

## GETTING STARTED GUIDE

This guide steps through the process of setting up the IRIS system hardware and software, conducting a measurement and analysing the results.

### PC REQUIREMENTS

- Windows 7 or Windows 8 (Windows Vista may work but has not been tested)
- Windows 7 only: Microsoft .NET Framework 4.0 including update KB2468871, or a newer framework. The installer will automatically download these files from the internet and install them if required. The .NET Framework 4.5 is included by default in Windows 8.
- 2x USB 2.0 ports (For the audio interface and dongle)
- The IRIS software requires about 70 MB.
- A large IRIS project may require hundreds of megabytes (and a lot more if the “save all signals” debugging option is enabled – which it will be for the test cases).

### SOFTWARE INSTALLATION

Please ensure the HASP and MOTU drivers are installed before running IRIS.

#### HASP Driver

<http://www.iris.co.nz/download>

Note the IRIS software will function as a viewer without the dongle connected. Projects may be opened, but measurements cannot be created or recorded.

#### MOTU 4PRE Driver

IRIS is designed to work with a MOTU 4pre audio interface. Before connecting it, download the driver from <http://www.iris.co.nz/download>

The MOTU Universal Audio Installer, v4.0.5.8373, released on 20 August 2013 has been tested and known to work with IRIS. During installation, when asked which product to install, select “Firewire/USB2 Audio”.

#### IRIS Software Installation

Run setup.exe to start the IRIS installer. An internet connection will be required if setup needs to download and install any prerequisites.

## IRIS Kit Contents

The IRIS kit is shipped in a Pelican Storm case with custom foam containing the following:

- IRIS software on a USB drive and a HASP USB dongle
- Core Sound TetraMic and microphone stand clip (standard 5/8" 27 TPI thread)
- TetraMic cable (female-to-female)
- MOTU 4pre and accessories
- CBM box (attached to back of MOTU)
- PPA box
- Microphone stand holster for PPA box
- 30 metre STP CAT5e cable with Ethercon connectors

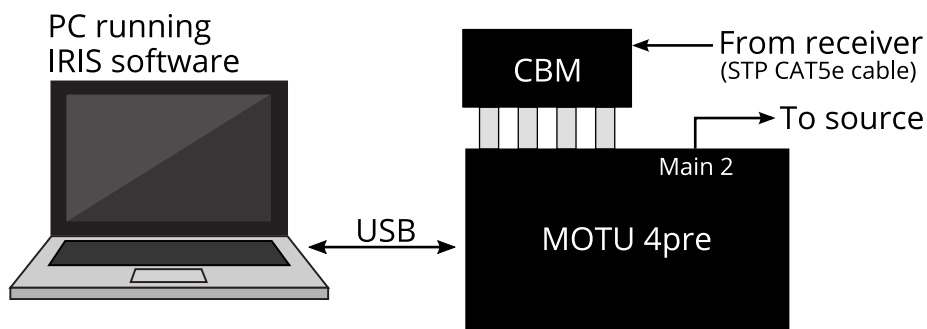
## Additional equipment provided by the user

- Laptop
- Microphone stand
- Source loudspeaker with cabling – the output from IRIS is balanced line level via TRS socket.
- Any necessary power extension cables and power strips.
- Electrical insulation tape or gaffer tape
- Headphones

## Hardware Setup

The IRIS measurement system is divided into three sections: (1) measurement controller, (2) source, (3) receiver. The following diagram illustrates how the equipment is connected.

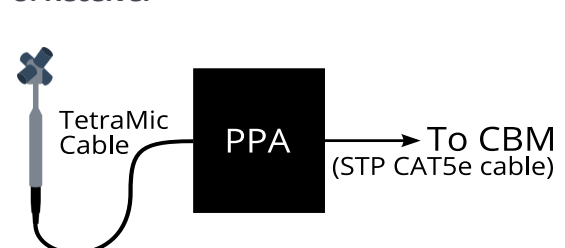
### 1. Measurement Controller



### 2. Source



### 3. Receiver



## Step-by-Step

### Measurement Controller Setup

1. Ensure the CBM box is properly connected to the four inputs on the back of the MOTU 4pre.
2. Connect power to the MOTU 4pre with the included DC power supply, and also connect the 4pre to the PC using the USB Cable. Power on the 4pre by pushing the power button on the front panel.
3. Power on the PC (the MOTU and HASP drivers should already be installed).

### Source Setup

4. Place the source loudspeaker in the initial desired position. Connect this (through any necessary amplification) to output "MAIN 2" on the back of the MOTU 4pre. It is recommended to use a right angle TRS lead to stay clear of the CBM box. (MAIN 2 is hardcoded as the output channel when the supplied calibration is enabled). Leave the loudspeaker powered off or turned down for now.



Note that all outputs on the MOTU 4pre are line level. Please do not use LINE 3 or 4, as it is not easy to control the level of these outputs.

