EPRI | ELECTRIC POWER RESEARCH INSTITUTE

NDE Technology Update

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NRC/Industry Meeting on Buried Pipe

December 5th, 2012 White Flint, MD

EPRI Buried/underground and Tank NDE Program

- Industry has significant commitment to buried/underground and tank NDE development and application
  - 16 active NDE projects in 2012
  - 3 additional NDE projects start in 2013

- General Purposes:
  - Provide utility support in implementing NDE technology
  - Benchmark existing NDE technology capabilities
  - Develop/improve NDE technology
  - Provide resources to improve NDE technologies and procedures

Industry Support and Guidance

Nondestructive Evaluation: Buried Pipe Nondestructive Evaluation Reference Guide (1022930)

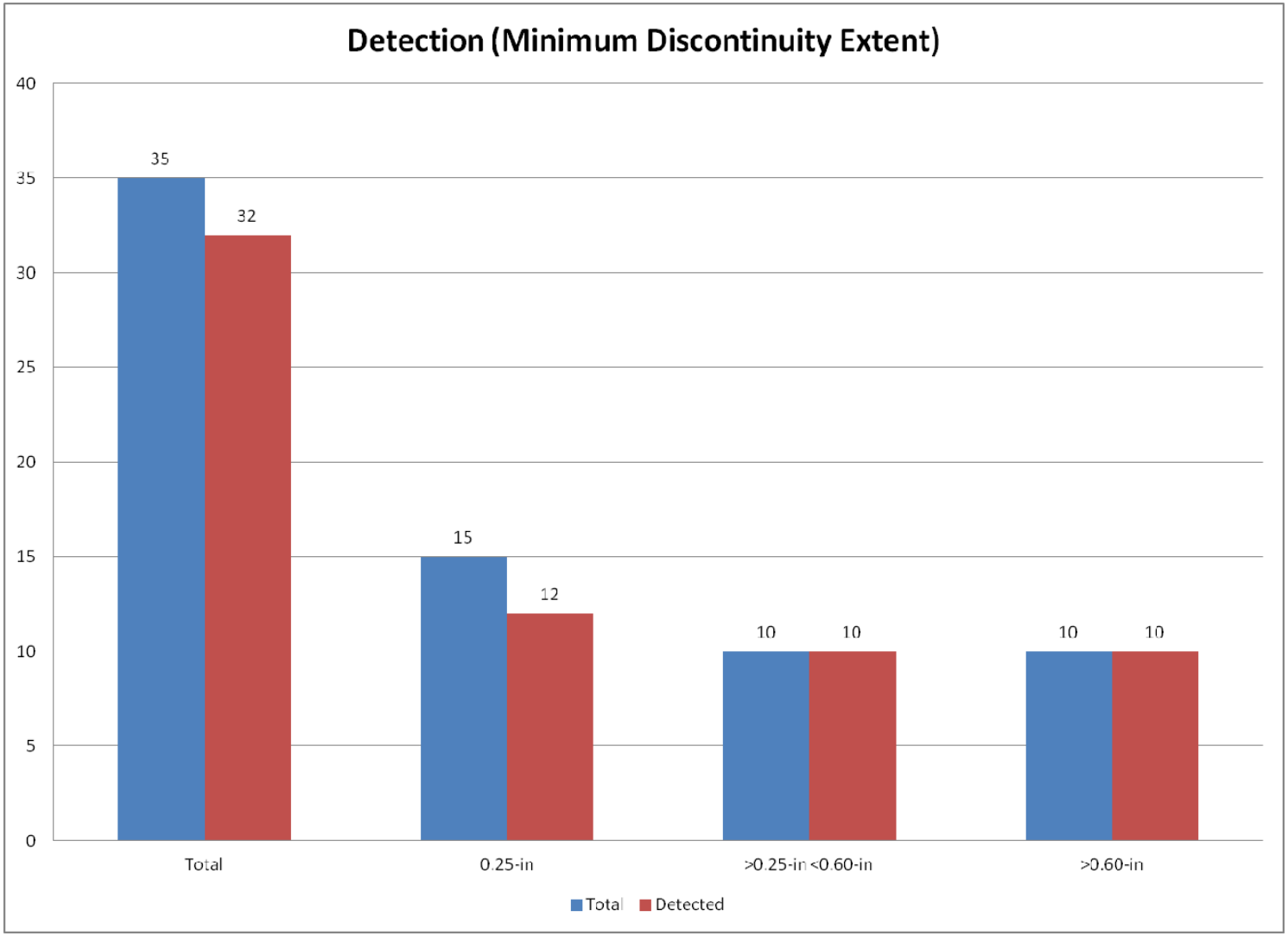
- Overview of commercially available NDE technologies for detection and characterization of wall-loss in buried and underground pipe
  - Basic theory
  - Technology selection guidance and limitations
  - Overview of techniques, equipment, and applications
  - Summary of remote delivery technology
- Living document – third revision to be published in December (1025220)

