NDE Solutions

Imaging SCC with Acoustic Techniques

Marcel Remillieux, TJ Ulrich, Pierre-Yves Le Bas

Context

- 2014 meeting at EPRI resulted in a 5 year plan to:
  - Provide point inspection on SCC → once an area of concern has been identified visually (e.g., camera), can we interrogate this specific area?
  - The interrogation technique should be able to quantify penetration depth + orientation of the SCC and indicate if through-thickness penetration is occurring.

Time Table

- 2014
- 2015

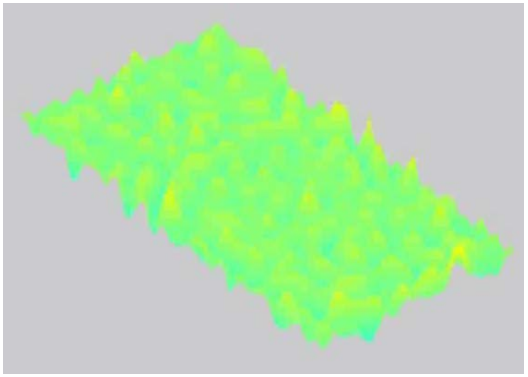
  - **Feasibility:** Can the proposed technique be used for SCC imaging?

- 2016
- 2017
- 2018

  - **Deployability:** Integration in a tool for use in tight/confined spaces?
  - **Understanding the Physics**: What happens when acoustic waves interact with SCC?

Proposed Approach

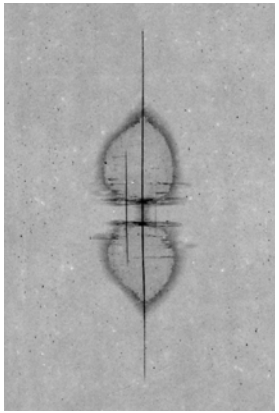
- Time reversal (TR) acoustics is used to focus energy onto a specific area and inspect this area.



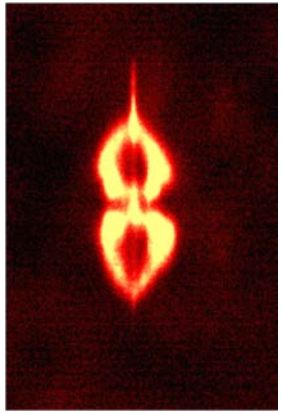
Previous Work – Orientation

- TR can focus acoustic energy independently in different directions:

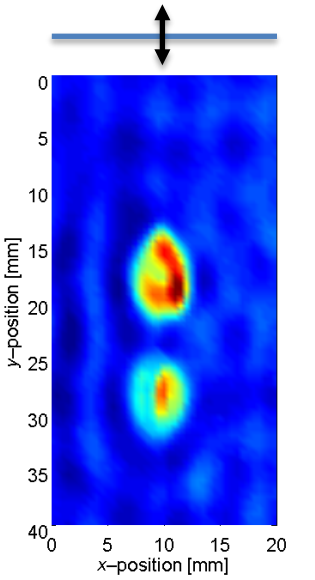
x-ray

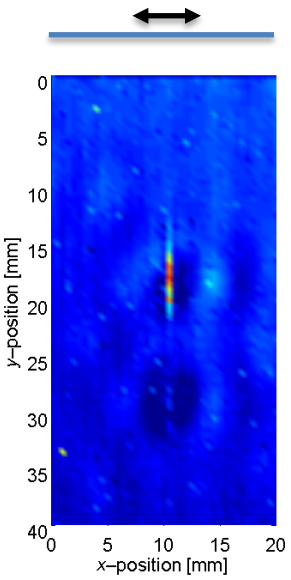


Vibro-thermo



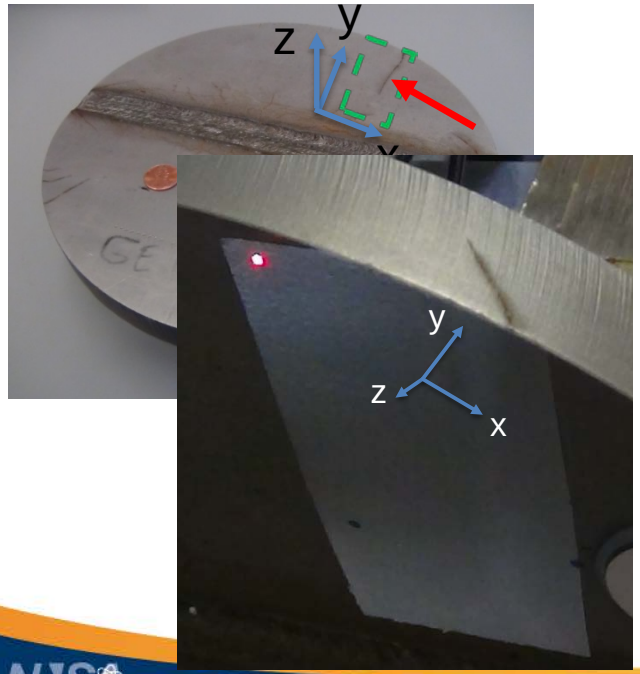
TR

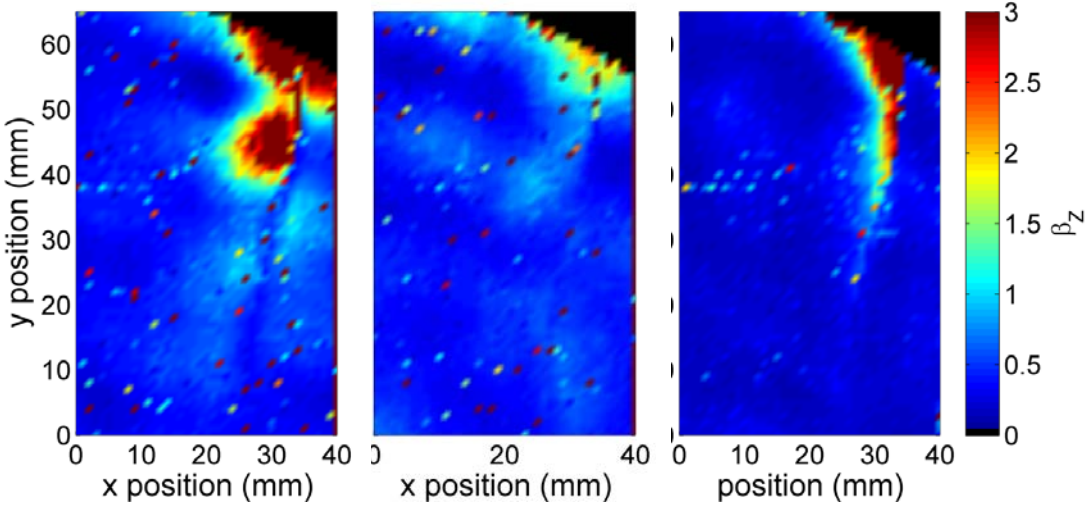




Previous Work – Orientation

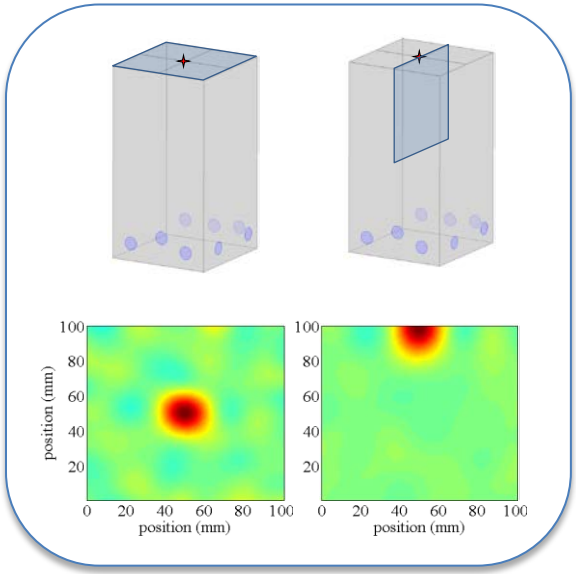
- SCC – Sample 1

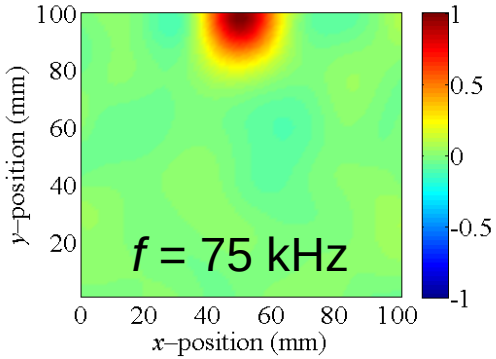


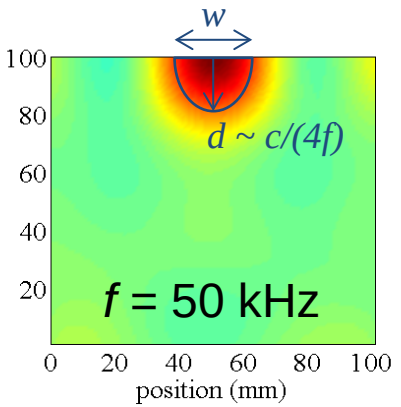


Penetration Depth

- Energy is focused on sample surface but also penetrates the sample, with a depth proportional to frequency.

