

# SoundCheck®

THE AUDIO TEST AND MEASUREMENT SYSTEM



## Practical Implementation of Perceptual Rub & Buzz Distortion and Experimental Results

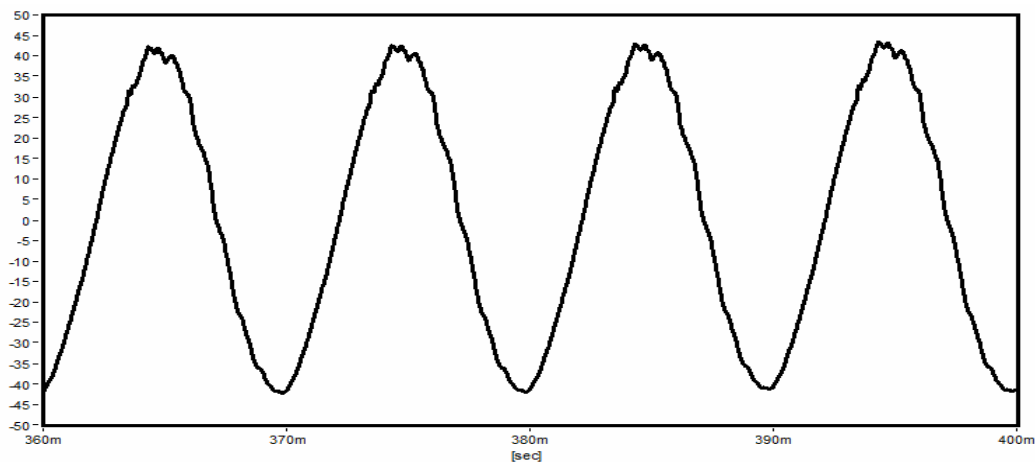
Steve Temme of Listen, Inc.

# Outline

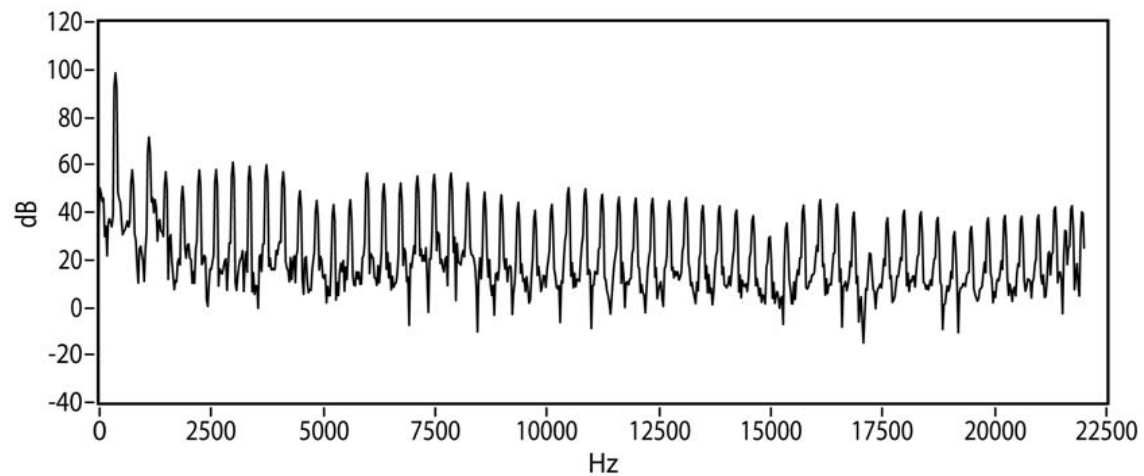
- What is “Rub & Buzz”?
- Test signal and high order harmonic analysis used to measure traditional Rub & Buzz in %
- CLEAR algorithm used to measure perceptual Rub & Buzz loudness in phons
- Experimental Data and Results
  - Listening Evaluation
  - Measurement Procedure
  - Data Analysis
  - Noise Immunity Tests and Results

