MPX over IP Compression

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V1.1

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The Goal

Determine the effects of IP transport on an MPX Signal

- MPX transport by IP is becoming more common
- Not everyone has the bandwidth to do linear IP transport (3Mb +)
- Data compression and transport methods have been developed that can reduce the necessary bandwidth to 320 kbps or lower.

- BUT – at what cost? What are the effects (if any) on the resulting MPX after compressed transport?
  - Focus on what acutally reaches the ears
  - Frequency response, THD, stereo separation
  - PPM decoding efficiency

2 The Team

Shane Toven and Paul Shulins

Shane Toven
Senior Broadcast Engineer
Educational Media Foundation (K-LOVE/Air1)

Paul Shulins
Broadcast Consultant
https://shulinssolutions.com/

3 The Field

A broad selection of available MPXoIP transport

2WCom – Linear 16 bit
MicroMPX @ 320 and 576

APT – Linear 16 bit
APTMPX @ 300, 600 and 900

GatesAir – Linear 16 bit

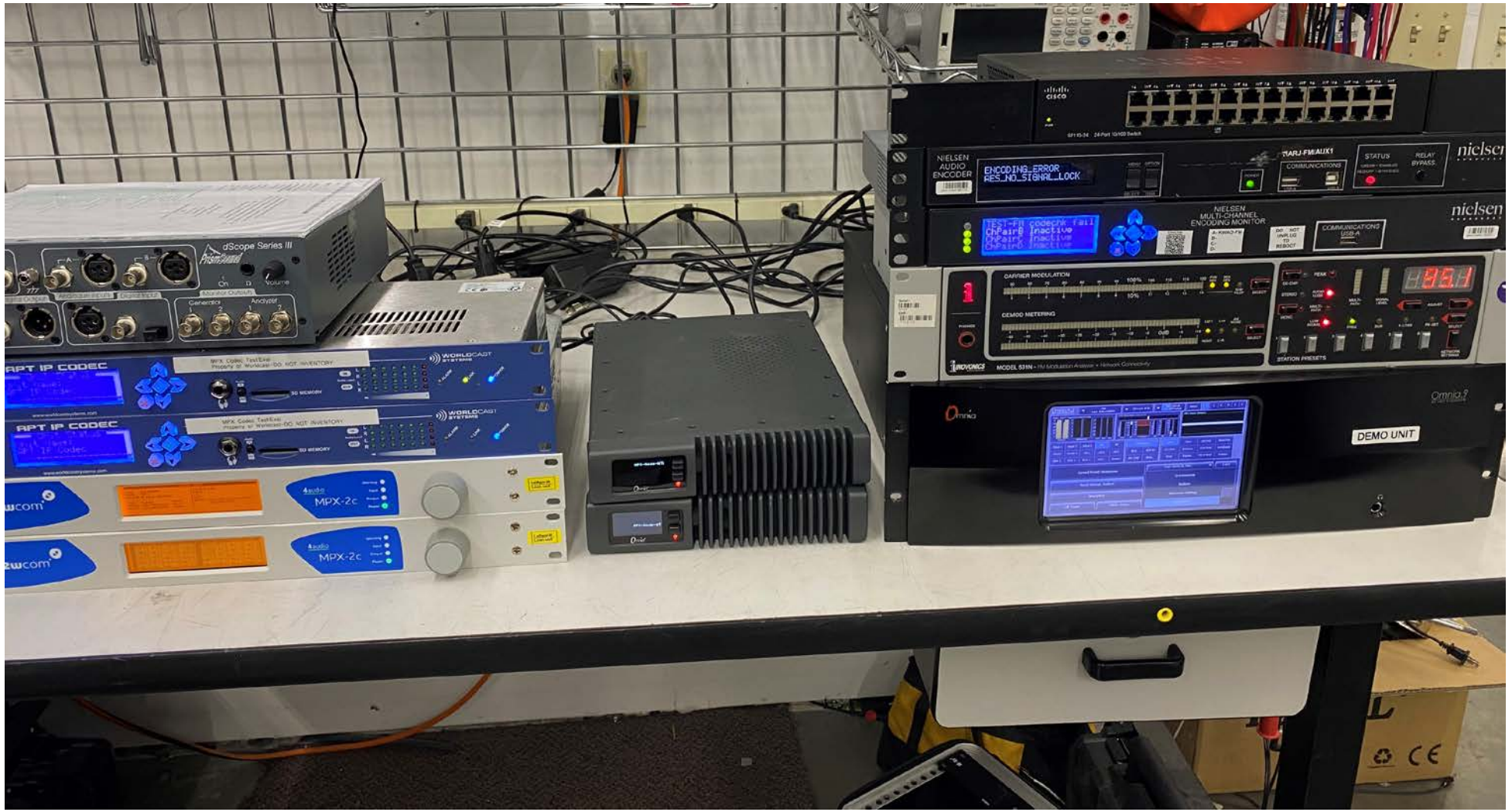
Omnia
MicroMPX @ 320 and 576

Micro MPX+
MicroMPX+ @ 176 and 800

For reduced bitrate, only two choices - APT or Micro MPX

3 The Bench

Controlled Chaos



Other than the codecs:

Omnia 9
- Became the hub for the tests
- Stereo Generator
- Composite Input Demodulator
- Audio Playback
- PPM Insertion
- Audio Recording

