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PWAS inspection in materials with different properties

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Summary

Lamb waves are dispersive waves that propagate parallel to the surface of the material. The propagation medium filters the excitation signal [1], and depending on the excitation waveform it is well known that tails with defined spectral components might show up limiting the frequency of Lamb wave inspections. Spatial resolution of the analyzed structure is limited by the frequency of inspection. Bonded PWAS to structure resonances limit inspection frequency. To get an insight about these resonances Multiphysics FEM analysis and experimental validations of these analysis where carried out.

[1] V. Giurgiutiu, Structural health monitoring: with piezoelectric wafer active sensors. Elsevier Inc., 2007.

INTRODUCTION

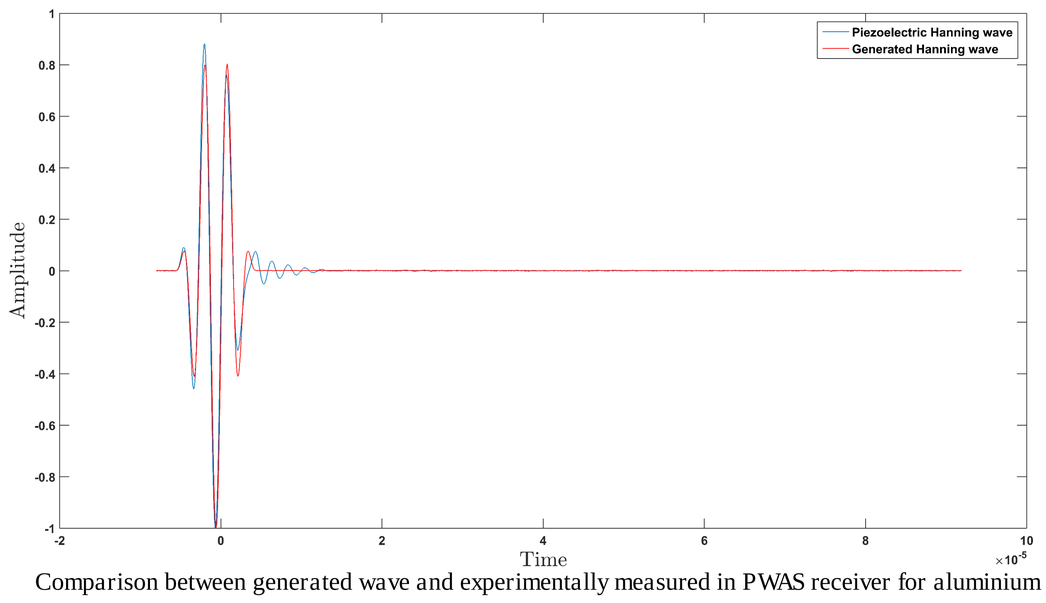
Problem

- Spatial resolution limited by frequency, $\boldsymbol{resolution_{max} = \lambda_{min}/2}$
- Resonances of the PWAS coupled to structure limit high frequency inspection
- The phenomena is not well understood

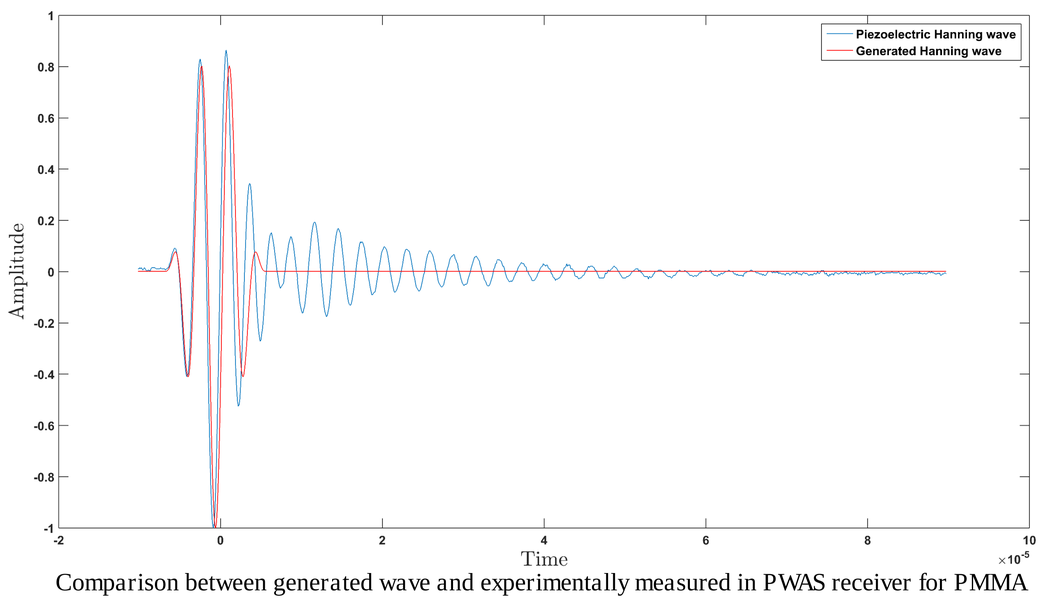
Procedure

- Multiphysics FEM analysis of the system made up by PWAS and the inspected structure, in order to understand the nature of the resonances.
- Experimental validation in methacrylate (PMMA) and aluminium 2mm plates.

