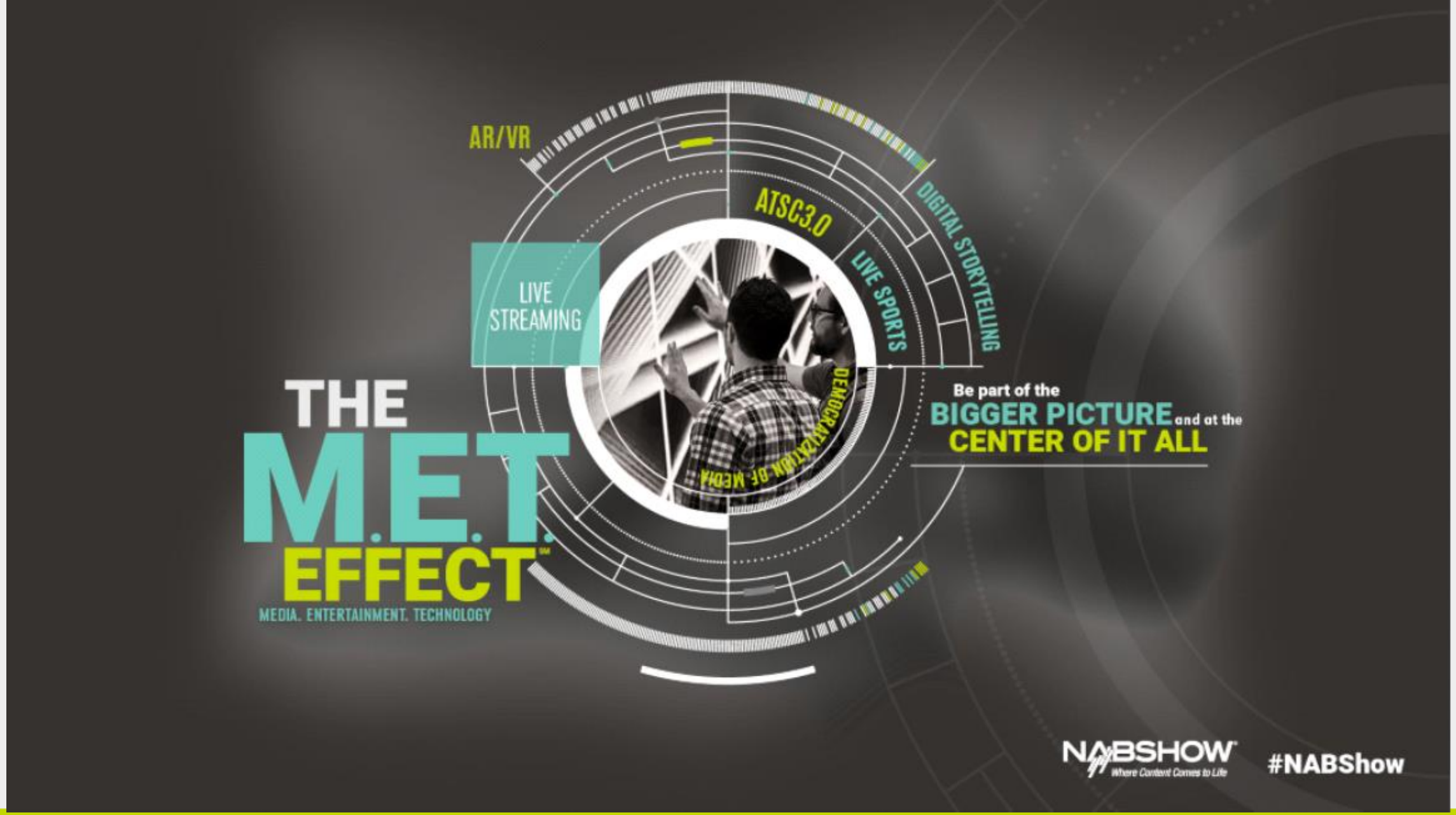

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The Effects of BIT RATE REDUCTION ON PHYCHOACOUSTICAL WATERMARKS

2017 NAB BEIC Conference

Sunday April 23, 2017 Las Vegas, NV

Paul Shulins, Director of Technical Operations

Beasley Broadcast Group, Boston, MA

Why this is important to understand?

- Watermarks are commonly used as a key part of a system to estimate radio and TV audiences
- Not all source material is delivered to the broadcast facility in a linear format
- Not all broadcast chains are linear. HD Radio is not linear.
- We do not yet fully understand the effects of audio compression with regard to the transmission of acoustical watermarks
- This could have a significant effect on reported ratings.

Phases of the research:

- Define the goals
- Engineer Test Setup
- Acquire equipment
- Obtain Permissions
- Part1: Verify the test devices are valid and correlate to real world effects
- Part2: Test for sensitivities to amplitude changes
- Part 3: Run a control test for repeatability
- Part 4: Test Different format music
- Part 5: Test different audio compression algorithms

How to measure Watermark transmission?

- Nielsen PPM Monitor
- Telos TVC Monitor
- Limitations of Nielsen Monitor Capabilities
- TVC Capabilities
- Confidence Level
- Reset Interval Count

How to measure Watermark Transmission?

Legacy Arbitron PPM Confidence Monitor

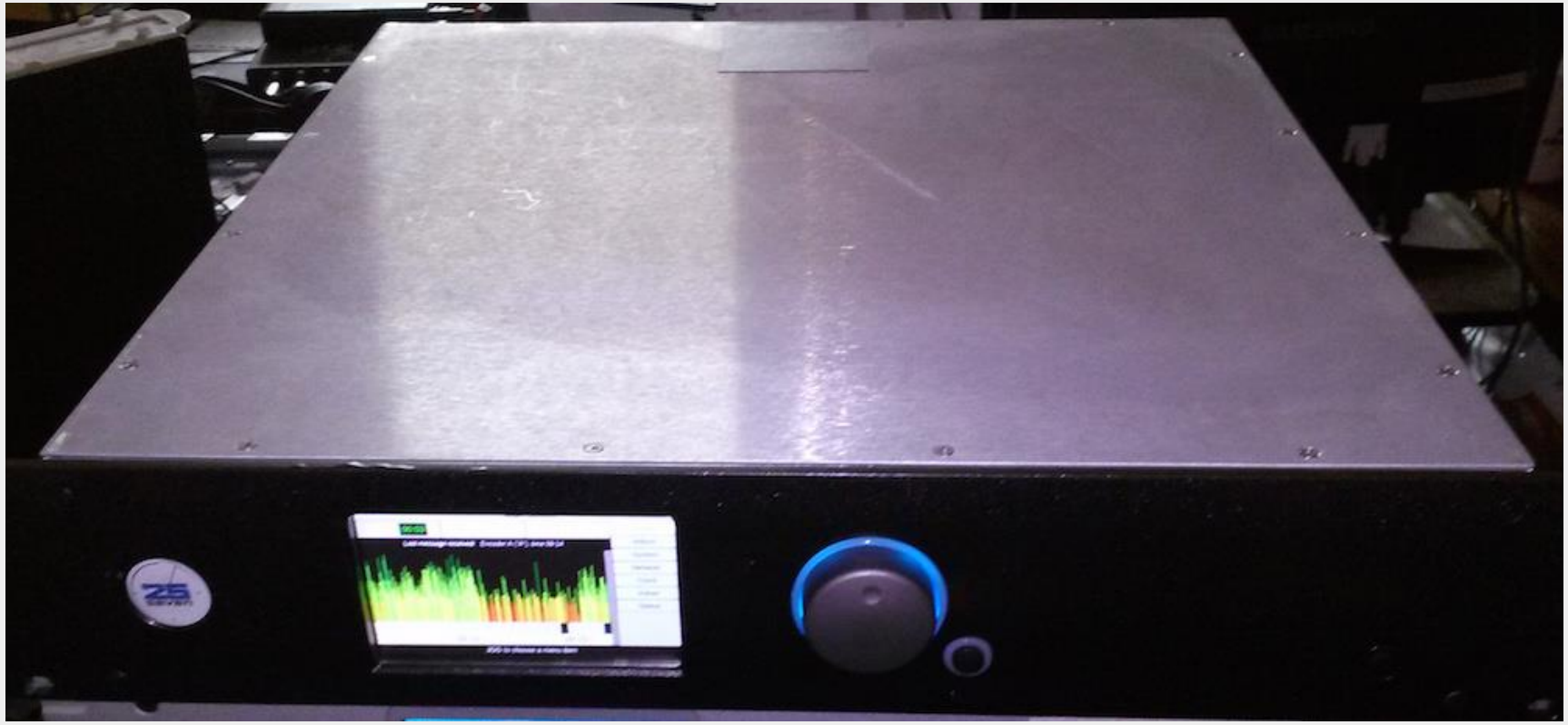
New Nielsen PPM Confidence Monitor

Telos Voltair

3 Parts to this research Project

- Test the TVC for correlation with Nielsen Meter Counts
- Evaluate the effects of bit rate reduction *BEFORE* PPM Encoding
- Evaluate the effects of bit rate reduction *AFTER* PPM Encoding