# Rub & Buzz Defect

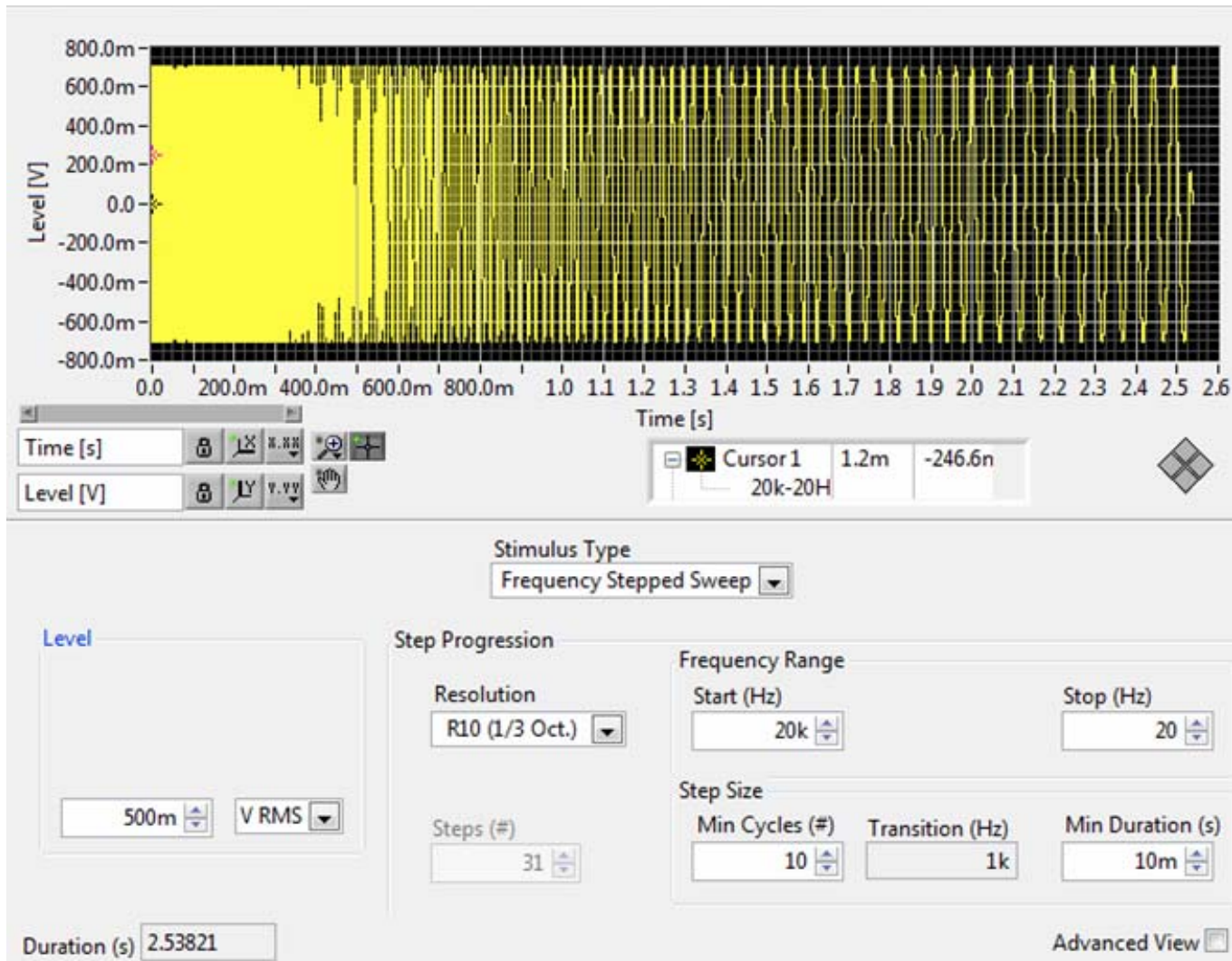
Waveform



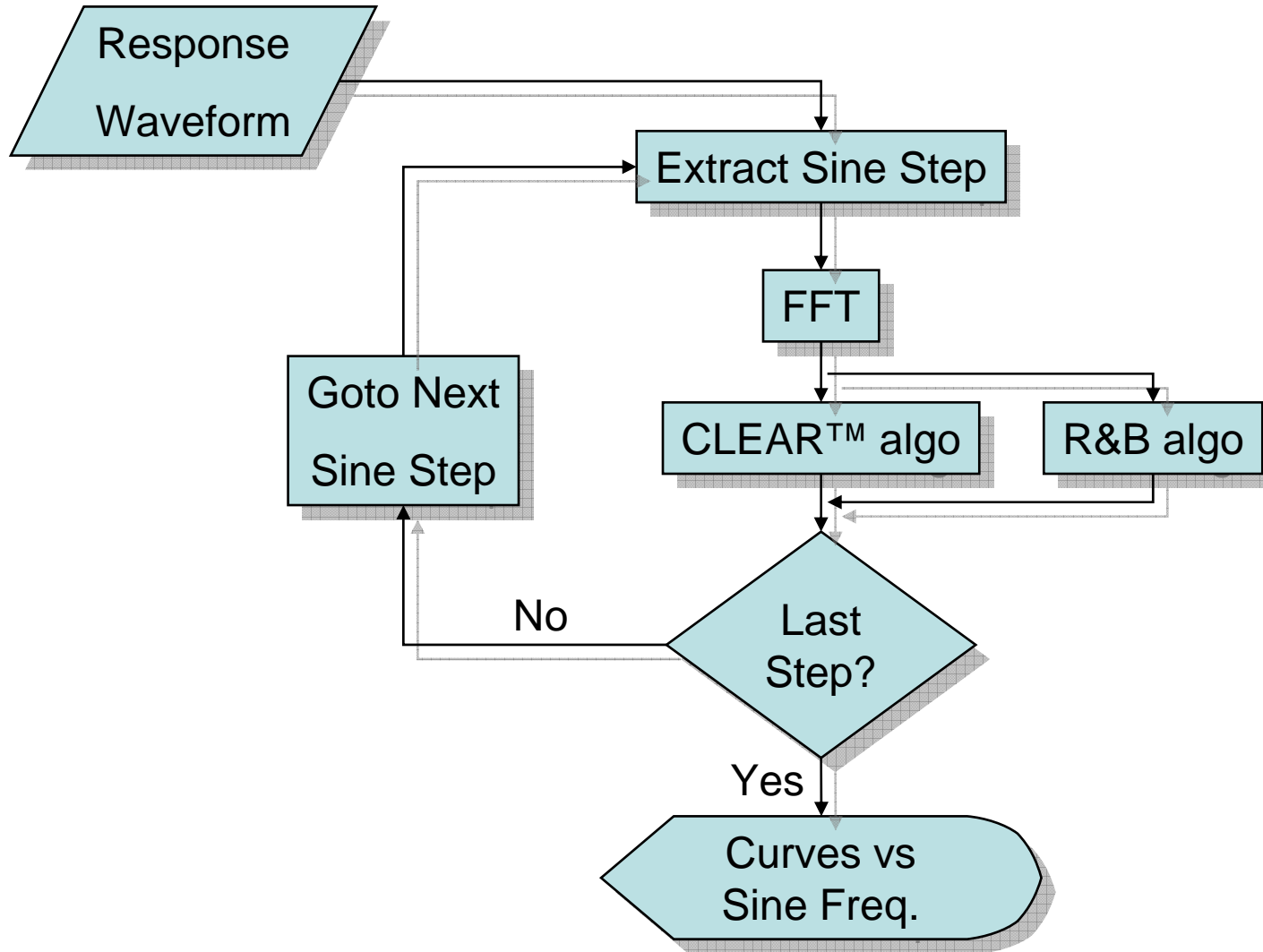
Spectrum



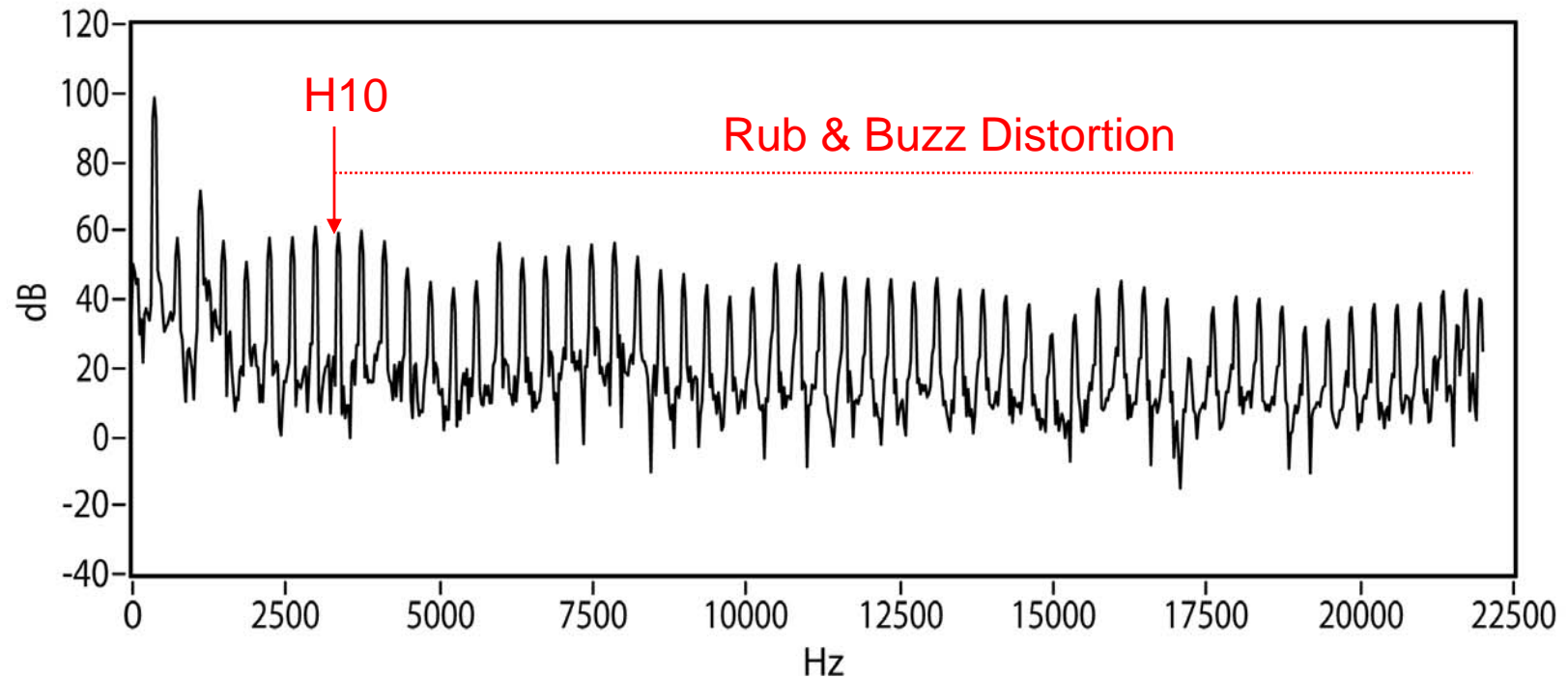
# Stepped Sine Stimulus



# HarmonicTrak™

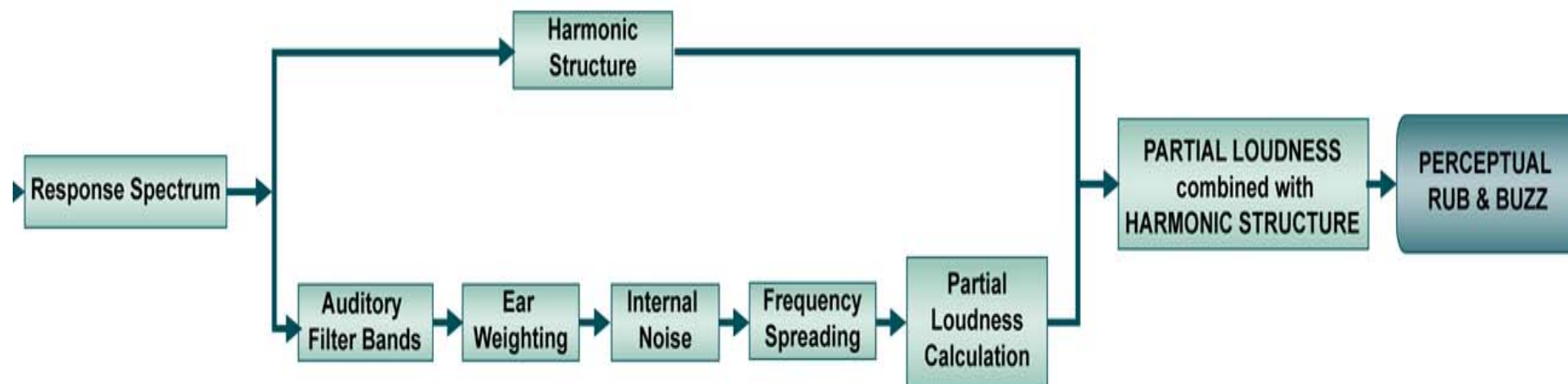


# Rub & Buzz Algorithm



Rub & Buzz Distortion is a THD that includes only harmonics 10 and above

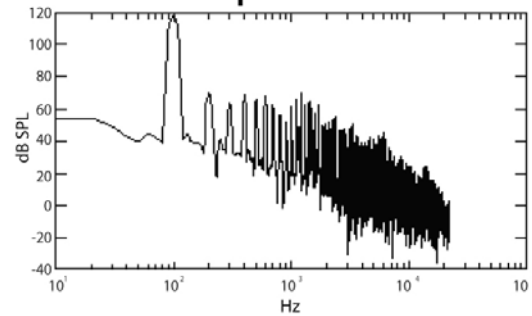
# CLEAR™ Algorithm



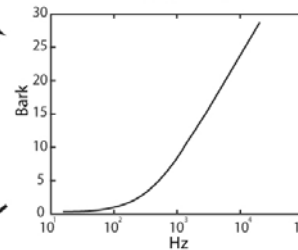
Reference: S. Temme, P. Brunet, and D. B. Keele, “Practical Measurement of Loudspeaker Distortion Using a Simplified Auditory Perceptual Model,” Presented at the AES 127th Convention, NYC (October 2009), Preprint 7905

