Thank you for signing in early

The webinar will begin promptly at
12:00 pm ET, 9:00 am PT

SERDP
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SERDP and ESTCP Webinar Series

The webinar will begin promptly at 12:00 pm ET, 9:00 am PT

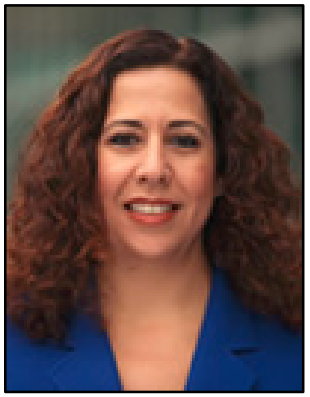
- You have two options for accessing the webinar
  1. Listen to the broadcast audio if your computer is equipped with speakers
  2. Call into the conference line: 303-248-0285
     Required conference ID: 6102000
- For any question or issues, please email serdp-estcp@noblis.org or call 571-372-6565

Award Winning Projects
Munitions Response

February 9, 2017

SERDP DOD • EPA • DOE | ESTCP

Welcome and Introductions



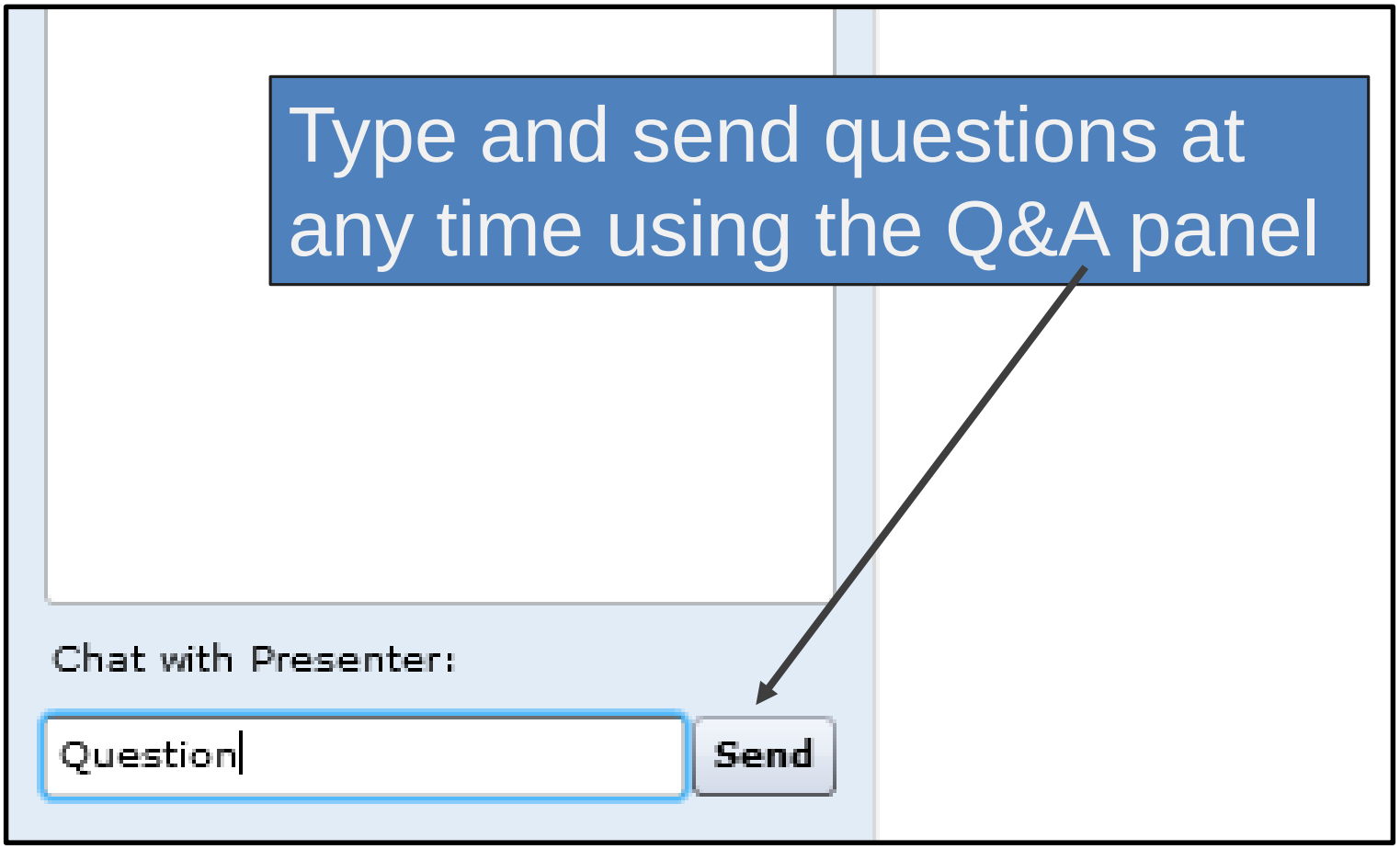
Rula A. Deeb, Ph.D.
Webinar Coordinator

SERDP DOD • EPA • DOE | ESTCP

Webinar Agenda

- **Webinar Logistics** (5 minutes)
  Dr. Rula Deeb, Geosyntec Consultants
- **Overview of SERDP and ESTCP** (5 minutes)
  Dr. Herb Nelson, SERDP and ESTCP
- **Decision Support Tools for Munitions Response** (50 minutes + Q&A)
  Dr. Laurens Beran, Black Tusk Geophysics
- **Final Q&A session**

How to Ask Questions



In Case of Technical Difficulties

- Delays in the broadcast audio
  - Click the mute/connect button
  - Wait 3-5 seconds
  - Click the mute/connect button again
  - If delays continue, call into the conference line
    - Call into the conference line: 303-248-0285
    - Required conference ID: 6102000
- Submit a question using the chat box

SERDP and ESTCP Overview

Herb Nelson, Ph.D.
Munitions Response Program Manager

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SERDP

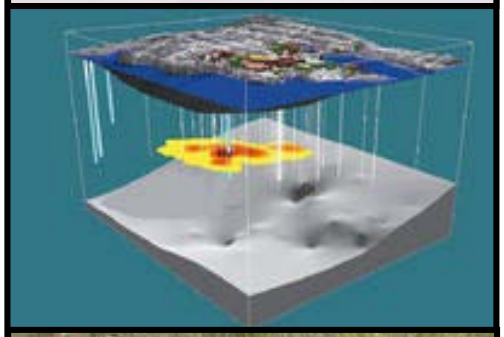
- Strategic Environmental Research and Development Program
- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

ESTCP

- Environmental Security Technology Certification Program
- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

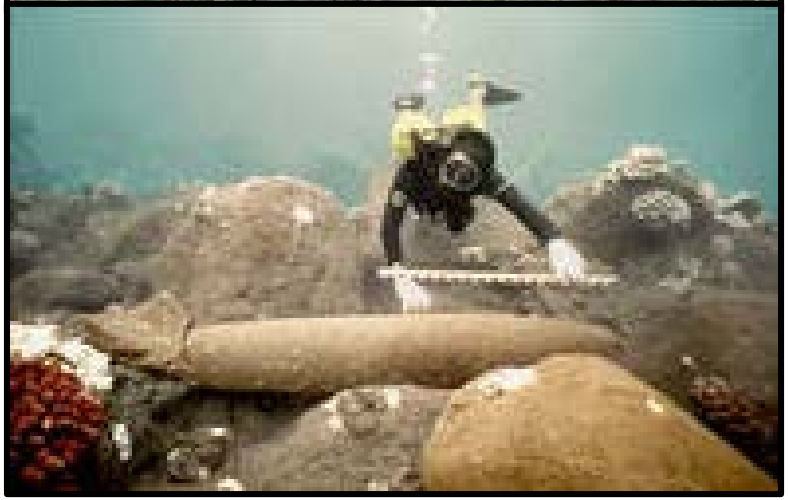
Program Areas

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Resiliency
5. Weapons Systems and Platforms



Munition Response

- Munitions on land
  - Classification
- Munitions underwater
  - Wide area and detailed surveys
  - Cost-effective recovery and disposal
  - Characteristics of munitions underwater, their environment and mobility



SERDP and ESTCP Webinar Series

Date	Topic
February 23, 2017	**Award Winning Projects** Resource Conservation and Resiliency
March 9, 2017	**Award Winning Projects** Environmental Restoration
March 23, 2017	Monitoring and Risk Assessment of Environmental Risks Posed by Munitions Constituents in Aquatic Systems
April 6, 2017	1,4-Dioxane Impacts and Innovative Cleanup Technologies at DoD Contaminated Sites
April 20, 2017	Solutions for Installations' Participation in Energy Markets
May 4, 2017	Novel Coatings Systems for Use as High Performance Chemical Resistant Power Topcoats

For upcoming webinars, please visit

http://serdp-estcp.org/Tools-and-Training/Webinar-Series

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SERDP • ESTCP SYMPOSIUM

2017 | Enhancing DoD's Mission Effectiveness

A three-day symposium showcasing the latest technologies that enhance DoD's mission through improved environmental and energy performance

- November 28 - November 30, 2017
- Washington Hilton Hotel
  1919 Connecticut Avenue, NW
  Washington, DC 20009
- ***Registration coming soon***

Decision Support Tools for Munitions Response

Laurens Beran, Ph.D.
Black Tusk Geophysics

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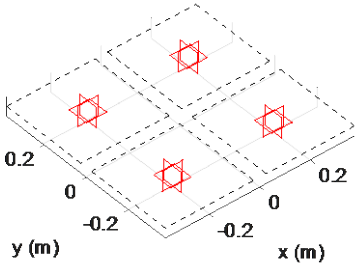
Agenda

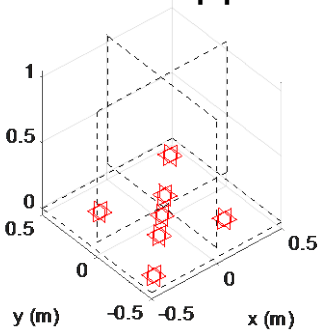
1. Detection with advanced sensors
   - Software for threshold modeling
   - Channel selection
   - Dealing with high density areas
2. Risk assessment
   - Synthetic seeding
   - Classification difficulty
   - Verification of stop dig point

Detection with Advanced Electromagnetic (EM) Sensors

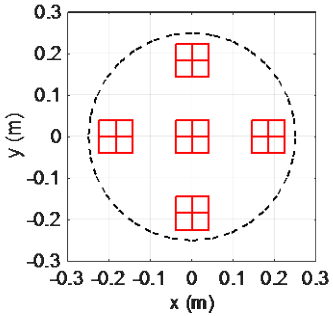
TEMTADS2x2



MetalMapper

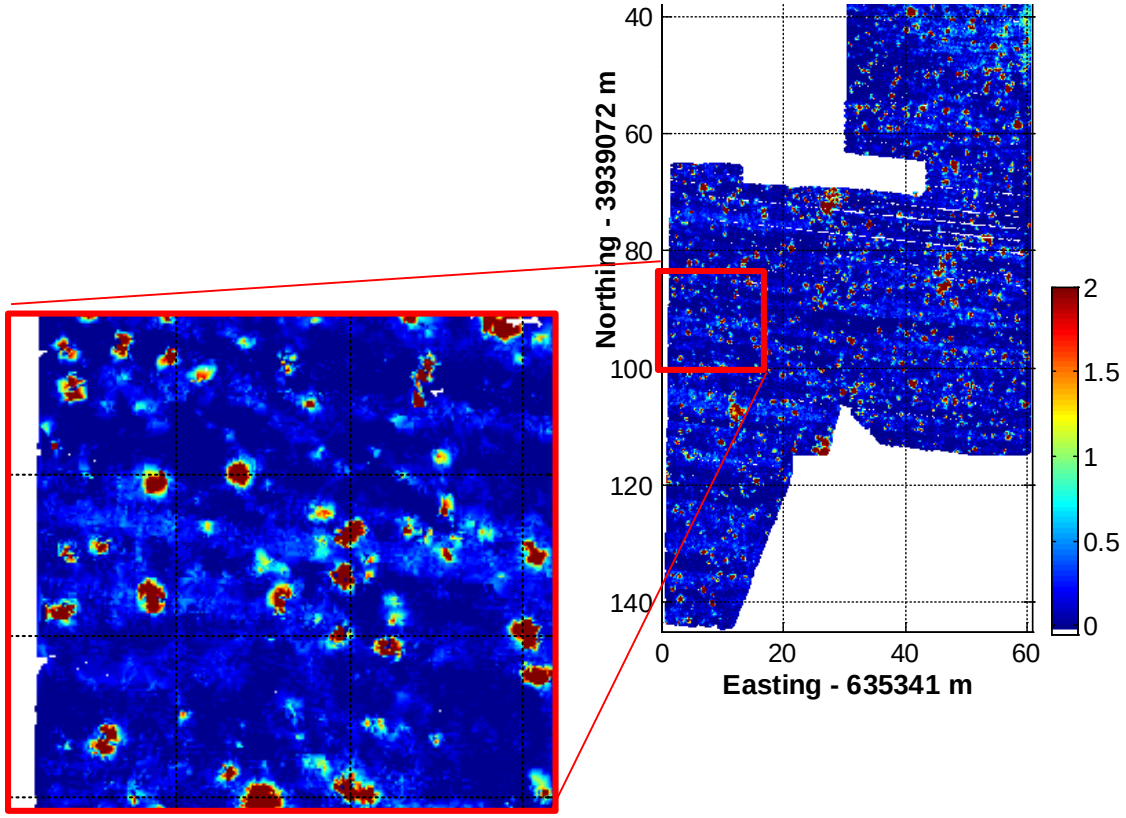


Man Portable Vector (MPV)



Advanced Classification Workflow

1. Detection → 2. Target picking → 3. Cued interrogation → 4. Feature extraction → 5. Classification



Advanced Classification Workflow

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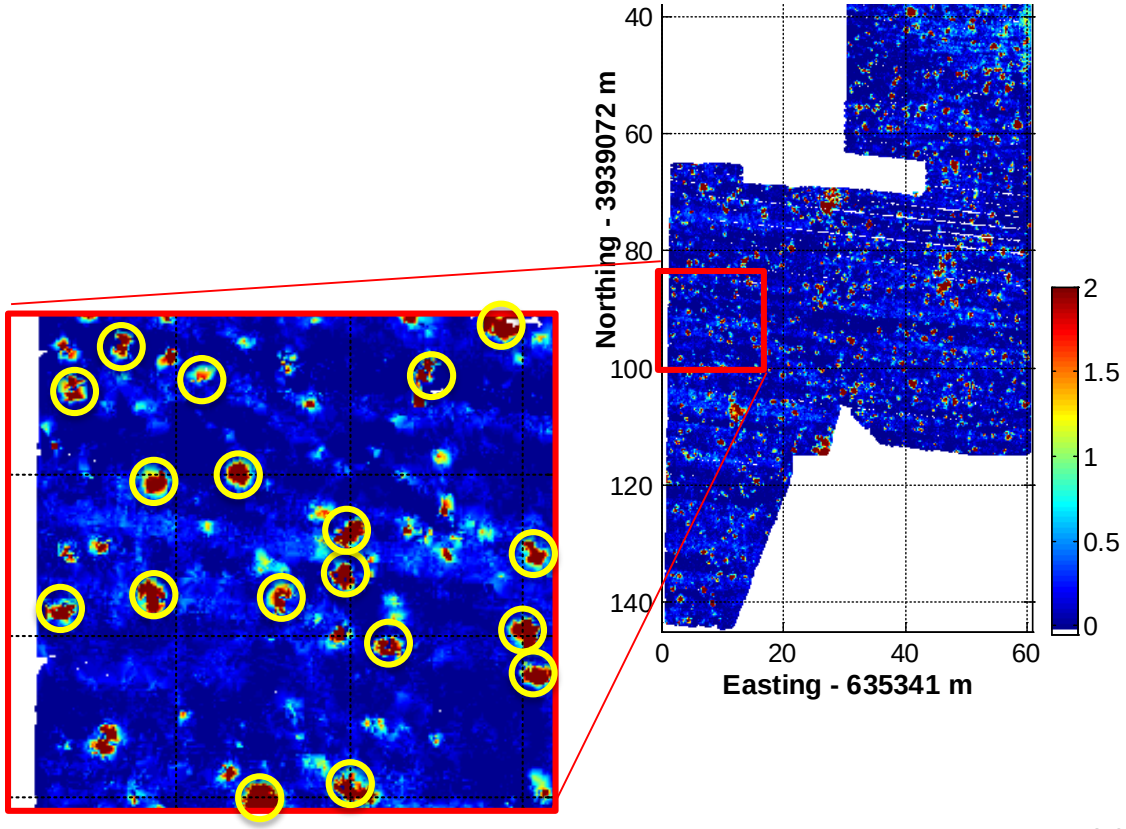


