# Tissue magnetic signals

## Magnetic properties of tissues

According to the electromagnetic field theory*, when electric charges move, an induced magnetic field* is created. We can therefore assume that the magnetic field will also be created during the electrical activity of living systems, as a result of ion currents arising during depolarization and repolarization of nerve and muscle tissue cells. These magnetic fields are very weak, and therefore methods have been developed to register the magnetic signals of the heart, skeletal muscle and brain, in order to gain new knowledge about the relevant organs.

## Detection of weak magnetic fields

The reason why we learned about the magnetic activities of the organs 60 years later than the electrical ones is the fact that the measurement of the magnetic activity requires a detector with a sensitivity of $10^{-14}$ T (the induction of the Earth's magnetic field is of the order of 10 $^{-5}$ T and the magnitude of its changes is $10^{-7}$ T; the induced magnetic field of heart and skeletal muscle is $10^{-11}$ T, as for the brain this value is lower by 1-2 rows). This condition is met by a superconducting quantum magnetometer (*SQUID – superconducting quantum interference device*). It operates at a temperature of 4.2 K (−268.95 °C), so it requires a special liquid helium *Dewar* to maintain the specified temperature. The sensed magnetic flux is fed to the sensor via a superconducting magnetic flux transformer. Depending on the design, the transformer can be sensitive either to the magnetic field strength or to its derivative. However, the high sensitivity of the superconducting magnetometer is also its disadvantage, as it also captures disturbing magnetic fields. Its construction requires the use of special metal materials with very high permeability. The SQUID detects both DC and AC components of the magnetic field.

## Peculiarities of tissue magnetic signals

Bioelectrical and biomagnetic activity have a common origin in ionic currents arising during irritation. However, the nature of the information obtained and the method of scanning are different. While the bioelectric activity is determined by the **magnitude of voltage changes**, the *magnitude of the current* flowing inside the tissues is decisive for the formation of a magnetic signal. These currents can also signal disorders in the given tissue. Another difference in sensing electrical and magnetic activity is its method of detection. Magnetic signals are sensed non-contact, which excludes artifacts caused by transient resistances between the electrode and the tissue during contact sensing of bioelectrical voltages.

## Links

### Literature


- HRAZDIRA, Ivo a Vojtěch MORNSTEIN. *Lékařská biofyzika a přístrojová technika.* 1. vydání. Brno : Neptun, 2001. 396 s. ISBN 80-902896-1-4.