

For very weak signals, change the position of the receiver, or elevate it, until radio signal lights turn on or at least flicker. You may have to use a long mini-stereo cable, or an extension, to place the receiver outside the vehicle. Always listen to the received signals, using a good-quality audio headset, to verify signal strength and to check for radio interference. If you believe you're experiencing wireless interference on regular basis in your area, contact Echologics, or an authorized distributor, for instructions on adjusting the wireless system.

Good practice tips

-  Accelerometers can be used for sensing leak noise in metallic pipes; however, hydrophones should be used for plastic and large-diameter pipes. Low-frequency vibration sensors may be used as an alternative to hydrophones.
-  For metal pipes, attach sensors directly to the pipe. To ensure good coupling with the pipe, clean the pipe's surface with a steel brush. If the pipe cannot be accessed directly, sensors can be attached to fire hydrants. Attaching accelerometers to fully charged and de-aired fire hydrants yields superior results. Sensors can also be attached to underground valves. Preferably, they should be lowered into access chambers and attached directly to valves. However, chambers may be filled with debris and many users prefer to attach accelerometers to valve keys.
-  If low-frequency vibration sensors (or accelerometers) are used instead of hydrophones for plastic pipes, they should be mounted vertically on top of fully charged and de-aired fire hydrants.
-  To maximize the similarity between leak noise signals, mount the sensors on similar fittings and in the same direction. For example, two sensors on valve keys but not one on valve key and the other on fire hydrant (unless necessary). Different fittings filter leak noise differently. Also, if the leak position is less than 20% of the sensors spacing, it's good practice to re-position the near sensor farther or the far sensor closer. Leak noise signals arriving at sensors that are positioned in a significantly unsymmetrical manner about the leak will be attenuated in significantly different degrees.

Good practice tips (continued)



When sensors are attached to fittings on lateral connections, the length of lateral connections, up to the position where the sensor is attached, should be included in the total sensor-to-sensor distance. If the lengths of lateral connections at the two sensor positions are equal, they may be excluded from the total distance. In the latter case, the leak distance will be with respect to the point where the lateral connection branches off the pipe.



For plastic pipes, it may not be possible to locate leaks with sensor-to-sensor spacing greater than 100 m (328 ft). For metal pipes, sensor-to-sensor spacing can be as large as 500 m (1640 ft) but a maximum spacing of 200 m (656 ft) is recommended.



Wireless transmitters and receiver should be placed at least 30 cm (1 ft) above ground to minimize RF signal loss.



Wireless transmitters should be in line-of-sight from the receiver's position and the latter should be positioned halfway between the transmitters to maximize the range.



Velocity values are calculated by LeakfinderRT on the assumption that the fluid carried by the pipe is water. These values are approximate and are provided only for the user's convenience for preliminary leak location. **Leak positions based these approximate values can be inaccurate.** It is strongly recommended that the propagation velocity be measured onsite using a known in-bracket or out-of-bracket simulated leak, e.g., by drawing water at a fire hydrant or service connection.

Good practice tips (continued)

-  When using LeakfinderRT in pinpointing mode, measure the distance between the leak sensors accurately, e.g., using a frequently calibrated measuring wheel.
-  Before excavating a leaking pipe, always confirm by listening with a ground mic the location of the leak position predicted by the correlator.
-  Some computer brands have a power management tool which if ON may limit the soundcard operation to MONO mode to conserve power. It's recommended to edit the computer's power management profile to exclude the soundcard or to disable power management altogether.
-  Handling sensors while they are powered ON can permanently damage them. Press the transmitter's power ON button only after the accelerometer has been attached to the pipe and press the power OFF button before detaching the sensor from the pipe.
-  Use care when inserting or removing cable connectors. Also, keep connectors clean, e.g., by not placing them on loose soil. Rough handling can damage the connectors or their sockets.
-  To prolong the life of cable connectors and sockets, minimize the frequency of connecting / disconnecting them.
-  For prolonged battery life and for achieving the highest possible charge level, charge the hardware's batteries at room temperature overnight.



Suggested carry-on tools (not supplied)

Work tools

9 Valve cover lifters

9 Valve keys

9 Meter box lid lifters

9 Curb stop keys

9 Fire hydrant keys

9 Pipe and service box locators 9

Modified fire hydrant caps with

$\frac{3}{4}$ inch 14 NPT tap

9 Spray paint

9 Measuring wheel and tape 9

Teflon tape 9 Pressure gauge 9

Plastic buckets

Safety Tools

9 First aid box

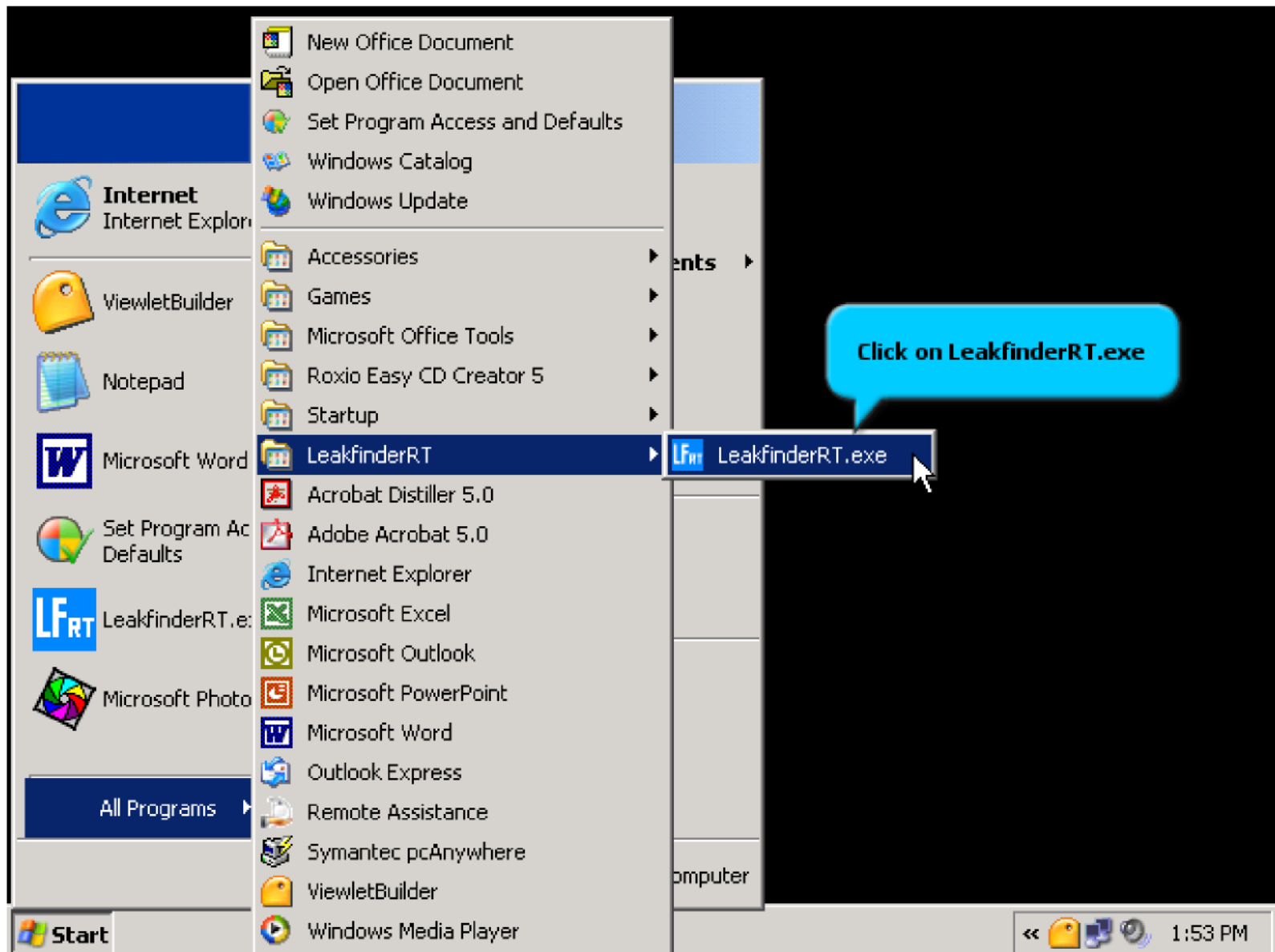
9 Reflective safety vests

9 Traffic cones and barricades

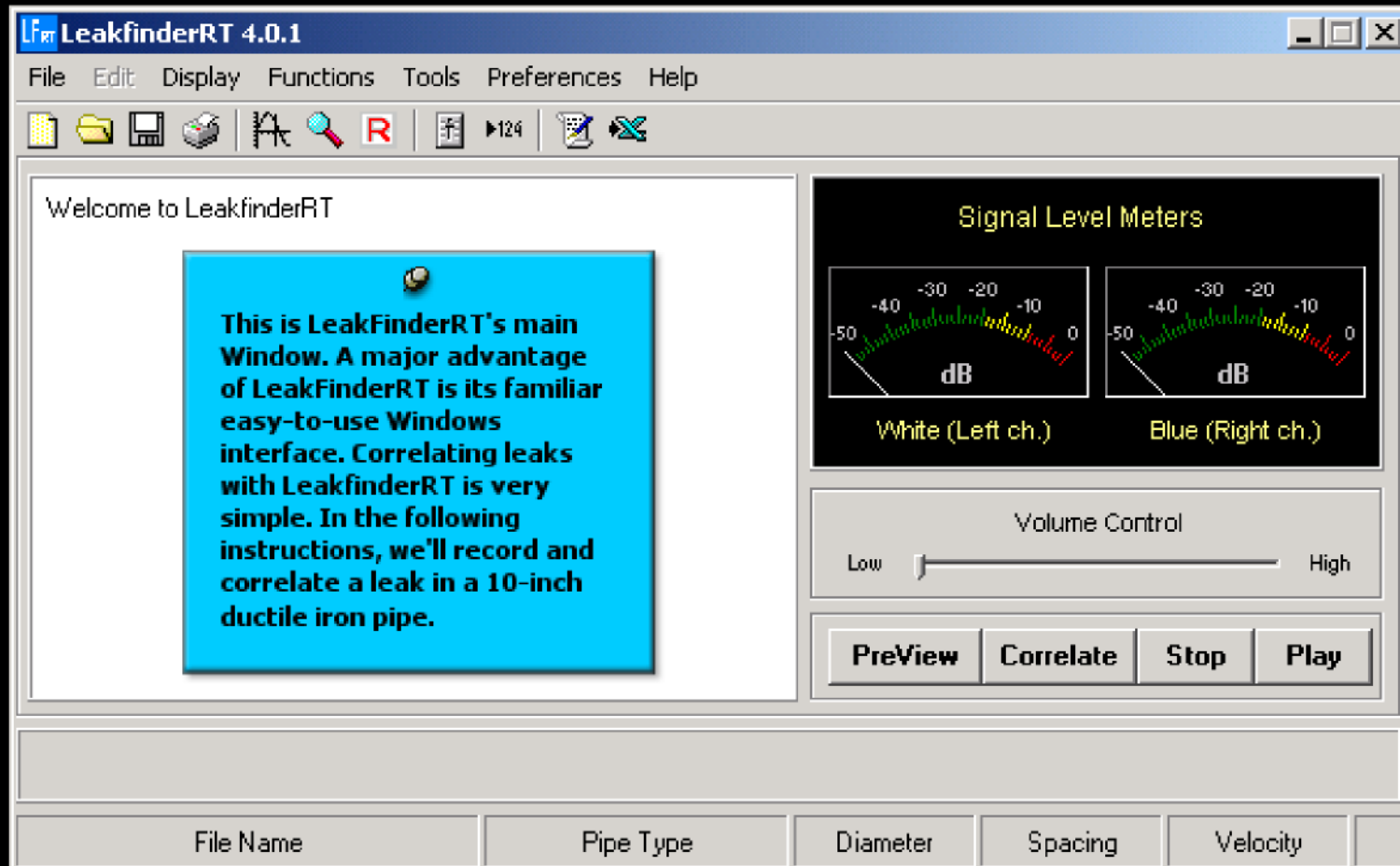
9 Radio or cellular communication link

9 Electrical connector cleaner

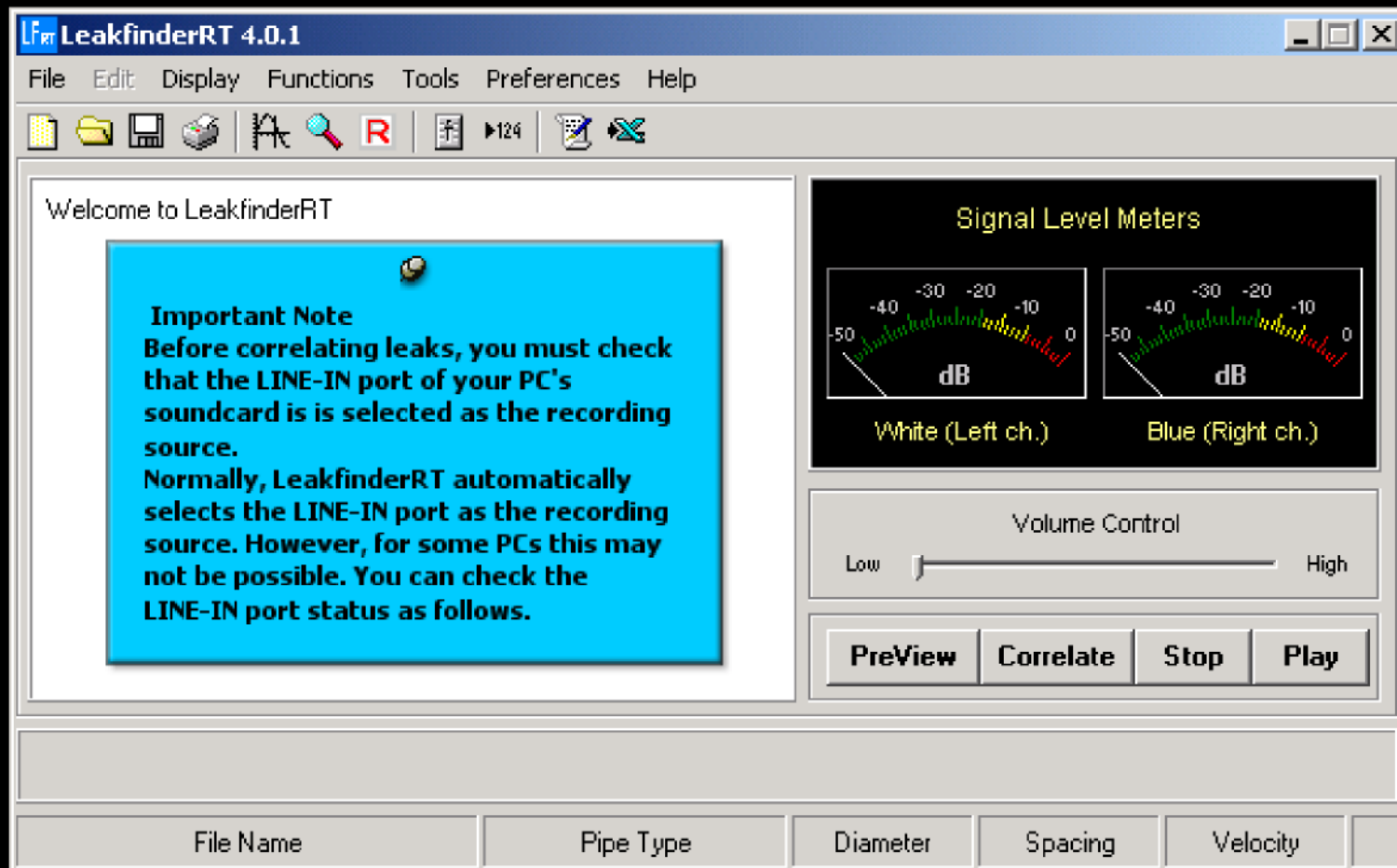
Starting LeakfinderRT (1)



