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GroundVision 2

User Guide

Our Thanks...

Thank you for choosing Guideline Geo and MALÅ as your Ground Penetrating Radar solution provider. The very core of our corporate philosophy is to provide our users with the very best products, support, and services. Our development team is committed to providing you with the most technologically advanced and easy-to-use GPR products with the capability to meet your needs for efficiency and productivity now, and into the future.

Whether this is your first MALÅ product, or addition to the MALÅ collection, we believe that small investment of your time to familiarize yourself with the product by reading this manual will be rewarded with a significant increase in productivity and satisfaction.

At Guideline Geo, we welcome comments concerning the use and experience with our products, as well as the contents and usefulness of this manual.

Guideline Geo team

Guideline Geo AB

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Introduction

MALÅ GroundVision 2 is the data acquisition software dedicated to the MALÅ ProEx system. GroundVision 2, installed on a laptop, acquires data from the MALÅ ProEx control unit with Ethernet communication. As a Windows™ based software GroundVision 2 gives you an easy-to-use user interface, file management, printing and other key features. Each measurement and associated settings are stored in files. Filtering can be performed with the measurement or as post-processing. GroundVision 2 software supports both GNSS logging and multiple markers during measurement. All radargrams can be printed as such, or post processed by further software.

Installation and Communication

The latest version of GroundVision 2 is always available to download from the web site www.guidelinegeo.com. It is also provided on a USB when you have purchased a ProEx control unit.

When you double click on the setup file (either from the installation USB or from the downloaded file) you will enter an installation wizard that will guide you through the rest of the installation process.

Note: If you are doing an upgrade installation of GroundVision 2 it is recommended to uninstall the previous version of GroundVision 2 first. This is easiest done from the Windows Control Panel, Add/Remove programs.

System requirements: Windows 95, 98, ME, 2000, NT or XP and Ethernet communication.

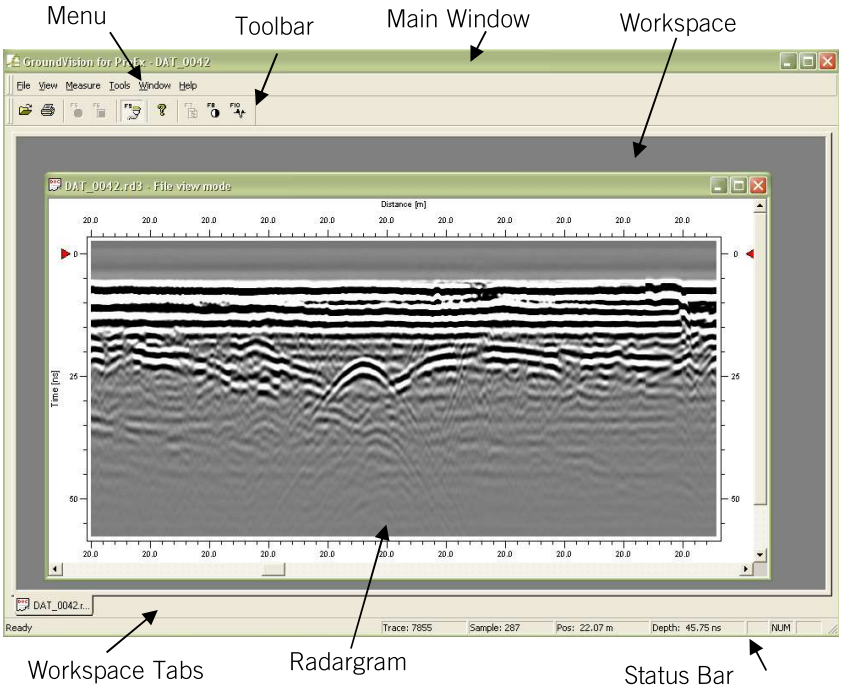
To make the communication run between the Control unit and the laptop used, start up Ground Vision 2 and go to the Tools menu -> Hardware setup.

In the Hardware setup window (see section *Change hardware setup*), the setting on how communication is performed between the laptop and the control unit is made. In the Ethernet interface drop-down-menu the available Ethernet-interfaces are seen. Choose the standard, most often a Generic VPN.

The communication between the laptop and the ProEx control unit will work only with Ethernet on wire.

User interface

The user interface of GroundVision 2 is following the standard of many other Windows-based programs. Printing as well as window managing is quite similar and follow standard Windows commands.



GroundVision 2 main window with a radargram opened.

Main Window

This can also be called the application window. This window holds the application's menu, status bar, toolbar, workspace, and the radargram windows. The main window can be minimized, maximized, or resized to any size by the user.

Workspace

One can say that the workspace is the area managed by the user. The main window determines the size of the workspace. The user can manipulate the radargram and trace view windows size and position inside the workspace.

Menu

The content of the menus varies depending on whether a file is open or not or if the program is in measuring mode. All choices that are not available are grey.

Toolbar

The toolbar holds all the buttons. A toolbar button is a shortcut to a menu command, i.e., every button corresponds to a menu choice. If a button is greyed out that menu alternative is not available.

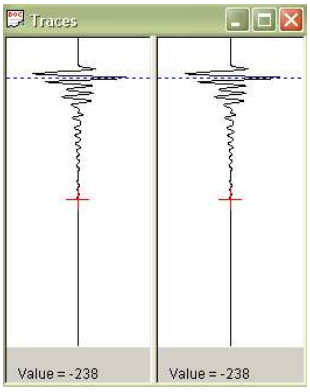
Radargram

The radargram is the image generated by the measured radar data. If the amount of data is larger than the window size, scrollbars are used to scroll the image, both horizontally and vertically. A

mouse left click at a certain trace in the radargram shows that trace in the trace view. A mouse right click shows a popup menu containing the radargram specific commands. When the mouse pointer is moved across the radargram the information menu shows the actual trace number, sample number, depth/time and position/time.

Trace View

The trace view displays a single trace, which is determined by position of the mouse cursor over the radargram. In data collection mode the trace window always shows the last incoming trace. The trace view is toggled On/Off from the keyboard with the F10 key or opened by choosing *Trace Window* under the View menu.



When measuring in multi-channel mode with the ProEx, there will be one trace view for each active channel.

File format

When measuring with GroundVision 2, several files are generated. The most important is the data file (.rd3) and the header file (.rad). The data file is a 16-bit binary file and contains the sample values. The header file is a text file and contains measurement specific information. Never edit and save the information in the header file that can cause errors in the file information and give corrupt data. If files are to be copied to or from another computer or disc it is important that both the data file (.rd3) and the header file (.rad) are copied.

The other files GroundVision 2 generates contains information on filter settings, palette, GPS and markers. All the file types of Ground Vision 2 are listed below.

