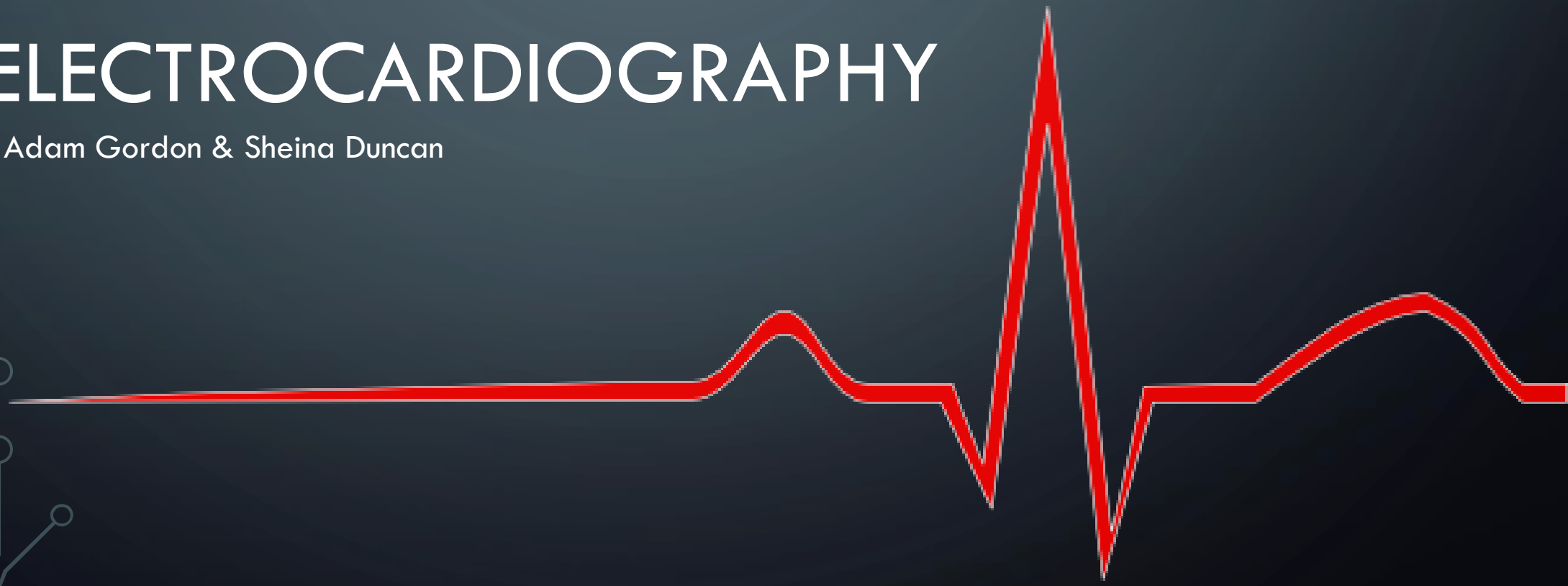
ELECTROCARDIOGRAPHY

Adam Gordon & Sheina Duncan



ECG

- Measures electrical activity of the heart
- Electrodes placed on the skin
  - Detect tiny electrical variations
  - One or more (but usually 12) leads
- Graph of voltage vs. time called electrocardiogram

