MALÅ MIRA System

(MALÅ Imaging Radar Array)

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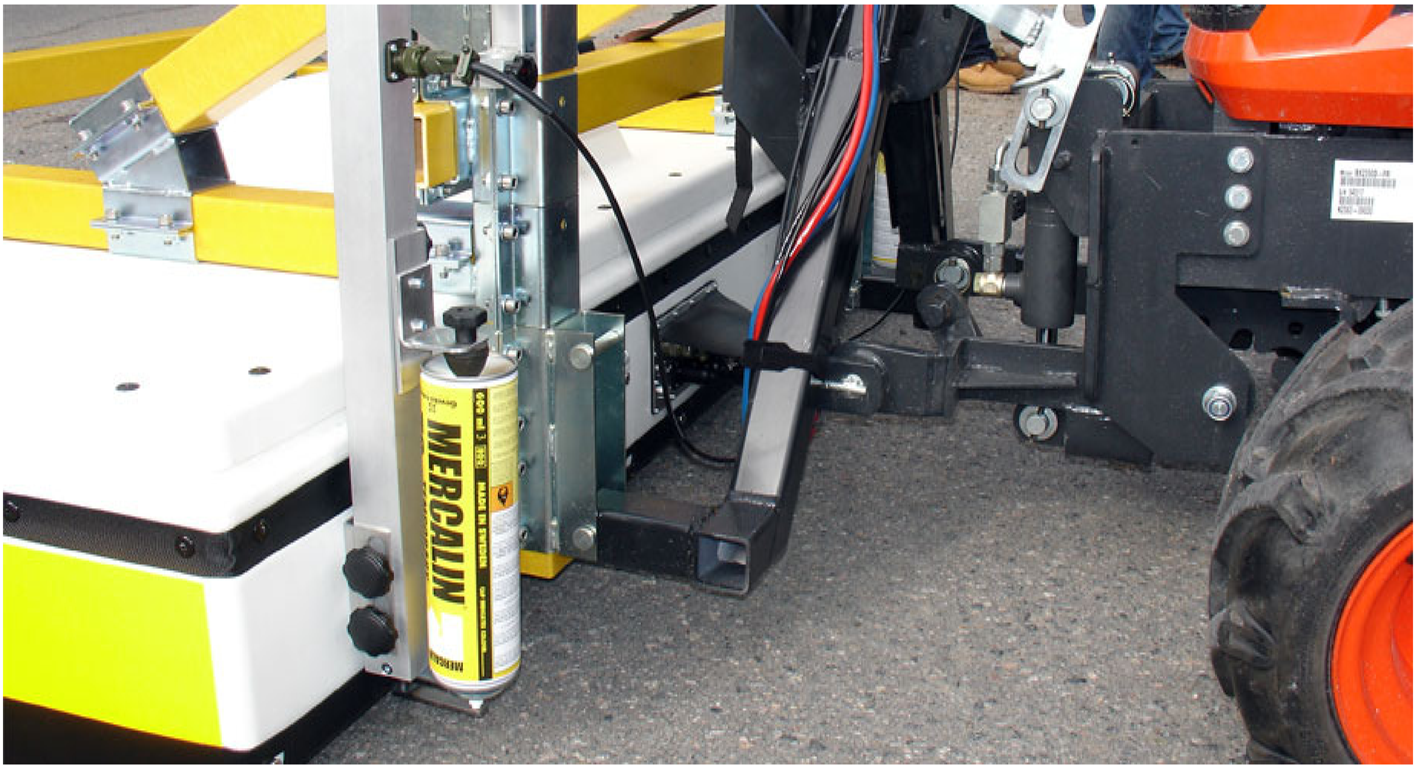
- 
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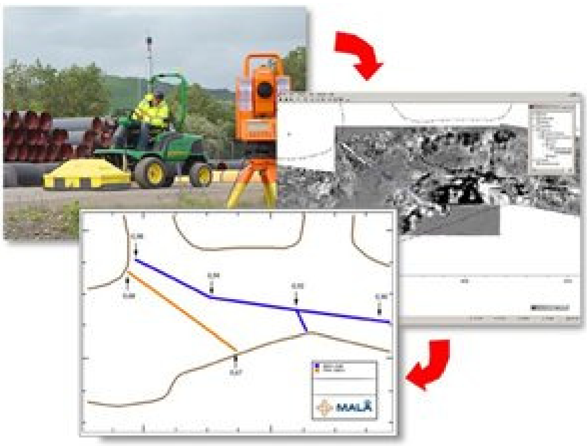
The most technically advanced 3D ground penetrating radar (GPR) system

MALÅ GPR Imaging Radar Array (MIRA) is the most technically advanced GPR system on the market. MALÅ GPR MIRA is a one-pass 3D system providing a cost-effective solution for large scale ground penetrating radar mapping and subsurface object identification. It is the only system of its kind that seamlessly integrates acquisition, processing, QA/QC, positioning data, interpretation and export of ground penetrating radar data.

