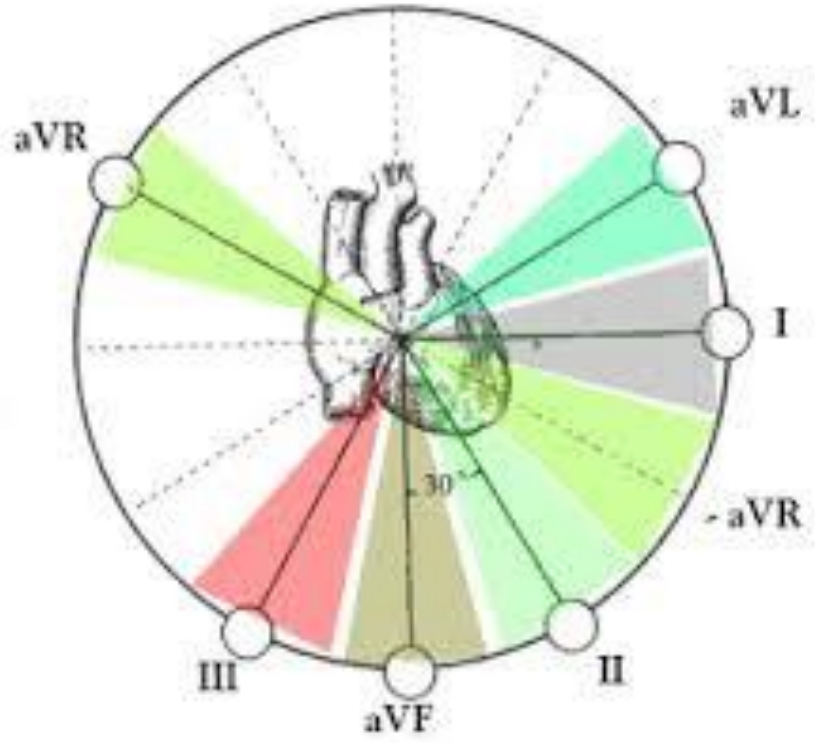
Basic ECG
Introduction



Prof.Otomar Kittnar,MD,PhD.

Augustus Waller,
1856 - 1922

1887 British physiologist Augustus D. Waller of St Mary's Medical School, London publishes the first human electrocardiogram. It is recorded with a capilliary electrometer from Thomas Goswell, a technician in the laboratory.

Waller´s dog Jimmy

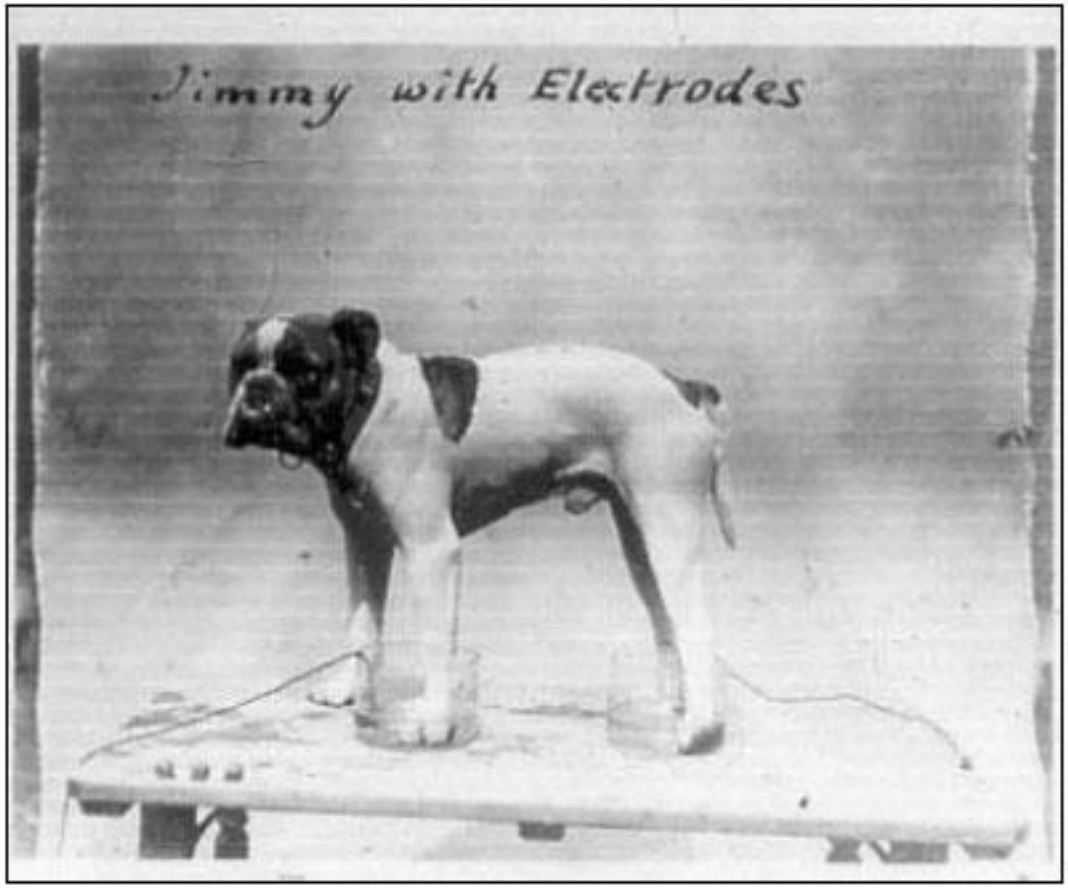
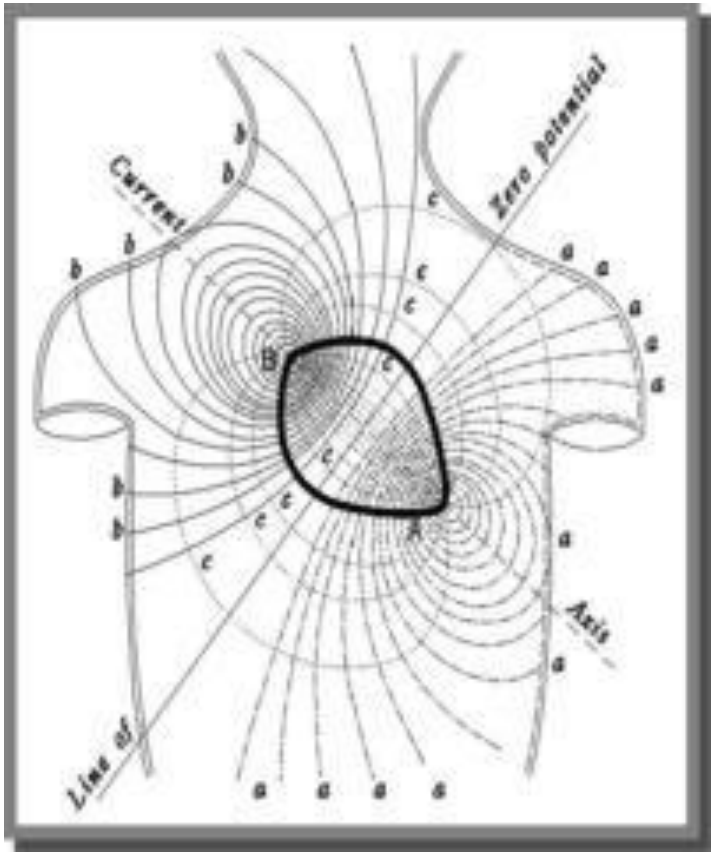


Fig. 3: Waller's dog, Jimmy, connected for electrogram with feet in saline.

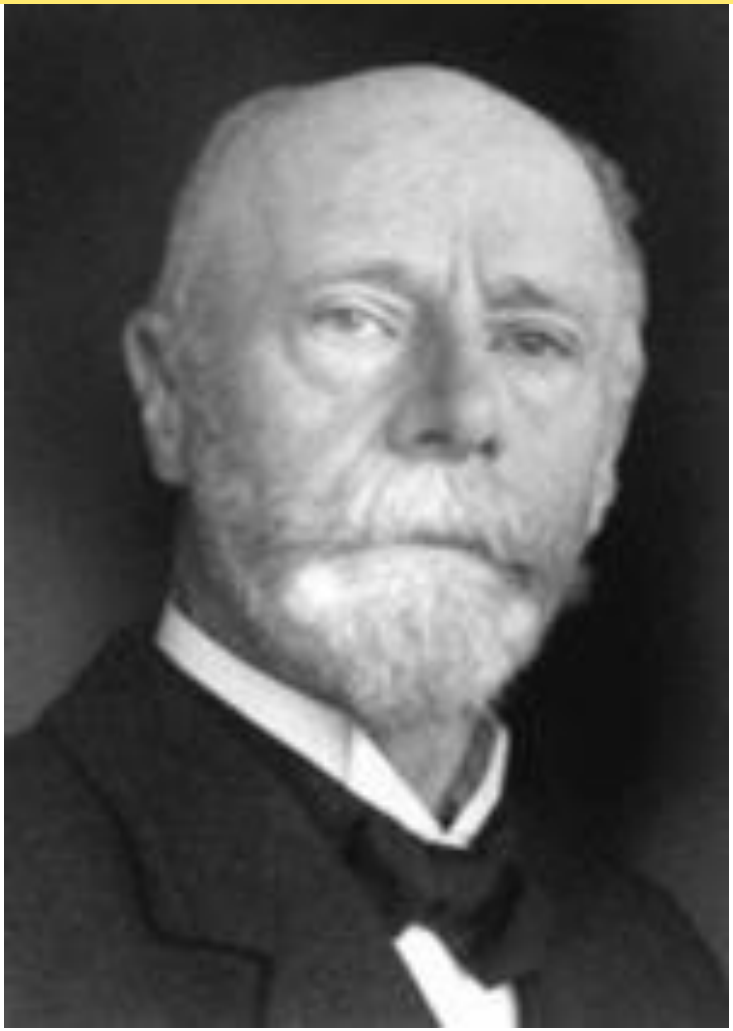
Waller´s dog Jimmi during presentation of ECG signal at the First International Congress of Physiologists in Bale. Waller often demonstrated by using his dog "Jimmy" who would patiently stand with paws in glass jars of saline.

