SPETM07

LIGO-T990178-00-D

SUBSTRATE

GENERAL OPTICS, INC. PRECISION OPTICAL COMPONENTS

554 FLINN AVENUE MOORPARK, CALIFORNIA 93021 (805) 529-3324 FAX (805) 529-4298

CERTIFICATE OF COMPLIANCE

Date: 10-30-97

To: Cal Tech

Purchase Order Number: PC203459

Part Number & Revision: D960791-A-D (w/Spec. #E950104-A-D)

Part Description: Ligo End Test Mass Substrate

Serial Numbers: SP ETM 07A

We certify that the above part was manufactured in compliance with all applicable requirements and specifications of the above purchase order and drawings except as noted below.

"Scratches" and "Point Defects" for the entire side 1 and side 2 surfaces were inspected using an high intensity white light source delivered perpendicular the surface. This was substituted for the method prescribed in specification E950104-A-D.

GENERAL OPTICS, INC.

By: _____

Ligo Test Mass
Drawing Number D960791-A-D
Specification NumberE950104-A-D
Serial Number SP ETM 07A

Final Inspection Report
Customer Supplied Serial Number FE11 13 458
Prefabricated and Polished Material

October 30, 1997

Feature	Requirement	Measured
Side 1		
Spherical Measurement	<1/20th Wave Concave	.018 λ P-V
Radius of Curvature	7400 M. ± 220 M.	7571.70 M.
Micro Roughness (rms)	< 1Å rms	.29 Å rms
Surface Quality	< 10 Defects Entire Surface	Verified
Side 2		
Flatness	< 1/10 λ P-V	.047 λ P-V
Micro Roughness (rms)	< 1Å rms	.31 Å rms
Surface Quality	< 10 Defects Entire Surface	Verified
Substrate Features		
Diameter of -A-	250 mm +1 mm / -0 mm	250.27 mm
Thickness (to sharp corner)	100 mm +0 mm / -.5mm	100.02 mm
Wedge (Surface 2)	2° ± 5'	1° 59'
Chamfers, After Polish, Surface 1	2 mm ± 0.3 mm (2 pls)	1.93 mm
Chamfers, After Polish, Surface 2	2 mm ± 0.3 mm (2 pls)	2.11 mm

A. DCN: LIGO-T970021-00-D **LIGO DETECTOR OPTICS**
B. LIGO S/N: SPETMØ7-A **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.: PC203459 D. Substrate Polisher: General Optics
E. Core optic Material: BS / FM / 2ITM / 4ITM / (SP ETM) / RM F. Date Received: 10-31-97

G ☑ Verify glass polisher's Certification with LIGO Component Specification No. E950104-A-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~~ tape in ASCII format of all Surface Data per the applicable LIGO Component Specification sheet format conversion required to read tape.

J ☑ Attach the surface maps supplied by vendor per above Component Specifications to the check off sheet.

K ☑ Visually inspect for shipping container damage. If applicable, describe damage on attached sheet and notify the Cognizant Engineer

L ☑ Visually inspect the polished substrate for shipping damage, for chips on surfaces and edges, or for other defects. If applicable, describe damage/defects on attached sheet and notify Cognizant Engineer.

M ☑ Verify polished substrate's physical dimensions per applicable LIGO drawing.

☑	Inspection of material diameter.	Diameter	9.85 in	250.27	mm
☑	Inspection of material thickness	Thickness	3.94 in	100.02	mm

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: 10-31-97

Reviewed and/or accepted by:

Cognizant Engineer: _____ Date: _____

LIGO QA Officer or Designee: _____ Date: _____

FM300

Figure 1

LIGO DETECTOR OPTICS
Incoming Inspection Check-off Sheet

Core Optics Polished Substrate

COMMENTS/DISCREPANCIES: (Disposition damage/discrepancies per LIGO Quality Assurance Plan (LIGO M960076-00-P) paragraphs 5.12 and 5.12.1.)

