

BS01-B

LIGO-T990134-00-D

BLANK

A. DCN: LIGO- T970200-00-D LIGO DETECTOR OPTICS
B. LIGO S/N: BS01 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: Hereaus/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 9031
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 birefringence or inclusion map

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. Samples sent 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.) Thickness not in spec. OK (S)

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.

OH content not reported

Serial number incorrectly marked - wrong serial number

SKETCHES:

DISPOSITIONS:

12-30-97 Received additional data packages & OH-content report

LIGO Component Specification Verification Sheet Mirror Blanks, Beam Splitter

		Serial Number: BS Ø1	Specification	Reported Value	✓
		Mirror Blanks, Beam Splitter	Requirements	Physical Dimensions	LIGO-D960793
Diameter	256mm +1.0mm, -0mm			256.7mm	✓
Thickness	61mm +1.0mm, -0mm			52.84	* ✓
Chamfer	2.0mm Max 2pl			—	
Clear Aperture	Central 235mm			—	
Material	Fused Silica Suprasil #3980 3115			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	No
Defect Depth	< 0.5mm			Hand Sketch w/location & dim.	
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 3½ 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	✓

Blnk_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 9031
Marking : 960095-IM 13 - B501 *BN 5061*

Diameter : 256,7mm
CA Diameter : $\varnothing 200 \text{ mm} = 1,3 \times E^{-6}$
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 $\varnothing 200 \text{ mm} \leq 5 \text{ nm/cm}$
Homogeneity : see Interferogram
Striae Grade : A
Granularity : none
Remark : Test Sample ($\varnothing 25 \times 25 \text{ mm}$) with the same marking

POL - Qualitätsprüfung Optik

Date : 06.10.1997

Inspector : Wink

Heraeus
QUARZGLAS

POL-QW

Order Nr.: 94908401 Pos.: 2

Ø 256,7 mm x 52,84 mm

Quality: Suprasil 311

Plate No.: 960095-M13 / 5061

Date: 6.10.97

Inspector: 



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

TBCS=

mm²
/100cm³

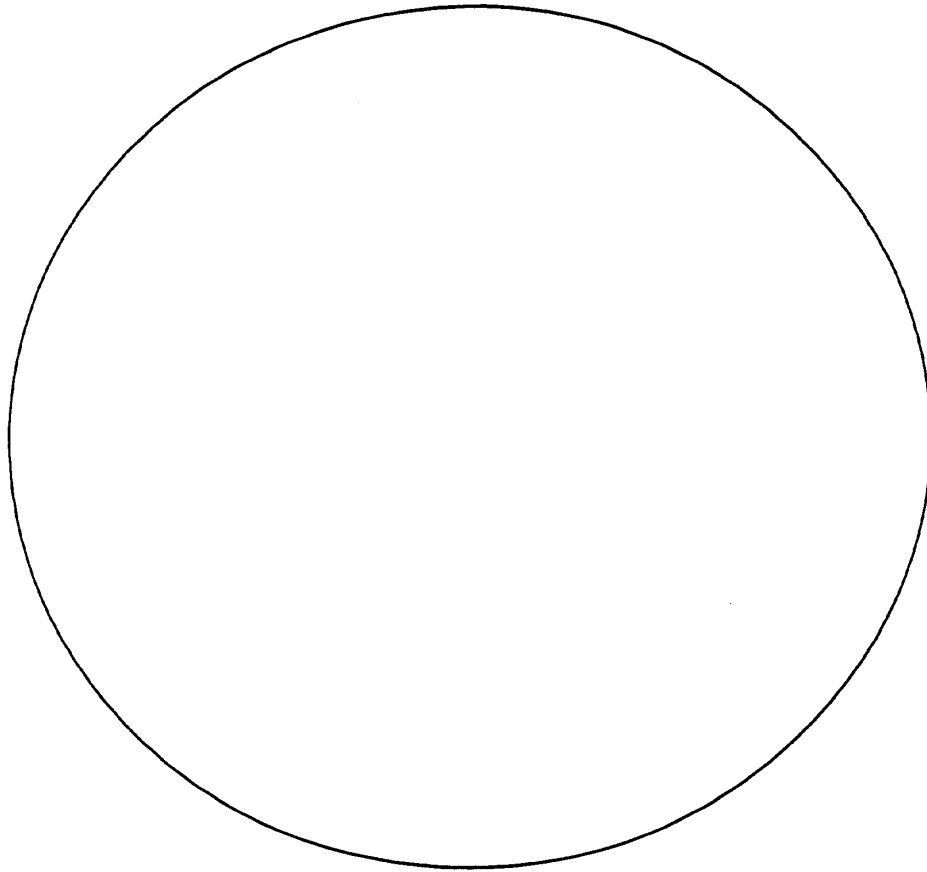
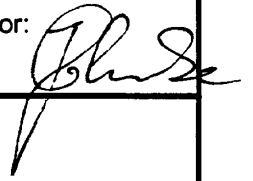
Heraeus
QUARZGLAS

POL - QW

Order No.: 94908401 Pos.: 2
Ø 256,7 mm x 52,84 mm
Plate No.: 960095-1M13/5061
Residual strain- Report

Date: 6.10.97

Inspector:



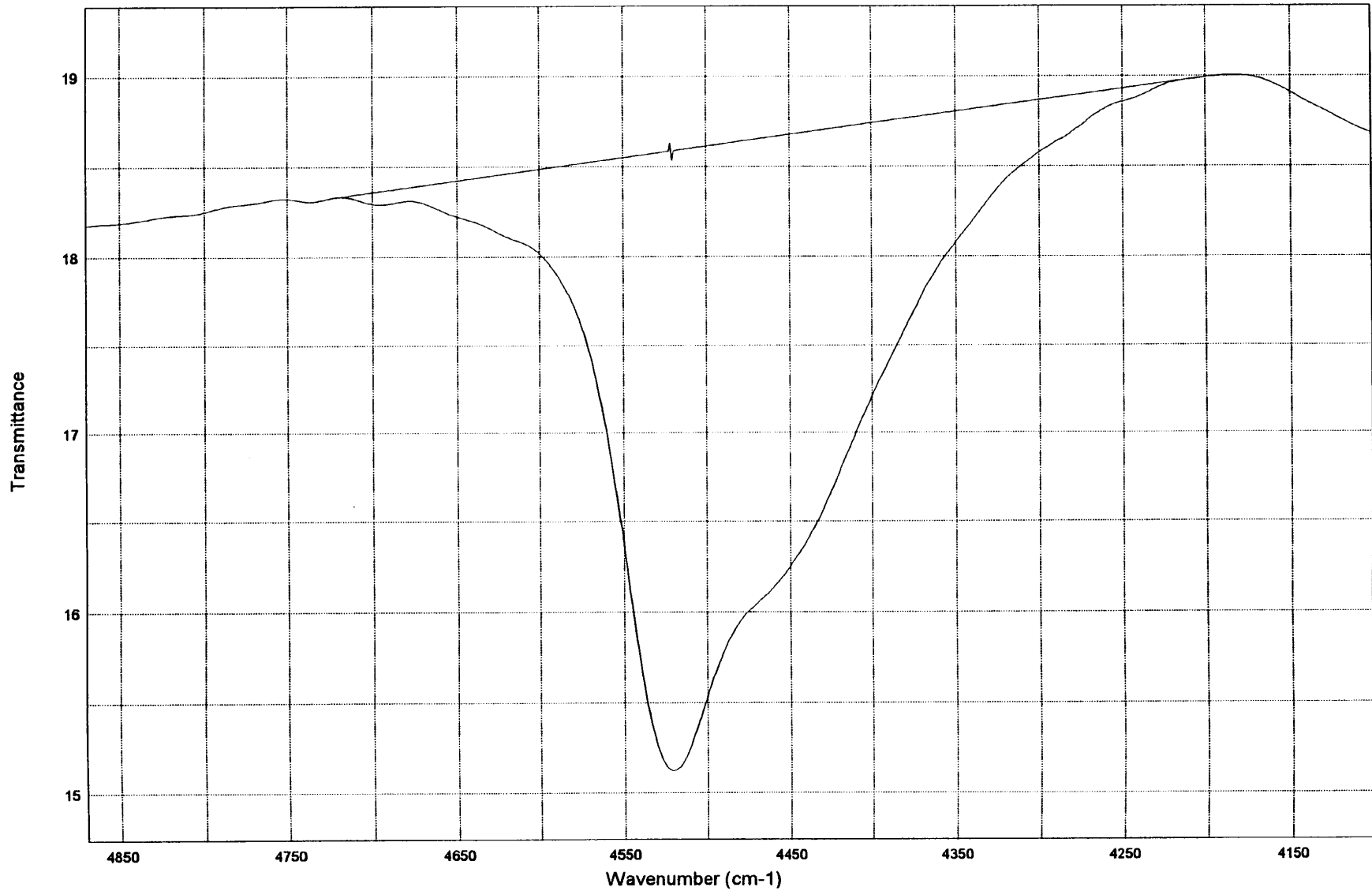
Edge	Center						Pos.
10							nm
2	<1						nm/cm

I0=18.5863 , I1=15.1238 at x=4521

OH-content: 153.9 ppm

Heraeus
QUARZGLAS

MEASURE NO. : ~~6857A~~ 5061
DATE : 07.10.1997 TIME : 15:00
MEASURE START : 10000 1/cm
MEASURE END : 2500 1/cm
OP-DISK-PATH LENGTH : Fisch-215-PL: 2.56 cm / Order No.: 99303974 / Material: Ligo Suprasil 311—OH-content: 153.9 ppm at x=4521



Heraeus
QUARZGLAS

POL-QW

Data taken at 632.8 nm

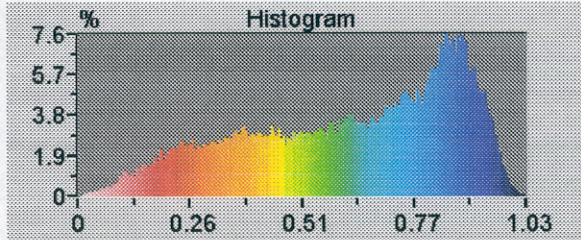
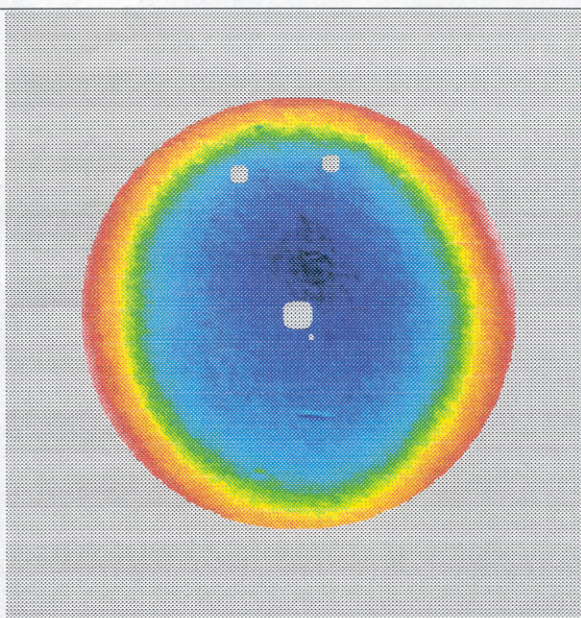
Date: 22.09.97 Operator: Da
ID: 506100 No.:

HQS-Order-No.: 98492874

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

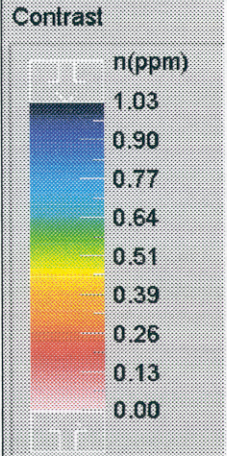
Thickness: 52.8 mm
sample diameter: 280.0 mm
CA diameter: 200.0 mm
examined diameter: 200.3 mm

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



Sub. Terms	Magn.	Angle
X Tilt	0.1255	-77.5915
Focus	-0.3975	
Astigm.	0.1112	11.3624
Coma	0.0623	74.0049
SA3	-0.0961	

Phase Data
Unit: n(ppm)
PV: 1.03
RMS: 0.240
Scale: 0.5

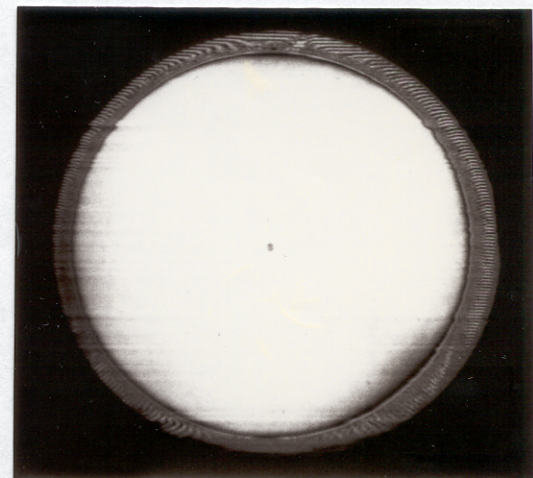
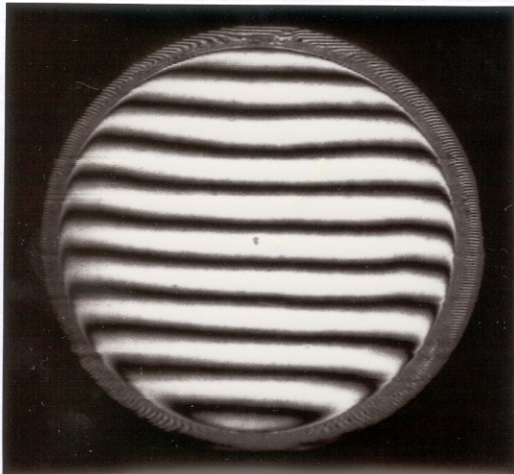


Reset
UpperL: 1.028
LowerL: 0.000

File: 506100.dat, 22.09.97, 15:52

XPS-12"

BSØ1



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: 0000020 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-T970200-01-D

LIGO DETECTOR OPTICS

Page ___ of ___

B. LIGO S/N: BS01-BIncoming 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: CSIROE. Core optic Material: BS / FM / 2ITM / 4ITM / ETM / RM F. Date Received: 10-01-98G 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 sheetJ 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 EngineerL 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>250.96</u>	mm
<input checked="" type="checkbox"/>	Inspection of material thickness	Thickness	<u>1.46</u>	in	<u>39.96</u>	mm
<input checked="" type="checkbox"/>	Wedge Angle	<u>1° 0'</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.

