MAGELLAN PROJECT

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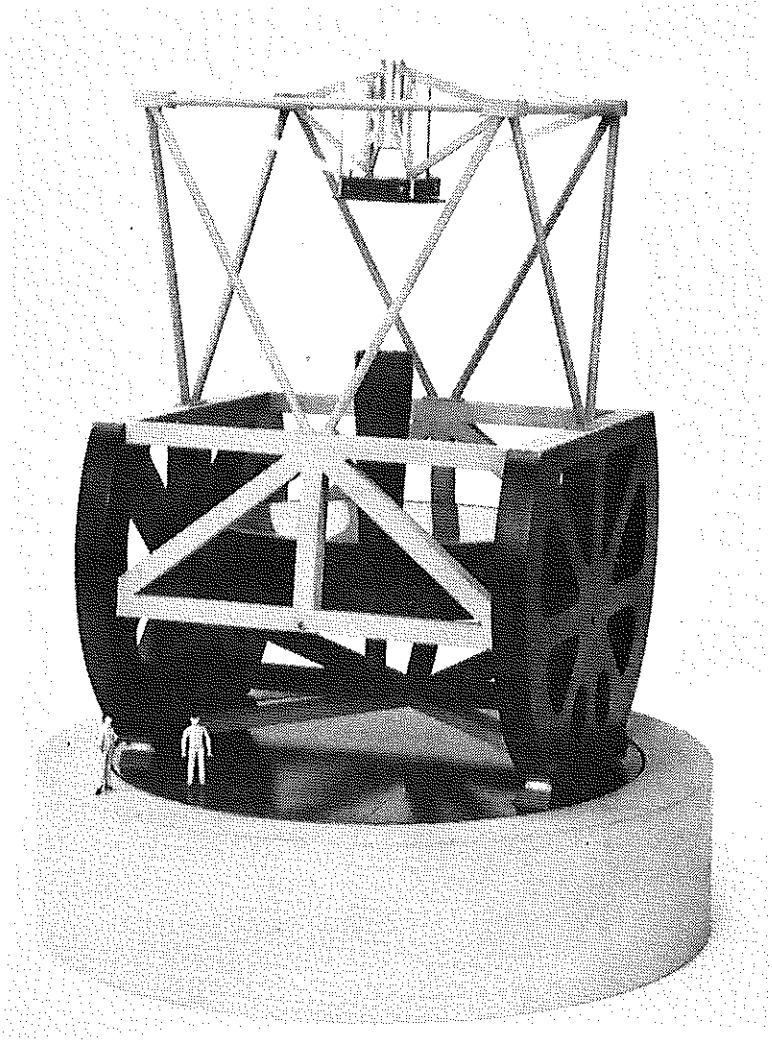

A 315-Inch f/1.20 Telescope for Las Campanas Observatory: Preliminary f/6.50 Wide-Field Corrector Alternatives

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University of California Los Angeles
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CONTENTS

1. Introduction

This study is closely related to a previous report, "A 315-inch f/1.40 Telescope for Las Campanas Observatory: 1) Preliminary f/6.50 Wide-Field Corrector, 2) Preliminary 6-inch All-refracting Collimator" (Epps, October 1987). Herein, a 315-inch f/1.20 parabolic primary mirror is substituted for the f/1.40 primary in the previous work and detailed attention is paid to the question of whether or not a wide-field, broad-passband refracting field corrector can be designed which contains spherical lens surfaces only. A study of corresponding all-refracting collimator designs will be presented in a subsequent report.

For reasons of mechanical convenience it was decided by Dr. Hiltner that the corrected wide-field focus should be located 80.0 inches behind the primary-mirror vertex. Stipulated design specifications require a 40-arcmin angular field diameter at the focal surface, over a chromatic interval from 0.33 to 1.10 microns (without refocus). A zero-deviation atmospheric dispersion compensator (ADC) containing a pair of FK5/LLF2 doublet prisms is also specified in the design requirements. It was stipulated that the field of view should be flat, if possible, but that a mildly curved (spherical) focal surface is acceptable if it improves the all-spherical corrector design substantially.

2. Image Quality Criteria

The primary purpose of this wide-field broad-passband corrector is to service a fiber-fed multiple-object spectrometer. It is envisioned that each individual fiber will subtend approximately 1.5 arcsec at the telescope focal surface. Therefore image quality criteria can be relaxed, if necessary in an all-spherical design, compared with image quality normally associated with a modern field corrector designed for direct imaging.

Since many specific designs are presented in this report, detailed spot diagram analysis does not seem appropriate as a means of intercomparison. Instead one can define a characteristic image diameter, (cid), which can reasonably be expected to contain more than 95% of the polychromatic energy in the (0.33 to 1.10 micron) chromatic interval without refocus, anywhere in the F.O.V. In practice this is sometimes an overly conservative image quality indicator.

$$(\text{cid}) = 1.5*(\text{rms diameter} + \sigma) + (\text{max rms lateral color})$$

The quantity (rms diameter) is the root mean square image diameter averaged over all field angles and colors. It is calculated by ray tracing in my design code and written on the system prescription page. The quantity (σ) is the standard deviation associated with the calculation of (rms diameter). The quantity (max rms lateral color) is the maximum value, anywhere in the F.O.V., of the standard deviation of system lateral magnification with respect to wavelength.

3. Run No. 417 (2/03/88) Baseline 40.0-Arcmin Flat F.O.V. (Aspheric) Corrector

This run represents the best in a sequence of 40.0-arcmin f/6.50 aspheric designs covering the (0.33 to 1.10 micron) chromatic interval without refocus. The refracting field corrector itself contains three (3) free-standing fused silica lens elements, FK5 and LLF2 material to be implemented as an

atmospheric dispersion compensator (ADC), and a 0.50-inch-thick plane-parallel fused silica window near the focal plane which represents a detector vacuum window, optical filter or the like. The rms image diameter averaged over all field angles and colors is (0.21 +/-0.07) arcsec with 0.12 arcsec of maximum rms lateral color. The worst-case image, which occurs in 0.33-micron light at full field, shows an rms diameter of 0.35 arcsec.

The system prescription for the baseline corrector Run No. 417 (2/03/88) is shown in Table 1 which includes the required diameters of the various optical elements. One notes that a 70.7-inch diameter secondary mirror is required and the all-spherical first lens element is 28.6 inches in diameter and 5.0 inches thick. Annotation near the bottom of this system prescription indicates that the system was refocused during analysis. However the amount of refocus is entirely negligible and the procedure is only an artifact of the design process which can be ignored.

System prescriptions are given in terms of "thicknesses" and "curvatures." For thickness, read "distance following surface #_." For curvature, read "reciprocal radius of curvature." All length-related dimensions are given in inches unless otherwise noted. The standard "sag" equation which defines the precise shape of each surface is shown below:

$$\text{"sag"} = \frac{C\,y^2}{1 + \left\{1 - C^2y^2(1+A_2)\right\}^{1/2}} + A_4y^4 + A_6y^6 + A_8y^8 + \ldots$$

where C is the curvature. If all A_ values higher than A2 are zero, the "sag" equation represents a general conic with $A_2 = -e^2$. By convention, light enters from the left, moving toward the right. Distances measured toward the right are (+); toward the left are (-). Any curvature is (+) if its center of curvature is to the right of the surface vertex; a curvature is (-) if its center of curvature is to the left of the surface vertex. The sign of the index of refraction changes sign upon reflection. Any distance is real if the algebraic product of itself multiplied by the index of refraction through which it is measured is a (+) value; a distance is virtual if said algebraic product is a (-) value.

This baseline design is comparable in physical characteristics to the f/1.40 to f/6.50 baseline corrector Run No. 9216 (10/01/87) which was presented and described in the aforementioned report (Epps, October 1987). However one notes that (cid)= 0.43 arcsec for Run No. 9216 while (cid)= 0.54 arcsec for Run No. 417. Thus, the transition from an f/1.40 primary in the previous report to an f/1.20 primary in the present report has resulted in a noticable decay in image quality.

It was also noticed during the optimization sequence that the design tended toward a very thick first lens element. One notes that the maximum available thickness of optical-quality fused silica is roughly 6.0 inches, while a 30-inch diameter disk weighs some 56.2 lbs. and costs some $15,500 per inch of thickness. Therefore, in the interest of economy and mechanical convenience, it was decided to re-optimize the baseline (aspheric) corrector with a 3.50-inch-thick first lens element.

4. Run No. 5115 (2/06/88) "Thinner" 40.0-Arcmin Flat F.O.V. (Aspheric) Corrector

This run represents the best in a sequence of designs similar to the baseline corrector in Section 3, except that the central thickness of the first lens element was arbitrarily held to 3.50 inches during optimization. The system prescription for Run No. 5115 (2/06/88) is shown in Table 2 which includes the required diameters of the various optical elements.

The rms image diameter averaged over all field angles and colors is (0.25 +/-0.06) arcsec with 0.15 arcsec of maximum rms lateral color. The worst-case image, which occurs in 0.33-micron light at full field, shows an rms diameter of 0.33 arcsec. One notes that (cid)= 0.62 arcsec for this corrector which is somewhat poorer than the baseline model and is probably not acceptable for a direct imaging corrector by modern standards. Thus a thick first lens element appears to be unavoidable in a corrector of this general description, if it is to be used for direct imaging.

5. Run No. 3586 (2/04/88) 40.0-Arcmin Flat F.O.V. (Spherical) Corrector

This run represents the best in a sequence of all-spherical flat-field designs. The system prescription for Run No. 3586 (2/04/88) is shown in Table 3 which includes the required diameters of the various optical elements. Since this corrector is primarily intended for fiber-fed spectroscopy, the plane-parallel exit window has been removed (in effect) by setting its refractive index to unity. There was a strong tendency during optimization for the first lens element to become thicker than availability of optical-grade fused silica allows. Therefore the first-lens-element thickness was constrained such that it became 5.64 inches in this model.

The rms image diameter averaged over all field angles and colors is (0.46 +/-0.13) arcsec with 0.20 arcsec of maximum rms lateral color. The worst-case image, which occurs in 1.10-micron light at full field, shows an rms diameter of 0.74 arcsec. One notes that (cid)= 1.09 arcsec which is acceptable for spectroscopy with 1.5-arcsec fibers but certainly not acceptable for direct imaging. The maximum angle between the local normal at the focal plane and the principal ray (called the non-telecentricity) is roughly 2.5 degrees at the edge of the F.O.V. which should be acceptable for the fibers.

6. Additional 40.0-Arcmin Flat F.O.V. (Spherical) Correctors

A sequence of additional all-spherical flat-field models was explored in which the central thickness (t) of the first lens element was systematically reduced. The salient parameters of this sequence are listed below.