TVC
Telos TVC Monitor



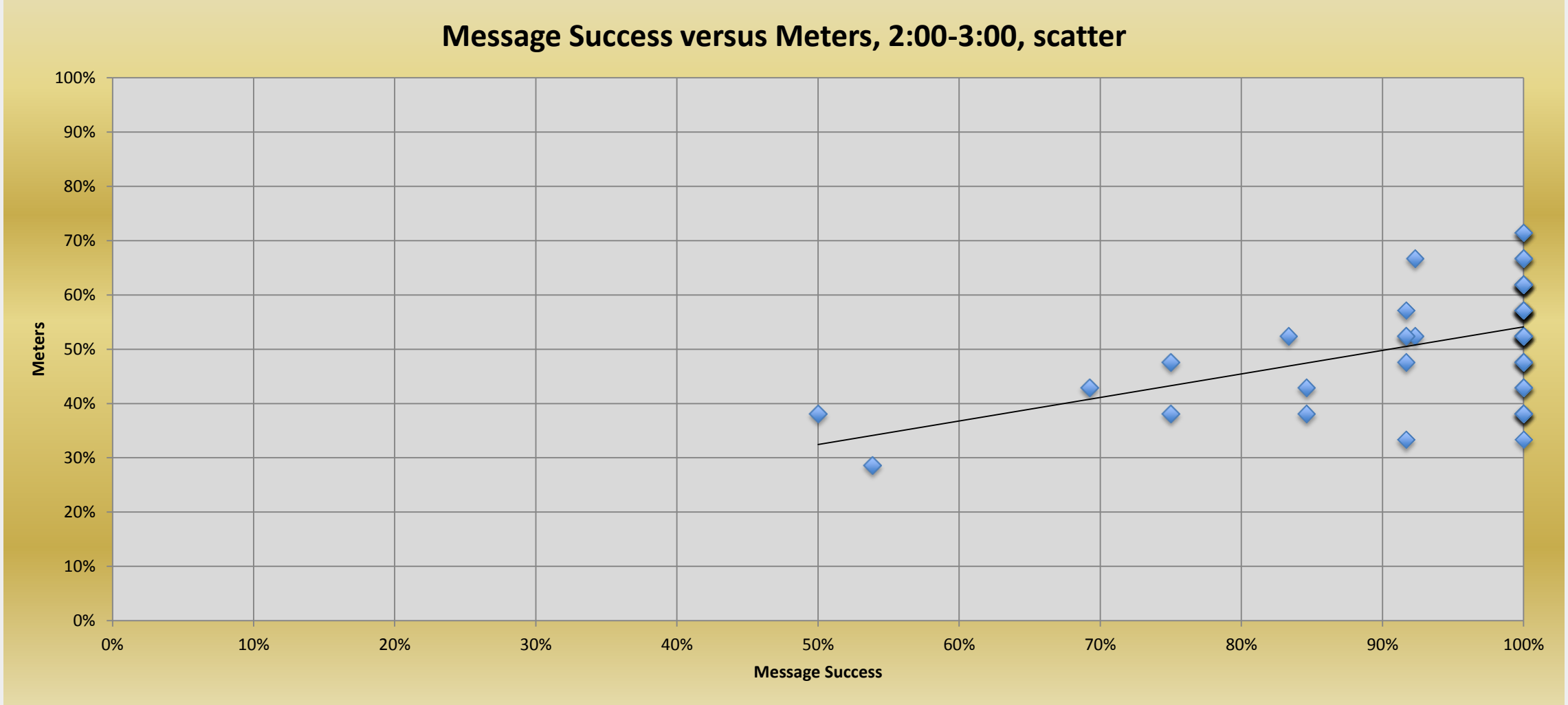
TVC Reporting capabilities

- IP Port with 400 millisecond updates
- Confidence level 0.00-1.00
- Reset Interval Indication
- Designed a program to capture and monitor data stream output from TVC
- This program counts the reset intervals per minute or per 10 second time frame depending on the duration of material being measured
- Program averages confidence level per minute or per 10 second time frame
- Used 1 minute averaging for long form analysis
- Used 10 second averaging for individual songs

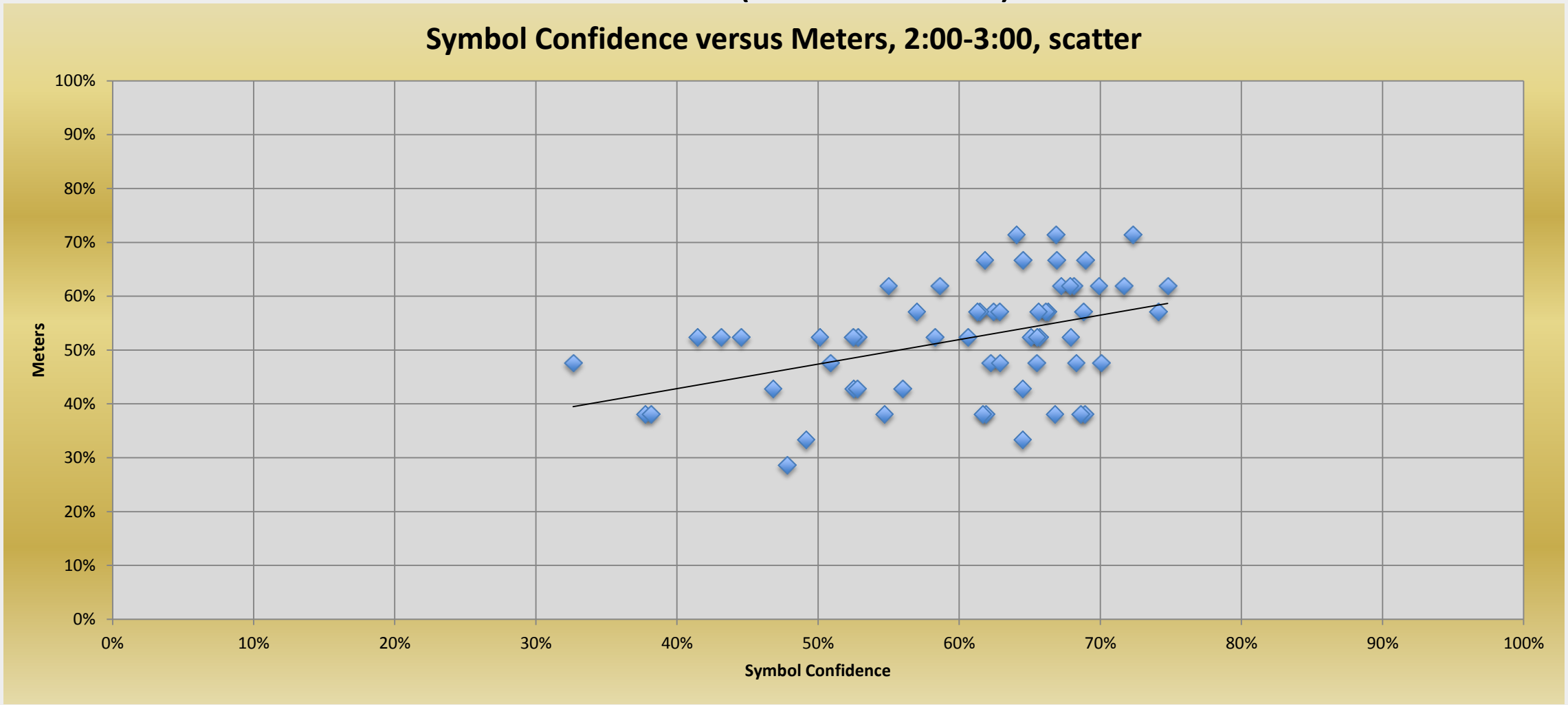
TVC Correlation with Real world results from Nielsen

- Several days of recording each station off the air from a tuner (Analog FM)
- Used 3 different musical formats (Hip Hop, Country, Soft Rock)
- Program averages each minute confidence level
- Program counts reset intervals/hour
- Raw meter count data from Nielsen for the same time period acquired
- Graphing same scale “X” axis for time to compare results of meter count verses confidence level and reset interval counts

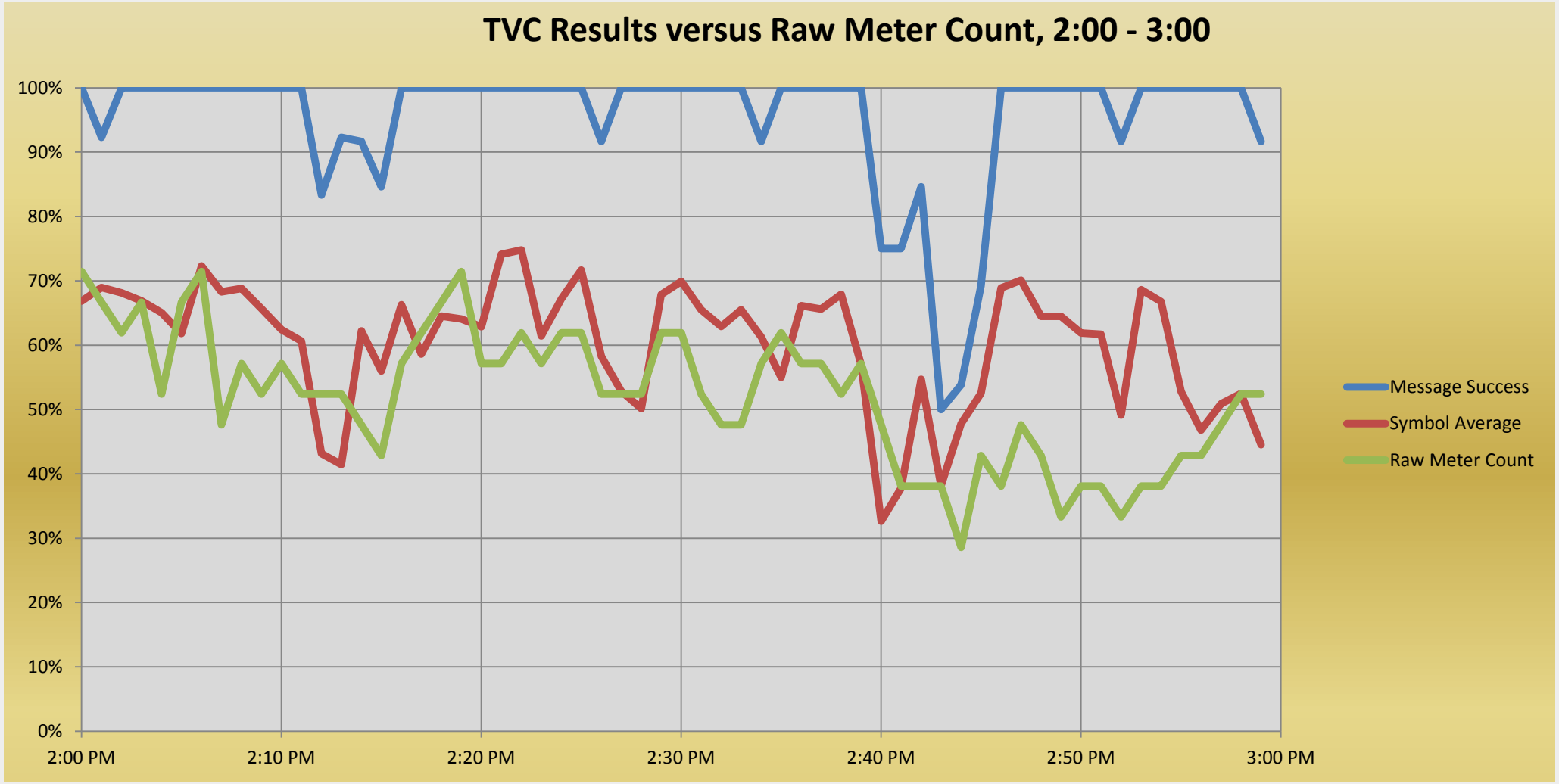
TVC Correlation with Nielsen Meter Counts (Classic Rock)



