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Inspiring people and enabling discovery about life

Fundamentals of Physiological Data Recording

BIOPAC® Systems, Inc.

Frazer Findlay

CEO

BIOPAC Systems, Inc.

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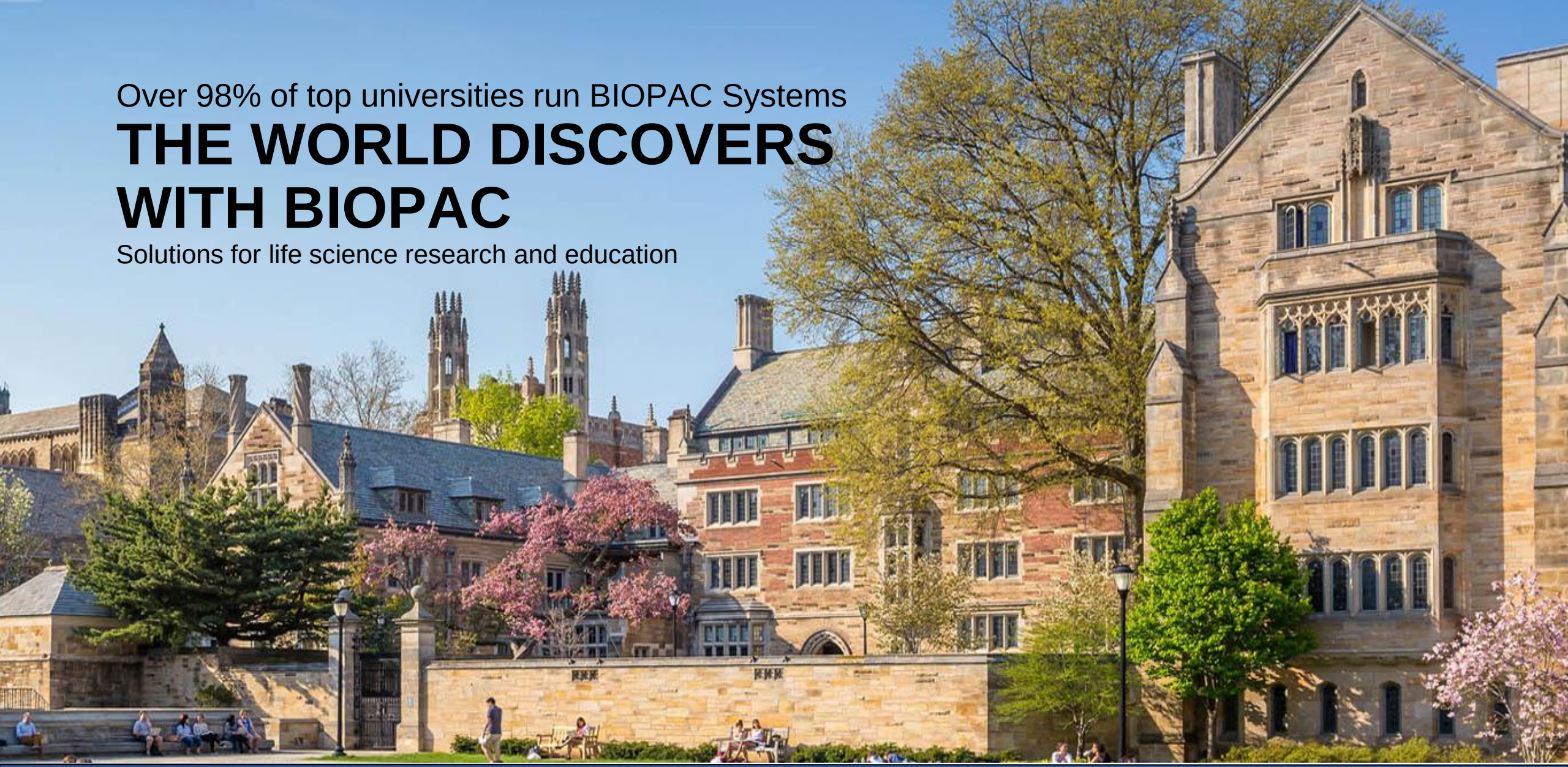

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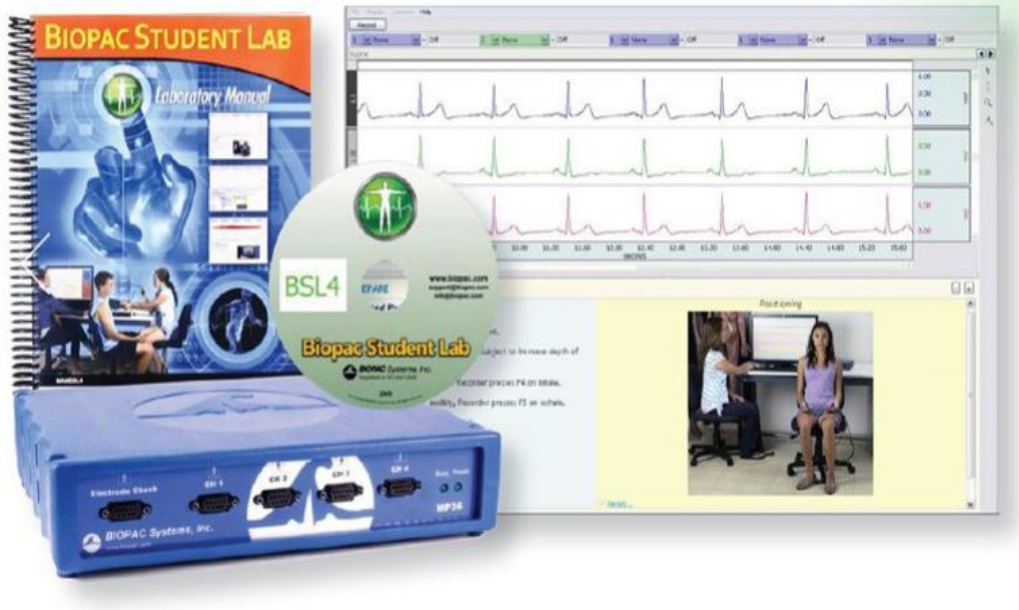

Biopac Student Lab Teaching Systems

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HAPS Member Survey 2017

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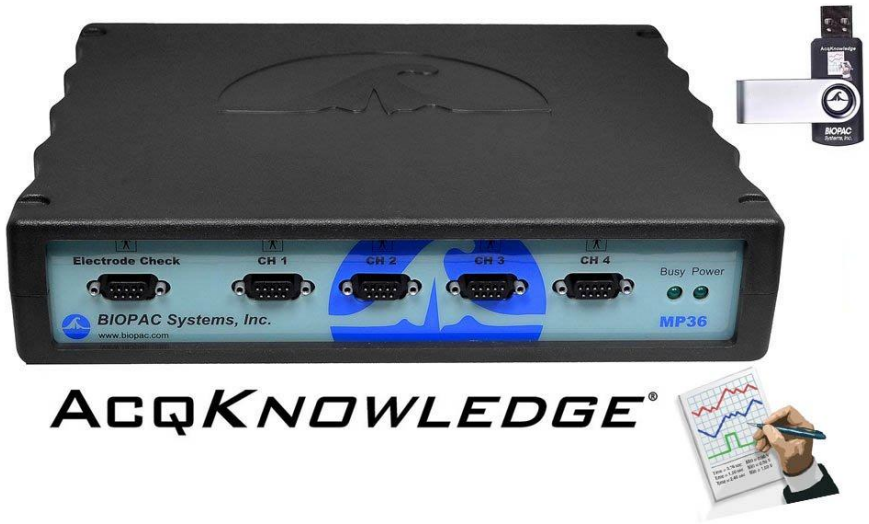
Agenda

- Data acquisition basics
- Sampling rate
- Amplifier gain
- Filtering
- Scaling/calibration
- Applying electrodes and transducers

