(Excerpts from) Vibration and Noise

IN AND NEAR ANIMAL FACILITIES

BYRON DAVIS / INFO@VIBRASURE.COM / AALAS PHOENIX 5-NOV-15

Highlights

- There's no "building code" for vibration and noise
  - Users, Facilities Groups, A/Es have to talk about it
  - I want to give you the tools to have good conversations
- ANSI (ASA) S3/SC1WG5

  Working group tasked to develop / maintain standards, guidelines, and technical reports for evaluation of noise and vibration and their effects in the design and construction of facilities conducting laboratory animal research.

Data – Complete Statements

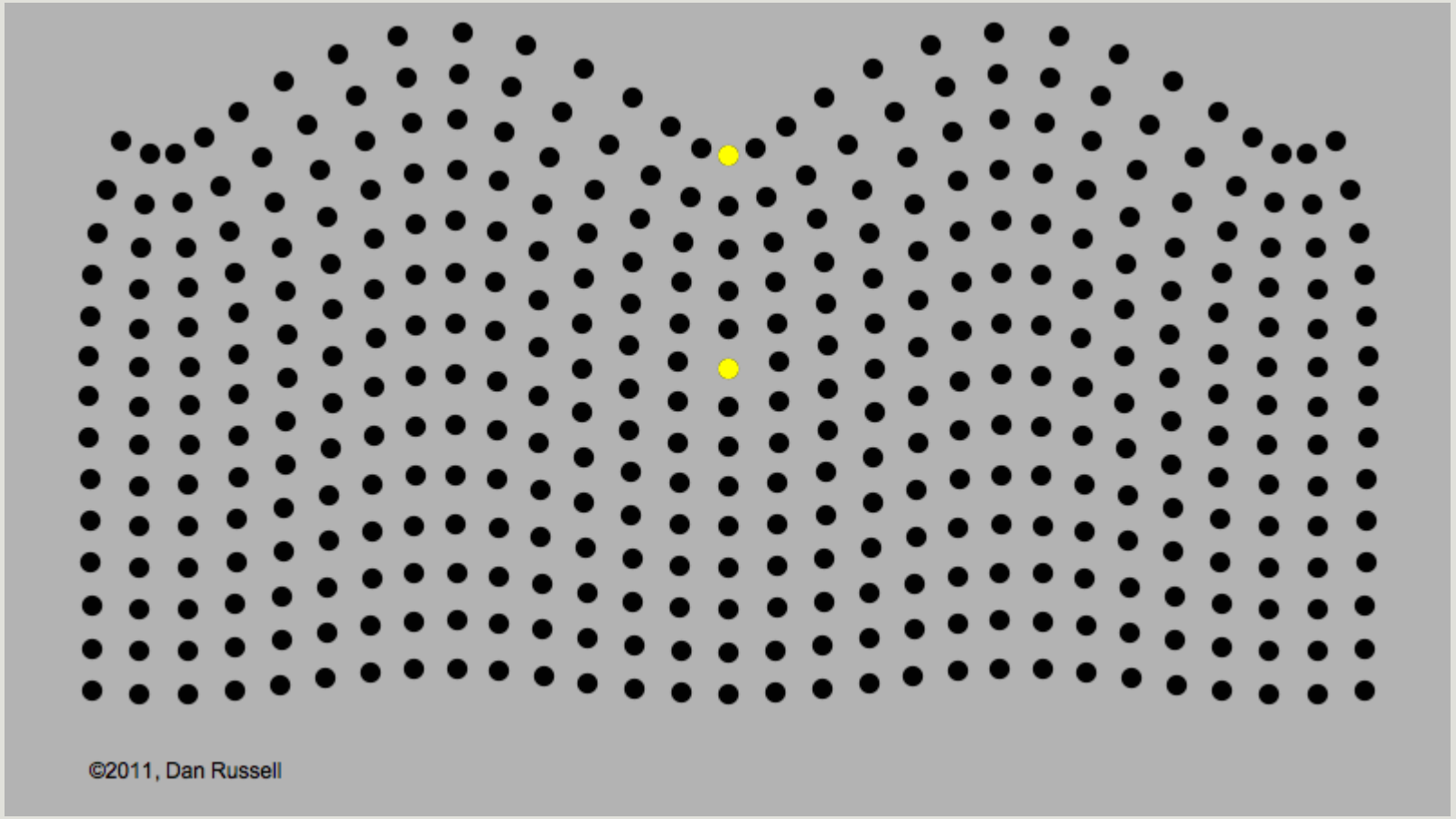
2,000 μin/sec RMS in the 1/3 octave band at 25Hz

36 μg 0-Peak at 44Hz (bandwidth = 2Hz)