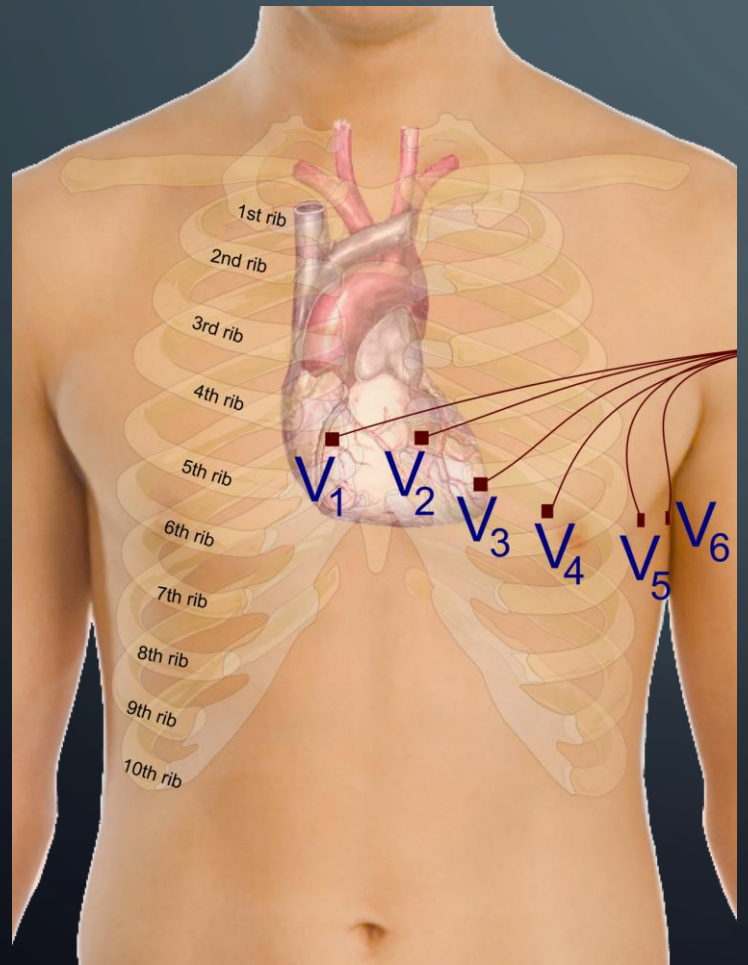
WHY USE AN ECG

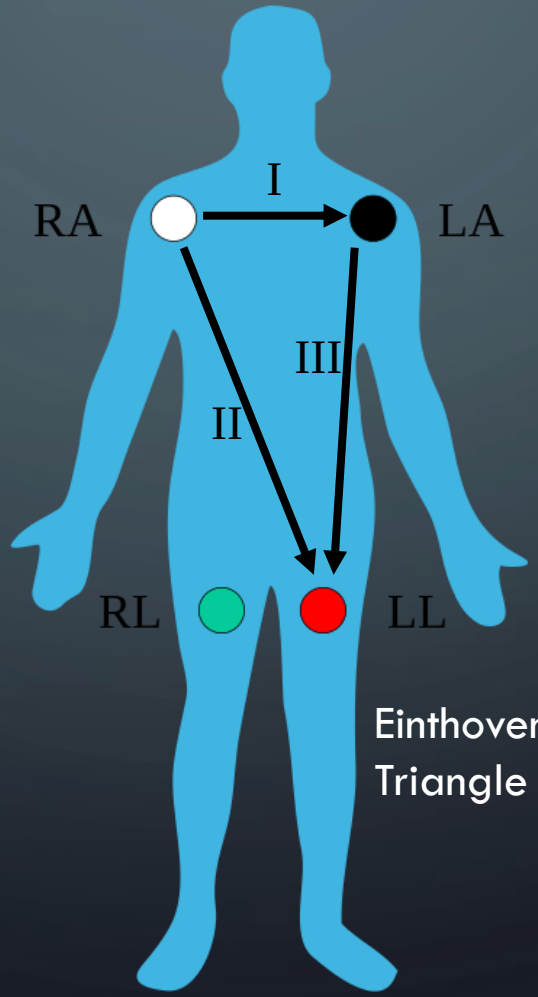
- Heart disease is #1 cause of death in US
- Using all 12 leads, doctors can get accurate measurements of the heart
  - Can detect shape, arrhythmia, thickening, heart attacks, heart rate, and more
- ECGs of healthy hearts have characteristic shape
- Safe and non-invasive
- Quick

