

“Piping Hot” Ultrasonic thickness monitoring at high temperatures (up to 600°C)

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Outline

- **An Industrial need**
- **“Acoustic Cable” waveguide for thickness gauging**
- **Lab and Field results**
- **Commercialization**
- **Future work**

Erosion/Corrosion monitoring in the Oil & Gas industry

HSE: ~20% of leaks due to erosion/corrosion



Current practice

- 200k-1M testpoints per plant
- Manual UT inspection at shut downs
- Poor repeatability + reliability
- Infrequent measurements
- Costs of access > than inspection cost



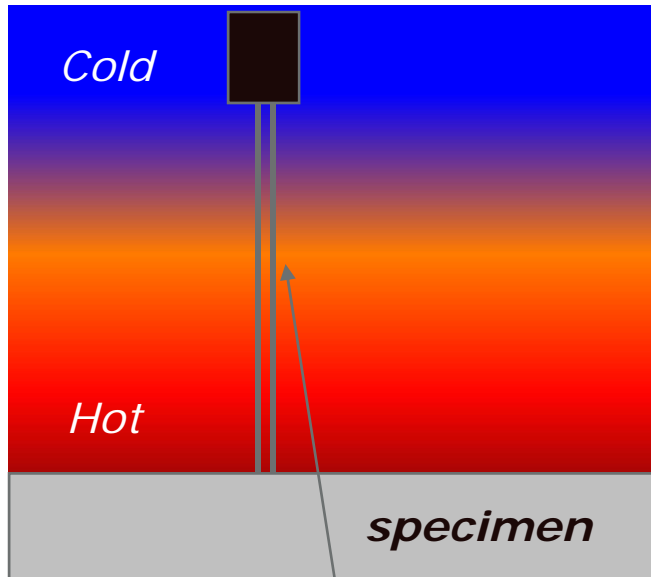
Potential for large improvement through permanently attached monitoring sensors

Erosion/Corrosion monitoring in the Oil & Gas industry

Problems to solve

- **Continuous operation above 200°C (Conventional UT rated up to 150°C)**
- **Use conventional electronics which are rated up to 85°C**
- **Wireless data transmission**
- **Intrinsic safety certification**

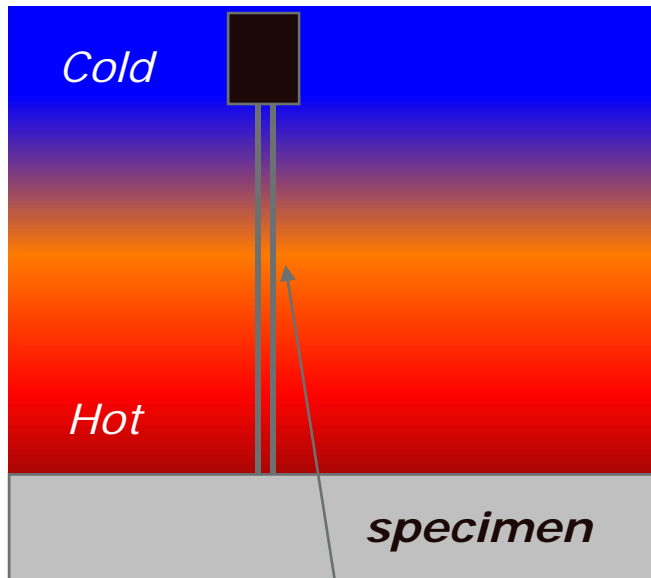
Permanently attached waveguide concept



*waveguides to
isolate transducer
from specimen*

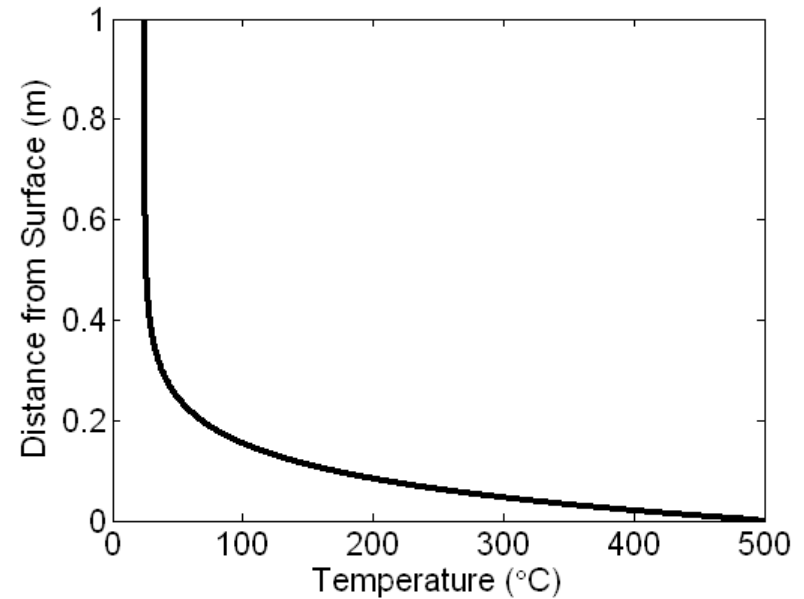
- *Temperature isolation*
- *Source characteristics*
- *Wave transmission*
/ propagation

