FARO®

SCENE

Apps

VOLUME MEASUREMENT 1.0 - USER MANUAL

FEBRUARY 2013

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1. Introduction

The Volume Measurement is a helpful add-on for SCENE or SCENE LT that extends the standard measurement functionality by enabling the user to measure volumes of complex objects in the 3D view of scans, workspaces or project point clouds.

This manual describes the Volume Measurement, its functions and how you can use it to determine the volume of objects in your scan data.

- *View online tutorials in the Internet at http://tutorial.faroeurope.com to learn more about the use of SCENE and the SCENE apps.*
- *The Volume Measurement 1.0 works with version 5.1 of SCENE or SCENE LT.*

2. Installing the App

1) Open SCENE or SCENE LT
2) If a previous version of the app is installed, remove this version first with the App Manager (available in SCENE or SCENE LT under **Tools ▸ Apps**).
3) Install the app by doing one of the following:
   - Drag & Drop the app file (.fpp file) into SCENE or SCENE LT.
   - Double click the app file in the Windows Explorer.
   - Use the App Manager (available under **Tools ▸ Apps)** to install the app (see the SCENE or SCENE LT manual for more information).
4) Once installed, you should have this icon in your toolbar:  .

3. Licensing the App

Once installed, you may fully test the Volume Measurement for 7 days without the need of a software license. After the trial period, the Volume Measurement will be disabled and you need a license to further use the app.

There are two licensing options:

- Single-user license.
- Network (floating) license

Both types of licenses can be locked either to the computer where the app is installed (soft lock) or to a SCENE USB dongle (hard lock).

***Please note**: For licensing, a third party software called Sentinel HASP is used and a driver has to be installed on your system to enable licensing of FARO software products. This driver will automatically be installed during the installation of SCENE, but not with SCENE LT. If the required driver is missing on your system, it will automatically be installed by SCENE LT's app manager when installing the app.*

3.1. Single-User License

A single-user license can be locked either to a computer or to a SCENE USB dongle.

You need a SCENE USB dongle in order to use the second option. A single-user license locked to an USB dongle is not bound to a single computer and adds mobility of the license between multiple computers. The USB dongle can be attached to an USB port on any computer running SCENE or SCENE LT. Once attached, the Volume Measurement has a valid license and can be used as normal.

Once you have bought a single-user license of the app you will get a product key which consists of 18 numbers. To validate this key and to activate the license, take the following steps:

- If you have a SCENE USB dongle and if you want to lock the license of the app to this dongle, attach it to the computer.
- Start SCENE or SCENE LT.
- Open the **Product Activation** dialog with the App Manager by clicking **Enter License** next to the app name or under **Help ▸ Licensing** (only SCENE).

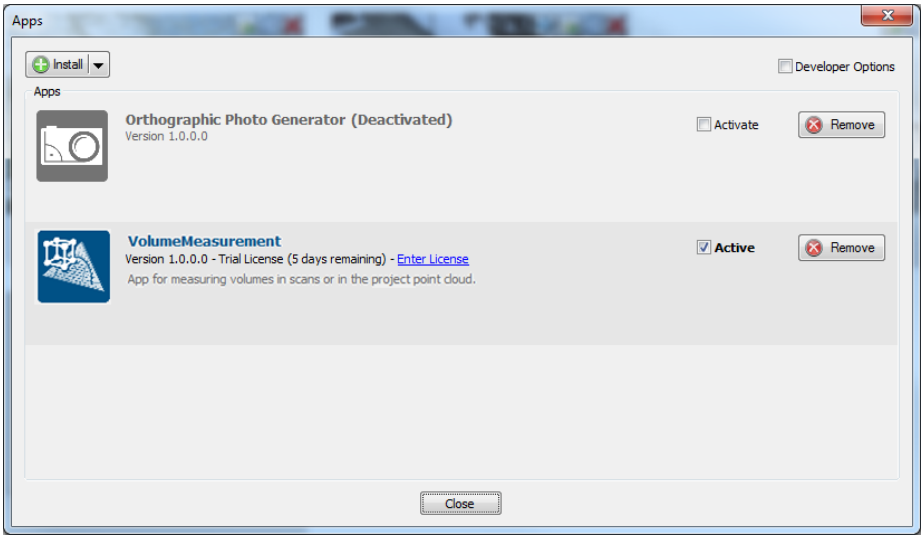

Figure 3-1: App manager

- The Product Activation dialog will show up. Use the automatic activation method via Internet on tab **Automatic Activation**.

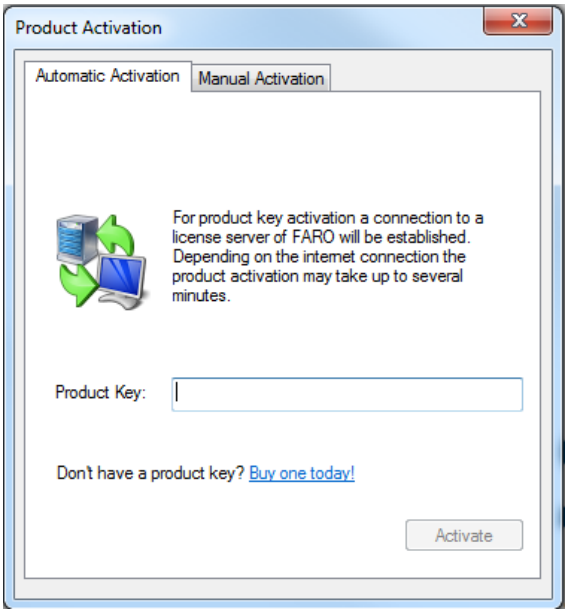

Figure 3-2: Activation dialog – Automatic Activation

- Enter your product key and click the **Activate** button (if a SCENE USB dongle is attached you will now be asked whether you would like to lock the license to the computer or to the USB dongle).
- SCENE or SCENE LT will now contact FARO's license server to validate the entered key. Depending on the Internet connection, this process might take up some time.
- Once the key has been successfully validated, the license will be activated and locked to your computer (or USB dongle).

***Please note**: If your single user license is locked to your computer and if you change your hardware or if you want to use the app on a different computer, you will have to renew the license as it is bound to a system ID. Please contact customer service in that case.*

If the automatic activation fails:

In case the automatic activation fails, please check your Internet connection or enter the product key again and retry. If activation still fails, you may activate the app manually on tab **Manual Activation**.

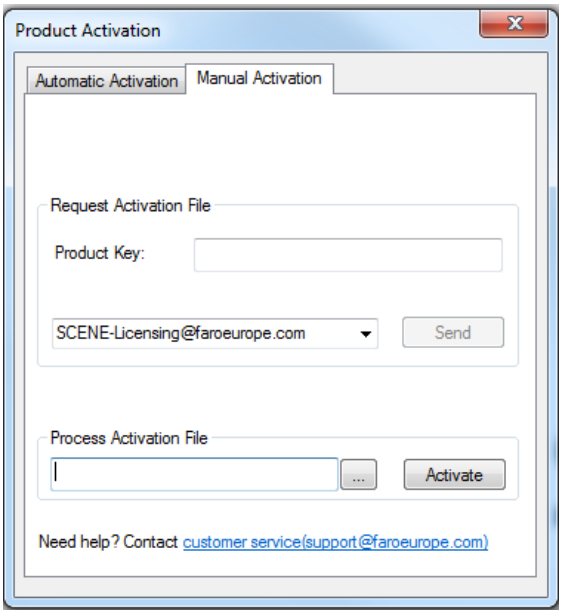

Figure 3-3: Activation dialog – Manual Activation

Enter your product key and click the **Send** button to create an activation request file (a file with the file extension .ar) which must be sent to FARO (this activation request file does not contain any private data):

- In case an E-Mail client is properly installed on your system an E-Mail with the activation request file attached will automatically be generated. Just send this E-Mail to the provided address.
- In case an E-Mail client is not installed on your system, you will be prompted to save the file to your hard disk. Please attach this file to an E-Mail and send it to the provided E-mail address.

