

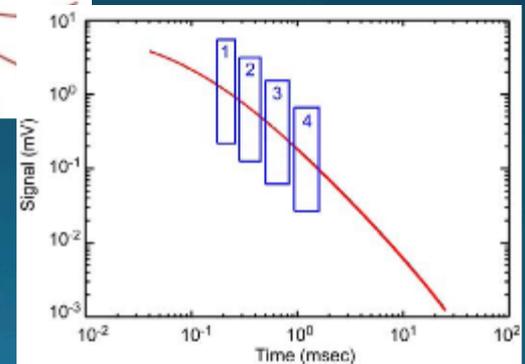
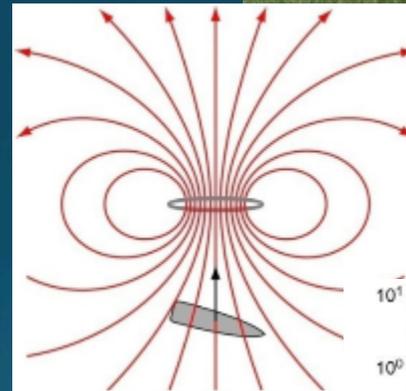
# Implementation of Advanced Classification On a Removal Action Project



**PARSONS**

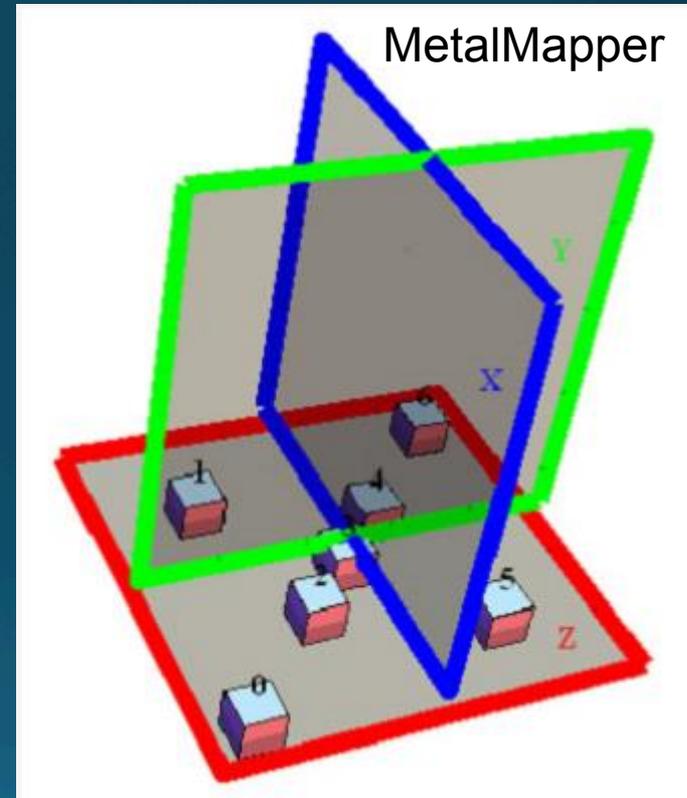
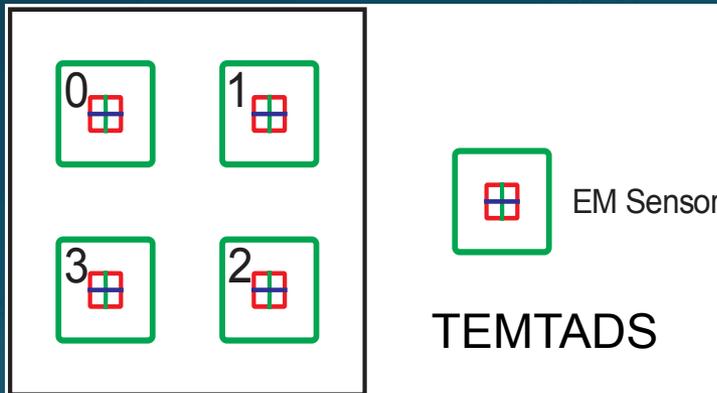
# Traditional Detection Sensor

- An electromagnetic induction (EMI) metal detector (EM61) – is the current industry standard for identifying subsurface metal
- Single transmitter fires and produces a current in subsurface objects
- Single receiver records 4 measurements of secondary magnetic field created as the current decays
- Response highly dependent on orientation of object