Temperature Isolation

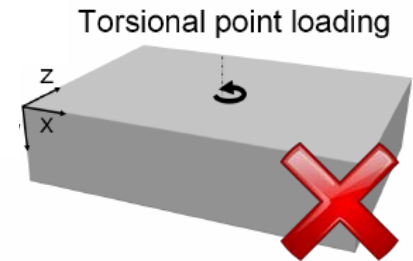
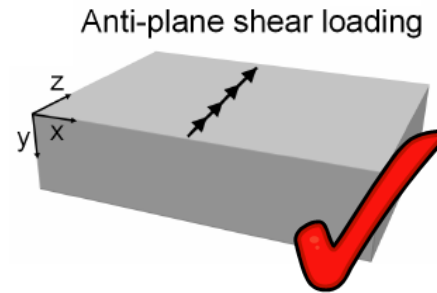
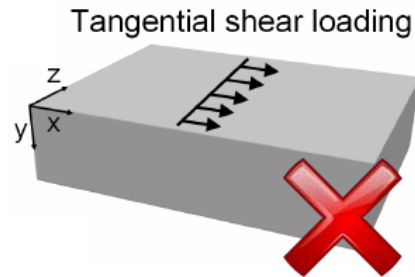
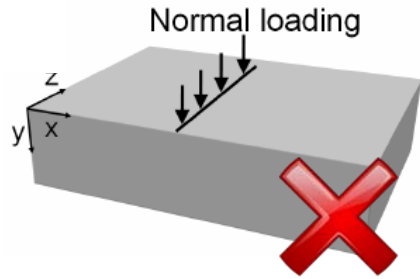


*waveguides to
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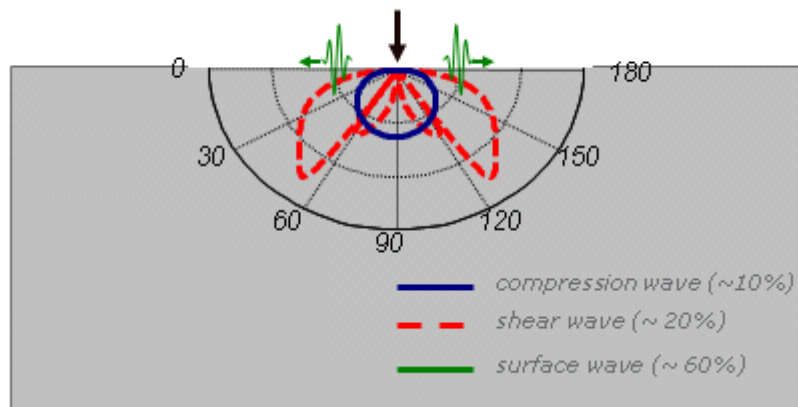
*For 1x15mm Steel strip
surrounded by 25°C air*



