

MAGELLAN PROJECT	
DOC #	<u>99GE0014</u>
DATE	<u>7-23-99</u>

Magellan Project  
#1 f/11 Secondary Mirror

Final Test Results

Contraves Brashear Systems  
7-23-99

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 1

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 2.1 Surface Figure

Parameter: Vertex Radius and Conic Constant

Method:  
Test and Analysis

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

Vertex radius and conic constant shall meet the specifications below. An additional combined specification of the vertex radius and conic constant shall also be met.

Vertex Radius:  $R_c = 2862.5 \pm 5\text{mm}$

Conic Constant:  $K = -0.63349 \pm 1.0\text{e-}3$

Combined Specification:  $\left| \Delta R_c - \frac{\Delta K}{1 \times 10^{-4}} \right| < 4.5\text{mm}$

**VERIFICATION APPROACH:**

Verification shall be by a conic conjugate test. Using measured wavefront Zernike terms along with the test parameters of thicknesses, radii, etc. raytrace best fit radius and conic using Zemax-EE.

Vertex Radius:

112.700 +/- 0.010 inch

Conic Constant:

-0.63358 +/- 0.00014

Combined Specification:

0.8 mm

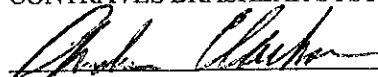
RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

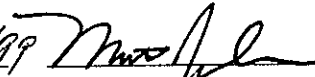
**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW



DATE 7/23/99



DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

*6.2.1 v.1 con] will 1.5 p6. sent to Matt Johns*

ZEMAX-EE - [C:\My Documents\CLARKSON\ZEMAX\magellan\sectactualconf\SN1.ZMX]

File Editors System Analysis Tools Reports Macros Extensions Window Help

Save Upa Gen Adv File Wav MFE Lay L3d Rms Rmf Rtr Int Zfr Enc Opt Gla Len Sys Pre

Surf:Type	Comment	Radius	Thickness	Glass	Semi-Diameter	Conic	Par 1 (unused)	Par 2
OBJ Standard	ACTUAL AIR	Infinity	552.390000	4-1/4"	0.000000	0.000000		
STO Standard	OPTIMIZED	-112.700252	61.839500	4-1/2" MIRROR	26.400000	-0.633579	V	<del>27</del>
2 Standard	CX TP RETRO	-0.912000	61.839500	MIRROR	0.369133	0.000000		47.00014
3 Standard		-112.700252	-552.390000	MIRROR P	26.400000	-0.633579	P	
IMA Standard		Infinity			3.19389e-011	0.000000		

*Actual figure with conjugate measurement uncertainty*

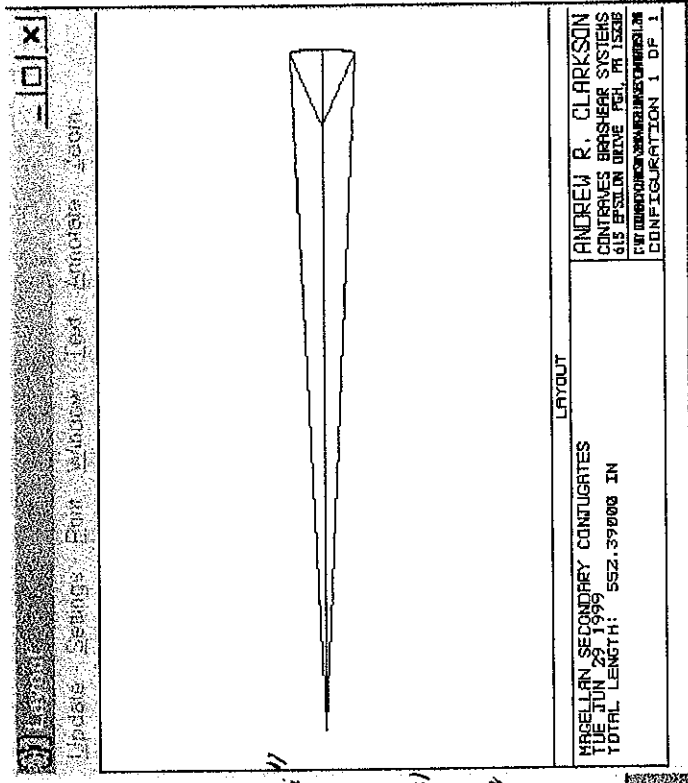
The RMS (to centroid) is the RMS after subtracting c...  
 The RMS (to centroid) is most physically significant  
 is meant by 'the RMS'. Although ZEMAX uses the term  
 the reference point is not the diffraction intensity  
 point which minimizes the variance of the wavefront.

Using Zernike Fringe polynomial set.

Field : 0.0000 deg  
 Wavelength : 0.6328 microns  
 Peak to Valley : 0.000000 waves  
 RMS (to chief) : 0.000000 waves  
 RMS (to centroid) : 0.000000 waves  
 Variance : 0.000000 waves squared  
 Strehl Ratio (Est): 1.000000  
 RMS fit error : 0.000000 waves  
 Maximum fit error : 0.000000 waves

2 1 0.000000 : 1

*ARC  
 7/23/99  
 Re-measured  
 Tape 478.95"  
 -WOP F/7.2 = 26.64"  
 Cell Sag Note > 6.00"  
 Long Conj = 552.34"  
 Short Conj 61.8395"*



EFFL -41.2058

WFNO: 10.4151

ENPD: 52.8000

TOTR: 552.3900

ZEMAX-EE - [C:\My Documents\CLARKSON\ZEMAX\magellan\sectactualconf\SN1.ZMX]

Update Settings

Update Settings Emf Window

Surf:Type	Comment	Radius	Thickness	Glass	Semi-Diameter	Conic	Par 1 (unused)	Par 2
OBJ	Standard	Infinity	552.221529 V		0.000000	0.000000		
STO	Standard	-112.696900	-61.751596 V	MIRROR	26.400000 U	-0.633490		
2	Standard	RETRO	61.751596 P	MIRROR	0.404751	0.000000		
3	Standard	-112.696900 P	-552.221529 P	MIRROR P	26.400000	-0.633490 P		
IMA	Standard	Infinity			6.63995e-010	0.000000		

6/29/99 48 3 1/8"

48' 3" = 579.0

Steel Tape

Zygo F/7.2

WD 676.0 ± 26.644"

Long Conjug = 552.394/4"

Actual to focus

Actual short = 62.7515  
to focus 4.002"

61.8395  
61.840

Note that RMS (to chief) is the RMS of the OPD after the RMS (to centroid) is the RMS after subtracting c The RMS (to centroid) is most physically significant is meant by 'the RMS'. Although ZEMAX uses the term the reference point is not the diffraction intensity point which minimizes the variance of the wavefront.

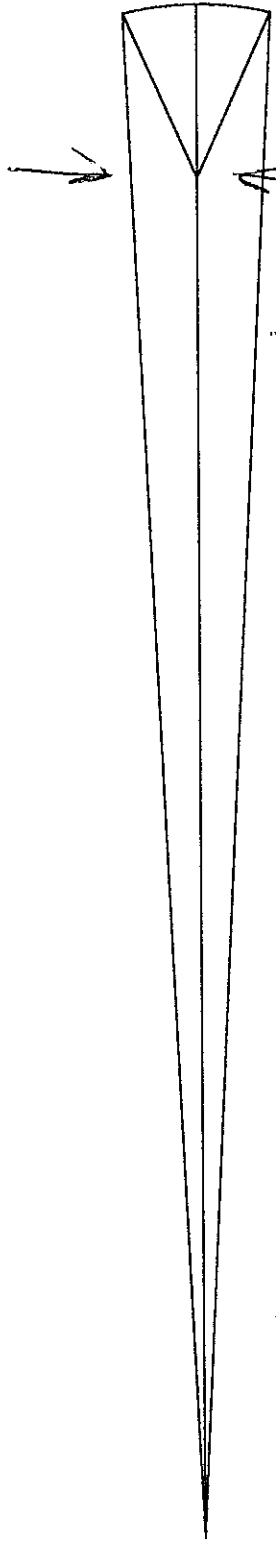
Using Zernike Fringe polynomial set.

Field : 0.0000 deg  
Wavelength : 0.6328 microns  
Peak to Valley : 0.000000 waves  
RMS (to chief) : 0.000000 waves  
RMS (to centroid) : 0.000000 waves  
Variance : 0.000000 waves squared  
Strehl Ratio (Est): 1.000000

MAGELLAN SECONDARY CONJUGATES  
FILED JUN 28 1999  
TOTAL LENGTH: 552.22153 IN  
LAYOUT  
ANDREW R. CLARKSON  
CONTRAVES BARBER SYSTEMS  
415 EUSLIM DRIVE PER. #1 J526  
PER INFORMATION@CONTRAVES.COM  
CONFIGURATION 1 OF 1

Actual 6/29/99  
 Air 61-8395<sup>h</sup>

With  $\rightarrow$  CX retro testplate  $\cdot 9/20$   
 (radius verified with CC testplate)



Long Conjugate "

552.2215

( $\pm .001$  short conjugate =  $\pm .0749$ " long conjugate.)

Short

1.000"

Concave retro nominal

Set up Short Conjugate

62.7516" - convex retro radius

Adjust for minimal spherical  
 Tolerance  $\pm .002$ "

Measurement  
 a.c. very tolerance

$\pm .002$ "

LAYOUT

MAGELLAN SECONDARY CONJUGATES  
 MON JUN 28 1999  
 TOTAL LENGTH: 552.22153 IN

ANDREW R. CLARKSON  
 CONTRAVES BRASHEAR SYSTEMS  
 615 EPSILON DRIVE PCH, PA 15238  
 C:\MY DOCUMENTS\CLARKSON\ZEPHYR\MAGELLAN\SEC\CONJUGATES\1.ZWY  
 CONFIGURATION 1 OF 1

Listing of Zernike Fringe Coefficient Data

file : C:\My Documents\CLARKSON\ZEMAX\magellan\sec\conjugatesN1.ZMX  
 Title: Magellan Secondary Conjugates  
 Date : MON JUN 28 1999

Note that RMS (to chief) is the RMS of the OPD after subtracting out piston.  
 The RMS (to centroid) is the RMS after subtracting out both piston and tilt.  
 The RMS (to centroid) is most physically significant and is generally what  
 is meant by 'the RMS'. Although ZEMAX uses the term 'centroid' for brevity,  
 the reference point is not the diffraction intensity centroid, but the reference  
 point which minimizes the variance of the wavefront.

Using Zernike Fringe polynomial set.

Field : 0.0000 deg  
 Wavelength : 0.6328 microns  
 Peak to Valley : 0.116084 waves  
 RMS (to chief) : 0.030286 waves  
 RMS (to centroid) : 0.030286 waves  
 Variance : 0.000917 waves squared  
 Strehl Ratio (Est): 0.964436

RMS fit error : 0.000000 waves  
 Maximum fit error : 0.000000 waves

Z 1	0.012523	:	1
Z 2	0.000000	:	(p) * COS (A)
Z 3	-0.000000	:	(p) * SIN (A)
Z 4	-0.037351	:	(2p^2 - 1)
Z 5	0.000000	:	(p^2) * COS (2A)
Z 6	0.000000	:	(p^2) * SIN (2A)
Z 7	0.000000	:	(3p^2 - 2) p * COS (A)
Z 8	-0.000000	:	(3p^2 - 2) p * SIN (A)
Z 9	-0.049513	:	(6p^4 - 6p^2 + 1)
Z 10	-0.000000	:	(p^3) * COS (3A)
Z 11	0.000000	:	(p^3) * SIN (3A)
Z 12	0.000000	:	(4p^2-3) p^2 * COS (2A)
Z 13	0.000000	:	(4p^2-3) p^2 * SIN (2A)
Z 14	-0.000000	:	(10p^4 - 12p^2 + 3) p * COS (A)
Z 15	-0.000000	:	(10p^4 - 12p^2 + 3) p * SIN (A)
Z 16	0.000357	:	(20p^6 - 30p^4 + 12p^2 - 1)
Z 17	0.000000	:	(p^4) * COS (4A)
Z 18	-0.000000	:	(p^4) * SIN (4A)
Z 19	-0.000000	:	(5p^2 - 4) p^3 * COS (3A)
Z 20	0.000000	:	(5p^2 - 4) p^3 * SIN (3A)
Z 21	0.000000	:	(15p^4 - 20p^2 + 6) p^2 * COS (2A)
Z 22	0.000000	:	(15p^4 - 20p^2 + 6) p^2 * SIN (2A)
Z 23	-0.000000	:	(35p^6 - 60p^4 + 30p^2 - 4) p * COS (A)
Z 24	-0.000000	:	(35p^6 - 60p^4 + 30p^2 - 4) p * SIN (A)
Z 25	-0.000004	:	(70p^8 - 140p^6 + 90p^4 - 20p^2 + 1)
Z 26	-0.000000	:	(p^5) * COS (5A)
Z 27	-0.000000	:	(p^5) * SIN (5A)
Z 28	0.000000	:	(6p^2 - 5) p^4 * COS (4A)
Z 29	0.000000	:	(6p^2 - 5) p^4 * SIN (4A)
Z 30	-0.000000	:	(21p^4 - 30p^2 + 10) p^3 * COS (3A)
Z 31	0.000000	:	(21p^4 - 30p^2 + 10) p^3 * SIN (3A)
Z 32	0.000000	:	(56p^6 - 105p^4 + 60p^2 - 10) p^2 * COS (2A)
Z 33	0.000000	:	(56p^6 - 105p^4 + 60p^2 - 10) p^2 * SIN (2A)
Z 34	0.000000	:	(126 p^8 - 280p^6 + 210p^4 - 60p^2 + 5) p * COS (A)
Z 35	-0.000000	:	(126 p^8 - 280p^6 + 210p^4 - 60p^2 + 5) p * SIN (A)
Z 36	0.000000	:	(252p^10 - 630p^8 + 560p^6 - 210p^4 + 30p^2 - 1)
Z 37	-0.000000	:	(924p^12 - 2772p^10 + 3150p^8 - 1680p^6 + 420p^4 - 42p^2 + 1)

$\Delta$  Nominal Short Conj  $H=0.001$ <sup>h</sup>  
 Long Conj  $H=0.075$ <sup>h</sup>

Surf:Type	Comment	Radius	Thickness	Glass	Semi-Diameter	Conic	Par 1 (unused)	Par :
OBJ Standard	ACTUAL AIR	Infinity	552.640000	$f=25''$	0.000000	0.000000		
STO Standard	OPTIMIZED	-112.702391 V	-61.837500	$f=20L$ MIRROR	26.400000 U	-0.633579		
2 Standard	CX TP RETRO	-0.912000	61.837500 P	MIRROR	0.369079	0.000000		
3 Standard		-112.702391 P	-552.640000 P	MIRROR P	26.390009	-0.633579 P		
IMA Standard		Infinity			0.001208	0.000000		

*Conjugate uncertainties max WFE*

ZEMAX SEESION Edit Saves Options Help

Update Settings Print Window Edit Annotate Zoom

Field : 0.0000 deg  
 Wavelength : 0.6328 microns  
 Peak to Valley : 0.371465 waves  
 RMS (to chief) : 0.096960 waves  
 RMS (to centroid) : 0.096960 waves  
 Variance : 0.009401 waves squared  
 Strehl Ratio (Est): 0.689945

RMS fit error : 0.000000 waves  
 Maximum fit error : 0.000000 waves

Z 1 -0.093281 : 1  
 Z 2 -0.000000 : (p) \* COS (A)  
 Z 3 0.000000 : (p) \* SIN (A)  
 Z 4 0.119923 : (2p^2 - 1)  
 Z 5 -0.000000 : (p^2) \* COS (2A)  
 Z 6 -0.000000 : (p^2) \* SIN (2A)  
 Z 7 0.000000 : (3p^2 - 2) p \* COS (A)  
 Z 8 0.000000 : (3p^2 - 2) p \* SIN (A)

*Handwritten:  $f=25$*

ZEMAX SEESION Edit Saves Options Help

Update Settings Print Window Edit Annotate Zoom

LAYOUT

MAGELLAN SECONDARY CONTIGUATES  
 FILE JUN 29 1999  
 TOTAL LENGTH: 552.640000 IN

ANDREW R. CLARKSON  
 CONTABLES BRASS-HEAR SYSTEMS  
 615 EFTON DRIVE EPHRATA PA 15208  
 (717) 839-3333 FAX (717) 839-3334  
 CONFIGURATION 1 OF 1

Conjugate Test 23 Jul spw.dat

Aug 20 in Cell HLOS  
frenes

ARC  
7/23/99

**Z490** Surface/Wavefront Map

Points: 158259 Removed: PST TLT PWR CMA Trimmed: 0  
Aperture OD (\$): Aperture ID (\$): Filter: Off

**Z490** Measurement Attributes

Measurement Attributes

Data Sign: Normal  
Factor: 0.5

**Z490** Surface/Wavefront Map

**Z490** Zernike Polynomials

**Z490** Save Processed Data

Filled Plot  
Solid Plot  
Oblique Plot

rms 0.110 wave  
Power -0.013 wave  
Wavelength-Out: 632.8 nm  
Pts in PV Spec +/- 0.125 wave (\$)

Size X 1343.3 mm  
Size Y 1331.7 mm

**Z490** Zernike Coefficients from data points

Order	Terms	rms
1	0.000	0.007
2	0.007	0.003
3	0.008	0.005
4	0.008	0.005
5	0.008	0.005
6	0.008	0.005
7	0.008	0.005
8	0.008	0.005
9	0.008	0.005
10	0.008	0.005
11	0.008	0.005
12	0.008	0.005
13	0.008	0.005
14	0.008	0.005
15	0.008	0.005
16	0.008	0.005
17	0.008	0.005
18	0.008	0.005
19	0.008	0.005
20	0.008	0.005
21	0.008	0.005
22	0.008	0.005
23	0.008	0.005
24	0.008	0.005
25	0.008	0.005
26	0.008	0.005
27	0.008	0.005
28	0.008	0.005
29	0.008	0.005
30	0.008	0.005
31	0.008	0.005
32	0.008	0.005
33	0.008	0.005
34	0.008	0.005
35	0.008	0.005
36	0.008	0.005
37	0.008	0.005
38	0.008	0.005
39	0.008	0.005
40	0.008	0.005
41	0.008	0.005
42	0.008	0.005
43	0.008	0.005
44	0.008	0.005
45	0.008	0.005
46	0.008	0.005
47	0.008	0.005
48	0.008	0.005
49	0.008	0.005
50	0.008	0.005

**Z490** Seidel Coefficients

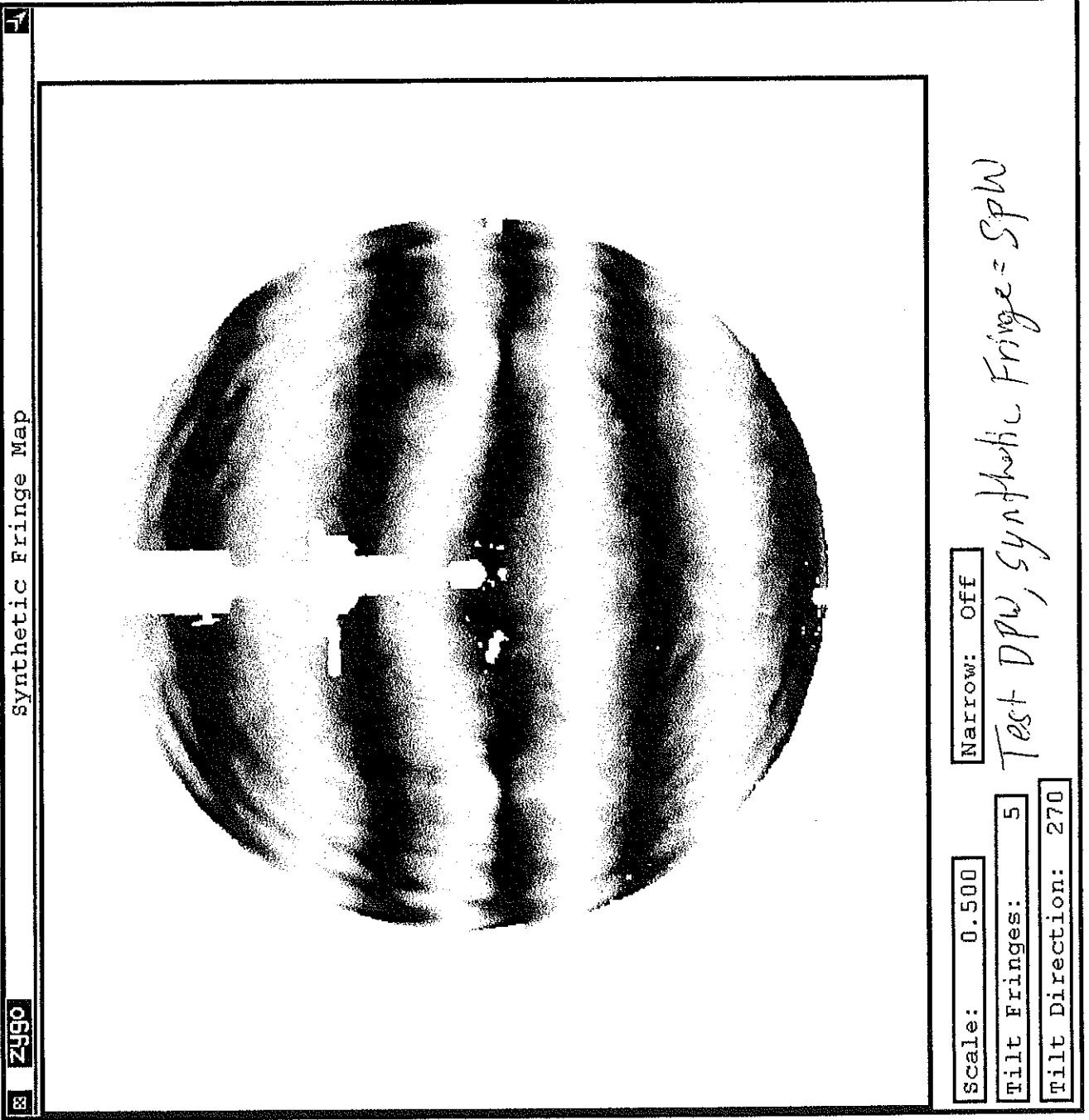
Aberration	Magnitude waves	Angle degs.
TILT	0.117	150
FOCUS	0.000	0.0
ASTIGMATISM	0.000	0.0
COMA	0.000	0.0
SPHERICAL	0.000	0.0

SPW



23 Jul spw.dat

ARC  
7/23/99



Synthetic Fringe Map

Zygo

Narrow: Off

Scale: 0.500

Tilt Fringes: 5

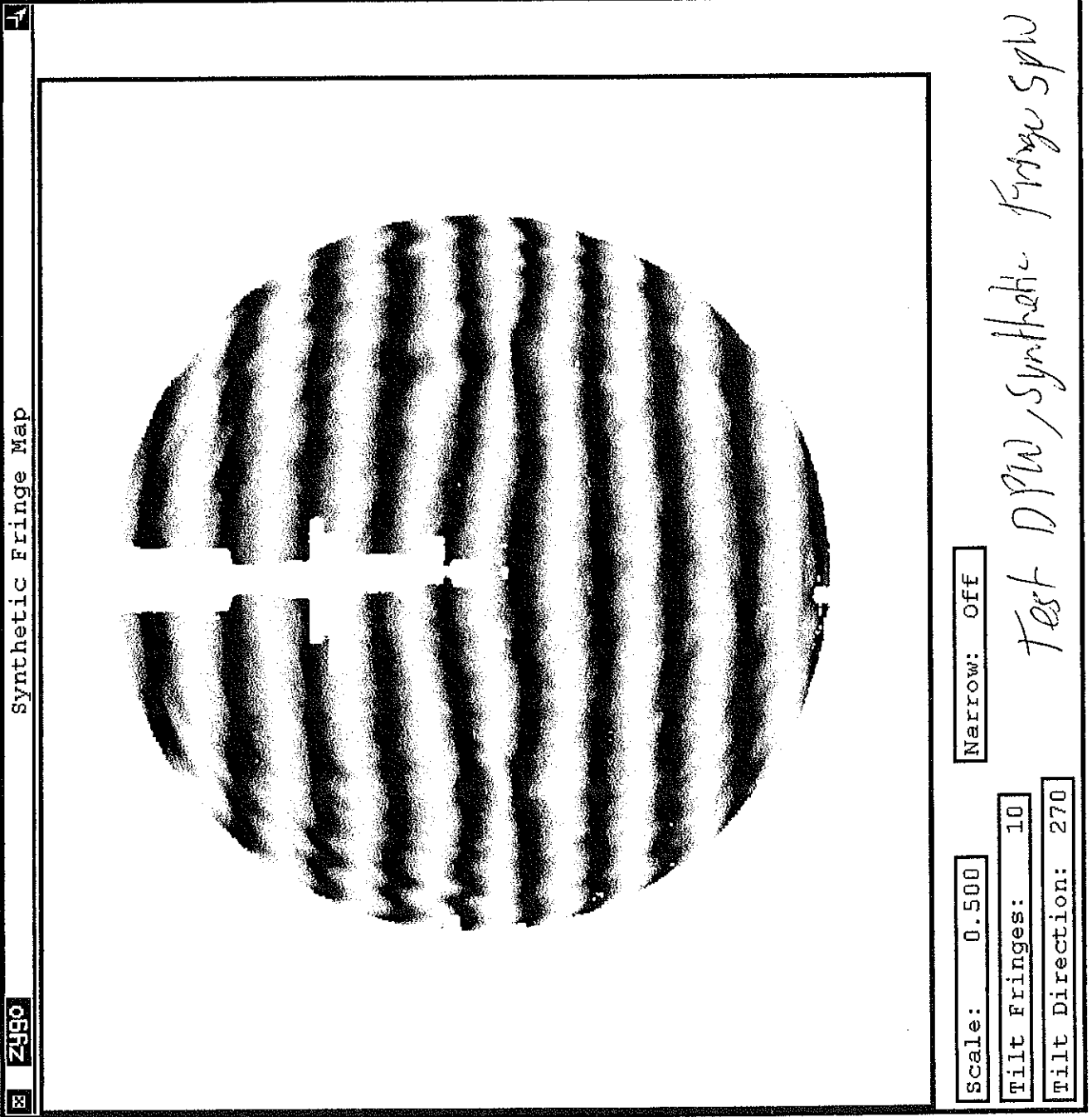
Tilt Direction: 270

Test DPW, Synthetic Fringe = SPW

SPW

23julspw-dat

AKC  
7/23/99



SPW

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project #11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 2

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 2.2 Clear Aperture

Parameter: Clear Aperture

Method:  
Test and Inspection

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

Outer clear aperture shall be 1339mm (52.72 inches). Inner clear aperture shall be 257mm (10.12 inches).

**VERIFICATION APPROACH:**

Four fiducials shall be placed at the outer clear aperture boundaries and four fiducials at the inner clear aperture boundaries. Verify visually that continual fringes exist beyond the fiducials on the interferogram.

Outer Clear Aperture

greater than 1339 mm

Inner Clear Aperture

less than 257 mm

RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

*As measured by Zygo Phase data 17 June testing in cell.*

**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW

*[Signature]*

DATE 7/23/99

*[Signature]*

DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 3

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 4.2 Centration Tolerance

Parameter: Centricity of Optical Axis to Mechanical Axis

Method:  
Test and Analysis

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

The optical axis shall be within 2mm of the mechanical axis.

**VERIFICATION APPROACH:**

Interferometric test with 0° and 180° positions. Use dial indicators to measure mechanical shift of mirror during rotation. Test for change in coma from the two positions. Raytrace system using mechanical shift and coma change to find location of optical axis relative to mechanical axis.

*The O.A. is 0.010" displaced from the mechanical center towards the right fiducial.*

RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW

*Anders Clarke*

DATE 7/23/99

*M. J. ...*

DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

Magellan Secondary  
Optical axis

$\Delta \text{image} .006''$

.003 TIR

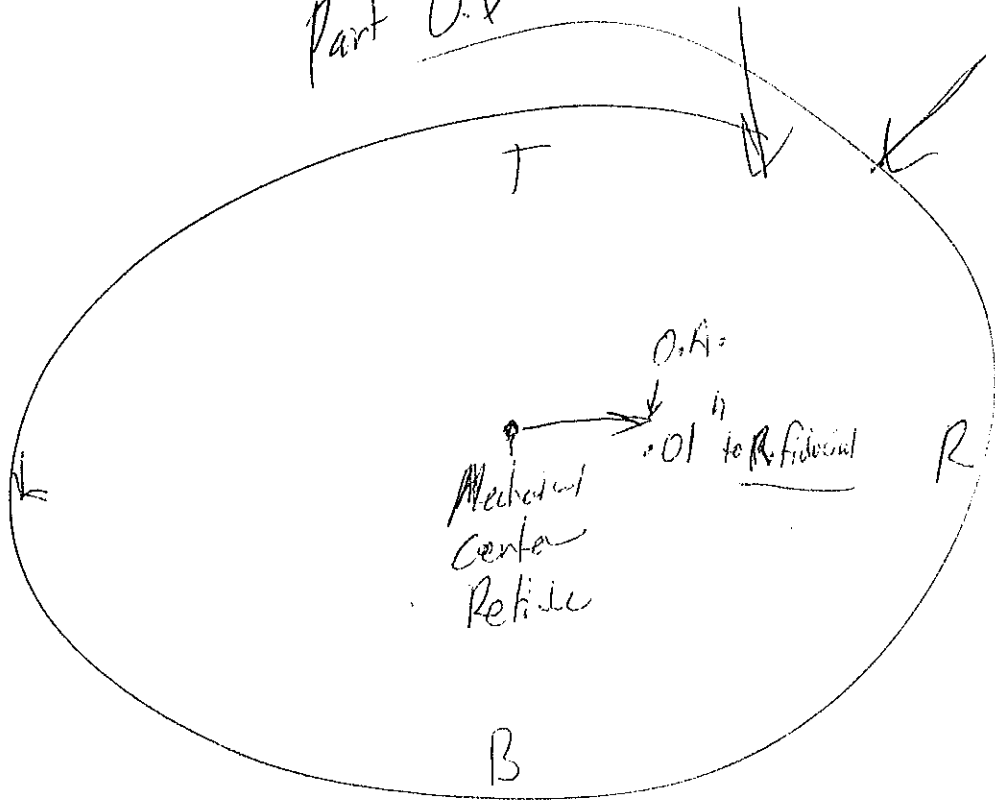
$\Delta \text{image} .003''$

Zero Reference  
Part O.D

Surface

.003'' TIR

O.D



measured on horizontal only shift null lens

180° part rotation

0° null zero coma

180° null plus coma Shift .020''

O.A. is 0.010''

ARC

5/27/99

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 4

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 5.1 Polish Area

Parameter: None

Method:  
Visual Inspection

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

Entire front face of mirror shall be polished.

**VERIFICATION APPROACH:**

Visual inspection of polished surface.

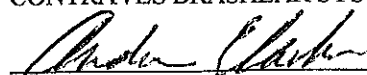
RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW



DATE 7/23/99



DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 5

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 5.2 Central Region

Parameter: None

Method:  
Visual Inspection

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

50mm central region of mirror shall be polished.

**VERIFICATION APPROACH:**

Visual inspection of polished surface.

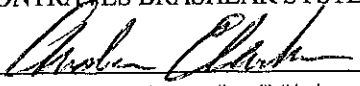
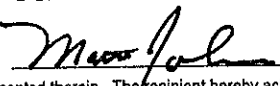
RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW

 DATE 7/23/99  DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 6

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 5.3 Surface Quality

Parameter: Structure Function

Method:  
Test and Analysis

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

Structure function shall have the following values.

S (cm)	$\sigma_{rms}$ (nm)	In Cell	Pitch Support
5	17	17 June	13 May
10	26	14.8 nm	13.2 nm
20	40	17.4	15.1
> 50	66	22.7	18.8
		35.4	30.8

**VERIFICATION APPROACH:**

The test method shall be in the vertical line of sight using the null lens. To simulate the zero g state, the secondary mirror shall be supported on its back on a layer of pitch. Interferometric data shall be taken at several orientations. Software shall be used to reduce the data into low order aberrations and high frequency errors. Correlation of data shall be made between null test and conjugate test.

RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW

*Charles Clark* DATE 7/23/99 *Marc J. ...* DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.



ARC  
6/17/99

In Cell Number LOS  
Q, R, S, T Ray

Magellan  
177junsur.dat

Surface/Wavefront Map

**Z490**

Save Processed Data

Rms 0.056 wave

Power 0.054 wave

Wavelength-Out: 632.8 nm

Pts in PV Spec +/- 0.125 wave (%) 98.1

Size X 1339.8 mm

Size Y 1336.7 mm

**Z490**

Oblique Plot

Points 144141 Removed: PST TLT PWR CMA

Aperture OD (%): [ ] Filter: Off

Aperture ID (%): [ ]

**Z490** Measurement Attributes

Fri Jun 04 03:34:57 1999

P/N: 95SE0512 REV B

Scale Factor: 0.5

---

**Z490** Measurement Controls

Comment: MAGELLAN 6.5M F/11 SECONDARY MIRROR

Part Number: 95SE0512 REV B

Serial Number: [ ]

Instrument: GPI Id 0 SN 65681 SB 0

Data Sign: Normal Max Sat Pts: 8

Intf Scale Factor: 0.5

F-number: 11.000

Exit Pupil Diam: 0 m

Part Thickness: 0 mm

Refractive Index: 1.00000

Wavelength-In: 632.8000 nm

Wavelength-Out: 632.6 nm

Manual Average

Add Data

Scale Data

Subtract Data

Invert Data

Rotate Data

Min Mod Pct: 10

Intens Avgs: 0

Phase Avgs: 0

Phase Res: High

AGC: On

Discon Action: Filter

Discon Filter: 60

Subtract Sys Err: Off

Sys Err File: SysErr.dat

Camera Mode: 640x480 25 Hz

Save Settings

Load Settings

Alignment Err: [ ]

Alignment: Fiducials

Alignment Tolerance: 2.0

Alignment Scaling: Isomorphic

Min Mod Pts: 10000

Light Level: 127

Light Level Pct: 50.3

Target Range: 0.10

AGC Mode: Normal Reflectivity

P2T Cal: Off

Surface

ARC  
6/17/99

17junsurZobmp

surface

**Zygo** Surface/Wavefront Map

**Zygo** Oblique Plot

Points 144141 Removed: PST TLT PWR CMA Trimmed: 0  
Aperture OD (%): Aperture ID (%): Filter: Off

**Zygo** Measurement Attributes

Fri Jun 04 03:34:57 1999 Data sign: Normal  
Factor: 0.5

**Zygo** Surface/Wavefront Map

**Zygo** Zernike Polynomials

data points

Order:	Terms:	rms:
0	-0.001 0.002	0.074
1	-0.015 0.017 0.008	0.017
2	0.049 0.004 0.002 -0.010 -0.002	0.002
3	0.003 0.000 0.010 0.014 -0.001 0.000 0.000	0.001
4	0.000 -0.001 0.000 -0.000 0.000 0.000 0.000 0.002	0.000
5	0.001 0.002 0.004 0.000 0.000 0.000 0.000 0.000 0.000	0.004
6	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000	0.001
7	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000
8	0.001 0.002 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.002
9	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.001
10	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000
11	0.001 0.002 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.002
12	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.001
13	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000
14	0.001 0.002 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.002
15	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.001
16	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000
17	0.001 0.002 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.002
18	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.001
19	0.000 0.000	0.000
20	0.001 0.002 0.002 0.000	0.002

**Zygo** Seidel Coefficients

From 3rd term Zernike fit

Aberration	Magnitude waves	Angle degs.
TILT	0.049	-1.38
FOCUS	-0.005	
ASTIGMATISM	0.000	0.01
COMA	0.004	4.0
SPHERICAL	0.000	

**Zygo** Save Processed Data

Peak Valley

+0.22372 -0.13608

Wave

rms 0.056 wave

Power 0.054 wave

Wavelength-Out: 632.8 nm

Pts in PV spec +/- 0.125 wave (%) 98.1

Size X 1339.8 mm

Size Y 1336.7 mm

**Zygo** Filled Plot

**Zygo** Solid Plot

**Zygo** Oblique Plot

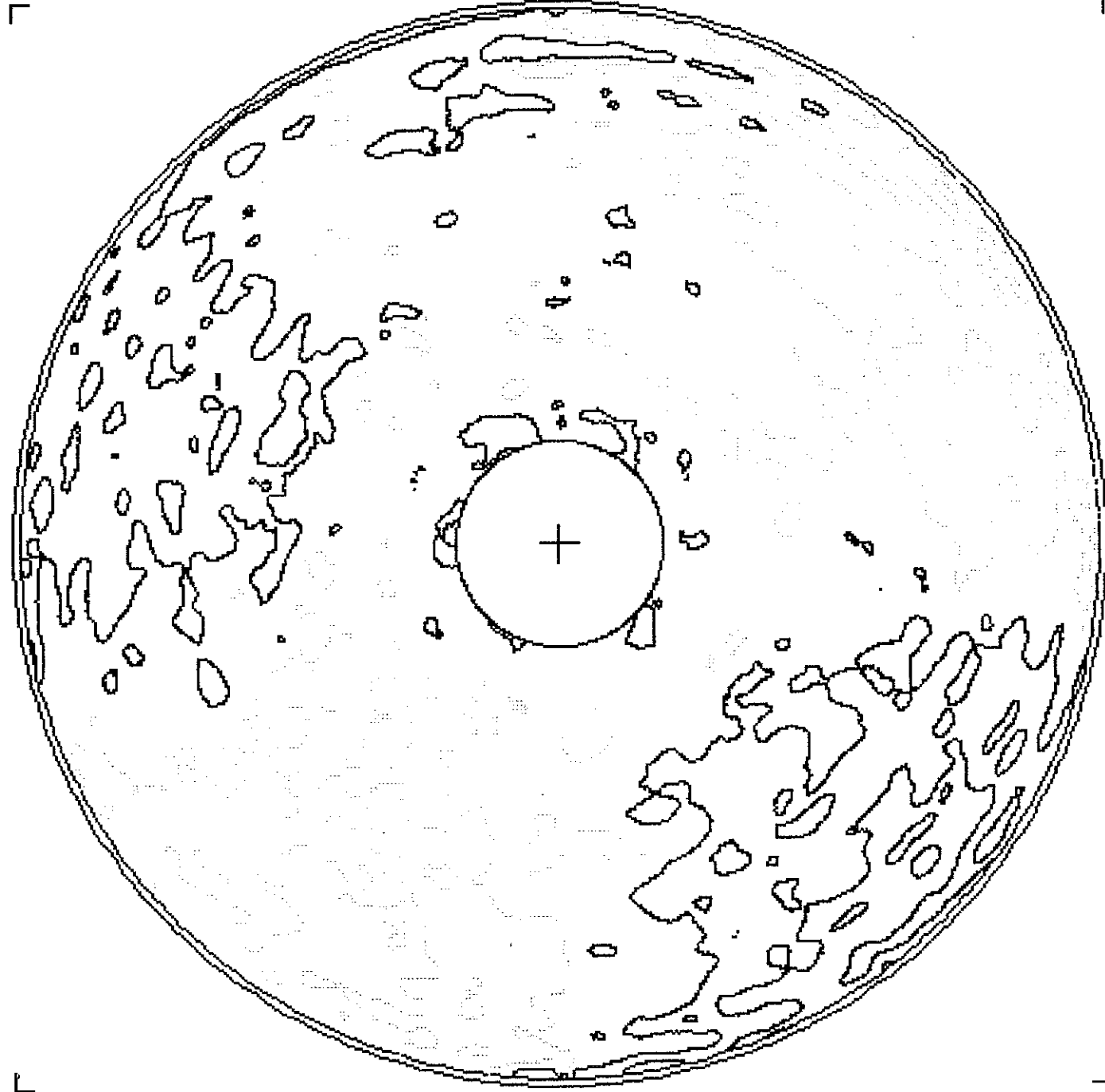
**Zygo** Surface/Wavefront Map

**Zygo** Zernike Polynomials

data points

Order:	Terms:	rms:
0	-0.001 0.002	0.074
1	-0.015 0.017 0.008	0.017
2	0.049 0.004 0.002 -0.010 -0.002	0.002
3	0.003 0.000 0.010 0.014 -0.001 0.000 0.000	0.001
4	0.000 -0.001 0.000 -0.000 0.000 0.000 0.000 0.002	0.000
5	0.001 0.002 0.004 0.000 0.000 0.000 0.000 0.000 0.000	0.004
6	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000	0.001
7	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000
8	0.001 0.002 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.002
9	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.001
10	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000
11	0.001 0.002 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.002
12	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.001
13	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.000
14	0.001 0.002 0.002 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.002
15	0.010 0.000 0.000 0.010 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000	0.001
16	0.000 0.000	0.000
17	0.001 0.002 0.002 0.000	0.002
18	0.010 0.000 0.000 0.010 0.000	0.001
19	0.000 0.000	0.000
20	0.001 0.002 0.002 0.000	0.002

FRED 5.07.1, PC, 9-98 MAGELLAN F/11 SECONDARY TOTAL surface over CA 17 JUNE 99  
17-JUN-99 8:14:57 File: D:\JOBS\MAGELLAN\SEC\17JUN\17JUNCA.POL



PLOTCON 4.10 9/98  
17-JUN-99 8:16:15  
*No Copy*  
RMS = 0.0392  
PV = 0.2662  
PEAK = 0.1354  
VALLEY = -0.1308

WAVE = 0.6328 MICRONS  
SCALE = FRINGES/ -2.000  
CONTOUR INC = 0.050  
MATRIX = 511  
POINTS = 191360

SEMI-DIA = 26.730  
VIGN E Y= 26.358  
BLOCK E Y= 5.059

UNITS = IN

CONTRAVES, INC.  
615 Epsilon Drive  
Pittsburgh, PA. 15238

FRED 5.07.1, PC,9-98 MAGELLAN F/11 SECONDARY TOTAL 17 JUN 99 17-JUN-99  
8:05:59 File: D:\JOBS\MAGELLAN\SEC\17JUN\17JUNTOT.POL

PLOTCON 4.10 9/98  
17-JUN-99 8:07:30

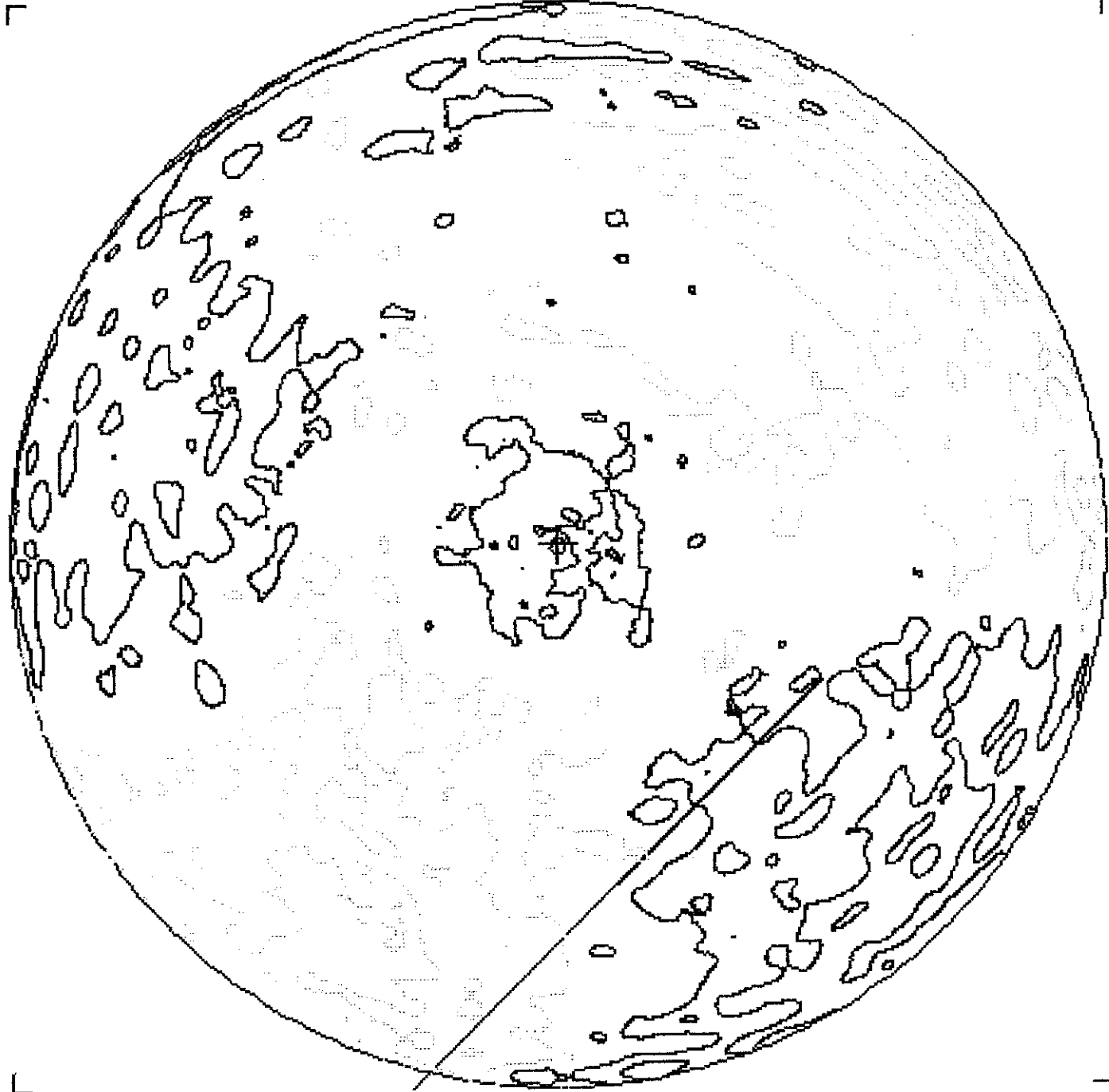
*No Cont*

RMS = 0.0396  
PV = 0.2802  
PEAK = 0.1353  
VALLEY = -0.1449

WAVE = 0.6328 MICRONS  
SCALE = FRINGES/ -2.000  
CONTOUR INC = 0.050  
MATRIX = 511  
POINTS = 204325

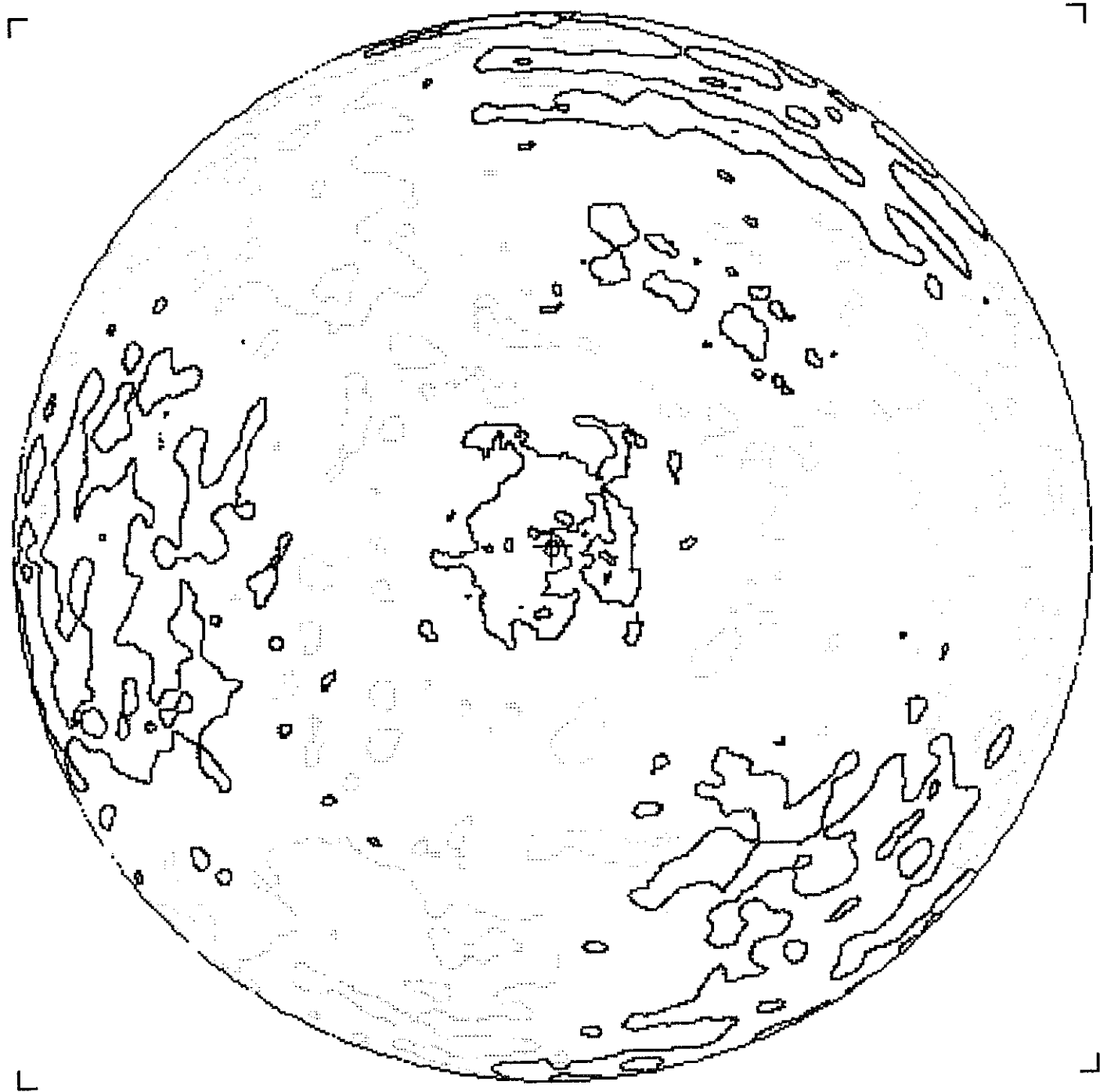
SEMI-DIA = 26.730

UNITS = IN



CONTRAVES, INC.  
615 Epsilon Drive  
Pittsburgh, PA. 15238

FRED 5.07.1, PC, 9-98 MAGELLAN F/11 SECONDARY TOTAL 17 JUN 99 17-JUN-99  
5:59:53 File: D:\JOBS\MAGELLAN\SEC\17JUN\17JUNTOT.POL



PLOTCON 4.10 9/98  
17-JUN-99 6:01:24  
*No Contour at All*  
RMS = 0.0265  
PV = 0.2059  
PEAK = 0.1149  
VALLEY = -0.0910

WAVE = 0.6328 MICRONS  
SCALE = FRINGES/ -2.000  
CONTOUR INC = 0.050  
MATRIX = 511  
POINTS = 204325

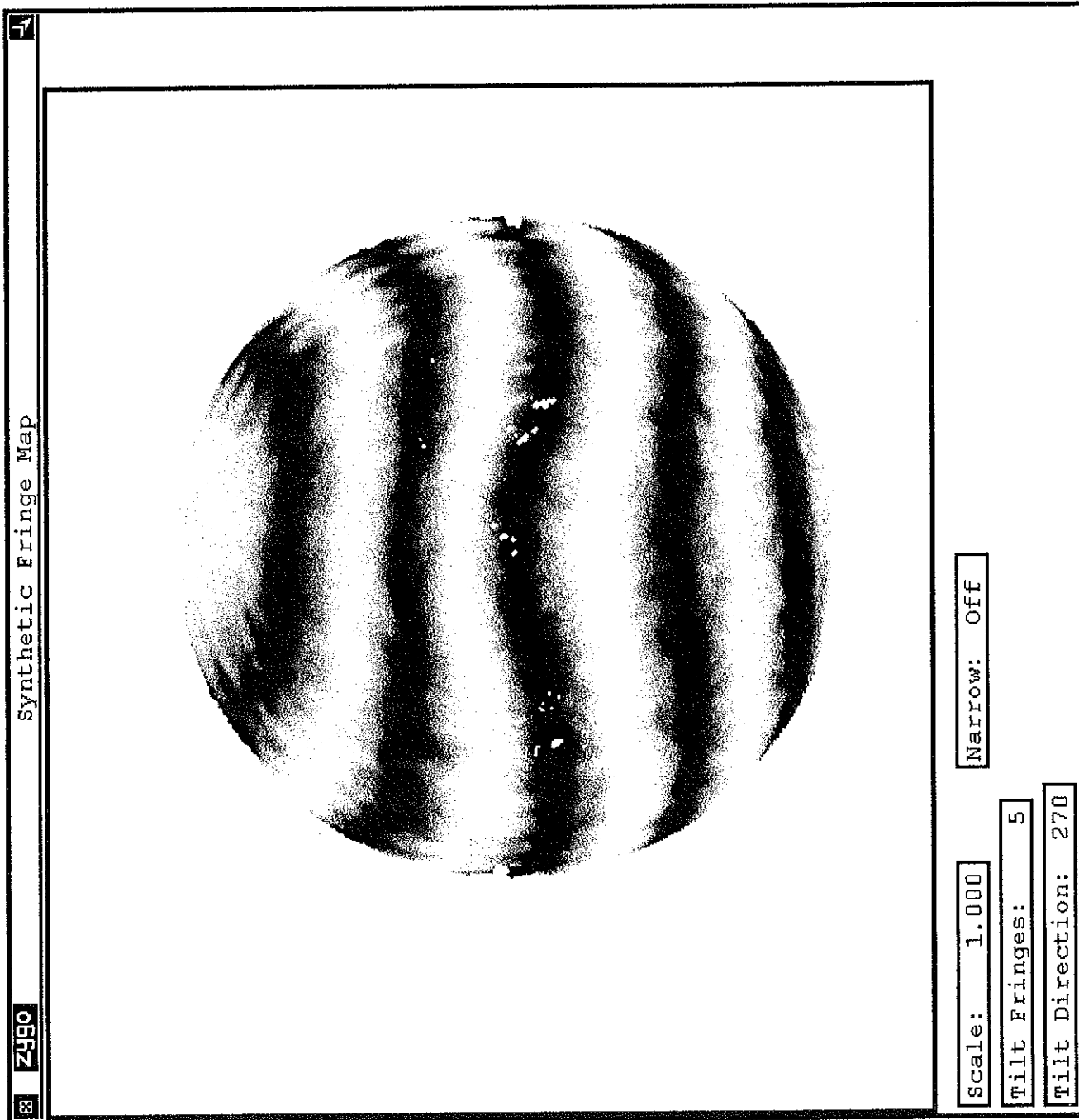
SEMI-DIA = 26.730

UNITS = IN

CONTRAVES, INC.  
615 Epsilon Drive  
Pittsburgh, PA. 15238

ARC  
6/17/99

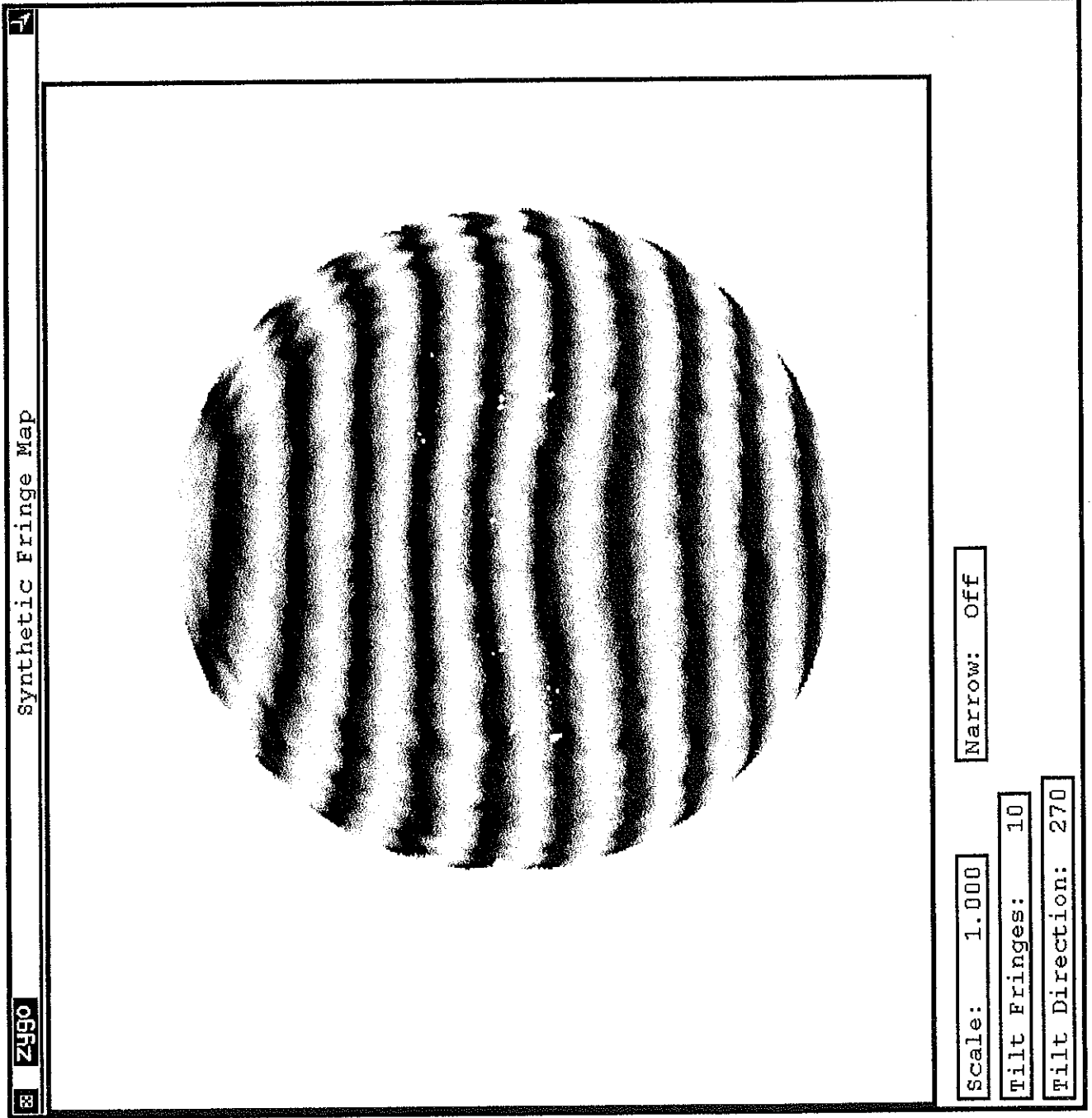
17 jan surf.bmp



SPW

ARC  
6/17/99

17junsurff.bmp



spw

ARC  
6/17/99

17junsurh.bmp

surface

**Z490** Surface/Wavefront Map

Peak  
wave  
Valley

+0.08800  
-0.06361  
1380

**Z490** Oblique Plot

432 mm 1772 mm 44 mm

**Z490** Save Processed Data

rms 0.011 wave Filled Plot

power -0.003 wave Solid Plot

Wavelength-Out: 632.8 nm Oblique Plot

Pts in PV Spec +/- 0.125 wave (%) 100.0

Size X 1305.6 mm

Size Y 1305.6 mm

**Z490** Measurement Attributes

Points 137829 Removed: PST TLT PWR CMA Trimmed: 0

Aperture OD (%): Aperture ID (%): Filter: High Pass

**Z490** Measurement Attributes

Fri Jun 04 03:34:57 1999 Data Sign: Normal

P/N: 95SE0512 REV B Scale Factor: 0.5

**Z490** Measurement Controls

Surface/Wavefront Map Controls

Remove Filter: High Pass

PST TLT PWR AST CMA SA3 Filter Type: FFR Fixed

Filter Trim: On Filter Window Size: 3

Auto Aperture: Off Filter High Freq: 1/m

Aperture OD (%): 98 Filter Low Freq: 10.00000 1/m

Aperture ID (%): 0 Filter High Wavelen: mm

Trim: 0 Filter Low Wavelen: 100.00000 mm

Trim Mode: Outside

Refractive Index: 1.0000

Wavelength-In: 632.8000 nm Save Settings Load Settings

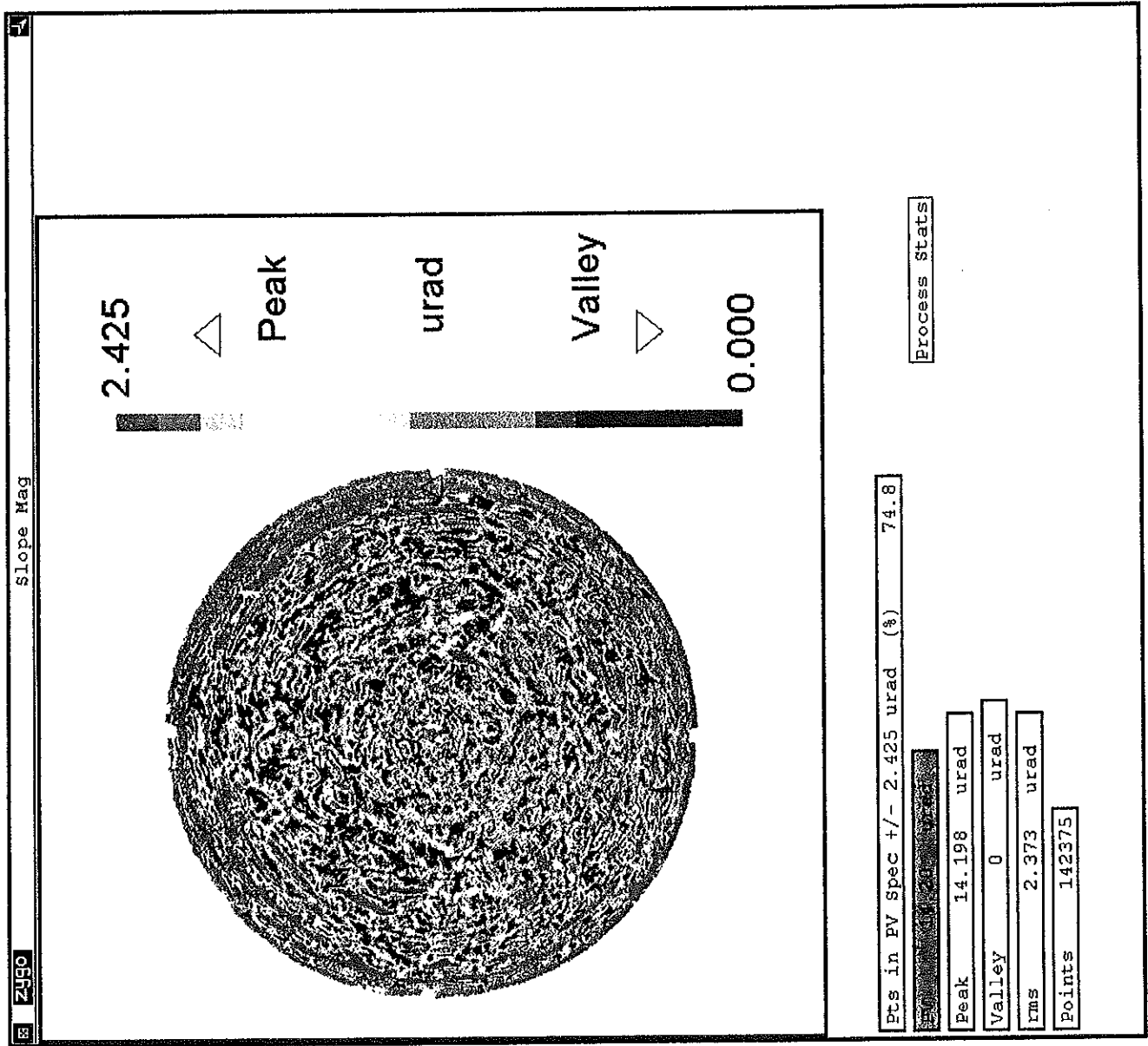
Wavelength-Out: 632.8 nm Alignment Err: Alignment: Fiducials

Alignment Tol: 2.0 Alignment Scaling: Isomorphic



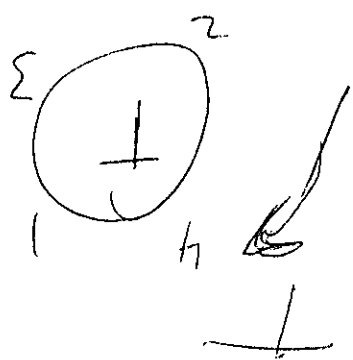
ARCC  
6/17/99

17junsplw.bmp

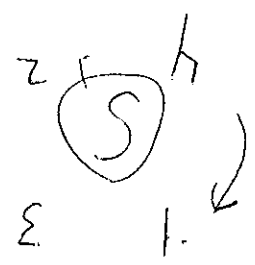


spw

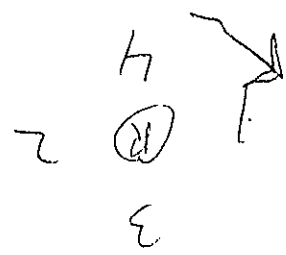
45m - Red  
 174  
 171



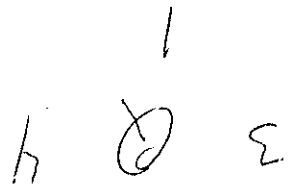
225  
 0



135  
 0



90  
 0



0

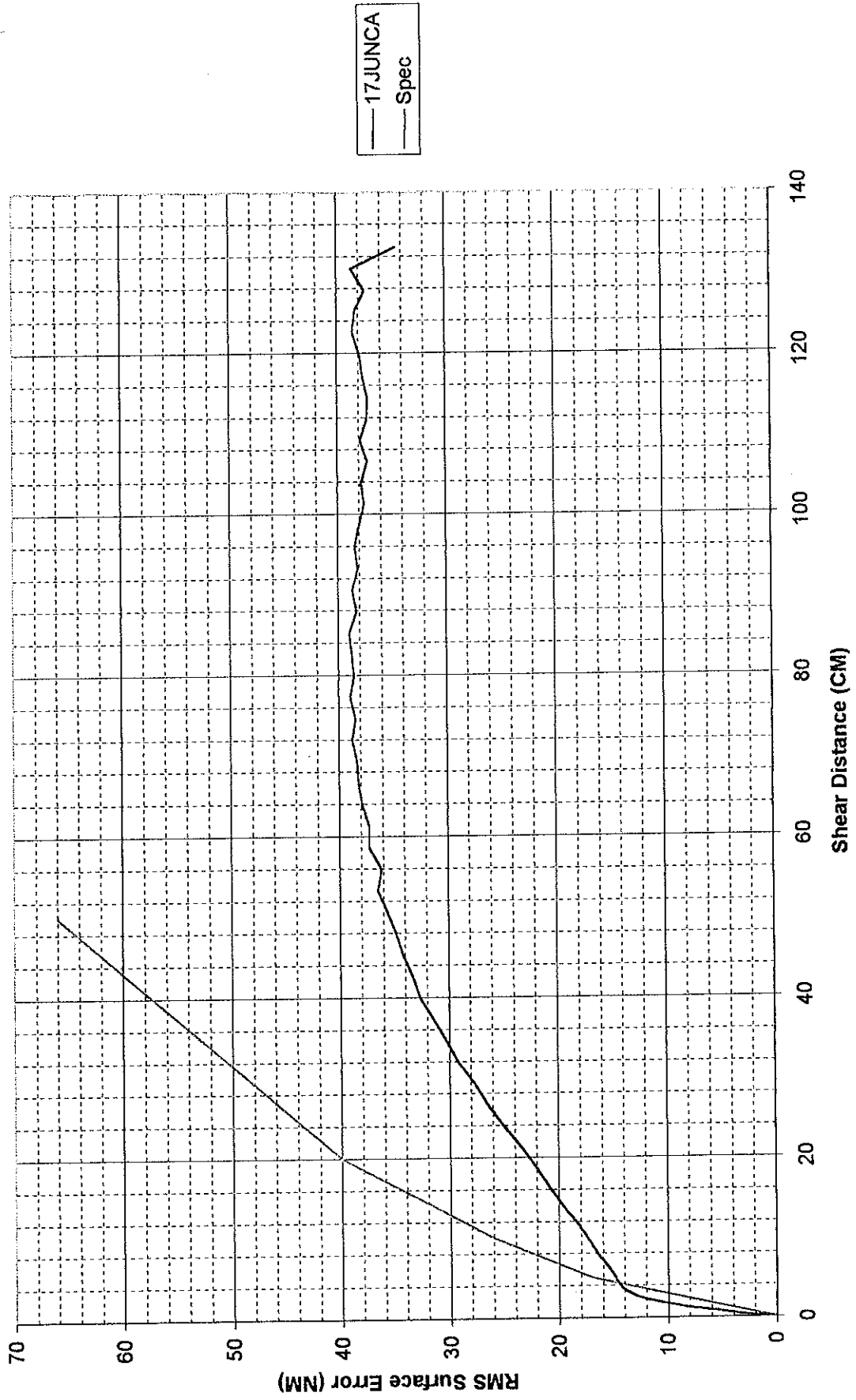
4  
 2  
 3  
 1

1  
 90  
 0

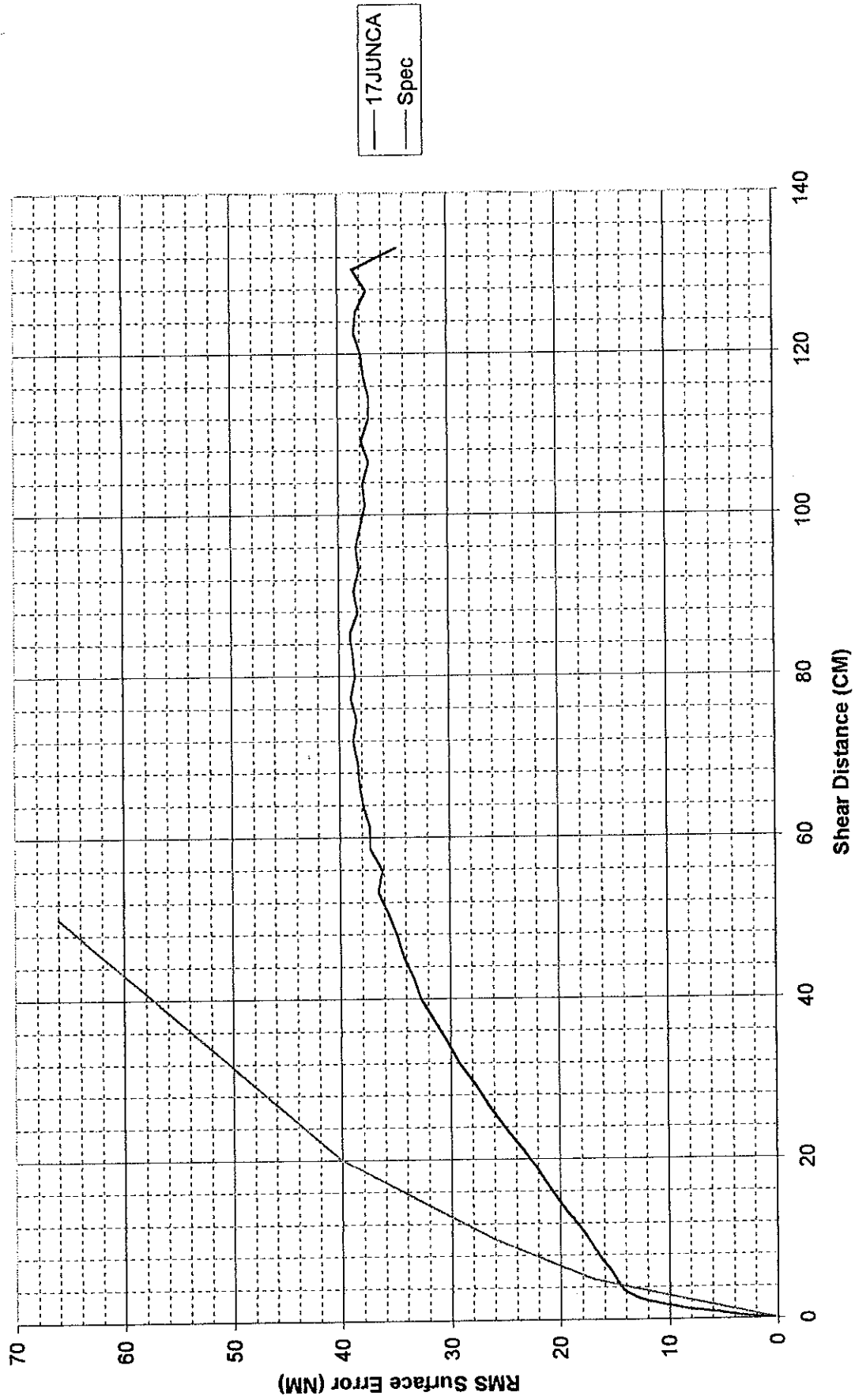
~~Project from 6/17/99~~

1339 outside to outside

MAGELLAN SECONDARY STRUCTURE FUNCTION in customer's cell 17 Jun. 1999



MAGELLAN SECONDARY STRUCTURE FUNCTION in customer's cell 17 Jun. 1999



Magellan Secondary Summary

DATE	TOTAL SURFACE		TOTAL SLOPE		SYM SURFACE		ASY SURFACE		ASY SLOPE
	RMS	P-V	RMS	P-V	RMS	P-V	RMS	P-V	
									(rms)
SPEC									
Start of bad data									
11-Nov	0.105	0.636	1.620	5.770			1.160		
20-Nov	0.106	0.634	1.490	5.870			1.170		
25-Nov	0.129	0.791	1.582	5.595			1.217		
24-Dec	0.133	0.761	1.281	3.994	0.122	0.652	0.995	0.374	0.806
27-Jan	0.121	0.707	1.311	4.148			1.077		
29-Jan	0.138	0.868	1.419	4.886			1.180		
8-Feb	0.130	0.640	1.703	5.559			1.532		
Start of good data									
24-Dec	0.169	1.569	3.613	107.677	0.084	0.531	1.440	0.146	1.582
8-Feb	0.216	2.183	5.484	130.723	0.136	0.843	2.874	0.167	2.185
9-Feb	0.201	5.969	5.989	331.232	0.071	0.638	1.537	0.188	5.959
10-Feb	0.158	1.186	1.780	11.717	0.052	0.458	1.091	0.150	1.182
23-Feb	0.188	1.484	2.034	55.236	0.059	0.557	1.038	0.179	1.482
25-Feb	0.204	1.669	2.634	115.242	0.060	0.572	1.041	0.195	1.673
26-Feb	0.246	1.585	1.958	57.654	0.061	0.564	1.146	0.239	1.537
24-Mar	0.163	1.161	1.581	19.171	0.054	0.401	1.073	0.154	1.154
6-Apr	0.090	0.892	1.985	35.113	0.053	0.409	1.216	0.074	0.890
22-Apr	0.058	0.579	1.672	18.106	0.029	0.319	1.106	0.050	0.579
27-Apr	0.045	0.559	1.733	25.163	0.023	0.099	1.147	0.039	0.569
30-Apr	0.034	0.347	1.184	19.344	0.013	0.059	0.722	0.031	0.328
6-May	0.033	0.241	0.950	7.490	0.013	0.050	0.487	0.030	0.237
13-May	0.035	0.282	0.928	9.658	0.006	0.036	0.457	0.034	0.273
17-Jun	0.039	0.266	0.998	7.257	0.008	0.036	0.496	0.038	0.258

Magellan Secondary Summary

DATE	29 MAV OF ASY	29 MDF OF ASY	STRUCTURE FN				ASTIGMATISM			3 THETA		SPHERICAL	
			5 CM	10 CM	20 CM	50 CM	SIN	COS	SIN	COS			
SPEC													
			17 nm	26 nm	40 nm	66 nm							
Start of bad													
11-Nov	0.260	1.130	43.200	64.900	80.500	105.100							
20-Nov	0.251	0.866	41.200	63.200	81.100	106.700							
25-Nov	0.264	0.953	43.880	69.800	102.650	142.540							
24-Dec	0.237	0.744	38.929	66.326	108.841	148.580							
27-Jan	0.227	0.681	39.560	63.630	101.840	132.660							
29-Jan	0.213	0.730					MtrX 511						
8-Feb	0.227	0.678	52.680	80.760	110.860	139.880							
Start of goo													
24-Dec	0.668	3.084	61.941	90.453	125.467	147.004							
8-Feb	0.443	4.419	15.506	30.174	56.971	102.727							
9-Feb	0.821	5.455	82.360	101.560	134.770	173.200							
10-Feb	0.699	1.093	46.560	71.720	106.790	135.630		0.1199	0.2424	0.1413	0.0483	0.0622	
	39 mav	39 mdf											
23-Feb	0.826	1.411	AFTER new pitch support						-0.1091	0.3368	0.2008	-0.0104	0.0996
25-Feb	0.850	1.695	Edge data is corrupted, part still settling on support?										
26-Feb	0.923	1.186	46.530	77.533	129.297	210.076		0.0704	0.5268	0.2075	-0.0352	0.1073	
24-Mar	0.726	0.817	40.11	63.97	101.16	139.78		0.0942	0.2806	0.1839	0.0087	0.0089	
6-Apr								0.0525	0.0977	0.0803	0.0215	0.0820	
22-Apr	0.430	1.632	32.89	38.48	45.29	49.69		0.0519	0.0368	0.0242	0.0456	0.0018	
27-Apr	0.320	1.770	29.19	30.18	33.93	38.22		0.0449	0.0366	0.0449	0.0366	-0.0163	
30-Apr	0.208	1.201	20.43	20.97	23.34	28.73		0.0389	0.0460	0.0142	0.0054	0.0039	
6-May	0.178	0.946	15.36	17.54	21.49	28.15		-0.0053	0.0597	-0.0116	-0.0073	-0.0194	
13-May	0.150	0.924	13.18	15.08	18.78	30.78		-0.0123	0.0744	-0.0081	0.0072	-0.0037	
17-Jun	0.179	0.993	14.84	17.39	22.72	35.42		0.0714	-0.0132	-0.0493	0.0112		

ARC  
5/13/199

Last Pitch Test  
Final Polished Data

13 May Sur Z.6mp

Surface

**Z490** Surface/Wavefront Map

Wavefront map showing surface profile with labels 1, 2, 3, 4 and wave height markers.

**Z490** Oblique Plot

Oblique Plot showing surface profile with dimensions 430, 1761, 43 mm.

Save Processed Data

Filled Plot  
 Solid Plot  
 Oblique Plot

rms 0.045 wave  
 Power 0.000 wave  
 Wavelength-Out: 632.8 nm

Pts in PV spec +/- 0.125 wave (\$) 99.0  
 Aperture OD (\$) 142345 Removed: PST TLT PWR CMA  
 Aperture ID (\$) 1761 Filter: Off  
 Trimmed: 0

Thu May 13 03:16:05 1999  
 Data Sign: Normal

Measurement Attributes  
 Z490  
 Reflectivity 0.0  
 Filter: 60  
 L: OFF  
 Wavelengths: 632.8 nm  
 Isomorphics: Isomorphics

**Z490** Surface/Wavefront Map

**Z490** Zernike Polynomials

Order:	Terms:	rms:	data points:
0.002	-0.001	0.005	
0.003	-0.001	0.005	
0.004	0.000	0.000	0.000
0.005	0.000	0.000	0.000
0.006	0.000	0.000	0.000
0.007	0.000	0.000	0.000
0.008	0.000	0.000	0.000
0.009	0.000	0.000	0.000
0.010	0.000	0.000	0.000
0.011	0.000	0.000	0.000
0.012	0.000	0.000	0.000
0.013	0.000	0.000	0.000
0.014	0.000	0.000	0.000
0.015	0.000	0.000	0.000
0.016	0.000	0.000	0.000
0.017	0.000	0.000	0.000
0.018	0.000	0.000	0.000
0.019	0.000	0.000	0.000
0.020	0.000	0.000	0.000
0.021	0.000	0.000	0.000
0.022	0.000	0.000	0.000
0.023	0.000	0.000	0.000
0.024	0.000	0.000	0.000
0.025	0.000	0.000	0.000
0.026	0.000	0.000	0.000
0.027	0.000	0.000	0.000
0.028	0.000	0.000	0.000
0.029	0.000	0.000	0.000
0.030	0.000	0.000	0.000
0.031	0.000	0.000	0.000
0.032	0.000	0.000	0.000
0.033	0.000	0.000	0.000
0.034	0.000	0.000	0.000
0.035	0.000	0.000	0.000
0.036	0.000	0.000	0.000
0.037	0.000	0.000	0.000
0.038	0.000	0.000	0.000
0.039	0.000	0.000	0.000
0.040	0.000	0.000	0.000
0.041	0.000	0.000	0.000
0.042	0.000	0.000	0.000
0.043	0.000	0.000	0.000
0.044	0.000	0.000	0.000
0.045	0.000	0.000	0.000
0.046	0.000	0.000	0.000
0.047	0.000	0.000	0.000
0.048	0.000	0.000	0.000
0.049	0.000	0.000	0.000
0.050	0.000	0.000	0.000
0.051	0.000	0.000	0.000
0.052	0.000	0.000	0.000
0.053	0.000	0.000	0.000
0.054	0.000	0.000	0.000
0.055	0.000	0.000	0.000
0.056	0.000	0.000	0.000
0.057	0.000	0.000	0.000
0.058	0.000	0.000	0.000
0.059	0.000	0.000	0.000
0.060	0.000	0.000	0.000
0.061	0.000	0.000	0.000
0.062	0.000	0.000	0.000
0.063	0.000	0.000	0.000
0.064	0.000	0.000	0.000
0.065	0.000	0.000	0.000
0.066	0.000	0.000	0.000
0.067	0.000	0.000	0.000
0.068	0.000	0.000	0.000
0.069	0.000	0.000	0.000
0.070	0.000	0.000	0.000
0.071	0.000	0.000	0.000
0.072	0.000	0.000	0.000
0.073	0.000	0.000	0.000
0.074	0.000	0.000	0.000
0.075	0.000	0.000	0.000
0.076	0.000	0.000	0.000
0.077	0.000	0.000	0.000
0.078	0.000	0.000	0.000
0.079	0.000	0.000	0.000
0.080	0.000	0.000	0.000
0.081	0.000	0.000	0.000
0.082	0.000	0.000	0.000
0.083	0.000	0.000	0.000
0.084	0.000	0.000	0.000
0.085	0.000	0.000	0.000
0.086	0.000	0.000	0.000
0.087	0.000	0.000	0.000
0.088	0.000	0.000	0.000
0.089	0.000	0.000	0.000
0.090	0.000	0.000	0.000
0.091	0.000	0.000	0.000
0.092	0.000	0.000	0.000
0.093	0.000	0.000	0.000
0.094	0.000	0.000	0.000
0.095	0.000	0.000	0.000
0.096	0.000	0.000	0.000
0.097	0.000	0.000	0.000
0.098	0.000	0.000	0.000
0.099	0.000	0.000	0.000
0.100	0.000	0.000	0.000

**Z490** Seidel Coefficients

Aberration	Magnitude waves	Angle degs.
TILT	0.000	0.000
FOCUS	0.000	0.000
ASTIGMATISM	0.000	0.000
COMA	0.000	0.000
SPHERICAL	0.000	0.000

13 May surch. bmp

ARC  
5/13/99

**Z490** Surface/Wavefront Map

**Z490** Save Processed Data

Filled Plot  
 Solid Plot  
 Oblique Plot

Rms: 0.010 wave  
 Power: -0.003 wave  
 Wavelength-Out: 632.8 nm  
 Pts in PV Spec +/- 0.125 wave (%): 100.0  
 Size X: 1300.0 mm  
 Size Y: 1296.9 mm

**Z490** Oblique Plot

Points: 135840 Removed: PST TLT PWR CMA Trimmed: 0  
 Aperture OD (%): Aperture ID (%): Filter: High Pass  
 Thu May 13 03:16:05 1999 Data Sign: Normal

---

**Z490** Measurement Controls

Comment: MAGELLAN 6.5M F/11 SECONDARY MIRROR

Part Number: 95SE0512 REV B  
 Serial Number:  
 Instrument: GPI T.D. SN 65681 SB 0

Min Mod Pct: 10  
 Intens Avgs: 0  
 Phase Avgs: 0  
 Min Mod Pts: 10000  
 Light Level: 135  
 Light Level Pct: 47.0

Filter: High Pass  
 Filter Type: FFT Fixed  
 Filter Trim: On  
 Filter Window Size: 3

Filter High Freq: 1/m  
 Filter Low Freq: 10.00000 1/m  
 Filter High Wavelen: mm  
 Filter Low Wavelen: 100.00000 mm

Auto Aperture: Off  
 Aperture OD (%): 98  
 Aperture ID (%): 0  
 Trim: 0  
 Trim Mode: Outside

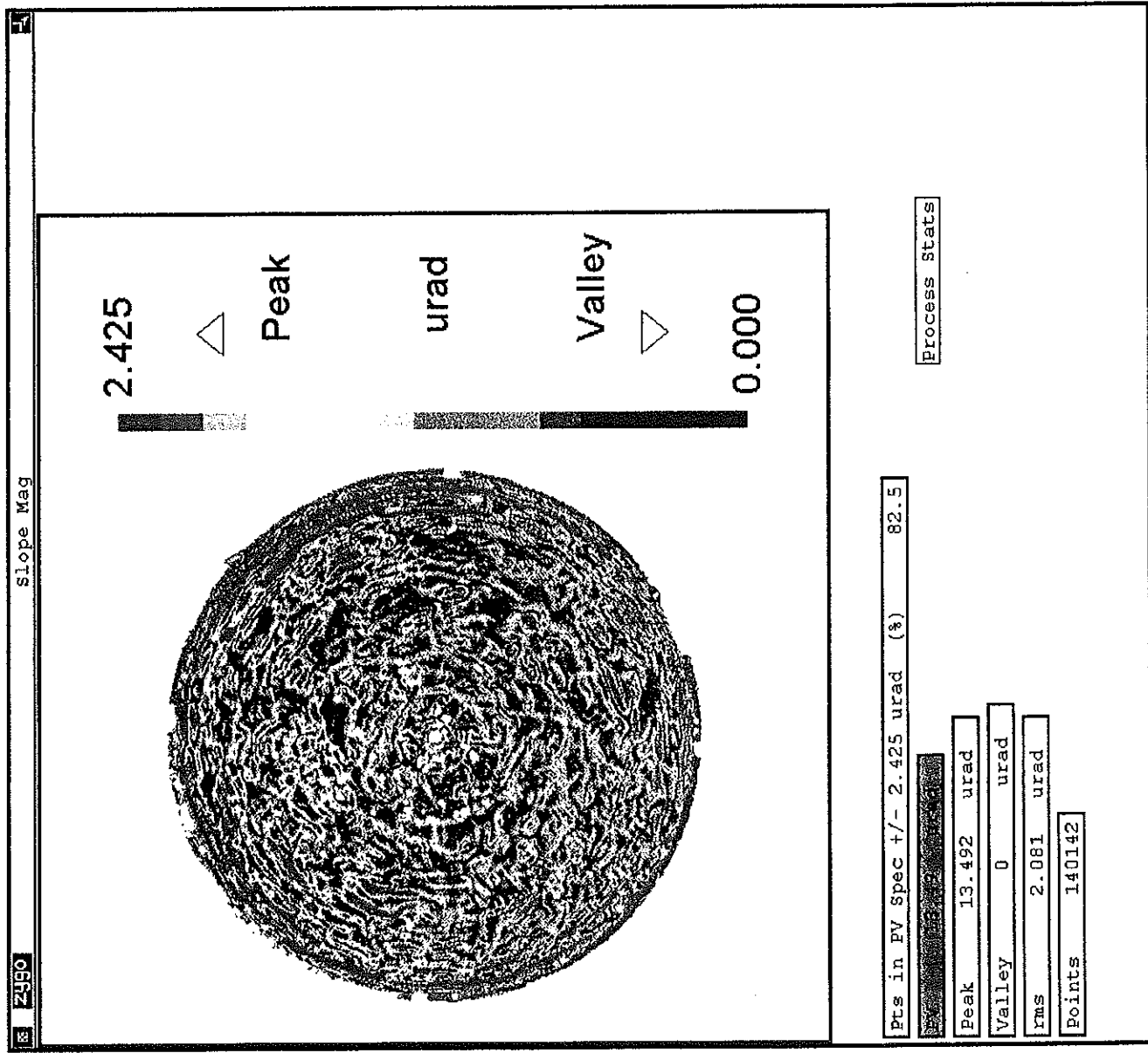
Remove  
 PST TLT PWR AST CMA SA3  
 Data sign: Surface/Wavefront Map Controls  
 Filter: High Pass  
 Filter Type: FFT Fixed  
 Filter Trim: On  
 Filter Window Size: 3  
 Filter High Freq: 1/m  
 Filter Low Freq: 10.00000 1/m  
 Filter High Wavelen: mm  
 Filter Low Wavelen: 100.00000 mm

Surface



ARC  
5/13/99

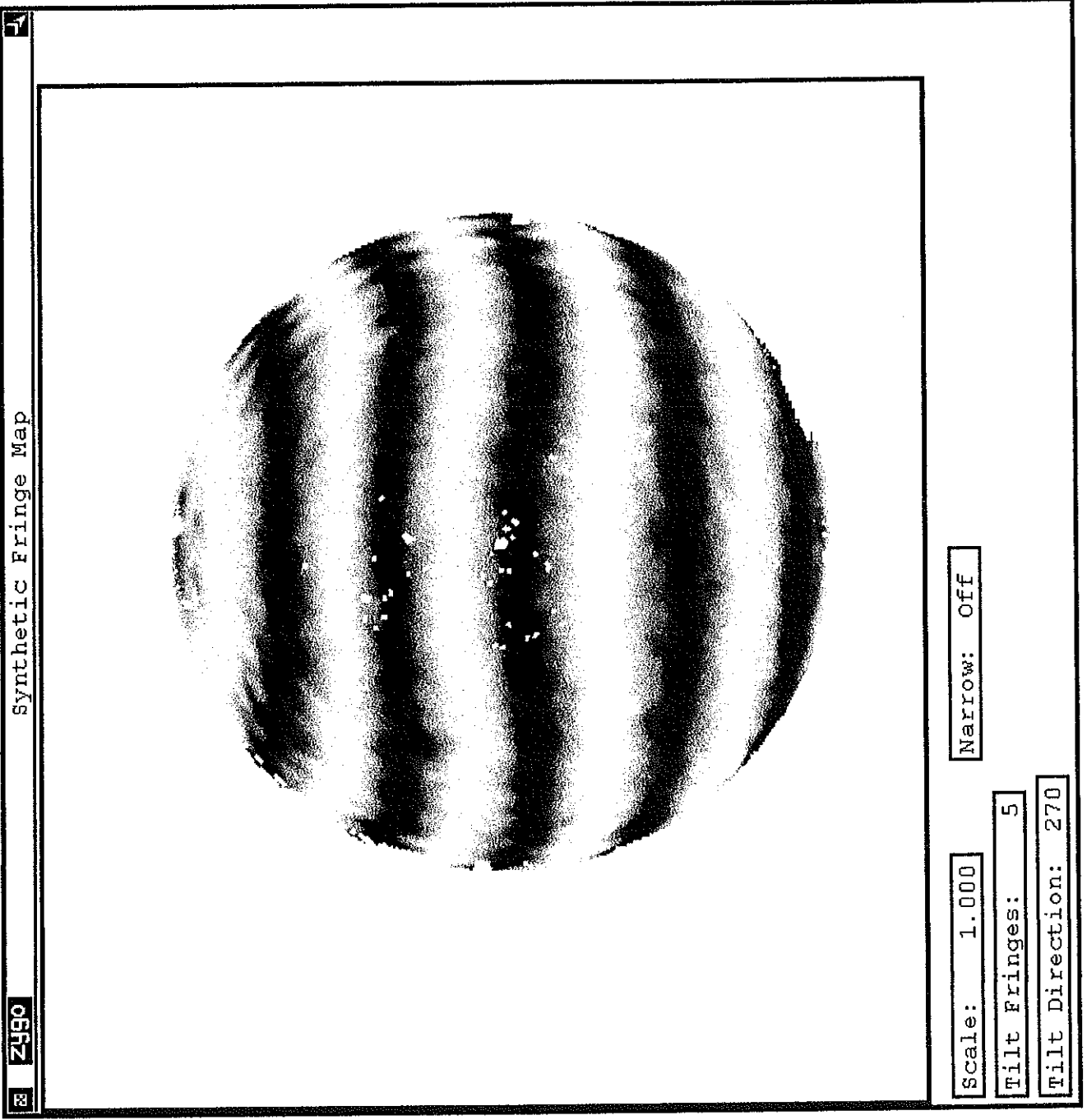
13 may spw . bmp



SPW

ARC  
5/13/99

13 May surf to map



SPW

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project #11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 7

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 5.5 Microroughness

Parameter: Surface Roughness

Method:  
Test and Analysis

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

Polished surface shall be smooth at spatial frequencies  $\ll 1$  cm such that microroughness shall not exceed 20 angstrom RMS.

**VERIFICATION APPROACH:**

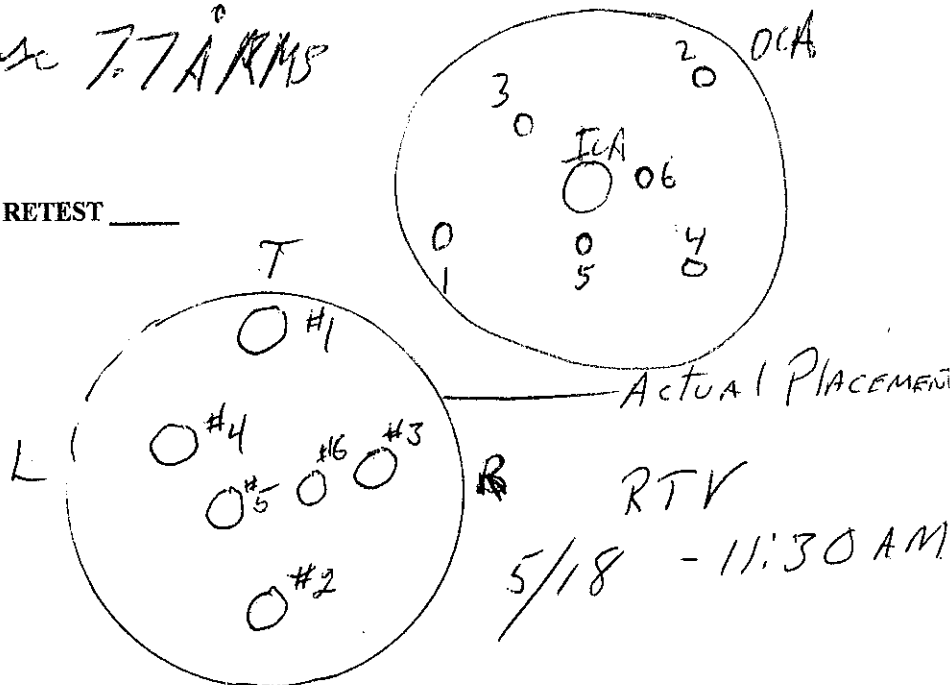
Three surface replicates shall be placed at 120° intervals such that the radial positions will be equi-spaced between the inner and outer clear aperture. Surface replicates shall be made using procedure TR-28956. Surface replicates shall be measured.

*Average 6 samples is 7.7 Å RMS*

RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

- 1 - 3" from OCA
- 2 - 6"
- 3 - 9"
- 4 - 12"
- 5 - 15"
- 6 - 18"



**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

*[Signature]*

DATE 7/23/99

OCIW *B*

*[Signature]*

DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

27-May-99	Magellan Secondary Replication Samples						
J. Arendt	P-V and RMS Surface Roughness						
	Roughness in Angstroms						
Sample	P-V Edge	P-V Center	P-V Avg.	RMS Edge	RMS Center	RMS Avg.	
1	130	132	131	7.9	9.3	8.6	
2	128	168	148	8.3	8.0	8.2	
3	141	172	157	6.8	6.3	6.6	
4	91	180	136	7.2	5.8	6.5	
5	108	194	151	9.4	6.9	8.2	
6	140	133	137	8.4	7.9	8.2	
<b>Cumulative Average</b>			<b>143</b>			<b>7.7</b>	

27-May-99	Magellan Secondary Replication Samples						
J. Arendt	P-V and RMS Surface Roughness						
	Roughness in Angstroms						
<b>Sample</b>	<b>P-V Edge</b>	<b>P-V Center</b>	<b>P-V Avg.</b>	<b>RMS Edge</b>	<b>RMS Center</b>	<b>RMS Avg.</b>	
1	130	132	131	7.9	9.3	8.6	
2	128	168	148	8.3	8.0	8.2	
3	141	172	157	6.8	6.3	6.6	
4	91	180	136	7.2	5.8	6.5	
5	108	194	151	9.4	6.9	8.2	
6	140	133	137	8.4	7.9	8.2	
<b>Cumulative Average</b>			143			7.7	

Mageellan Sec. Sample 1 Mir Edg

Microscope Application

20X Mirau Z490 Surface Map Oblique Plot

MEASURE  
Analyze  
Mask Data  
Save Data  
Load Data  
Calibrate  
Reset

Measure Cntrl  
Analyze Cntrl  
Test+Ref Cntrl

Surface Profile

Slope Mag  
Slope X  
Slope Y

Spectrum Map  
Spectrum Prof

Intensity  
SynthFringes

Analyze Attr  
Report  
Process  
Units  
Video Monitor

Z490 Z490 Z490

Height (A)

Distance (mm)

PV 30.850 A  
Rms 6.265 A

Ra 5.190 A  
Profile Stats

PV 130.023 A  
Rms 7.913 A  
Ra 6.242 A  
Size X 0.35 mm  
Size Y 0.26 mm

Removed: Cylinder  
Trimmed: 0  
Filter: Off

Solid Plot

Measure Attributes

Thu May 27 10:57:32 1999 Objective: 20X Mirau Camera Res: 0.548 um Zoom: IX Data Sign: Inverted

S/N: P/N:

Mag. Sec. Sample 1 Center

Zygo 20X Mirau Zygo Surface Map Zygo Oblique Plot

MEASURE  
Analyze  
Mask Data  
Save Data  
Load Data  
Calibrate  
Reset

Measure Cntrl  
Analyze Cntrl  
Test+Ref Cntrl

Surface Profile

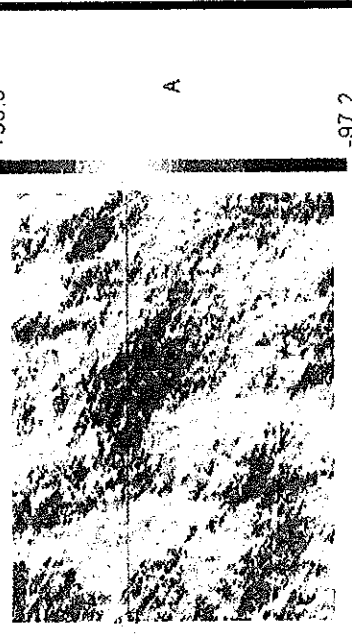
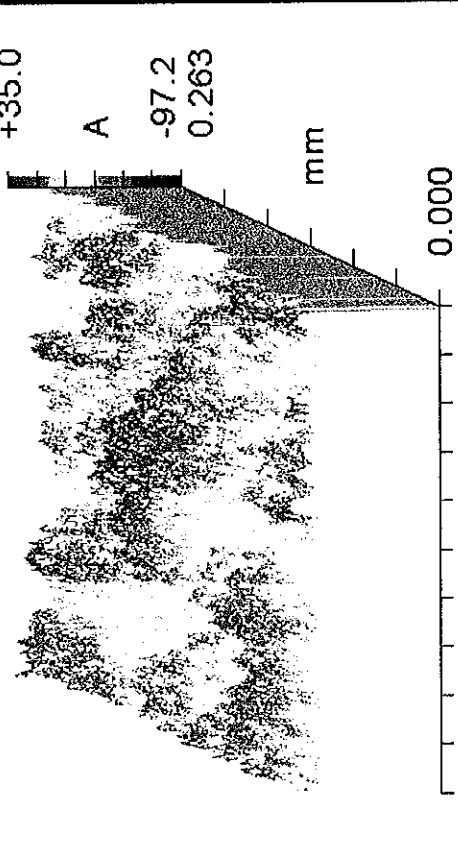
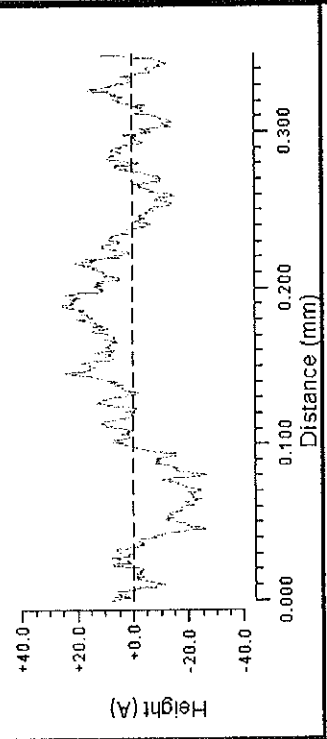
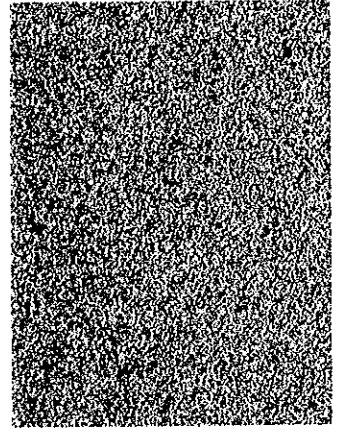
PV	132.198	A
rms	9.259	A
Ra	7.354	A
Size X	0.35	mm
Size Y	0.26	mm

Slope Mag  
Slope X  
Slope Y

Spectrum Map  
Spectrum Prof

Intensity  
SynthFringes

Analyze Attri  
Report  
Process  
Units  
Video Monitor

Removed: Cylinder  
Trimmed: 0  
Filter: Off

Zygo Zygo Zygo Measure Attributes

Thu May 27 11:40:53 1999 Objective: 20X Mirau Camera Res: 0.548 um Zoom: IX Data Sign: Inverted

S/N: P/N:

Mag. Sec. Sample Z Edge

Z490 20X Mirau Z490 Surface Map Z490 Oblique Plot

MEASURE  
 Analyze  
 Mask Data  
 Save Data  
 Load Data  
 Calibrate  
 Reset

Measure Cntrl  
 Analyze Cntrl  
 Test+Ref Cntrl

Surface Profil

Slope Mag  
 Slope X  
 Slope Y

Spectrum Map  
 Spectrum Prof

Intensity  
 SynthFringes

Analyze Attrr  
 Report  
 Process  
 Units  
 Video Monitor

MEASURE  
 Analyze  
 Mask Data  
 Save Data  
 Load Data  
 Calibrate  
 Reset

Measure Cntrl  
 Analyze Cntrl  
 Test+Ref Cntrl

Surface Profil

Slope Mag  
 Slope X  
 Slope Y

Spectrum Map  
 Spectrum Prof

Intensity  
 SynthFringes

Analyze Attrr  
 Report  
 Process  
 Units  
 Video Monitor

Z490 Z490 Z490

Surface Profile

PV	128.936	A
rms	8.331	A
Ra	6.666	A
Size X	0.35	mm
Size Y	0.26	mm

Height (A)

Distance (mm)

PV	34.805	A
rms	7.240	A
Ra	6.073	A

Profile Stats

Z490 Z490 Z490

Surface Map

Oblique Plot

Removed: Cylinder  
 Trimmed: 0  
 Filter: Off

Measure Attributes

Thu May 27 11:55:27 1999 Objective: 20X Mirau Camera Res: 0.548 um Zoom: 1X Data Sign: Inverted

S/N: P/N:



Mag. Sec. Sample 2

Center

Microscope Application  
Surface Map

ZYGO ZY90

20X Mirau

MEASURE  
Analyze  
Mask Data  
Save Data  
Load Data  
Calibrate  
Reset

Measure Cntrl  
Analyze Cntrl  
Test+Ref\_Cntrl

Surface Profile

Slope Mag  
Slope X  
Slope Y

Spectrum Map  
Spectrum Prof

Intensity  
SynthFringes

Analyze Attl  
Report  
Process  
Units  
Video Monitor

ZY90 ZY90

Oblique Plot

+30.4  
A  
-137.6  
0.263  
mm  
0.000 0.350 mm

Removed: Cylinder  
Trimmed: 0  
Filter: Off

ZY90 ZY90

solid Plot

ZY90 ZY90

Surface Profile

PV	1.67.992	A
rms	7.960	A
Ra	6.281	A
Size X	0.35	mm
Size Y	0.26	mm

+30.0  
+15.0  
+0.0  
-15.0  
-30.0  
Height (A)

0.000 0.100 0.200 0.300  
Distance (mm)

PV	41.726	A	Ra	5.214	A
rms	7.088	A	Profile Stats		

ZY90

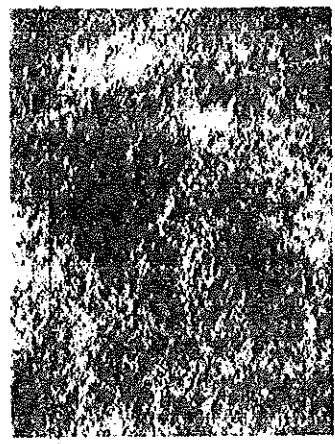
Measure Attributes

Thu May 27 12:01:25 1999  
Objective: 20X Mirau  
Camera Res: 0.548 um  
Zoom: 1X  
Data Sign: Inverted

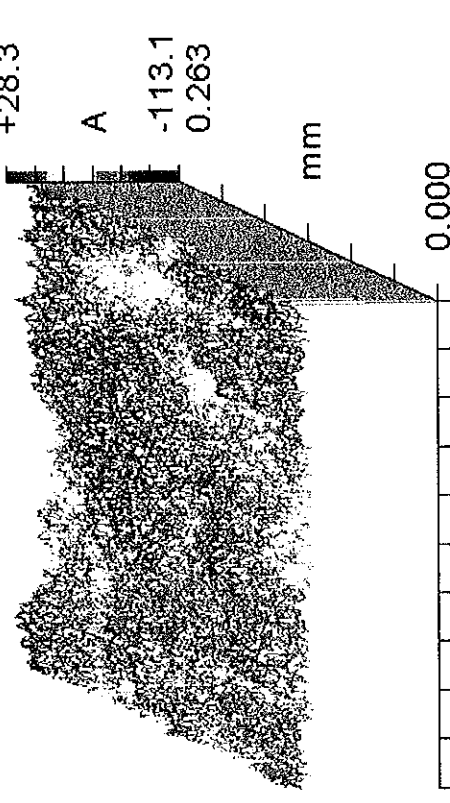
S/N:

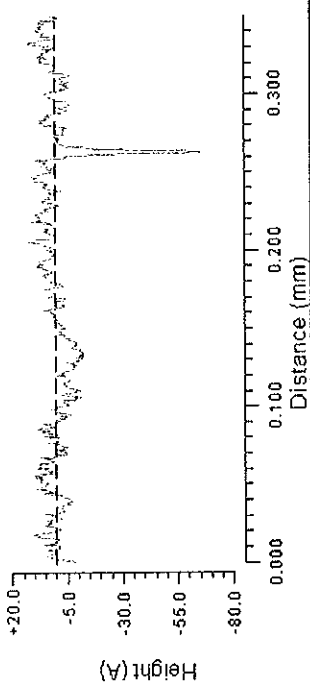
Magn. Sec. Sample 3 Near Edge

Z490
20X Mirau
Z490
Surface Map
Z490
Oblique Plot

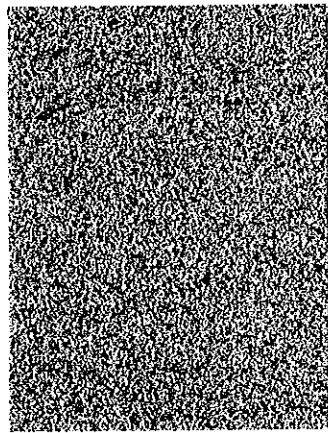


PV	141.394	A
Rms	6.796	A
Ra	5.379	A
Size X	0.35	mm
Size Y	0.26	mm





PV	77.816	A
Rms	7.009	A
Ra	4.720	A



MEASURE

Analyze

Mask Data

Save Data

Load Data

Calibrate

Reset

Measure Cntrl

Analyze Cntrl

TestRef Cntrl

Surface Profil

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

SynthFringes

Analyze Attr

Report

Process

Units

Video Monitor

Removed: Cylinder

Trimmed: 0

Filter: Off

Z490

Surface Profile

Z490

Solid Plot

Measure Attributes

Objective: 20X Mirau Camera Res: 0.548 um Zoom: 1X Data Sign: Inverted

Thu May 27 14:11:16 1999 S/N: P/N:

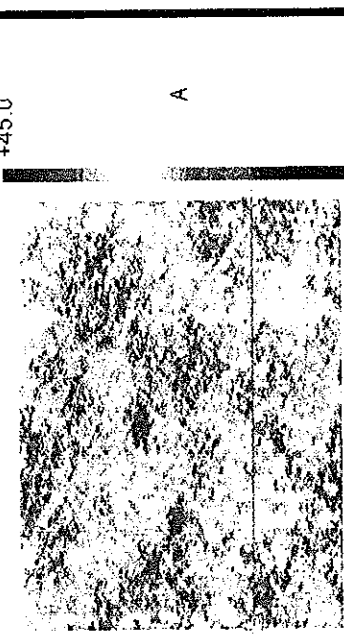
Mag. Sec.

Sample 3

Center

**Z490** 20X Mirau **Z490** Microscope Application **Z490** Surface Map **Z490** Oblique Plot

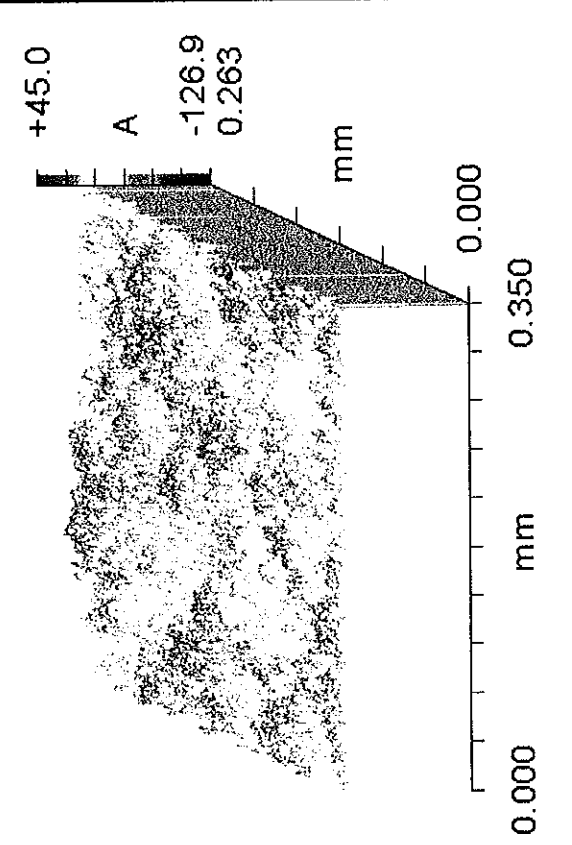
**Z490** **Z490**



+45.0  
A  
-126.9

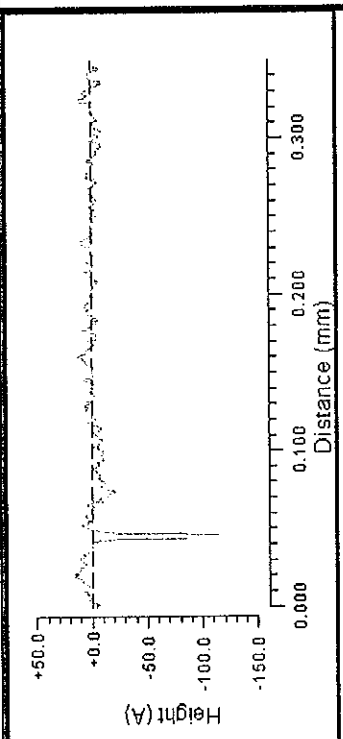
PV	171.848	A
rms	6.296	A
Ra	4.997	A
Size X	0.35	mm
Size Y	0.26	mm

**Z490** **Z490**



+45.0  
A  
-126.9  
0.000 0.350 0.000  
mm

**Z490** **Z490**

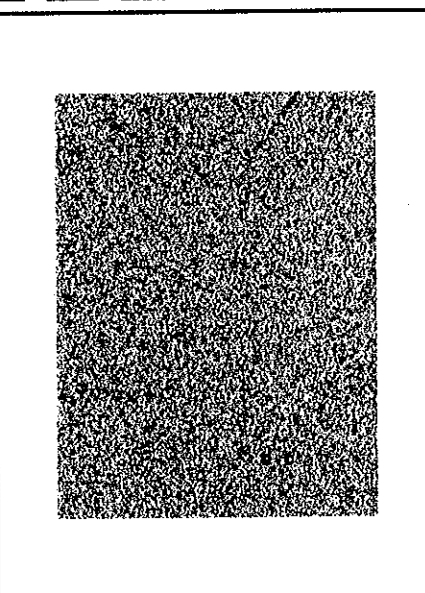


+50.0  
+0.0  
-50.0  
-100.0  
-150.0  
Height (A)

0.000 0.100 0.200 0.300  
Distance (mm)

PV	131.309	A	Ra	4.881	A
rms	8.495	A	Profile Stats		

**Z490** **Z490**



Removed: Cylinder  
Trimmed: 0  
Filter: Off

**Z490** **Z490**

MEASURE

- Analyze
- Mask Data
- Save Data
- Load Data
- Calibrate
- Reset

Measure Cntrl

Analyze Cntrl

Test+Ref Cntrl

Surface Profi

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

SynthFringes

Analyze Attr

Report

Process

Units

Video Monitor

**Z490** **Z490**

Measure Attributes

Thu May 27 14:18:53 1999 Objective: 20X Mirau Camera Res: 0.548 um Zoom: 1X Data Sign: Inverted

S/N: P/N:

Mag. Sec Sample 4 Near Edge

Z490 20X Mirau

MEASURE

- Analyze
- Mask Data
- Save Data
- Load Data
- Calibrate
- Reset

Measure Cntrl

Analyze Cntrl

Test+Ref Cntrl

Surface Profil

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

Synthfringes

Analyze Attr

Report

Process

Units

Video Monitor

Z490 Surface Map

Oblique Plot

Surface Profile

PV	91.165	A
rms	7.159	A
Ra	5.610	A
Size X	0.35	mm
Size Y	0.26	mm

Height (A)

Profile Stats

PV	45.978	A
rms	8.431	A
Ra	6.577	A

Z490 Solid Plot

Removed: Cylinder

Trimmed: 0

Filter: Off

Z490 Measure Attributes

Thu May 27 13:27:39 1999

Objective: 20X Mirau Camera Res: 0.548 um

Zoom: 1X

Data Sign: Inverted

S/N:

P/N:

Mag. Sec. Sample 4 Center

**Z490** 20X Mirau

MEASURE

Analyze

Mask Data

Save Data

Load Data

Calibrate

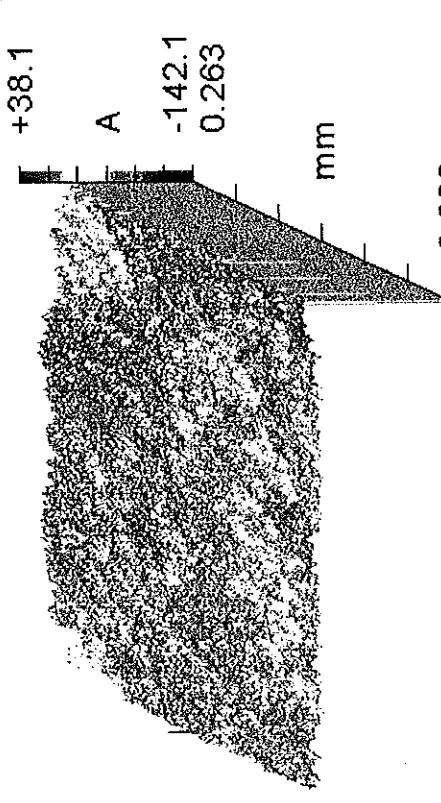
Reset

Microscope Application

Surface Map

**Z490**

Oblique Plot



+38.1

A

-142.1

0.263

mm

0.000

0.350

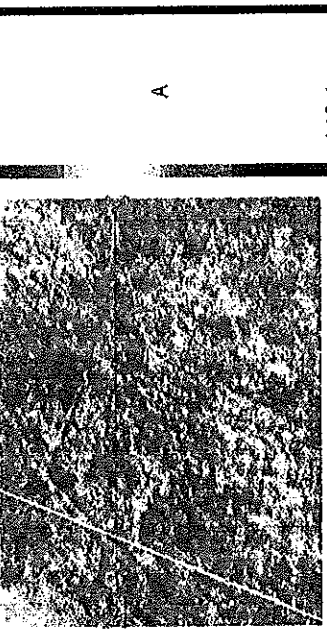
0.000

Removed: Cylinder

Trimmed: 0

Filter: Off

**Z490**



+38.1

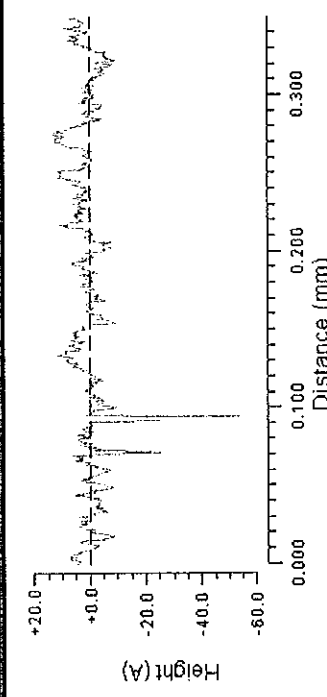
A

-142.1

Surface Profile

PV	180.154	A
Rms	5.842	A
Ra	4.301	A
Size X	0.35	mm
Size Y	0.26	mm

**Z490**



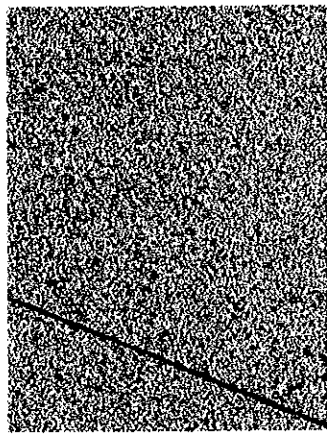
Height (A)

Distance (mm)

PV	66.544	A
Rms	5.293	A
Ra	3.712	A

Profile Stats

**Z490** Solid Plot



Measure Cntrl

Analyze Cntrl

Test+Ref Cntrl

Surface Profile

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

SynthFringes

Analyze Attr

Report

Process

Units

Video Monitor

Measure Attributes

Thu May 27 13:40:34 1999

Objective: 20X Mirau Camera Res: 0.548 um Zoom: 1X

Data Sign: Inverted

S/N:

P/N:

Mag. Scan Sample 5 New Edge

Z490

20X Mirau

MEASURE

Analyze

Mask Data

Save Data

Load Data

Calibrate

Reset

Measure Cntrl

Analyze Cntrl

Test+Ref Cntrl

Surface Profi

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

SynthFringes

Analyze Attr

Report

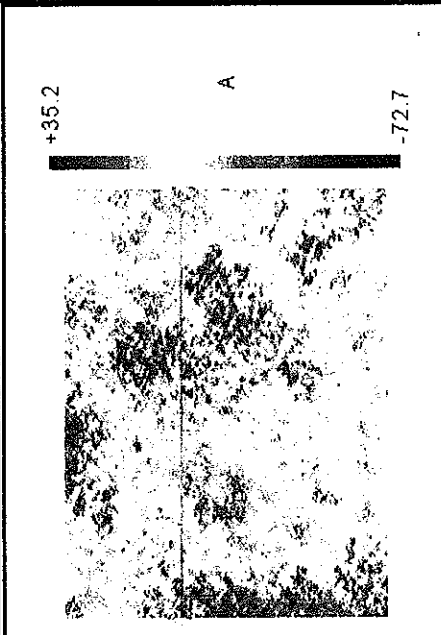
Process

Units

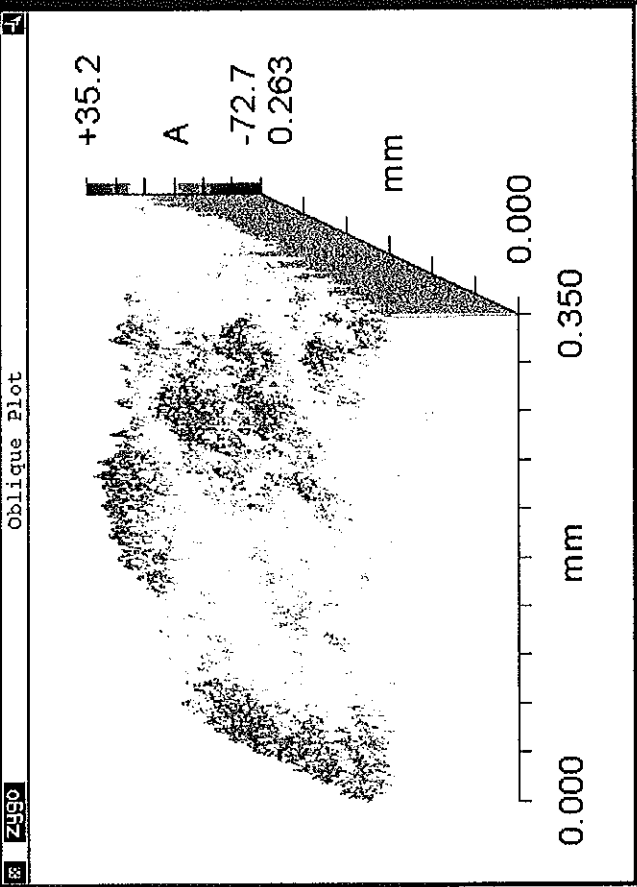
Video Monitor

Surface Map

Z490



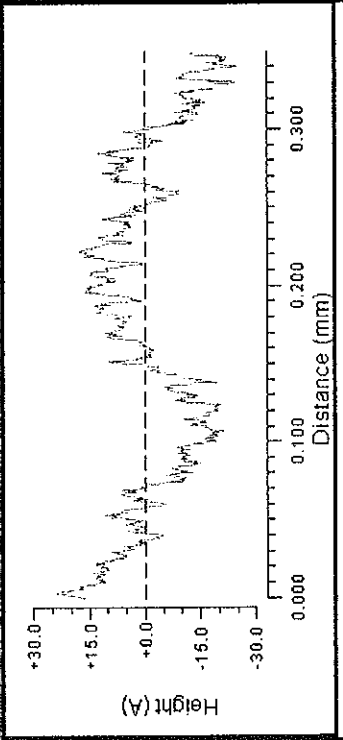
Oblique Plot



Z490

FV	107.875	A
rms	9.386	A
Ra	7.549	A
Size X	0.35	mm
Size Y	0.26	mm

Surface Profile



FV	48.746	A
rms	10.733	A
Ra	9.168	A

Profile Stats

Removed: Cylinder

Trimmed: 0

Filter: Off

Z490

Measure Attributes

Thu May 27 14:29:41 1999

Objective: 20X Mirau Camera Res: 0.548 um

Zoom: 1X

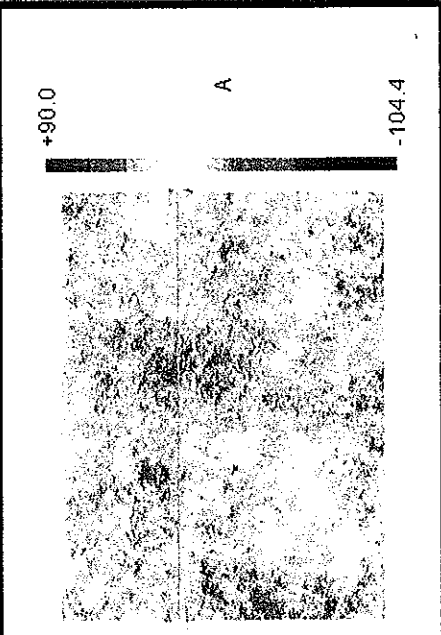
Data Sign: Inverted

S/N:

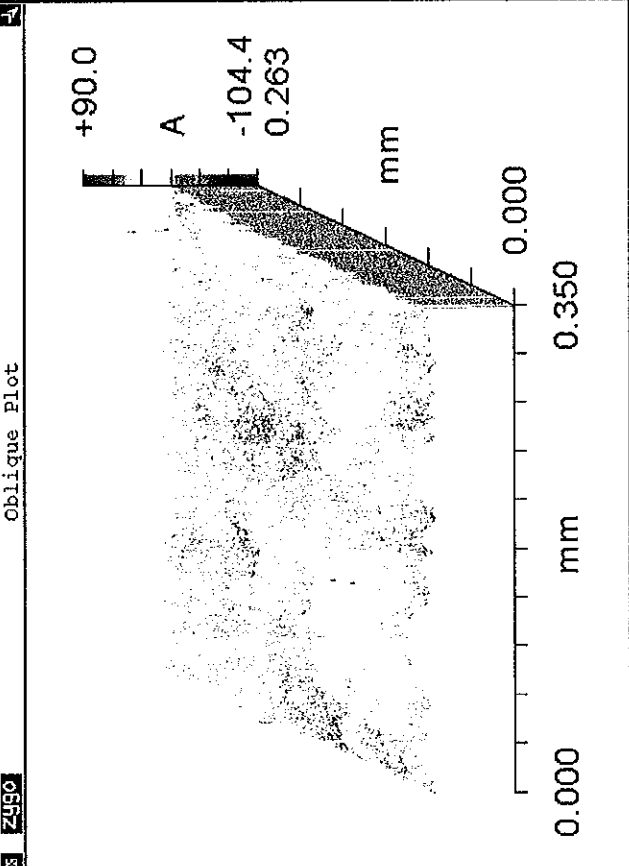
P/N:

Mag. Sec. Sample 5 Center

20X Mirau Z490 Microscope Application Surface Map Oblique Plot



+90.0  
A  
-104.4



+90.0  
A  
-104.4

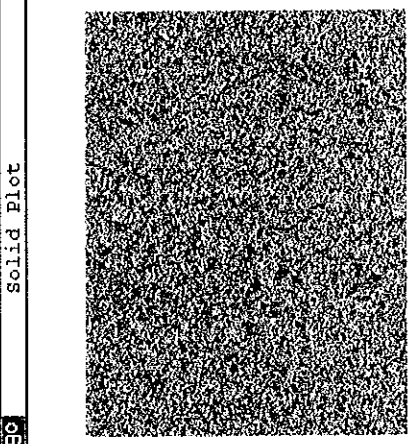
mm

0.000 0.350 0.000

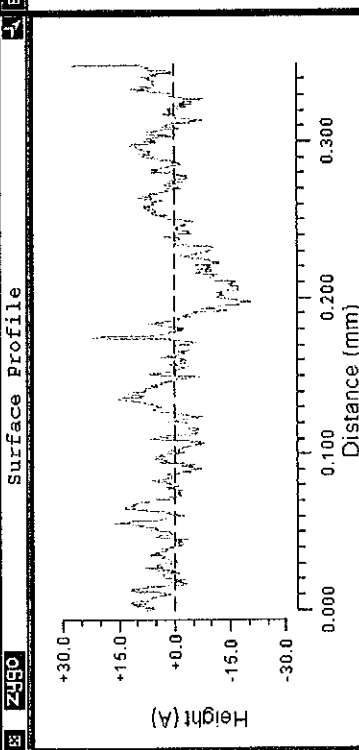
**Z490** Surface Profile

PV	194.392	A
rms	6.882	A
Ra	5.397	A
Size X	0.35	mm
Size Y	0.26	mm

**Z490** Solid Plot



**Z490** Surface Profile



Height (A)

Distance (mm)

PV	48.252	A
rms	6.583	A
Ra	5.028	A

[Profile Stats](#)

**Z490** Measure Attributes

Thu May 27 14:32:36 1999 Objective: 20X Mirau Camera Res: 0.548 um Zoom: 1X Data Sign: Inverted

S/N:  P/N:

MEASURE

Analyze

Mask Data

Save Data

Load Data

Calibrate

Reset

Measure Cntrl

Analyze Cntrl

Test+Ref Ctrl

Surface Profil

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

SynthFringes

Analyze Attr

Report

Process

Units

Video Monitor

Removed: Cylinder

Trimmed: 0

Filter: Off

Mag. Sec Sample 6 Near Edge

**Z490**

20X Mirau

MEASURE

- Analyze
- Mask Data
- Save Data
- load Data
- Calibrate
- Reset

Measure Cntrl

Analyze Cntrl

Test+Ref Cntrl

Surface Profi

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

SynthFringes

Analyze Attri

Report

Process

Units

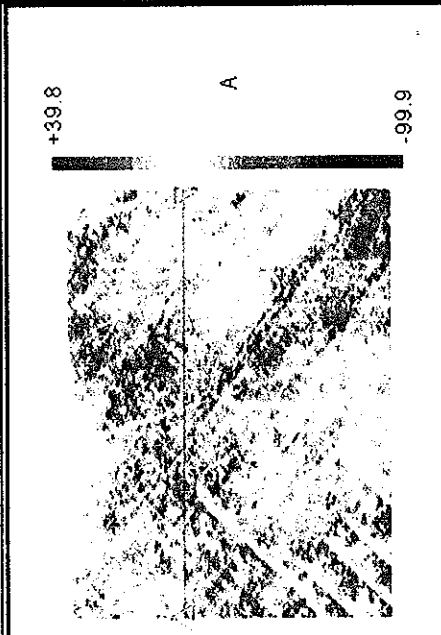
Video Monitor

**Z490**

Microscope Application

Surface Map

**Z490**

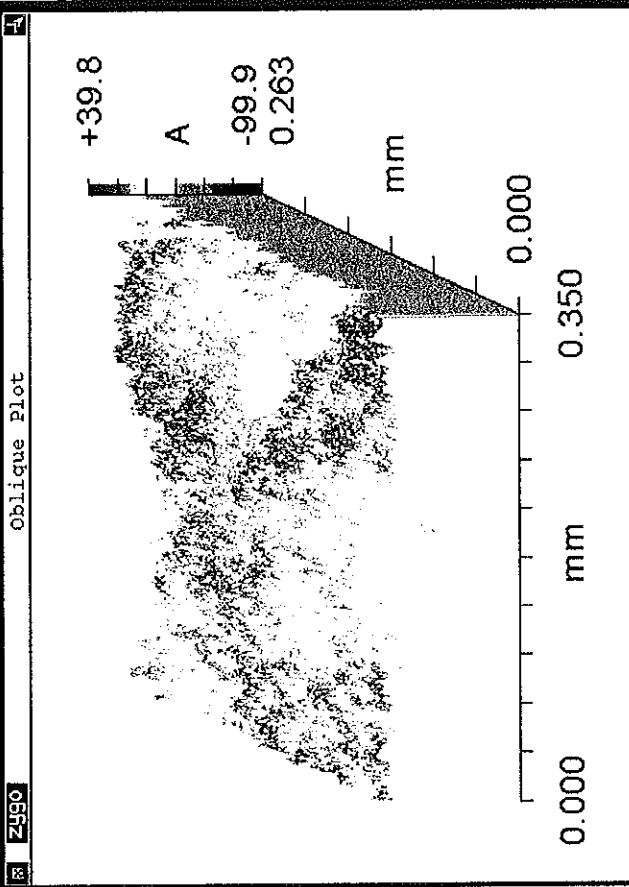


+39.8  
A  
-99.9

PV	139.713	A
rms	8.447	A
Ra	6.806	A
Size X	0.35	mm
Size Y	0.26	mm

**Z490**

Oblique Plot



+39.8  
A  
-99.9  
0.263

mm

0.000 0.350 0.000

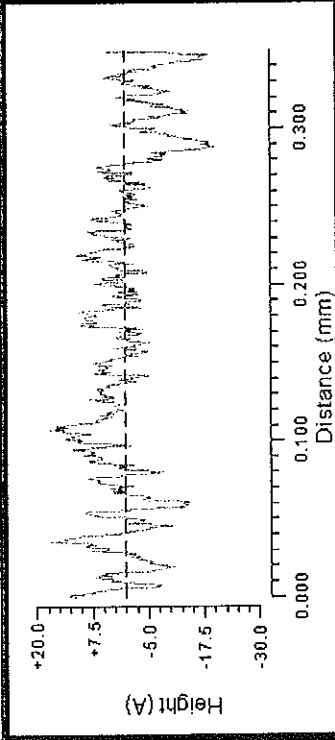
Removed: Cylinder

Trimmed: 0

Filter: Off

**Z490**

Surface Profile



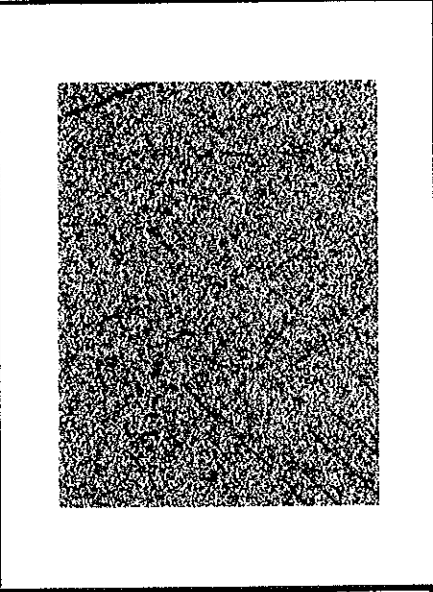
Height (A)

Distance (mm)

PV	37.277	A	Ra	5.258	A
rms	6.812	A	Profile Stats		

**Z490**

Solid Plot



**Z490**

Measure Attributes

Thu May 27 13:54:48 1999

Objective: 20X Mirau Camera Res: 0.548 um Zoom: 1X

Date Sign: Inverted

S/N:

P/N:



Mag. Sec. Sample 6 Center

Z490

20X Mirau

MEASURE

Analyze

Mask Data

Save Data

Load Data

Calibrate

Reset

Measure Cntrl

Analyze Cntrl

Test+Ref Cntrl

Surface Profil

Slope Mag

Slope X

Slope Y

Spectrum Map

Spectrum Prof

Intensity

SynthFringes

Analyze Attr

Report

Process

Units


Video Monitor

Z490

Microscope Application

Surface Map

Z490



+38.3

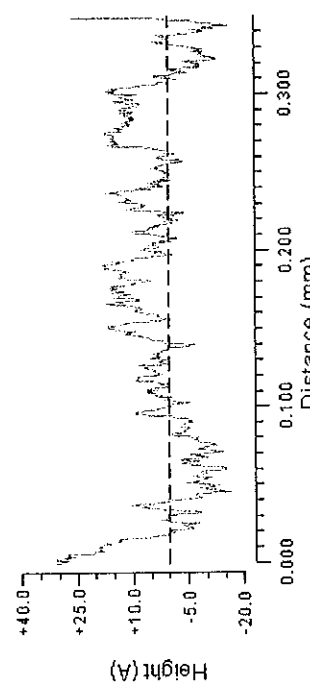
A

-94.8

PV	133.088	A
Rms	7.892	A
Ra	6.302	A
Size X	0.35	mm
Size Y	0.26	mm

Z490

Surface Profile



Height (A)


Distance (mm)

PV	47.362	A	Ra	7.159	A
Rms	8.878	A	Profile Stats		

Z490

Surface Map

Z490



+38.3

A

-94.8

0.000

0.350

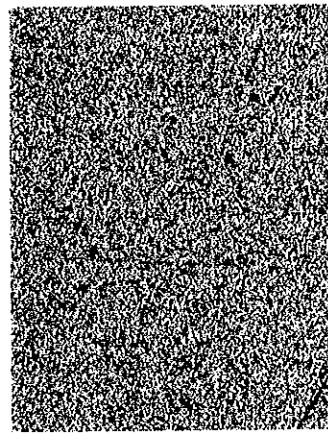
0.000

mm

mm

Z490

Solid Plot



Removed: Cylinder

Trimmed: 0

Filter: Off

Z490

Oblique Plot

Z490

Measure Attributes

Thu May 27 14:03:53 1999

Objective: 20X Mirau Camera Res: 0.548 um

Zoom: 1X

Data Sign: Inverted

S/N:

P/N:

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 8

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 5.6 Scratch/Dig

Parameter: Surface Quality

Method:  
Visual Inspection

Configuration:  
Part Assembly

Schedule:  
Final Acceptance Test

**REQUIREMENT:**

Physical quality of the surface shall have a maximum scratch/dig of 60/40 over 99.9% of the clear aperture.

**VERIFICATION APPROACH:**

Per MIL-O-13830A.

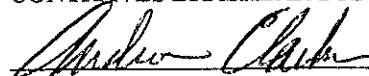
RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

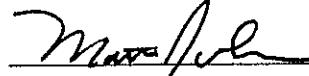
**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW



DATE 7/23/99



DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

AT Final Factory Acceptance

VIS #

in shipping crate ARC

7/23/99

**SCRATCH & DIG MAP**

Description: Magellan Sec Mirror

Date: 7-23-99

Drawing Number: 955E0512

Revision: \_\_\_\_\_

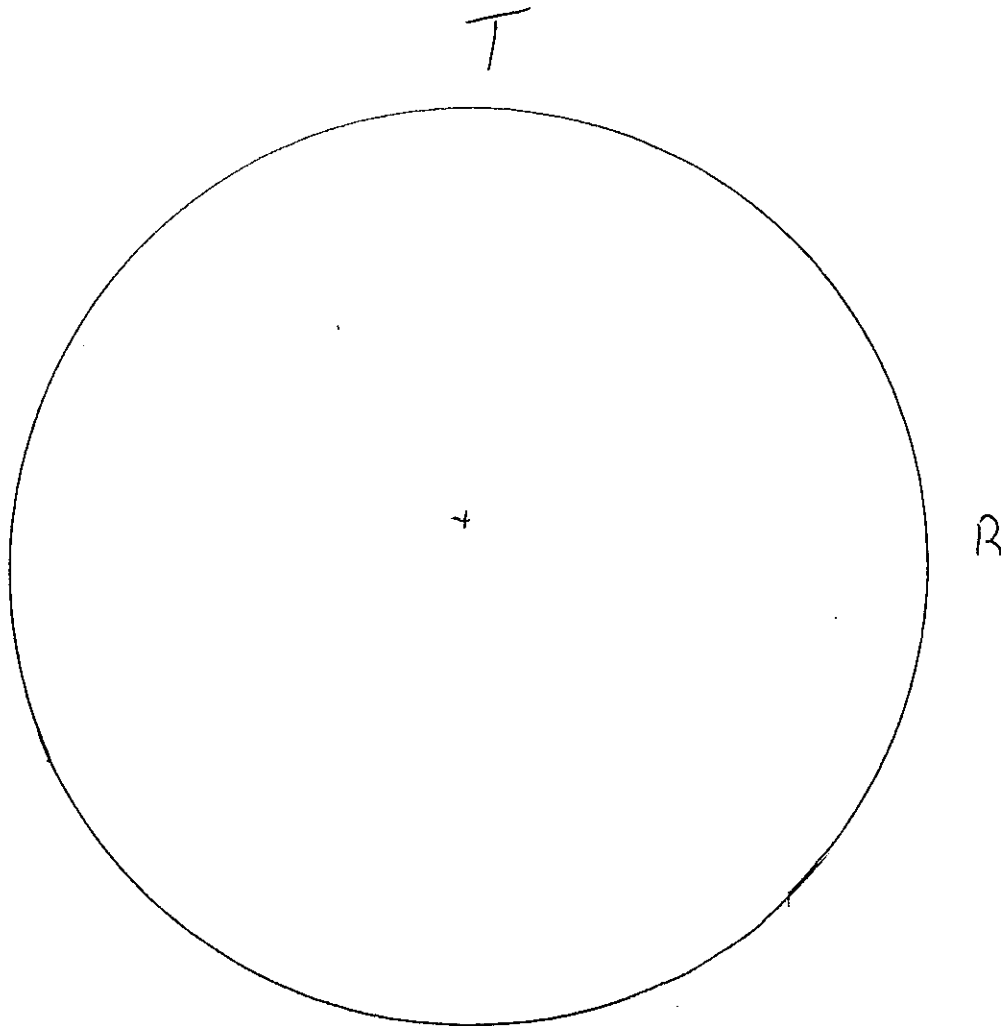
Order Number: \_\_\_\_\_

S/N: 1

Accept

Blueprint Requirement: 60/40 Actual: 10/5

Inspector M.E.C. Reject



**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**  
 Magellan Project f/11 Secondary Mirror  
 Specification:  
OCIW Document No. 95SE0008  
 4 September 1998

VIS# 9

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 5.7 Alignment Mark

Parameter: Centration and width of alignment reticle.

Method:  
 Visual Inspection

Configuration:  
 Part Assembly

Schedule:  
 Final Acceptance Test

**REQUIREMENT:**

A cross with a minimum diameter of 6 mm and maximum diameter of 10mm with a nominal line width of 0.5mm shall be ground concentric with the optical center of the polished surface within 0.5mm

Cross = 8mm leg X 8mm leg X 0.5mm wth.  
 Concentric = 0.15mm

*R.* 5-26-99

**VERIFICATION APPROACH:**

The position of the alignment mark shall be verified using a microscope objective with the mirror on an adequate bearing.

*R.* 5-26-99

RESULTS: PASSED  FAILED  RETEST

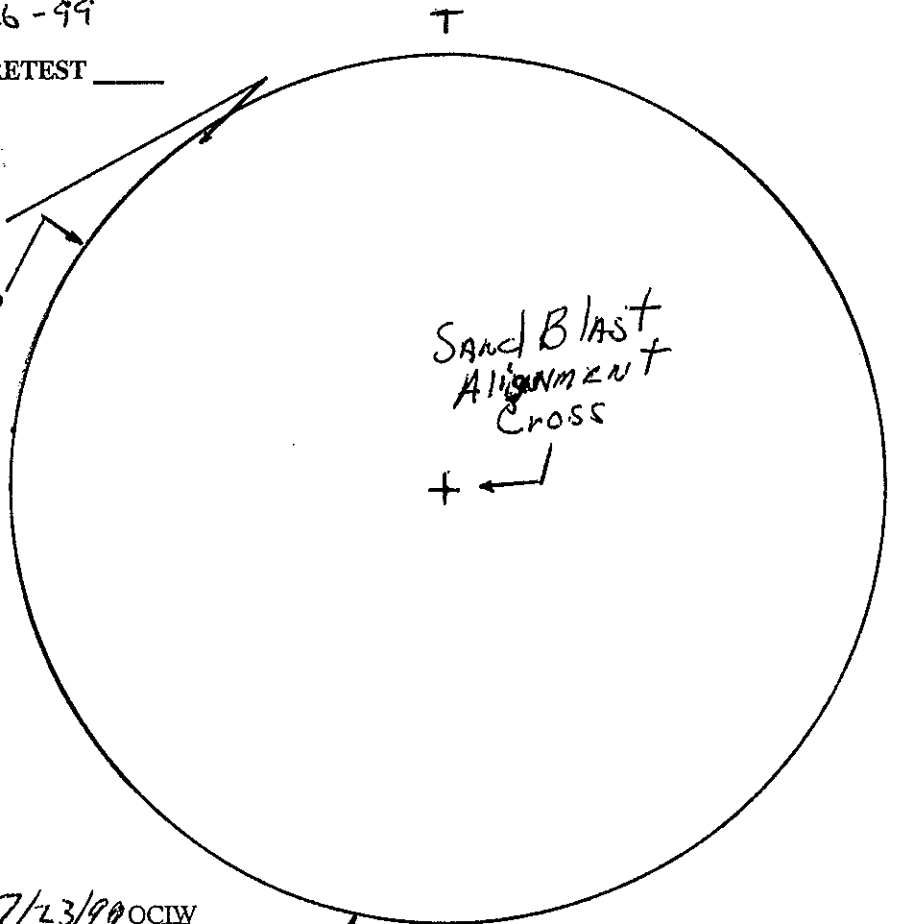
COMMENTS (optional):

- Preliminary Set Up
- 1) Indicate Top Surface .002TIR
  - 2) Indicate Outer Diameter .003TIR

Alignment Scope

- 1) Top 180° to Bottom = 0
  - 2) Right Eccentric 180° to Left = .005"
- Center = .0025"

*R.* 5-26-99



**VERIFICATION APPROVAL:**

CONTRAVES INC) *Robert Clark* 7/23/99 OCIW

*Robert Clark*

DATE 5-26-99

*Mark [Signature]* B

DATE 7-23-99

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 10

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 3.4 Center of Gravity

Parameter: Center of Gravity

Method:

Measure

Configuration:

Part Assembly

Schedule:

Final Acceptance Test

**REQUIREMENT:**

The center of gravity shall be measured so that an Invar ring may be bonded to the center of gravity plane.

**VERIFICATION APPROACH:**

The mirror shall be mounted in a vertical fixture. The fixture is tipped forward until the mirror tips forward; the fixture is then tipped backward until the mirror tips back. The center of gravity plane can be determined from the angle that causes the mirror to tip forward or backward. This process shall be repeated several times to calculate an average value.

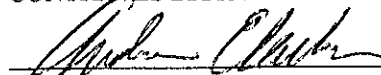
RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW



DATE 7/23/99



DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project #11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 11

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 3.3 Weight

Parameter: Weight

Method:

Measure

Configuration:

Part Assembly

Schedule:

Final Acceptance Test

**REQUIREMENT:**

*Estimated* The finished weight of the mirror shall be 187kg.

*Mirror + lifting fixture*  
527 #  
- 121 #  
-----  
406 = mirror

*-9#  
Zeroing error  
all measurements  
not subtracted  
yet!!*

*and weight of total 7/23/99*

*Secondary Assembly*  
864 # with lift fixture  
75 #

**VERIFICATION APPROACH:**

By certified scale, accurate to within 2 kg.

*789 # mirror in cell*

RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW

*[Signature]*

DATE *7/23/99*

*[Signature]*

DATE *7-23-99*

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.

**contraves**  
**Brashear Systems**

**VERIFICATION INFORMATION STATEMENT**

Magellan Project f/11 Secondary Mirror

Specification:

OCIW Document No. 95SE0008

4 September 1998

VIS# 12

1 OF 1

REV: - Date: 4 September 1998

Specification Paragraph Title: 7.2 Shipping Container

Parameter: Shipping

Method:

Measure

Configuration:

Part Assembly

Schedule:

Final Acceptance Test

**REQUIREMENT:**

The shipping container shall protect the mirror from shock during transport with moisture protection incorporated in the shipping container. The polished surface shall be protected from scratching with a removable protective coating.

**VERIFICATION APPROACH:**

Design and analysis.

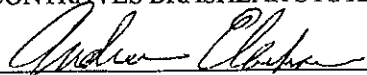
RESULTS: PASSED  FAILED  RETEST

COMMENTS (optional):

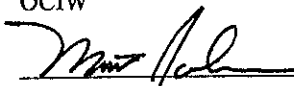
**VERIFICATION APPROVAL:**

CONTRAVES BRASHEAR SYSTEMS

OCIW



DATE 7/23/99



DATE 7-23-99

We reserve all rights in connection with this document and in the subject matter represented therein. The recipient hereby acknowledges these rights and shall not, without permission in writing, disclose or divulge this document in whole or in part to third parties or use it for any purpose other than that for which it was delivered to recipient.