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Carl Zeiss Jena GmbH
NRIAG Helwan/ Cairo

74" optics Kottamia

Test certificate

CZJ/Kott-Contract AG 13 95702
KOTECEM2/czj

Test certificate

Test of the Secondary mirror

Jena
13.06.1997

Scope

The scope of the test is to check the optical quality of the newly manufactured secondary mirror for the Kottamia observatory of the National Research Institute of Astronomy and Geophysics (NRIAG).
The main task of the test is to verify, that the optical surface has the quality to insure the required energy concentration of the complete mirror system.

Applicable documents

- CALL OF AN INTERNATIONAL TENDER FOR THE SUPPLY OF THE BLANK OF THE PRIMARY MIRROR FOR ITS OPTICAL FIGURING AND COATING

  November 1993

- The Supply Of The Blank Of The Primary Mirror
  Its Optical Figuring, Polishing And Coating
  Technical proposal

  Carl Zeiss Jena GmbH
  January 94

- The Supply Of The Blank Of The Primary Mirror
  Its Optical Figuring, Polishing And Coating
  Commercial and Administrative Section

  Carl Zeiss Jena GmbH
  January 94

- Contract No. 7 Year 1994
- Supply and Installation of the Main mirror and Subsidiary mirror for the Kottamia Astronomical Observatory

- Test plan for the 74" optics Kottamia issue 04/ June 1997

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- *Determination of optical parameters*

Location of focus position F and F2 of secondary mirror were determinated from test scheme by way of direct measurement of distance between mirrors, as well as location of focus F1 and curvature radius of HINDLE sphere.

Test criteria

Main criterion of the test is the 80% encircled energy of the secondary mirror E(89) ≤ 0.26 arcsec by use of a grid of 20 to 20 points. This will insure, that E(80) for M1+cell and M2 ≤ 0.35arcsec.

Test results

• *Focal length of the finished mirror:*

Location of focus positions:
- **focus position F1:**   **2148.5 ± 1 mm;**
- **focus position F2:**   **7990 ± 1 mm.**

• *Wavefront error of the secondary mirror. (Wavelength = 633 nm.)*

Wavefront error	18.4 nm RMS
	134nm P-V

• *Zernike coefficients*
•

Astigmatic error of wavefront	30.4nm
position of astigmatism	32.2 ° clockwise of the 0 mark
Zonal wavefront error:	24.7nm
Local wavefront error:	124nm

• *Encircled energy:*

80 % encircled energy of secondary mirror in a diameter of 0.22 arcsec for clear aperture with central screen 95 by use of a grid of 34 to 34 points. (=> 0.18arcsec by use of a grid of 20 to 20 points)
This E(80) in ∅ 0.22arcsec < E(80) required in ∅ 0.26 insure the quality of the mirror system E(80) in ∅ 0.35 arcsec.

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Test definition

In order to control the polishing process and in order to verify the optical quality of the KOTTAMIA secondary mirror we use an interferometer procedure. The result of this process is the wavefront error due to the mirror shape. The calculation of the encircled energy is based on the measured wavefront.
The test of the secondary mirror will be made in the scheme with a HINDLE sphere.

Test equipment

The secondary mirror was hanging by means of steel tapes along its cylinder surface in a special installation, which has necessary movement for mirror centring in respect to the HINDLE mirror. The interferometrical set-up of Twyman-Green type was mounted close to the focus F1 at an adjustable table. A HeNe type laser is applied as the light source. The measuring wavelength was 633nm. A CCD camera was used for registration of interferograms.

Test arrangement

1 – Interferometer
    of Twyman Green type
2 – Hindle sphere
3 – Hyperbolic mirror
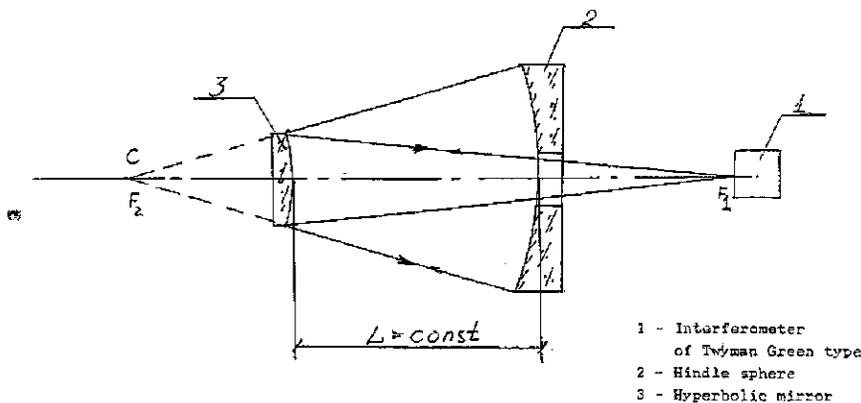
Test procedure

