



## CrossPoint® User manual

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## About this manual

ImpulseRadar CrossPoint® is a Windows™ based software program for the visualisation of ImpulseRadar ground penetrating Radar (GPR) data files collected with either CrossOver® or Raptor® systems. The software also supports some third-party GPR file formats, which are documented in Appendix ?

This manual is structured as follows:

- Section 1 – Introduction software installation, setup, features and functions
- Section 2 – Tutorial menus and working with files
- Section 3 – Appendices additional notes and technical information

For further information on the use of this software, please contact your local ImpulseRadar representative, or our support team at: [support@impulseradar.se](mailto:support@impulseradar.se)

We welcome your feedback in relation to this manual and its content. Please send your comments or suggestions to us at: [info@impulseradar.se](mailto:info@impulseradar.se)

## Licence Agreement

During the installation and setup of ImpulseRadar CrossPoint® software, you will be prompted to read and accept the following license agreement. You must accept the terms of this agreement before continuing with the installation.

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## Notice

ImpulseRadar products are under continuous development and we reserve the right to change specifications and the content of this manual at any time and without prior notice. You may verify product specifications or current versions of this manual at any time by contacting our headquarters using the details listed herein.

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# Introduction

## Overview

ImpulseRadar CrossPoint® is a proprietary Windows™ based software program for the visualisation and interpretation of ImpulseRadar data files. CrossPoint® can import and work with data files collected with ImpulseRadar CrossOver® and Raptor® systems, as well as some other third-party GPR file formats (refer to Appendix ?). The software works with profiles from single or multi-line projects; for those collected with GPS, a background map overlay can be activated for geo-referencing marked data points.

The software includes features to efficiently process data, mark points of interest within radar profiles, visualise markers on a map, and export markers for geo-referencing in Google Earth and supported CAD/GIS platforms.

## PC Requirements

- OS Windows™ 7 or later
- Processor 1 GHz or faster, 32-bit (x86) or 64-bit (x64)
- Memory 1 GB RAM (32-bit), or 2 GB RAM (64-bit)
- Storage 16 GB available hard disk space (32-bit), or 20 GB (64-bit)
- Graphics DirectX 9 graphics device with WDDM 1.0 or higher driver

## Installation & Setup

CrossPoint® is typically supplied with your ImpulseRadar GPR system on a USB flash-drive. It is also available for download from the 'Resources' area of the ImpulseRadar website at: <http://www.impulseradar.se/resources/>

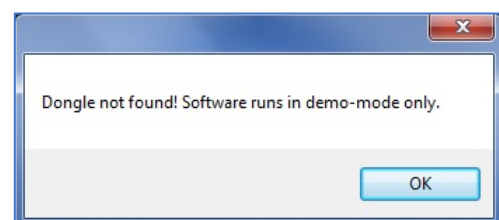
### Installation process

- Locate and open the setup file to begin installation
- Click 'Run' and 'Allow' if prompted with security warnings for unknown publisher
- Read and accept the license agreement, then click 'Next' to continue
- Click 'Install' to continue with the installation
- Click 'Finish' to exit Setup

CrossPoint® should now be installed on your PC and available from either the Windows start menu, or from the CrossPoint® icon on your desktop.

### Protection

CrossPoint® software is protected by a software key contained on a USB dongle. Ensure the dongle is connected before starting the software. If the dongle is not detected at start-up, a warning message will be displayed, as shown in **Figure 1**. The software can still run without the dongle, but only in 'demo' mode with limited functionality to open and view files only.

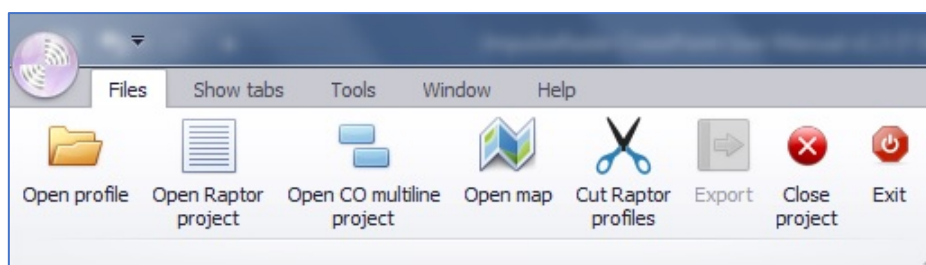


*Figure 1 Software protection warning*

# Tutorial

## Home Screen Menus

At launch, the main home screen is displayed, which includes several drop-down menu options as shown in **Figure 2** below. The following sections provide an overview of these menu options.



*Figure 2 Home screen menu bar*

## Files

This is the main menu for working with files. The function of each option is described below in **Table 1**. A detailed explanation with guidance can be found under the section titled 'Working with files'.

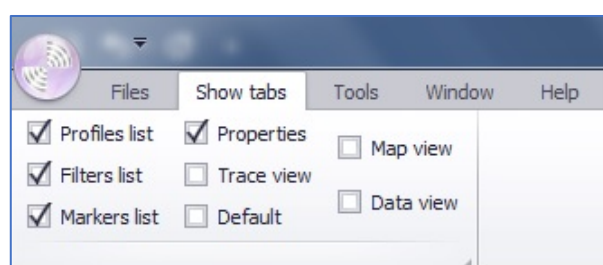
Files Option	Description
Open profile	Import single CrossOver® or Raptor® data file (*.iprb)
Open Raptor® project	Import all swaths included in a Raptor® project (*.ord)
Open CO multiline project	Import all data files included in a CrossOver® multiline project (*.mlproj)
Open map	Load background map and overlay CrossOver® and Raptor® profiles to show location (only if GPS coordinates have been saved)
Cut Raptor® profiles	Import single Raptor® data file and cut profile into smaller sections for easier handling in 3 <sup>rd</sup> -party processing software
Export	Export of selected markers to text (*.txt) or Google (*.kmz) format
Close project	Save and close the active project
Exit	Quit the software

*Table 1 Explanation of 'Files' menu options*

## Show Tabs

This menu controls the different tabs that can be displayed when working with files. Tab choices can be set by selecting/deselecting the appropriate check-boxes, as shown in **Figure 3**.

The function of these tabs is described below in **Table 2**.



*Figure 3 'Show tabs' menu*

Files Option	Description
Profiles list	Provides a list of imported profiles. The user can select which profiles to view in the data view (radargram) window.
Filters list	Different filters can be applied within the filter tab. CrossOver® profiles with both low and high frequency antenna data need to be filtered separately. When working with CrossOver® multi-line and Raptor® projects, the selected filters are applied to all profiles within the project. Such projects do not permit the filtering of individual profiles.
Markers list	Displays information about applied markers, including which profile they belong to, position and depth. The user can select markers for export in either ASCII or KML format.
Properties	
Trace view	Displays the radar trace for a given position within a profile. The user can change the amplitude scale using the zoom buttons (+/-). Selecting the 'eye' icon activates a function to measure different parameters on the trace itself, such as peak-to-peak value, frequency and more. Once activated, use the left-mouse button to move the solid red cursors to the desired position on the trace.
Default	
Map view	
Data view	

**Table 2** Tabs and their function

## Tools

This menu includes the palette manager and settings menu, as shown in **Figure 4**.

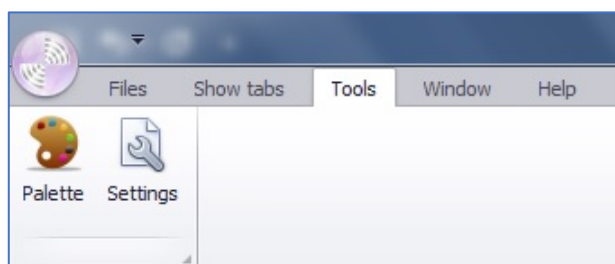
### Palette Manager

The palette manager gives you the ability to change the radargram colour scheme from the default (black/white) to a new user-defined arrangement, or to a previously saved scheme.

