

Achieving Studio-Quality Sound in your Listening Room

By David Das

It was a pleasure to demonstrate the results of Digital Room Correction on a 2 channel playback system in front of all the Club Members who attended this event at the Faith Lutheran Church on Thursday, July 24th.

This event was put together by Club Secretary David Snyder, Club Secretary Paul Johnson and me at the request of Club President John Harvell.


John was thrilled with the improvement he heard on his Martin Logan CLX speakers using the FIR Filters we built using ACOURATE on June 13th. He wanted to give our Club Members an opportunity to watch how these FIR Filters are built and hear the sonic differences with the Filters turned on and off.

John welcomed everyone at the event with a brief introduction to Digital Room Correction. Your room has the biggest impact on how well your speakers will perform. Typically, your room can cause +/- 20dB swings in the Frequency Response. This far exceeds the peaks and valleys on the Frequency Response curve of your speakers.

	Typical Frequency Response	Benchmark (SOTA)
Room	+/- 20 dB	+/- 20dB
Speakers	+/- 10 dB w/ Limited Range	
Power Amplifier	+/- 1 dB	+0/-0.2 dB
Preamplifier	+/- 0.5 dB	+0/-0.001 dB
DAC	+/- 0.5 dB	+0/-0.015 dB
Speaker Cables	+/- 0.1 dB	+0/-0.1 dB
Just Noticeable Difference (JND)	About 1 dB	

Your listening experience is diminished by any background noise in your room. Typically, the room contributes to about 40dB of noise. This may come from air conditioners, refrigerators and outside noise from cars, trucks, leaf blowers, lawn mowers and other machinery leaking through the doors and windows.

	Typical Noise (dB SPL)	Benchmark
Room	40 dB SPL	
Speakers	None	
Power Amplifier	5 dB SPL	-22 dB SPL
Preamplifier	5 dB SPL	-25 dB SPL
DAC	1 dB SPL	-14 dB SPL
Speaker Cables	<< 0 dB SPL	<< 0 dB SPL
Threshold of Hearing	0 dB SPL	



Having an acoustically treated sound proof room is essential for maximizing your listening experience.

Soundproofing is a specialist field and can be beneficial for home recording studios (less background noise entering the room) and home theater applications (not disturbing other parts of the house), but it's not something that's often applied to 2-channel setups.

It typically involves installing two or more layers of sheetrock, often with mass loaded vinyl sheets between them to absorb acoustic energy. In extreme cases, folks will build a room within a room with the interior room supported by a vibration dampening structure.

Digital room correction can address uneven response at the listening position due to room modes and nodes, but, of course, it can't counter external sounds entering the room or prevent acoustic energy leaking from the room.

The amount of bass traps, in particular, required to achieve even response in the room is completely impractical (ten feet or more in thickness) in domestic living spaces. This is where digital room correction solves a problem that really can't be solved any other way.

If you were to upgrade any component in the audio chain, your room should be your first priority.

Priority		Main Factor	Second Factor	Other Factors
1	Room	Frequency Response	Noise	Reflections, Vibrations
2	Speakers	Frequency Response	Distortion	Imaging, Polar Response, etc
3	Power Amplifier	Distortion	Noise	Reliability, Protection
4	Preamplifier	Distortion	Noise	Volume Control
5	DAC	Distortion	Noise	Headroom
6	Speaker Cables	Frequency Response		Durability, Appearance

John shared this YouTube Video that drives home the point that you will achieve far greater improvement in sound quality by treating your room rather than spending money on expensive speaker cables, interconnects, DACs and amps.

https://www.youtube.com/watch?v=Alv79_NRASw



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To properly treat a room, you need to eliminate first reflections from the side walls, ceiling and the floor. You need bass traps on all 4 corners of the room and intersection points of the ceiling and the wall. In addition you need diffusers and absorbers on the front and back wall.

This can quickly become expensive when you have a large room.

Digital Room Correction software on the other hand provides a more economical solution. It can tailor the sound to match your preferred target curve at your specific listening position while accounting for any room asymmetry.

