Production Asset Integrity and Corrosion Management: Best Practices and Innovations

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HIC Damage Assessment Techniques

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Agenda

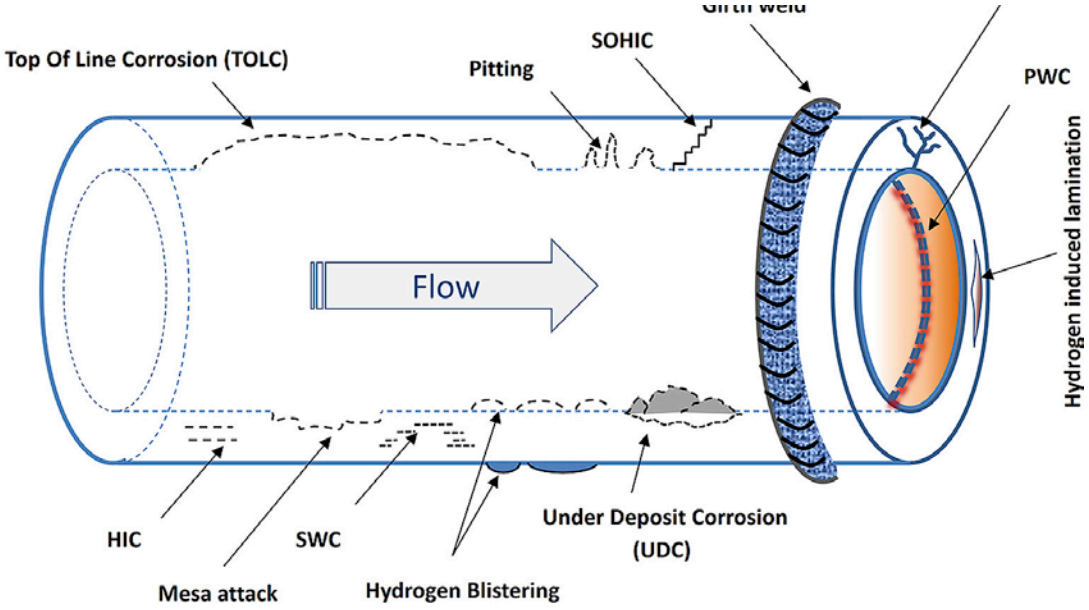
- Addressing challenges
- Conventional & non-conventional approach
- Results & Conclusion
- Q&A

Advanced NDT Techniques

- AUT (Automated UT): Fast, repeatable scanning of large surfaces.
- PAUT (Phased Array UT): Real-time imaging with electronic focusing.
- TOFD (Time-of-Flight Diffraction): Accurate sizing using diffracted signals.
- TFM (Total Focusing Method): Superior imaging using full matrix data.
- PCI (Phase Cohrenceve Imaging): High SNR imaging.

HIC is a damage mechanism occurs by the formation of cracking in metals or alloy caused by the absorption of hydrogen which can severely affect material integrity

