Large Binocular Telescope

ARGOS

Advanced Rayleigh Ground layer adaptive Optics System

Dichroic Specifications

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TABLE OF CONTENTS

1 Scope 4
2 Applicable documents 4
3 Introduction 5
4 Product and Quantities 5
5 Substrate specifications 6
5.1 Geometry and material 6
5.2 Optical quality in reflection (First Surface - S1, flat) 6
5.3 Optical quality in transmission (single-pass) 7
5.4 Other specifications 7
6 Coating specifications 10
7 Environment specifications 11
8 Shipping and Delivery 12
9 Contacts 13
Appendix A - List of acronyms 14

LIST OF FIGURES

Figure 1: Geometry of the optical component to be manufactured (drawing not in scale). The gray surface corresponds to the optical area, the 10mm blank edge is needed by the mount system. The double arrow in centre shows the direction of polarization of the laser light. 8
Figure 2: Horizontal cut of the two optical windows to be manufactured (drawing not in scale). 8
Figure 3: Top: footprint of the three LGS beams on dichroic S1. The NGS footprints at the edge of the scientific FoV are also reported. Bottom: footprint of the NGS only on dichroic S2. The beams are shifted by 20mm in y direction. 9

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1 Scope

The document defines the specifications of the dichroic, which reflects the laser light to the laser wavefront sensor and transmits the remaining light to the instrument focus.

2 Applicable documents

No. Title	Number & Issue
AD 1	
AD 2	
AD 3	

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3 Introduction

ARGOS is the Ground Layer Adaptive Optics System for the Large Binocular Telescope, which is built in German-Italian-US collaboration. The Max-Planck-Institute für Astronomie (MPIA) in Heidelberg and the INAF-Osservatorio Astrofisico di Arcetri (OAA) in Florence are the responsible institutes to procure the optical elements as specified in this document.
The requested optical elements are needed to transmit the science light (600-2450nm) toward the telescope instrumentation and to reflect the polarized laser light (532 and 589nm) to the ARGOS wavefront sensors. The particular geometry of the telescope requests to polish two symmetric optical elements, as shown later in Figure 1and Figure 2.
We are aiming on a procurement of the units, including coating, within one contract. But we see the Challenge and encourage offers either for procurement of the optics only, including reusable shipping box and delivery to a coating facility, or for coating only, including delivery to the destination of optomechanical integration in Valmadrera (LC) - ITALY. Therefore, we request from companies giving a combined order to separate substrate processing and coating.

4 Product and Quantities

The following items are matter of procurement:

Item	***Quantity***	***Description***
001	**2**	Glass blanks
002	**2**	Processing of substrate according to specifications (the geometry is mirrored)
003	**1**	Set of documentation for substrates
004	**2**	Boxes for storage and transportation
005	**2**	Processing of coating
006	**1**	Set of documentation for coating

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5 Substrate specifications

5.1 Geometry and material

Req. ID	*Requirement description*	*Specification*
REQ01	**Material**	INFRASIL 302
REQ02	**Shape**	Elliptical: 300x400mm (see Figure 1)
REQ03	**Optical Area**	Elliptical: 290x390mm (centered with outer edge, see Figure 2)
REQ04	**Central Thickness**	(40±0.5) mm (see Figure 2)
REQ05	**Wedge angle**	(0.56±0.02)° (see Figure 2)
REQ06	**Wedge direction**	along major axis (see Figure 2)
	First Surface (S1)	
REQ07	**Surface shape**	Flat
	Second Surface (S2)	
REQ08	**Surface shape**	Concave Cylindrical
REQ09	**Radius of Curvature (RoC)**	(230±20)m
REQ10	**Cylinder axis Direction**	along minor axis (see Figure 2)

5.2 Optical quality in reflection (First Surface - S1, flat)

Req. ID	*Requirement description*	*Specification*	
		baseline	***Goal***
REQ11	**Average surface tilt on any circular patch of 13mm diameter in the optical area (global tilt on the full optical area removed)**	≤26 nm/mm	≤15 nm/mm
REQ12	**Surface error on any circular patch of 13mm diam. (tilt rem.) in the optical area**	≤50 nm rms	≤30 nm rms

