2ITM02-C

LIGO-T990148-00-D

BLANK

A. DCN: LIGO-T970035-00-D
B. LIGO S/N: IMØ5

LIGO DETECTOR OPTICS
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.: PC 208421
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 MF.F 8538
I. Date Received at Caltech: 10-06-97

J ☑ Verify glass manufacturer's ~~Certification~~ inspection report against LIGO Component Specification No. E960095-A-D [redacted]
Attach the applicable Component Specification Verification sheet.

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

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

M ☑ Visually inspect for shipping container for damage. If applicable, describe the damage on attached. Some carton damage (crushing, tearing, and was opened and resealed).

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. Very slight scuffed area near edge.

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.

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 Gibson 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

Mirror Blanks, Input Test Mass	Serial Number: ITM05		Specification	Reported Value	✓
	Requirements	Physical Dimensions	LIGO-D960794		✓
		Diameter	256mm +1.0mm, -0mm	256.6mm	✓
		Thickness	108mm +1.0mm, -0mm	108.8 mm	✓
		Chamfer	2.0mm Max 2pl	minimal	✓
		Clear Aperture	Central 235mm ⌀		—
		Material	Fused Silica ~~#7980~~ Suprasil 312,5	Certification	✓
		Registration Mark	"Top" of Optic, 80mm Arrow Points to Side 1	Certification	none
		Witness Sample	25mm dia. x 25mm cylindrical	shipped separately	✓
		Witness Sample Map		Map Attached	—
		Defect Depth	< 0.5mm	Hand Sketch w/location & dim.	No
		Homogeneity Within the Central 80mm	$\leq 5.0 \times 10^{-7}$ p – v $\lambda = 632.8$nm	Interferogram Homogeneity Map	No
		Homogeneity Within the Central 200mm	$\leq 2.5 \times 10^{-6}$ p - v $\lambda = 632.8$nm	Interferogram Homogeneity Map	No
		Homogeneity Data	ASCII Format	PC Compatable 3½ in. Disk	No
		Birefringence Within the Central 80mm	≤ 1 nm/cm	Certification, Birefringence Map	No
		Birefringence Within the Central 200mm	≤ 5 nm/cm	Certification, Birefringence Map	No
		Bubble & Inclusion within the clear aperture. Max. Inclusion Diameter	Total $\leq 0.03mm^2$ Per $100cm^3$ of Glass. ≤ 0.1mm	Hand Sketch w/location & dim.	No
		Absorption	2 ppm/cm $\lambda = 1.06\mu m$	Certification	No
		Striae within the Clear Aperture	Grade A per MIL-G-174	Inspection Report	No

Heraeus QUARZGLAS
POL-QW

INSPECTION REPORT

Project LIGO

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 8538
Marking	: 960095-IM05 BN 5318

Diameter		: 256,6 mm
CA Diameter		: Ø 200 mm = 0,87xE^{+0}
Thickness		: 108,8 mm
Edge		: 0,3 - 0,5 mm
Parallelism		: < 0,08 mm
Roughness		: ground
	R_a	: 1,08 µm
	R_t	: 8,86 µm
Bubble class		: 0 ; none bubbles
Birefringence		: CA Ø200 mm <= 5nm/cm
Homogeneity		: see Interferogram
Striae Grade		: A
Granularity		: none
Remark		: Test Sample (Ø25 x25 mm) with the same marking

POL - Qualitätsprüfung Optik

Date : 29.01.1997

Inspector :F.Wink

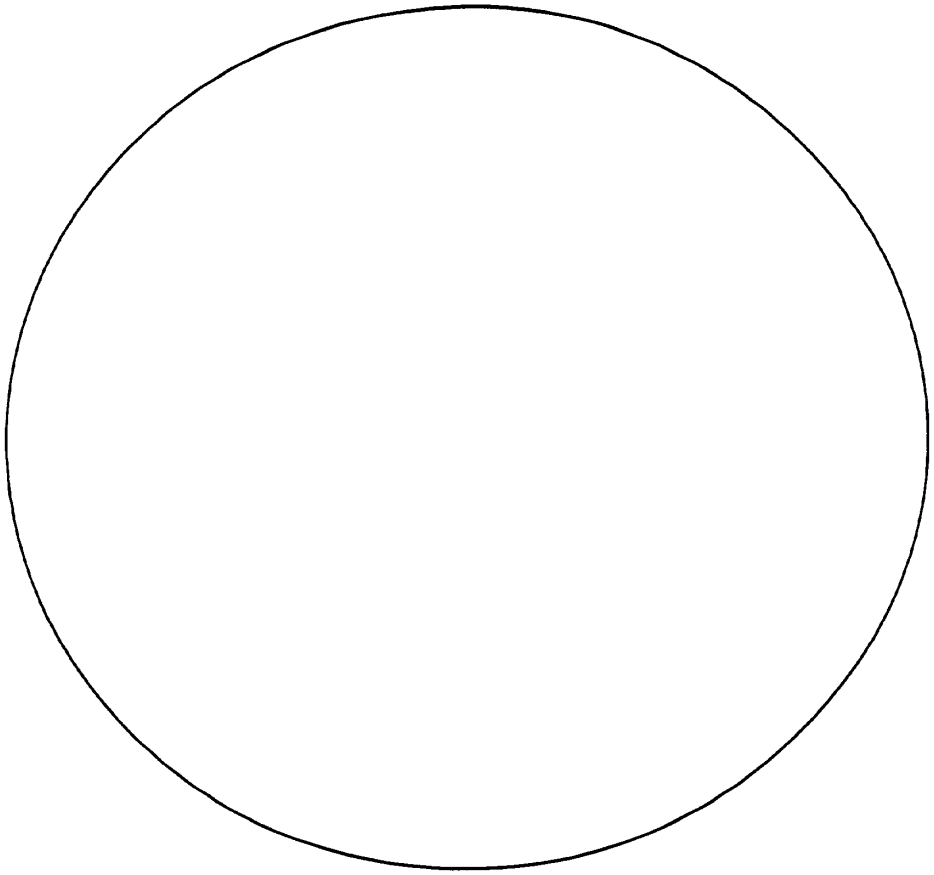
Heraeus QUARZGLAS POL- QW	Order Nr.: 94908401 Pos.: 1 Ø 256,6 mm x 108,8 mm Quality: Suprasil 312 Plate No.: 960095-1M05/5318	Date: 29.1.97 Inspector:

Diameter	0,03mm	0,05mm	0,08mm	0,12mm	0,2mm	0,31mm	Sum
piece							
mm^2							

TBCS= mm^2 /100cm^3

g:\groups\pol\pol-qw\amipro\form\pro_Bub3.sam

Heraeus QUARZGLAS POL - QW	Order No.: 94908401 Pos.: 1 Ø 256,6 mm x 108,8 mm Plate No.: 960095-1M05/5318 Residual strain- Report	Date: 29.1.97 Inspector:

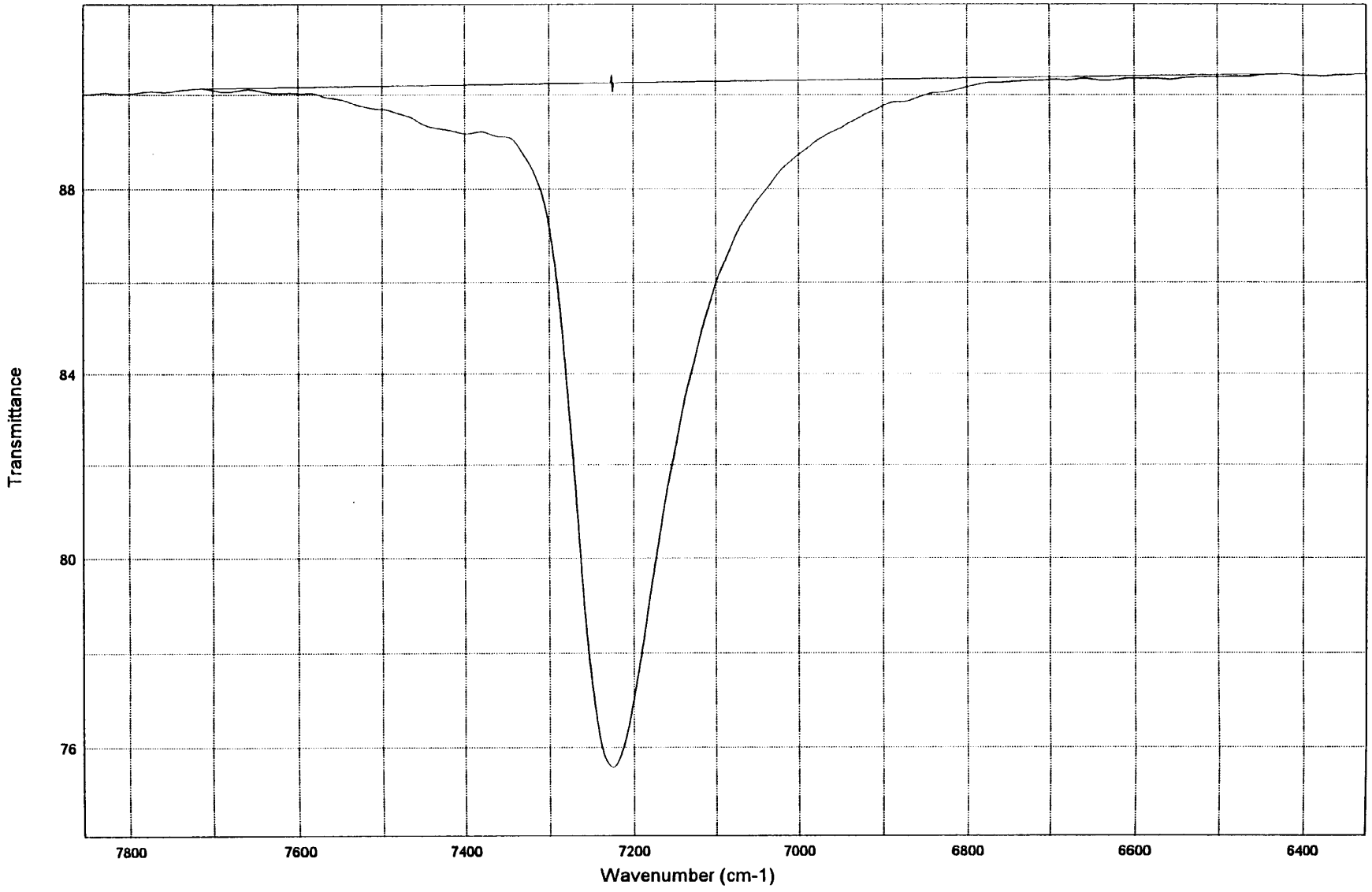


Edge	Center						Pos.
20							nm
2	< 1						nm/cm

I0=90.2575 , I1=75.5702 at x=7225 OH-content: 308.5 ppm

Heraeus
QUARZGLAS

MEASURE NO. : 5318
DATE : 02.09.1997 TIME : 10:38
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: 308.5 ppm at x=7225