dScope Series III
- Audio Generator
- Frequency Response
- THD

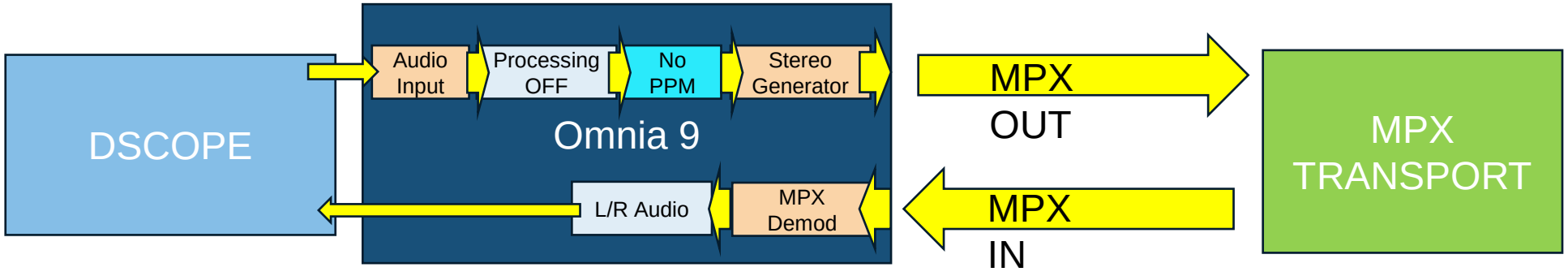
Nielsen PPM Encoder

Nielsen MCEM Monitor

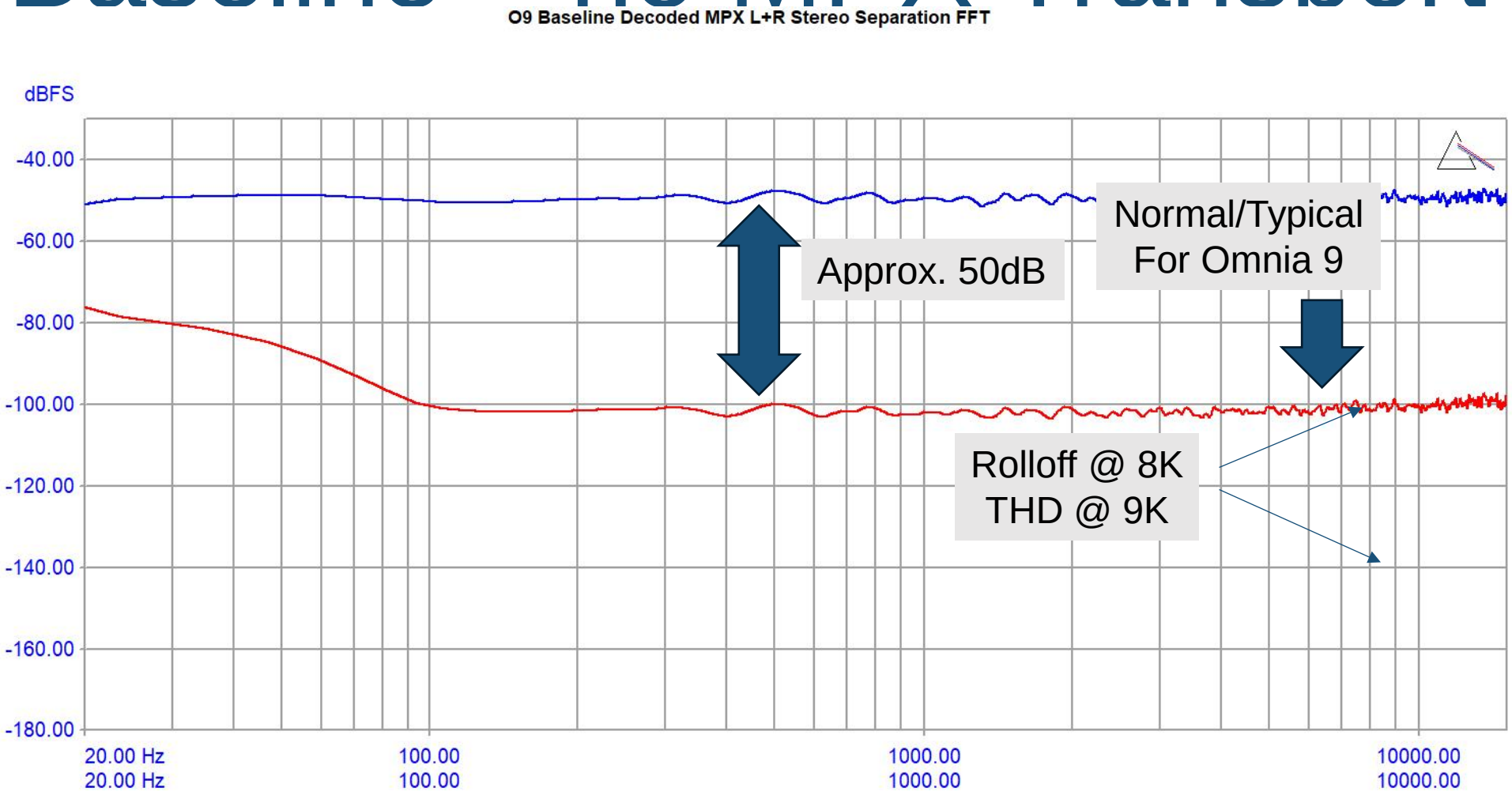
Audio Performance

Audio Performance Measurements

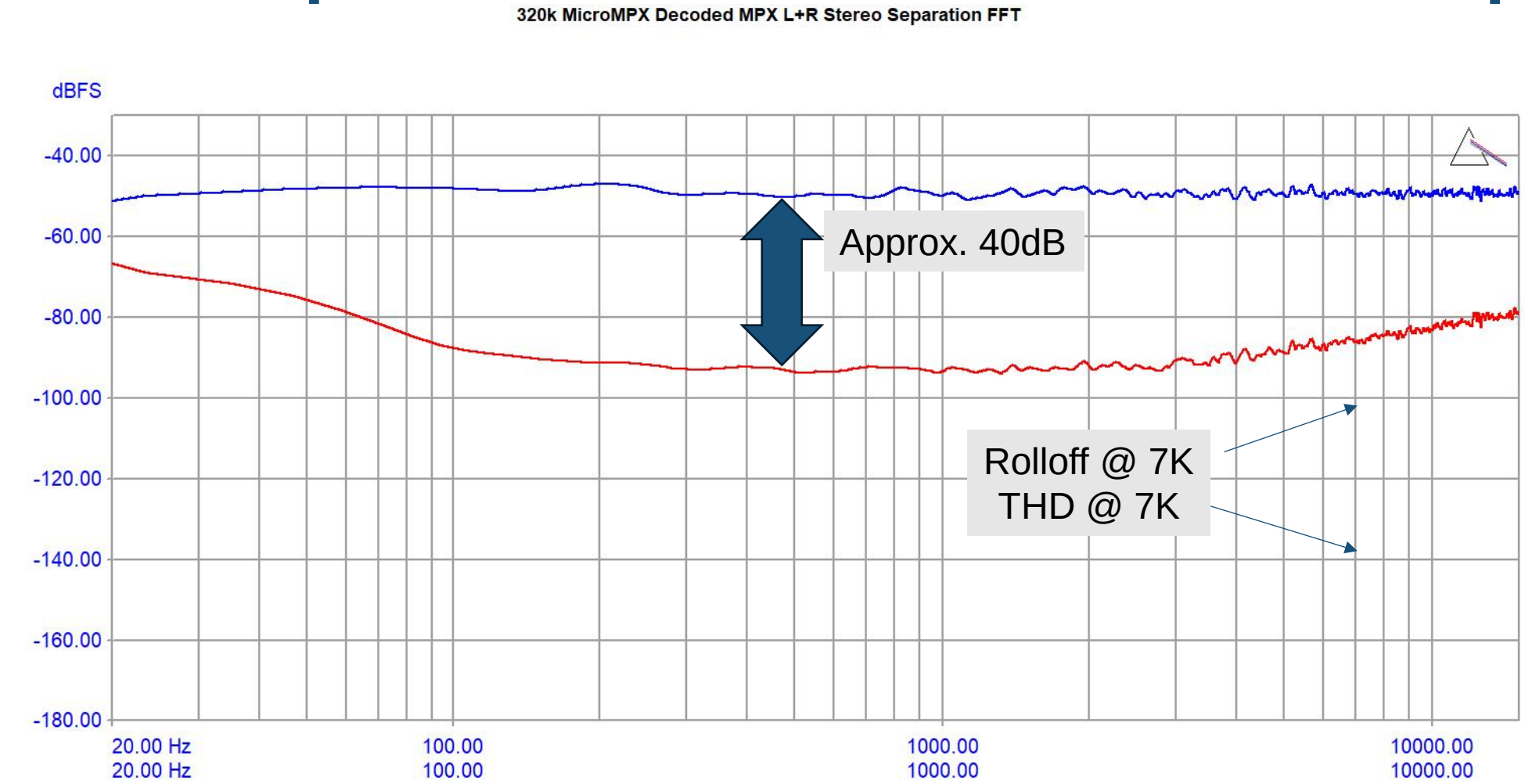
- Test Configuration



