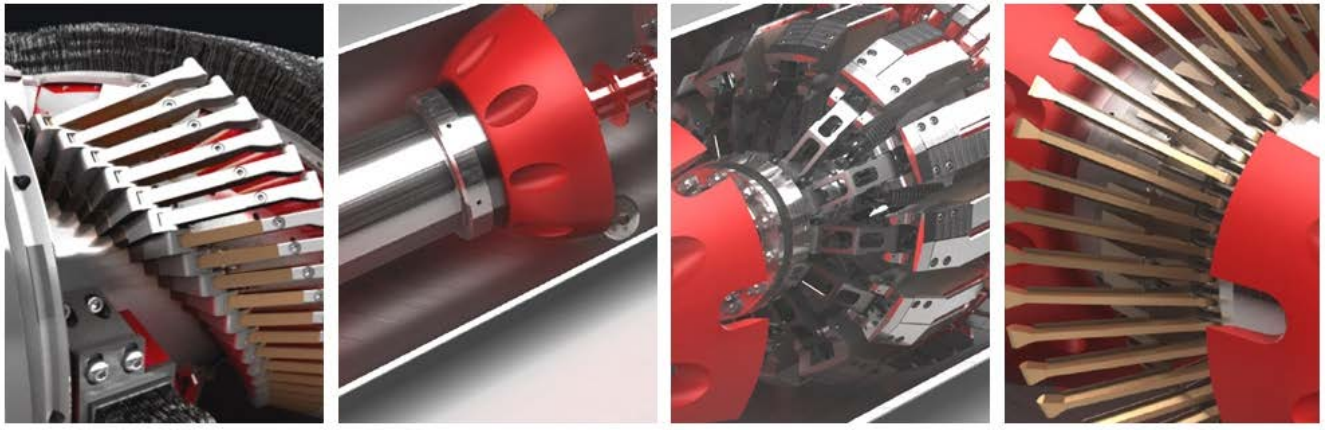


TDW Pipeline Integrity Solutions

Expanding In-line Inspection Capabilities & Applications

Senior Product Manager - Tod Barker

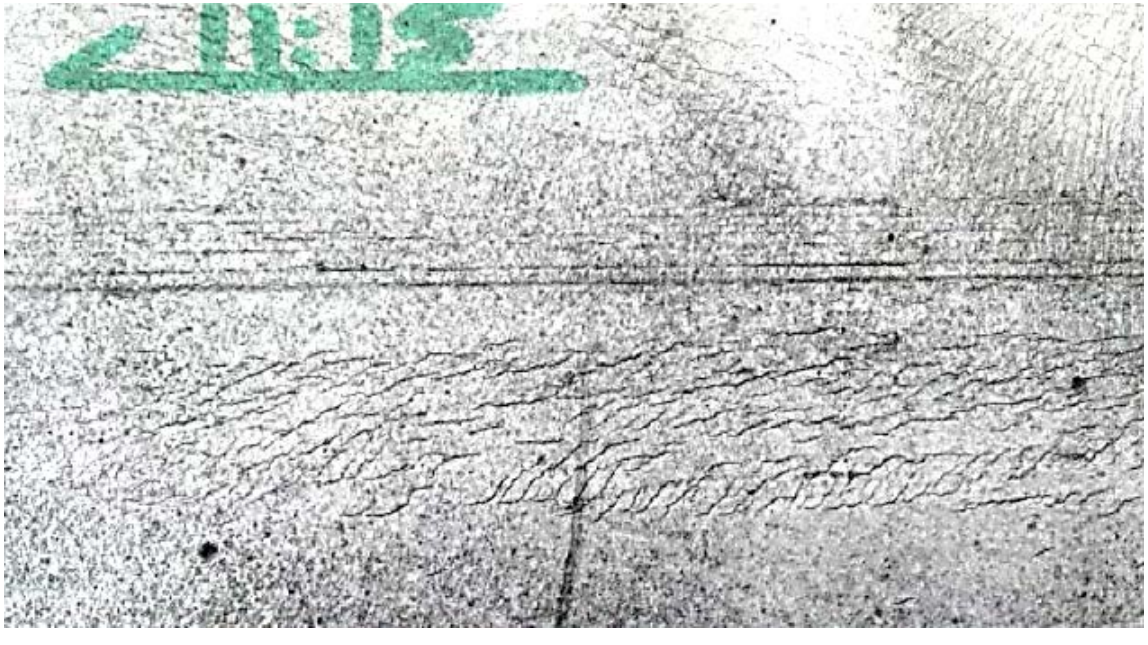
September 11,2018

Contents

- **10 Inch EMAT**
- **In-line Inspection of Hydrogen Pipelines**
- **Advances in Data Analysis – Integrating Multiple Technologies**

