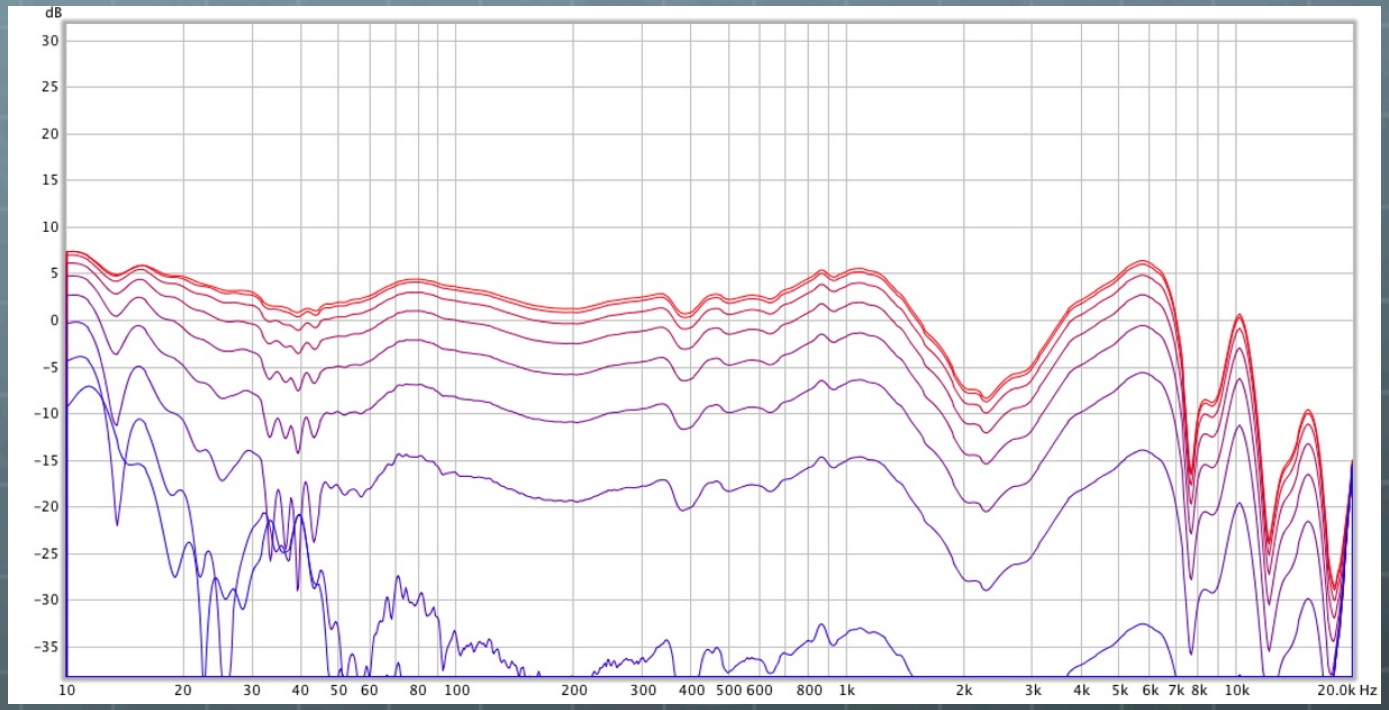


Measuring Headphone Frequency Response

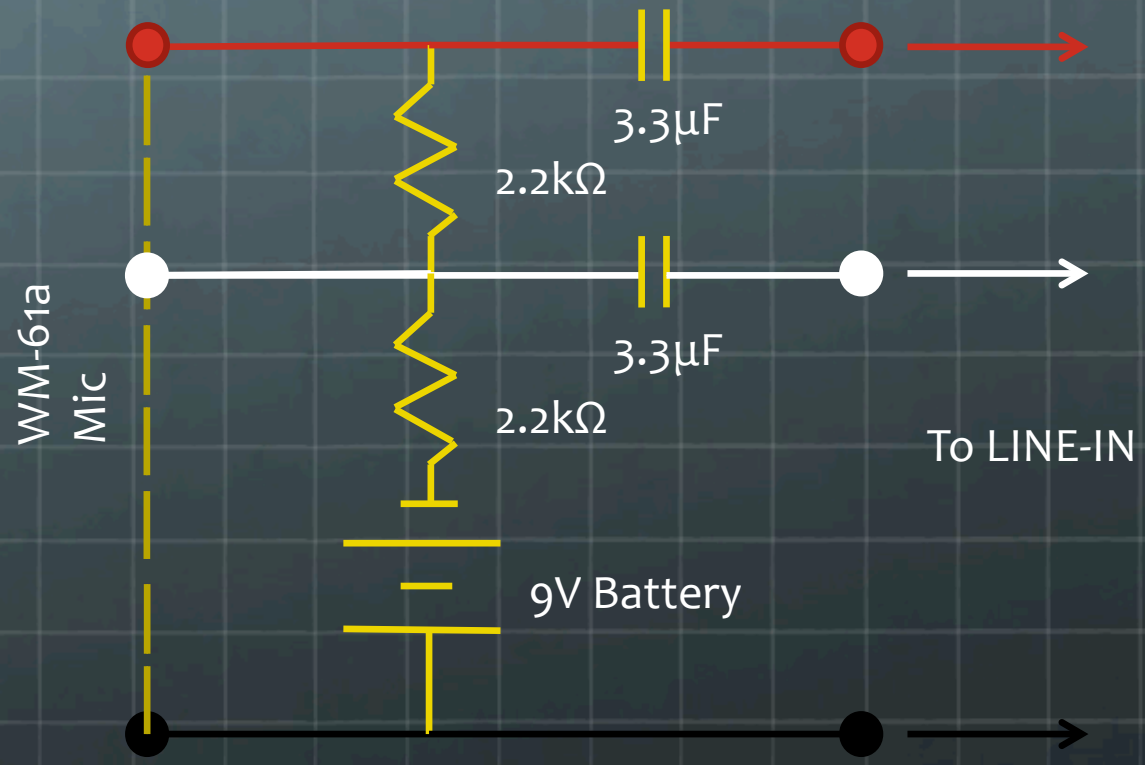
Werner Dahm

The Basics

- Tools and Equipment you'll need to measure headphone response
  - REW: Room Equalization Wizard
    - M3DMixer only for OS X 10.6 and older (10.7 doesn't need it)
  - Phantom Power Supply (9V)
  - Panasonic WM-61a electret capsule mic
  - One or two RCA male to 1/8" female cables
  - One male 1/8" TRS to male 1/8" TRS cable
  - Headphones to measure

