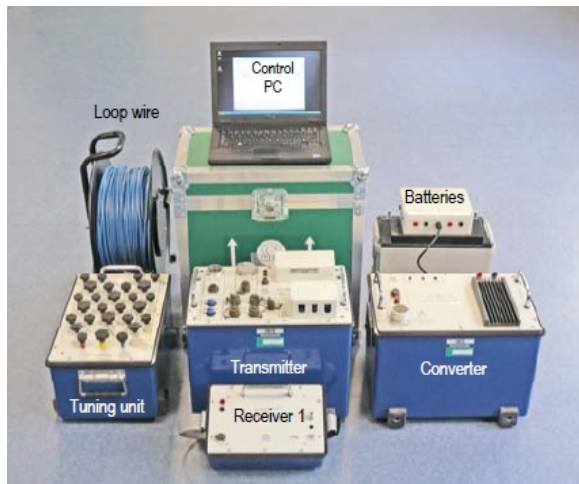


NUMIS Poly

MULTI CHANNEL
MAGNETIC RESONANCE
SOUNDING SYSTEM FOR
**DIRECT DETECTION
OF GROUND WATER**

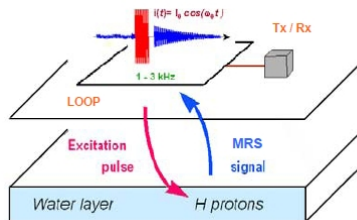
DOWN TO 150m DEPTH

water content
permeability estimate
depth of water layers



NUMIS^{Poly} is a modular MRS equipment consisting of :

- a transmitter unit for pulse generation and up to four receiver units for signal measurement
- a PC computer for the control of the whole system and for data processing and interpretation
- 2 converter units powered by two 12 V batteries each
- 2 tuning units for optimizing the excitation energy
- wire for transmitting and receiving loop coils



The Magnetic Resonance Sounding method (MRS):

The MRS is the only **non-invasive** method which directly studies groundwater reservoirs from surface measurements:

A pulse of current, at a given frequency, is transmitted into a loop.

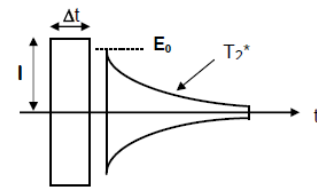
The signal produced in return by the H protons (water molecules) is measured within the same loop.

How to carry out a Magnetic Resonance Sounding ?

- 1- Measure the Earth magnetic field to know the frequency to apply
- 2- Transmit a pulse of current into a loop, at this frequency
- 3- Measure the amplitude of the water MR signal ($\approx$ porosity)
- 4- Measure the time constant of the signal ($\approx$ mean pore size)
- 5- Change the pulse intensity to modify the depth of investigation
- 6- Use the inversion program to get the porosity versus the depth

GROUNDWATER RESOURCES EVALUATION

Determination of water level and quantity Lateral extension of an aquifer layer
Selection of the best place to drill
Prediction for yield, after calibration



E_0 : Initial amplitude of signal (nV)

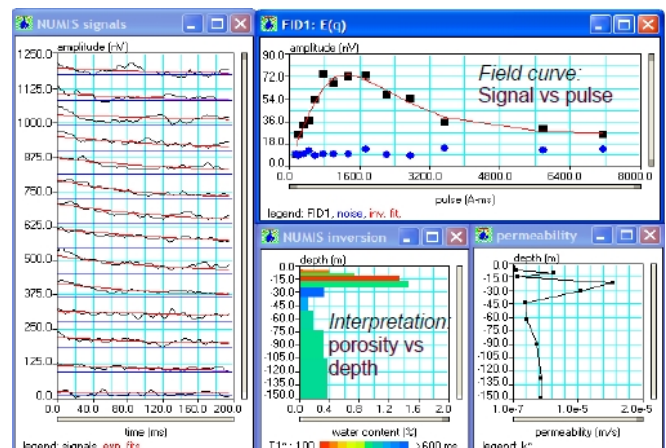
Proportional to the **water content (%)**

T_2^* : Decay time constant of signal (ms)

Related to the **mean pore size** (permeability)

$I, \Delta t$: Excitation pulse moment (A.ms)

Related to the **investigation depth** (m)



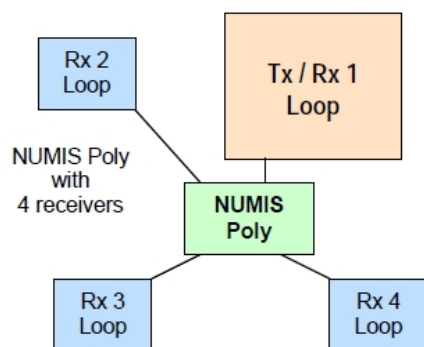
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NUMIS^{Poly} MRS equipment