SKETCHES:

DISPOSITIONS:

Figure 2

Substrate, SP End Test Mass	Serial Number: SPETMØ7-A		Specification	Reported Value	✓
	Surface 1	Spherical Measurement	< 1/20 wave (13.64nm)	0.018λ P-V (11.39nm)	✓
		Absolute Radius of Curvature Tolerance	7,400m + 220m - 220m	7,571.7m	✓
		Astigmatism	< 10nm p-v		
	Surface 2	Spherical Measurement	< 1/10 wave (63.28nm)	0.047 P-V (29.74nm)	✓
		Radius of Curvature	> 80 Km		
		Astigmatism	< 64nm p-v		
	Physical Dimensions	Substrate Diameter	250mm +1mm/-0mm	250.27 mm	✓
		Substrate Thickness	100mm +0/-.5mm	100.02 mm	✓
		Wedge Angle, Surface 2	2° ± 5'	1° 59'	✓
	Physical Dimensions	Chamfers, After Polish			
		Side 1	2mm ±0.3mm	1.93 mm	✓
		Side 2	2mm ±0.3mm	2.11 mm	✓
	Surface Error	High Spatial Frequency Band Central 80 & 200 mm	σ_{rms}<0.1nm		

Scratches, Point Defects & Polish Side 1		Specification	Certification	✓
	Scratches	The Total Area of scratches within the central 80mm diameter shall not exceed 25 X 10^3 square micrometers (width x length).	Hand Sketch w/dimensions	
		The total area of scratches outside the central 80 mm diameter shall not exceed 250 x 10^3 square micrometers.	Hand Sketch w/dimensions	
	Point Defects	There shall be no more than 10 point defects within the central 80mm diameter.	Certified Only	✓
		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	✓

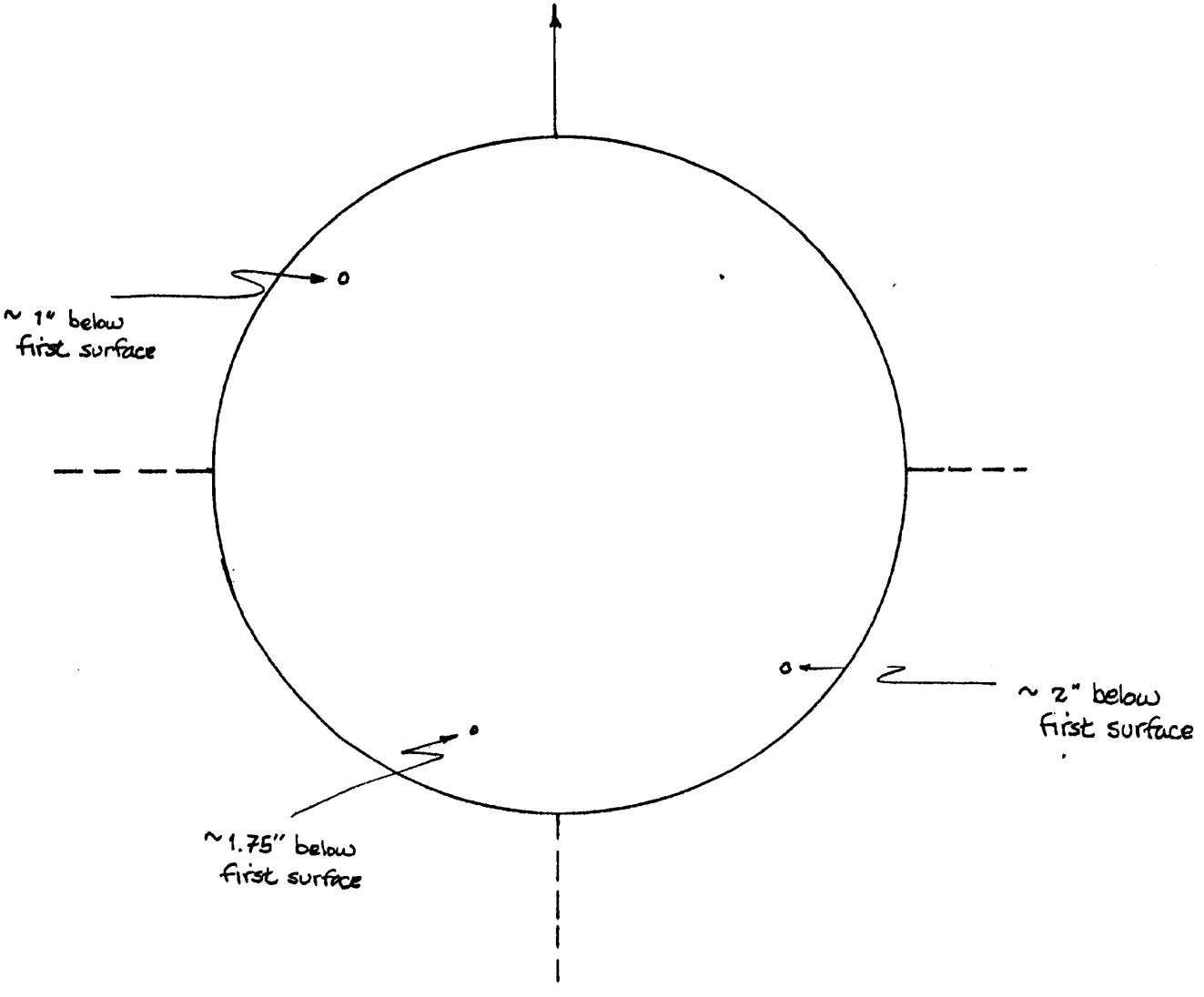
LIGO Component Specification Verification Sheet
Super Polished End Test Mass

