

PHMSA Mechanical Damage Workshop



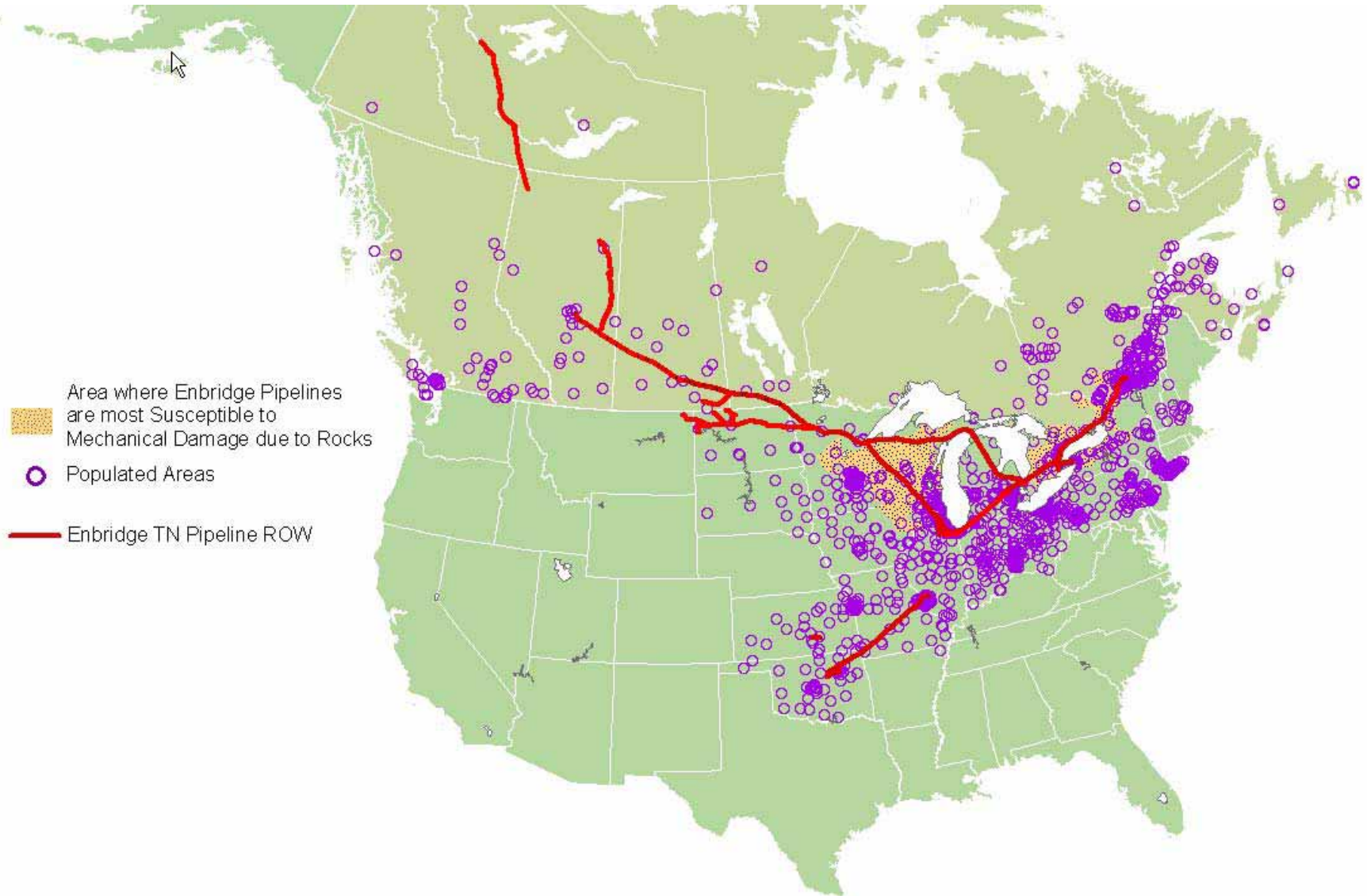
Walter Kresic

Enbridge Pipelines Inc.