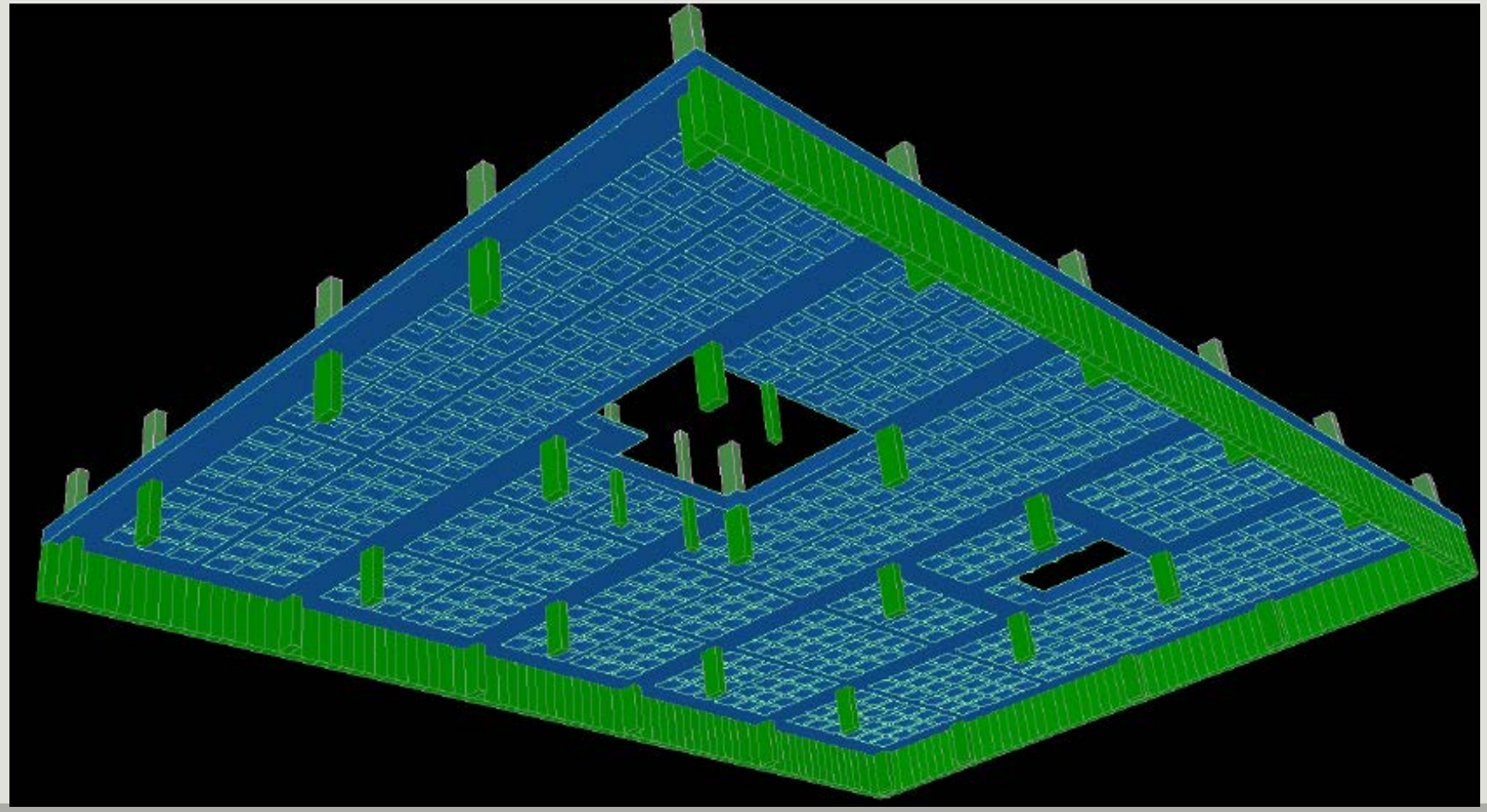
48 dB re: 20μPa in the octave band at 120kHz

55 dB(R)

Vibration

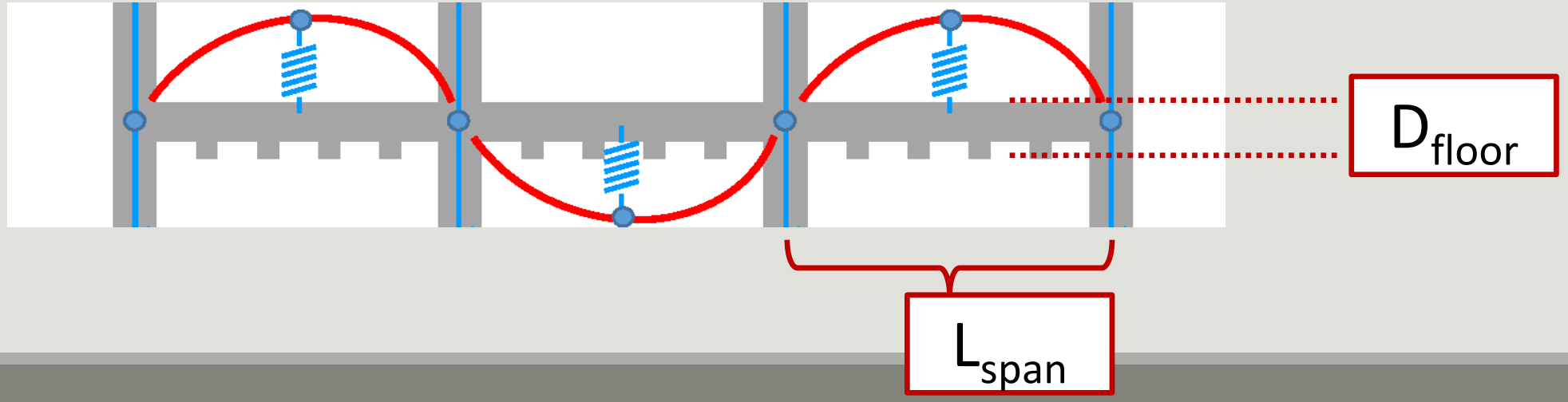


Vibration – in Structures



Vertical Vibration – Superstructure

- Performance determined by local sources, for soft floors, anyway
- For typical lab floors, walker impact dominates (in good designs)
- **Usually, vibration levels on the order of 1,000's of µin/sec**
- Vibration levels highly-localized across building, w.r.t. column grid

