Specifications for the procurement of collimators

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DOCUMENT HISTORY

Issue	Date	ECN	Change Description
Version 1.0	14th Dec 2016	All	First version
Version 1.1	28th Mar 2017	Sect. 4.2 & 5.3	Surface figure defined on clear aperture
Version 1.2	4th May 2017	All	Consortium logos on front page reformatted. Minor updates to text. Added sub-section summarising the deliverables. Organised the specifications into numbered lists for easier cross-referencing.
Version 2.0	5th May 2017	All	Specification released.
Version 2.1	5th May 2017	Table 3	Updated material specification and deleted reference document 3.
Version 2.2	12th May 2017		Removed reference documents RD1 and RD2 as they are not needed for the procurement activity. Updated Figure 2. Changed text in section 5.2.

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LIST OF ACRONYMS AND ABBREVIATIONS

A	Fraction of light absorbed by a given optical surface
AIV	Assembly, Integration and Verification
A/R	Anti-Reflection
CAD	Computer Aided Design
CGH	Computer Generated Hologram
COTS	Commercial Off-The-Shelf
CTE	Coefficient of Thermal Expansion
FDR	Final Design Review
ICD	Interface Control Document
MOONS	Multi Objects Optical and Near Infrared Spectrograph
MTTR	Mean-Time-To-Repair
PA	Product Assurance
PDR	Preliminary Design Review
ppm	Parts per million
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Control
R	Fraction of light reflected by a given optical surface
RMS	Root Mean Square
T	Fraction of light transmitted through a given optical surface
TBC	To be confirmed
TBD	To be decided

1 INTRODUCTION

1.1 Purpose and scope of Document

MOONS (acronym for Multi-Objects Optical and Near-infrared Spectrograph) is a new concept for an astronomical spectrograph for the European Southern Observatory's Very Large Telescope (VLT). It has been selected by the European Southern Observatory (ESO) in response to a call for proposals for the study of new instruments. The project was officially approved by ESO; the preliminary and final design phases of the optics were successfully completed. This document describes and specifies the parameters of the collimator mirrors. It also describes the acceptance tests that the manufacturer must fulfill prior to delivering the collimator mirrors.

1.2 Intended Audience

This specification document defines the parameters and the acceptance tests necessary for the procurement of the collimators. It is the reference document for the commercial contract that will be signed with the manufacturing company. The main audience consists of the manufacturing company and the persons of the MOONS consortium in charge of the specific task.

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

The following documents at their indicated revision form part of this document to the extent specified herein.

Table 1 Applicable Documents

Ref No	Document/Drawing Number	Document Title	Issue Number
AD1			
AD2			

2.2 Reference Documents

The following documents provide useful reference information associated with this document. These documents are to be used for information only. Changes to the date and/or revision number do not make this document out of date.

Table 2 Reference Documents

Ref No	Document/Drawing Number	Document Title	Issue Number and date

3 DESCRIPTION OF THE COLLIMATOR

This section gives a brief description of the MOONS instrument and of the collimator mirrors.

3.1 Overall description of the MOONS spectrograph

The MOONS project foresees the construction of two identical, cryogenic spectrographs fed by optical fibres. Therefore, we need two items for all the sub-systems and components listed below. The layout of one spectrograph is shown in Figure 1 . The optics can be conveniently divided into the following sub-systems:

- **Fibres, dichroics, dispersers, H, YJ, RI cameras;** not pertinent to this document.
- **Collimator;** the subject of this document. It consists of a spherical mirror and is used to create a collimated beam. It operates over the wavelength range from 640nm to 1800nm.

All the optical elements will be mounted on an optical bench inside a vacuum tank, cooled to cryogenic temperatures (about 120K).