https://www.medicalnewstoday.com/articles/282929.php

LEAD PLACEMENT

- Clinical ECGs use 10 electrodes to form 12 different leads





Einthoven's Triangle

LEAD PLACEMENT

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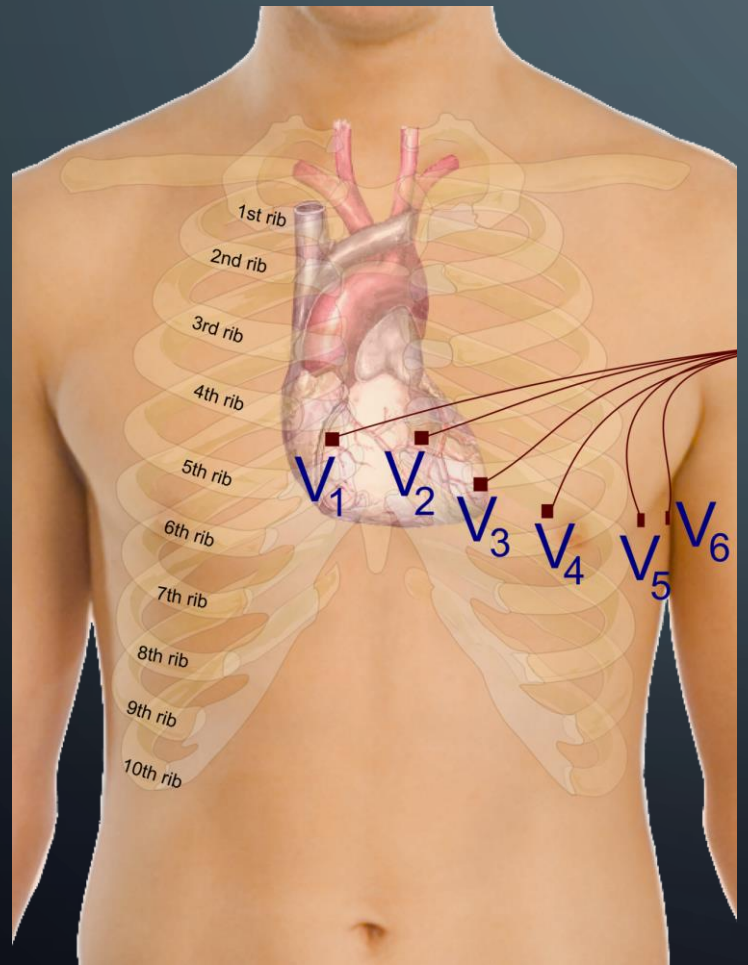
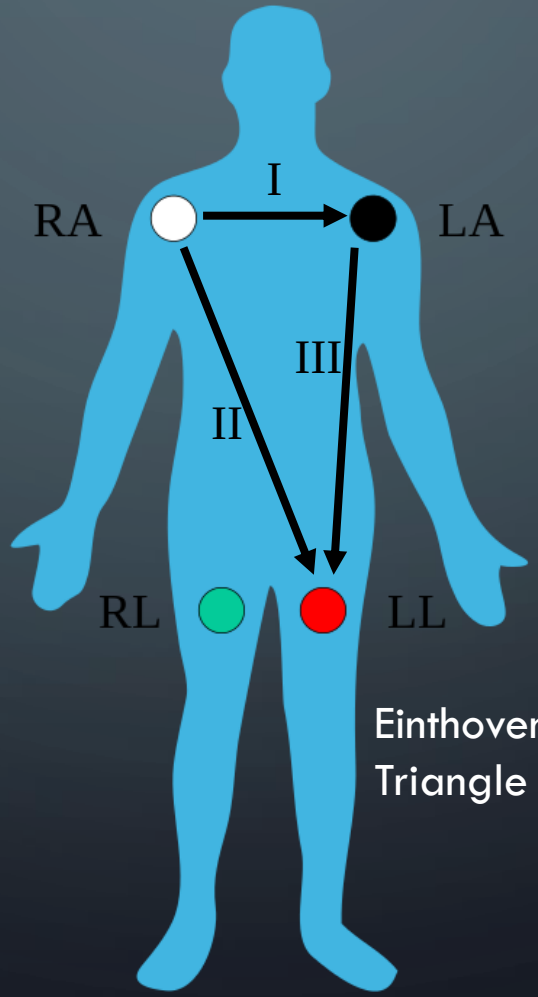
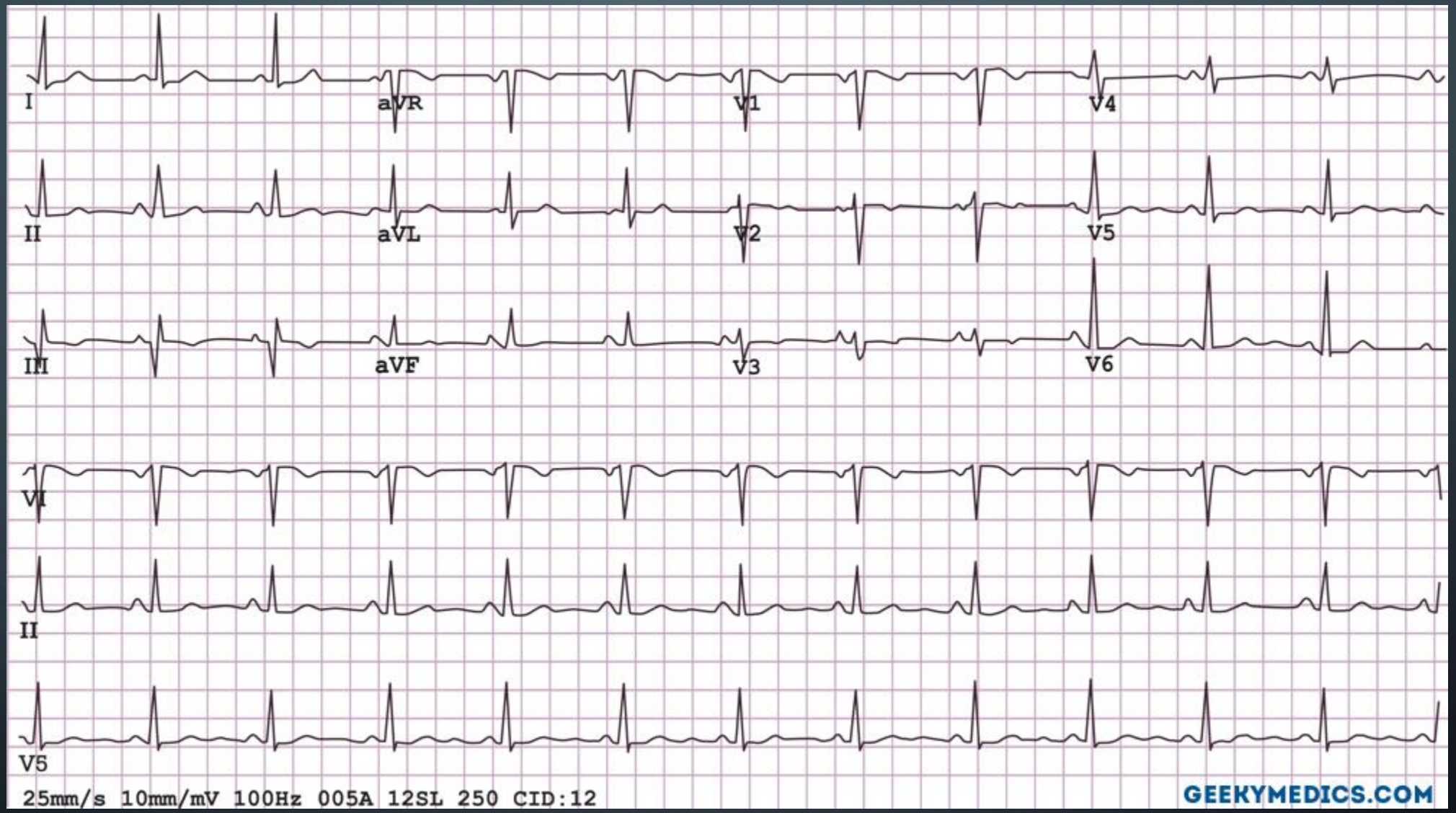




Einthoven's Triangle

In our device, we only used 3 electrodes, and are only able to measure one lead. We will use Lead II, as it is the strongest signal



Example of an electrocardiogram, showing the signal generated from all 12 different leads

https://geekymedics.com/understanding-an-ecg/

ECG MACHINES ARE EXPENSIVE

Nihon Kohden CardioFax S EKG Machine
Price: $2800.00

Nihon Kohden CardioFax V EKG Machine
Price: $2845.00

Welch Allyn CP100 Interpretive EKG Machine - EMR Compatible -NEW
Price: $2295.00

https://www.absolutemed.com/ekg-ecg-machines/

OUR ECG DEVICE

- Implementation amp
  - Reads tiny variations in potential and amplifies them
- Filters
  - Active or Passive
  - Used to reduce noise

STEP 1: INSTRUMENTATION AMP

- We used the AD620 instrumentation amp
- Gain calculated with this formula:

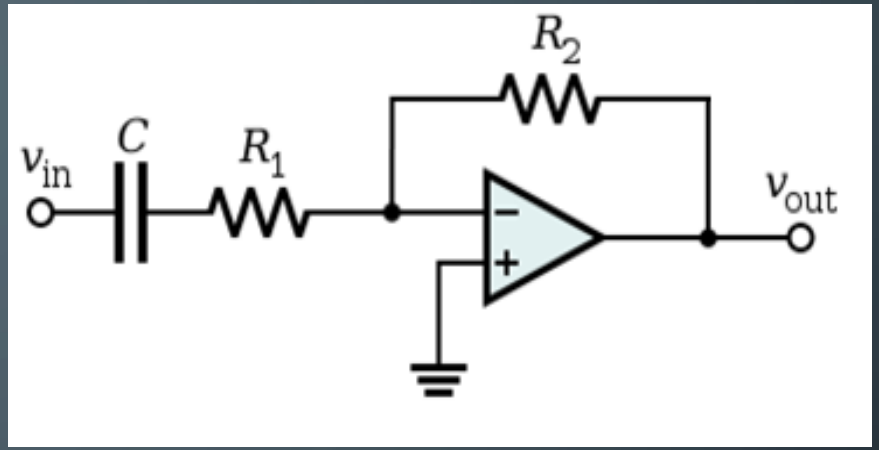
$$G = \frac{49.4\ k\Omega}{R_G} + 1$$

- To achieve gain of ~100, we used a 499Ω resistor

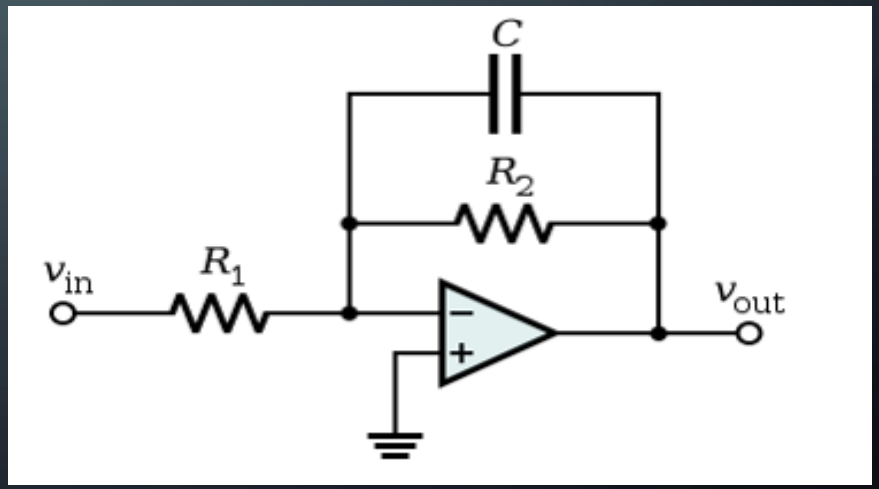
FILTERS

- Environment provides a lot of noise
  - Power line interference
  - Fluorescent Lights
  - Muscular Noise