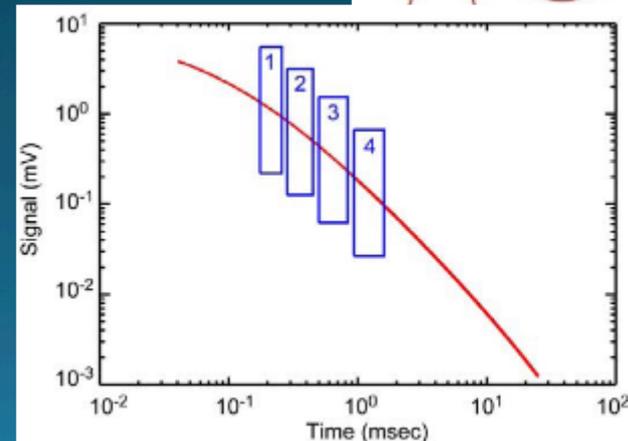
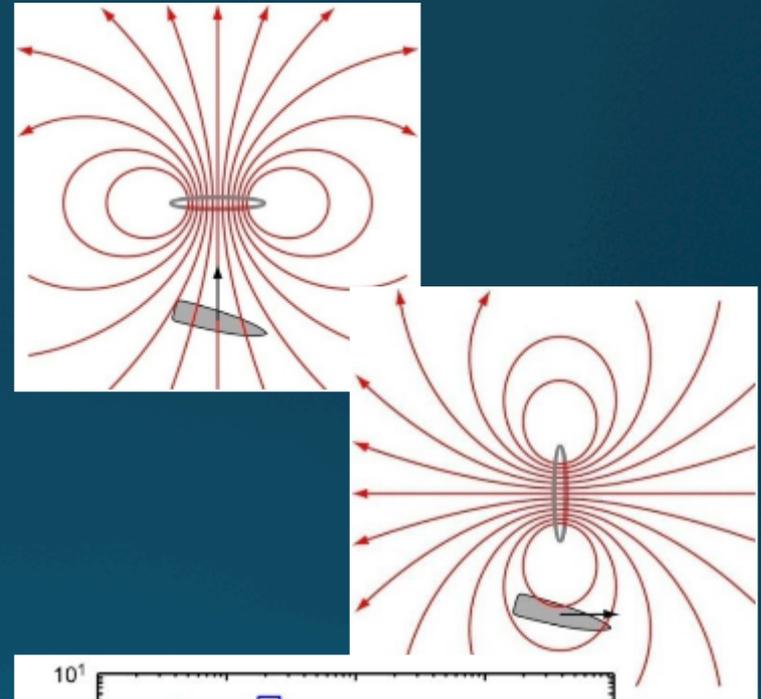
# Advanced Sensor Design

- Multiple transmitters, either offset or in orthogonal orientations
- All include multiple tri-axial receivers positioned across the anomaly



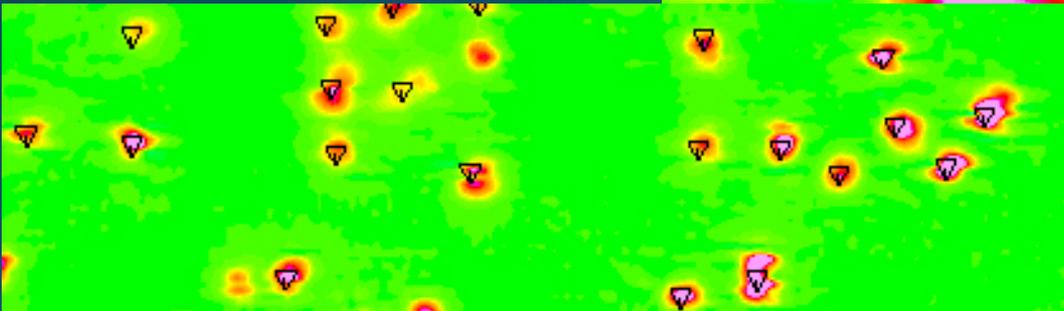
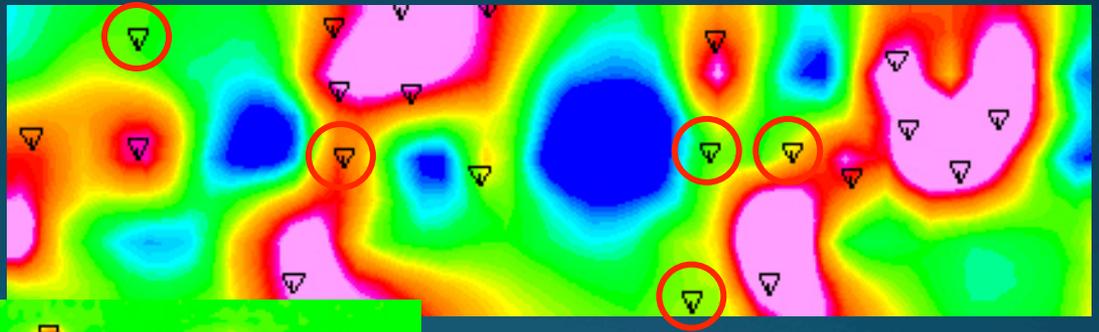
# Advanced Sensor Data

