2ITM03-C

LIGO-T990149-00-D

BLANK

A. DCN: LIGO- T970206-00-D **LIGO DETECTOR OPTICS**

B. LIGO S/N: 2ITMØ3-C **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.: 7273

I. Date Received at Caltech: 01-09-98

J ☑ Verify glass manufacturer's 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 Certification to check-off sheet.

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

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	108.7	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 or arrow

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 direct

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

Inspect By: Steve Tien Date Inspected: 01-09-98

Reviewed and/or accepted by:

Cognizant Engineer: _____ Date: _____

LIGO QA Officer or Designee: _____ Date: _____

Figure 1

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: 2ITMØ3-C		Specification	Reported Value	✓
	Requirements	**Physical Dimensions**	LIGO-D960794		✓
		Diameter	256mm +1.0mm, -0mm	256.6mm	✓
		Thickness	108mm +1.0mm, -0mm	108.7mm	✓
		Chamfer	2.0mm Max 2pl	minimal	✓
		Clear Aperture	Central 235mm		
		Material	Fused Silica ~~7980~~ Suprasil 312S	Certification	✓
		Registration Mark	"Top" of Optic, 80mm Arrow Points to Side 1	Certification	No
		Witness Sample	25mm dia. x 25mm cylindrical	shipped direct	✓
		Witness Sample Map		Map Attached	—
		Defect Depth	< 0.5mm	Hand Sketch w/location & dim.	✓
		Homogeneity Within the Central 80mm	$\leq 5.0 \times 10^{-7}$ p – v $\lambda = 632.8$nm	Interferogram Homogeneity Map	~~No~~ delivered separately
		Homogeneity Within the Central 200mm	$\leq 2.5 \times 10^{-6}$ p - v $\lambda = 632.8$nm	Interferogram Homogeneity Map	~~No~~ ✓ 0.28×10^{-6} p-v 1.43×10^{-6} BJS
		Homogeneity Data	ASCII Format	PC Compatable 3½ in. Disk	No
		Birefringence Within the Central 80mm	≤ 1 nm/cm	Certification, Birefringence Map	✓
		Birefringence Within the Central 200mm	≤ 5 nm/cm	Certification, Birefringence Map	✓
		Bubble & Inclusion within the clear aperture. Max. Inclusion Diameter	Total ≤ 0.03mm^2 Per 100cm^3 of Glass. ≤ 0.1mm	Hand Sketch w/location & dim.	✓
		Absorption	2 ppm/cm $\lambda = 1.06\mu$m	Certification	
		Striae within the Clear Aperture	Grade A per MIL-G-174	Inspection Report	A

Blnk_ITM.doc

Heraeus QUARZGLAS

INSPECTION REPORT

POL-QW

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 9282
Marking	: 960094-IM19 -IM13 13N 7273

Diameter		: 256.6 mm
CA Diameter		: Ø 200 mm = 1.43xE^{7}
Thickness		: 108.7 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 ~~not present~~
Striae Grade		: A
Granularity		: none
Remark		: Test Sample (Ø25 x25 mm) with the same marking

Received 12-30-98

POL - Qualitätsprüfung Optik

Date : 19.11.1997

Inspector : O.Dauth

Heraeus QUARZGLAS POL- QW	Order Nr.: 94908401 Pos.: 1 Ø 256,6 mm x 108,7 mm Quality: Suprasil 312 Plate No.: 960095/-0419/7273	Date: 19.11.97 Inspector:

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

TBCS= mm^2 /100cm^3

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Heraeus QUARZGLAS

POL - QW

Order No.: 94908401 Pos.: 1

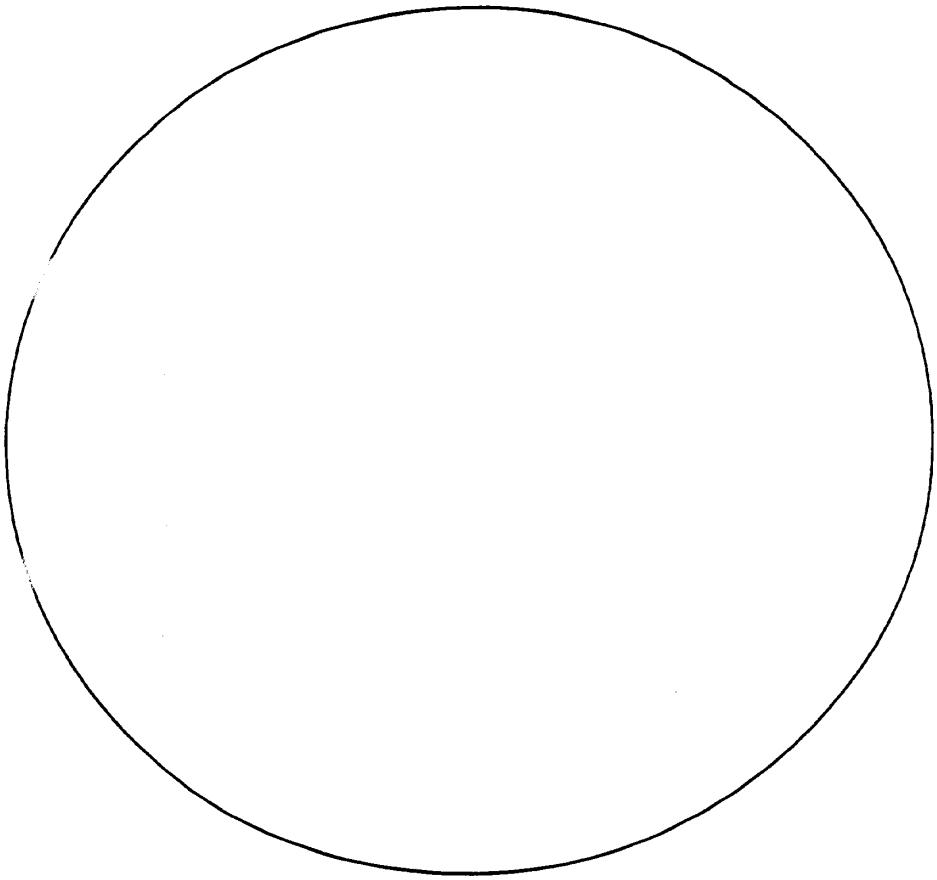
Ø 256,6 mm x 108,7 mm

Plate No.: 960095-IH19/7273

Residual strain- Report

Date: 19.11.97

Inspector:



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

Heraeus QUARZGLAS

POL-QW

INSPECTION REPORT

Project LIGO

Customer	:	HERAEUS Amersil Inc. Duluth, Ga 30136-5821
Order No.	:	45000023300dtd 30.09.96as
HAI-Order No.	:	none
HQS-Order No.	:	94908401
Item No.	:	1
Quality	:	Fused silica Suprasil 312 S
HQS melt No.	:	MF.F 9282
Marking	:	960094-IM19 -IM13 BN 7273

Diameter	:	256.6 mm
CA Diameter	:	Ø 200 mm = 1.43xE^{-7}
Thickness	:	108.7 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 ~~not present~~
Striae Grade	:	A
Granularity	:	none
Remark	:	Test Sample (Ø25 x25 mm) with the same marking

Received 12-30-97

<u>POL - Qualitätsprüfung Optik</u>

Date : 19.11.1997

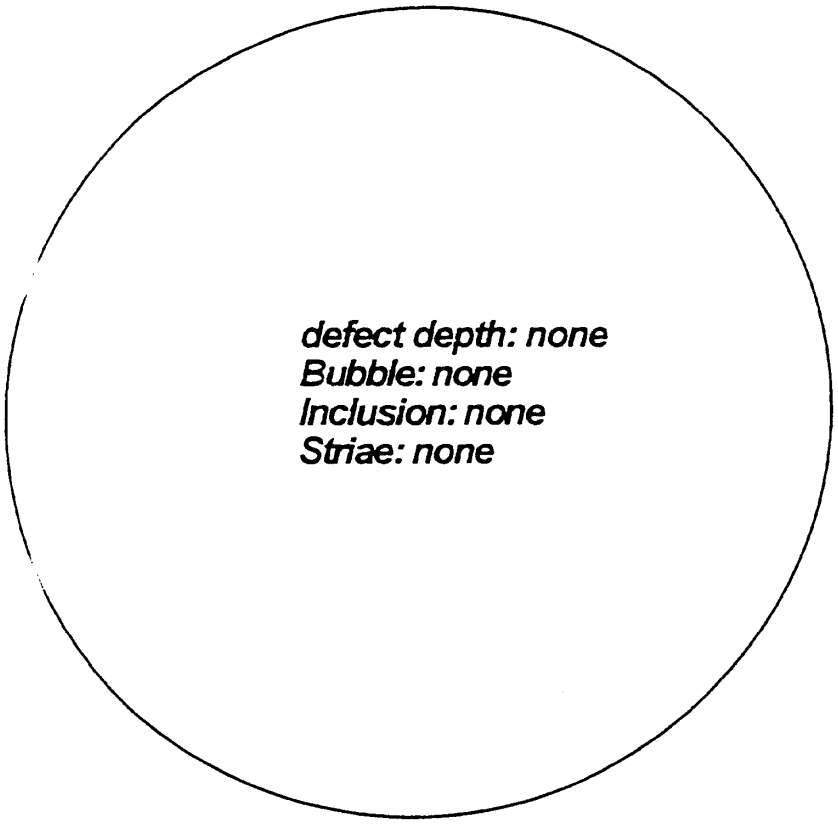
Inspector : O.Dauth

Heraeus
QUARZGLAS

POL- QW

Order Nr.: 94908401 Pos.: 1
Ø 256,6 mm x 108,7 mm
Quality: Suprasil 312
Plate No.: 96C095/-H19/7273

Date: 19.11.97
Inspector:



Diameter	0,03mm	0,05mm	0,08mm	0,12mm	0,2mm	0.31mm	Sum
piece							
mm^2							

TBCS= mm^2 /100cm^3

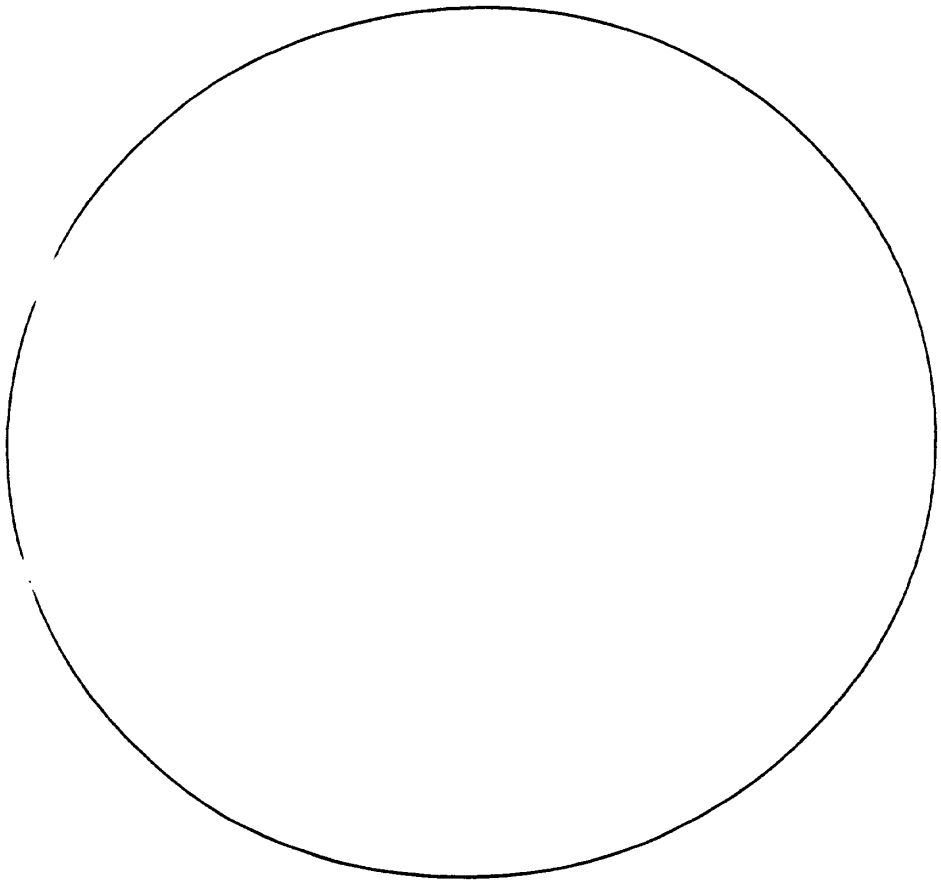
g:\groups\pol\pol-qw\amipro\form\pro_Bub3.sam

Heraeus
QUARZGLAS

POL - QW

Order No.: 94908401 Pos.: 1
Ø 256,6 mm x 108,7 mm
Plate No.: 960095-1H19/7273
Residual strain- Report

Date: 19.11.97
Inspector:



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

Heraeus
QUARZGLAS
POL-QW

Data taken at 632.8 nm

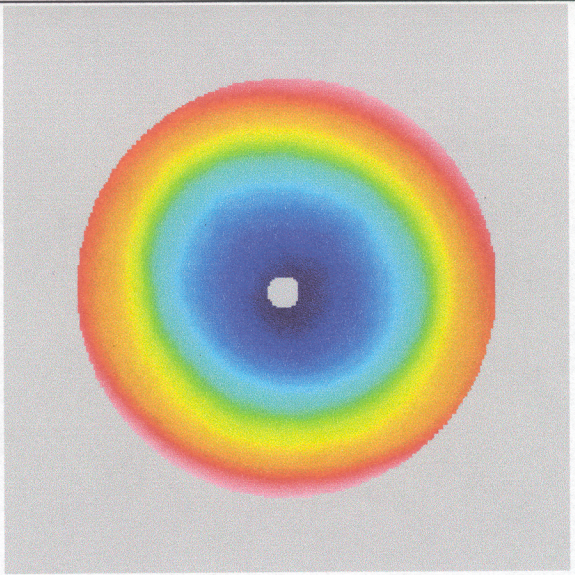
Date: 17.11.97
ID: 727300

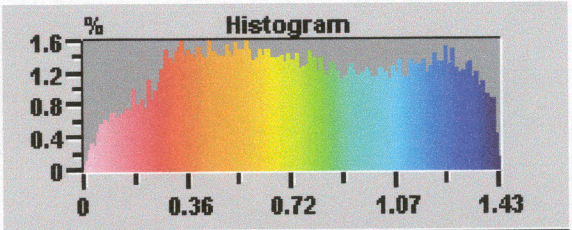
Operator: Fu
No.:

HQS-Order-No.: 98492868
Customer: HAI
Product: LIGO
Pos.-No.: 1
Order-No.:
Comment: 960095-im-xx

thickness: 108.7 mm
sample diameter: 280.0 mm
CA diameter: 200.0 mm
examined diameter: 200.3 mm

Center: (0.0mm,0.0mm)
Radius: 100.1mm
Points: 69729

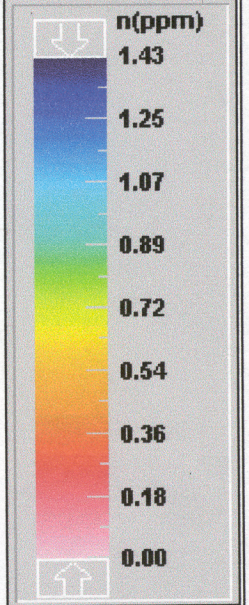




Sub. Terms		Magn.	Angle
X	Tilt	0.2533	78.0929
	Focus	-0.6362	
	Astigm.	0.1129	63.6323
	Coma	0.0089	18.8326
	SA3	0.0266	

Phase Data	
Unit	n(ppm)
PV:	1.43
RMS:	0.369
Scale:	0.5

Contrast



Reset

UpperL	1.431
LowerL	0.000

File: 727300.tif, 25.11.97, 08:53

IFM-1 12"

Heraeus
QUARZGLAS

POL-QW

Data taken at 632.8 nm

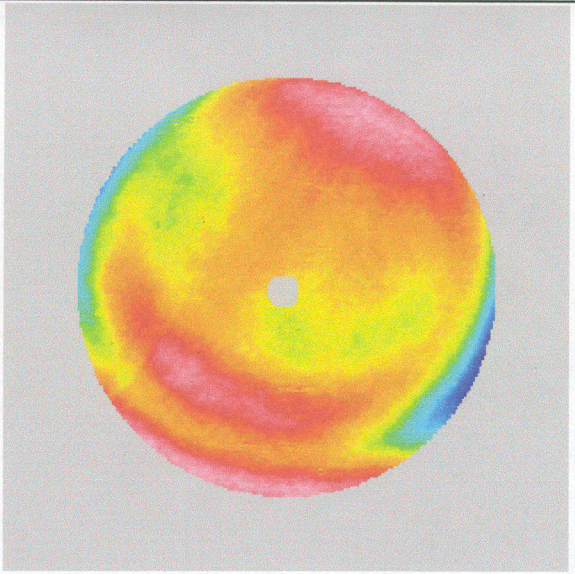
Date: 17.11.97
ID: 727300

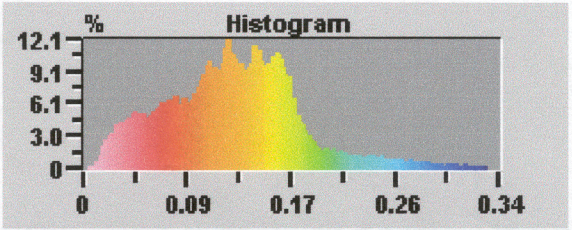
Operator: Fu
No.:

HQS-Order-No.: 98492868
Customer: HAI
Product: LIGO
Pos.-No.: 1
Order-No.:
Comment: 960095-im-xx

thickness: 108.7 mm
sample diameter: 280.0 mm
CA diameter: 200.0 mm
examined diameter: 200.3 mm

Center: (0.0mm,0.0mm)
Radius: 100.1mm
Points: 69729

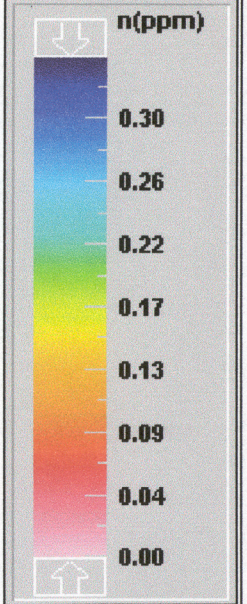




Sub. Terms		Magn.	Angle
X	Tilt	0.2533	78.0929
X	Focus	-0.6362	
	Astigm.	0.1129	63.6323
	Coma	0.0089	18.8326
	SA3	0.0266	

Phase Data
Unit n(ppm)
PV: 0.34
RMS: 0.054
Scale: 0.5

Contrast



Reset
UpperL 0.345
LowerL 0.000

File: 727300.tif, 25.11.97, 08:53
IFM-1 12"

Heraeus Amersil Inc
3473 Satellite Blvd.
DULUTH GA 30096

Heraeus
AMERSIL

Sales Order #: 5001652
Delivery #: 30041835

Delivery Note/ Packing List

Terms: FOB Duluth
Customer PO #: pc208421

SOLD TO: Customer # 1658
CALIFORNIA INST OF TECH
ACCOUNTS PAYABLE 201-6
PASADENA CA 91125
USA

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

Order Date: 09/24/1996
Account #:
Tracking #: 1Z3944240200070349

Salesman: 00000020 Marc Schneider
Route: UPS002 UPS Blue 2 Day PPA
Total Weight: 19.051 KG
Shipping Cartons: 00001

