GUIDELINEGEO | MALÅ

MALÅ MIRAsoft HDR

User Guide

Our Thanks...

Thank you for choosing Guideline Geo and MALÅ! The very core of our philosophy is to provide our users with great products, support, and services. Our team is committed to providing you with the most efficient and easy-to-use solutions with the capability to meet your needs for efficiency and productivity.

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.

Please let us know about your use and experience of our products as well as the contents and usefulness of this manual. We're excited to be part of your journey!

Guideline Geo AB

www.guidelinegeo.com

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Preface

About this Manual

This manual is written for the end user of the product and explains how to set up and configure the product, as well as providing detailed instruction on its use.

Additional Resources

Training: www.guidelinegeo.com/training-gpr-resistivity-seismics-tem/

Downloads: www.guidelinegeo.com/support-service-advice-training/resource-center/

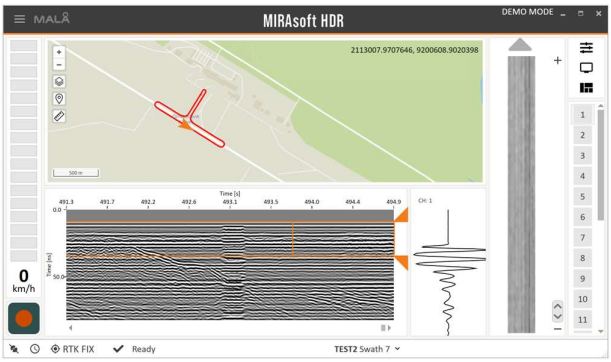
Applications: www.guidelinegeo.com/application-areas/

Feedback

Feedback regarding the contents of this manual or the product may be sent using any of the contact details found at www.guidelinegeo.com

About MIRAsoft HDR

MALÅ MIRAsoft HDR is the data acquisition software dedicated to the MALÅ MIRA HDR (MALÅ Imaging Radar Array, High Dynamic Range) system from Guideline Geo. MIRAsoft HDR acquires data from the MIRA HDR array system. As a Windows 10™ based software MIRAsoft HDR gives you an easy-to-use user interface, file management, and other key features. Each measurement and associated settings are stored in files. Real-time filtering can be performed during measurement, all radargrams viewed as top view and MIRAsoft HDR supports logging of positioning information during measurement. Projects can be exported for post-processing and interpretation to other software, such as rSlicer and GPR-SLICE.



Installation

The MIRAsoft HDR software is downloadable from the Guideline Geo´s homepage.
www.guidelinegeo.com

The software runs on Windows 10 (64 bit). It is recommended to have an i7 processor and 8GB of RAM and a minimum of 1GB RAM is required. The MIRA HDR system collects approximately 246 kb data/m^2.

Overview MIRAsoft HDR

MIRAsoft HDR is the data acquisition software for the MIRA HDR system. MIRAsoft HDR is used for collecting new multichannel GPR data and to view already collected data. Post-processing and interpretation of MIRA HDR are done in other 3D GPR processing software such as rSlicer and GPR-SLICE.

This manual (together with the *MALÅ MIRA HDR User Guide*) explains how to set up the measurements with the MIRA HDR antenna array, collect data and save it to a suitable format. During data collection it is also possible to view one radargram and traces from all channels.

The user interface of MIRAsoft HDR is developed to be easy to handle during field work and work as well on a touch screen, as on a field computer. The workflow is straight forward and consists of the following steps:

1. Make sure that the MIRA HDR antenna box is on and connected to the data acquisition platform
2. Create a new project (with name and type) or open an existing project
3. Measurement settings (different acquisition options, channel selection and trigger type)
4. Positioning (GPS and Total Station parameters)
5. Advanced settings (trace position, geometry settings, power settings, GPS settings)
6. Ready to Measure

The following definitions are used in this User Guide:

Sample	Instant, digital value of recorded radar signal at one specific time.
Trace	The recorded radar signal from one channel at one point, built up over a short time by a certain number of samples.
Point distance	Distance between each trace collected for all individual channels.
Stacks	Number of averages for each trace.
Swath	One complete profile line including all channels in the array. The coverage every swath depends on the individual channel spacing multiplied by the number of channels.
Tx	Abbreviation for a transmitter antenna.
Rx	Abbreviation for a receiver antenna.

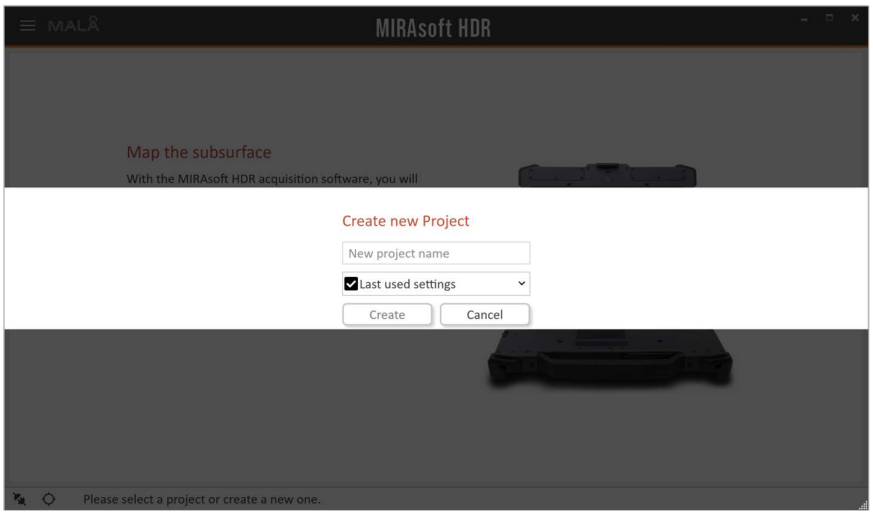
Start the software

When you start MIRAsoft HDR you are asked to *Create* or *Open* a project.

At any time, you can go back to this *Projects* menu (found in the main menu) to change, create, or delete projects. See also *Projects* section, below.

Create new project

The *Create new project* option creates a new MIRA HDR project, with your own defined project name and possibility to choose between different pre-defined settings (as standard settings for 11 T_x x12 R_x or 15 T_x x16 R_x) or the last used setting. If you have saved a template, it can be found in the dropdown list as well (see section *Projects* below).



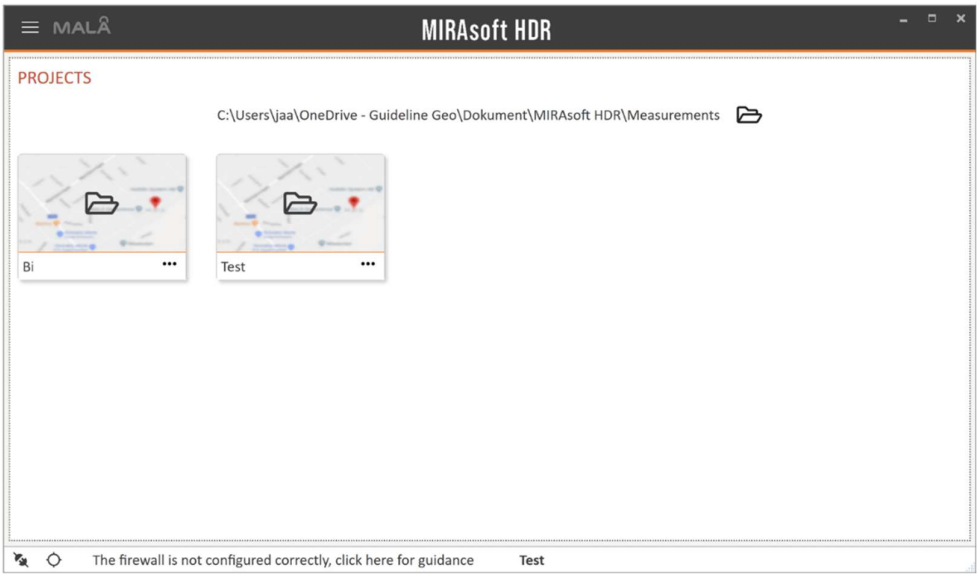
When you press create you will immediately reach the Measurement options page. See section *Antenna* below.