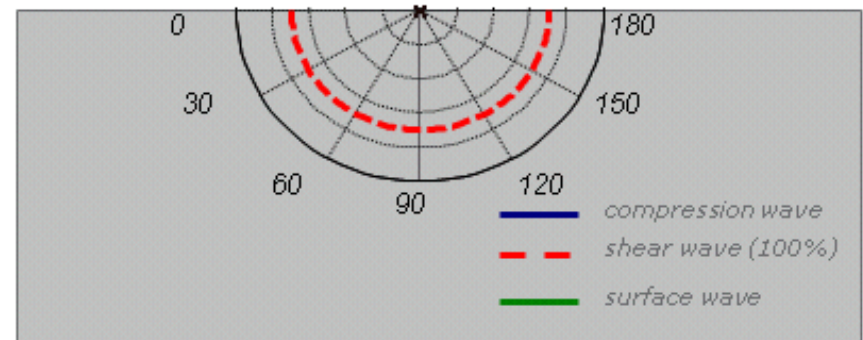
Source characteristics



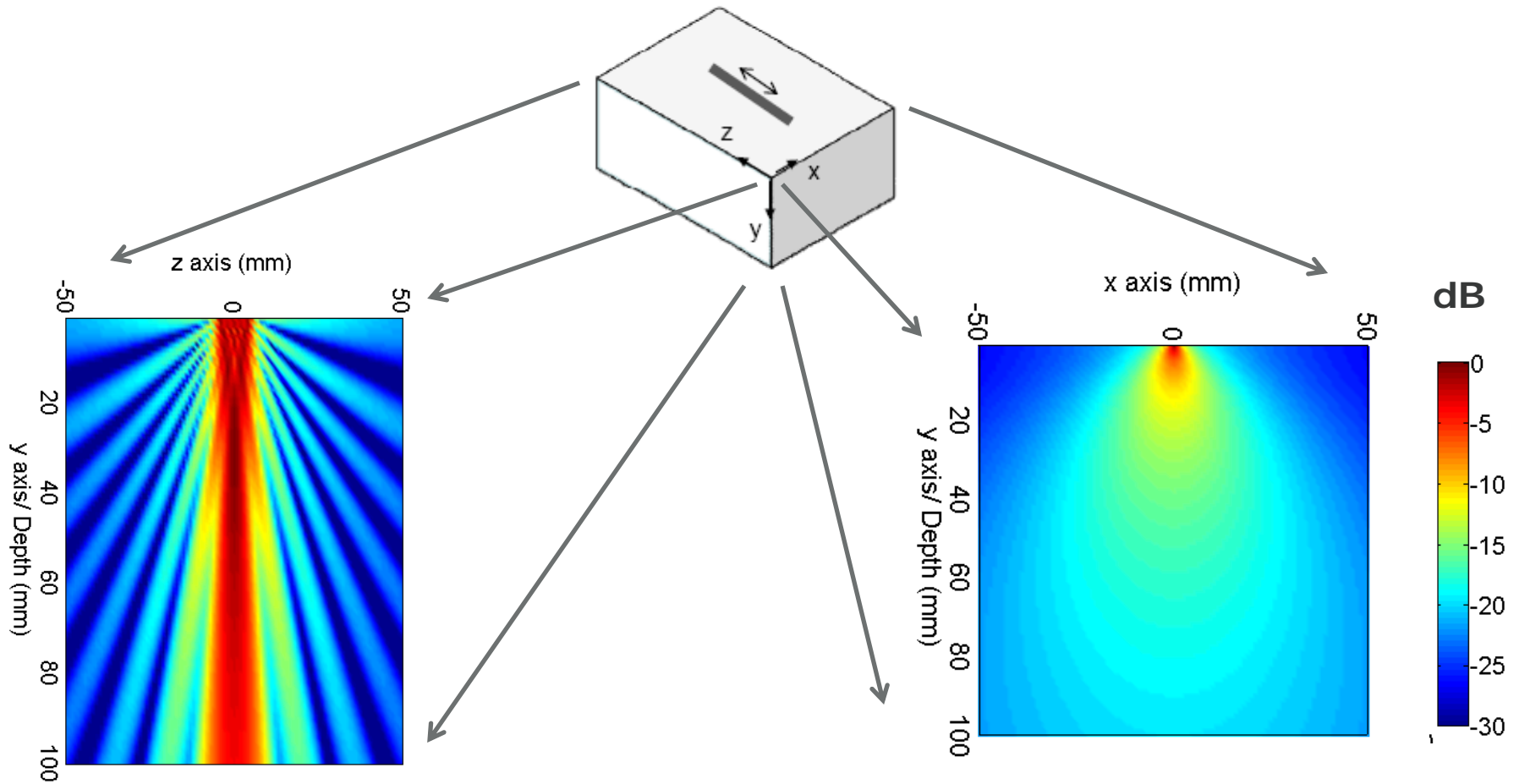
Normal line loading



Shear line (into screen) loading

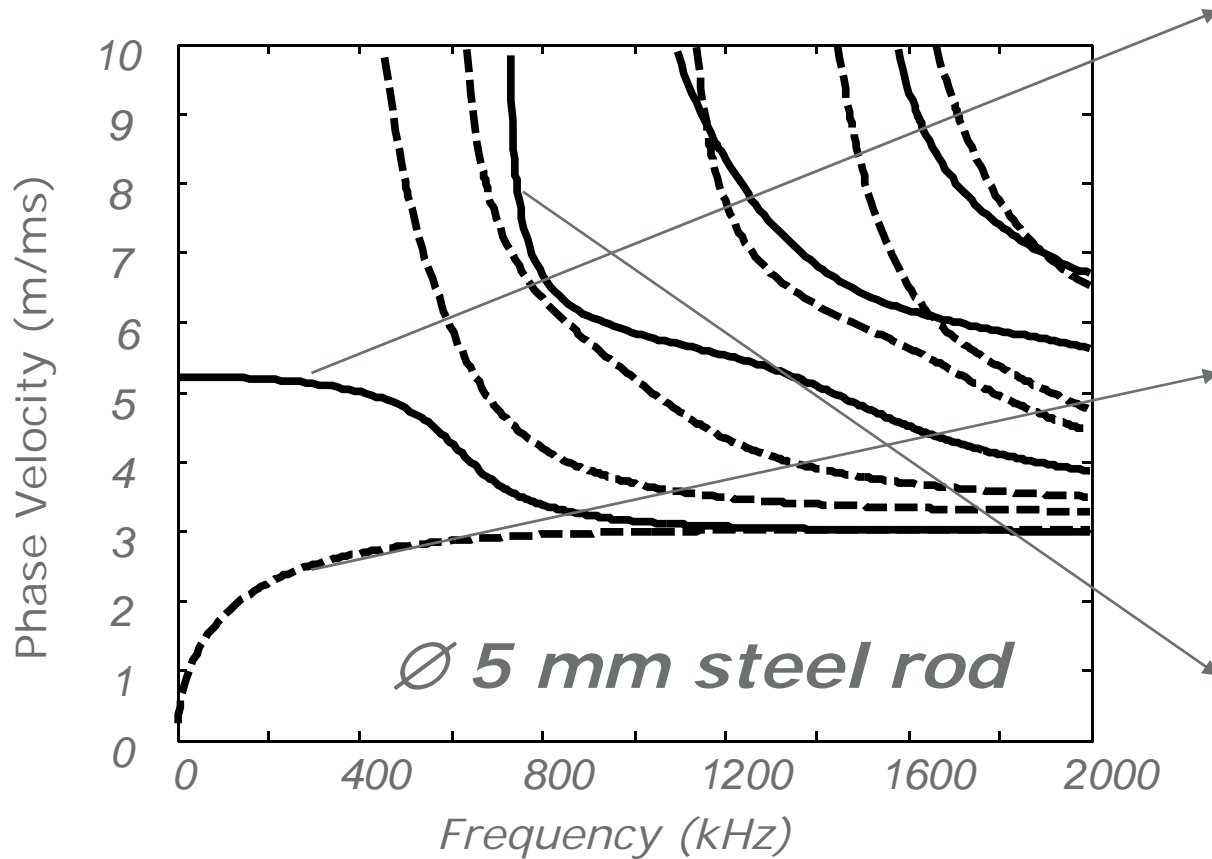


Source characteristics

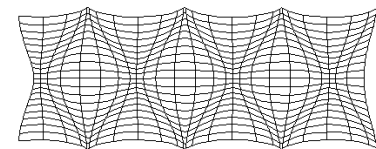
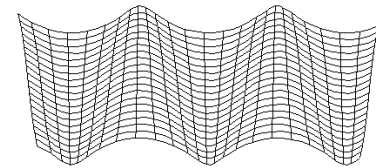
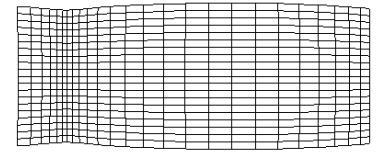