Feb.28 & Mar.1, 2006

Houston

Enbridge Liquid System Most Damage Caused by Rocks



Mechanical Damage (M/D) Defect Management Approach



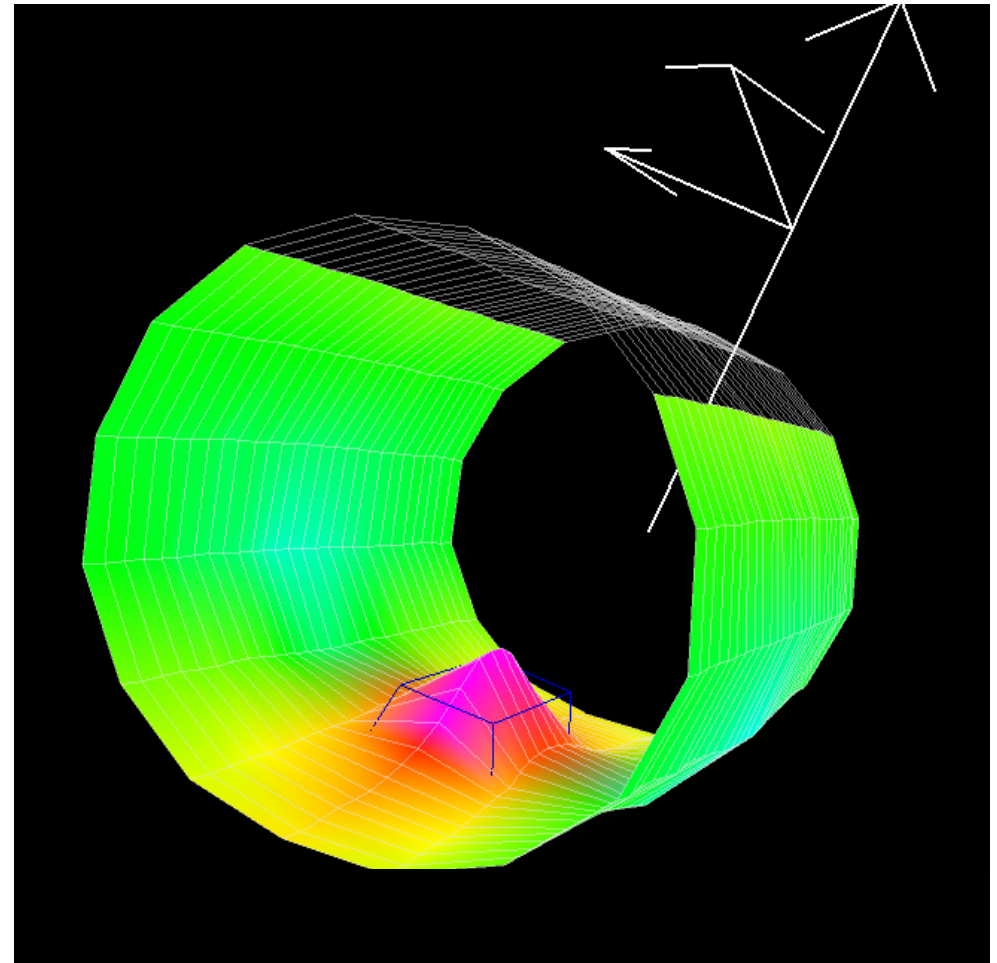
- **Leverage all available resources**
 - Codes & Standards (DOT 195, CSA Z662)
 - Research (PRCI, API, ASME, etc.)
- **Uncertainty creates risk**
 - What are the parameters that define damage?
 - What are the fitness-for-purpose thresholds?
- **Focus on risk management**
 - Enbridge experience is leaks, not ruptures
 - Integrity science + operational practices

Detection Techniques

Full Range of Technologies Utilized



- **Caliper tools**
 - Multi channel
- **MFL tools**
 - M/D reported during corrosion inspection
 - New research
- **Ultrasonic tools**
 - M/D reported during corrosion or crack inspection
 - Not relied upon to find cracks in dents



