



*Team 15 | Collaboration with Dr. Mark Stecker
University of California, San Francisco | Fresno*

Quantifying Vibration Perception Threshold in Peripheral Neuropathy Patients

Team 15



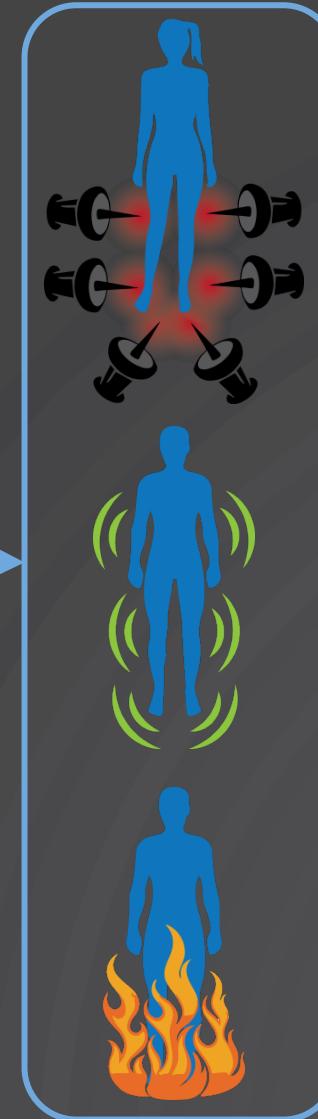
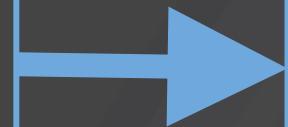
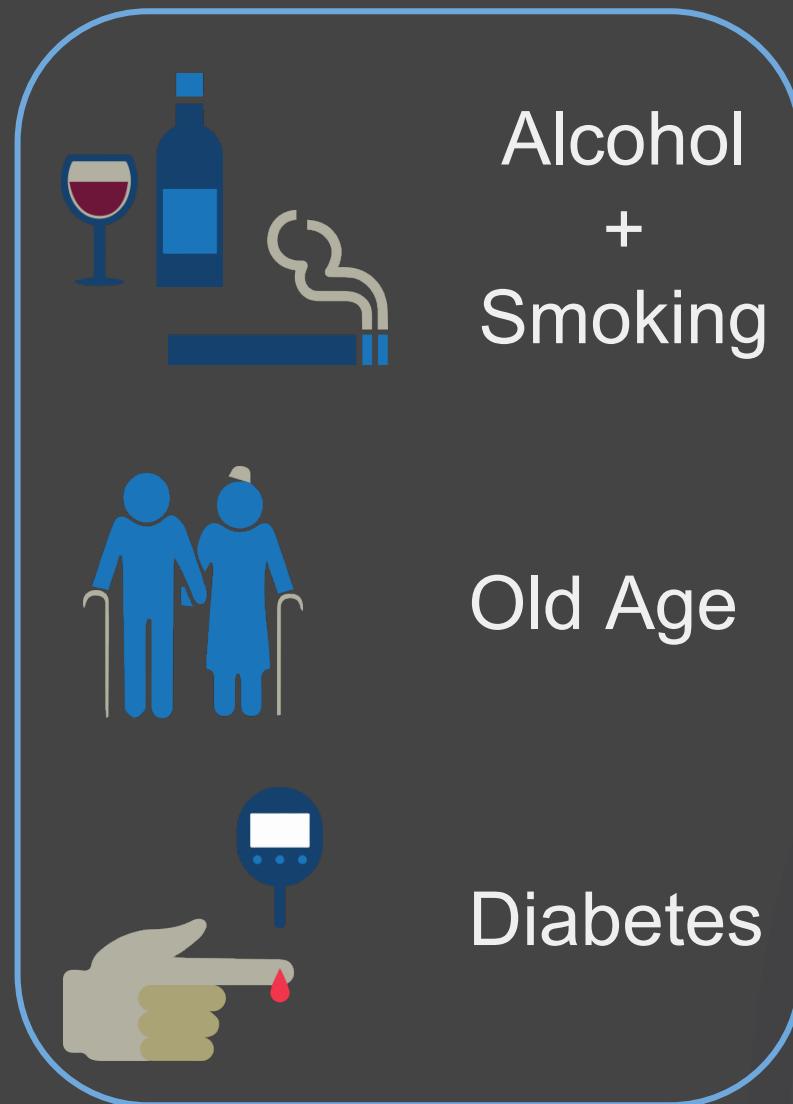
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Jasmine Nguyen² | Safety Officer
Forrest Yeh² | Chief Medical Officer
Kevin Martinez¹ | Chief Financial Officer

Mechanical Engineering¹, Bioengineering² | University of California, Merced

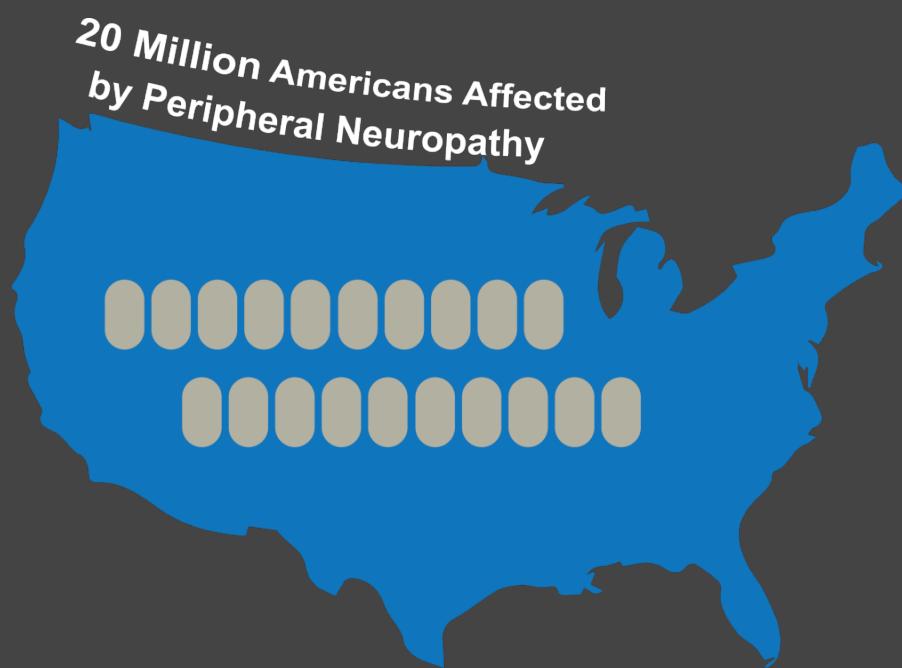
2nd leading
cause of
**ACCIDENTAL
DEATH**
in the World



