CLAS-2D™
Wavefront Analysis

Measuring phase and irradiance of laser beams and beams propagating through optical systems is fast, easy, and accurate using AMO WaveFront Sciences CLAS-2D™ family of wavefront sensors (CLAS-2D™, CLAS-XP™, CLAS-HP™, CLAS-NearIR-320™, CLAS-NearIR-640™). Phase parameters, such as wavefront tilt, peak-to-valley error, rms wavefront error, astigmatism, coma, spherical aberration, and focus error/collimation, give practical beam characteristics for designing, evaluating, and adjusting lasers and optical systems.

AMO WaveFront Sciences wavefront sensors combine the features of interferometers, beam profilers, beam quality meters, autocollimators, and quadrant detectors into a single, fast, compact instrument.

Hardware

AMO WaveFront Sciences designs and manufactures complete turnkey Shack-Hartmann wavefront sensor systems, including the sensor head, computer, software, and cabling. The sensor head consists of a digital CCD camera and a custom micro lenslet array with a patented fixed mount design for accurate and repeatable measurements and permanent alignment. High quality accessories are offered for tip-tilt sensor head alignment, input beam expansion, beam reduction, and beam attenuation.

Software

CLAS-2D™ software drives all models of AMO WaveFront Sciences wavefront sensors. The software is designed to provide thorough and accurate metrology of phase, irradiance, and beam geometry characteristics of laser beams and beams propagating through optical systems. The software is easy to use and contains features that have evolved through practical experience by hundreds of users.

Phase parameters:

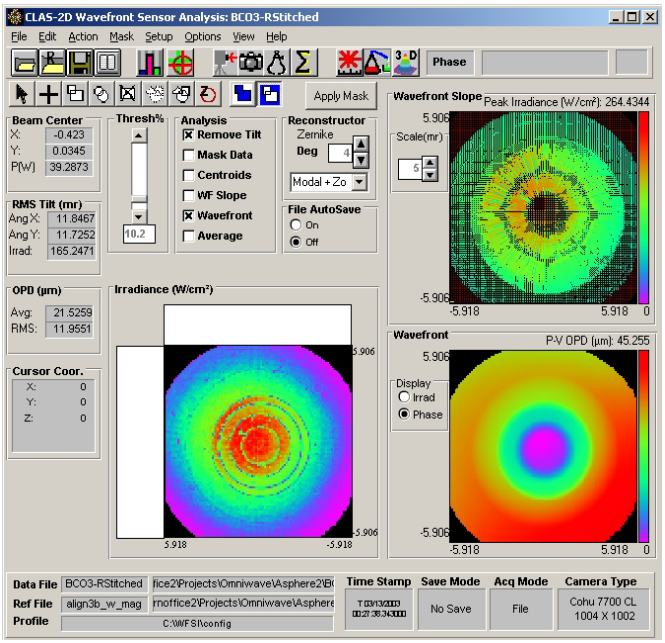
AMO WaveFront Sciences software displays and reports the following phase data:

· Peak-to-valley error
· rms wavefront error
· Tilt
· Focus error (defocus, collimation)
· Radius of curvature of wavefront
· Astigmatism
· Coma
· Spherical aberration
· Higher order Zernike aberrations (polynomial degree/order definable by user)
· Seidel aberrations
· 2D & 3D wavefront image
· Fringe representation

Other beam parameters:

In addition to phase measurement, the software displays and reports other beam diagnostic data:

· Laser beam quality, M^2
· Angular alignment (input beam with respect to sensor head)
· 2D & 3D irradiance image
· Strehl ratio
· Beam waist location and radius
· Beam diameter
· Beam ellipticity
· Beam divergence
· Far field irradiance distribution (Point Spread Function)
· Irradiance distribution at the focal point of a lens
· Modulation Transfer Function MTF
· Power Spectral Density PSD
· Beam propagation: calculated beam size and image at user-entered distance from wavefront sensor (uses Fast Fourier Transform)



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Software controls

CLAS-2D™ software incorporates years of user experience, making it practical even in difficult optical applications. Some of the software controls are:

Measurement units - displays results in waves, microns, meters, or radians

Wavelength - defines operating wavelength for accurate calculations

Camera acquisition speed - adjusts camera acquisition speed to accommodate source intensity and pulsed measurement

Thresholding - adjusts thresholds for ambient conditions and accurate calculations

Masking - manually draws masks to define measurement area with single or multiple masks (round, elliptical, square, rectangular) or selects automatic masking criteria