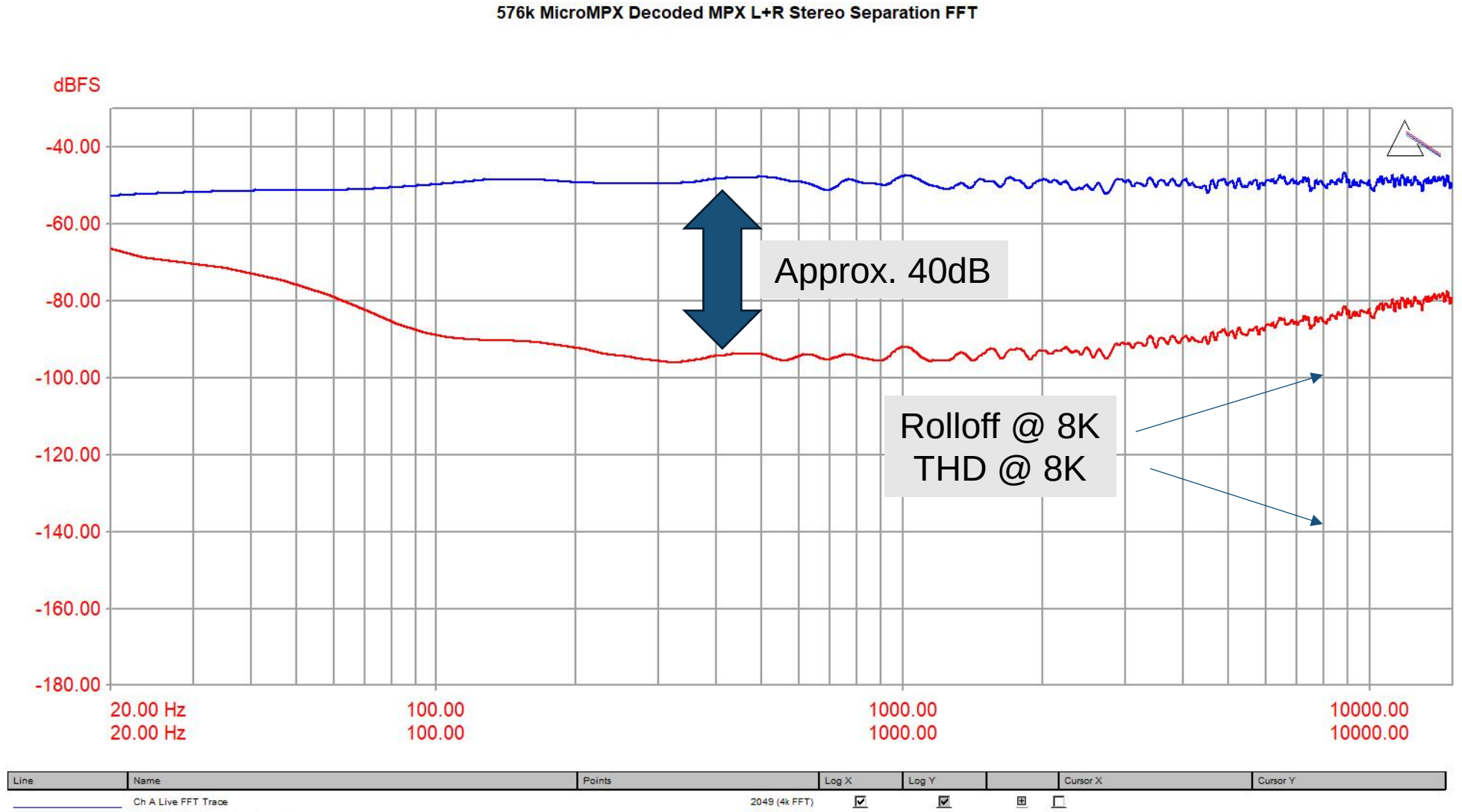
Baseline – no MPX Transport



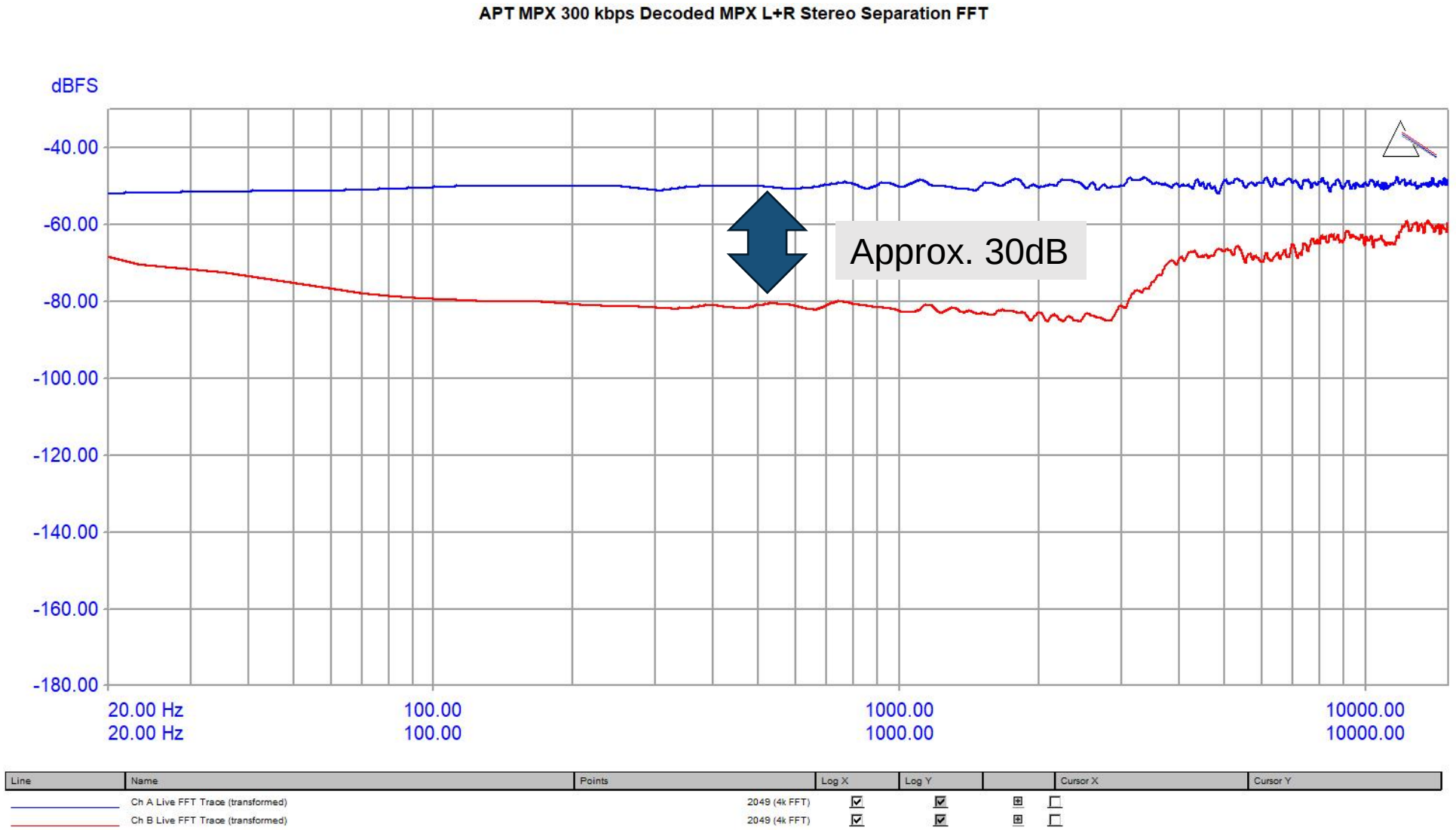
Omnia µMPX Nodes @ 320 kbps



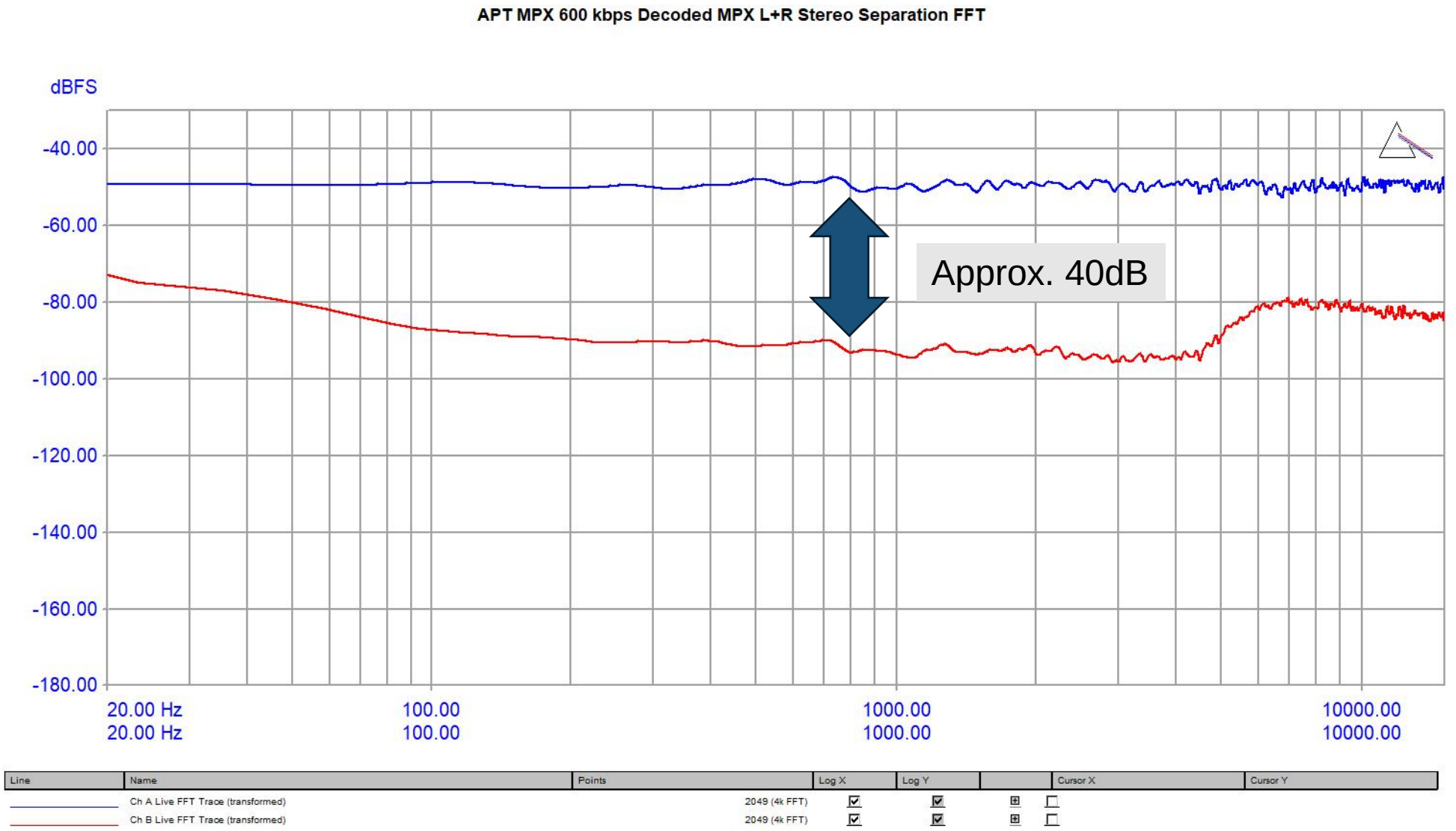
Omnia µMPX Nodes @ 576 kbps



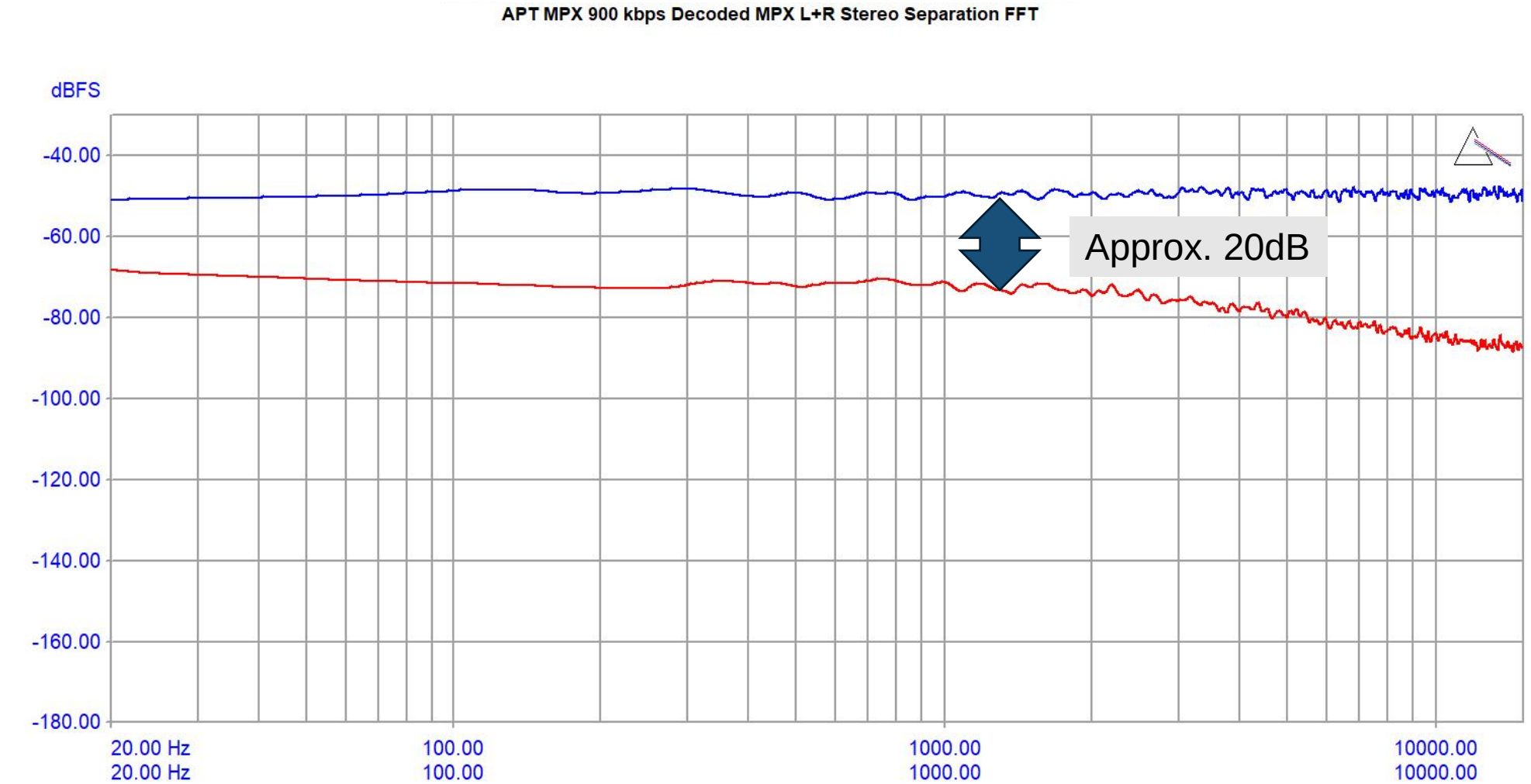
APTMPX @ 300 kbps



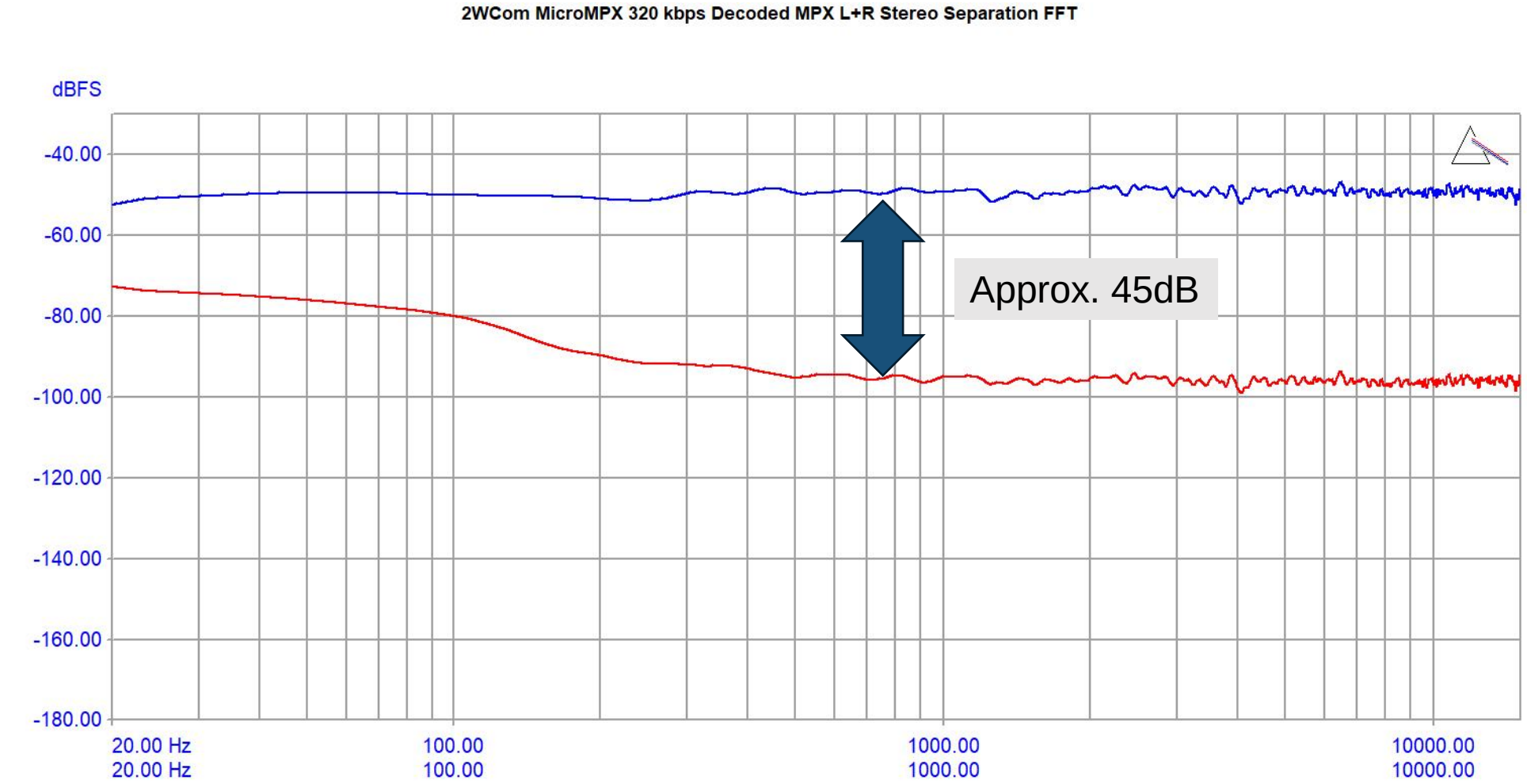
APTMPX @ 600 kbps



