

Impulse Response Final

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What is Impulse Response?

- A technique of audio recording in which an **impulse**, or sound containing a range of frequencies, is played within a space and recorded.
- The collection of an impulse response provides an analysis of the specific space's **timbre, acoustics, and properties of reverberation**.
- A **sine sweep** is a common and effective method of impulse response.
 - Playing and recording a “**sine tone** that pitches up through the audible frequency spectrum” (20Hz-20kHz)
- After this process, you are left with an audio file that can be imported into **convolution software**.

What is Convolution?

- A type of **cross-synthesis** in which the sonic characteristics of one signal are applied to alter the sonic characteristics of another signal.
- This requires two audio sources:
 - An **input signal**—the source that will be altered
 - An **impulse response**—the source containing the sonic characteristics to be imposed onto the **input signal**
- Convolution **plug-ins** offer thousands of pre-made reverbs that can recreate the timbre and acoustics of various spaces.
- These plug-ins, like Altiverb, also allow users to record their own impulse responses, import the recordings into the plug-in and generate their own unique convolution reverb.

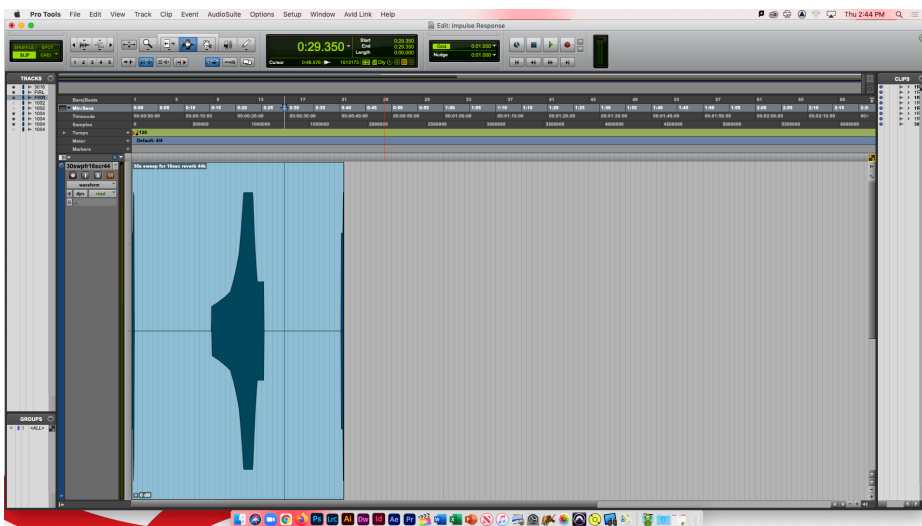


Required Equipment

- The quality of the end-product (**reverb convolution**) is directly affected by the quality of the equipment used to record the **impulse response**.
- A clear **signal chain** is imperative!
- **Speakers**
 - the number of speakers needed varies based on the source and recording equipment used
 - Ideally, the speakers used can reproduce a sine sweep containing the entire range of human hearing
- **Microphones**
 - Different polar patterns will produce different sonic analyses of the area
 - Multiple configurations, angles, and setups will provide a more whole analysis of the space



Demonstration



Pro Tools File Edit View Track Clip Event AudioSuite Options Setup Window Avid Link Help

Edit: Impulse Response

0:29.350 Start 0:28.300 End 0:29.350 Length 0:00.000

Cursor 0:01:161 28288 Div 0.01000

Gain 0:01.000 Nudge 0:01.000

TRACKS

Bars/Beats	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31
Min:Secs	0:00	0:02	0:04	0:06	0:08	0:10	0:12	0:14	0:16	0:18	0:20	0:22	0:24	0:26	0:28	0:30
Timecode	00:00:00:00	00:00:05:00	00:00:10:00	00:00:15:00	00:00:20:00	00:00:25:00	00:00:30:00	00:00:35:00	00:00:40:00	00:00:45:00	00:00:50:00	00:00:55:00	00:01:00:00	00:01:05:00	00:01:10:00	00:01:15:00
Samples	0	200000	400000	600000	800000	1000000	1200000	1400000	1600000	1800000	2000000	2200000	2400000	2600000	2800000	3000000

