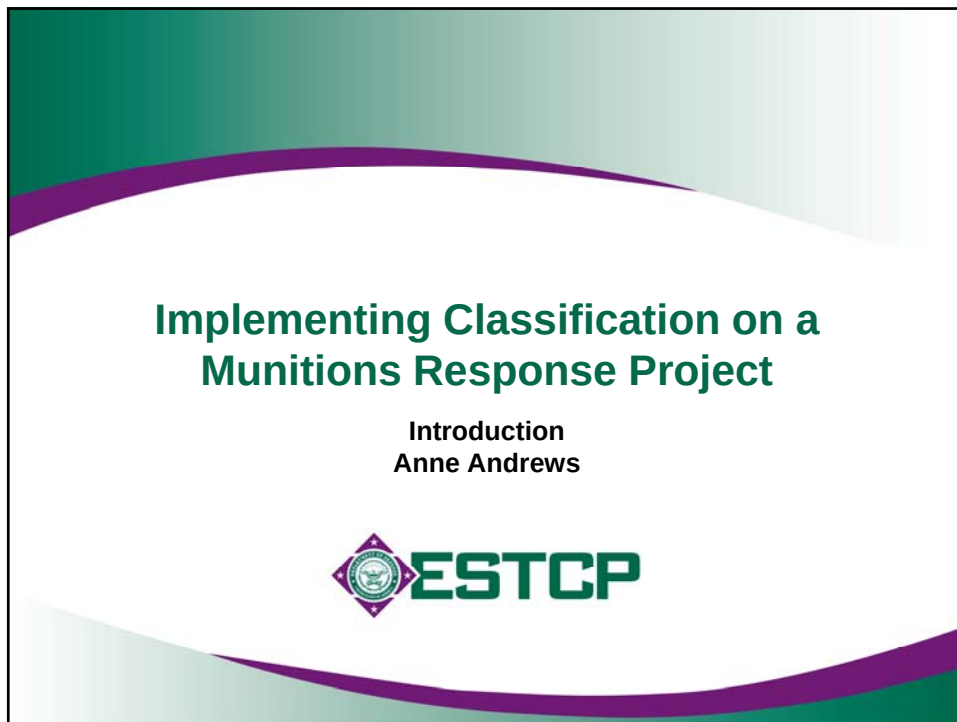




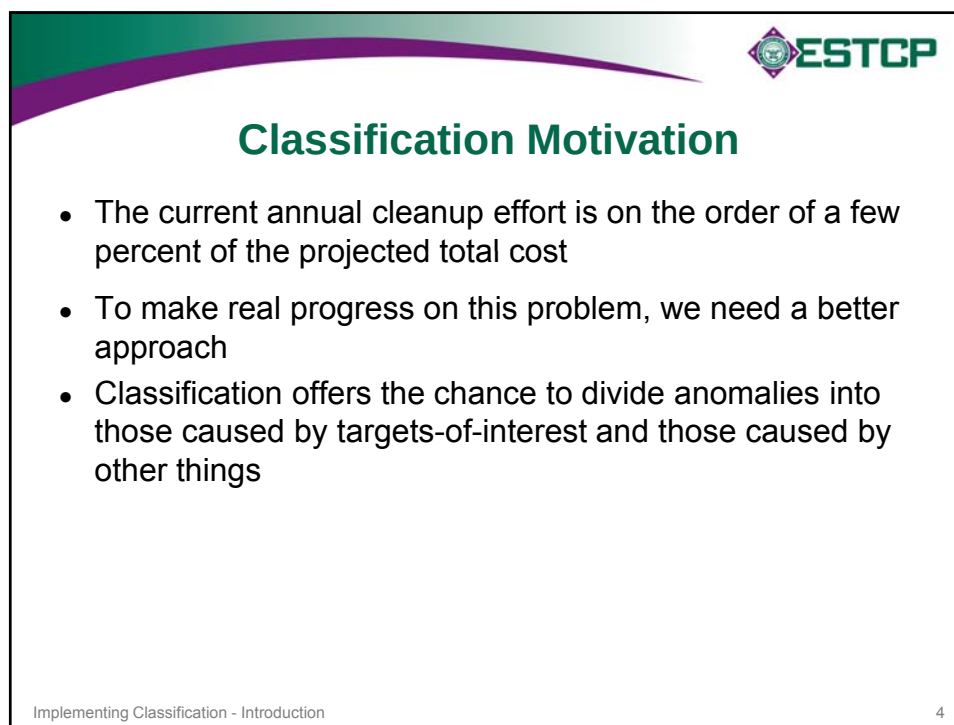
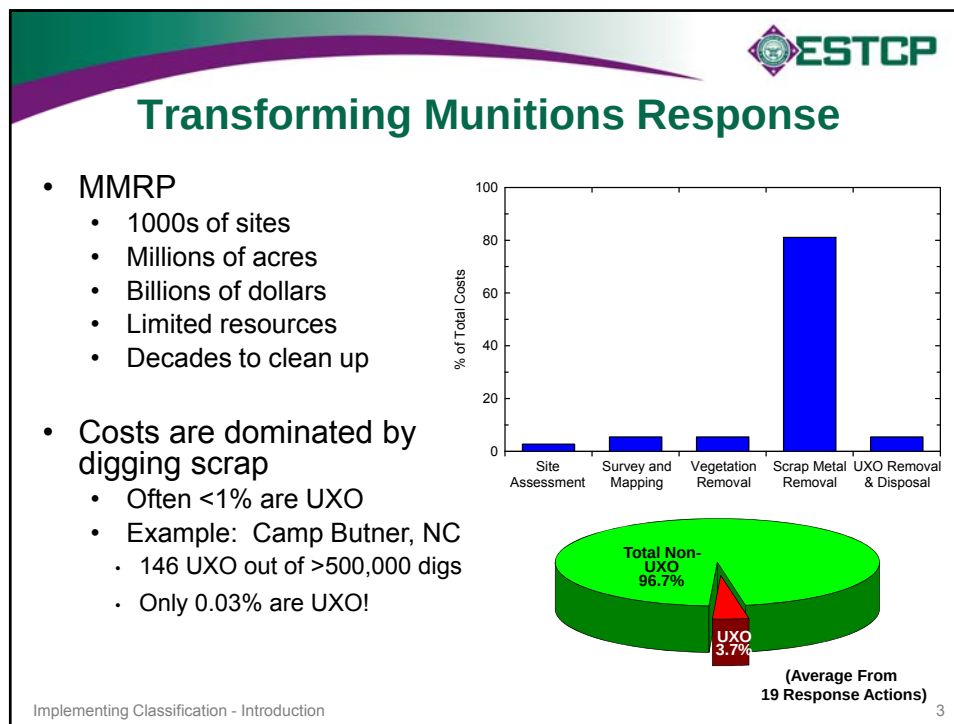
The slide has a white background with a green and purple wavy border at the top. The ESTCP logo is in the top right corner. The title 'Presenters' is centered in a green, sans-serif font. Below the title is a bulleted list of presenters and topics. At the bottom left, the text 'Implementing Classification - Introduction' is displayed, and at the bottom right, the number '2' is displayed.

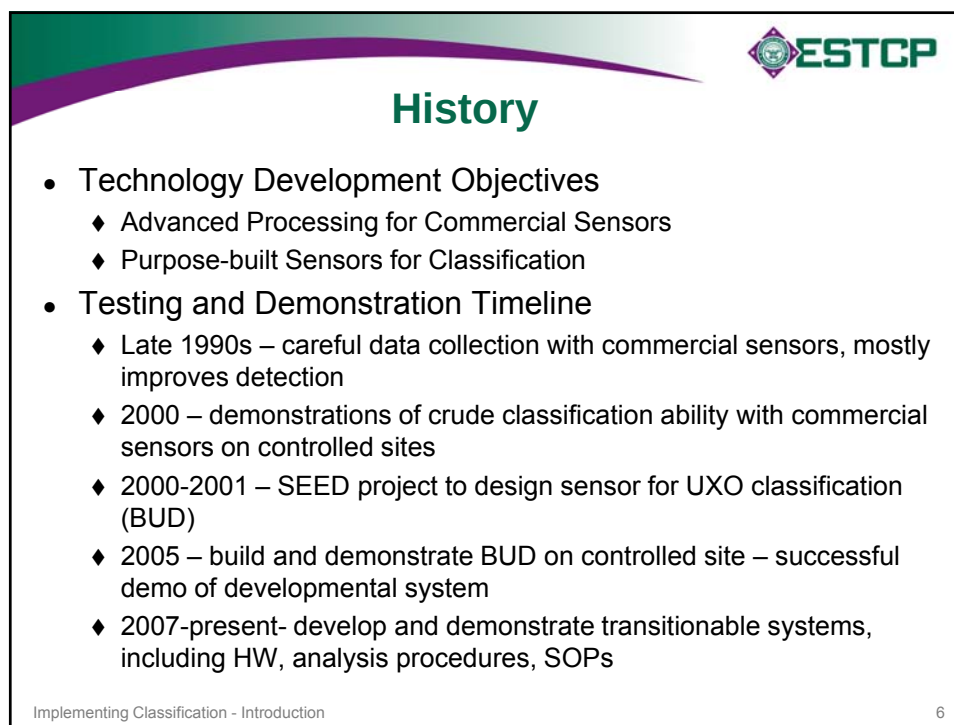
Presenters

- Introduction
 - ♦ Dr. Anne Andrews - SERDP/ESTCP
- Classification Basics
 - ♦ Dr. Tom Bell – SAIC
- Workflow and Quality Control
 - ♦ Mr. Bryan Harre - NAVFAC ESC
- Case Study – Pole Mountain, WY
 - ♦ Dr. Herb Nelson – SERDP/ESTCP
- Wrap Up
 - ♦ Mr. Vic Wieszek - ODUSD(I&E)/EM

Implementing Classification - Introduction 2

Report Documentation Page			Form Approved OMB No. 0704-0188		
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Live Site UXO Classification Demonstrations

- Goal: Validate Classification Technologies
 - ◆ Establish performance capability as function of site conditions
 - ◆ Establish operational procedures and costs
 - ◆ Train government and contractor community
 - ◆ Gain regulatory acceptance
- Multiple Live Sites Required
 - ◆ Munitions type
 - ◆ Site conditions



Implementing Classification - Introduction 7



Demonstrations to Date

- Completed
 - ◆ Former Camp Sibert, AL – simple site, single munitions type
 - ◆ Former Camp San Luis Obispo, CA – more difficult terrain, mix of munitions, medium to large size
 - ◆ Former Camp Butner, NC – mix of small and large munitions - 37 mm, 105 mm, 155 mm
- Ongoing
 - ◆ Mare Island Naval Shipyard, CA – industrial site
 - ◆ Pole Mountain, WY – case study in implementation
 - ◆ Former Camp Beale, CA – trees, restricted access
 - ◆ Fort Sill, OK – using classification in an RI
- Planned – additional demonstrations in FY12-14

Implementing Classification - Introduction 8



Demonstration Flow

- Seed the site with inert munitions
- Collect geophysical survey data
- Select potential targets – science-based threshold for anomaly picking
- Collect “cued” geophysical data
- Dig every anomaly that exceeds threshold for validation – close hold
- Pass anomaly locations to analysts – one answer for every location
- Score blind test against ground truth – seeds and dug targets

Implementing Classification - Introduction 9

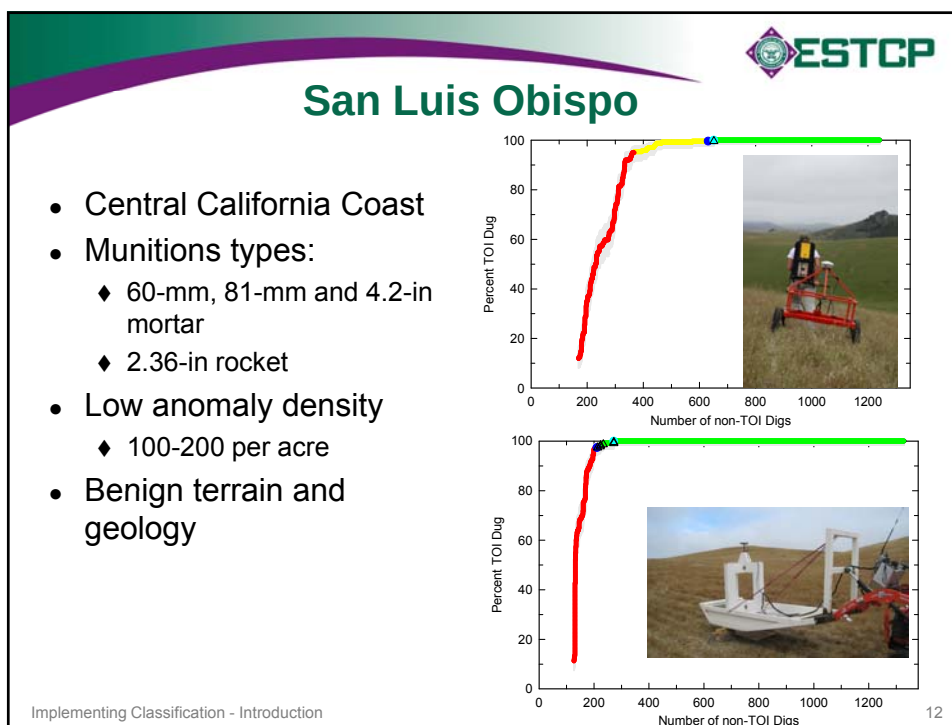
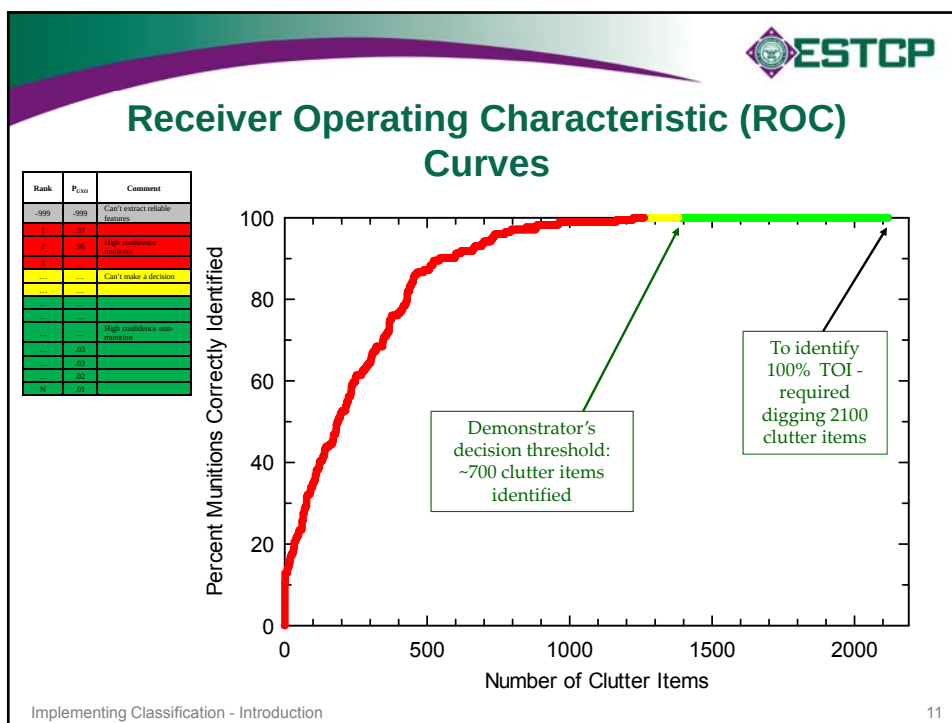


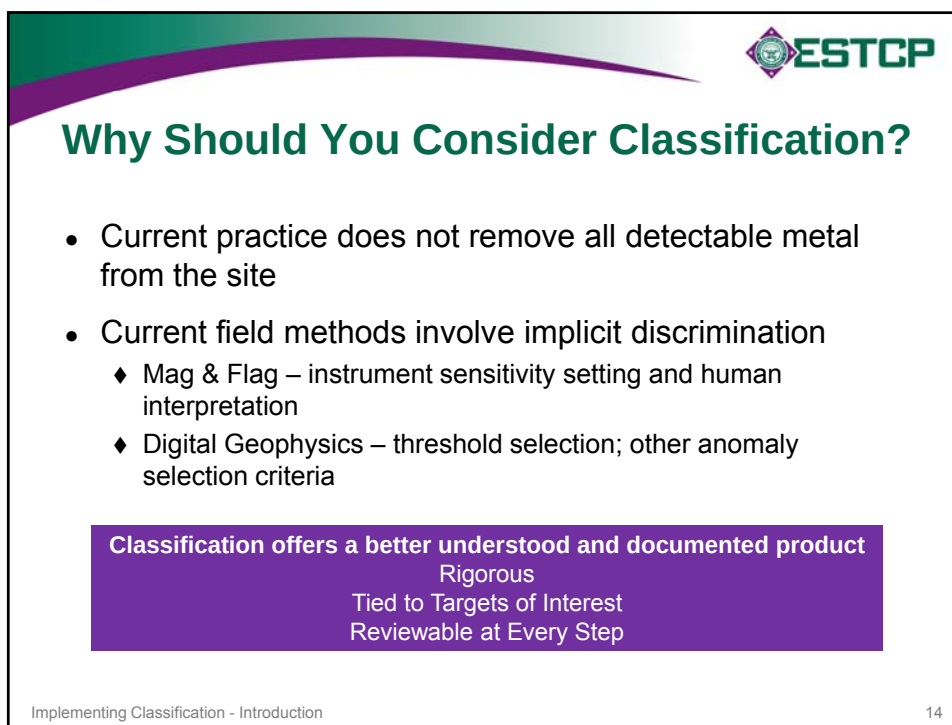
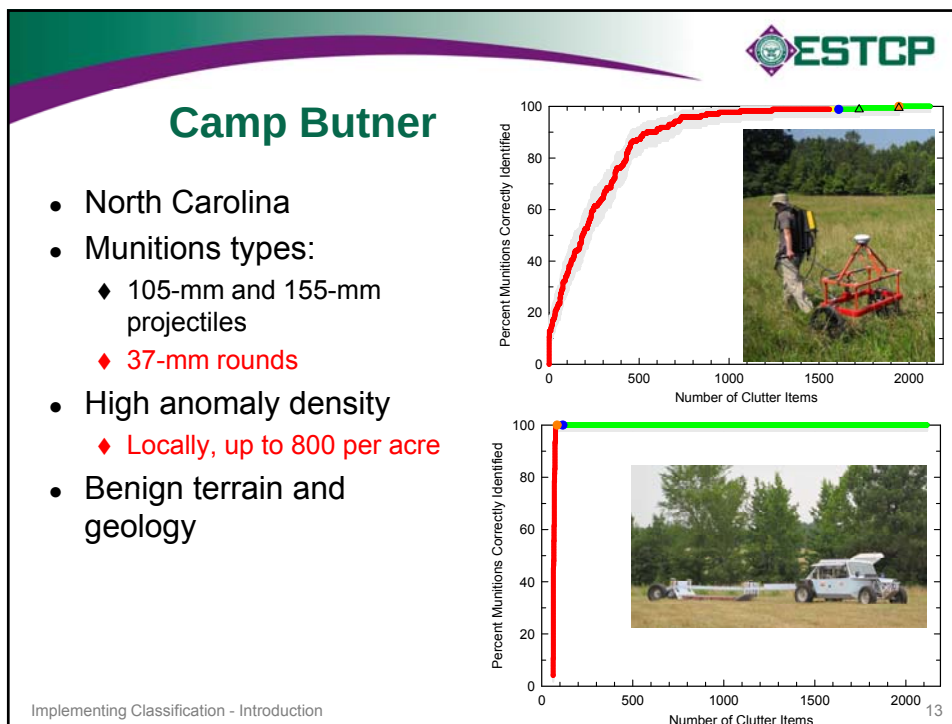
Dig List Example

Rank	P _{UXO}	Comment
-999	-999	Can't extract reliable features
1	.97	
2	.96	High confidence munition
3	...	
...	...	Can't make a decision
...	...	
...	...	
...	...	
...	...	High confidence non-munition
...	.03	
...	.03	
...	.02	
N	.01	

Threshold

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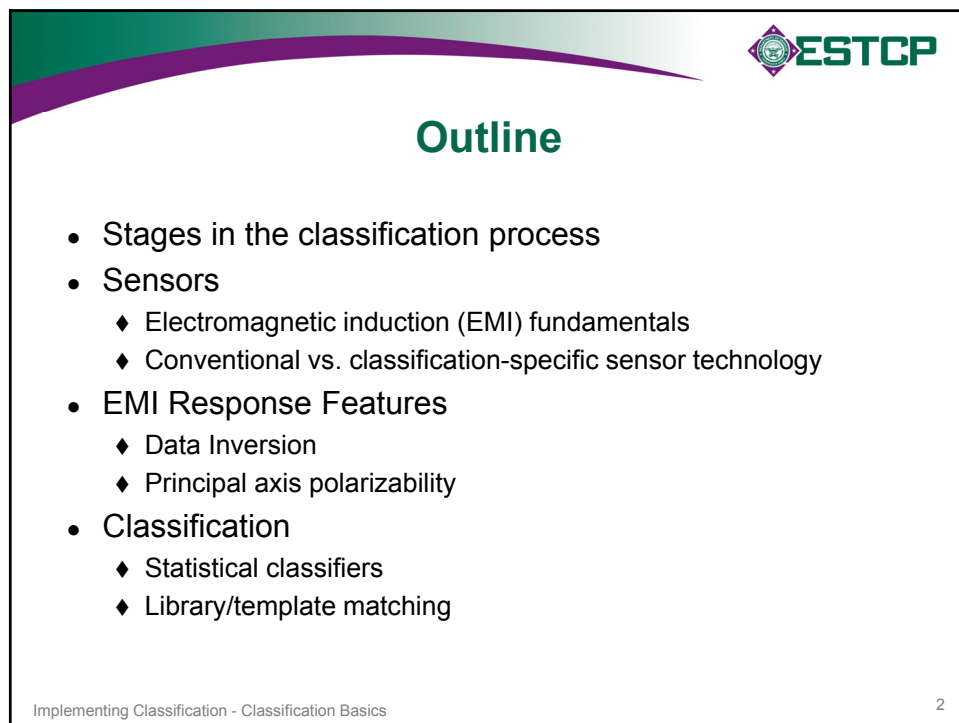
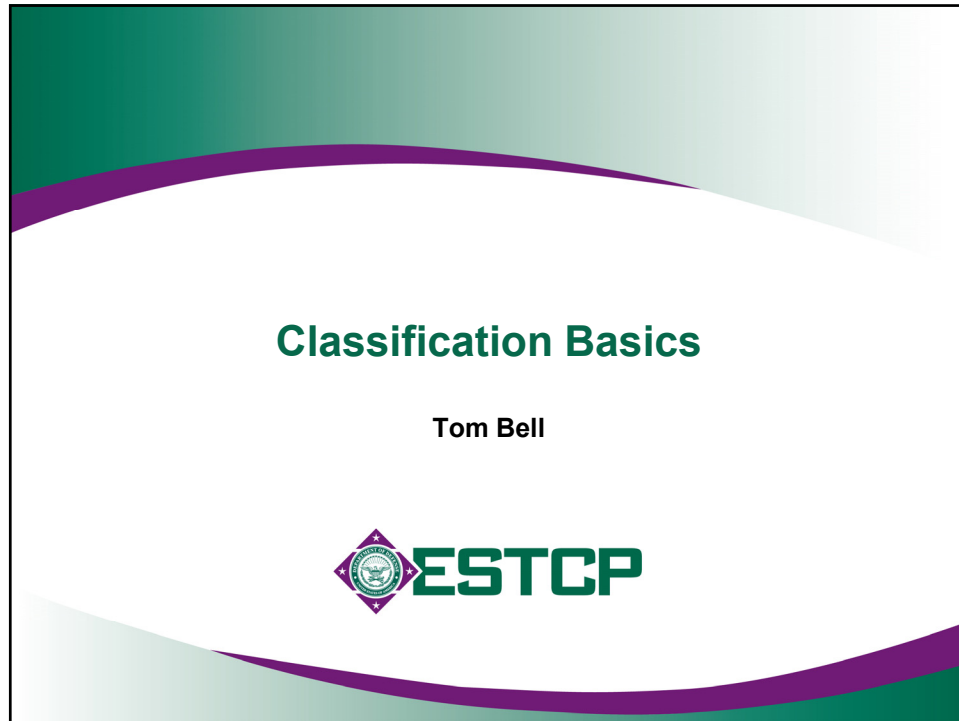






What You Should Get From This Course

- Classification has been successfully demonstrated on several sites
- It is likely to be proposed for use while demonstrations are ongoing
- You should be able to
 - ◆ Determine if a proposed classification method is valid
 - Method and workflow consistent with what has been demonstrated
 - Site conditions suitable
 - ◆ Know what questions to ask and what deliverables to expect
 - ◆ Understand quality control considerations



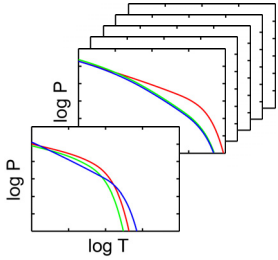


Stages in the Classification Process



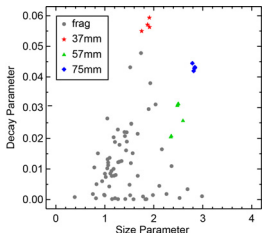
1. Measure target responses with suitable sensor

- Classification-specific EMI



2. Extract target features from the measured responses

- Data Inversion
- Target polarizabilities



3. Classify targets based on the features

- Statistical classifiers
- Library matching

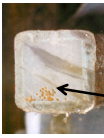
Implementing Classification - Classification Basics3



EMI Sensors

- Electromagnetic Induction (EMI) sensors measure the response of nearby metal objects to magnetic fields created by currents running through a loop of wire





Induced field receive coils



Primary field transmit coil

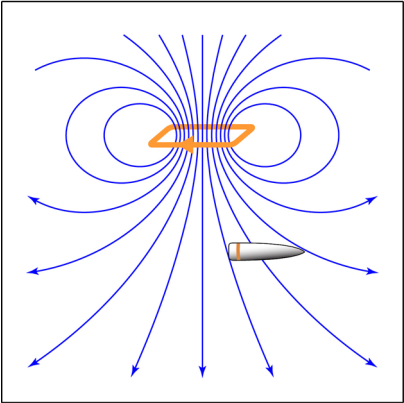
Geonics EM614



Electromagnetic Induction (EMI)

- Magnetic field is produced by running current through the transmit coil

Primary Field



Implementing Classification - Classification Basics

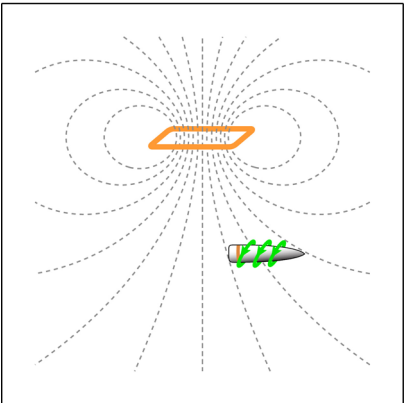
5



Electromagnetic Induction (EMI)