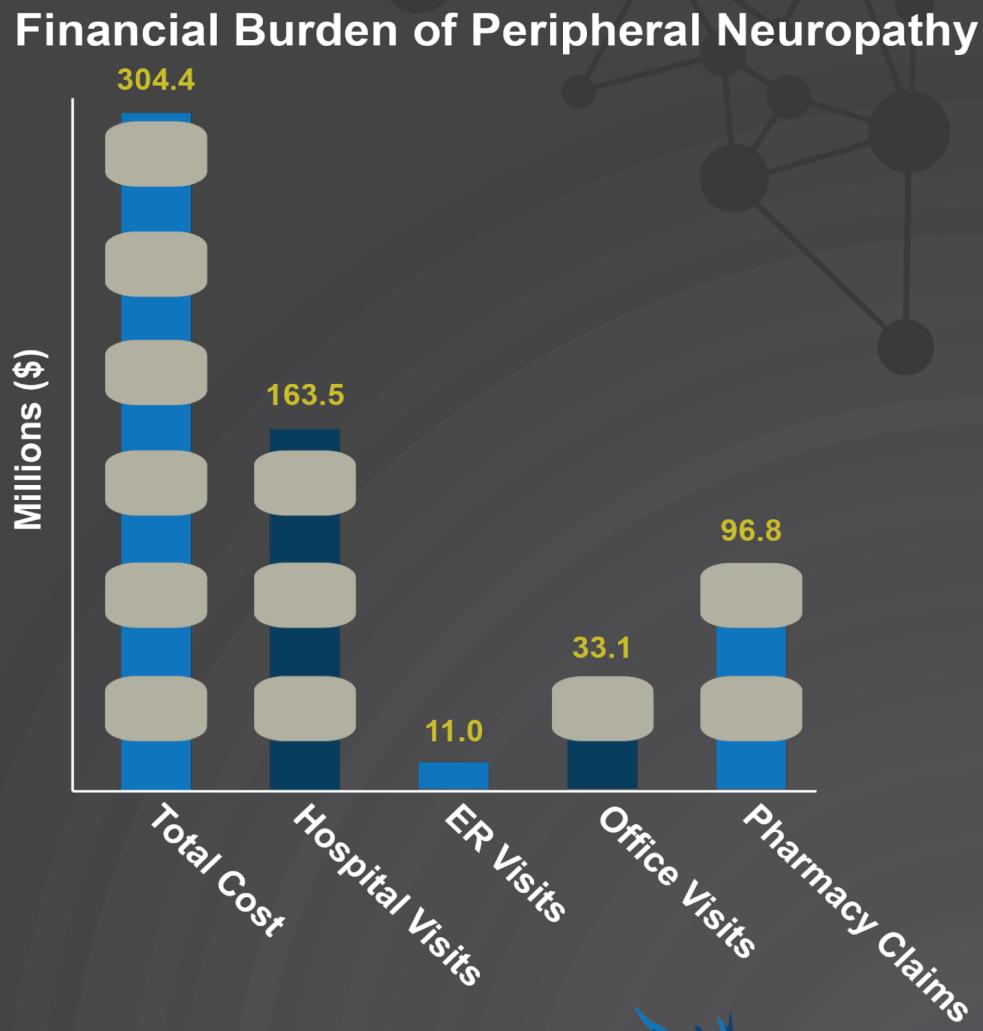
Peripheral = extremities
Neuropathy = nerve damage



Public Health Impact



Reduced Quality of Life **50%**



Tuning Fork Test



128Hz

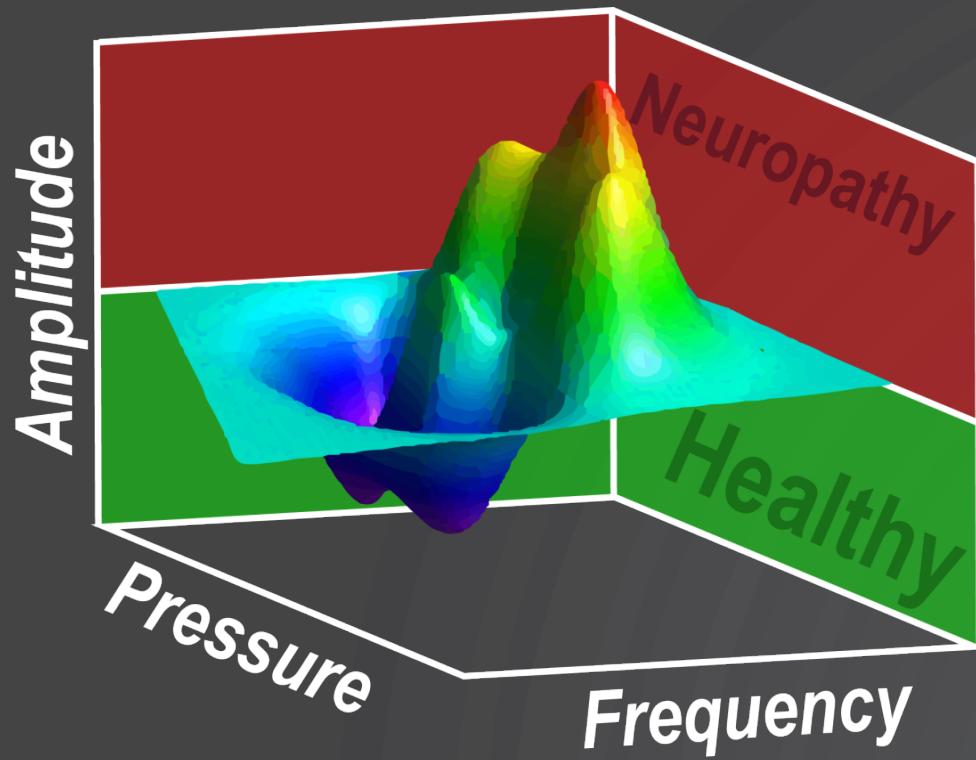
One Frequency
Inconsistent Amplitude
Variable Pressure



- Bickley, 2009, [ISBN 978-0-7817-8058-2](#).
- Griffin, 2012, Industrial Health 2012, 50, 354–369

Vibronerv's Mission

Goal was to create a device that will quantify the range of frequency a patient can feel vibration, known as the Vibration Perception Threshold (VPT).



