**Experiment No. 29**  
**Neutron activation analysis**

1. **Introduction**

   Neutron activation analysis is a nuclear measuring method for non-destructive material testing. With its help, the qualitative and quantitative detection of even small quantities of certain elements is successful in the examined samples. For this purpose, the samples are bombarded by neutrons from $^{252}\text{Cf}$ and $^{241}\text{Am}$-$^{9}\text{Be}$ sources, causing nuclear reactions and as a result radioactive isotopes. From their activity, the nature and amount of the output elements can be concluded.

2. **Literature**

3. **Preparation**

   Principle of the neutron activation analysis; explanation of terms activity and activation; scheme and advantages of the (n, $\gamma$)-reaction for activation; reaction sequence in the activation of vanadium and copper; $\gamma$ spectroscopy with semiconductor detectors (interaction of $\gamma$-radiation with matter, absorption law, detection electronics); sketch and brief description of the activation space used in the experiment and of the measuring system.

4. **Experimental procedure and analysis**

   To allow for easy analysis of the measurement results, the test conditions for the standard sample and the sample with "unknown" metal content must be chosen as equally as possible. This applies particularly to: activation time period between activation and the beginning of the $\gamma$-spectroscopy, measurement time of the $\gamma$-spectrum, mounting in the holder, position of the holder at activating and measuring station, geometry of the samples.

4.1. Take an energy calibration spectrum using a gamma calibration source ($^{22}\text{Na}$, emission lines at 511 keV and 1275 keV). In all spectrum measurements, Multi Channel Analyzer operates in Pulse Height Analysis (PHA)-mode, and acquisition time is set to 10 min. Analysis: calibration curve; resolution as a function of energy

4.2. Take background spectra with the Ge-detector inside and outside the lead shielding.

   **Caution:** The detector is very sensitive to shock!

   Analysis: try to identify the most intense peaks and discuss the effectiveness of lead shielding while considering the shielded solid angle and the energy dependence of absorption in lead.
4.3. Activation and measuring of the spectrum of a copper standard sample. Analysis: identification and measurement of occurring peaks; estimating the smallest, still detectable, Cu amount in a sample of similar size under the present conditions; discussion of statistical and systematic errors in measurement.

4.4. Activation and measuring of the spectrum of 1 Euro coins. Analysis: determination of the copper content

4.5. Activation and measuring of the spectrum of a vanadium standard sample. Analysis: similar to 4.3

4.6. Activation and measuring the spectra of 2 types of steel containing vanadium. Analysis: determination of the vanadium content

4.7. Determination of the $^{52}\text{V}$ half-life by measuring the decay curve of the vanadium sample (powdery sample). For this purpose, the Multi Channel Analyzer operates in Multi-channel Scaling (MCS) mode. Here, the number of detected events within a fixed time interval (10 seconds) is written in the incremented channels of the MCA.