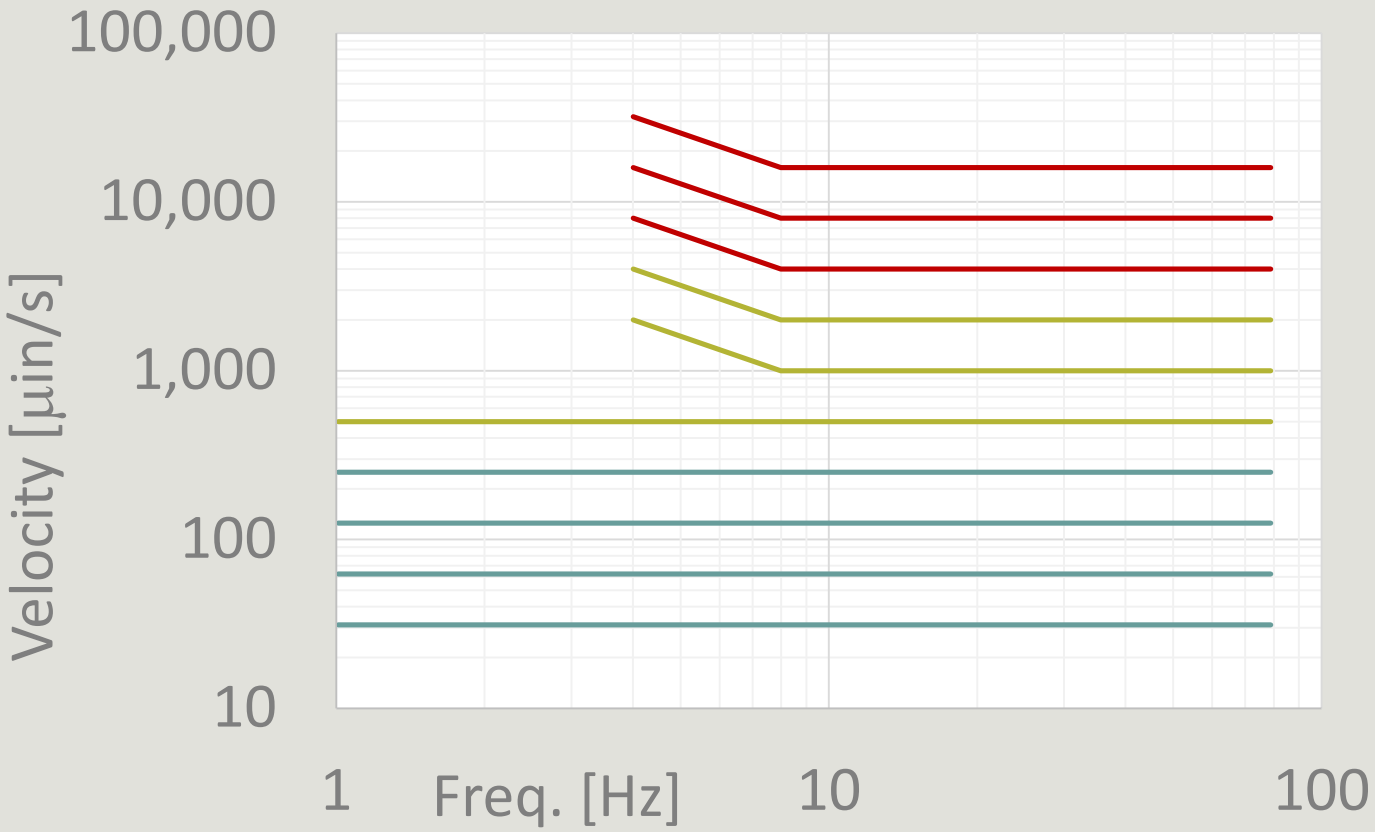


Vertical Vibration Levels

- 16,000+ µin/sec: office, workshop, etc.
- 8,000 µin/sec: residential settings
- 4,000 µin/sec: threshold of human perception
- 2,000 µin/sec: routine laboratories
- 1,000 µin/sec: very good general laboratories

- Ground floors: 10s (maybe 100s) of µin/sec

Generic VC Criterion System



Human/Animal-scale (feelable)

General Laboratories

Highest-End Imaging

Vibration – Criteria

- **Instruments**: generic VC for hand-built, or vendor-supplied
- **Animals**: no good system of criteria exists
  - lots of data suggest behavioral and physiological effects
  - few data on sensitivities
  - fewer treatments on developing and meeting criteria
- Architects, engineers are familiar with VC System
- **Current best-practice: VC language for animal facilities**

Vibration – Criteria for Animals

- Chronic sensitivities
  - impacts considered over longer periods
  - for example, noise-induced stress in holding rooms
  - undermines experimental assumptions
- Acute sensitivities
  - impacts considered “in the moment”
  - for example, distractions during behavioral testing
  - injects confounding variables into datasets

“Empathic Design”

- Consider the animals’ physiologies
- Consider the animals’ perspectives

- Examples:
  - Maintenance catwalk over primate holding
  - Incompatible species sharing cage change swing space
  - Acute vs. chronic forcings

Measurements and Data

- The animals can’t easily communicate annoyance
- We really need spectral (rather than overall) data
- Importantly, animals’ bodies don’t respond like human bodies

Vibration – Instrumentation

- Need data to single-digit Hz and 100's of µin/sec

- For structures, high sensitivity sensors (1 ~ 10V/g)
- For cages, modest sensitivity (10 ~ 100mV/g)

c › Test, Measure & Inspect › Recorders & Data Acquisition › Data Loggers

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from Reed Instruments

Reed SD-8205 Vibration Meter and Data Logger, 0.1 mm/s Resolution, +/-5 Percent Accuracy, 0.5 to 199.9 mm/s Velocity Range

3 customer reviews

List Price: ~~$695.00~~

Price: $608.50

You Save: $86.50 (12%)

Only 3 left in stock

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Want it tomorrow, Oct. 27? Order within **17 hrs 55 mins** and choose **Same-Day Delivery** at checkout. Details

5 new from $608.50

that's 20,000µin/sec (5x typical criteria)