- Magnetic field is produced by running current through the transmit coil
- Current eddies spring up in nearby metal objects when the field is cut off, then quickly (~10 msec) decay

Eddy Currents



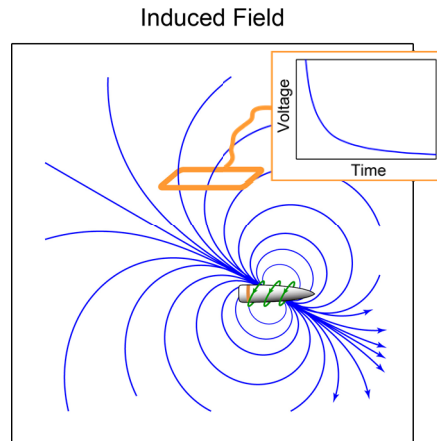
Implementing Classification - Classification Basics

6



Electromagnetic Induction (EMI)

- Magnetic field is produced by running current through the transmit coil
- Current eddies spring up in nearby metal objects when the field is cut off, then quickly (~10 msec) decay
- Sensor measures voltage induced in receive coil by decaying magnetic field from eddy currents



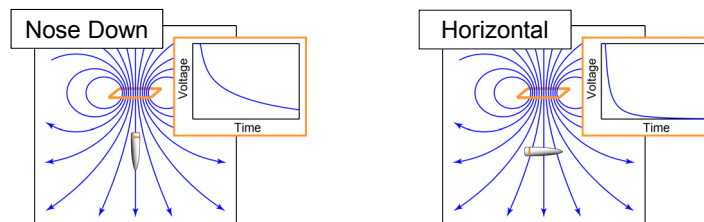
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EMI Signals

- EMI response signal determined by target properties
 - ◆ Size and Shape
 - ◆ Material type and thickness



- Muddled by response variation with target location and orientation relative to primary field
 - ◆ Signal strength varies as sixth power of range

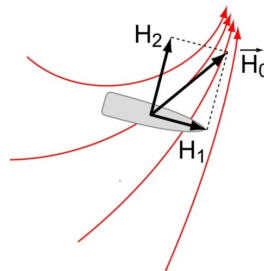
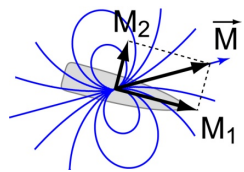
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EMI Response – Dipole Model

- Eddy current effects can be represented by an induced magnetic moment (M)
 - Strength decays with time as eddy currents die out, decay trajectory is determined by physical properties of target
 - Orientation determined by direction of primary field (H_0) relative to target's principal axes



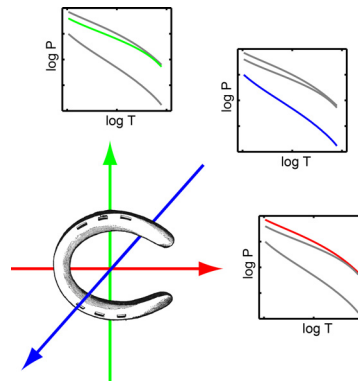
Implementing Classification - Classification Basics

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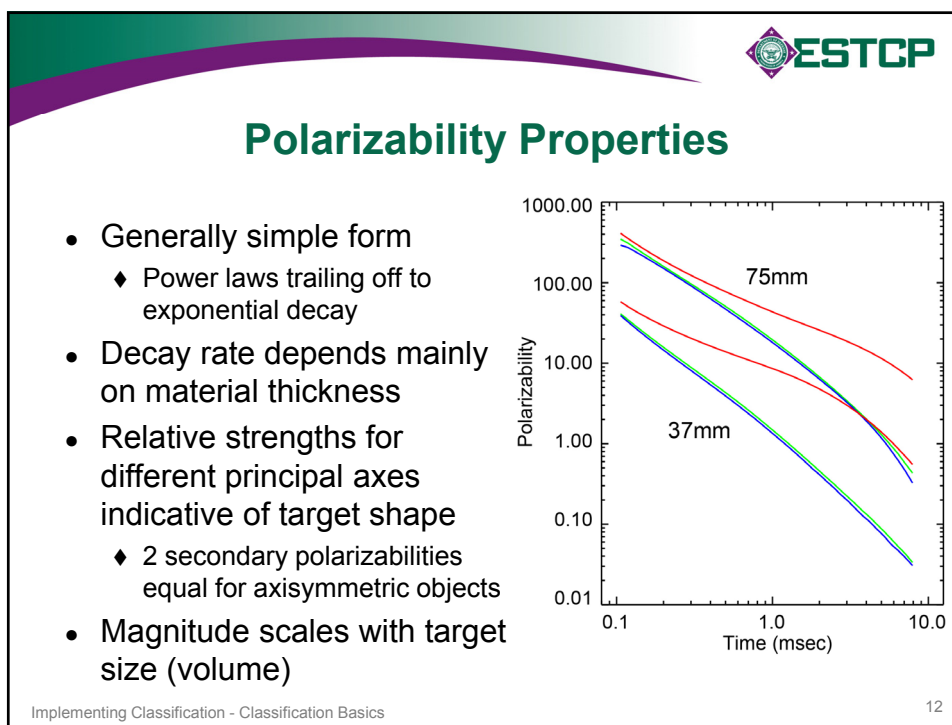
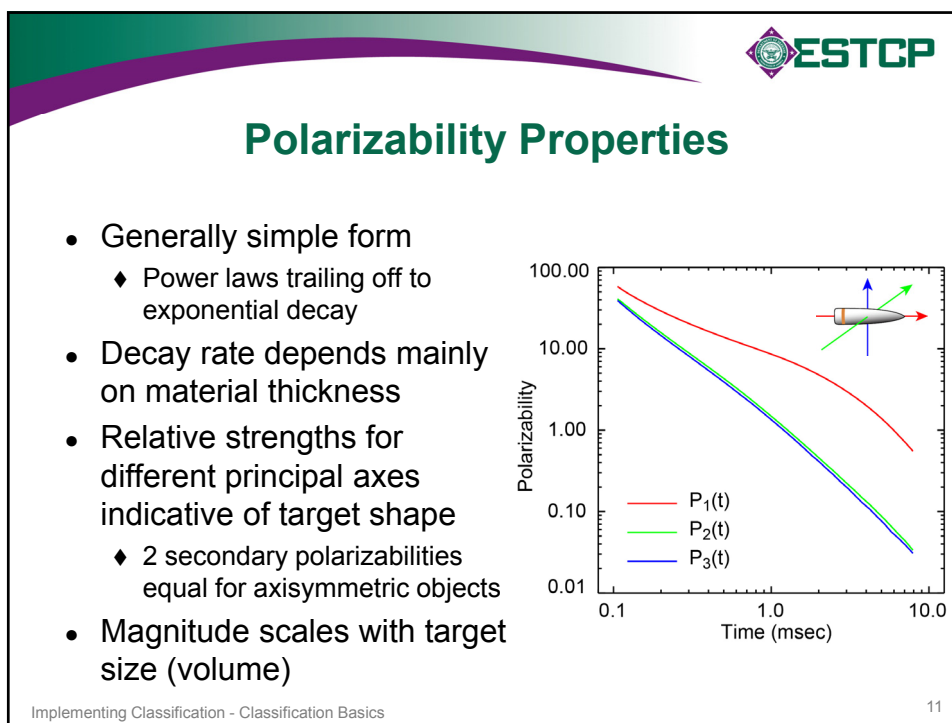
Principal Axes & Polarizabilities

- EMI response is decomposed into components along three orthogonal principal axis directions
 - Principal axis *directions* correspond to fundamental excitation modes of target
 - Magnetic *polarizabilities* are specific responses to unit excitation along each of target's principal axis
- Principal axis polarizabilities completely describe EM response of target



Implementing Classification - Classification Basics

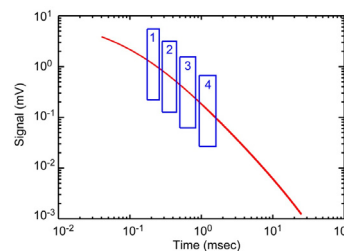
10





Conventional EMI Technology

- EM61 – Industry standard for UXO detection work
- Not usually good for classification (some simple case exceptions)
 - ◆ Coarse measurement of eddy current decay (four time windows or gates)
 - ◆ Point response measured at series of locations must be combined to fully interrogate target
 - ◆ Small sensor location errors (~1 cm) compromise ability to estimate polarizability



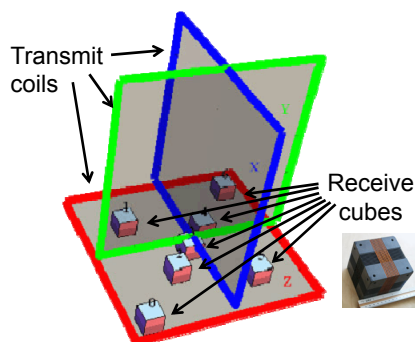
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Advanced Sensors

- Specifically designed for classification
 - ◆ Measure complete eddy current decay signal
 - ◆ Employ fixed arrays for precise sensor positioning, and
 - ◆ Multi-axis transmit/receive coils for complete target illumination



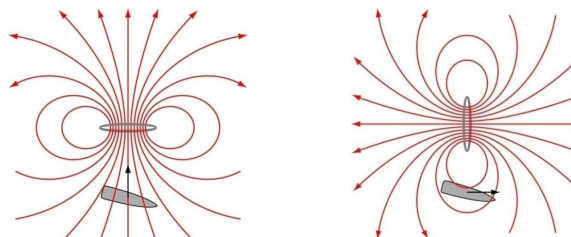
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Classification-Specific Sensors

- Multi-axis coils excite target (or measure its response) in different directions to fully sample polarizability



- Multiple receivers enable precise determination of target location
 - ◆ Crucial for accurate calculation of polarizability

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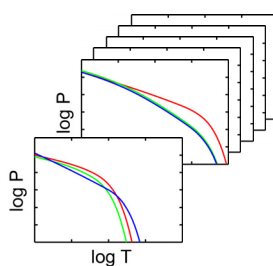
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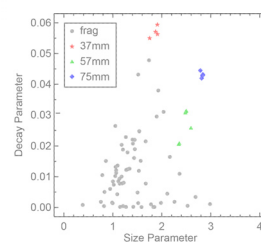
Stages in the Classification Process



1. Measure target responses with suitable sensor
 - Classification-specific EMI



2. Extract target features from the measured responses
 - Data Inversion
 - Target polarizabilities



3. Classify targets based on the features
 - Statistical classifiers
 - Library matching

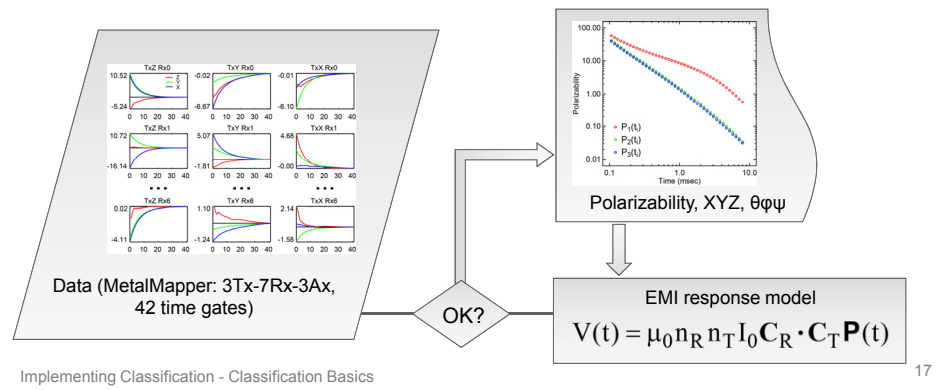
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Feature Extraction (Inversion)

- Iterative search determines target parameters (LOCATION, ORIENTATION, POLARIZABILITY) for best match between EMI response model and measured response



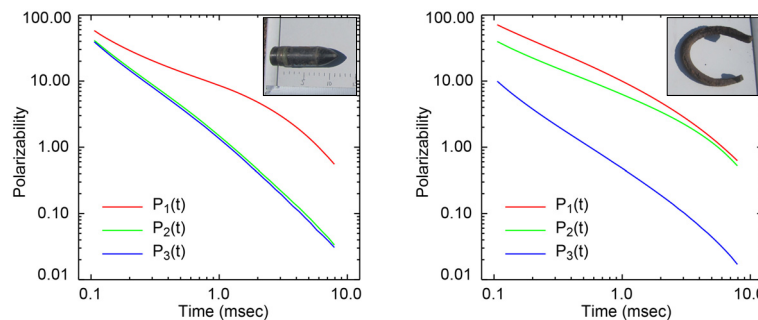
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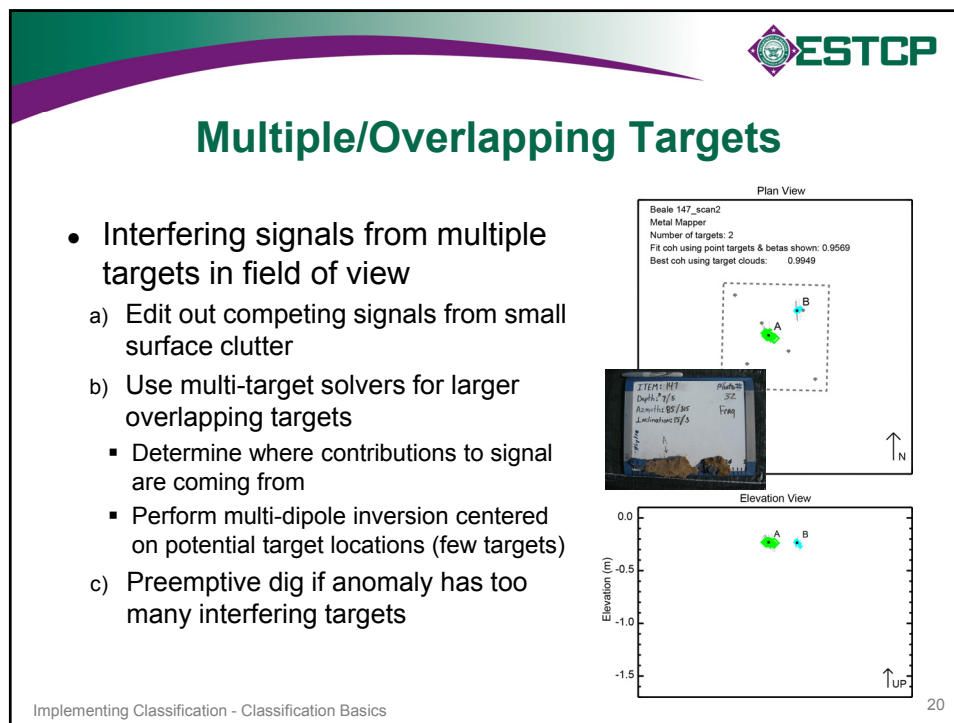
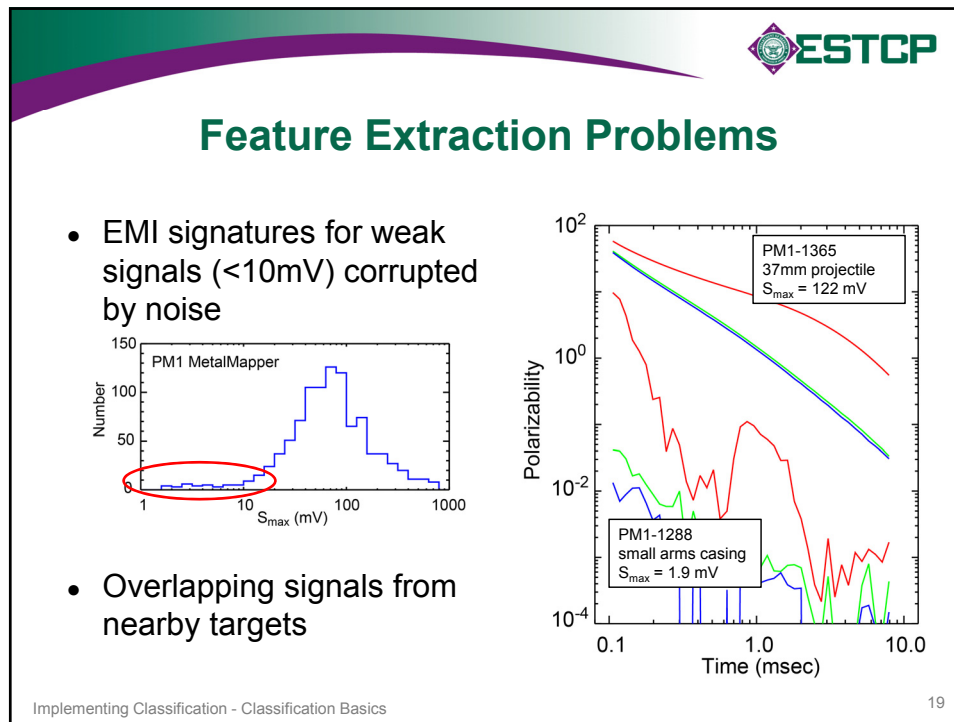
Principal Axis Polarizability

- Principal axis polarizability curves completely specify target's EMI response characteristics
 - Independent of sensor/geometry
 - Contain all information useful for classification



Implementing Classification - Classification Basics

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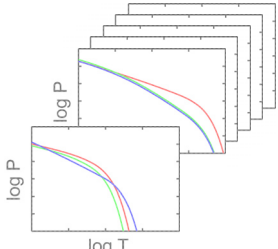


Stages in the Classification Process



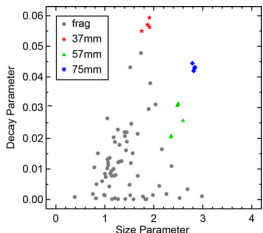
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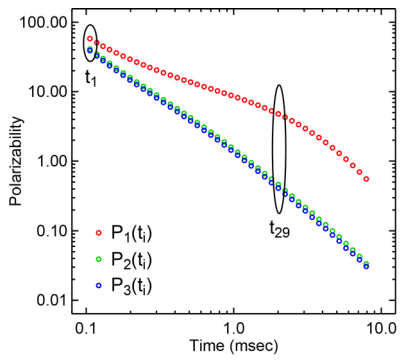
- Statistical classifiers
- Library matching

Implementing Classification - Classification Basics 21



Simple Response Features

- Simple properties of principal axis polarizabilities can distinguish between some types of objects
- Large vs. small
 - ◆ Overall strength of response at early time (~ 0.1 msec) scales with size of object
- Thin- vs. thick-walled
 - ◆ Strength of response at later time (~ 2 msec) relative to early time scales with thickness of material



Implementing Classification - Classification Basics 22



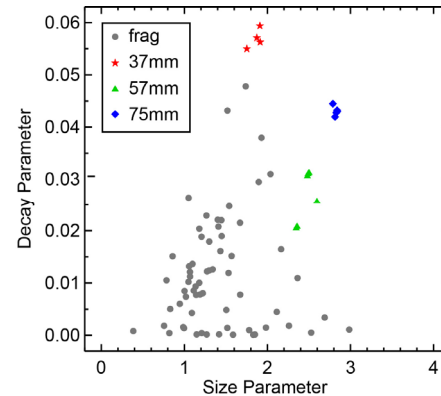
Simple Feature Spaces

- Simple two dimensional “feature spaces” like size/decay can be useful for visualizing data and identifying clusters of similar objects
 - “Feature vector” is a point (size, decay) in the feature space

$$Size = \log \sqrt{p_1^2(t_1) + p_2^2(t_1) + p_3^2(t_1)}$$

$$Decay = \frac{\sqrt{p_1^2(t_{29}) + p_2^2(t_{29}) + p_3^2(t_{29})}}{\sqrt{p_1^2(t_1) + p_2^2(t_1) + p_3^2(t_1)}}$$

$$t_1 \sim 0.1 \text{ msec}, t_{29} \sim 2 \text{ msec}$$



Implementing Classification - Classification Basics

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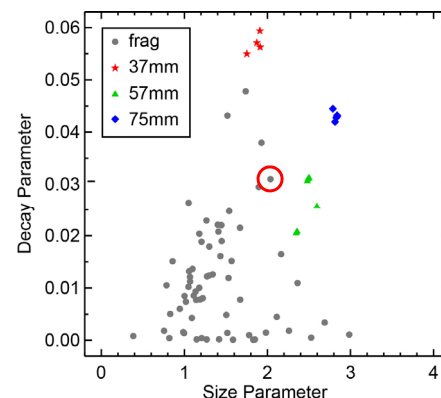
Simple Feature Spaces

- Simple two dimensional “feature spaces” like size/decay can be useful for visualizing data and identifying clusters of similar objects
 - “Feature vector” is a point (size, decay) in the feature space – e.g. (2, 0.03)

$$Size = \log \sqrt{p_1^2(t_1) + p_2^2(t_1) + p_3^2(t_1)}$$

$$Decay = \frac{\sqrt{p_1^2(t_{29}) + p_2^2(t_{29}) + p_3^2(t_{29})}}{\sqrt{p_1^2(t_1) + p_2^2(t_1) + p_3^2(t_1)}}$$

$$t_1 \sim 0.1 \text{ msec}, t_{29} \sim 2 \text{ msec}$$



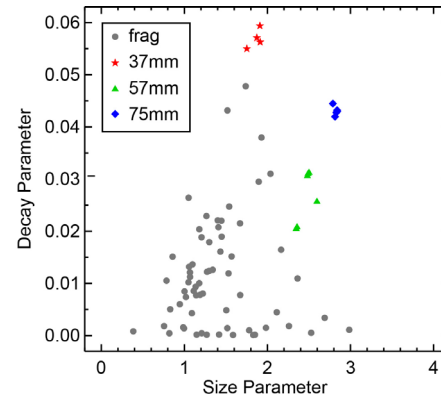
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Simple Feature Spaces

- Simple two dimensional “feature spaces” like size/decay can be useful for visualizing data and identifying clusters of similar objects
 - ◆ “Feature vector” is a point (size, decay) in the feature space
- Limited classification power relative to complete set of polarizability curves



Implementing Classification - Classification Basics

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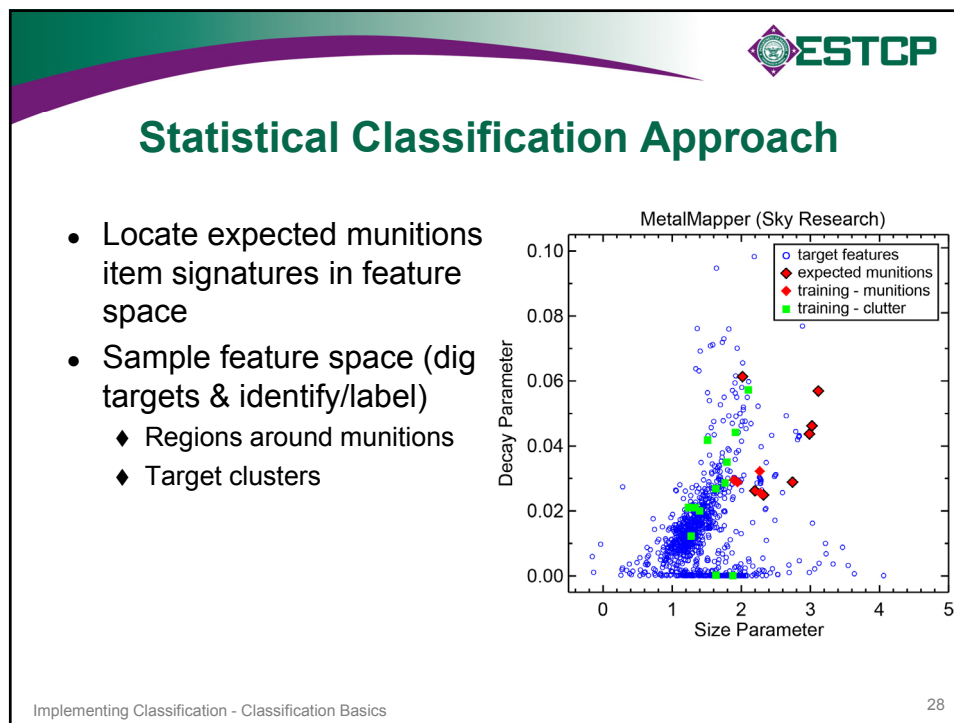
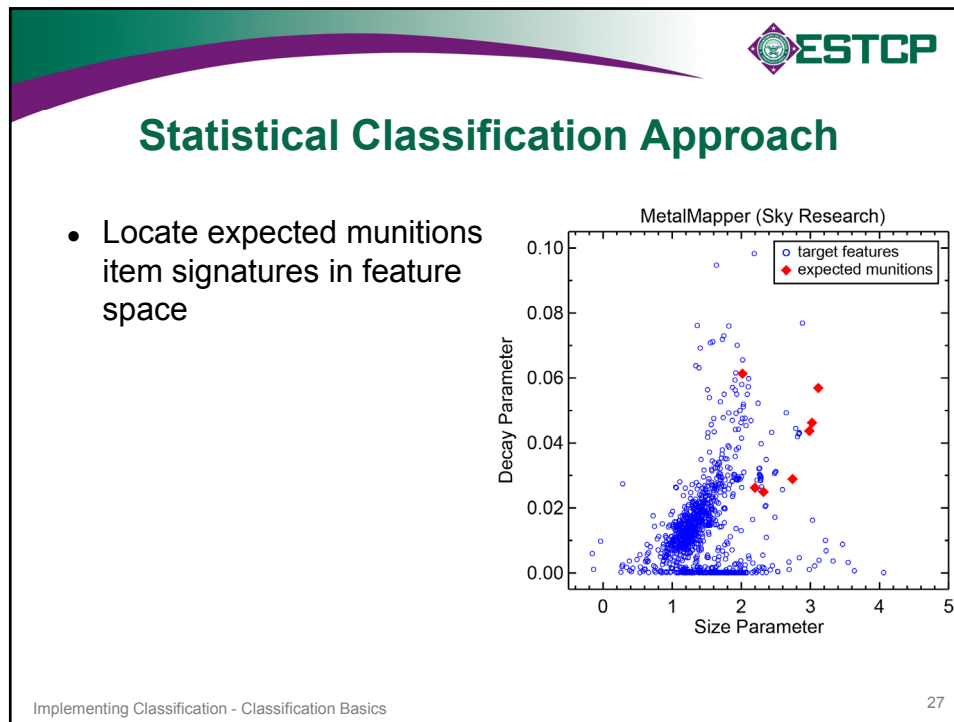