### Receiver Setup

5. Place the microphone stand at the initial receiver position. Connect one end of the TetraMic cable to the Tetramic, and then attach the TetraMic to the stand using the included clip, as shown below. Attach the clip to the bottom of the TetraMic to prevent damage to the knurling. The TetraMic should ideally be in an upright position, and the x-direction is indicated by Core Sound logo on the TetraMic.



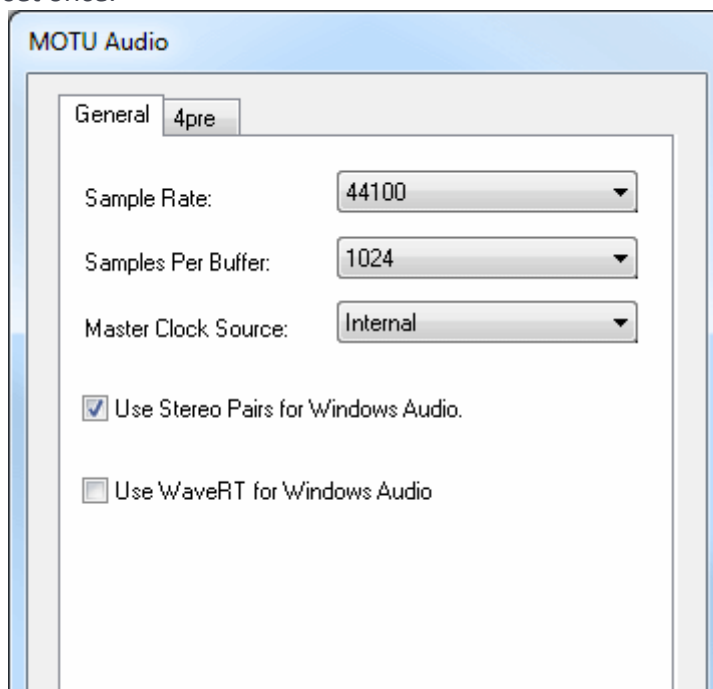
- Attach the other end of the TetraMic cable to the PPA, and using the included holster, mount the PPA to the base of the microphones stand. An example is shown below.



- Connect the receiver assembly to the measurement controller using the included 30 metre STP cable. One end connects to the PPA, and the other to the CBM box. Please provide some form of strain relief on the ethernet cable at both ends, but most importantly at the receiver as this will be moved around. An example is shown in the image above – here electrical tape has been used to tie the STP cable to one of the microphone stand legs.

#### *MOTU 4pre Configuration Steps*

- Ensure the 4pre is powered on. On the PC, open “MOTU Audio Console” and select the maximum value for “Samples Per Buffer”, which should be 1024. This should only need to be set once.



- Open “CueMix FX”. This is the MOTU mixing application. Before you do anything else, ensure that the microphone inputs are not being sent to the outputs. This should never be the case, but as a check, select “Mix 1”, and make sure that “MUTE” is enabled on all the input channels as shown below:



- Enable 48V phantom power on each input channel, and set all trims to +30, as shown:



- To check that signal is being received, observe the level meters on the front of the 4pre unit and make some noise in the room – all four input meters should light up!

12. It's a good idea to listen to the received sound. Set the MIX to "Mix 4" in CueMix FX, and unmute the input channels. The level meters in the CueMix FX software should now be working. For example:



Connect headphones to the "PHONES" jack on the front of the 4pre. Adjust the PHONES level knob as desired, and ensure you can hear the microphone signals. If nothing can be heard, check that the Phones menu is set to "Phones 1-2".

13. The final stage of configuration is to set the level to the source loudspeaker. This is described in the next part of this guide – the IRIS software needs to be running to generate a test signal for setting the output level. In the mean time, ensure the source loudspeaker is turned down, and the MAIN knob on the 4pre front panel is turned down.

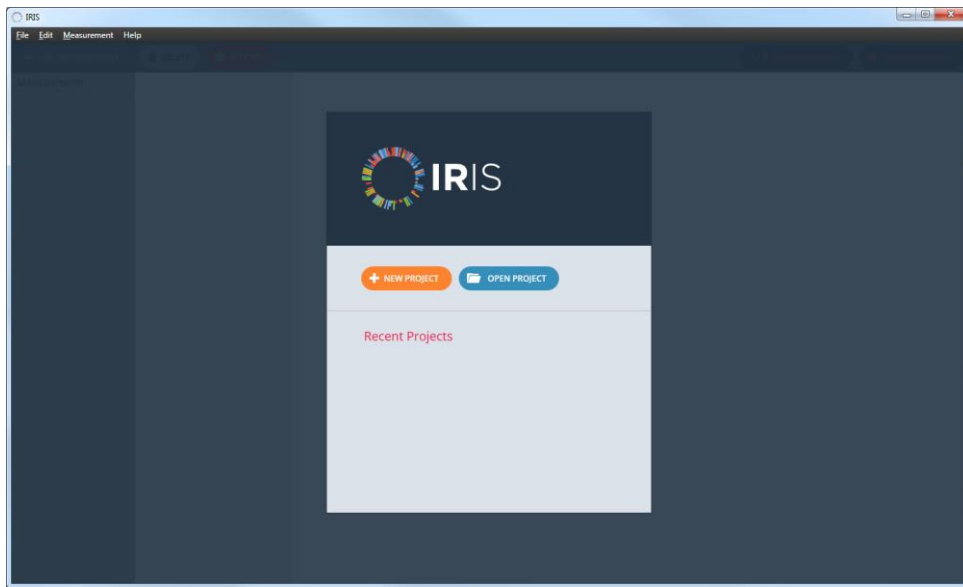
## IRIS Software

An IRIS project represents a single room or “measurement session”, and consists of a collection of measurements.

