

**4ITM03-C**

**LIGO-T990153-00-D**

**BLANK**



A. DCN: LIGO-T970033-00-D LIGO DETECTOR OPTICS  
B. LIGO S/N: IM03 Incoming Inspection Check-off Sheet  
Core Optics Blank Material

The purpose of this sheet is to verify material physical dimensions, perform visual inspection, and to facilitate material traceability of LIGO Detector optics. This sheet is to be included in the LIGO Quality Assurance traceability file. Complete a check-off sheet for each optic blank received and inspected.

C. LIGO Contract No.: PC208421 D. Glass Mfg./Order No: Heraeus/5001652  
E. Core optic Material: (BS / FM / ITM / ETM / RM) F. Glass Mfg. Part No.: 50784  
G. LIGO Drawing No.: D960794-A-D H. Manufacturer's Boule No.: Melt M.F.F 8458  
I. Date Received at Caltech: 10-06-97

J  Verify glass manufacturer's <sup>inspection report</sup> ~~Certification~~ against LIGO Component Specification No. E96095-A-D  
Attach the applicable Component Specification Verification sheet.

K  Attach a copy of the glass manufacturer's <sup>inspection report</sup> ~~Certification~~ to check-off sheet.

L  Attach the glass manufacturer's birefringence map, inclusion map, and data sheet per the above Component Specification. birefringence map, inclusion map not present

M  Visually inspect for shipping container for damage. If applicable, describe the damage on attached.

N  Visually inspect the blanks for damage, for chips on surfaces and edges, or for other defects. If applicable, describe damage/defects on attached sheet.

O  Verify core optic blank physical dimensions per applicable LIGO drawing.

Inspection of material diameter. Diameter 10.10 in 256.6 mm

Inspection of material thickness. Thickness 4.28 in 108.8 mm

P  Verify that the Registration Mark is present (with arrow pointing to the first surface) as required by LIGO Component Specification. No registration marks present

Q  Verify receipt of 25mm X 25mm cylinder Witness Sample(s) required by the LIGO Component Specification and visually inspect for damage. Describe damage on the attached sheet. shipped separately

R  Sign and date original packing slip (shipper) and distribute per paragraph 3.R.

Inspect By: Steve Fierman Date Inspected: 10-07-97

Reviewed and/or accepted by:

Cognizant Engineer: \_\_\_\_\_ Date: \_\_\_\_\_

LIGO QA Officer or Designee: \_\_\_\_\_ Date: \_\_\_\_\_

**LIGO DETECTOR OPTICS**  
**Incoming Inspection Check-off Sheet****Core Optics Blank Material**

**COMMENTS/DISCREPANCIES:** (Disposition damage/discrepancies per LIGO Quality Assurance Plan (LIGO M960076-00-P) paragraphs 5.12 and 5.12.1.) No data disk (FTP not referenced)

Minimal chamfer. No defect map. No registration marks.  
No interferograms or homogeneity maps. No birefringence  
map. No inclusion sketch. No absorption certification.  
Striae not reported. No OH-content reported.

Witness sample shipped separately.

**SKETCHES:**

**DISPOSITIONS:** Received new inspection report 12-30-97  
Received defect, inclusion, and striae sketch.  
Received residual strain report.  
Received OH-content report and graph.  
Received interferograms and homogeneity maps.

## LIGO Component Specification Verification Sheet Mirror Blanks, Input Test Mass

		Serial Number: <i>IMØ3</i>	Specification	Reported Value	✓
		<b>Mirror Blanks, Input Test Mass</b>  Requirements		<b>Physical Dimensions</b>	LIGO-D960794
<b>Diameter</b>	256mm +1.0mm, -0mm			<i>256.6 mm</i>	✓
<b>Thickness</b>	108mm +1.0mm, -0mm			<i>108.8 mm</i>	✓
<b>Chamfer</b>	2.0mm Max 2pl			<i>minimal</i>	✓
<b>Clear Aperture</b>	Central 235mm				—
<b>Material</b>	Fused Silica <i>#7980-632</i>			Certification	✓
<b>Registration Mark</b>	"Top" of Optic, 80mm Arrow Points to Side 1			Certification	<i>None</i>
<b>Witness Sample</b>	25mm dia. x 25mm cylindrical			<i>shipped separately</i>	✓
<b>Witness Sample Map</b>				Map Attached	—
<b>Defect Depth</b>	< 0.5mm			Hand Sketch w/location & dim.	<i>No</i>
<b>Homogeneity Within the Central 80mm</b>	$\leq 5.0 \times 10^{-7}$ p - v $\lambda = 632.8\text{nm}$			Interferogram Homogeneity Map	<i>No</i>
<b>Homogeneity Within the Central 200mm</b>	$\leq 2.5 \times 10^{-6}$ p - v $\lambda = 632.8\text{nm}$			Interferogram Homogeneity Map	<i>No</i>
<b>Homogeneity Data</b>	ASCII Format			PC Compatible 3½ in. Disk	<i>No</i>
<b>Birefringence Within the Central 80mm</b>	$\leq 1$ nm/cm			Certification, Birefringence Map	<i>No</i>
<b>Birefringence Within the Central 200mm</b>	$\leq 5$ nm/cm			Certification, Birefringence Map	<i>No</i>
<b>Bubble &amp; Inclusion within the clear aperture. Max. Inclusion Diameter</b>	Total $\leq 0.03\text{mm}^2$ Per $100\text{cm}^3$ of Glass. $\leq 0.1\text{mm}$			Hand Sketch w/location & dim.	<i>No</i>
<b>Absorption</b>	2 ppm/cm $\lambda = 1.06\mu\text{m}$			Certification	<i>No</i>
<b>Striae within the Clear Aperture</b>	Grade A per MIL-G-174			Inspection Report	<i>No</i>

Blk\_ITM.doc

Project LIGO

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Customer : HERAEUS Amersil Inc. Duluth, Ga 30136-5821  
Order No. : 45000023300dtd 30.09.96 as  
HAI-Order No. : none  
HQS-Order No. : 94908401  
Item No. : 1  
Quality : Fused silica Suprasil 312 S  
HQS melt No. : MF.F 8458  
Marking : 960095-IM03 *BN 5013*

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Diameter : 256,6 mm  
CA Diameter :  $\varnothing 200 \text{ mm} = 1,9 \times E^{-9}$   
Thickness : 108,8 mm  
Edge : 0,3 - 0,5 mm  
Parallelism : < 0,08 mm  
Roughness : ground  
 $R_a$  : 1,08  $\mu\text{m}$   
 $R_z$  : 8,86  $\mu\text{m}$   
Bubble class : 0 ; none bubbles  
Birefringence : CA  $\varnothing 200 \text{ mm} \leq 5 \text{ nm/cm}$   
Homogeneity : see Interferogram  
Striae Grade : A  
Granularity : none  
Remark : Test Sample ( $\varnothing 25 \times 25 \text{ mm}$ ) with the same marking

**POL - Qualitätsprüfung Optik**

Date : 15.08.1997

Inspector : O.Dauth *Munk*

**Heraeus**  
QUARZGLAS

POL-QW

Order Nr.: 94908401 Pos.: 1  
Ø 256,6 mm x 108,8 mm  
Quality: Suprasil 312  
Plate No.: 960095-1403/5013

Date: 15.8.97

Inspector: 



Diameter	0,03mm	0,05mm	0,08mm	0,12mm	0,2mm	0,31mm	Sum
piece							
mm <sup>2</sup>							