Heraeus
QUARZGLAS

POL-QW

Meßwellenlänge 632.8 nm

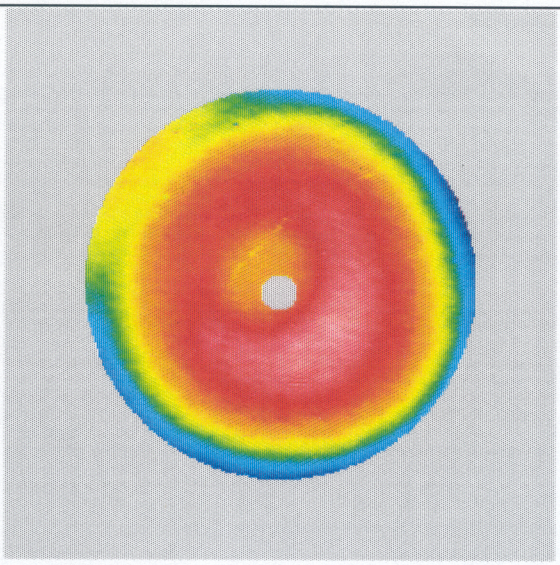
Datum: 02.08.97
ID: 531800

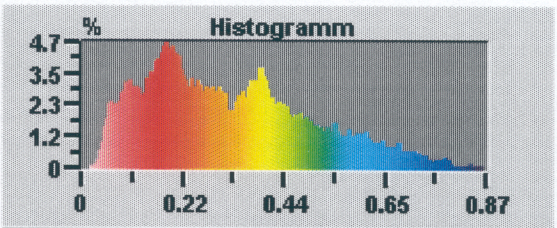
Bediener: Rt
Nr.:

HQS-Auftr.-Nr.: 98492867
Kunde: HAI
Produkt: LIGO
Pos.-Nr.: 1
Auftrags-Nr.:
Kommentar: 960095-im-05

Probendicke: 109.0 mm
Probendurchm.: 280.0 mm
CA-Durchm.: 200.0 mm
Bilddurchm.: 200.3 mm

Mittelpunkt: (0.0mm,0.0mm)
Radius: 100.1mm
Punkte: 69729



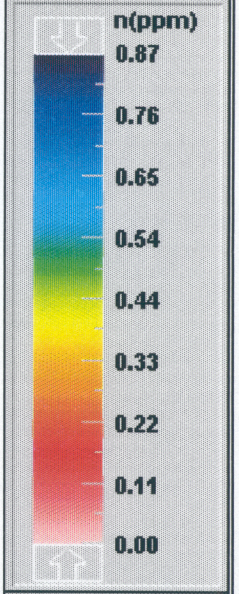


Sub.	Terme	Betrag	Winkel
X	Tilt	0.1645	-49.9433
	Fokus	0.2585	
	Astigm.	0.0728	-48.3361
	Koma	0.1135	138.2426
	SA3	0.1102	

Phasendaten

Einheit	n(ppm)
PV:	0.87
RMS:	0.171
Scale:	0.5

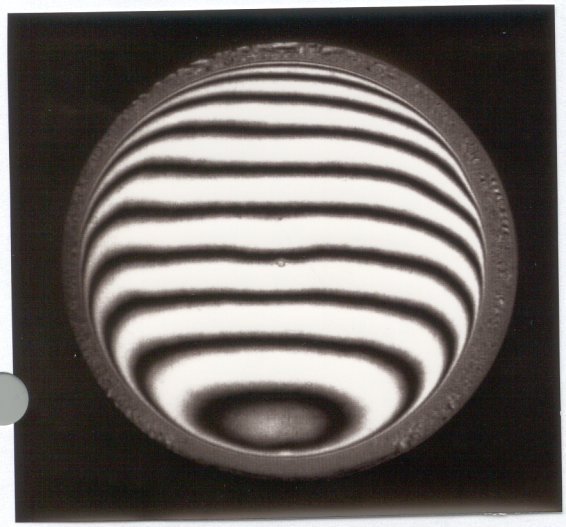
Kontrast

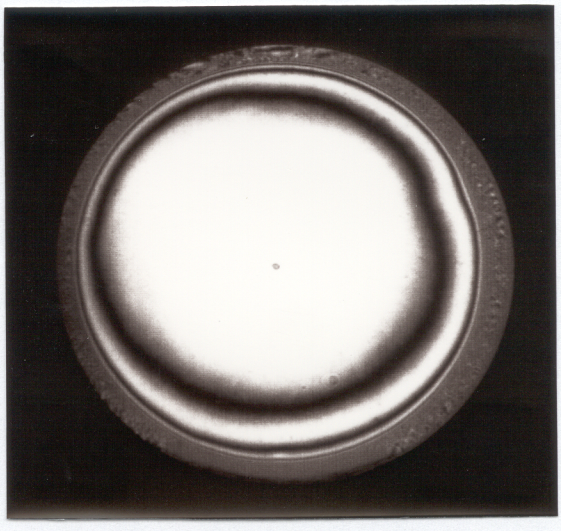


Reset

OberG	0.871
UnterG	0.000

Datei: 531800.tif, 02.08.97, 10:48





Heraeus Amersil Inc
3473 Satellite Blvd.
Duluth, GA 30136

Heraeus
AMERSIL

Pick Ticket

Sales Order #: 5001652
Delivery #: 30035153

Terms: FOB Duluth
Customer PO # pc208421

6.5"x2.5"x.5"

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

ref quote# 9607054

78462731

Order Entered By: DANB
Salesman: 00000020 MARC SCHNEIDER

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. dlvry 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	EA	10/07/1998	11.000	11		

IM Ø5

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-T970035-01-D **LIGO DETECTOR OPTICS**
B. LIGO S/N: 2ITM02-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.: PC167159 D. Substrate Polisher: CSIRO

E. Core optic Material: BS / FM / (2ITM) / 4ITM / ETM / RM F. Date Received: 07-05-98

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 compatable disc in ASCII format of all Surface Data per the applicable LIGO Component Specification sheet From 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.

☑	Inspection of material diameter.	Diameter	9.88 in	250.98	mm
☑	Inspection of material thickness	Thickness	3.94 in	99.96	mm
☑	Wedge Angle 0°34'				

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. No packing slip

Inspection By: _____ Date Inspected: 07-05-98

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.)

Replaced tripped 60g accelerometer

several scratch locations on surface 2

SKETCHES:

See CSIRO surface sketch (side 2)

DISPOSITIONS:

Substrate, Input Test Mass	Serial Number:		Specification	Reported Value	✓
	Surface 1	Surface Figure Over Central 200mm dia.	Spherical, Concave		
		Radius of Curvature Tolerance	14,180m +140m, -1000m	13.61 Km	✓
		Astigmatism	< 13nm p-v	2.3 nm	✓
	Surface 2	Surface Figure Over Central 200mm dia.	Nominally Flat		
		Radius of Curvature of the Wavefront	9,740m +500m, -100m	13.38 Km -4.98 Km	✓ ✓
		Astigmatism	< 15nm p-v	6.0 nm	✓
	Surface Errors Surface 1	Low Spatial Frequency Band Central 80mm	≤ 4.3 cm^{-1} σ_{rms} < 0.8nm	0.6 nm	✓
		Low Spatial Frequency Band Central 200mm	≤ 4.3 cm^{-1} σ_{rms} < 1.6nm	0.8 nm	✓
		High Spatial Frequency Band Central 80 & 200 mm	≤ 4.3 – 7,500 cm^{-1} σ_{rms}<0.2nm	0.2 0.21	✓
	Surface Errors Surface 2	Low Spatial Frequency Band Central 80mm	≤ 4.3 cm^{-1} σ_{rms} < 1.6nm	0.6 nm	✓
		Low Spatial Frequency Band Central 200mm	≤ 4.3 cm^{-1} σ_{rms} < 3.2nm	1.1 nm	✓
		High Spatial Frequency Band Central 80 & 200 mm	≤ 4.3 – 7,500 cm^{-1} σ_{rms}<0.2nm	0.07 0.1	✓

Scratches, Point Defects & Polish Side 1		Specification	Certification	✓
	Scratches	The Total Area of scratches within the central 80mm diameter shall not exceed 25 X 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 x 10^3 square micrometers.	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

		Specification	Certification	✓
Scratches, Point Defects & Polish Side 2	Scratches	The total area of scratches shall not exceed 75 X 10^3 square micrometers over the central 80mm (width x length). 25,000 m^3	Hand Sketch w/dimensions	✓
		The total area of scratches outside the central 80 mm diameter shall not exceed 750 x 10^3 square micrometers. 100,000 m^3	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

This Certification Package relates to the following substrate: **Input Test Mass(2 KM)**

Serial number: 2ITM02-C

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: for	Certification of Surface Errors - Low Frequency, 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 2A	Hard copy print out of LADI data for Side 2 with piston, tilt, removed and also for piston, tilt, power, astigmatism removed
Attachment 2B	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)

2. Electronic data

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

LADI data:	2ITM2C1.zip (Side 1)	2ITM2C2.zip (Side 2)
		2ITM2C2A.zip (wave front)
TOPO data: (2.5X)	T22IM21A.asc (Side 1)	T22IM22A.asc (Side 2)
	T22IM21B.asc	T22IM22B.asc
	T22IM21C.asc	T22IM22B.asc
(40X)	T42IM21A.asc	T42IM22A.asc
	T42IM21B.asc	T42IM22B.asc
	T42IM21C.asc	T42IM22C.asc

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM02-C**
3	**Physical quantity certified:**	**Physical Dimensions and Registration Mark**
4	**LIGO specification reference:**	**D960803-B-D**
5	**CSIRO measurement/inspection procedure reference:**	**HABA-LIGO-M-PD**
6	**Variations to the measurement/inspection procedure:** (indicate Yes/No and attach separate sheet if Yes)	**No**
7	**CSIRO Log Book Reference**	**LN00028 p 23**
8	**Team member responsible for measurement/inspection:**	**C Sona**
9	**Measurement/inspection results reviewed by:**	**C Walsh**

10. Results

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

Physical Quantity	Result
Diameter	250.98 mm
Cylindricity	0.01 mm
Thickness (maximum - for FM, RM, ETM) (minimum - for BS)	99.96 mm
Bevel as per drawing (height, angle):	(S1) Height:2.06 mm Angle: $45^0 23'$ (S2) Height:2.14 mm Angle: $44^0 40'$
Wedge angle:	$0^0 34'$
Location of registration mark ($\pm$ angle with respect to minimum part thickness):	+26"
Location of other 3 marks (with respect to registration mark at minimum thickness)	90^0, $179^0 59'$, $270^0 02'$
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

Date: 18 June 98

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM02-C**
3	**Physical quantity certified:**	**Side and Bevel Polish**
4	**LIGO specification reference:**	**E960093-C-D**
5	**CSIRO measurement/inspection procedure reference:**	**HABA-LIGO-M-SB-A**
6	**Variations to the measurement/inspection procedure:** (indicate Yes/No and attach separate sheet if Yes)	**No**
7	**CSIRO Log Book Reference**	**LN00062**
8	**Team member responsible for measurement/inspection:**	**E Pavlovic**
9	**Measurement/inspection results reviewed by:**	**J Seckold**

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: 18 June 98

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM02-C**
3	**Physical quantity certified:**	**Serial Number and location**
4	**LIGO specification reference:**	**E960093-C-D**
5	**CSIRO measurement/inspection procedure reference:**	**HABA-LIGO-M-SN-A**
6	**Variations to the measurement/inspection procedure:** (indicate Yes/No and attach separate sheet if Yes)	**No**
7	**CSIRO Log Book Reference**	**LN00062**
8	**Team member responsible for measurement/inspection:**	**E Pavlovic**
9	**Measurement/inspection results reviewed by:**	**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

Date: 18 June 98

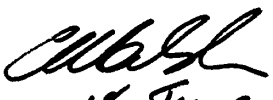
1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM02-C**
3	**Physical quantity certified:**	**Scratches and Point Defects**
4	**LIGO specification reference:**	**E960093-C-D**
5	**CSIRO measurement/inspection procedure reference:**	**HABA-LIGO-M-SP-A**
6	**Variations to the measurement/inspection procedure:** (indicate Yes/No and attach separate sheet if Yes)	**No**
7	**CSIRO Log Book Reference**	**LN00062**
8	**Team member responsible for measurement/inspection:**	**E Pavlovic**
9	**Measurement/inspection results reviewed by:**	**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**	**nil**
Surface 2	**nil**	**nil**	**25,000**	**100,000**

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:  Chris Walsh

Date: 18 June 98

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM02-C**
3	**Physical quantity certified:**	**Surface Figure**
4	**LIGO specification reference:**	**E960093-C-D**
5	**CSIRO measurement/inspection procedure reference:**	**HABA-LIGO-M-SF-A**
6	**Variations to the measurement/inspection procedure:** (indicate Yes/No and attach separate sheet if Yes)	**No. Data files for transmitted wave front represent two passes**
7	**CSIRO Log Book Reference**	**LLN/0137-01 pp 27-28**
8	**Team member responsible for measurement/inspection:**	**D Farrant**
9	**Measurement/inspection results reviewed by:**	**B Oreb**

10. Results

	Radius of Curvature in km	**Astigmatism (nm)**	**Electronic data file reference**
Surface 1	**13.61 km**	**2.3 nm**	2ITM2C1.zip
Surface 2	**13.38 km**	**6.0 nm**	2ITM2C2.zip
Wave front*	**-4.98 km**		2ITM2C2A.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

Date: 18 June 98 .

