VirtuSurv
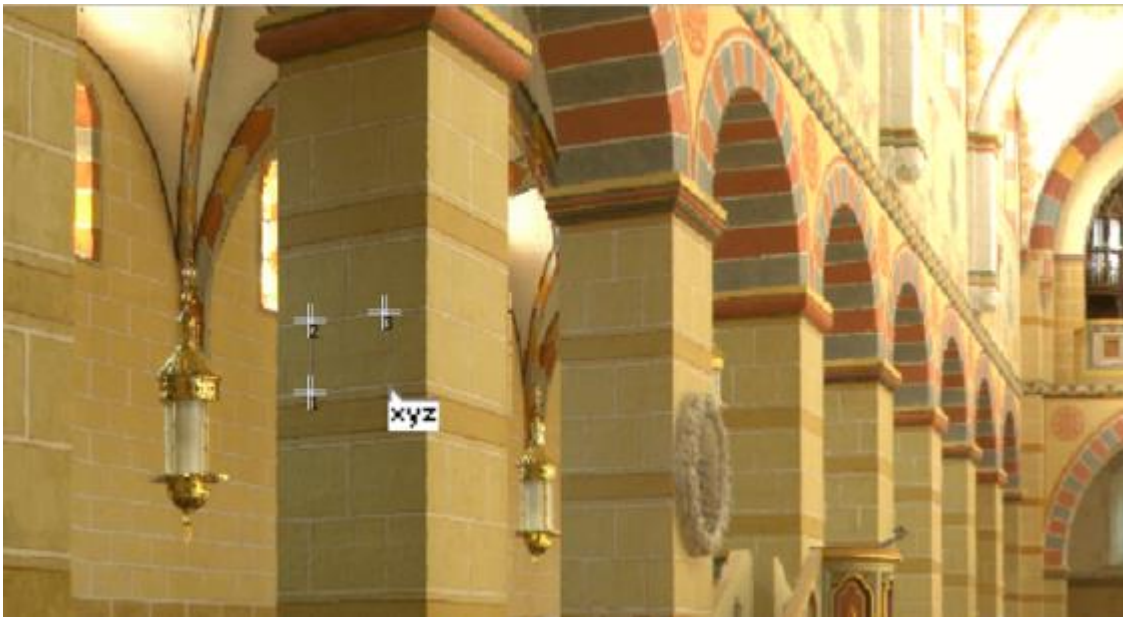
Elegant interaction with laser scan data

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VirtuSurv 2018.0

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A few Words concerning this Manual

Dear VirtuSurv users,

We would like to thank you for the trust you put in us and wish you lots of success in your daily work with VirtuSurv.

You can rest assured that we have done our best to develop VirtuSurv into a system that enables you to much more easily complete your tasks.

In order to guarantee the best introduction into how VirtuSurv works this manual contains multiple examples that will demonstrate and explain the possibilities available to you when using this FARO product. At the beginning of this manual you will find instructions on installation and licence management. You are then introduced to working with VirtuSurv. The user interface is described in detail and the various functionalities for processing laser scan data with VirtuSurv are explained. You will get to know how you can customise VirtuSurv for your particular tasks.

Please don't be afraid when you have questions or problems to take advantage of our support team. Your questions and advice concerning VirtuSurv are important to us and always welcome. A system like VirtuSurv depends on the ideas and creativity of its users.

On this note, we are looking forward to working with you and hope you enjoy working with VirtuSurv.

Contents

1 What does VirtuSurv do?

VirtuSurv is a standalone Windows application for displaying and the evaluating 3D laser scanner data from all common scanner manufacturers, with and without the use of CAD. Thanks to the optimized format even large scan projects are displayed fast and without waiting time. Different photo-like display modes allow an intuitive orientation within the scan and help with the analysis of the scanned object.

The project management of VirtuSurv enables the combination of scans of different types in one project, if they have been referenced in the same system. Among the basic functions are the measurements of point coordinates and of distances between two points in the scan project. The distance measurement can be done across the boundaries of single scans.

In addition it is possible to export complete projects, scans or of parts of the displayed data as point clouds.

Thanks to a direct connection, coordinates and distances can be measured in the scan and simultaneously transferred into any Windows application. This allows to fill Excel tables, data bases or forms with information from laser scan data and to send geometric information into any CAD system.

VirtuSurv provides macros for sending data to Windows (e.g. Excel or Rhinoceros 3D), AutoCAD (LT) or BricsCAD that speed up the evaluation of laser scanner data and allow a fast and easy start in working with VirtuSurv and your familiar software. With the help of the editor the macros may be customized at will. The experienced user may also create his own macros in order to optimize his evaluation. Once you have defined your macros, you will not have to switch between VirtuSurv and the target application anymore.

With a special set of commands VirtuSurv supports processing laser scan data in Revit.

With the function for creating a coded field book, VirtuSurv takes on the established role of the surveyor. It addresses users who have, so far, observed their objects coded with a total station, in order to automatically generate a finished drawing with the help of the codes when importing the measurement data into their CAD system. Now these users may also use laser scanner data in order to create their coded point lists, their field book.

With VirtuSurv drawings may be generated from laser scans fast and easy without having to load the large and ponderous point clouds into the CAD system.

The software may be used anywhere where measurement data are to be generated from laser scans, e.g.:

- As built documentation for the conservation of historical monuments, buildings and architecture
- Measurements for window construction, interior fitting, etc.
- Survey of technical plants

- Archaeological excavation documentation
- Accident and crime scene documentation
- Conservation of evidence

2 Installation of VirtuSurv

The installation of VirtuSurv consists of a number of steps which have to be carried out in sequence. Administrator rights are required for the installation.

2.1 System requirements

VirtuSurv works on Windows 7, 8, 8.1 and 10. We recommend using a computer with a 64 bit operating system, at least 2.5 GHz processor and a minimum of 8 GB RAM.

2.2 Installation

The current setup files of VirtuSurv can be downloaded from the internet site:

setups.faro3dsoftware.com

Please run the setup file by double clicking and following the instructions of the installation program.

If you want to use the function for sending data and commands to AutoCAD (LT) or to BricsCAD make sure you read and observe the relevant instructions.

2.3 Installation of VirtuSurv's AutoCAD plug-in

Before you can use VirtuSurv's AutoCAD macros, you need to load a small plug-in to AutoCAD. This is done automatically during the VirtuSurv setup. Please ensure that AutoCAD is installed **before** you run the VirtuSurv setup and enable the "Install AutoCAD receiver" option in the according setup dialog. Note, the dialog will only be displayed if AutoCAD has already been installed.

If you use more than one version of AutoCAD on your computer, please select the version you want to use together with VirtuSurv when you are prompted to.

2.4 Installation of VirtuSurv's BricsCAD plug-in

Before you can use VirtuSurv's BricsCAD macros, you need to load a small plug-in to BricsCAD. This is done automatically during the setup process, if BricsCAD is already installed on your computer.

If you want to insert the plug-in later, please go to the installation folder of VirtuSurv (e.g. C:\Program Files\FARO\VirtuSurv v2018.0.0.26986 English) and there under \Receiver_Setups run the DrawToBricsCAD_receiver_setup.exe with administrative rights.

The plug-in should now be properly installed and will be present when BricsCAD is started.

2.5 First Start up of VirtuSurv

Start VirtuSurv. If you have a valid license, you may now start working with VirtuSurv. **Chapter 3** of the manual will give you an introduction.

The licence status can be accessed using the licence manager 🔒 in the "Help" menu.

If you do <u>not have</u> a valid licence, you may use VirtuSurv in **Viewer mode**. In Viewer mode you may: import and export scan data and measure coordinates and distances. You need a licence for sending coordinates and commands into other software packages.

If you would like to **try** VirtuSurv (full version) please select a trial option in the licence manager. The free trial lasts several days. If you want a trial extension, please contact FARO or a FARO reseller.

A detailed description of VirtuSurv license management can be found in the [Knowledge Base](#).

If you own a network license, please read the according FARO [Knowledge Base article](#).

3 Working with VirtuSurv

This chapter introduces you to working with VirtuSurv. First you will learn how to import and open scan data and then you will get an overview of the user interface of VirtuSurv. The following chapters will explain how to use the functions of VirtuSurv for evaluating laser scans, how to import data and how to generate a new project. Lastly, you will learn how to export scan data into point clouds.

3.1 First steps - opening scan data

We have prepared a sample project in order for you to immediately be able to try and get to know VirtuSurv. You can find it under following web link: http://download.faro-3d-software.com/VirtuSurv/Examples/. You may also start VirtuSurv and hit the 🐞 icon in the Welcome screen to access this website.

Download the EXAMPLE02_KUBIT_HOUSE_FIVESCANS.ZIP file. Save it to your computer and then decompress it.

Start VirtuSurv. In the Welcome dialog click on "Open existing project" 📂. The dialogue box for the selection of VirtuSurv scan files (PVS) or project files (PVP) will open:

VirtuSurv
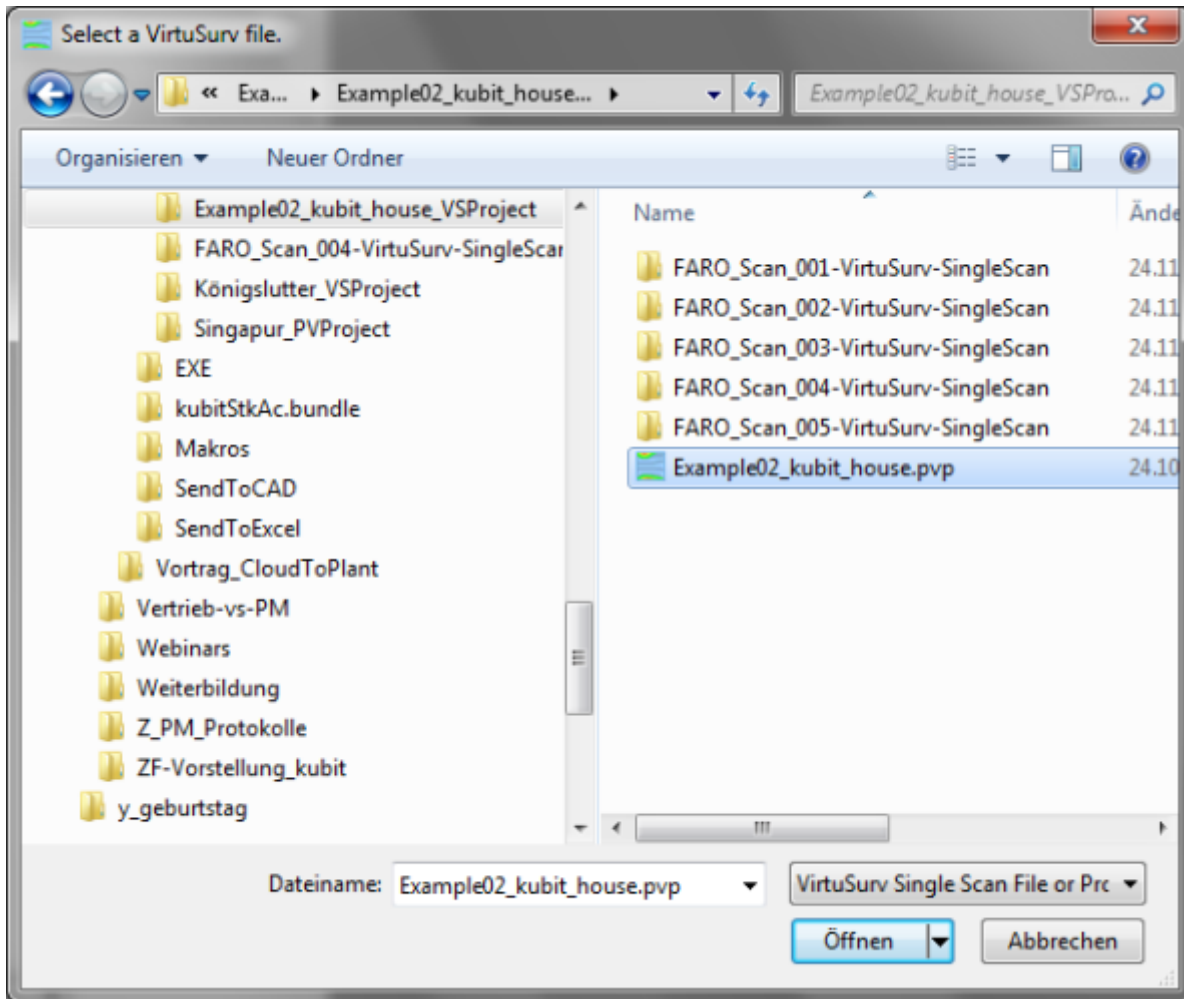
Browse to the place, where you have saved the example from the internet. Move to the project directory EXAMPLE02_KUBIT_HOUSE_VSPROJECT, select the EXAMPLE02_KUBIT_HOUSE.PVP file and click [Open].

Now open the view of the third scan. In order to do so select the FARO scan 003 from the Project Explorer, click the right mouse button and select the "True color (RGB)" option from the context menu.
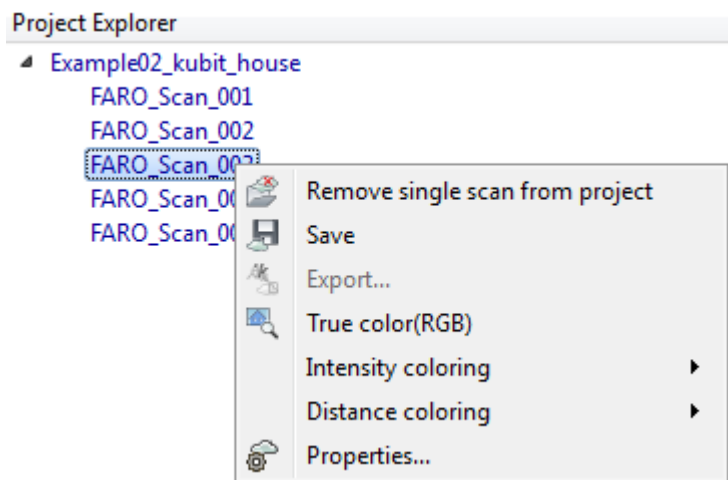
A window with the coloured scan of a living room will now be opened within the main window.

Use the mouse wheel for zooming in or out. For panning press down and hold the mouse wheel. The mouse pointer will turn into a hand. If, for any reason, the pan function of your mouse should be inactive, please use Ctrl + right mouse button as alternative.

Open the remaining scans from the sample project. **Hint**: With short cut keys such as "Ctrl + A" or "Shift or Ctrl + left mouse button" you may select all or multiple scans for opening them.

Now you are ready to familiarise with the user interface and to try out the first functions such as the distance measurement.

3.2 The user interface

In this chapter you will get to know the user interface of VirtuSurv with its different components.
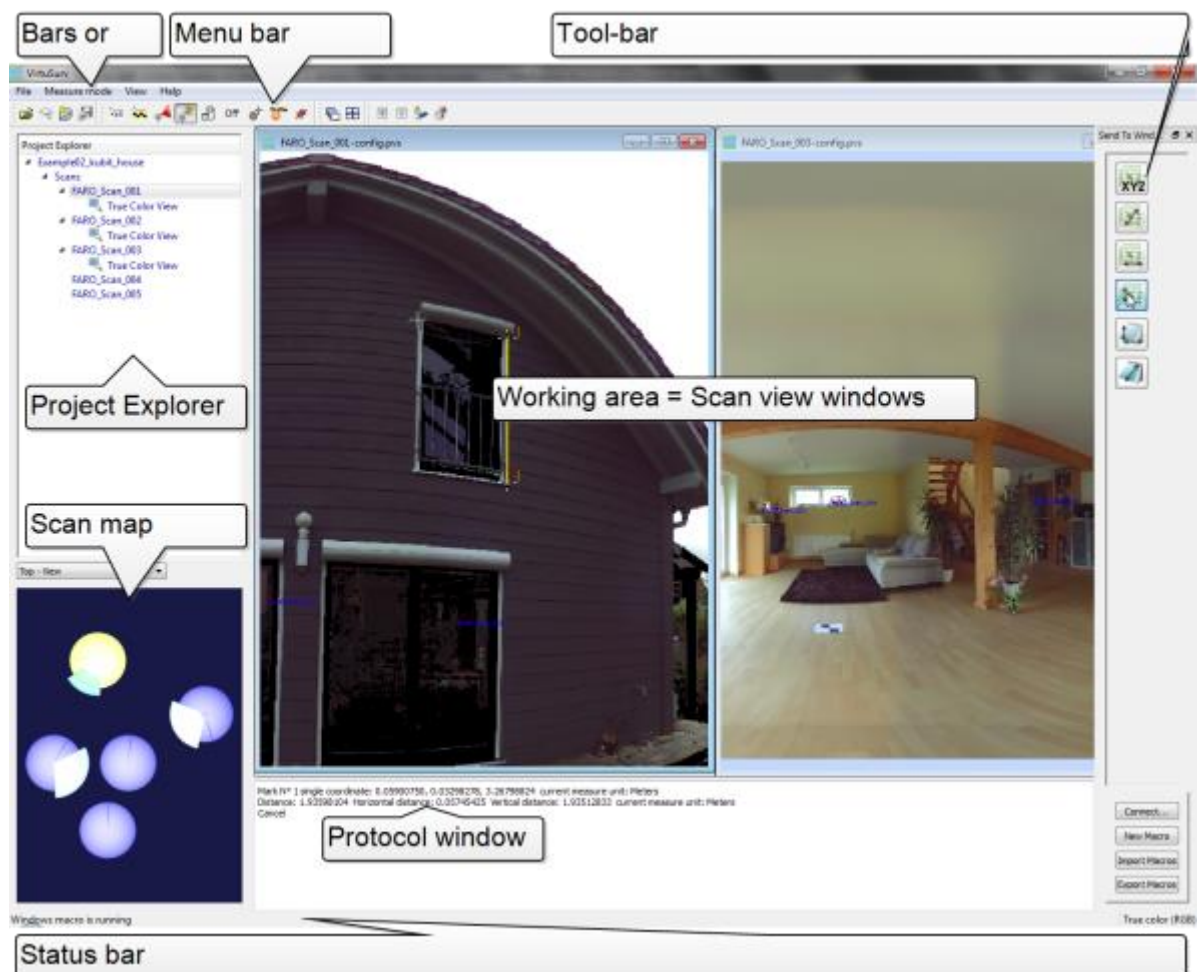
3.2.1 The menu bar

As usual you will find the menu bar in the top area. It contains in four menus, all of the general VirtuSurv commands.

In the "File" menu you will find commands for opening, importing, saving and creating projects. The "Measure modes" menu provides all commands for the measurement and evaluating the scans. Via the "View" menu you may control the display of the tool-bars as well as the arrangement of the scan windows. You will also find a button for closing all scan windows. In the "Help" menu you will find a link to the manual, information regarding VirtuSurv, the licence manager for the licence configuration and a link to the download page for sample files and additional useful macros.

3.2.2 The tool-bars

For fast access, the tool-bars with the most important general commands have been placed directly underneath the menu bar. You may show or hide these via the "View" menu. You may also release the tool-bars from the upper frame and place them floating or attach them to any other frame. To do so simply move the mouse over the point line at the left edge of a tool-bar, when the cursor turns into a cross of arrows, press and hold down the left mouse button until you have moved the bar to the desired position.

3.2.3 The Project Explorer

The Project Explorer is situated left of the main window. The scan project that has been loaded and its single scans are listed here in a structure view. Only *one* project can be opened at a time. Single scans always belong to a project.

When selecting a scan in the Project Explorer (click with the left mouse button) the corresponding scan view is activated in the working window and where applicable put to front. The active scan will also be highlighted in the scan map.

By clicking the right mouse button you can open context menus with project-specific, scan related or view related commands. Following, these context menu commands are explained briefly.
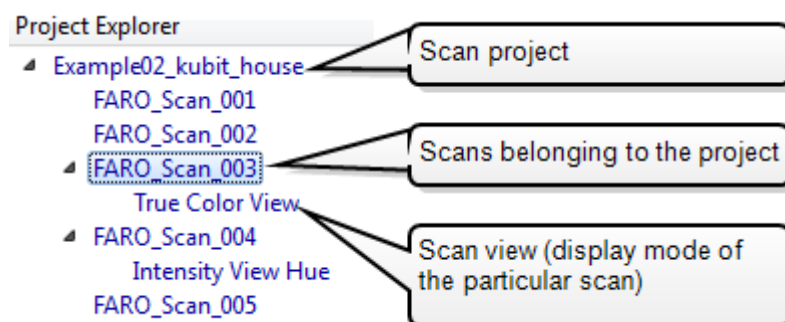
Context menu of the project
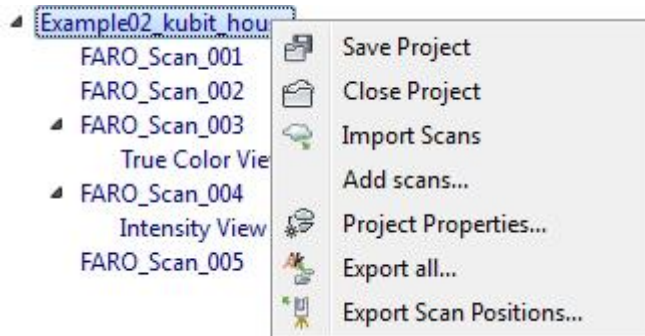
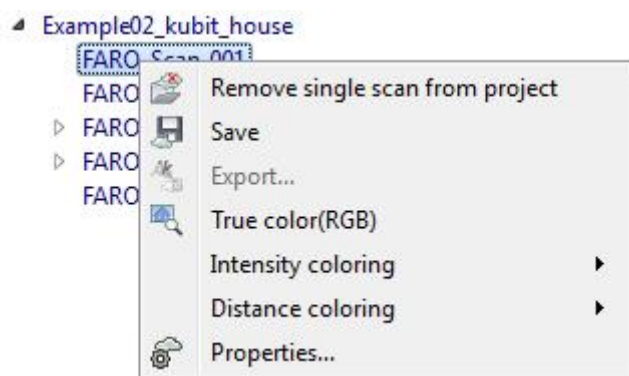The context menu of the project contains the commands for saving and closing the project as well as for adding scans, which can likewise be found within the "File" menu. Furthermore you can check the project properties (project name, path and number of scans) and *export the complete project into one or several point clouds (LAS, PTS or PTC).* You can find more information regarding exporting to point clouds in chapter **3.7** .

With "**Add Scans**" you may add multiple single scans that already exist in VirtuSurv format to your project. A dialogue box opens. There you click the [Add scans from directory] button and simply browse to the directory where the scans you want to add are stored. VirtuSurv will list all single scans it found there. You may now select all or just some of the scans and add them to your new project by clicking [OK].