The MALÅ GPR MIRA system is designed using multiple antennas configured in an Array (see definition under technical specification). Up to 30 antennas can be used simultaneously to gather data in real time. It was designed to retain survey speed regardless of number of antennas used. The MALÅ GPR MIRA System is based on the MALÅ GPR ProEx Control Unit and its MALÅ GPR Array Option.



The power within this product lies in its ability to quickly and easily gather full 3D data in broad paths, so called "swots". Results are processed in 3D, displayed and interpreted through a dedicated software package and then exported into suitable GIS or CAD data formats.

The MALÅ GPR MIRA System is a complete solution, from survey to end results.

MALÅ MIRA System was used to map the Roman forum at Carnuntum, see data example below:
A client presentation from the tests at the Roman forum at Carnuntum can also be viewed here MALÅ GPR MIRA Client Presentation

The MALÅ GPR MIRA System was also deployed on the site of the ancient viking town of Birka. The purpose of the project was to map the burials sites and to give a more detail overview of the site.

The total site covered 30 000 m2. The MALÅ GPR MIRA System surveyed the area with a grid spacing of 8 x 8 [cm] and with a survey speed of: 2500m2/hour.

3D GPR solutions explained

MALÅ MiRA 3D GPR Array solutions are a completely new generation of GPR equipment that has been under development at MALÅ Geoscience for more than a decade. “It is a huge step in GPR development, much larger than people initially might think”, says Bernth Johansson Head of Development at MALÅ Geoscience. MALÅ MIRA is probably the first GPR equipment ever where final results can be viewed and interpreted by anyone, not only trained specialists. “It is very satisfying to watch people looking at MIRA data for the first time. We realize that we have created an instrument that truly will remove obscurity and bring more decision power to more people. As far as removing the ambiguity in GPR data, MALÅ MIRA solutions are a quantum leap forward”, states Bernth.

MALÅ Ground Penterating Radar Research Lab.

The ideas and theories behind MALÅ MIRA are nothing new. MALÅ has had these since the mid 90-ies, if not earlier, but with improvements in digital components and computing power these ideas have suddenly become possible to realize in a practical, efficient and economical way. The true strength of the MIRA system lies in the integration of the various parts of the solution. It is not only about the hardware and the GPR unit itself, it is also about the quality of positioning, the attention to quality and control, the way data is processed, viewed and reported but also the smoothness in the integration of these essential parts. At the core of each MIRA system there is the hyper modern MALÅ ProEx controller, the most modern and versatile GPR controller currently available. “The MALÅ ProEx controller is a new breed of GPR controller and it is the platform MALÅ will build upon and profit from for many years to come”, says Bernth Johannson. The MALÅ (Ground Pentrating Radar) ProEx controller was designed from scratch with multi-channel and array data collection in mind.

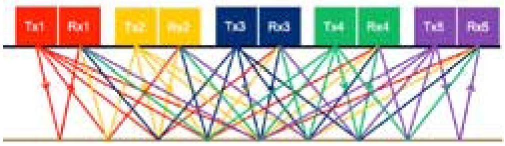
Improvements in GPR data quality through the use of more densely collected data has been raised by many researchers over the years (e.g. Pipan et al. 1999; Whiting et al. 2001; Neubauer et al. 2002; Leckebusch 2005; Seren et al. 2004, only mentioning a few) but data collection and the integration of exact positioning is very time consuming (Leckebusch & Peikert 2001; Slob et al. 2003). The only way to overcome this is to build a densely spaced multi-channel GPR array.

To achieve full-resolution 3D GPR imaging without aliasing the data, the equipment used needs to satisfy a number of requirements. As a summary, a 3D GPR Array can be defined by four criteria:

1) The individual channel spacing should not exceed ¼ of the wavelength of the wavelength transmitted. (Grasmueck et al. 2005; Novo et al. 2008; Booth et al. 2008 and others).

“The channels in a true 3D GPR Array needs to be closely spaced, much closer than what is physically possible using standard equipment.”, says Bernth Johansson.

2) Free combination of receiver and transmitter antennas within the Array.



Communication between all included antennas in an Array is possible

The ability to freely chose any transmitter/receiver combination within the array will effectively reduce the physical channel spacing by half. This second criterion is in essence a solution to the problem caused by the previous but it also widens the use of the Array by allowing gathering of multi-offset data at each measuring position.