LADI CERTIFICATION DATA

Title: 2ITM021

Date: 05/15/98

Diameter: 200 mm

Astig: 2.3 nm

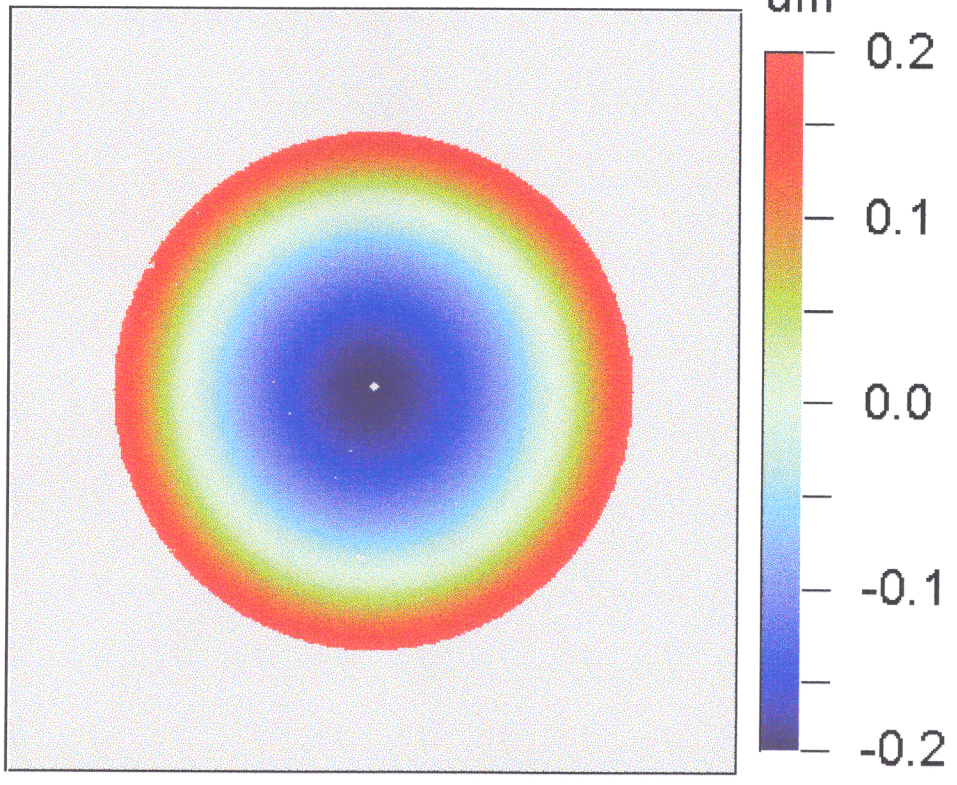
Power: 367.7 nm

CSIRO

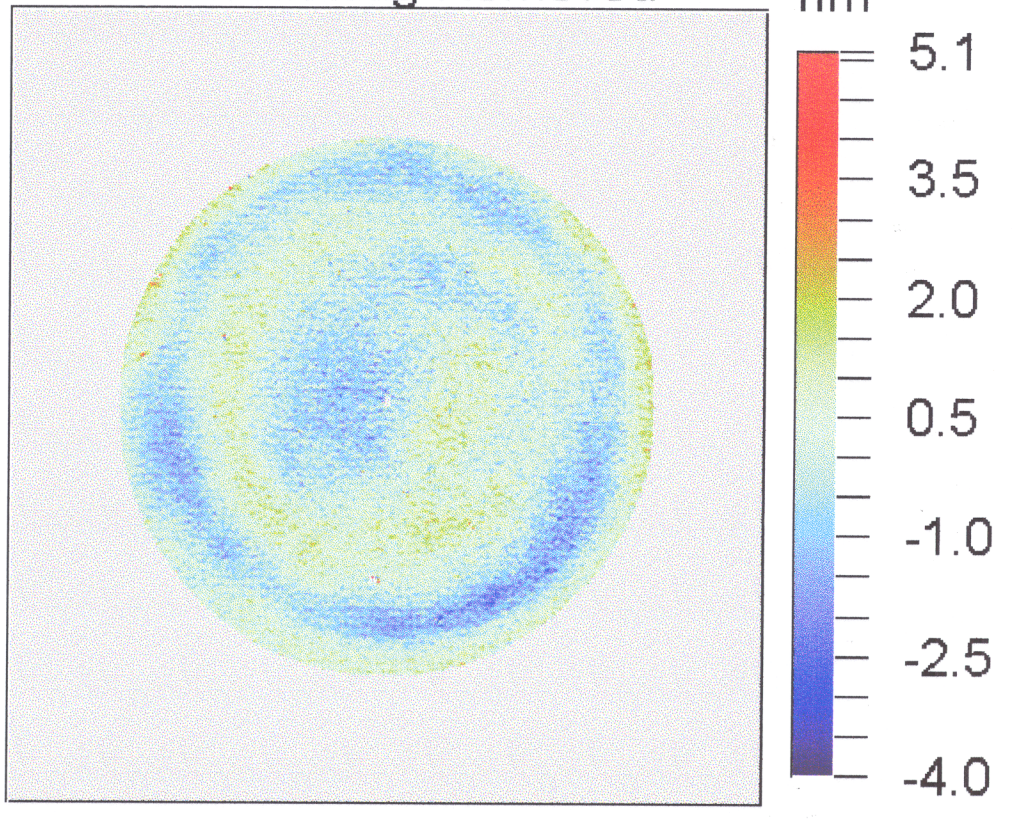
PV: 9.1 nm

RMS: 0.8 nm

Tilt Removed



Tilt/Power/Astig Removed



AH.2

LADI CERTIFICATION DATA

Title: 2ITM022

Date: 05/15/98

Diameter: 200 mm

Astig: 6.0 nm

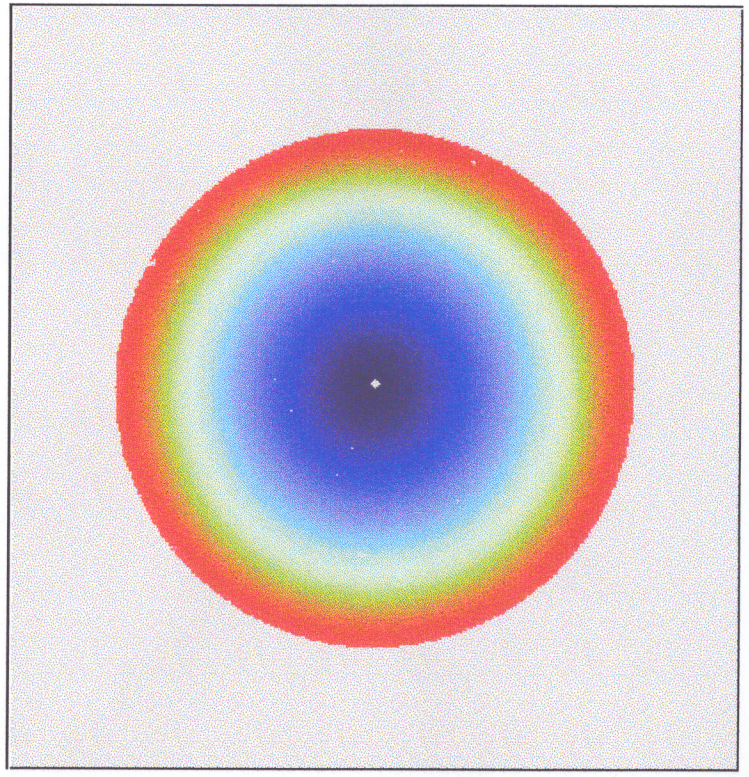
Power: 373.7 nm

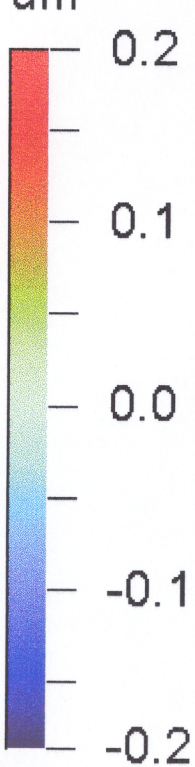
CSIRO

PV: 11.5 nm

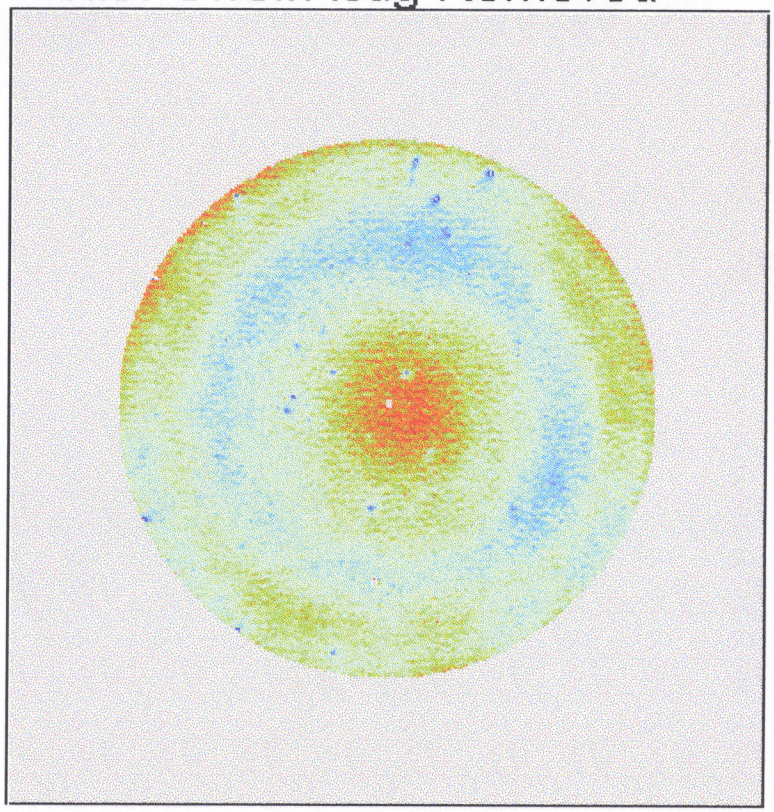
RMS: 1.1 nm

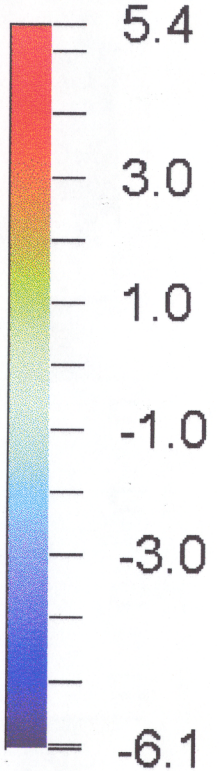
Tilt Removed





Tilt/Power/Astig Removed





Att. 2A

LADI CERTIFICATION DATA

Title: 2ITM2TA

Date: 06/04/98

Diameter: 200 mm

Astig: -29.8 nm

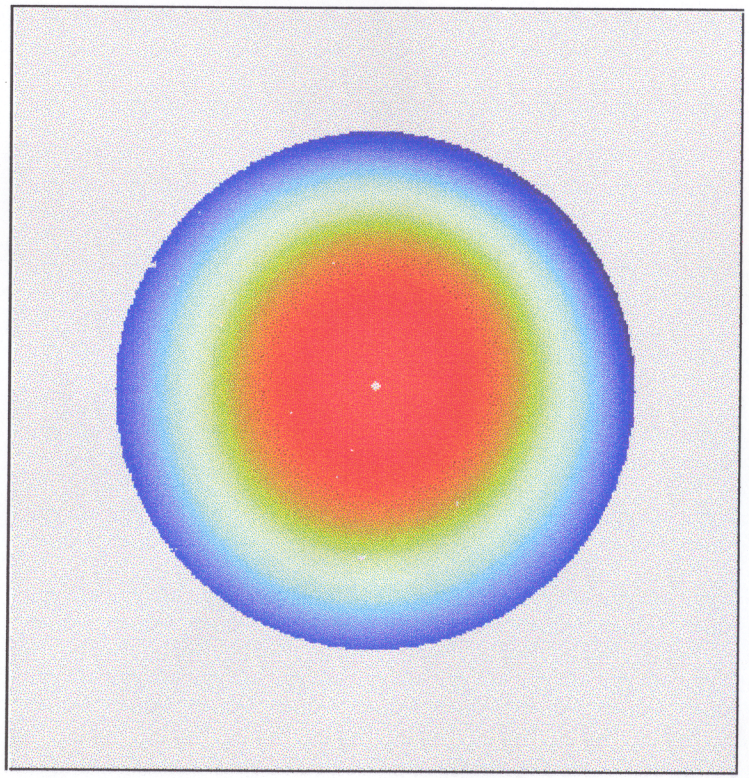
Power: -1003.5 nm

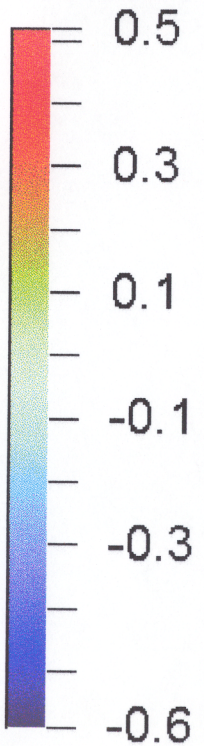
CSIRO

PV: 126.0 nm

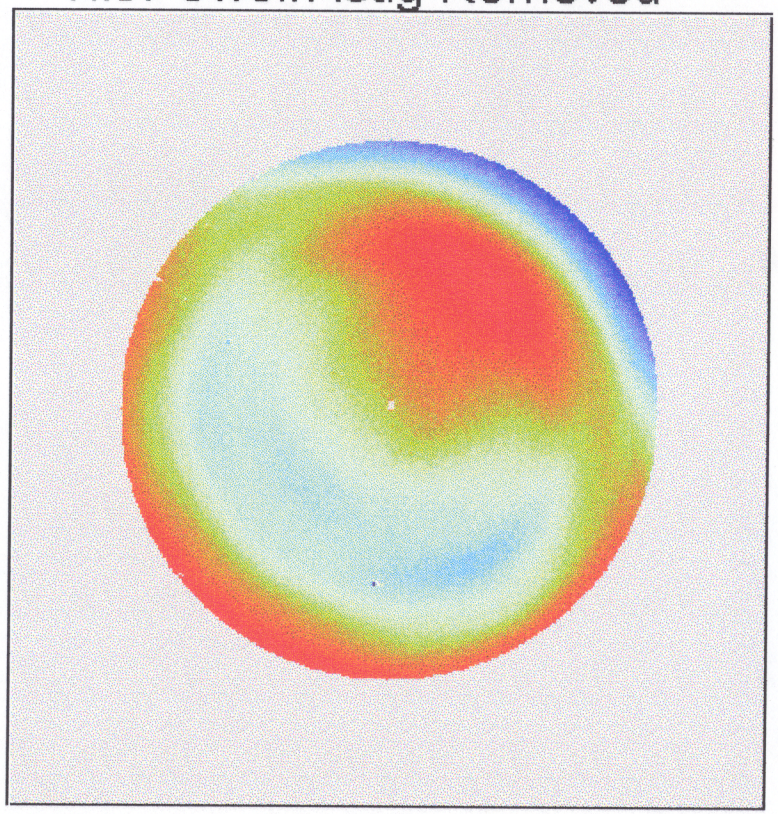
RMS: 20.9 nm

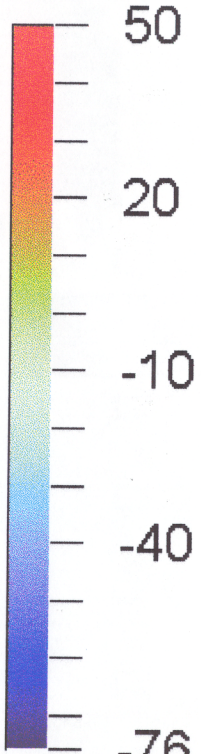
Tilt Removed





Tilt/Power/Astig Removed





AH. 2B

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM02-C**
3	**Physical quantity certified:**	**Surface Errors - Low Spatial Frequency**
4	**LIGO specification reference:**	**E960093-C-D**
5	**CSIRO measurement/inspection procedure reference:**	**HABA-LIGO-M-SL-A**
6	**Variations to the measurement/inspection procedure:** (indicate Yes/No and attach separate sheet if Yes)	**No**
7	**CSIRO Log Book Reference**	**LLN/0137-01 pp 27-28**
8	**Team member responsible for measurement/inspection:**	**D Farrant**
9	**Measurement/inspection results reviewed by:**	**B Oreb**