.rd3	16-bit binary data file
.rad	Header information file
.cor	Coordinate file acquired from a GPS
.mkn	File with markers 1-9 with colour codes and names
.fil	Saved filter parameters
.pal	Saved palette settings

When working with several antennas and extension modules (the different slots) with the ProEx control unit, the name for the files generated will follow this convention:

If the file name is set to PROF the file names generated by ProEx will be PROF_nnn_SC (.rad, .rd3, .add) and PROF_nnn_S (.mrk), where:

- nnn is an automatically given number
- S gives the slot the data belongs to, A to H
- C gives the channel, 1 for internal Tx and 2 for external Tx.

The file *PROF_0042_B1.rd3* is accordingly radar data from slot B, internal Tx.

Quick start

This chapter deals with the most essential steps for making, viewing, and printing a radar image. Follow the five quick steps below and most of the basic functionality of GroundVision 2 is covered. More detailed descriptions can be found in the different sections of *Detailed instructions*.

Power ON

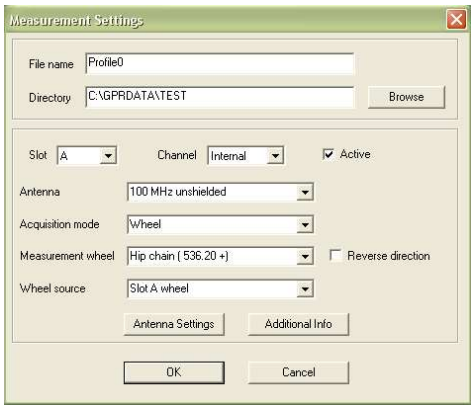
First, make sure that the hardware is connected correctly, and power is on. The circle of the *Start F5* button in the tool bar of GroundVision 2 is red when the communication is working with the ProEx control unit.

If the circle is not red, press the auto-detect key in the toolbar *F9*. F5 should turn red within 5 seconds otherwise a communication failure, incorrect cable connections or power failure has occurred.

Select Measurement Settings

Chose *Measurement Settings* in the Measure menu or right-click on the channel to use in the Channel navigator (F7) to access the measurement settings dialog. Here the desired filename, directory, antenna, and trigger can be chosen.

Detailed data collection settings are found in the Antenna Settings dialog opened by pressing the *Antenna Settings* button.



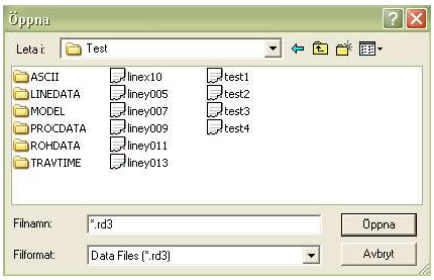
Start and stop a measurement

Click on the start button on the toolbar, press *F5* on the keyboard or select *Start* from the Measure menu to start a measurement with the selected settings. To stop the measurement, click on the stop button, press *F6* or select *Stop* from the Measure menu.

In distance triggering mode a new trace is collected every time the wheel or hip-chain has moved a distance interval as set in the Antenna Settings dialog. Time triggering mode works in the same way, using the elapsed time and the time interval to determine when to collect a new trace. In keyboard triggering mode one trace is collected every time the Enter button on the keyboard is pressed.

View a measured file

To open a file, choose *Open* (Ctrl-O) under File in the menu or click the *Open file* button in the toolbar. This displays an ordinary Windows "open file dialog" in which the user specifies the file to open.



When a file is opened the horizontal scrolling position is zero, i.e., the first trace is shown to the left in the radargram. Likewise, the vertical scrolling position is also zero, i.e., the first samples are shown in the top of the radargram. Use the windows scrollbars or the arrow keys to navigate through the radargram.

Apply filters

Start by choosing *Filter Manager* under View in the menu or right click in the radargram and choose *Edit Filter List* or press the *F* key. This activates the Filter Manager. To the left, there is a list of available filters and to the right the list of the applied filters is shown.

The functionality of the Filter Manager is straightforward. Choose a filter and click either the *Add* or the *Remove* button and the chosen filter will be either removed or applied. It is also possible to double click the filter to be added. By drag-and-drop the order of the filters in the Applied list can be altered without removing and applying. The most common filters to use are DC Filter and Time Gain Filter. See *Appendix 1 Filters* for more information.

The filters applied can be turned OFF and ON by pressing  in the toolbar.

Change the palette

Start by choosing *Palette Manager* under View in the menu or right click in the radargram and choose *Change Palette* in the popup menu or press the *P* key. This activates the Palette Manager.

Double clicking on a specific color box opens a Windows color dialog and a new color can be chosen. One single right-click on a color box makes it activate for interpolating colors (indicated by a red frame around the colour box). Another single right-click on the same color box deactivates it. When interpolating the palette, it's recalculated depending on the colors in the active color boxes. *OK* closes the Palette Manager and applies the palette to the radargram.

Note: On start-up, GroundVision 2 loads the previously used palette automatically.

Use Contrast

The Contrast Control is found in the View menu, the Toolbar or by pressing *F8*, and it is used to increase the contrast of the different radargram views. The effect of changing the contrast is, somewhat similar to a change in the gain function, but much easier and faster to do.

Print

To print a radargram click on the *Print* button in the toolbar or choose *Print* in the File menu. A standard Windows print dialog will appear in which the printer to use and pages can be altered. The default settings are the same as the default print settings for your Windows operating system. Clicking *OK* prints, the radargram with the actual settings. The printout can also be inspected prior to printout with the *Print Preview* in the File menu. A *Print Setup* function is also available in the File menu. A standard Windows print setup dialog will appear in which the printer, paper, and format can be altered.

Note: A Windows printer driver must be installed for the print preview function to work.

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Detailed instructions – Files and Measurements

Files and radargrams

The technique used when managing the files and the radargrams in GroundVision 2 is very similar to any other Windows program. Every radargram opens in its own window, which the user can maximize, minimize, and resize using the standard Windows commands. No data is changed in the data file (*.rd3) when the file is open for viewing. For this reason, there is no need for saving when the file is closed.

Handle the trace window

The Trace Window shows a number of panels with a single trace in each. There is one panel for every active channel. The position of the mouse cursor over the radargram determines which trace is shown. Toggle (turn on/off) the trace window by pressing *T* on the keyboard, clicking the trace window button on the toolbar or select *Trace Window* from the *View* menu.

Measuring issues

To start a measurement the communication between the laptop and the ProEx control unit has to be functioning. If the button *F5* is red the measurement can start. Otherwise *F9* can be used to connect the laptop to the control unit. During measurement the *F6* button is used to stop a profile. It can be started again by pressing *F5*.

Note: If a profile is closed it cannot be restarted again.

