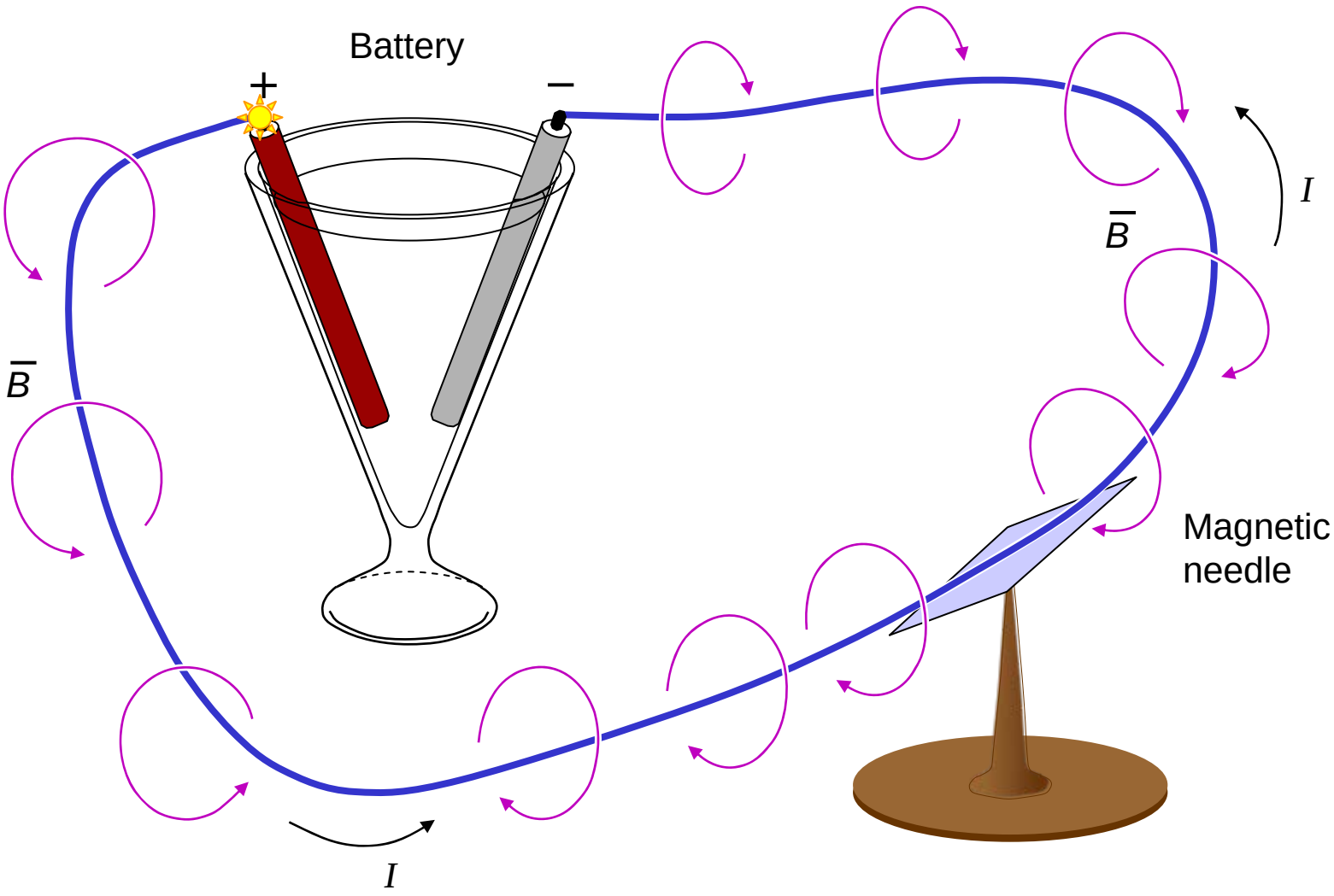
BIOELECTRO-MAGNETISM

Jaakko Malmivuo

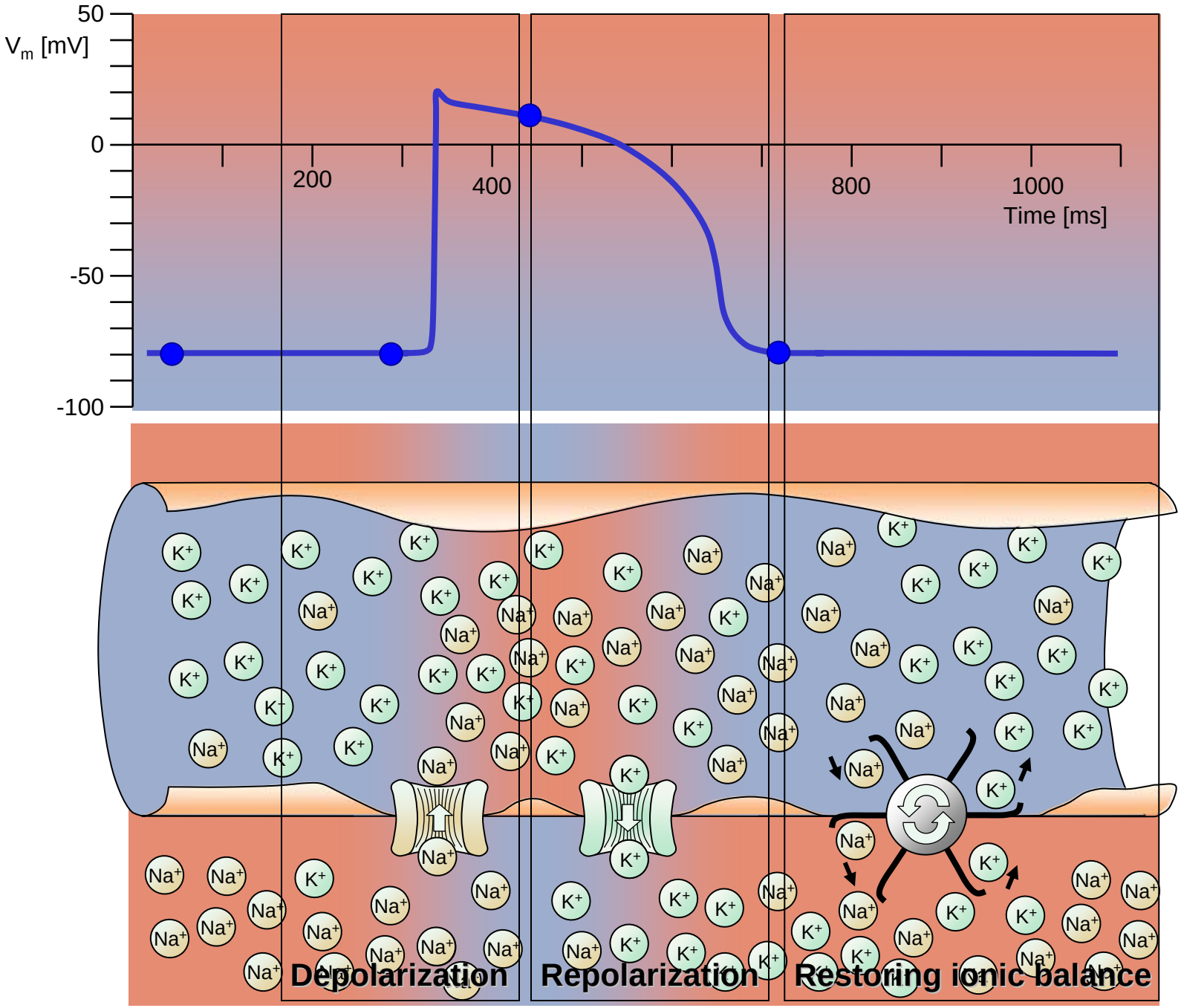
Demo Slides

$\eta\lambda\varepsilon\kappa\tau\rho o\nu$ = amber

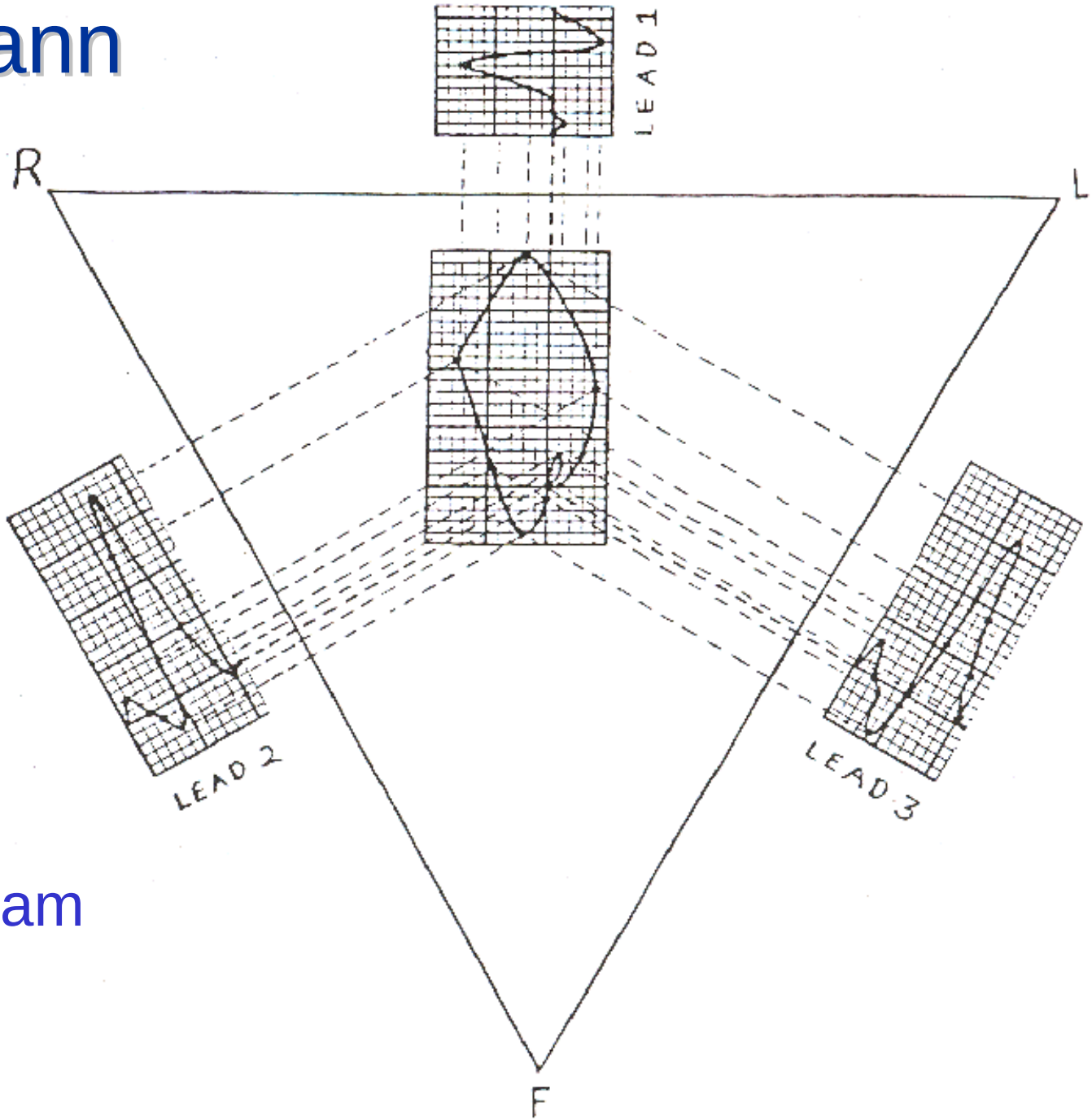