- At first, we used two active filters
  - High Pass
  - Low Pass



Schematic of an active high pass filter

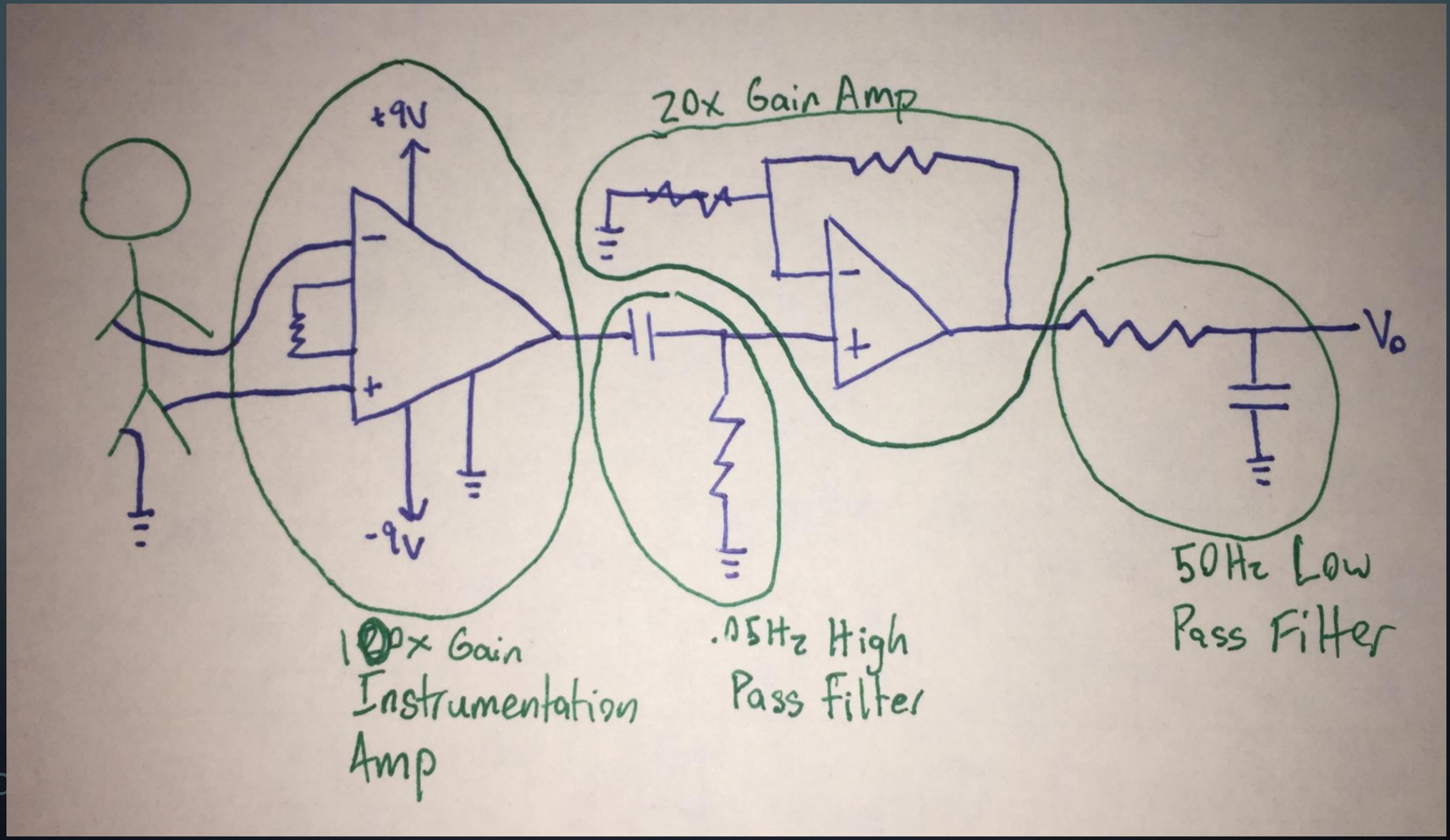


Schematic of an active low pass filter

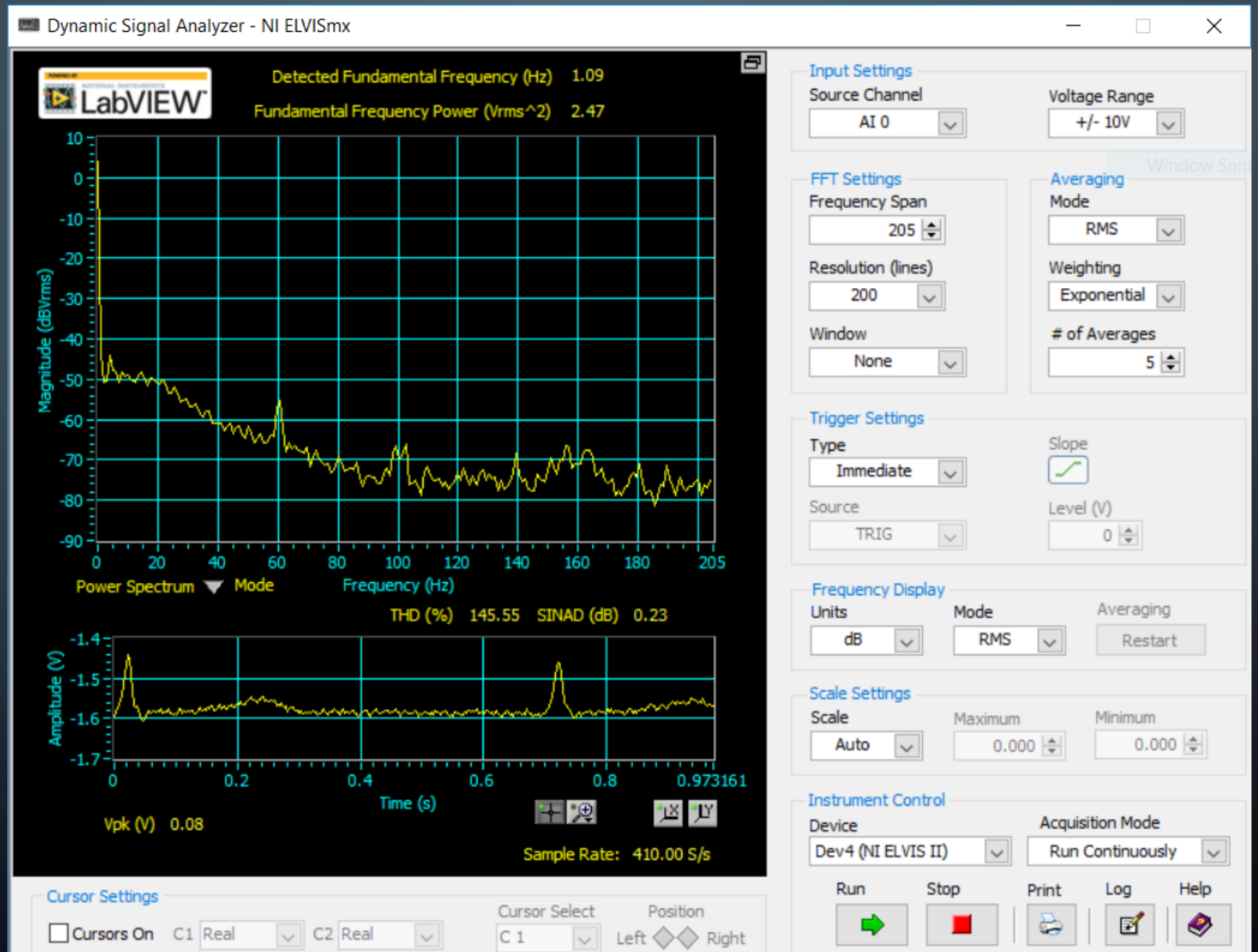
OUR REVISIONS

- Use passive filters
- High pass filter first, to filter very low (< .05 Hz) frequencies
- Add gain separately using op amp
- Low pass filter last, to filter > 50 Hz noise

