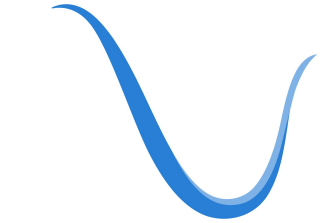

USKIN

Acoustic Analyser User Manual

Uskin Therapy Ltd

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V1.0

Contents

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Chapter 1

Introduction

1.1 The System

The Acoustic Spectrum Analyzer is a precision measurement system developed to evaluate the acoustic and mechanical properties of plate-shaped samples through transmission-mode spectroscopy.

A comprehensive software suite enables real-time data acquisition and advanced analysis, including parameter extraction using spectral and curve-fitting techniques.

The system is fully compatible with third-party NDT immersible probes, ensuring seamless integration into laboratory or industrial setups.

Measured data are stored in ASCII format for easy use with third-party software. Configuration file export is also supported for repeatable production-floor measurements.

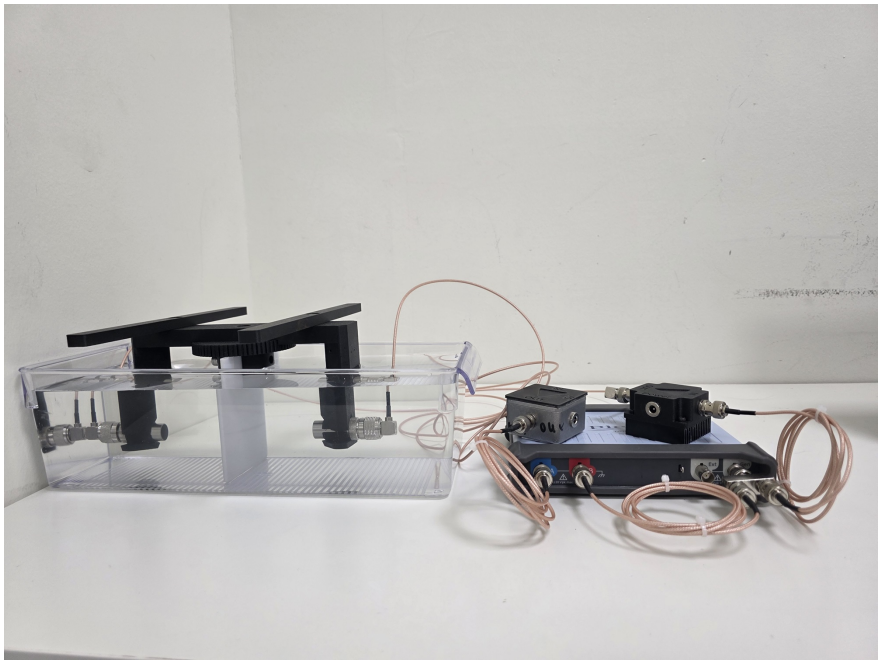

Figure 1.1: The system view.

1.2 Components

The **Acoustic Analyzer** system consists of:

- Mechanical fixture
- Acquisition/Waveform Generator Card
- Transmitter amplifier
- Receiver pre-amplifier
- Water container
- Control PC

1.2.1 Mechanical fixture

The fixture is designed to mount the transmitter and receiver transducers together with the sample holder. The sample holder includes a manual rotation stage that allows precise control of the specimen's incident angle. Both transmitting and receiving transducers are standard NDT immersible probes. The working frequency is selected according to the specimen thickness—for example, using 1 MHz transducers allows accurate measurements of samples ranging from approximately 1 mm to 5 mm in thickness.