Tempo 120

Meter Default: 4/4

Markers

Full Room L 1R-03.A1

Full Room Right 1R-03.A2

Bars/Beats	1	5	9	13	17	21	25	29	33	37
Min:Secs	0:00	0:05	0:10	0:15	0:20	0:25	0:30	0:35	0:40	0:45
Timecode	00:00:00:00	00:00:10:00	00:00:20:00	00:00:30:00	00:00:40:00	00:00:50:00	00:01:00:00	00:01:10:00	00:01:20:00	00:01:30:00
Samples	0	500000	1000000	1500000	2000000	2500000	3000000	3500000	4000000	4500000

Tempo 120

Selection: AltiVerb 7 (Mono) playlist USE IN PLAYLIST Preset: <factory default>

create continuous file entire selection COMPARE

No IRs Installed please run full installer

Drag and Drop IR Import

Enhance, add highs

< Click here or drag audio into this area >

save to user IR folder

ir not found (possibly because of No AltiVerb 7 IR sets found)

reverb time

bright size

I/O in out mix EQ bass treble DAMPING low mid high TIME pre delay attack

alतिverb Sampled Acoustics Processor

BYPASS 0.0 Reverse WHOLE FILE 2.00 Render

Bounced Files

Impulse Res...se Test.mov

Impulse Res...e Tone.wav

Impulse Response Tone.wav

Waveform audio - 13.5 MB

Tags Add Tags...

Created Today, 2:47 PM

Modified Today, 2:47 PM

Duration 00:51

Sample rate 44.1 kHz

Bits per sample 24

Show More

Cancel Open

Reverb Nitty Gitty

- The auditory phenomena of reverberation has multiple components when occurring in a normal space. The sounds we hear back from an impulse (such as hands clapping) are layered and occur in sequence rather than all at once.
 - The first sound to reach the ears is the **direct impulse** (the sound of the clap travels directly from the hands to the listener), as it has the shortest path.
 - The second sounds to reach the ears is that which is reflected off surfaces in the room, such as walls, floor, and ceiling. These reflections are called **early reflections**
 - “The timing of each reflection will vary on the size of the room, but they will always arrive after the direct sound.”
 - A room's size, scale, and floorplan will greatly affect the rate at which these layers reach the ears.
 - **Pre-delay** defines the time between the direct impulse and the first reflection
 - The impulse will continue to bounce off surfaces in the room and reach the ears later and later until the energy of the sound wave is absorbed by the room and the dying reverb creates a **reverb tail**.



Avid Space

Claims to use less CPU power

Has adjustable reverb tails

Uses non-reverb impulse responses, Space sells itself on being “useful for many types of audio processing”

Users can download additional IR libraries from Avid’s online library or use third-party libraries