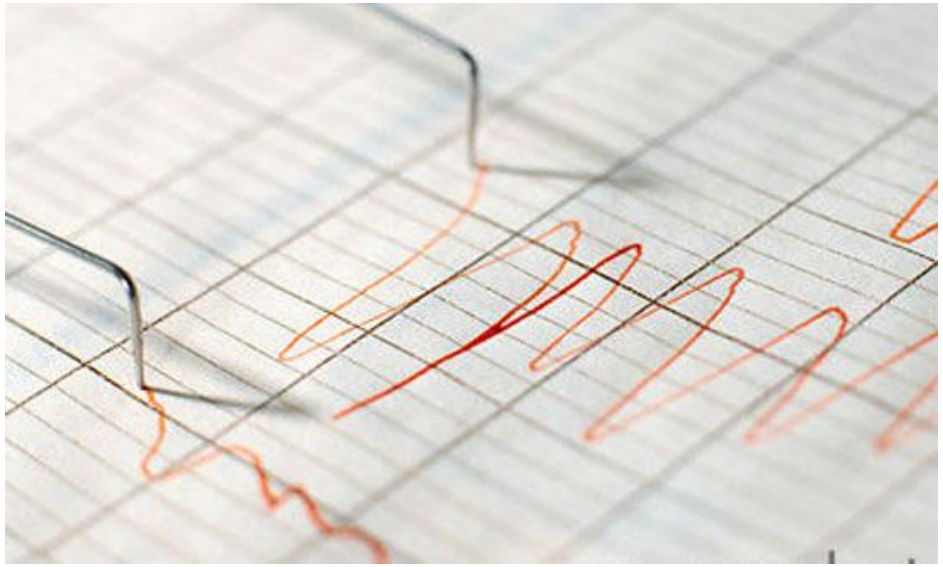
Data acquisition basics

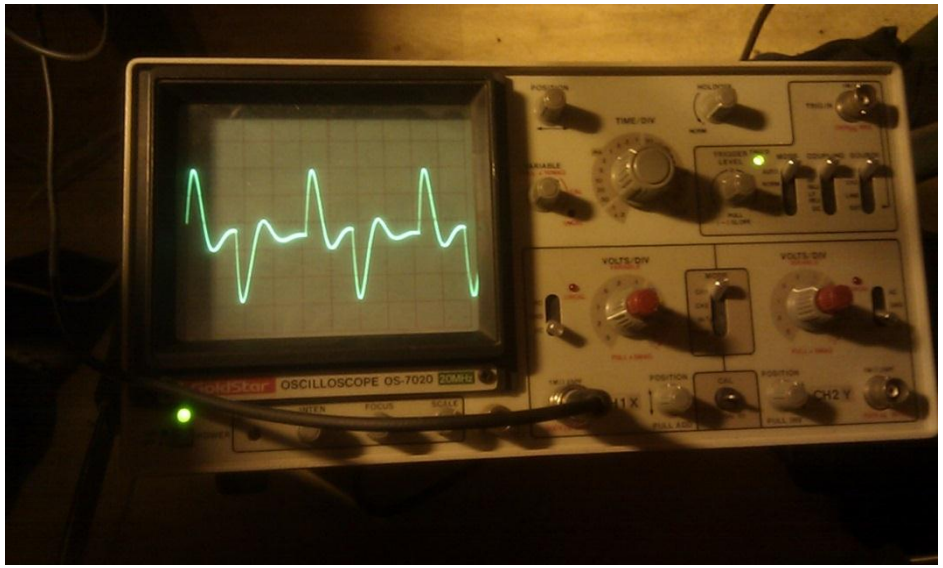
What is an A/D converter?

Devices that convert analog signals to a digital format.



Analog chart recorders and oscilloscopes





The body as a battery – heart, brain, muscle

Biopotential signals vs. Transducer signals

Biopotential Signals

Heart – ECG Electrocardiogram
Brain – EEG Electroencephalogram
Brain – ERS Evoked Response
Muscle – EMG Electromyogram
Eyes – EOG Electrooculogram
Stomach – EGG Electrogastrogram

Transducer Signals

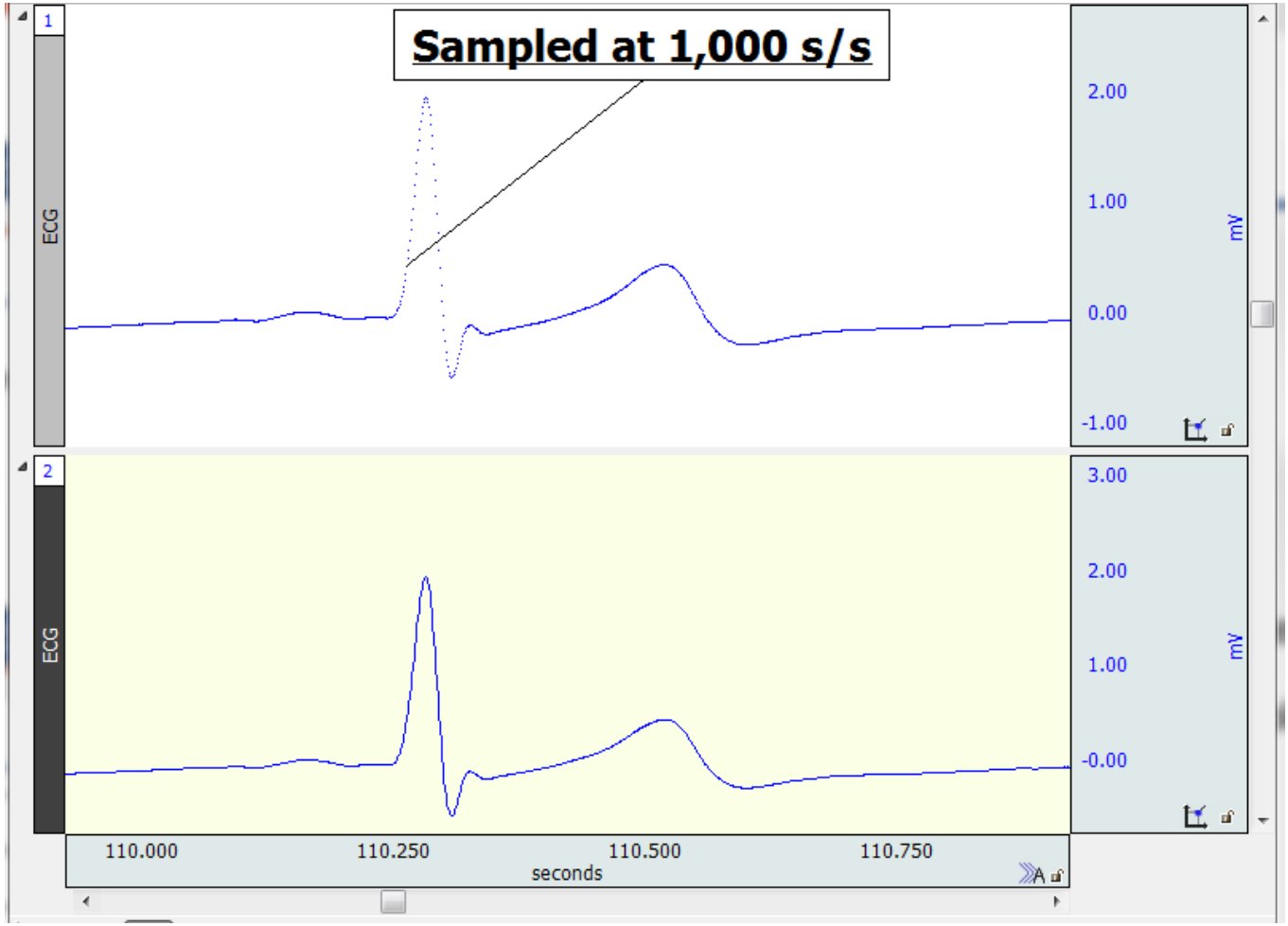
Respiration – Respiratory Effort Transducer
Temperature – Thermistor / Thermocouple
Airflow – Pneumotachogram
Force – Hand clench, Grip, Tissue Transducer
Blood Pressure – BP cuff or continuous

Electrodermal – EDA Skin Conductance Level and Skin Conductance Response
Impedance Cardiography – ICG stroke volume and cardiac output