Augustus Waller

Augustus Waller suggested a configuration of the electrical heart field. There are isopotential lines and the electrical axis of the heart on his drawing.

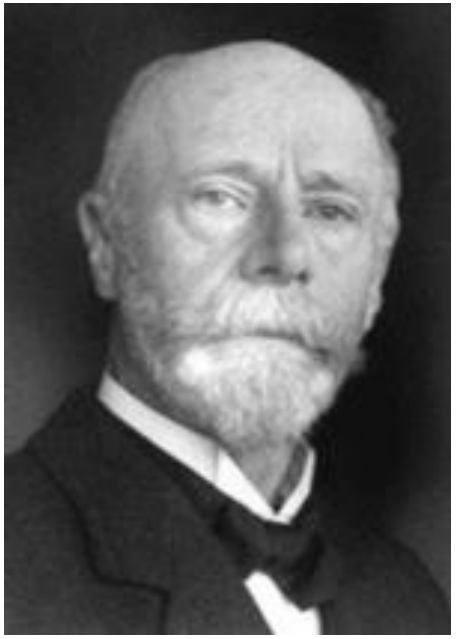


Willem Einthoven,
22.5.1860 - 29.9.1927



1889 Dutch physiologist Willem Einthoven sees Waller demonstrate his technique at the First International Congress of Physiologists in Bale.

1893 Willem Einthoven introduces the term 'electrocardiogram' at a meeting of the Dutch Medical Association. (Later he claims that Waller was first to use the term).

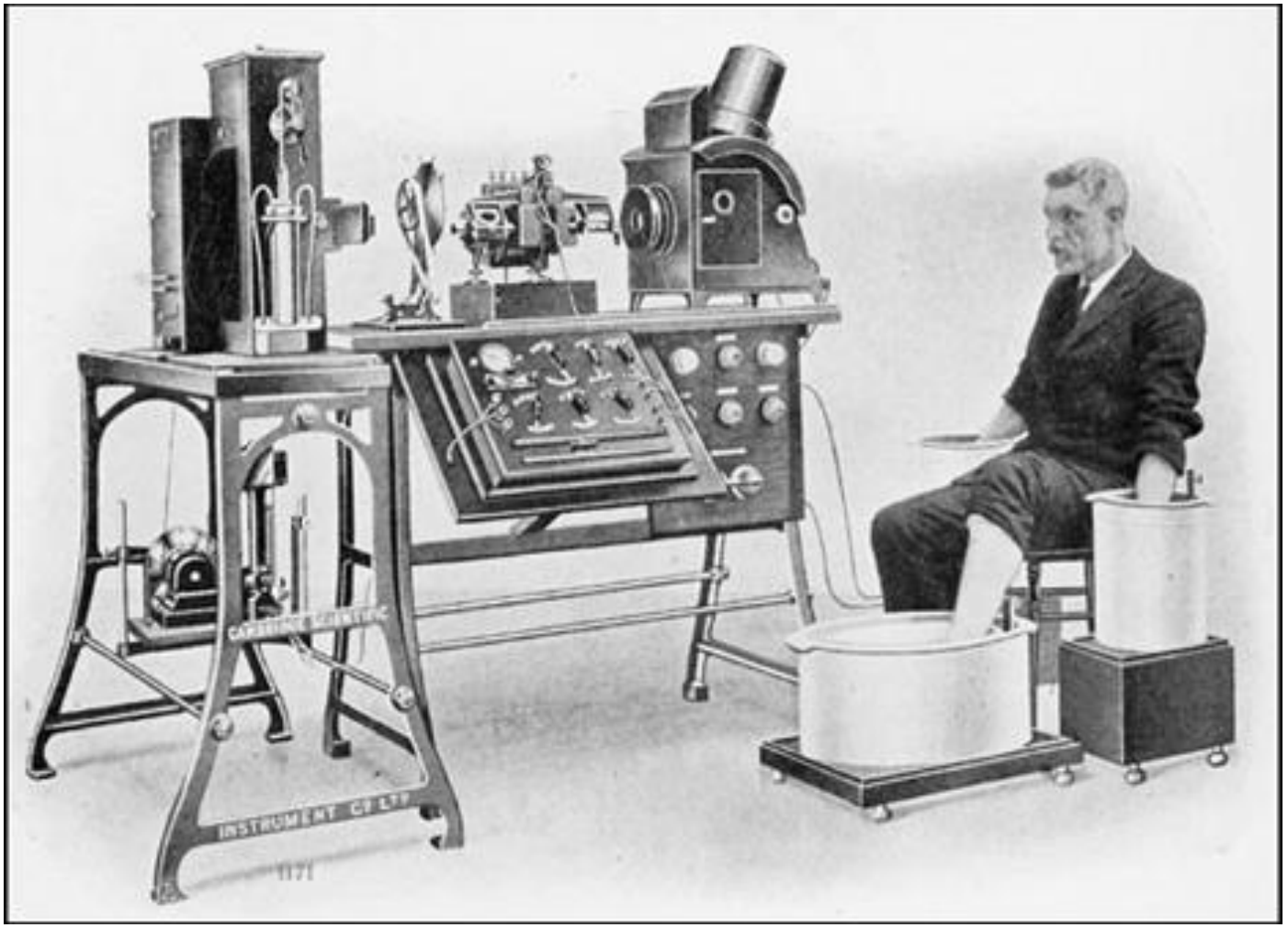


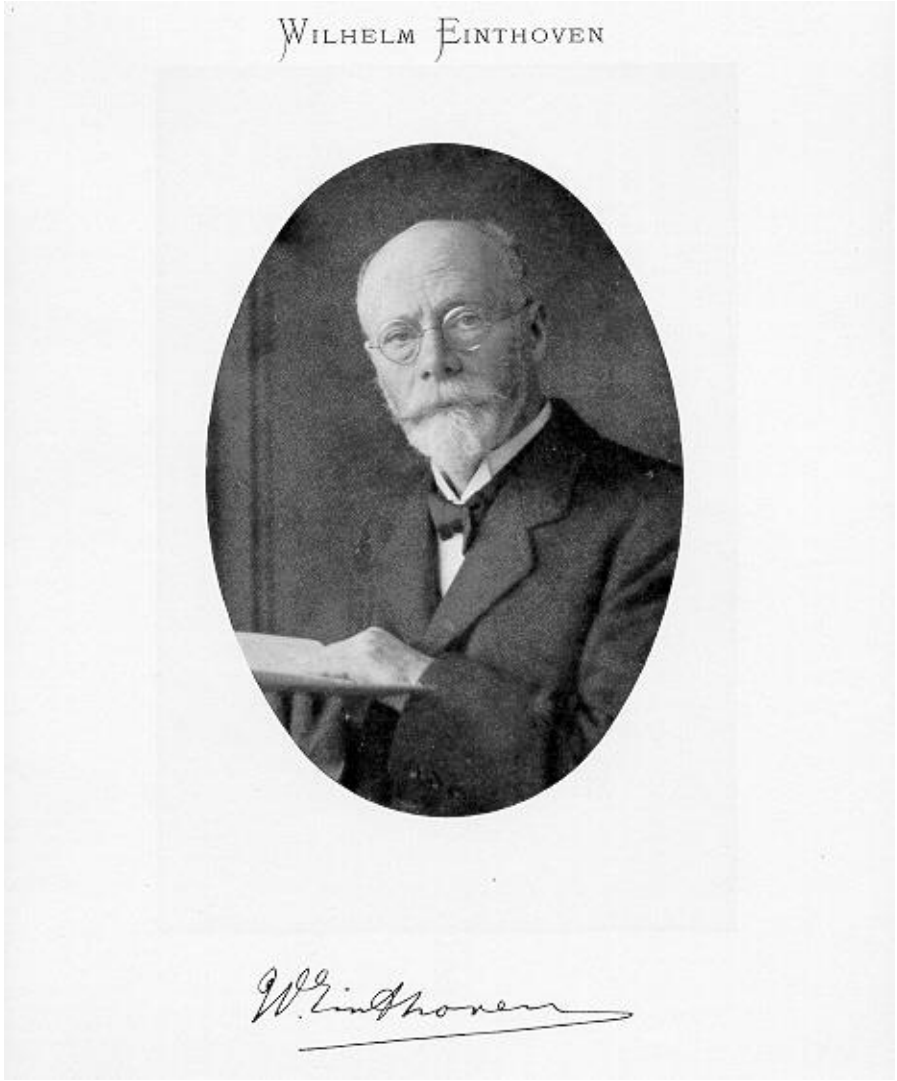
1901 Willem Einthoven invents a new galvanometer for producing electrocardiograms using a fine quartz string coated in silver, based on ideas by Deprez and d'Arsonval (who used a wire coil). His "string galvanometer" weighs 600 pounds. Einthoven acknowledges the similar system by Ader but later (1909) calculates that his galvanometer is in fact many thousands of times more sensitive.