Advanced Classification Workflow

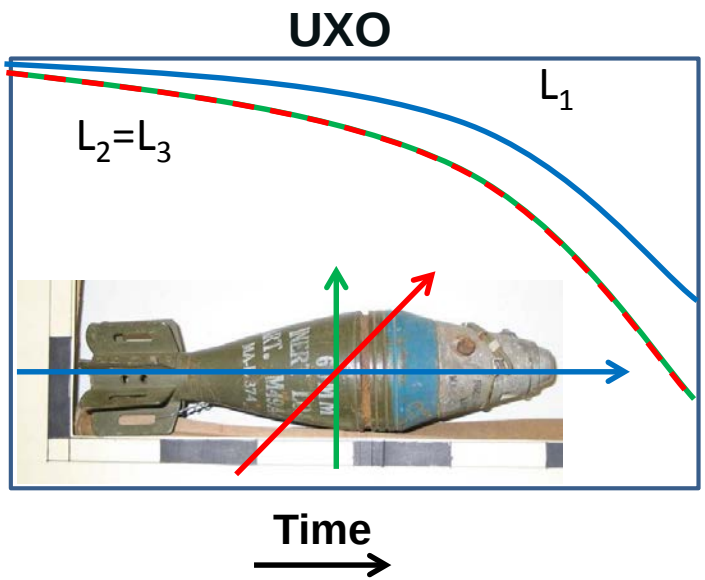
1. Detection → 2. Target picking → 3. Cued interrogation → 4. Feature extraction → 5. Classification

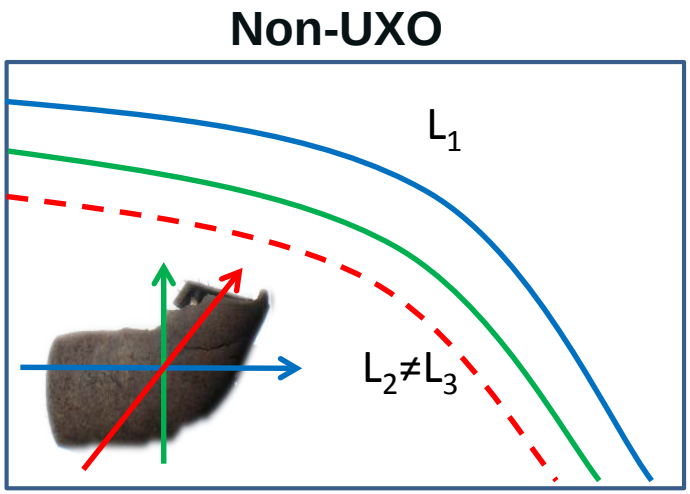
Advanced Classification Workflow

1. Detection → 2. Target picking → 3. Cued interrogation → 4. Feature extraction → 5. Classification

Model measurements to estimate each target's

1. Location and depth
2. Orientation
3. **Polarizabilities**





Advanced Classification Workflow

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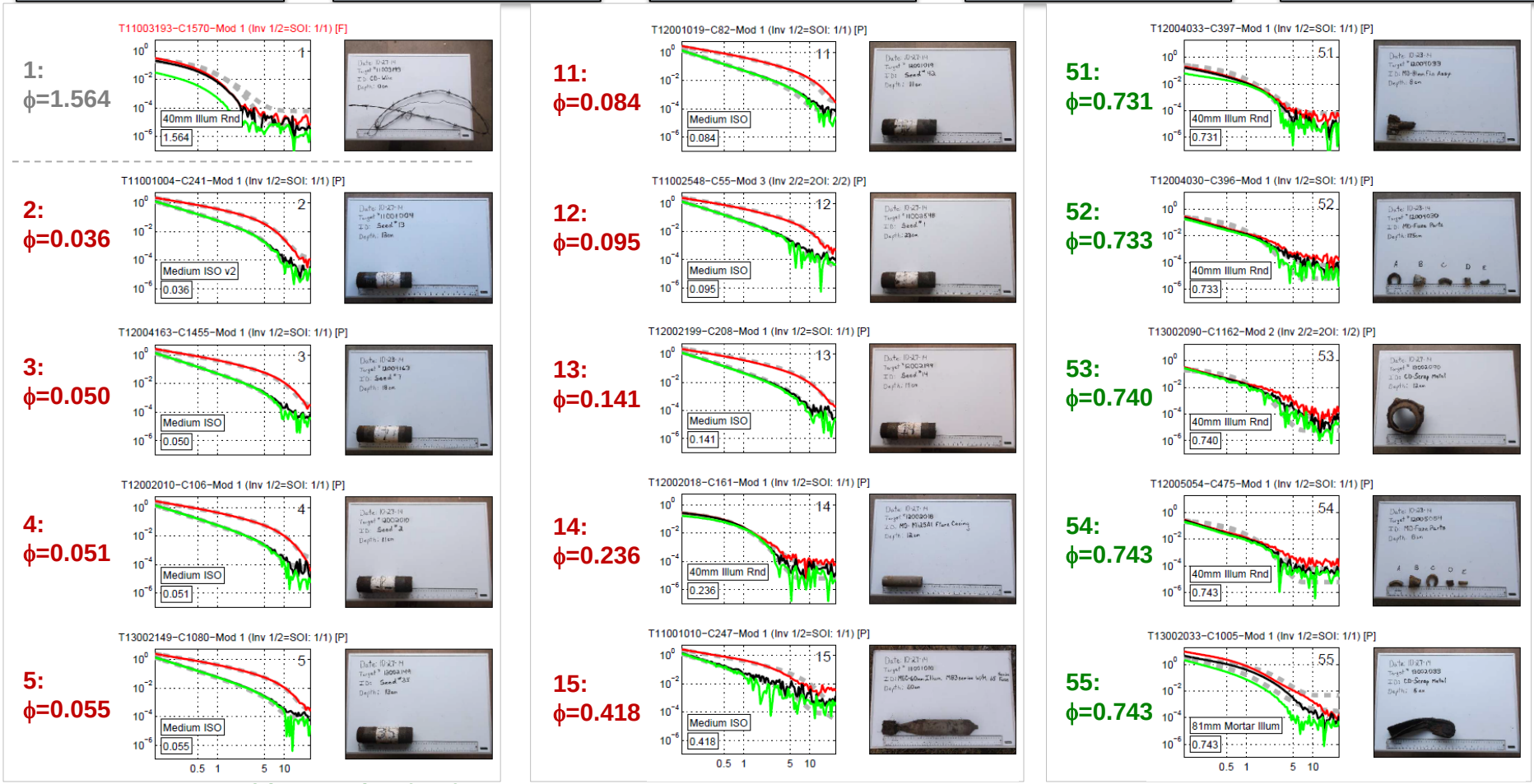
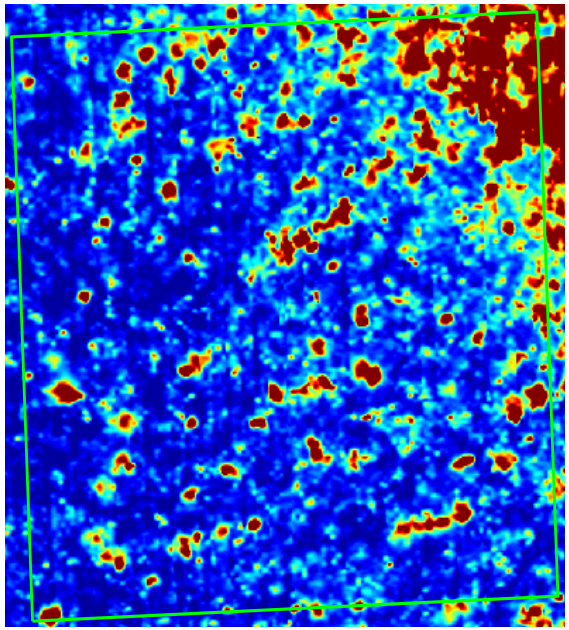


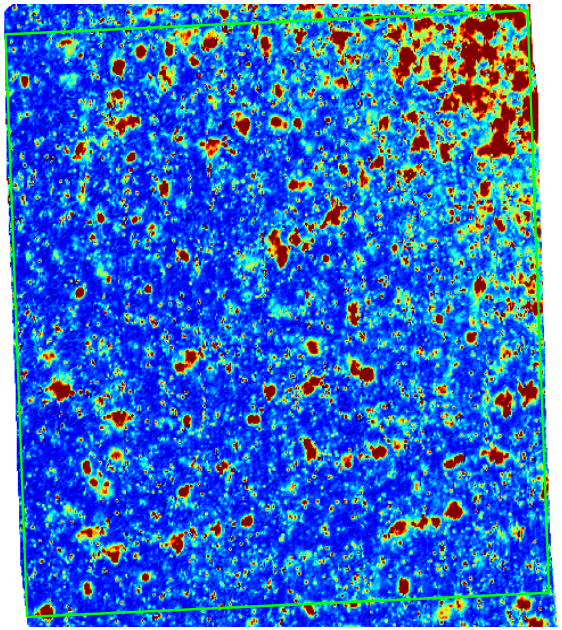
Detection with Advanced Sensors

1. Detection → 2. Target picking → 3. Cued interrogation → 4. Feature extraction → 5. Classification

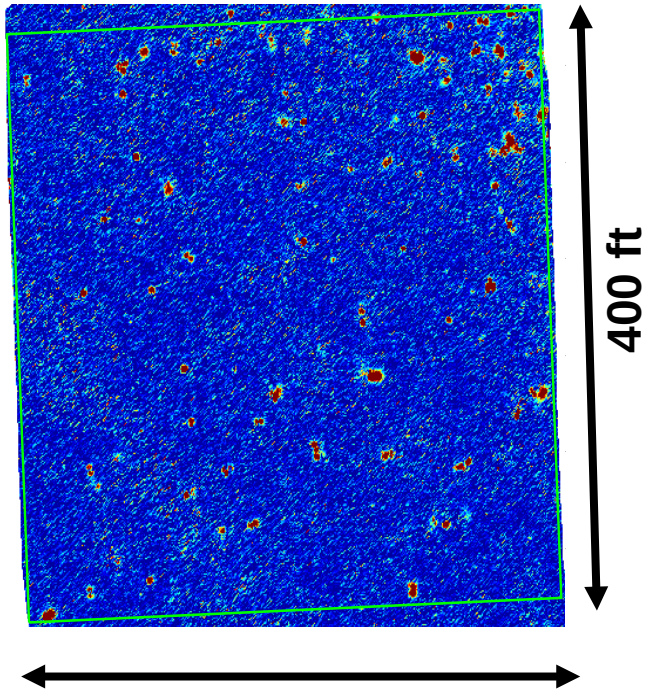
EM61 - 1.27ms



MetalMapper - 1.23ms



MetalMapper - 9.2ms



Detection with Advanced Sensors

1. How should I pick targets?
2. What time channel should be used for detection?
3. How deep can I detect and classify?
4. Where can classification be applied?

How Should I Pick Targets?

- **Informed Source Selection**: Use modeling and inversion to pick and screen targets

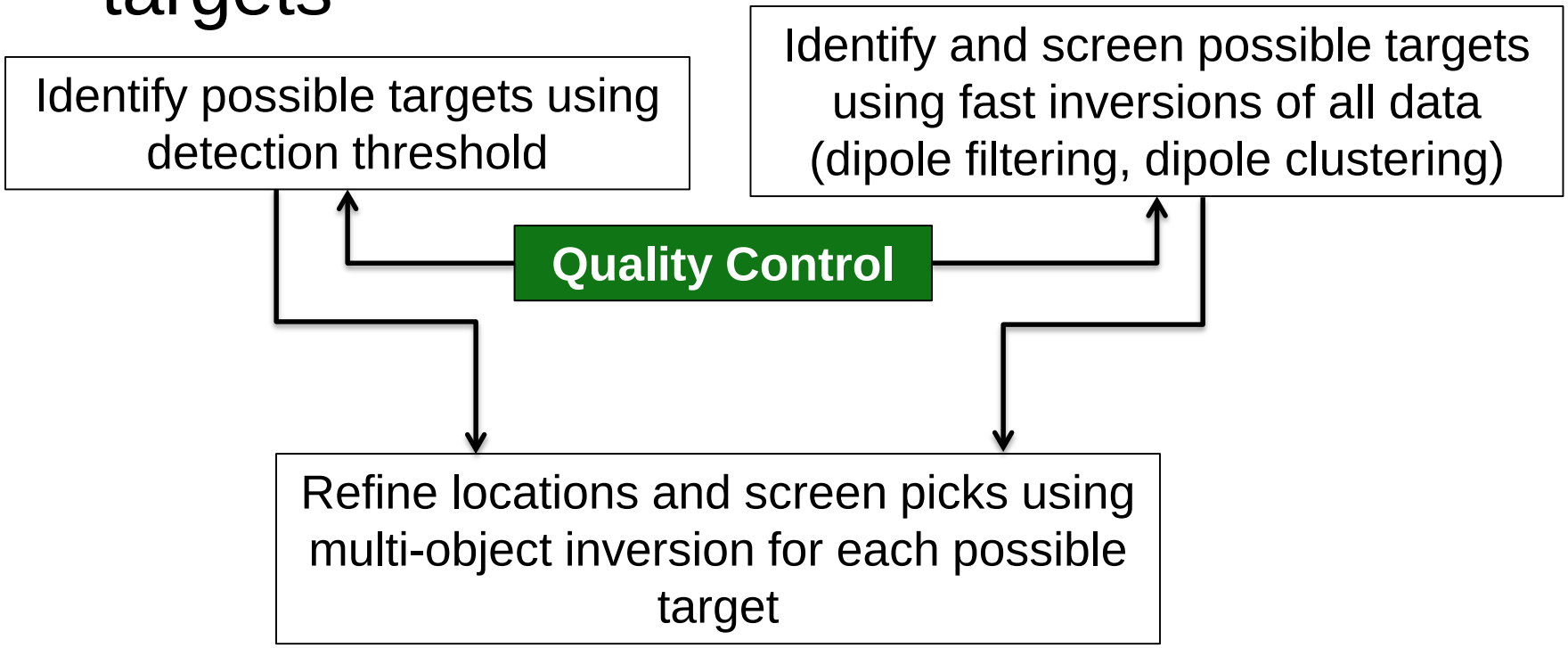
Identify possible targets using detection threshold

Identify and screen possible targets using fast inversions of all data (dipole filtering, dipole clustering)

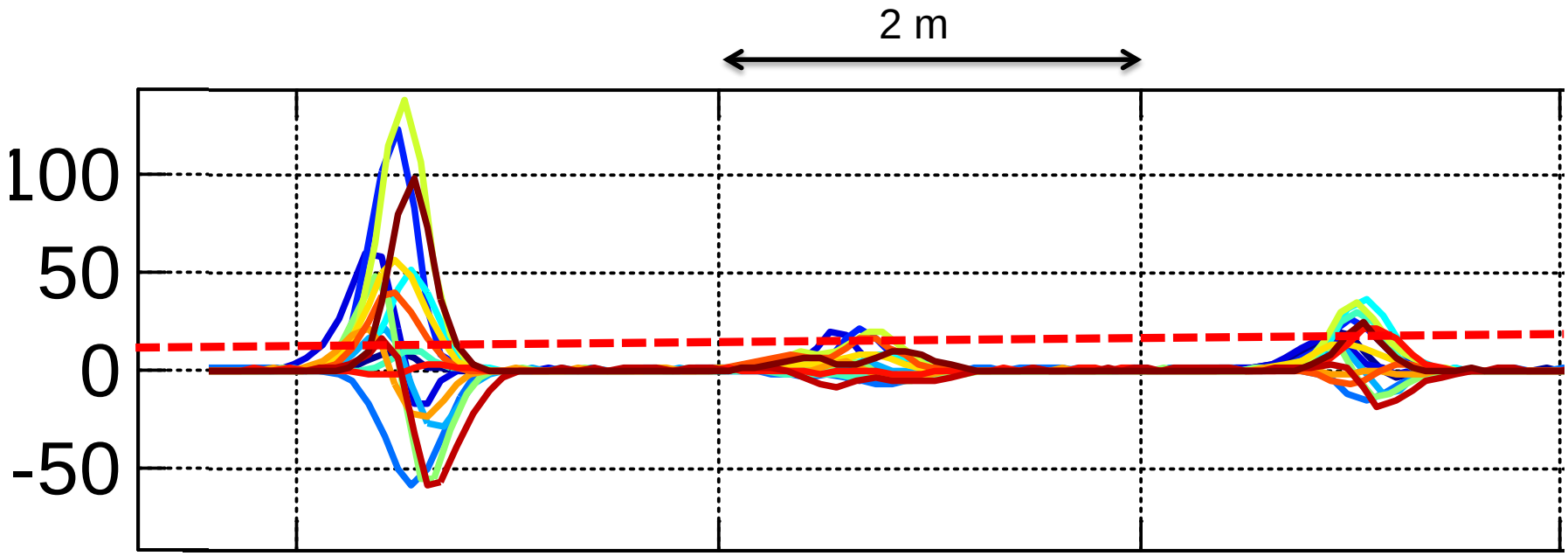
Refine locations and screen picks using multi-object inversion for each possible target

How Should I Pick Targets?