		Specification	Certification	✓
Scratches, Point Defects & Polish Side 2	**Scratches**	The total area of scratches shall not exceed 1 X 10^6 square micrometers over the central 235 mm.	Hand Sketch w/dimensions	
	Point Defects	There shall be no more than 100 point defects within the central 80mm diameter.	Hand Sketch w/dimensions	✓
		There shall be no more than 300 point defects on the entire optic. Point defects of radius greater than 25 micrometers are treated like scratches for the purpose of this specification. Point defects of radius less than 2.5 micrometers are disregarded.	Hand Sketch w/dimensions	✓
	Side/Bevel Polish	Sides and bevels shall be polished from a three micrometer grit finish. These surfaces shall appear transparent with no gray, scuffs or scratches visible to the naked eye when viewed in normal room light against a black background.	Inspection Report	✓

LIGO Component Specification Verification Sheet
Super Polished End Test Mass

Serial #: SPETMØ7-A

Date: 11-03-97

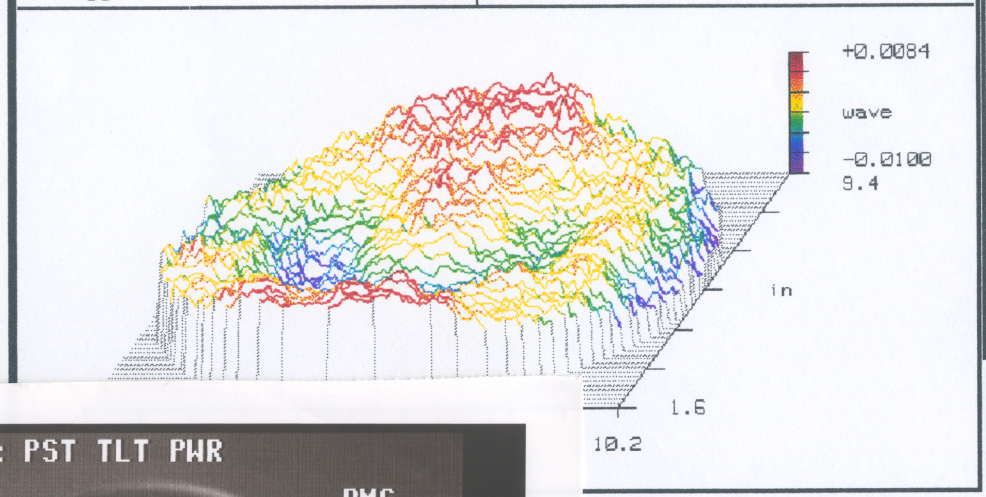


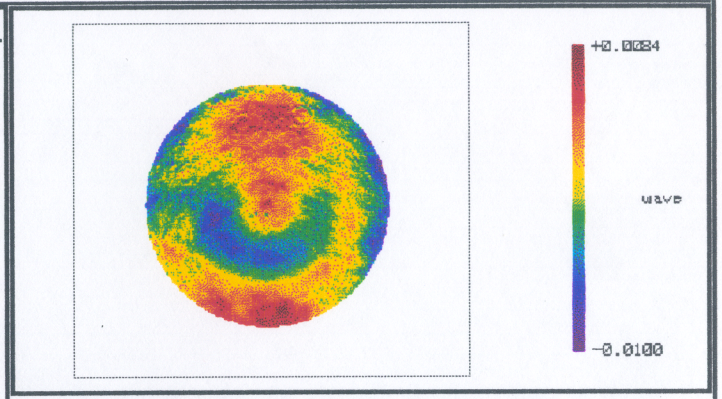
Location of inclusions

Found no scratches

zygo General Optics, Inc. 554 Flinn Ave, Moorpark, CA 93021 805) 529-3324

zygo Oblique Plot





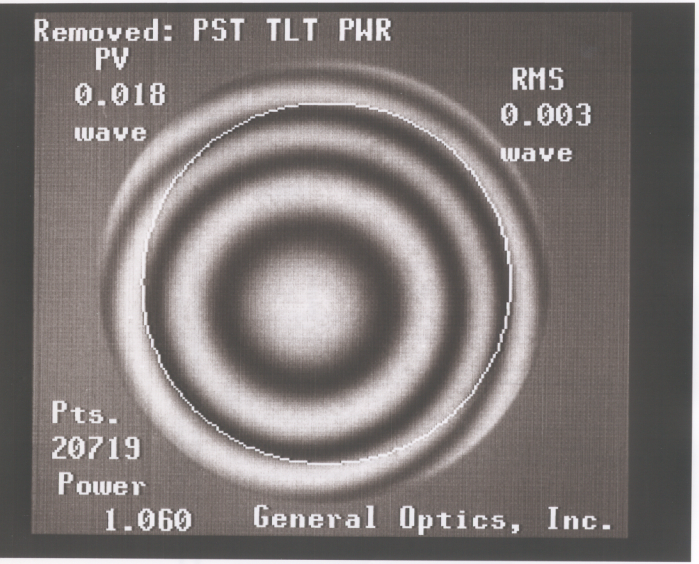
PV	0.018	wave
rms	0.003	wave
Power	1.060	wave

Solid Plot

3D Plot

7.87 in | Removed: PST TLT PWR | Aperture(%dia.)

-1.06 wave | Points 20719



Measurement Controls

Part Number: LIGO TEST MASS - SIDE 1

Serial Number: SP ETM 07A | Min Mod Pct: 3

Inspector: GENE LAPP | Intens Avgs: 4

Intf Scale Factor: 0.5 | Phase Avgs: 4

Refractive Index: 1.500000 | AGC: On | Phase Res: Normal

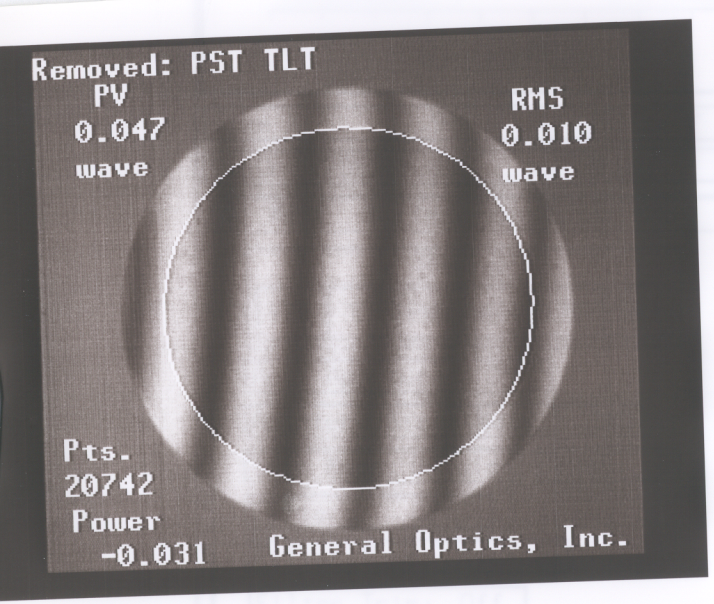
Time: Wed Oct 15 11:13:31 1997 | AGC Mode: Normal Reflectivity

Instrument: Mark IVxp Id 0 SN 4532 SB 0 | Phase Avg Pause: Off

Wavelength-In: 6328.0 A | Wavelength-Out: 6328.0 A

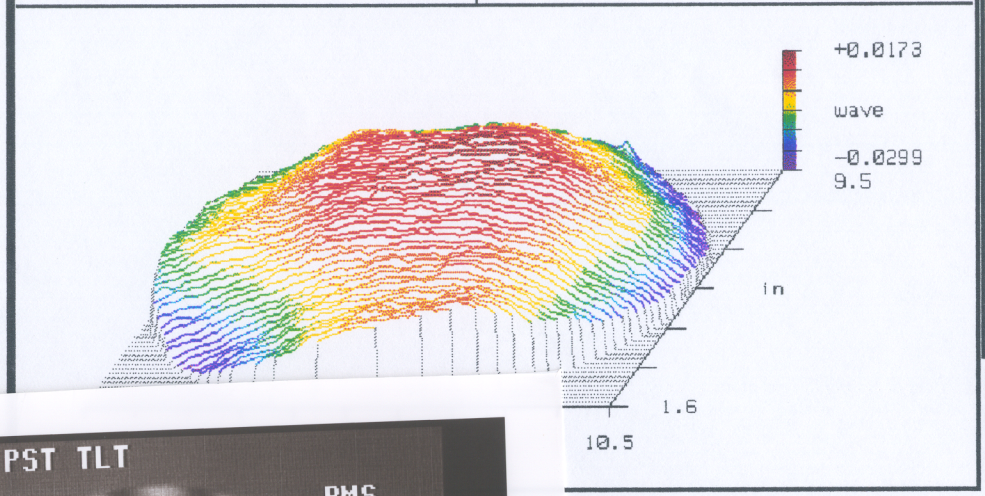
Subtract Sys Err: Off | Sys Err File: SysErr.dat