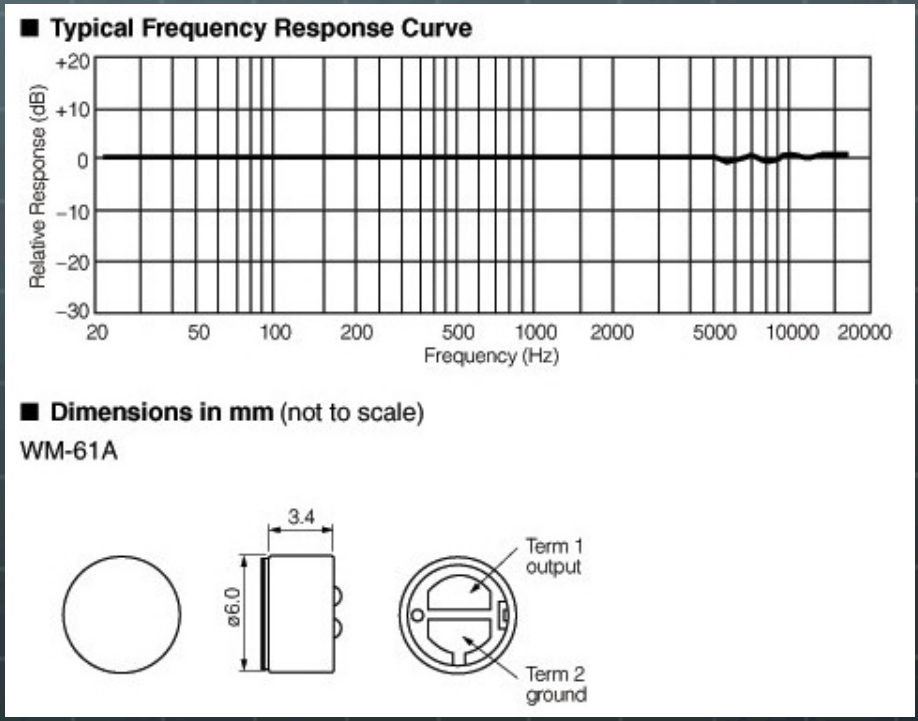
Phantom Power Supply

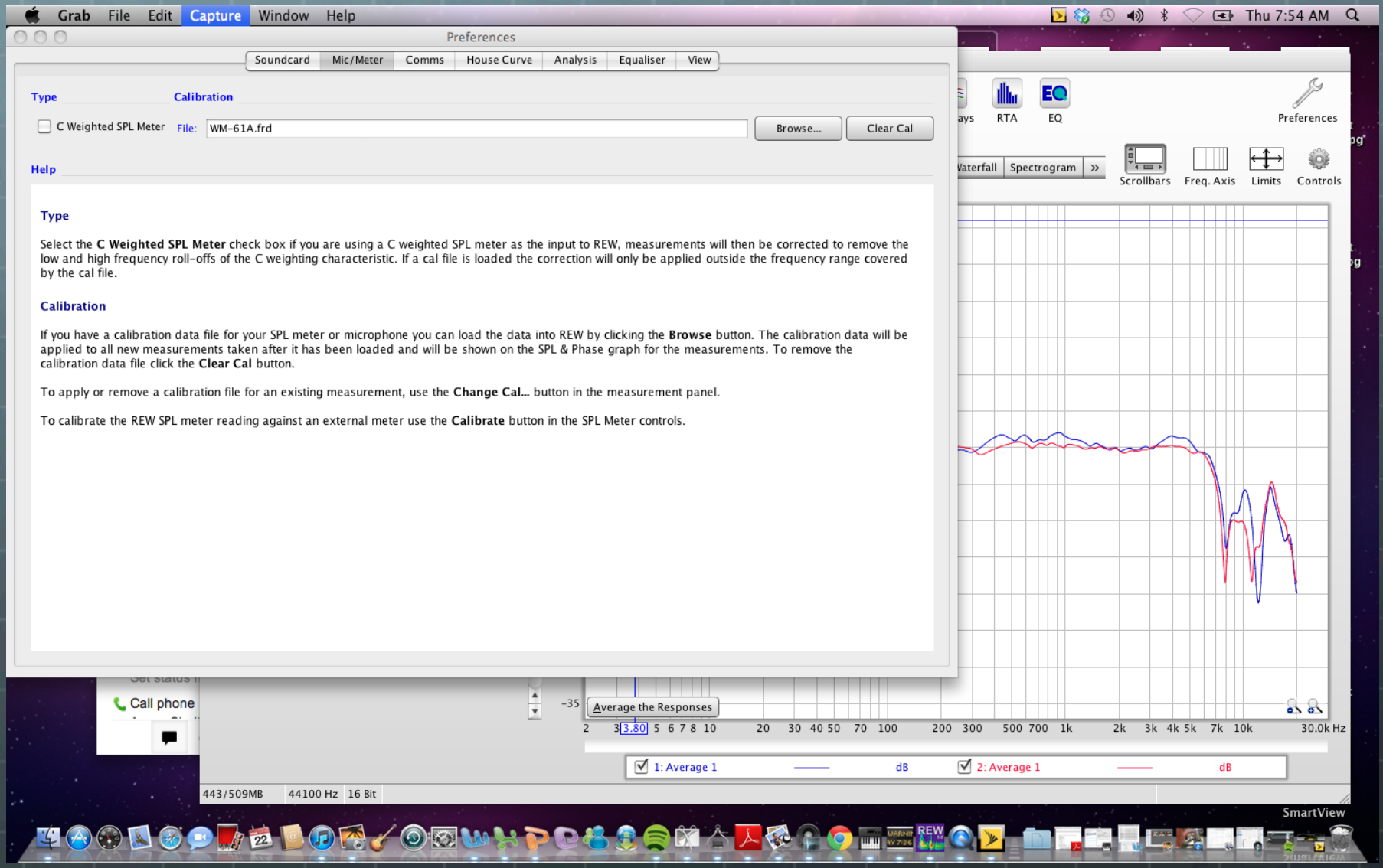
- Using a reference schematic from a friend, determined the correct components



Mic calibration

- Since the Panasonic WM-61a is a well-regarded measurement electrec capsule mic, it has its own calibration file readily available online