Project Constraints

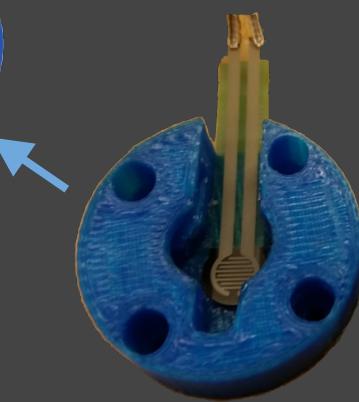
Diagnosis Technique	 VIBRONERV
Multiple Frequencies	2-2000 Hz
Time efficiency	2-3 min
Cost	< \$300
Pressure range	5-1000 kPa
User Friendly	✓
Sterilization	✓
Descending/ Ascending Amplitude	✓



CS17 Prototype Mechanism

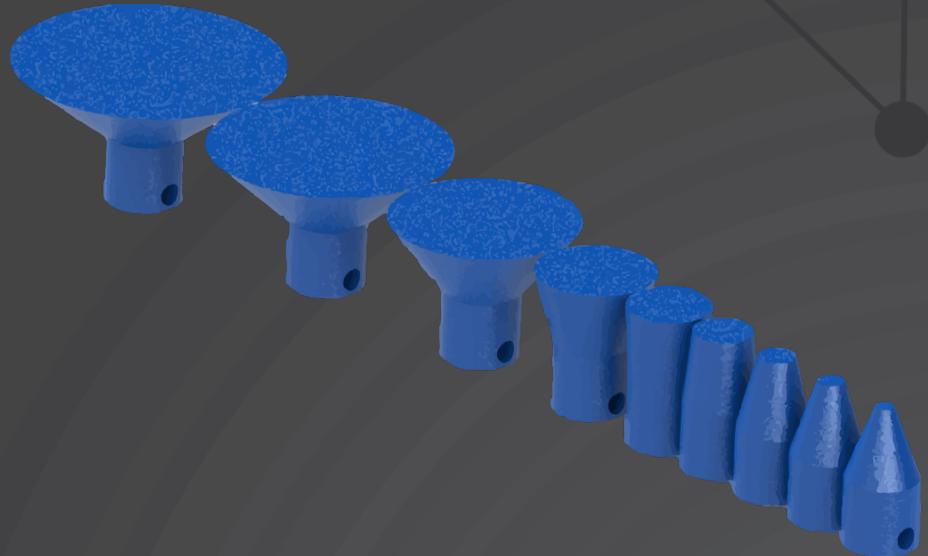


