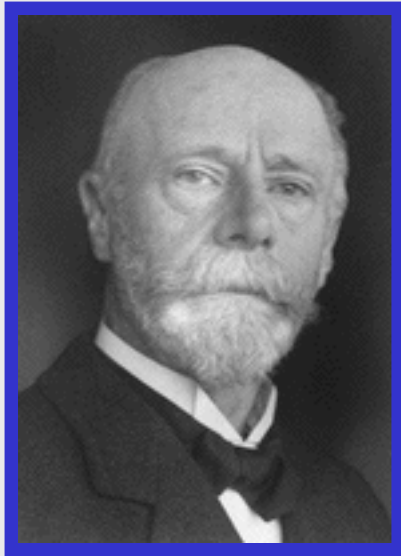


ELECTROCARDIOGRAPHY



1893 Einthoven introduces the term 'electrocardiogram'

1895 Einthoven distinguishes five deflections - P, Q, R, S and T

1902 Einthoven publishes the first electrocardiogram

1905 Einthoven starts transmitting electrocardiograms from the hospital to his laboratory 1.5 km away via telephone cable

1924 the Nobel prize

Willem Einthoven

1860 - 1927

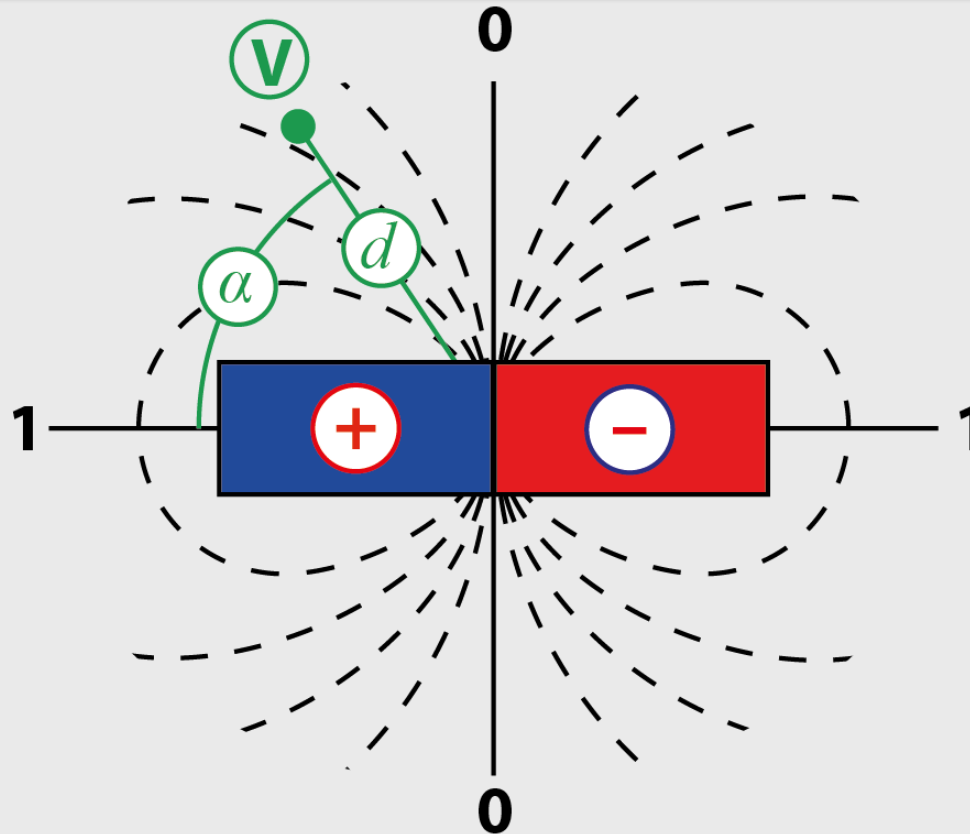
ELECTROCARDIOGRAPHY = methods enabling to register electrical changes caused by heart activity from body surface.

ECG – information about:

1. **Frequency disorders** (changes of HR in SA node or arrhythmias, sick sinus syndrome)
2. **Conduction disorders** (blocks – SA, AV)
3. **Rhythm disorders** (ES – supraventricular, ventricular)
4. **Disorders of ventricular gradient** (relationship between depolarisation and repolarisation:
origin – metabolic, haemodynamic, anatomic, physical...ischemia, hypertrophy, dilatation, cardiomyopathy, inflammations, changes in electrolytes, drugs...)

ELECTRICAL DIPOLE

stationary in homogenously conducting environment



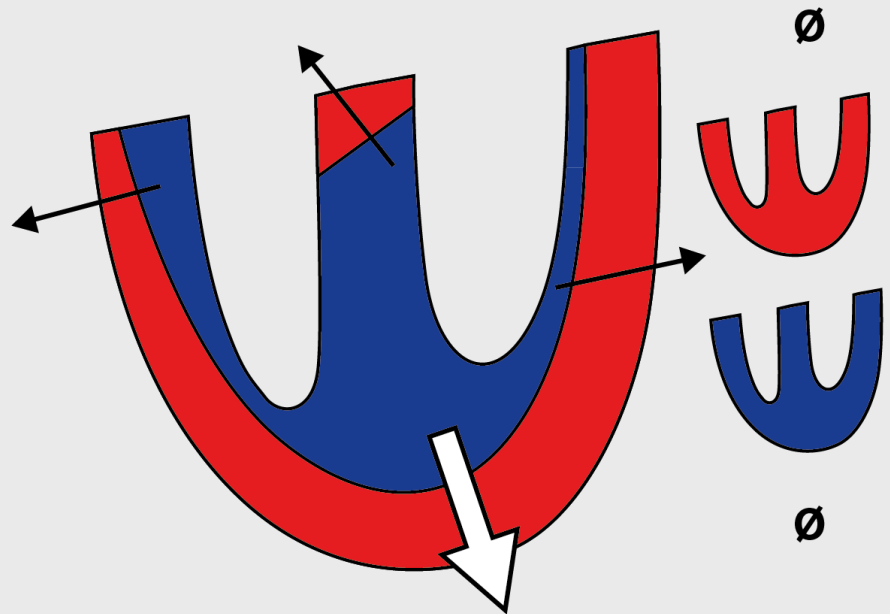
Local currents

- Maximal in dipole axis (1)
- Zero in the place of the centre (0)

SPREADING OF DEPOLARIZATION FRONT

ELECTRICAL FIELD OF THE HEART (vector)

- Consists of sum of momentary dipoles on the depolarization front
- **Its size** is a function of number of dipoles and steepness of boundary line
- **Direction from** depolarized (-) to (re)polarized (+) area

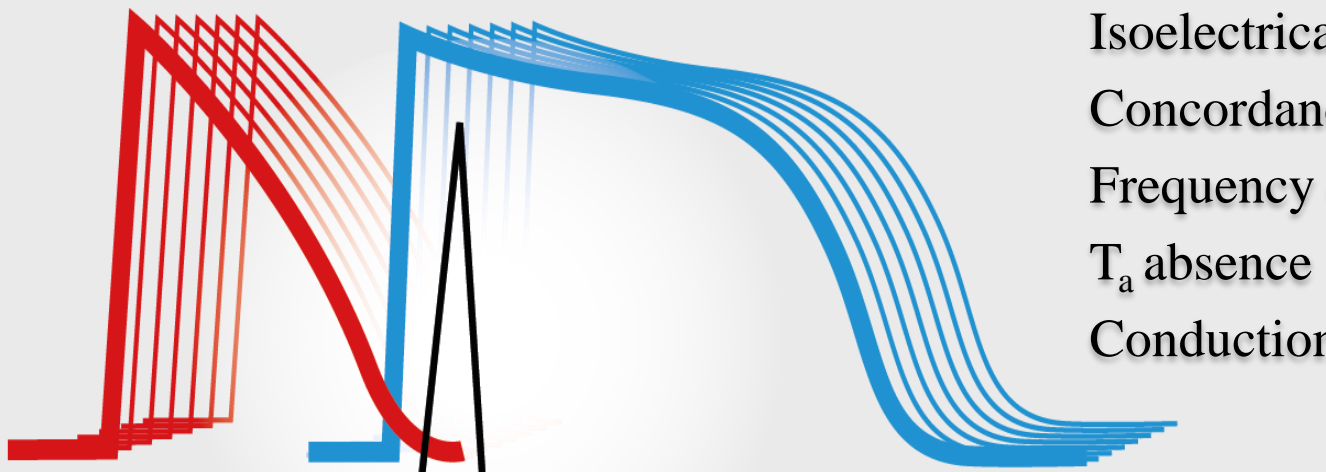


REGIONAL VECTORS

INTEGRAL VECTOR

during excitation is changing:

- Size of momentary dipoles
- Their direction
- They are spreading to body surface – **ELECTROCARDIOGRAPHY**



Isoelectrical segments
 Concordance of T wave
 Frequency dependence
 T_a absence
 Conduction system



PQ interv.
 0,16

QRS
 0,1

QT
 0,3

Atrial depol.

Ventricular complex

(depol.)

(repol.)