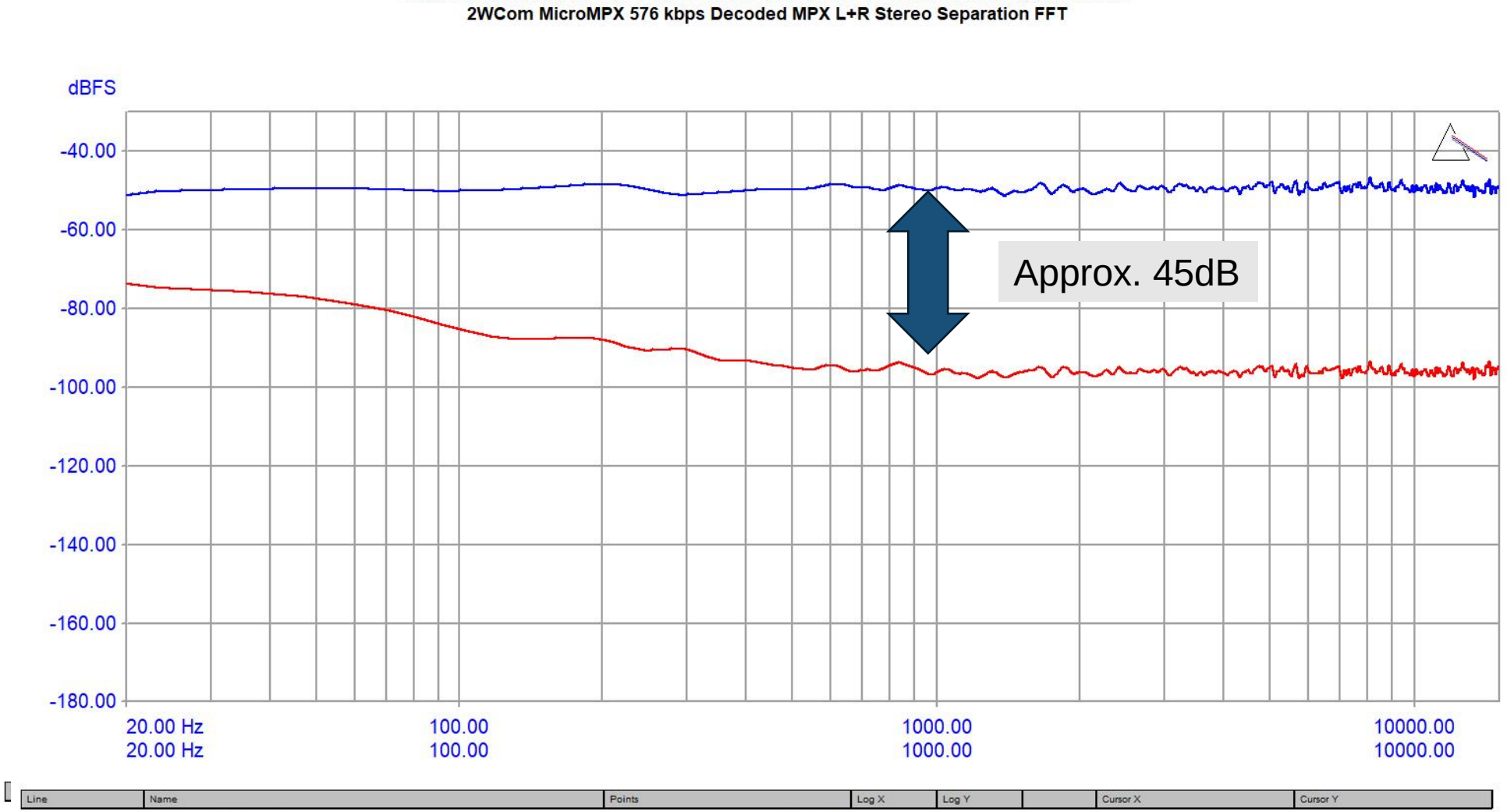
APTMPX @ 900 kbps



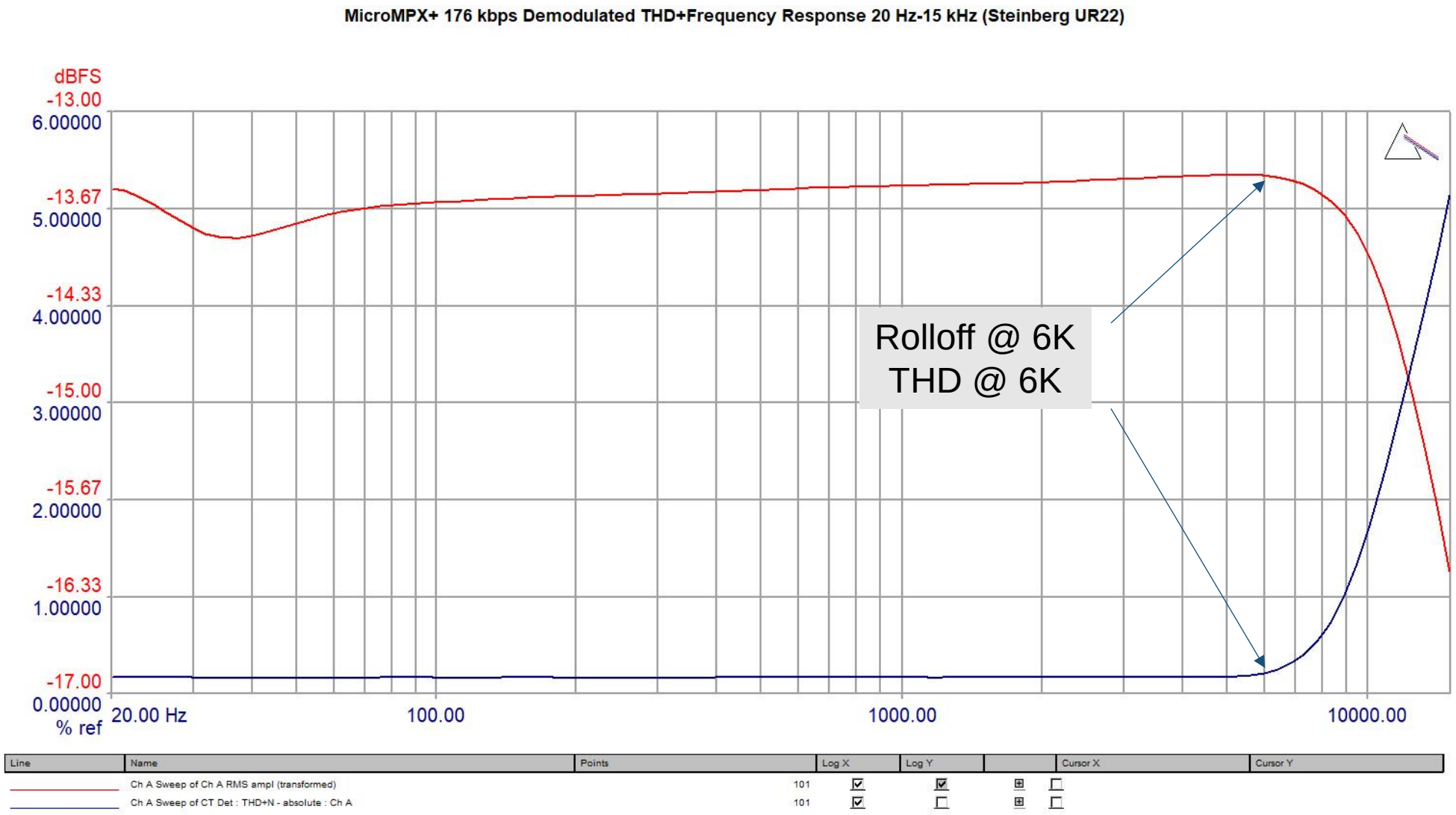
2WCom µMPX @ 320 kbps



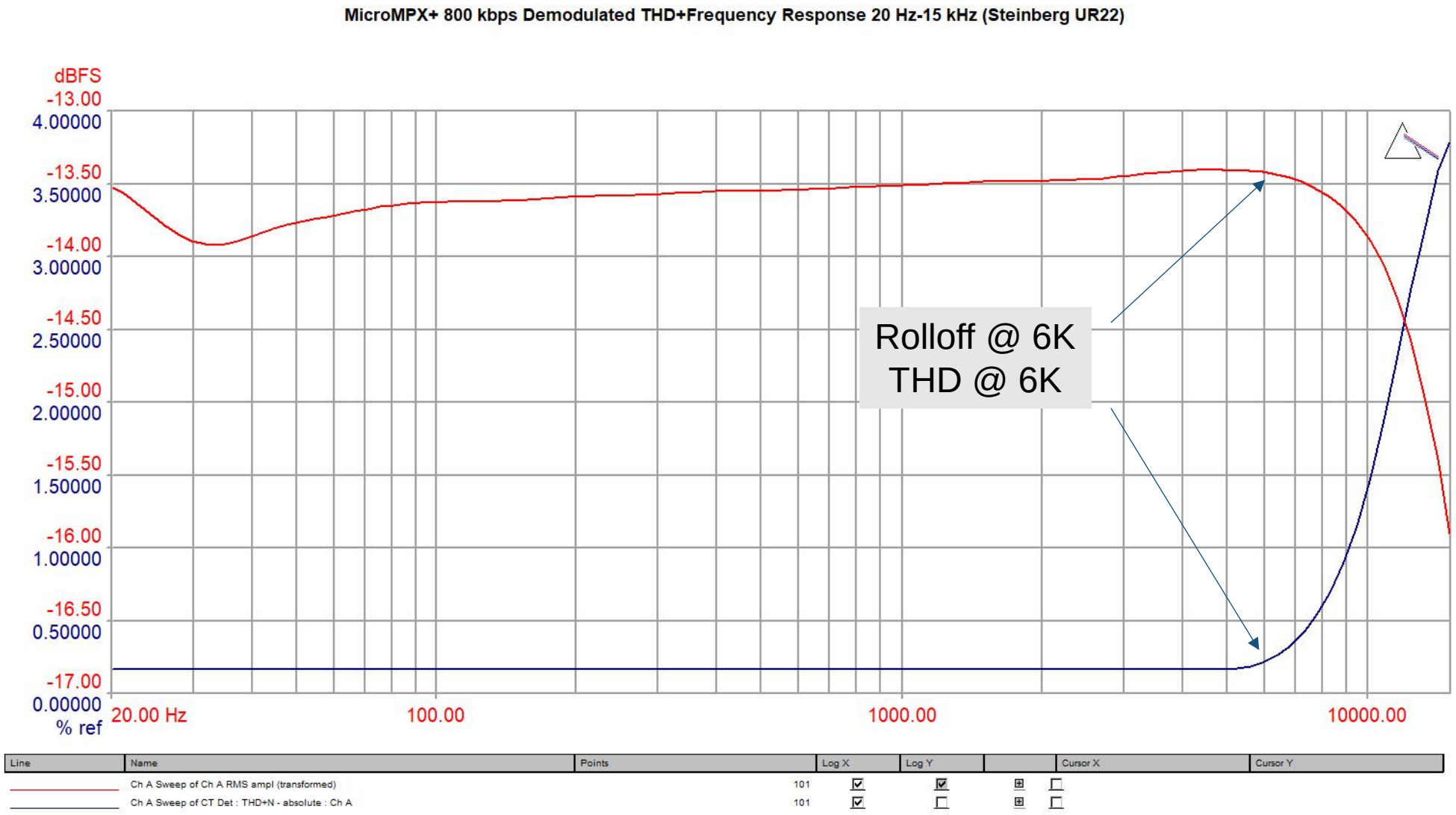
2WCom µMPX @ 576 kbps



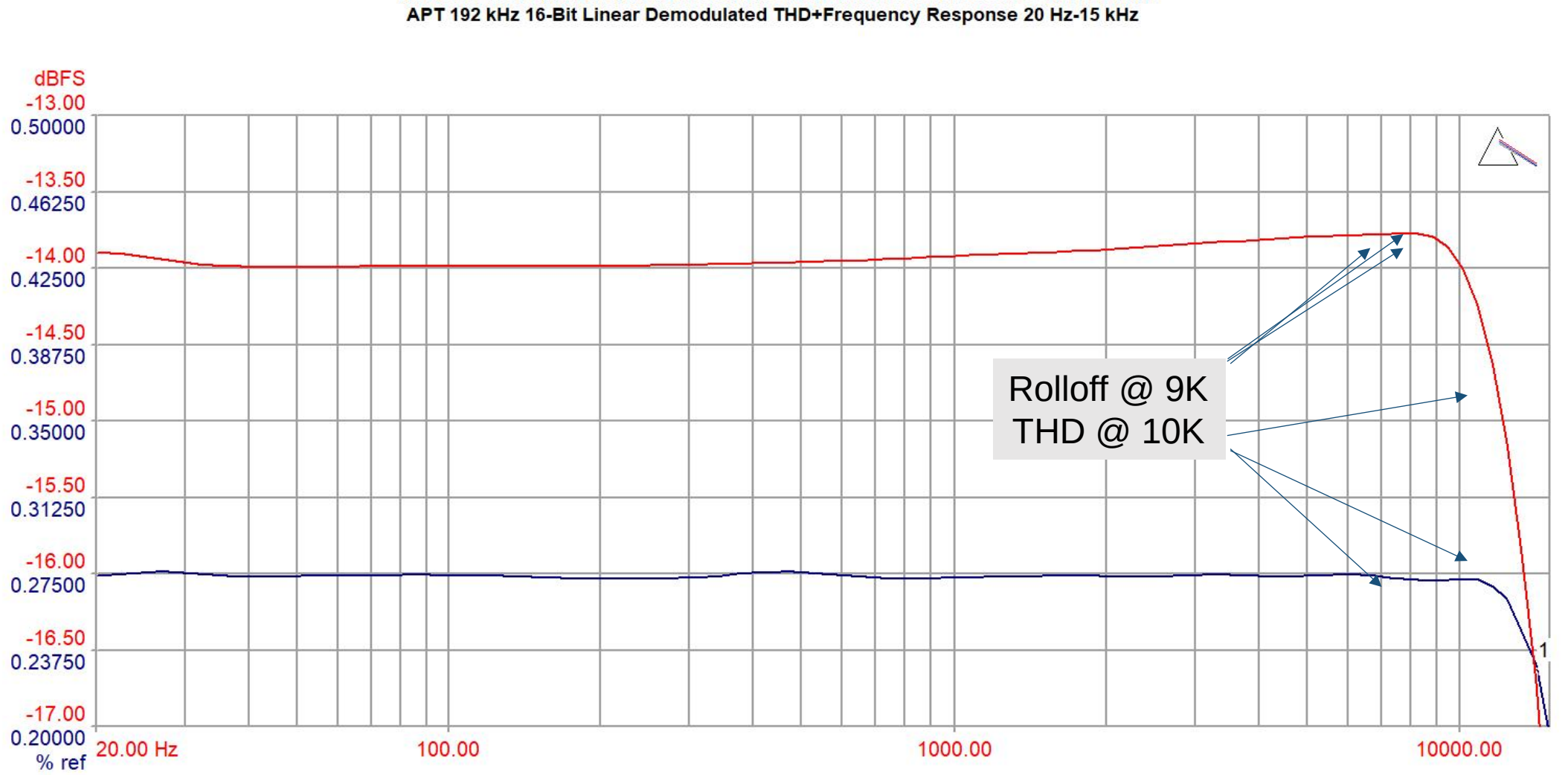
µMPX + @ 176 kbps



µMPX + @ 800 kbps



Linear – if you can't get this right….

