

2ITM04-C

LIGO-T990150-00-D

BLANK

A. DCN: LIGO- T970040-00-D LIGO DETECTOR OPTICS

B. LIGO S/N: IM 10 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 8561
I. Date Received at Caltech: 10-06-97

J Verify glass manufacturer's ^{inspection report} ~~Certification~~ against LIGO Component Specification No. E 960095-A-D
Attach the applicable Component Specification Verification sheet.

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

L Attach the glass manufacturer's birefringence map, inclusion map, and data sheet per the above Component Specification. No birefringence or inclusion map 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 256.7 mm

Inspection of material thickness. Thickness 4.29 in 108.9 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: [Signature] Date Inspected: 10-08-97

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: IM 10	Specification	Reported Value	✓
		Mirror Blanks, Input Test Mass	Requirements	Physical Dimensions	LIGO-D960794
Diameter	256mm +1.0mm, -0mm			256.7 mm	✓
Thickness	108mm +1.0mm, -0mm			108.9 mm	✓
Chamfer	2.0mm Max 2pl			minimal	—
Clear Aperture	Central 235mm				—
Material	Fused Silica #7980			Certification	✓
Registration Mark	"Top" of Optic, 80mm Arrow Points to Side 1			Certification	No
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 $\lambda = 632.8\text{nm}$			Interferogram Homogeneity Map	No
Homogeneity Within the Central 200mm	$\leq 2.5 \times 10^{-6}$ p - v $\lambda = 632.8\text{nm}$			Interferogram Homogeneity Map	No
Homogeneity Data	ASCII Format			PC Compatible 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 $\leq 0.03\text{mm}^2$ Per 100cm^3 of Glass. $\leq 0.1\text{mm}$			Hand Sketch w/location & dim.	No
Absorption	2 ppm/cm $\lambda = 1.06\mu\text{m}$			Certification	No
Striae within the Clear Aperture	Grade A per MIL-G-174			Inspection Report	No

Blnk_ITM.doc

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 8517
Marking : 960095-IM10 *BN 5054*

Diameter : 256,6 mm
CA Diameter : Ø 200 mm = 2,27xE⁹
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 : 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.: 960095-1M 10/ 5054

Date: 18.08.97

Inspector: 



defect depth: none
Bubble: none
Inclusion: none
Striae: none

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

TBCS=

mm²
/100cm³

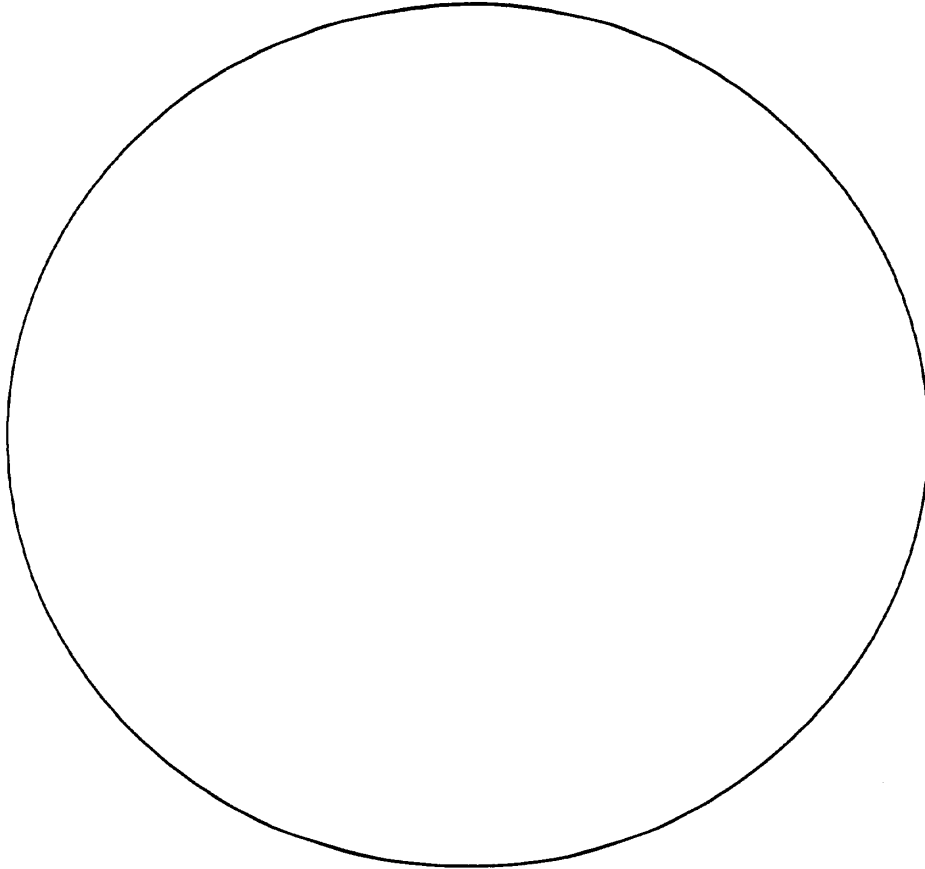
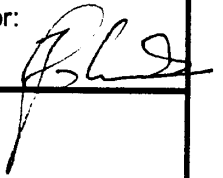
Heraeus
QUARZGLAS

POL - QW

Order No.: 94908401 Pos.: 1
Ø 256,6 mm x 108,8 mm
Plate No.: 960095-14 10 / 5054
Residual strain- Report

Date: 15.08.97

Inspector:

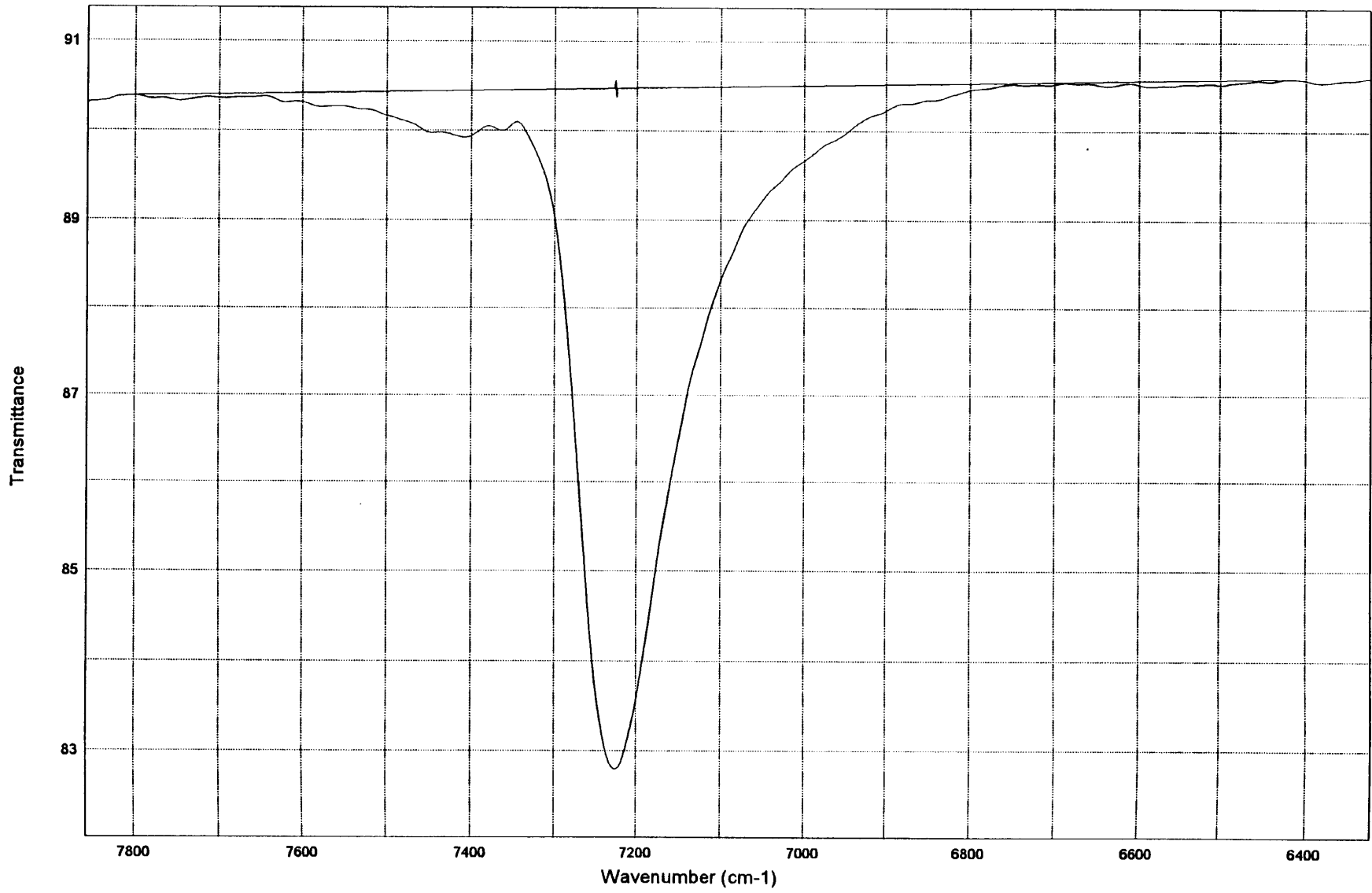


Edge	Center						Pos.
20							nm
2	<1						nm/cm

I0=90.4698 , I1=82.7961 at x=7225 OH-content: 154 ppm



MEASURE NO. : 5054
DATE : 02.09.1997 TIME : 10:35
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: 154 ppm at x=7225



Heraeus
QUARZGLAS

POL-QW

Meßwellenlänge 632.8 nm

Datum: 02.08.97

Bediener: Rt

ID: 505400

Nr.:

HQS-Auftr.-Nr.: 98492867

Kunde: HAI

Produkt: LIGO

Pos.-Nr.: 1

Auftrags-Nr.:

Kommentar: 960095-im-10

Probendicke: 108.8 mm

Probendurchm.: 280.0 mm

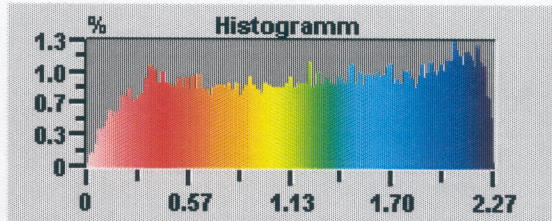
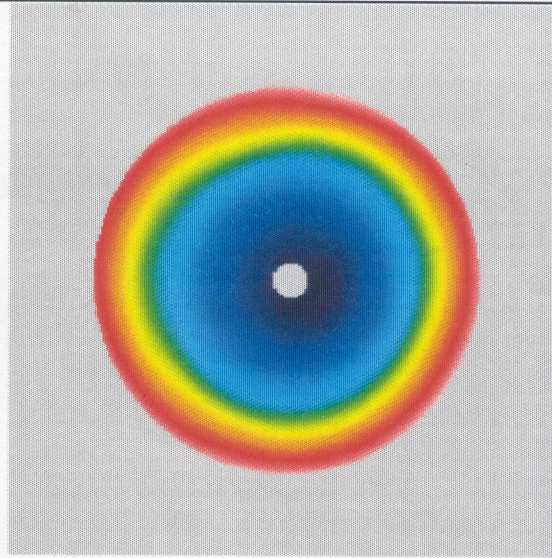
CA-Durchm.: 200.0 mm

Bilddurchm.: 200.3 mm

Mittelpunkt: (0.0mm,0.0mm)

Radius: 100.1mm

Punkte: 69729



Sub. Terme	Betrag	Winkel
X Tilt	0.0396	102.2547
Fokus	-1.0816	
Astigm.	0.0724	-83.8917
Koma	0.1097	-22.2222
SA3	-0.0741	

Phasendaten

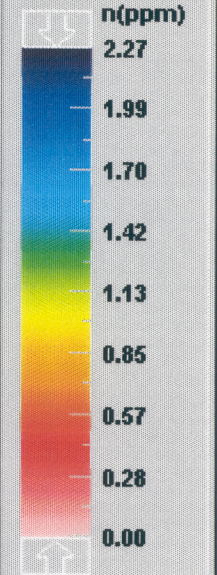
Einheit n(ppm)

PV: 2.27

RMS: 0.625

Scale: 0.5

Kontrast

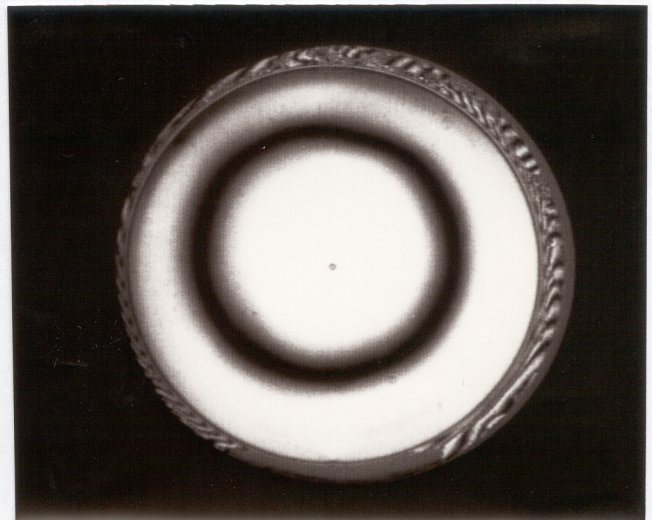
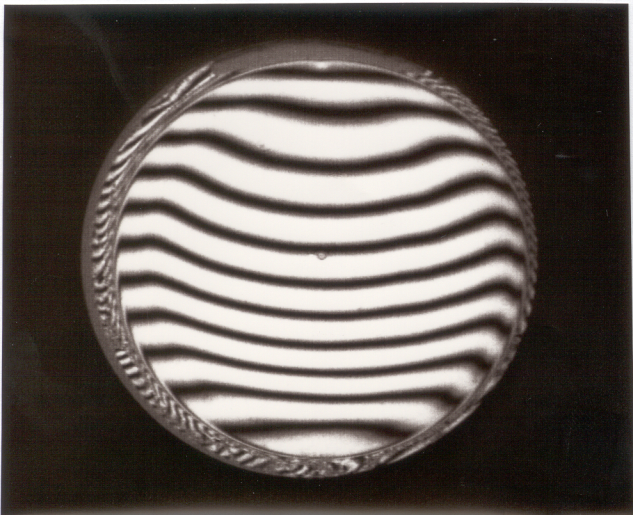


Reset

OberG 2.270

UnterG 0.000

Datei: 505400.tif, 02.08.97, 07:35



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

78462731

Route: ~~UPS 002 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 IM 10	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-T970040-01-D LIGO DETECTOR OPTICS
B. LIGO S/N: 2ITM04-C Incoming Inspection Check-off Sheet
Core Optics Polished Substrate

Page 1 of 3

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: 06-27-98

- 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
- 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 checked="" type="checkbox"/> | Inspection of material diameter. | Diameter | <u>9.88</u> in | <u>250.94</u> mm |
| <input checked="" type="checkbox"/> | Inspection of material thickness | Thickness | <u>3.94</u> in | <u>99.99</u> mm |
| <input checked="" type="checkbox"/> | Wedge Angle | | <u>0°34'</u> | |
- 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 shipper*

Inspection By: *[Signature]* Date Inspected: *06-30-98*

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.) _____

SKETCHES:

DISPOSITIONS: _____

Substrate, Input Test Mass		Serial Number:	Specification	Reported Value	✓
				2ITMØ4-C	
Surface 1	Surface Figure Over Central 200mm dia.		Spherical, Concave		
	Radius of Curvature Tolerance		14,180m +140m, -1000m	13,480 m	✓
	Astigmatism		< 13nm p-v	3.4 nm	✓
Surface 2	Surface Figure Over Central 200mm dia.		Nominally Flat		
	Radius of Curvature of the Wavefront		-9,740m +500m, -100m	13,630 m - 4.90	✓
	Astigmatism		< 15nm p-v	2.3 nm	
Surface Errors Surface 1	Low Spatial Frequency Band Central 80mm		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 0.8\text{nm}$	0.6nm	✓
	Low Spatial Frequency Band Central 200mm		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 1.6\text{nm}$	0.9 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		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 1.6\text{nm}$	0.5 nm	✓
	Low Spatial Frequency Band Central 200mm		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 3.2\text{nm}$	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 - 0.17	✓

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 25×10^3 square micrometers (width x length).		Hand Sketch w/dimensions	✓
	The total area of scratches outside the central 80 mm diameter shall not exceed 250×10^3 square micrometers. < 50,000		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 75×10^3 square micrometers over the central 80mm (width x length). $< 10,000$	Hand Sketch w/dimensions	✓
		The total area of scratches outside the central 80 mm diameter shall not exceed 750×10^3 square micrometers. $< 5,000$	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**



Telecommunications & Industrial Physics

Bradfield Road, West Lindfield
PO Box 218
Lindfield NSW 2070
Tel: 9413.7620
Fax: 9413.7200

LIGO Document Control Center
c/o Linda Turner
LIGO Project, Mail Code 51-33
California Institute of Technology
Pasadena, CA 91125
USA

17 August 1998

Attention: Garilynn Billingsley

Attached is the certification package for LIGO core optics substrate 2ITM04-C, produced by CSIRO as a deliverable for LIGO under purchasing contract PC167159.

Regards

A handwritten signature in black ink that reads "Chris Walsh".

Chris Walsh
Optics and Surface Science Leader

LIGO Certification Report

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

Serial number: 2ITM04-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:	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 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)

LIGO Certification Report

2. Electronic data

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

LADI data:	2ITM4C1.zip (Side 1)	2ITM4C2.zip (Side 2) 2ITM4C2A.zip (wave front)
TOPO data: (2.5X)	T22IM41A.asc (Side 1)	T22IM42A.asc (Side 2)
	T22IM41B.asc	T22IM42B.asc
	T22IM41C.asc	T22IM42B.asc
(40X)	T42IM41A.asc	T42IM42A.asc
	T42IM41B.asc	T42IM42B.asc
	T42IM41C.asc	T42IM42C.asc

LIGO Certification Report **Physical Dimensions**

1	Substrate Type:	Input Test Mass (2 km)
2	Serial Number:	2ITM04-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. 28
8	Team member responsible for measurement/inspection:	Carl Sona
9	Measurement/inspection results reviewed by:	Chris 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	250.94 mm
Cylindricity	0.01 mm
Thickness (maximum - for FM, RM, ETM) (minimum - for BS)	99.99 mm
Bevel as per drawing (height, angle):	(S1) Height:2.17 mm Angle:45 ⁰ 19' (S2) Height:2.14 mm Angle:44 ⁰ 41'
Wedge angle:	0 ⁰ 34'
Location of registration mark (\pm angle with respect to minimum part thickness):	+2'
Location of other 3 marks (with respect to registration mark at minimum thickness)	89 ⁰ 58', 179 ⁰ 59', 270 ⁰ 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:


17 August 98

Chris Walsh

Date:

LIGO Certification Report Side and Bevel Polish

1	Substrate Type:	Input Test Mass (2 km)
2	Serial Number:	2ITM04-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:	Edita 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
17. August . 98

Chris Walsh

Date:

1	Substrate Type:	Input Test Mass (2 km)
2	Serial Number:	2ITM04-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:	Edita 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
17. August. 98

Chris Walsh

Date:

1	Substrate Type:	Input Test Mass (2 km)
2	Serial Number:	2ITM04-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	< 50,000
Surface 2	nil	nil	< 10,000	< 5,000

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:

Date:

Chris Walsh
17. August. 98

Chris Walsh

0000

3000

↑
Thin

21TMO4 C

SIDE 1

0000

1500

3000

2000

3000

ZITMO 4 SIDE 2 ~~WIN~~

1986

5000

1	Substrate Type:	Input Test Mass (2 km)
2	Serial Number:	2ITM04-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
7	CSIRO Log Book Reference	LLN/0137-01 pp. 71, 72
8	Team member responsible for measurement/inspection:	D.Farrant
9	Measurement/inspection results reviewed by:	C Walsh

10. Results

	Radius of Curvature in km	Astigmatism (nm)	Electronic data file reference
Surface 1	13.48	3.4	2ITM4C1.zip
Surface 2	13.63	2.3	2ITM4C2.zip
Wave front*	-4.90		2ITM4C2A.zip

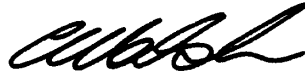
* Measured as per the test procedure in E960093-C-D.