With **"Export Scan Positions"** the scan positions of the whole project can be exported to a TXT or CVS file. This export is matched to be used in combination with FARO PointSense and As-Built products, but it is also helpful for creating a scan map outside VirtuSurv.

Context menu of a scan

The context menu of a single scan contains commands for saving and removing a scan from the project. You can check the properties of the particular scan. You can export *the complete scan or marked parts of it into a point cloud file (LAS, PTS or PTC)* with the export command. You will find more information regarding this command in chapter **3.7** .

The most important commands in the context menu of a scan are the ones to open the scan in a certain display mode. You may select one of the following display modes:
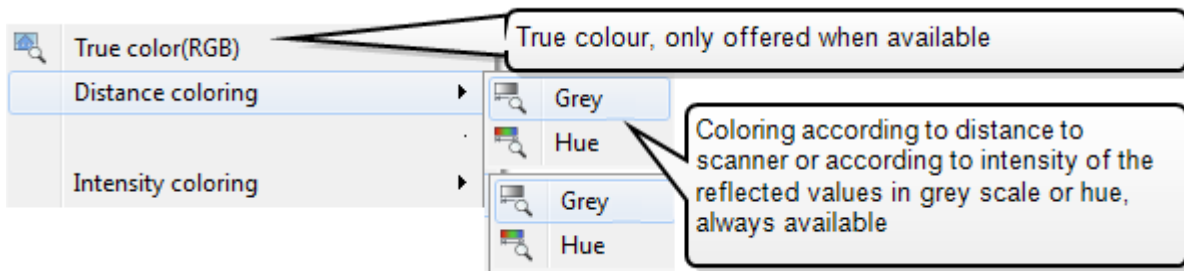
Clicking on one of these entries opens the scan and shows it correspondingly in the scan view window.

Hint: With short cut keys such as "Ctrl + A" or "Shift or Ctrl + left mouse button" you may select all or multiple scans for opening them.

Context menu of a scan view

The context menu of a scan view includes the command for closing the view and – as long as it is not a true colour view – the histogram stretching command.

3.2.4 The scan map

The scan map is placed below the Project Explorer. It shows the distribution of the scanner positions.
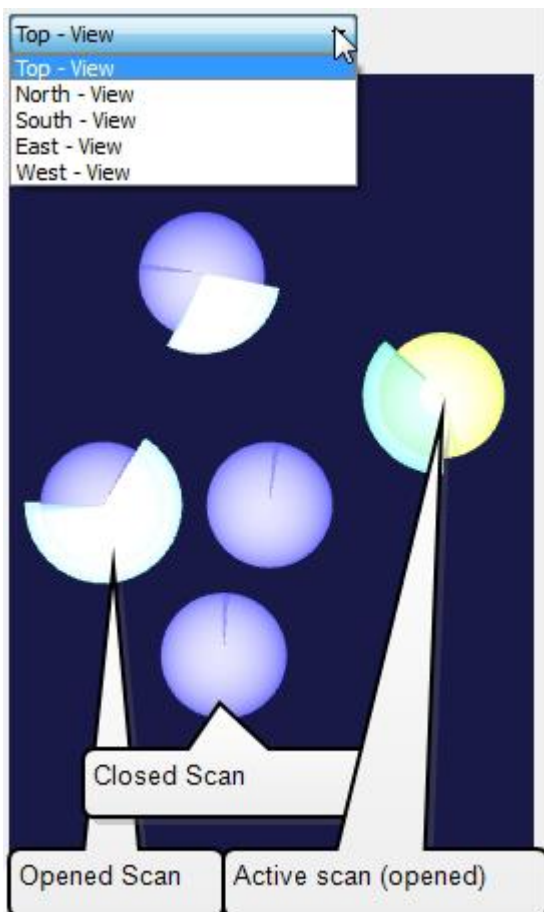
In the scan map you may zoom with the help of the mouse wheel and pan the view by pressing down the mouse wheel.

Via the pulldown menu to the left above the scan map you may switch from the top view to another view. This is useful for projects, where the scans are not only spread horizontally but also vertically.

The active scan is highlighted. Click on a scan to put it to front in the working window or to open it.

For all scans opened in a view window the currently visible area is outlined in the scan map.

3.2.5 The working window

The working window is the central element of the user interface of VirtuSurv. The scans for evaluating are displayed here. Via the context menu of the scan you determine how it shall be displayed (see chapter **3.2.3**).

When several scans have been opened you may arrange the scan view windows manually or - with the help of these buttons - automatically. If the full screen mode is active, use the scan map or the Project Explorer for putting the desired scan forward.

Use the mouse wheel in order to zoom in or out. For panning press down and hold the mouse wheel. The mouse pointer will turn into a hand. If, for any reason, the pan function of your mouse should be inactive, please use the Ctrl + right mouse button instead.

You may change the size of the working window to the left, right, top or bottom. Move the mouse over the according grey edge until the mouse pointer changes . Then press down the left mouse button and move the edge to the desired position.

3.2.6 The protocol window

Measured distances and coordinates are displayed in the protocol window. Macros used for the measurements are also recorded here.

3.2.7 The status bar

The status bar is placed at the lower edge of the VirtuSurv window. On the left you see which measure mode is active at the moment. Information regarding the current view mode of the currently active scan can be seen at the very right.

3.2.8 Windows for macros and special commands

In addition to the so far described components of the user interface, windows for macros and special commands are opened according to the selected measurement or evaluation mode. By default these are attached to the right edge of the VirtuSurv window, but they may be detached from the edge and moved to another position manually. This is especially useful for users working with two screens.

In chapter **3.3** the different windows for macros and special commands are described in detail.

3.3 Evaluating with VirtuSurv

This chapter introduces you to the possibilities for the evaluation of 3D laser scan data with VirtuSurv. Please feel free to use the sample data set, which you have opened according to chapter **3.1** of this manual.

Before the functions are explained in detail you will get some general information.

3.3.1 Measurement unit, accuracy, etc

When importing scan data (see chapter **3.6**) you will have to enter in which unit of length you have scanned. Independent of this scan unit at import, you can state the measurement unit which you want to use for the measurements in VirtuSurv. VirtuSurv will automatically convert all measurement values into this unit.

Use the "**Configure Measurement Unit**" 🔧 command from the "Measure mode" menu in order to set the measurement unit. The following dialogue box opens, next to the unit you can state the display accuracy, the decimal separator and also the thousands separator here.
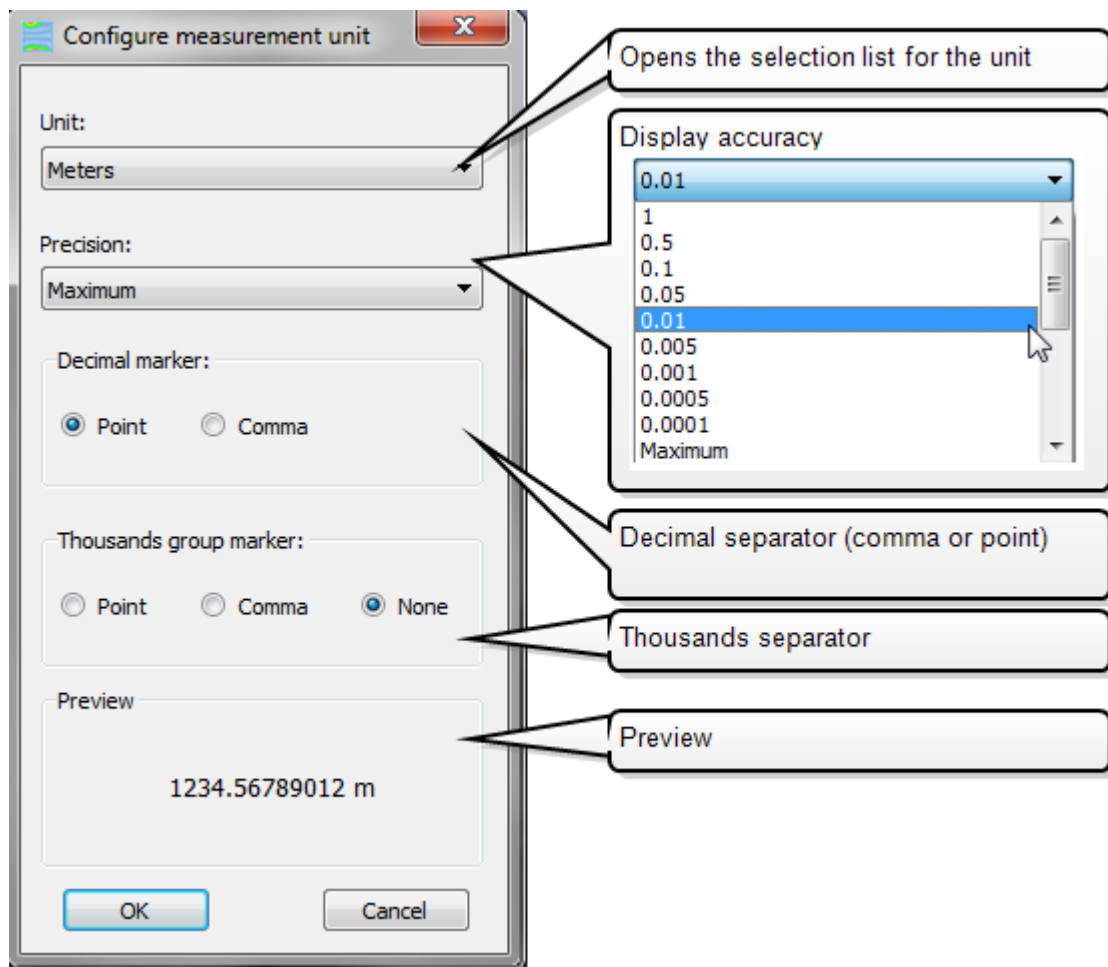
The settings which you set here will affect *all* measurement modes. When sending the measured values to AutoCAD (LT) or BricsCAD always the maximum measurement accuracy is transferred.

Important information:

The accuracy of the evaluation of scan objects depends on the quality of the scans that means, from their resolution, the quality of the registration as well as the quality of the colouring of the scans with RGB colour values. Especially when colouring the scans, the results of the scanner manufacturers are very different regarding the quality. Therefore we recommend to switch from the attractive true colour (RGB) display to the display of intensity values in grey scale when the measurement accuracy is especially important during the evaluation. In order to switch the *display mode for a scan*, go to the Project Explorer move to the context menu of the scan and select the desired view. If you would like to adapt brightness and contrast move to the option "Histogram stretching" via the context menu of the scan view. (See chapter **3.2.3**).

If *highly reflective surfaces have been scanned* too, the coordinates, which are measured on these surfaces, are often wrong, since the distance measurement of the scanner provides falsified values for such surfaces. You will be able to recognise reflecting surfaces in the true colour view and the intensity view, but not, whether the distance measurement of the scanner is incorrect. You can only see that in the distance colouring view. Switch to the distance view if you are unsure whether measurements on reflecting surfaces are still providing correct results. If there are colour or grey scale bounds distinguishable in the continuous surface you should not take any measurement values from this surface.

If you measure in the true colour view and do *not get a measurement value for t*he clicked point *th*en the reason for this is that there is image information from photos but no object data for this point. That happens, for example, for highly absorbent surfaces, which swallow the laser signal, for the sky or for distant points, which lie outside of the scan range. In the distance view such areas without scan information are immediately visible as gaps in the image.

Hints:

Measured points are labelled by a marker (cross) in the scan. The appearance of the marker illustrates with the help of which measurement tool the respective point has been measured.

With the "**Configure Markers**" command from the "Measure mode" menu you may determine the size, the start value for numbering the markers as well as the font size and colour of the point numbers:
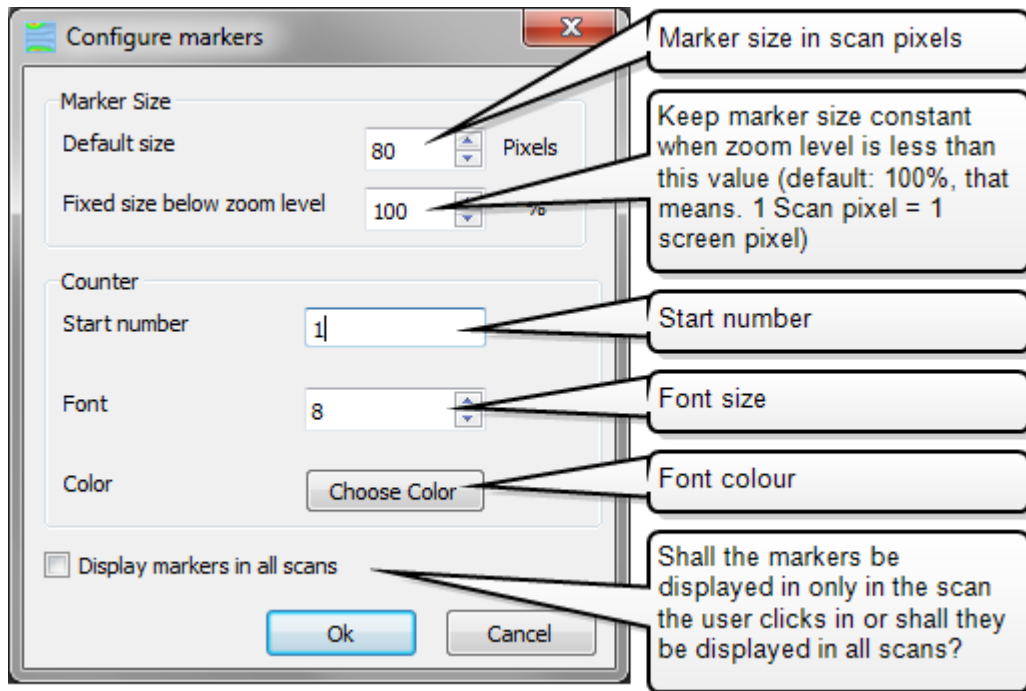
Caution: When you enable the "display markers in all scans" option the performance of VirtuSurv may slow down. The setting will only be valid for the points clicked after enabling.

After taking many measurements the number of markers in the scan view could become very large and clarity gets lost. Use the "**Delete Markers**" ⚡ command from the "Measure mode" menu in order to *delete all markers* from the scans.

If you want to finish a *measurement mode* without activating another measurement mode, simply click the ᴼᶠᶠ button in the tool-bar or in the "Measure mode" menu.

3.3.2 Measuring point coordinates

If you want to know the coordinates of one or a few points just for informational reasons run the "**Get Coordinates**" 🔲 command from the "Measure mode" menu and click the desired point/s in the scan. The clicked points are marked 🔲 and the according coordinates are displayed in the protocol window.

Mark N° 2 single coordinate: 2.360; -4.990; 0.968 current measure unit: Meters
Mark N° 3 single coordinate: 2.008; -4.485; 0.968 current measure unit: Meters
Mark N° 4 single coordinate: 1.871; -5.675; 0.968 current measure unit: Meters
Mark N° 5 single coordinate: 2.155; -7.132; 0.887 current measure unit: Meters
Mark N° 6 single coordinate: 2.221; -6.511; 0.967 current measure unit: Meters

You may change the measurement unit and the accuracy of the display with the "Configure Measurement Unit" 🌼 command. (See chapter **3.3.1**).

If you want to generate a *coordinate list* for further application, it is best to use one of the provided "Send to Windows" macros 🪟 , e.g. 🔲. You find detailed information regarding these macros in chapters **3.3.4** and **3.4** .

Do you have a CAD system that can generate a drawing with the help of coded points? Please refer to chapter **3.3.10** in order to learn how to generate a coded coordinate list with VirtuSurv.

3.3.3 Measuring distances

You want to take a distance from a scan, quickly? Run the "**Get Distance**" command from the "Measure mode" menu. Then click the end points of the distance to be determined. The clicked points and the connecting line will be marked and the slope distance as well as the horizontal and vertical distance of the points is displayed in the protocol window:

Mark N° 6 single coordinate: 2.221; -6.511; 0.967 current measure unit: Meters
Distance: 1.897 Horizontal distance: 1.801 Vertical distance: 0.596 current measure unit: Meters
Distance: 1.796 Horizontal distance: 1.796 Vertical distance: 0.003 current measure unit: Meters
Distance: 2.143 Horizontal distance: 0.048 Vertical distance: 2.143 current measure unit: Meters
Distance: 2.154 Horizontal distance: 0.026 Vertical distance: 2.154 current measure unit: Meters

You may change the measurement unit and the accuracy of the display with the "Configure Measurement Unit" command . (See chapter **3.3.1**).

Hint:

You may measure the width <u>and</u> height of a window with only <u>one</u> measurement (two clicks), by clicking the end points of the window diagonal. Simply try it.

```
Distance: 2.143 Horizontal distance: 0.048 Vertical distance: 2.143 current measure unit: Meters
Distance: 2.154 Horizontal distance: 0.026 Vertical distance: 2.154 current measure unit: Meters
Distance: 0,55 Horizontal distance: 0,55 Vertical distance: 0,05 current measure unit: Meters
Distance: 1,90 Horizontal distance: 1,80 Vertical distance: 0,60 current measure unit: Meters
Distance: 1902.55 Horizontal distance: 1805.50 Vertical distance: 599.85 current measure unit: Millimeters
```

You would like to use the measured distances in other Windows programs, e.g. in order to sum them up or to fill in forms? Please refer to chapters **3.3.4** and **3.4** in order to learn how to use provided macros and your own customised ones.

3.3.4 Filling in forms, tables, data bases, etc

Use the "Send to Windows" command from the "Measure mode" menu if you want to get coordinates of discrete points such as:

- Excavation finds (archaeology),
- Trees for the tree cadastre
- Connection points of industrial plant components
- Power sockets, signs, hydrants, telephone booths, etc.

or distances such as:

- Width and height of windows, doors, etc.
- Clearances, spaces
- Wall lengths etc.

from your scan project and transfer them into an information system, into lists, tables or forms. To the right of the VirtuSurv scan window the macro bar for sending to Windows applications opens. You may move the bar and attach it to any other edge. In order to do so click and hold the left mouse button on the head of the bar until you have moved the bar to

the desired position. The macro bar may be closed via the cross in the top right corner of the window or by clicking on the Off button in the tool-bar.

VirtuSurv provides several predefined macros:
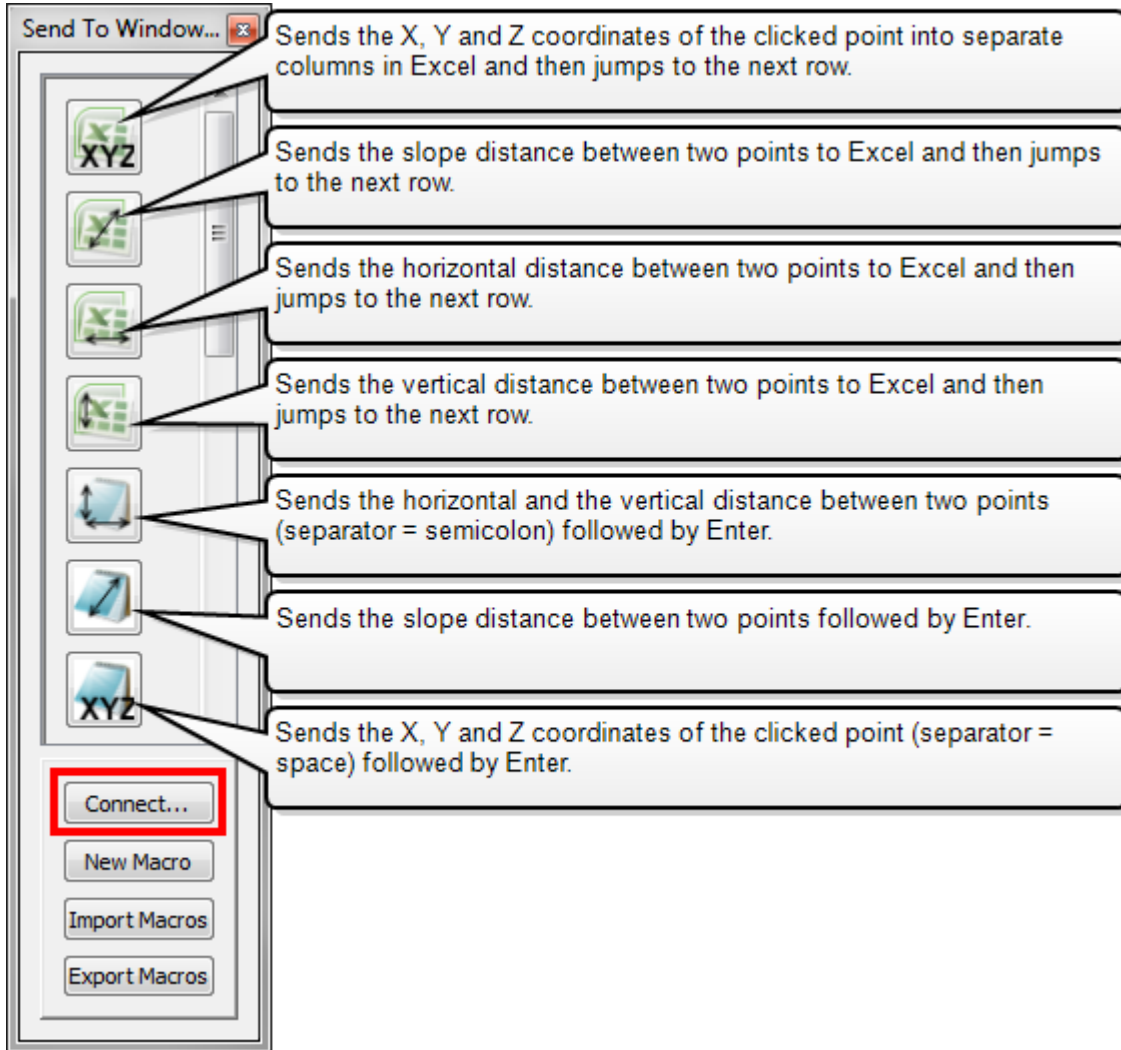
Before you can use the macros, you have to connect VirtuSurv with the Windows application to which you want to transfer the measurement values. Open the target program first. Then click on [Connect…] in the VirtuSurv macro bar. The following dialogue opens:
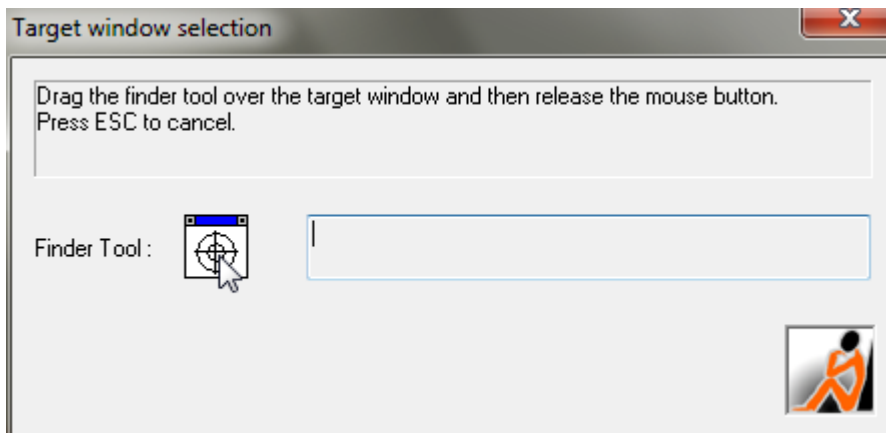
Move the mouse over the cross hairs ("Finder Tool"). Click and hold the left mouse button. Drag the cross hairs into the window, into which you would like to transfer the VirtuSurv measurement values. The recognised application is displayed in the dialogue box. Release the mouse button. VirtuSurv now reports successful connection.

