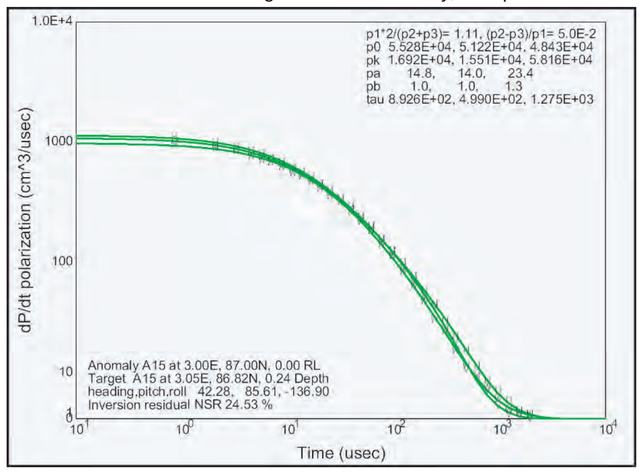
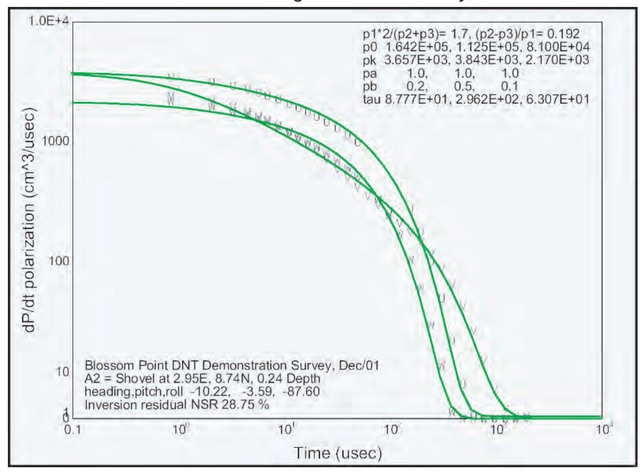
NRL Baseline Ordnance Classification Test Site, Blossom Point

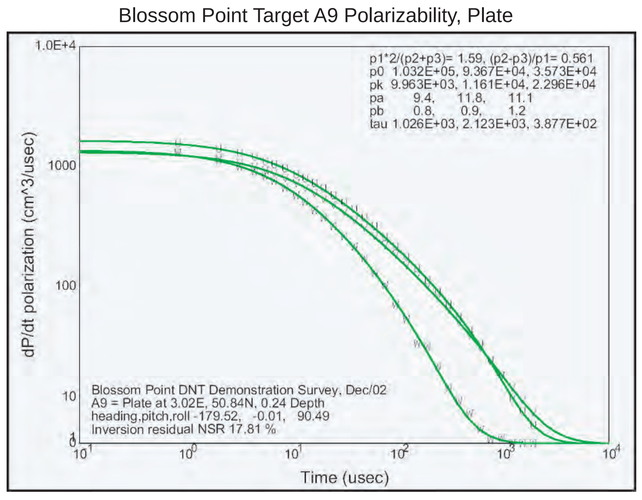
Blossom Point Target A15 Polarizability, Shotput



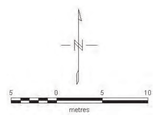
Blossom Point Target A2 Polarizability, Shovel