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Roll over image to zoom in

Extech SDL800 Vibration Meter SD Logger

from Extech

Be the first to review this item

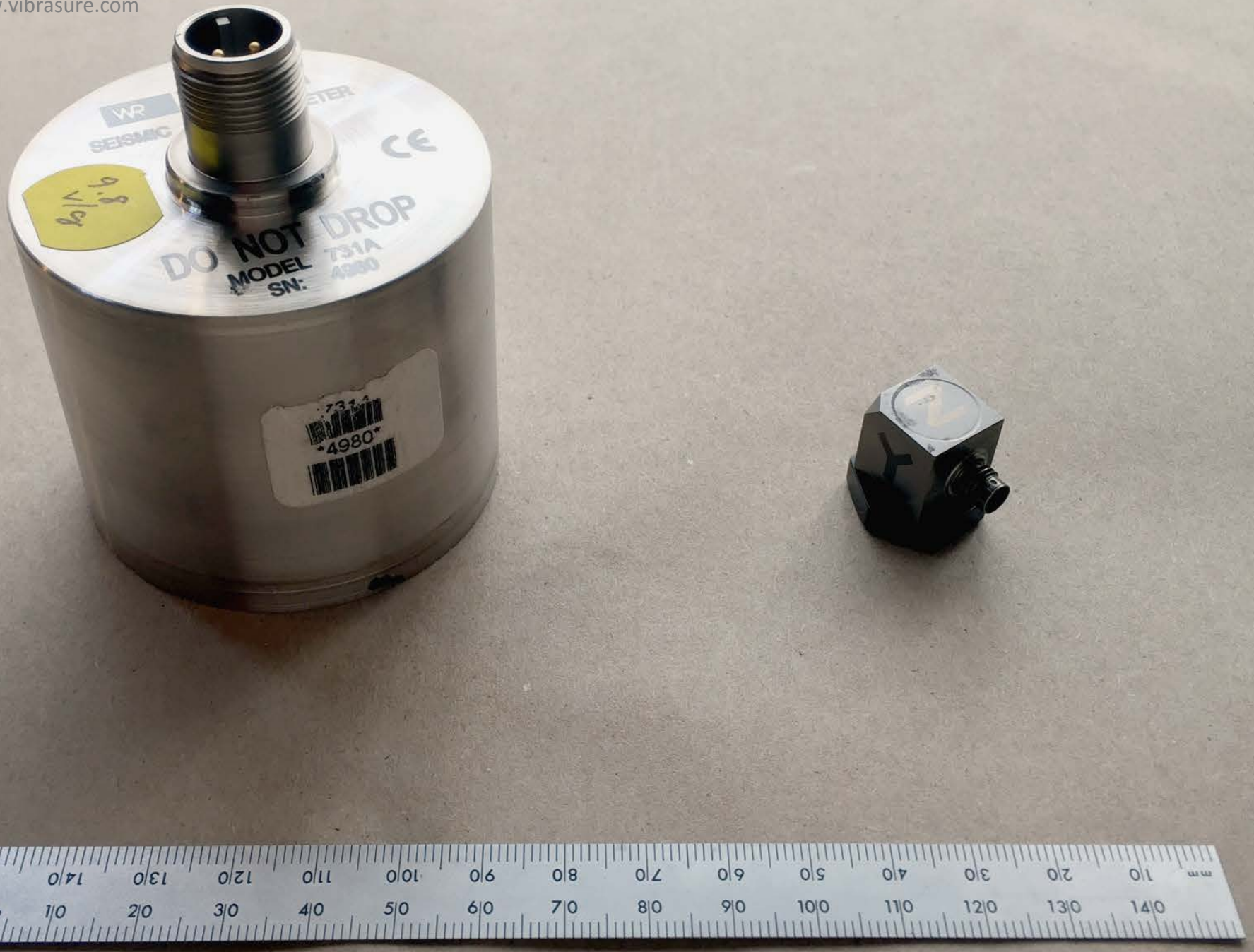
Price: $1,049.00 & **FREE Shipping**

Note: Not eligible for Amazon Prime.

we need data to 1Hz
(criteria start at 1 or 4Hz)

n you choose

- Remote vibration sens r with magnetic adapter on 47.2"(1.2m) cable
- Wide frequency range of 10Hz to 1kHz
- Datalogger date/time stamps and stores readings on an SD card in Excel format for easy transfer to a PC
- Meets ISO2954
- RMS, Peak Value or Max Hold measurement modes



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1000
100
10
1
0.1

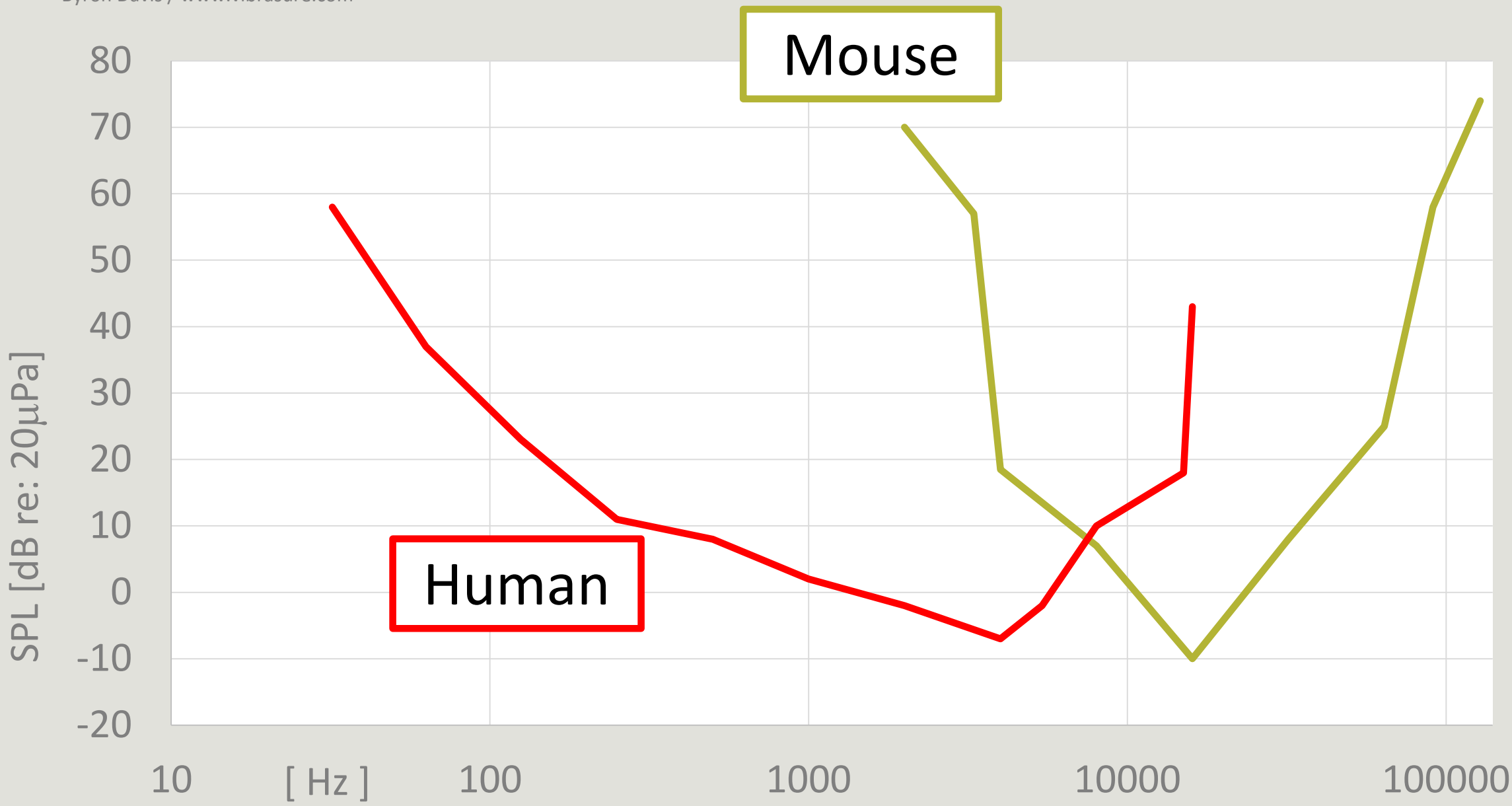
RMS Velocity [µin/s]