Industry Support and Guidance

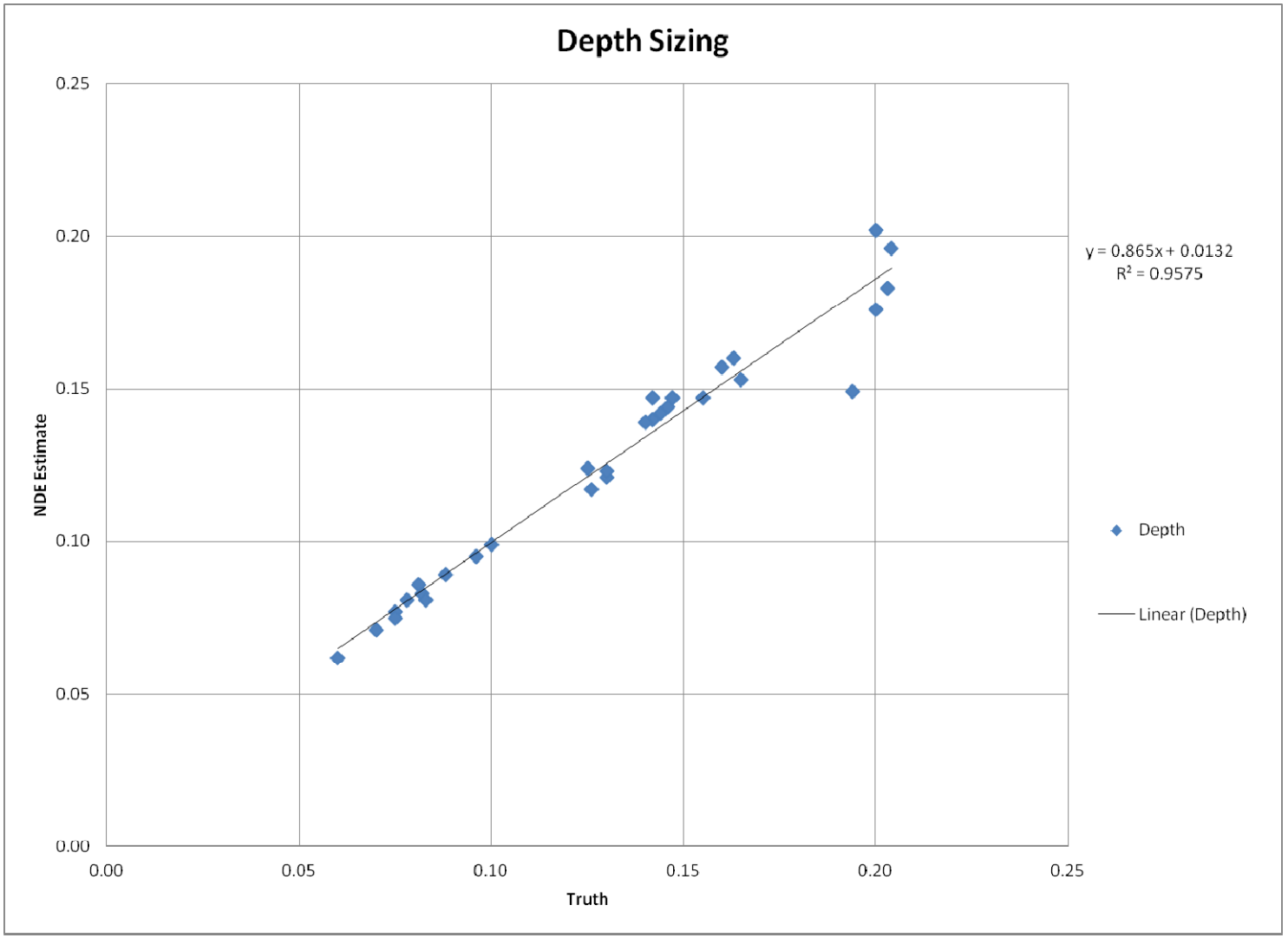
Nondestructive Evaluation: Buried Pipe NDE Technology Assessment and Development Interim Report (1025219)

- Benchmark of buried pipe NDE sensor capabilities for:
  - In-line robotic ultrasonics
  - In-line flow through ultrasonics
  - In-line robotic saturated low frequency eddy current
- Technical basis for phased array wheel probe
- Description of EPRI mock-ups
- Final report scheduled for 2013

Example of Detection Assessment Results



Example of Depth Size Assessment Results



Industry Support and Guidance

Buried Pipe Guided Wave Examination Reference Document (1019115)

- Guided wave theory
- Data acquisition and analysis factors
- Buried pipe examination variables and limitations
- Project management protocol (for utilities)
- Guided wave literature study

