of OpenGL, most systems support only up to six clipping planes. In this context, every side of a clipping box that actually clips the object counts as a separate clipping plane.

In the 3D view only the front face of the polygon object is rendered by default. The material properties for front and back face can be specified independently. The polygon object can not only be rendered solid, but also as wireframe or point cloud.

In the 2D view one slice of the polygon object is rendered. The color of the outline can be chosen.

Status information

Displays the name of the selected polygon object.

General

Preset selection

Save your changes by choosing Save preset from right pull down menu. With Export preset and Import preset the settings made in the tool can be saved and loaded into a file. Choose one of the default presets to exclu-

sively set one of the following options: Render solid, Render wireframe, Render point cloud. All changes made in the tool are overwritten by choosing a preset.

Render solid

Activate this option to render the triangles of the polygon object.

SHADING MODEL

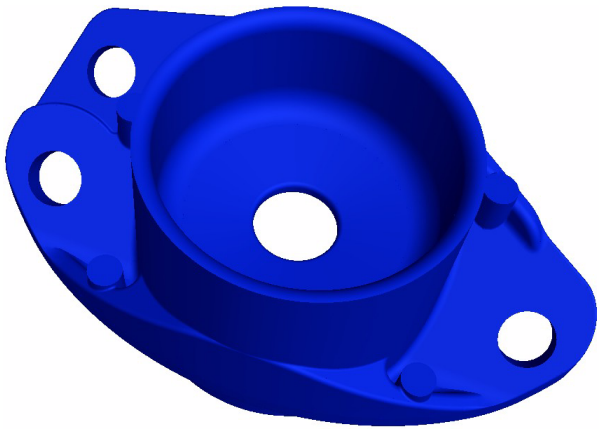
Choose Flat to show each triangle of the polygon object. The color between the triangle vertices is not interpolated.

Choose Smooth to get the color of the triangle vertices interpolated. This results in a much cleaner object surface.

CULL FACE

In the Cull face pull-down menu you specify the face of the polygon object that is not rendered. Choose Front to render the back face only. Choose Back to render the front face only. Choose Disabled to render both faces.

The image below shows a polygonal object that is rendered solid.

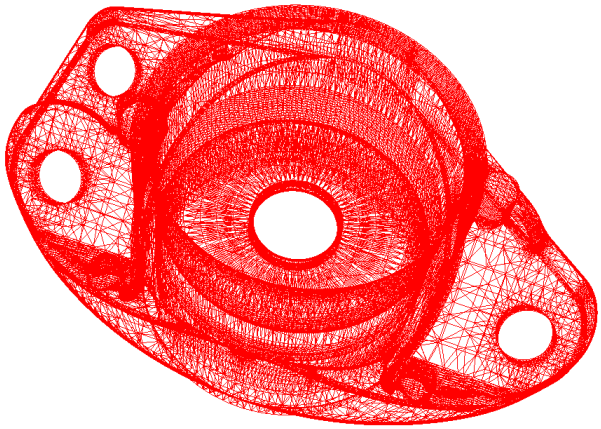


Render wireframe

Activate this option to render the wireframe of the polygon object, i.e. the lines between the triangle vertices.

Double click the quadratic box to select the line Color. Use the spin box to specify the Line width in pixels.

The image below shows a the wireframe of a polygonal object.

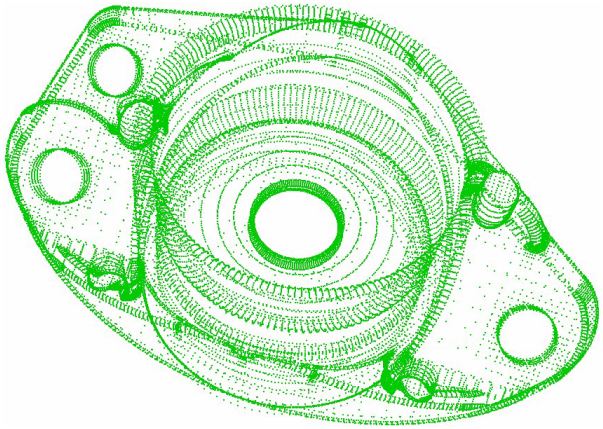


Render point cloud

Activate this option to render the point cloud of the polygon object, i.e. triangle vertices.

Double click the quadratic box to select the point Color. Use the spin box to specify the Point size in pixels.

The image below shows a the point cloud of a polygonal object.



Material

Assign a material to every face of the polygon object and a color to the outline in the 2D view.

Tips and tricks

The ambient and diffuse color of the front face of a certain polygon define the color of the corresponding icon in the Scene Tree to allow an easy identification.

Material face settings

Choose Front face or Back face whether you want to change the Color and Intensity of the front or back side of the polygon object.

Tips and tricks

The Back face of the polygon object is only relevant if you clip the object or if you search visually for mesh defects. Switch off rendering the Back face by choosing Back from the Cull face pull down menu in the Advanced tab to gain rendering performance.

Color and Intensity

Double click the respective quadratic box to choose the color for the Ambient, Diffuse or Specular component of the material. Use the spin box to choose the intensity of the material color component.

The color and intensity of the material defines how much of the light is reflected from the object's surface in each of the three components ambient, diffuse and specular. The Shininess controls the size and brightness of the highlight of the specular component.

Slice color

Double click the quadratic box to choose the Color for the outline of the polygon object in the 2D views.

16 LIGHT TOOL

Light sources in myVGL2.0 can be of type directional, point and spot. Both volume and polygon objects can be illuminated with the phong shading algorithm. Shadows are supported by software volume renderers only and have to be activated for each light source.

The light sources can be created by choosing New > and the type of light source from the context menu of the Scene Tree Tool. Only if selected in the Scene Tree the light source is shown in the 2D and 3D view and can be modified there with the mouse:

- In the 3D view it can be rotated and moved.
- In the 2D view start and end point can be modified. To initially place a light source click somewhere in the window and move the mouse into the light direction while holding down the left mouse button.

Warning The light object can be modified only if the lock icon in the Scene Tree is opened for this object.

Status information

Displays the name of the selected light source.

General

Preset selection

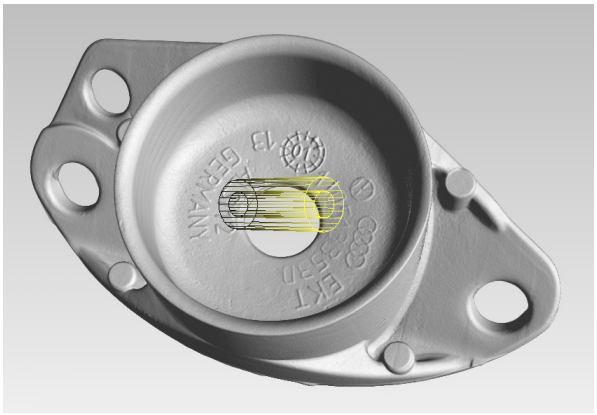
Choose Default light to set the default attributes for the light source. This overwrites all changes in the tool. To save your own changes choose Save preset from the right pull down menu.
With Export preset and Import preset the attributes of the light source can be saved and loaded into a file.

Type

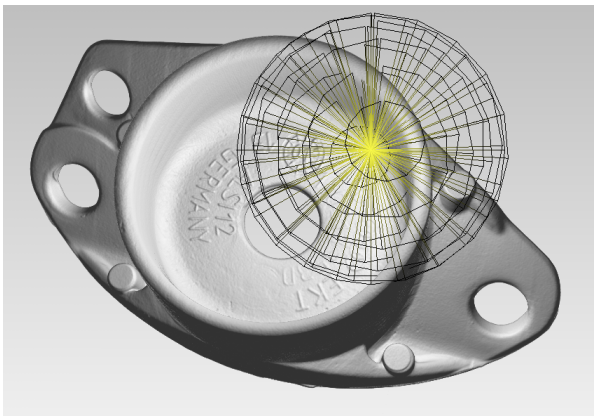
Select the type of the light source.

- Directional
  A light source sending out a parallel bundle of light rays in a particular

direction. The light intensity does not drop with distance. See the figure below for an example of a Directional light source.

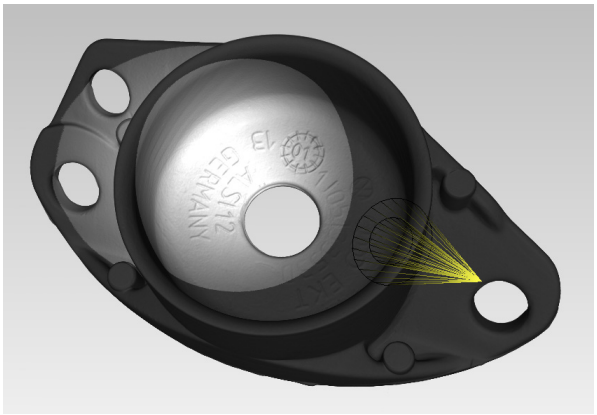


- Point
  A single point in space sending out light equally in all directions. The intensity of the light decreases proportional to the square of the distance to the light source. This is comparable to an infinitely small unshaded light bulb. See the figure below for an example of a Point light source.



- Spot
  Similar to a point light but emission is limited to within a cone much like a regular desk lamp. Thus this light type has an angular setting to define the size of the cone: The Cutoff Angle and an additional attenuation

Exponent can be set in the Advanced tab.See the figure below for an example of a Spot light source.



Color and Intensity

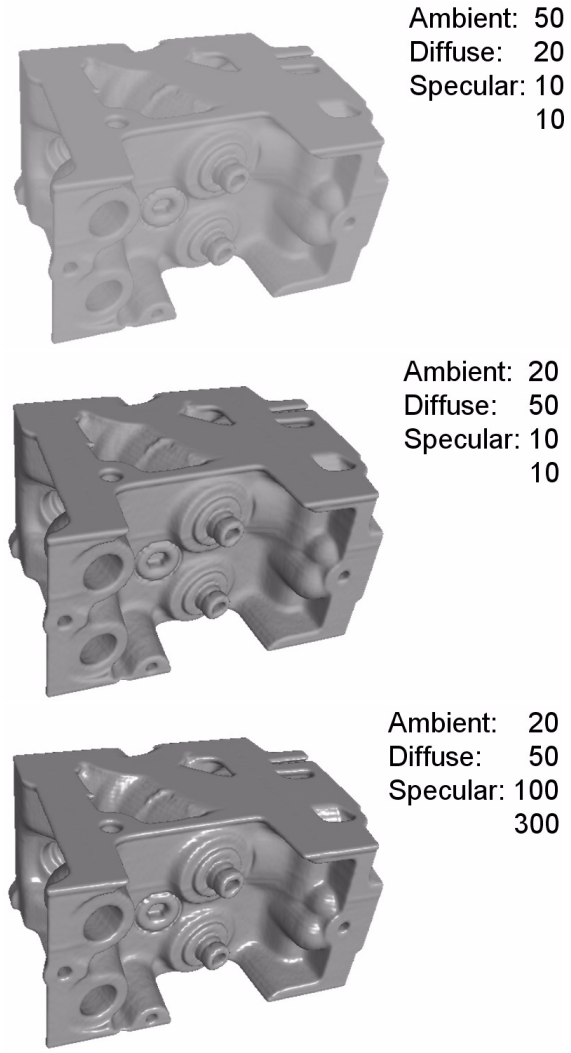
Specify the intensity and color of the light components here: Double click the quadratic box to select the color of the respective light component. Enter its intensity into the text field.