1
Freq. [Hz]
10
100

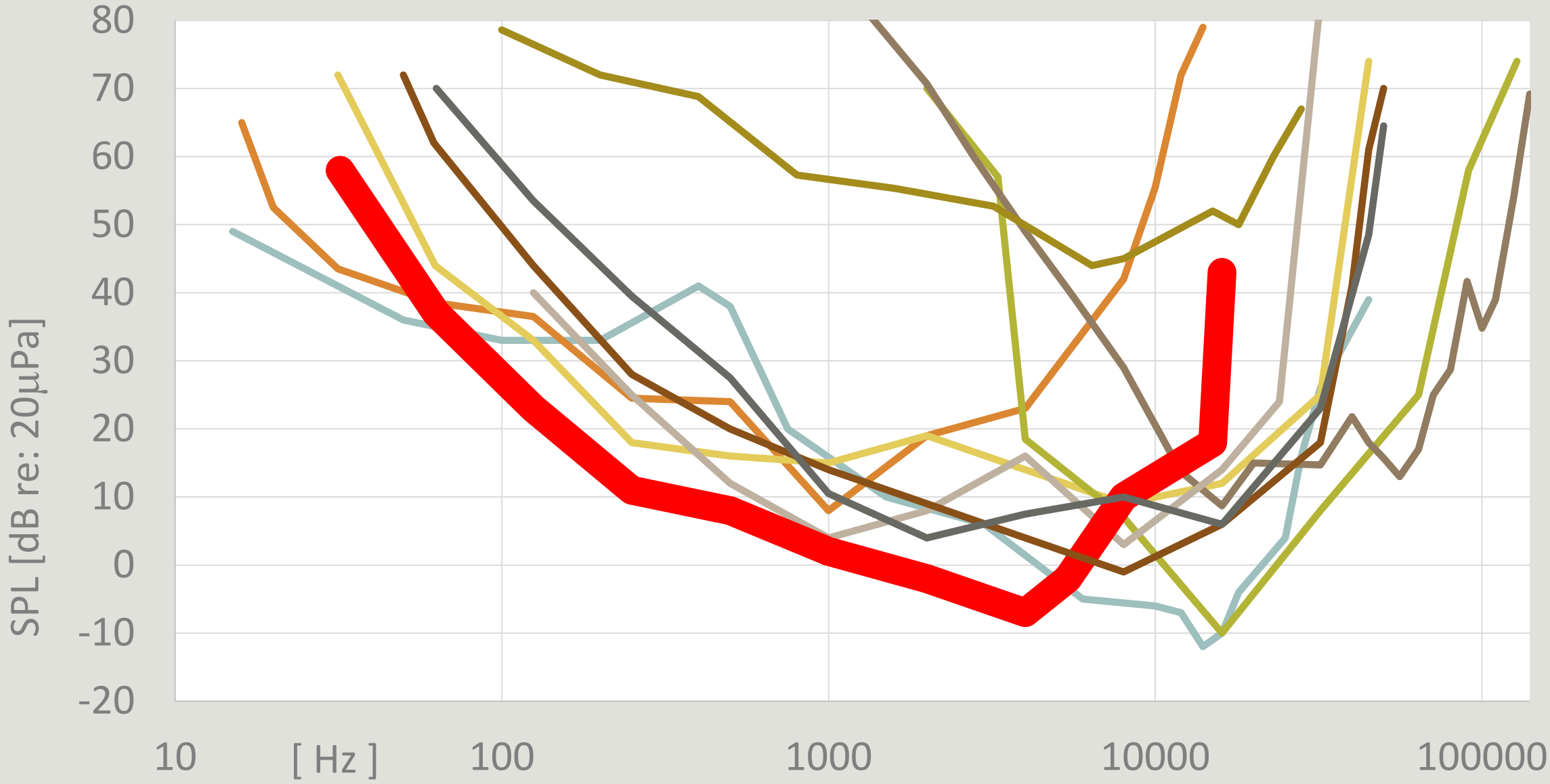
Sound – Airborne Vibrations

- Still have environmental sources, but local sources dominate
- Frequency is more important, due to range of sensitivities
- Your sense for “problematic” sounds is pretty good
- Data can inform your intuition about what the animals hear

- But there are still no hard-and-fast rules



Hearing thresholds: Human from ISO Standard (1961); Mouse from Heffner & Masterson (1980)



Threshold data compiled by R. Heffner; http://homepages.utoledo.edu/rheffne/Hearing%20in%20Mamm/HearingMamm.html

Sound – Criteria for Animals

- Again: chronic-vs-acute
- Again: no good systems of criteria
- All well-developed criteria are human-focused
- “Empathic design”
- **Best-practices approaches**

Ultrasound – f> 10kHz

- Bad news: you can’t hear it
- Worse: poorly supported by instrumentation

- Good news: highly localized
- Even better news: easily attenuated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Start Page | M500_20151101_104550.wav

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100 %
50 %
0.00 %
-50 %
10.6 s
10.0 s

Recording 14.074 s

0 db -10 db -20 db -30 db -40 db -50 db -60 db -70 db -80 db

100 kHz
50 kHz
0.00 Hz
7.5 s
10.0 s

Recording 14.074 s

Location: 37.7551796809788 -122.410199736518

Recording stopped.

Start Page | M500_20151101_102056.wav

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40 %
20.0 %
0.00 %
-20.0 %
-40 %
2.0 s
4.0 s
6.0 s

Recording 15.286 s

0 db -10 db -20 db -30 db -40 db -50 db -60 db -70 db -80 db

100 kHz
50 kHz
0.00 Hz
6.6 s
2.0 s
3.0 s
4.0 s
5.0 s
6.0 s

Recording 15.286 s

Location: 37.755135971205 -122.410178432682

Recording stopped.

Start Page | M500_20151101_102614.wav

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40 %
20.0 %
0.00 %
-20.0 %
-40 %
5.0 s

Recording 11.026 s

0 db -10 db -20 db -30 db -40 db -50 db -60 db -70 db -80 db

100 kHz
50 kHz
0.00 Hz
5.0 s
7.5 s

Recording 15.286 s

Location: 37.7551347758687 -122.410353229868

Recording stopped. Live monitoring - press a record key to save data.

Start Page | M500_20151101_101758.wav

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40 %
20.0 %
0.00 %
-20.0 %
-40 %
2.0 s
4.0 s

Recording 9.667 s

0 db -10 db -20 db -30 db -40 db -50 db -60 db -70 db -80 db

100 kHz
50 kHz
0.00 Hz
1.0 s
2.0 s
3.0 s
4.0 s
5.0 s

Recording 10.093 s

Location: 37.755263843221 -122.410310910498

Recording stopped. Live monitoring - press a record key to save data.

Start Page | M500_20151101_112313.wav

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100 %
50 %
0.00 %
-50 %
5.0 s

Recording 6.570 s

0 db -10 db -20 db -30 db -40 db -50 db -60 db -70 db -80 db

250 kHz
200 kHz
150 kHz
100 kHz
50 kHz
0.00 Hz
2.5 s
5.0 s

Location: 37.7552081280568 -122.41024803077

Recording stopped. Live monitoring - press a record key to save data.