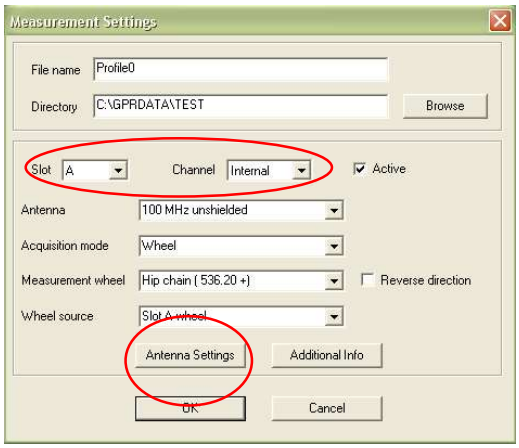
Start a measurement and change the settings

A measurement is carried out with the following steps:

1. Make the correct settings for the antennas used
2. Start the measurements *F5*
3. Stop the measurements *F6*
4. If a new profile is started with the same settings, go to 2, otherwise 1.

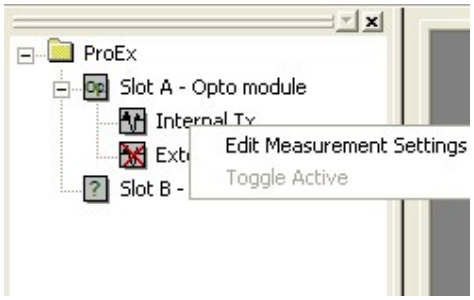
The file name is given in the Measurement settings dialog, as well as the directory where to save it. Observe that the file name will be automatically extended according to the convention in section *File format*. Choose the correct antenna, acquisition mode measurement.

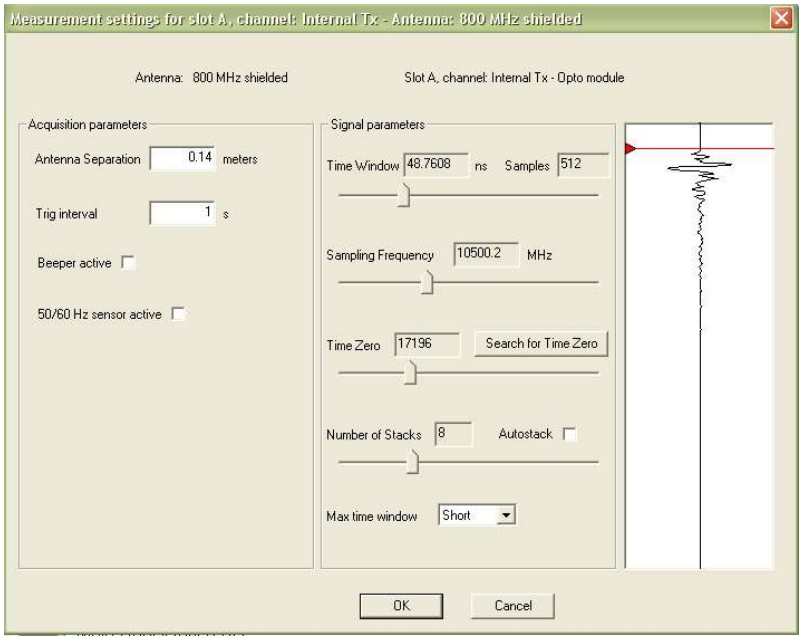
In order to view or change the measurement settings, click the Antenna Settings button in the Measurement settings dialog.



The antenna settings are changed for the Slot and Channel viewed in the Measurement Settings pop-up. In the example at right; Slot A and Channel Internal.

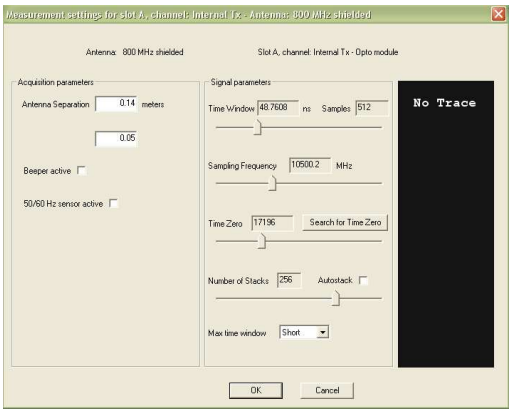
If the Channel navigator is opened (*F7* or under the View menu) the settings for the different antennas connected can be changed by first marking the antenna to change and then by right-click on the same and choose the option *Edit Measurement Settings*. This opens the same settings dialog as explained above and viewed below.





Example of an Antenna Settings pop-up, reached by clicking Antenna settings in the Measurement Settings pop-up.

If there is something wrong in the communication, for instance for the transmitter antenna, the trace will not be viewed, instead the trace window will be black.



All measurement specific settings can be viewed and manipulated in the Antenna settings dialog. The trace view displays a trace measured with the actual parameters and is updated for every change. All controls can be managed both with the keyboard and the mouse. In the header of the dialog the antenna changed are seen as a description of the slot and the channel.

Adjusting the *Sampling Frequency* and/or the *Number of Samples* controls the length of the Time Window.

Note: When using GroundVision 2, do NOT set the time window to more than 3400 ns. If you need a larger time window, contact support@guidelinegeo.com.

Sampling Frequency shall be set to approximately 10 to 12 times the antenna frequency. If the trace view only displays a straight line, make sure that the transmitter is turned on and is correctly connected. Does not that help; try the *Search for Time Zero* button.

Number of Samples shall be set to a value near 500 for the best performance. A higher number increase the total measured time window but slow down the measuring speed and creates larger data files.

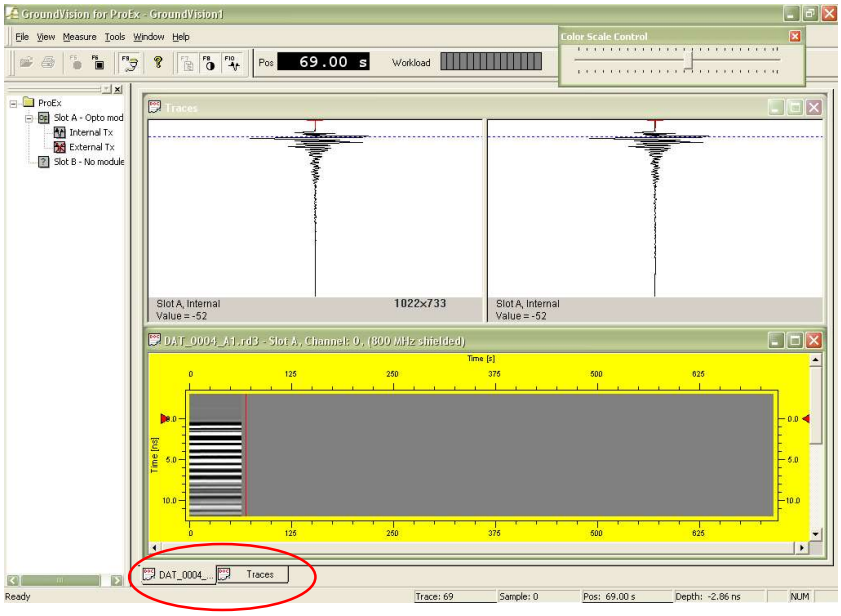
Alter the *Trig Interval* (Point distance) if the default settings are not appropriate. Make sure that the *Antenna Separation* is correct (this should be applied automatically depending on chosen antenna). Otherwise, the calculation of the zero for the vertical scale will be incorrect.