Run No.	t (inches)	rms image (arcsec)	max lat clr (arcsec)	worst im (arcsec)	cid (arcsec)	system presc.
3586 (2/04/88)	5.64	0.46 +/-0.13	0.20	0.74	1.09	Table 3
3134 (2/05/88)	5.00	0.50 +/-0.16	0.24	0.80	1.23	Table 4
3159 (2/05/88)	4.50	0.54 +/-0.17	0.24	0.87	1.31	Table 5
4428 (2/06/88)	4.00	0.57 +/-0.18	0.25	0.92	1.38	Table 6
4660 (2/06/88)	3.50	0.61 +/-0.19	0.26	0.96	1.46	Table 7

All of these models behave generally in the same fashion. Each has a first lens element roughly 28.5 inches in diameter. The sagittal depth of the front surface increases gradually as the lens thickness decreases, reaching roughly 6.5 inches in the 3.50-inch-thick model Run No. 4660 (2/06/88). It can be seen that image quality decreases linearly with decreasing lens thickness reaching a limiting acceptable value for fiber-fed spectroscopy (cid)= 1.46 arcsec in the 3.50-inch-thick model.

7. Run No. 4881 (2/06/88) 40.0-Arcmin Curved F.O.V. (Spherical) Corrector

This run represents the best in a sequence of all-spherical designs without a plane-parallel exit window, in which the focal surface is allowed to adopt the optimum spherical shape. The system prescription for Run No. 4881 (2/06/88) is shown in Table 8 which includes the required diameters of the various optical elements. In this model, the radius of field curvature became -190.5 inches (concave toward the sky) which is somewhat flatter than the average radius of 3rd-order field curvature -162.3 inches. The first lens is 30.1 inches in diameter, 5.64 inches thick with a front surface sagitta of 4.85 inches. The rms image diameter averaged over all field angles and colors is (0.16 +/-0.09) arcsec with 0.11 arcsec of maximum rms lateral color. The worst-case image, which occurs in 0.33-micron light at full field, shows an rms diameter of 0.32 arcsec. One notes that (cid)= 0.49 arcsec for this corrector. Its overall image quality is thus better than the aspheric models discussed in Sections 3 and 4 and is roughly comparable to the baseline f/1.40 to f/6.50 (aspheric) corrector Run No. 9216 (10/01/87) previously referenced (Epps, October 1987).

One concludes that the aspherics enable the distribution of lens curvatures to manipulate the Petzval sum while still balancing spherical aberration and coma, in such a way that the resulting F.O.V. can be flat. Elimination of the aspherics prevents this manipulation, such that the image quality is compromised in all-spherical flat-field models because the Petzval sum required by spherical aberration and coma balance results in an excessive (uncorrected) 3rd-order field curvature. Relaxation of the flat-field design requirement removes the problem and provides an additional free parameter (optimum field curvature) which can be selected in such a way as to partially compensate higher order residual aberrations. This results in an all-spherical (curved-field) corrector of uncompromised image quality.

8. Additional 40.0-Arcmin Curved F.O.V. (Spherical) Correctors

Two additional curved-field all-spherical models were explored in which the central thickness (t) of the first lens element was systematically reduced. The salient parameters of this sequence are listed below.

Run No.	t (inches)	rms image (arcsec)	max lat clr (arcsec)	worst im (arcsec)	cid (arcsec)	system presc.
4881 (2/06/88)	5.64	0.16 +/-0.09	0.11	0.32	0.49	Table 8
2765 (2/10/88)	3.50	0.18 +/-0.07	0.14	0.29	0.52	Table 9
2970 (2/10/88)	2.50	0.19 +/-0.06	0.17	0.29	0.55	Table 10

It can be seen that to the first approximation the performance of all three of the curved-field, all-spherical correctors is roughly independent of first-lens thickness. Performance is excellent, even for direct imaging applications. The choice of central thickness for the first lens thus becomes a mechanical rather than optical question. For the purpose of further discussion, I have arbitrarily chosen the 3.50-inch-thick Run No. 2765 (2/10/88) as the baseline system.

The 315-inch diameter f/1.20 parabolic primary mirror in Run No. 2765 (2/10/88) is followed by a 65.8-inch diameter hyperbolic secondary mirror. The naked two-mirror system with its refracting corrector removed produces an f/6.258 focus some 79.31 inches behind the primary-mirror vertex. The secondary mirror must be moved 0.0853 inches toward the primary mirror in order to go from the corrected to the naked mode. Spherical aberration is corrected in the naked system and a field diameter of about 9.2 arcmin can be expected to contain images smaller than 2/3 arcsec in rms diameter. Coma (and atmospheric dispersion away from the zenith) will be the dominant residual aberrations in the naked system.

The optimum radius of field curvature with the field corrector is -162.7 inches (concave toward the sky). This is not very dissimilar to the average 3rd-order radius of field curvature in the naked mode which is -78.5 inches. The maximum non-telecentricity with the field corrector is less than 2.5 degrees at the edge of the F.O.V. which should be acceptable for fiber-fed spectroscopy.

The amount of asphericity on the secondary mirror is modeled in Table 11, relative to the best starting sphere from which the optician would normally work toward the desired asphere. One notes that material removal begins slowly near the center of the secondary mirror and increases, reaching a maximum amplitude of about 0.0128 inches (about 650 waves) some 23.0 inches from the center. Thereafter removal diminishes, reaching zero at the edge of the 65.8-inch diameter secondary mirror. This amount of asphericity is somewhat greater than the 480 waves reported for the 76.0-inch diameter secondary in the previously referenced f/1.40 to f/6.50 baseline (aspheric) corrector Run No. 9216 (10/01/87), primarily because of the optically faster f/1.20 primary mirror in the present report. However it is less than the 696 waves of asphericity calculated for the 70.7-inch diameter secondary mirror of baseline (aspheric) corrector Run No. 417 (2/03/88) in this report.

9. Imaging Characteristics of All-Spherical Corrector Run No. 2765 (2/10/88)

Polychromatic spot diagrams containing seven colors (0.33, 0.35, 0.385, 0.435, 0.52, 0.70, 1.10 microns) are shown at five (5) field angles (0, 8, 14, 18, 20 arcmin) in Figures P-1 through P-5 inclusive. The graphical scale is 1/3 arcsec per inch in all cases. Each spot diagram includes an integrated point spread function table in the upper right-hand corner of the page. The item called "partial" shows the amount of energy included within 1/4 arcsec in each of the images. No refocus has been allowed between any of these five (5) polychromatic spot diagrams. One notes that the energy is highly concentrated within 1/4 arcsec over most of the field of view and that the polychromatic image energy distribution is exceptionally well defined. One notices an asymmetry in the central image which is produced by the fully-implemented (ADC), in its "off" position. It acts like a thick plane-parallel plate which is tilted slightly with respect to the telescope's optical axis. This results in a printed line on each spot diagram which says "the system is not collimated."

No calculations were performed in this study to determine mechanical alignment tolerances which must be maintained to achieve the optical performance described above. However preliminary collimation tolerances for the secondary mirror in the 256-inch MMT upgrade f/1.00 to f/4.50 wide-field broad-passband Cassegrain corrector were found to be approximately +/-0.05 arcmin in tilt and +/-0.001 inches in decentration (Epps, March 1986). It is suspected that similar tight tolerances will be found for the optical trains presented in this report. It is suggested that comprehensive collimation study be conducted in order to establish the relevant alignment constraints quantitatively.

10. Summary of Conclusions

A. It is a straightforward matter to design a broad-passband wide-flat-field corrector in the f/1.2 to f/6.50 domain, which makes use of two (2) aspheric lens-element surfaces. However, the resulting image quality is substantially poorer than the corresponding f/1.4 to f/6.50 corrector reported previously (Epps, October 1987).

B. There is a tendency for the first lens element to approach a 6-inch central thickness which is at or near the limits set by suppliers of optical-grade fused silica.

C. Reduction of the first-lens-element central thickness leads to designs with degraded performance.

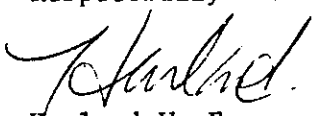
D. An all-spherical flat-field corrector can be designed which is suitable for fiber-fed multiple-object spectroscopy with 1.5 arcsec diameter fibers, but not suitable for imaging. Image quality is inversely proportional to the first-lens-element central thickness which must be at least 3.50 inches for barely acceptable performance. Considering the cost of materials and labor, it would not seem advisable to construct a limited-purpose all-spherical flat-field corrector.

E. An all-spherical curved-field corrector can be designed with image quality that exceeds that of the best aspheric flat-field corrector. Such a corrector could be used for fiber-fed spectroscopy as well as for direct imaging upon a 40.0-arcmin diameter field whose radius of curvature is roughly -160 inches (concave toward the sky).

F. The first-lens-element central thickness in the all-spherical curved-field case is not strongly related to image quality. Thus, that parameter becomes a mechanical rather than optical issue.

G. Severe collimation constraints are anticipated for correctors discussed in this report. A detailed collimation study is recommended.

Respectfully submitted,



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Consultant in Optical Design

APPENDIX

A. Referenced Tables

1. System Prescription: Baseline (Aspheric) Run No. 417 (2/03/88)
2. System Prescription: "Thinner" (Aspheric) Run No. 5115 (2/06/88)
3. System Prescription: Flat F.O.V. (Spherical) Run No. 3586 (2/04/88)
4. System Prescription: Flat F.O.V. (Spherical) Run No. 3134 (2/05/88)
5. System Prescription: Flat F.O.V. (Spherical) Run No. 3159 (2/05/88)
6. System Prescription: Flat F.O.V. (Spherical) Run No. 4428 (2/06/88)
7. System Prescription: Flat F.O.V. (Spherical) Run No. 4660 (2/06/88)
8. System Prescription: Curved F.O.V. (Spherical) Run No. 4881 (2/06/88)
9. System Prescription: Baseline (Spherical) Run No. 2765 (2/10/88)
10. System Prescription: Curved F.O.V. (Spherical) Run No. 2970 (2/10/88)
11. Aspheric for Secondary Mirror in Baseline (Spherical) Run No. 2765 (2/10/88)

B. Referenced Figures

Spots (P-1...P-5) Five (5) polychromatic spot diagrams illustrating image quality for baseline (spherical) corrector Run No. 2765 (2/10/88) over the full (0.33 to 1.10 micron) passband

OPTICAL OPTIMIZATION RUN====PROGRAM DARSA(06/03/87 VERSION)====EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.8?) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN

RMS IMAGE(S) TYP DIAM= 54.2 +/- 18.0 MICRONS
0.21 +/- 0.07 ARC SEC
MAX RMS LATERAL COLOR= 30.7 MICRONS (0.12 ARC SEC

NS	NNE,CRV, NSE,X,4RN,2ICR,NSA	SASC,NNA							NS	DIAM	SAG
1	0								0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	2 1	315.000	0.0
2	3 -0.13227513D-02	-0.10000000D+01	0.0	0.0	0.0	0.0			0 2		
2	8 =0.29866600D+03	=0.10000000D+01	0.0	=0.10000000D+01	0.0		0	0	0 2	316.718	-16.586
3	3 -0.49538984D-02	-0.23794310D+01	0.0	0.0	0.0	0.0			0 3		
3	9 0.30719218D+03	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 3	70.725	-3.065
4	3 0.48663485D-01	0.0	0.0	0.0	0.0	0.0			0 4		
4	1 0.50429434D+01	0.14758040D+01	0.395900000-02	0.14574120D+01	0.50660000D-02		21	-239	0 4	28.611	5.797
5	3 0.44022855D-01	0.0	0.0	0.0	0.0	0.0			0 5		
5	1 0.79026746D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 5	26.385	4.223
6	3 0.11891521D-01	0.0	0.0	0.0	0.0	0.0			0 6		
6	1 0.17364439D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 6	24.899	0.927
7	3 0.52657136D-01	0.0	-0.28638845D-05	0.60841343D-08	0.18541261D-10	0.0			0 7		
7	9 0.60000001D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 7	23.435	4.014
8	3 0.0	0.0	0.0	0.0	0.0	0.0			0 8		
8	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31	-189	0 8	23.932	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0			0 9		
9	1 0.13999986D+01	0.15729500D+01	0.76290000D-02	0.15389730D+01	0.75140000D-02		28	21	0 9	24.122	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0			0 10		
10	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31	-189	0 10	24.336	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0			0 11		
11	1 0.32107394D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 11	24.525	0.0
12	3 0.26676729D-01	0.0	-0.22950208D-05	0.60999786D-08	0.0	0.0			0 12		
12	9 0.28517113D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 12	25.814	2.257
13	3 0.62064570D-02	0.0	0.0	0.0	0.0	0.0			0 13		
13	1 0.38914801D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 13	25.736	0.515
14	3 0.0	0.0	0.0	0.0	0.0	0.0			0 14		
14	1 0.49999950D+00	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 14	24.879	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0			0 15		
15	1 0.15375110D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 15	24.871	0.0
16	320 0.0	0.0	0.10663967D+00	0.32223014D+00	0.0	0.20938251D+04			1 16		
16	2 -0.13102006D-01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 16	24.471	0.0
16	*2 -0.15565926D-01	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS									

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 1 Run No. 417 (2/03/88)

OPTICAL OPTIMIZATION RUN----PROGRAM DARSA[06/03/87 VERSION]----EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT [F/5.8?] CASS FOC

FINAL SYSTEM: SCALED TO DABS[GAUSSIAN FOCAL LENGTH]= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN

RMS IMAGE[S] TYP DIAM= 62.9 +/- 15.1 MICRONS
0.25 +/- 0.06 ARC SEC
MAX RMS LATERAL COLOR= 39.0 MICRONS [0.15 ARC SEC

NS	NNE,CRV, SASC,NNA NSE,X,4RN,2ICR,NSA							NS	DIAM	SAG
1	0							0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 2 1	315.000	0.0
2	3 -0.13227513D-02	-0.10000000D+01	0.0	0.0	0.0	0.0		0 2		
2	8 -0.29869383D+03	-0.10000000D+01	0.0	-0.10000000D+01	0.0		0 0	0 2	316.718	-16.586
3	3 -0.49570775D-02	-0.23770434D+01	0.0	0.0	0.0	0.0		0 3		
3	9 0.30600483D+03	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 3	70.701	-3.065
4	3 0.47648444D-01	0.0	0.0	0.0	0.0	0.0		0 4		
4	1 0.35000006D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21 -239	0 4	28.823	5.730
5	3 0.42381329D-01	0.0	0.0	0.0	0.0	0.0		0 5		
5	1 0.13746805D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 5	27.446	4.401
6	3 0.81161360D-02	0.0	0.0	0.0	0.0	0.0		0 6		
6	1 0.10646073D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21 -239	0 6	24.451	0.608
7	3 0.52874558D-01	0.0	-0.72971879D-05	0.52819507D-08	0.19133396D-10	0.0		0 7		
7	9 0.60000001D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 7	23.317	3.906
8	3 0.0	0.0	0.0	0.0	0.0	0.0		0 8		
8	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31 -189	0 8	23.942	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0		0 9		
9	1 0.13999986D+01	0.15729500D+01	0.76290000D-02	0.15389730D+01	0.75140000D-02		28 21	0 9	24.169	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0		0 10		
10	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31 -189	0 10	24.426	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0		0 11		
11	1 0.22902798D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 11	24.653	0.0
12	3 0.38720884D-01	0.0	-0.77068441D-05	0.23119756D-08	0.0	0.0		0 12		
12	9 0.34532329D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21 -239	0 12	26.278	3.374
13	3 0.13922526D-01	0.0	0.0	0.0	0.0	0.0		0 13		
13	1 0.36803004D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 13	26.087	1.194
14	3 0.0	0.0	0.0	0.0	0.0	0.0		0 14		
14	1 0.49999950D+00	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21 -239	0 14	24.824	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0		0 15		
15	1 0.15396408D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 15	24.812	0.0
16320	0.0	0.0	0.94558569D-01	0.28215708D+00	0.0	0.20881407D+04		1 16		
16	2 -0.10351013D-01	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 16	24.389	0.0
16	*2 -0.11551978D-01	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS								

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 2 Run No. 5115 (2/06/88)

OPTICAL OPTIMIZATION RUN----PROGRAM DARSA(06/03/87 VERSION)----EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.8?) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN

RMS IMAGE(S) TYP DIAM=115.9 +/- 33.7 MICRONS
0.46 +/- 0.13 ARC SEC
MAX RMS LATERAL COLOR= 50.9 MICRONS (0.20 ARC SEC

NS	NNE,CRV, SASC,NNA NSE,X,4RN,2ICR,NSA							NS	DIAM	SAG
1	0							0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	2 1	315.000	0.0
2	3 -0.13227513D-02	-0.10000000D+01	0.0	0.0	0.0	0.0		0 2		
2	8 -0.29741839D+03	-0.10000000D+01	0.0	-0.10000000D+01	0.0	0	0	0 2	316.718	-16.586
3	3 -0.48479947D-02	-0.24308943D+01	0.0	0.0	0.0	0.0		0 3		
3	9 0.30401140D+03	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 3	71.778	-3.089
4	3 0.48305696D-01	0.0	0.0	0.0	0.0	0.0		0 4		
4	1 0.56447712D+01	0.14758040D+01	0.395900000-02	0.14574120D+01	0.50660000D-02	21	-239	0 4	28.563	5.797
5	3 0.38169734D-01	0.0	0.0	0.0	0.0	0.0		0 5		
5	1 0.58665496D+01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 5	26.349	3.553
6	3 0.12200642D-01	0.0	0.0	0.0	0.0	0.0		0 6		
6	1 0.15962711D+01	0.14758040D+01	0.395900000-02	0.14574120D+01	0.50660000D-02	21	-239	0 6	24.947	0.955
7	3 0.55727032D-01	0.0	0.0	0.0	0.0	0.0		0 7		
7	9 0.60000001D+01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 7	23.124	4.221
8	3 0.0	0.0	0.0	0.0	0.0	0.0		0 8		
8	1 0.12000008D+01	0.15053180D+01	0.401000000-02	0.14864080D+01	0.50660000D-02	31	-189	0 8	23.444	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0		0 9		
9	1 0.13999986D+01	0.15729500D+01	0.762900000-02	0.15389730D+01	0.75140000D-02	28	21	0 9	23.579	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0		0 10		
10	1 0.12000008D+01	0.15053180D+01	0.401000000-02	0.14864080D+01	0.50660000D-02	31	-189	0 10	23.731	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0		0 11		
11	1 0.10825747D+02	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 11	23.866	0.0
12	3 0.95632351D-02	0.0	0.0	0.0	0.0	0.0		0 12		
12	9 0.24286426D+01	0.14758040D+01	0.395900000-02	0.14574120D+01	0.50660000D-02	21	-239	0 12	25.843	0.801
13	3 -0.66828326D-02	0.0	0.0	0.0	0.0	0.0		0 13		
13	1 0.35270663D+02	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 13	25.887	-0.561
14	3 0.0	0.0	0.0	0.0	0.0	0.0		0 14		
14	1 0.49999950D+00	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 14	24.997	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0		0 15		
15	1 0.15388307D+01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 15	24.985	0.0
16	320 0.0	0.0	0.11963563D+00	0.37842442D+00	0.0	0.21015036D+04		1 16		
16	2 -0.83212567D-02	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 16	24.578	0.0
16	*2 -0.96411775D-02	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS								

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 3 Run No. 3586 (2/04/88)

OPTICAL OPTIMIZATION RUN----PROGRAM DARSA(06/03/87 VERSION)----EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.8?) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN MAX RMS LATERAL COLOR= 61.8 MICRONS (0.24 ARC SEC)

RMS IMAGE(S) TYP DIAM=127.2 +/- 40.9 MICRONS
0.50 +/- 0.16 ARC SEC

NS	NNE,CRV, NSE,X,4RN,2ICR,NSA	SASC,NNA							NS	DIAM	SAG
1	0								0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	2 1	315.000	0.0
2	3 -0.13227513D-02	-0.10000000D+01	0.0	0.0	0.0	0.0			0 2		
2	8 -0.29780663D+03	-0.10000000D+01	0.0	-0.10000000D+01	0.0		0	0	0 2	316.718	-16.586
3	3 -0.48813337D-02	-0.24153129D+01	0.0	0.0	0.0	0.0			0 3		
3	9 0.30444234D+03	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 3	71.450	-3.082
4	3 0.49100662D-01	0.0	0.0	0.0	0.0	0.0			0 4		
4	1 0.49999991D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 4	28.664	5.897
5	3 0.37394115D-01	0.0	0.0	0.0	0.0	0.0			0 5		
5	1 0.65204581D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 5	26.860	3.617
6	3 0.10944184D-01	0.0	0.0	0.0	0.0	0.0			0 6		
6	1 0.16989951D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 6	25.200	0.873
7	3 0.55551567D-01	0.0	0.0	0.0	0.0	0.0			0 7		
7	9 0.60000001D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 7	23.295	4.276
8	3 0.0	0.0	0.0	0.0	0.0	0.0			0 8		
8	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31	-189	0 8	23.622	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0			0 9		
9	1 0.13999986D+01	0.15729500D+01	0.76290000D-02	0.15389730D+01	0.75140000D-02		28	21	0 9	23.764	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0			0 10		
10	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31	-189	0 10	23.924	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0			0 11		
11	1 0.88469062D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 11	24.066	0.0
12	3 0.96689753D-02	0.0	0.0	0.0	0.0	0.0			0 12		
12	9 0.25276568D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 12	25.783	0.807
13	3 -0.71297695D-02	0.0	0.0	0.0	0.0	0.0			0 13		
13	1 0.36998356D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 13	25.835	-0.596
14	3 0.0	0.0	0.0	0.0	0.0	0.0			0 14		
14	1 0.49999950D+00	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 14	25.005	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0			0 15		
15	1 0.15761377D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 15	24.994	0.0
16320	0.0	0.0	0.12074853D+00	0.38233220D+00	0.0	0.21020529D+04			1 16		
16	2 -0.52205700D-02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 16	24.586	0.0
16	*2 -0.27642841D-02	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS									

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 4 Run No. 3134 (2/05/88)

OPTICAL OPTIMIZATION RUN----PROGRAM DARSA[06/03/87 VERSION]----EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.82) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES RMS IMAGE(S) TYP DIAM=137.3 +/- 42.7 MICRONS
OBJECT DISTANCE= INFINITY 0.54 +/- 0.17 ARC SEC
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN MAX RMS LATERAL COLOR= 61.5 MICRONS (0.24 ARC SEC)