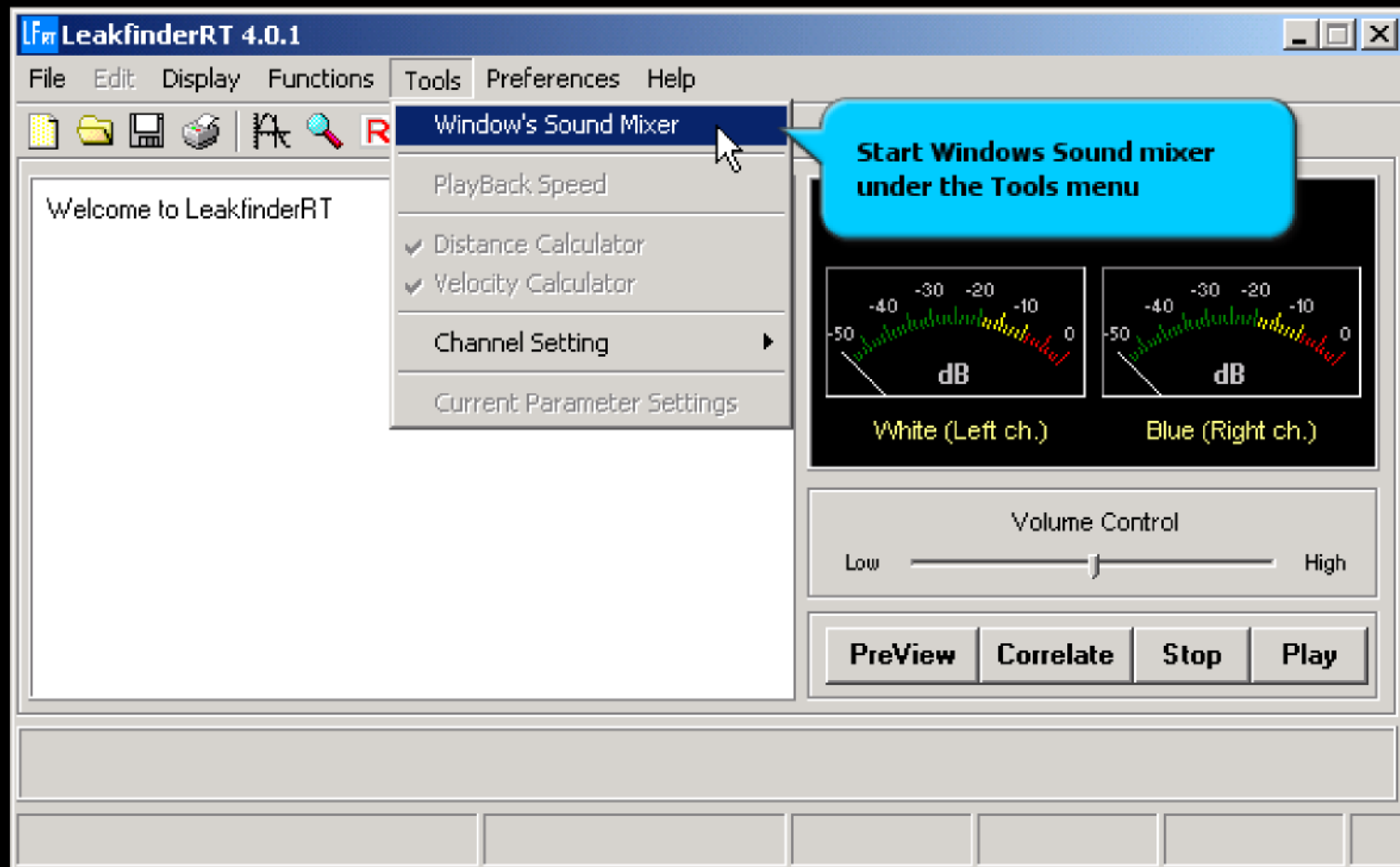
Starting LeakfinderRT (2)



Starting LeakfinderRT (3)



Selecting Line-in port as recording source (1)



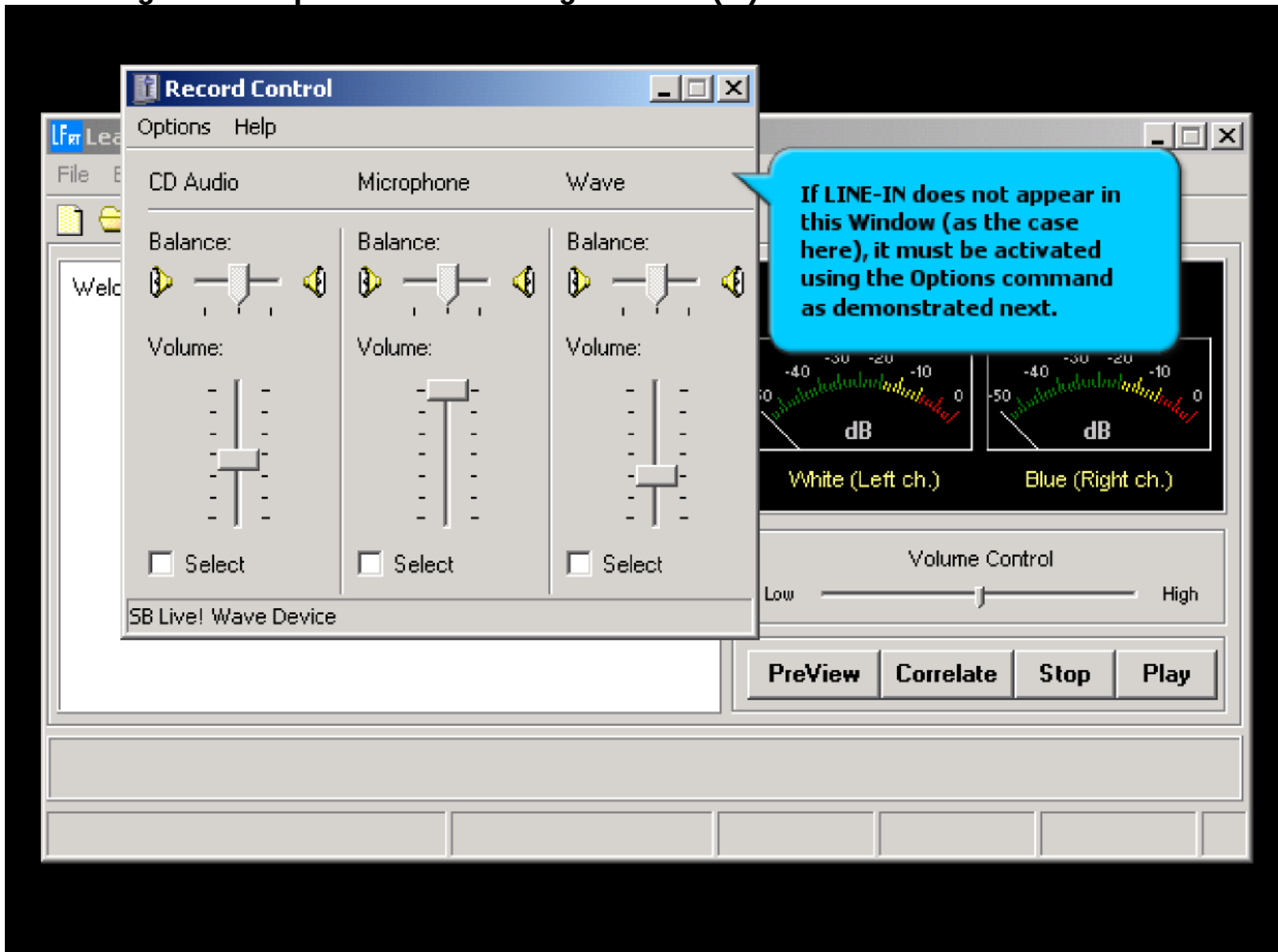
Selecting Line-in port as recording source (2)

The screenshot shows the 'Record Control' window from the Windows Sound Mixer. It features four tabs: 'CD Audio', 'Line-In', 'Microphone', and 'Wave'. Each tab has a 'Balance' slider with speaker icons, a 'Volume' slider, and a 'Select' checkbox. The 'Line-In' tab's 'Select' checkbox is checked, and a mouse cursor is pointing at it. To the right, a 'Level Meters' section shows a dB scale from -50 to 0, with the label 'Blue (Right ch.)'. Below the tabs are buttons for 'PreView', 'Correlate', 'Stop', and 'Play'. Two blue callout boxes provide instructions: one points to the 'Line-In' 'Select' checkbox, and the other is a general note about the mixer's 'Record' mode.

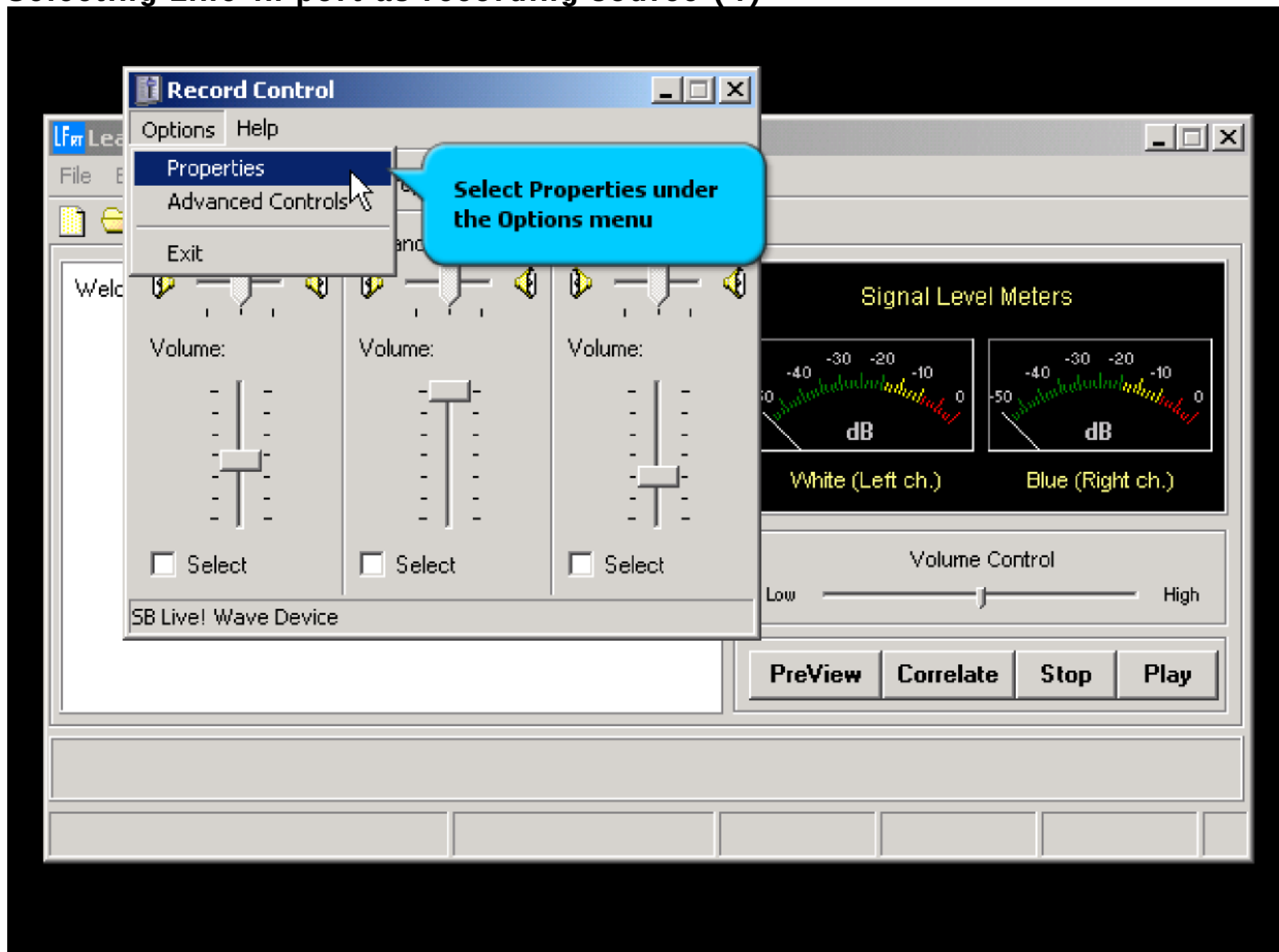
Windows Sound Mixer provides controls for Playback and Record levels. LeakfinderRT starts the mixer in Record mode.