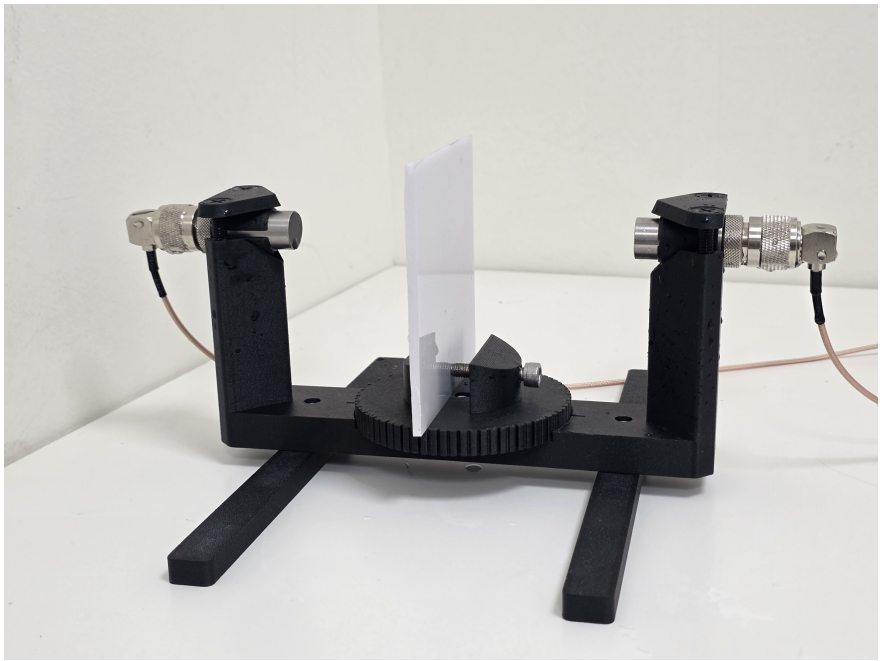

Figure 1.2: Mechanical fixture view.

1.2.2 Acquisition card

The acquisition card has two sampling inputs (CHA, CHB) and a waveform generator output. The card is controlled by the PC through a USB3 connection.

Figure 1.3: Control Box front panel with data acquisition card.

Acquisition card is fully integrated into the software.

1.2.3 Transmitter amplifier

The amplifier is used to drive the transmitting transducer. The excitation signal is generated by the acquisition card and then amplified to the required power level.

Amplifier specifications:

- Frequency bandwidth: 20 kHz – 20 MHz
- Voltage gain: 10×
- Output swing: ±20 V / 500 mA

1.2.4 Receiving Amplifier

The receiving amplifier boosts the low-level signal from the receiving transducer while maintaining low noise and wide bandwidth performance. It ensures a clean signal for accurate data acquisition and spectral analysis.

Amplifier specifications:

- Frequency bandwidth: 5 kHz – 10 MHz
- Voltage gain: 20×
- Output swing: ±2 V
- Input noise density: 4 nV/$\sqrt{\text{Hz}}$

Figure 1.4: Ultra-Wideband PZT Driver Amplifier

Figure 1.5: Low Noise Pre-Amplifier

Chapter 2

Signal Interconnection Scheme

- The acquisition card directly drives the transmitting transducer through the transmitter amplifier.
- Channel B (CHB) records the reference waveform.
- Channel A (CHA) receives the amplified signal from the receiving transducer.

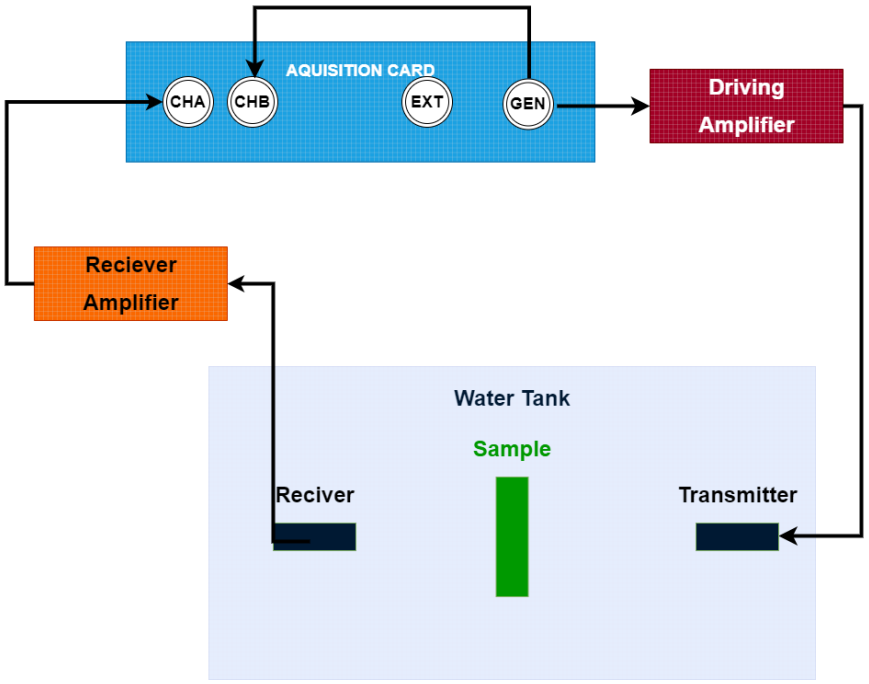

Figure 2.1: Signal interconnection

Chapter 3

Software Manual

3.1 Software Structure

The software consists of multiple GUI application windows. Each window is intended for a different operation mode.