You start a macro by clicking on the appropriate button in the macro bar. Then click the points or distances in the scan which you would like to evaluate. You finish a macro by clicking its button again.

Examples:

Sending coordinates to Excel:

Open an empty Excel table. In VirtuSurv run the "Configure Measurement Unit" command and set the desired measurement unit, e.g. metre. Make sure that the decimal separator has been set to the same as used in Excel.

If you have not already done so open the macro bar by clicking on "Send to Windows" . Then go to **[Connect…]** and drag the cross hairs into the Excel window. Now VirtuSurv and Excel are linked. Start the macro by clicking the button in the macro bar. Now, the coordinates of the points that you click on in one or several scans are written into the Excel table:
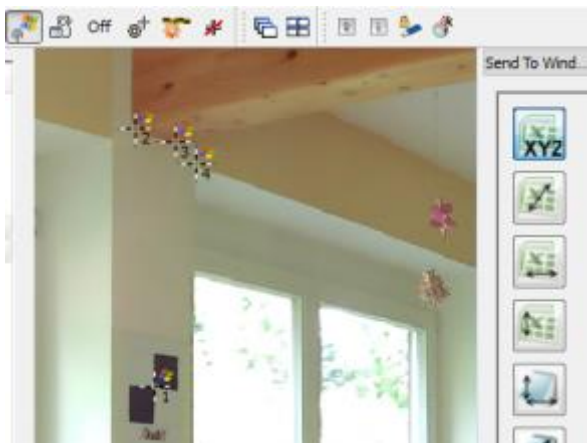
You finish the macro by clicking the button again.

You finish the macro by clicking the button again.

Open the text file and in VirtuSurv the scan project with the windows that are to be measured. Connect VirtuSurv with this file as described above. Start the macro for the sending the horizontal and vertical distances . Click the ends of the window diagonals in order to determine the width and height with only two clicks per window and to write them into a text file.

Window Dimensions

Width;Height

1.809 m; 0.596 m

1.775 m; 2.115 m

1.780 m; 2.110 m

1.765 m; 2.120 m

You finish the macro by clicking the 🔳 button again.

If you would like to measure the distances in millimetres instead of metres, use the "Configure Measurement Unit" command 🔧 , that is described in detail in chapter **3.3.1**.

Summing up distance lengths

You may also send distance lengths to the Windows calculator and add them up or subtract them from each other. In order to do so start the Windows calculator and link it to VirtuSurv as described above. Make sure you have set the desired measurement unit.

Try out the different macros with the sample project you have downloaded in chapter **3.1** or with your own scans.

In chapter **3.4 Optimised evaluation – customised macros**, you will learn how to *customise macros and create your own*.

3.3.5 Sending observations to the clipboard

With VirtuSurv you can send direct to the clipboard coordinates of discrete points or distances you have obtained from your scan project and then with Ctrl+V insert them back into any Windows application. In this way, other than with the other measurement modes, observed data can also be inserted into dialogue windows within the program. This is an extremely flexible function.

"Send to clipboard" 🔳 is started from the "Measure mode" menu (under "Send to other systems"). On the right hand side of the VirtuSurv window the macro bar opens with the

macros for sending information to Windows clipboard. You may move the bar and attach it to any other edge. In order to do so click and hold the left mouse button on the head of the bar until you have moved the bar to the desired position. The macro bar may be closed via the cross in the top right corner of the window or by clicking on the Off button in the tool-bar.

VirtuSurv provides several predefined macros:

You start a macro by clicking on the appropriate button in the macro bar. Then pick the points that you need in the scan, switch to the target program of your choice, click in the desired dialogue field and insert the measured value using Ctrl+V.

You finish a macro by clicking its button again.

In chapter **3.4 Optimised evaluation – customised macros**, you will learn how to *customise macros and create your own*.

3.3.6 Drawing with any CAD system

VirtuSurv enables you to directly draw in CAD systems using the points and distances you measure in the scan project, without ha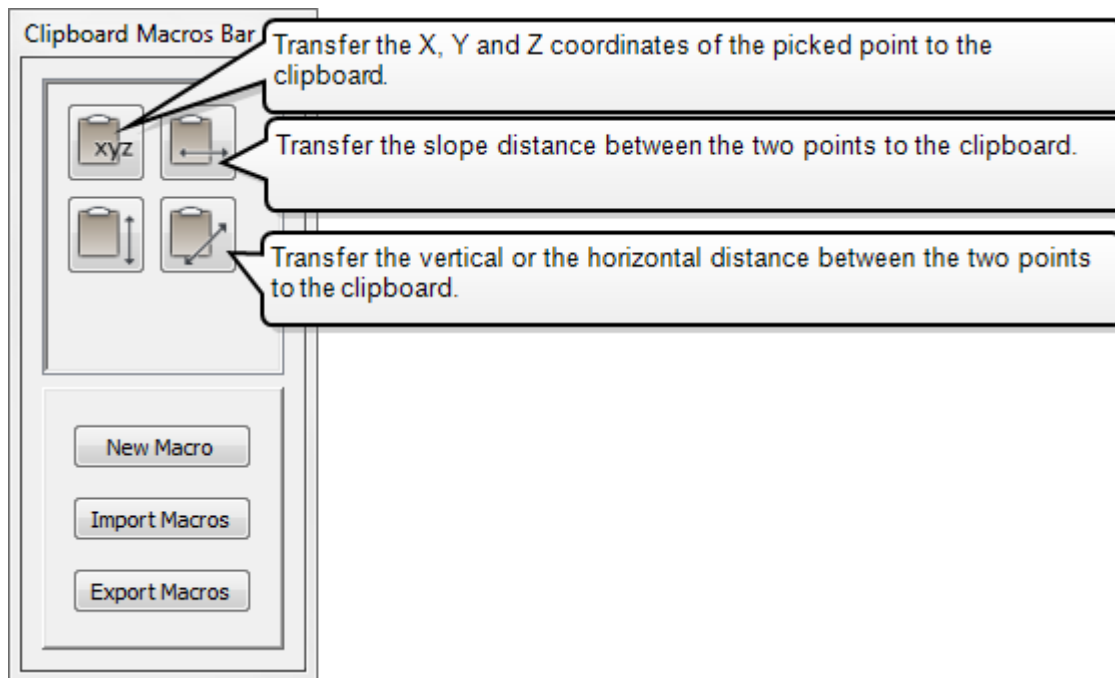ving to load the large ponderous data sets as point clouds into your CAD system. This way you can even evaluate laser scans in CAD systems that do not support point clouds.

As described in chapter **3.3.4** VirtuSurv can be connected to any CAD system, which is capable of receiving data by "copy and paste" – usually those CAD systems do have a command line (e.g. Rhinoceros 3D, IntelliCAD, etc.). In order to draw, you start the relevant command within the CAD system. The command will generally expect the coordinates of a point as input. In VirtuSurv you start a macro which *provides the point coordinates in the format expected by your CAD system* and click the respective point in the scan. This way you

can draw ground floor plans, views and sections in CAD and model them in 3D. Even drawing commands, that expect distance lengths as input can be "fed" with the measurement data from VirtuSurv.

The following two predefined macros for sending coordinates into CAD systems are delivered with the "Send to Windows" macro bar .

Caution! The coordinates will not be converted into the user coordinate systems, since there is no bidirectional connection into the CAD system.

We provide further useful macros on a special website which you can access via the "Download Examples & Macros" entry from the "Help" menu or the icon within the tool-bar.

In chapter **3.4 Optimised evaluation – customised macros**, you learn how to *customise macros and create your own*.
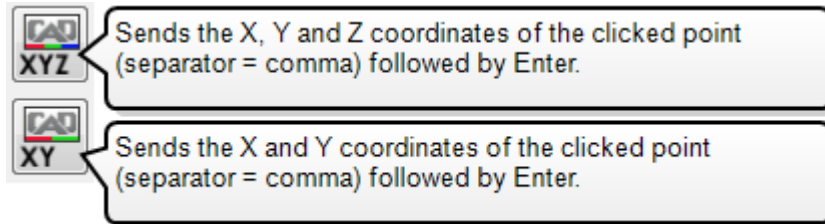
Tutorial – Modelling with VirtuSurv and Rhinoceros 3D [1]

This tutorial explains how you can use VirtuSurv together with Rhino 3D for constructing geometric objects directly from the laser scan data. The macros provided speed up the processing in Rhino and exemplary demonstrate the versatility of the VirtuSurv macro system.

Opening the scan project:

Please load the sample project from the VirtuSurv web site and open it, if you have not done so already. In chapter **3.1** you will find instructions for doing so.

Open the true colour views of scan 3 and scan 5 from the Example02_kubit_house project and change the scan window to full screen. By selecting it in the structure view of the Project Explorer you must ensure scan 3 is at first in front. With the mouse wheel zoom out, so that preferably the complete living room is visible in the scan window (scan_003).

Use the "Send to Windows" command from the "Measure mode" menu or click on the icon for sending information to Rhino. To the right of the VirtuSurv scan window the macro bar for sending to Windows applications opens.

Importing the macros:

---

[1]Rhinoceros (Rhino) is a product of Robert McNeel & Associates. www.rhino3d.com

VirtuSurv is shipped with some predefined macros for sending coordinates and distances e.g. to Excel (see chapter **3.3.4**). We have also prepared some special macros for working with Rhino. You can find these macros on our web page, which you can access by clicking the 🏆 button in the "Help" menu or in the VirtuSurv tool-bar. Please, download the MACROS_FOR_RHINO.ZIP file. Save it to your computer and uncompress it. Then copy the "RHINO MACROS.TXT" file and the "MacroImages" folder from the folder "Macros_for_Rhino" to your VirtuSurv application data folder. Usually you will find the application data folder here:

„C:\Users\{username}\AppData\Roaming\FARO\VirtuSurv_{versionsnummer}"

To import the Rhino macros click **[Import Macros]** in the lower part of the macros bar. Then browse to "RHINO MACROS.TXT" and click [Open].

The following dialogue box opens:
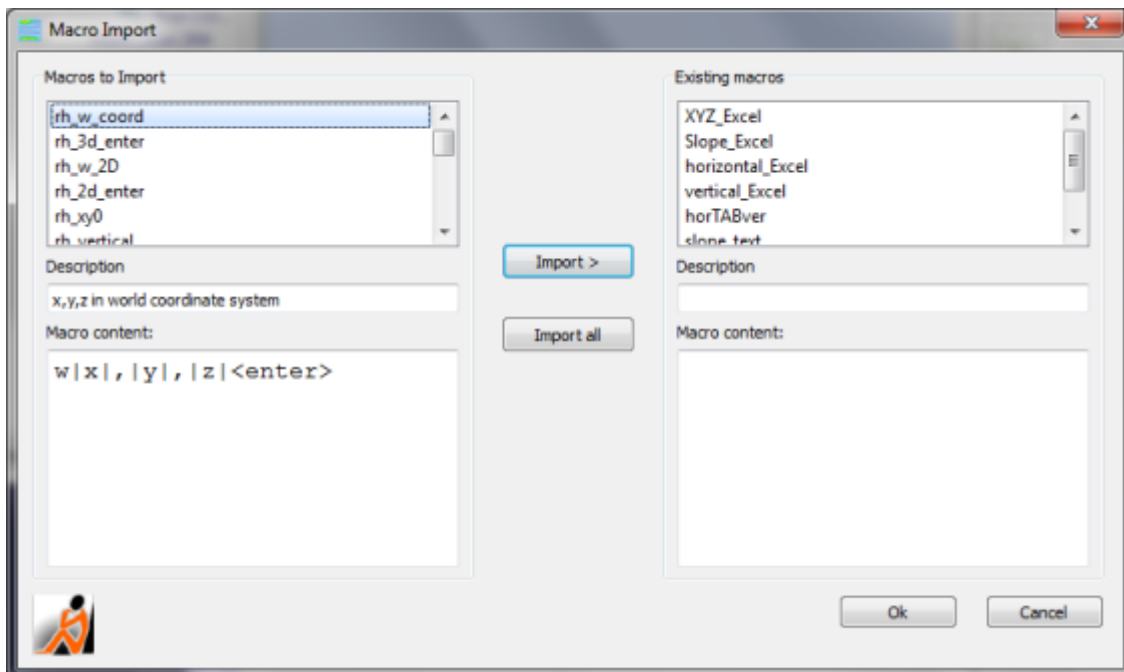
On the left you find the list of the macros for the import, contained in the TXT file, on the right the list with the macros already existing in VirtuSurv. Select the macros you would like to import and then click **[Import >]**. With **[Import all]** you can import all macros at once.

When you have made your choice for the import, confirm with **[OK]**. The predefined Rhino macros are now shown in the macros bar. You may now delete the other Windows macros you do not need, gaining more clarity. To do so, right-click the macro button and select **"Delete the macro"** in the context menu.

The VirtuSurv macros bar should now contain following buttons:
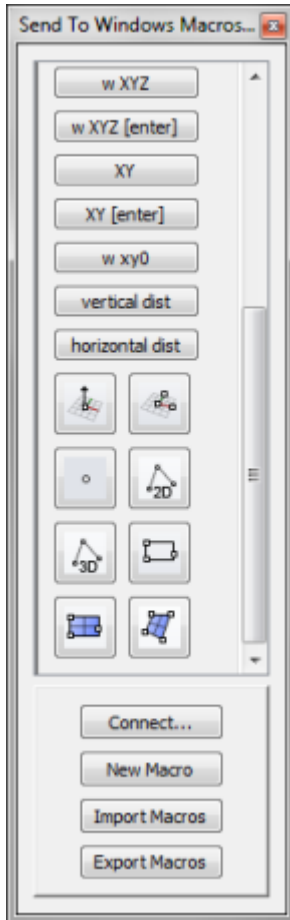
Connecting with Rhino:

In the next step VirtuSurv will be connected to Rhino. First start Rhino and open "Large projects – metres" as the template. Rhino version 5.0 was used for this tutorial.

To get a better overview of both programs we recommend minimising the program windows to half the screen width and arranging them side by side.
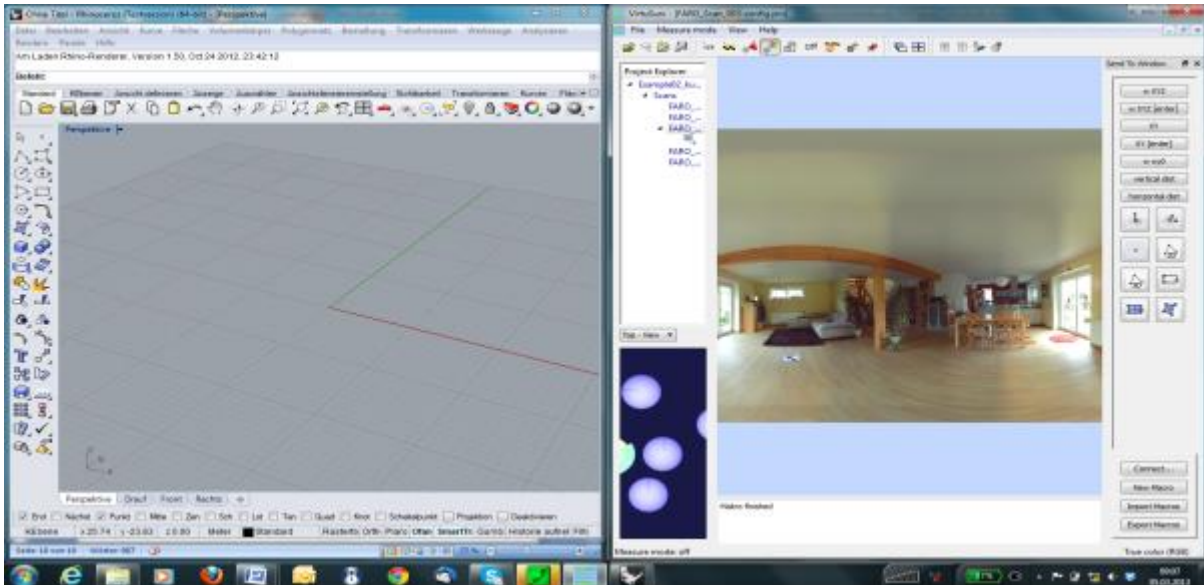
For sending the coordinates to Rhino with the correct units VirtuSurv has to be configured the same as the Rhino settings. In our example we work in metres in Rhino. In VirtuSurv use the "Configure Measurement Unit" command and configure there the units as you want them to be. (See also chapter **3.3.1**). Now also check the unit settings in Rhino at "File Properties Units":
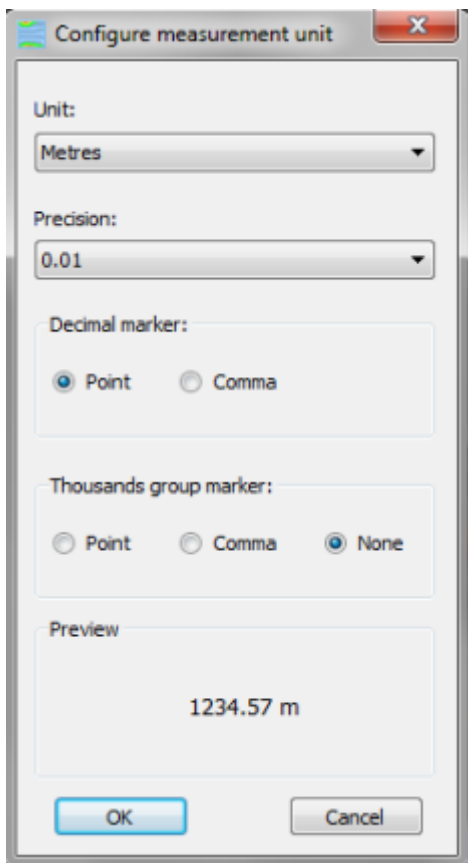
Now also check the unit settings in Rhino at „File → Properties → Units":
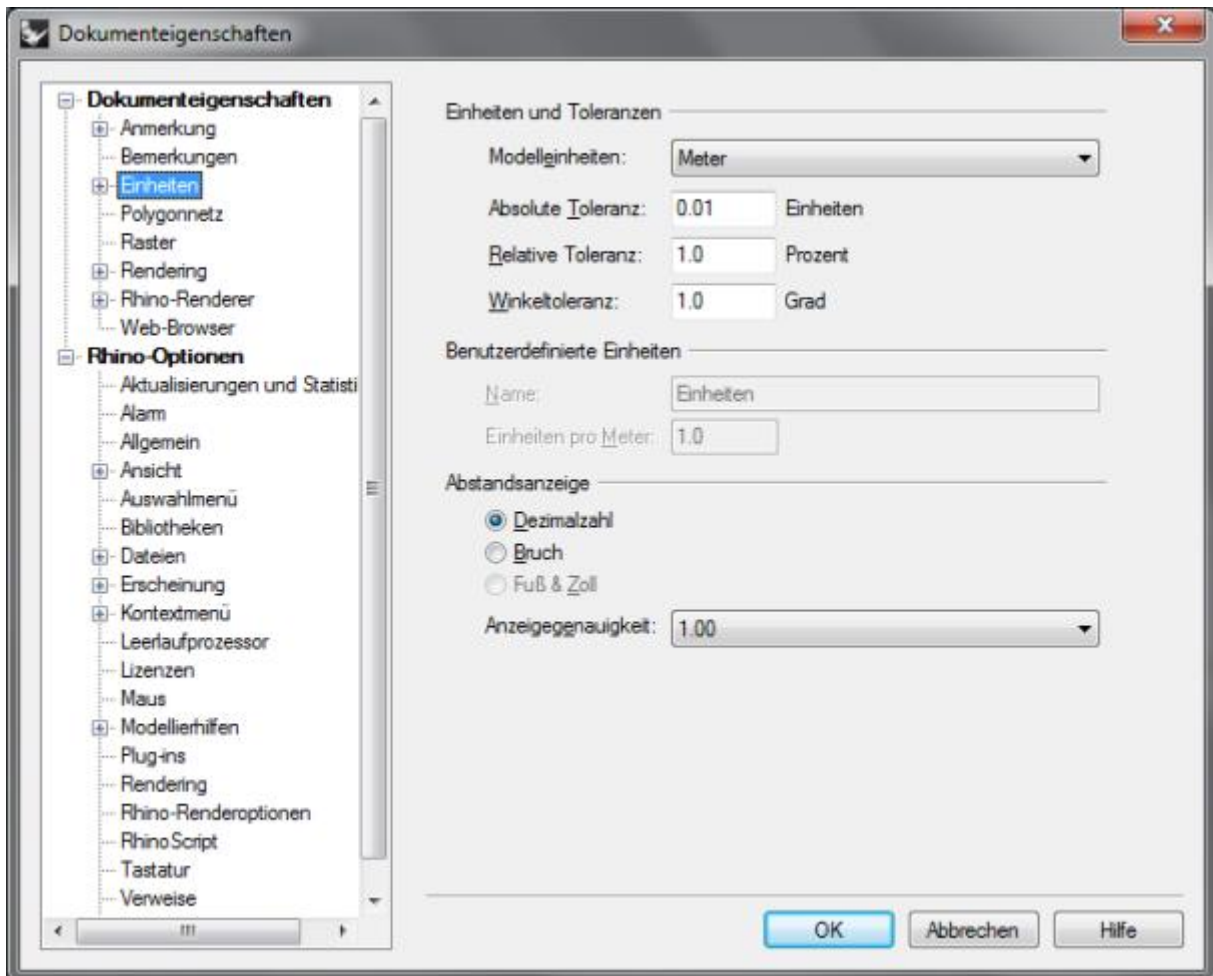
Before you can use the macros, you have to connect VirtuSurv with Rhino. Just click on the **[Connect…]** button in the VirtuSurv macro bar. The following dialog opens:
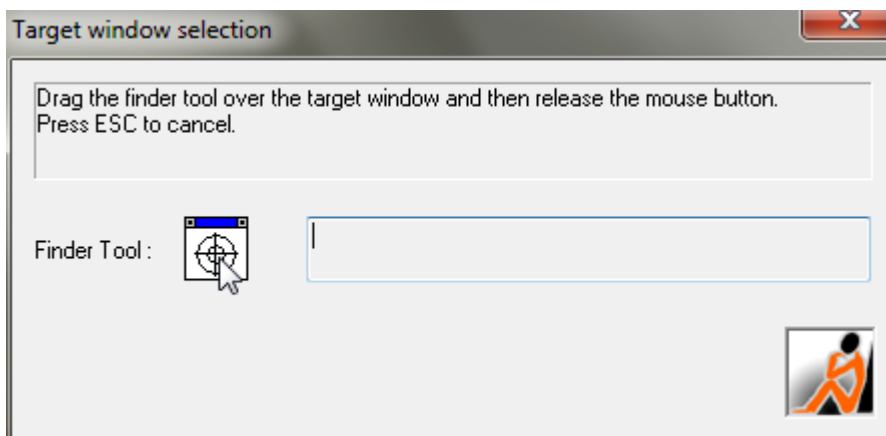
Move the mouse over the cross hairs ("Finder Tool"). Click and hold the left mouse button. Drag the cross hairs into Rhino's command line. The dialogue box confirms Rhinoceros has recognised application. Release the mouse button. VirtuSurv now reports successful connection.