Note: If the project name already exists, the *Create* option is greyed out.

Note: The project name is also used for the separate, single swaths in a project, but with an extension: 1, 2 and so on.

Open project

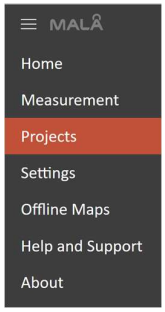
When choosing the option Open project, you can choose to open an already made project.



Click on the project to open and you will immediately reach the Measurement options page. See section *Antenna* below.

MIRAsoft HDR Main Screen

The Main menu is found in the left upper corner:



At the bottom of the main screen, in the status bar, system information and basic viewing choices can be made.

Left side of status bar when MIRA HDR is disconnected: 

Left side of status bar when MIRA HDR is connected: 

From left-to-right:

- Connection to the antenna box, active or not
- GPS time from MIRA HDR
- GPS or Total Station status
- Battery level
- Status of the connection to the MIRA HDR system

Centre of status bar: 

- Name of the current project and which swath is shown on the screen. By pressing the arrow you can change the displayed swath

MIRAsoft HDR Function keys

- F1 - opens About page
- F2 - toggles to Main menu
- F3 - starts measurement
- F5 - stops measurement
- ALT+arrows up/down - switches between channels
- F8 – F11 toggles the different views in the measurement tab.

File Directory

MIRAsoft HDR creates a file directory in Documents called *MIRAsoft HDR*. This file directory contains a folder called *Measurements* where all the projects created can be found.

The location of this folder cannot be changed. You can open data from other locations, by changing the file directory route in the Project window, see section *Open project*.

In detail, the following file folders and files are created by MIRAsoft HDR:

1. Measurement folder in users' documents  Documents

2. For each project, the user creates a project folder. This folder can be named freely. In that folder a <project_name>.yml file and a <project_name_backup>.yml file are created that contain all information related to the project (channel selection, channel settings and everything else). These files can be opened in a simple text editor such as Notepad.

3. For each measurement, the following files are created per swath:

   - < project_name >_<swath>.YML (snapshot of system settings when measurement was done)
   - < project_name >_<swath>.mpos (if positioning is available, it will contain raw GNSS positions for the measurement stored in GeoJSON format)
   - < project_name >_<swath>.mcor (if positioning is available it will contain the interpolated GNSS positions in GeoJSON format)
   - < project_name >_<swath>.mtts (if positioning is available it will contain the timestamps for all traces)

   And the following files are created per channel:

   - < project_name >_<swath>_<channel>.rd7 (32 bit GPR raw data)
   - < project_name >_<swath>_<channel>.rad (information on channel settings)

4. If data are exported (e.g. to rSlicer format) a folder is created to store all files in that export. If export is made to rSlicer format, the folder is called rSlicer as well.

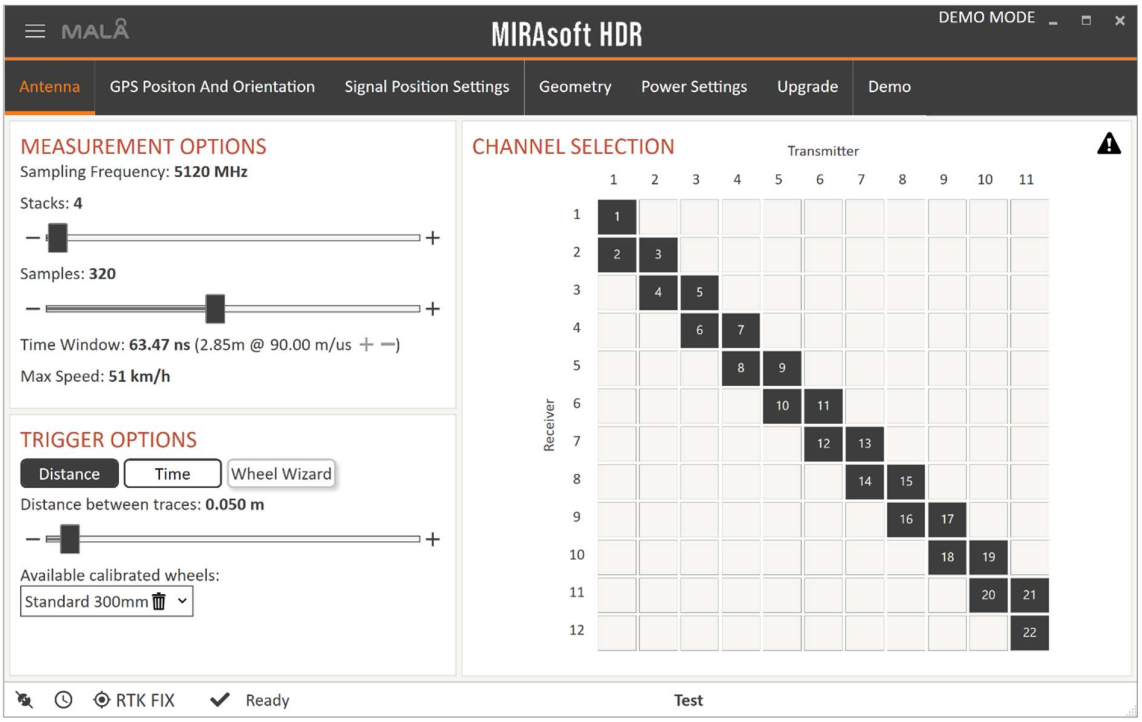
Note: All configuration data are saved to disk (in the settings files). The configurations that are written to the MIRA HDR firmware are: measurement settings (e.g. stacks, samples, trigger), power settings, trace alignment and line adjustment settings if a calibration is made in the advanced settings page.

Settings

In the Settings menu (found in the Main menu) you do all measurement settings for the antenna, the used GNSS, signal positions, geometry, and power. Firmware upgrade is also found here.

Antenna

When you have created or opened a project you automatically open the Antenna tab in the Settings Menu. Here you find measurement options for traces, trigger, measurement wheel and channel selection.



Note: You can have different settings for different swaths measured within the same project. However, in rSlicer, the swaths will need to be processed in groups of profiles which share the same settings.

The warning triangle (upper right corner) is shown if the settings have changed since the last made measurements in the open active project. This means that the signal position needs to be calibrated (see section *Signal Position Settings*).

Measurement Options

- Sampling Frequency: A fixed value, optimized for the antenna frequency used.
- Stacks: How many times each trace is to be stacked; higher numbers give better data quality but will lower the maximum acquisition speed.
- Samples: How many samples are collected for each trace.
- Time window: Time window for current settings, adjust the velocity (with the + and – signs) to get the estimated depth value.

Note: The maximum measurement speed is shown for the current settings when using distance triggering.

Depending on the number of Tx units used in the array the number of available samples will change, as below:

- 1-4 Tx: 1984 samples
- 5-8 Tx: 1728 samples
- 9-16 Tx: 672 samples

Trigger Options

The MIRA HDR can be trigged with *Distance* or *Time*.

For *Distance*, choose the *Distance between traces* and the *Available calibrated wheel*. If a new wheel is needed, or a re-calibration must be carried out, use the option *Wheel Wizard* which will guide you through some easy steps to calibrate and save a new measurement wheel.