The FIR Filters are easy to build. They can be hosted by Roon's Convolution Engine. All the necessary hardware and software can be purchased for less than \$1,200.

Here is the breakdown:

Mini PC to run your ROON Server \$144

<https://www.amazon.com/Micro-Mini-PC-Computers-N5105/dp/B09Q8Z6VB7/>

ROON Ready Lossless Music Streamer \$100

<https://www.amazon.com/FiiO-SR11-Streamer-Receiver-Multiroom/dp/B0DFCQPZQY/>

MicroSD Card to store your Local Music Library \$42

<https://www.amazon.com/SanDisk-Extreme-microSDXC-Memory-Adapter/dp/B09X7C2GBC>

USB Thumb Drive to install the ROON OS on your Mini PC \$15

<https://www.amazon.com/Samsung-MUF-256AB-AM-Plus-256GB/dp/B07D7PDLXC>

Dayton Audio EMM-8 Omnidirectional Condenser Microphone \$70

<https://www.amazon.com/Dayton-Audio-EMM-6-Measurement-Microphone/dp/B002KI8X40>

Microphone Stand \$70

https://www.bhphotovideo.com/c/product/1447612-REG/auray_ms_65hd_pro_hd_microphone_stand.html

USB Audio Interface \$220

<https://www.amazon.com/Focusrite-Scarlett-Interface-Bundle-Polishing/dp/B09WJFHJZY>

Acourate Personal License \$520

<https://www.audiovero.de/en/acourate.php>

\$520

Grand Total = **\$1,181**

Digital Room Correction Solutions

Here is a list of available solutions:

Acourate (This is the most advanced Digital Room Correction Software available)

<https://www.audiovero.de/en/acourate.php>

\$530

Audiolense

<https://juicehifi.com/>

\$475

Dirac Live

<https://www.dirac.com/live/>

\$375

IK Multimedia ARC Studio

<https://www.ikmultimedia.com/products/arcstudio>

\$300

Sonarworks

<https://www.sonarworks.com/soundid-reference/pricing>

\$249

Audyssey

<https://audyssey.com/2023/03/14/audyssey-announces-multeq-x-pro/>

\$199

Anthem ARC Genesis

<https://anthemarc.com/arc-genesis/>

Free

Yamaha Parametric Room Acoustic Optimizer (YPAO)

<https://manual.yamaha.com/av/18/rxv685/en-US/311793035.html>

Free

RePhase

<https://rephase.org/>

Free

DRC

<https://drc-fir.sourceforge.net/doc/drc.html>

Free

Legacy Audio Wavelet 2 DAC/Preamp/Processor

<https://legacyaudio.com/products/view/wavelet-dac-preamp-processor>

\$7,950



Trinnov

<https://www.trinnov.com/en/products/altitude32/>

\$42,000



Equipment used in the demo

Paul Johnson was kind enough to haul his Samsung UN40C6400 40" HDTV along with power outlets, power cords and HDMI cables.

David Snyder brought with him all the equipment to set up a 2 channel mobile streaming playback system.

- Neumann KH 150 active DSP monitors
- [Two 25' power cables](#)
- Monitor stands
- [WORLDS BEST CABLES 20 Foot SPDIF Cable](#)
- [WORLDS BEST CABLES 12 Foot SPDIF Cable](#)
- [SMSL PO100 PRO MQA DDC](#) (USB to COAX S/PDIF converter)
- Diretta Host/Target Pair
 - Two Raspberry Pi 4 computers with 5V power supplies
 - USB to Ethernet adapter (for connecting to the travel router)
 - AudioQuest Forest Ethernet cable + iFi Audio LAN iSliencer (connects the two RPi4 computers)
- GL.iNet [Slate GL-AR750S-Ext](#) travel router
- Micro USB to USB A cable + 5V power adapter for the travel router
- GMKTec NucBox G5 (N97) Roon Server with 512 GB microSD card containing demo music
- 12V power supply for Roon Server
- Two CAT6 Ethernet cables (for Diretta Host and Roon Server)
- USB C to A cable for USB tethering from my phone (for Roon Server and Qobuz)
- Google Pixel Tablet for Roon Remote app
- [Cable Matters 4 Outlet Power Splitter Cord](#) (for all of the wall wart power supplies)
- My Dell XPS15 laptop (just for setting up the network and checking on things)