Once the E-Mail has been sent to FARO you will receive an automatic E-Mail with an activation file (a file with the extension .v2c). Save this file to your hard disk, open it with the **Manual Activation** dialog under **Process Activation File**, and then click **Activate**. Your product should now be activated and have a permanent license.

3.2. Network Licensing (Floating License)

If you have bought a network license of the Volume Measurement you will receive a license that is linked to a software product key. Like single-user licenses, you can lock network licenses either to a computer (license server) or, if available, to a SCENE USB dongle. To do this and to activate the license, follow the steps described in chapter 3.1.

Network licenses are hosted by a license server computer and will be shared to client computers over the network. If you start the app on any computer in your network it will search the network for available licenses. If one is found, it will be used for the time the app is started. When disabling the app or closing SCENE or SCENE LT, the license will be released again and will be available to other installations in the network.

To run a computer as a license server licensing software has to be installed on that computer. This is done automatically with the installation of SCENE. If you do not want to install SCENE on the computer that hosts the network licenses, you have to install this software manually. You may find it on the SCENE DVD or in the installation folder of SCENE. The file name of the setup is "haspdinst.exe". Run this installer and follow the prompts.

To administrate your network licenses on the license server, open http://localhost:1947/ in an Internet browser on this computer to run the *Sentinel Admin Control Center*. Please read the online help of this software for more information.

If your license server hosts network licenses of the Volume Measurement that are locked to the computer (and not to an attached USB dongle) you can detach such a network license and bound it to a client computer for a certain period of time. The license can then be used locally on that computer without the need to be connected to the license server. When the detached license expires, it will automatically be disabled on the client computer and restored to the server. For more information, see the online help of the *Sentinel Admin Control Center* that can be found on your client computer or on the license server under http://localhost:1947/.

For more information on network licensing, please read the SCENE manual.

4. Measuring the Volume of an Object

Depending on the complexity of the shape of the object you would like to measure you have two options to determine its volume:

- To measure an object with complex shape, create a frame (in the form of an extruded polygon) that encloses all the scan points of this object (and as few unwanted scan points as possible). The object's surface will be reconstructed by creating a triangular mesh from the scan points within this frame. The object's volume will be determined by measuring the volume between the mesh and the base of the frame.
- The volume of less complex objects in the form of extruded polygons, for example rooms, can be measured by recreating their shape in the point cloud. To do this, create an extruded polygon or frame that matches the shape of the object. The object's volume will be determined by simply calculating the volume of this frame.

The main focus is on creating the frame in the point cloud, which requires the following steps to be accomplished:

1) Define the (two-dimensional polygonal) base of the frame. See chapter 4.1 for more information.
2) Extrude the base: specify the frame's height and the extrusion direction. See chapter 4.2 for more information.
3) Finally, to complete the measurement, select between the two above mentioned measuring options and simply calculate the volume of the frame or create a mesh from the scan points in the frame to calculate the volume between the mesh and the frame's base. See chapter 4.3 for more information.
4) Improving the completed measurement, for example by removing unwanted points from the mesh, might be necessary. See chapter 4.4 for more information.

4.1. Creating the Base of the Frame

The Volume Measurement offers different possibilities to create the base of the frame:

- Create the base from a selection of scan points in the point cloud. From this selection, a planar polygon will be created that matches best the selected points. This polygon will be used as the base of the frame. For more information, see chapter 4.1.1.
- Select an area in a pre-defined plane (limited or unlimited plane) and use this area as the frame's base. For more information, see chapter 4.1.2.
- Create a new plane first, select an area in this plane and use this area as the frame's base. For more information, see chapter 4.1.3.
- Use the area of an area measurement that was made with the app ***Area Measurement*** as the base of the frame. For more information, see chapter 4.1.4.

Select one of these options from the drop-down menu of the Volume Measurement toolbar:

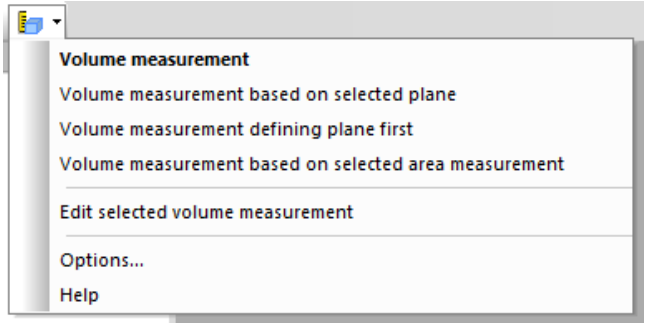

Figure 4-1: Volume measurement menu

4.1.1. Creating the Base from a Selection of Scan Points

1) Open the 3D view of a scan, scan folder, workspace or the project point cloud.
2) Click the **Volume Measurement icon** in the toolbar or select **Volume measurement** from its drop-down menu. A crosshair cursor in the 3D view indicates that the Volume Measurement is enabled.
3) As known from the polygon selection tool in SCENE or SCENE LT, make a polygonal point selection of the area you would like to use as the base for the frame.

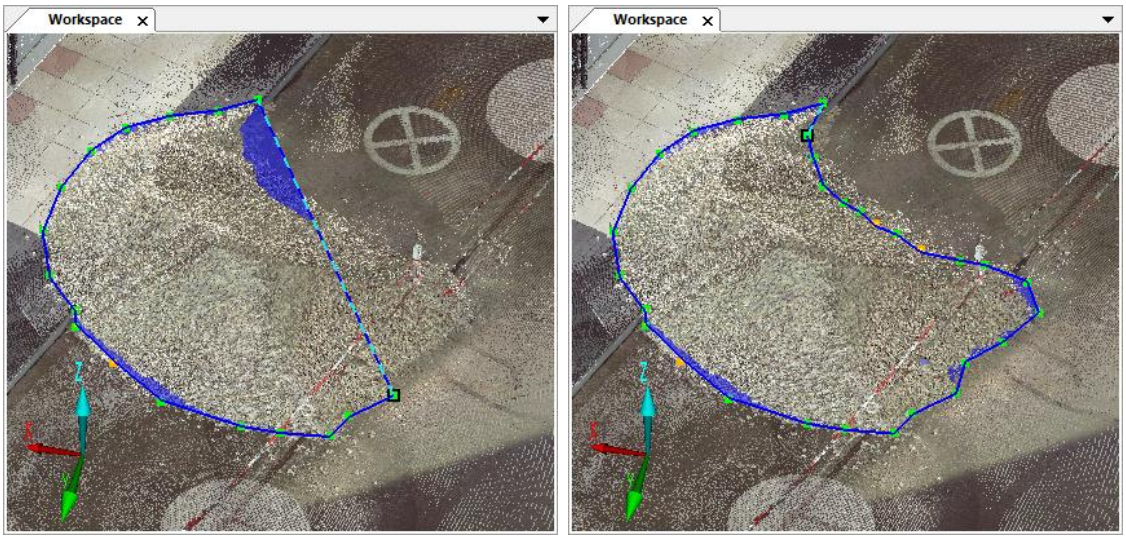

Figure 4-2: Creating a polygonal point selection

4) Complete the selection (if there are no intersections) with **RETURN** or double click on the last selected corner point. When completing, the line will be closed; in other words, the last fixed corner point is connected to the starting corner. The selection comprises all the scan points that are enclosed within the outline. An orthogonal regression plane which matches best the selected scan points will be created and the created polygon will be fitted to this plane. This fitted polygon will be used as the base for the volume measurement. The base will be extruded and, in the next step, you may adjust height and direction of extrusion. Continue with chapter 4.2.