Sampling Rates

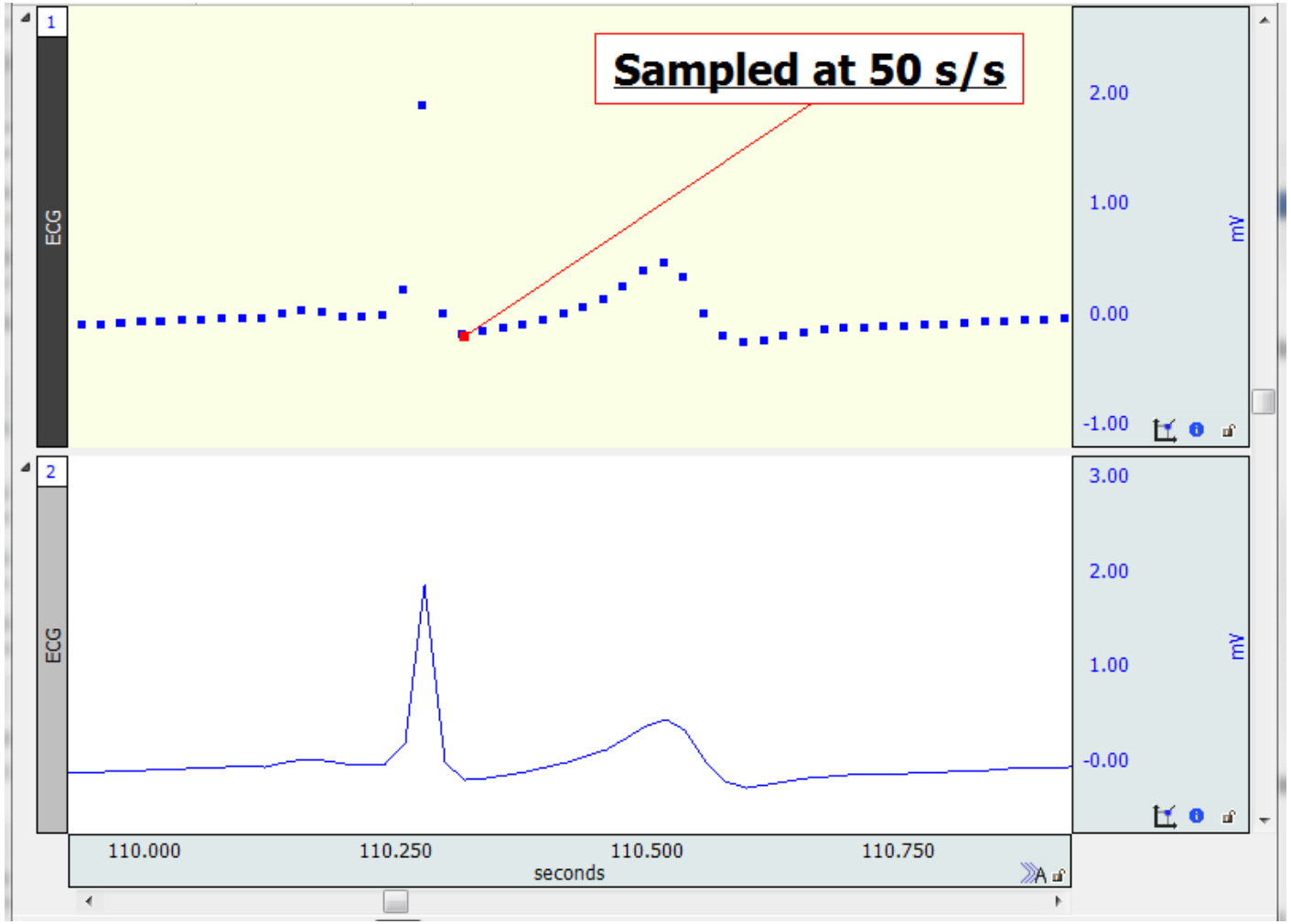
Sample rate

- Great Data
- Hz = samples/second
- Why does sample rate matter?