Wave propagation

Mode control

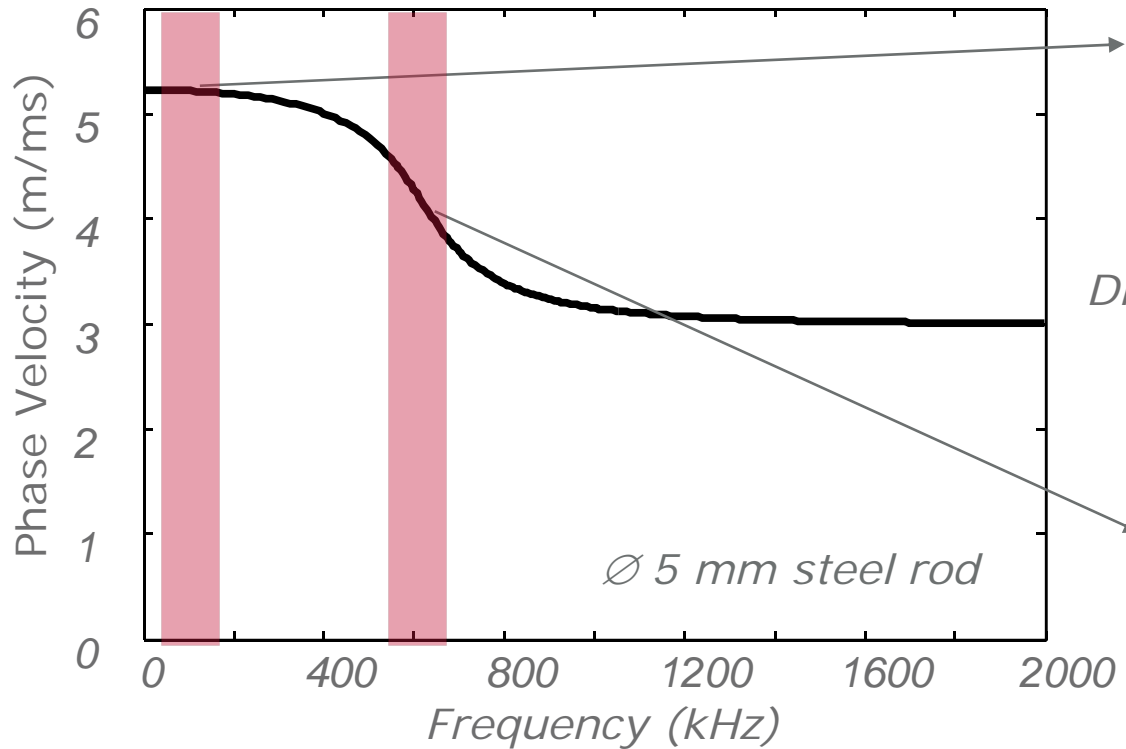


Propagation direction →

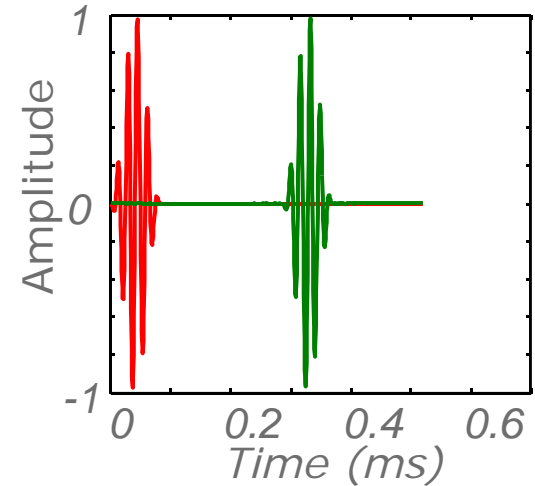


Wave propagation

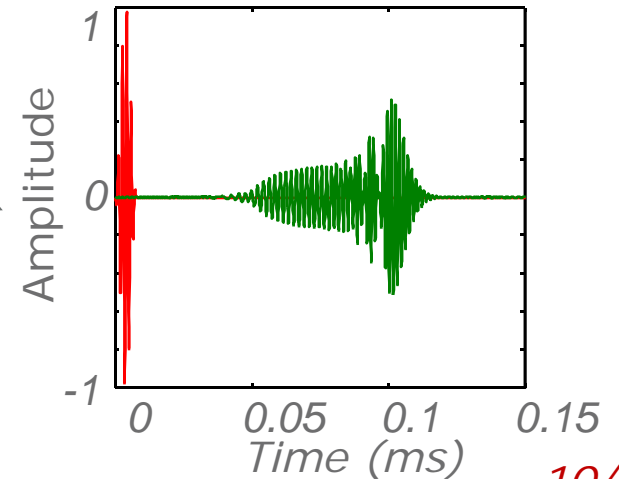