HR – dependent

3D SMYČKY SRDEČNÍHO VEKTORU

F – frontální rovina hrudníku

S – sagitální rovina hrudníku

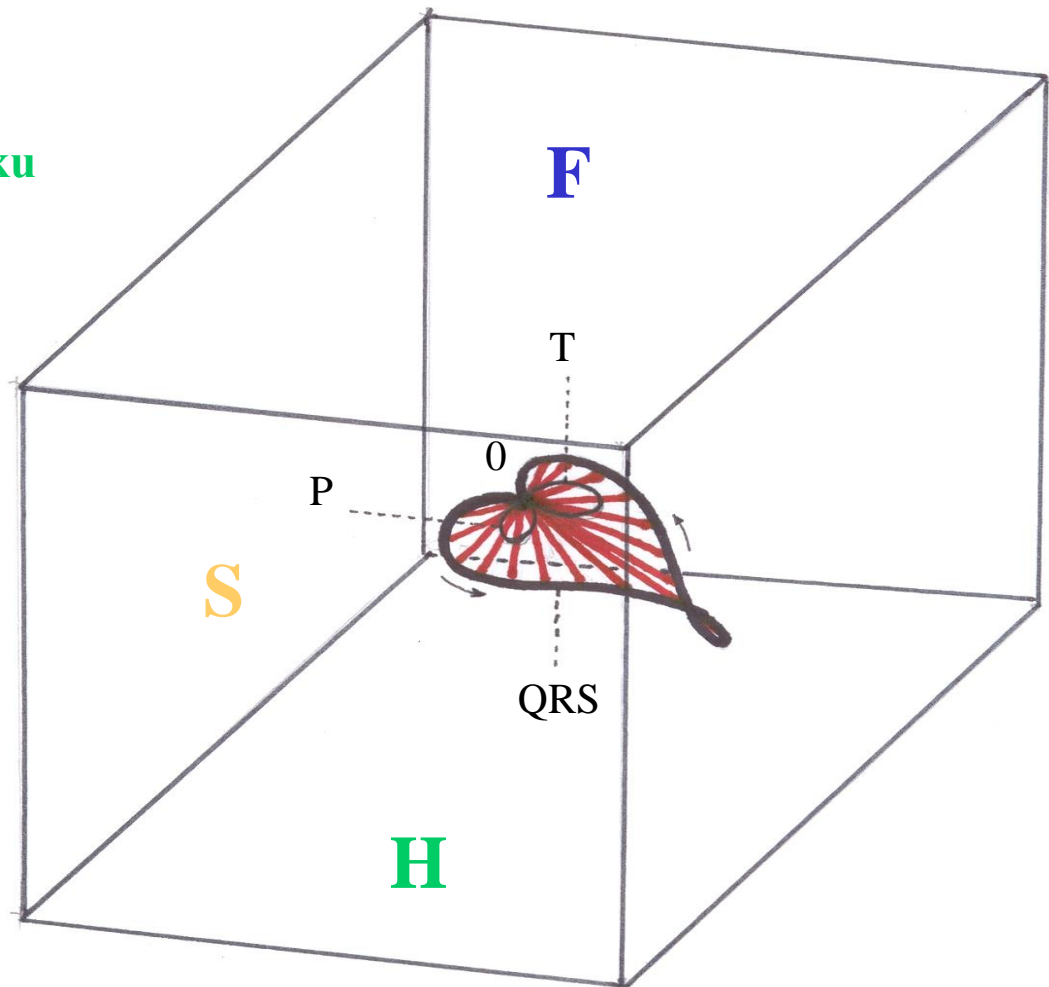
H – horizontální rovina hrudníku

0 – elektrický střed srdce

P – síňová depolarizace

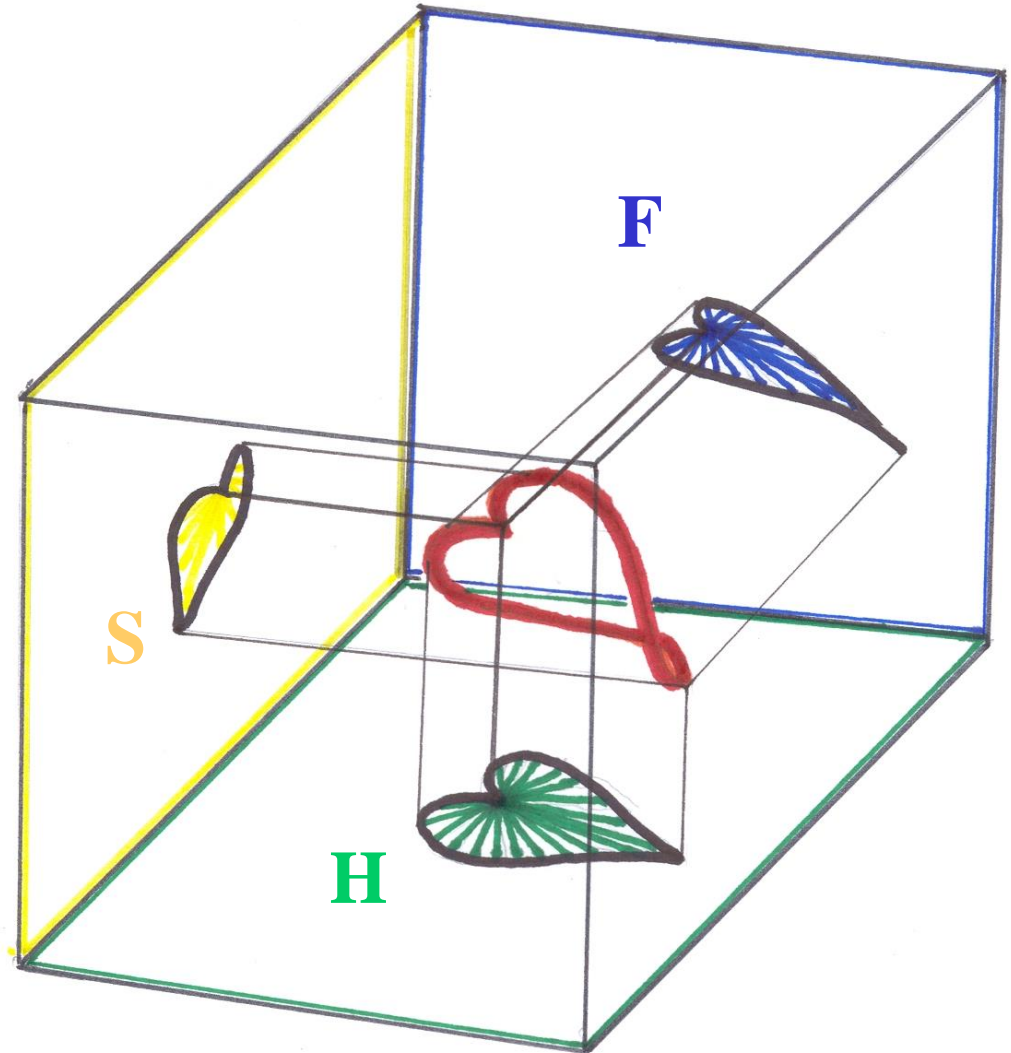
QRS – komorová depolarizace

T – komorová repolarizace



2D PROJEKCE HLAVNÍHO SRDEČNÍHO VEKTORU

F – frontální rovina hrudníku
S – sagitální rovina hrudníku
H – horizontální rovina hrudní



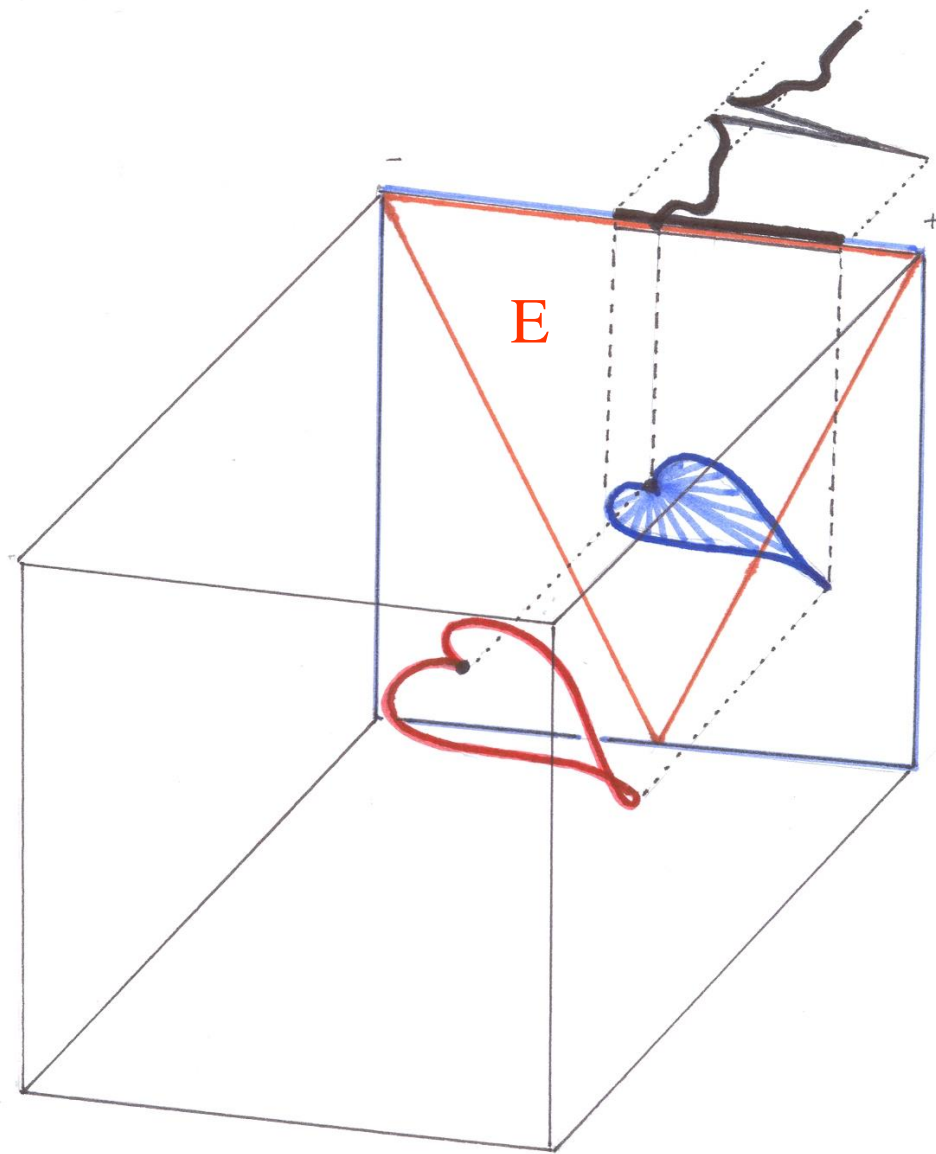
1D PROJEKCE HLAVNÍHO SRDEČNÍHO VEKTORU

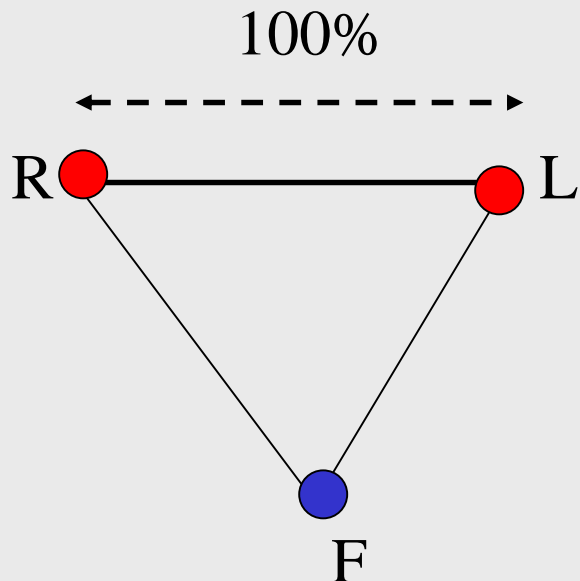
Projekce na povrch hrudníku
do frontální roviny (2D)

