TECHNOLOGY IMPROVEMENTS FOR DENT ECA USING ILI

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CONTENT

1. Industry Gap
2. Technologies Insight
3. Development & Research

INDUSTRY GAP

Regulatory

Proposed Engineering Critical Assessment (ECA) for advanced dent assessment.

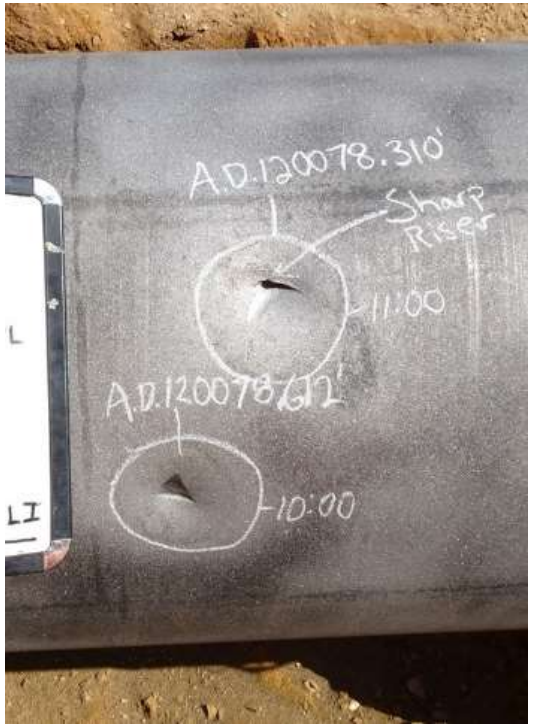
Dents with associated metal loss

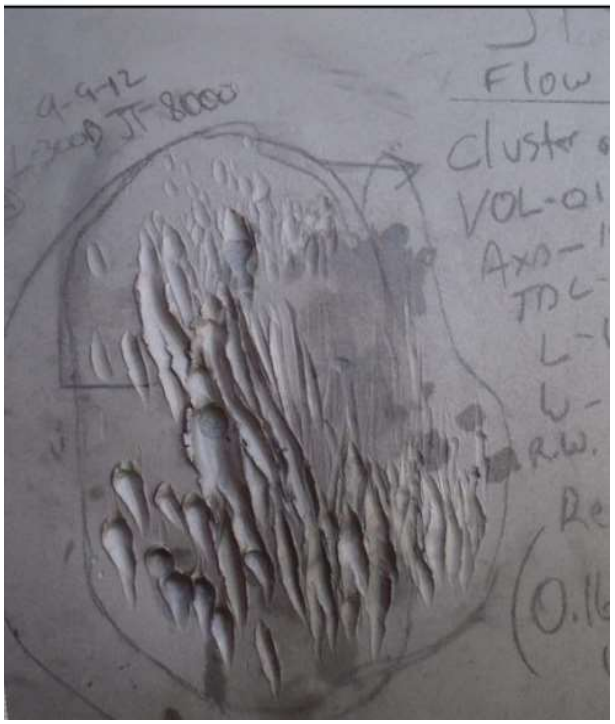
For year many dents with associated metal loss have been responded to as immediate integrity concerns without leveraging ILI technology advancements.

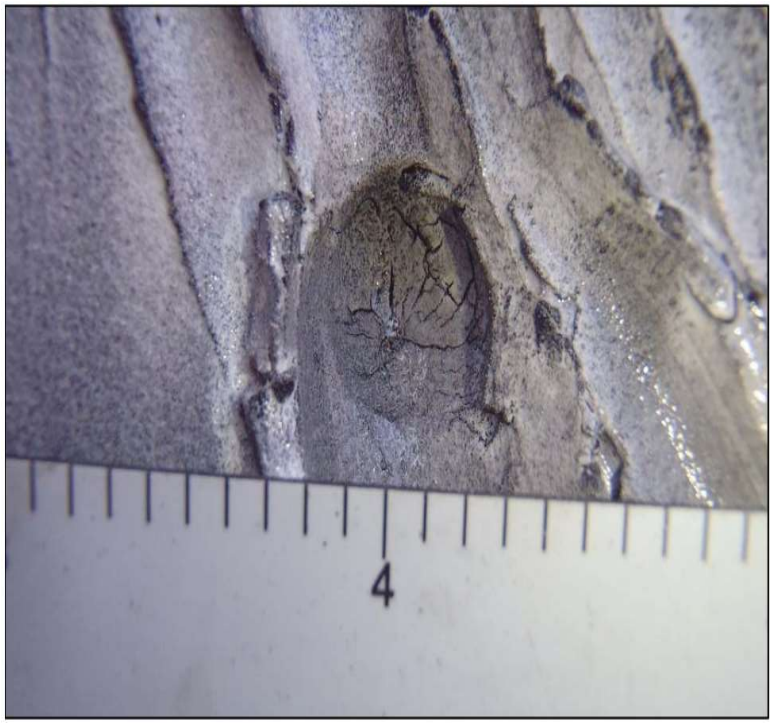
Gap

Response to reported features often do not leverage the ILI systems full capabilities or data integration capabilities. An In-Line Inspection (ILI) system is defined by API 1163 as an inspection tool with all associated hardware, software, procedures, and personnel. Integrating ILI data sets can allow for a better understanding of the severity of dents with interacting threats and establish appropriate response criteria.