10 Inch EMAT Development

SCC Discovered by Pipeline Operator



EMAT Development

Natural gas pipeline operator with known SCC partnered with **TD Williamson** in the development of a **10” EMAT** tool

- First 10” EMAT inspection April 2016

10” EMAT Development

Development Challenges:

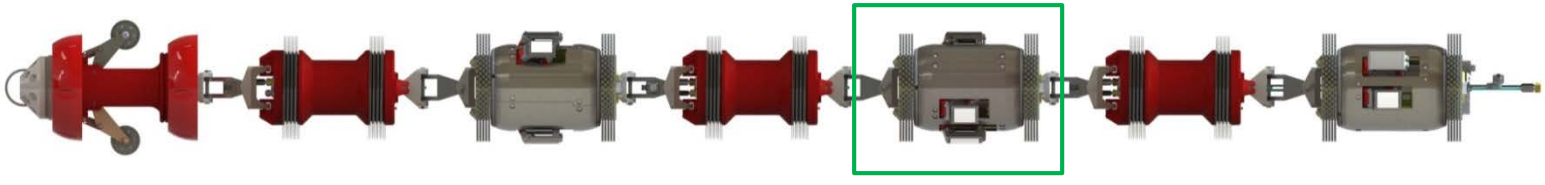
- Accommodating large sensors
- Dealing with a power hungry technology
- Sensor durability

Sensor Geometry Limitations

- The technology of EMAT requires large sensors compared to MFL technology.

- Sensor size does not scale with tool size.