Make sure that LINE-IN is selected as the recording source. If it's not selected, mark this box to select it.

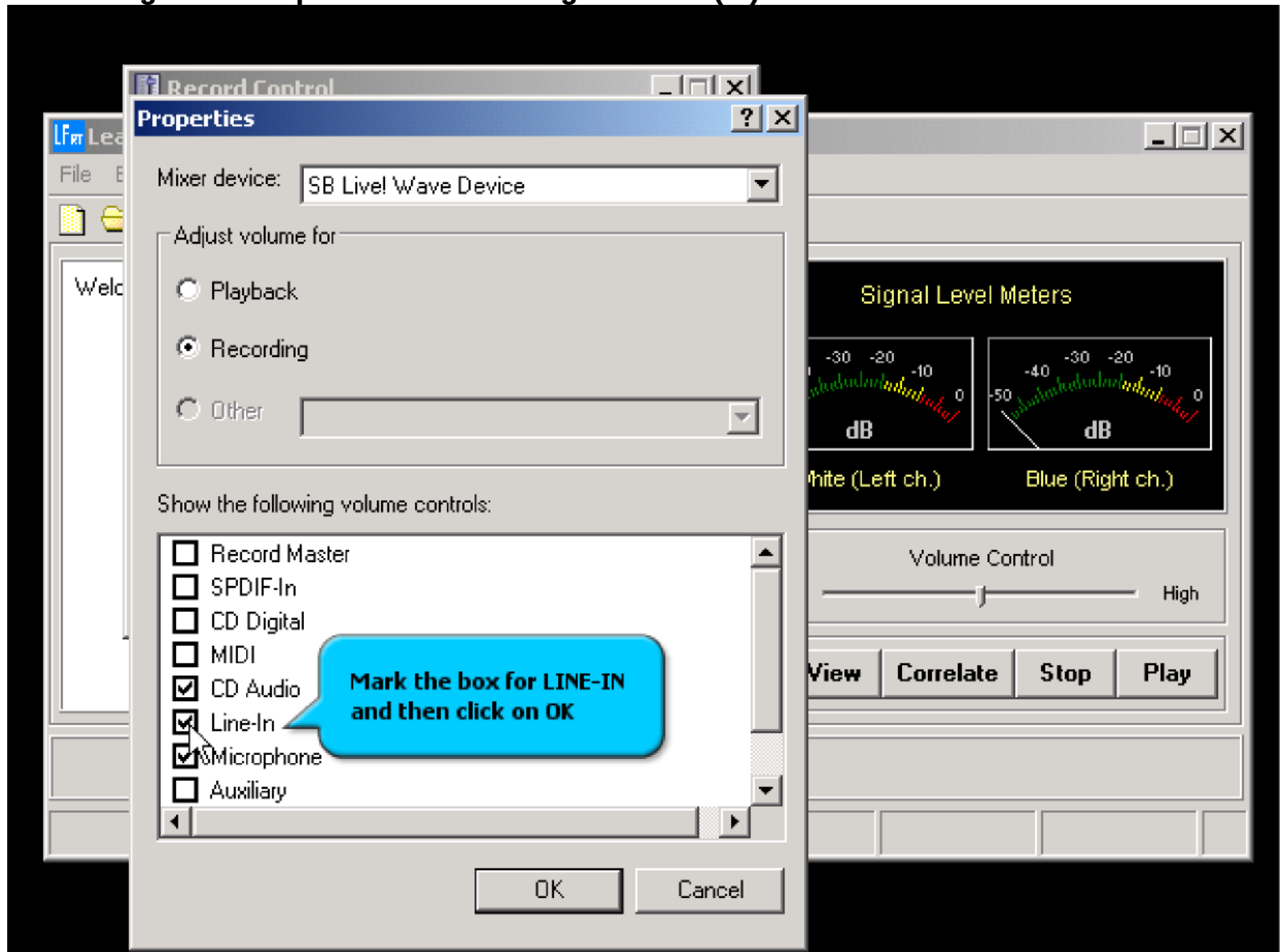
Selecting Line-in port as recording source (3)



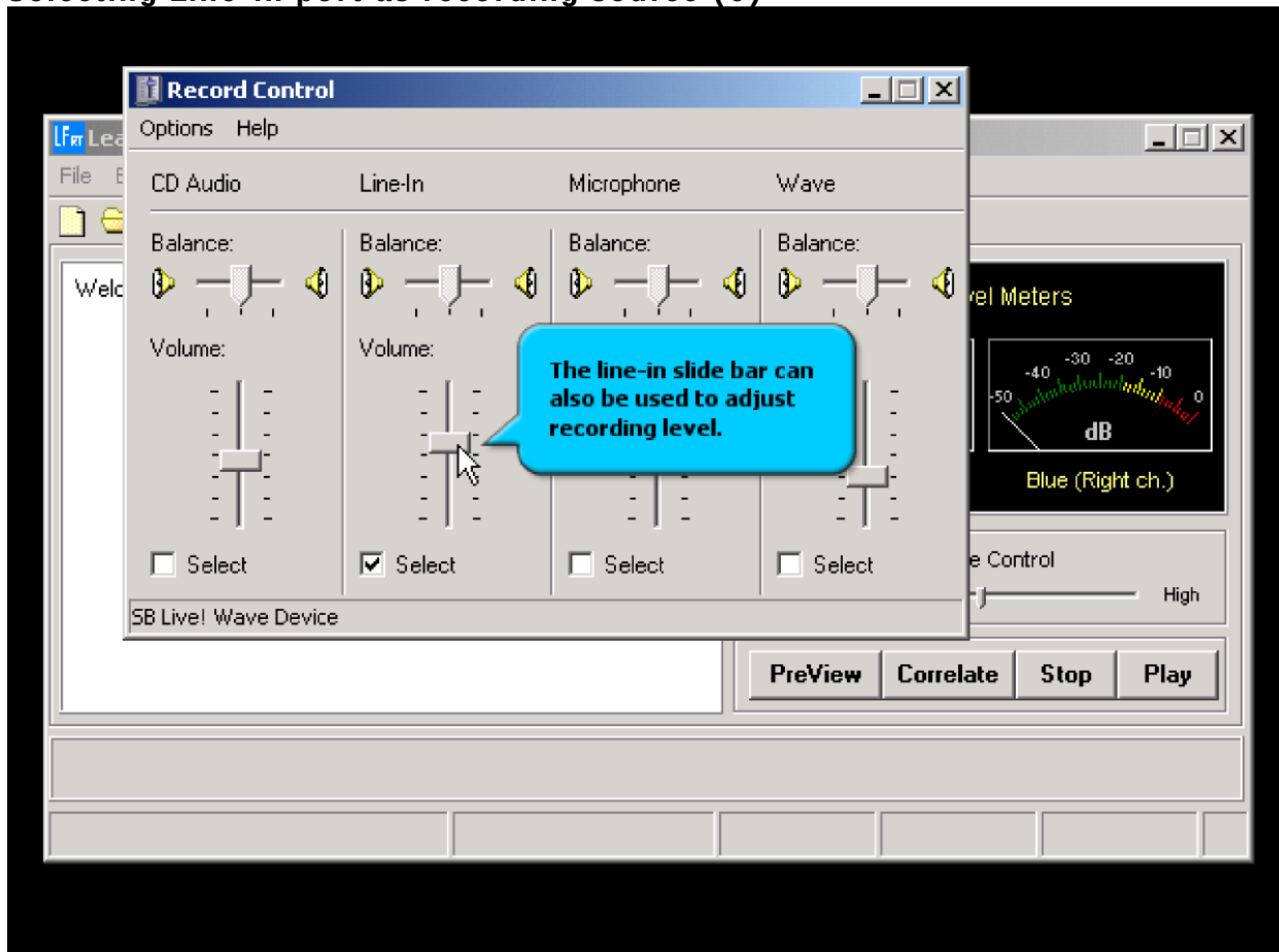
Selecting Line-in port as recording source (4)



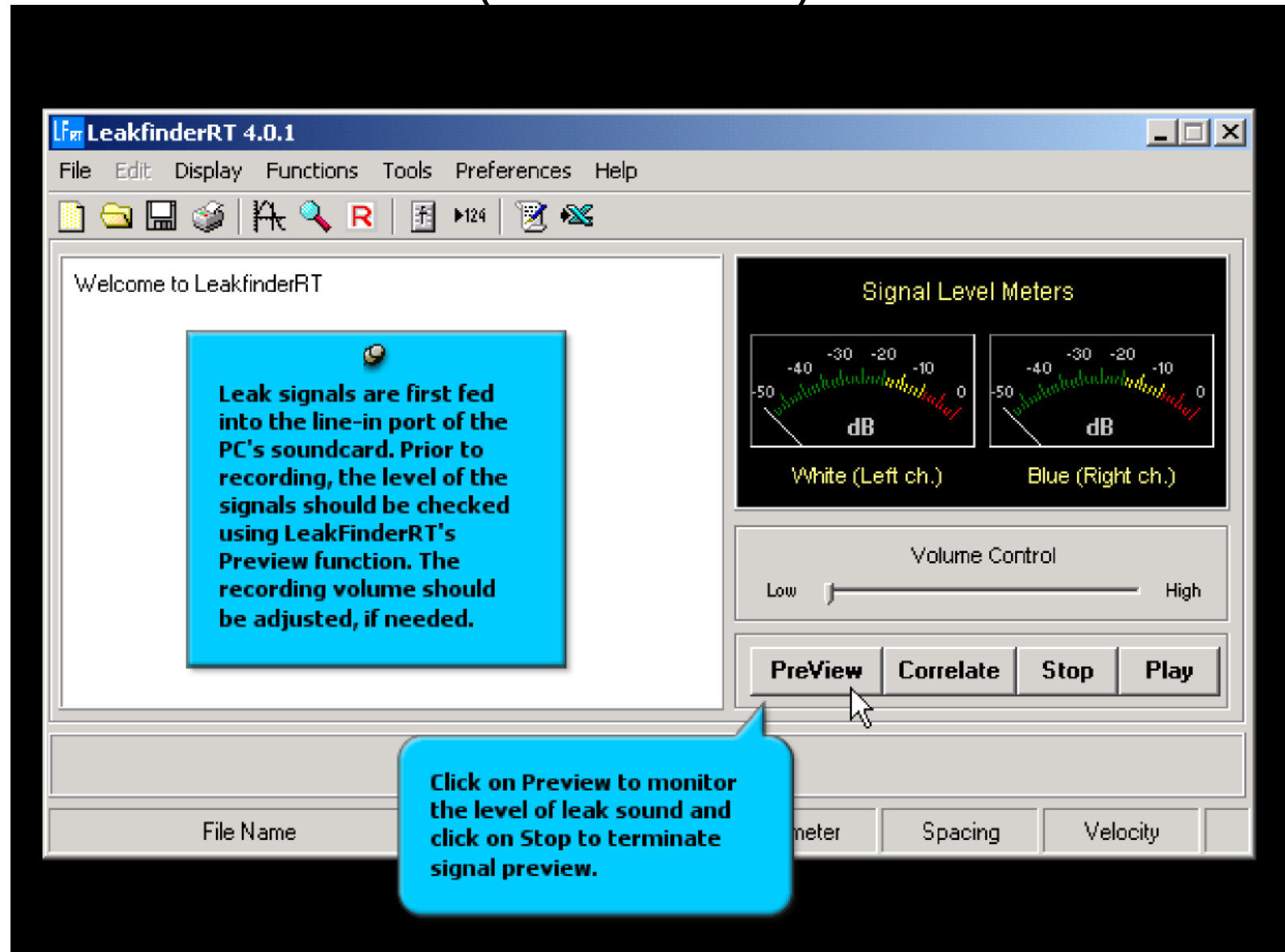
Selecting Line-in port as recording source (5)



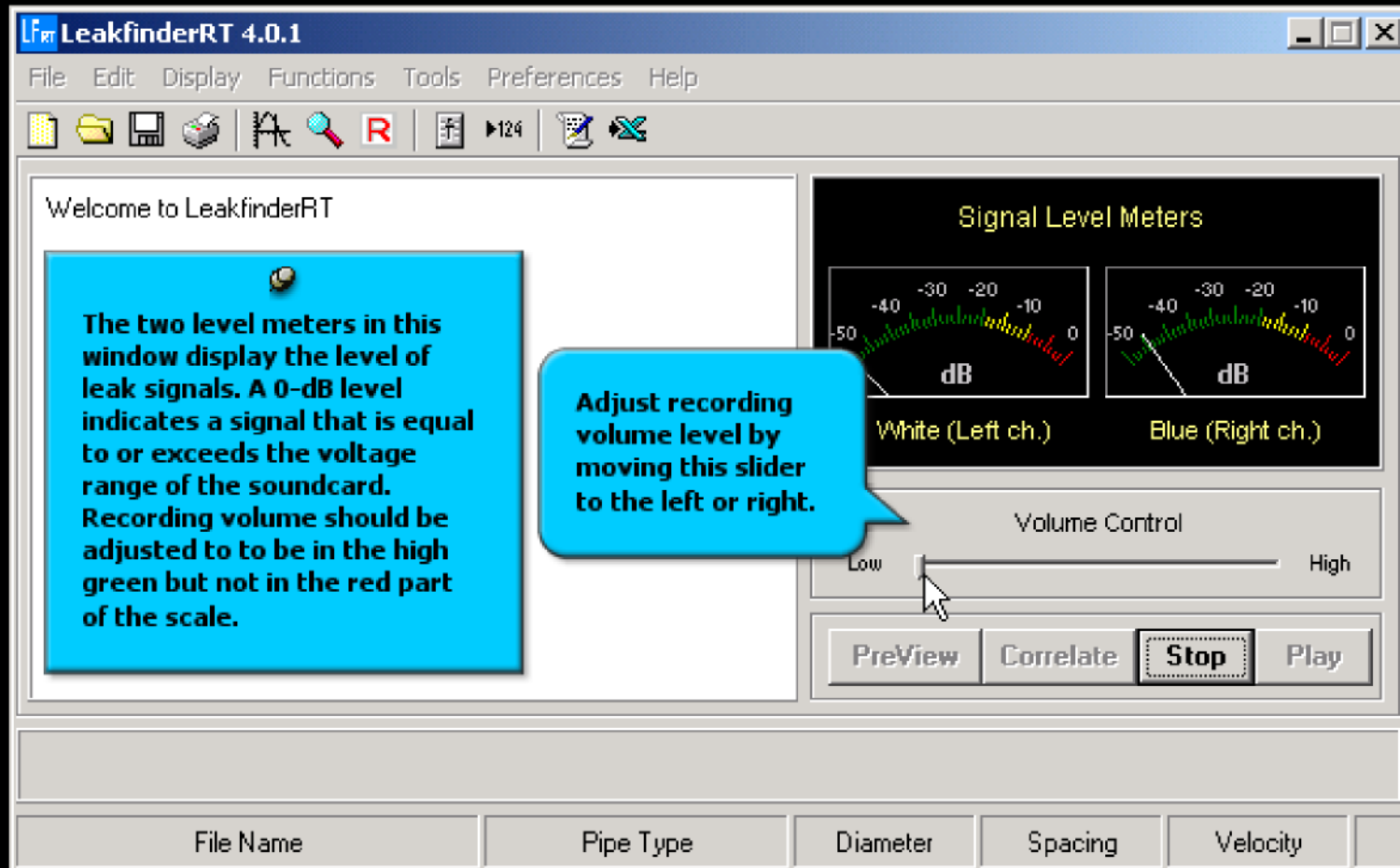
Selecting Line-in port as recording source (6)



