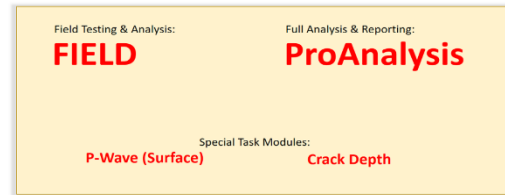


Purpose

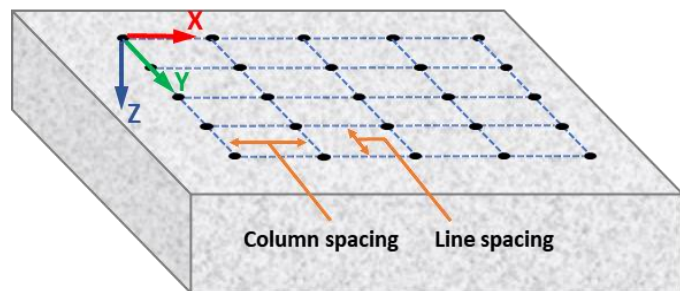
Echolyst is an advanced data acquisition and data analysis software for the impact-echo method. It is used along with the **Mirador** system (see datasheet). Besides the traditional use for interpretation of results of the impact-echo method, the **Echolyst** software incorporates innovative techniques to create 2-dimensional (2-D) and 3-dimensional (3-D) visual representations of measurements obtained from a grid test points. The key features of the software include:

- Simple interfaces for setting up data acquisition parameters and defining the testing grid
- Audio assisted prompts during testing to speed up data acquisition
- Visualization of impact-echo tests results by creating a 3-D volume model of the test region
- Ability to look at reflecting interface on different cutting planes
- Ability to superimpose test results on real world image of a test location
- Report generation

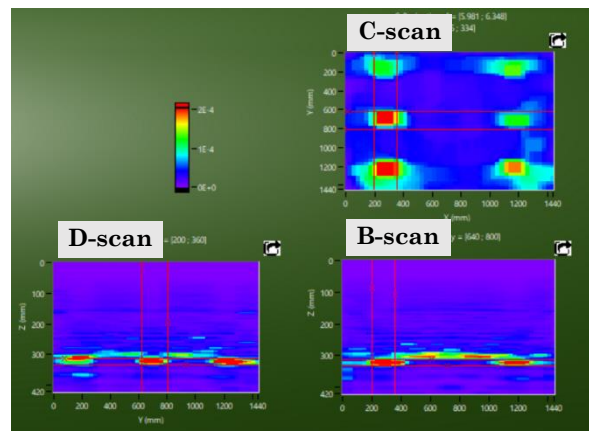
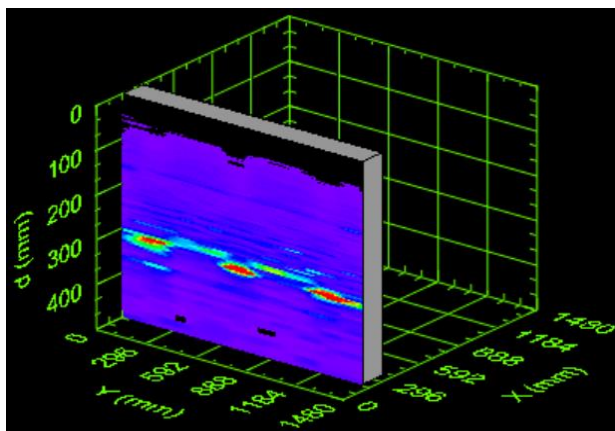


Principle

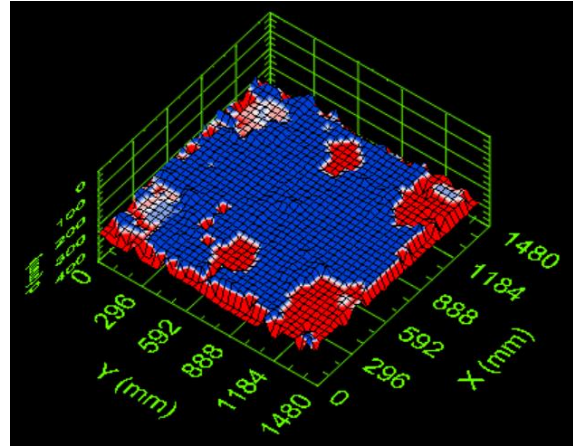
The principle of the impact-echo method is described in the **Mirador** system's datasheet. To take full advantage of **Echolyst**, the user can generate a grid of test points at the inspection site. A series of equally-spaced scan lines of equal length are marked on the test surface, and equally spaced test points are marked along each line. The distance between test points on a scan line defines the column spacing. The combination of "lines" and "columns" defines the 2-D grid that is the basis for subsequent displays. An X-Y-Z coordinate system is defined as shown, where the X-axis is parallel to the scan lines, and the Y-axis is parallel to the columns. The Z-axis is the depth axis into the test object.