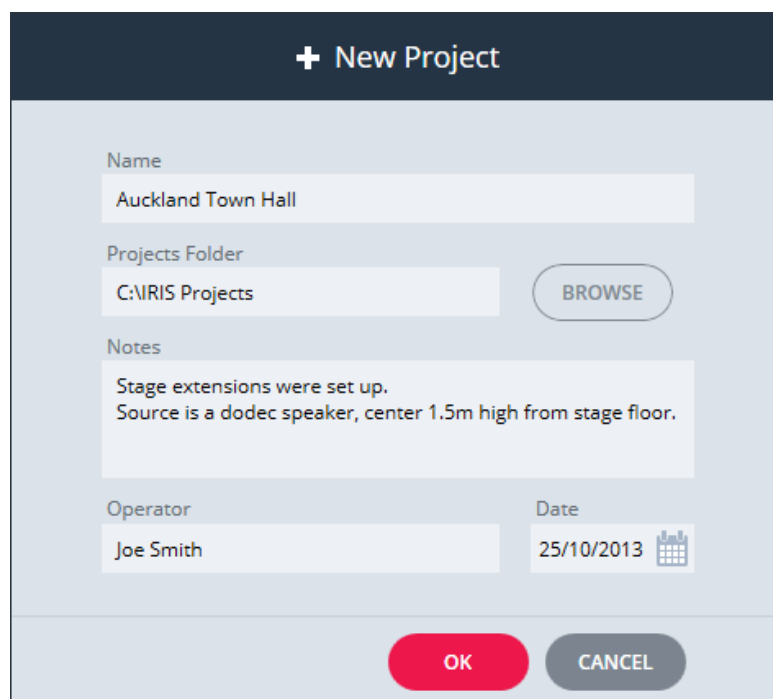
Ensure the HASP and MOTU 4pre devices have been installed and connected before starting IRIS. IRIS will run in evaluation mode if the HASP dongle is not connected – projects can be opened, but measurements cannot be conducted.

### Creating a New Project

The initial IRIS window is shown below.



Click the New Project button to create a project. Fill in the project details. At least a name should be provided. Click OK to create a project. IRIS creates a folder with the project name in the “Projects Folder” directory. This contains a .iris file and any future measurement data.

The image shows the "New Project" dialog box. The title bar reads "+ New Project". The form contains the following fields and controls:

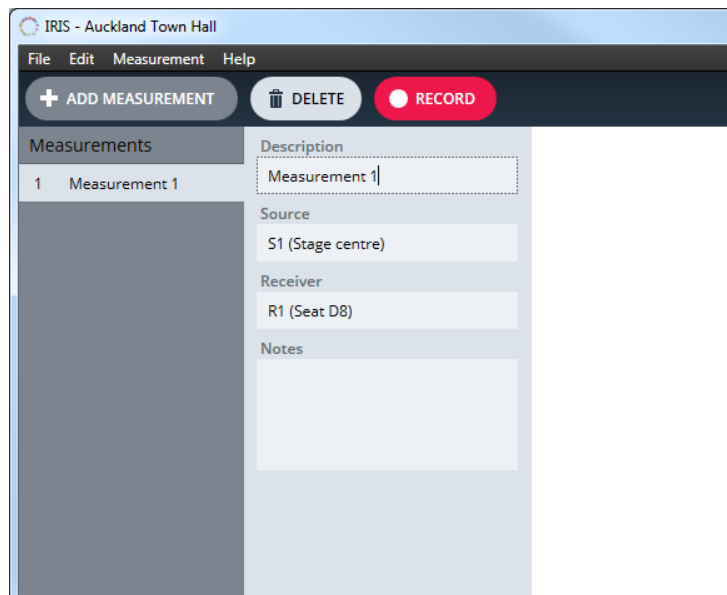
- Name:** A text input field containing "Auckland Town Hall".
- Projects Folder:** A text input field containing "C:\IRIS Projects" and a "BROWSE" button to the right.
- Notes:** A text area containing the text "Stage extensions were set up. Source is a dodec speaker, center 1.5m high from stage floor."
- Operator:** A text input field containing "Joe Smith".
- Date:** A date input field containing "25/10/2013" and a calendar icon to the right.

At the bottom of the dialog are two buttons: a red "OK" button and a grey "CANCEL" button.