1902 Einthoven publishes the first electrocardiogram recorded on a string galvanometer.

1903 Einthoven starts transmitting electrocardiograms from the hospital to his laboratory 1.5 km away via telephone cables. On March 22nd the first 'telecardiogram' is recorded from a healthy and vigorous man and the tall R waves are attributed to his cycling from laboratory to hospital for the recording.

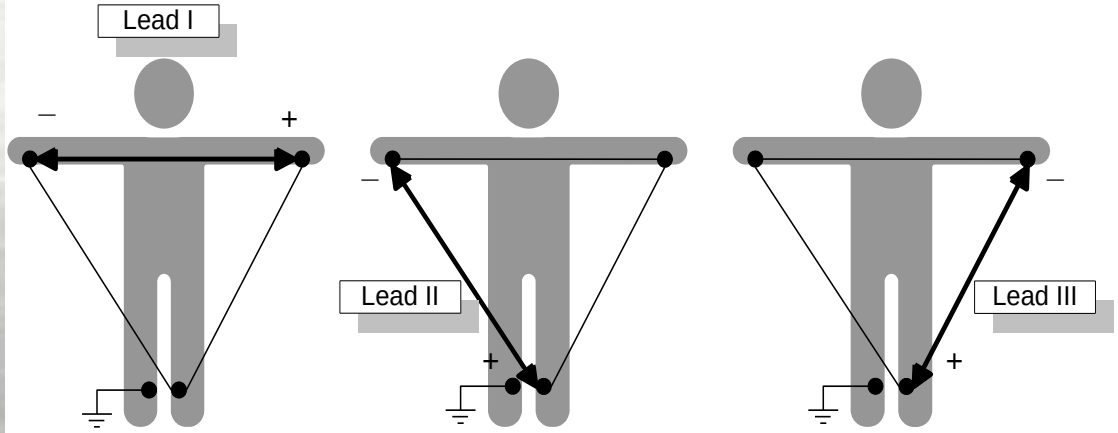
Einthoven´s string galvanometer
1901



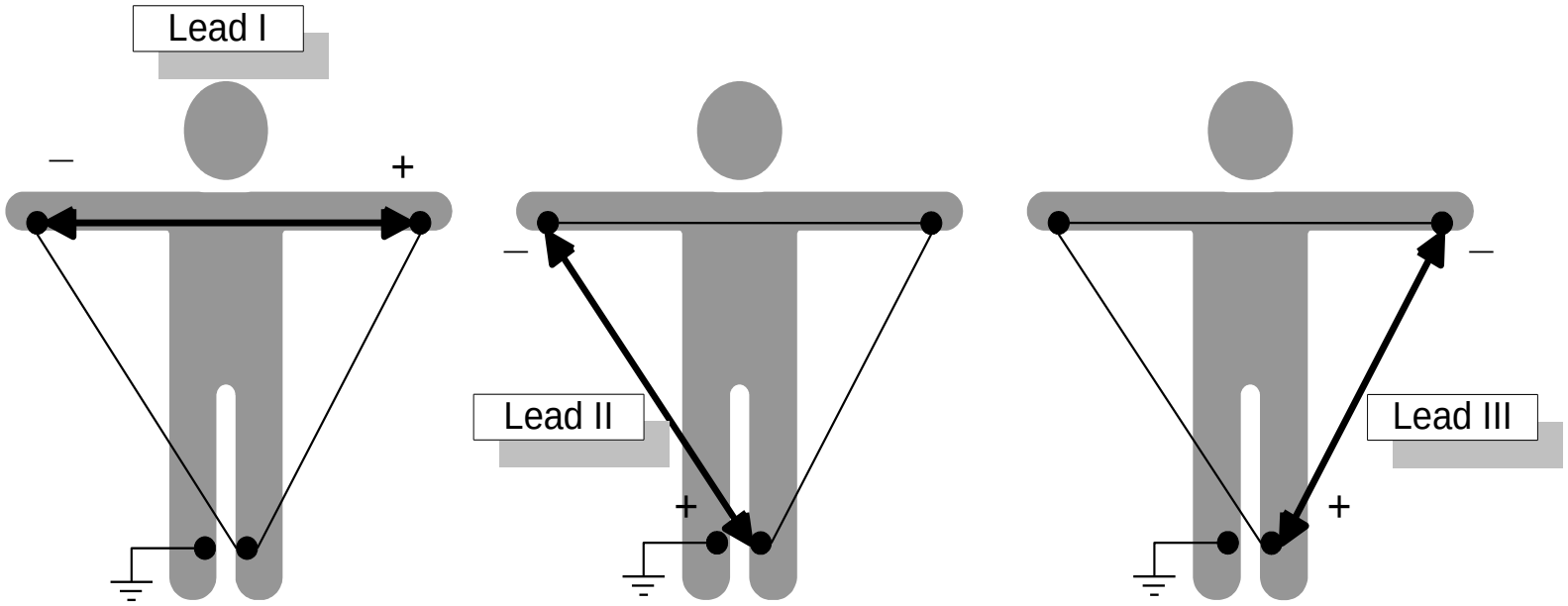


1906 Willem Einthoven publishes the first organized presentation of normal and abnormal electrocardiograms recorded with a string galvanometer. Left and right ventricular hypertrophy, left and right atrial hypertrophy, the U wave (for the first time), notching of the QRS, ventricular premature beats, ventricular bigeminy, atrial flutter and complete heart block are all described.

Einthoven´s triangel



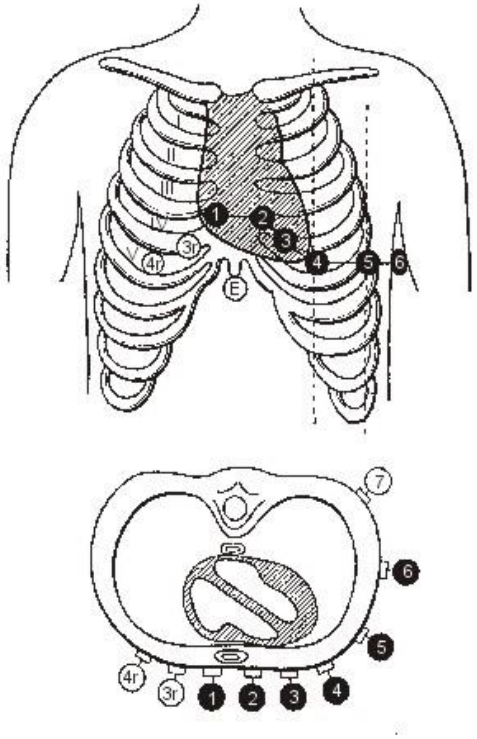
Einthoven´s triangel



Bipolar limb leads.

Frank Norman Wilson
1890 - 1952

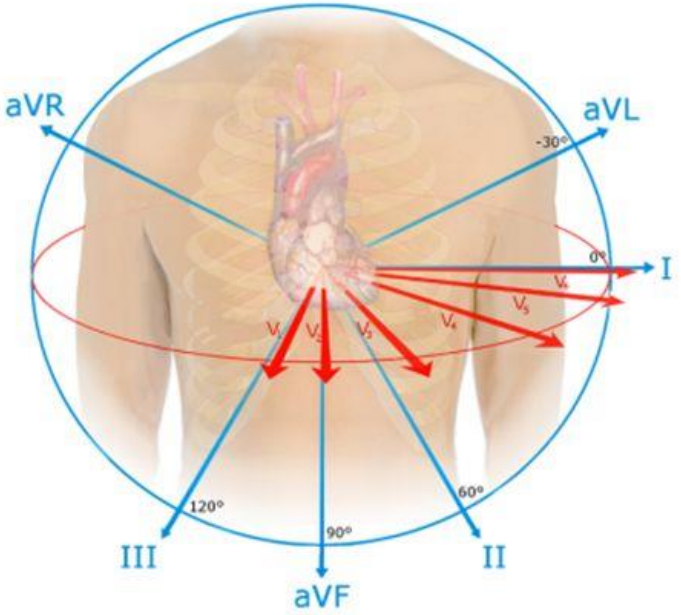
Frank Norman Wilson is an American cardiologist known primarily for his contribution to electrocardiography - introducing of precordial (chest) leads.



Chest leads

Precordial leads

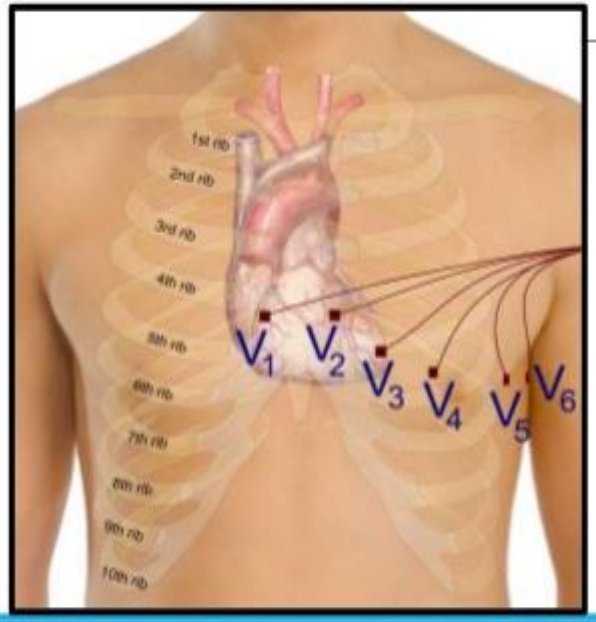
The precordial leads lie in the transverse (horizontal) plane, perpendicular to the other six leads. The six precordial electrodes act as the positive poles for the six corresponding precordial leads: $(V_1, V_2, V_3, V_4, V_5, V_6)$. Wilson's central terminal is used as the negative pole.