Pressure Application and Sensing Mechanism



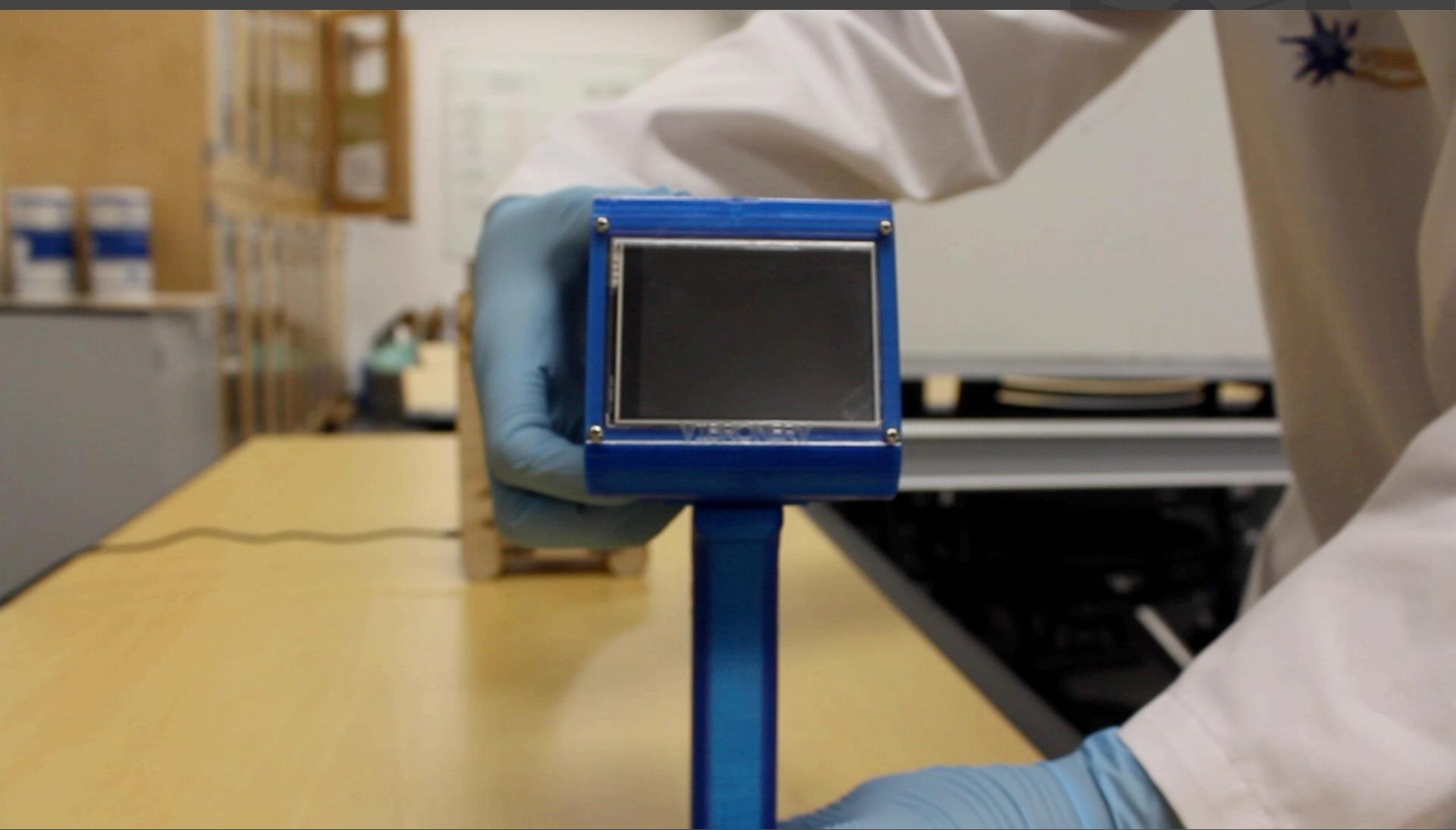
Force Sensor

Variable Contact Surface Area
 $5\text{mm}^2 - 1000\text{mm}^2$



$$\text{Pressure} = \frac{\text{Force (N)}}{\text{Area (mm}^2\text{)}}$$

Using the Device



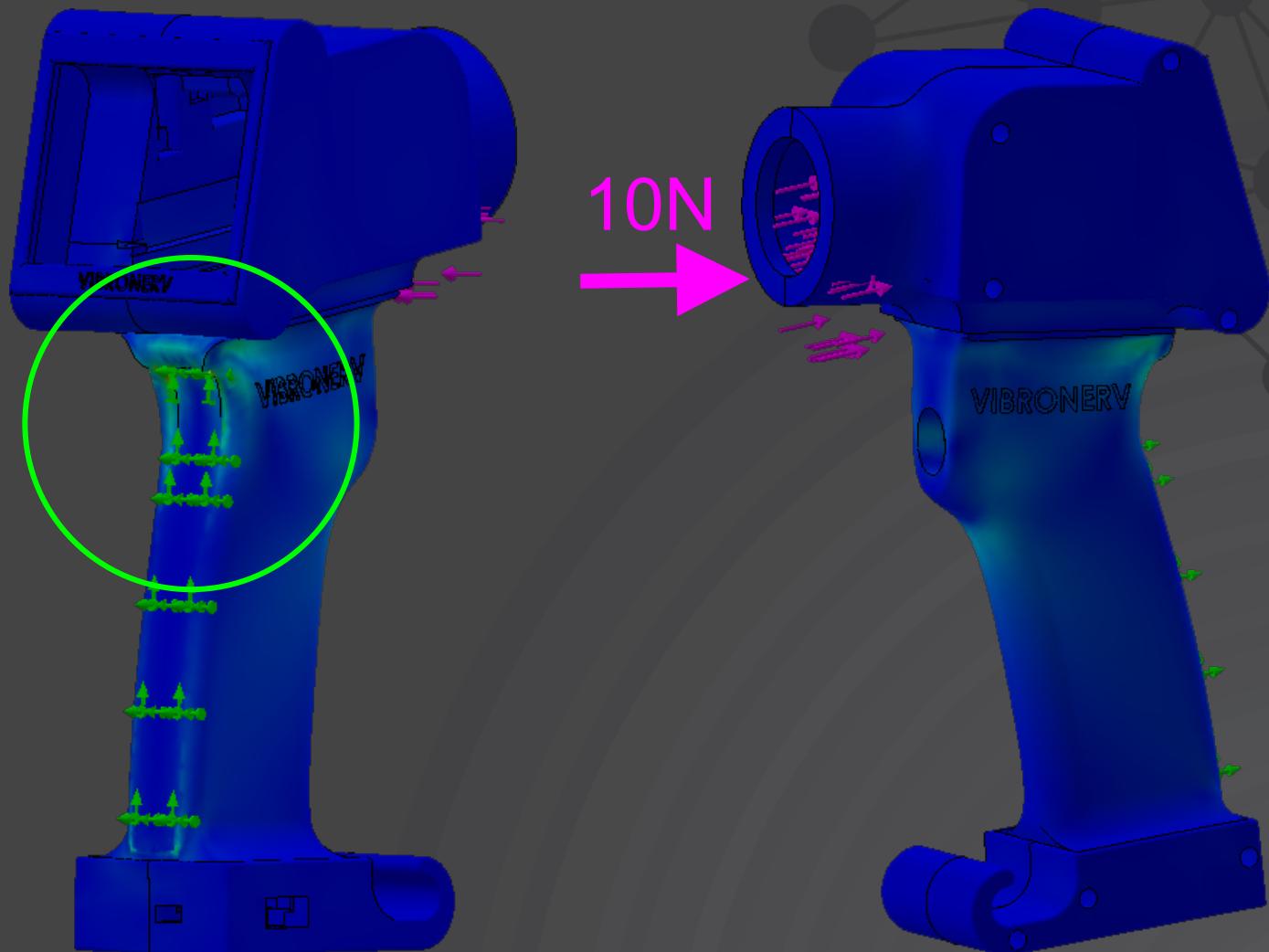
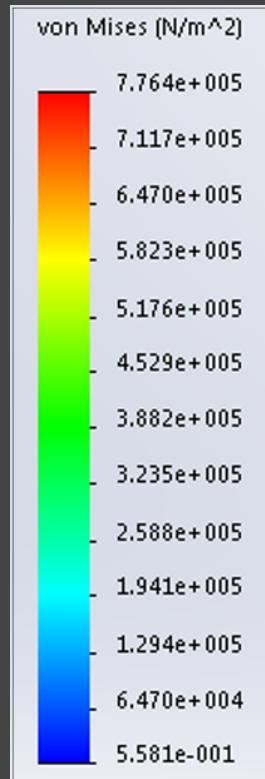
Safety Precautions