Start Page | M500_20151101_105310.wav

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100 %
50 %
0.00 %
-50 %
3.3 s
5.0 s

Recording 10.813 s

0 db -10 db -20 db -30 db -40 db -50 db -60 db -70 db -80 db

3.5 s

100 kHz
50 kHz
0.00 Hz

5.0 s
7.5 s

Recording 10.813 s

Location: 37.7552038796292 -122.410219084203

Recording stopped.

Start Page | M500_20151203_145546.wav

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60 %
40 %
20.0 %
0.00 %
3.50 s
3.00 s
4.00 s

Recording 5.046 s

0 db -10 db -20 db -30 db -40 db -50 db -60 db -70 db -80 db

60 kHz
40 kHz
20.0 kHz
0.00 Hz
2.50 s
3.00 s
3.50 s
4.00 s

Recording 5.046 s

Location: 37.755818838711 -122.410268728077

Press the escape key to exit full screen mode.

Noise – Meters? It depends…

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from Parts Express

153 customer reviews | 34 answered questions

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In Stoc

Ships fro

Estimate en you choose Standard at checkout.

A-weighting is for ***human*** hearing

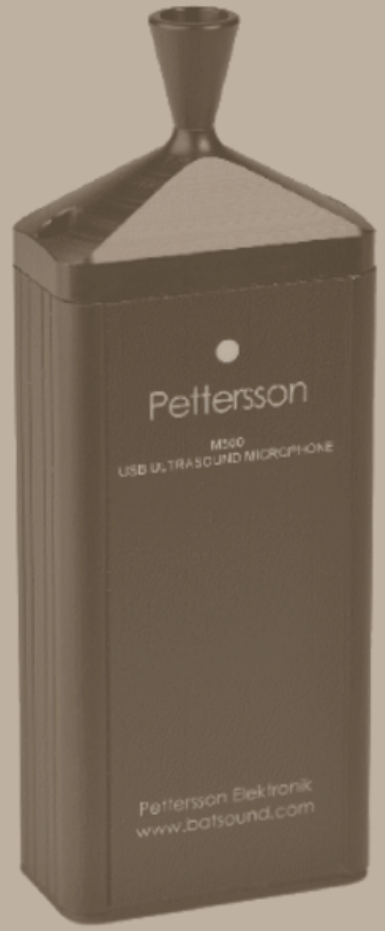
- One-button operation for easy handheld measurements
- A-Weighted
- Large 3/4" backlit display clearly shows your reading
- Auto power off
- Threaded insert for standard tripod mount

› See more product details

6 new from $22.00

The M500 is ideal for:

- Education programs
- Voucher calls
- Active monitoring and selective recording
- Mobile transects
- Short term passive recording where a tablet/netbook may be deployed
- Microphone may be extended over 40' using an inexpensive USB active extension (some tablets may not allow this extension)



Pettersson M500 Specifications:

- Sampling frequency: 500 kHz; the fastest sampling rate of any USB bat detector microphone in the world.
- Used as either directional or omni-directional configuration
- Frequency range:10 - 190 kHz
- Microphone: Advanced electret
- ADC resolution: 16 bits
- Interface: USB 2.0, high speed
- Anti-aliasing filter: 8th order, 190
  although this does not mean that it is
  filter to start attenuating at a higher fre
  aliasing. This may be special ordered
- Real-time monitoring: Through th
- Size: 42 x 114 x 23 mm (incl mic
- Weight: 75 g
- Power: USB bus powered
- Operating system: Windows Vista, Windows 7, Windows 8, or Mac via Parallels
- Includes Bat Mic Recorder software, a simple recording app that visualizes bat calls, and can make auto or manually triggered recordings
- The M500 is directional to minimize echos from the ground and tablets, and to better capture recordings from bats of interest. Omni-directional microphones for handheld use is ***NOT*** recommended!

10～190kHz works for small mammals

Price

Pettersson M500: **$395.00 USD** Add To Cart View Cart

Price includes (1) M500, (1) 1' USB-to-Micro USB cable, digital instruction manual, and Pettersson M500 capture software

Shipping charge will be calculated during checkout. International shipping will be quoted after you place your order.

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Click to zoom

Model: 378C01

1/4" free-field, prepolarized 377C01 microphone and 426B03 preamplifier. TEDS 0.9

This model includes a 1/4" microphone cartridge, a mated preamplifier with TEDS, and system calibration. Click the following for individual component information.

377C01

426B03

Price: $1,300.00 USD (US Domestic pricing only)

Add this product to my product comparison

Compare selected models (0)