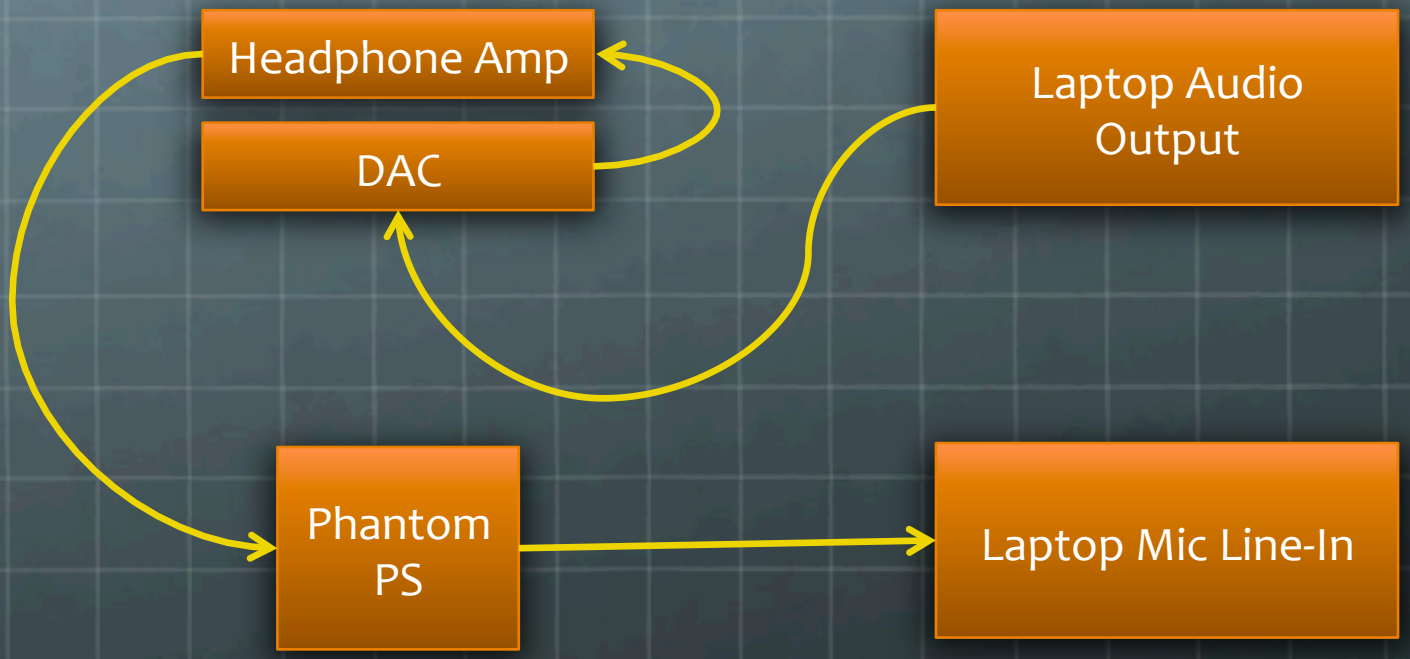


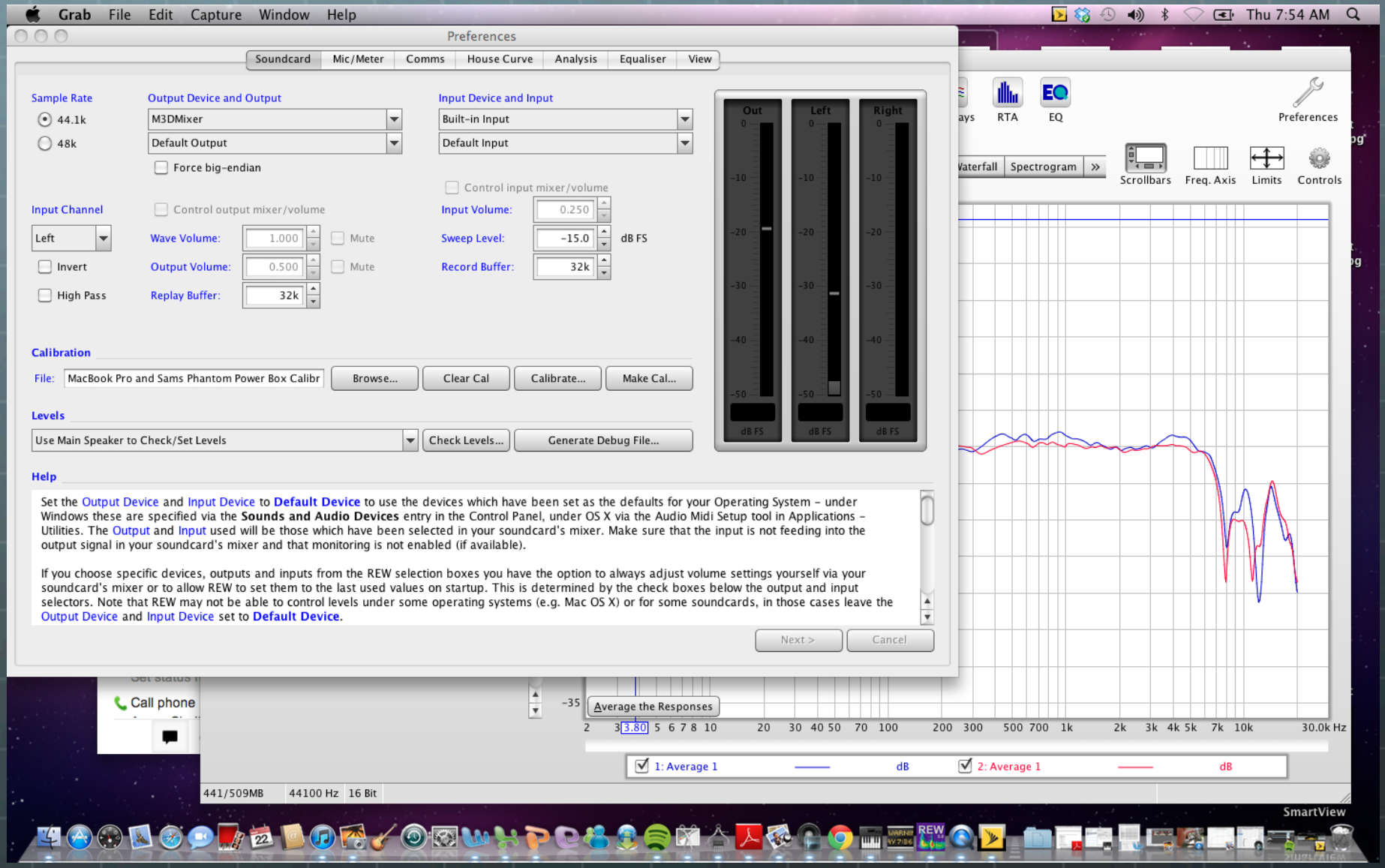
Screenshot from Keith Atkins

REW

- Before measurements are accurate, the user must calibrate their recording system
  - Includes everything before the headphones and mic
    - DAC/Soundcard
    - Amp
    - Phantom power supply
- We do this calibration by creating a feedback loop and using the software to make corrections to account for non-linearity in the system