Reference files - nulls aberrations in beam expanding or reducing optics for measuring large and small beams or creating reference wavefront file of "golden part" for quality comparison

Wavefront parameters - isolates or combines specific Zernike wavefront aberrations for analysis

External triggering - synchronizes wavefront data acquisition with pulsed laser (optional) or externally triggers wavefront data capture from an external program

Multi-buffer acquisition - captures raw data at camera frame rate for post analysis

Data averaging - averages wavefront data to compensate for environment

Data saving - saves all data and images or any user-selected data for post analysis

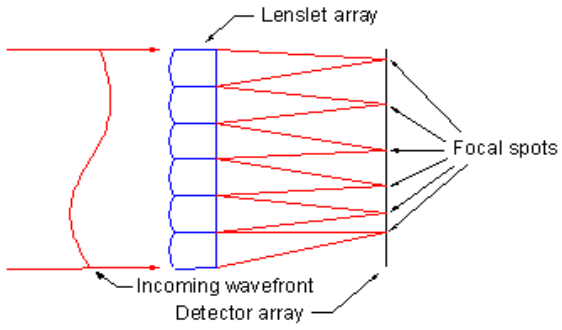
Report formats - allows changes to Microsoft Word™ report format

Data exporting - controls which data is exported and file format: ZEMAX, Matlab, Grid, ASCII, Excel

Graphing - graphs phase and irradiance data; changes presentation between sequential and time (seconds, minutes, hours, days)

Color representation - changes false color for highlighting important features

Remote operation CLAS-2D™ server - allows full control of the wavefront sensor system from an external program through an optional Active X component; this can be used to customize the wavefront sensor operation for production applications or for operating in remote locations, such as in clean rooms



CLAS-2D™ uses a micro-optic lenslet array to dissect a light beam into multiple focal spots. The positions of these focal spots are used to measure the optical wavefront.

Specifications are subject to change without notice.

Advantages

Shack-Hartmann wavefront sensors measure both phase and irradiance, combining the benefits of interferometers and beam profilers. Furthermore, they provide you with the following advantages:

Fast Acquisition

Capturing all phase and irradiance information in as quickly as a few micro seconds (see specifications for specific models), gives the wavefront sensor a practical laboratory advantage over interferometers. Fast acquisition eliminates vibration issues. It also allows you to minimize environmental variations by averaging data. For adjusting optical systems, you get nearly real time wavefront analysis and reporting.

Pulsed Measurement

AMO WaveFront Sciences offers a patented method and proprietary software for measuring full wavefront characteristics and M^2 beam quality of individual pulses in a pulsed laser beam. All the same beam diagnostic data are provided for pulsed beams as for CW beams. This feature is a practical and easy way to make measurements that would normally be difficult.

Broadband

AMO WaveFront Sciences offers wavefront sensor models that measure phase accurately over three wavelength ranges: 300nm - 1100 nm, 1100nm - 1700nm, and 8 microns - 9.2 microns. Using proprietary algorithms, the focal spot locations used to determine wavefront tilt are located precisely over the designed wavelength ranges. See performance specifications in the specifications data sheet.

High Dynamic Range

The Shack-Hartman method, along with AMO WaveFront Sciences lenslet design and proprietary software algorithms, give you many waves of tilt measurement, the specific amount depending on your choice of lenslet focal length. In angular terms, you can typically expect several milliradians of tilt capability.

Small Size

AMO WaveFront Sciences sensor heads are only a few inches long, the exact length depending on the model. The small and lightweight sensor heads easily fit in any optical setup, in any orientation, and can be readily moved.

Rugged

The patented sensor head design features a fixed mount lenslet array, maintaining permanent physical alignment and calibration. AMO WaveFront Sciences customers use their sensors in a wide range of conditions, including aircraft and industrial environments.

Low Cost

Compared to interferometers for a given wavelength and beam size, prices for AMO WaveFront Sciences wavefront sensors are typi-

Applications

AMO WaveFront Sciences Shack-Hartmann wavefront sensors are used for optical characterization in a wide variety of applications:

- Laser rods, Laser diodes, VCSELs, CW, & pulsed lasers
- Lenses and micro-optics
- Optical system testing
- Free space communications
- Very large and very small optics
- Surface defects, flatness, and deformation
- Dynamic structure analysis
- Turbulence
- QA and prodution testing (production environment inter face available)
- Alignment
- Collimation

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