Add To Cart

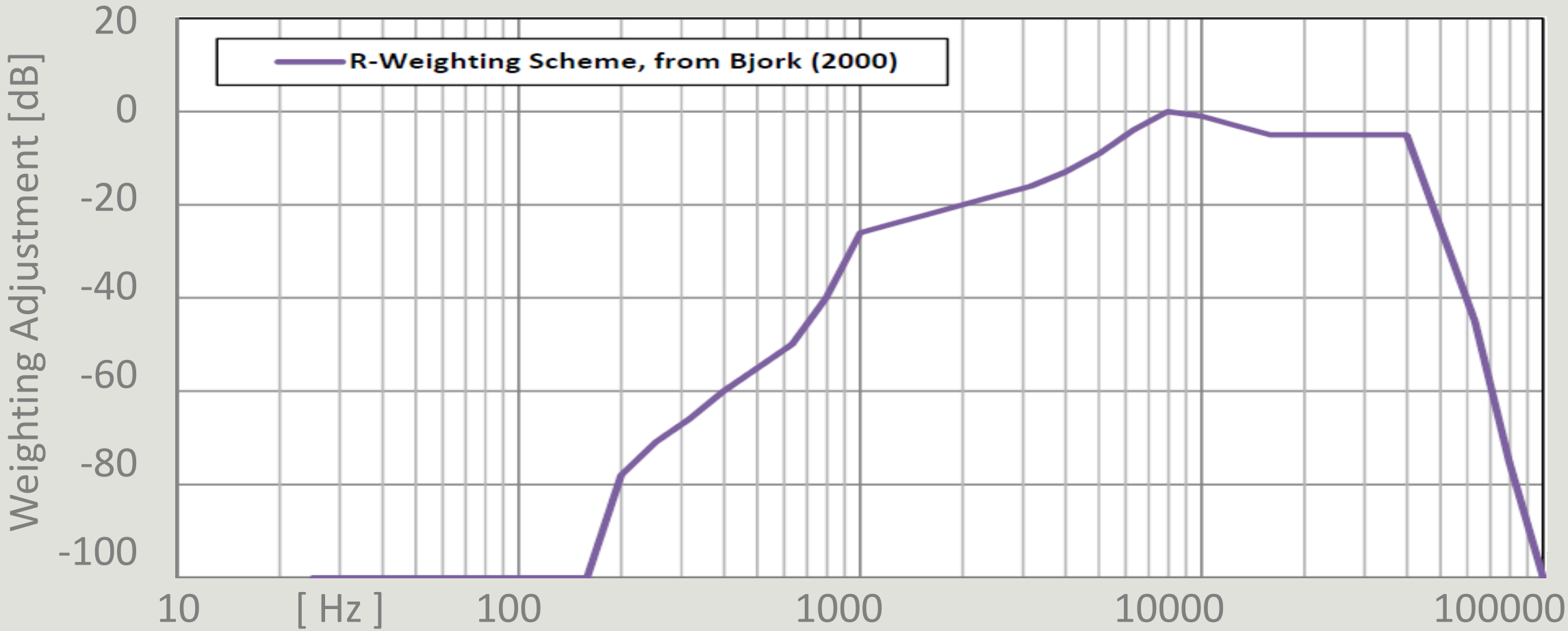
Specifications | Documents & Downloads

	ENGLISH	SI	
Performance			
Nominal Microphone Diameter	1/4"		
Frequency Response Characteristic	Free-Field		
Open Circuit Sensitivity	2.0 mV/Pa		
Open Circuit Sensitivity (+/-3.0 dB)	-54 dB re 1 V/Pa	-54 dB re 1 V/Pa	[1]
Frequency Range (+/-1 dB)	7 to 12500 Hz	7 to 12500 Hz	
Frequency Range (+/-2 dB)	5 to 80000 Hz	5 to 80000 Hz	
Frequency Range (+/-3 dB)	4 to 100000 Hz	4 to 100000 Hz	
Lower Limiting Frequency (3 dB)	0.75 to 4.0 Hz	0.75 to 4.0 Hz	
Inherent Noise	<53 dB re 20 µPa	<53 dB re 20 µPa	[3]
Inherent Noise	<45 dB(A) re 20 µPa	<45 dB(A) re 20 µPa	[4]
Dynamic Range	>162 dB re 20 µPa	>162 dB re 20 µPa	
TEDS Compliant	Yes	Yes	[2]

