Threshold testing in noise using a mobile, noise attenuating audiometric headset

Odile Clavier, PhD
Jesse Norris, PhD
Brendan Flynn, PhD

Creare, LLC

Sig Soli, PhD
AnnMarie Reebernacker

House Clinic

Conflicts of Interest

- No conflicts of interest

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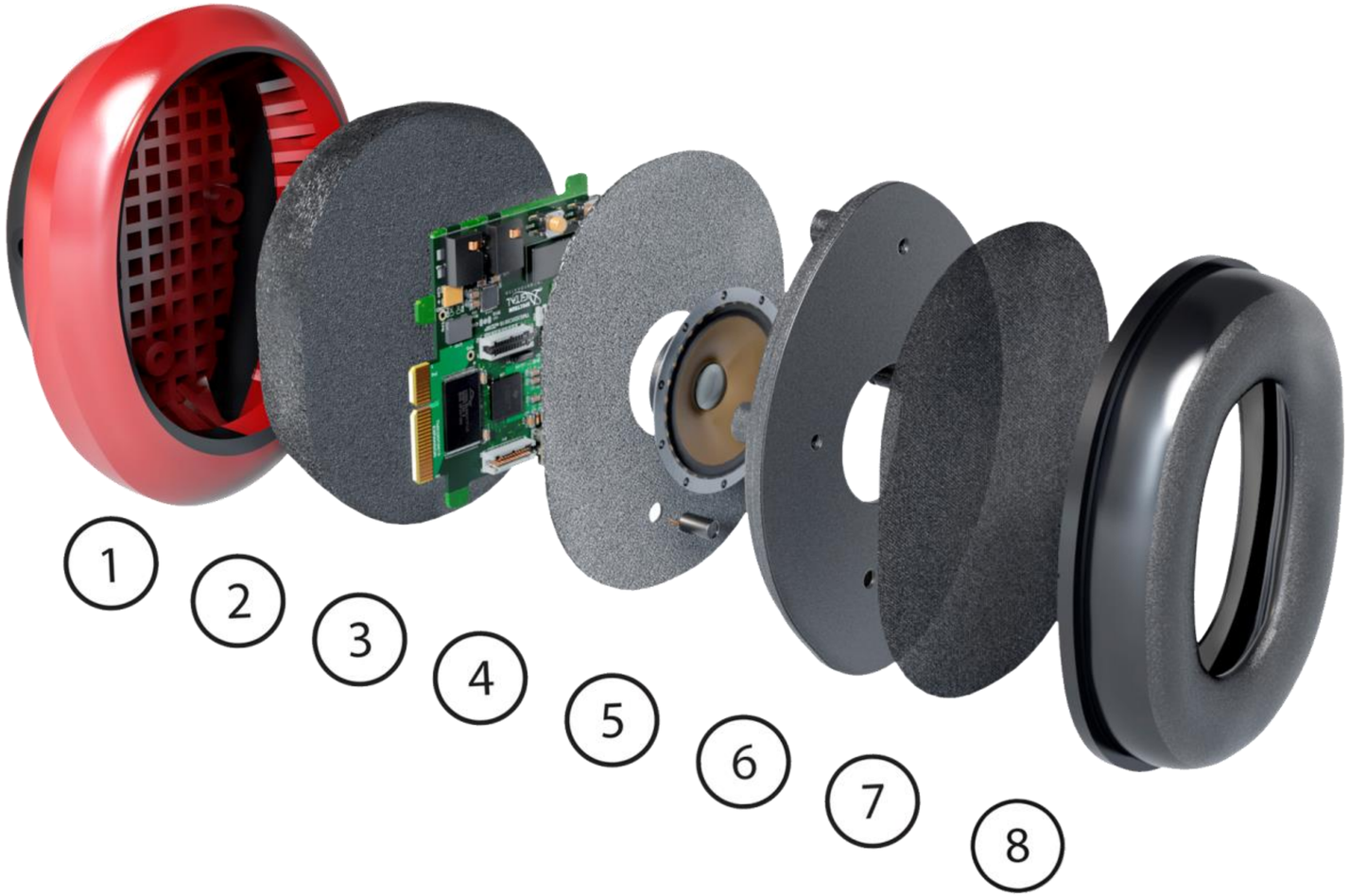
Increasing access to hearing healthcare