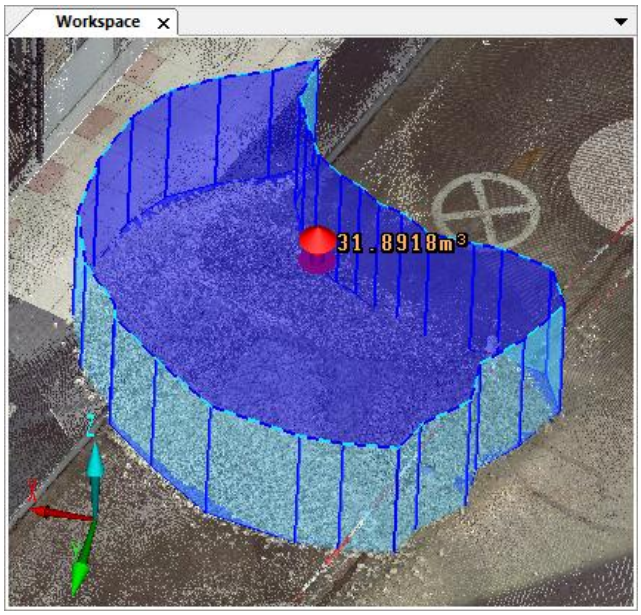

Figure 4-3: Frame

- *The surface of the selected polygon is visualized in transparent blue. If there are scan points in front of the polygon, its surface will not appear as fully closed.*
- *While selecting the polygon, the edge between the first and the last added point is drawn as a dashed line. This indicates that this edge will be replaced by two new edges when adding the next corner point. To add the next corner point to a different edge, select this edge with the mouse (it will be drawn as a dashed line), and then add the new point as usual.*

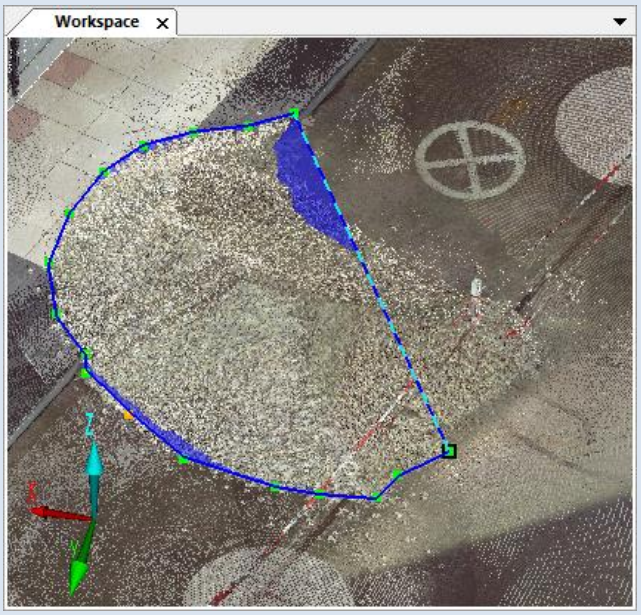

Figure 4-4: *Edge displayed with a dashed line*

- *Corner points of the polygonal selection can be moved at any time during the selection of the polygon. Just select a corner point and drag it with the mouse to another position. This point will be moved along the already fitted polygon.*

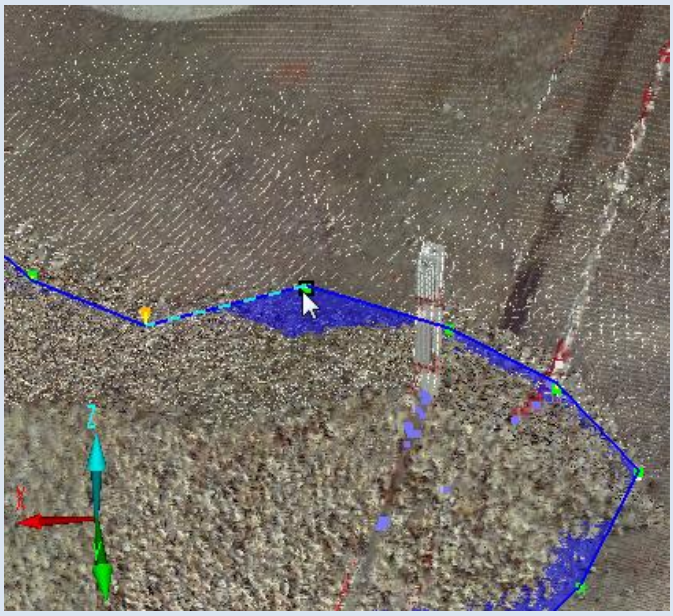

Figure 4-5: *Moving a point*

- *The base can only be created from non-intersecting polygons. If there are intersections, only the outline of the fitted polygon is drawn and intersecting edges will be shown in red. In that case you may delete the last selected corner point(s) (with **BACKSPACE**) or move corner points by dragging them with the mouse until the intersections are resolved.*

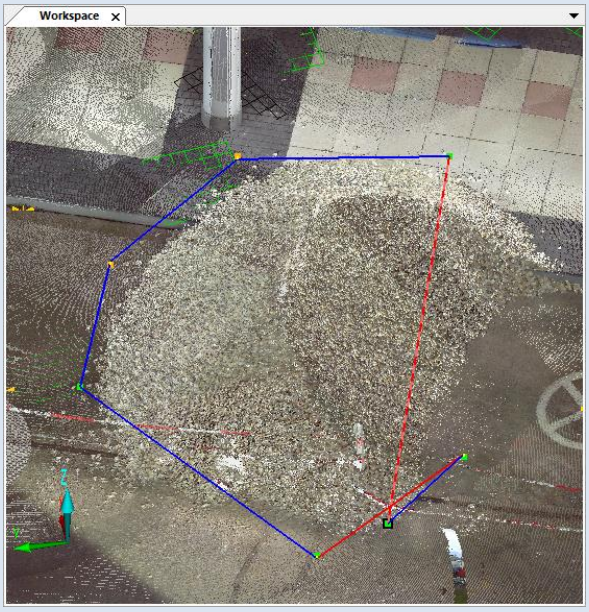

Figure 4-6: Intersections

Right from the beginning, ensure that the base matches the shape of the object as good as possible and that it encloses as few unwanted scan points as possible. This leads to more precise measurement results and reduces the rework effort of editing the resulting mesh (see chapter 4.4).

Available hot keys in this measurement mode are:

Backspace	Removes the selected corner point from the polygon.
ESCAPE	Disables the Volume Measurement; unfinished polygonal selections will be removed.
Keeping **CTRL** pressed	Temporarily disables point selection, allows navigating in the view in examine mode
Keeping **SHIFT** pressed	Temporarily disables point selection, allows navigating in the view in the currently selected navigation mode.
W, **A**, **S**, **D**, etc	Movement in 3D view as usual.
I	Defines a plane from the selected scan points, the points used to define the plane will be projected onto the plane. The base will now be created based on a selected area in the created plane. This corresponds to the measurement method described in chapter 4.1.3.
RETURN	Complete the selection and create the base.

4.1.2. Creating the Base in an Already Existing Plane

1) Open the 3D view of a scan, scan folder, workspace or the project point cloud.
2) Select an already available plane in the structure view or the 3D view. This plane will be highlighted in the view.

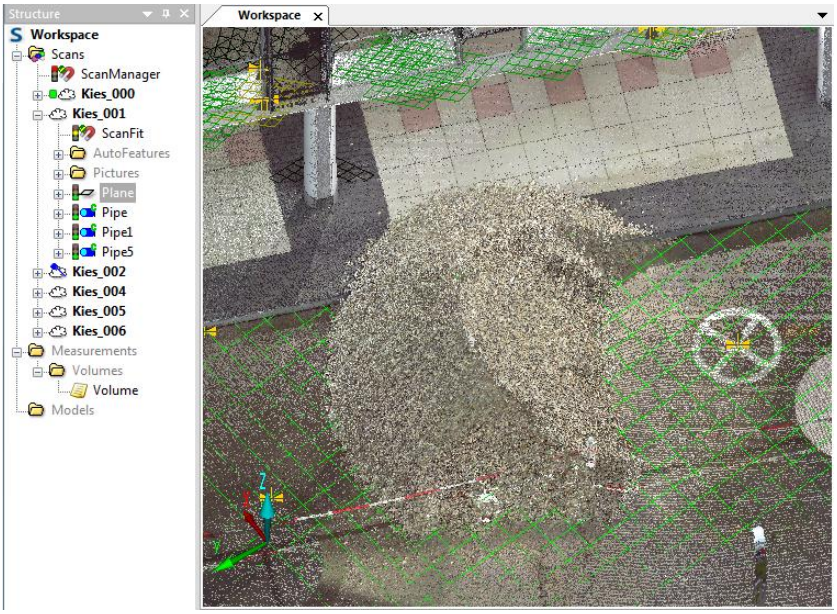

Figure 4-7: Selected plane

3) Select **Volume Measurement based on selected plane** from the drop-down menu of the Volume Measurement toolbar. A crosshair cursor in the 3D view indicates that the Volume Measurement is enabled.

