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Pan-STARRS Project Management System

The PS-1 Corrector Lens Specifications

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10 November 2005

PSDC-330-009-00

Revision History

Version/Revision	Date	Comments
00	10 Nov 2005	Creation of the report

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1 Scope of Document

This document contains the manufacturing specifications for the L1, L2, and L3 corrector lenses.

2 Referenced Documents

Table 1. PSDC Documents

Pan-STARRS ID	Title	Authors
PSDC-330-004-00	The Baseline Optical Design for PS-1	Morgan
PSDC-330-008-00	The PS-1 Coating Specifications	Morgan
PSTD-020-005-01	L1 Corrector Lens	Morgan
PSTD-020-006-00	L2 Corrector Lens	Morgan
PSTD-020-007-00	L3 Corrector Lens	Morgan

Table 2. External Documents

Source Reference	Title	Authors
http://medusa.as.arizona.edu/lbtwww/tech/ua9401.htm	Optical Design, Error Budget and Specifications for the Columbus Project Telescope	J. Hill

3 Introduction

This report defines the specifications of the corrector optics that the Pan-STARRS project requires for the PS-1 prototype telescope. Figure 1 shows the optical layout of the PS-1 telescope. Primary (M1) and secondary (M2) mirrors are arranged in a Cassegrain configuration. There are three corrector lenses in this wide-field telescope labeled L1, L2, and L3 in the figure. Between L2 and L3 are located 3 layers of filters denoted F1, F2, and F3 in the figure. At any given time only a single filter lies in the optical beam. A total of 6 filters will be inserted and removed from the optical beam by means of a custom designed filter mechanism.

The L3 lens forms the window of the camera dewar. It therefore supports an atmospheric pressure load and is radiatively cooled by proximity to the CCD focal plane which is held at a temperature of approximately -70° C. The outer vertex of L3 is predicted to be cooled to a temperature of -16° C. It is therefore necessary to keep moisture off of the L3 window in order to avoid condensation on its outer surface. For this purpose, the telescope support structure is being designed to allow purging of the space between L2 and L3 with dry nitrogen.

A separate report (PSDC-330-008-00) describes the AR coating specifications for the corrector lenses.