NUMIS^{Poly} MAIN FEATURES

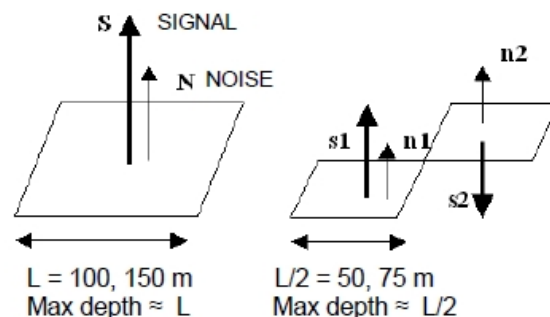
- **NUMIS^{Poly}** is modular multi channel MRS equipment designed with units weighting 25 kg or less, making it man portable.
- **The transmitter unit** produces pulses at the Larmor frequency
- **The receiver units (up to 4)** measure the MRS signal and the noise, after filtering, amplification and analog to digital conversion.
- **The PC computer** receives raw data, then processes, displays and stores them (including time series) for further interpretation
- **The two DC / DC converter units** are required for a maximum investigation depth of 150 m, to energize the 150 m side square loop (600 m total length). However, if an investigation of 100 m is sufficient; one converter unit only is required with a 100 m side square loop (400 m total length) With one only converter, just the **transverse time constant (T_2^*)** is measured, while with two converters, the transverse and **the longitudinal (T_1) time constants** are measured; T_1 offers a better estimation of the permeability than T_2^*
- **The two tuning units** must be used at lower magnetic latitudes (for an Earth's field lower than 31 000 nT with the 150 m side square loop, or 37 000 nT with the 100 m side square loop), while one tuning unit only is needed at medium and higher latitudes
- **The receivers 2 to 4** can be used for remote reference purposes (signal to noise enhancement) or 2D acquisition



NUMIS Poly
4 channel MRS system
- signal to noise ratio enhancement through remote reference techniques with the simultaneous acquisition of various receiving channels and cross spectra analysis

- 2D acquisition on the four receiving channels

SQUARE (standard) and EIGHT (noise reduction) loop shapes for MRS soundings



NUMIS Poly CONFIGURATIONS			
Investigation depth	Converter number	Tx Loop dimensions	Receiver number
100m	one	100 x 100 m	1 to 4
150m	two	150 x 150 m	1 to 4



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NUMIS^{Poly}

TECHNICAL SPECIFICATIONS

DC/DC CONVERTER UNIT

- power supply: two 12 V batteries (65 Ah each)
- 12 hours reading autonomy
- capacitance: 84 mF
- outputs: ± 430 V DC; 0.5 A
- two converters may be used in parallel
- dimensions: 43 x 30 x 41 cm; weight: 23 kg

TRANSMITTER (Tx) UNIT

- supplied by one or two DC/DC converters
- frequency range: 0.8 to 3 kHz
- maximum outputs: 4000 V, 600 A
- pulse amplitude and duration: programmable
- pulse moment: 100 to 24 000 A.ms (loop and frequency dependant) for 40 ms standard pulse
- dimensions: 43 x 30 x 44 cm; weight: 23 kg

REVEIVER UNIT (up to 4 units: Rx1 to Rx4)

- band pass filter width: 150 Hz; automatic range
- noise: less than 10 nV / sqrt(Hz)
- A/D converter: 16 bits
- sampling frequency: up to 76.8 kHz
- raw data (time series) storage for post processing
- calibration procedure for phase reference
- measurement of T_2^* (with one converter) and of T_2^* and T_1 (with two converters)
- 24 hours autonomy
- dimensions: 30 x 21 x 21 cm; weight: 4 kg

TUNING UNIT

- tuning of the loop to the Larmor precession frequency by capacitors
- capacitance of 6 to 30 μ F with one tuning unit and up to 60 μ F with two tuning units
- dimensions: 43 x 30 x 34 cm; weight: 20 kg

TRANSMITTING / RECEIVING LOOP

- wire for Tx & Rx1 loops: 100 m, 10 mm² section
- 4 reels for 100 m investigation, 0.7 ohm, 0.8 mH
- 6 reels for 150 m investigation, 1.0 ohm, 1.2 mH
- other Tx & Rx1 loop configuration: on request
- loops for Rx2 to 4: 2 reels 200m; 1 reel 7 x 40m
- cable between Rx2 to Rx4 and Transmitter: 100m

PC COMPUTER

- control of the whole system: converter, transmitter, receivers; data storage
- data processing: DFT and cross correlation
- data interpretation: 1D inversion

