Comparison of Different Systems for the Measurement of Aspheric Lenses

APOMA Tucson Workshop
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Donald A. Pearson II
Content provided by Dr. Andreas Beutler
Overview

1. Mahr Company
2. MarSuf LD260 Aspheric 3D
3. MarForm MFU200
4. MarSurf TWI 60
5. Results Asphere #1, #2, #3, #4
6. Asphere production
7. Summary
Mahr - Company Summary

- Business Concentration: Metrology, Rotary Stroke Bearings, Spinning Pumps, Blending and Mixing Systems
- Established: 1861 in Esslingen, Germany
- Headquarter: Göttingen, Germany
- Turnover 2015: ~$300M
- Employees 2015: 1865 worldwide
- Subsidiaries: in 18 countries
- Globally active in over 60 countries
Mahr History

1861
1936
1945
1973
1990
1994
1995
1998
1999
2001
2004
2006
2011
2013
2015

Indicating measuring devices, gages, inspection devices, measuring machines
Length measuring units
Metering systems, rotary stroke bearings
Form and surface measuring units

Mahr s.r.o, Probostov, Czech Republic
One brand name: Mahr
Mahr international / Mahr Precision Metrology, Suzhou, China
Mahr Federal, Providence, USA
Mahr Metering Systems, Göttingen
Mahr OKM, Jena
Mahr Helios Metrology, Göttingen
150 years Mahr
Consolidated to Mahr GmbH Germany
The MWF Roland Friedrich GmbH and ESDI join the Mahr Group
Mahr - Worldwide

Company

Industries

Products
Mahr - Worldwide Customer Base

[Logos of various companies and industries]
Mahr/ESDI - Partial Customer List
Business Units
Mahr offers the right Measuring Instrument for the different Production Processes of Precision Optics

Z40, Z100, PS, VB

LD Aspheric

MFU 200 Aspheric 3D

Fizeau Interferometers

PS, VB, AS

aspheres

off-axis, cylinder, toroids, free-forms,

flats, prisms, spheres,

MarOpto Product Portfolio

Mahr

ESDI

150 YEARS

Mahr

EXACTLY

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High precision contour measuring instrument

MarSurf LD 260/130

- Traveling length X: 0.1 to 260 mm
- Measuring range Z: 13 mm (26 mm with double probe arm length)
- Resolution: 0.8 nm
- Residual noise Rq: < 1 nm
- Measuring speed: 0.02 to 10 mm/s
- Positioning speed: 0.1 to 200 mm/s
Form measurements

Rotationally symmetric samples
Combination of contour and form
= new metrology approach

Contour measuring instrument

Aspheric lens

Rotational axis from formtester

Circular and linear scans
= 3D-Topography
Measured Points
Discontinuous surfaces
MarSurf LD260/130 Aspheric 3D

Application:
- Aspheres
- Spheres
- Cones

No additional costs per lens or lens type
High Precision Formtester

Cylinder coordinate measuring system

Probe

Z

Workpiece

Measuring Circuit

Compensation system

MFU 200
Aspheric 3D
MarForm MFU 200 Aspheric 3D

- Probe system with different probe arms/tips
- Probe arm can be tilted/rotated
- Automatic centering and tilting table
Probes

Tactile probe with ruby ball

Optical probe tip > ± 20°

Probe arm with optical and tactile tip
Goran Baer: Measurement Results of the Tilted Wave Interferometer
Product Development MarSurf TWI 60

1. AMA Innovation Award 2014
2. Finalist PRISM Awards 2015
Measurements

MarSurf **LD260** Aspheric 3D
tactile – single point

MarForm **MFU200** Aspheric 3D
Non-contact – single point

MarSurf **TWI 60**
Interferometer - area
Asphere #1

MarSurf LD260 Aspheric 3D
tactile – single point

MarForm MFU200 Aspheric 3D
Non-contact – single point

MarSurf TWI 60
Interferometer - area

PV = 0.248 ± 0.05μm
nominal: 40.619300
geffitted: 40.614919

PV = 0.131 ± 0.05μm
Rfit = 40.617mm
Measuring error found

PV = 0.129 ± 0.05μm
Asphere #2 inside

MarSurf LD260 Aspheric 3D tacticle – single point

PV = 0.248µm

MarForm MFU200 Aspheric 3D Non-contact – single point

PV = 0.138µm
Asphere #2 inside

MarForm MFU200 Aspheric 3D
Non-contact – single point
Asphere #3

MarSurf LD260 Aspheric 3D
tactile – single point

MarForm MFU200 Aspheric 3D
Non-contact – single point

PV = 0.245µm
RMS= 0.053µm

PV = 0.177µm
RMS=0.027µm
Asphere #4

MarSurf LD260 Aspheric 3D
tactile – single point

MarForm MFU200 Aspheric 3D
Non-contact – single point

MarSurf TWI 60
Interferometer - area

PV = 0.487µm
PV = 0.377µm
PV = 0.405µm
Process Control with Mahr Aspheric 3D

Sphere

Pre-grinding

Grinding

MarSurf Aspheric 3D Tactile – 2D + 3D

Final polishing

MFU200 Aspheric 3D - non-contact – TWI 60 FI AS

Pre-polishing

Asphere
Metrology for Diamond Turning and Molding

Contour (Radius) MarSurf LD 260 2D/3D

fine structure
MarSurf WM 100

3-D Measurement
MarForm MFU 200
MarOpto TWI60
MarOpto FI AS
Mahr – Aspheric-Optics

- Grinding
- Polishing
- Diamond turning
- Glass
- Plastics
- Injection moulding
- Compression moulding
- Molds/UP

Equipment:
- LD260 2D/3D
- MFU200 3D
- TWI 60
- FI 2100 AS
- WM 100

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Summary

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* Near future - Objective

**Outlook**

**Freeform:** MFU200 and TWI 60

Thanks to my colleagues:
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Thank you for your attention!