

Multiphysics Simulations in the Ultrasonic Industry

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Introduction: “Business under the hood” could be the subtitle of this poster.

The beginning of everything was a breakage in the stainless steel cover of a submersible ultrasonic transducers array box resting on the bottom of a cleaning tank.

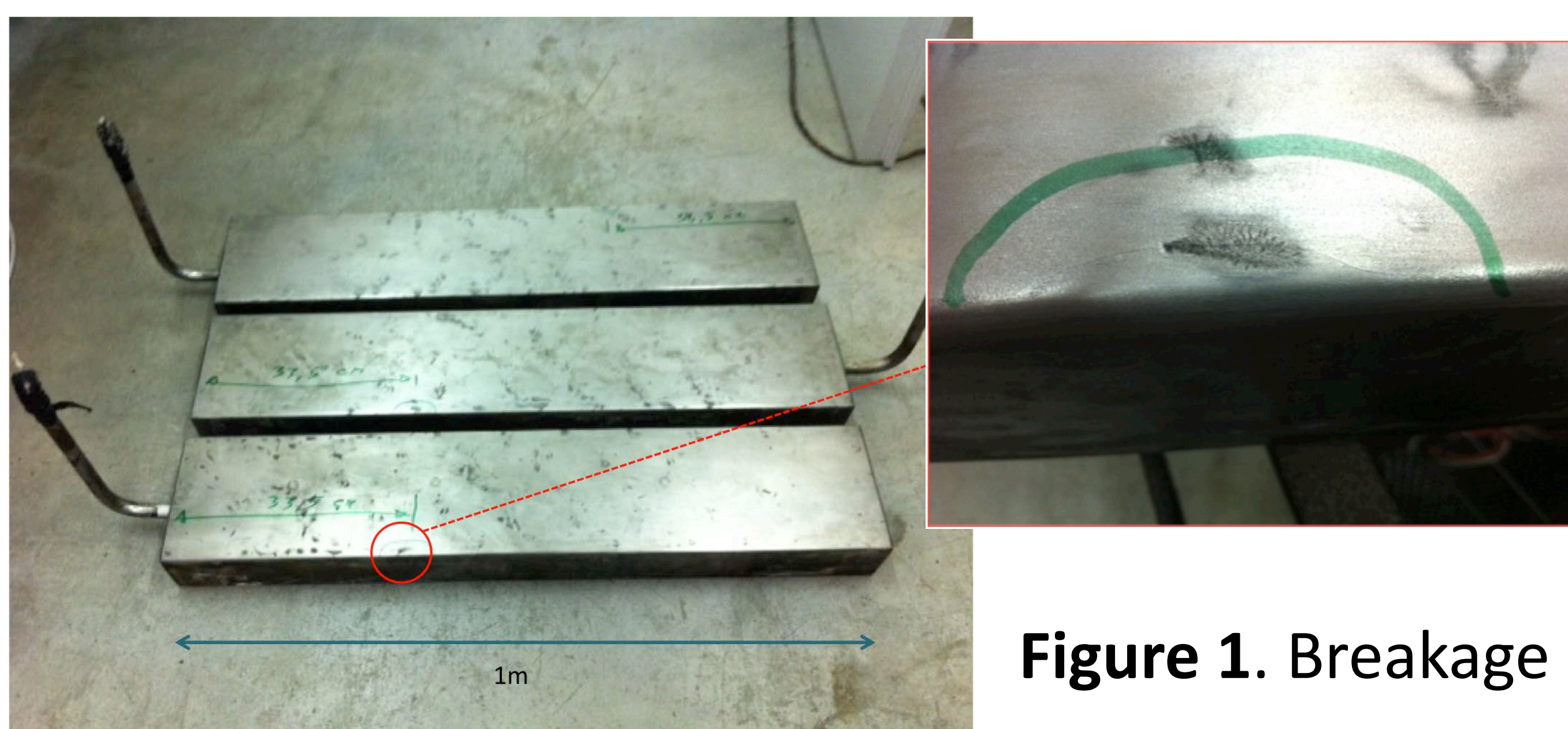


Figure 1. Breakage

Images courtesy of Unitech S.r.l.