The essence of **Echolyst** is the technique for using the amplitudes of the different frequency components obtained at the grid points to construct a volumetric model of the test region from which locations of reflecting interfaces can be presented as images. Each spectrum along a scan line is represented as a vertical strip, with a width equal to the test point spacing. The vertical axis of the strip corresponds to frequency and color coding is used to represent the relative amplitude of each frequency. The strips are placed side-by-side, and the end result is a cross-section picture of the



frequency peaks along a scan line. This image is called a **B-scan** (XZ-plane view) and all the B-scans obtained from all the scan lines are used to create a 3-D model of the test region, from which **D-scans** (YZ-plane view) and **C-scans** (XY-plane view) can also be generated. In addition to views on individual planes, there is the option to create **B-, C-, and D-projections** which are based on averaging the amplitude spectra from two or more adjacent planes. Since the measured frequency is related to an equivalent depth according to the basic equation of impact-echo, the measured depths can also be plotted along the scan grid to generate 2-D and 3-D representations (e.g. depth plot on the right) with depth values instead of frequency values representing the Z-axis.



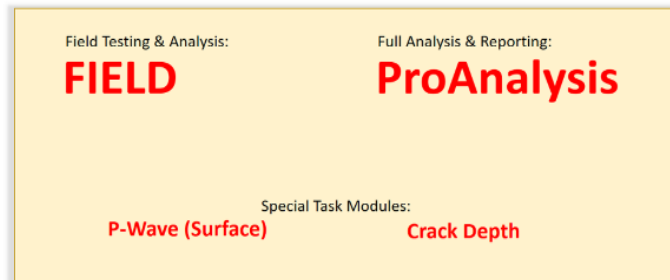
The Four Modules

FIELD Module

Acquisition and analysis of individual waveforms collected. It contains the tools for setting the acquisition parameters, calibration of wave speed and collecting data points.

ProAnalysis Module

Full analysis of grid data and reporting. It contains the tools for statistical analysis, creating 2D and 3D thickness plots, 2D and 3D tomographic images, projections on imported photos or drawings.



P-Wave Module

For measuring wave velocity at the surface according to ASTM C1383.

Crack Depth Module

Apply standard method to measure the depth of surface opening cracks.

Data Acquisition Parameters

Sound Settings

To speed up data acquisition, two sound options are provided:

- Voice output that gives the peak frequency, calculated flaw depth, and test position upon completion of the test at a grid point
- Audible sounds indicate a signal was acquired and the relative magnitude of the peak frequency in the waveform

The intent of these audible prompts is to eliminate having to look at the captured waveform and amplitude spectrum before moving on to the next point. If the audible prompts are as expected, the

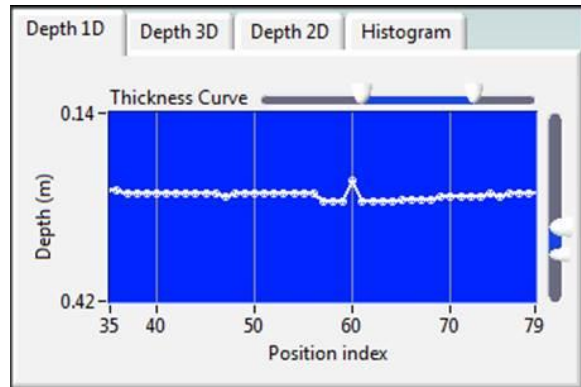
operator can move to the next point without having to review the results. If the audible prompts are unexpected, the operator can stop data acquisition, review the results, and decide whether to re-test before moving to the next point.

Scans and Projections

Depth Plots

If the P-wave speed is known, the frequency axis in a B-scan can be converted to depth using the approximate equation on page 50. The result is called a **depth plot**, and four types of depth plots are available:

- **1-D plot:** shows the depths of reflecting interface along a scan line (as shown on right)
- **2-D plot:** provides a plan view of the depth at each grid point using a color scale to represent different depths
- **3-D plot:** the same information as in the 2-D plot is shown in 3-D by plotting the depth at each grid point along with color
- **Histogram:** shows the distribution of the calculated depths at the grid points