Inspection Methods for Tanks and Containment Liners (1025215 – Scheduled for December)

- Identifies commercially available NDE tools
- Overview of inspection techniques, and delivery systems

Industry Support and Guidance

Nondestructive Evaluation of Underground Piping and Tanks Seminar

- Held in conjunction with the 9th International Conference on NDE in Relation to Structural Integrity for Nuclear and Pressurized Components on May 21st, 2012 in Seattle, WA
- Well attended by utilities and service providers

Guided Wave Training Seminar

- Four seminars conducted at EPRI over past 3 years
- ~60 attendees

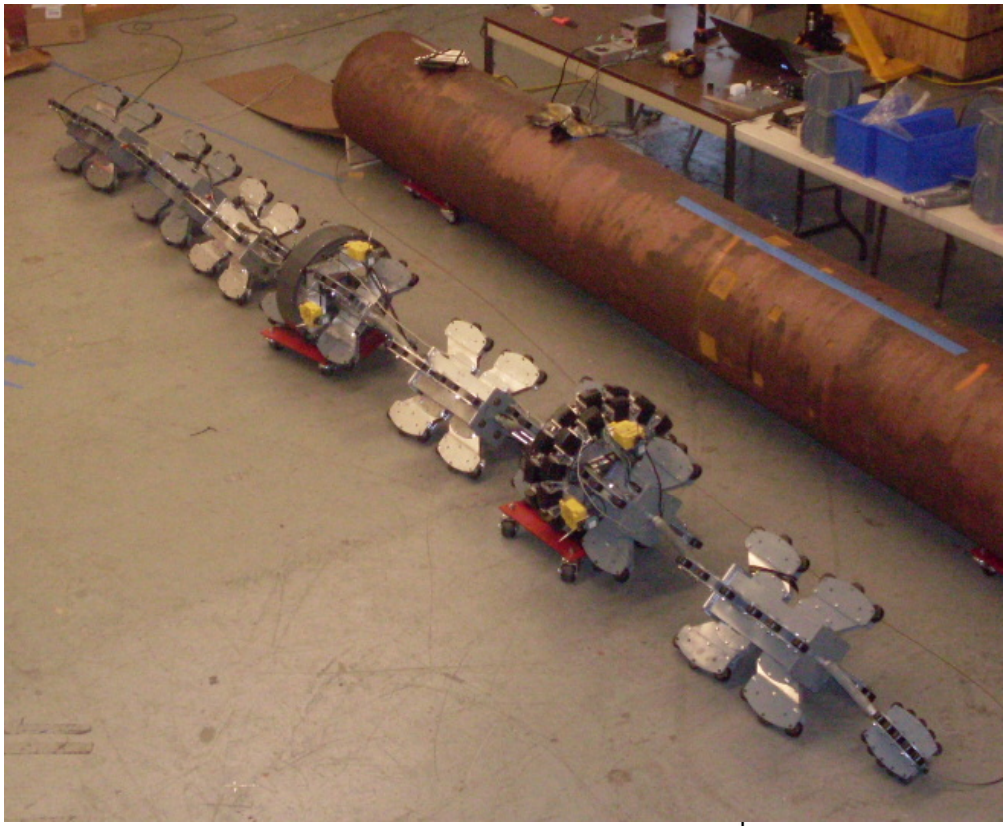
EPRI NDE Program

High Density Polyethylene (HDPE) NDE Technology

- Determine morphology of cold fusion
- Determine how to create cold fusion
- Determine size of cold fusion to be detected
  - BOPC has proposed project for critical flaw size
- Continue to collaborate with:
  - EDF
  - NRC Nuclear Reactor Regulation
  - BOPC IC

EPRI NDE Buried Pipe Reports

- Report 1025231: Nondestructive Evaluation: Buried Pipe In-Line NDE Depth Sizing Procedure
  - Analysis procedure for EPRI developed remote field eddy current array technology
    - Wall loss accuracy evaluation
    - Effect of material permeability variations and internal deposits or bumps in the accuracy assessment



Technology development and Assessment
EPRI 24-inch Mock-up

Saturated Low Frequency Eddy Current (SLOFEC)

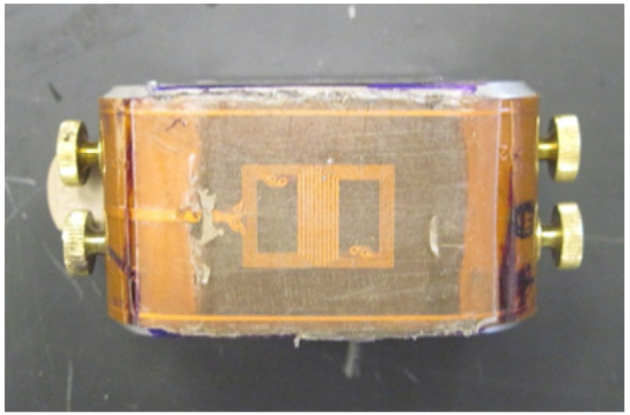
- Detect and map internal and external corrosion
- Examines through coating and linings
- Self-propelled tethered robot
- Traverse 1.5-diameter bends

