Optical Design and specifications for the 90–in Prime Focus Corrector
Part 1: specifications and tolerances

Revision D

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This memo summarizes the optical design for the 90–in Prime Focus Corrector. The final specifications and tolerances for the individual lenses and for the mounting are given. Part 2 of this memo gives the analysis of the performance of the optical system.

Design revisions:

Rev. A Sept. 1, 1999 – original memo

Rev. B Sept. 9, 1999
Filter moved 28 mm towards the CCD
(spacing from filter to lens 4 changed from 44 to 16 mm
spacing from lens 3 to filter changed from 172 to 200 mm)
Drawing and tables modified to reflect this change
This does not affect performance

Rev. C Oct. 25, 1999
Incorporated measurements of the primary mirror from Sarlot et al.
Some lens spacings were changed
The figure on the aspheric surface was changed (Lens 2, concave surface)
The overall performance and the tolerances are not affected

Rev D April 20, 2000
Accommodated radius change for L2 for available test plate
Incorporated as–built dimensions for L3, L4 (they were within spec)
Slight re–spacing of elements to re–optimize

System specifications

Primary mirror (from Sarlot et al.)

Radius of curvature R	12281 ± 4 mm
Conic constant K	−1.0646 ± 0.001
Clear aperture D	90" ± 0.06"
Central obscuration	33.5 ± 0.1"

Spacings (in mm)

	Rev. D	Rev D change	Rev. C	Rev B
Primary mirror – Lens1 spacing	5010.4 ± 1		5009.4 ± 1	4958.2 ± 1
Lens1 thickness	45 ± 0.1		45 ± 0.1	45 ± 0.1
Lens1 – Lens2 spacing	429.9 ± 0.3		430.5 ± 0.3	434.8 ± 0.3
Lens2 thickness	14 ± 0.1		14 ± 0.1	14 ± 0.1
Lens2 – Lens3 spacing	441.6 ± 0.3		442.3 ± 0.3	450.8 ± 0.3
Lens3 thickness	30.21 ± 0.005		30 ± 0.3	30 ± 0.3
Lens3 – filter spacing (focus adjust for system)	204.4 ± 5		204.9 ± 5	200.± 5
Filter thickness	8 ± 4		8 ± 4	8 ± 4
Filter – Lens4 spacing	16 ± 3		16 ± 3	16 ± 3
Lens4 thickness	17.75 ± 0.005		17.3 ± 0.5	17.3 ± 0.5
Lens4 – focal plane spacing	5 ± 1		5 ± 1	5 ± 1
Overall length Lens 1 to FP	1212	❐	1213	1221

The overall design is shown below. We have divided the system into two parts – Can 1 and Can 2. Can 1 which holds the filter mechanism, Lens 4 (which is the dewar window) and the focal plane array. Can 2 holds Lens1, Lens 2, and Lens 3. The entire unit is supported by a spider, which is bolted to the telescope.

The requirements for the systems are

<u>Overall system, supported by spider</u>
Held with Lens1 – PM distance of 5010.4 ± 5. (Must maintain this to ±1 mm.)
Centered to telescope axis to 0.1 mm
Aligned in rotation to 0.05 mrad (about middle of system)