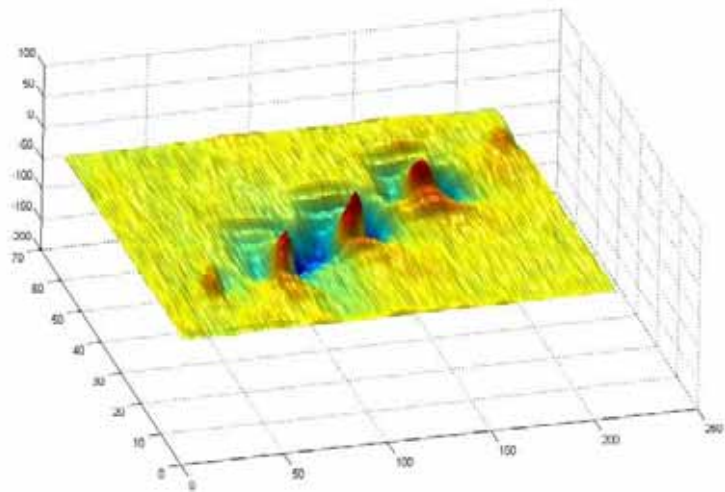
Characterization Techniques

Concurrent Developments

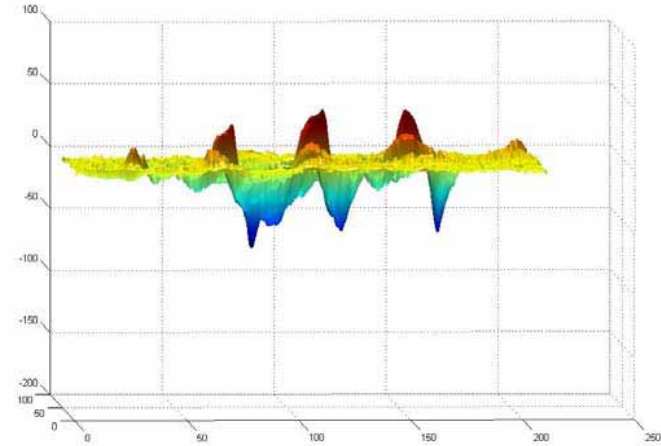


- **Based on mechanical parameters**
 - Geometries or combo defects as stated by code
 - Finite element analysis
 - Semi-empirical approaches that utilize improved MFL characterizations
- **Identification of cracks**
 - ILI data
 - Leak survey
- **Stress / Strain fields**
 - New research using MFL tools

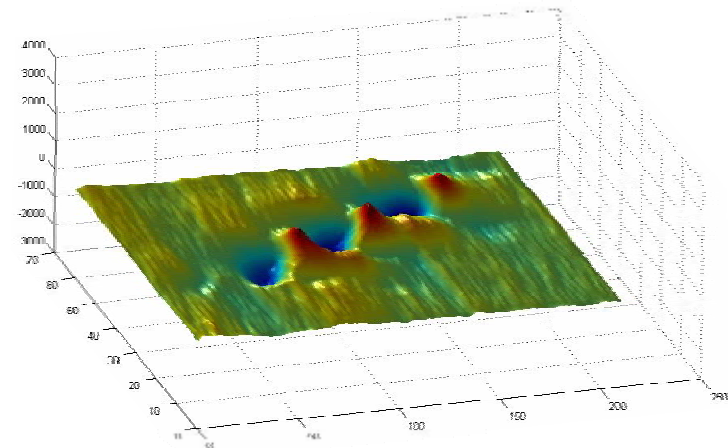
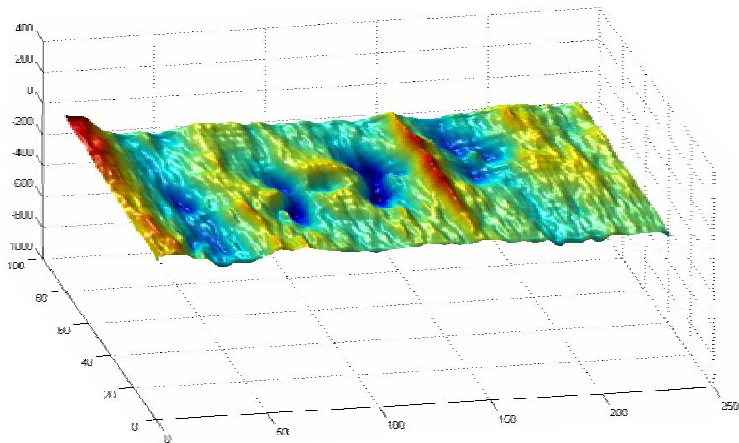
Commercial MFL Identifies Detailed Geometry Info