Backup Equipment:

- SMSL D-6s DAC + power cord
- Two 30' analog XLR cables
- Libre Computer Le Potato running Roon Bridge + 5V power supply

I brought along the following gear for taking measurements with ACOURATE.

- Samsung Series 9 NP900X4C 15" Ultrabook, Intel Core i5, 8GB RAM, Windows 7 Pro.
- ACOURATE License
- Focusrite Scarlett 2i2 USB Audio Interface
- 4-Port USB Hub
- SanDisk USB 3.0 64GB Thumb Drive
- Logitech Nano USB Mouse
- iSEMCon EMX-7150 XLR Measurement Microphone
- BOSCH GLM50C Laser Distance Finder
- Radio Shack 33-2050 Analog SPL Meter
- Apple 12.9" iPad Pro



- APC Surge Protector
- Extension Cable
- HDMI Adapter for Samsung S900 Laptop
- 30ft HDMI Cable
- 10ft Microphone Cable
- 6ft USB A to USB B Cable
- Switchcraft SC600 Dual Adapter Box
- 13ft Stereo ¼" to RCA audio cable
- 3ft Stereo ¼" to RCA audio cable
- Samsung S900 Power Adapter



- Microphone Stand
- Mic holder for iSEMcon EMX-7150 measurement microphone.



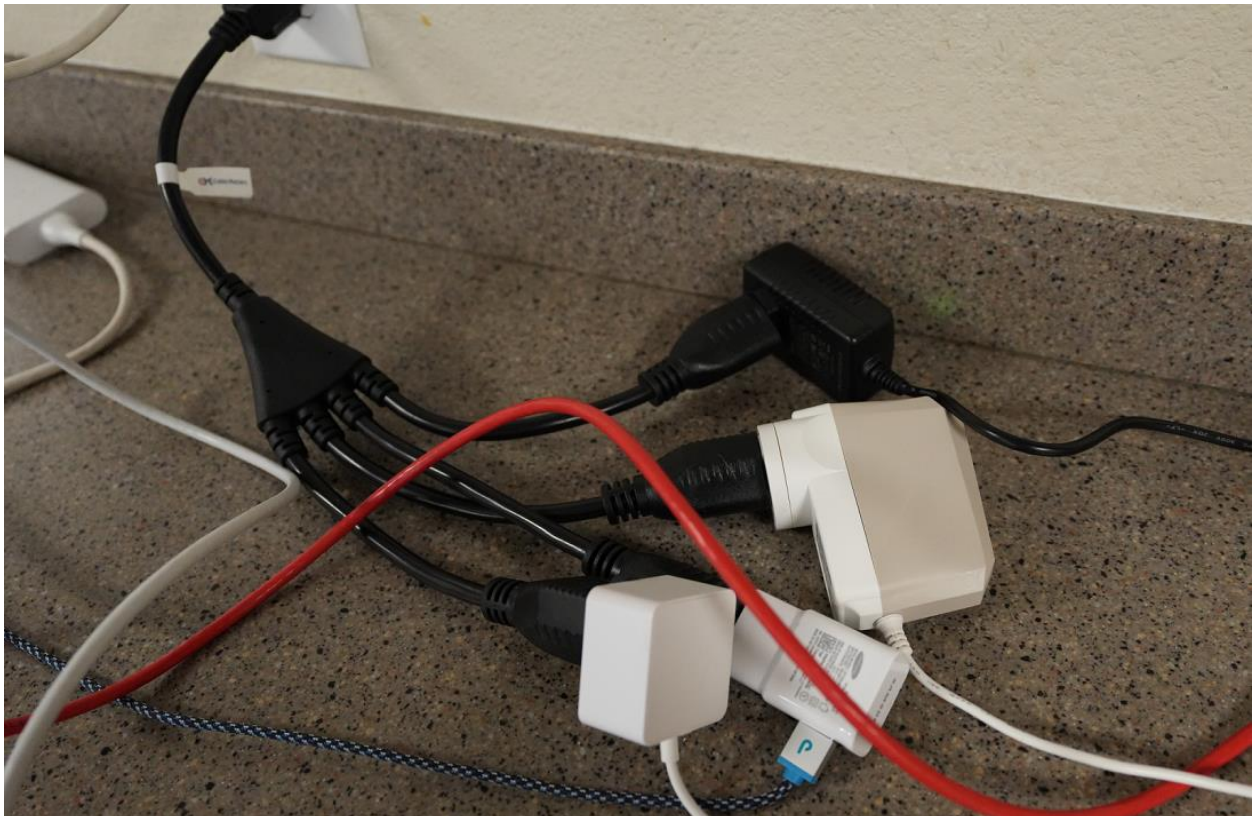
Paul let us into the Parish Hall at 4pm and David Snyder set up his mobile streaming solution using his smartphone.