a její projekce na přímku
(1D), osu I. EKG svodu

rozepsaná v čase

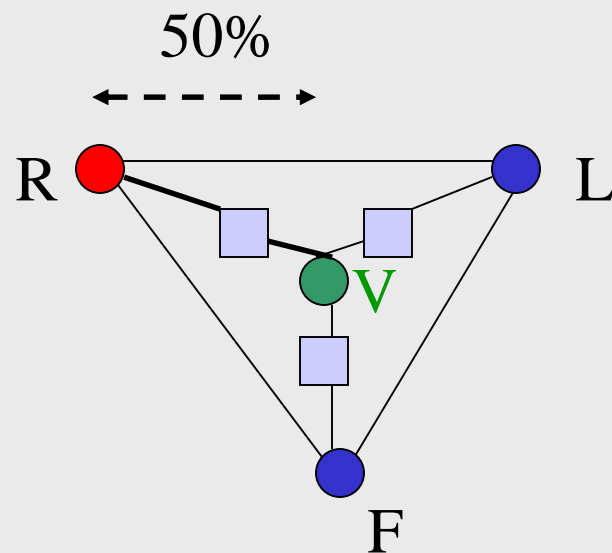
E – Einthovenův trojúhelník



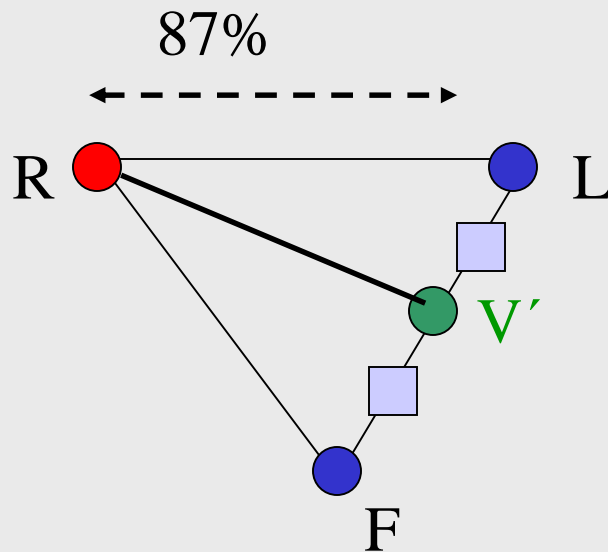


Einthoven, 1913

I, II, III

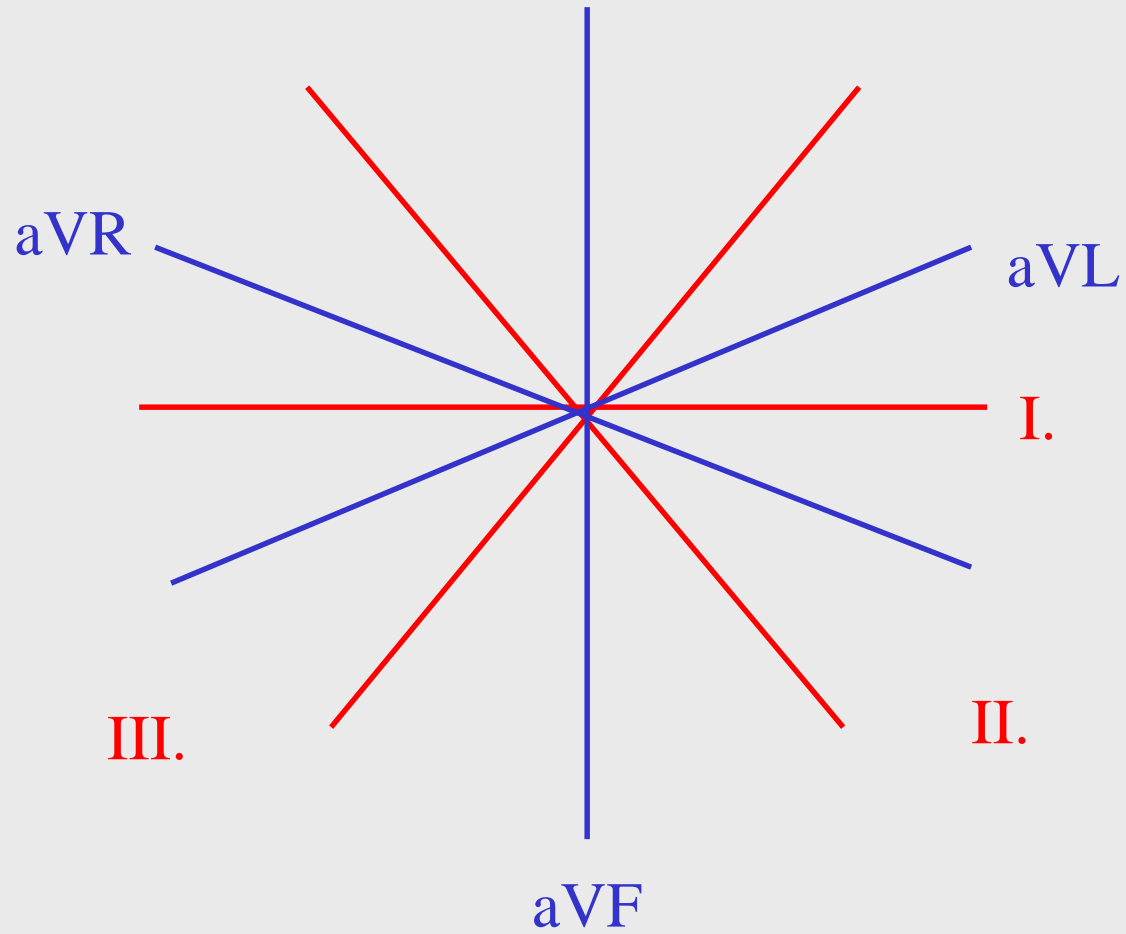


Wilson, 1934, VR, VL, VF

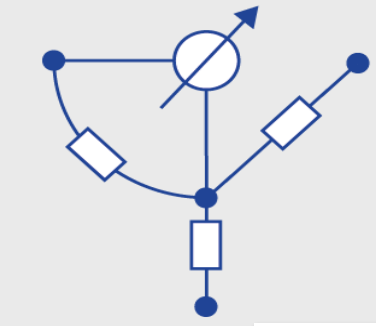
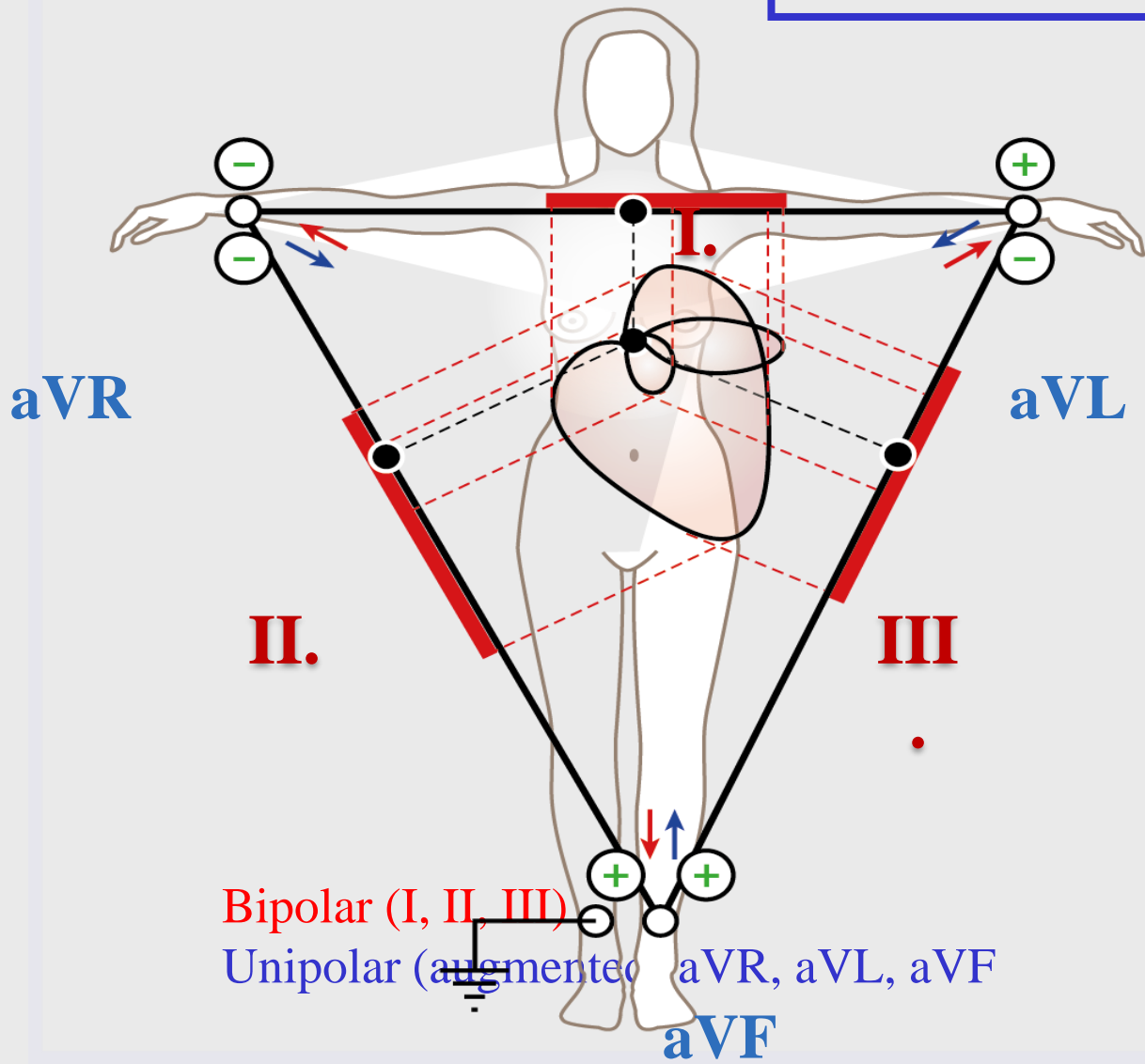