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5.3 Optical quality in transmission (single-pass)

Req. ID	*Requirement description*	*Specification*	
		baseline	***Goal***
REQ13	**Wavefront error on any circular patch of 85mm diameter (tilt+cylinder removed) in the optical area. Only the cylinder aberration (particular combination of focus and astigmatism) having RoC and direction as stated in REC09 and REQ10 is allowed to be removed for checking the present requirement**	≤48 nm rms WFE	≤30 nm rms WFE
REQ14	**Low order aberrations: sum of first 21 fitted Zernike-Noll polynomials over full optical area. Maximum derivative of fitted wavefront (global tilt+cylinder removed). Only the cylinder aberration (particular combination of focus and astigmatism) having RoC and direction as stated in REC09 and REQ10 is allowed to be removed for checking the present requirement**	≤9 nm/mm	≤4 nm/mm

5.4 Other specifications

Req. ID	*Requirement description*	*Specification*	
		baseline	***goal***
REQ15	**Scratches and digs (S1)**	DIN 3140 part 7 5/6x0.4; K2x0.025	
REQ16	**Micro-Roughness (S1)**	<2 nm rms	<1 nm rms
REQ17	**Scratches and digs (S2)**	DIN 3140 part 7 5/6x0.4; K2x0.025	
REQ18	**Micro-Roughness (S2)**	<2 nm rms	<1 nm rms

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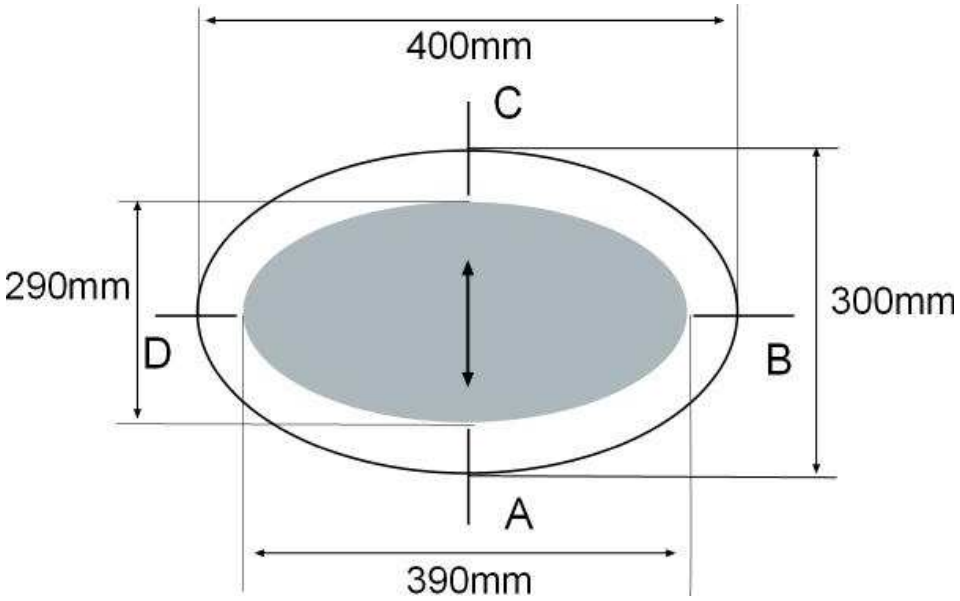

Figure 1: Geometry of the optical component to be manufactured (drawing not in scale). The gray surface corresponds to the optical area, the 10mm blank edge is needed by the mount system. The double arrow in centre shows the direction of polarization of the laser light.