- Overall
  Sets the light intensity globally and affects all three light components: ambient, diffuse and specular.

Tips and tricks You can also modify the overall intensity of a selected light source by moving the scroll wheel while the mouse pointer is over the 3D window.

- Ambient
  The light component for general illumination.
- Diffuse
  The light component that comes from one direction and scatters equally into all directions.
- Specular
  The light component that comes from a particular direction and bounces of into a preferred direction. It is responsible for the shininess of a lighted object.

See the figure below for an illustration of the different light components.



Shadow mode

Switch shadows of the selected light source on or off here. Not all renderers support shadows or only for one light source.

Advanced

Attenuation

Point and spot light sources support attenuation. This is the intensity decrease of the light source along the light direction. The easiest way to work with it is to use the Constant or Gradient buttons:

- Constant sets the light source to have no attenuation at all. The Linear and Quadratic factors are set to 0. The Constant factor is set to 1. This is the default.
- Gradient sets the attenuation so that the half of the intensity decrease of the light source lies within the 2D view. This intensity is shown by a dashed circle around the light source and can be modified with the mouse.

Spot

- The spot light source supports a Cutoff Angle for its shade. You can either enter a value in the text box or modify it with the mouse: Use <*Ctrl*> + left mouse button on it and move up or down in the 2D view to open or close the shade.
- The Exponent value controls the decrease of the light intensity along the cone radius. The higher the exponent, the faster the decrease of the light intensity.

17 CAMERA TOOL

The 3D view of myVGL is rendered using a virtual camera placed in the scene together with the volumetric/polygonal data. Various properties such as camera position, viewing direction and aperture angle can be controlled using this tool.

General

Camera Orientation

DEFAULT CAMERA VIEWS.

The Camera tool includes shortcuts to fourteen default camera views, relative to the selected coordinate system. They can be used for quick viewing and generation of reference screenshots. These default views are along the three major axis (in both directions) as well as from positions along each of the four diagonals (one position for each corner).

The  button centers the selected object in the 3D view (via a translation along the screen plane).

The  button focuses the selected object in the 3D view (via a translation along the viewing direction).

POSITION

Display and manipulate the position of the camera (in the current coordinate system) here.

FOCAL POINT

Display and manipulate the position to which the camera is focused here.

The view direction can be obtained by subtracting the Position coordinates from the Focal point coordinates (and normalizing the result).

UP VECTOR

Specifies the vertical orientation of the camera, that means it implicitly sets the axial rotation of the camera relative to the view direction.

Projection mode

PERSPECTIVE

Renders the 3D models as seen by a single human eye: Spatial forshortening and apparent size as a function of distance is taken into account. That means that objects look smaller the further away they are.

PARALLEL

Renders the 3D models without perspective correction such that the relative proportions of an object are maintained independent of distance.

STEREO-PERSPECTIVE

Renders a pair of perspective images of the scene. The camera positions of the two images are slightly offset to mimic for example the offset between the right and left eye. When viewed correctly the image pair will create the perception of observing the objects in the scene in three dimensions.

Stereo viewing requires additional hardware either in the form of special glasses or dedicated displays.

View Angle

Specifies the vertical viewing angle (in degrees) of the camera.

Stereo

This tab is only active when Projection mode: Stereo-Perspective is chosen.

Image mode

ANAGLYPH IMAGE RED-GREEN, RED-BLUE, RED-CYAN

Encodes the left and right eye images into the respective color channels of the display (anachrome stereo). To view the result in stereo, a pair of (inexpensive) 2 color glasses are required.

INTERLACED

Encodes the left and right eye images into one image where either the rows or columns are alternatively taken from the left or right image. This mode requires special display video formats and/or special glasses.

LEFT IMAGE ONLY

Displays the left eye image only.

RIGHT IMAGE ONLY

Displays the right eye image only.

OPENGL

Alternates between showing the left and right eye images (active stereo). This mode requires additional hardware for stereo viewing (stereo glasses and a synchronization transmitter).

Settings mode

The degree of stereo perception depends on the relative scale of such parameters as eye, focal and image plane distances relative to the distance to the viewed object and its size. By tuning these parameters to the specific scene the 3D experience can be optimized.

FIXED FOCAL DEPTH

Lets you vary the focal distance, but uses fixed scaling.

FIXED VIEWER-SCENE SCALING

Assumes an infinite focal distance and lets you scale the viewing parameters relative to the Scene (Scene Zoom).

Eye distance

Sets the interocular (eye) distance.

Display distance

Sets the distance between the eyes/cameras and the 2D image plane.

Focal depth

Set the distance at which the eyes are focused, i.e the distance at which the view vectors from each eye/camera cross. Only available in the Fixed Focal Depth mode.

Scene Zoom

Sets the scale between the viewing parameters and the Scene. Only available in the Fixed viewer-scene scaling mode.

18 TEXT OVERLAY EDITOR

The Text overlay editor is designed to decorate 2D windows and the 3D window with customizable text overlays. The text overlays will supply you with additional information (e.g. current slice position, the window name or even DICOM tags) about the specific 2D/3D view. This feature is useful for reporting/documentation purposes (see also *Save image(s)...* in chapter *File menu on page 3-9* and *Save AVI/image stack ...* in chapter *File menu on page 3-10*).

Configure the text overlay via Window > Text overlay editor or by right-clicking into the 3D or 2D windows and choosing Text overlay > Configure...

The dialog is organized into two tab pages, the Slice views and the Scene view tab page. Both pages are structured identically. Click the Font settings button to show the preferences available for fonts. Click the Ok button to apply the current settings and close the editor. Click the Cancel button to close the dialog without applying any changes. Click the Apply button to get a preview of the current settings.

Slice Views (and Scene View)

On each tab page you modify and inspect your text overlays.

Preset Selection

In the Preset selection section you manage text overlay presets. Select a preset from the pull down to apply it to the current text overlay settings.

- Save
  Click the Save button to execute the Save preset dialog. Enter a name for the preset or choose an entry from the pull down and click the Save button to store the current text overlay settings.Click the Cancel button to abort the save process
- Remove
  Click the Remove button to remove a preset from the pull down preset list.
- Reset
  Click the Reset button to reset any modifications made on the active preset.

Text labels

The Text labels section contains the currently available text labels. Select either predefined text labels or create custom text labels. The Available text labels section is a table containing the currently available text labels. The Selected text labels section is a table containing the currently selected text labels. Select an entry from the Available text labels table and click the > button to add an entry to the Selected text labels table. Select an entry from the Selected text labels table and click the < button to remove the entry from the Selected text labels table.

Available default text labels:

The following text labels are available by default.

- **<CoordinateSystem>**
  Displays the name of the currently active coordinate system for the respective window.
- **<SlicePosition>**
  Displays the current slice position (only available for 2D windows)
- **<ViewZoom>**
  Displays the current zoom factor (only available for 2D windows)
- **<WindowName>**
  Displays the name of the window. The name indicates the window type, e.g., Top, Front or Back refers to a 2D window, whereas Scene refers to a 3D window.
- **<PatientID>**
  Displays the PatienID DICOM tag (only available for DICOM data sets).
- **<PatientName>**
  Displays the PatientName DICOM tag (only available for DICOM data sets).
- **<PixelSize>**
  Displays the size of a pixel respective to the currently selected application unit.
- **<SerialNumber>**
  Displays the SerialNumber DICOM tag (only available for DICOM data sets)
- **<StudyDescription>**
  Displays the StudyDescription DICOM tag (only available for DICOM data sets)

- **Ex: <StudyID>**
  Displays the StudyID DICOM tag (only available for DICOM data sets)
- **Se: <StudyNumber>**
  Displays the StudyNumber DICOM tag (only available for DICOM data sets)
- **<CustomLogo>**
  Displays your custom logo. Drag this entry into the Selected text labels section and double-click it to show the Select logo image dialog. In the dialog you specify the location of your custom logo.
- **<CustomText>**
  Displays your custom text. Drag this entry into the Selected text labels section and double-click it to modify its text.

Preview

The Preview area shows eight boxes in which you can place the selected text labels. The boxes indicate where the text labels will be positioned inside either the 2D or the 3D window. You can insert multiple text labels in each box.

Available default text labels:

19 MEASUREMENTS MENU

The Measurements menu of ***VGStudio MAX 2.0*** provides means for coordinate measuring, i.e. enables you to fit reference objects to your calibrated volumetric or geometric data and define measurements on the data based on the reference objects.

Coordinate measurement (CM) is an optional add-on module for ***VGStudio MAX 2.0****. It is not available for* ***myVGL****. However, if a project contains coordinate measurements, those measurements are available in* ***myVGL****.*

If you are interested in more extensive functionality than the one offered by ***myVGL****, you have the chance to evaluate our other products,* ***VGStudio 2.0*** *or* ***VGStudio MAX 2.0****:*

www.volumegraphics.com/products/evaluation/form.html

For further questions about our product portfolio, please contact

sales@volumegraphics.com

In ***myVGL***, there are seven types of Reference Objects (see description below), an arbitrary number of which can be shown for any calibrated volumetric or geometric object. In the Scene Tree, Reference objects are listed in the Coordinate Measurement > Reference Objects section.

Based on existing reference objects, *features* show measured positions, distances, angles and radii.

Features rely on the definition of distinct *coordinate systems*.

Point

A reference point was fitted to the object based on one or more fit points. A point's only geometric property is its position.

Line

A reference line was fitted to the object based on two or more fit points. A line's geometric properties are its position and direction.

Circle

A reference circle was fitted to the object based on three or more fit points. A circle's geometric properties are its center position, its orientation normal and its radius.

Pplane

A reference plane was fitted to the object based on three or more fit points. A plane's geometric properties are its center position and orientation normal.

Sphere

A reference sphere was fitted to the object based on four or more fit points. A sphere's geometric properties are its center position and radius.

Cylinder

A reference cylinder was fitted to the object based on three or more fit points. A cylinder's geometric properties are its center position, its direction and its radius.

Cone

A reference cone was fitted to the object based on three or more fit points. A cone's geometric properties are its center position, its direction, its center radius and its conicity angle.

Dialog: Reference object properties

Warning In ***myVGL***, all grayed settings are displayed for informational value only. Editing those settings or making new measurements is only possible using ***VGStudio MAX 2.0*** with the Measurements module installed.

To show the properties of a reference object either double click the reference object in the Scene Tree or select the Properties option from the Scene Tree context menu.

Warning Be aware that all geometric properties like positions and directions will be displayed with respect to the currently selected coordinate system!

Properties

Shows geometric and status properties of the reference object.

DESCRIPTION

The object's type and name. The name can be edited.

CONSTRUCTION METHOD

Information about how this object was defined:

- [Least-squares/Minimum-zone] fitted
- Result of [intersection/combination/projection/...]
- Manually defined reference object

SIZE STATUS

Status information about how the actual size of the reference object is determined. In most cases, the size of fitted reference objects depends on all its fit points, and the size of intersected/combined objects depends on their source objects. Other sizing methods can be forced by Measurements > Resize reference objects.

FIT STATUS

Status information about the last fitting process of the reference object:

- Valid: Successfully fitted to current calibrated material
  Last fitting or refitting process succeeded without problems. Reference object is synchronized with current situation.
- Invalid: Not synchronized with current situation (calibration change?)
  The underlying data (voxel data, calibration material, polygon data) has changed since the last fitting process.
- Invalid: Automatic refit failed
  Last refitting process (due to resolution adjustment or template import) failed, most likely because too few fit points could be adjusted to the new underlying surface.
- Valid: Isosurface not found for iteration >0, but previous result could be taken
  Last (iterative) refitting process (due to resolution adjustment or template import) did not succeed completely, but a valid result could still be taken from a previous iteration.