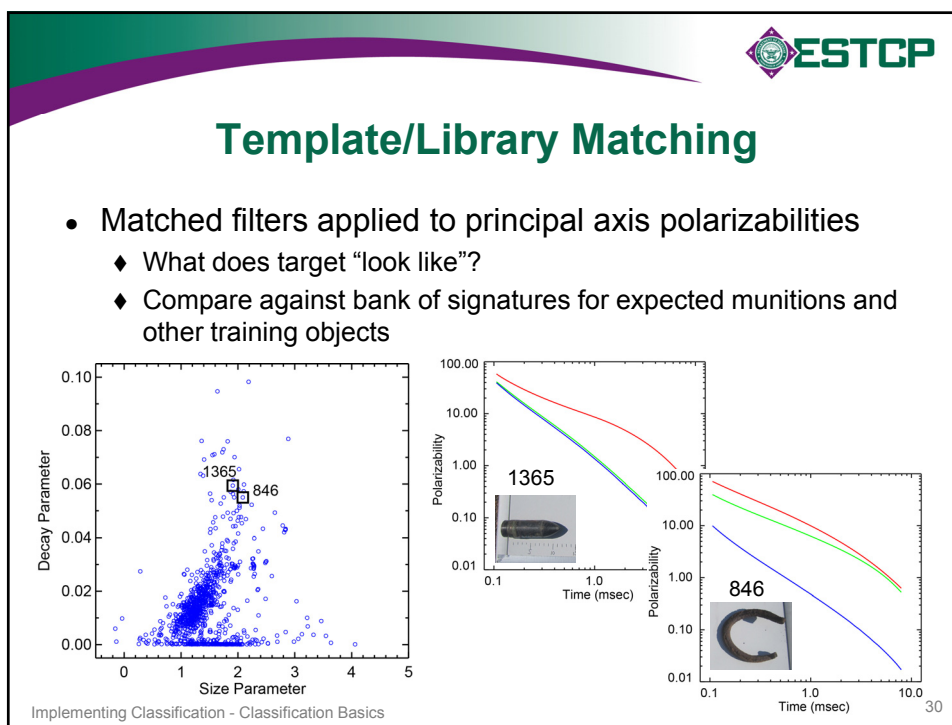
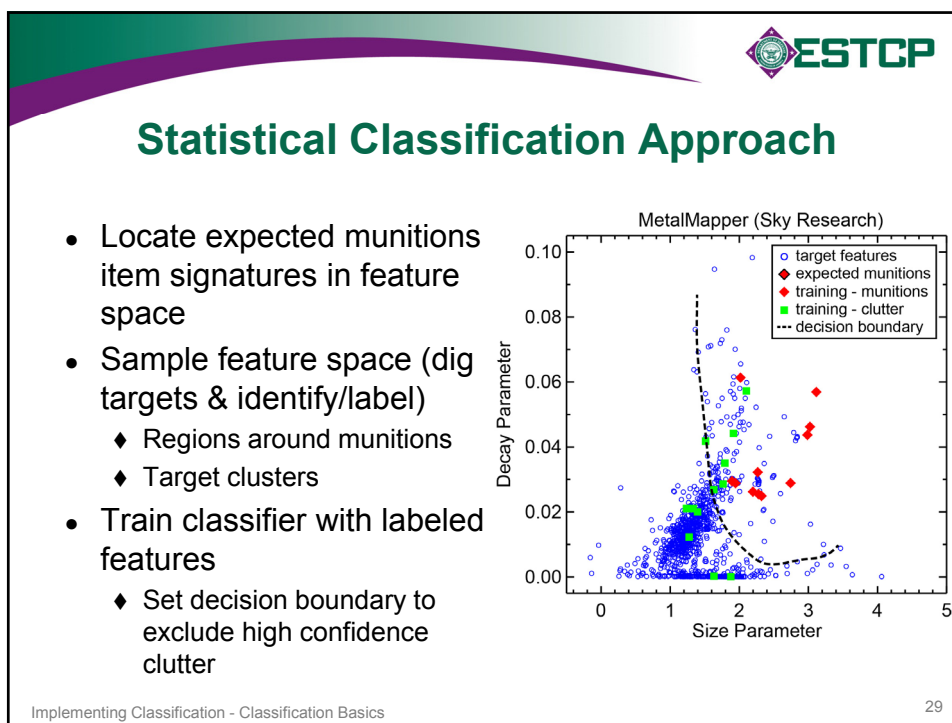
Classification Techniques

- Statistical Classifiers
 - ◆ Input features include all $3_{\text{axes}} \times N_{\text{gates}}$ polarizabilities
 - ◆ Machine learning – support vector machines, neural nets, etc.
 - ◆ Trained on prior target information and labeled training data
- Library matching
 - ◆ Asks what an unknown target “looks like” in EMI sense
 - ◆ Compares polarizability against bank of signatures for expected munitions and other training objects
- Both approaches are based on signal matching
 - ◆ Statistical classifiers create their own library
 - ◆ Both can have problems with unexpected munitions types

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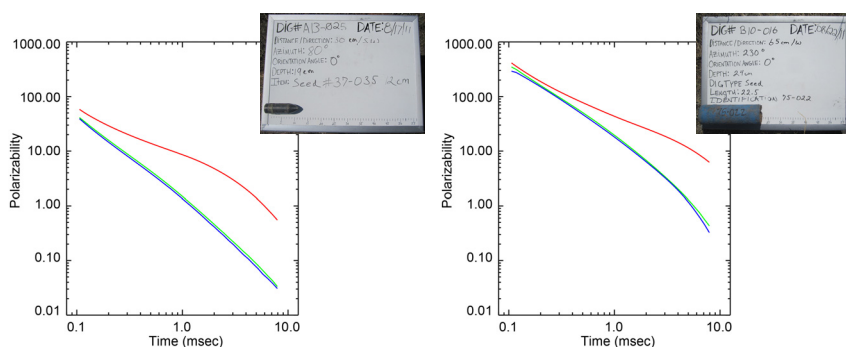






Signature Matching

- How much alike do a pair of EMI signatures look?
- 37mm and 75mm projectile look somewhat similar but different size



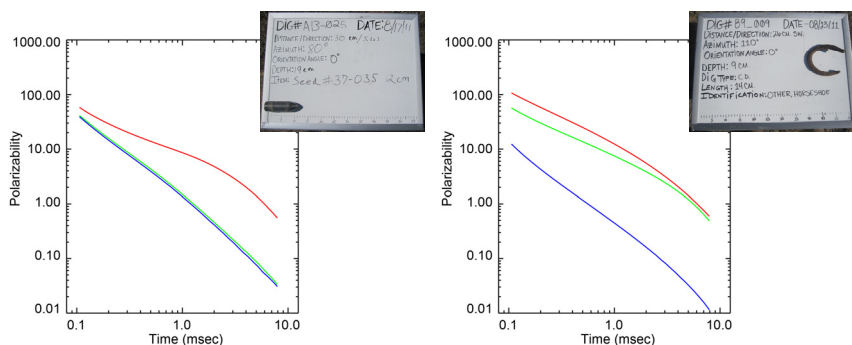
Implementing Classification - Classification Basics

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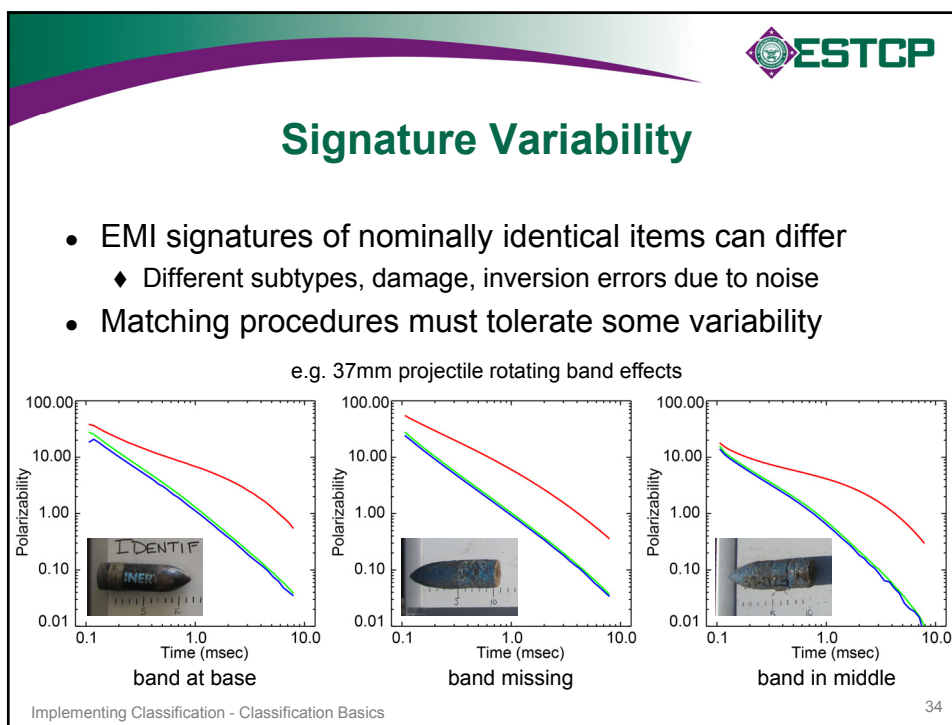
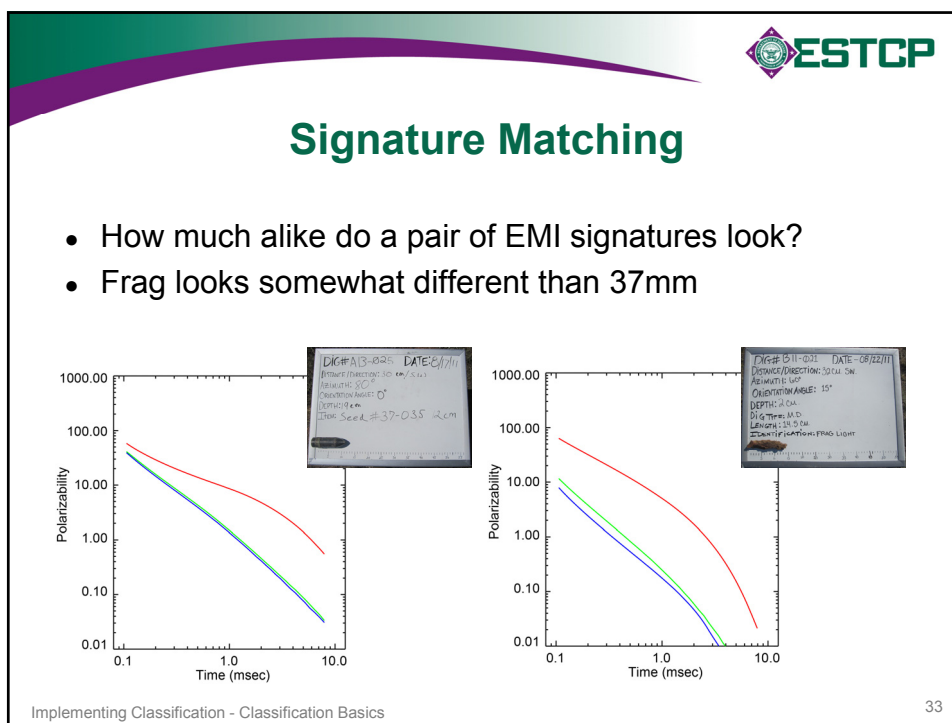
Signature Matching

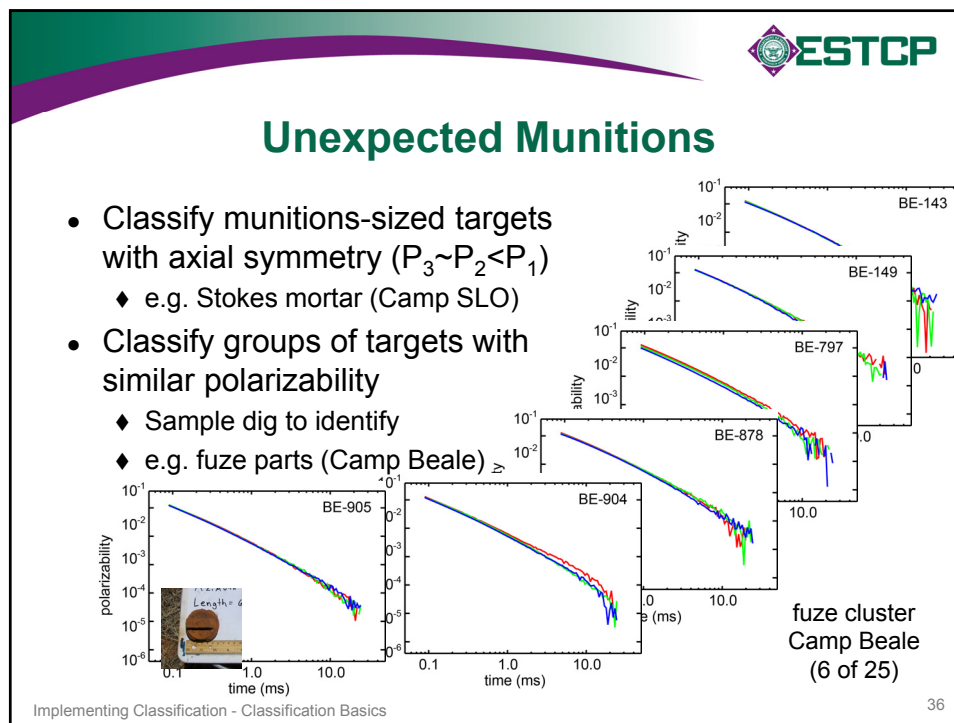
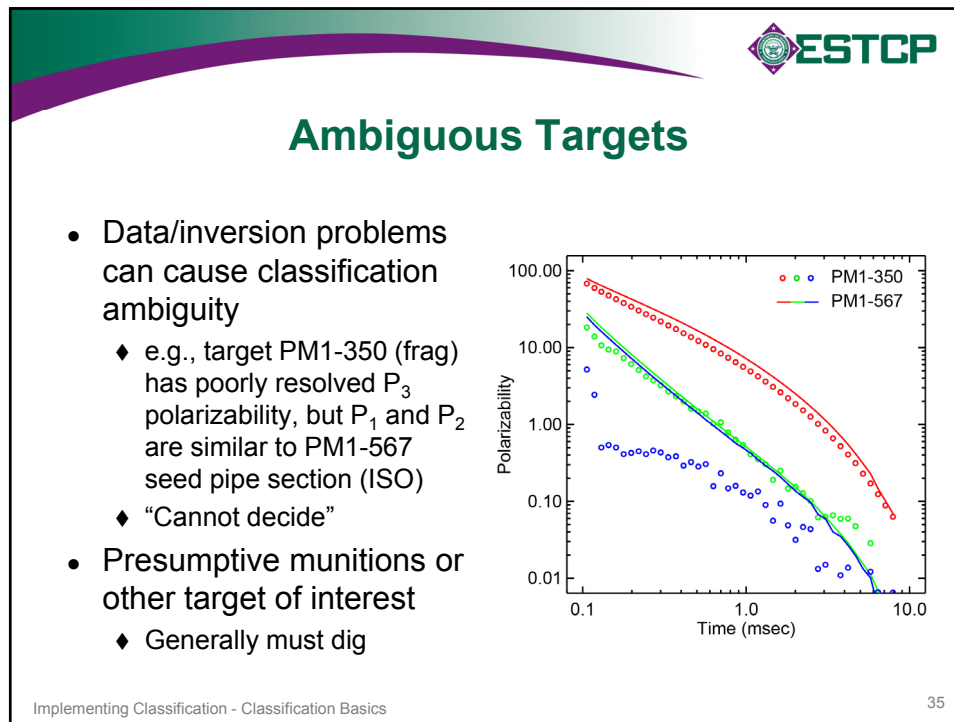
- How much alike do a pair of EMI signatures look?
- Horseshoe looks very different than 37mm



Implementing Classification - Classification Basics

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Classifier Output

- Ranked anomaly list
 - ◆ Likely munitions
 - ◆ Likely clutter
 - ◆ Can't tell
- "Stop dig" threshold
 - ◆ Set to exclude only high confidence clutter
 - ◆ Dig all uncertain targets (and likely munitions)

Rank	P _{UXO}	Dig	Comment
-9999	-9999	1	Can't extract reliable features
1	.97	1	
2	.96	1	High confidence munition
3	...	1	
...	...	1	Can't make a decision
...	...	1	Can't make a decision
...	...	0	
...	...	0	
...	...	0	High confidence non-munition
...	.03	0	
...	.03	0	
...	.02	0	
N	.01	0	

Implementing Classification - Classification Basics 37



Summary

- Modern sensors accurately measure EMI response information needed for reliable classification
- Analysis procedures remove sensor/geometry effects to extract target's intrinsic EMI signature
 - ◆ Depends only on size, shape and material properties of target
- Statistical and library-based classifiers can reliably distinguish between munitions and clutter items
 - ◆ Match unknown targets with other objects with similar EMI signatures (i.e., things they "look like")
 - ◆ Presumptive UXO (dig) if EMI "vision" is fuzzy or obscured

Implementing Classification - Classification Basics 38

Workflow and Quality Control Products

Bryan Harre



Objectives

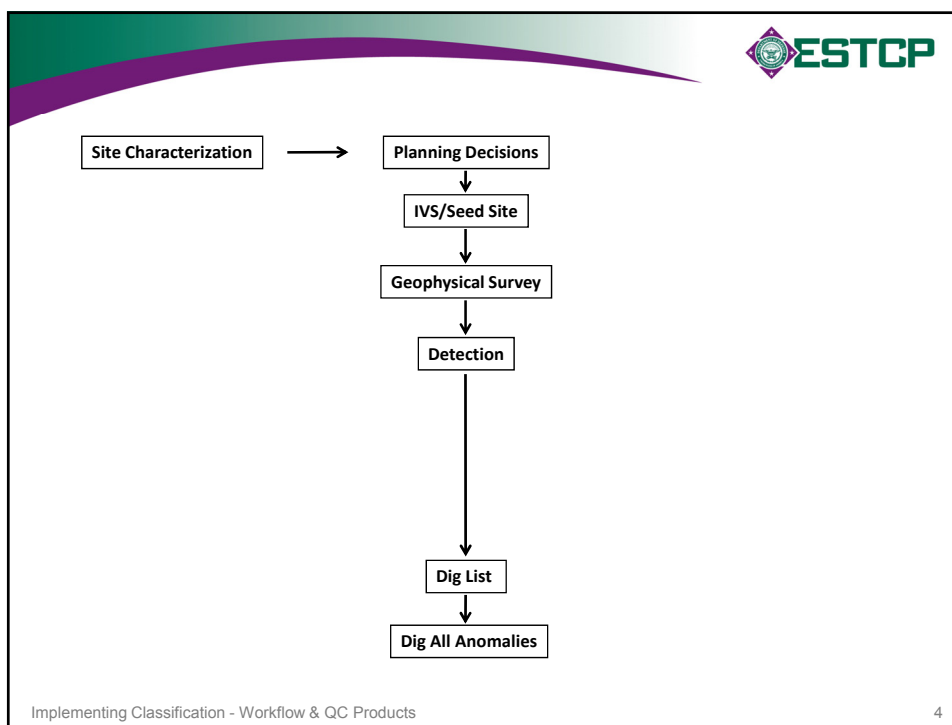
- Identify important questions to ask on a project involving classification for different phases of the work
- Provide example data products for each phase of the work
- Describe the quality control (QC) considerations for each task
- Discuss where QC considerations are documented in MEC UFP-QAPP

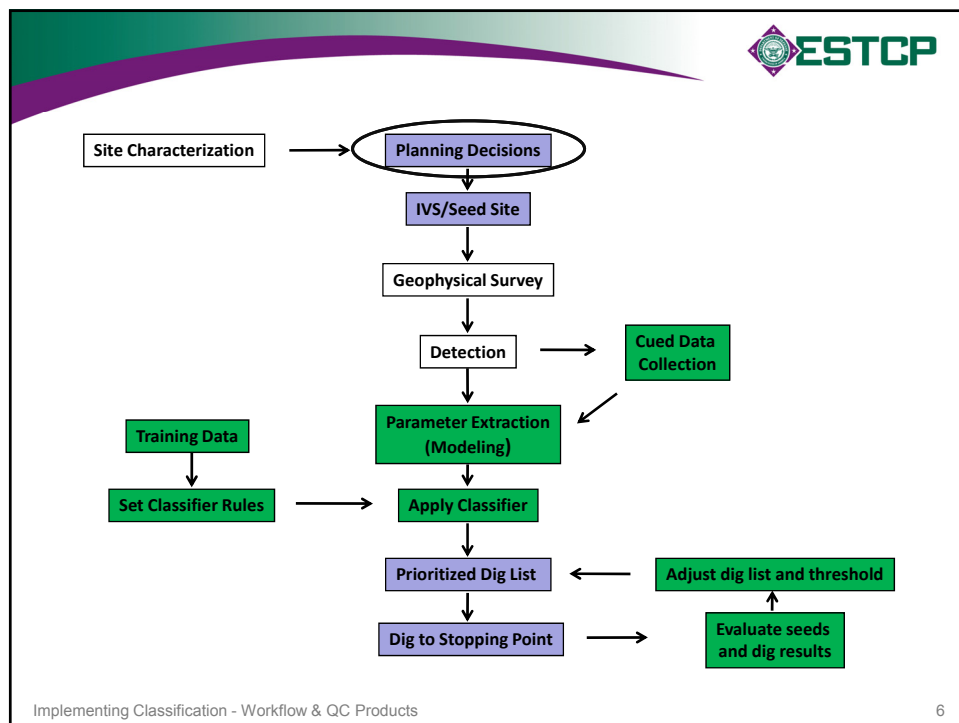
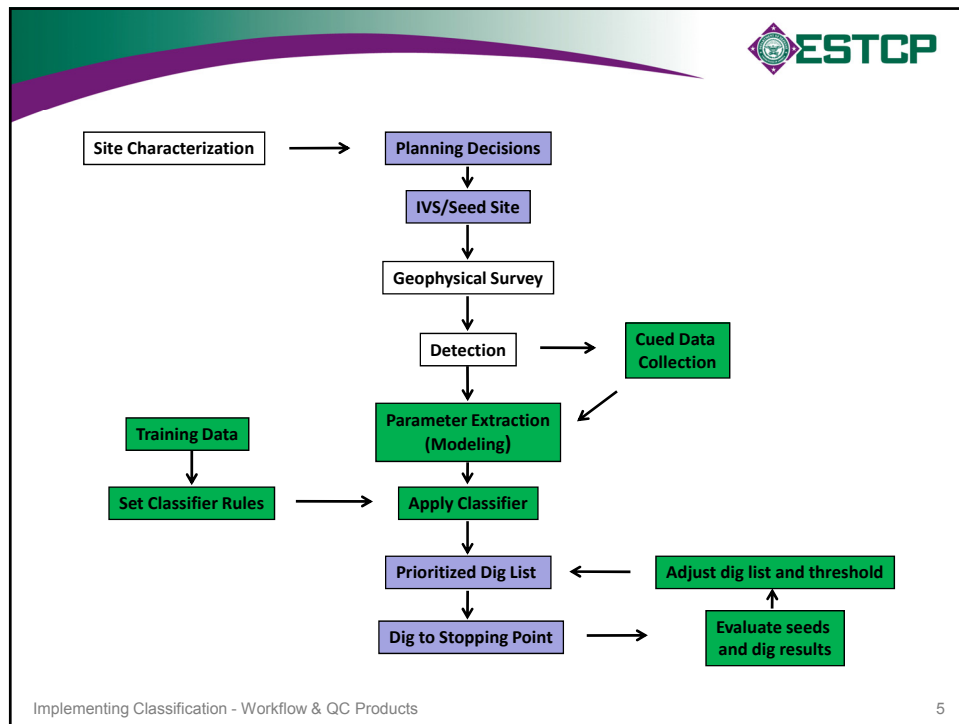


MR Project Work Elements that Classification Significantly Changes

- GIS setup
- Document management and control
- Subcontracting
- Technical and operational approach
- Work Plan preparation and approval
- Site prep and mobilization
- Site survey/grid layout
- Vegetation removal
- Surface removal
- Geophysical System Verification (GSV)
- Geophysical survey, data collection, and processing
- Anomaly reacquisition and investigation
- MEC/MPPEH management
- Demobilization
- Final report
- Archiving
- Project closeout

Implementing Classification - Workflow & QC Products 3







Is Classification Applicable at This Site

- What are the targets of interest at this site?
 - ◆ Historical research
 - ◆ Recovered munitions and fragments/scrap
 - ◆ Depth and density



Photo courtesy of Estrella Warbirds Museum.

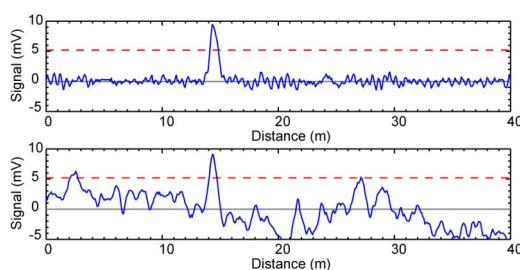
Implementing Classification - Workflow & QC Products

7



Is Classification Applicable at This Site?

- What is the appropriate threshold for detection?
 - ◆ Clutter environment and geology affect detection threshold and the ability to classify
 - ◆ If project objectives require “picking into the noise,” you need a new plan.



Implementing Classification - Workflow & QC Products

8



Classification Planning

- What classification sensor is appropriate for the site?
 - ◆ Benign terrain – MetalMapper
 - ◆ Rougher terrain with steeper slopes and trees – TEMTADS 2x2, MPV, handheld BUD



MetalMapper. Photo courtesy of ESTCP.



TEMTADS 2x2. Photo courtesy of ESTCP.



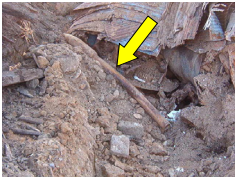
MPV. Photo courtesy of ESTCP.

Implementing Classification - Workflow & QC Products 9



Classification Planning

- What parts of the site have an anomaly density that will allow classification to be successful and at what cost?
 - ◆ Small sites and densities greater than 1000 per acre may not be appropriate.
 - ◆ For sites with few anomalies, the costs of remediation must justify the extra expense required for data collection
 - Wetlands, chemical sites, etc.