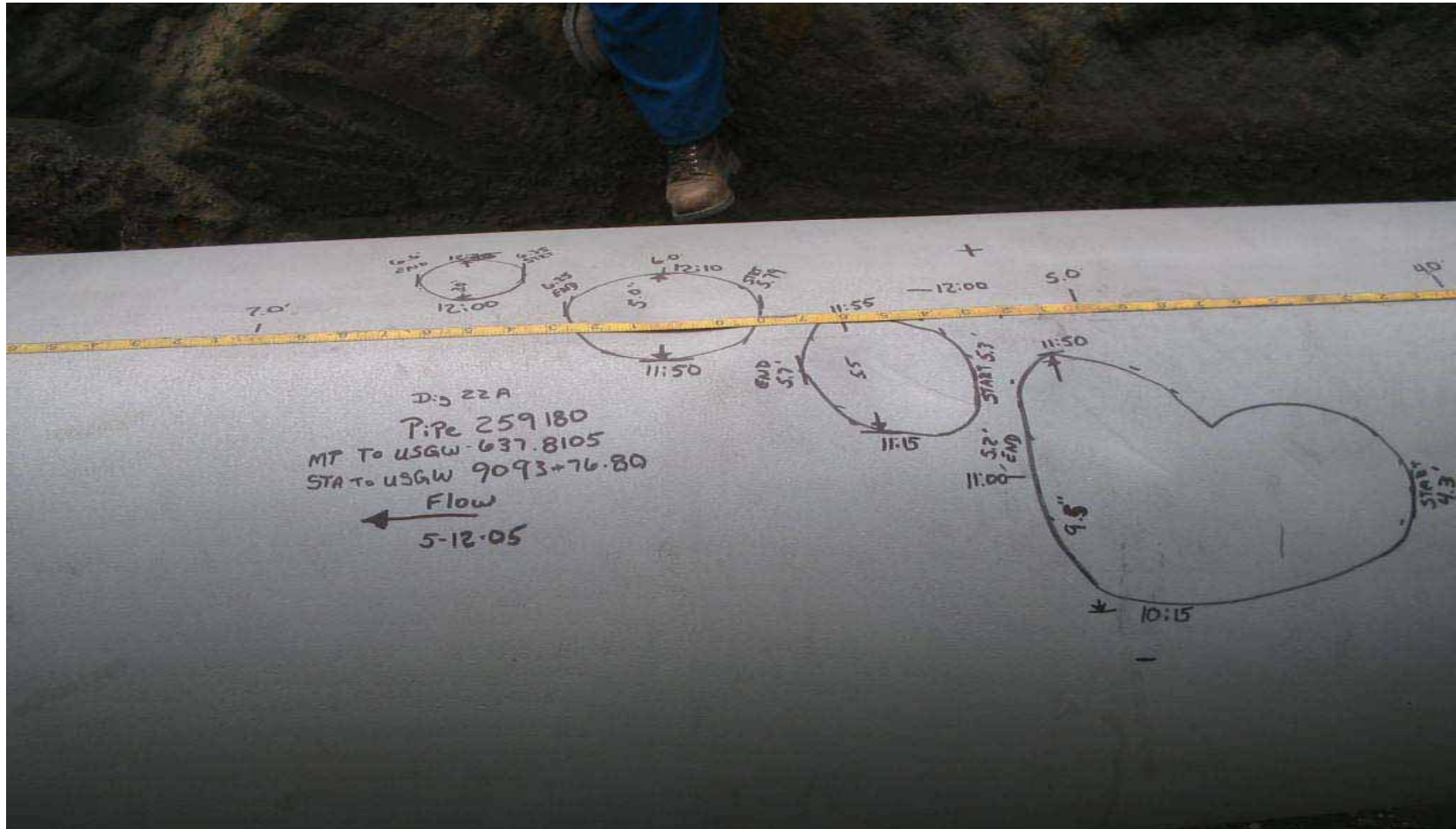
Axial Sensors



Radial Sensors