Saturated Low Frequency Eddy Current (SLOFEC)

- Operates on eddy current principles with superimposed DC magnetization. The field distribution is:
  - Constant in areas free of discontinuities
  - Increased in areas of localized corrosion
- Assessment conducted on EPRI mock-ups with results published in report 1025219.
- Technology available and used in other industries

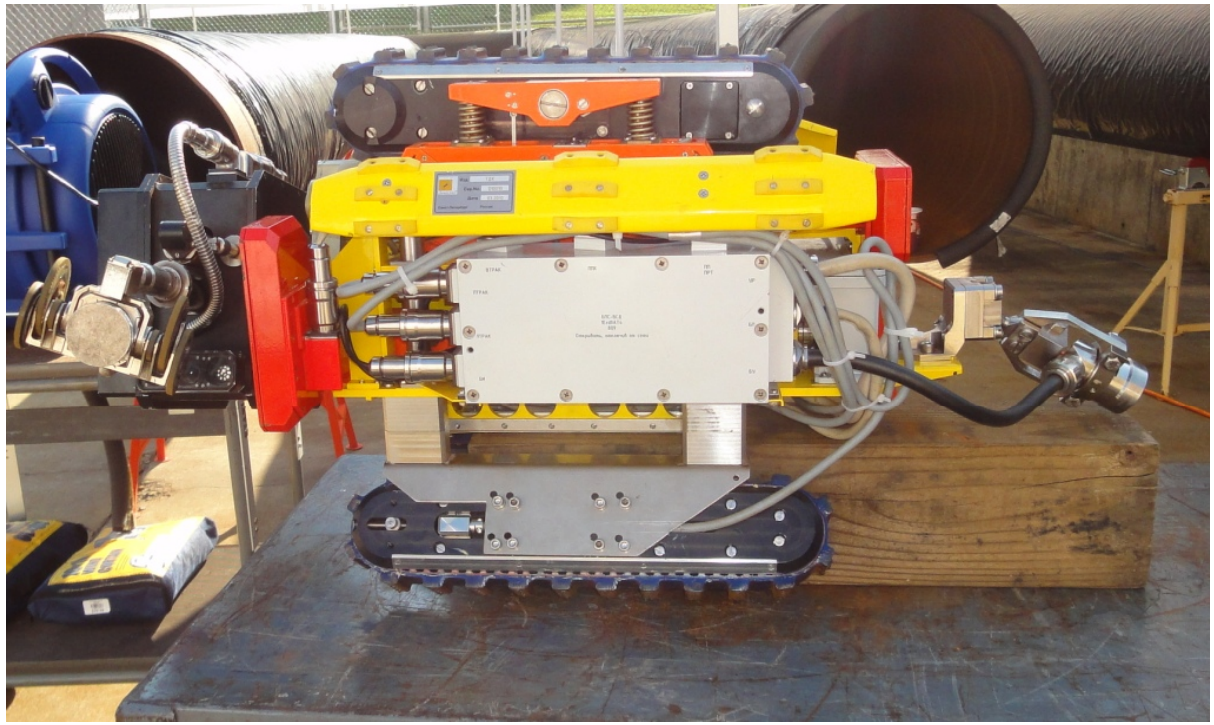
EMAT Ultrasonics

- Electromagnetic Acoustic Transducers (EMAT) generate ultrasonic waves
  - Can examine through coatings and linings
  - Reduced surface preparation
  - Couplant is not needed
  - Can be used in high-temperature environments