¼” mics for ultrasound

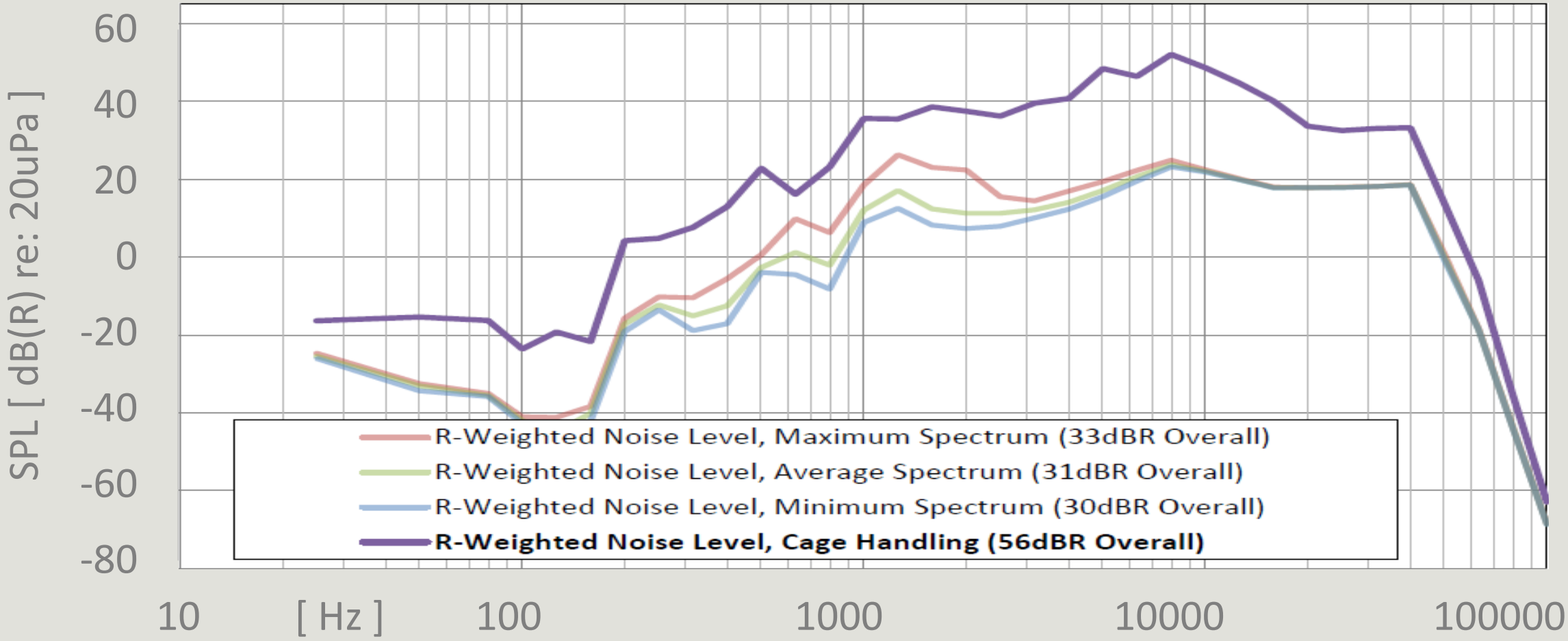
Now for some real-life data

We can attempt an R-Weighting

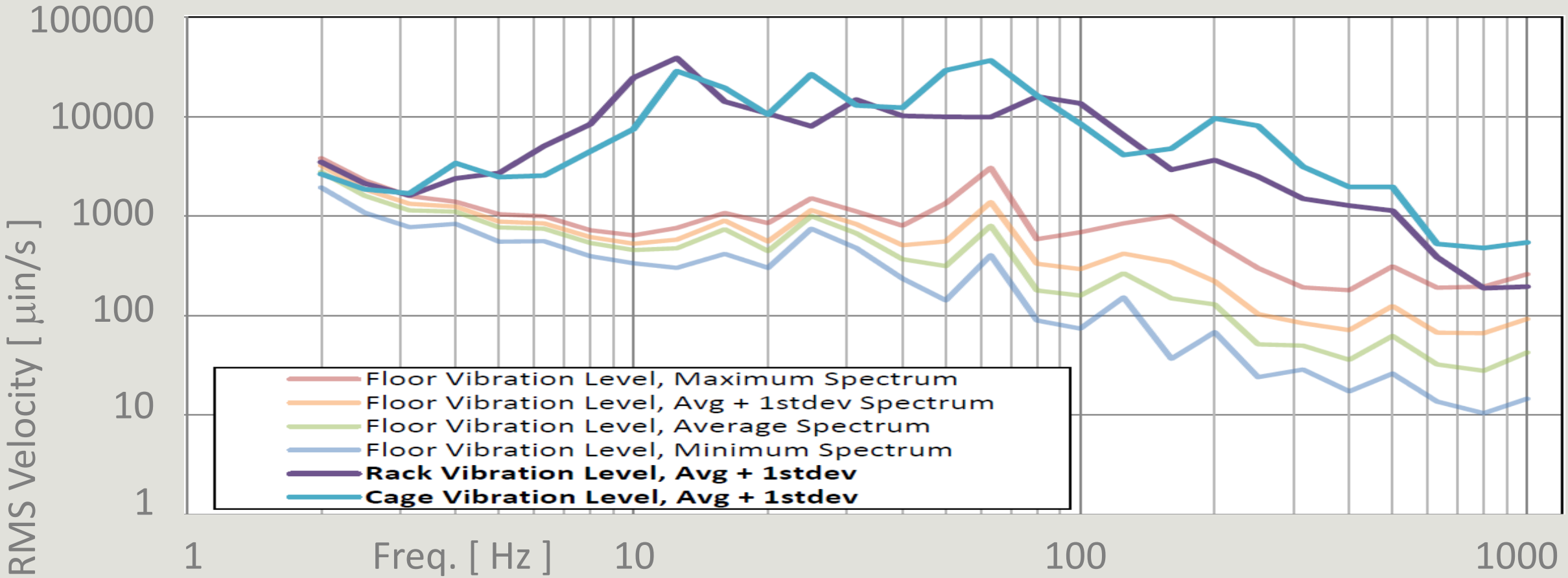


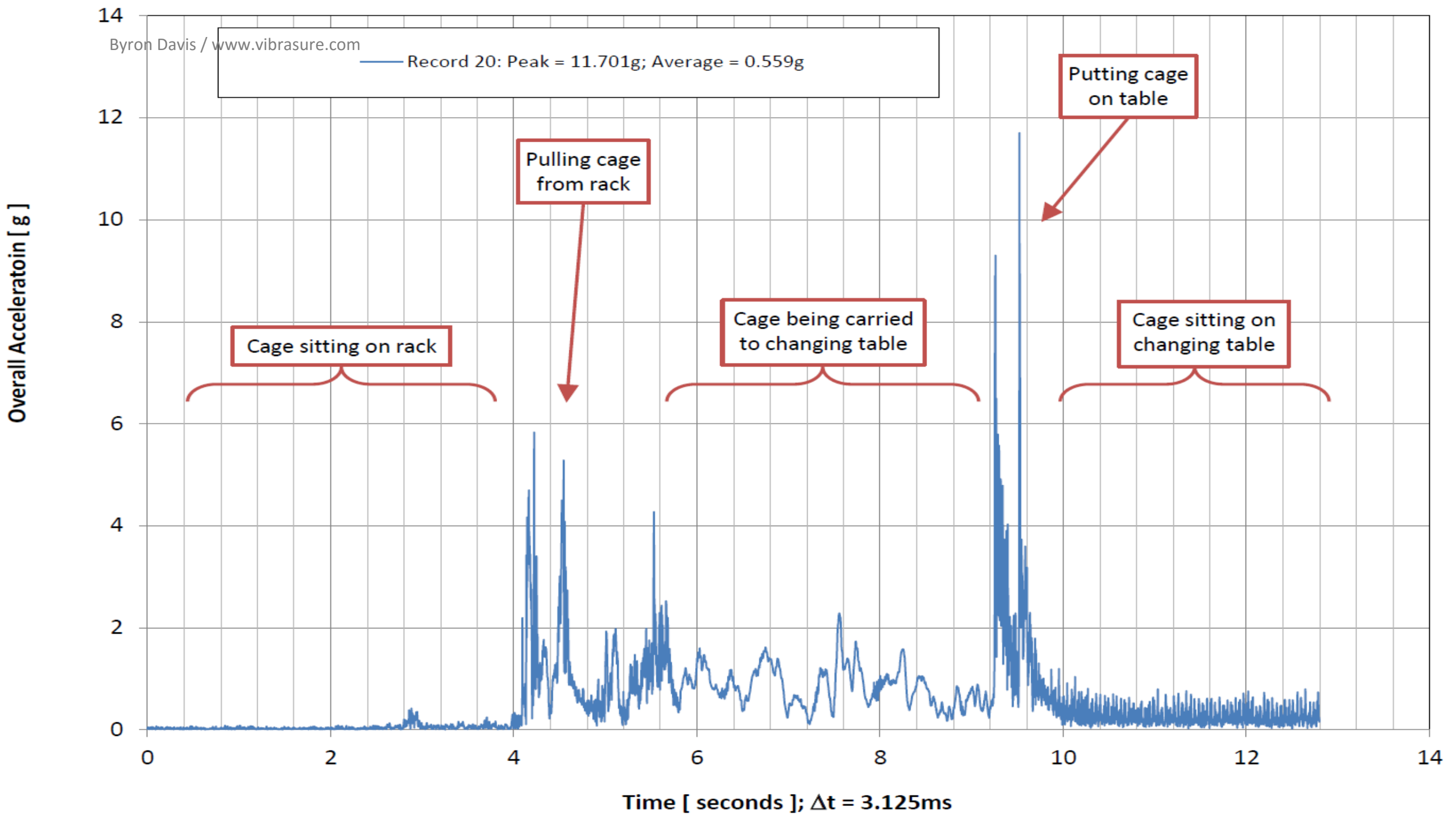
After E. Bjork, T. Nevalainen, M. Hakumaki, H.M. Voipio (2000)
R-weighting proves better estimation for rat hearing sensitivity. Laboratory Animals (2000) 34, p136~144

R-Weighted Sound Data



Cages, Racks Create Vibrations




Byron Davis / www.vibrasure.com
Record 20: Peak = 11.701g; Average = 0.559g
Overall Acceleratoin [g]
Time [seconds]; Δt = 3.125ms
Cage sitting on rack
Pulling cage from rack
Cage being carried to changing table
Putting cage on table
Cage sitting on changing table
0
2
4
6
8
10
12
14

Take-away Thoughts

- No formal criteria, but we have ideas
- “Empathic design” is required
- Be careful with instrumentation and data
- Chronic vs acute impacts
- Building vibration/sound only part of the picture

Thanks for listening!