VirtuSurv has now been prepared to send coordinates and commands to Rhino. For a first test select the point macro ° from the VirtuSurv macros bar and click any point in the scan

view with the left mouse button. VirtuSurv now sends the "Point" command followed by the x, y, z coordinates to Rhino, which then draws the according point.

Rhinoceros macros overview:

The pre-defined Rhino macros are divided in two classes:

1. Macros for sending coordinates or distances
2. Macros for starting Rhino commands

The first class can be used whenever Rhino demands a point or a distance as input. The second class does not only send the coordinate of the point clicked in VirtuSurv but at the same time sends a command or even a command option to the Rhino command line.

Following table lists all pre-defined macros:

Macro	Usage	Remarks
Macros for sending coordinates or distances		
w XYZ	Click point in scan Sends x, y, z coordinates as world coordinates	
w XYZ [enter]	Click point in scan Sends x, y, z coordinates as world coordinates followed by [Enter]	The [Enter] at the end simultaneously closes the current Rhino command
XY	Click point in scan Sends x, y coordinates	The coordinates refer to the current Rhino construction plane. Caution! The global coordinates of VirtuSurv will not be converted into the coordinates of the current construction plane. This macro should only be used together with construction planes that have been created by shifting the world coordinates along the z-axis.
XY [enter]	Click point in scan Sends x, y coordinates followed by [Enter]	Also see macro "XY" The [Enter] at the end simultaneously closes the current Rhino command

Macro	Usage	Remarks
w xy0	Click point in scan Sends x, y coordinates and z = 0 as world coordinates	This macros is used in combination with the command "Construction plane by 3 points"
vertical dist	Click two points in scan Sends vertical distance between both points	
horizontal dist	Click two points in scan Sends horizontal distance between both points	

Macros for starting Rhino commands

Macro	Usage	Remarks
	Click point in scan z-coordinate defines height of a new construction plane	Current construction plane will be aligned with the world coordinates. Origin of the new construction plane is 0,0,z
	Click point in scan Starts the command "Construction plane by 3 points"	Afterwards use [w xy0] and click the second point in direction of the x-axis. Then use [w XYZ] and click the third point. The construction plane is created in a way the x-axis lays in the xy-plane of the world coordinate system.
	Click point in scan Draws a point at x, y, z	
	Click point in scan Starts the "Polyline" command	Afterwards use [XY] to click further points and [XY [enter]] for the last point and finishing the command. The polyline is drawn on the XY plane of the current construction plane. Caution! The global coordinates of VirtuSurv will not be converted into the coordinates of the current construction plane. This macro should only be used together with construction planes that have been created by shifting

Macro	Usage	Remarks
		the world coordinates along the z-axis.
	Click point in scan Starts the "Polyline" command	Afterwards use [w XYZ] to click further points and [w XY [enter]] for the last point and finishing the command.
	Click point in scan Starts the "Rectangle" command with the "3 points" option	Afterwards use [w XYZ] and click the second point on the end of the edge. Then use [w XYZ] and click the points to define the width.
	Click point in scan Starts the "PlanarFace" command with the "3 points" option	Afterwards use [w XYZ] and click the second point on the end of the edge. Then use [w XYZ] and click the points to define the width.
	Click point in scan Starts the "PlaneThroughPoints" command	Afterwards use [w XYZ] and click three further points or finish the command with [w XYZ [enter]] after the third points.

Using the Rhino macros

You have already tried a simple macro when sending a point to Rhino. In the following paragraphs it will be shown how to combine various macros for Rhino.

Select the (3D Polyline) macro from the VirtuSurv macros bar and click any point in the scan to run the command. For drawing the window outline select the "w XYZ" macro and click the points you need in the scan. You may also open several scans at once and click the coordinates in different scans if needed. The macro is active until you click on its button again or select another macro. To finishing the polyline use the [w XYZ [enter]] macro or switch to Rhino and finish the command there by pressing [Enter]. You should now see a similar result as shown in the figure below.
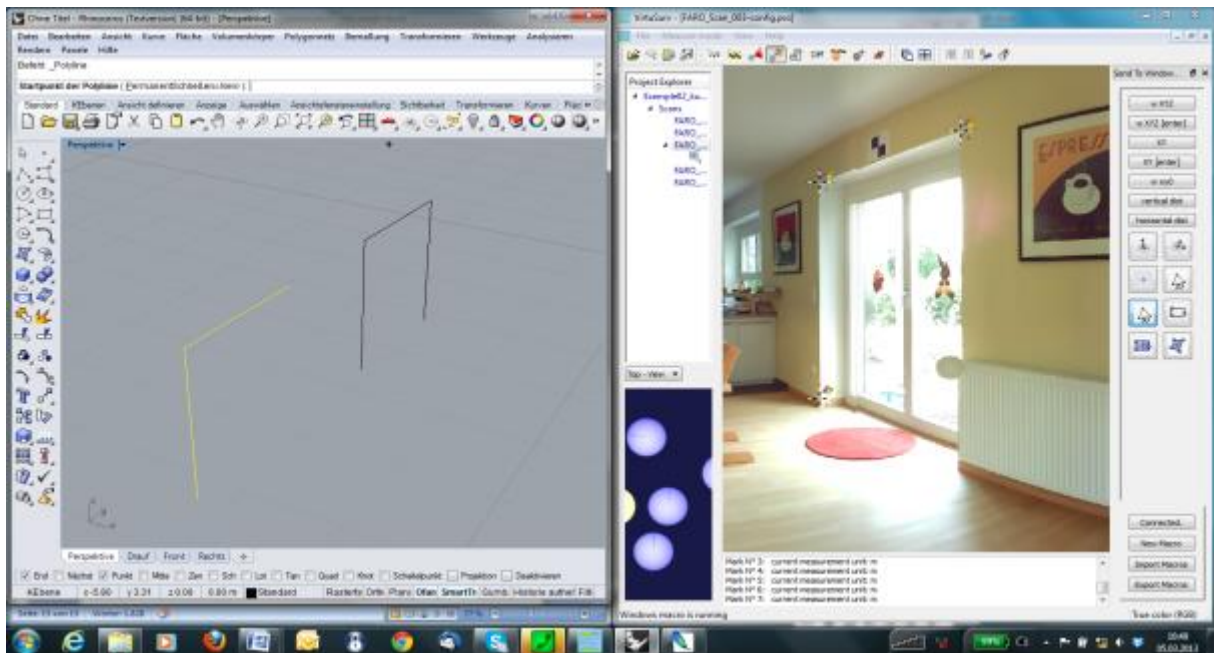
Check for videos on andhttps://youtu.be/igp4FUjdKtc.

Do you want to run more drawing commands directly from VirtuSurv? In chapter **3.4** you learn how to generate your own macros.

3.3.7 Drawing with SEMA

VirtuSurv provides a direct connection for users of the timber construction CAD system SEMA. To connect VirtuSurv with SEMA go in the "Measure mode" menu to "Send to other systems" and click there on "Send to SEMA":

To be able to receive data from VirtuSurv in the SEMA software, you must have purchased and activated a SEMA licence for the bill of quantities module.

If the connection between VirtuSurv and SEMA has been established, simply start the drawing command of your choice in SEMA and then pick the points in the scan in VirtuSurv that you need for your construction.

The transfer of the survey points from VirtuSurv is integrated into the SEMA program in the form of a "3D mouse". In every situation in SEMA where you would normally define a point by a mouse click in the drawing, you can select a point in the VirtuSurv scan. The coordinates will be transferred to the construction command in SEMA.

It is recommended to open both programs next to one another.
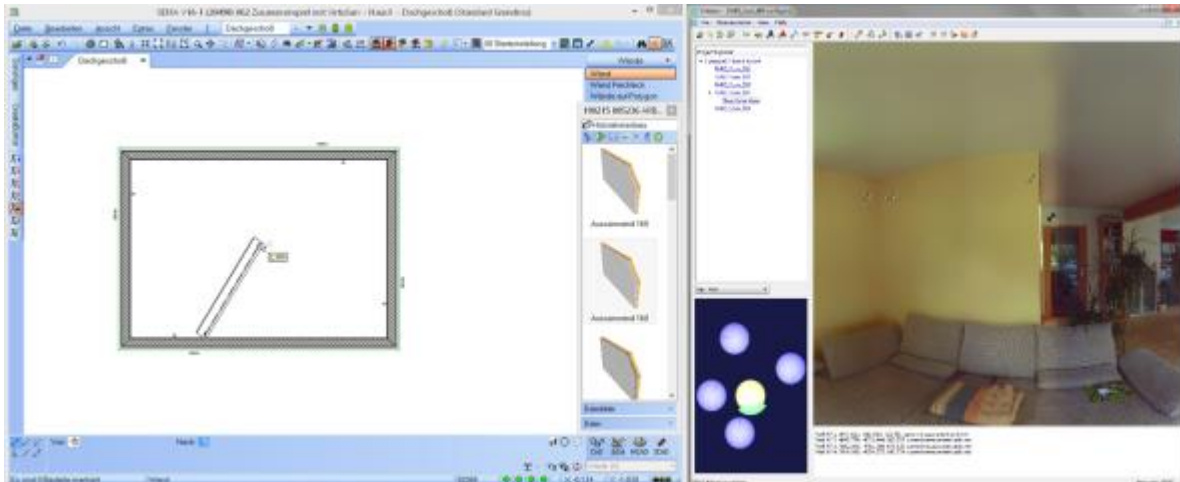
Example: Enter a wall over two points.

You will be prompted on the SEMA input line to enter two points ("from point", "to point"). That is usually done by a mouse click on an object in the drawing window. In this example you define the desired points by clicking on existing walls in the VirtuSurv scan.

To be able to send the coordinates to SEMA in the correct units, the VirtuSurv settings have to be configured in the same way as the SEMA settings. In VirtuSurv use the "Configure Measurement Unit" command 🛠 and configure there the units as you want them to be. (See section **3.3.1**).

3.3.8 Drawing with AutoCAD (LT)

VirtuSurv provides a special macro system for evaluating with AutoCAD and AutoCAD LT. In this way it is especially comfortable for AutoCAD users to draw and model. You may run the drawing commands directly from VirtuSurv and do not have to switch between VirtuSurv and AutoCAD. Besides that, the connection to AutoCAD and AutoCAD LT is established automatically.

And this is how it works:

Open the macro bar for the transfer to AutoCAD and AutoCAD LT by running the "Send to AutoCAD (LT)" 🖌 command from the "Measure mode" menu. The connection to AutoCAD is established at the same time.

The AutoCAD macro bar is being opened on the right hand edge of the VirtuSurv window. You may move the bar and attach it to any other edge. In order to do so click and hold the left mouse button on the head of the bar until you have moved the bar to the desired position. The macro bar may be closed via the cross in the top right corner of the window or by clicking on the Off button in the tool-bar.

VirtuSurv provides several predefined AutoCAD macros:

| Drawing 3D polylines within AutoCAD: starts the command and sends the 3D coordinates of the points clicked in the scans. |

| Drawing lines in AutoCAD: starts the line command and sends the 3D coordinates of the points clicked in the scans. |

| Sending 3D or 2D coordinates to the AutoCAD command line. Useful for all AutoCAD commands and commands of AutoCAD plug-ins, which expect coordinates. In order to do so, start the desired command in AutoCAD first, e.g. "Insert Block" and then click the insertion point of the block within the scan. The block will be inserted at the correct position in the AutoCAD drawing. |

| Sends ENTER: used to repeat or finish AutoCAD commands. |

| Sends ESC: used to finish or cancel the running AutoCAD command. |

| Undo previous AutoCAD command. |

| Create UCS by 3 points: starts the relevant AutoCAD command. |

| Switch to plan view of the current UCS. |

| Zoom the AutoCAD view to its extents. |

You start a macro by clicking on the appropriate button in the macro bar. Then, in the scan, click the points you need to draw. You finish a macro by clicking its button again.

Tutorial – drawing the outline plan of a room in AutoCAD

Please load the sample project from the VirtuSurv web site and open it, if you have not done so already. In chapter **3.1** you will find instructions for doing so.

Open the true colour views of scan 3 and scan 5 from the Example02_kubit_house project and change the scan window to full screen. By selecting it in the structure view of the Project Explorer you must ensure scan 3 is at first in front. With the mouse wheel zoom out, so that preferably the complete living room is visible in the scan window (scan_003).

Start AutoCAD and open a new empty drawing.

Open the AutoCAD macro bar in VirtuSurv by running the "Send to AutoCAD (LT)" command from the "Measure mode" menu. Click on the button in order to start the macro for drawing lines. Now click two points on every wall as follows in order to draw the outline line of the living room in AutoCAD. Ensure that you do not click directly in the corners; such a measurement would be too inaccurate. You will generate the correct sharp corners later on in AutoCAD.

Then continue with the separating wall at the stairs.

Then proceed clockwise:
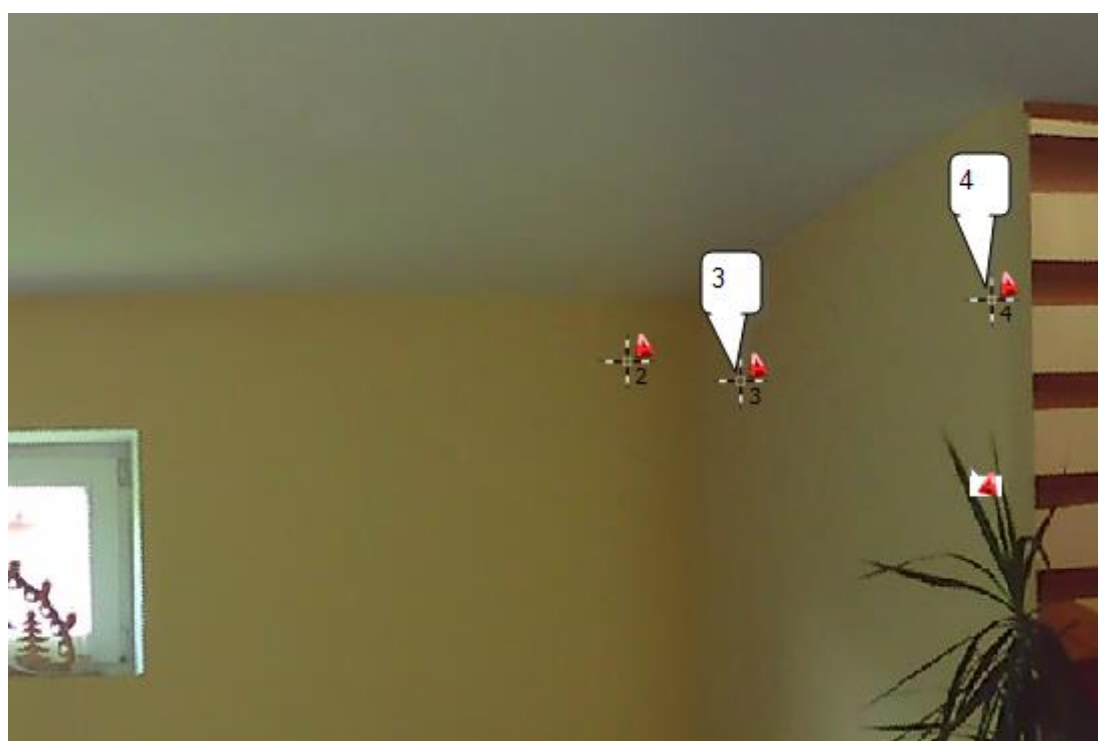
Now change to scan 5, by selecting it in the Project Explorer. Then zoom to the small part of the wall which separates the sitting area from the niche of the staircase and click two points on this narrow area.
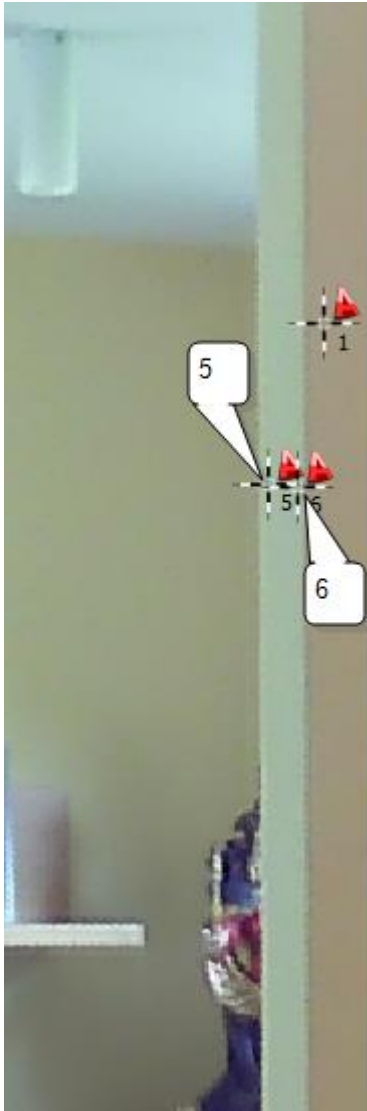
Follow the run of the wall in the niche of the staircase:
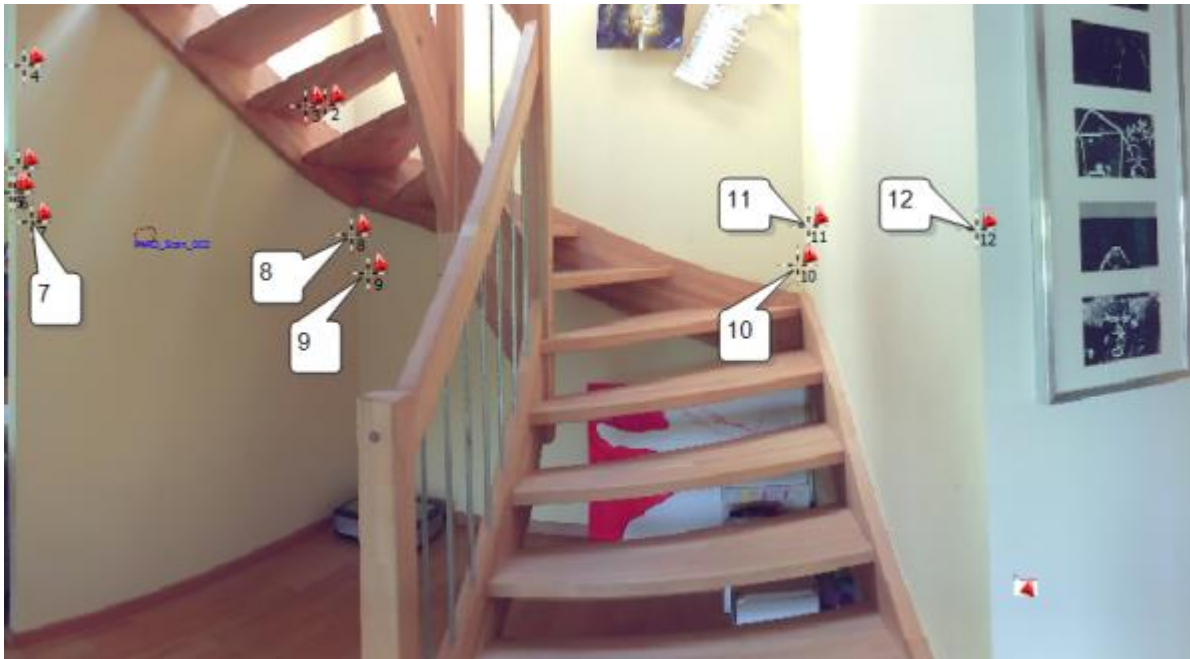
Being still in scan 5, leave the niche of the staircase:
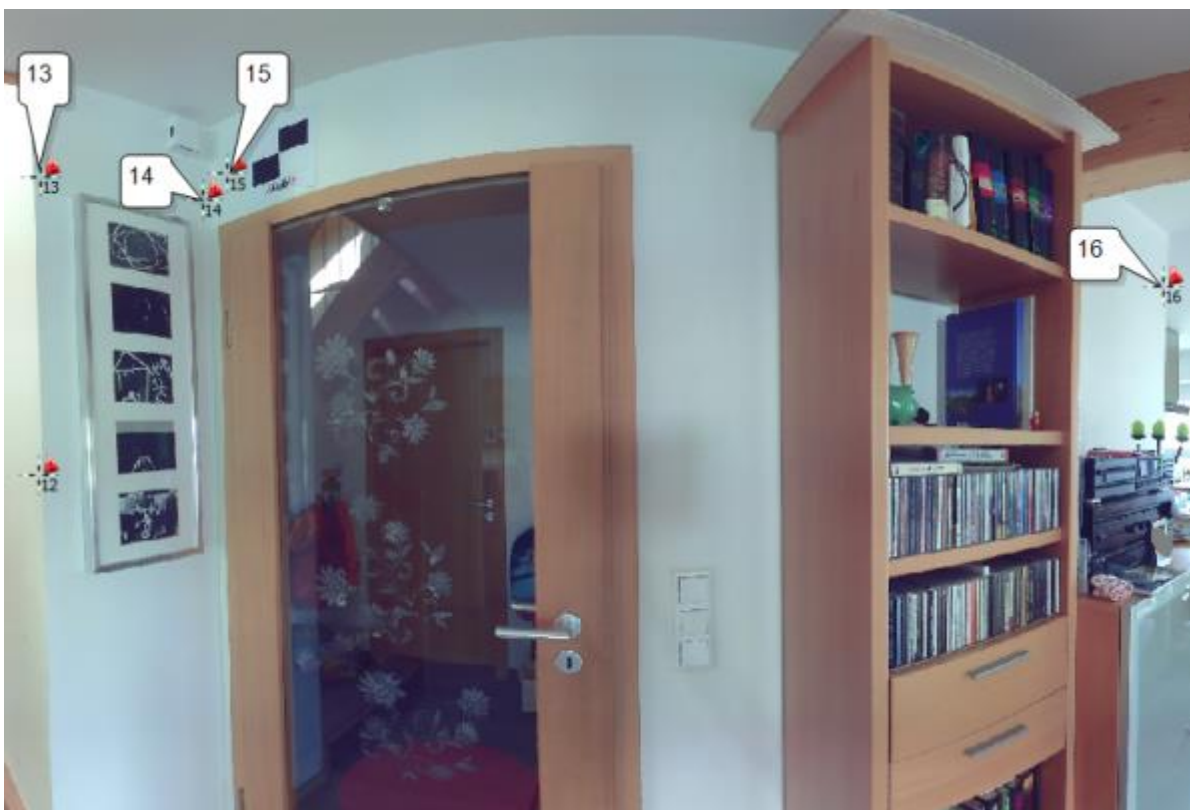
Remember to click the wall surface close to the corners not directly in the corners or on the edges.