Feedback Loop





Screenshot from Keith Atkins

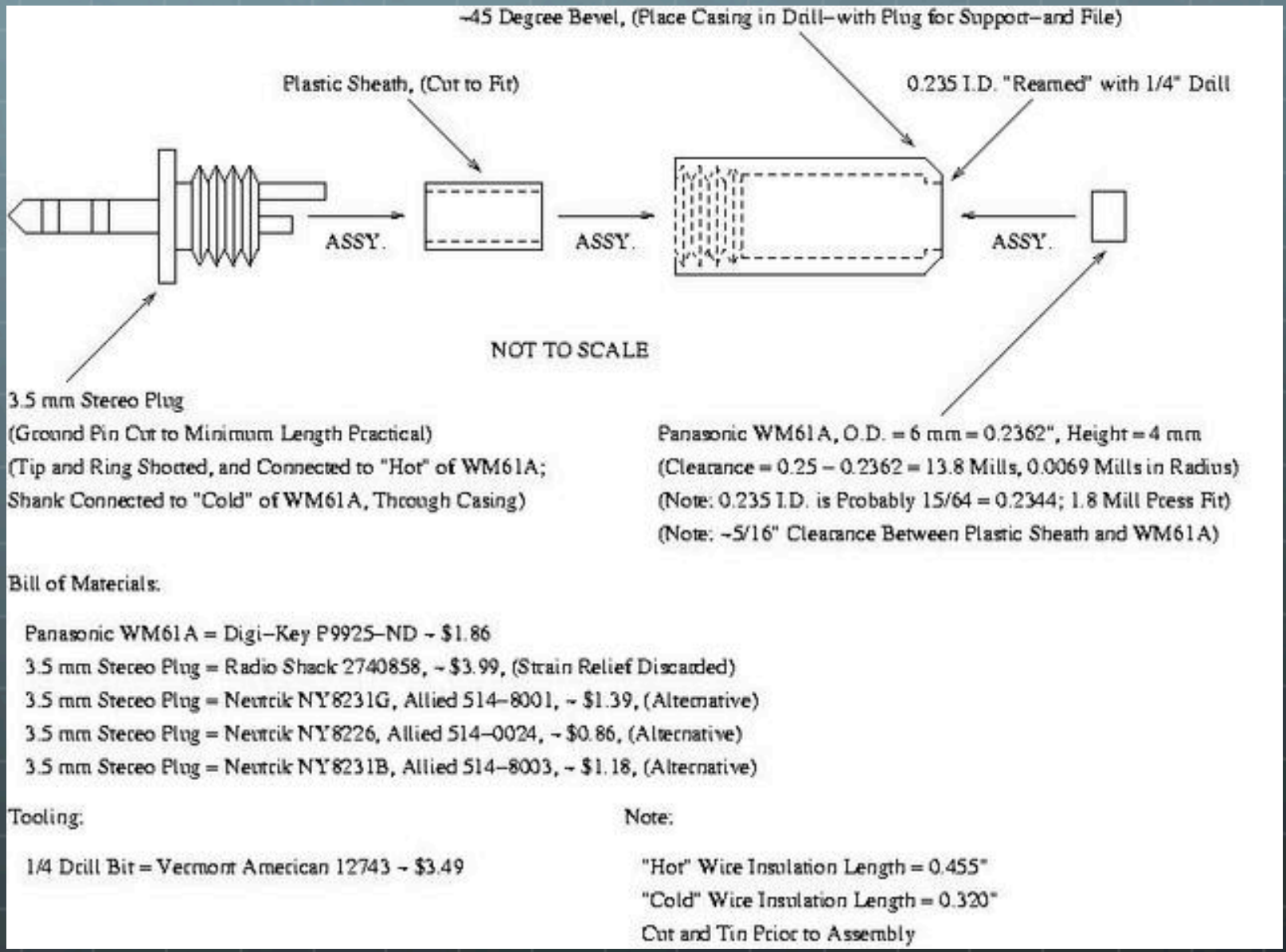
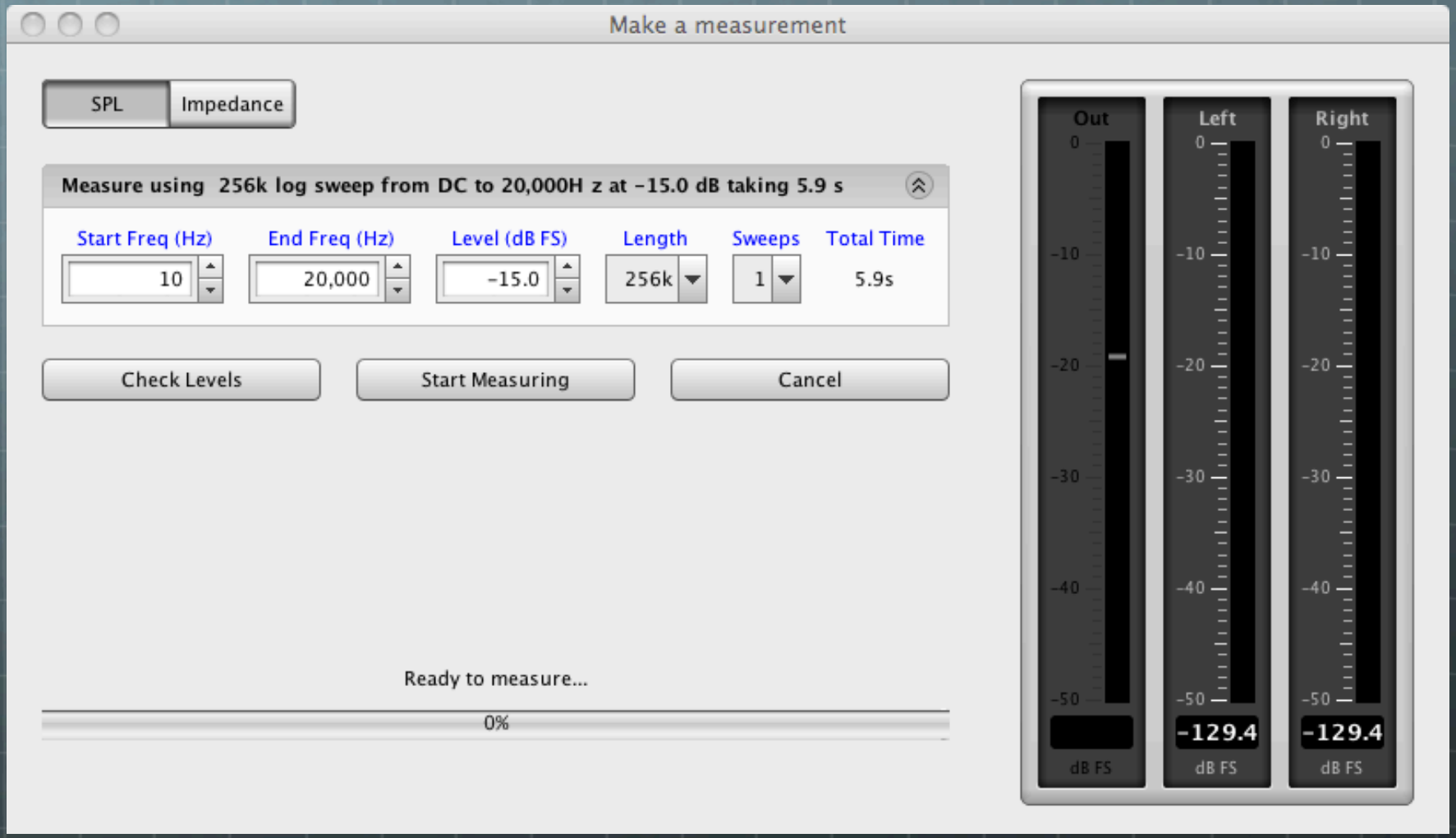