For derived reference objects, i.e. manipulation results, the status information has similar meanings, but it refers to the status of the source objects: if one of the source objects has a warning or error status, this status will be repeated for the derived object.

POSITION / RADIUS / CONICITY / DIRECTION / NORMAL

Geometric parameters. Position always denotes the center of the object. Direction and normal vectors are normalized to unit length. For cones, the radius at the center position is given.

DEVIATIONS

Statistic measures of the fit point distribution. Peak/valley deviations denote the maximum positive/negative distances of any fit point to the reference object's surface. The form deviation equals the sum of peak and valley.
Notes:

- For circles, the deviation is the distance to the actual circle outline, not merely the circle's plane.
- For lines that were initially specified in a 2D window, the 2D orientation at fitting time is stored and used to provide a "left of line / right of line" distinction for signed distances (like for all other reference object types except the point). If a line has no orientation information, all distances, will be positive (valley deviation zero per definition).
- The deviation signs are chosen such that positive deviations indicate points outside the calibrated material.

Fit points

Shows a list of the fit points used to calculate the properties of the reference object. The list includes information such as the position, deviation and gray value for each point. The list can be sorted according to each property by selecting the property column. Points can be visualized individually or in groups by selecting them in the list.

Histogram

Shows the histogram plot of the fit point count against deviation. The coloring is determined by the reference deviation in the Colors section.

BINNING

In the Binning pull-down menu, you can choose between no binning and a binning according to the sections of the color bar.

Cumulated

Shows the accumulated percentile of fitpoints against their deviation. The accumulated statistics can be shown for fitpoints with either a positive or negative deviation or for all fitpoints as a function of their absolute numerical deviation by selecting the corresponding entry in the Cumulation box. By moving the green cross-hair in the diagram the percentage of points within a given deviation (or alternatively the max deviation for a given percentage) can be obtained. The latter is also possible by directly typing in the values in the Deviation or Percentage dialogs.

Tips and tricks In contrast to the other properties sections, the Histogram and Cumulated graphs are also available when multiple reference objects are selected. They will then reflect the union of both sets of fit points.

Colors

Sets the interval width and colors used in the histogram plot and for the color-coded visible fit points in 2D and 3D. By default the interval width is in units of the automatically determined standard deviation. This is the standard deviation of all selected reference objects or (if no objects are selected) all reference objects found in the scene.
By unchecking the auto box a custom value can be specified. To change the color used for a specific interval range double click the corresponding color bar to launch the color selection tool.

CM Reporting

Warning In ***myVGL***, all grayed settings are displayed for informational value only. Editing those settings or making new measurements is only possible using ***VGStudio MAX 2.0*** with the Measurements module installed.

Use the CM reporting dialog to view, edit and print detailed information about reference objects and features. The dialog will show reference objects and features connected to a single volume/polygon, which depends on the current Scene Tree selection. The name of the current volume/polygon is shown in the caption of the dialog.

Tips and tricks ***myVGL*** will automatically show the CM reporting dialog when you double-click on any CM feature in the Scene Tree.

General remarks

The Features and Reference objects pages basically employ myVGL's standard reporting table functionality:

TABLE SELECTION

Select one or more table rows by left-clicking while holding <*Ctrl*> or <*Shift*> or by using the up-down arrow-keys while holding <*Shift*>.
Selecting rows will also select corresponding objects in the Scene Tree.

EDITING

Double-click into text cells with white background to edit their contents (e.g. object name). Grayed-out cells are not editable.

SCREENSHOTS

Use the Screenshots section below the table to capture images from one of the 2D or 3D views for the currently selected item in the table. Only available if exactly one row is selected.
You can provide a description for every captured image by clicking the default <no description> text.
Delete existing screenshots by pressing <*Del*>.

CONTEXT MENU

Right-click anywhere in the table to bring up the table's context menu:

- Columns: Toggle the visibility of any available column
- Store current visibilities and widths as default settings: Store column visibility and order on disk to remember them for the next time you restart myVGL.
- Remove entries: Removes a complete row from the table.
- Export as CSV: Exports the table values as CSV (Comma Separated Values) list.
- Copy to clipboard: Copy the selected rows (and the table header texts) into the system's clipboard. The clipboard information is provided both as plain text and a rich-text table, so when pasting into a rich-text-capable application like a wordprocessor, you will see a proper table with cells borders and bold headers.

COLUMN-ORDER

Left-click on any table header on top of each column while holding <*Ctrl*>. You can now move the column left or right to another place.

ROW-SORTING

Left-click on any table header on top of each column to sort the entire table according to this column. Click again to reverse the sort order. The current sort order is indicated by an arrow inside the column header.

SPECIAL COLUMNS

In addition to text cells, some columns contain combo-boxes for selecting special options.

Features

Lists all existing reference objects and their properties here.

As each feature is defined in a distinct coordinate system, lengths and positions displayed in the table do *not* refer to the currently selected coordinate system, but to the coordinate system of the feature itself!

FEATURE LIST

- Name
  The name of the feature. Column is editable.
- Type
  The type of the feature. Can be one of the following:
  - Distance
    Default distance measuring method. The distance line between the center positions of the two reference objects is calculated.
  - Distance (mid perpendicular)
    Reference object A is considered as finite, while reference object B is considered as infinitely extended. The mean between minimum and maximum distance (orthogonal to reference object A) between the two objects is determined.
  - Distance (min perpendicular)
    Reference object A is considered as finite, while reference object B is considered as infinitely extended. The minimum distance (orthogonal to reference object A) between the two objects is determined.
  - Distance (max perpendicular)
    Reference object A is considered as finite, while reference object B is considered as infinitely extended. The maximum distance (orthogonal to reference object A) between the two objects is determined.
  - Distance (min finite)
    Both reference objects are considered as finite. The minimum distance between the two objects is determined.

- Distance (max finite)
  Both reference objects are considered as finite. The maximum distance between the two objects is determined.
- Distance (min infinite)
  Both reference objects are considered as infinitely extended. The minimum distance between the infinite objects is determined if they are not intersecting.
- Distance (min)
  Reference object A is considered as finite, while reference object B is considered as infinitely extended. The minimum distance (orthogonal to reference object B) between the two objects is determined.
- Distance (centroid)
  The distance between the geometrical center of all fit points used to fit reference object A and object B is determined. Please note that the geometrical center of an object is calculated with respect to the fit point coordinates only. It is not calculated as the geometrical center of the fitted reference object A or B.
- Angle
  Angle between two reference objects. Angles can be measured between line and line, line and plane or plane and plane.
- Position
  Determines the position of a single reference object in the current Coordinate system, that is its distance to the origin.
- Radius
  Radius of a single reference object. Radii can be measured for circles, spheres, cylinders and cones. For spheres and cones, the position of the radius measurement, which is determined at creation time, is relevant. For circles, cylinders and cones, radius features are only well-defined if their coordinate system is aligned to the measured object's axis/normal.
- Diameter
  Diameter of a single reference object. Equals twice the Radius.

- Projection
  Available for Distance, Position and Angle features. These can be projected along one or two spatial dimensions:

  A dX (or dY or dZ) Distance/Position feature refers to the x (or y or z)-component of the measured distance-line only.
  A dXY (or dXZ or dYZ) Distance/Position feature refers to the distance-line projected onto the according plane.

  If no projection is desired, use a dXYZ feature.

Angles cannot be projected onto a single axis. For Angle features, only dXY, dXZ, dYZ and dXYZ projections are available.

Projection directions are always referring to the axes of the feature's Coordinate system.

- View
  Distance or position features with dX, dY or dZ Projection can exist in two possible orientations (a dX-feature can show up in a Top/Bottom (XY)-slice or a Front/Back (XZ)-slice). The View determines this orientation.
- Coordinate system
  Specifies the coordinate system in which the feature is defined.
- Source A / Source B
  The reference object(s) used to define this feature. For position, radius and diameter features, only Source A is present. Distance and angle features have both source objects.
- Relative
  Available and relevant for projected (non-dXYZ) distance features only. In relative mode, the feature does not visualize the measured distances directly, but rather visualizes the distances to the coordinate system origin for each endpoint.
  The Relative setting has no effect on the numerical value of the feature.
- Depth
  Available and relevant for projected (non-dXYZ) features only. The feature depth determines the position in which the projected feature is visualized in 3D. The feature's orientation being determined by its Projection and View, there is still one degree of freedom when displaying it in a 3D view. When dragging a feature in a 2D view, the initial depth is determined from the slice position in which the feature was dragged out. The depth can later be changed freely.
- Snap
  Available and relevant for projected (non-dXYZ) distance features only. The snap fixes the feature's Depth to either the start- or the end-point of the distance measurement (Begin/End), or retains the given depth (Free).
- Value
  The feature's numerical value. For angle features, the value is displayed in the current angle unit, for all other types of features it is displayed in the current length unit.
- Nominal
  The desired nominal value for the feature. This cell is editable. Together with the Tolerance neg./pos. settings, myVGL will determine whether the feature is inside the prescribed tolerance band and set the features status

accordingly. If either nominal value or tolerances are not set, the tolerance test is omitted.

- Tolerance neg. / Tolerance pos.
  The allowed tolerance of the feature's actual Value towards the given Nominal value. This column is editable. After initially entering one of the neg./pos. tolerance values, the other value will be set to the same value, providing a symmetric tolerance band. Afterwards, you can change the positive and negative tolerances independently.
- Status
  Status information about the feature:
  - Ok
    No errors or warnings.
    Feature and source objects are well defined.
    Tolerance band is present and feature lies within.
  - Ok, but no tolerance settings
    Feature and source objects are well defined, but no tolerance band is given. The feature value is not tested against any allowed range.
  - Out of tolerance band
    Feature and source objects are well defined, but the feature's actual value lies outside the prescribed tolerance band.
  - Invalid measurement
    Although the source objects are valid, measurement of the desired feature is not possible. This can happen in case of undefined measurement modes (such as a centroid-distance between objects without fit points).
  - Invalid source object(s)
    The feature's source objects indicate an error status.
  - Inconsistent source object(s)
    Feature could be measured, but its source objects are indicate a warning status. Probably the source objects need to be refitted, or the last refit succeeded only partially.
- Image
  Choose On if you want a detailed 2D-image and feature description to be generated on a separate page of the report. ***myVGL*** will automatically create a suitable slice image for the feature.

  Note that the generated image will only contain the reported feature, its source reference objects and its parent volume/polygon. All other reference objects, features, analyses etc. will be hidden. The 2D slice position used for taking the image is determined by the feature's position. The zoom fac-

tor of the image is chosen such that the entire parent volume/polygon is visible. For all features with a preferred orientation (namely all except dXYZ-positions and -distances), a single image in this orientation will be created. Otherwise an orthographic projection with three orthogonal views relative to the feature's coordinate system is generated.

- Captures
  The number of images captured for this objects in the Screenshots section.

Reference objects

Lists all existing reference objects and their properties.

Warning All geometric properties like positions and directions will be displayed and reported with respect to the currently selected coordinate system and the currently selected display unit.

For possible details on reference object properties refer to *Dialog: Reference object properties* on page 19-2.