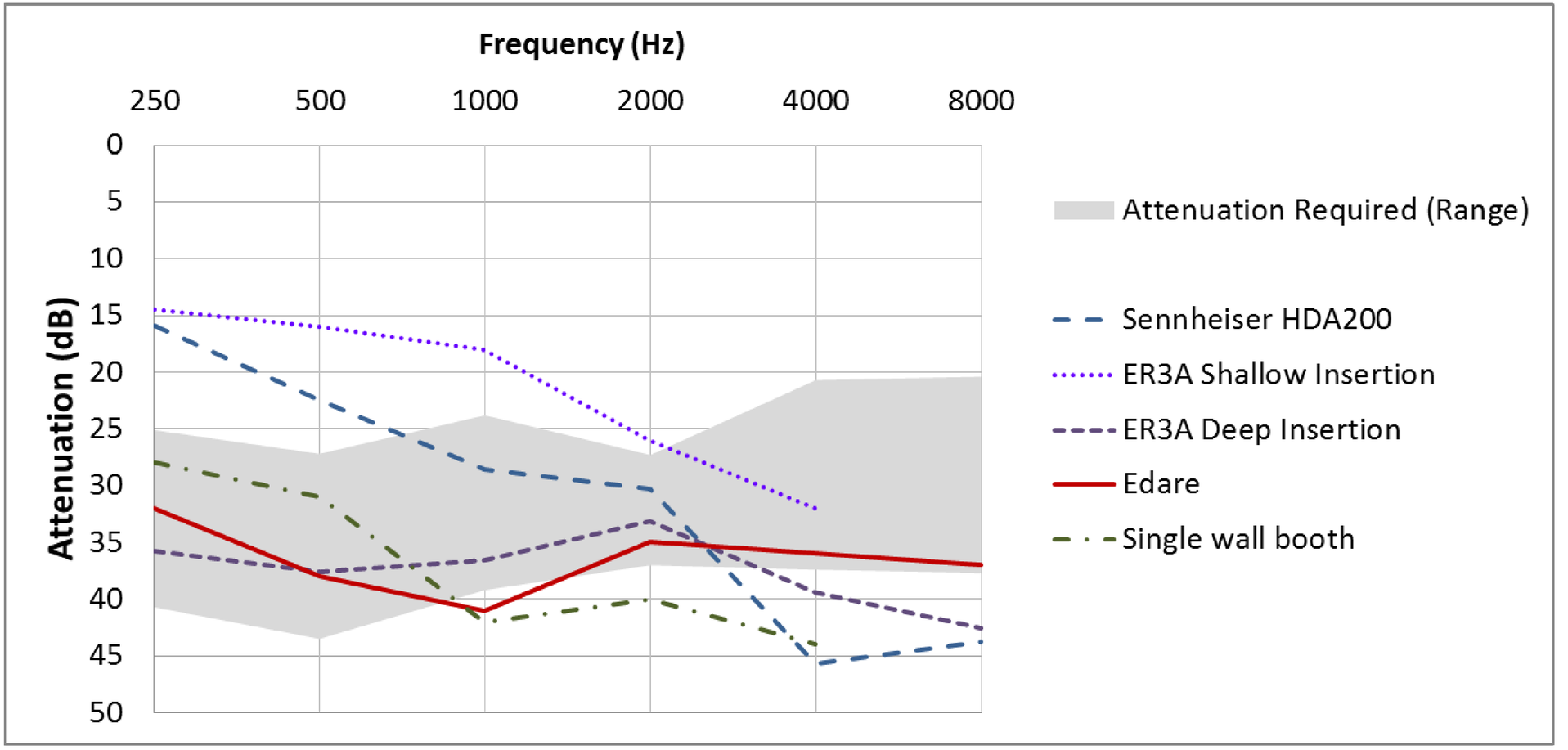
- Go mobile
- Put the audiometer in the earcups for calibrated stimuli
- Put the sound booth on the head
- Make it usable by untrained personnel

Integrated Audiometer Design

1. Deep earcup
2. Foam
3. Electronics
4. Speaker plate
5. Speaker and microphone
6. Grill
7. Fabric cover
8. Earseal and spacer



How much attenuation?