INDUSTRY GAP
WHAT WE ARE LOOKING FOR







INDUSTRY GAP
WHAT WE ARE OFTEN EXCAVATING

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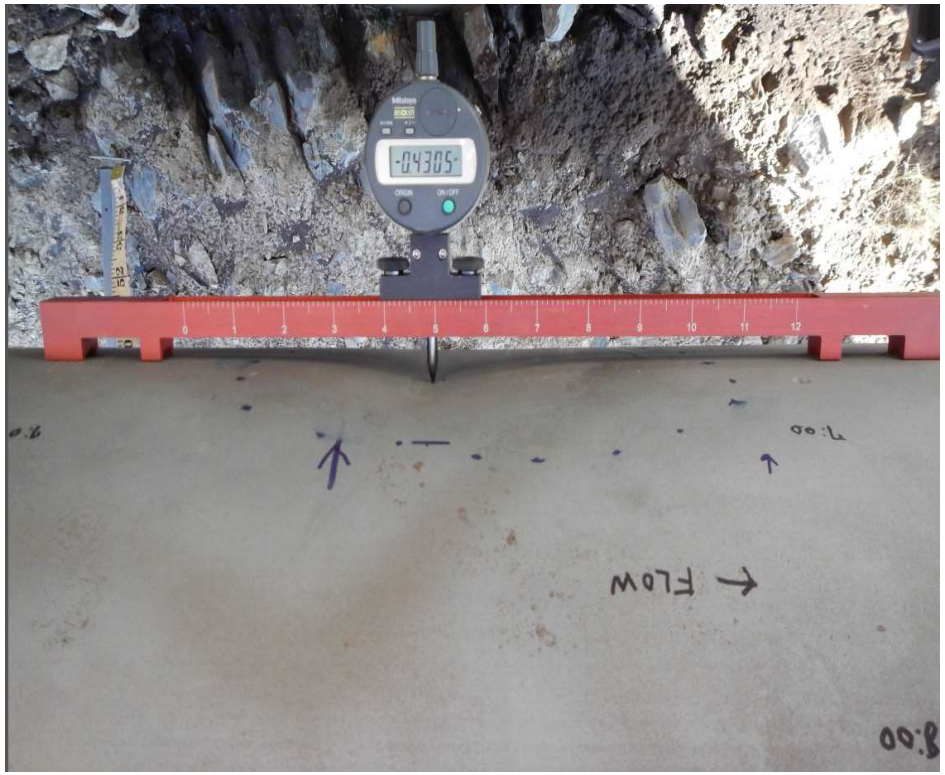

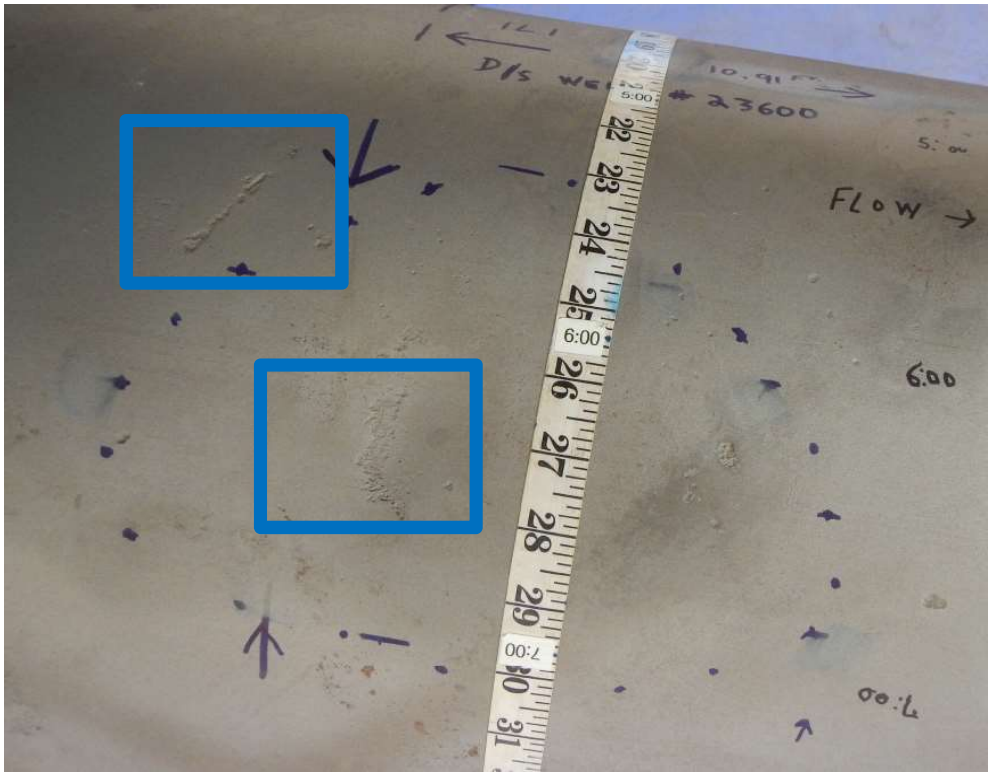

INDUSTRY GAP
ENGINEERING CRITICAL ASSESSMENT

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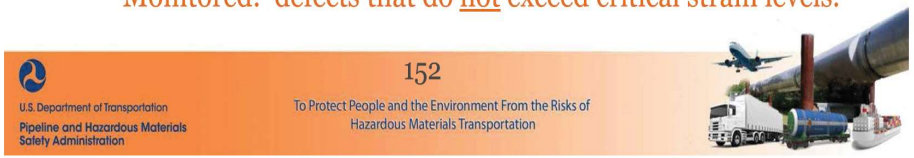
6. Repair Criteria
192.485(c); 192.711; 192.713; 192.933

Public/Committee Comments on Repair Criteria (3/2/18):

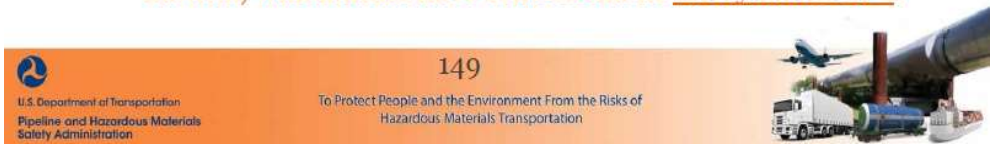
- Repair criteria for dents with metal loss should distinguish between topside and bottom-side dents (similar to the repair criteria for smooth dents). (cont.)
- **PHMSA**: (cont.) Also, to reduce unnecessary excavations, PMSA suggests revising this immediate condition as follows:
  - Allow engineering critical assessment (ECA) to analyze dent anomalies with indications of metal loss, cracking or stress riser, and prioritize repair criteria as follows:
  - Immediate: topside defects that exceed critical strain levels,
  - 2 Year: bottom-side that exceed critical strain levels, and
  - Monitored: defects that do not exceed critical strain levels.



6. Repair Criteria
192.485(c); 192.711; 192.713; 192.933

Public/Committee Comments on Repair Criteria (3/2/18):

- **PHMSA**:
  Summary of suggested ECA for Denting (cont.):
  - Identify and quantify all loads acting on the dent for a basis for ECA;
  - Evaluate strain level associated with dent and any welds using Finite Element Analysis (FEA), and calculate the plastic strain limit damage factors to infer the possibility of a crack;
  - Estimate the fatigue life of the dent using FEA with the operational pressure data and different fatigue life prediction models, which must have reassessment safety factor of 2.