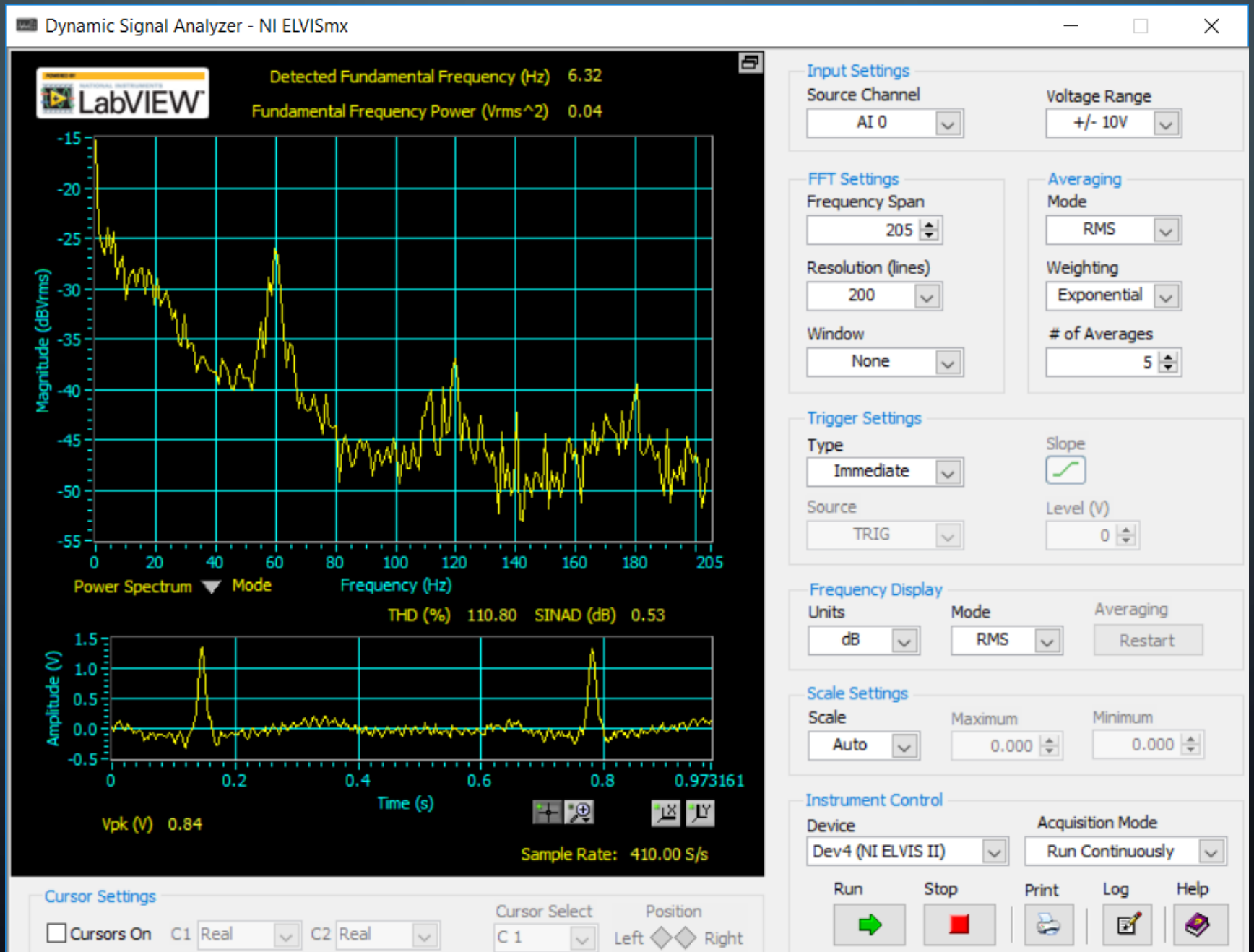
OUR FINAL CIRCUIT DESIGN



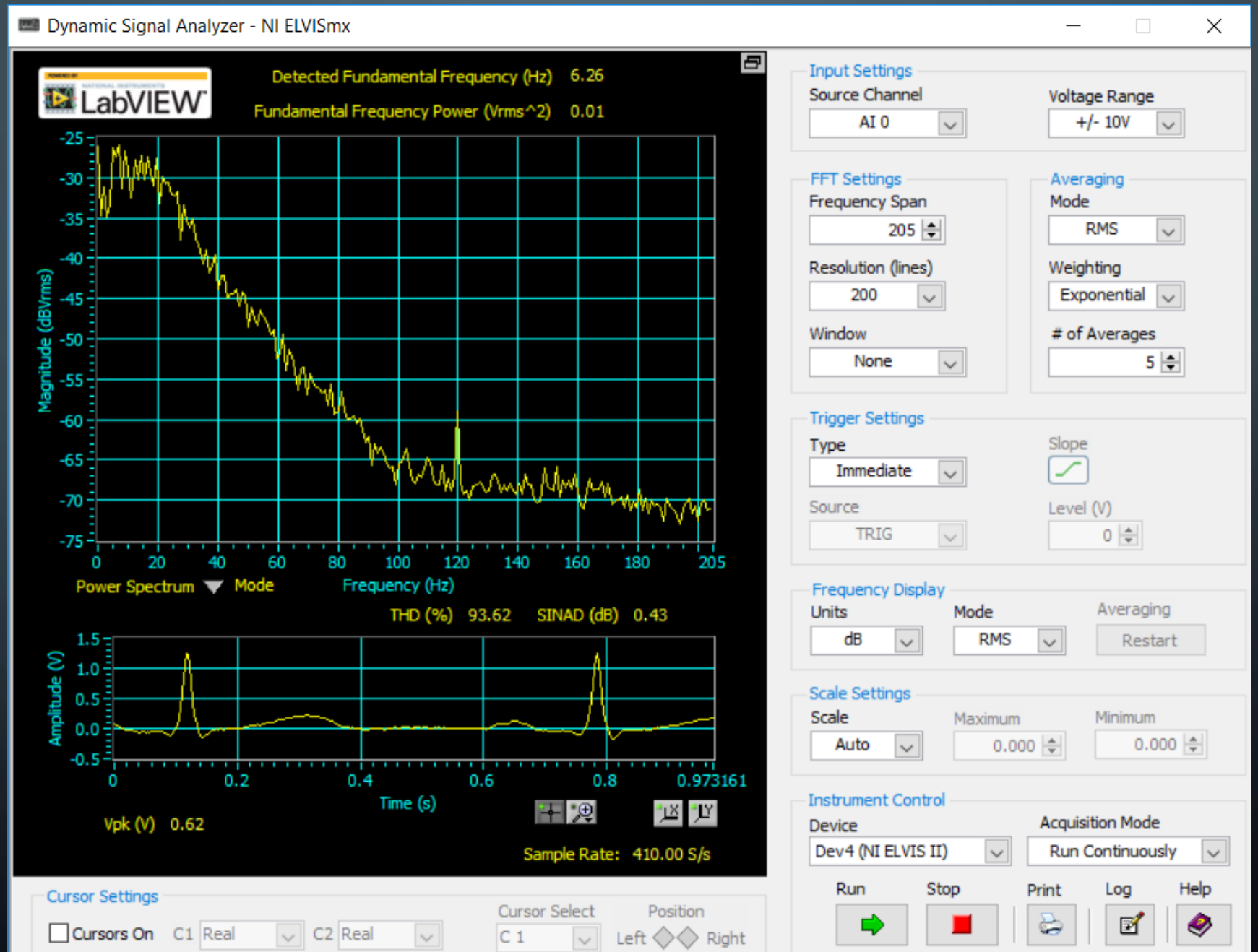
SPECTRUM ANALYZER (JUST INSTRUMENTATION AMP)



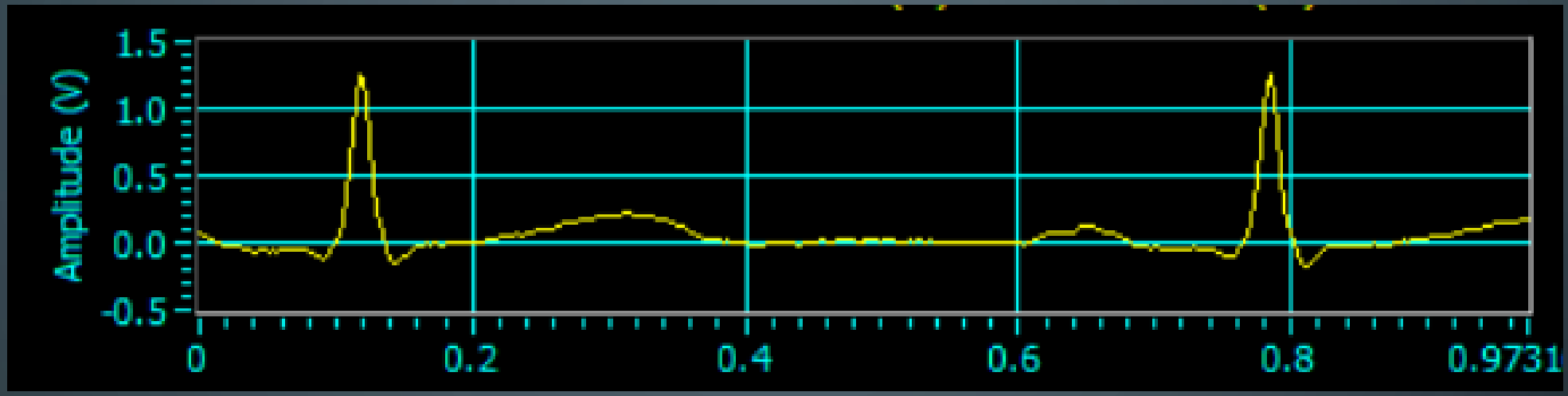
SPECTRUM ANALYZER (AFTER ADDING HIGH PASS FILTER AND 20X AMP)