# Auditory Filters

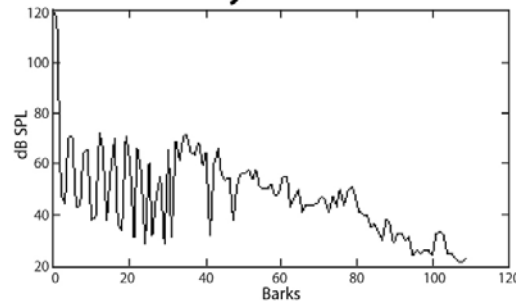
FFT Spectrum



Hz to Bark

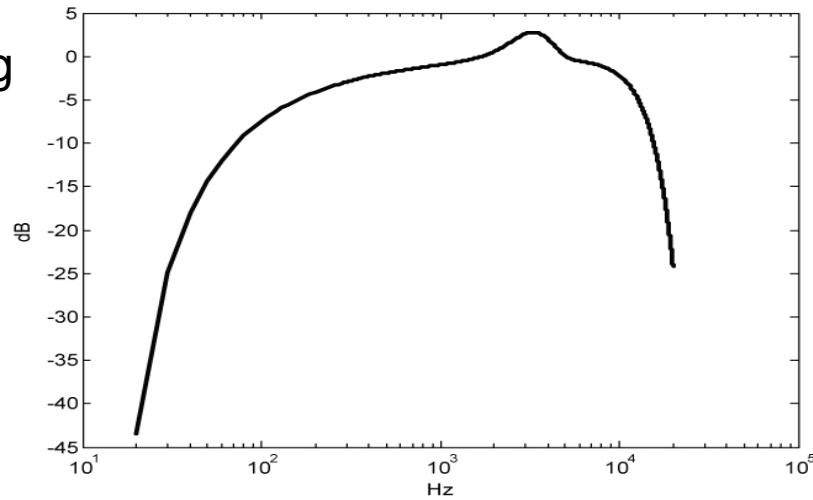


Auditory Filter Bands

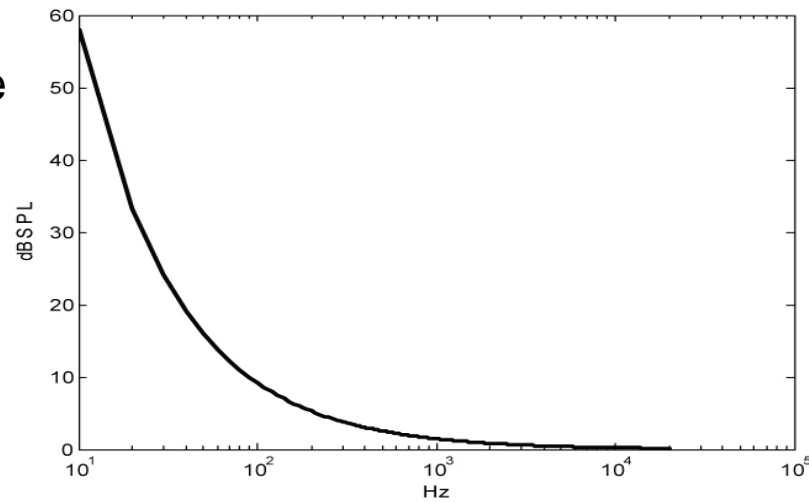


# Ear Weighting & Internal Noise

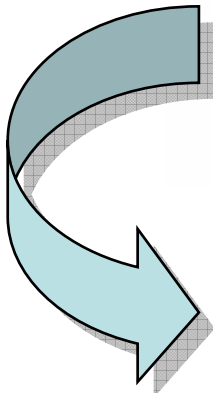
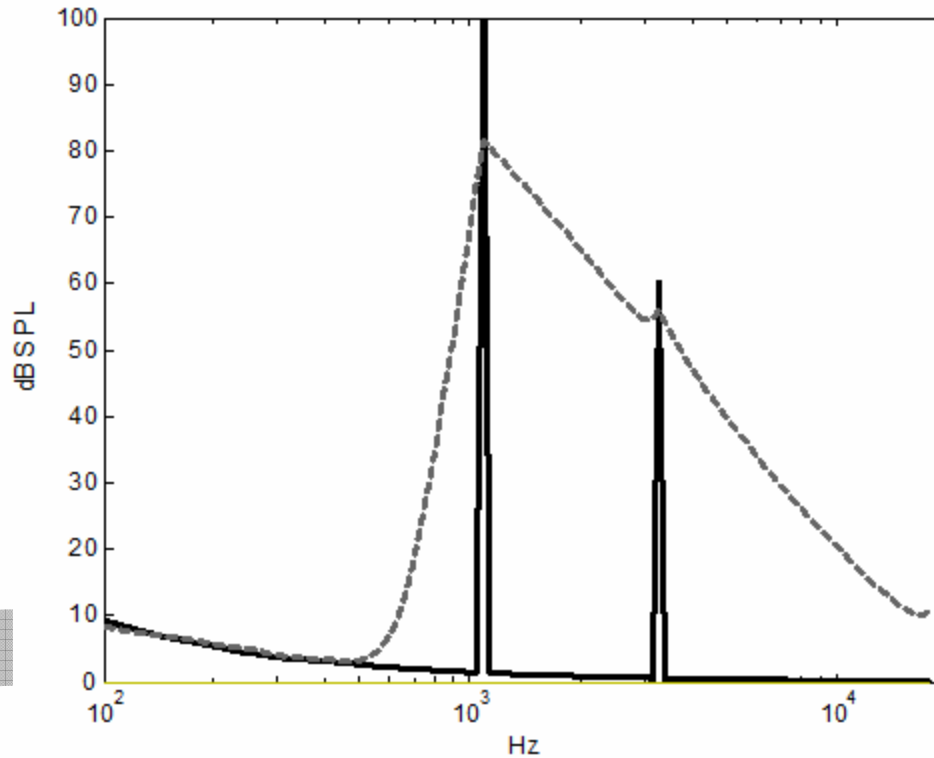
Ear Weighting