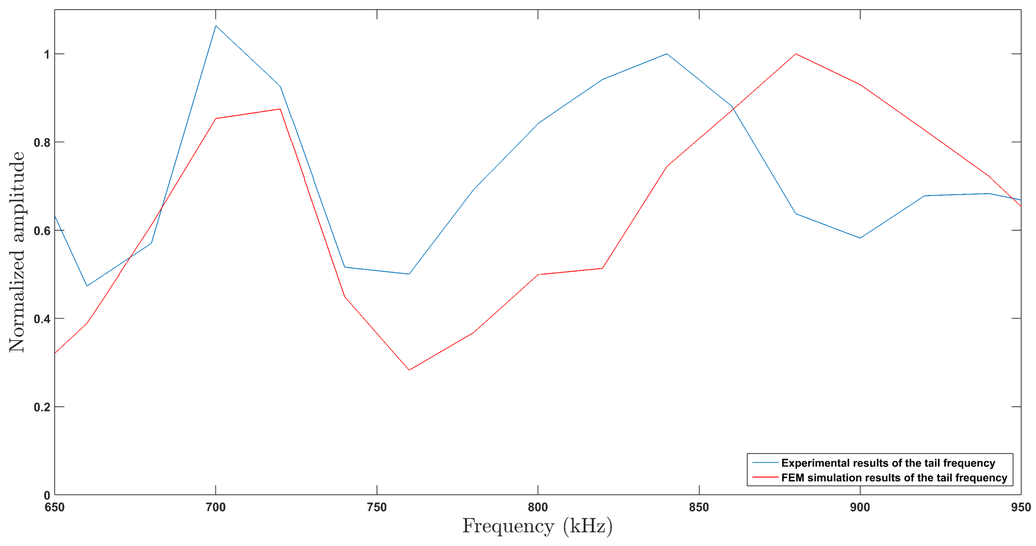
RESULTS



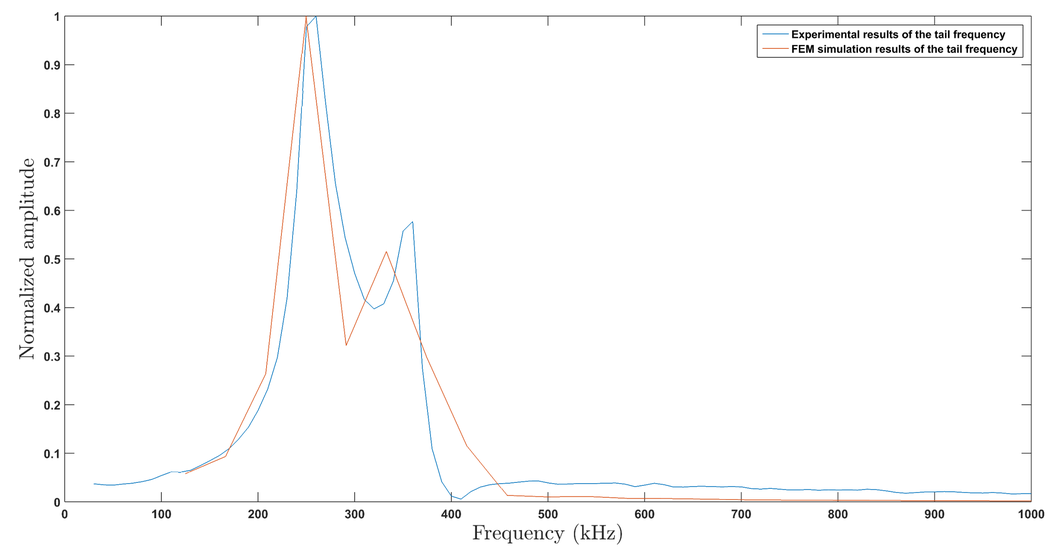
Comparison between generated wave and experimentally measured in PWAS receiver for aluminium



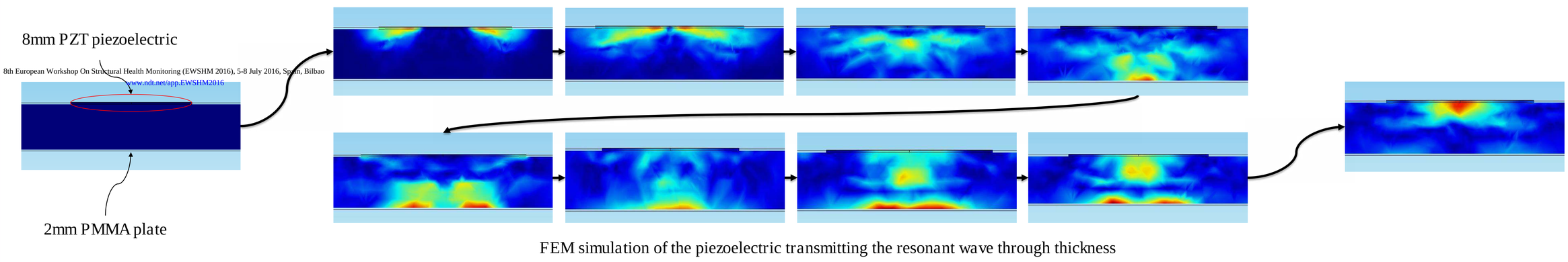
Comparison between generated wave and experimentally measured in PWAS receiver for PMMA



Spectrum of the tail. Comparison of FEM and experimentally results for aluminium



Spectrum of the tail. Comparison of FEM and experimentally results for PMMA



FEM simulation of the piezoelectric transmitting the resonant wave through thickness

DISCUSSION

- Frequency of the tail's resonant signal is related to piezoelectric and plate's material's elastic properties
- Higher frequencies stimulate higher frequency resonances of the piezo-structure joint system

CONCLUSIONS

PWAS attached to the structure present local piezo-plate resonances that affect the measured signal, which are dependent on PWAS geometry and structure material.

FEM analysis and experimental results agree, a local resonance transmitted through the plate's thickness can be observed

Avoiding these frequencies would improve inspection techniques, increasing the achievable resolution.