# ELECTROCARDIOGRAPHY Adam Gordon & Sheina Duncan

ECG

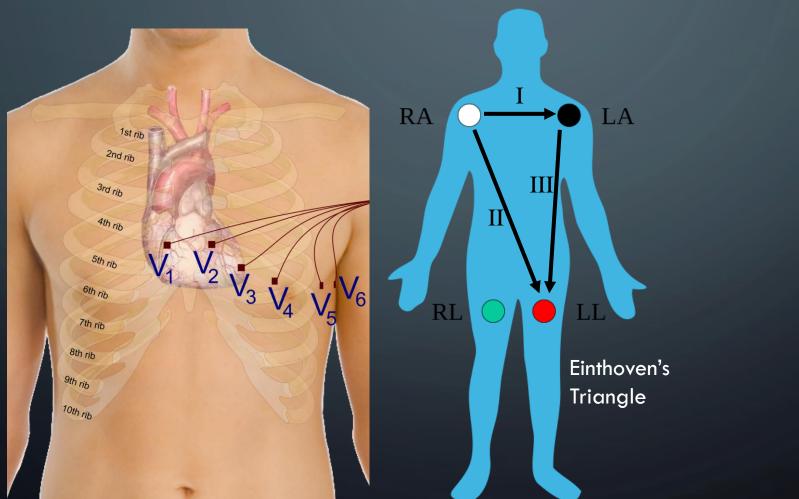
- Measures electrical activity of the heart
- Electrodes placed on the skin
  - Detect tiny electrical variations
  - One or more (but usually 12) leads
- Graph of voltage vs. time called electrocardiogram