- **Informed Source Selection**: Use modeling and inversion to pick and screen targets



Detection Threshold

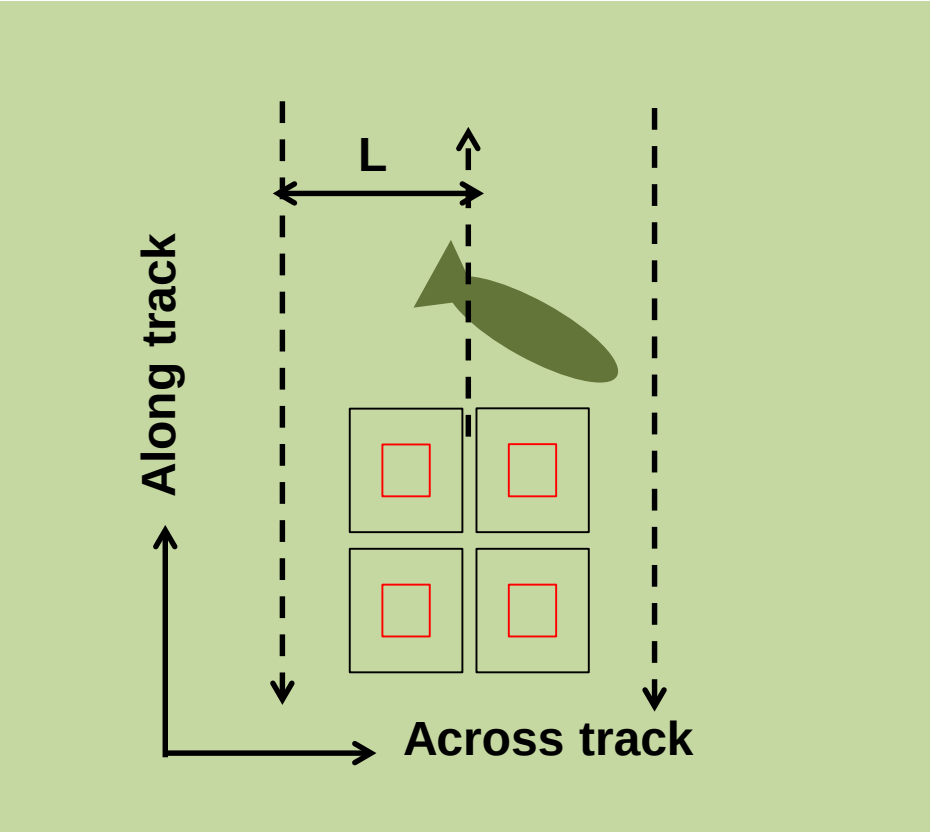


Small ISO	Small ISO	Small ISO
d = 18.5 cm	d = 24.5 cm	d = 16.5 cm
Vertical	Horizontal	Horizontal

ISO: industry standard object

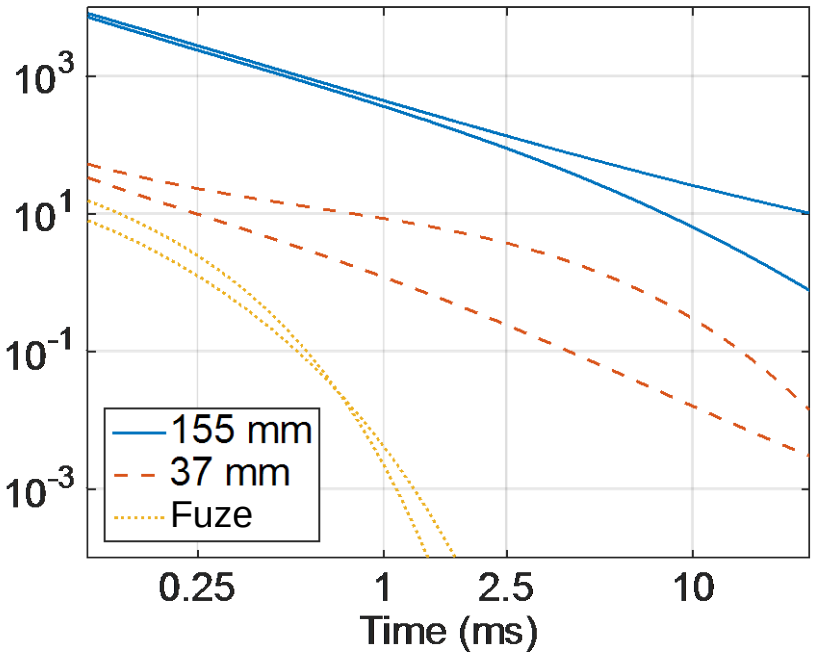
How Do I Calculate a Detection Threshold?

- Amplitude of observed data depends on
  - Target depth
  - Line spacing
  - Sensor height
  - Target orientation

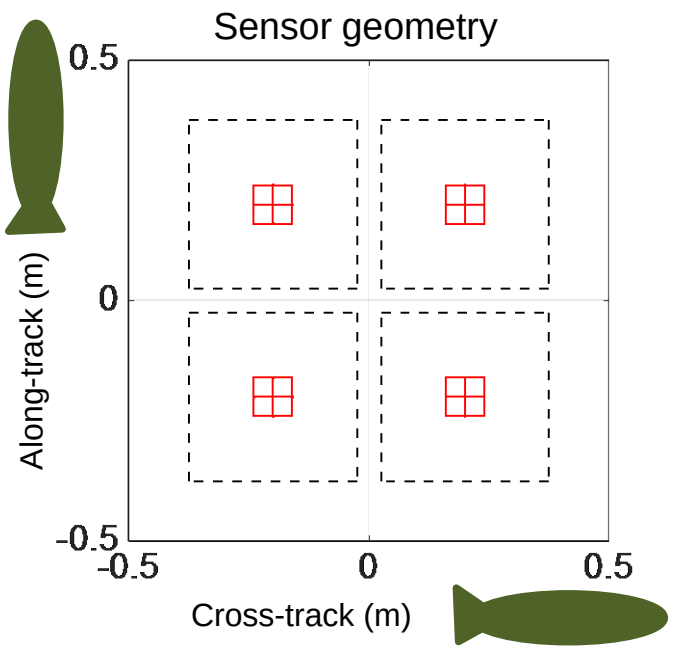


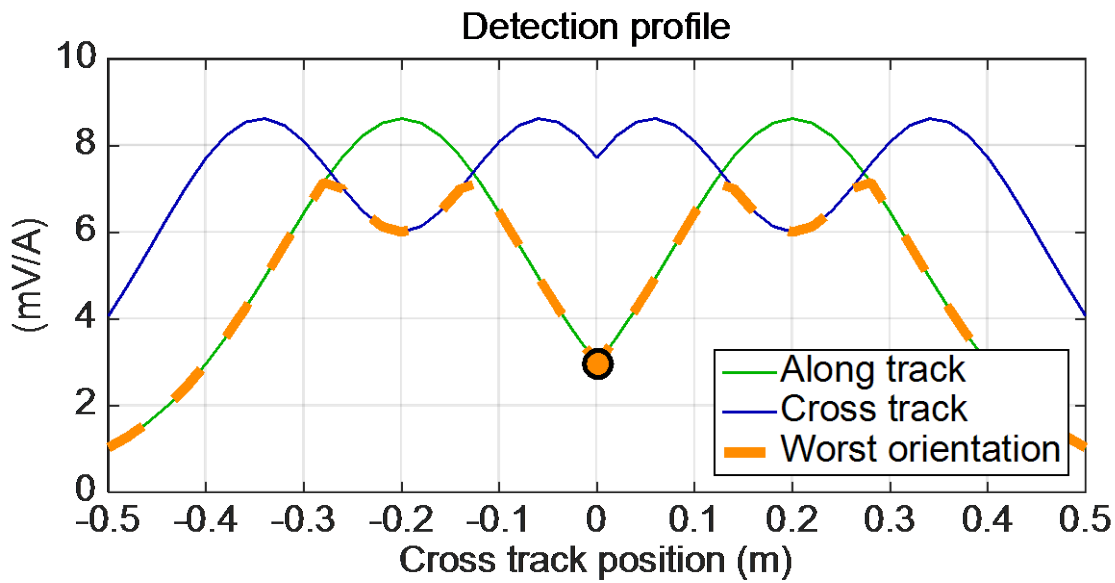
How Do I Calculate a Detection Threshold?

- Amplitude of observed data depends on
  - Target depth
  - Line spacing
  - Sensor height
  - Target orientation
  - Target polarizabilities