TBCS=

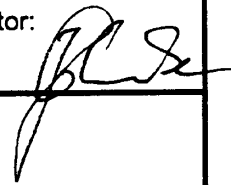
mm<sup>2</sup>  
/100cm<sup>3</sup>

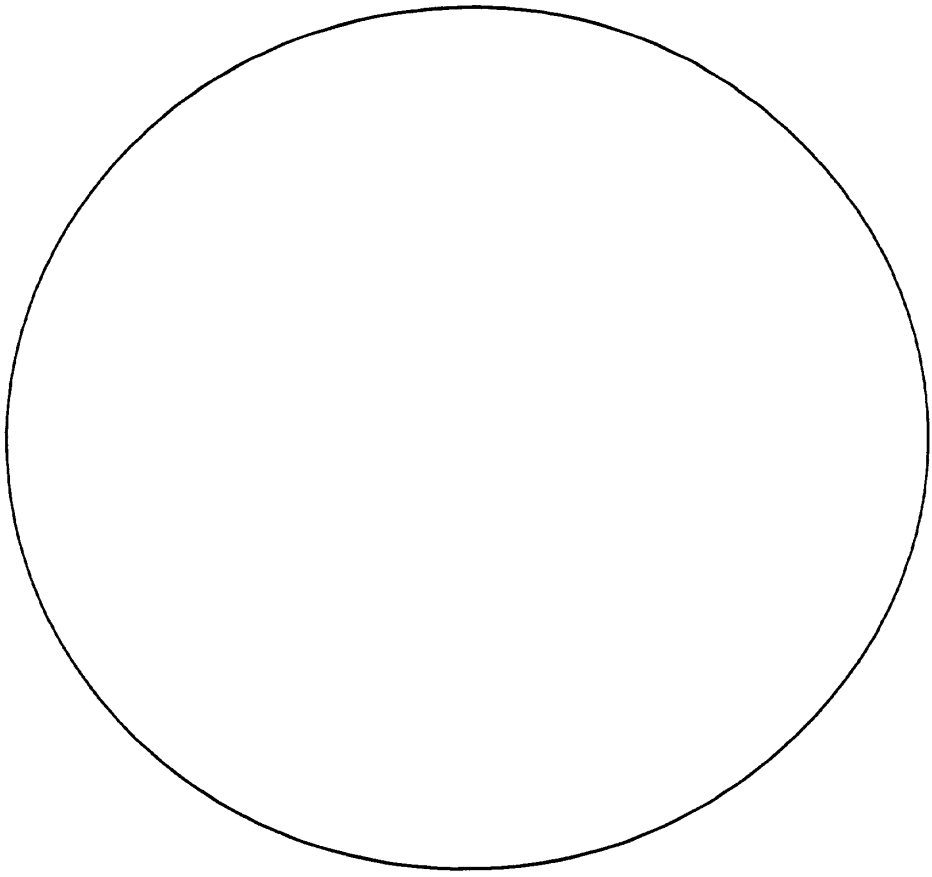
**Heraeus**  
QUARZGLAS

POL - QW

Order No.: 94908401 Pos.: 1  
Ø 256,6 mm x 108,8 mm  
Plate No.: 960095-1403/5013  
Residual strain- Report

Date: 15.8.77

Inspector: 



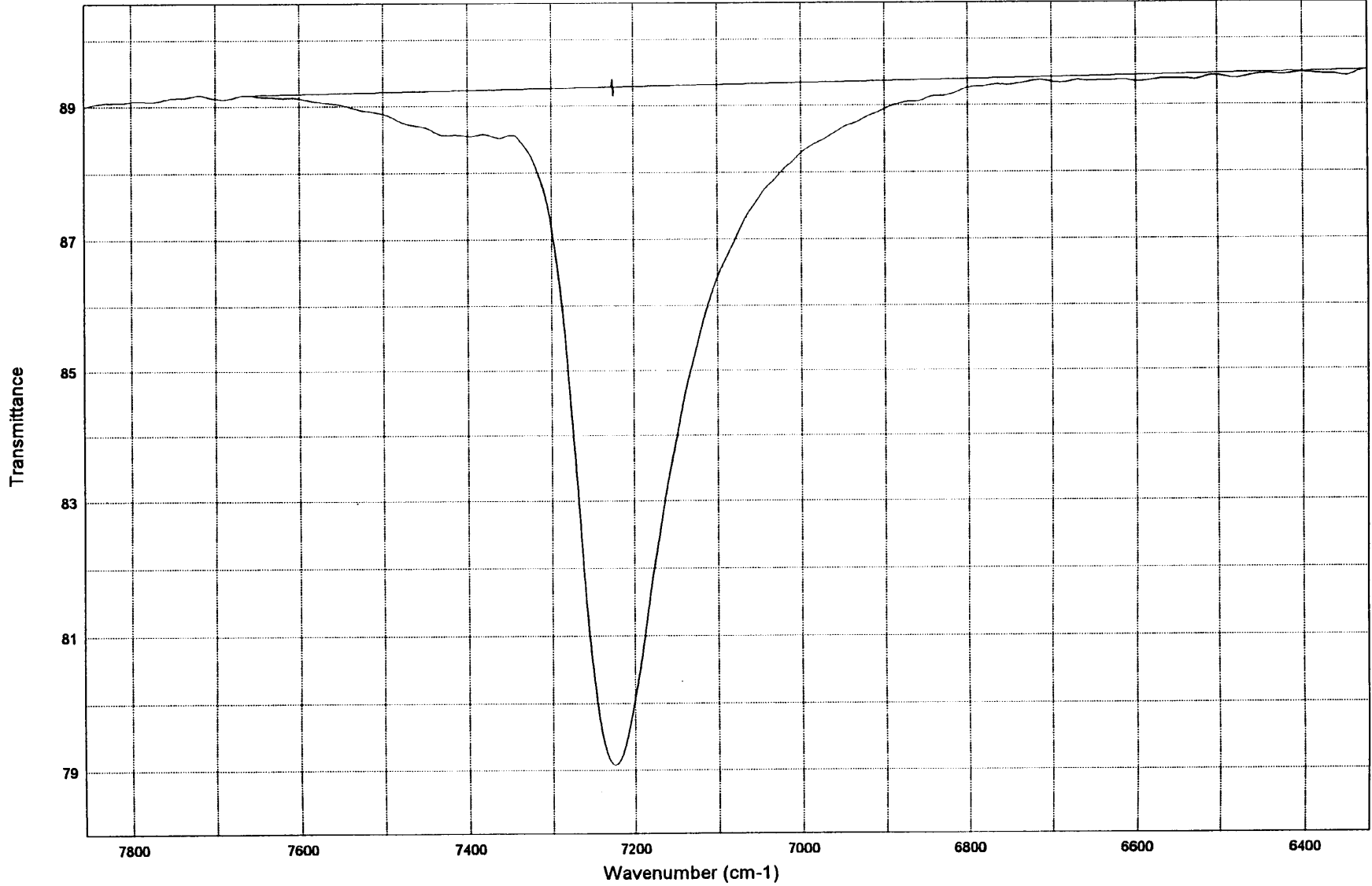
Edge	Center						Pos.
20							nm
2	<1						nm/cm

IO=89.283 , I1=79.0768 at x=7225

OH-content: 210.9 ppm



MEASURE NO. : 5013  
DATE : 02.09.1997 TIME : 10:24  
MEASURE START : 10000 1/cm  
MEASURE END : 2000 1/cm  
OP-DISK-PATH LENGTH : Ko-200-PL: 4.0 cm / Order No.: 9999 9999 / Material: Su 311—OH-content: 210.9 ppm at x=7225





**Heraeus**  
QUARZGLAS

POL-QW

Meßwellenlänge 632.8 nm

Datum: 02.08.97

Bediener: Rt

ID: 501300

Nr.:

HQS-Auftr.-Nr.: 98492868

Kunde: HAI

Produkt: LIGO

Pos.-Nr.: 1

Auftrags-Nr.:

03

Kommentar: 960095-im-~~xxx~~

Probendicke: 108.8 mm

Probendurchm.: 280.0 mm

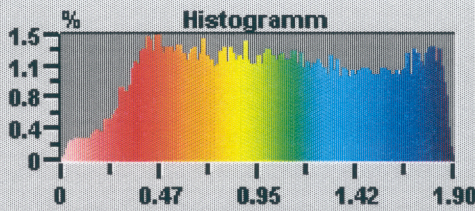
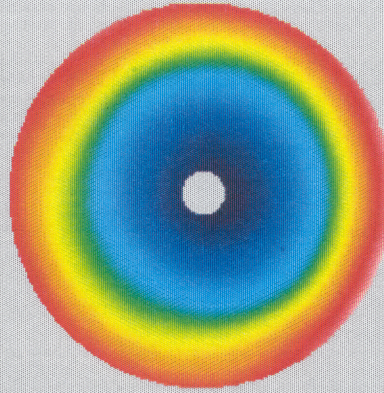
CA-Durchm.: 200.0 mm

Bilddurchm.: 200.3 mm

Mittelpunkt: (0.0mm,0.0mm)

Radius: 100.1mm

Punkte: 69729



Sub. Terme	Betrag	Winkel
X Tilt	0.2889	70.0660
Fokus	-0.8278	
Astigm.	0.0773	-22.0883
Koma	0.1517	19.1273
SA3	0.0367	

Phasendaten

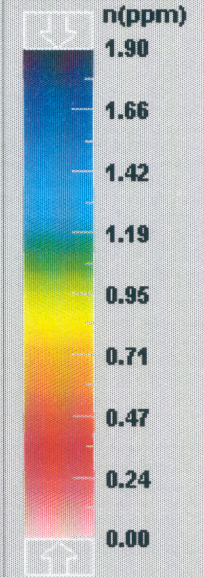
Einheit n(ppm)