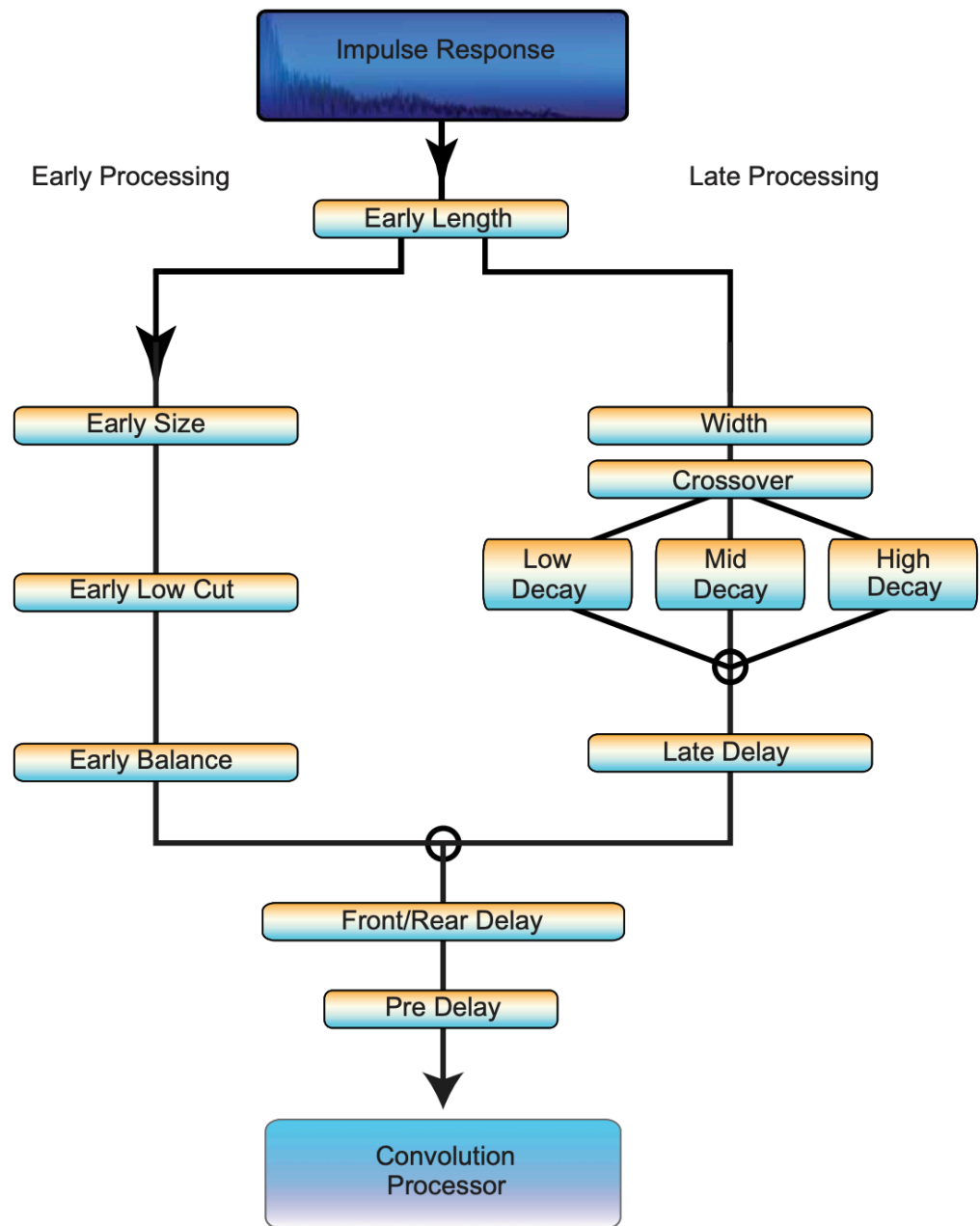
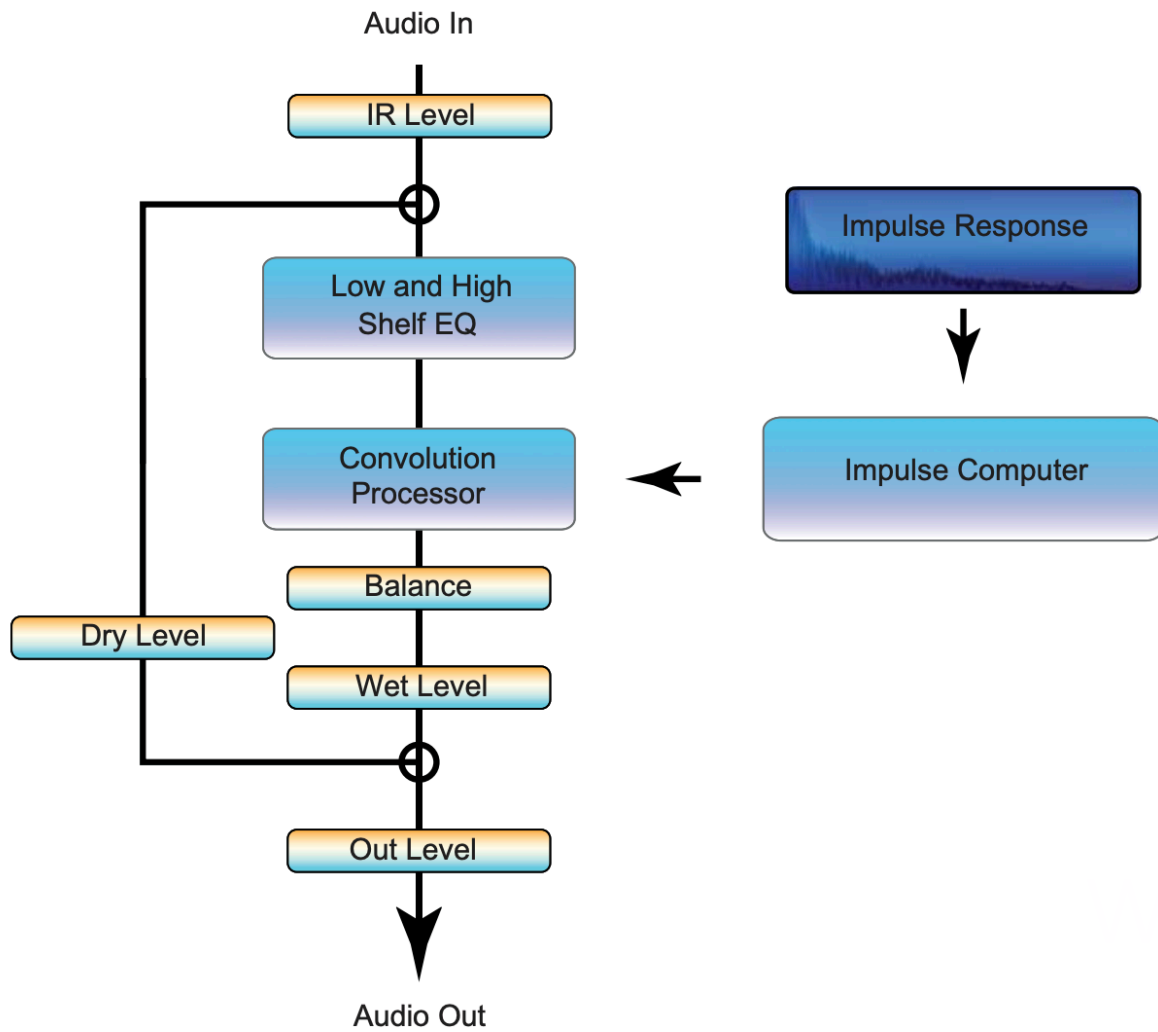
Snapshot workflow makes for fast IR comparison

