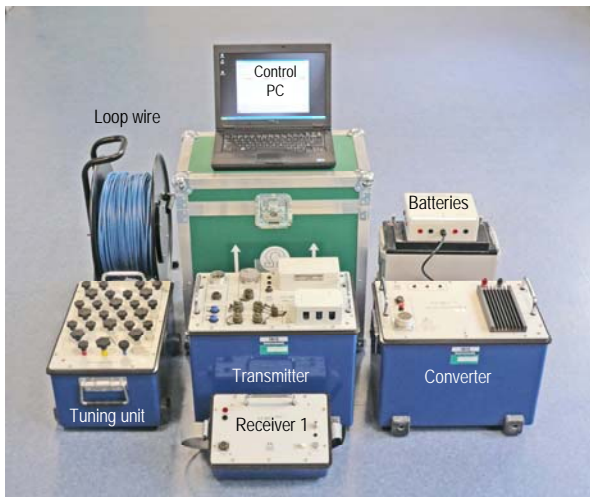


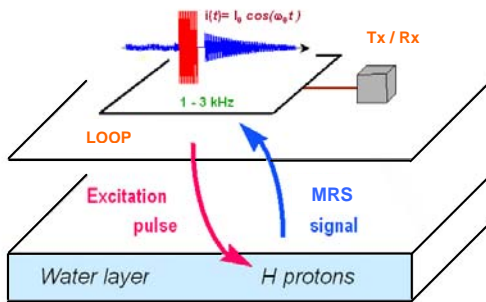
# IRIS INSTRUMENTS

## MAGNETIC RESONANCE SOUNDING SYSTEM



NUMIS<sup>Poly</sup> is a modular MRS equipment consisting of :

- a transmitter unit for pulse generation
- up to four receivers 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.

# NUMIS<sup>Poly</sup>

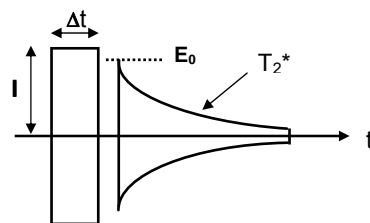
multi channel  
MAGNETIC RESONANCE  
SOUNDING SYSTEM FOR  
**DIRECT DETECTION  
OF GROUNDWATER**

**DOWN TO 150 m DEPTH**

water content  
permeability estimate  
depth of water layers

### GROUNDWATER RESOURCES EVALUATION:

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



$E_0$ : Initial amplitude of signal (nV)

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

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

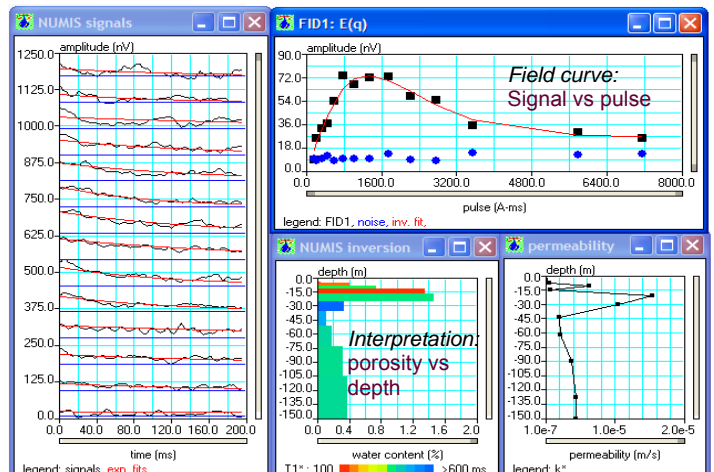
Related to the **mean pore size** (permeability)

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

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

### How to carry out a Magnetic Resonance Sounding ?

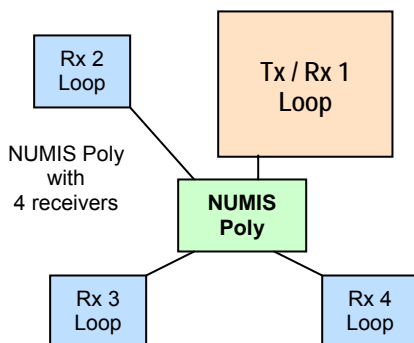
- 1- Measure the Earth magnetic field to know the frequency to apply
- 2- Transmit a pulse of current into a loop, at this frequency
- 3- Measure the amplitude of the water MR signal ( $\approx$  porosity)
- 4- Measure the time constant of the signal ( $\approx$  mean pore size)
- 5- Change the pulse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



# NUMIS<sup>Poly</sup> MRS equipment

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

- NUMIS<sup>Poly</sup> is a 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

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<sup>Poly</sup>

### TECHNICAL SPECIFICATIONS

#### DC/DC CONVERTER UNIT

- power supply: two 12 V batteries (65 Ah each)
- 12 hours reading autonomy
- capacitance: 84 mF
- outputs:  $\pm 430$  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 0.1 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  $\mu$ F with one tuning unit and up to 60  $\mu$ 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 mm<sup>2</sup> 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

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