Hans Christian Örsted 1819



Generation of bioelectric signal

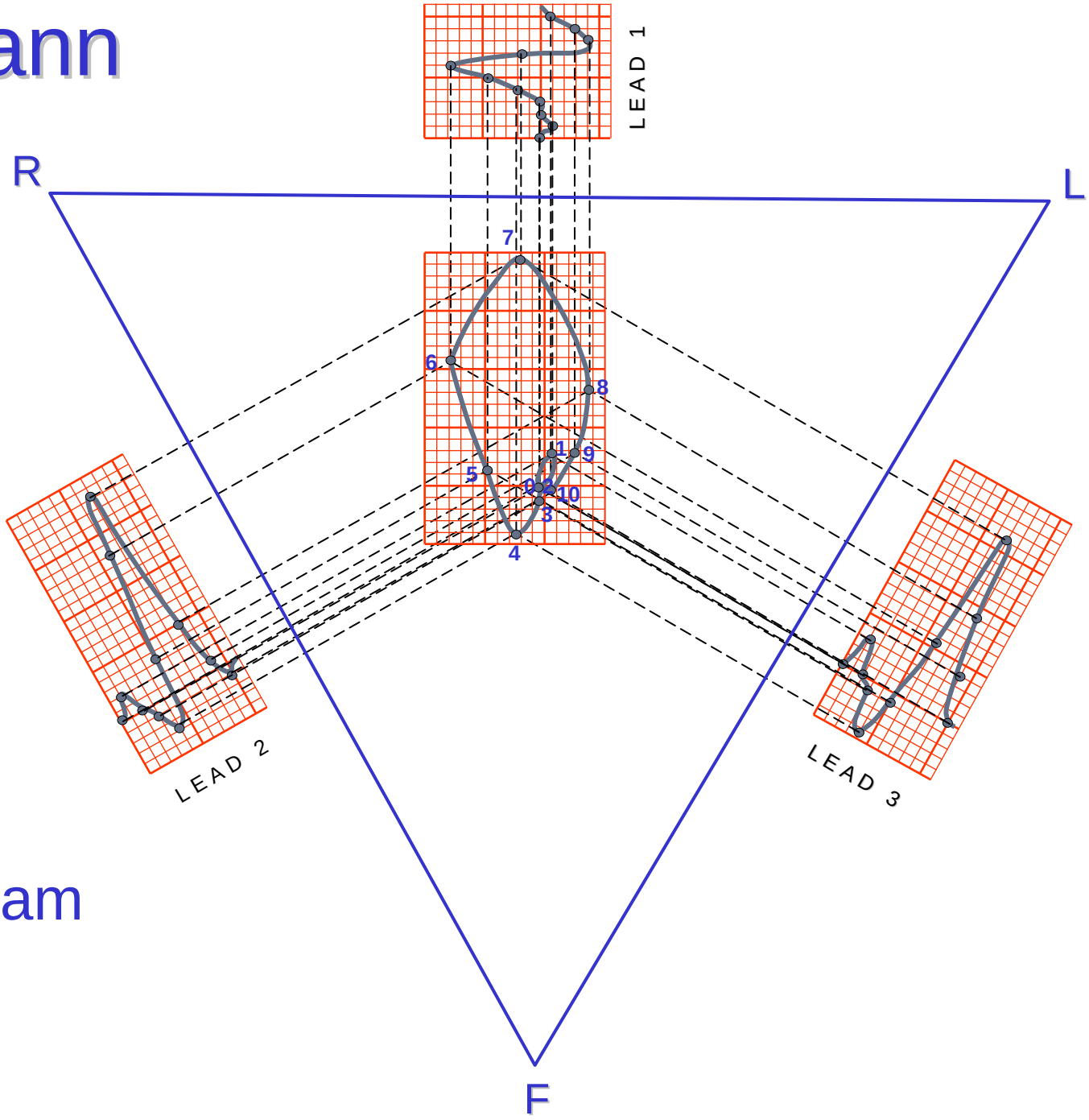


Hubert Mann



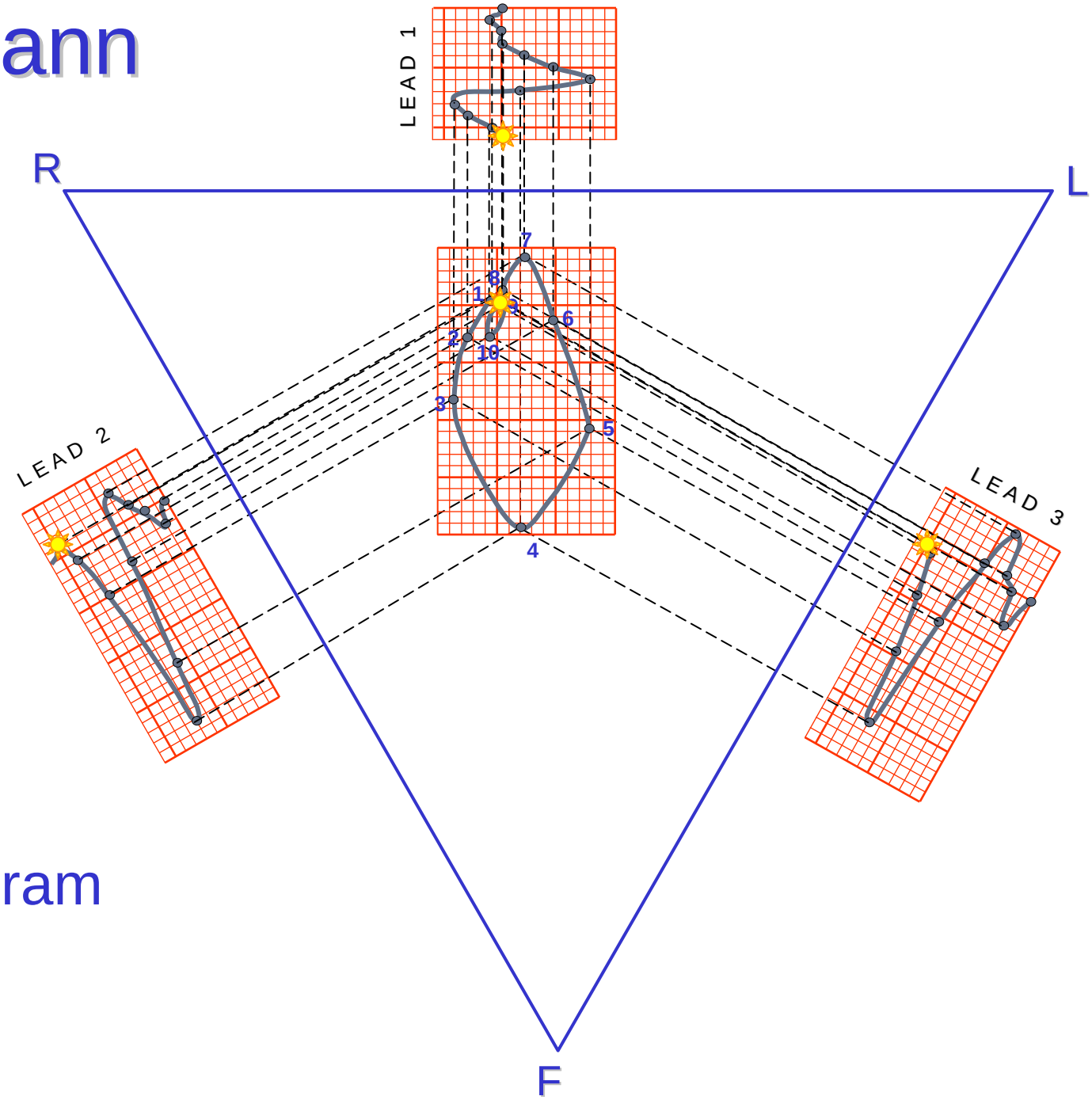
Monocardiogram
1916

Hubert Mann