Dispersion



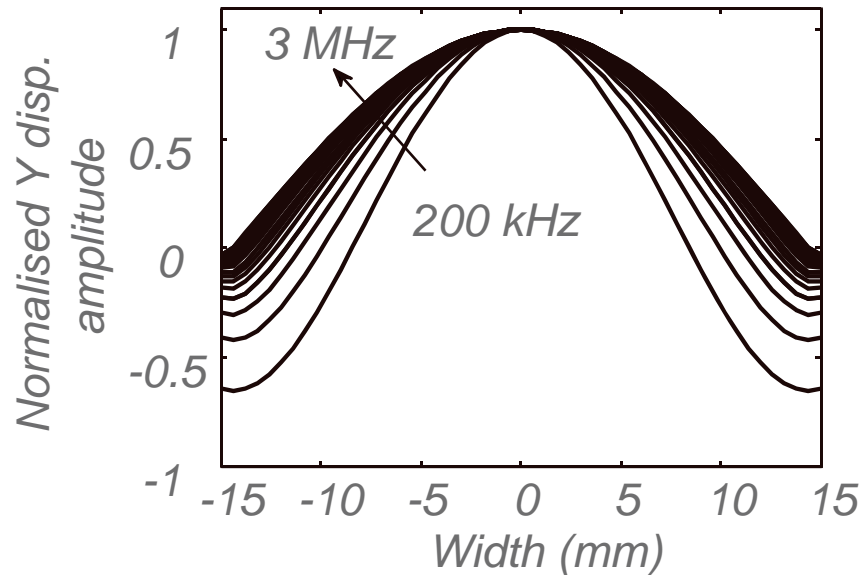
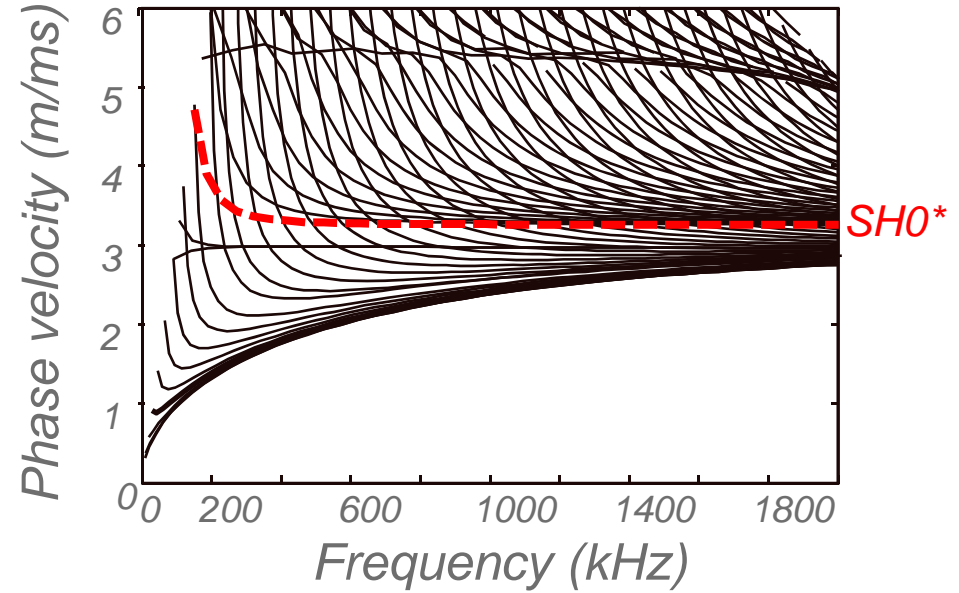
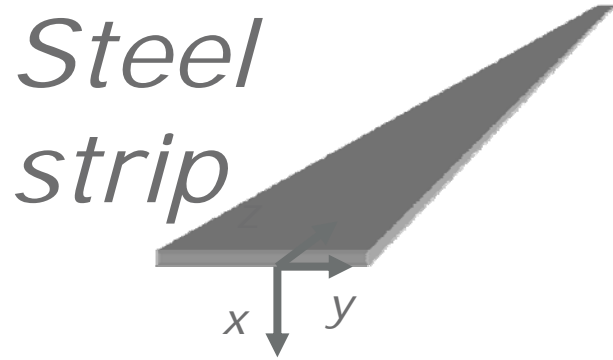
Non Dispersive wave propagation



