



October 9, 2009

Technical Specifications for the
Advanced Rayleigh Ground layer adaptive Optics System (ARGOS)
Large Aspheric Lens

The *Advanced Rayleigh Ground layer adaptive Optics System (ARGOS)* is a laser-based instrument that will mount directly on one of the wind-bracing platforms of the *Large Binocular Telescope (LBT)*. Two identical systems will be built: one for each of the 8.4m primary ‘eyes’. The ARGOS instrument requires the procurement of two (2) large aspheric lenses.

The large aspheric lens is the final powered optic for the *Laser Launch Telescope (LLT)*. Its purpose is to focus the three (3) high-powered 532 nm laser beams to a height of 12 km into the atmosphere, thus generating bright guide stars. The telescope will use these guide stars for alignment and atmospheric wavefront correction. The lens will require tight tolerances on the surface quality, roughness, and surface wavefront error based on high laser power per unit area at the lens surfaces and optical constraints of the focused laser spot. The lens is convex-plano in shape, with a relatively small aspheric (hyperbolic) departure. The physical specifications are as follows: $R_1 = 3905.1 \text{ mm} +1.0 / -0.5$, $R_2 = \text{Infinity}$; $k_1 = -2.14 +0.2 / -0.4$, $k_2 = 0$; 450 mm \pm 1.0 diameter; 400 mm clear aperture; and 50.8 mm \pm 0.25 center thickness.

SCOPE OF WORK:

Vendor will provide lens blanks. The substrate material is a Corning High Purity Fused Silica (HPFS). Given the laser power requirements, the substrate must have low index homogeneity and low bubble inclusions. Homogeneity should be less than 1 ppm, Grade A. Inclusions should be smaller than 0.10 mm² per 100 cm³ and have a maximum diameter of 0.25 mm, Class 1. Vendor must provide copy of material certifications to the University prior to polishing.

Surface 1, the convex aspheric surface, should have $< \lambda/10$ PTV surface error over 98% of the clear aperture (392 mm) and $< \lambda/40$ RMS surface error over 100% of the clear aperture (400 mm) at $\lambda = 632.8$ nm. Surface 2, the plano surface, should have $< \lambda/5$ PTV surface error over 98% of the clear aperture (392 mm) and $< \lambda/20$ RMS surface error over 100% of the clear aperture (400 mm) at $\lambda = 632.8$ nm.

The surface quality should be better than 60-40 across the entire clear aperture. The micro-roughness post-polish should be less than 15 Angstroms. All edges of the lens should have a 1.5 mm bevel at 45 degrees. This corresponds to a 2.12 mm face width on the bevel. The vendor is asked to polish both bevels and the outside edge of the lens to an inspection level polish (SQ of 80-50 with roughness of < 50 nm).

The vendor shall provide an anti-reflection coating on both surfaces of the lenses. The coating should have a reflectance of less than 0.1% at 532 and 589 nm. A test run with a witness sample confirming the reflectance spec is required before the actual lens coating run.

The vendor shall demonstrate that the lenses meet these specifications using their test setup. They will provide 9 to 10 meters of horizontal test space for a secondary full-system test setup provided by the University of Arizona. If the lenses do not meet spec via vendor tests, they will be re-figured at no charge. The vendor shall deliver the lenses on or before TBD (9 months).



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	Large Aspheric Lens (LAL)
Description (qualitative)	On-axis, convex-plano, aspheric lens [surface 1 (S₁) is aspheric, surface 2 (S₂) is plano]
Substrate Material	Corning HPFS, Grade A, Class 1
- HPFS	High Purity Fused Silica
- Homogeneity Grade A	≤ 1 ppm
- Inclusion Class 1	≤ 0.10 mm²/ total cross section, 0.28 mm max size
- Index Uncertainty	≤ 20 ppm/K @ 532 nm
Diameter [mm]	450.0 ± 1.0
Clear Aperture [mm]	400.0 (88.9%)
Center Thickness [mm]	50.80 ± 0.25
Radius R₁ [mm]	3905.1 + 1.0 / - 0.5
Radius R₂ [mm]	Infinity (plano)
Conic Constant k₁	-2.14 + 0.20 / - 0.40
Conic Constant k₂	-
PTV Surface Error for S₁ over 98% of Clear Aperture (392 mm) @ 632.8nm	< λ/10
RMS Surface Error for S₁ over 100% of Clear Aperture (400 mm) @ 632.8nm	< λ/40
PTV Surface Error for S₂ over 98% of Clear Aperture (392 mm) @ 632.8nm	< λ/5
RMS Surface Error for S₂ over 100% of Clear Aperture (400 mm) @ 632.8nm	< λ/20
Wedge over full Diameter [arcsec]	< 36 (0.01°)
RMS Surface Micro-roughness [nm]	< 1.5
Surface Quality (scratch/dig)	60–40
Total Indicated Runout (TIR) [mm]	0.1
Concentricity of optical axis to mechanical axis [mm]	< 0.25
Bevel	1.5 mm x 45°, (2.12mm face width), polish (SQ of 80-50, roughness of < 50 nm)
Edge Surface	polish (SQ of 80-50, roughness of < 50 nm)
Anti-reflection coating @ 532 & 589 nm	< 0.1%
Delivery Date [9 months ARO]	August 2010

Table 1: Lens Specification Summary