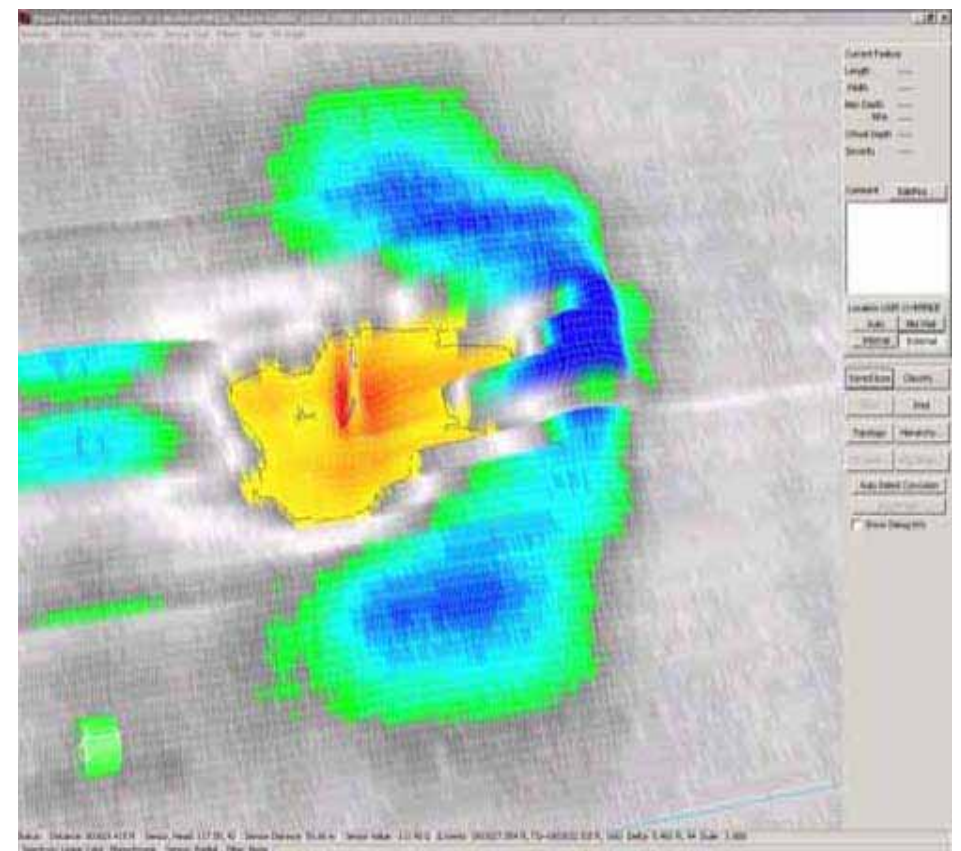
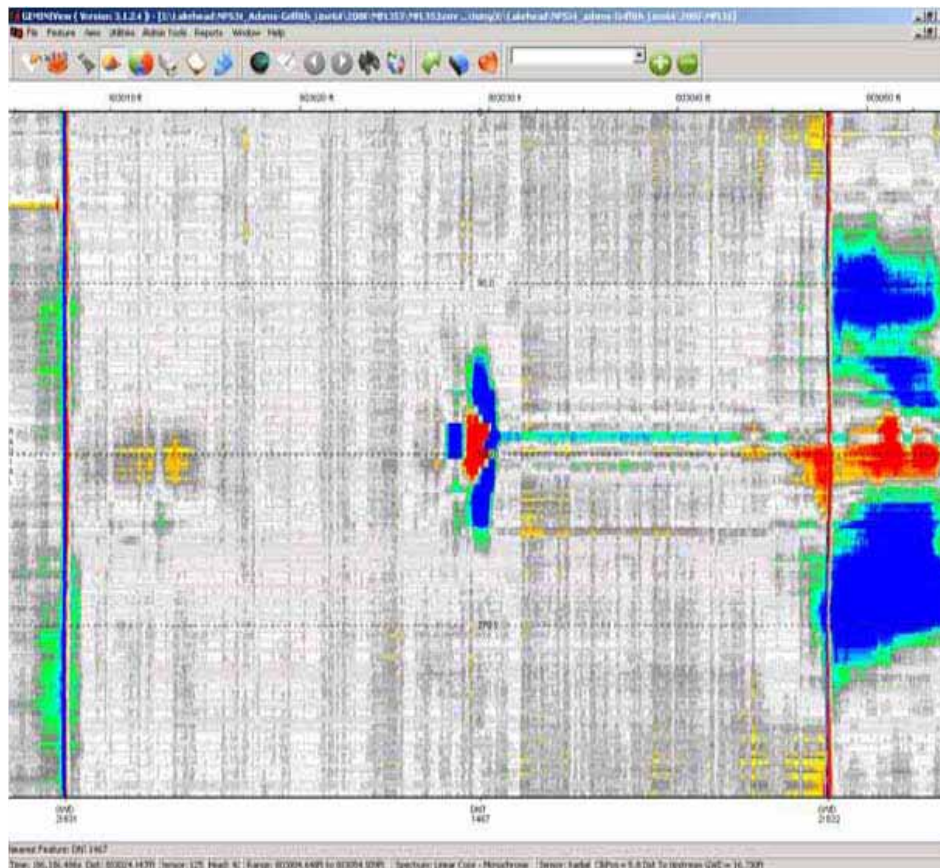