Adkisson MH. Ambient Noise Levels Present During School Hearing Screenings. University of Northern Colorado; 2012

Study Objectives

- Evaluate device performance in controlled noise environment

- Key question:

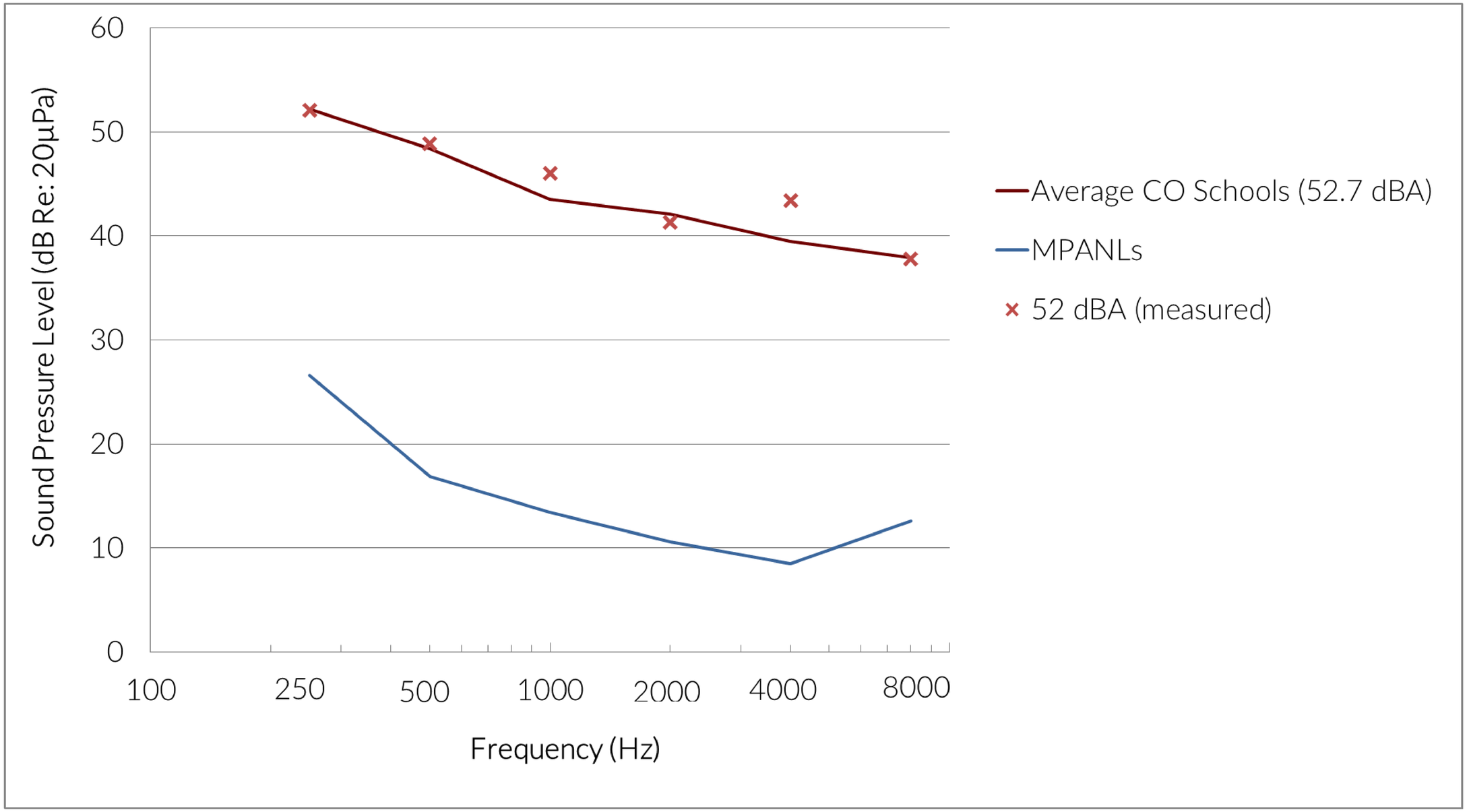
  How much noise can device tolerate before we see threshold shifts?