PV: 1.90

RMS: 0.477

Scale: 0.5

Kontrast

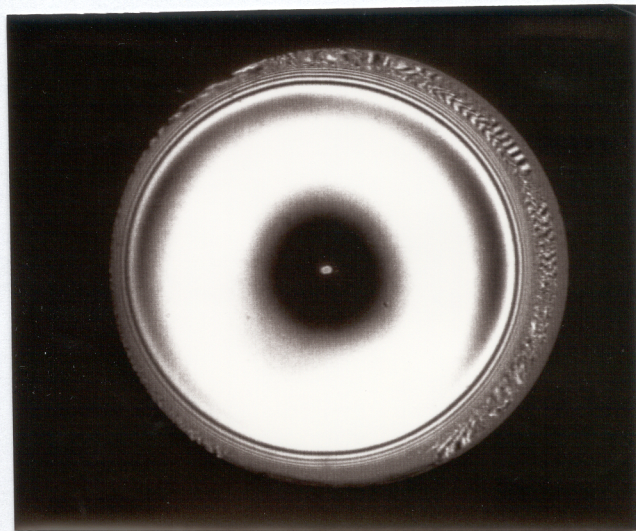


Reset

OberG 1.899

UnterG 0.000

Datei: 501300.tif, 02.08.97, 07:53





Heraeus Amersil Inc  
 3473 Satellite Blvd.  
 Duluth, GA 30136

# Heraeus AMERSIL

## Pick Ticket

Sales Order #: 5001652  
 Delivery #: 30035153

Terms: FOB Duluth  
 Customer PO # pc208421

65" x 25" x 5"

SHIP TO: 5594  
 CALIFORNIA INST OF TECH  
 Attn: Gari Billingsley  
 391 SOUTH HOLLISTON  
 PASADENA, CA 91125

ref quote# 9607054

Order Entered By: DANB  
 Salesman: 00000020 MARC SCHNEIDER

75462731

Route: ~~UPS002 UPS Blue 2 Day PPA~~  
 Actual Route: Lynden Overnight

LINE ITEM	PART NUMBER	DESCRIPTION	UNIT MEAS	SHIP DATE	PICK QTY	ACTUAL PICK QTY	PICK LOCATION	UNIT PRICE
000002	50784	DISC, SUP 312, G, 256 X 108 order from HQS \$43,910 ea. dlrvy approx. 12 months.....part includes a witness aproximately 25mm diameter X 25mm thick from a nearby portion of the ingot prior to hot form flow out  IMØ3	EA	10/07/1998	11.000	11		

Special Packaging: \_\_\_\_\_ @ \$ \_\_\_\_\_ a piece

# of Shipping Cartons: 1

Total Weight of Shipment: 356

Insurance Charge: \_\_\_\_\_ Freight Charge: \_\_\_\_\_

Picked By: DI / gm

Date: 10-1-97

**SUBSTRATE**

A. DCN: LIGO- 970033-01-D

## LIGO DETECTOR OPTICS

Page 1 of 3B. LIGO S/N: 4ITM03-C

## Incoming Inspection Check-off Sheet

## Core Optics Polished Substrate

The purpose of this sheet is to verify material physical dimensions, perform visual and microscopic inspection, and to facilitate material traceability of LIGO Detector optics. This sheet is to be included in the LIGO Quality Assurance traceability file. Complete a check-off sheet for each optic blank received and inspected.

C. LIGO Contract/Purchase No.: PC 167159D. Substrate Polisher: CSIROE. Core optic Material: BS / FM / 2ITM (4ITM) / ETM / RMF. Date Received: ~~10~~-04-98

- G  Verify glass polisher's Certification with LIGO Component Specification No. E960093-C-D.  
Attach the completed LIGO Component Specification Verification Sheet.
- H  Attach a copy of the glass polisher's Certification Document and data sheet to check-off sheet.
- I  Verify receipt of an IBM PC compatible disc in ASCII format of all Surface Data per the applicable LIGO Component Specification sheet see FTP site
- J  Attach the surface maps supplied by vendor per above Component Specifications to the check off sheet.
- K  Visually inspect for shipping container damage. If applicable, describe damage on attached sheet and notify the Cognizant Engineer
- L  Visually inspect the polished substrate for shipping damage, for chips on surfaces and edges, or for other defects. If applicable, describe damage/defects on attached sheet and notify Cognizant Engineer.
- M  Verify polished substrate's physical dimensions per applicable LIGO drawing.
- |                          |                                  |           |          |                  |
|--------------------------|----------------------------------|-----------|----------|------------------|
| <input type="checkbox"/> | Inspection of material diameter. | Diameter  | _____ in | <u>250.98</u> mm |
| <input type="checkbox"/> | Inspection of material thickness | Thickness | _____ in | <u>99.98</u> mm  |
| <input type="checkbox"/> | Wedge Angle                      | _____     |          |                  |
- N  Verify that the Serial Number is present in the proper format as required by LIGO Component Specification.
- O  Verify that the Registration Mark (line with arrow pointing toward surface #1) is present as required by LIGO Component Specification.
- P  Inspect the sides and bevels with the naked eye in normal room light and against a black background to verify that there is no gray, scuffs or scratches per the applicable LIGO Component Specification.
- Q  Use a dark field microscope at 5X magnification to inspect the polished optic for scratches and defects over the central 80 mm diameter per the applicable LIGO Component Specification.

R  Sign and date original packing slip (shipper) and distribute per paragraph 3.R.

Inspection By:  Date Inspected: Nov. 4, 1998

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Reviewed and/or accepted by:

Cognizant Engineer: \_\_\_\_\_ Date: \_\_\_\_\_

LIGO QA Officer or Designee: \_\_\_\_\_ Date: \_\_\_\_\_

FM300

Figure 1

**LIGO DETECTOR OPTICS**  
**Incoming Inspection Check-off Sheet**

**Core Optics Polished Substrate**

**COMMENTS/DISCREPANCIES:** (Disposition damage/discrepancies per LIGO Quality Assurance Plan (LIGO M960076-00-P) paragraphs 5.12 and 5.12.1.) \_\_\_\_\_

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**SKETCHES:**

Vendor supplied sketches included.

**DISPOSITIONS:** \_\_\_\_\_

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Substrate, Input Test Mass		Serial Number: <b>4ITMØ3-C</b>	Specification	Reported Value	✓
		Surface 1	Surface Figure Over Central 200mm dia.	Spherical, Concave	
Radius of Curvature Tolerance	14,180m +140m, -1000m		14,170 m	✓	
Astigmatism	< 13nm p-v		1.2 nm	✓	
Surface 2	Surface Figure Over Central 200mm dia.	Nominally Flat			
	Radius of Curvature of the Wavefront	<del>-9,740m</del> <del>+500m, -100m</del>	- 4.92 Km	✓	
	Astigmatism	< 15nm p-v	3.0 nm	✓	
Surface Errors Surface 1	Low Spatial Frequency Band Central 80mm	$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 0.8\text{nm}$	0.6 nm	✓	
	Low Spatial Frequency Band Central 200mm	$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 1.6\text{nm}$	0.8 nm	✓	
	High Spatial Frequency Band Central 80 & 200 mm	$\leq 4.3 - 7,500 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 0.2\text{nm}$	0.17    0.18	✓	
Surface Errors Surface 2	Low Spatial Frequency Band Central 80mm	$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 1.6\text{nm}$	0.6 nm	✓	
	Low Spatial Frequency Band Central 200mm	$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 3.2\text{nm}$	1.0 nm	✓	
	High Spatial Frequency Band Central 80 & 200 mm	$\leq 4.3 - 7,500 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 0.2\text{nm}$	0.19    0.19	✓	

5.12  
4.82

Scratches, Point Defects & Polish Side 1		Specification	Certification	✓
		Scratches	The Total Area of scratches within the central 80mm diameter shall not exceed $25 \times 10^3$ square micrometers (width x length).	Hand Sketch w/dimensions
The total area of scratches outside the central 80 mm diameter shall not exceed $250 \times 10^3$ square micrometers. < 10,000	Hand Sketch w/dimensions		✓	
Point Defects	There shall be no more than 10 point defects within the central 80mm diameter.	Hand Sketch w/dimensions	✓	
	There shall be no more than 100 point defects on the entire surface. Point defects of radius greater than 25 micrometers are treated like scratches for the purpose of this specification. Point defects of radius less than 2.5 micrometers are disregarded.	Hand Sketch w/dimensions	✓	
Side/Bevel Polish	Sides and bevels shall be polished from a three micrometer grit finish. These surfaces shall appear transparent with no gray, scuffs or scratches visible to the naked eye when viewed in normal room light against a black background.	Inspection Report	✓	

**LIGO Component Specification Verification Sheet  
Input Test Mass**

Scratches, Point Defects & Polish Side 2	Specification		Certification	✓
	Scratches	The total area of scratches shall not exceed $75 \times 10^3$ square micrometers over the central 80mm (width x length).	Hand Sketch w/dimensions	✓
		The total area of scratches outside the central 80 mm diameter shall not exceed $750 \times 10^3$ square micrometers. <b>&lt; 10,000</b>	Hand Sketch w/dimensions	✓
	Point Defects	There shall be no more than 30 point defects within the central 80mm diameter.	Hand Sketch w/dimensions	✓
		There shall be no more than 100 point defects on the entire optic. Point defects of radius greater than 25 micrometers are treated like scratches for the purpose of this specification. Point defects of radius less than 2.5 micrometers are disregarded.	Hand Sketch w/dimensions	✓
Side/Bevel Polish	Sides and bevels shall be polished from a three micrometer grit finish. These surfaces shall appear transparent with no gray, scuffs or scratches visible to the naked eye when viewed in normal room light against a black background.	Inspection Report	✓	