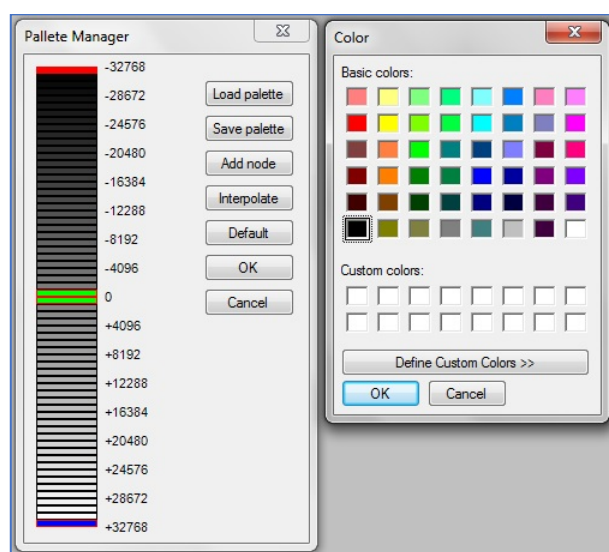
As shown in **Figure 5**, any given point on the amplitude scale can be assigned an individual colour. Simply double-click a point on the scale to bring up the colour options. Each point on the scale can be assigned an individual colour manually as per your preference.

Alternatively, the interpolate function allows you to build a colour scheme by changing the colour of a few key points, such as max +/- and zero, then the palette manager will develop a spectrum of colours accordingly.

User-defined palettes can be saved for future use.



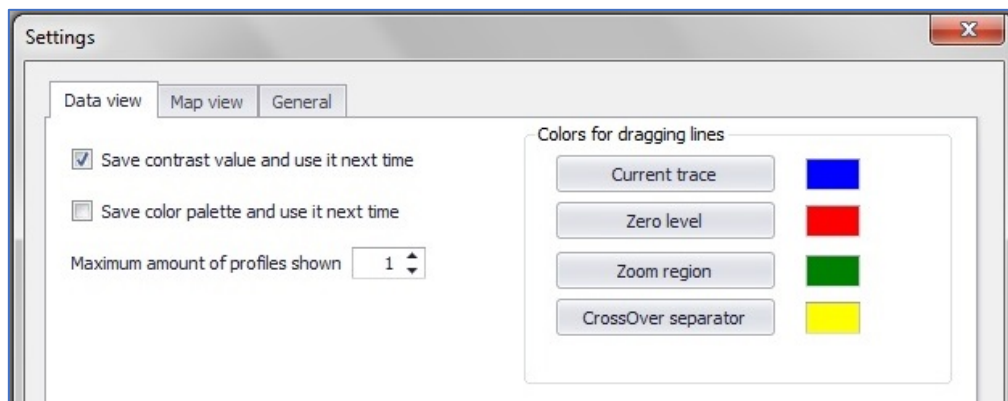
**Figure 4** Tools menu



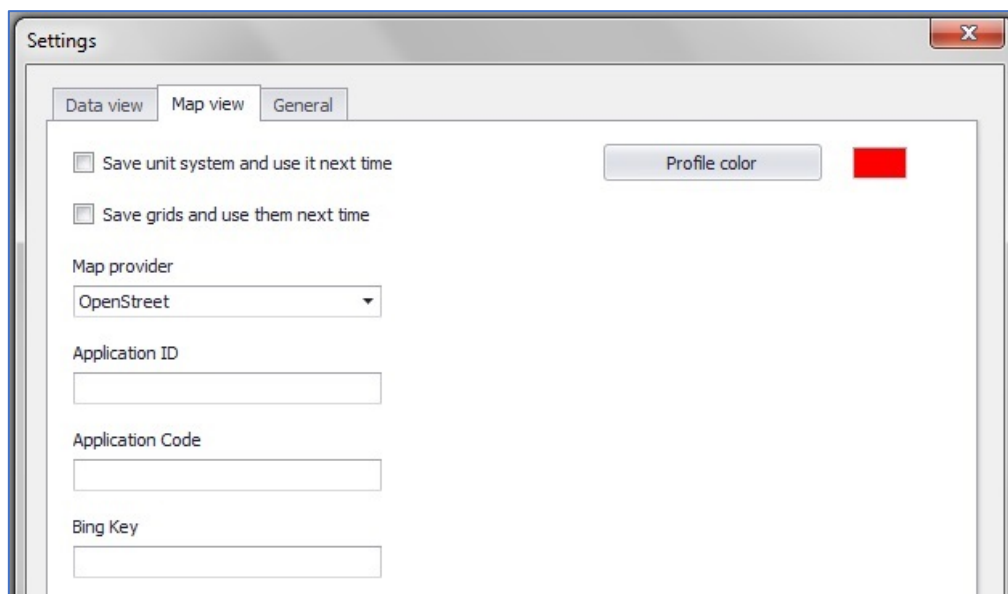
**Figure 5** Palette manager

## Settings

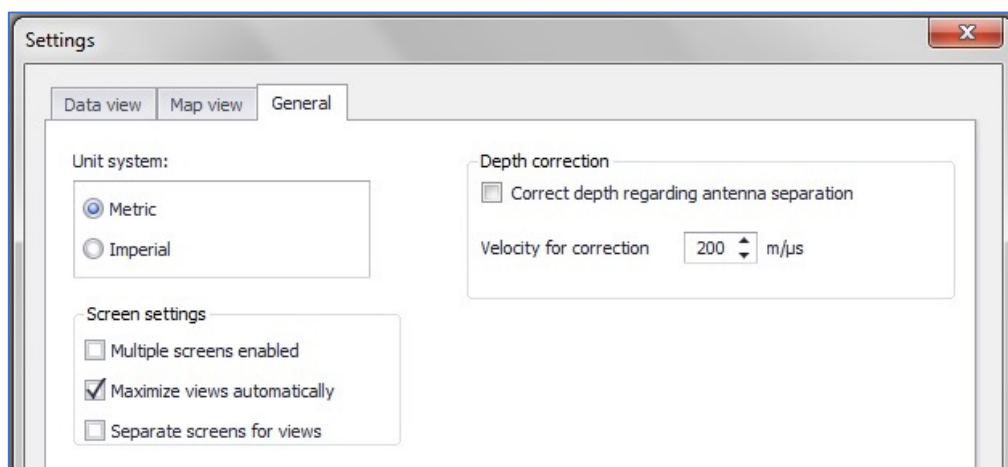
This menu includes several self-explanatory sub-menus, which include options related to general settings and those specifically for data and map views. Refer to **Figure 6**, **Figure 7** and **Figure 8** below.



*Figure 6 Settings – data view*



*Figure 7 Settings – map view*



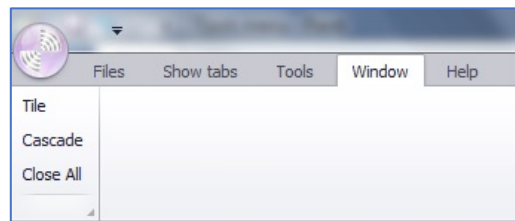
*Figure 8 Settings - general*



## Window

This menu allows you to control the way that CrossPoint® windows are displayed on screen.

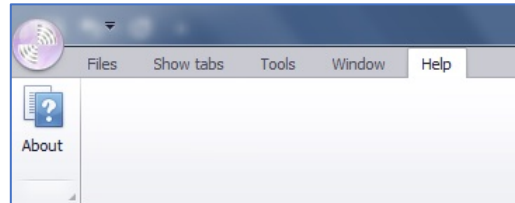
- **Tile** – organizes the windows into mutually non-overlapping frames within the screen
- **Cascade** – display windows in a progressive order, so that all title bars appear on screen



*Figure 9 Window menu*

## Help

This menu includes help topics and general information about the software, such as version/release number.