The *Auto stacking* option is enabled by checking the Auto check box to the right of the Number of stacks. When automatic stacking is enabled then the radar system automatically performs as many stacks as possible for each trace. In practice this means that the number of stacks will decrease if the antenna is moved faster and increase if the antenna is moved slower.

If the option *Beeper* is ticked, a beep will be given for each measurement.

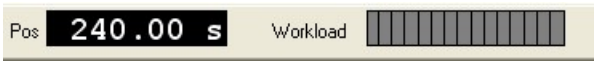
When the *50/60 MHz sensor* is active, EM data from the MALÅ HF antennas with EM option will be collected. See *HF antennas User Manual* for more information.

In active mode, when the ProEx and GroundVision 2 are collecting data the radargram screen is yellow; otherwise, the radargram window is white. An example of GroundVision 2 for ProEx in active mode is shown below.



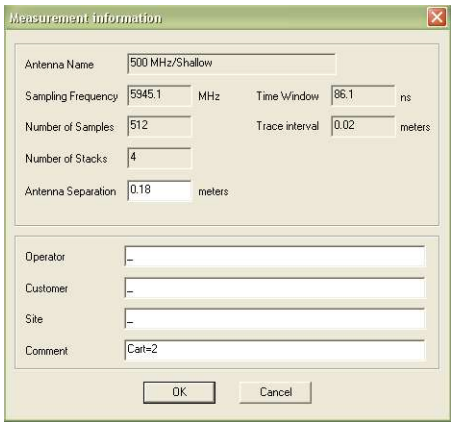
When using several antennas only one radargram is shown at the time. To select which data to show just click on the channel you want to activate in the Channel navigator (F7), right-click and choose *Toggle active*.

In the main menu the position is of the profile is viewed, together with the workload indicator. This should not go up to red more than occasionally, to give data of good quality.



Edit the measurement information

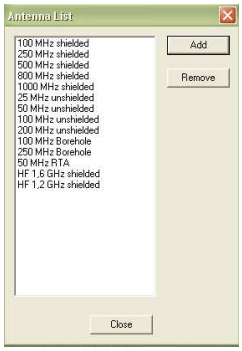
There are two ways to bring up the Measurement Information dialog. Either when a new measurement is started or by selecting *Measurement Information* under View in the menu.

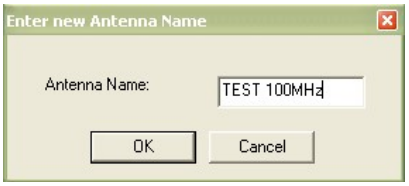


Only the white areas allow typing/editing. When desired editing has been made, *OK* saves the new information in the header file (.rad).

Define, save, and delete antenna settings

As changes has been made in the Antenna Settings dialog these are immediately saved for that given antenna. To create a new antenna setting, open the *Edit Antenna list* dialog in the Tools menu and press *Add*. The name can freely be given. Then go the Antenna settings menu and do the correct settings.





Apply filters during measurement

Filters (see also *Appendix 1 Filters*) can be applied during measurement. However, the filter manager is not accessible during measurement. To add or remove filters or alter the settings of applied filters the user must do the following:

- Stop the measurement (F6).
- Apply filters
- Restart the measurement (F5).

The data shown in the radargram is now filtered and the incoming data during measurement will be filtered before shown on the display. The filters applied can be turned off and on by pressing  in the toolbar.

Note: Filtering during measurement increases the workload on the laptop. The acquisition speed while heavy filtering is applied is much correlated to the power of the laptop. When the power of the laptop is the limiting factor, vertical fields without data may occur in the radargram.

Note: Applied filters only affect the view on the display, the raw data saved on the computer is always kept unaffected.

Change the palette when measuring

The user can define any palette and use it during measurement. The palette can be altered when measuring, by right-click on the radargram and the choosing *Change palette*.

50/60 MHz EM sensor data

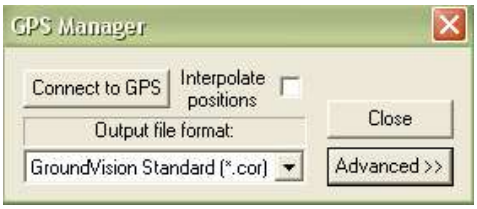
When measuring with MALÅ HF antennas with EM option the EM data can be viewed by selecting *50/60 MHz sensor data* in the View menu. Both gradients of the EM sensors are viewed in the same EM window. The EM data can also be turned on and off with the  in the toolbar.

Detailed instructions – GNSS

GNSS Support

GroundVision 2 supports logging of GNSS data during measurement. The result of such a measurement is a GNSS log file (*.cor, *.utm or *.lcf, see section *File Format*) in which GNSS data are written together with the corresponding trace number. GroundVision 2 can read GNSS data from any GNSS receiver that supports output of data with the NMEA or TSIP communication protocols. The GNSS receiver should be connected to the serial port of the laptop. In order to make the GNSS Manager visible chose *GPS Manager* under View in the main menu. This menu alternative toggles the GPS Manager On/Off.

When first shown the GPS manager window (found under the view menu) gives access to basic options only. To access the advanced options just press the *Advanced* button. Pressing it again will close the Advanced section of the dialog.



See *Appendix 2 GNSS Measurements* for more information.

Basic options

Connect to GPS

Press this button to activate the communication with the GNSS receiver. If there is no contact, make sure that the communications settings (see below) match those of the GNSS receiver. When this button is activated the GroundVision 2 software will create a *.cor-file for each radar file produced and 

is viewed on the main menu, giving the GNSS-position.

Interpolate positions

When the *Interpolate positions* checkbox is checked interpolation between positions in the data file takes place. This procedure will give best results if the radar unit is moved with constant velocity.

Output file format

Use this selection box to choose between the four different position output formats supported by GroundVision2 : GroundVision 2 Standard (*.cor), WSKTRANS (*.fri), UTM coordinates (*.utm) and Local coordinates (*.lcf).

The option Local coordinates supports GNSS systems that directly can send transformed coordinates (with an extended NMEA-protocol).

Advanced options

The advanced options are all communications settings. Normally the default settings should work but if there is no contact with the GNSS receiver use these options to make sure that the communications settings match those of the receiver.

