Phase and Pupil Amplitude Recovery for JWST Space-Optics Control

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Abstract: Phase and pupil amplitude recovery are presented for the JWST NIRCam using OMA test data. Two algorithm approaches are considered to establish error bars and to provide an optical characterization of the NIRCam.

OCIS codes: (100.5070) Phase Retrieval; (110.6770) Telescopes; (120.5050) Phase Measurement

1. Introduction

The successor to the Hubble Space Telescope, the James Webb Space Telescope [1] (JWST) is one of NASA's great observatories of the Origins program [2] and is scheduled to launch in 2014. JWST commissioning and periodic optical maintenance will incorporate image-based wavefront sensing and control (WFSC) to align the primary mirror segments, minimize the effects of optical figure error, and correct the secondary mirror position of the 3-mirror anastigmat design [3, 4]. The wavefront sensing method specified for JWST is image-based in the sense that point-source stellar images are collected and processed to recover optical phase information (phase retrieval). The primary camera for this function is the JWST Near Infrared Camera (NIRCam) [5]. In this paper we report recent results on both the phase and pupil amplitude recovery using two separate algorithm approaches, the non-linear optimization (NLO) approach [6] and the HDA-VSM iterative transform method [7, 8]. We compute gradients, discuss algorithm features, and demonstrate results using recent data from the NIRCam Optical Metrology Assembly (OMA) testing.

2. Results

A number of image-based phase retrieval techniques have been developed that can be classified into two general categories, the (a) iterative-transform [9] and (b) methods based on the NLO approach [6]. From these two main approaches, some variations have been developed that are driven by NASA's Technology Readiness Level 6 [10] and also on the availability of both image and pupil aperture plane data. E.g., during the OMA Testing held at Lockheed Martin, the pupil imaging lens subassembly was not functional, and thus, both estimation of the pupil phase and amplitude was required. In Fig. 1 we show typical phase and amplitude retrieval resulting from these algorithms. A related but more specialized amplitude recovery technique has been reported earlier [11]. In this study, one of the methodologies used was to implement a straightforward calculation of the gradient, in combination with a conjugate gradient optimization procedure [12], as shown in Fig. 1.

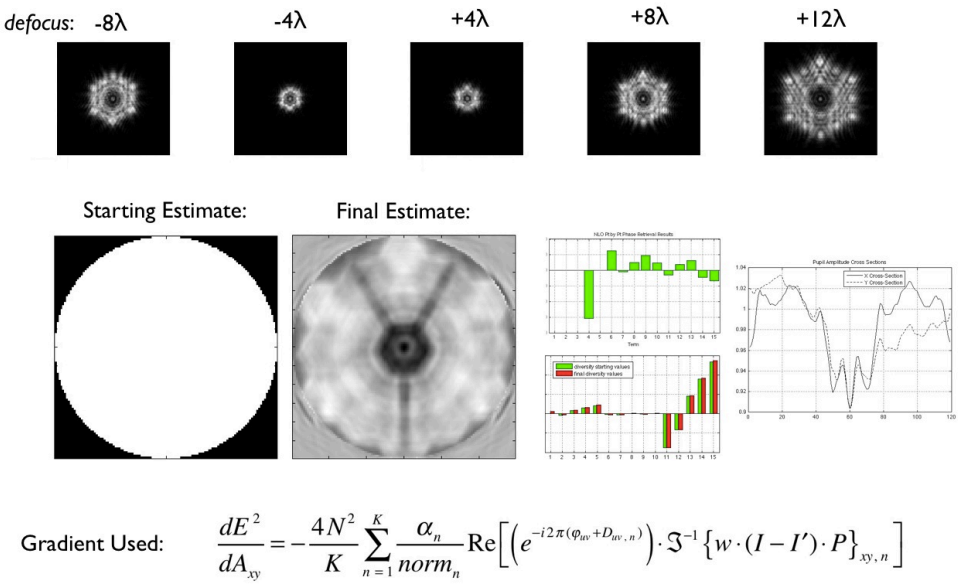

Fig. 1. NIRCam Image-Based Data, Phase and Amplitude Recovery Results.

3. References

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