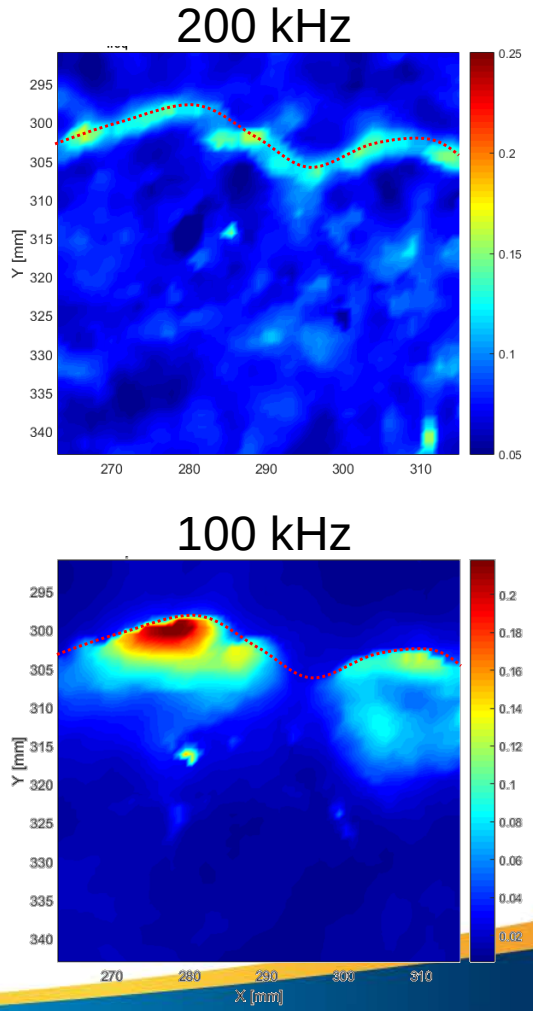




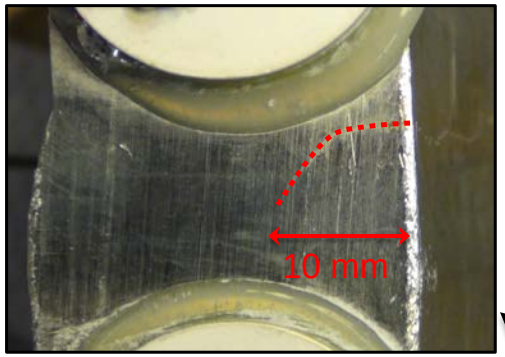


Penetration Depth

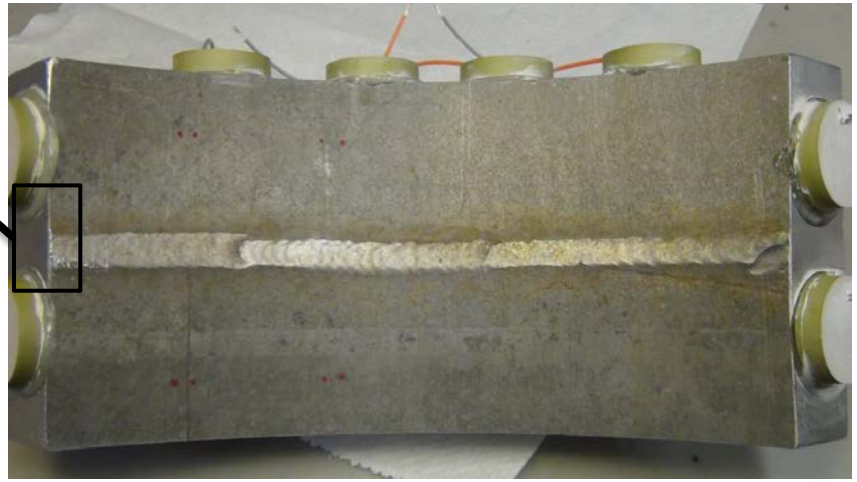
- SCC – Sample 2



Penetration Depth



The SCC crack actually goes below the weld line



Focal spot depths:
@100kHz = 9.75 mm
@200kHz = 4.87 mm

Deployability

- Experimental setup for the proof of concept