Since years the design of submersible ultrasonic boxes is unchanged and many units has been successfully installed. That’s why this breakage problem was so unusual that many years of practical experience could not fix it. Therefore a more scientific approach to study the problem has been required.

Computational Methods: The piezoelectric device interface of Comsol multiphysics has been used in order to model the strong coupling between piezoelectric phenomena and mechanical effects:

$$\sigma = c_E \varepsilon - e^T E$$

$$D = e \varepsilon + \varepsilon_0 \varepsilon_{rS} E$$

$$\varepsilon = \frac{1}{2} (\nabla u + \nabla u^T)$$

This device has a quite complex geometry, different materials are used and 20 high power piezoelectric transducers are working in sync at high frequencies.

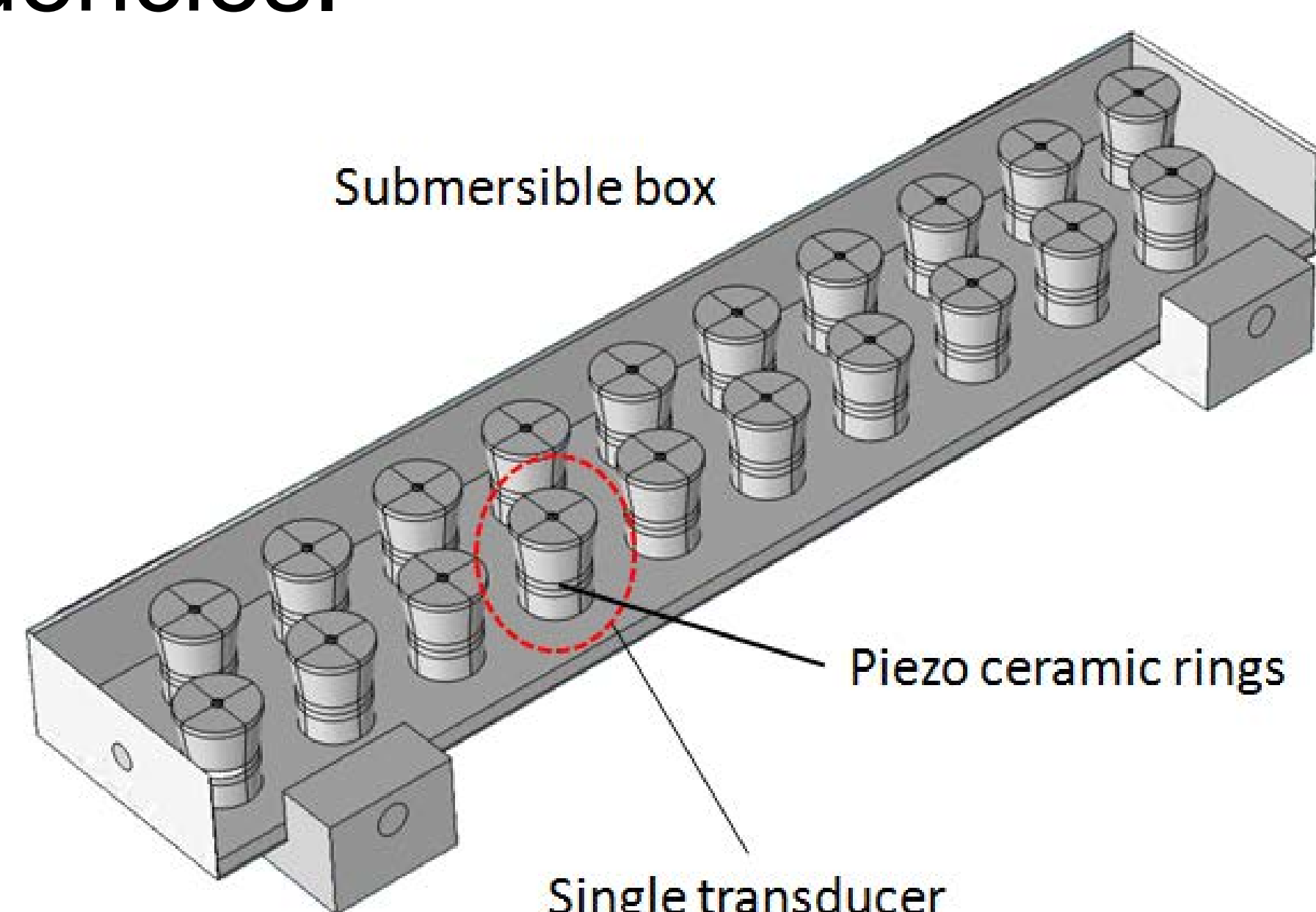


Figure 2. Submersible transducers array box

Frequency domain studies has been performed and several variables has been considered: mechanical constraints, material and position of the supports, operation voltage and frequencies ...