Monocardiogram
1916

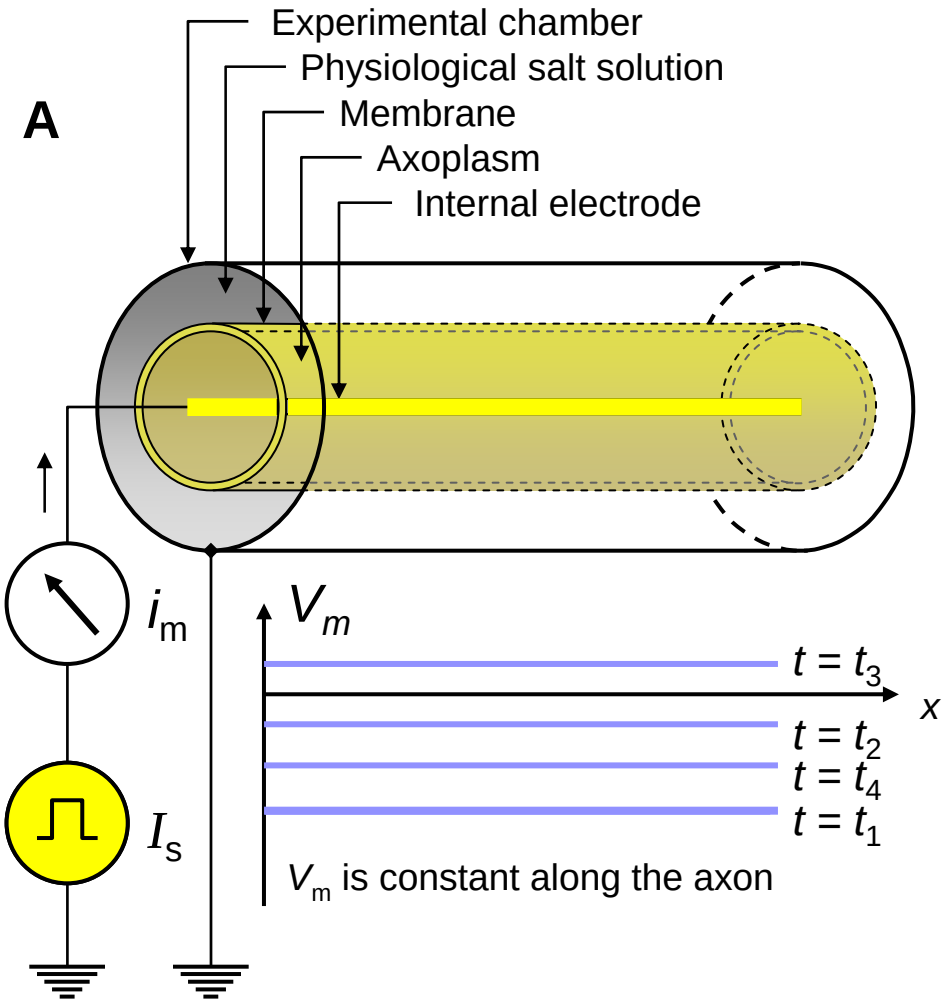
Hubert Mann

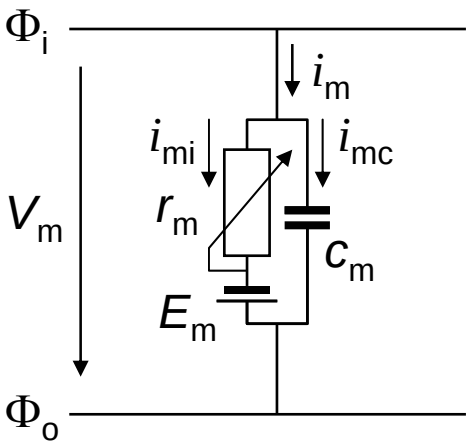


Monocardiogram
1916

Squid

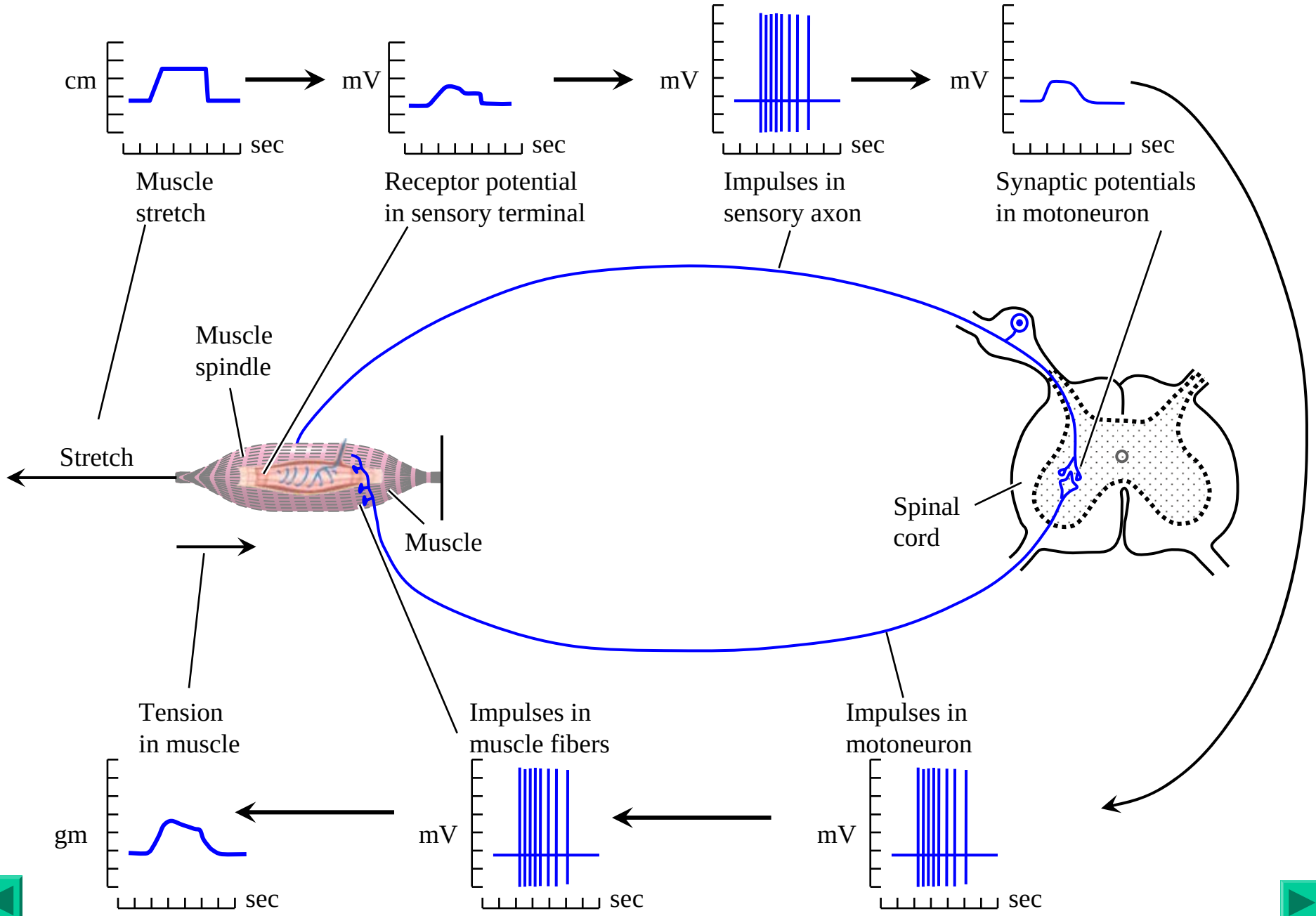
Space clamp

