

BS04-B
(Repolished, Recoated)

LIGO-T990137-01-D

BLANK

A. DCN: LIGO-T970203-00-D LIGO DETECTOR OPTICS
B. LIGO S/N: BS04 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.: 50785
G. LIGO Drawing No.: D960793-B-D H. Manufacturer's Boule No.: M.F.F 8965
I. Date Received at Caltech: 12-01-97

J Verify glass manufacturer's ^{inspection report} ~~Certification~~ against LIGO Component Specification No. E960094-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 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 10.11 in 256.70 mm

Inspection of material thickness. Thickness 2.08 in 52.84 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 directly to Heraeus (France)

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

Inspect By: [Signature] Date Inspected: 12-02-97

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 registration marks

No data disc

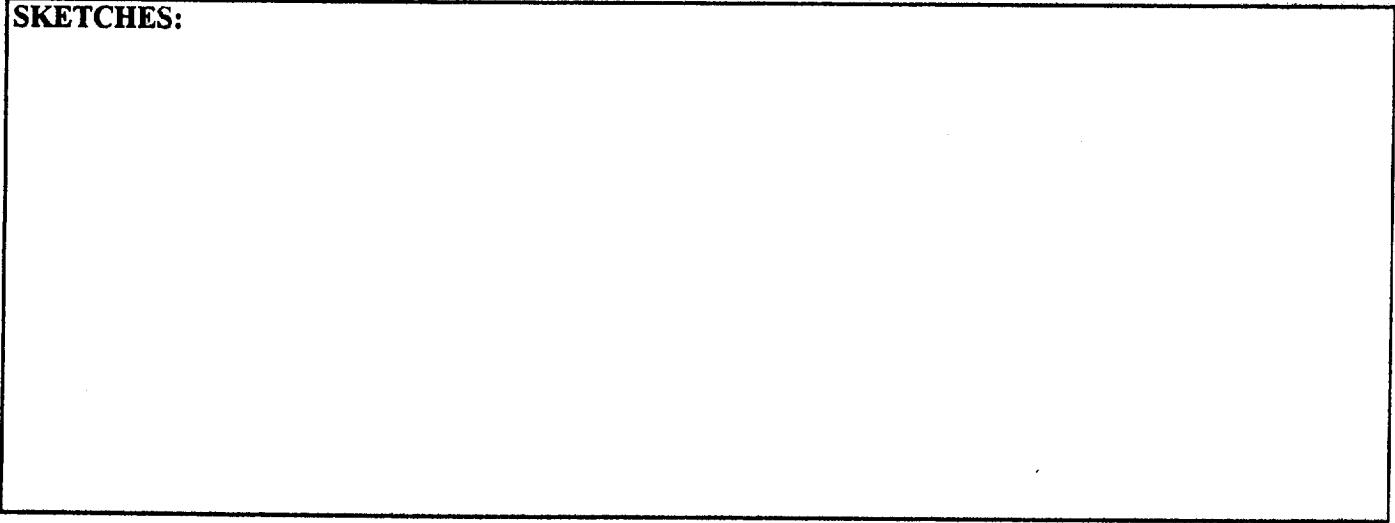
No birefringence or inclusion map (report \emptyset inclusions)

witness sample is being sent directly to Heraeus (France) by direction.

s/n not correctly marked - wrong serial number

OH content not reported

SKETCHES:



DISPOSITIONS: _____

12-30-97 Received additional data package and OH-content report.

**LIGO Component Specification Verification Sheet
Mirror Blanks, Beam Splitter**

Mirror Blanks, Beam Splitter	Serial Number: BS04		Specification	Reported Value	✓
	Physical Dimensions		LIGO-D960793-β		✓
	Diameter		256mm +1.0mm, -0mm	256.7 mm	✓
	Thickness		52.61mm +1.0mm, -0mm	52.84mm	✓
	Chamfer		2.0mm Max 2pl		
	Clear Aperture		Central 235mm		
	Material		Fused Silica Suprasil #7980 311S	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.	No
	Homogeneity Within the Central 150mm		$\leq 5.0 \times 10^{-7}$ p - v $\lambda = 632.8\text{nm}$	Interferogram Homogeneity Map	✓
	Homogeneity Within the Central 225mm		$\leq 2.5 \times 10^{-6}$ p - v $\lambda = 632.8\text{nm}$	Interferogram Homogeneity Map	✓
	Homogeneity Data		ASCII Format	PC Compatible 3 1/2 in. Disk	No
	Birefringence Within the Central 150mm		≤ 1 nm/cm	Certification, Birefringence Map	✓
	Birefringence Within the Central 225mm		≤ 5 nm/cm	Certification, Birefringence Map	✓
	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.	✓
	Absorption		2ppm/cm $\lambda = 1.06\text{nm}$	Certification	No
	Striae within the Clear Aperture		Grade A per MIL-G-174	Inspection Report	✓

Blink_BS.doc

OH: _____

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. : 2
Quality : Fused silica Suprasil 311 S
HQS melt No. : MF.F 8965
Marking : 960095-IM 16 - B504 BN 5060

Diameter : 256,7mm
CA Diameter : $\emptyset 200 \text{ mm} = 0,74 \times E^{-6}$
Thickness : 52,84 mm
Edge : 0,3 - 0,5 mm
Parallelism : 0,08 mm
Roughness : ground
 R_a : 1,08 μm
 R_z : 8,86 μm
Bubble class : 0 ; none bubbles
Birefringence : CA $\emptyset 200 \text{ mm} \leq 5 \text{ nm/cm}$;
Homogeneity : see Interferogram
Striae Grade : A
Granularity : none
Remark : Test Sample ($\emptyset 25 \times 25 \text{ mm}$) with the same marking

POL - Qualitätsprüfung Optik

Date : 06.10.1997

Inspector : Wink

Heraeus
QUARZGLAS

POL-QW

Order Nr.: 94908401 Pos.: 2
Ø 2,56,7 mm x 52,84 mm
Quality: Suprasil 3M
Plate No.: 960095-1M16 / 5060

Date: 6.10.97

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

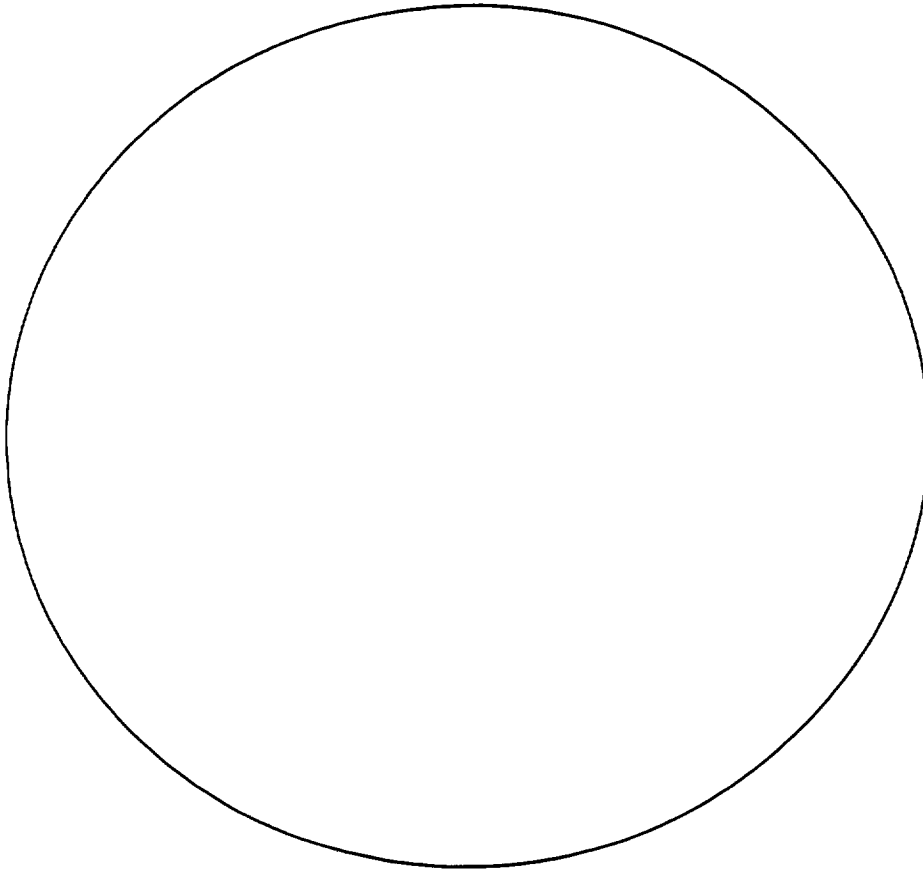
Heraeus
QUARZGLAS

POL - QW

Order No.: 94908401 Pos.: 2
Ø 256,7 mm x 52,84 mm
Plate No.: 960095-1416/5060
Residual strain- Report

Date: 6.10.97

Inspector: 