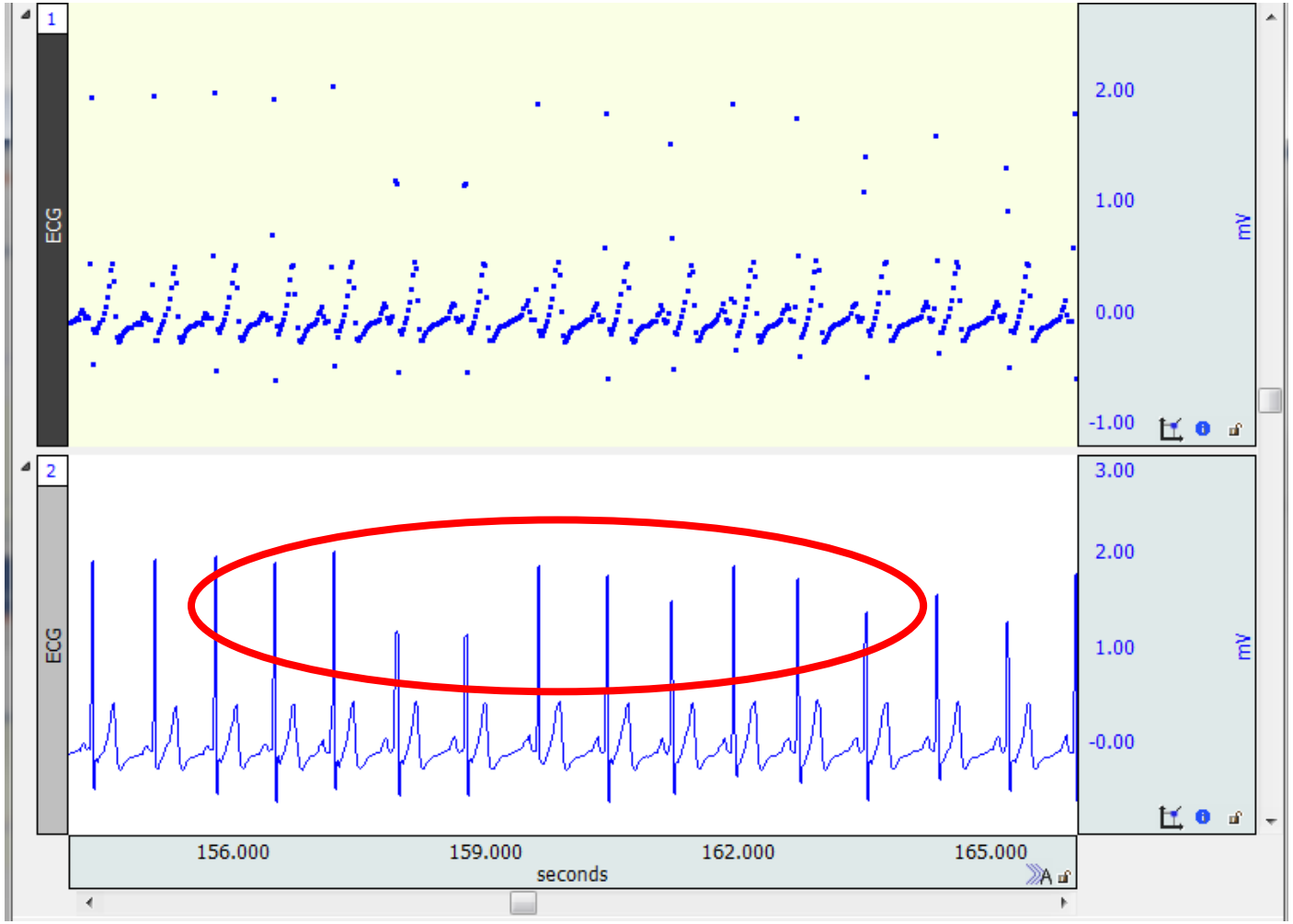
Sample rate too low

Under sampled data



Sample rate

Not good for HRV studies or waveform analysis



Signal characteristics

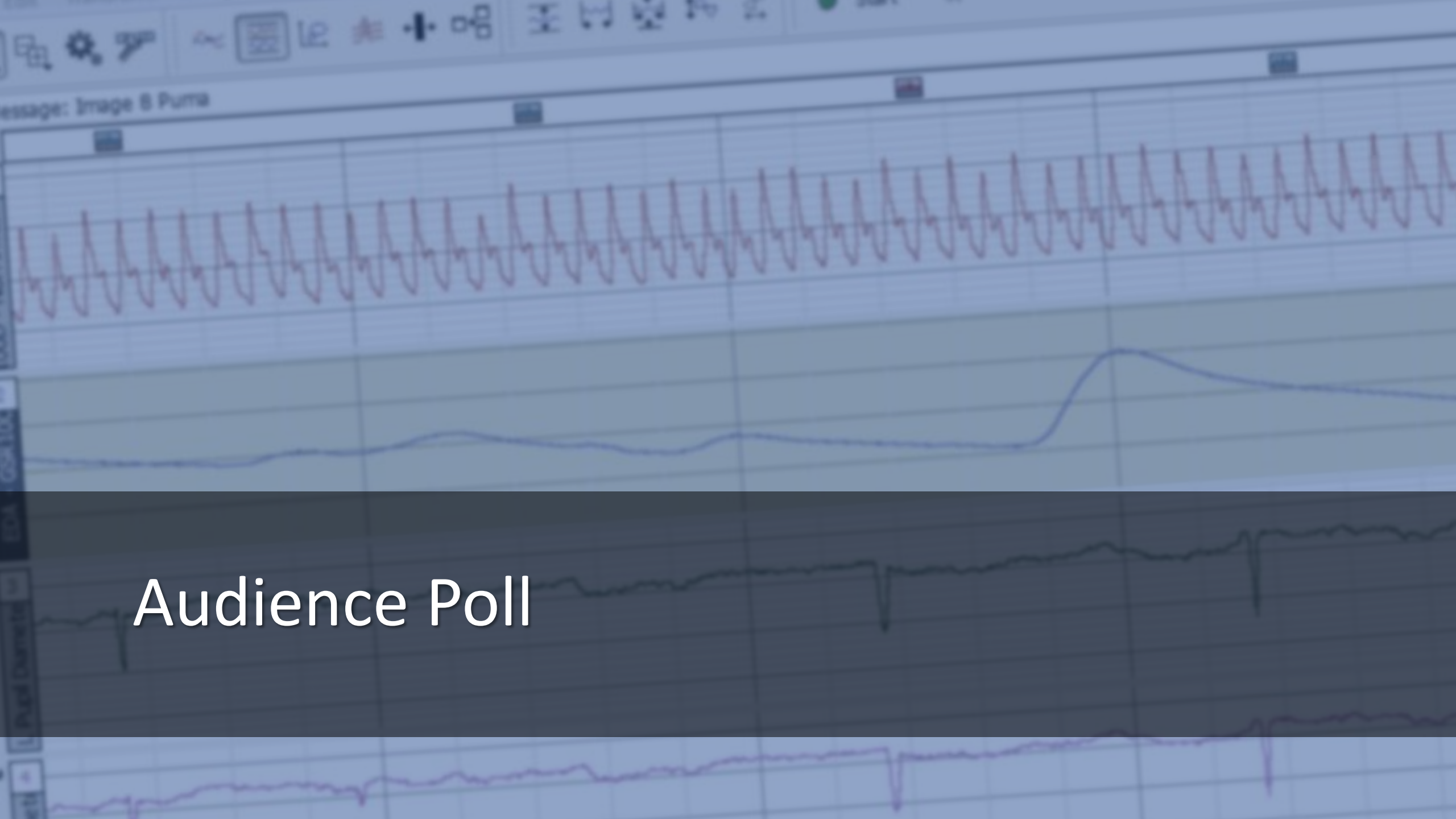
Signal	Amplitude	Frequency
Heart Potential (ECG)	50 microvolts to 5 millivolts	.05-100Hz
Brain Potential (EEG)	2 to 10 microvolts	1-100 Hz
Muscle Potential (EMG)	20 microvolts to 10 millivolts	10 Hz to 2,000 Hz
Electro-oculogram (EOG)	10 microvolts to 4 millivolts	0.1 -100 Hz
Electro-gastrogram (EGG)	10 microvolts to 80 millivolts	0-1 Hz

Setting the sample rate

Two times the highest frequency component of a bandwidth limited signal

TIP: A good rule of thumb is to set the sampling rate to at least three to four times the highest frequency component of interest.