Internal Noise

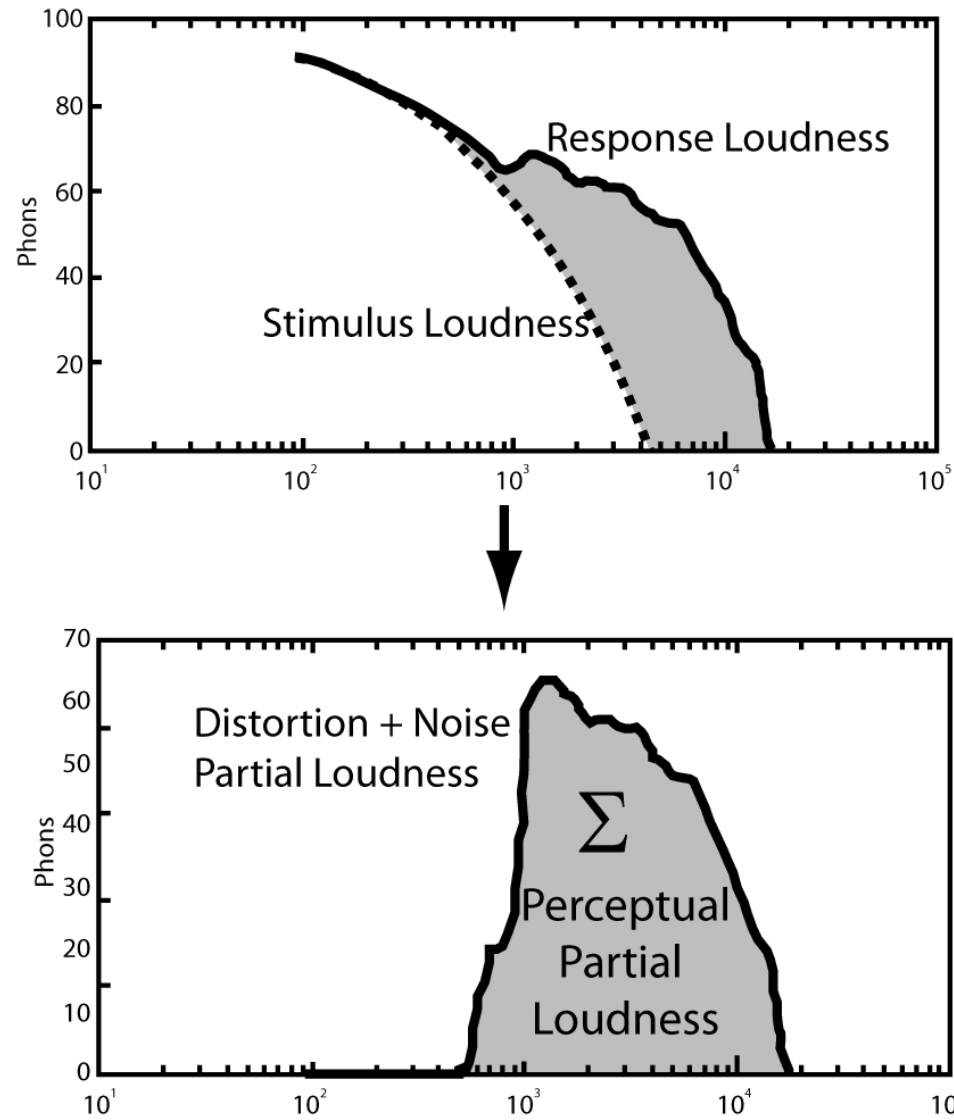


# Frequency Spreading



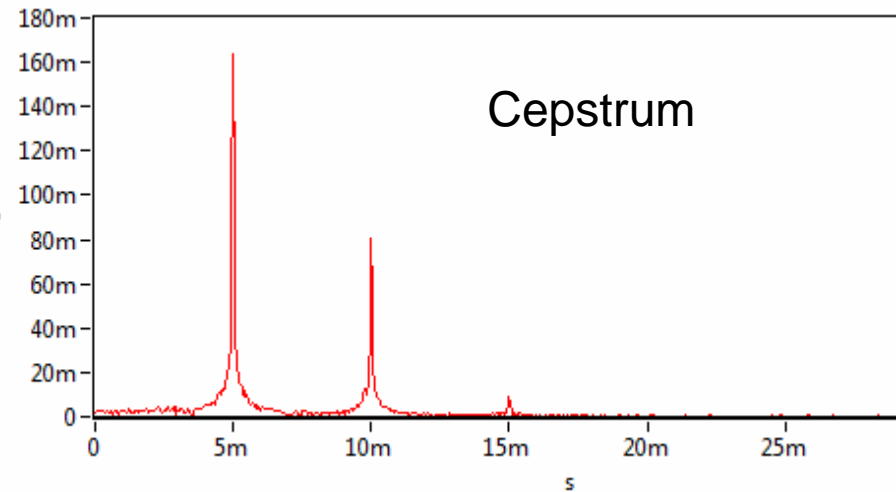
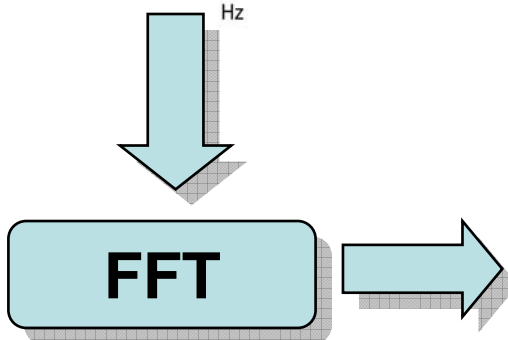
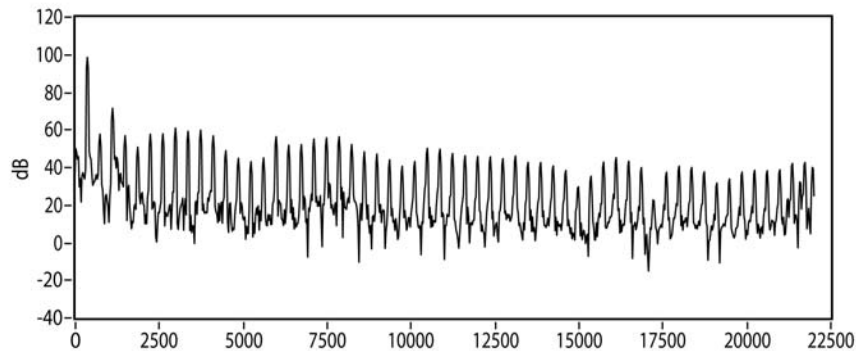
Results in Masking Effect