EMAT Ultrasonic Applications

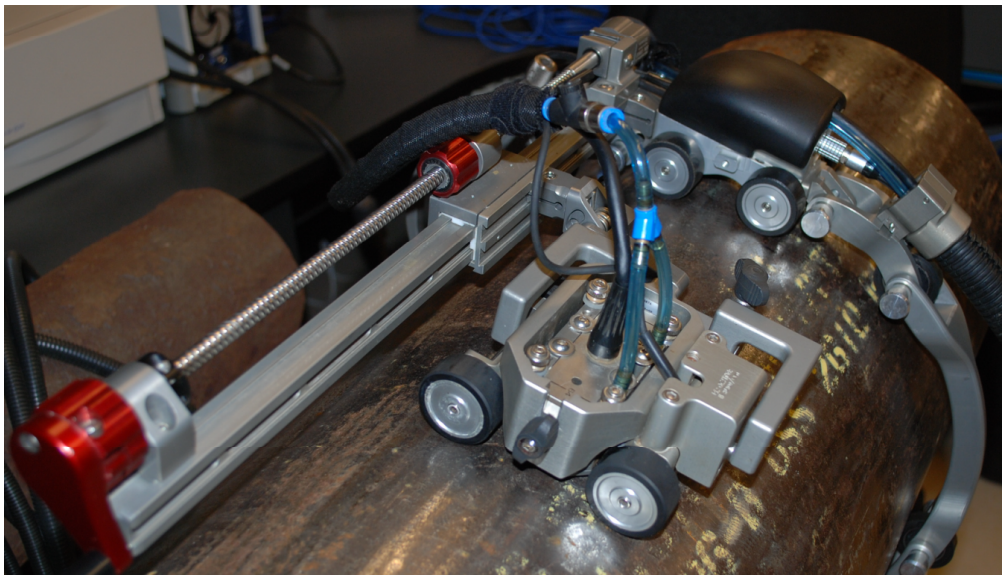
- Robotic EMATS system tested at EPRI in summer 2012
  - Mechanical issues identified and subsequently resolved
- Technology implemented at nuclear power plant (Q3 2012)
  - Demonstrated on plant mock-up prior to exam
- Assessment on EPRI mock-ups scheduled for Q1 2013



Ultrasonic Phased Array Technology

Phased array probes

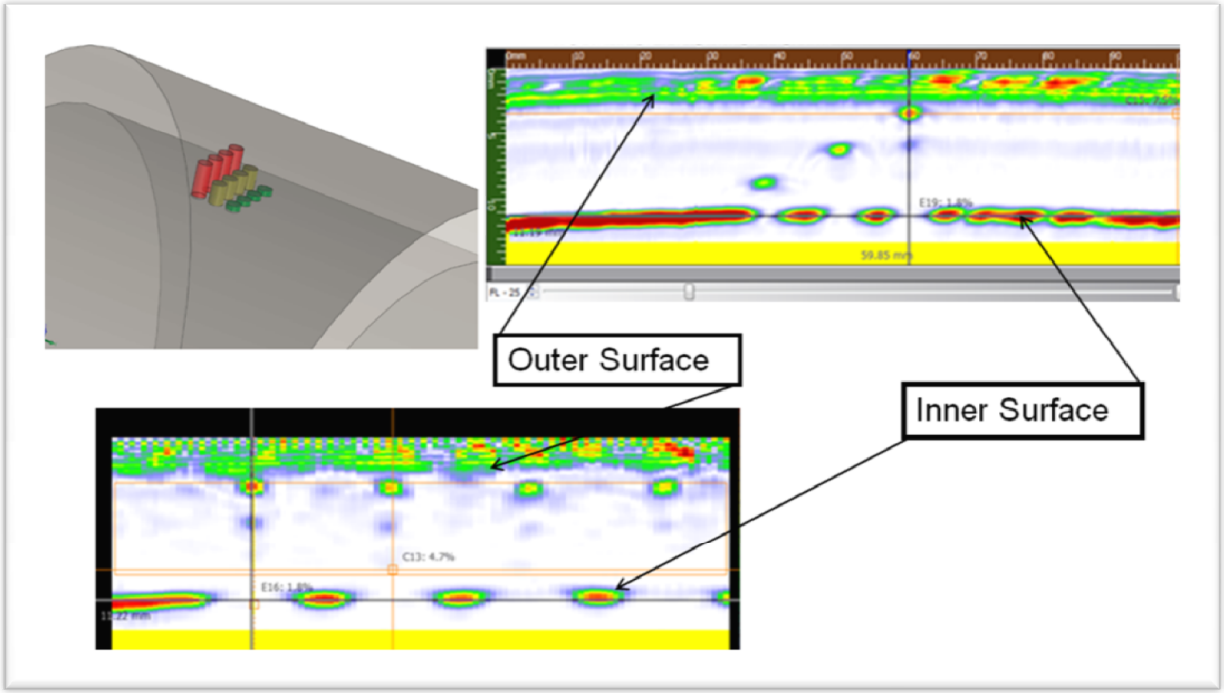
- Advantages
  - Rapid Scanning
  - 100% coverage over probe width
  - Permanent data storage
  - Imaging capabilities