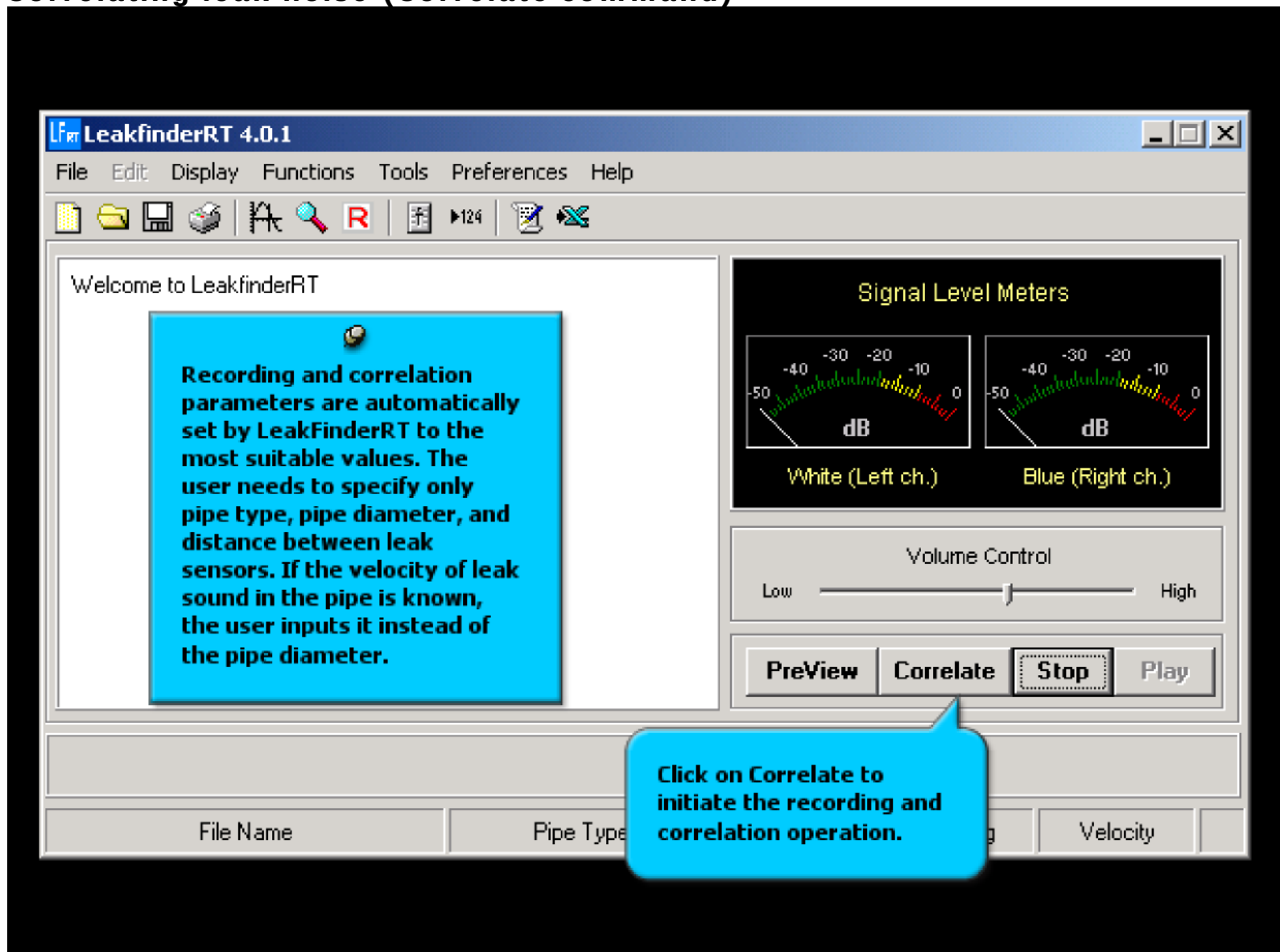
Preview of leak sound level (Preview command)



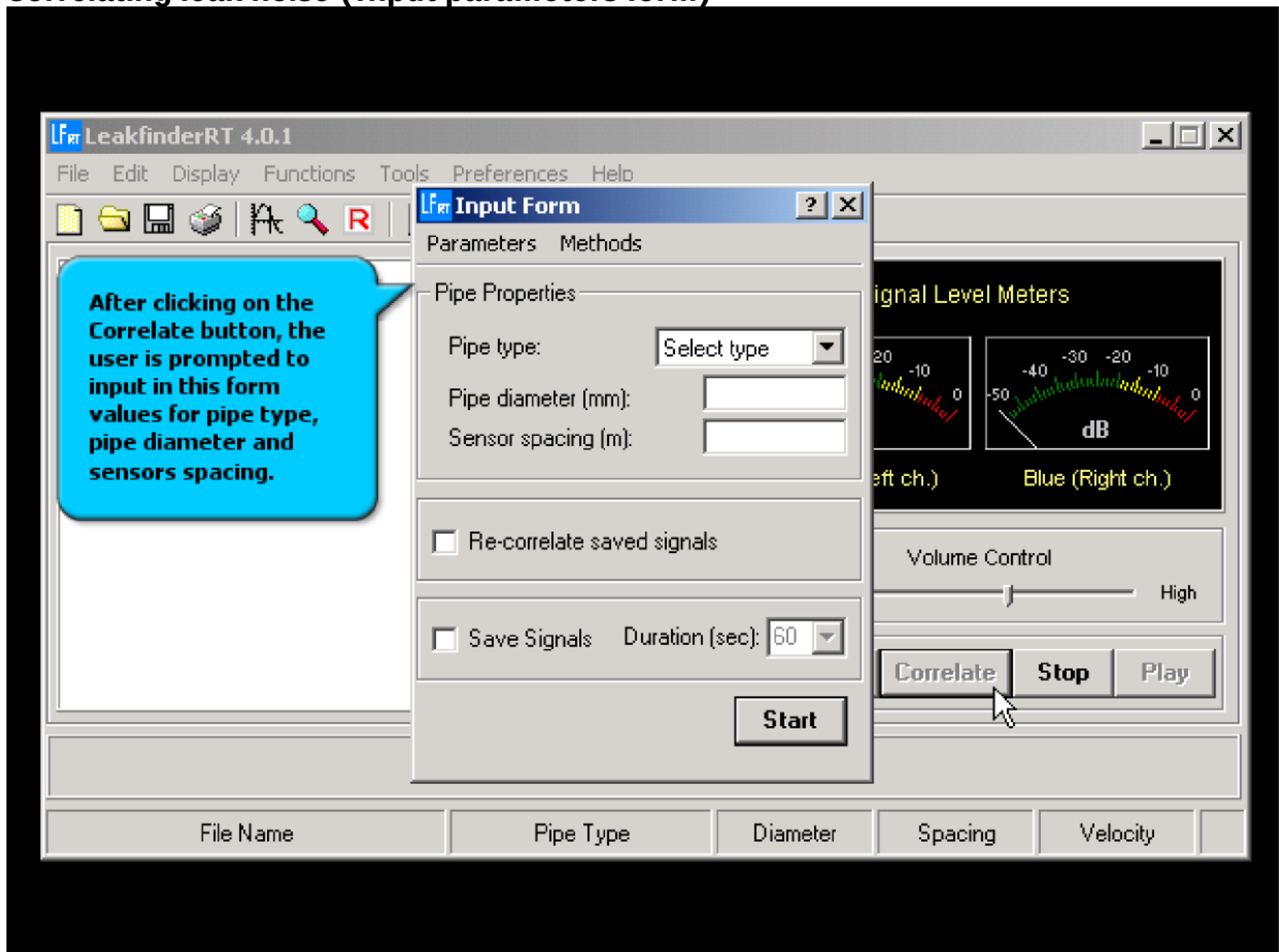
Preview of leak sound level (Adjusting volume level)



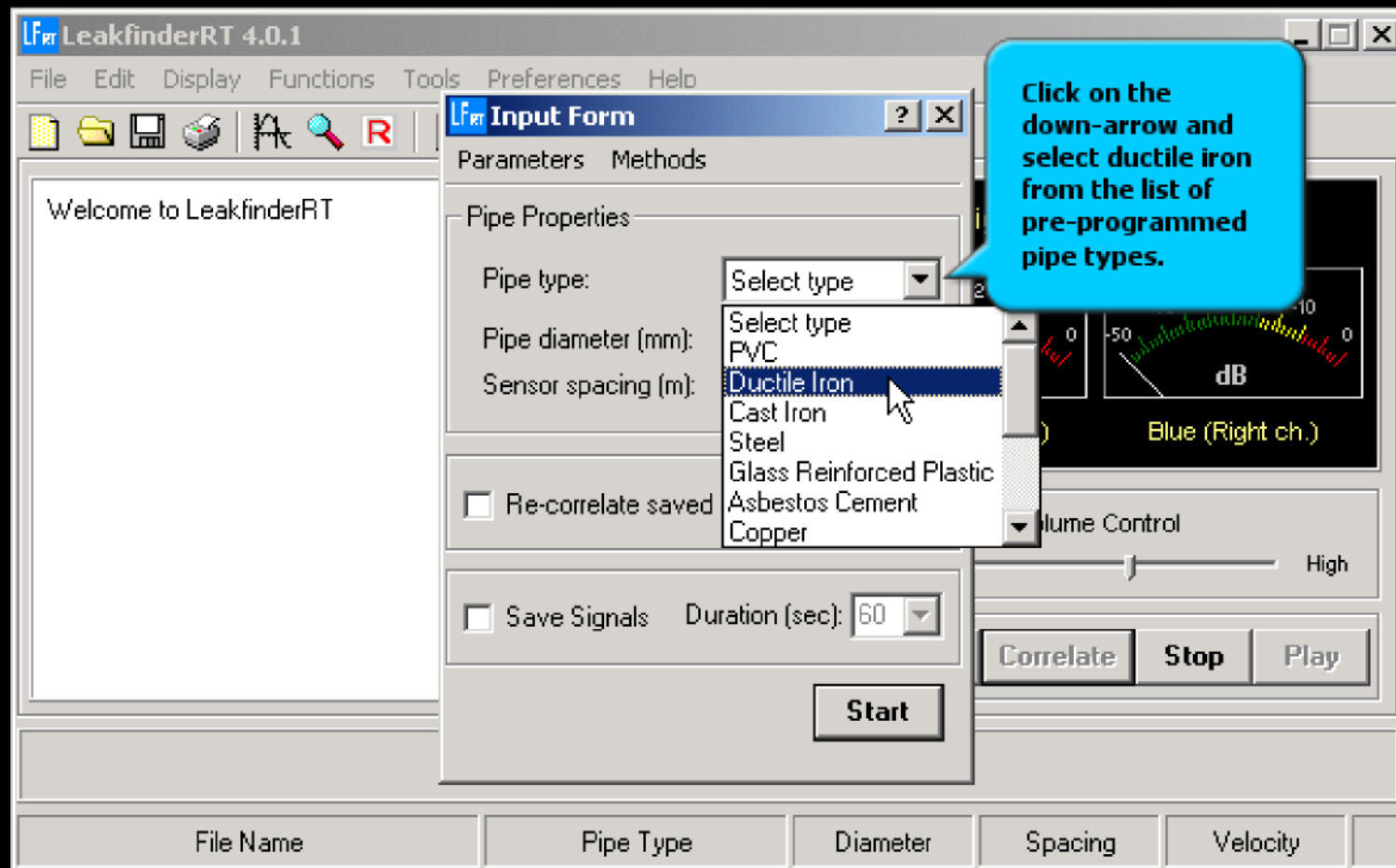
Correlating leak noise (Correlate command)



Correlating leak noise (Input parameters form)



Correlating leak noise (Input parameters: pipe type)



Correlating leak noise (Input parameters: pipe diameter)

The screenshot displays the LeakfinderRT 4.0.1 software interface. The main window has a menu bar (File, Edit, Display, Functions, Tools, Preferences, Help) and a toolbar with icons for file operations and analysis. A 'Welcome to LeakfinderRT' message is visible in the background. Overlaid on the main window is the 'Input Form' dialog box, which has two tabs: 'Parameters' and 'Methods'. The 'Parameters' tab is active, showing the following fields:

- Pipe Properties:**
 - Pipe type: Ductile Iron (selected from a dropdown menu)
 - Pipe diameter (mm): 250 (entered in a text box)
 - Sensor spacing (m): (empty text box)
- ☐ Re-correlate saved signals
- ☐ Save Signals Duration (sec): 60 (selected from a dropdown menu)
- Start** button

To the right of the dialog box, a 'Signal Level Meters' display shows a scale from -40 to 20 dB. Below this is a 'Volume Control' slider set to 'High'. At the bottom of the main window are buttons for 'Correlate', 'Stop', and 'Play'. At the very bottom of the interface is a table with the following headers: File Name, Pipe Type, Diameter, Spacing, Velocity.