To follow the run of the wall into the kitchen, change back to scan 3 by selecting it in the Project Explorer. Now move the view in the scan window (hold down mouse wheel or Ctrl + right mouse button), so you can see the kitchen area. Now click the next wall point:

Point 23 is the first point on the last wall. The scan is an all around scan (360°) and it has been unpicked on the last wall for creating the planar view. Therefore you have to zoom out, pan the view to the left part of the scan and zoom onto the corner with which you have started to draw the outline of the living room in order to measure the second point on the last wall: Now click point 24.

You finish the line macro and at the same time close the line run by right clicking in the scan. After "Zoom to extents" you will see the outline of the living room which you have just drawn with VirtuSurv.

Note: If you want to finish a line run without closing it, just click again on the macro button. This will finish the line macro. For finishing the line command in AutoCAD you click the "ENTER" button in VirtuSurv. You do not have to switch to AutoCAD for this.
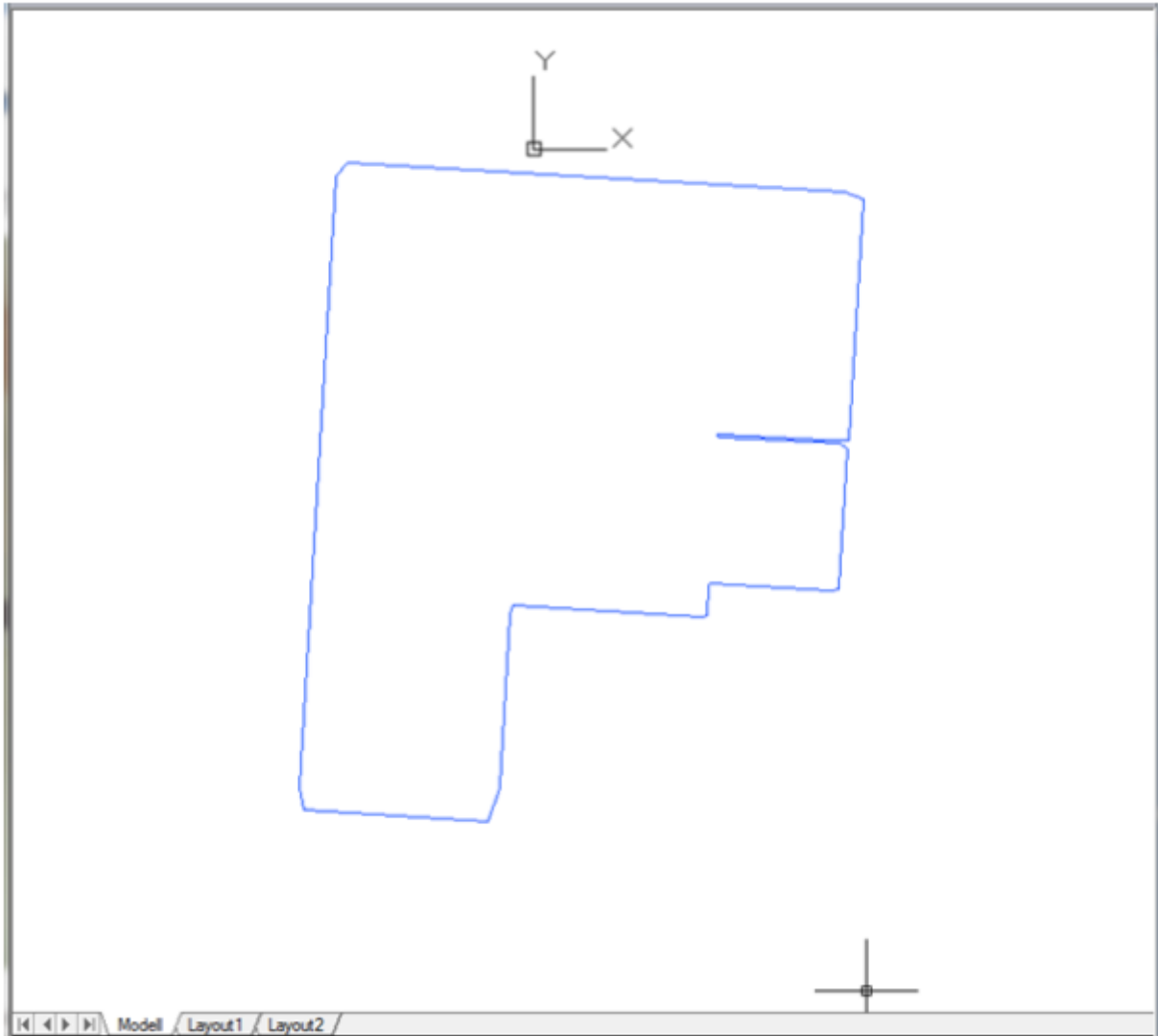
So far, the corners are cut off and the lines are positioned on the height, measured in the scan. You level the lines by selecting them all and setting the Z values of the starting points and end points to zero in the properties window.

Hint: If you adapt the line macro so it will draw 2D instead of 3D you will not have to level the lines afterwards. You learn how to do that in the next chapter.

Now the corners have to be sharpened. In order to do so, use the AutoCAD command FILLET with the following settings:

```
Current settings: Mode = TRIM, radius = 0.0000
```

Select the wall lines that run towards the corner when you are asked for the first and the second object. Lastly, delete the short sloped line segments. With this the floor plan has been corrected.

If you use AutoCAD plug-ins from FARO or kubit, e.g. As-Built, TachyCAD or PointSense, thanks to the provided special commands, you draw far more efficiently, since you do not have to sharpen the corners manually.

Using the line macro you can also draw the staircase and the run of the ceiling beam. To do so, choose the suitable scans. Unfortunately there is no scan available for the upper part of the staircase.

In completion of this tutorial there are blocks to be inserted into the floor plan at the positions of the ceiling lamps. At first generate the block in AutoCAD. Draw two concentric circles ("Circle" command and "Centre" object snap).

Then run the BLOCK command. Assign a name to the block (e.g. lamp) and determine the insertion point, by clicking the "Pick point" button and then snap the centre of the circle in the drawing. Via the "Select objects" button you assign the two circles that you have just drawn to the block.
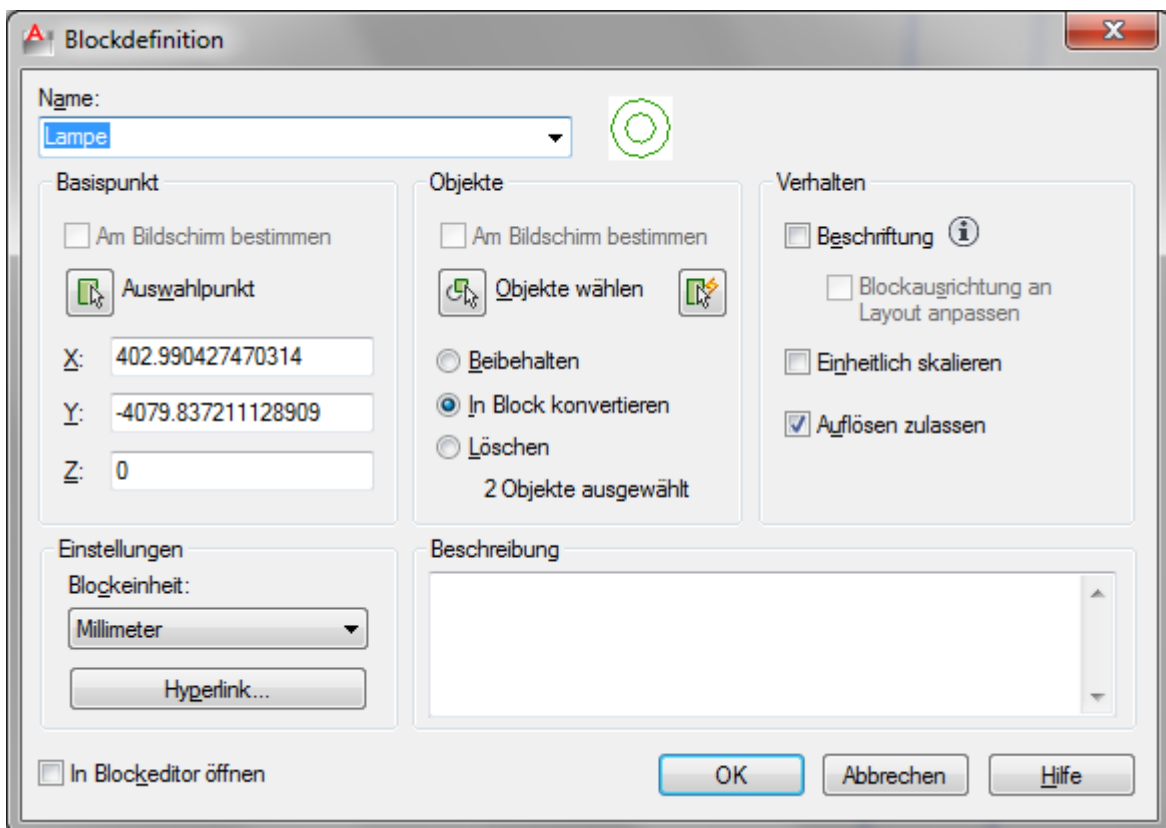
The block will be defined in the drawing when you press the [OK] button.

Start the "Insert" command of AutoCAD.
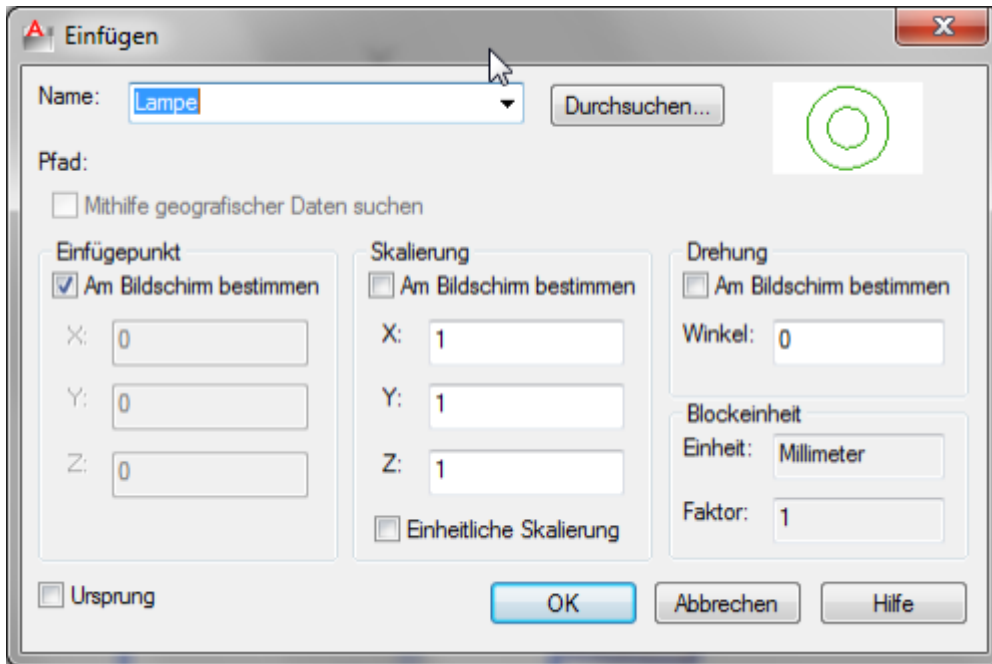
Now select the name of the block definition you have just generated. The other options should be set as can be seen in the above screen shot. Confirm with [OK]. Now AutoCAD expects the input of a set of coordinates for the insertion point.

Change to VirtuSurv. Start the macro for sending 3D coordinates to AutoCAD. Activate scan 3. Zoom to the lamps in the sitting area and click on the socket of the first ceiling lamp and about in the middle of the lamp chimney.

The coordinate of the clicked point is transmitted to AutoCAD and the block is inserted into the drawing at that exact position.

Start the "Insert" command of AutoCAD again and repeat the sequence for the remaining lamps.

The result of the exercise should look like this:
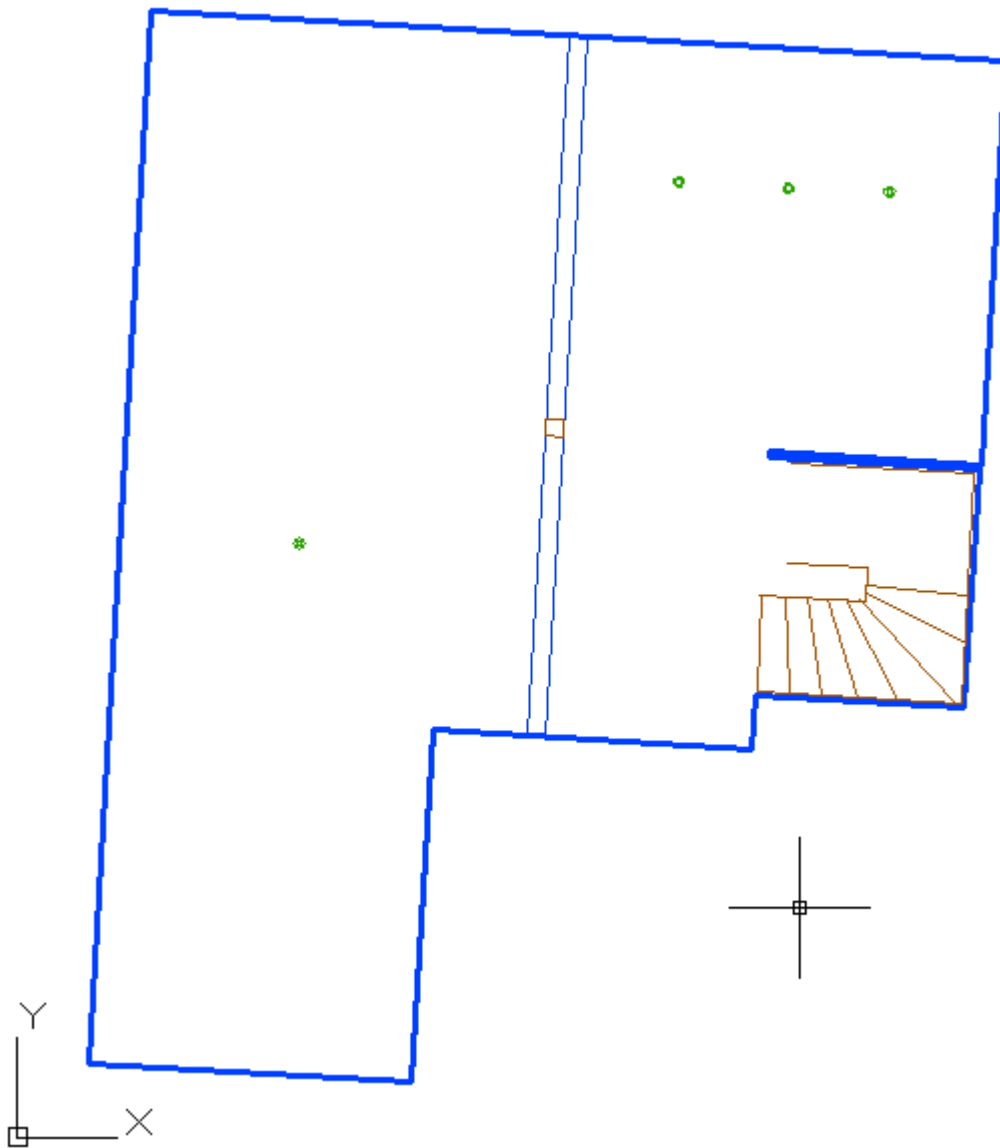
Windows and doors can be drawn and dimensioned more efficiently when using special commands. FARO or kubit offer different AutoCAD plug-ins for this. When using those you run the according command and measure the needed points with VirtuSurv.

Do you want to run more drawing commands directly from VirtuSurv? In chapter **3.4** you learn how to generate your own macros.

Hint: We have prepared further useful macros (e.g. for drawing 2D). You find these macros on our webpage which you can access by clicking the button in the "Help" menu or on the VirtuSurv tool-bar. In Chapter **3.4.4** you learn how to import these macros.

3.3.9 Drawing with BricsCAD

VirtuSurv provides a special macro system for evaluating with BricsCAD. In this way it is especially comfortable for BricsCAD users to draw and model. You can run the drawing commands directly from VirtuSurv and do not have to switch between VirtuSurv and BricsCAD. Besides that, the connection to BricsCAD is established automatically.

And this is how it works:

Open the macro bar for the transfer to BricsCAD by running the "Send to BricsCAD" command from the "Measure mode" menu. The connection to BricsCAD is established at the same time.

The BricsCAD macro bar is being opened on the right hand edge of the VirtuSurv window. You may move the bar and attach it to any other edge. In order to do so click and hold the left mouse button on the head of the bar until you have moved the bar to the desired position. The macro bar may be closed via the cross in the top right corner of the window or by clicking on the Off button in the tool-bar.

VirtuSurv provides several predefined BricsCAD macros:

Drawing 3D polylines in BricsCAD: starts the command and sends the 3D coordinates of the points clicked in the scans.

Drawing lines in BricsCAD: starts the line command and sends the 3D coordinates of the points clicked in the scans.

Sending 3D or 2D coordinates to the AutoCAD command line. Useful for all AutoCAD commands and commands of AutoCAD plug-ins, which expect coordinates. In order to do so, start the desired command in AutoCAD first, e.g. "Insert Block" and then click the insertion point of the block within the scan. The block will be inserted at the correct position in the AutoCAD drawing.

Sends ENTER: used to repeat or finish BricsCAD commands.

Sends ESC: used to finish or cancel the running BricsCAD command.

Undo previous BricsCAD command.

Create UCS by 3 points: starts the according BricsCAD command.

Switch to plan view of the current UCS.

Zoom the BricsCAD view to its extents.

You start a macro by clicking on the appropriate button in the macro bar. Then, in the scan, click the points you need to draw. You finish a macro by clicking its button again.

If you want to practice working with VirtuSurv and BricsCAD, you may download example data from the VirtuSurv example web page and open it. In chapter **3.1** you will find instructions for doing so. Then just follow the tutorial provided for AutoCAD (LT) (on page **37ff).**

Do you want to run more drawing commands directly from VirtuSurv? In chapter **3.4** you learn how to generate your own macros.

3.3.10 Creating a coded field book

With the function for creating a coded field book, VirtuSurv takes on the established role of the surveyor. It addresses users who have, so far, observed their objects coded with a total station, in order to automatically generate a finished drawing with the help of the codes when importing the measurement data into their CAD system. Now these users may also use laser scanner data in order to create their coded point lists, their field book.

In this chapter you will learn, with the help of a notional example, how to generate, transfer and edit your code list. You will learn how to use the code list, in order to create a coded field book. And you will learn how to configure, edit and save the field book.

Please note that this function is only of use for you, when your CAD system comes with a function for importing coded data. Please use those codes, that your CAD system needs for the drawing and which fit your field of application.

Run the "Create Field Book" command from the "Measure mode" menu under "Send to other systems". The task bar for the generation of a coded field book opens at the right hand edge of the VirtuSurv window. You may move the bar freely or attach it to the left hand edge. In order to do so click and hold the left mouse button on the head of the bar until you have moved the bar to the desired position. The task bar can be closed via the cross in the top right corner or by clicking Off in the tool-bar.

Create Field Book	
Point	
Point ID	Increment
1025	1	Entry of the point ID and of the increment in order to automatically count up (default setting: increment=1).
Codes	
Code group filter	
(All codes) ▼	List for pre-filtering the codes. Only the codes belonging to the selected code group will be provided in the code selection list below.
Code	
▼	Code selection list is empty if no code list has been loaded. You may enter new codes in this field and add them to your code list. The description will – for the time being - be empty but you can edit it via [Create/edit code list].
Description	
▼	Selection list for the descriptions of the codes. Every code in the code list has exactly one description.
Create/edit code list...	Opens the dialog for creating, editing, saving and importing a code list.
Comment	
▼	Input box for any comments regarding the measured point. All comments, which have been used, will be provided as select list.
Open field book...	Opens the dialog to view, edit, save or delete the field book.
Close	Closes this working window

Creating a code list

To generate a code list, you may simply enter your codes into the relevant field. They will be added to the code list. If you want to create a larger code list with code groups and a description for every code, click the **[Create/edit code list...]** button. The following dialog opens:
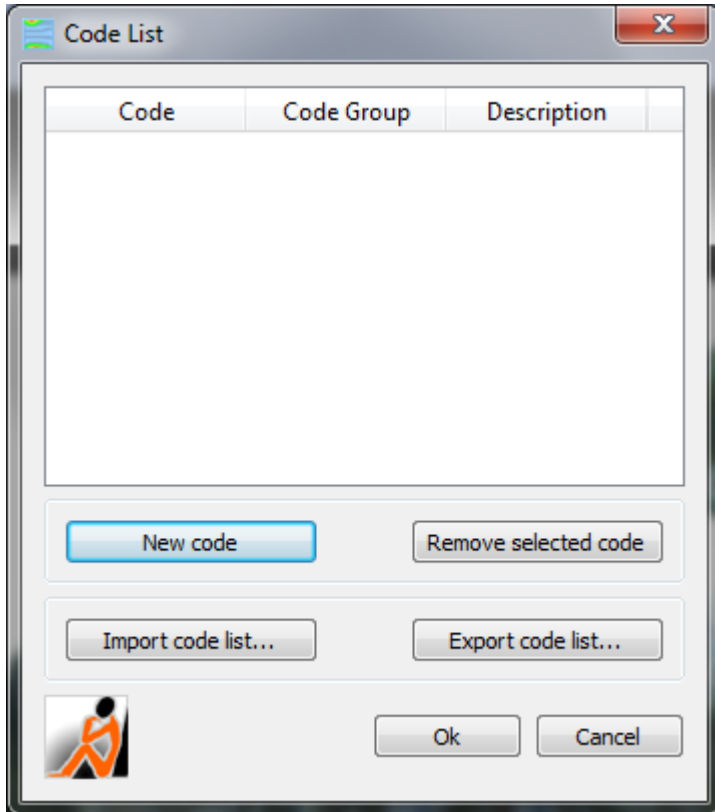
You may enlarge the window to get an overview of the list without having to scroll a lot.