Hydrogen Induced Cracking

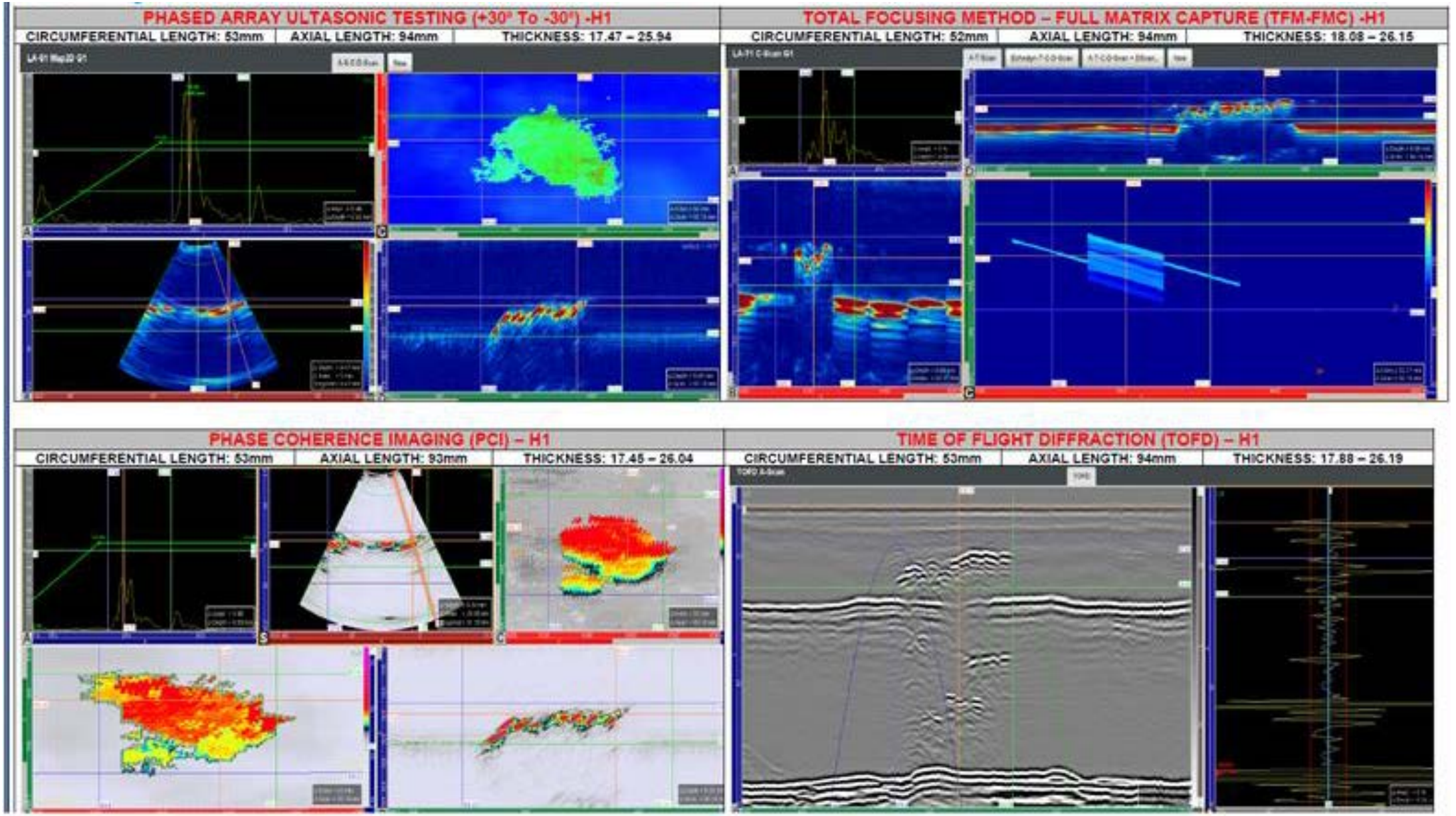


Causes of HIC

Occur when atomic hydrogen penetrate or diffuses into the microstructure

This process can be exacerbated by environmental factor such as moisture and temperature

Advanced Inspection Techniques



Comparative Summary of NDT Techniques

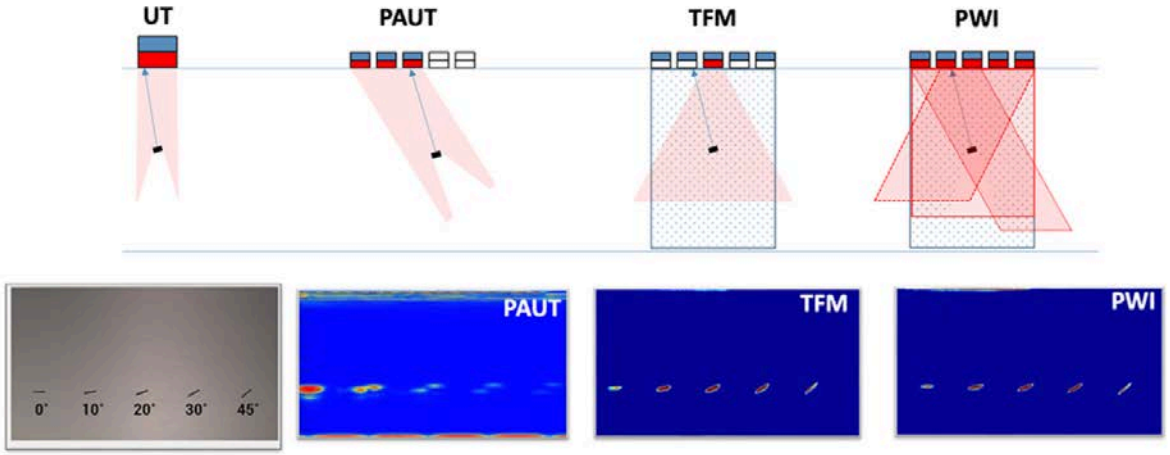


Figure 4. Comparison of different UT techniques. Aluminum block with artificial notches created at different angles (left, bottom), and the corresponding B-scan images at the right.

Each method complements others for robust HIC assessment.