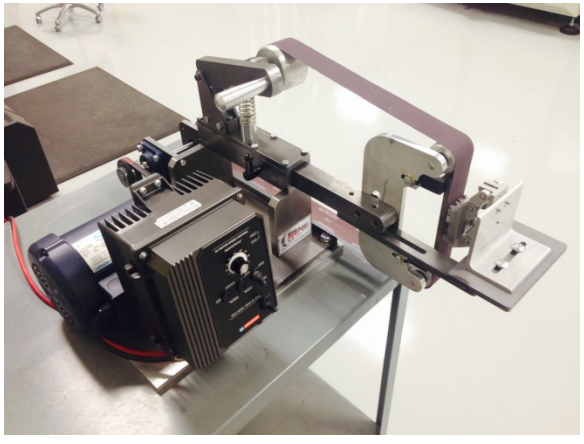
Finding Sensor Real Estate



- Optimized magnet arrangements
- Protected magnet design

Sensor Robustness

- In depth materials evaluation
- > 25X Improvement in wear



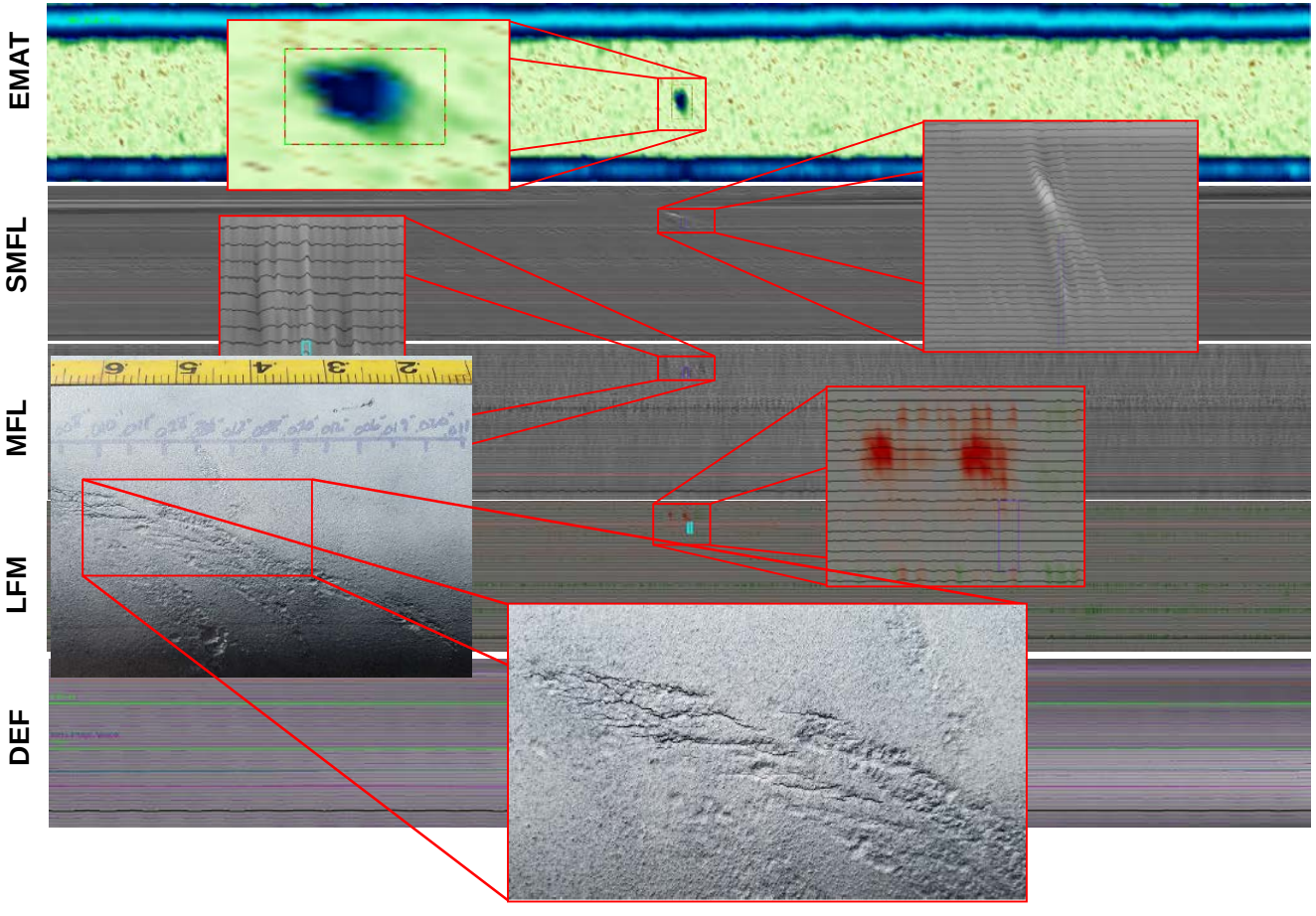
Comparative Test

Pipe Simulation

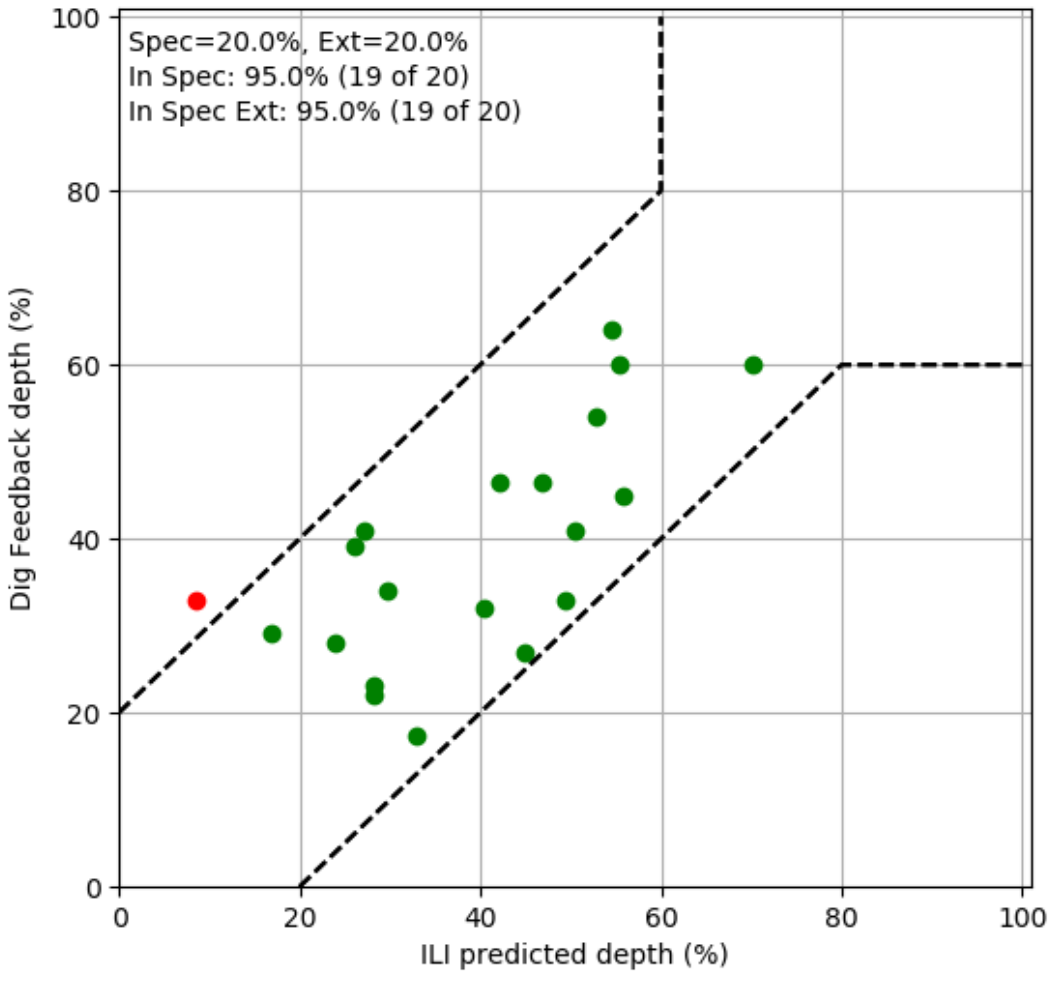
Electronics Improvements

- ~50% reduction in power consumption
- Noise reduction
- Reduced system voltage (higher efficiency)

Stress Corrosion Cracking (SCC)



Results: Unity Plot



10 EMAT Highlights Summary

- Robust Sensors
- More power efficient
- Higher quality data
- Longer run capability

In-line Inspection of Hydrogen Pipelines

Growing Demand for Hydrogen

- U.S. hydrogen demand (2008 – 14)