Electrical Safety

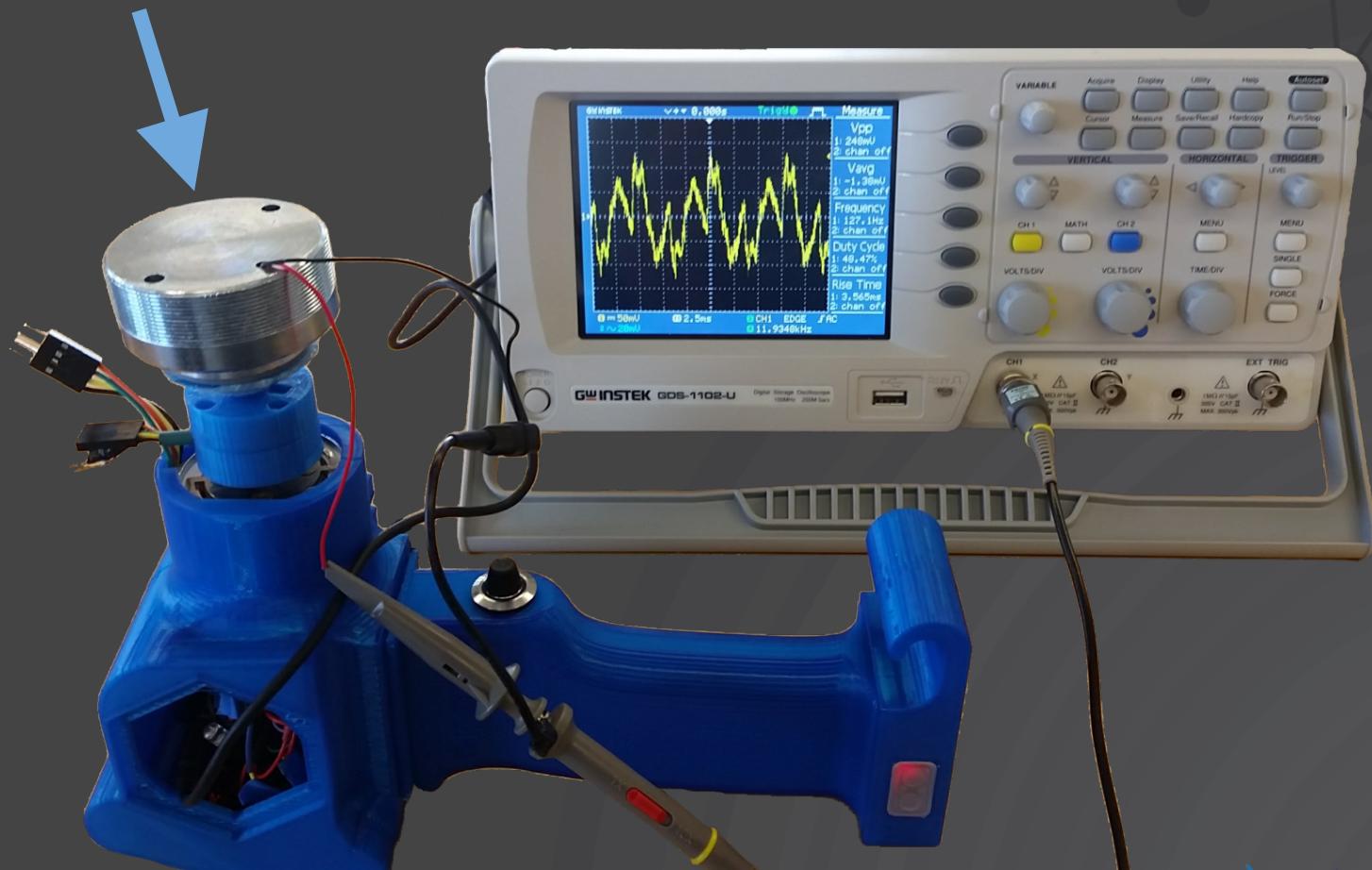
Sterilization

Analysis 1: Structure

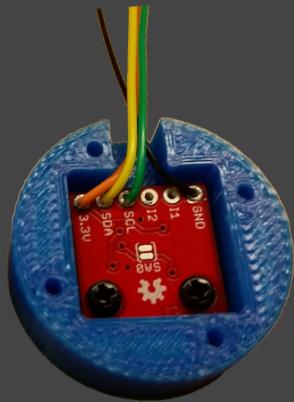


Analysis 2: Vibration

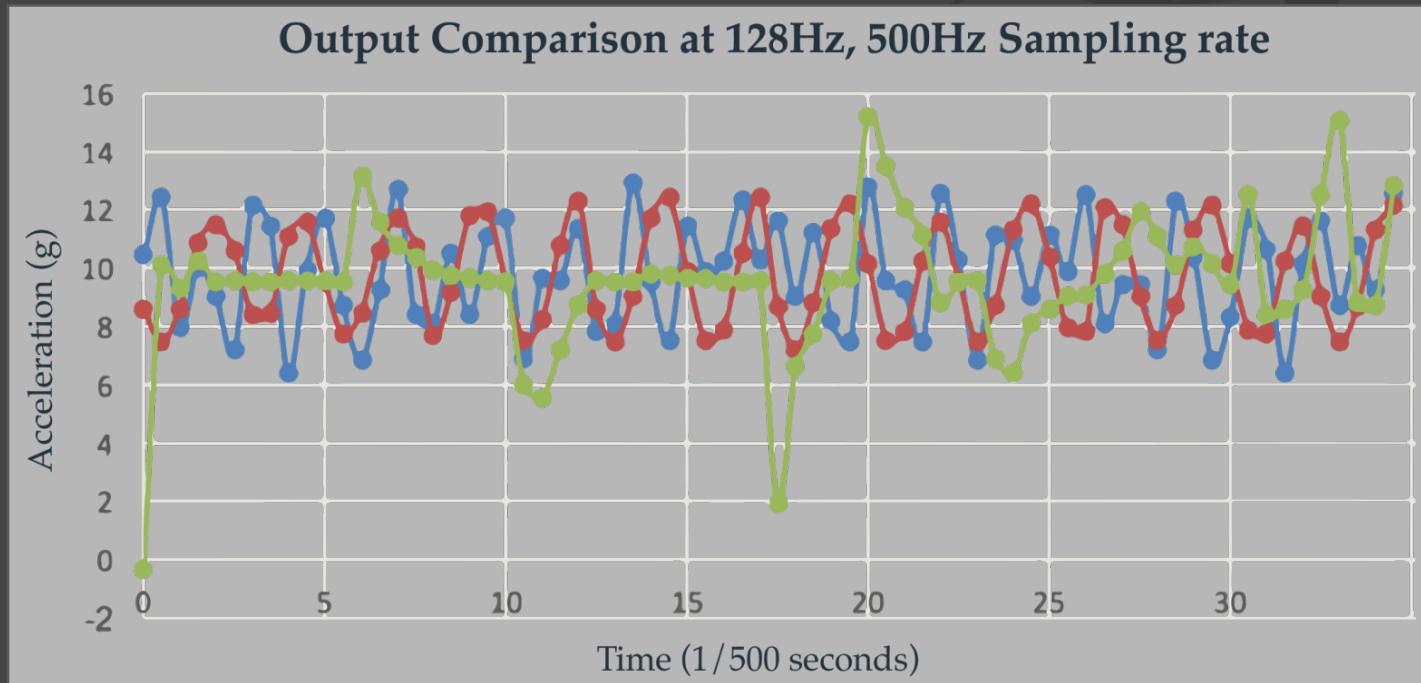
Sensing Transducer



Analysis 3: Root Mean Square (RMS)



Accelerometer



RMS	Standard Deviation (from generator)	Percent Error
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Tuning Fork

Waveform
Generator

Financial Analysis

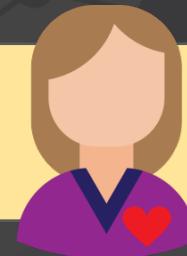
21,000 Unit Cost:
\$64.01 per unit
MSRP = **\$200**



Prototype Cost:
\$263.49 per unit



Payback:
10 Tests



General Consumers

Net Profit:
\$472,860



Care Providers

Profit Margin:
68%



Investors

Return On Investment Breakdown

Medicare Reimbursement:

\$26.27

Patient Copay:

80% of \$26.27

Device Lifetime:

10,000 tests



Gain = \$472,860

$$ROI = \frac{Gain - Cost}{Cost} = 236,350\%$$

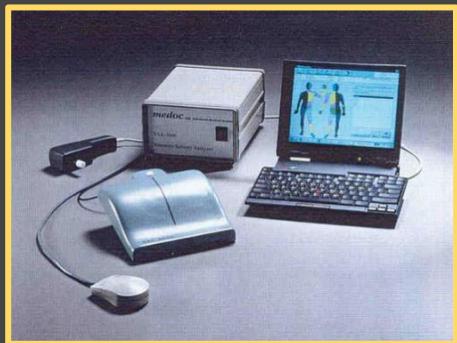
Device Cost:

\$200.00

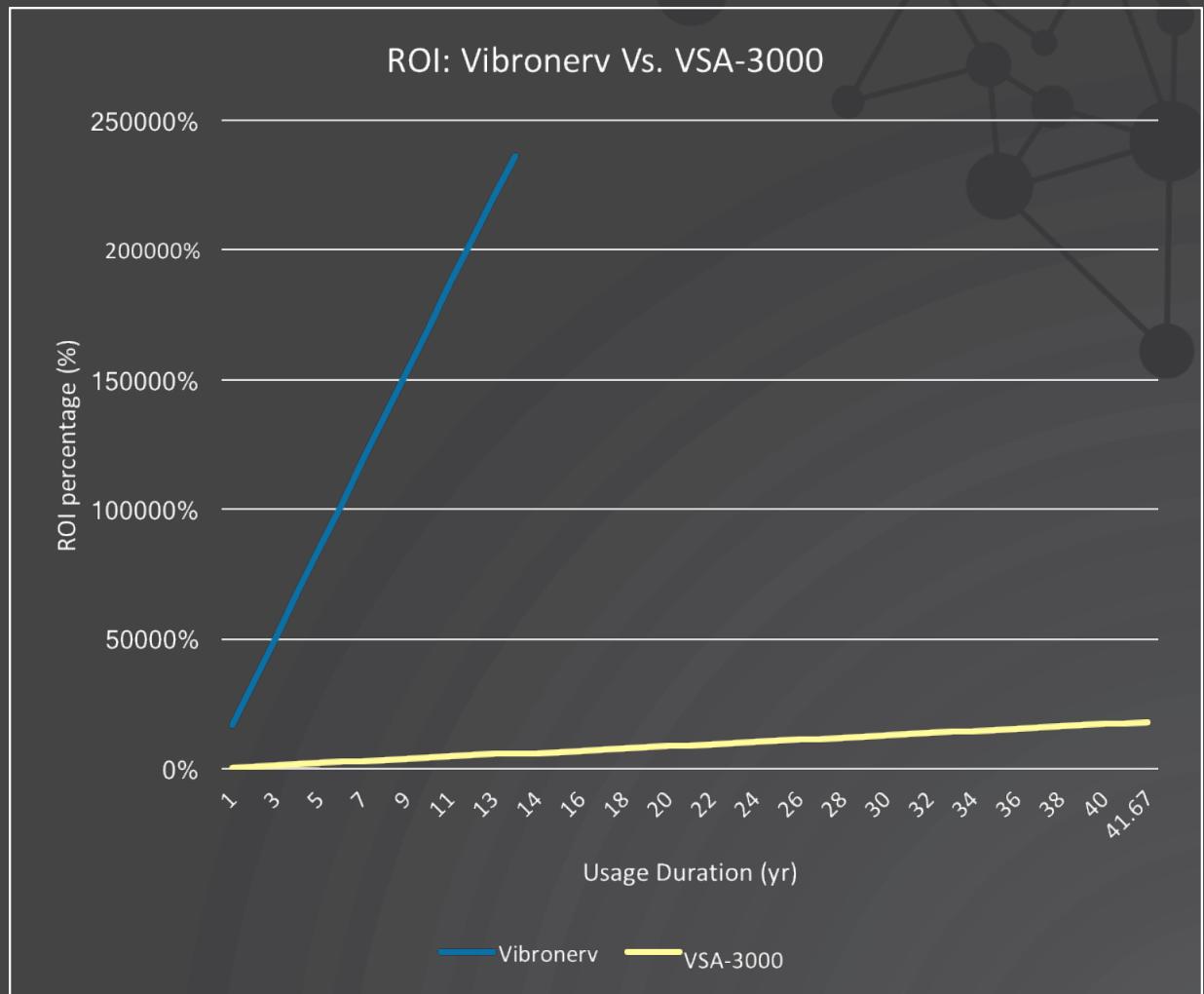


Cost = \$200

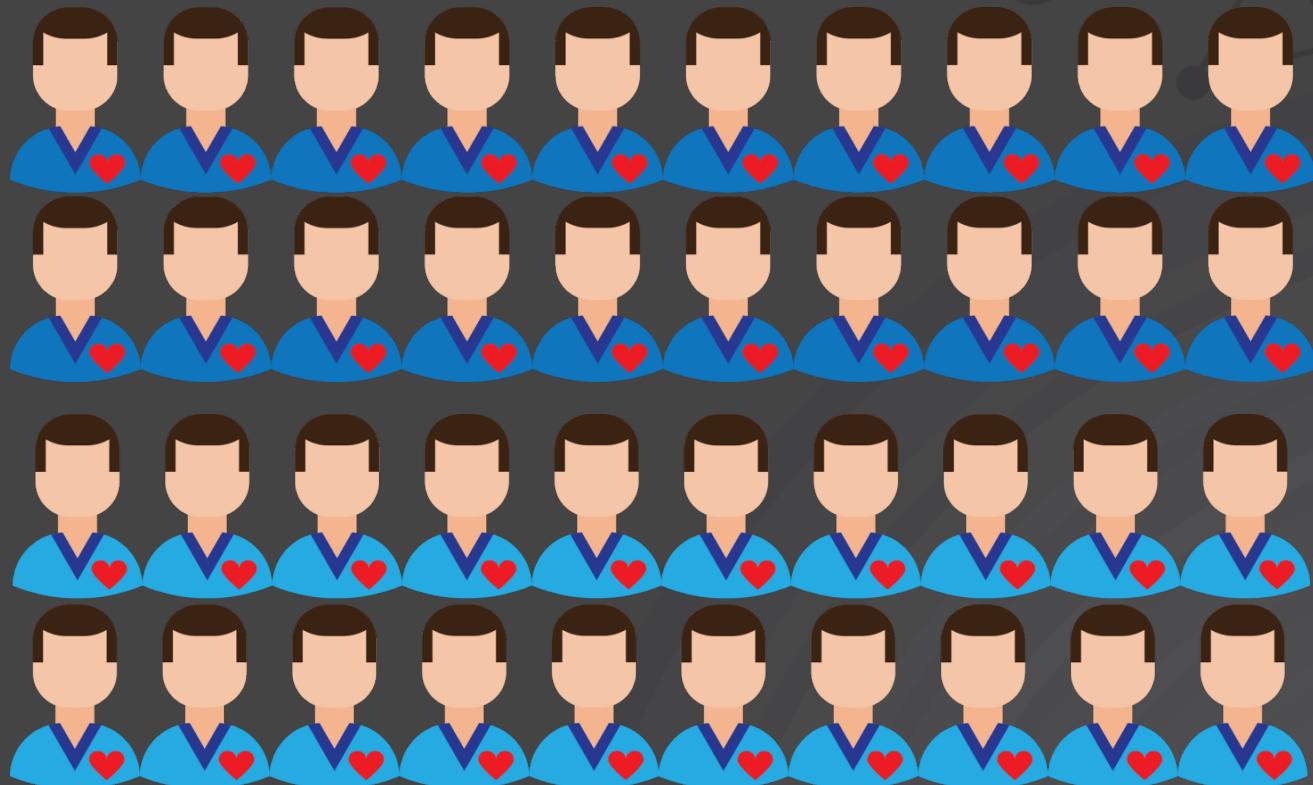
Return On Investment Analysis



