#1

Magellan 6.5 M Telescope Tertiary Mirror

Polishing Final Results

OCIW Document No. 97TE0002

Table of Contents

11/4/97

To: Matt Johns
Systems Engineer
Carnegie Observatories

From: John DeRock
Precision Optics
Eastman Kodak Co.

RE: Data package for Magellan 6.5 M Telescope Tertiary Mirror

Dear Mr. Johns:

As per our most recent telephone conversation, I have enclosed a data package for the Tertiary Mirror recently manufactured at Kodak. As indicated the package consists of surface quality maps (shifted wavefronts), surface roughness data as recorded from the Chapman MP-2000 measurements, and a surface inspection map. I have not included mirror dimensional data as the mirror was processed as received.

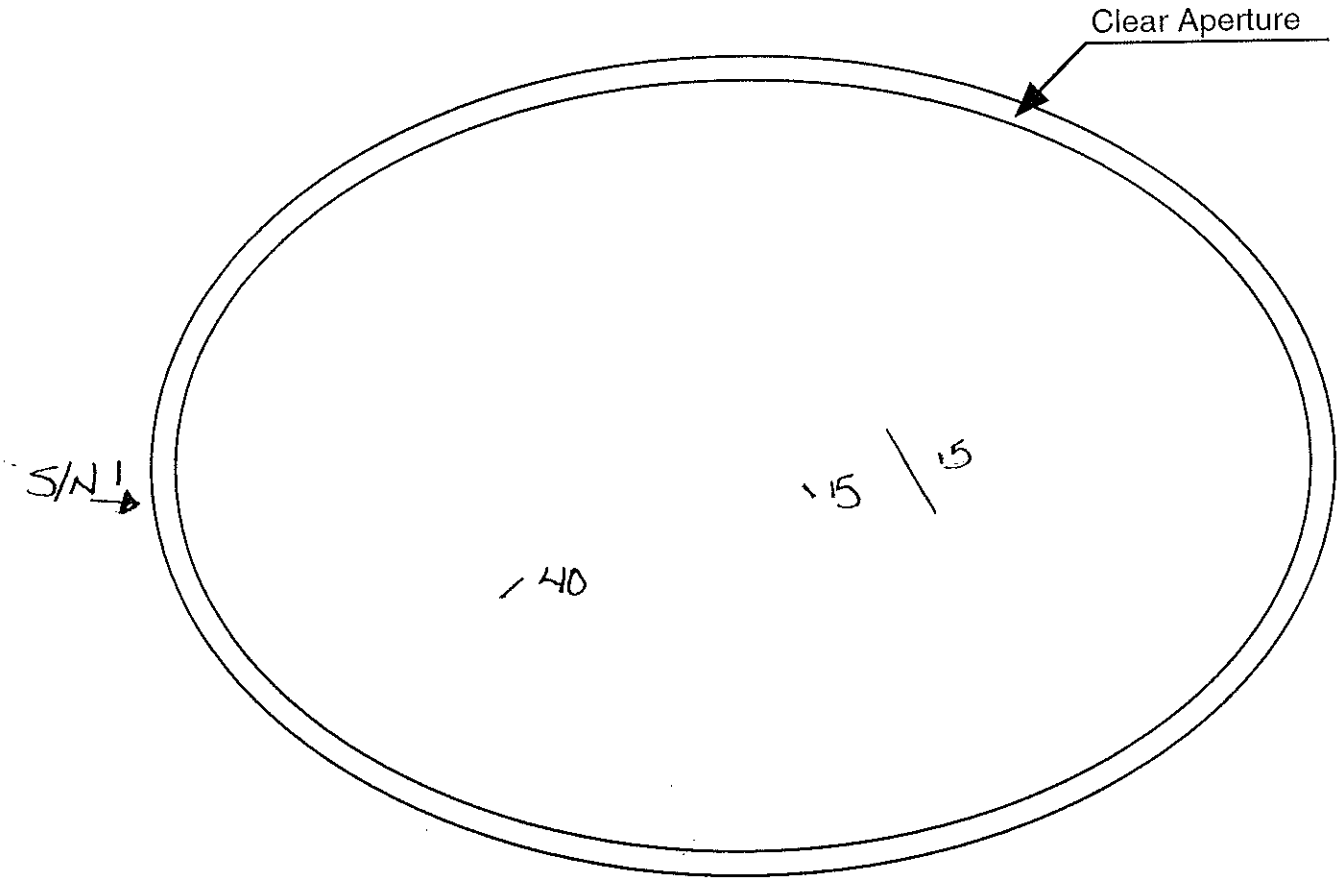
The mirror is currently packed in the shipping crate awaiting instruction for shipment. It is my understanding that the mirror will be shipped to California but that direction needs to be directed through our contracts department.

Please contact me directly with your questions or concerns at (716) 588-4891.