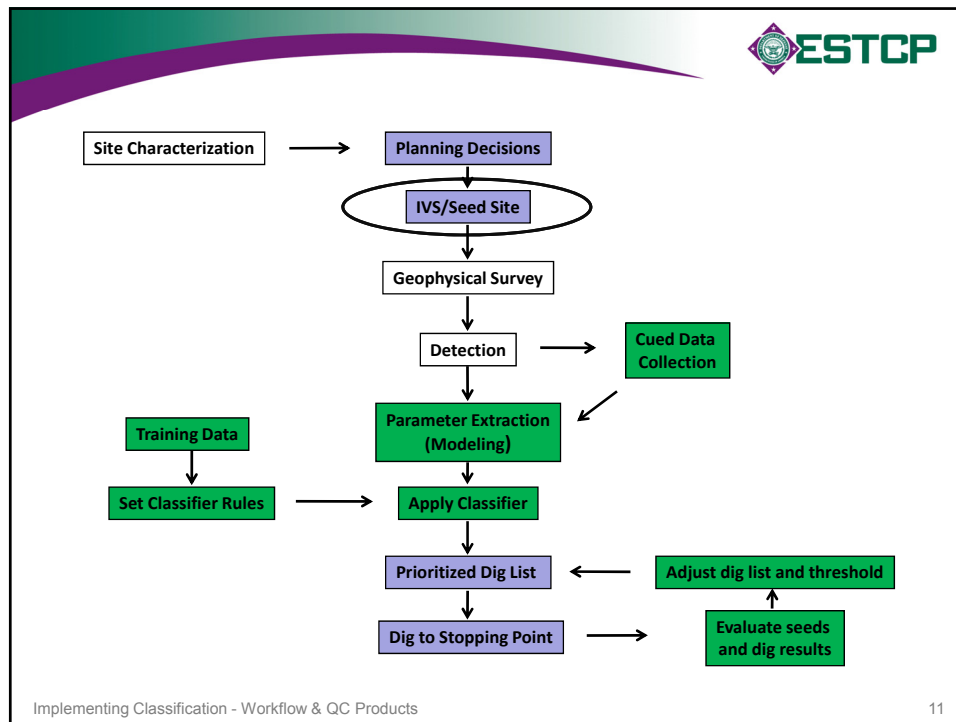


Landfill surprise.



40-mm Anti-Aircraft Projectile.
Photos courtesy U.S. Navy

Implementing Classification - Workflow & QC Products 10



11

IVS and QC Seeds

- What are the appropriate seed items and how deeply should they be buried?
 - ◆ Surrogates
 - ◆ ISOs similar to known munitions
 - ◆ Surrogates of unknown munitions
- How many production area seeds?
 - ◆ Encountered daily
- How often should the IVS and noise strip be surveyed?
 - ◆ Twice daily



Blind seed bagged and buried.
Photo courtesy of ITRC

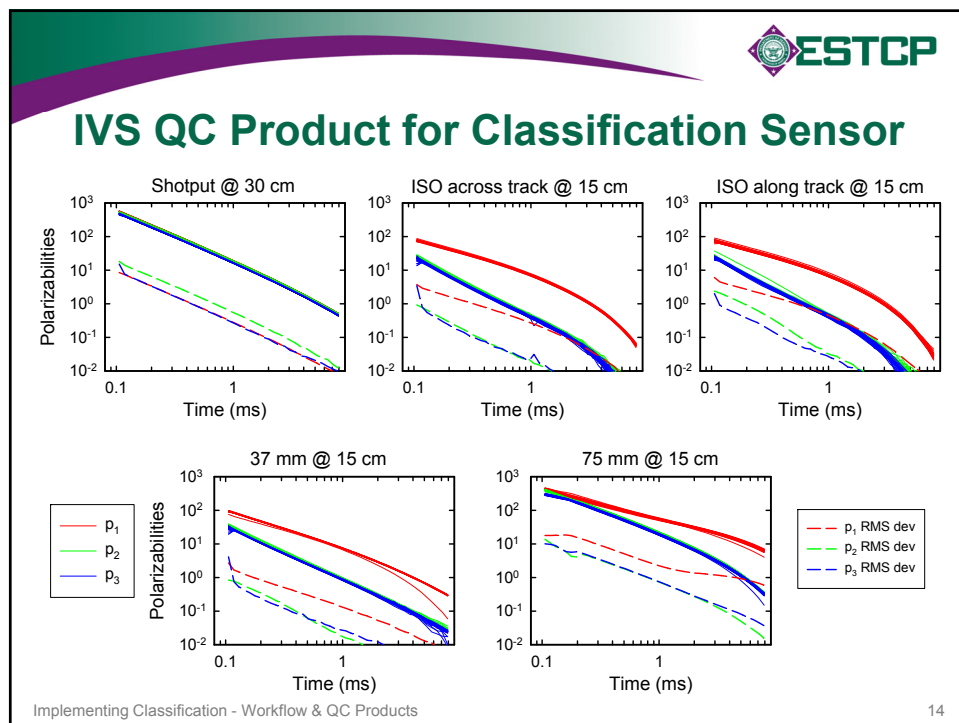
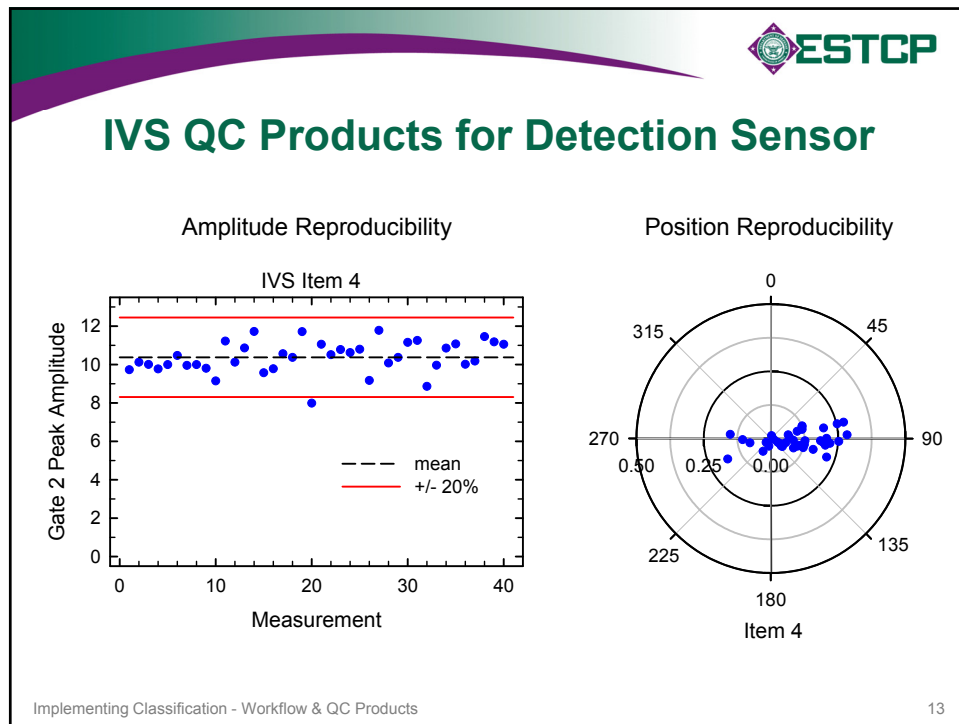


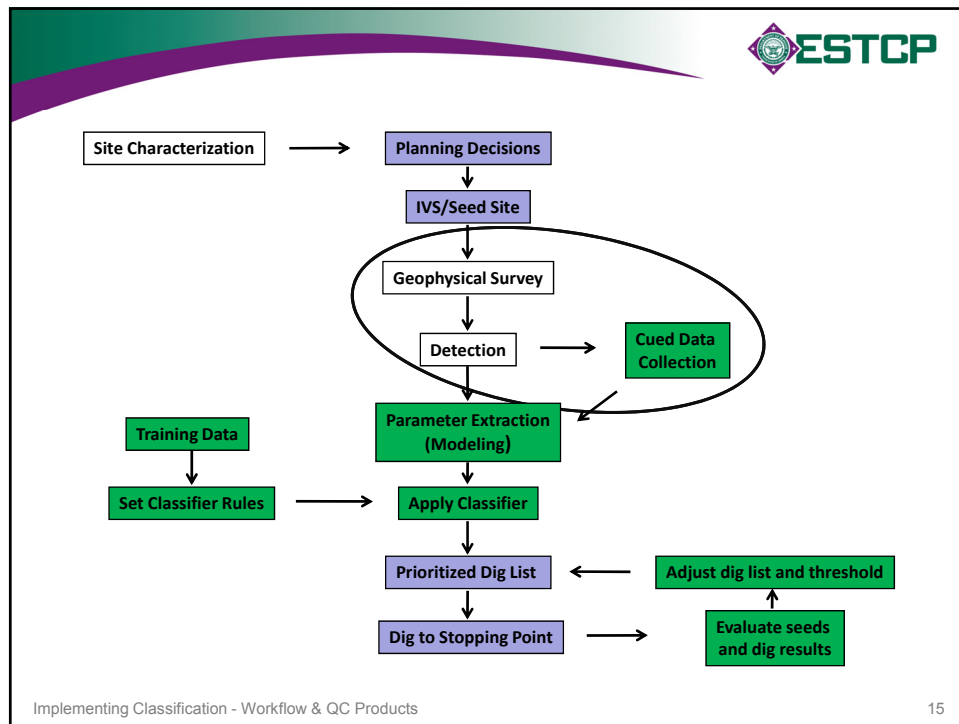


Photos courtesy of ESTCP

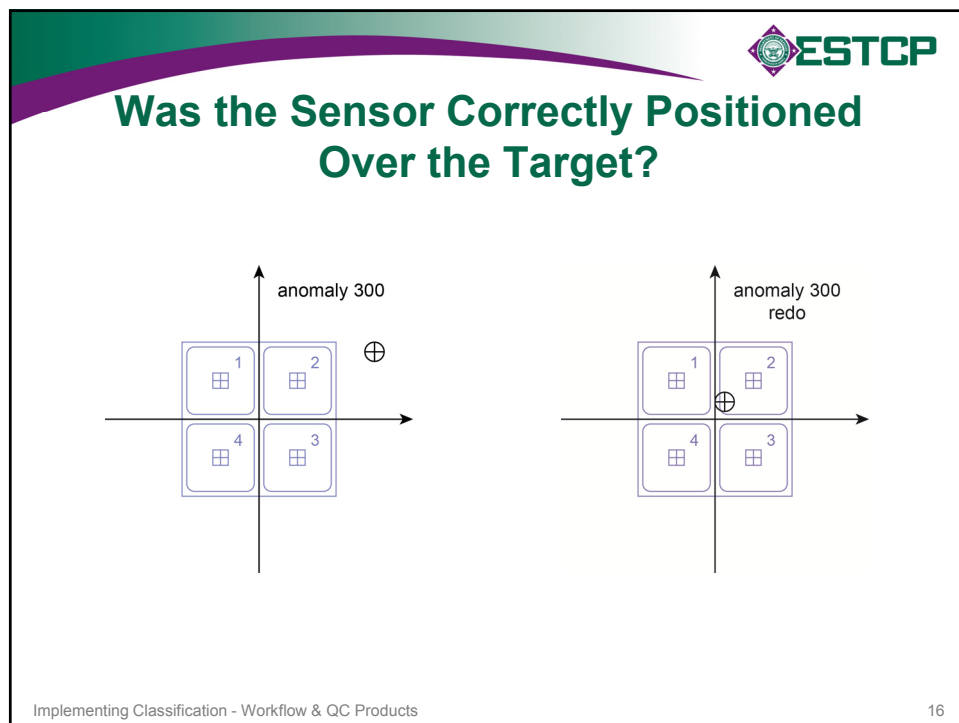
Implementing Classification - Workflow & QC Products

12

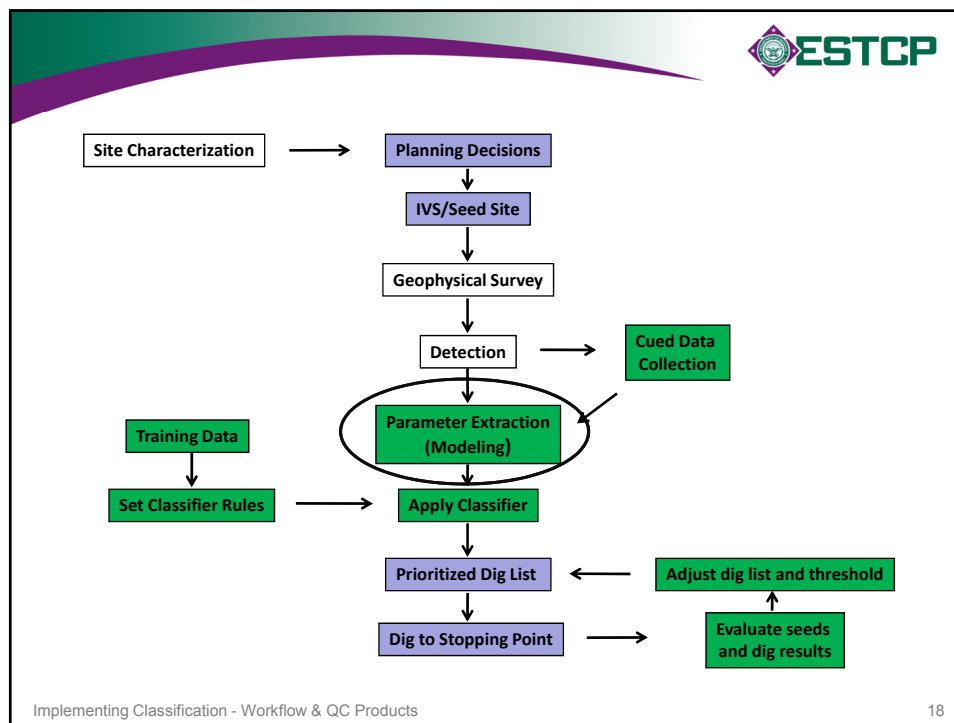
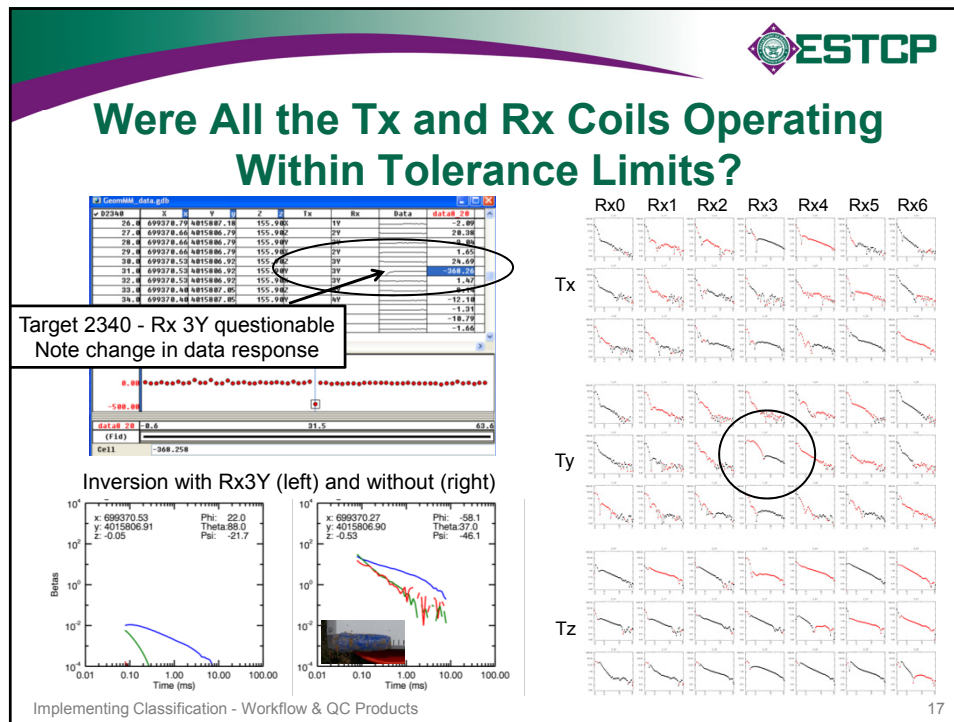




15



16



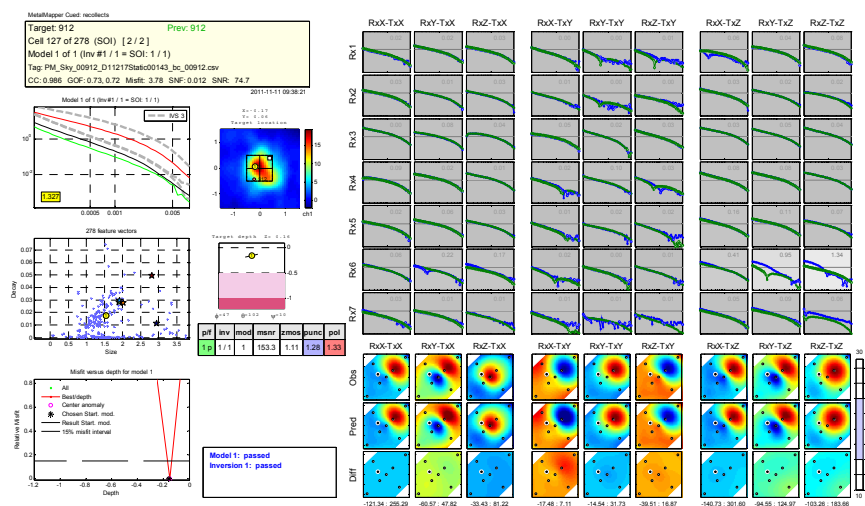


Important Feature Extraction Questions

- What are the criteria for deciding a solution has been reached?
- What are the criteria for determining that reliable features cannot be extracted for a particular anomaly and how is that anomaly treated?



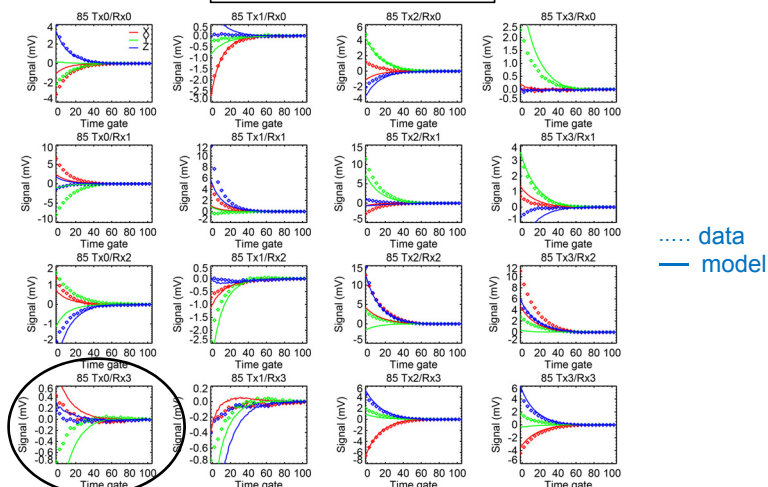
Does an Analyst Examine Each Anomaly?





How Are Multiple Targets Identified and Evaluated?

single-source solver



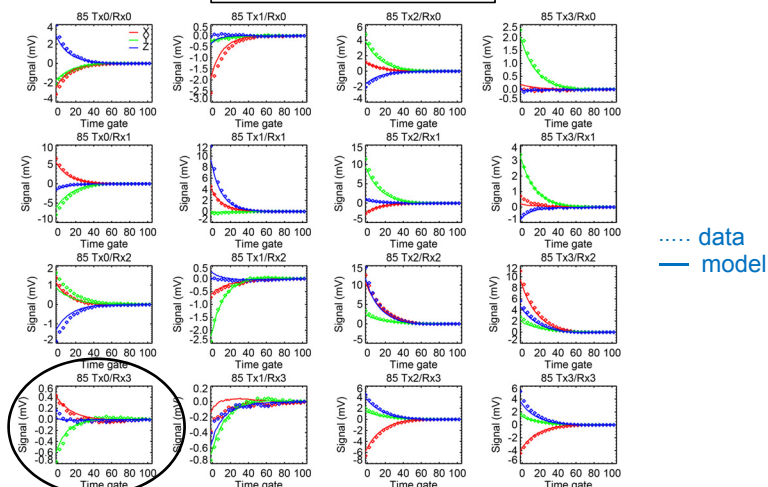
Implementing Classification - Workflow & QC Products

21



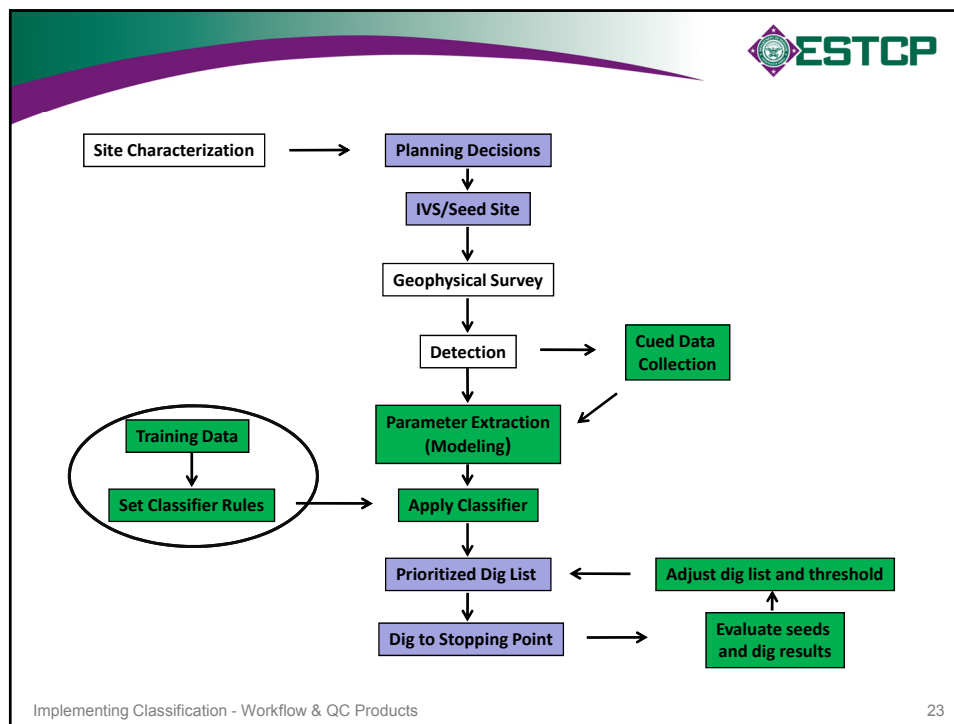
How Are Multiple Targets Identified and Evaluated?

multiple-source solver



Implementing Classification - Workflow & QC Products

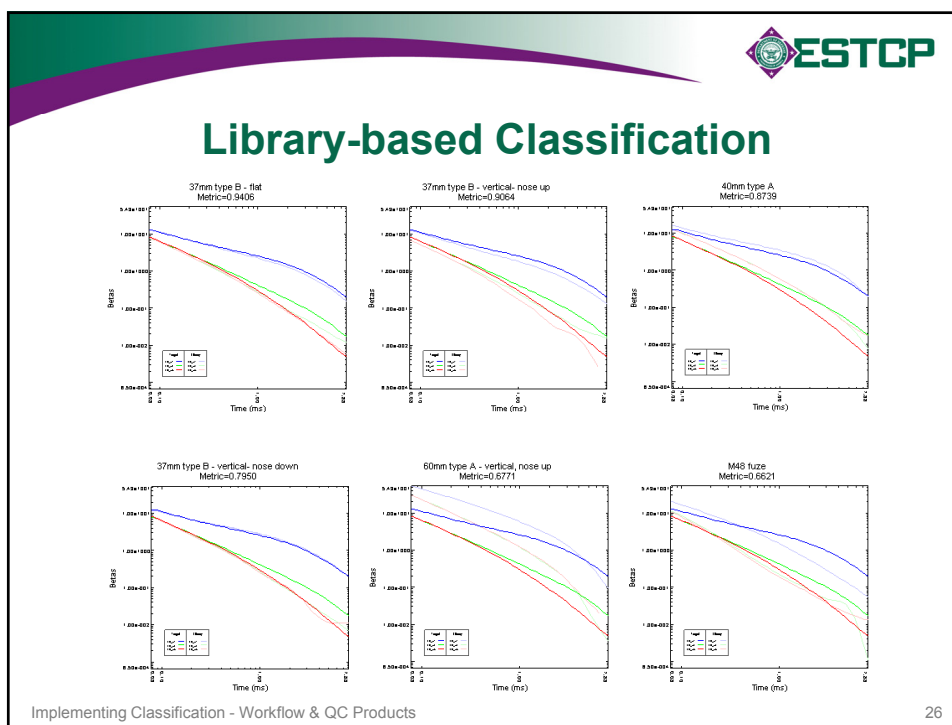
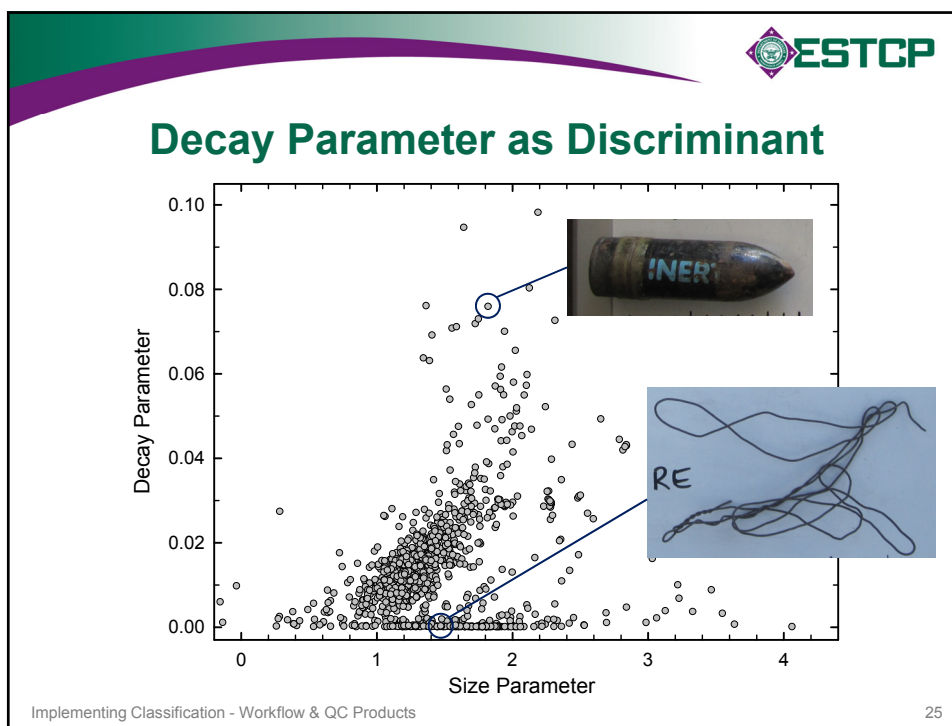
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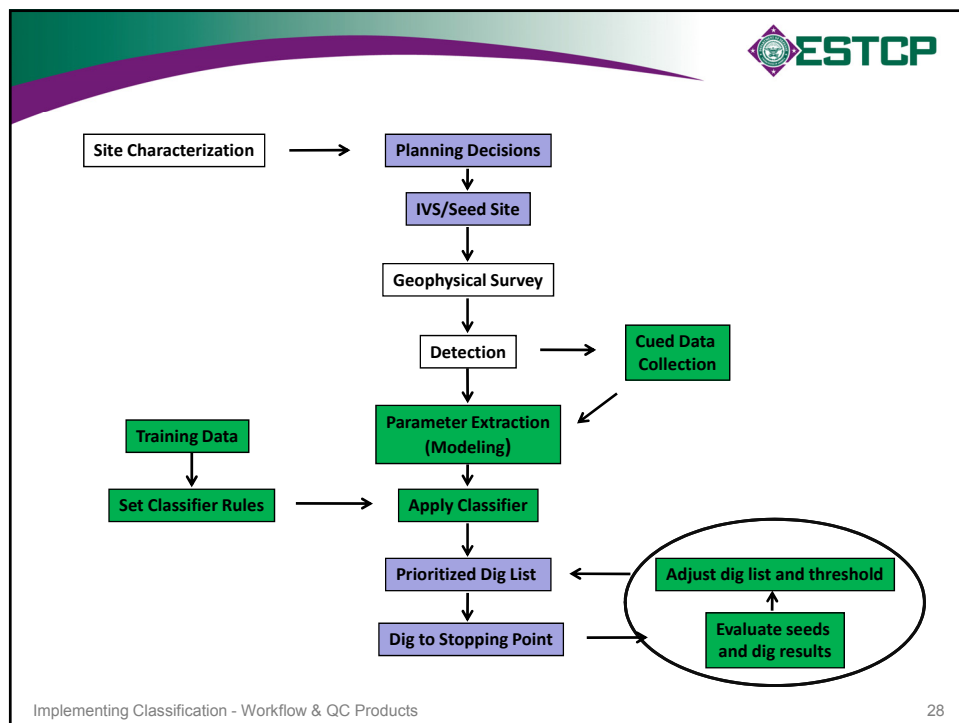
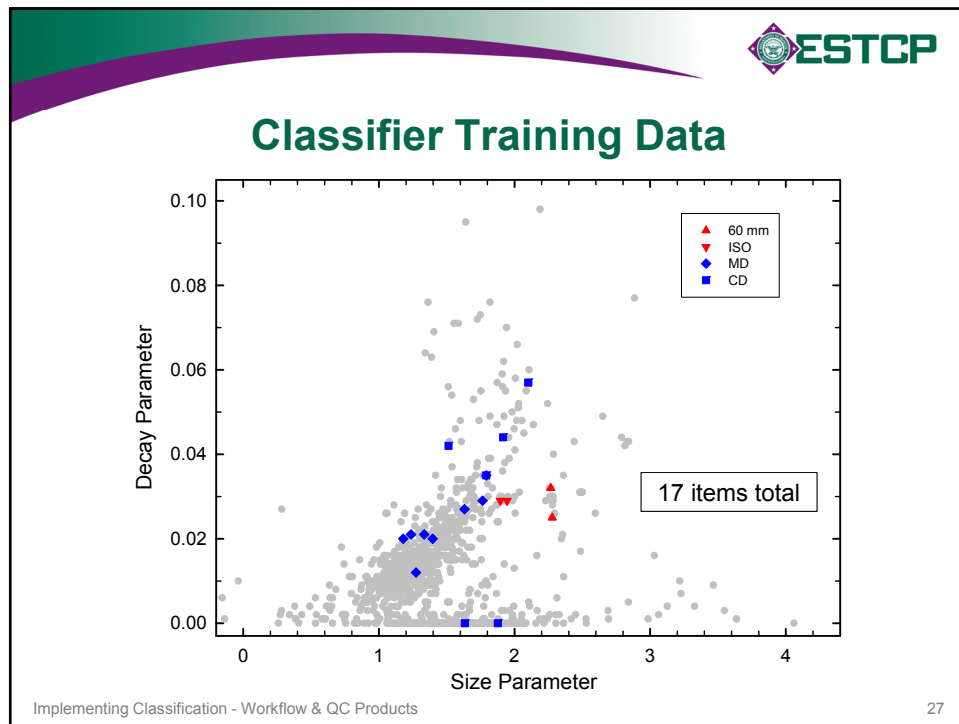