Image from John Conover's site: http://www.johncon.com/john/wm61a/

Taking Measurements

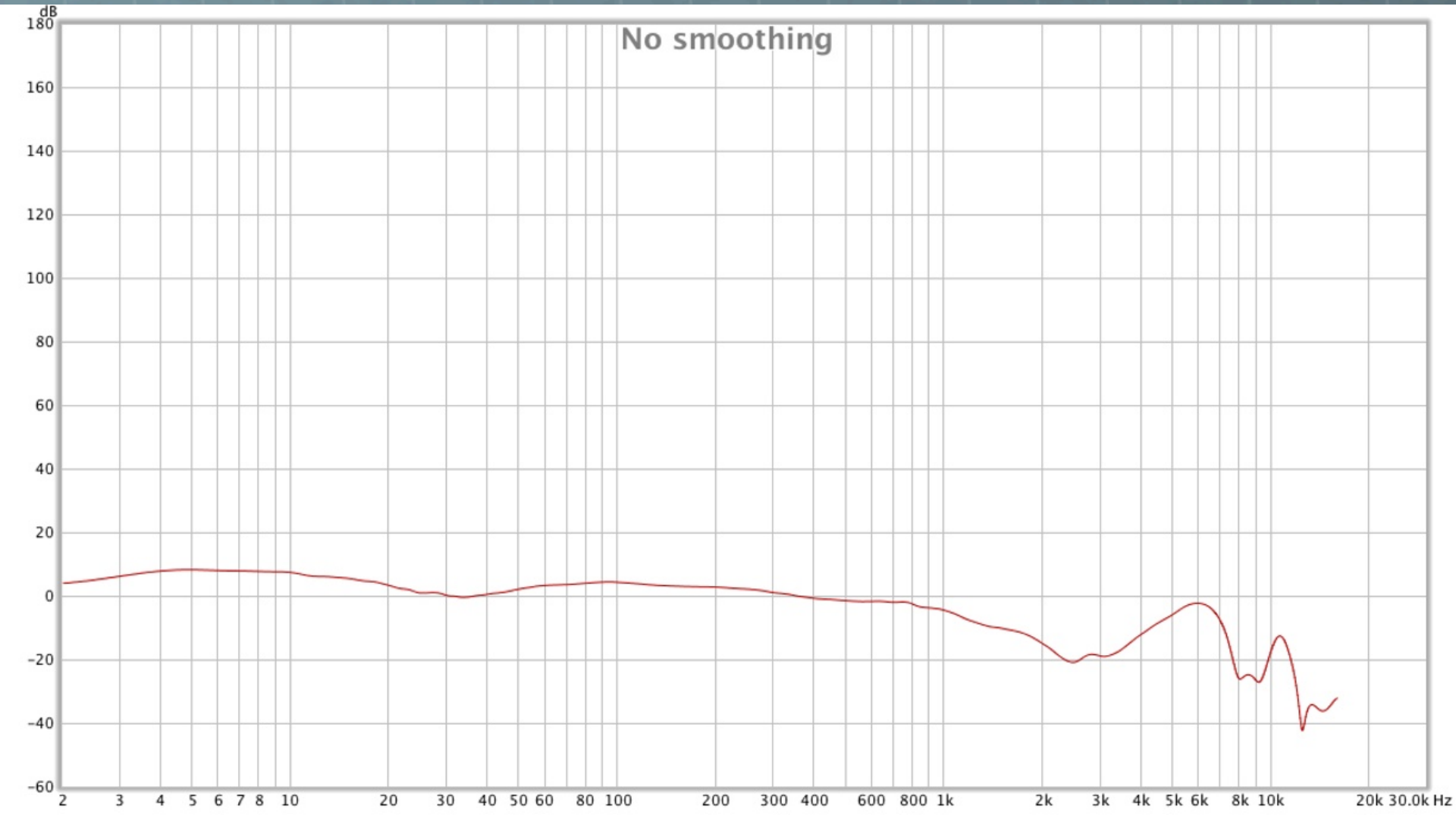
- Connect the mic to the left channel of the RCA to 1/8” male cable
- Connect this cable to the input (mic) side of the phantom power supply
- Connect the 1/8” male to male cable from the phantom power supply output to the mic line-in on the laptop
- Hook up the headphones as if you were going to listen to music (Audio Out USB → DAC → Amp → Headphones)
- Position the mic in your ear carefully, and place headphones on your head