Hardcopies of the phase maps are attached to this certification as part of Attachment 1 for Side 1 and Attachment 2A for Side 2 and Attachment 2B for the transmitted wavefront. 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:

17. August 1998

LADI CERTIFICATION DATA

Title: 2ITM042

Date: 06/15/98

Diameter: 200 mm

Astig: 2.3 nm

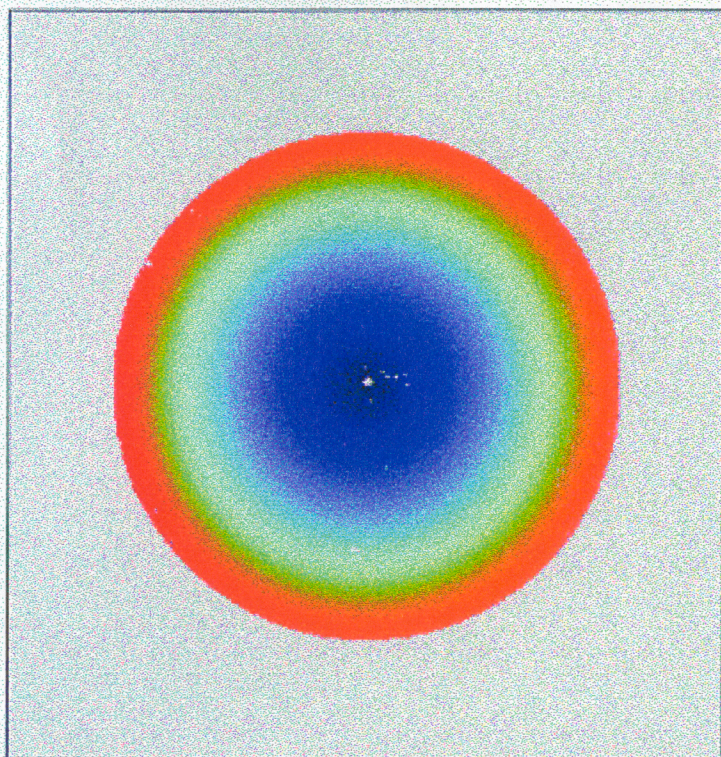
Power: 367.7 nm



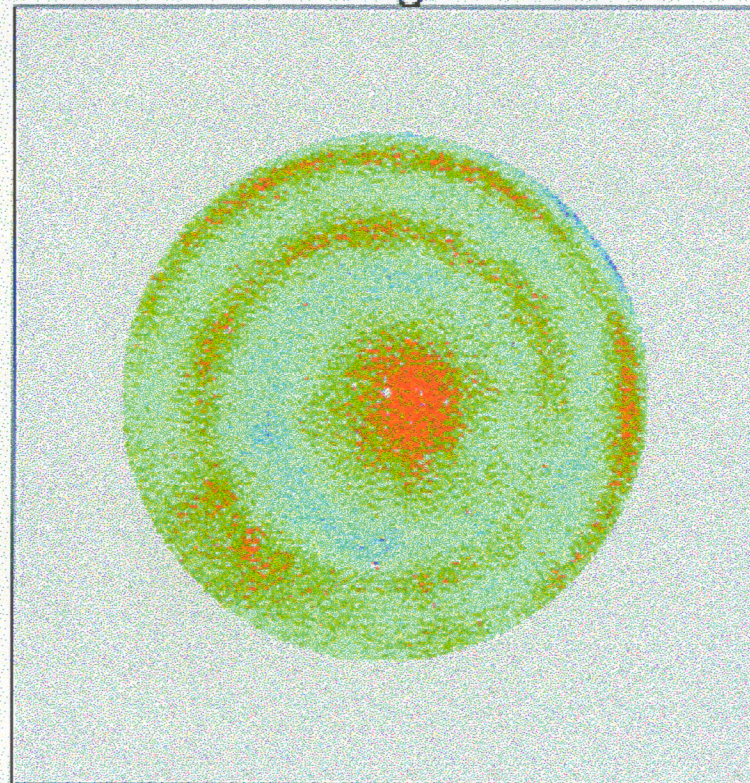
PV: 8.5 nm

RMS: 0.8 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: 2ITM041

Date: 07/28/98

Diameter: 200 mm

Astig: 3.4 nm

Power: 371.9 nm

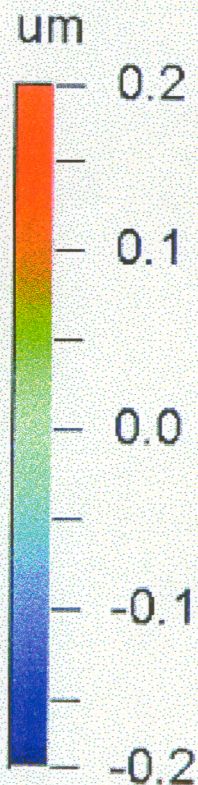
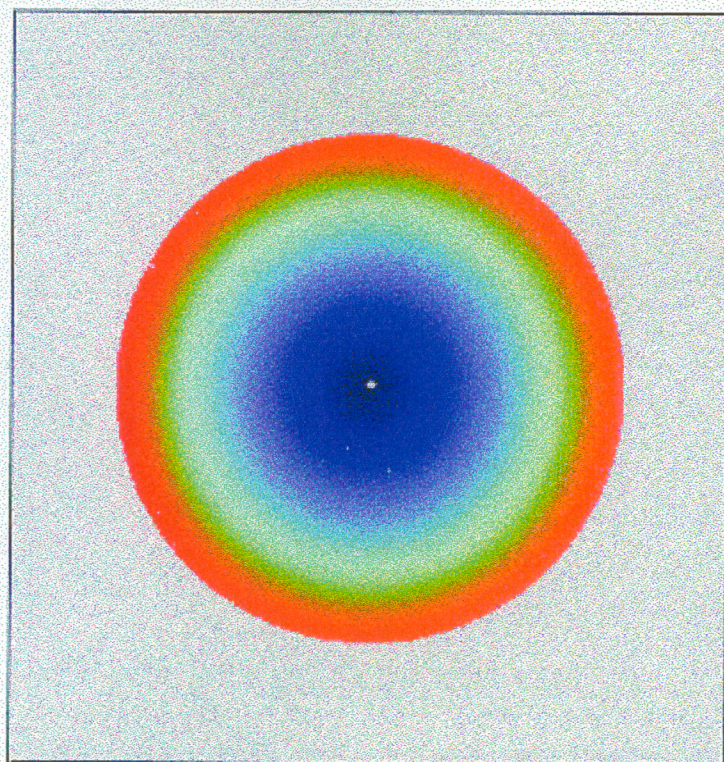


CSIRO

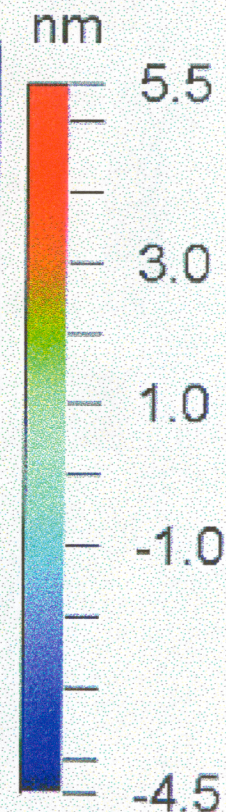
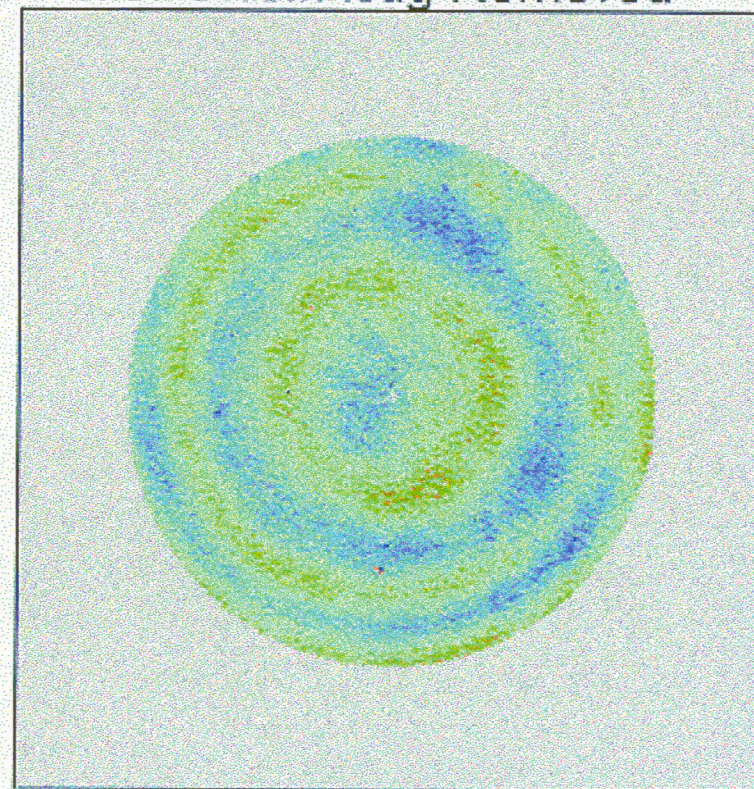
PV: 10.0 nm