Velocity of leak sound is calculated by LeakfinderRT based on input for pipe type, diameter, and wall thickness. By default, the wall thickness is assigned by LeakfinderRT based on the pipe type and diameter; however, the user has the option to specify it if known. If the diameter is unknown, LeakfinderRT estimates the velocity as the average of velocities of several diameters between 100 and 300 mm.

Input 250 mm for pipe diameter

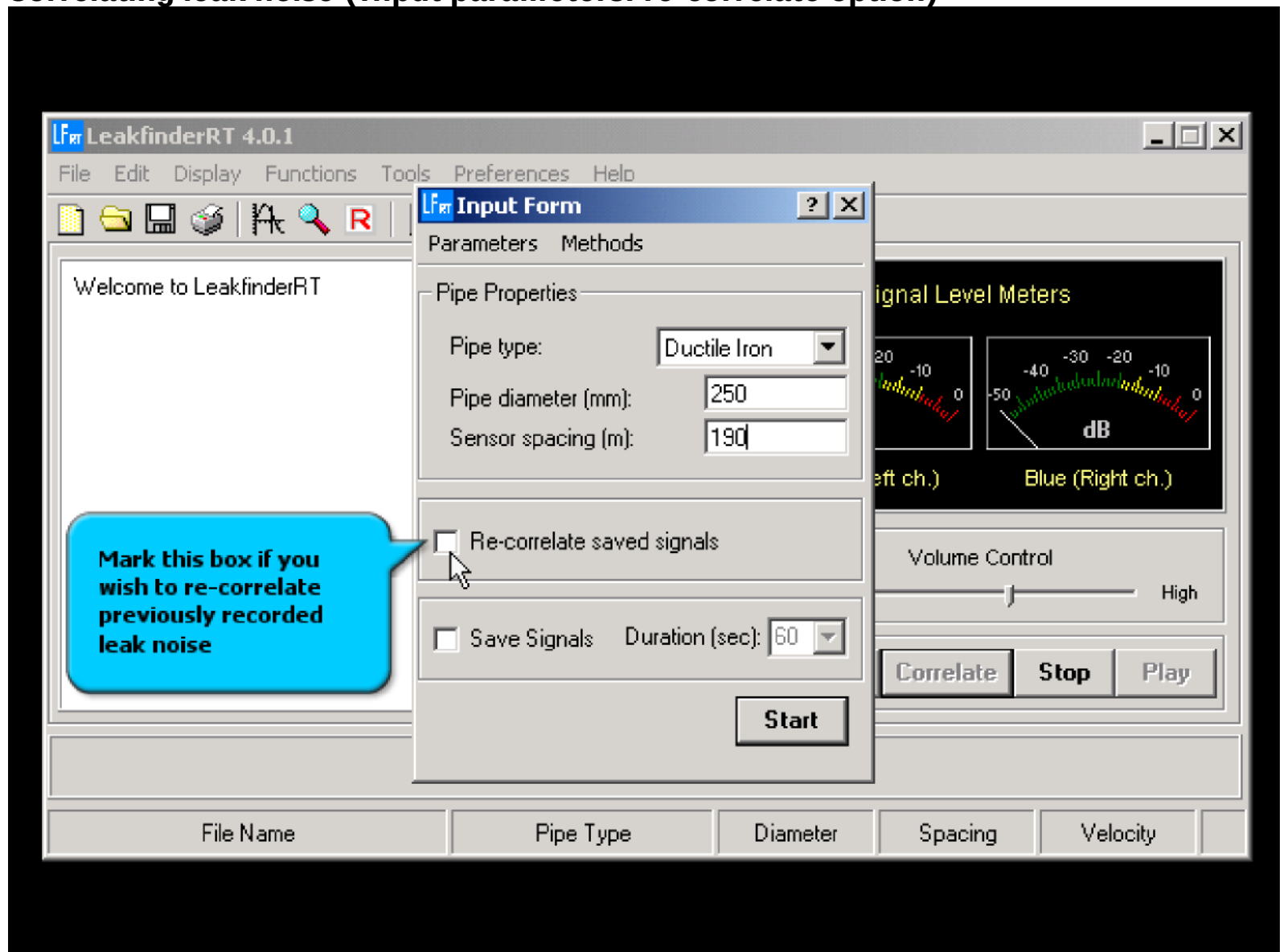
Correlating leak noise (Input parameters: sensors spacing)

The screenshot displays the LeakfinderRT 4.0.1 software interface. The main window has a menu bar (File, Edit, Display, Functions, Tools, Preferences, Help) and a toolbar with icons for file operations and analysis. The main area shows a 'Welcome to LeakfinderRT' message. Overlaid on this is the 'Input Form' dialog box, which has two tabs: 'Parameters' and 'Methods'. The 'Parameters' tab is active, showing the following settings:

- Pipe Properties:**
 - Pipe type: Ductile Iron (selected from a dropdown)
 - Pipe diameter (mm): 250 (text input)
 - Sensor spacing (m): 190 (text input)
- ☐ Re-correlate saved signals
- ☐ Save Signals Duration (sec): 60 (dropdown)

A blue callout bubble points to the 'Sensor spacing (m)' field with the text: "Input 190 m for distance between leak sensors." At the bottom of the dialog is a 'Start' button. To the right of the dialog, part of the main application window is visible, showing 'Signal Level Meters' with two circular gauges and a 'High' label. Below the gauges are buttons for 'Correlate', 'Stop', and 'Play'. At the very bottom of the software window is a status bar with fields for 'File Name', 'Pipe Type', 'Diameter', 'Spacing', and 'Velocity'.

Correlating leak noise (Input parameters: re-correlate option)



Correlating leak noise (Input parameters: save option)

By default, leak sounds are recorded and correlated by LeakfinderRT for an indefinite duration, without being saved to the PC's hard disk. The correlation operation can be terminated at any time by pressing the Stop button. This default mode is helpful for situations where leak signals are weak and have to be correlated for a long time to average out interfering noise.

Mark this box if you wish to permanently save leak noise in a file on the PC's hard disk. Input the duration of the record manually or select it from the drop-down list.