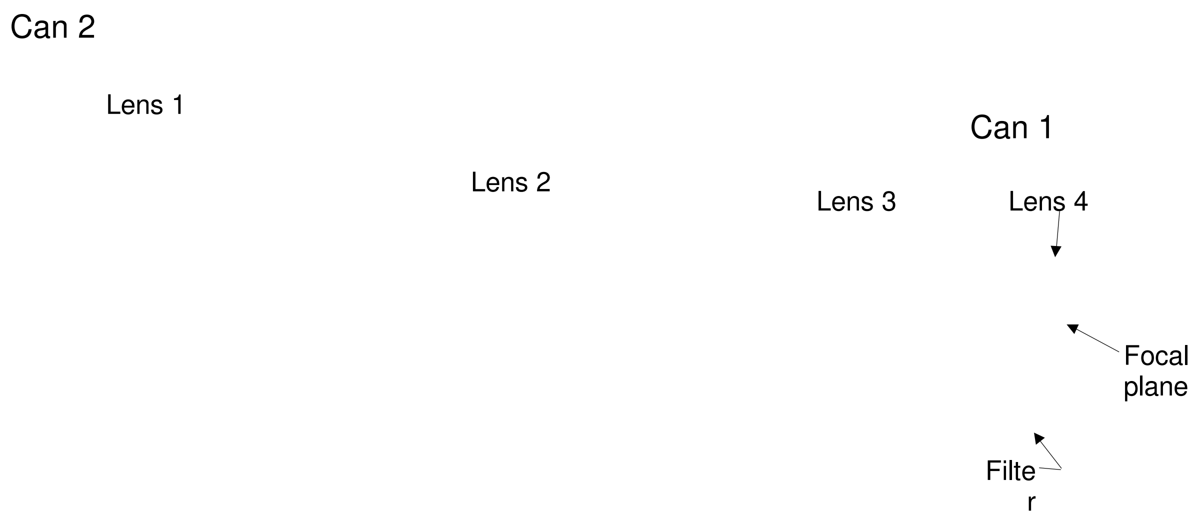
<u>Can 1, Focal plane assembly</u>
Driven axially for focus adjustment
10 µm resolution and stability for axial motion
0.2 mrad rotation about interface to Can 2
0.5 mm centration

<u>Can 2, Lens housing</u>
50 µm stability for axial motion
0.1 mrad rotation about interface to Can 1
0.1 mm centration

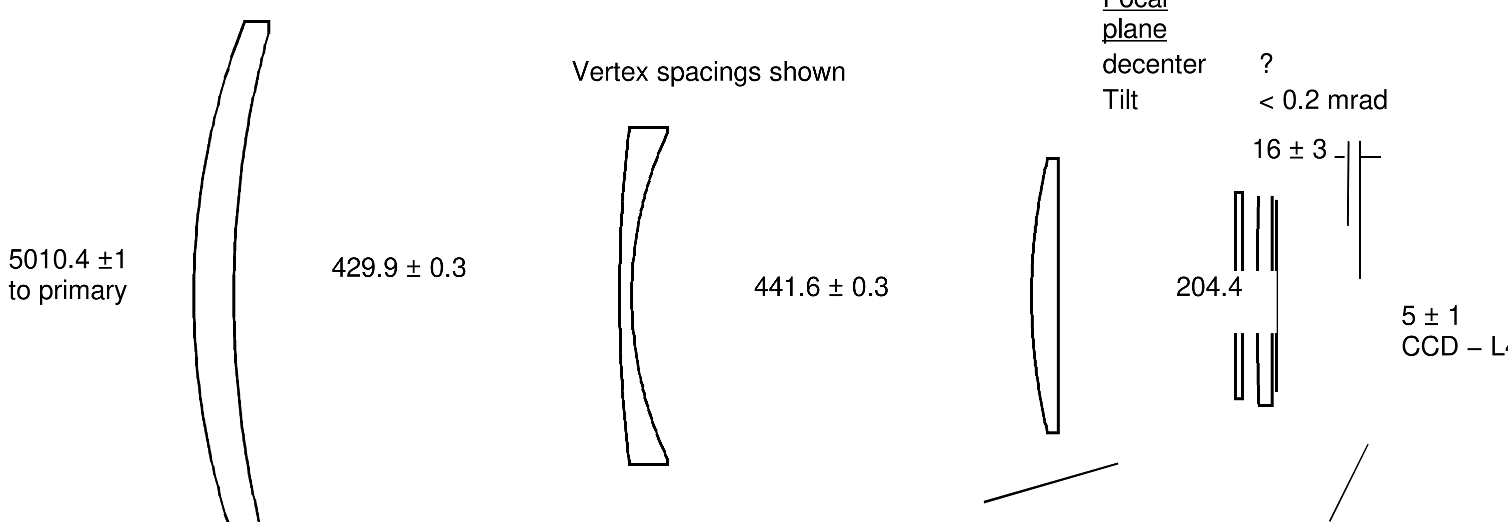
Primary mirror

Can 2

Can 1



Lens mounting specifications



Lens 1	
Diameter	520
CA1	495
CA2	480
CT	45.0 ± 0.1
(ET	27.4)
Wedge	< 0.05 mm
decenter	< 0.1 mm
Tilt	< 0.05 mm (0.1 mrad)