Space Convolution Reverb

Convolution reverb goes beyond traditional analog and algorithmic digital reverb techniques to directly model the reverb response of an actual reverb space. First, an *impulse response* (IR) is taken of an actual physical space or a traditional reverb unit. An IR can be captured in mono, stereo, surround, or any combination. The IR, as displayed by Space, clearly shows the early reflections and the long decay of the reverb tail.



Impulse Response sample



Space internal system design

The impulse computer is an internal module of Space that provides extensive control over the currently loaded impulse response waveform. When you adjust the parameters shown below, the IR is automatically recalculated by the impulse computer and reloaded into the convolution processor.

Avid Space

“An IR can be loaded by double clicking with the mouse, or using the Load button displayed at the top of the IR browser drawer. The currently loaded IR is highlighted with a small dot next to the file name in the browser”

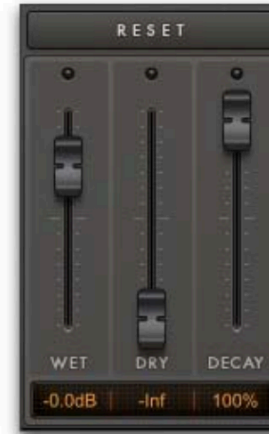
IR Browser Shortcuts

Browser Navigation	Arrow Keys
Load IR	Enter (Windows) Return (Mac)
Open/close all folders	Alt-click (Windows) Option-click (Mac)
Edit menu	Right-click (Windows or Mac) Control-click (Mac)
Return keyboard focus to Pro Tools	Escape key



Avid Space Primary Controls

The primary control group is visible at all times and allows control of key reverb parameters. This includes the wet and dry levels of the audio passing through Space.



Space primary controls

Reset Resets all Space parameters except Wet, Dry, and Input and Output Level.

Wet Controls the level of wet or effected reverb signal, from $-\text{inf}$ dB to +12 dB.

Dry Controls the level of dry or unaffected reverb signal, from $-\text{inf}$ dB to +12 dB.

Decay Controls the overall decay of the IR waveform and is displayed as a percentage of the original. When Decay is adjusted, the waveform is recalculated in real time.