### 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

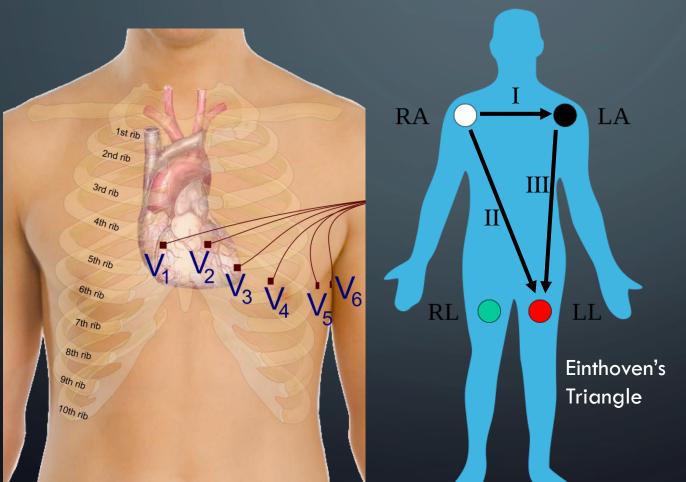
### LEAD PLACEMENT

• Clinical ECGs use 10 electrodes to form 12 different leads

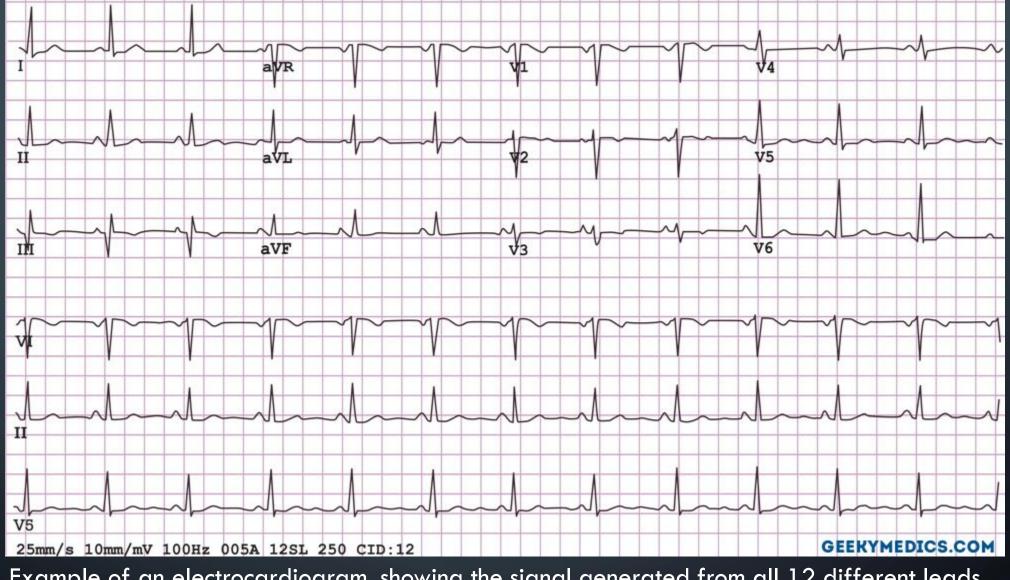


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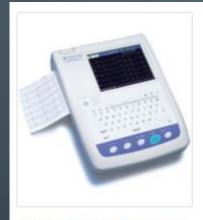


In our device, we only used 3 electrodes, and are only able to measure one lead. We will use Lead II, as it is the strongest signal