RMS: 0.9 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: 2ITM4TA

Date: 08/12/98

Diameter: 200 mm

Astig: -47.2 nm

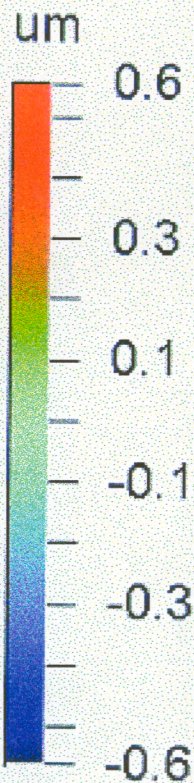
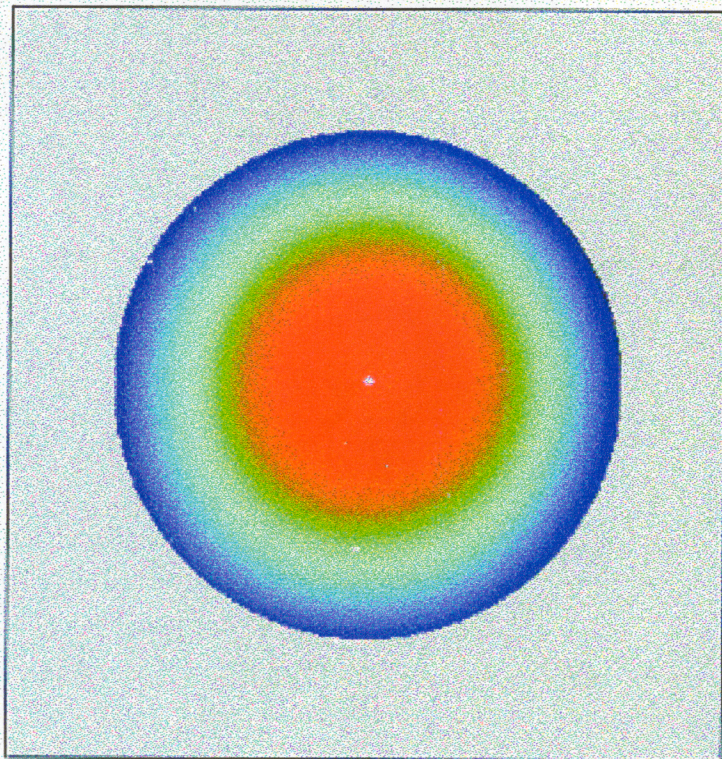
Power: -1023.1 nm



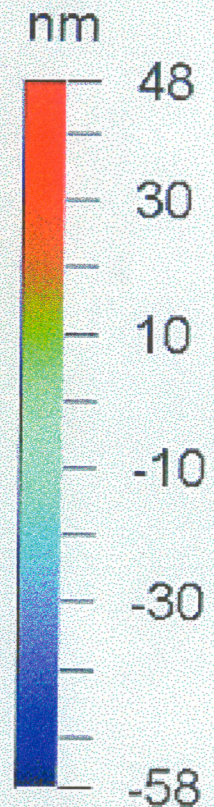
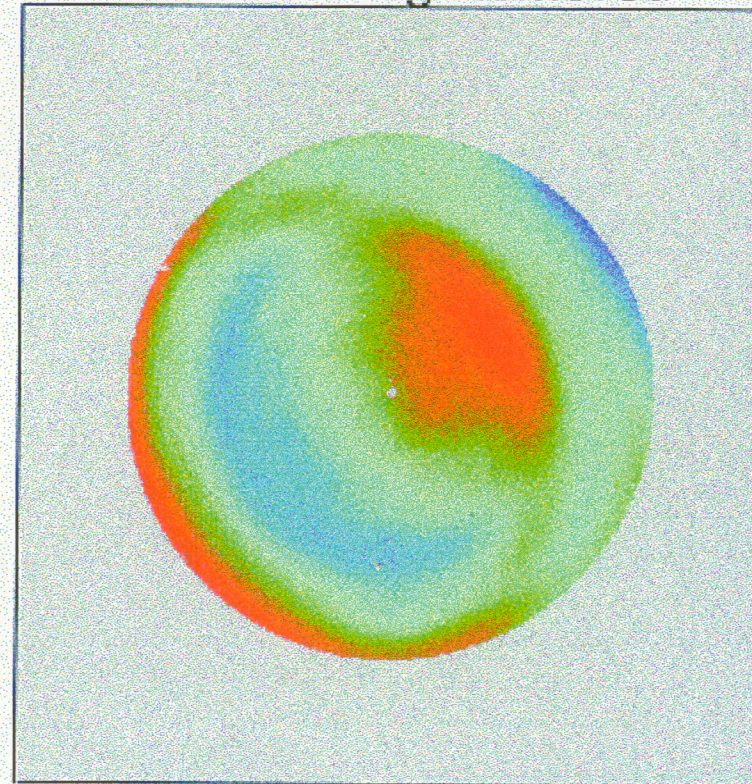
PV: 105.4 nm

RMS: 15.1 nm

Tilt Removed



Tilt/Power/Astig Removed



LIGO Certification Report Surface Errors - Low

1	Substrate Type:	Input Test Mass (2 km)
2	Serial Number:	2ITM04-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 71, 72
8	Team member responsible for measurement/inspection:	D Farrant
9	Measurement/inspection results reviewed by:	C Walsh

10. Results

	Low Frequency Surface Errors (nm)	
	80 mm aperture	200 mm aperture
Surface 1	0.6	0.9
Surface 2	0.5	0.8

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:

17. August 1998

LIGO Certification Report Surface Errors - high

1	Substrate Type:	Input Test Mass (2 km)
2	Serial Number:	2ITM04-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	LLN/091
8	Team member responsible for measurement/inspection:	F Lesha
9	Measurement/inspection results reviewed by:	C Walsh

10. Results

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

Side 1: 0.17

Side 2: 0.17

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

Side 1: 0.18

Side 2: 0.17

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

	A	B	C	D	E	F	G	H
Surface 1	0.16	0.19	0.17	0.16	0.18	0.17	0.20	0.17
Surface 2	0.17	0.17	0.17	0.16	0.17	0.20	0.19	0.18

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), 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:



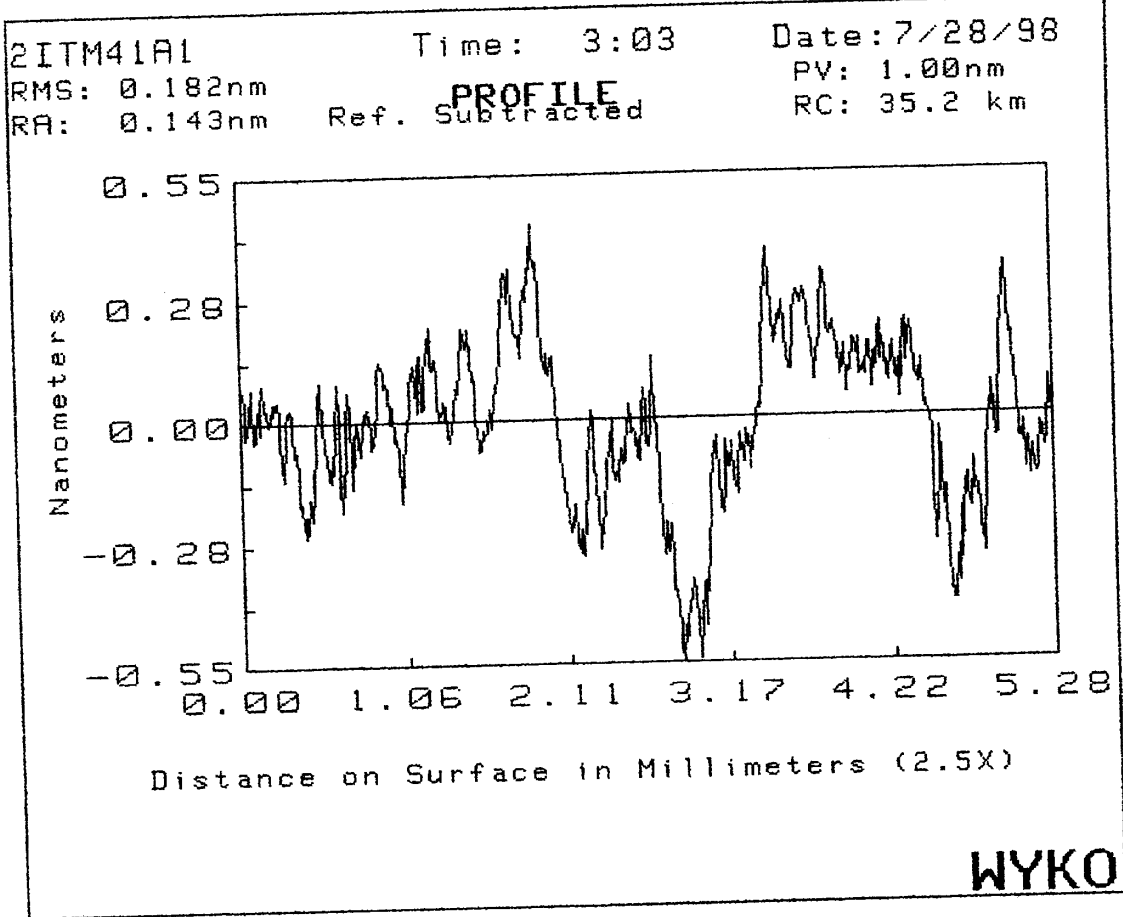
Chris Walsh

Date:

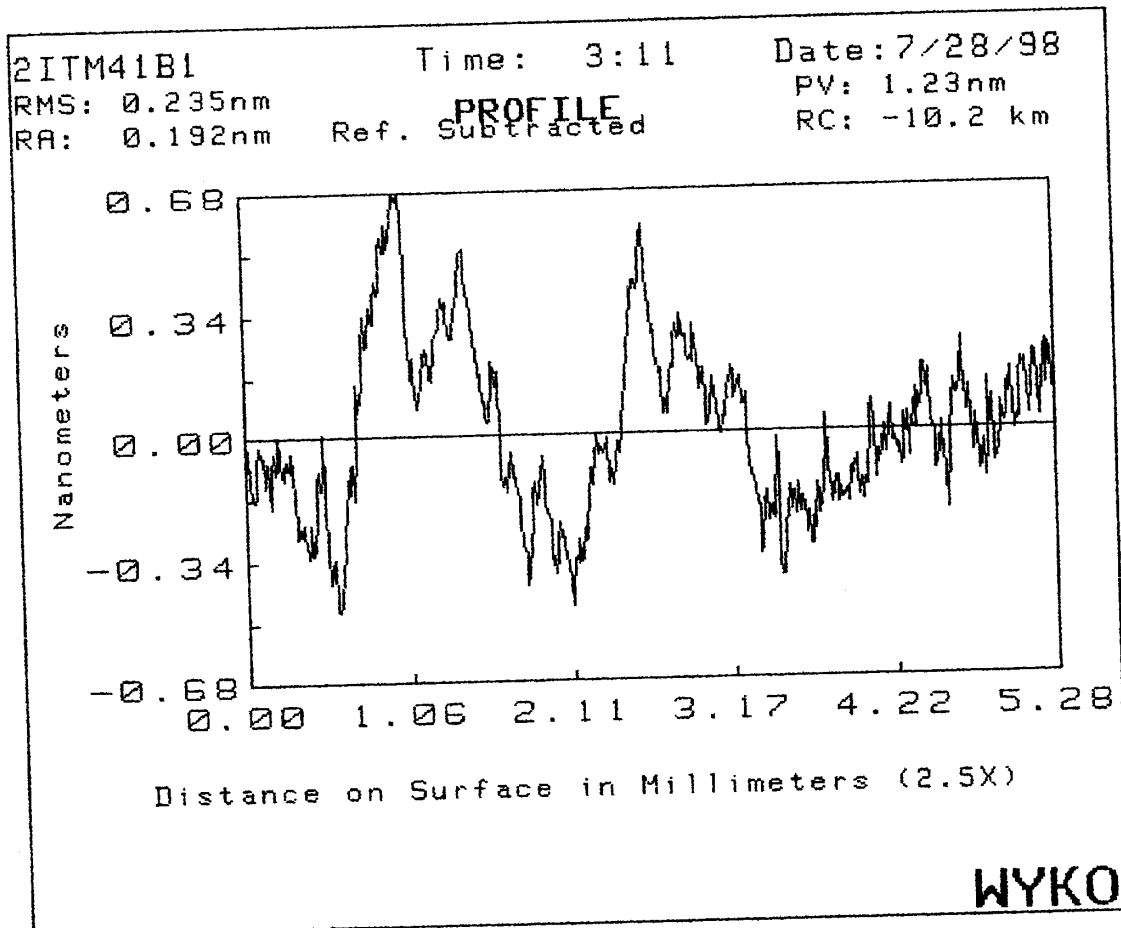
17. August 1998

AHch. 3

T221M41A.ASC



T221M41B.ASC



T221M41C.ASC

2ITM41C1

Time: 3:15

Date: 7/28/98

RMS: 0.179nm

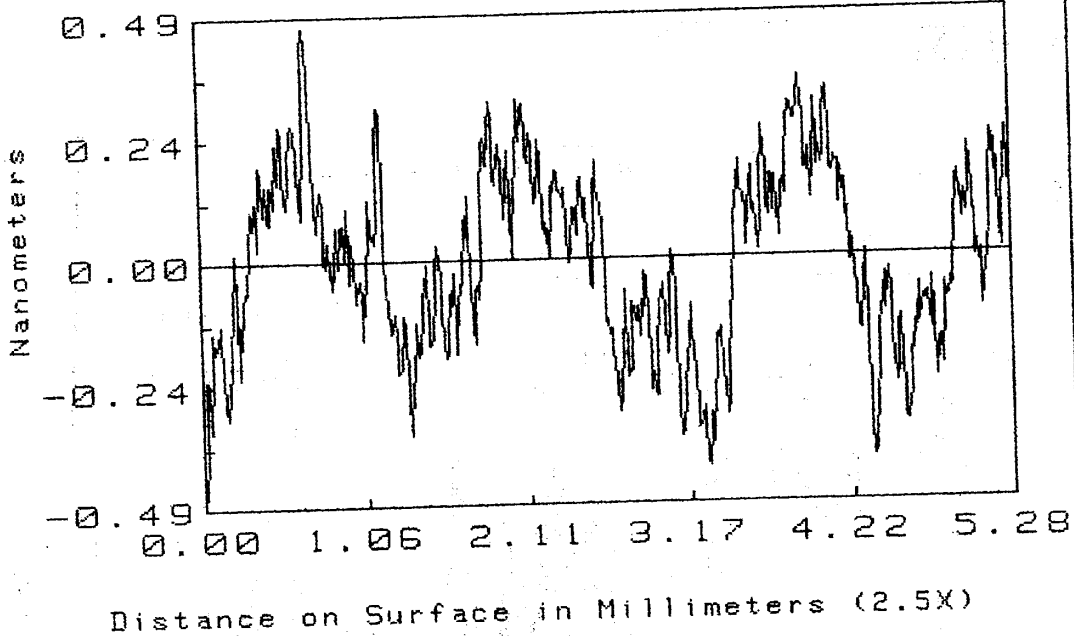
PV: 0.955nm

RA: 0.151nm

Ref. Subtracted

RC: 12.3 km

PROFILE



WYKO

T421M41A.ASC

2ITM41A4

Time: 4:44

Date: 7/28/98