- Baud rate, Parity, Data bits, and Stop bits. These are serial port communication settings, which must match those of the GNSS receiver.
- Com Port. This setting determines which serial port on the computer to use for the GNSS receiver. The default selection is the first serial port (COM 1).
- Protocol. Selects which communication protocol to use. NMEA0183 is a standard protocol that should work with most GNSS receivers. TSIP is a protocol supported by Trimble GNSS units. The default selection is NMEA.

Typical settings for the advanced option, for the communication between the GNSS and GroundVision 2, are shown on the right-hand side. The GNSS used should of course also be set according to this and connected to the Com-port on the laptop used.

Output file formats

When a new measurement is started a GNSS data file is created in the same directory as the files containing GPR data. The file name of the GNSS data file is the same as for the GPR data with a different file extension. During measurement the GNSS data file is continuously updated to minimize data loss in occasion of a crash. A GNSS data file is created for each slot when measuring with the ProEx control unit.

GroundVision Standard

This data file format contains the following information: trace number, date, latitude, longitude, height above mean sea level, and HDOP. HDOP is a theoretical measure of the accuracy in the horizontal coordinates based on the positions of the available GPS satellites. A lower value indicates better accuracy. The date and time are expressed in Greenwich time zone.

The following is an excerpt of a *.cor file (Trace# date time latitude N longitude E “height above MSL” M HDOP):

```
105   2000-9-13   11:9:33   65.18164955141  N   18.75051193218  W   357.26  M   1.454542
106   2000-9-13   11:9:34   65.18164955141  N   18.75051193218  W   357.26  M   1.454657
107   2000-9-13   11:9:35   65.18164955141  N   18.75051193218  W   357.26  M   1.454898
```

EU89-Geodetisk,P,G,HE

“Trace #” latitude longitude “height above ellipsoid”

UTM-coordinates

This file format contains coordinates in the global UTM system. The coordinates are calculated from the GPS data using Redfearn’s formulas on the WGS84 ellipsoid. The file format is defined as “Trace #” northing easting “height above MSL” “UTM zone”

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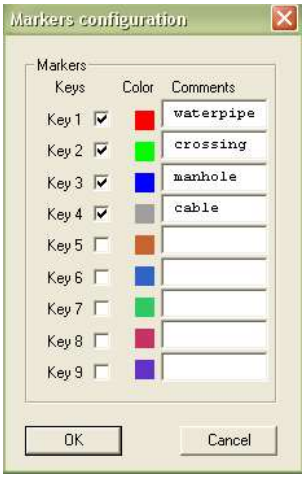
Detailed instructions – Markers, Filtering, Palette

Markers

GroundVision 2 supports a multiple marker function during measurement. Up to nine markers of different type and colour can be configured in the marker dialog.

The *Markers configuration* dialog is opened from the Tools menu in the main window. All the boxes in this window will be empty the first time GroundVision 2 is started. The nine numerical keys 1-9 on the keyboard are predefined as marker keys. Each key needs to be enabled by checking the white box to the right of each key number. A new colour can be selected by a double click on the colour box. Any comment for each marker type can be entered in the comments field.



A new marker file with the extension *.mkn is generated if any marker keys are pressed during measurement. The marker file is a text file.

The first lines contain information about the header version. Following in the file there is four columns (should be tab-separated) with trace number, sample number, marker type and marker label.

Filtering

To be able to apply filters at least one data file must be open. The filter commands are only valid for the active radargram. Much of the functionality described in the topics below is for mouse usage. However, the keyboard can be used in many of these cases. Use the Tab on the keyboard to move the input focus between functions and press the Spacebar instead of clicking the mouse.

Apply and remove filters

Start by choosing *Filter Manager* under View in the menu or right click in the radargram and choose *Filter* in the popup menu. This activates the Filter Manager. To the left, there is a list of available filters and to the right; there is a list of the applied filters.

The functionality of the Filter Manager is straightforward. Choose a filter and click either the *Add* or the *Remove* button and the chosen filter will be either removed or applied. You can also apply a filter by pressing the space key and remove a filter by pressing the *Alt+R* or *Del*, or you can both apply and remove by holding down the mouse button and dragging the filter to the list of available filters. By drag-and-drop-function the order of the filters in the applied list can be altered without removing and applying.

When a filter is being applied, a filter-settings dialog appears. Each type of filter has its own settings dialog with the specific parameters. The trace window is common to all filter settings dialogs. It displays the trace chosen with the Trace Control with filters applied, including the previous filters from the applied list.

Double clicking on a filter in the applied list brings up the filter's settings dialog where the filter parameters can be altered.

There is an option to disable all filters. To do this, press the shortcut *Ctrl+F* or press  in the toolbar.

Decide what filter to use

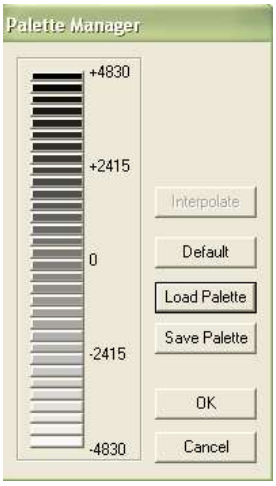
There is no simple answer to that question. A filter very useful for some applications can be useless in others. Depending on the application and the quality of the radar image a range of different filters can be applied. The knowledge and experience of the user often determines the time it takes to produce a useful image. A general recommendation is to start with DC Filter and Time Gain Filter, after that perhaps a frequency filter or background removal filter is needed. A detailed description of the filters is found in *Appendix 1 Filters*.

Palette

To be able to view, alter, load, and save the palette at least one data file must be open. The palette commands are only valid for the active radargram.

Change the palette

Start by choosing *Palette Manager* under View in the menu or right click in the radargram and choose *Palette* in the pop-up menu. This activates the Palette Manager. The palette has 30 colors.



Double clicking on a specific colour box opens a Windows colour dialog and a new colour can be chosen.

One single right-click on a colour box makes it activated, which means that it will be used when interpolating the palette. Another single right-click on the same colour box deactivates it. When interpolating the palette is recalculated depending on the colours in the activated colour boxes. *OK* closes the Palette Manager and applies the new palette to the radargram.

Save a palette

To save a palette click the *Save Palette* button and a standard Windows save dialog will appear. Choose directory in which the palette is to be saved, type in a file name, and click the *OK* button. The palette will now be saved in the specified directory with the file extension ".pal".

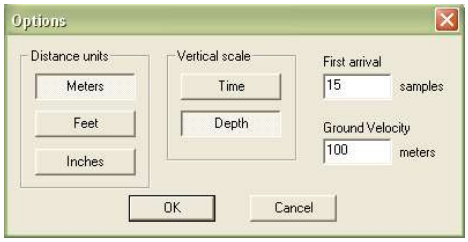
Load a palette

To open a saved palette, click the *Open Palette* button and a standard Windows open dialog will appear. Select the palette file to be opened and click the *OK* button. The palette is now loaded into the Palette Manager.