LINE ITEM	MATERIAL NUMBER	DESCRIPTION	UOM	SHIP DATE	NOTICE	CURRENT SHIPMENT
000002	50784	DISC, SUP 312, G, 256 X 108 SUPRASIL 312 DISC, GROUND, 256MM DIA X 108MM THK LIGO PROJECT DWG D960794-A-D REV A AND SPECIFICATION LIGO-E960095 REV A Rec'd complete 01-09-98	EA	11/09/1998	Open cartons and compare to bill of lading and packing list promptly. Claims for shortages or breakage must be made within 15 days after receipt of goods. Unpack with great care. Please do not discard the packing case nor any of the packing material until contents of case have been carefully checked and found correct and in good order. In case of damaged materials regardless of the external condition of the cartons, the consignee must institute the following procedure. Where shipments are made FOB Point of Shipment, it is the consignee's responsibility to file claim with the carrier and obtain an inspection report from the carrier for truck, air freight or parcel post shipments. For UPS shipments or FOB Destination shipments, all requests for inspection of damaged material should be made by the shipper and the consignee must notify Heraeus-Amersil Inc. promptly of such breakage to institute a claim. Damaged material, packing material, and packing case must be retained for carrier's inspection. Return no goods unless authorized. If material is not satisfactory, notify us and hold material subject to our order.	1.000

EJ

SUBSTRATE

A. DCN: LIGO-T790206-01-D LIGO DETECTOR OPTICS
B. LIGO S/N: 2ITM03-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: 06-22-98

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 FTP files

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	_____ in	250.97	mm
☑	Inspection of material thickness	Thickness	_____ in	99.99	mm
☑	Wedge Angle 0°35′				

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. (positioned with arrow ↑ - replaced in carrier with arrow ↓)

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: Steve Gleason Date Inspected: 06-23-98

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.)

Removed the optic from the carrier and replaced it properly positioned with the arrow down.

Scratches not seen refered to on vendor sketches.

SKETCHES:

See two surface sketches (side 1 and side 2)

DISPOSITIONS:

Substrate, Input Test Mass	Serial Number: 2ITMØ3-C		Specification	Reported Value	✓
	Surface 1	Surface Figure Over Central 200mm dia.	Spherical, Concave		
		Radius of Curvature Tolerance	14,180m +140m, -1000m	13.41 Km	✓
		Astigmatism	< 13nm p-v	1.7 nm	✓
	Surface 2	Surface Figure Over Central 200mm dia.	Nominally Flat		
		Radius of Curvature of the Wavefront	9,740m +500m, -100m	18.01 Km -5.01 ok	✓ ✓
		Astigmatism	< 15nm p-v	2.1 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	1.0 nm	✓
		High Spatial Frequency Band Central 80 & 200 mm	≤ 4.3 – 7,500 cm^{-1} σ_{rms}<0.2nm	0.15 0.12	✓
	Surface Errors Surface 2	Low Spatial Frequency Band Central 80mm	≤ 4.3 cm^{-1} σ_{rms} < 1.6nm	0.8 nm	✓
		Low Spatial Frequency Band Central 200mm	≤ 4.3 cm^{-1} σ_{rms} < 3.2nm	2.2 nm	✓
		High Spatial Frequency Band Central 80 & 200 mm	≤ 4.3 – 7,500 cm^{-1} σ_{rms}<0.2nm	0.16 0.13	✓

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. 16,000	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

		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).	Hand Sketch w/dimensions	✓
		The total area of scratches outside the central 80 mm diameter shall not exceed 750 x 10^3 square micrometers. 41,000	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

LIGO Certification Report

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

Serial number: 2ITM03-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)

* Not included - refer correspondence.

2. Electronic data

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

LADI data:	2ITM3C1.zip (Side 1)	2ITM3C2.zip (Side 2)
		2ITM3C2A.zip (wave front)
TOPO data: (2.5X)	T22IM31A.asc (Side 1)	T22IM32A.asc (Side 2)
	T22IM31B.asc	T22IM32B.asc
	T22IM31C.asc	T22IM32B.asc
(40X)	T42IM31A.asc	T42IM32A.asc
	T42IM31B.asc	T42IM32B.asc
	T42IM31C.asc	T42IM32C.asc

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM03-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**
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	250.97 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:2.20 mm Angle:$45^0$24' (S2) Height:2.23 mm Angle:$44^0$36'
Wedge angle:	$0^0$35'
Location of registration mark ($\pm$ angle with respect to minimum part thickness):	+6'
Location of other 3 marks (with respect to registration mark at minimum thickness)	$90^0$0', $180^0$0', $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:  Chris Walsh

Date: 19 June 98

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM03-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**	**LN00024**
8	**Team member responsible for measurement/inspection:**	**J Seckold**
9	**Measurement/inspection results reviewed by:**	

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: CWalsh Chris Walsh

Date: 19 June 98

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM03-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**	**LN00024**
8	**Team member responsible for measurement/inspection:**	**J Seckold**
9	**Measurement/inspection results reviewed by:**	**C Walsh**

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: C Walsh Chris Walsh

Date: 19 June 98

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM03-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**	**LN00024**
8	**Team member responsible for measurement/inspection:**	**J Seckold**
9	**Measurement/inspection results reviewed by:**	**C Walsh**

10. Results

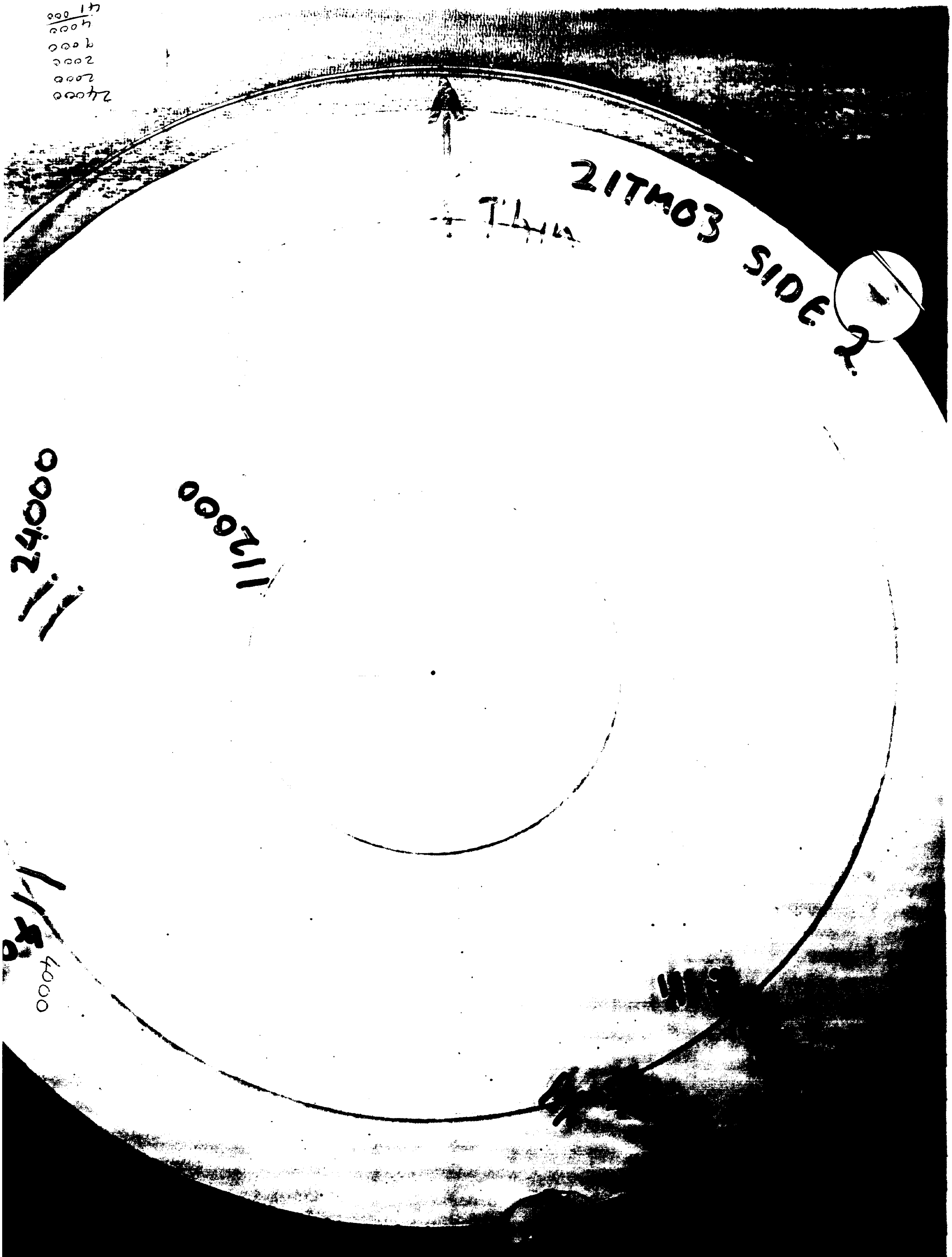
	Numbers of point defects		**Total Area of scratches (square micrometres)**	
	Inside central 80 mm	**Entire surface (235 mm)**	**Inside central 80 mm**	**Outside central 80 mm (235 mm)**
Surface 1	**nil**	**nil**	**nil**	**16,000**
Surface 2	**nil**	**nil**	**nil**	**41,000**