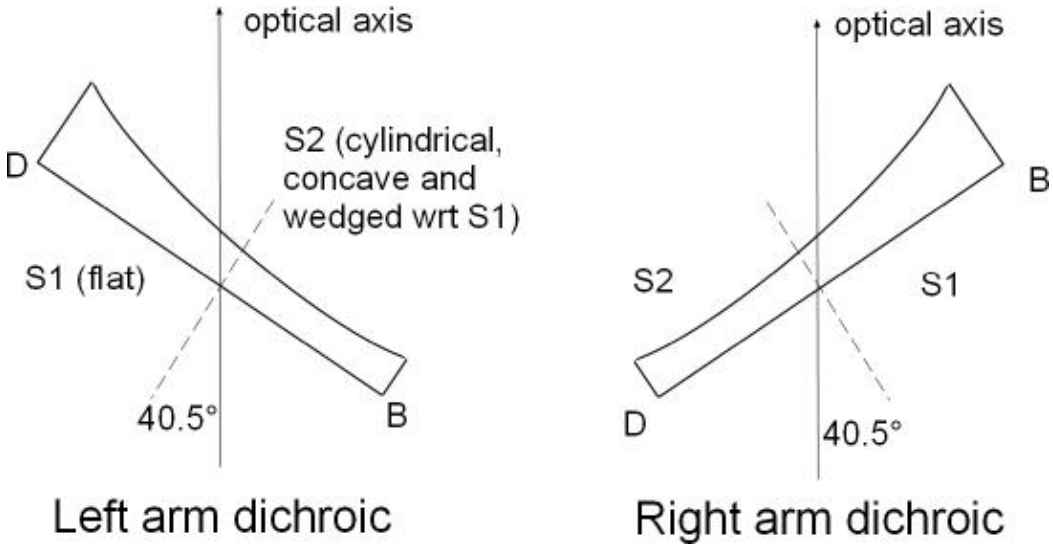

Figure 2: Horizontal cut of the two optical windows to be manufactured (drawing not in scale).

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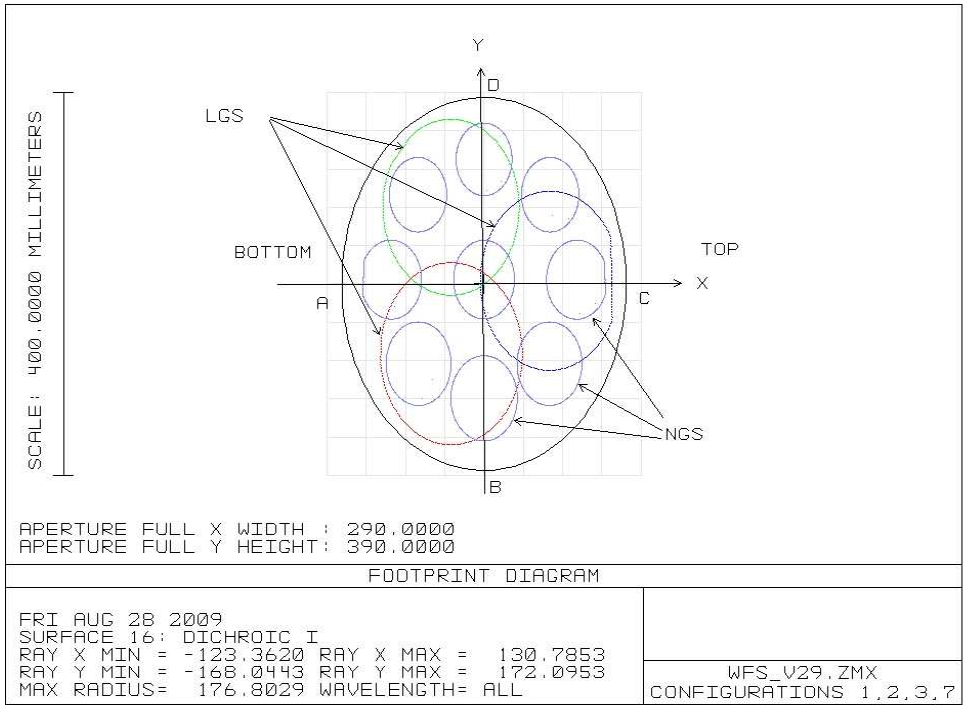