This is the GL.iNet Travel Router.



This is the Cable Matters 4 outlet splitter cord for powering the adapters.



This is the GMKTec NucBox G5 (N97) Roon Server.



This is the Diretta Host/Target Pair





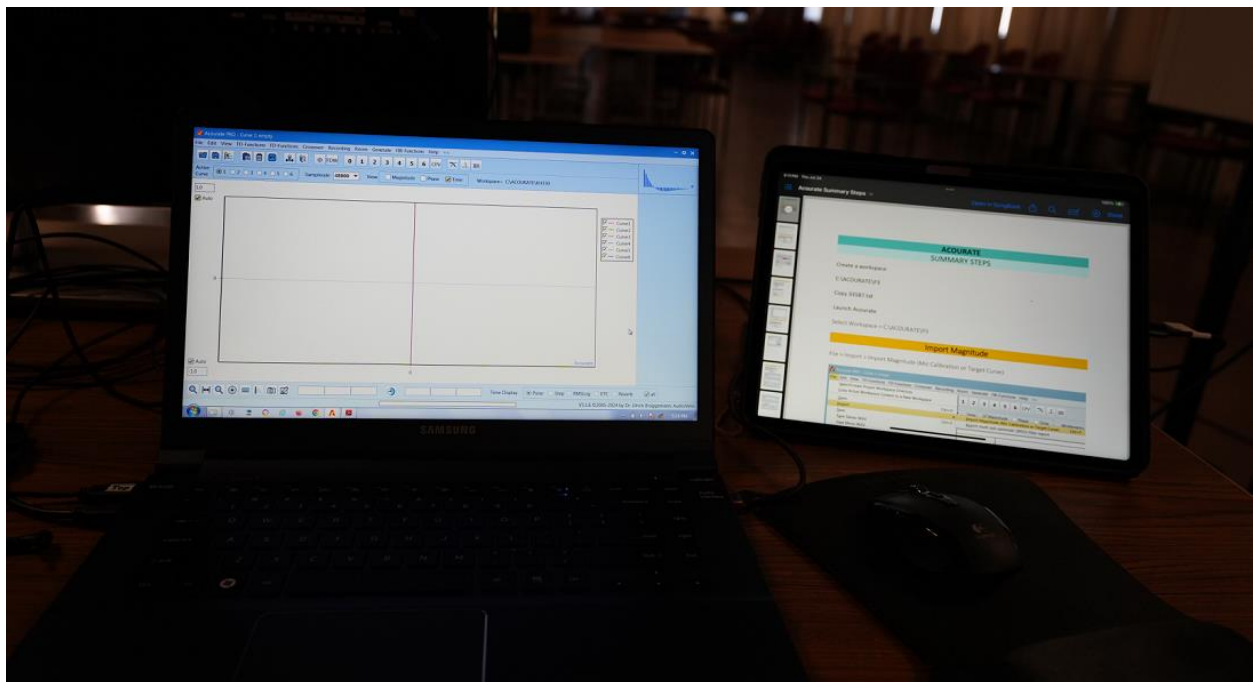
This is the S.M.S.L USB to COAX S/PDIF converter.