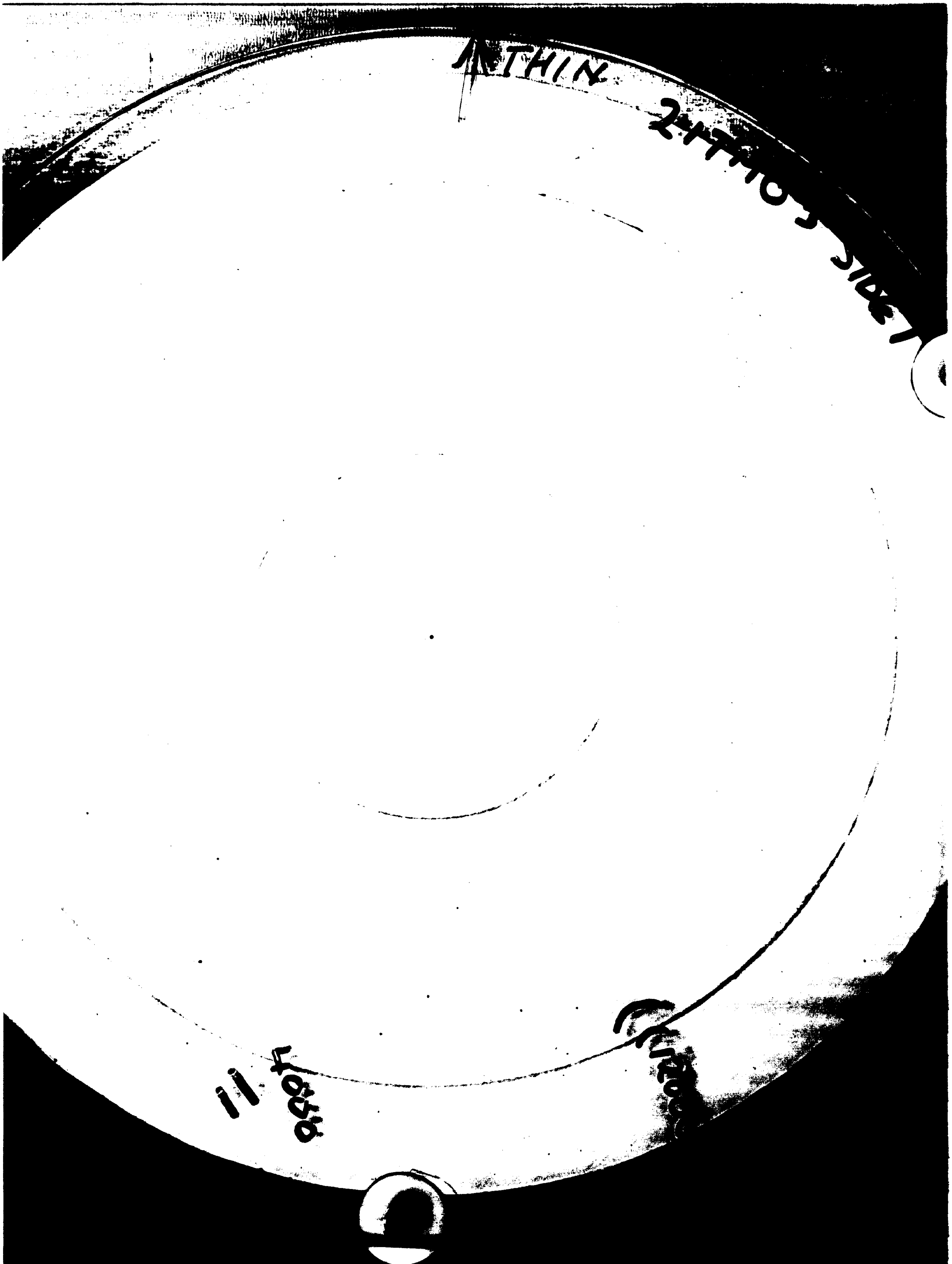
11. Certification

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: 19 June 98


21TM03 SIDE 2.


THIN

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM03-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 26-27**
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	**13.41**	**1.7**	2ITM3C1.zip
Surface 2	**18.01**	**2.1**	2ITM3C2.zip
Wave front*	**-5.01**		2ITM3C2A.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: 19 June 98