**LIGO Component Specification Verification Sheet  
Input Test Mass**

# LIGO Certification Report

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This Certification Package relates to the following substrate: **Input Test Mass (4 km)**

**Serial number: 4ITM03C**

The Package consists of the following documents:

## 1. Printed documents

HABA - LIGO - C - PD:	Certification of Physical Dimensions and Registration Mark location, orientation and dimensions
HABA - LIGO - C - SB:	Certification of Side and Bevel Polish
HABA - LIGO - C - SP:	Certification of Scratches and Point Defects
HABA - LIGO - C - SN:	Certification of Serial Number location, dimensions
HABA - LIGO - C - SF:	Certification of Surface Figure for Sides 1 and 2
HABA - LIGO - C - SL:	Certification of Surface Errors - Low Frequency, for Sides 1 and 2
HABA - LIGO - C - SH:	Certification of Surface Errors - High Frequency, for Sides 1 and 2
Attachment 1	Hard copy print out of LADI data for Side 1 with piston, tilt removed and also for piston, tilt, power, astigmatism removed
Attachment 2	Hard copy print out of LADI data for Side 2 with piston, tilt, removed and also for piston, tilt, power, astigmatism removed
Attachment 2A	Hard copy print out of LADI data for transmitted wave front in measurement configuration where beam enters through side 2, reflects from side 1 and exits through side 2, with piston, tilt removed and also for piston, tilt, power, astigmatism removed
Attachment 3	Hard copy printouts of TOPO 2D data obtained with 2.5X and 40X heads at three central positions (side 1)
Attachment 4	Hard copy printouts of TOPO 2D data obtained with 2.5X and 40X heads at three central positions (side 2)



# LIGO Certification Report

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## 2. Electronic data

Surface maps for sides 1 and 2 are available at the CSIRO ftp site under the following file names:

LADI data:	4ITM3C1.zip (Side 1)	4ITM3C2.zip (Side 2) 4ITM3C2A.zip (wave front)
TOPO data: (2.5X)	T24IM31A.asc (Side 1)	T24IM32A.asc (Side 2)
	T24IM31B.asc	T24IM32B.asc
	T24IM31C.asc	T24IM32B.asc
(40X)	T44IM31A.asc	T44IM32A.asc
	T44IM31B.asc	T44IM32B.asc
	T44IM31C.asc	T44IM32C.asc

LIGO Certification Report      Physical Dimensions

<b>1</b>	<b>Substrate Type:</b>	<b>4ITM</b>
<b>2</b>	<b>Serial Number:</b>	<b>4ITM03C</b>
<b>3</b>	<b>Physical quantity certified:</b>	<b>Physical Dimensions and Registration Mark</b>
<b>4</b>	<b>LIGO specification reference:</b>	<b>D960803-B-D</b>
<b>5</b>	<b>CSIRO measurement/inspection procedure reference:</b>	<b>HABA-LIGO-M-PD</b>
<b>6</b>	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	<b>No</b>
<b>7</b>	<b>CSIRO Log Book Reference</b>	<b>LN00028, p.29</b>
<b>8</b>	<b>Team member responsible for measurement/inspection:</b>	<b>C Sona</b>
<b>9</b>	<b>Measurement/inspection results reviewed by:</b>	<b>C Walsh</b>

**10. Results**

[Measurement errors ( $\pm 1\sigma$ ) shown only where they are comparable to tolerances specified or when measurement is within  $2\sigma$  of boundary of acceptability]

Physical Quantity	Result
Diameter	250.98 mm
Cylindricity	0.02 mm
Thickness      (maximum - for FM, RM, ETM) (minimum - for BS)	99.98 mm
Bevel as per drawing (height, angle):	(S1) Height:2.28 mm Angle: 45 <sup>0</sup> 04' (S2) Height:2.20 mm Angle: 44 <sup>0</sup> 52'
Wedge angle:	1 <sup>0</sup> 12'
Location of registration mark ( $\pm$ angle with respect to minimum part thickness):	-4'
Location of other 3 marks (with respect to registration mark at minimum thickness)	89 <sup>0</sup> 59', 179 <sup>0</sup> 59', 270 <sup>0</sup> 0'
Registration mark dimensions (OK/ not OK)	OK

## 11. Certification

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager: *Chris Walsh*      Chris Walsh

Date: *30 October 98*

**LIGO Certification Report    Side and Bevel Polish**

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<b>1</b>	<b>Substrate Type:</b>	<b>4ITM</b>
<b>2</b>	<b>Serial Number:</b>	<b>4ITM03C</b>
<b>3</b>	<b>Physical quantity certified:</b>	<b>Side and Bevel Polish</b>
<b>4</b>	<b>LIGO specification reference:</b>	<b>E960093-C-D</b>
<b>5</b>	<b>CSIRO measurement/inspection procedure reference:</b>	<b>HABA-LIGO-M-SB-A</b>
<b>6</b>	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	<b>No</b>
<b>7</b>	<b>CSIRO Log Book Reference</b>	<b>LN00062</b>
<b>8</b>	<b>Team member responsible for measurement/inspection:</b>	<b>E Pavlovic</b>
<b>9</b>	<b>Measurement/inspection results reviewed by:</b>	<b>J Seckold</b>

**10. Results**

Defects, if any, in the side and bevel polish compared to the LIGO specification (4 above) are detailed below (*team member to note defects here; if none seen, note "no defects observed"*).

**No defects observed**

**11. Certification**

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:  Chris Walsh  
 Date: *30 October 98*

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM03C
3	<b>Physical quantity certified:</b>	Serial Number and location
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SN-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LN00062
8	<b>Team member responsible for measurement/inspection:</b>	E Pavlovic
9	<b>Measurement/inspection results reviewed by:</b>	J Seckold

### 10. Results

Quantity inspected	Result of Inspection (OK / not OK)
Location of serial number as per drawing (sec. 4)	OK
Orientation of serial number as per drawing (sec. 4)	OK
Height of lettering	OK

### 11. Certification

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:

*Chris Walsh*  
30 October 98

Chris Walsh

Date:

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM03C
3	<b>Physical quantity certified:</b>	Scratches and Point Defects
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SP-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No
7	<b>CSIRO Log Book Reference</b>	LN00062
8	<b>Team member responsible for measurement/inspection:</b>	E Pavlovic
9	<b>Measurement/inspection results reviewed by:</b>	J Seckold

### 10. Results

	Numbers of point defects		Total Area of scratches (square micrometres)	
	Inside central 80 mm	Entire surface (235 mm)	Inside central 80 mm	Outside central 80 mm (235 mm)
Surface 1	Nil	Nil	Nil	< 10,000
Surface 2	Nil	Nil	Nil	< 10,000

### 11. Certification

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:

*Walsh*

Chris Walsh

Date:

*30 October 98*

NB Side 1 and Side 2 scratches shown below on the one map.

↑  
Thin

41TM03

2000  
SIDE 2

10000  
SIDE 1

4000  
SIDE 2

1	<b>Substrate Type:</b>	4ITM
2	<b>Serial Number:</b>	4ITM03C
3	<b>Physical quantity certified:</b>	Surface Figure
4	<b>LIGO specification reference:</b>	E960093-C-D
5	<b>CSIRO measurement/inspection procedure reference:</b>	HABA-LIGO-M-SF-A
6	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	No. Data files for transmitted wavefront represent two passes
7	<b>CSIRO Log Book Reference</b>	LLN/0137-02 (Bk 5) p 12
8	<b>Team member responsible for measurement/inspection:</b>	E Pavlovic
9	<b>Measurement/inspection results reviewed by:</b>	B Oreb

### 10. Results

	<b>Radius of Curvature in km</b>	<b>Astigmatism (nm)</b>	<b>Electronic data file reference</b>
<b>Surface 1</b>	14.17 km	1.2	4ITM03C1.zip
<b>Surface 2</b>	14.8 km	3.0	4ITM03C2.zip
<b>Wave front*</b>	-4.92 km		4ITM03CT.zip

\* Measured as per the test procedure in E960093-C-D.

Hardcopies of the phase maps are attached to this certification as part of Attachment 1 for Side 1 and Attachment 2 for Side 2. Phase map data is stored in electronic format at the CSIRO ftp site under the filenames shown in the third column.