The upper part contains the list of defined codes. At the moment this is empty. Every code will be assigned to exactly one code group. The description helps the user to understand the often cryptic code and to select the correct point code when measuring points.

Click the **[New code]** button in order to add a new code to the list. A new line will be added to the list (at the lower end).
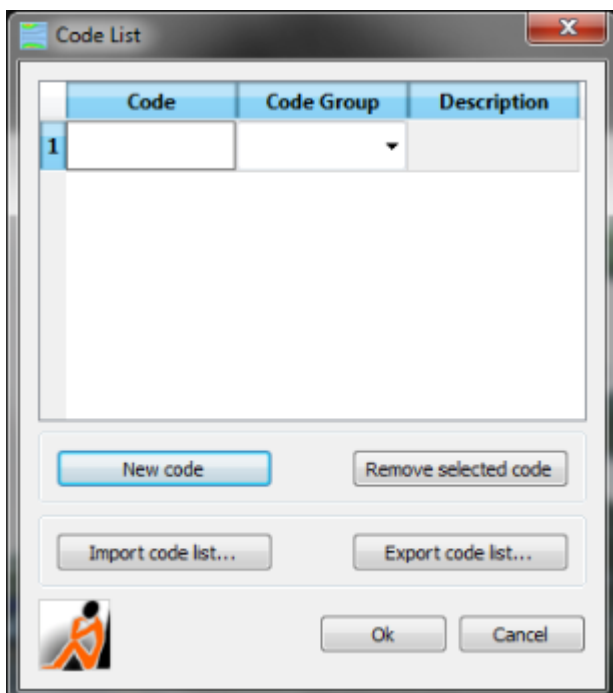
To enter or edit a code, double click into the code field and enter the code. The entry of the description works analogue. You may either enter a new code group or select one from the list of code groups.

Simply try it. *Use the codes, which you use for your total station survey! (The example in this manual is only notional).*
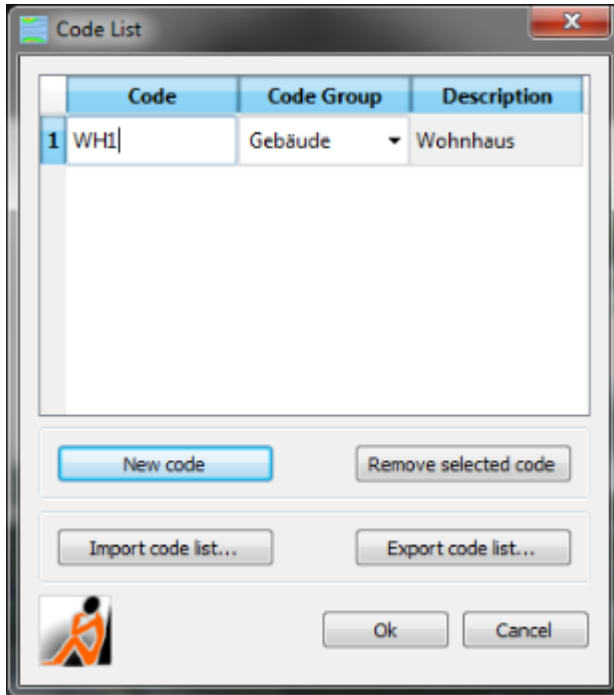
VirtuSurv allows codes which are composed of a string of digits or letters or a combination of both. The CAD software Geograf for example expects point codes which consist of four digits.

The codes do not only control what will be drawn in your CAD system but also how it will be displayed (line width, symbols, hatches, etc.).

No code or description are allowed to be assigned twice. VirtuSurv checks this and secures this uniqueness by warning the user:
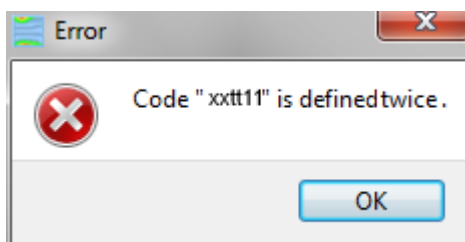
You may generate different code lists for different tasks. If you have entered all codes you need, save the code list by clicking [OK]. [Cancel] drops your changes in the code list

If you want to delete a code from the list, select the code and click the **[Remove selected code]** button. You may also select several codes to be deleted by using the Ctrl or Shift keys.

Export your code list, generated in VirtuSurv, in order to be able to use it on all of your computers, or to keep it when installing a VirtuSurv update. Click on **[Export code list…]** and save the list with a meaningful name. Copy the exported code list file to the new computer. There start the "Create Field Book" 🗗 command from the "Measure mode" menu in VirtuSurv. Click on the **[Create/edit code list…]** button and then on the [Import code list…] button when in the code list window. Select the code list file to be imported. Now you can use the codes here as well.

Using the code list – create field book

When you have defined the code list as described above, you can now use it for creating a coded field book when measuring in the scan project.

At the very top of the field book task bar, enter the point ID of the point to be measured and define the increment. After measuring the point (by clicking in the scan) the next point number is displayed, according to the increment. Enter a negative increment if the measurement points are to be counted downwards from the starting point number.

Select the desired code from the list, before measuring the point. Via the code group list, you may pre-filter the codes and then get only the codes belonging to the code group. The description for the selected code is displayed too. You may enter any comment in the "Comment" field. Of course you may also select a code by its description.

After you have selected point number and code, click the point to be measured in the scan. It will be written to the field book with its coordinates and the code.

To view, edit and save the field book click the **[Open field book…]** option. The field book will be opened:
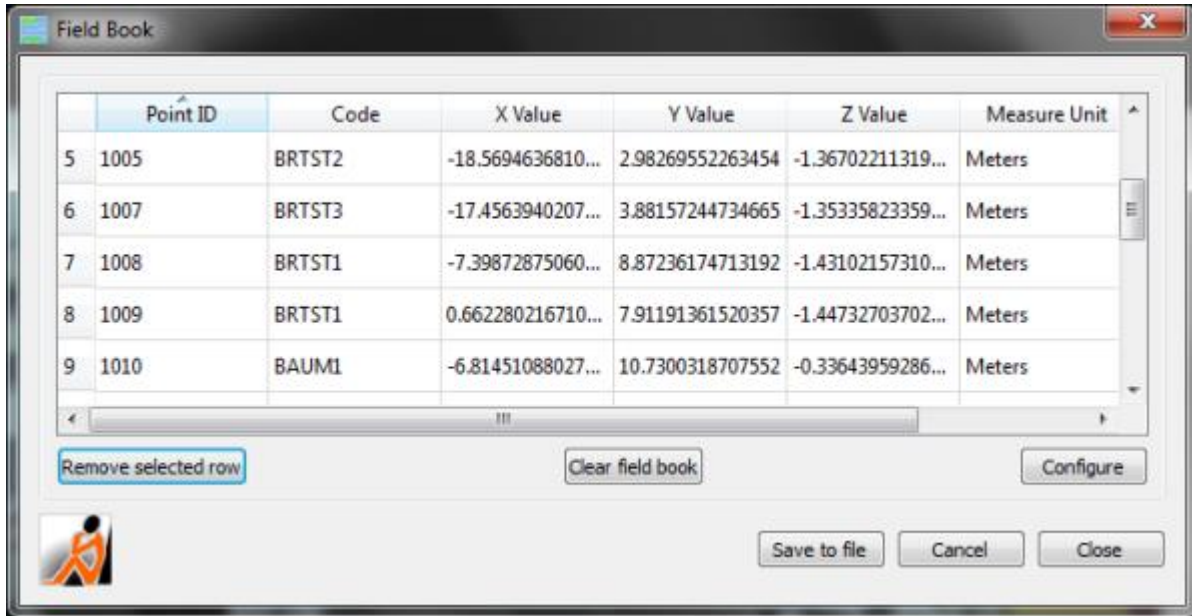
You may enlarge the window to get an overview of the list without having to scroll a lot. You may sort the field book by columns by clicking the according column header.

Measurement unit, display accuracy and decimal separator must agree with the settings under "Configure Measurement Unit" 🐝 from the "Measure mode" menu. Make sure to set the correct unit **before** you start measuring!

By default the point ID, the point code, the point coordinates and the measurement units are displayed in the field book. If you want to display and save the description and the comment for every point or change the order of the columns in addition to the above, click on **[Configure…]**. The following dialogue box opens:
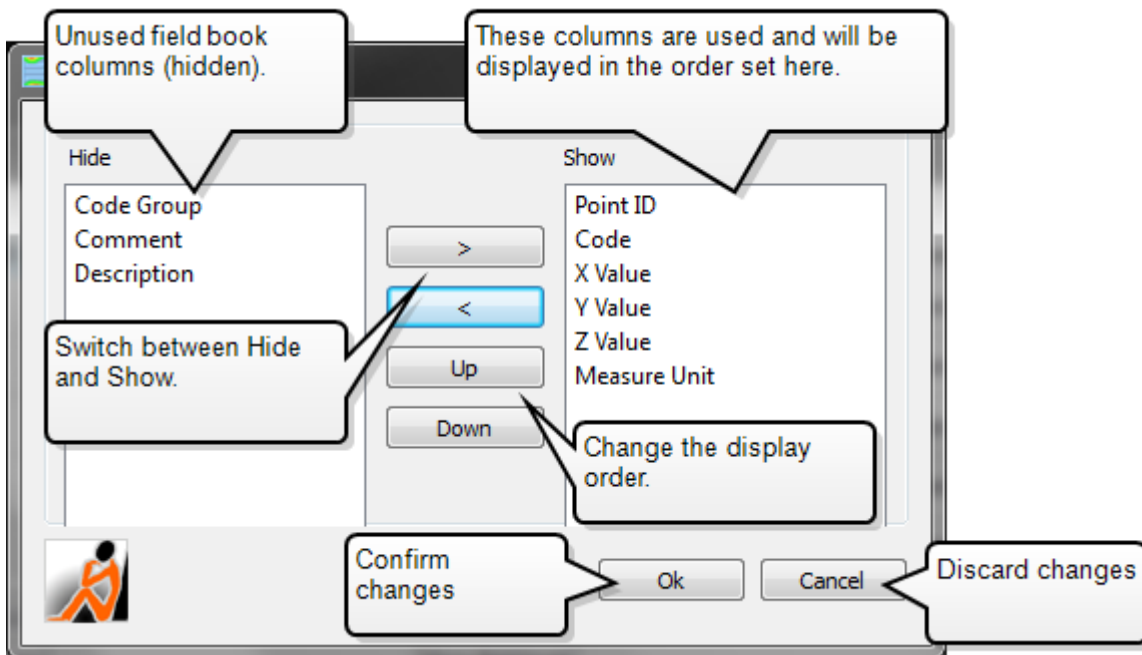
Make sure, the coded field book has a format which can be imported from your CAD system.

If you want to delete single points from the field book, select them and click on **[Remove selected row]**. You may also select several codes to be deleted by using the Ctrl or Shift keys.

With the [Cancel] button you close the field book and discard all changes. With **[OK]** all changes are adopted upon closing.

When you have measured everything that has to be drawn afterwards in the CAD system, click on **[Save to file]**, in order to save the field book to a text file. After you have entered a name for the field book file and clicked on save, a dialogue box with the preview opens, where you may determine the separator for the columns:
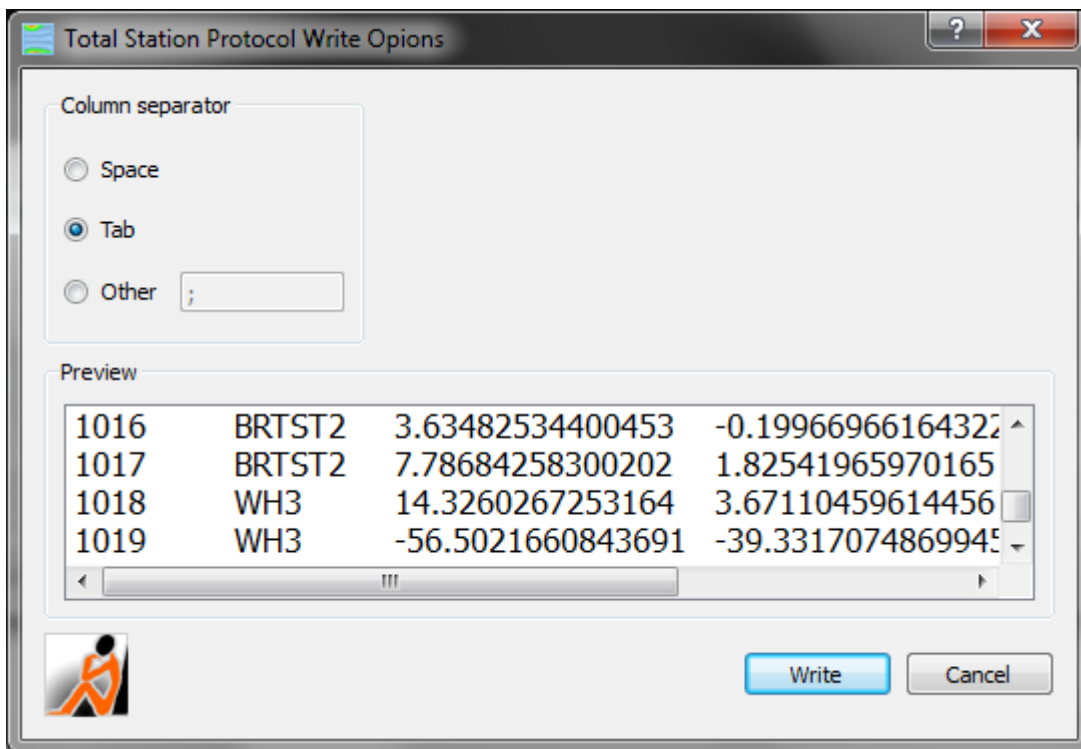
By clicking [Write] the field book file is written. Since it is a text file, it may be opened and edited with a text editor at any time.

Make sure, the coded field book has a format which can be imported from your CAD system.

Important note:

VirtuSurv continues to write to the existing field book until the user clears it with the **[Clear field book]** button. Newly measured points are added at the end. When you have finished a measurement project, save it with [Save to file] and then *clear* the field book *before* creating the next field book.

3.4 Optimised evaluation – customised macros

You are already familiar with the advantages and the use of VirtuSurv macros in chapters **3.3.4** to **3.3.9**. Laser scan data are gathered and evaluated for many different tasks/results. Therefore VirtuSurv provides functions, so that you may optimise the software for your own special tasks. In this chapter you will learn how to customise the predefined macros and create new macros with the help of the macro editor.

There are two kinds of macros in VirtuSurv:

- one type of macro is for the structured sending of measurement values (coordinates or distances) to any Windows application, such as Excel, data bases, any CAD software,

- on the other hand special macros for the sending to AutoCAD (LT) or BricsCAD, where not only measurement values can be transferred but also CAD commands can be started and controlled.

There are separate macro bars for the different macro types. Layout and handling of the macro bars are analogue. The buttons with the predefined macros are in the upper part, the buttons for the creation of new macros and for the import and export of macros are in the lower part.
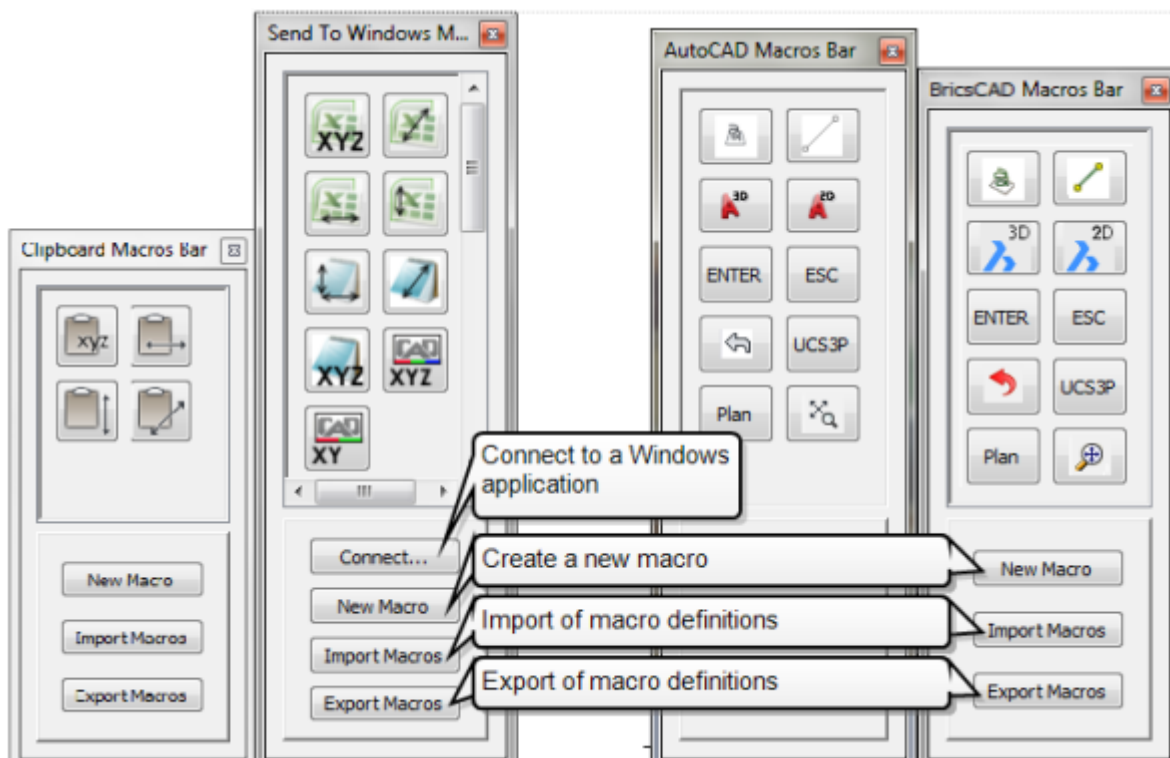
3.4.1 Customise predefined macros

To customise an existing macro, right-click, in the macro bar, on the macro button. A **context menu** will open:
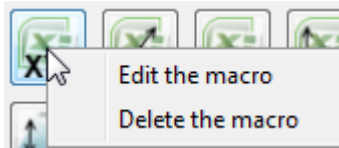
Click "***Delete the macro***" in order to remove the macro from the bar. ***Caution:*** If you have not exported the macro in advance, it will be lost! You may read how to export and import macros again on page **66.**

Click the "**Edit the macro**" button in order to open the macro in the editor. The editor for Windows macros and the editor for AutoCAD (LT) or BricsCAD macros are very similar. They only differ in the kind of the macro that is generated. You will learn more about the components and functions of the editor starting on page **61.**

Let's take a look on how to adapt the macro for sending coordinates to a text file, so that you will be able to send the coordinates of a point that you have measured in a scan to a CAD system, e.g. to IntelliCAD. Open the macro as described above:
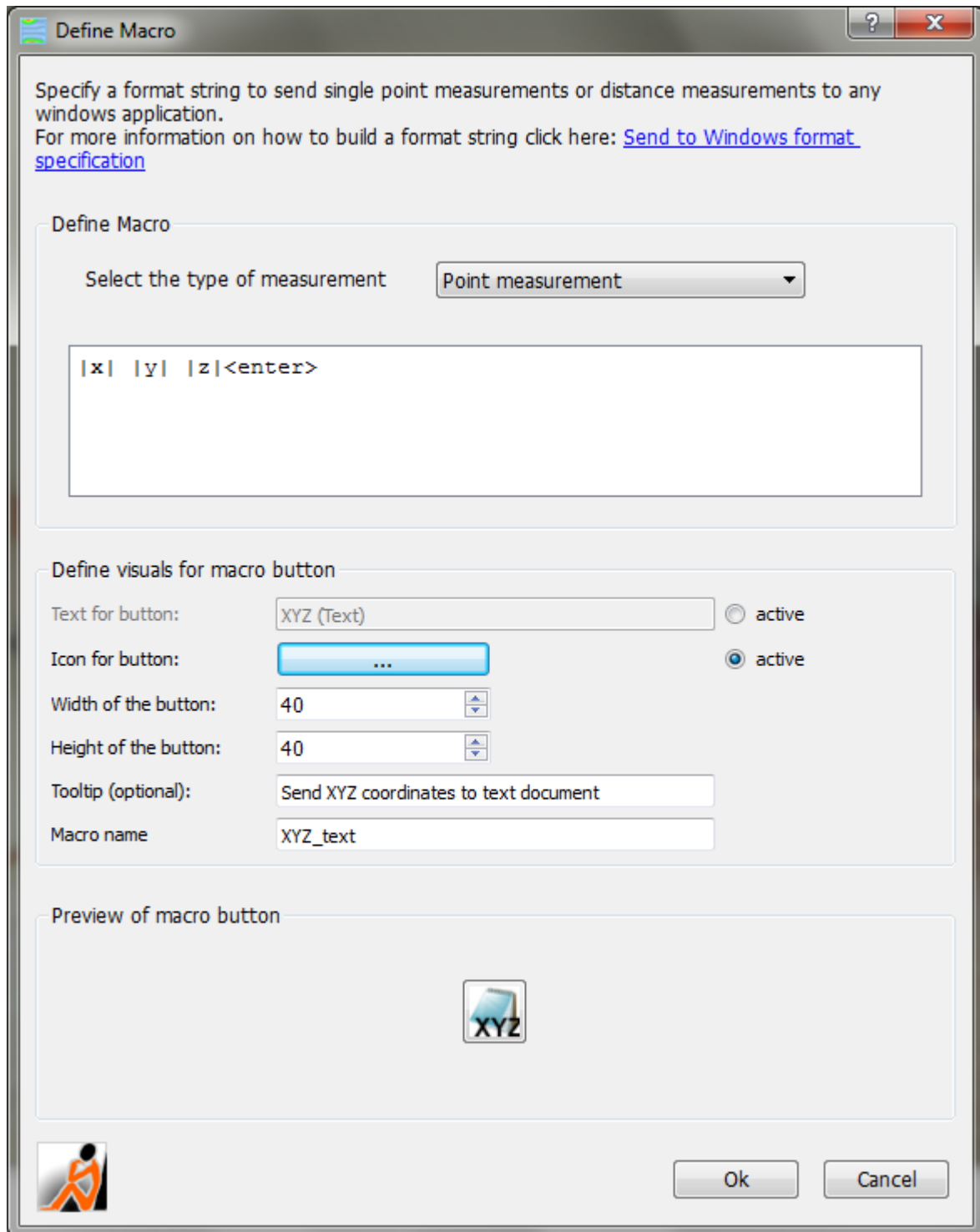
In the upper part of the editor you find the macro definition. The type of measurement has been set to point measurement. Keep this setting since you want to send point coordinates. The macro itself is, at the moment, described with:

```
|x| |y| |z|<enter>
```

That means, VirtuSurv sends the X, Y and Z coordinates, each separated by space and followed by ENTER, into the selected Windows application.