LADI CERTIFICATION DATA

Title: 2ITM031

Date: 05/20/98

Diameter: 200 mm

Astig: 1.7 nm

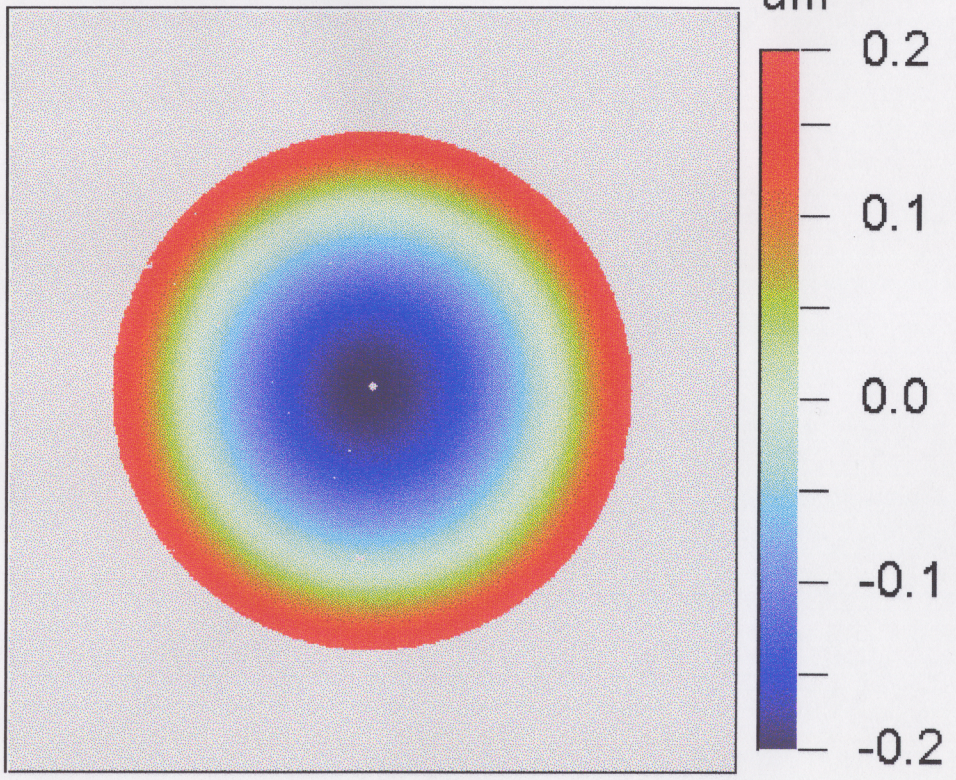
Power: 372.8 nm

CSIRO

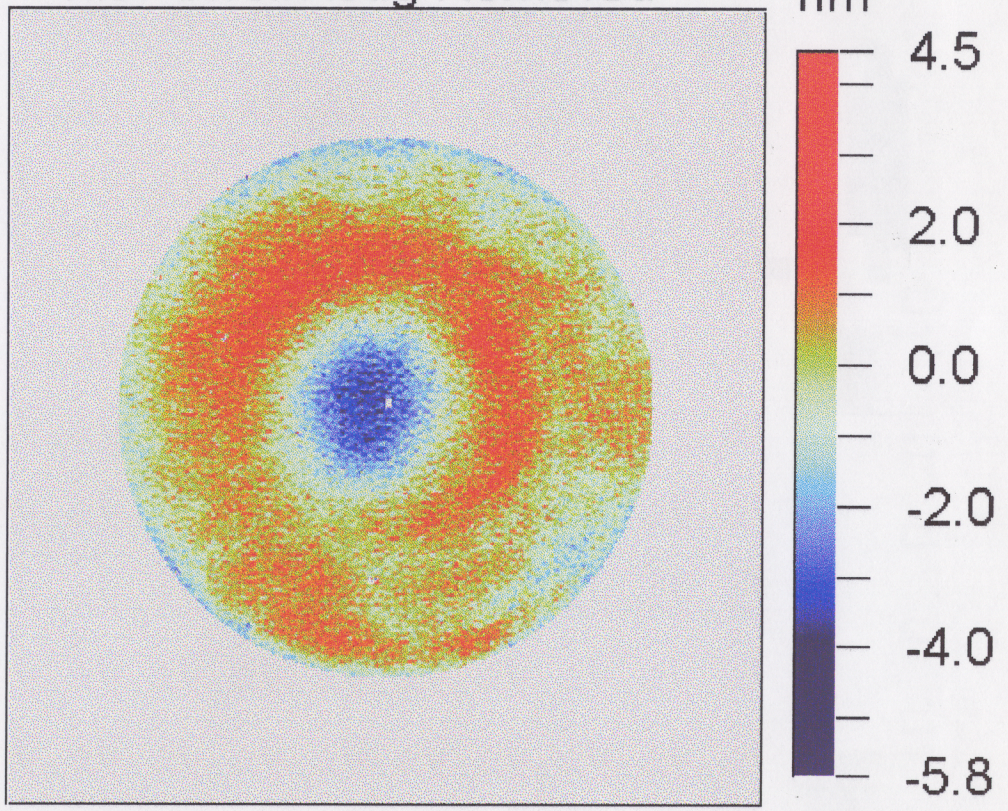
PV: 10.3 nm

RMS: 1.0 nm

Tilt Removed



Tilt/Power/Astig Removed



AH. 1

LADI CERTIFICATION DATA

Title: 2ITM032

Date: 05/20/98

Diameter: 200 mm

Astig: 2.1 nm

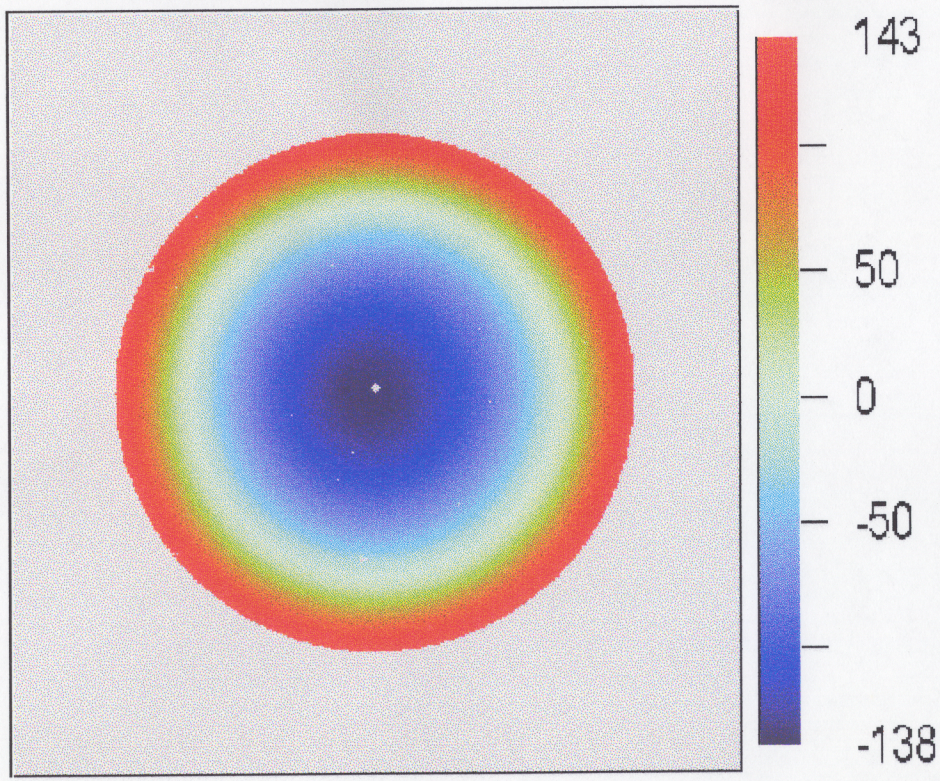
Power: 277.7 nm

CSIRO

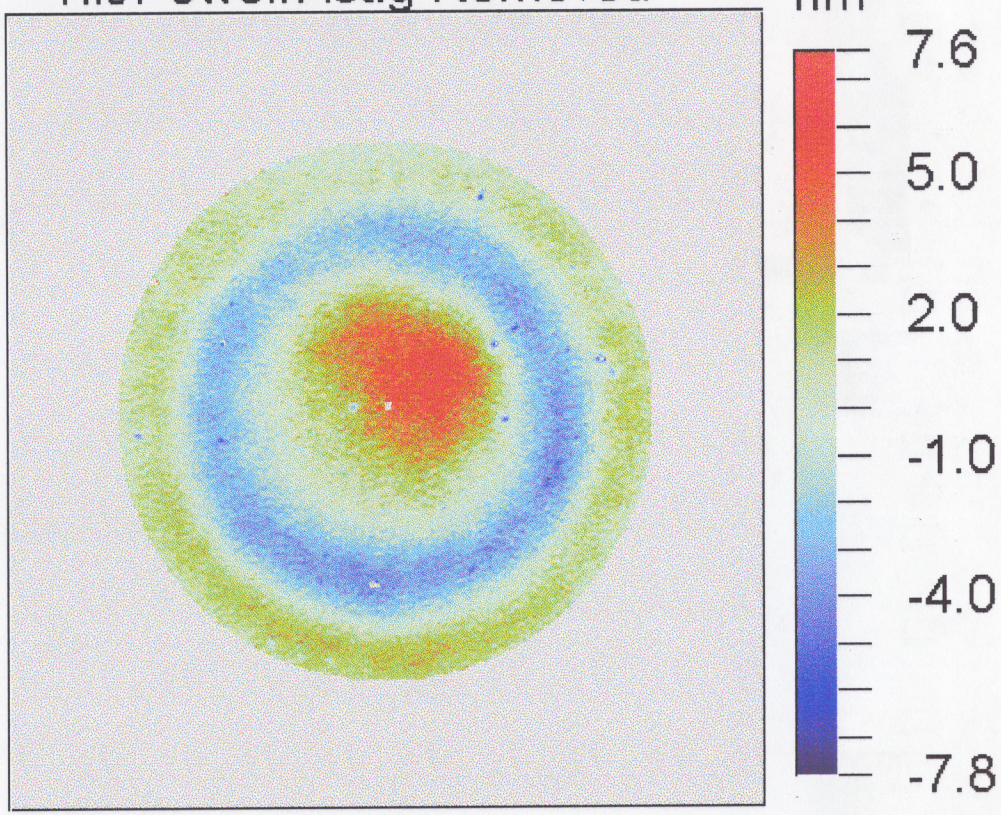
PV: 15.4 nm

RMS: 2.2 nm

Tilt Removed



Tilt/Power/Astig Removed



AH. 2A

LADI CERTIFICATION DATA

Title: 2ITM3TA

Date: 06/03/98

Diameter: 200 mm

Astig: -50.4 nm

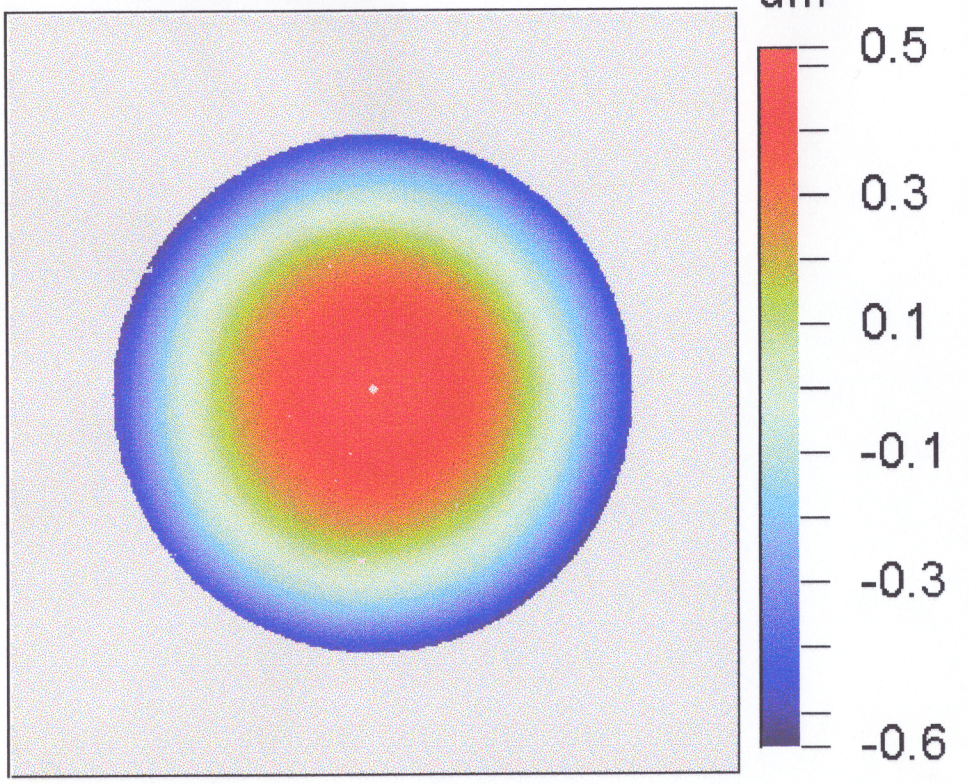
Power: -998.5 nm

CSIRO

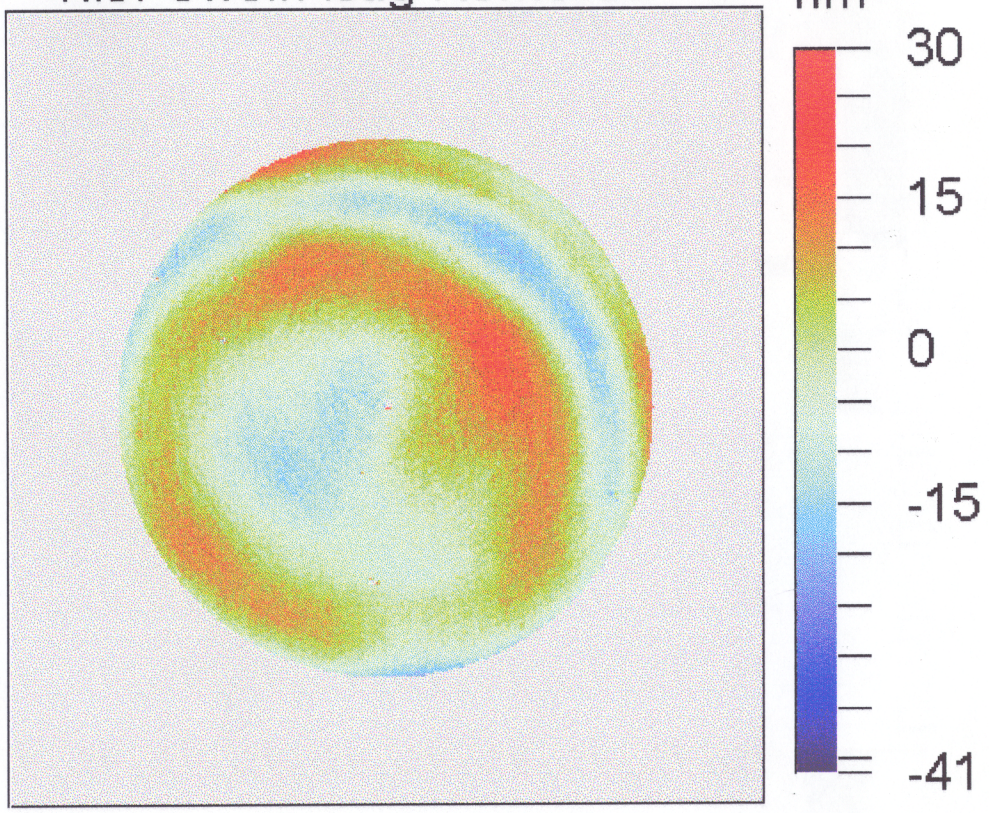
PV: 71.1 nm

RMS: 8.1 nm

Tilt Removed



Tilt/Power/Astig Removed



AH. 28

1	**Substrate Type:**	**Input Test Mass (2 km)**
2	**Serial Number:**	**2ITM03-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 26-27**
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	1.0
Surface 2	0.8	2.2

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:**	**2ITM03-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: **0.15**

Side 2: **0.12**

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

Side 1: **0.16**

Side 2: **0.13**

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

	A	B	C	D	E	F	G	H
Surface 1	**0.13**	**0.14**	**0.16**	**0.17**	**0.15**	**0.20**	**0.19**	**0.16**
Surface 2	**0.11**	**0.11**	**0.12**	**0.12**	**0.13**	**0.15**	**0.13**	**0.14**

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).