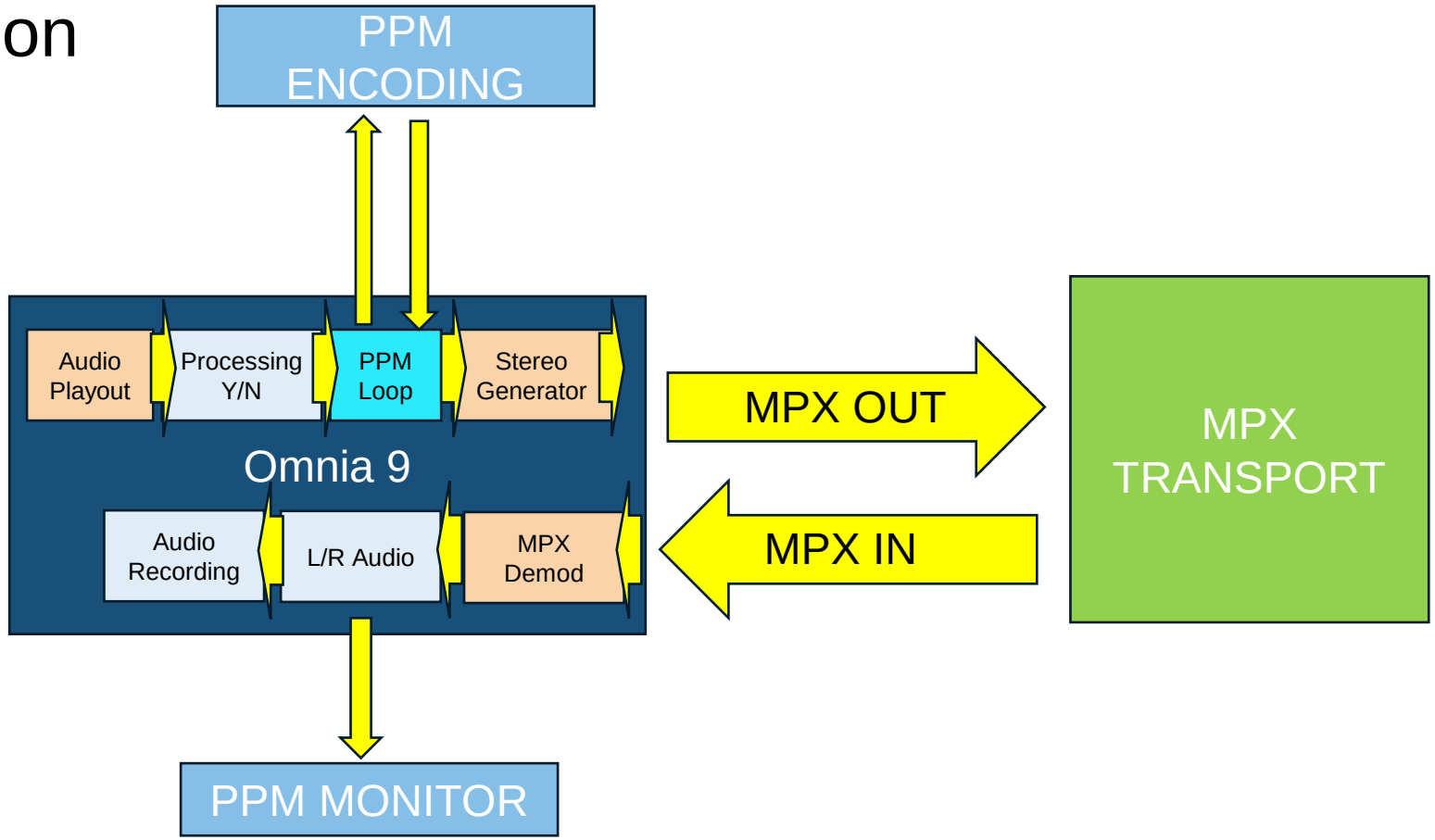


Line	Name	Points	Log X	Log Y		Cursor X	Cursor Y	Comment/label
	Ch A Sweep of Ch A RMS ampl (transformed)	101	☑	☑	⊞	☐		
	Ch A Sweep of CT Det : THD+N - absolute : Ch A	101	☑	☐	⊞	☐		

5 PPM Encoding

PPM Encoding Tests

- Test Configuration



Methodology

- Play a long audio file from the Omnia 9 – tip o' the had to Garrett
  - 6 min dry voice – 6 min dense music – 6 min ambient music



- Processing (2 passes – with and without "Reference" setting processing enabled)

- Loop through the PPM Encoder
- Omnia 9 Stereo Generator
- Through target MPX transport, 2 passes for each bit rate (proc./no proc.)
- Back into Omnia 9 MPX demodulator
- Audio feed into Nielsen MCEM
- Audio Recorded in WAV format
- Audio files fed through TVC15 monitor, 2 passes for each file, averaged

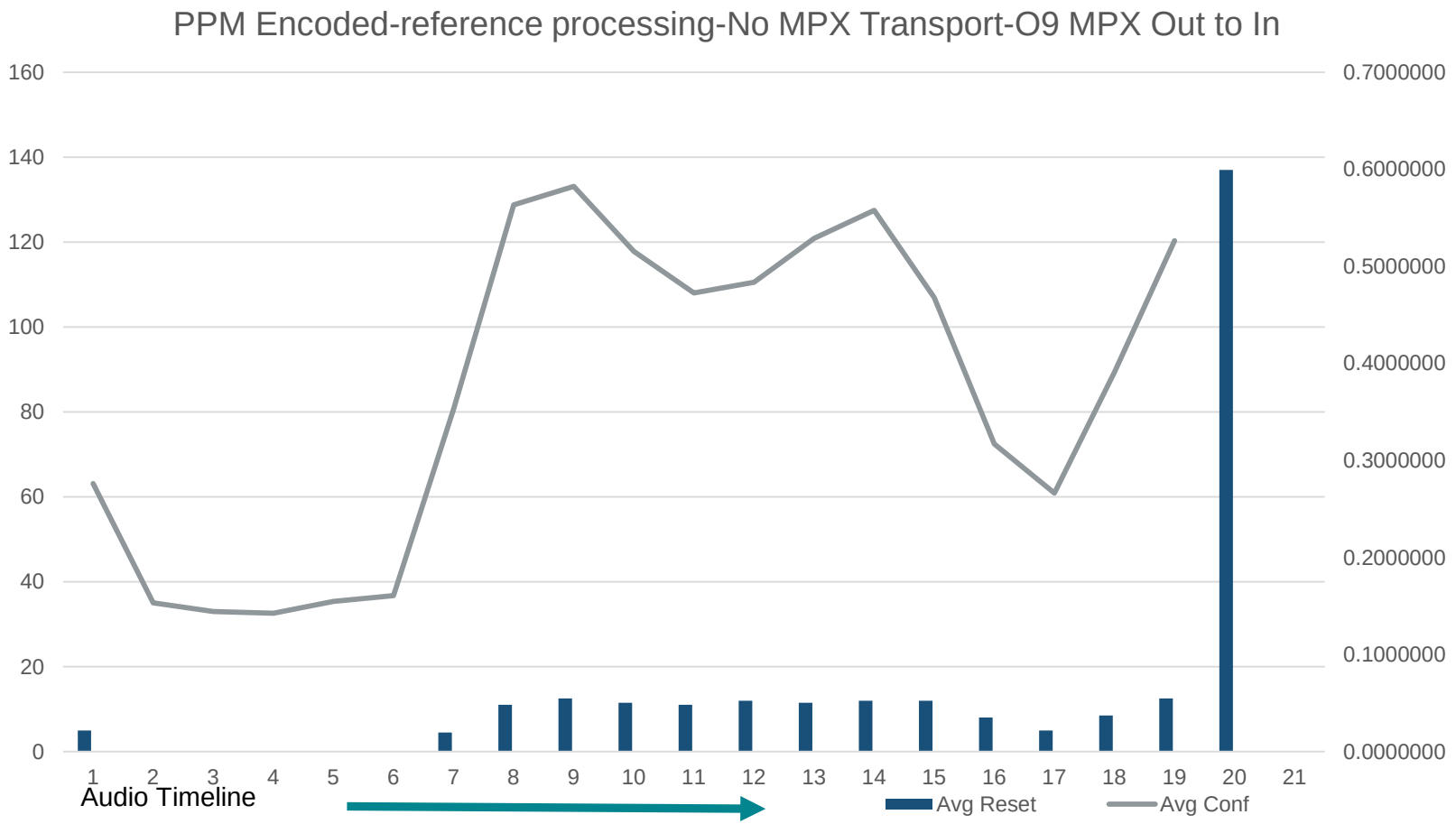
5 PPM Encoding Results


INCONCIEVABLE!


INCONSISTENT!

Date	Time	Reset Count	Confidence
8/31/2023	11:10:59 AM	0	0
8/31/2023	11:12:00 AM	1	0.1362112
8/31/2023	11:13:00 AM	0	0.106422
8/31/2023	11:14:00 AM	0	0.13032
8/31/2023	11:15:00 AM	0	0.127148
8/31/2023	11:16:00 AM	0	0.1292447
8/31/2023	11:17:00 AM	0	0.1393374
8/31/2023	11:18:00 AM	10	0.5339133
8/31/2023	11:19:00 AM	12	0.5801086
8/31/2023	11:20:00 AM	13	0.6034573
8/31/2023	11:21:00 AM	7	0.4347194
8/31/2023	11:22:00 AM	11	0.471336
8/31/2023	11:23:00 AM	9	0.4647687
8/31/2023	11:24:00 AM	9	0.424172
8/31/2023	11:25:00 AM	10	0.3760586
8/31/2023	11:26:00 AM	11	0.3402607
8/31/2023	11:27:00 AM	1	0.1518286
8/31/2023	11:28:00 AM	0	0.14327
8/31/2023	11:29:00 AM	8	0.5448839
8/31/2023	11:30:00 AM	13	0.555594

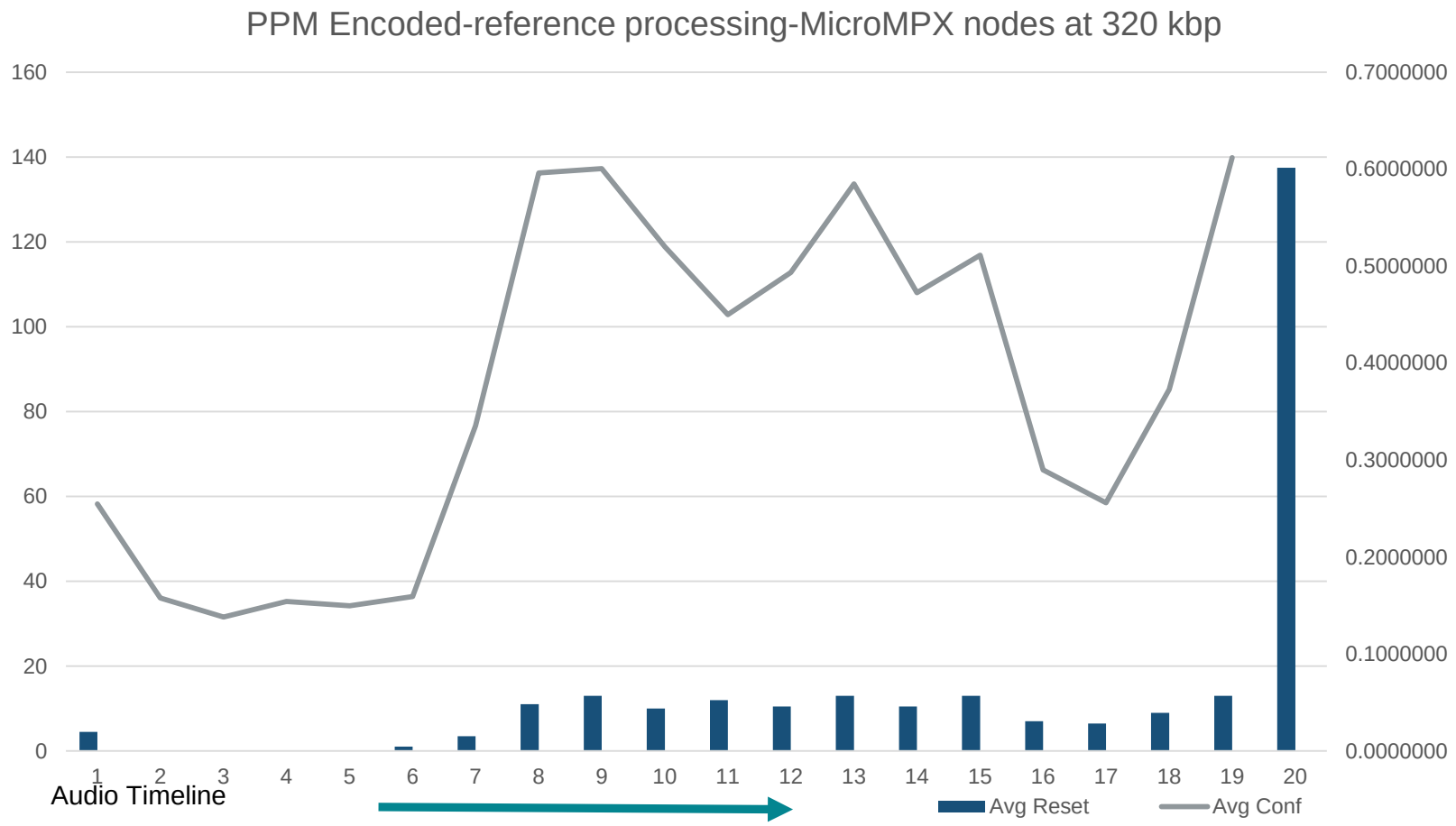
Date	Time	Reset Count	Confidence
8/31/2023	2:43:04 AM	0	0
8/31/2023	2:44:00 AM	1	0.1403114
8/31/2023	2:45:00 AM	0	0.106908
8/31/2023	2:46:00 AM	0	0.1231093
8/31/2023	2:47:00 AM	0	0.1279827
8/31/2023	2:48:00 AM	0	0.1310074
8/31/2023	2:49:00 AM	0	0.13724
8/31/2023	2:50:00 AM	8	0.5021639
8/31/2023	2:51:00 AM	12	0.5765942
8/31/2023	2:52:00 AM	13	0.6008114
8/31/2023	2:53:00 AM	7	0.4542434
8/31/2023	2:54:00 AM	13	0.4672234
8/31/2023	2:55:00 AM	9	0.4477013
8/31/2023	2:56:00 AM	11	0.4420756
8/31/2023	2:57:00 AM	9	0.369436
8/31/2023	2:58:00 AM	13	0.3771941
8/31/2023	2:59:00 AM	0	0.1580467
8/31/2023	3:00:00 AM	3	0.1413
8/31/2023	3:01:00 AM	8	0.5279806
8/31/2023	3:02:00 AM	13	0.5679998