- Dynamic or static (cued)
- Dynamic uses Z-direction transmitter and all receiver orientations
- Cued uses all transmitters and receivers, also includes stacking
- Response measured for each axis of source rather than just the axis facing the receiver
- Response measured ~20 times after each transmit pulse for dynamic data and from 50 to over 100 times for static

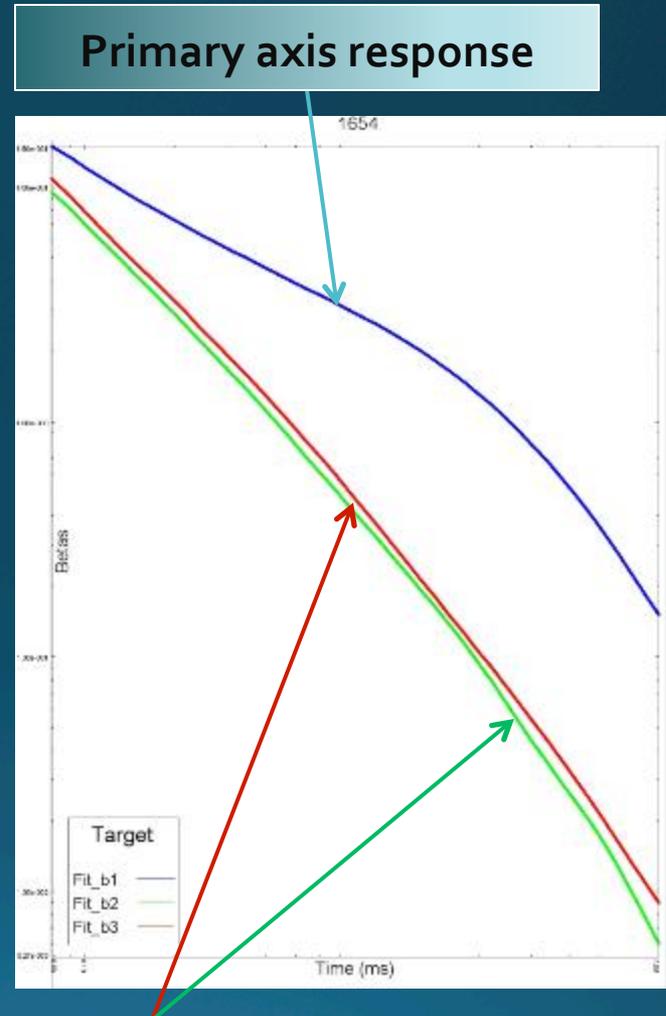
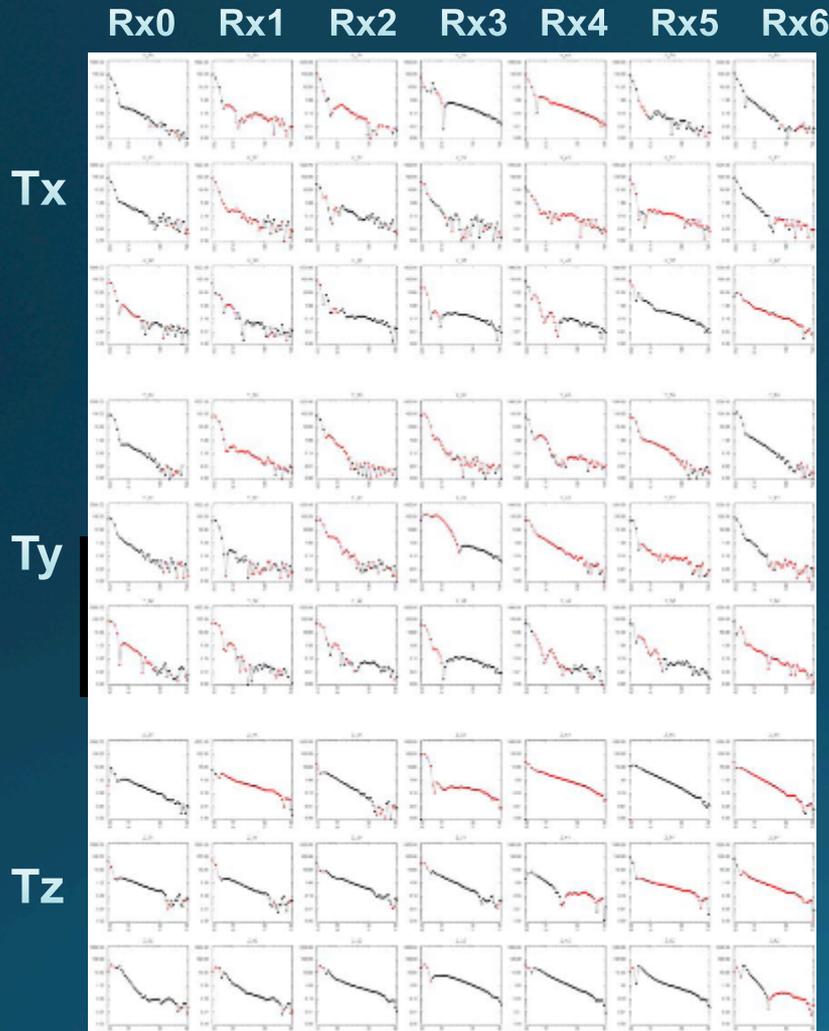


