

Contents

- 3 Overview
- 4 Tolerance Chart
- 6 Options
- 7 First Article Inspection (FAI)
- 10 Coating
 - A. Spectral Performance
 - B. Environmental Data
 - C. Coating Witness Piece Samples
 - D. Laser Damage Certifications
- 16 Inspection Data
 - A. White Light
 - Interferometer Scans
 - B. Profilometer Traces
 - C. Ultrasurf 3D Scans
 - D. Inspection Data Machines
- 25 Material Certification
- 27 Certificate of Conformance
- 28 ROHS Certification
- 30 Index

Overview

Inspection data is a valuable tool used to verify the optics produced meet customer specifications. LaCroix Precision Optics offers several forms of inspection data to validate the following specifications:

- Material
- Diameter
- Center Thickness
- Optical Power and Irregularity
- Surface Roughness
- Bevel Size
- Surface Quality
- Coating Performance
- Coating Durability
- Laser Damage
- Etc.

The following reference guide will provide an overview of the various forms of inspection data LaCroix Precision Optics can provide.

Inspection Data Reference Guide



www.lacroixoptics.com

Batesville, AR

870.698.1881

CUSTOM MANUFACTURER OF PRECISION OPTICS:

Lenses • Achromats • Aspheres • Windows • Prisms • Wedges • Coatings

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Spherical Tolerance Chart



Materials:	Schott and Ohara Optical Glass, Fused Silica, Fused Quartz, Filter Glass, Float Glass, and Silicon
Diameter Range:	4mm - 150mm
Coatings:	Coatings Ranging from 280-2400nm (High UV to SWIR), BBARs, V-Coats, High Laser Damage Resistance, Hydrophobic Coatings, Dielectric Mirrors, Beam Splitters, and Custom Coatings
Lead Time:	8-10 Week Standard Delivery, Expedite Service 2-6 Weeks
Core Competencies:	Spherical Lenses, Achromats, Aspheres, Windows, Wedges, Prisms, and Axicons
Ideal Quantities:	1 - 100,000+

ATTRIBUTE	STANDARD	PRECISION	HIGH PRECISION
Glass Material (Nd, Vd)	±0.001, ±0.8%	0.0005, ±0.5%	Melt Data
Diameter (mm)	≥ ±0.00/-0.10	0/-0.025	≤ 0/-0.015
Center Thickness (mm)	≥ ±0.10	±0.050	≤ ±0.025
SAG (mm)	≥ ±0.025	±0.020	≤ ±0.010
Clear Aperture	≤ 80%	90%	≥ 95%
Radius	≥ 8 Fr	≥ 5 Fr	≤ 1 Fr
Irregularity - Interferometer (fringes)	≥ 2	1 - 0.5	≤ 0.2
Irregularity - Profilometer (microns)	±1	±.5	≤ ±0.1
Optical Centration	≥ 5'	3'	≤ 1'
Wedge Prism (TIA, arc min)	≥ ±5'	±3'	≤ 1'
Bevels (face width @ 45 degrees, mm)	≥ Nom. ±.5	≥ Nom. ±.25	≤ Nom. ±.15
Scratch - DIG (MIL- PRF - 13830B)	80-50 to 60 - 40	40 - 20	20 - 10 to 10-5
Surface Roughness (Å rms)	≥ 50	20	≤ 10

[Download Tolerance Chart](#)

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Aspherical Tolerance Chart

ASPHERE CHEAT SHEET



Metrology	2-D and 3-D Metrology		
Diameter (mm)	10-200mm		
Frequency Errors	Specify Spatial Frequency Bands as Necessary		
Attribute	Standard	Precision	High Precision
Form Error (microns)	±1	±.5	±.1
Slope Error (µm/mm) 1mm Integration Window	.5 µm/mm	.25 µm/mm	.1 µm/mm
Surface Roughness	25 Å	15 Å	5-8 Å
Centration (Optical Deviation)	3'	1'	30"

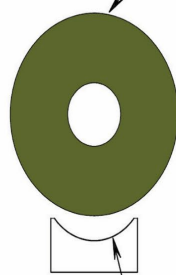
Top 10 Design Tips

- Increment your sag table by .5 mm or an integer.
- Define which aspheric equation you are using; most manufacturing machines use the the even aspheric equation.
- Avoid using odd term coefficients.
- Try to avoid using an A2 term.
- Include a tolerance for the following:
 - Vertex Radius
 - Form Error
 - Slope Error
 - Centration/Decentration
 - Geometric Tolerancing
 - Non-Aspheric Tolerancing
- Consider equivalent materials, which can potentially save time and money.
- Get your manufacturer involved early on in your design for manufacturability.
- Do not tolerance the deformation terms or conic constant.
- Watch the minimum local radius on concave aspheres, minimum 15 mm.
- Edge thickness at processing diameter, which is typically 2-4 mm outside the final diameter should be 1 mm or more.

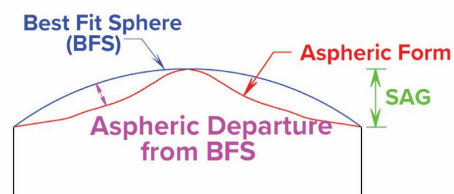
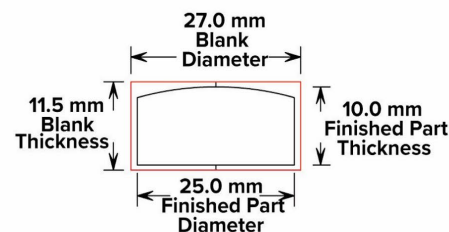
Even Aspheric Equation:

$$z = \frac{cr^2}{1 + \sqrt{1 - (1+k)c^2r^2}} + \sum_{i=1}^N A_i E_i(x, y)$$

Grinding Wheel



Tool Clearance Issues
Minimum Local Radius 15mm



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Options

Inspection Data	
Standard	Material Certification Certificate of Conformance Coating Chart Coating Adhesion/Abrasion Test
Options	
First Article Inspection ¹	
Coating Environmental Testing	
Witness Piece Samples	
Laser Damage Testing/Certification	
Mechanical Inspection Data	
100% Inspection	
Lens Serialization	
Interferograms	
Profilometer Traces	
3D Aspheric Surface Scan	
White Light Interferometer Scans	
ROHS Certification	
1. First Article Inspection quantity will default to the standard AQL level unless specified.	