LeakfinderRT 4.0.1
File Edit Display Functions Tools Preferences Help

Input Form
Parameters Methods

Pipe Properties

Pipe type: Ductile Iron

Pipe diameter (mm): 250

Sensor spacing (m): 190

☐ Re-correlate saved signals

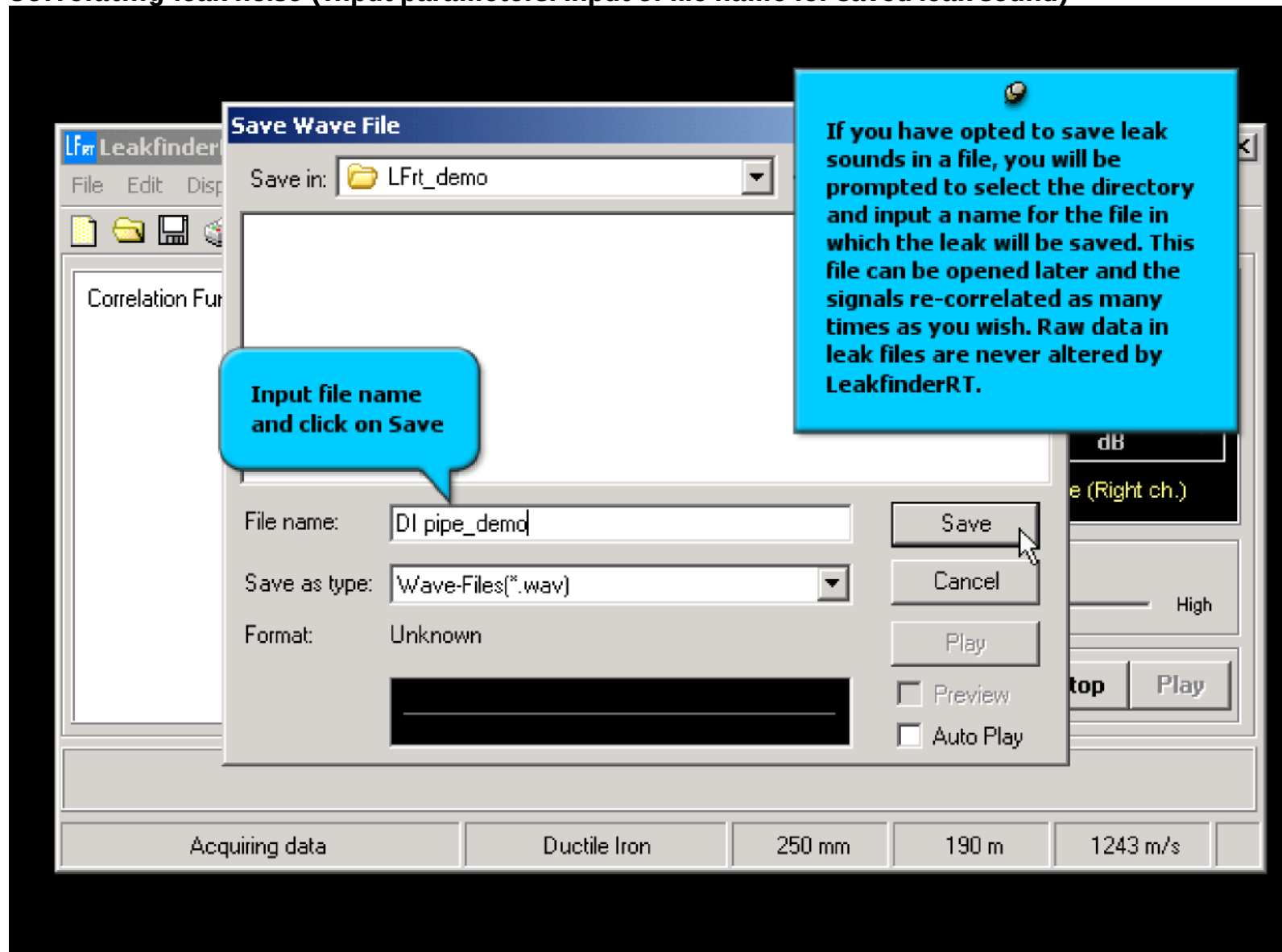
☒ Save Signals Duration (sec): 60

Volume Control: High

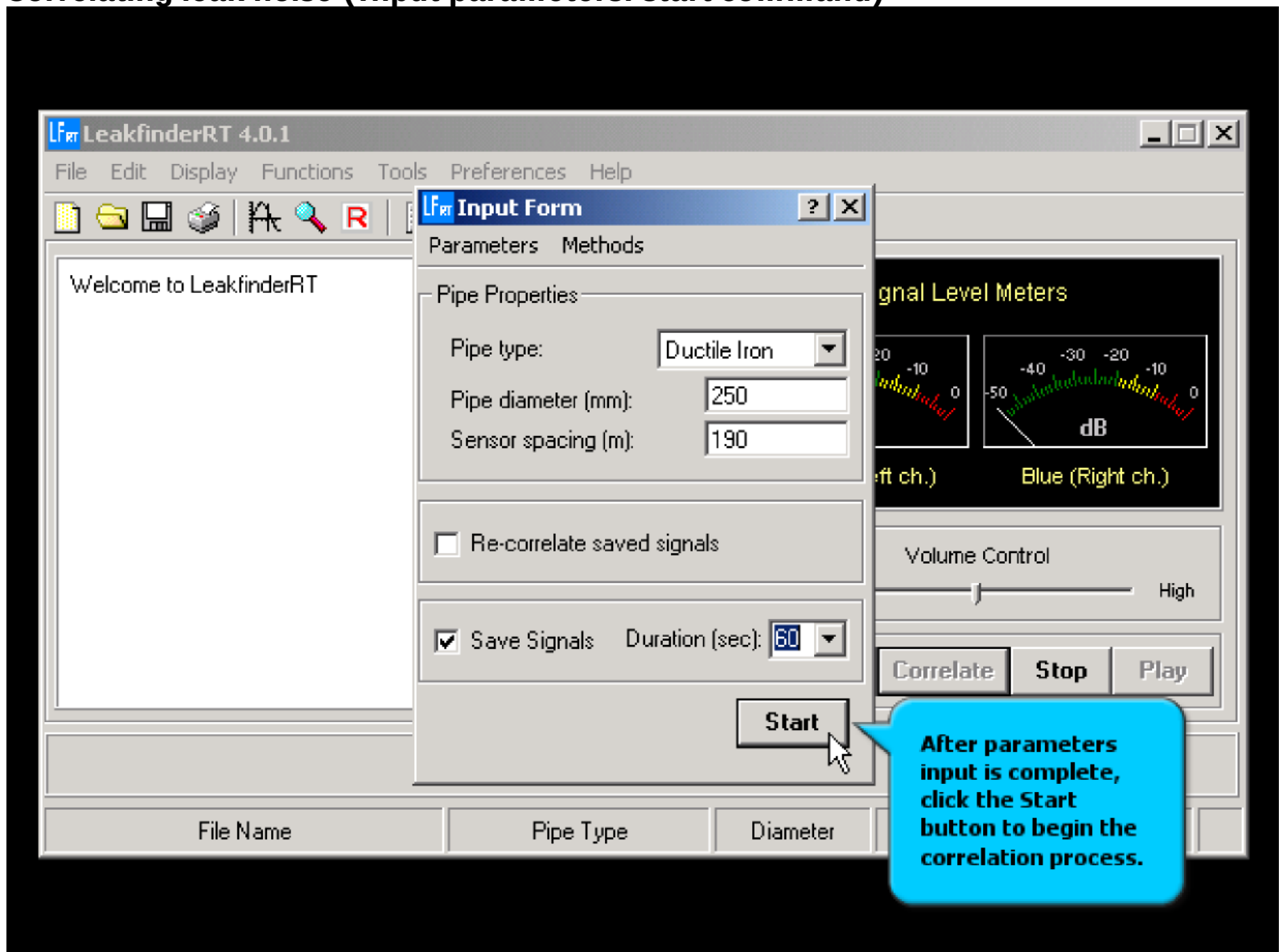
Correlate Stop Play

Pipe Type Diameter Spacing Velocity

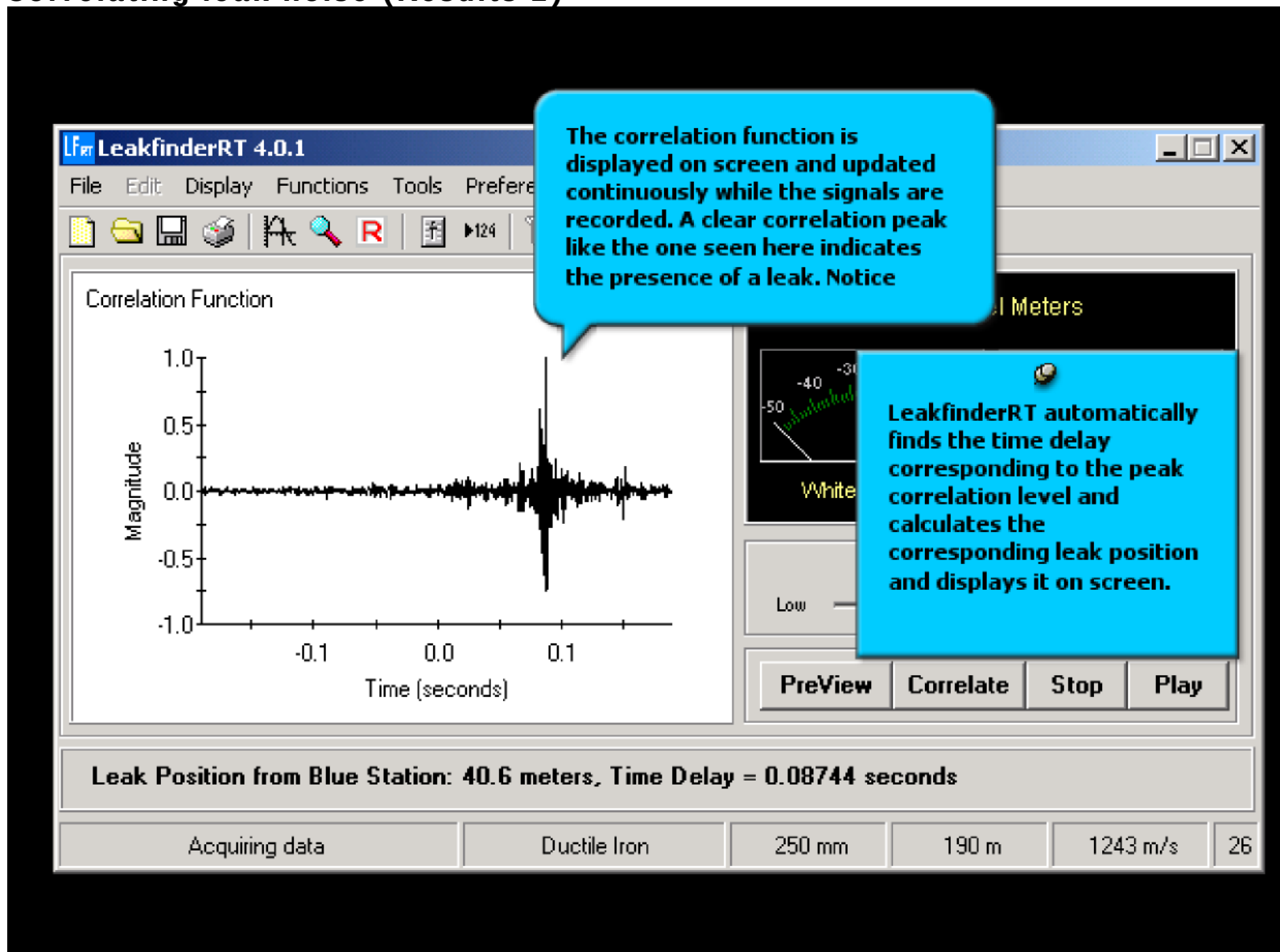
Correlating leak noise (Input parameters: input of file name for saved leak sound)



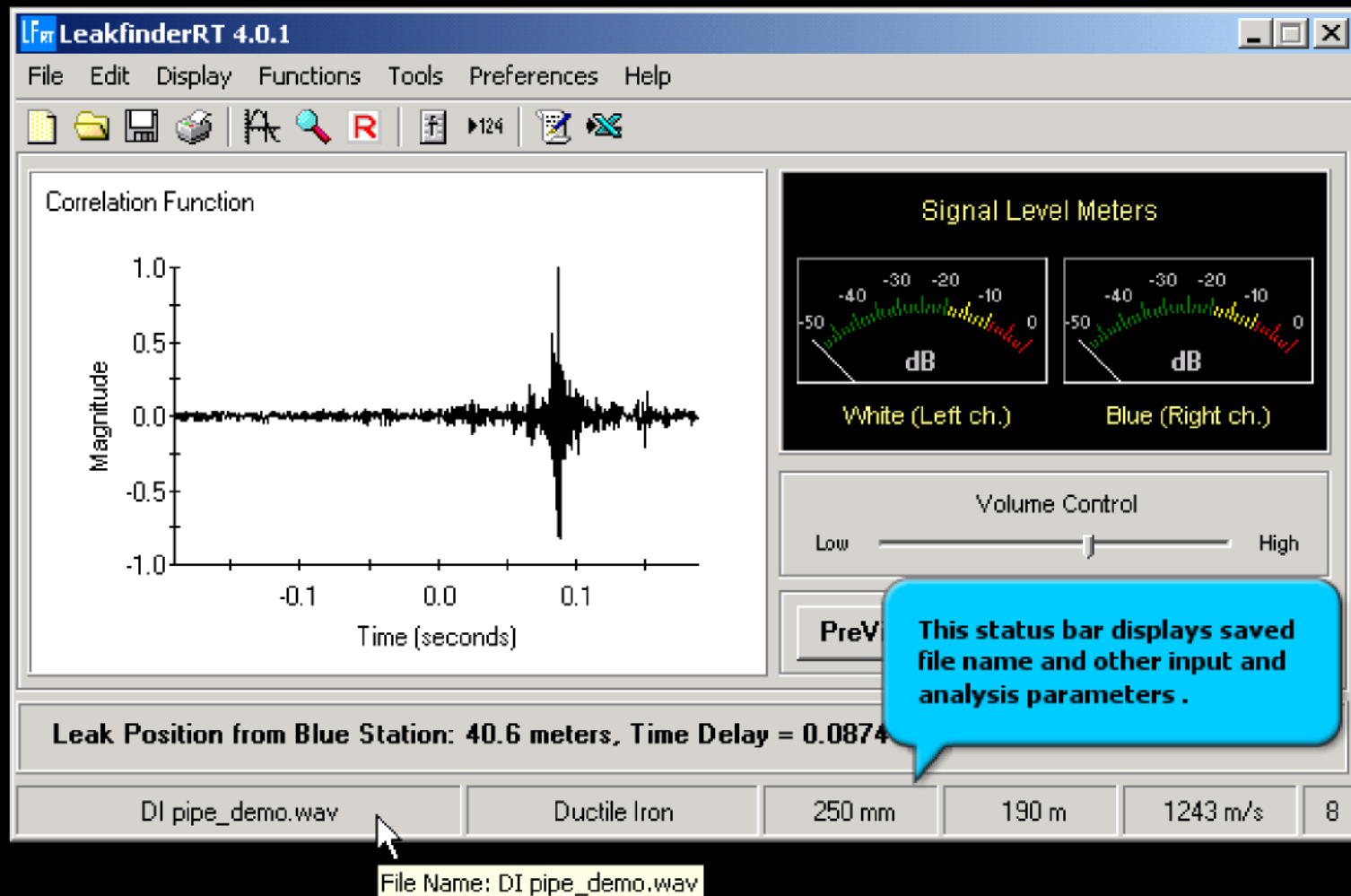
Correlating leak noise (Input parameters: start command)



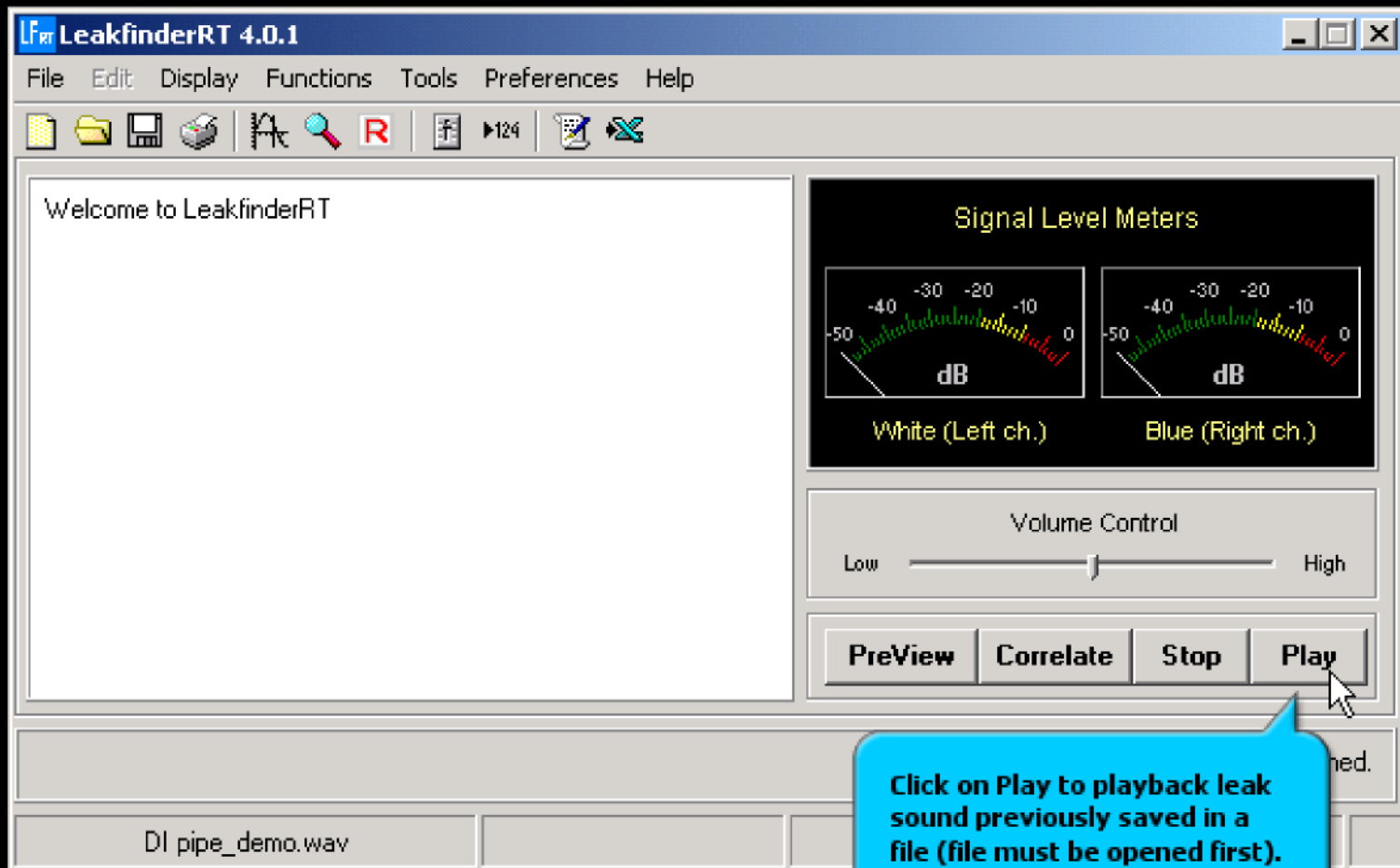
Correlating leak noise (Results 1)



