



# LINC-NIRVANA Warm Optics

## Technical Specifications

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### 1. Introduction

LINC-NIRVANA is an adaptive interferometer for astronomy built for Large Binocular Telescope sited in Arizona, USA. The warm optics of LINC-NIRVANA includes two identical collimators and two identical F20 cameras.

The collimator changes the light from the telescope into collimated beam. It has focal length  $f_{\text{col}} = 1923.545\text{mm}@0.8\mu$ , focal ratio  $F_{\text{col}} = 15.27$ , field of view  $\text{FoV}_{\text{col}} = 2.2^\circ$  and wavelength range  $0.6\mu$  to  $2.4\mu$ .

A dichroic plate following the collimator reflects the light from wavelength  $0.6\mu$  to  $0.9\mu$  to the F20 camera. The beam at the reimaged focal plane is telecentric.

### 2. Optical prescription data

The collimator consists of two lens groups, each group includes three air-spaced lenses. The F20 camera consists of 4 lenses. The prescription data is given in Table 1.

The surface curvatures will be finally test plate fitted based upon the manufacture's test plate list.

### 3. Specifications for lens manufacture

(1) The surface tolerances are given in Table 2.

(2) Micro roughness: 2nm

(3) Scratch / Dig: CaF2 lenses 40-20, others 20-10.

(4) Thickness tolerance: + / - 0.05mm.

(5) Bevels:  $45^\circ \times 1.0\text{mm}$

(6) Anti-reflection coating:

Col\_1 – Col\_6, wavelength range  $0.6 \mu\text{m} \sim 2.4\mu\text{m}$ , surface reflection  $< 1.5\%$ ;

Cam\_1 – Cam\_4, wavelength range  $0.6 \sim 0.9\mu\text{m}$ , surface reflection  $< 1.0\%$ .

(7) All the glass blanks will be provided by Max Planck Institute for Astronomy, Heidelberg, Germany.



Comment	Radius	Thickness	Glass	Free Aperture	Diameter
OBJ	Infinity	681.043		73.8	
Col_1	1466.417 794.4216	12 3.039	Infrasil301	124.0 124.3	134.3 134.3
Col_2	811.9156 -991.2119	13 4.004	CAF2	124.6 124.8	134.8 134.8
Col_3	-813.3631 -1003.209	10 1826.814	IRG2_22760	124.8 125.4	135.4 135.4
Col_4	2847.622 1314.224	13 16.331	Infrasil301	141.7 141.6	151.7 151.7
Col_5	1241.466 -1369.727	14 3.090	CAF2	142.1 142.0	152.1 152.1
Col_6	-851.3132 -987.5413	10 375.092	IRG2_22130	141.9 142.4	152.4 152.4
PUPIL	Infinity	100		126.0	
Cam_1	896.8284 -746.6842	14 52.558	S-FPL51	131.9 131.7	141.9 141.9
Cam_2	-720.0222 -5829.229	12 1880.41	S-LAL61	125.4 125.5	135.5 135.5
Cam_3	-248.1815 -266.6762	12 302.761	S-LAL61	108.8 111.0	121.0 121.0
Cam_4	-1282.929 -550.2228	11 300	S-FPL51	113.5 113.8	123.8 123.8
IMA	Infinity			96.6	

Table 1. The prescription data of the collimator and F20 camera. All dimensions are in millimeters.

Name	Material	Tolerance on Surface		
		r / irreg.(fringe)	decenter(mm)	tilt (ETV mm)
<b>Collimator</b>				
col_1	Infrasil 301	1 / 0.4	0.03	0.015
col_2	CaF2	1 / 0.4	0.03	0.015
col_3	IRG2_22760	1 / 0.4	0.03	0.01
col_4	Infrasil 301	1 / 0.4	0.03	0.02
col_5	CaF2	1 / 0.4	0.03	0.02
col_6	IRG2_22130	1 / 0.2	0.03	0.02
<b>F20 camera</b>				
cam_1	S-FPL51	1 / 0.2	0.03	0.02
cam_2	S-LAL61	1 / 0.2	0.03	0.02
cam_3	S-LAL61	1 / 0.4	0.02	0.01
cam_4	S-FPL51	1 / 0.4	0.03	0.01

Table 2. Surface tolerances. Test wavelength 0.6328 $\mu$ m.



#### 4. Specifications for lens mount

The tolerance on decenter of each lens is +/- 0.02mm, on tilt is +/- 0.0083°. The distance between two lenses should be within 0.05mm accuracy. These specifications must be met over a temperature range from -15°C to +25°C (working temperature) and for all pointing positions of the telescope (gravity vector changes between -30° and +30°). The storage temperature range is from -30°C to 50°C, the humidity 5% ~ 95%.