Sent for repolish 8-14-98

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.) _____

Returned to CSIRO for re-polish (8-14-98) - see H. Armandula

SKETCHES:

See scratch drawing from CSIRO for Locations.

DISPOSITIONS: _____

		Serial Number:	Specification	Reported Value	✓
				BSØ1-B	
Substrate, Beam Splitter	Surface 1	Surface Figure Over Central 200mm dia.	Flat		
		Radius of Curvature	> 200 km convex > 720 km concave	-7200 Km (-0.7 nm)	✓
		Astigmatism	< 16nm p-v	-6.4 nm	✓
	Surface 2	Surface Figure Over Central 200mm dia.	Nominally Flat		
		Radius of Curvature of the Wavefront	> 140 km convex > 500 km concave	140 Km (35.7 nm)	✓
		Astigmatism	< 23nm p-v	9.0 nm	✓
	Surface Errors	Low Spatial Frequency Band Central 80mm	$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 1.6\text{nm}$	0.7 nm	✓
		Low Spatial Frequency Band Central 200mm	$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 3.2\text{nm}$	0.9 nm	✓
		High Spatial Frequency Band Central 80 & 200 mm	$\leq 4.3 - 7,500 \text{ cm}^{-1}$ $\sigma_{\text{rms}} < 0.4\text{nm}$	0.19nm - 0.20nm	✓

		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). < 55,000	Hand Sketch w/dimensions	✓
		The total area of scratches outside the central 80 mm diameter shall not exceed 750×10^3 square micrometers. < 150,000	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



Telecommunications & Industrial Physics

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Lindfield NSW 2070
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Facsimile +61-2-9413 7631

Dennis N Cooper BE PhD FTS
Chief of Division

10 July 1998

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

Purchase Order PC167159

Please find enclosed one of the deliverables under the above purchase contract:

- Certification package for BS01.

I would appreciate it if this could be forwarded to Garilynn Billingsley.

Regards

A handwritten signature in black ink, appearing to read "Chris Walsh".

Chris Walsh

LIGO Certification Report

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

Serial number: BS01-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 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:	BS1B1.zip	(Side 1)	BS1B2.zip (Side 2)
			BS1B2A.zip (wave front)
TOPO data: (2.5X)	T2BS11A.asc	(Side 1)	T2BS12A.asc (Side 2)
	T2BS11B.asc		T2BS12B.asc
	T2BS11C.asc		T2BS12C.asc
(40X)	T4BS11A.asc		T4BS12A.asc
	T4BS11B.asc		T4BS12B.asc
	T4BS11B.asc		T4BS12C.asc

LIGO Certification Report **Physical Dimensions**

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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]

Physical Quantity	Result
Diameter	250.96 mm
Cylindricity	0.02 mm
Thickness (maximum - for FM, RM, ETM) (minimum - for BS)	39.96 mm
Bevel as per drawing (height, angle):	(S1) Height:2.07 mm Angle:45 ⁰ 15' (S2) Height:2.11 mm Angle:44 ⁰ 39'
Wedge angle:	1 ⁰ 0'
Location of registration mark (\pm angle with respect to minimum part thickness):	+3'
Location of other 3 marks (with respect to registration mark at minimum thickness)	89 ⁰ 59', 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
10 July 98

Chris Walsh

Date:

LIGO Certification Report Side and Bevel Polish

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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"*).

No defects observed

11. Certification

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

Project Manager:



Chris Walsh

Date:

10 July 98

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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
10 July 98

Chris Walsh

Date:

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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	<55,000	<150,000
Surface 2	nil	nil	<7,000	<11,000

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
10 July 98

Chris Walsh

Date:

BSOI SIDE!

Thin

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

THIN
BS01 SIDE 2

0001

0002

0003

0004

0005

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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/0137-01 p.50
8	Team member responsible for measurement/inspection:	D Farrant
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	>-7200 (-0.7 nm)	-6.4	BS1B1.zip
Surface 2	140 (35.7 nm)	9.0	BS1B2.zip
Wave front*	>500 (9.6 nm)		BS1B2A.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 9.6 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:


10 July 98

Chris Walsh

Date:

LADI CERTIFICATION DATA

Title: BS_11

Date: 06/25/98

Diameter: 200 mm

Astig: -6.4 nm

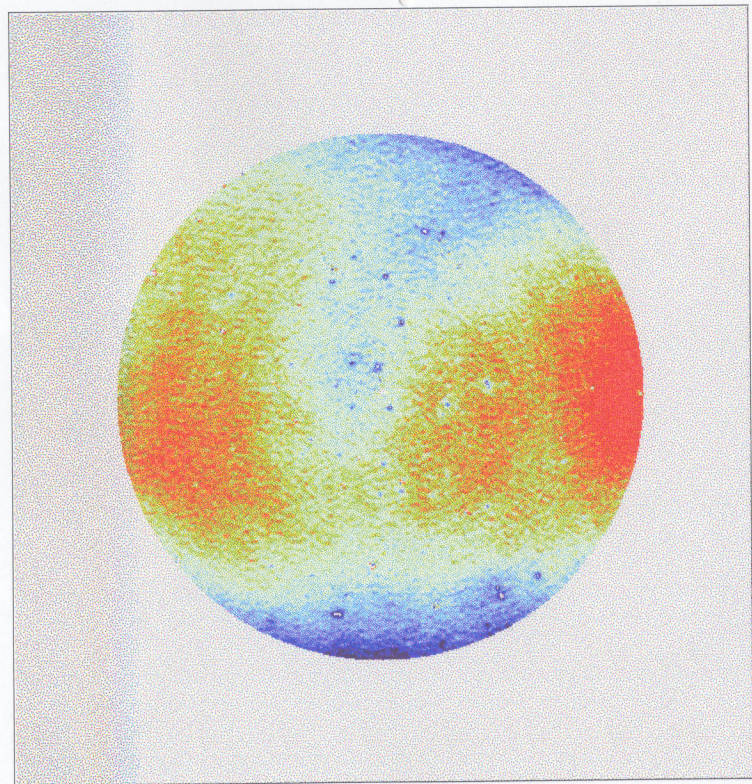
Power: -0.7 nm



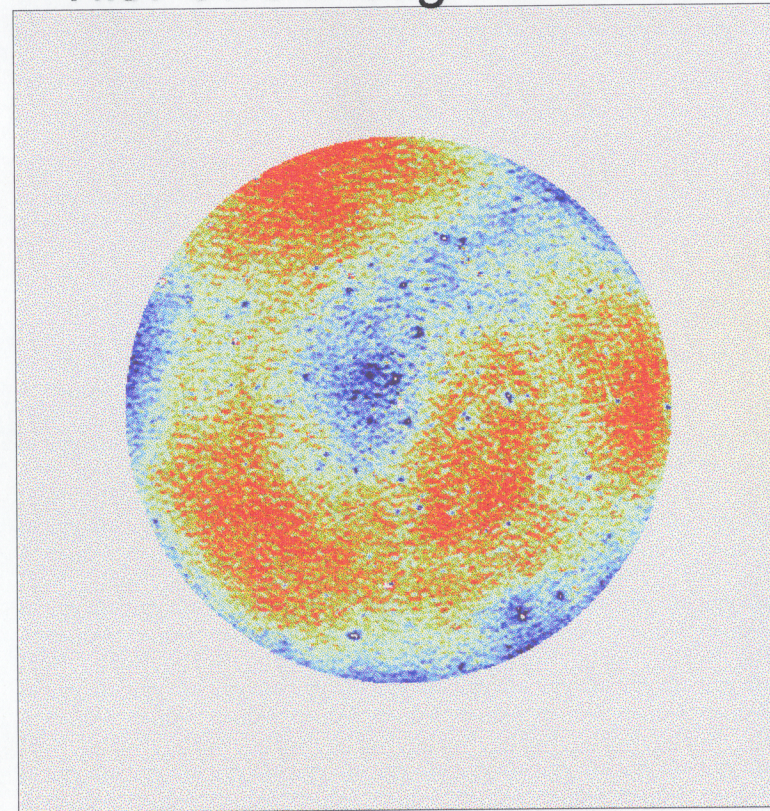
PV: 10.0 nm

RMS: 0.9 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: BS_12

Date: 06/25/98

Diameter: 200 mm

Astig: 9.0 nm

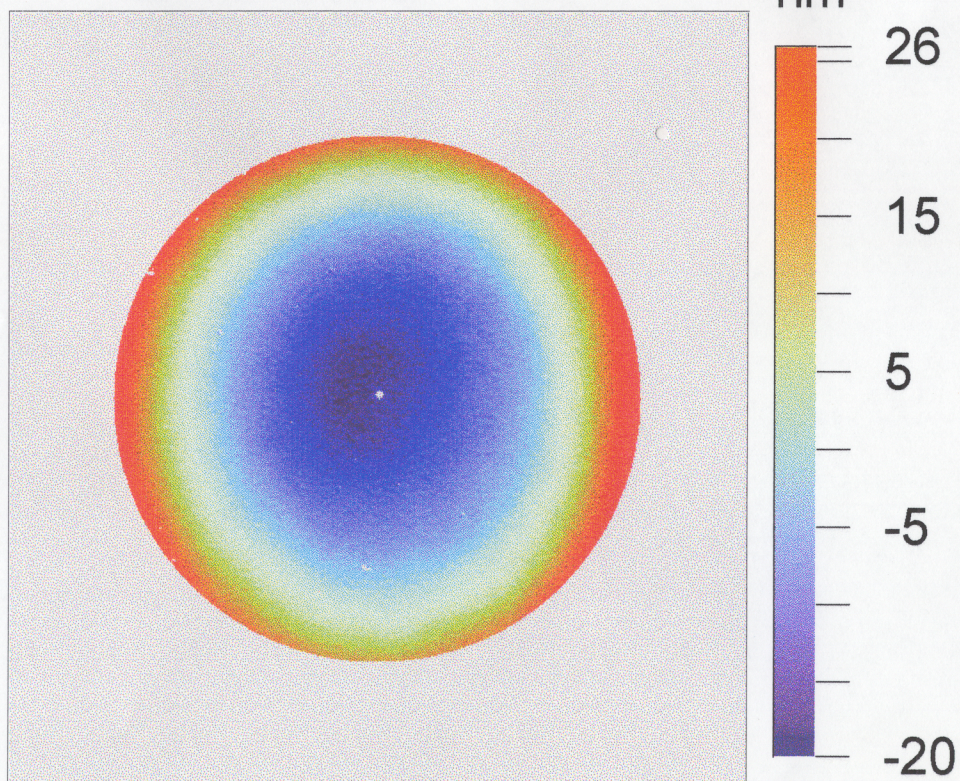
Power: 35.7 nm



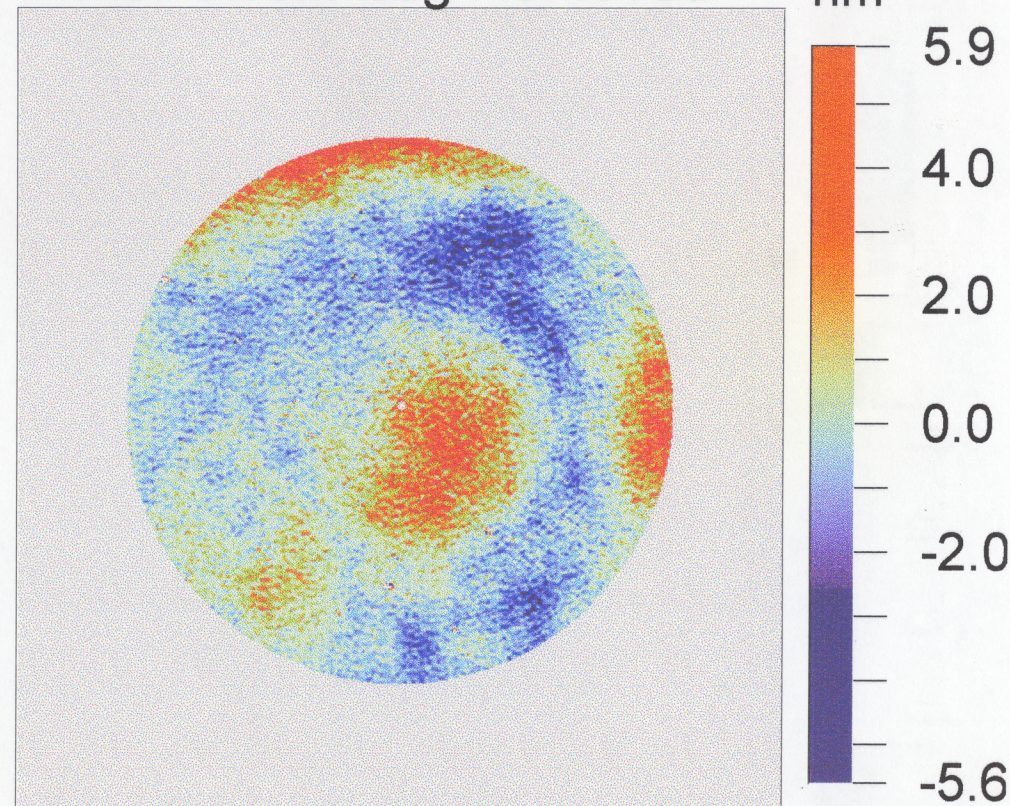
PV: 11.5 nm

RMS: 1.1 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: BS_1T

Date: 06/25/98

Diameter: 200 mm

Astig: 4.1 nm

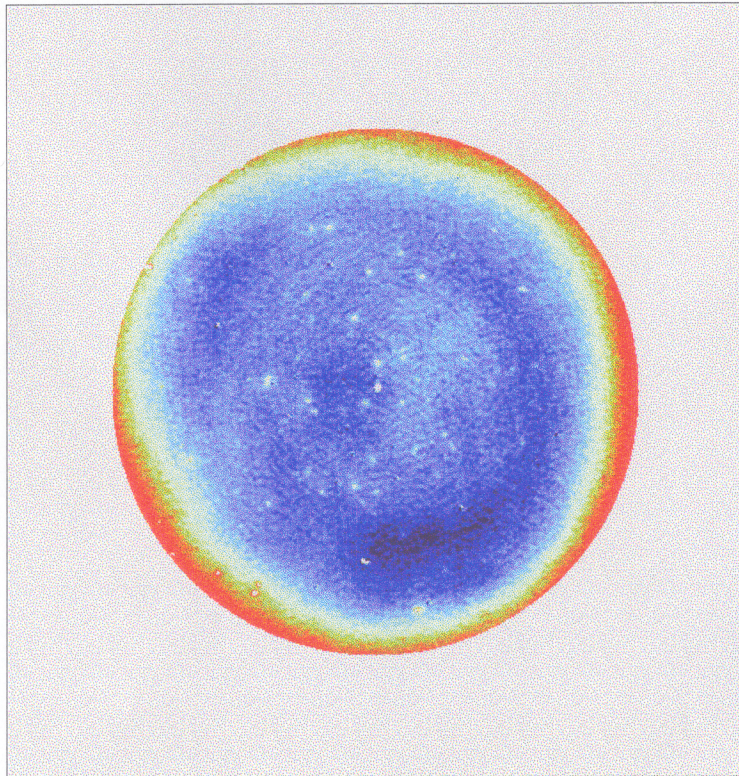
Power: 10.3 nm



PV: 18.4 nm

RMS: 2.4 nm

Tilt Removed



nm

15

10

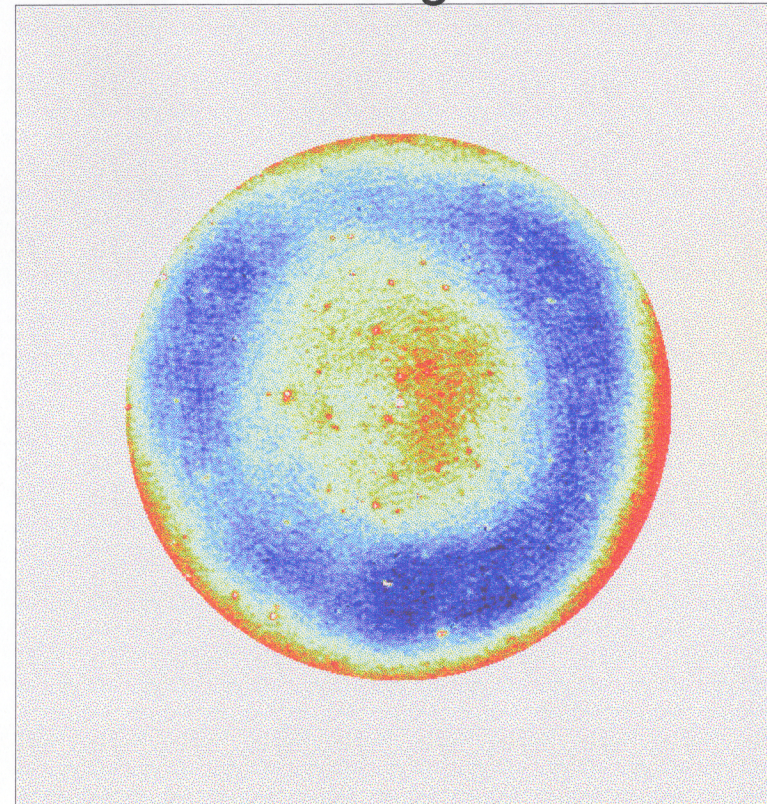
5

0

-5

-9

Tilt/Power/Astig Removed



nm

10.4

7.0

4.0

1.0

-2.0

-5.0

-8.1

LIGO Certification Report Surface Errors - Low

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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/0137-01 p.50
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	0.7	0.9
Surface 2	0.6	1.1

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
10 July 98

Chris Walsh

Date:

LIGO Certification Report **Surface Errors - high**

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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)	Data were analysed using PC-based software routines rather than HP-based routines.
7	CSIRO Log Book Reference	<i>LLN/091</i>
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: 0.19

Side 2: 0.27

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

Side 1: 0.20

Side 2: 0.28

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

	A	B	C	D	E	F	G	H
Surface 1	0.20	0.18	0.20	0.18	0.19	0.20	0.21	0.23
Surface 2	0.26	0.28	0.28	0.29	0.27	0.28	0.32	0.30

Two - dimensional surface maps at three central locations are available at the CSIRO ftp site under filenames of the form TMBS0YZA.asc, where M is the objective used (M=2 for 2.5X, 4 for 40X), BS 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:

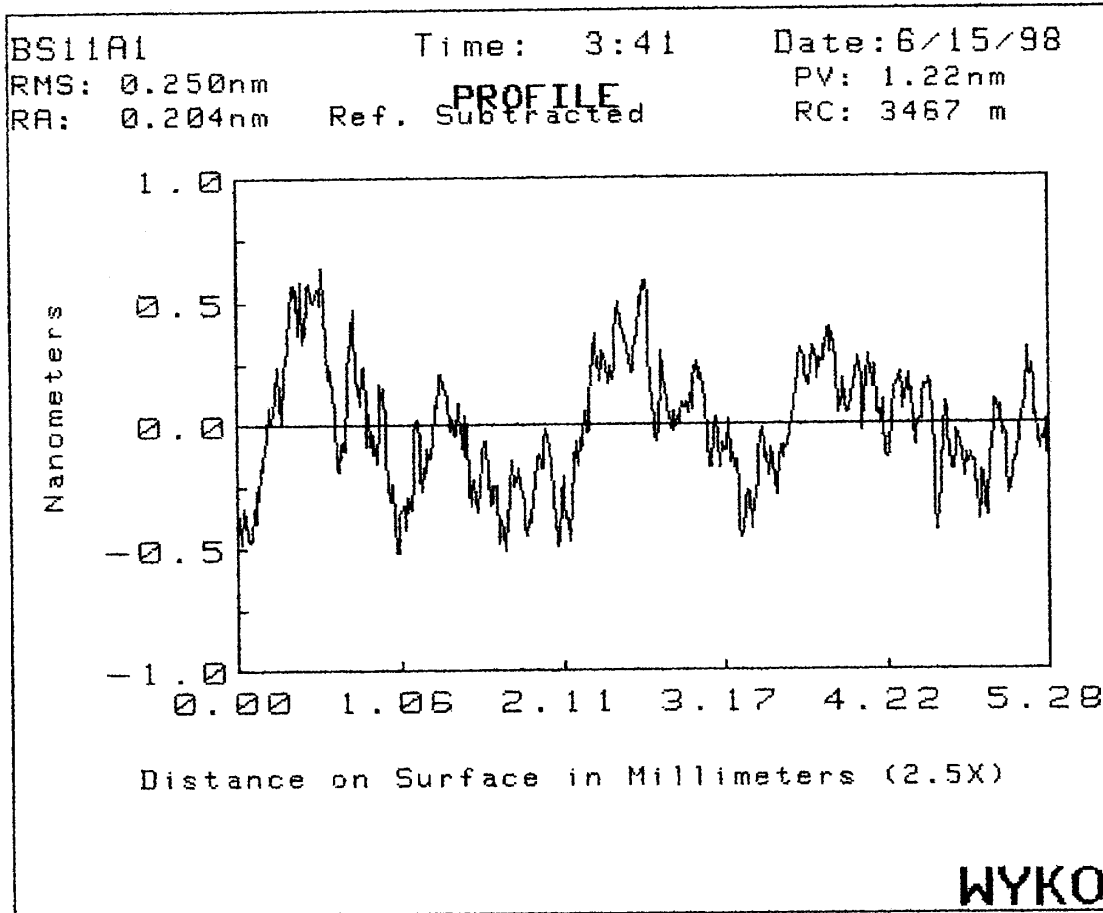


Chris Walsh

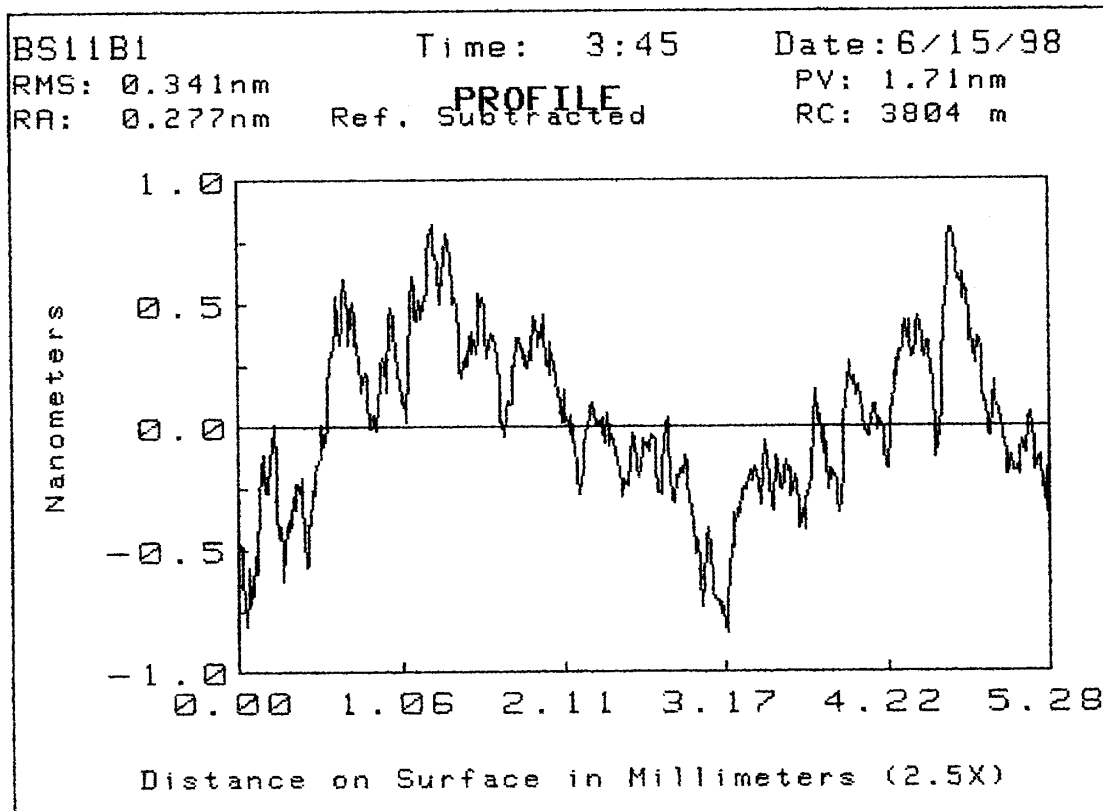
Date:

10 July 98

T2BS11A.asc

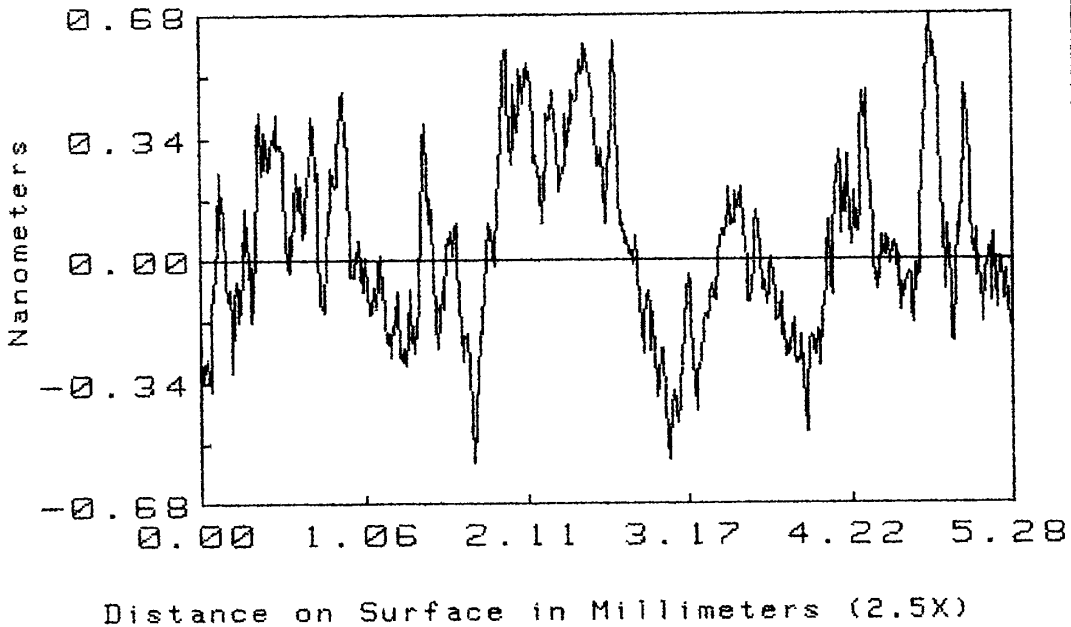


T2BS11B.asc



T2BS11C.25C

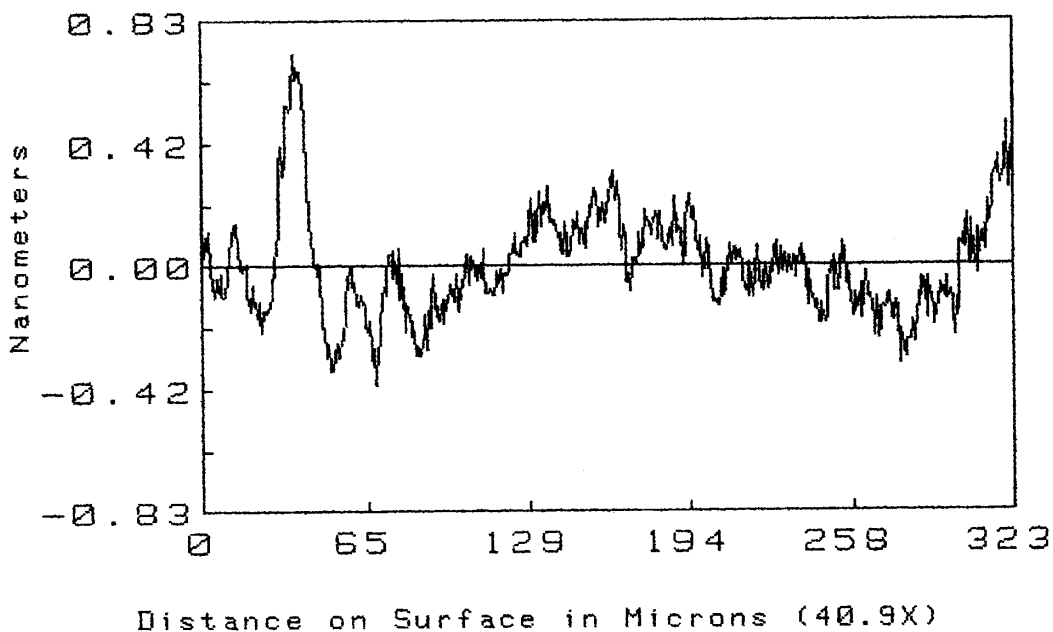
BS11C1 Time: 4:19 Date: 6/15/98
RMS: 0.256nm PV: 1.32nm
RA: 0.208nm Ref. Subtracted RC: 8487 m



WYKO

T4BS11A.25C

BS11A4 Time: 14:35 Date: 6/15/98
RMS: 0.177nm PV: 1.24nm
RA: 0.134nm Ref. Subtracted RC: -35.8 m