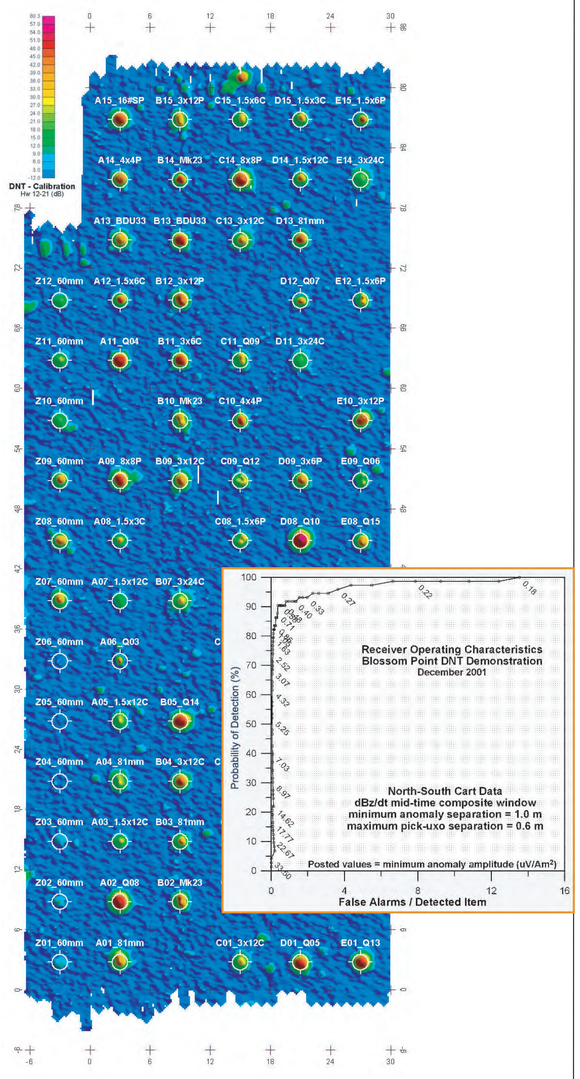


Blossom Point Target A9 Polarizability, Plate



Blossom Point Standardized UXO Test Site





Model-Based Parameterization

We analyzed 3-component transient data from the vicinity (i.e., 1m radius data patches) of each of the 67 target positions in order to extract target characteristics using DNT_Dipole. These data illustrate the efficacy of the model-based approach to target discrimination. The polarizability transient plots (left of the map) show results from model-based target parameterization of data patches over 3 different targets :

* Sphere - The sphere target has three nearly identical polarizability transients

* Plate - The equi-dimensional plate target is characterized by having two nearly identical major polarizability transients and a smaller minor polarizability transient.

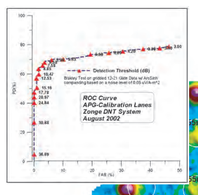
* Clutter - The clutter target, a shovel blade, is illustrative of a target with no axis of symmetry. Lack of symmetry is indicated by the fact that the three polarizability transients are generally different at all times.

Detection Characteristics

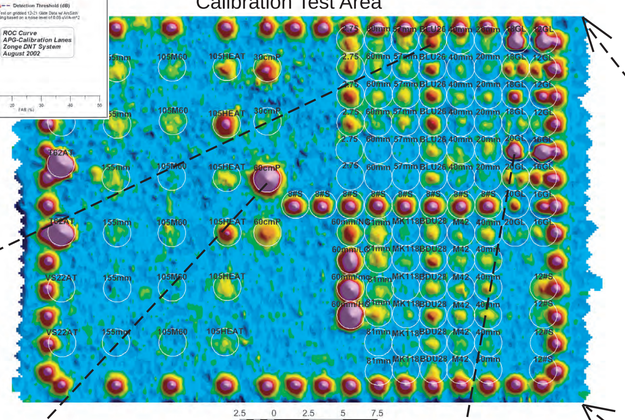
The ROC curve exhibits a sharp knee at approximately 0.5 (V/Am^2. We compared signal-to-noise ratios of the 3 systems (DNT, man-portable MTADs, and EM-63) for each of the 67 targets at Blossom Point. This comparison demonstrates that the sensitivity of the DNT system compares favorably with that of the other systems.