## Adding a Measurement

Select the Add Measurement button to add a measurement to the newly created project. This will add a new measurement to the “Measurements” list (leftmost column of the IRIS window). This will be created with a default name of “Measurement 1” so change this to something more meaningful. Source, receiver and notes fields are also provided.

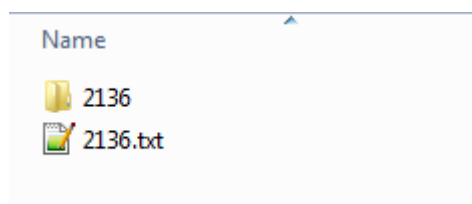


Before this measurement is conducted, the calibration, audio and sweep settings should be checked.

## Calibration Data

The IRIS kit comes bundled with a MOTU 4pre which has been calibrated. This calibration (for now) simply corrects for relative gain differences between input channels. This is very important – any gain mismatches between input channels will add error into the results. The calibration document is an xml file named with the serial number of the MOTU device.

The Core Sound TetraMic also includes a calibration document supplied by Core Sound. This is not an absolute level type of calibration, but ensures the TetraMic performs correctly. The calibration document is a text file alongside a folder, both named with the serial number of the TetraMic, for example:



The calibration for your specific IRIS kit should be imported automatically during installation. If not, it can be imported manually using the Calibration Manager (Edit -> Calibration Manager).

- To import a TetraMic calibration, click the plus button next to “TetraMic Calibration” and select the text file.
- To import the Audio Device calibration, click the plus button next to “Audio Device Calibration” and select the xml file.

Click OK to exit the calibration manager. The added calibration data will now be available to choose from in the Audio Settings dialog.

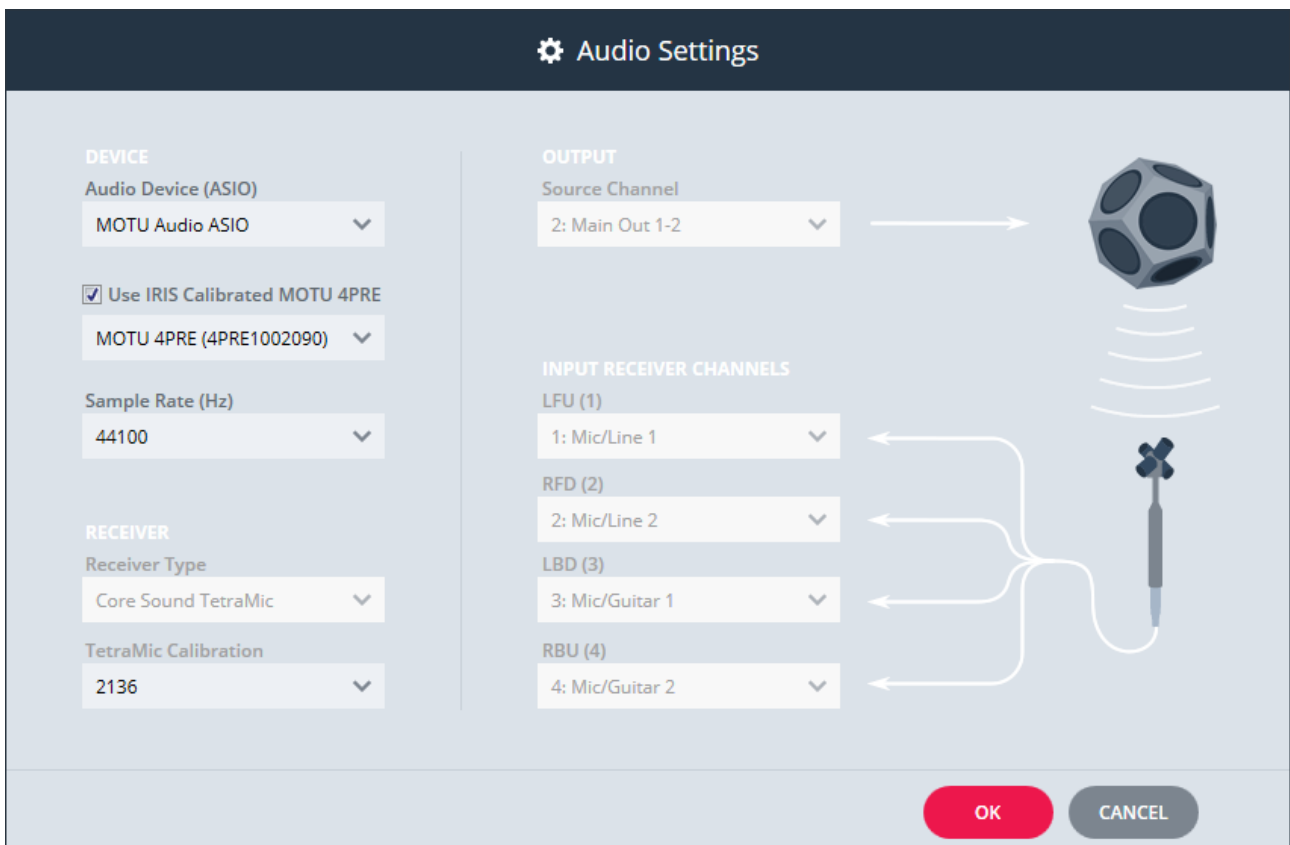




## Audio Settings

Click the Audio Settings button. This window is used to configure the audio device and the receiver type. IRIS is capable of 3D and single-channel measurements. We will deal with just 3D measurements for now.