WYKO

1455110.asc

BS11B4

Time: 14:39

Date: 6/15/98

RMS: 0.091nm

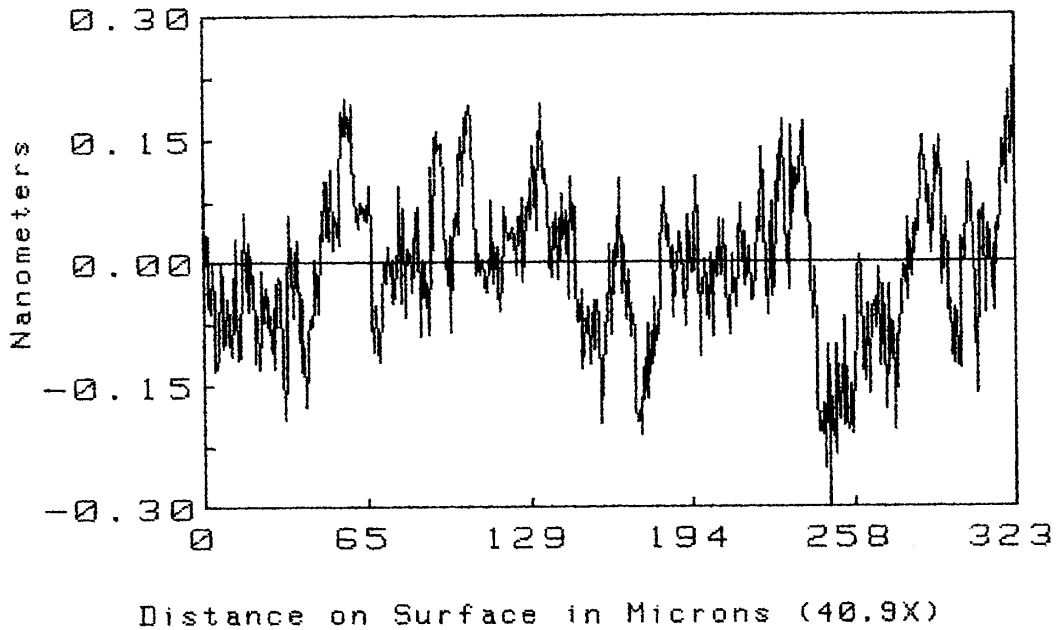
PROFILE

PV: 0.560nm

RA: 0.072nm

Ref. Subtracted

RC: -31.3 m



WYKO

T4BS11C.asc

BS11C4

Time: 14:49

Date: 6/15/98

RMS: 0.163nm

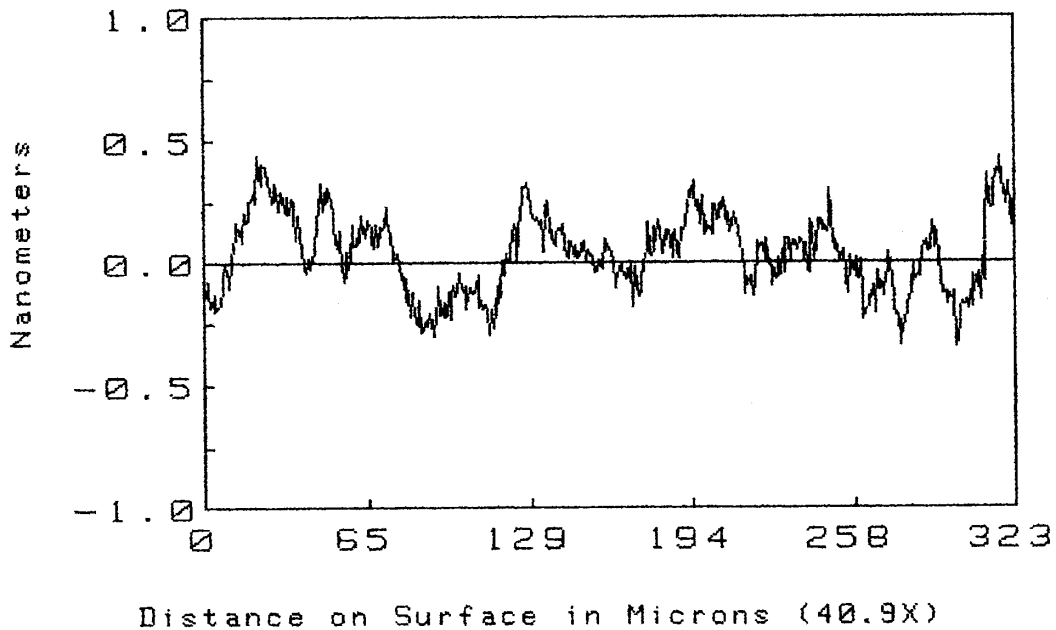
PROFILE

PV: 0.824nm

RA: 0.133nm

Ref. Subtracted

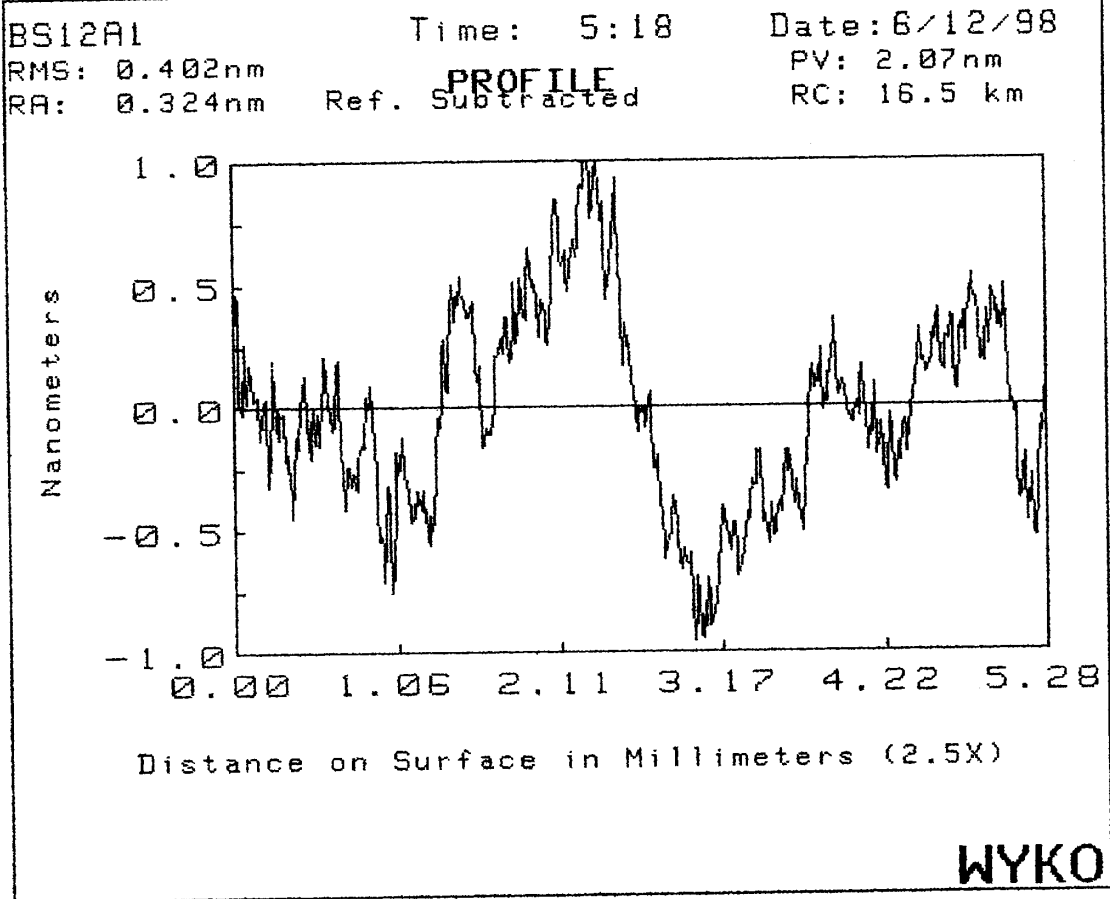
RC: 196 m



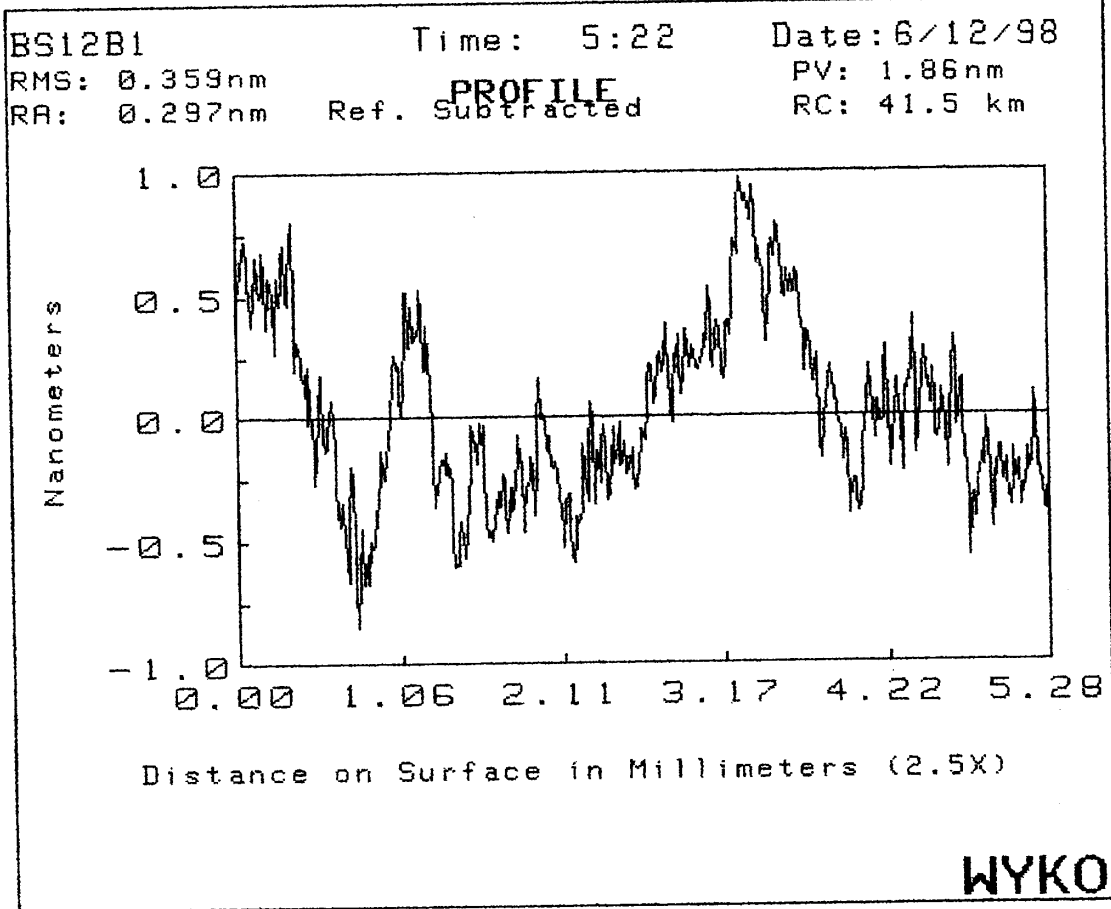
WYKO

I 2 BS12A.ASC

Attch. 4

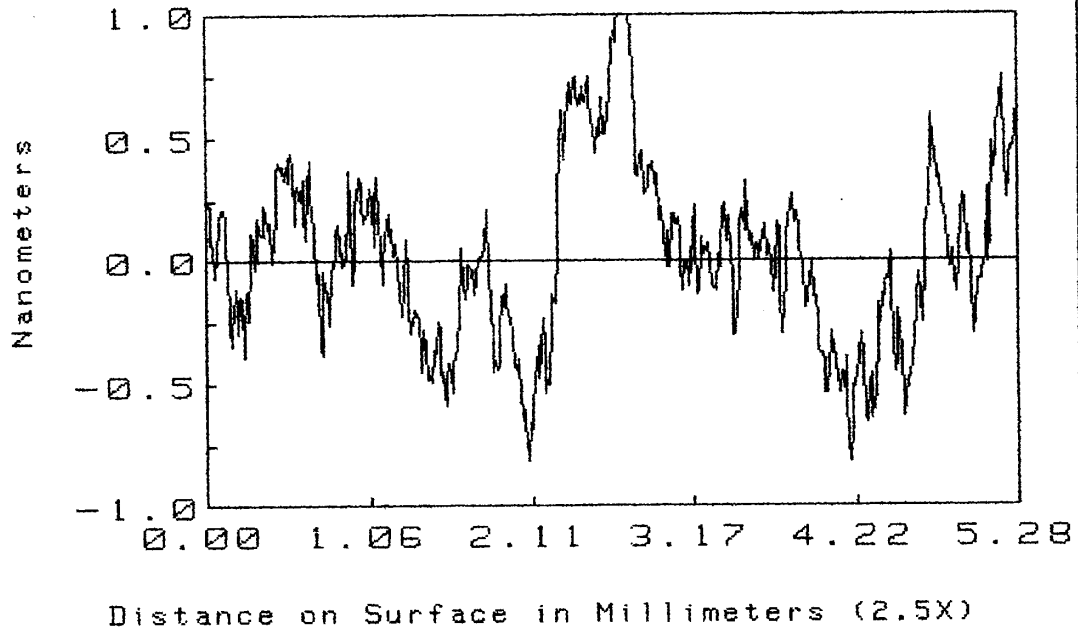


T2BS12B.ASC



120512C.asc

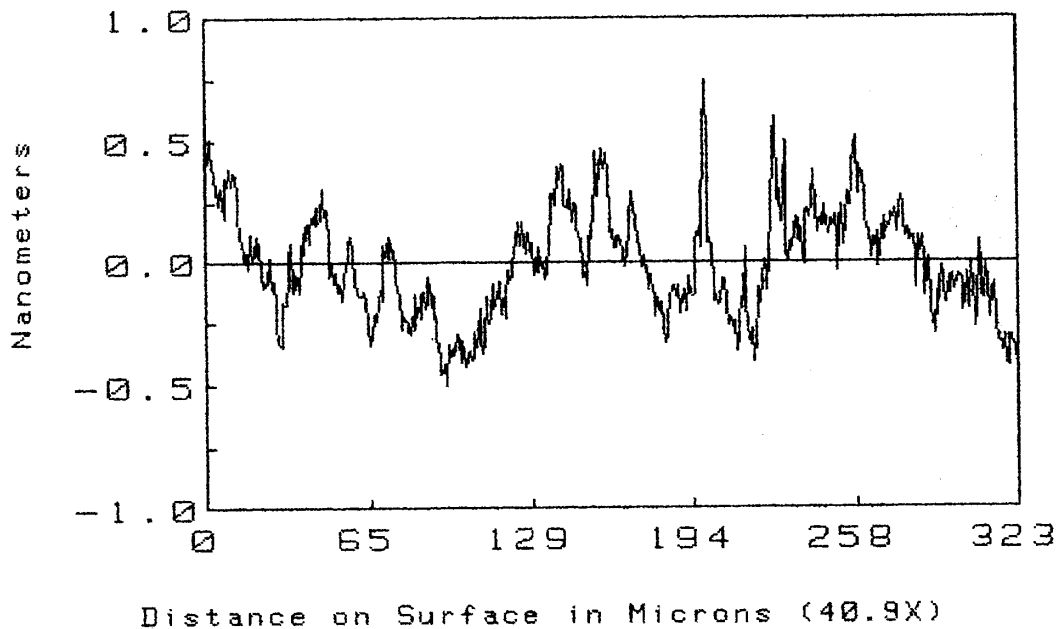
BS12C1 Time: 5:25 Date: 6/12/98
RMS: 0.371nm PV: 2.09nm
RA: 0.290nm Ref. Subtracted RC: -58.4 nm



WYKO

T4 BS12A.asc

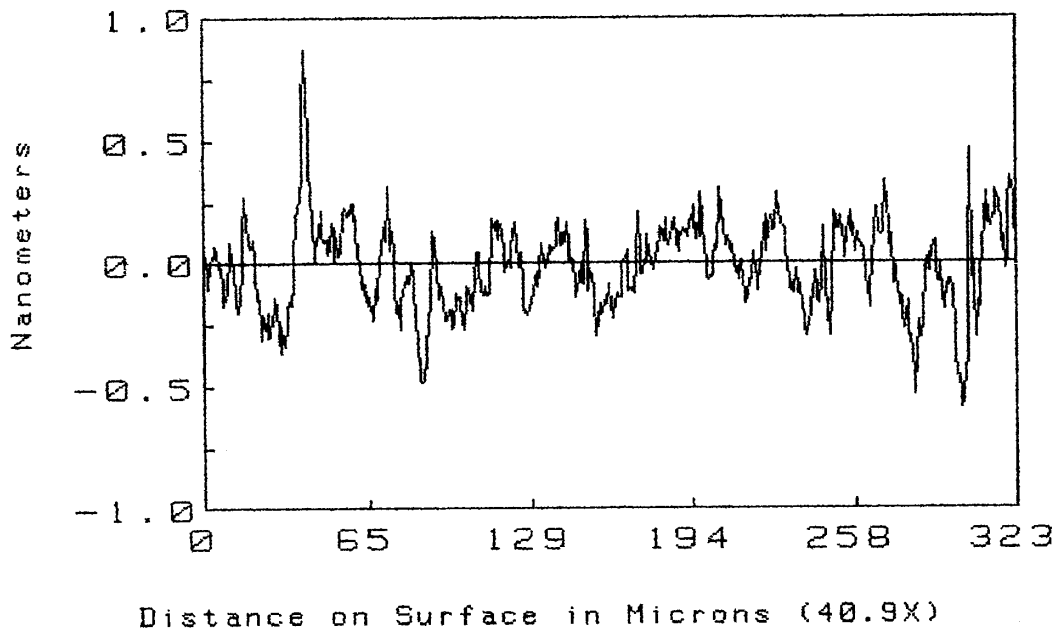
BS12A4 Time: 10:24 Date: 6/15/98
RMS: 0.217nm PV: 1.25nm
RA: 0.178nm Ref. Subtracted RC: -78.6 nm



WYKO

1403120.asc

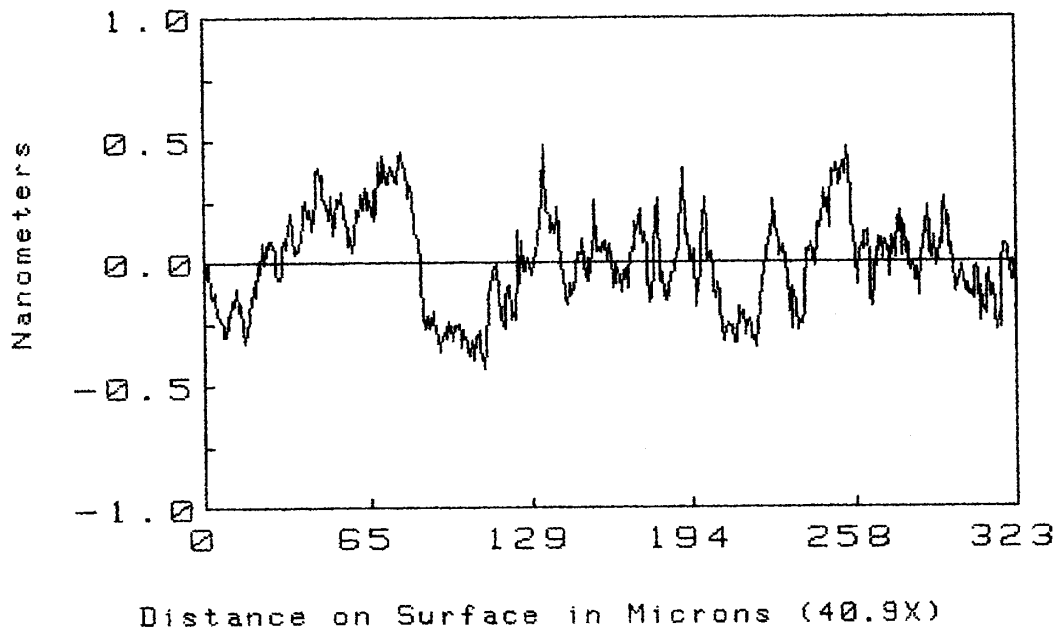
BS12B4 Time: 10:28 Date: 6/15/98
RMS: 0.183nm PV: 1.48nm
RA: 0.144nm Ref. Subtracted RC: -16.9 m



WYKO

T4 BS12C .asc

BS12C4 Time: 10:32 Date: 6/15/98
RMS: 0.194nm PV: 0.980nm
RA: 0.157nm Ref. Subtracted RC: 98.5 m



WYKO

LINDA STOHR CHB, INC
 11099 S LA CIENEGA BLVD #258
 LOS ANGELES, CA 90045
 (310)216-6446

DATE

7/06/98

OUR REF. NO.