Straight Coax w/Proc

AVG RESET: 137

AVG CONF: .3741

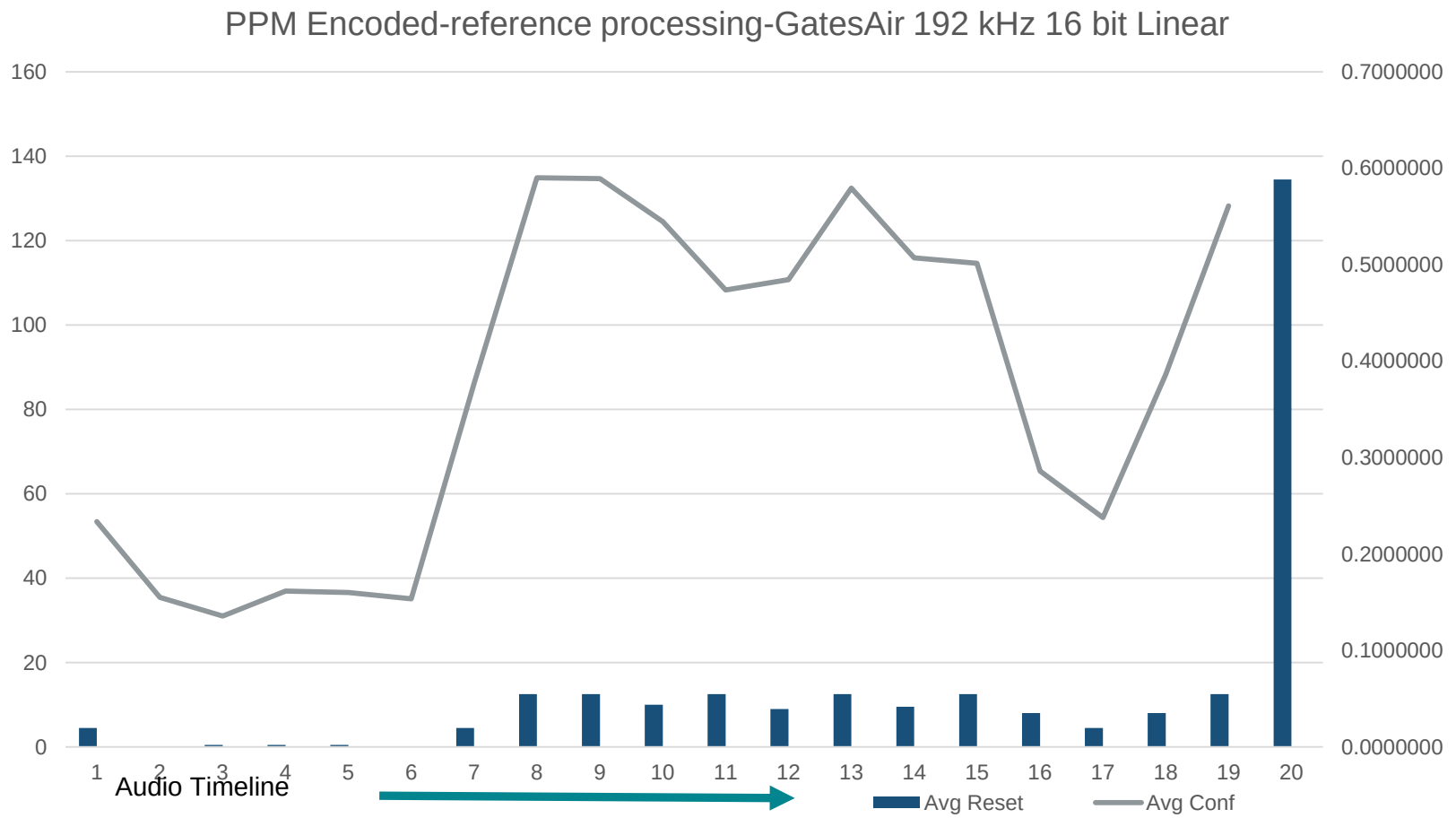


MPX Nodes @ 320 w/Proc

AVG RESET: 137.5

AVG CONF: .3741

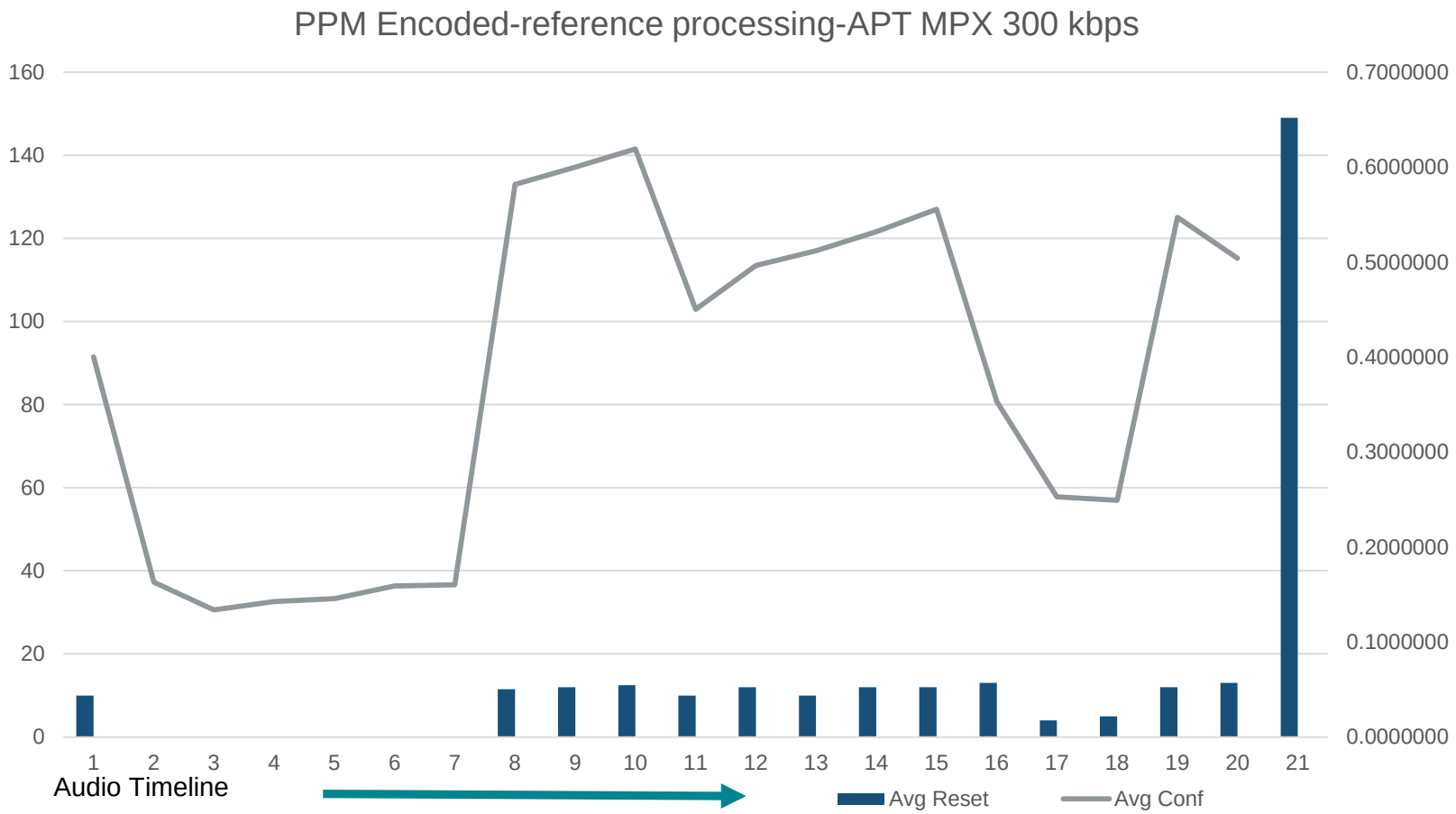

INCONCIEVABLE!



GatesAir 16 bit Linear w/Proc

AVG RESET: 134.5

AVG CONF: .3746



APT MPX @ 300 w/Proc

AVG RESET: 149

AVG CONF: .3780

Rankings – no processing

Micro MPX + 800 No Proc

AVG RESET: 128.5

AVG CONF: .3473

GatesAir 16 bit Linear No Proc

AVG RESET: 128.5

AVG CONF: .3417

2WCom Linear 16 bit No Proc

AVG RESET: 128

AVG CONF: .3487

MPX Nodes @ 320 No Proc

AVG RESET: 117.6

AVG CONF: .3198

APT MPX 600 No Proc

AVG RESET: 117.5

AVG CONF: .3388

APT Linear 16 bit No Proc

AVG RESET: 117

AVG CONF: .3381

2WCom Micro MPX @ 320 No Proc

AVG RESET: 116.5

AVG CONF: .3411

APT MPX 300 No Proc

AVG RESET: 116

AVG CONF: .3400

Straight Coax No Proc

AVG RESET: 115.5

AVG CONF: .3322

MPX Nodes @ 576 No Proc

AVG RESET: 114.5

AVG CONF: .3349

APT MPX 900 No Proc

AVG RESET: 113

AVG CONF: .3390

Rankings – With processing

2WCom Micro MPX @ 320 W/Proc AVG RESET: 150 AVG CONF: .3862	APT MPX @ 600 w/Proc AVG RESET: 141 AVG CONF: .3812	Straight Coax w/Proc AVG RESET: 137 AVG CONF: .3741	Micro MPX + 800 W/Proc AVG RESET: 132.5 AVG CONF: .3793	APT MPX @ 900 w/Proc AVG RESET: 127 AVG CONF: .3761
APT MPX @ 300 w/Proc AVG RESET: 149 AVG CONF: .3780	APT Linear 16 bit w/Proc AVG RESET: 138.5 AVG CONF: .3688	MPX Nodes @ 576 w/Proc AVG RESET: 134.5 AVG CONF: .3755	APT MPX @ 300 w/Proc (2) AVG RESET: 131.5 AVG CONF: .3547	
Micro MPX + 176 W/Proc AVG RESET: 146 AVG CONF: .3826	MPX Nodes @ 320 w/Proc AVG RESET: 137.5 AVG CONF: .3741	GatesAir 16 bit Linear w/Proc AVG RESET: 134.5 AVG CONF: .3746	2WCom Linear 16 bit W/Proc AVG RESET: 129.5 AVG CONF: .3784	