IRIS will initially attempt to configure these settings automatically, as long as the MOTU 4pre is installed and connected, and the calibration data is loaded into IRIS. An example is shown below:



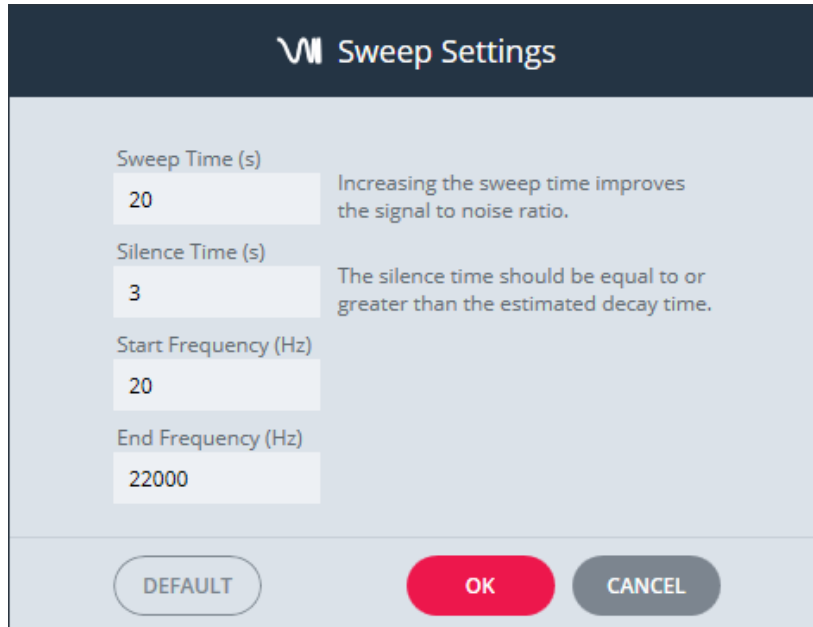
- If MOTU 4pre is connected and the calibration is available, tick the box “Use IRIS Calibrated MOTU 4PRE” if it is not already ticked. Select your 4pre calibration serial number in the dropdown box – normally this would have one entry. This enforces the Receiver Type to Core Sound TetraMic, and automatically selects the correct input and output channels.
- The sample rate may be changed as desired – at the moment only 44100 and 48000 Hz are available.

- Also check the TetraMic Calibration is set to the serial number of your TetraMic.

Once everything is correct, click the OK button. The OK button will be disabled if any settings are invalid.

### Sweep Settings

The sweep settings window is used to control the parameters of the sweep excitation signal.

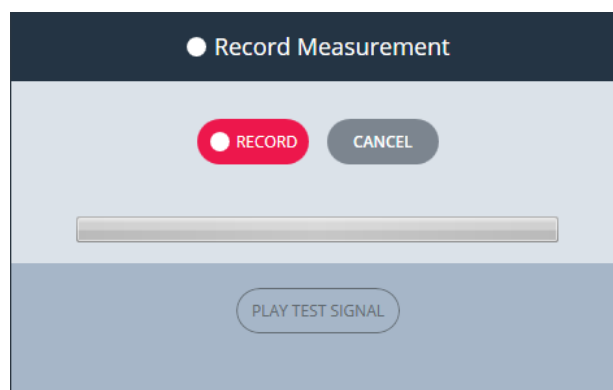


- Sweep Time: The length of the sweep is related to the resulting signal-to-noise ratio. A longer sweep time improves the signal-to-noise ratio. In my experience, for a large concert hall with a dodecahedron speaker at full volume, a sweep time of about 30 seconds worked well.
- Silence Time: This should be long enough to capture all decaying components after the sweep has finished. As a rule of a thumb, this should be slightly longer than the estimated decay time in the room.
- The start and end frequency default should be acceptable in most circumstances (20 Hz to 22 kHz). This may need adjustment if there is risk of damaging the excitation loudspeaker and amplifier.

Click OK to exit the sweep settings window.

### Record Measurement

With the audio and sweep settings configured correctly, the record button in the main IRIS window should now be enabled. Click to open the Record Measurement window.



## Pre-recording Steps

Before recording for the first time the output level to the excitation speaker must be set correctly.

1. Turn on the source loudspeaker, but ensure its volume is turned down.
2. On the 4pre, turn down the output by turning the “MAIN” knob all the way down. (This knob controls the level of the outputs labelled MAIN (channels 1 and 2) on the back of the 4pre).