7291

THE MERCHANDISE DESCRIBED BELOW
 WILL BE ENTERED AND/OR FORWARDED
 AS FOLLOWS:

CARRIER NZ		LOCATION Y350 AIR NEW ZEALAND		ORIGIN/DESTINATION PORT	
B/L OR AWB NO. 08691504405	ARR./DEPT. DATE 7/01/98	FREE TIME EXP. 0/00/00	LOCAL DELIVERY OR TRANSFER BY (DELIVERY ORDER ISSUED TO) CUSTOM AIR TRUCKING		
LINDA STOHR CHB, INC		HOUSE NO.	ENTRY-B/L NO. AWS-0007291-9	CUST. REF. NO.	
FOR DELIVERY TO			ROUTE		
CA INSTITUTE OF TECHNOLOGY 1201 E CALIFORNIA BLVD PASADENA, CA 91125 ATTN: LIGO PROJECT					

NO. OF PKGS.	DESCRIPTION OF ARTICLES, SPECIAL MARKS & EXCEPTIONS	WEIGHT	DO NOT USE
1	FUSED SILIA FREIGHT PREPAID BY CENTRA WORLDWIDE. PO#6884 07-09-98 BS01-B <i>Steve Tison</i>	66 Lb	

INLAND FREIGHT

PREPAID / COLLECT

Prepaid

Received in Good Order

By: *[Signature]*

DATE:

TIME:

PER:

[Signature]
 (310)216-6446

FILE
 COPY

DELIVERY CLERK: DELIVER
 TO CARRIER SHOWN ABOVE

REPOLISHED

A. DCN: LIGO-T970200-02-D **LIGO DETECTOR OPTICS**
B. LIGO S/N: BS01-B **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.: PC 167159 D. Substrate Polisher: CSIRO
E. Core optic Material: BS FM / 2ITM / 4ITM / ETM / RM F. Date Received: _____

- 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 CSIRO ftp site
- J Attach the surface maps supplied by vendor per above Component Specifications to the check off sheet.
- K Visually inspect for shipping container damage. If applicable, describe damage on attached sheet and notify the Cognizant Engineer
- L Visually inspect the polished substrate for shipping damage, for chips on surfaces and edges, or for other defects. If applicable, describe damage/defects on attached sheet and notify Cognizant Engineer.
- * M Verify polished substrate's physical dimensions per applicable LIGO drawing.
- | | | | | |
|--------------------------|----------------------------------|-----------|----------|----------|
| <input type="checkbox"/> | Inspection of material diameter. | Diameter | _____ in | _____ mm |
| <input type="checkbox"/> | Inspection of material thickness | Thickness | _____ in | _____ mm |
| <input type="checkbox"/> | Wedge Angle | _____ | | |
- This is a re-polish. No significant changes in dimension. See previous alerts.*
- 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: *Jason Fison* Date Inspected: _____

Reviewed and/or accepted by:

Cognizant Engineer: _____ Date: _____

LIGO QA Officer or Designee: _____ Date: _____

FMB00

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.) The substrate was not remeasured since the

surfaces were polished, not ground to remove the coatings.

SKETCHES:

See map supplied 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			> - 500 Km (- 9.8 nm)	✓
Astigmatism	< 16nm p-v			- 5.3 nm	✓
Surface 2	Surface Figure Over Central 200mm dia.		Nominally Flat		
	Radius of Curvature of the Wavefront		> 140 km convex > 500 km concave	> 100 Km (47.3 nm)	✓
	Astigmatism		< 23nm p-v	5.7 nm	✓
Surface Errors	Low Spatial Frequency Band Central 80mm		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{rms} < 1.6\text{nm}$	S1 0.9 nm S2 0.9 nm	✓
	Low Spatial Frequency Band Central 200mm		$\leq 4.3 \text{ cm}^{-1}$ $\sigma_{rms} < 3.2\text{nm}$	S1 1.1 nm S2 1.0 nm	✓
	High Spatial Frequency Band Central 80 & 200 mm		$\leq 4.3 - 7,500 \text{ cm}^{-1}$ $\sigma_{rms} < 0.4\text{nm}$	0.20 0.20	✓

wavefront: 306 (16.2 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). $< 20,000$
The total area of scratches outside the central 80 mm diameter shall not exceed 750×10^3 square micrometers. $< 30,000$	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. <i>Light scratch ~ 1mm in from bevel running around nearly 70% of the full circumference.</i>		Inspection Report	✓

LIGO Component Specification Verification Sheet Beam Splitter

LIGO Certification Report

This Certification Package relates to the following substrate: **Beamsplitter**
(October 98 re-work)

Serial number: BS01-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 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:	BS1B1R.zip	(Side 1)	BS1B2R.zip (Side 2) BS1BTR.zip (wave front)
TOPO data: (2.5X)	T2BS11AR.asc	(Side 1)	T2BS12AR.asc (Side 2)
	T2BS11BR.asc		T2BS12BR.asc
	T2BS11CR.asc		T2BS12CR.asc
(40X)	T4BS11AR.asc		T4BS12AR.asc
	T4BS11BR.asc		T4BS12BR.asc
	T4BS11CR.asc		T4BS12CR.asc

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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:	BS01-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"*).

A light scratch was seen on side 1 about 1 mm in from the bevel, running around nearly 70% of the full circumference. The scratch was seen during unpacking, before the coating was removed.

There are a few scratches on the side near the serial number. Again, 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: 

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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

Date:

30 October 98

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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	<20,000	<30,000
Surface 2	nil	nil	<10,000	<35,000

*Refer discussion in side/bevel polish section

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
BSO1
SIDE 1

3000

2000

4000

2000

10000

2000
~~1000~~

15000

4000

5000

2000

~~BS01~~

SIDE 2

0004

0001

0007

0002

0003
0001
0002

0004
0001
0003

4000

4000
2000

5000

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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.2
8	Team member responsible for measurement/inspection:	B Oreb
9	Measurement/inspection results reviewed by:	C Walsh

10. Results

	Radius of Curvature in km (Parabolic sag in nm)	Astigmatism (nm)	Electronic data file reference
Surface 1	>-500 (-9.8 nm)	-5.3	BS1B1R.zip
Surface 2	>100 (47.3 nm)	5.7	BS1B2.zip
Wave front*	306 (16.2 nm)		BS1B2A.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 **6.4 nm**, which lies within the tolerance band agreed with Caltech of $14 \text{ nm} > \text{Sag} > -50 \text{ nm}$.

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:


30 October 98

Chris Walsh

Date:

LIGO Certification Report Surface Errors - Low

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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.4
8	Team member responsible for measurement/inspection:	B Oreb
9	Measurement/inspection results reviewed by:	C Walsh

10. Results

	Low Frequency Surface Errors (nm)	
	80 mm aperture	200 mm aperture
Surface 1	0.9	1.1
Surface 2	0.9	1.0

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

Date:

30 October 98

1	Substrate Type:	Beamsplitter
2	Serial Number:	BS01-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)	Data were analysed using PC-based software routines rather than HP-based routines.
7	CSIRO Log Book Reference	LLN091
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: 0.21
Side 2: 0.20

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

Side 1: 0.20
Side 2: 0.20

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

	A	B	C	D	E	F	G	H
Surface 1	0.26	0.23	0.19	0.23	0.17	0.18	0.18	0.20
Surface 2	0.23	0.18	0.20	0.20	0.18	0.24	0.19	0.19

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

11. Certification

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

Project Manager:



Chris Walsh

Date:

30 October 98 .

LADI CERTIFICATION DATA

Title: BS_12R

Date: 10/10/98

Diameter: 200 mm

Astig: 5.7 nm

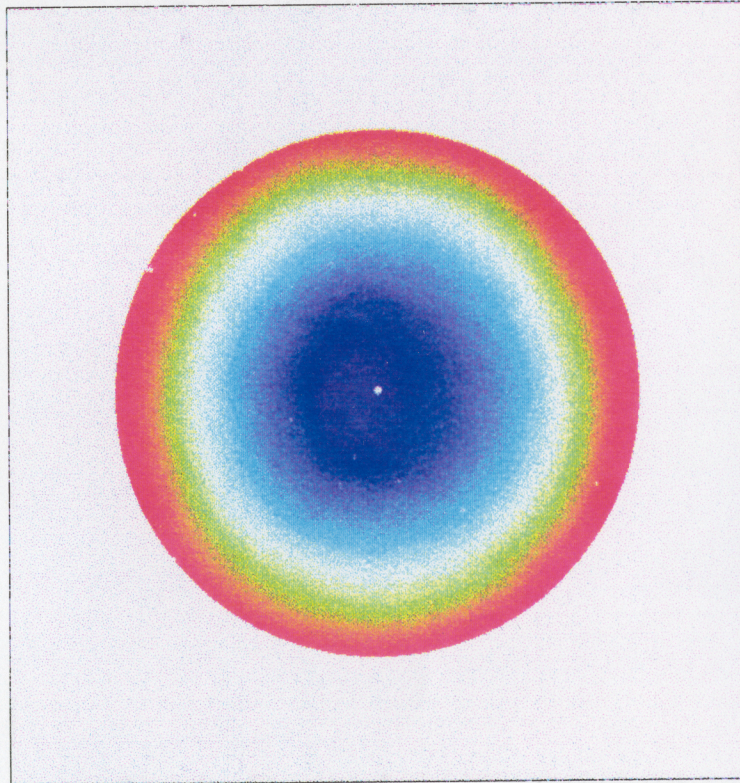
Power: 47.3 nm



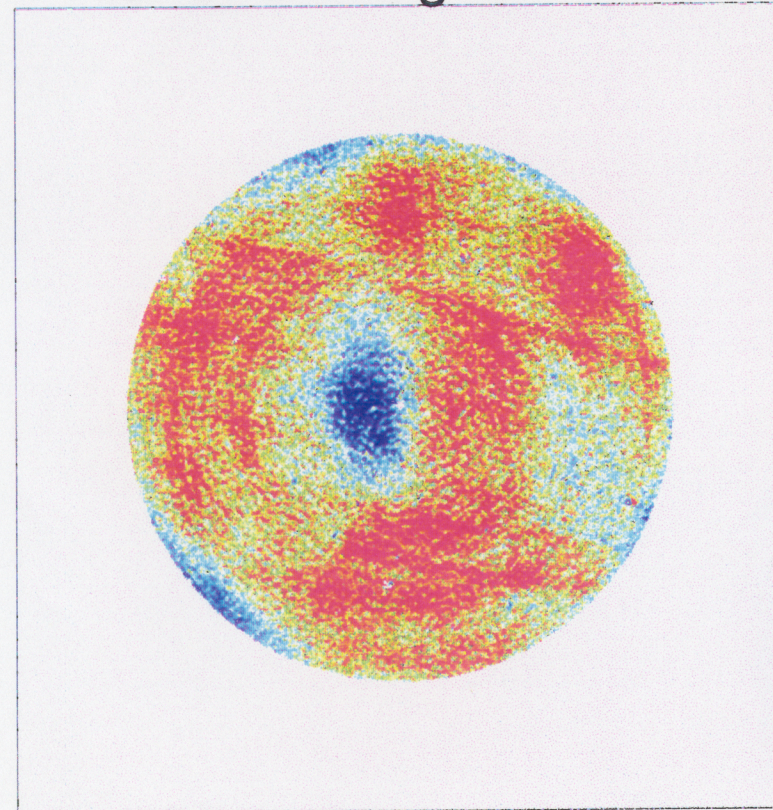
PV: 11.0 nm

RMS: 1.0 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: BS_11R

Date: 10/11/98

Diameter: 200 mm

Astig: -5.3 nm

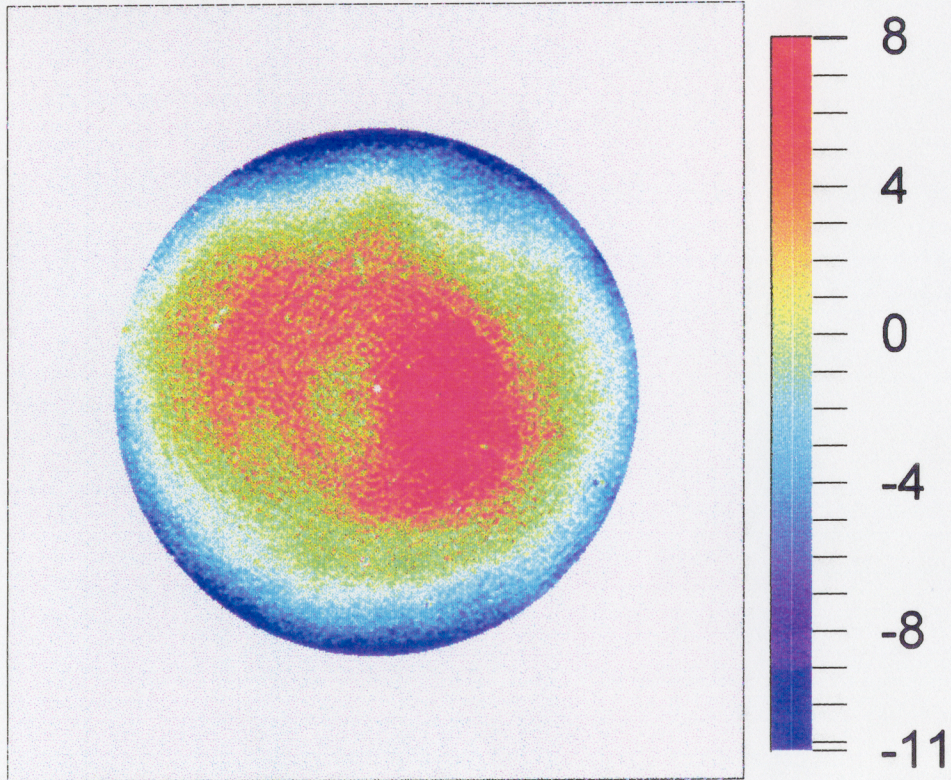
Power: -9.8 nm



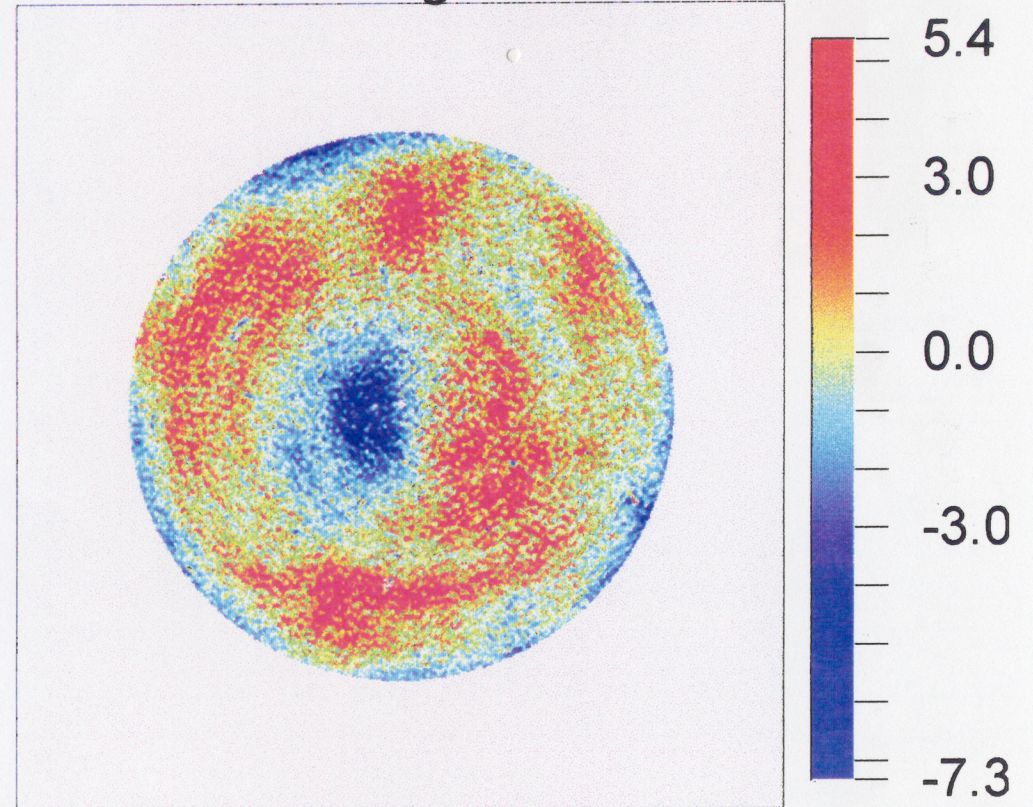
PV: 12.7 nm

RMS: 1.1 nm

Tilt Removed



Tilt/Power/Astig Removed



LADI CERTIFICATION DATA

Title: BS_1TR

Date: 10/10/98

Diameter: 200 mm

Astig: 3.8 nm

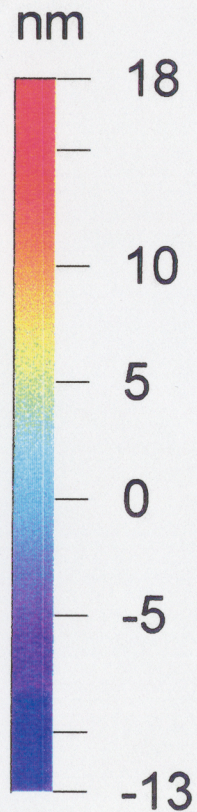
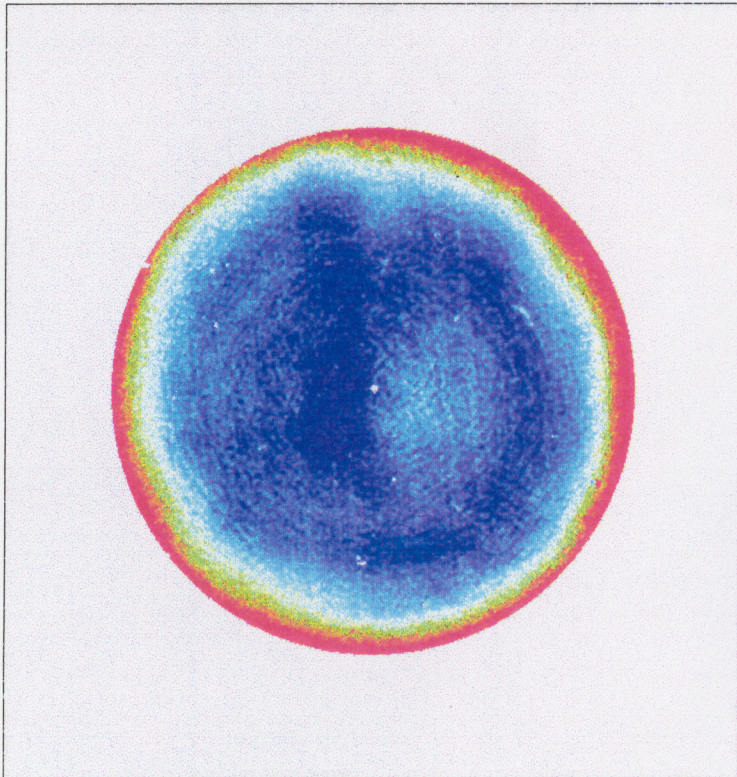
Power: 16.2 nm



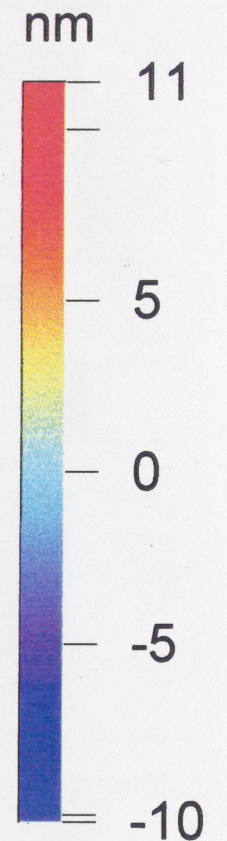
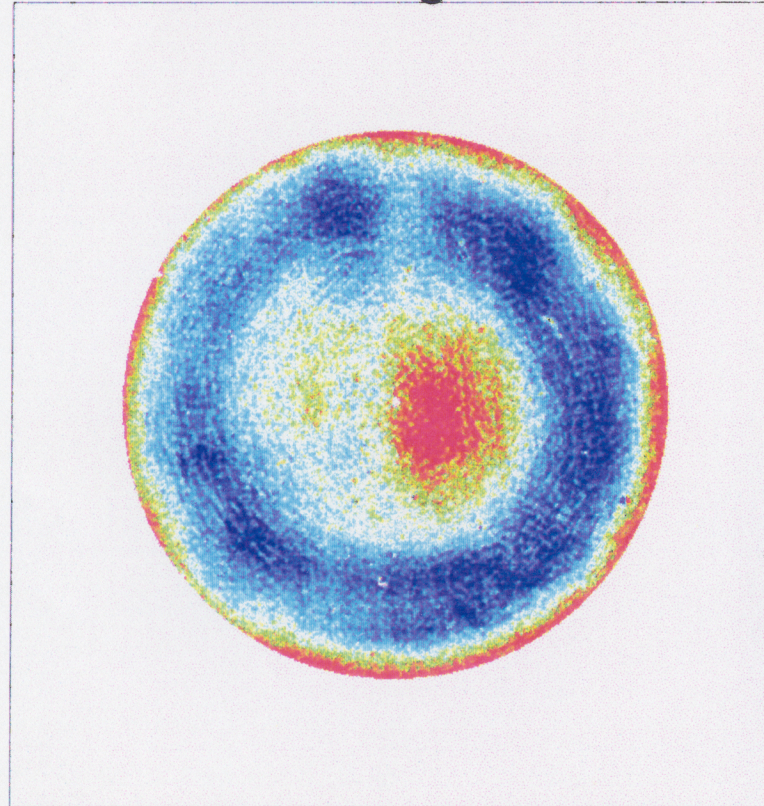
PV: 21.6 nm