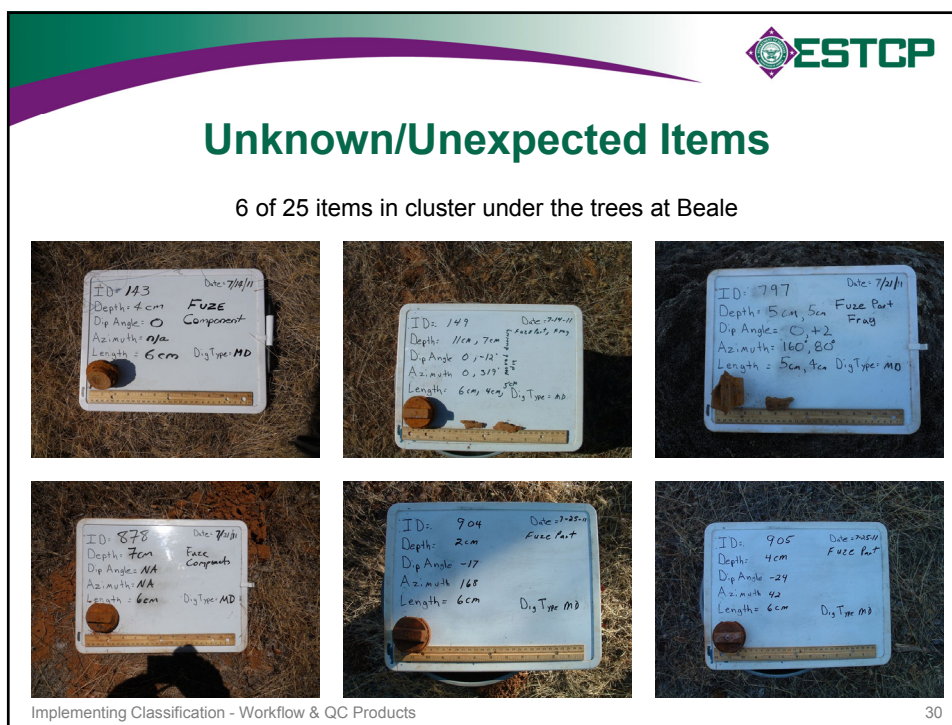
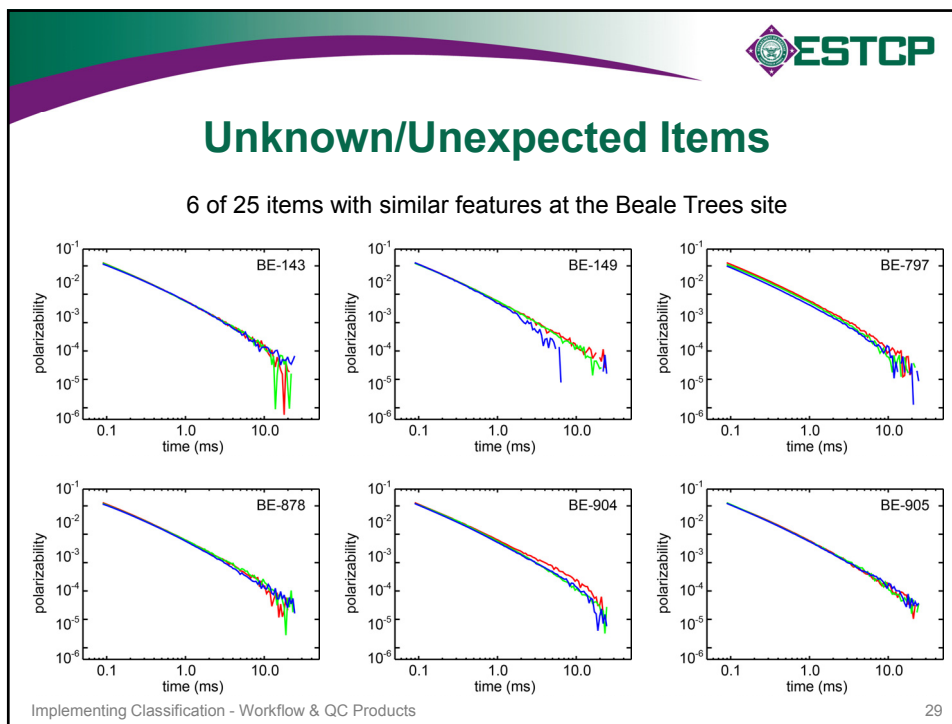
Documentation Required for the Classifier

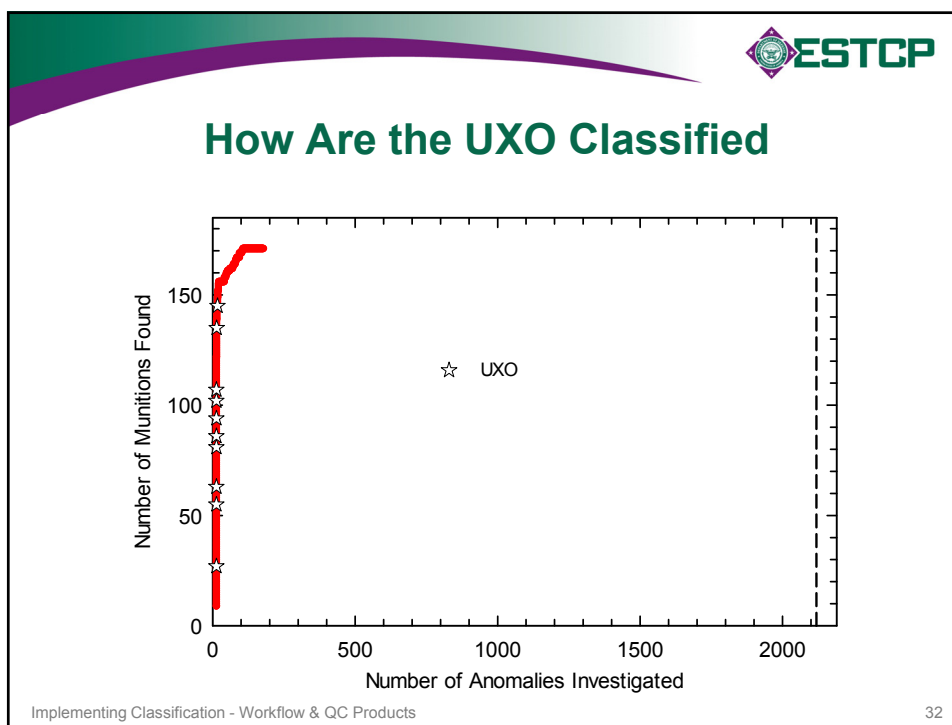
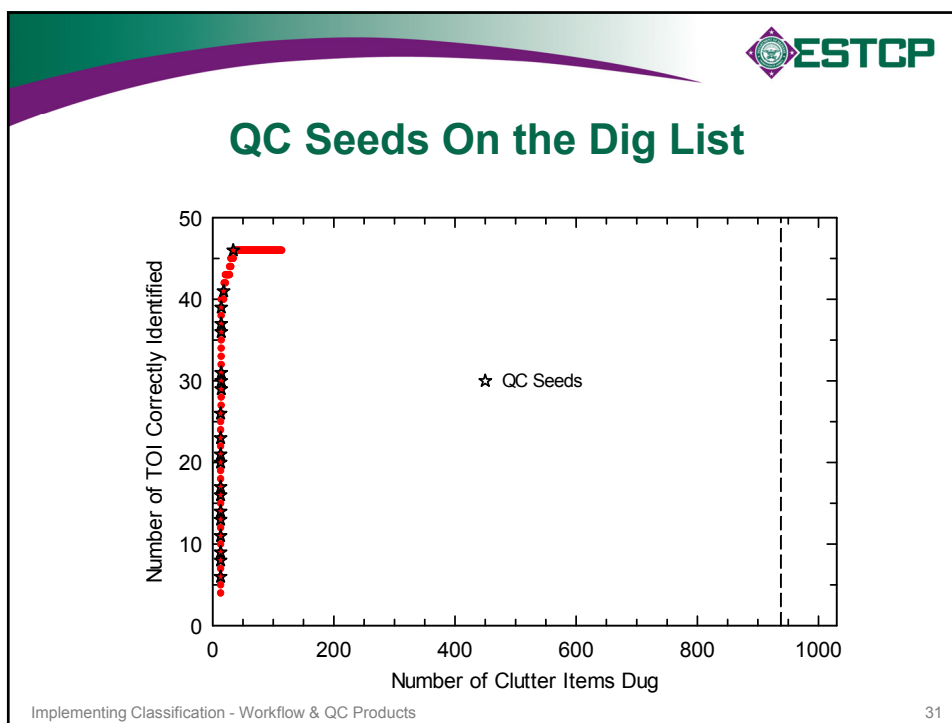
- What features been identified that will allow classification
 - ♦ polarizability amplitude and decay
 - ♦ depth and signal decay
- Will a library matching or a statistical based approach be used to classify the anomalies?
- Does the classifier require training data, how many, and how are they chosen?

Implementing Classification - Workflow & QC Products 24











Systematic Planning Process

- Systematic Planning Process is based on the scientific method and will help answer the previous questions in the different phases of work
- Ensures
 - ◆ Appropriate amount and type of data for decision
 - ◆ Data collected addresses characteristics of the site
- Commonsense graded approach
- Promotes communication between all organizations and individuals involved and is documented in the UFP-QAPP

Implementing Classification - Workflow & QC Products 33



Quality Assurance Project Plan (QAPP)

- Why is it so important to accurately document the QAPP/SAP?
 - ◆ SAP documents how QA and QC are applied to ensure that the results obtained will satisfy the stated performance criteria.
 - ◆ Purpose of a SAP is to document the planned activities data collection operations.
 - ◆ Provide a project-specific “blueprint” for obtaining the type and quality of environmental data needed for a specific decision or use.
 - ◆ Without a properly documented plan there is no way to historically reconstruct what was done for the project
- ESTCP is developing example classification QAPPs

Implementing Classification - Workflow & QC Products 34

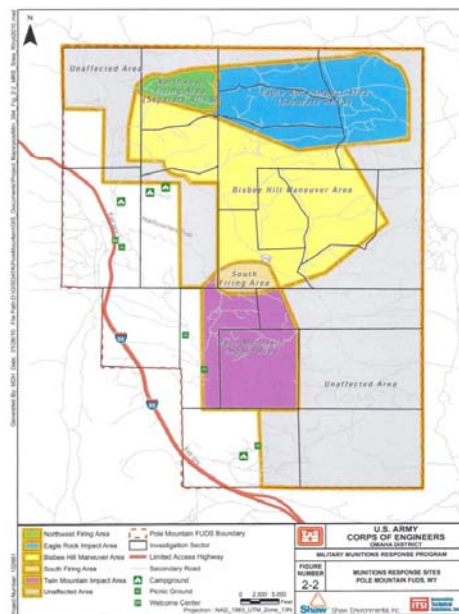
Pole Mountain, WY Case Study

Herb Nelson



Pole Mountain Training and Maneuver Area

- Bisbee Hill Maneuver Area
- South Firing Area
- Twin Mountain Impact Area



Implementing Classification - Case Study

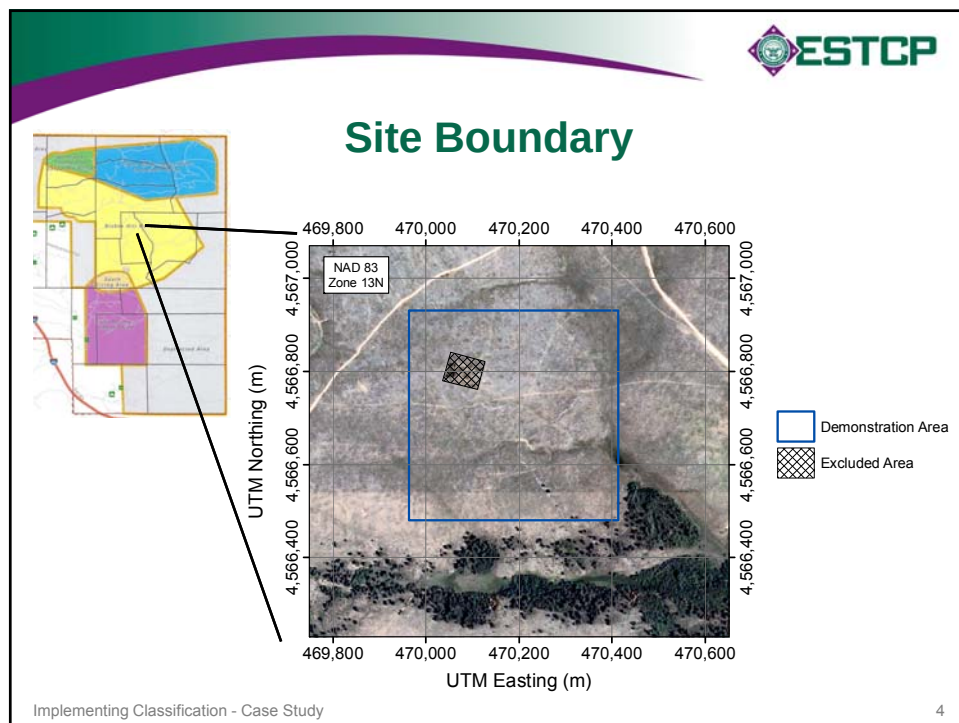
2



Munitions At the Site

- A variety of munitions have been reported as used at Pole Mountain. Physical evidence for the following items was discovered during the RI:
 - ◆ Projectiles containing high explosive (HE) filler (37-mm to 155-mm, and 2.95-inch);
 - ◆ Shrapnel projectiles (75-mm and 3-inch);
 - ◆ 37-mm projectiles (inert and unfuzed);
 - ◆ 3-inch Stokes mortars (practice, fuzed); and
 - ◆ 60-mm mortars containing HE filler.

Implementing Classification - Case Study 3





Project Details

- Seed emplacement
- EM61-MK2 detection survey
 - ◆ RTK GPS
- Select anomalies for further investigation
- Collect cued data using MetalMapper
- Intrusive investigation

Implementing Classification - Case Study 5



Seed Details

Item	Depths
37-mm projectile	15 – 30 cm
57-mm projectile	20 – 35 cm
60-mm mortar	30 cm
75-mm projectile	20 – 40 cm
3-in stokes mortar	30 cm
Small ISO	15 – 25 cm

Implementing Classification - Case Study 6





The Premise

- The first ~25% of the Pole Mountain site was surveyed in the first field season
 - ◆ Anomalies selected from the EM61 survey data
 - ◆ Cued MetalMapper data collected
- Data analysis is complete and it is time for the site team to make some decisions
 - ◆ Are the data acceptable?
 - ◆ Is the analysis acceptable?
 - ◆ Can we stop digging at the contractor's stop-dig point?

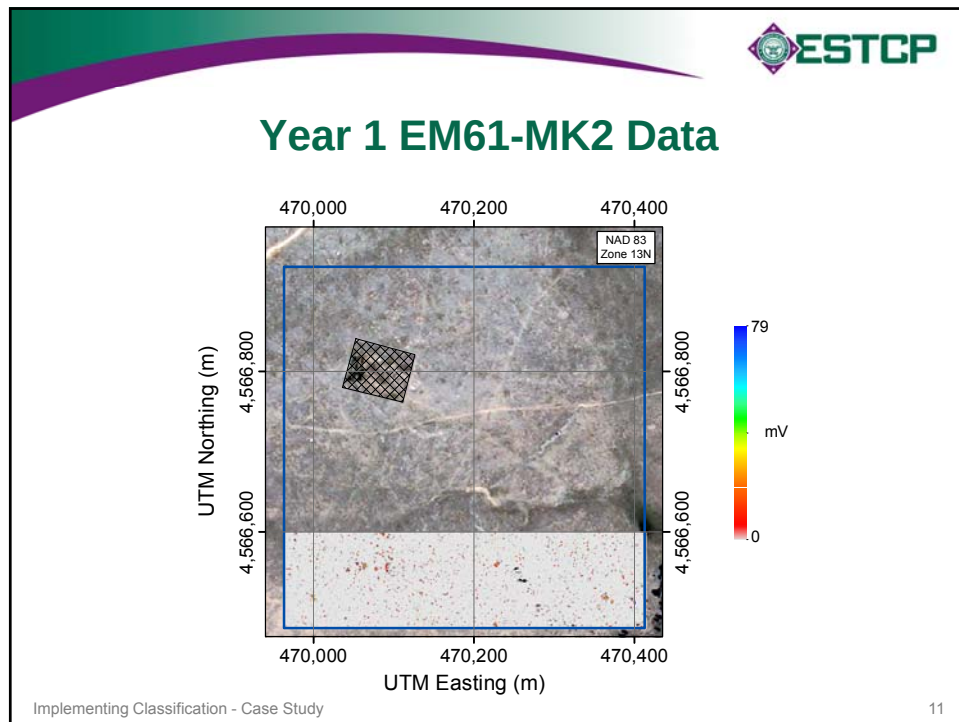
Implementing Classification - Case Study 9



Decision 1

EM61-MK2 Data

Implementing Classification - Case Study 10

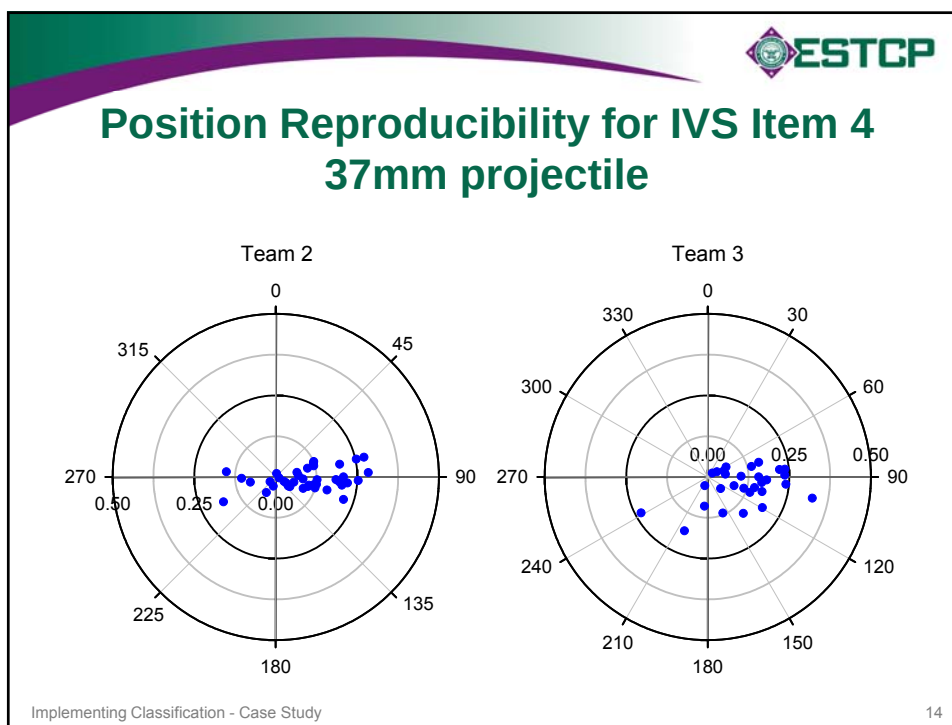
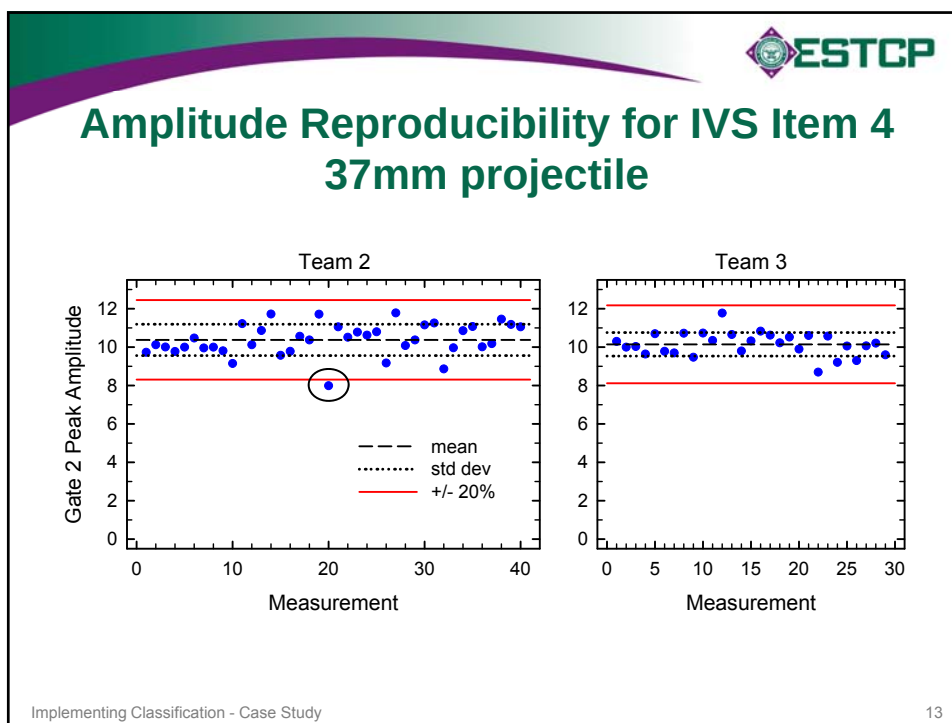


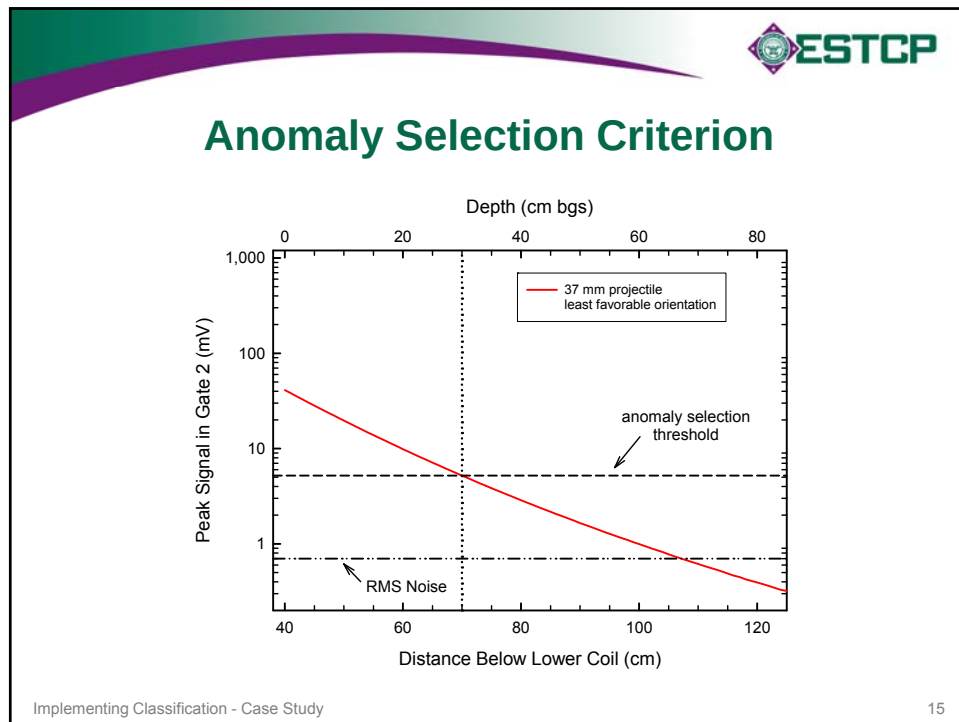
QC Data Collection

- Static Instrument Tests
- Twice daily IVS
 - ◆ One sphere
 - ◆ Two small ISOs
 - ◆ One 37-mm projectile
 - ◆ One 75-mm projectile

Implementing Classification - Case Study

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The slide, titled "What We Know So Far", lists the following information:

- Anomaly selection based on 37mm projectile at 30 cm
 - ◆ EM61 is appropriate sensor for this job
 - RMS noise ≈ 0.7 mV in channel 2
 - Selection threshold = 5.2 mV in channel 2
 - 938 anomalies selected
- All QC seeds detected using this threshold
 - ◆ Some just inside the 60-cm halo
- IVS reproducibility within requirements
- Coverage and measurement density within requirements

Implementing Classification - Case Study 16



EM61-MK2 Data

- Are the data acceptable?
- Is the analysis acceptable?