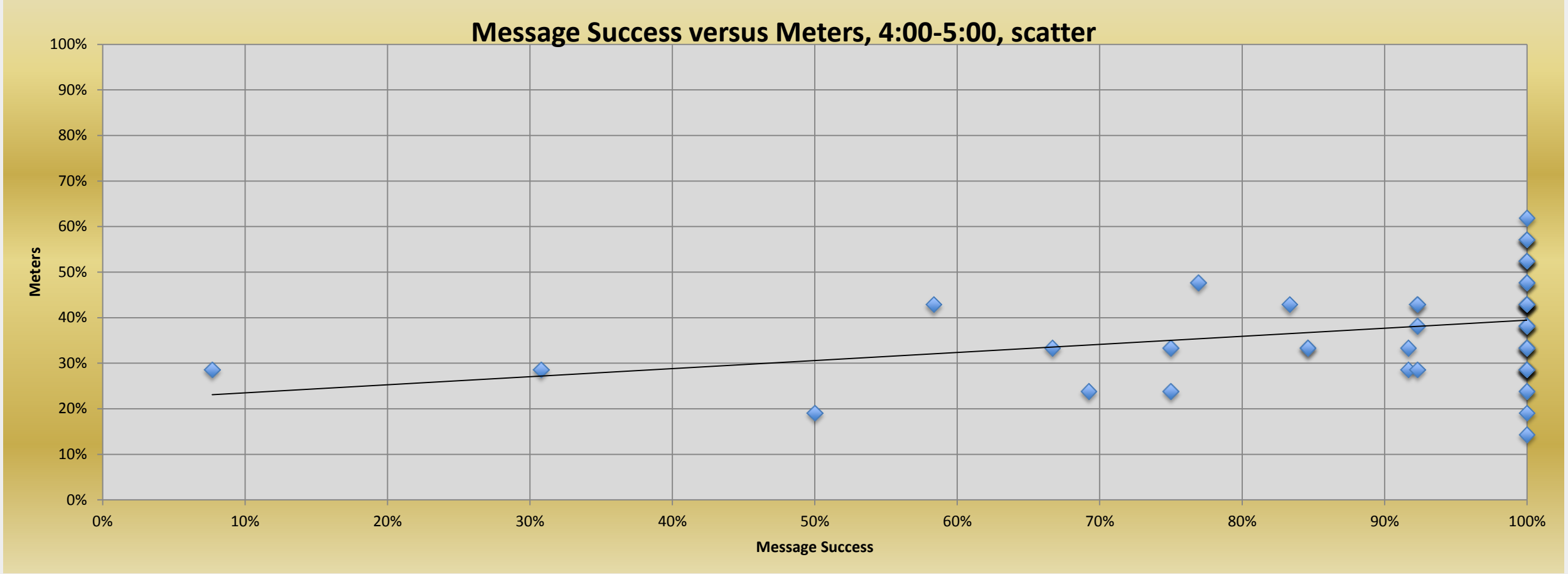
TVC Correlation with Nielsen Meter Counts (Classic Rock)



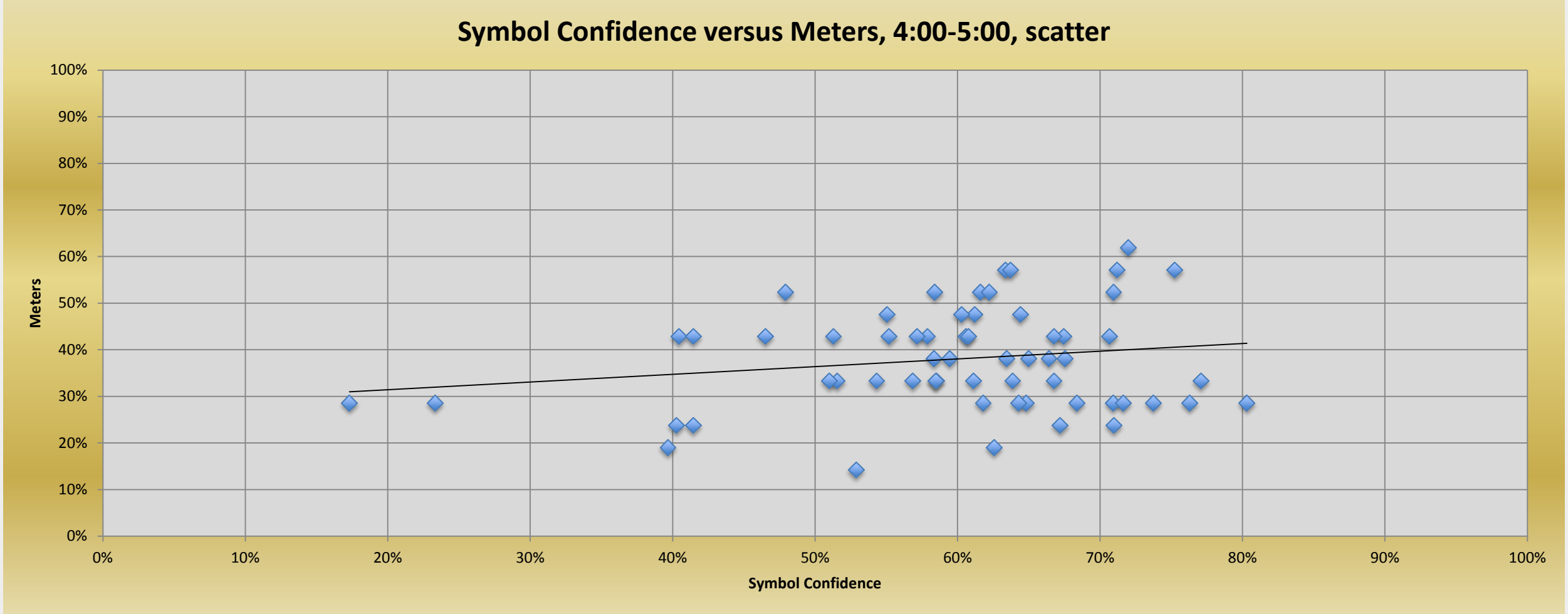
TVC Correlation with Nielsen Meter Counts (Classic Rock)



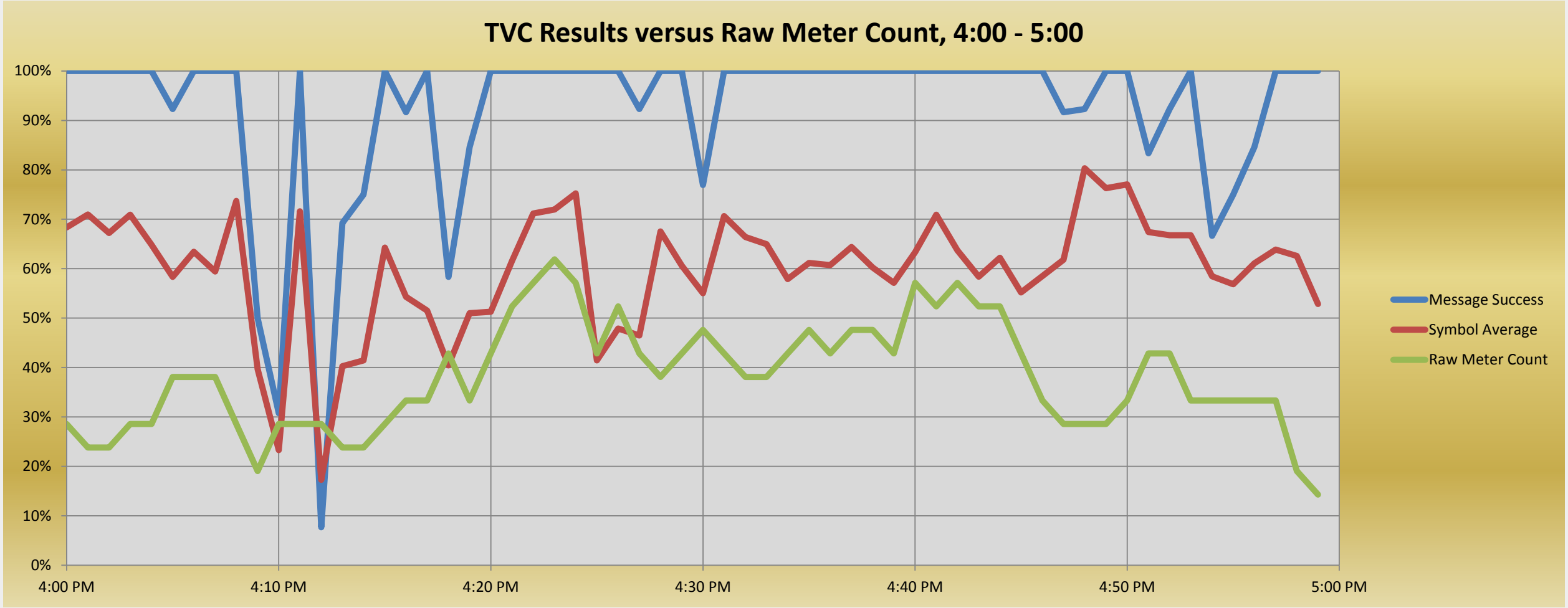
TVC Correlation with Nielsen Meter Counts (Classic Rock)



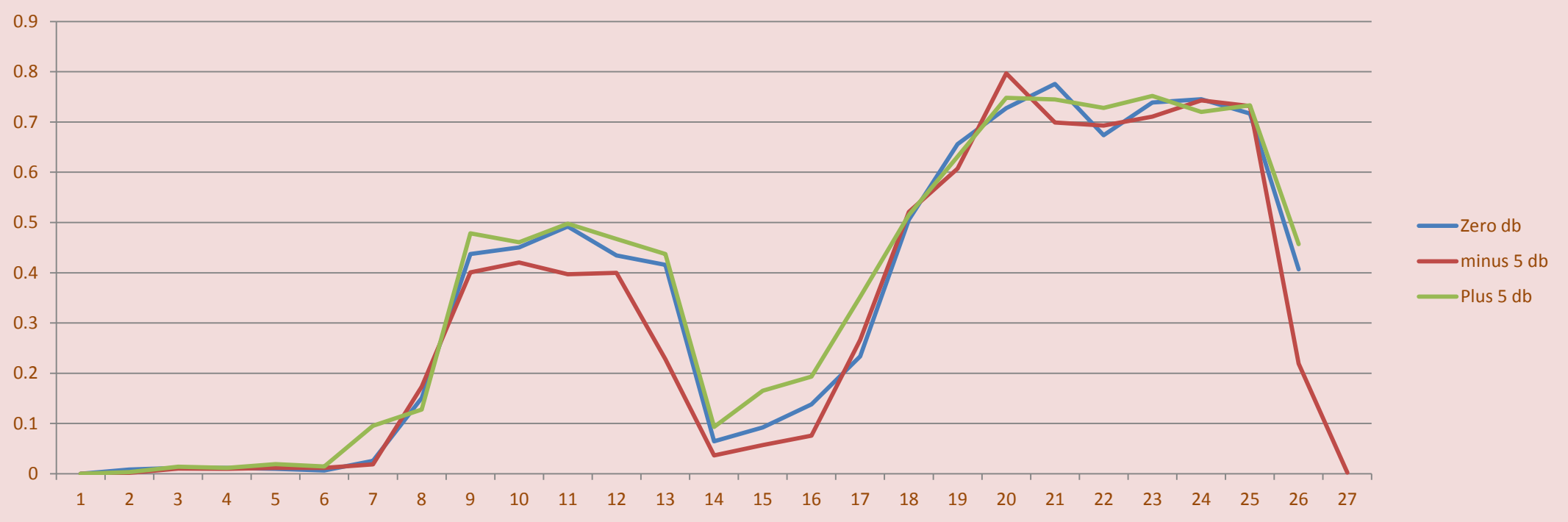
TVC Correlation with Nielsen Meter Counts (Classic Rock)