4) Make a (non-intersecting) polygonal selection to define the base by selecting points in the selected plane. These points don't have to be scan points. As described in chapter 4.1.1, you can change the position of already selected points at any time during the selection by dragging them with the mouse.

Figure 4-8: Selected area on a plane

5) Complete the selection and the base with **RETURN** or double click on the last corner point of the selection. The selected polygon will be extruded and you can now adjust the height and direction of the extrusion. Continue with chapter 4.2.

*The available hot keys are identical to the hot keys described in chapter 4.1.1. Hot key **I** has no function in this measuring mode.*

4.1.3. Creating a Plane and Defining the Base in this Plane

1) Open the 3D view of a scan, scan folder, workspace or the project point cloud.
2) Select Volume measurement defining plane first from the drop-down menu of the Volume Measurement toolbar. A crosshair cursor in the 3D view indicates that the Volume Measurement is enabled.
3) Make a polygonal point selection in the 3D view to define the plane.

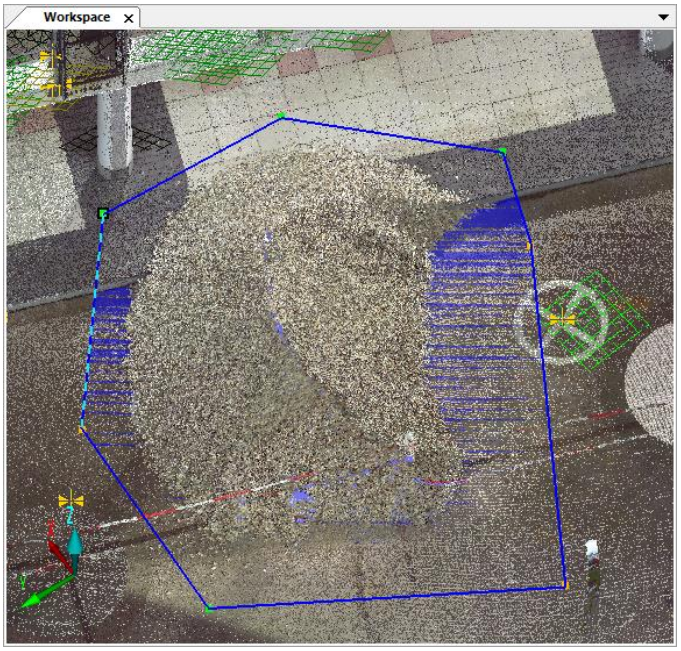

Figure 4-9: Points selection to define the plane

4) Create the plane from the selected scan points with **Return**, **I** or double click on the last corner point of the selection. The created plane will be added to the Workspace and will be available in the *Volumes* folder (under *Measurements*) in the structure view. The corner points selected to define the plane will be kept and projected onto the plane. This selection will then be the starting point for the next step, the creation of the base.

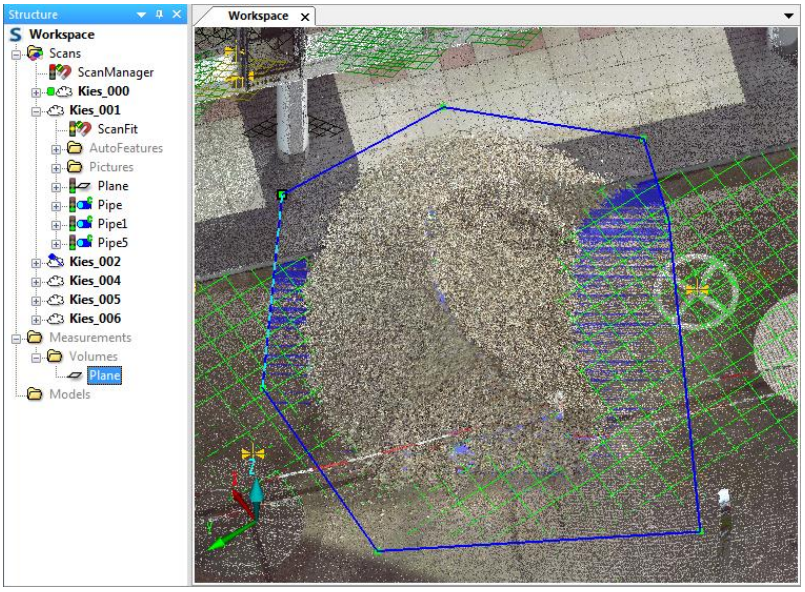

Figure 4-10: Plane created from the points selection

5) Continue creating a (non-intersecting) polygonal selection to define the base by moving, removing or adding points in the plane. These points don't have to be scan points. As

described in chapter 4.1.1, you can change the position of already selected points at any time during the selection by dragging them with the mouse.

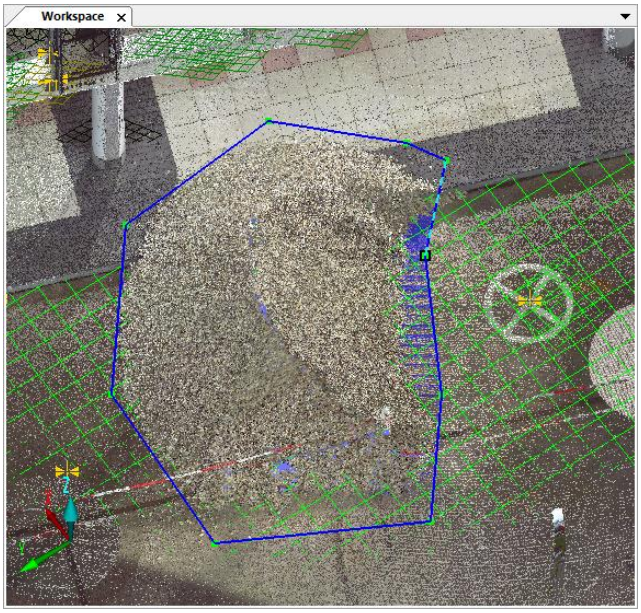

Figure 4-11: Selected area on the plane

6) Complete the selection and the base with **RETURN** or double click on the last corner point of the selection. The selected polygon will be extruded and you can now adjust the height and direction of the extrusion. Continue with chapter 4.2.

The available hot keys are identical to the hot keys described in chapter 4.1.1

4.1.4. Using an Area Measurement as the Base of the Frame

With this option you can create a volume measurement based on the area used for an area measurement that was made with the app *Area Measurement*. This area will be used as the base for the volume measurement.

1) Select the area measurement that you would like to use as the base for the frame in the structure view or in the 3D view.