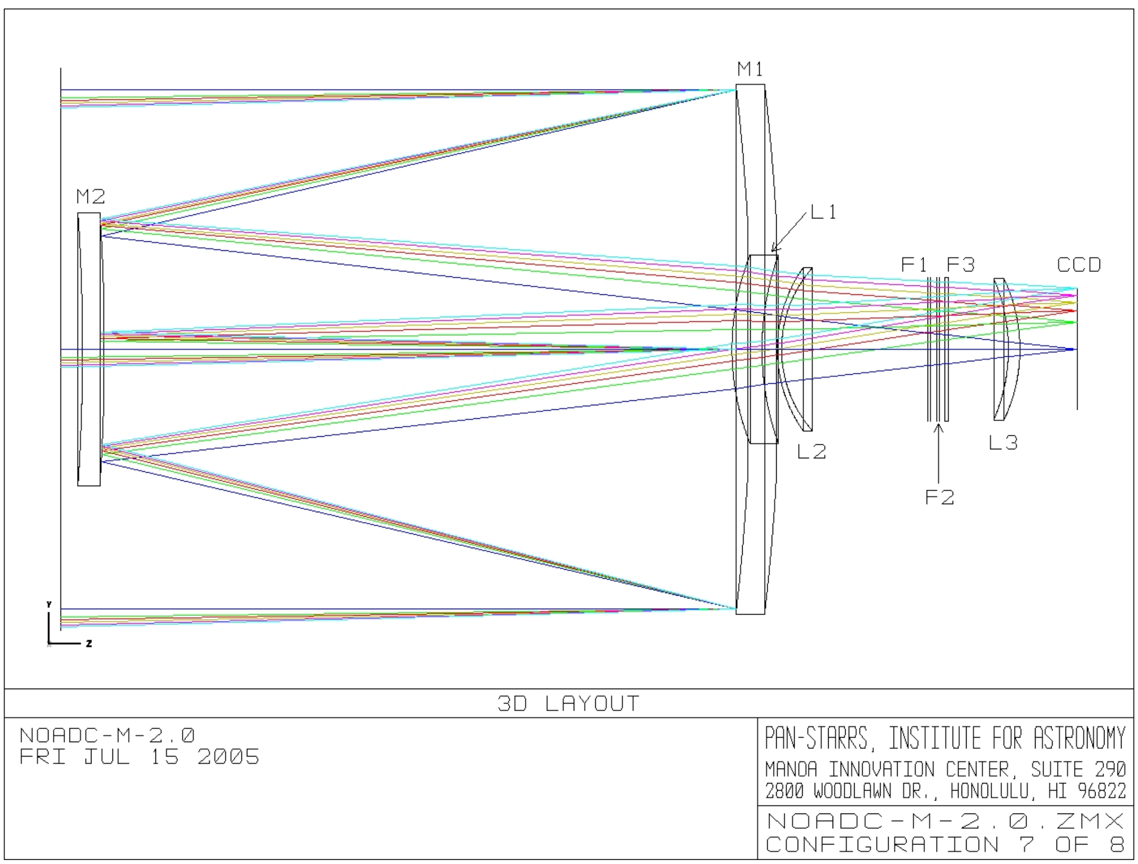

Figure 1. The PS-1 optical layout

4 Lens Specifications

4.1 Glass type: fused silica

Note that Corning Fused Silica 7980, 2B is consistent with this specification.

4.2 Glass inclusions: Corning Class 2

The inclusion allowance for this class is defined to be: $\leq 0.25\ mm^2$ for all inclusions in 100 cm^3 of glass and a maximum diameter of 0.5 mm for any single inclusion. Note that if a vendor believes that substantial savings may be obtained by reducing this specification, this option should be explored with the Pan-STARRS telescope engineer.

4.3 Radioactive contaminants: Radioisotopes in the lens blanks shall have the following limits: U ≤ 0.8 ppm, Th ≤ 2.5 ppm, and K ≤ 0.03 % (by weight).

4.4 Scratch and dig: 80/50

4.5 The transmitted wavefront accuracies required are dependent on the lens and are given as follows: L1=λ/3.2, L2=λ/3.2, L3=λ/1.6

In this specification λ is a reference wavelength of 633 nm and the wavefront accuracies are RMS variations from the ideal optical wavefront.

4.6 Radius of curvature accuracy: The tolerances for these radii depend on the lens as follows: L1 = ±0.35 mm, L2 = ±0.33 mm, and L3 = ±0.70 mm.

The radius of curvature of each surface is given in Table 3 through Table 5. At the full radius for each lens, these tolerances correspond to errors in the sags of the surfaces of ±20.3 µm, ±54.8 µm, and ±56.4 µm, respectively.

4.7 Vertex-to-vertex thickness: The tolerances for these thicknesses depend on the lens as follows: L1 = ±0.20 mm, L2 = ±0.10 mm, and L3 = ±0.30 mm.

The vertex-to-vertex thickness of each lens is given in Table 3 through Table 5.

4.8 Lens fiducial marks: as described below.

The vendor shall supply two permanent mechanical fiducial marks to each lens. The first shall be a dimple ground into one surface of the lens that marks the optical axis of that lens.

The appropriate surfaces for these optical axis fiducials are given in Figure 2 through Figure 4. The diameter of these dimples shall be ≤ 100 μm. The second mark on each lens shall be a ground dimple or spot of epoxy with a diameter ~1 mm on the perimeter of the lens marking a radius at 0° from the lens center. The expected position of the optical center of each lens shall be given with respect to the lens mechanical center and the perimeter fiducial mark.

The mechanical and optical figures of the lens surfaces are given below in Figure 2 through Figure 4 and in Table 3 through Table 5. Note that the lens surface figures come from the optical design of NOADC-M-2.0. A Zemax file containing this design may be provided to the vendor by the customer upon request. Likewise, PDF versions of Figure 2 through Figure 4 may also be provided upon request. Figure 2 through Figure 4 specify the accuracies of all of the mechanical dimensions of the lenses except for the radii of curvature and the vertex-to-vertex thickness of the lens surfaces, which are specified above.

4.9 Rough blank dimensions and properties

It is expected that the finish on the rough blanks before polishing will be 120 grit roughness with protective bevels on all edges. The blanks for these lenses are expected to be cylindrical in form with the following dimensions:

L1 = 660 (diameter) x 165 (thickness) mm
L2 = 614 x 136 mm
L3 = 560 x 106 mm

Table 3. The optical description of the L1 corrector.