Study Design

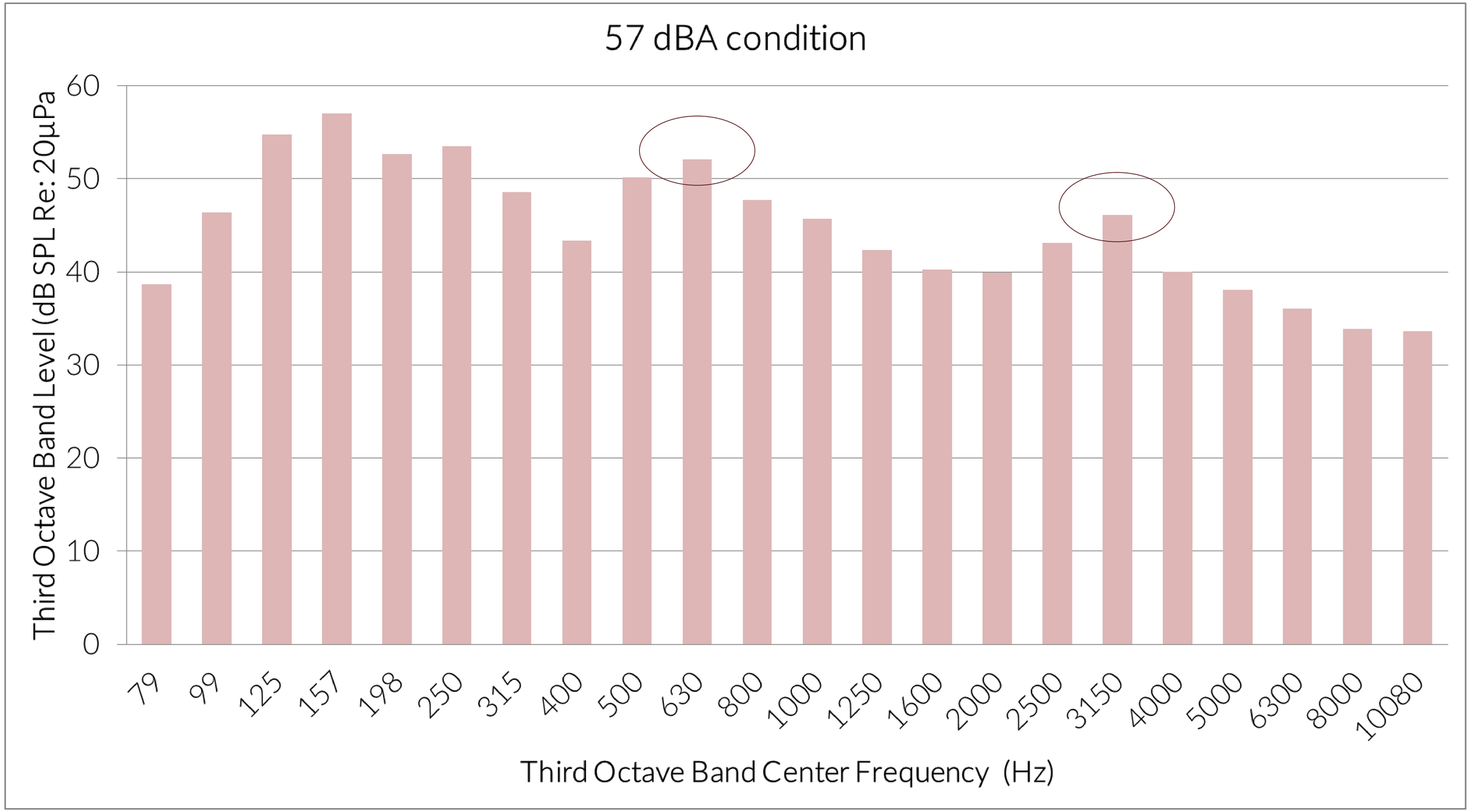
- 21 subjects (21 ears) with normal hearing (<20 dBHL)

- Study conducted at House Clinic in Los Angeles, CA
  - Subjects were seated in audiometric booths
  - Subjects completed 7 audiograms each
    - Twice in quiet (before and after noise conditions)
    - 47 dBA, 52 dBA, 57 dBA, 62 dBA, 67 dBA, brown noise
    - Noise condition order randomly selected for each subject