Goldberger, 1947, aVR, aVL, aVF

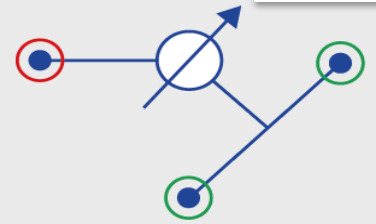
HEXAAXIAL SYSTEM



LIMB LEADS



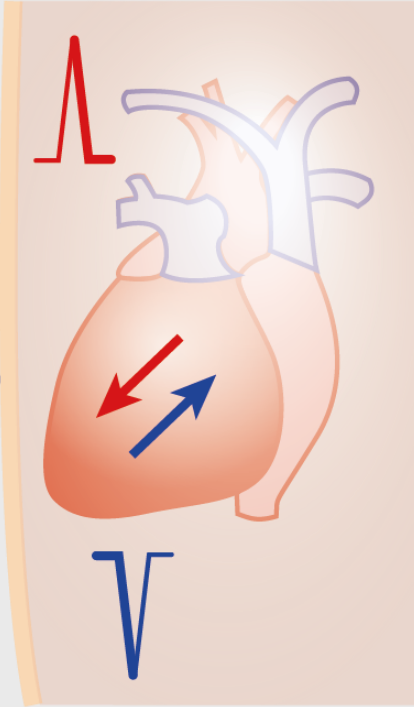
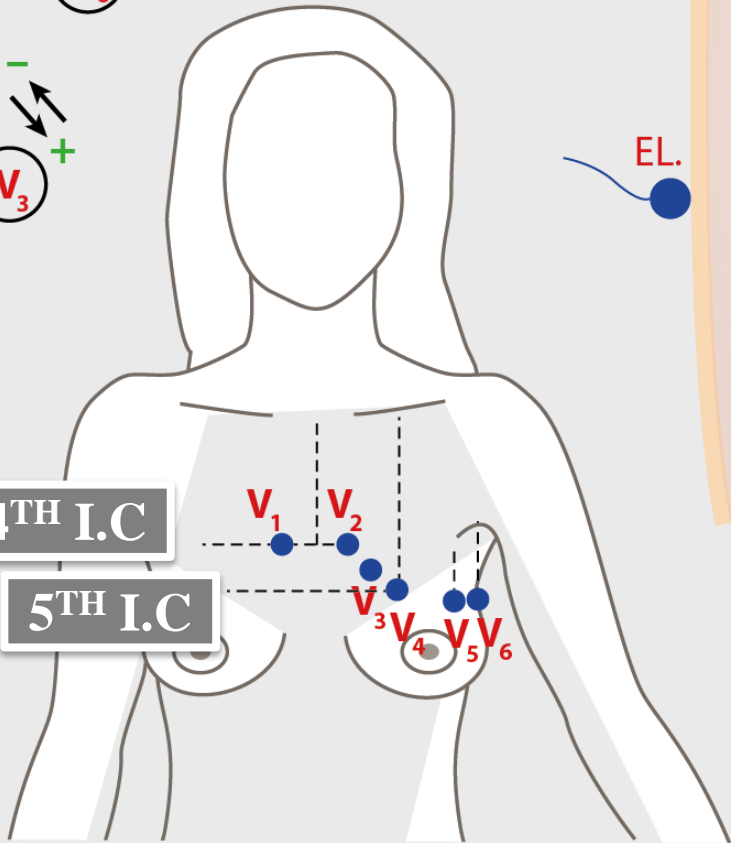
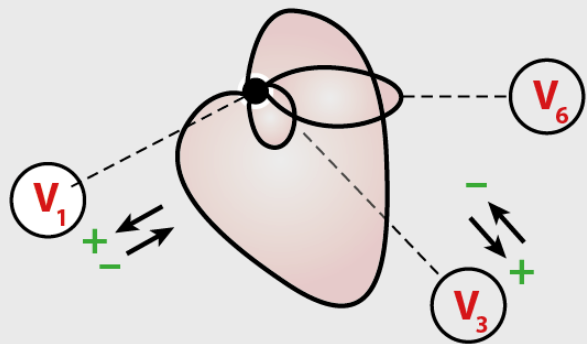
WILSON



GOLDBERG
augmented

Frontal projection of vector!

CHEST LEADS



Horizontal projection of vector!

PROJECTION PLANES OF CARDIAC VECTOR AND ECG LEADS

Frontal plane

limb leads

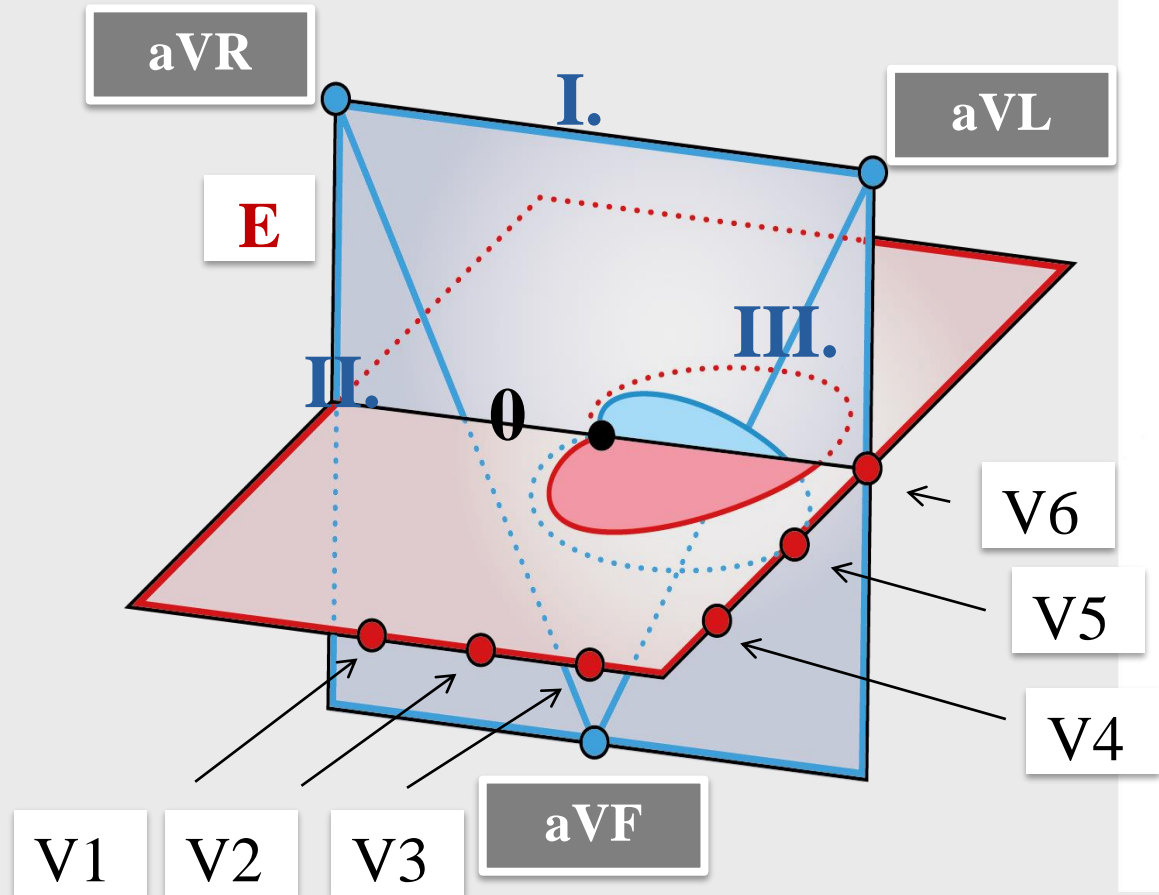
I., II., III., aVR, aVL, aVF

Horizontal plane

V1 – V6

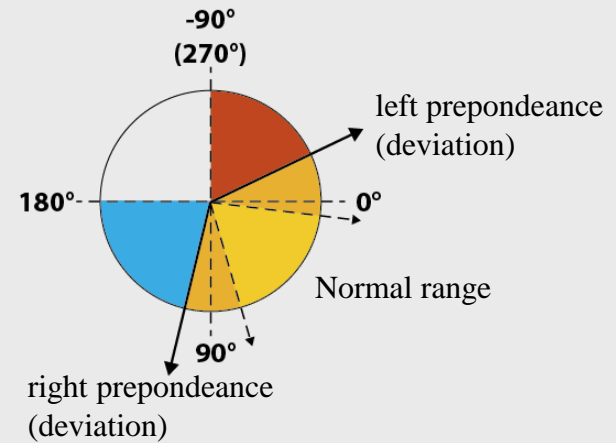
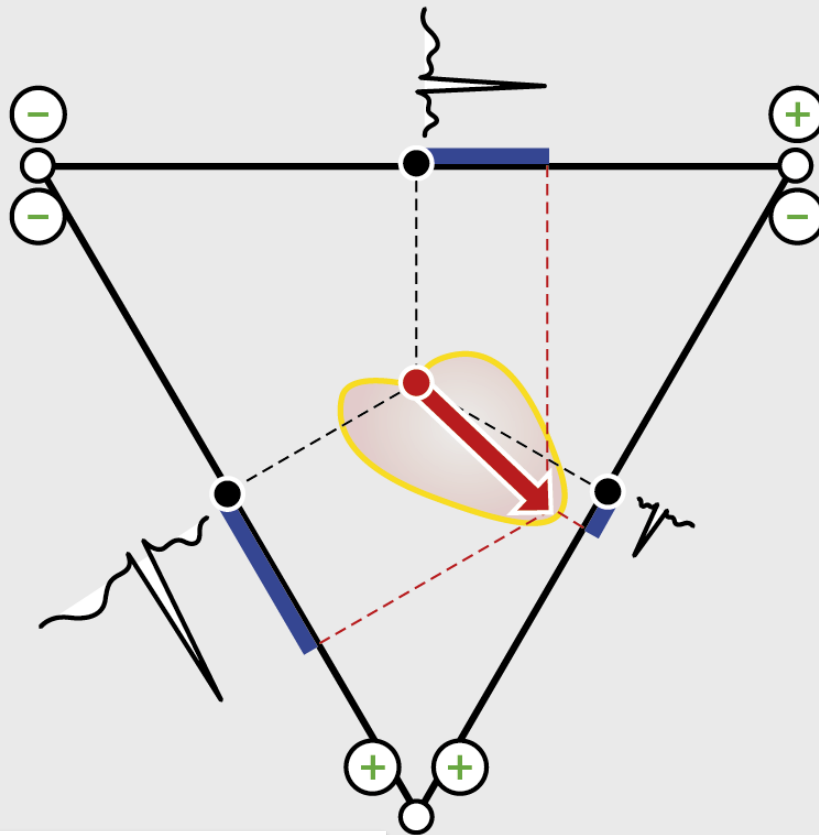
Both planes are shifted into the level of electrical centre of the heart (0)

E – Einthoven triangle



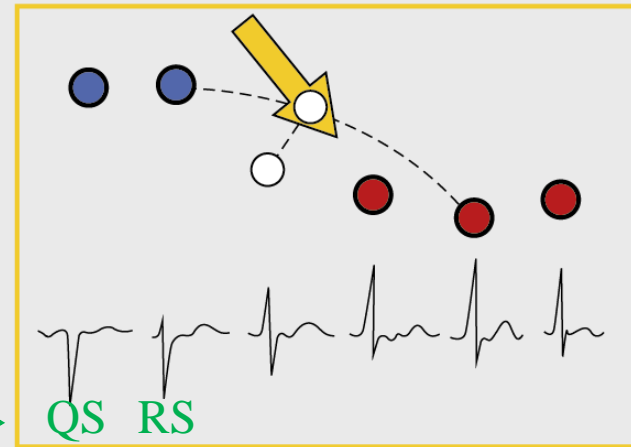
ELECTRICAL AXIS – in the frontal plane

(R–Q–S) in lead I, II, III.