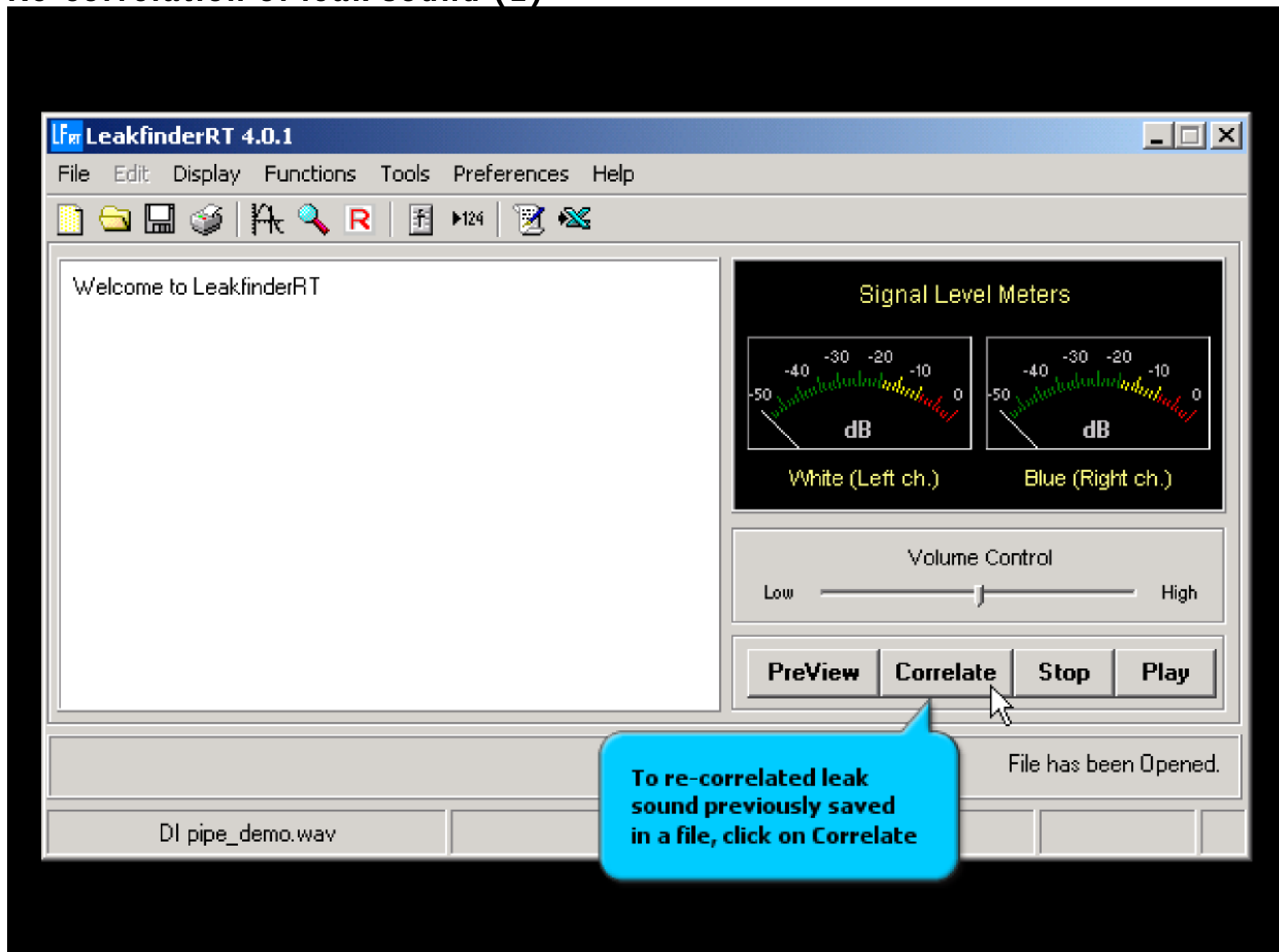
Correlating leak noise (Results 2)



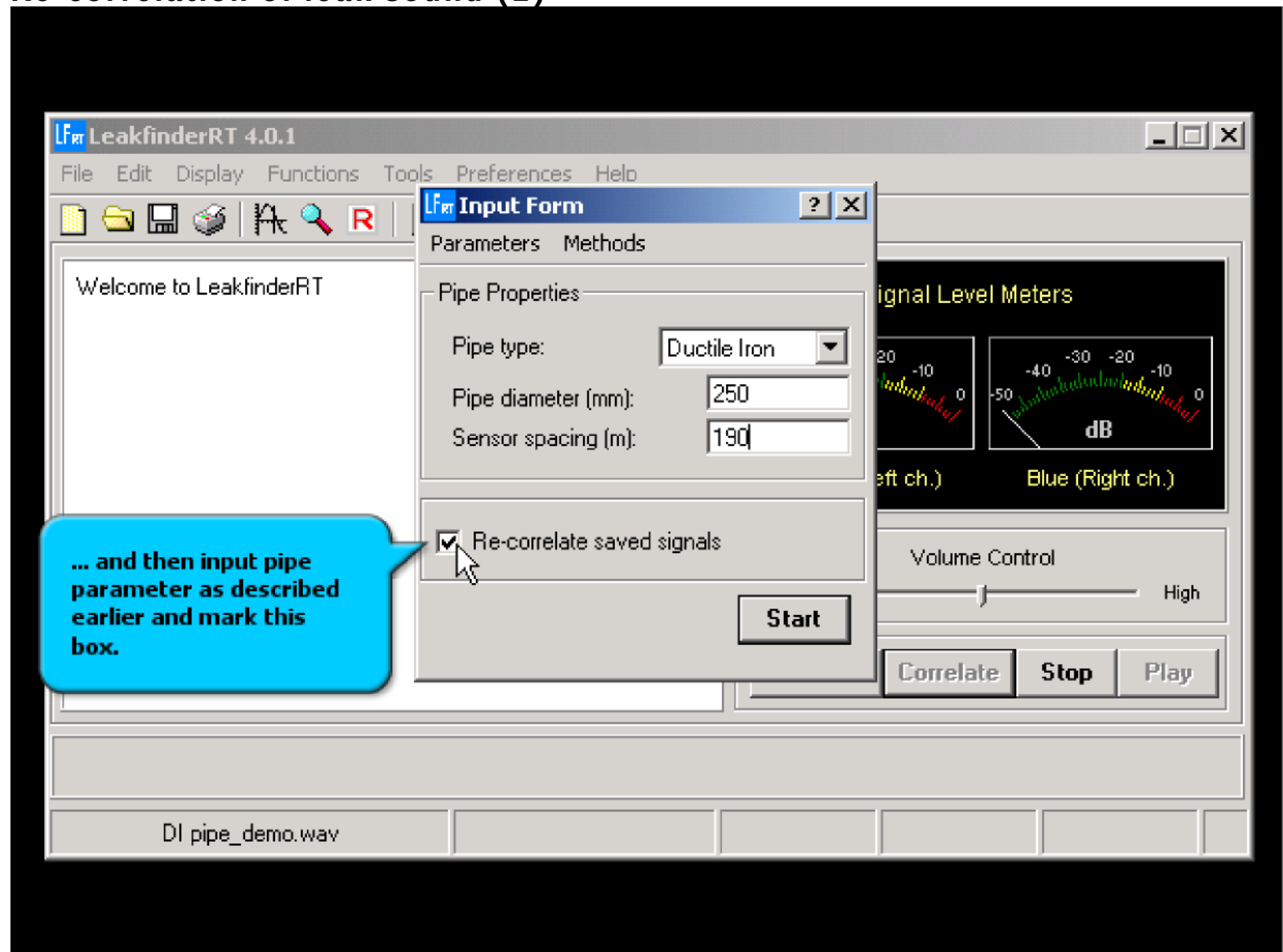
Playback of leak sound



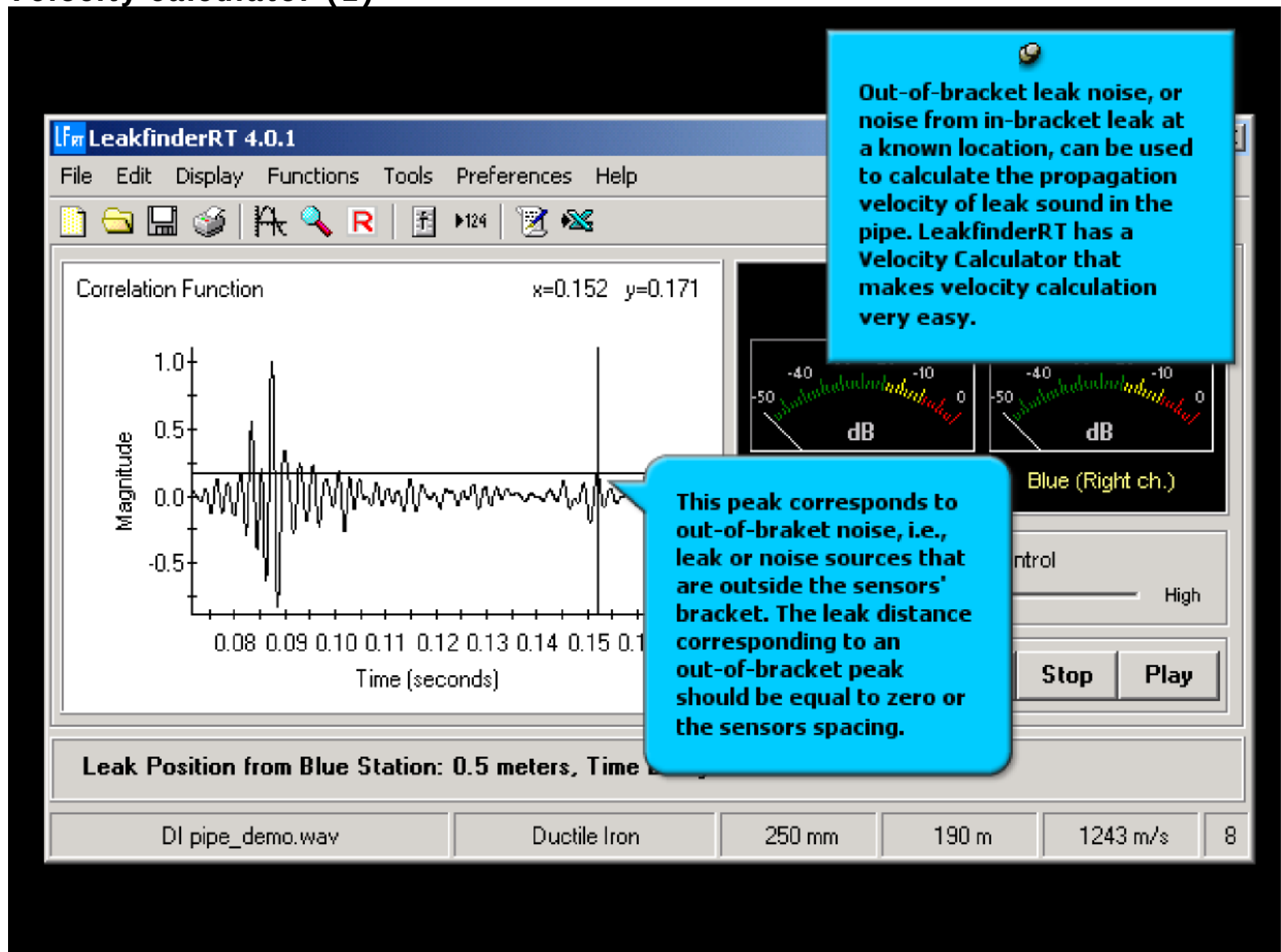
Re-correlation of leak sound (1)



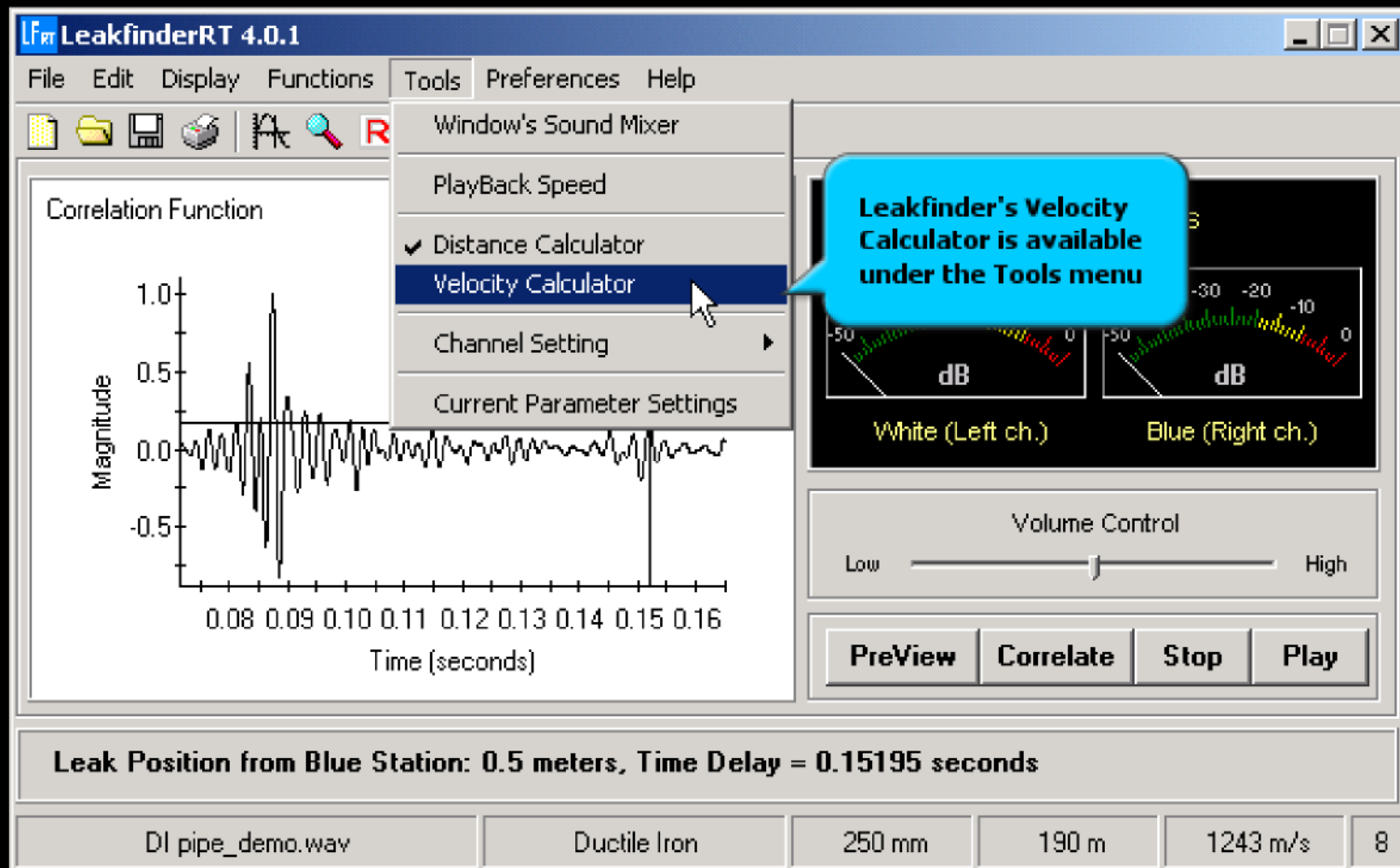
Re-correlation of leak sound (2)