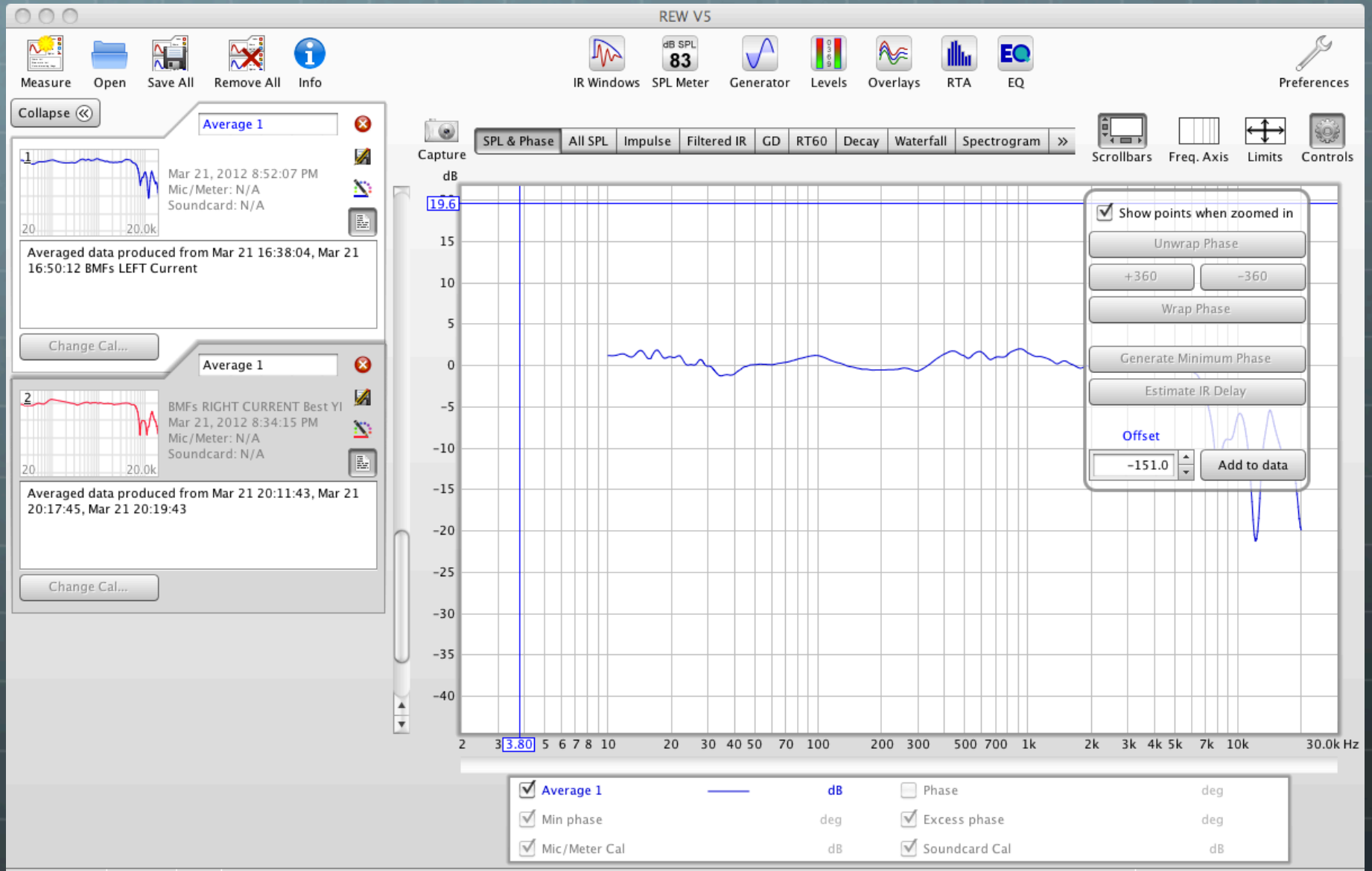
Screenshot from Keith Atkins

Interpreting the Graphs

- After measurements have been taking, set up of the limits needs to be done in order interpret the graphs correctly
- The y-axis (dB) should be in 5 dB intervals
- The x-axis (Hz) should range from 20Hz to 20,000Hz in a logarithmic scale
- The offset must be set to general “guess” where 0 dB might be to obtain a good representation of the data


No smoothing
dB
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
2
3
4
5
6
7
8
10
20
30
40
50
60
80
100
200
300
400
600
800
1k
2k
3k
4k
5k
6k
8k
10k
20k
30.0k
Hz

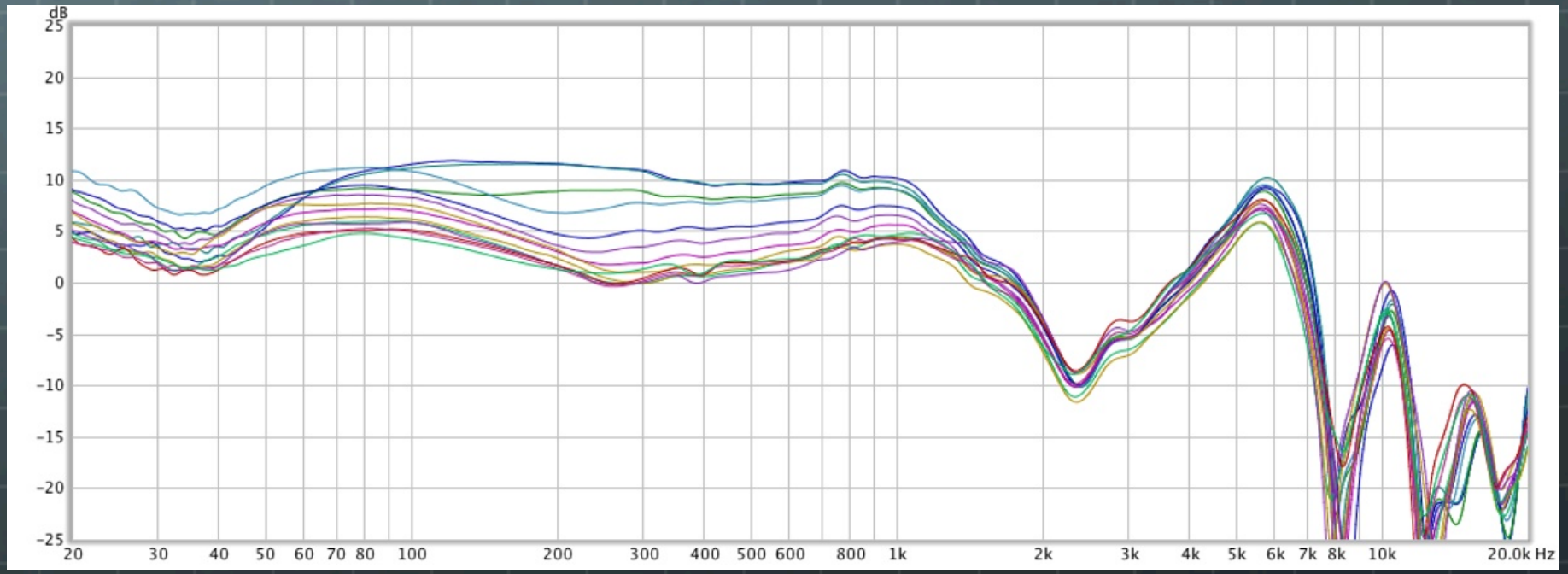

No smoothing
dB
10
5
0
-5
-10
-15
-20
-25
10
20
30
40
50
60
80
100
200
300
400
500
600
800
1k
2k
3k
4k
5k
6k
7k
8k
10k
20.0k Hz