Implementing Classification - Case Study 17

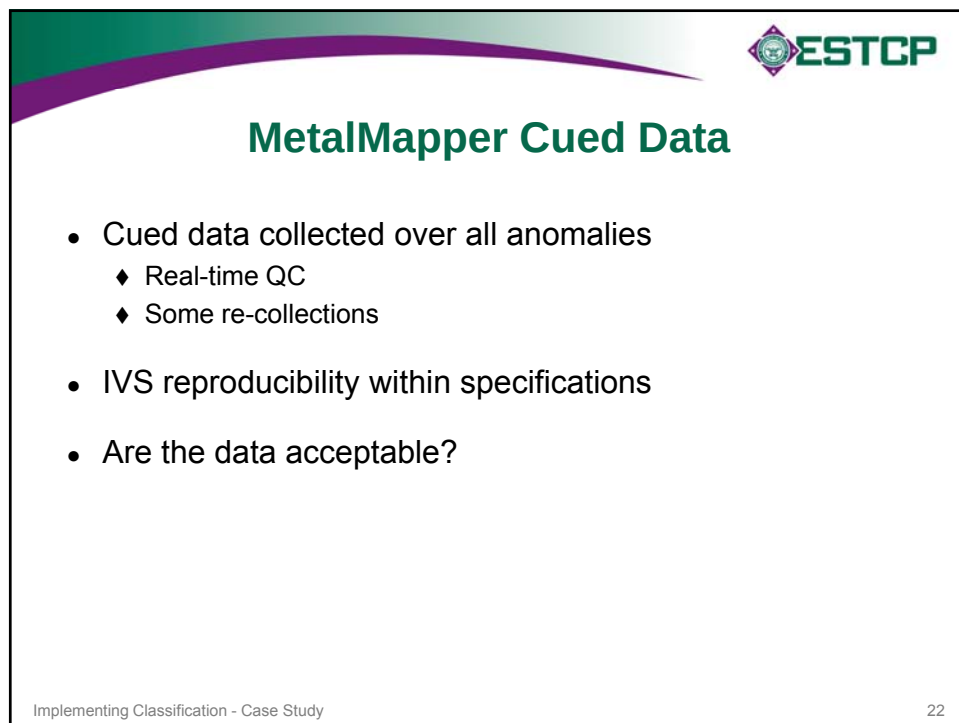
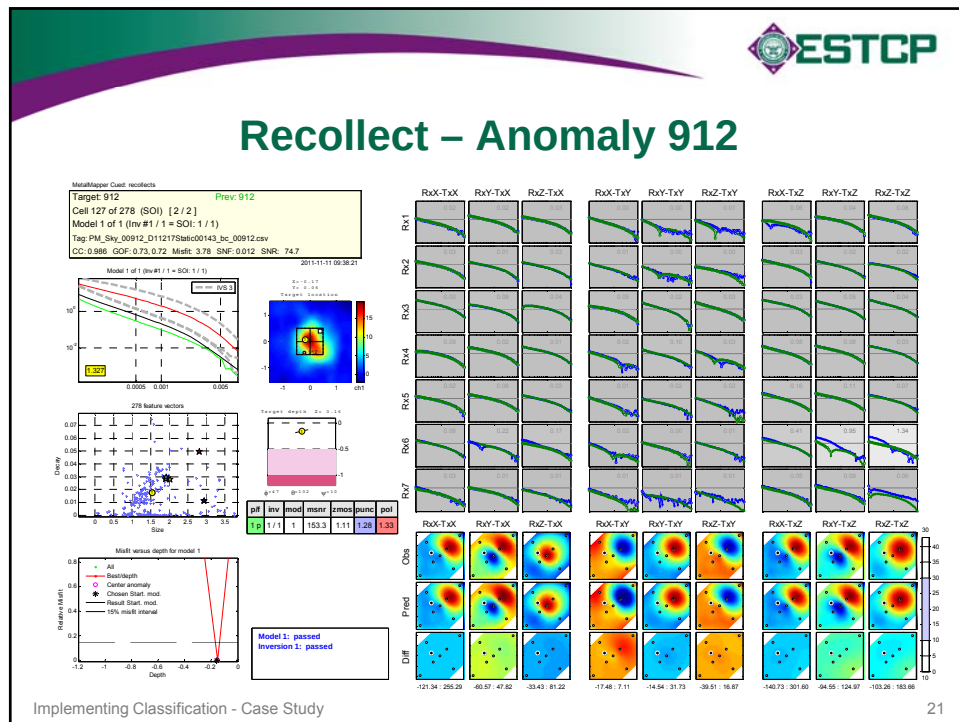


Decision 2

MetalMapper Cued Data

Implementing Classification - Case Study 18



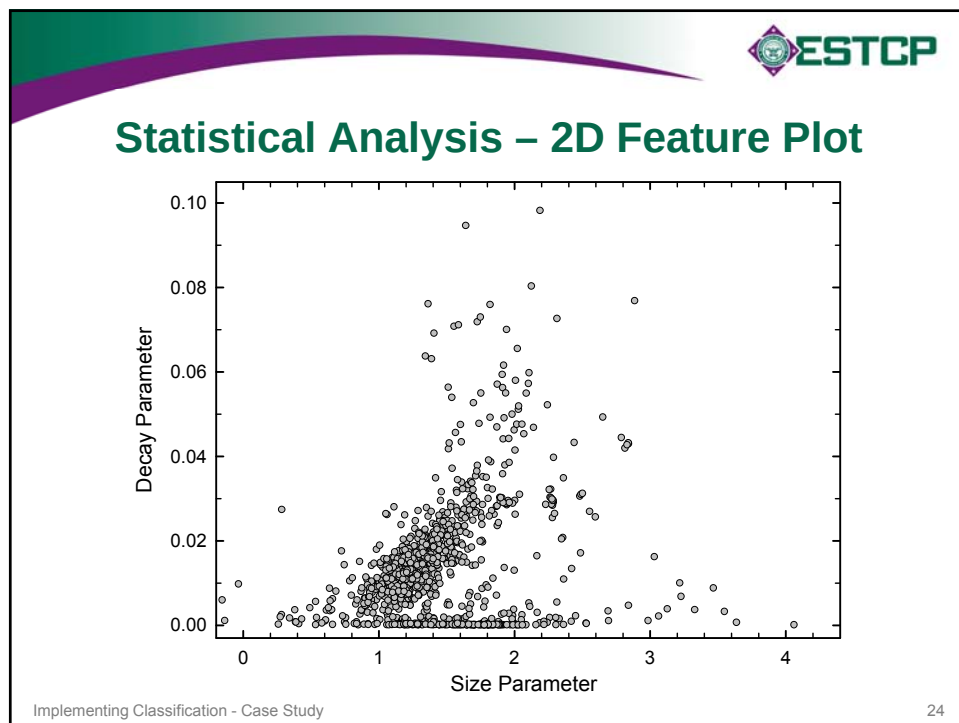




Decision 3

MetalMapper Analysis and Anomaly Ranking

Implementing Classification - Case Study 23

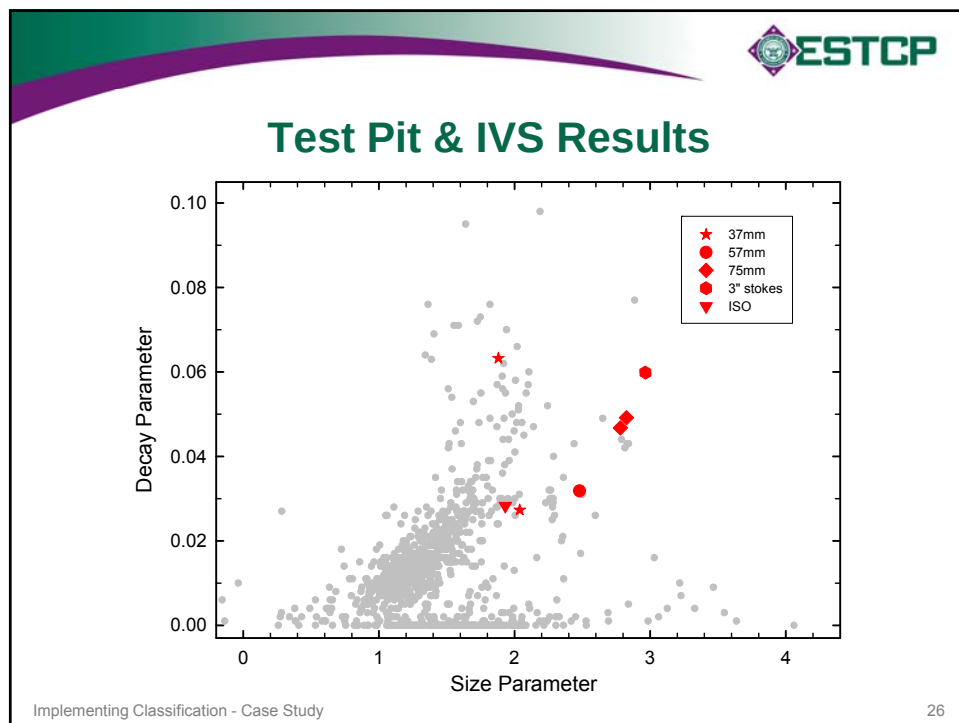


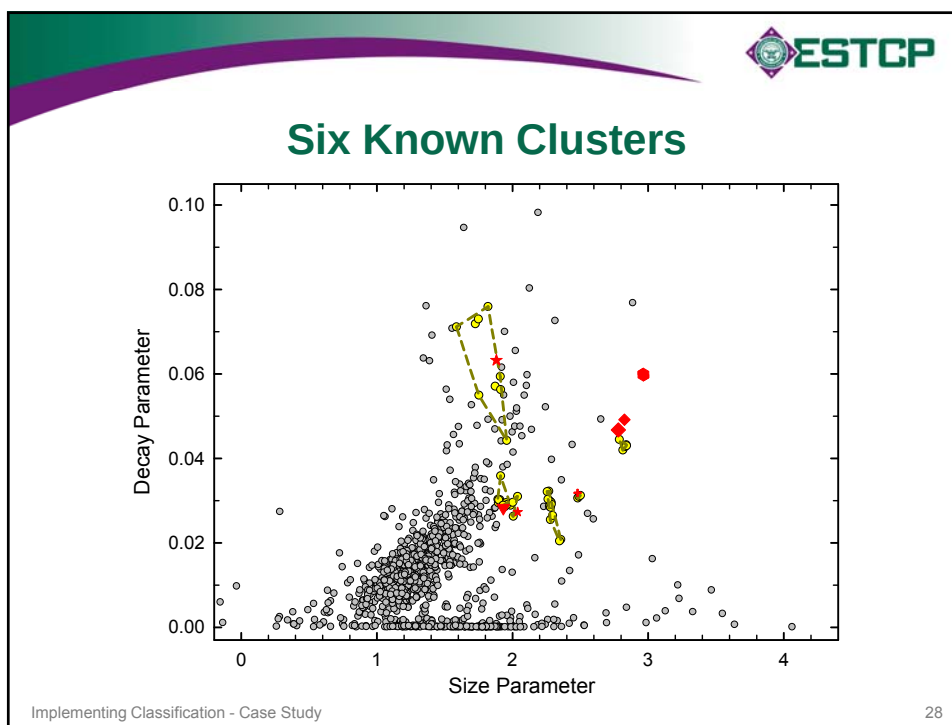
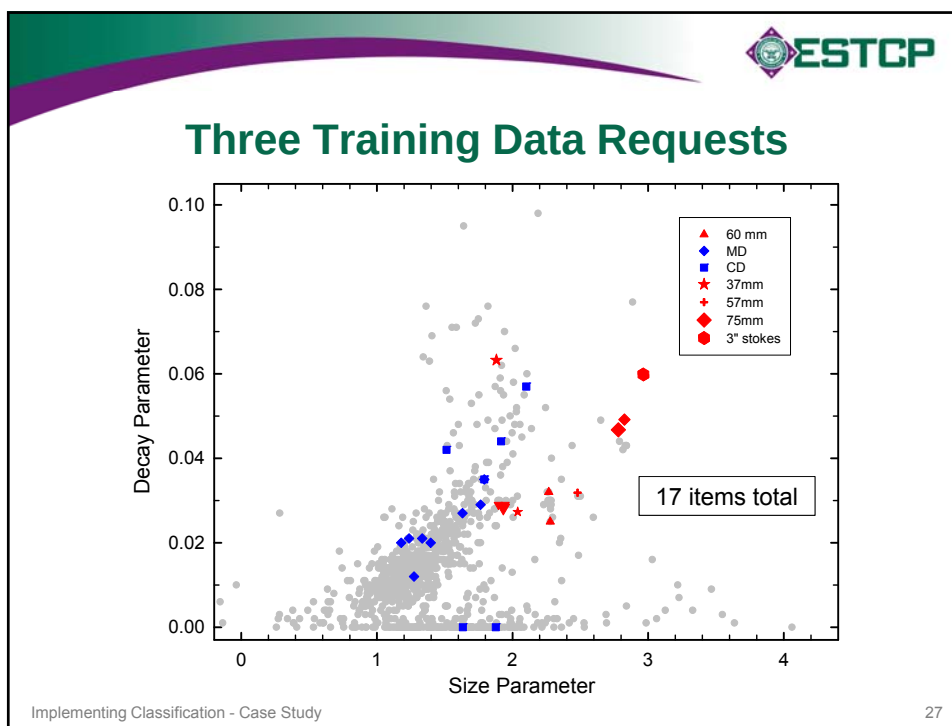


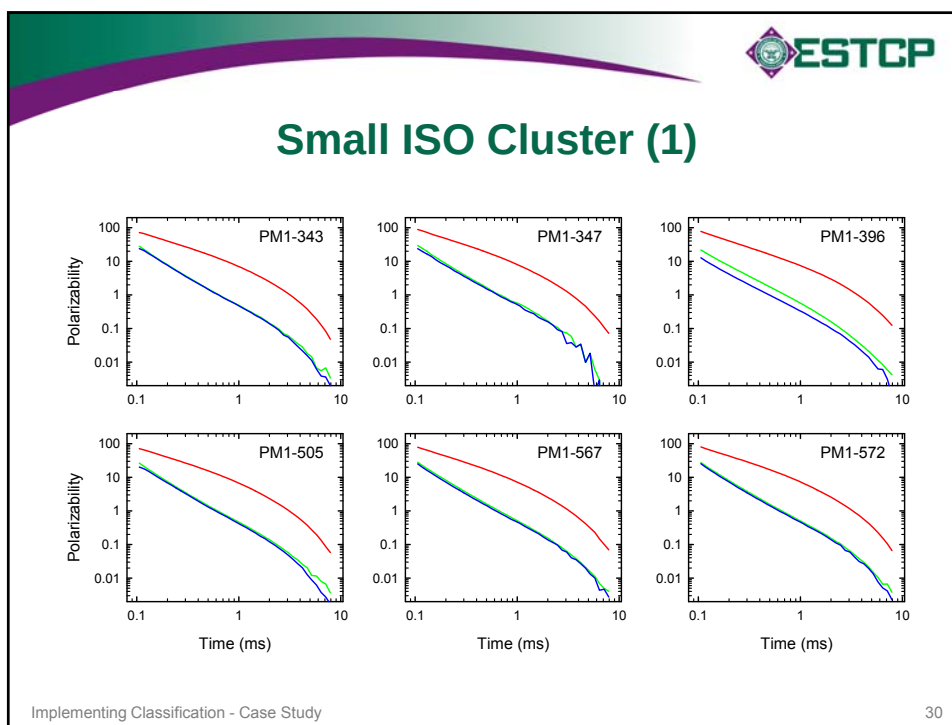
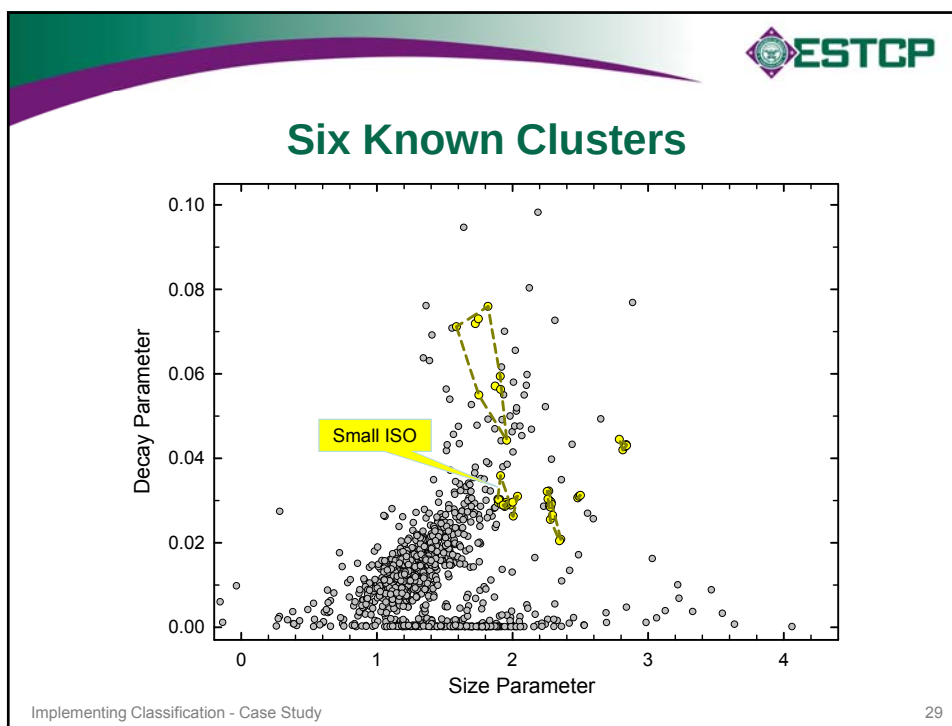
Training Data

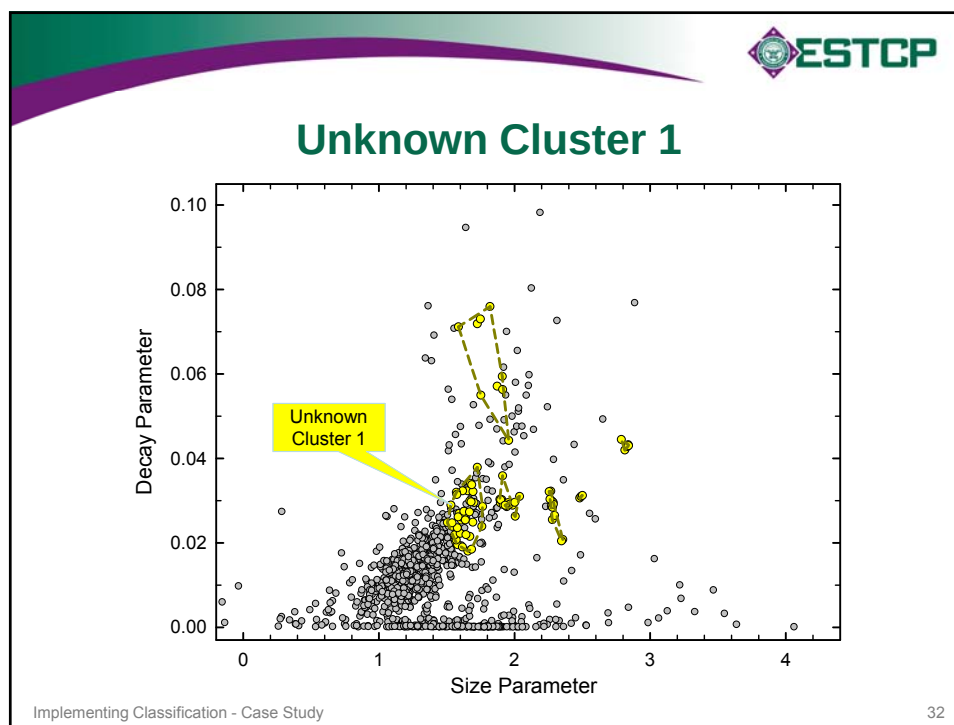
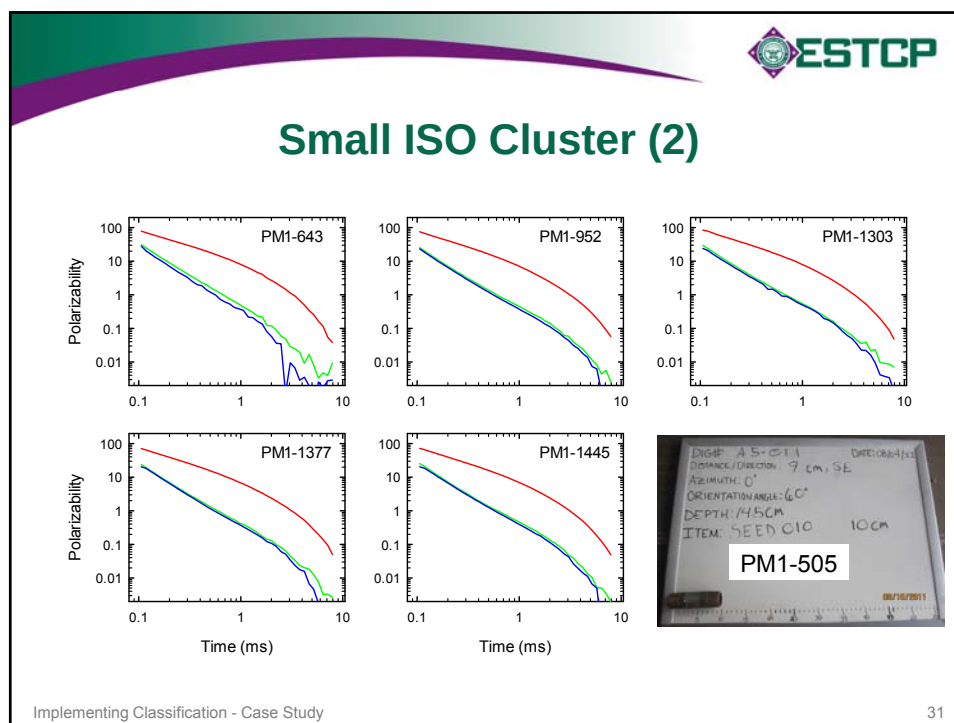
- Twice daily IVS + Static Tests
 - ◆ One sphere
 - ◆ Two small ISOs
 - ◆ One 37-mm projectile
 - ◆ One 75-mm projectile
- Training Pit
 - ◆ 37-mm, 57-mm, and 75-mm projectiles and 3-in stokes mortar
 - ◆ Two depths (at least one with good SNR)
 - ◆ Four orientations

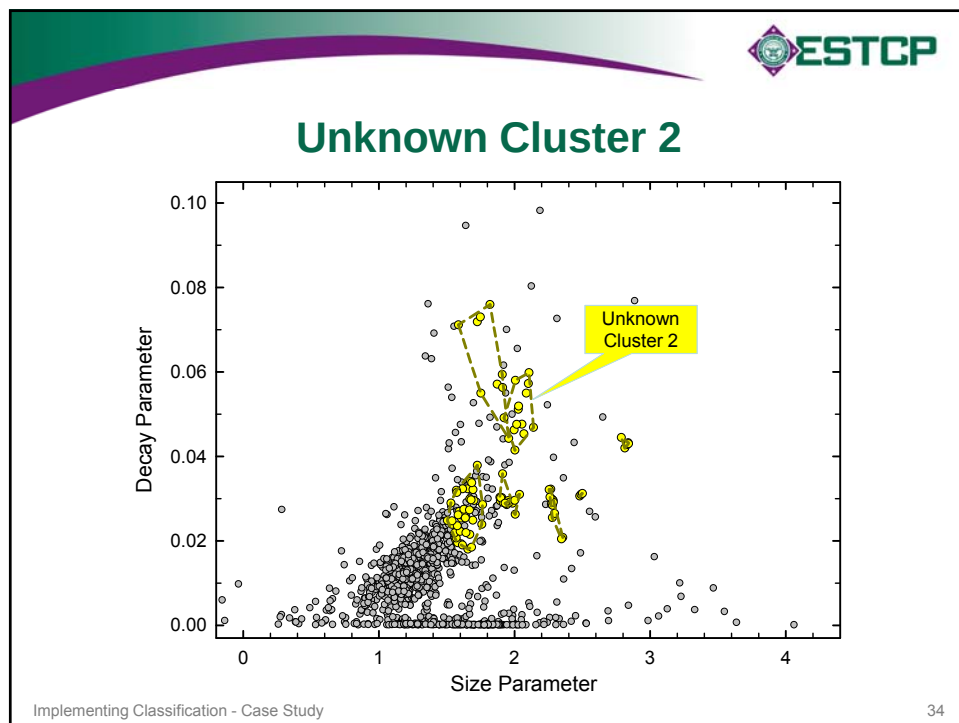
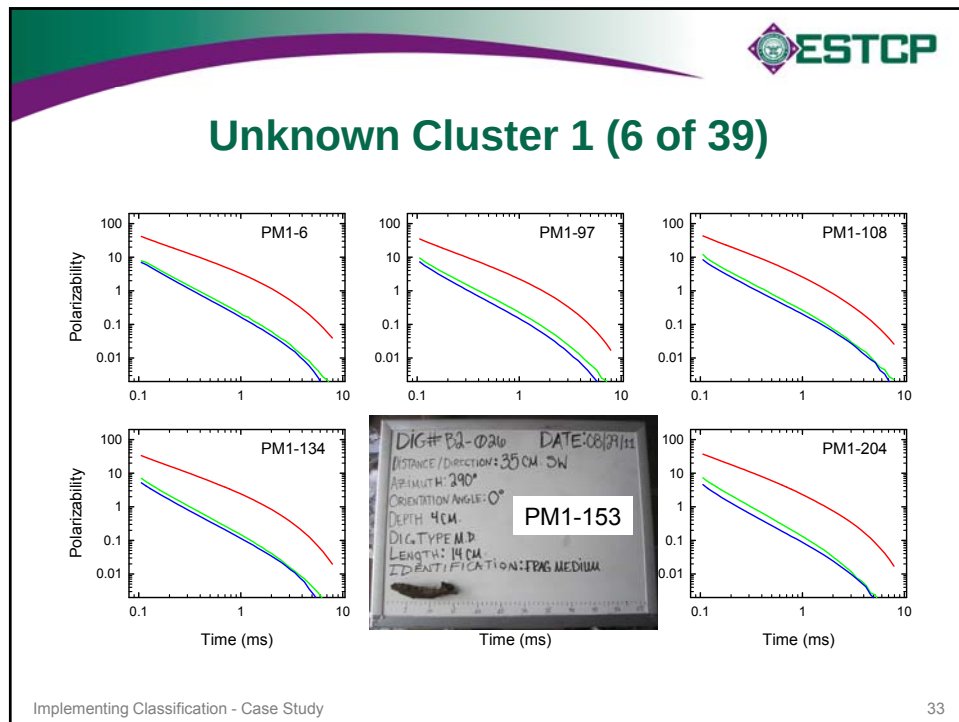
Implementing Classification - Case Study 25