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First Article Inspection (FAI)

AS9102 REV A. FIRST ARTICLE INSPECTION			LPO #
FORM 1: Part Number Accountability		First Article Qty 2 PC	
1. Part Number	2. Part Name	3. Serial Number	4. FAI Report Number
5. Part Revision Level	6. Drawing Number	7. Drawing revision	8. Additional Changes
9. Manufacturing Process Reference	10. Organization Name LACROIX PRECISION OPTICS	11. Supplier Code	12. P.O. Number
13. Detail FAI	14. Full FAI	<i>Baseline Part Number including revision level</i>	
Assembly FAI	Partial FAI		
<i>Reason for Partial FAI:</i>			
a) if above part number is a detail part only, go to Field 19			
b) if above part number is an assembly, go to the "INDEX" section below .			
INDEX of part numbers or sub-assembly numbers required to make the assembly noted above.			
15. Part Number	16. Part Name	17. Part Serial Number	18. FAI Report Number
1) Signature indicates that all characteristics are accounted for; meet drawing requirements or are properly documented for disposition.			
2) Also indicate if the FAI is complete per Section 5.4: FAI complete * FAI not Complete			
19. Signature :			20. Date
21. Review ed By			22. Date
23. Customer Approval			24. Date

Inspection Data Reference Guide



Coating



Our in-house coating facility houses seven coating chambers.



Our optical coating technologies include resistive heat deposition, electron-beam deposition, ion-assisted deposition, and plasma-assisted deposition.

Optical coatings can drastically improve optical system performance by enhancing the transmission or reflection properties of optical surfaces. Coatings are produced by deposition of critically controlled layers of various index materials onto the surfaces. Each coating is designed specifically for substrate index, spectral specifications, and environmental durability requirements. Qualifications of performance include spectral measurements as well as environmental durability testing.

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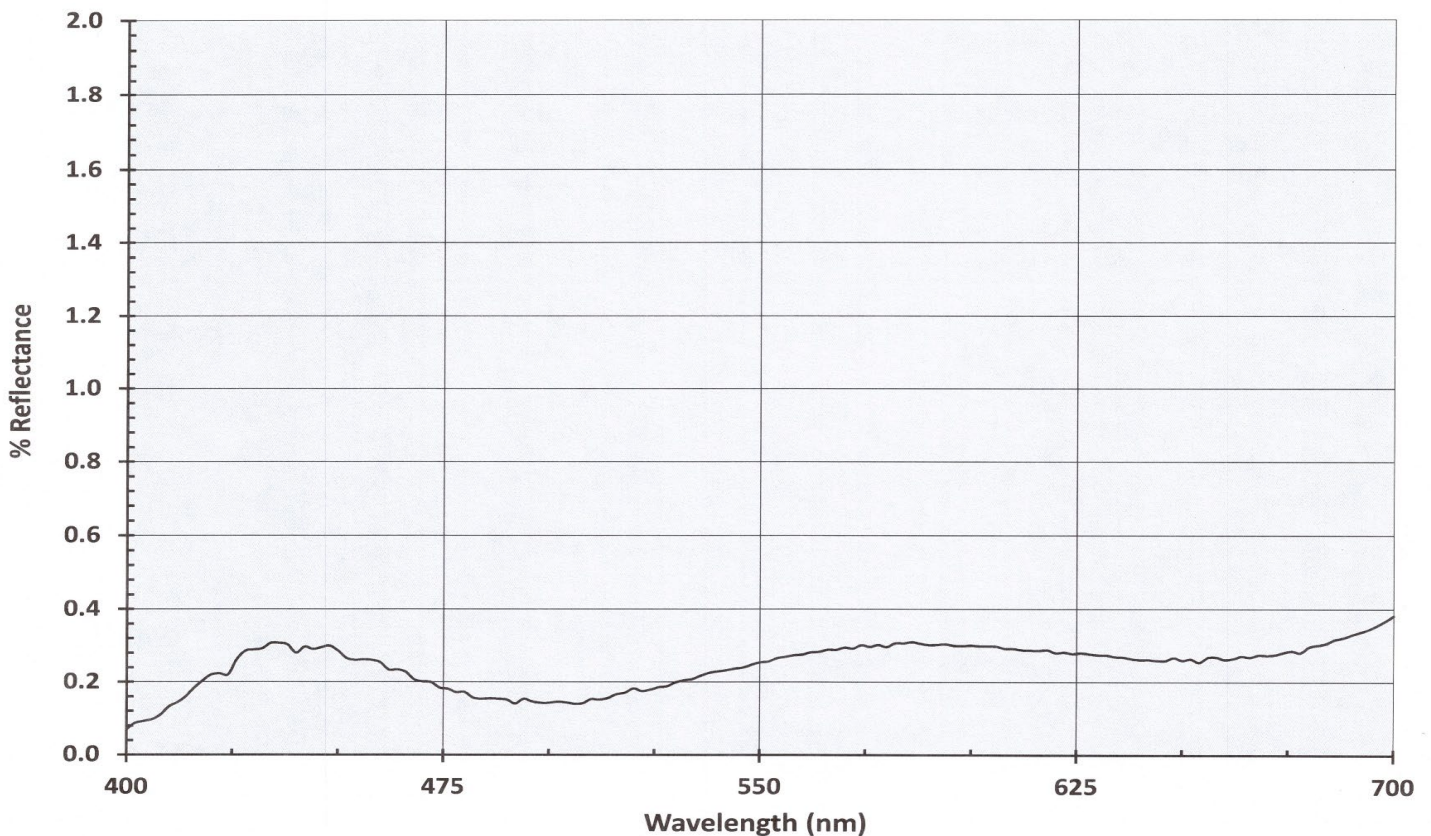
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Spectral Performance

Spectral performance is verified by measuring the reflectance and/or transmittance of witness samples of similar index from the production batch using spectrophotometers. The actual performance is compared with the specified performance for qualification.