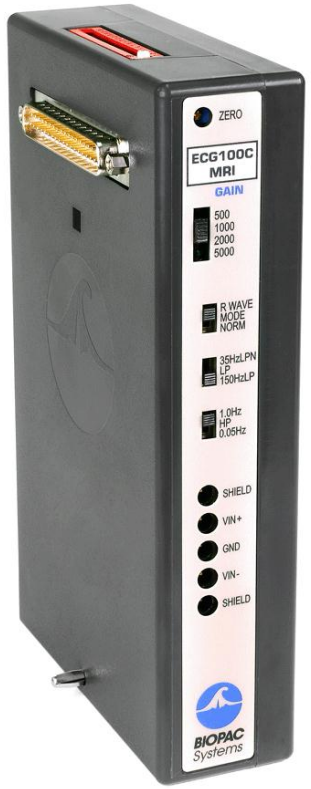
Demonstration time



Audience Poll

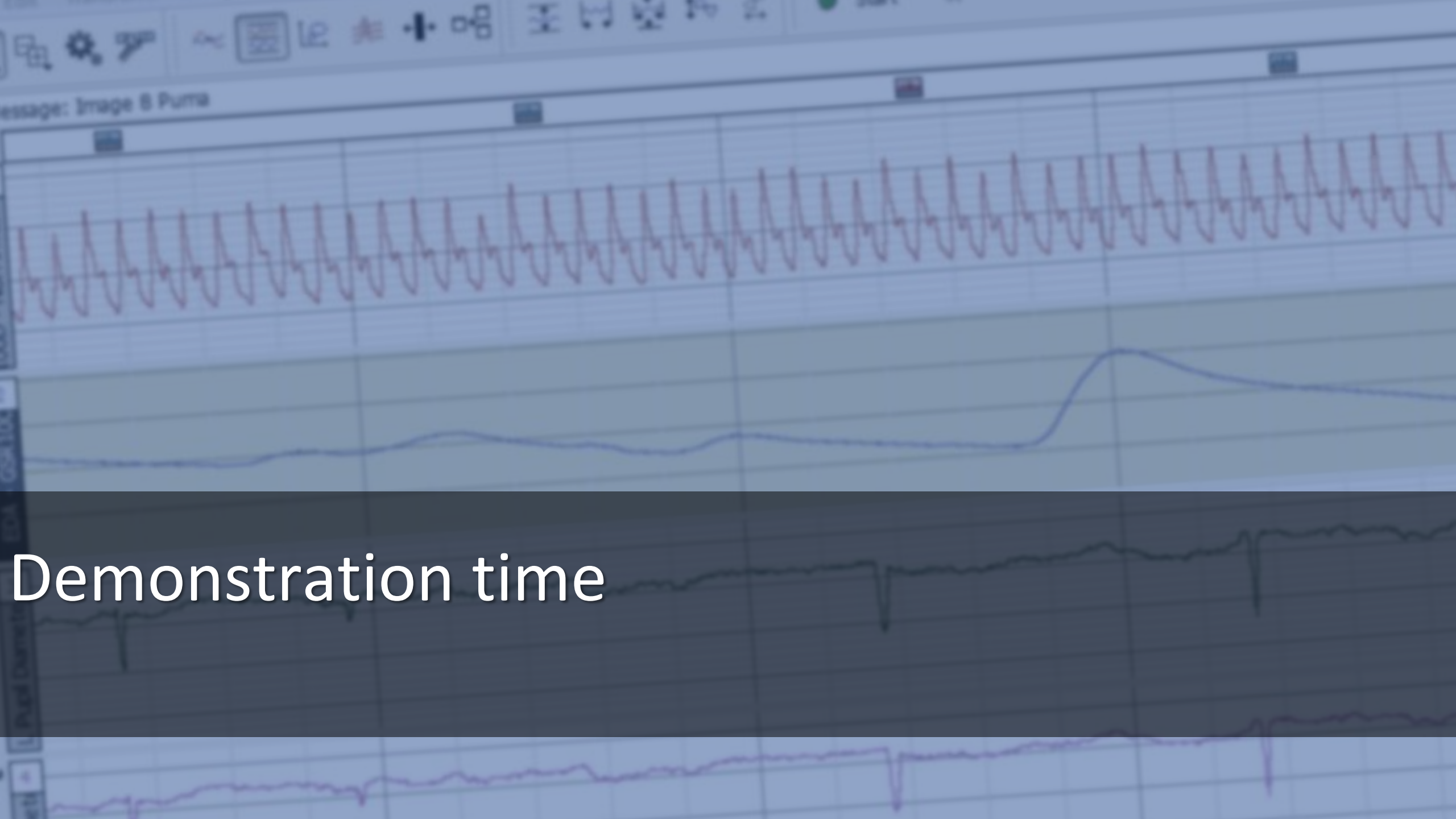
Amplifier Gains

BIOPAC Amplifiers

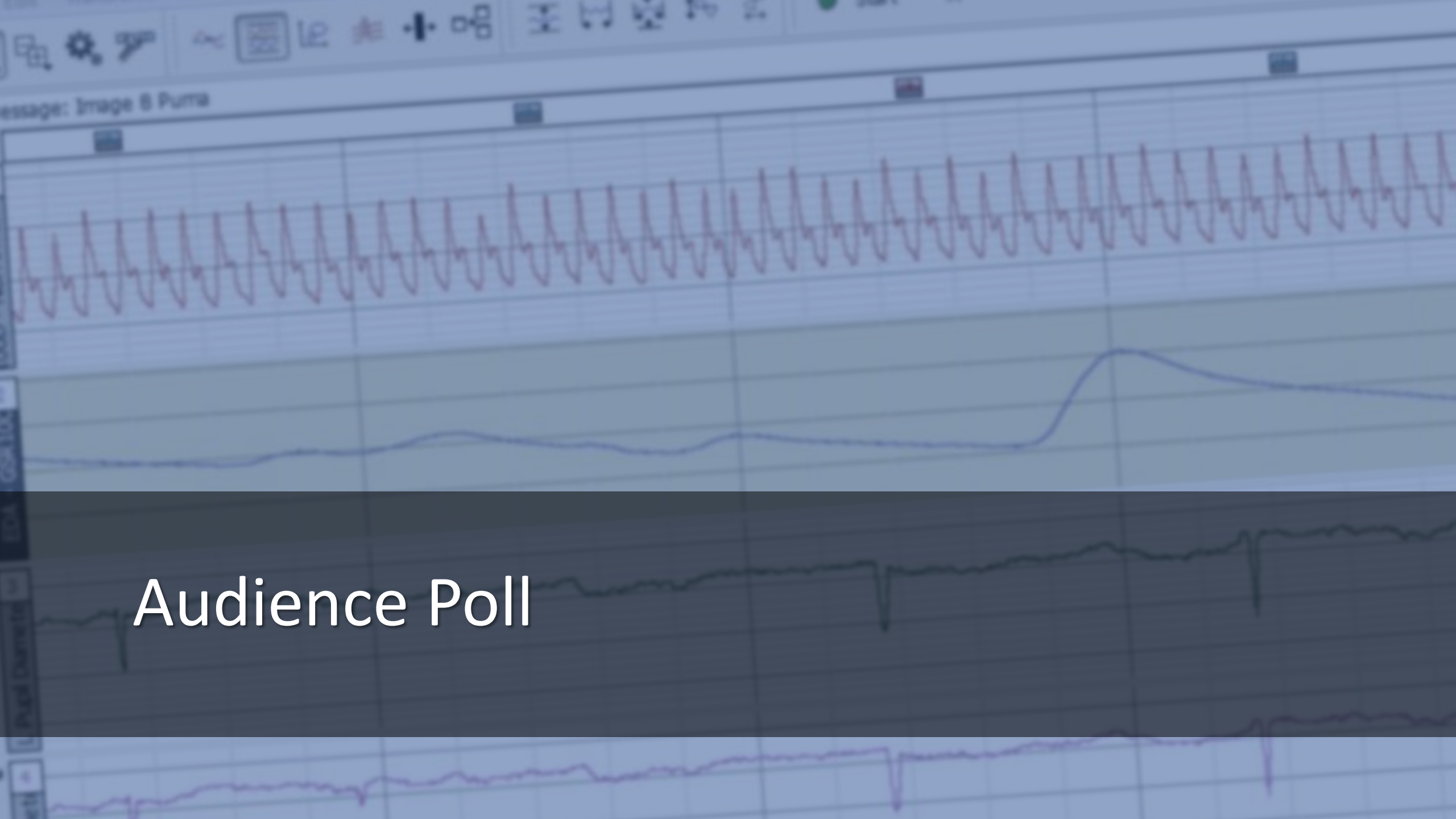


Amplifier Gains

- Need to match the size of the signal
  - A smaller amplitude signal requires a higher gain
  - A larger amplitude signal can tolerate a lower gain