REFERENCE OBJECT LIST

- Name
  The name of the reference objects. This column is editable.
- Type
  The object's type. Either point, line, circle, plane, sphere, cylinder, cone.
- Position X / Position Y / Position Z
  The object's position in physical length units.
- Direction X / Direction Y / Direction Z
  The object's normalized direction vector (available for line, cylinder, cone).
- Normal X / Normal Y / Normal Z
  The object's normalized normal vector (available for circle, plane).
- Radius
  The object's radius (available for circle, sphere, cylinder, cone).
- Conicity
  The object's conicity in angle units (available for cone).
- Form / Peak / Valley
  The object's fit point deviation measures (available for fitted reference objects only).
- Construction method
  The object's construction method (see *Properties* on page 19-3).

- Image
  Choose an option other than None if you want a detailed 2D-image and object description to be generated on a separate page of the report. The selected option determines the type of image myVGL will automatically create for the object. Orthographic projection will produce three orthogonal views, the Top, Bottom, Left, Right, Front, Back options each produce a single 2D view in the specified orientation.

  The image orientation is relative to the currently selected coordinate system!

  Note that the generated image will only contain the reported reference object and its parent volume/polygon. All other reference objects, features, analyses etc. will be hidden. The reference object is always shown without visible fit points and in a “highlighted” visual state. The 2D slice position used for taking the image is determined by the reference object’s position. The zoom factor of the image is chosen such that the entire parent volume/polygon is visible.

- Zoomed image
  The zoom view is almost identical to the Detail view, but will generate an image that is additionally zoomed in by a Zoom factor prescribed on the Report page.

- Histogram image
  Choose whether to include the fit point histogram and/or the cumulated histogram in the reporting details for this reference object (available for fitted reference objects only).

- Captures
  The number of images captured for this objects in the Screenshots section.

Capture images

The Capture images tab allows to take screenshots from the selected workspace widget. The captured images are listed separately within the final report apart from screenshots created in the Features or Reference objects section.

Report

The Report page lets you specify the content and layout of the final report.

Use the Print button to show the Print preview dialog. There, use the Previous page and Next page buttons to navigate through the report preview. Click the Layout button to bring up the Print layout dialog. There you can specify the orientation (Portrait or Landscape), the paper size and the desired output resolution.

Use the Save button to save the report to disk in the desired format:

- Rich Text Format:
  Save the entire report with tables and images as an .rtf-document.
- HTML Format:
  Save the entire report with tables and images as an .html-document.
- Comma Separated Values:
  Save only the table(s) without images and further formatting as a .csv-file.

REPORT SECTIONS

Choose whether the report should contain the list of Features and/or Reference objects.

DETAIL IMAGES SETTINGS

Use these settings to change the appearance of the detail images you specified in the Features and/or Reference objects tables. Zoom factor sets the zoom level for all Detail zoom view images in the respective tables. By enabling the Manual check box you can change Color mode and or the Background color of the various workspace widget screenshots created within the analysis.

LOGO

Specify an image file that should be utilized as a logo within the report.

CELLS

Each report page will contain a set of user defined cells. These cells are part of the report layout and their content is customizable. Simply click on a cell and select an attribute from the pull down. Either assign the attribute to the Cell title or to the Cell content. The Cell title is a textual description of the cell content. The Cell content defines what shall be displayed within the cell. You can append attributes to previous attributes by clicking the assign button again.

20 NOMINAL/ACTUAL COMPARISON MODULE

The nominal/actual comparison tool is designed to compare voxel data sets with CAD polygonal models or voxel data sets with voxel data sets. As a result of such an analysis the user will get a detailed report about the detected deviations and a false color coded data set for documentation purposes.

Nominal/actual comparison is an optional add-on module for ***VGStudio MAX 2.0****. It is not available for* ***myVGL****. However, if a project contains an analysis, the result of this analysis is available in* ***myVGL****.*

If you are interested in more extensive functionality than the one offered by ***myVGL****, you have the chance to evaluate our other products,* ***VGStudio 2.0*** *or* ***VGStudio MAX 2.0****:*

www.volumegraphics.com/products/evaluation/form.html

For further questions about our product portfolio, please contact

sales@volumegraphics.com

The nominal/actual comparison dialog consists of several pages in which you can inspect the nominal/actual analysis result. Each page shares in its display a Close button which closes the dialog without performing an analysis. A status bar at the bottom of each page signals the current status of the analysis. The status can either be

- ready to go

Everything needed for the analysis is available.

- analysis is up to date

The current analysis result is valid.

- analysis update required

Some user action led to an invalidation of the current analysis result.

- object is not calibrated

No calibration information is available for actual object.

- no valid reference object

The nominal object is either missing or (if it is a volume data set) not properly calibrated.

Settings

Warning In ***myVGL***, all grayed settings are displayed for informational value only. Editing those settings or running the analysis is only possible using ***VGStudio MAX 2.0*** with the Nominal/Actual comparison module installed.

Preset Selection

Select or remove a user defined preset from the preset selection pull down. Any parameter set applied within the Settings page can be saved as a user defined preset. Presets can be deleted, exported or imported via the respective buttons.

Calculation parameters

In the Nominal/Reference object pull-down menu select the nominal object against which the actual object will be compared.

The surface of the nominal object can be either above or below the surface of the actual object within a certain distance. Specify the Max. distance to determine how far away from one surface the other will be sought. Distances exceeding the specified Max. distance value will be marked as undefined.

The Skip X, Skip Y and Skip Z parameters can be used to skip voxels and thus reduce the time to perform the analysis at the cost of lower accuracy.

Options

If the surface of the nominal object is below the surface of the actual object the variance between the two surfaces is positive. If the surface of the nominal object is above the surface of the actual object the variance is negative. If both surfaces match there is zero variance. By enabling the swap distance signs option, you invert the variance value. The variance must be between +/- Max. distance. Variances above or below +/- Max. distance are marked as undefined which is represented through the special values +/- inf.

Colors

Here you can specify a color coding scheme used for the representation of the analysis result mask.

LUT

Gives you a preview of how the color lookup table is partitioned into color sections.

Sections

In the Sections element the appearance of each color section is defined. Create smooth will generate one color section. Clicking the button will show the Create smooth table dialog. Define the variance range by entering from and to values.

Create stepped generates a set of color sections. Clicking the button will show the Create stepped table dialog. Define the variance range by entering from, to and step values.

Clicking Auto scale fits the LUT to the range of analysis results.

There are two special color sections defining the color value for variances above and below the specified Max. Distance. The variances above the positive Max. Thickness are marked as +inf, the variances below the negative Max. Thickness are marked as -inf.

Each generated color section can be modified individually. In the Sections table simply click onto an entry to modify its value. From and To define the start and end values of the color sections. Type switches between the coloring schemes Constant, Gradient, Rainbow and Reverse Rainbow. Detail lets you modify the appearance of the selected Type color scheme. Right-clicking onto a color section shows a context menu with the options split and merge. Splitting a color section divides it up into two new color sections where each represents half of the original section. Merging several color sections results into a single color section. Only consecutive intervals can be merged.

Options

Variance values outside the specified Max. Distance value (see *Calculation parameters* on page 20-2) are coded with specific color values. Select the Yes option from the Clamp outside distances pull down to map the color of these variances to the one specified in the Clamp colors section on the Colors page.

Tips and tricks

Use this option if you have several nominal/actual analyses with different Max. Thickness values. In this case, every analysis shares a common LUT, whose +/- inf values are specified by the analysis with the largest Max. Thickness. This might obscure the variance values of analyses with smaller Max. Thickness values.

By choosing Yes or No for Show 3D result overlay or Show 2D result overlay you determine whether the color coded result is visible in the 3D and 2D views respectively. If the comparison has been performed, switching these settings will be of immediate effect in the views.

Clamp colors

Select a color for the clamped variance values by clicking on the Negative and/or Positive labeled color chooser (see *Options* on page 20-3).

Tickmarks on color bar

If Auto tickmarks is enabled, equidistant tick marks are produced for the color bars. If Auto tickmarks is disabled, tick marks appear only at the color section boundaries.

Preset selection

Here you can load, save, delete, import and export LUT presets.

When saving a LUT, you can choose if you want to save an Absolute Preset, i.e. a preset that maps colors to absolute variance. If the checkbox is not activated, colors are saved relative to the range of the analysis.

Histogram

This tab shows a histogram of the calculated deviations over the entire analyzed surface of the actual object. The histogram bars are colored according to the current Colors settings.

Type

Histograms of the Type: Point count are based upon a finite number of tested positions on the actual object's surface. If you switch to Type: Surface, the histogram is calculated with regard to the physical surface covered by each test position. The label of the y-axis will adjust accordingly. This switch is significant for strongly anisotropic data sets where the mapping of probed positions to their covered surface is recommended.

Binning

In the Binning pull-down menu, you can choose between no binning and a binning according to the sections of the color bar.

Context menu

Right-click the histogram area to bring up a context menu offering the following options:

- Copy to clipboard
  Copies a screenshot of the histogram to the system clipboard.
- Show grid lines X/Y
  Toggles the display of dashed indicator lines for the respective axis.

- Reset zoom
  Zooms the entire histogram to the current window size.

Cumulated

This tab displays the cumulated percentage relative of deviations. It is derived from the Histogram data. You can use the Cumulated curve to answers questions like “How many percent of the analyzed surface differ less than x mm from the nominal value?” or, conversely, “What is the smallest deviation that ninety percent of the analyzed surface do not exceed?“.

Type

The Type pull-down menu is the same as in Histogram tab. See *Histogram on page 20-4* for more details.

Cumulation

Cumulation does not make sense for mixed positive and negative deviations. Thus, you can choose either a Cumulation of Absolute deviations, or restrict the cumulation to Only positive or Only negative deviations. The label of the x-axis will adjust accordingly.

Deviation / Percentage

The Deviation and Percentage controls show the cumulated percentage value below a certain deviation. They are synchronized with the green indicator lines in the graphical view. You can enter a desired reference deviation or percentage in the controls or drag the indicator lines with the mouse to change the current position.

Context menu

Right-click within the graph to bring up a context menu offering the following options:

- Copy to clipboard
  Copies a screenshot of the graph to the system clipboard.
- Show grid lines X/Y
  Toggles the display of dashed indicator lines for the respective axis.
- Reset zoom
  Zooms the entire histogram to the current window size.

General table features

Right click anywhere into the Annotations table to show its context menu. The menu contains the following options:

- Columns
  Here you toggle the visibility status of each column by enabling / disabling the respective checkbox.
- Save as default column layout
  Any modifications applied to the table e.g. changing the sorting order of a column, enabling / disabling of columns or changing the order in which each column appears can be saved as default column layout. This layout will be active until you selected Original column layout.
- Original column layout
  Restores the original table layout and discards any modifications applied by the user.
- Copy to clipboard
  Copies the table into the clipboard.
- Export as CSV ...
  Exports the table values as CSV (Comma Separated Values) list.
- Remove entries
  Removes a complete row from the table

  To change the order in which each column appears in the table press <*Ctrl*> and left click the desired column header. Keep the <*Ctrl*> key pressed and drag the mouse over the available column headers until the new position is reached. Release the mouse button to insert the column at its new position.

Annotations

The Annotations table lists every annotation created for the selected analysis. Here you can see or edit information about the annotations.

The Annotations table lists every annotation created for the selected nominal/actual analysis. Here you can inspect information supplied by the annotations or edit annotations properties.

To create an annotation select the desired nominal/actual analysis within the Scene Tree and click the right mouse button to show the analysis context menu. Select New > Analysis annotation and click into any 2D window or the 3D window to position the annotation.