Screenshot from Keith Atkins

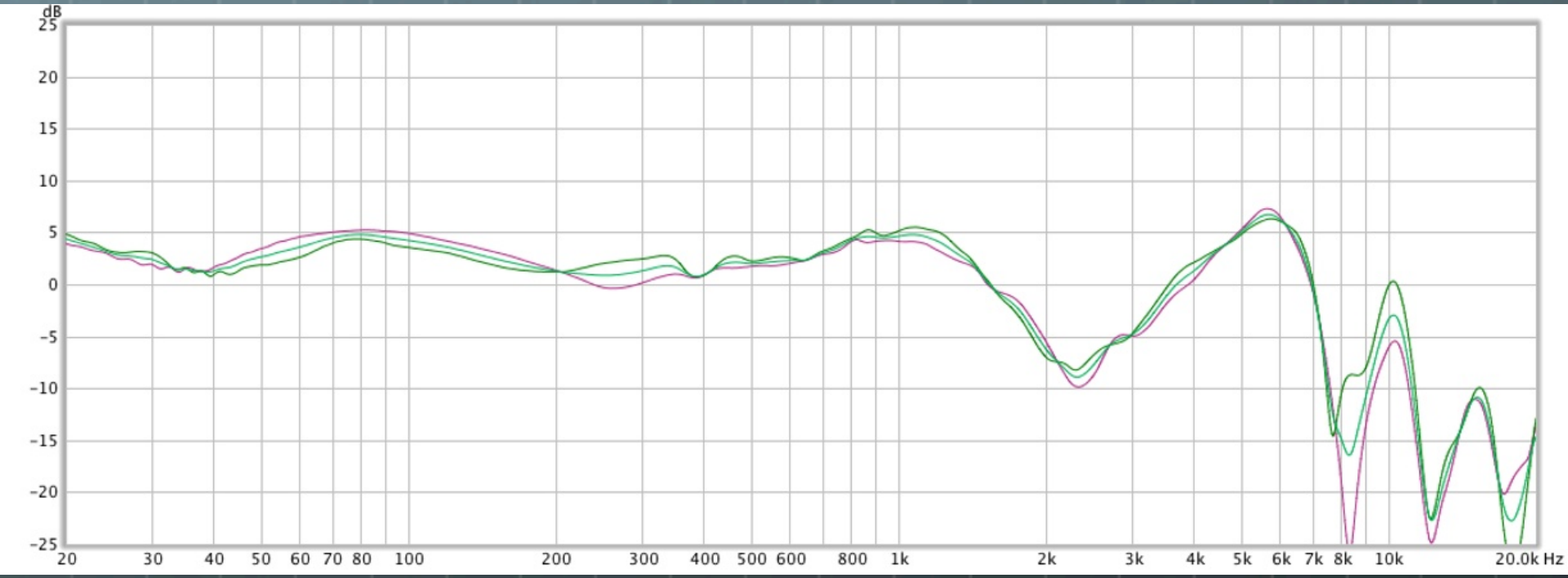
Qualifying Results Graphically

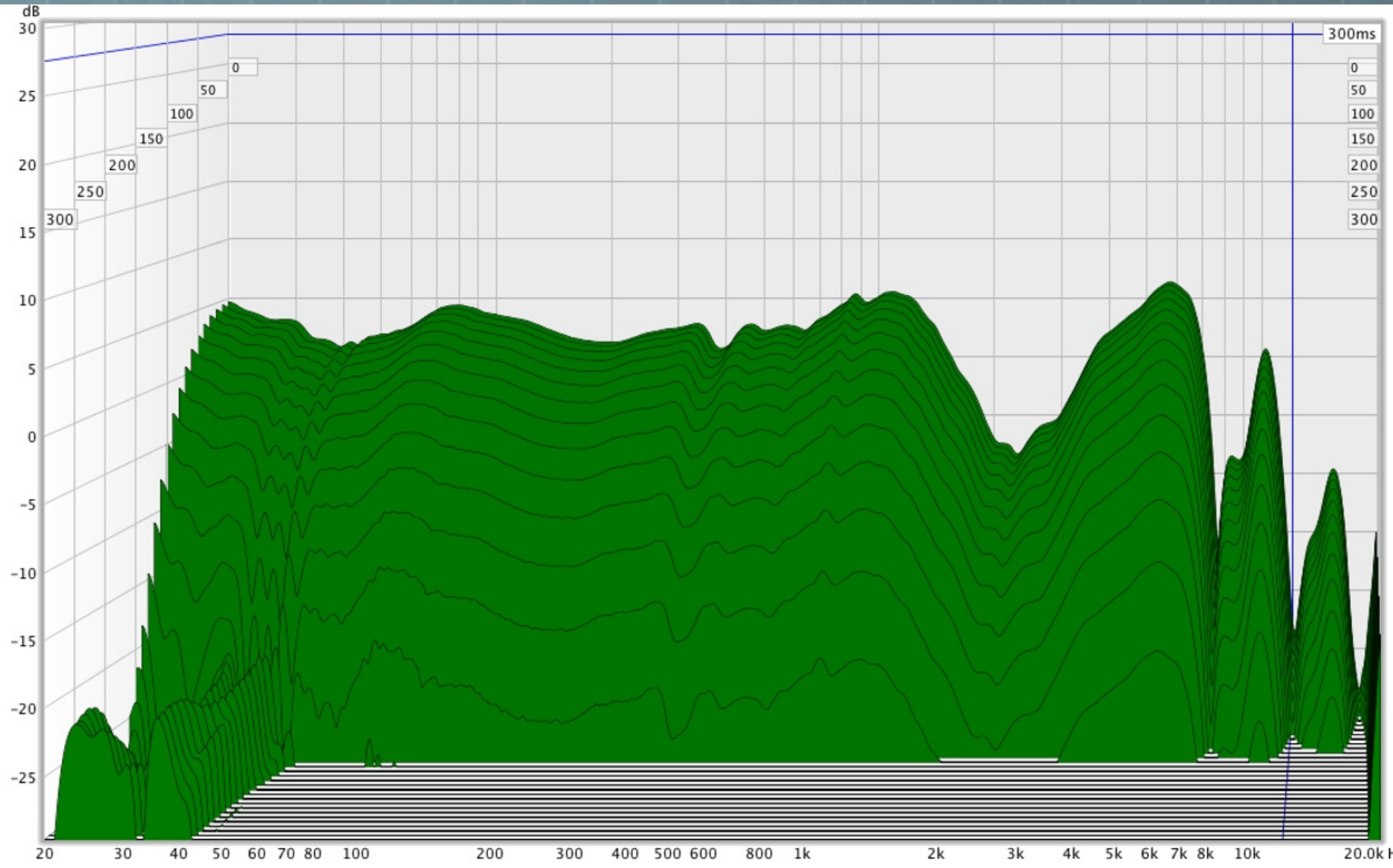
- Can see changes in the frequency response due to modifications with consistent measurement techniques