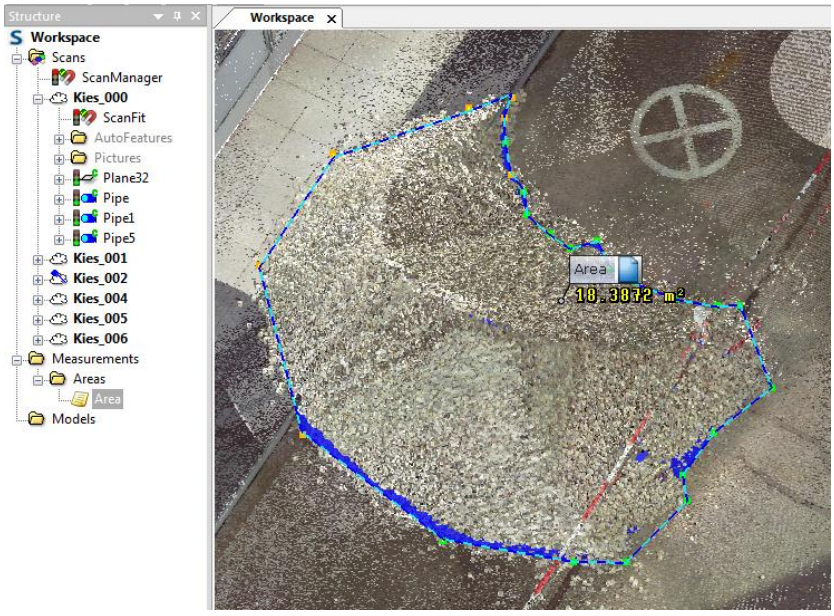

Figure 4-12: Selected area measurement

2) Select **Volume Measurement based on selected area measurement** from the drop-down menu of the Volume Measurement toolbar.

3) The area of the selected measurement will be extruded and you can now adjust the height and direction of the extrusion. Continue with chapter 4.2.

4.2. Defining Height and Extrusion Direction of the Frame

Once the base is completed you can adjust the height and direction of its extrusion.

Increase / Decrease the height of the frame by dragging the red manipulator with the mouse or by pressing **CTRL+UP** or **CTRL+DOWN** on your keyboard (keep **SHIFT** pressed to increase the speed). The current volume of the frame is shown beneath the manipulator.

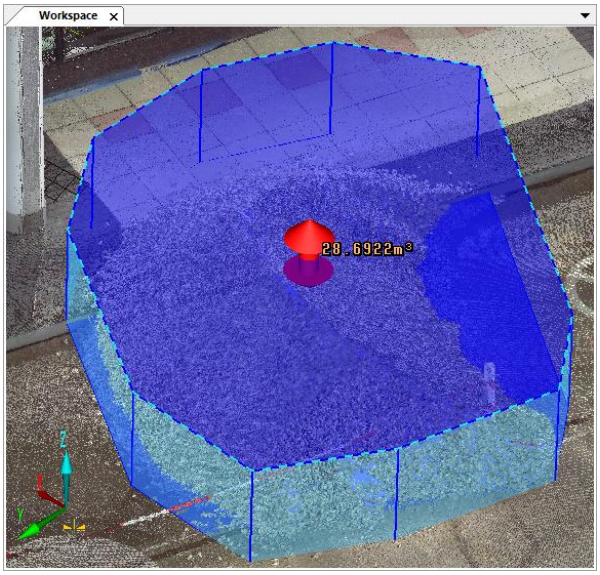

Figure 4-13: Frame

The default extrusion direction is perpendicular to the base. You can change this direction when you right click in the view and choose Set extrusion direction in the upcoming context menu.

You can select between:

- Perpendicular to the base (default)
- Along the x axis
- Along the y axis
- Along the z axis

- *Only axes with big enough angles to the normal of the base can be selected.*
- *If you want to determine the volume based on a mesh created from the scan points within the frame you should ensure that the frame encloses all the scan points of the object and as few unwanted points as possible.*

Available hot keys in this step are:

Backspace	Return to the previous step (defining the frame's base)
ESCAPE	Abort measurement. If you were editing an already completed and saved measurement, the state of the measurement before editing will be restored.
CTRL+UP / **CTRL+DOWN**	increase / decrease the height of the frame (hold down **SHIFT** to increase the speed)
+ / - on the Numpad	Increase / decrease the size of the manipulators
RETURN	Complete the frame and the measurement

4.3. Completing the Measurement

Once the height of the frame has been defined, complete the measurement with **RETURN**. You will be prompted to select the method of measuring the volume:

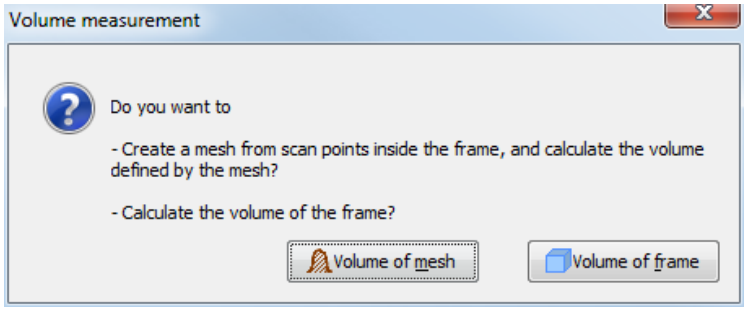

Figure 4-14: Two options to complete the measurement

- **Volume of mesh: Create a triangular mesh** from the scan points within the frame and calculate the volume between the mesh and the base of the frame.
- **Volume of frame: Calculate the volume of the created frame**: The volume of the frame will be calculated without taking the scan points within the frame into account. No mesh will be created. This option is useful if you want to calculate the volume of e.g. rooms.

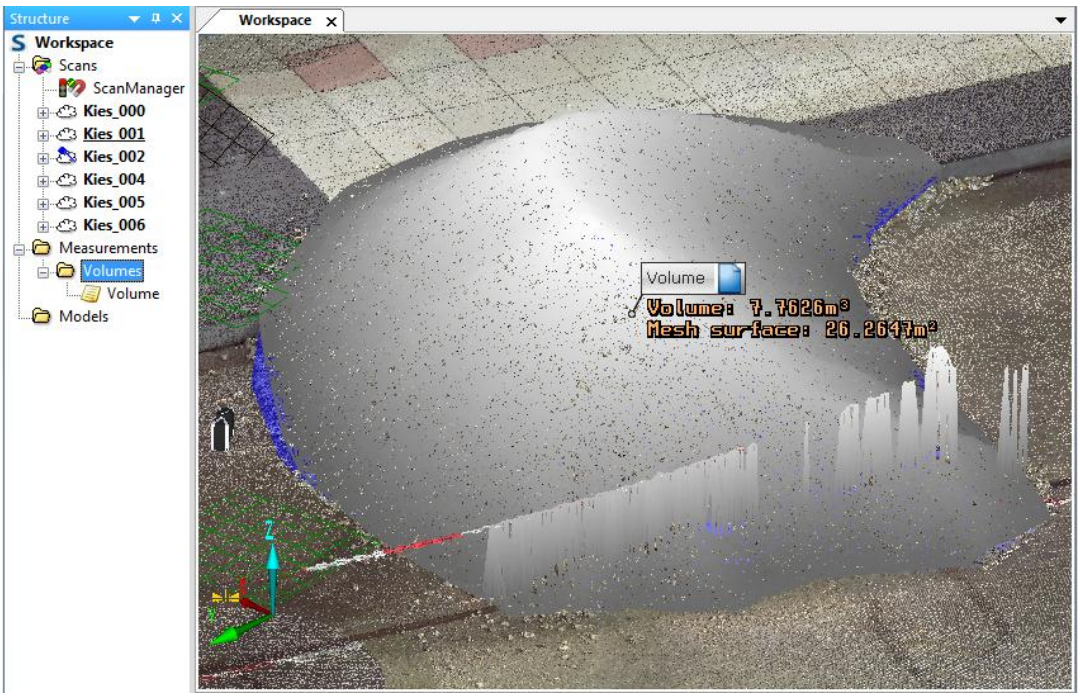

Figure 4-15: Mesh created from the scan points within the frame

The measurement result will be shown in the 3D view. Completed measurements will be stored in the workspace. They are available in a sub folder of the *Measurements* folder. This sub folder is called *Volumes*.

You may apply the surface smoothing filter when creating the mesh. This filter removes outlier points from the mesh that do not belong to the surface of your object. It is only useful if your object has a smooth surface. You can enable or disable this filter in the options of the Volume Measurement.