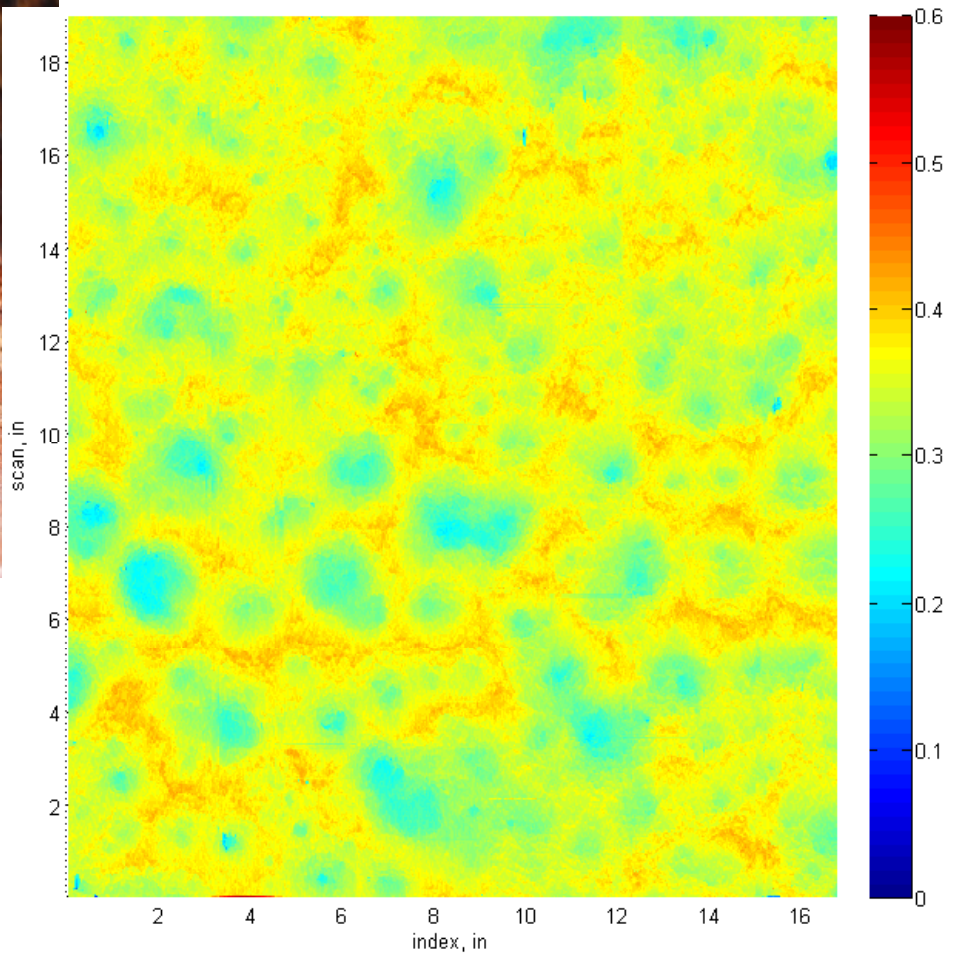
Ultrasonic Phased Array Technology

Phased array status

- EPRI published technical basis in: Buried Pipe NDE Technology Assessment and Development Interim Report (1025219)
- Inspection vendors and utilities starting to use



Ultrasonic Phased Array Technology on Corroded Sample



Leveraging Industry Resources

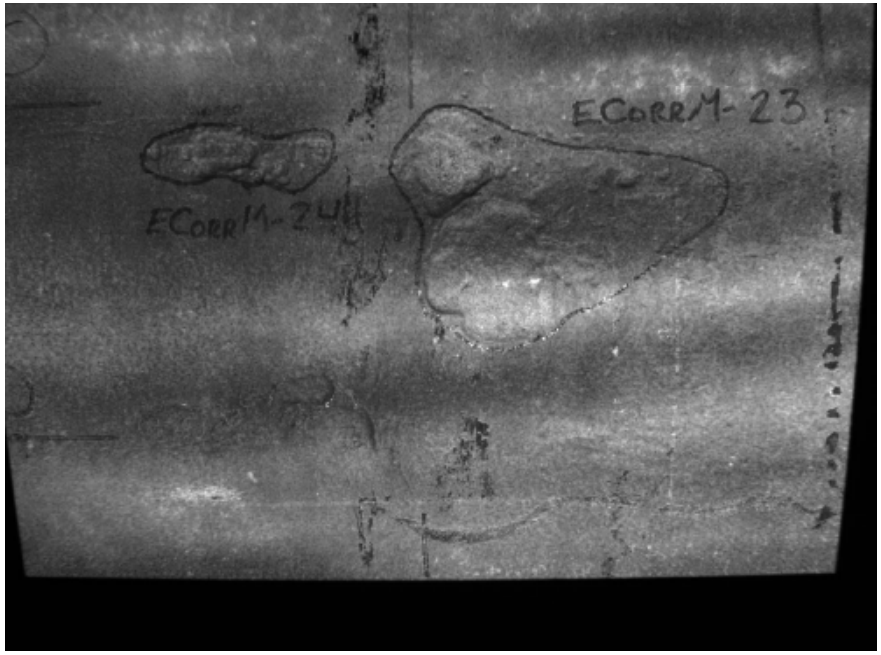
- EPRI is now a member of Pipeline Research Council International (PRCI)
  - Similar to EPRI but focused on transmission pipeline
  - Significant emphasis on pipeline inspection technology
    - Pipe repository center
    - Inspection technology development