# Partial Distortion Loudness

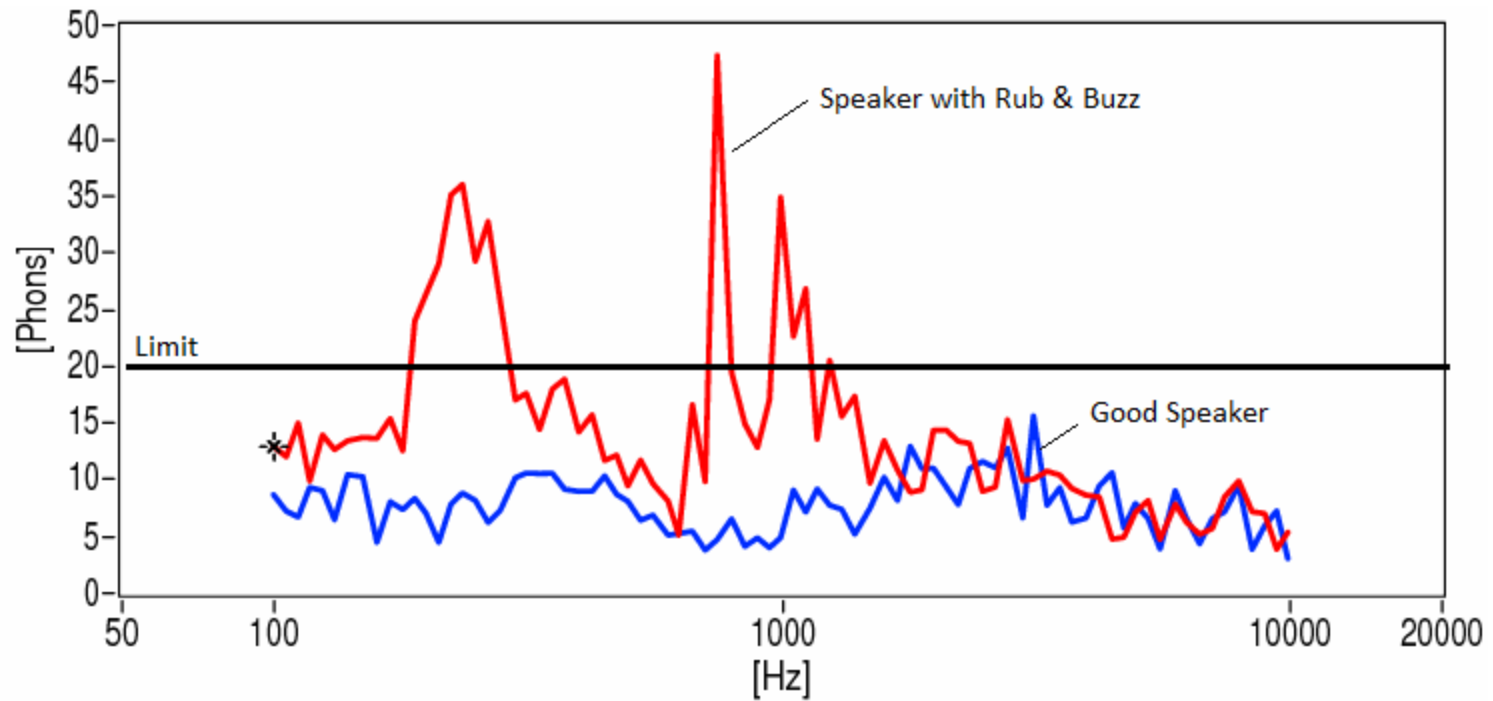


# Error Harmonic Structure

Spectrum



# Final Result: Perceptual R&B Curve



# Experimental Data and Results

## Objectives:

- Compare CLEAR algorithm to traditional Rub & buzz test methods
- Compare CLEAR algorithm to a competitive “perceptual” distortion method

## Criteria:

- Correlation to human listeners’ perception of distortion
- Noise immunity
- A sample lot of 50 loudspeakers of varying performance were used

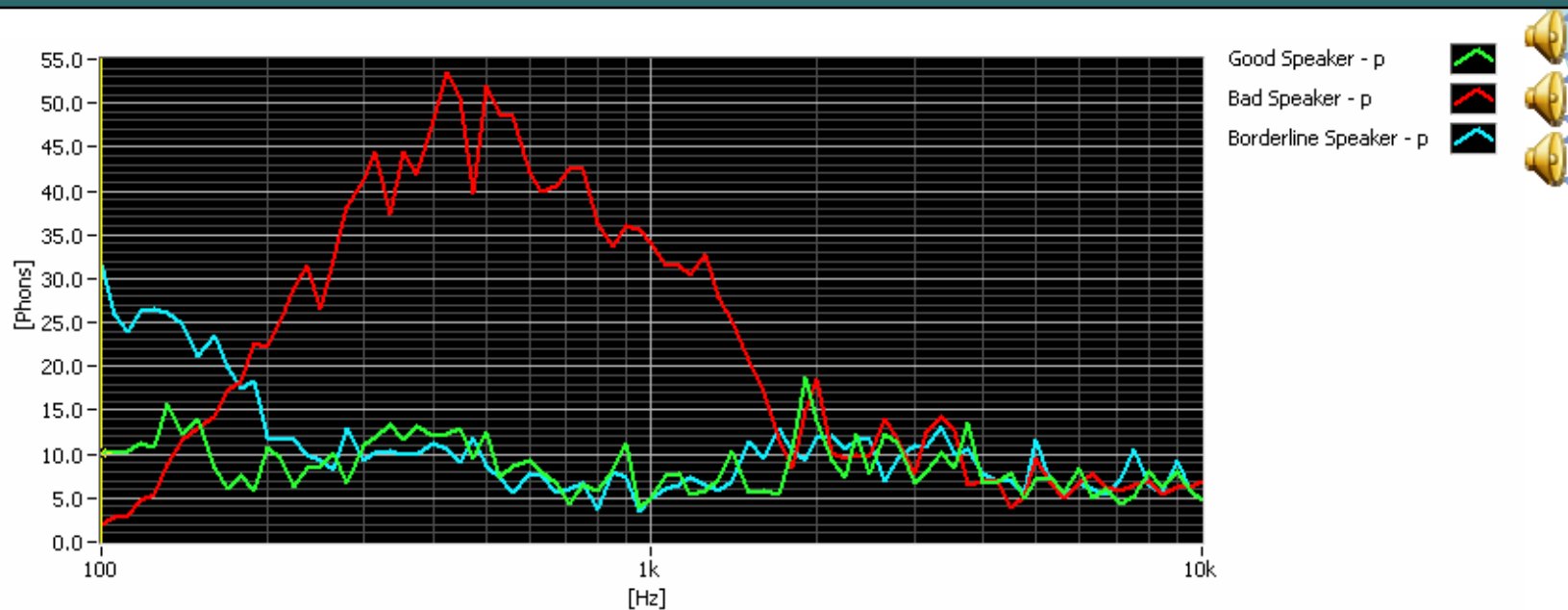
# Listening Evaluation

- 10 listeners evaluated all 50 speakers
- Sine sweeps and pure tones used
- Each unit rated 1-5 (1 being best) in terms of audible distortion
- Ratings were averaged across the 10 listeners

# Measurement Procedure

- All units tested using SoundCheck for Rub & Buzz Normalized as well as Perceptual Rub & Buzz
- All units tested on competitive test system with “perceptual” distortion feature
- Frequency range: 100 Hz to 10 kHz
- Test level: approx. 100 dBSPL at 1 kHz (same level used in listening evaluation)