Demonstration time

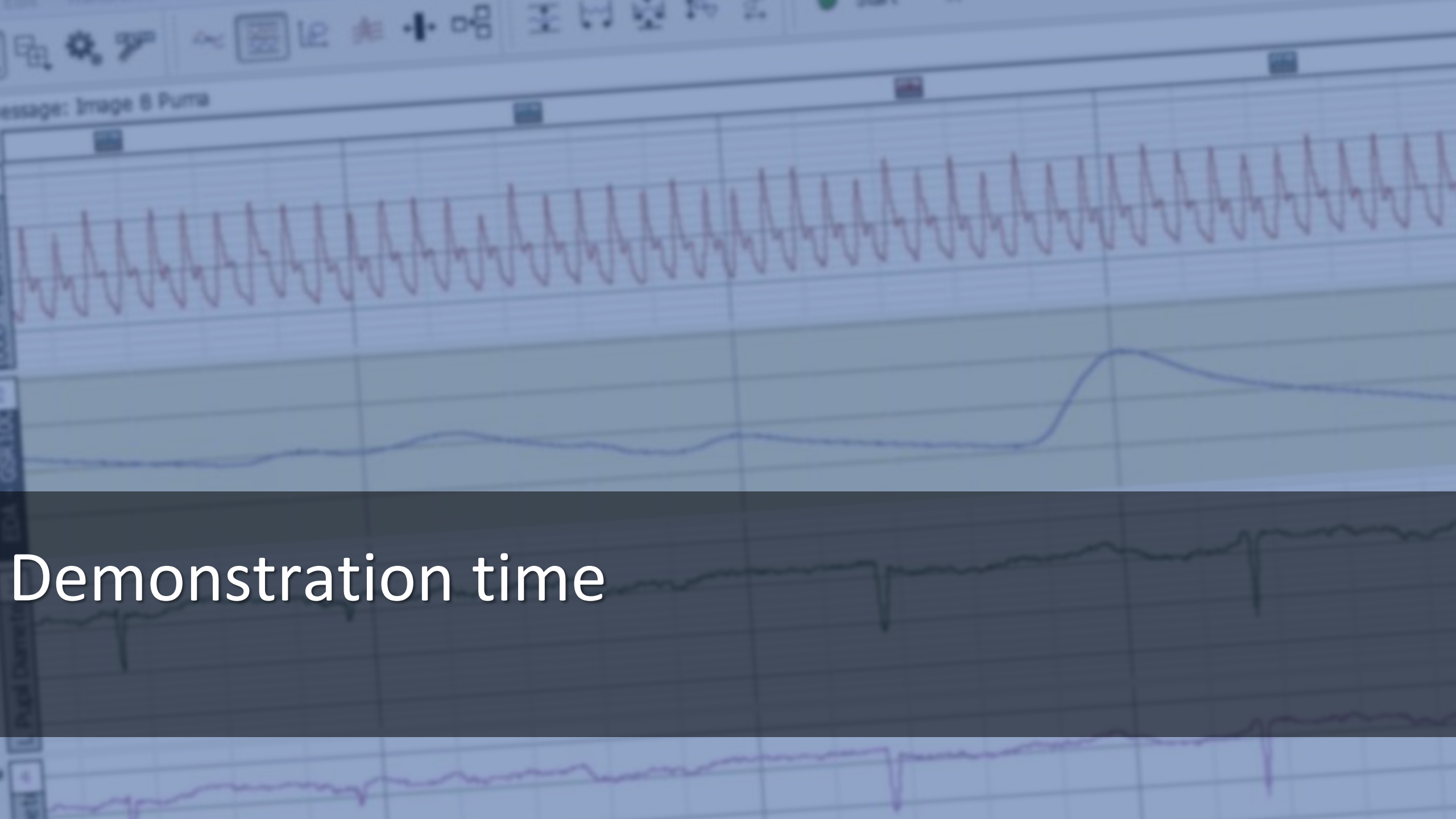


Audience Poll

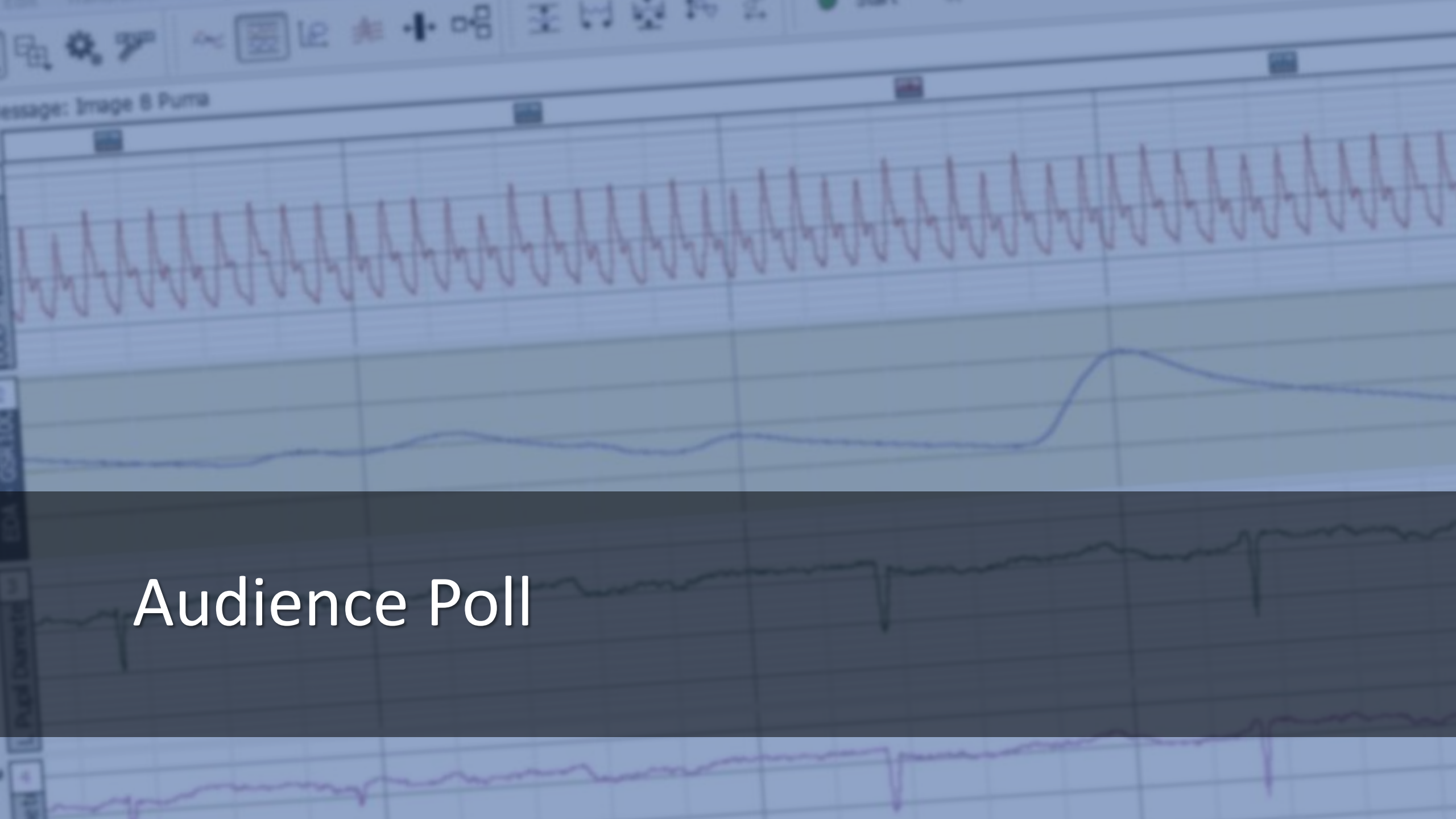
Filtering

Filtering

- High Pass, Low Pass, Band Pass, Band Stop, Comb Band Stop filtering
- AC vs. DC (let's use EDA as an example)
- Using FFT to identify frequencies



Demonstration time

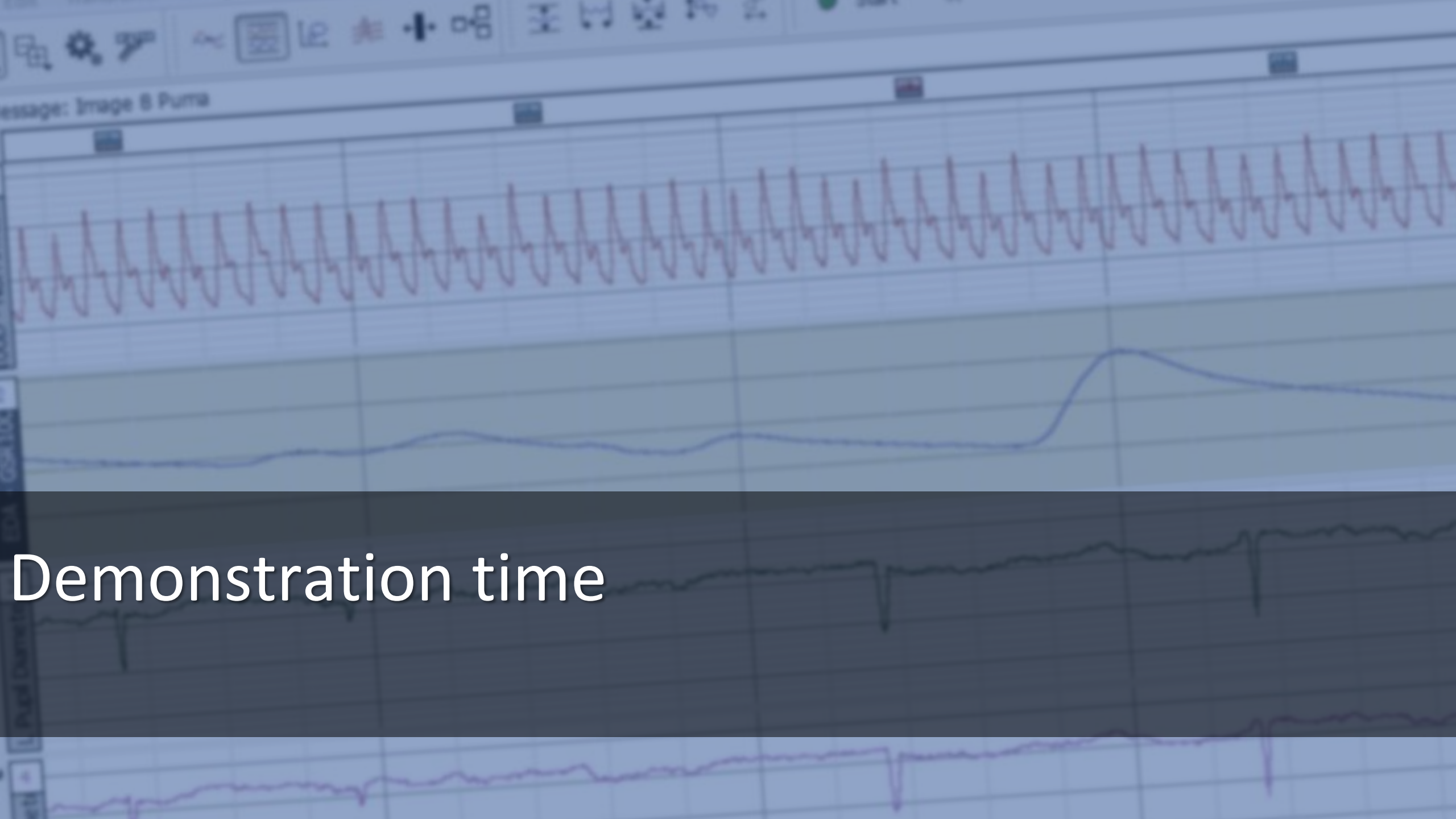


Audience Poll

Scaling and Calibration

Scaling/Calibration

- Transducer calibration
- Signal Scaling for viewing



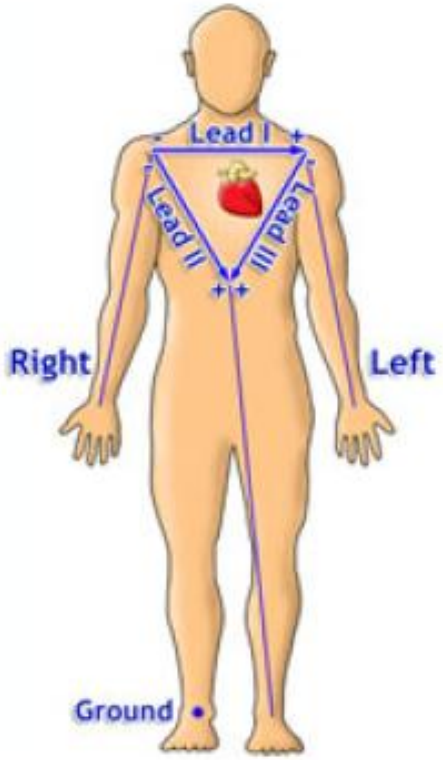
Demonstration time

Applying Electrodes and Transducers

- Skin preparation
- Consider the subject and what they're doing
- Place electrodes and transducers to avoid artifact
- Tape leads and electrodes in place
- Test signals before recording
- Understand the signal you are recording