Spectral Performance



17071253A, 7/12/2017, BB-510, AOI 6 Deg, R-pol, PN P17128,

Coating Witness Piece Samples Chart

Witness piece samples are placed in each coating run in order to verify performance and durability. The material of the witness piece uses the same material or a material with a similar index. The chart below lists all of our stock witness piece material samples. Special material witness samples are available at an additional charge upon request.

Active - Witness Samples	
Glass	Index (Nd)
FS	1.45844
S-FSL5	1.48749
N-BK-7	1.51680
N-BAK2	1.53996
N-BAK1	1.57250
N-SK2	1.60738
N-PSK53A	1.61800
S-TIM2	1.62004
F-1	1.62600
N-SF2	1.64769
N-SF5	1.67271
N-SF15	1.69892
N-LAK8	1.71300
N-SF10	1.72828
S-TIH3	1.74000
S-LAM2	1.74400
N-SF4	1.75513
N-SF14	1.76182
SF-11	1.78472
S-TIH6	1.80518
S-TIH53	1.84666
S-LAH58	1.88300
S-NPH2	1.92286
S-LAH79	2.00330

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Laser Damage Threshold Certification



LASER DAMAGE THRESHOLD SPECIFICATION SHEET AND CERTIFICATE OF COMPLIANCE

DATE: June 16, 2014

CUSTOMER: LaCroix Optical Company

ADDRESS: 50 LaCroix Drive
Batesville, AR 72503-2556

P.O. NUMBER: 007913

ATTN: Mike Parker

PART ID: AR-039

TEST TYPE: Laser Damage Threshold

QUANTITY: 1

TEST LOG NUMBER: 48104

SUBSTRATE MATERIAL: Fused Silica

SAMPLE SIZE: ~

TEST PREP: Methanol drag

COATING TYPE: V-coat

INCIDENCE ANGLE: 0°

TEST WAVELENGTH: 1064 nm

PRF: 20 Hz

POLARIZATION: Random

TEST BEAM PROFILE: TEM₀₀

PULSEWIDTH (FWHM): 20 ns

AXIAL MODES: Multiple

SPOT DIAMETER (1/e²): 454 μm

NUMBER OF SITES: 100

TEST METHOD: Least Fluence Failure

EXPOSURE DURATION: 200 shots/site

DAMAGE DEFINITION: Plasma, increased He-Ne scatter. Visible damage as observed with 150x Nomarski darkfield microscope.

COMMENTS: Laser damage threshold measured as 63.00 J/cm², peak fluence. Part irradiated at 63.00 J/cm² with no damage in 10 sites. See data on page 2.

Spica Technologies certifies that this sample has been exposed to the conditions described above. All test and calibration data are maintained on file. All instrument calibration is traceable to NIST.

Test conducted by 

18 Clinton Drive #3
Hollis, NH 03049
www.spicatech.com
603-882-8233

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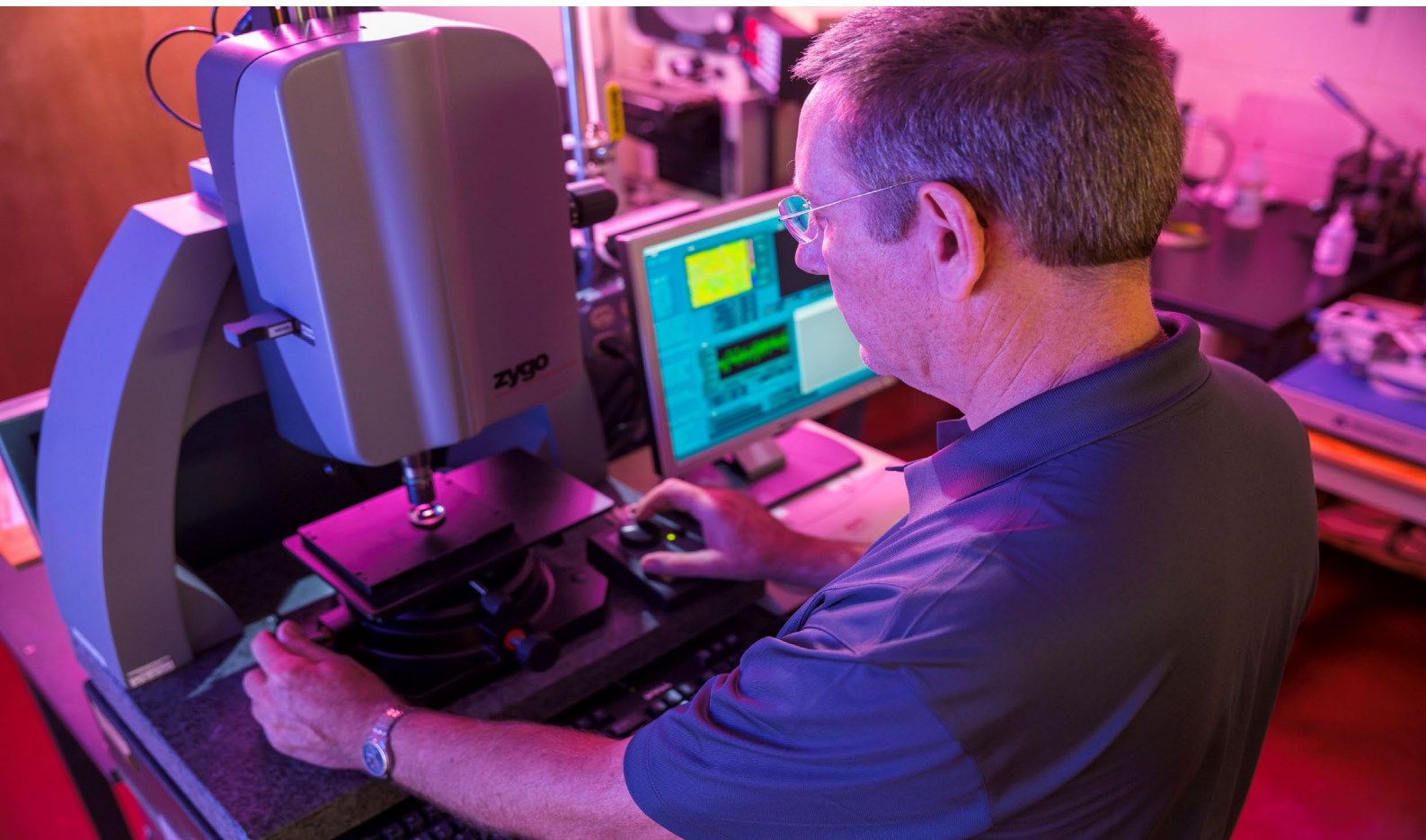
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Inspection Data