This is the Dell XPS15 laptop with the OLED Touchscreen display.



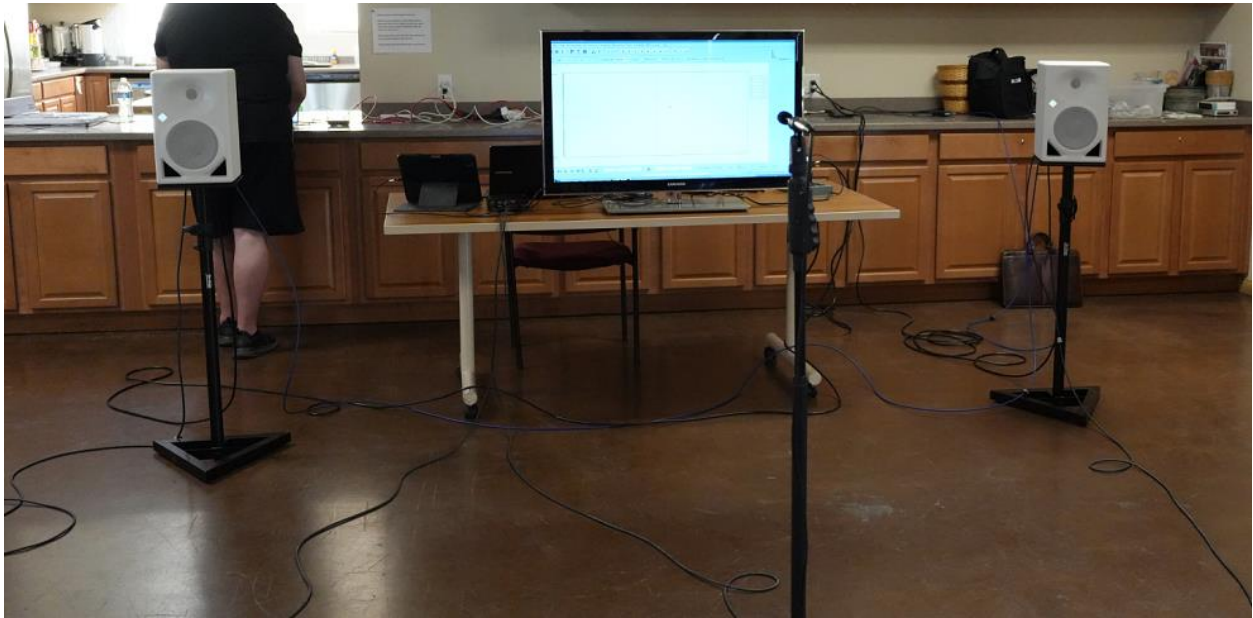
This is the Samsung 15" Ultrabook running ACOURATE and the Apple 12.9" iPad Pro.



These were the Neumann KH 150 active DSP monitors.



The monitors were spaced about 10ft apart flanking the Samsung 40" HDTV.



The measurement microphone was positioned equidistant from the left and right speakers.



It took us about 3 hours to set up and test all the equipment and complete a dry run.



















John Harvell started the demo at 7pm.

I launched ACOURATE on my Samsung Ultrabook and mirrored the display on the Samsung 40" HDTV so that everyone could see what I was doing.

I analyzed the Impulse Response Curves of the Left and Right Channels, ran through the Macros in ACOURATE and built the FIR Filters while David Snyder gave a running commentary explaining to the audience what was happening at every step.