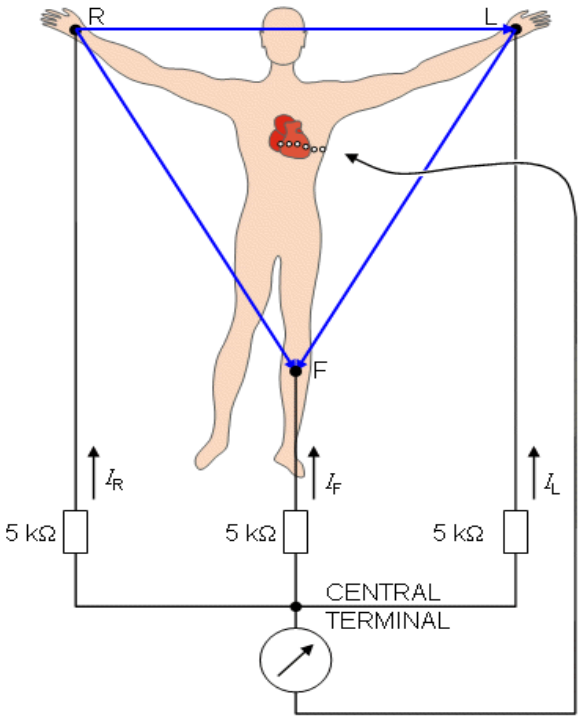
Additional electrodes may rarely be placed to generate other leads for specific diagnostic purposes. Like right sided precordial lead, posterior leads, Lewis lead, and another leads depends on the diagnostic purposes.

Chest leads

Chest (Precordial) leads

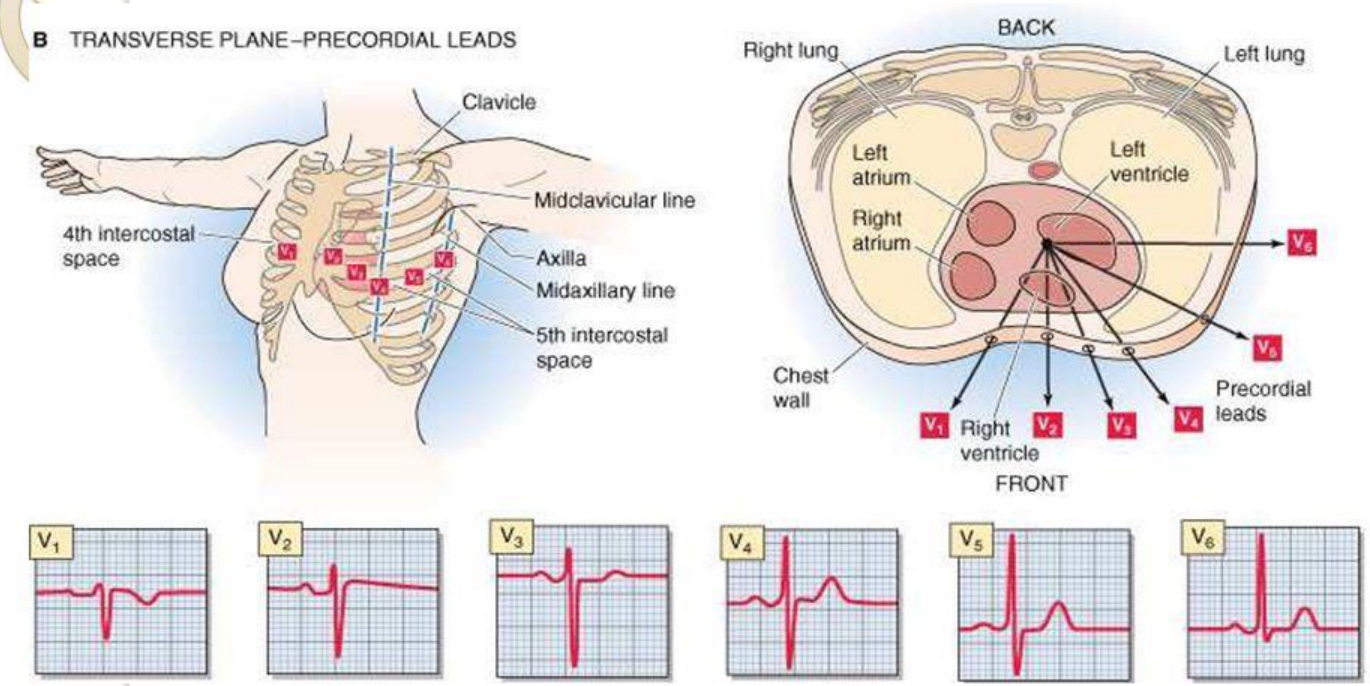


- The 6 precordial electrodes act as the **+ve** poles for the 6 corresponding precordial leads: (V1:V6).
- Wilson's central terminal is used as the **–ve** pole.
- **Wilson's central terminal:** the average measurement from the electrodes placed on RA, LA, and LL indicating the *average potential across the body*.