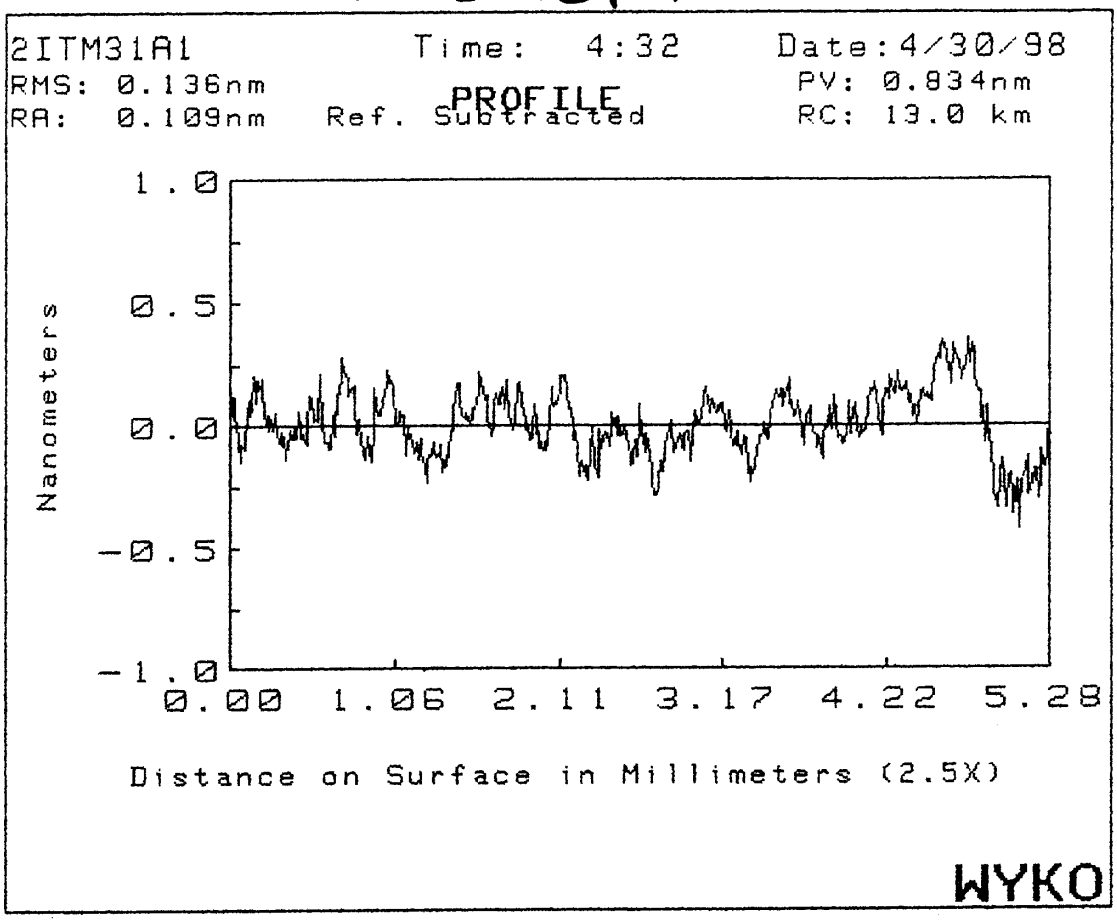
11. Certification

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

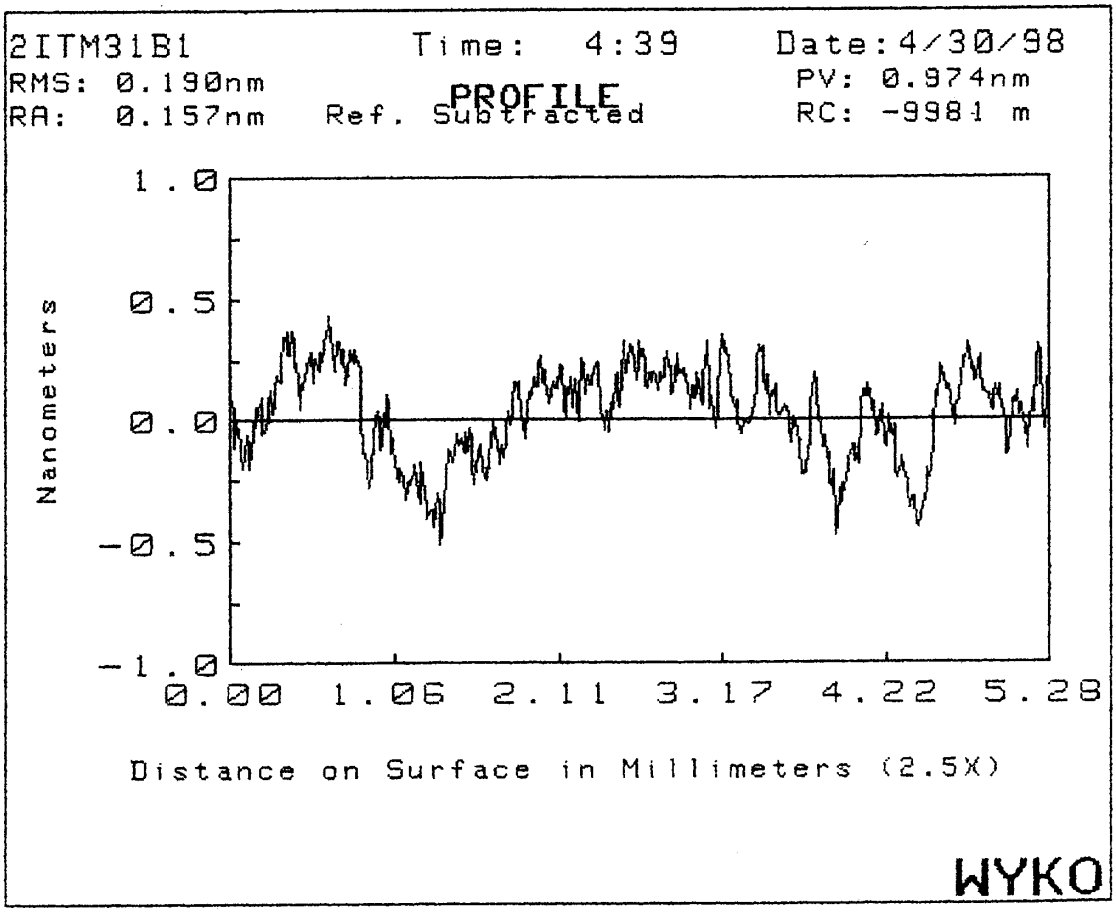
Date: 19 June 98

T22IM31A.asc

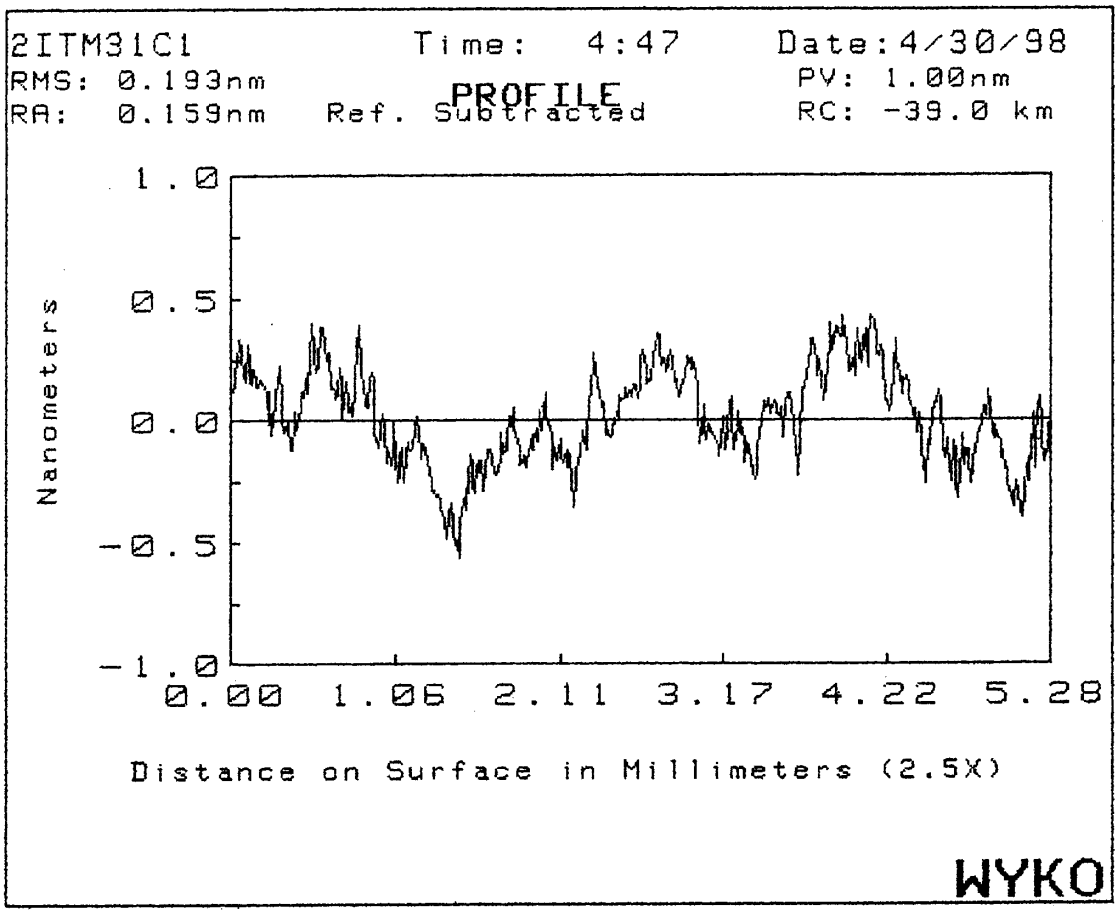


Att. 3

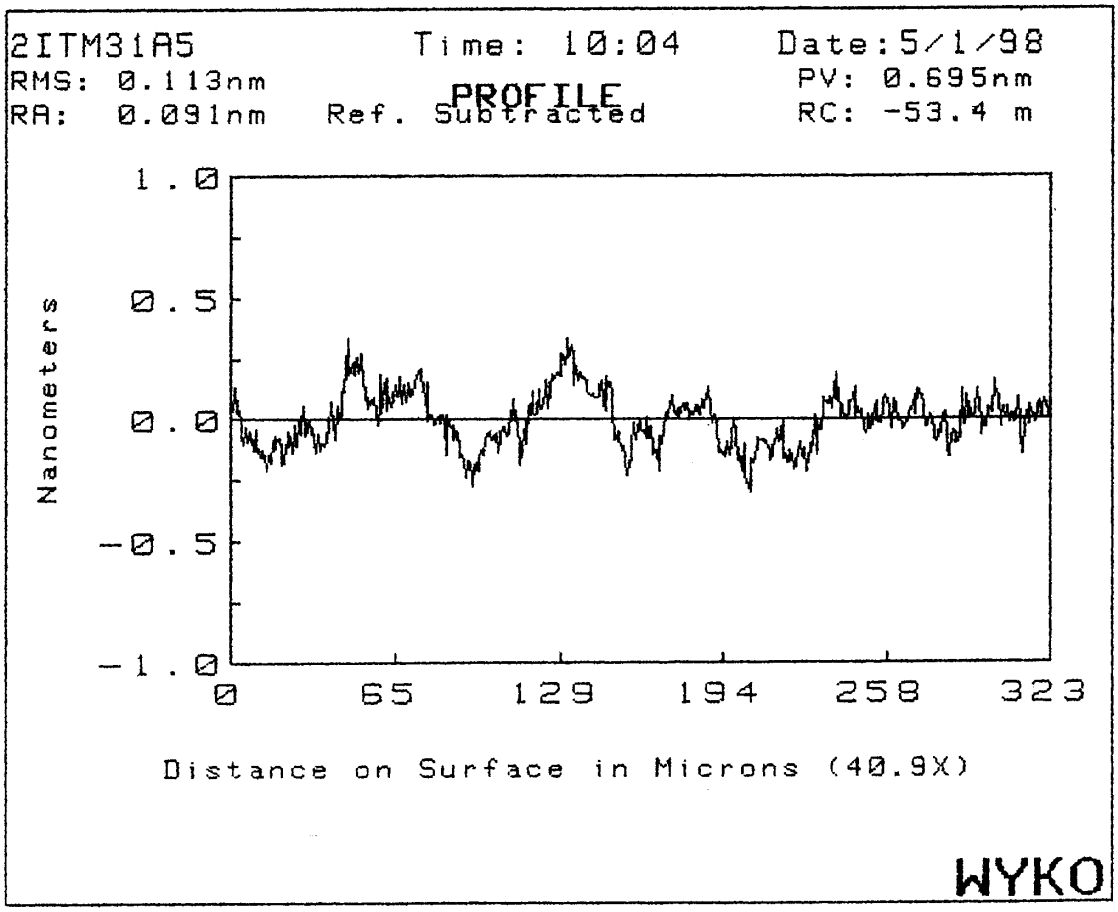
T22IM31B.asc



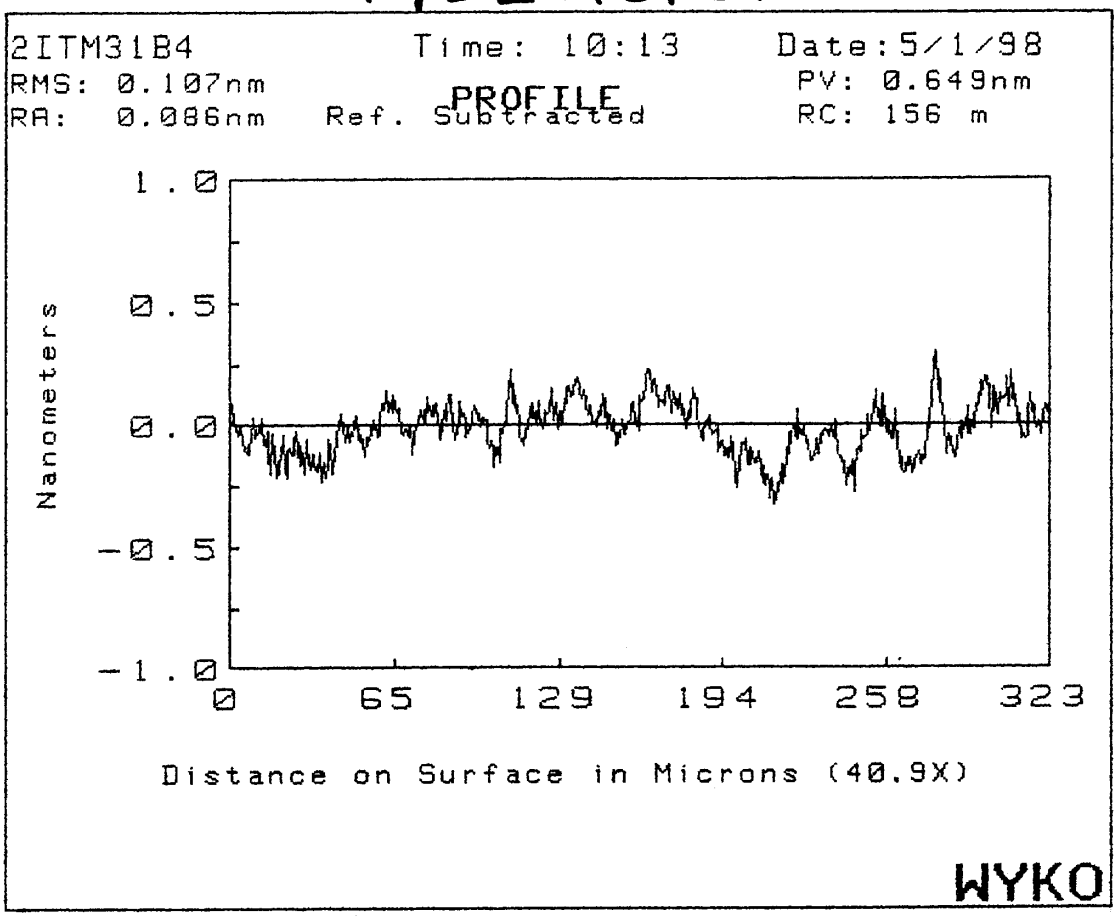
T22IM31C.asc



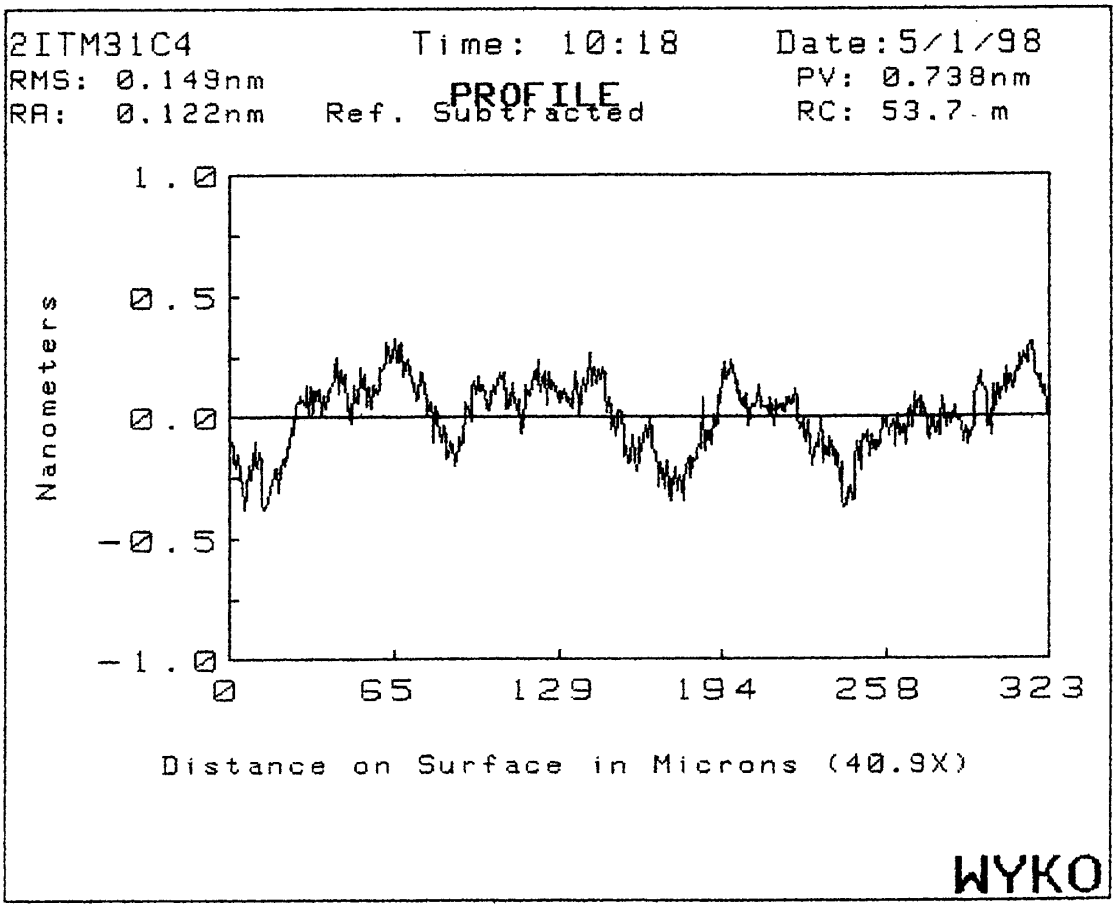
T42IM31A.asc



T42ITM31B.asc



T42ITM31C.asc




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 : 25 Sept 98
- Customer Name, Purchase Order No. : Ligo ; po# pc 162519 / conos
- Customer Part Number & Revision : 2ITM01 , 2ITM03
- Part Description : S1: T = 3% @ 1064nm S2: R = 600ppm @ 1064nm
- REO Job No. : OPT05831-023 Run No.: S1: OX814 S2: OX818
- Qty. Shipped/Lot No. : 2 ea 25 cm ∅ FS
  2 ea 1" ∅ witness