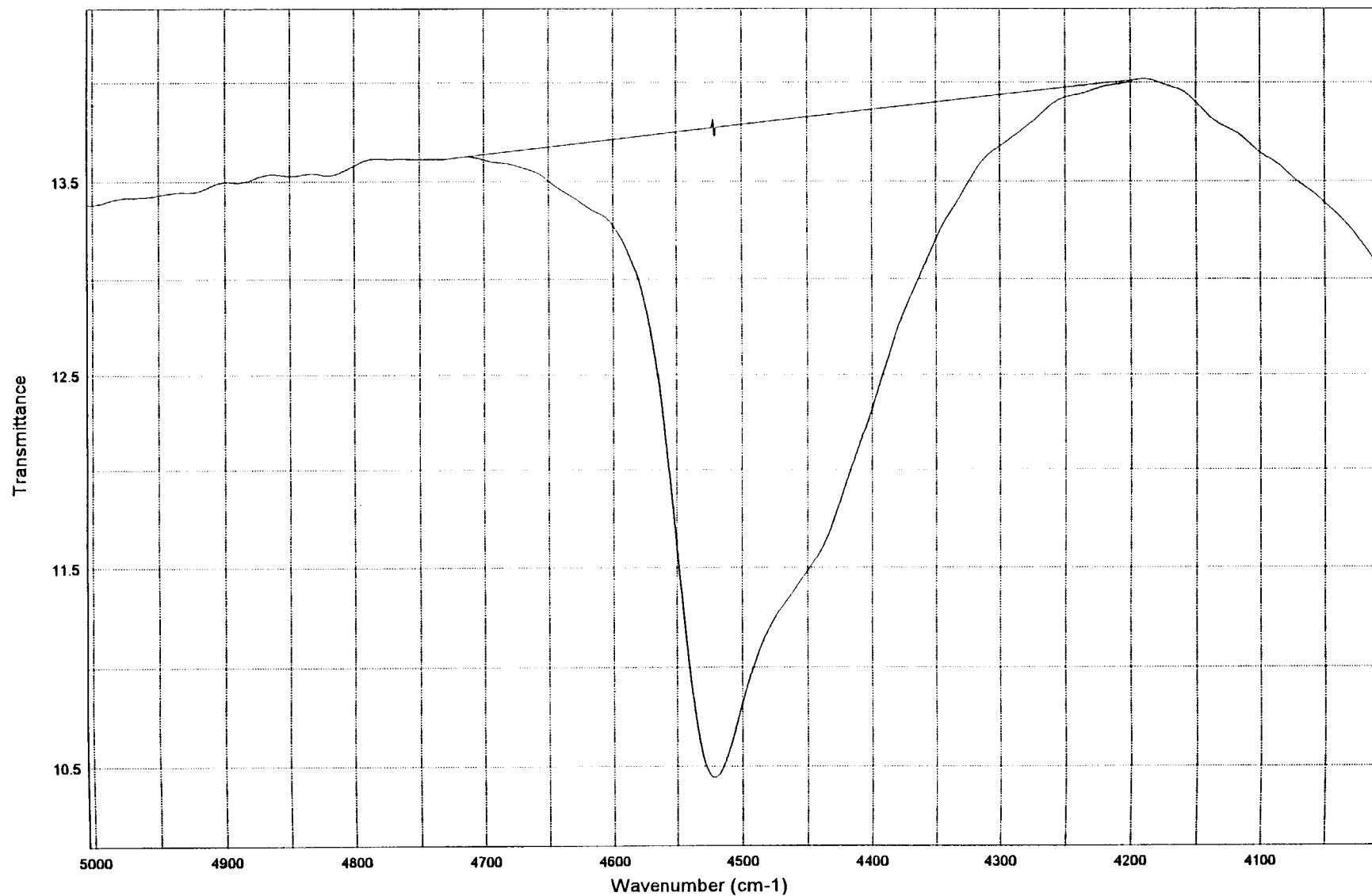


Edge	Center						Pos.
10							nm
2	<1						nm/cm

l0=13.7711 , l1=10.4409 at x=4521

OH-content: 202.7 ppm

MEASURE NO. : 5060
DATE : 05.09.1997 TIME : 12:27
MEASURE START : 10000 1/cm
MEASURE END : 2500 1/cm
OP-DISK-PATH LENGTH : Ko-203-PL: 2.61 cm / Order No.: 9930 3974 / Material: 5060----OH-content: 202.7 ppm at x=4521



Heraeus
QUARZGLAS

POL-QW

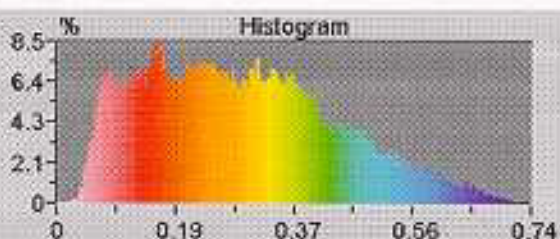
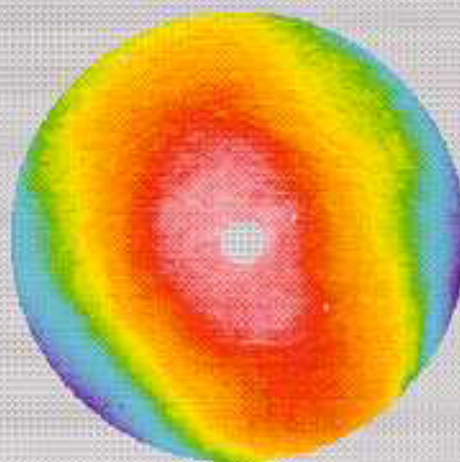
Data taken at 632.8 nm

Date: 04.09.97 Operator: RJ
ID: 506000 No.:

HQS-Order-No.: 98492874
Customer: HAI
Product: LIGO
Pos.-No.: 2
Order-No.:
Comment: 960094-im-xx

thickness: 63.0 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

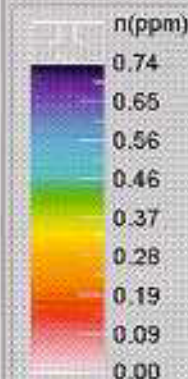


Sub. Terms	Magn.	Angle
XTilt	0.1048	-16.7039
Focus	0.2116	
Astigm.	0.1771	-67.7109
Coma	0.0230	52.3769
SAS	-0.0142	

Phase Data

Unit: n(ppm)
PV: 0.74
RMS: 0.146
Scale: 0.5

Contrast



Reset

UpperL: 0.740
LowerL: 0.000

File: 506000.dat, 04.09.97, 18:12

XPS-12"

BSØ4



Heraeus AMERSIL

Heraeus Amersil Inc
3473 Satellite Blvd.
Duluth, GA 30096

Sales Order #: 5001652
Delivery #: 30039279

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 #: 1Z3944240200060485
0476 0467 0458 0449 0430

Salesman: 00000020 MARC SCHNEIDER
Route: UPS002 UPS Blue 2 Day PPA
Total Weight: 252.000 LB
Shipping Cartons: 00006

LINE ITEM	MATERIAL NUMBER	DESCRIPTION	UOM	SHIP DATE	NOTICE	CURRENT SHIPMENT
000001	50785	DISC, SUP 311, G, 256 X 52 SUPRASIL 311 DISC, GROUND, 256MM DIA X 61MM THK. PER LIGO PROJECT DRAWING D960793-A-D REV A AND SPECIFICATION LIGO-E960094 REV A	EA	11/24/1997	<p>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.</p> <p>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.</p> <p>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.</p> <p>Return no goods unless authorized. If material is not satisfactory, notify us and hold material subject to our order.</p>	6.000
		<p>Received complete 12-02-97 </p>				

jm

Heraeus Amersil Inc
 3473 Satellite Blvd.
 Duluth, GA 30096

Heraeus AMERSIL

Sales Order #: 5001652
 Delivery #: 30039279

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 #: 1Z3944240200060485
 0476 0467 0458 0449 0430

Salesman: 00000020 MARC SCHNEIDER
 Route: UPS002 UPS Blue 2 Day PPA
 Total Weight: 252.000 LB
 Shipping Cartons: 00006

LINE ITEM	MATERIAL NUMBER	DESCRIPTION	UOM	SHIP DATE	NOTICE	CURRENT SHIPMENT
000001	50785	DISC, SUP 311, G, 256 X 52 SUPRASIL 311 DISC, GROUND, 256MM DIA X 61MM THK. PER LIGO PROJECT DRAWING D960793-A-D REV A AND SPECIFICATION LIGO-E960094 REV A <i>Received complete 12-02-97 </i>	EA	11/24/1997	<p>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.</p> <p>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.</p> <p>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.</p> <p>Return no goods unless authorized. If material is not satisfactory, notify us and hold material subject to our order.</p>	6.000

Jm

SUBSTRATE

A. DCN: LIGO-T990203-D1-D

LIGO DETECTOR OPTICS

B. LIGO S/N: 8504-B

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: 11-04-98

G Verify glass polisher's Certification with LIGO Component Specification No. E960100-B-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.

- Inspection of material diameter. Diameter _____ in _____ mm
- Inspection of material thickness Thickness _____ in _____ mm
- Wedge Angle _____

the substrate was not remeasured since the surfaces were polished, not ground to remove the coatings.

N Verify that the Serial Number is present in the proper format as required by LIGO Component Specification.

O Verify that the Registration Mark (line with arrow pointing toward surface #1) is present as required by LIGO Component Specification.

P Inspect the sides and bevels with the naked eye in normal room light and against a black background to verify that there is no gray, scuffs or scratches per the applicable LIGO Component Specification.

Q Use a dark field microscope at 5X magnification to inspect the polished optic for scratches and defects over the central 80 mm diameter per the applicable LIGO Component Specification.