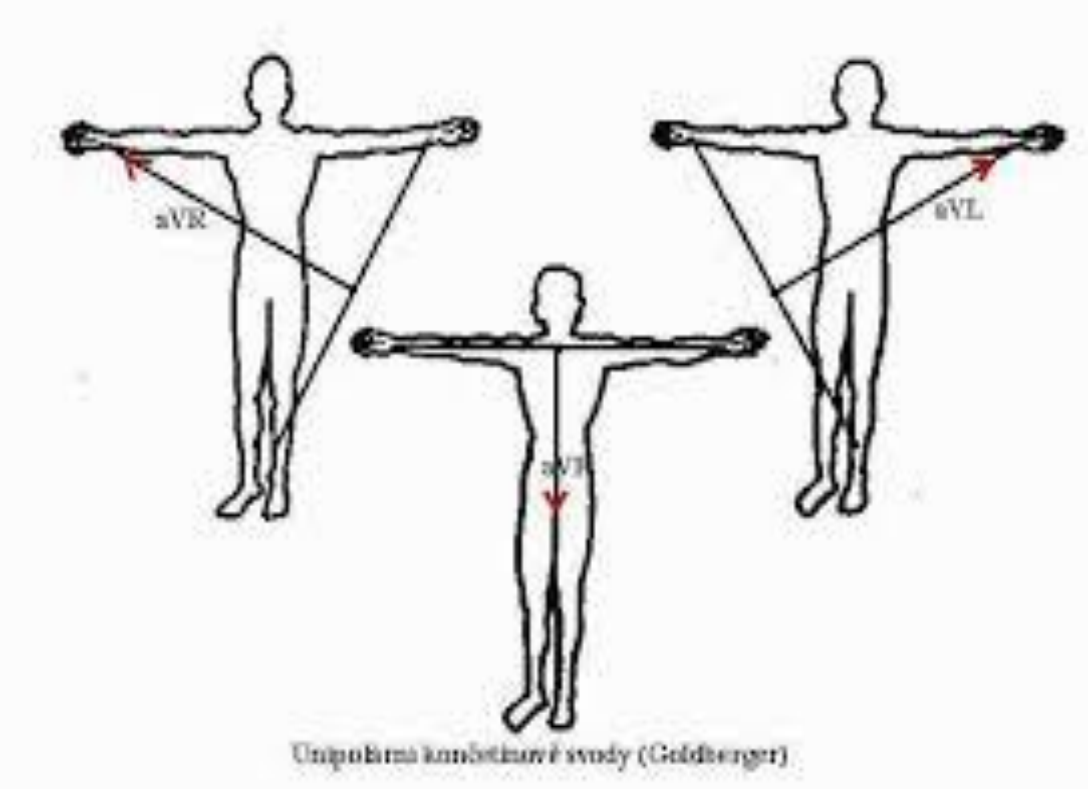


Chest leads

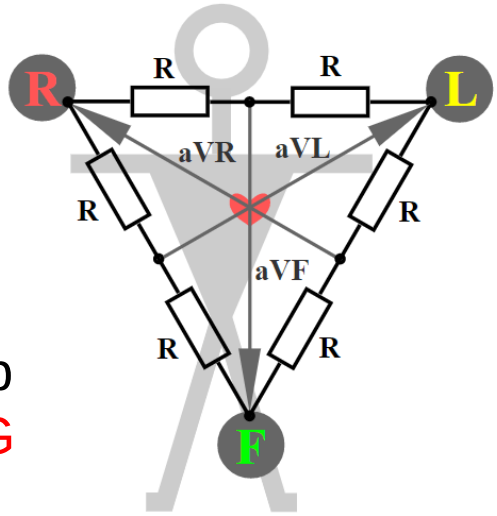
Precordial Leads



Augmented limb leads

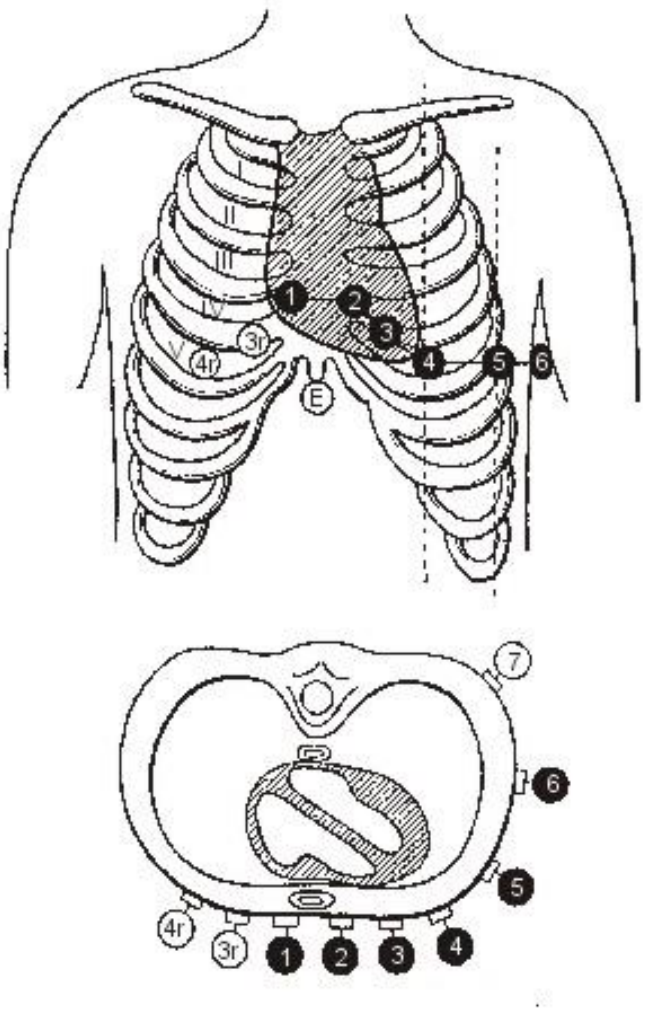


1942 Emanuel Goldberger increases the voltage of Wilson's unipolar leads by 50% and creates the augmented limb leads **aVR**, **aVL** and **aVF**.



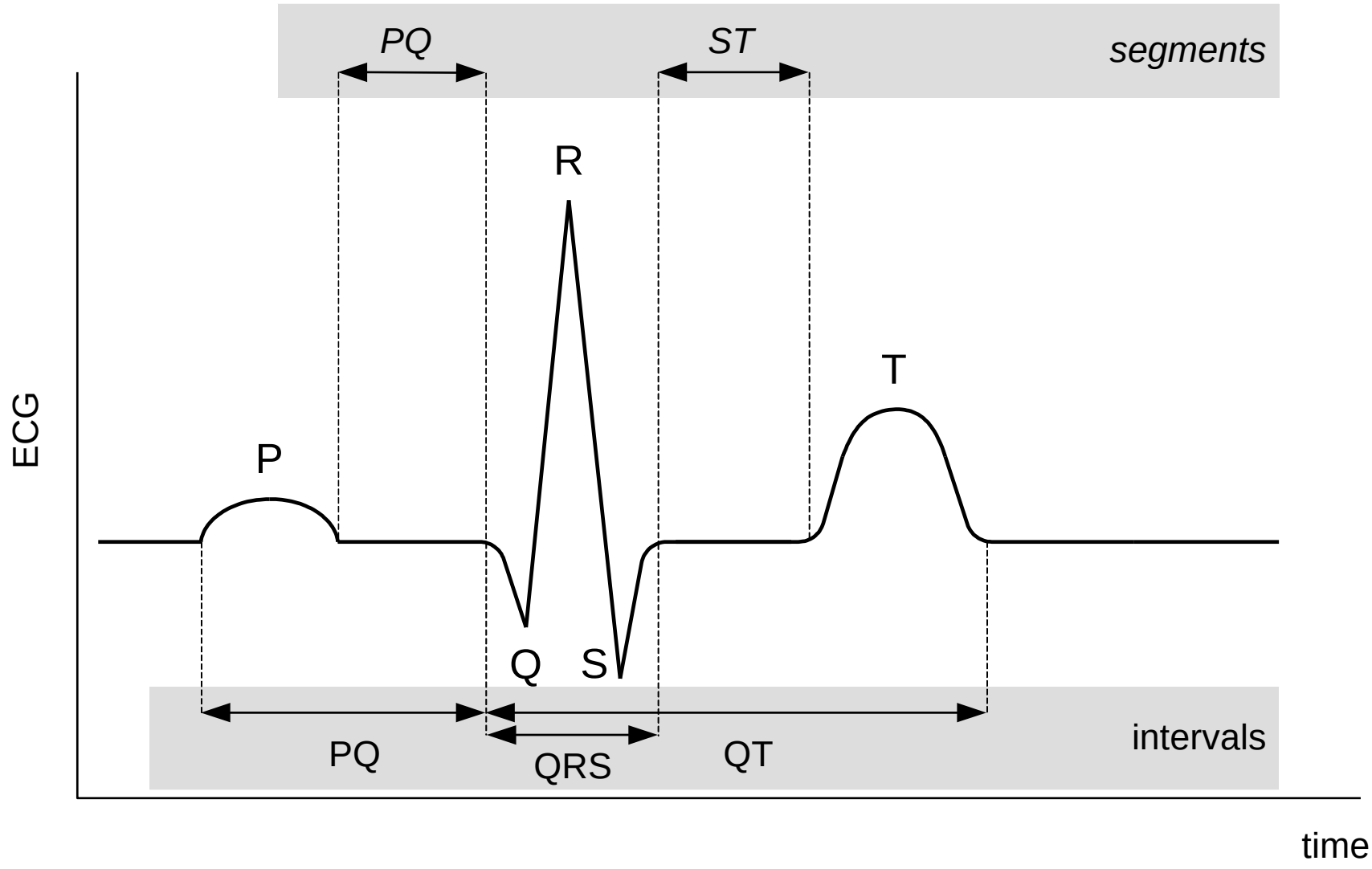
When they are added to Einthoven's three limb leads and the six chest leads, the 12 lead ECG that we know today emerges.

ECG curve

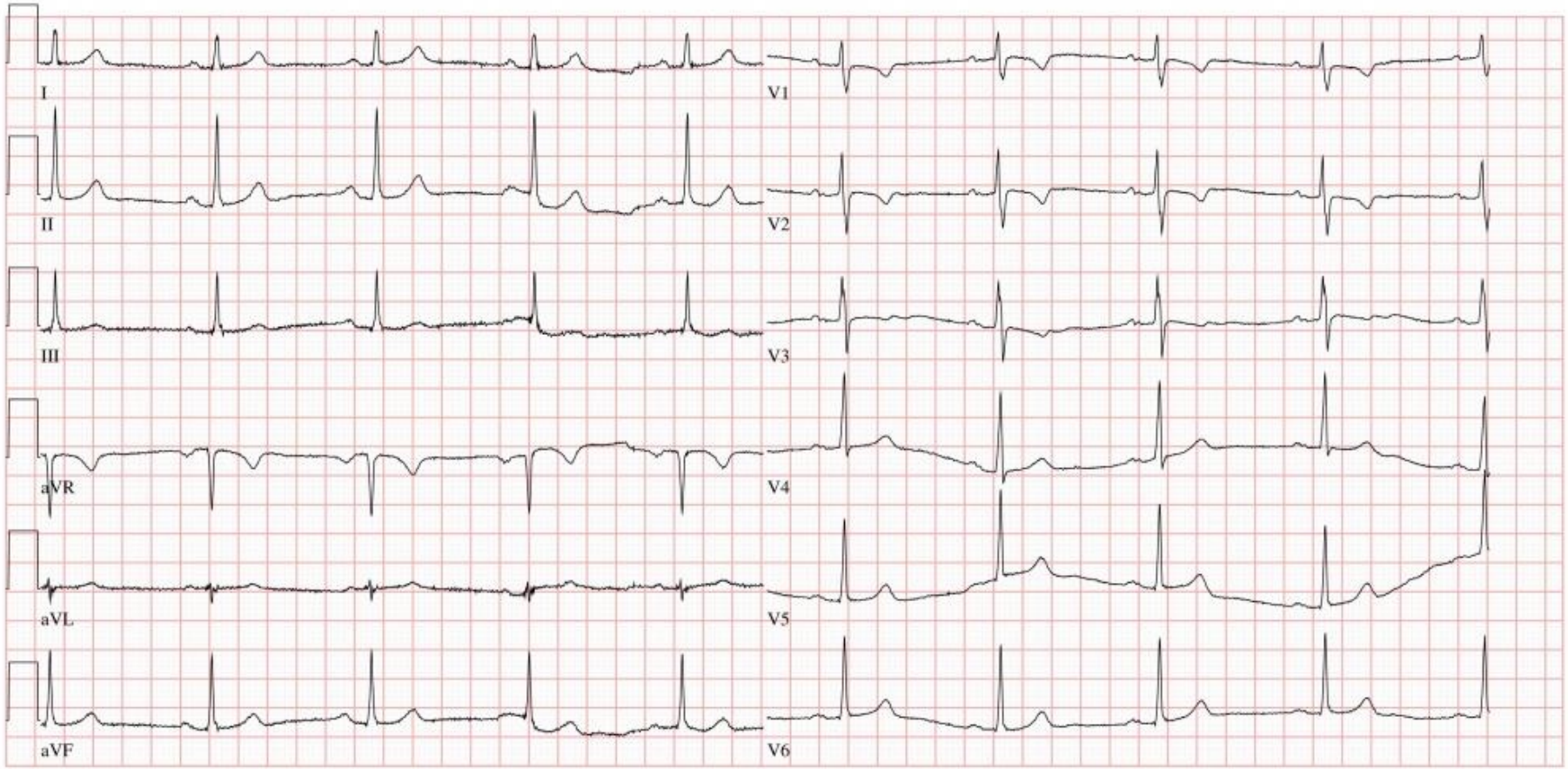


- The cardiac impulse progresses through the heart in a complex 3D pattern.
- Hence, the precise configuration of the ECG varies from person to person, and in any given individual the pattern varies with the anatomical location of the recording electrodes.
- In general: the pattern consists of P, QRS, and T waves.