For the *Time* triggering option set the *Time between traces*.

Channel Selection

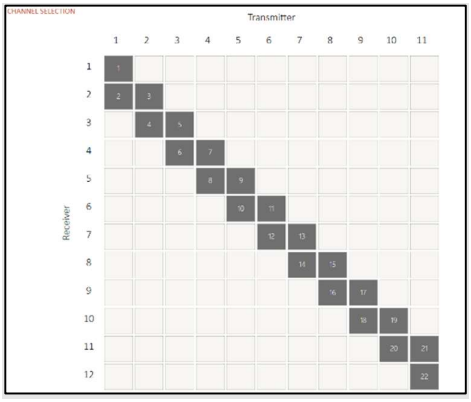
In the channel selection matrix, the operator selects how the radar antenna array should be set up to collect data. The user defines a firing sequence by clicking in the squares of the matrix; this will turn them grey and display the channel number assigned to that combination of Tx (columns) and Rx (rows). This sequence of Tx-Rx combinations is repeated every time a measurement is triggered.

Note: If the selection turns red, it indicates that an antenna used in that combination is not working properly.

It is possible to add up to 132 channels, in any combination. But it should be noted that only the channels that have the same Rx to Tx distance can be shown together in the top view (see *Measurements* section). This means that the largest group of channels with equal Tx-Rx distance are shown in the top view.

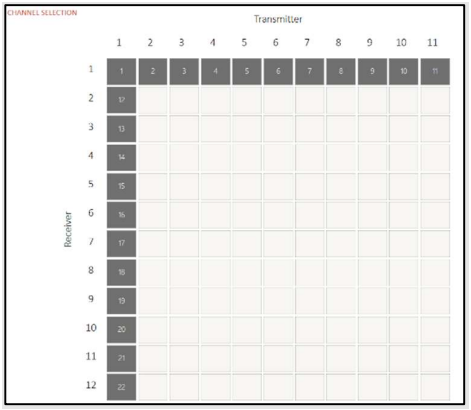
The default 22 channel configuration for a MIRA 500 HDR 1.4 m antenna array is shown in the picture below. This is also provided within the software at purchase.

Default MIRA 500 HDR 1.4 m set-up; 22 channels with 11 Transmitters and 12 Receivers antennas.



On the right hand-side an example of a user-defined channel set-up is shown. This layout is automatically saved and connected to the project.

Click on the grey box to either choose or remove an antenna combination.



Positioning Menu

Positioning of the MIRA HDR antenna array is done with an external GNSS system such as an RTK-GNSS or a Total Station.

It is highly recommended to use an accurate GNSS solution or a Total Station to position the MIRA HDR measurements as this will increase the quality of the resulting time slice images. The GNSS is connected to the computer used for data collection.

MIRAsoft HDR reads standard NMEA data, specifically G*GGA messages, from the connected GNSS; it will by default discover the COM port settings automatically to enable communication between the GNSS and MIRAsoft HDR. If you wish to set the COM port and baud rate manually simply use the drop-down menus to change from Auto to your preferred setting.

INGGA messages is also supported.

The positioning data is written in a so called *.mpos file that will contain the raw positioning data received from the used positioning device and is in GeoJSON format. A *.mcor file is also created and contain interpolated positions for all traces collected during the measurement. The *.mcor file is also in GeoJSON format and differs from the *.mpos file in that it contains a reference to the associated trace. The *.mcor file is structured as follow:


```
{
    "type": "FeatureCollection",
    "features": [
        {
            "type": "Feature",
            "geometry": {
                "type": "Point",
                "coordinates": [
                    20.2338662818,
                    63.842677564,
                    10.989915602840484
                ]
            },
            "properties": {
                "PositionTime": "2020-10-16T14:19:31.5341705+02:00",
                "TraceNumber": 1
            }
        },
        .
        .
        .
        {
            "type": "Feature",
            "geometry": {
                "type": "Point",
                "coordinates": [
                    20.2352142097,
                    63.8433977665,
                    12.089915601536632
                ]
            },
            "properties": {
                "PositionTime": "2020-10-16T14:19:59.5988422+02:00",
                "TraceNumber": 1635
            }
        }
    ]
}
```

For the *GPS Settings* the system automatically recognizes the com port and baud rate for communications. These two can also be selected from the drop-down menus.

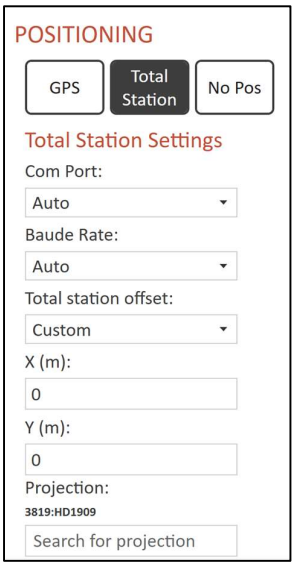
Acceptable *GPS fix levels* can be set as:

- *RTK GPS*. Best quality, should be used during measurement
- *GPS.* Positioning is of poor quality
- *Float RTK.* Ok quality

The *GNSS offset* measurements are defined as the distance from the GPS antenna's reference position (usually marked on the GNSS antenna itself but check the supporting documentation for your system) and the positioning reference point on the MIRA HDR; this positioning zero point is located at the left corner on the antenna box and clearly marked. See below, in section *Geometry Settings.*

The *GPS offset* also has three pre-sets, for the MALÅ MIRA HDR field trailer, front carrier and road trailer

If the GNSS antenna is attached elsewhere on the measurement set-up, as on top of the carrier vehicle, the position needs to be adjusted accordingly. See picture below, where green represent the location of connectors and red the positioning zero point. See section *Geometry* below.



For the *Total Station*, as well as for the GPS, the system automatically recognizes the com port and baud rate for communications or can be selected from the drop-down menus.

The *Total Station offset* (location of your prism) is defined as for the GPS offset, see above.

To be able to fully utilise the positioning support in MIRAsoft HDR a total station establishment must be done.

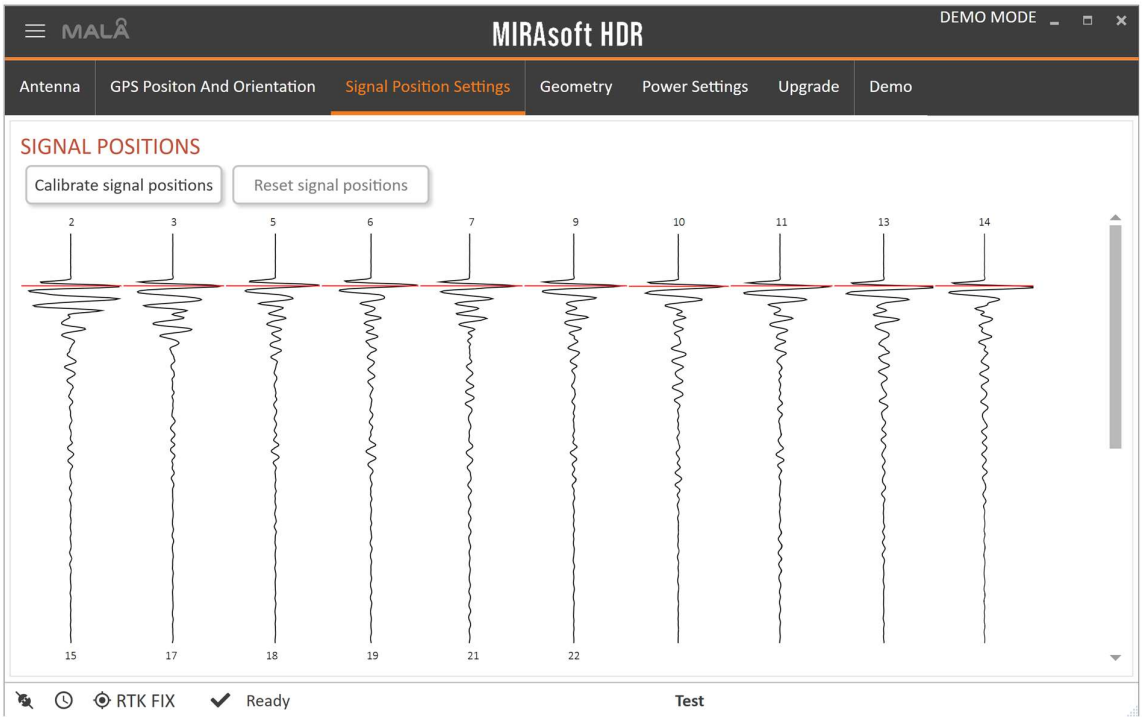
Once this is done the projection for the used coordinate system can be selected in MIRAsoft HDR. This can be done by searching for the projection in the smart search box that allow searching by EPSG code or projection identifier.