All windows may be launched from the master window called `MaterialTestFlowChart`. When launched from the master, all settings are re-initialized from the *.ini file that is defined in the master window. All windows allow for independent relevant control adjustments that remain in memory until relaunched from the master. Therefore, do not close a relevant GUI window if you plan to readjust parameters or repeat the action with the latest adjustments.

The master window has the option to export a user-defined *.ini file with the latest adjustments. Use it to save the current test configuration for future use. The *.ini file is a regular text file. It can be copied and viewed in any text editor. *Manual editing will result in a corrupted *.ini file.*

The design of application GUI windows uses color coding to group controls for better navigation:

- **Yellow** – Parameters that require special attention, like power and signal generator controls. Take care while adjusting them.
- **Green** – Data acquisition and processing parameters.
- **Light Blue** – Plot control.
- **Blue** – Advanced parameters, generally not required to be adjusted.

3.2 Quick Start

3.2.1 Program Launch

1. Open the application `D:\AcousticTest\Acoustic_Analyzer\Acoustic_Analyzer.exe`. The window "MaterialTesterFlowChart" will appear, as shown below:

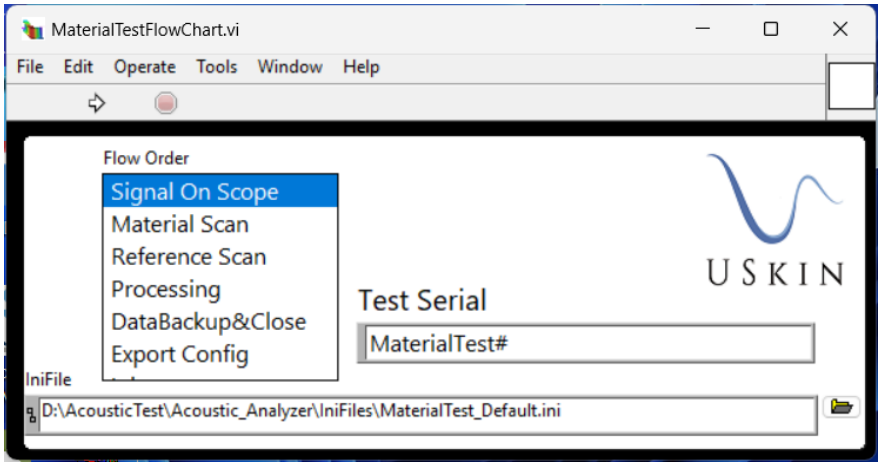

Figure 3.1: MaterialTester Flow Chart.

2. Modify the `IniFile` path as appropriate for your setup.

3.2.2 Scope Control

This GUI is intended to define the optimal transmit-receive parameters.

1. Validate the electrical connections as described in the *Signal Interconnection Schemes* chapter and put fixture to water tank.