VSA-3000



The Next Step



UCSF Fresno



Our Vision



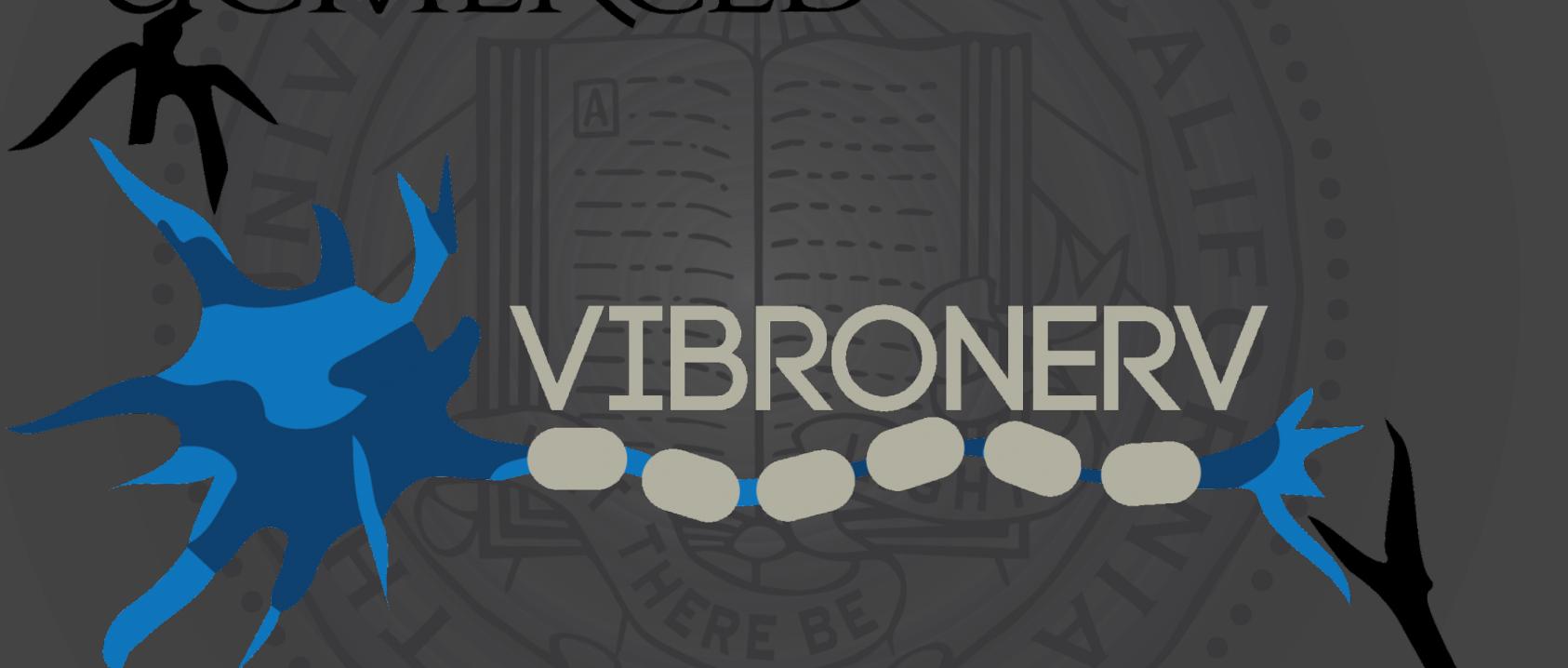
Thank you!