  - Hydrogen supplied to refineries increased 135%

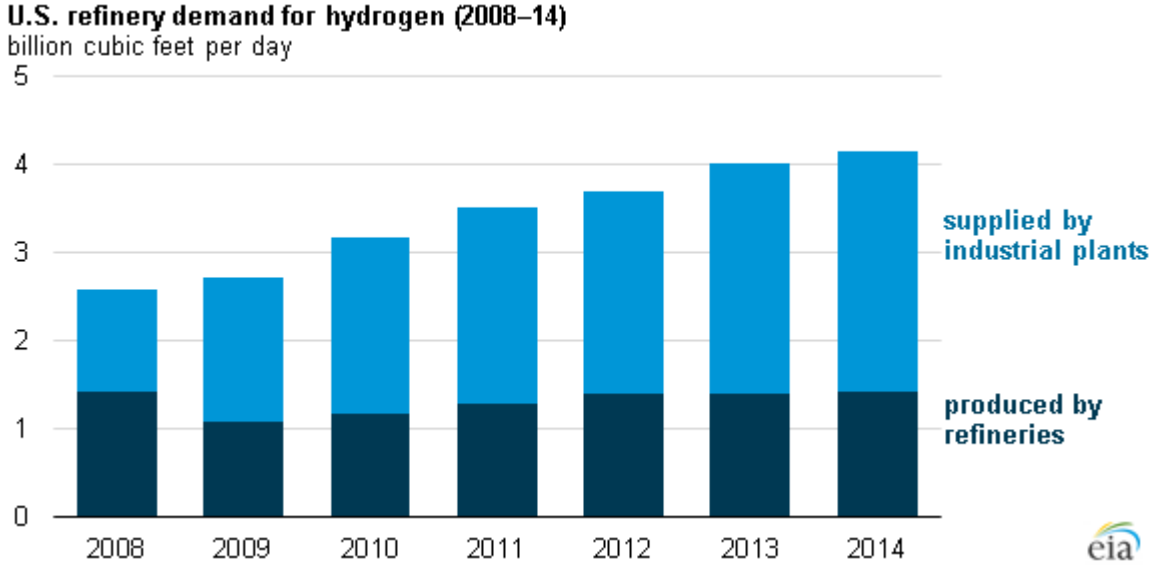


Image from https://www.eia.gov/todayinenergy/detail.php?id=24612

Hydrogen

- Smallest, lightest and most abundant element
- Predominately used for refining diesel and gasoline
    - Fertilizer, food processing and transportation
- Extremely flammable

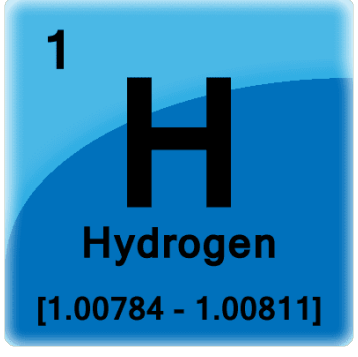


Image from https://www.twilio.com/blog/2016/06/air-products-uses-twilio-sms-to-prevent-on-site-incidents.html

Need for In-line Inspection (ILI):

- Hydrogen is flammable
  - DOT 192 regulations (ASME B31.12)
  - ILI in Hydrogen was preferred option

Image from https://pgjonline.com/2016/10/20/inside-iraq-stringent-security-required-for-first-inline-inspection/