The annotation is designed as a movable label displaying informations about the current analysis. A nominal/actual annotation contains the annotation name, the current Variance (Var), the tolerance values specified via Tolerance from and Tolerance to and the position of the annotation.

The Variance value is color coded. The green color signalizes an available Variance value for the current position and the current tolerance values. The yellow color signalizes that for the current annotation position there is no Variance value available. This happens if the annotation is moved outside the nominal/actual result area.The red color signalizes that the Variance value at the current annotation position is not inside the specified tolerance interval.

To minimize/maximize the annotation double-click anywhere inside the annotation.

Furthermore, you can arrange all annotations automatically by right-clicking within the respective window and choosing Annotations > Arrange.

The individual columns within the nominal/actual‘s Annotations table are:

- Name

The name of the annotation.

- in Comparison

The name of the Nominal/Actual comparison the annotation belongs to.

- Pos (X, Y, Z)

Position of the annotation.

- Variance

The nominal/actual variance of the analyzed voxel set at the given annotation position.

- Tolerance from/to

The maximum nominal/actual deviation for the respective annotation.

- Description

Enter a description of the annotation used for reporting.

- Detail view

Select a view mode for reporting. Either choose one of the six view directions (top, bottom, front, back, right or left) or choose orthographic projection.

- Detail zoom view

Select a zoomed Detail view for reporting.

- Images

Displays the amount of images generated with the Capture from function. Below the Annotations table is an area reserved for screenshots. To capture

a screenshot first select a view from the pull down, then click the Capture from button. Each screenshot will be displayed in the area above. The screenshots can be chosen to appear in the final report. You can specify a name for the image by clicking the <*no description*> label twice.

Capture images

The Capture images page allows to take screenshots from the selected workspace widget. The captured images are listed separately within the final report apart from screenshots created in the Annotations section.

Report

The Report page lets you specify the content and the layout of the final report. Either save the report as .rtf (Rich Text Format) or .html document by clicking the Save button, or print it by clicking the Print button. The Print button will show you a Print preview dialog. Use the Previous page and Next page button to navigate through the report preview. Click the Layout button to bring up the Print layout dialog. There you specify the orientation (Portrait or Landscape), the paper size and the resolution.

Report sections

Select which sections of the analysis should be included or excluded from the report be either enabling or disabling the corresponding checkboxes Settings, Annotations, Deviation histogram or Cumulated histogram.

Detail images settings

Use these settings to change the appearance of the detail images you specified in the Annotations table. Zoom factor sets the zoom level for the Detail zoom view images in the respective tables. By enabling the Manual check box you can change Color mode and or the Background color of the various workspace widget screenshots created within the analysis.

Logo

Specify an image file that should be utilized as a logo within the report.

Cells

Each report page will contain a set of user defined cells. These cells are part of the report layout and their content is customizable. Simply click on a cell and select an attribute from the pull down. Either assign the attribute to the Cell title or to the Cell content. The Cell title is a textual description of the cell content. The Cell content defines what shall be displayed within the

cell. You can append attributes to previous attributes by clicking the assign button again.

21 DEFECT DETECTION MODULE

The Defect Detection tool is designed to process voxel data sets for internal defects and provides detailed analysis results with information on each individual defect as well as overall statistical information. A defect analysis report will be generated, containing information like position, size, surface and volume of each individual defect.

Defect detection is an optional add-on module for ***VGStudio MAX 2.0****. It is not available for* ***myVGL****. However, if a project contains an analysis, the result of this analysis is available in* ***myVGL****.*

If you are interested in more extensive functionality than the one offered by ***myVGL****, you have the chance to evaluate our other products,* ***VGStudio 2.0*** *or* ***VGStudio MAX 2.0****:*

www.volumegraphics.com/products/evaluation/form.html

For further questions about our product portfolio, please contact

sales@volumegraphics.com

The defect detection dialog consists of several pages in which you can inspect the defect detection analysis result. All pages share the button Close.

- Close
  Exits the dialog without performing an analysis. Parameter settings will be saved. Reopen the analysis by double-clicking its entry in the Scene Tree.

A status bar at the bottom of each page signals the current status of the analysis. The status can be one of the following:

- ready to go
  Parameters are specified and consistent.
- analysis is up to date
  The current analysis result is valid..
- analysis update required
  Some user action led to an invalidation of the current analysis result.
- invalid parameter
  At least one of the parameters has an invalid value. Check the parameters or click Close.

Tips and tricks An invalid or not up-to-date status of an analysis is accentuated in the Scene Tree with a warning sign. Double-click this analysis to open it and check the status bar for messages.

Settings

Warning In ***myVGL***, all grayed settings are displayed for informational value only. Editing those settings or running the analysis is only possible using ***VGStudio MAX 2.0*** with the Defect detection module installed.

Preset Selection

Select or remove a user defined preset from the preset selection pull down. Any parameter set applied within the Settings page can be saved as a user defined preset. Presets can be deleted, exported or imported via the respective buttons.

Algorithm

Select an algorithm from the pull down which the defect detection should use for the analysis. Based on the selected algorithm the Calibration parameters will differ.

The defect detection procedure consists of two steps.

- Check each voxel if it might be part of a defect or not. Create groups of connected defect candidates.
- Check each group of defect candidates if it fits the parameters specified by the user.

The following algorithms are available:

- Only threshold
  Every group of candidate defects matching the size specifications is considered a defect if the gray value is below the specified threshold.
- Default
  To allow for gray value variations, a more sophisticated approach is used, thus also detecting defects, e.g., in dark areas.
- Enhanced
  This is a variation of the Default algorithm in a more fine-grained mode, thus providing more sophisticated results but requiring more time.

- Custom defect mask
  The defect analysis is based on a region of interest (ROI). The ROI is supposed to contain the defect candidates. To each voxel group of the ROI the analysis parameters will be applied. Define the ROI manually, by importing a ROI template or via a defect mask.

  See the definition of the parameters for more detailed information on the algorithms.

Calibration parameters

(This section is not available for the Custom defect mask algorithm; see *Defect mask selection* on page 21-4 for parameters applicable to this algorithm instead).

- Threshold
  (Only Threshold algorithm only)

  Defect voxels are defined only by a gray value threshold. Threshold defines the maximum defect gray value, every voxel with a gray value below Threshold is considered as part of a defect.

- Defect Max
  (Default and Enhanced algorithms only)

  Seed voxels (defect candidates) are identified in an iterative manner. The gray value of these seed voxels has to be below the Defect Max value.

- Background
  (Default and Enhanced algorithms only)

  Background is the lower limit of the interval for the iterations. Changing this value has less significance than changing Defect Max or Runs.

- Runs
  (Default and Enhanced algorithms only)

  In Default algorithm, the number of the Runs determines the number of iterations when determining and flooding a potential defect. High values will lead to more reliable results at the cost of longer processing time.

  In Enhanced algorithm, Runs determines the fineness when identifying seed voxels. Flooding will be executed until a precision of one gray value is reached.

- Use calibration
  Click Use calibration to set Defect Max and Background values automatically based on the calibration of the object. This mode is recommended for single material objects and images with only a very low noise level.

- Define manually

  Click Define manually to specify background and material gray values by sample areas. This procedure is similar to a calibration, but does not (re-)calibrate the object. This mode is recommended for multi-material objects and/or images with an average or above average noise level as it allows you to select the sample areas specifically with regard to defects.

Defect mask selection

(This section is only available for the Custom defect mask algorithm; see *Calibration parameters* on page 21-3 for parameters applicable to other algorithms instead).

- Custom defect mask

  Choose the defect mask defining which voxels are part of defects and which are not from the drop-down list.

Analysis parameters

The analysis parameters influence the second stage of the defect detection procedure.

- Min. size / Max. size

  Specified minimum and maximum defect size.

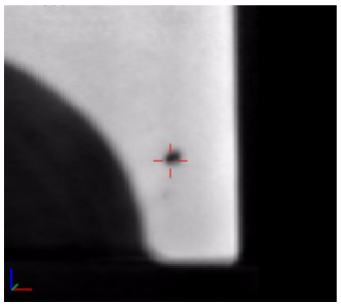
  Due to the nature of CT data, the value for Min. size should be no less than 8 voxel edge lengths (i.e. an area of 2x2x2 voxels). Increase the value decreasing data quality.

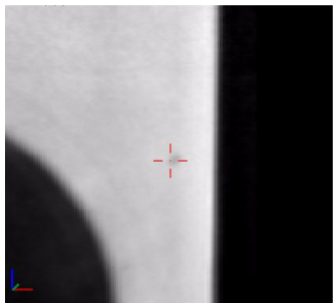
  When specifying the Max. size of the defect, consider that longish cracks have a rather large volume and that an accumulation of nearby very small defects might be interpreted as one large defect. Specify the Max. size rather generously.

- Probability threshold

  All potential defect areas passing the size check will be further processed by several analysis stages. These stages try to differentiate between real defects and artifacts by utilizing sophisticated image processing algorithms. Each detected defect is tagged with a value indicating the probability that it is a real defect. Specify the Probability threshold so that only defects with a probability above the threshold will be included in the list.

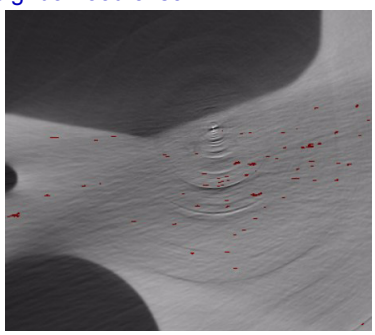
The figure below shows two defects with different Probabilities where the left defect has a ten times higher Probability than the defect on the right hand side.

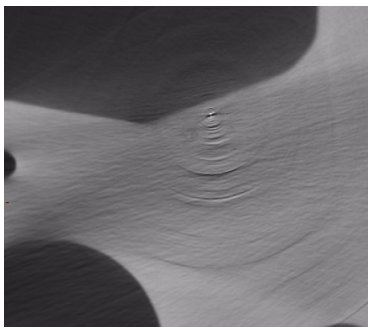




- check neighborhood

  If this option is enabled the defect detection algorithm compares the potential defect with its local neighborhood. If a potential defect‘s appearance is very similar to the surrounding structure, its probability will be reduced. This option is useful to reduce the number of erroneously detected artifacts. The figure below illustrates the effect of this option: The image on the left hand side has been obtained without, the one on the right hand side with neighborhood check.

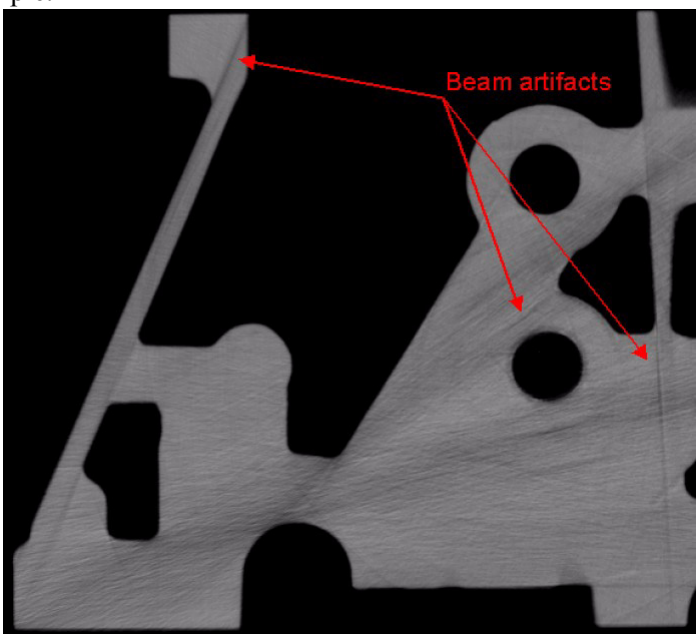




- ignore streak artifacts

  Beam artifacts may appear within (industrial) CT data as linear dark streaks. If Ignore streak artifacts is activated these structures are detected and

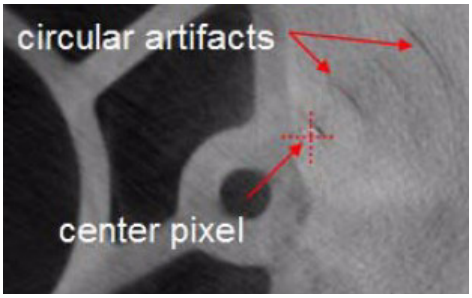
assigned with a low defect probability value. See the figure below for an example.