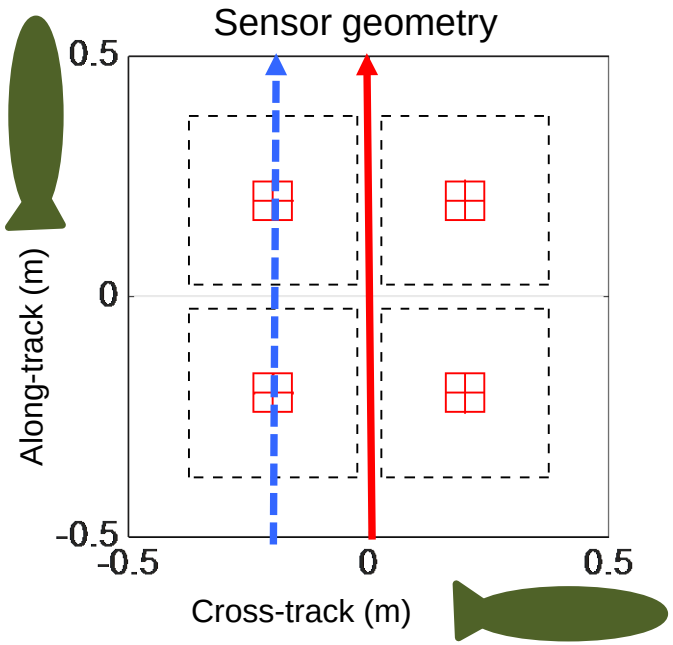


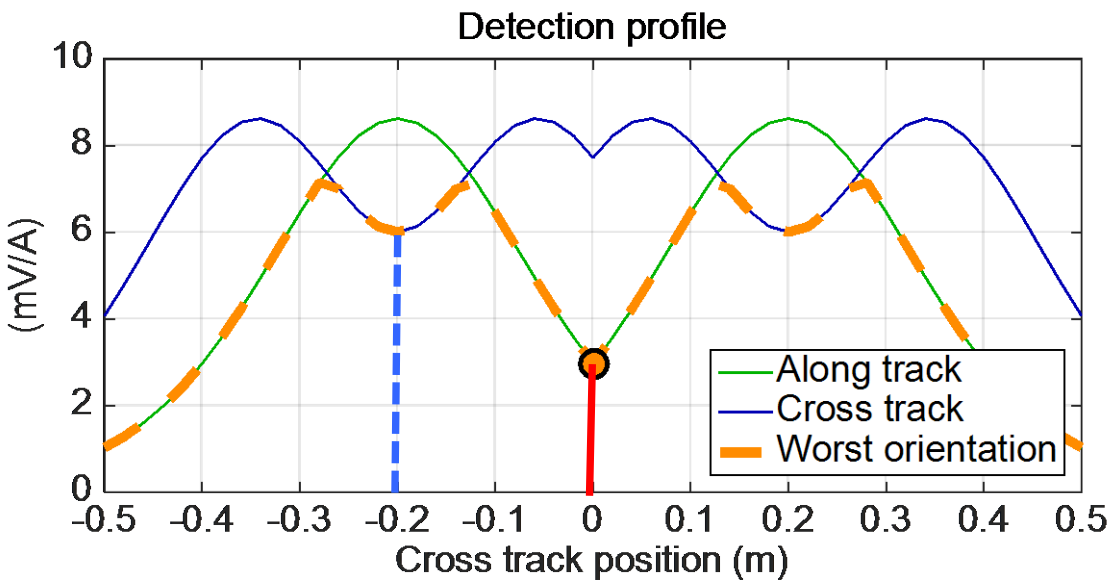
Threshold Calculation: TEMTADS2x2



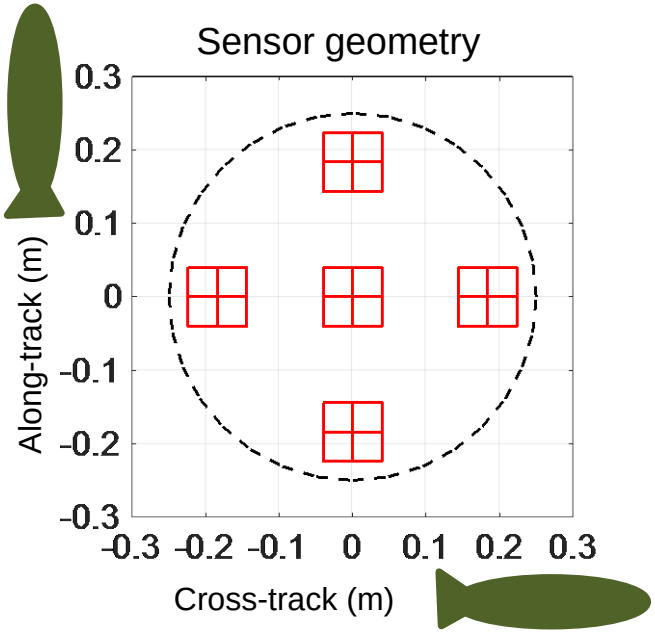


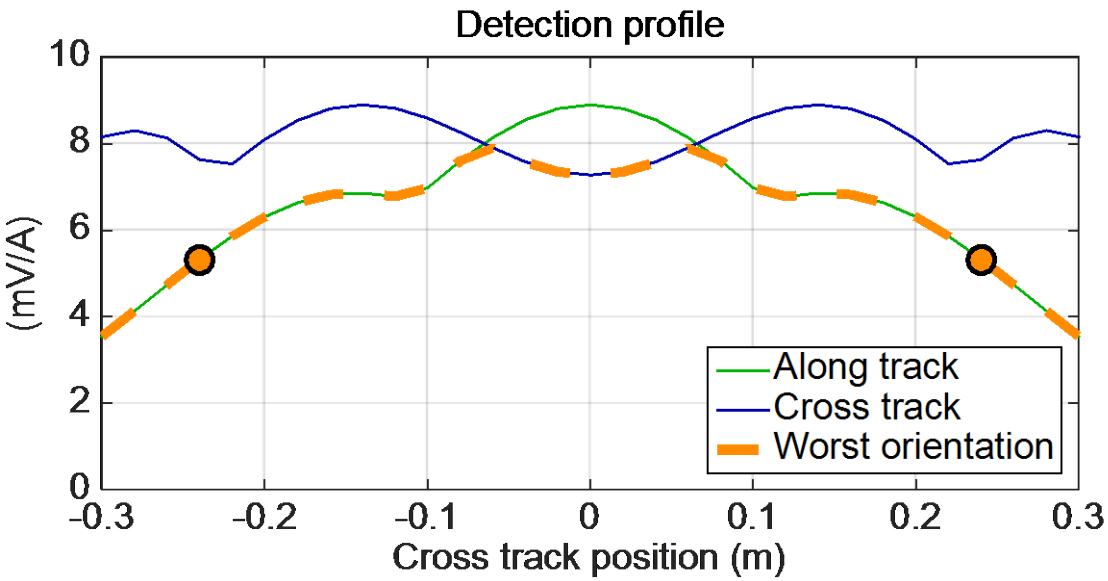
Threshold Calculation: TEMTADS2x2



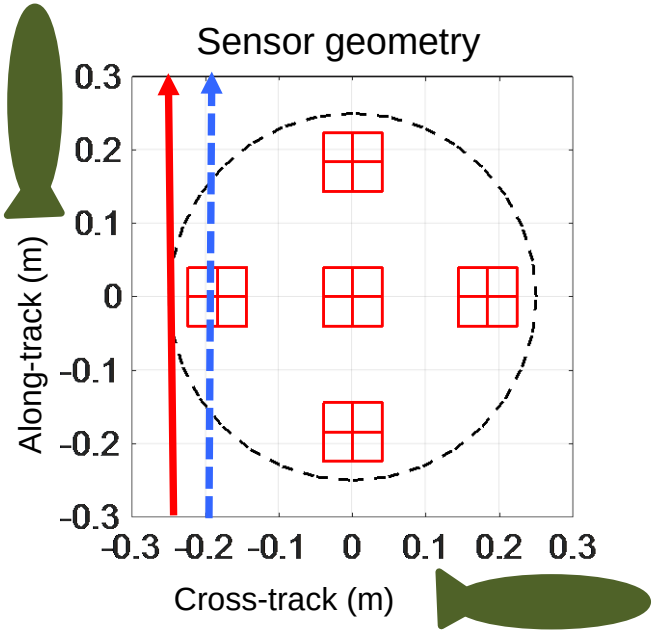


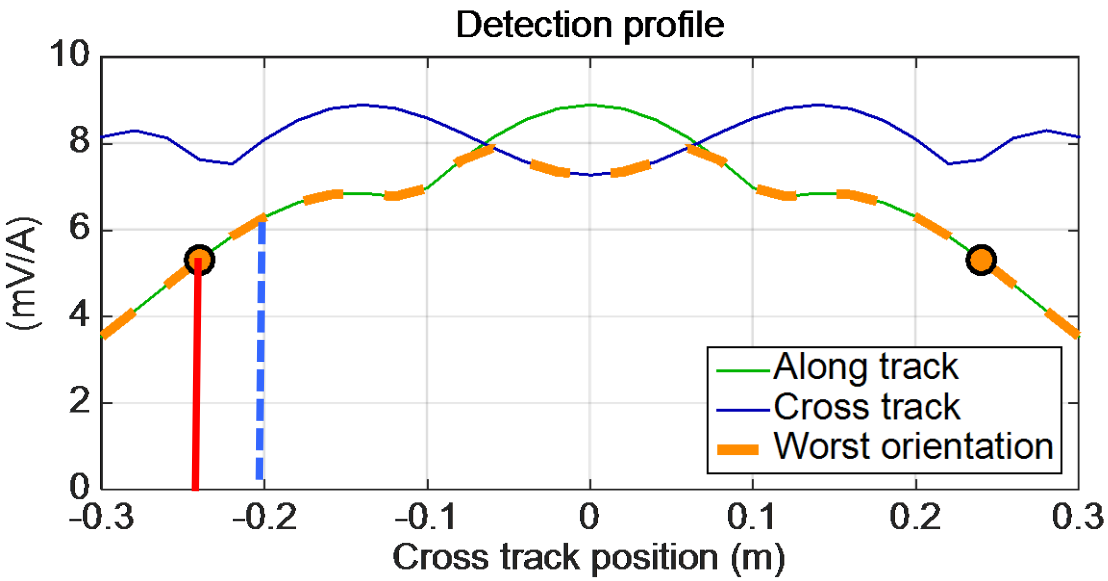
Threshold Calculation: MPV





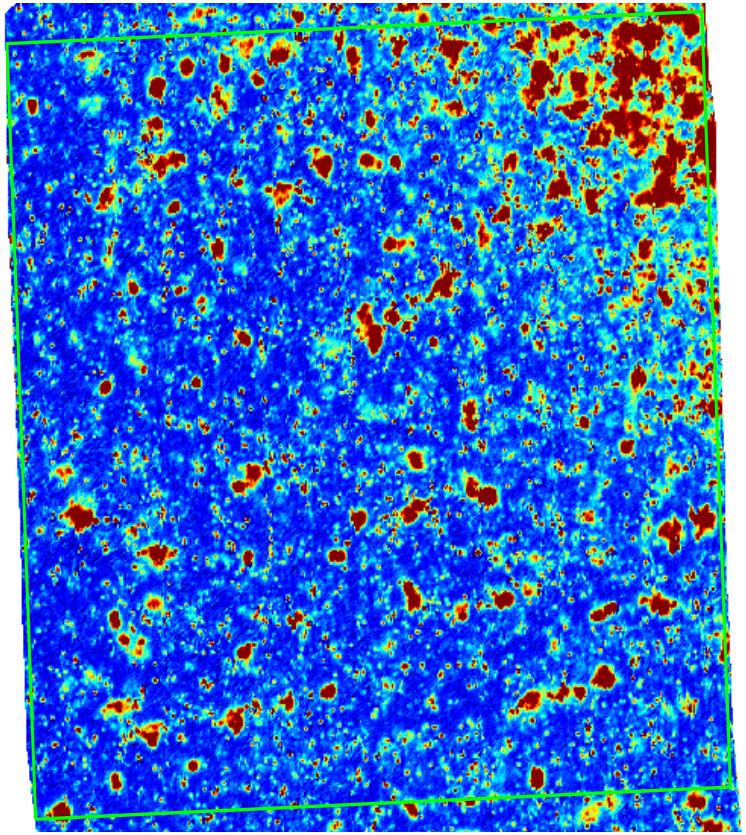
Threshold Calculation: MPV



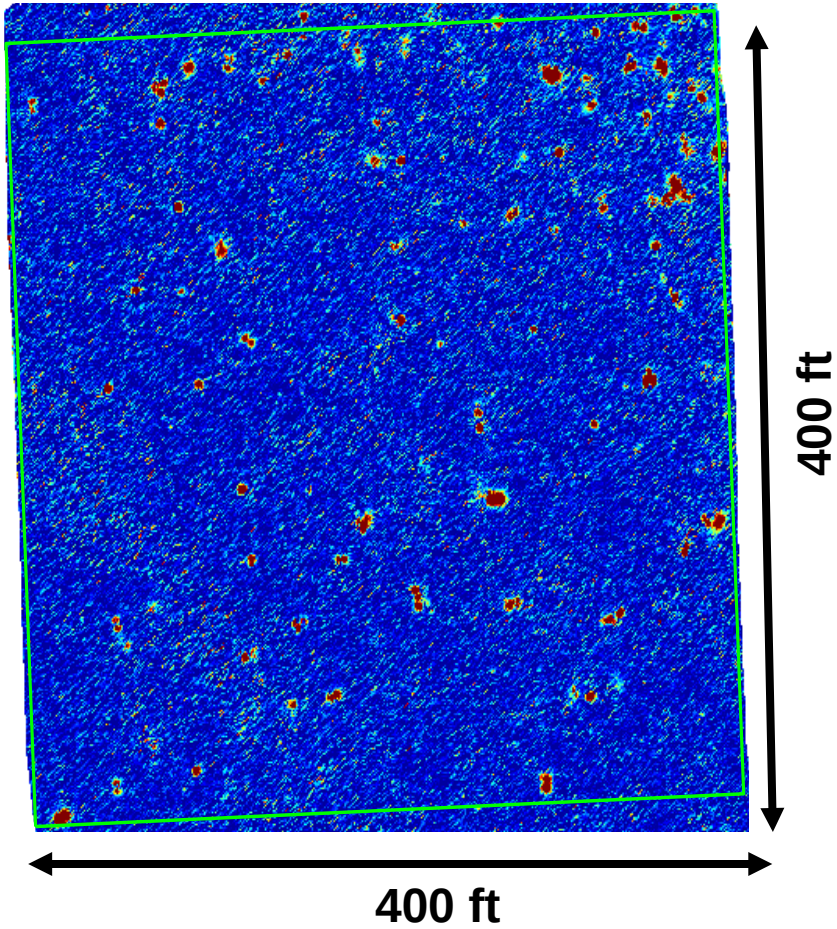


What Channel Should I Use for Picking?

MetalMapper - 1.23ms

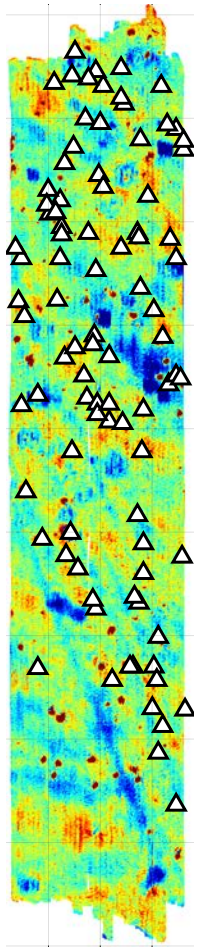


MetalMapper - 9.2ms

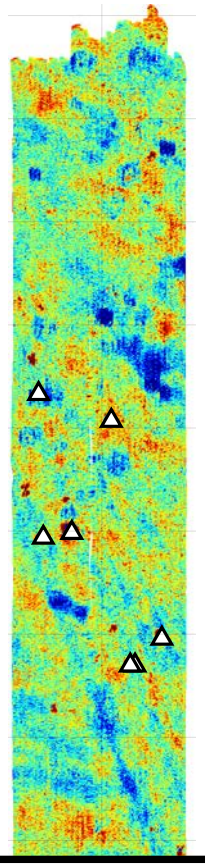


What Channel Should I Use for Picking?

0.11 ms: 90 picks



0.34 ms: 7 picks



Target pick

Channel Optimization for a Sum of Channels

- "Maxmin" approach: Maximize signal to noise ratio (SNR) for worst case detection scenario

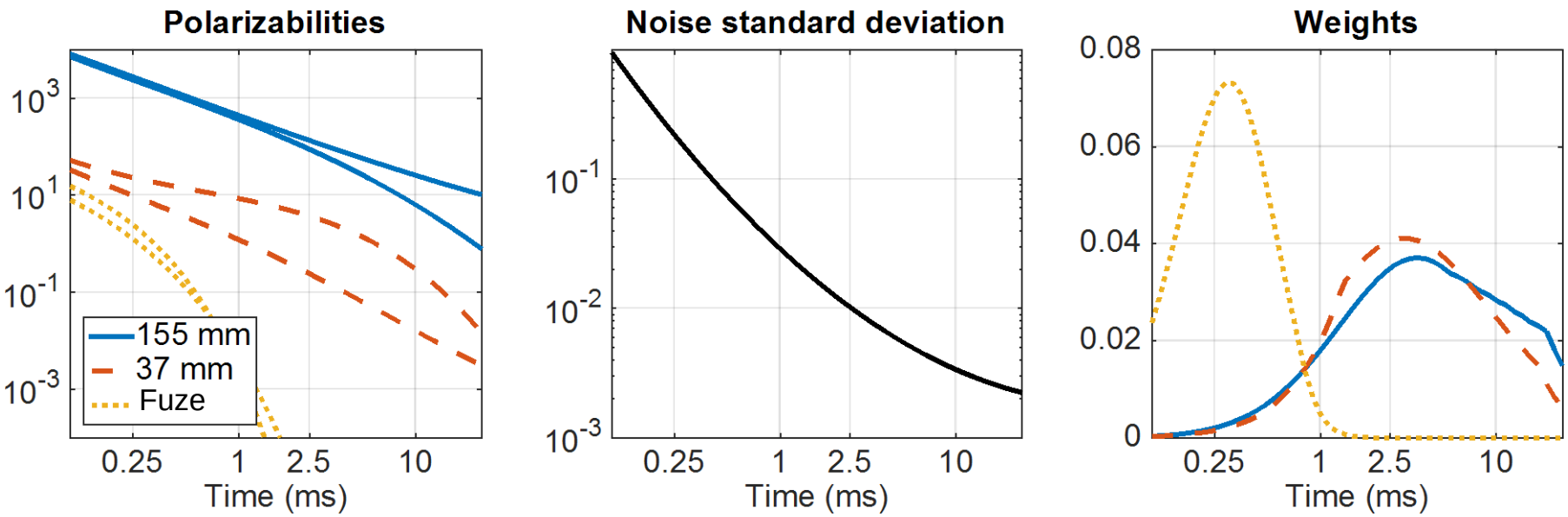
$$\mathrm{SNR} = \frac{d_{detect}^2}{\sigma_{detect}^2}$$

$$d_{detect} = \sum_{i=1}^{M} w_i d_i$$

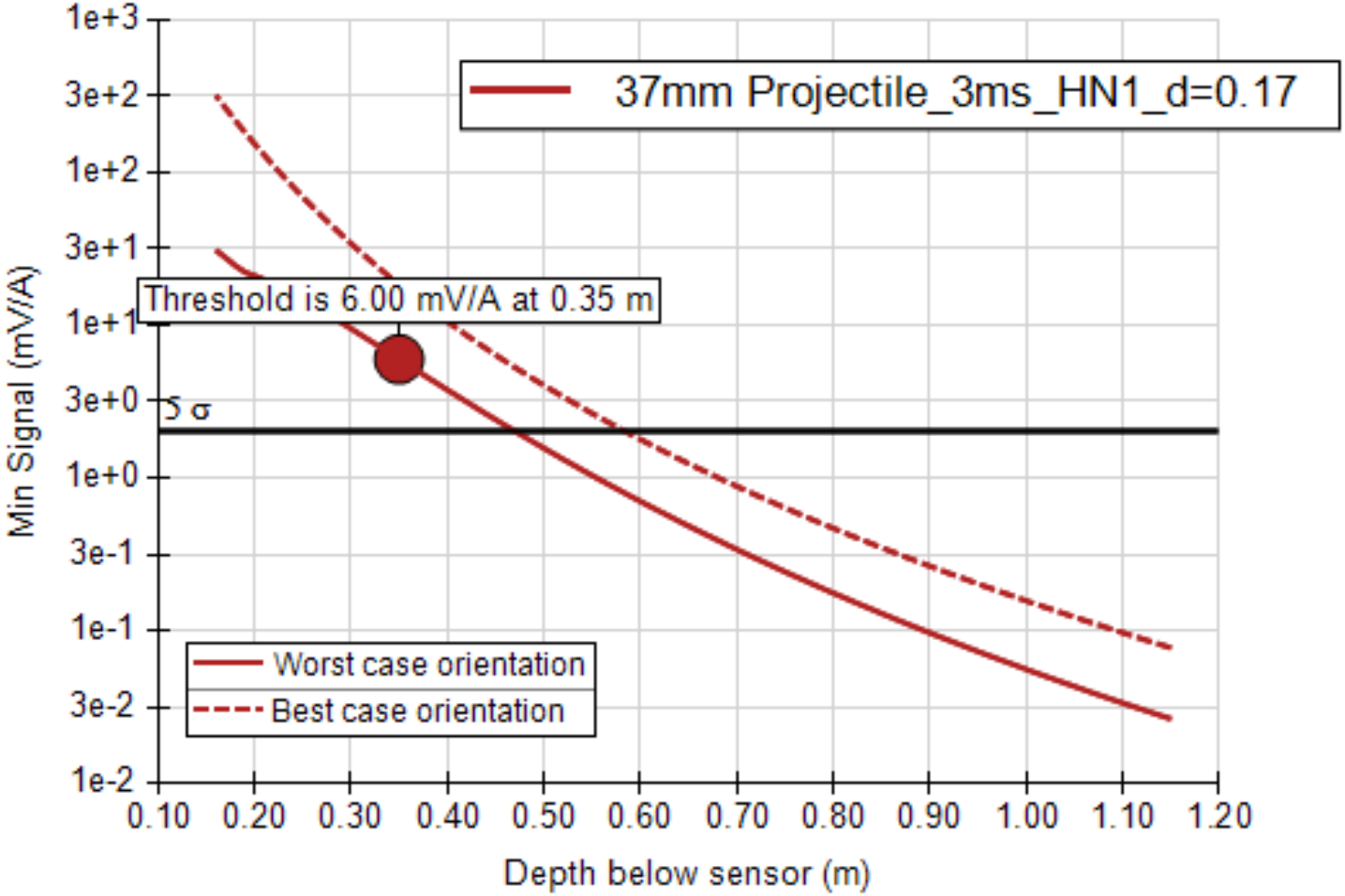
$$(\sigma_{detect})^2 = \sum_{i=1}^{M} w_i^2 \sigma_i^2$$

Channel Optimization

- Optimal weights: $w_i \propto \frac{d_i}{\sigma_i^2}$

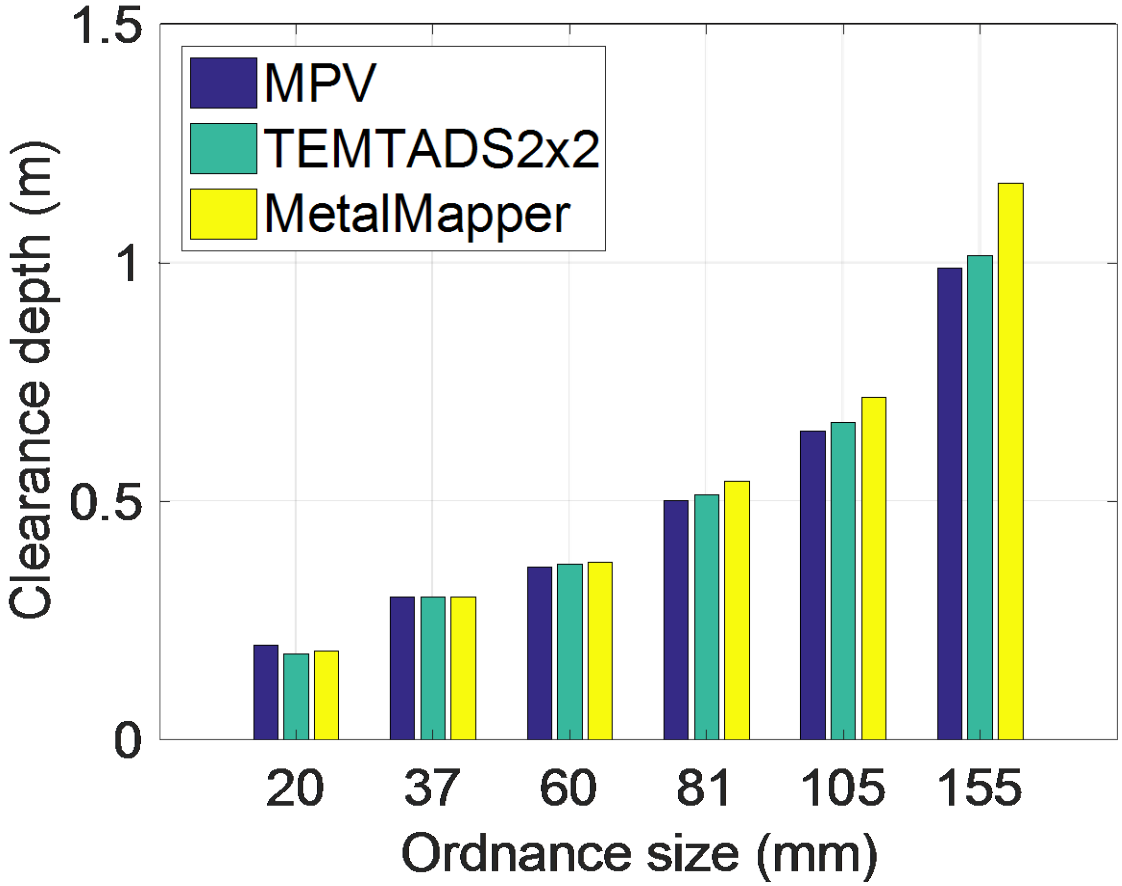


How Deep Can I Detect and Classify?