How to get great ECG Data

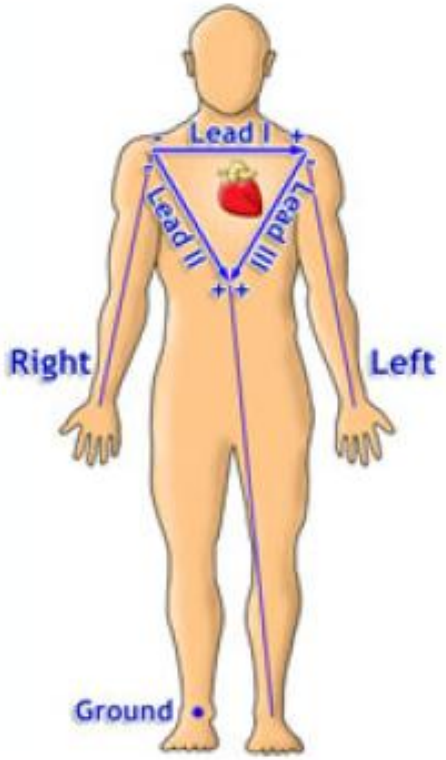
Lead Configuration



Lead	Polarity
Lead I	right arm (-) to left arm (+)
Lead II	right arm (-) to left leg (+)
Lead III	left arm (-) to left leg (+)

How to get great ECG Data

Lead Configuration



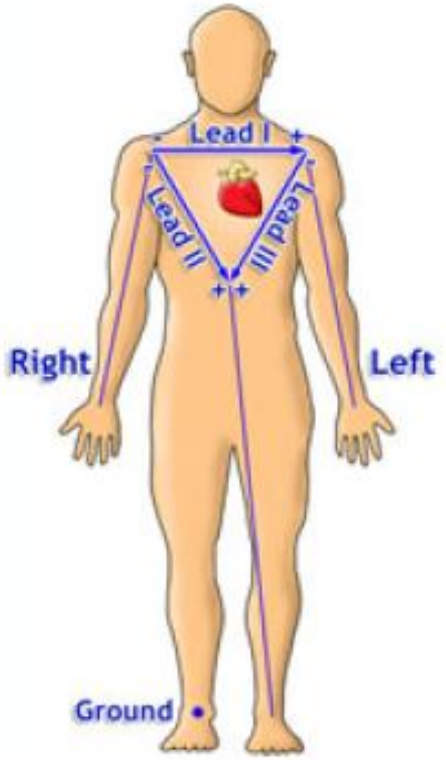
If you record LEAD I and LEAD III, you can calculate LEAD II

LEAD I + LEAD III = LEAD II

Use the Expression calculation to calculate the 3rd Lead, plus the Augmented leads.

How to get great ECG Data

Augmented LEAD Calculations



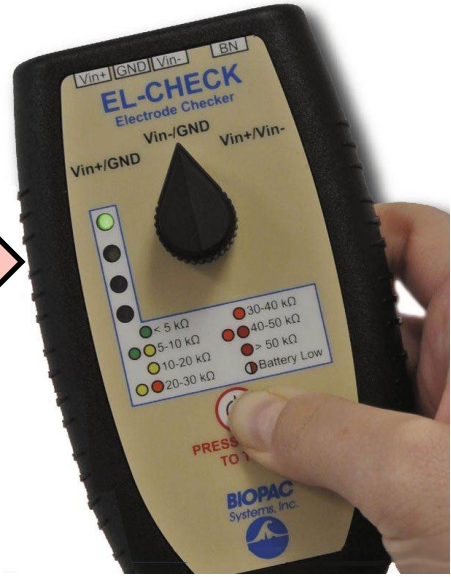
aVR = (Lead I + Lead II)/2
aVL = (Lead I - Lead III)/2 = Lead I - ((Lead II)/2)
aVF = (Lead II + Lead III)/2 = Lead II - ((Lead I)/2)