Results: The study showed that a combination of many factors contributed to create a very asymmetric stress and strain distribution with strong concentration in the breakage region (Fig.3).

Many important solutions has been found in terms of: design, installation procedure and electrical characteristics.

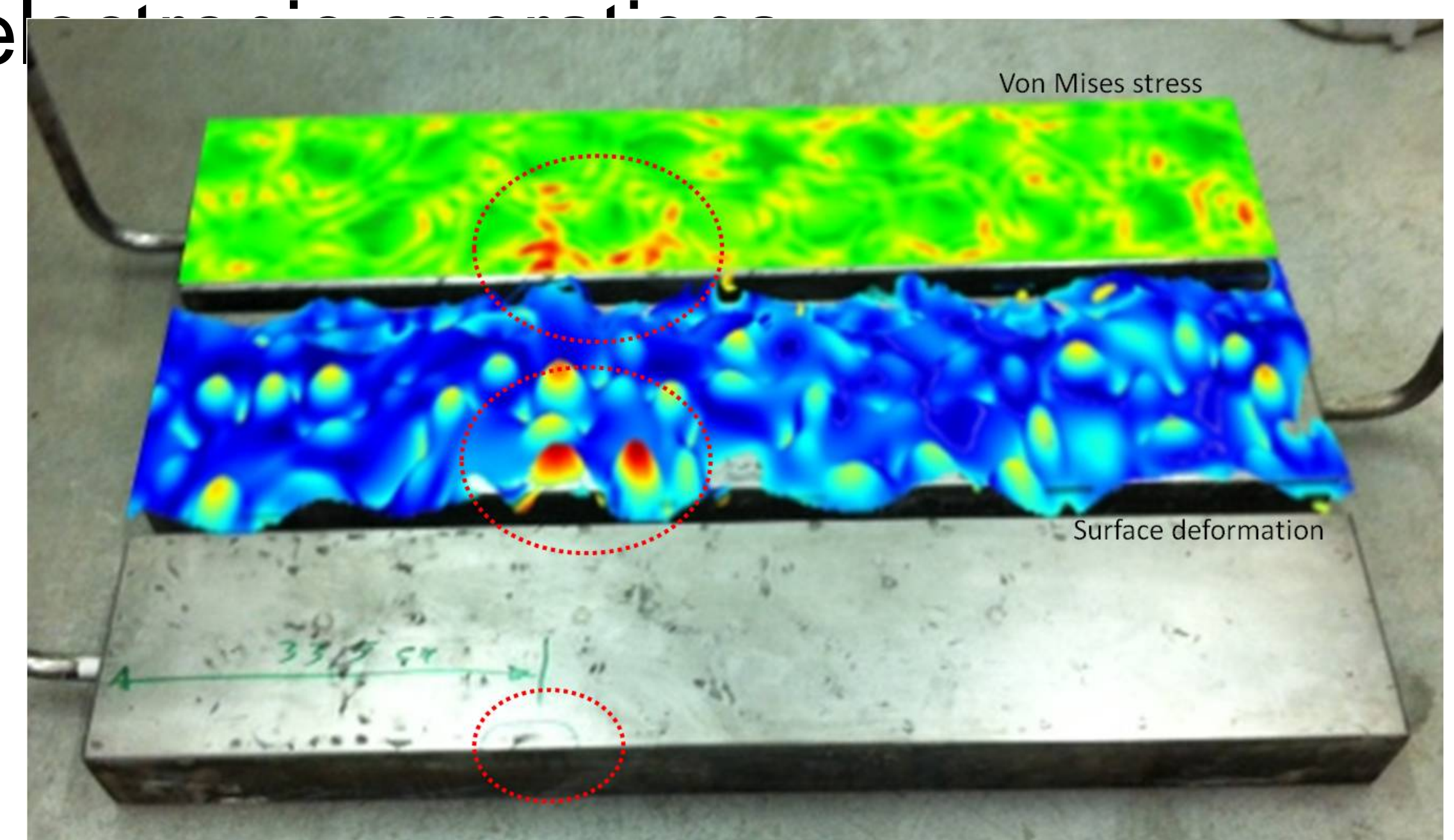


Figure 3. Breakage explained

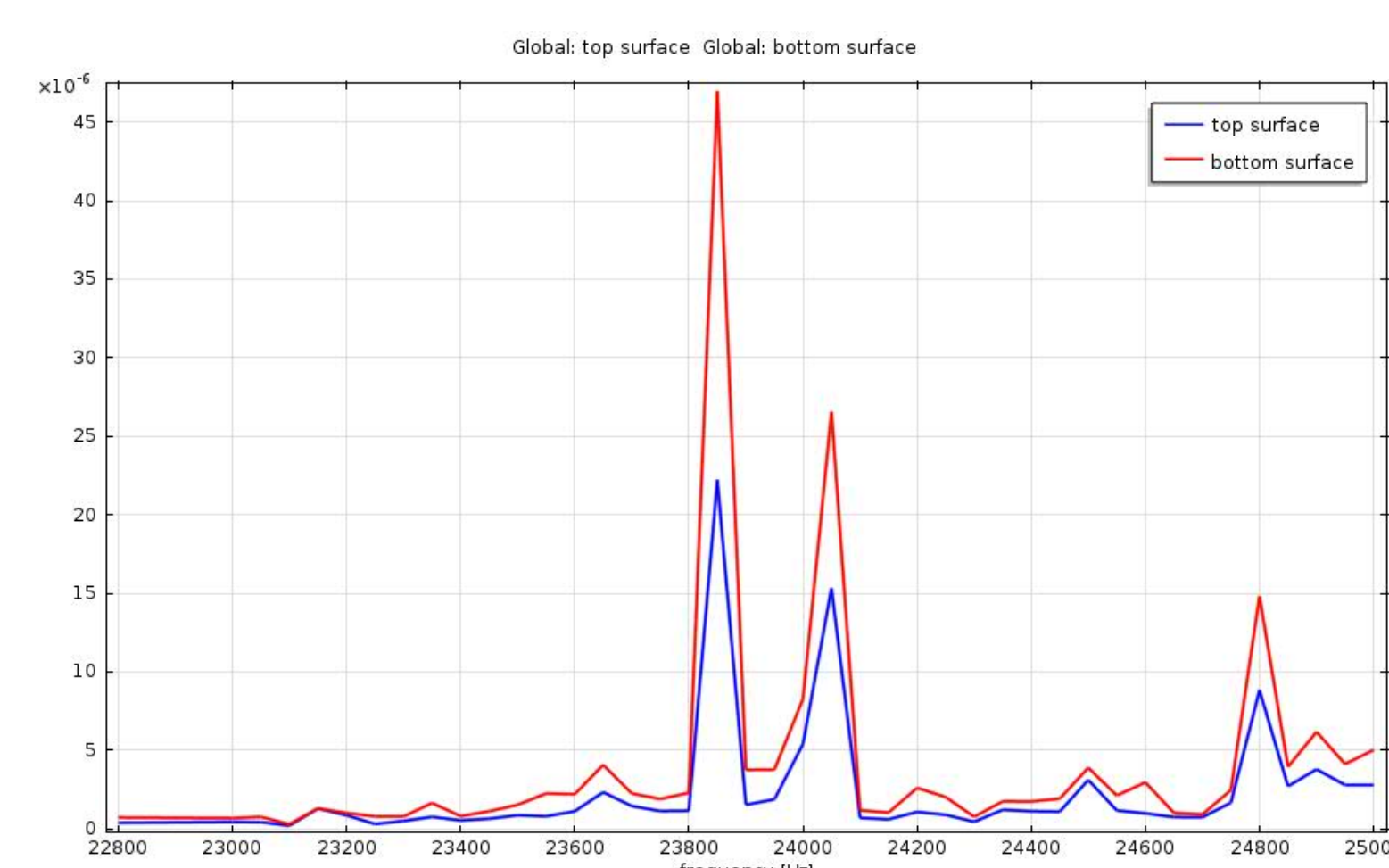


Figure 4. Resonance spectrum

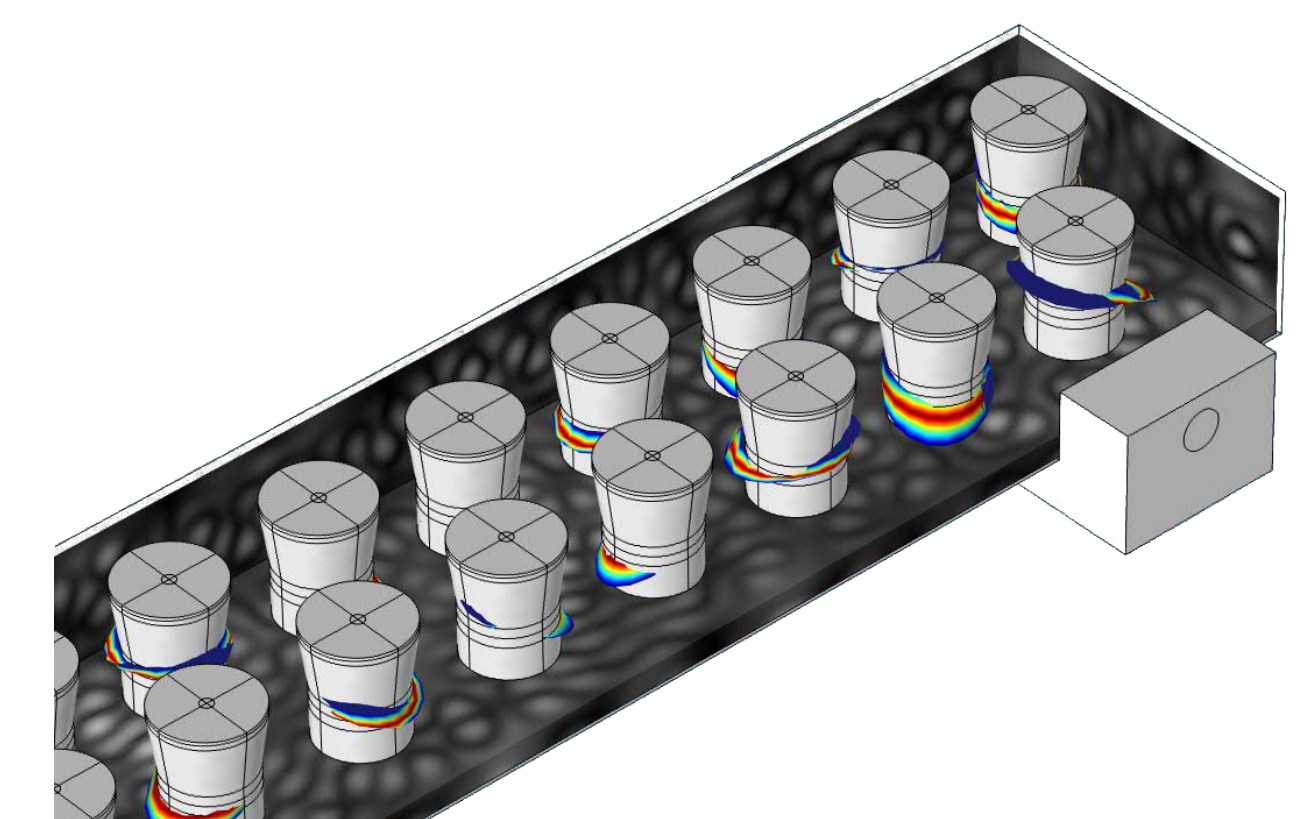


Figure 5. Different transducers efficiency

Conclusions: Unexpected new business can be just around the corner. Long time consolidated products can hide new developments. From this work a new optimized products line will be developed.

References:

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