*Figure 10 Help menu*

## Working with Files

### Open Profile

From the home screen menu, select 'Files' and 'Open profile' to choose the data file to be opened. CrossPoint® is generally used to open CrossOver® data files but can also work with several other file formats. Therefore, when opening a file, the software will prompt you and ask about the file type, as shown in **Figure 11**. Unless opening a Raptor® file, or other supported third-party data file, select 'Yes'.

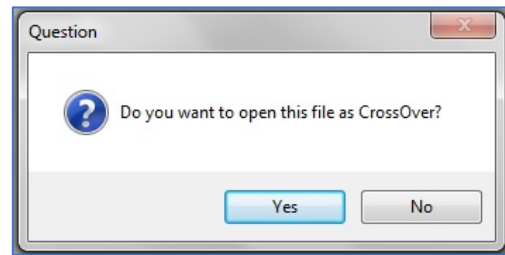


Figure 11 Open file question prompt

The corresponding radar data is imported, and three windows will be displayed, as shown in **Figure 12** below.

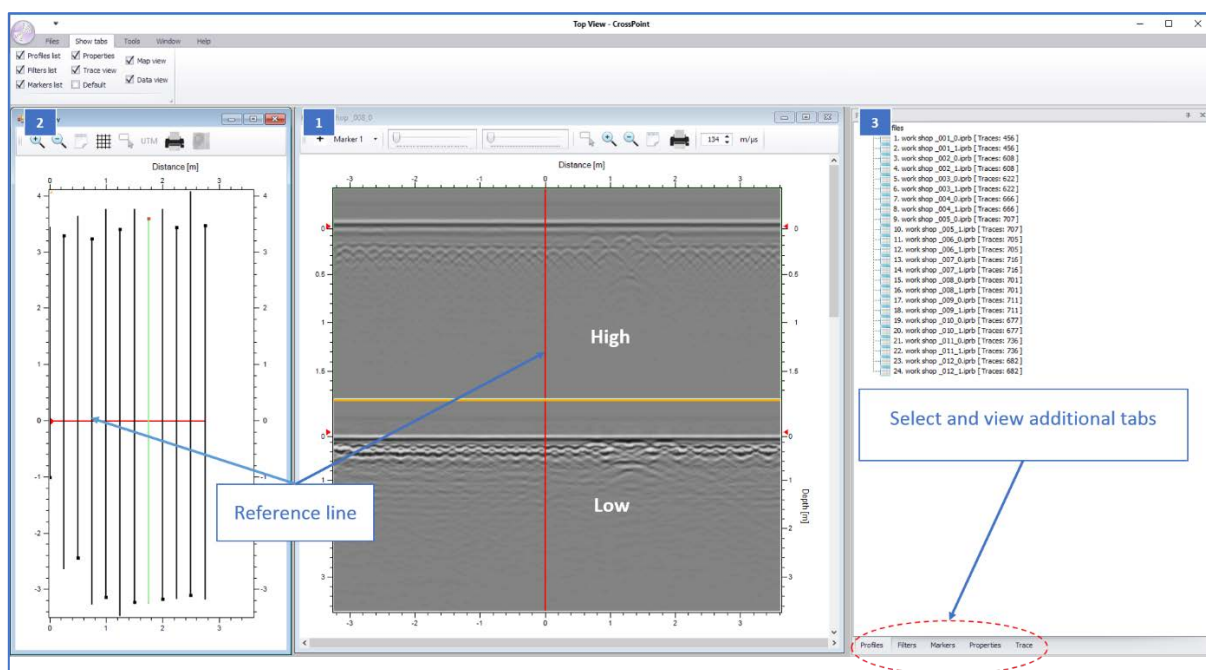


Figure 12 Layout after opening data file

The function of these windows is detailed below in **Table 3**, with a detailed explanation in the following sections.

Files Option	Description
1. Data view	Shows the radar data for the imported file/s (up to the maximum number of profiles defined in settings).
2. Top view	Shows a graphical representation of the open profile, or group of profiles (multi-line project), including associated alignment. If selected, a background map will also be shown, but only if the radar data includes GPS. The profile/s will be overlaid as black lines.
3. Trace view	Displays the trace for any given point in the radar data. Additional tabs, selected via the <b>Show Tabs</b> menu, are also pinned to this menu by default.

Table 3 Description of window functions when working with files

## Data View Window

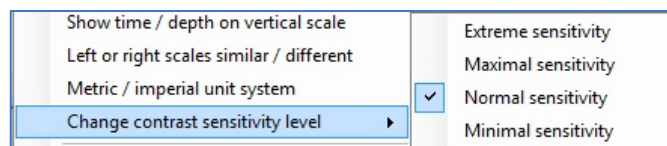
As the name suggests, this is where radar data is displayed. CrossOver® data is always displayed with the high frequency data positioned above the low frequency data set, separated equally by a moveable cursor. This cursor can be moved into a different position depending on your needs, simply click and hold the line to drag it where needed. To completely hide the high or low frequency data, simply drag the cursor to either the top or bottom of the data view screen respectively.

Individual contrast control bars are available at the top of the data view window, as per **Figure 13** below. The contrast of the high frequency channel is adjusted by the left control bar, whilst the low frequency channel is adjusted by the right control bar.



**Figure 13** Data View window control menu bar

**Tip:** if the contrast effect appears too strong, the sensitivity can be adjusted by accessing the 'change contrast sensitivity level' option from the data view menu options. Simply right-click within the data view window and select the appropriate options, as shown in **Figure 14**.



**Figure 14** Changing the contrast sensitivity level

The menu bar at the top of the data view screen (as shown above in **Figure 13**) also offers control of horizontal and vertical zoom. Use the 'select area' button to highlight the area to zoom. The magnification of the data can also be controlled using the +/- buttons. In either case, use the 'fit' button to revert to the original size. The average velocity of the GPR signal (in m/μs) can also be set by adjusting the value displayed in the 'velocity' box.

The horizontal and vertical scroll bars allow you to move the data display along the profile, or up/down within it.

**Tip:** If you are using a mouse with a rolling wheel, this can also be used to control the scroll functions.

It is possible to view several profiles simultaneously in the Data View window and this is particularly useful when trying to mark POIs that occur in similar positions on adjacent profiles. Access the 'Settings' option under the 'Tools' menu and adjust the maximum amount of profiles under the 'Data view' tab.

## Time-zero adjustment

One of the most important things to do when working with a new profile, is to set the 'time-zero' position. This is most important if you want to accurately measure depth, or layer thickness, to reflectors within the radar data. Adjustment is made by clicking and dragging one of the red arrows positioned at the zero (0) points either side of the vertical scale. With the trace view window active, you will see a corresponding red dotted cursor that will move simultaneously to aid in the positioning and adjustment, as shown in **Figure 15** below.

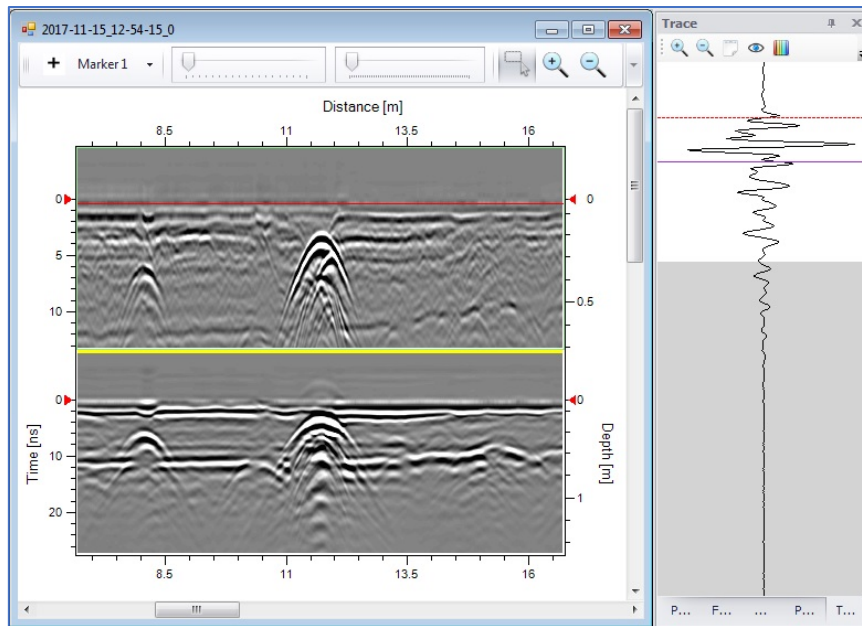


Figure 15 Time-zero setting and adjustment

Depending on your preference, time-zero is commonly set to either the first positive or negative peak, or the zero-amplitude point between them.