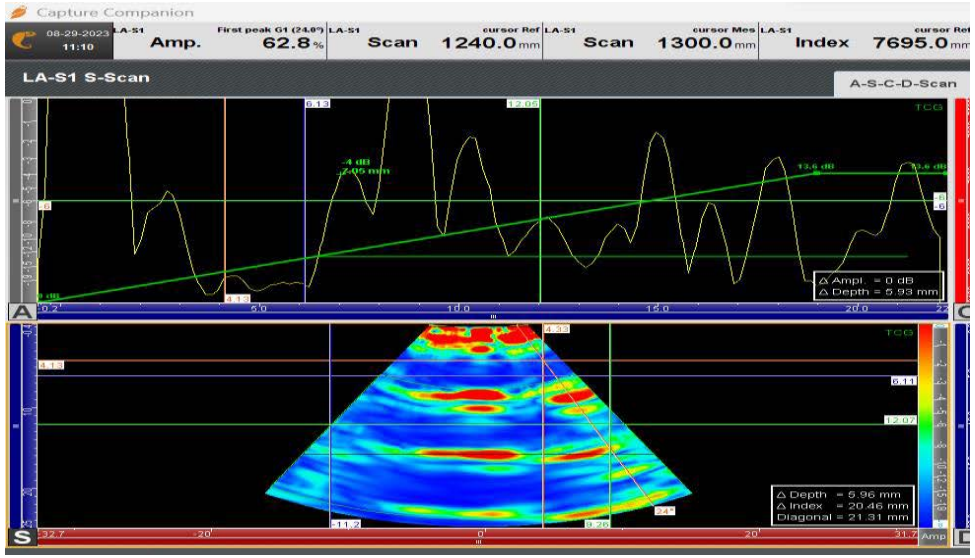
- **AUT** – Fast scanning, limited resolution.
- **PAUT** – Good resolution, flexible beam control, moderate speed.
- **TOFD** – Highly accurate sizing, limited to mid/deep cracks.
- **TFM** – Highest image quality, slow acquisition.
- **PCI** – Very high SNR, experimental stage for HIC.

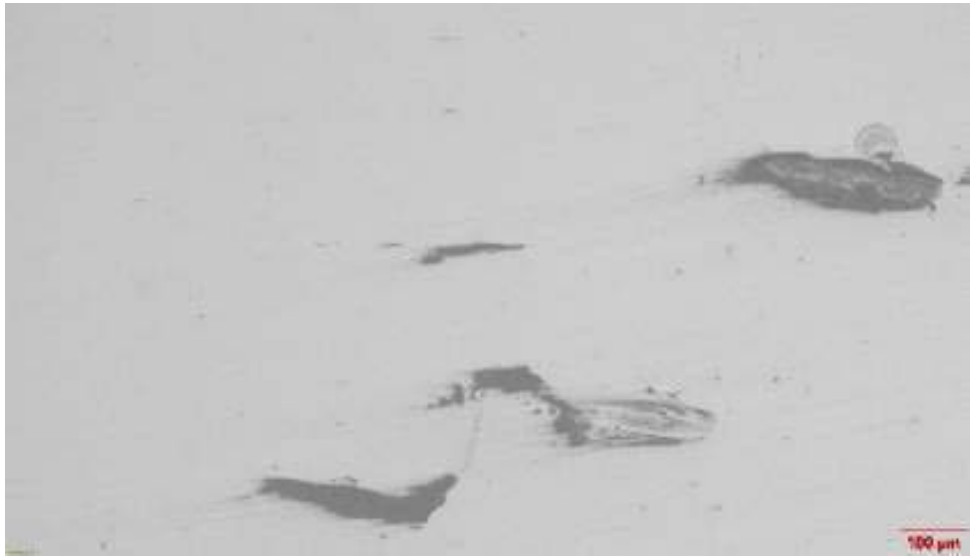
Phased Array TFM Benefits

- **Enhanced Precision:** TFM delivers superior clarity, resolution, and defect characterization compared to standard PAUT.
- **True Depth Imaging:** Provides easier-to-interpret "true depth" images instead of waveforms.
- **Defect Detection:** Identifies and characterizes HIC, SCC, and SOHIC damage effectively.
- **FFS Compliance:** Supports API-579-1 Level 3 Fitness-for-Service assessments.

Results & impact

- **Screening Success:** 15+ HIC-affected equipment (DRA-4 & DRA-5) screened using Phased Array TFM techniques with precise defect characterization.
- **Alignment with FFS Standards:** Results comply with API 579-1 Level 3 FFS requirements.
- **Validated Accuracy:** Destructive testing matches PAUT-TFM findings 100%,proving reliability.
- **Promising Technique:** Establishes PAUT-TFM as a key tool for HIC damage assessment in critical environments.





Destructive testing results for severely affected equipment exactly matches the PAUT-TFM findings and 100 % accurate which is very promising technique for HIC damage assessment.

Thank you!