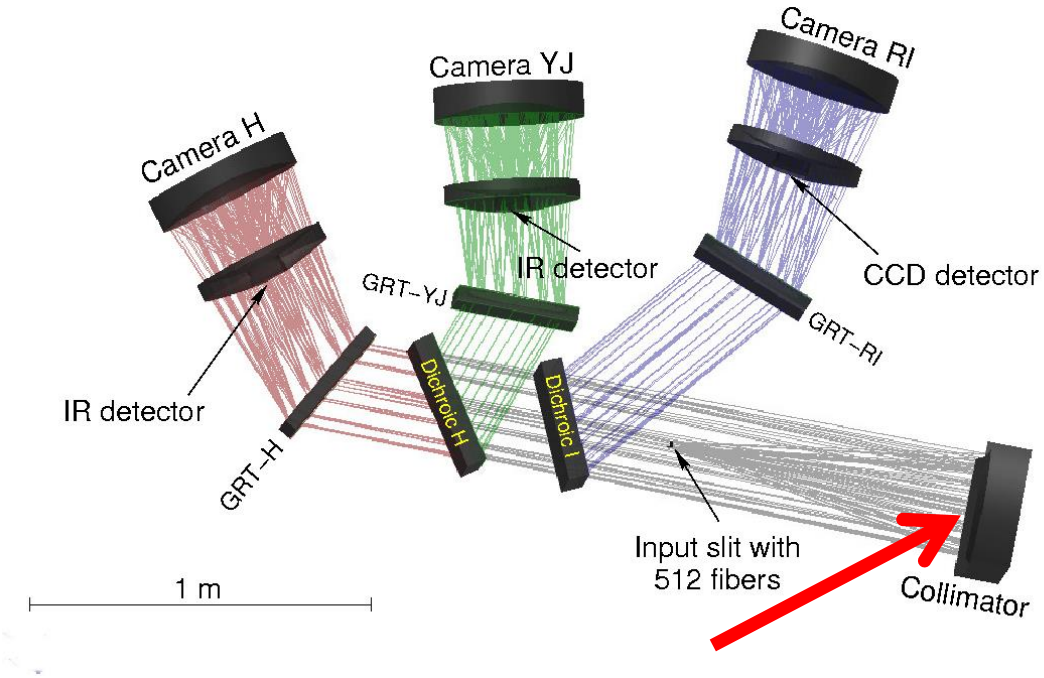

Figure 1 Optical layout of the MOONS spectrograph, the collimator mirror is indicated by the red arrow.

4 MANUFACTURING SPECIFICATIONS

This section summarizes all the parameters of the optical elements of the collimators. We need two collimators (order quantity is 2-off).

4.1 General specifications

All the dimensions are in mm at room temperature, unless otherwise specified. The main environmental specifications are as follows:

1. Operational temperature 120 K
2. Operational pressure $<10^{-6}$ mbar
3. Minimum temperature during tests 70 K
4. Storage/handling temperature -10 ^{o}C to +60 ^{o}C
5. Storage/handling relative humidity <95% non-condensing

4.2 Description and requirements for the collimators

The parameters of the collimator are summarized in Figure 2 and Table 3. The parameters are defined at room temperature. Note that **Figure 2** is provided for information purposes only and does not represent the final manufacturing drawing.