TVC Correlation with Nielsen Meter Counts (Classic Rock)



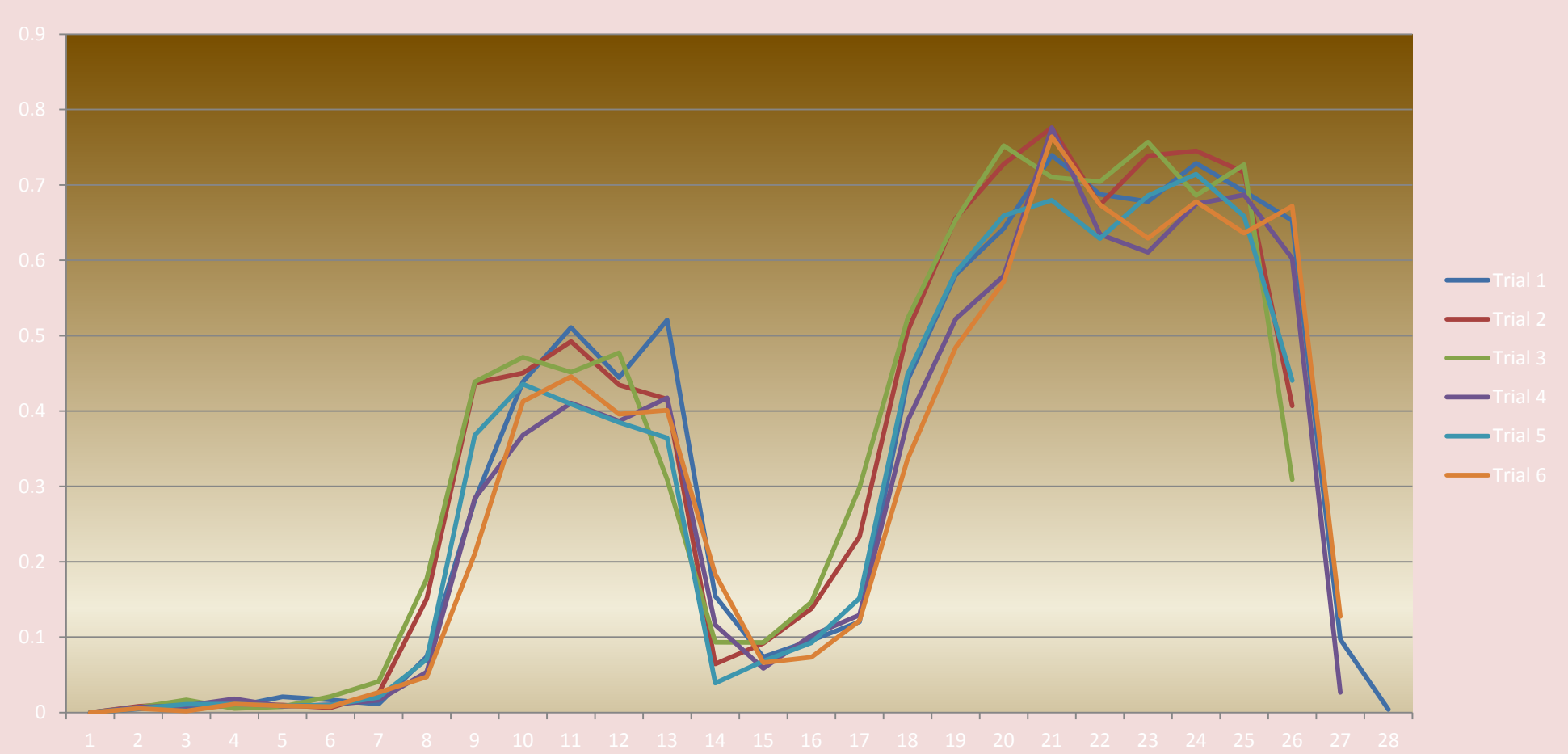
TVC Immunity to different Audio Drive levels



Vertical Scale: Confidence Level
Horizontal Scale: seconds into song (x10)

Song: Adele,
Hello

TVC repeatability



Vertical Scale: Confidence Level
Horizontal Scale: seconds into song (x10)

Song: Adele, Hello

Bit rate reduction testing of music

BEFORE ENCODING

- Different bit rates used
- MP3 Favors Tested:18 kbps/32kbps/64kbps
- AAC 64 kbps
- Reset Interval Indication
- Confidence Level

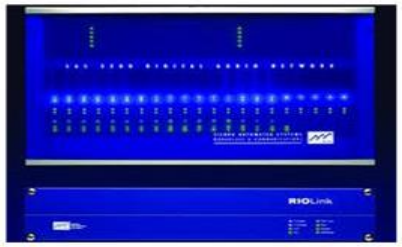
Computer with Audio Files

Unbalanced to Balanced Audio Converter

Aphex Compellor for audio Processing

Nielsen PPM Encoder (analog I/O)

Block diagram of test setup for evaluating audio files that were bit rate reduced BEFORE watermark encoding

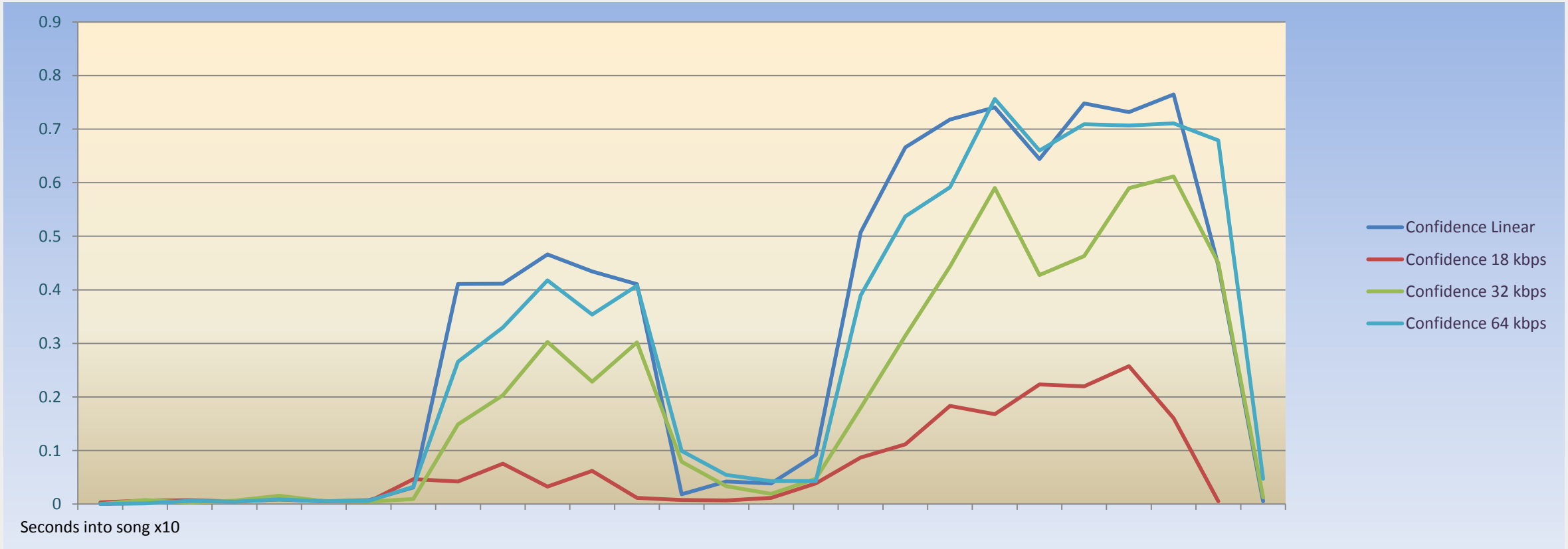


SAS 32KD Audio Router

Telos TVC

PC Running data capture program

Bit rate reduction results Song #1



Vertical Scale: Confidence Level
Horizontal Scale: seconds into song (x10)

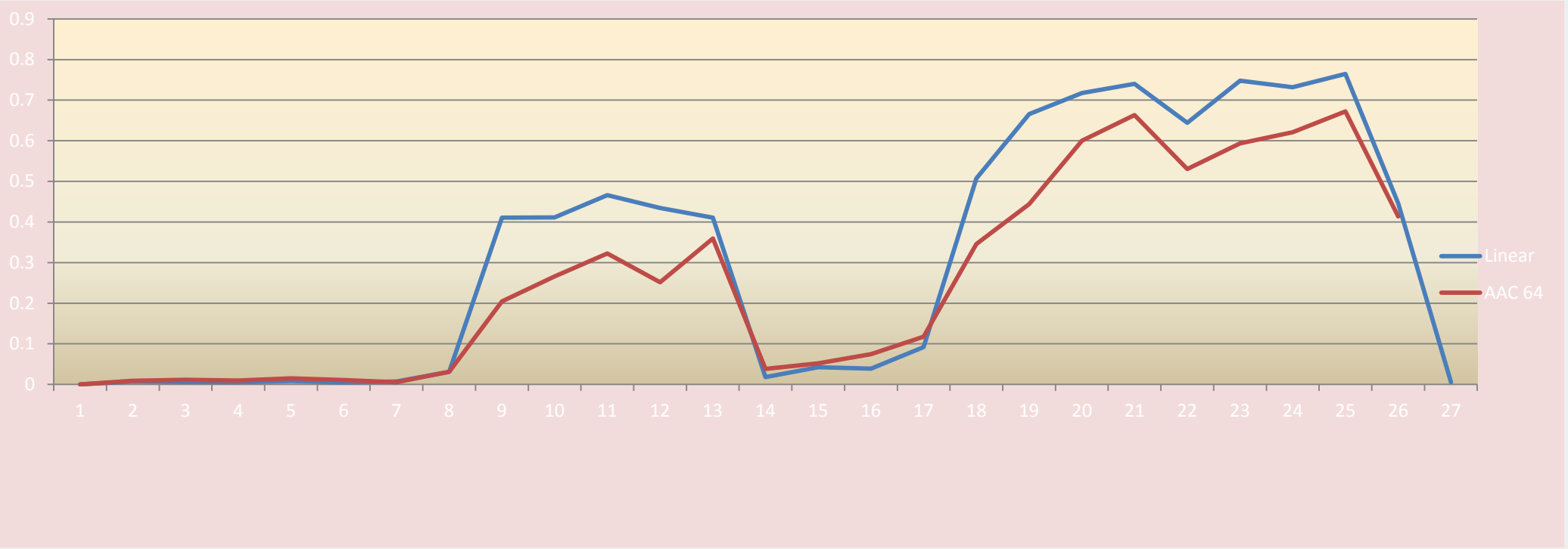
Linear

32 kbps

18 kbps

Song: Adele, Hello (soft rock)