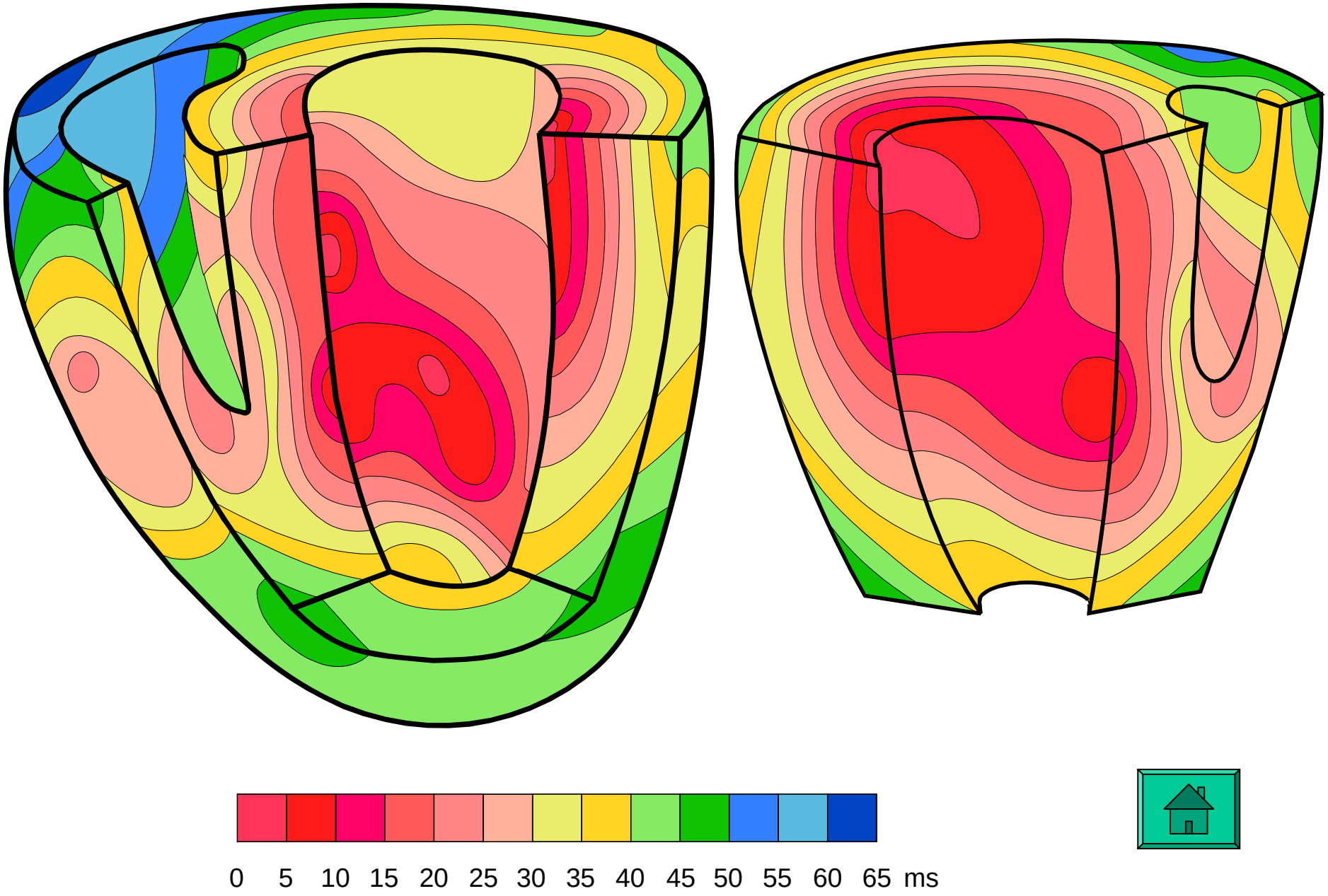




$$i_m = i_{mI} + c_m \frac{\partial V_m}{\partial t}$$

Reflex Arch

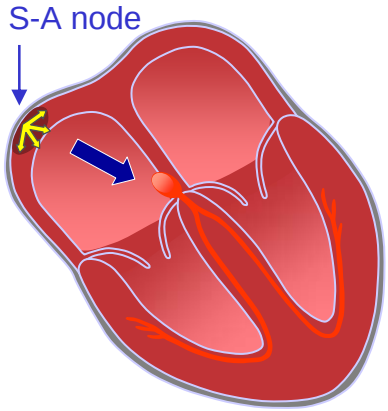

cm
sec
Muscle stretch
mV
sec
Receptor potential in sensory terminal
mV
sec
Impulses in sensory axon
mV
sec
Synaptic potentials in motoneuron
Muscle spindle
Stretch
Muscle
Spinal cord
Tension in muscle
Impulses in muscle fibers
Impulses in motoneuron
gm
sec
mV
sec
mV
sec