NS	NNE,CRV, SASC,NNA NSE,K,4RN,2ICR,NSA								NS	DIAM	SAG
1	0								0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	2 1	315.000	0.0
2	3 -0.132275130-02	-0.10000000D+01	0.0	0.0	0.0	0.0			0 2		
2	8 -0.29774940D+03	-0.10000000D+01	0.0	-0.10000000D+01	0.0		0	0	0 2	316.718	-16.586
3	3 -0.48758967D-02	-0.24182529D+01	0.0	0.0	0.0	0.0			0 3		
3	9 0.30433948D+03	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 3	71.499	-3.083
4	3 0.504263180-01	0.0	0.0	0.0	0.0	0.0			0 4		
4	1 0.449999960+01	0.14758040D+01	0.395900000-02	0.14574120D+01	0.50660000D-02		21	-239	0 4	28.606	6.094
5	3 0.367972810-01	0.0	0.0	0.0	0.0	0.0			0 5		
5	1 0.633537710+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 5	27.178	3.641
6	3 0.114436710-01	0.0	0.0	0.0	0.0	0.0			0 6		
6	1 0.173380960+01	0.14758040D+01	0.395900000-02	0.14574120D+01	0.50660000D-02		21	-239	0 6	25.455	0.932
7	3 0.571102090-01	0.0	0.0	0.0	0.0	0.0			0 7		
7	9 0.600000010+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 7	23.346	4.458
8	3 0.0	0.0	0.0	0.0	0.0	0.0			0 8		
8	1 0.120000080+01	0.15053180D+01	0.401000000-02	0.14864080D+01	0.50660000D-02		31	-189	0 8	23.627	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0			0 9		
9	1 0.139999860+01	0.15729500D+01	0.762900000-02	0.15389730D+01	0.75140000D-02		28	21	0 9	23.762	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0			0 10		
10	1 0.120000080+01	0.15053180D+01	0.401000000-02	0.14864080D+01	0.50660000D-02		31	-189	0 10	23.914	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0			0 11		
11	1 0.969945430+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 11	24.049	0.0
12	3 0.904008540-02	0.0	0.0	0.0	0.0	0.0			0 12		
12	9 0.247093740+01	0.14758040D+01	0.395900000-02	0.14574120D+01	0.50660000D-02		21	-239	0 12	25.820	0.756
13	3 -0.709368980-02	0.0	0.0	0.0	0.0	0.0			0 13		
13	1 0.368604420+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 13	25.871	-0.595
14	3 0.0	0.0	0.0	0.0	0.0	0.0			0 14		
14	1 0.499999500D+00	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 14	25.008	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0			0 15		
15	1 0.153675770+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 15	24.996	0.0
16320	0.0	0.0	0.12027783D+00	0.33220921D+00	0.0	0.21020046D+04			1 16		
16	2 -0.204428120-02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 16	24.586	0.0
16	*2 -0.312221350-03	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS									

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 5 Run No. 3159 (2/05/88)

OPTICAL OPTIMIZATION RUN----PROGRAM OARSA(06/03/87 VERSION)----EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.8?) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN

RMS IMAGE(S) TYP DIAM=144.7 +/- 46.0 MICRONS
0.57 +/- 0.18 ARC SEC
MAX RMS-LATERAL COLOR= 63.9 MICRONS (0.25 ARC SEC

NS	NNE,CRV, SASC,NNA NSE,X,4RN,2ICR,NSA							NS	DIAM	SAG
1	0							0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	2 1	315.000	0.0
2	3 -0.13227513D-02	-0.10000000D+01	0.0	0.0	0.0	0.0		0 2		
2	8 -0.29778223D+03	-0.10000000D+01	0.0	-0.10000000D+01	0.0		0 0	0 2	316.718	-16.586
3	3 -0.48786691D-02	-0.24173410D+01	0.0	0.0	0.0	0.0		0 3		
3	9 0.30435794D+03	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 3	71.471	-3.082
4	3 0.51562637D-01	0.0	0.0	0.0	0.0	0.0		0 4		
4	1 0.40000001D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21 -239	0 4	28.589	6.287
5	3 0.36126113D-01	0.0	0.0	0.0	0.0	0.0		0 5		
5	1 0.63169084D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 5	27.562	3.674
6	3 0.11680823D-01	0.0	0.0	0.0	0.0	0.0		0 6		
6	1 0.16695005D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21 -239	0 6	25.725	0.972
7	3 0.58246463D-01	0.0	0.0	0.0	0.0	0.0		0 7		
7	9 0.60000001D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 7	23.459	4.631
8	3 0.0	0.0	0.0	0.0	0.0	0.0		0 8		
8	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31 -189	0 8	23.701	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0		0 9		
9	1 0.13999986D+01	0.15729500D+01	0.76290000D-02	0.15389730D+01	0.75140000D-02		28 21	0 9	23.830	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0		0 10		
10	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31 -189	0 10	23.975	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0		0 11		
11	1 0.10033400D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 11	24.104	0.0
12	3 0.90003257D-02	0.0	0.0	0.0	0.0	0.0		0 12		
12	9 0.24027360D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21 -239	0 12	25.850	0.754
13	3 -0.65438823D-02	0.0	0.0	0.0	0.0	0.0		0 13		
13	1 0.37159276D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 13	25.895	-0.549
14	3 0.0	0.0	0.0	0.0	0.0	0.0		0 14		
14	1 0.49999950D+00	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 14	25.002	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0		0 15		
15	1 0.15544221D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 15	24.990	0.0
16	320 0.0	0.0	0.11855520D+00	0.37697363D+00	0.0	0.21012533D+04		1 16		
16	2 -0.28709626D-02	0.10000000D+01	0.0	0.10000000D+01	0.0		0 0	0 16	24.576	0.0
16	*2 0.98096706D-03	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS								

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 6 Run No. 4428 (2/06/88)

OPTICAL OPTIMIZATION RUN----PROGRAM OARSA(06/03/87 VERSION)----EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.8?) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN

RMS IMAGE(S) TYP DIAM=154.6 +/- 47.7 MICRONS
0.61 +/- 0.19 ARC SEC
MAX RMS LATERAL COLOR= 65.0 MICRONS (0.26 ARC SEC

NS	NNE,CRV, SASC,NNA NSE,X,4RN,2ICR,NSA								NS	DIAM	SAG
1	0								0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	2 1	315.000	0.0
2	3 -0.13227513D-02	-0.10000000D+01	0.0	0.0	0.0	0.0			0 2		
2	8 -0.29776454D+03	-0.10000000D+01	0.0	-0.10000000D+01	0.0		0	0	0 2	316.718	-16.586
3	3 -0.48770434D-02	-0.24184704D+01	0.0	0.0	0.0	0.0			0 3		
3	9 0.30429947D+03	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 3	71.486	-3.083
4	3 0.52746074D-01	0.0	0.0	0.0	0.0	0.0			0 4		
4	1 0.35000006D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 4	28.558	6.487
5	3 0.35397710D-01	0.0	0.0	0.0	0.0	0.0			0 5		
5	1 0.62482837D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 5	27.965	3.703
6	3 0.12122831D-01	0.0	0.0	0.0	0.0	0.0			0 6		
6	1 0.16608481D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 6	26.016	1.032
7	3 0.59561377D-01	0.0	0.0	0.0	0.0	0.0			0 7		
7	9 0.60000001D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 7	23.547	4.820
8	3 0.0	0.0	0.0	0.0	0.0	0.0			0 8		
8	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31	-189	0 8	23.749	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0			0 9		
9	1 0.13999986D+01	0.15729500D+01	0.76290000D-02	0.15389730D+01	0.75140000D-02		28	21	0 9	23.870	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0			0 10		
10	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02		31	-189	0 10	24.006	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0			0 11		
11	1 0.10840558D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 11	24.127	0.0
12	3 0.86019505D-02	0.0	0.0	0.0	0.0	0.0			0 12		
12	9 0.23471235D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02		21	-239	0 12	25.892	0.723
13	3 -0.62346450D-02	0.0	0.0	0.0	0.0	0.0			0 13		
13	1 0.37024802D+02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 13	25.933	-0.525
14	3 0.0	0.0	0.0	0.0	0.0	0.0			0 14		
14	1 0.49999950D+00	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 14	24.999	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0			0 15		
15	1 0.15550623D+01	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 15	24.987	0.0
16	320 0.0	0.0	0.11695290D+00	0.37309578D+00	0.0	0.21006730D+04			1 16		
16	2 -0.73084870D-02	0.10000000D+01	0.0	0.10000000D+01	0.0		0	0	0 16	24.570	0.0
16	*2 -0.17796990D-02	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS									

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 7 Run No. 4660 (2/06/88)

OPTICAL OPTIMIZATION RUN====PROGRAM DARSAT 06/03/87 VERSION1====EPPS/ASTRONOMY/UCLA

RN* 1 315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.8?) CASS FOC

FINAL SYSTEM: SCALED TO DARS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN

RMS IMAGE(S) TYP DIAM= 39.6 +/- 21.7 MICRONS
0.16 +/- 0.09 ARC SEC
MAX RMS LATERAL COLOR= 28.6 MICRONS (0.11 ARC SEC

NS	NNE,CRV, SASC,NNA NSE,X,4RN,2ICR,NSA								NS	DIAM	SAG
1	0								0 1		
1	0 0.0	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	2 1	315.000	0.0
2	3 -0.13227513D-02	-0.100000000D+01	0.0	0.0	0.0	0.0			0 2		
2	8 -0.30364708D+03	-0.100000000D+01	0.0	-0.100000000D+01	0.0		0	0	0 2	316.718	-16.586
3	3 -0.54084538D-02	-0.22014866D+01	0.0	0.0	0.0	0.0			0 3		
3	9 0.31109159D+03	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 3	66.526	-2.964
4	3 0.38724953D-01	0.0	0.0	0.0	0.0	0.0			0 4		
4	1 0.36447712D+01	0.14758040D+01	0.395900000D-02	0.145741 20D+01	0.506600000D-02		21	-239	0 4	30.128	4.849
5	3 0.39339884D-01	0.0	0.0	0.0	0.0	0.0			0 5		
5	1 0.34014063D+01	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 5	27.688	4.101
6	3 0.23540270D-01	0.0	0.0	0.0	0.0	0.0			0 6		
6	1 0.12238861D+01	0.14758040D+01	0.395900000D-02	0.145741 20D+01	0.506600000D-02		21	-239	0 6	27.414	2.272
7	3 0.39051081D-01	0.0	0.0	0.0	0.0	0.0			0 7		
7	9 0.60000001D+01	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 7	26.568	3.715
8	3 0.0	0.0	0.0	0.0	0.0	0.0			0 8		
8	1 0.12000008D+01	0.15053180D+01	0.401000000D-02	0.148640 80D+01	0.506600000D-02		31	-189	0 8	26.707	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0			0 9		
9	1 0.13999860+01	0.15729500D+01	0.762900000D-02	0.153897 30D+01	0.751400000D-02		28	21	0 9	26.755	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0			0 10		
10	1 0.12000008D+01	0.15053180D+01	0.401000000D-02	0.148640 80D+01	0.506600000D-02		31	-189	0 10	26.808	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0			0 11		
11	1 0.16091818D+01	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 11	26.855	0.0
12	3 -0.23302471D-02	0.0	0.0	0.0	0.0	0.0			0 12		
12	9 0.18462895D+01	0.14758040D+01	0.395900000D-02	0.145741 20D+01	0.506600000D-02		21	-239	0 12	26.937	-0.211
13	3 -0.10944890D-01	0.0	0.0	0.0	0.0	0.0			0 13		
13	1 0.46667453D+02	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 13	27.002	-1.003
14	3 0.0	0.0	0.0	0.0	0.0	0.0			0 14		
14	1 0.49999950D+00	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 14	24.730	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0			0 15		
15	1 0.18759139D+01	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 15	24.707	0.0
16	3 2 0 -0.52495826D-02	0.0	0.74089678D-01	0.226728510+00	0.0	0.0			1 16		
16	2 -0.29404106D-02	0.100000000D+01	0.0	0.100000000D+01	0.0		0	0	0 16	24.275	-0.387
16	*2 -0.35317127D-02	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS									