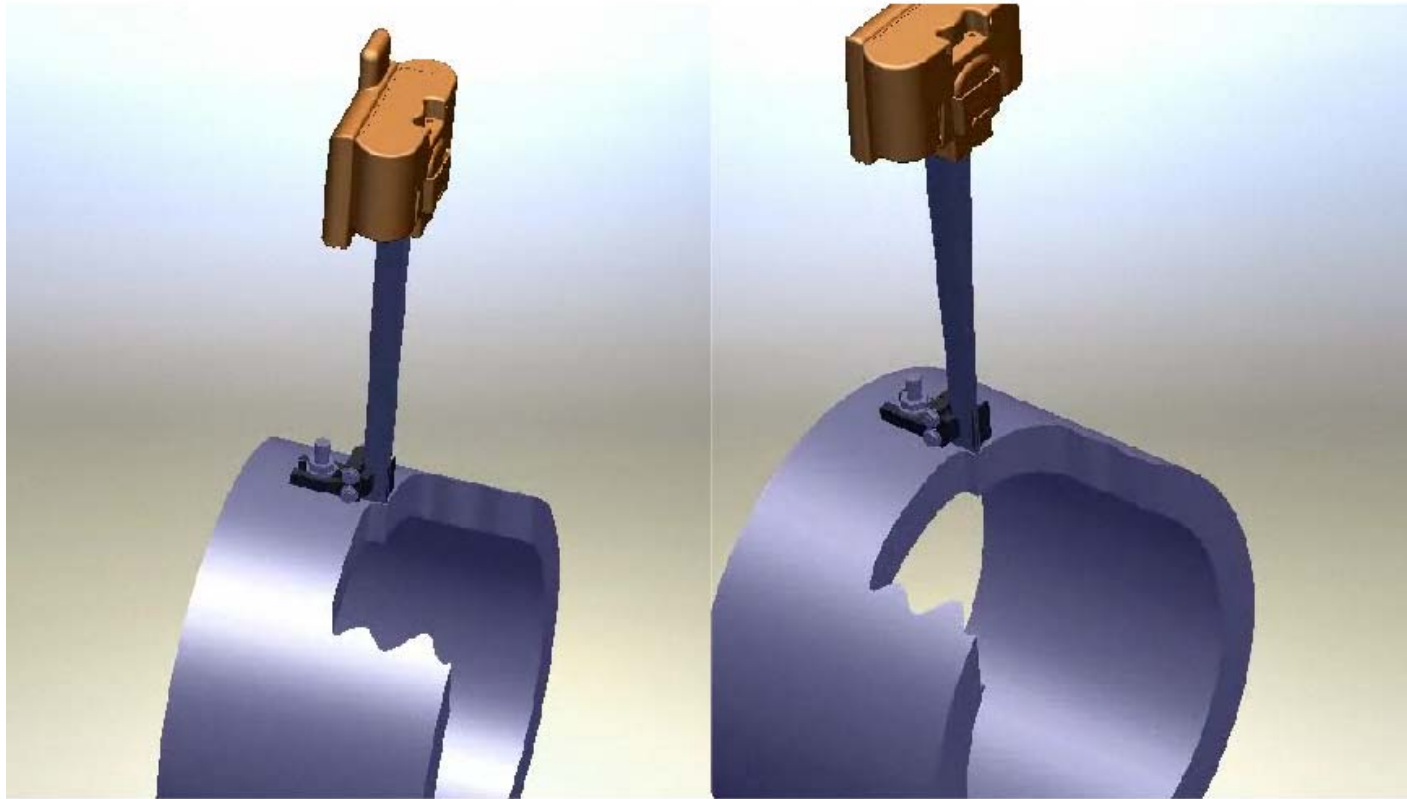
Dispersive wave propagation



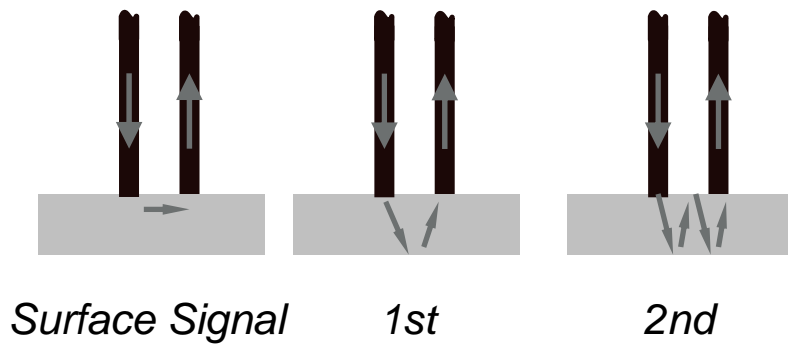
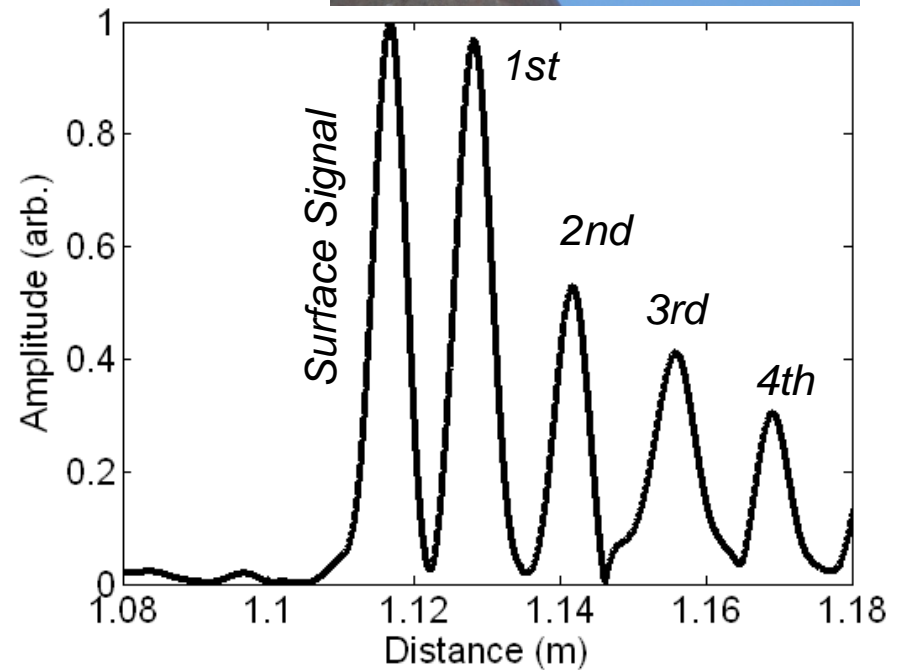
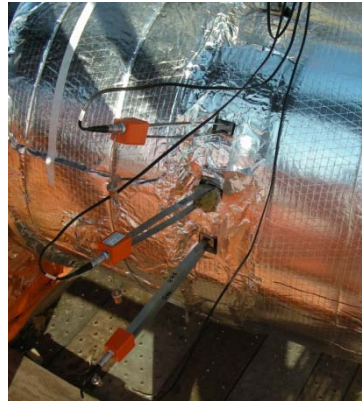
Non-Dispersive wave propagation in a steel strip