RMS: 0.104nm

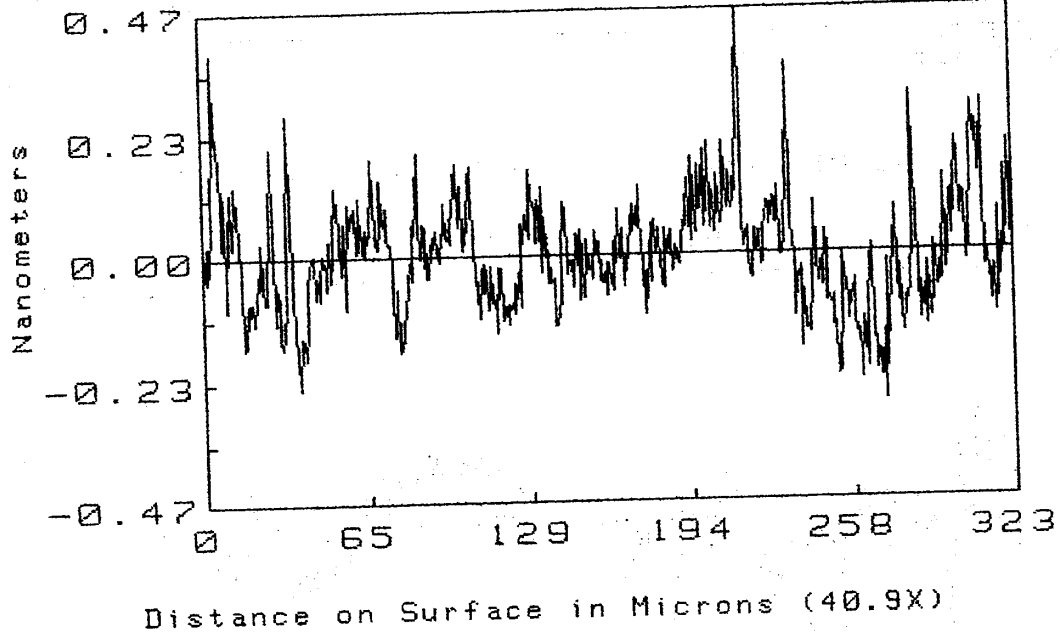
PV: 0.750nm

RA: 0.082nm

Ref. Subtracted

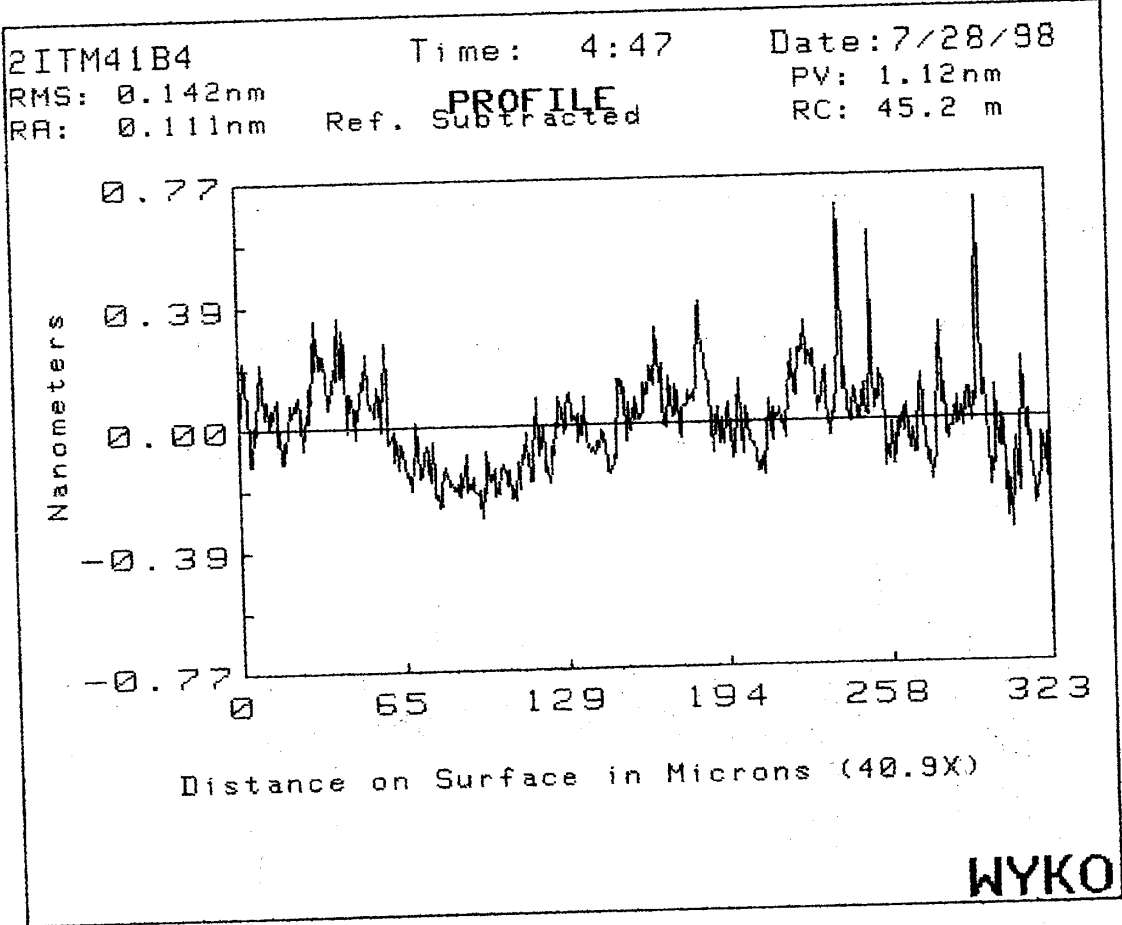
RC: 62.5 m

PROFILE

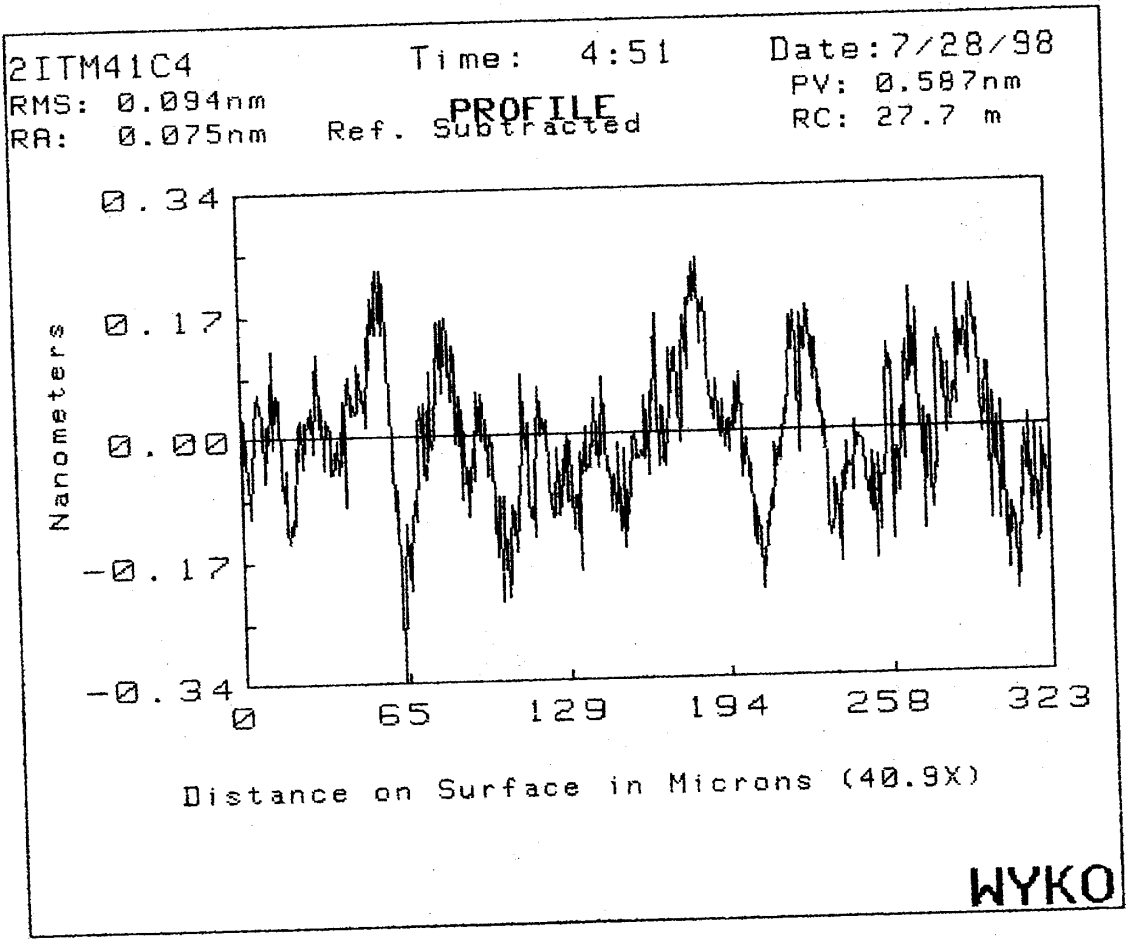


WYKO

T421M41B.H3C

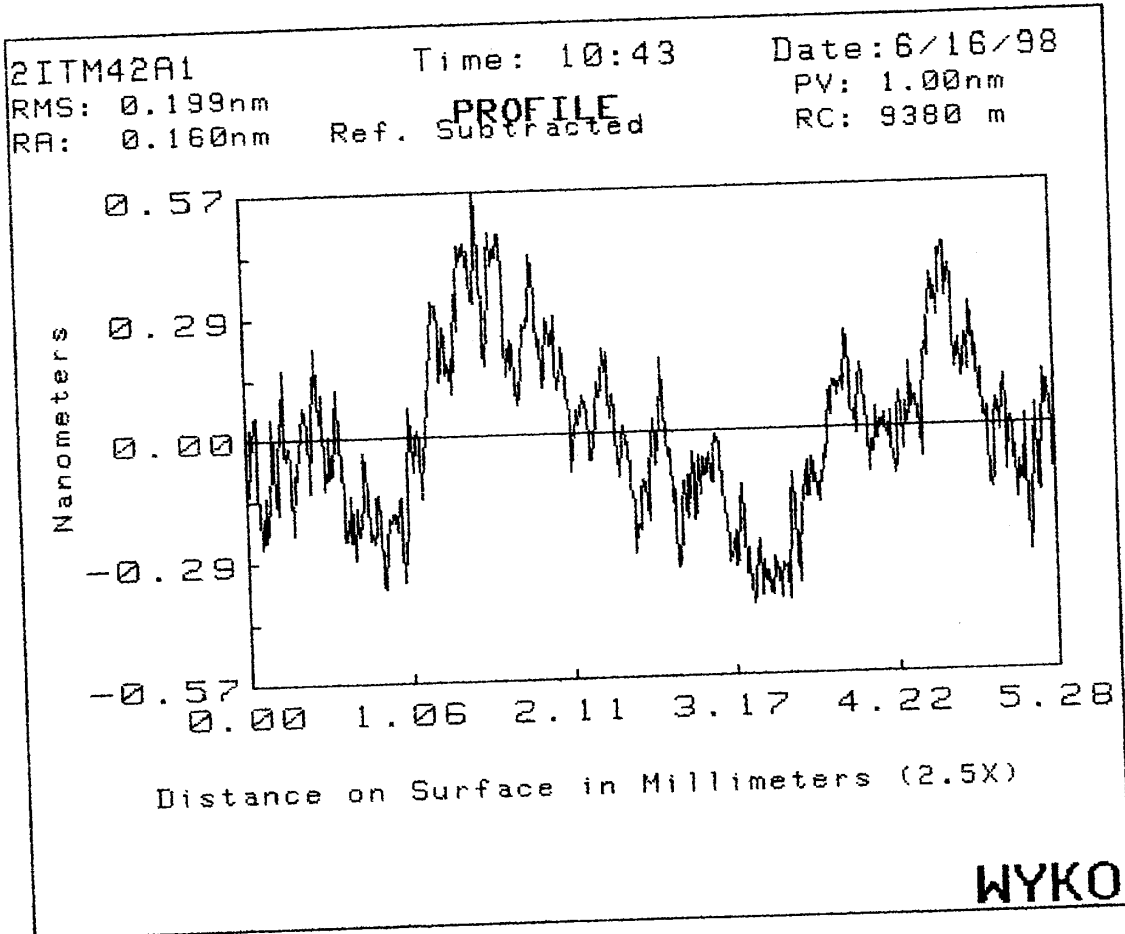


T421M41C.ASC

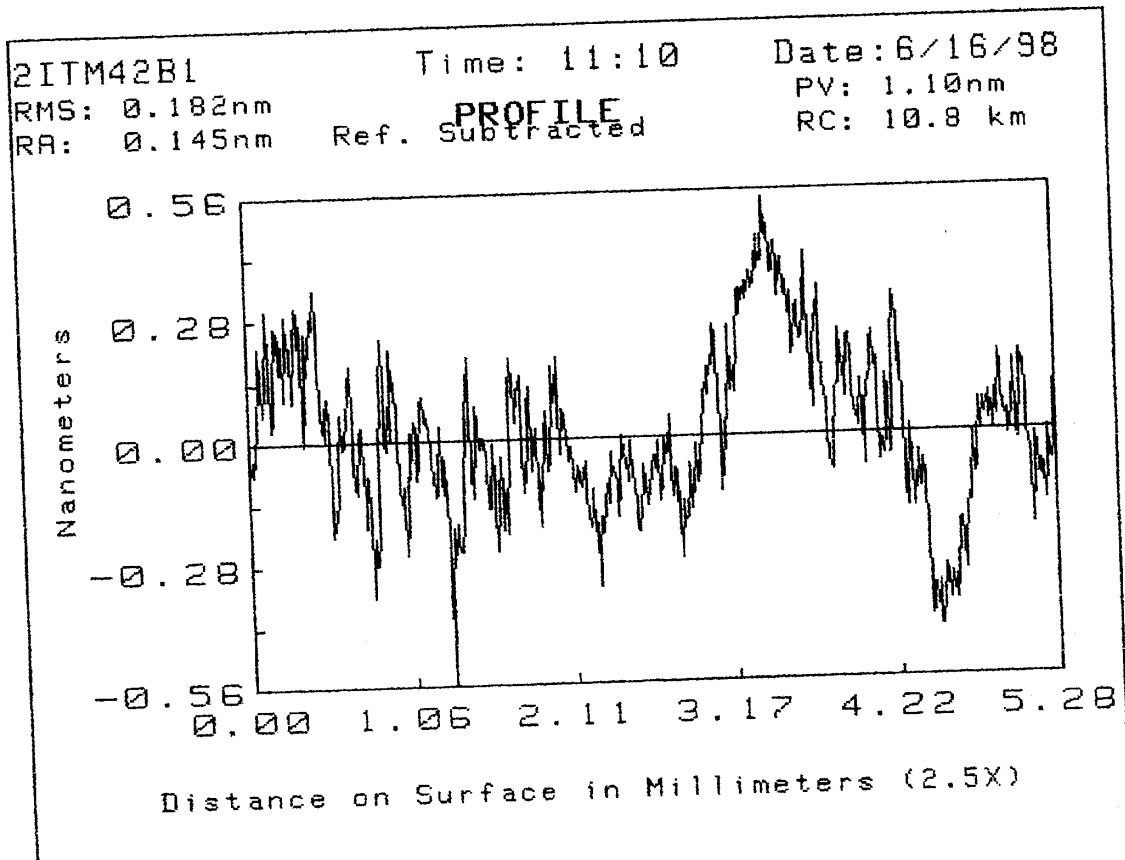


Attach 4.