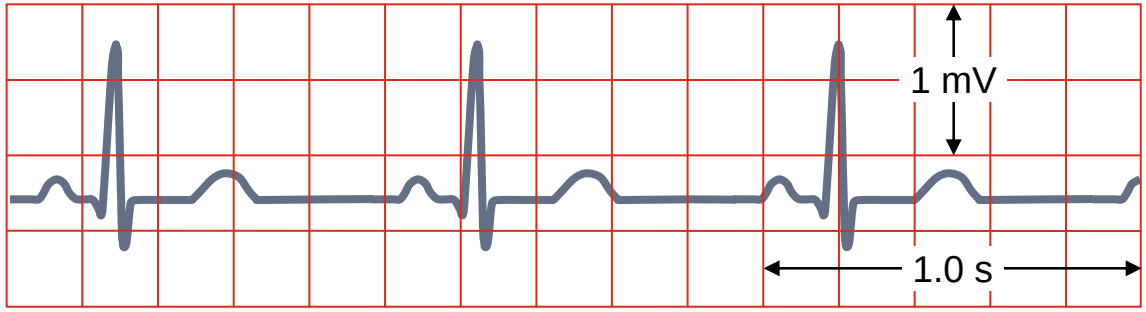

0 5 10 15 20 25 30 35 40 45 50 55 60 65 ms

2 Heart rate 1/2

NORMAL SINUS RHYTHM

Impulses originate at S-A node at normal rate

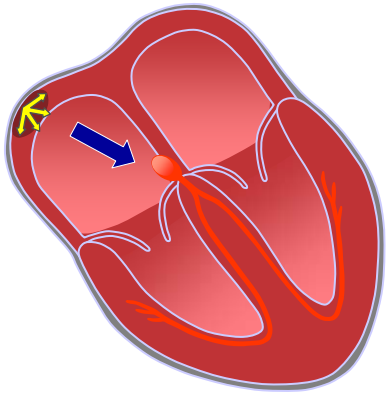


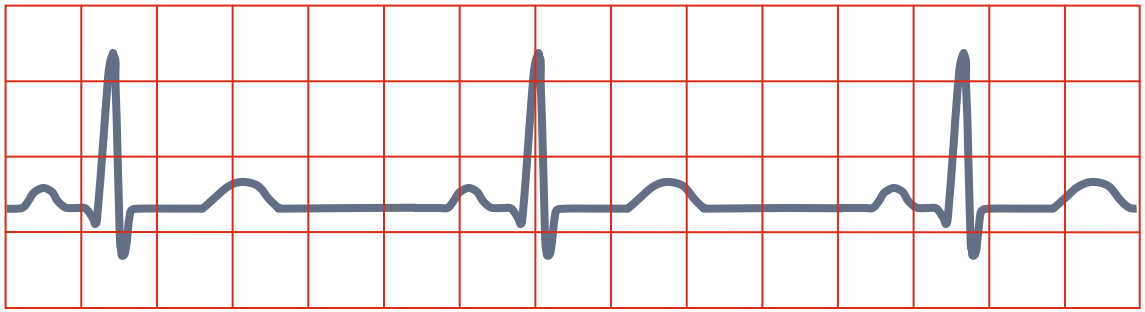


All complexes normal, evenly spaced. Rate 60 – 100/min.

SINUS BRADYCARDIA

Impulses originate at S-A node at slow rate



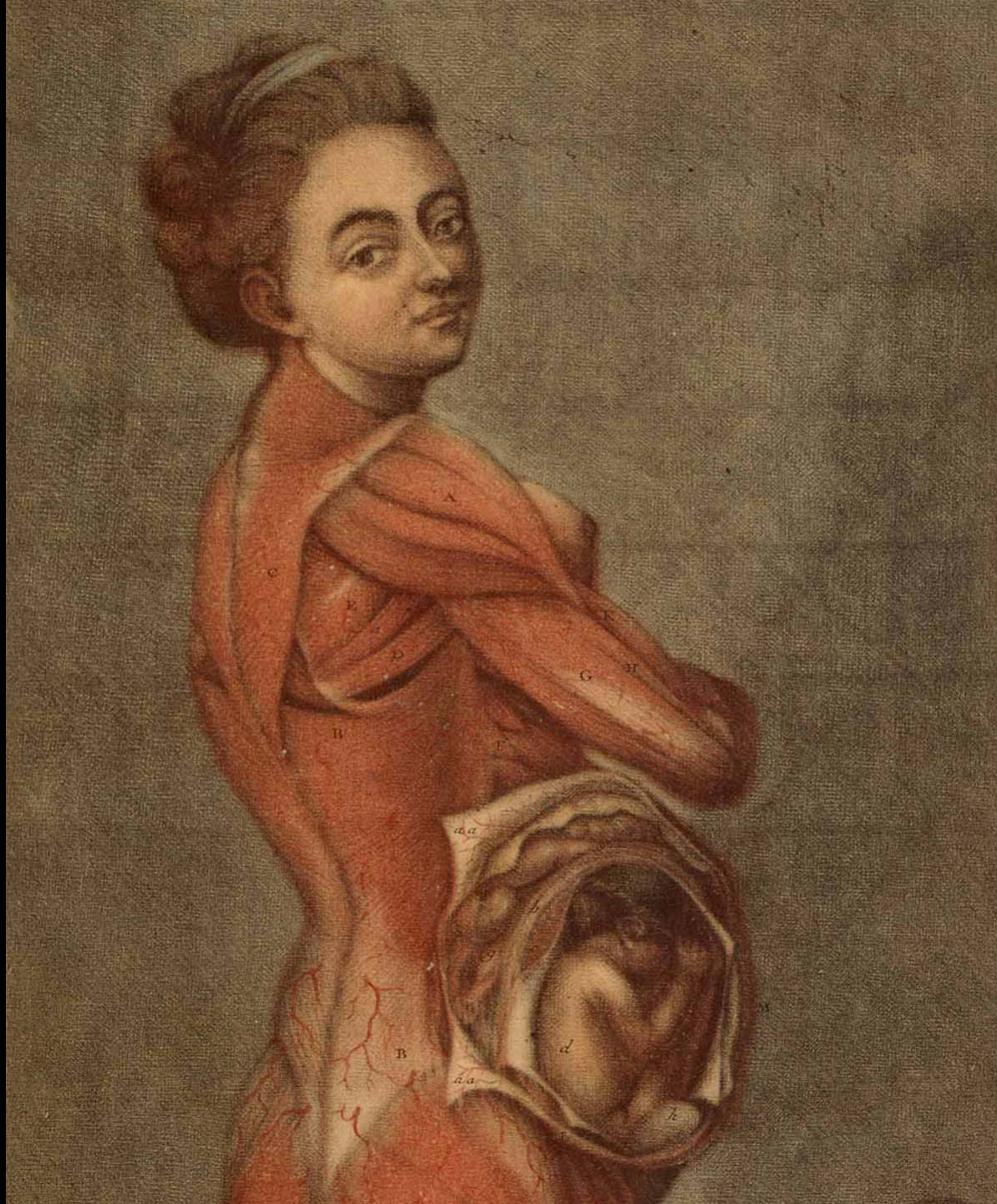


All complexes normal, evenly spaced. Rate < 60/min.