Most CAD systems (IntelliCAD as well) expect the X, Y, Z coordinates separated by a comma for their drawing commands. Go to the macro definition and replace the spaces between the coordinates by commas. Leave the <enter>. Most CAD systems finish the entry of the coordinates with ENTER.

```
|x|,|y|,|z|<enter>
```

The unit and the decimal separator are not configured in the macro definition but with the global command "Configure Measurement Unit" from the "Measure mode" menu (see chapter **3.3.1**). Usually, CAD software expects a point as decimal separator in the coordinate. Therefore ensure, that the measurement unit has been configured accordingly before sending the coordinates.

You may customise the appearance of the buttons for the macro in the lower part of the macro editor. Keep width and height as they are. Activate the "Text for Button" option and enter "XYZ" as Text for the button. As text for the tool-tip enter for example "Send XYZ coordinates to CAD". The name of the macro is to be "XYZ CAD". At the very bottom you will see a preview for the button.

Confirm you adaptation with [OK]. You now have a macro with which you can send coordinates to IntelliCAD and to other CAD systems. Of course it is possible, to simply generate coordinate lists in a text file with the same macro.

3.4.2 Create new Windows macros

Open the macro bar and click the **[New Macro]** button in order to create a new macro for the sending of measurement values into any application. The macro editor will open. You define the macro in the upper part, in the lower part you configure the appearance of the button. Please do not forget to assign a meaningful name to the macro. The macro name will be displayed when exporting or importing macros.

Selection of the kind of measurement:
Point measurement or distance

Link for opening the guide for the creation
of VirtuSurv Windows-macros.

Define Macro

Specify a format string to send single point measurements or distance   surements to any
windows application.
For more information on how to build a format string click here: Send to Windows format
specification

Define Macro

Select the type of measurement   Point measurement ▼
                                        Point measurement
                                        Distance measurement (2 points)

Input field for the definition of the macro: What is to be
sent? Coordinates? Horizontal distances? Slope
distances? ...

Define visuals for macro button

Text for button: macro button text   ● active

Icon for button: ...   ○ active

Width of the button: 71

Height of the button: 23

Tooltip (optional):

Macro name

What shall the button for the macro look like? Text or icon?
Width+Height? Tool-tip? Name of the macro

Preview of macro button

Preview of the button.   macro name

Ok   Cancel

For macros for sending to any Windows application, VirtuSurv distinguishes between two
kinds of measurement: point measurement and distance measurement. A macro for point
measurement is composed of coordinates and control characters. For the distance

measurement you can decide whether the slope distance, the horizontal distance, the vertical distance or a combination of distances is to be sent.

Grammar used in VirtuSurv Windows-macros

General control items:

Tabulator	<tab>
Enter	<enter>
Cursor control	
Left, right	<left>, <right>
Up, down	<up>, <down>

Components for point measurement:

X coordinate	|x|
Y coordinate	|y|
Z coordinate	|z|

Components for distance measurement:

Slope distance	|slope|	
Horizontal distance	|horizontal|	*(e.g. for the width of things, doors, windows)*
Vertical distance	|vertical|	*(e.g. for the height of things, doors, windows)*

Text that is not included in <> or | | will be passed directly to the application. If you would like to separate the coordinates by a semicolon, just enter the semicolon. If you want to write a prefix or suffix in front of or behind a measurement, simply enter it as text. Spaces, which have been entered between components, will also be passed directly.

Examples:

Sending the X, Y and Z coordinate into three different Excel columns with line break:

```
|x|<right>|y|<right>|z|<down><left><left>
```

Sending the horizontal distance and the vertical distance between two points, separated by semicolon, followed by ENTER (with "Width" or "Height" as prefix and "m" for metre as suffix):

```
Width: |horizontal| m; height: |vertical| m<enter>
```
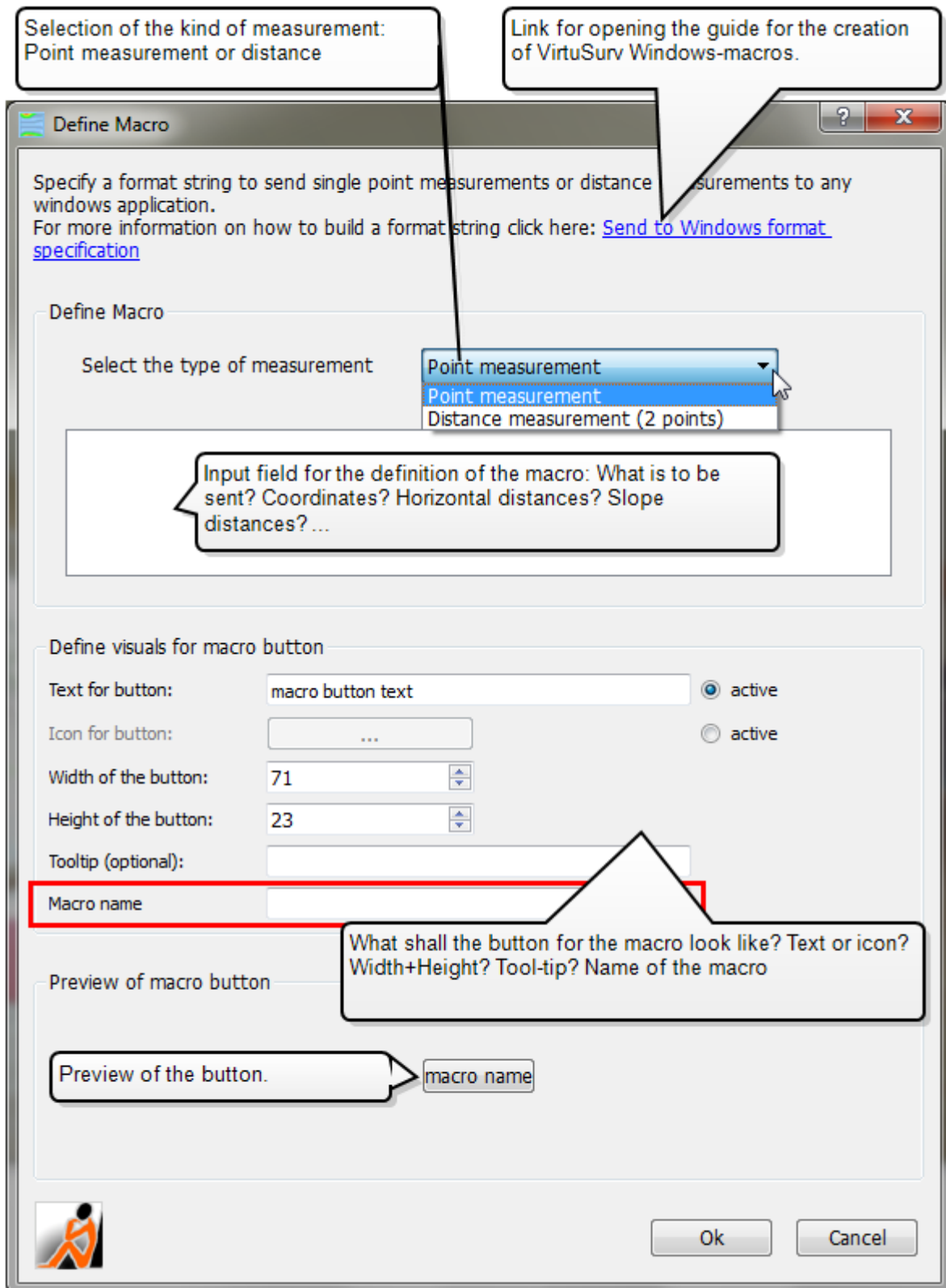
Hint:

The unit and the decimal separator are not configured in the macro definition but with the global command "Configure Measurement Unit" 🌵 from the "Measure mode" menu (see chapter **3.3.1**).

Example macros for Rhinoceros:

Macro for creating a planar surface:

```
_Plane<enter>_3Point<enter>w|x|,|y|,|z|<enter>
```

VirtuSurv sends this macro definition into Rhino's the command line as soon as you click a point in the scan:

_Plane	starts the command "PlanarSurface"
<enter>	control string for "Enter" confirms the command input
_3Point	calls the command option "3Points"
<enter>	control string for "Enter" confirms the command option
w	the „w" in front tells Rhino the coordinates refer to the world coordinate system.
|x|	X coordinate of the clicked point
,	Comma as coordinate separator
|y|	Y coordinate of the clicked point
,	Comma as coordinate separator
|z|	Z coordinate of the clicked point
<enter>	control string for "Enter" confirms the coordinate input

With the mouse click into the scan the macro is finished. If further coordinates are needed for the command, another macro needs to be started. For the "Create PlanarSurface" command this can be accomplished by sending further coordinates using following additional macro:

```
w|x|,|y|,|z|<enter>
```

This macro does not send any command to Rhino but simply the coordinate of the clicked point with a "w" for the world coordinate system in front of it. The macro is finished by sending an "Enter". This macro can be used universally and in combination with different Rhino commands. Even if you have not created a VirtuSurv macro for the Rhino command.

With this knowledge of the structure of the Rhino macro definitions you can now create your own individual macros for customising VirtuSurv to your needs when working with Rhino.

Hint: We have prepared further useful Rhino macros. You find these macros on our webpage which you can access by clicking the button in the "Help" menu or on the VirtuSurv tool-bar. In Chapter **3.4.4** you learn how to import these macros. Also read on page **27ff, how you can work with VirtuSurv and Rhino.**

3.4.3 Create new AutoCAD macros or BricsCAD macros

Open the relevant macro bar or and click on the **[New Macro]** button in order to create a new macro for sending AutoCAD or BricsCAD commands. The macro editor will open. You define the macro in the upper part, in the lower part you configure the appearance of the button. Please do not forget to assign a meaningful name to the macro. The macro name will be displayed when exporting or importing macros.

Link for opening the guide for the creation of VirtuSurv macros.

Define Macro

You can use macros to send commands and points to AutoCAD/LT.
For more information click here: AutoCAD/LT Macro description

Define Macro

Input field for the definition of the macro: What is to be sent? Commands? 2D coordinates? 3D coordinates?

Define visuals for macro button

Text for button:	macro button text	⦿ activ
Icon for button:	...	◯ activ
Width of the button:	71	
Height of the button:	23	
Tooltip (optional):		
Macro name		

What shall the button for the macro look like? Text or icon? Width+Height? Tool-tip? Name of the macro

Preview of macro button

Preview of the button.

macro name

Ok   Cancel

Grammar used in VirtuSurv AutoCAD/BricsCAD macros

Components for sending coordinates:

3D coordinates for exactly one point	|@3d|
2D coordinates for exactly one point	|@2d|
3D coordinates for an infinite number of points	|~3d|
2D coordinates for an infinite number of points	|~2d|

A macro consists of:

- CAD control items (e.g. ^C in front for cancelling or ^M or space for ENTER)
- CAD commands (displayed in **blue** below)
- Where applicable command line options of the CAD commands (displayed in **green** below)
- As well as the coordinate components specified above.

With the help of examples it will be easiest for you to learn which manifold options you have and how the control items are to be used. The use of upper and lower case letters is not important. Knowledge about the functioning of CAD command line call up is an advantage for the generation of macros. We would be happy to train you.

Important: There is a command line version (command name with minus prefix) for every AutoCAD command (the dialogue based as well). Everything you can enter into the AutoCAD command line can be transferred with a VirtuSurv macro.

Examples:

Drawing lines in 3D in AutoCAD:

```
^C^C_LINE |~3D|_CL ^M
```

The AutoCAD control characters **^C^C** finish commands, which could still be active in AutoCAD. **_LINE** is the language independent AutoCAD command for drawing lines. In this way the macro will work in a Russian or German AutoCAD as well. Between the AutoCAD command and the component for sending coordinates is a **space**, since in AutoCAD the space is used to confirm the inputs or commands. That means the space is the same as ENTER. You may also write **^M** (as ENTER) instead of the space into the macro. AutoCAD expects any number of 3D points for drawing lines, therefore the **|~3d|** component is used. **_CL** is the AutoCAD command line option for closing the line run.

To finish the macro you can click the button in the macro bar. You will have to finish the line command in AutoCAD yourself, since it is an open macro with an infinite number of points.

You can decide yourself whether to finish with ENTER or ESC or if you want to use the "Close" option. ***You may also finish the macro by clicking the right mouse button in the scan window. At the same time the command in AutoCAD is finished too using the "close" option.***

You want to draw only <u>one</u> line (two 3D points)? Change the macro as follows:

```
^C^C_LINE |@3d||@3d|^C^C
```

Please note that there must <u>not</u> be any space between the placeholders for the 3D coordinates. Since the number of points is limited to two, the line command can be finished at the end of the macro - therefore ^C^C at the end. Macro and line command are here automatically finished.

Drawing a circle *through three points in AutoCAD:*

```
^C^C_CIRCLE^M3p |@3d||@2d||@2d|
```

Please note that there has to be a space or ^M behind the AutoCAD command. The 3P option has to be called up in order for the circle to be drawn through three points on the circumference. A circle is a plane element in AutoCAD, which will always be drawn parallel to the XY plane of the current user coordinate system (UCS) at the height of the Z value of the first point. Therefore AutoCAD expects 3D coordinate for the first point but only 2D coordinates for the following two points. Keep this in mind for all 2D AutoCAD drawing elements. The circle command is automatically finished after entering the three points and the macro is also finished without any further interaction.

Defining UCS *through three points in AutoCAD:*

```
^C^C_UCS _3 |@3d||@3d||@3d|
```

This macro runs the AutoCAD command for the definition of a UCS. Please note that there has to be a **space (or ^M for ENTER)** after the command name. _3 is the command line option, which states, that the UCS will be defined by three points. Firstly, AutoCAD expects the point for the origin of the new UCS, then the direction of the positive X axis and at last a point with positive Y coordinate. As user of this macro you have to know this in order to click the three points in the scan in the correct order.

You may also run **several commands successively** in one macro.

Here an example:

```
^C^C_Line |~3d|^C^C_Circle 3p |@3d||@2d||@2d|^C^C
```

A run of lines is drawn through a previously not defined number of points and afterwards a circle through three points. *How does VirtuSurv know when the line is finished* and when to

begin drawing the circle? When you have clicked enough points for the line run in the scan, simply click the right mouse button in the scan window. With this the sub macro for the drawing of the line is finished and VirtuSurv executes the next command in the macro – here the drawing of the circle.

Drawing a **line on a certain layer** (AutoCAD):

```
^C^C_-LAYER^M_T^MWand^M_M^MWand^M_S^MWand^M^M_LINE^M|~3d|^M
```

The language independent command line version of the layer manager will be started

(**_-LAYER**). After that the **_T** option unfreezes the layer with the name *Wall* if it should be frozen. Then the **_M** (make) option is used in order to create the layer Wall if it does not yet exist in the AutoCAD drawing. The layer *Wall* is set 'current' with the **_S** option. The layer command is finished by a double ENTER and the line command will be called up. ^M was written as closure, so the line command and the macro can be finished by a right-click in the scan. If you finish the macro per click on the relevant button, the line command in AutoCAD will still be active and you can decide yourself whether you want to close the line run or not.

Do you always want to generate closed line runs with the macro? Then insert the **_C** option for "Close" before the last ^M.

Inserting a block *that is* **already defined** *in the drawing (AutoCAD):*

```
^C^C_-INSERT^Mlampe^M|@3D|^M^M^M
```

The language independent command line version of the INSERT command will be started (**_-INSERT**). "Lamp" is the name of the block definition in the AutoCAD drawing template. With |@3d| the 3D coordinates of a single point are transferred to AutoCAD. The macro ends with three times ^M for ENTER: the first one confirms the coordinate. The other two ENTER confirm the insertion scale and the rotation of the block like they have been entered during previous block insertion (default: 1 for the scale, 0 for the rotation).

Hint: Not only AutoCAD commands but also commands of AutoCAD plug-ins are usable in the VirtuSurv macros. FARO provides a number of AutoCAD plug-ins.

Hint: We have prepared additional useful macros (e.g. for drawing 2D). You find these macros on our webpage which you can access by clicking the 🐞 button in the "Help" menu or on the VirtuSurv tool-bar. In Chapter **3.4.4** you learn how to import these macros.

3.4.4 Transfer macro definitions to other computers

In order for you to be able to transfer VirtuSurv macros to other computers and to make it available to other users, there are the [Export Macros] and [Import Macros] buttons at the bottom of all macro bars (🔺 , 🔧 and 🗂).

Click **[Export Macros]** to save your macros to an external text file. Select the folder where you want to file the macros and confirm with [OK]. In the target folder a sub directory with the name "VirtuSurvMacros" will be created. It contains a folder "MacroImages" where the icons of your self-defined macros will be stored if applicable. The macros themselves are written to AUTOCAD MACROS.TXT or WINDOWS MACROS.TXT.

Just forward the "VirtuSurvMacros" folder to other VirtuSurv users or copy the folder to the new computer.

On the target computer open the desired macro bar in VirtuSurv. Then click on **[Import Macros]**. Browse to the copied "VirtuSurvMacros" folder in the file selection window and open AUTOCAD MACROS.TXT, BRICSCAD MACROS.TXT or WINDOWS MACROS.TXT according to the kind of macro you would like to import. The following dialogue box opens:
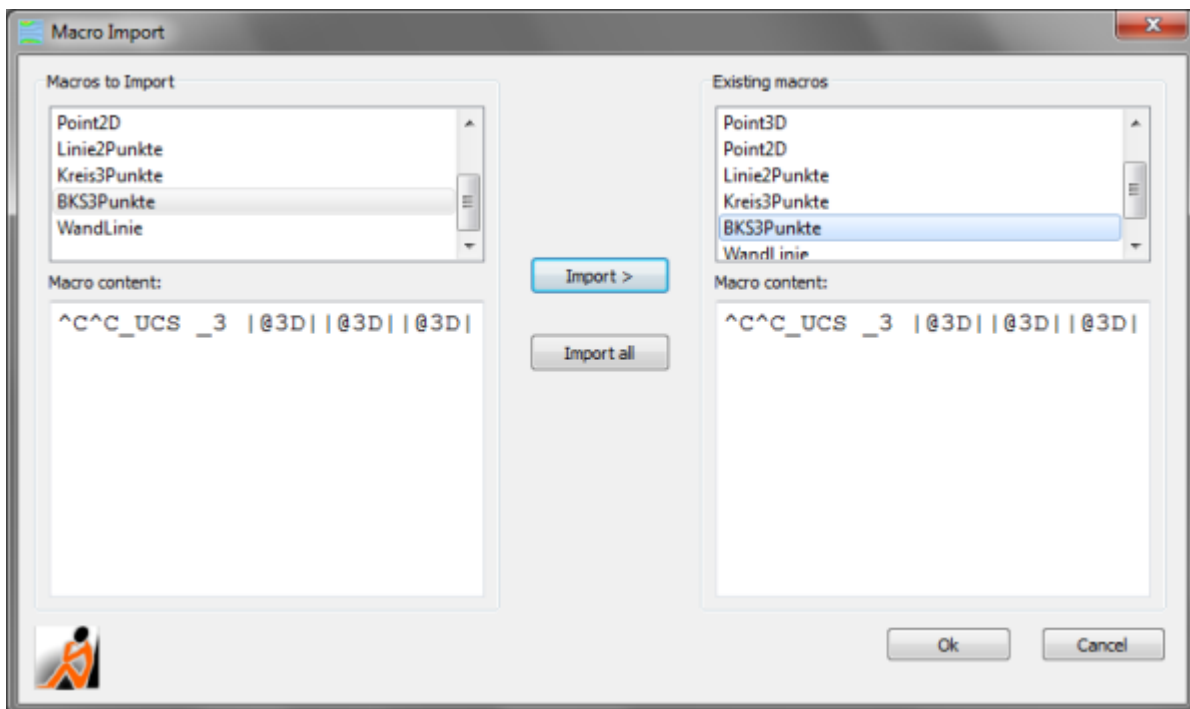
On the left you find the list of the macros for the import, contained in the TXT file, on the right the list with the macros already existing in VirtuSurv. Select the macros you would like to import and then click [Import >]. With [Import all] you can import all macros at once.

If a macro to be imported has the same name as an existing macro a dialogue box will open,
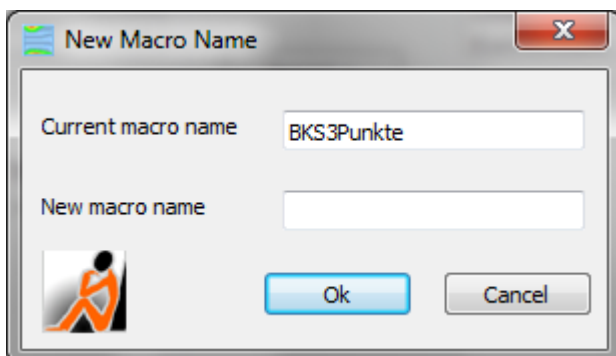
where you can change the name of the macro to be imported. For safety reasons existing macros are not automatically overwritten.

In order that you do not have the same macro twice in the macro bar, but just with different names, it is possible to compare the contents of an existing macro with the contents of a macro to be imported. To do so select the macros you want to compare in the left and right list. The content of the according macro is displayed in the window below.

When you have made your choice for the import, confirm with [OK].

3.5 Create a new project

VirtuSurv can only be used with one project opened. Therefore you may create a new project directly from the Welcome screen. Just click the relevant button . Now enter a project name and select the path for where to save the project.

If you have just been working on a project in VirtuSurv and want to create a new one you may run the "New Project" command **from the "F**ile" menu or the tool-bar. After entering directory and name the previous project will be closed. If relevant you are asked if you want to save changes.