### 11. Certification

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:

*Chris Walsh*  
4 Nov 98

Chris Walsh

Date:



LIGO Certification Report      Surface Errors - Low

---

<b>1</b>	<b>Substrate Type:</b>	<b>4ITM</b>
<b>2</b>	<b>Serial Number:</b>	<b>4ITM03C</b>
<b>3</b>	<b>Physical quantity certified:</b>	<b>Surface Errors - Low Spatial Frequency</b>
<b>4</b>	<b>LIGO specification reference:</b>	<b>E960093-C-D</b>
<b>5</b>	<b>CSIRO measurement/inspection procedure reference:</b>	<b>HABA-LIGO-M-SL-A</b>
<b>6</b>	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	<b>No</b>
<b>7</b>	<b>CSIRO Log Book Reference</b>	<b>LLN/0137-02 (Bk 5) p 12</b>
<b>8</b>	<b>Team member responsible for measurement/inspection:</b>	<b>E Pavlovic</b>
<b>9</b>	<b>Measurement/inspection results reviewed by:</b>	<b>B Oreb</b>

**10. Results**

	<b>Low Frequency Surface Errors (nm)</b>	
	<b>80 mm aperture</b>	<b>200 mm aperture</b>
<b>Surface 1</b>	0.6	0.8
<b>Surface 2</b>	0.6	1.0

Hardcopies of the phase maps over the central 200 mm with piston, tilt, power and astigmatism removed are attached to this certification in Attachment 2 for Side 1 and Attachment 2 for Side 2.

**11. Certification**

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:  Chris Walsh  
 Date: *30 October 98*

LIGO Certification Report    Surface Errors - high

<b>1</b>	<b>Substrate Type:</b>	<b>4ITM</b>
<b>2</b>	<b>Serial Number:</b>	<b>4ITM03C</b>
<b>3</b>	<b>Physical quantity certified:</b>	<b>Surface Errors - high spatial frequency</b>
<b>4</b>	<b>LIGO specification reference:</b>	<b>E960093-C-D</b>
<b>5</b>	<b>CSIRO measurement/inspection procedure reference:</b>	<b>HABA-LIGO-M-SH-A</b>
<b>6</b>	<b>Variations to the measurement/inspection procedure:</b> (indicate Yes/No and attach separate sheet if Yes)	<b>No</b>
<b>7</b>	<b>CSIRO Log Book Reference</b>	<b>LLN/091</b>
<b>8</b>	<b>Team member responsible for measurement/inspection:</b>	<b>F Lesha</b>
<b>9</b>	<b>Measurement/inspection results reviewed by:</b>	<b>C Walsh</b>

**10. Results**

*10.1 Surface errors in nanometres averaged over sampling locations within central 80 mm:*

**Side 1:            0.17 nm**

**Side 2:            0.19 nm**

*10.2 Surface errors in nanometres averaged over all sampling locations on surface:*

**Side 1:            0.18 nm**

**Side 2:            0.19 nm**

*10.3 Surface errors in nanometres at different positions A through H on surface:*

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>
<b>Surface 1</b>	<b>0.18</b>	<b>0.17</b>	<b>0.19</b>	<b>0.15</b>	<b>0.17</b>	<b>0.20</b>	<b>0.22</b>	<b>0.19</b>
<b>Surface 2</b>	<b>0.19</b>	<b>0.19</b>	<b>0.19</b>	<b>0.19</b>	<b>0.20</b>	<b>0.21</b>	<b>0.19</b>	<b>0.20</b>

Two - dimensional surface maps at three central locations are available at the CSIRO ftp site under filenames of the form TMXX0YZA.asc, where M is the objective used (M=2 for 2.5X, 4 for 40X), XX is the substrate type, 0Y is the number, Z = 1 or 2 is the side and A = A, B, C, ... is the sampling position. Hard copies of the data are at Attachment 3 (Side 1) and Attachment 4 (Side 2).

## 11. Certification

The measurements and inspection data presented in this report were obtained using the procedures outlined in the relevant CSIRO procedures document (sec. 5). These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:



Chris Walsh

Date:

30 October 98



# LADI CERTIFICATION DATA

Title: 4ITM031

Date: 10/16/98

Diameter: 200 mm

Astig: 1.2 nm

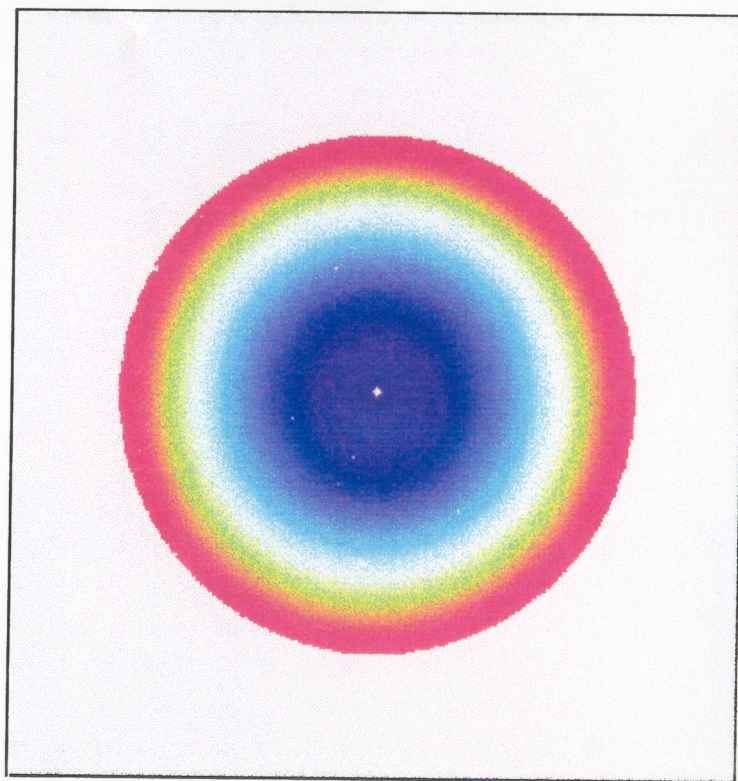
Power: 353.6 nm



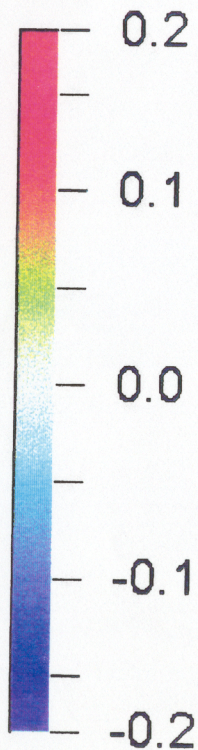
PV: 8.9 nm

RMS: 0.8 nm

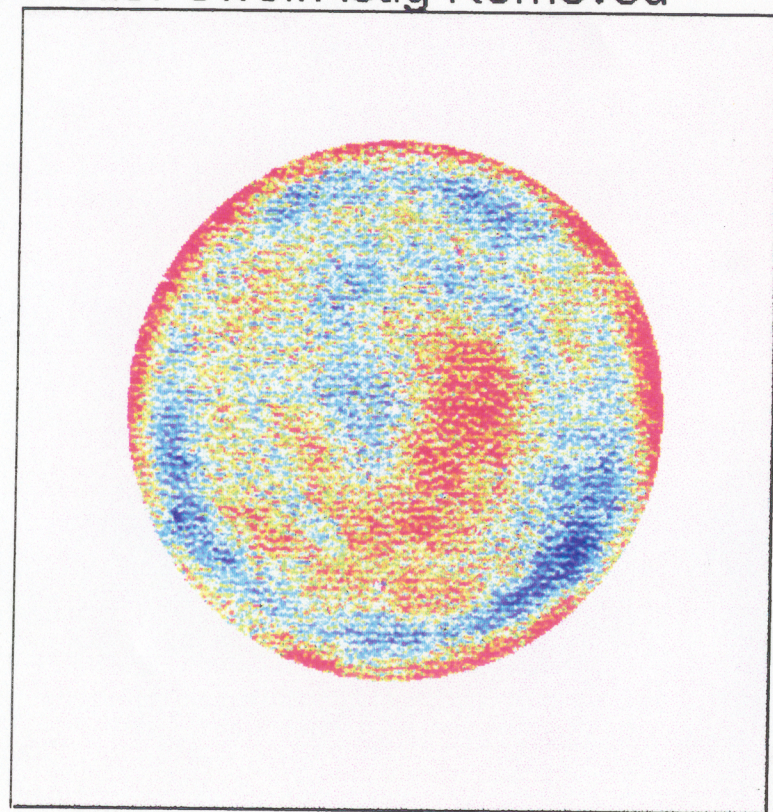
Tilt Removed



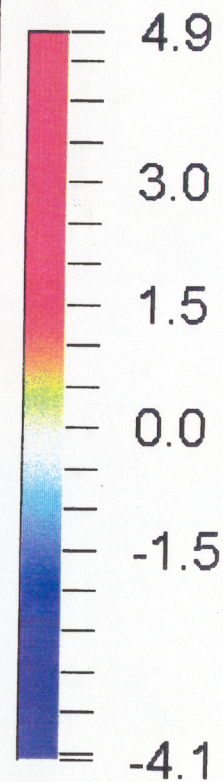
um



Tilt/Power/Astig Removed



nm





# LADI CERTIFICATION DATA

Title: 4ITM032

Date: 10/20/98

Diameter: 200 mm

Astig: 3.0 nm

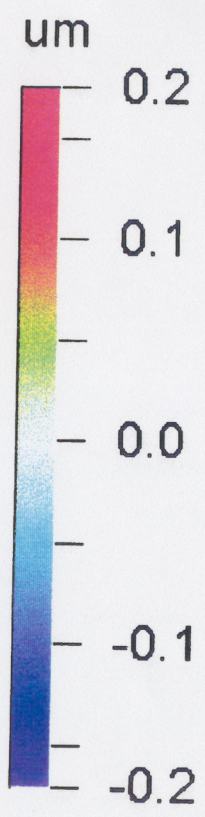
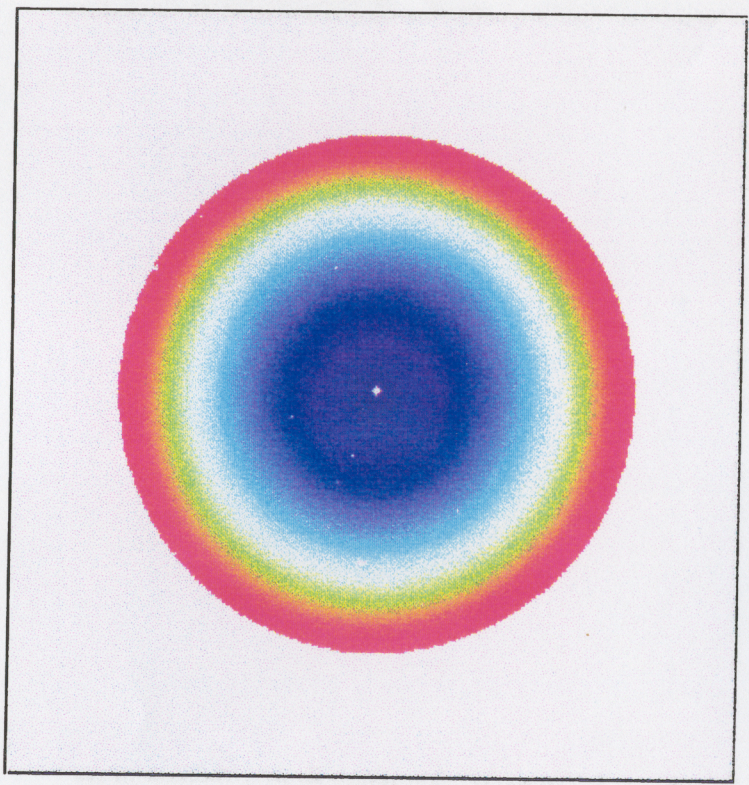
Power: 338.2 nm



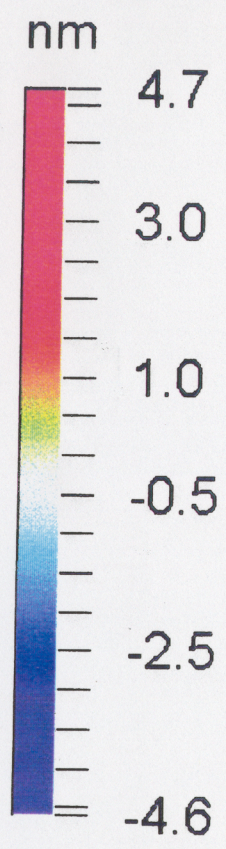
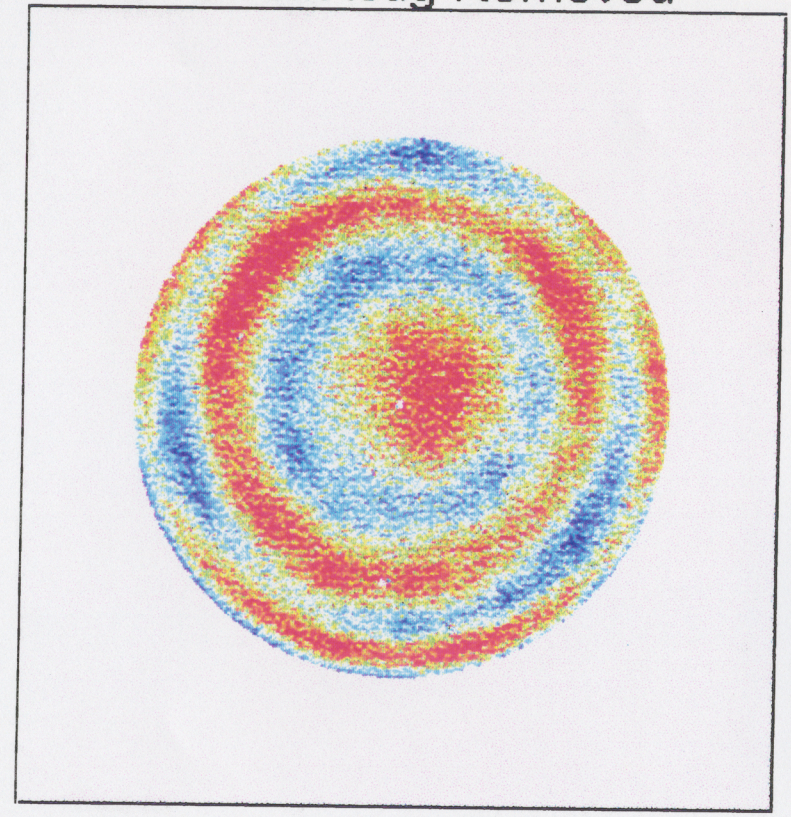
PV: 9.3 nm

