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Chirp-coded excitation applied with advanced pulse inversion for nonlinear acoustics in complex steel samples

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Nonlinear acoustics for nondestructive testing is still an emergent technique in complex materials with localized cracks because linear effects can be cancelled using specific symmetries for the pre- and post- signal processing. The local nonlinear signature is accessible even in complex aeronautic structure by using the symmetry properties : i. e. time reversal invariance and pulse inversion associate to chirp-coded excitation. Excitation Symmetry Analysis Method [Dos Santos et al., JNLM, 2007] which is an extension of the pulse inverted method for extraction of third order nonlinearity is applied experimentally for the measurement of relative level of nonlinearity on a airplane steel bracket, on which visible crack was created by fatigue tests. This pre-processing method has been coupled to a 100-250 kHz bandwidth chirp-coded ultrasonic excitation, realized at various amplitude (A, $A/2$, $3^{1/2}A/2$, etc.), and performed with DAKEL IDK09 200 kHz PZT sensors. Signal processing based on correlation measurements, allow an extraction of the nonlinear signature versus fatigue level. Experiments and data processing have been conducted with a 12 bit DAKEL - DTR system in the bandwidth 80-800 kHz and compared with a continuous 4 channel acoustic emission device.