Hydrogen Pipeline operator and TDW Partnership

- TDW’s R&D capabilities
- Technology selection
- Tool capability evaluation

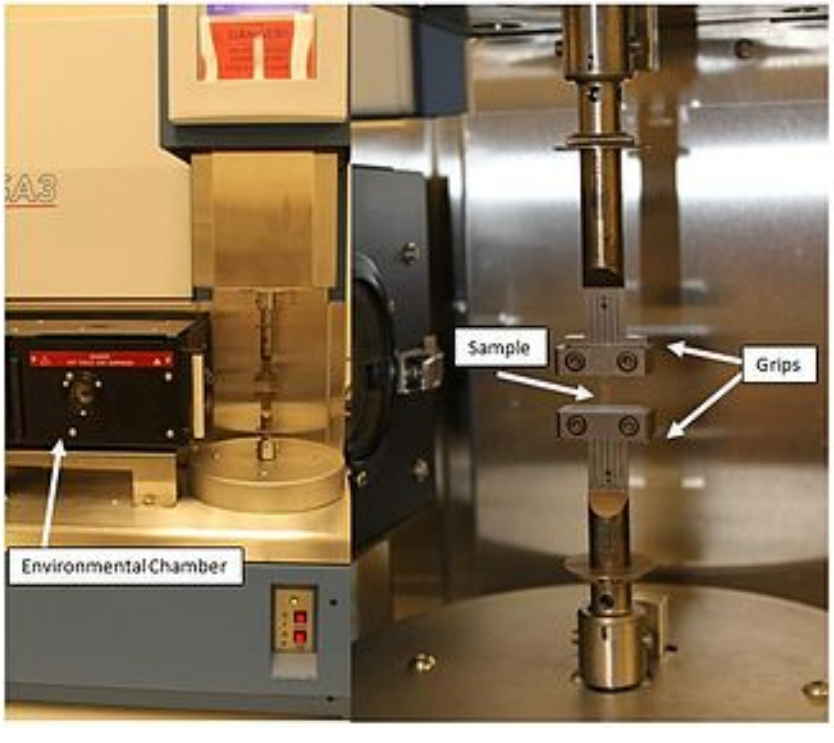
T.D. Williamson, Inc.