Noise Characteristics



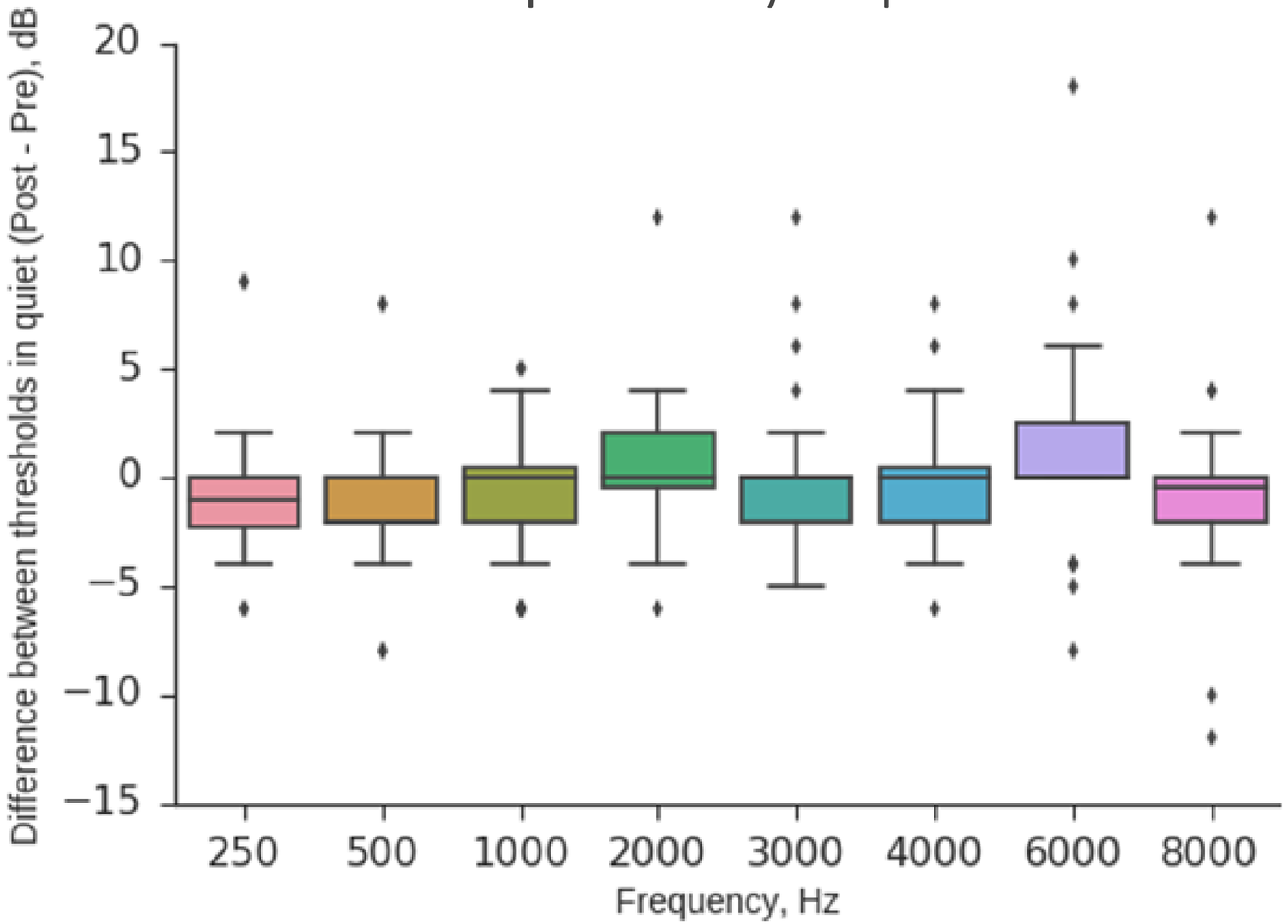
Noise Characteristics



Threshold test

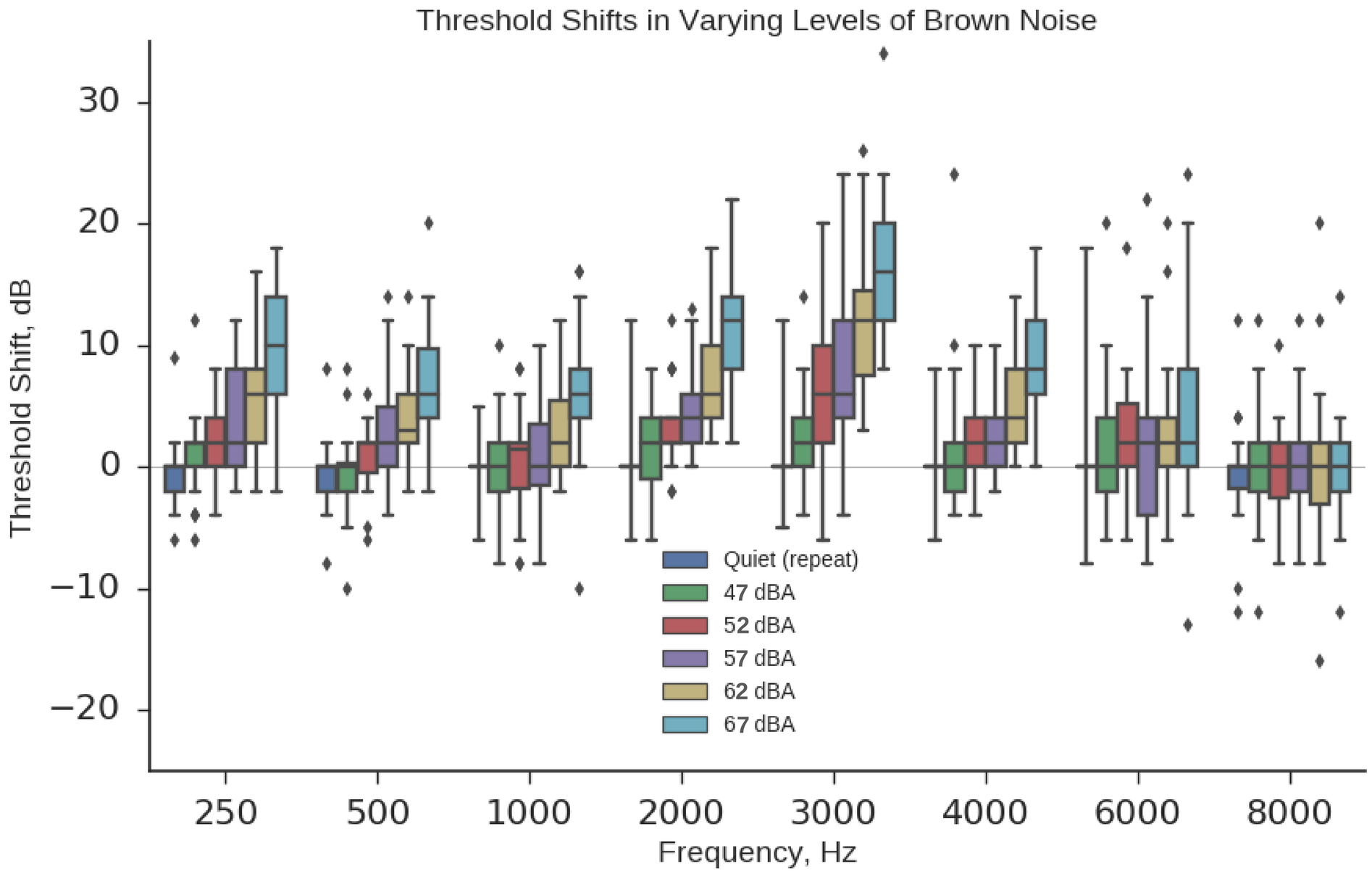
- Modified Hughson Westlake algorithm (automated)
- Step size of 2 dB
- Start level of 10 dB HL, maximum presentations = 35
- Traditionally: threshold determined as level where more than 50% of responses to ascending presentations are identical
- This can be too stringent with a 2dB step size – modified to: if three of five responses were within +/- 2 dB, the threshold is computed as the average of those three responses

Repeatability in quiet



Frequency (Hz)	250	500	1000	2000	3000	4000	6000	8000
Average difference (dB)	-0.9	-1.4	-0.8	0.4	0.2	-0.1	1.3	-0.9
Standard deviation (dB)	3.0	2.9	2.7	3.4	3.9	3.1	5.4	4.5

Results


Threshold Shifts in Varying Levels of Brown Noise
Threshold Shift, dB
30
20
10
0
−10
−20
250
500
1000
2000
3000
4000
6000
8000
Frequency, Hz
Quiet (repeat)
47 dBA
52 dBA
57 dBA
62 dBA
67 dBA

OSHA criteria (industrial applications)

- Average thresholds at 2 – 4 kHz for each noise condition
- Compare each threshold to first measurement in quiet
- Shift = Differences of 10 dB or more
- ~~Average greater than 25 dB HL~~

Condition	% number of subjects
Quiet	0
47 dBA	0
52 dBA	0
57 dBA	4.8
62 dBA	28.6
67 dBA	71.4

Conclusions

- Normal thresholds can be reliably measured at ~55 dBA with only 5-10% of false positives according to several STS guidelines
- Screening at 20 dB HL could occur at even higher noise levels
- Adding high passive attenuation to the audiometric headset can greatly increase access to hearing testing across the world