2. Choose the "Signal On Scope" option in the `MaterialTesterFlowChart` GUI window. Press the "Run" arrow.

3. The `P5000ScopeGen` GUI window will appear and continuous acquisition will start immediately:

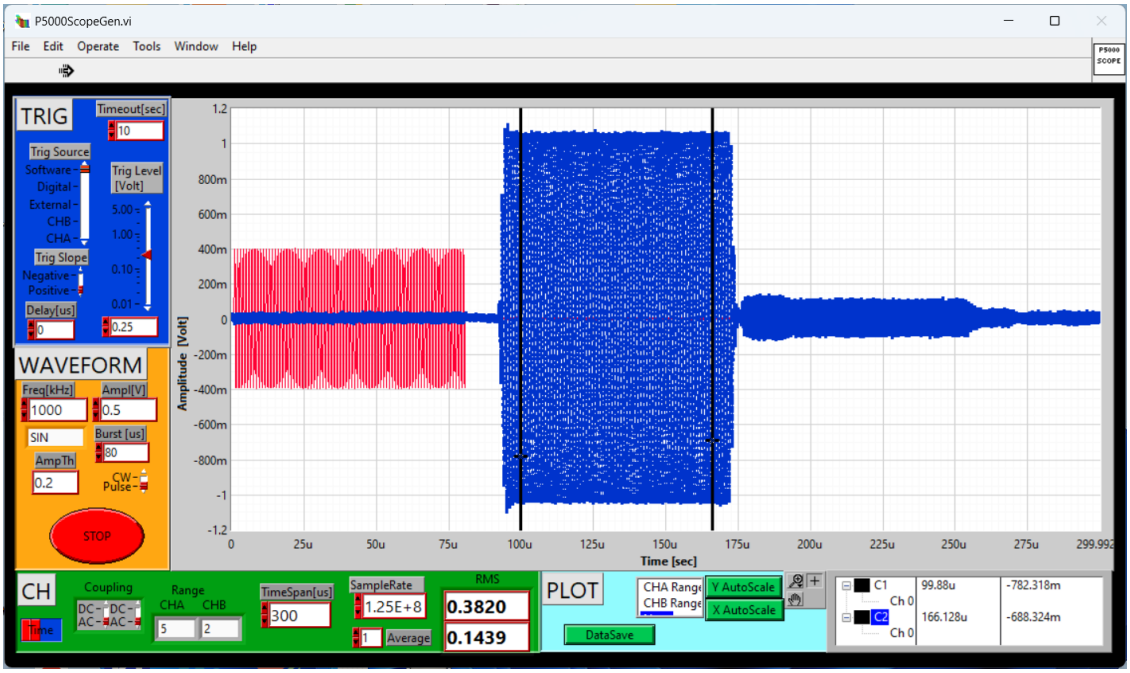

Figure 3.2: Scope GUI

4. The red signal measures the transmitter excitation reference (CHB). The blue signal shows the receiver signal (CHA).

5. The optimal sequence is to maximize the "Burst" time while keeping the reference and received signals separated in time. While the GUI is running, adjust the following parameters and monitor their effect:

   (a) "Freq [kHz]", "Amp [Vp]", and "Burst [us]" are waveform parameters for transducer excitation.

   (b) "TimeSpan (us)" sets the acquisition time.

   (c) Move the cursors (black vertical lines) to define the received acoustical signal time window.

6. Press the "STOP" button to finish and load parameters into memory.

7. You may run the GUI at any time by pressing the "Run" arrow. The window will use the last saved parameters. For a default reset (from the IniFile), launch it from the `MaterialTesterFlowChart` GUI.

3.2.3 Material Scan

This GUI is designed to perform frequency-scan measurements with the sample installed in the holder, providing transmission spectra.