3. Click the “Play Test Signal” button in the IRIS software. This will play back a series of sweeps.
4. Increase the output levels on the amplifiers and 4pre until the excitation volume in the space is acceptable. Louder means more signal-to-noise ratio, but be careful not to drive the speaker into distortion. Wear hearing protection if necessary.
5. Click the “Play Test Signal” button again to stop the test signal. The measurement is now ready for recording.

Note that the setup steps leading up to this point should only need to be carried out once for a measurement session.

## Record Measurement

The measurement can now be conducted – push the record button. The progress bar will indicate how far through the excitation is. The recording can be stopped at any time if necessary (the record button changes to a stop button during a recording).

The room should be as silent as possible during a recording. Be careful not to make noise during the period of silence following the sweep. If any impulsive noises happen during a recording, stop the measurement and redo it when the room is silent again.

If something was not connected correctly, or there is too much noise in the recording, the software should display an error message.

## Completed Measurement Layout

After a measurement has been recorded and processed, the IRIS window looks similar to:



The IRIS window is divided into several regions:

### 1. List of measurements

All the measurements belonging to the currently open project are stored here. Click on an entry to view a measurement.

### 2. Measurement information

Information relating to the current open measurement is displayed here – editable fields describing the measurement (Description, Source, Receiver and Notes), the mid-band parameters results, and details of the measurement setup.

### 3. IRIS 3D Plot or Parameters

This region either displays the IRIS plot or the auditorium parameters for the opened measurement.

### 4. Impulse response waveform

The broadband pressure impulse response waveform is displayed here, either in its original form (“Pressure Waveform”) or as an energy signal with a dB scale (“log(p<sup>2</sup>) Waveform (dB)”).

## Measurement Validity

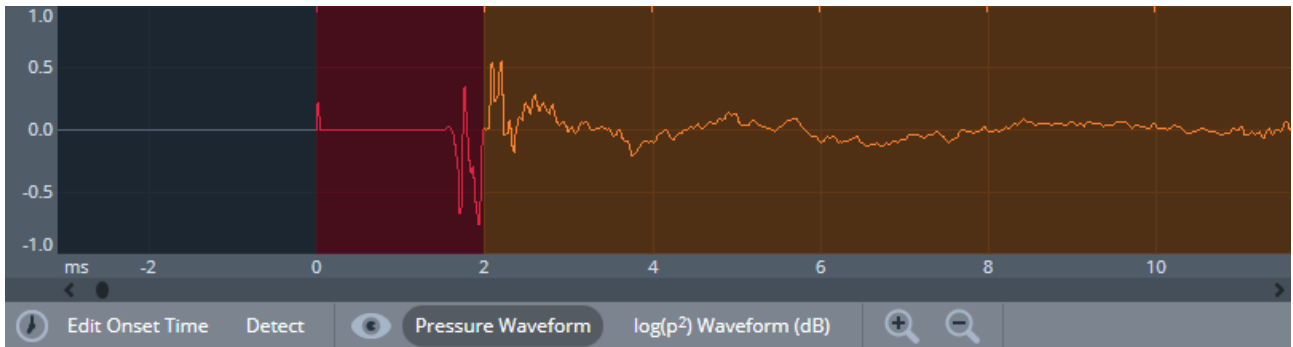
It is very important for the operator to manually check the validity of the measurement immediately after it has been conducted.

### *Signal-to-noise Ratio*

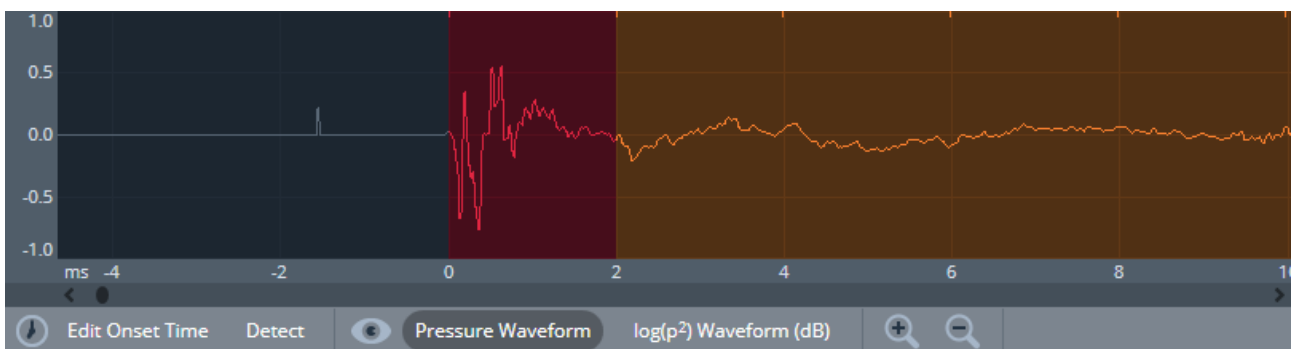
Currently IRIS measures a peak signal-to-noise ratio (PSNR), which is the energy of the peak of the pressure impulse response compared to the mean square energy of the noise. This needs to be interpreted carefully as noise itself may have a PSNR of 10 – 15 dB. **A PSNR of at least 60 dB is recommended in each band of interest.** Open the “Parameters” view to see this information.