4.4. Editing Completed Volume Measurements

You can edit already completed volume measurements at any time. To edit an already completed volume measurement, select it in the structure view and then select **Edit selected volume measurement** in the drop-down menu of the volume measurement toolbar or right click the measurement's label in the 3D view and select **Edit selected volume measurement** in the upcoming context menu.

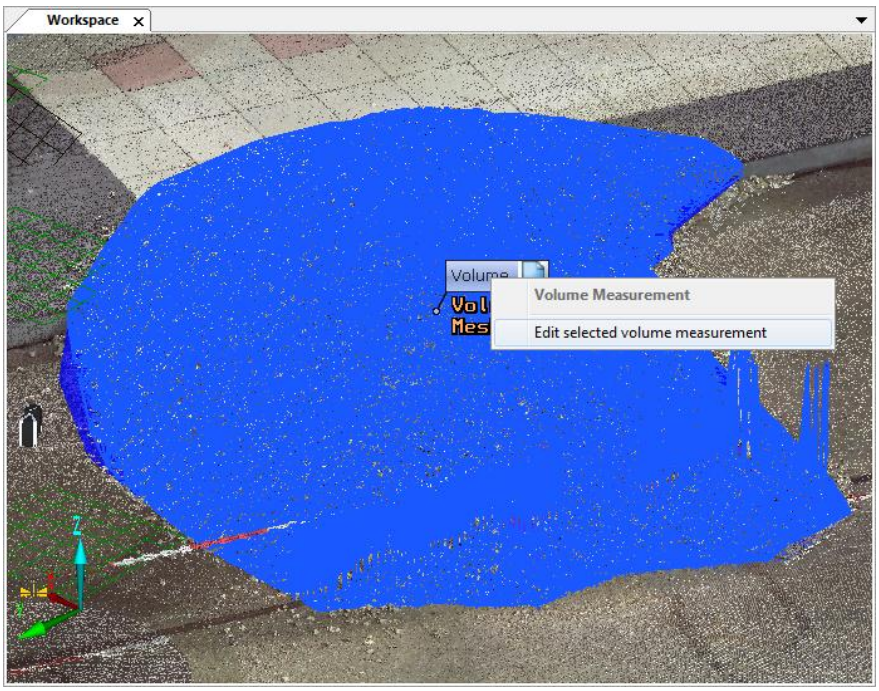

Figure 4-16: Context menu of selected mesh in 3D view

Once you are in the "edit mode" the colors of the mesh change according to the settings in the options of the Volume Measurement.

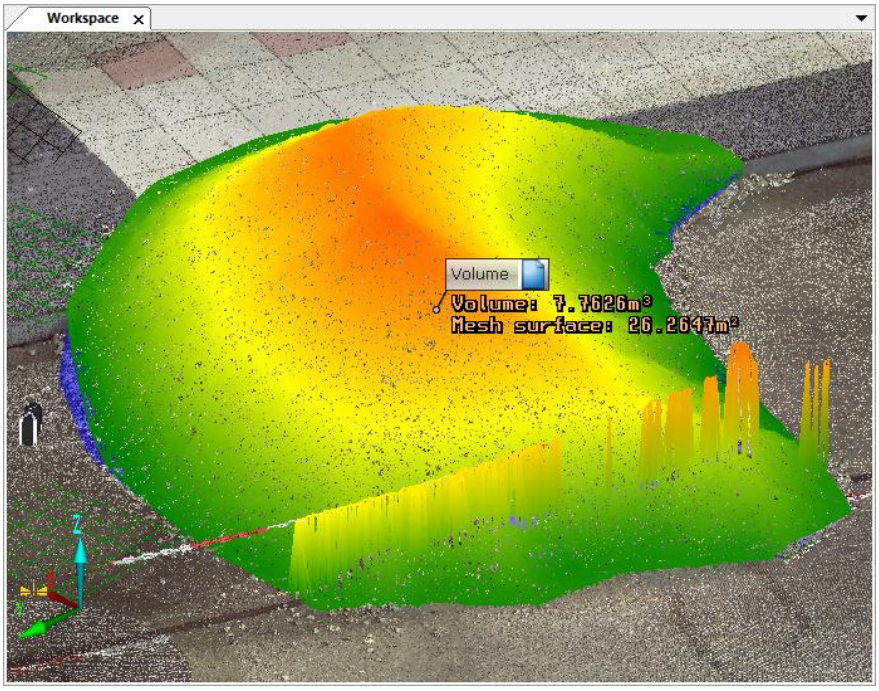

Figure 4-17: Colored mesh in "Edit mode"

Right clicking the mesh brings up a context menu with a range of options:

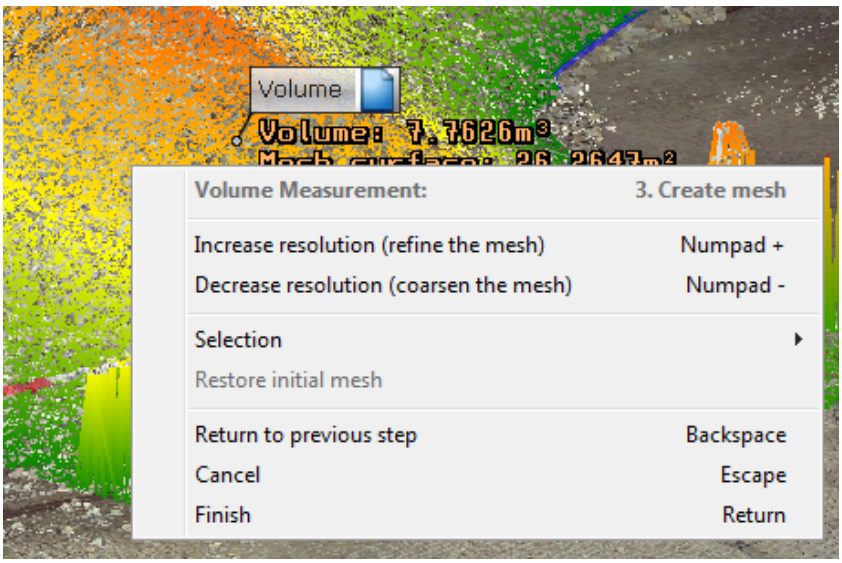

Figure 4-18: Colored mesh in "Edit mode"

Increase resolution (refine the mesh) – The mesh will be refined by decreasing the size and thus increasing the number of the triangles. The finer the mesh, the longer will it take to calculate it.

Decrease resolution (coarsen the mesh) – The mesh will be coarsened by increasing the size and thus decreasing the number of the triangles.

Restore initial mesh – restore the initial state of the mesh and undo all changes that were made to the mesh during editing.

Return to previous step – go to the previous step to change the height of the frame. For more information, see chapter 4.2.

Cancel – Cancel editing the volume measurement and quit the "edit mode".

Finish – Finish editing the measurement, save the changes and quit the "edit mode".

Selection - You can also select unwanted points and delete them from the mesh. The selected points and the corresponding triangles will be colored red. Once a selection has been made, you can apply several commands:

Clear selection – Clears the available selection without further action.

Remove points and smooth selected region – Removes the selected points and triangles from the mesh and closes the resulting hole in the mesh with triangles of greater size. This will smooth the surface of the mesh. Use this, for example, to remove points or triangles that stick out of the surface of the object.