# Advanced Sensor Detection Surveys

- Improved delineation for multiple small sources in high density areas
- Improved positioning
- Later time gates can reduce response from small, near surface sources
- Data can be modeled; potential reduction in targets for cued survey
- Relatively slow



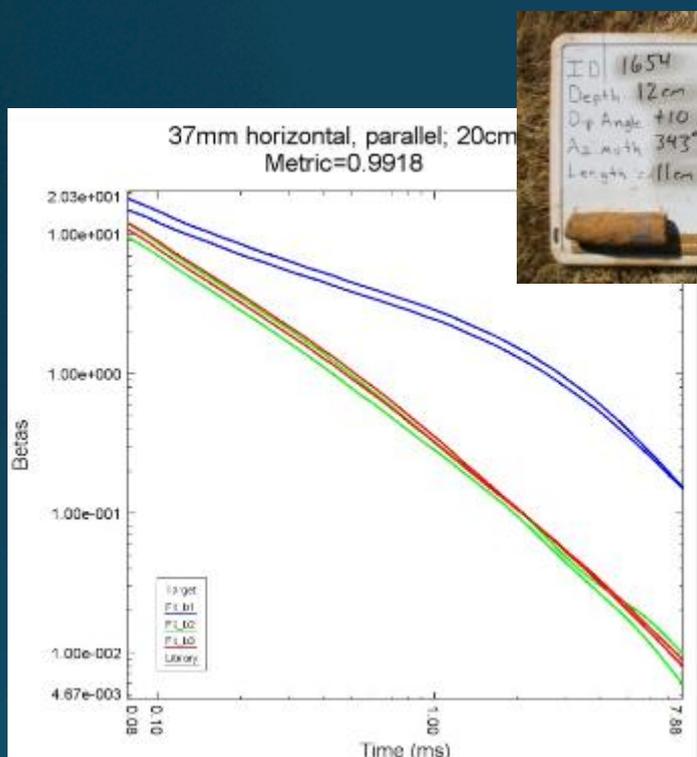
# Cued Advanced Sensor Output



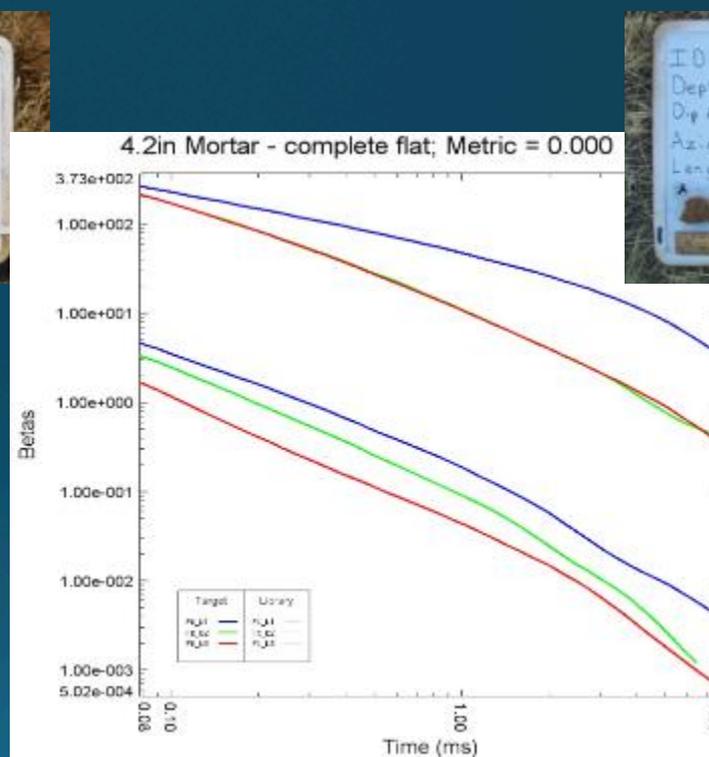
Secondary axis responses

# Library Matching

Results are a measure of the degree of match between an unknown target and a known signature in the library; expressed as a decision metric. High matches are investigated; low left in ground