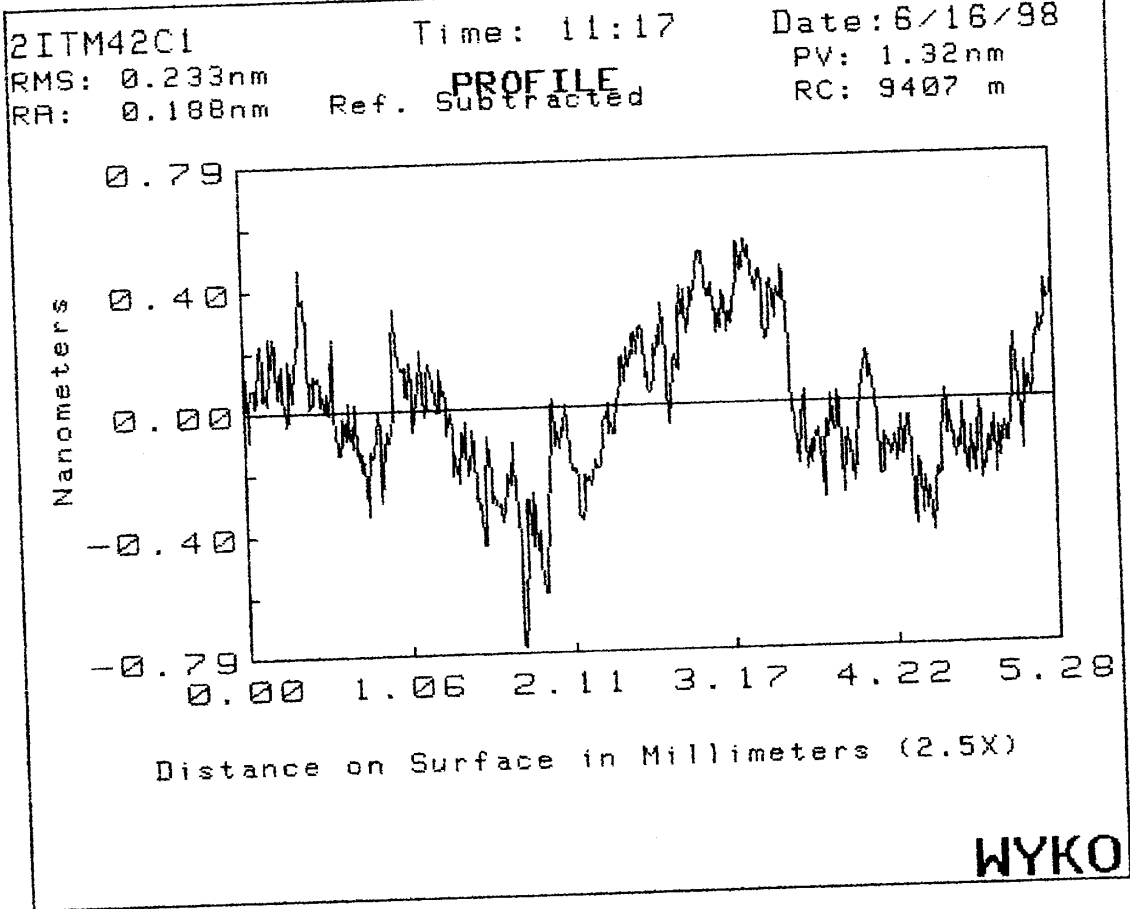
T221M42A.ASC



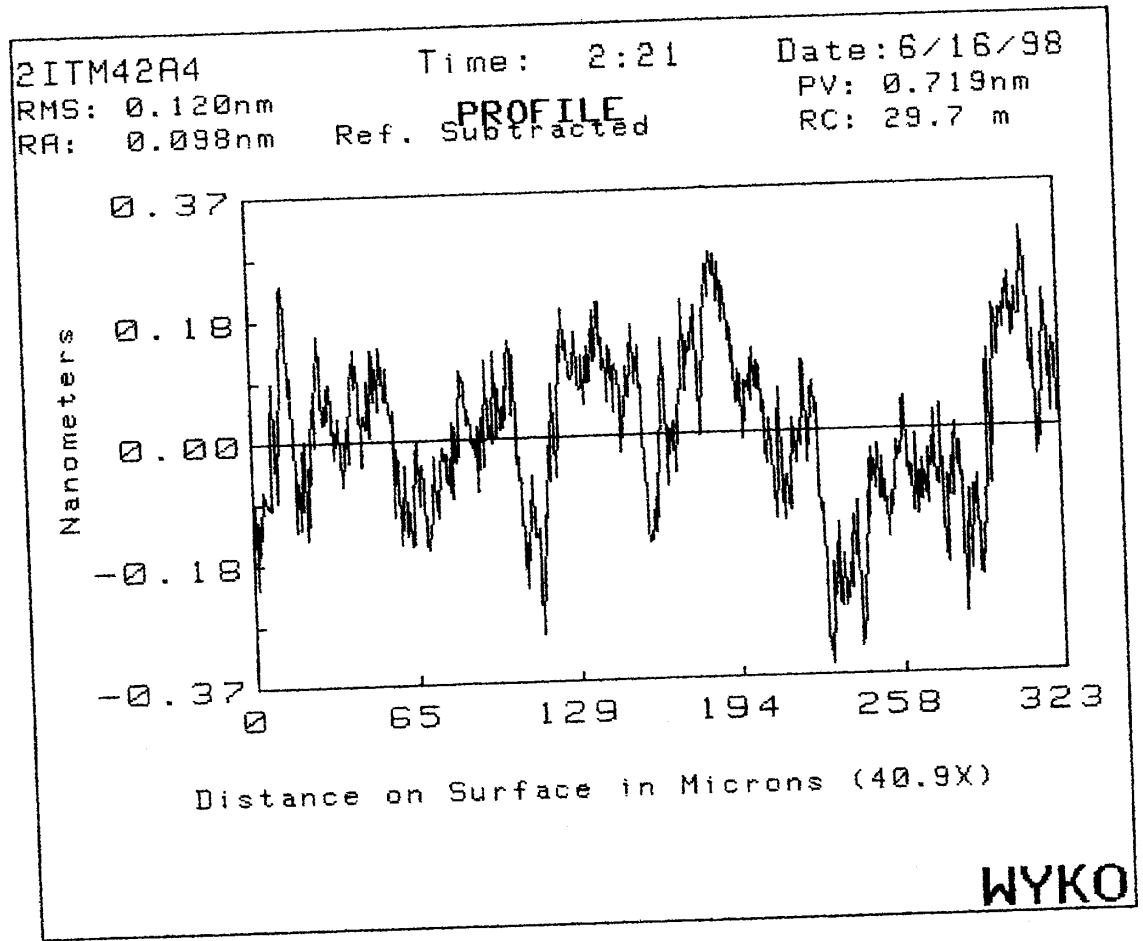
T221M42B.ASC



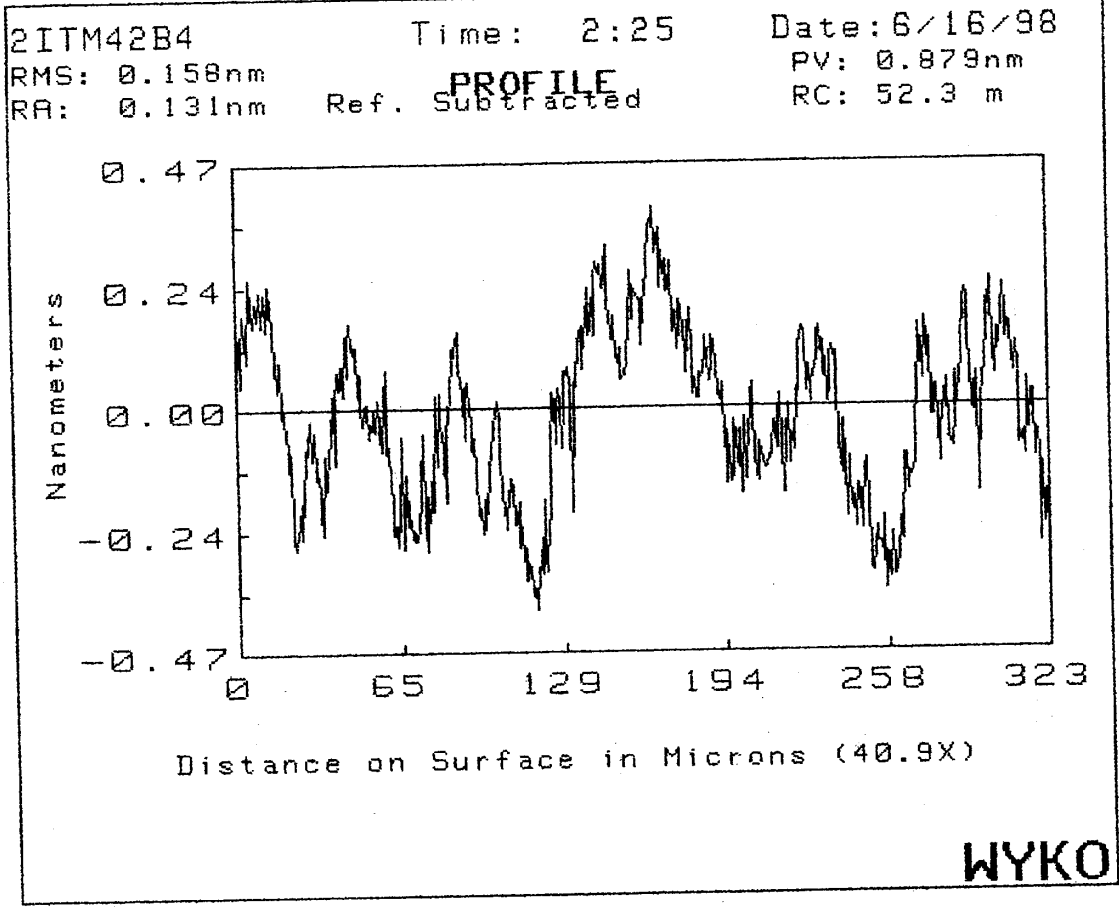
1221M42C.nsc



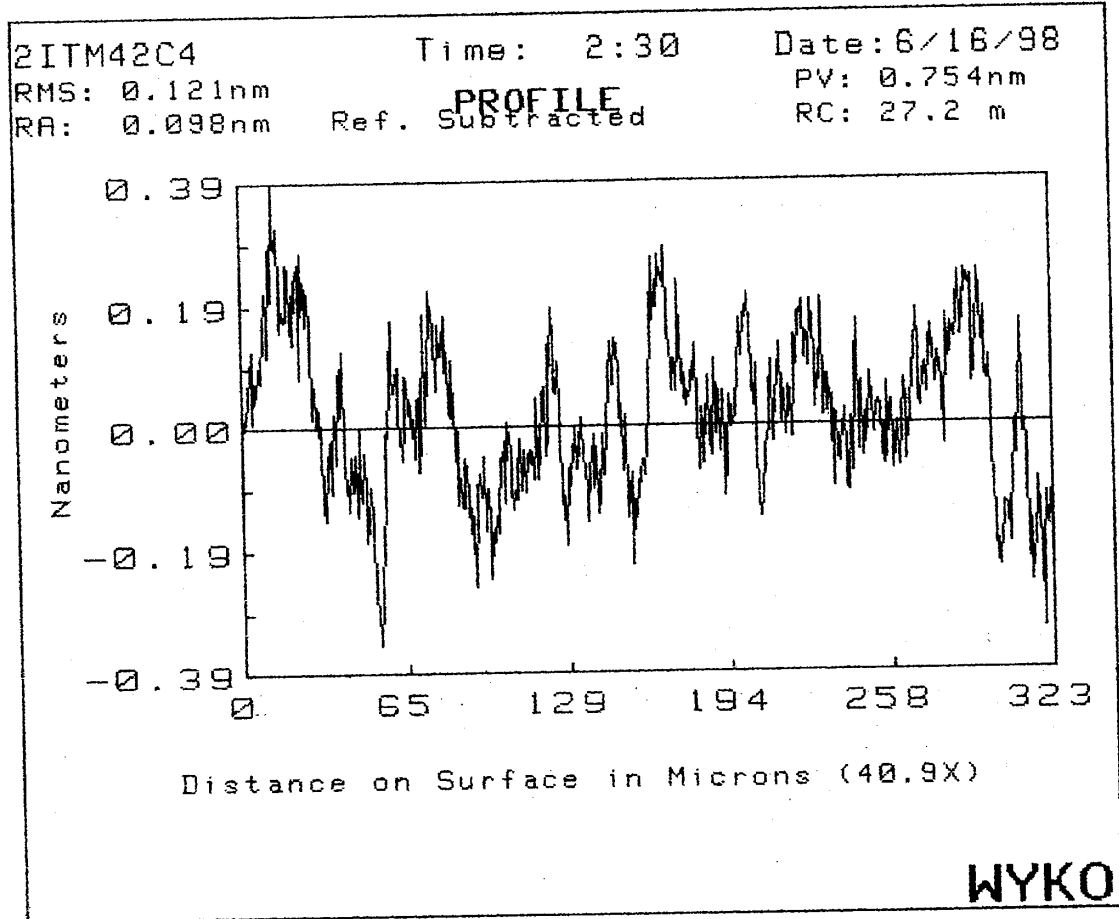
T421M42A.ASC



T421M42B.ASC



T421M42C.ASC



MIRROR



Research Electro-Optics Inc.

CERTIFICATE OF CONFORMANCE

Section 3.14/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 PC 162519 / CONOS
- Customer Part Number & Revision : 2ITM02, 2ITM04
- Part Description : S1: T = 3% @ 1064nm S2: R = 600 ppm @ 1064nm
- REO Job No. : OPT05831-024 Run No.: S1: 0X815 S2: 0X817
- Qty. Shipped/Lot No. : 2 ea. 25cm Ø FS
2 ea 1" Ø FS witness

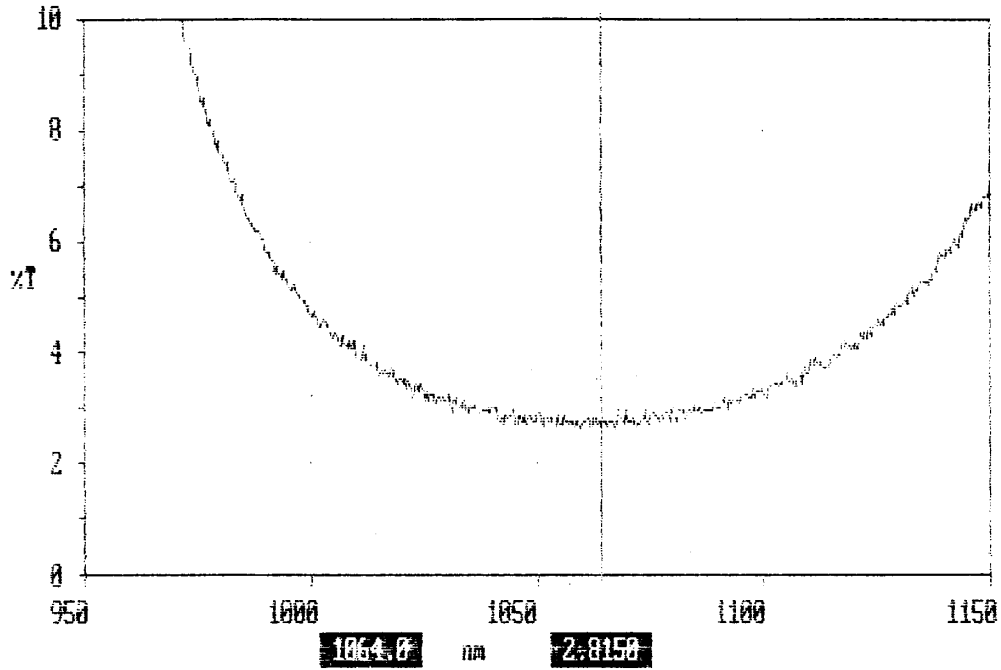
Test data (included)

Comment:

Certified by: , 9/29/98
Quality Assurance
Verified by: , 29 Sept 98
Engr/Tech

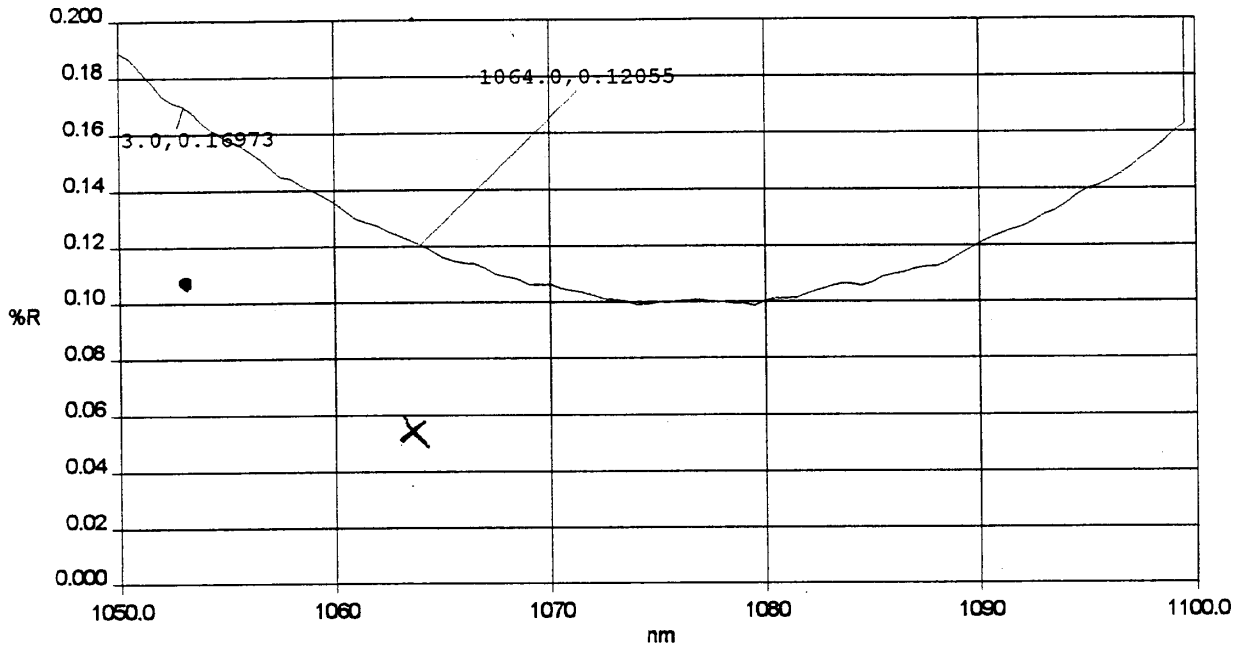
NOTE
Certificate must accompany the package to be shipped or attached to the outside of the same box to which the "Packing Slip" envelope is attached.

X: user004: 1150.0 - 950.0 nm: pts 1001: int 0.20: ord 2.6100 - 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 @ 1053 nm
R = 1042 ± 35 ppm
- X - inferred level @ 1064 nm
R = $551 \text{ ppm} \pm 35 \text{ ppm}$

2 ITM04



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/CONDOR

PACKING LIST

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 TECHNOLOGY
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	BACKORDER QUANTITY
-----	-------------------	----	----------------	--------------	------------------	--------------------

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

PER QUOTES OPQ-2403 & OPQ-2472

REFERENCE: CALTECH LIGO-C98-000/LIGO-C980963-00-0
LIGO-C950494-05-1

Technical Contact:

Helena Armandula 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.

2ITM04-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: _____