Inconsistencies

- First part of audio file is dry voice
- Expect low encode/decode score

Reset Count
0
1
0
0
0
0
0
10

Reset Count
0
0
0
0
0
0
0
9

Reset Count
5
0
0
1
0
0

Reset Count
10
0
0
0
0
0

Reset Count
0
0
0
0
0
0

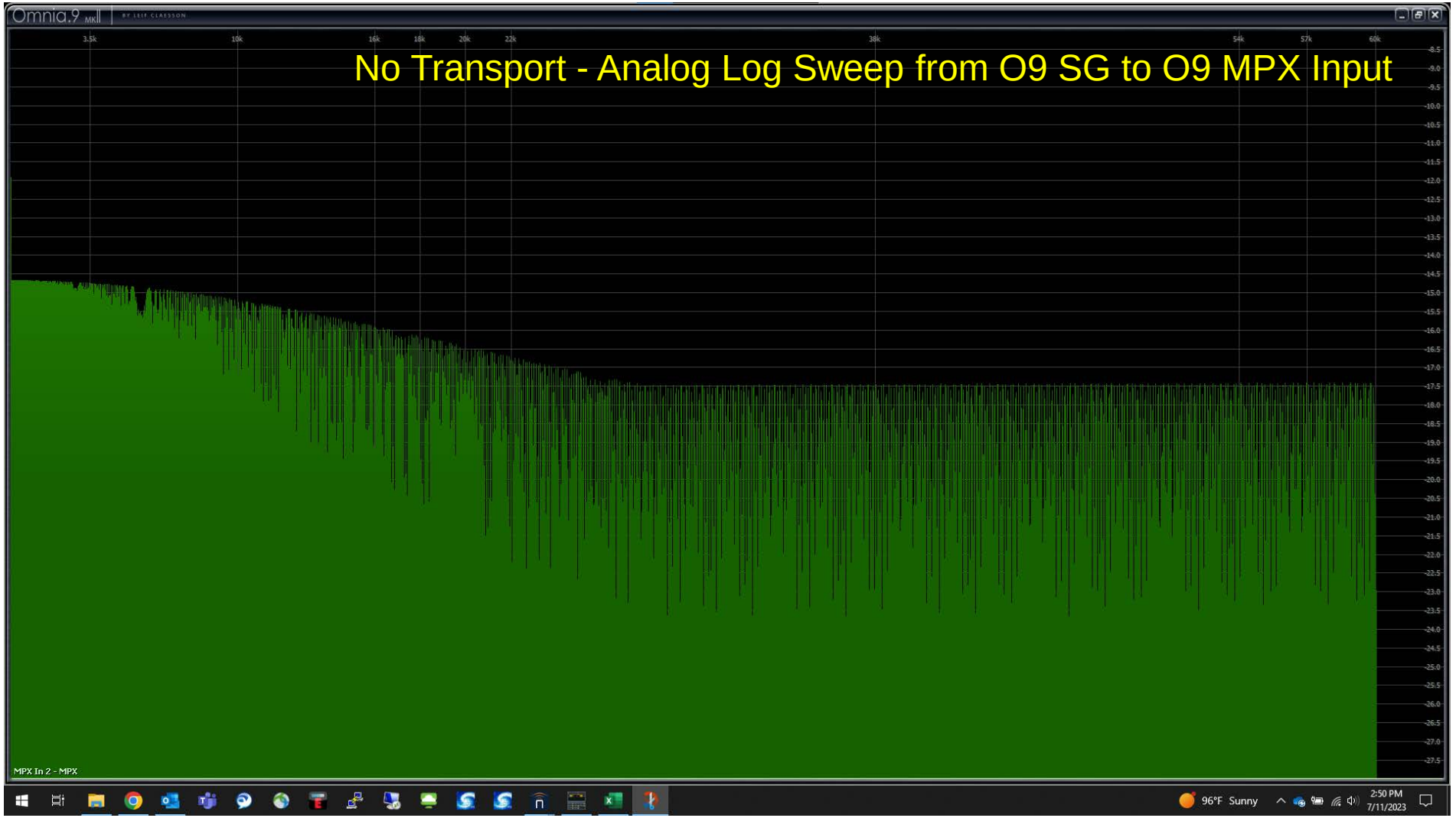
- Some anomalous readings even between two passes of the same file on the TVC15
- Ex. 2 passes of the same file (no MPX transport w/reference processing)
- Oddly, the two passes yielded the exact same total reset count (137)

Planned PPM test refinements

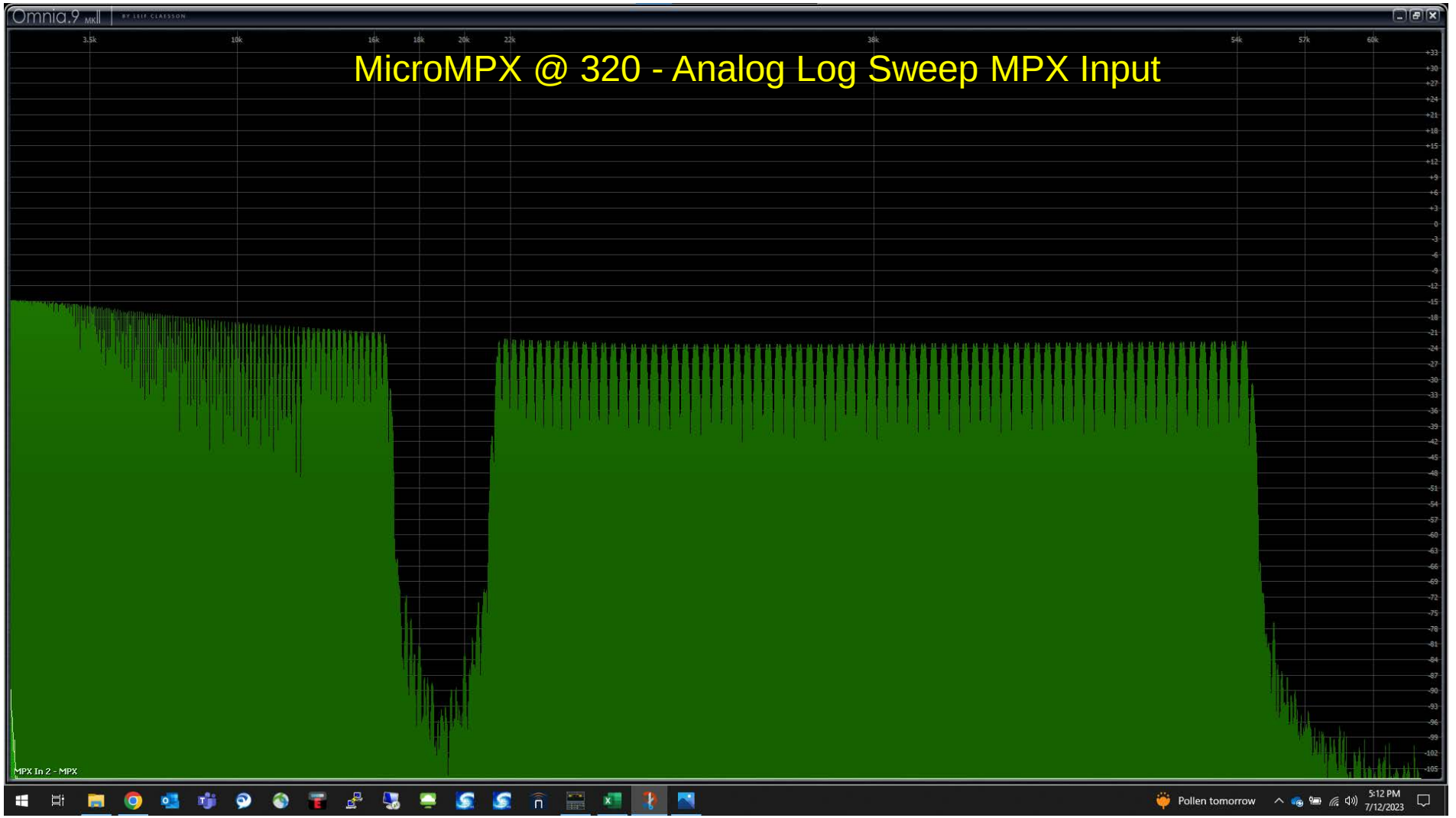
- Use only dense audio
- Heavy processing
- Shorter file
- Increase TVC15 runs to 10+
- Try and find some consistency
- Record single file with PPM and use that for all testing –
  Too much variability in the encoding process