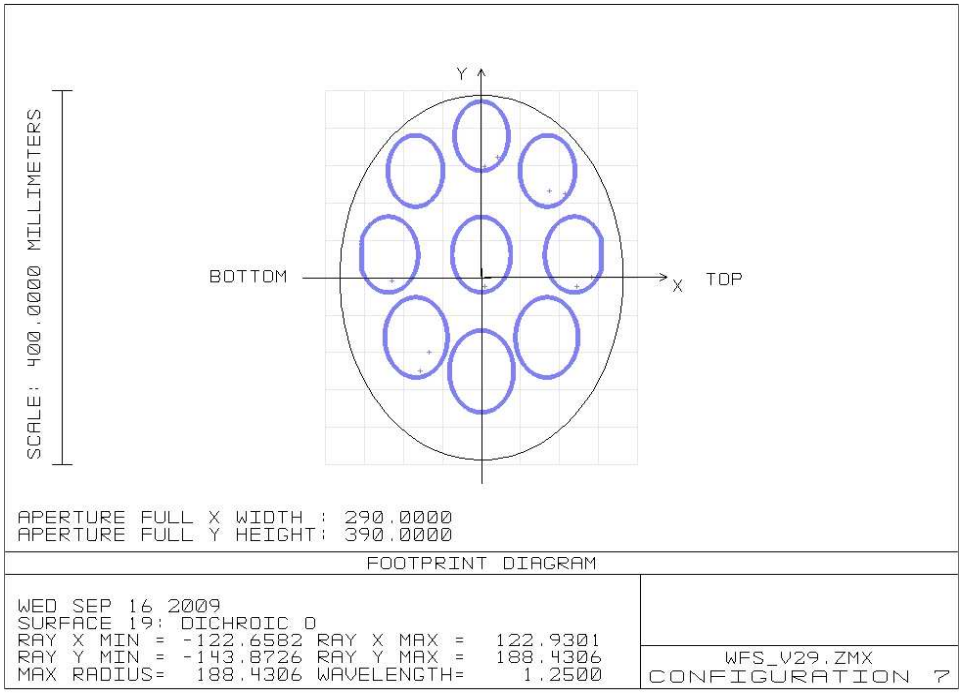

Figure 3: Top: footprint of the three LGS beams on dichroic S1. The NGS footprints at the edge of the scientific FoV are also reported. Bottom: footprint of the NGS only on dichroic S2. The beams are shifted by 20mm in y direction.

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6 Coating specifications

Req. ID	*Requirement description*	*Specification*	
	First Surface (S1)	***baseline***	***goal***
REQ19	**Reflected wavelengths**	<600nm (optimized for 532 and 589nm)	
REQ20	**Reflectivity at 532 and 589nm**	>90%	>95%
REQ21	**Transmission in 600-1000nm range**	>90%	>95%
REQ22	**Transmission in 1000-2000nm range**	>95%	>97%
REQ23	**Transmission in 2000-2450nm range**	>98%	>99%
REQ24	**Reflectivity in 2000-2450nm range (to avoid dome thermal background reflection to instrumentation)**	<2%	<1%
REQ25	**Coating defects area**	$<3mm^2$	$<1mm^2$
REQ26	**Coating defects number on optical area**	<20	<7
	Second Surface (S2)	***baseline***	***goal***
REQ27	**Transmission in 600-1000nm range**	>90%	>95%
REQ28	**Transmission in 1000-2000nm range**	>95%	>97%
REQ29	**Transmission in 2000-2450nm range**	>98%	>99%
REQ30	**Reflectivity in 2000-2450nm range (to avoid dome thermal background reflection to instrumentation)**	<2%	<1%

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7 Environment specifications