### *Onset Time*

The onset time is the start of the impulse response, when the direct sound first arrives. IRIS will automatically detect this time, but this may be incorrect if there is excessive crosstalk. The results are dependent on this time, so it’s vitally important it is correct. Zoom in to the start of the waveform where time = 0 (use the mouse wheel or buttons on waveform toolbar). Crosstalk will present itself as a short peak before the actual start of the impulse response, something like:



In this hypothetical example, IRIS thinks the start of the impulse response is at the crosstalk peak. This can be manually edited by selecting “Edit Onset Time” button. Use the cursor to select on the impulse response waveform where the actual onset time is, for example:

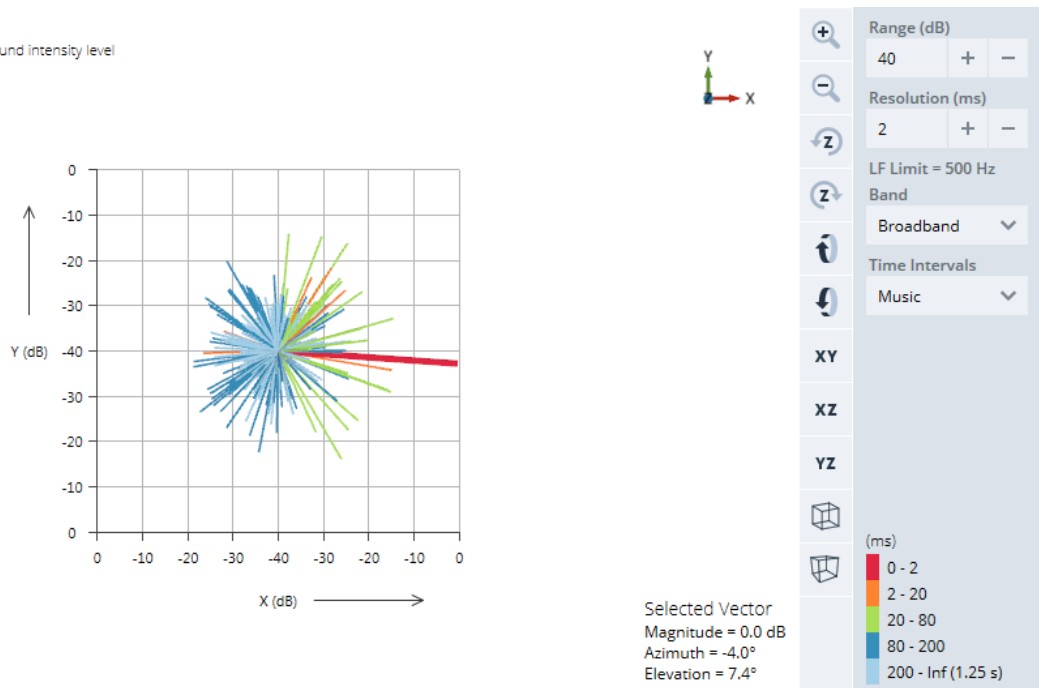


## ANALYSING A 3D IMPULSE RESPONSE MEASUREMENT

An IRIS plot is a representation of the 3D impulse response at the measurement position. An example IRIS plot in a 2D view (XY plane) is shown below.

3D Sound Intensity Vectors

Normalised to broadband direct sound intensity level



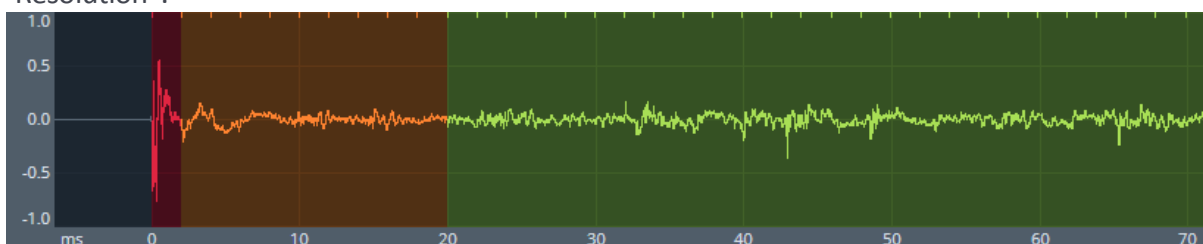
Sound energy arriving to the measurement position is visualised as a series of rays or spikes. The spike length corresponds to sound strength, the angle represents the direction of incoming sound energy, and the rays are coloured according to when they arrive (refer to the colour key to the right). These regions are also shaded in colour on the waveform.

In this example, the direct sound is the first to arrive and coloured red. The spikes coloured orange and green show early sound rays which are mostly arriving from lateral and frontal directions. As time progresses (dark blue to light blue) the sound rays become more uniformly distributed about the measurement position, indicating the sound field is becoming diffuse.