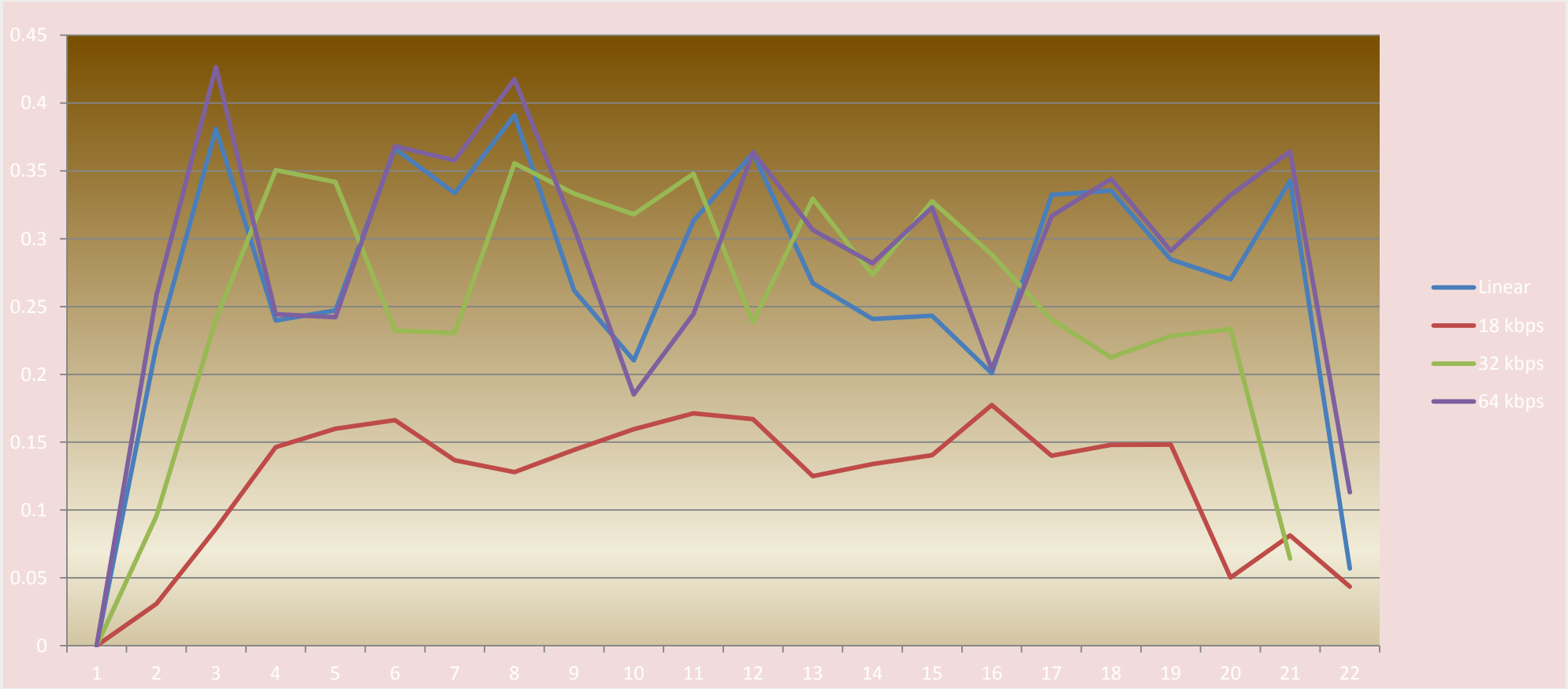
Bit rate reduction results Song #1



Vertical Scale: Confidence Level
Horizontal Scale: seconds into song (x10)

Song: Adele,
Hello (soft rock)

Bit rate reduction results Song #2



Vertical Scale: Confidence Level
Horizontal Scale: seconds into song (x10)
Note: Scale-Maximum confidence below 0.45

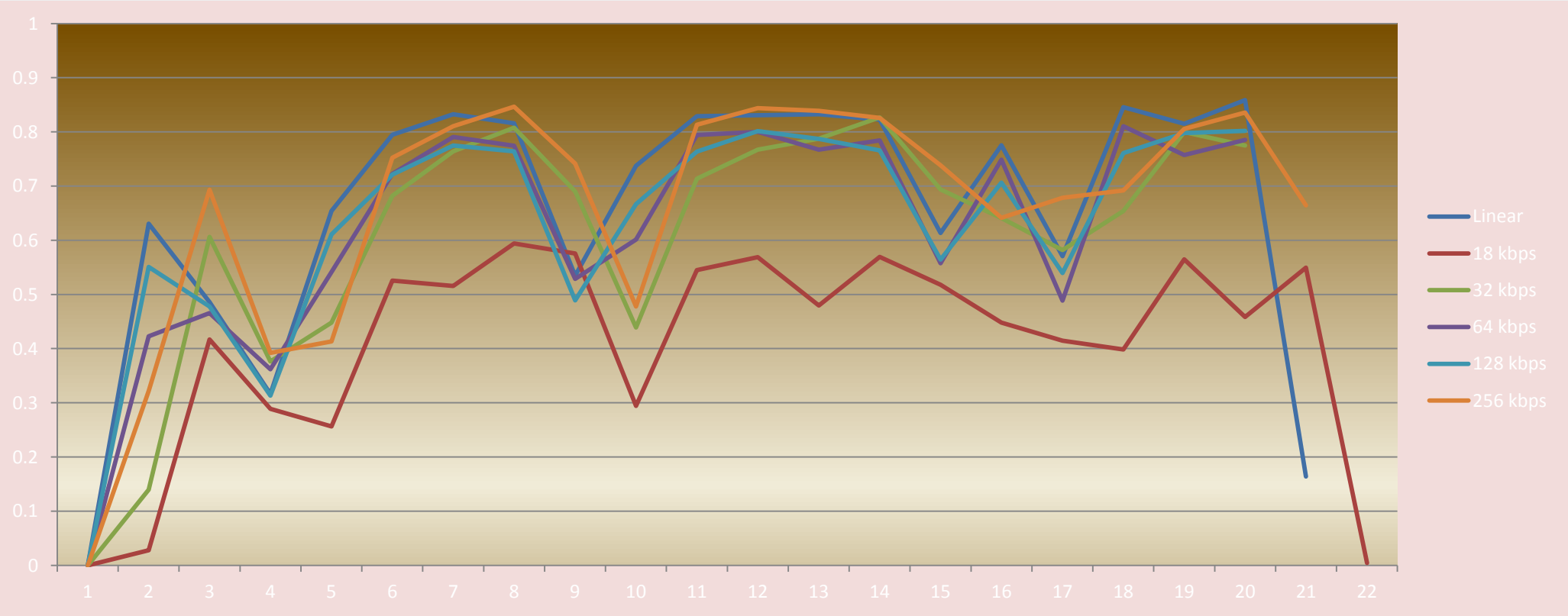
Linear

32 kbps

18 kbps

Song: The Game (hip hop)

Bit rate reduction results Song #3



Vertical Scale: Confidence Level
Horizontal Scale: seconds into song (x10)

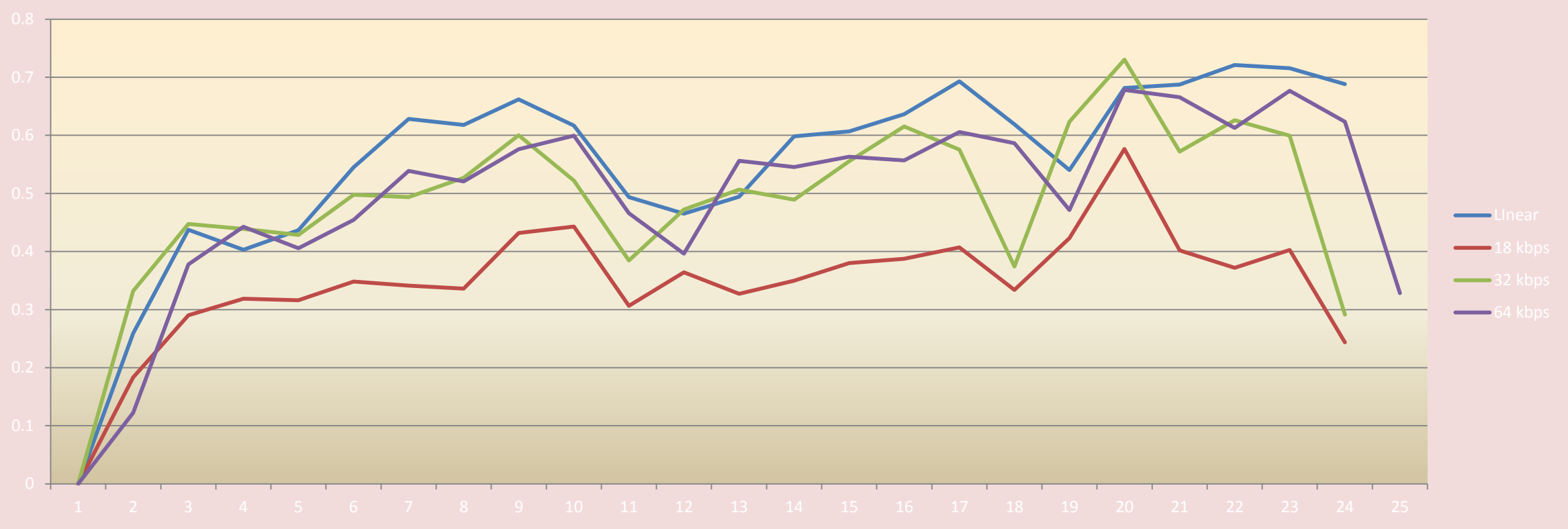
Linear

32 kbps

18 kbps

Song: Jason Aldean (country)