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 8 Run No. 4881 (2/06/88)

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CAL OPTIMIZATION RUN----PROGRAM OARSA(06/03/87 VERSION)----EPPS/ASTRONOMY/UCLA

RN* 1  315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.87) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES          RMS IMAGE(S) TYP DIAM= 44.2 +/- 17.5 MICRONS
              OBJECT DISTANCE= INFINITY                                                              0.18 +/- 0.07 ARC SEC
              APERTURE RADIUS=  157.50 INCHES  FIELD RADIUS= 20.00 ARC MIN   MAX RMS LATERAL COLOR= 35.5 MICRONS ( 0.14 ARC SEC

    NNE,CRV,  SASC,NNA
 NS NSE,X,4RN,2ICR,NSA                                                                                  NS      DIAM       SAG
  1  0                                                                                                  0 1
  1  0  0.0                 0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  2 1  315.000     0.0
  2  3 -0.13227513D-02 -0.10000000D+01  0.0             0.0             0.0          0.0                0 2
  2  8 -0.30449932D+03 -0.10000000D+01  0.0            -0.10000000D+01  0.0                0    0  0 2  316.718   -16.586
  3  3 -0.54917648D-02 -0.21742424D+01  0.0             0.0             0.0          0.0                0 3
  3  9  0.31121441D+03  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 3   65.809    -2.945
  4  3  0.39244916D-01  0.0             0.0             0.0             0.0          0.0                0 4
  4  1  0.35000006D+01  0.14758040D+01  0.39590000D-02  0.14574120D+01  0.50660000D-02    21 -239  0 4   30.410     5.034
  5  3  0.34782556D-01  0.0             0.0             0.0             0.0          0.0                0 5
  5  1  0.52372334D+01  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 5   29.156     3.970
  6  3  0.23840852D-01  0.0             0.0             0.0             0.0          0.0                0 6
  6  1  0.99798561D+00  0.14758040D+01  0.39590000D-02  0.14574120D+01  0.50660000D-02    21 -239  0 6   28.285     2.456
  7  3  0.41501974D-01  0.0             0.0             0.0             0.0          0.0                0 7
  7  9  0.60000001D+01  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 7   27.264     4.227
  8  3  0.0             0.0             0.0             0.0             0.0          0.0                0 8
  8  1  0.12000008D+01  0.15053180D+01  0.40100000D-02  0.14864080D+01  0.50660000D-02    31 -189  0 8   27.344     0.0
  9  3  0.0             0.0             0.0             0.0             0.0          0.0                0 9
  9  1  0.13999986D+01  0.15729500D+01  0.76290000D-02  0.15389730D+01  0.75140000D-02    28   21  0 9   27.378     0.0
 10  3  0.0             0.0             0.0             0.0             0.0          0.0                0 10
 10  1  0.12000008D+01  0.15053180D+01  0.40100000D-02  0.14864080D+01  0.50660000D-02    31 -189  0 10  27.416     0.0
 11  3  0.0             0.0             0.0             0.0             0.0          0.0                0 11
 11  1  0.15798313D+01  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 11  27.450     0.0
 12  3 -0.18075325D-02  0.0             0.0             0.0             0.0          0.0                0 12
 12  9  0.18575316D+01  0.14758040D+01  0.39590000D-02  0.14574120D+01  0.50660000D-02    21 -239  0 12  27.509    -0.171
 13  3 -0.97853675D-02  0.0             0.0             0.0             0.0          0.0                0 13
 13  1  0.47801343D+02  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 13  27.558    -0.933
 14  3  0.0             0.0             0.0             0.0             0.0          0.0                0 14
 14  1  0.49999950D+00  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 14  24.723     0.0
 15  3  0.0             0.0             0.0             0.0             0.0          0.0                0 15
 15  1  0.20261210D+01  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 15  24.695     0.0
16320 -0.61466595D-02  0.0             0.17755470D-01  0.84988801D-01  0.21113464D+00  0.0                1 16
 16  2 -0.40601076D-02  0.10000000D+01  0.0             0.10000000D+01  0.0                0    0  0 16  24.244    -0.452
 16 *2 -0.35934272D-02 *SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM.  TERMINATION WAS NORMAL.
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Table 9 Run No. 2765 (2/10/88)

OPTICAL OPTIMIZATION RUN----PROGRAM OARSA(06/03/87 VERSION)----EPPS/ASTRONOMY/UCLA

RN* 1 .315-INCH F/1.2 PARABOLA CORRECTED TO F/6.5 AT (F/5.8?) CASS FOC

FINAL SYSTEM: SCALED TO DABS(GAUSSIAN FOCAL LENGTH)= 2047.500 INCHES
OBJECT DISTANCE= INFINITY
APERTURE RADIUS= 157.50 INCHES FIELD RADIUS= 20.00 ARC MIN

RMS IMAGE(S) TYP DIAM= 47.7 +/- 15.6 MICRONS
0.19 +/- 0.06 ARC SEC
MAX RMS LATERAL COLOR= 42.0 MICRONS = 0.17 ARC SEC

NS	NNE,CRV, SASC,NNA NSE,X,4RN,2ICR,NSA							NS	DIAM	SAG
1	0							0 1		
1	0 0.0	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 2 1	315.000	0.0
2	3 -0.13227513D-02	-0.10000000D+01	0.0	0.0	0.0	0.0		0 2		
2	8 -0.30505885D+03	-0.10000000D+01	0.0	-0.10000000D+01	0.0	0	0	0 2	316.718	-16.586
3	3 -0.55474977D-02	-0.21575771D+01	0.0	0.0	0.0	0.0		0 3		
3	9 0.31176422D+03	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 3	65.338	-2.933
4	3 0.38242963D-01	0.0	0.0	0.0	0.0	0.0		0 4		
4	1 0.24999995D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02	21	-239	0 4	30.568	4.932
5	3 0.33347466D-01	0.0	0.0	0.0	0.0	0.0		0 5		
5	1 0.76073554D+01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 5	29.795	3.962
6	3 0.23695439D-01	0.0	0.0	0.0	0.0	0.0		0 6		
6	1 0.99651609D+00	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02	21	-239	0 6	28.417	2.464
7	3 0.40835601D-01	0.0	0.0	0.0	0.0	0.0		0 7		
7	9 0.60000001D+01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 7	27.423	4.199
8	3 0.0	0.0	0.0	0.0	0.0	0.0		0 8		
8	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02	31	-189	0 8	27.503	0.0
9	3 0.0	0.0	0.0	0.0	0.0	0.0		0 9		
9	1 0.13999986D+01	0.15729500D+01	0.76290000D-02	0.15389730D+01	0.75140000D-02	28	21	0 9	27.536	0.0
10	3 0.0	0.0	0.0	0.0	0.0	0.0		0 10		
10	1 0.12000008D+01	0.15053180D+01	0.40100000D-02	0.14864080D+01	0.50660000D-02	31	-189	0 10	27.574	0.0
11	3 0.0	0.0	0.0	0.0	0.0	0.0		0 11		
11	1 0.14716101D+01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 11	27.607	0.0
12	3 -0.70963324D-03	0.0	0.0	0.0	0.0	0.0		0 12		
12	9 0.18969156D+01	0.14758040D+01	0.39590000D-02	0.14574120D+01	0.50660000D-02	21	-239	0 12	27.665	-0.068
13	3 -0.89684462D-02	0.0	0.0	0.0	0.0	0.0		0 13		
13	1 0.46564974D+02	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 13	27.703	-0.864
14	3 0.0	0.0	0.0	0.0	0.0	0.0		0 14		
14	1 0.49999950D+00	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 14	24.732	0.0
15	3 0.0	0.0	0.0	0.0	0.0	0.0		0 15		
15	1 0.19604290D+01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 15	24.701	0.0
16320	-0.66264490D-02	0.0	0.18148122D-01	0.86519557D-01	0.21534732D+00	0.0		1 16		
16	2 -0.15023744D-01	0.10000000D+01	0.0	0.10000000D+01	0.0	0	0	0 16	24.253	-0.488
16	*2 -0.14056761D-01	*SYSTEM WAS REFOCUSED FOR SECONDARY MEAN WAVELENGTH ANALYSIS								

NOTICE: END OF COMPUTATIONS FOR THIS SYSTEM. TERMINATION WAS NORMAL.

Table 10 Run No. 2970 (2/10/88)

OPTIMUM INITIAL SPHERE FOR ASPHERIC SURFACE----PROGRAM GRINDIT(06/22/87 VERSION)----EPPS/ASTRONOMY/UCLA

SECONDARY MIRROR: 31S-INCH F/6.5 CASS FOCUS, RUN NO. 2765 (02/10/88)

ASPHERIC SURFACE DESCRIPTION (IN INCHES):

CURVATURE	A2	A4	A6	A8	A10
-0.005491765	-2.17424240	0.0	0.0	0.0	0.0

DIAMETER	SCALES
65.8100	1.0000000

THE SUBSTRATE IS TO THE LEFT OF THE SURFACE AS SEEN IN A STANDARD OPTICAL DIAGRAM

OPTIMUM INITIAL SPHERE:

CURVATURE= -0.005396820 ABS(EXTRA VERTEX THICKNESS)= 0.0

(RAD) IS ZONAL RADIUS; (TRUSAG) IS TRUE SAG OF ASPHERE; (REMOVE) IS GLASS DEPTH TO GRIND OFF INITIAL SPHERE

RAD	TRUSAG	REMOVE
0.0	0.0	0.0
1.000	-0.00275	0.00005
2.000	-0.01098	0.00019
3.000	-0.02471	0.00042
4.000	-0.04393	0.00075
5.000	-0.06863	0.00116
6.000	-0.09882	0.00165
7.000	-0.13449	0.00222
8.000	-0.17564	0.00286
9.000	-0.22226	0.00356
10.000	-0.27435	0.00431
11.000	-0.33190	0.00510
12.000	-0.39490	0.00592
13.000	-0.46336	0.00677
14.000	-0.53726	0.00762
15.000	-0.61660	0.00846
16.000	-0.70136	0.00927
17.000	-0.79154	0.01005
18.000	-0.88713	0.01077
19.000	-0.98812	0.01142
20.000	-1.09449	0.01196
21.000	-1.20624	0.01240
22.000	-1.32336	0.01269
23.000	-1.44583	0.01283
24.000	-1.57364	0.01279
25.000	-1.70678	0.01253
26.000	-1.84524	0.01204
27.000	-1.98899	0.01130
28.000	-2.13803	0.01026
29.000	-2.29234	0.00891
30.000	-2.45191	0.00721
31.000	-2.61672	0.00514
32.000	-2.78674	0.00266
** 32.9050	-2.94511	0.00003 ** EDGE