The option *No Pos* (No positioning) should only be used for testing.

Note: The measurement direction is set here as well, forward or backward (i.e. push or tow) by choosing the correct arrow (green indicates the chosen direction).

Signal Position Settings

In the *Signal Position Settings* tab, you can calibrate the signal position or reset the same.



The most important difference with MIRA HDR measurements compared to single channel operations, is the time zero setting. Since there is no way to guarantee that all channels have the same lead time in the electronics and cables, as well as the geometry of the signal path, the time zero must be set so that it safely registers the first arrival of all the used channels.

To help the operator in aligning the trace position a set of commands/buttons are provided to accomplish this task:

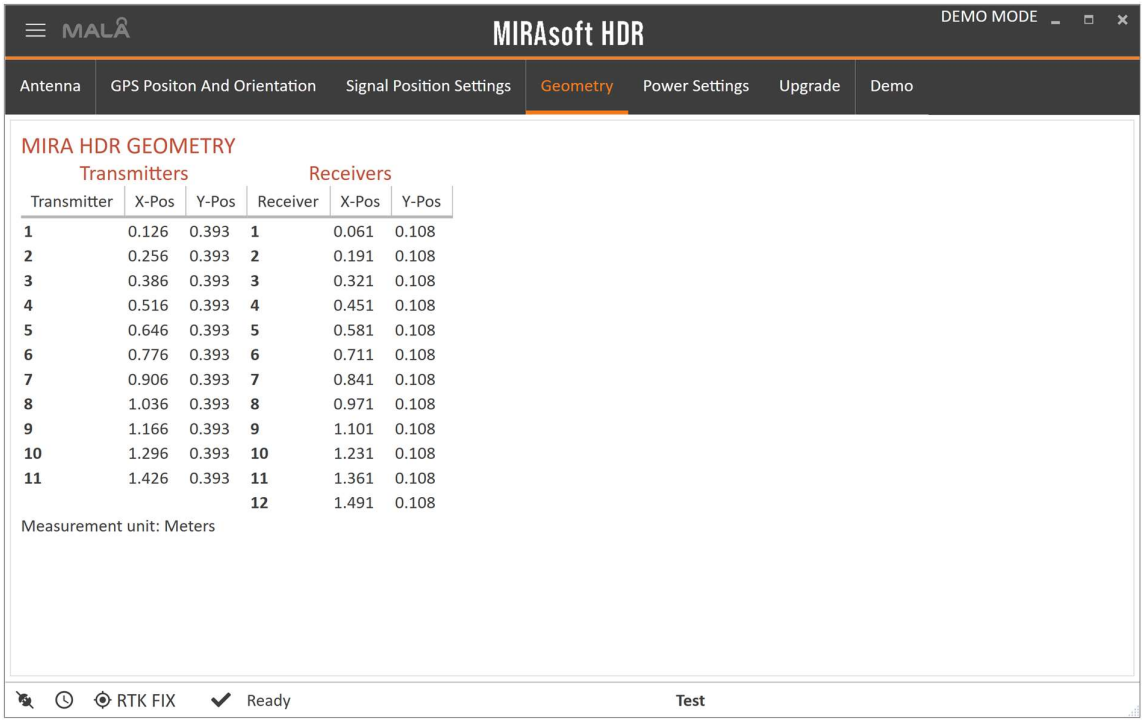
- Calibrate signal positions. MIRAsoft HDR automatically calibrates the channels activated in the Channel selection (see section *Antenna*), to locate the zero level on the same position.
- Reset signal positions. The signal positions are Reset back to the last stored/saved values.

Geometry Settings

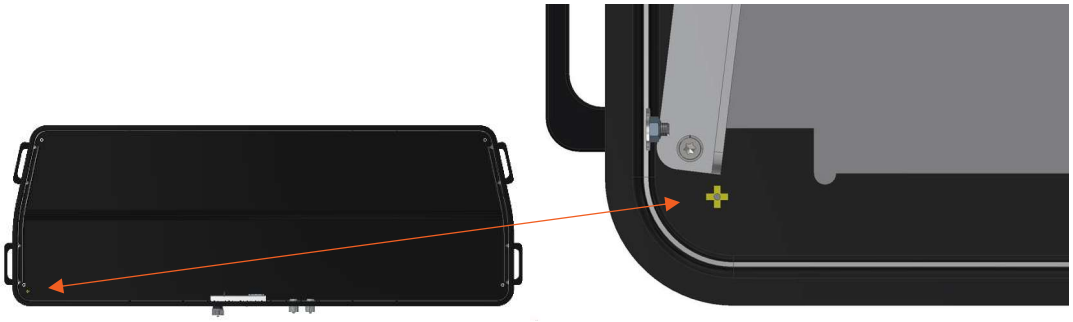
In the geometry settings you define the location of each antenna element (Tx and Rx), related to the 0,0-position of the enclosing array box. These distances are needed to be able to assign and sort the location of all individual channels in the chosen post-processing software.

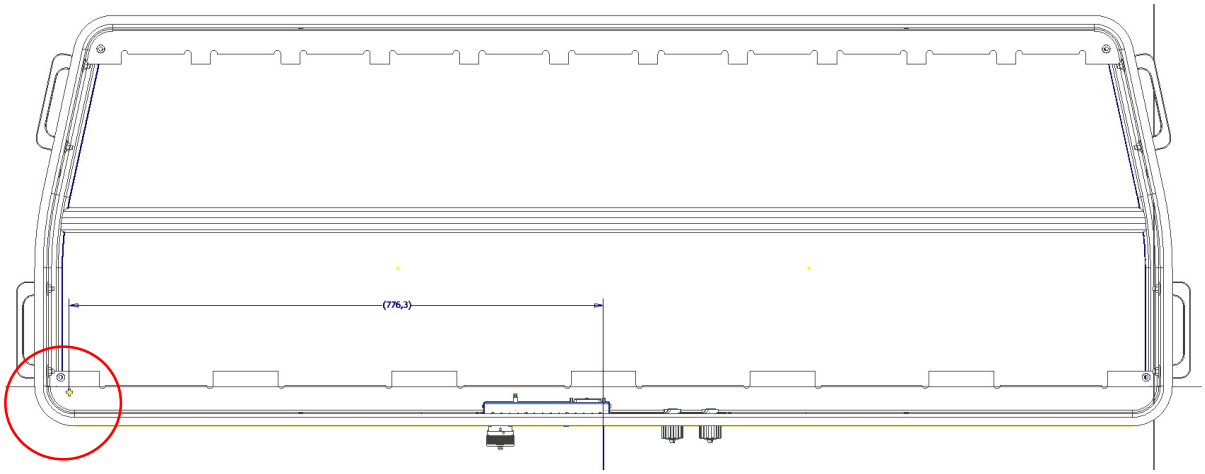
If choosing the MIRA 500 HDR 11x12 or 15x16 template when creating a project, these numbers are added automatically and are correct. The measurements are made from the 0-point of the individual Tx/Rx antennas to the 0,0-point of the array box.