Clearance Depths

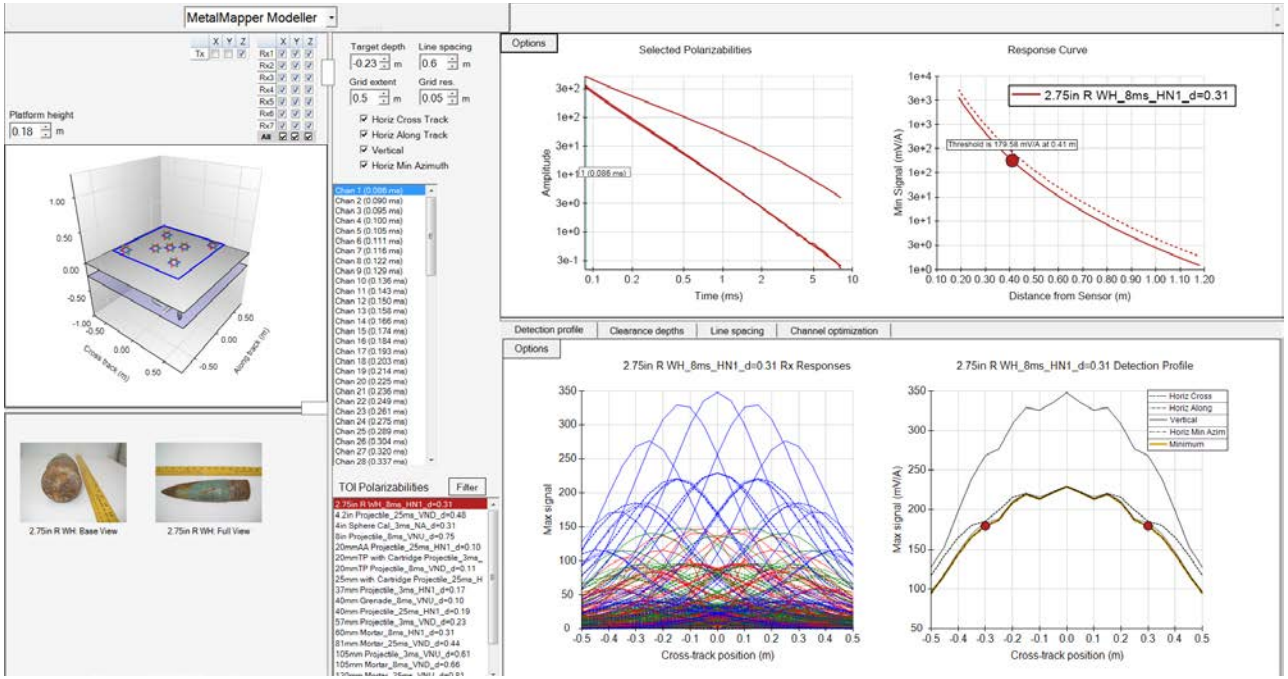
- Given a prescribed clearance objective (e.g., 37 mm at 30 cm), how deep can we detect other targets?



Detection Modeller

- Free windows-based application
- Works with DoD polarizability library files
- Functionality for MetalMapper and TEMTADS2x2 sensors includes
  - Response curve
  - Detection profile
  - Clearance depths
  - Line spacing analysis
  - Channel optimization
- For download, please email info@btgeophysics.com

Q&A Session 1



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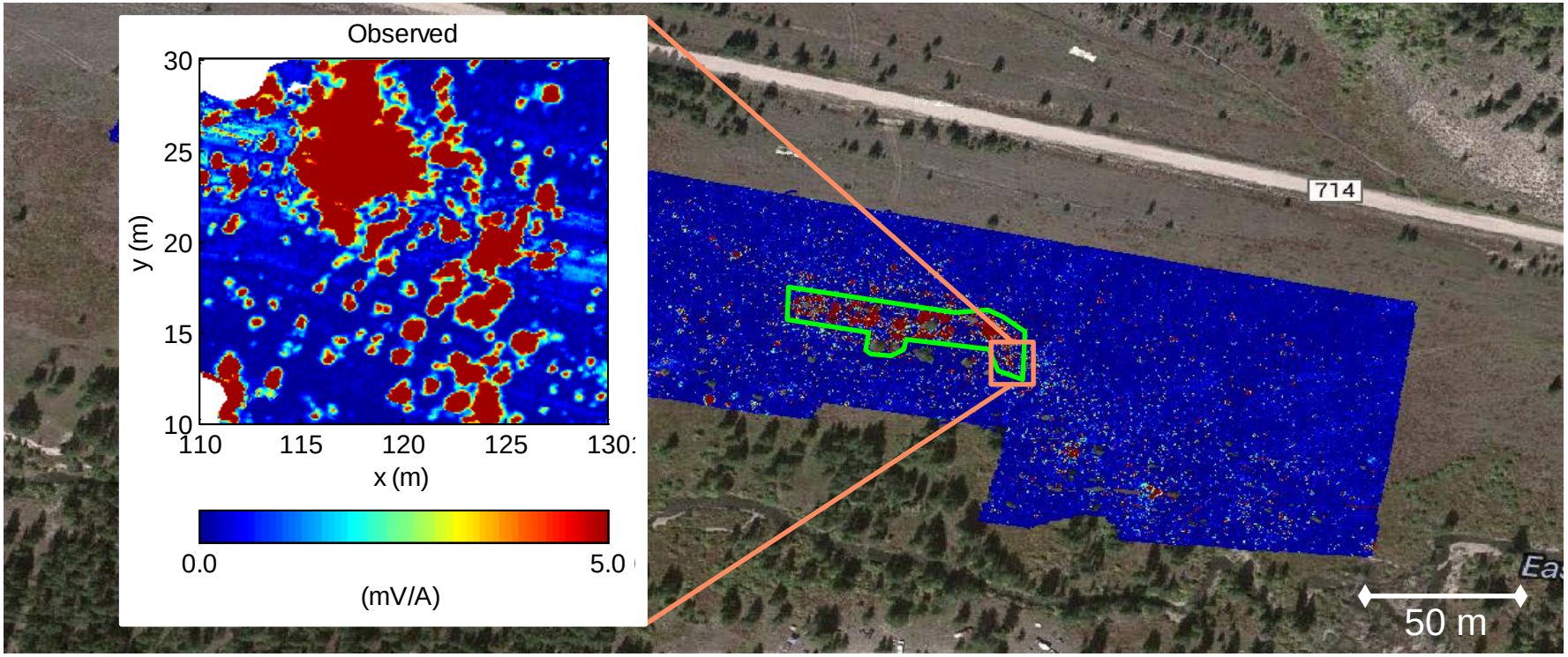
Agenda

1. Detection with advanced sensors
   - Software for threshold modeling
   - Channel selection
   - **Dealing with high density areas**
2. Risk assessment
   - Synthetic seeding
   - Classification difficulty
   - Verification of stop dig point

Where Can Classification be Applied?

1. Detection → 2. Target picking → 3. Cued interrogation → 4. Feature extraction → 5. Classification



Where Can Classification be Applied?

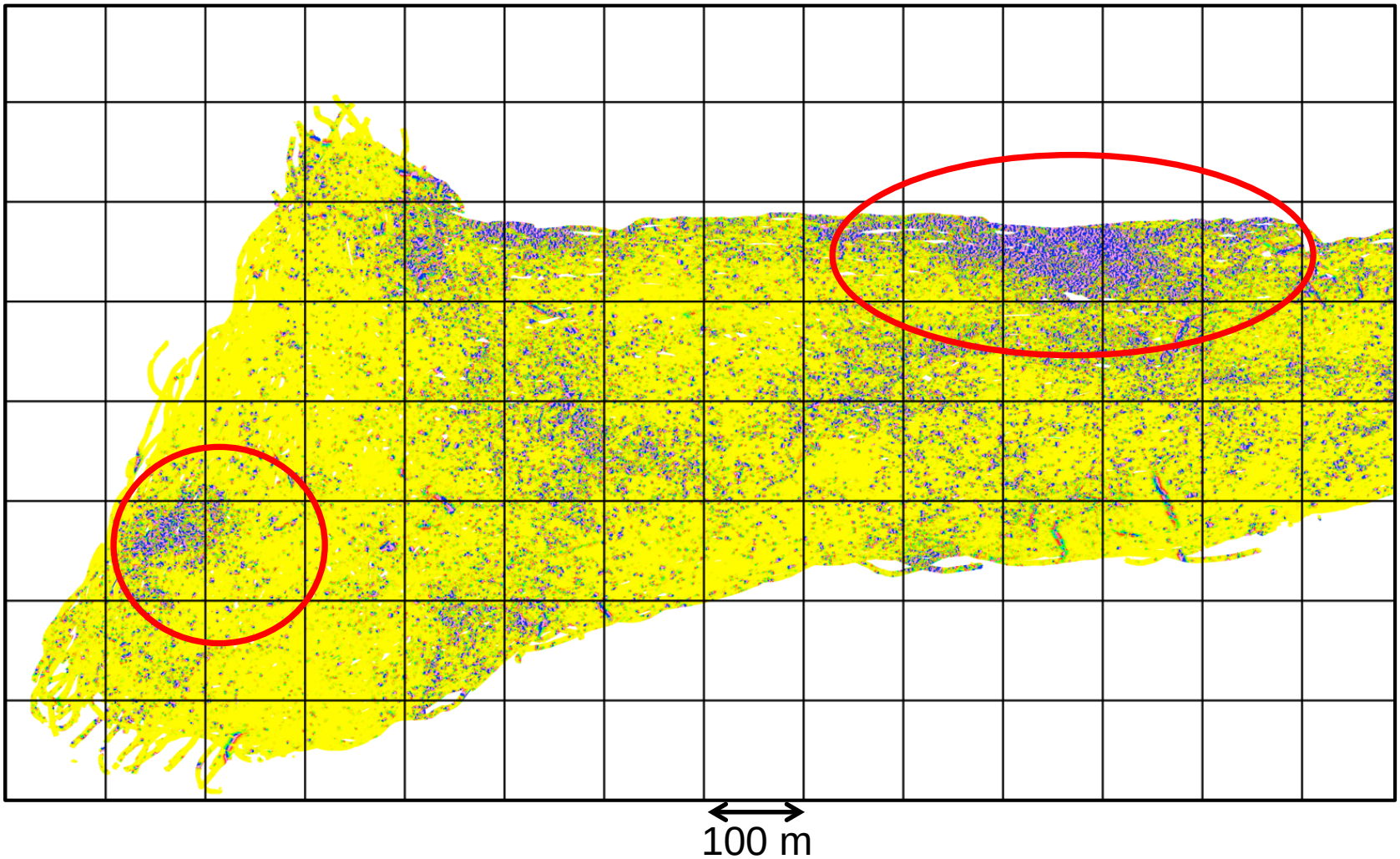
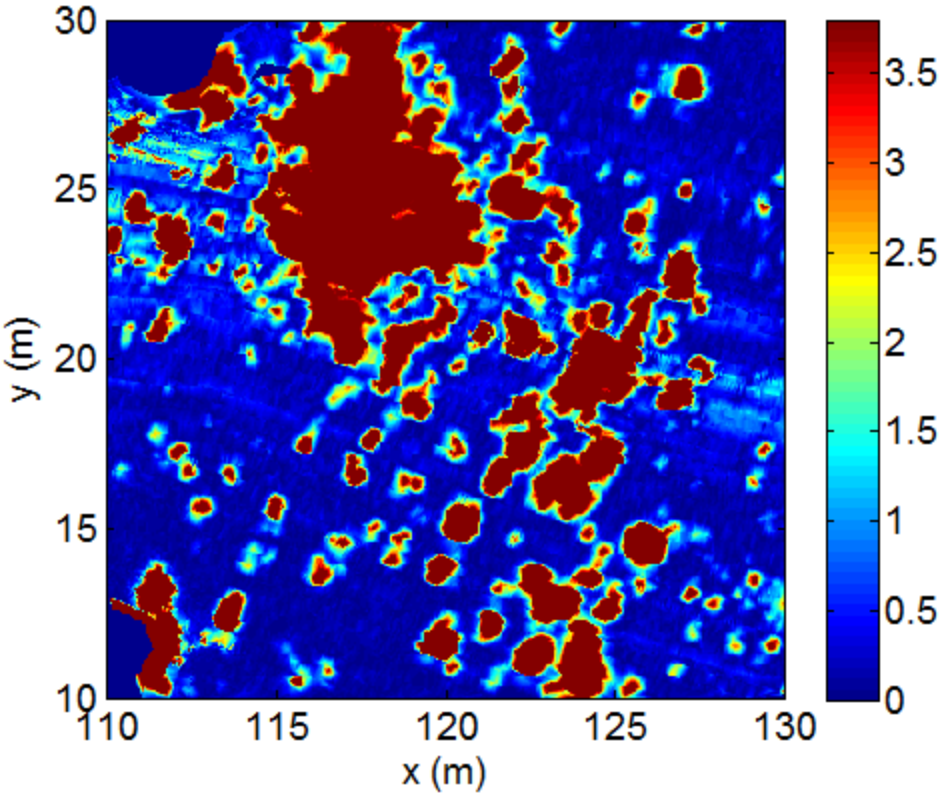


Image courtesy of Heinrich Hirdes GmBH

Automated Delineation of High Density Areas

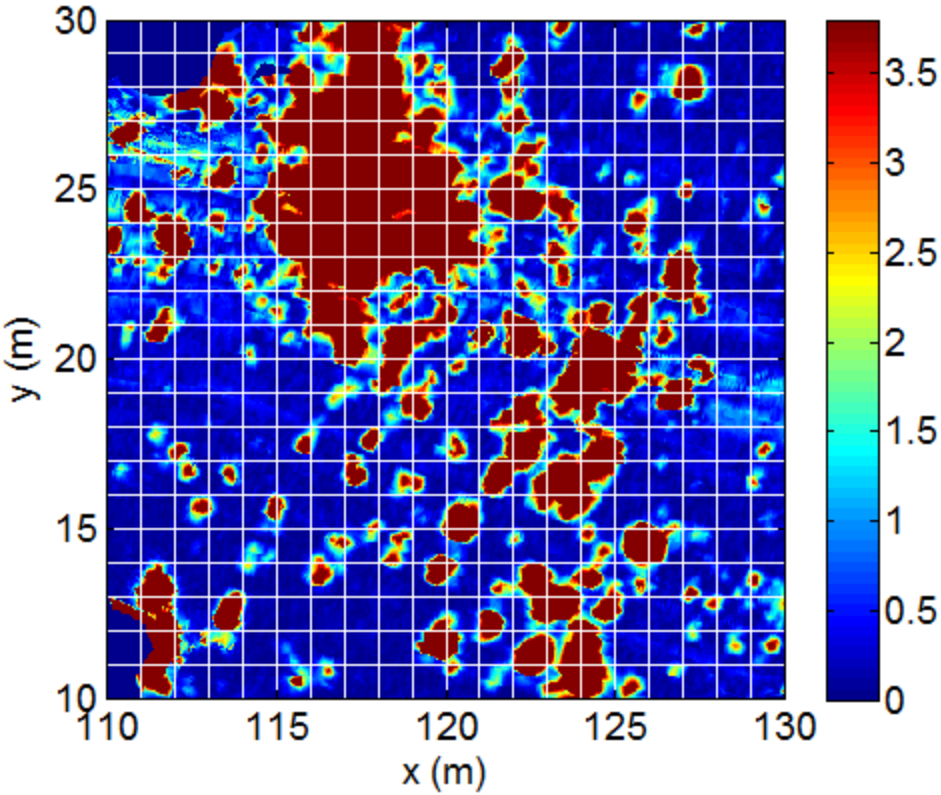
- Image segmentation
- Data-based
  - Amplitude threshold
  - Data transformations
- Model-based
  - Dipole filter
  - Multi-object inversion