10. Results

	Low Frequency Surface Errors (nm)	
	80 mm aperture	**200 mm aperture**
Surface 1	0.6	0. 8
Surface 2	0.6	1.1

Hardcopies of the phase maps over the central 200 mm with piston, tilt, power and astigmatism removed are attached to this certification in Attachment 1 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: 18 June 98.

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM02-C**
3	**Physical quantity certified:**	**Surface Errors - high spatial frequency**
4	**LIGO specification reference:**	**E960093-C-D**
5	**CSIRO measurement/inspection procedure reference:**	**HABA-LIGO-M-SH-A**
6	**Variations to the measurement/inspection procedure:** (indicate Yes/No and attach separate sheet if Yes)	**No**
7	**CSIRO Log Book Reference**	
8	**Team member responsible for measurement/inspection:**	
9	**Measurement/inspection results reviewed by:**	

10. Results

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

Side 1: **0.20**

Side 2: **0.07**

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

Side 1: **0.21**

Side 2: **0.10**

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

	A	B	C	D	E	F	G	H
Surface 1	**0.17**	**0.22**	**0.22**	**0.19**	**0.20**	**0.22**	**0.21**	**0.20**
Surface 2	**0.07**	**0.08**	**0.07**	**0.07**	**0.07**	**0.17**	**0.17**	**0.11**

Two - dimensional surface maps at three central locations are available at the CSIRO ftp site under filenames of the form TM2IM0YZA.asc, where M is the objective used (M=2 for 2.5X, 4 for 40X), 2IM 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).