Table 11 Aspheric For Secondary - Run No. 2765 (2/10/88)

POLY: WL'S= .33, .35, .385, .435, .52, .70, 1.10

WAVELENGTH (ANGSTROMS) = 4652.9
ABSOLUTE B.F.D. VALUE (INCHES) = 50.324
CURVATURE OF FIELD (INCHES^{-1}) = -0.00614665
THE FOCUS IS NOMINAL
THE OPTIC AXIS IS DIVERTED

NS= 6	XPVOT= 0.000 (INCHES) YPVOT= 0.000	ALPHA= 0.0000 (DEGREES) BETA= 0.0000 ZROT= 90.0000
NS= 9	XPVOT= 0.000 YPVOT= 0.000	ALPHA= 0.0000 BETA= 0.0000 ZROT= -180.0000
NS= 11	XPVOT= 0.000 YPVOT= 0.000	ALPHA= 0.0000 BETA= 0.0000 ZROT= 90.0000

THE SYSTEM IS NOT COLLIMATED

NS= 7	XDISP= 0.000 (INCHES) YDISP= 0.000	THETA= -6.11 (ARC MIN) PHI= 0.00
NS= 8	XDISP= 0.000 YDISP= 0.000	THETA= 52.27 PHI= 0.00
NS= 10	XDISP= 0.000 YDISP= 0.000	THETA= -52.27 PHI= 0.00
NS= 11	XDISP= 0.000 YDISP= 0.000	THETA= 6.11 PHI= 0.00

THE OBJECT IS AT INFINITY
ZETA= 0.00 (ARC MIN) GAMMA= 0.00 (ARC MIN)
X AVERAGE (MICRONS) = 28.7
Y AVERAGE (MICRONS) = -0.0
RMS IMAGE DIAMETER (MICRONS) = 29.8

DIAMETER (MICRONS)	RAYS (PERCENT)
14.9	18.4
19.8	35.5
24.8	48.7
29.8	61.7
34.7	71.2
39.7	80.6
44.6	89.8
49.6	94.1
54.6	98.2
59.5	100.0

MAXIMUM = 57.8 RAYS = 100.0

PERCENTAGE VIGNETTING = 9.7
NUMBER OF RAYS TRACED = 784

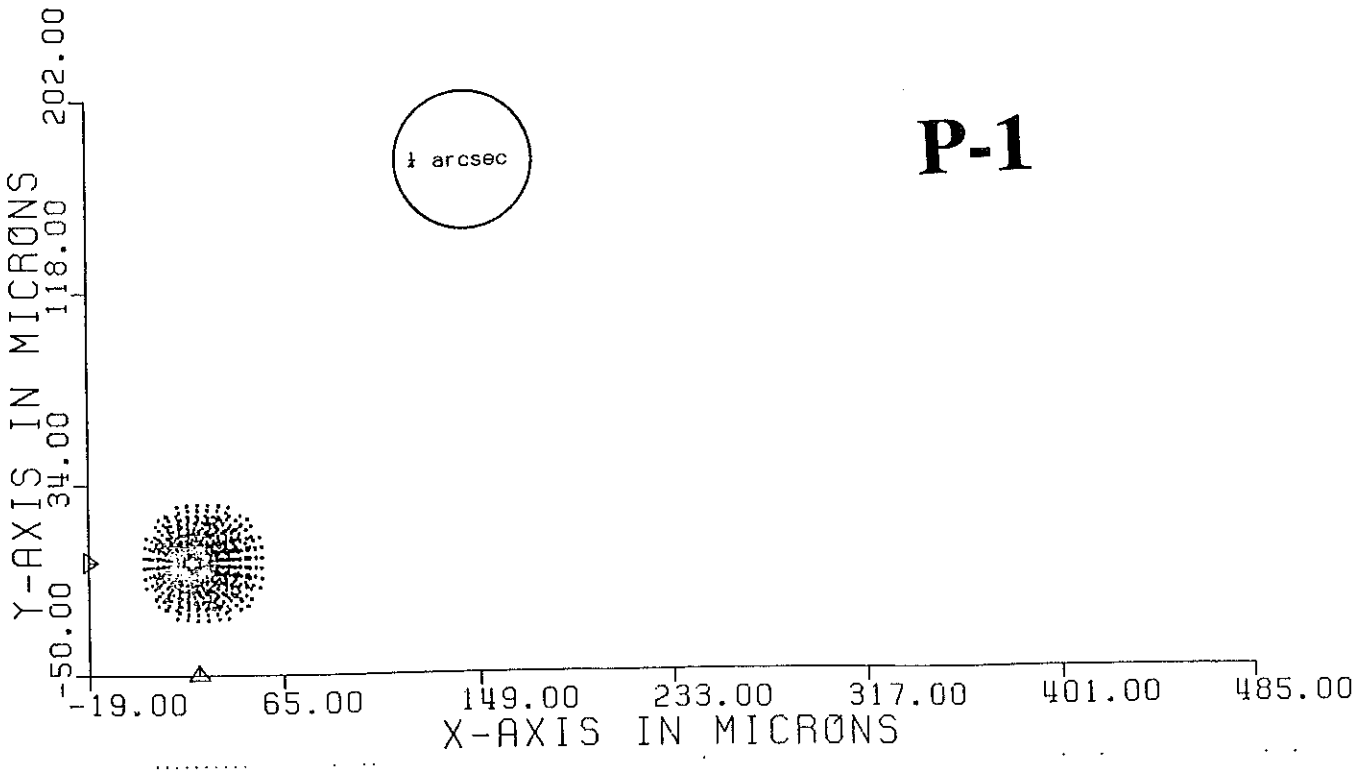
LAS CAMPANAS 315-INCH TELESCOPE WITH AN F/1.2 PARABOLIC PRIMARY. NAKED (B=+79.31 IN) CASS FOCUS IS F/6.258, CORRECTED TO F/6.50.

THIS ALL-SPHERICAL CORRECTOR HAS 3 QUARTZ LENS ELEMENTS, TWO (2) FK5/LLF2 ZERO-DEVIATION PRISMS FOR ATMOSPHERIC DISP COMP (ADC) DOWN TO Z=60.0 DEGREES, AND A CURVED (R= -162.69-INCH) F.O.V.

COLOR CORRECTED 0.33 TO 1.10 MI. 40.0-ARCMIN FULL FIELD DIAMETER.

RUN NO. 2765 (02/10/88).

(ADC) IS 'FULL-OFF' IN THIS RUN.



P-1

EPPS/ASTRONOMY/UCLA PROGRAM 'GEOMRAY' SPOT NUMBER 1 OF 1

POLY: WL'S= .33, .35, .385, .435, .52, .70, 1.10

WAVELENGTH (ANGSTROMS) = 4652.9
ABSOLUTE B.F.D. VALUE (INCHES) = 50.324
CURVATURE OF FIELD (INCHES^{-1}) = -0.00614665
THE FOCUS IS NOMINAL
THE OPTIC AXIS IS DIVERTED

NS= 6	XPVOT= 0.000 (INCHES)	ALPHA= 0.0000 (DEGREES)
	YPVOT= 0.000	BETA= 0.0000
		ZROT= 90.0000
NS= 9	XPVOT= 0.000	ALPHA= 0.0000
	YPVOT= 0.000	BETA= 0.0000
		ZROT= -180.0000
NS= 11	XPVOT= 0.000	ALPHA= 0.0000
	YPVOT= 0.000	BETA= 0.0000
		ZROT= 90.0000

THE SYSTEM IS NOT COLLIMATED

NS= 7	XDISP= 0.000 (INCHES)	THETA= -6.11 (ARC MIN)
	YDISP= 0.000	PHI= 0.00
NS= 8	XDISP= 0.000	THETA= 52.27
	YDISP= 0.000	PHI= 0.00
NS= 10	XDISP= 0.000	THETA= -52.27
	YDISP= 0.000	PHI= 0.00
NS= 11	XDISP= 0.000	THETA= 6.11
	YDISP= 0.000	PHI= 0.00

THE OBJECT IS AT INFINITY
ZETA= 0.00 (ARC MIN) GAMMA= 8.00 (ARC MIN)
X AVERAGE (MICRONS) = 121382.0
Y AVERAGE (MICRONS) = -0.0
RMS IMAGE DIAMETER (MICRONS) = 38.9

DIAMETER (MICRONS)	RAYS (PERCENT)
19.4	25.8
25.9	41.1
32.4	49.7
38.9	59.4
45.4	72.7
51.8	81.6
58.3	87.8
64.8	93.9
71.3	97.7
77.8	98.7

