

HarbourDom GmbH
 50668 Cologne
 Riehler Platz 1, Germany
 Tel: +49-221-7392599, Fax +49-221-733598,
 Email: info@harbourdom.de

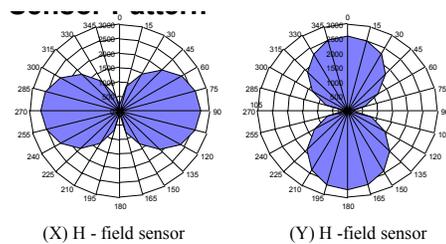
Deep reading exploration with EM-reflections (borehole radar)

Ground penetrating or ground probing radar (GPR) is a frequently used technique in surface geophysics. It is mainly used for geotechnical, environmental and hydro-geological applications. The depth of penetration depends on the conductivity of the strata and thus on the water or moisture content and on the dominant frequency of the instrument. The penetration is in the range of meters to tens of meters. In hard dry rock like limestone or granite the penetration may be hundreds of meters. The only natural rocks where radar penetrates more is salt and ice.

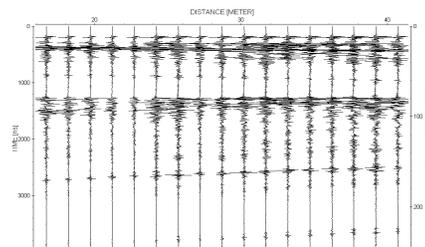
For exploration of deeper layers that are interesting for the oil-gas industry, for the mining industry or also for deep civil engineering GPR from the surface can not be used due to the limited penetration.

To explore deeper strata GPR or more generally a deep reading EM-reflection method can only be used from well bores allowing placement of the instruments closer to the targets.

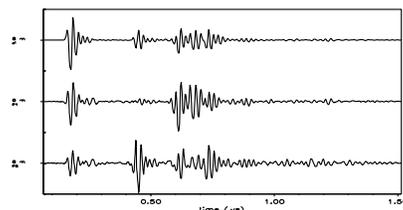
GPR is a wave-equation based method and the imaging or proper spatial resolution of the targets is gained from placing transmitter and receiver antennas at many positions at the Earth's surface above the target (synthetic aperture). For measurements from a well bore the possibilities to position antennas are limited and thus



Directivity of the two H-field sensors



Traces showing direct arrivals and two reflections



Trace separation showing low cross feed

the image of a reflector will be smeared around the borehole. This can be overcome if the antennas (transmitter or receiver) have some **directivity**.

There are different possibilities to gain directivity in a borehole radar antenna. The method used here is, combining signals from an axial electrical dipole antenna with two crossed horizontal coil antennas, measuring the two components of the horizontal H-field. The directivity realized with this is excellent, as the measured radiation patterns show.

Innovative in the tool is also a completely redesigned **high speed A/D-conversion** technology. It allows 9 GHz sampling rate with 16 bit resolution.

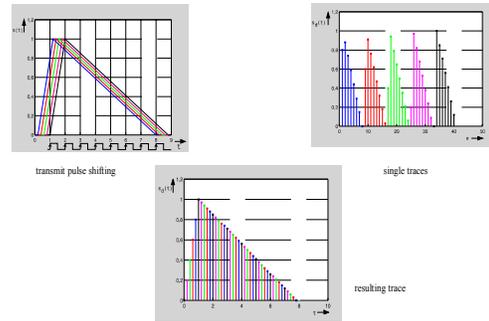
The tool has a modular design. Transmitter- and receiver antennas may be placed in different well or combined to a single tool with adjustable transmitter-receiver spacing. This means, the tool may be use for **single well and cross well applications** as well.

The data acquired with the described system need specific processing including imaging and 3D-animation. An appropriate **software** has been developed by the German Geological Survey (BGR) in is available there.

The tool has bin successfully used so far for the exploration of salt domes (for nuclear waste dumps) from drill holes made in mines. Those surveys were made in cooperation between the manufacturer of the instrument and the German Geological Survey. The instrument was also successfully used for engineering gas-storage caverns in salt. For exploration in deeper holes the temperature and pressure range of the present instrument has to be increased.

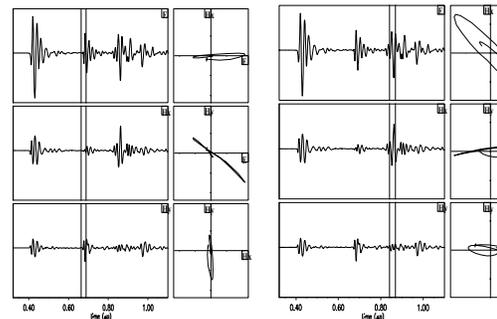
What does HarbourDom offer?

HarbourDom is a technology transfer company. It offers, regarding the borehole radar tool, to make a contact between an interested client and the manufacturer of the tool. HarbourDom will help developing additional applications, design modifications of the tool and helps with field testing and debugging. It's the interest of HarbourDom to make this tool used in many more applications, as applications in the oil-gas business.