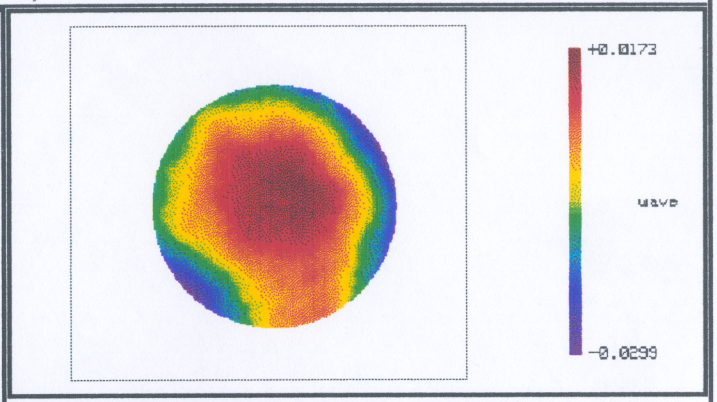
Discon Action: Ignore | Discon Filter: 50 | Light Level: 38



zygo General Optics, Inc. 554 Flinn Ave, Moorpark, CA 93021 805) 529-3324

zygo Oblique Plot





PV	0.047	wave	Solid Plot
rms	0.010	wave	3D Plot
Power	-0.031	wave	

7.91 in	Removed: PST TLT	Aperture(%dia.)
0.03 wave	Points 20742	

Measurement Controls

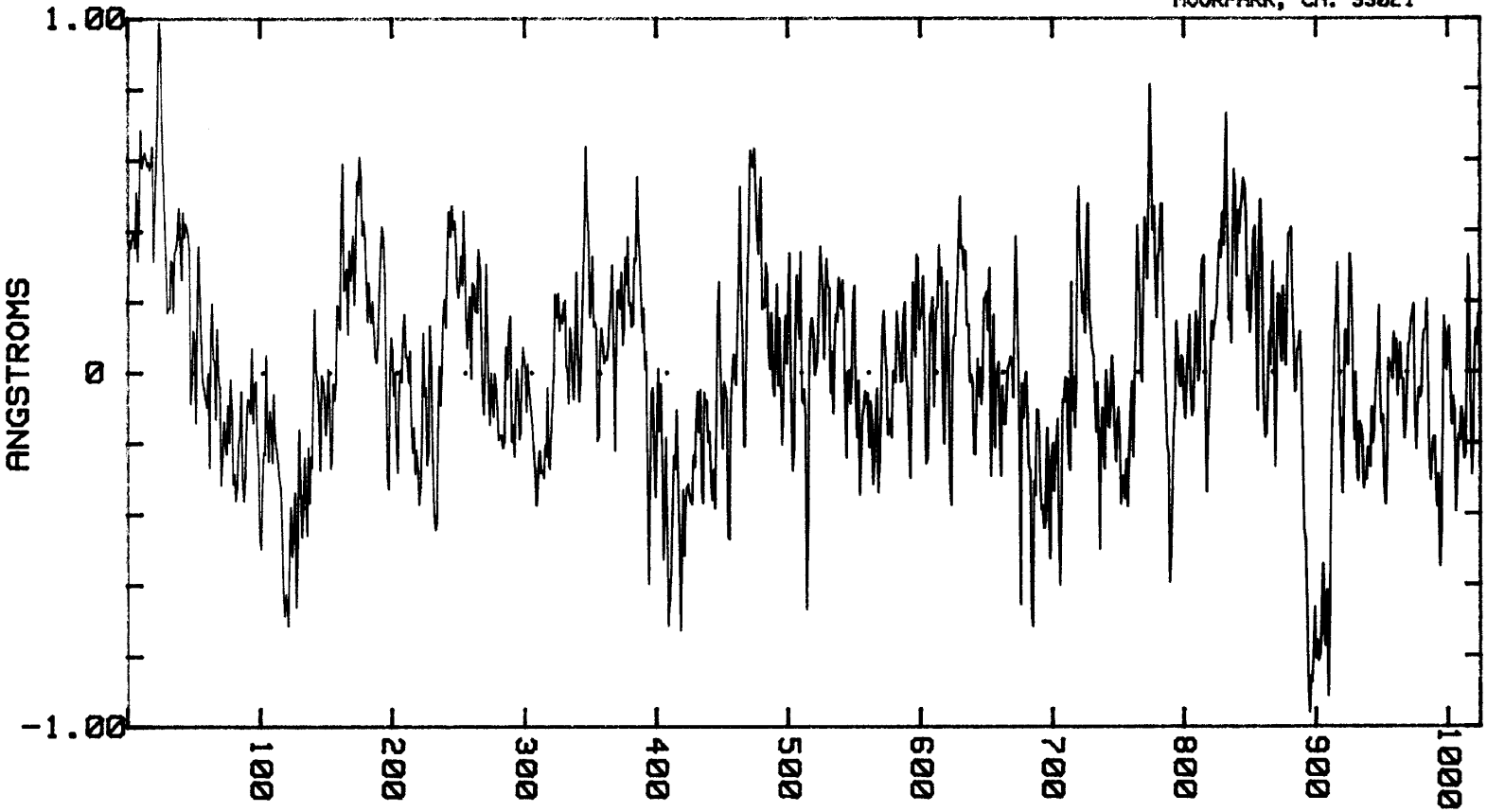
Part Number: LIGO TEST MASS - SIDE 2			
Serial Number: SP ETM 07A		Min Mod Pct:	3
Inspector: GENE LAPP		Intens Avgs:	4
Intf Scale Factor: 0.5		Phase Avgs:	4
Refractive Index: 1.500000	AGC: On	Phase Res:	Normal
Time: Wed Oct 15 11:29:28 1997	AGC Mode: Normal Reflectivity		
Instrument: Mark IVxp Id 0 SN 4532 SB 0		Phase Avg Pause:	Off
Wavelength-In: 6328.0 A	Wavelength-Out: 6328.0 A		
Subtract Sys Err: Off	Sys Err File: SysErr.dat		
Discon Action: Ignore	Discon Filter: 50	Light Level:	43