Delineating High Density Areas: Image Segmentation



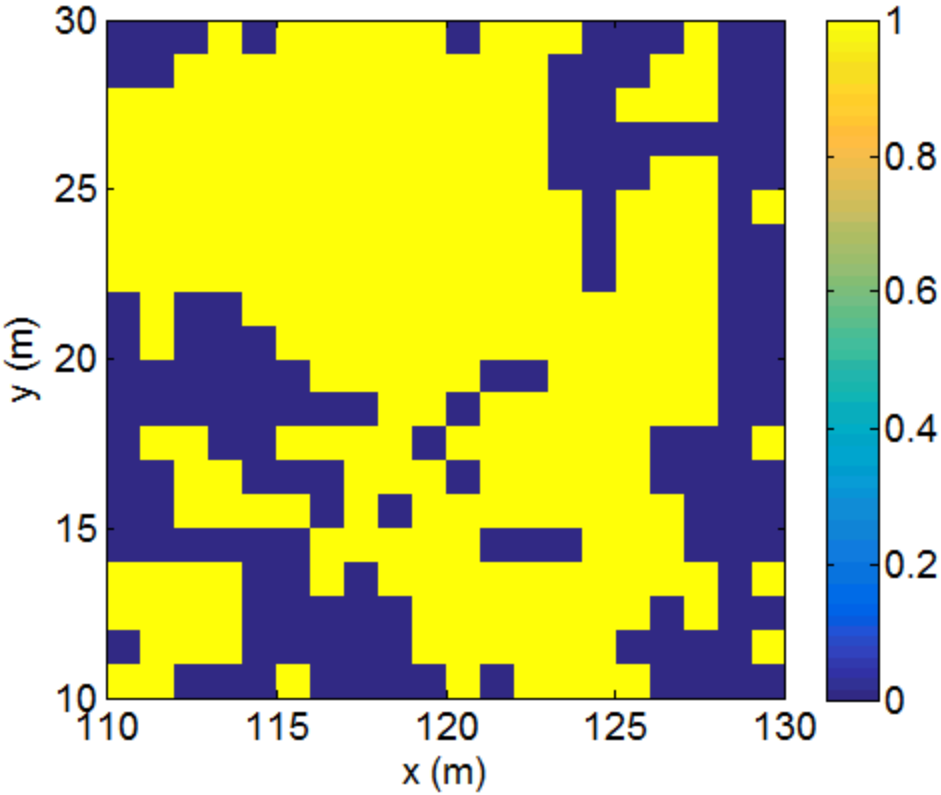
Delineating High Density Areas: Image Segmentation

1. Define grid



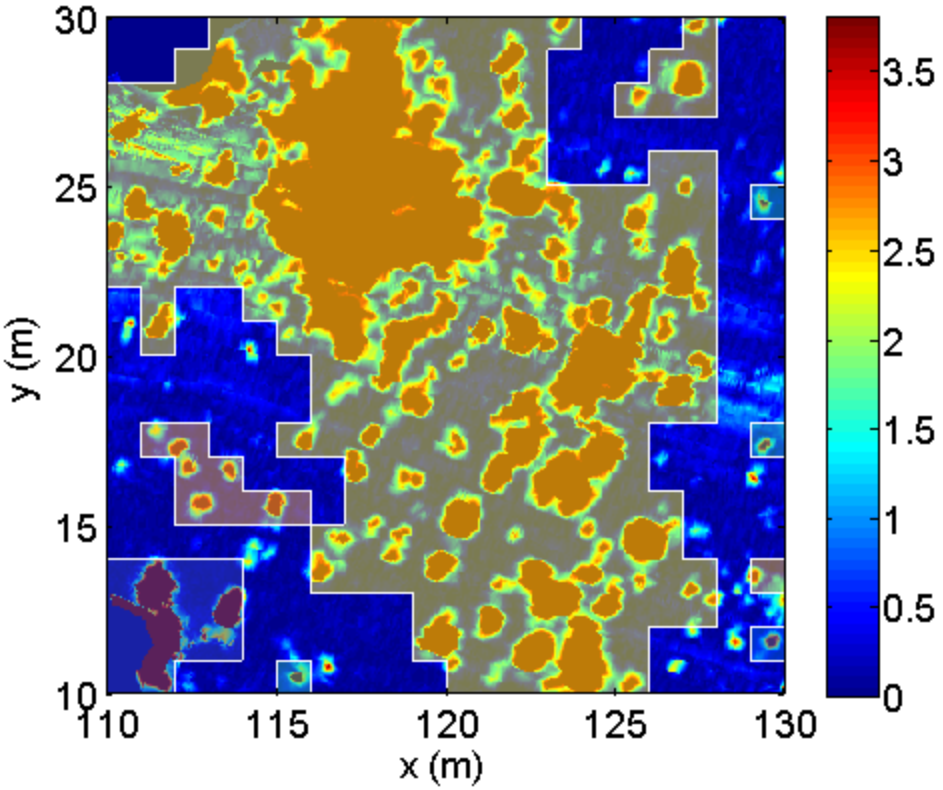
Delineating High Density Areas: Image Segmentation

1. Define grid
2. Binary map by thresholding



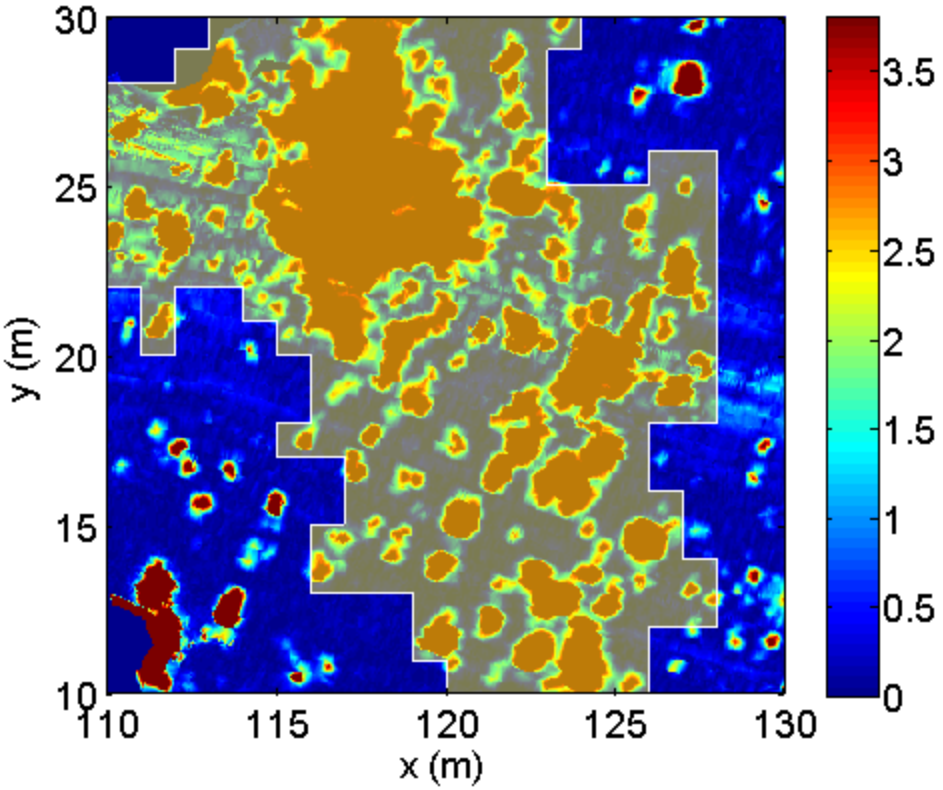
Delineating High Density Areas: Image Segmentation

1. Define grid
2. Binary map by thresholding
3. Identify blobs



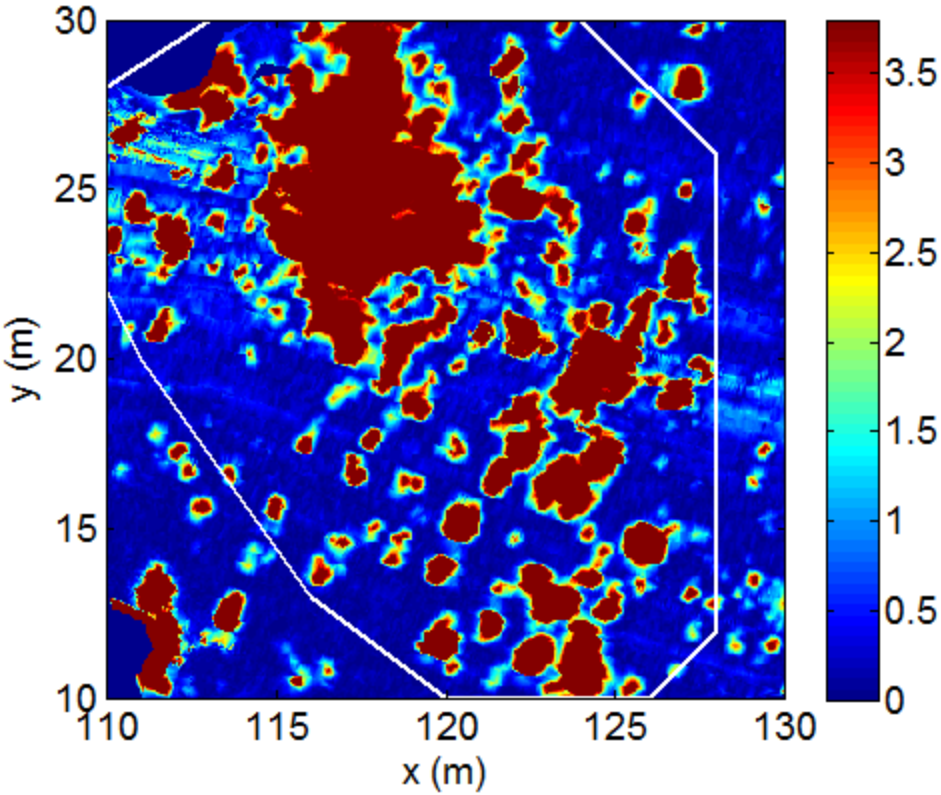
Delineating High Density Areas: Image Segmentation

1. Define grid
2. Binary map by thresholding
3. Identify blobs
4. Eliminate small blobs

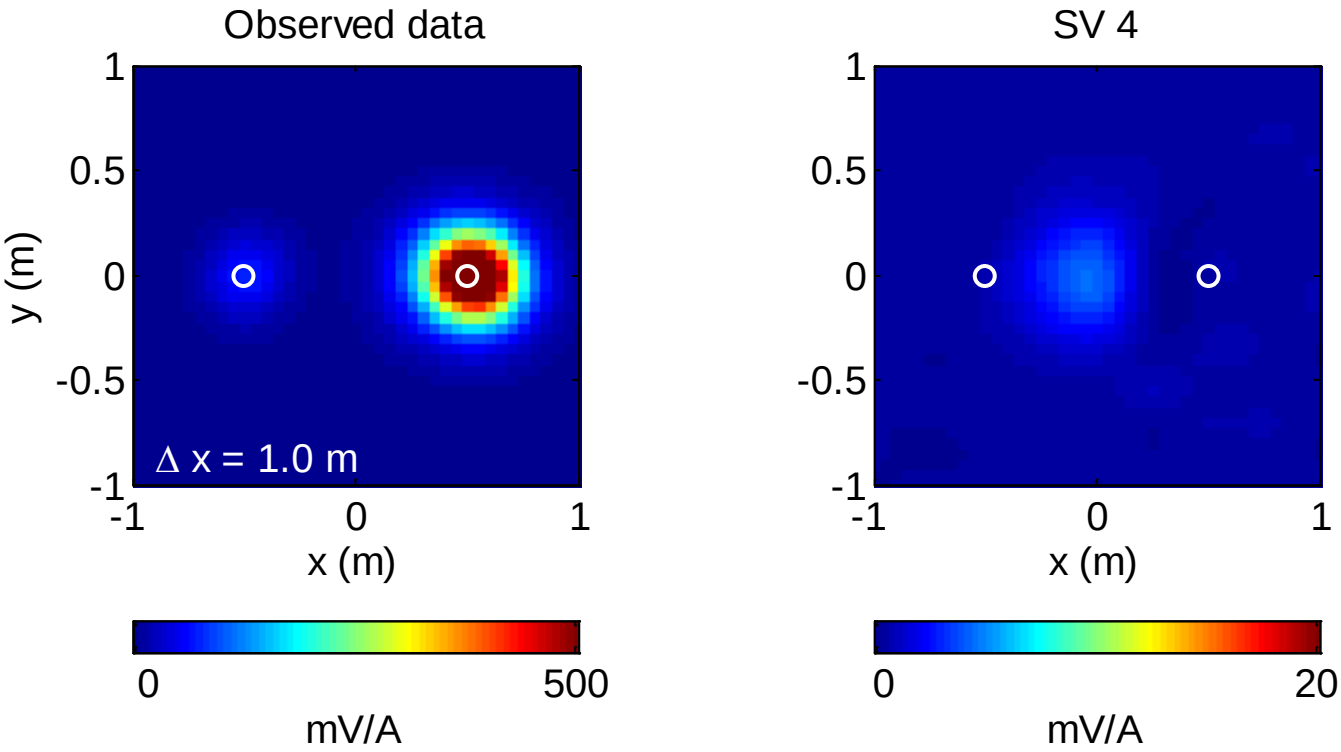


Delineating High Density Areas: Image Segmentation

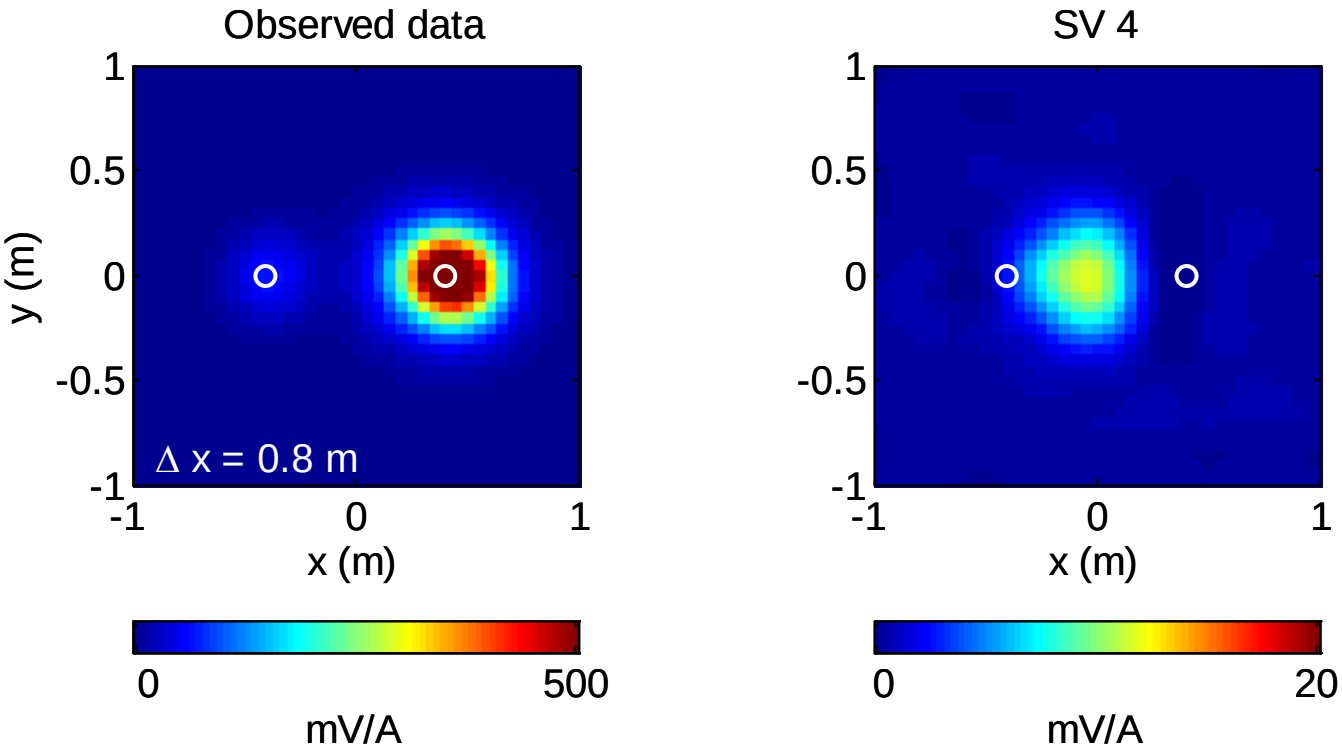
1. Define grid
2. Binary map by thresholding
3. Identify blobs
4. Eliminate small blobs
5. Simplify boundary