Sincerely yours,

John W. DeRock

Surface / Inspection Map
for Magellan Tertiary Mirror
Part No. 95TE0501

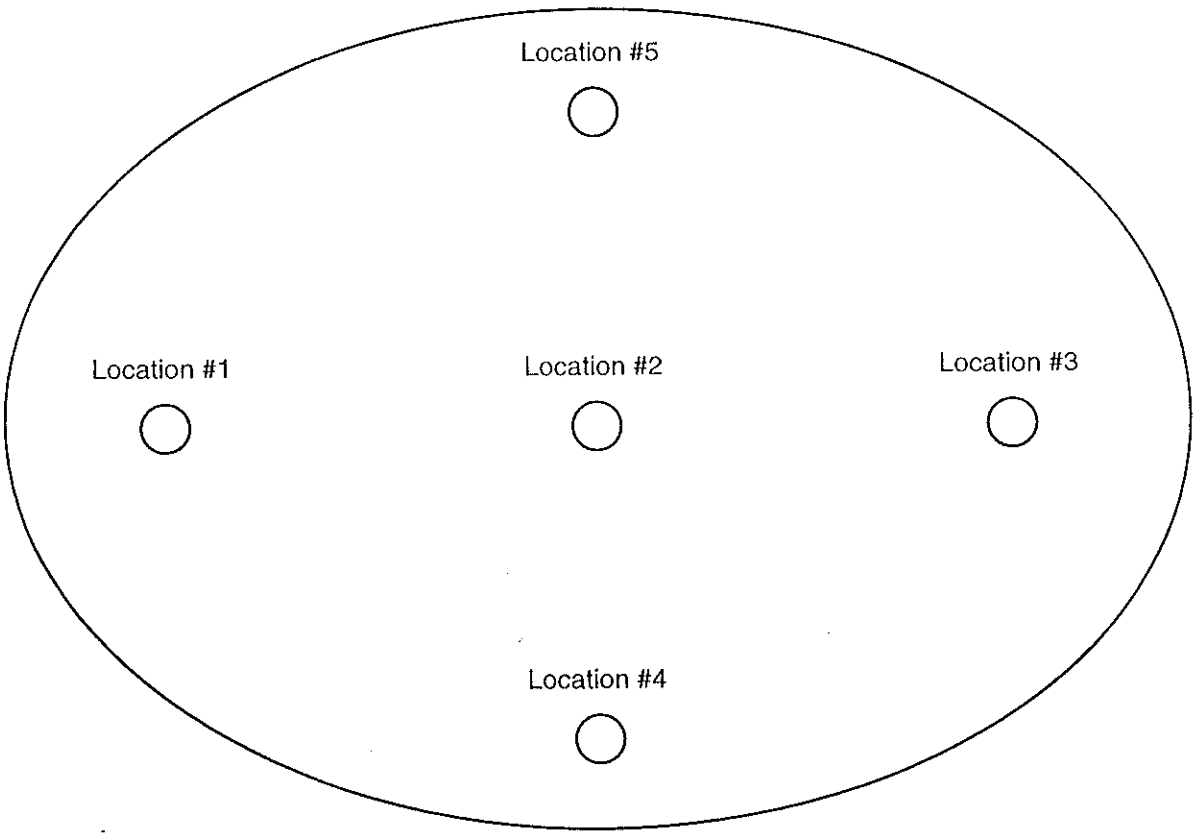


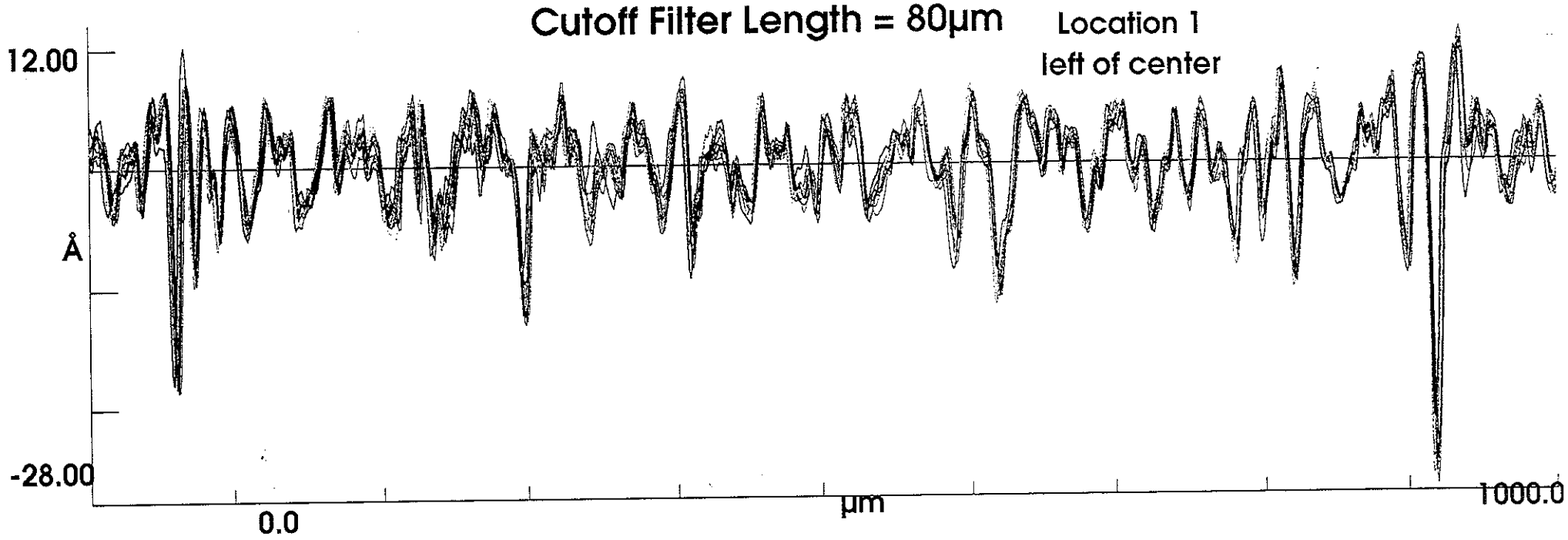
Inspected By: LB & WF

S/N: 1

Date: 11/3/97

Location Map for Magellan
Surface Roughness Measurements





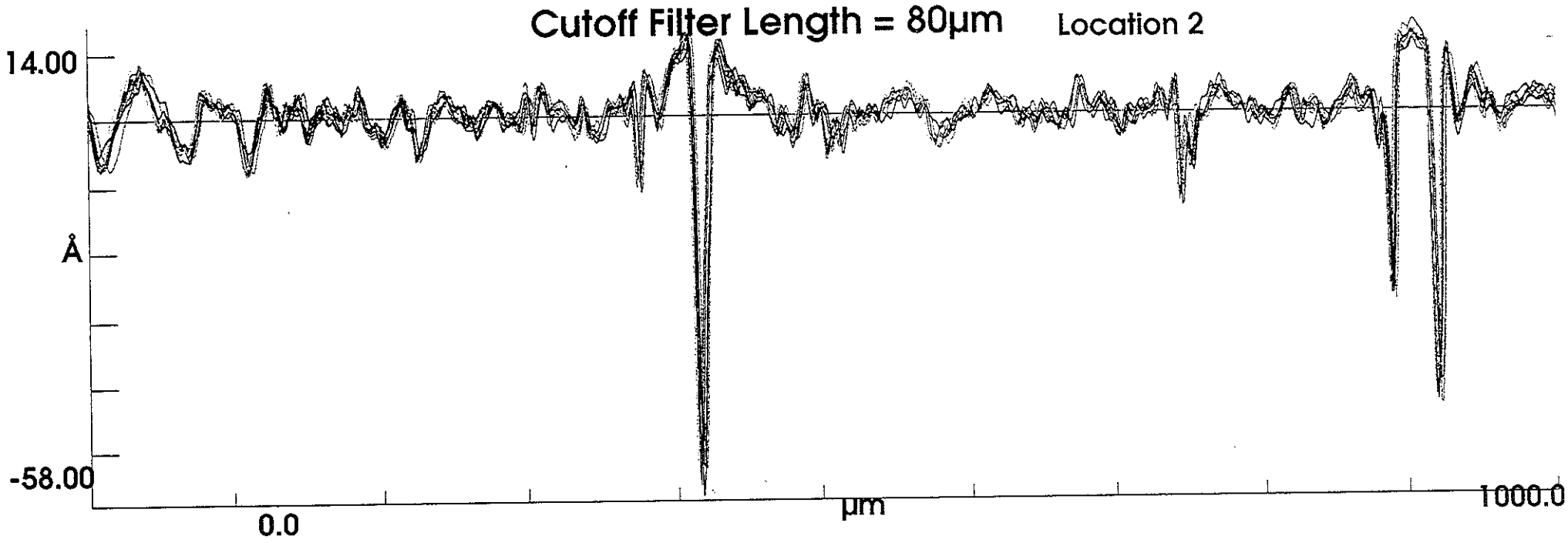
Ra = 2.86 Å

RMS (Rq) = 3.91 Å

PV (Rt) = 34.96 Å

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan A	2.71	3.68	31.85
Scan B	2.71	3.70	32.36
Scan C	2.73	3.78	33.51
Scan D	2.74	3.79	34.42
Scan E	2.75	3.84	34.13
Scan F	2.87	3.99	35.90

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan G	2.93	3.98	34.55
Scan H	3.05	4.16	37.47
Scan I	2.98	4.05	36.09
Scan J	3.00	4.09	37.29
Scan K	2.93	3.97	36.58
Scan L	2.92	3.93	35.33



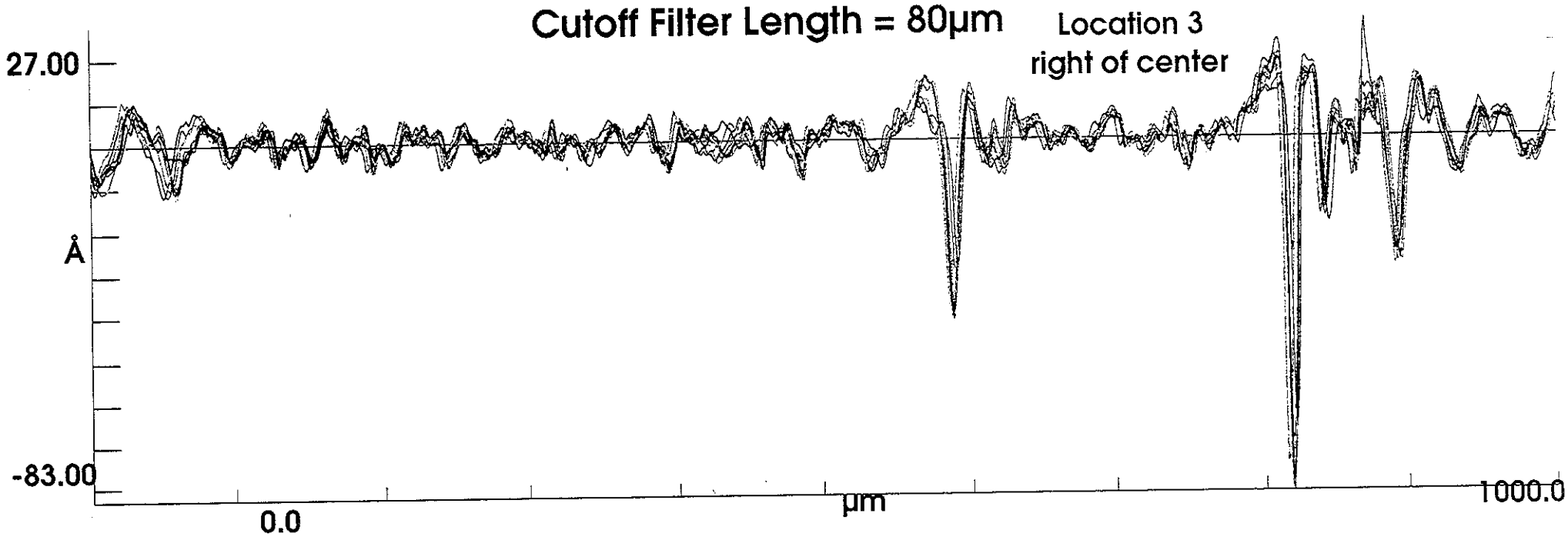
Ra = 3.04 Å

RMS (Rq) = 5.89 Å

PV (Rt) = 66.83 Å

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan A	2.96	5.70	64.47
Scan B	3.01	5.97	70.32
Scan C	2.97	5.91	68.02
Scan D	2.98	5.96	67.68
Scan E	3.00	5.93	69.14
Scan F	3.00	5.80	66.10

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan G	2.98	5.72	64.01
Scan H	3.06	5.84	66.45
Scan I	3.09	5.91	66.48
Scan J	3.10	5.98	67.37
Scan K	3.13	6.02	65.72
Scan L	3.18	6.00	66.17



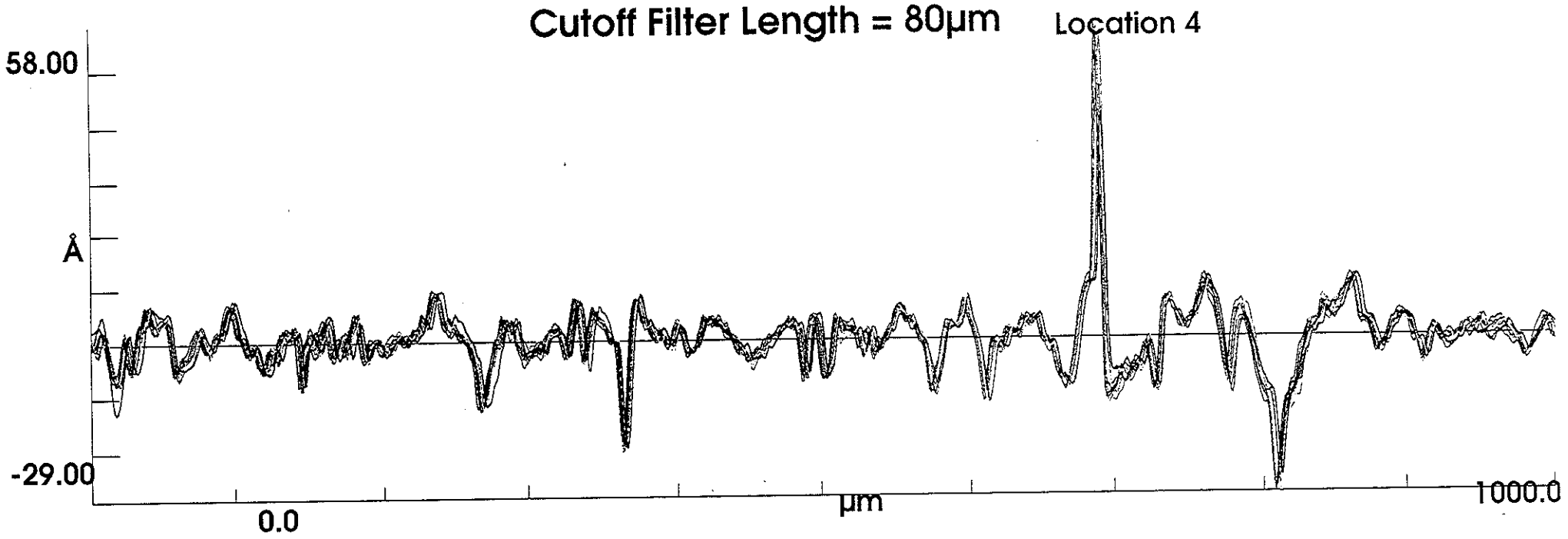
Ra = 4.28 Å

RMS (Rq) = 7.73 Å

PV (Rt) = 95.12 Å

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan A	3.81	6.84	92.61
Scan B	4.02	7.07	87.80
Scan C	4.15	7.19	86.17
Scan D	4.23	7.49	89.69
Scan E	4.31	7.63	94.50
Scan F	4.29	7.72	93.60

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan G	4.40	7.92	96.75
Scan H	4.36	7.87	95.36
Scan I	4.49	8.28	100.43
Scan J	4.45	8.27	99.62
Scan K	4.40	8.15	100.11
Scan L	4.43	8.35	104.84