Precise Detection Accurate Characterization?



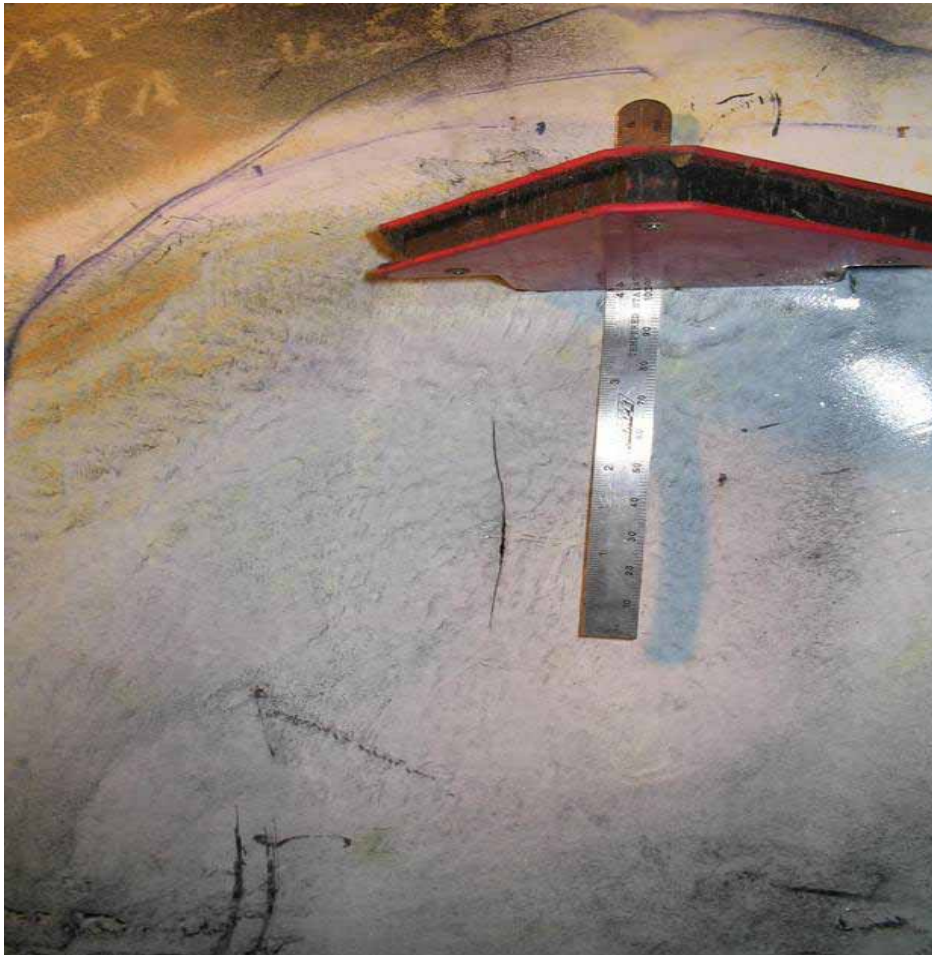
Top of Pipe Mechanical Damage/Gouge Multiple Dents