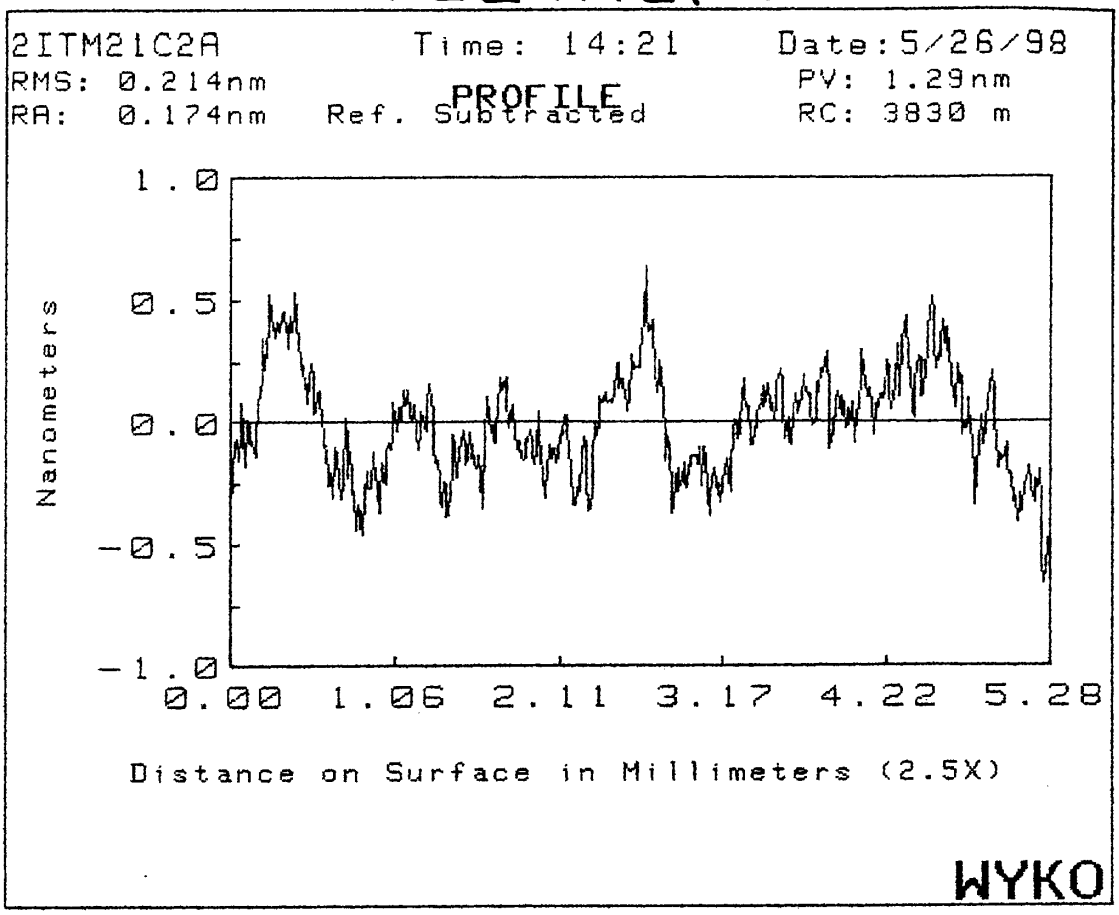
11. Certification

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

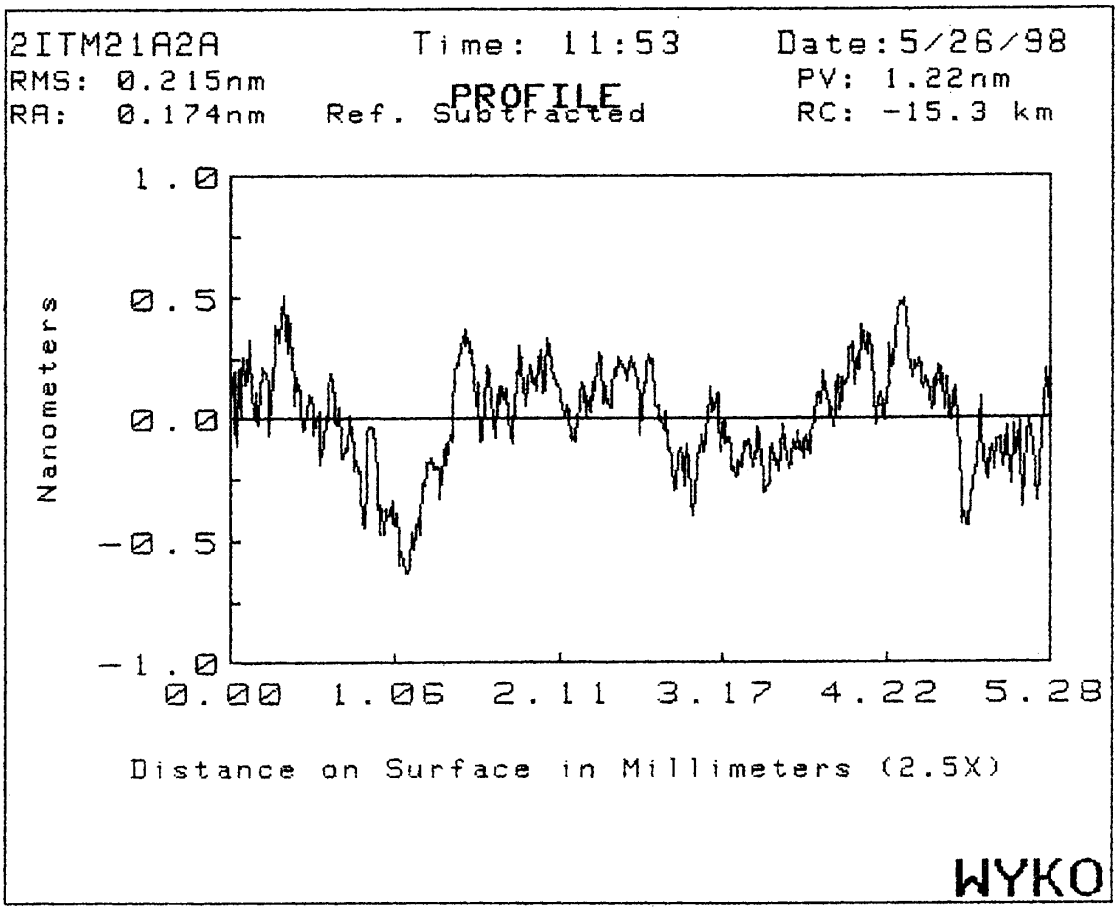
Date: 18 June 98

T22IM21A.asc



AH.3

T22IM21B.asc



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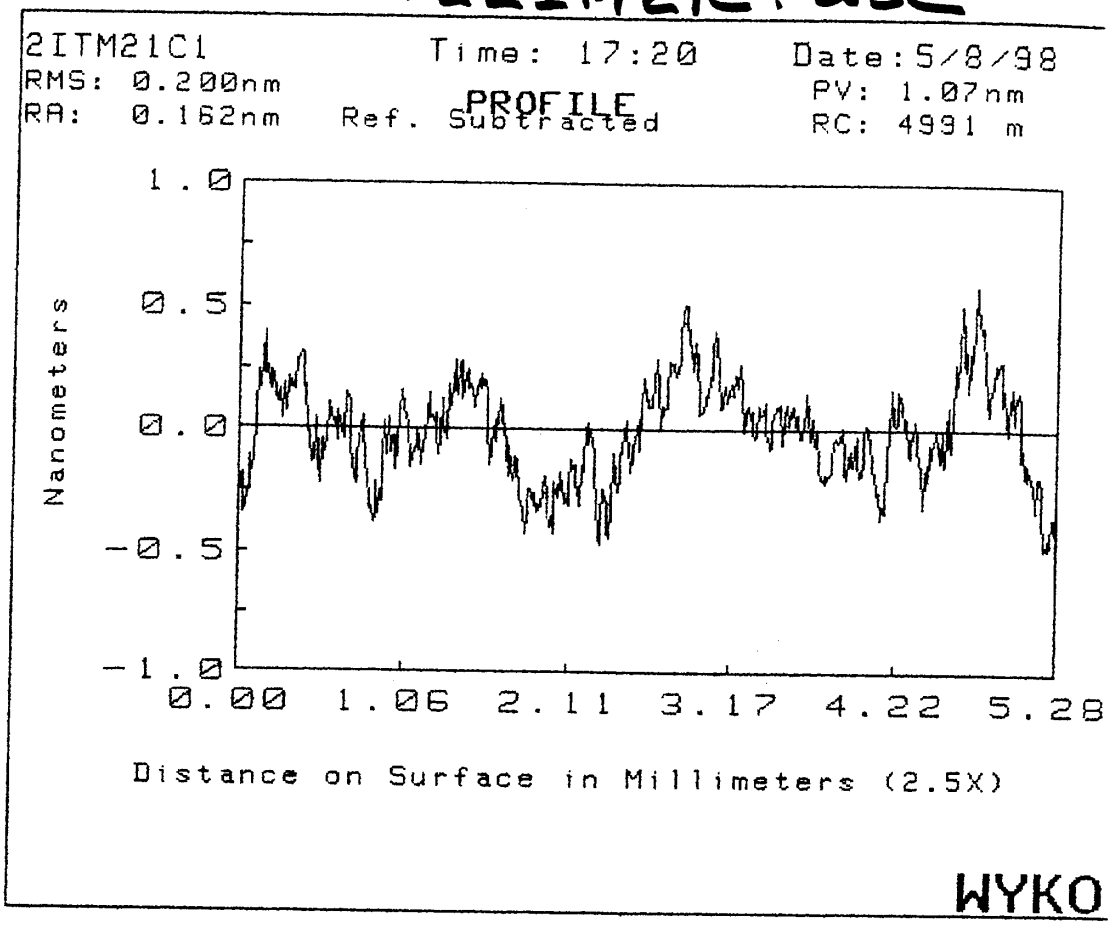

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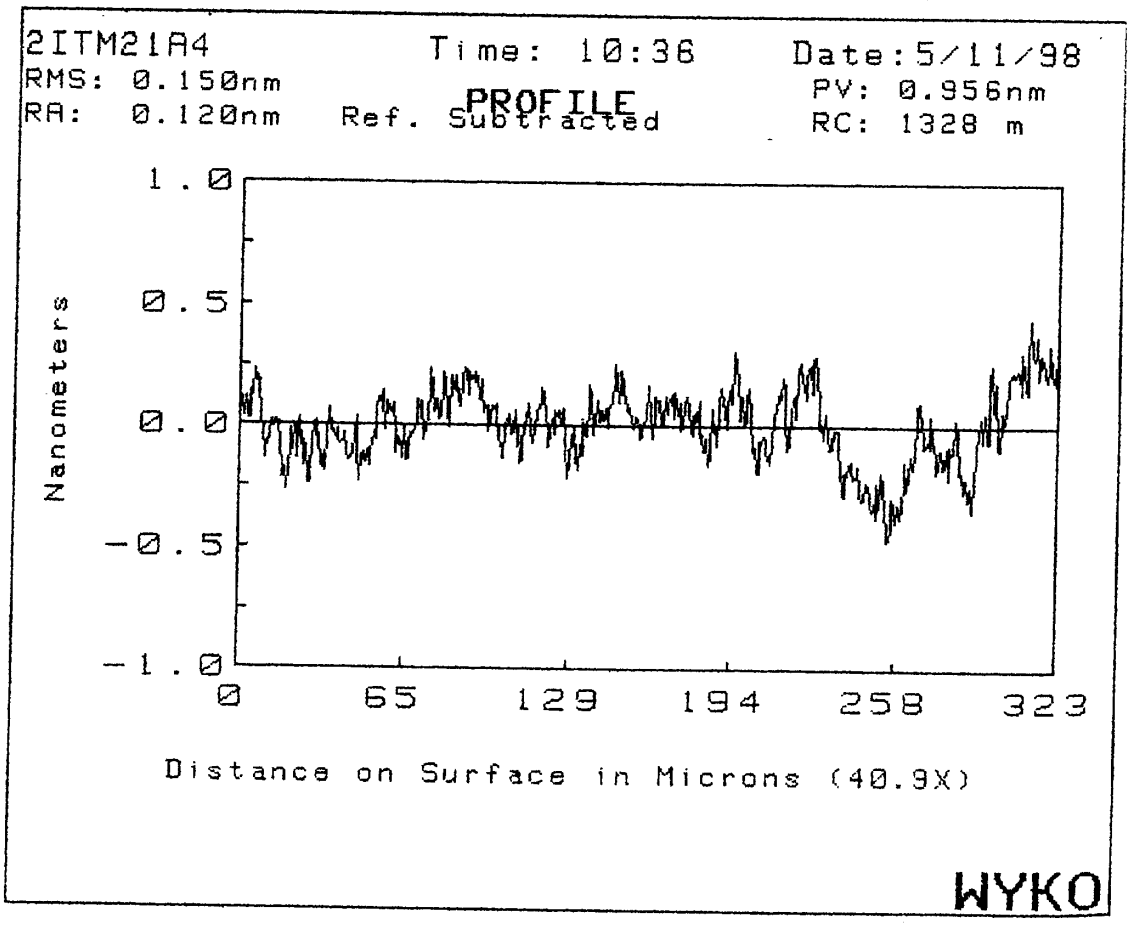