TECHNOLOGY INSIGHT
HIGH RESOLUTION GEOMETRY

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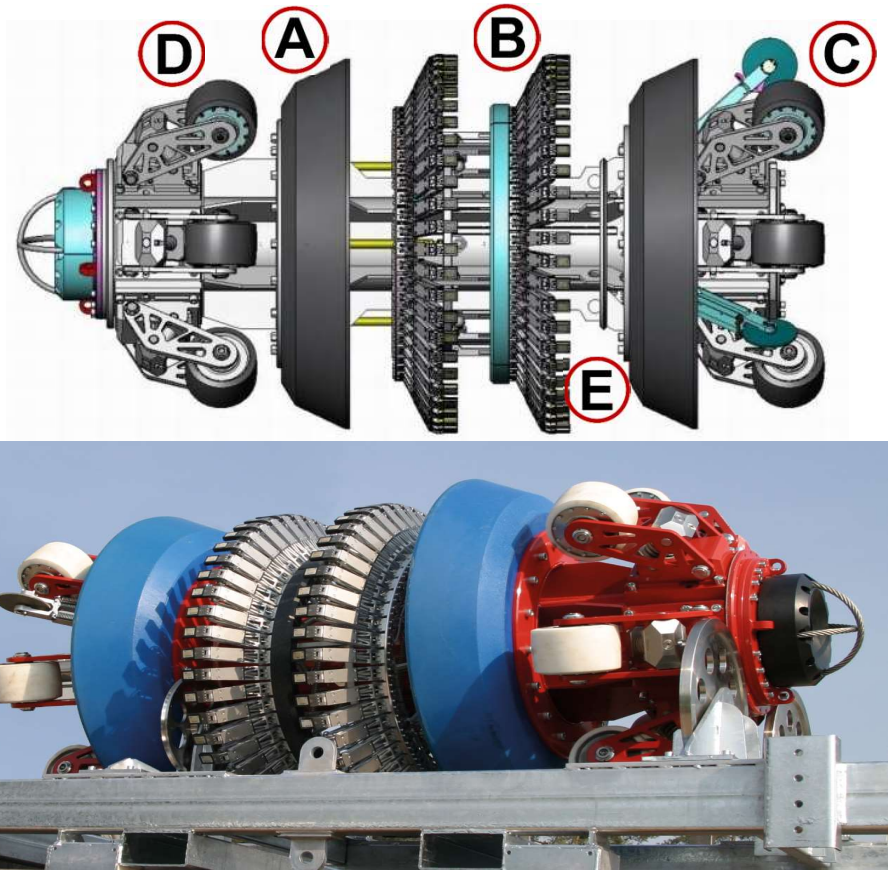

TECHNOLOGY INSIGHT
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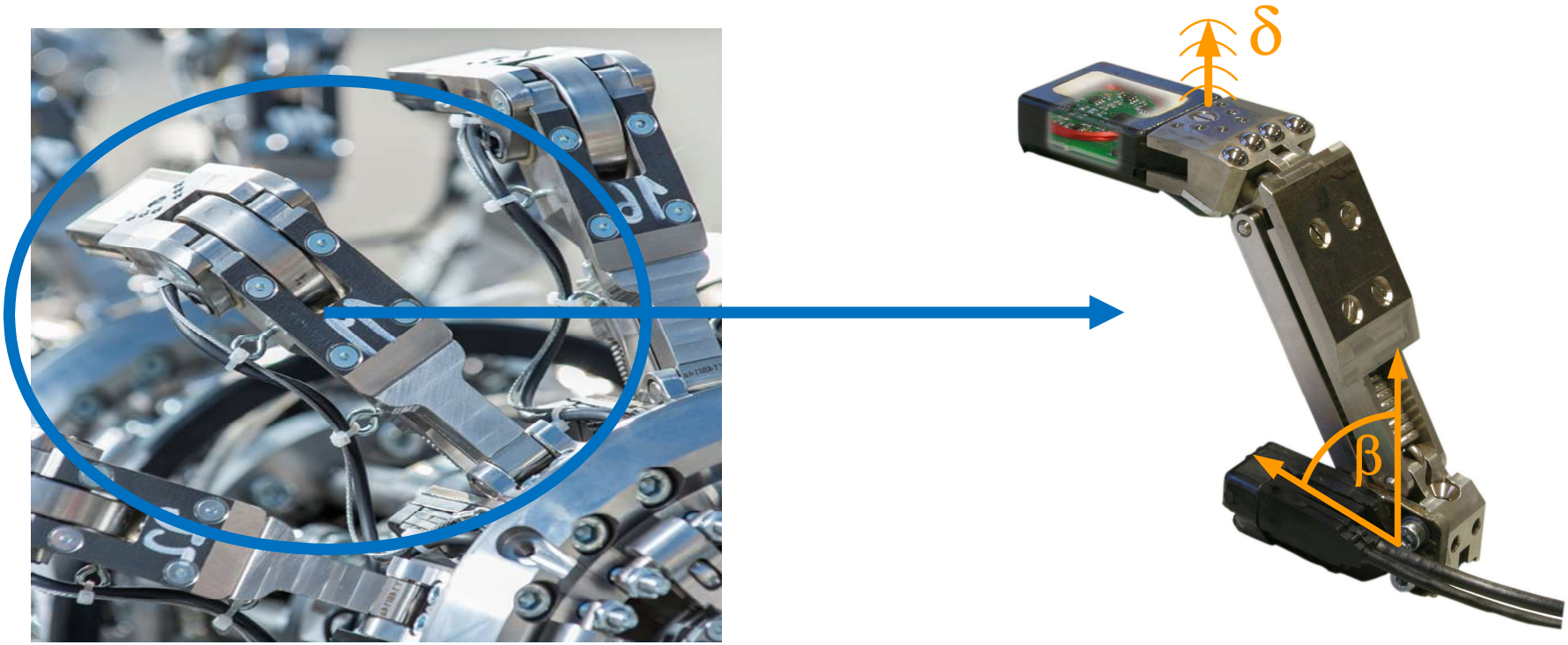
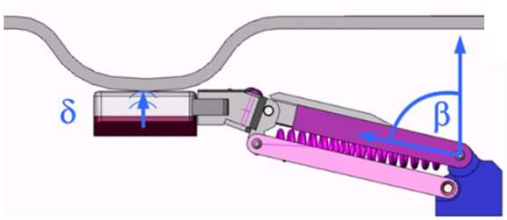
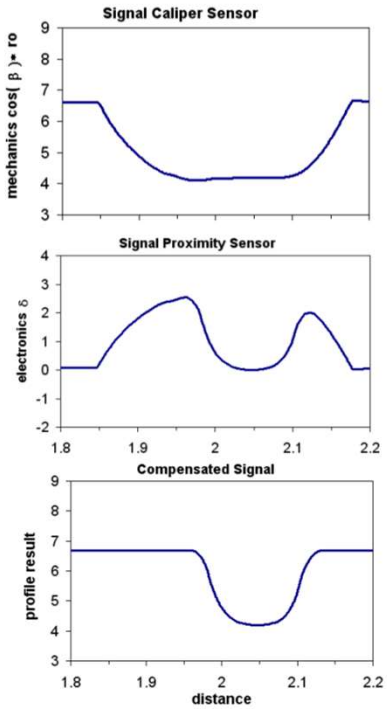


