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# CYBRES EIS spectrometer

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The MU EIS is a compact device for differential Electrochemical Impedance Spectroscopy (EIS). The distinctive feature of this system is its capability for thermal stabilizing the electronic system and samples. This enables accurate differential measurements, where properties of two fluidic or organic samples are compared with each other. Such task appears in applications, where e.g. weak electrochemical changes should be detected. The MU EIS can be also used as a differential conductivity meter with thermal stabilization of samples for long-term measurements or a signal scope for distortion analysis. The system is developed for a single measurement or for a long-term monitoring with online graphical output in web.

The integrated thermostatic system utilizes two channel digital PID controller with multiple temperature sensors. The MU EIS is thermostabilized on PCB level. The system features internal 3D accelerometer/magnetometer, energy independent real-time clock, EM power meter (optional), humidity/pressure sensors (optional) and voltage sensors for monitoring environmental conditions during long-term experiments. USB interface is used for data transfer and for powering the device. Digital I/O lines are galvanically isolated. All data are recorded in real time and can be stored in the on-board flash memory with time stamps.


Fig. 1. CYBRES EIS differential impedance spectrometer.

**Applications.** General applications are precise industrial fluidic/organic tissue measurements and differential EIS meters in research/laboratory usage, detectors of weak electromagnetic and non-electromagnetic emissions by analysing electrochemical changes. Since the samples are protected from temperature variations and electric fields, the device is suitable for the analysis of electrochemical properties of fluids impacted by non-chemical, non-temperature, non-acoustic, non-mechanical and non-electromagnetic factors. Such an impact can be investigated also during the experiment. These measurements are characteristic for analysis of weak and ultraweak interactions, in particular in research of certain quantum effects appearing in macroscopic systems. The device allows statistically significant measurements of these effects with the standard EIS method.

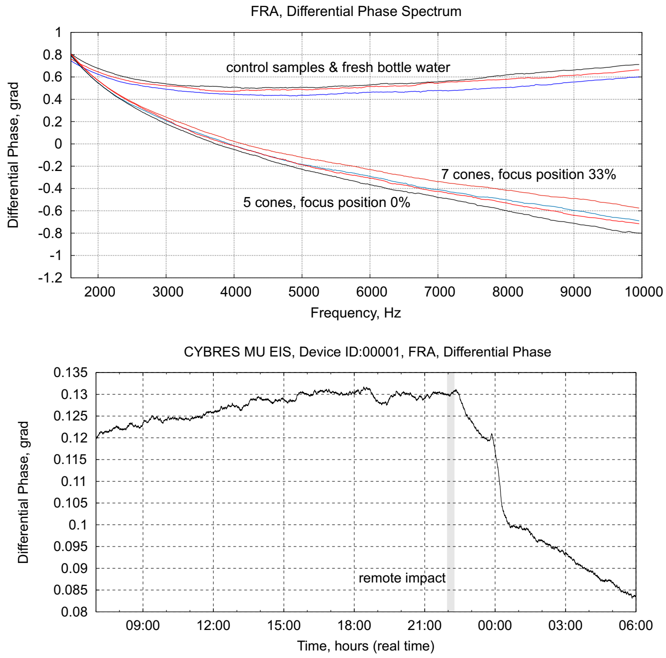


Fig. 2. FRA, differential phase **(top)** of water samples placed in front of the passive generator 'Contur'; **(bottom)** remote impact (grey bar) at the distance of 590km.

**Used methods of analysis**. This method consists in applying a small AC voltage into a test system and registering a flowing current. Based on the voltage and current ratios, the electrical impedance $Z(f)$ for a harmonic signal of frequency $f$ is calculated. The frequency response analysis (FRA) is applied, which is based on the single point Fourier transform and synthesis of ideal frequencies. Additionally, the differential EIS meter uses phase-amplitude detection of excitation and response signals, the frequency response is analyzed also by the correlation analysis for harmonic and non-harmonic signals. This system is implemented in hardware in the system-on-chip. Analysis allows identifying four main values (among others): the differential signal amplitude (this value is included in all amplitude characteristics obtained by FRA); the interference phase shift; imaginary and real parts of the impedance as well as the ration between them (as shown e.g. by the Nyquist plot) and a variation of electrochemical stability of samples.