Bit rate reduction results Song #4

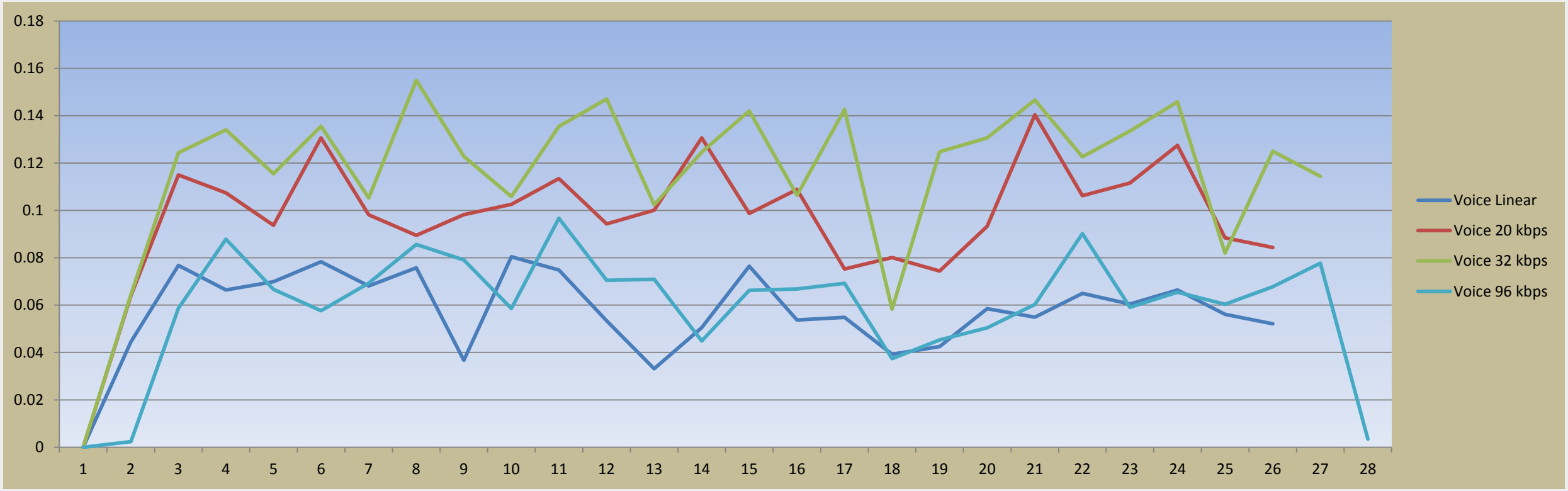


Vertical Scale: Confidence Level
Horizontal Scale: seconds into song (x10)

Linear 32 kbps 18 kbps

Song: Katy Perry: Last Friday Night (soft rock)

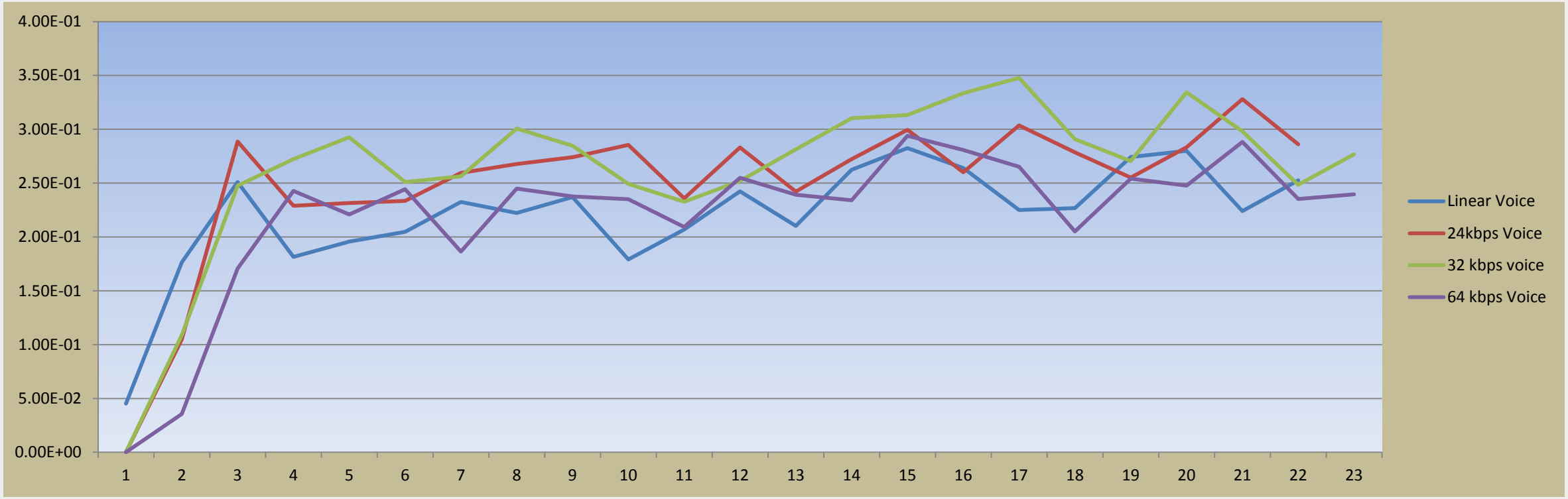
Bit rate reduction results FEMALE VOICE



Vertical Scale: Confidence Level

Horizontal Scale: seconds into voice (x10)

Bit rate reduction results MALE VOICE



Vertical Scale: Confidence Level

Horizontal Scale: seconds into voice (x10)

Bit rate reduction testing of music

AFTER ENCODING

- Different bit rates used
- MP3 Favors Tested:18 kbps/32kbps/64kbps
- AAC 64 KBPS
- Reset Interval Indication
- Confidence Level
- Measurements made off the air from a tuner
- HD Radio Importer configuration adjusted to different bandwidth allocations for each test on the WBQT HD-2 Channel
- 31.1 kbps, 26 kbps, 20 kbps, 15 kbps, and 10 kbps

Audio Vault Computer with Audio Files Runnnig HD2

Aphex Compellor for audio Processing

Nielsen PPM Encoder (analog I/O)

HD Radio Importer (at studio) The setting on this machine determine the bit rate allocation for the HD2 Signal

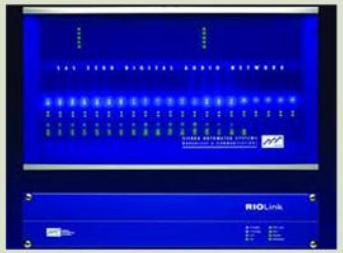
text

BE HD Radio Exporter (at transmitter site)

BE HD Radio Transmitter

Inovonics 632 HD Tuner

SAS 32KD Router



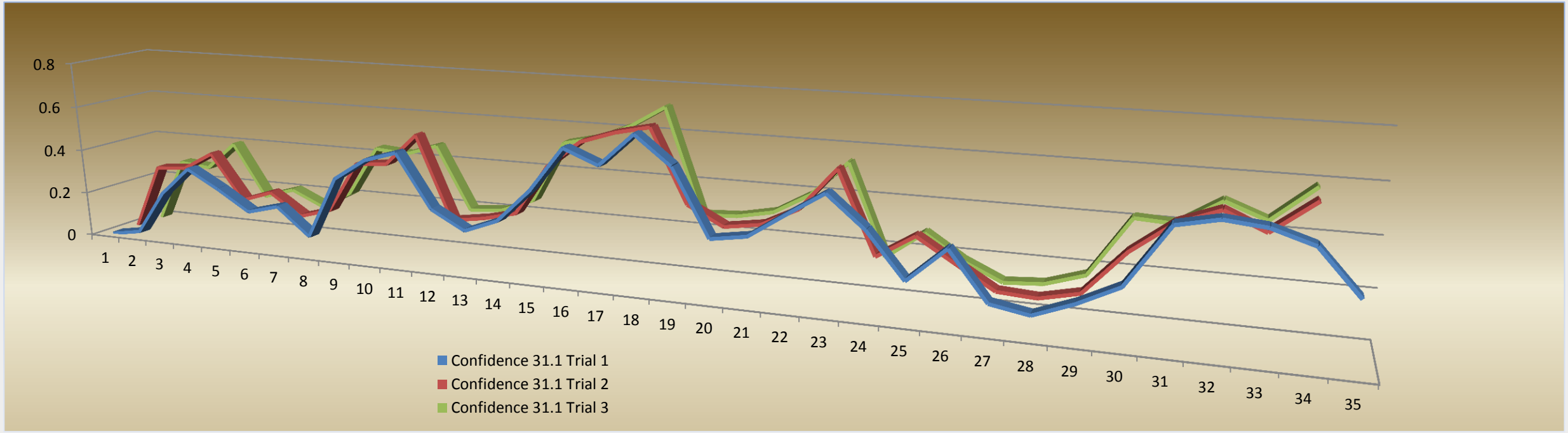
Telos TVC

Ethernet Connection

PC Running data capture program

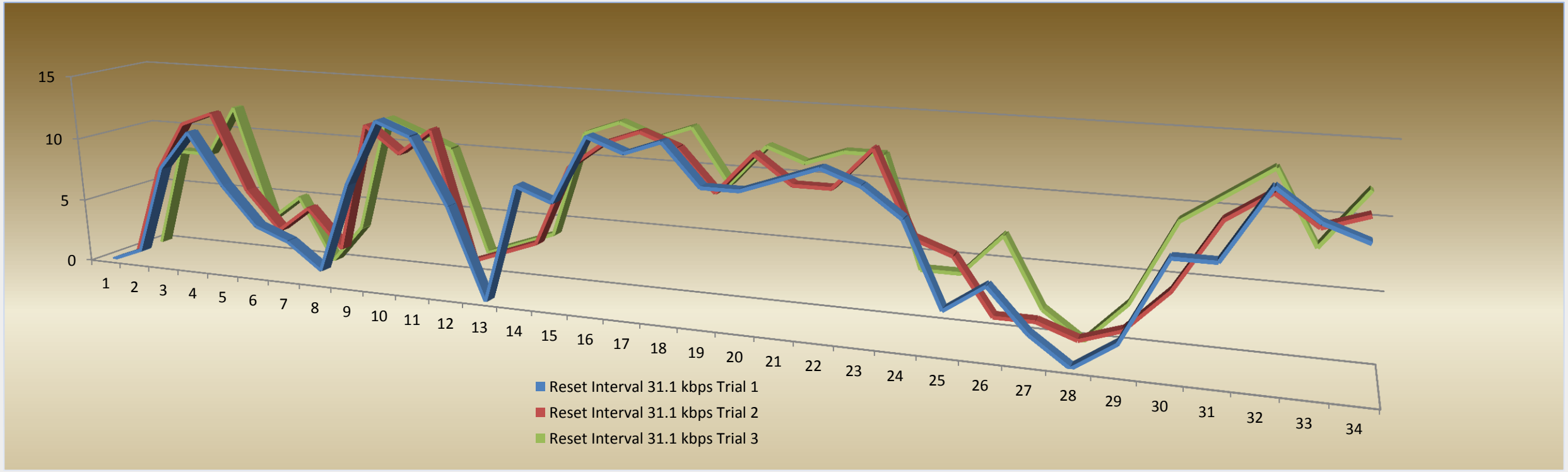
Block diagram of test setup for evaluating audio files that were bit rate reduced AFTER watermark encoding