Standardized UXO Technology Demonstration Site, Aberdeen Test Center

ROC Curve
Calibration Test Area

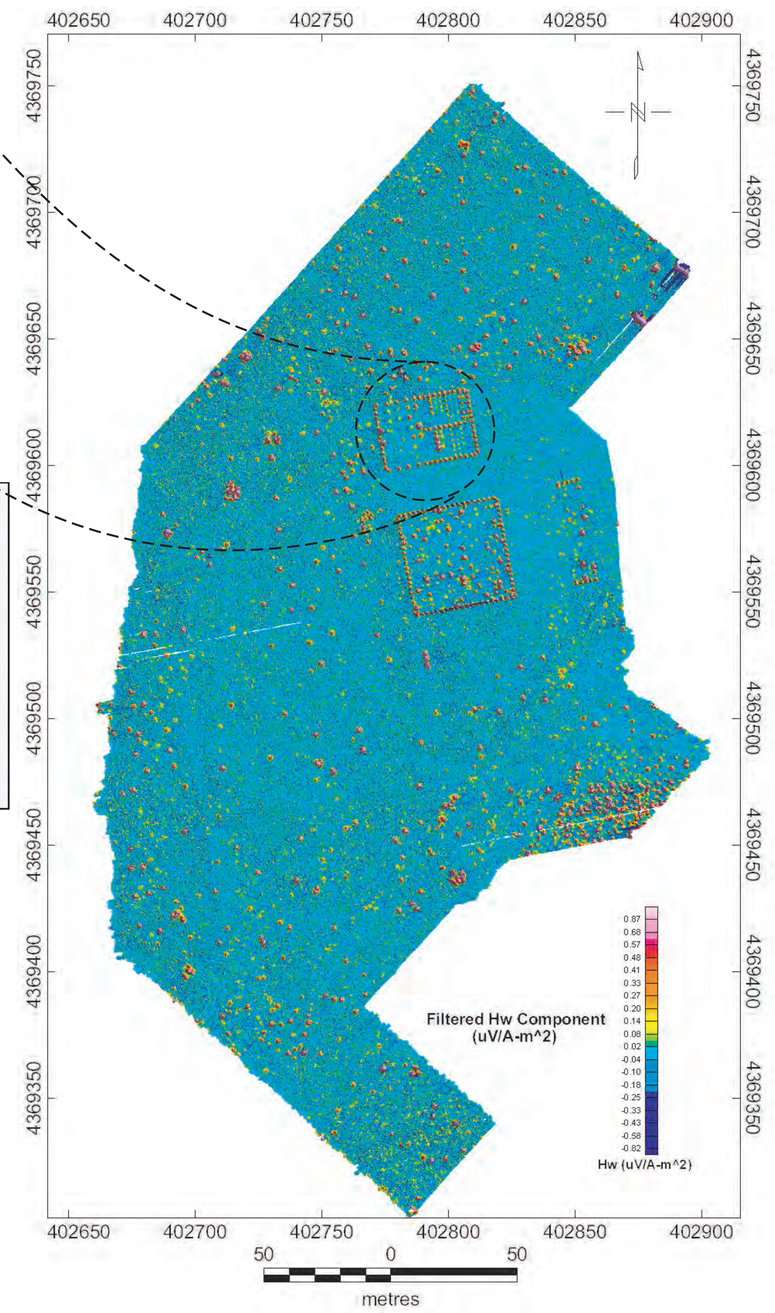


Calibration Test Area

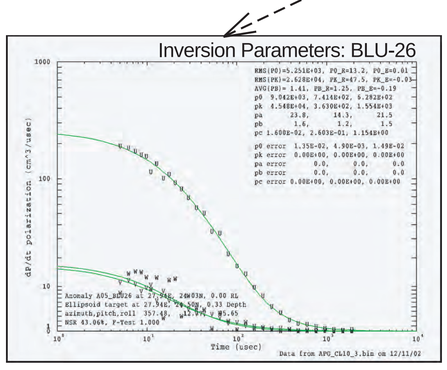


Zonge NanoTEM System Demonstration

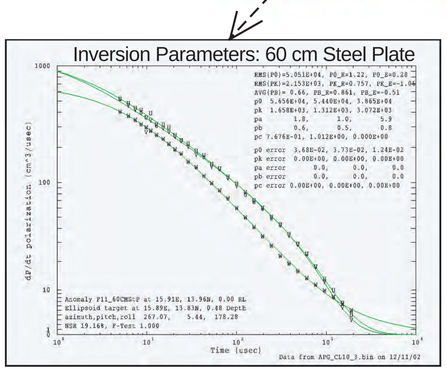
In August, 2002, Zonge acquired NanoTEM data over approximately 17 acres comprising the Standardized UXO Technology Demonstration Site at the Army Aberdeen Test Center, Maryland. A total of 3 seeded grids (Calibration Test Area, Blind Test Grid, and Mine Grid) were surveyed plus an Open Field area comprised of randomly seeded UXO targets and clutter. The large map at far-right is a color-shaded contour map of the vertical componet (dBz/dt, mid-time composite window) TEM data over the entire test area. Many 100's of anomalies were identified from these data for UXO detection and discrimination analysis which is discussed further below.