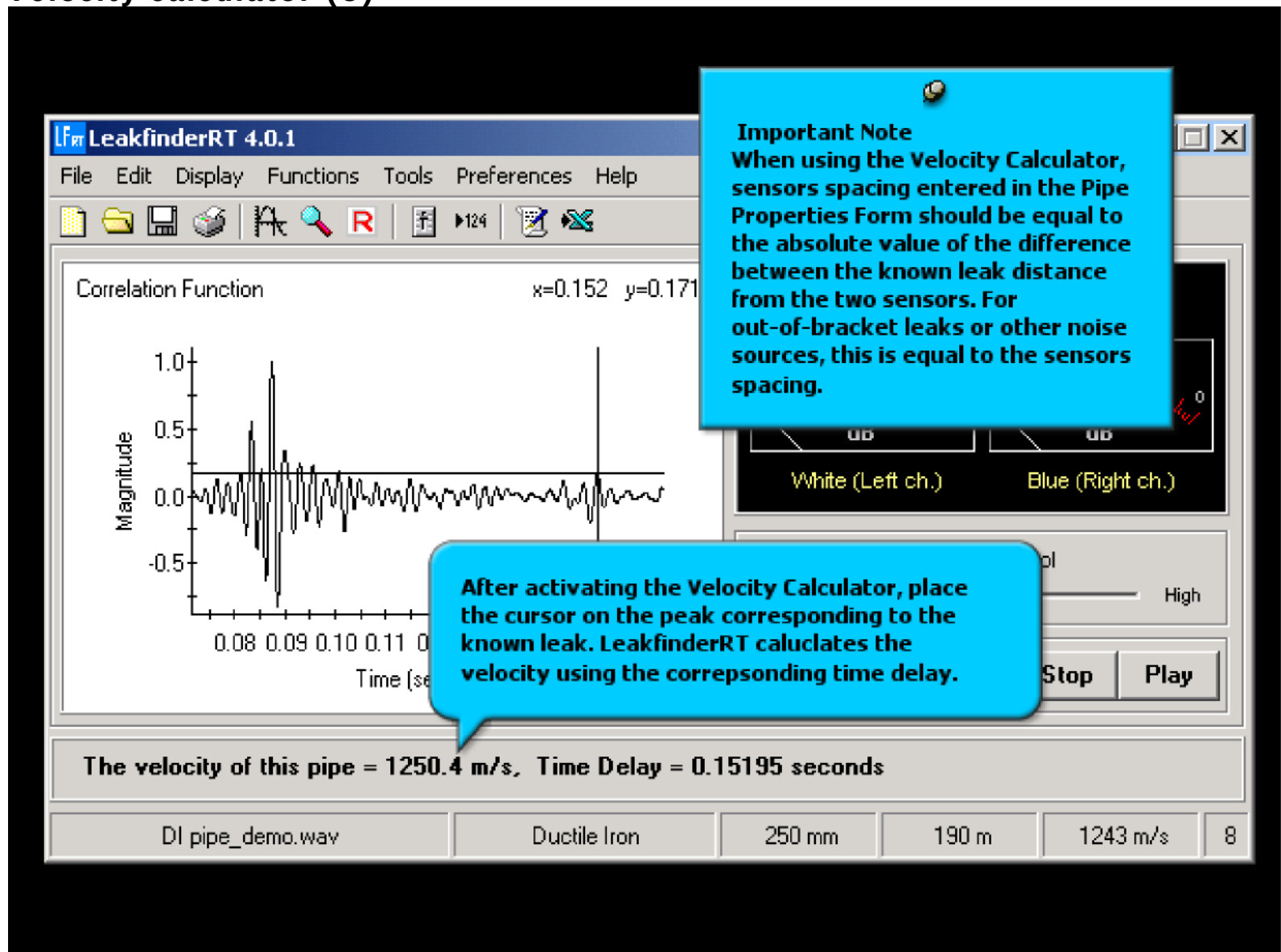
Velocity calculator (1)



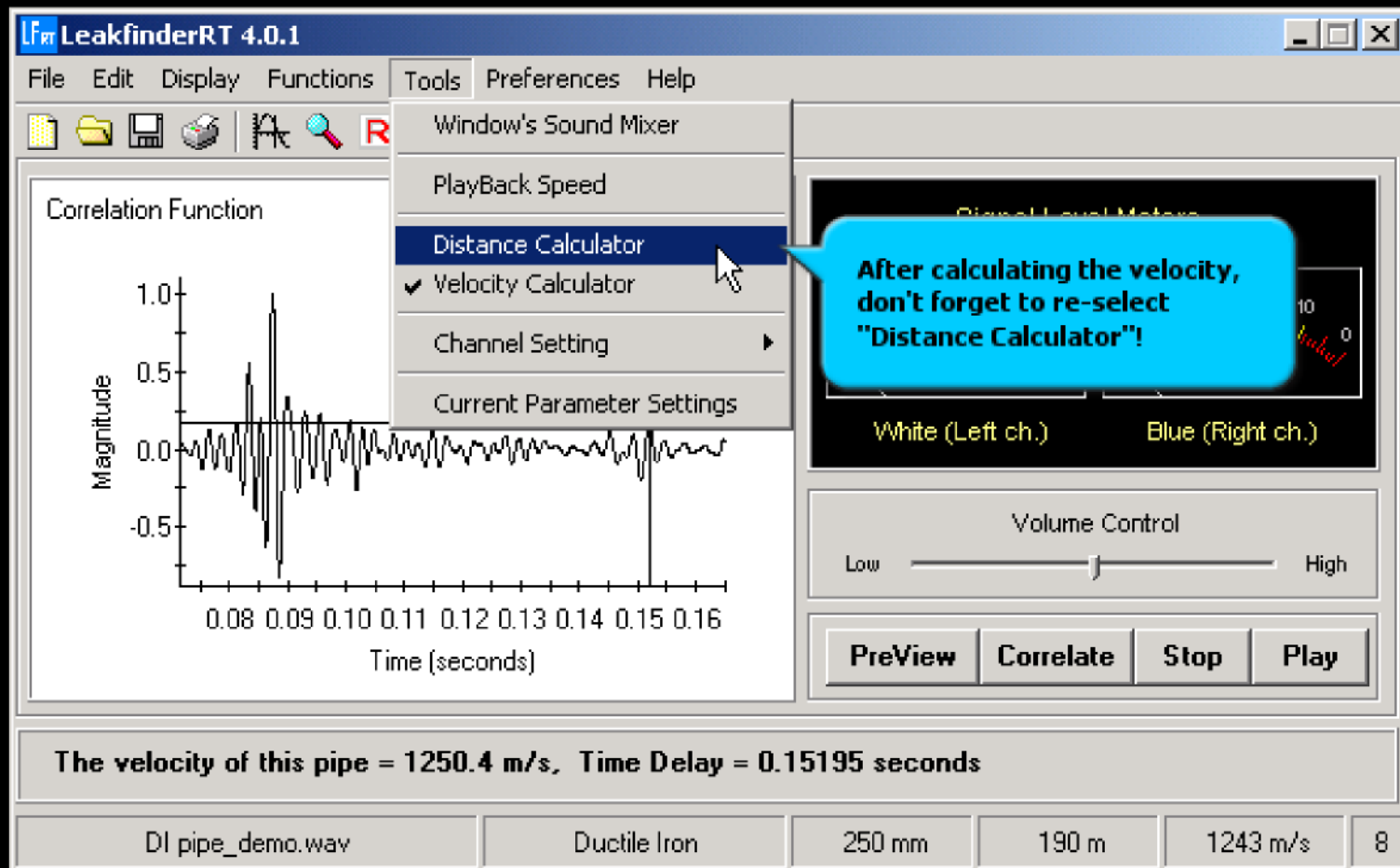
Velocity calculator (2)



Velocity calculator (3)



Velocity calculator (4)



Options for pipe input parameters

Velocity of leak sound is calculated by LeakfinderRT based on input for pipe type, diameter, and wall thickness. By default, the wall thickness is assigned by LeakfinderRT based on the pipe type and diameter; however, the user has the option to specify it if known. If the diameter is unknown, LeakfinderRT estimates the velocity based as the average of velocities of several diameters between 100 and 300 mm for the specified pipe type.

By default, the pipe diameter is the input parameter required by LeakfinderRT to calculate the leak sound velocity. Also, LeakfinderRT assumes by default that the pipe consists of one material type. However, different input parameter(s) and multiple material types can be specified under the Parameters menu.

LeakfinderRT 4.0.1
File Edit Display Functions Tools

Input Form
Parameters Methods

Pipe Property Input
No. of Pipe Types

Pipe type: Ductile Iron

Pipe diameter (mm): 250

Sensor spacing (m): 190

☐ Re-correlate saved signals

☐ Save Signals Duration (sec): 60

Start

Left ch.) Blue (Right ch.)

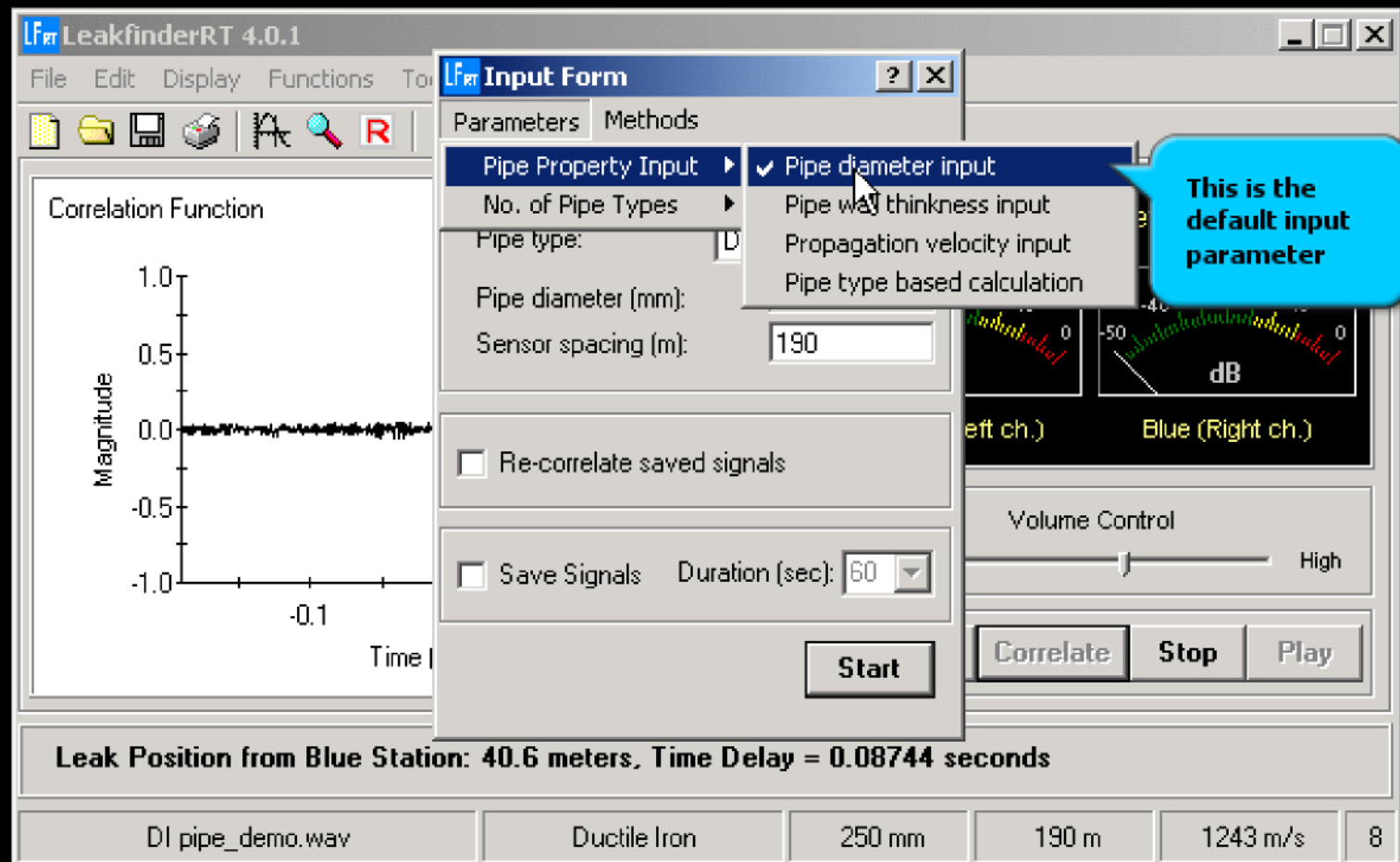
Volume Control High

Correlate Stop Play

Duration: 40.6 meters, Time Delay = 0.08744 seconds

Ductile Iron	250 mm	190 m	1243 m/s	8
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Options for pipe input parameters (default setting)



Options for pipe input parameters (pipe wall thickness)

The screenshot displays the LeakfinderRT 4.0.1 software interface. The main window shows a 'Correlation Function' plot with 'Magnitude' on the y-axis (ranging from -1.0 to 1.0) and 'Time' on the x-axis (ranging from -0.1 to 0.1). The plot shows a noisy signal centered around zero. Overlaid on this is the 'Input Form' dialog box, which has two tabs: 'Parameters' and 'Methods'. The 'Parameters' tab is active, showing fields for 'Pipe type' (set to 'D'), 'Pipe diameter (mm)' (empty), and 'Sensor spacing (m)' (set to '190'). A dropdown menu is open for 'Pipe Property Input', showing four options: 'Pipe diameter input' (checked), 'Pipe wall thickness input' (highlighted by a mouse cursor), 'Propagation velocity input', and 'Pipe type based calculation'. A blue callout bubble points to the 'Pipe wall thickness input' option with the text: 'Select this option only if the pipe wall thickness is known.' Below the input fields are checkboxes for 'Re-correlate saved signals' and 'Save Signals', and a 'Duration (sec)' dropdown set to '60'. A 'Start' button is at the bottom of the dialog. To the right of the dialog, there are volume control sliders for 'Left ch.' and 'Blue (Right ch.)', and buttons for 'Correlate', 'Stop', and 'Play'. At the bottom of the main window, a status bar displays 'Leak Position from Blue Station: 40.6 meters, Time Delay = 0.08744 seconds'. Below this is a table with the following data:

DI pipe_demo.wav	Ductile Iron	250 mm	190 m	1243 m/s	8
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