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

### 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

### 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:

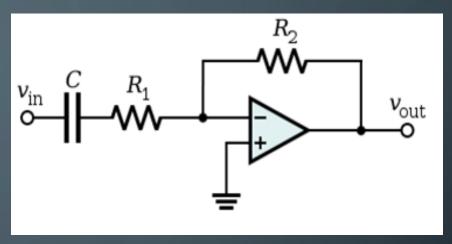
$$G = \frac{49.4 \, k\Omega}{R_G} + 1$$

 $^{ullet}$  To achieve gain of  $\sim$ 100, we used a  $499\Omega$  resistor

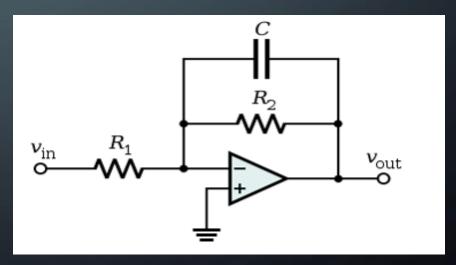
### **FILTERS**

- 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

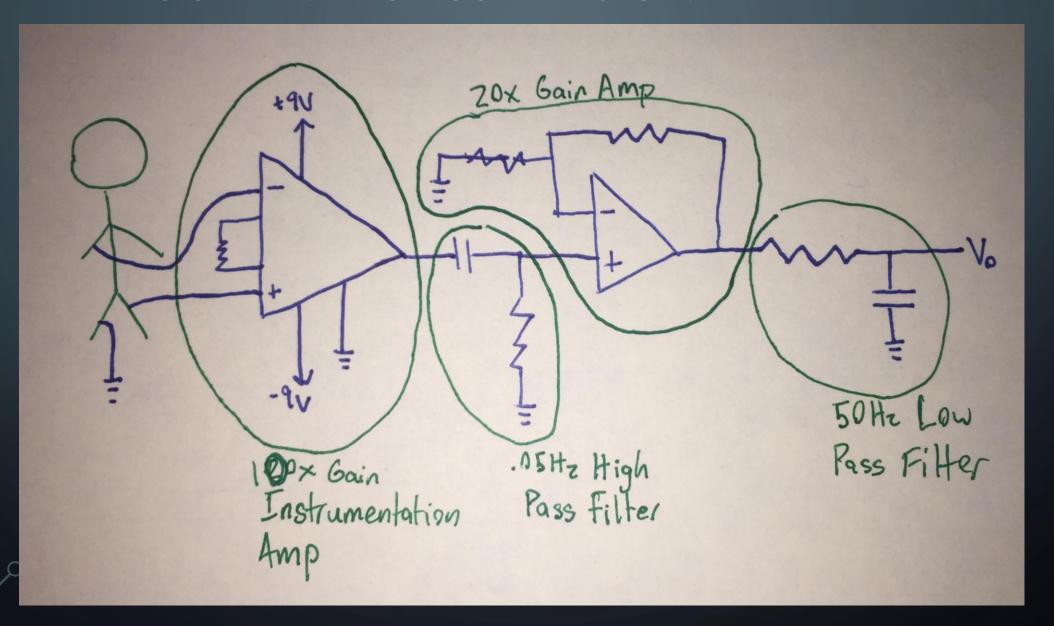


Schematic of an active low pass filter

### OUR REVISIONS

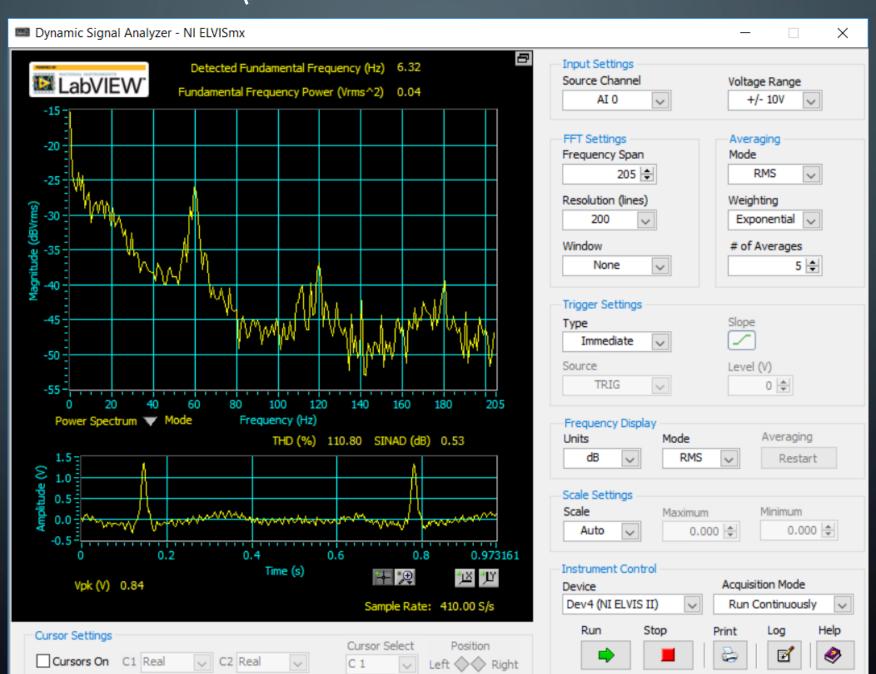
- Use passive filters
- High pass filter first, to filter very low (< .05 Hz) frequencies
- Add gain separately using op amp
- Low pass filter last, to filter > 50 Hz noise

