# SIP-LAB-FAST

**Spectral Induced Polarization**

**Geophysics**

- **For comfortable frequency domain measurements on complex resistivity of sediment and rock samples.**



Front view: SIP-LAB-FAST instrument with 88 channels.

The **SIP-LAB-FAST** system measures the frequency dependence of the electrical impedance (amplitude and phase) of rocks and sediments over 8 decades. The frequency dependence of mineralized rocks is controlled by the grain size of the electronic conducting minerals, while it is controlled for non-mineralized rocks by the pore space geometry and fluids. Therefore the frequency dependence delivers additional information for an improved characterization and discrimination of the materials. The instrument is optimized for real multi-channel measurements in the laboratory. 8 voltages can be measured synchronously per measuring unit. The software selects the two active current electrodes via multiplexer units. 8 current electrodes can be selected per multiplexer unit. An optional noise monitor helps to detect possible interference voltages from the laboratory environment and to remove them from the voltage signals. A scheduler combined with an automatic data quality check makes the measurements very convenient.

**SIP-LAB-FAST equipment consists of:**

- a signal source to generate sinusoidal shaped currents.
- 2 - 6 multiplexer units to control 8 current electrodes each.
- 1 -12 voltage measuring unit with 8 channels each.
- an optional noise sensor to record and reduce lab noise in the voltage records.
- a comfortable PC operating software to measure, display and export resistivity data.

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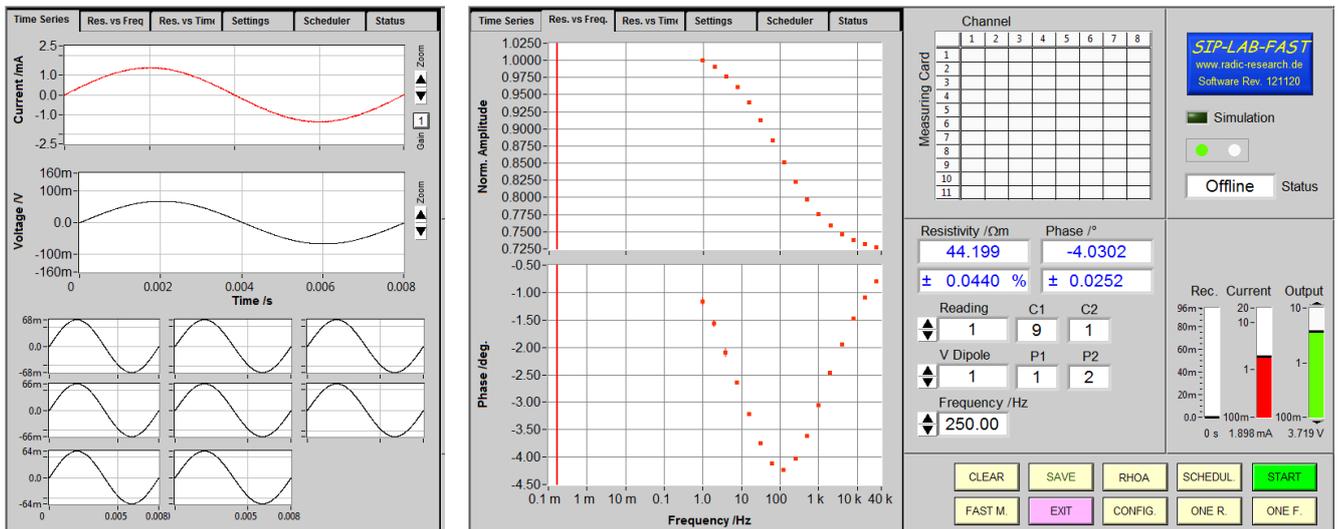
**Main screen of PC operating software, left: recorded time series, right: measured impedance spectrum**

## ▲ OPERATING SOFTWARE

The main menu of the operating software displays (real time) the recorded time series of current and voltages during the measurement. This makes a first data quality check very easy. Recording starts at highest frequency. The recording time increases therefore from a few milliseconds up to tens of minutes per frequency. Depending on the lowest measured frequency, the acquisition of a complete spectrum takes from a less a minute ($f_{min}$=1 Hz) up to hours ($f_{min}$=100 µHz). A second quality check permits the observation of the confidence limits of amplitude and phase. Moreover, the current intensity and whether the measured impedances fulfil a smoothness criterion is checked.