Evaluations and Testing

- High strength steels
- Magnets
- Brushes
- Seals

Image from https://www.creativesafetysupply.com/glossary/pdca-cycle/

H2 Saturation Testing

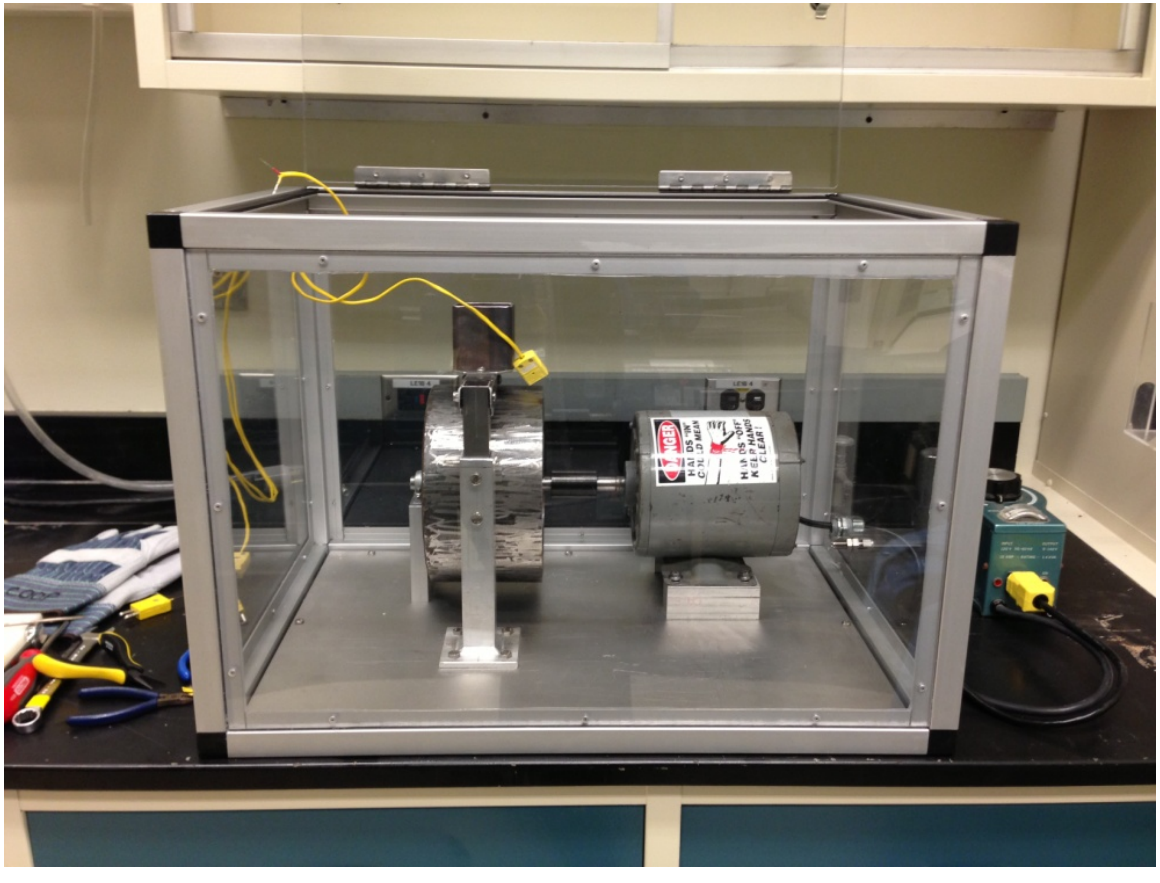


Rare Earth Magnet in H2 Testing