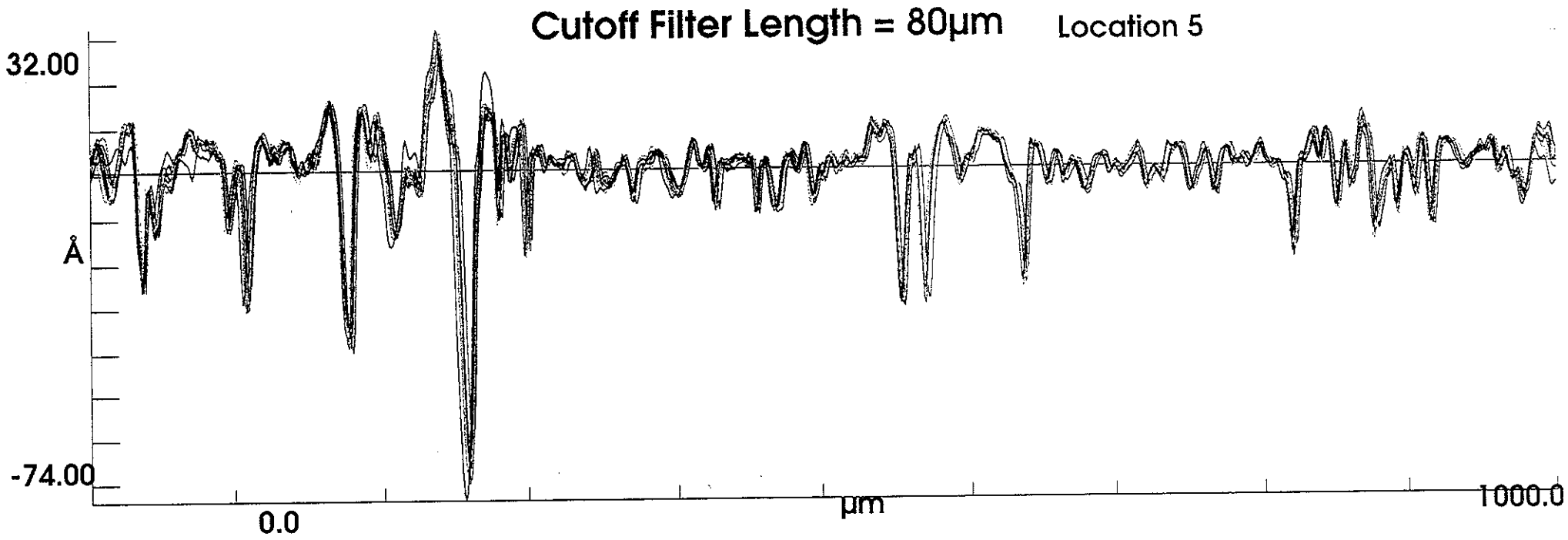
Ra = 3.66 Å

RMS (Rq) = 5.68 Å

PV (Rt) = 75.22 Å

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan A	3.70	5.50	66.53
Scan B	3.57	5.39	67.95
Scan C	3.52	5.24	63.24
Scan D	3.62	5.48	68.69
Scan E	3.75	5.62	71.51
Scan F	3.67	5.65	73.51

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan G	3.58	5.51	72.17
Scan H	3.76	6.01	83.34
Scan I	3.64	5.76	81.19
Scan J	3.79	5.97	83.93
Scan K	3.69	6.03	84.48
Scan L	3.69	6.02	86.05



Ra = 5.54 Å

RMS (Rq) = 9.10 Å

PV (Rt) = 94.17 Å

	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan A	5.74	9.95	105.07
Scan B	5.78	9.67	100.70
Scan C	5.69	9.49	100.53
Scan D	5.66	9.28	96.12
Scan E	5.57	8.99	92.00
Scan F	5.72	9.37	97.81

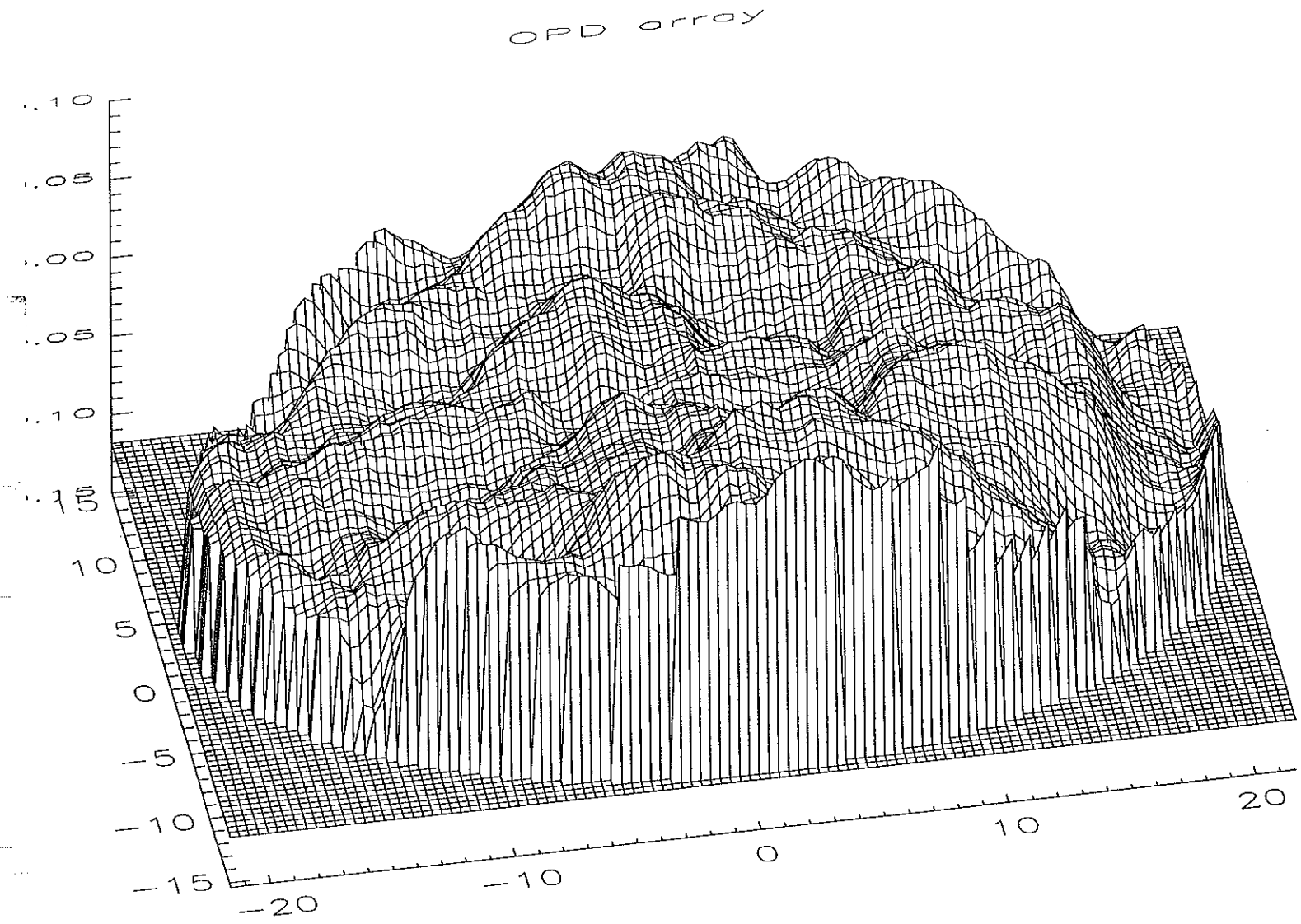
	Ra (Å)	Rq (RMS) (Å)	Rt (PV) (Å)
Scan G	5.64	9.16	95.44
Scan H	5.38	8.74	90.72
Scan I	5.36	8.60	89.56
Scan J	5.45	8.76	89.41
Scan K	5.29	8.58	86.21
Scan L	5.27	8.56	86.50

Avg on Clean Ap. with New B/O

TA 971326 P732

RMS: 0.02936

P/V: 0.1690



********** WAVEFRONT COMBINATION PROCESS started at 9710281607 **********

JOHN HANON —

SURFACE HEIGHT DEV IN λ (630NM)

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: wedge

TA	Pic	Flip	Rot	Mult	Focus
971326	731	--	--	1.0000	none

Lower LT.

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326731	magellan tertiary fu	111	079	-21.653	-15.354	0.39370	0.39370	6681	6681	0.122	-0.094	0.031
999999999	AGGREGATE = CLEAR APERTURE → 732	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2	1S	2S	3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326731	0.001	1.000	38	66	96	99	0.025	0.020	0.019	0.019	0.019	0.016
999999999	①		39	67	95	99	0.024	0.019	0.018	0.018	0.018	0.015

RMS AFTER REMOVAL OF TERM1, TERM2, ...

TA/PIC	Power mag	Astig mag	Astig ang	Coma mag	Coma ang	Spher mag	Trefoil mag	Trefoil ang	Tetra mag	Tetra ang
971326731	-0.044	0.133	-87.1	0.030	159.1	-0.014	0.017	32.2	0.091	2.2
999999999	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6

— ϕ° @ 3 PM
— M,NW → CW

① RMS BETWEEN SERIES OF AVERAGED FRAMES. DOES NOT APPLY HERE.

SURFACE HT.
ENTRIES IN TABLE
DISKETTE WT DATA.

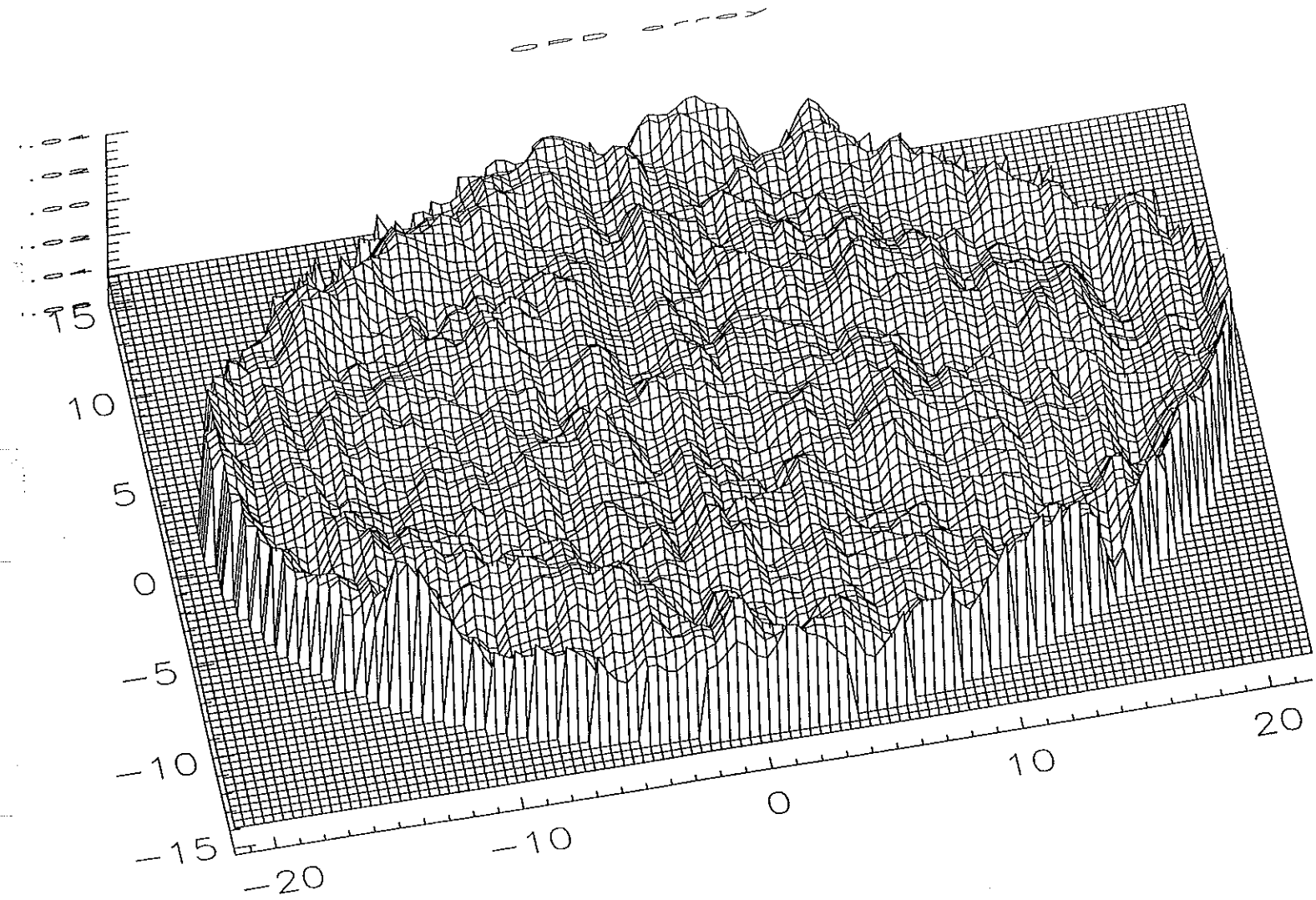
New B/O

Δ.2 CM X

TA 971326 P771

RMS: 0.008297 Req. → .024 RMS

P/V: 0.07292



********** WAVEFRONT COMBINATION PROCESS started at 9710290917 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	741	--	--	-1.0000	none

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326741	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	6103	0.039	-0.034	0.008

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2 1S 2S 3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.029	0.228	39 67 95 99	0.024	0.019	0.018	0.018	0.018	0.015
971326741	0.029	0.175	39 67 95 99	0.024	0.020	0.018	0.018	0.018	0.015
999999999			44 73 94 98	0.008	0.008	0.008	0.008	0.007	0.007

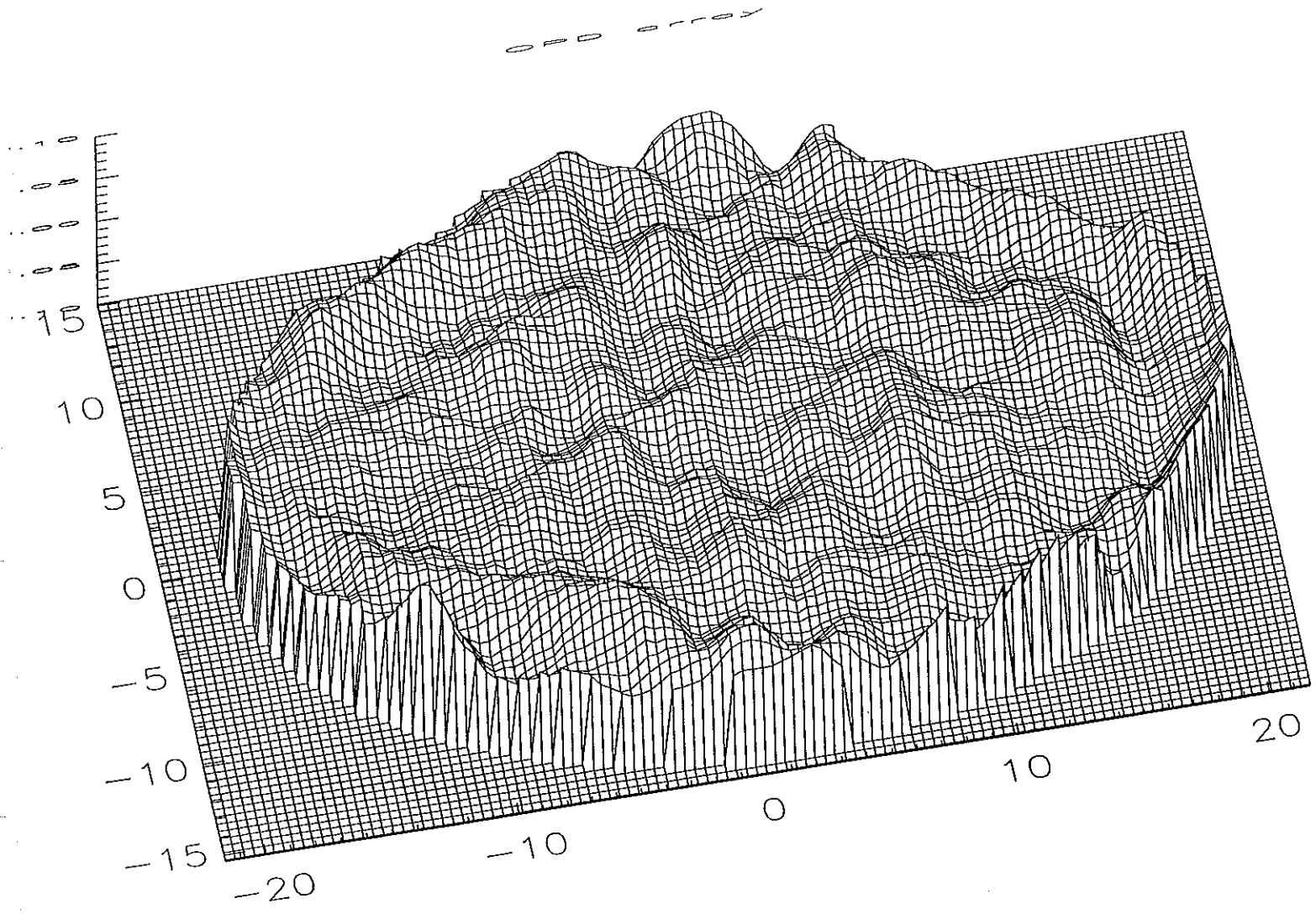
TA/PIC	Power mag	Astig mag	Astig ang	Coma mag	Coma ang	Spher mag	Trefoil mag	Trefoil ang	Tetra mag	Tetra ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326741	-0.059	0.132	-86.5	0.044	137.3	-0.024	0.013	46.5	0.106	2.6
999999999	0.002	0.009	89.2	0.005	-90.4	0.004	0.010	2.9	0.007	-6.9

New B/O △ 5CM X

TA 971326 P772

RMS: 0.01699 Req → .043 RMS

P/V: 0.1510



********** WAVEFRONT COMBINATION PROCESS started at 9710291033 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	742	--	--	-1.0000	none

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326742	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6212	6212	0.075	-0.094	0.029
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	5878	0.075	-0.076	0.017

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2	1S	2S	3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.027	0.417	39	67	95	99	0.024	0.019	0.018	0.018	0.018	0.015
971326742	0.029	0.304	39	67	95	99	0.024	0.020	0.019	0.017	0.017	0.014
999999999			43	72	94	99	0.015	0.015	0.015	0.015	0.014	0.014

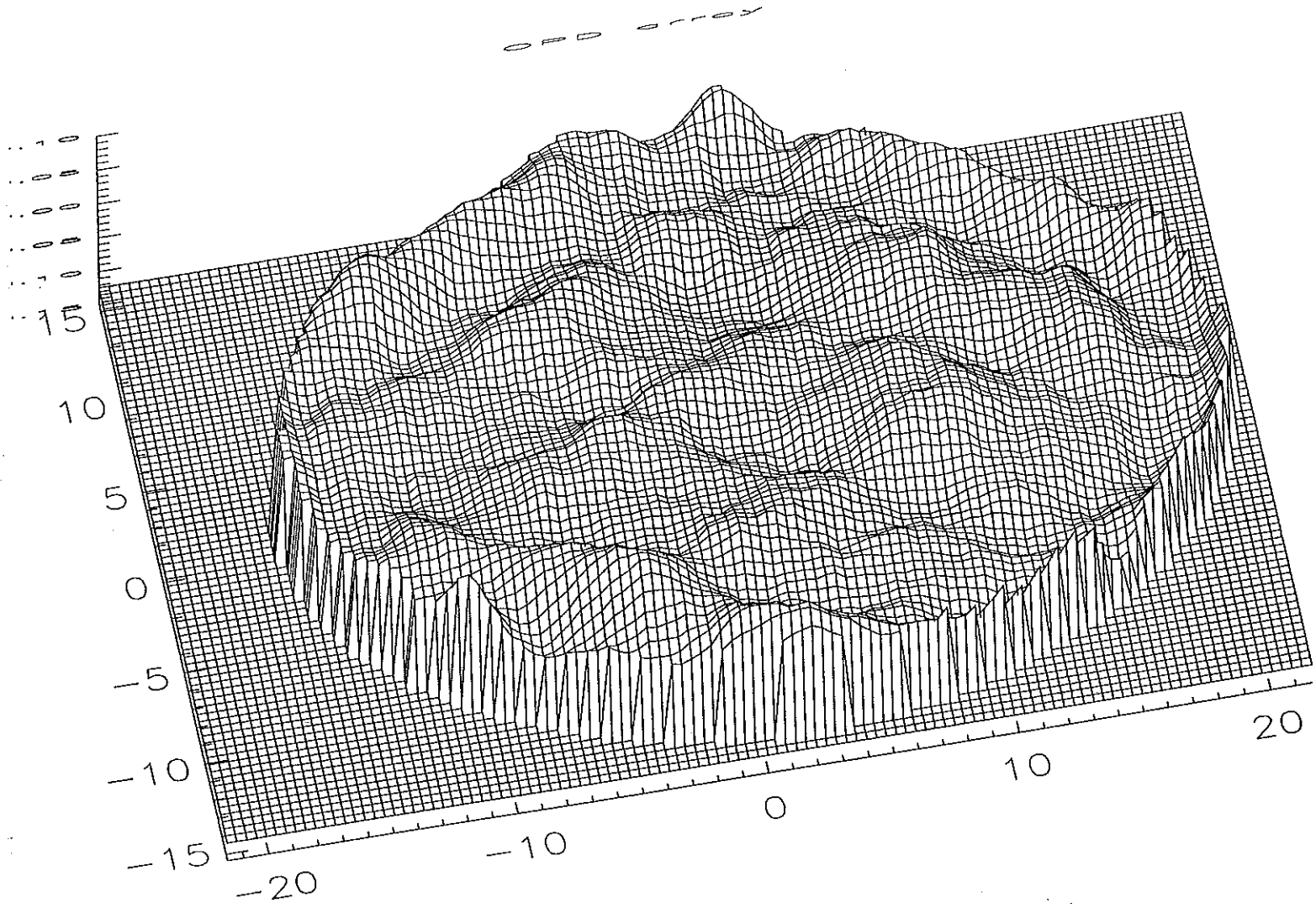
TA/PIC	Power	Astig		Coma		Spher	Trefoil		Tetra	
	mag	mag	ang	mag	ang	mag	mag	ang	mag	ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326742	-0.068	0.128	-84.7	0.040	117.5	-0.029	0.036	57.2	0.115	2.8
999999999	-0.002	0.020	87.5	0.010	-176.4	0.005	0.031	6.2	0.014	-6.7

New B/O △ 10 CM X

TA 971326 P773

RMS: 0.02707 Reg → RMS .065

P/V: 0.1753



********** WAVEFRONT COMBINATION PROCESS started at 9710291034 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	743	--	--	-1.0000	none

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326743	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6053	6053	0.075	-0.094	0.028
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	5503	0.076	-0.099	0.027

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2 1S 2S 3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.025	0.614	39 67 95 99	0.024	0.019	0.018	0.018	0.018	0.015
971326743	0.029	0.452	39 67 96 99	0.025	0.021	0.020	0.016	0.018	0.014
999999999			41 70 94 99	0.022	0.022	0.020	0.020	0.019	0.019

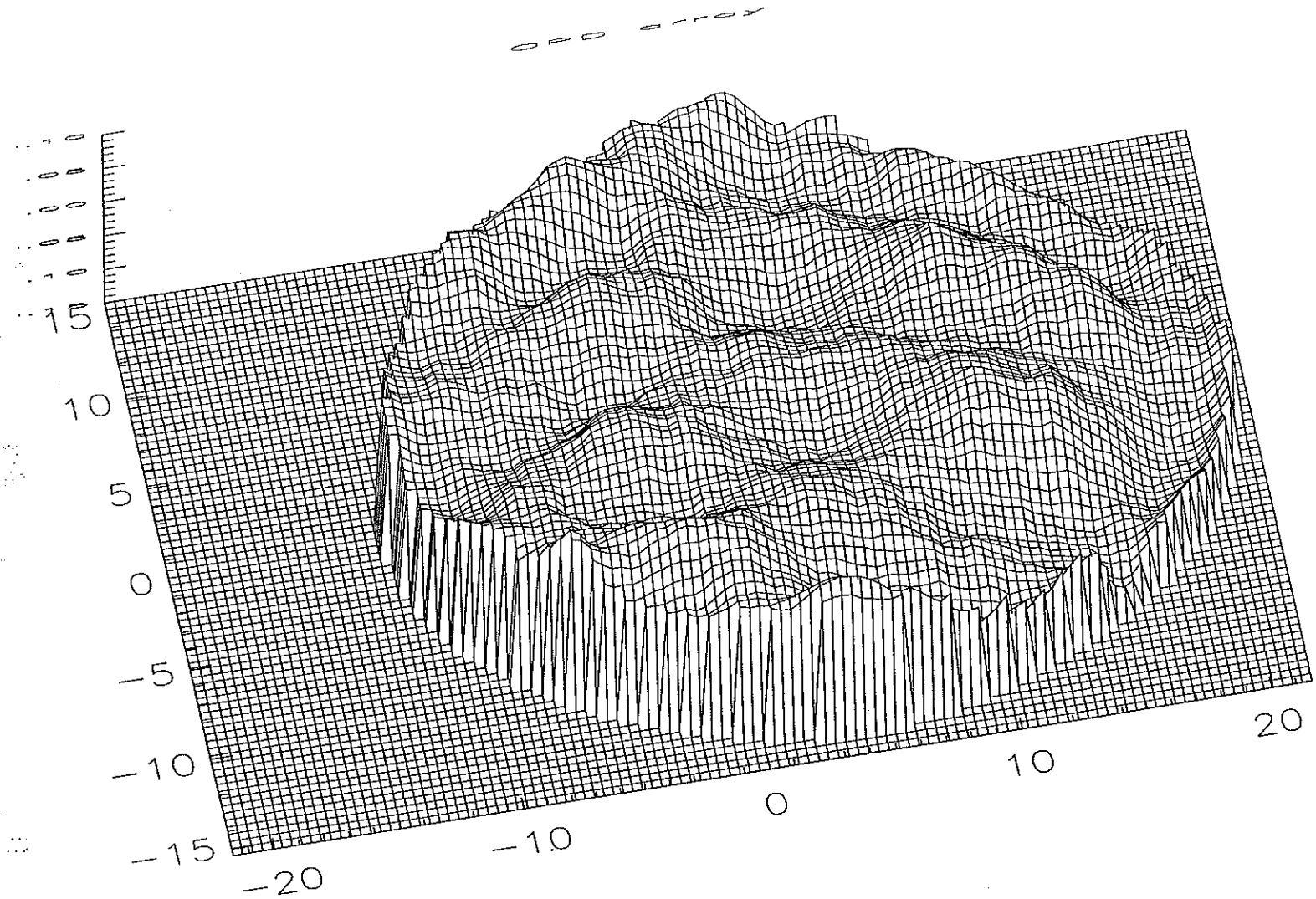
TA/PIC	Power mag	Astig mag	Astig ang	Coma mag	Coma ang	Spher mag	Trefoil mag	Trefoil ang	Tetra mag	Tetra ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326743	-0.088	0.120	-81.5	0.038	70.5	-0.039	0.083	-59.0	0.125	3.3
999999999	-0.007	0.036	-89.2	0.048	144.9	0.001	0.075	7.5	0.008	-19.8

New B/O △ 20 CM X

TA 971326 P774

RMS: 0.03940 Req. → .090 RMS

P/V: 0.2169



********** WAVEFRONT COMBINATION PROCESS started at 9710291034 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	744	--	--	-1.0000	none

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326744	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	5575	5575	0.075	-0.094	0.025
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	4759	0.098	-0.119	0.039

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2 1S 2S 3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.025	0.771	39 67 95 99	0.024	0.019	0.018	0.018	0.018	0.015
971326744	0.029	0.667	40 65 97 99	0.030	0.026	0.022	0.018	0.019	0.014
999999999			38 68 95100	0.029	0.032	0.029	0.029	0.020	0.019

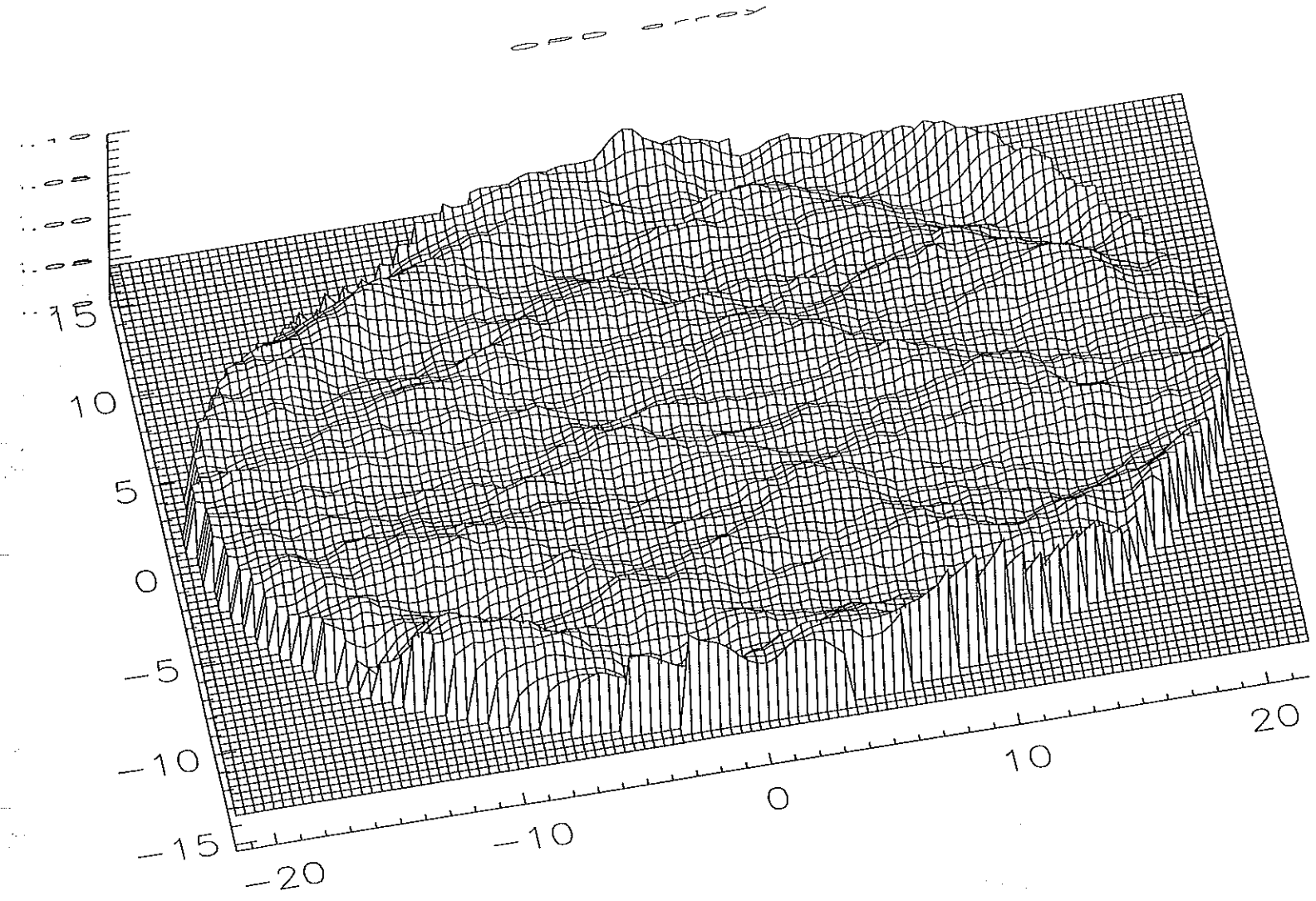
TA/PIC	Power mag	Astig mag	Astig ang	Coma mag	Coma ang	Spher mag	Trefoil mag	Trefoil ang	Tetra mag	Tetra ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326744	-0.144	0.097	-74.2	0.107	22.7	-0.047	0.203	-57.3	0.163	3.1
999999999	-0.013	0.107	-85.1	0.098	139.0	-0.013	0.214	5.1	0.021	-41.1

New B/O Δ 2CM Y

TA 971326 P775

RMS: 0.01023 Rms Req.→ .024

P/V: 0.1124



********** WAVEFRONT COMBINATION PROCESS started at 9710291035 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	745	--	--	-1.0000	none

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326745	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	6039	0.071	-0.042	0.010

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2 1S 2S 3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.029	0.232	39 67 95 99	0.024	0.019	0.018	0.018	0.018	0.015
971326745	0.029	0.190	39 67 95 99	0.024	0.019	0.018	0.018	0.018	0.015
999999999			44 74 95 98	0.011	0.011	0.010	0.010	0.010	0.010

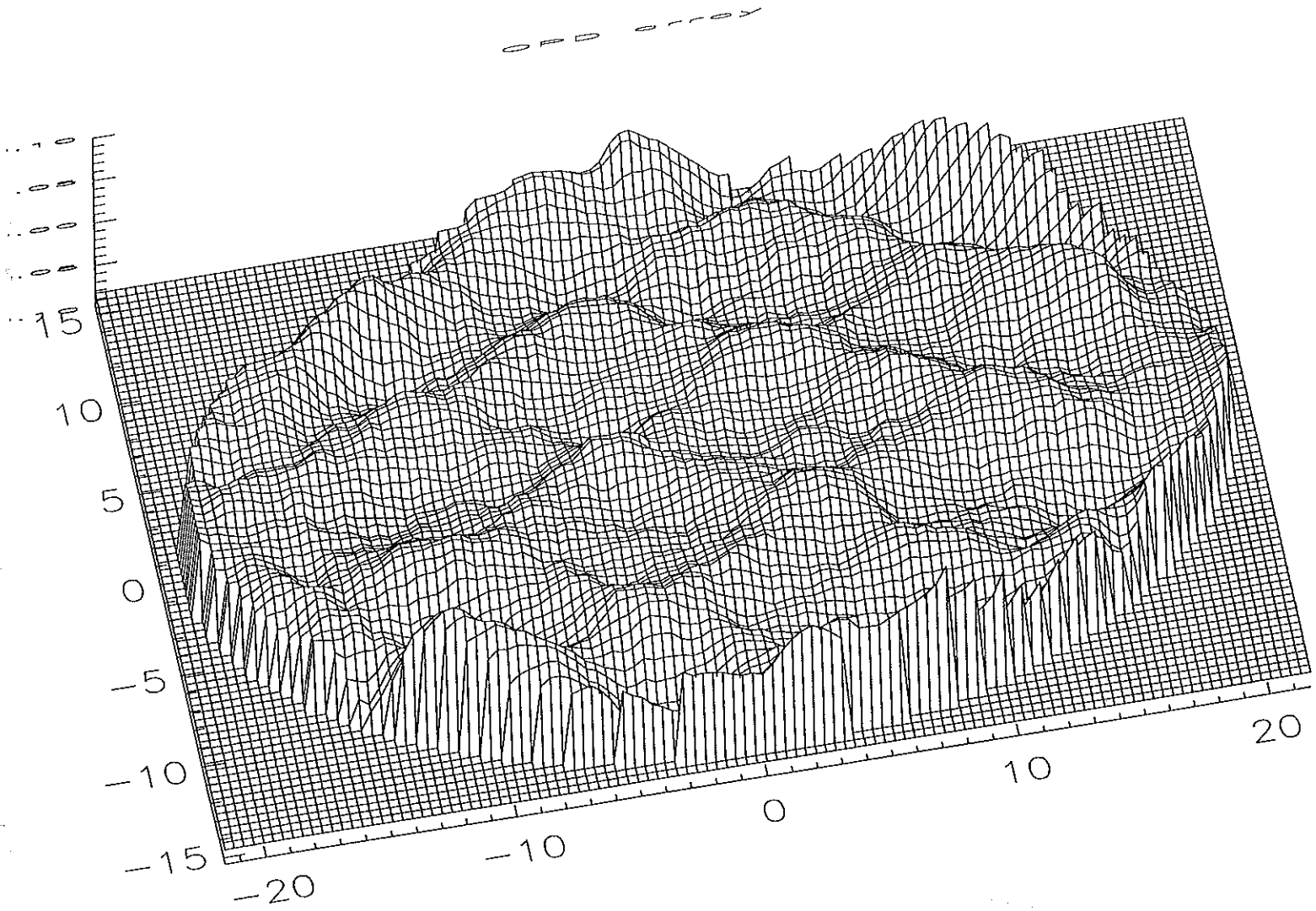
TA/PIC	Power mag	Astig mag	Astig ang	Coma mag	Coma ang	Spher mag	Trefoil mag	Trefoil ang	Tetra mag	Tetra ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326745	-0.050	0.129	-86.4	0.041	153.9	-0.021	0.008	-8.5	0.092	2.6
999999999	0.011	0.017	81.4	0.019	77.8	0.004	0.010	-52.2	0.001	-14.7

New B/O Δ.5 CM Y

TA 971326 P776

RMS: 0.01877 Reg → .043 RMS

P/V: 0.1405



********** WAVEFRONT COMBINATION PROCESS started at 9710291035 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	746	--	--	-1.0000	none

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326746	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6168	6168	0.065	-0.094	0.029
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	5718	0.078	-0.063	0.019

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2 1S 2S 3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.028	0.386	39 67 95 99	0.024	0.019	0.018	0.018	0.018	0.015
971326746	0.029	0.331	38 67 95 99	0.024	0.020	0.018	0.018	0.018	0.014
999999999			41 71 94 99	0.021	0.020	0.018	0.018	0.018	0.018

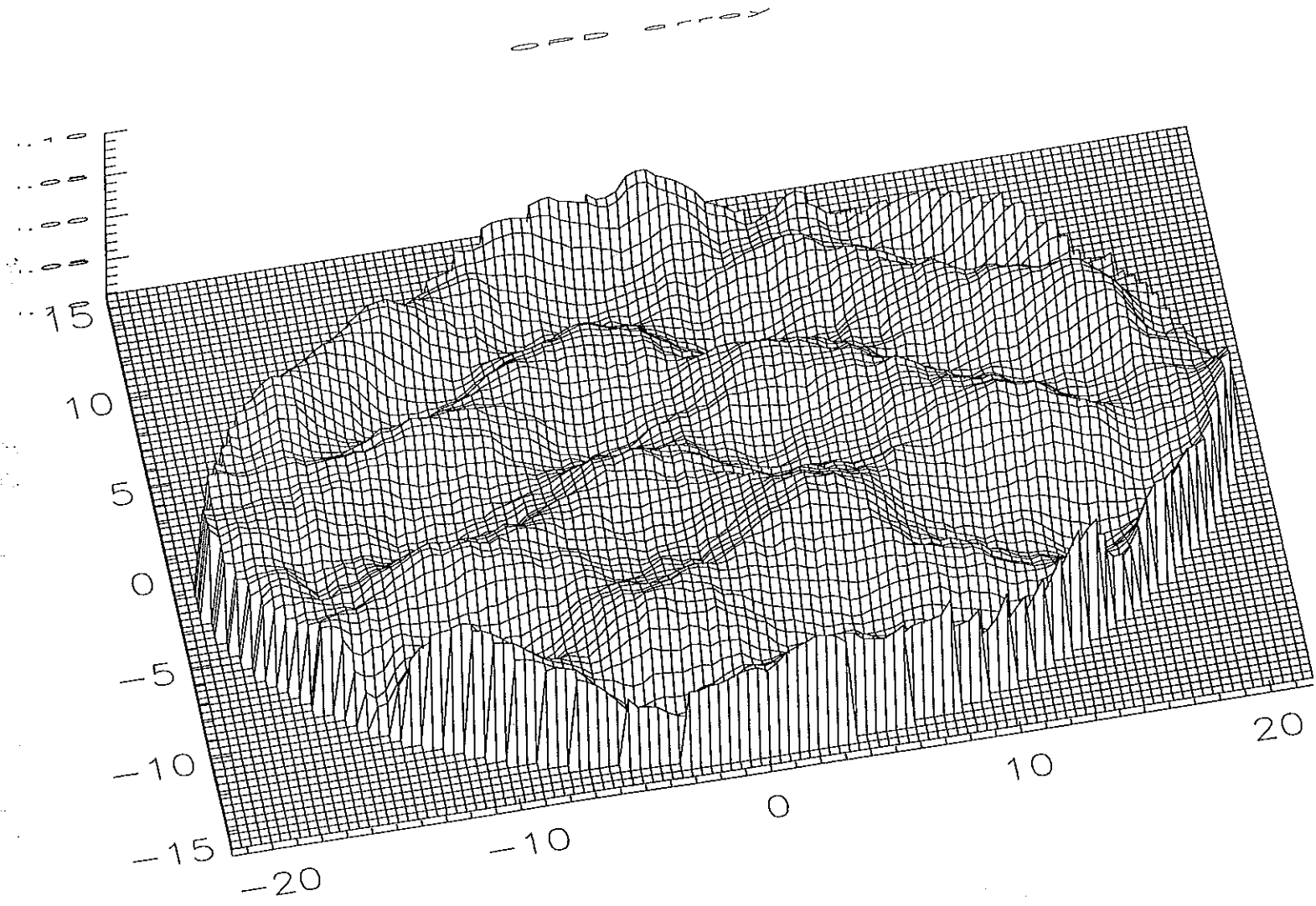
TA/PIC	Power mag	Astig mag	Astig ang	Coma mag	Coma ang	Spher mag	Trefoil mag	Trefoil ang	Tetra mag	Tetra ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326746	-0.047	0.142	-85.1	0.041	160.9	-0.021	0.036	-21.2	0.096	2.1
999999999	0.016	0.020	79.2	0.056	98.5	0.008	0.015	-13.6	0.009	-30.8

New B/O Δ 10cm Y

TA 971326 P777

RMS: 0.02215 Req → RMS .065

P/V: 0.1338



********** WAVEFRONT COMBINATION PROCESS started at 9710291036 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	747	--	--	-1.0000	none

OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326747	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	5895	5895	0.065	-0.094	0.029
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	5193	0.061	-0.072	0.022

TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2	1S	2S	3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.027	0.500	39	67	95	99	0.024	0.019	0.018	0.018	0.018	0.015
971326747	0.028	0.426	38	67	96	99	0.023	0.021	0.019	0.018	0.019	0.014
999999999			37	66	95	99	0.034	0.032	0.021	0.020	0.019	0.019

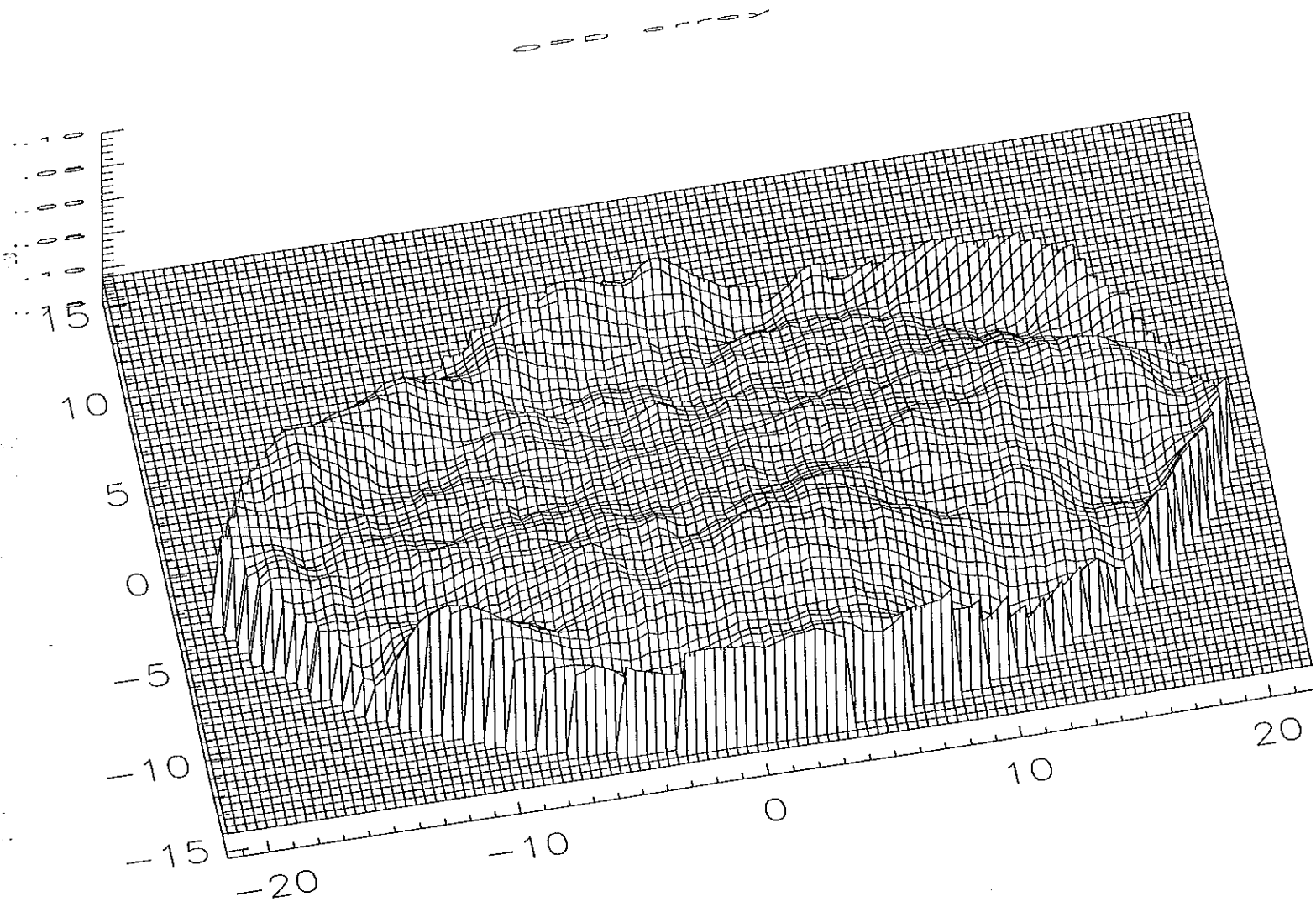
TA/PIC	Power	Astig		Coma		Spher	Trefoil		Tetra	
	mag	mag	ang	mag	ang	mag	mag	ang	mag	ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326747	-0.061	0.154	-82.5	0.054	-136.7	-0.024	0.054	-24.0	0.114	2.3
999999999	0.040	0.045	-85.4	0.160	102.5	0.010	0.061	-8.1	0.005	-24.8

New B/O Δ 20cm Y

TA 971326 P778

RMS: 0.02559 Rms Req→ .090

P/V: 0.1651



********** WAVEFRONT COMBINATION PROCESS started at 9710291036 **********

WAVEFRONT COMBINATION PARAMETERS ----------
combination type: add area: common aggregate focus: none

TA	Pic	Flip	Rot	Mult	Focus
971326	732	--	--	1.0000	none
971326	748	--	--	-1.0000	none

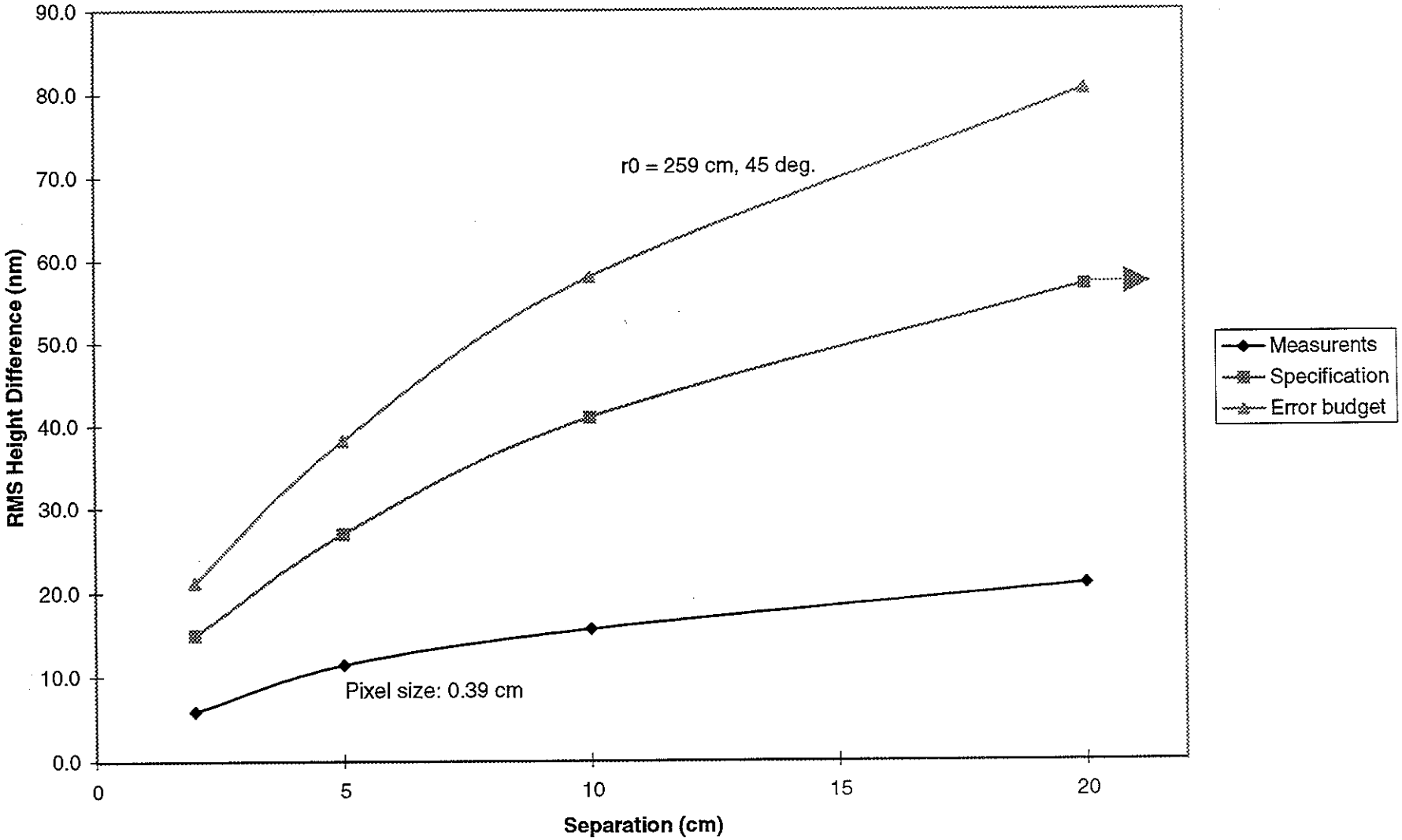
OPD SUMMARY **********

TA/PIC	Title	X	Y	XST	YST	XINC	YINC	Exist pts	Valid pts	Peak	Valley	RMS
971326732	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	6253	6253	0.075	-0.094	0.029
971326748	magellan tertiary cl	111	079	-21.653	-15.354	0.39370	0.39370	5101	5101	0.062	-0.087	0.028
999999999	AGGREGATE	111	079	-21.653	-15.354	0.39370	0.39370	6253	4153	0.075	-0.090	0.026

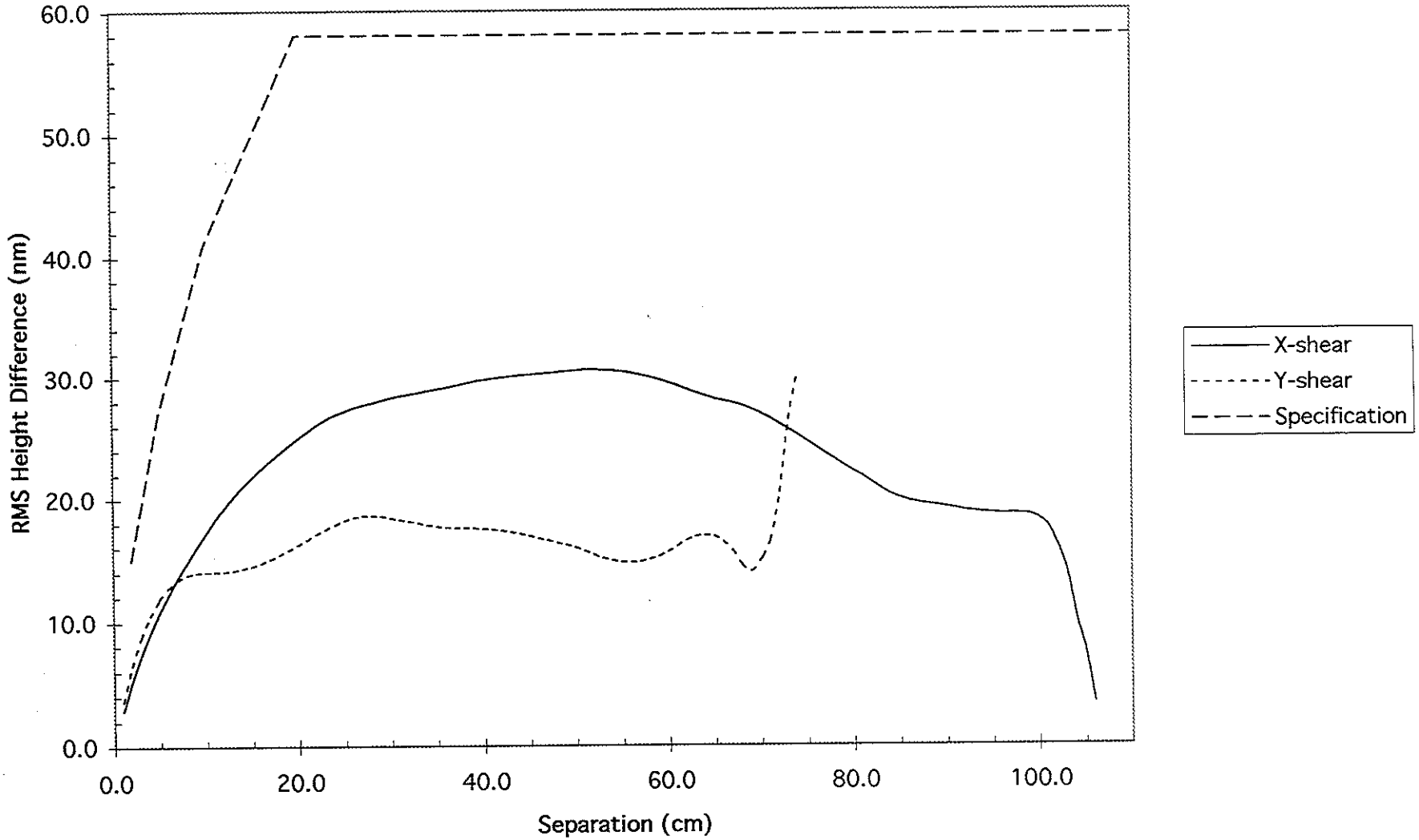
TA/PIC	Diff. RMS	Corr. ind.	--Barchart-- S/2 1S 2S 3S	Power rms	Astig rms	Coma rms	Spher rms	Tref rms	Tetra rms
971326732	0.024	0.627	39 67 95 99	0.024	0.019	0.018	0.018	0.018	0.015
971326748	0.028	0.445	37 68 94 99	0.031	0.038	0.024	0.020	0.022	0.013
999999999			34 67 95 99	0.057	0.046	0.022	0.022	0.017	0.016

TA/PIC	Power mag	Astig mag	Astig ang	Coma mag	Coma ang	Spher mag	Trefoil mag	Trefoil ang	Tetra mag	Tetra ang
971326732	-0.052	0.126	-87.5	0.045	144.4	-0.021	0.011	21.8	0.092	2.6
971326748	-0.195	0.147	-71.7	0.212	-101.2	-0.038	0.123	-23.1	0.185	4.2
999999999	0.138	0.155	-75.2	0.293	105.2	0.012	0.134	-0.1	0.012	23.2

M3 Structure Function



Magellan 1 Tertiary Mirror Structure Function



Magellan 6.5 Meter Telescope Project

TECHNICAL SPECIFICATIONS

for the

Magellan 6.5 M Telescope Tertiary Mirror

OCIW Document No. 95TE0006

May 12, 1995

1. General Description

The Magellan Project under the auspices of the Observatories of the Carnegie Institution of Washington (OCIW) is building a new 6.5 meter telescope at Las Campanas Observatory, Chile. The optical design calls for an elliptical flat tertiary mirror 1.1 meters by 0.78 meters in size. This document contains specifications for the fabrication, testing and handling of the mirror.

2. Optical Prescription

2.1 Surface Figure

The front surface of the mirror shall be flat within polishing tolerances.

2.2 Clear Aperture

An elliptical shaped region centered on the front surface of the mirror will be used for imaging. The major and minor clear aperture diameters shall be:

Minor diameter:	750 mm
Major diameter:	1062 mm

The long dimension of the clear aperture shall be aligned with the long dimension of the blank.

3. Physical Parameters

3.1 Design

The tertiary mirror design is shown on Magellan drawing No. 95TE0501. The light-weighting is part of the overall strategy of reducing the thermal mass and time constant of the telescope optics to reduce image blur due to local "seeing". The uniform front-to-back thickness, hole pattern and dimensions are chosen to give an equal mass distribution per unit area over the entire blank as required by the air bag support. The face plate thickness is a compromise between the goal of reducing weight and the need for adequate stiffness to minimize print through of the rib structure during polishing.

3.2 Material

Acceptable blank materials are:

a. Corning code 7971 ULE, mirror grade.

b. Schott Zerodur, standard grade, expansion class 2.

The physical properties of the selected material shall meet the glass manufacturer's published specifications for these grades.

3.2.1 Bubbles & Inclusions

The critical zone in the blank is herein defined as the volume extending to a depth of 5 mm below the final polished surface of the mirror. The selected blank shall meet the glass manufacturer's published specifications for critical zone bubbles and inclusions within this volume.

3.3 Weight

The estimated finish weight of the mirror is 59 kg.

3.4 Supports

The mirror will be supported in the telescope on an air bag. The mirror piston and tilt will be defined by three flexures that clamp to the back plate. A single flexure at the center of the mirror will carry lateral loads and define the mirror position parallel to the plane of the front surface. Figure 1 shows a preliminary design of the center support.

4. Generation

4.1 General Procedure

The mirror shall be generated from a blank of low expansion glass (see material specification) to near net shape by machining. The blank will be lightweighted as shown on drawing 95TE0501. Two fabrication techniques are acceptable:

a. Machined from a solid billet of blank material.

or

b. Front and back face sheets frit bonded to a machined core.

4.3 Surface Finish

The finish for non-polished surfaces shall be 120 grit or better.

4.4 Microfractures

Cutting speeds and tool pressures shall be selected to limit subsurface damage due to microfractures.

4.5 Stress Relieve

The blank shall be annealed following generation to remove stresses introduced by the lightweighting process.

4.6 Acid Etch

The unpolished generated surfaces of the mirror shall be etched with acid to relieve microfractures.

5. Polishing

5.1 Polish Area

The entire front face inside of the edge bevel shall be polished. Surface quality shall be measured in the area defined by the clear aperture.

5.3 Surface Quality

Surface maps shall be prepared from the interferometric tests that show surface deviation from the target conic shape. Height differences shall be calculated for pairs of measurement points as a function of separation. The RMS of such measurements shall not exceed the following:

s (cm)	σ_{rms} (nm)
2	15
5	27
10	41
greater than 20	57

where s is the separation of point pairs measured in the plane perpendicular to the optical axis and σ_{rms} is the root mean square deviation between points.

σ_{rms} shall be calculated by shearing the surface map a distance s and subtracting the result from a copy of the original. Overlapping point-pairs that fall outside of the clear aperture on either map are discarded. The rms shall then be calculated from the residuals for shears in two orthogonal directions.

5.4 Print-through

Tool pressure shall be selected to limit print through of the internal rib structure on the polished surface. Figure 2 shows the surface deflection of a 1/4 model of the face plate over a single cell with a uniform applied pressure of 1 PSI.

5.5 Microroughness

The polished surface shall be smooth at spatial frequencies << 1 cm such that microroughness shall not exceed 20 A rms.

5.6 Scratch/dig

Max. scratch/dig: 60/40.

6. Metrology

6.1 Support During Testing

The mirror shall be supported during optical testing in a manner that allows residual support induced errors to be measured and removed from the test results and preferably in a manner that duplicates, to the extent possible, the minimum stress condition of the mirror supported upward facing in the telescope.

6.2 Test Methods

Surface quality shall be measured interferometrically with sufficient spatial and wave-front resolution to demonstrate compliance with the specification of Section 5.3. A full aperture test is preferred. Calibration procedures shall be specified for removing wavefront errors introduced by any auxiliary optics in the test.

Microroughness shall be measured from a representative number of replicated samples taken at locations specified by OCIW.

6.3 Test Records

Records shall be maintained for both in-process and acceptance testing. The records shall contain the date of test, test conditions, and results.

Surface maps from interferometric tests shall be made available to OCIW in digital format prior to acceptance.

7. Shipping Container

The shipping container shall protect the mirror from shock while in route from the polisher to Las Campanas Observatory, Chile. The mirror will be shipped air freight to Santiago, Chile, and motor freight from Santiago to the observatory.

The polished surface of the mirror shall be protected against scratching. A removable protective coating shall be applied to the surface prior to shipping.

Moisture protection shall be incorporated in the shipping container.

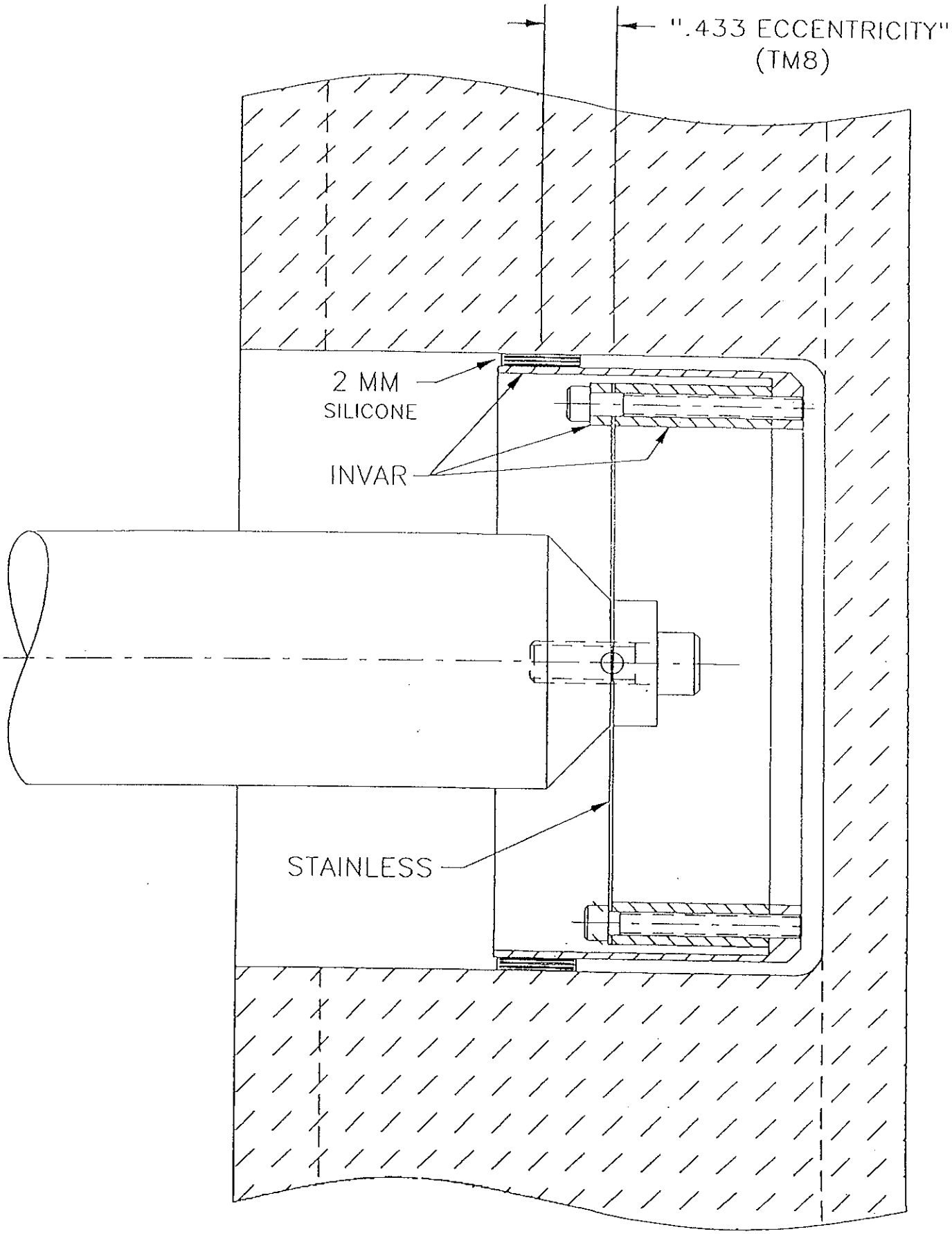


Figure 1. Tertiary mirror central lateral support.

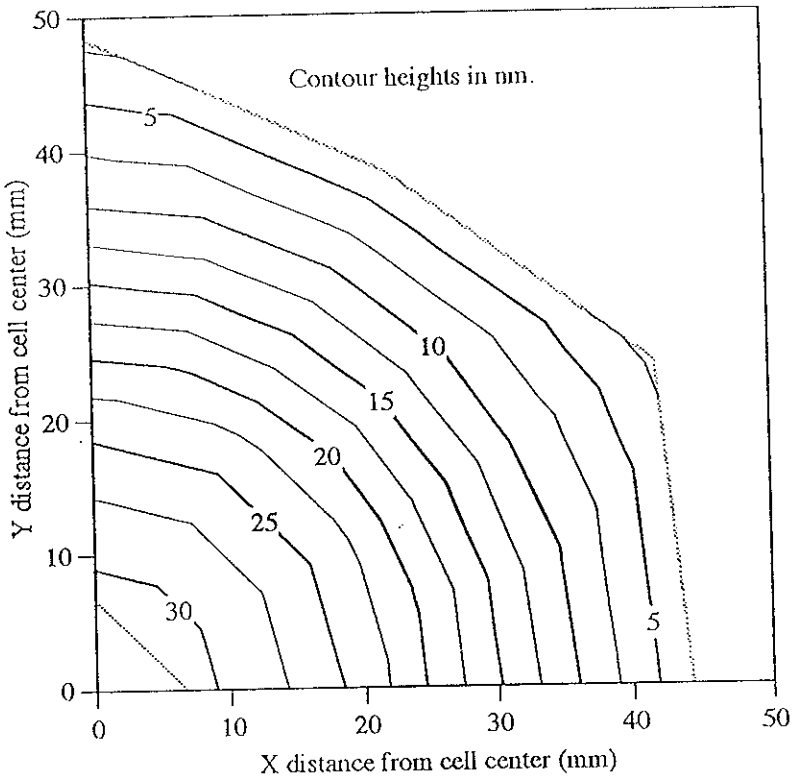


Figure 2. Deflection due to 1 PSI Uniform Surface Pressure.