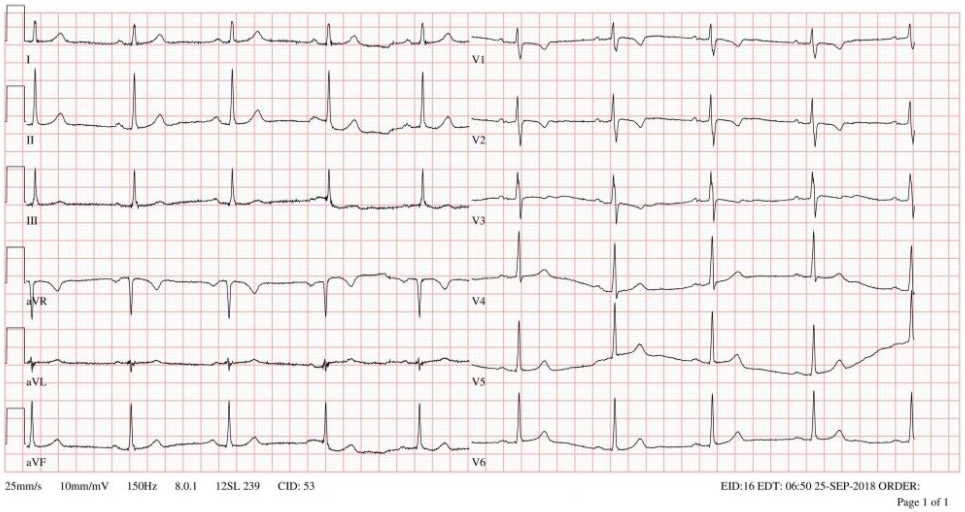
ECG curve



12 lead ECG


I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
25mm/s 10mm/mV 150Hz 8.0.1 12SL 239 CID: 53
EID:16 EDT: 06:50 25-SEP-2018 ORDER:
Page 1 of 1

12 lead ECG



Rhythm: sinus (= from SA node)

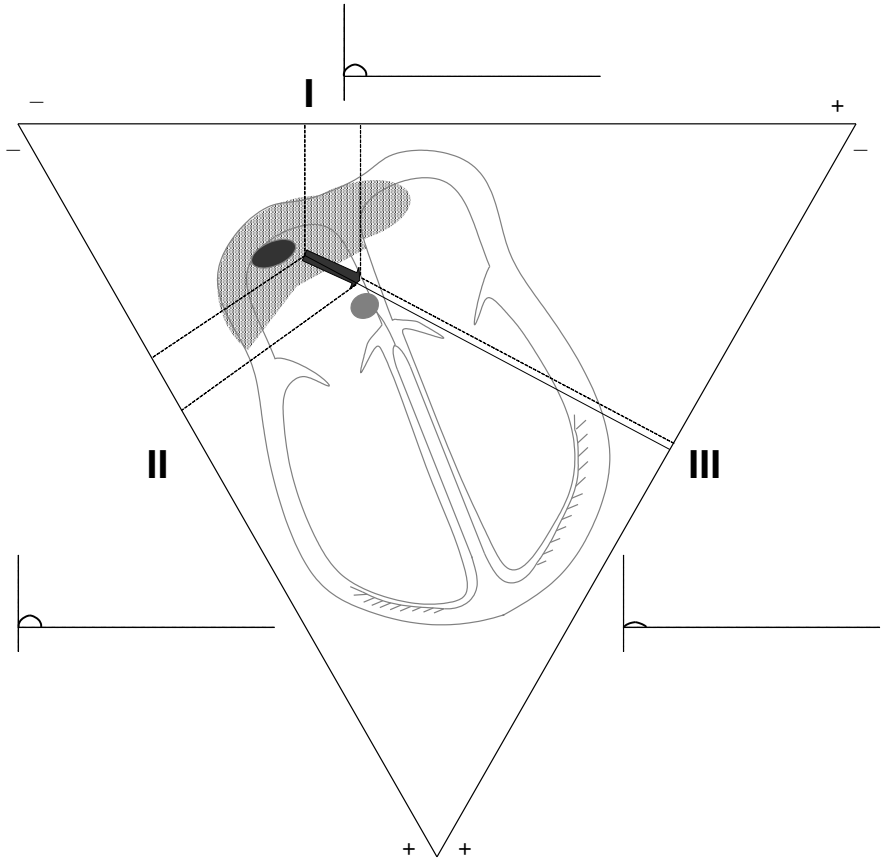
Heart rate: 55 beats/min

PQ 190 ms

QRS 80 ms

QT 420 ms

ECG curve origin

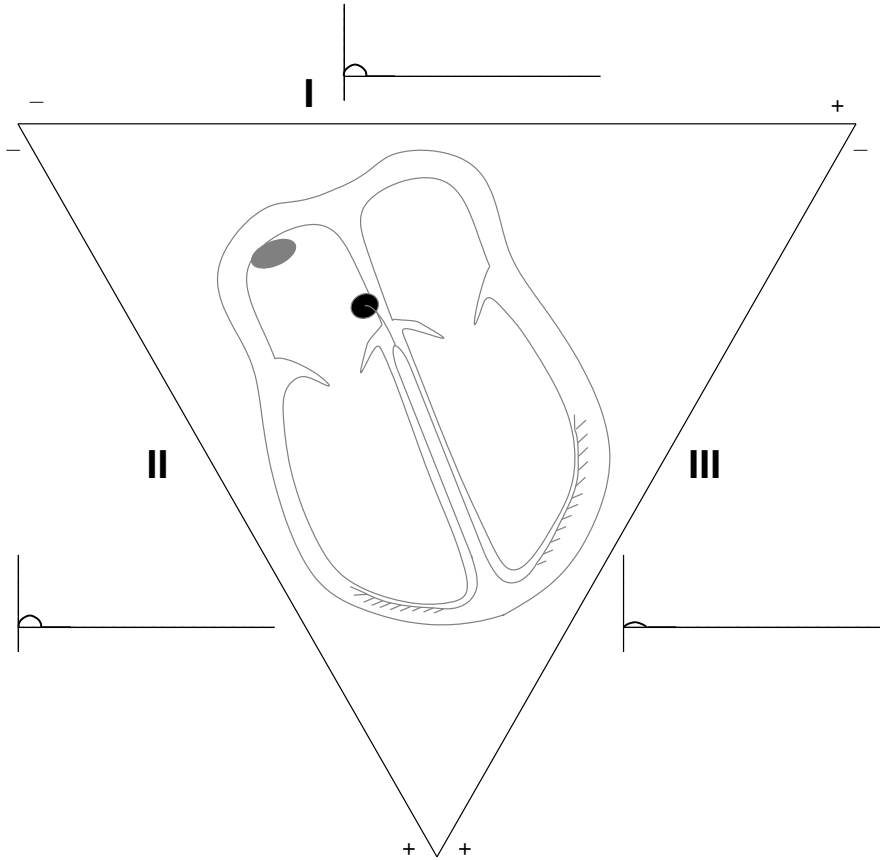


P wave origin:

depolarization of atria

duration: 80 ms

ECG curve origin

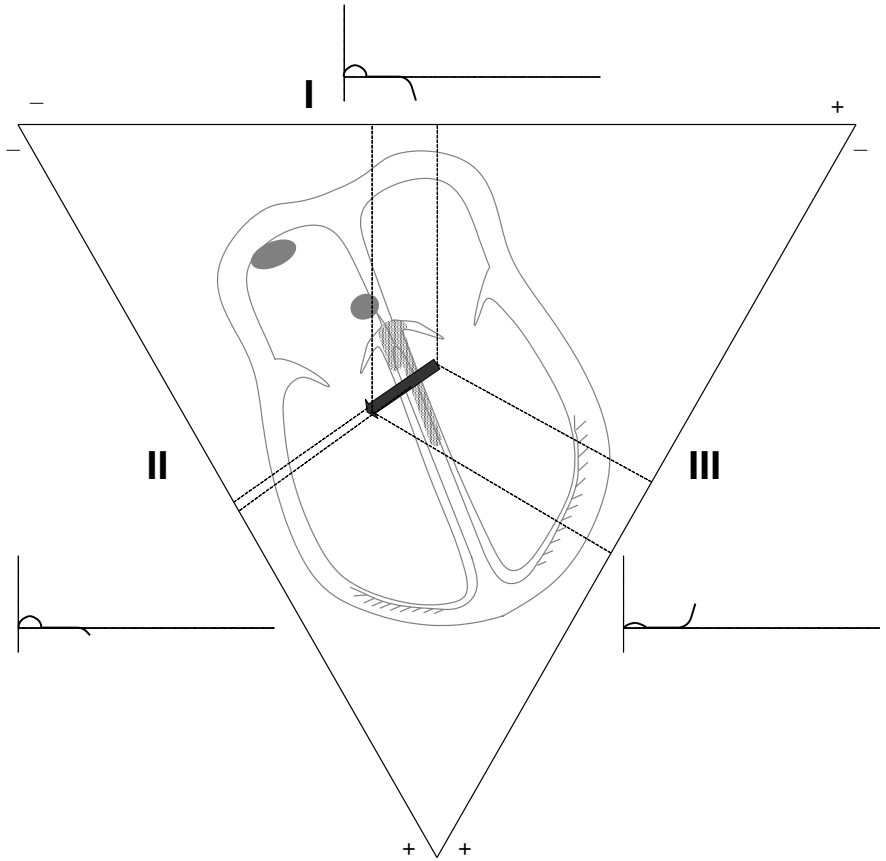


PR segment origin:

depolarization of AV node

duration: 80 ms

ECG curve origin

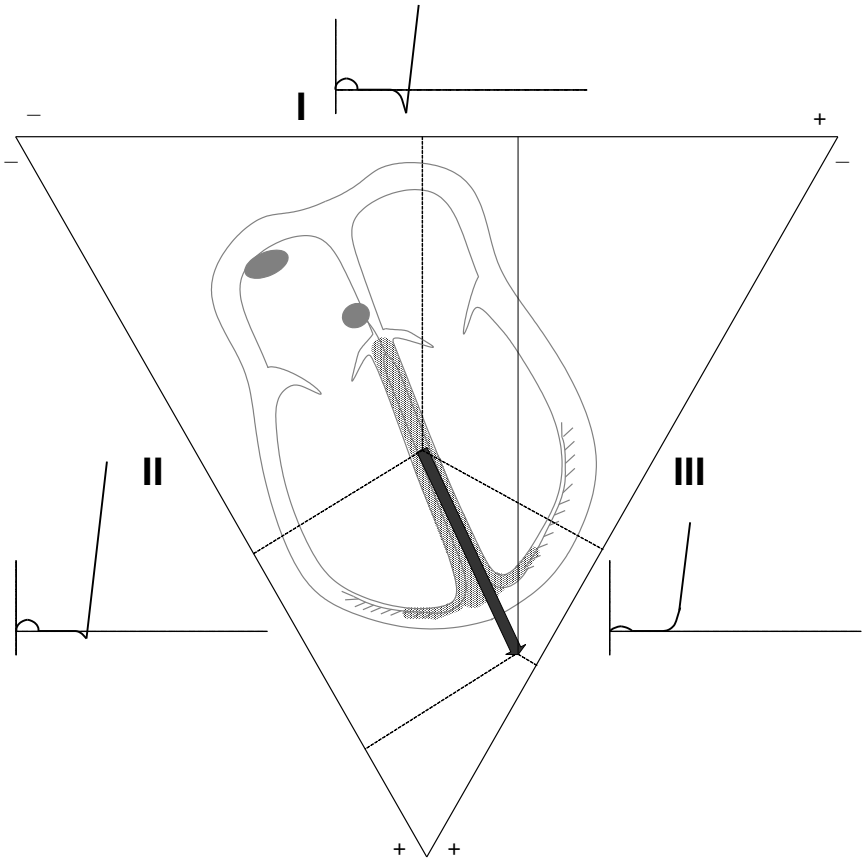


QRS complex origin:

1. depolarization of interventricular septum

Duration of QRS: 80 ms

ECG curve origin

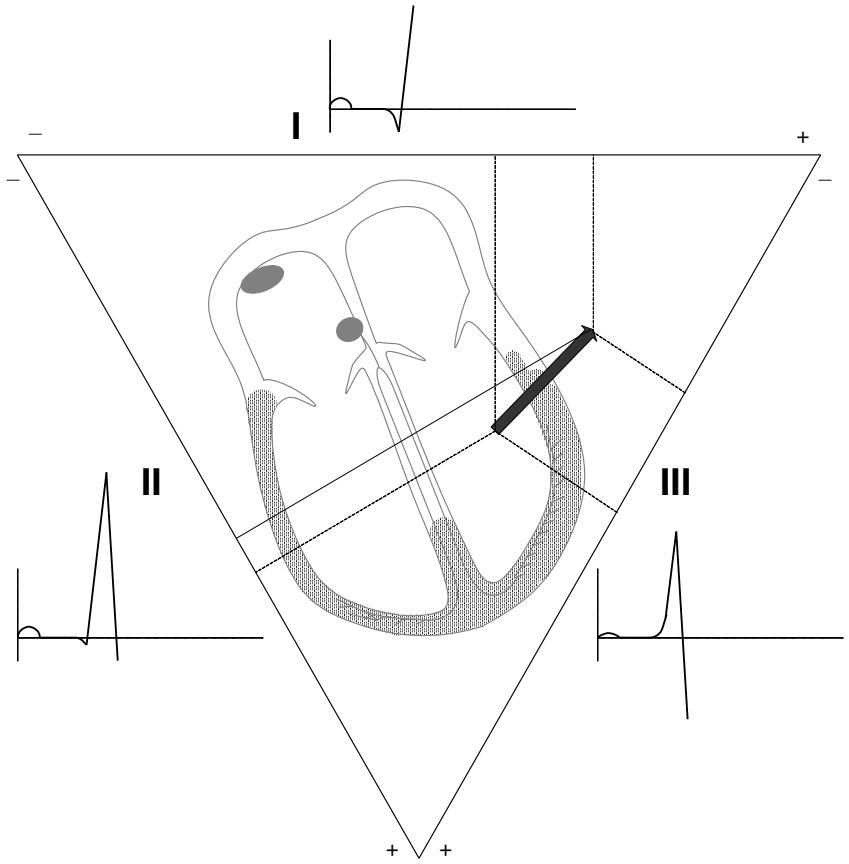


QRS complex origin:

2. depolarization of apex

Duration of QRS: 80 ms

ECG curve origin

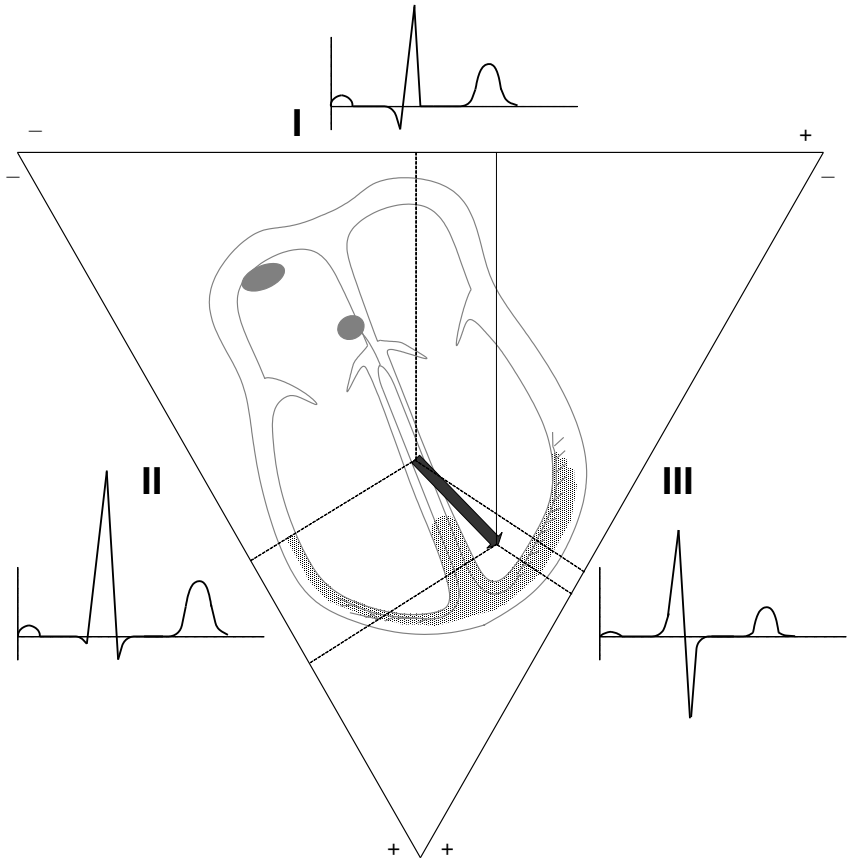


QRS complex origin:

3. depolarization of ventricular free walls

Duration of QRS: 80 ms

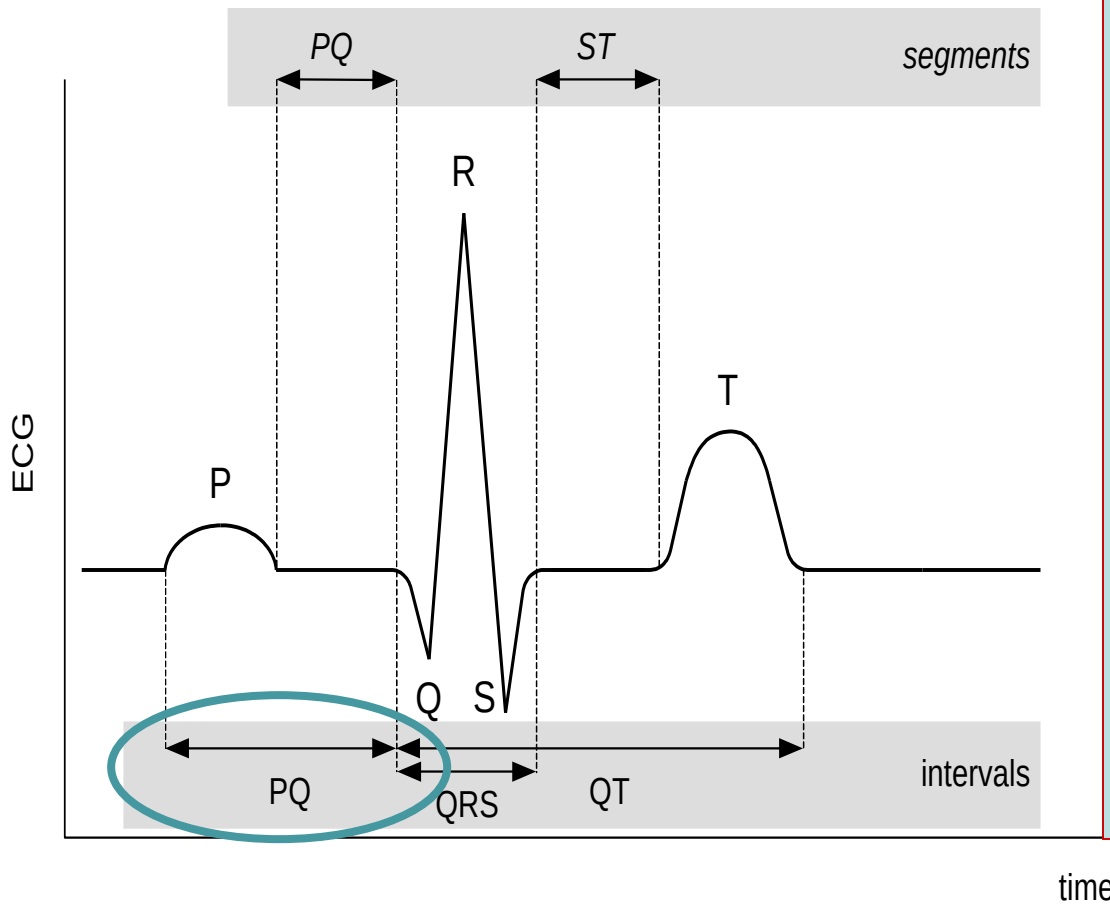
ECG curve origin



T wave origin:

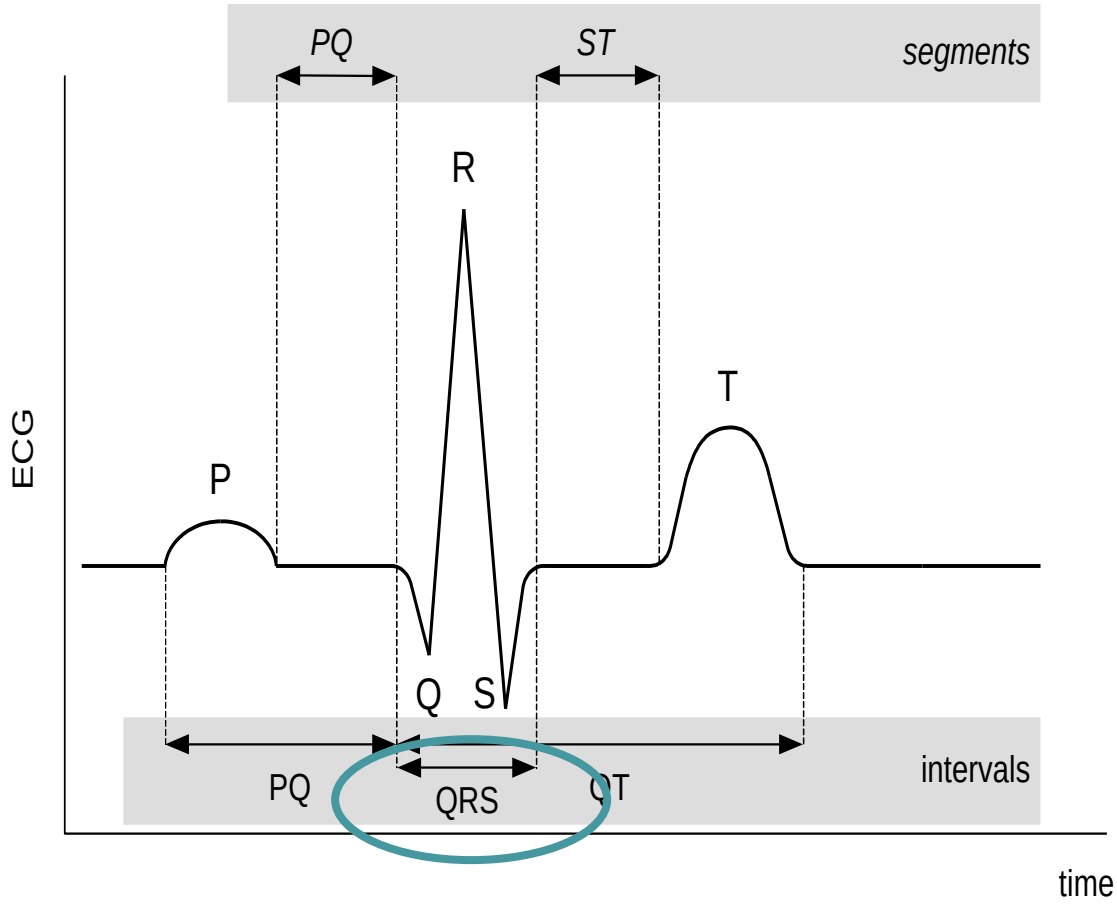
repolarization of ventricles

ECG curve



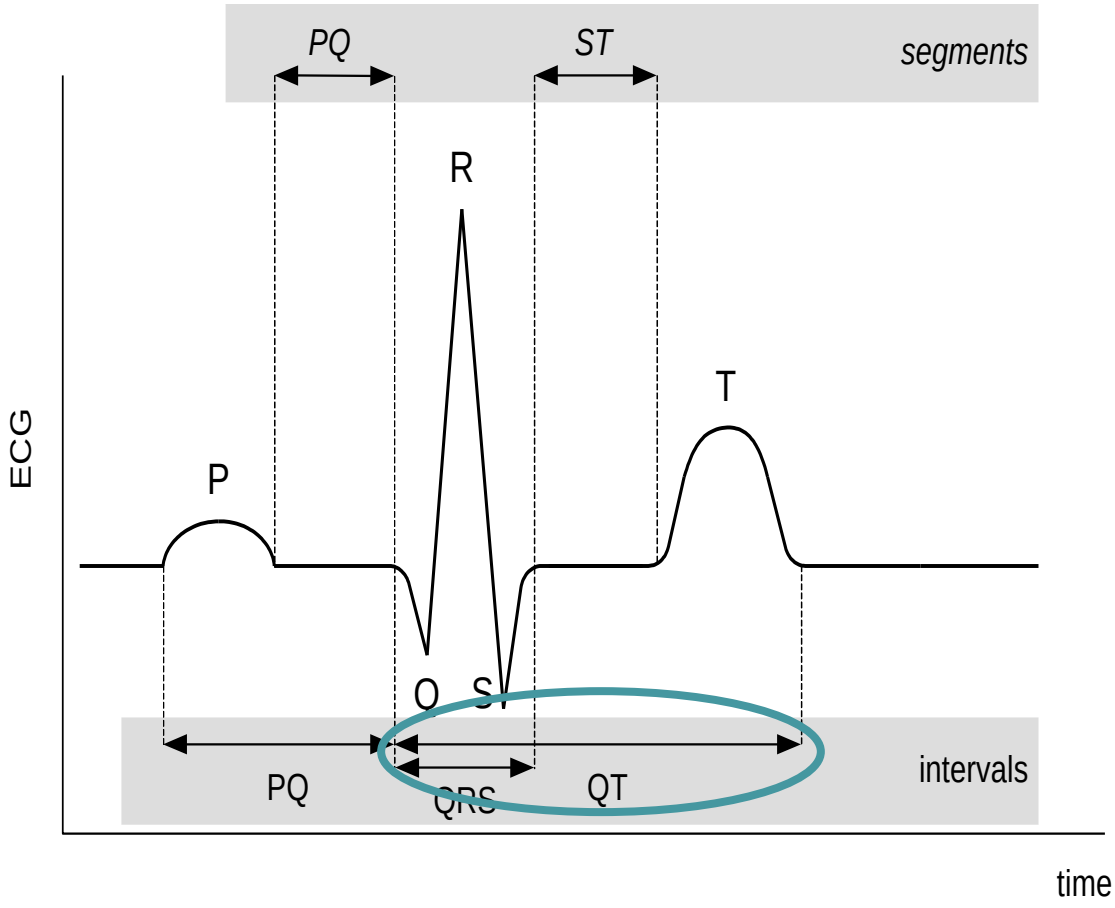
- The P-R(Q) interval is the time from the beginning of atrial activation to the beginning of ventricular activation.
- It normally ranges 0,12 to 0,20 sec.
- Most of this time involves passage of the impulse through the AV node.
- Pathological prolongations are associated with disturbances of AV conduction.

ECG curve



- The QRS complex vary considerably among individuals.
- It normally ranges 0,06 to 0,10 sec.
- Pathological prolongations are associated with disturbances of intraventricular conduction (block).

ECG curve



- The T wave reflects the repolarization of the ventricular myocardial cells.
- The Q-T interval is reffered to as the period of electrical activity of ventricles.
- It normally ranges 0,34 to 0,46 sec.
- The duration of the interval varies inversely with the heart rate