TECHNOLOGY INSIGHT
EXTENDED RESOLUTION GEOMETRY





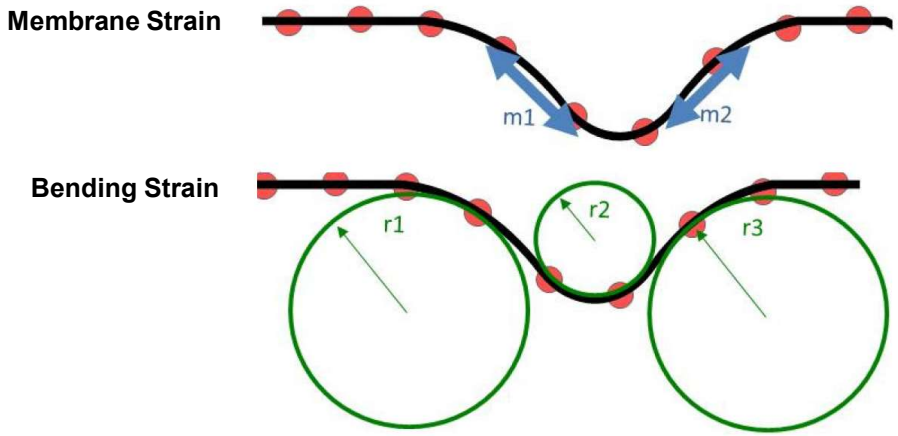
Measurement of conventional High Resolution Caliper arm (Angle Measurement - Beta) – *Measured shape is too long.*

Measurement of High Resolution Proximity Sensor (Distance Measurement - Delta).

Result after addition of both measurements provides exact defect shape.
(Angle + Distance Measurement) –
Length and Depth is accurately measured.

ENGINEERING ASSESSMENT
DENT STRAIN

Total dent strain is the combination of the membrane/extensional strain and the bending strain.



A plain dent is considered critical if the total strain value exceeds 6% strain - ASME B31.8 (2003)

ADVANCED DENT ASSESSMENT
STRESS CONCENTRATION USING FEA

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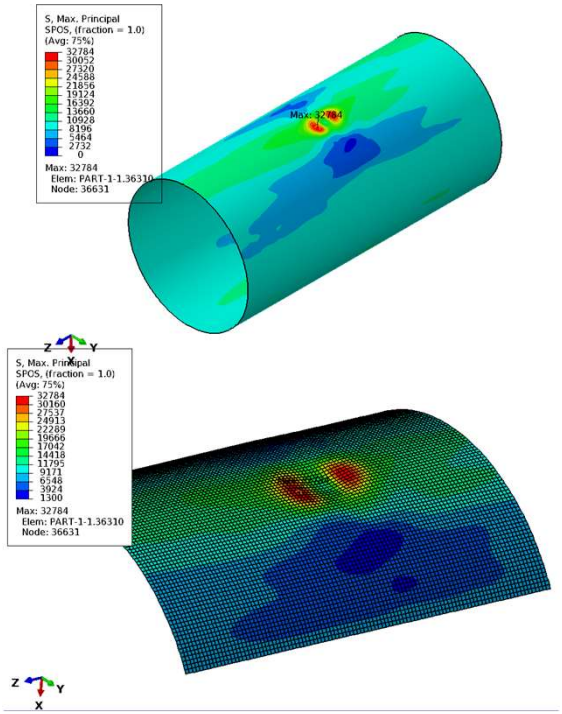
Finite Element Analysis

Streamlined process integrating the analysis of ILI data analysis and sound engineering practice for severity ranking.

Recent case demonstrated >1500 dents could be assessed in one month with 2 engineers and 1 Sr Engineer.

FEA based on RoGeo-XT data



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DEVELOPMENT & RESEARCH
PLAIN DENT ASSESSMENTS

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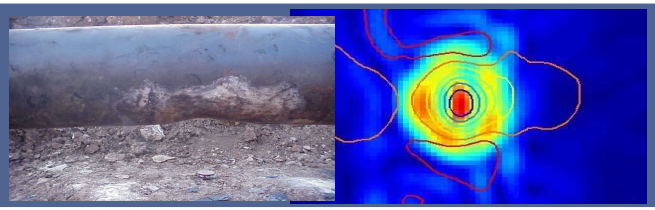
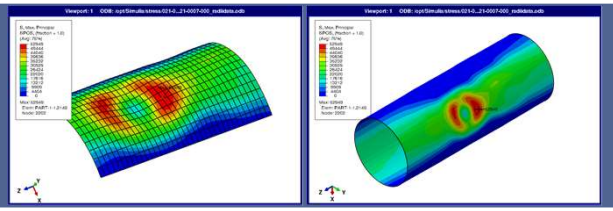
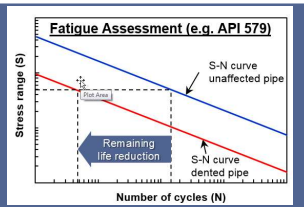
Strain Assessment
In accordance to common standards (e.g. ASME B31.8)