Warning A real defect might not be detected with ignore streak artifacts activated if it is connected to and/or fits into the shape of a beam artifact.
A beam artifact might not be removed by the ignore streak artifacts algorithm in cases where a beam artifact is connected to another defect so that the total shape of both is no longer a straight line-like structure.

- ignore circular CT-artifacts

  Circular artifacts may appear within (industrial) CT data as dark circles or arcs. See the figure below for an example.

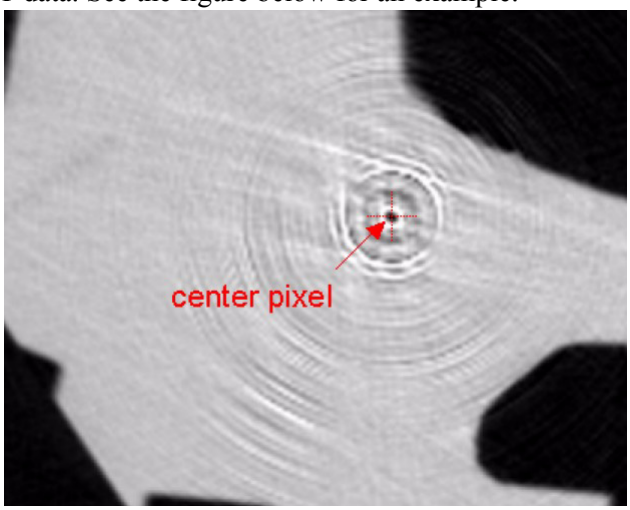


  Activate ignore circular CT-artifacts to avoid an erroneous interpretation of those circular structures as defects. A dialog will prompt you to draw a circle around such artifacts. Position the cross hair cursor within the center of a circular artifact. All circular structures around this center (but not the center itself) will be considered circular artifacts and will be discounted when building the defects list.

The center will not be visibly marked. To redefine it, deactivate and then reactivate the option.

Warning A real defect connected to a circular artifact will not be detected if ignore circular CT-artifacts is activated.
A real defect with the shape of a circle (or a part of a circle) will not be detected if the center of this circle would be the rotation center defined.

- ignore center CT-artifacts
  The pixel in the rotation center may appear as a dark area within (industrial) CT data. See the figure below for an example.



Activate ignore center CT-artifacts to avoid an erroneous interpretation of this center pixel as defect. A dialog will prompt you to draw a circle around the rotation center. Position the cross hair cursor within the center pixel.

Warning A real defect connected to a center artifact will not be detected if ignore center CT-artifacts is activated.
A real defect with a point-like shape will not be detected if it is positioned in the rotation center defined.

Additional defect properties

The Defects table has columns for size (SizeX, SizeY, SizeZ) and projections along one axis (PX, PY, PZ). These values will only be calculated if the calculate size and projections checkbox is activated.

The projection values are the area of the defect projected flat along one of the axes of the currently selected coordinate system (see *Coordinate System* in chapter *Window menu* on page 9-2).

See *Defects* on page 21-11 for further information on the columns of the Defects table.

Process

Enable the defect size color coding checkbox to apply the color scheme defined in the Colors page to the detected defects.

Warning If this option is enabled the analysis requires more memory and needs more time for the calculation.

Colors

By default, defects are marked in red in the CT data. Apply a color coding scheme to mark defects depending on their size in different colors.

LUT

Preview how the detected defects are grouped according to size and mapped to a specified color.

Sections

The Sections table defines intervals of defect sizes and assignes a color or a color gradient to each interval. Define the size range of defects that are to be colored by entering a minimum and maximum defect volume (From and To, respectively).

The coloring can be based on a single size interval or a number of size intervals. To create an interval, click Create smooth or Create stepped:

- Create smooth
  Generates one single color section. Clicking the button will show the Create smooth table dialog.
- Create stepped
  Generates a set of color sections. Clicking the button will show the Create stepped table dialog. Define the defect size range covered by the sections and the step size.

Clicking Auto scale fits the LUT to the range of analysis results.

Warning Clicking Create smooth or Create stepped will delete all sections in the table and create new sections.

Each generated color section can be modified individually. In the Sections table simply click onto an entry to modify its value.

- From / To
  Define the start and end values of the color sections (size intervals).

- Type
  Switches between the coloring schemes Constant, Gradient, Rainbow and Reverse Rainbow, thereby applying a single color or a multi-color scheme to the selected interval.
- Detail
  Modifies the appearance of the selected Type color scheme. Double-click to open a dialog to select a color and/or specify color attributes (for the rainbow schemes, only the alpha channel can be modified).
- split / merge
  Right-clicking onto a color section produces a context menu with the options split and merge. Splitting a color section divides it up into two new color sections where each represents half of the original section. Merging several color sections results into a single color section. Only consecutive intervals can be merged.

Options

Select an entry from the Defect opacity mode pull-down menu to specify the opacity of a defect. Each defect consists of a voxel set. Each voxel has an assigned intensity. Based on the intensity and the selected mode the defect opacity is calculated. The following modes are available:

- Ramp
  The lower the defects intensity value the lower is its opacity value. The higher the defects intensity value the higher is its opacity value.
- Inverse ramp
  The lower the defects intensity value the higher is its opacity value. The higher the defects intensity value the lower is its opacity value.
- Constant
  Every defect is fully opaque independently of its intensity value.

Other colors

Select a color from the Uncoded defect color chooser by double-clicking the colored area with the left mouse button. A Select color dialog will appear in which you choose the desired color.

This option only influences the color coding of the detected defects if you did *not* enable the defect size color coding option on the Settings page (see *Process* on page 21-8).

Tickmarks on color bar

If Auto tickmarks is enabled, equidistant tickmarks are produced for the color bars. If Auto tickmarks is disabled, tickmarks appear only at the color section boundaries.

Preset selection

Select, remove, export or import a user defined preset from the preset selection pull down.

When saving a LUT, you can choose if you want to save an Absolute Preset, i.e. a preset that maps colors to absolute defect size. If the checkbox is not activated, colors are saved relative to the range of the analysis.

General table features (Context Menus)

Right click anywhere into the Defects or Annotations tables to show their context menu. The menu contains the following options:

- Columns
  Here you toggle the visibility status of each column by enabling / disabling the respective checkbox.
- Save as default column layout
  Any modifications applied to the table e.g. changing the sorting order of a column, enabling / disabling of columns or changing the order in which each column appears can be saved as default column layout. This layout will be active until you selected Original column layout.
- Original column layout
  Restores the original table layout and discards any modifications applied by the user.
- Copy to clipboard
  Copies the table into the clipboard.
- Export as CSV ...
  Exports the table values as CSV (Comma Separated Values) list.
- Remove entries
  Removes a complete row from the table
- Create annotations
  Creates annotations for the selected defects.

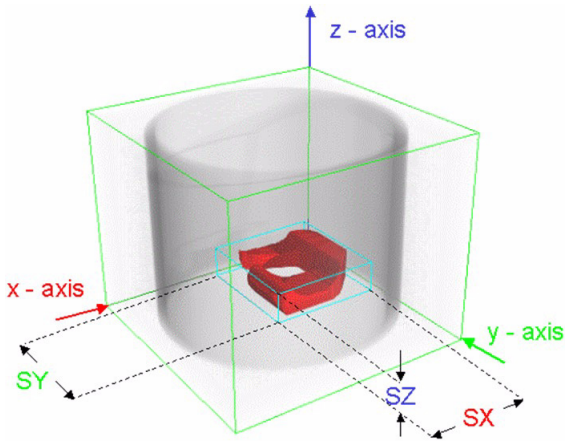
  To change the order in which each column appears in the table press <*Ctrl*> and left click the desired column header. Keep the <*Ctrl*> key pressed and drag the mouse over the available column headers until the new position is reached. Release the mouse button to insert the column at its new position.

Defects

The Defects table lists every defect detected by the defect detection analysis module. By using the up and down cursor keys you step through the defects table. Each defect is marked with a cross-hair cursor in each of the slice views. You also can access any defect within the table by left-clicking on it.

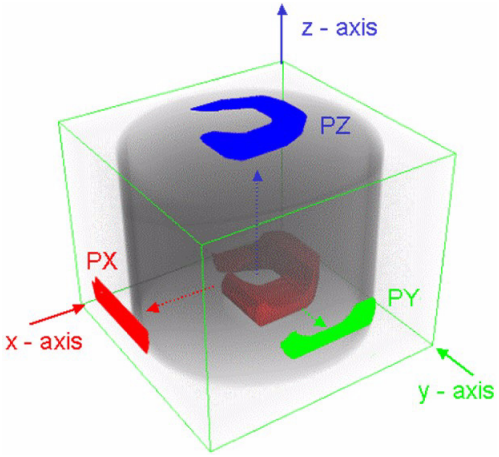
The individual columns within the Defects table are:

- Analysis
  The name of the analysis the defect belongs to.
- Probability
  The defect‘s probability (see *Analysis parameters* on page 21-4).
- Volume
  The defect‘s volume.
- Voxel
  The amount of voxels the defect consists of.
- PosX / PosY / PosZ
  The center position of the defect.
- SizeX / SizeY / SizeZ
  The size of the bounding box encapsulating the defect. See the figure below for an illustration. These values will only be calculated if the appropriate checkbox is activated (see *Additional defect properties* on page 21-7).



- Surface
  The surface of the defect.
- PX / PY / PZ
  The surface area of the defect‘s shape projected along each of the axes of the currently selected coordinate system (see *Coordinate System* in chapter

Window menu on page 9-2). See the figure below for an illustration. These



values will only be calculated if the appropriate checkbox is activated (see *Additional defect properties* on page 21-7)

- Min
  The minimum gray value within the defect.
- Max
  The maximum gray value within the defect.
- Mean
  The mean gray value within the defect.
- Deviation
  The gray value deviation within the defect.
- Description
  Enter a description for the component used for reporting.
- Detail view
  Select a view mode for reporting. Either choose one of the six view directions top, bottom, front, back, right or left or choose orthographic projection.
- Detail zoom view
  Select a zoomed Detail view for reporting.
- Images
  Displays the amount of images generated with the Capture from function. Below the Components table is an area reserved for screenshots. To capture a screenshot first select a view from the pull down, then click the Capture from button. Each screenshot will be displayed in the area above. The screenshots can be chosen to appear in the final report.You can specify a name for the image by clicking the <*no description*> label twice.

Statistics

You inspect various statistical data on this page. The page consists of a histogram showing the defect volume distribution within the voxel data set, the Options area and the two sections Defects and Material.