PARTIAL = 63.0 RAYS = 91.8

PERCENTAGE VIGNETTING = 9.7
NUMBER OF RAYS TRACED = 784

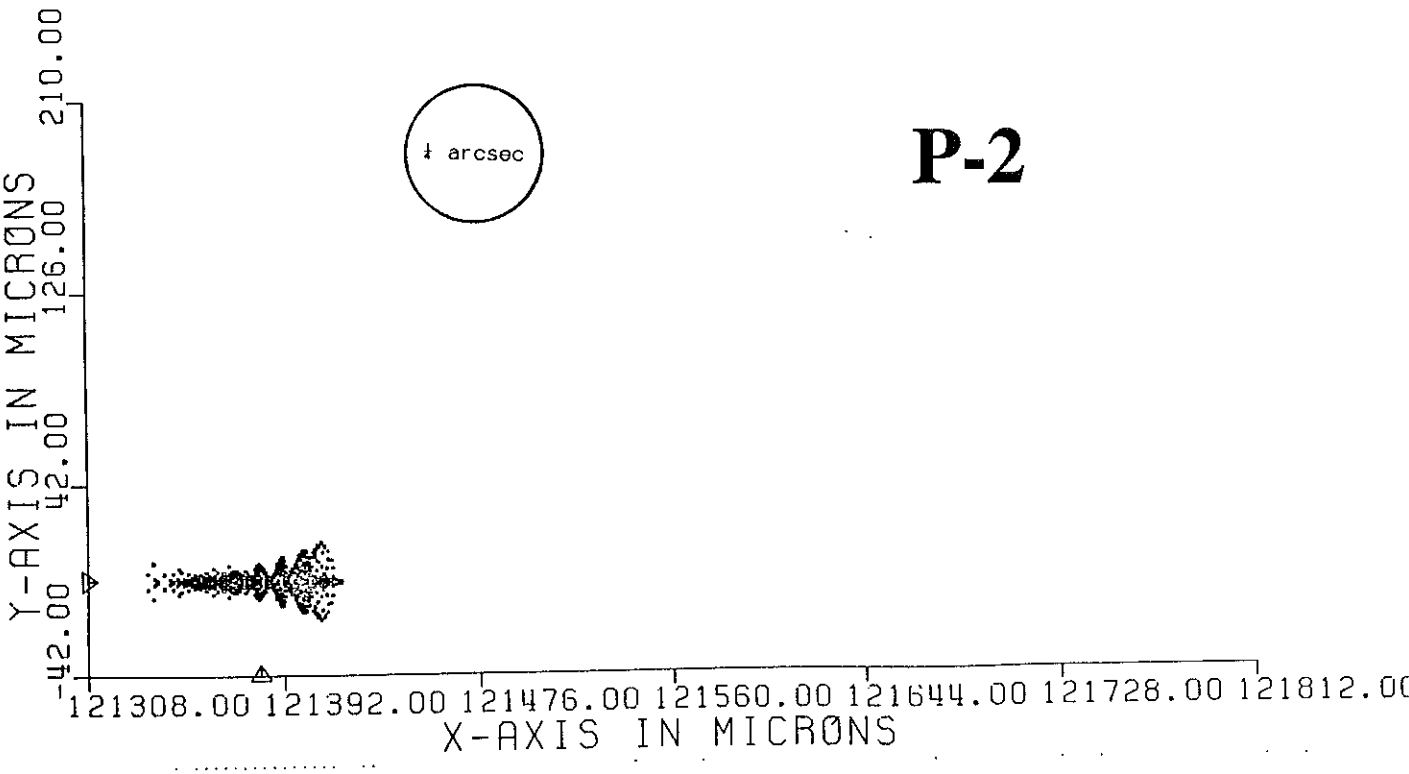
LAS CAMPANAS 315-INCH TELESCOPE WITH AN F/1.2 PARABOLIC PRIMARY. NAKED (B=+79.31 IN) CASS FOCUS IS F/6.258, CORRECTED TO F/6.50.

THIS ALL-SPHERICAL CORRECTOR HAS 3 QUARTZ LENS ELEMENTS, TWO (2) FK5/LLF2 ZERO-DEVIATION PRISMS FOR ATMOSPHERIC DISP COMP (ADC) DOWN TO Z=60.0 DEGREES. AND A CURVED (R= -162.69-INCH) F.O.V.

COLOR CORRECTED 0.33 TO 1.10 MI. 40.0-ARCMIN FULL FIELD DIAMETER.

RUN NO. 2765 (02/10/88).

(ADC) IS 'FULL-OFF' IN THIS RUN.



P-2

POLY: WL'S= .33, .35, .385, .435, .52, .70, 1.10

WAVELENGTH (ANGSTROMS) = 4652.9
ABSOLUTE B.F.D. VALUE (INCHES) = 50.324
CURVATURE OF FIELD (INCHES^{-1}) = -0.00614665
THE FOCUS IS NOMINAL
THE OPTIC AXIS IS DIVERTED

NS= 6	XPVOT= 0.000 (INCHES) YPVOT= 0.000	ALPHA= 0.0000 (DEGREES) BETA= 0.0000 ZROT= 90.0000
NS= 9	XPVOT= 0.000 YPVOT= 0.000	ALPHA= 0.0000 BETA= 0.0000 ZROT= -180.0000
NS= 11	XPVOT= 0.000 YPVOT= 0.000	ALPHA= 0.0000 BETA= 0.0000 ZROT= 90.0000

THE SYSTEM IS NOT COLLIMATED

NS= 7	XDISP= 0.000 (INCHES) YDISP= 0.000	THETA= -6.11 (ARC MIN) PHI= 0.00
NS= 8	XDISP= 0.000 YDISP= 0.000	THETA= 52.27 PHI= 0.00
NS= 10	XDISP= 0.000 YDISP= 0.000	THETA= -52.27 PHI= 0.00
NS= 11	XDISP= 0.000 YDISP= 0.000	THETA= 6.11 PHI= 0.00

THE OBJECT IS AT INFINITY
ZETA= 0.00 (ARC MIN) GAMMA= 14.00 (ARC MIN)
X AVERAGE (MICRONS) = 213574.8
Y AVERAGE (MICRONS) = -0.0
RMS IMAGE DIAMETER (MICRONS) = 45.7

DIAMETER (MICRONS)	RAYS (PERCEN
22.9	35.2
30.5	50.8
38.1	61.7
45.7	69.6
53.4	77.6
61.0	82.4
68.6	86.5
76.2	90.1
83.9	93.1
91.5	94.6

PARTIAL = 63.0 RAYS = 83.9

PERCENTAGE VIGNETTING = 9.7
NUMBER OF RAYS TRACED = 784

LAS CAMPANAS 315-INCH TELESCOPE
WITH AN F/1.2 PARABOLIC PRIMARY
NAKED (B=+79.31 IN) CASS FOCUS
IS F/6.258, CORRECTED TO F/6.50

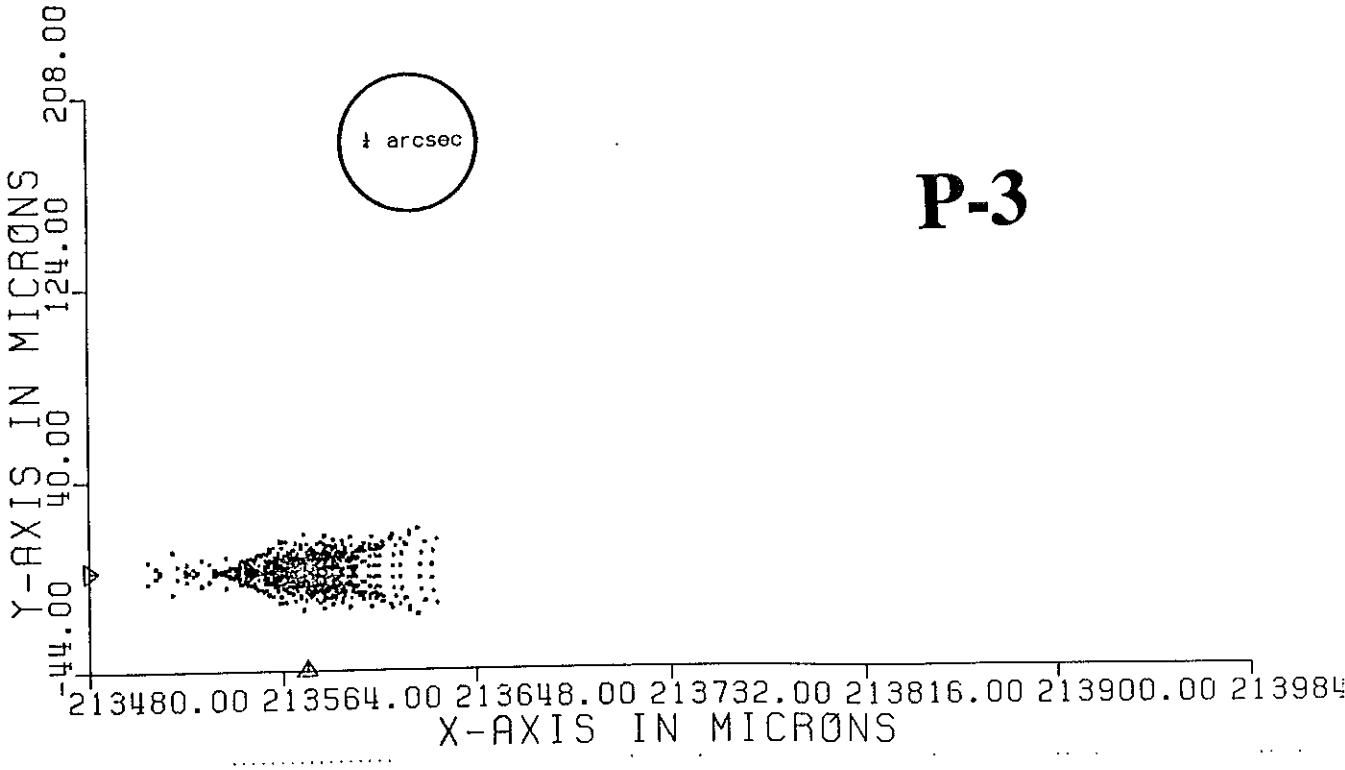
THIS ALL-SPHERICAL CORRECTOR HA
3 QUARTZ LENS ELEMENTS, TWO (2
FK5/LLF2 ZERO-DEVIATION PRISMS
FOR ATMOSPHERIC DISP COMP (ADC)
DOWN TO Z=60.0 DEGREES, AND A
CURVED (R= -162.69-INCH) F.O.V.

COLOR CORRECTED 0.33 TO 1.10 MI.
40.0-ARCMIN FULL FIELD DIAMETER.

RUN NO. 2765 (02/10/88).

(ADC) IS 'FULL-OFF' IN THIS RUN.

EPPS/ASTRONOMY/UCLA PROGRAM 'GEOMRAY' SPOT NUMBER 1 OF 1



P-3

POLY: WL'S= .33, .35, .385, .435, .52, .70, 1.10

WAVELENGTH (ANGSTROMS) = 4652.9
ABSOLUTE B.F.D. VALUE (INCHES) = 50.324
CURVATURE OF FIELD (INCHES^{-1}) = -0.00614665
THE FOCUS IS NOMINAL
THE OPTIC AXIS IS DIVERTED

NS= 6	XPVOT= 0.000 (INCHES)	ALPHA= 0.0000 (DEGREES)
	YPVOT= 0.000	BETA= 0.0000
		ZROT= 90.0000
NS= 9	XPVOT= 0.000	ALPHA= 0.0000
	YPVOT= 0.000	BETA= 0.0000
		ZROT= -180.0000
NS= 11	XPVOT= 0.000	ALPHA= 0.0000
	YPVOT= 0.000	BETA= 0.0000
		ZROT= 90.0000

THE SYSTEM IS NOT COLLIMATED

NS= 7	XDISP= 0.000 (INCHES)	THETA= -6.11 (ARC MIN)
	YDISP= 0.000	PHI= 0.00
NS= 8	XDISP= 0.000	THETA= 52.27
	YDISP= 0.000	PHI= 0.00
NS= 10	XDISP= 0.000	THETA= -52.27
	YDISP= 0.000	PHI= 0.00
NS= 11	XDISP= 0.000	THETA= 6.11
	YDISP= 0.000	PHI= 0.00

THE OBJECT IS AT INFINITY
ZETA= 0.00 (ARC MIN) GAMMA= 18.00 (ARC MIN)
X AVERAGE (MICRONS) = 276162.5
Y AVERAGE (MICRONS) = -0.0
RMS IMAGE DIAMETER (MICRONS) = 32.0

DIAMETER (MICRONS)	RAYS (PERCENT)
16.0	28.1
21.3	40.6
26.7	54.3
32.0	65.6
37.3	76.3
42.7	82.7
48.0	88.0
53.3	91.6
58.7	94.1
64.0	97.2