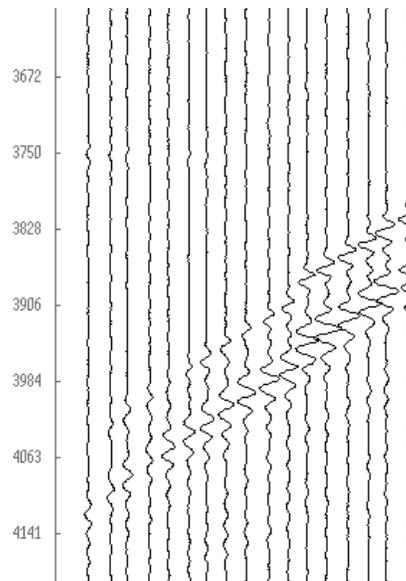


New high speed sampling concept,

8 Ghz, 16 bit



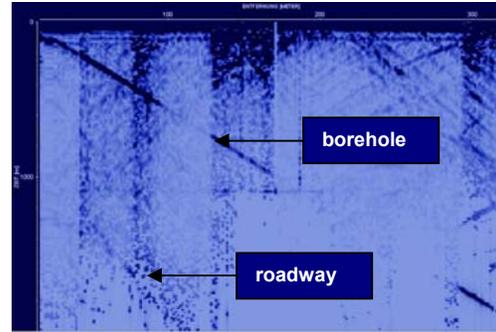
Getting the direction



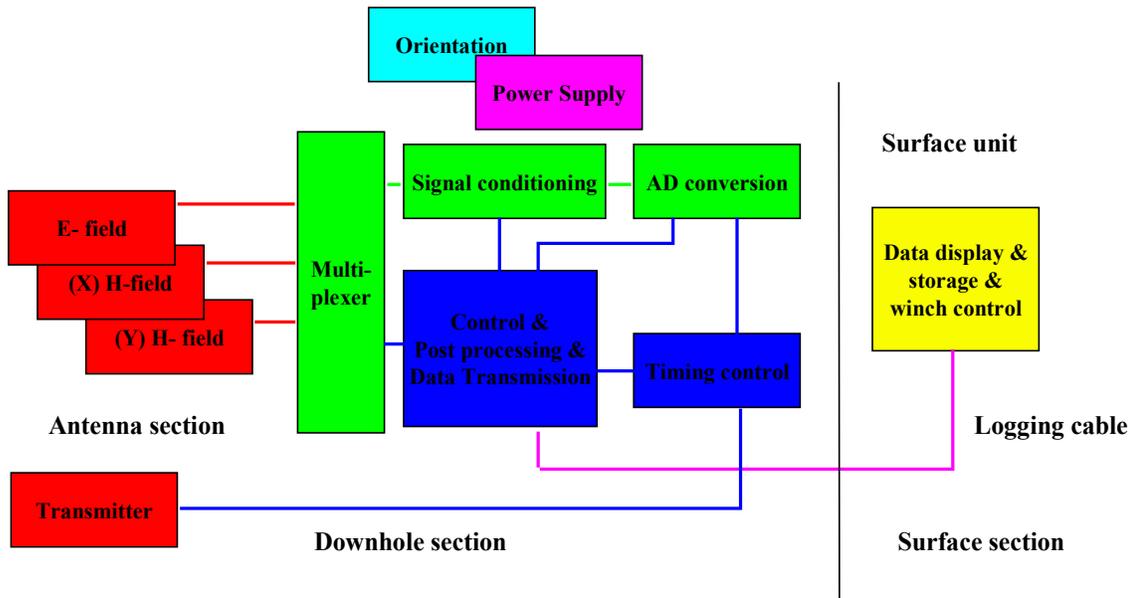
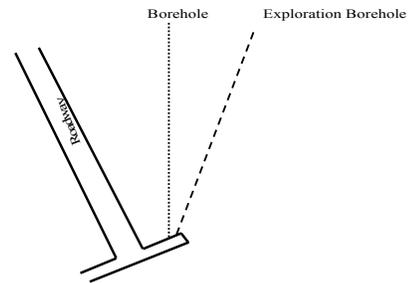
Reflection from a target 240 m away (times in nsec)

Tool specifications:

■ System diameter	80 mm
■ System length	up to 20 m
■ Cable head	Gearhart 7 conductor
■ Power consumption	35 W
■ Voltage Range	36 to 72 VDC
■ ADC	16 bit
■ Preamp.	12 dB/ 16 dB/ 32 dB
■ Sampling frequency	up to 8 GHz
■ Trace length	up to 16 μ s
■ Center frequency	25 MHz, 50 MHz, 100 MHz
■ Stacks	up to 256
■ Peak power	5 kW



Reflection of a borehole close to the exploration borehole and from a roadway farer away (see below)



Block diagram of main tool parts

All pictures are © DMT