Options

In the Binning pull-down menu, you can choose between no binning and a binning according to the sections of the color bar.

Furthermore, you can choose between Linear and Logarithmic scaling for both axes in the Scale X and Scale Y pull-down menus.

Defects

The Defects section contains the following statistical values:

- Σ Voxel
  The sum over all voxels contained within defects
- Σ Volume
  The sum over all defect volumes
- Σ Surface
  The sum over all defect surfaces
- Σ PX / PY / PZ
  The sum over all projected defect surfaces

Material

The Material section contains the following values:

- Iso value
  Specify an iso value which defines the material boundary of the to be analyzed voxel data set. This option is only available if your volume is not calibrated.
- Volume
  The volume of the to be analyzed voxel data set. It is either defined by an Iso value, in case your object is not calibrated or by the calibration.
- Defects
  The sum over all defect volumes.
- Porosity
  The defect volume/(material volume + defect volume) ratio.

Annotations

The Annotations table lists every annotation created for the selected defect detection analysis. Here you can inspect information supplied by the annotations or edit annotation properties.

To create an annotation select the desired defect detection analysis within the Scene Tree and click the right mouse button to show the analysis context menu. Select New > Analysis annotation and click into any 2D window or the 3D window to position the annotation.

The annotation is designed as a movable label displaying informations about the current analysis. A defect detection annotation contains the annotation name, the defect‘s Volume (Vol), the defect‘s Probability (Prob) and the position of the annotation.

The Volume value is color coded. The green color signalizes an available Volume value for the current position. The yellow color signalizes that for the current annotation position there is no Volume value available. This happens if the annotation is moved outside a defect.

To minimize/maximize the annotation double-click anywhere inside the annotation.

Furthermore, you can arrange all annotations automatically by right-clicking within the respective window and choosing Annotations > Arrange.

The individual columns within the defect detection’s Annotations table are:

- Analysis
  The name of the analysis the annotation belongs to.
- Name
  The name of the annotation.
- PosX / PosY / PosZ
  Position of the annotation.
- Volume
  The volume of the defect at the given annotation position.
- Description
  Enter a description for the annotation used for reporting.
- Image
  Select a view mode for reporting. Either choose one of the six view directions top, bottom, front, back, right or left or choose orthographic projection.
- Zoomed image
  Select a zoomed Detail view for reporting.

- Captures
  Displays the amount of images generated with the Capture from function. Below the Annotations table is an area reserved for screenshots. To capture a screenshot first select a view from the pull down, then click the Capture from button. Each screenshot will be displayed in the area above. The screenshots can be chosen to appear in the final report You can specify a name for the image by clicking the <*no description*> label twice.

Capture images

The Capture images page allows to take screenshot from the selected workspace widget. The captured images are listed separately within the final report apart from screenshots created in the Defects or Annotations section.

Report

The Report page lets you specify the content and the layout of the final report. Either save the report as .rtf (Rich Text Format) or .html document by clicking the Save button, or print it by clicking the Print button. The Print button will show you a Print preview dialog. Use the Previous page and Next page button to navigate through the report preview. Click the Layout button to bring up the Print layout dialog. There you specify the orientation (Portrait or Landscape), the paper size and the resolution.

Report sections

Select which sections of the analysis should be included or excluded from the report be either enabling or disabling the corresponding checkboxes Settings, Defects, Statistics or Annotations.

Detail images settings

Use these settings to change the appearance of the detail images you specified in the Components and/or Annotations tables. Zoom factor sets the zoom level for the Detail zoom view images in the respective tables. By enabling the Manual check box you can change Color mode and or the Background color of the various workspace widget screenshots created within the analysis.

Logo

Specify an image file that should be utilized as a logo within the report.

Cells

Each report page will contain a set of user defined cells. These cells are part of the report layout and their content is customizable. Simply click on a cell and select an attribute from the pull down. Either assign the attribute

to the Cell title or to the Cell content. The Cell title is a textual description of the cell content. The Cell content defines what shall be displayed within the cell. You can append attributes to previous attributes by clicking the assign button again.

22

WALL THICKNESS MODULE

The Wall Thickness Analysis tool processes a voxel data set for areas within a user defined wall thickness interval (or, inversely, gap width interval). As a result of such an analysis the user will get a detailed report about the detected wall thickness and a miscolored data set for documentation purposes.

Wall thickness analysis is an optional add-on module for ***VGStudio MAX 2.0****. It is not available for* ***myVGL****. However, if a project contains an analysis, the result of this analysis is available in* ***myVGL****.*

If you are interested in more extensive functionality than the one offered by ***myVGL****, you have the chance to evaluate our other products,* ***VGStudio 2.0*** *or* ***VGStudio MAX 2.0****:*

www.volumegraphics.com/products/evaluation/form.html

For further questions about our product portfolio, please contact

sales@volumegraphics.com

The wall thickness dialog consists of several pages in which you can inspect the wall thickness analysis result. Each page shares in its display a Close button which closes the dialog.

A status bar at the bottom of each page signals the current status of the analysis. The status can either be

- **ready to go**

Everything needed for the analysis is available.

- **analysis is up to date**

The current analysis result is valid.

- **analysis update required**

Modifying any Settings parameters will lead to an invalidation of the current analysis result.

- **object is not calibrated**

No calibration information is available.

Settings

Warning In ***myVGL***, all grayed settings are displayed for informational value only. Editing those settings or running the analysis is only possible using ***VGStudio MAX 2.0*** with the Wall thickness module installed.

Preset Selection

Select or remove a user defined preset from the preset selection pull down. Any parameter set applied within the Settings page can be saved as a user defined preset.

Material

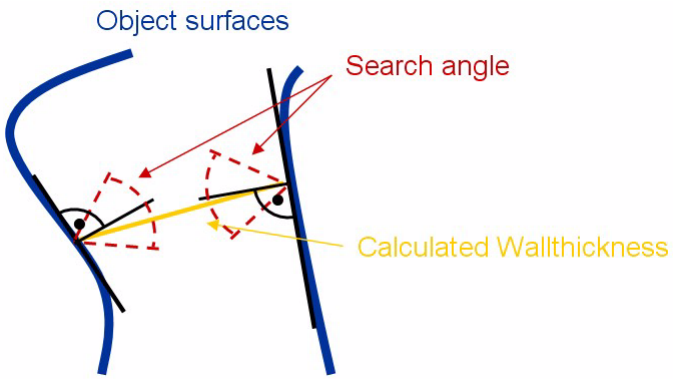
If Use calibration is enabled, the analysis uses the calibration information to determine the transition between background and material. This requires the object to be calibrated before performing the analysis. If Use calibration is disabled, an iso value has to be specified manually.

Under Analysis mode, you can specify if you want the algorithm to run on the actual Material or on the Background. The latter option can be used determine the gap width of objects.

Wall thickness

Use the Min. thickness and Max. thickness values to specify which wall thickness interval you are interested in.

To measure meaningful distances, ***VGStudio MAX 2.0*** searches the opposite surface by sending a measurement line orthogonal to the current surface. *The surface area of the opposite surface is taken into account for the end point of the measurement line is defined by a search cone.* Search angle specifies the search cone‘s aperture angle. See the figure below for an illustration of this principle.



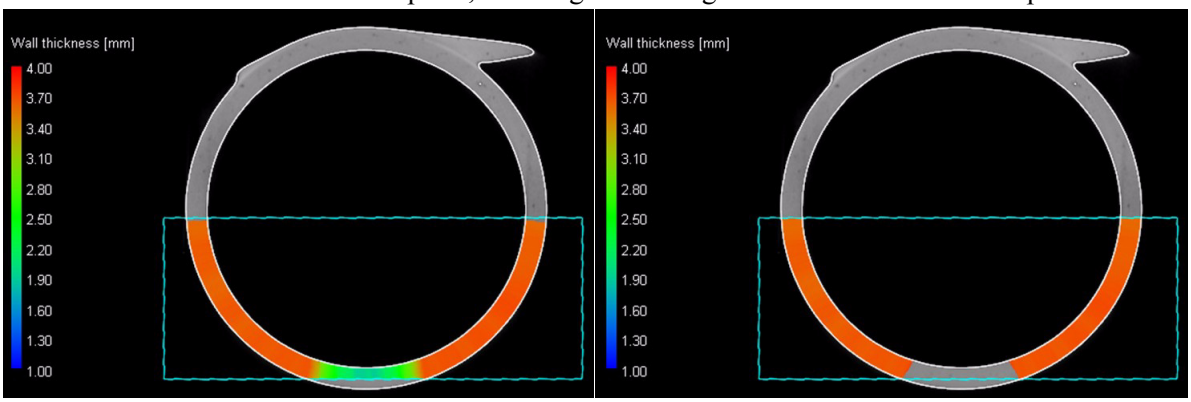
Component analysis

The Min. volume value specifies the minimal size for a component to be listed as a result.

In the Position property pull-down menu you can specify which part of a component is to be it recognized as its position: the point of its Min. thickness, Max. thickness or its Spatial center. This influences for example the values in the Pos X/Y/Z column of the Components table.

Algorithm details

By activating Create closed surface, additional boundaries are introduced. For example if the analysis is performed within a region of interest (ROI) and Closed surface is enabled, the ROI boundaries can be interpreted as opposite surface. See the figure below for an illustration of this principle: The image on the left hand side has been obtained using the Create closed surface option, the image on the right hand side without this option.



Enabling the Advanced mode reduces the chance to get gaps in the analysis - at the cost of significantly longer computing time.

When the High encoding precision option is enabled, the algorithm uses a finer sampling rate which will produce more precise results at the cost of significantly higher computing time. The resulting precision is displayed below this option.

Colors

Define the color coding scheme used for the representation of the analysis result mask.

LUT

The color lookup table (LUT) preview shows the partitioning into color sections.

Sections

In the Sections element the appearance of each color section is defined. Create smooth will generate one color section. Clicking the button will show the Create smooth table dialog. There the wall thickness range represented by the respective section is defined.

Create stepped generates a set of color sections. Clicking the button will show the Create stepped table dialog. Define the thickness range by entering from and to values.

Clicking Auto scale fits the LUT to the range of analysis results.

Each generated color section can be modified individually. In the Sections table simply click onto an entry to modify its value. From and To define the start and end values of the color sections. Type switches between the coloring schemes Constant, Gradient, Rainbow and Reverse Rainbow. Detail lets you modify the appearance of the selected Type color scheme. Right-clicking onto a color section shows a context menu with the options split and merge. Splitting a color section divides it up into two new color sections where each represents half of the original section. Merging several color sections results into a single color section. Only consecutive intervals can be merged.

Options

Show result lets you enable/disable the visual representation of your analysis result. It does not modify the analysis result itself.

Select an entry from the Display mode pull-down menu to specify visual representation of the analysis results. The following modes are available:

- **Ramp**
  The lower the gray value of the respective wall segment, the lower is its opacity value. The higher the defects intensity value the higher is its opacity value.
- **Inverse ramp**
  The lower the gray value of the respective wall segment the higher is its opacity value. The higher the defects intensity value the lower is its opacity value.
- **Constant**
  Every wall segment is fully opaque independently of its gray value.
- **Overlay**
  The color of the analyzed object will be set according to its local wall thickness. This mode does not make sense if the analysis was run on the Background of an object.

Tickmarks on color bar

If Auto tickmarks is enabled, equidistant tick marks are produced for the color bars. If Auto tickmarks is disabled, tick marks appear only at the color section boundaries.