• **Eqilateral**
Einthoven
triangle

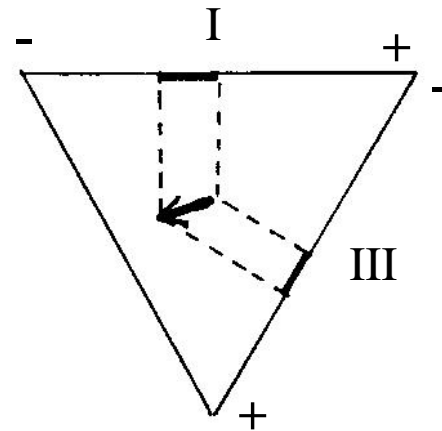
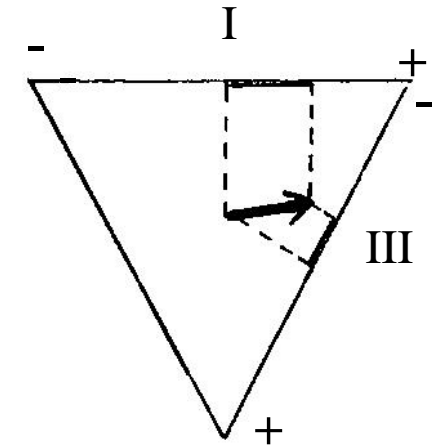
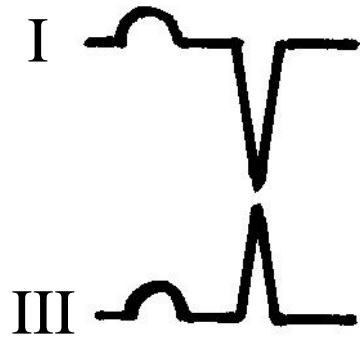
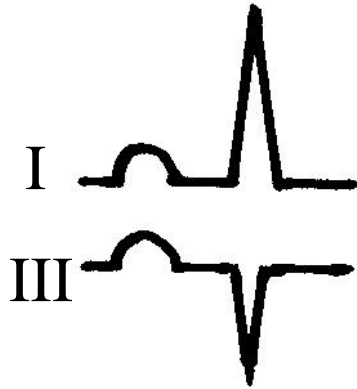
Terminology →



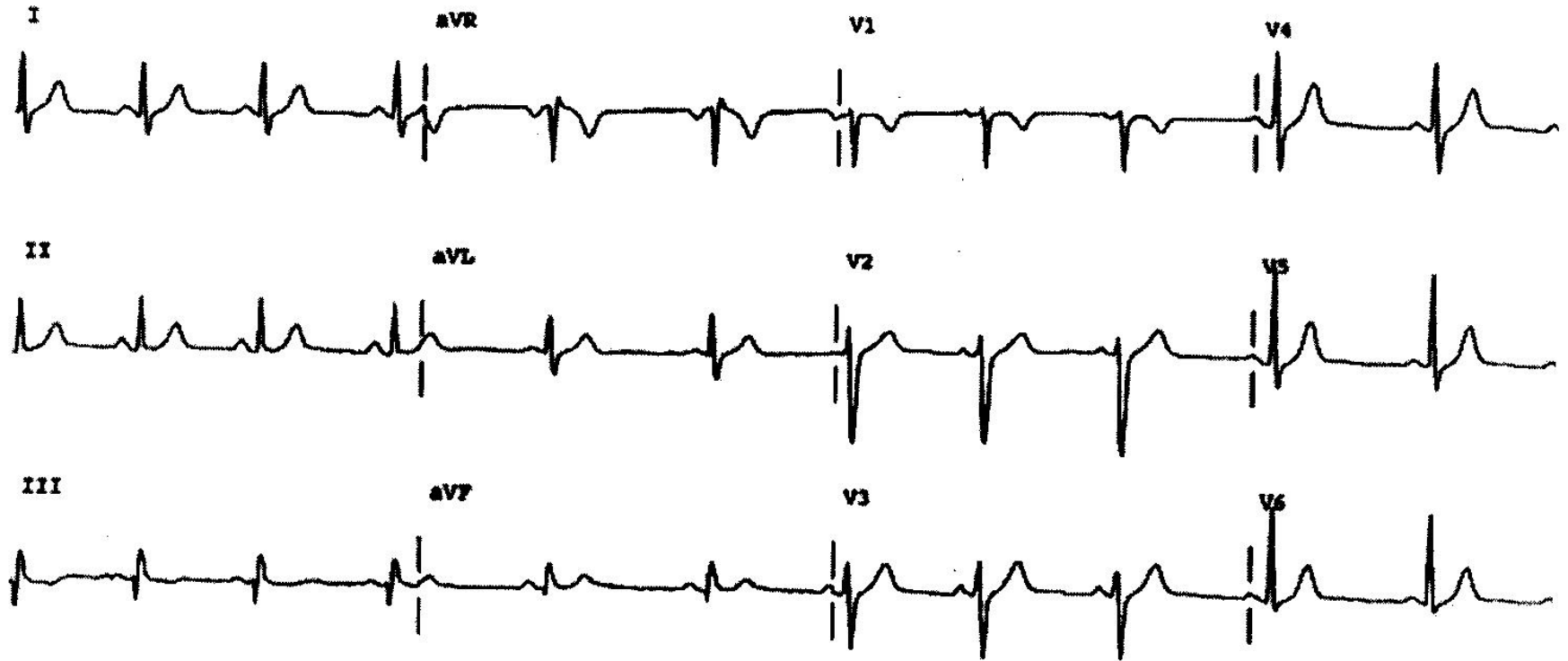
ELECTRICAL AXIS OF THE HEART

Summary of all momentary vectors, which form ventricular depolarisation loop. Expresses the direction of ventricular activation. Reflects asymmetry in ventricular wall thickness and the position of the heart in the chest.

LEFT DEVIATION, RIGHT DEVIATION

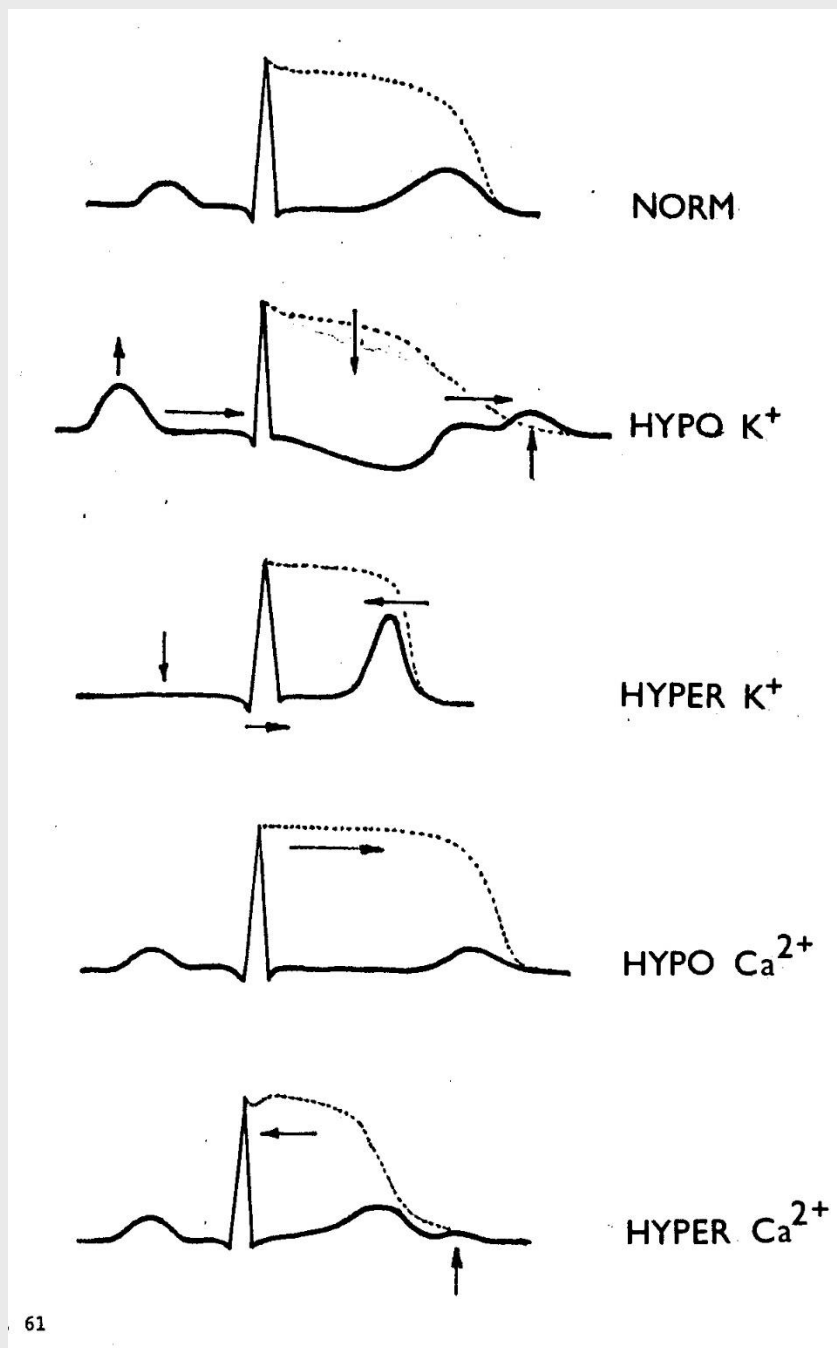
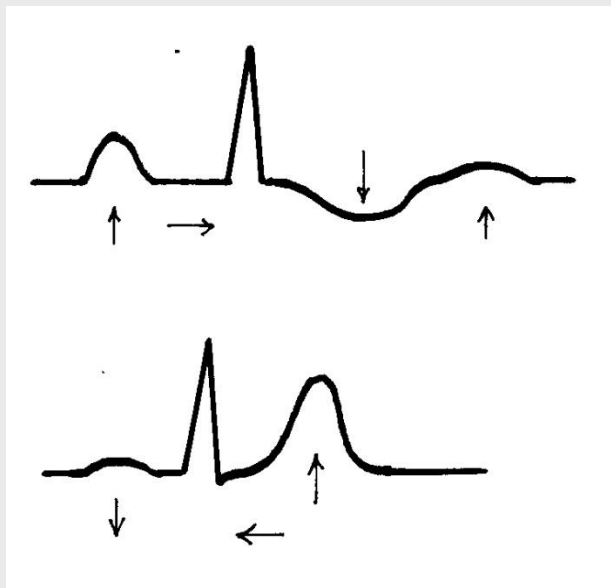