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

Inspection By:  Date Inspected: 11-06-98

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:

See the map included by CSIRO

DISPOSITIONS: _____

		Serial Number:	Specification	Reported Value	✓
		Substrate, Beam Splitter	Surface 1	Surface Figure Over Central 200mm dia.	Flat
Radius of Curvature	> 200 km convex > 720 km concave			> - 250 Km (-18.5 nm)	✓
Astigmatism	< 16nm p-v			-5.1 nm	✓
Surface 2	Surface Figure Over Central 200mm dia.		Nominally Flat		
	Radius of Curvature of the Wavefront		> 140 km convex > 500 km concave	> 190 Km (25.8 nm)	✓
	Astigmatism		< 23nm p-v	3.0 nm	✓
Surface Errors	Low Spatial Frequency Band Central 80mm		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 1.6\text{nm}$	S1 1.0 nm S2 1.0 nm	✓
	Low Spatial Frequency Band Central 200mm		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 3.2\text{nm}$	S1 1.6 nm S2 1.3 nm	✓
	High Spatial Frequency Band Central 80 & 200 mm		$\leq 4.3 - 7,500 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 0.4\text{nm}$	see cert. report	✓

Wavefront: > 900 (5.4 nm)

		Specification	Certification	✓
		Scratches, Point Defects & Polish	Scratches	The Total Area of scratches within the central 80mm diameter shall not exceed 75×10^3 square micrometers (width x length). < 35,000
The total area of scratches outside the central 80 mm diameter shall not exceed 750×10^3 square micrometers. < 50,000	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 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 Beam Splitter

This Certification Package relates to the following substrate: **Beamsplitter**

(October 98 re-work)

Serial number: BS04-B

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 and transmitted wave front
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 head at four positions (side 1)
Attachment 4	Hard copy printouts of TOPO 2D data obtained with 2.5X head at four 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:	BS4B1R.zip	(Side 1)	BS4B2R.zip	(Side 2)
			BS4BTR.zip	(wave front)

LIGO Certification Report **Physical Dimensions**

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS04-B
3	Physical quantity certified:	Physical Dimensions and Registration Mark
4	LIGO specification reference:	D960789-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:	Carl 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]

The substrate was not re-measured since the sides were polished, not ground to remove the coatings. We expect the dimensional change in the thickness to be insignificant.

C Walsh
30 October 98

LIGO Certification Report **Side and Bevel Polish**

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS04-B
3	Physical quantity certified:	Side and Bevel Polish
4	LIGO specification reference:	E960100-B-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"*).

There are a few scratches on the side near the lettering of the serial number. These were seen during unpacking.

11. Certification

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

Project Manager:



Chris Walsh

Date:

30 October 98

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS04-B
3	Physical quantity certified:	Serial Number and location
4	LIGO specification reference:	E960100-B-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
30 October 98

Chris Walsh

Date:

LIGO Certification Report Scratches / Defects

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS04-B
3	Physical quantity certified:	Scratches and Point Defects
4	LIGO specification reference:	E960100-B-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	<35,000	<50,000
Surface 2	nil	nil	<10,000	<20,000

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:

30 October 98



Thin ~~edges~~

6000

BSC4
SIDE 1

2000

3000

4000

5000

2006
0009

~~0000~~

1000

8000

3000

1000

1000

2000

2000

2000

4000

7000
7000



Thin

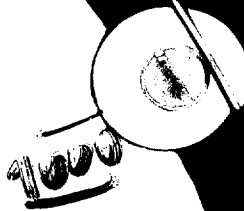
BSO 4/SIDE 2

4000

3000

2000

5000



1	Substrate Type:	Beamsplitter
2	Serial Number:	BS04-B
3	Physical quantity certified:	Surface Figure
4	LIGO specification reference:	E960100-B-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)	The measurement of wave front as per E960100-B-D has been replaced by a specification on the wave front transmitted through the substrate, and is calculated as a sum of the measurement on side 1 and the wave front measured as per E960100-B-D (refer CSIRO/Caltech fax correspondence)
7	CSIRO Log Book Reference	LLN/0137-02 (book 5) p.11
8	Team member responsible for measurement/inspection:	J Seckold/E Pavlovic
9	Measurement/inspection results reviewed by:	B Oreb

10. Results

	Radius of Curvature in km (Parabolic sag in nm)	Astigmatism (nm)	Electronic data file reference
Surface 1	>-250 (-18.5 nm)	-5.1	BS4B1R.zip
Surface 2	>190 (25.8 nm)	3.0	BS4B2.zip
Wave front*	>900 (5.4 nm)		BS4BT.zip

* Measured as per the test procedure in E960100-B-D. Figure quoted and phase map are for the equivalent of a single pass.

Transmitted wave front (single pass): The parabolic sag equivalent to that of a wave front transmitted through the beam splitter can be found by adding the sag measured for surface 1 to that measured for the single pass-equivalent of a wave front double passing the material after reflection from side 1 (shown in the table above).

The combined sag is **-13.1 nm**, which lies within the tolerance band agreed with Caltech of **14 nm > Sag > -50 nm**.

Hardcopies of the phase maps are attached to this certification as part of Attachment 1 for Side 1, Attachment 2A for Side 2 and Attachment 2B for the wave front measured as per E960100-B-D. The phase of the wave front shown in Attachment 2B is equivalent to a single pass measurement. 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), modified during subsequent discussions and fax correspondence. These results have been reviewed against the LIGO specifications (sec. 4). Taking into account the variations (if any) from these measurement procedures noted in sec.6, CSIRO certifies the substrate to comply with the LIGO specification for this physical quantity.

Project Manager:



Chris Walsh

Date:

30 October 98

LIGO Certification Report Surface Errors - Low

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS04-B
3	Physical quantity certified:	Surface Errors - Low Spatial Frequency
4	LIGO specification reference:	E960100-B-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/0137-02 (bk 5) p.11
8	Team member responsible for measurement/inspection:	J Seckold/E Pavlovic
9	Measurement/inspection results reviewed by:	B Oreb

10. Results

	Low Frequency Surface Errors (nm)	
	80 mm aperture	200 mm aperture
Surface 1	1.0	1.6
Surface 2	1.0	1.3

Hardcopies of the phase maps over the central 200 mm with piston, tilt, power and astigmatism removed are enclosed with 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
30 October 98

Chris Walsh

Date:

LIGO Certification Report **Surface Errors - high**

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS04-B
3	Physical quantity certified:	Surface Errors - high spatial frequency
4	LIGO specification reference:	E960100-B-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)	Full measurement data set not recorded; spot measurements only at 4 locations on each surface.
7	CSIRO Log Book Reference	LLN00022, pp. 108 and 111
8	Team member responsible for measurement/inspection:	F Lesha
9	Measurement/inspection results reviewed by:	C Walsh

10. Results

By oversight, a full set of certification measurements was not recorded on sides 1 or 2. Four 'spot' measurements using the 2.5X objective were recorded on each side: two at the centre, one at 40 mm radius and one at 100 mm. Experience has shown with surfaces polished on LIGO substrates that the unfiltered measurement using the 2.5X objective only gives a surface roughness estimate within 10% of that obtained by combining spectrally filtered measurements made with the 40X and 2.5X objectives, combined using the procedures outlined in HABA-LIGO-M-SH-A. RMS roughness measured at the four locations are given below:

Side 1: 0.18 nm, 0.23 nm (centre), 0.20 nm (40 mm radius), 0.21 nm (100 mm radius)

Side 2: 0.27 nm, 0.27 nm (centre), 0.27 nm (40 mm radius), 0.27 nm (100 mm radius)

Hard copies of the data are at Attachment 3 (Side 1) and Attachment 4 (Side 2).