Inspection Data helps us verify the optics are made to specification. LaCroix Precision Optics does not only invest heavily into our production capabilities, we also invest heavily in our inspection machines and tools. Like the old saying goes: if you can't measure it, then you can't make it.



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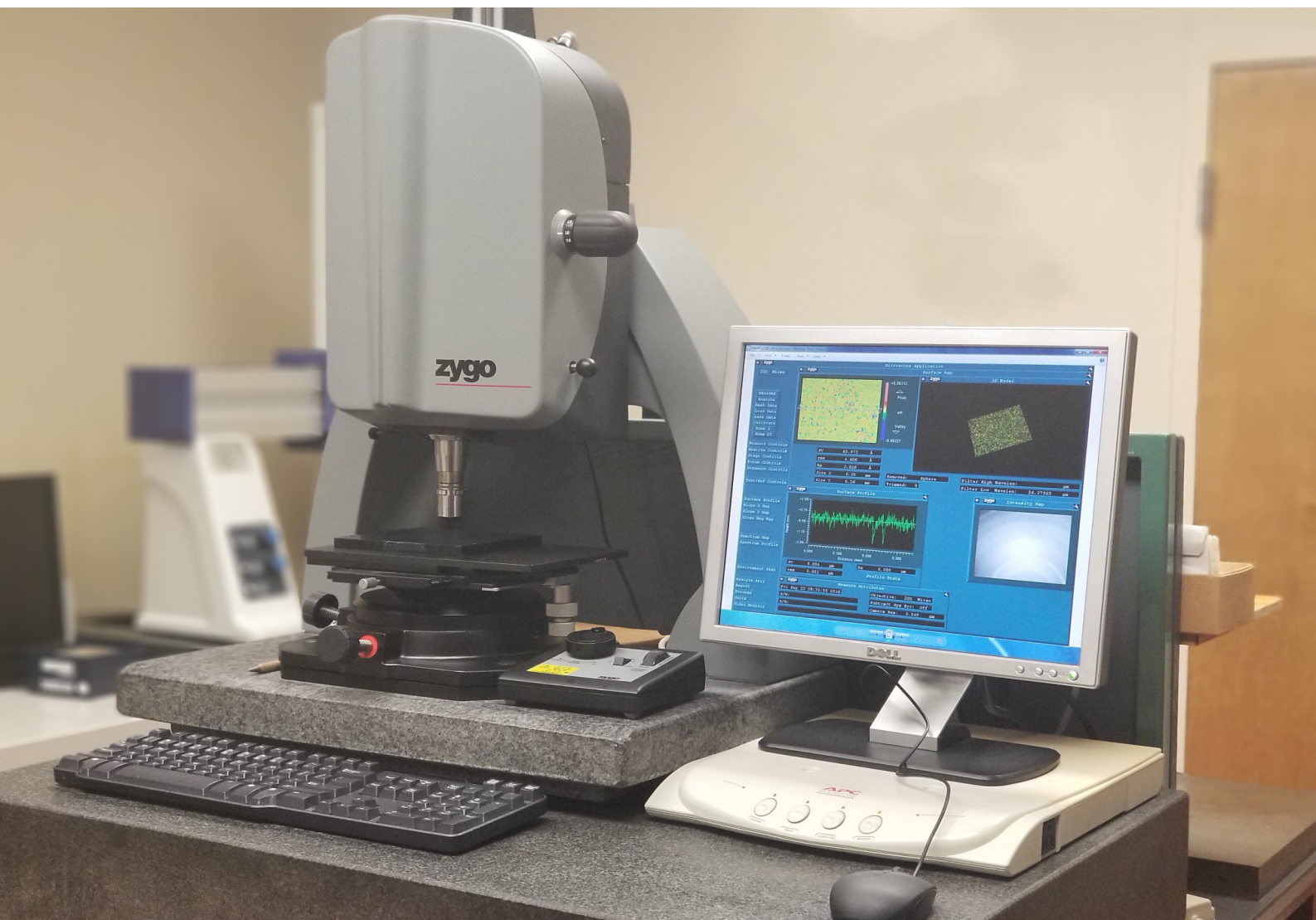
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Zygo – NewView White Light Interferometer

This machine measures the surface roughness on a lens. Scans can be provided upon request. The following page provides a sample scan output from this white light interferometer.