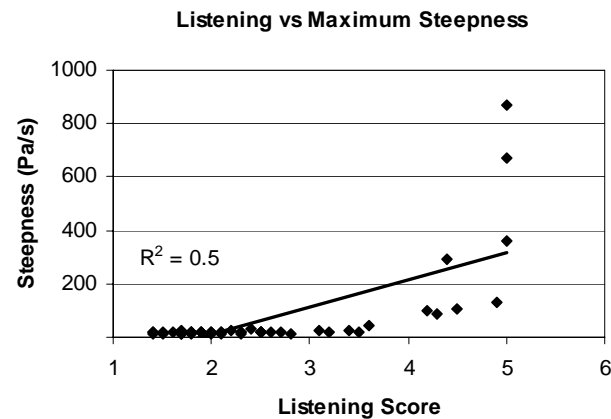
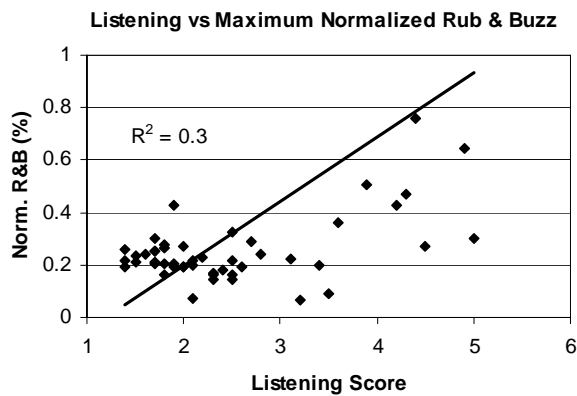
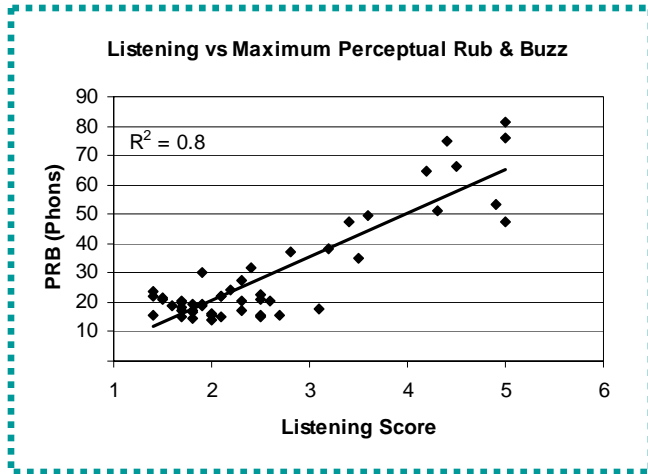
# Data Analysis



- Extracted the maximum value of each distortion curve for each unit
- Plotted the max distortion versus average listening score

# Results

- SoundCheck's Perceptual Rub & Buzz (CLEAR) provided the best correlation to the listening evaluation



# Noise Immunity Tests

## Three Measurements:

- Baseline (no background noise)
- Steady state noise (pink noise – weighted to better represent factory noise)
- Transient noise (bursts of band-limited white noise randomly spaced)
- The background noise signals were calibrated to a level of 72 dBSPL

# Noise Immunity Data

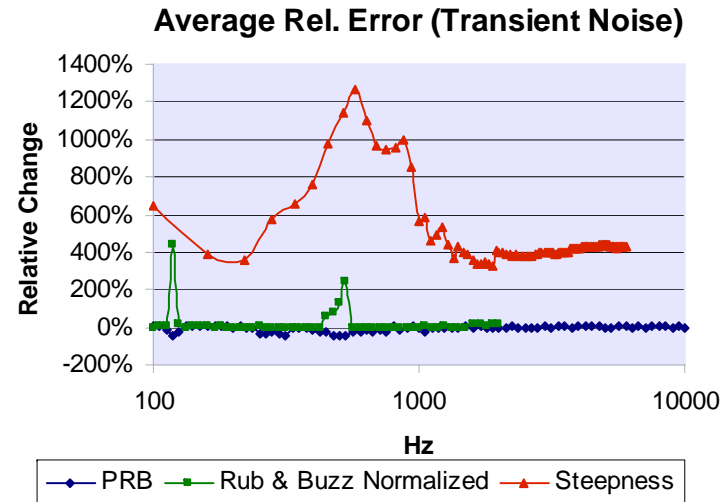
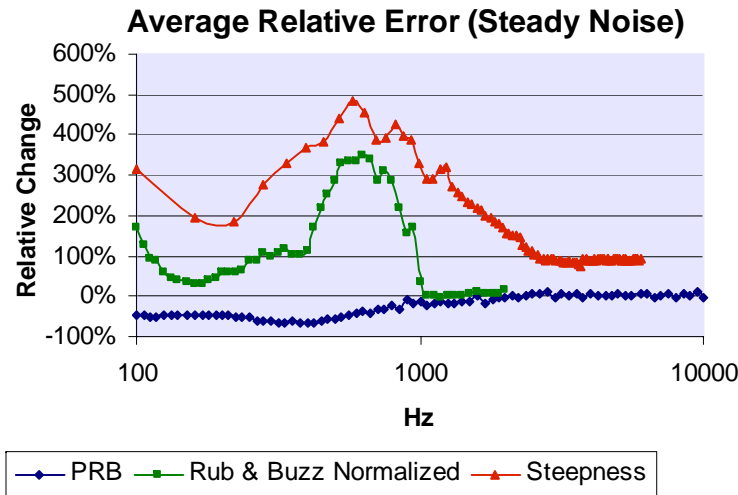
- Calculated the change in distortion with noise present as a function of percentage:

$$\frac{\text{Distortion (steady noise)} - \text{Distortion (baseline)}}{\text{Distortion (baseline)}}$$

$$\frac{\text{Distortion (transient noise)} - \text{Distortion (baseline)}}{\text{Distortion (baseline)}}$$

- These values were averaged across the 50 speakers, generating two curves for each analysis method

# Noise Immunity Results



- Perceptual Rub & Buzz performed better in the presence of steady state and transient noise than the other two methods

# Conclusions

- SoundCheck's CLEAR Perceptual Rub & Buzz algorithm correlates better to human listening perception than existing methods
- CLEAR is also more immune to environmental noise and thus more flexible in a production setting
- If you would like a demonstration please visit our booth