The geometry settings for a MIRA 500 HDR system are shown below.



The 0,0-point of the system is located in the back-left corner of the array box:



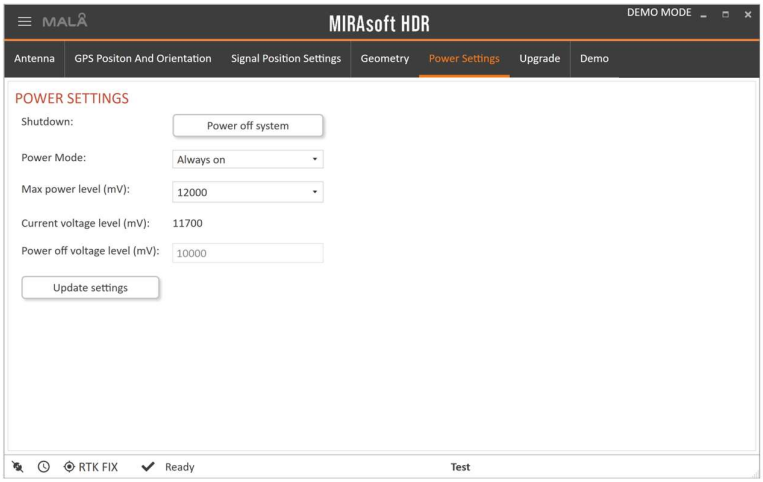


Power Settings

In this tab you can power off the system and make adjustments to power levels:

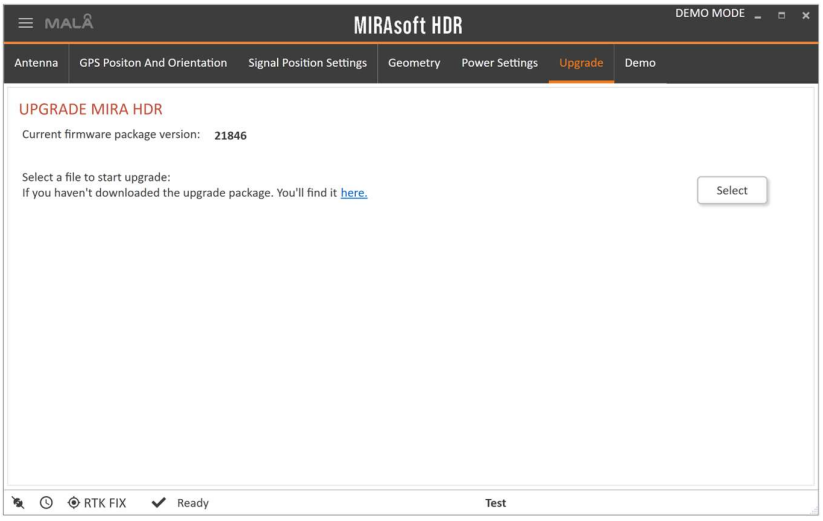
- *Power Mode*: choose between *Always On* or *Power off at voltage level*.
- *Max power level*: choose between 12000 or 24000 mV
- Current voltage level: this will be the maximum battery voltage registered by MIRA HDR; this setting affects the battery level displayed in the status bar.
- *Power off voltage level*: decide at which battery level (mV) the system should be turned off.

When changes are made, press *Update settings*, to send the new information to the firmware of the antenna box.



Upgrade

The *Upgrade* tab displays information on the current software and firmware versions and how to upgrade the firmware of the MIRA HDR system. Press *Upgrade* and then follow the instructions below; there will be an on-screen guide to help you through the upgrade procedure.



Download the installation package to the computer where MIRAsoft HDR is installed. The installation package is in a special format with *.GGM extension. Only files with this format are compatible and can be chosen.

Note: The file downloaded from the resource center is a zip file that needs to be extracted to get hold of the actual firmware file that is used to upgrade the antenna system.

MIRAsoft HDR determines, based on the current system status and the chosen firmware package, which components will need to be upgraded. It will display the time required for the upgrade.

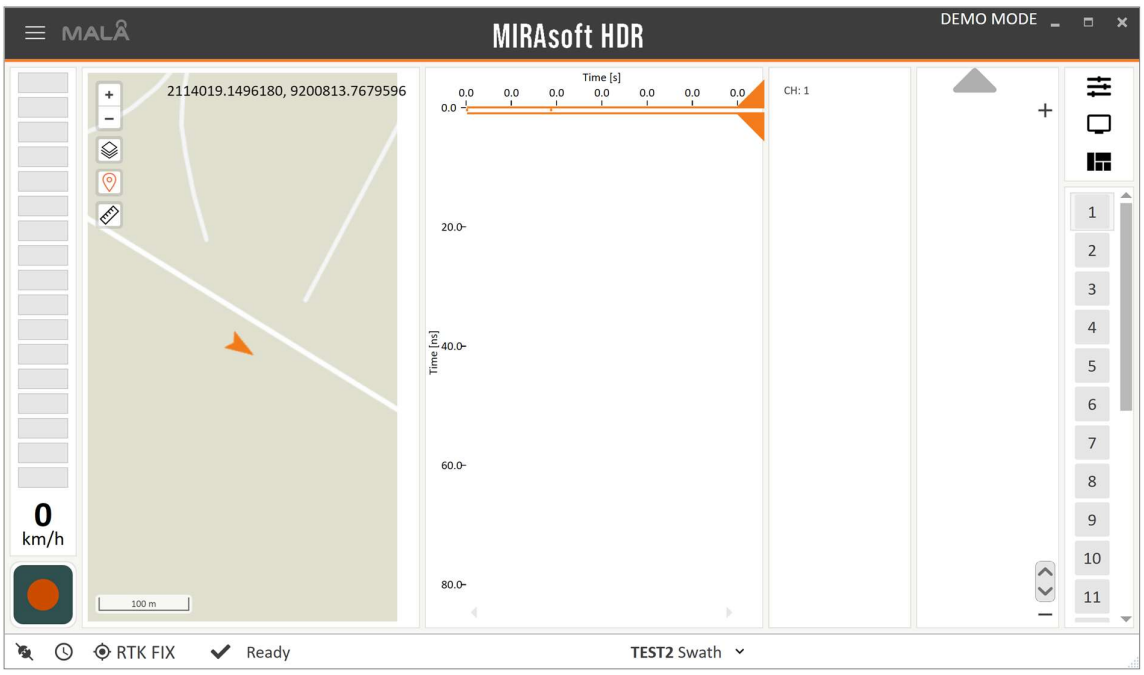
Note: If running the system on battery power, make sure that you have enough battery before starting a system upgrade. Do NOT disconnect the system during the upgrade procedure.

Note: If you get a message, stating that the firmware upgrade failed, you MUST try again until the message saying the upgrade was a success is displayed.

After the upgrade, the customer should do a hard reboot of the antenna system and restart MIRAsoft HDR.

Measurements

When all settings are done, choose the *Measurement* option in the main menu. In the *Measurement* tab you see the map, the radargram, a trace and a top view at the same time.



Press  to start.

This brings up the Positioning pop-up window. The system waits for a good and accurate GPS position before it starts (or ends) a measurement.