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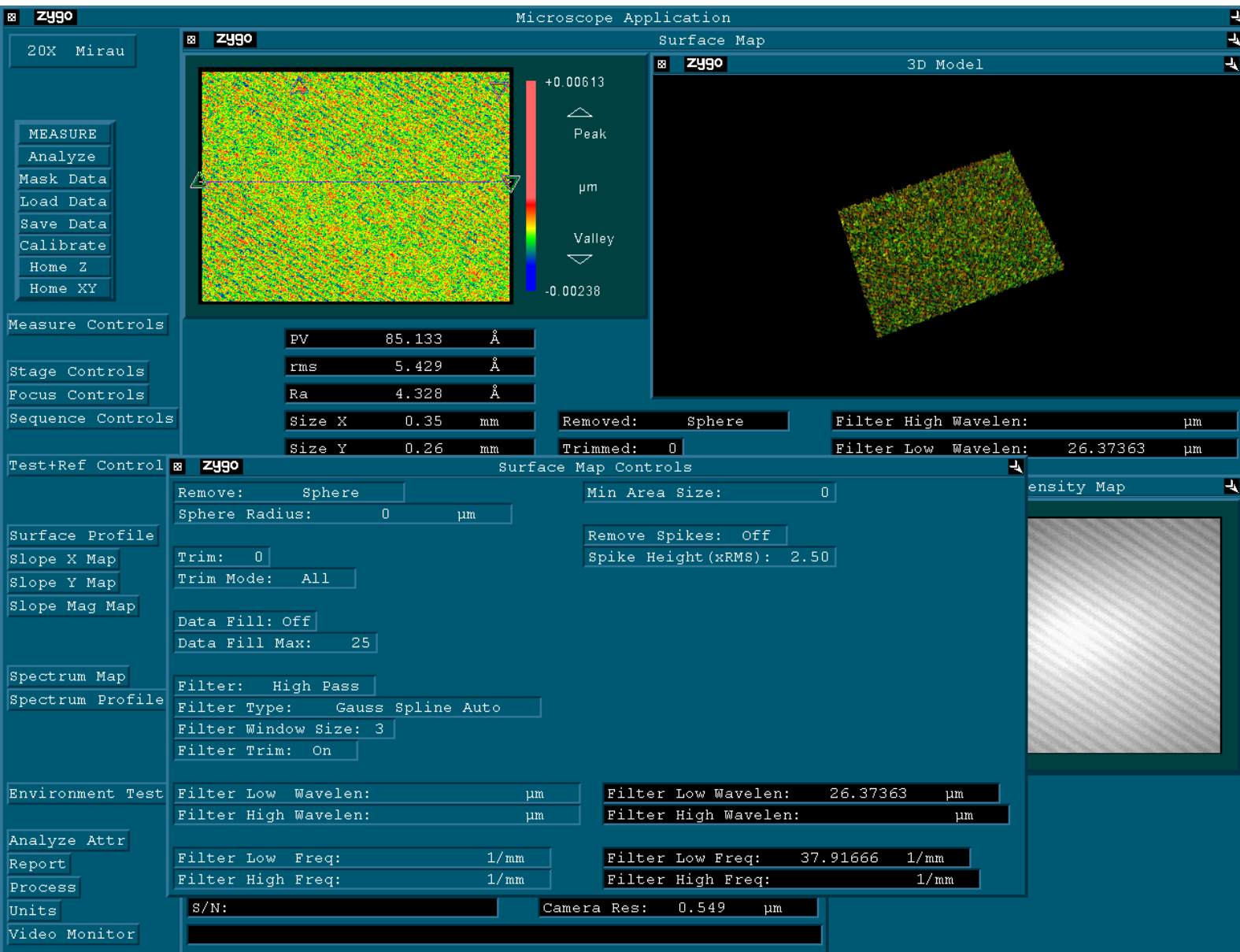
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White Light Interferometer Scans

This machine utilizes noncontact scanning white light interferometry to acquire ultrahigh Z-resolution images. Profile heights range from <math><1\text{ nm}</math> up to