### OUR FINAL CIRCUIT DESIGN

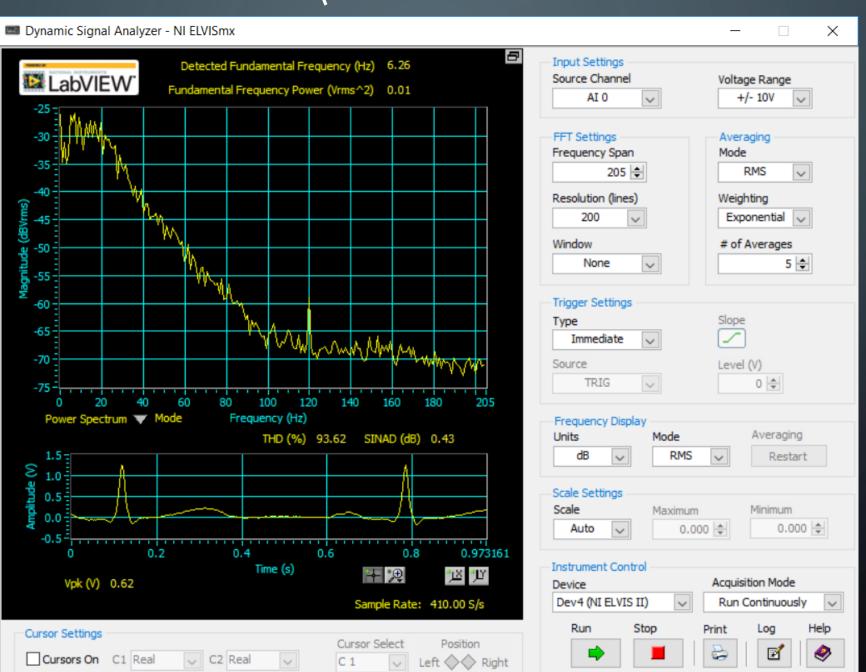


### SPECTRUM ANALYZER (JUST INSTRUMENTATION AMP) Dynamic Signal Analyzer - NI ELVISmx X Input Settings Detected Fundamental Frequency (Hz) 1.09 LabVIEW Source Channel Voltage Range Fundamental Frequency Power (Vrms^2) 2.47 AI 0 FFT Settings Averaging Frequency Span Mode -10 205 🖨 Weighting Resolution (lines) 200 Exponential 🗸 Window # of Averages 5 💠 None ~ Trigger Settings Type Immediate -80 Level (V) Source TRIG 80 120 140 160 100 Power Spectrum V Mode Frequency (Hz) Frequency Display Averaging THD (%) 145.55 SINAD (dB) 0.23 Mode RMS Restart Scale Settings Scale Maximum Minimum 0.000 Auto 0.000 0.973161 0.2 0.4 0.6 0.8 Time (s) Instrument Control <u> YY</u> <u>XY</u> + ⊕ Acquisition Mode Vpk (V) 0.08 Device Dev4 (NI ELVIS II) Run Continuously Sample Rate: 410.00 S/s Run Stop Help Print Cursor Settings Cursor Select 8 **3** √ C2 Real Cursors On C1 Real Left 🔷 Right

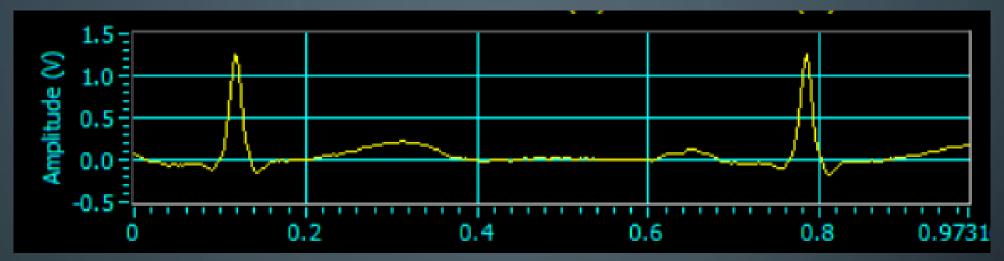
### SPECTRUM ANALYZER (AFTER ADDING HIGH PASS FILTER AND 20X AMP)



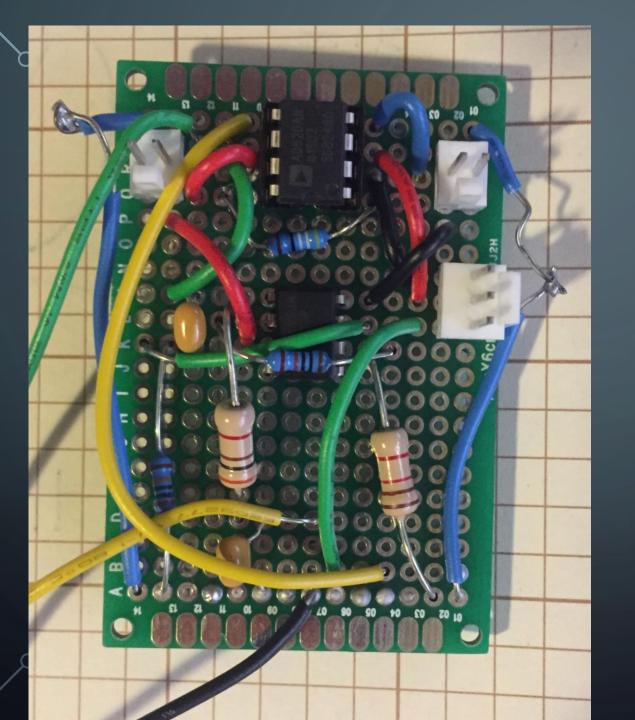
# SPECTRUM ANALYZER (AFTER ADDING LOW PASS FILTER) Dynamic Signal Analyzer - NI ELVISmx



## COMPARISON







### FINAL PRODUCT