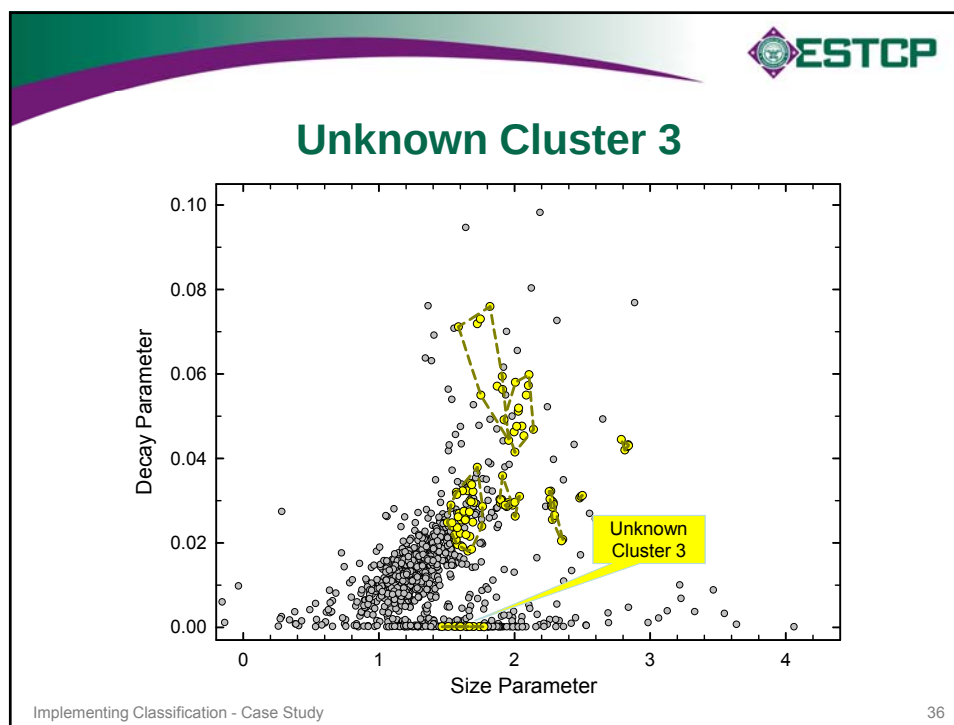
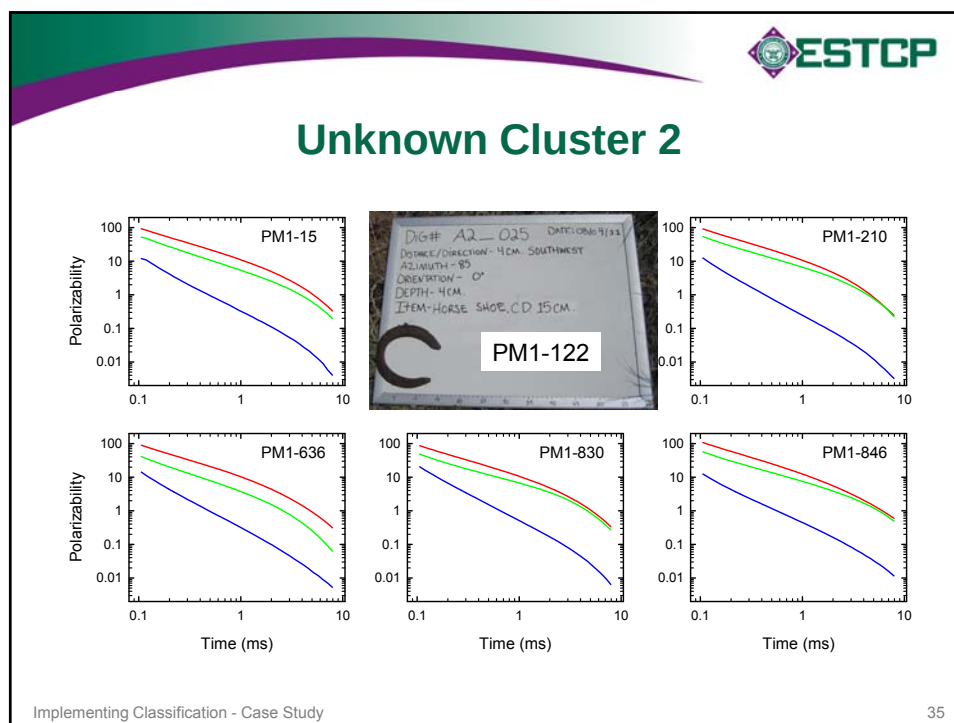


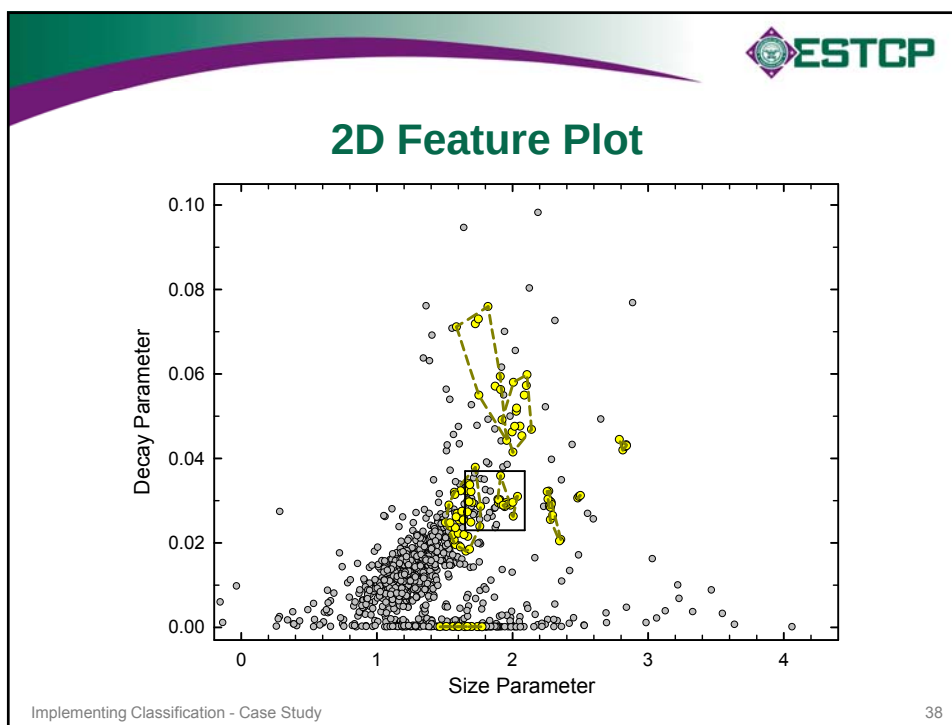
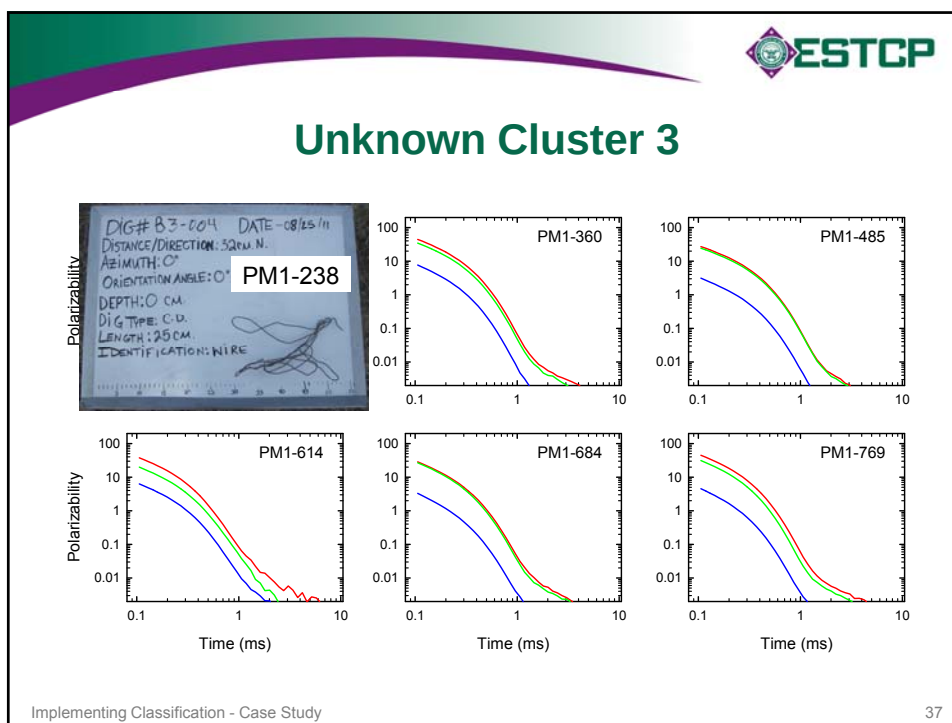


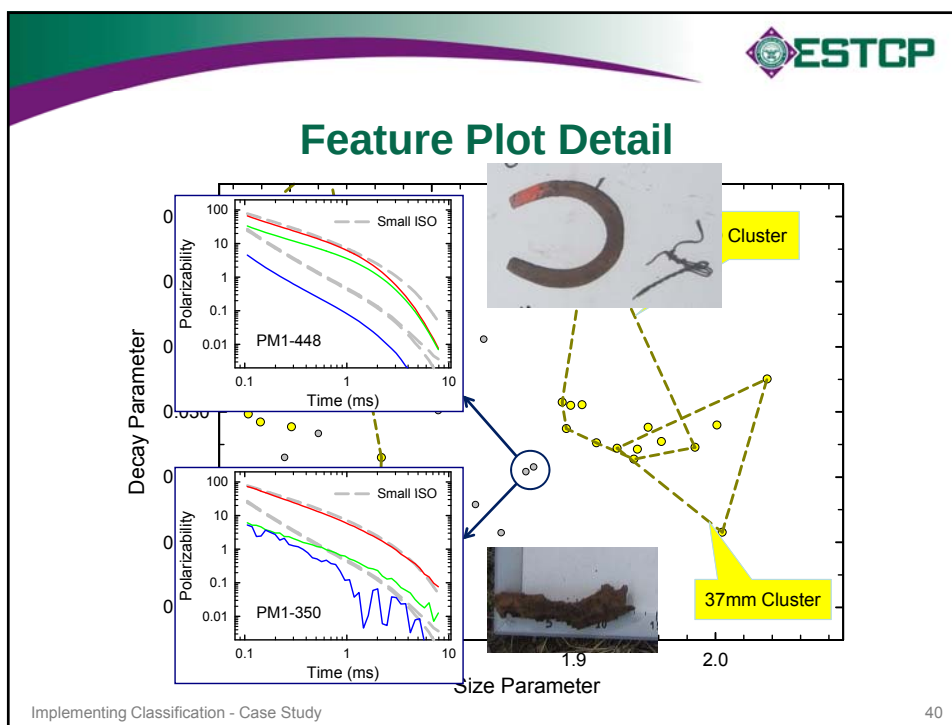
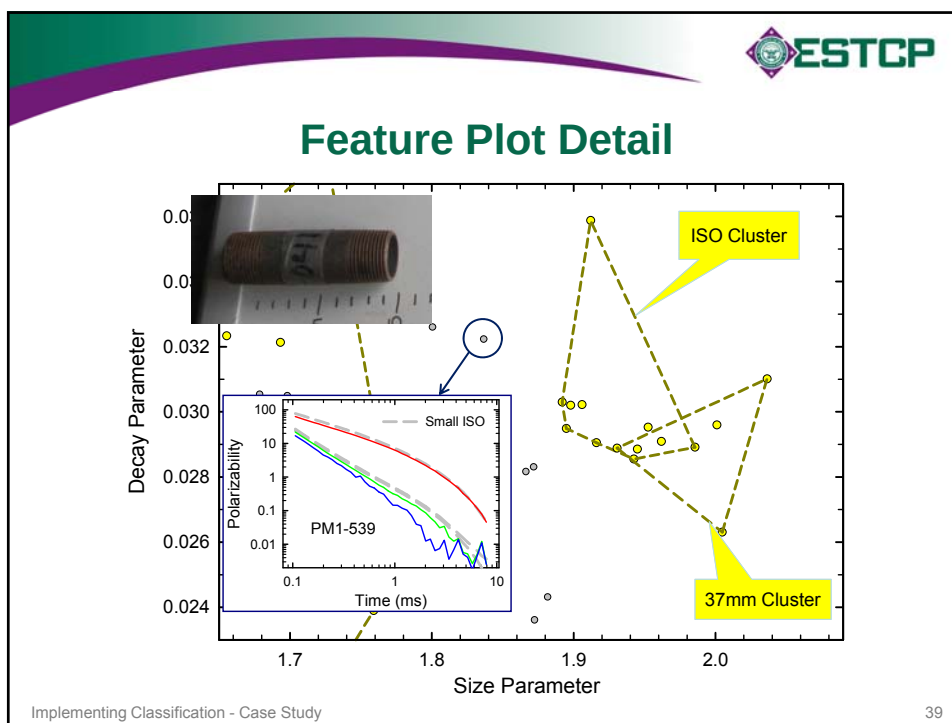


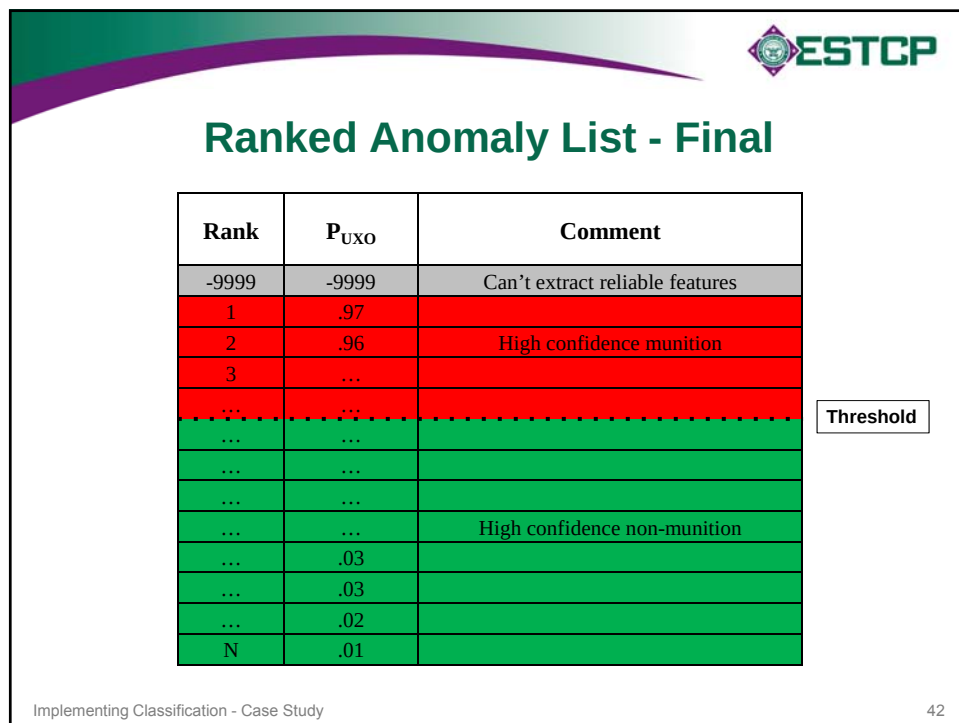
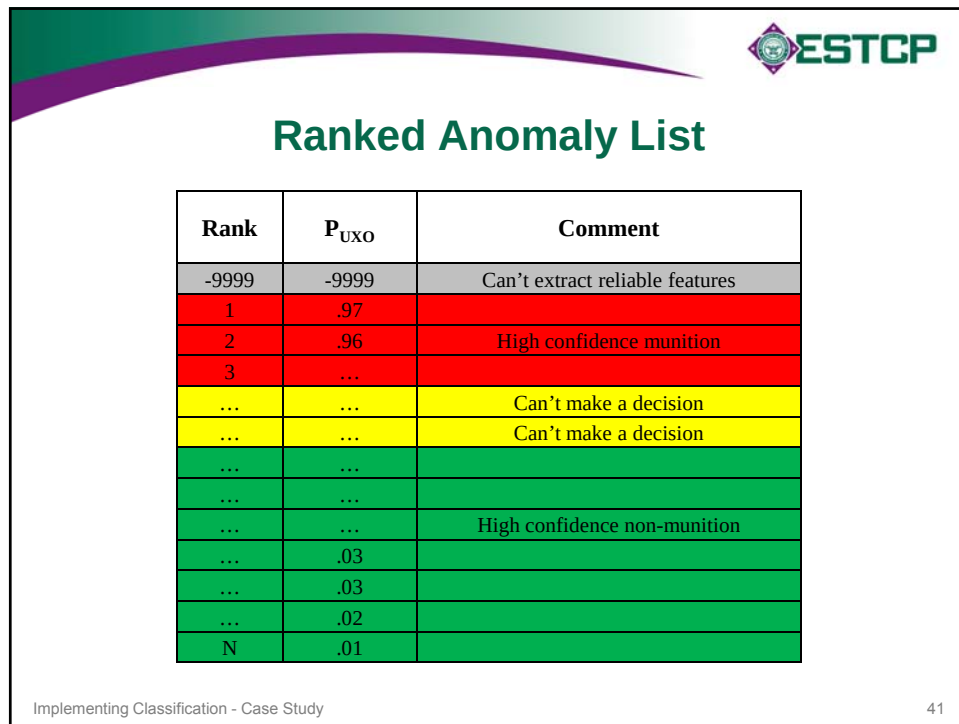


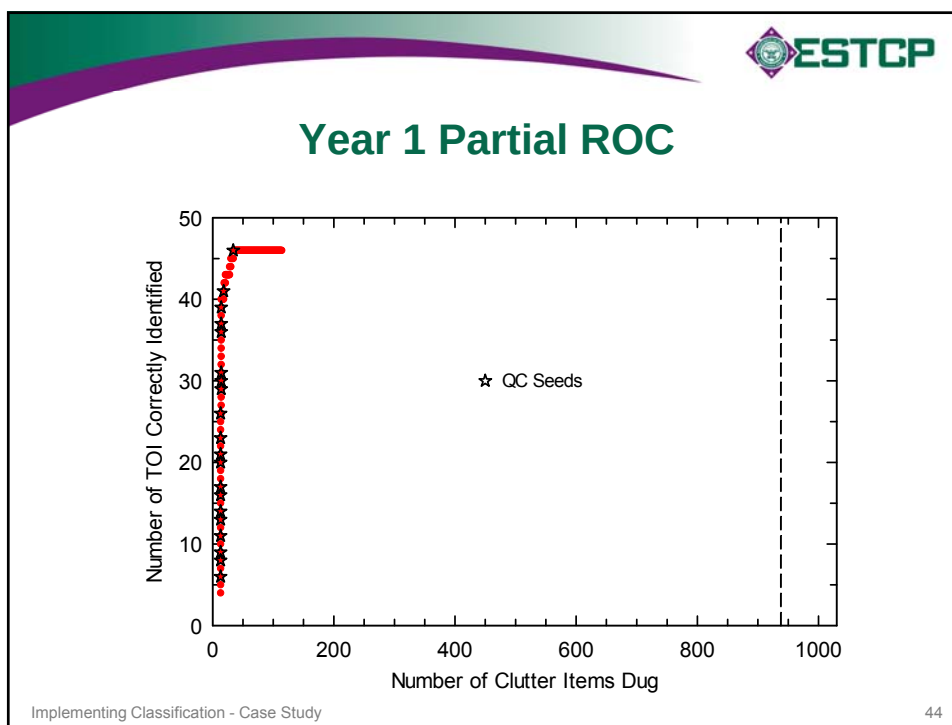
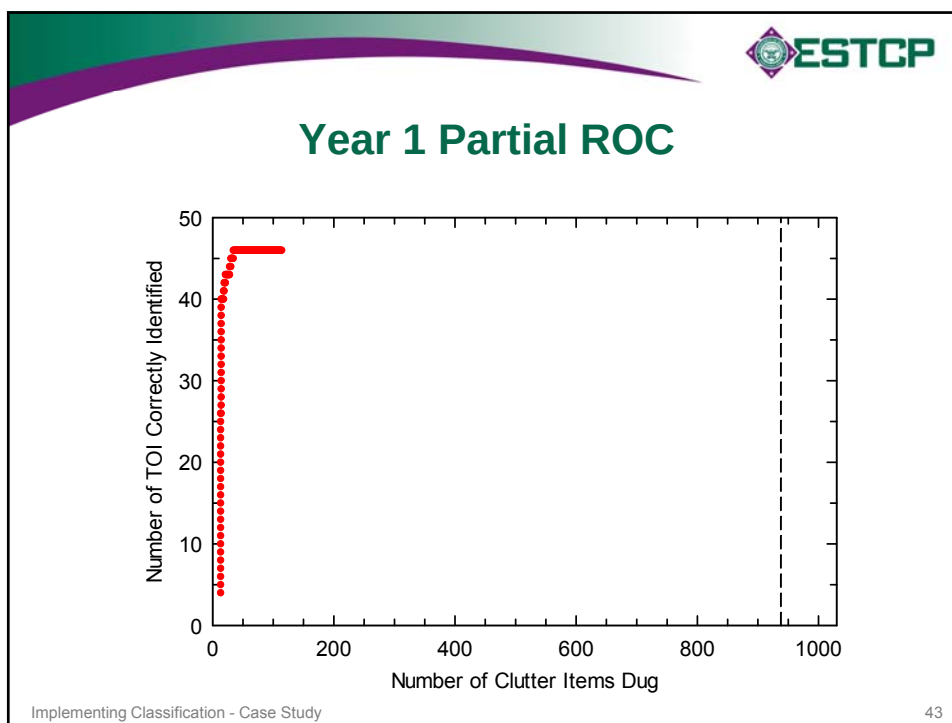












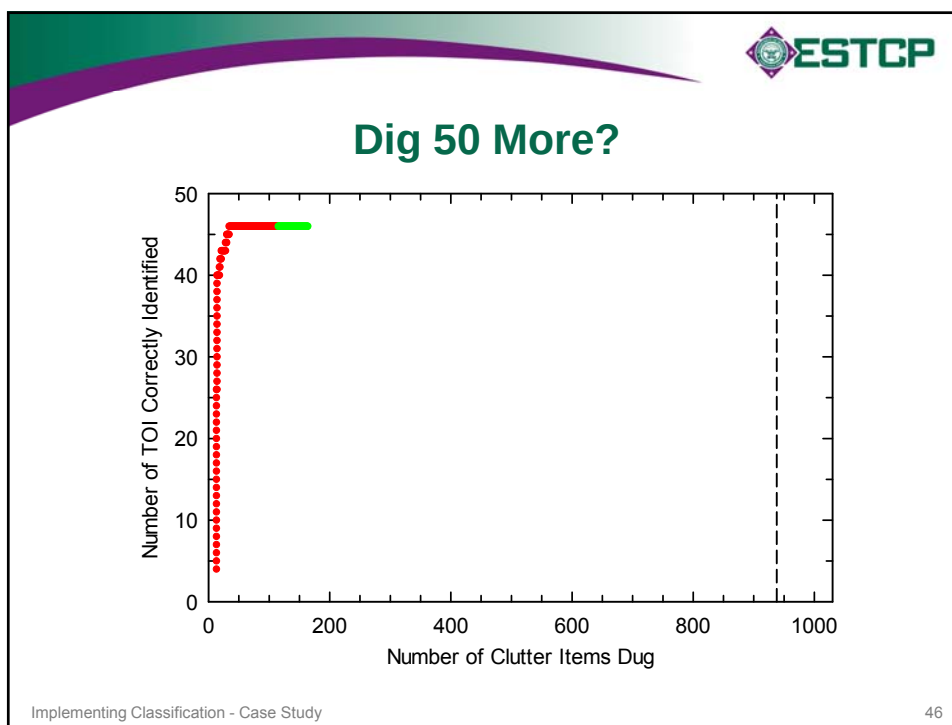
 ESTCP

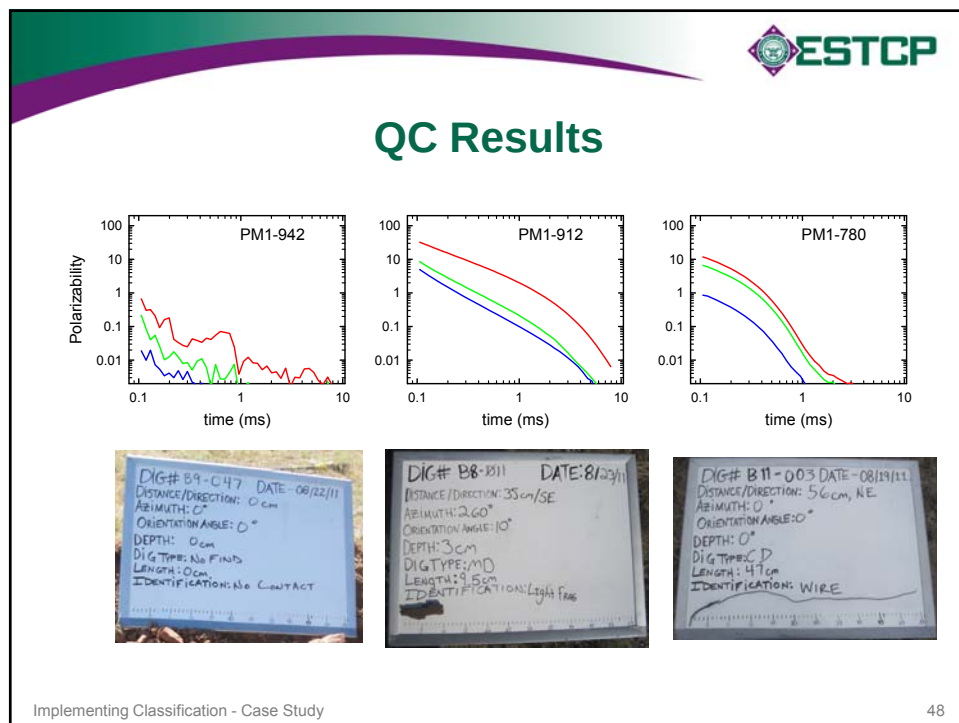
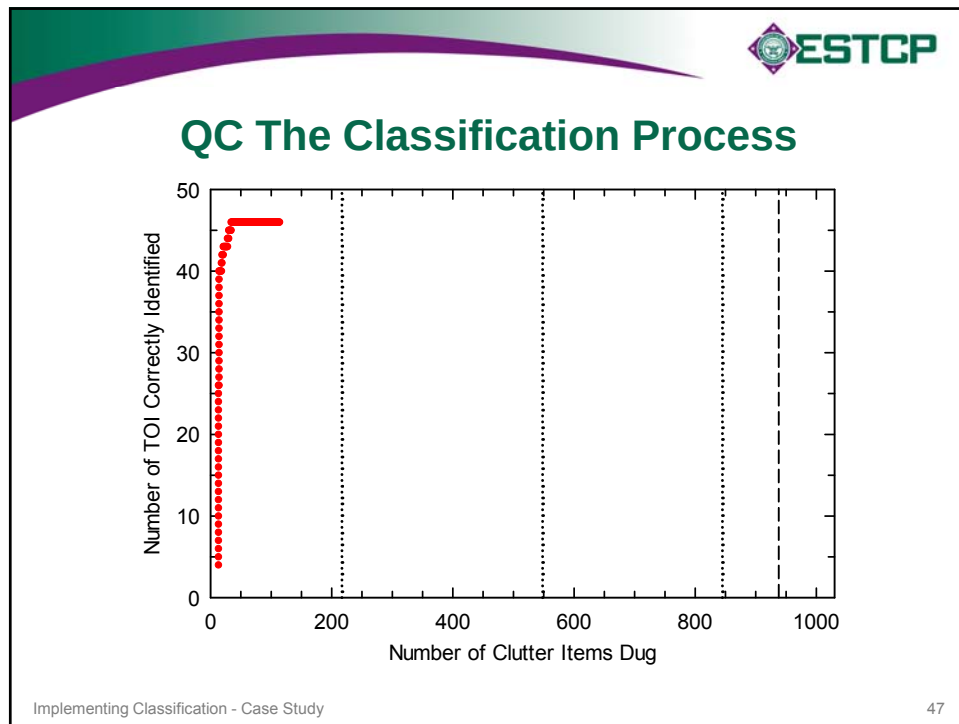
Year 1 Analysis

- Is the analysis acceptable?
- Do we accept the stop-dig point?