1. Insert the sample into the sample holder with zero incident angle and place the fixture inside the water tank.

2. Choose the "Material Scan" option in the `MaterialTesterFlowChart` window and press the "Run" arrow.

3. A file name prompt will appear. Add a scan nickname if needed.

4. The `Freq_Scan_P5000` GUI window will appear:

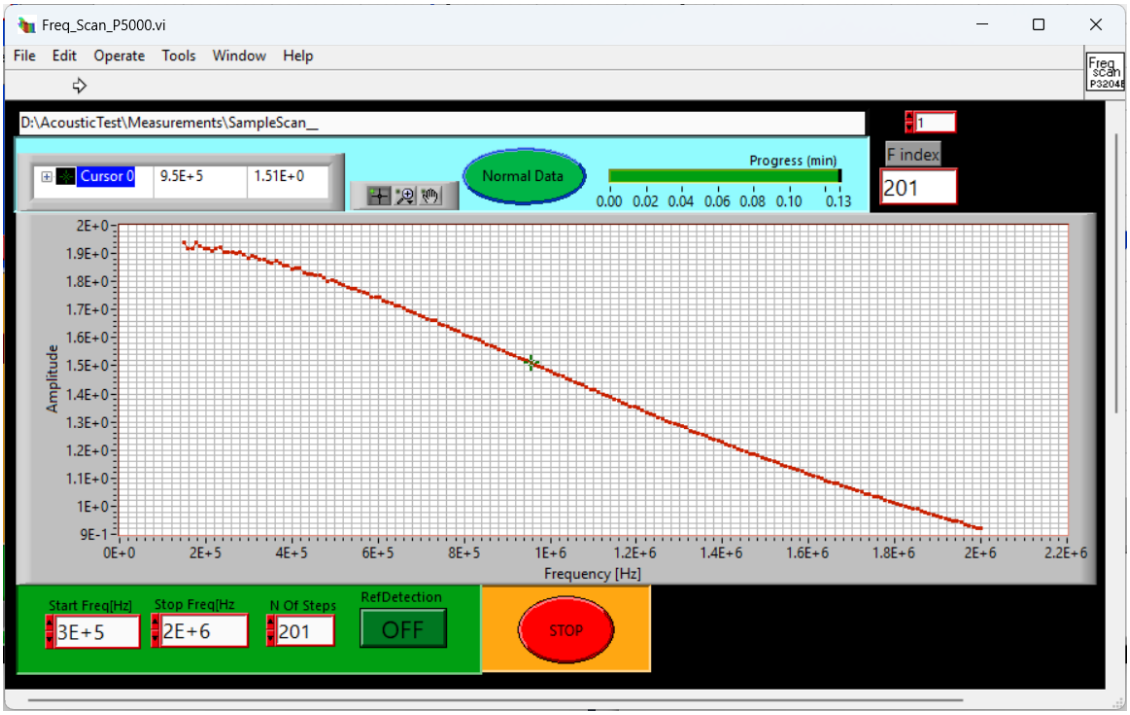

Figure 3.3: Raster Scan GUI.

5. Adjust the "Start Freq", "Stop Freq", and "N of Steps" parameters.

6. Data saving parameters:

   - Processed scan data will be saved using the file name defined in the upper control line.
   - The file number will increase automatically to prevent data overwriting.

7. Press the "Run" arrow to start the scan. The plot will display the waveform of the measured signal.

8. Use the "STOP" button to interrupt the scan if needed.

9. At the end of the scan, the plot will display the measured transmission spectrum.

10. You may run the scan at any time by pressing the "Run" arrow. The window will retain the latest parameters. For a default reset (from the IniFile), relaunch it from the `MaterialTesterFlowChart` window.

3.2.4 Reference Scan

This GUI is designed to perform frequency-scan measurements without the sample, providing the bare transducer response. This measurement is essential for correctly extracting the sample transmission spectrum during analysis.

1. Remove the sample from the sample holder and place the fixture inside the water tank.
2. Choose the "Reference Scan" option in the `MaterialTesterFlowChart` window and press the "Run" arrow.
3. The `Freq_Scan_P5000` GUI window will appear, and the scan will start automatically.
4. At the end of the scan, the plot will display the measured reference response spectrum.

3.2.5 Processing

This GUI is intended to fit the measured transmission spectra to a theoretical model and extract the acoustic and mechanical parameters of the tested material.

1. Choose the "Processing" option in the `MaterialTesterFlowChart` window and press the "Run" arrow.
2. The `RunOctaveFit` GUI window will appear:

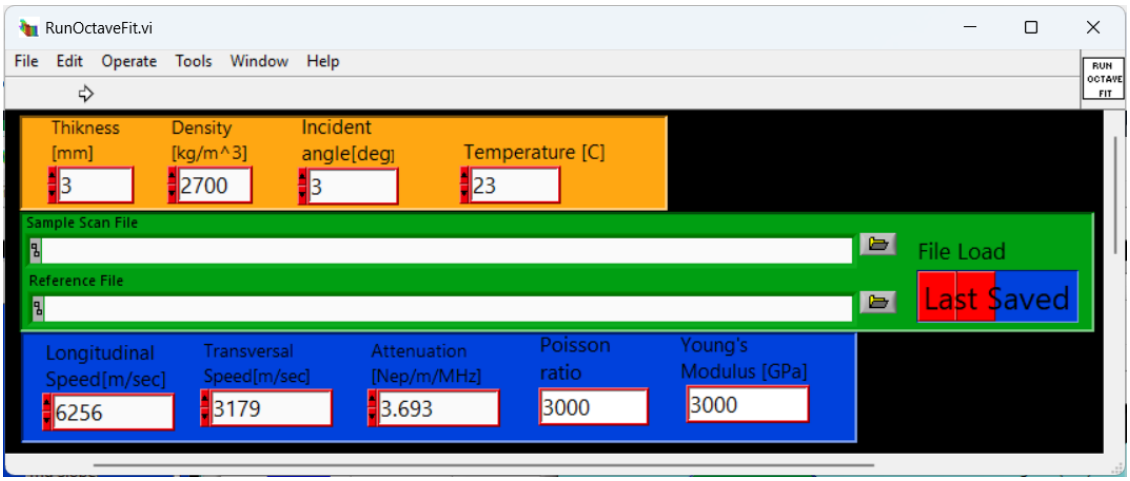

Figure 3.4: Processing GUI.