**Note:** your selection of the time-zero point will influence where in the radargram, the depth to reflectors is made.

Another important setting to make in relation to time-zero adjustment is the velocity correction factor. Access the 'Settings' option under the 'Tools' menu and enable this option under the 'General' tab, as shown in Figure 16.

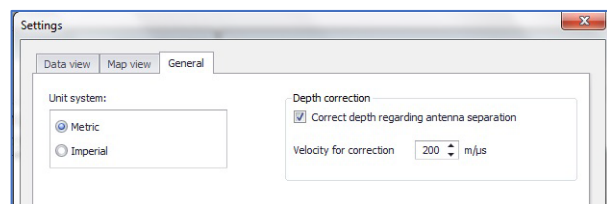


Figure 16 Depth / velocity correction

**Note:** The direct wave for surface radar data is a mixture of waves traveling in air (at 300 m/μs) and in the ground (with an average velocity of approx. 100 m/μs). The standard recommendation for the velocity for correction, is to use a value somewhere in between, e.g. 200 m/μs.

## Filters

CrossPoint® includes a set of common filters to assist in data processing and are intended to enhance the visualization of data for interpretation and analysis. Every GPR data set is to some extent unique, so the application of filters and their corresponding settings will vary depending on the ground conditions at time of acquisition. Refer to **Appendix A** for a detailed explanation of the available filters.

Since CrossOver® data sets typically consist of two-channels, and it is necessary to select and apply filters to each channel individually.

To add a filter, or to edit an existing one, right-click the filter area to activate the filter dialogue, as shown in Figure 17.

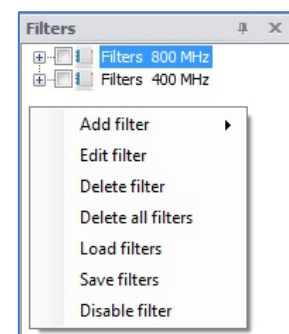


Figure 17 Filter dialogue

To help with processing work flow, it is recommended that filters are used in the order they are listed. However, this is only a recommendation, rather than a strict rule. Apply them successively as needed or chose the ones you prefer.

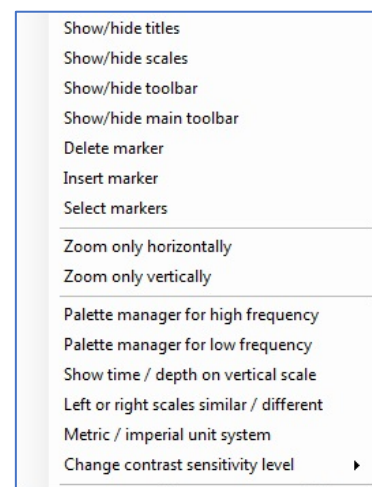
As a new user, knowing which parameters to chose may be somewhat challenging. However, in many cases the system default values will offer perfectly acceptable results. Should you wish to adjust the settings for any given filter, simply double-click it to access the settings dialogue. To deactivate a filter, simply uncheck it from the active list.

Filter sequences and settings can also be saved for future use as a filter definition file (\*.fdf). Such files can be loaded via the filter dilaogue shown above in **Figure 17**.

## Palette

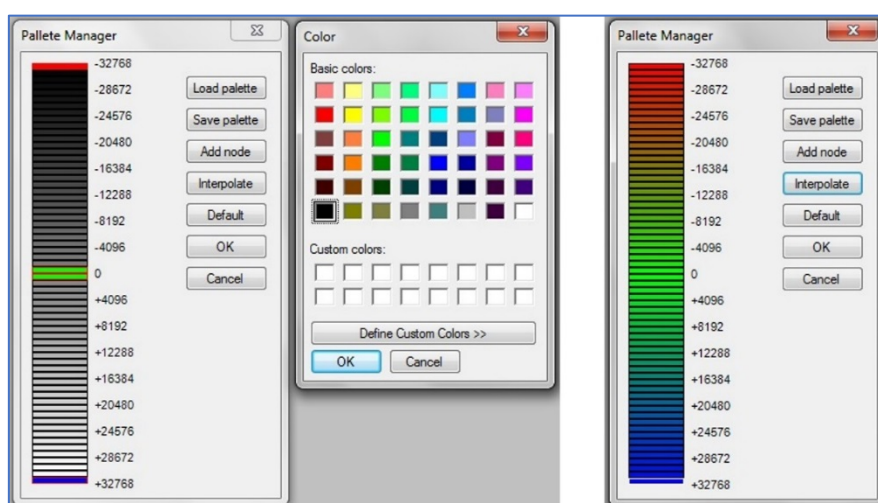
Further to the information provided earlier in this manual, the palette manager determines the colour scheme for radar data in the data view window. It allows you to change between the default (black/white) colour scheme to something user-defined. Typically, GPR radargrams are best viewed in a black/white or greyscale format, which lend themselves well to data interpretation. However, you can create unique user-defined colour schemes according to your personal preferences.

Access the palette manager from either the main 'Tools' menu, or by right-clicking within the data view window itself to activate the options menu as shown in **Figure 18**. When working with CrossOver® data sets, an individual palette manager is available for both the high and low frequency channels; all other data sets will show a single palette manager only.



*Figure 18 Data view options menu*

The palette manager scale relates to the amplitude of the radar signal and shows both positive and negative values, centered around zero. To change the colour of any value, simply double click its position on the scale and select the desired colour. You can choose to select individual values or interpolate between two or more values to create a colour spectrum across the complete scale, as shown below in **Figure 19**.



*Figure 19 Changing colour schemes within the palette manager*

If you find a colour scheme that you like, you may save it for future use by clicking the ‘save palette’ button. Previously saved colour schemes can be selected by clicking the ‘load palette’ button.

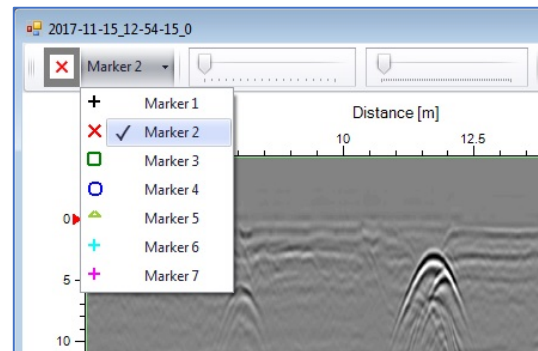
## Markers

The primary concept of CrossPoint® is to simplify the visualization and interpretation of radar data and the marking of points of interest (POIs) within it. Marking POIs can greatly assist in the identification and mapping of subsurface objects and features.