Normal 12-lead electrocardiogram

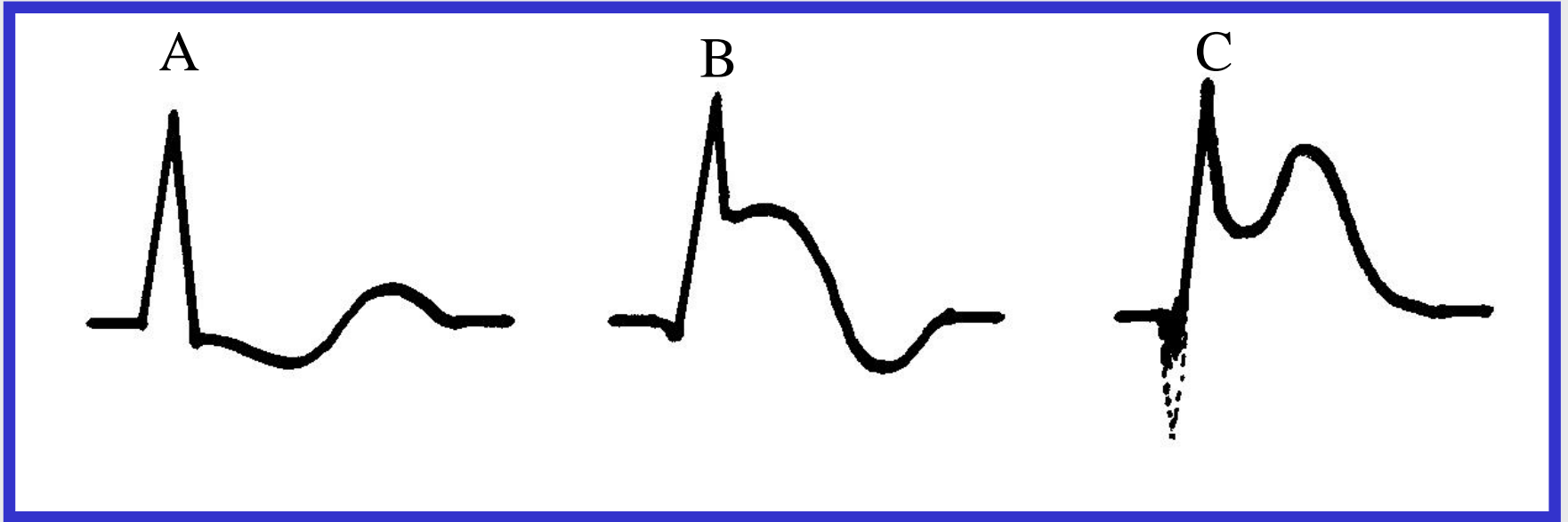


ECG – information about:

1. Magnitude and position of the heart (electrical axis)
2. Site of impulse origin (P, QRS)
3. Conduction path (P-Q, QRS)
4. Impulse regression (T)
5. Rhythm (P-P, R-R)
6. Action potential alterations (ST, T)
7. Effect of drugs, remedies, ion composition changes,...



HEART ISCHEMIA



A: exercise angina pectoris

B: acute non-Q myocardial infarction

C: acute Q myocardial infarction

ARRHYTHMIAS

DISTURBANCES OF IMPULSE GENERATION OR CONDUCTION

RHYTHM: Regular

HEART RATE (normal range: 70 – 220 bpm; effect of age)

1. Sinus tachycardia (60 - 100 bpm; exercise; aging)
2. Sinus bradycardia (below 60 bpm; athletes' heart)
(nodal rhythm below 40 bpm, ventricular rhythm below 20 bpm)

RHYTHM: Irregular

sinus respiratory arrhythmia (**physiological**)

extrasystoles (ES) single, coupled (bigeminy, trigeminy)

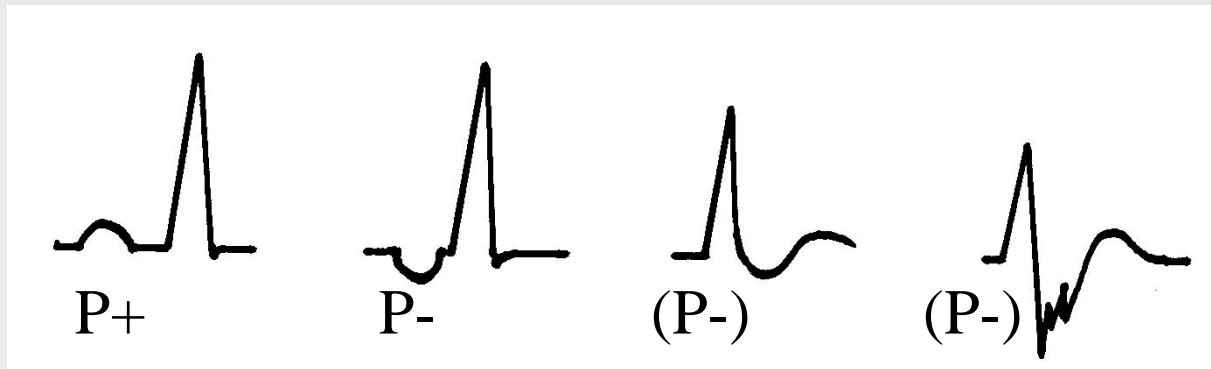
sinus, atrial, junction, ventricular

- Sick sinus syndrome
- Syncope

ARHYTHMIAS

SITE OF ORIGIN

SINUS ATRIA JUNCTION VENTRICLES



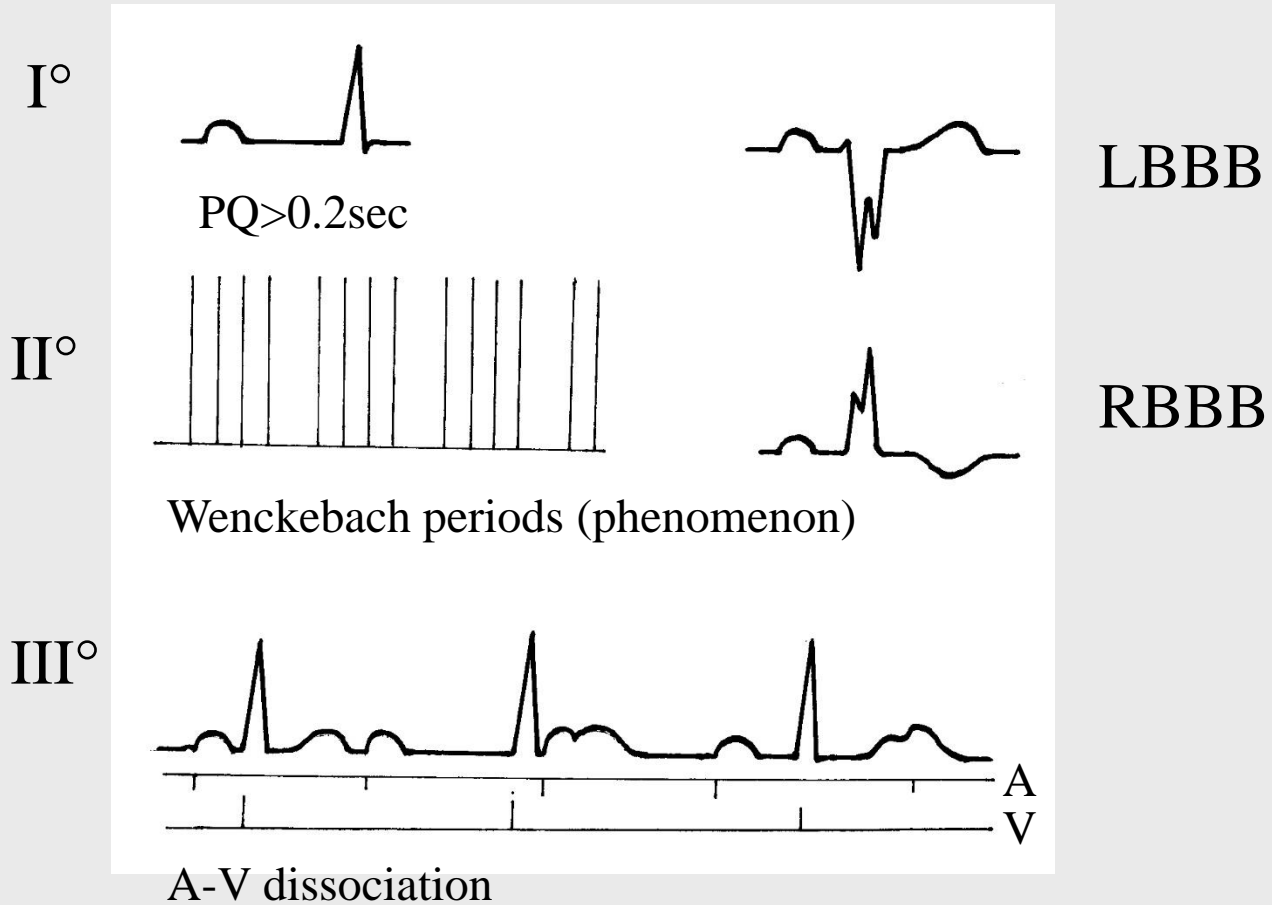
- Polarity of P wave

- PQ interval (QP)

(physiological PQ interval: 0.12 – 0.2 s)