Commercial MFL Extended Capabilities



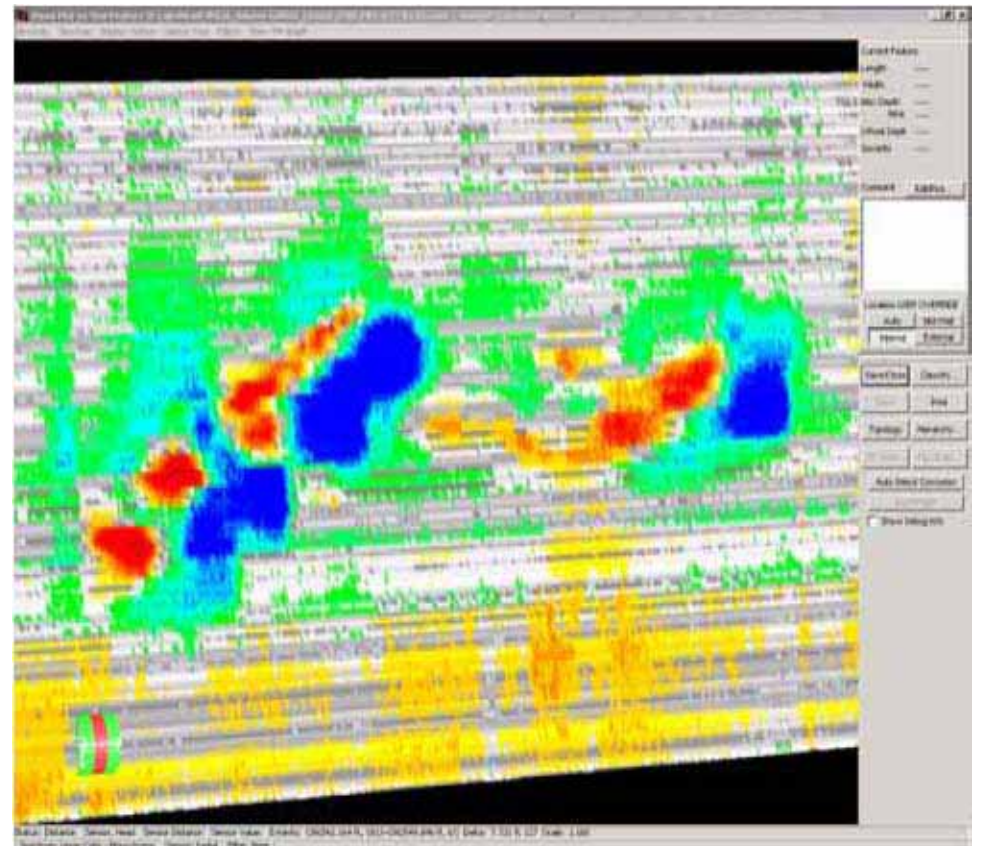
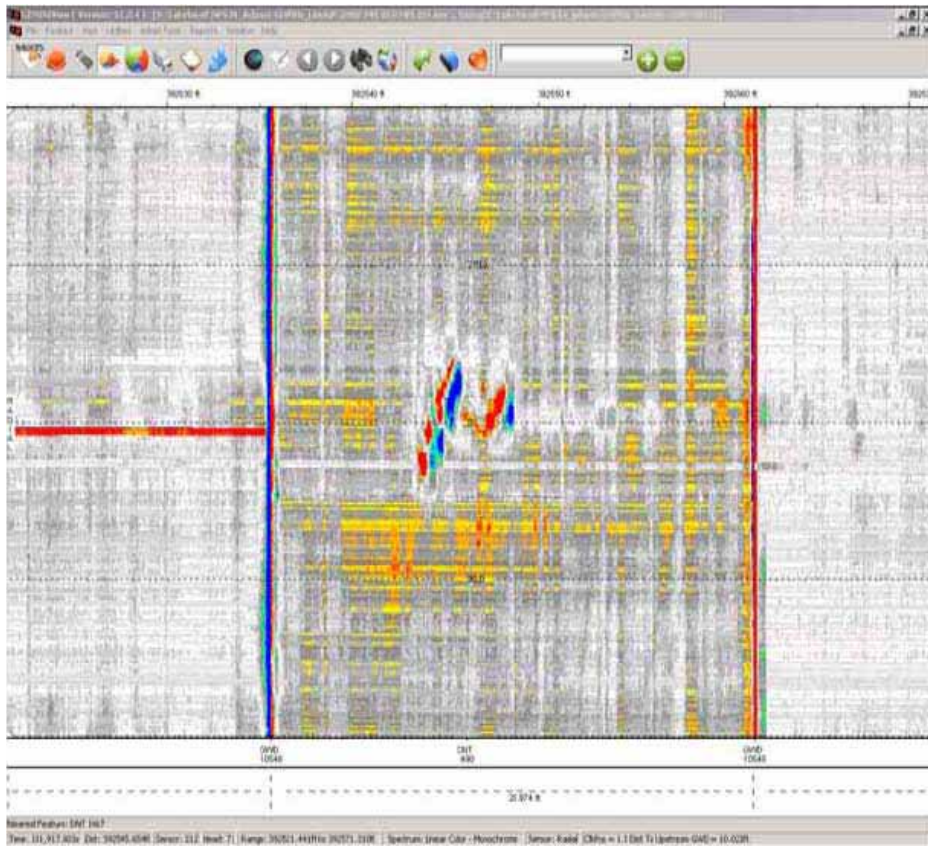
Positive Detection