PARTIAL = 63.0 RAYS = 96.9

PERCENTAGE VIGNETTING = 9.7
NUMBER OF RAYS TRACED = 784

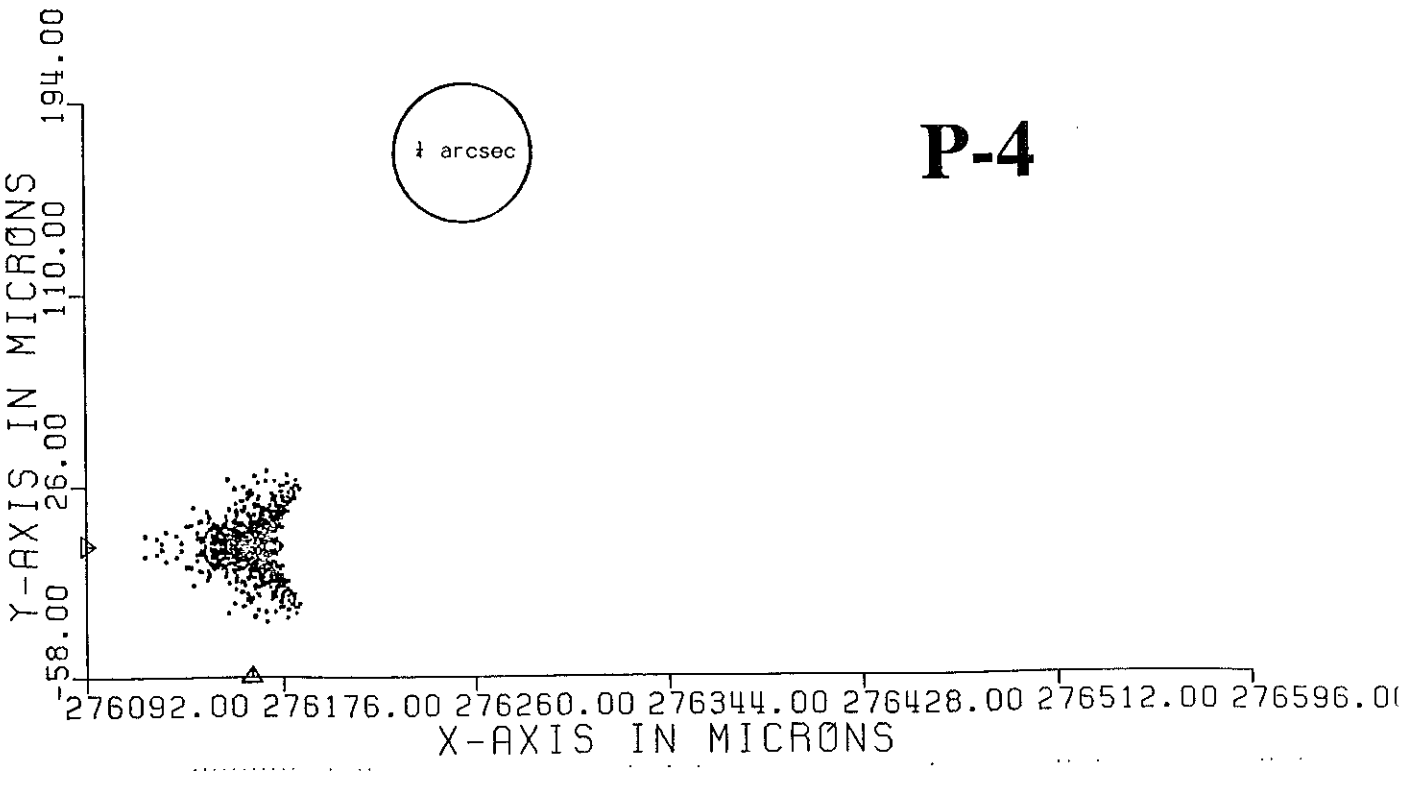
LAS CAMPANAS 315-INCH TELESCOPE WITH AN F/1.2 PARABOLIC PRIMARY. NAKED (B=+79.31 IN) CASS FOCUS IS F/6.258, CORRECTED TO F/6.50.

THIS ALL-SPHERICAL CORRECTOR HAS 3 QUARTZ LENS ELEMENTS, TWO (2) FK5/LLF2 ZERO-DEVIATION PRISMS FOR ATMOSPHERIC DISP COMP (ADC) DOWN TO Z=60.0 DEGREES, AND A CURVED (R= -162.69-INCH) F.O.V.

COLOR CORRECTED 0.33 TO 1.10 MI. 40.0-ARCMIN FULL FIELD DIAMETER.

RUN NO. 2765 (02/10/88).

(ADC) IS 'FULL-OFF' IN THIS RUN.



P-4

POLY: WL'S= .33, .35, .385, .435, .52, .70, 1.10

WAVELENGTH (ANGSTROMS) = 4652.9
ABSOLUTE B.F.D. VALUE (INCHES) = 50.324
CURVATURE OF FIELD (INCHES^{-1}) = -0.00614665
THE FOCUS IS NOMINAL
THE OPTIC AXIS IS DIVERTED

NS= 6	XPVOT= 0.000 (INCHES)	ALPHA= 0.0000 (DEGREES)
	YPVOT= 0.000	BETA= 0.0000
		ZROT= 90.0000
NS= 9	XPVOT= 0.000	ALPHA= 0.0000
	YPVOT= 0.000	BETA= 0.0000
		ZROT= -180.0000
NS= 11	XPVOT= 0.000	ALPHA= 0.0000
	YPVOT= 0.000	BETA= 0.0000
		ZROT= 90.0000

THE SYSTEM IS NOT COLLIMATED

NS= 7	XDISP= 0.000 (INCHES)	THETA= -6.11 (ARC MIN)
	YDISP= 0.000	PHI= 0.00
NS= 8	XDISP= 0.000	THETA= 52.27
	YDISP= 0.000	PHI= 0.00
NS= 10	XDISP= 0.000	THETA= -52.27
	YDISP= 0.000	PHI= 0.00
NS= 11	XDISP= 0.000	THETA= 6.11
	YDISP= 0.000	PHI= 0.00

THE OBJECT IS AT INFINITY
ZETA= 0.00 (ARC MIN) GAMMA= 20.00 (ARC MIN)
X AVERAGE (MICRONS) = 307942.1
Y AVERAGE (MICRONS) = -0.0
RMS IMAGE DIAMETER (MICRONS) = 70.4

DIAMETER (MICRONS)	RAYS (PERCENT)
35.2	18.1
46.9	29.8
58.7	43.9
70.4	60.5
82.1	74.0
93.9	83.4
105.6	89.8
117.3	96.4
129.1	99.2
140.8	100.0

PARTIAL = 63.0 RAYS = 50.3

PERCENTAGE VIGNETTING = 9.7
NUMBER OF RAYS TRACED = 784

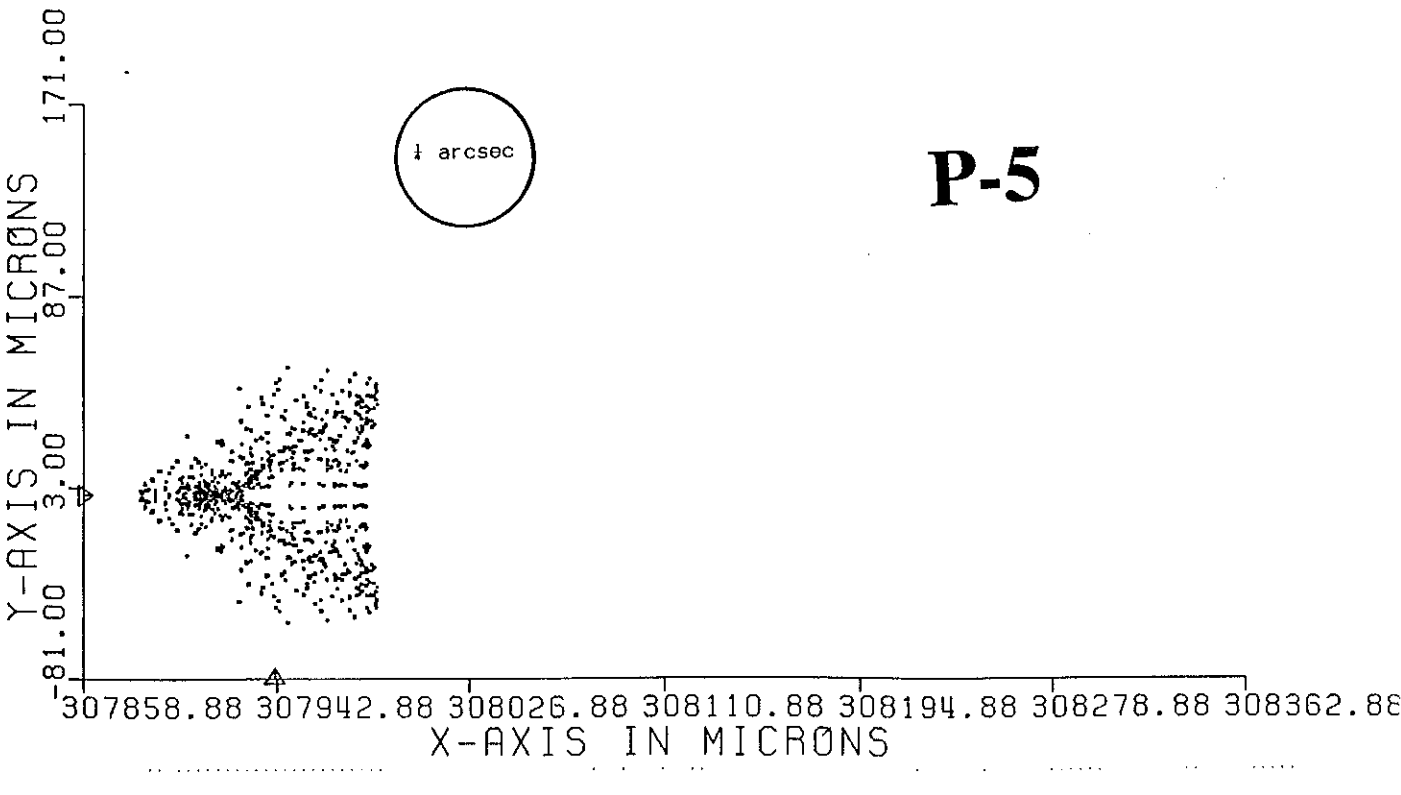
LAS CAMPANAS 315-INCH TELESCOPE WITH AN F/1.2 PARABOLIC PRIMARY. NAKED (B=+79.31 IN) CASS FOCUS IS F/6.258, CORRECTED TO F/6.50.

THIS ALL-SPHERICAL CORRECTOR HAS 3 QUARTZ LENS ELEMENTS, TWO (2) FK5/LLF2 ZERO-DEVIATION PRISMS FOR ATMOSPHERIC DISP COMP (ADC) DOWN TO Z=60.0 DEGREES, AND A CURVED (R= -162.69-INCH) F.O.V.

COLOR CORRECTED 0.33 TO 1.10 MI. 40.0-ARCMIN FULL FIELD DIAMETER.

RUN NO. 2765 (02/10/88).

(ADC) IS 'FULL-OFF' IN THIS RUN.



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