You can find the step-by-step instructions at this link:

<https://bit.ly/3RJtFxR>

	1. Setting up your ROON Server.pdf 	 me
	2. Taking Initial Measurements with REW.pdf 	 me
	3. Using Acourate to Generate FIR Filters.pdf 	 me
	4. Importing the FIR Filters into ROON.pdf 	 me
	5. Verifying the Measurements in REW.pdf 	 me
	6. Closing Thoughts and References.pdf 	 me

You can see the Impulse Response Curves of the Left and Right Channels in Red and Green.

It is always a good practice not to boost any frequency. This is the reason we drew the blue Target Curve below the Red and Green curves.

Everything above the Target Curve gets pulled down by the FIR Filters.

This resulted in a -5dB attenuation of the signal also known as the Filter Insertion Loss.

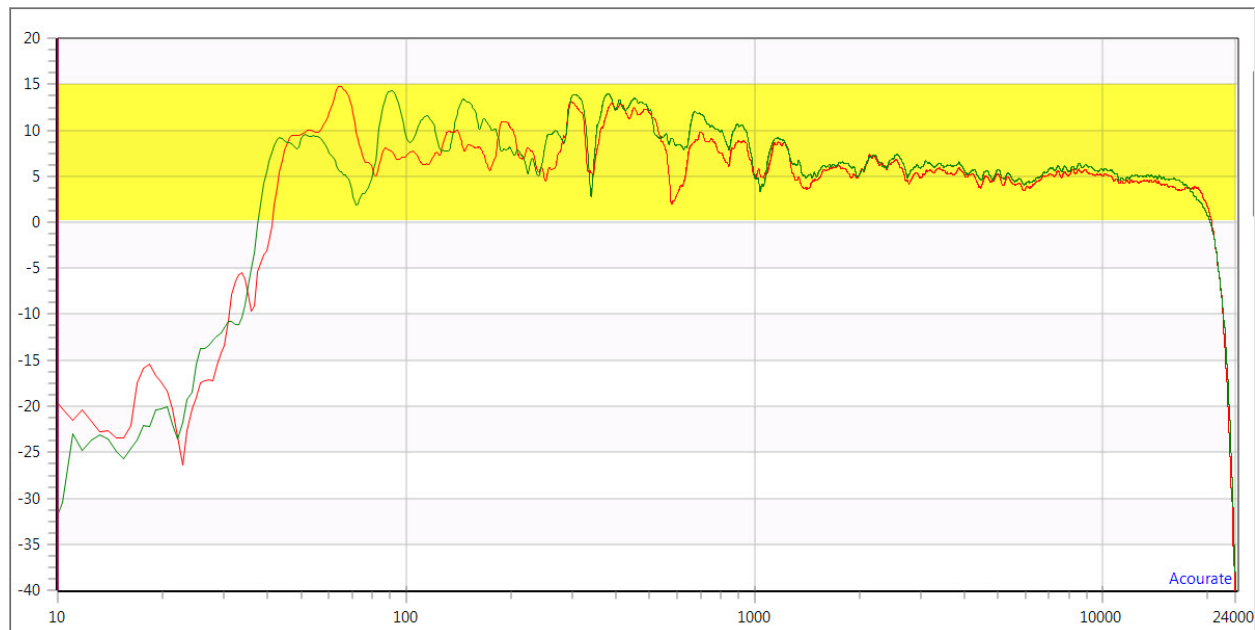


We were able to smoothen out the bass response between 40Hz and 120Hz with the use of Pre Filters. This contributed most to the sonic improvements after applying the filters.