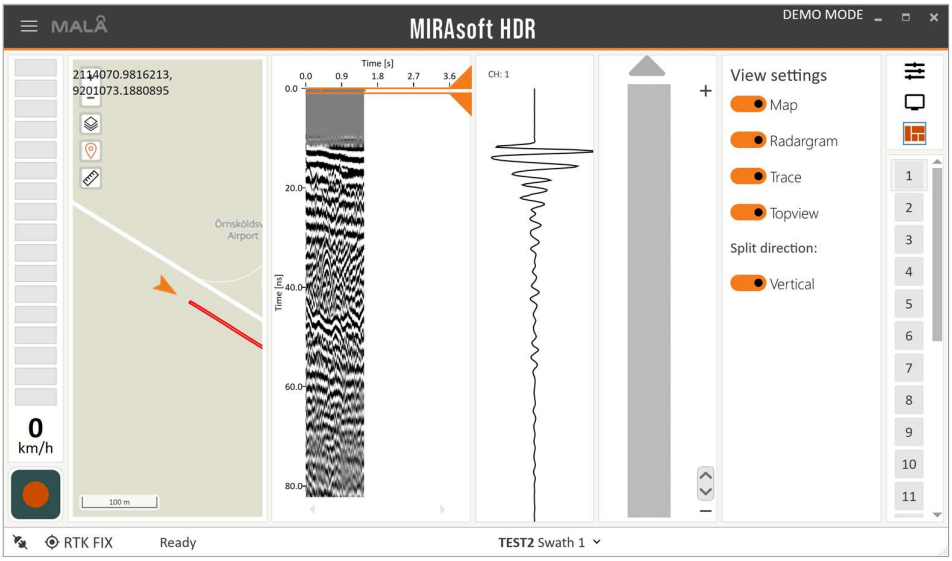
Note: Sometimes, if GPS conditions are bad, you may need to move your starting position, e.g., if you are too close to a building or underneath tree cover.

When a swath is complete, press  to stop the measurement.

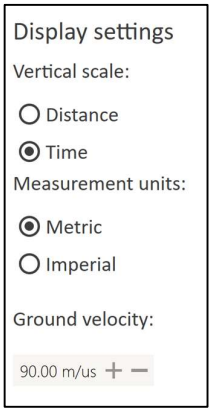
To view data from previous swaths either select it in the map view or use the swath selector at the bottom of the screen 

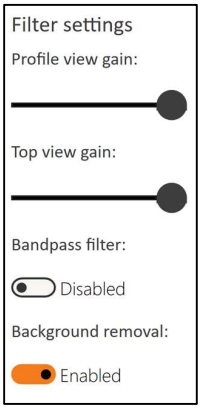
When pressing  data are automatically saved by MIRAsoft HDR and, again, the system waits for correct positioning before continuing.

During measurements, the data and positioning can be viewed in different ways. Press the Toggle view settings button  , on the right-hand side of the screen and choose among the view options. Close the window by pressing  again.



You can also change the display settings and change the radar wave velocity with the Display button  and add filters with the Filter button  on the right hand side of the measurement window.





Note: Any filtering or gain applied on the data are only for display, and do not affect the recorded data which are saved in a raw state.

Note: The colour bar at left shows the measurement speed, it should not be red, as this may cause loss of traces. A loss of trace will show up as a grey vertical line in the radargram.

Note: On the right-hand side, you can toggle between the different measured channels, and by that decide which is displayed in the radargram window.

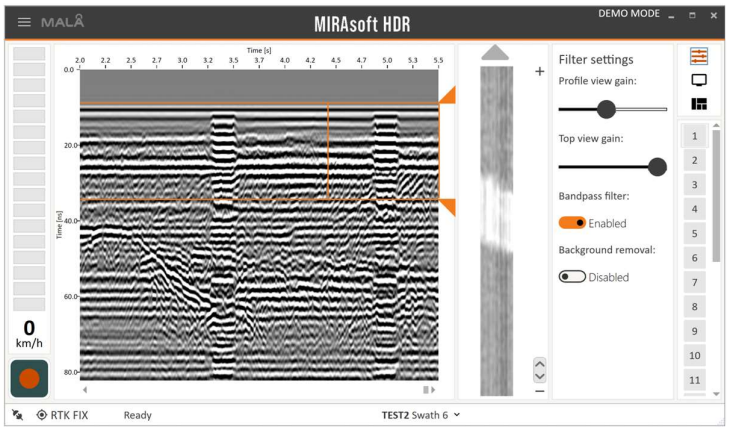
Note: When the mouse pointer is above the radargram or the top view, information on distance and depth is shown.

Note: If several swaths have been collected, you can choose which to display by clicking in the map view. Alternatively, you can choose the swath to be displayed in the swath-selector in the status bar.

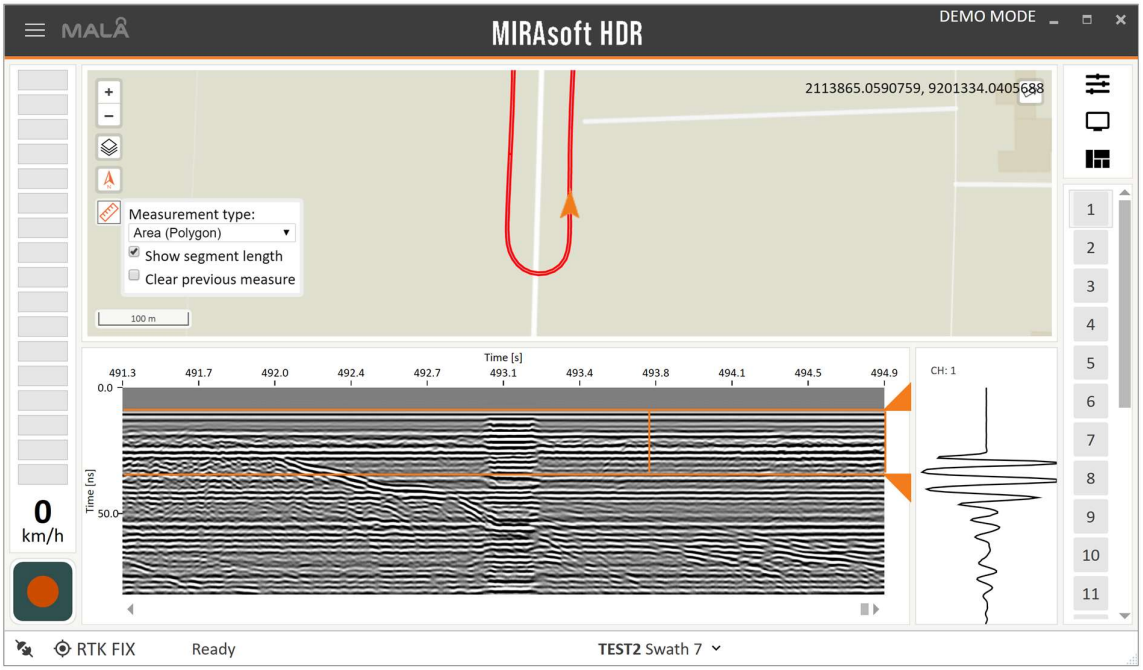
The part shown as top view (time slice) is indicated in the radargram view by two orange vertical lines.