Scales

To be able to view and alter the scale settings at least one data file must be open. The scale settings are only valid for the active radargram.

In the Tools menu, *Options* is found. Here the vertical scale can be set to Time or Depth together with the first arrival and the velocity to use.



Adjust for first arrival travel time

Due to antenna separation, the wave travelling from the transmitter directly to the receiver (the direct wave) is received some time after the actual transmission. This means that the transmitted pulse has already penetrated the medium a certain distance before the direct wave is received. The result of this is that the depth scale zero must be corrected to be accurate.

The zero for the depth scale is calculated using the first arrival value, the antenna separation, and the first arrival adjustment velocity. The adjustment velocity can be set to any value. Practically however, it can be the ground velocity, the air velocity, or anything in between depending on the antenna configuration.

Printing

Print a radargram

To print a radargram click on the *Print* button in the toolbar or chose *Print* in File menu. A standard Windows print dialog will appear in which the printer to use and pages can be altered. The default settings are the same as the default print settings for your Windows operating system. Clicking *OK* prints the radargram with the actual settings.

Choose the printer

There are two ways of changing the printer. If the printer is to be changed just for the actual printing job it can be done in the Windows print dialog that appear when printing (see section *Print a radargram*). If one wants to print several radargrams on a printer other than the default, that printer can be chosen as default (see section *Alter the filter settings*).

Alter the printer settings

To alter the default printer settings in Ground Vision 2 chose *Print Setup* in the File menu. A standard Windows print setup dialog will appear in which the printer, paper, and format can be altered. Clicking *OK* makes the settings default for future print jobs. Note that these settings are not saved and will not be the same if restarting Ground Vision 2.

Use the print preview

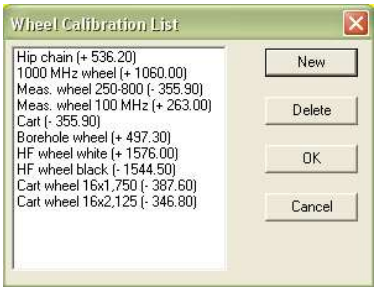
The print preview functionality is similar to Microsoft Word. Chose *Print Preview* in the File menu and the radargram will be displayed as if it were to be printed. The print preview uses the default printer settings. To change the appearance of the radargram in the print preview mode, change the default printer settings (see section *Alter the printer settings*). When done viewing the radargram in print preview mode, click on the *Close* button.

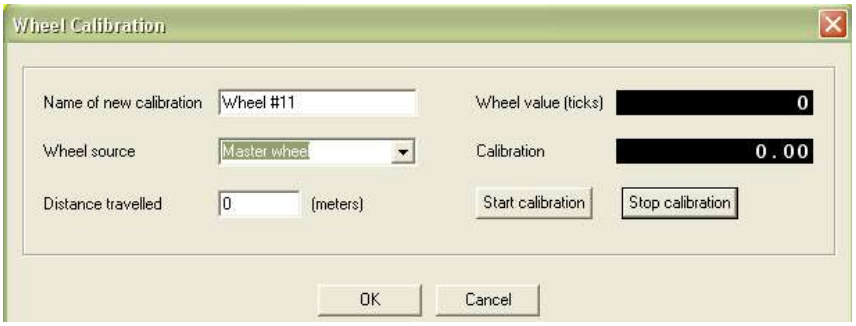
System settings

Perform a wheel calibration

Start with connecting the control unit and the wheel to calibrate, and switch on the control unit. Choose *Edit Wheel List* under Tools menu and the Wheel Calibration List dialog will appear. Press *New*.

In in this dialog, the option of deleting wheel calibrations is also found. Mark the wheel name and press *Delete*.



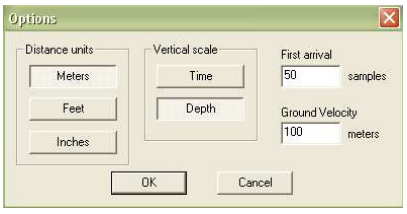


Type the desired name of the calibration in the Name box and choose the correct wheel source; Master, Slot A, B, C or D. Give the correct distance for the calibration, and press *Start calibration*. When the distance is travelled press *Stop calibration* and the option *OK* saves the new wheel calibration in the control unit memory.

Note: The precision of the encoder wheel is not infinite and depending on several factors as; the measurement surface, the pressure applied on the wheel and possible wear. If you are unsure of the encoder wheel precision a re-calibration should be made.

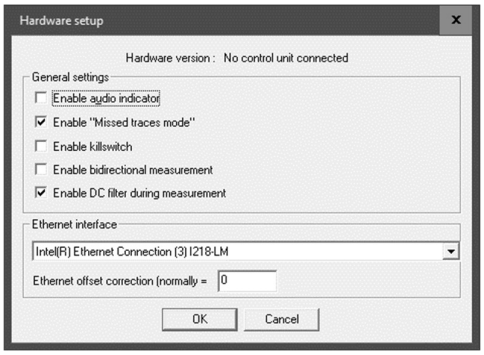
Choose Measurement Units

Choose *Options* under Tools and the Options dialog will appear. Select the unit you wish to use and then press the *OK* button to confirm.



Change Hardware Setup

The Hardware Setup dialog is divided into three areas. The first area shows the current version of the control unit firmware. If the control unit is disabled or communication doesn't work, the status line of this dialog will be shown as *No control unit connected.*



The second area is for general settings with five checkboxes. The first is for enable or disable the audio device on the ProEx. If it is enabled, the control unit will give an audio signal at each measured trace. The second enables the Missed traces mode. In this mode the ProEx will skip traces when over-speeding the system. This means that the position of each trace is correct but that there may be empty traces in the data set.

The third checkbox enables or disables a kill switch function when using the MALÅ High Frequency antennas (1.2 and 1.6 GHz, US models only). If it is enabled measurements can only be carried out if the kill switch button on the antenna is pressed down. The measurements will continue for 8 seconds when the button is released, and the stop. More information is found in *High frequency antennas User manual*.

The fourth checkbox enables bidirectional measurements, used when you want to trig measurements in both directions.

The fifth box is checked if you want to apply an DC-removal filter during measurements.

The third group in the Hardware Setup is the communication settings on how communication is performed between the laptop and the ProEx control unit. In the Ethernet interface drop-down-menu the available Ethernet-interfaces are seen. The communication between the PC and the ProEx control unit will work only with Ethernet on wire.

Ethernets offset correction gives you the possibility to change the number of the network card used. This can be needed if GroundVision 2 does not connect to the ProEx.