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

LADI CERTIFICATION DATA

Title: BS_41R

Date: 10/13/98

Diameter: 200 mm

Astig: -5.1 nm

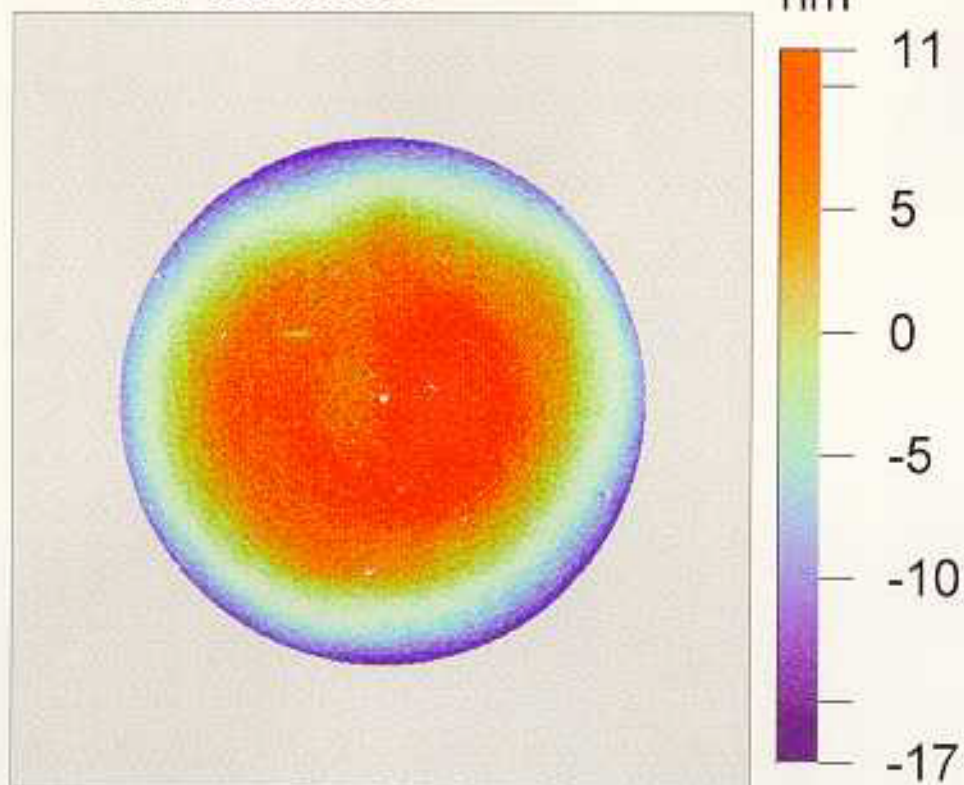
Power: -18.5 nm



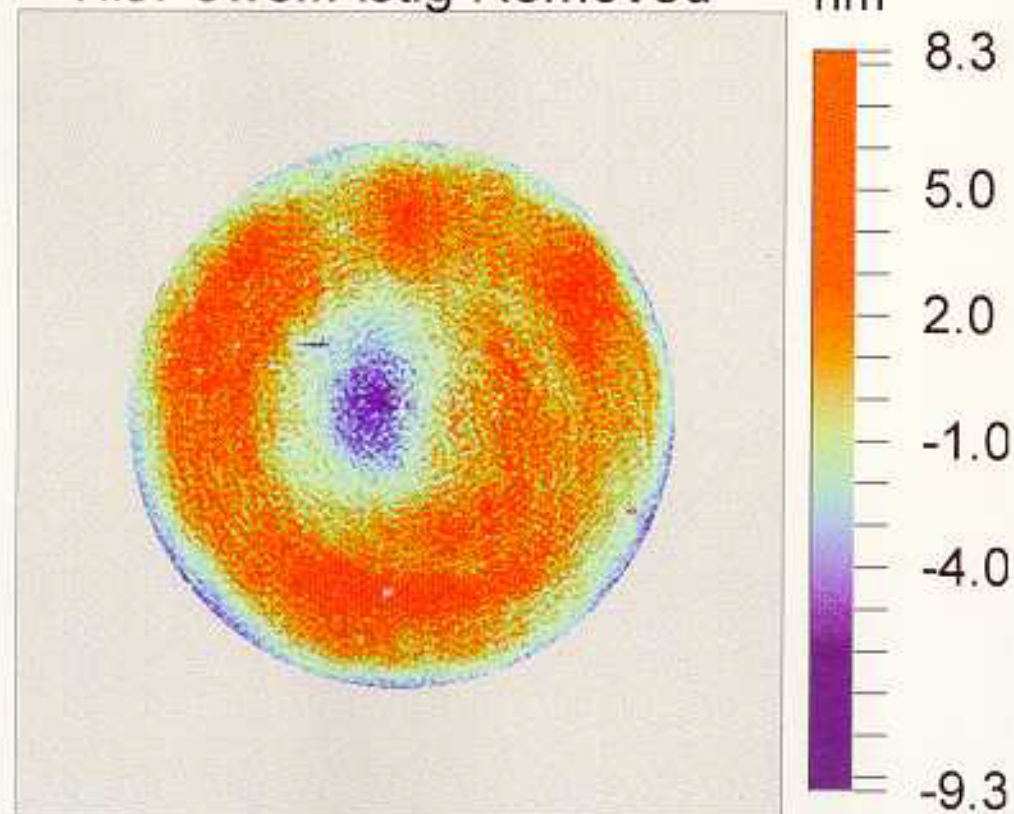
PV: 17.6 nm

RMS: 1.6 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: BS_42R

Date: 10/13/98

Diameter: 200 mm

Astig: 3.0 nm

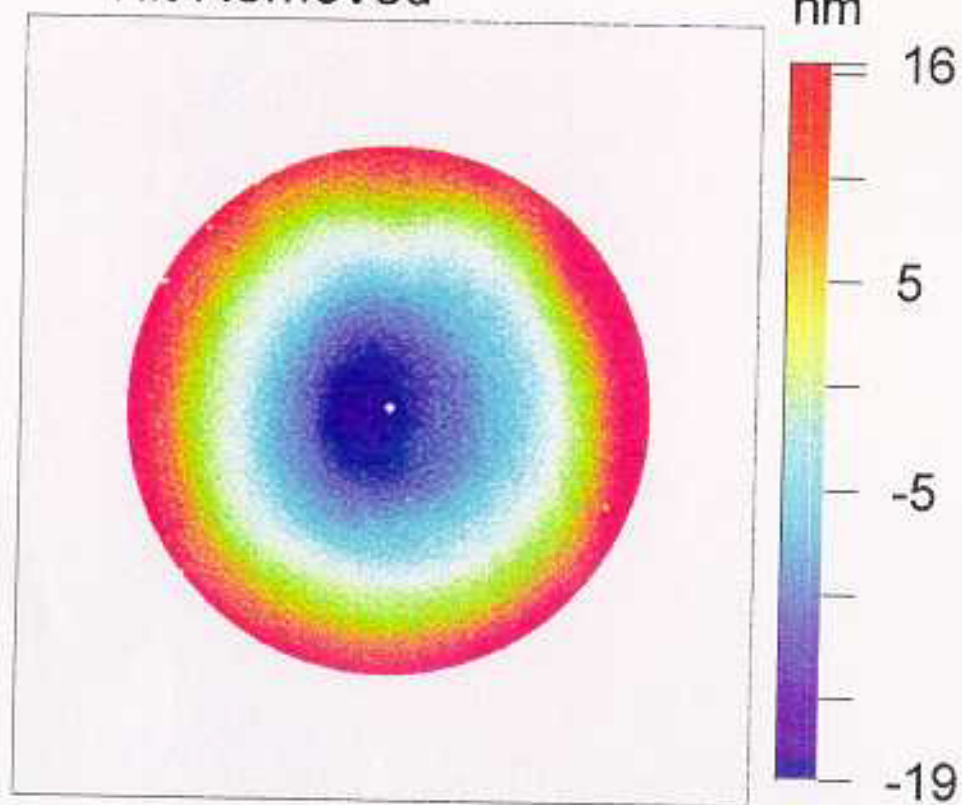
Power: 25.8 nm



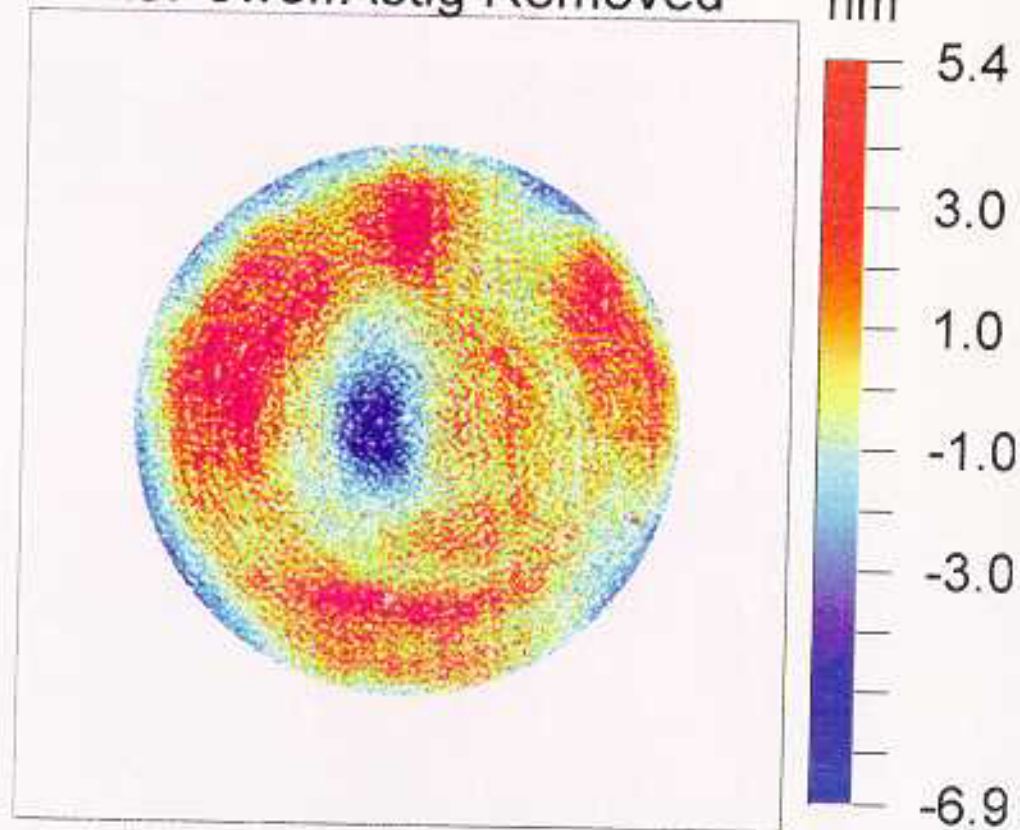