Surface	Surface Type	Surface Parameter	Parameter Value
L1-A	S	Radius of Curvature (mm)	881.3
"	-	Thickness to next surface (mm)	104.3
L1-B	A	Radius of Curvature (mm)	963.7
"		Conic Constant	0
"		r^4 Coefficient	9.94×10^{-12}
"		r^6 Coefficient	-1.19×10^{-16}

These values are taken from the optical design NOADC-M-2.0

Table 4. The optical description of the L2 corrector.

Surface	Surface Type	Surface Parameter	Parameter Value
L2-A	S	Radius of Curvature (mm)	491.2
"	-	Thickness to next surface (mm)	14.7
L2-B	S	Radius of Curvature (mm)	427.5

These values are taken from the optical design NOADC-M-2.0

Table 5. The optical description of the L3 corrector.

Surface	Surface Type	Surface Parameter	Parameter Value
L3-A	A	Radius of Curvature (mm)	-610.5
"		Thickness to next surface (mm)	40
		Conic Constant	0
"		r^4 Coefficient	-2.34×10^{-11}
"		r^6 Coefficient	2.34×10^{-15}
L3-B	S	Radius of Curvature (mm)	-568.7

These values are taken from the optical design NOADC-M-2.0

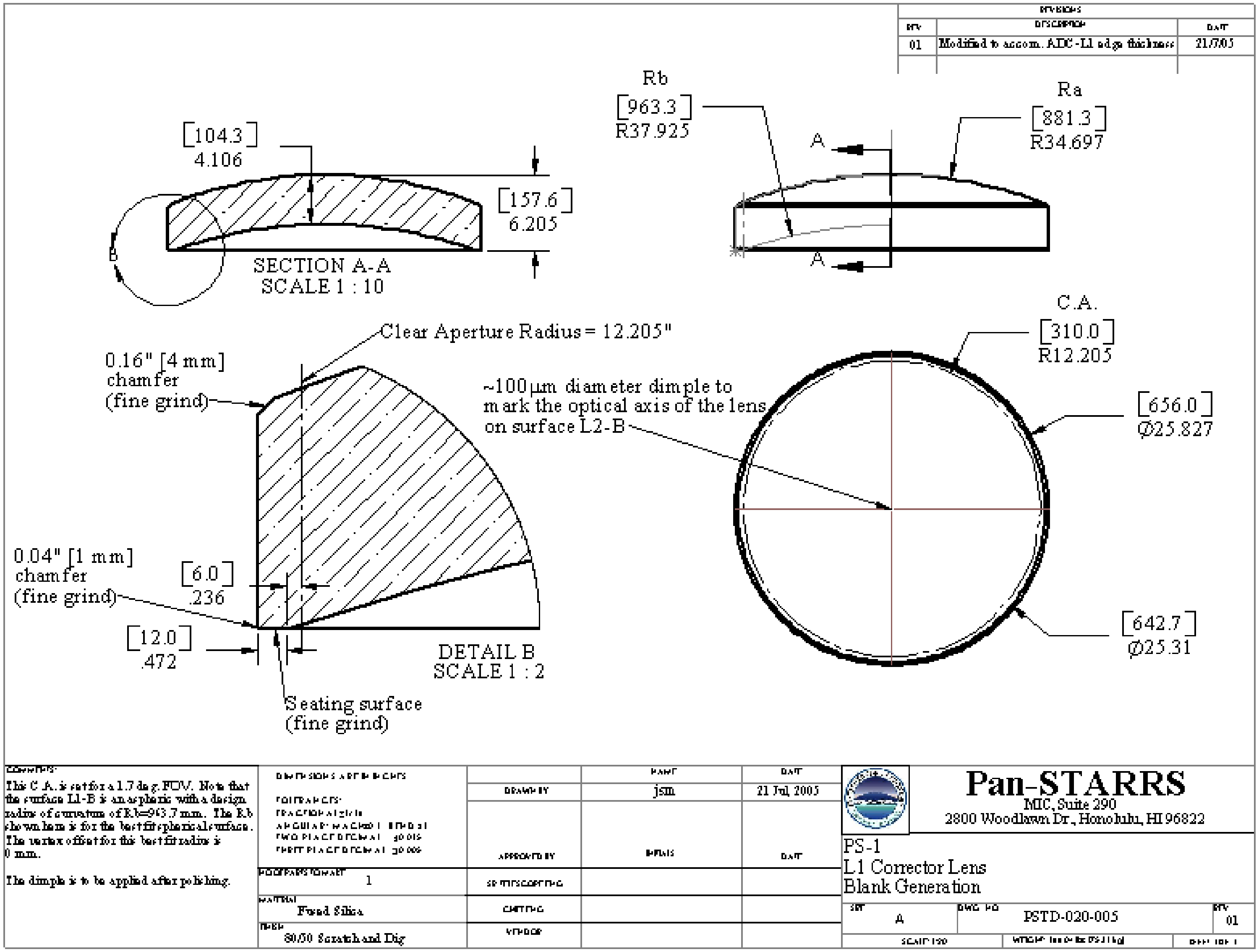

Figure 2. The mechanical drawing of the L1 corrector.

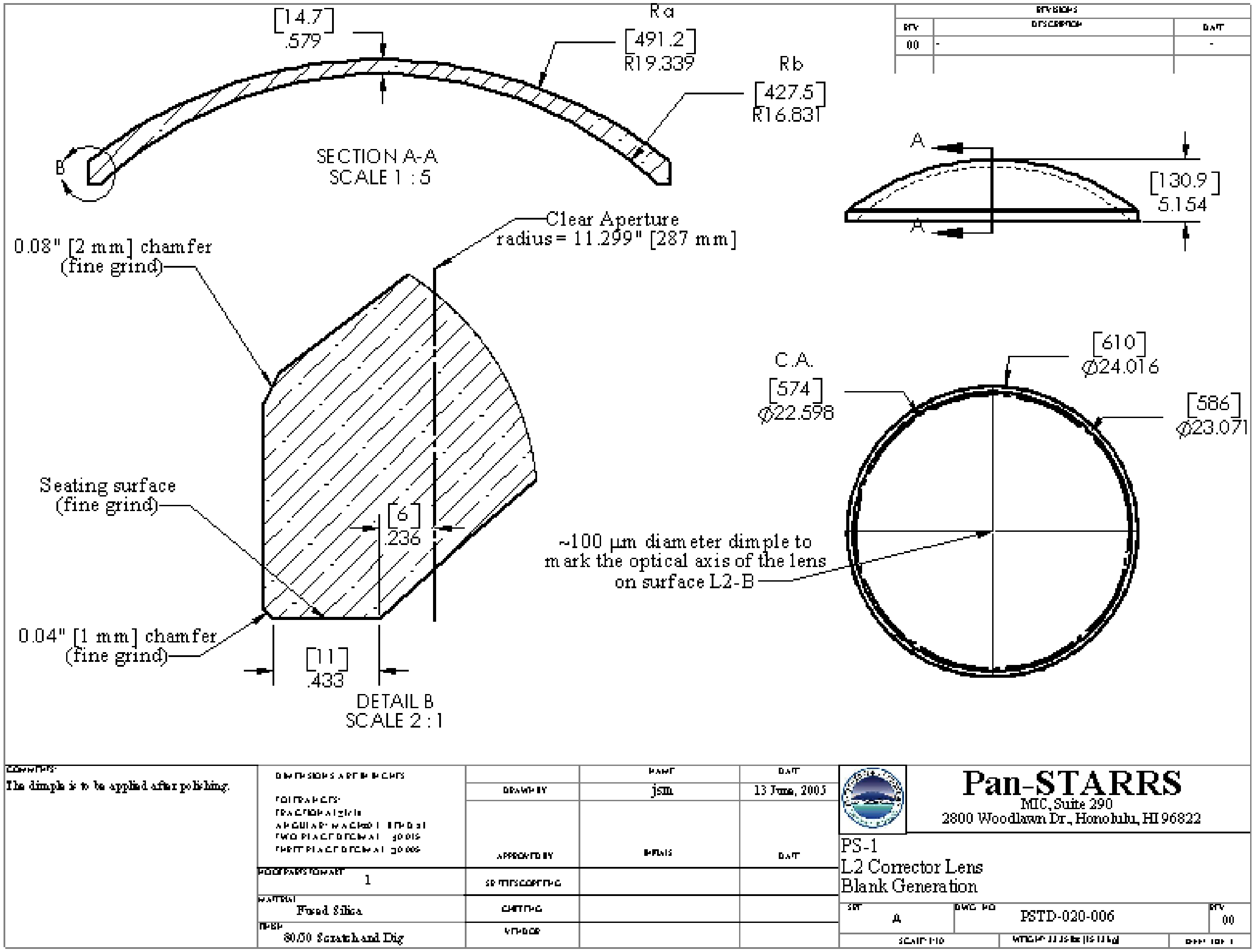

Figure 3. The mechanical drawing of the L2 corrector.

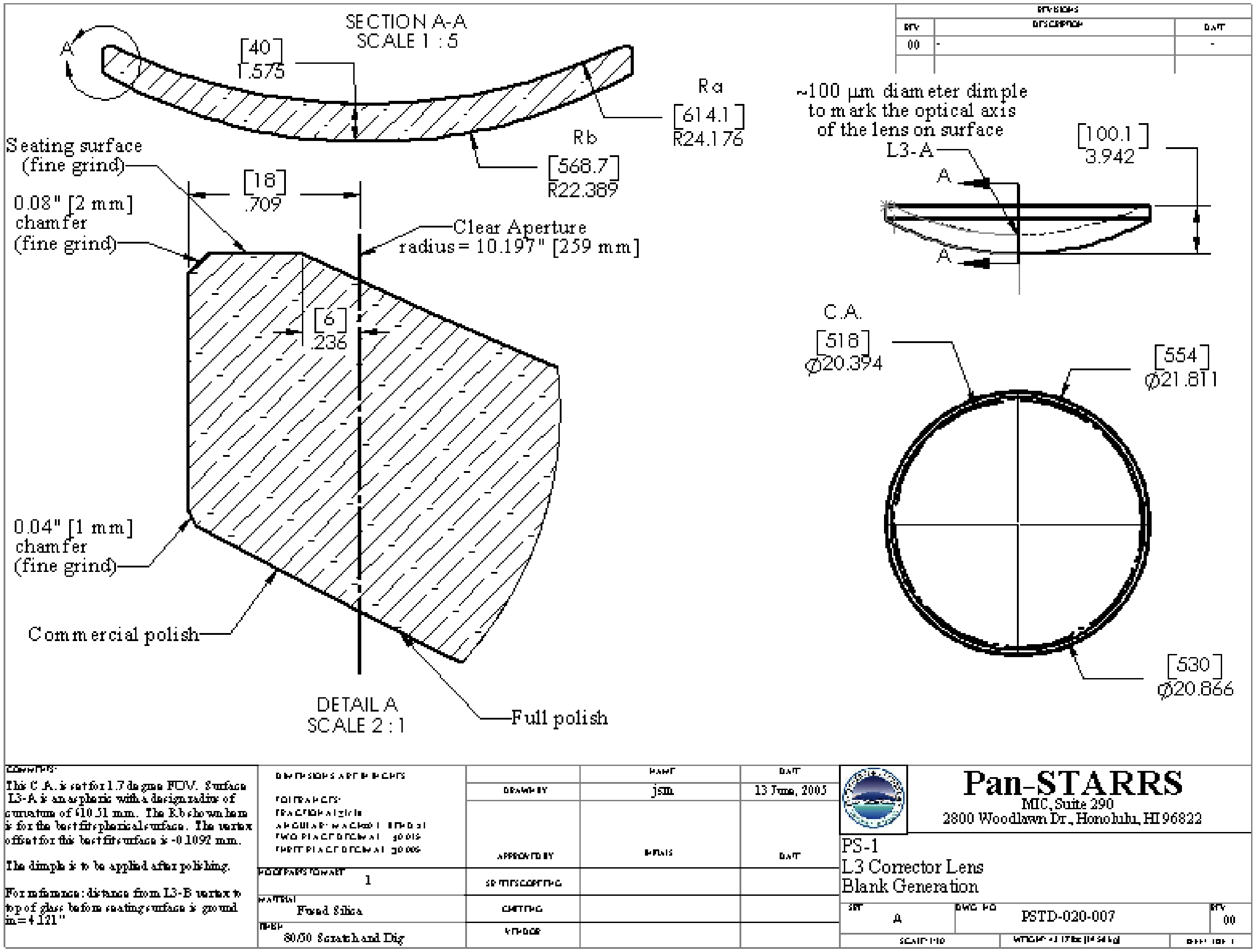

Figure 4. The mechanical drawing of the L3 corrector.