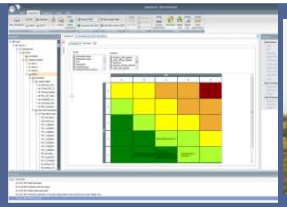
Stress Assessment
Semi-automated for plain dent conditions using Finite Element Analysis (FEA)

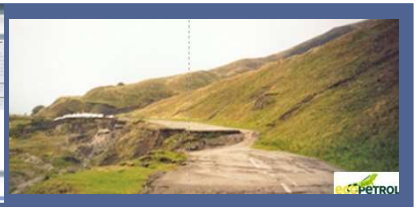


Remaining Life Assessment (RLA)
Plain dent conditions



Bending Strain & Pipeline Movement Assessment
Level approach: from analysis up to assessment providing prioritizations and assessing criticality





ADVANTAGES OF MULTI-DATASETS
ROCORR MFL-A + ROGEO XT

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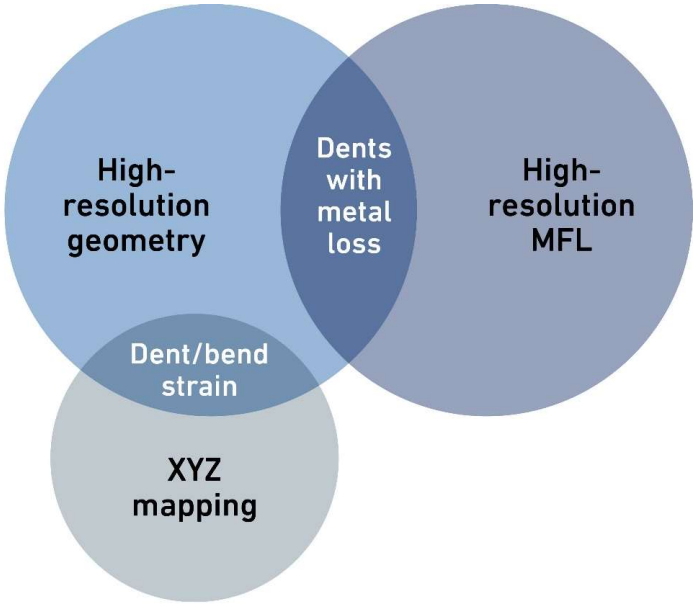
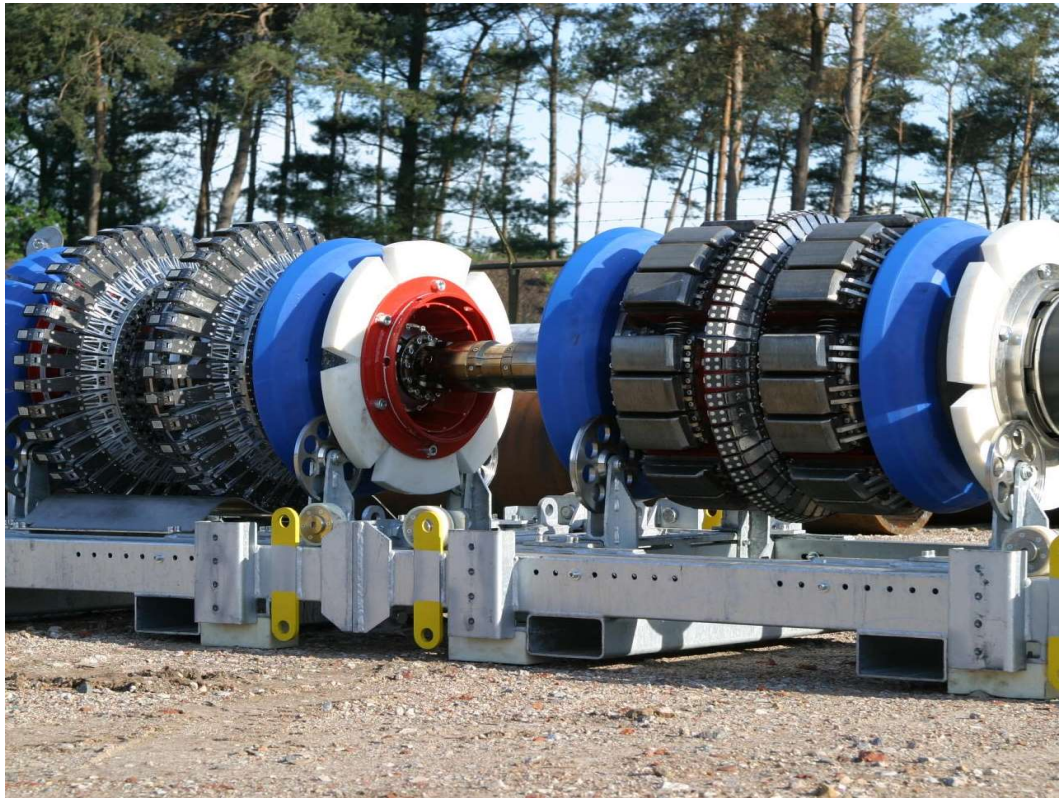