Steel pipe fitted in a block of sandstone

Sensor: laser head mounted on wheels

Source: transducers on inflatable device

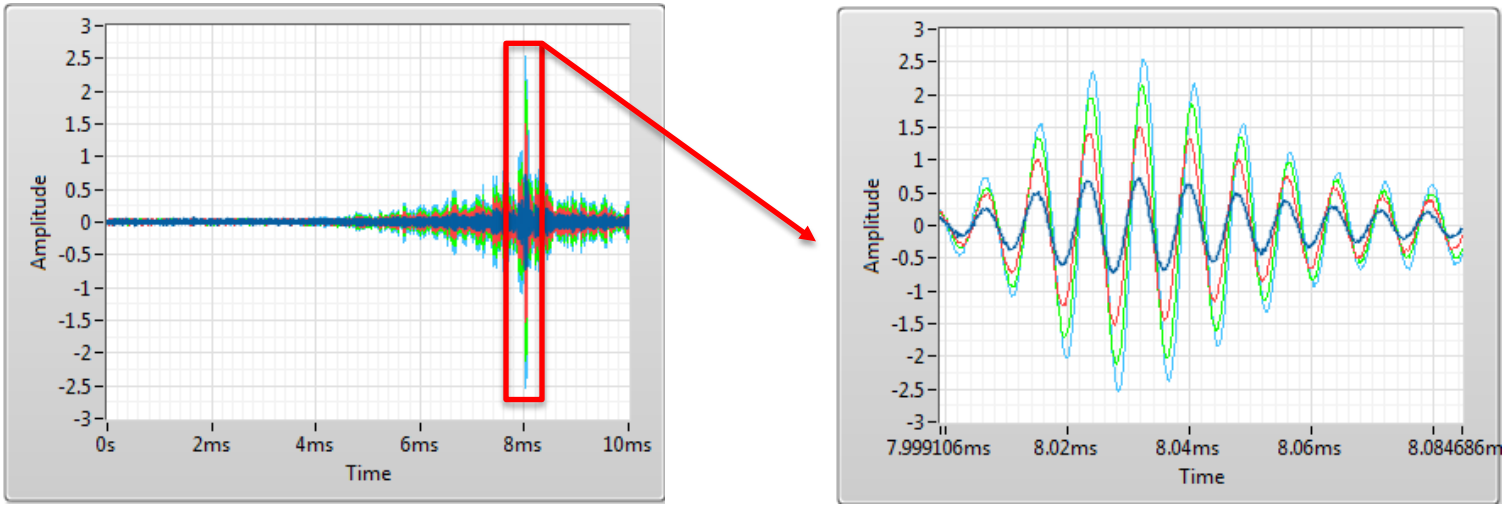
Deployability

Acoustic source inside pipe

Use of laser head inside pipe

Deployability

- Focusing and probing inside a steel pipe fitted in a block of sandstone and consolidated with cement