In the target folder VirtuSurv creates a project directory with the name of the project. It contains the VirtuSurv project file {PROJECTNAME}.PVP, which is opened in VirtuSurv and will reference the single scans you add to the project.

The name of the newly generated, empty project appears in the Project Explorer.

Now you can *add* scans to the project either by importing new scan data (see chapter **3.6**) or by adding VirtuSurv single scans (PVS files). For the second option just right click on the project name in the Project Explorer and run the "**Add scans**" command from the context menu. A dialogue box opens. Click the [Add scans from directory] button and browse to the directory containing the scans. VirtuSurv will list all single scans it found there. You may now select all or just some of the scans and add them to your new project by clicking [OK]. VirtuSurv will copy them to the new project directory. Please save the project (→). The changes are now written to the project file.

If scans of different scanner types have been registered in the same superior coordinate system, you can combine them in *one* project.

3.6 Import scan data

In VirtuSurv the scan data is displayed in a photo-like planar view. The three dimensional information of the scan is maintained. VirtuSurv works with an optimised format to avoid long waiting times when opening the scan data and when working with them.

VirtuSurv supports the import of different scan data formats. At the moment these are:

- PTX (format which is supported by different scanner manufacturers)

- PTG (Leica, but also supported by other manufacturers)

- FLS, FWS, LSPROJ (FARO single scans and projects)

- CL3, CLR (Topcon)

- E57 (independent standard exchange format, supported by Riegl, Trimble, FARO, Autodesk and many more manufacturers)

If the scans have been registered in the same superior coordinate system, the single scans of different scanner types can be combined in one project. *You learn how to create a new project in chapter3.5*.

If you want to import a scan or a scan project, run the **"Import Scans"** 🔍 command from the "File" menu. The import dialogue box opens:
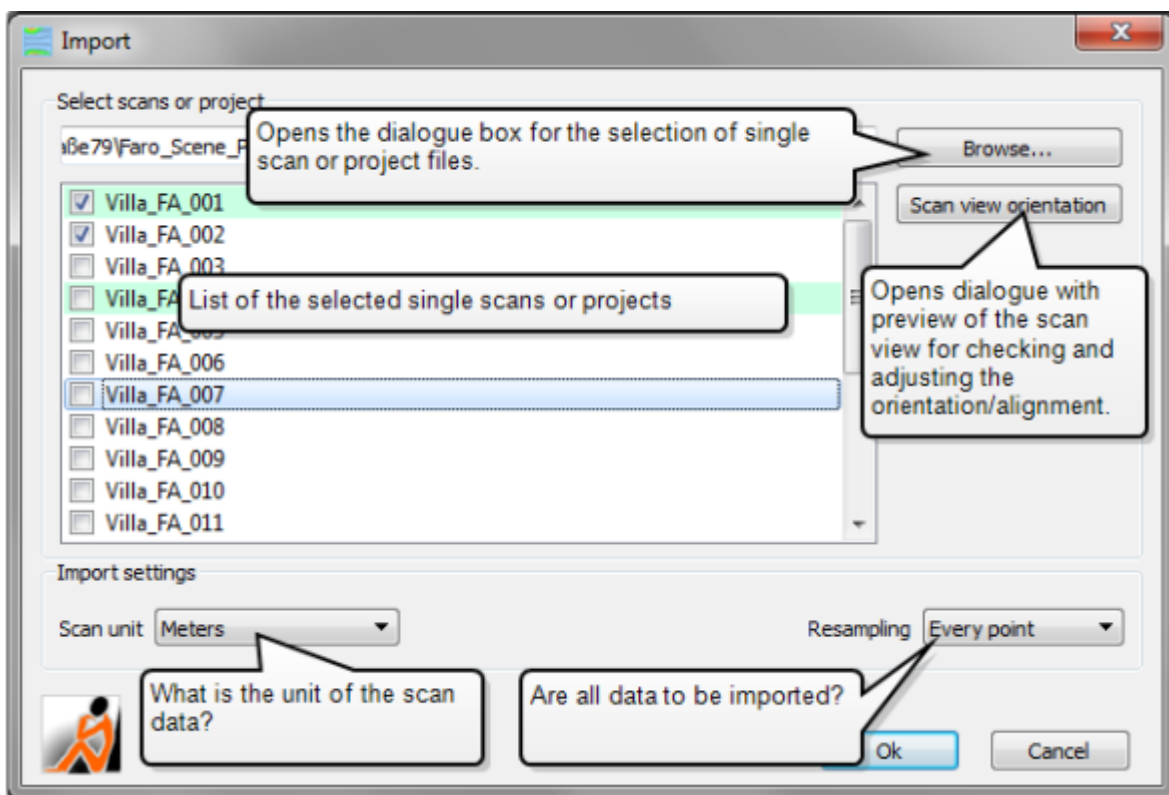
Section "Select scans or project"

Select the data you want to import under "Select scans or project". Click on [Browse] and browse to your single scan files or your scan project. You may select several single scans at the same time. If the single scans are filed in different directories, press [Browse] again until you have selected all of the scans that you want to import. If, instead of single scans, you have selected a scan project file (e.g. FWS, LSPROJ or ZFPRJ), it can take a few seconds

before the single scans will be displayed in the import list. All of the selected scan files will be shown together in the import list. Should you want to exclude individual files from being imported, remove the selection tick before the particular scan. Hint: You can highlight (light blue) all scans with Ctrl+A, or Ctrl+left mouse button or Shift+left mouse button for multiple scans. The selection tick will then be respectively removed or set for all highlighted scans.

Button [Scan view orientation]

Use this option when you are unsure whether your scans have been saved standing on their heads or as a mirrored image, as the case may be. You can then ensure **before** the time-consuming import, whether the scans will be correctly aligned when imported. Also take note of the information further below on specific scan data formats.

With a single click on the button [Scan view orientation] you can create a preview for one of the scans highlighted (light blue) in the list. It can take a few seconds before the dialogue box opens, as the preview must first be computed:
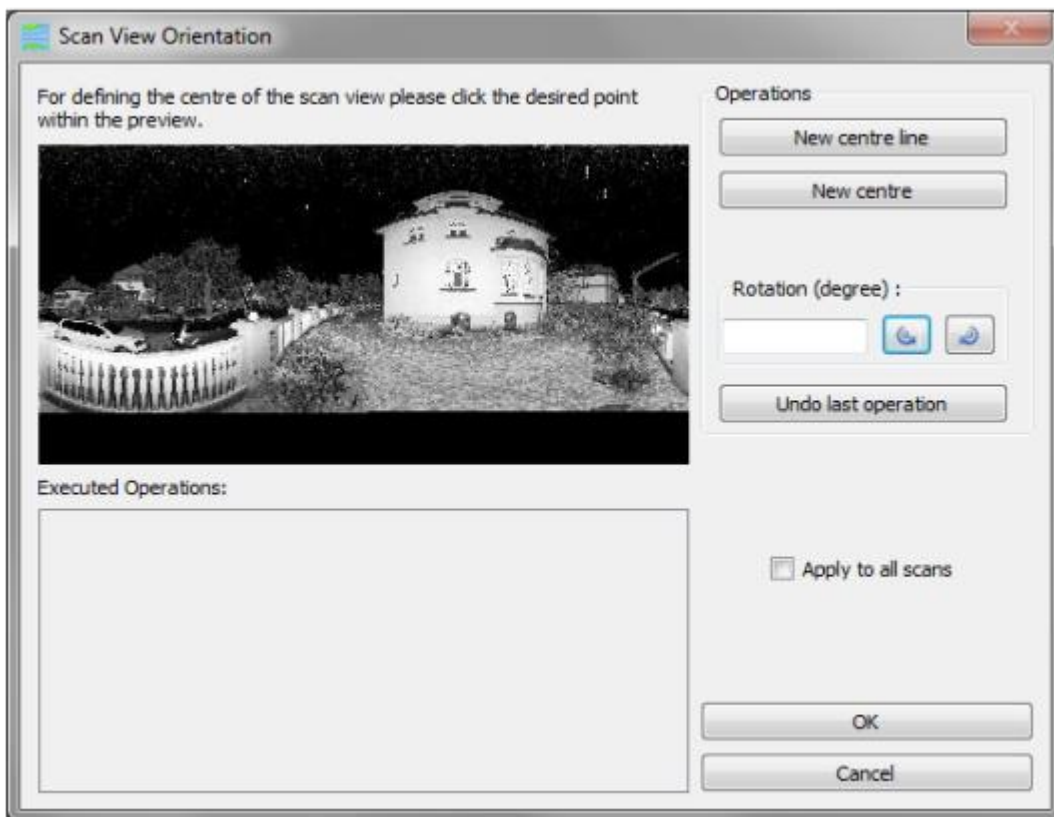
You can see in the black and white preview how the scan that you selected will look like after it has been imported. To the right of the preview pane in the "Operations" group you will find some tools with which you can correct the alignment of the scan view.

▪ [New centre line]: Click on this button and then in the preview precisely where you want to define the new vertical centreline of the scan view. This is useful should a scan be split on an inappropriate position.

- [New centre]: Click on this button and then in the preview precisely where you want to set the new centre point of the scan view. This is useful where the scanner has been set up horizontally, but you now want to work on a fresco on the ceiling. In the preview click on a point on the ceiling:

This now becomes the centre of the new view
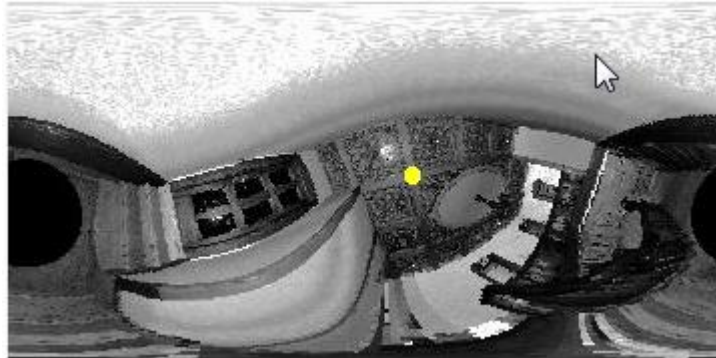
- [Rotation]: Here you can rotate the scan view by a defined angular value.

You can use multiple operations in succession on a single scan.

Example of use PTX scans:

Preview without any operations

270° clockwise rotation

In the pane under the preview you can see which operations have been carried out, to show how it now is and how it will be imported, just as it can now be seen in the preview.

With [Undo last operation] you can in each case undo the previous operation. Should you want to apply the operations to all of the scans that are to be imported, activate the option "Apply to all scans". **Caution**: It is not advisable to apply the operation "New centre line" to all scans, as it is rather an individual operation for single scans.

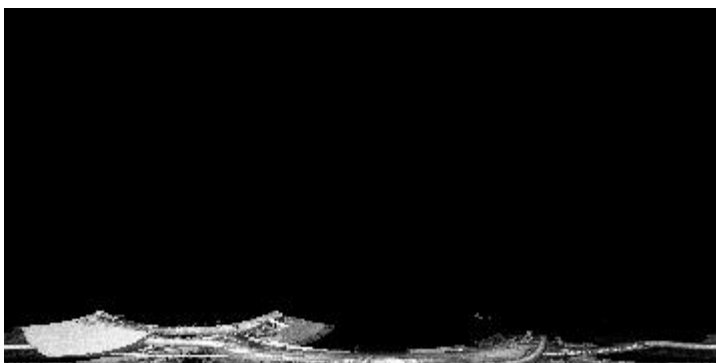With [OK] you accept all of the settings for the import and return to the import dialogue box, whereas with [Cancel] the settings will be discarded.

Scans with a preview already calculated are highlighted light-green in the scan list.

Section "Import settings"

Here you state in which unit (Scan unit) your scan data exist. This information is ***very important!*** It is the basis for the conversion into the measurement unit. VirtuSurv can only calculate the measurement values correctly, when you state the correct Scan unit during the import.

With the 'resampling' you determine, whether you want to import all scan points to VirtuSurv or if the scans are to be thinned out. Thinning out reduces the data volume. It is only recommendable, if you scanned with a much higher resolution as is needed for the required evaluation.

After you have entered all settings, start the import by clicking **[OK]**. According to the project size (resolution, number of scans) and processor power this may take a fairly long time (up to several hours).

When the import is finished and all scans have been imported successfully, you will get an appropriate message, which you close by clicking [OK]. Now the scans will be displayed in the Project Explorer. The scanner positions will also be displayed in the scan map.

VirtuSurv will automatically generate one folder per single scan in the project directory.

The name is {Name of the original scan file}-SingleScan.

The SingleScan directory contains the PVS file, which can be opened with VirtuSurv, as well as a folder with images that are referenced in the PVS file. The PVS file itself is referenced in

the VirtuSurv project file (*.PVP). Also every VirtuSurv single scan knows which project it belongs to.

3.6.1 Remarks on the PTG format

PTG files do sometimes contain data upside down.

Should you be unsure whether your scans will be standing on their heads and thereby must be rotated on import, use the preview in the import dialogue box (button **[Scan view orientation]**).

3.6.2 Remarks on PTX import

PTX is an ASCII-Format, which is supported by different scanner manufacturers. Unfortunately this format is not standardised and scanner manufacturers save the format of their PTX files differently. They will be correctly displayed in the manufacturers' software. Whilst the manufacturers software will display its own PTX format correctly it is difficult for us and VirtuSurv to automatically accommodate all of the differences. We therefore highly recommend that with this format to use the preview in the import dialogue box (button **[Scan view orientation]**).

3.6.3 Remarks on Topcon import

Please note that CL3 files can only be imported, if the relevant *.ij and *.alg files are available it the same folder.

CLR files can only be imported, if the relevant *.alg files are available it the same folder.

3.7 Exporting point clouds

An advantage of VirtuSurv, is that you do not have to import the large and ponderous laser scan data into the CAD system in order to be able to draw with them. However, if you want to generate point clouds from the data, in order to forward them to customers and other users for example, you may do that with VirtuSurv.

You can export projects, scans and parts of scans into point clouds. At the moment VirtuSurv supports the export to LAS format, PTS (ASCII) format and FARO/kubit's point cloud format PTC. LAS files can for example be imported into AutoCAD (starting with version 2011). With FAROs AutoCAD plug-in "PointSense" for the evaluation of laser scanner data, PTS and PTC files can be imported, even into older AutoCAD versions.

3.7.1 Exporting complete projects

For the export of a complete project right-click on the project name in the Project Explorer and select the 🐾 **"Export all…"** option from the context menu. The export dialogue box opens:
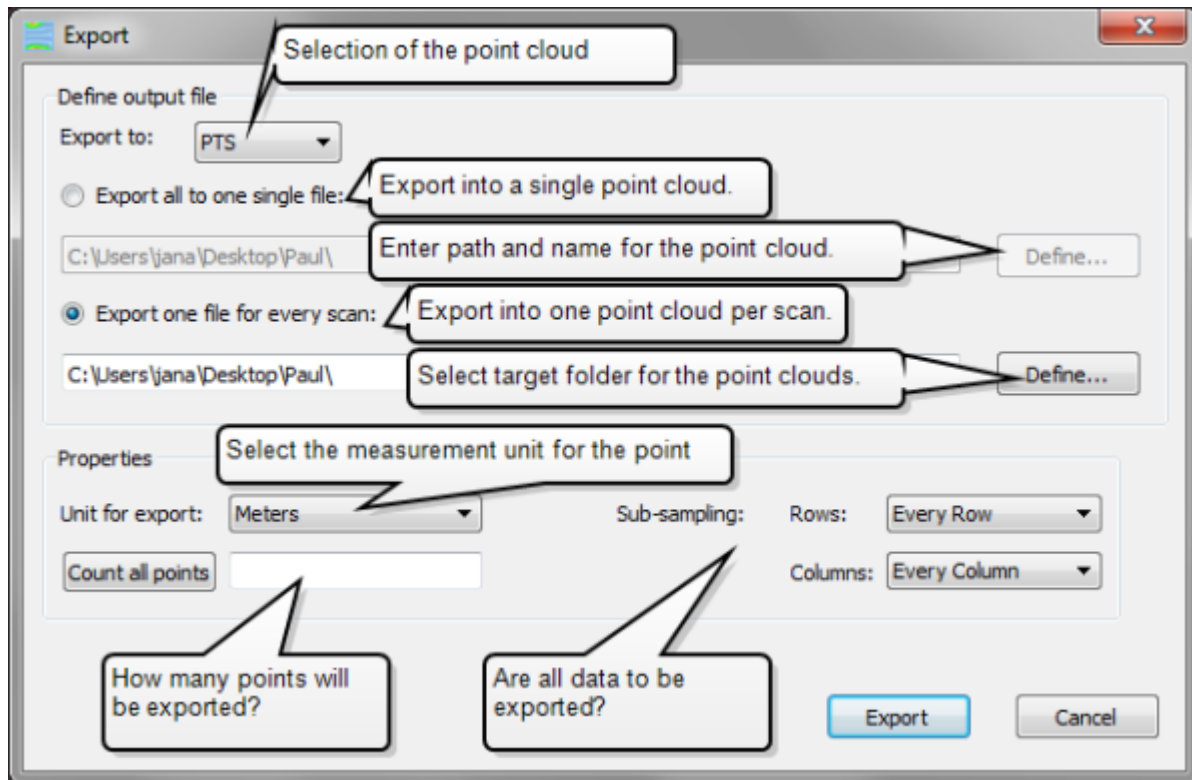
Section "Define output file"

Here you determine, into which point cloud format will be exported and if the complete project is to be written into one single point cloud or if one point cloud is to be generated for every scan. If you want to export only one point cloud, you are prompted for the target folder and the name for the point cloud file after clicking **[Define]**. When exporting into several point clouds you only have to state the name of the target folder and the name of the single point clouds are generated form the name of the according scan.

Please note, that it is only possible to export into several point cloud files, when exporting into the PTC format, since very large (more than 50 million points) PTC point clouds cannot be handled in AutoCAD.

Section "Properties"

Determine the desired measurement unit for the point cloud to be generated.

You may thin out the data during the export by rows and columns. The default setting is "Every Row" and "Every Column" that means everything will be exported and nothing will be thinned out.

When clicking on [Count all points], VirtuSurv will determine how many points will be exported. This way you can control, how large the point cloud is going to be and you can estimate if it can still be handled in AutoCAD for example.

Click **[Export]** in order to start the export.

3.7.2 Export of scans and parts of scans

In order to export selected scans or certain parts of scans - in the Project Explorer – right-click on the desired scan and select the **"Export..."** entry from the context menu. Please note that the scan view has to be opened to do so. The export dialogue box for single scans opens:

Under "Define output file" you determine the target folder for the exported point cloud, enter the file name and define the file type (LAS, PTS or PTC). To do so click [Define].

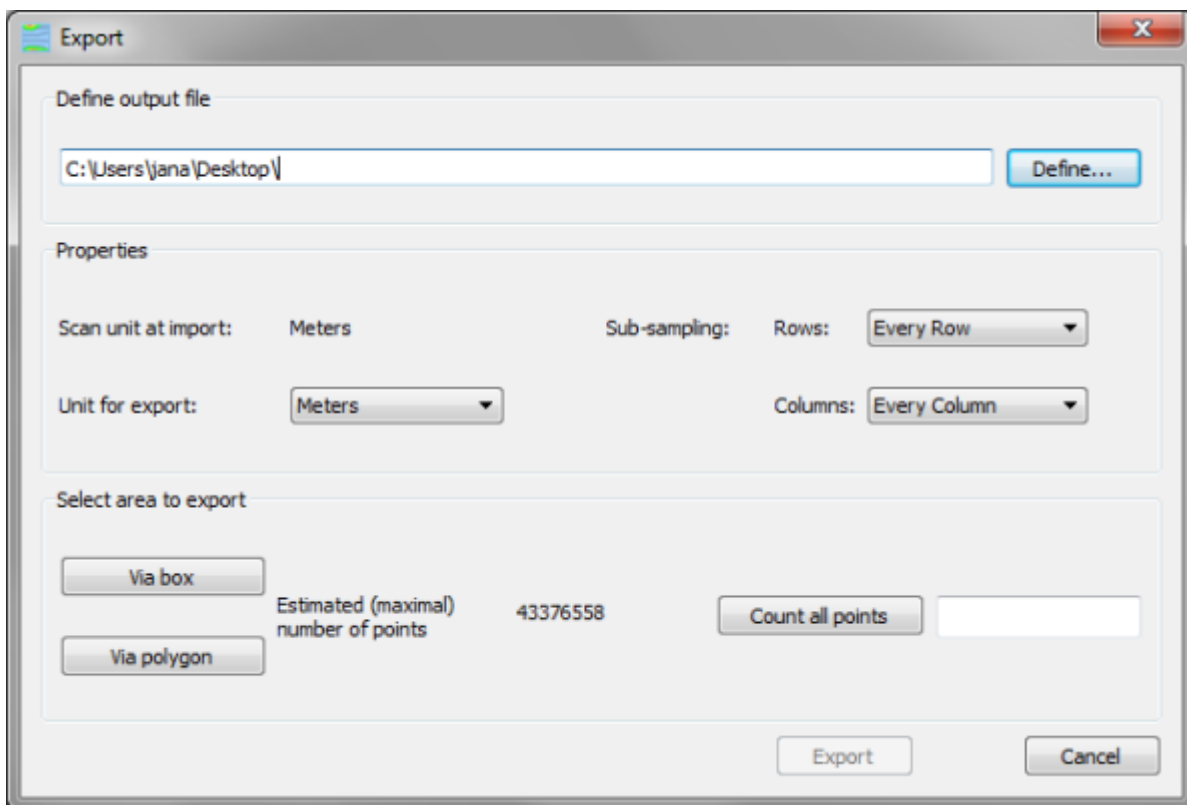In the **"Properties"** section you determine the desired measurement unit for the point cloud to be generated (Unit for export). You may thin out the data during the export by rows and columns. The default setting is "Every Row" and "Every Column" that means everything will be exported and nothing will be thinned out.

Section "Select area to export"

Here you can define the area which is to be exported. When clicking on [Count all points] VirtuSurv will determine how many points lie in the selected area. This way you can estimate if the exported point cloud will be manageable.

With the **[Via box]** button you start the area selection with a rectangular selection window. The dialogue disappears and you can select the area to be exported.

With the **[Via polygon]** button you start the area selection via a freely definable polygon. The dialogue box disappears and you select the area to be exported by clicking the surrounding polygon. Caution, the first line will only be visible, when you have clicked the second point. You close the polygon by clicking the right mouse button.

If you want to export the complete scan, you do not have to select an area, simply click **[Export]**.

4 3rd Party Libraries

4.1 VXL Library

VirtuSurv uses the VXL library

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4.2 Qt Framework

VirtuSurv uses Qt

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