LEVELS

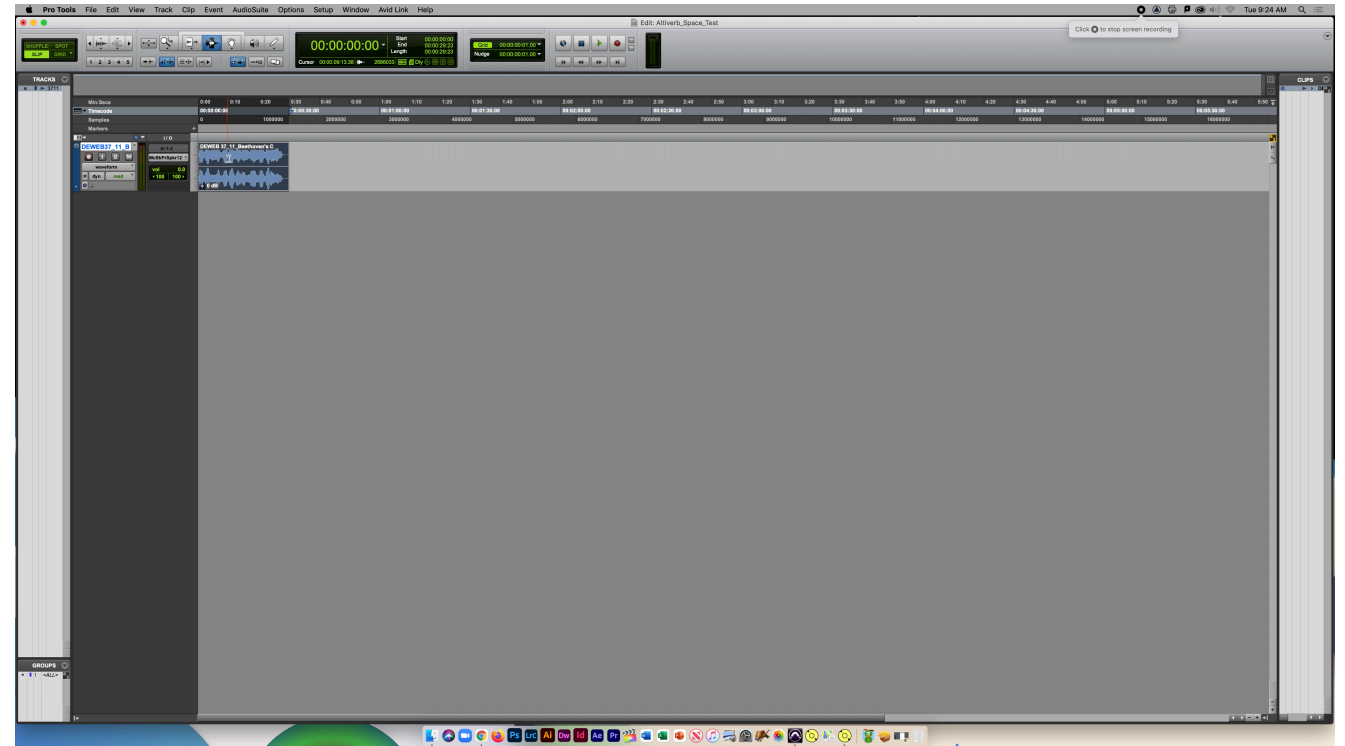
DELAYS

EARLY

REVERB

DECAY

Space Demo



Comparison



Waves IR-L



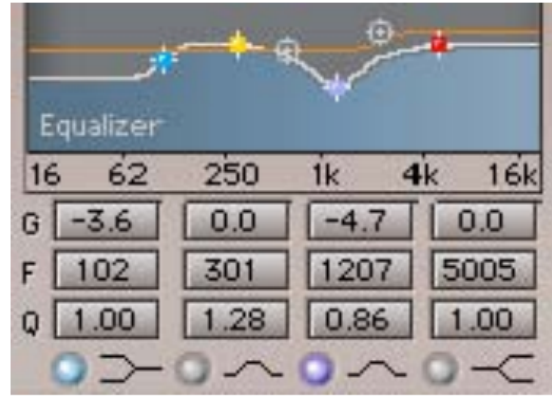
- “In math, the term convolution means an integral which expresses the amount of overlap of one function x as it is shifted over another function y . In the literal sense, it means to “roll together” or to “fold together”. A convolution reverb blends together an input signal with another type of audio signal called an impulse response.”
- Designed to combine a **synthetic digital reverberation** with a **sampled acoustic convolution reverb**
- This method requires quite a bit of power, but in order to combat CPU drainage, the IR manipulations are performed offline