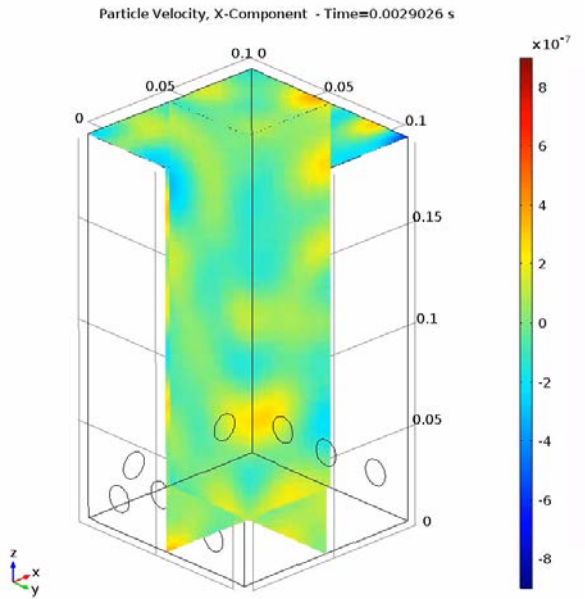
Understanding the Physics

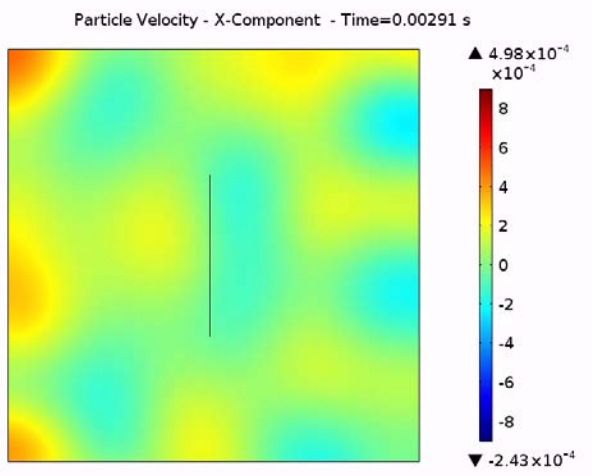
- In experiments, we scan the surface of the sample

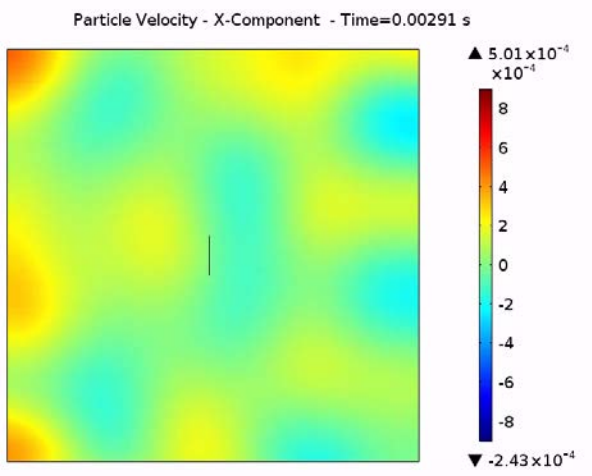
- We need to complement experiments with numerical modeling:
  - Analysis of the results related to what is below the surface
  - Resolution of an inverse problem on the size of the crack

Understanding the Physics

- Finite-element method







Conclusions and Path Forward

- 2014
- 2015

- **Feasibility:** TR can image SCC.

- 2016
- 2017

- **Deployability:** TR can be integrated in a tool for imaging in tight spaces – we need to go beyond proof of concept now.

- 2018

- **Understanding the Physics**: Numerical analysis seems essential at this stage.