3. Enter the correct **sample thickness**. This is a critical parameter that strongly affects the accuracy of the extracted acoustic properties.
4. Enter the **sample density**. While important, its accuracy is less critical than the thickness.
5. The **incident angle** is typically set to 3°, corresponding to the normal acoustic beam spread. Keep this default value if the sample is mounted perpendicular to the beam.

6. The **temperature** parameter is not relevant for solid samples.
7. Set **File Load** to "Last Saved" for automatic loading of the latest data. Set to "Manual" to select files manually.
8. If approximate values of the **longitudinal** and **shear** wave speeds are known, enter them in the corresponding fields.
9. Press the "Run" arrow. Wait for the plot window to appear:

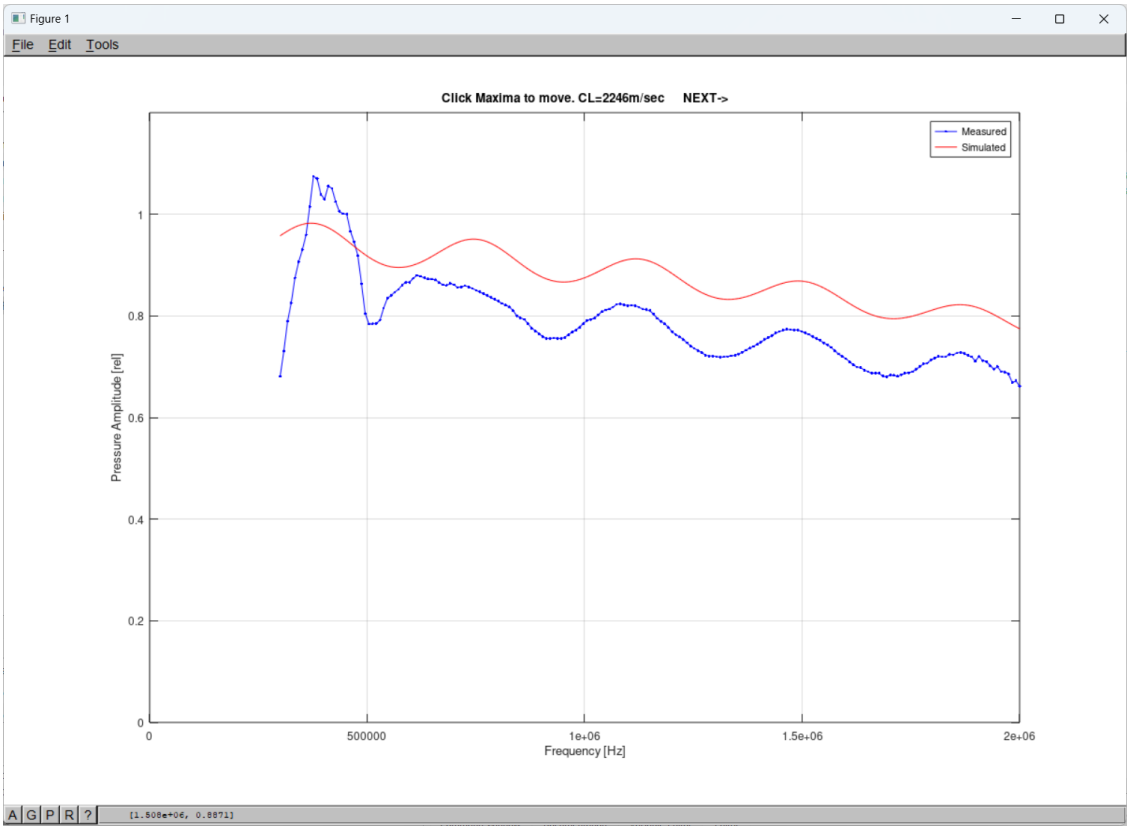

Figure 3.5: Fitting plot window.