PV: 12.3 nm

RMS: 1.3 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: BS_4TR

Date: 10/13/98

Diameter: 200 mm

Astig: 2.6 nm

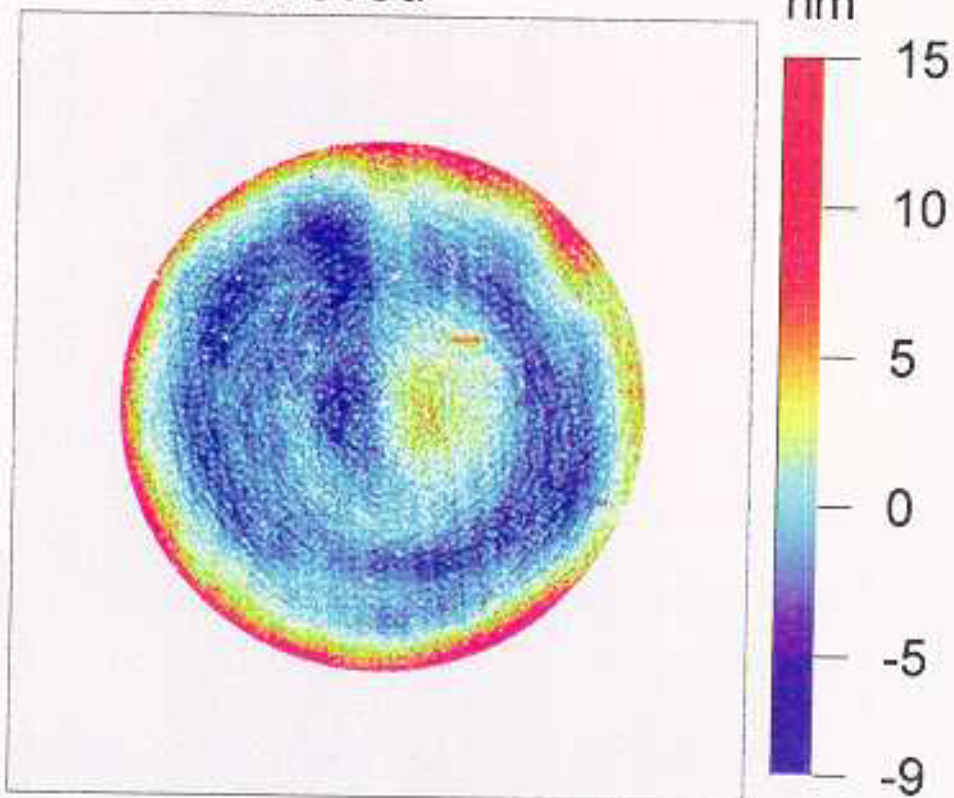
Power: 5.4 nm



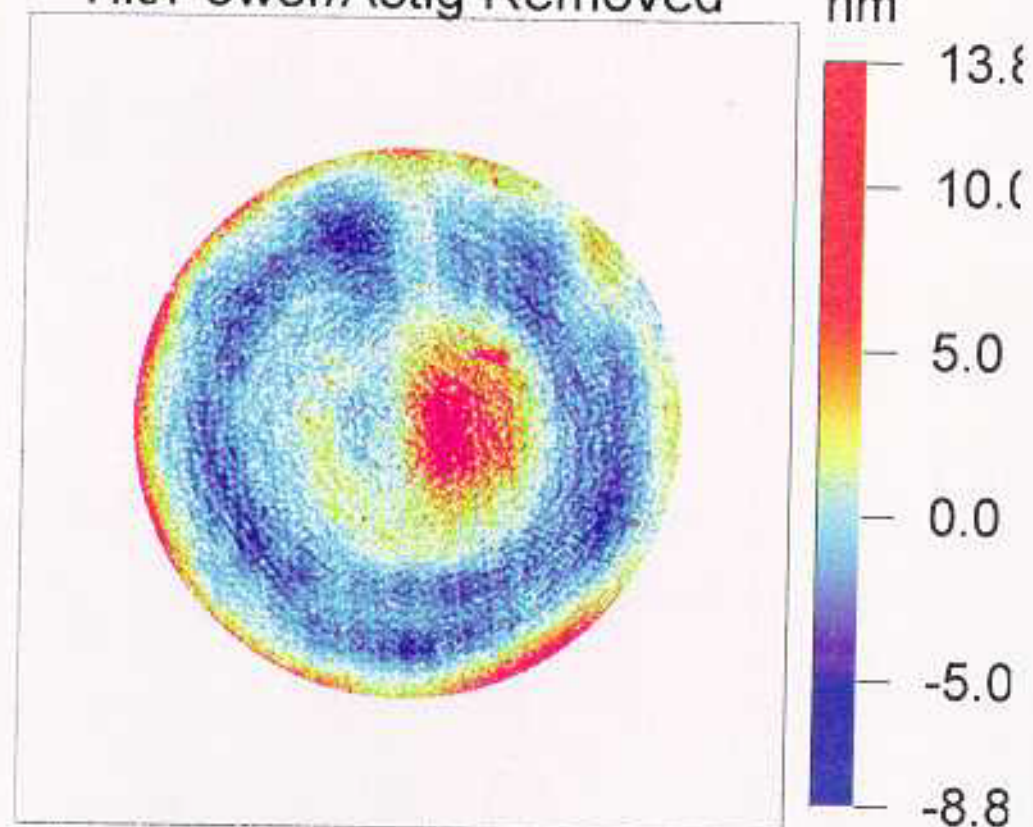
PV: 22.6 nm

RMS: 2.1 nm

Tilt Removed



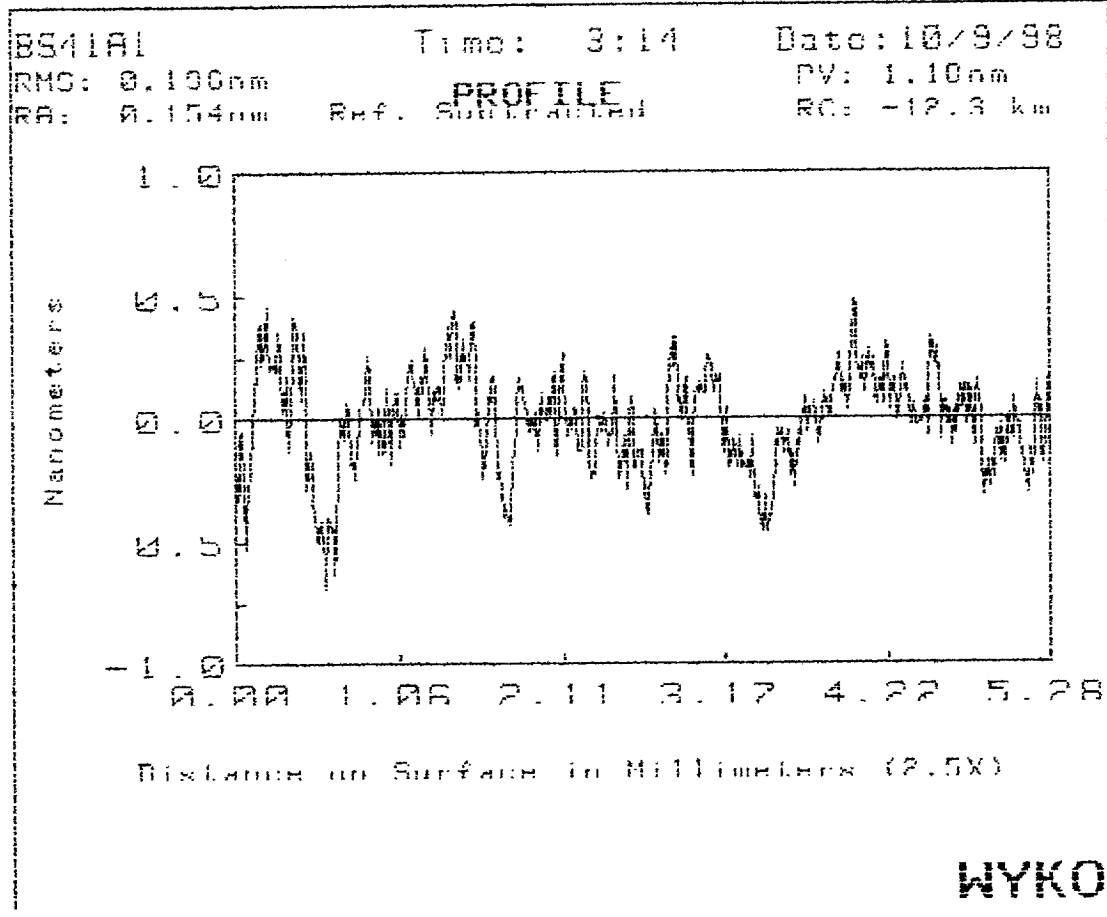
Tilt/Power/Astig Removed



Pol. run # 187

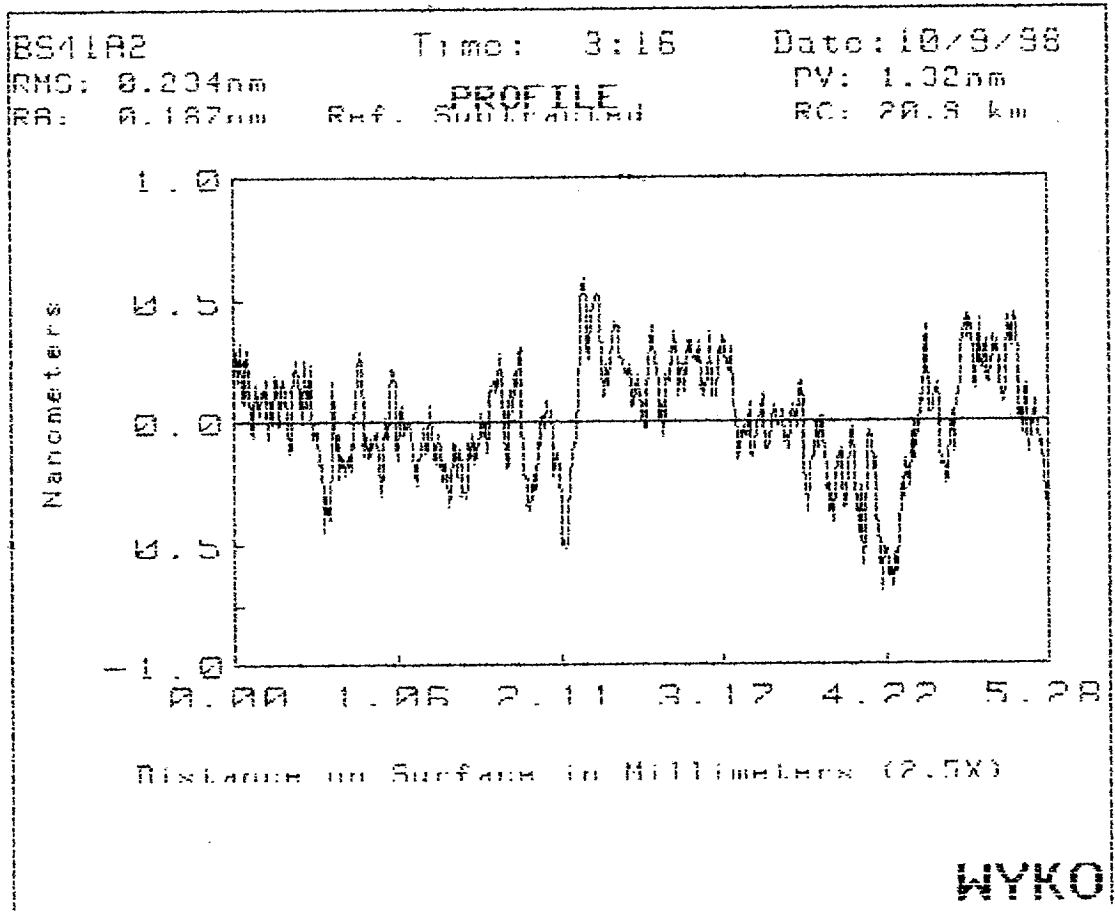
Liqu. 85

R = 11.6 μ m
over ϕ 200 μ m
R = 10.0 μ m
over 80 μ m