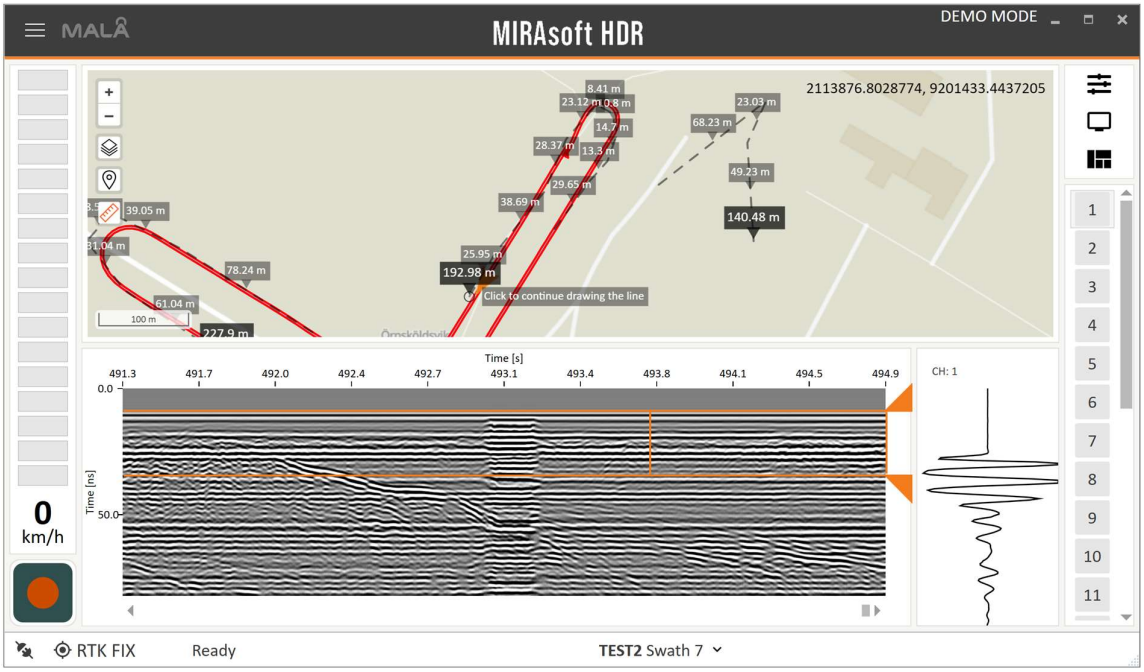
The horizontal orange lines define the data used to create the time slice, seen to the right.

The time slice is set by simply sliding the two red horizontal lines on top of the radargram. The slice thickness and location can be changed freely.



In the map view you can zoom in and zoom out, decide to use an online or offline base map (see section Offline maps), center the map, or orientate it to North or measure distances or areas. Choose Length (Line string) or Area (Polygon) and mouse click on the map. Double-click will end the line or polygon.





Tips and tricks during measurement

- Prior to GPR data acquisition, thorough planning of the survey should be done. It is advisable to conduct the data acquisition in straight lines, whenever possible. Although the MIRA HDR system does not require straight swaths, positioning errors will be reduced, and achieving full coverage of the survey area will be easier to manage if the geometry is kept simple.
- The MIRAsoft HDR application has a moving map navigation aid, showing swath coverage, which can be used to ensure total coverage of the investigation area. It is wise to have a reference point far away for each swath, to keep the measurements straight, and then use the map to see that data is collected side by side, without gaps. Swaths shown on the map are partially transparent and will darken where they overlap; try to maintain a small overlap for best results.
- For every swath, each channel will be precisely positioned. To avoid gaps in data, it is recommended to collect data with one channel overlap. Uncovered areas will produce artefacts in the resulting images. The processing software has been designed to minimize these effects but nevertheless, a careful data collection procedure is essential for the resulting image quality.
- The antenna array box should be kept on the ground, or as close to the ground as possible, for best possible data quality.
- Be aware of all system warning messages from MIRAsoft HDR, such as exceeding maximum measurement speed etc.
- Utilities are best detected if the measurement swaths are collected in the same direction that the utilities are running. If utilities run predominantly in two directions attempt to work diagonally with respect to their orientation. If the direction is unknown, some test lines might be advisable.
- It is ok to stop the movement of the antenna array and take a rest within a traverse. If the break is for a long time, make sure to turn off the antenna array, as it will otherwise continue to use power; however, traces are only collected when the encoder wheel is moving.
- If a measurement swath is wrongly made, stop it, and use the restart option. Even if a bad line has been collected, you can easily remove bad swaths from the project folder.
- Swaths can also be remade later and included in earlier projects; double-check those settings of the new swaths match the old ones if you intend to process the whole project as one.
- Practically, the site conditions usually define the limit of survey speed. Surface roughness, obstacles preventing straight lines, crossing traffic and other details often limit the average speed to below 20 km/h.

Measurements in any direction

Measurements with the MIRA HDR system can be carried out in any direction.

Note: Measurements made with straight lines will create a better end result than very curved lines.

Measurement with a highly elevated GNSS position or remote GNSS position (i.e. on survey vehicle)

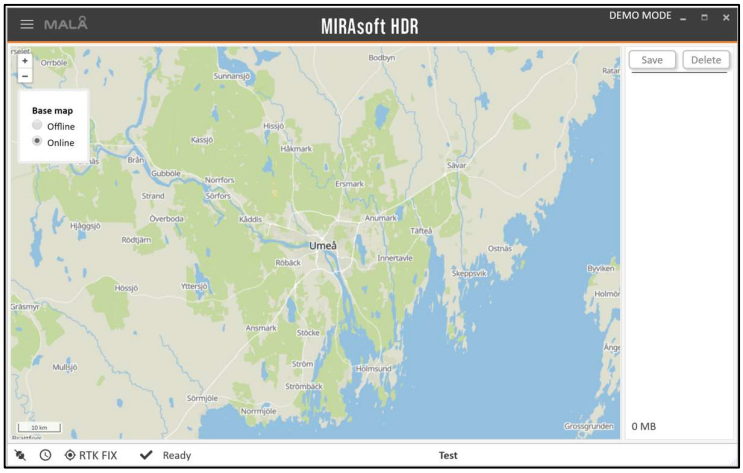
The advantage of a high GNSS position is a clear view to the sky, thus a larger number of satellite signals resulting in a more stable fix and improved accuracy. The disadvantage with a high elevated GNSS antenna is that real-world positional accuracy decreases if the ground is uneven or steeply sloping, as the offsets introduced by tilting of the system and movement of the antenna mast can become large.

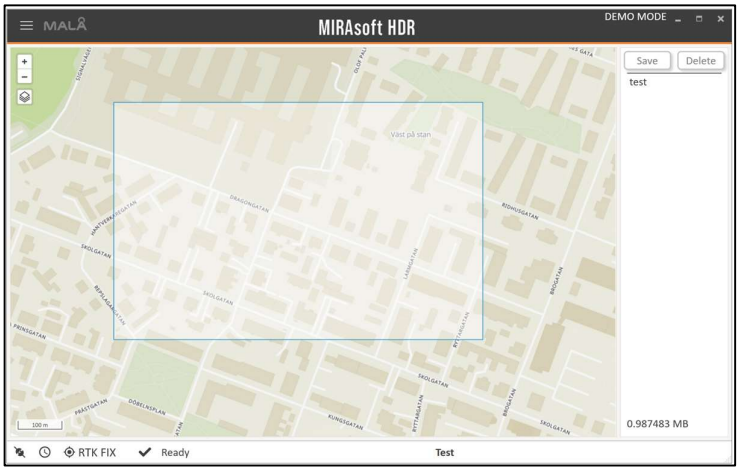
If the GNSS antenna is placed further away from the antenna box (distances exceeding approximately 2 meters), it should be noted that there might be a changeable element to the offset (compared to the Geometry Settings entered under the Advanced menu), especially in curves, resulting in positioning discrepancies in the end result.

When the GNSS antenna location is decided, or if it is ever changed, remember to change the GNSS settings (*Advanced Menu*) to fit the present set-up.