RMS: 2.8 nm

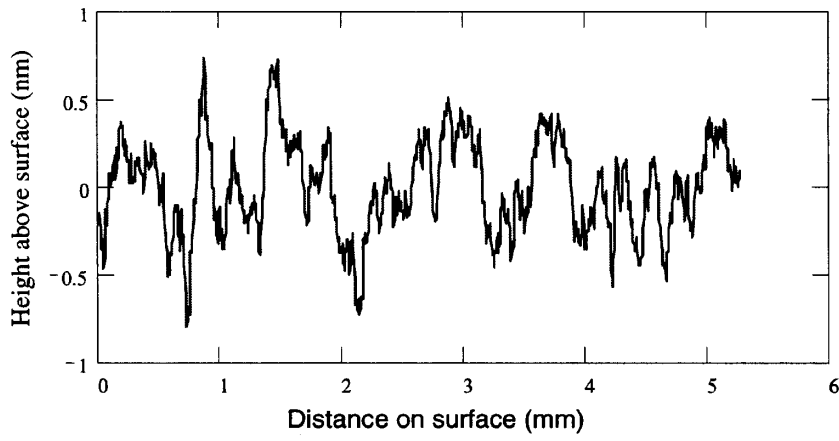
Tilt Removed



Tilt/Power/Astig Removed

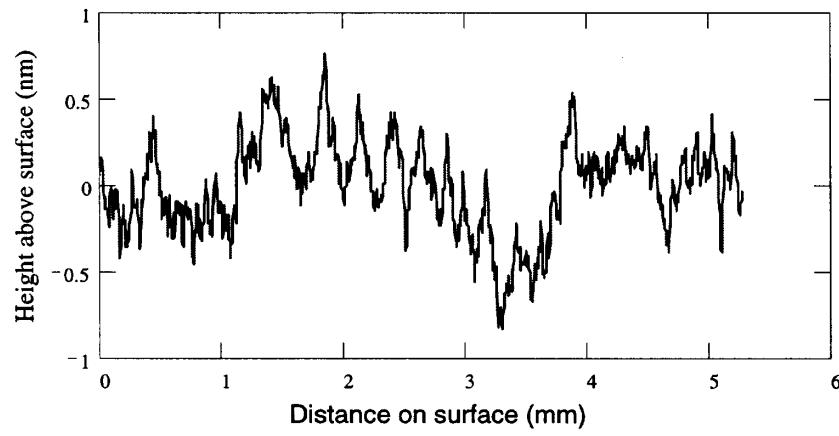


$$\text{RMS} = 2.685 \cdot 10^{-10} \cdot \text{m}$$



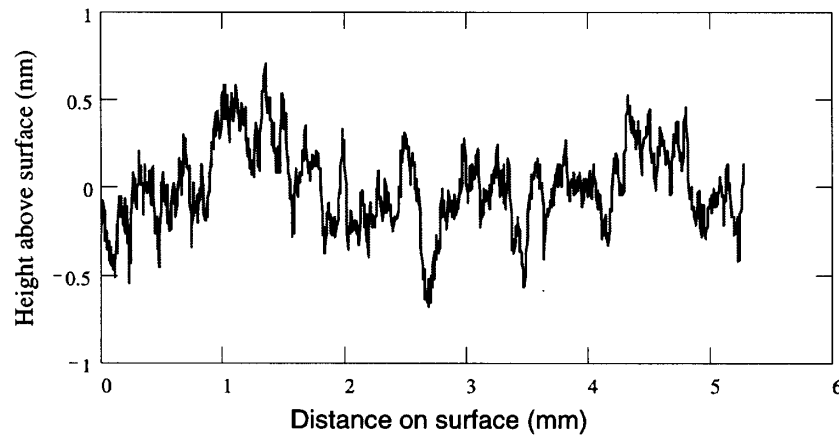
T2BS11AR.asc

$$\text{RMS} = 2.678 \cdot 10^{-10} \cdot \text{m}$$



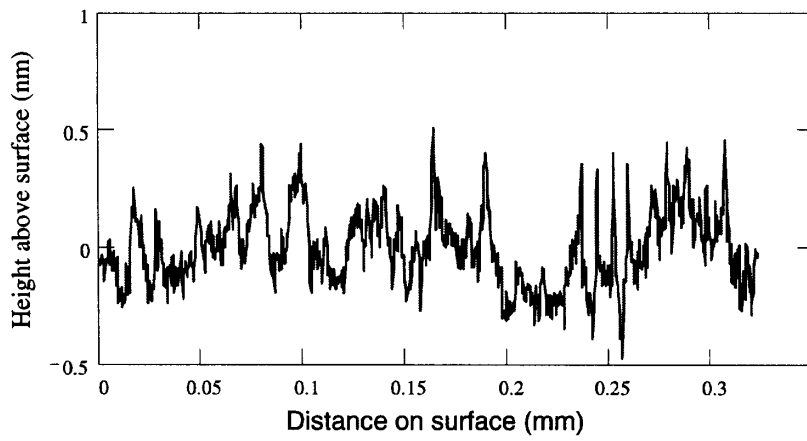
T2BS11BR.asc

$$\text{RMS} = 2.328 \cdot 10^{-10} \cdot \text{m}$$



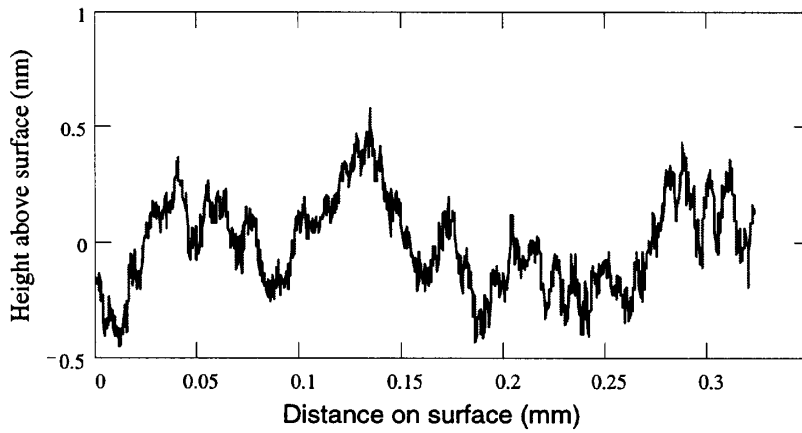
T2BS11CR.asc

$$\text{RMS} = 1.597 \cdot 10^{-10} \cdot \text{m}$$



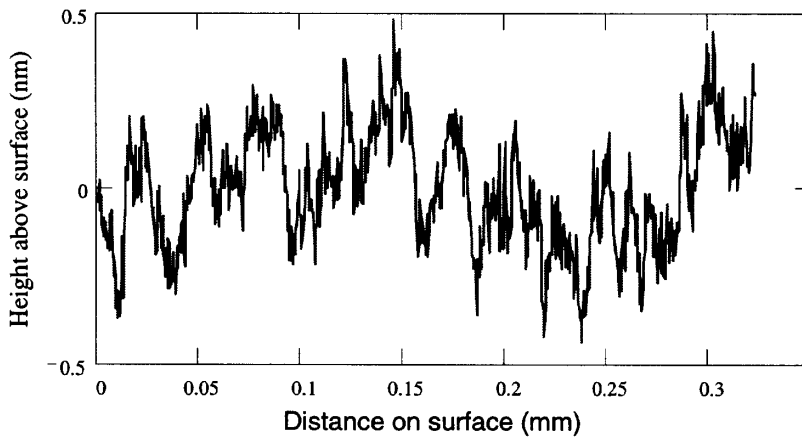
T4BS11AR.asc

$$\text{RMS} = 2.009 \cdot 10^{-10} \cdot \text{m}$$



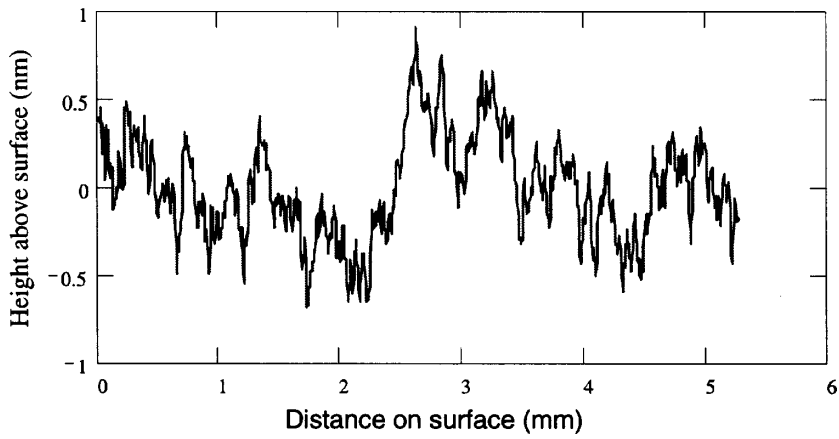
T4BS11BR.asc

$$\text{RMS} = 1.649 \cdot 10^{-10} \cdot \text{m}$$



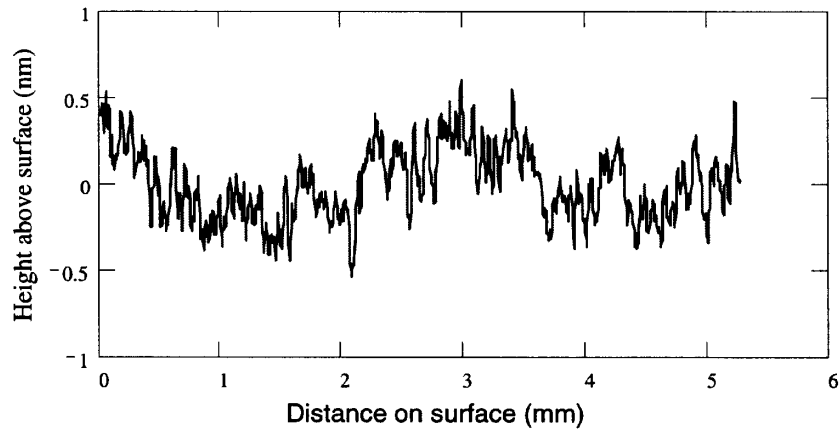
T4BS11BR.asc

$$\text{RMS} = 2.889 \cdot 10^{-10} \cdot \text{m}$$



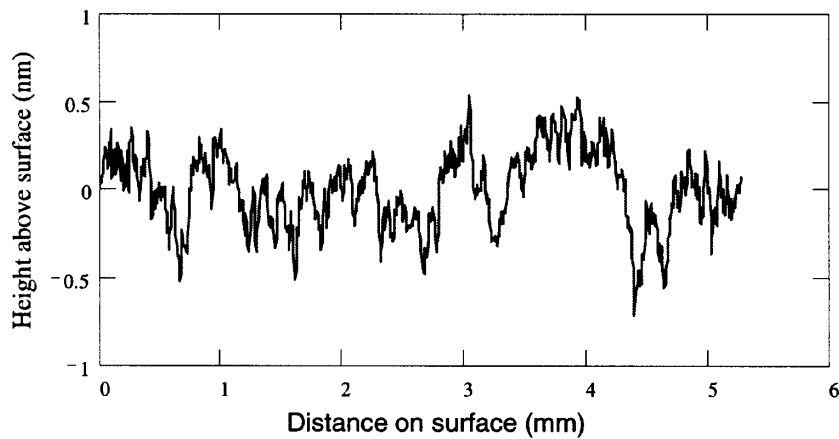
T2BS12AR.asc

$$\text{RMS} = 2.092 \cdot 10^{-10} \cdot \text{m}$$



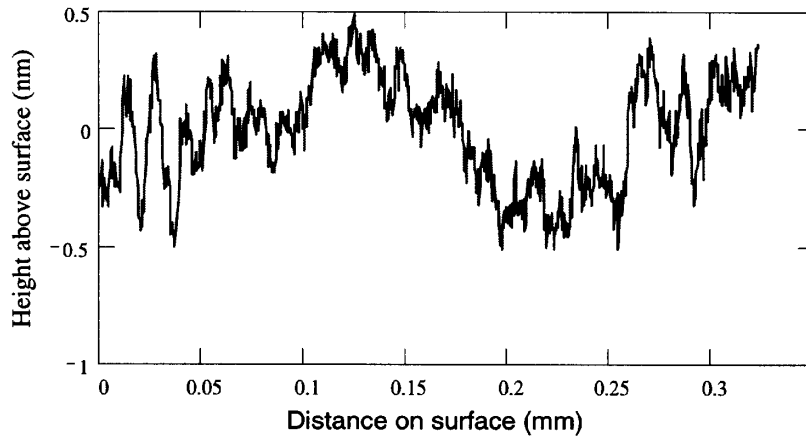
T2BS12BR.asc

$$\text{RMS} = 2.164 \cdot 10^{-10} \cdot \text{m}$$



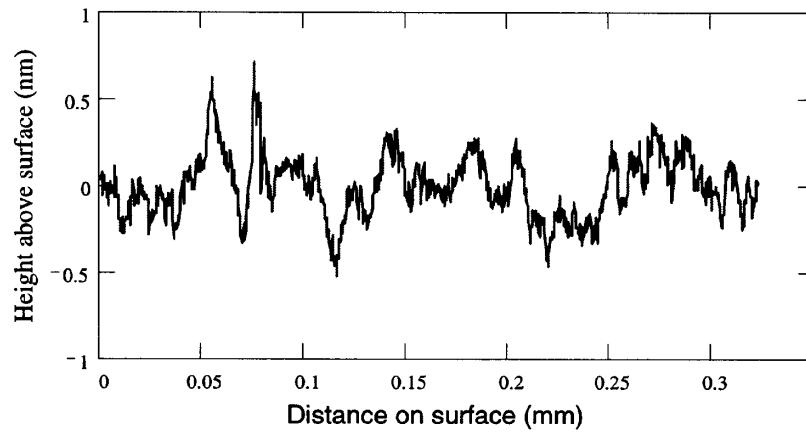
T2BS12CR.asc

$$\text{RMS} = 2.288 \cdot 10^{-10} \cdot \text{m}$$



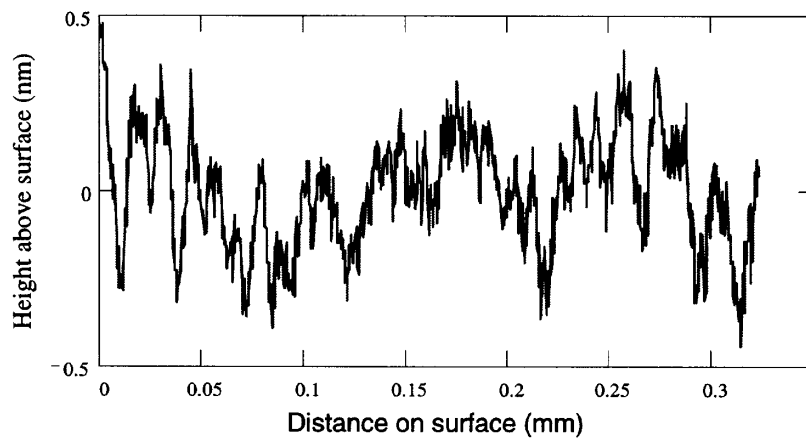
T4BS12AR.asc

$$\text{RMS} = 1.778 \cdot 10^{-10} \cdot \text{m}$$



T4BS12BR.asc

$$\text{RMS} = 1.615 \cdot 10^{-10} \cdot \text{m}$$



T4BS12CR.asc