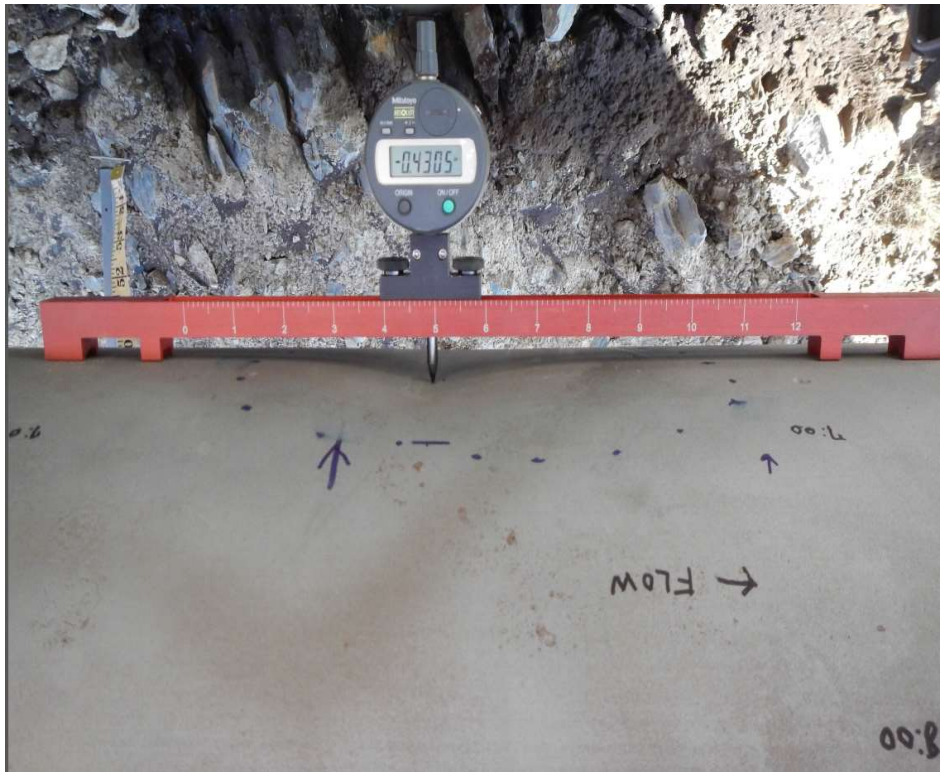
TECHNOLOGY INSIGHT
COMBINED INSPECTION

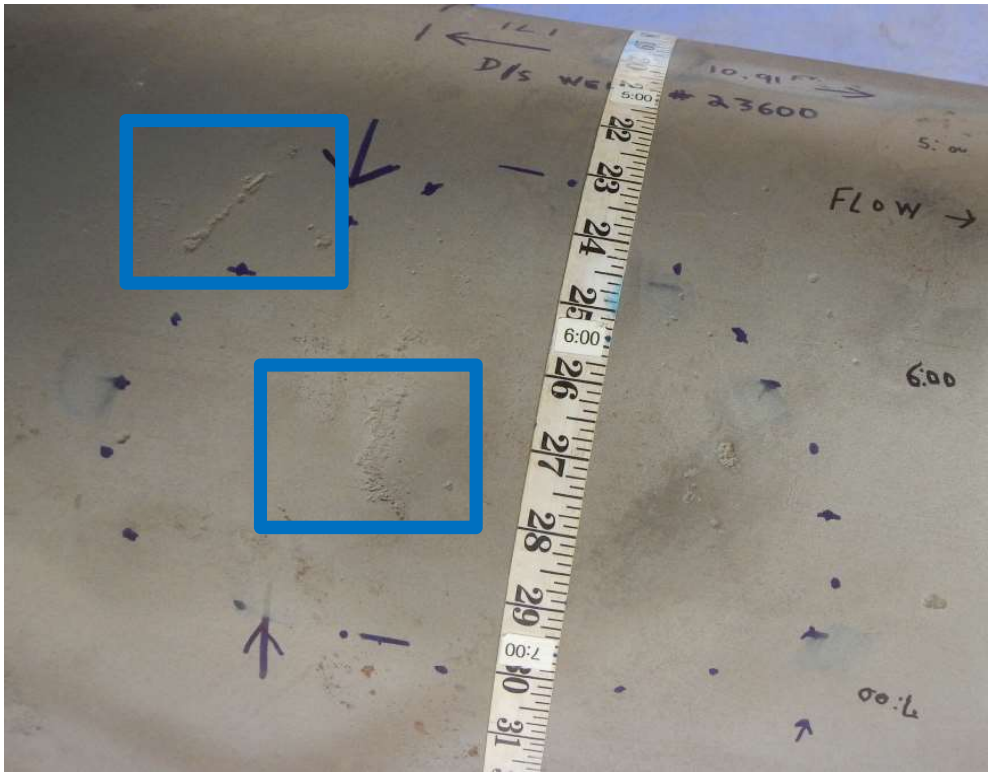


Measurement principle: mechatronic sensor based on electronic angle sensor and lift-off sensor combined with an intelligent MFL measuring system

- Size: 06” – 48“
- High-resolution geometry tool combined with MFL technology
- 100% coverage with mechatronic sensor
- Unaffected by debris, wax or scale
- Compensation of speed excursions and bouncing effects
- Usage of Gyro and SCU possible

WHAT WE ARE OFTEN EXCAVATING





IN-LINE INSPECTION
ADVANCED DENT ASSESSMENT

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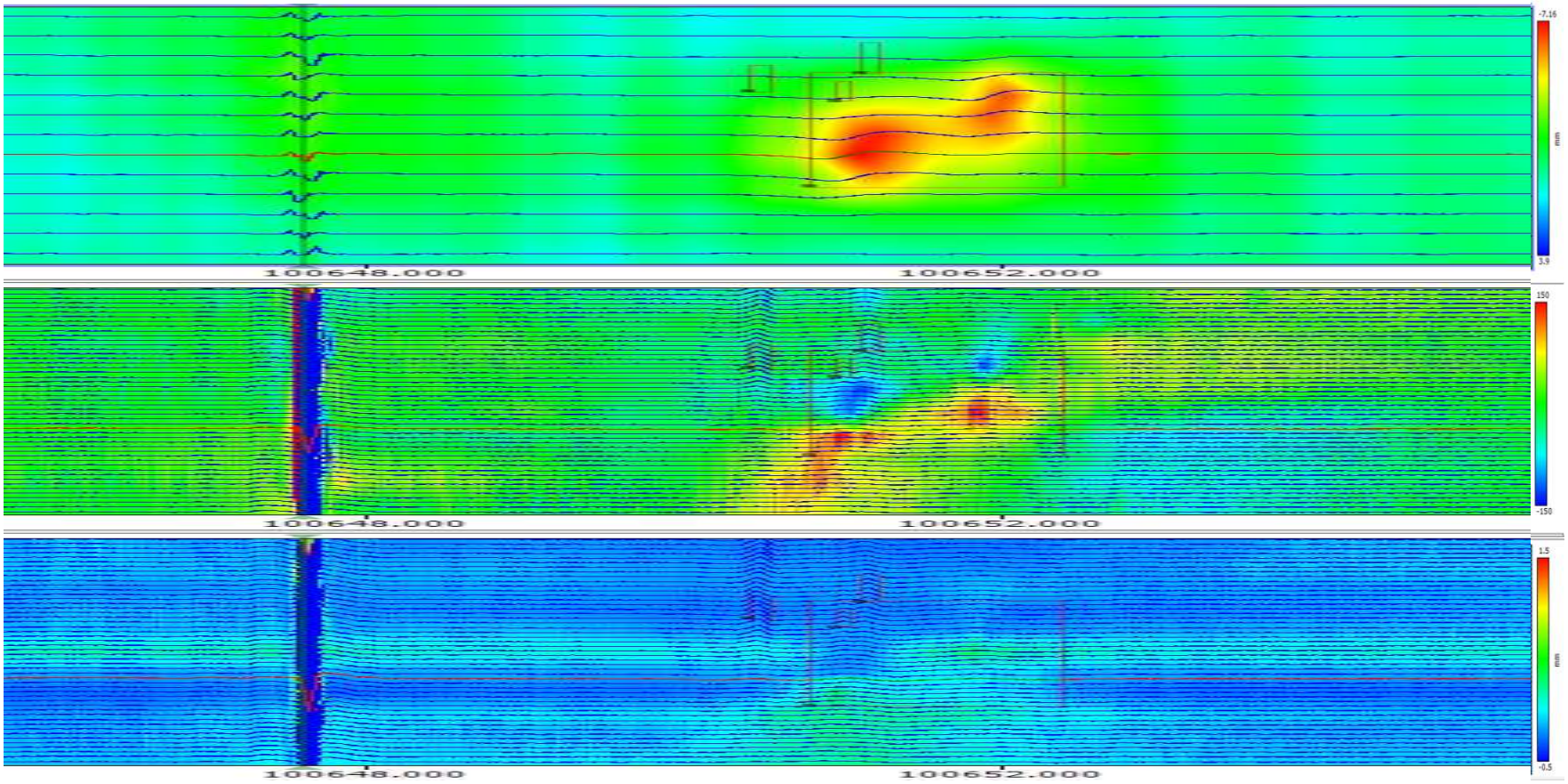