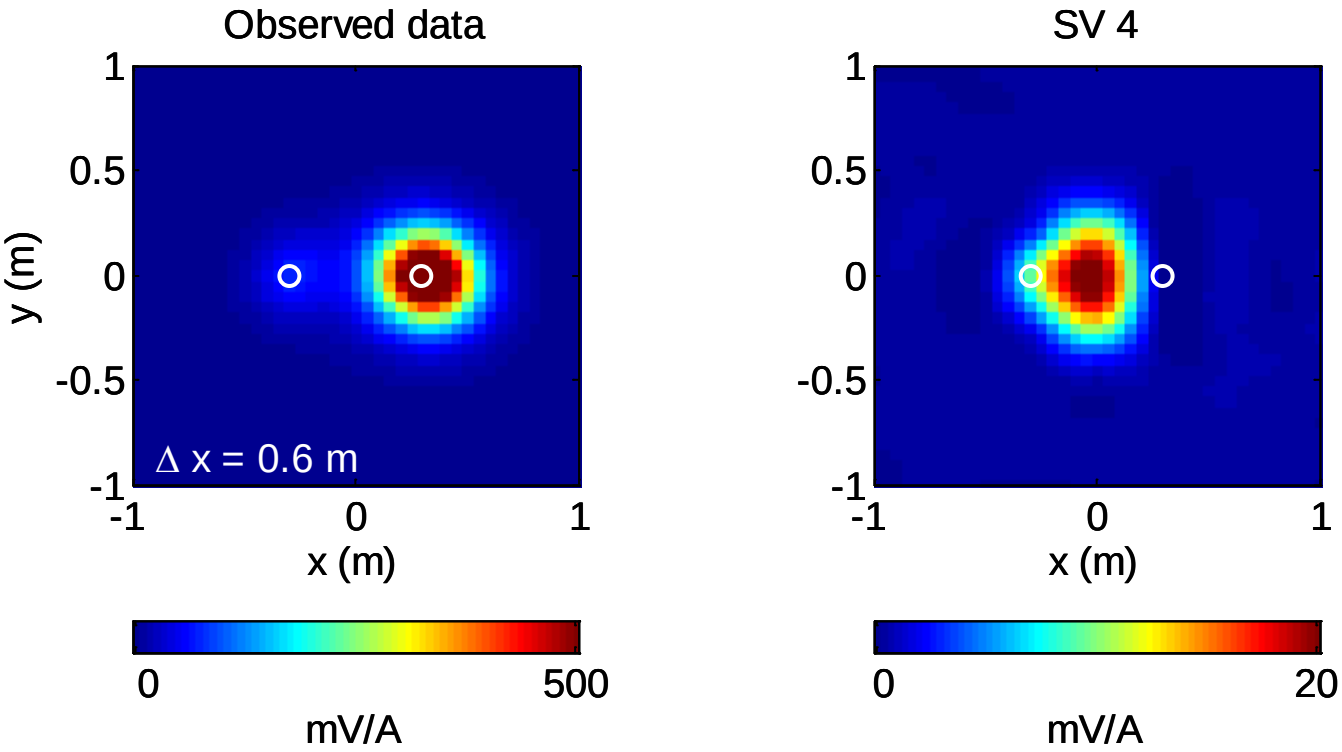
Resolving Closely-Spaced Anomalies



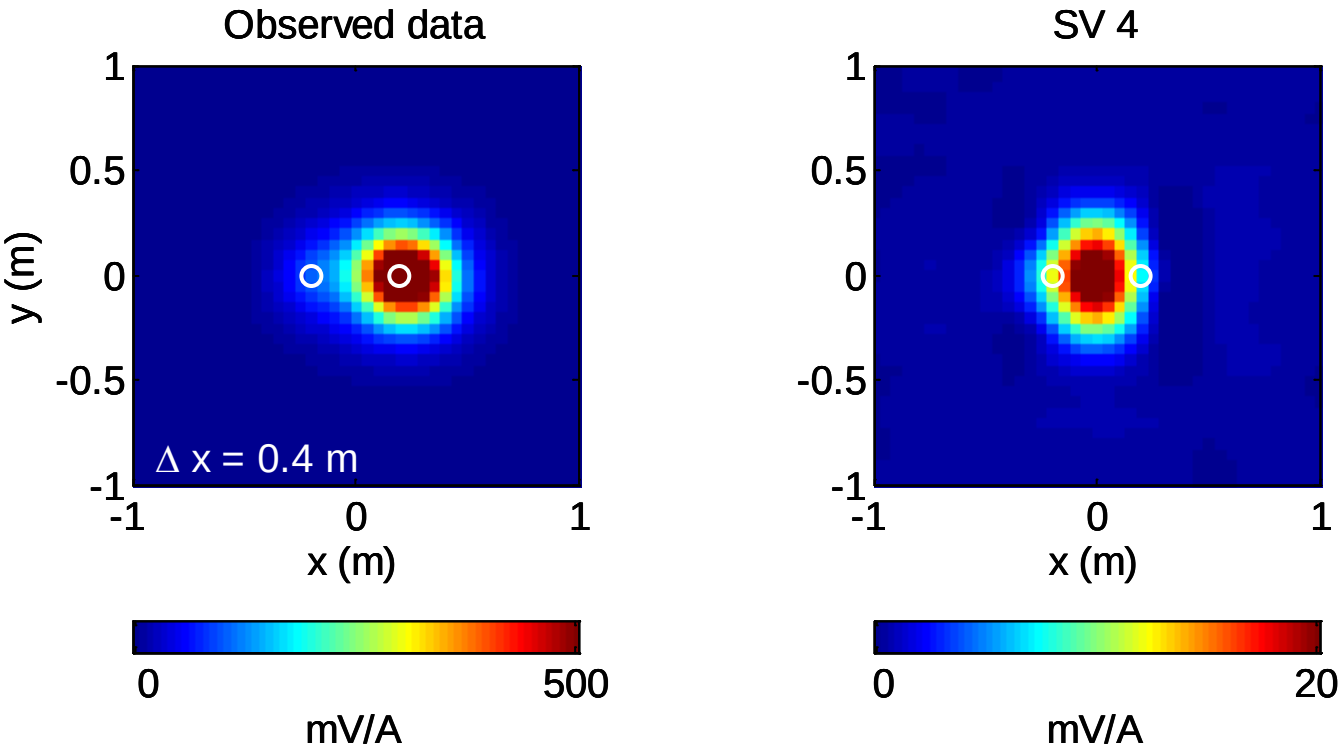
Resolving Closely-Spaced Anomalies



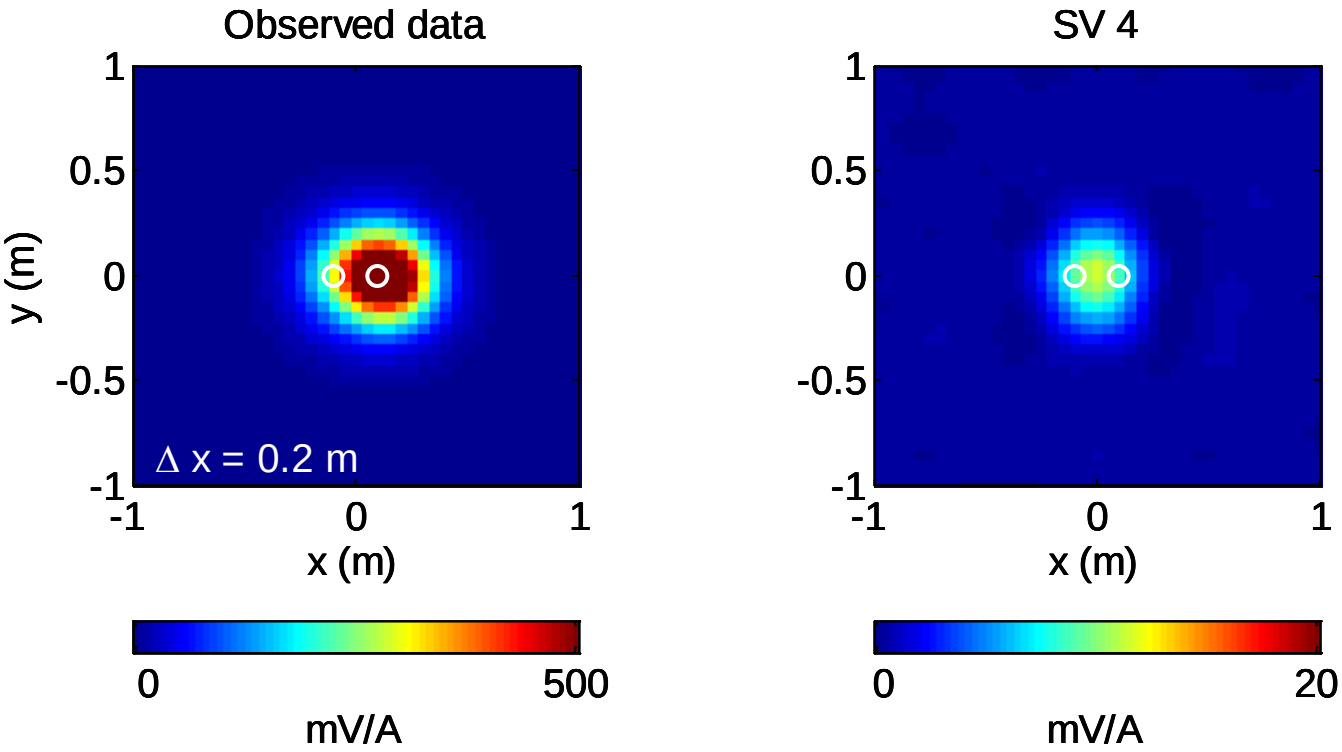
Resolving Closely-Spaced Anomalies



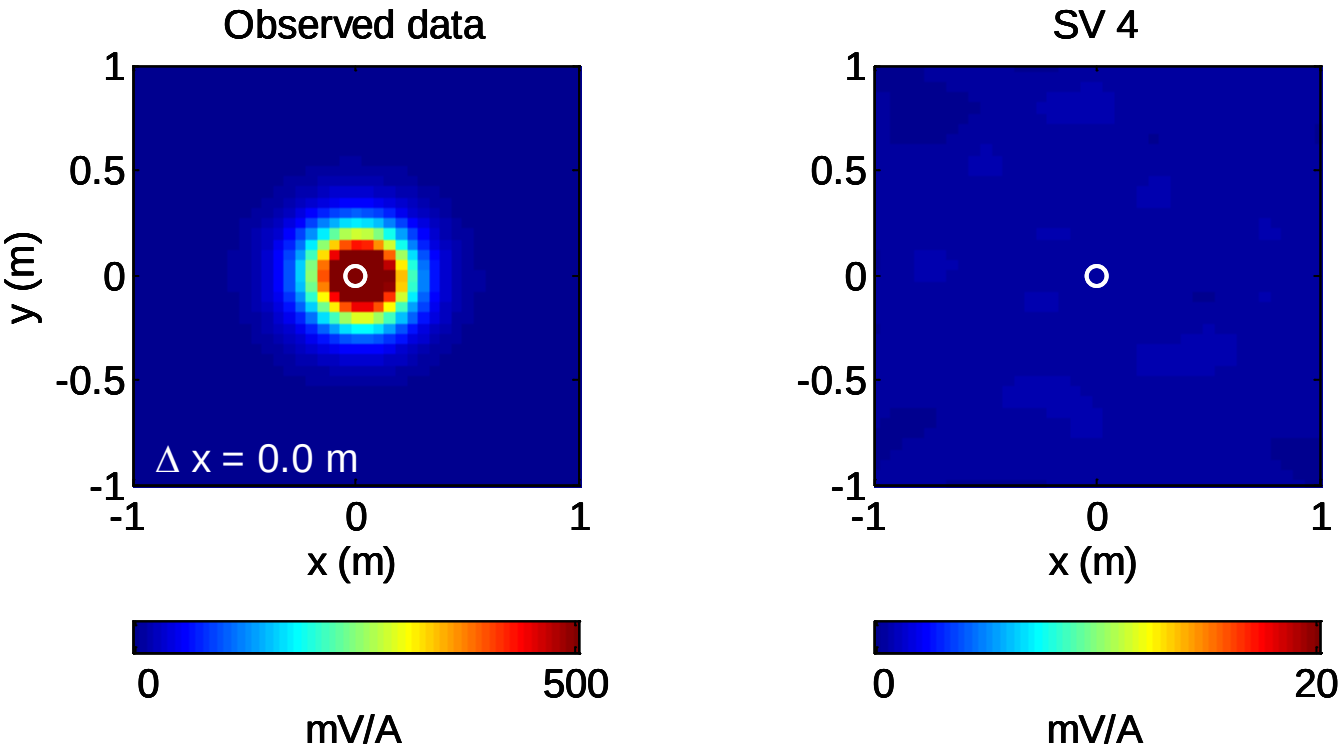
Resolving Closely-Spaced Anomalies



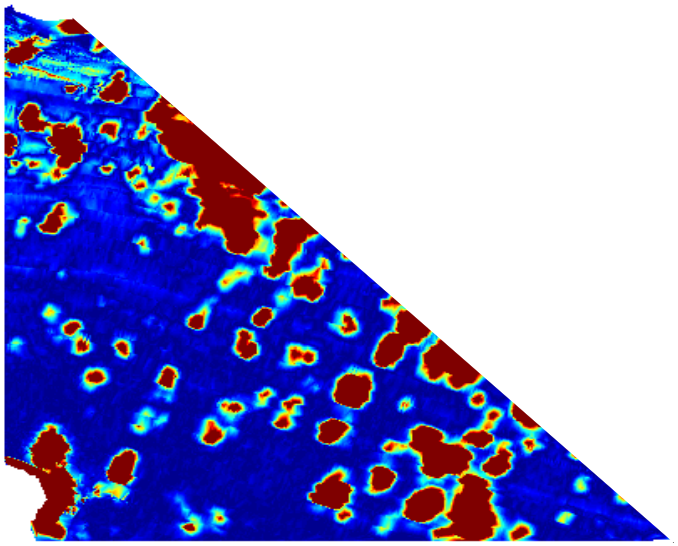
Resolving Closely-Spaced Anomalies



Resolving Closely-Spaced Anomalies

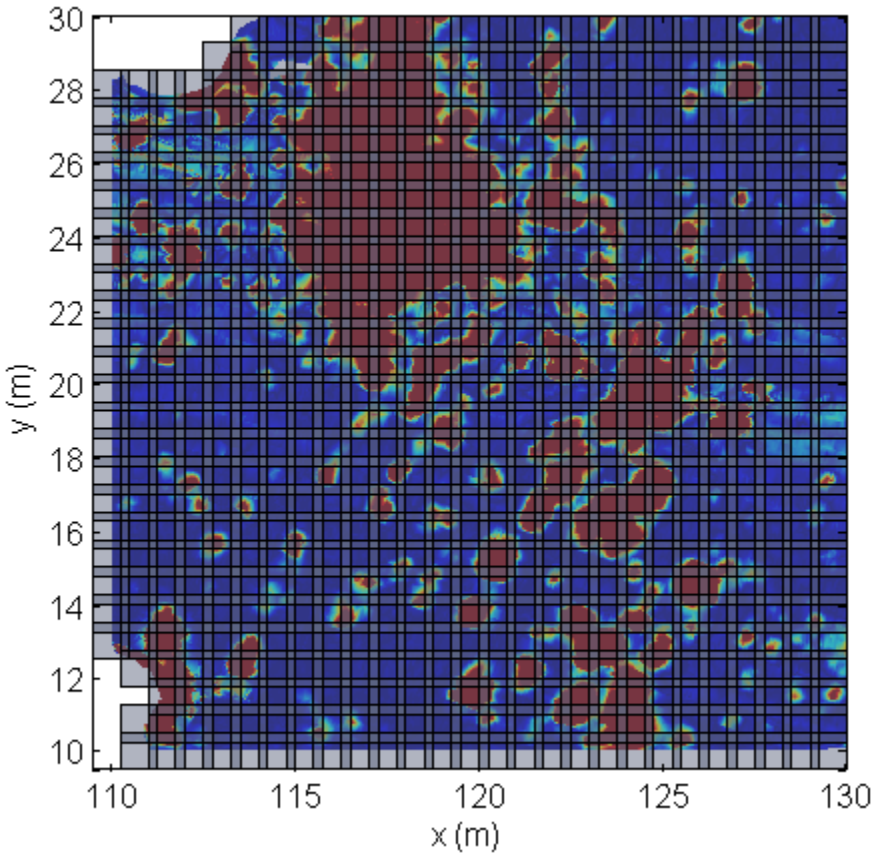


Application: Camp Hale TEMTADS 2x2

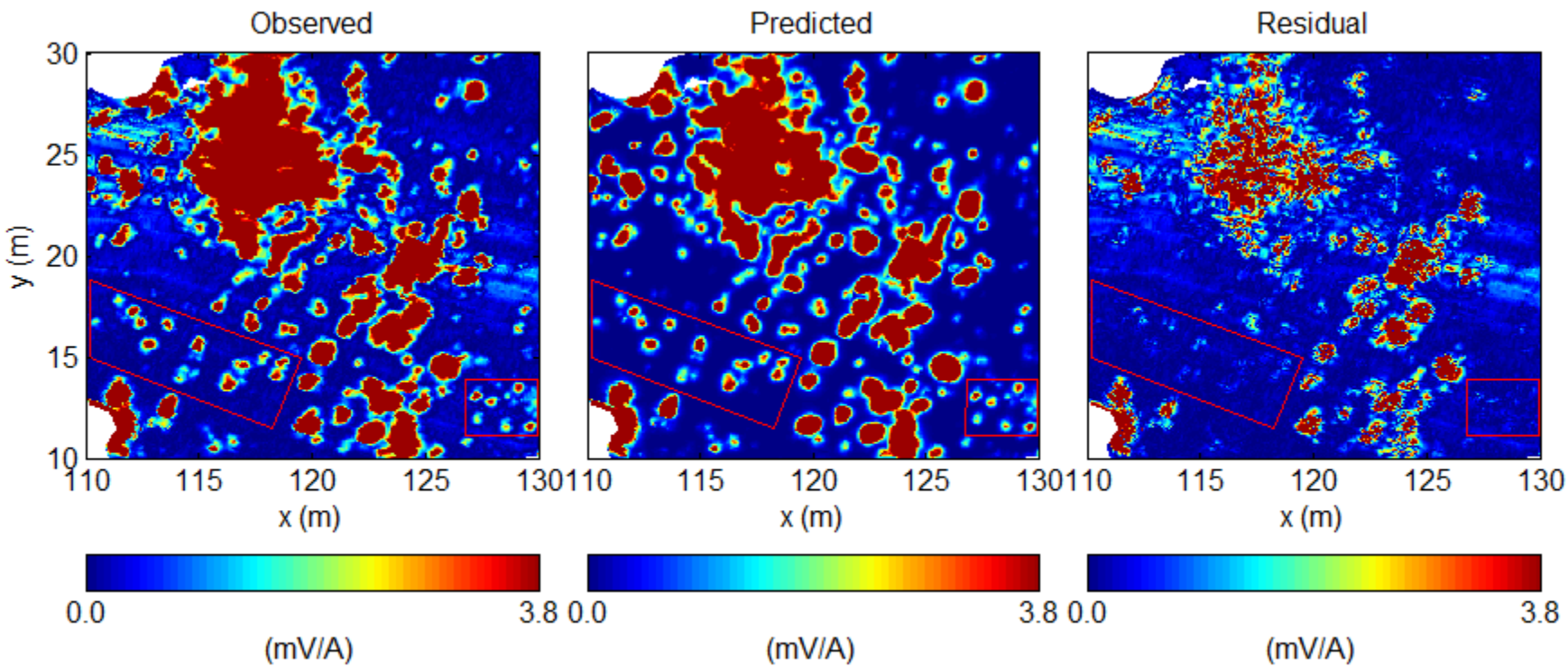


Multi-Object Inversion

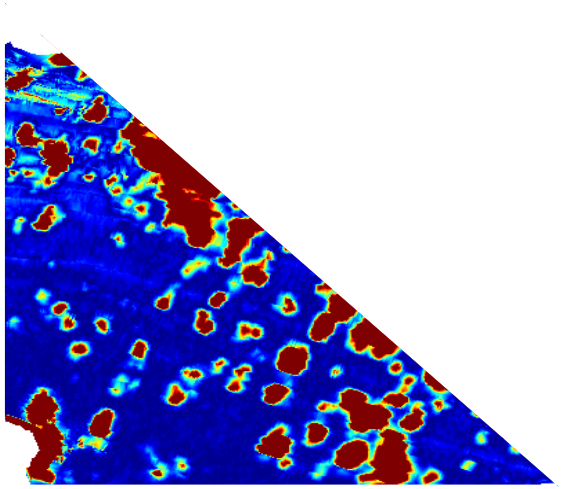
- Divide area into overlapping cells
- Carry out 3-object inversion in each cell



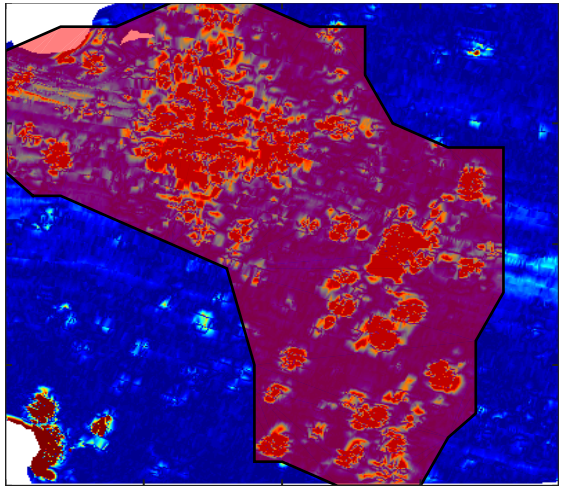
Multi-Object Inversion



Comparison



Residual



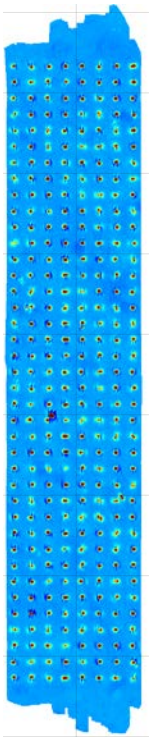
Agenda

1. Detection with advanced sensors
   - Software for threshold modeling
   - Channel selection
   - Dealing with high density areas
2. **Risk assessment**
   - Synthetic seeding
   - Verification of stop dig point
   - Classification difficulty

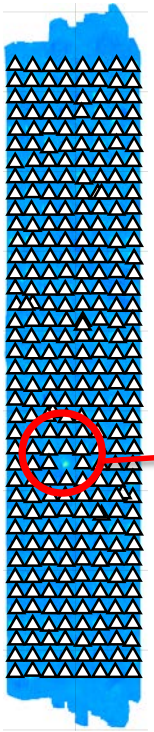
Risk Assessment – Synthetic Seeding

1. Detection → 2. Target picking → 3. Cued interrogation → 4. Feature extraction → 5. Classification

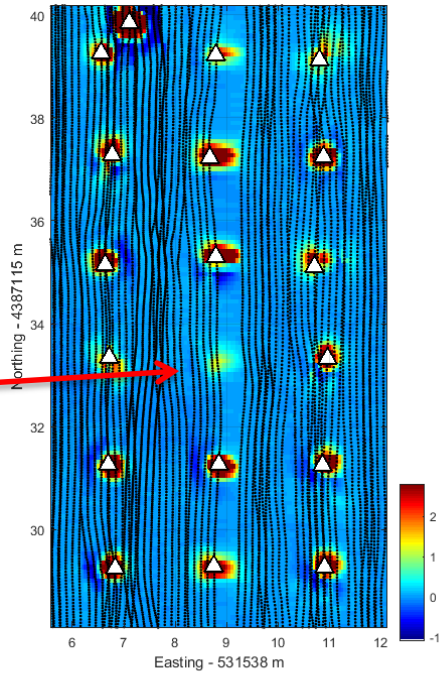
Synthetic data



Picked targets



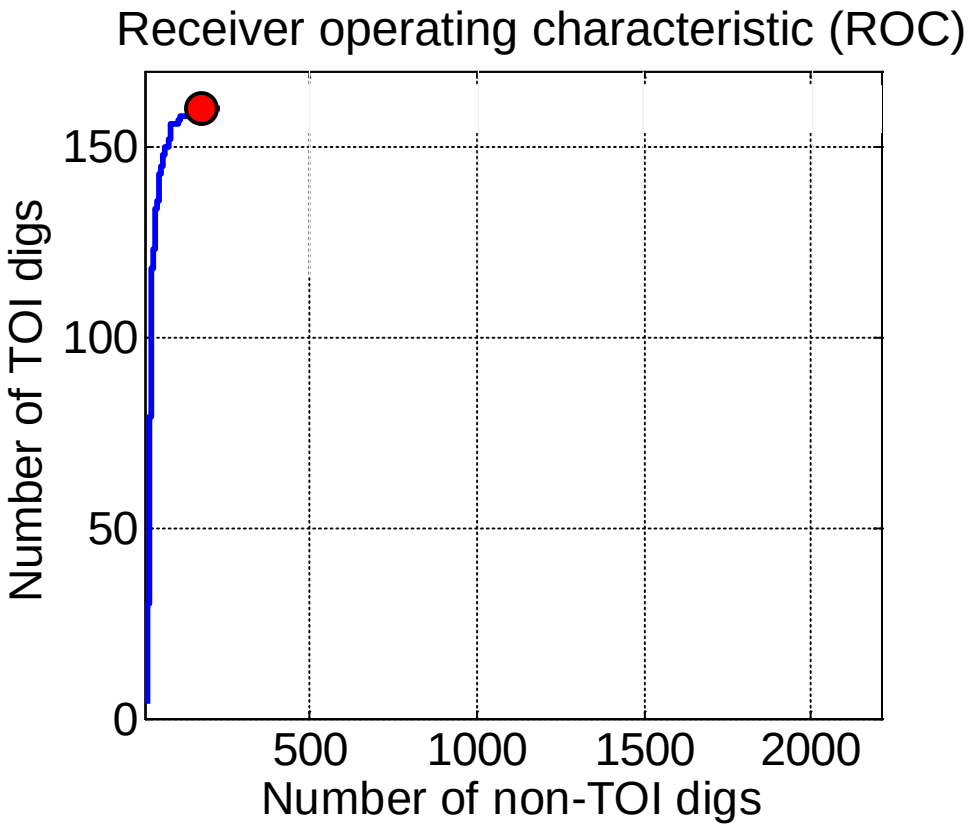
Missed synthetic seed



Risk Assessment – Stop Dig Point

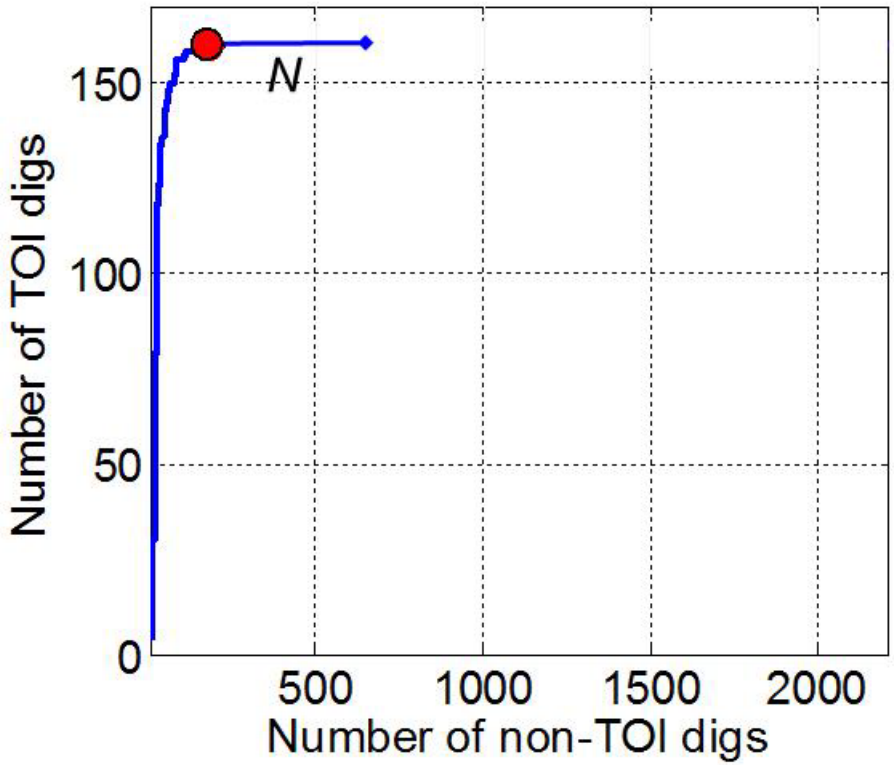
1. Detection → 2. Target picking → 3. Cued interrogation → 4. Feature extraction → **5. Classification**

Were all targets of interest (TOI) identified at the stop dig point?

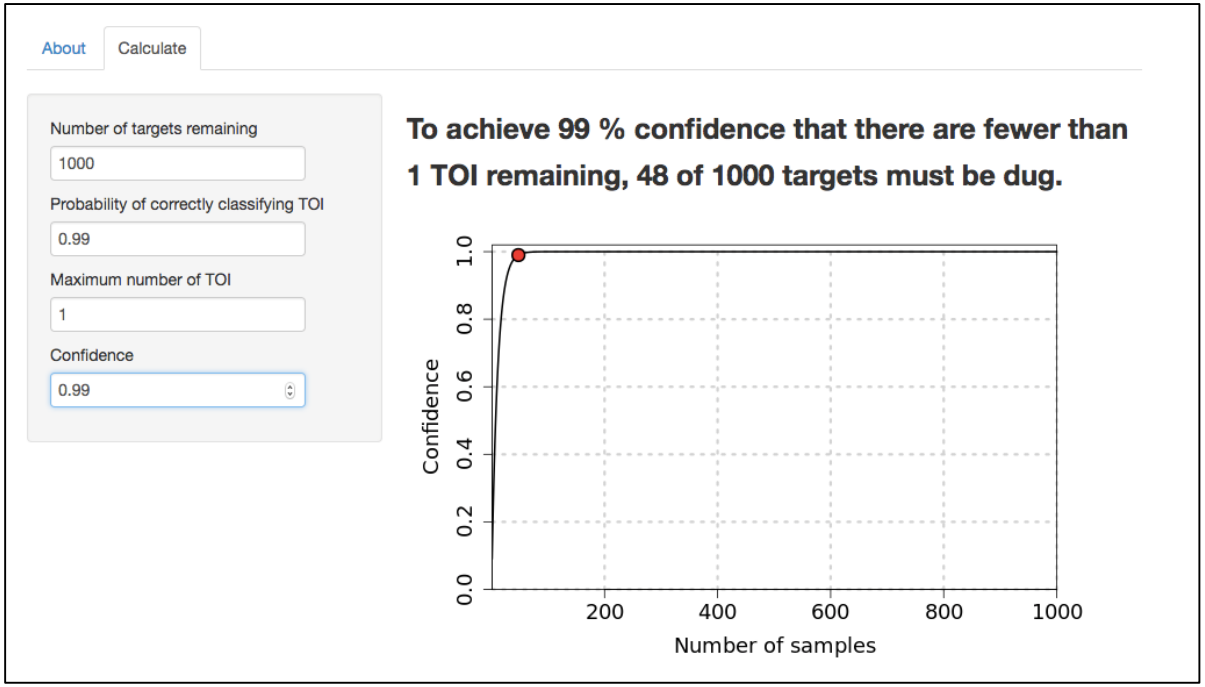


Verifying the Stop Dig Point

- Dig an additional N items for verification of stop dig point
- N=200 determined by regulation/ stakeholders



Compliance Sampling



- Model digging as sampling with bias
- Number of verification digs N depends on confidence level and **probability of correct classification**

http://www.btgeophysics.com/Risk

Estimating Classification Difficulty

- **Dataset degree of difficulty (DDD)**: Combine data and model metrics into a single measure of site-specific classification difficulty