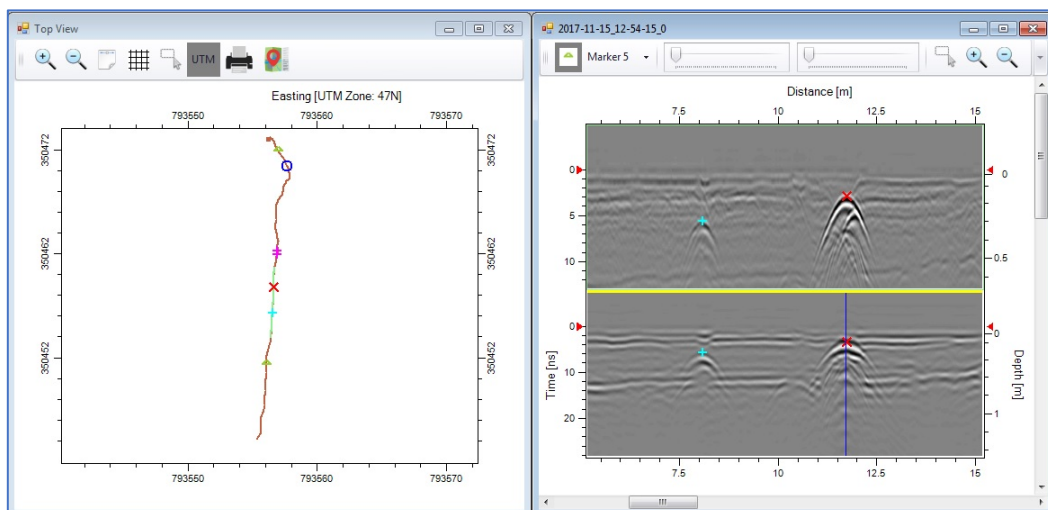
To enable this, CrossPoint® includes seven Marker types, each represented by a different symbol and colour. These markers can be selected from the top-left part of the data view menu bar, as shown in **Figure 20**.

Once a Marker type has been actively selected, you may start to mark points in the radar data by simply clicking where you want the marker to be set.

As markers are deposited within the radar data, they will simultaneously appear at the appropriate point on the profile shown within the Top View window, as shown in **Figure 21** below.



*Figure 20 Selecting a Marker type*

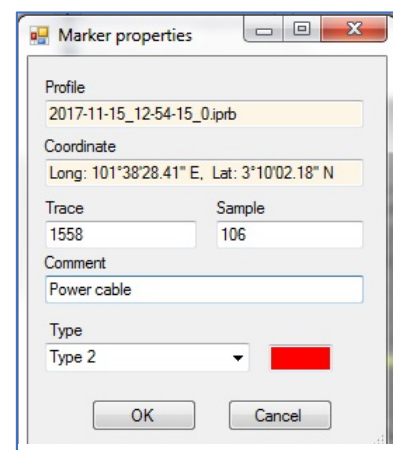


*Figure 21 Marker placement*

To remove a Marker, deactivate the Marker function then right-click the marker and select ‘delete marker’ from the options dialogue.

To edit a Marker, simply double-click it to open the Marker properties dialogue, as shown in **Figure 22**.

Here you can change the marker type and its position by entering in new values for ‘Trace’ and ‘Sample’. You may also enter a supporting comment, which will be displayed next to the marker displayed in the radar data. This comment line can also be selected for display when printing the radar data for reporting purposes.



*Figure 22 Marker properties*



## Exporting markers

The key objective of using markers is to export that information for mapping or reporting purposes. Markers can be exported in one of two file formats:

1. ASCII – text file (\*.txt)
2. KML – Google Earth file (\*.kmz)

**Note:** the kmz file format is primarily for use within the Google Earth application, but this file type is now supported by many of the popular CAD and GIS software platforms, as well as imaging software such as Adobe Photoshop.

Before they can be exported, Markers must first be selected. Selection can be managed via the Markers window, or by right clicking any marker within the radar data and choosing ‘Select markers’ from the options dialogue. This will open the ‘Select markers’ settings dialogue, as shown in **Figure 23**.

This settings window allows you to define the type of markers to be exported. Select all markers, only those created during data collection, or only those created within CrossPoint®. Markers can also be selected by type.

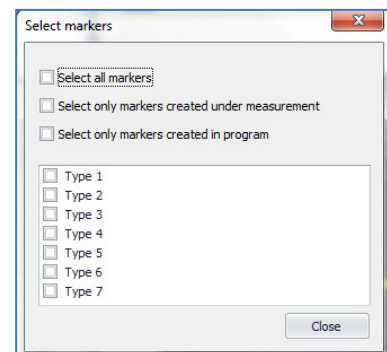


Figure 23 Select markers settings

Markers selected for export can easily be identified within the data view or top view windows by the black box that surrounds them. Once marker selection is complete, press the ‘Export’ button from the main menu bar and select either the ‘Export to ASCII’ or ‘Export to KML’ option, as shown in **Figure 24** below.

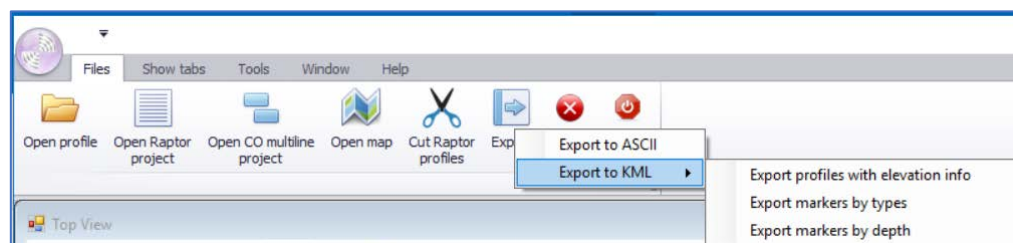


Figure 24 Export of Markers

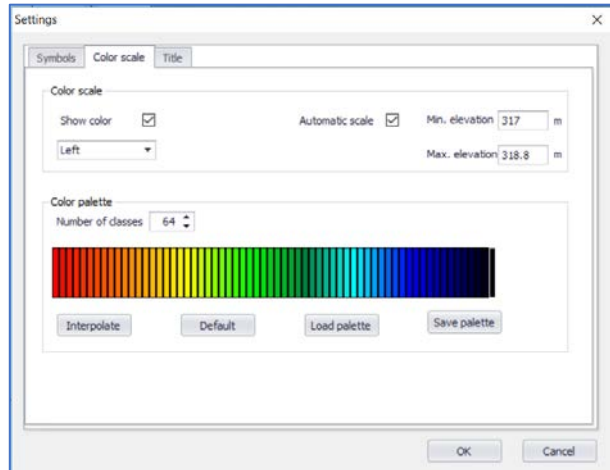
The ‘Export to KML’ option has three choices:

1. **Export profiles with elevation info** – outputs a visual representation of the GPR profile/s with a colour scale related to elevation. *No need to select markers.*
2. **Export markers by types** – displays the position of markers using the same symbols generated within CrossPoint®.
3. **Export markers by depth** – outputs a visual representation of the GPR profile/s with a colour scale related to the depth of selected markers.

When selecting option 1 or 3, the colour scale dialogue is activated under settings, as shown in **Figure 25**.

This gives you the ability to adjust the palette for the colour scale and works in the same way as the colour palette manager described in earlier sections of this manual.

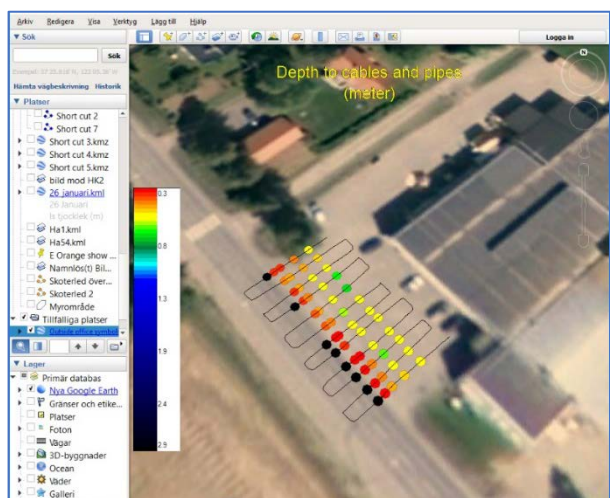
If the 'Automatic scale' box is checked, the software will automatically calculate the min/max values for either elevation or depth. If unchecked, you can define these values manually.