BLOCKS

- SICK SINUS SYNDROM
- AV BLOCKS

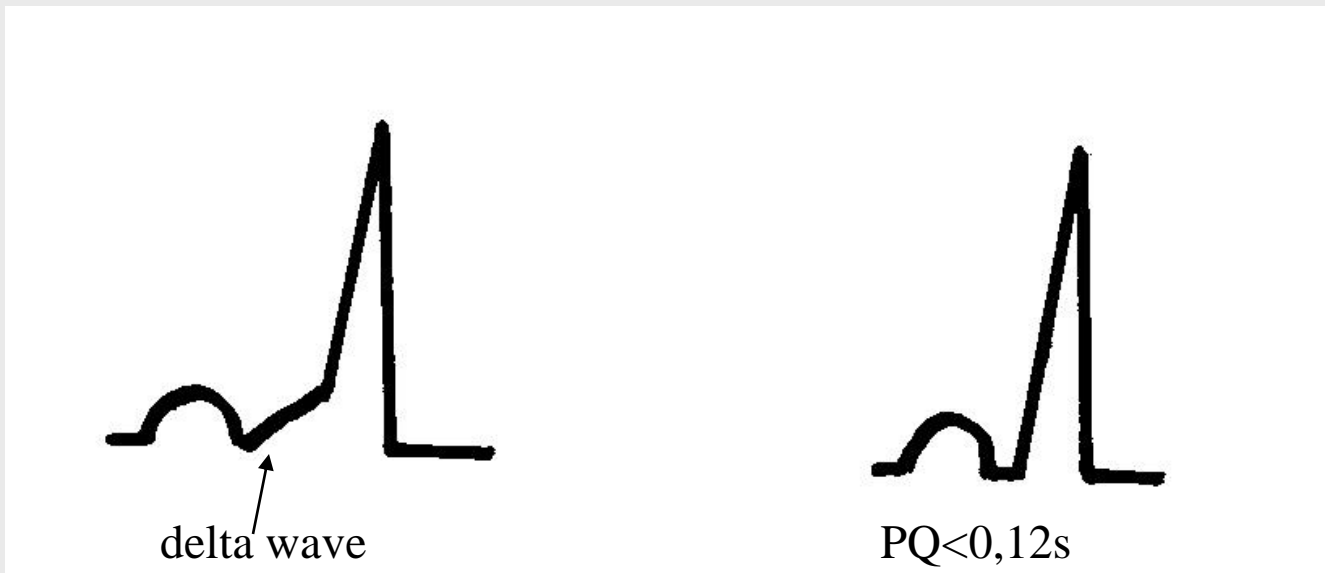


- BUNDLE BRANCH BLOCK (BBB) – LEFT, RIGHT

PREEXCITATION

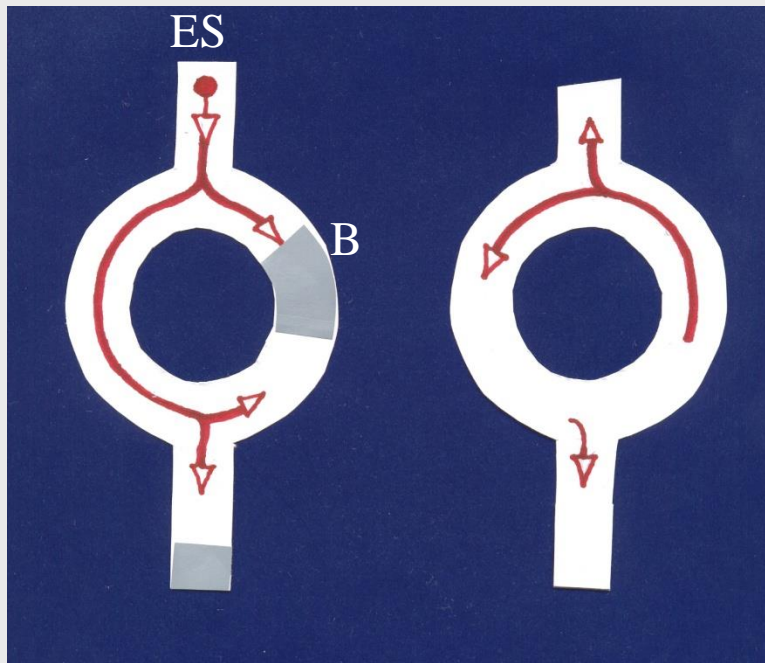
AV node is „by-passed“, fast conduction

- „short nodus“
- Wolf-Parkinson-White syndrome (WPW) – sensitive to paroxysmal tachycardia – see re-entry



REENTRY

Common mechanism of (paroxysmal) tachycardias, extrasystoles, bigeminy, etc.



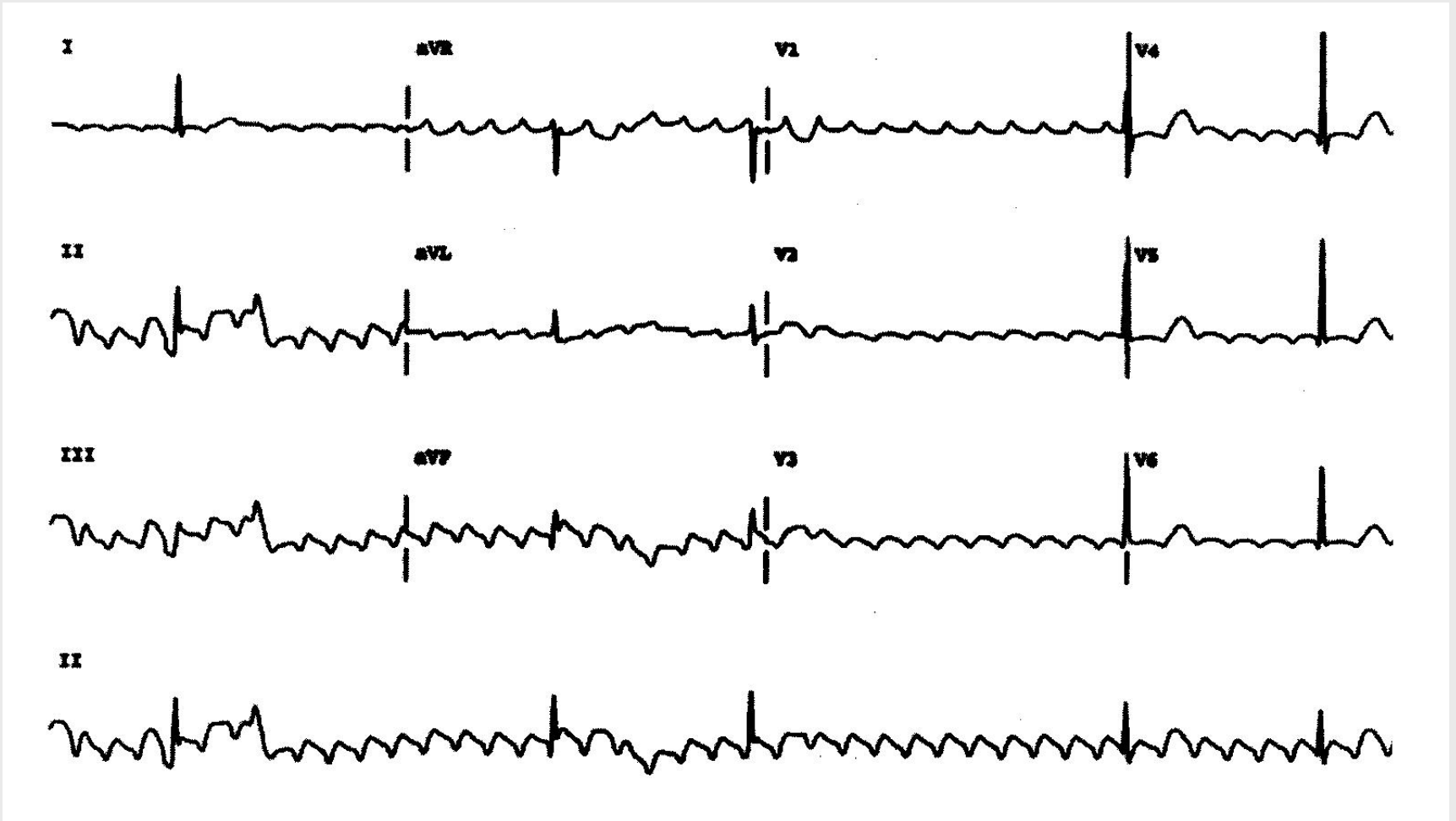
- **Loops most often at the level of AV junction**
- **Determinants of re-entry:**
 1. Proper dimension of the loop
 2. Proper timing of the trigger ES

- **Double pathway**
Diverging and converging of excitation pathways
- **Unidirectional block**
 1. Long refractory period
 2. Slowed conduction
 3. **Reentry**

TACHYARYTHMIA

- **SINUS TACHYCARDIA**
- **PAROXYSMAL TACHYCARDIA** (supraventricular, ventricular)
- **FLUTTER** (>250/min; atrial)
- **FIBRILLATION** (>600/bpm; **atrial, ventricular; breakdown of electrical homogeneity**)