The IRIS plot can be rotated and zoomed in 3D using a mouse, or using the buttons on toolbar to the right.

### IRIS Plot Calculation Process

1. The recorded signals are filtered according to the selected “Band”.
2. The impulse response is then divided into small segments, visually indicated by small marks at the top of the waveform when zoomed in. The length of these segments is determined by the “Resolution”.



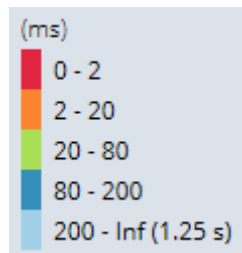
Note that available band filters (point 1.) are limited according to the specified time resolution – refer to the “LF Limit”.

3. The magnitude and direction for each segment is then determined (a relative sound intensity vector). The magnitude of vectors are referenced to the broadband direct sound vector (i.e. 0 dB).

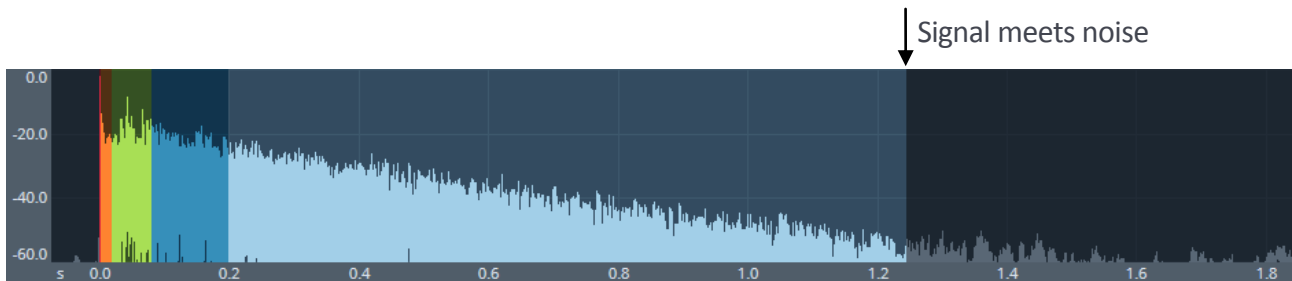
The “Range” field controls the lowest magnitude to be displayed on the IRIS plot. For example, a range of 40 dB means any vectors of magnitude 40 dB below the broadband direct sound level (0 dB) are ignored. Magnitudes greater than 0 dB are still shown.

4. Each vector, within the visible magnitude range, forms one spike on the IRIS plot.
5. The vectors are coloured according to when they arrived in time. There are two choices of colouring: Music and Speech.

IRIS will only analyse the impulse response up to the point where it becomes noise. This time is displayed in parentheses at the end of the colour key, as shown below.



This is also visually indicated on the waveform:

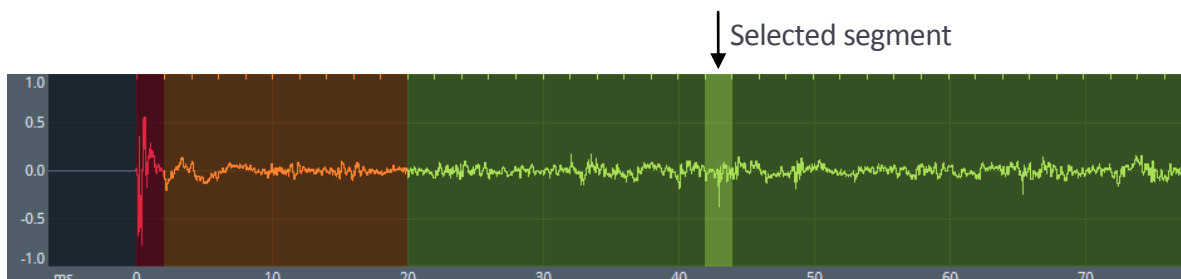


This time will change with the selected band, even though the waveform always displays the original (broadband) signal.

### Analysis of Individual Rays

Individual rays may be selected and analysed.

1. Hold down Ctrl while clicking on a ray with the left mouse button.
2. The selected ray will increase in thickness (e.g. the direct sound is selected in the screenshot above).
3. The corresponding segment in the waveform will also be highlighted. For example:



4. The opposite also works: rays may be selected from the waveform view – hold down Ctrl and click on part of the waveform. This might be useful for identifying the directions of early reflections, or a late echo.
5. Rays may be unselected from either view by holding down Ctrl and clicking the selected ray/segment.



When a ray is selected the IRIS plot view will display the data for that vector, including the magnitude (relative to the broadband direct sound level), azimuth and elevation.

### **A Note on Magnitude Information**

After a measurement has been recorded IRIS will normalise the 3D impulse response recordings. This means that different IRIS plots cannot easily be compared in terms of magnitude information – a measurement close to the source and a measurement far away from the source will both show the broadband direct sound vector as 0 dB. We are working on a way to show the changes in amplitude between different IRIS plots.

(Note that the normalisation amount is stored with each measurement, so this feature should work with previous measurements once it becomes available).