RMS: 1.0 nm

Tilt Removed



Tilt/Power/Astig Removed





# LADI CERTIFICATION DATA

Title: 4ITM03T

Date: 10/28/98

Diameter: 200 mm

Astig: -54.4 nm

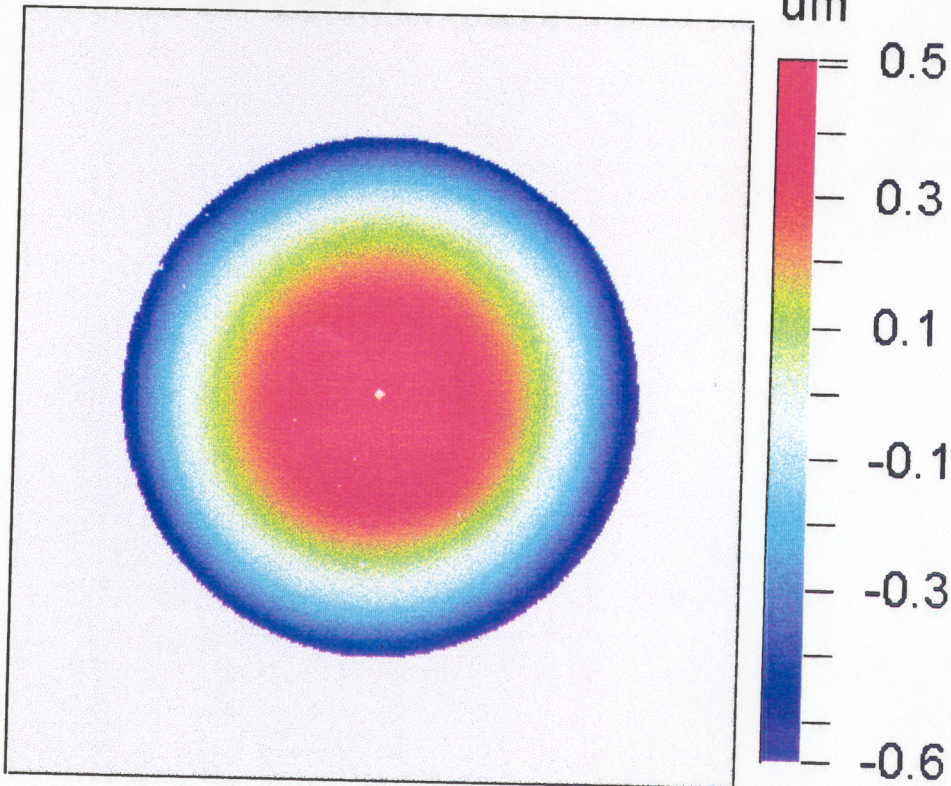
Power: -1017.2 nm



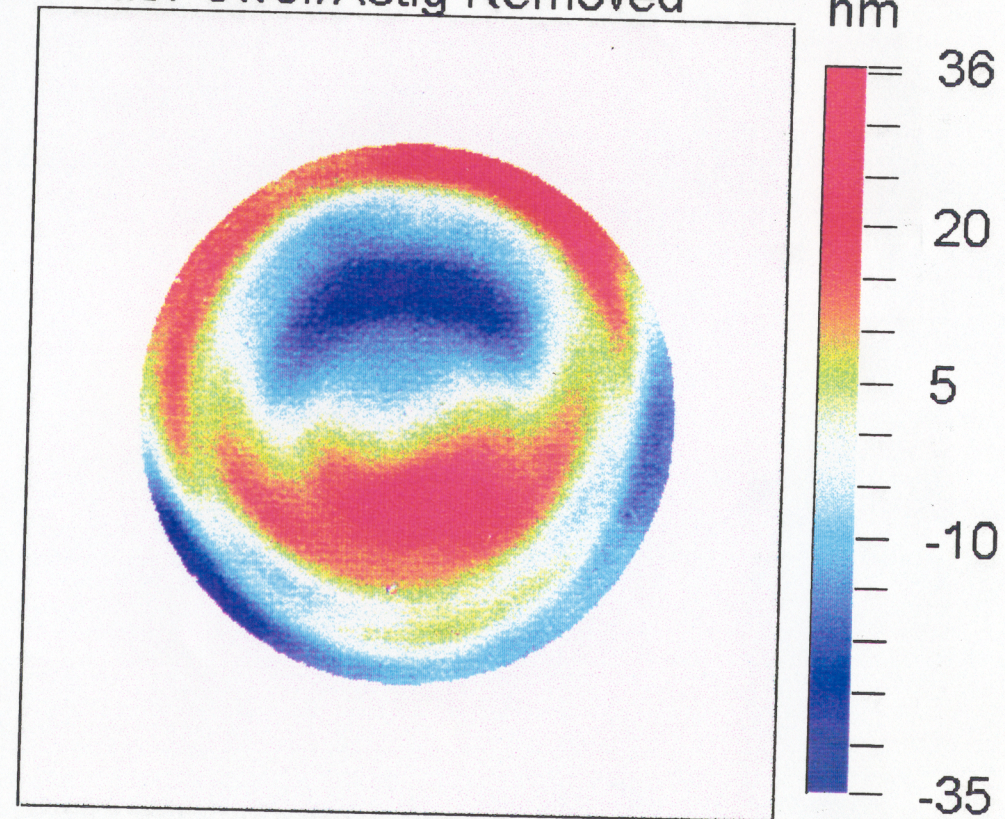
PV: 70.4 nm

RMS: 12.5 nm

Tilt Removed

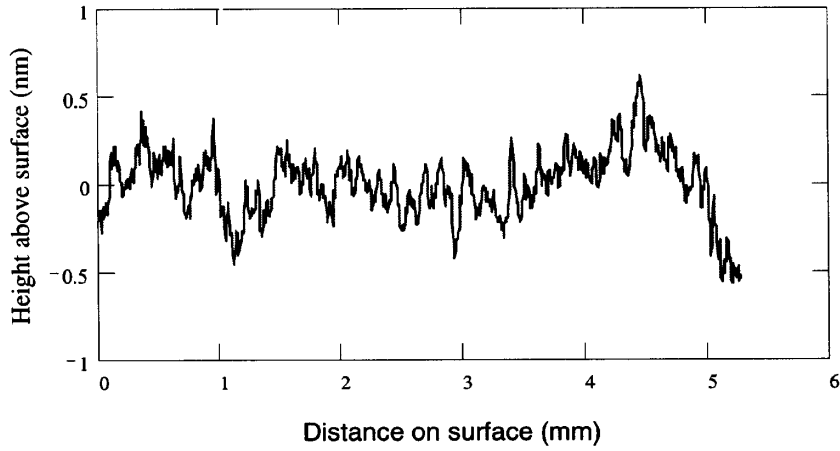


Tilt/Power/Astig Removed



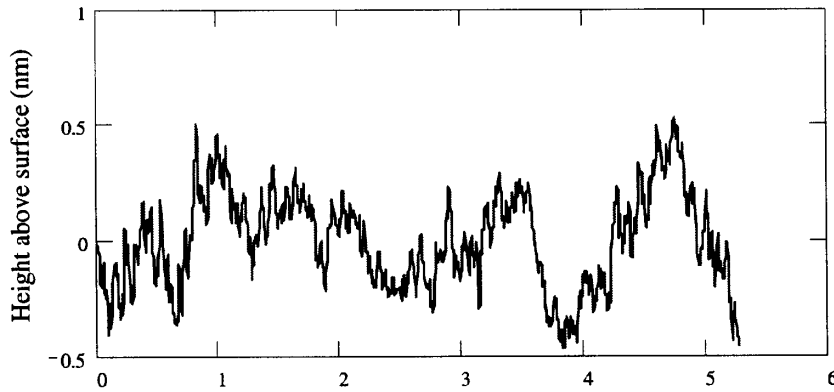


RMS =  $1.874 \cdot 10^{-10}$  m



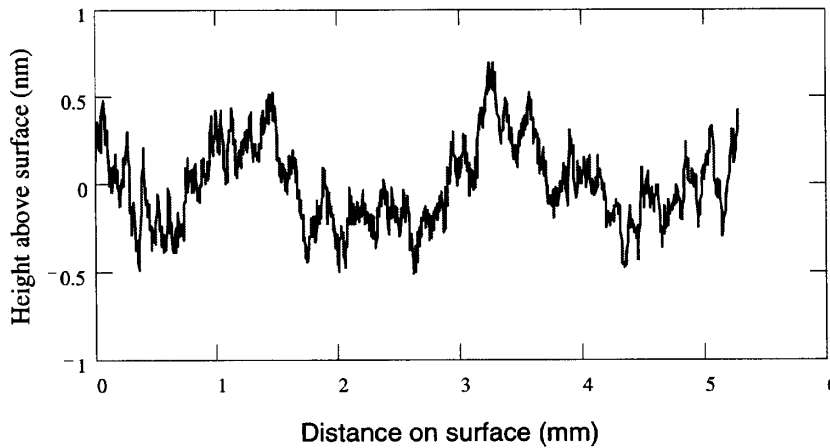
T24IM31.asc

RMS =  $2.067 \cdot 10^{-10}$  m



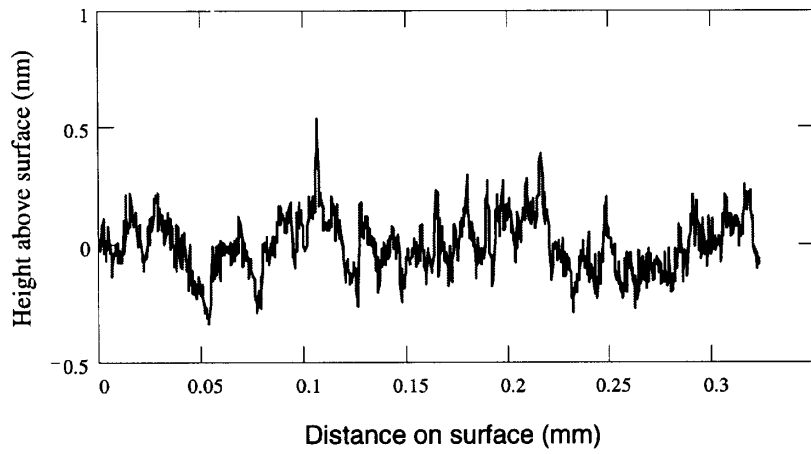
T24IM31B.asc

RMS =  $2.329 \cdot 10^{-10}$  m



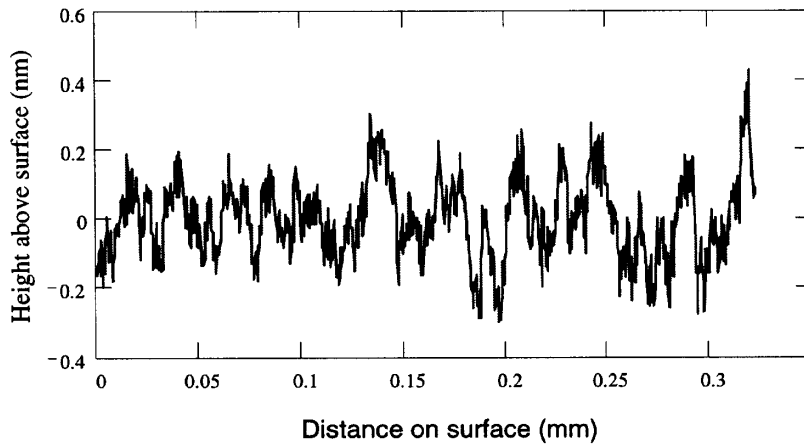
T24IM31C.asc

$$\text{RMS} = 1.215 \cdot 10^{-10} \cdot \text{m}$$



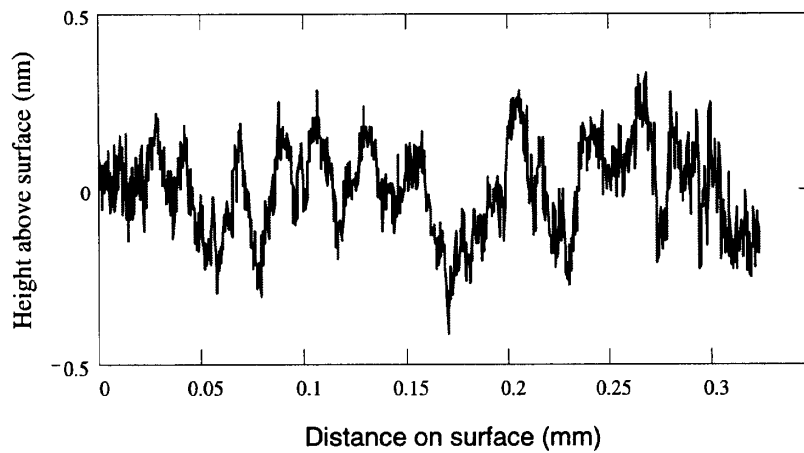
T44IM31A.asc

$$\text{RMS} = 1.156 \cdot 10^{-10} \cdot \text{m}$$