The Fetus

Jacques Fabien Gautier D'Agoty: "*Anatomie des parties de la génértion de l'homme et de la femme*". Paris, 1773. Colored mezzotint. National Library of Medicine

Gautier D'Agoty's colored mezzotints have a painterly quality. This pregnant woman calmly looks back at the viewer, a characteristic pose of 18th-century French portraiture.

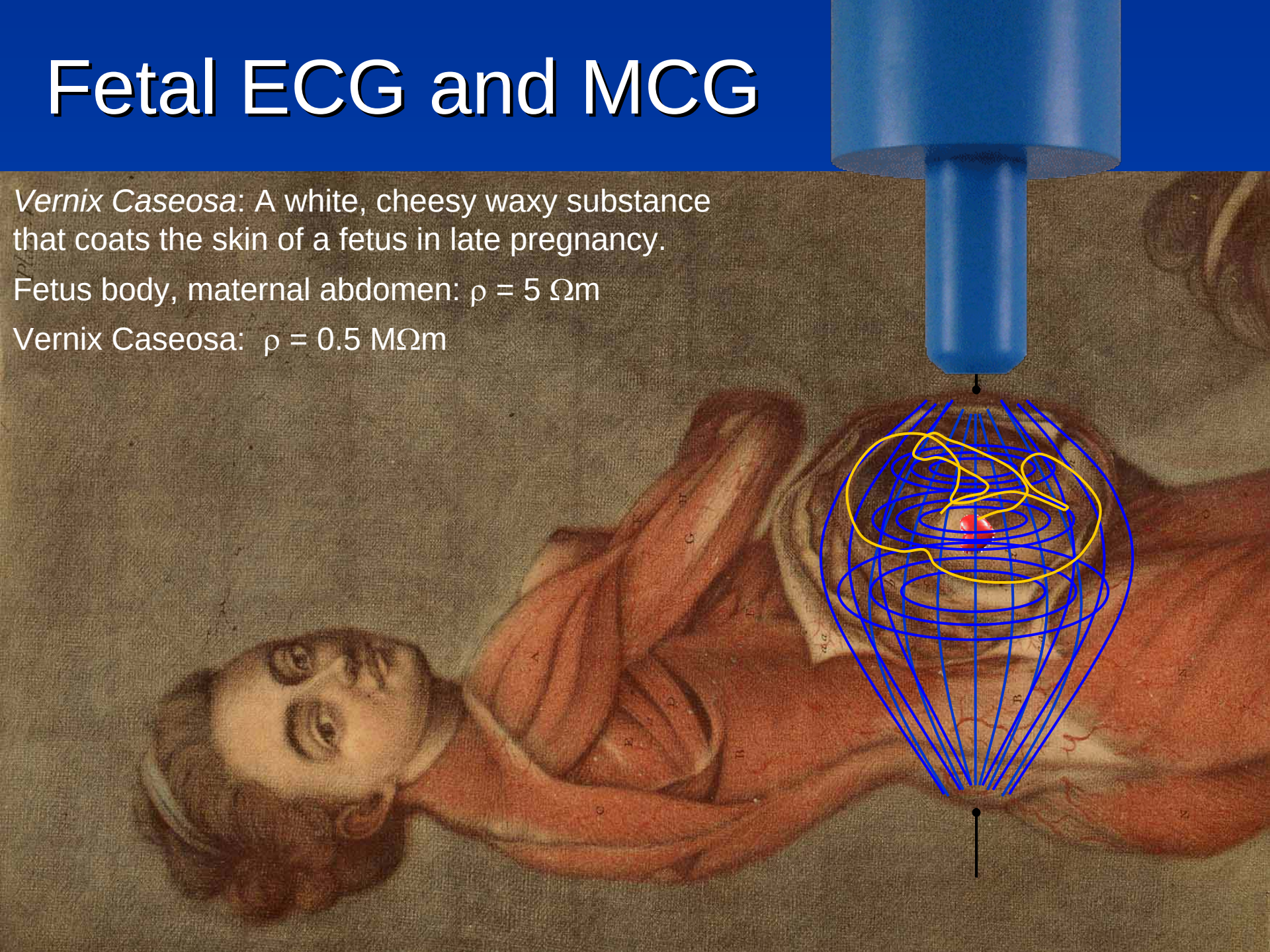


Fetal ECG and MCG

Vernix Caseosa: A white, cheesy waxy substance that coats the skin of a fetus in late pregnancy.