3D Optical Scanner

- Technology development being funded by EPRI, PRCI, and Chevron
  - Technology from military and gaming industries
  - Scanner used on piping at PRCI repository early 2012
  - Demonstration at PRCI last week showed very good progress

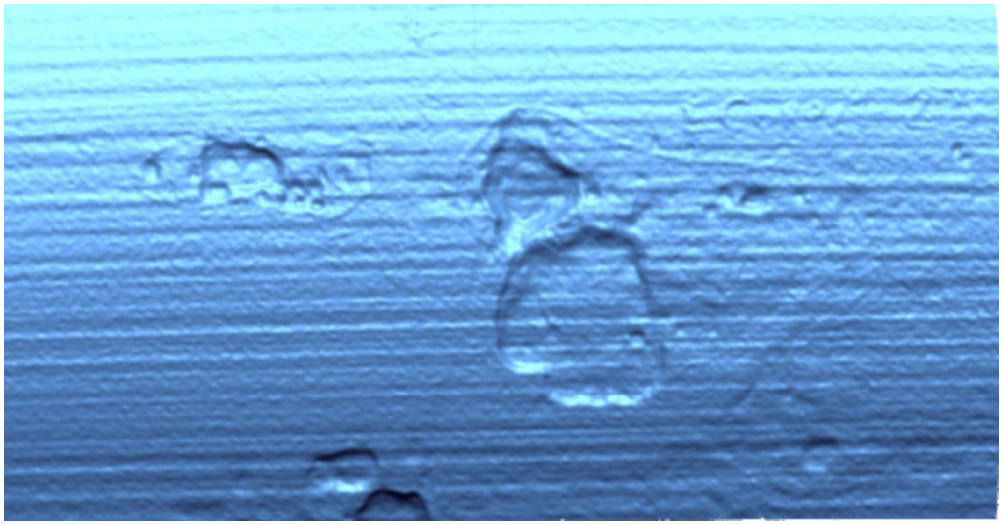
3D Optical Scanning System Process

- Acquire High resolution 3D image with optical scanner
  - 250K points per point cloud
  - 1K points clouds per second
- Process data to produce a photograph like image