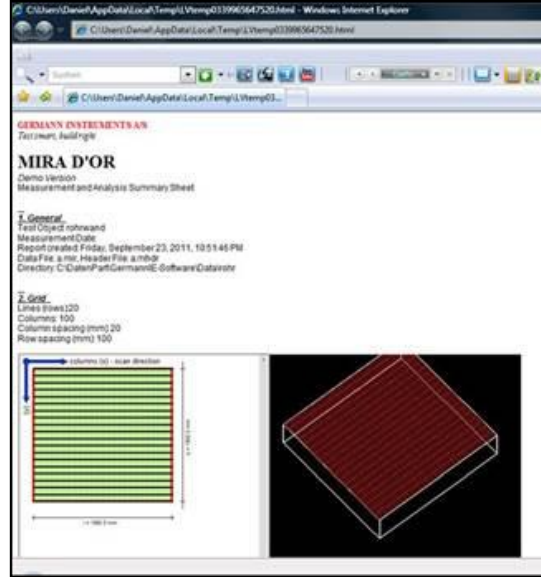


Overlay of Results on Photo

One of the unique features of **MIRA d'Or** software is the ability to superimpose an image created during data analysis onto a photograph of the test site. This provides an effective way to present test results to the client. First, a photo of the test site is imported. Four points are selected on the photo and their coordinates relative to the origin of the test grid are entered. It is best to take the photo after the test grid has been marked on the structure and to use the corners of the test grid the four reference points. An image of the test results is superimposed on the photo (as shown to the left). The superimposed image can be a C-scan, a C-projection, or a 2-D depth plot.

Report Preparation

Images created during data analysis can be saved as JPEG files by clicking on check boxes next to the names of the corresponding images. When a test report is to be created, the user selects the images to be included in the report by clicking on their file names. After the desired files are selected, **MIRA d'Or** generates a draft test report, which will be displayed in a browser window and also saved as an HTML file. In addition to the selected images, the report will include automatically the testing parameters entered during set up. The file can be opened and edited with a word processor such as MS WORD®.



Thickness Measurement by ASTM C1383

Accurate measurement of thickness requires knowledge of the in-place P-wave speed. ASTM C1383,

Depth of Surface-Opening Cracks

depth of 87 mm was estimated for a time difference (Δt) of 35 μs and a P-wave speed of 3155 m/s.

Testing Examples



Detection of delaminations and honeycomb in sewer pipe



Measurement of P-wave speed by surface method

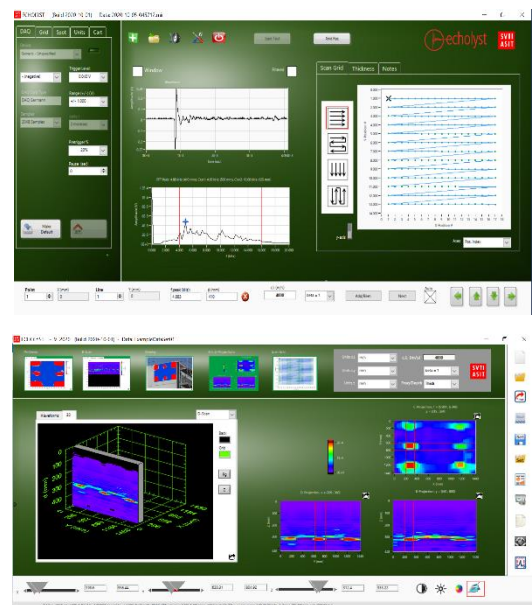


Testing for quality of grout injection in cable ducts

Mirador Specifications

- Data Acquisition System:
 - 2 channels, 4 MB/channel
 - 8 bits resolution, 50 MHz bandwidth
 - -5V to 5V Input Voltage Range
 - USB interface
- Dry contact, high sensitivity, piezoelectric handheld transducers
- Equipped with **Echolyst** software that allows:
 - real-time waveform display while testing
 - create 2-D and 3-D visual representations
 - look at reflecting interface on different cutting planes
 - audio assisted prompts to speed up data acquisition
 - superimpose test results on real image of test location
 - report generation
- Accuracy (assuming a constant P-wave speed):
 - Thickness measurement, direct calibration: $\pm 2\%$
 - Thickness measurement by surface P-wave speed measurement: $\pm 3\%$

Echolyst screenshots



- Depth of surface-opening cracks: $\pm 4\%$
- Operating conditions: Temperature: -10 to 50 °C, RH $\leq 95\%$

Mariador Ordering Numbers

Mirador -3000

Item	Order #
Laptop computer	MRD-10
Data acquisition module with USB cable	MRD-20
Echolyst software	MRD-30
Mark IV transducer	MRD-40
Star support with 5, 8 and 12 mm impactors	MRD-60
Impactors on spring rods, 5, 8, and 12 mm	MRD-70
Protection caps for transducer tips, 4 pcs	MRD-80
BNC cable	MRD-90
User Manual for Echolyst software	MRD-150
Operation manual	MRD-160
Binder with testing case studies	MRD-170
Attaché case	MRD-120