T44IM31B.asc

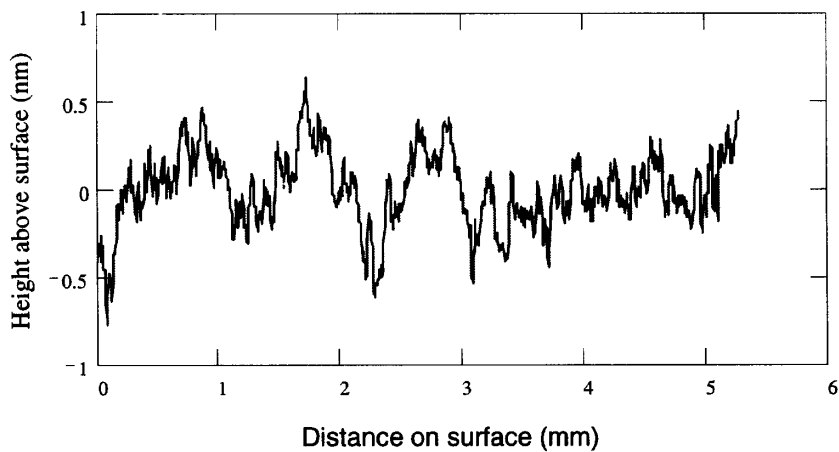
$$\text{RMS} = 1.287 \cdot 10^{-10} \cdot \text{m}$$



T44IM31C.asc

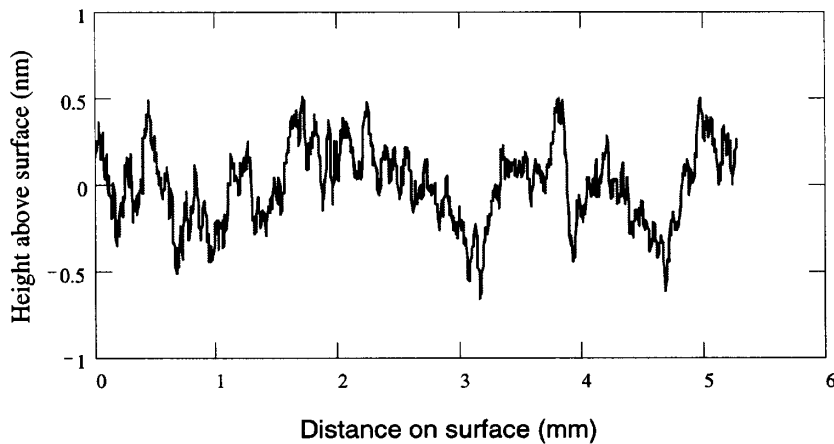


$$\text{RMS} = 2.152 \cdot 10^{-10} \cdot \text{m}$$



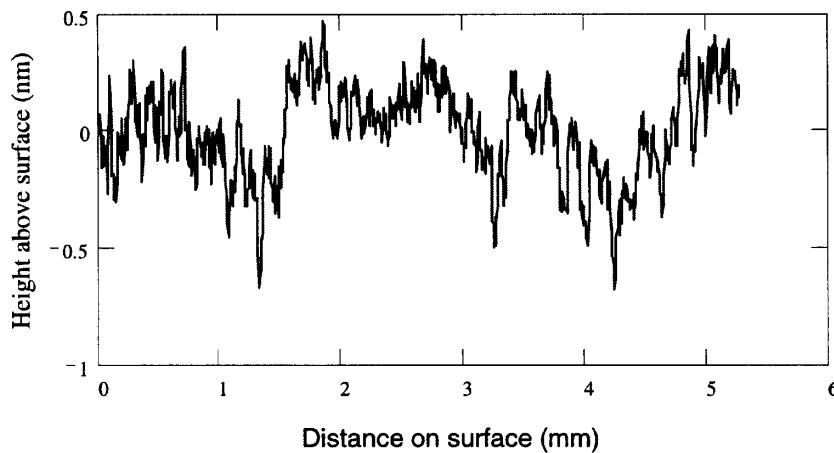
T24IM32A.asc

$$\text{RMS} = 2.253 \cdot 10^{-10} \cdot \text{m}$$



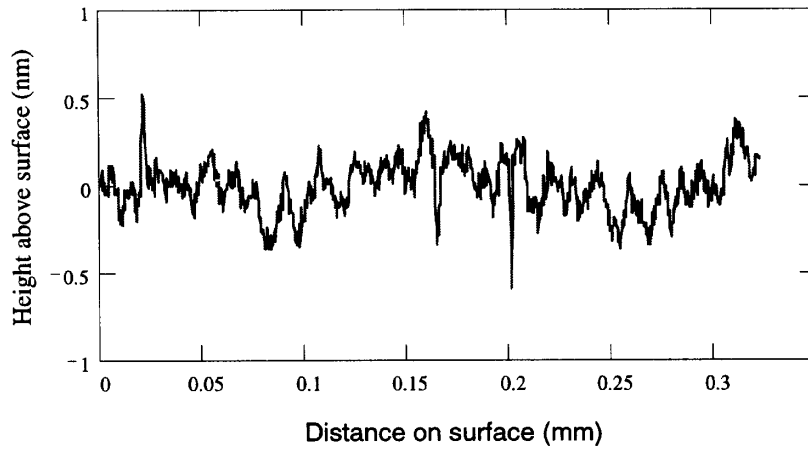
T24IM32B.asc

$$\text{RMS} = 2.027 \cdot 10^{-10} \cdot \text{m}$$



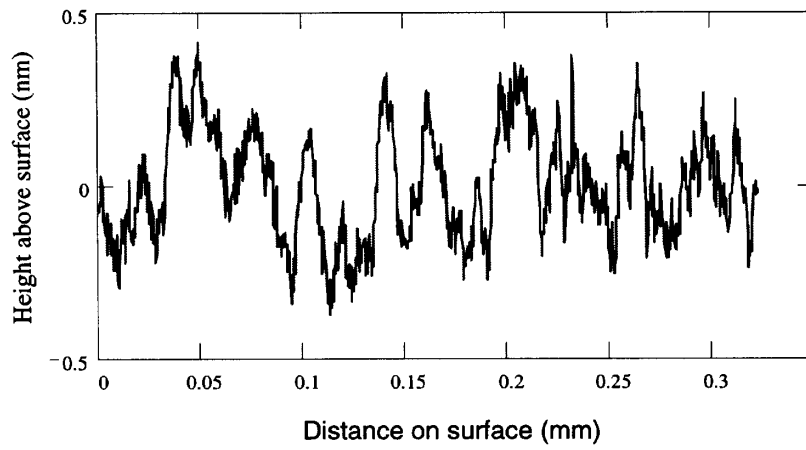
T24IM32C.asc

$$\text{RMS} = 1.464 \cdot 10^{-10} \cdot \text{m}$$



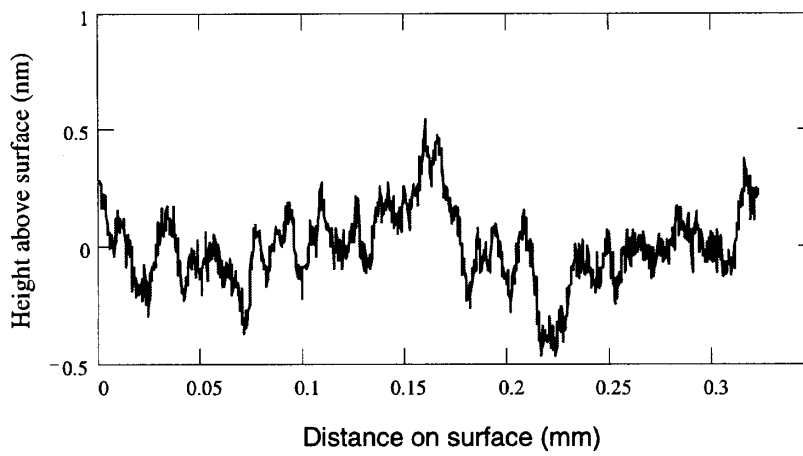
T44IM32A.asc

$$\text{RMS} = 1.588 \cdot 10^{-10} \cdot \text{m}$$



T44IM32B.asc

$$\text{RMS} = 1.614 \cdot 10^{-10} \cdot \text{m}$$



T44IM32C.asc

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