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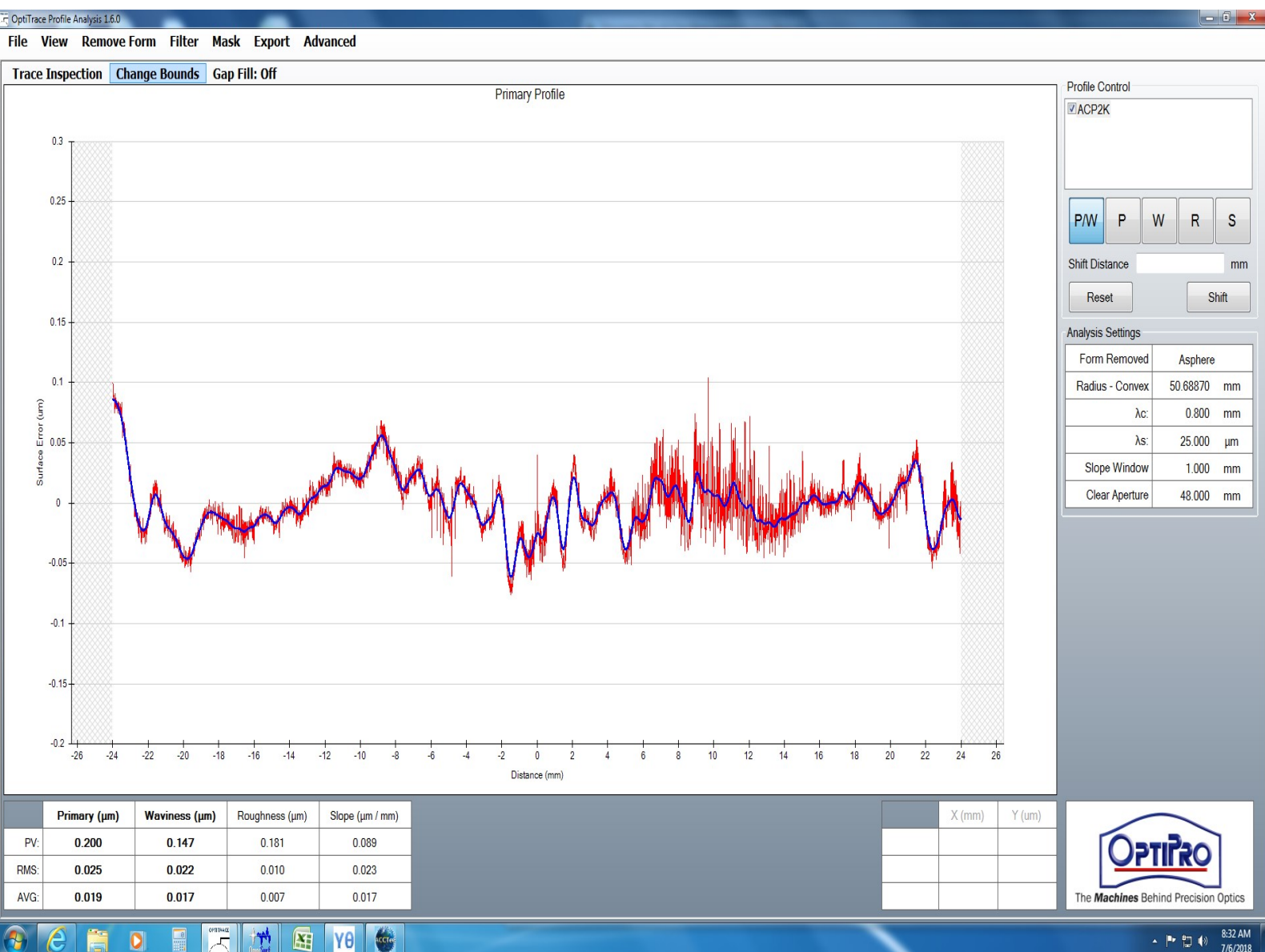
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Profilometer Traces

Profilometer traces measure the aspheric surface of a lens. The waviness measurement in microns corresponds with the form error in a peak-to-valley measurement. The slope error is measured in microns over a given integration window. A typical integration window would be 1 millimeter. Below is a sample of a profilometer trace.



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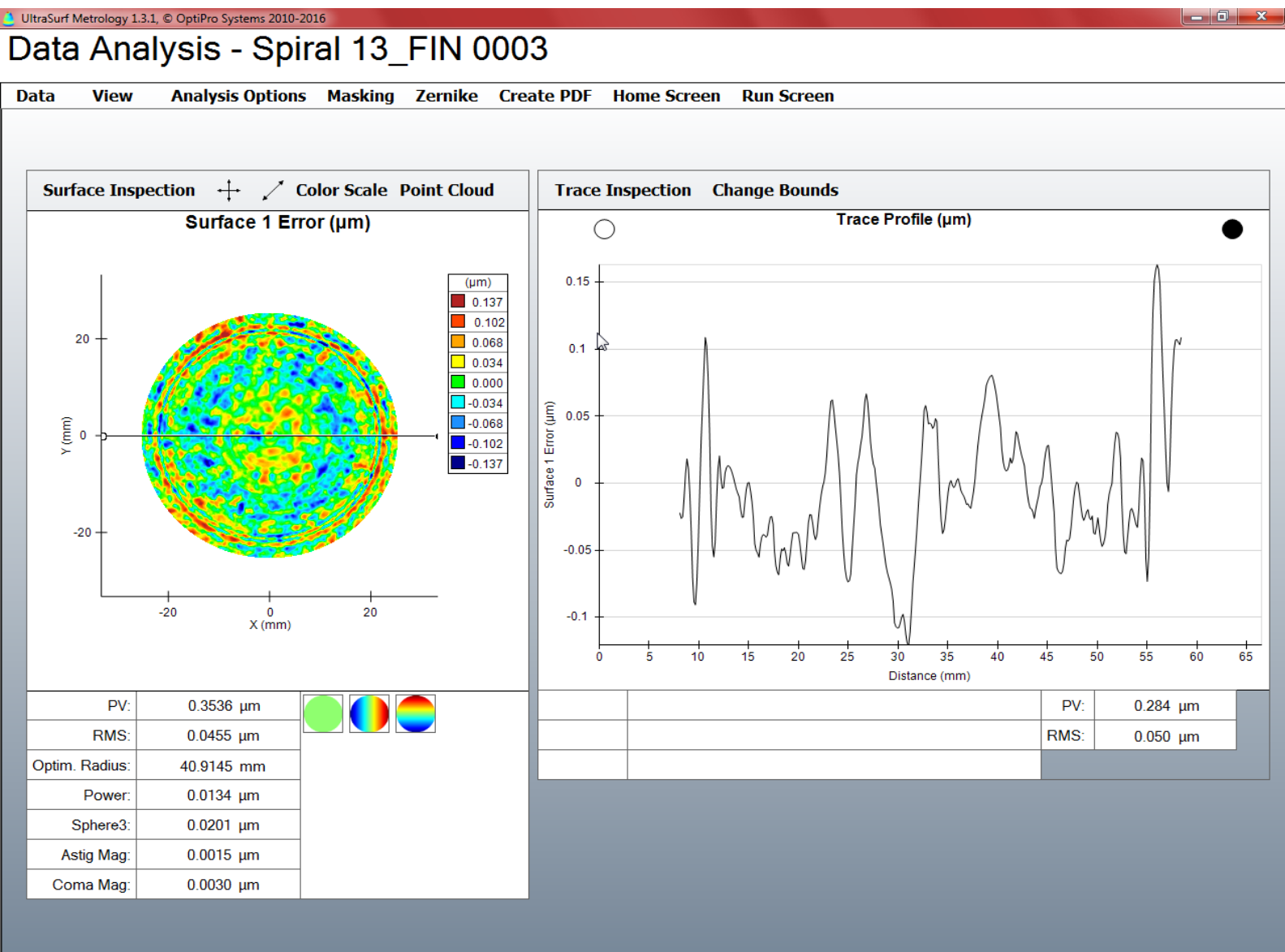
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Ultrasurf 3D Traces

LaCroix Precision Optics also offers 3D metrology for Aspheres, allowing for correction of asymmetry as well as providing full aperture measurements. Below are examples of a form and slope error measurement. The form error is measured in microns and the slope error is measured in microns per millimeter with a 1 millimeter integration window.