**Figure 25** Colour scale settings

Once the file is saved, it can be opened in Google Earth, or any other supported software program. **Figure 26**, shows an example of an exported marker file opened within Google Earth. The marker file was generated from radar data collected outside the ImpulseRadar office in Malå, Sweden.

The markers are displayed based on their geo-referenced position. In this case, the exported markers correspond to buried utility lines (cables and pipes) and the colour scheme relates to the actual depth.



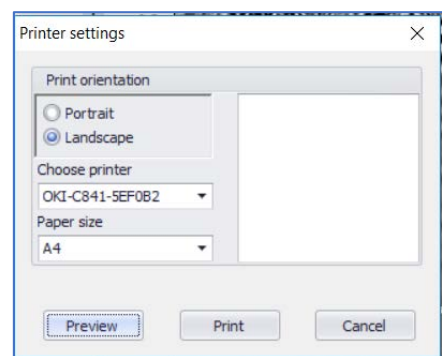
**Figure 26** Visualisation of Marker export in Google Earth

Importing such files into supporting CAD or GIS-based software programs can make mapping of such features much more efficient.

## Print

The print function is available for both the Data View and Top View windows. Print functions are accessible via the printer icon located in the menu bar at the top of these windows. The print settings for the Top View window are rather simple as shown in **Figure 27**.

The site map shown in the Top View window will be printed with the same scaling as shown on screen. Markers will also be printed as shown on-screen, i.e. in the same location and with the same symbols and colour.



**Figure 27** Top View print settings



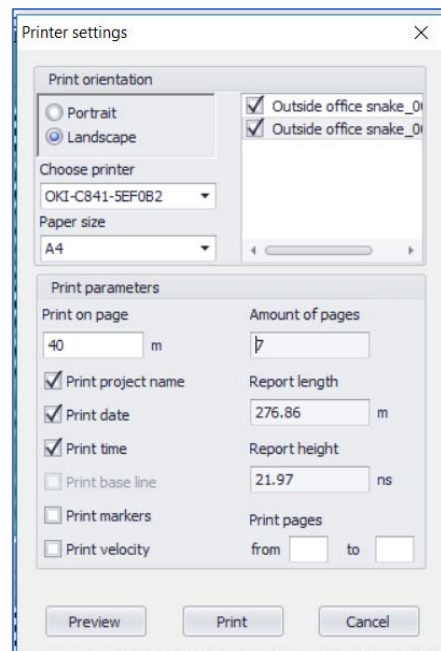
The print settings for the Data View window are slightly more complex, since they control the way radar data is presented.

**Figure 28**, shows the various options available under the Data View window printer settings.

To start, select the radar data files you want to print by ticking the relevant checkboxes. If more than one profile is selected, they will be printed in the order listed, with the first one on page 1 and so forth.

The vertical scale will be the same as it appears on screen. The horizontal scale needs to be entered under 'Print parameters' to set the distance to be printed on each page.

Select the other parameters according to your preferences. You may preview the page before confirming to print. Depending on your PC set-up and printer access, you may have one or more printers to choose from. If appropriate software is installed on your PC you will also be able to print to PDF.



**Figure 28** Data View window print settings

## Top View Window

As the name suggests, this window provides a top-view (birds-eye view) of the open profile, or group of profiles (multi-line project), including alignment, as shown in **Figure 29**.

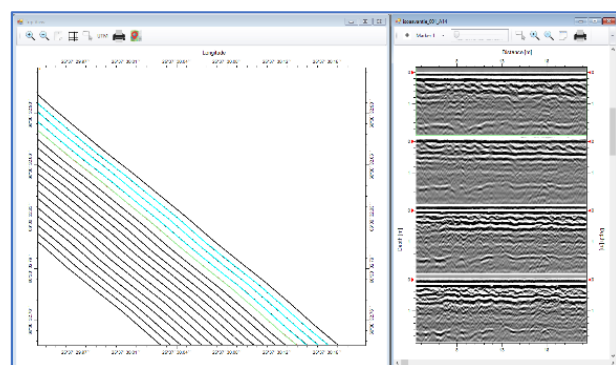
The Top View window shows all the profiles within a project, regardless of the number of radar profiles being viewed in the Data View window.

Any markers inserted into the radar data will automatically appear at the appropriate position along the profile/s in the Top View window. This greatly aids the location and mapping of subsurface features, especially linear ones, like utility lines.

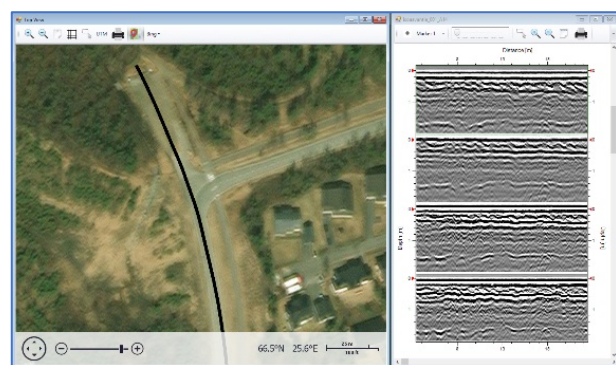
If the data has been collected with GPS, then a background map can be activated to show the geo-referenced position of the profile/s, as shown in **Figure 30**.

Obviously, the quality of GPS used during radar data acquisition will determine the accuracy of the profile position on the background map.

You can show/hide the map view by pressing the 'map' icon button in the menu bar at the top of the window.



**Figure 29** Top view window



**Figure 30** Background map showing GPR profile

Currently, CrossPoint® supports the following map providers, which can be selected from the menu bar, or set on the 'Map view' tab under the 'Settings' option from the 'Tools' menu.

- **OpenStreet** – a collaborative opensource platform (open license)
- **Bing** – Microsoft platform requires license key
- **Here** – former Nokia platform requires license key

**Note:** map API interaction and support are determined by the license conditions of the respective provider. Advanced use of any given map API for commercial applications generally requires a paid subscription.

When viewing a profile/s in the Top View window, the active portion of the profile, i.e. what is displayed in the Data View window, will be highlighted in green. When scrolling along the profile in the Data View window, the green highlighted section will move to follow the appropriate position on in the Top View window. Any other profiles will be shown highlighted in blue.

The default colour for profiles in the Top View window is black, but this can be changed under 'Settings' if it conflicts with the selected background map.

Access the 'Settings' option under the 'Tools' menu and set 'Profile colour' under the 'Map view' tab, as shown in Figure.

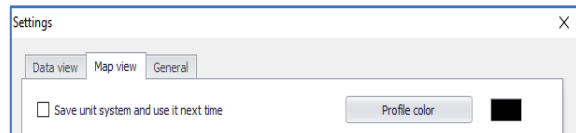


Figure 31 Map view settings

When viewing profiles for a multi-line project, with local baseline, it is possible to change the position for the start and end of the baseline. This means that you can add the appropriate coordinates to convert this to a GPS project and activate a background map.

Simply double-click the baseline to open the 'Base line settings' dialogue and make the necessary changes.

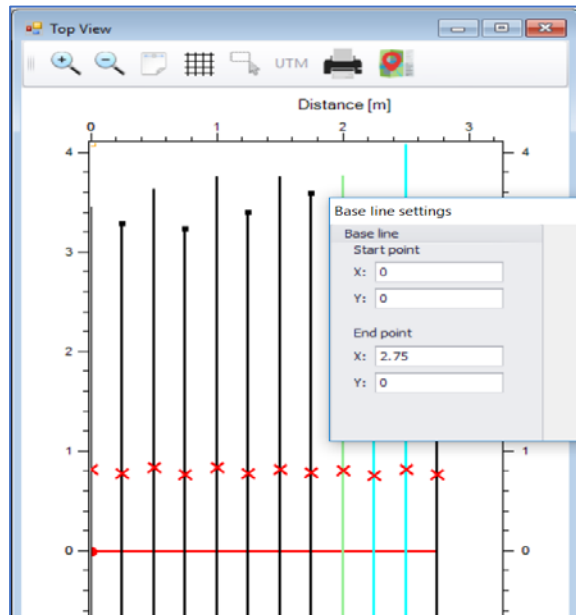


Figure 32 Base line start/end-point settings

## Trace view window

As the name suggests, this window displays the GPR trace. It allows you to see the recorded GPR signal in analogue form, with time-variation of the amplitude, for any given point in the radar data.

