

# Self-calibration of Large-scale Planar Variable-line-spacing Gratings with a Conjugate Differential Interferometric Method

Xin Xiong<sup>1,#</sup>, Chenguang Yin<sup>2</sup>, Ziran Chen<sup>1</sup>, Xiaokang Liu<sup>2,#</sup> and Wei Gao<sup>2</sup>

<sup>1</sup> Engineering Research Center of Mechanical Testing Technology and Equipment, Chongqing University of Technology, Chongqing, China

<sup>2</sup> Department of Finemechanics, Tohoku University, Sendai, Japan

# Corresponding Author / Email: Corresponding Author: xinxiong@cqut.edu.cn

KEYWORDS: Diffraction Grating , Optical Encoder, Interferometry, Optical Measurement

---

**Abstract:** This paper introduces a conjugate differential interferometric self-calibration method for assessing the variable-line-spacing (VLS) parameters of large-scale VLS gratings. The method involves measurement schemes with small transverse shifts at orthogonal symmetry positions. At each position, the positive and negative first-order diffracted wavefronts are measured, and the differential result is calculated to reduce the impact of out-of-flatness errors in the reference flat and the grating substrate. The differential wavefronts at the original and conjugate positions are then used to evaluate the VLS parameters. By minimizing the coupling components between multi-step tests, the precision of the VLS parameter evaluation is enhanced, thereby improving the reliability of the results. The performance of this method on VLS gratings is examined, and the pitch variation of the VLS grating is assessed through the analysis of the conjugate diffracted beams. Simulations and experiments are provided to confirm the feasibility of the proposed method.

---