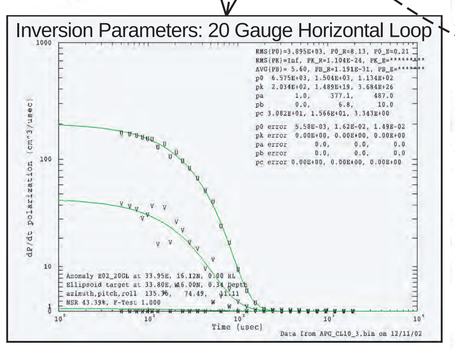
Inversion Parameters: BLU-26



Inversion Parameters: 60 cm Steel Plate



Inversion Parameters: 20 Gauge Horizontal Loop



Calibration Test Lanes

Shown at top-center is a color map of the vertical component of the induced magnetic field (dBz/dt, mid-time composite window), generated from dynamically acquired DNT data at the Aberdeen Calibration Test Lanes. Ground truth has been provided for this area: the seeded UXO item labels are posted on the map. White circles indicate 1 m radius data patches that were used for target modeling and discrimination.

A ROC curve generated from the calibration data is shown in the upper corner of the map. The curve indicates the correlation between detection amplitude threshold (shown as dB above ambient noise level), false alarm rate (FAR), and percent UXO detected (PD). There is a clearly defined knee in the curve indicating that about 70% of the targets are detected, with less than 5% FAR, using detection threshold of about 8 dB above background. Note that the knee in the curve for the Aberdeen test at 70% detection is significantly lower than that for the Blossom Point test (>90% detection).

The Aberdeen Calibration Test Area is bounded by a series of 8# shot puts, that in some places create interfering anomalies. Moreover, many of the targets have been placed too deep to enable useful discrimination experiments. Nevertheless, our modeling using Zonge's DNTdipole program yields good discrimination results, when the signal-to-noise ratio is adequate (see Inversion Parameter plots, above, and related discussion, right).

Target Discrimination Modeling

Zonge's DNTdipole program was employed to model hundreds of identified TEM anomalies. Multi-component DNT data from a 1 m radius data patch around anomaly peaks were inverted for a best-fitting anisotropic dipole model. The inversion yields estimates of parameters for location, magnitude and orientation of the 3 principal polarizations (eigenvectors of the polarization tensor), and other components of the decay transient.

Inversion Parameter plots from DNT data over three known targets buried on the Calibration Test Lanes are shown above (a BLU-26, a 60 cm steel plate, and a 20 gauge horizontal wire loop). The curves indicate the polarization transients in the 3 principal directions (U, V, W) for both the data (posted letters U, V, and W) and for the best-fit theoretical model (green curves).

As expected, targets with very different morphologies and/or magnetic permeabilities yield very different model parameter relationships. Typical UXOs with rodlike-ellipsoidal shapes in the near-surface are expected to yield parameters such as those shown above for the BLU-26. Here, the inverted data indicate a rod-like ellipsoidal model at about 0.3 m depth, with {P0-u >> (P0-v ~ P0-w)}. For the BLU-26, the decay is fairly rapid: more rapid than for the steel plate, and less rapid than for the horizontal loop.

The polarization parameters computed from the DNT anomaly over a 60 cm steel plate are shown as well. In this case, modeling indicates large polarizations, with {(P0-u ~ P0-v) > P0-w}, and relatively slow decay times. In contrast, the modeled data over a 20 gauge horizontal wire loop indicates very fast decay times, one well-fit principal polarization component (P0-u, vertical), one minor component poorly resolved, and the other minor component polarization transient near zero.

2001 ESTCP Contract

With ESTCP funding, Zonge was able to perfect its high-speed acquisition software, develop data processing software, and construct a 3rd-generation antenna cart. The system was deployed at the NRL's Blossom Point test facility in early December, 2001.

In 2002, a ruggedized 4th generation NanoTEM cart is developed (below). The system continues to be deployed in innovative configurations for environmental and other applications.

Left: An alternate NanoTEM configuration is used for environmental work in China.

Right: 'Big' NanoTEM is used for mapping leaking underground sewer lines in urban Tucson, Arizona.

2002 UXO Technology Demonstrations and Expanding Environmental Applications

Successful UXO technology demonstrations at the Army Aberdeen Test Center, Maryland, and at the ODDS (Ordnance Detection and Discrimination Study) site at Fort Ord, California are conducted in the summer of 2002. Analysis of detailed static data (e.g., 9-spot platform tests, below) over known UXO targets, and improved signal processing and inversion algorithms enhance the target discrimination capabilities of the NanoTEM system.