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



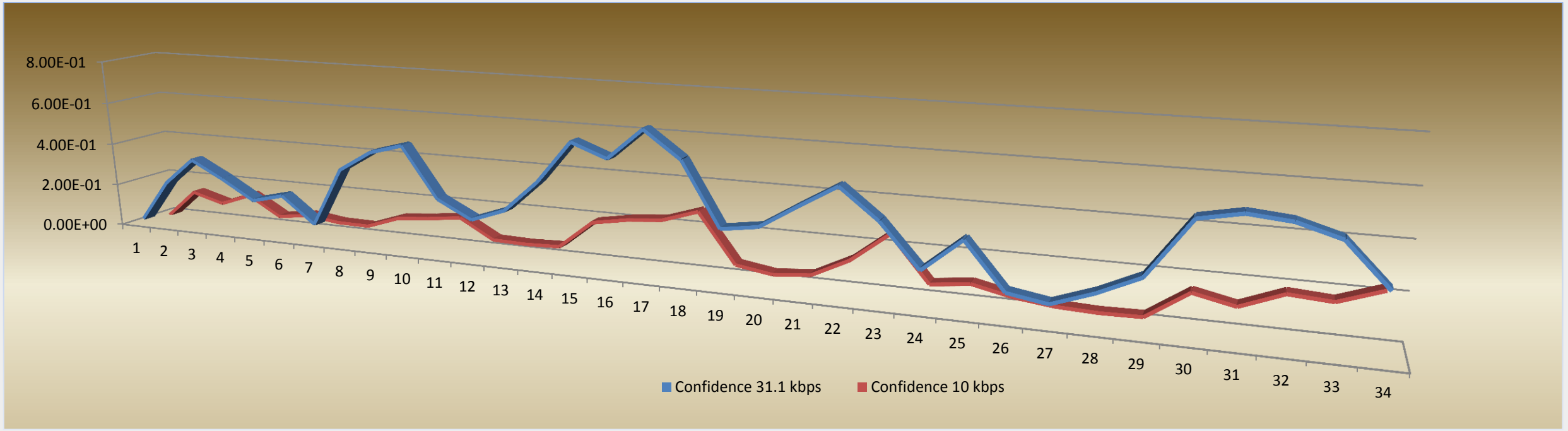
Vertical Scale: Confidence Level
Horizontal Scale: Minutes into program
(Irish Music WBQT HD-2)
3 trials to demonstrate repeatability

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



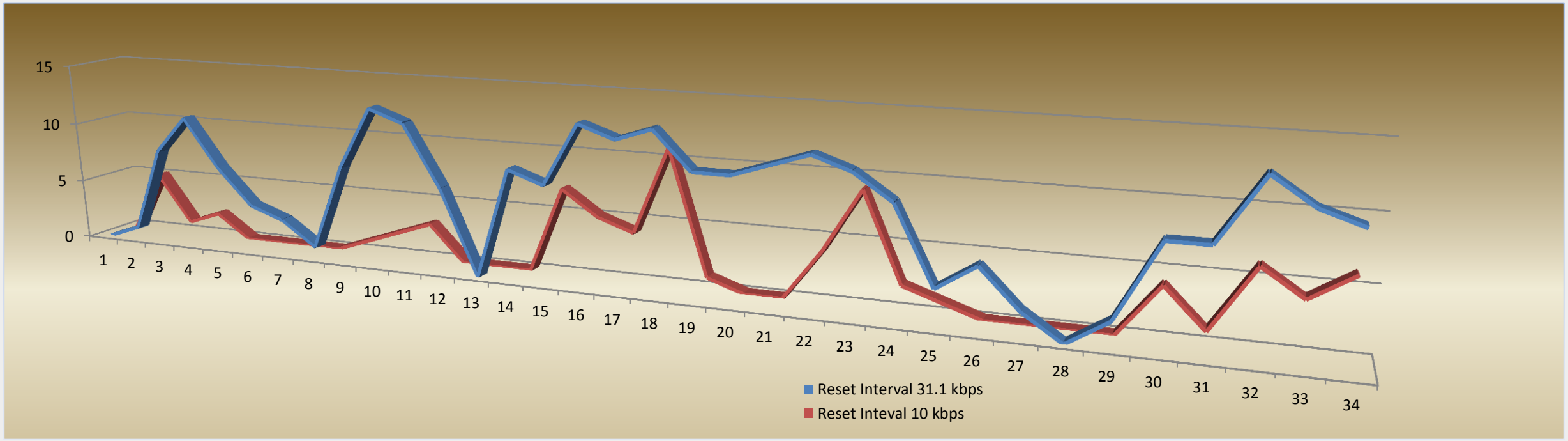
Vertical Scale: Reset Interval Count
Horizontal Scale: Minutes into program
(Irish Music WBQT HD-2)
3 trials to demonstrate repeatability

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



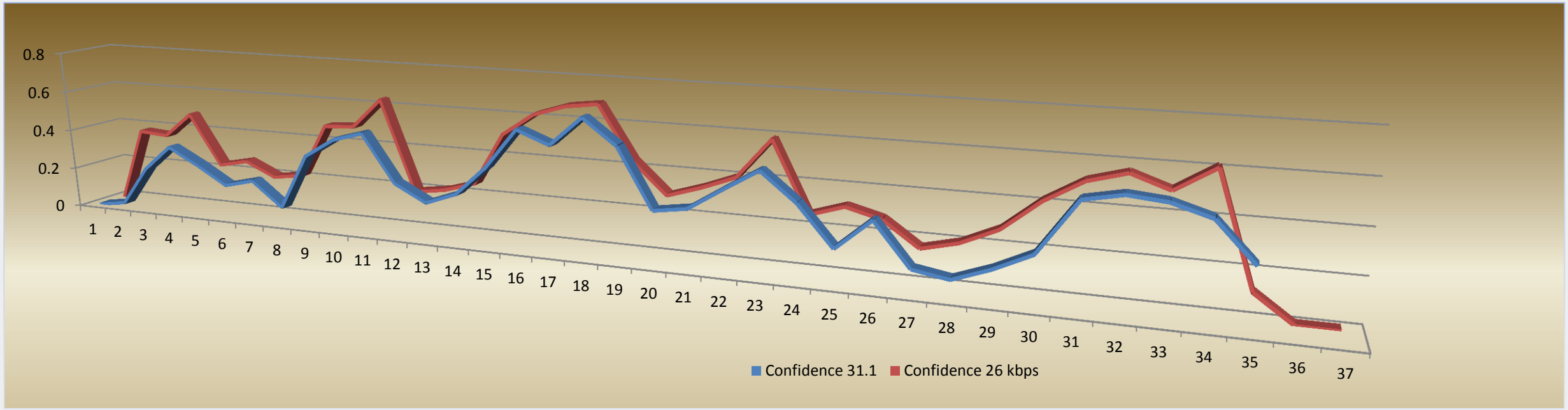
Vertical Scale: Confidence Level
Horizontal Scale: Minutes into program
(Irish Music WBQT HD-2)
31.1kbps is Normal, 10 kbps minimum

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



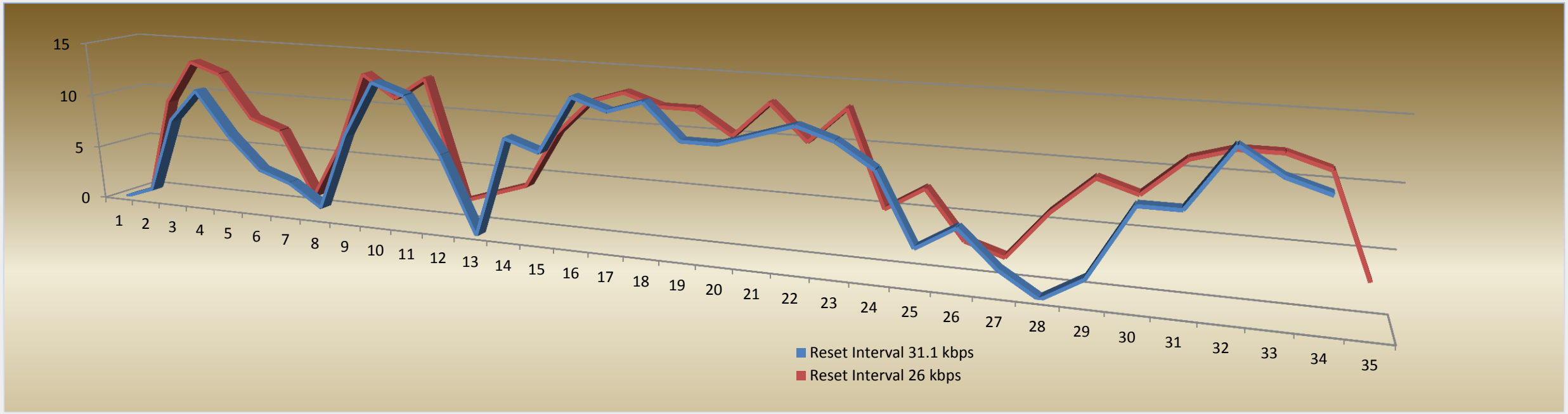
Vertical Scale: Reset Interval Count
Horizontal Scale: Minutes into program
(Irish Music WBQT HD-2)
31.1kbps is Normal, 10 kbps minimum