10. The red line represents the simulated spectrum, while the blue line shows the measured data.
11. Click on a feature of the red (simulated) curve—such as a minimum or maximum—then click the desired position on the blue (measured) curve to align it. Horizontal adjustments modify the longitudinal sound speed (updated in the plot title). Vertical adjustments affect attenuation. Try to match the periodic oscillation pattern; ignore spike positions at this stage.
12. Click "NEXT" in the plot title to proceed to the next step. Now align the spike features between the simulated and measured curves. This step adjusts the shear sound speed. If spike features are not clearly visible, click "FINISH", then repeat the measurement with a finite incident angle (typically 20°) and rerun the "Processing" GUI.

13. Until “FINISH” is pressed, you can return to the first plot by clicking “PREVIOUS”.

14. A successful fit should resemble the examples below:

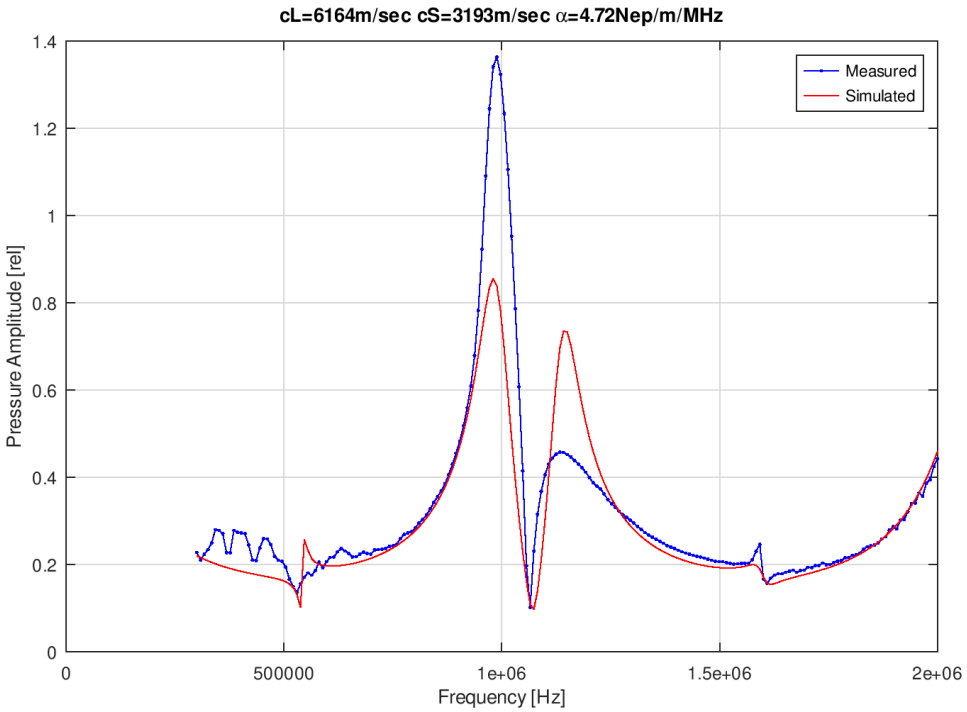

Figure 3.6: Aluminum fit example.