Offline Maps

In the Offline Maps menu, you can decide to use an online or offline base map. You need to be online when creating an offline map. At a certain zoom level, the background map can be saved locally so it can be used if you need to work in offline mode. You can name the map as you want, and the extent of the saved map is shown as a blue area. The name of the map is shown to the right and can be deleted.





The layer switcher allows for selection between displaying the offline or the online base map.

Projects

The *Projects* menu can be accessed from the MIRAsoft HDR Main menu. It shows all existing projects and gives the option to delete old ones or select projects to view after a measurement is finished.

The project is opened with a single click on the chosen project folder.

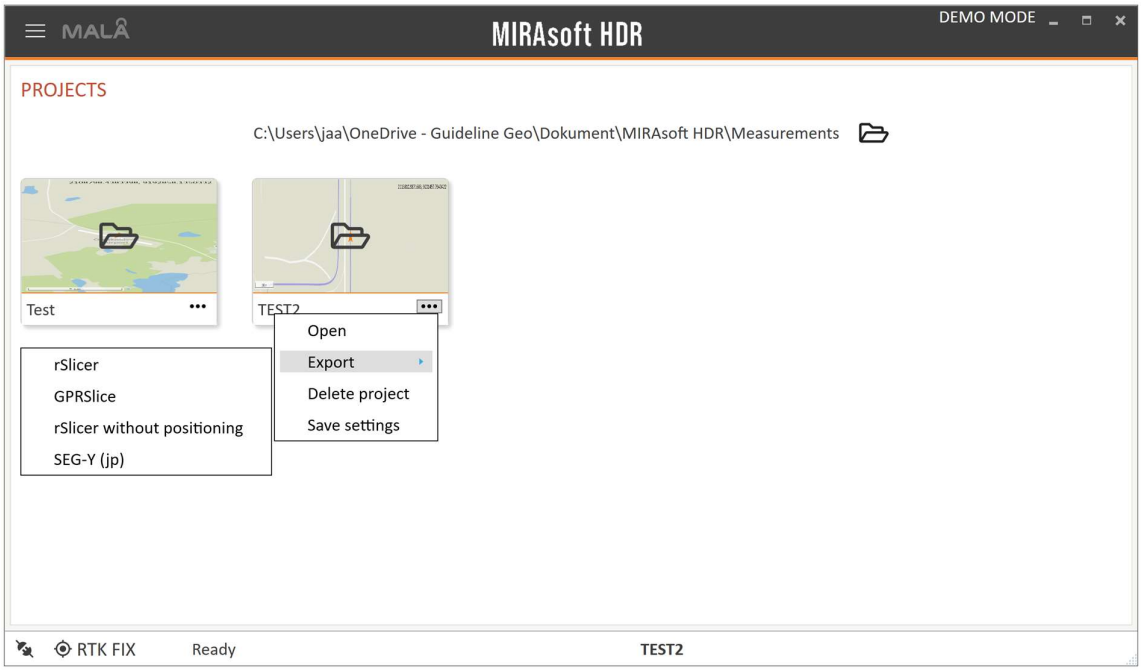
When an existing project is opened, it can be:

- Supplemented with new swaths -> check measurement settings first in the *Settings* menu
- Viewed, by choosing *Measurement* from the main menu

Note: If several swaths have been measured it is easy to change the radargram view by clicking on the swath in the map view, or you can choose which swath to display in the swath-selector in the status bar.

In the *Projects* menu you can also export your data. Click  to export data to rSlicer, GPR-Slice and SEG-Y (jp) format.

Note: If measurements have been done with different settings for different swaths, the rSlicer export will be divided into several projects, grouping together swaths with the same settings.



When exporting to rSlicer the coordinates will be exported as UTM.

When exporting to rSlicer without positioning, each of the collected swaths are lined up next to each other based on the width of the channel selection. The swaths are assumed to be collected in the same direction.

When exporting data to SEG-Y (jp) format an additional positioning file (.txt) is generated for each swath.

```
#Index  DateTime        Latitude        Longitude       Elevation       Velocity        Heading HeadingRate
#FormatVersion=1.0
#Culture=ja-JP
0       2019-11-11T01:32:30.4480Z       33.805986565    132.79415733866668      41.000999450683594      0       357.201233      0
1       2019-11-11T01:32:31.9400Z       33.80598754527707       132.7941572975775       40.995021820068359      0.0205356982    357.1706        -0.0421775021
2       2019-11-11T01:32:32.2230Z       33.805988250996847      132.79415718497987      41.017658233642578      0.0296556782    357.104156      -0.0116234021
3       2019-11-11T01:32:32.4320Z       33.80598894273097       132.79415712690329      41.028999328613281      0.0372865424    357.139862      0.0169308763
```

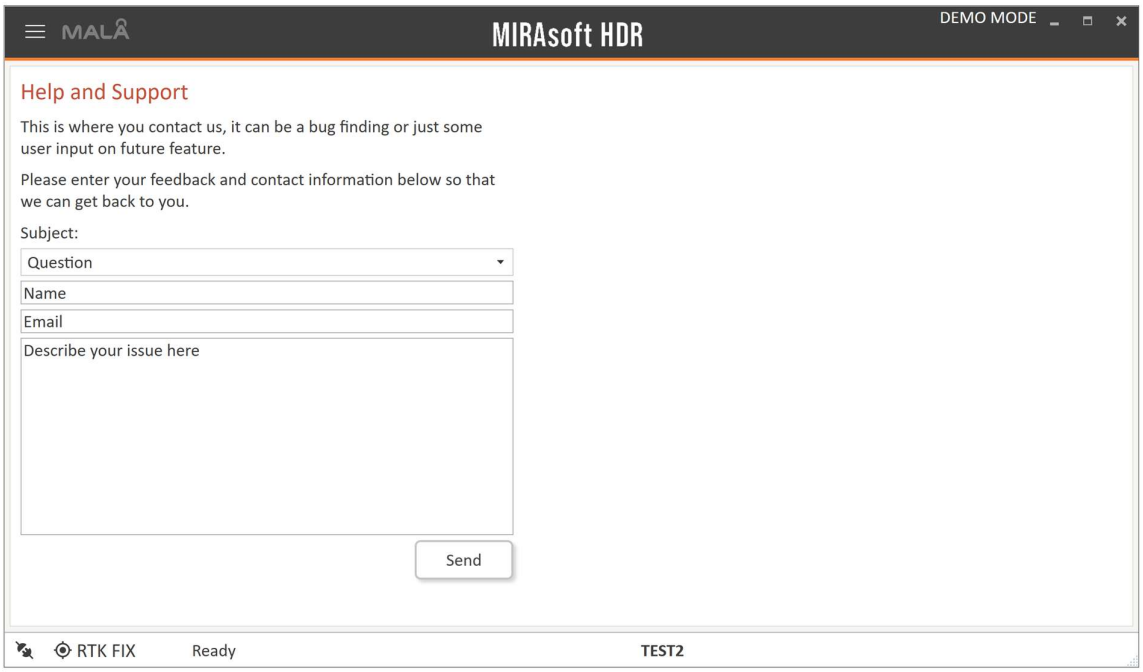
Save settings

The option *Save settings* found in a project's options menu:  Save settings. This gives the possibility to save settings used for a project so that you can reuse them in new projects. A template is saved with a user-defined name and will show in the list of templates that you can choose from when creating new projects; see section *Create new projects*.

Saved templates can be deleted in the drop-down menu, when you create a new project. See section *Create new projects*.

Help and Support

If you are online with your measurement computer, you can reach out to our Help and Support team directly from MALÅ MIRAsoft HDR. Enter your name and email address and describe your problem.



About

In the *About* menu, you find information on the current software and firmware versions installed.