Site	Year	Cells	ZMOS	MSNR	Pol rel	Pol jitter	Data misfit	Data rel	Data noise	Data badness	L123 misfit	Feat. dist.	DDD (Kingdons)
Pole Mtn	2011	2370	0.50	165.02	39.33	13.63	0.11	31.82	0.34	0.17	1.70	0.62	4.06
Spencer U Dyn	2012	339	0.52	165.27	38.00	13.15	0.10	28.70	0.56	0.23	0.97	0.59	9.11
Spencer N	2012	1286	0.54	151.67	39.00	11.47	0.12	30.18	0.48	0.32	0.82	0.54	12.64
Spencer U	2012	1104	0.53	139.67	38.67	11.39	0.11	30.70	0.46	0.39	0.84	0.55	12.68
Beale P	2011	1547	1.21	76.97	35.33	16.23	0.20	25.32	0.71	0.54	1.07	0.81	15.80
SWPG	2013	1398	1.61	55.00	30.00	24.75	0.23	21.61	1.07	0.66	0.87	1.37	19.34
Ellis	2013	1233	0.33	173.80	39.33	10.17	0.11	33.25	0.31	0.40	0.49	0.44	19.42
MMR 1	2012	892	0.61	154.12	40.00	11.44	0.12	35.52	0.16	0.15	0.53	0.30	21.51
Butner	2010	2672	1.00	74.51	33.67	16.78	0.22	25.21	0.76	0.71	0.99	0.53	28.82
Beale C	2011	1507	1.46	52.71	34.67	17.10	0.24	25.30	0.67	0.63	1.38	0.40	31.16
Bellows best	2013	7044	1.58	72.04	26.33	22.86	0.23	18.33	1.70	0.66	1.17	0.51	42.97
MMR 2	2012	1410	0.70	143.70	40.00	11.83	0.13	34.54	0.19	0.17	0.53	0.15	52.13
Wittstock	2013	509	1.20	95.92	38.00	13.26	0.20	30.33	0.42	0.32	0.55	0.25	63.39
Rucker PoP	2013	413	0.46	179.54	38.67	13.19	0.09	32.40	0.30	0.16	0.54	0.11	63.73
Vieques	2012	1124	1.37	83.27	33.67	15.22	0.22	22.98	0.99	0.81	0.90	0.28	67.72
Current site	----	800	0.52	139.03	40.00	7.25	0.19	32.35	0.41	1.13	0.31	0.13	185.55
Bellows worst	2013	2451	2.38	12.55	10.33	25.74	0.38	8.49	7.03	1.69	1.02	0.33	416.39

Easy

↓

Hard

Conclusions

1. Detection with advanced sensors
   - Software for threshold modeling
   - Channel selection
   - Dealing with high density areas
2. Risk assessment
   - Synthetic seeding
   - Verification of stop dig point
   - Classification difficulty

For additional information, please visit https://serdp-estcp.org/Program-Areas/Munitions-Response/Land/Modeling-and-Signal-Processing/MR-2226

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Q&A Session 2

SERDP DOD • EPA • DOE | ESTCP

The next webinar is on February 23, 2017

Award Winning Projects

Resource Conservation and Resiliency

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Survey Reminder

Please take a moment to complete the survey that will pop up on your screen when the webinar ends

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