## SCHEDULER ▶

The scheduler menu supports auto repetitions of measurements. Time intervals between cycles of measurements can be set as constant as well as exponential in- or decreasing.
Left: Settings for start time, number of repetitions, first time interval length and exponent.
Right: Resulting start times of individual cycles.
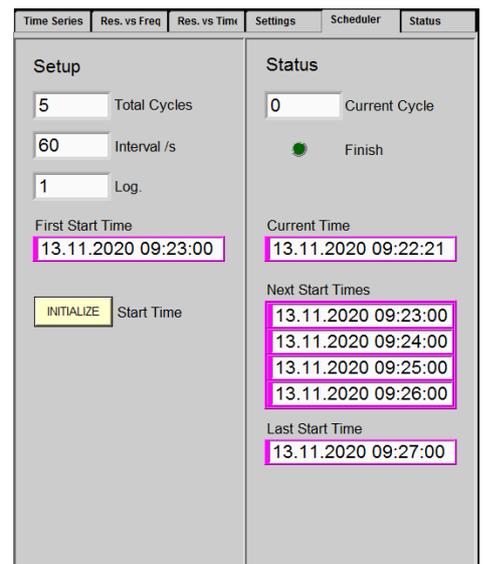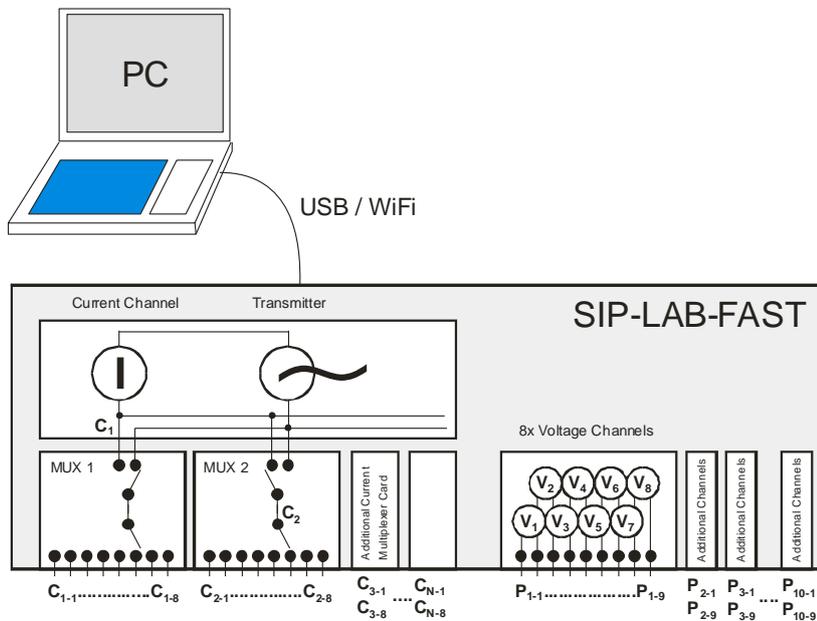


## ACTIVE GUARDING TECHNIQUE

Active guarding technique minimizes the input capacity of the voltage measuring channels. Low input capacity is most important to increase the noise immunity in a laboratory environment. It also reduces systematic errors, which appear at high frequencies if the contact resistance of the potential electrodes is high. This technique improves measuring accuracy especially when unsaturated or low porous samples are investigated.

## GEOELECTRICAL REFERENCE TECHNIQUE

Strong electrical fields from the lab environment can interfere with the voltage measurements and lower the data quality. To record this noise the **SIP-LAB-FAST** instrument possesses a special noise monitor. A multi-channel coherency analysis routine was implemented which allows an identification and cancellation of these external noise voltages. Therefore the confidence intervals of the data can be reduced up to more than a factor of ten. This new technique does not prolong the measuring time.

## HIGH-SPEED MODUS

In the special case that the 3-D conductivity distribution in the object under investigation changes significantly within seconds, the hardware supports a high-speed measurement mode. The current dipole can be changes every 0.01 sec. Up to 10 complete 3-D images of the conductivity distribution at (>10 kHz) can then be measured per second.