Req. ID	*Requirement description*	*Specification*
REQ31	**Storage temperature range**	-30 to 80°C
REQ32	**Working temperature range**	-20 to 25°C
REQ33	**Humidity**	up to 95%
REQ34	**Pressure**	650 to 1300mb
REQ35	**Operation angle**	40.5° wrt the normal to S1 (see Figure 2)

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8 Shipping and Delivery

The following points shall be considered during the manufacturing and delivery process:

- Review of final manufacturing drawings and the coating design by OAA

Req. ID	*Requirement description*	*Specification*
REQ36	**Packing and shipping**	a. Quote including packing and shipping into a coating protecting box out of plastic. b. No wooden boxes allowed. c. The items shall be packed in clean and sealed plastic bags, filled with dry nitrogen or shrink wrapped. d. All documentation shall be supplied in hardcopy with delivery and in electronic form (Word or PDF) in advance of delivery.
REQ37	**Delivery Time**	Estimate the delivery time at receipt of order
REQ38	**Acceptance**	All specifications must be met. Various specifications cannot be traded.
REQ39	**Delivery Destination**	ADS Via Roma, 87 – 23868 Valmadrera
REQ40	**Number of units**	TWO UNITS (see Figure 2)

Payment plan:

- 20% at receipt of glass blank(s)
- Any payment at order needs a bank guarantee.
- Balance after check of agreed specifications within 30 days (from receiving of goods).
- All payments by bank transfer within 30 days (from receiving of goods).

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9 Contacts

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Appendix A - List of acronyms

AGN	Active Galactic Nuclei
AGW	Acquisition Guiding and Wavefront sensing
AIA	Automated Imaging Association
AIP	Astrophysical Institute Potsdam
AIT	Assembly, Integration and Testing
AIV	Assembly, Integration and Verification
ALFA	Adaptive optics with a Laser For Astronomy
AOA	Adaptive Optics Arbitrator
AOS	Adaptive Optics System
APD	Avalanche Photo Diode
ARIES	Arizona infraRed Imager and Echelle Spectrograph
ASM	Adaptive Secondary Mirror
BCU	Basic Computational Unit
BH	Black Hole
BLINC	Bracewell Infrared Nulling Cryostat
CAAO	Center for Astronomical Adaptive Optics
CAHA	Centro Astronómico Hispano Alemán
CAOS	Code for Adaptive Optics Systems
CCD	Charged Coupled Device
CONICA	COudé Near Infrared CAmera
CSW	Common SoftWare
CUS	Calibration Unit Software
CW	Contiunious Wave
DIMM	Differantial Image Motion
DIQ	Delivered Image Quality
DM	Deformable Mirror
DMD	Deformable Mirror Diagnostics
DSP	Digital Signal Processor
ECSS	European Coorperation on Space Standardization
E-ELT	European - Extremely Large Telescope
EMCCD	Electron Multiplied CCD
ESO	European Southern Observatory
FAA	Federal Aviation Administration
FLAO	First Light Adaptive Optics
FOROT	Forecast Optical Turbulence
FOV	Field of View
FPGA	Field Programalbe Gate Array
FTE	Full Time Equivalent
FWHM	Full Width Half Maximum
GLAO	Ground Layer Adaptive Optics
GLAS	Ground layer Laser Adaptive optics System
GS	Guide Star
GSAOI	Gemini South Adaptive Optics Imager
HLL	HalbLeiterLabor
HST	Hubble Space Telescope
HVR	High Vertical Resolution
ICD	Interface Control Document
IDL	Interactive Data Language
IEC	International Electrotechnical Commission
IIF	Instrument InterFace
ILT	Instrument Level Test
IMF	Initial Mass Function