The collimator consists of two separate lens groups: Col\_1\_2\_3, Col\_4\_5\_6. The camera lenses Cam\_1 and Cam\_2 should also be mounted into one unit. Cam\_3, Cam\_4 are individually mounted. Special care needs to be made for the mount of lens groups because the optical materials have very different thermal expansion coefficients (see Table 3).

	Infrasil 301	CaF2	IRG2	S-FPL51	S-LAL61
TCE (10 <sup>-6</sup> / K)	0.51	16.7	7.75	13.3	5.7

Table 3. Expansion coefficients of the optical materials.

Each mount unit should be adjustable in 3 dimensions. The range and accuracy is given in Table 4. The center of tilt is on the optical axis, roughly in the middle between the first and last optical surface.

	Decenter and axial (mm)	tilt (°)
Range	+/- 2	2
Accuracy	0.02	0.0083

Table 4. Specifications for unit adjustment.

There is no dimension restraint on the appearance of the assemblies Col\_1\_2\_3, Cam\_3 and Cam\_4.

Fig.1 is a mount sketch for Col\_4\_5\_6. This design allows the lens group tilt on a spherical surface by 3 or 4 fine adjustment screws. The physical size of the assembly Col\_4\_5\_6 shouldn't exceed the dimensions indicated in Fig.1.

The mount of the assembly Cam\_1\_2 shouldn't extend outwards more than 22.6mm from the vertex of the first optical surface (R 896.8284). The layout should be as compact as possible.

#### 5. Test and acceptance

- (1) All the specifications for lens manufacture and mount should be met.



- (2) All physical parameters of the lens (diameter, central thickness, wedge and centering) should be measured.
- (3) The radii of curvature should be measured with the accuracy better than 0.05%. The optical surface figure should be measured by the interferometer. The related certificate should be provided to MPIA.
- (4) The coating efficiency should be measured on witness samples.
- (5) The drawings of the mount interface should be supplied to MPIA before manufacturing for approval. The drawings with the exact dimensions of the assembly should be delivered. The manufacturer should also prove that the mount tolerances are met at required working environment.

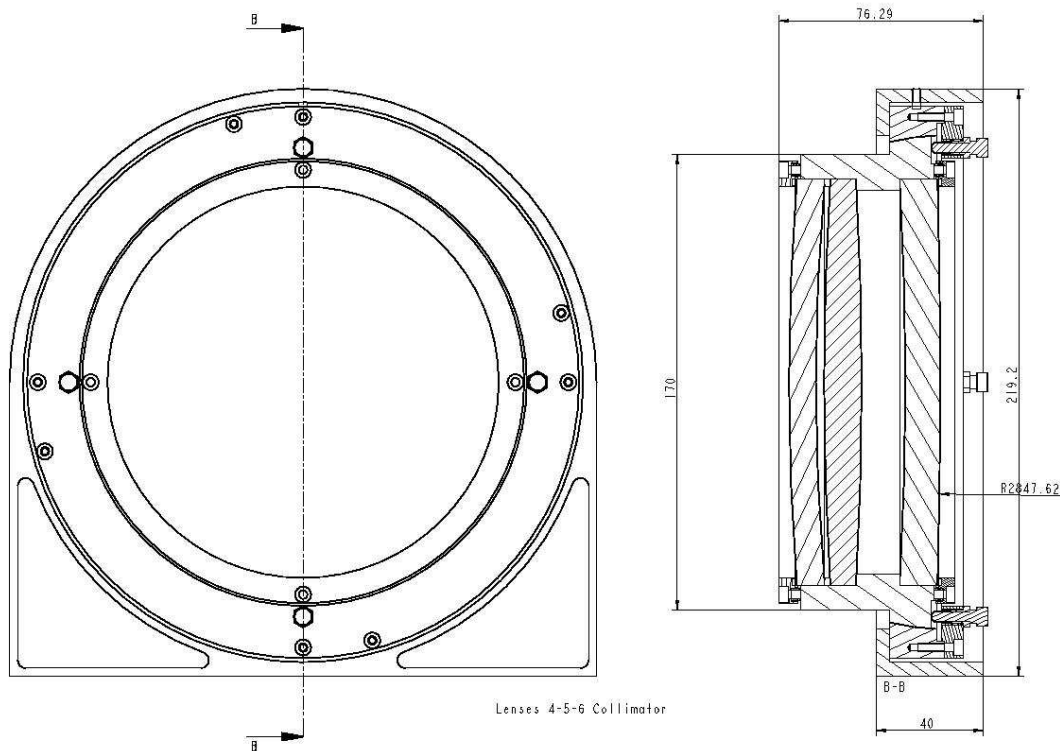


Fig.1 The mount sketch of Col\_4\_5\_6. The dimensions indicated shouldn't be exceeded.