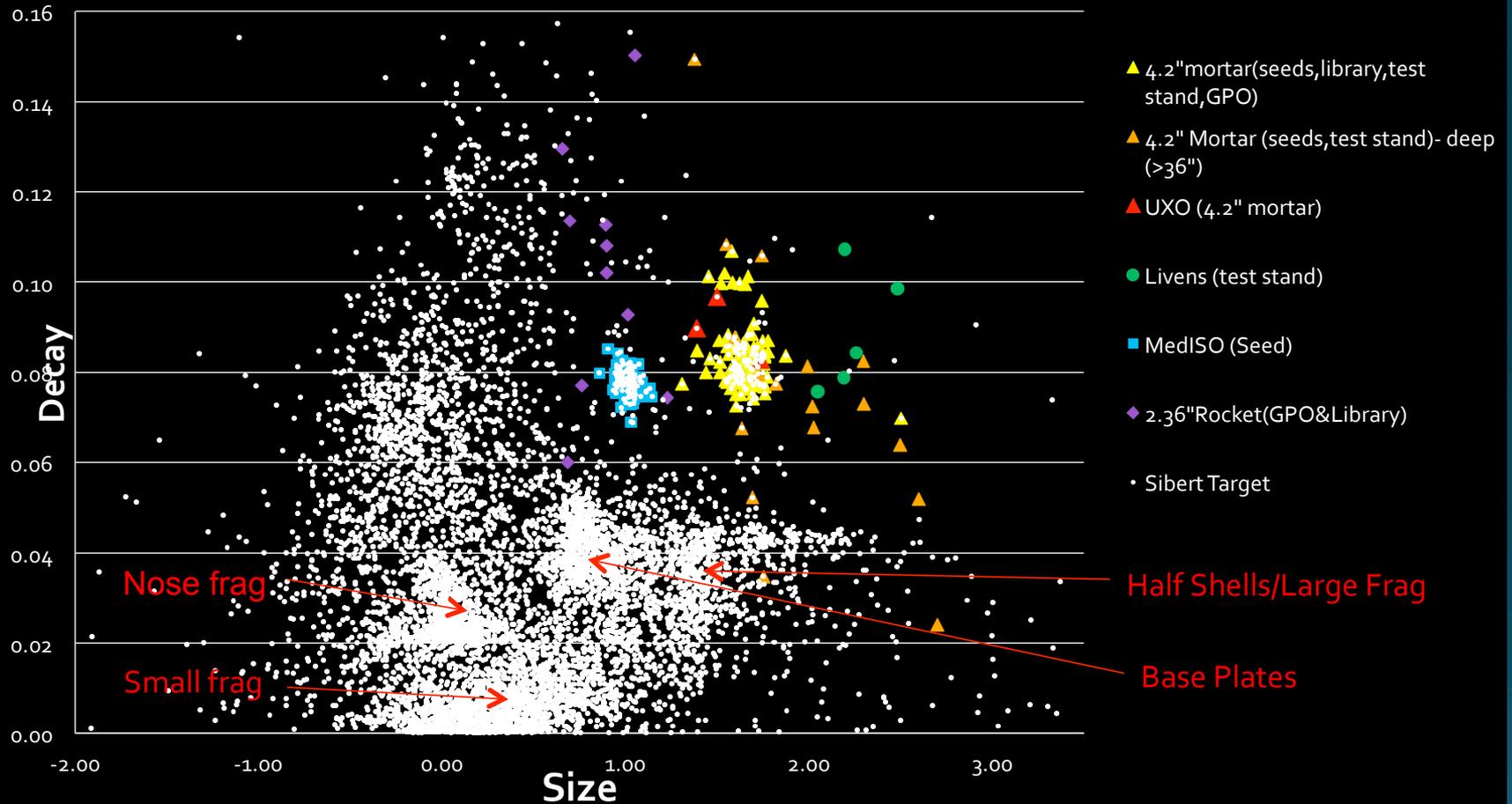
Good Match



Poor Match

# Self-Matching / Clustering

## MetalMapper Classification Feature Space - Camp Sibert



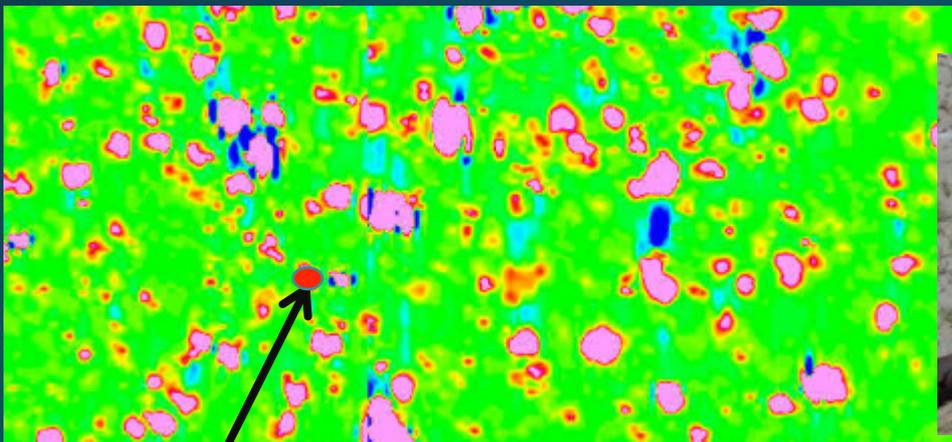
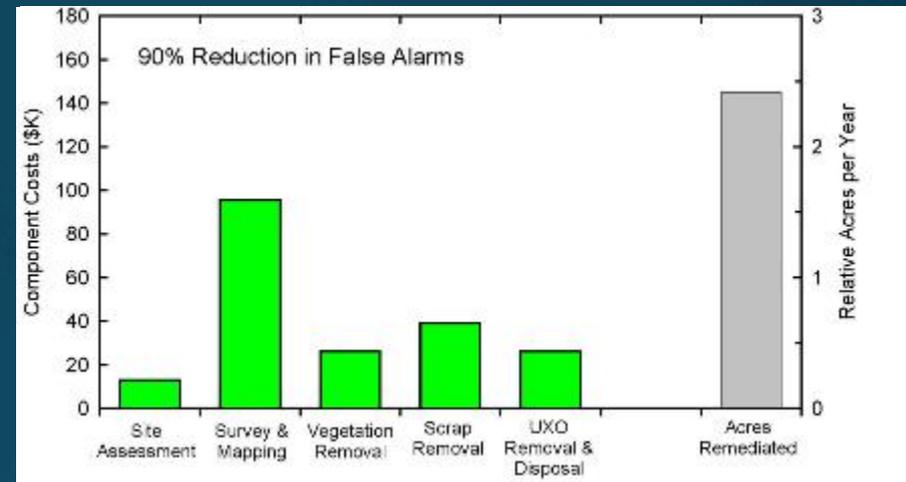
# Ranked Dig List

		Target ID	Conf	Dig	Comment
<b>Dig</b>	Dig Threshold	472	-9999	Y	Inconclusive
		115	.97	Y	Can Analyze: 105mm
		23	.96	Y	Can Analyze: 105mm
		303	.96	Y	Can Analyze: 37mm
		15	...	Y	Can Analyze: 155mm
		300	.79	0	Can Analyze: Horseshoe
<b>Do Not Dig</b>		41	.79	0	Can Analyze: Horseshoe
		2	.78	0	Can Analyze: Likely clutter
		131	...	0	Can Analyze: Likely clutter
		77	.03	0	Can Analyze: Likely clutter
		78	.03	0	Can Analyze: Likely clutter
		21	.02	0	Can Analyze: Likely clutter
		222	.01	0	Can Analyze: Likely clutter

- Verification digs – typically 200 past last TOI
- Validation digs – chosen by PDT, also typically 200

# Deciding on Classification

- Costs dominated by digging scrap
  - <1% are UXO
  - Camp Butner Example:
    - 146 UXO in >500,000 digs
    - Only 0.03% were UXO!