There are view options that include measurement data and the frequency spectrum of the trace, as shown in Figure 28 and Figure 29.

This view and associated information is useful to aid in certain processing actions, like adjusting and setting time-zero, as well as filter selection and adjustments, for enhanced data visualization.

### Additional Tabs

By default, any additional tabs selected under the **Show Tabs** menu, will be pinned automatically to the trace view window. The window view can be toggled by selecting the desired tab from either the bottom of the window, or the right-side (if auto-hide is active), as shown in Figure 30 below.

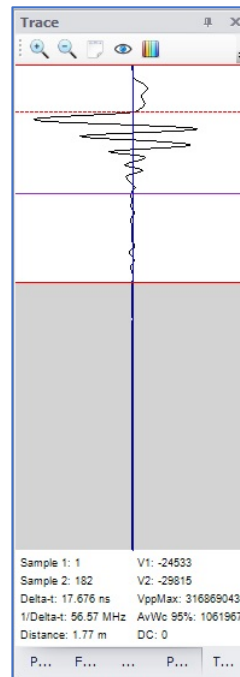


Figure 33 Trace view

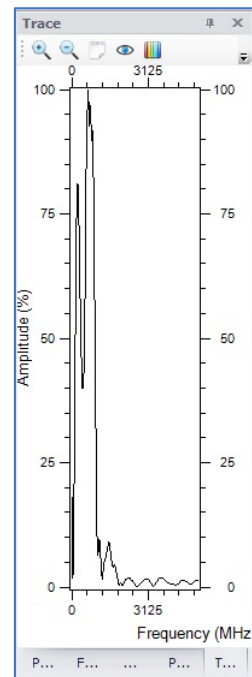


Figure 34 f-spectrum

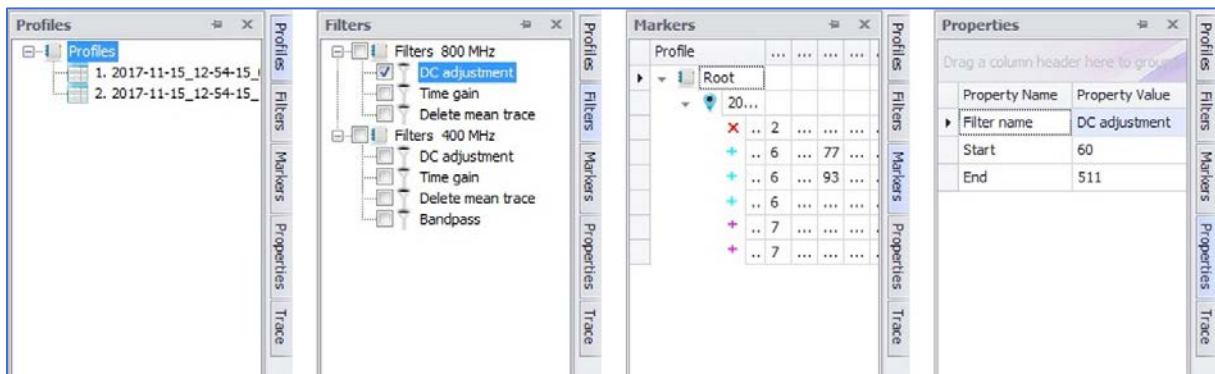


Figure 35 Trace view window – toggled views for additional tabs

## Filters

To add a filter, or edit an existing filter, right-click the filter area to activate the filter dialogue, as shown in Figure 13.

To help with processing work flow, it is recommended that filters are used in the order they are listed. However, this is only a recommendation, rather than a strict rule. Apply them successively or chose the ones you prefer as needed.

### Suggested order for filter application

1. DC adjustment
2. Delete mean trace
3. Time gain
4. AGC
5. Custom gain
6. Bandpass
7. Boxcar
8. Average
9. Threshold

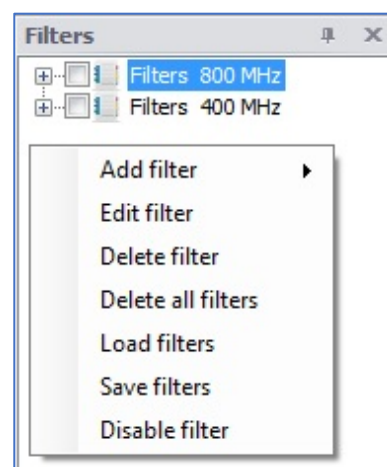


Figure 36 Filter dialogue

As a new user, knowing which parameters to chose may be somewhat challenging. However, in many cases the system default values will offer perfectly acceptable results. Should you wish to adjust the settings for any given filter, simply double-click it to access the settings dialogue. To deactivate a filter, simply uncheck it from the active list.

Filter sequences and settings can also be saved for future use as a filter definition file (\*.fdf). Such files can be loaded via the filter dilaogue shown above in Figure 13.

**Note:** *if collected data is of poor quality to start with, no amount of processing will rescue it!*

## DC adjustment

The DC adjustment filter removes any constant DC component within the GPR signal. CrossOver® and Raptor® data rarely needs this filter, but the data will not be negatively affected if applied.

The filter is set by entering the value for the start and end sample. This can be done by entering values directly into the boxes, adjusting the up/down cursors, or by clicking and dragging the filter mask itself (red highlight area).

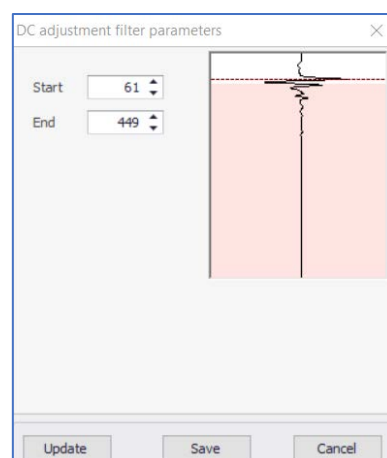


Figure 37 DC adjustment filter parameters

## Delete mean trace

Under some conditions, the radar data can show persistent horizontal lines, which result from artifacts in the signal that have a fixed time position and intensity. This can effectively lead to the masking of real reflected signals. When applied, this filter can suppress such unwanted “background” signals.

The filter essentially subtracts the mean trace from the entire data file, or between a group of traces, which is defined by setting the first and last trace number.

The filter can remove unwanted artefacts that result from disturbances near the antenna. Proximity to metallic objects, poor matching of antenna elements, and highly conductive soils are common causes of such disturbance.

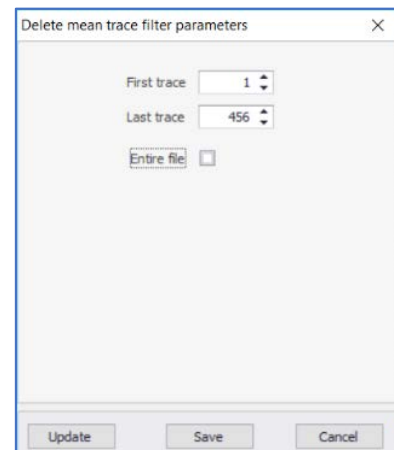


Figure 38 Delete mean trace filter parameters

**Note:** use this filter with caution if you are looking for real horizontal reflectors, since they can also be filtered out. When applying this filter, it will also remove the direct wave that arrives directly from the transmitting antenna.