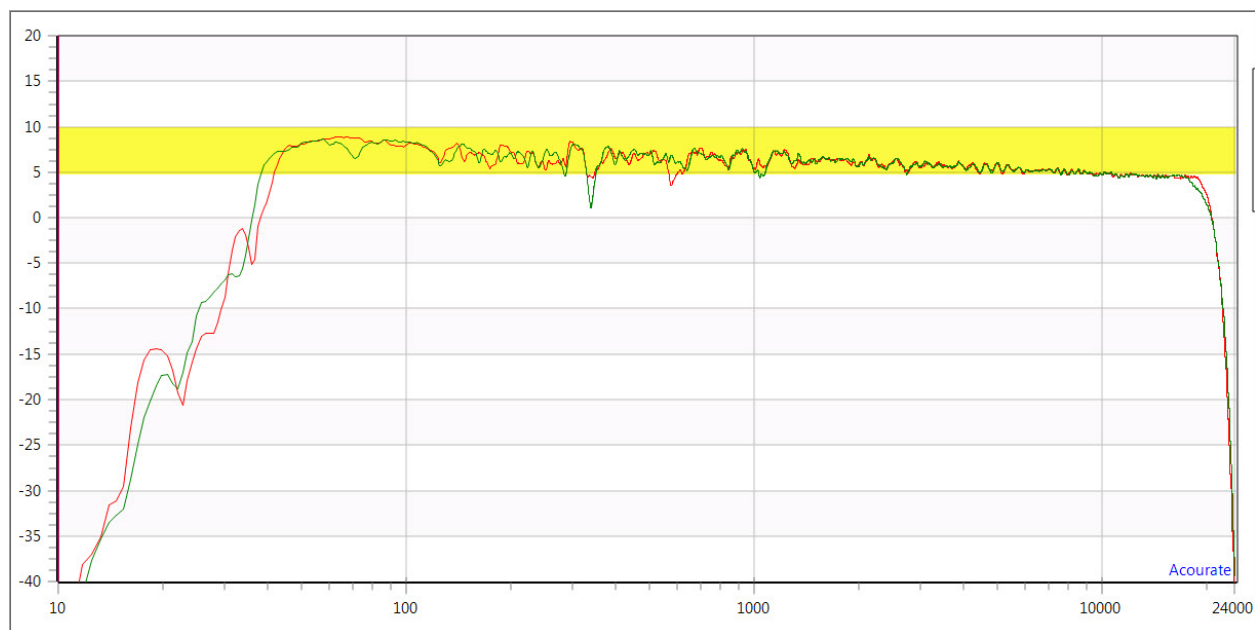
When we played back several audiophile recordings through Roon we heard more clarity due to the bass being more even.

Impulse Response of the Left and Right Channels

Before Room Correction.



After Room Correction.



Digital Room Correction allowed the frequency response to be flattened within $\pm 2.5\text{dB}$ from 40Hz to 20kHz.

Closing thoughts

Digital Room Correction can bring immediate benefits to your 2 channel audio system. Using a state of the art DRC Software like ACOURATE allows you to tailor the sound from your speakers to match your listening tastes.

