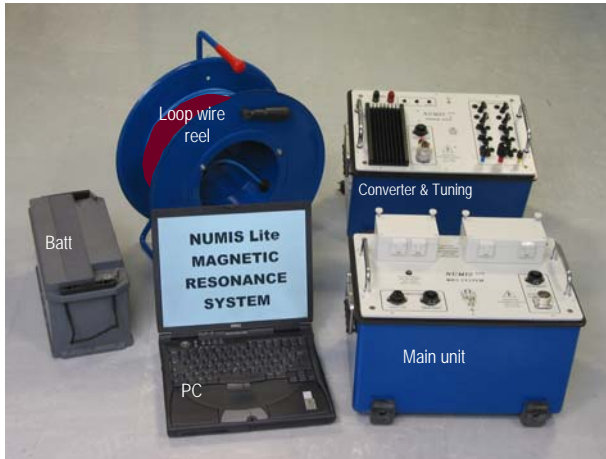
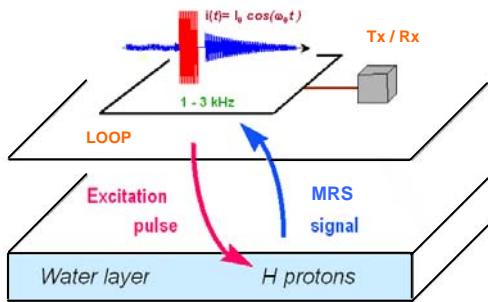




# MAGNETIC RESONANCE SOUNDING SYSTEM



- NUMIS<sup>LITE</sup>** is compact MRS equipment consisting of :
- a converter/tuning unit powered by two 12 V batteries,
  - a transmitter-receiver unit for pulse generation and signal measurement,
  - a wire loop used as a transmitting and a receiving coil,
  - a PC computer for the control of the whole system, and for data processing and interpretation



### 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

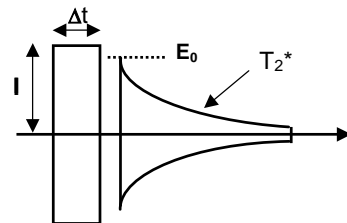
# NUMIS<sup>Lite</sup>

## MAGNETIC RESONANCE SOUNDING SYSTEM FOR *DIRECT DETECTION OF SHALLOW GROUNDWATER DOWN TO 50 m DEPTH*

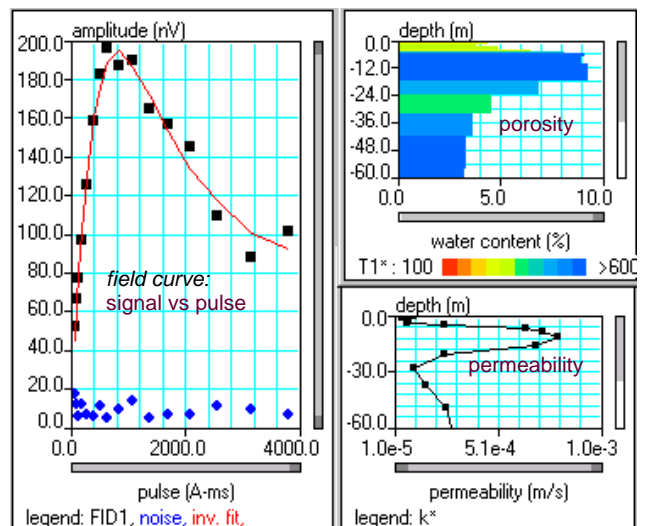
- water content
- permeability estimate
- depth of water layers

### GROUNDWATER AND ENVIRONMENTAL APPLICATIONS:

- Shallow groundwater resources evaluation
- Non invasive water level determination
- Pollution studies: mapping of shallow aquifers