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PC

USB / WiFi

Current Channel    Transmitter

SIP-LAB-FAST

C$_1$

8x Voltage Channels

MUX 1    MUX 2    Additional Current Multiplexer Card

C$_2$

V$_2$ V$_4$ V$_6$ V$_8$
V$_1$ V$_3$ V$_5$ V$_7$

Additional Channels   Additional Channels   Additional Channels

C$_{1-1}$..............C$_{1-8}$   C$_{2-1}$..............C$_{2-8}$   C$_{3-1}$  C$_{N-1}$
C$_{3-8}$ .... C$_{N-8}$

P$_{1-1}$..................P$_{1-9}$   P$_{2-1}$  P$_{3-1}$  P$_{10-1}$
P$_{2-9}$  P$_{3-9}$ .... P$_{10-9}$

**Schematic diagram of SIP-LAB-FAST.**

## ▲ CONTROLLING THE CURRENT ELECTRODES

Multiplexer units connect the signal source of the meter to the current electrodes. Each multiplexer unit controls 8 electrodes. Additional multiplexers can be used to further increase the number of possible current input points.

## ▲ VOLTAGE MEASURING UNITS

Measuring cards with 8 channels each are available for voltage measurement. Each additional measurement card increases the measurement progress, since all channels measure synchronously and independently calculate Fourier Coefficients. In order to minimize the number of measurement cables, the measurement channels of a measurement card are connected to form a chain. Instead of 16, only 9 measurement cables are required per measurement card. With a sufficient number of measuring channels, the 3-dimensional conductivity distribution of a test object can be determined in an acceptable time for the first time.



**1-D Column measurement**

**3-D Lysimeter tomography**
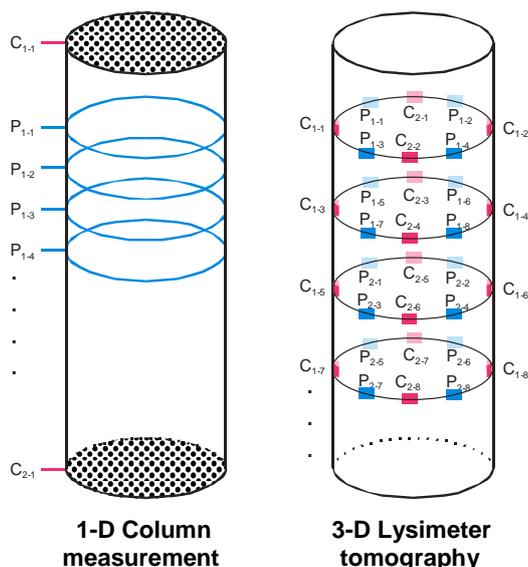
## ◄ TYPICAL APPLICATIONS

The **SIP-LAB-FAST** instrument is suitable at best to measure the spatial distribution and variation with time of the complex resistivity. For the most investigations, columns and lysimeters are used to enclose the sample material. The graphic shows two typical (simplified) measuring arrays.

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# SIP-LAB-FAST
## Technical Specifications
### General
- Frequency Range: 100 µHz - 40 kHz
- Voltage Source: ±10 V, ±10 mA
- Signal: mono/multi sinusoidal
- Buffer Length: 128 k samples / ch.
- Data Format: 32 Bit
- PC Interface: USB (WLAN on req.)
- Powered by: 12 VDC battery or 110-230 VAC (50/60 Hz)
- Weight: 5 kg
- Case: 19-inch rack, 3U

### Measuring Unit Current
- A/D Converter: 24 Bit
- Data Rate: 128 kHz / $2^n$
- Input Range: ±20 mA / ±0.5 mA
- Shunt: 120 Ω (default)

### Measuring Unit Voltage
- Channels: 8 / Unit
- A/D Converter: 24 Bit
- Data Rate: 128 kHz / $2^n$
- Input Range: ±10.0 V
- Minimum Voltage Units: 1

### Current Multiplexer Unit
- Minimum Multiplexer Units: 2
- Each multiplexer controls 8 electrodes.

### PC Operating Software
- Control of the whole system
- Time series recording, displaying, storing, calculation of transfer function and confidents limits
- Data export

### Minimum PC requirements
- Windows 7 - 10
- Clock: 1 GHz, RAM: 1 GB
- Display: 768 x 1024 pixel
- USB interface