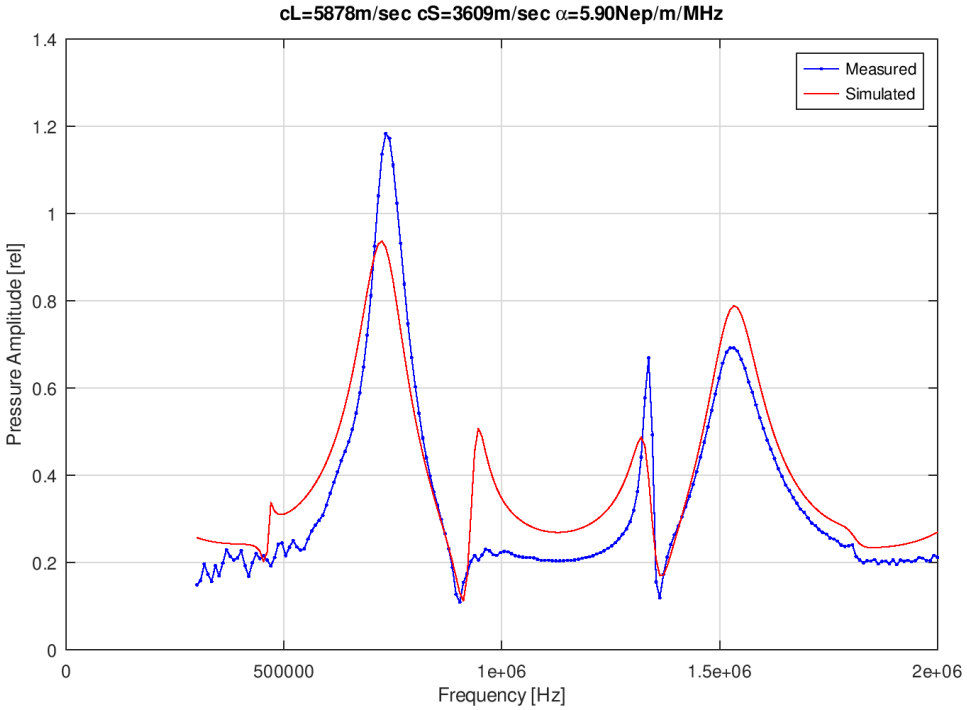

Figure 3.7: Glass fit example.

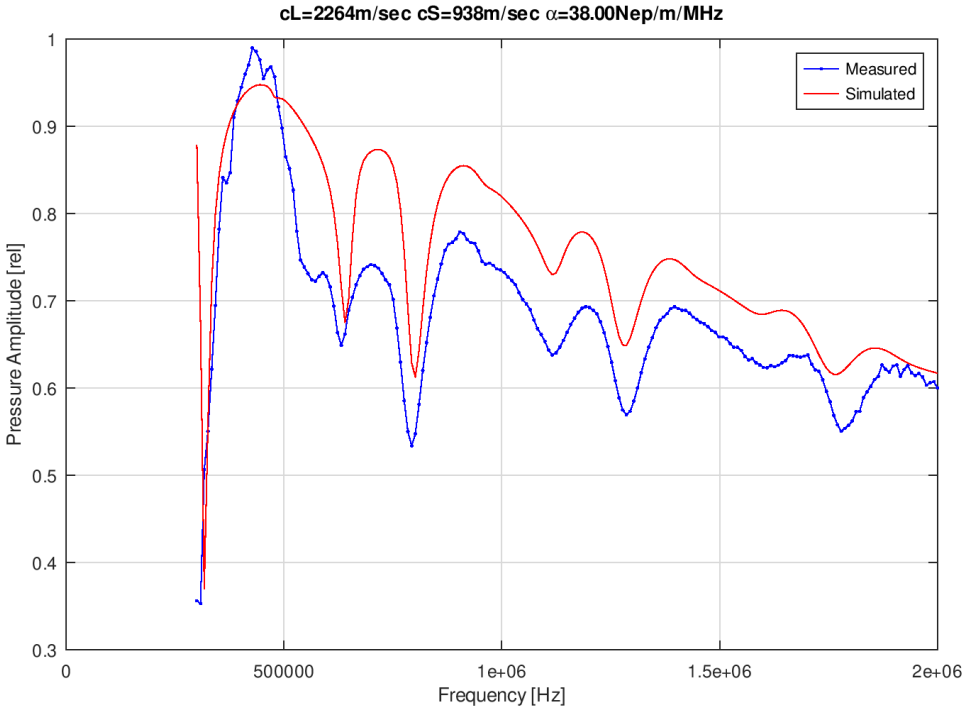

Figure 3.8: Plastic fit example.

15. After pressing "FINISH", the fitting window will close and the extracted acoustic and mechanical parameters will appear in the `RunOctaveFit` GUI window.

3.2.6 Data Backup

1. This option is useful for controlled data logging.
2. Choose the "DataBackup" option on the `MaterialTesterFlowChart` window. Press the "Run" arrow.
3. The data will be backed up in the directory `D:\AcousticTest\MeasurementLog`, under a folder with the "Test Serial" prefix, including the date and time in the folder name.

3.2.7 Ini File Exporting

1. This option is useful for producing a valid configuration Ini file from recently used settings. Make sure that each GUI has been run at least once to validate the settings before exporting.
2. Choose the "Export Config" option on the `MaterialTesterFlowChart` window. Press the "Run" arrow.
3. You will be prompted to specify the location and file name for the generated Ini file.