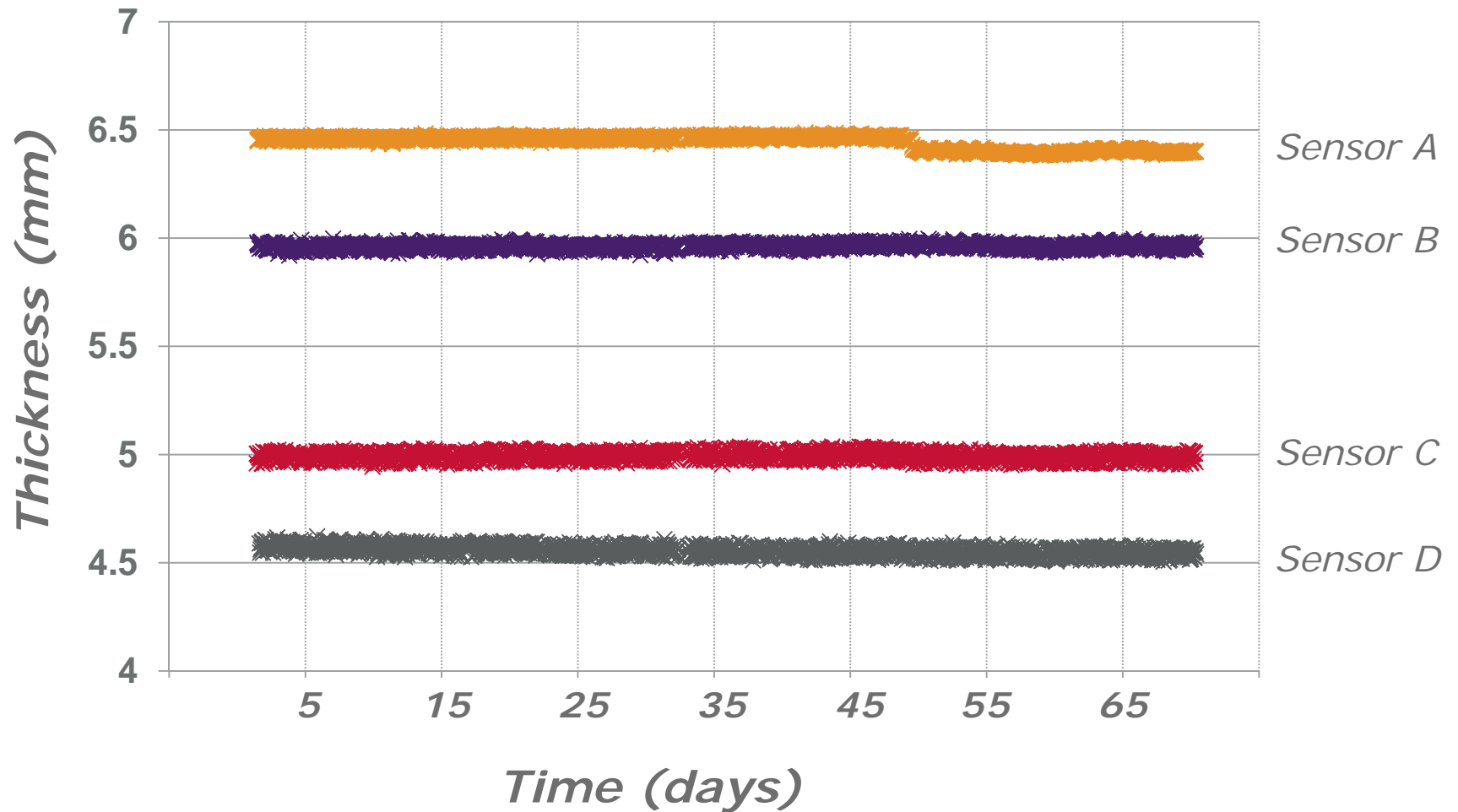
Wave propagation



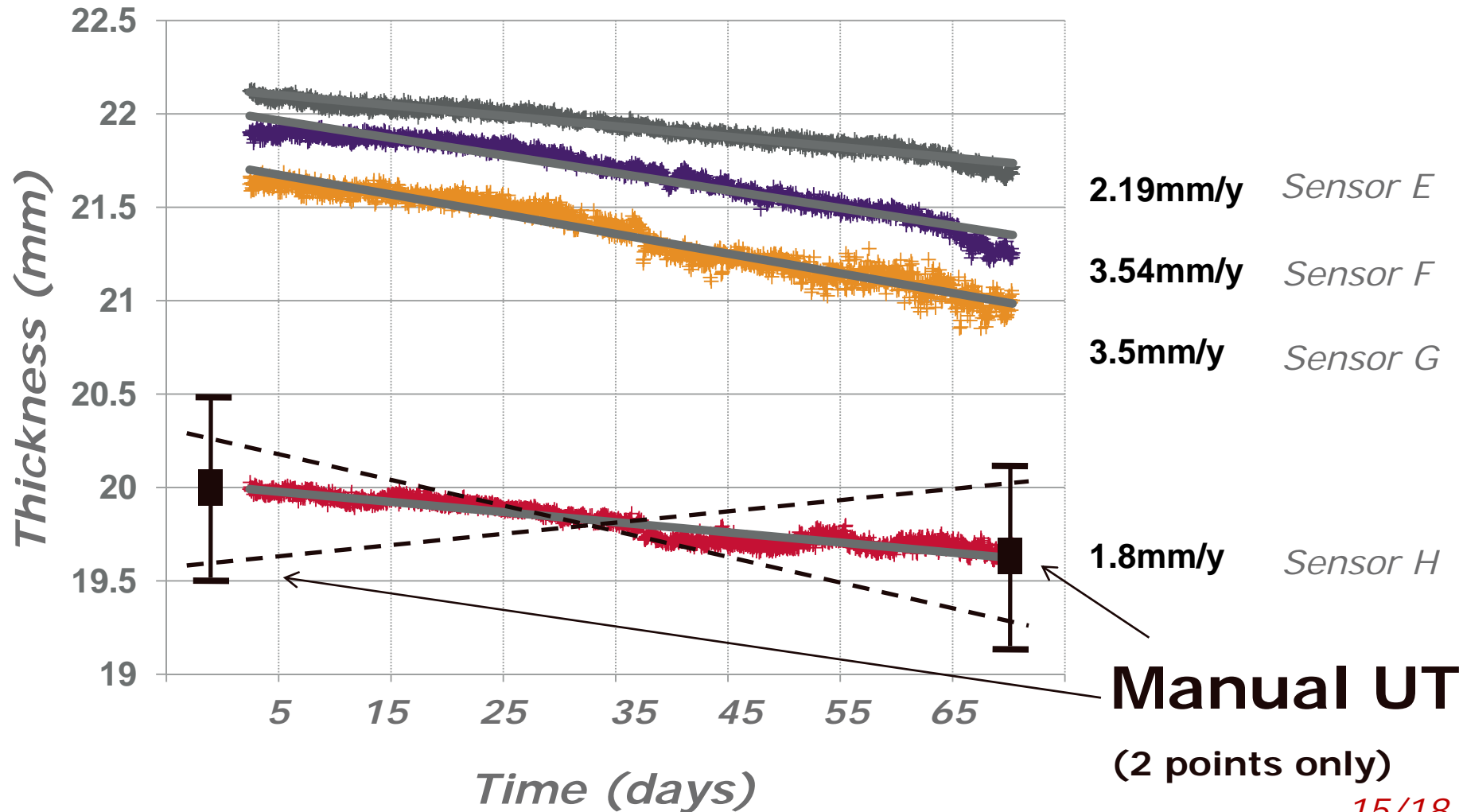
Designed transducer



Field data

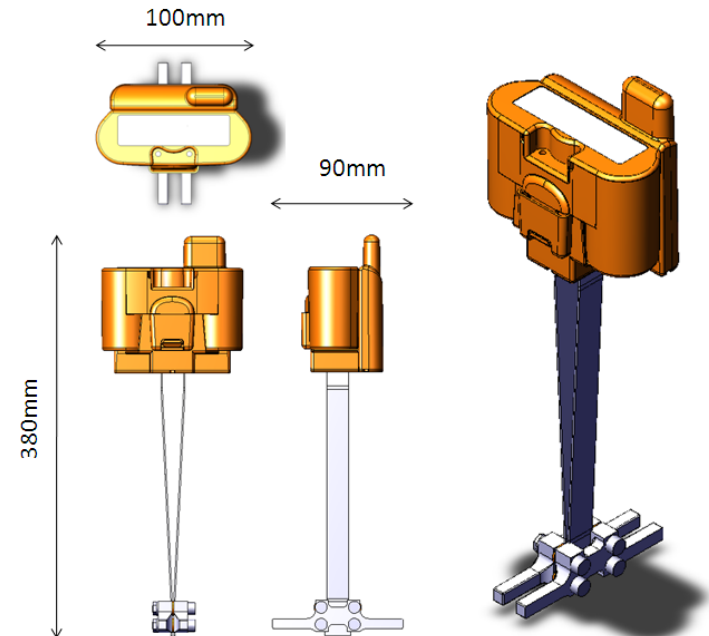
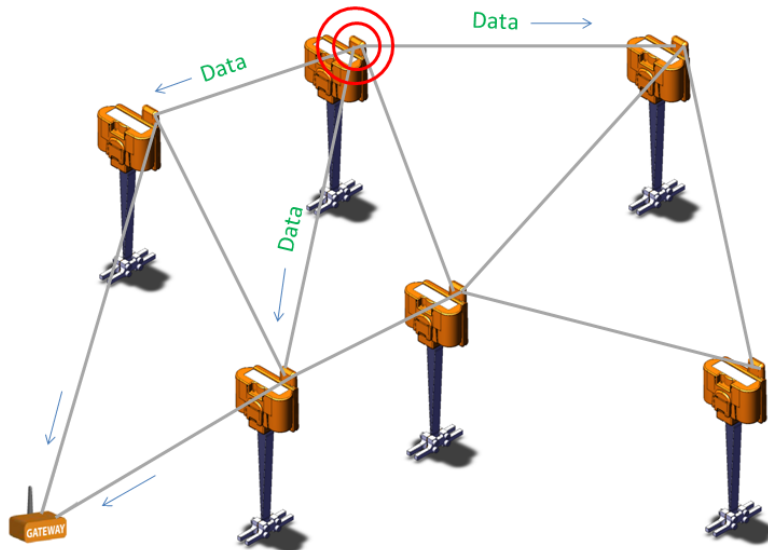


Accelerated corrosion test data



Designed product & Solution

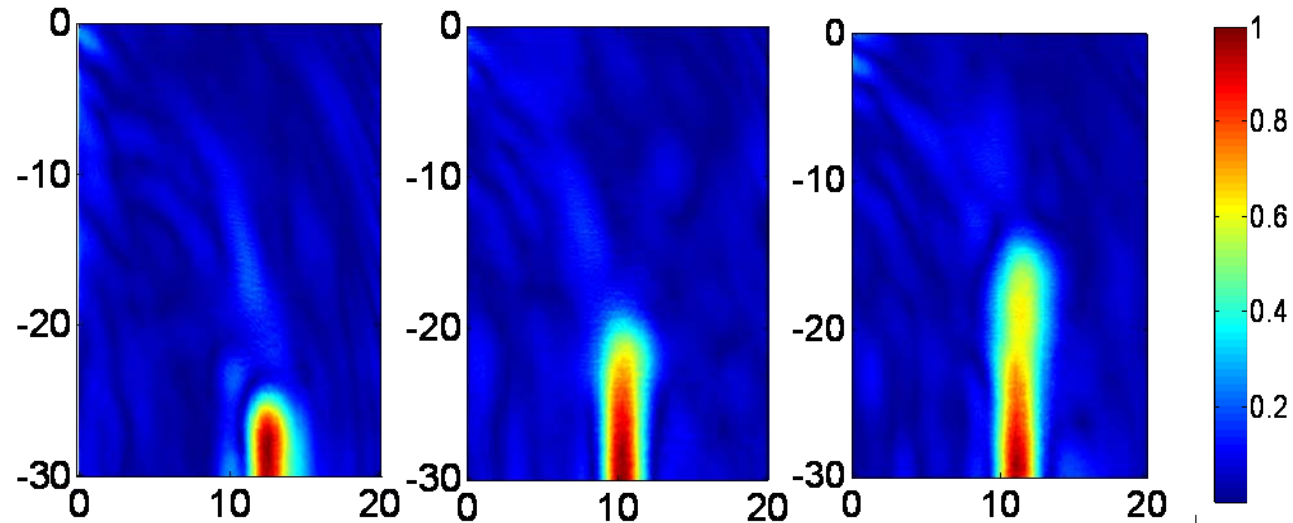
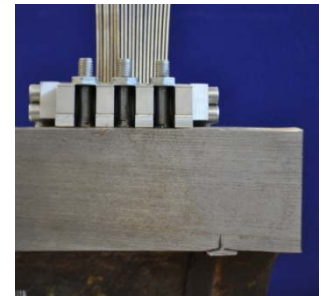
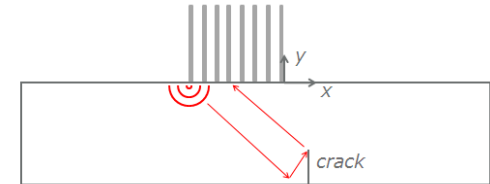
- *ATEX / FM approved*
- *3-25mm thickness*
- *$\pm 0.1\text{mm}$*
- *wireless data transmission*



High temperature crack monitoring

EDM notch results

- 5, 10, 15mm notch length
- Linear images



Acknowledgements and Questions

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and the **really upset person** that I **forgot to mention!**

Questions ?