Sq = 0.108



LN00022
AL

Attach 3



BS41B1

Time: 3:19

Date: 10/9/98

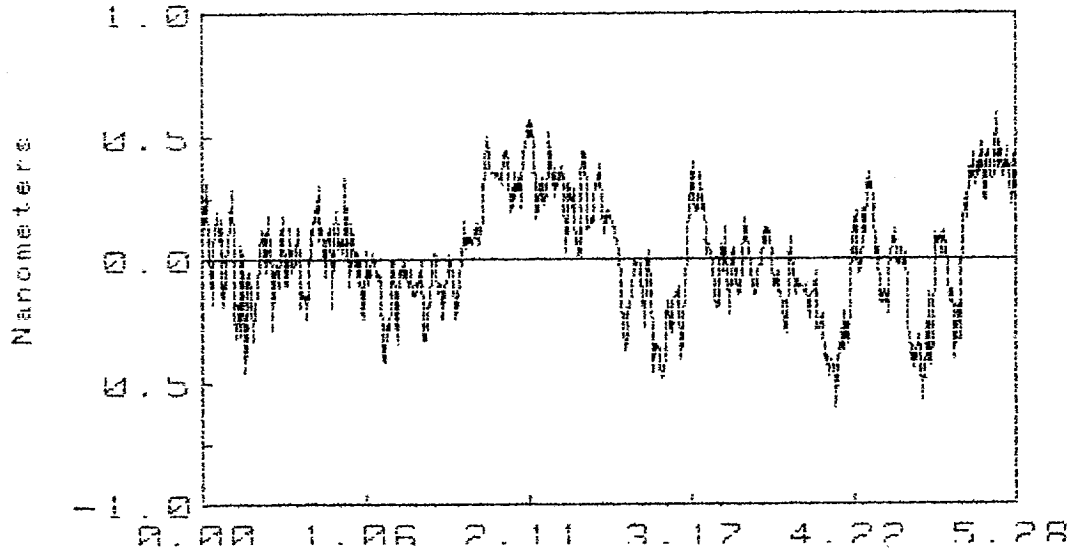
RMC: 0.200nm

PV: 1.20nm

RA: 0.184nm

Ref. PROFILE
SUBSTRATE

RC: 35.0 km



Distance on Surface in Millimeters (2.5X)

HYKO

BS41F1

Time: 3:21

Date: 10/9/98

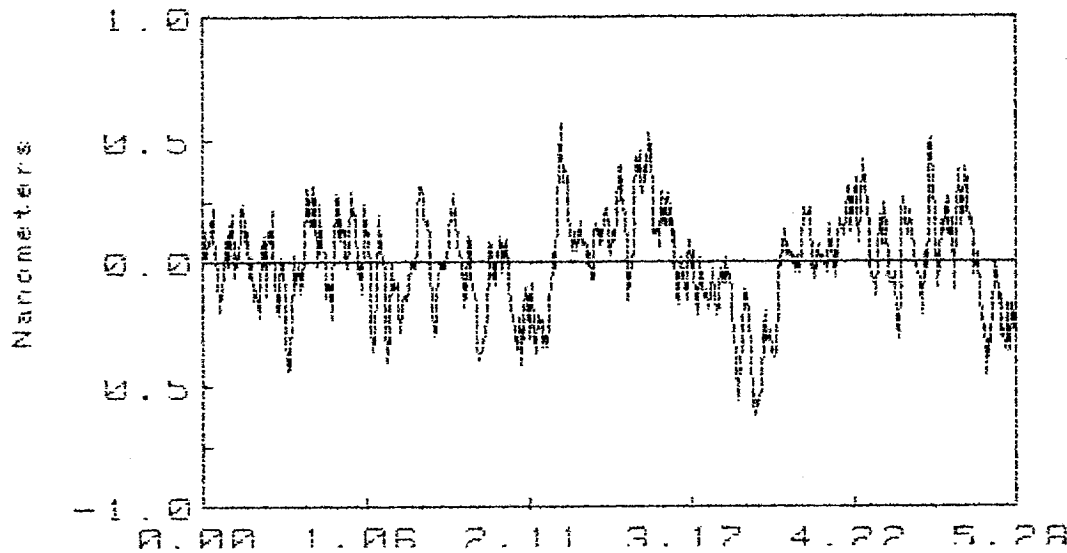
RMC: 0.205nm

PV: 1.10nm

RA: 0.183nm

Ref. PROFILE
SUBSTRATE

RC: -12.4 km

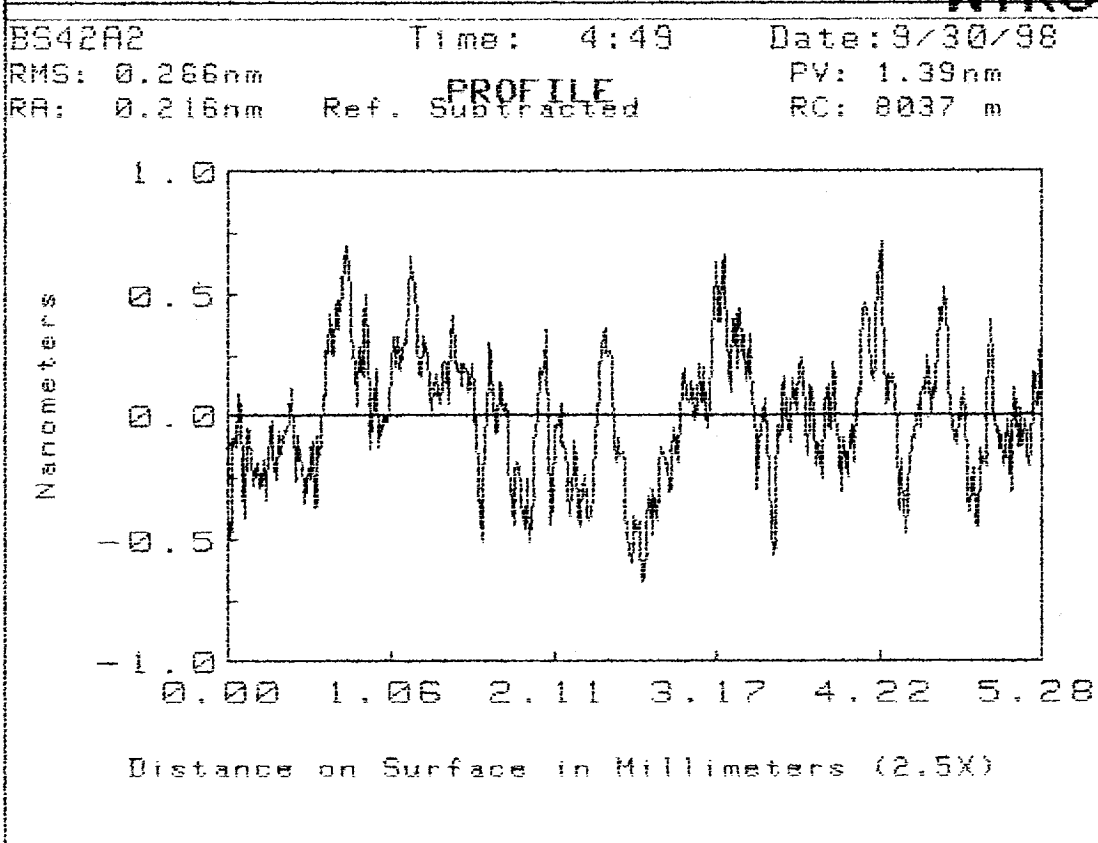
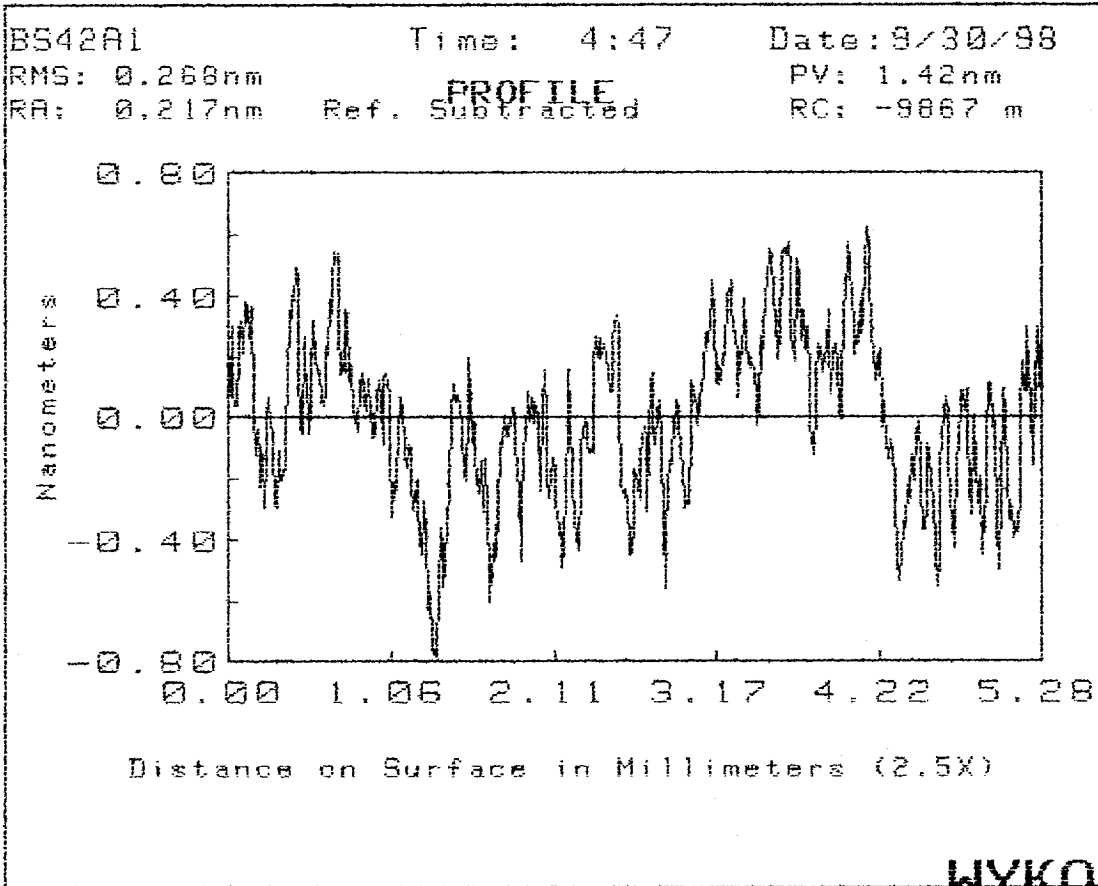


