Extending the Limits of GPR Penetration

(without magic)
Conventional GPR

- Designed for shallow surveys
- Impulse transmitter
- Sequential sampling receiver
- Large antennas
- Slow moving
Latest low-frequency GPR

- < 4 kgs
- In-line antennas
- Real-time sampling
- Wireless and waterproof
- Realistic penetration to 125 m
Latest low-frequency GPR

Penetration Depth for 30 MHz UltraGPR [m]
Can we go deeper?

- Increase transmitter power?
- Increase returned signal SNR?
- Increase signal wavelength?
Increasing Transmitter Power

 Doesn’t work. Penetration is a function of **mean power**, not peak power.
Increasing Signal SNR

We already have the fastest sampling (fast stacking)
Improve SNR by transmitting coded sequence
Increasing Wavelength

Most GPR systems are limited to 10 wavelengths. Longer $\lambda$ = lower resolution, but deeper penetration.
Increasing Wavelength

Can a UWB antenna be made electrically large but physically small?

Magnetic loop antennas are a possible solution
Bridging the EM-GPR Gap

AMIRA Project to create a hybrid EM-GPR technology operating the in 300 kHz – 300 MHz band

![Amplitude vs Frequency Chart]
Smaller and Lower Cost Borehole Radars

Combined suite of BHR & Televiwer for fracture detection and orientation, NMR for moisture

“Look ahead” borehole radar with 25 mm diameter
New processing approaches

Poor GPR data with air-wave reflections
New processing approaches

Image processing used to remove air-waves
New processing approaches

Dielectric (water content) from backscatter wavefield analysis
New processing approaches

Electrical resistivity from backscatter wavefield analysis