[X] **Test data (included)**

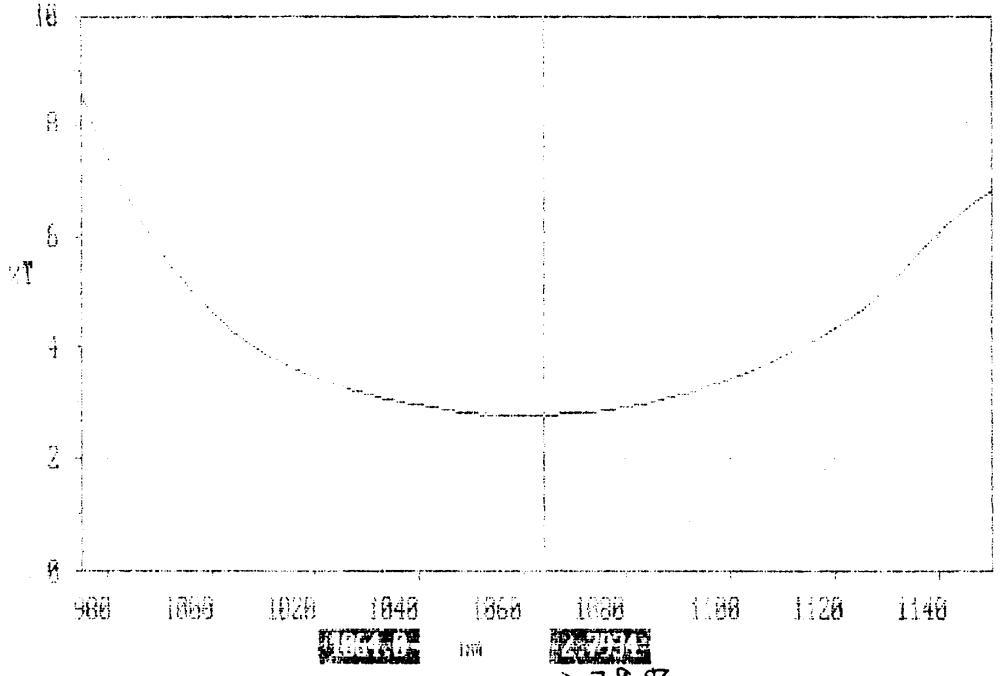
Comment:

Certified by: _____, 9/25/98
Quality Assurance

Verified by: Dale C Nolt, 25/Sept/98
Engr/Tech

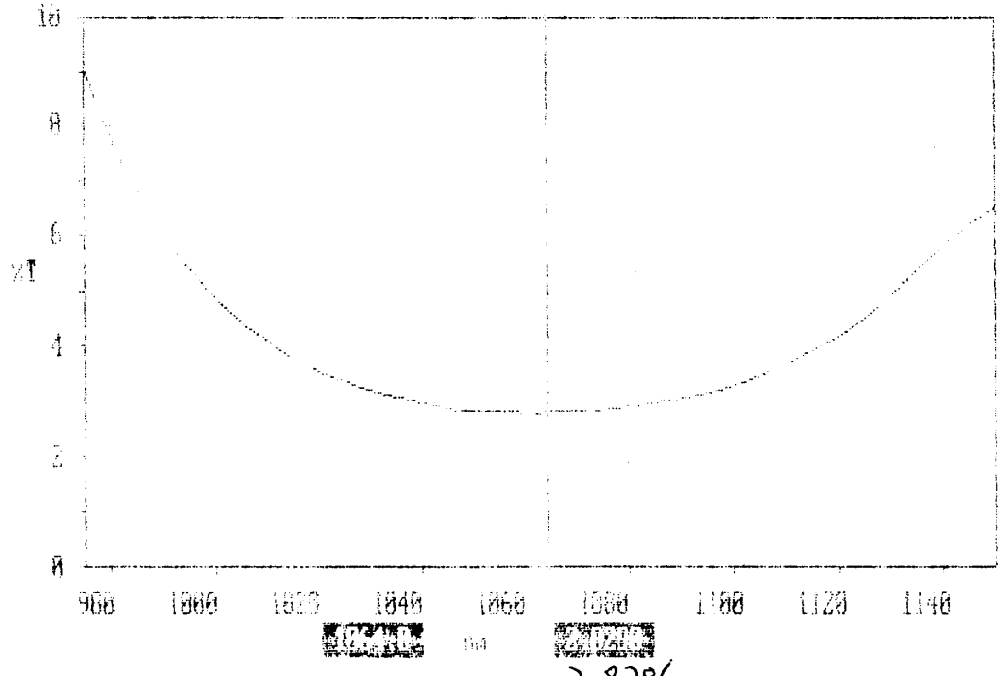
NOTE
Certificate must accompany the package to be shipped or attached to the outside of the same box to which the "Packing Slip" envelope is attached.

T: user#01: 1150.0 - 950.0 nm; pts 201; int 1.00; ord 2.7089 - 19.014 %T
Int: ord14 0CW1064NM PARTIAL TRANSMITTER AFTER PROCESSING



2.79%

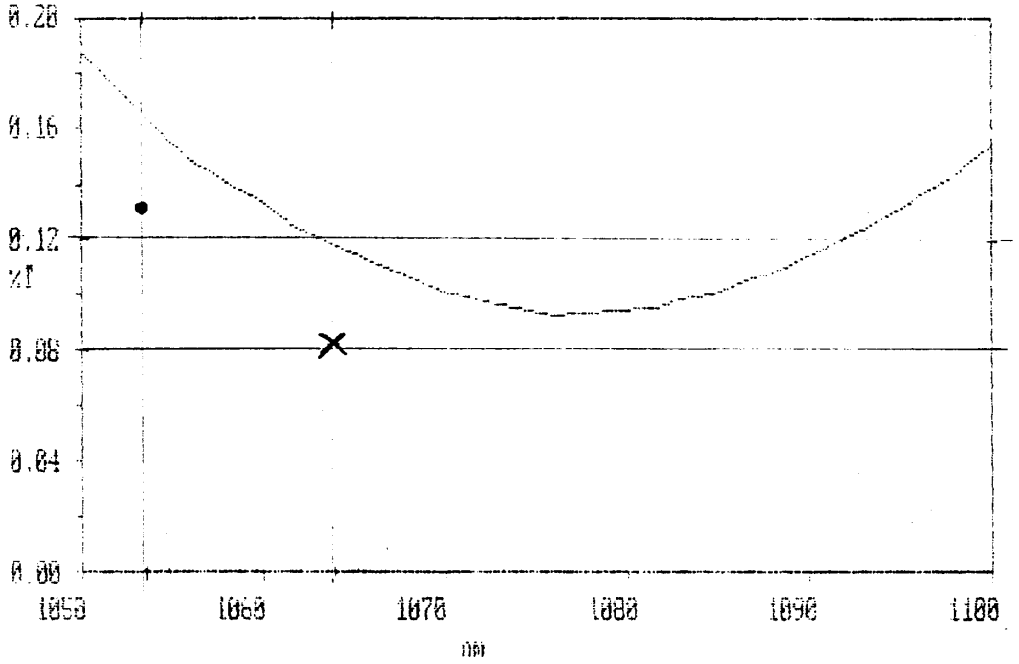
T: user#02: 1150.0 - 950.0 nm; pts 201; int 1.00; ord 2.9158 - 20.585 %T
Int: ord14 0CW1064NM PARTIAL TRANSMITTER AFTER PROCESSING



2.82%

2ITMØ3

X: USER001: 1150.0 - 950.0 nm; pts 201; int 1.00; ord 0.0933 - 1.7674 %T
Int: 0X818 AR@1064NM AFTER PROCESSING



- Measured with Laser @ 1053nm:
  R = 0.134%

X inferred Level @ 1064nm:
  R = 0.082%

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

ORDER NO: OPT05831
SHIPMENT NO: 005865
PAGE: 1
DATE: 09/25/1998
CUST PO NUMBER: PC162519/CON05

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: 0 WEIGHT: 0 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-C980963-00-0
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.

023 LIGOE980066 EA 2 0 2 0
INPUT TEST MASS, 2K, COATED
PER PART #2ITM, SPEC #LIGO-E980066-00-D.

2ITM03-C

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

RUN #OX814(S1), OX818(S2)

Two 1" diameter witness pieces.

FED EX TRACKING #7901 4150 2636, 7901 4150 2934

PACKED BY: CHECKED BY: DATE: