

NDE Solutions: Imaging SCC with Acoustic Techniques

Prepared for
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Used Fuel Disposition
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NDE Solutions: ***Imaging SCC with Acoustic Techniques***

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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.

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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?

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Proposed Approach

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

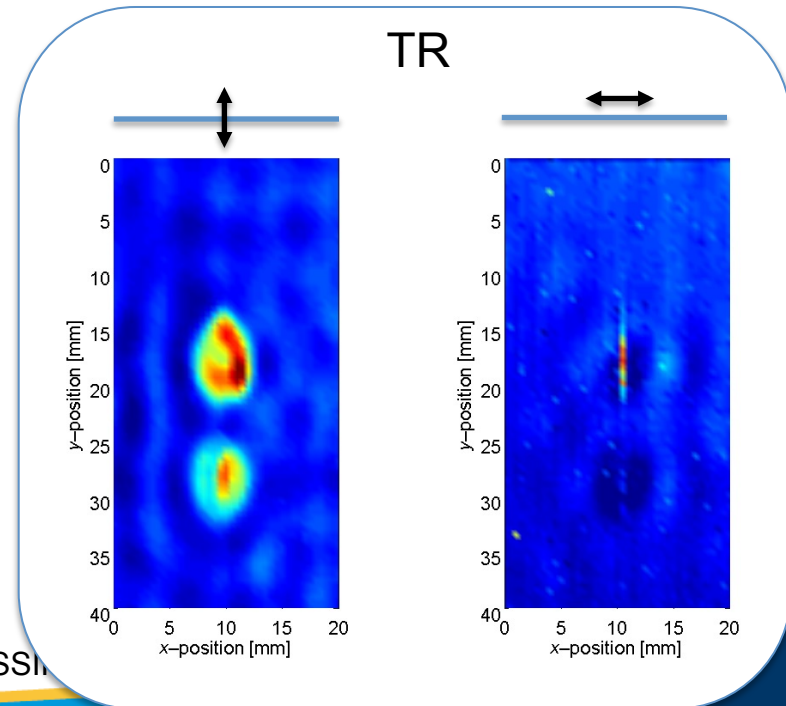
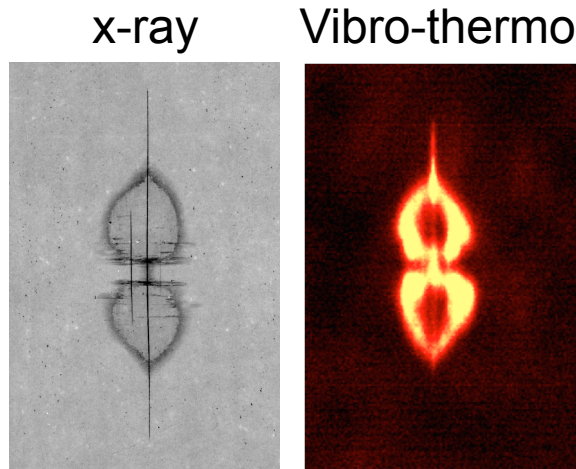


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Previous Work – Orientation

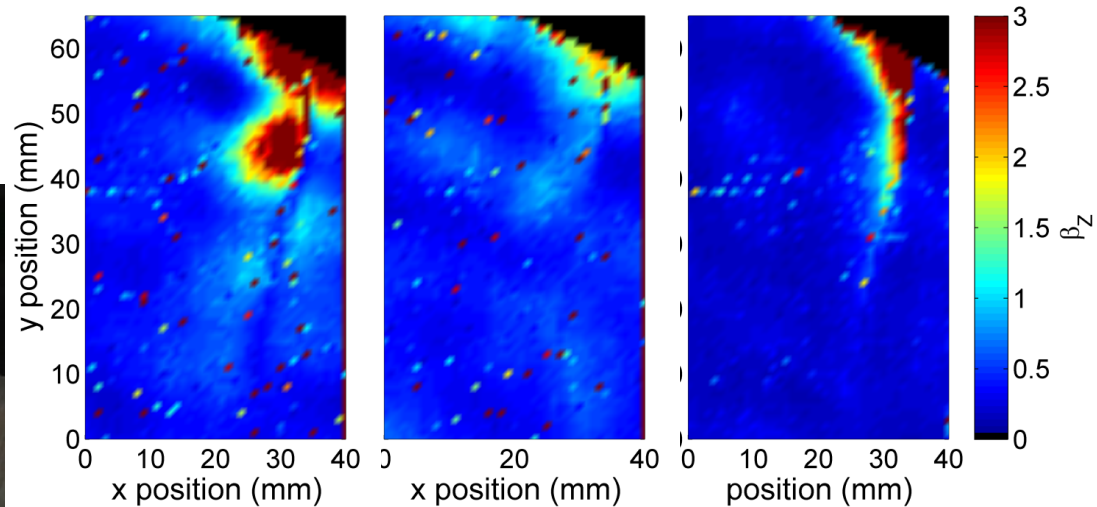
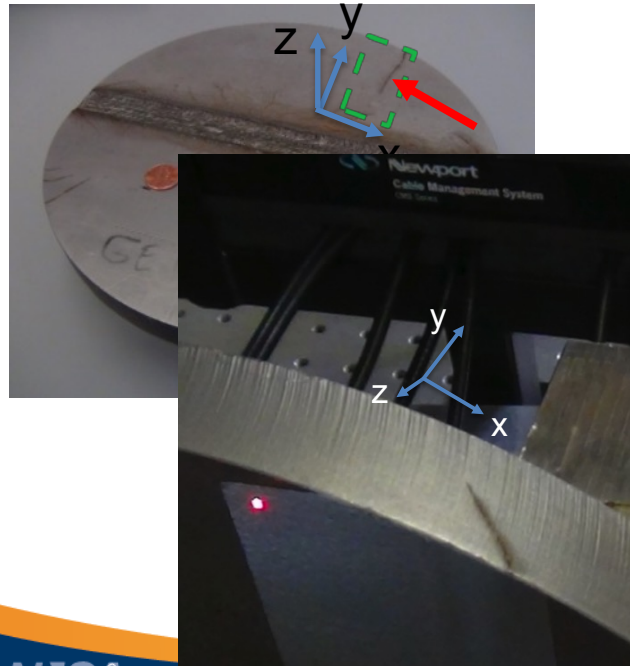
- TR can focus acoustic energy independently in different directions:



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Previous Work – Orientation

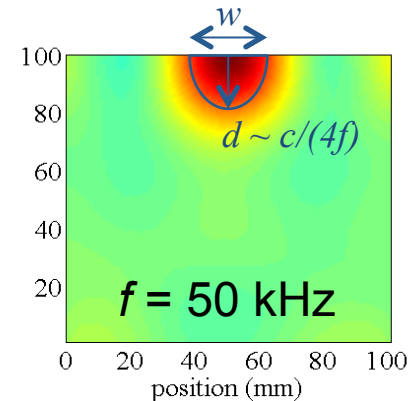
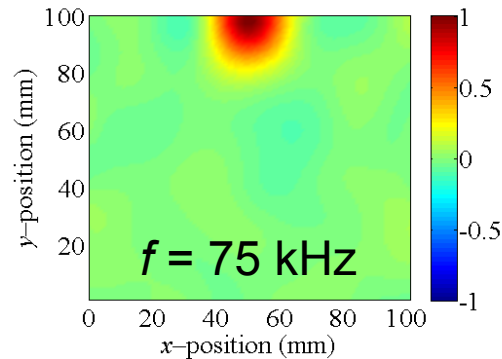
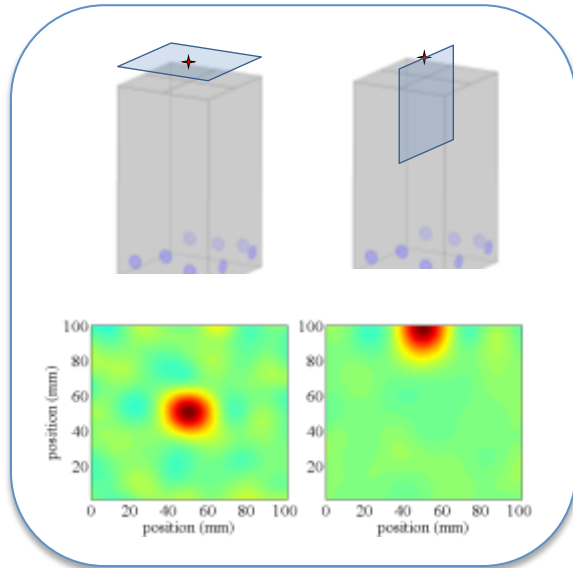
- SCC – Sample 1