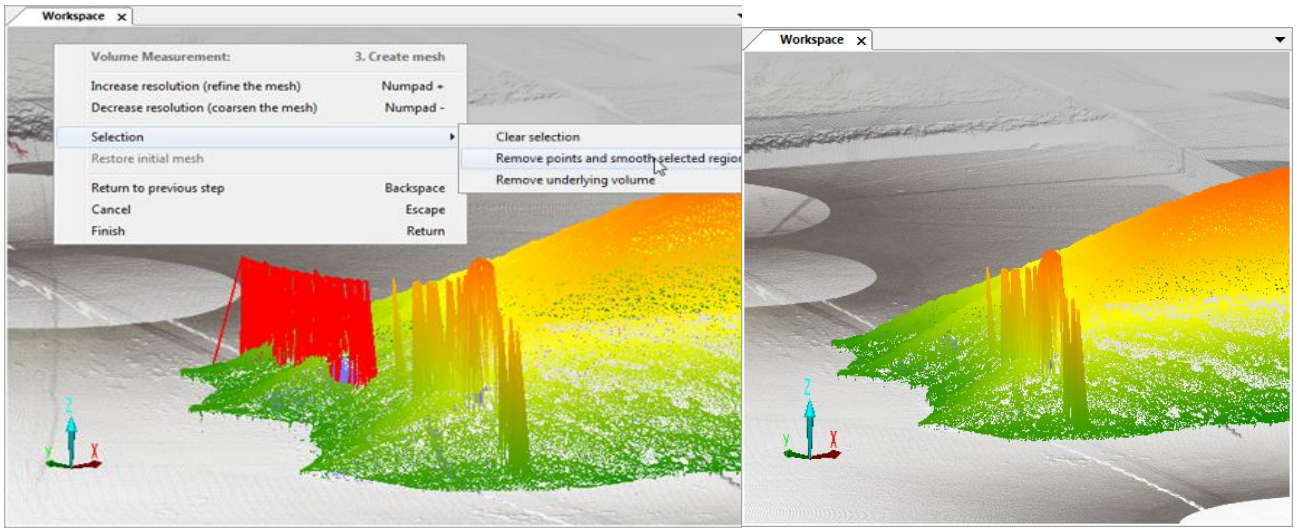

Figure 4-19: Removing points from mesh by smoothing the selected region

Remove underlying volume – Removes the selected points or triangles from the mesh without closing the resulting hole in the surface of the mesh. This removes the underlying volume from the measurement. Use this, for example, to remove triangles at the border of the mesh, if you made the base too big.

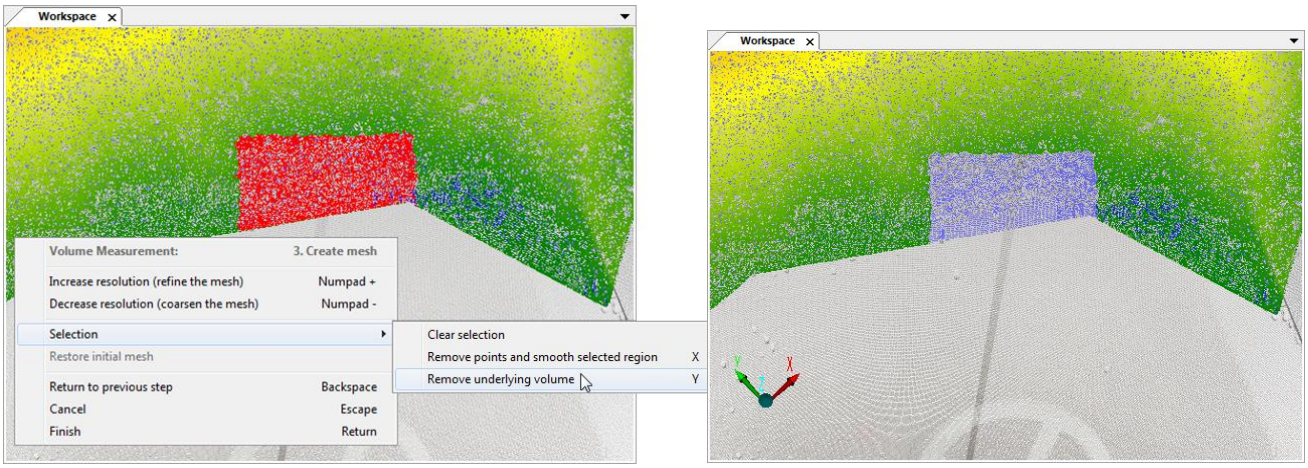

Figure 4-20: Removing points from mesh by removing the underlying volume

5. Reference Handbook

5.1. Toolbar

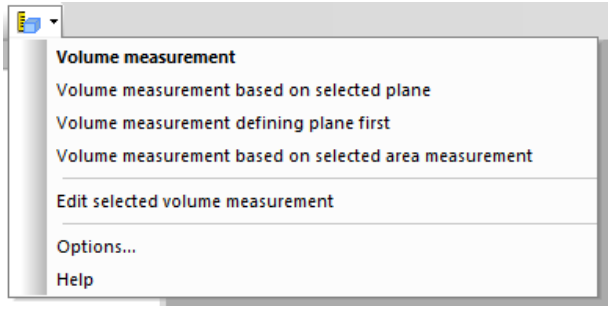

Figure 5-1: Volume measurement toolbar

Clicking the icon - Start a volume measurement by creating the base from a selection of scan points. For more information, see chapter 4.1.1.

Drop-down menu:

Volume measurement – Same effect as clicking the icon (see above).

Volume measurement based on selected plane – Start a volume measurement by creating the base in an already available plane. For more information, see chapter 4.1.2.

Volume measurement defining plane first – Define a plane in the point cloud first and create the base of the frame in this plane. For more information, see chapter 4.1.3.

Volume measurement based on selected area measurement – Use an existing area measurement (created with the app Area Measurement) as the base of the frame. For more information, see chapter 4.1.4.

Edit selected volume measurement – Edit an already completed volume measurement. For more information, see chapter 4.4.

Options… – Open the options dialog. For more information, see chapter 1.1.

Help – Open this manual.

5.2. Options

Access the option of the Volume Measurement from its toolbar.

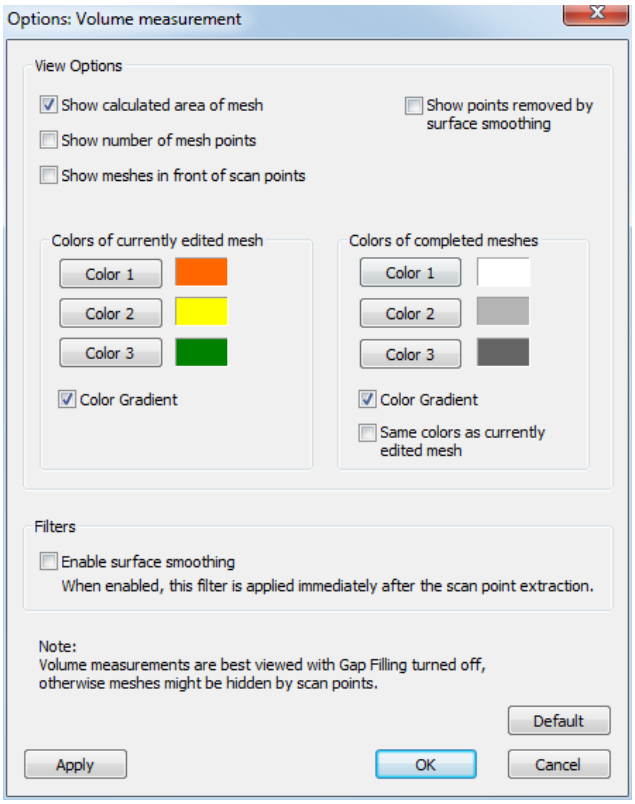

Figure 5-2: Options

View Options

Show calculated area of mesh – The calculated area of the mesh's surface will be displayed in the 3D view under the label of the volume measurement.

Show number of mesh points – The number of mesh points will be displayed in the 3D view under the label of the volume measurement.

Show meshes in front of scan points – The mesh will always be displayed in front of the scan points in the 3D view.

Show points removed by surface smoothing – Highlight the points that were removed by the surface smoothing filter during mesh creation (see below for more information).

Color of currently edited mesh –Specify the mesh color(s) of the currently edited measurement. If **Color Gradient** is enabled the mesh will be displayed in gradient colors, starting with **Color 1** for points and triangles that are furthermost from the base and transitioning linearly via **Color 2** to **Color 3** for points and triangles near the base. If **Color Gradient** is disabled the mesh will be displayed in **Color 1.**

Color of completed meshes - Specify the mesh color(s) of completed measurements. If **Color Gradient** is enabled the mesh will be displayed in gradient colors, starting with **Color 1** for points and triangles that are furthermost from the base and transitioning linearly via **Color 2** to **Color 3** for points and triangles near the base. If **Color Gradient** is disabled the mesh will be displayed in **Color 1.** Enable **Same colors as currently edited mesh** to use the color settings of the currently edited meshes also for the completed meshes.

