

# **Time reversal and phase coherent MUSIC imaging methods for ultrasonic nondestructive evaluation**

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In this paper, time reversal with multiple signal classification (TR-MUSIC) and its phase form, phase coherent MUSIC (PC-MUSIC), have been introduced into the area of ultrasonic nondestructive evaluation (NDE). And their performance has been experimentally demonstrated via detecting and imaging the defects in solids. The experimental system, including linear array and array controller, has been designed and built to capture the real ultrasonic array data from the test object via full matrix capture (FMC) process. In the experiment, two typical defects are considered and machined: side-drilled hole (SDH) and slot, corresponding to the point-like defect and non-point-like defect respectively. In the pre-processing stage, a window function in time domain is applied to extract the scattered signals reflected by the defect from the pulse-echo signals belonging to the ultrasonic array data. These time-gated signals are then post-processed by TR-MUSIC and PC-MUSIC over the given frequency bandwidth to obtain the ultrasonic images. Here, the singular values from different defects are calculated, and their distributed characteristic is compared. The experiment implemented on the test object with SDH shows that both TR-MUSIC and PC-MUSIC can locate the position of point-like defect in solid. And the experiment implemented on the test object with slot shows that PC-MUSIC considering the phase information can assess the length of non-point-like defect, but TR-MUSIC fails.