Distance on Surface in Millimeters (2.5X)

HYKO

Pol. run # 176

L94.85



BS42B1

Time: 4:52

Date: 9/30/98

RMS: 0.263nm

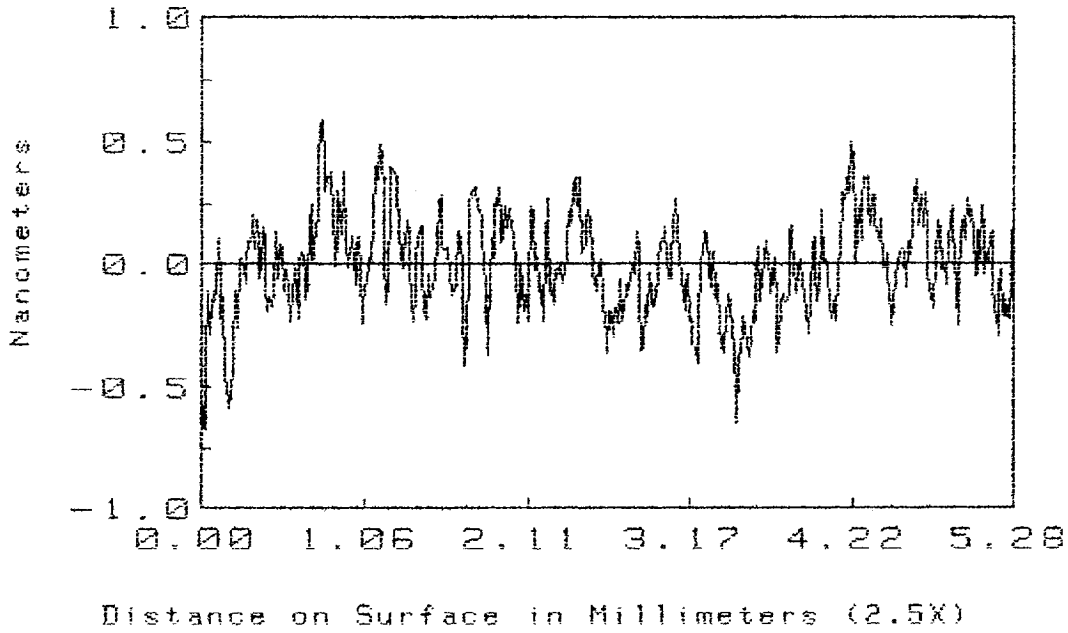
PV: 1.27nm

RA: 0.181nm

Ref. Subtracted

RC: 9014 m

PROFILE



WYKO

BS42F1

Time: 4:54

Date: 9/30/98

RMS: 0.325nm

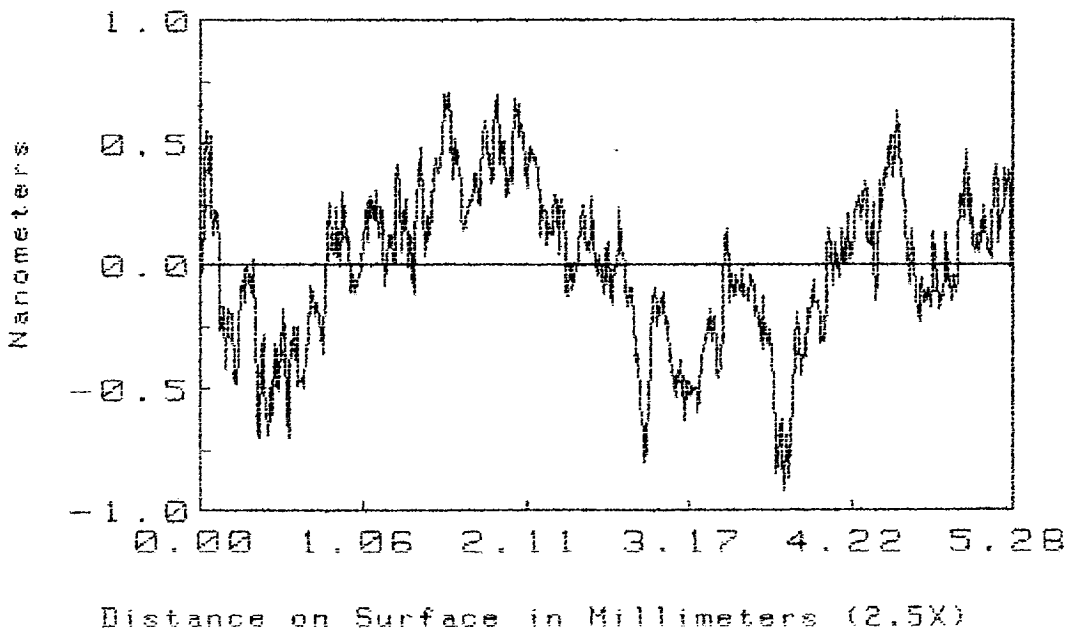
PV: 1.67nm

RA: 0.264nm

Ref. Subtracted

RC: 6610 m

PROFILE



WYKO

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 : 22 Feb 99
- Customer Name, Purchase Order No. : Cal Tech / LIGO PC162519
- Customer Part Number & Revision : LIGO-980069-00-D
- Part Description : Beam Splitter
- REO Job No. : OPT05831 511 0X917
OPS00743 Run No.: 521 0X919
- Qty. Shipped/Lot No. : 2 ea Beam Splitter, B508, B504
2 ea. FS witness PC.

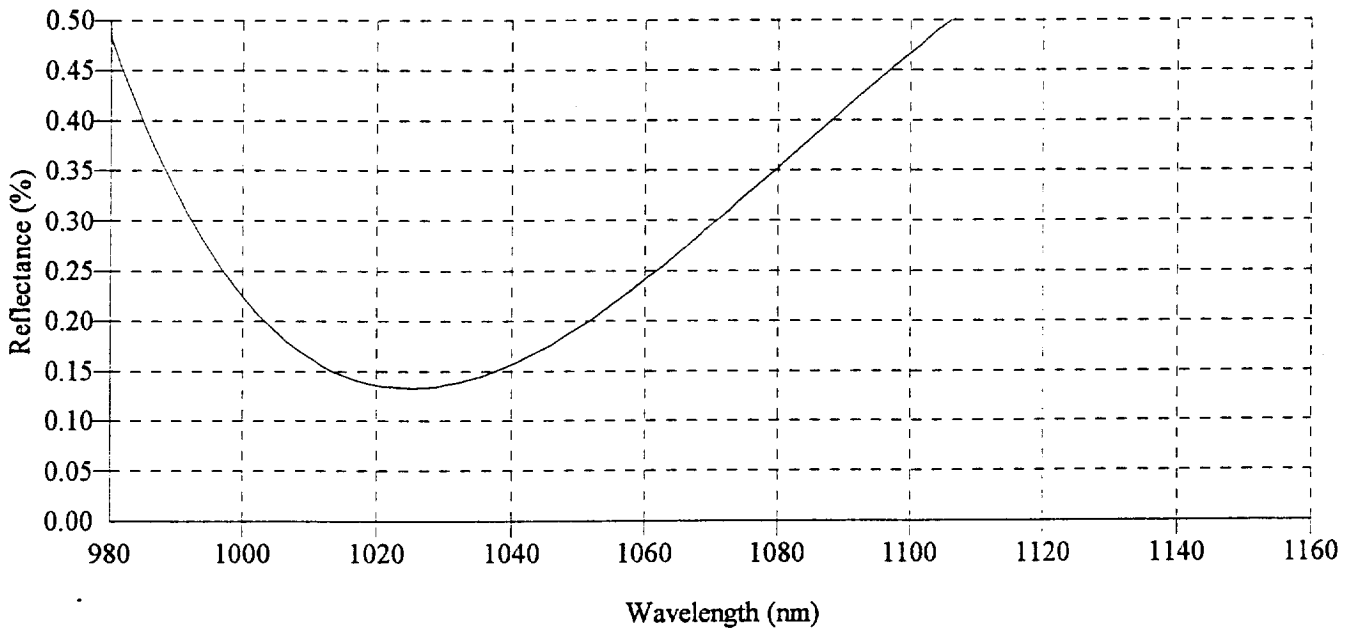
Test data (included)

Comment:

Certified by: [Signature], 2/22/99
Quality Assurance
Verified by: [Signature], 22, Feb, 99
Engr/Tech

