

SPETM06

LIGO-T990177-00-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: 10-15-97

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 06A

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 Number E950104-A-D
Serial Number SP ETM 06A

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

October 15, 1997

Feature	Requirement	Measured
<u>Side 1</u>		
Spherical Measurement	<1/20 th Wave Concave	.020 λ P-V
Radius of Curvature	7400 M. \pm 220 M.	7478.43 M.
Micro Roughness (rms)	< 1 \AA rms	.30 \AA rms
Surface Quality	< 10 Defects Entire Surface	Verified
<u>Side 2</u>		
Flatness	< 1/10 λ P-V	.062 λ P-V
Micro Roughness (rms)	< 1 \AA rms	.33 \AA rms
Surface Quality	< 10 Defects Entire Surface	Verified
<u>Substrate Features</u>		
Diameter of -A-	250 mm +1 mm / -0 mm	250.54 mm
Thickness (to sharp corner)	100 mm +0 mm / -.5mm	99.95 mm
Wedge (Surface 2)	2 $^{\circ}$ \pm 5'	1 $^{\circ}$ 58'
Chamfers, After Polish, Surface 1	2 mm \pm 0.3 mm (2 pls)	1.98 mm
Chamfers, After Polish, Surface 2	2 mm \pm 0.3 mm (2 pls)	2.03 mm

A. DCN: LIGO-T970019-00-D

B. LIGO S/N: SPETM06-A

LIGO DETECTOR OPTICS
Incoming Inspection Check-off Sheet
Core Optics Polished Substrate

Page 1 of 2

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 203459 D. Substrate Polisher: General OpticsE. Core optic Material: BS / FM / 2ITM / 4ITM / (ETM/SP) RM F. Date Received: 10-20-97G. 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 in ASCII format of all Surface Data per the applicable LIGO Component Specification sheet. No data disk presentJ. 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 9.86 in 250.54 mm Inspection of material thickness Thickness 3.94 in 99.95 mmN. 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: [Signature] Date Inspected: 10-20-97

Reviewed and/or accepted by:

Cognizant Engineer: _____ Date: _____

LIGO QA Officer or Designee: _____ Date: _____

LIGO DETECTOR OPTICS
Incoming Inspection Check-off Sheet

Core Optics Polished Substrate

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

No data disc present.

SKETCHES:

DISPOSITIONS: _____

Figure 2

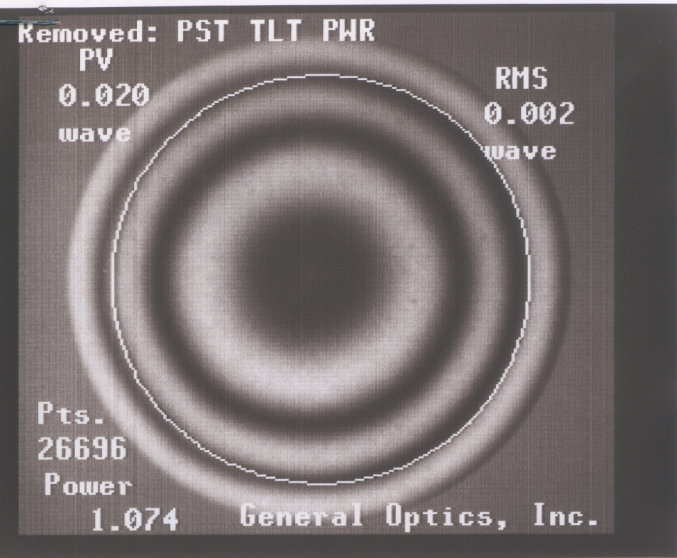
Substrate, SP End Test Mass	Serial Number:		Specification	Reported Value	✓
	Surface 1	Spherical Measurement	< 1/20 wave (13.64nm)	< 1/20 wave (12.66nm PV)	✓
		Absolute Radius of Curvature Tolerance	7,400m + 220m - 220m	7478 m	✓
		Astigmatism	< 10nm p-v		
	Surface 2	Spherical Measurement	< 1/10 wave (63.28nm)	39.23	✓
		Radius of Curvature	> 80 Km		
		Astigmatism	< 64nm p-v		
	Physical Dimensions	Substrate Diameter	250mm +1mm/-0mm	250.54 mm	✓
		Substrate Thickness	100mm +0/- .5mm	99.95 mm	✓
		Wedge Angle, Surface 2	2° ± 5'	1° 58'	✓
Physical Dimensions	Chamfers, After Polish				
	Side 1 Side 2	2mm ± 0.3mm 2mm ± 0.3mm	1.98 mm 2.03 mm	✓ ✓	
Surface Error	High Spatial Frequency Band Central 80 & 200 mm	$\sigma_{rms} < 0.1nm$.33Å rms	✓	

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		

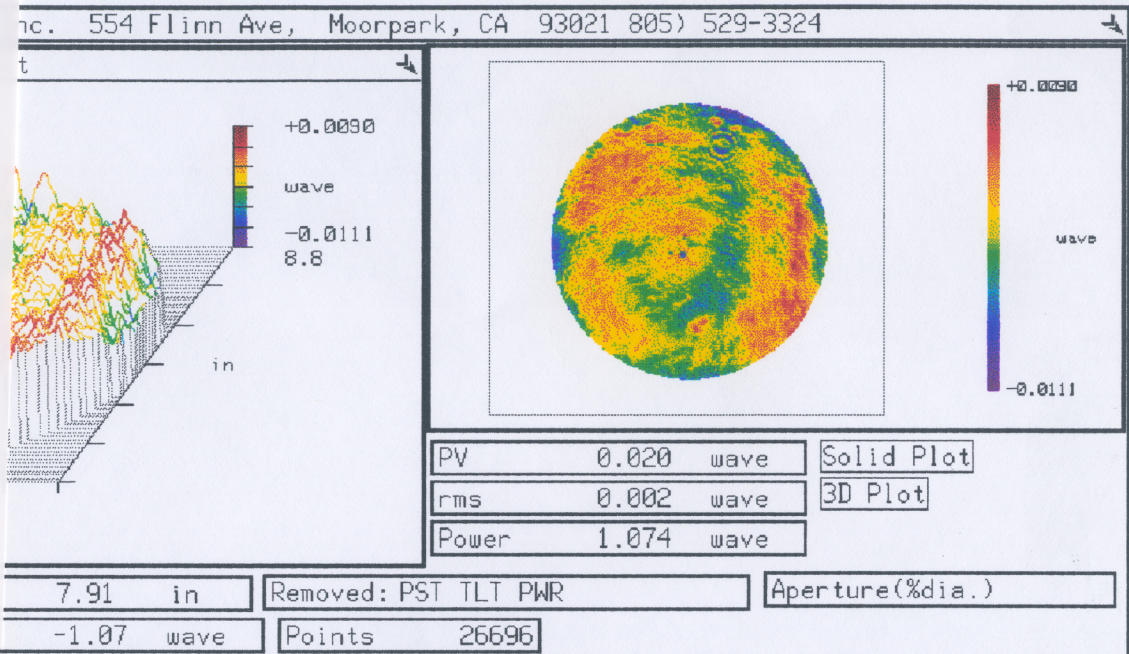
**LIGO Component Specification Verification Sheet
Super Polished End Test Mass**

Scratches, Point Defects & Polish Side 2	Specification		Certification	✓
	Scratches	The total area of scratches shall not exceed 1×10^6 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**



SIDE 1
 SP ETM 06A



zygo Surface/Wavefront Map

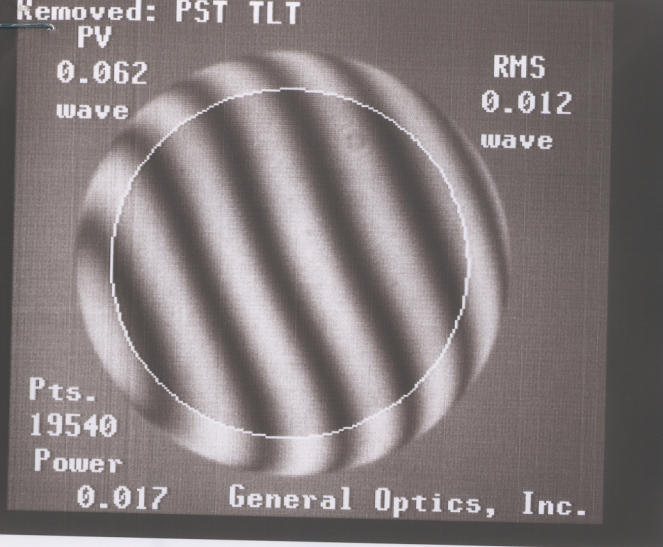
Remove
 PST TLT PWR AST CMA SA3

Auto Aperture: Off
 Aperture Size (%dia.) 100
 Trim Mode: Outside Trim: 0
 Filter: Off
 Filter Type: Average
 Filter Trim: Off
 Filter Window Size: 3

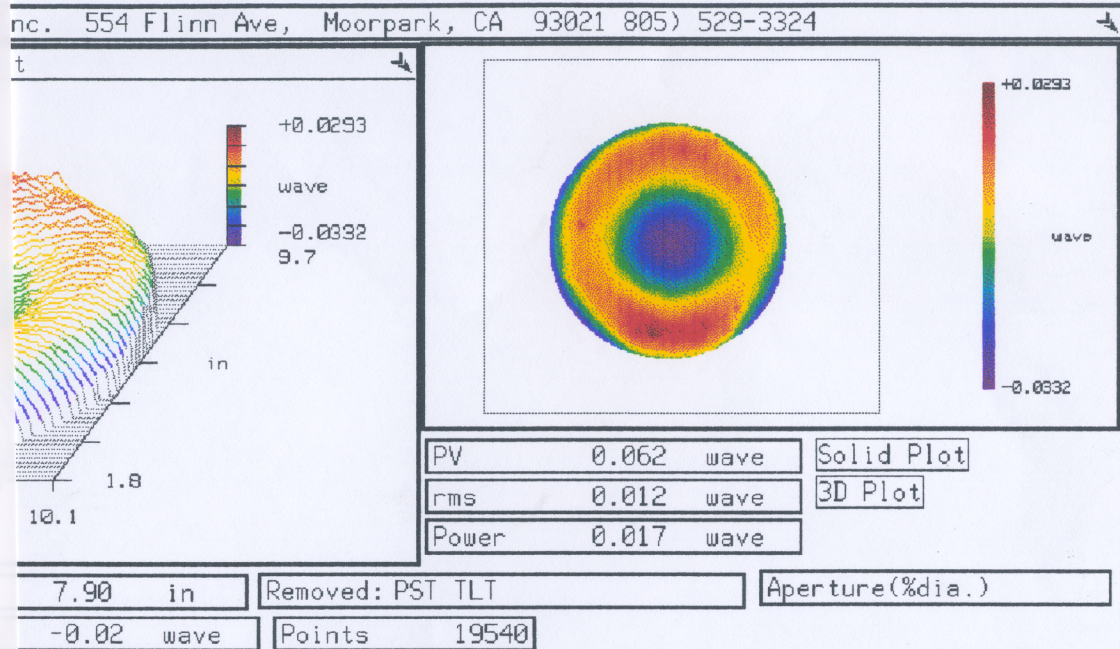
Measurement Controls

Part Number: LIGO TEST MASS - SIDE 1
 Serial Number: SP-ETM-06A
 Inspector: GENE LAPP
 Intf Scale Factor: 0.5
 Refractive Index: 1.500000
 Time: Fri Aug 15 13:41:50 1997
 Instrument: Mark IVxp Id 0 SN 4532 SB 0
 Wavelength-In: 6328.0 A
 Subtract Sys Err: Off
 Discon Action: Ignore

Min Mod Pct: 3
 Intens Avgs: 4
 Phase Avgs: 4
 Phase Res: Normal
 AGC: On
 AGC Mode: Normal Reflectivity
 Phase Avg Pause: Off
 Wavelength-Out: 6328.0 A
 Sys Err File: SysErr.dat
 Discon Filter: 45
 Light Level: 17



SIDE 2
SP ETM 06A

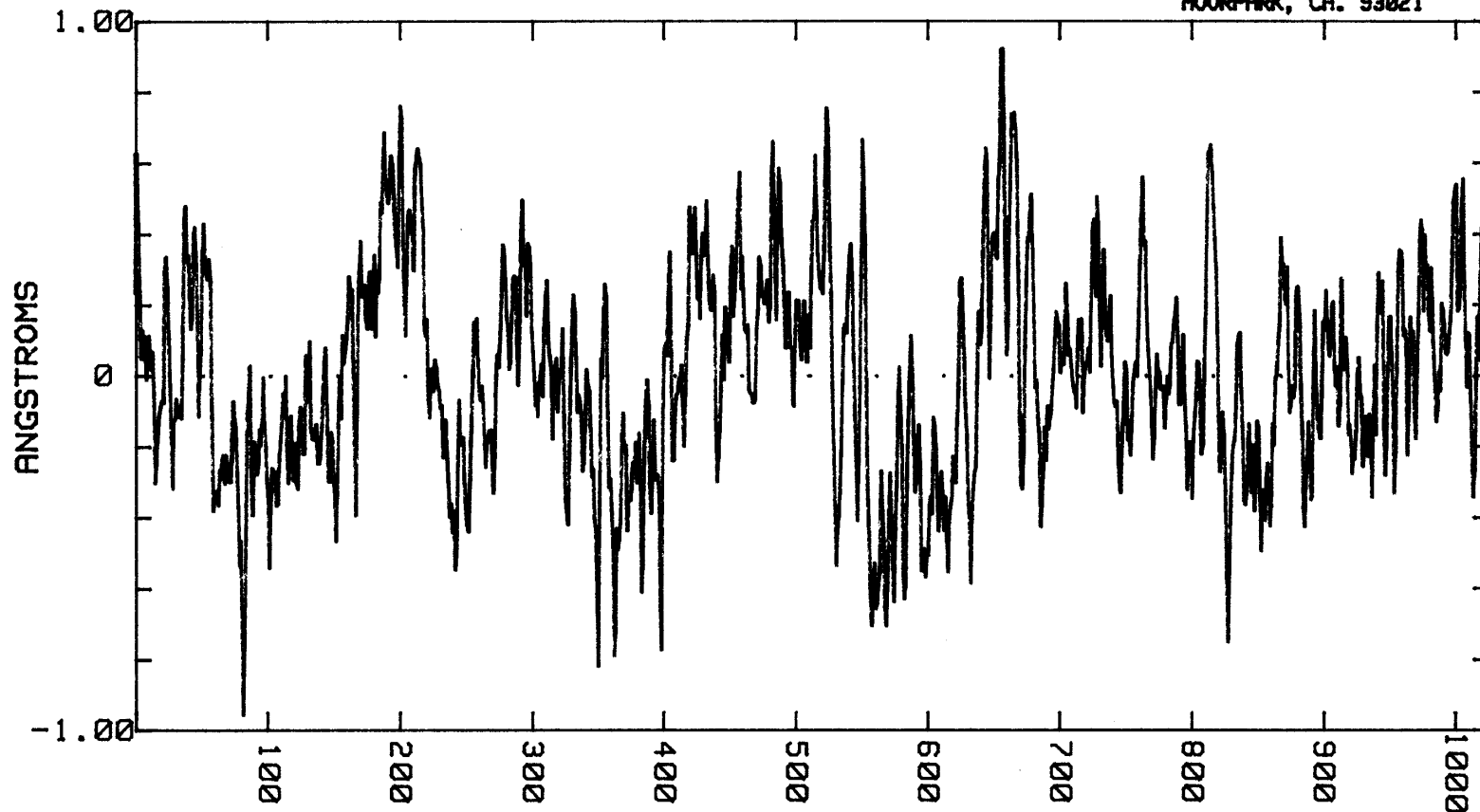


zygo Surface/Wavefront Map		Measurement Controls	
Remove PST TLT PWR AST CMA SA3		Part Number: LIGO TEST MASS SIDE-2	
Auto Aperture: Off		Serial Number: SPETM-06A Min Mod Pct: 3	
Aperture Size (%dia.) 80		Inspector: J. LONGO Intens Avgs: 4	
Trim Mode: Outside Trim: 0		Intf Scale Factor: 0.5 Phase Avgs: 4	
Filter: Off		Refractive Index: 1.500000 AGC: On Phase Res: Normal	
Filter Type: Average		Time: Tue Aug 5 06:41:52 1997 AGC Mode: Normal Reflectivity	
Filter Trim: Off		Instrument: Mark IVxp Id 0 SN 4532 SB 0 Phase Avg Pause: Off	
Filter Window Size: 3		Wavelength-In: 6328.0 A Wavelength-Out: 6328.0 A	
		Subtract Sys Err: Off Sys Err File: SysErr.dat	
		Discon Action: Ignore Discon Filter: 45 Light Level: 48	

J-6108 LIGO TEST MASS SP ETM 06A S-1

Processed
RMS 0.30 angstroms
P-V 1.88
1024 points

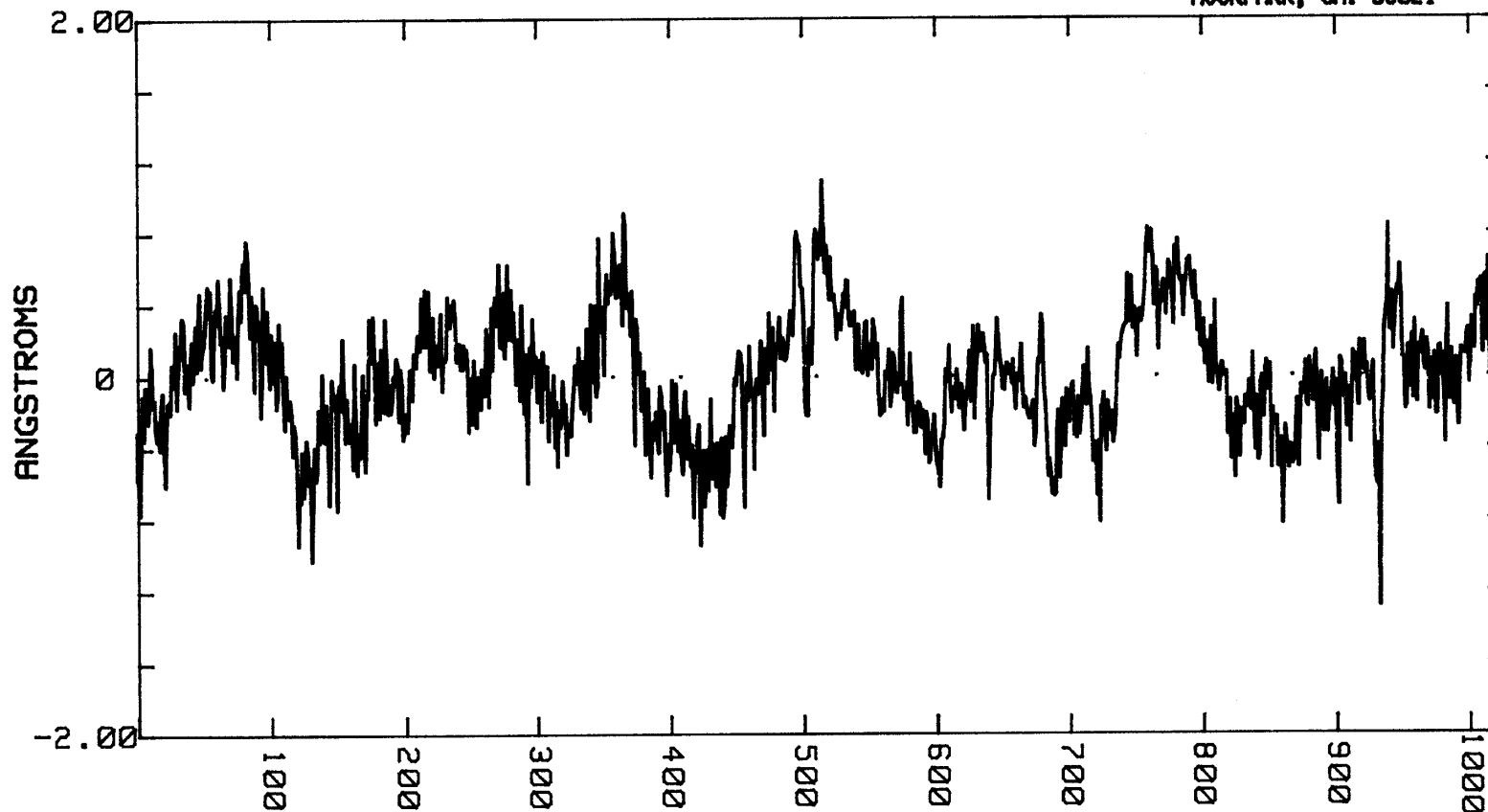
15 Aug 1997 14:49:11
GENERAL OPTICS, INC.
(805) 529-3324
554 FLINN AVENUE
MOORPARK, CA. 93021



J-6108 LIGO TEST MASS SPETM06A S-2

Processed
RMS 0.33 angstroms
P-V 2.38
1024 points

5 Aug 1997 09:05:23
GENERAL OPTICS, INC.
(805) 529-3324
554 FLINN AVENUE
MOORPARK, CA. 93021





GENERAL OPTICS, INC.

554 Flinn Avenue
Moorpark, CA 93021

INVOICE NO
0000025253

Phone: (805) 529-3324

Fax: (805) 529-4298

Email: genoptics@iccas.com

Sales Order: 000003

Customer PO Number	Invoice Date	Terms	FOB	Ship Via
PC203459	10/20/1997	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	<p>POLISH LIGO TEST MASS per Specification E950104-A-D and per Drawing D960791-A-D.</p> <p>All work to be performed on a best-effort basis.</p> <p>S/N: SPETM06A</p> <p>Data Included with shipment: - Certificate of Compliance - Inspection Data Sheet - Interferograms, both sides - Profiler Readouts, both sides</p> <p>J-6108, 6118</p>	1 EA		