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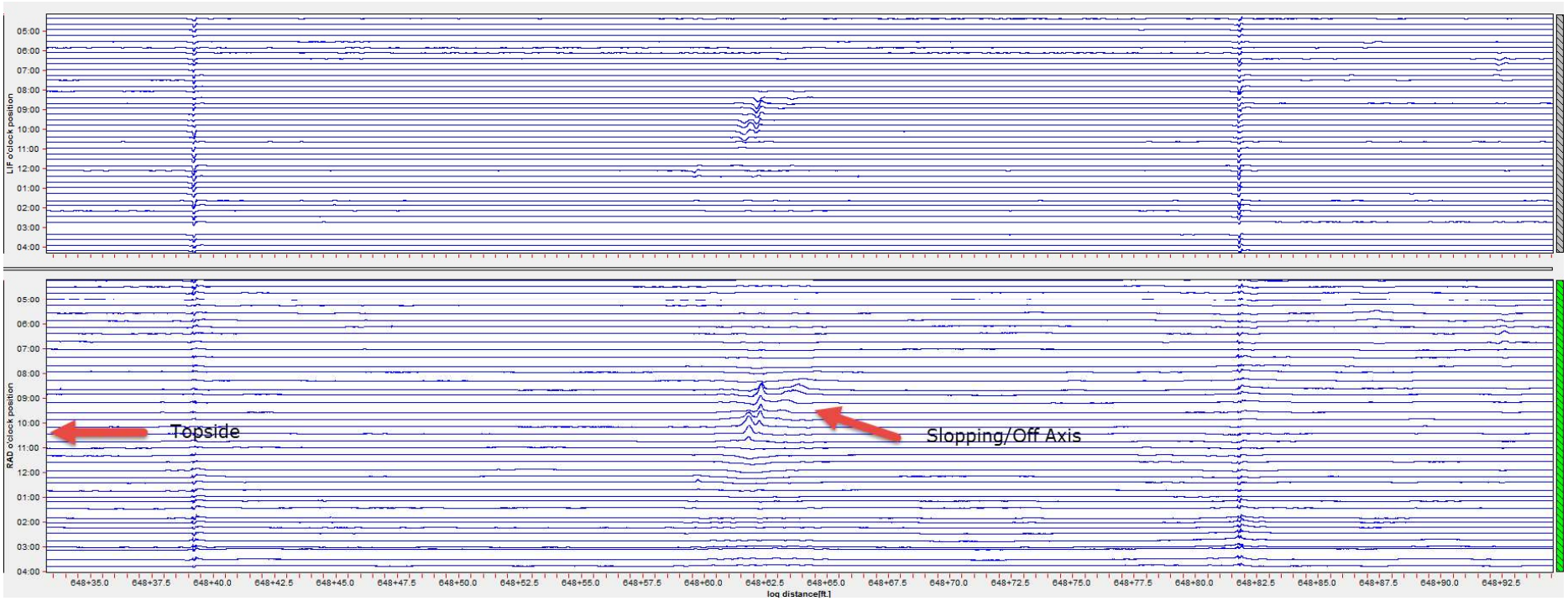
ADVANCED DENT ASSESSMENT