Trouble shooting

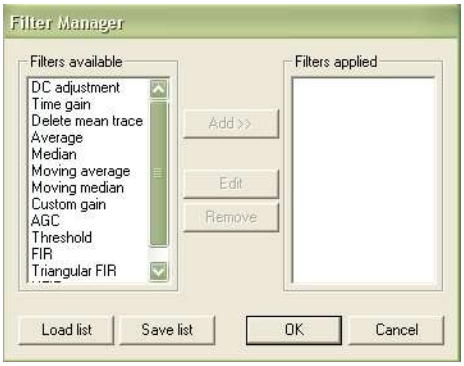
Wheel calibration

The wheel calibration list is full! Remove wheel calibrations before adding another.
The control unit memory is limited. If the area dedicated for wheel calibrations is full this error message occurs. Remove unused wheel calibration and try again.

Wheel calibration distance is too short.
In order to make a proper wheel calibration a quite large distance should be used. Redo the calibration over a longer distance.

Appendix 1 Filters

This appendix covers the available filters in the Ground Vision filter manager. The filters that have settings that need to be set have a dialog connected to them. This dialog can be called from the Filter Manager and is shown in each filter description. Common to all filter dialogs is the trace window that shows the filtered trace. The trace window is updated when there is a change in the filter settings.

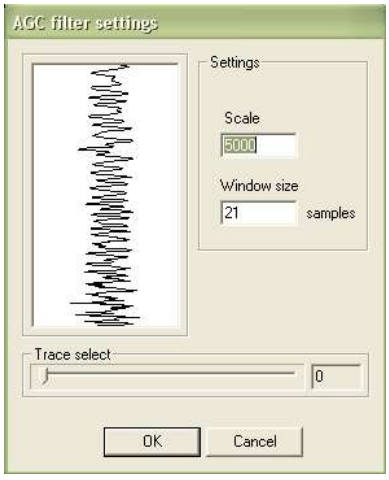


Which filter to use is depending on the application and the quality of the radar image. A filter very useful for some applications can be useless in others. The knowledge and experience of the user often determines the time it takes to produce a useful image. A general recommendation is to start with DC filter and Gain. Below the available filters are listed and also if they are always, often, seldom or very seldom used in common GPR applications.

Always used:	DC-shift
Often used:	Delete Mean Trace, FIR, Time Gain
Seldom used:	Custom Gain, Moving Average, Moving Median, Threshold
Very seldom used:	Average, Median, AGC, Triangular FIR, HFIR

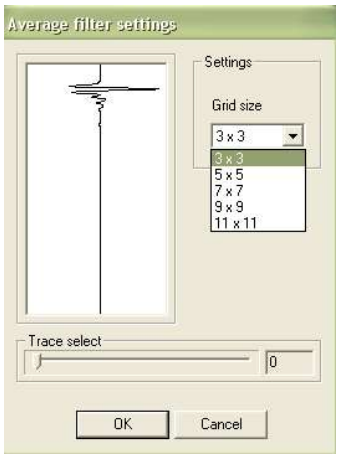
Automatic gain control AGC

This filter attempts to adjust the gain of each trace by equalizing the mean amplitudes observed in a sliding time window. A short window gives a more pronounced effect, the extreme of which would be a one-sample window, which would cause all amplitudes to be equal. The other extreme would be a time window of the same length as the trace. This would have no effect on the trace. After equalization a constant multiplier is applied to the trace to make the resulting amplitudes reasonable.



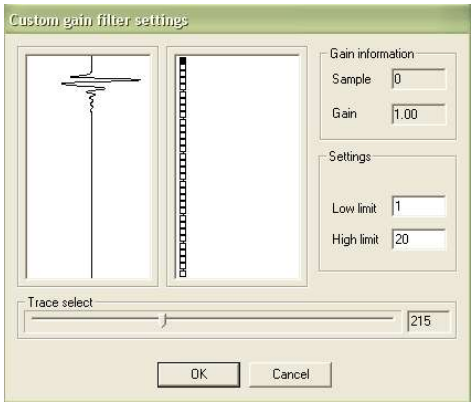
Average

The Average filter calculates a mean over a given number of samples and traces. The sample in the middle of the grid is replaced by the average value. This filter acts as a simple 2D-lowpass filter and gives a softer picture.



Custom Gain

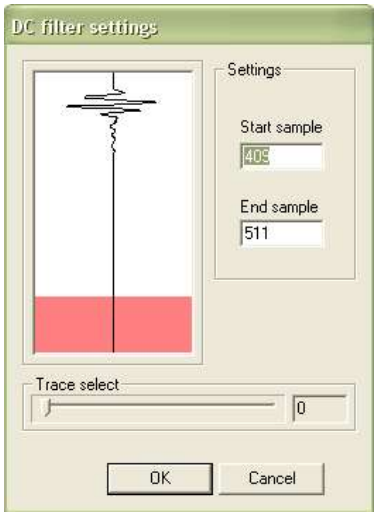
An amplifying filter where the gain factor is given manually for 32 different sections of the trace.



DC-Filter

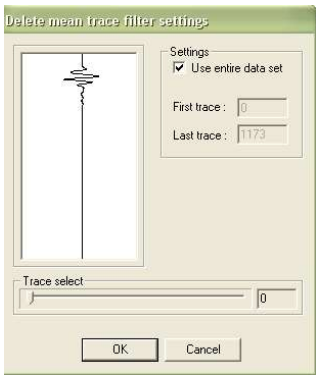
There is often a constant offset in the amplitude of the registered trace, this is known as the DC level or the DC offset. This filter removes the DC component from the data. The DC component is individually calculated and removed for each trace.

In the dialog the sample interval on which the DC component is calculated is specified. Values for the start and end samples can be entered in the edit boxes or by click-dragging in the trace view. The sample interval is shown as a red area in the trace view.



Delete mean trace

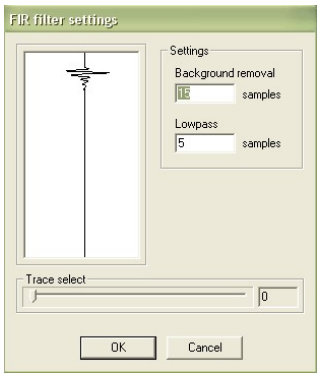
This filter is used to remove horizontal and nearly horizontal features in the radargram by subtracting a calculated mean trace from all traces, sample by sample. The mean trace can be calculated for the whole profile or for a specified section of the profile.