J-6108 LIGO TEST MASS SPETM07A S-1

Processed
RMS 0.29 angstroms
P-V 1.95
1024 points

15 Oct 1997 17:14:13

GENERAL OPTICS, INC.
(805) 529-3324
554 FLINN AVENUE
MOORPARK, CA. 93021

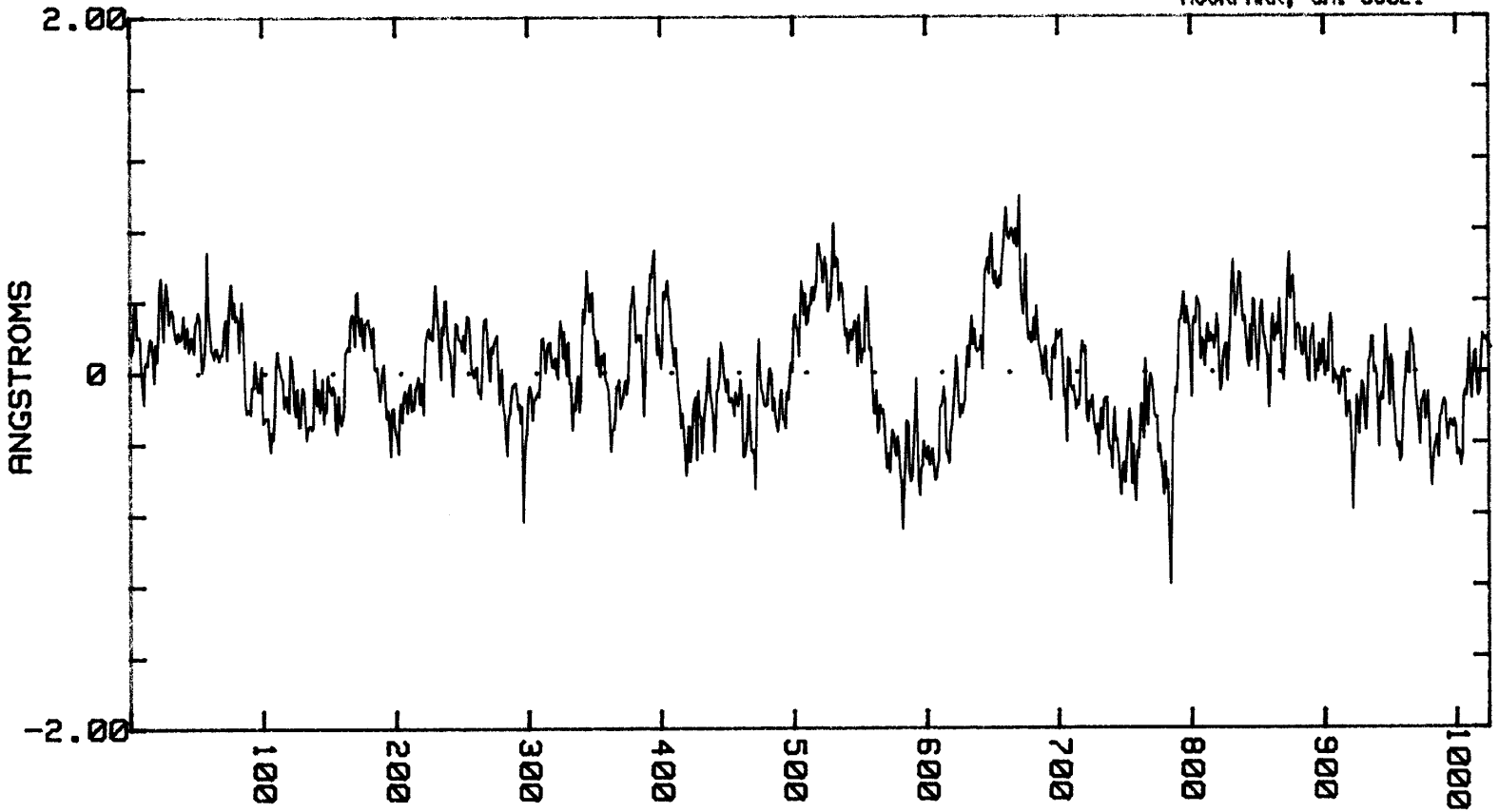


J-6108 LIGO TEST MASS SPETM07A S-2

Processed
RMS 0.31 angstroms
P-V 2.19
1024 points

16 Oct 1997 08:51:25

GENERAL OPTICS, INC.
(805) 529-3324
554 FLINN AVENUE
MOORPARK, CA. 93021



GENERAL OPTICS, INC.

554 Flinn Avenue
Moorpark, CA 93021

Phone: (805) 529-3324 Fax: (805) 529-4298 Email: genoptics@iccas.com

INVOICE NO
0000025316

Sales Order: 000003

Customer PO Number	Invoice Date	Terms	FOB	Ship Via
PC203459	10/31/1997	NET 30	MOORPARK	WILL CALL

Cust No: 000110 Buyer: TINA LOWENTHAL Phone (818) 395-6278 Fax (818) 577-5693

Bill to : CAL TECH
ACCOUNTS PAYABLE 201-6
PASADENA, CA 91125
USA

Ship to : CAL TECH
LIGO 75 AK
391 SOUTH HOLLISTON AVENUE
PASADENA, CA 91125
USA

Item	Cust #-Part No. / Description / Details	Quantity	Unit Price	Extended Price
000001	POLISH LIGO TEST MASS per Specification E950104-A-D and per Drawing D960791-A-D. All work performed on a best-effort basis. S/N: SPETM07A Data Included with shipment: - Certificate of Compliance - Inspection Data Sheet - Interferograms, both sides - Profiler Readouts, both sides	1 EA		

Rec'd 10-31-97

J-6108, 6118

PACKING SLIP


MIRROR

Research Electro-Optics Inc.

CERTIFICATE OF CONFORMANCE

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

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

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

- Date of Shipment: 06/21/99
- Customer Name Purchase Order No.: California Inst. of Tech / PC162519/C0N05
- Customer Part Number & Revision: LIGOE980068
- Part Description: END TEST MASS, COATED
- REO Job No.: OPT05831-28 Run No: OX987/OX991
- Qty. Shipped/Lot No.: 2 PCS / M1001-01

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

Comments:

SPETMØ5

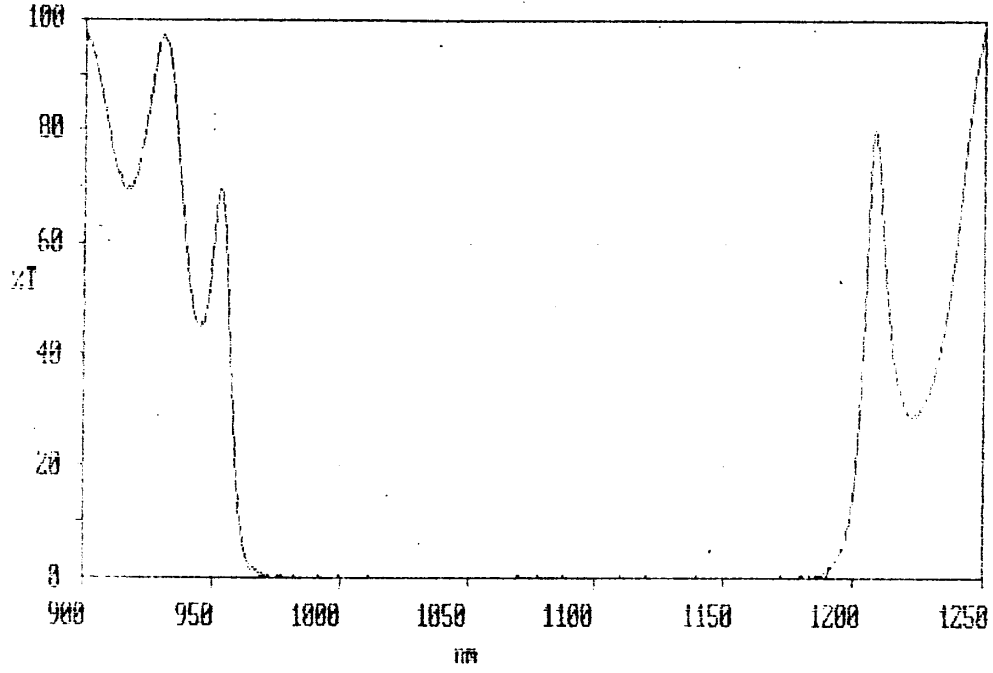
SPETMØ7

Certified by: Jesus Reinado Quality Assurance 6/21/99 **Date**

Verified by: Dale C Nestd Engr/Tech 21 June 99 **Date**

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

X: user003: 1250.0 - 900.0 nm; pts 1751; int 0.20; ord -0.449 - 98.191 %T
Inf: 0X987, HR @ 1064nm, SPETM05,07 baked, 1" FS witness piece



X: user003: 1250.0 - 900.0 nm; pts 1751; int 0.20; ord -0.217 - 97.260 %T
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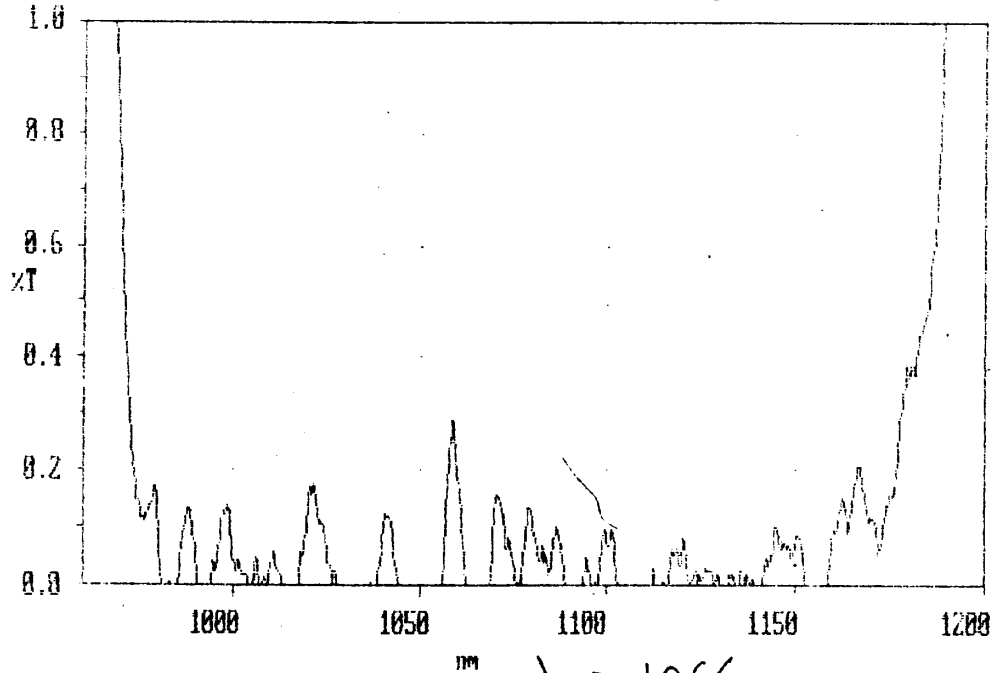

$\lambda_c = 1066\,nm$

V: user002; 1100.0 - 1000.0 nm; pts 1001; int 0.10; ord -0.007 - 0.1762 %T
Inf: 0X991, AR @ 1064nm, SPETM05,07 baked, 1" fs witness