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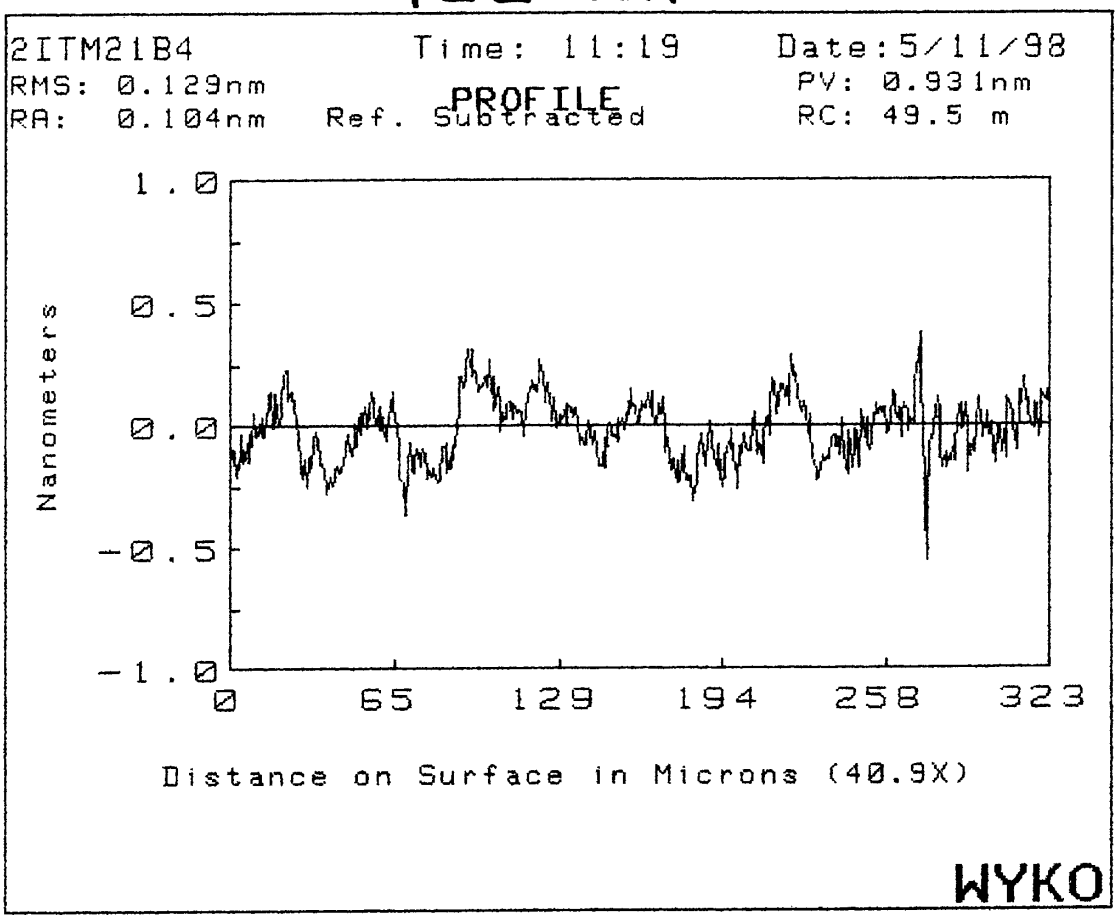

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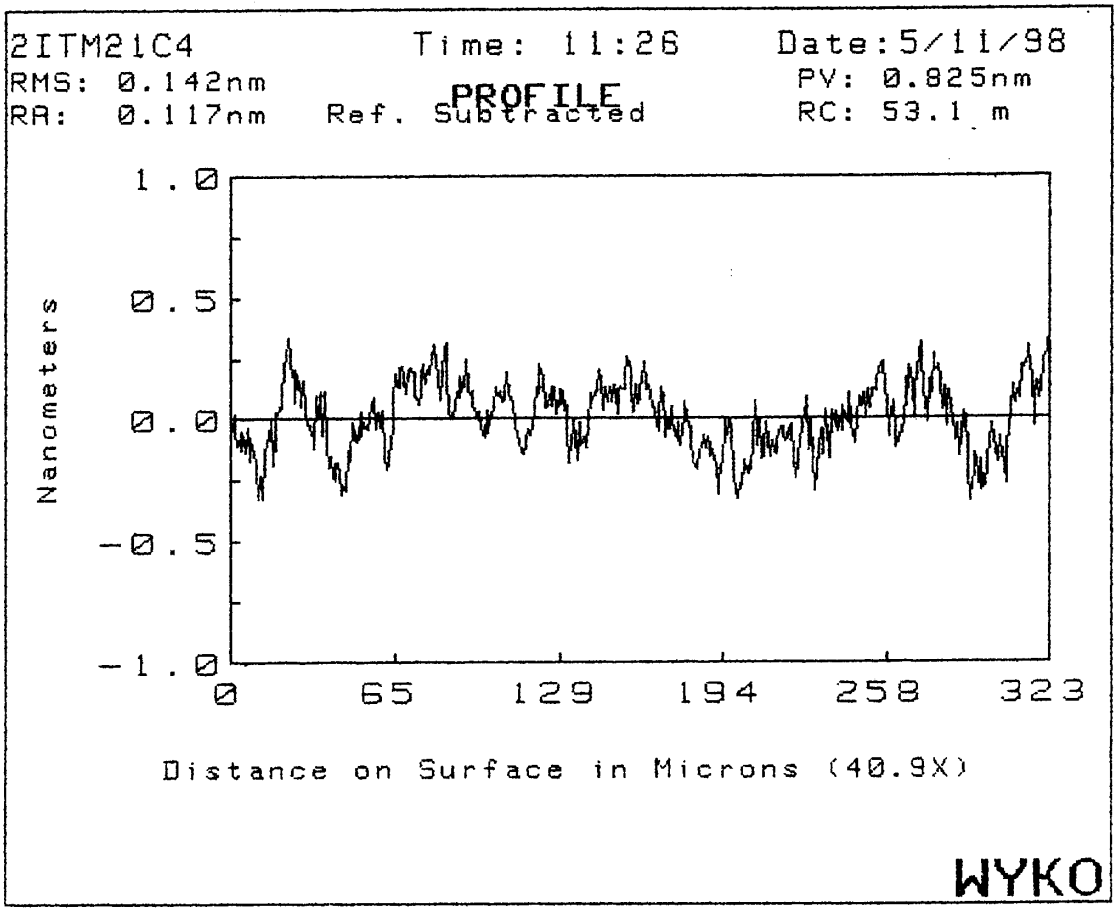

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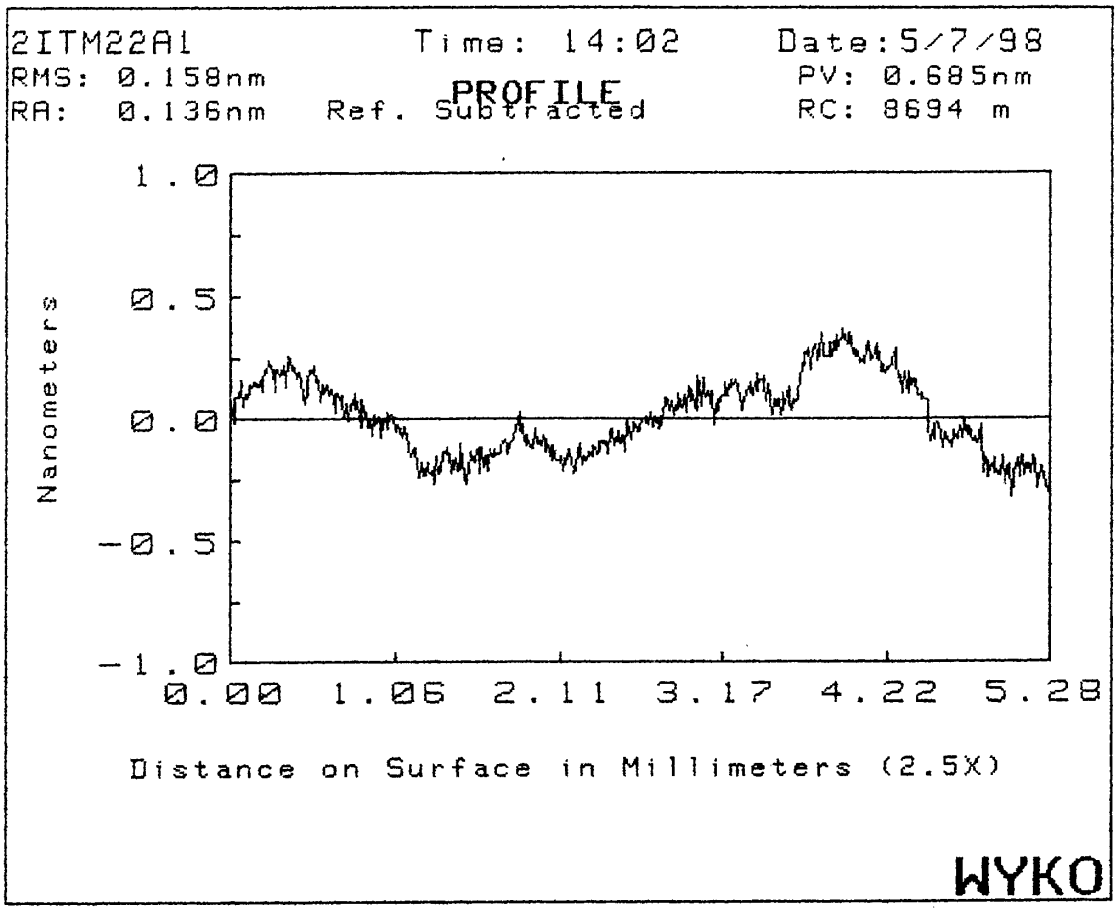

AH.4

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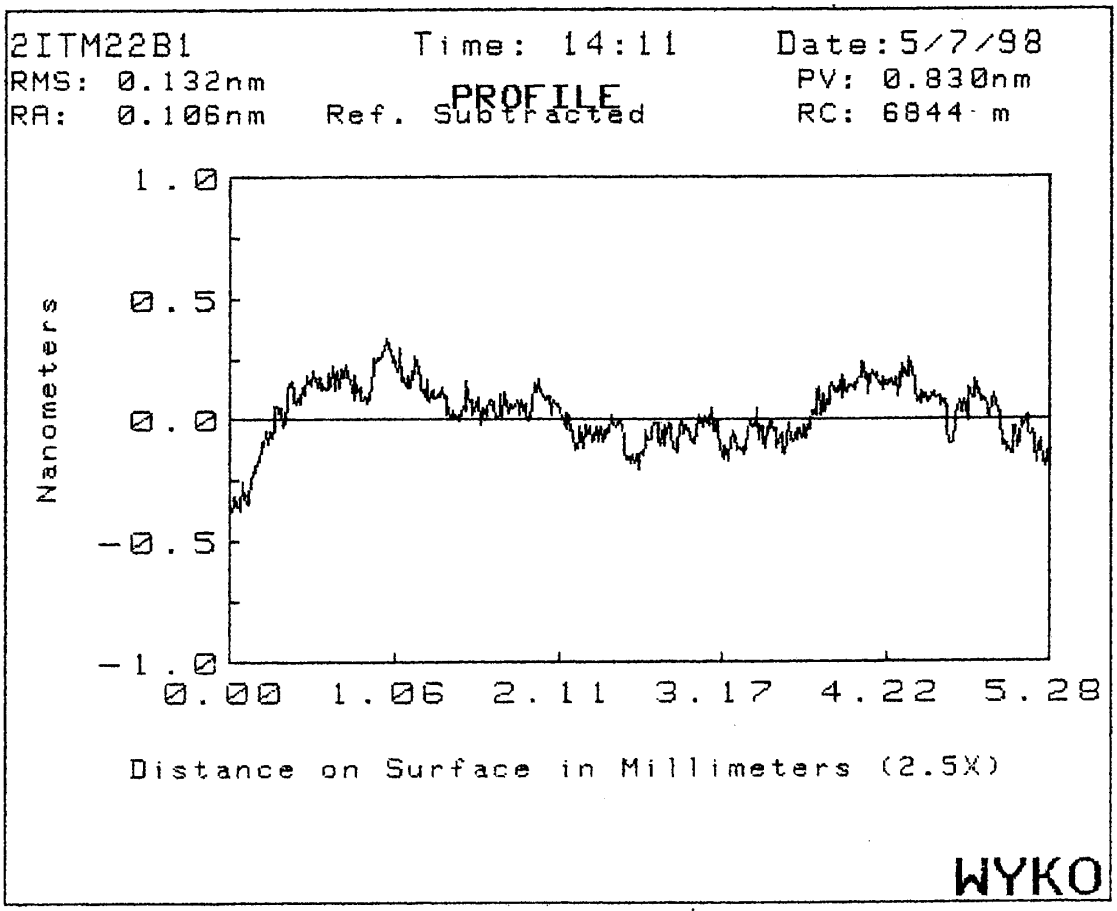