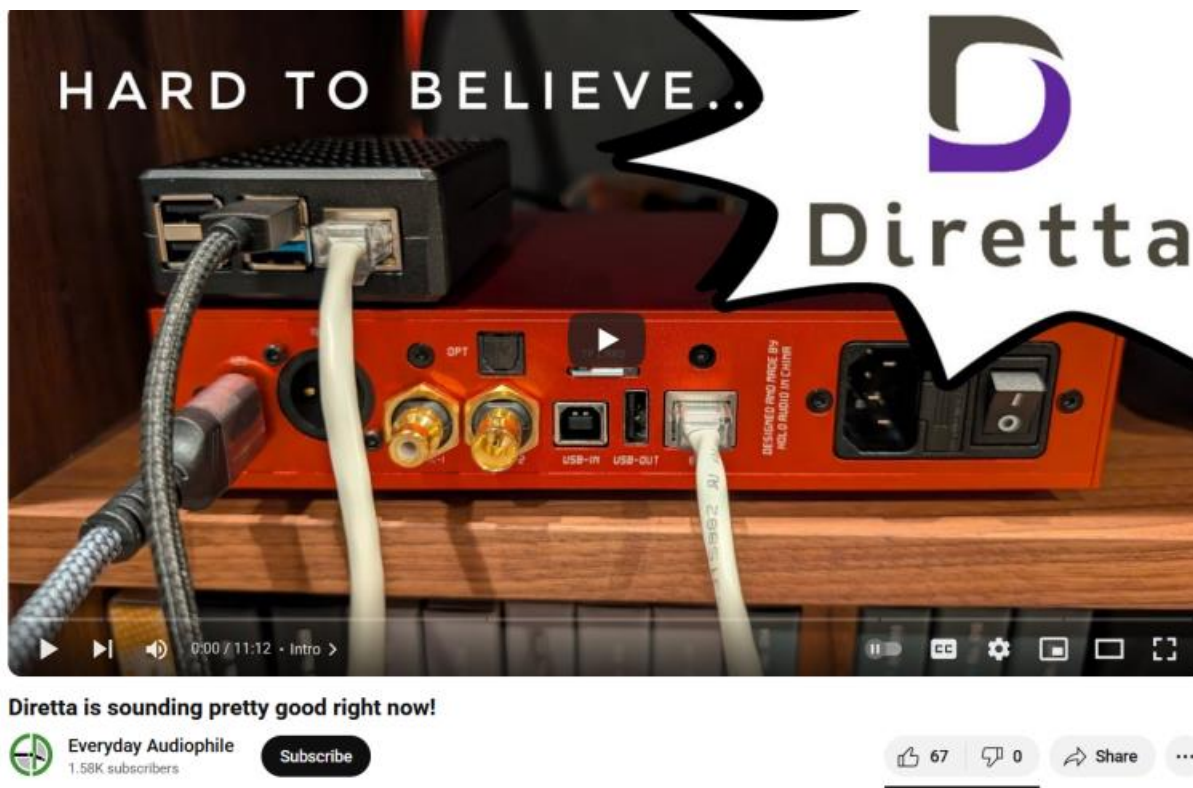
It is fairly simple to build the FIR Filters and import them into Roon's Convolution Engine where you could readily compare the before and after results. All the necessary hardware and software can be purchased for around \$1,180.

If you wish to experience the benefits of Digital Room Correction in your own system, please feel free to contact **David Snyder** dsnyder0cnn@gmail.com or **David Das** das.t@att.net

David brought in a Diretta Host/Target pair to feed the Neumann KH150 active studio monitors. He used this in place of the FiiO SR11 Music Streamer he normally deploys for his mobile setup.

Here is a YouTube video that explains the benefits of using Diretta.

<https://www.youtube.com/watch?v=QWKT2msXyb8>



David Snyder strongly recommends adding at least one Diretta enabled endpoint to your dedicated Roon Server. It is the best sounding Roon bridge solution by a significant margin.

The total cost for a Diretta build is \$495. This is insignificant compared to the price of a dCS, Wadax or Linn DAC and can sound better by leveraging the power of a superior Network Architecture.

David Snyder has posted a comprehensive guide on Building a Dedicated Diretta Link with AudiLinux on Raspberry Pi. Consider implementing this solution for the ultimate refinement in streaming playback.

<https://github.com/dsnyder0pc/rpi-for-roon/blob/main/Diretta.md>

Building a Dedicated Diretta Link with AudiLinux on Raspberry Pi

This guide provides comprehensive, step-by-step instructions for configuring two Raspberry Pi devices as a dedicated Diretta Host and Diretta Target. This setup uses a direct, point-to-point Ethernet connection between the two devices for the ultimate in network isolation and audio performance.

The **Diretta Host** will connect to your main network (for Roon Core, etc.) and will also act as a gateway for the Target. The **Diretta Target** will connect only to the Host and your USB DAC or DDC.

One club member asked David Snyder if an analog source could benefit from Digital Room Correction. David replied that indeed the analog signal from a Turntable can be converted to a digital signal where the necessary Digital Room Correction can be applied resulting in a vastly improved listening experience.

David may demonstrate how this can be implemented in a future “**Digital Vinyl**” club event. He has achieved great success with his own Turntable setup at home.