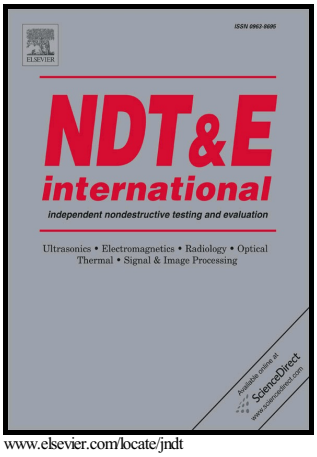
# Phased array ultrasonic signal compressive detection in Low-Pressure Turbine Disc

Zhiliang Bai, Shili Chen, Lecheng Jia, Zhoumo Zeng




www.elsevier.com/locate/jndt

PII: S0963-8695(17)30144-5
DOI: http://dx.doi.org/10.1016/j.ndteint.2017.03.002
Reference: JNDT1851

To appear in: *NDT and E International*

Received date: 4 August 2016
Revised date: 18 February 2017
Accepted date: 6 March 2017

Cite this article as: Zhiliang Bai, Shili Chen, Lecheng Jia and Zhoumo Zeng Phased array ultrasonic signal compressive detection in Low-Pressure Turbine Disc, *NDT and E International,* http://dx.doi.org/10.1016/j.ndteint.2017.03.002

# Phased array ultrasonic signal compressive detection in Low-Pressure Turbine Disc

Zhiliang Bai, Shili Chen*, Lecheng Jia, Zhoumo Zeng

State Key Laboratory for Precision Measurement Technology and Instrument, Tianjin University, Tianjin 300072, P. R. China

slchen@tju.edu.cn (S. Chen),

zhl_bai@tju.edu.cn (Z. Bai)

*Corresponding author



**Abstract**

As the core component of nuclear units, the inspection of Low-pressure (LP) turbine disc is of particular importance to assure their quality and safety. Nevertheless, the complex structure makes the position of transducer very limited and the huge size brings about a significant amount of data. Recently, it has been suggested that compressive sensing (CS) may be promising to implement the sampling far below the Nyquist rate. In this work, a novel CS-based procedure specifically dedicated to phased array ultrasonic signals in LP turbine disc NDE is proposed, aiming to achieve high compression rate with low signal distortion. Taking the effect of sampling frequency into account, the simulation is first conducted on the signals derived from CIVA platform. An excellent recovery is reached using measurement points less than the Nyquist sampling limitation required, which confirms the miraculous power of the CS. Then experimental verification is presented on a proportional mockup with EDM notches and the reconstruction performance is compared between five greedy algorithms, like used in the simulation. Although not as impressive as the results obtained from simulated data, the Orthogonal Matching Pursuit (OMP) algorithm verifies its feasibility and effectivity in ultrasonic array signal compression with sufficient recovery accuracy. Finally, the performance of OMP-based CS is compared with the gold standard for signal compression, namely, the discrete wavelet transform (DWT).

**Keywords** Low-pressure turbine disc; Phased array ultrasonic; Compressive sensing; CIVA simulation

## 1. Introduction

Low-pressure (LP) turbine disc failure can have catastrophic consequences. Since its first