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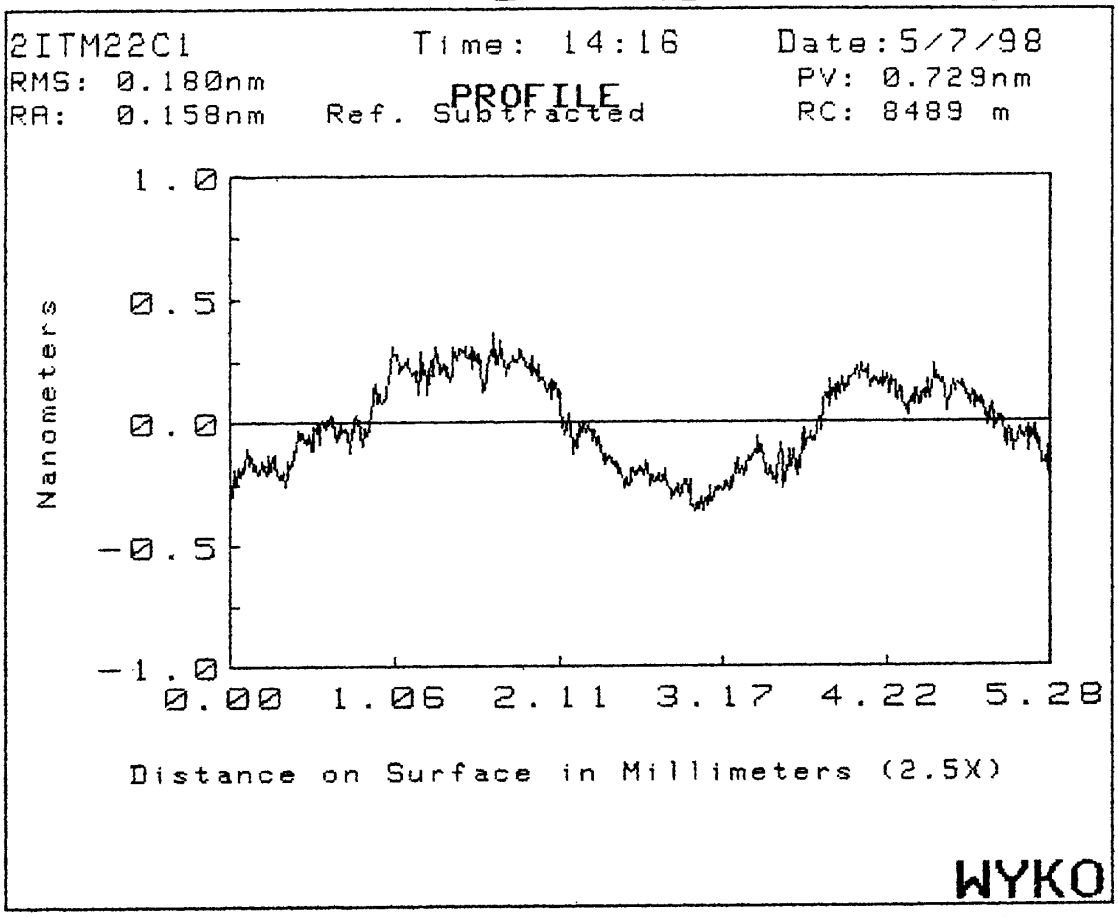

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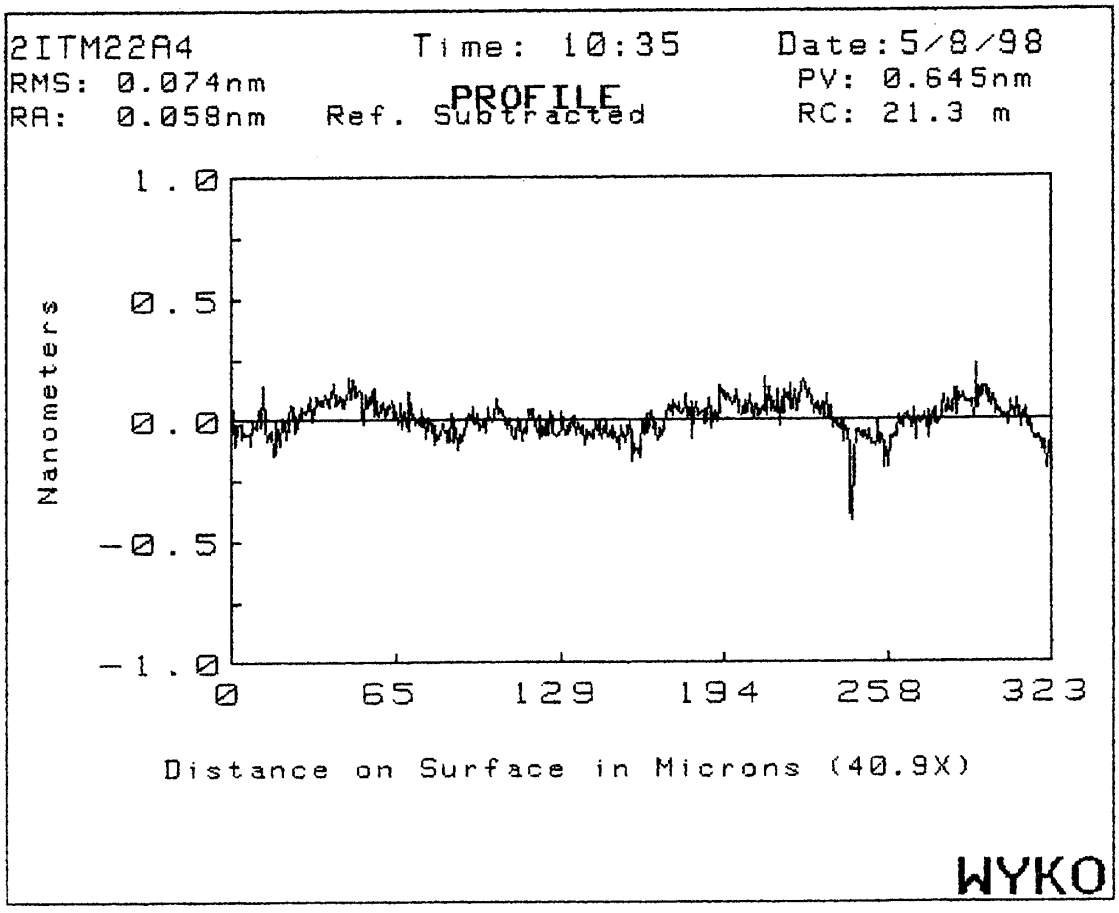

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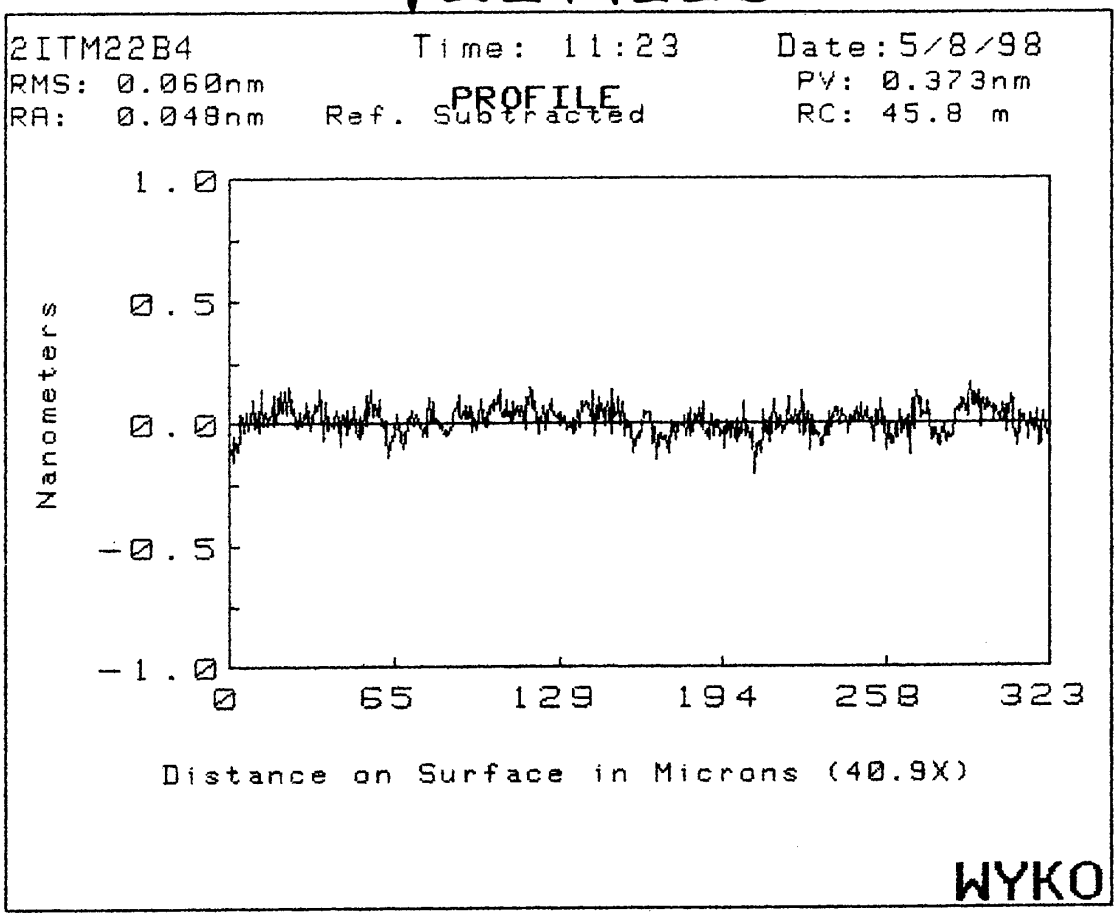