Huge thanks to Dr. Mark Stecker, UCSF Fresno, our mentor Rachel Hatano, and the Capstone faculty!



Questions?

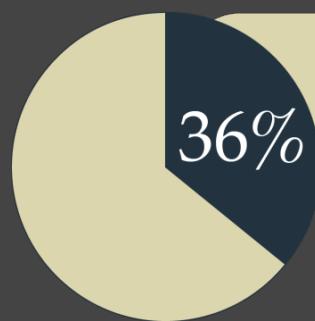
UCMERCED



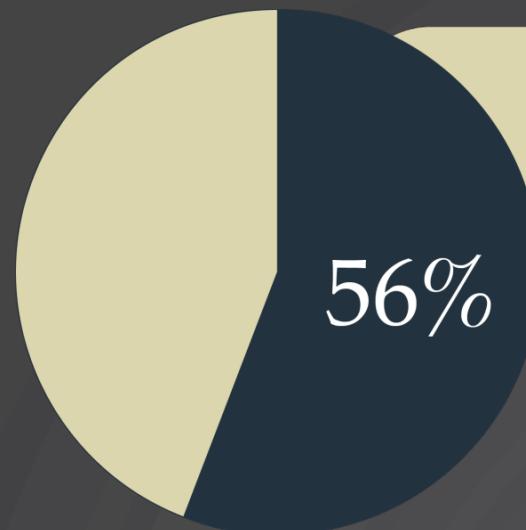
UCSF Fresno

Appendix I: Full Scale Implementation

Percent of Total Cost from Electrical Components



Scaled-up

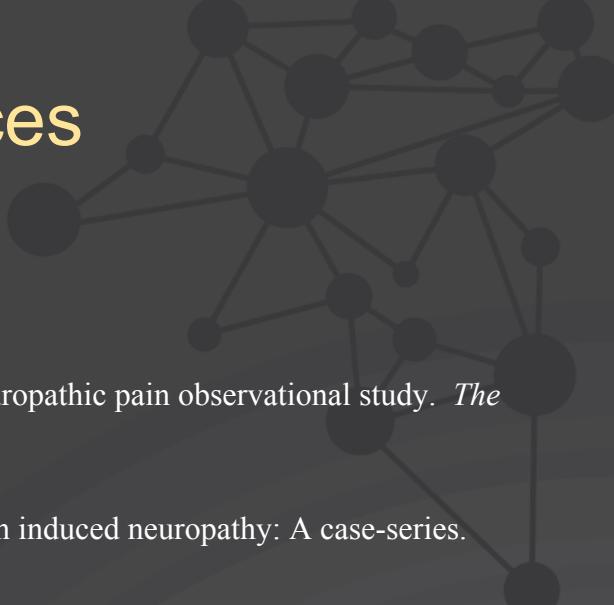


Prototype

Appendix II: Bill of Materials

Bill of Materials	
Product	Cost
EM Surface Transducer	\$17.50
1kg PLA Filament	\$24.99
Wood Sheets (1 charging station)	\$0.94
Acrylic Plastic Sheets (per device)	\$0.10
Small Force Sensor	\$5.95
Accelerometer	\$9.95
Momentary Button	\$4.95
20W Amplifier	\$19.95
2.8" Touchscreen	\$34.95
Arduino Nano	\$34.99
Logic Level Converter	\$2.95
BLE Nano & MK20	\$32.99
4400mAh LiPo Battery	\$19.95
Qi Wireless Transmitter	\$26.95
Qi Wireless Receiver	\$14.95
LiPo Battery Management	\$19.95
Screws (Prototype) – 25 pack	\$10.63
Screws (Final Design) – 100 pack	\$10.09
Wires	\$3.94
MicroBan Plastic (per lb)	\$8.00
Bluno Nano	\$33.55

Appendix III: References

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- [1] Sadosky, A. et al.. Economic burden of neuropathic pain in the United States: BEAT neuropathic pain observational study. *The Journal of Pain*, Volume 14 , Issue 4 , S13
 - [2] The Foundation of Peripheral Neuropathy. Facts and Risk Factors. Accessed April 2017
 - [3] Rosén, B., Björkman, A., & Lundborg, G. (2011). Improving hand sensibility in vibration induced neuropathy: A case-series. *Journal of occupational medicine and toxicology*, 6(1), 13
 - [4] Griffin MJ. Frequency-dependence of psychophysical and physiological responses to hand-transmitted vibration. *Ind Health*. 2012; 50(5): 354-369.
 - [5] "License for Use of Current Procedural Terminology, Fourth Edition ("CPT®")." CMS.gov Centers for Medicare & Medicaid Services. N.p., n.d. Web. 10 May 2017.
 - [6] "Journal of Medical Economics." *Taylor and Francis Online*. N.p., n.d. Web. 05 Apr. 2017.
 - [7] Nabuurs-Franssen MH, Huijberts MS, Nieuwenhuijzen Kruseman AC, Willems J, Schaper NC. Health-related quality of life of diabetic foot ulcer patients and their caregivers. *Diabetologia*. 2005;48(9):1906-10.
 - [8] Northouse LL, Mood D, Kershaw T, Schafenacker A, Mellon S, Walker J, et al. Quality of life of women with recurrent breast cancer and their family members. *J Clin Oncol*. 2002;20(19):4050-64.