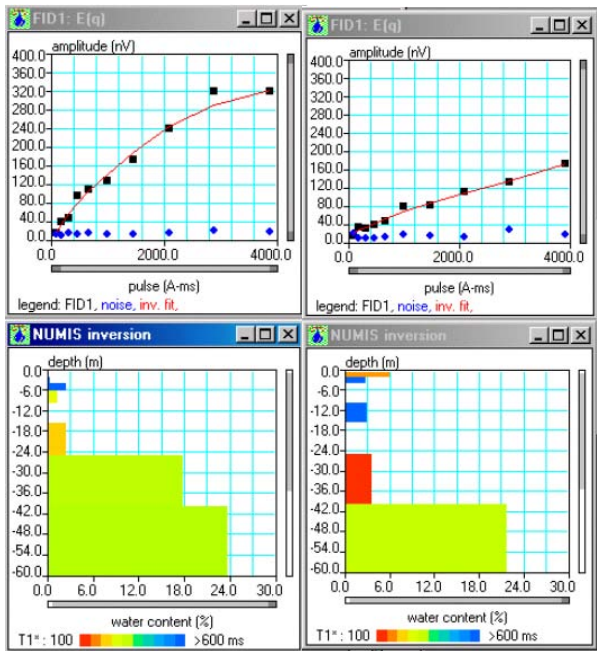
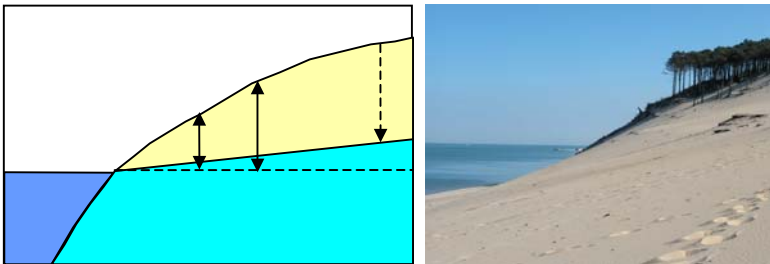
- $E_0$ : Initial amplitude of signal (nV)  
Proportional to the **water content** (%)
- $T_2^*$ : Decay time constant of signal (ms)  
Related to the **mean pore size** (permeability)
- $I, \Delta t$ : Excitation pulse moment (A.ms)  
Related to the **investigation depth** (m)





## NUMIS<sup>Lite</sup> MAIN FEATURES

- **NUMIS<sup>LITE</sup>** is a compact MRS equipment designed for shallow groundwater investigations (down to approximately 50 m depth). It consists in two pieces of 20 kg each, making it easily portable.
- **The Tx / Rx unit** is the core of the system. It ensures the production of the energizing pulses at the Larmor frequency, also the measurement of the MRS response with filtering, amplification and analog to digital conversion.
- **The PC computer** receives raw data, then processes, displays and stores them for further interpretation.
- **The DC / DC converter and tuning unit** for both increasing the voltage supplied by the batteries and optimizing the energy transmitted into the loop.
- **The wire loop (240 m long)** can take the following shapes:
  - *the square one*, 60 m side, for standard applications
  - *the eight one*, 30 m side, in case of noise perturbations
  - *the square two turns*, 30 m side, when the area available does not permit to lay out the standard square 60 m side loop.



## NUMIS<sup>LITE</sup>

### TECHNICAL SPECIFICATIONS

#### DC/DC CONVERTER / TUNING UNIT

- Power supply: two 12 V batteries (38 Ah each)
- 10 to 12 hours reading autonomy
- Capacitance: 0.14F
- Outputs:  $\pm 110$  V DC; 0.5 A
- Tuning of the loop to the Larmor precession frequency by capacitors
- Capacitance of 12 to 54  $\mu$ F
- Dimensions: 43 x 30 x 33 cm; weight: 21 kg

#### Tx / Rx MAIN UNIT

- Dimensions: 43 x 30 x 30 cm; weight: 19 kg

#### TRANSMITTER SPECIFICATIONS

- Frequency range: 1.4 to 3 kHz
- Maximum outputs: 1000 V, 150 A
- Pulse amplitude and duration: programmable
- Pulse moment: 100 to 6000 A.ms (loop and frequency dependant) for 40 ms standard pulse duration

#### RECEIVER SPECIFICATIONS

- Band pass filter width: 100 Hz
- Programmable gain:  $10^4$  to  $10^6$
- Noise: less than 10 nV / sqrt(Hz)
- A/D converter: 14 bits
- Sampling frequency: four times the Larmor frequency
- Calibration procedure for phase reference
- Measurement of  $T_2^*$  (transverse) and  $T_1$  (longitudinal) time constants

#### TRANSMITTING / RECEIVING LOOP

- Four reels of 60 m wire, 6 mm<sup>2</sup> section: impedance 0.7 ohm, 0.5 mH
- Other loop configuration on request

#### PC COMPUTER

- Control of the whole system: converter, transmitter, receiver
- Data processing: DFT and weighted stacking
- Data interpretation: 1D inversion