FIR

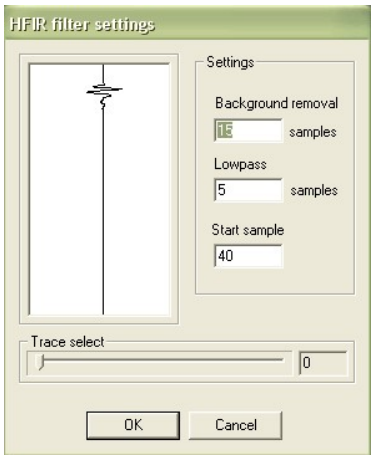
A quick band-pass filter, working with a combination of two boxcar (averaging) filters. The filter is run in two stages. First the lower frequencies are attenuated by subtracting the average in the longer boxcar from the raw data at the centre of the boxcar. Then the higher frequencies are attenuated by replacing each sample with the average calculated in the shorter boxcar.

Both boxes calculate along the whole trace.



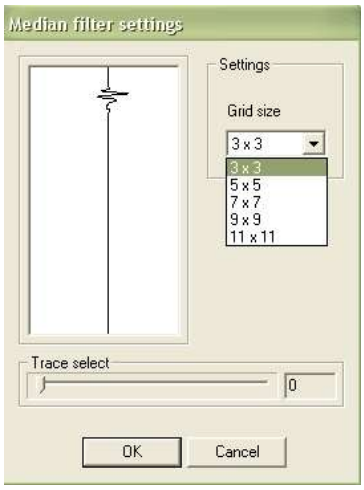
HFIR

The HFIR filter functions as the FIR filter, but the filter runs along the profile - not along the trace. The filter is a spatial band-pass filter, and its effect is similar to that of the background removal filter



Median

The Median filter functions as the Average filter, but instead of the mean value a median value is used. It removes spikes in the data efficiently while not blurring the image quite as much as the average filter does.

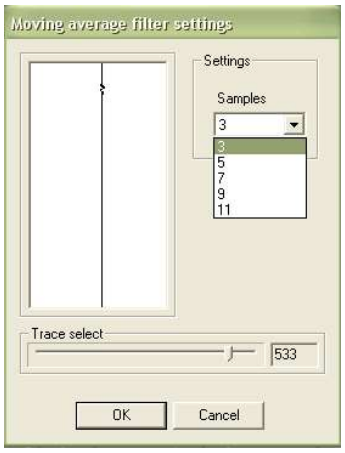


Moving average

This filter takes the average as calculated by the average filter described above and subtracts it from the sample at the centre of the filter. Its effect is that of a simple 2D high-pass filter.

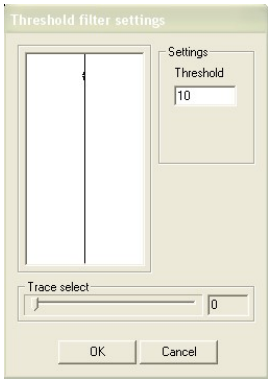
Moving median

As the Moving average filter, but with the median value instead of the average.



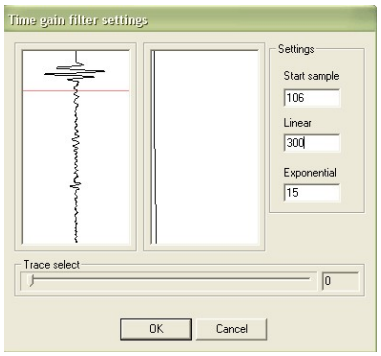
Threshold

All samples with a value below the threshold are set to zero.



Time-Gain Filter

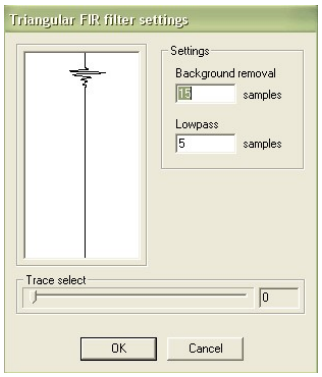
The Time-Gain filter applies a time-varying gain to compensate for amplitude loss due to spreading and attenuation. The trace is multiplied by a gain function combining linear and an exponential gain, with coefficients set by the user. In the Time-Gain dialog, there is one trace window and one gain window. The trace window shows a filtered trace, and the gain window shows the gain function applied.



The red line in the trace window indicates the start of the filter (before this point the gain of the filter is unity).

Triangular FIR

The Triangular FIR filter functions as the FIR filter, but instead of using boxcar averages it uses averages in symmetrical triangular windows.



Appendix 2 GNSS measurements

This appendix covers some important issues when using a GNSS to position the GPR measurements.

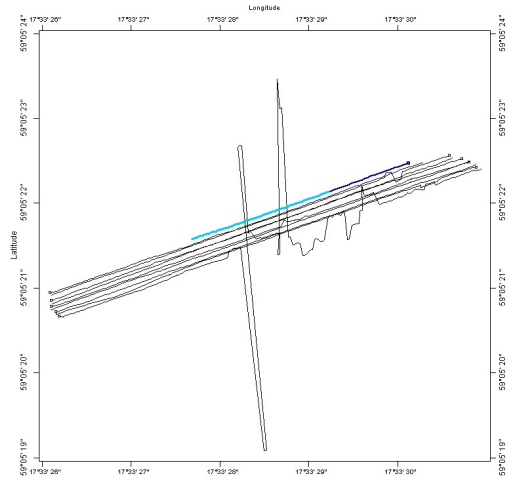
The Guideline Geo MALÅ XV Monitor or GroundVision software can be used together with GNSS equipment which communicates via a 9-pin series connector. The GNSS must communicate with NMEA 0183 protocol with GGA sentence. For the XV Monitor there is also one type of USB GPS available, see the *XV Monitor User manual* for more information.

The GNSS equipment available today can be divided into three different types:

- GPS: Inexpensive, the GPS is using only satellites for positioning, accuracy around ±4 m. Suitable for large scale layer mapping etc.
- DGPS: Differential GPS, uses satellites and a correction from a reference station, accuracy around ± 0.5 m. Similar systems are EGNOS (Europe), WAAS (USA) and MSAS (Japan).
- RTK GNSS: Real Time Kinematic GNSS, uses two GNSS receivers (one stationary base and one rover) and correction signal from the base antenna, accuracy around ± 1 cm. Network RTK is also available in many locations, where the correction is received via GSM. RTK GNSS accuracy is recommended for utility mapping.

For all the three different GNSS systems the following is very important to remember:

1) Regardless the system used; GPS, DGPS or RTK, the positioning data gathered will be of bad quality if the measurements are made under bridges, in dense forest, close to high buildings etc. In the example below the lowermost line is measured 1 m from a building, resulting in incorrect positioning of that measurement line.



2) When using a GNSS in motion, the GNSS system is updated more or less seldom. Inexpensive systems may update 1 time/second while RTK systems can update 10 or more times/second.

3) The GNSS antenna should be placed in the middle of the GPR antenna to give the most correct position of the GPR traces. This will be a problem when measuring with the MALÅ RT antennas and should be corrected afterwards.

4) It should be observed that during the day the connection to satellites can change, giving better or worse positioning possibilities.