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Penetration Depth

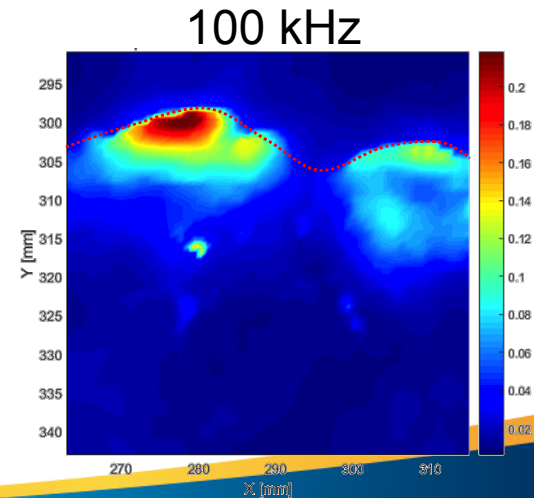
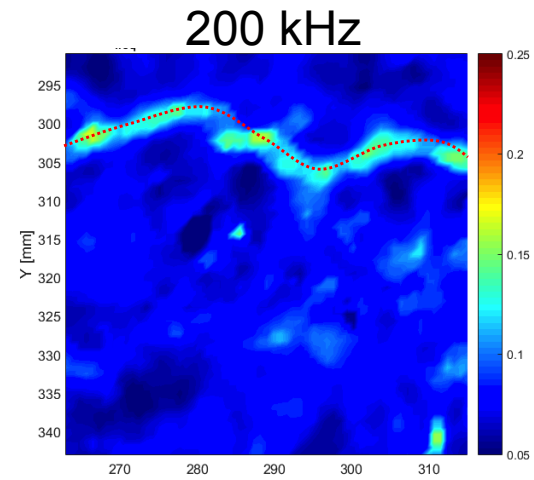
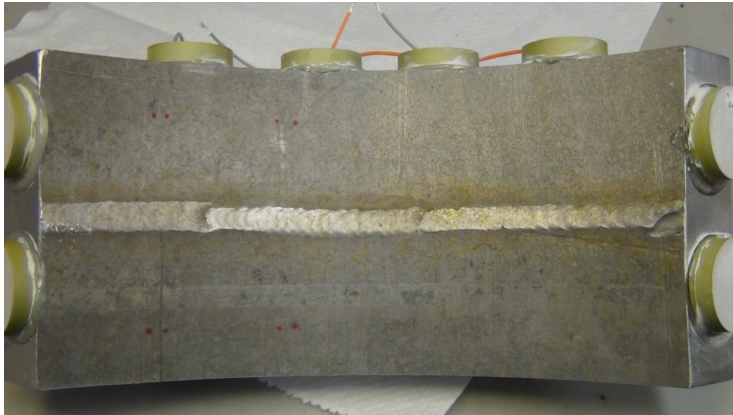
- Energy is focused on sample surface but also penetrates the sample, with a depth proportional to frequency.