Filters

Enable surface smoothing – Remove outlier points that do not belong to the surface of your object. This filter will be applied when creating the mesh (see chapter 4.3) and is only useful if your object has a smooth surface. You can view the removed points by enabling **Show points removed by surface smoothing** (see above).

Default – Restores the settings to their default values.

5.3. Context Menus

5.3.1. Context Menu While Defining the Base

Context menu, accessible when you right-click in the 3D view while defining the base of the frame:

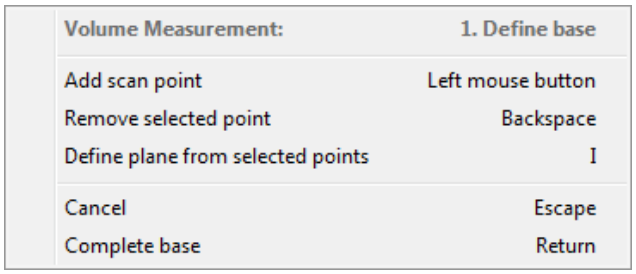

Figure 5-3: Context menu while defining the base

Add scan point – Add another scan point to the polygon.

Remove selected point – Remove the selected point from the polygon.

Define plane from selected points – Define a plane from the selected scan points; the points used to define the plane will be projected onto the plane. The base will be created based on a selected area in the created plane. This corresponds to the measurement method described in chapter 4.1.3.

Cancel - Cancel the started volume measurement, an unfinished selection will be removed. If you were editing an already completed and saved measurement, the state of the measurement before editing will be restored.

Complete base - Complete the selection and the base, and go to the next step to set the height of the frame.

For more information, see chapter 4.1.

5.3.2. Context Menu While Defining the Height of the Frame

Context menu, accessible when you right-click in the 3D view while defining the height and the extrusion direction of the frame:

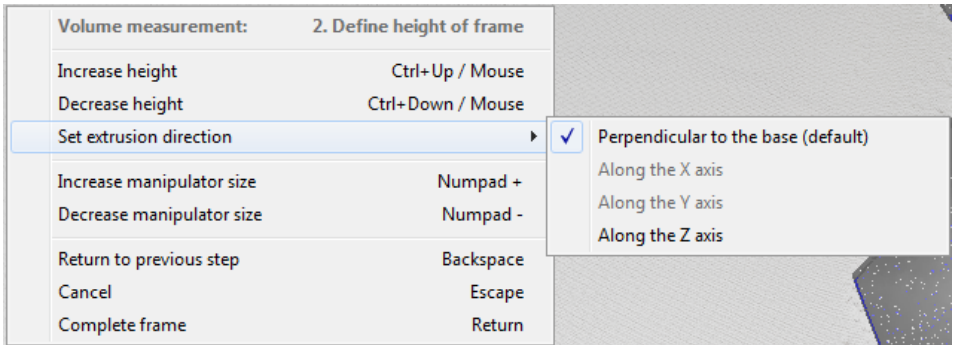

Figure 5-4: Context menu while defining the height of the base

Increase / Decrease height – Increase or decrease the height of the frame.

Set extrusion direction – The default extrusion direction of the frame is perpendicular to the base. Change this direction here. You can select between:

- Perpendicular to the base (default)
- Along the x axis
- Along the y axis
- Along the z axis

Increase / Decrease manipulator size – Increase / decrease the size of the manipulator.

Return to previous step – Go back to the previous step to change the base.

Cancel – Cancels the measurement; the unfinished measurement will be deleted. If you were editing an already completed and saved measurement, the state of the measurement before editing will be restored.

Complete frame – Complete the frame and the measurement.

For more information, see chapters 4.2 and 4.3.

5.3.3. Context Menu While Editing a Volume Measurement

See chapter 4.4 for a detailed description of this context menu.

5.3.4. Context Menu of the Volume Measurement Object in the 3D View

Context menu, accessible when you right-click the label of a completed measurement in 3D view:

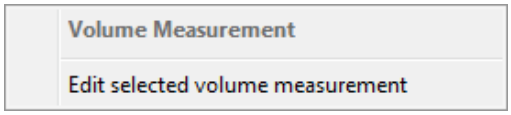

Figure 5-5: Context menu of measurement object in 3D view

Edit selected volume measurement – Edit the volume measurement. For more information, see chapter 4.4.

5.3.5. Context Menu of a Volume Measurement Object in the Structure View

Context menu, accessible when you right-click the volume measurement object in the structure view:

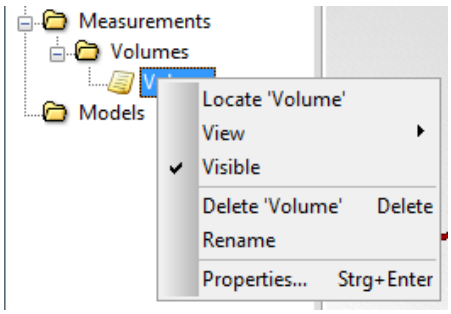

Figure 5-6: Context menu of measurement object in structure view

Locate - Find the measurement in the currently opened and active 3D view of the workspace. The volume measurement will be displayed in the center of this view.

View ▸ 3D View – Open a 3D view of the volume measurement object.

Visible –Toggle visibility of the area measurement.

*Toggle the visibility of all measurement objects in the view by enabling or disabling the layer for **Measurements** in the **Visibility Settings**.*

Delete – Delete the volume measurement object.

Rename – Rename the volume measurement object.

Properties –Open the properties dialog of the volume measurement object.

5.4. Properties

Access the properties of a volume measurement object from its context menu.

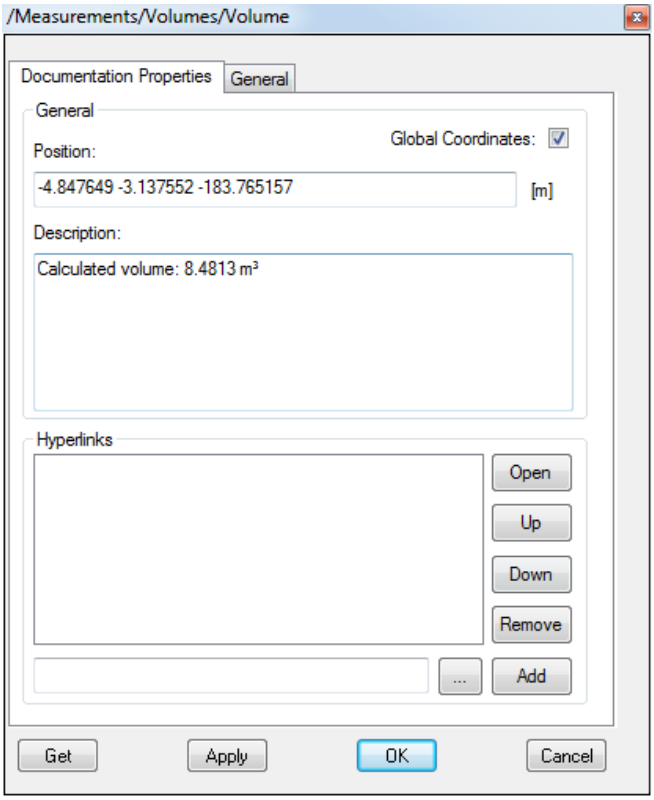

Figure 5-7: Properties

This properties dialog is similar to the properties dialog of a documentation object.

Position - The position of the center of the volume.

Description - Information about the calculated volume. You may edit this information.

Hyperlinks – Add hyperlinks to web sites, local or shared documents.

For more information, see the properties dialog of the documentation object in the SCENE or SCENE LT manual.

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