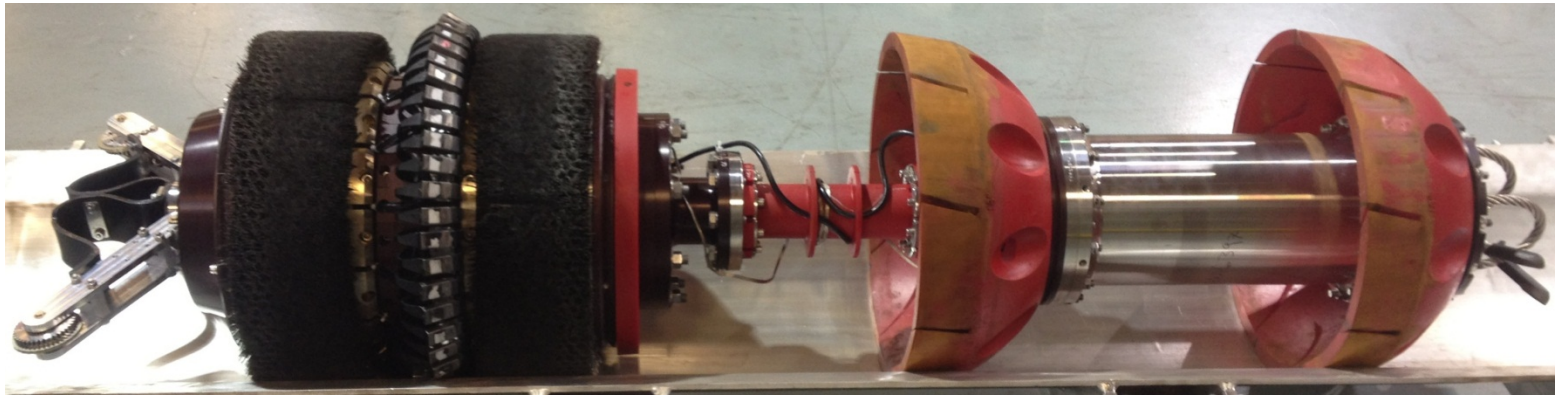
Before

After

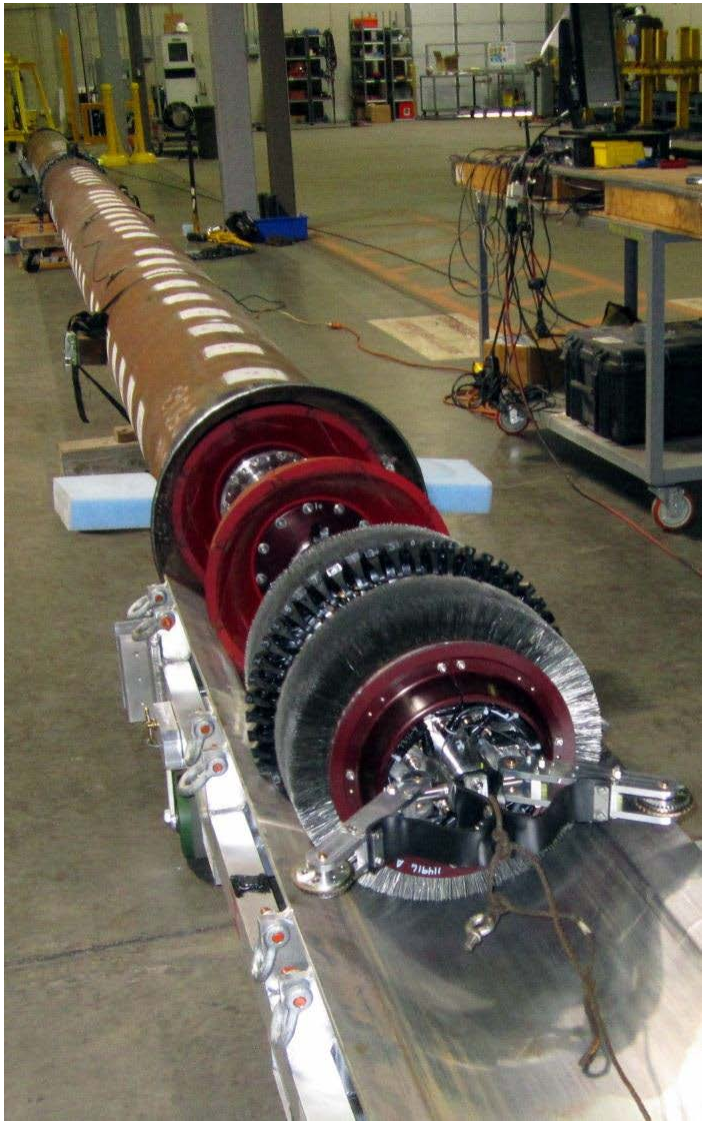
Wear Testing



Tool Design



Tool Testing



Success

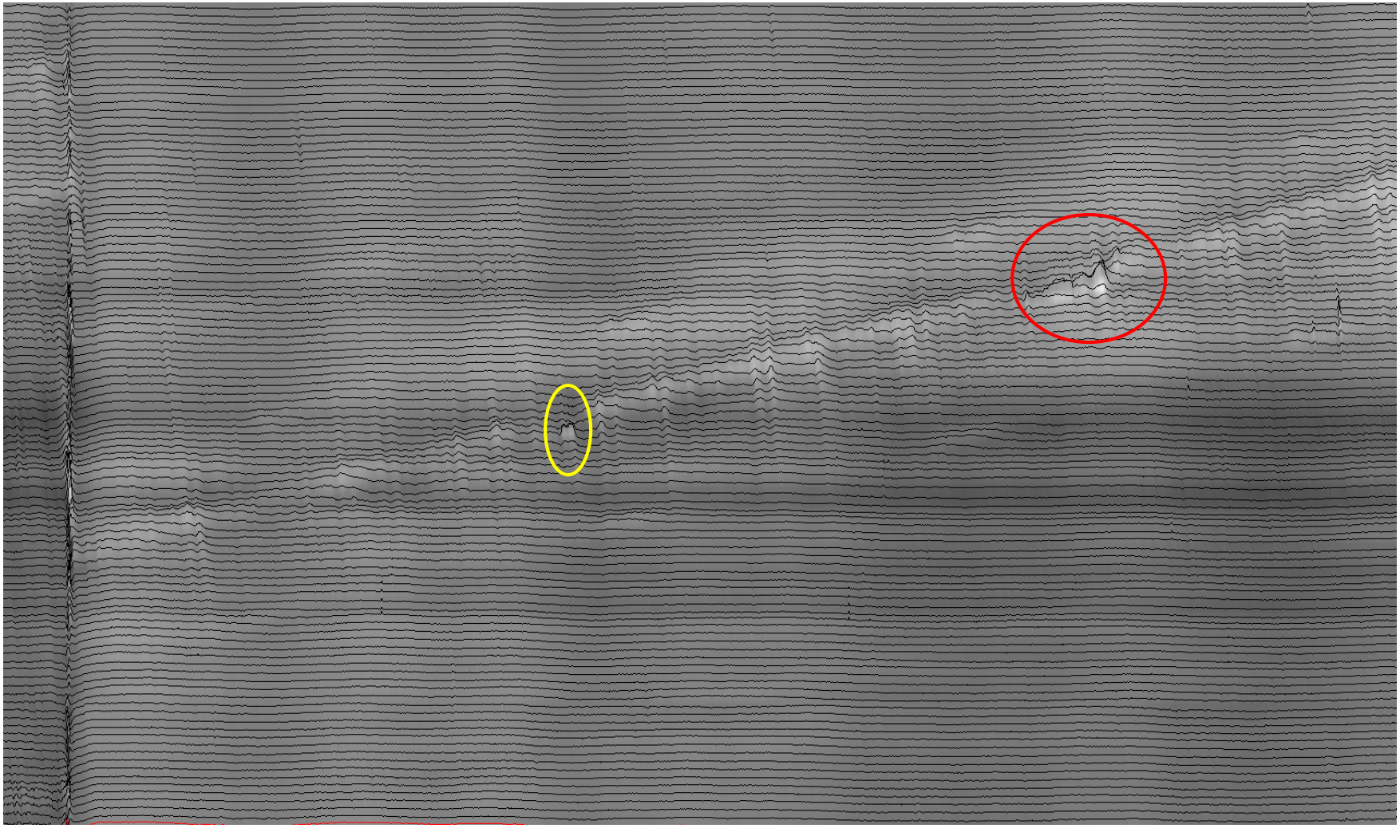
- 61 miles inspection of H2
- 100% data collection