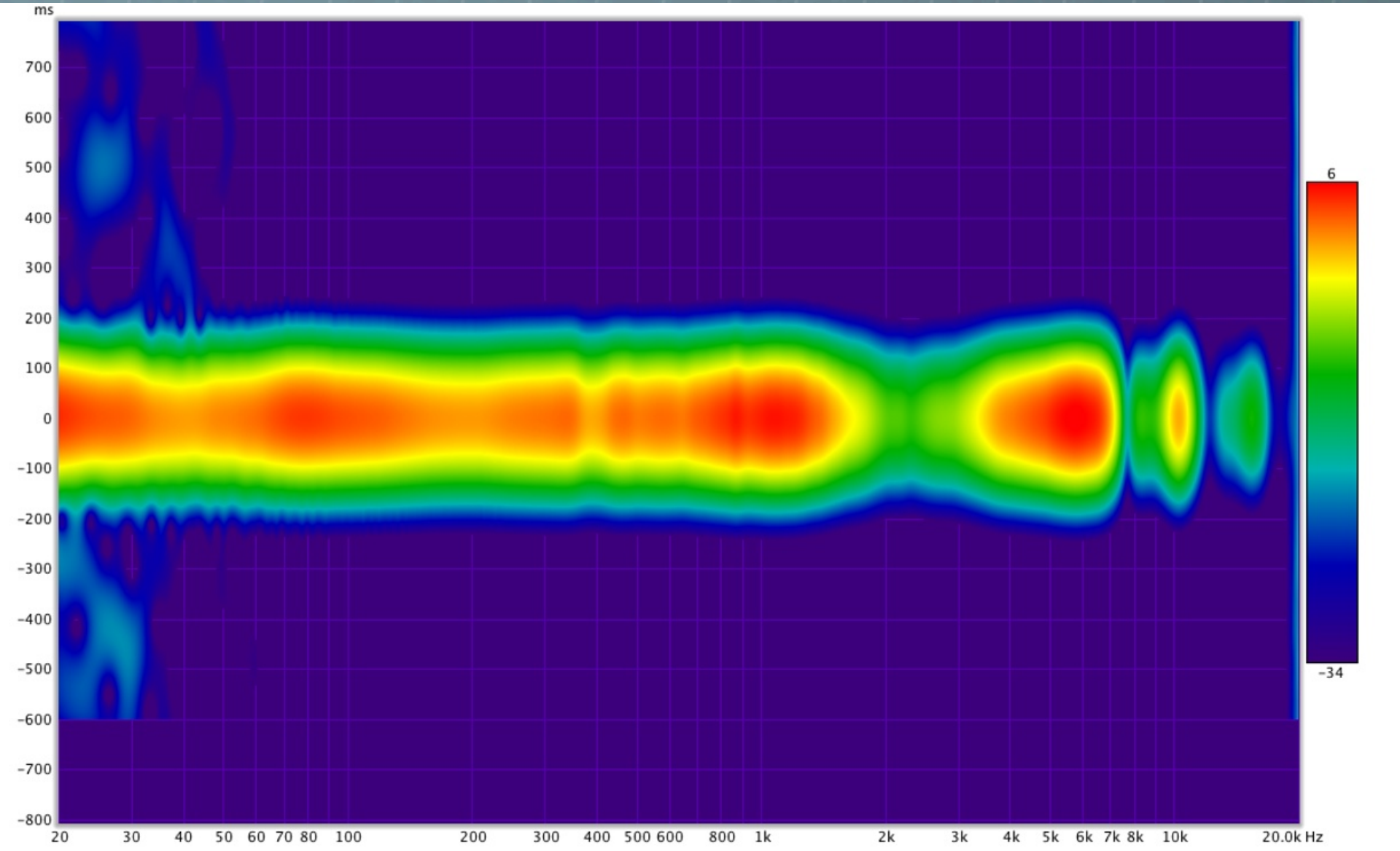


Different Plots

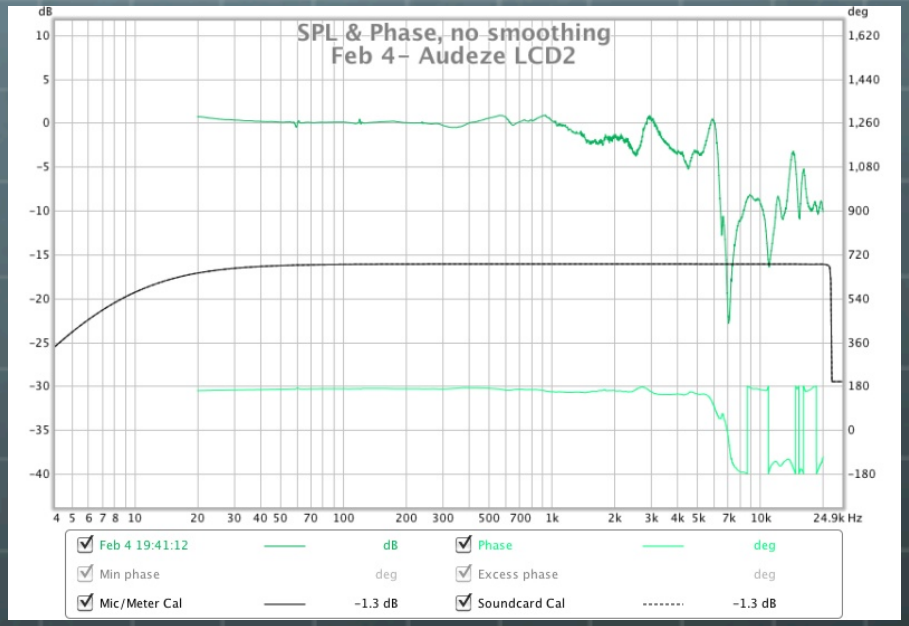
- REW can plot data in many different ways
- Need to choose the type of graph given your specific interest
- Types of graphs available:
  - SPL & Phase
  - All SPL
  - Impulse, Filtered IR, GD, RT60, Decay
  - Waterfall
  - Spectrogram
  - Scope

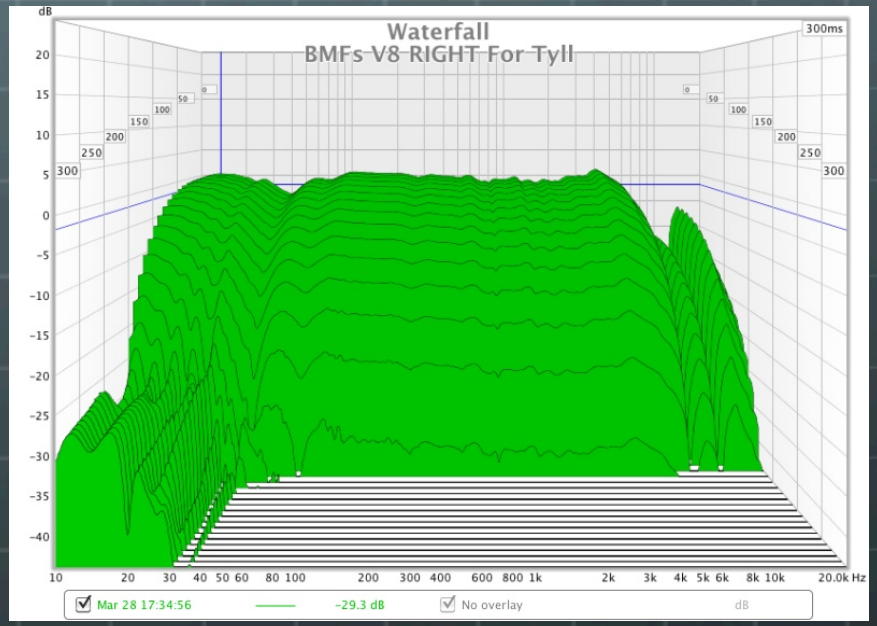

dB
25
20
15
10
5
0
-5
-10
-15
-20
-25
20
30
40
50
60
70
80
100
200
300
400
500
600
800
1k
2k
3k
4k
5k
6k
7k
8k
10k
20.0k Hz


dB
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
300ms
0
50
100
150
200
250
300
20
30
40
50
60
70
80
100
200
300
400
500
600
800
1k
2k
3k
4k
5k
6k
7k
8k
10k
20.0k
Hz


ms
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
6
-34
20
30
40
50
60
70
80
100
200
300
400
500
600
800
1k
2k
3k
4k
5k
6k
7k
8k
10k
20.0k
Hz

Future Work


SPL & Phase, no smoothing
Feb 4- Audeze LCD2
dB
deg
Feb 4 19:41:12
dB
Phase
deg
Min phase
deg
Excess phase
deg
Mic/Meter Cal
-1.3 dB
Soundcard Cal
-1.3 dB


Waterfall
BMFs V8 RIGHT For Tyll
300ms
dB
Mar 28 17:34:56
-29.3 dB
No overlay
dB