• *Processing of interferogram*
In the process of the test the interferograms was registered in a very short time. The interval of this registration not exceeds 1-2 micro seconds. This procedure allows to avoid influence of vibration and air turbulence streams. Fixed set of interferograms is consecutively processed at amplitudes.

• *Calculation of optical surface parameters*
To calculate the optical parameters of the secondary mirror surface a special software is used. This program allows to obtain regular and irregular components of surface error, as well as to calculate energy concentration.

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Test results

- *Radius of the sphere:*   3200 mm;

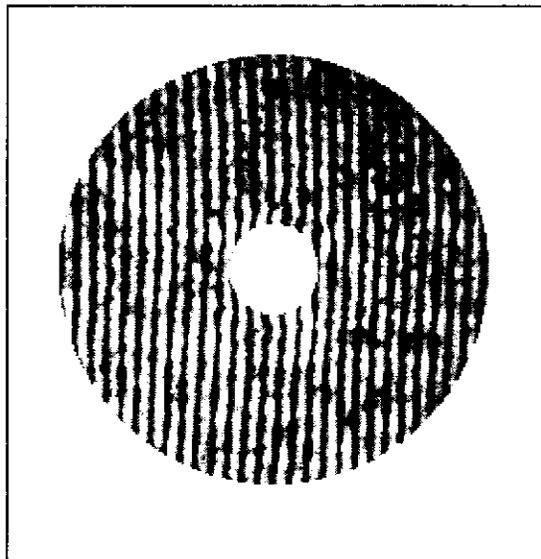- *Wavefront error of the HINDLE mirror:*

Wavefront error:	29.75nm RMS
	176 nm PV

- *Zernike coefficients*

Astigmatic error of wavefront	52.5nm
position of astigmatism	12.6° clockwise of the 0 mark
Zonal wavefront error:	25.9nm
Local wavefront error:	116.4nm

- *Interferometer image:*

Interferogram of the HINDLE spherical mirror.
(Wavelength = 633 nm.)

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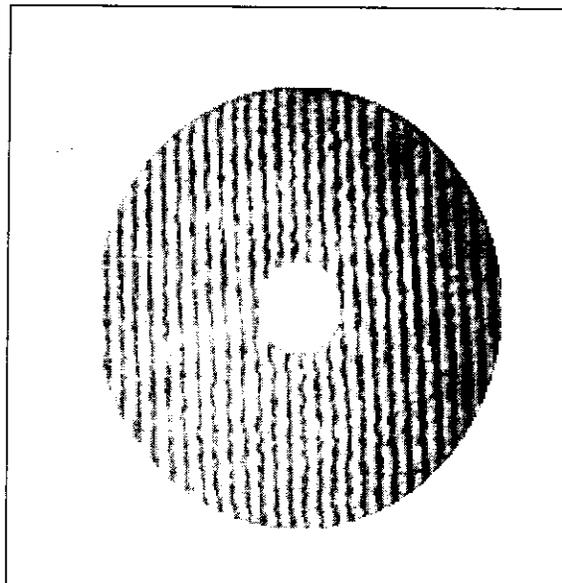**NRIAG Helwan/ Cairo**

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- ***Interferometer image:***

Interferogram of the secondary mirror with the control spherical mirror.
(Wavelength = 633 nm.)

Test of the HINDLE sphere:

Parameters of the HINDLE sphere:

Optical clear aperture	1338mm
Measured radius of the HINDLE sphere	6200mm
Invisible diameter	275mm

- HINDLE sphere test

For interferometrical testing of the HINDLE sphere it was be hanged in special support by means of steel tape. Test was made from curvature centre with interferometrical set-up of Twyman Green type. A HeNe laser was applied as the light source. The measuring wavelength is 633 nm. A CCD camera was used for registration of interferograms.

- Determination of curvature radius

Determination of actual value of curvature radius R of HINDLE sphere is made by means of special tolls with measurement accuracy better 0.1mm,