## Time gain

This filter increases the amplitude of the signal, by using both a linear and exponential value to multiply data points in time. This is often used to compensate for losses resulting from dampened signals or geometric spreading.

Values for both parameters must be set, either directly into the corresponding boxes, adjusting the up/down cursors, or by clicking and dragging the filter mask itself (red highlight area).

Typical values are LG: 1000 and EG: 50. The start sample must also be set, which is typically at a point slightly after the first arrival, as shown in Figure 16.

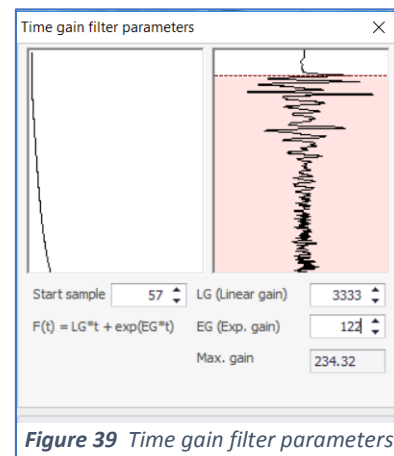


Figure 39 Time gain filter parameters

Soils with higher conductivity generally require a higher gain factor than low conductive soils. However, a gain value that is set too high will reduce your ability to interpret small anomalies. If using a traditional black/white colour scheme and the resulting radargram shows only black and white without grayscales in-between, then the gain values is set too high and must be reduced.

**Note:** the sensitivity of the contrast bar also influences the effect of the time gain filter. Higher sensitivity combined with high time gain values can destroy the visibility of anomalies within the radar data.

## AGC (Automatic Gain Control)

The aim of the AGC filter is to automatically equalize the signal amplitudes along traces. This occurs separately for every trace in the running window, as defined by the 'window length'. The average amplitude is calculated for every position of the running window, after which, the signal value in the application point is divided by this average value.

Lower Scale values reduce the amplitudes and higher raise the amplitudes.

The window length (ns) is the value that defines a window length (expressed in ns) that will be used for gain calculation. The gain factor is calculated for every position of the window with specified length that slides down the trace with the one reading interval. Shorter Window length value make the equalize effect stronger.

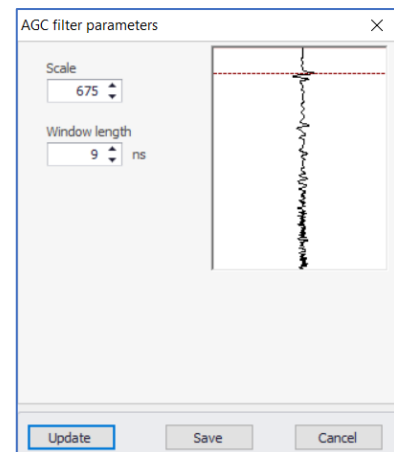


Figure 40 AGC filter parameters

## Custom Gain

This filter is mostly used to visualize strong horizontal layers or point reflectors that do not change in depth along the profile.

The filter acts on each trace independently. This option allows you to interactively define a digitized gain curve along the sample/time axis by positioning the individual gain nodes (black dots).

Each node is positioned separately by clicking on it and dragging into the desired position. The higher a node is positioned, the greater the gain factor. The software interpolates linearly between the set points to create the gain curve.

Use the update button to observe the effect of any changes made.

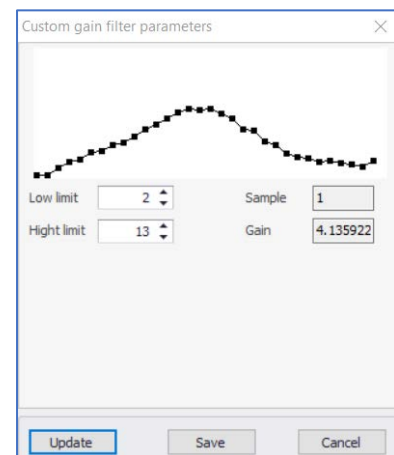


Figure 41 Custom gain filter parameters

## Bandpass

This filter is used to suppress unwanted signals either side of the antenna center frequency and works in the frequency domain.

The algorithm used is based on three steps (i) application of direct FFT (fast Fourier transform) for transition from the time domain into the frequency domain, (ii) suppression of low-frequency and high-frequency components of a trace spectrum, and (iii) application of reverse FFT for transition from the frequency domain back into the time domain.

The filter band is specified by the setting the low and high frequency cut-off values. This can be done by entering values directly into the corresponding box, adjusting the up/down cursors, or by clicking and dragging the filter mask itself (red highlight area). Use the update button to observe the effect and to set the optimum values.

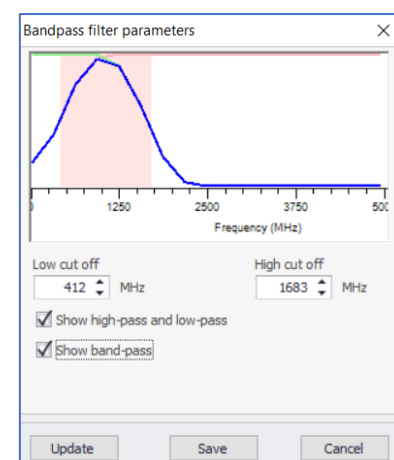


Figure 42 Bandpass filter parameters



## Box car

The Box car filter eliminates unwanted low and high frequency components. The result is like a traditional bandpass filter but works only in the time domain. To make effective adjustments, it is necessary to understand how many data points cover one wavelength of the data set in use.

A good starting point for this filter is to set Background removal and Low-pass values to 20 and 5 respectively.

**Note:** *CrossOver® and Raptor® both have a data point value slightly more than 10 over one wavelet.*



Figure 43 Boxcar filter parameters

## Average

This filter smooths the radargram image and is effective when you want to remove small unwanted reflections like back-scatter or other types of distortion. The objective is to make the more prominent anomalies more visible. You must select the grid size for each time step and the average is performed over that number of traces and samples. The filter area is centered around the current data point. The selections are from 3x3 to 11x11 trace and samples. The smoothing effect will be greater if a larger grid size is selected.

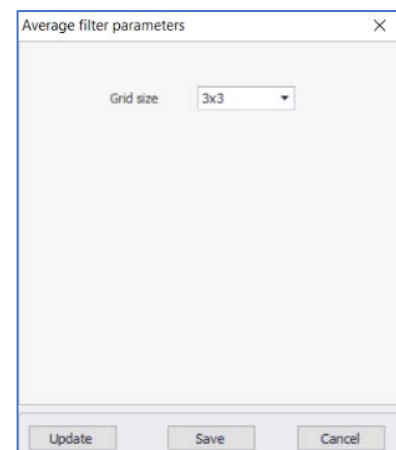


Figure 44 Average filter parameters

## Threshold

The Threshold filter removes signals based on the actual amplitude value for every sample in the data file. For example, values of 1000 change all sample values lower than 1000 to a zero value.

The filter makes stronger reflectors more visible by getting rid of weaker reflectors that are of no interest.

To see the effect of adjusting the threshold value, click the update button. Alternatively, keep the trace view window open to see the effect of the applied filter on each trace.

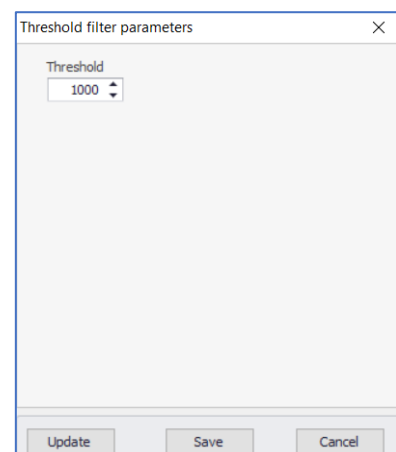


Figure 45 Threshold filter parameters

## Positioning

### GPS

[content needed]

### Total Station

[content needed]