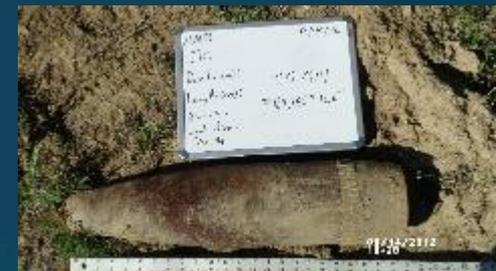
UXO Item



# Targets of Interest

- **Size**

- 20mm and 25mm
- 37mm and 40mm
- Larger



- **Diversity**

- One or two specific munitions
- Extensive list
- Possible unknowns



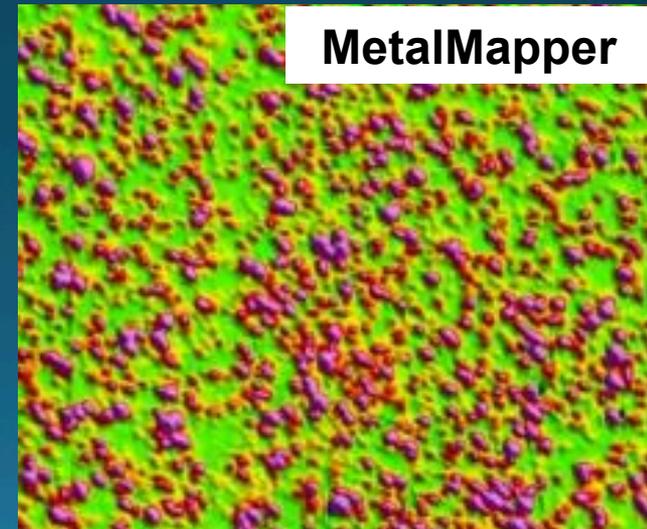
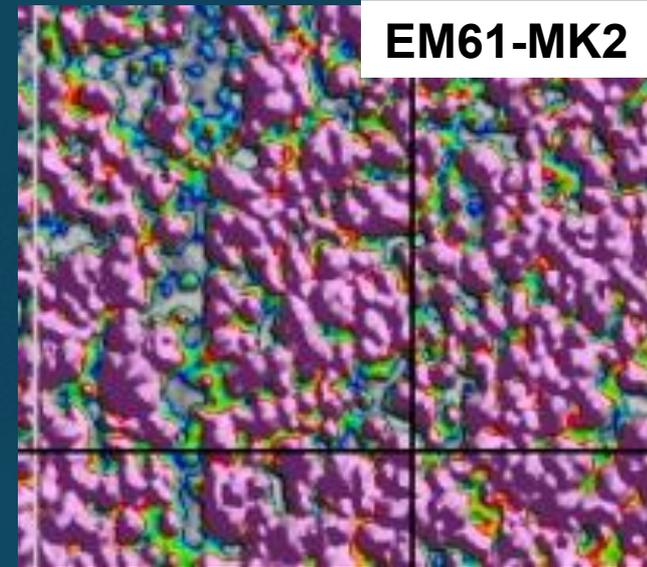
- **Composition**

- Rarely a concern
- Ex: Thin, easily erodible walls; mostly plastic land mines



# Anomaly Density

- **Very High**
  - 3,000-4,000 Anom/Acre, maybe higher
  - M+D / scrape and sift territory
- **High, But Not That High**
  - 500+ Anom/Acre
  - Use of AC Sensor for dynamic survey may identify individual sources
- **Relatively Low**
  - < 500 Anom/Acre
  - Standard detection sensors suitable (and cheaper) for detection survey
- **TOI Density vs Clutter Density**



# Site Conditions

- **Terrain**

- Flat? Hills? Sand dunes? Lava flows?
- Vehicle-based survey or hand-towed/pushed

- **Vegetation**

- Open? Thick brush? Trees? Jungle?
- Brush cutting
- Vehicle or hand-operated
- Coverage

- **Environmental Interference**

- Radio towers
- Power lines

- **Area Closures or Sensitive Sites**

- Beaches, parks, roads
- Wetlands, conservancy areas

- **Evacuations**



# Sensor Options

- **MetalMapper**

- Most often vehicle transported, highest production rates
- No anomaly reacquisition necessary