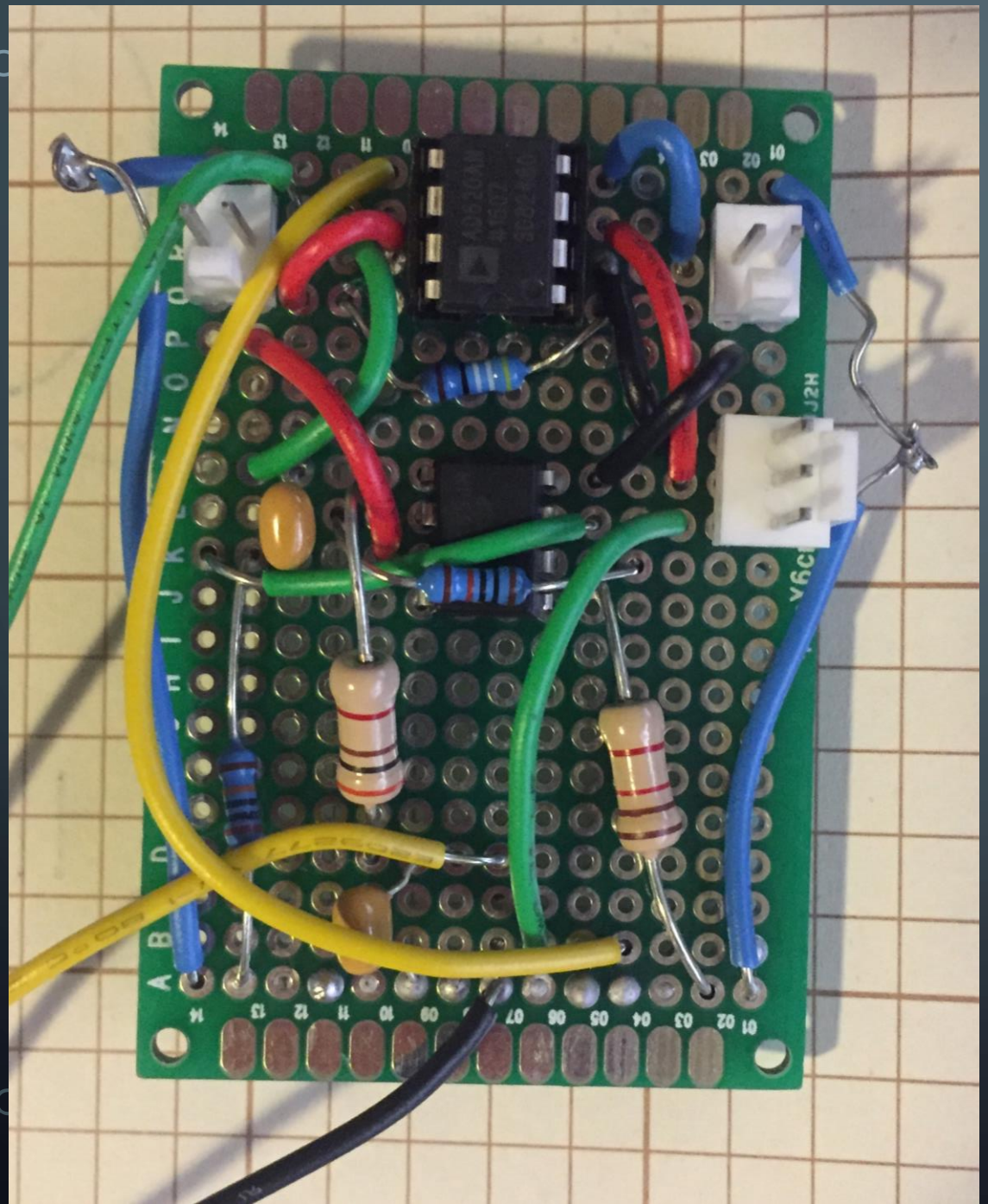
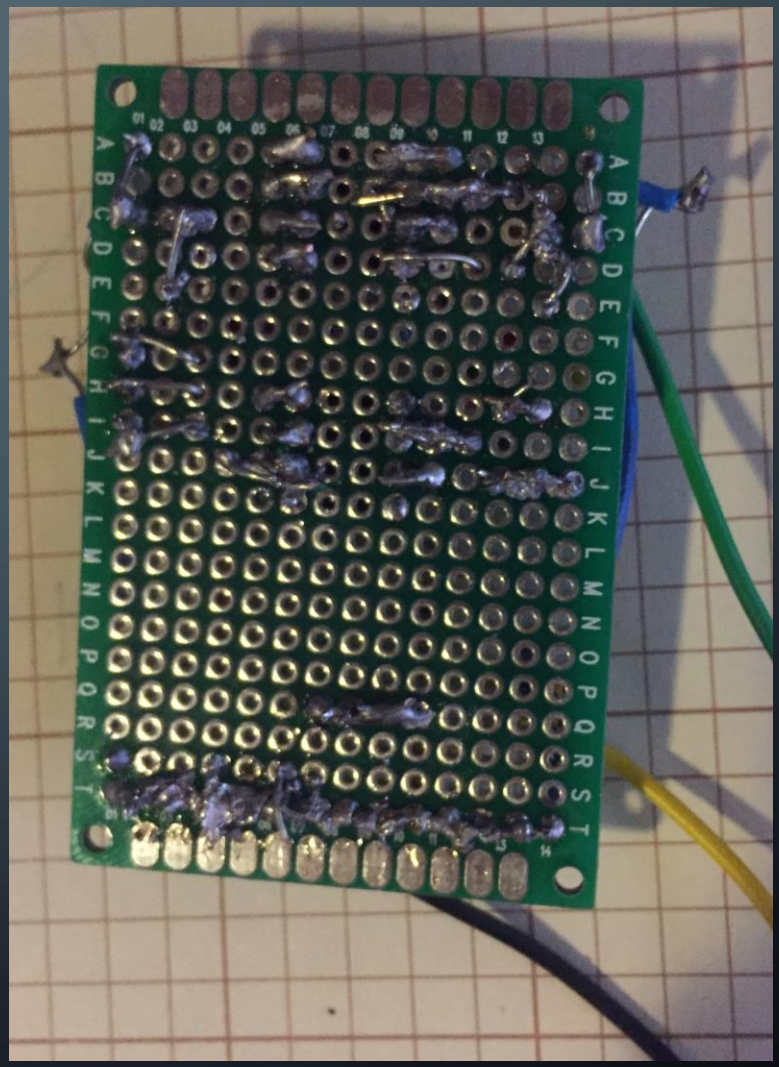


SPECTRUM ANALYZER (AFTER ADDING LOW PASS FILTER)



COMPARISON


Amplitude (V)
1.5
1.0
0.5
0.0
-0.5
0
0.2
0.4
0.6
0.8
0.9731

1 sec
40 ms
200 ms
R
P
T
Q
S

FINAL PRODUCT