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INAF	Istituto Nazionale di Astrofisica
ING	Isaac Newton Group
IPC	Inter Process Communication
IR	InfraRed
IRCAL	IR Camera for Adaptive optics at Lick
ISAAC	Infrared Spectrometer And Array Camera
LBC	LBT Camera
LBT	Large Binocular Telescope
LBTB	LBT Beteiligungsgesellschaft
LBTC	Large Binocular Telescope Corporation
LBTI	LBT Interferometer
LBTO	LBT Observatory
LCSW	LGS Common SoftWare+B112
LCU	Local Computational Unit
LGS	Laser Guide Star
LGSF	LGS Facility
LGSW	LGS Wavefront Sensor
LINC	LBT Interferometric beam Combiner
LL	Laser Launch
LLNL	Lawrence Livermore National Laboratory
LLS	Laser Launch System
LLT	Laser Launch Telescope
LMC	Large Magellanic Cloude
LSW	LandesSternWarte
LUCIFER	LBT Near Infrared Spectroscopic Utility with Camera and Integral Field Unit for Extragalactic Research
MAD	Multi conjugated Adaptive optics Demonstrator
MAIT	Manufacturing, Assembly, Integration and Testing
MCAO	Multi Conjugated Adaptive Optics
MIRAC	Mid-Infrared Array Camera for Astronomy
MIT	Massachusetts Institute of Technology
MMT	Multi Mirror Telescope
MODS	Multi-Object Double Spectrograph
MOU	Memorandum of Understanding
MPE	Max-Planck Institute for Extraterrestric
MPG	Max-Planck Gesellschaft
MPI	Max-Planck Institute
MPIA	Max-Planck Intitute for Astronomy
NACO	NAOS CONICA
NAOS	Nasmyth Adaptive Optics System
NGS	Natural Guide Star
NICMOS	Near Infrared Camera and Multi-Object Spectrometer
NIF	
NIFS	Near-Infrared Integral-Field Spectrograph
NIR	Near InfraRed
NIRI	Near InfraRed Imager
NIRSPEC	Near Infrared Spectrograph
NIRVANA	Near-IR / Visible Adaptive INterferometer for Astronomy.
NOAO	National Optical Astronomy Observatory
OSIRIS	OH-Suppressing InfraRed Imaging Spectrograph
PA	Product Assurance
PAH	Polycyclic Aromatic Hydrocarbons
PCI	Peripheral Component Interconnect
PHL	Preliminary Hazard List
PID	Proportional, Integral and Differential
pnCCD	
PO	Project Office

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PSF	Point Spread Function
PW	Pulsed Wave
PXI	PCI eXtensions for Instrumentation
QA	Quality Assurance
QSO	Quasi Stellar Object
RCO	Radiation Control Office
RLGS	Rayleigh Laser Guide Star
RMS	Root Mean Square
RON	Read Out Noise
RPC	Remote Procedure Call
RTC	Real Time Control
SAM	SOAR Adaptive Module
SCAO	Single Conjugated Adaptive Optics
SCIDAR	SCIntillation Detection And Ranging
SDSS	Sloan Digital Sky Survey
SDT	Science Demonstration Time
SFR	Star Formation Rate
SH	Shack Hartmann
SINFONI	Spectrograph for INtegral Field Observations in the Near Infrared
SMBH	Super Massive Black Hole
SMT	Sub Millimeter Telescope
SNR	Signal to Noise Ratio
SOAR	Southern Astrophysical Research
SOR	Starfire Optical Range
SR	Strehl Ratio
STIS	Space Telescope Imaging Spectrograph
STScI	Space Telescope Science Institute
SVD	Single Value Decomposition
TBC	To Be Confirmed
TBD	To Be Defined
TCS	Telescope Control Software
TMT	Thiry Meter Telescope
TRE	Test Review Europe
TT	Tip Tilt
TTW	Tip Tilt Wavefront sensor
UA	University of Arizona
UKIDSS	United Kingdom Infrared Deep Sky Survey
UMAC	Universal Motion and Automation Controller
UNISIS	University of Illinois Seeing Improvement System.
VATT	Vatican Advanced Technology Telescope
VLT	Very Large Telescope
WDHS	Wavefront Data Handling
WFS	WaveFront Sensor
WHT	William Herschel Telescope
WIYN	Wisconsin Indiana Yale & NOAO

End of document

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