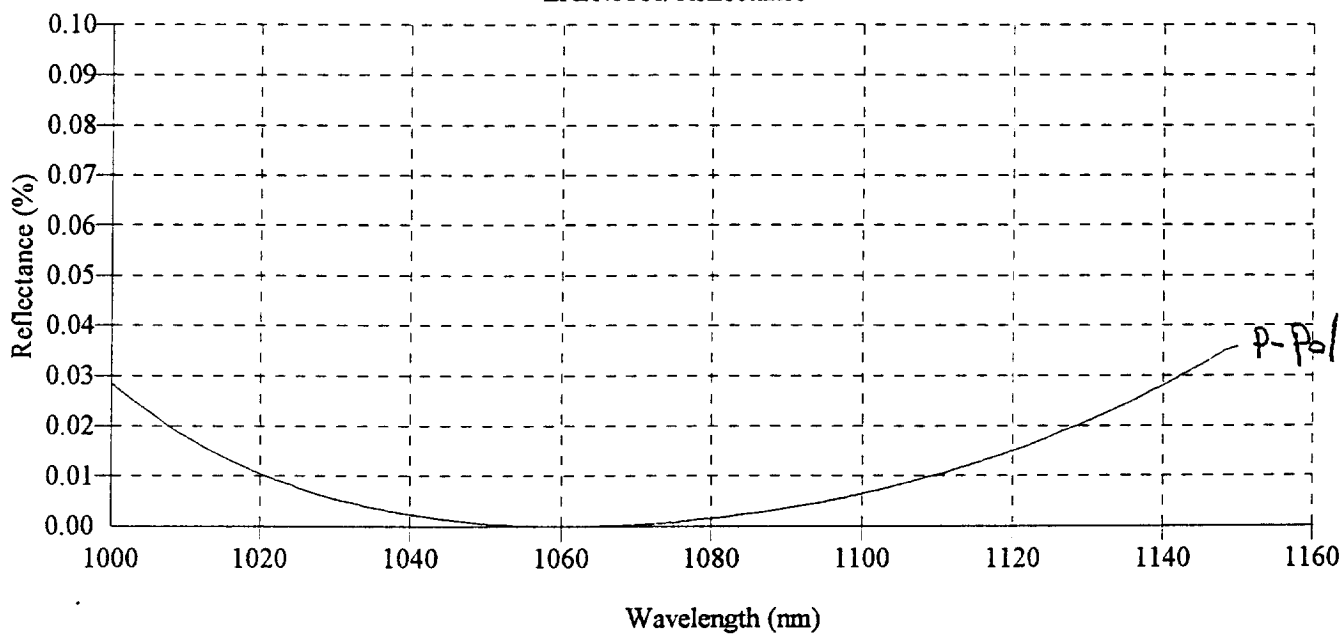
NOTE
Certificate must accompany the package to be shipped or attached to the outside of the same box to which the "Packing Slip" envelope is attached.

LAR45PA: Reflectance



Model of #OX918 @ 0°

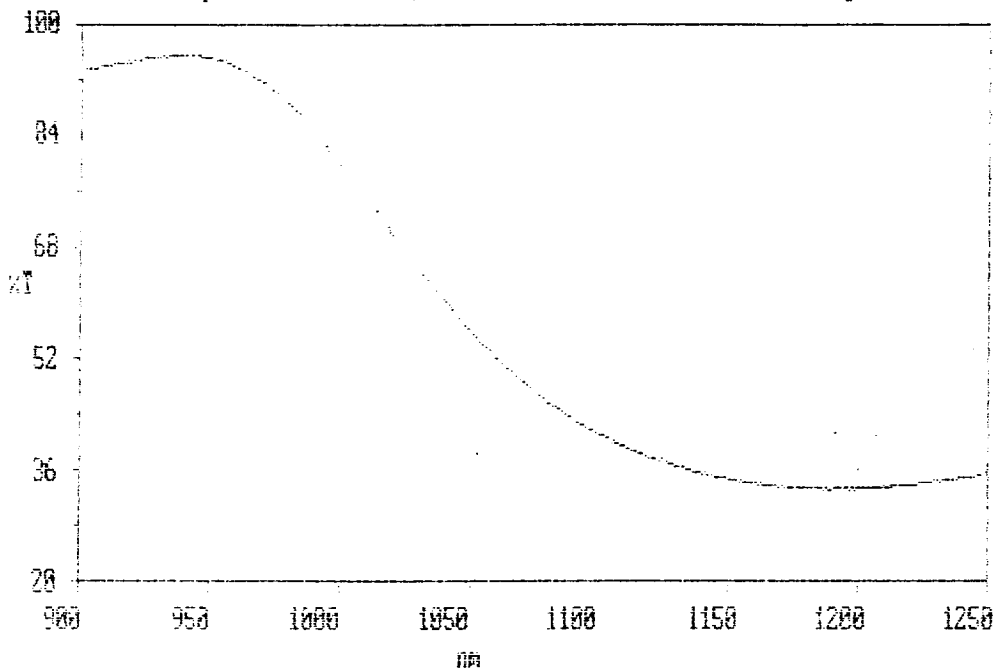
LAR45PA: Reflectance



Model of #0X918 at 45°
witness piece measured
with Laser.

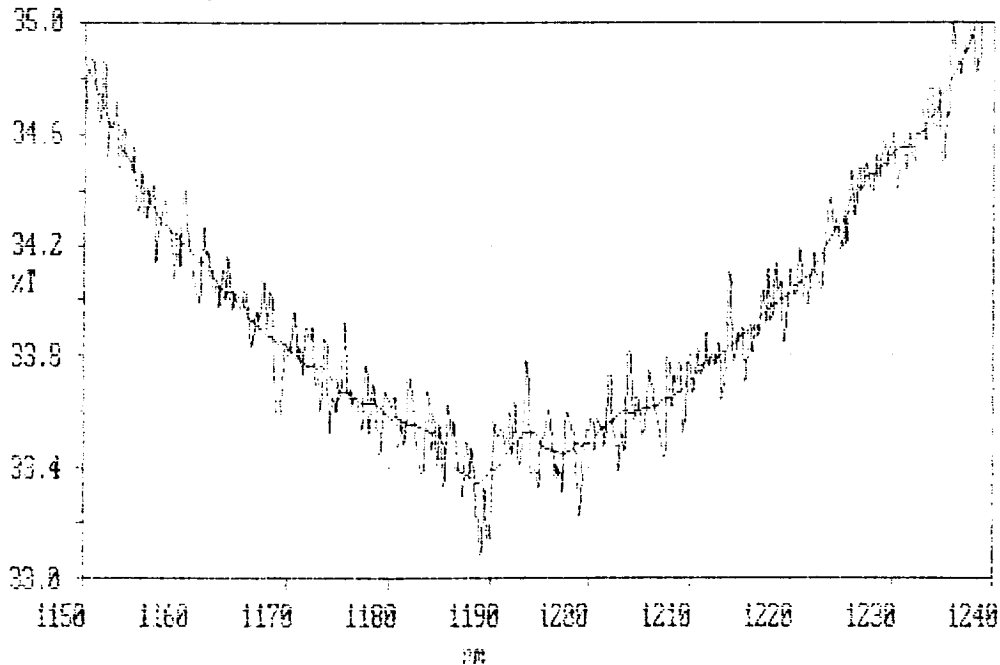
$$R = 187 \text{ ppm @ } 1053 \text{ nm}$$

X: user004; 1250.0 - 900.0 nm; pts 1751; int 0.20; ord 33.885 - 95.870 %T
Inf: #0X917, Beamsplitter for BS03, BS04, baked, 1" FS witness, 0 degree scan

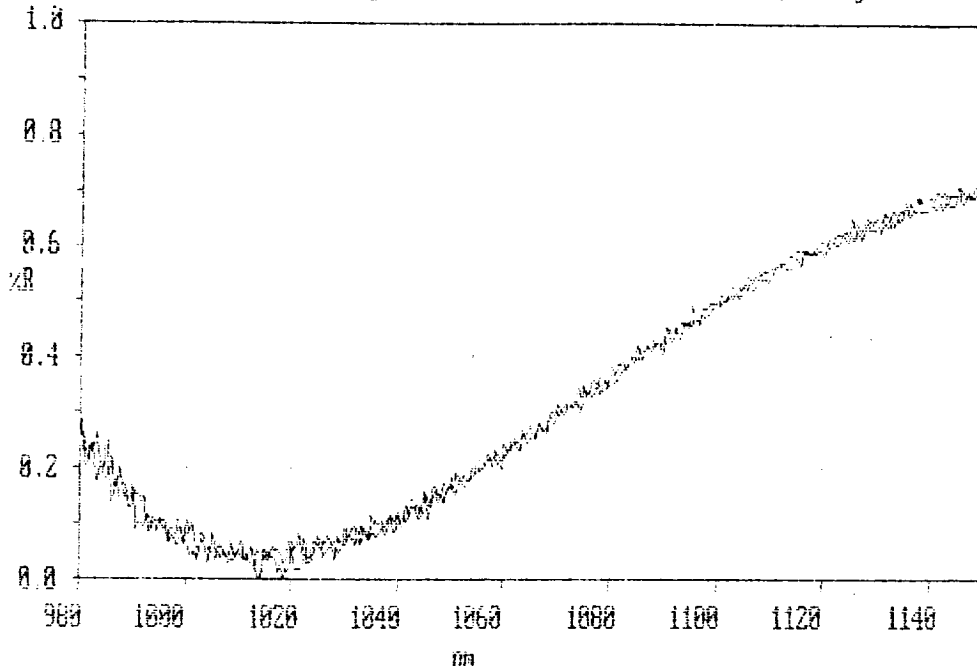


T = 50.5%
R = 49.5%
@ 1053 nm
@ 45°
P-Pol

X: user004; 1250.0 - 900.0 nm; pts 1751; int 0.20; ord 33.358 - 95.689 %T
Inf: #0X917, Beamsplitter for BS03, BS04, baked, 1" FS witness, 0 degree scan



Y: user003; 1150.0 - 980.0 nm; pts 341; int 0.50; ord 0.0177 - 0.7115 %R
Inf: #0X919, AR @ 1064nm, 45 deg, BS03,04, 1" FS witness, baked, 0 deg scan



R = 70 ppm
@ 1053 nm
@ 45°
P-Pol

X: user004; 1150.0 - 980.0 nm; pts 341; int 0.50; ord -0.806 - 0.7183 %R
Inf: #0X919, AR @ 1064nm, 45 deg, BS03,04, 1" FS witness, baked, 0 deg scan