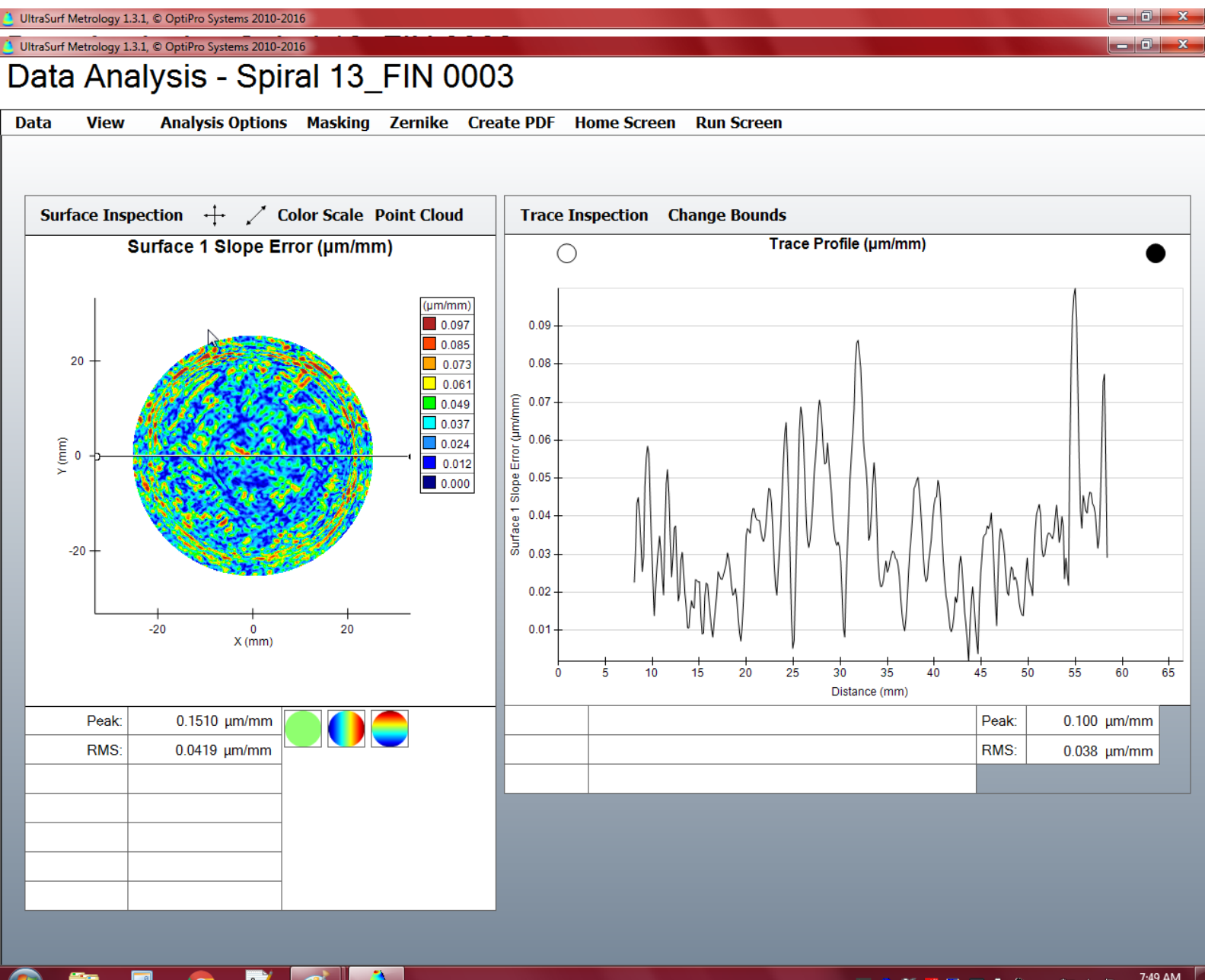


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Ultrasurf 3D Traces

Slope Error ($\mu\text{m}/\text{mm}$)



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Trioptics - Opticentric

This machine tests and measures optical centering errors. The errors we test and measure includes surface tilt error of a spherical surface, shift of a lens, tilt of a lens, cementing error, tilt of the aspherical axis, center thickness, and if air gaps are not correct.



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Xonox – Precision CT Gauge

This center thickness gauge measures SAG depth, surface aperture diameter, total lens height, and stock removal in addition to CT measurement. This gauge causes low impact on the lens we measure.



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Zygo GPI XP Interferometer with DMI

This interferometer has displacement measuring interferometer capabilities. This is performed by using two light beams, which form an interference pattern when these two beams overlap. Since the wavelength of the visible light is very short, slight changes in the differences in distance travelled between the two beams can be detected. As a result, this DMI feature precisely measures relative changes in distance to a target.



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Material Certification

Material certifications are provided by the material manufacturer and verify the actual index and dispersion of the optical glass. Material certifications are standard with orders and can be provided at no additional charge upon request.

