Nonlinear phased array imaging

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Nonlinear diffuse imaging has proven to be an effective method for the detection of closed cracks, or closed surfaces. This technique capitalises on the effects of harmonic generation from nonlinear cracks (essentially clapping interfaces), using sequential and parallel transmission modes and the movement of energy from the transmission bandwidth to harmonics can be spatially resolved. The diffuse field technique allows for detection of nonlinear features without the requirement of coherent reflections, meaning this technique has potential for resolving bulk material nonlinearity. The detection and spatial resolution of bulk nonlinearity has huge potential, allowing for the localisation of stress fields induced from loading and mechanical fatigue. The harmonics contributions are caused by both classical (bulk material) and non-classical nonlinearity (crack tips) and therefore can be resolved individually by implementing phased arrays with different reception frequencies. In particular, the low frequency components, induced by mixing within the transmission bandwidth, will be explored. The relatively low attenuation at this low frequency compared to the transmission bandwidth means the nonlinear information preserved in the diffuse field will theoretically will be higher than that of the transmission bandwidth. It is this increased nonlinear sensitivity which has potential to resolve bulk nonlinearity. Using a dual phased array configuration, a spectral study will be conducted to increase the sensitivity of the technique for detecting closed cracks tips, which will be used as insight for achieving bulk nonlinearity imaging. Simulations of this experiment will be used to evaluate the influence of attenuation in practical experiments.