How to get great ECG Data

Subject Preparation

ELPAD

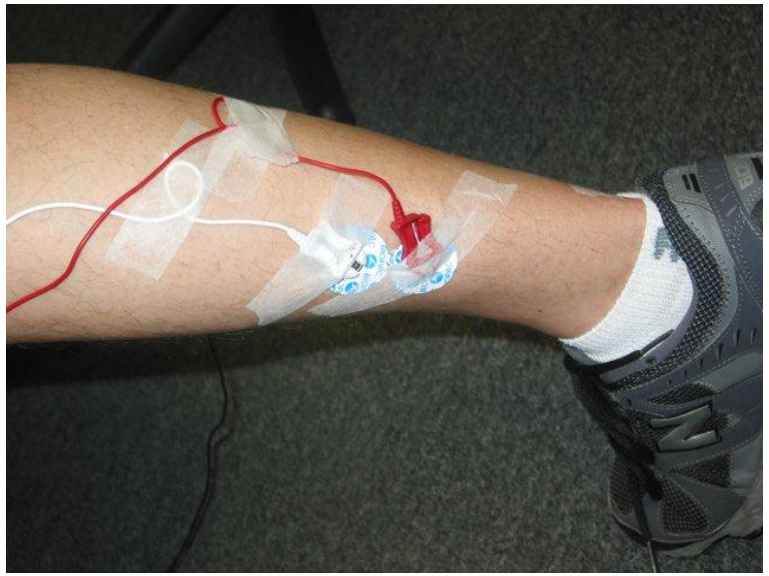
GEL100



EL-CHECK

How to get great ECG Data

Subject Preparation



TAPE1

How to get great ECG Data

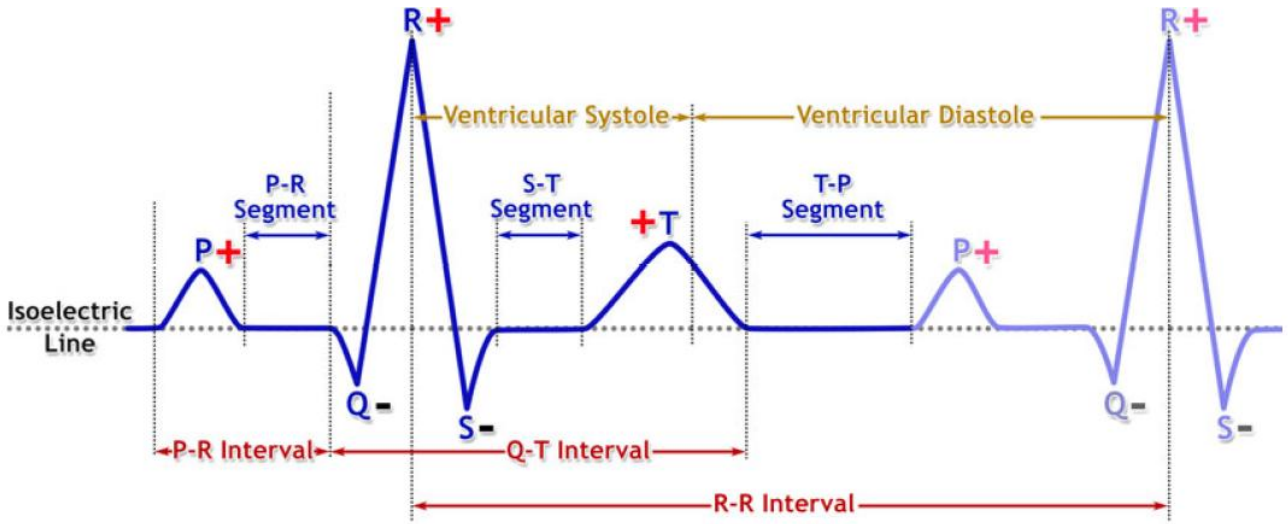


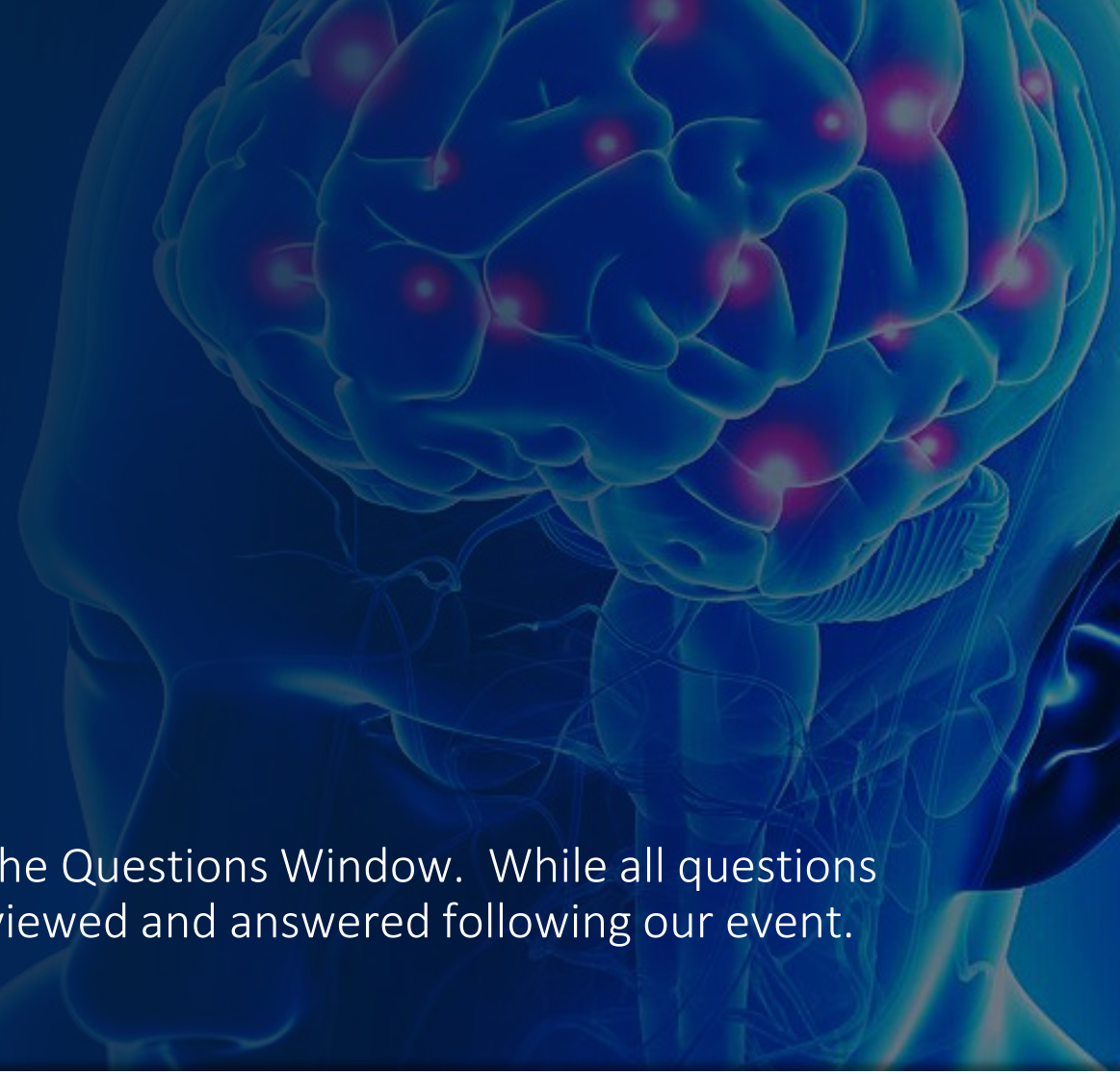
Fig. 5.2 Components of the ECG & Electrical and mechanical events of the cardiac cycle

How to get great ECG Data

ECG COMPONENT		*Measurement area...*	*Represent...*	**Duration** *(seconds)*	**Amplitude** (millivolts)
Waves	**P**	begin and end on isoelectric line (baseline); normally upright in standard limb leads	depolarization of the right and left atria.	0.07 – 0.18	< 0.25
	QRS complex	begin and end on isoelectric line (baseline) from start of Q wave to end of S wave	depolarization of the right and left ventricles. Atrial repolarization is also part of this segment, but the electrical signal for atrial repolarization is masked by the larger QRS complex (see Fig. 5.2)	0.06 – 0.12	0.10 – 1.50
	T	begin and end on isoelectric line (baseline)	repolarization of the right and left ventricles.	0.10 – 0.25	< 0.5
Intervals	**P-R**	from start of P wave to start of QRS complex	time from the onset of atrial depolarization to the onset of ventricular depolarization.	0.12-0.20	
	Q-T	from start of QRS complex to end of T wave	time from onset of ventricular depolarization to the end of ventricular repolarization. It represents the refractory period of the ventricles.	0.32-0.36	
	R-R	from peak of R wave to peak of succeeding R wave	time between two successive ventricular depolarizations.	0.80	
Segments	**P-R**	from end of P wave to start of QRS complex	time of impulse conduction from the AV node to the ventricular myocardium.	0.02 – 0.10	
	S-T	between end of S wave and start of T wave	period of time representing the early part of ventricular repolarization during which ventricles are more or less uniformly excited.	< 0.20	
	T-P	from end of T wave to start of successive P wave	time from the end of ventricular repolarization to the onset of atrial depolarization.	0.0 – 0.40	

* Notes: Tabled values represent results from a typical Lead II setup (wrist and ankle electrode placement) with Subject heart rate ~75 BPM. Values are influenced by heart rate and placement; values for torso placement would be different.

Q&A Session:



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-- Thank you for your participation

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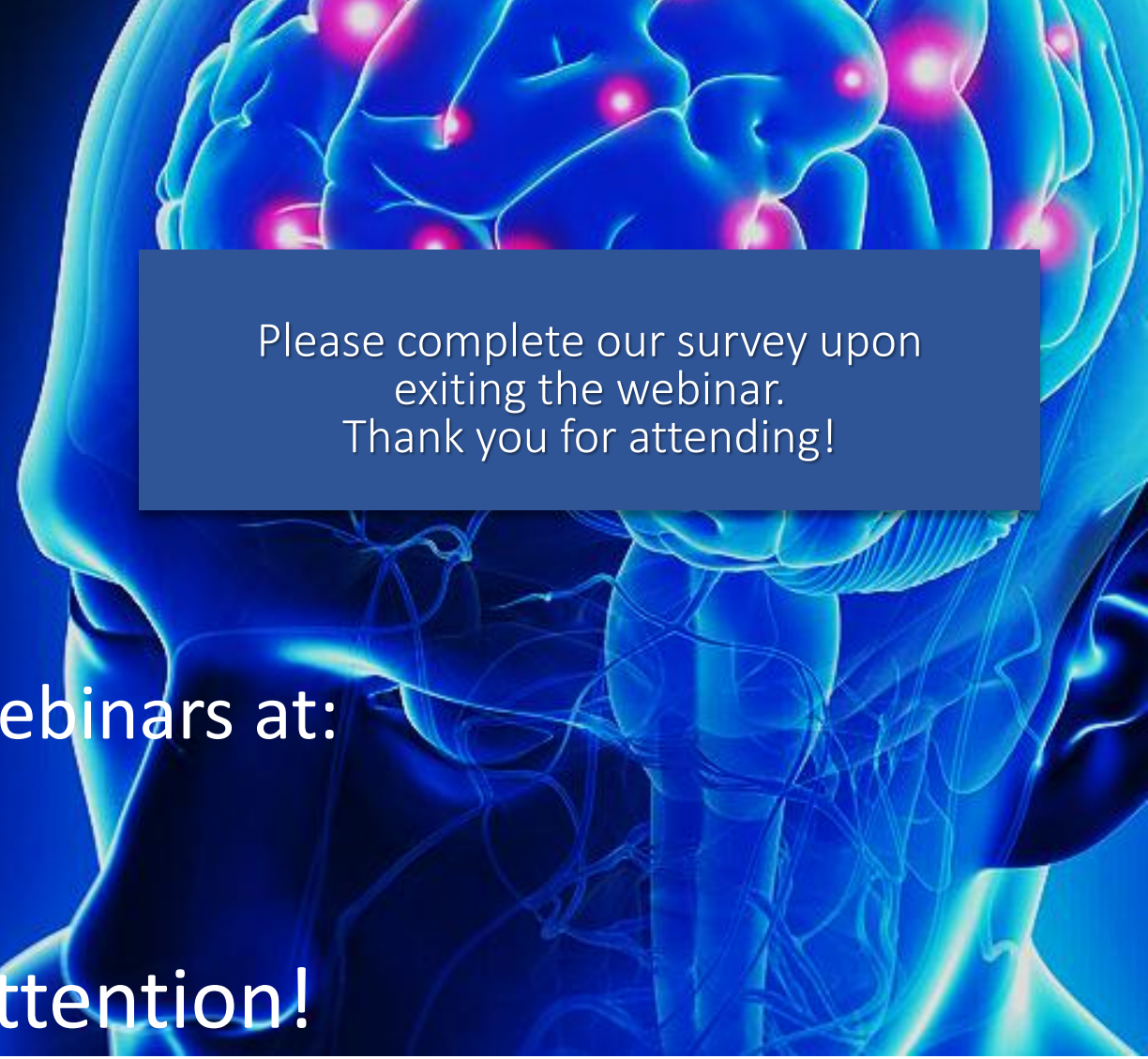
Thank you for your time and attention!



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