- **TEMTADS / MetalMapper 2x2**

- Commercial production underway
- Operator transported, no heavy equipment
- Can be used in wooded or rough terrain
- Reacquisition survey necessary for TEMTADS, not for 2x2



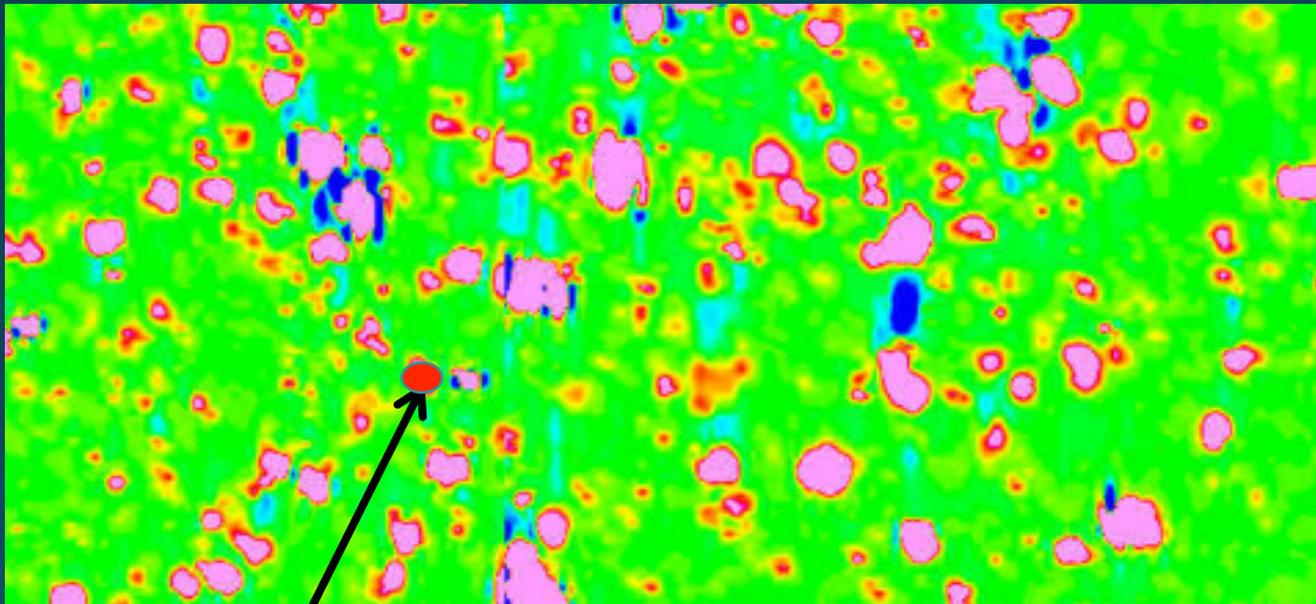
- **MPV**

- Least commercially available
- Single operator
- Can be used in wooded or rough terrain



# Stakeholder Input and Contracting

- **Stakeholder input**
  - OK with metal left in ground?



**UXO Item**

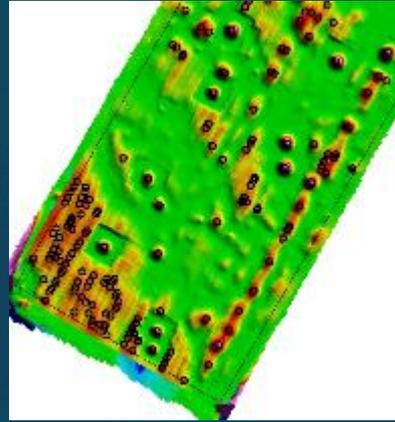
- 3<sup>rd</sup> party review

# Ideal Site – West Mesa, NM



- Two large TOIs; few native TOI
- EM61 towed array used for all but 6 acres of dynamic data collection over 198 acres
- Flat and open; little geologic variability
- NMED and EPA on board from start
- AC eliminated need for closure of nearby airport; no residential evacuations necessary
- Eliminated need for scrape and sift at target center; 94% reduction in digs

# Less than Ideal Site – Marpi Point Field, Saipan, CNMI



- 20mm to 5-in projectiles, mortars, rockets, grenades
- Pacific island jungle; extensive brush cutting required
- Significant effects from across-site geologic changes
- High native TOI rate; deformed and deteriorated TOI
- Dynamic production slow but improved results from EM6<sub>1</sub>
- 46.5% dig rate; cued data collection and classification deemed more expensive than digging everything