Hydrogen ILI Summary

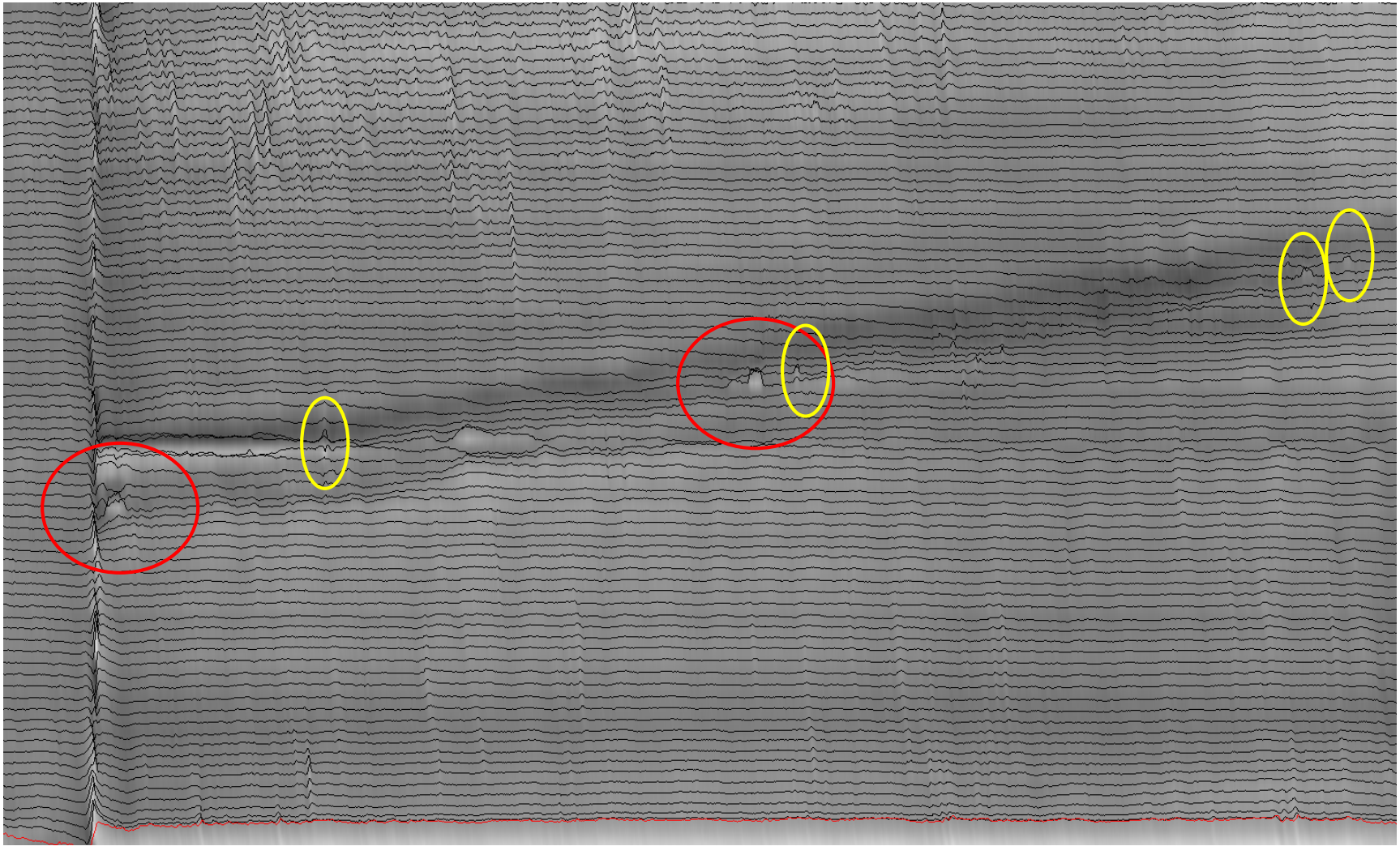
- Partnership between hydrogen pipeline operator and TDW was key.
- Required new tool design
- In-line inspection of Hydrogen is possible

Advances in data analysis in consideration of integrating multiple technologies

Axial Planar Improvements



Axial Planar Improvements



Advances in Data Analysis Summary

- Enhancements to processes and dig results feedback improved Axial Planar identification.