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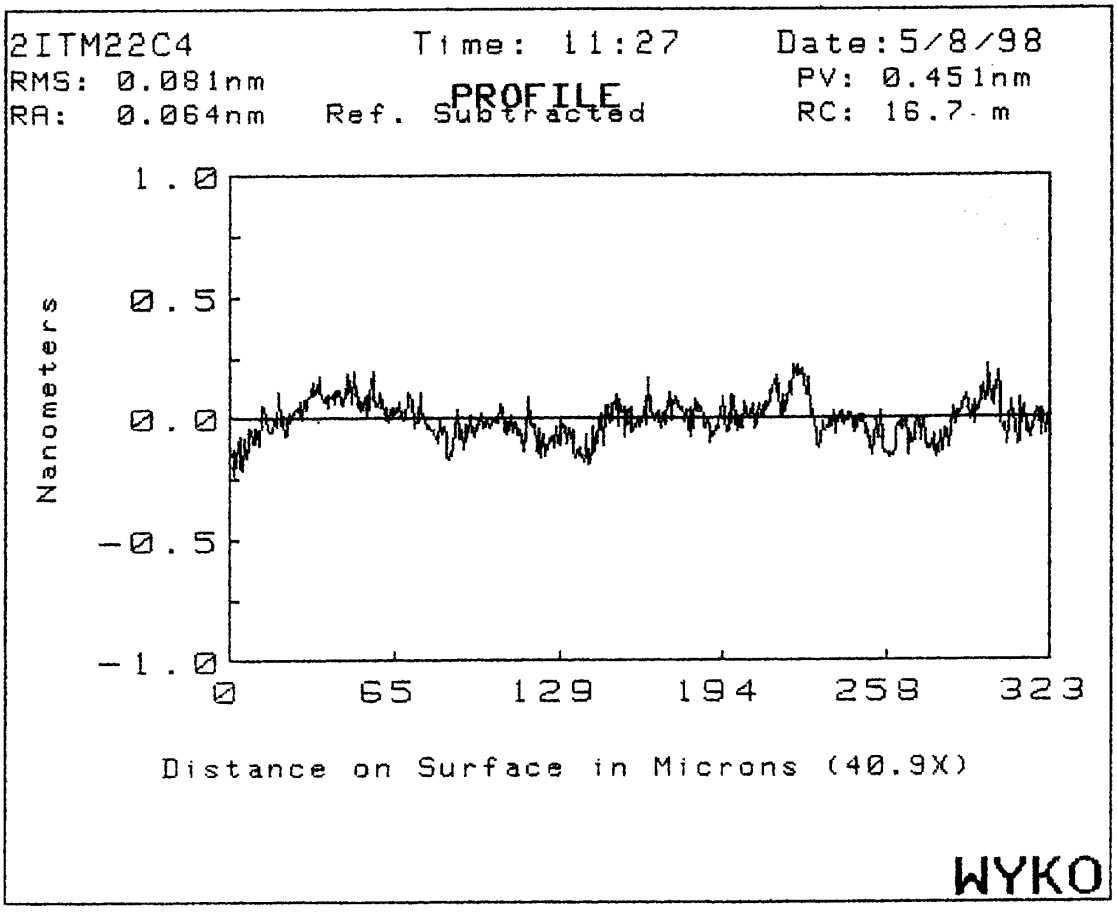



MIRROR

Research Electro-Optics Inc.

CERTIFICATE OF CONFORMANCE

Section3.14/REO QC Manual, Q-001, Doc. No. V:QA:REO 014, Rev."B", 09/13/96

Certificate of Conformance from: **Research Electro-Optics (REO) Inc.**
1855 South 57th. Court
Boulder, Colorado 80301
(303) 938-1960, Fax (303) 447-3279

Research Electro-Optics (REO), Inc. hereby certifies that the items listed below have been inspected and tested to the extent necessary to conform with all the requirements of the noted Purchase Order, drawing, and applicable specification(s). Inspection and test data are on file at our facility and will be furnished to customer upon request.

- Date of shipment : 29 Sept 98
- Customer Name, Purchase Order No. : Caltech/Ligo ; po PC162519/CONOS
- Customer Part Number & Revision : 2ITM02, 2ITM04
- Part Description : S1: T = 3% @ 1064nm S2: R = 600 ppm @ 1064nm
- REO Job No. : OPTO5831-024 Run No.: S1: OX815 S2: OX817
- Qty. Shipped/Lot No. : 2 ea. 25cmØ fs
  2 ea 1"Ø fs witness

X **Test data (included)**

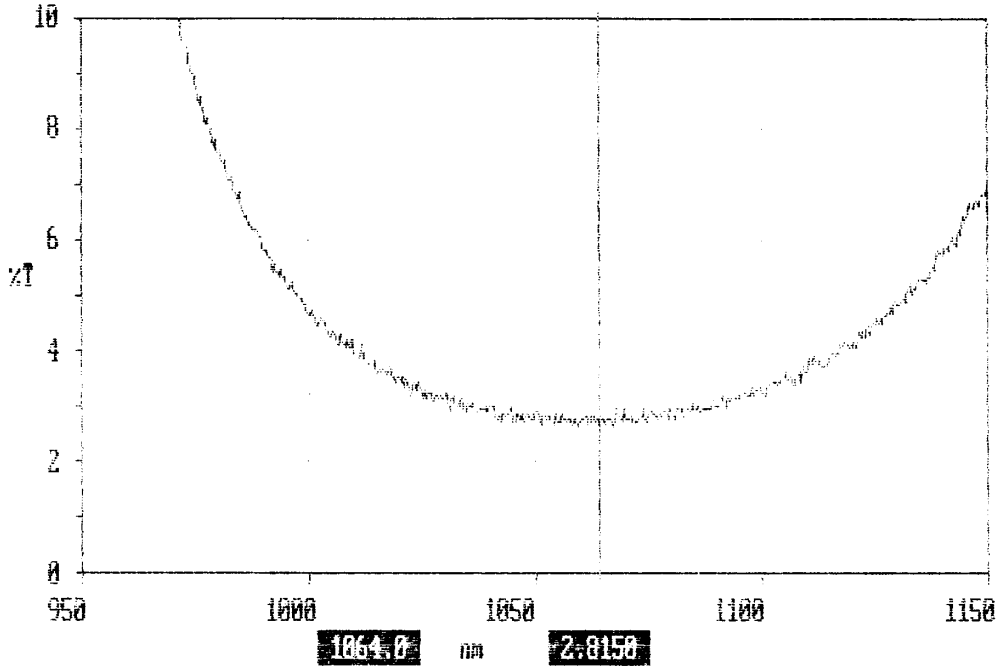
Comment:

Certified by: _____, 9.29.98
Quality Assurance

Verified by: _____, 29 Sept 98
Engr/Tech

NOTE
Certificate must accompany the package to be shipped or attached to the outside of the same box to which the "Packing Slip" envelope is attached.

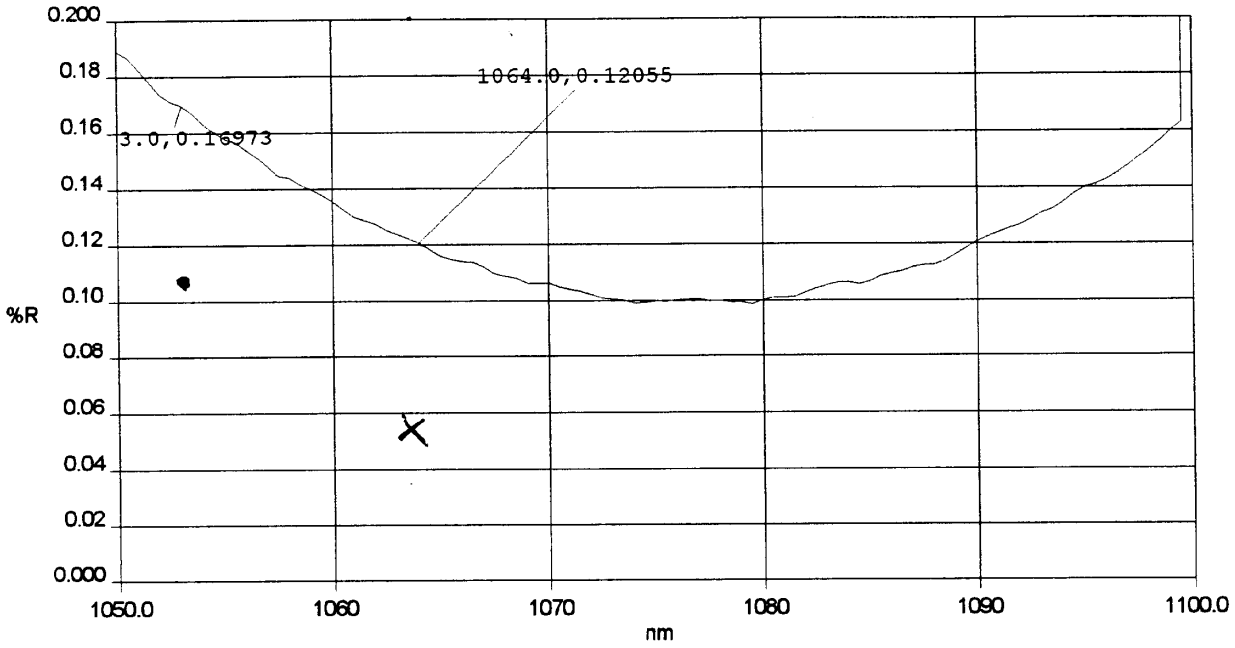
X: user004; 1150.0 - 950.0 nm; pts 1001; int 0.20; ord 2.6180 - 22.560 %T
Inf: #0X815, 3% transmitter after processing, for ZITM02, 04



Research Electro-Optics, Inc.

Spectrophotometer Data

Date: 9/29/98



——— SCAN061.SP - 9/29/98 - #ox817, 600ppm AR@1064nm, after processing

• - Measured with Laser @ 1053nm
R = 1042 ± 35 ppm

X - inferred Level @ 1064nm
R = 551 ppm ± 35 ppm

2 ITMØ2

Research Electro-Optics Inc.
1855 South 57th Court, Boulder, Colorado 80301 (303) 938-1960 FAX (303) 447-3279

ORDER NO: OPT05831
SHIPMENT NO: 005876
PAGE: 1
DATE: 09/29/1998
CUST PO NUMBER: PC162519/CONO5

P A C K I N G L I S T

SOLD TO:2040A
CALIFORNIA INST. OF TECHNOLOGY
I PETRAC, M/C: 18-34 LIGO
51-33 EAST BRIDGE LABORATORY
PASADENA, CA 91125

SHIP TO:000007
CALIFORNIA INST. OF TECHNOLOG
51-33 EAST BRIDGE LAB, LIGO
ATTN: HELENA ARMANDULA, 18-34
PASADENA, CA 91125

SHIP VIA:FED-EX P1 COL

MISC #1:
MISC #2:

FOB: FACTORY TERMS: .0% - 0 DAYS; .0% - 0 DAYS; NET: 30 DAY
TOTAL: PIECES: 2 WEIGHT: 196 LBS VOLUME: 0 CU FT

LN#	ITEM/CATALOG ITEM	UM	ORDER QUANTITY	QUANTITY DUE	SHIPPED QUANTITY	BACKORDE QUANTIT

THIS ORDER IS A CHANGE ORDER TO REO JOB# OPT04124.

PER QUOTES OPQ-2403 & OPQ-2472

REFERENCE: CALTECH LIGO-C98-00D/LIGO-C980963-00-D
LIGO-C950494-05-1

Technical Contact:
Helena Armadula Tel: 626-395-2070
Mail Code 18-34

Contractual Representative:
Irena Petrac Tel: 626-395-2975
Mail Code 18-34

Items #001 thru' #014 is per PO# PC162519 Change Order 5

Items #015 thru' #039 is per PO# PC162519 Change Order 6
Per REO quote #OPQ-2537. No Item #027 on this order
acknowledgment.

024 LIGOE980066 EA 2 0 2 0
INPUT TEST MASS, 2K, COATED

ER PART #2ITM, SPEC #LIGO-E980066-00-D.

2ITM02-C

CHANGE ORDER, July 14, 1998 ** JM
Change ship date from 7/15/98 to 8/28/98.

RUN #OX815(S1), OX817(S2)
PLUS TWO 1" DIAMETER WITNESS PIECES

FED EX TRACKING #7916 2423 2010, 7916 2423 2215.

Rec'd 10-01-98

PACKED BY: _____ CHECKED BY: _____ DATE: _____