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



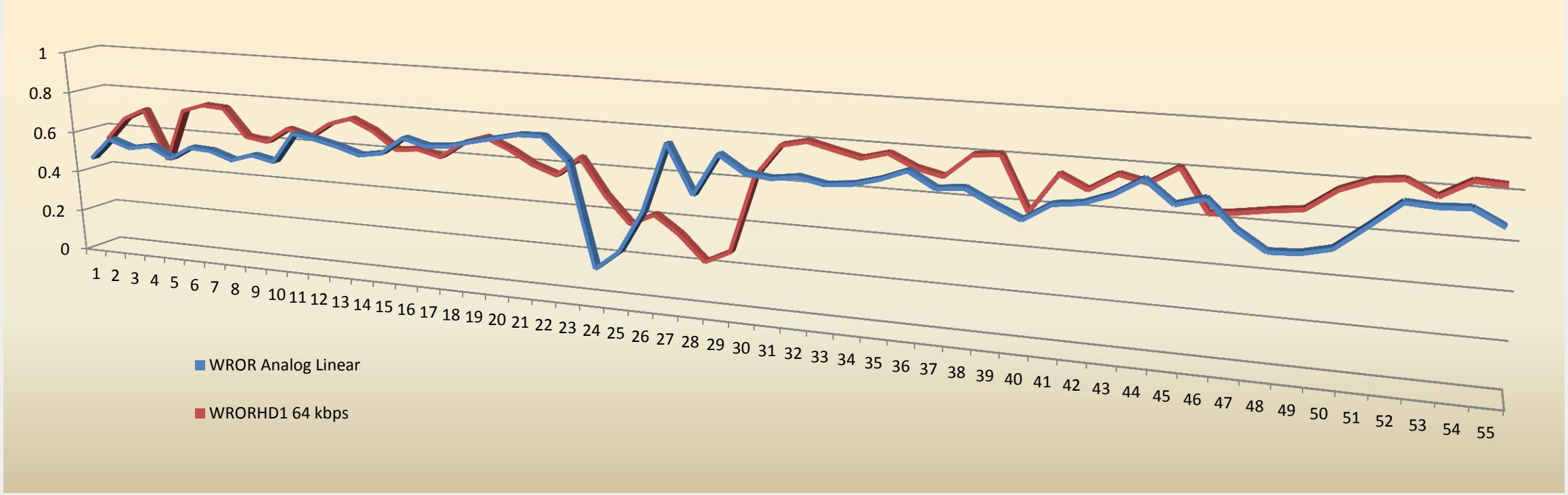
Vertical Scale: Confidence Level
Horizontal Scale: Minutes into program
(Irish Music WBQT HD-2)
31.1 kbps is Normal, 26 kbps second step down

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



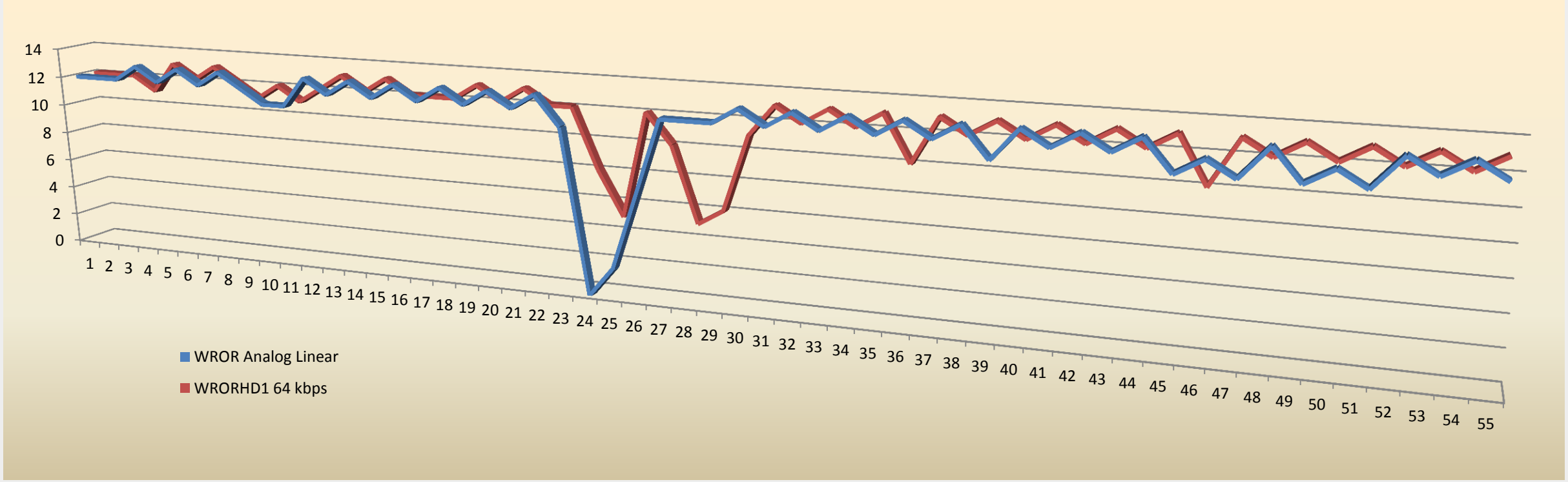
Vertical Scale: Reset Interval Count
Horizontal Scale: Minutes into program (Irish Music WBQT HD-2)
31.1 kbps is Normal, 26 kbps second step down

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



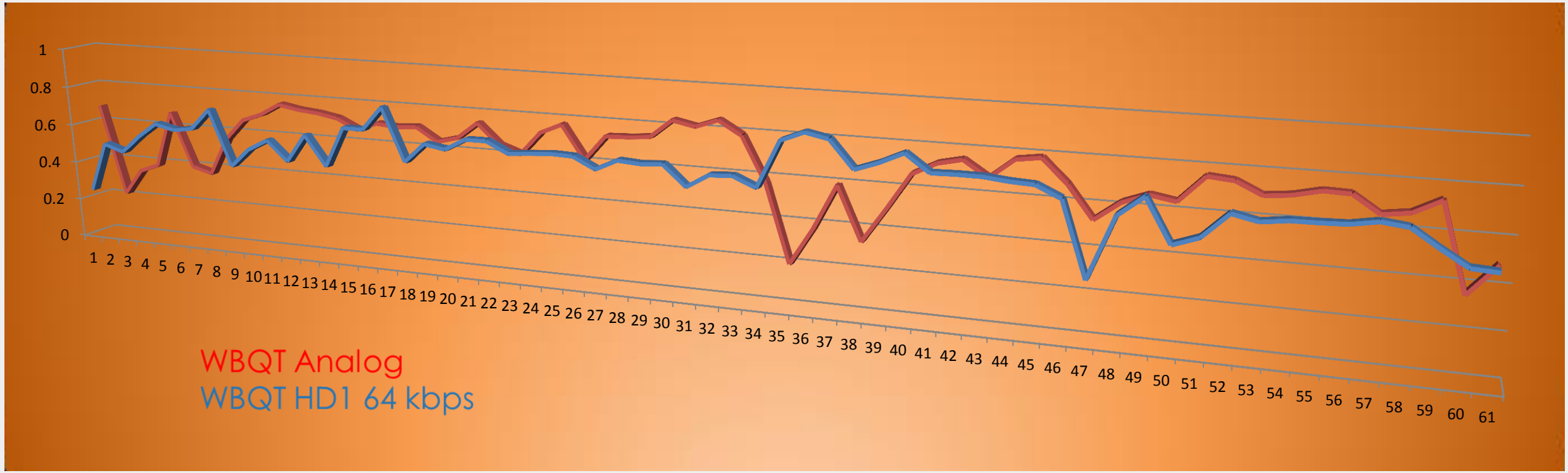
Vertical Scale: Confidence Level
Horizontal Scale: Minutes into program.
WROR (60's 70' and 80's rock) off air test
Analog vs. HD1 @ 64 kbps

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



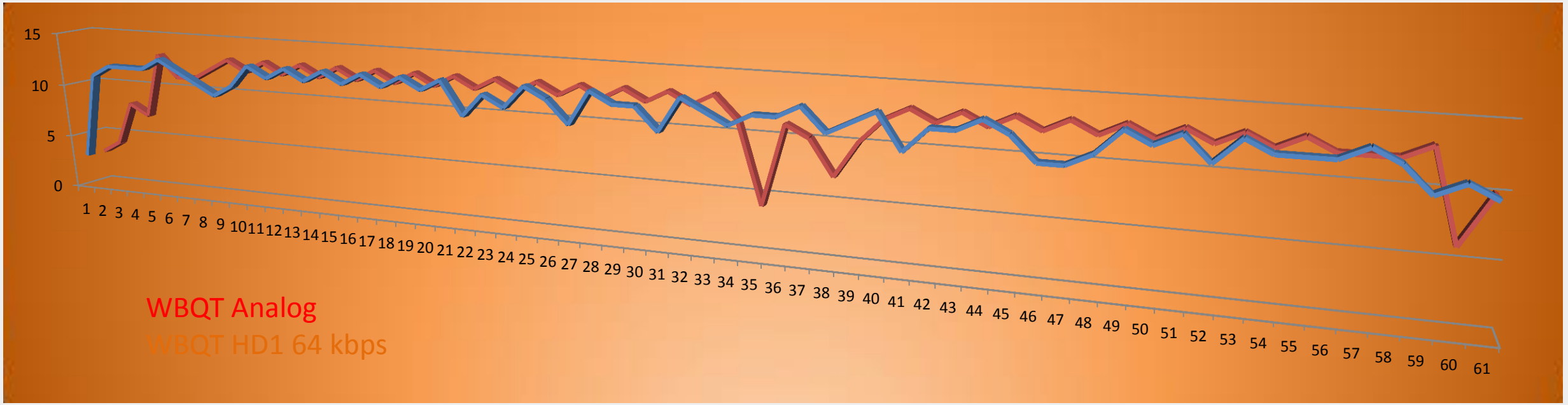
Vertical Scale: Reset Interval Count
Horizontal Scale: Minutes into program.
WROR (60's 70' and 80's rock) off air test analog vs. HD1 @ 64 kbps

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



Vertical Scale: Confidence Level
Horizontal Scale: Minutes into program.
WBQT (Hip Hop) off air test analog vs.
HD1 @ 64 kbps

Part 3: Over the air tests
Bit Rate reduction AFTER ENCODING



Vertical Scale: Reset Interval Count
Horizontal Scale: Minutes into program.
WBQT (Hip Hop) off air test analog vs.
HD1 @ 64 kbps

Conclusions:

- Bit Rate Reduction does have an effect on passing the acoustical watermarks
- Most music benefits from a higher bit rate, although 64 kbps does not seem to suffer much compared to linear
- Voice seems to benefit from MP3 compression especially at 32 kbps
- These measurements are a moving target and have many variables. The more data obtained, the higher confidence in the meaning of the measurements
- More study is needed to raise the confidence in the ideas presented here today.

Special Thanks to:

- Telos for the TVC Evaluation
- Milford Smith and Greater Media for the ability to test on air during the experimental period
- Dan Griscom for his guidance in programming and designing tests
- Dr. Barry Blesser for his advice and knowledge
- Geoff Steadman for his insight and loaner equipment
- Ted Ruscitti for advice and guidance
- Neil Werfel Greater Media for assistance in the lab
- Mark Pagliarulo for adjusting the HD Radio Importers for testing
- Justin Weiner for obtaining test audio samples

Questions?