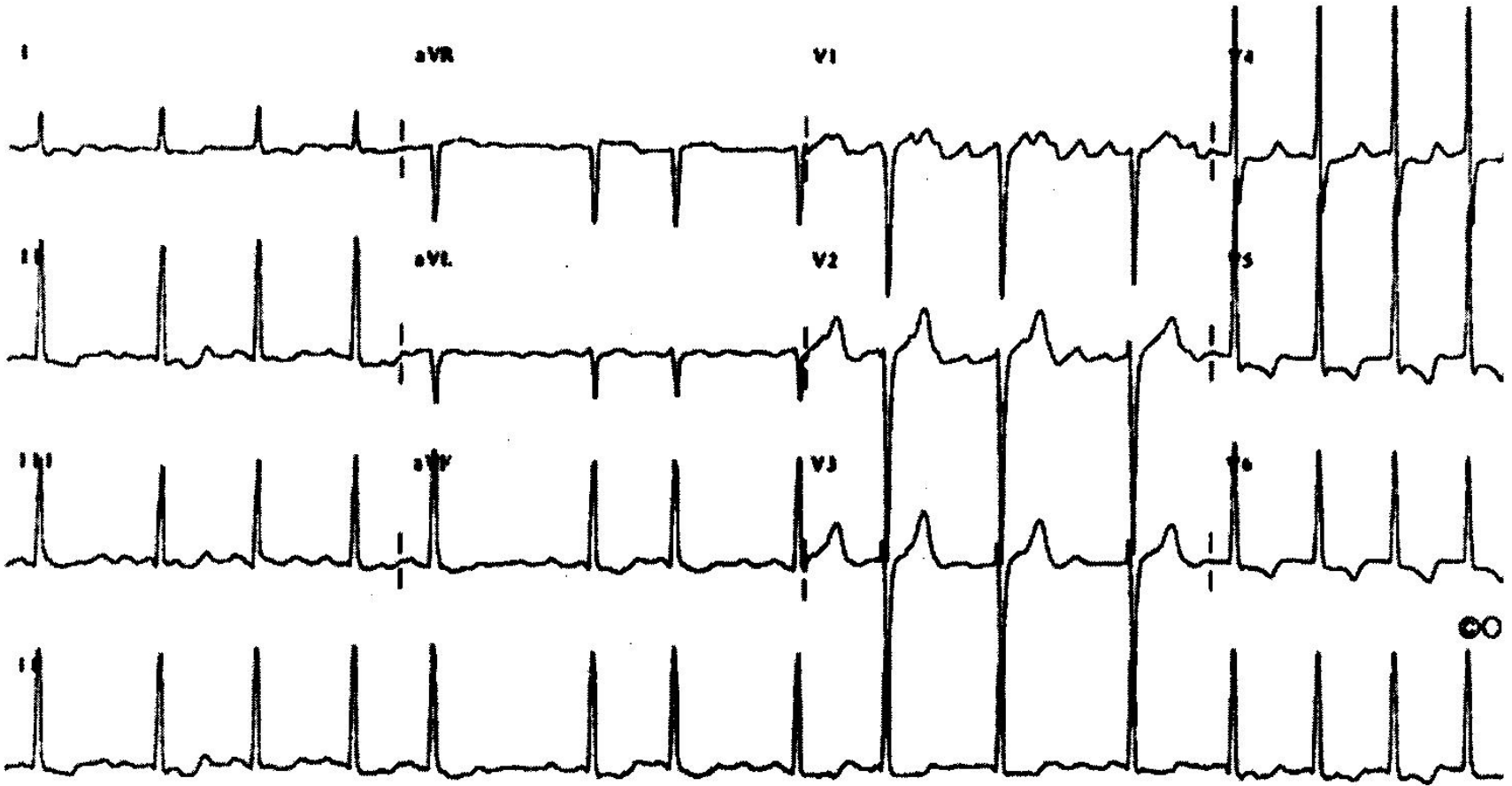
ATRIAL FLUTTER



Frequency 250 – 600/bpm

Atrioventricular block n:1

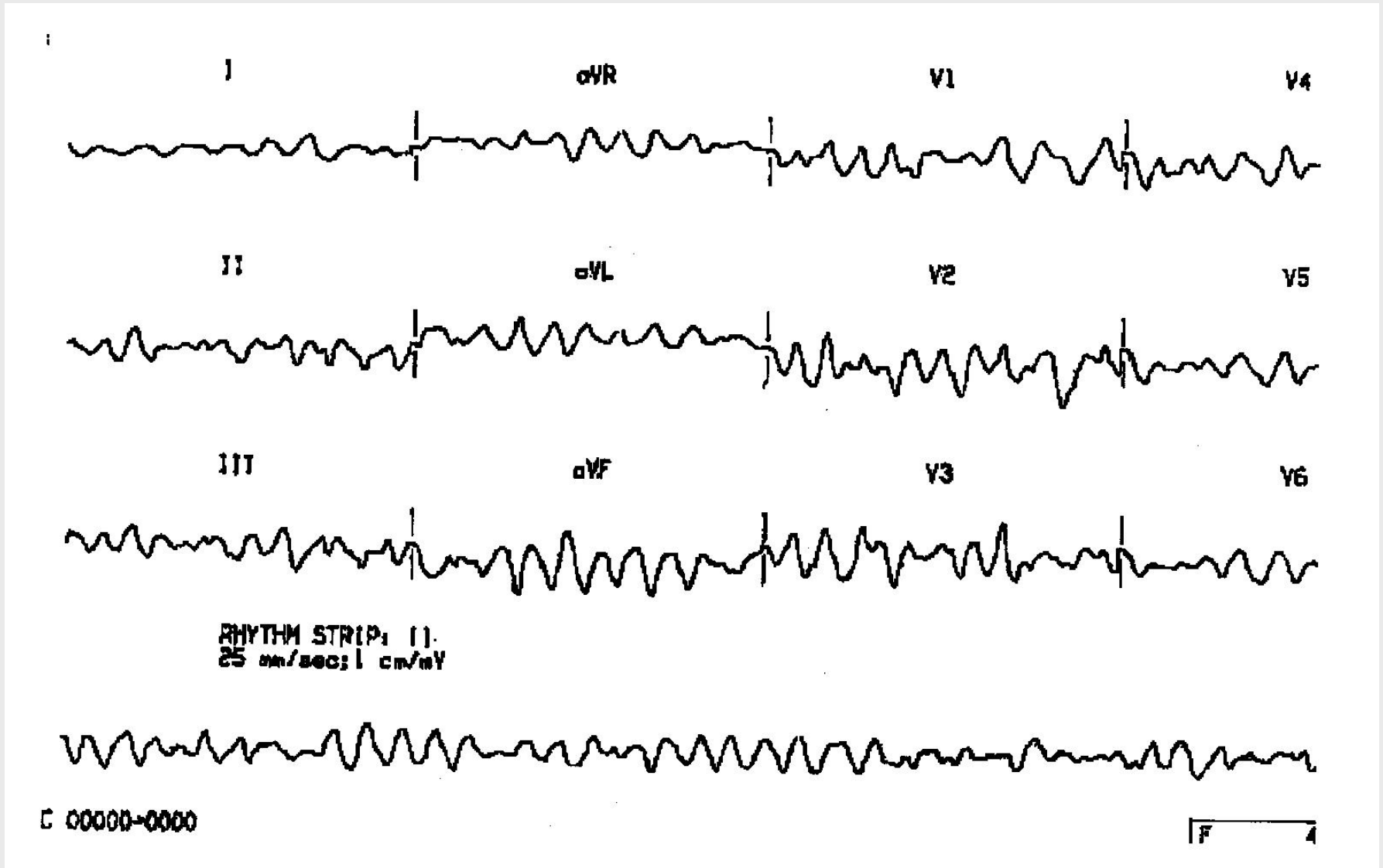
ATRIAL FIBRILLATION



Irregular ventricular rhythm

+ f-waves

VENTRICULAR FIBRILLATION



Frequency above 600/bpm, **LETHAL**

ANTIARRHYTHMICS

- **BLOCKERS OF Na CHANNEL** – prolong inactivation of I_{Na} , e.g. refracterity, „block“ fast ways
- **BLOCKERS OF Ca CHANNELS** – „block“ fast ways
- **BLOCKERS OF K CHANNEL** – prolong refractory period
- **β -SYMPATOLYTICS** – slowing of heart rate

Schémata a animace zpracovalo

Servisní středisko pro e-learning na MU

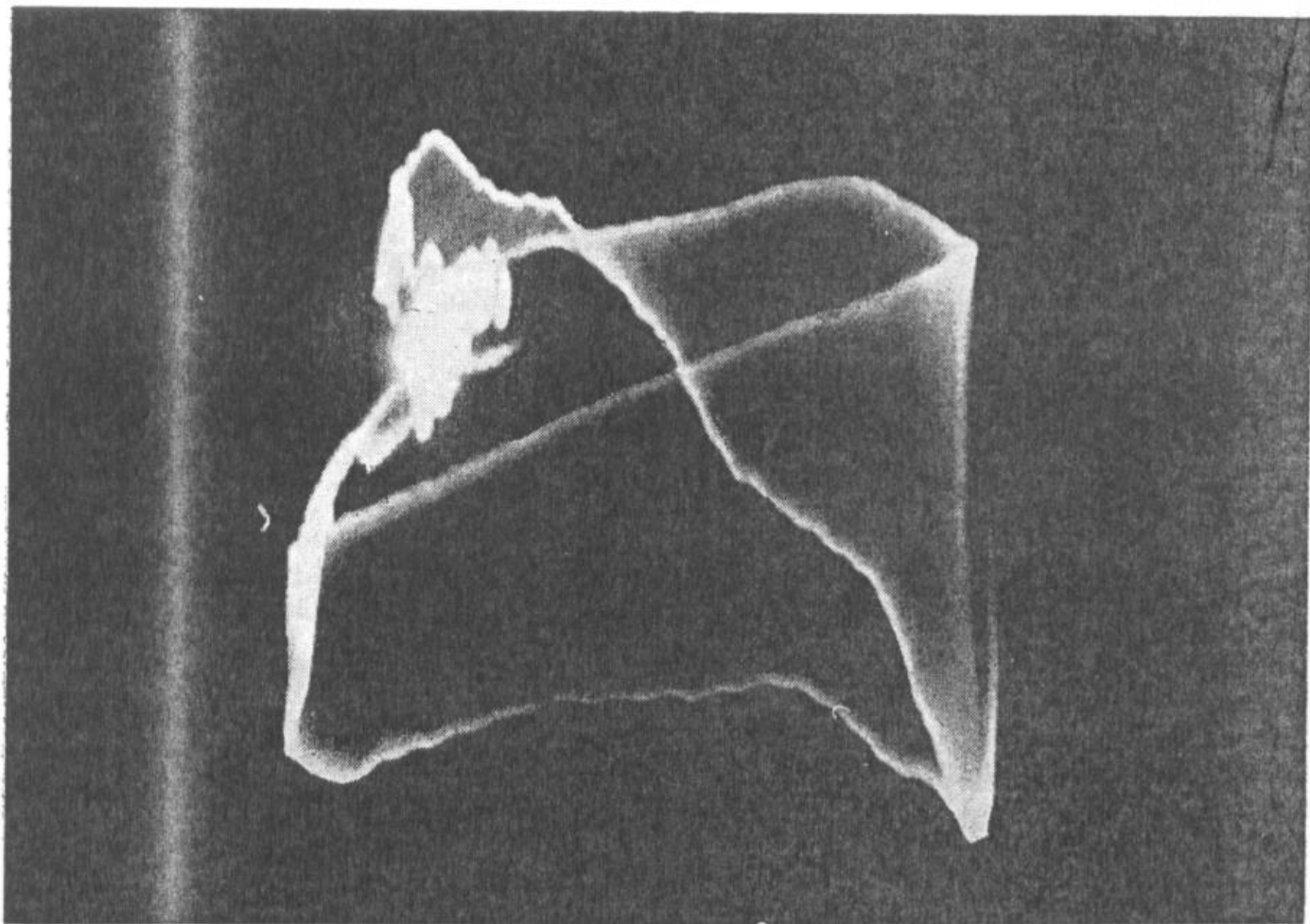
<http://is.muni.cz/stech/>

CZ.1.07/2.2.00/28.0041

Centrum interaktivních a multimediálních studijních opor pro inovaci výuky a efektivní učení



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ



V. Spaciokardiogram zdravého člověka.