Lens 2	
Diameter	320.65
CA1	296
CA2	276
CT	14.0 ± 0.1
(ET	43)
Wedge	< 0.05 mm
decenter	< 0.1 mm
Tilt	< 0.05 mm (0.16 mrad)

Lens 3	
Diameter	260
CA1	240
CA2	240
CT	30.21± 0.005
(ET	12.2)
Wedge	< 0.05 mm
decenter	< 0.1 mm
Tilt	< 0.05 mm (0.2 mrad)

Lens 4	
Diameter	208
CA1	188
CA2	188
CT	17.75 ± 0.005
(ET	15.5)
Wedge	< 0.05 mm
decenter	< 0.2 mm
Tilt	< 0.2 mm (1 mrad)

Lens 1 Rev D.

Outside diameter	520
Center thickness	45.0 ± 0.1 mm
(Edge thickness	27.4 mm)
Wedge	< 0.05 mm

Surface 1

CA1	495
R1	622.0 ± 0.15 (cvx)
Figure	Measured by custom 250 mm test plate
	0.5 fringes power
	0.25 fringes irregularity

Surface 2

Diam	500
CA2	480
R2	813 ± 0.3 (ccv)
Figure	Measured by PSI
	Rms slopes < 0.025 waves/cm

Material
Fused silica (equivalent with Amersil Grade 4000 or Hereaus Herasil 3)
Refractive index inhomogeneity < 1e−5 P−V
Birefringence < 10 nm/cm
Total inclusion cross section < 1 mm/100 cc
Maximum inclusion 1 mm

Lens 2 – Rev. D.

Outside diameter	320.65 *as built*
Center thickness	14.0 ± 0.1 mm
(Edge thickness	43 mm)
Wedge	< 0.05 mm

Surface 1

CA1	296
R1	1128.1 ± 1 (cvx)
Figure	Measured by Kreisher 150 mm test plate 0.5 fringes power 0.25 fringes irregularity

Surface 2, asphere

Diam	310
CA2	276
R2	312.58
K2	−0.249
Figure	Measured by PSI Using ellipse test 0.2 waves/cm

Material

Fused silica (equivalent with Amersil Grade 4000 or Hereaus Herasil 3)
Refractive index inhomogeneity < 1e−5 P−V
Birefringence < 10 nm/cm
Total inclusion cross section < 1 mm/100 cc
Maximum inclusion 0.76 mm

Ellipse test – Rev. D

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Aspheric surface
R = 312.58 mm
K = −0.249

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conic constant tolerances follow from the tolerances defined for the test conjugates.

C1 = 623.9 ± 0.3 mm
C2 = 208.5 ± 0.1 mm

Rms surface slopes < 0.2 waves/cm

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208.5 ± 0.1 mm

Lens 3 Rev D

Outside diameter	260
Center thickness	30.21 *as built*
(Edge thickness	12.2 mm)
Wedge	< 0.05 mm

Surface 1

CA1	240
R1	478.54 *as built*
Figure	Measured by Kreisher 100 mm test plate 1 fringes power 0.5 fringes irregularity

Surface 2

CA2	240
R2	Flat (1 fringe convex/25cm TP)
Power	< 9 fringes / 100 mm
Figure	Measured with 100 mm test plate 1 fringes power 0.5 fringes irregularity

Material
Fused silica (equivalent with Amersil Grade 4000 or Hereaus Herasil 3)
Refractive index inhomogeneity < 1e−5 P−V
Birefringence < 10 nm/cm
Total inclusion cross section < 1 mm/100 cc
Maximum inclusion 0.76 mm

Lens 4 Rev D

Outside diameter	208
Center thickness	17.75 *as built*
(Edge thickness	15.5 mm)
Wedge	< 0.05 mm

Surface 1

CA1	188
R1	2370.5 *as built*)
Figure	Measured by Kreisher 100 mm test plate 4 fringes power 2 fringes irregularity

Surface 2

CA2	188
R2	Flat (1 fringe concave over full aperture))
Power	< 10 fringes / 100 mm
Figure	Measured with 100 mm test plate 4 fringes power 2 fringes irregularity

Material
Fused silica (Amersil Grade 4100 or Hereaus Herasil 2)
Refractive index inhomogeneity < 6e−6 P−V
Birefringence < 10 nm/cm
Total inclusion cross section < .1 mm/100 cc
Maximum inclusion 0.3 mm