What Degree of Confidence?

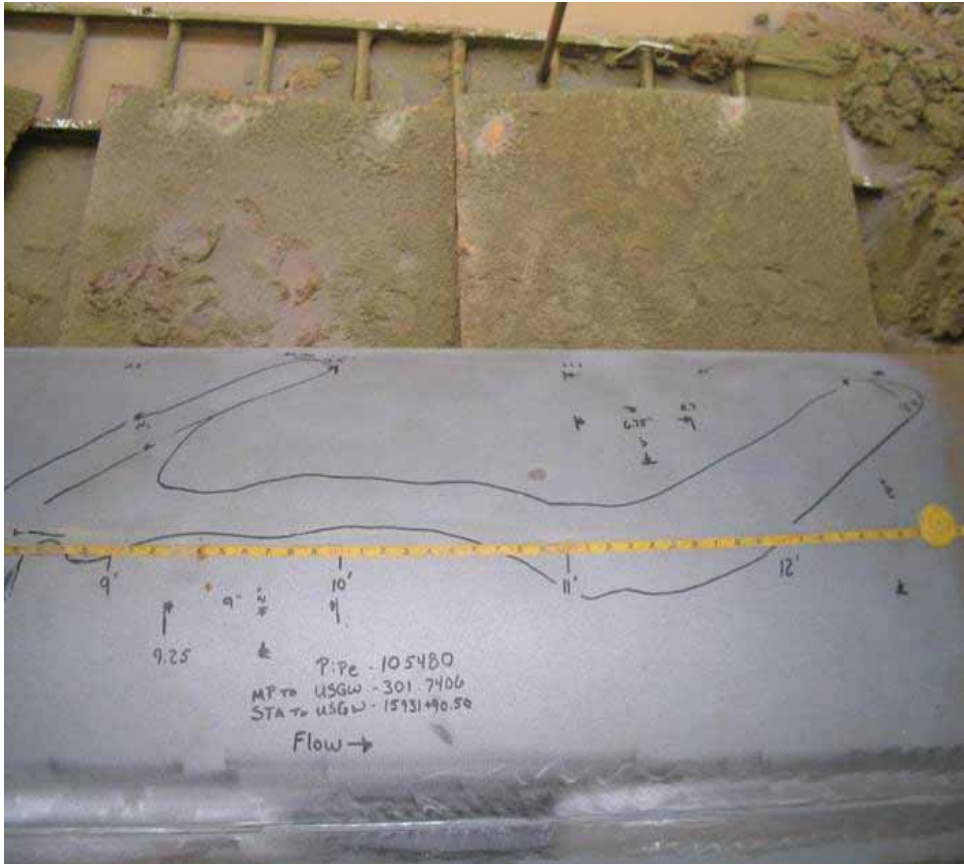


**Bottom of Pipe Dent
(3.5%) with
Circumferential
Crack**

Commercial MFL Extended Capabilities



Interesting Field Results More Questions than Answers



Top of Pipe Mechanical Damage/Gouge Multiple Dents

PRCI Research Alongside In-house Work



- **Provides a community of expertise**
- **Detection**
 - MD-1-1 – Test dual-field MFL
 - MD-1-2 – Examine existing commercial equipment
 - Influence continuing research and development
- **Characterization**
 - Variety of projects regarding mechanical modeling, full-scale testing, high level prioritization and field assessment guidance

Enbridge M/D Summary



- **Defect management is supplemented with risk management tools**
 - This is a very complex type of defect with complex industry issues
 - Not “one size fits all”
- **Crack identification is our primary interest**
- **New developments are underway**