Implementing Classification - Case Study

45



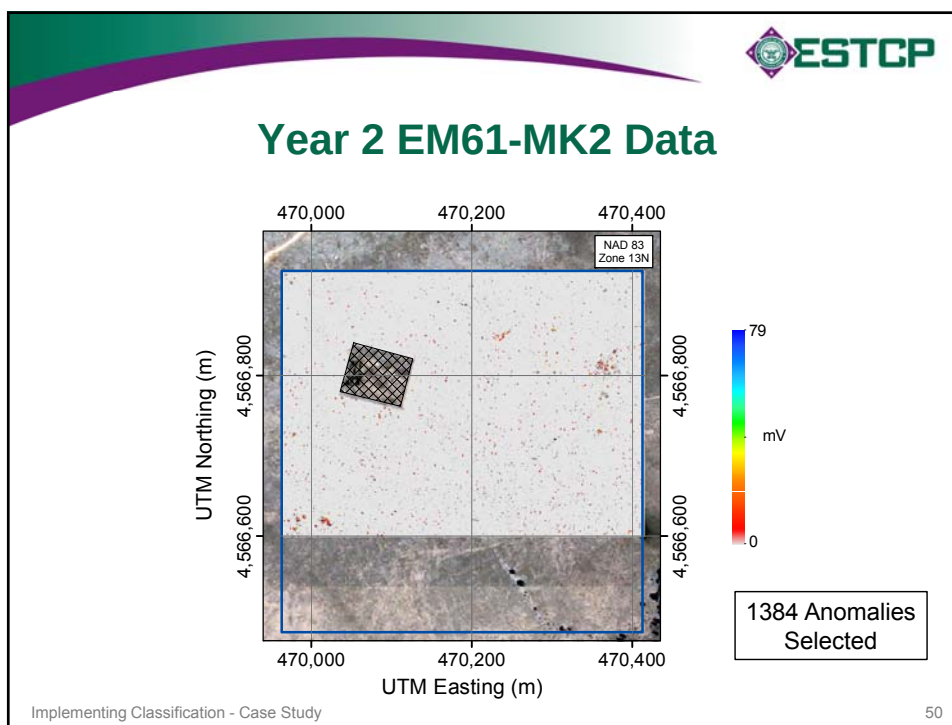


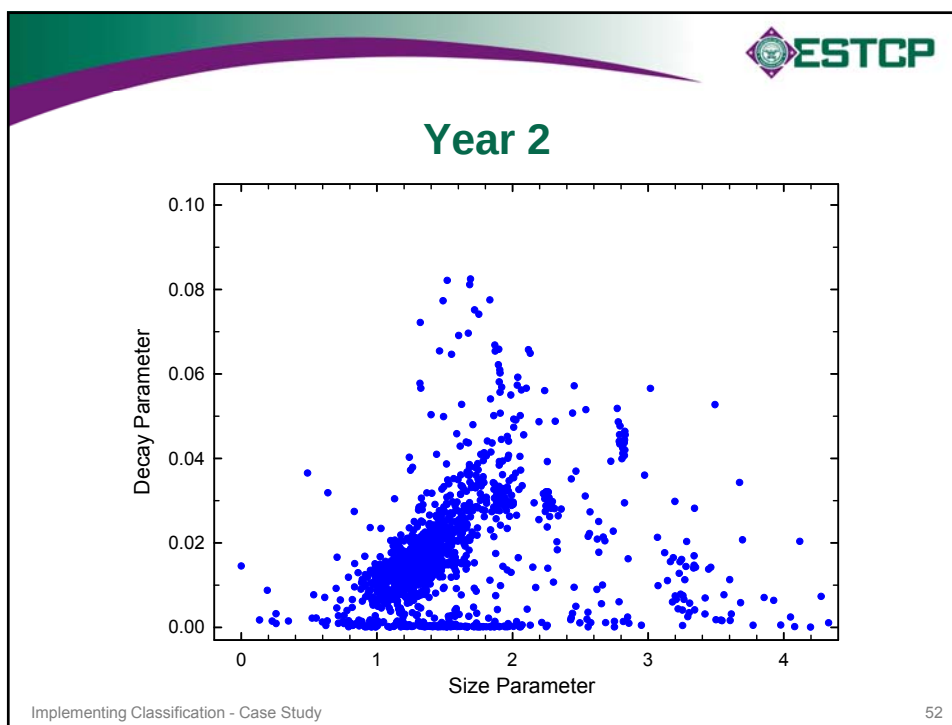
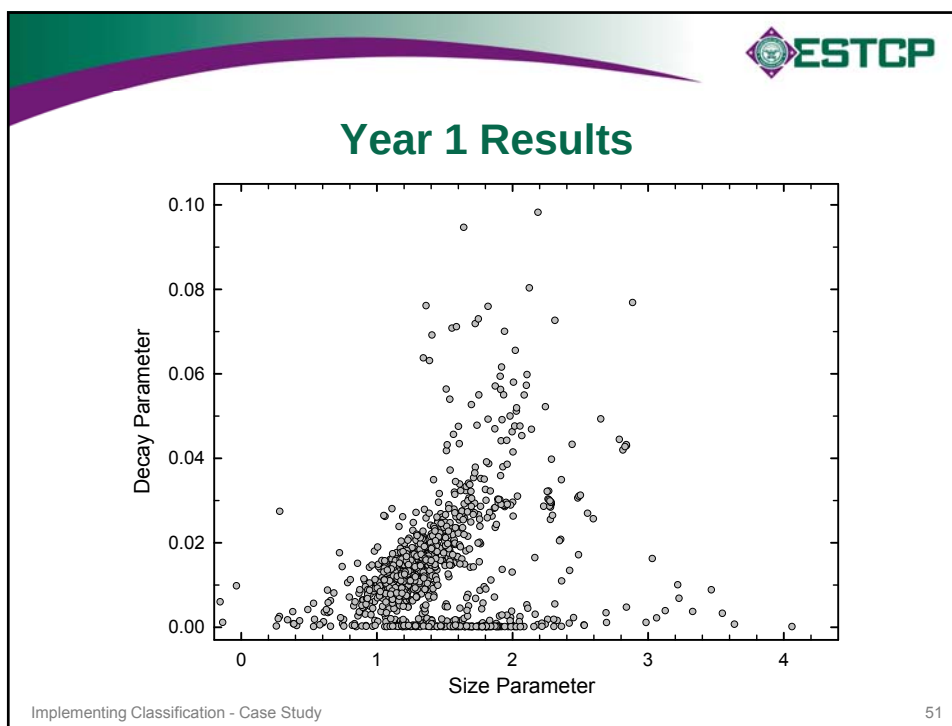


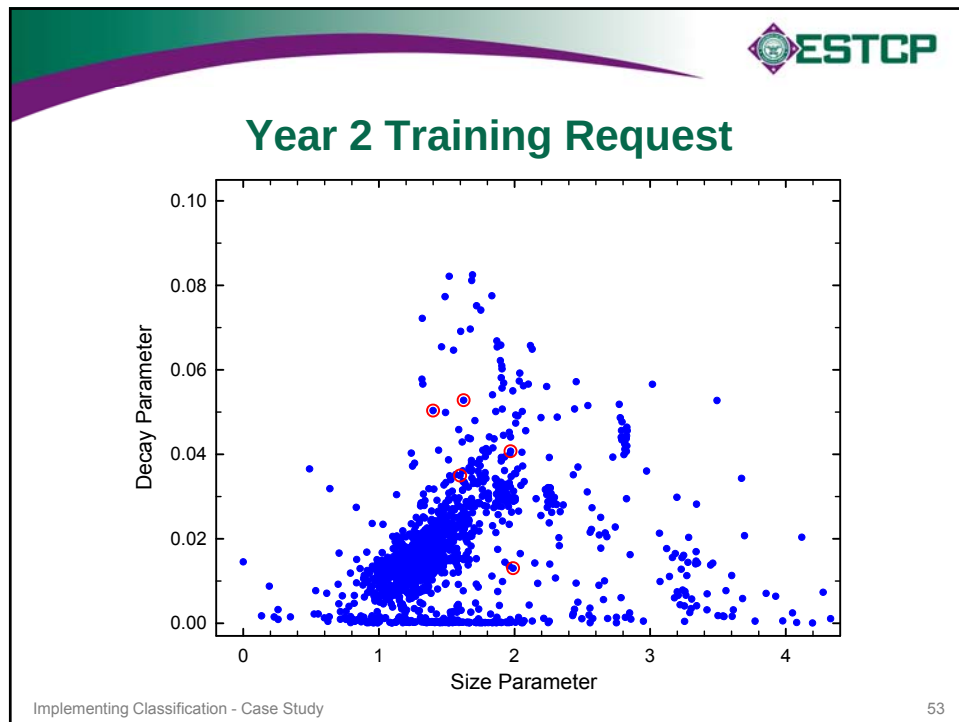
Decision 4

Year 2 Analysis and Anomaly Ranking

Implementing Classification - Case Study 49



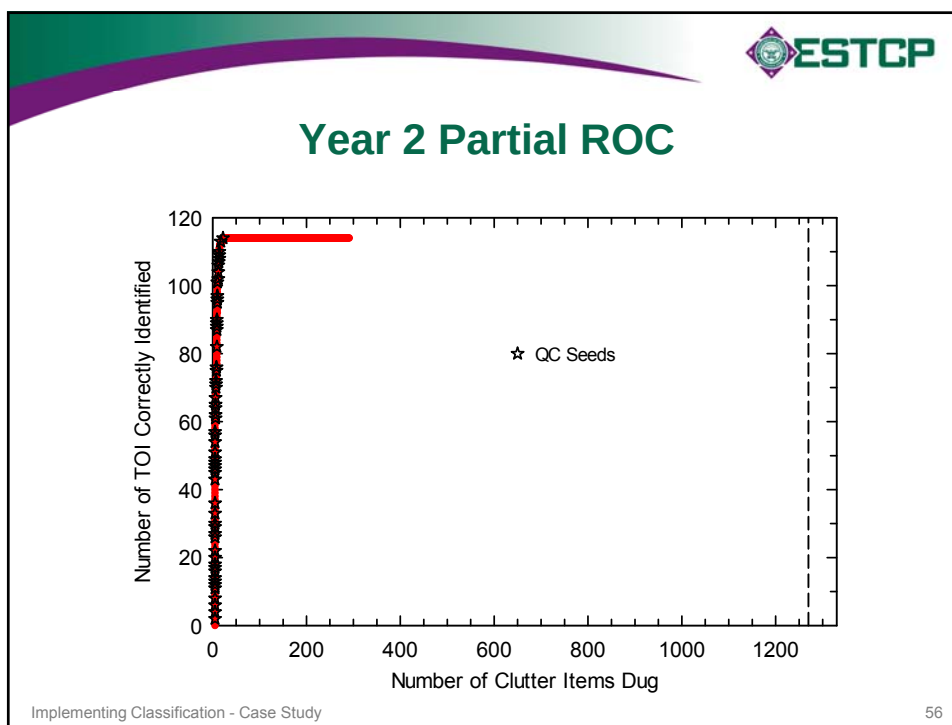
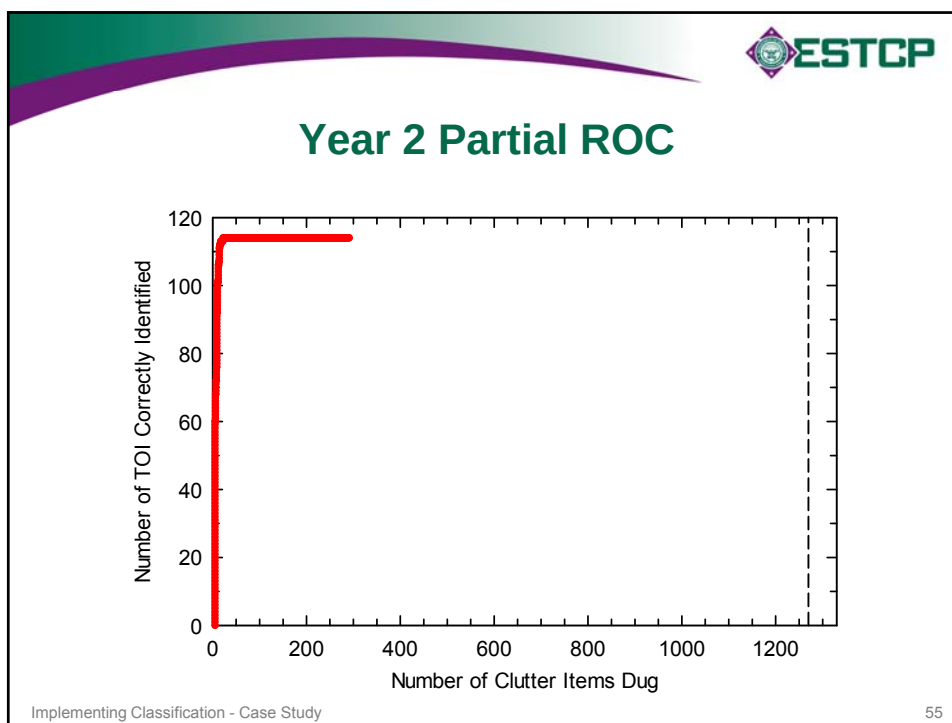




The figure is a slide titled "Statistical Year 2". It contains two bullet points:

- Do we need more training?
- Can we use the same classifier thresholds?

The ESTCP logo is in the top right corner. At the bottom left, it says "Implementing Classification - Case Study" and at the bottom right, it says "54".





Year 2 Analysis

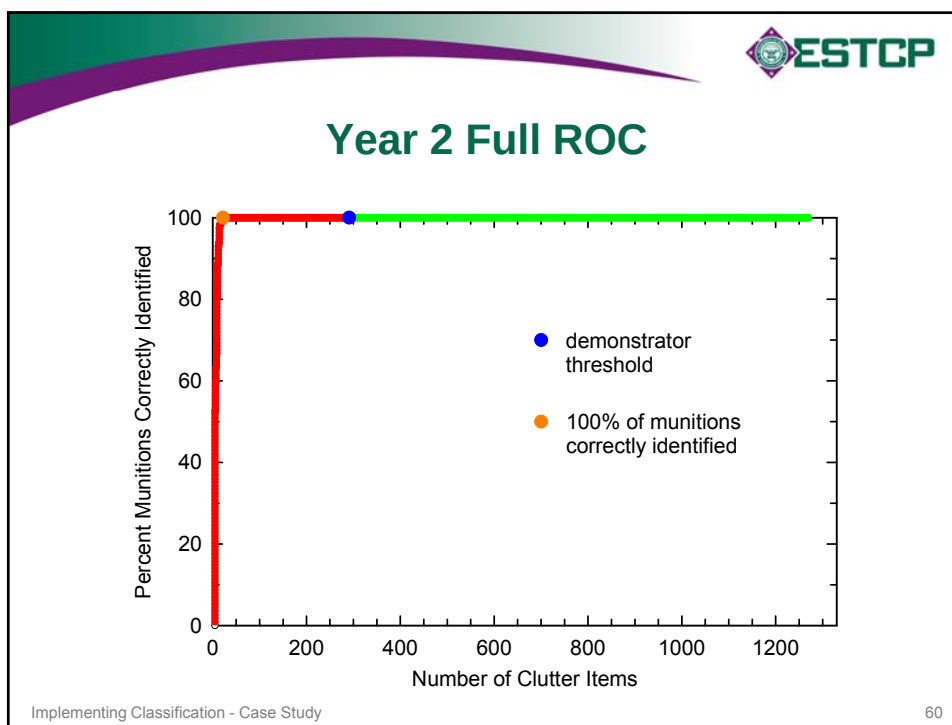
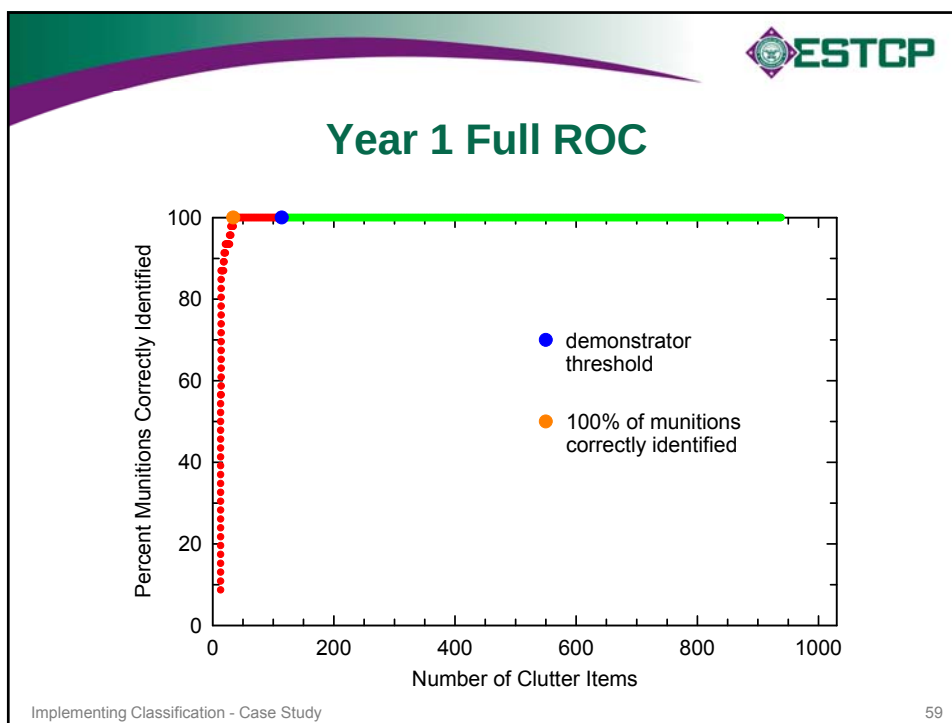
- Is the analysis acceptable?
- Do we accept the stop-dig point?

Implementing Classification - Case Study 57



How Did We Do?

Implementing Classification - Case Study 58



Implementing Classification on a Munitions Response Project

Wrap Up
Vic Wieszek



Is This Ready for Transition?

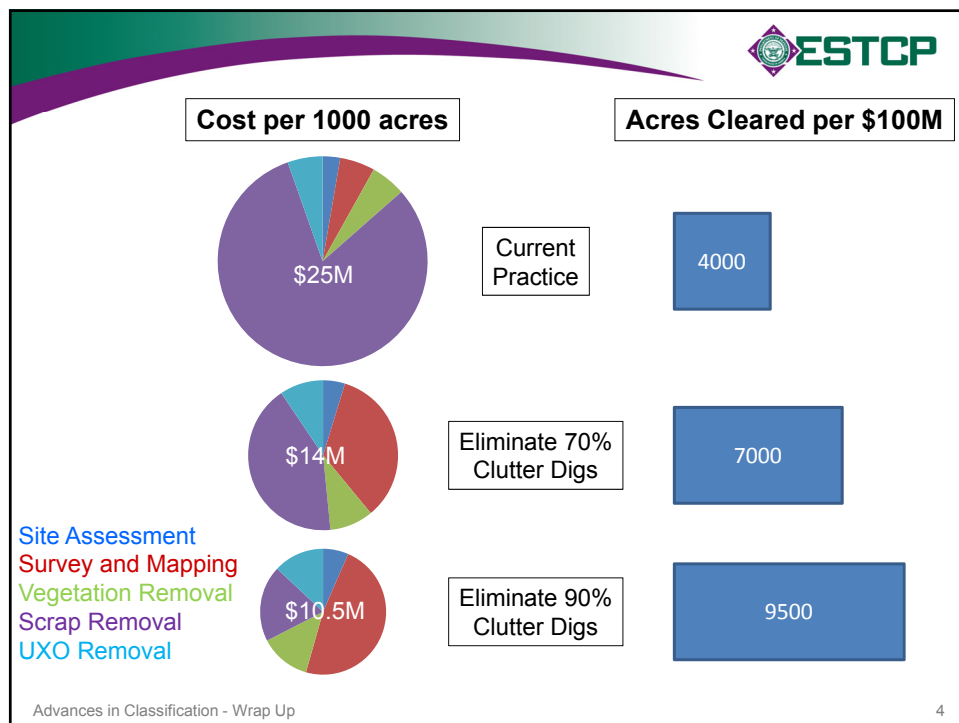
Demonstrated on a variety of site conditions	Yes, with more to come
Good understanding of applicability and limitations	
Commercially available sensor	Yes
Freely available analysis software	Yes
OSD support	Yes
Contracting challenges	Ongoing
Regulatory acceptance	Ongoing
Train contractor work force and DoD PMs	Yes, and ongoing



Who Should Be Interested?

- Those responsible for sites that have these characteristics
 - ◆ Removal of subsurface munitions is desired
 - ◆ Munitions types – 37-mm and larger
 - ◆ Anomaly density up to about 1000 per acre
 - ◆ Benign geology
 - ◆ Benign to moderate terrain and vegetation

Advances in Classification - Wrap Up 3





Is This Method Proposed To Me Really “Classification”?

- Many approaches will be called “Classification”
- Hallmarks of success
 - ◆ Advanced sensors
 - ◆ Principled, physics-based analysis
 - ◆ Transparent – all decisions documented and reviewable
- Things to watch for
 - ◆ EM61 and magnetometers = very limited classification potential
 - ◆ “Black boxes”
 - ◆ No independent, blind testing of the approach

Results shown here apply only to the systems and methods demonstrated in the ESTCP Live Site Program

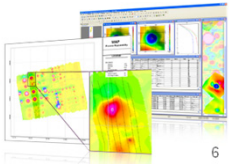
Advances in Classification - Wrap Up
5



Where Are We Going?

- Smaller sensors for use in challenging terrain and vegetation
 
- One-pass classification – eliminate the need for stationary cued data
 
- Transition from developers to production geophysics companies

$$\mathbf{H}(\mathbf{r}) = \sum_{i=1}^{N_s} \bar{\psi}_i(\mathbf{r}) \cdot \mathbf{b}_i$$



Advances in Classification - Wrap Up
6



Take Home Message

- Accelerate pace of cleanup at a constant funding level
 - ◆ Completion dates forecast decades out
 - ◆ Reduce risk more rapidly
- Better understood and transparent process
 - ◆ Higher quality data collected
 - ◆ All decisions documented and reviewable
 - ◆ Minimize operator effect on quality
 - ◆ Ability to adapt to new information
- Managing residual risk
 - ◆ Removals are not perfect under current practice
 - ◆ Some residual risk will always remain and must be managed
 - ◆ Clearing more land sooner is better

Advances in Classification - Wrap Up 7



Advisory Group

• James Austreng, USACE • Harry Craig, US EPA • Jon Haliscak, AFCEE • Bryan Harre, NAVFAC ESC • Robert Kirgan, USAEC • Doug Maddox, USEPA • Doug Murray, NOSSA • Andy Schwartz, USAEC • Steve Sterling, CA DTSC • Jeff Swanson, Colorado DPHE • Jon Ussery, AFCEE • Ken Vogler, Colorado DPHE • Amy Walker, USACE • Ed Walker, CA DTSC • Vic Wiesek, ODUSD(I&E)	• Camp Butner ◆ Marty Morgan ◆ Raye Livermore • Pole Mountain ◆ Adrienne Nunn ◆ Jane Francis ◆ Rick Grabowski ◆ Dave Rathke • Camp Sibert ◆ Steve Cobb ◆ Tracy Strickland
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Advances in Classification - Wrap Up 8



The slide features the logos for SERDP (Serious Environmental Response Demonstration Project) and ESTCP (Environmental Site Treatment Cooperative Program). The SERDP logo includes the text 'DOD • EPA • DOE' below it. The ESTCP logo is a green diamond shape with a globe inside. The URL 'serdp-estcp.org' is centered below the logos.

serdp-estcp.org

- Featured Initiative on Classification – updated as demonstrations proceed
- Tools and Training
 - ◆ Webcasts of short courses
 - ◆ Animation tutorial
 - ◆ Summary reports
 - ◆ Interim Guidance Document on Implementing Classification
- Funding Opportunities
 - ◆ Submit proposals for upcoming live site demonstrations

Advances in Classification - Wrap Up 9