3) The signature of each antenna pair (transmitter/receiver combination) needs to be as similar as possible.

The ideal situation would of course be to have exactly identical antenna responses but this can only be achieved if exactly the same antenna pair is used to collect every data point in your data set. However, this would then be a single antenna GPR system, which would defy the much-needed efficiency of the system.

4) Each data point position needs to be accurately determined, within half the channel spacing used in the Array.

The importance of correct positioning cannot be overestimated. Without a proper and fully integrated high resolution positioning system to support the GPR Array system while measuring, the data quality cannot be guaranteed and would render in-the-field quality control to almost non-existent.

The MALÅ MIRA 3D Array standard solution consists of 17 GPR antennas positioned in two overlapping rows of 9 transmitter and 8 receiver antennas and collecting 16 channels of densely spaced GPR data. The system is, neither by hardware nor by software, limited to 16 channels of data. In fact, the MALÅ MIRA solution is unlimited and can virtually hold and collect any number of data channels. The standard use of 16 channels is merely for practical reasons, creating a flexible system easy to manage logistically and easy to use in the field, without giving up on quality of data.

MIRA Array interior revealed

In standard mode, each receiver antenna is recording signals of two adjacent transmitter antennas, resulting (in case of the 400 MHz antenna system) in 16 channels with a cross-line trace spacing of 8 cm, corresponding to ¼ of the wavelength. The 16 channel, 400 MHz, standard system covers a 128 cm wide swath for each driven track. The antenna array is normally placed in a box mounted ahead of a motorized front mower with hydraulic lift

There is a huge advantage of using of a motorized vehicle to push or pull the GPR antenna array not only because of the unlimited power supply, to feed both the field computer and the GPR system while collecting data, but also for efficiency reasons.

The MALÅ MIRA system at site near Marlbourough, UK (2009)

Accurate positioning of the GPR measurements is crucial. For this purpose either a robotic total station or a Real Time Kinematic-GPS (RTK-GPS) can be used. The position information from the total station, respectively RTK-GPS, is transferred via radio link to the measurement vehicle where the information is recorded together with the GPR data. The fully integrated positioning system ensures on-the-fly quality control and reduces post-processing to a minimum.

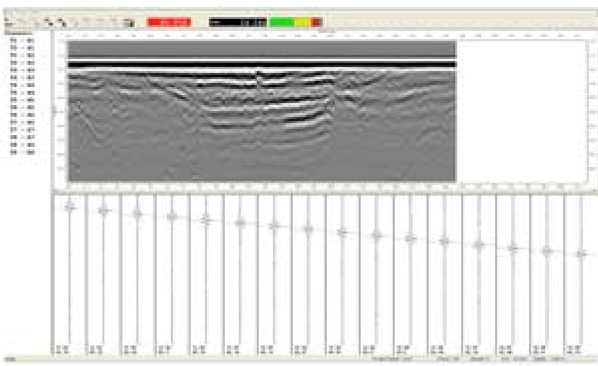
The MALÅ MIRA, and positioning system, at Birka, Sweden (2007)

The total station prism or GPS rover antenna is mounted on the GPR antenna array.


MIRA system details

Additionally, a carefully calibrated odometer is attached to a wheel of the carrier vehicle, providing exact inline distance information. For orientation of the individual swaths, a spray paint marker device or/and an independent navigation and guidance system can be used to mark the start- and end-points as well as the course of individual profiles. Start and stop positions for individual survey swaths can be chosen freely. The definition of a virtual baseline may help to achieve full area coverage by collecting data along parallel swaths oriented approximately perpendicular to the baseline.

The proprietary MIRAsoft data acquisition software was specifically designed for MALÅ MIRA 3D Array data collection. “In order to make 3D GPR Array data collection intuitive and efficient it was essential for us (MALÅ) to build a completely new type of data collection software. Decades of experience of building data acquisition software went into this development and it handles and integrates all crucial parts of the data acquisition very smoothly. We are proud of the results we have accomplished but we won’t rest on our laurels, together with feedback from our users we plan to continue to improve this software over many years to come”, says Johan Friborg, geophysicist and software engineer at MALÅ.


Screenshot from MIRAsoft data acquisition software

The GPR and positioning data from the MALÅ MIRA system is directly handled in the proprietary rSlicer processing software, completely avoiding complicated and time-consuming import routines. This software allows the pre-processing, interpolation, coordinate system transformation and 3D migration of the GPR data, followed by interactive interpretation of the observed features. The results can be printed and exported as geo-referenced TIFF- or DXF-files for use and further analysis in GIS environments.