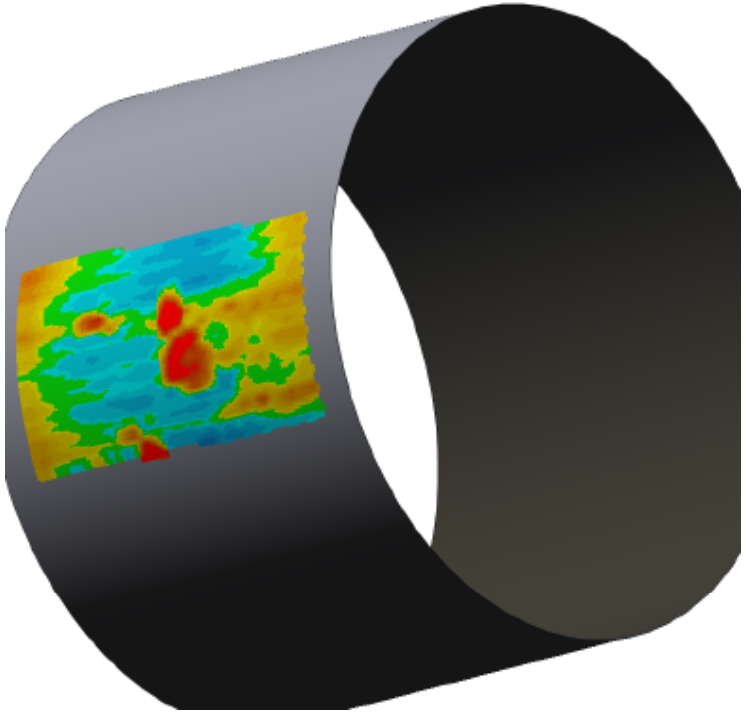


3D Optical Scanning Process

Apply Gaussian filter to remove high frequency noise



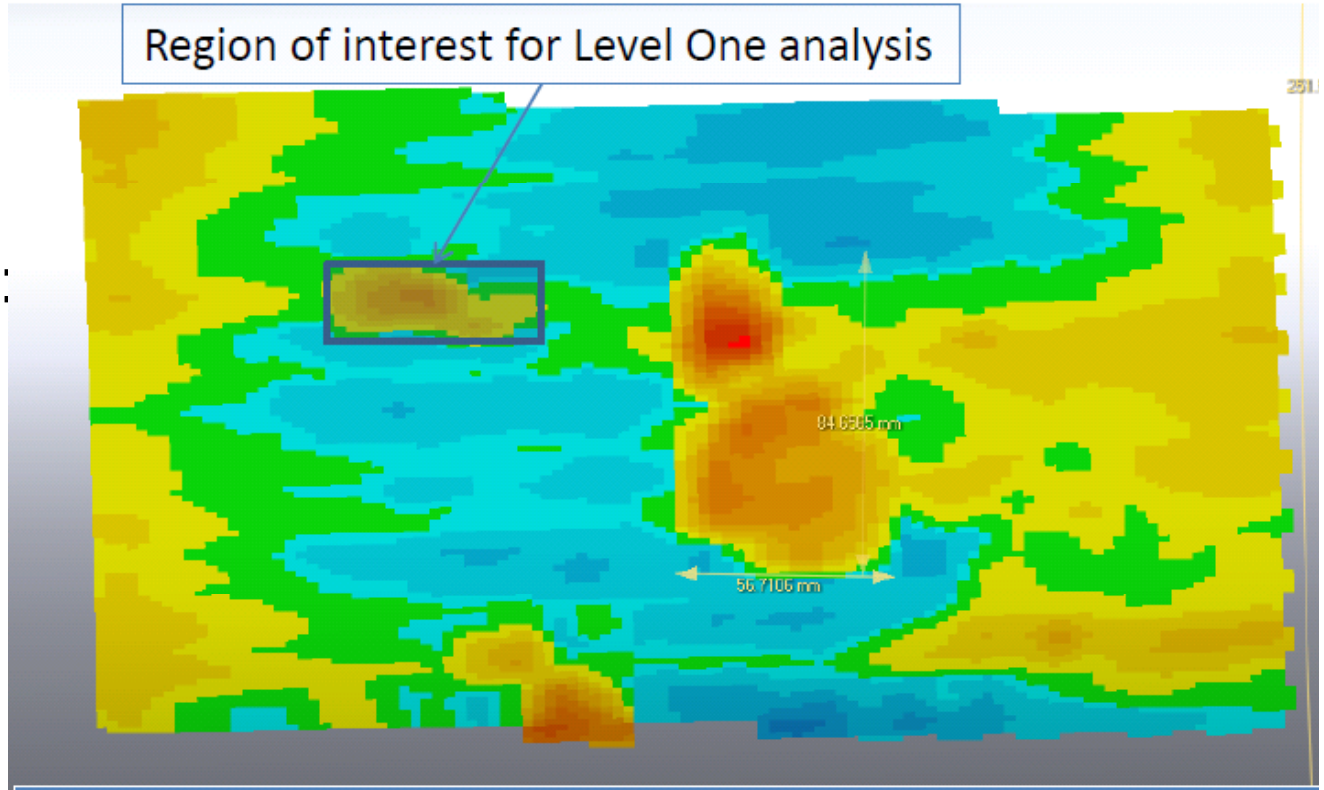
Fit data to pipe section and extract pipeline radius



3D Optical Scanning System Process

Identify region of interest and extract:

- Length
- Depth
- Area extent
- Volume loss



ECORRM-24

Level One input data	Level One metal loss
• Length = 53.7mm • Circumferential width = 24.0mm • Deepest point = 1.6mm	• 2,063mm^3

Optical Scanner Technology Going Forward

- Support/engage in 2013 PRCI proposed project
  - Ruggedize tool
  - Develop analysis software to near real time results

Published Buried Pipe NDE Reports

- EPRI Report 1022930: Nondestructive Evaluation: Buried Pipe Nondestructive Evaluation Reference Guide—Revision 1 to Report 1021626
- EPRI Report 1019115: Buried Pipe Guided Wave Examination Reference Document
- Report 1025219: Nondestructive Evaluation: Buried Pipe NDE Technology Assessment and Development Interim Report
- EPRI Report 1021153: Remote Field Technology Assessment for Piping Inspection Including Buried and Limited Access Components

Published Buried Pipe NDE Reports (cont.)

- Inspection Including Buried and Limited Access Components
- EPRI Report 1022929: Nondestructive Evaluation: Guided Wave Status Report
- EPRI Report 1025231: Nondestructive Evaluation: Buried Pipe In-Line NDE Depth Sizing Procedure
- EPRI Report 1022926: Intermediate Diameter Buried Piping Instrumented Vehicle--Evaluation
- EPRI Report 1016676: Catawba Field Trial of EPRI's Large Diameter Buried Pipe Instrumented Vehicle

To be Published Buried Pipe NDE Reports

- EPRI Report 1025220: Nondestructive Evaluation: Buried Pipe Nondestructive Evaluation Reference Guide—Revision 2
- EPRI Report 1025215: Inspection Methods for Tanks and Containment Liners
- EPRI Report 1025228: Buried Pipe Direct Examinations Through Coatings
- EPRI Report 1025212: Guided Wave Analysis Tools Update
- EPRI Report 1025213: Buried Pipe Structural Health Monitoring Sensitivity Studies

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