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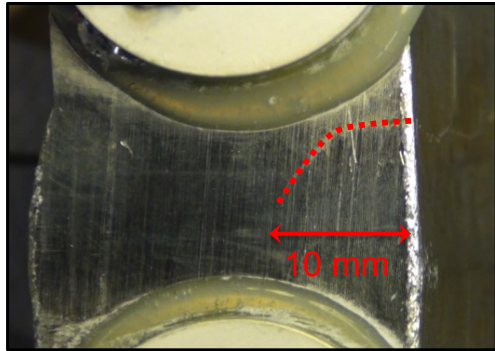
Penetration Depth

- SCC – Sample 2

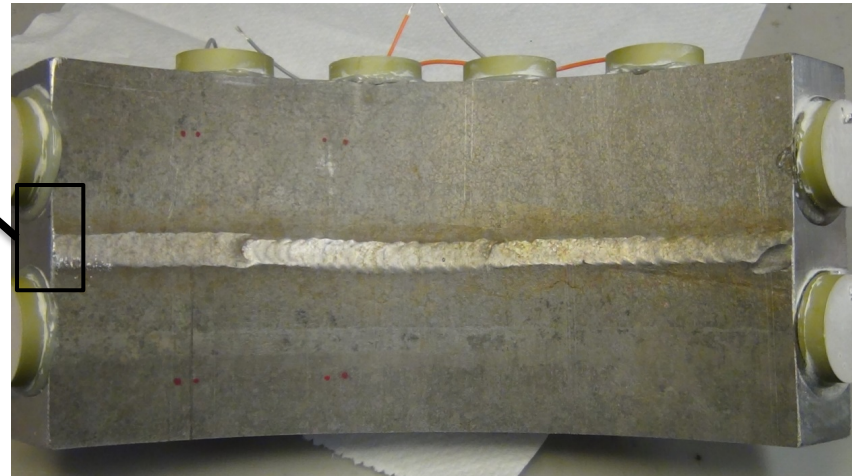


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Penetration Depth



The SCC crack actually goes below the weld line



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

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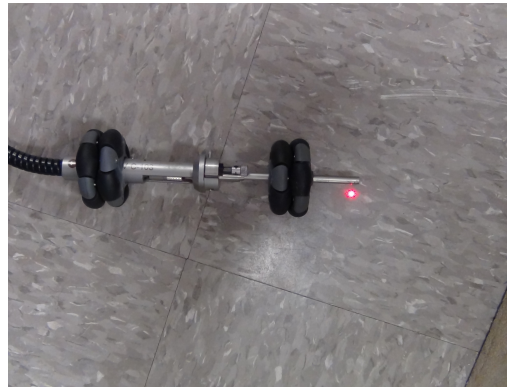
Deployability

- 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



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Deployability

Use of laser head inside pipe

Acoustic source inside pipe

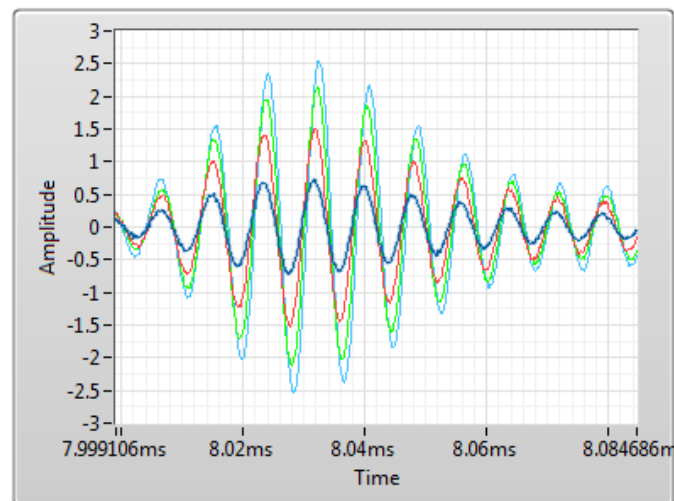
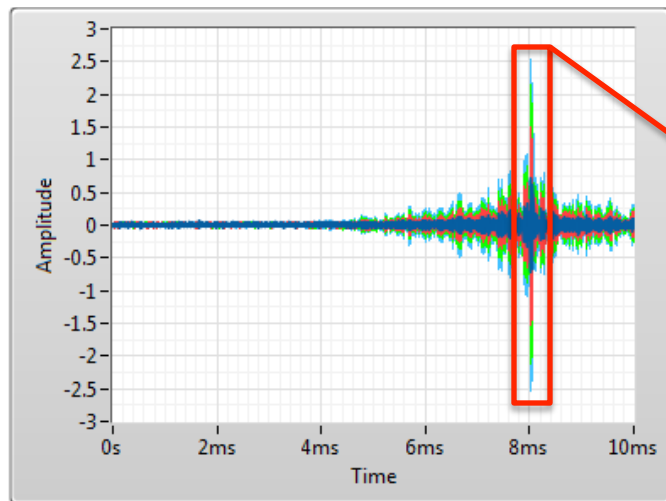