Preset selection

Select, remove, export or import a user defined preset from the preset selection pull down.

When saving a LUT, you can choose if you want to save an Absolute Preset, i.e. a preset that maps colors to absolute wall thickness. If the checkbox is not activated, colors are saved relative to the range of the analysis.

General table features

Right click anywhere into the Components or Annotations tables to show their context menu. The menu contains the following options:

- **Columns**
  Here you toggle the visibility status of each column by enabling / disabling the respective checkbox.
- **Save as default column layout**
  Any modifications applied to the table e.g. changing the sorting order of a column, enabling / disabling of columns or changing the order in which each column appears can be saved as default column layout. This layout will be active until you selected Original column layout.
- **Original column layout**
  Restores the original table layout and discards any modifications applied by the user.
- **Copy to clipboard**
  Copies the table into the clipboard.
- **Export as CSV ...**
  Exports the table values as CSV (Comma Separated Values) list.
- **Remove entries**
  Removes a complete row from the table

  To change the order in which each column appears in the table press <*Ctrl*> and left click the desired column header. Keep the <*Ctrl*> key pressed and drag the mouse over the available column headers until the new position is reached. Release the mouse button to insert the column at its new position.

Components

The Components table lists connected regions detected by the wall thickness analysis.

Warning Removing a Components entry will invalidate the current analysis. Click the Update button to update the analysis.

The individual columns within the Components table are:

- **Analysis**

The name of the analysis the component belongs to. If you select more than one wall thickness analysis, the annotations of every wall thickness analysis are listed. With the analysis information you can distinguish between annotations belonging to different wall thickness analyses.

- **Min thickness**

The minimal thickness detected within the component.

- **Max thickness**

The maximum thickness detected within the component.

- **PosX, PosY, PosZ**

Depending on what has been chosen as Position property (see *Component analysis* on page 22-3), this column lists the position of the Min. thickness, Max. thickness or Spatial center of the respective component.

- **Bottom (X, Y, Z) and Top (X, Y, Z)**

The bottom and top values for each direction provide information about the extent of an individual component.

- **Volume**

The volume of the component.

- **Description**

Enter a description for the component used for reporting.

- **Images**

Select a view mode for reporting. Either choose one of the six view directions top, bottom, front, back, right or left or choose orthographic projection.

- **Zoomed image**

Select a zoomed Detail view for reporting.

- **Captures**

Displays the amount of images generated with the Capture from function. Below the Components table is an area reserved for screenshots. To capture a screenshot first select a view from the pull down, then click the Capture from button. Each screenshot will be displayed in the area above. The screenshots can be chosen to appear in the final report. You can specify a name for the image by clicking the <*no description*> label twice.

Annotations

The Annotations table lists every annotation created for the selected wall thickness analysis. Here you can inspect information supplied by the annotations or edit annotations properties.

To create an annotation select the desired wall thickness analysis within the Scene Tree and click the right mouse button to show the analysis context menu. Select New > Analysis annotation, hold down <*Ctrl*> and click into any 2D window or the 3D window to position the annotation.

The annotation is designed as a movable label displaying informations about the current analysis. A wall thickness annotation contains the annotation name, the current Thickness, the tolerance values specified via Min thickness and Max thickness and the position of the annotation.

The Thickness value is color coded. The green color signalizes an available Thickness value for the current position and the current tolerance values. The yellow color signalizes that for the current annotation position there is no Thickness value available. This happens if the annotation is moved outside the wall thickness result area. The yellow color can also mean that within the chosen encoding precision (see *Algorithm details* on page 22-3) it can not be decided if the annotation lies inside the specified tolerance interval.The red color signalizes that the Thickness value at the current annotation position is not inside the specified tolerance interval.

To minimize/maximize the annotation double-click anywhere inside the annotation.

Furthermore, you can arrange all annotations automatically by right-clicking within the respective window and choosing Annotations > Arrange.

The individual columns within the wall thickness‘s Annotations table are:

- **Analysis**

The name of the analysis the annotation belongs to.

- **Name**

The name of the annotation.

- **Pos (X, Y, Z)**

Position of the annotation.

- **Thickness**

The thickness of the analyzed voxel set at the given annotation position.

- **Enc. precision**

This column is disabled per default and can be enabled via the context menu. It displays the thickness interval for the respective component. The displayed uncertainty results from the chosen encoding precision.

- **Min thickness**

By specifying Min thickness you introduce a tolerance value which states that the thickness at the annotation‘s position must not be smaller than Min thickness.

- **Max thickness**

By specifying Max thickness you introduce a tolerance value which states that the thickness at the annotation‘s position must not be larger than Max thickness.

- **Description**

Enter a description for the annotation used for reporting.

- **Image**

Select a view mode for reporting. Either choose one of the six view directions top, bottom, front, back, right or left or choose orthographic projection.

- **Zoomed image**

Select a zoomed Detail view for reporting.

- **Captures**

Displays the amount of images generated with the Capture from function. Below the Annotations table is an area reserved for screenshots. To capture a screenshot first select a view from the pull down, then click the Capture from button. Each screenshot will be displayed in the area above. The screenshots can be chosen to appear in the final report. You can specify a name for the image by clicking the <*no description*> label twice.

Capture images

The Capture images page allows to take screenshots from the selected workspace widget. The captured images are listed separately within the final report apart from screenshots created in the Components or Annotations section.

Report

The Report page lets you specify the content and the layout of the final report. Either save the report as .rtf (Rich Text Format) or .html document by clicking the Save button, or print it by clicking the Print button. The Print button will show you a Print preview dialog. Use the Previous page and Next page button to navigate through the report preview. Click the Layout button to bring up the Print layout dialog. There you specify the orientation (Portrait or Landscape), the paper size and the resolution.

Report sections

Select which sections of the analysis should be included or excluded from the report be either enabling or disabling the corresponding checkboxes Settings, Components or Annotations.

Detail images settings

Use these settings to change the appearance of the detail images you specified in the Components and/or Annotations tables. Zoom factor sets the zoom level for the Detail zoom view images in the respective tables. By enabling the Manual check box you can change Color mode and or the Background color of the various workspace widget screenshots created within the analysis.

Logo

Specify an image file that should be utilized as a logo within the report.

Cells

Each report page will contain a set of user defined cells. These cells are part of the report layout and their content is customizable. Simply click on a cell and select an attribute from the pull down. Either assign the attribute to the Cell title or to the Cell content. The Cell title is a textual description of the cell content. The Cell content defines what shall be displayed within the cell. You can append attributes to previous attributes by clicking the assign button again.

23

SHORTCUTS

This chapter lists shortcuts used by myVGL2.0.

Shortcuts in 2D / 3D window

<Ctrl> + scroll wheel

Zoom to/away from position of the mouse pointer.

double-click middle mouse button

Switch between Rotate and Move mode.

Shortcuts in 2D window

scroll wheel

Scroll through slices.

hold middle mouse button + move mouse

Drag the slice around in the 2D window.

Shortcuts in 3D window

hold middle mouse button and move mouse up/down

In Move mode, this brings the camera closer to/farther away from the object.

In Rotate mode, this rotates the object clockwise/counterclockwise.

<Ctrl> + move/rotate object

Move/rotate the object in fine steps.

<Shift> + move/rotate object

Move/rotate the object along the vertical or horizontal direction only.

double-click object

Select object (double-click into the background to deselect it)

<Ctrl> + double-click object

Select/deselect multiple objects.

scroll wheel (if light source selected)

Modify intensity of selected light source.

Shortcuts in Scene Tree

double-click object

Open the properties dialog of the respective object, e.g. Render object properties dialog for a voxel object, parameter settings for an analysis.

Shortcuts for menu entries

<Ctrl> + N

New

<Ctrl> + O

Open

<Ctrl> + Z

Undo

<Ctrl> + Y

Redo

<Del>

Delete

<Ctrl> + <Shift> + R

Rotate

<Ctrl> + <Shift> + M

Move

24 GLOSSARY

This chapter explains some of the terms used throughout the documentation and in the software. The explanations are tailored to the usage of the respective term in the myVGL environment.

C

- **Coordinate system**
  myVGL uses right-handed, Cartesian coordinate systems to display data. The orientation of each 2D or 3D window with respect to the currently chosen coordinate system is indicated by the tripod in the lower left corner. To align the slices seen in the 2D windows in different ways, you can choose between several coordinate systems.
- **Comma separated values (.csv)**
  Files of the .csv format store tabular data using a *comma* to separate values.

E

- **Endianness**
  This specifies the byte order used to represent certain data. There are two choices: *big-endian* and *little-endian*.

P

- **Partial Volume Effect**
  This describes the effect that due to the limited resolution of CT-scans, properties of different materials can be merged within a single voxel. For

example, if you zoom into an air-metal transition, you will see voxels with intermediate gray values (see picture below).

VGStudio MAX 2.0 uses these voxels of intermediate gray value to find the surface of an object with sub-voxel precision.

- **Polygon**
  A polygon is a plane figure enclosed by straight line segments, for example a triangle. In computer graphics, triangular polygons are used to model and display surfaces of objects.

- **Preset**
  In ***myVGL2.0***, you can save various sets of parameters as presets, for example the settings made for a specific object in the Volume Rendering tool. You can load these presets later to apply them to different objects or export them to different computers.

R

- **Reference object**
  VGStudio MAX 2.0 offers the following reference objects: points, lines, circles, planes, spheres, cylinders and cones. They are fitted to your data and can be used to measure features of your data. Reference objects can also be combined to measure for example the angle between two planes. Furthermore, you can use reference objects to register an object.

- **Registration**
  In some cases multiple data sets belong to one object, for example a scanned object and its CAD model or partly overlapping sub-volumes of an object too large to be scanned in one pass. The process of transforming these different data sets into one coordinate system is called registration. ***VGStudio MAX 2.0*** offers various algorithms to perform 3-D registration.

- **Rendering**
  The process of computing and displaying an image based on a model is called rendering. The rendering process can include the application of shadows, lighting, perspective and texture.

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File Extensions

This chapter lists file extensions used by ***myVGL 2.0***.

Warning We strictly warn you against editing or deleting files in the project folder: This can lead to inconsistencies and systems crashes or simply destroy your project.

- **.act**
  Denotes a color table file. *Do not edit these files.*
- **.lic**
  Denotes a license file. To activate the software, copy the license file into the installation directory of ***myVGL***. *Do not edit, delete or otherwise modify these files as this will invalidate your license.*
- **.lut**
  Denotes a color table file. *Do not edit these files.*
- **.pst**
  Denotes a preset file. Presets are available for various areas of the application. Each preset combines parameters of a specific area. You can transfer these files to another computer, but be warned that presets of the same name will be overwritten on that computer. *Do not edit these files.*
- **.vgl**
  Denotes a project file. Project files include references to all imported objects, modifications such as rotation, opacity settings and analysis results. *Do not edit these files.*

  One .vgl files combines with a correspondingly named project folder to a project. None is usable without the other.
- **.vgp**
  Denotes a file that contains preview information that can be used by file managers to create thumbnails. *Do not edit or delete these files.*
- **.vgr**
  Denotes a file containing information about ROIs (references to a .vgm file). *Do not edit or delete these files.*

- **.vgs**
  Denotes a file containing information about polygons or point clouds. *Do not edit or delete these files.*
- **.vgt**
  Denotes a measurement template file. *Do not edit or delete these files.*
- **.vgx**
  Denotes a CT-reconstruction parameter file. *Do not edit or delete these files.*

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