

# GEM-5 Broadband EM Sensor Array for Detecting Tunnels, Utilities, UXO, and Landmines

The GEM-5 sensor has a transmitter in the middle straddled by two identical receiver coils below and above. The difference between the two receiver coils constitutes the signal. The gradiometer sensor has the following advantages:

- Broadband operation, typically 10-12 frequencies between 90 Hz – 96kHz
- Ability to work as an array in which all sensors can operate simultaneously,
- Immunity to noise induced by sensor motion,
- Immunity to ambient environmental EM noise, and
- Increased signal-to-noise ratio (SNR) owing to the noise immunities.



GEM-5 Array at Geophex Test Site

## GEM-5 Sensors

The GEM-5 is highly scalable. It may be built as a single handheld or cart-mounted sensor, or an array of an arbitrary number of individual sensors



A single GEM-5 sensor on cart

## GEM-5 Array Sensors



## GEM-5 Array Specifications

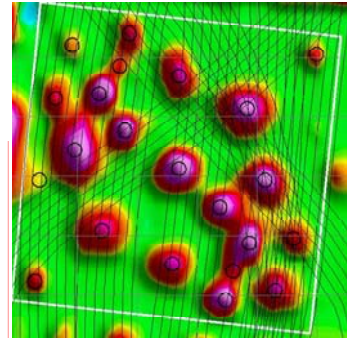
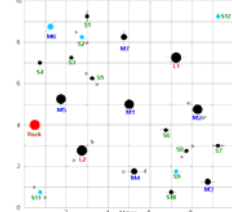
Swath	210 cm (7 ft)
Dimensions	30cm x 50 m x 210cm
Coils configuration	Coaxial
Transmitter current	20 amp RMS max
Transmitter moment	180 Am <sup>2</sup> at 270 Hz
Power supply	12 VDC
Frequency range	90 Hz to 96 kHz
Number of frequencies	Programmable 10-12
Sampling rate	30 Hz

## Geophex Test Site Target List

Target ID	Description	X (m)	Y (m)	Depth (m)
L1	1.5' x 1.5' steel pipe, horizontal, 0-10'	7.25	7.25	100
L2	1.5' x 1.5' steel pipe, 45 deg, 0-10' depth	7.25	7.25	100
<b>Total</b>				
M1	3.1' x 1.0' x 1.0' steel pipe, vertical	5.00	5.00	70
M2	3.1' x 1.0' x 1.0' steel pipe, 45 deg, 0-10' depth	5.00	5.00	80
M3	2.5' x 1.0' x 1.0' steel pipe, horizontal, 0-10'	3.25	3.25	100
M4	2.5' x 1.0' x 1.0' steel pipe, 45 deg, 0-10' depth	3.25	3.25	100
M5	2.5' x 1.0' x 1.0' steel pipe, horizontal, 0-10'	1.25	1.25	80
M6	2.5' x 1.0' x 1.0' steel pipe, 45 deg, 0-10' depth	1.25	1.25	80
M7	2.5' x 1.0' x 1.0' steel pipe, horizontal, 0-10'	4.75	4.75	80
M8	2.5' x 1.0' x 1.0' steel pipe, 45 deg, 0-10' depth	4.75	4.75	80
<b>Total J</b>				
S1	0.0' x 0.0' x 4' steel pipe, horizontal, N-S	5.00	9.25	10
S2	0.0' x 0.0' x 4' steel pipe, horizontal, E-W	5.00	9.25	10
S3	1.5' x 0.0' x 4' steel pipe, vertical	2.25	2.25	30
S4	1.5' x 0.0' x 4' steel pipe, horizontal, N-S	5.75	2.25	30
S5	1.5' x 0.0' x 4' steel pipe, horizontal, E-W	2.25	5.75	30
S6	1.5' x 0.0' x 4' steel pipe, vertical	5.75	5.75	30
S7	1.5' x 0.0' x 4' steel pipe, horizontal, N-S	5.75	5.75	30
S8	1.5' x 0.0' x 4' steel pipe, horizontal, E-W	2.25	2.25	40
S9	1.5' x 0.0' x 4' steel pipe, horizontal, N-S	2.25	2.25	40
S10	0.0' x 0.0' x 4' steel pipe, horizontal, E-W	7.00	0.75	10
S11	0.0' x 0.0' x 4' steel pipe, horizontal, N-S	5.25	2.25	10
S12	0.0' x 0.0' x 4' steel pipe, horizontal, E-W	5.25	5.25	10
S13	0.0' x 0.0' x 4' steel pipe, horizontal, N-S	5.25	5.25	10
S14	0.0' x 0.0' x 4' steel pipe, horizontal, E-W	5.25	5.25	10
S15	300.00 x 0.00 x 0.00 shallow located up to 15cm	5.50	4.00	37
<b>Total K</b>				

All depths are in the center of object

## Geophex Test Site Map



GEM-5 Array Plot over Geophex Test Site

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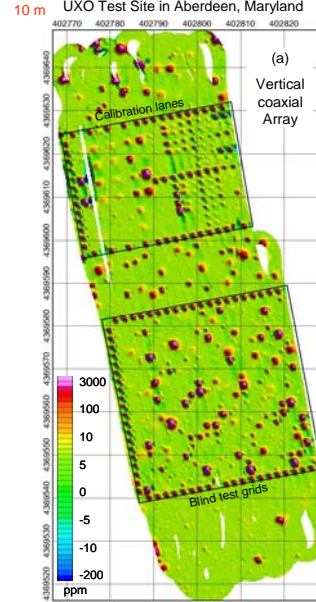


GEM-5 Array Mounted on an Armored Robotic Vehicle for Landmine Clearance

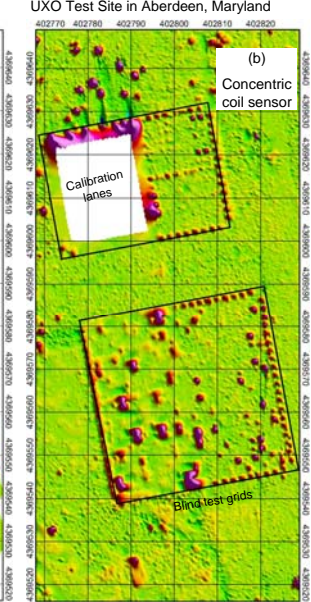


GEM-5 Array Mounted on a Sled

## GEM-5 Array Data Plot over UXO Test Site in Aberdeen, Maryland



## Handheld GEM-3 Data Plot over UXO Test Site in Aberdeen, Maryland



Targets were re-seeded between the two surveys



A GEM-5 data plot along streets near Geophex in Raleigh, NC. Dotted lines are the ground tracks of the midpoint of the array. Most red "pimples" are manholes (along the center, storm drains (along the curve), and small metal caps containing waterlines. Several straight lines across the roads are culverts and utility lines.