Fetus body, maternal abdomen: $\rho = 5\ \Omega m$

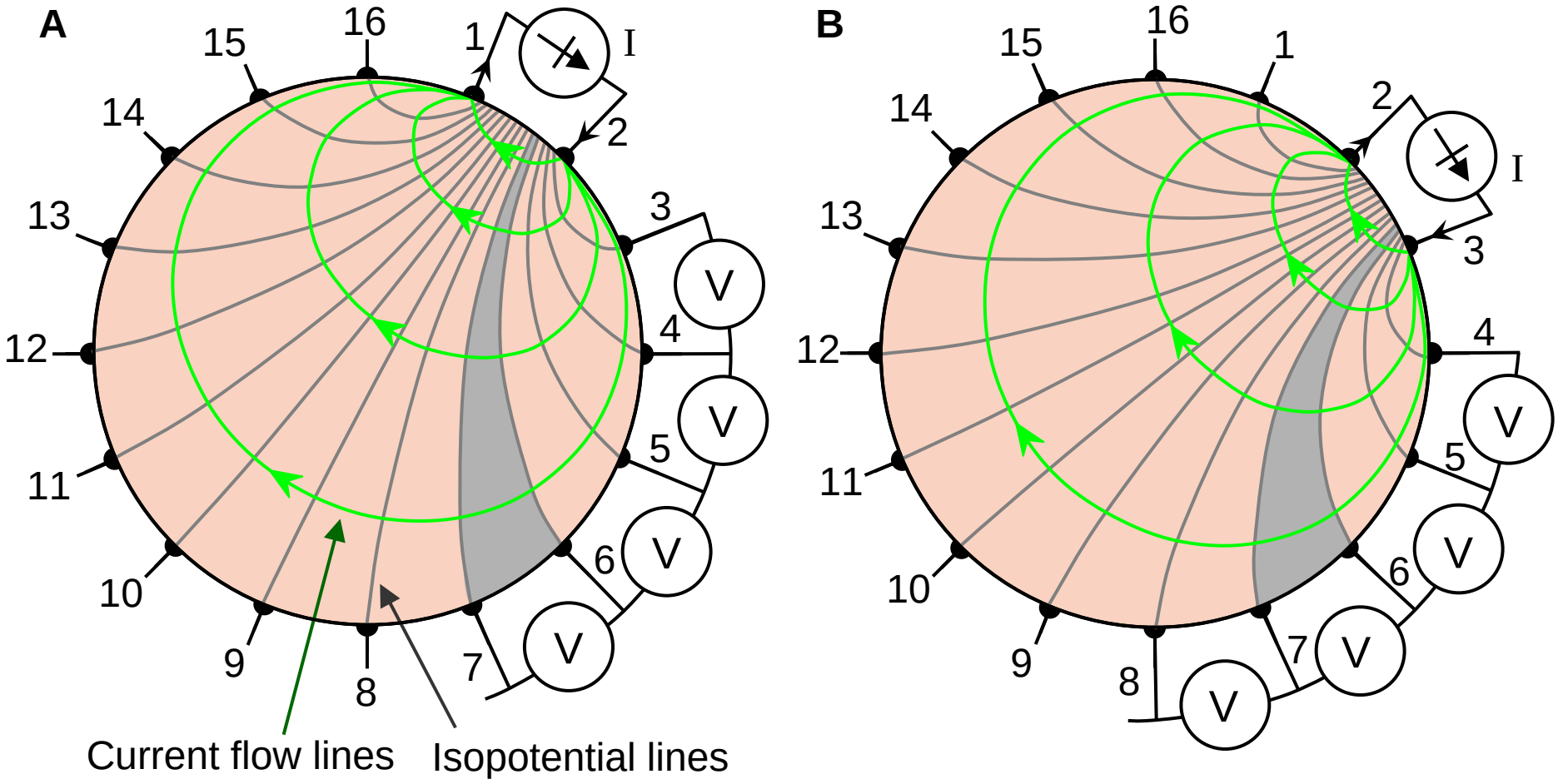
Vernix Caseosa: $\rho = 0.5\ M\Omega m$

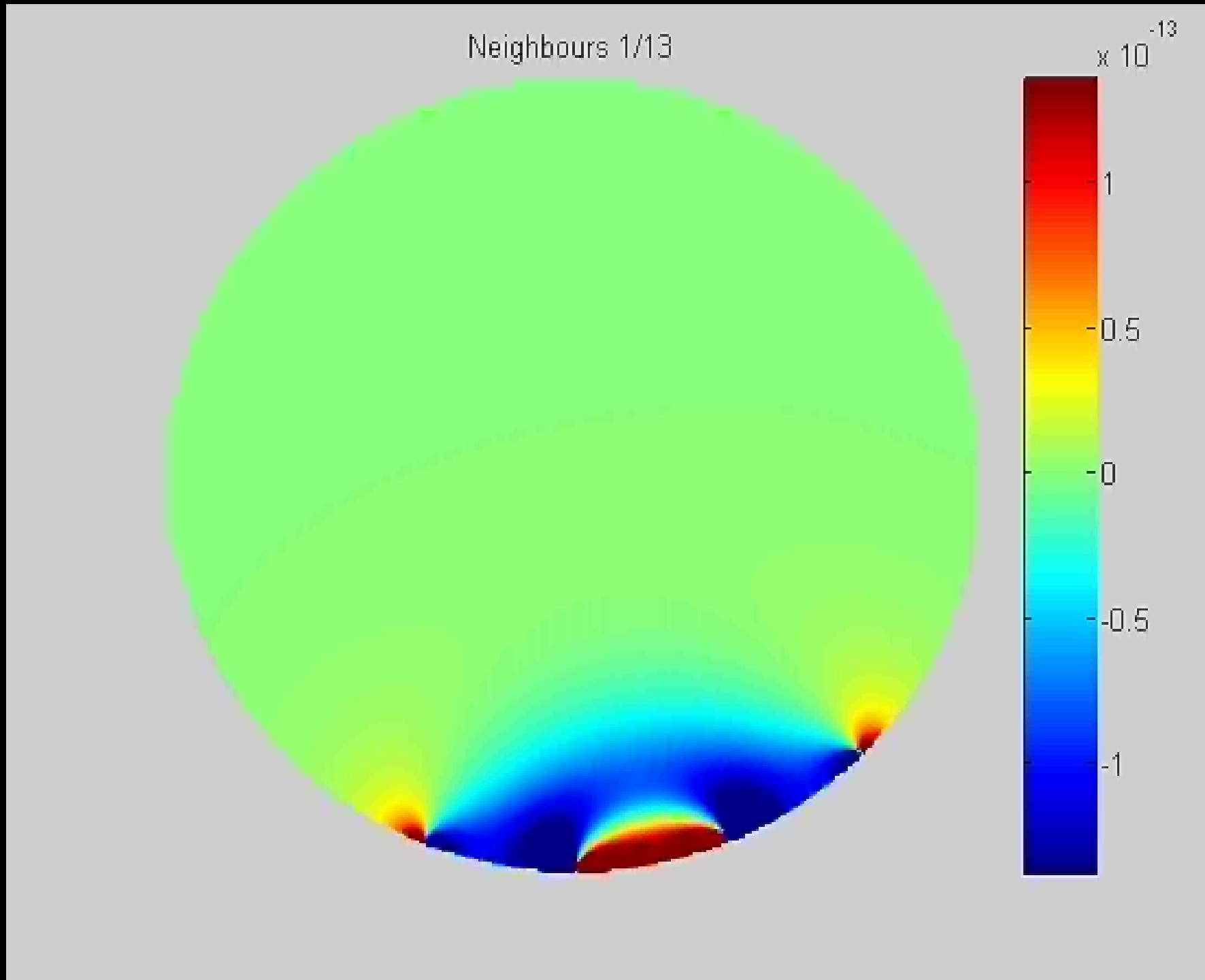


Neighboring Method

B.H. Brown and A.D. Segar, (Sheffield) 1987

Current is applied through neighboring electrodes.
Voltage is measured successively from all other adjacent electrode pairs.
16×13 = 208 voltage measurements, 104 independent.




Neighbours 1/13
x 10^-13
1
0.5
0
-0.5
-1