Supplier Name

Supplier Address

Phone: (xxx) xxx -xxxx

Certificate of Conformance / Melt Data

Customer:	<u>LaCroix Precision Optics</u>		
Purchase Order:	<u>XXXX</u>		
Part Number:	<u>PXXXXX</u>		
Quantity	<u>33 P/O</u>		
Glass Type:	<u>S-LAH60 834-372</u>		
Grade:	<u>A</u>		
Anneal:	<u>Fine</u>		
Bubble:	<u></u>		
Requested Nd:	<u>1.83400</u>	Tol +/-: <u>0.0005</u>	Actual Nd: <u>1.83407</u>
Requested Vd:	<u>37.16</u>	Tol +/-: <u>+438-158</u>	Actual Vd: <u>37.2</u>
Melt Number:	<u>SCP4812X605-14D</u>		

The above mentioned parts and materials are certified to have been produced in conformance with the requirements, specifications and or drawings listed on this Purchase Order.

This form is to certify that the above mentioned item (s) have been supplied without alterations to the manufacturers supplied measurements, values and quality unless otherwise noted.

Special Notes: Dia: 11.00 mm

Ct: 4.50 mm

reference dimensions

HOMO: A20

Signed by: _____ **Date:** 7/13/18

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Melt Data

Supplier Name
Supplier Address

Ohara Corporation
50 Columbia Road
Branchburg, NJ 08876
Tel: (908) 218-0100
Fax: (908) 218-1685

Ohara Order No. **J3021005**

Date **2/15/2013**

Ohara Stock No. **J2071057F**

Customer P.O. No. **XX**

Glass Type	S-LAH60	n_C	1.82745 / 7	V_d	37.2 / 0
Form	FSTP	n_d	1.83407 / 7		
Melt No.	SCP4812X605-140	n_F	1.84989 / 7	Weight	13.70 lb
Anneal No.	E001	n_g	1.86285 / 7	Quantity	1 Pc.

Measured at 25 °C

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Certificate of Conformance

A certificate of conformance verifies that we made the product to the given print. This document is standard with every order.



50 LaCroix Drive - P.O. Box 2556
Batesville, AR 72503-2556
Ph: 870.698-1881 Fax: 870-698-1880

Certificate of Compliance

Customer: XXXX
PO Number: XXXX

LaCroix Part: XXXXX
Cust Part#: #XXXX
Quantity: XXXX

LaCroix Precision Optics hereby certifies that all materials and parts supplied on the above purchase order are in conformance with all requirements, specifications, and drawings to the extent specified. The required test and/or inspection reports resulting from compliance with applicable contract/purchase order requirements are on file and available for review by customer inspectors at any reasonable time.

The optical materials are deemed compliant with Directive 2011/65/EC (RoHS2) or exemptions stated in 2011/65/EC Exemption 13 (a).
Country of Manufacture - USA

Darrell Gilley

Quality Control

Darrell Gilley

7/27/2018

Date

QF 120001

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Restriction of Hazardous Substances

An ROHS certification can be requested.

Certification of Compliance

EUROPEAN DIRECTIVE (EU) 2015/863 RESTRICTION OF HAZARDOUS SUBSTANCE (RoHS Recast)

I hereby certify compliance to RoHS/RoHS 2 Directive as described in this document.

Signature of Supplier representative
Jimmy Crafton

Name of Supplier representative
Quality Assurance

Title of Supplier representative

Date:

The following item is produced by: LaCroix Precision Optics
(hereafter referred to as "Supplier")

LaCroix Part Number:

Part Number	Rev	Description	Exem #

The Supplier hereby certifies one of the following (check the appropriate box):

The items listed above is **FULLY COMPLIANT** to the requirements of Directive 2011/65/EC (RoHS Recast). The Supplier also certifies that any and all processing of the materials listed above does not change the RoHS compliance of the item per Directive 2011/65/EC (RoHS Recast).

The item listed above is **COMPLIANT WITH EXEMPTIONS**. The exemptions are to be indicated in Appendix A of this document.

DISCLAIMER

This determination is based upon information obtained from sources which the Supplier believes are reliable. However, the information is provided without any representation of warranty, expressed or implied, regarding accuracy or correctness. The Supplier does not specifically run any analysis on our raw material or end product to measure these substances.

The information provided in this statement is correct to the best of the Supplier's knowledge, information and belief.

REFERENCE

This Maximum Concentration Values (MCV) table defines the maximum amount of an individual restricted substance within each homogeneous material that compose the component.

Material	Maximum Allowable Limits by Weight
Cadmium (Cd)	<0.01% (100 ppm)
Lead (Pb)	<0.10% (1000 ppm)
Mercury (Hg)	<0.10% (1000 ppm)
Hexavalent Chromium (Cr6+)	<0.10% (1000 ppm)
Polybrominated Biphenyls (PBBs)	<0.10% (1000 ppm)
Polybrominated Diphenylethers (PDBEs)	<0.10% (1000 ppm)
Bis (2-Ethylhexyl) phthalate (DEHP)	<0.10% (1000 ppm)
Benzyl butyl phthalate (BBP)	<0.10% (1000 ppm)
Dibutyl phthalate (DBP)	<0.10% (1000 ppm)
Diisobutyl phthalate (DIBP)	<0.10% (1000 ppm)

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Index

Topic	Page Number
3D Metrology	20-21
Center Thickness	4
Certificate of Conformance	27
Diameter	4-5
Environment Testing	12
First Article Inspection	7-9
Form Error	4-5
Laser Damage Certification	14-15
Material Certification	25-26
Optical Centration	4-5
Optical Irregularity	4
Profilometer Trace	19
Radius	5
Sag	5
Slope Error	4-5, 20-21
Spectral Performance Chart	11
Surface Quality	4
Surface Roughness	4
Wedge	4

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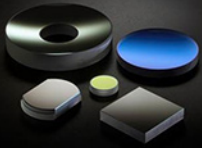
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