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ADVANCED DENT ASSESSMENT

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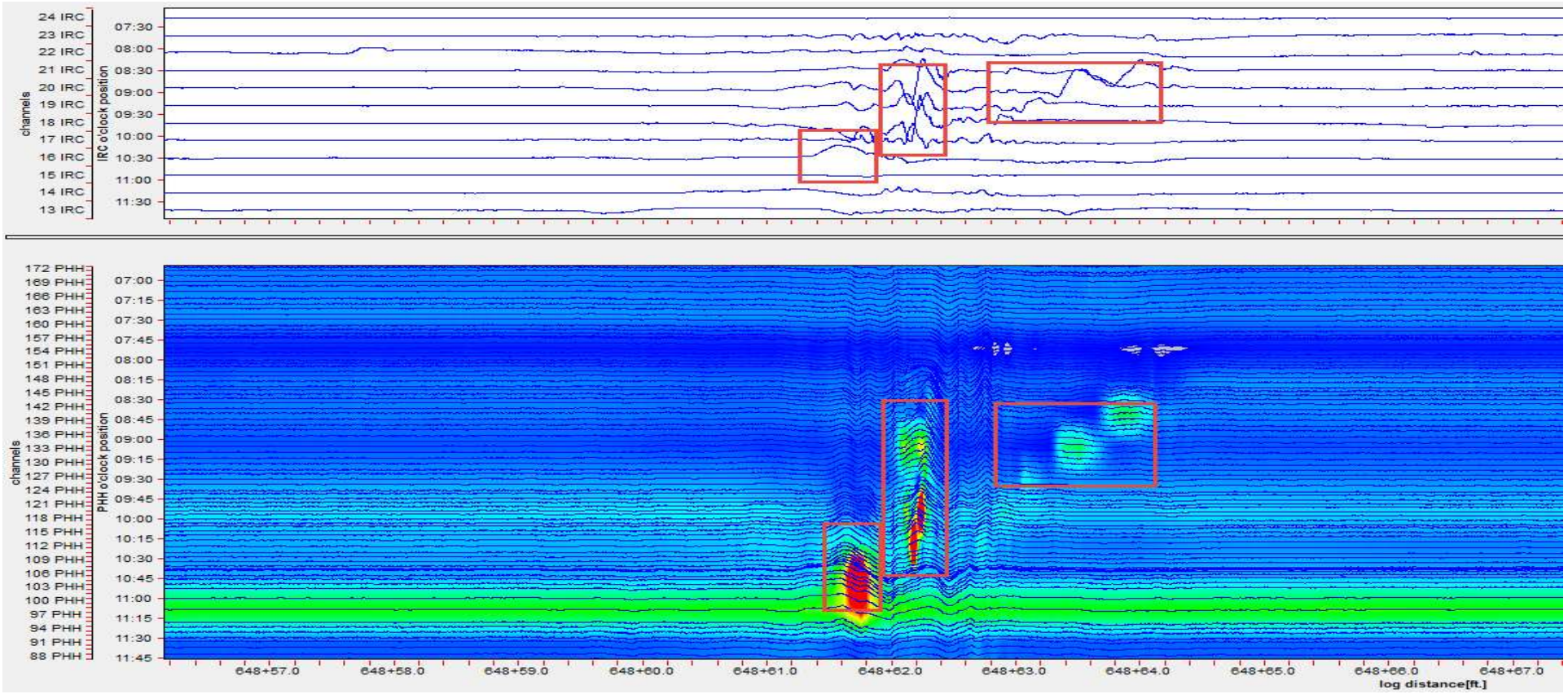

MECHANICAL DAMAGE - GOUGE

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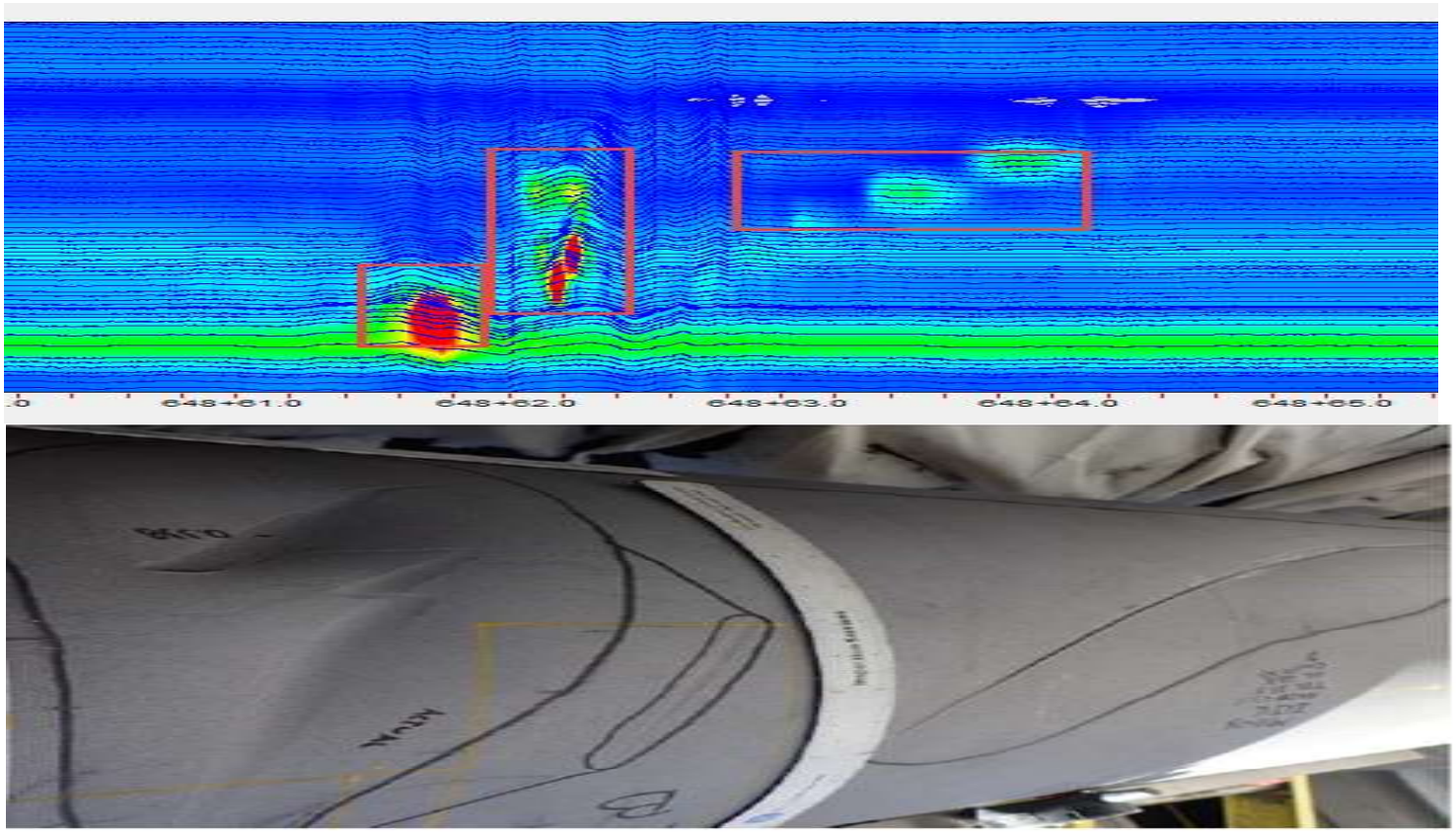
MECHANICAL DAMAGE



CONCLUSION

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Gap

Response to reported features often do not leverage the existing ILI system's full capabilities, data integration opportunities, or advanced analysis techniques.

Integrating ILI data sets with advanced analysis can allow for a better understanding of the severity of dents with interacting threats and establish appropriate response criteria.

Development

- Improved dent assessments and their acceptance.
- Consensus guidance on ECA process and practice.