6 Composite Tests

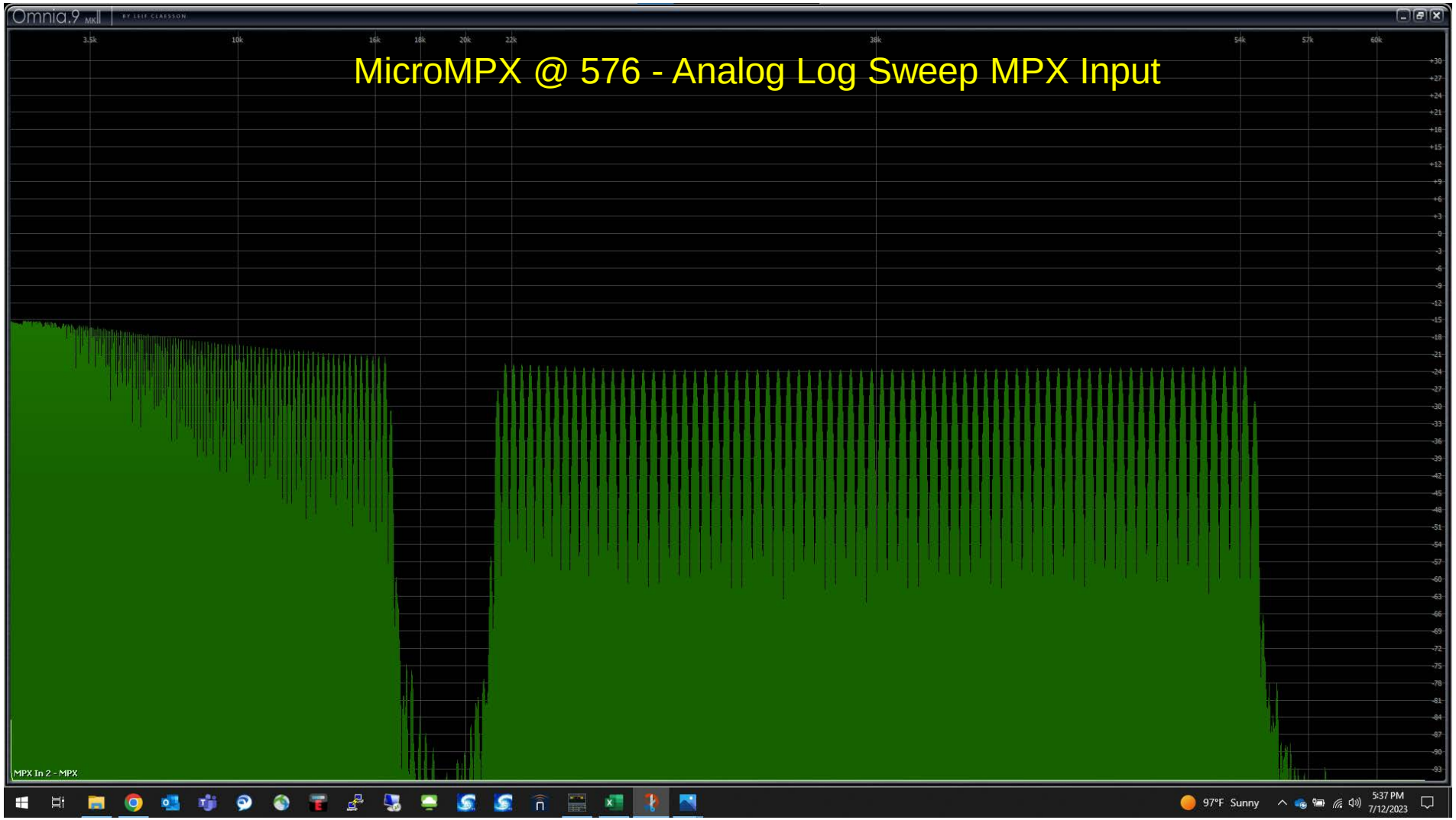
Composite Input Log Sweep



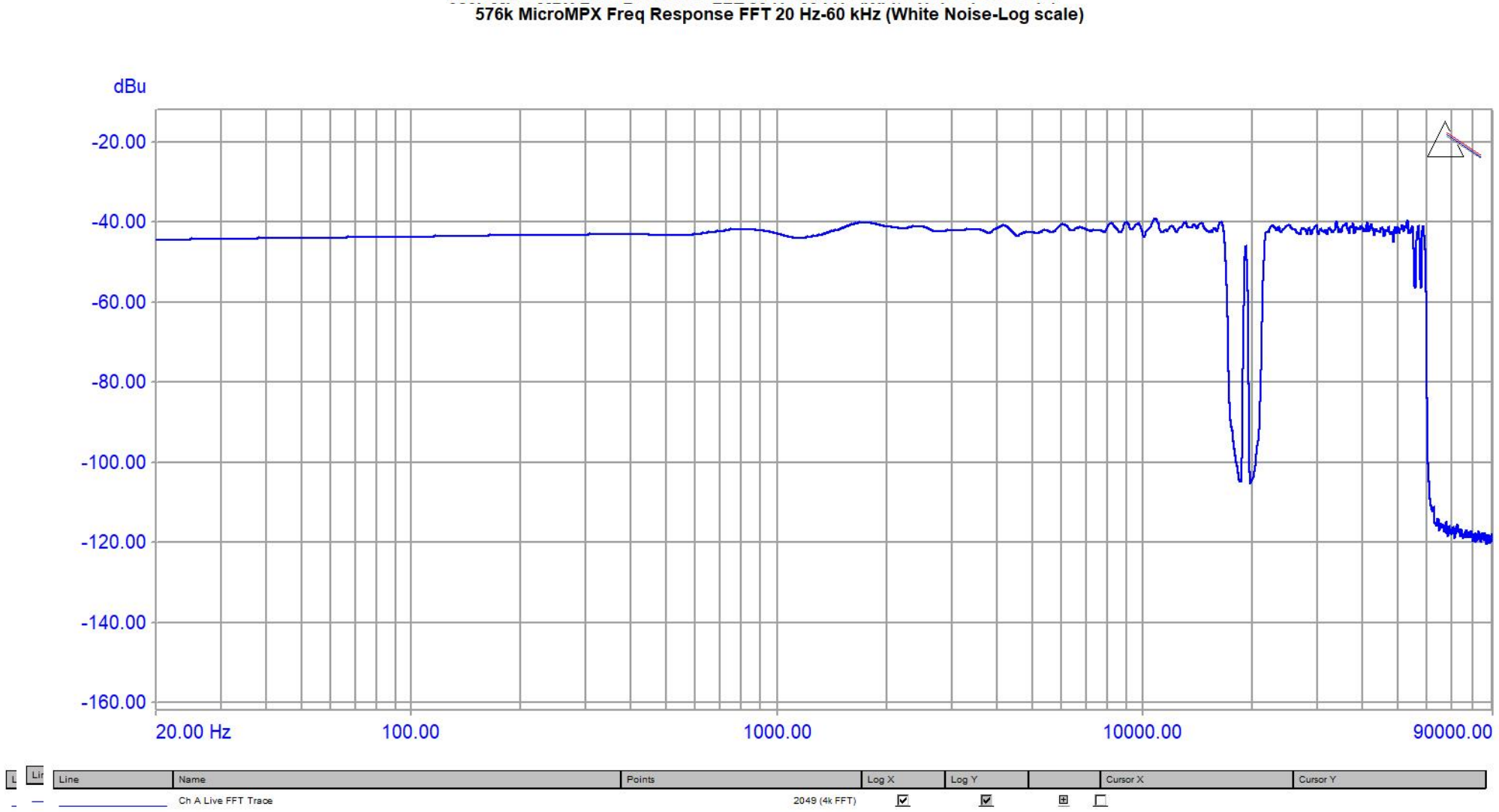
Composite Input Log Sweep



Composite Input Log Sweep



Composite Input Log Sweep



Summary

Some slight degradations

- Stereo separation
- Frequency Response

More testing needed for PPM

- Single file for
- Increase TVC15 runs to 10+
- Try and find some consistency

Also more contestants (Digigram and ??)

And now, it’s time for…

Shane’s Takeaways

Shane's Takeaways

Only two compressed MPX methods available
- MicroMPX and APT MPX (Hans and Hartmut)
- Two different approaches – each with + and –

Depending on hardware, either could support SFN
- Software version only on MicroMPX

Implementations of MicroMPX are consistent – but some differences in hardware (A/D, etc.)

AES MPX offers better performance (morte testing needed)

APT MPX (subjectively) performs best in terms of overall audio

Shane's Takewaways

MicroMPX was the winner in terms of stereo separation on compressed modes

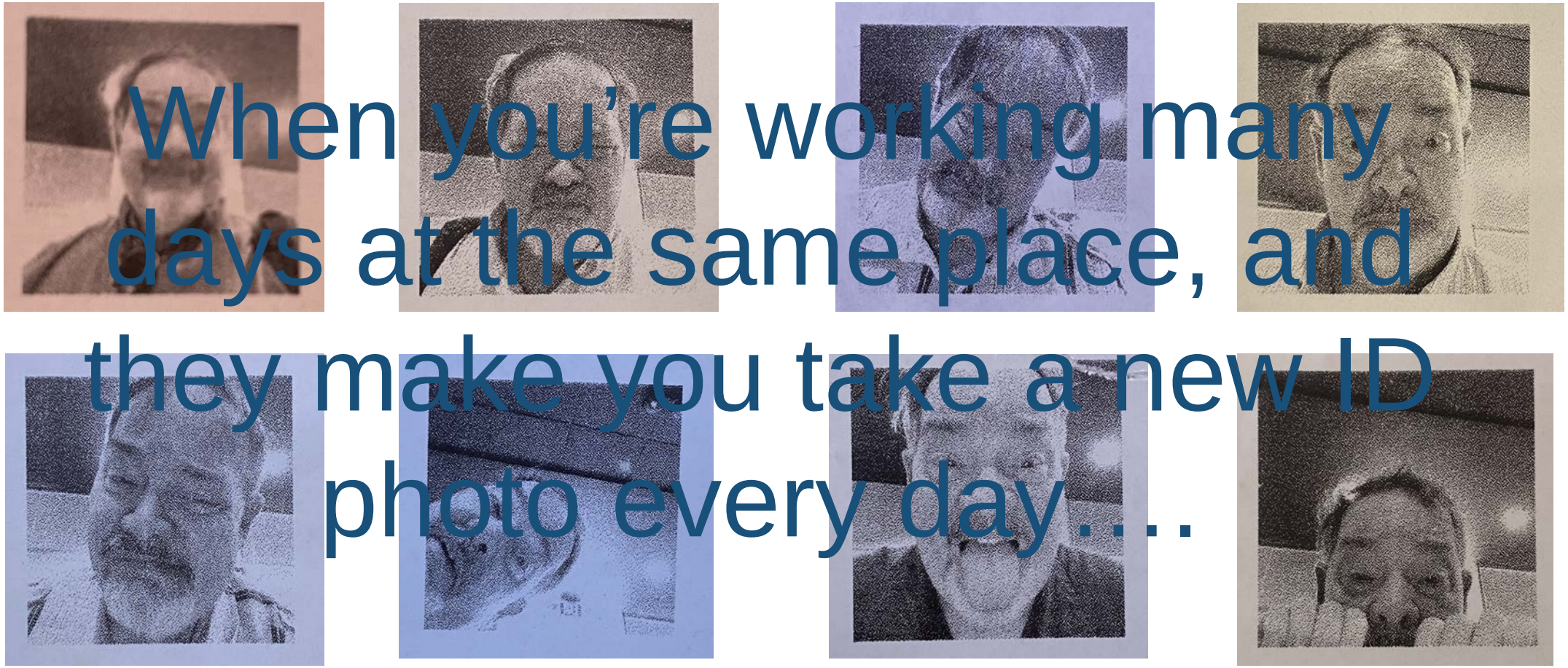
Watermark Encoding tests seemed to indicate
That all codecs will pass the signal relatively well, though there were some inconsistencies in the data. More testing needed

All codecs offer some means of mitigating packet loss and the effects thereof. Future testing will explore this aspect.

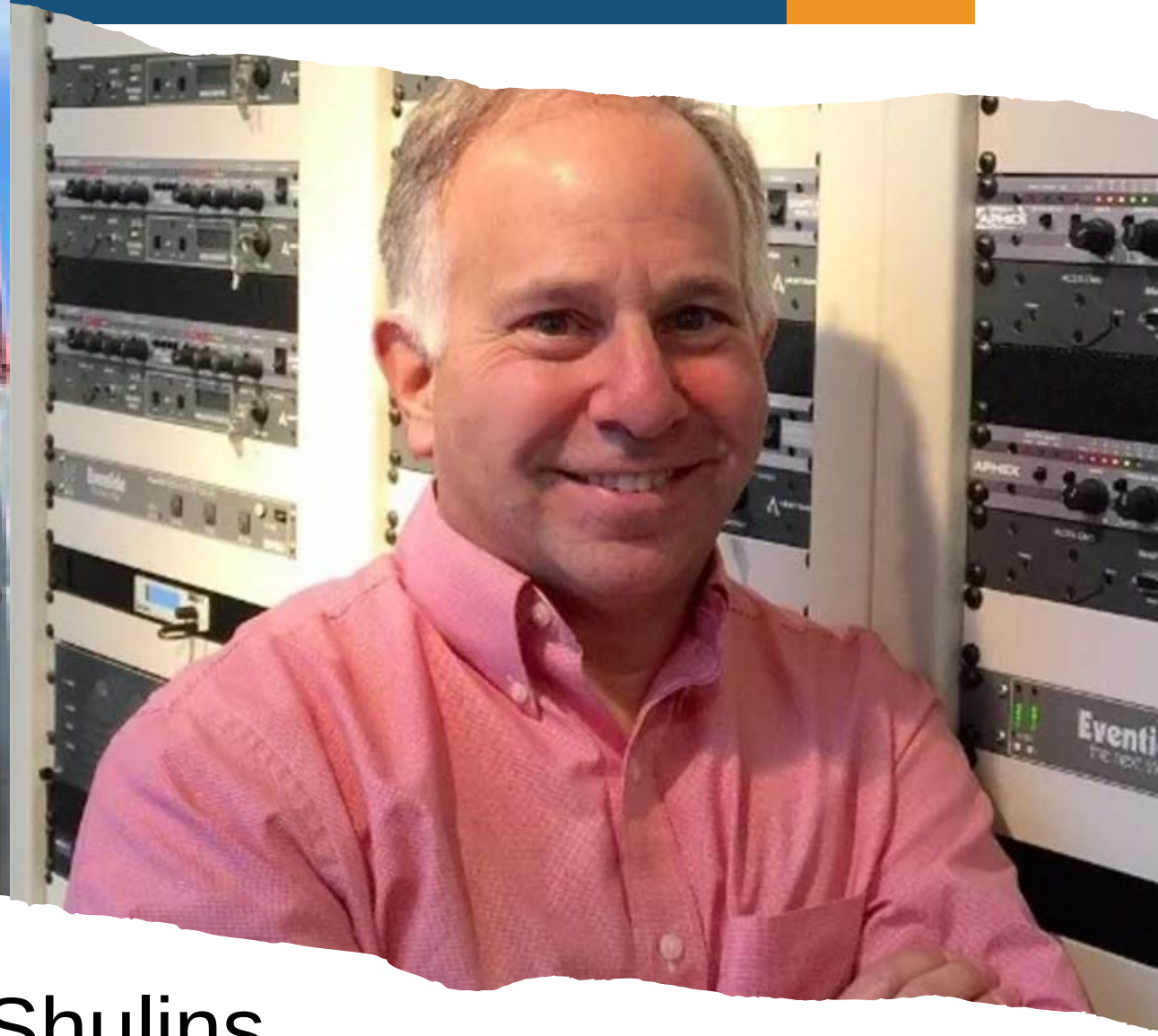
Also plan ‘Null’ testing to hear ‘what gets thrown out’ of the various compression methods

Choice of compression aside, it comes down to ‘bells and whistles’

ID Photo Collage



When you're working many days at the same place, and they make you take a new ID photo every day….



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