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Deployability

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



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Understanding the Physics

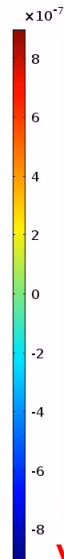
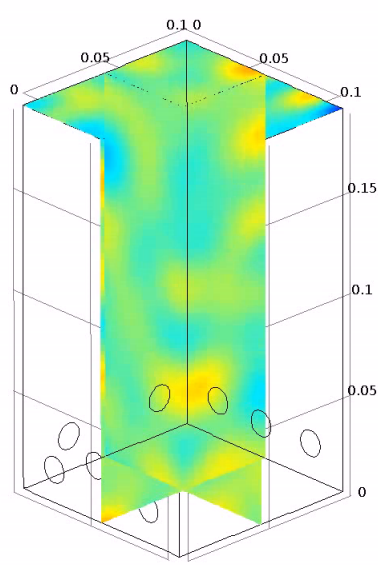
- In experiments, we scan the surface of the sample
- We need to complement experiments with numerical modeling:
 - Analysis of the results related to what is below the surface
 - Resolution of an inverse problem on the size of the crack

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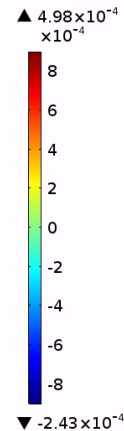
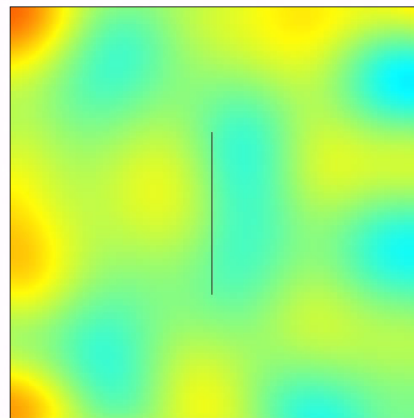
Understanding the Physics

- Finite-element method

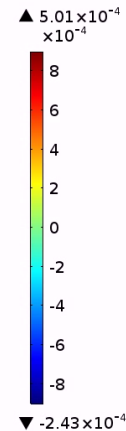
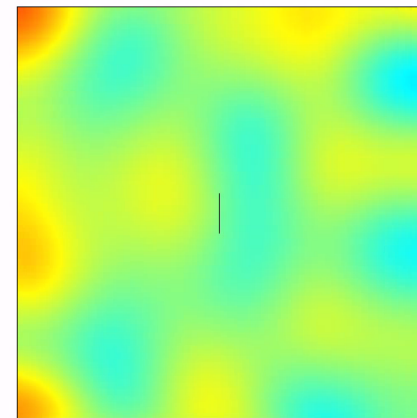
Particle Velocity, X-Component - Time=0.0029026 s



Particle Velocity - X-Component - Time=0.00291 s



Particle Velocity - X-Component - Time=0.00291 s



Videos available from authors

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Conclusions and Path Forward

- 2014 } - **Feasibility:** TR can image SCC.
- 2015 }
- 2016 } - **Deployability:** TR can be integrated in a tool for imaging in tight spaces – we need to go beyond proof of concept now.
- 2017 }
- 2018 } - **Understanding the Physics:** Numerical analysis seems essential at this stage.

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