Waves Primary Controls

REVERB DAMPING



Reverb EQ



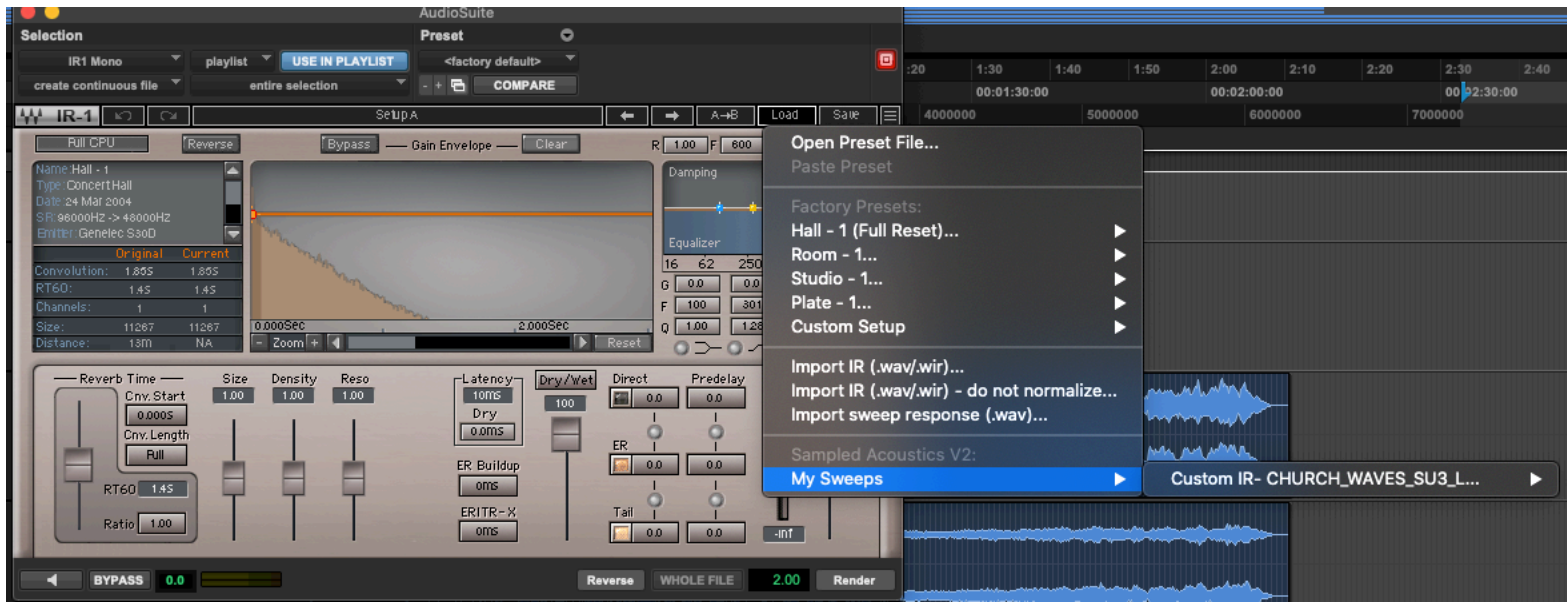
Only operates on the wet signal

Waves Primary Controls interface showing various parameters for reverb. The parameters include Reverb Time (RT60 1.4s, Ratio 1.00), Size (1.00), Density (1.00), Reso (1.01), Decorr (0), Latency (10ms, Dry, 0ms), Dry/Wet (100), Direct (0.0), Predelay (0.0), Output (-inf, -inf), ER (0.0), and Tail (0.0).

Waves Import Steps

Here are step by step instructions to make your own IR:

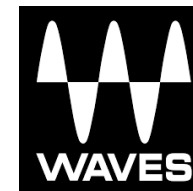
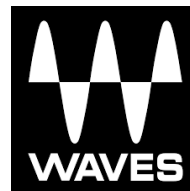
- Play your sweep file supplied on the CD and also downloadable from the Waves website (a 15 second sweep followed by 10 seconds of silence) through speakers in the room to be captured.
- Record the result with 1 or more microphones to 1 or more tracks.
- Create a new folder (We'll name it "My Sweeps") inside your "IR1Impulses V2". folder, where the plug-in searches for new IRs.
- Put your recorded sweep files inside your new "My Sweeps" folder.
- Load the **IR-1** or **IR-360**; Press Import Sweep Response From File...
- Guide the browser to the "My Sweeps" folder.
- Load the .wav files one by one as you are prompted by the plug-in.
- After some calculations, an Impulse Response .wir file will be automatically saved next to your sweep files in the "My Sweeps" folder.
- To save this new IR as a preset, press Save, then select Save to New File.
- Navigate to the "My Sweeps" folder.
- Reload the **IR-1** or **IR-360**; The new preset will appear in the load menu.
- Congratulations! You have created a new IR! You may now optionally delete the recorded sweep files from the "My Sweeps" folder.



Waves Demo



Comparison



Work Cited

- Brown, Griffin. *The Basics of Convolution in Audio Production*. 22 Jan. 2019, www.izotope.com/en/learn/the-basics-of-convolution-in-audio-production.html.
- Deruty, Emmanuel. *Creative Convolution: New Sounds From Impulse Responses*, Sept. 2010, www.soundonsound.com/techniques/creative-convolution-new-sounds-impulse-responses.
- Martinovich, Audrey. *How to Capture an Impulse Response of a Space and Create a Convolution Plugin Preset*. 7 Oct. 2019, www.pro-tools-expert.com/production-expert-1/2019/10/2/how-to-capture-an-impulse-response-of-a-spacer-and-create-a-convolution-plugin-preset.