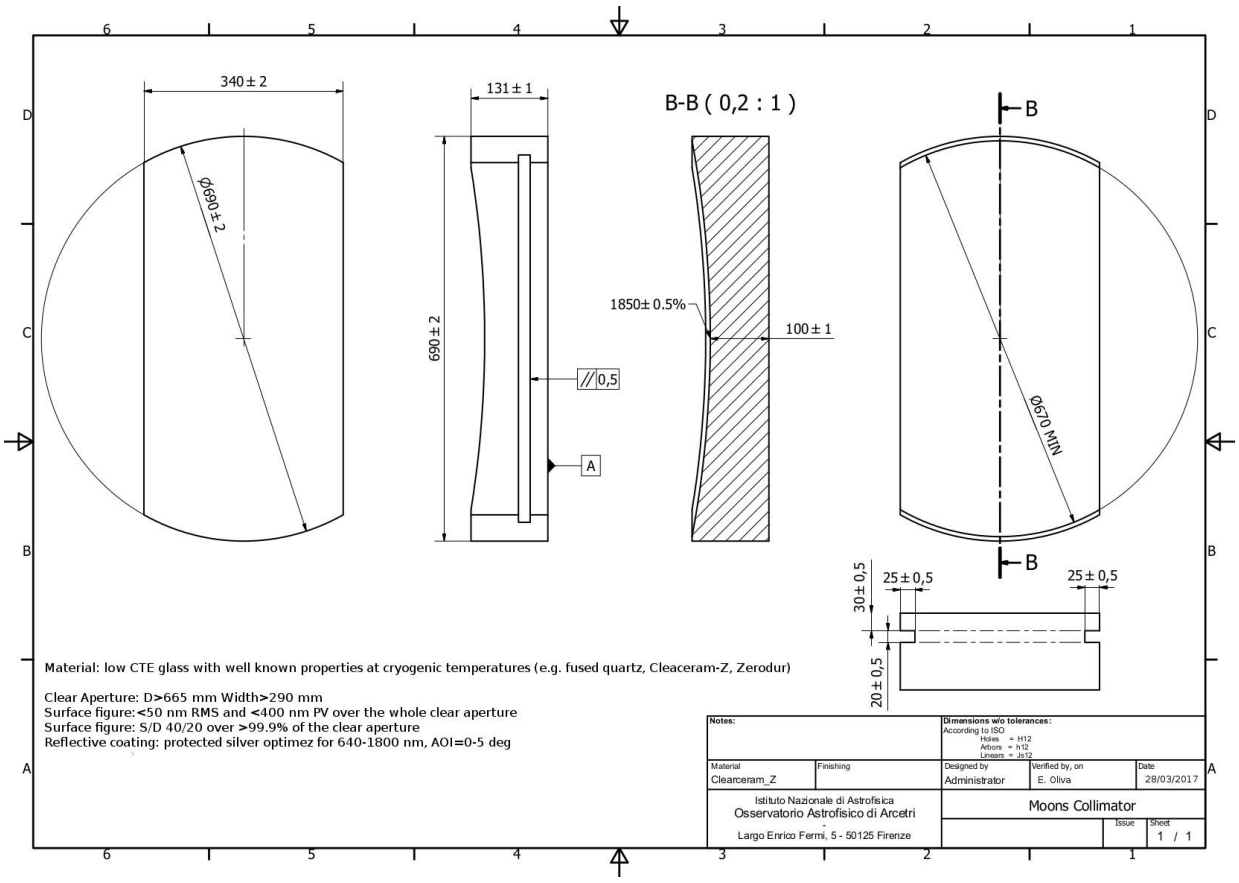

Figure 2 Layout of the MOONS collimator mirror. Drawing for information only – not to be manufactured.

Table 3 Parameters of the MOONS collimator mirror

Ref	Parameter	Value	Comment
1	Substrate material	Low CTE glass (CTE<10^{-6} K^{-1}) with well-known properties at cryogenic temperatures. For example: fused quartz, fused silica, Clearceram-Z®, or Zerodur®.	If an alternative material is suggested the supplier shall provide detailed data regarding the material properties.
2	External size	Circular Ø=690 mm ±2 mm with central rectangular cut width=340 mm ±2 mm	See Figure 2.
3	Clear aperture (CA)	Ø>665 mm and width>290 mm	Note the symbol Ø and the letter D are used to represent diameter in Figure 2.
4	Central thickness	100 mm ± 1 mm	
5	Mirror surface	Concave spherical R=1850 mm ± 9.25mm	Manufactured to 0.5 % radius tolerance.
6	Surface figure	<50 nm RMS and <400 nm PV measured on the whole clear aperture.	It does not include power that is separately specified as metrological accuracy on the curvature radius.
7	Surface finish	S/D 40/20	Over >99.9% of the CA
8	Reflective coating	Protected silver optimized over λ=640-1800 nm and incidence angles 0-5 degrees	
9	Chamfers	Smaller than 2mm × 45°	
10	De-centre tolerance	±0.5mm	
11	Tilt tolerance	±3arc-minutes	Relative to the back surface of the mirror.

5 PROCUREMENT, FABRICATION AND ACCEPTANCE

The quotation from the company shall include as many details as possible on the costs, methods and time-schedule foreseen for each of the main tasks necessary for the fabrication of the optical elements. The following sections describe the main steps of procurement, fabrication and the procedures for acceptance.

5.1 Glass blanks

The procurement of the glass blanks and the polishing of the collimator mirrors shall be in charge of the same company. The acceptance of the blanks will be based on the results given in the delivery report of the blank manufacturing company. The UKATC shall agree acceptance of the blanks before the start of the polishing. The unused spare blanks and cuts (if any) shall be returned to the MOONS consortium together with the final collimators.

5.2 Reflective coating of the mirror

The company shall include reflectivity curves (data) with the theoretically expected and/or measured reflectivity over the range of wavelengths and angles specified in Table 3.

The company shall provide evidence of the resistance of the reflective coating to the environmental specifications listed in section 4.1. This evidence could be to demonstrate the performance of the coating on a sample that is similar in size to the MOONS collimator, or to provide documentary evidence of tests already performed on previously manufactured mirrors, that have similar material and coatings to the MOONS collimators.

The company shall coat and test a witness piece. Following thermal cycling, the mirror coating shall not show any deterioration such as change in appearance of the coating, change in optical performance, peeling, or failure of an adhesion test.

5.3 Detail design and manufacturing of the mirrors

The detailed mechanical drawing of the mirror shall be prepared by the manufacturing company. This work shall be performed in strict interaction/collaboration with the MOONS team to guarantee that the interfaces with the mechanical mounts are properly taken into account. This task shall start as soon as possible after the project kick-off.

The optical elements shall be manufactured according to the specifications given in Table 3 and the manufacturer's detailed drawing discussed above.

The final acceptance will be based on the following measurements to demonstrate compliance with the specifications:

1. Mechanical metrology of each mirror.
2. Visual inspection and measurements of the surface finish of the optical surface.
3. Interferometric measurements in reflection covering the whole clear aperture of each mirror.
4. Accurate (<0.1% of mirror radius) metrology measurement of the curvature of each mirror.
5. Measurements of the reflectivity of the surfaces performed either on the final mirror or on witness samples coated in the same batch as the mirror.

5.4 Summary of deliverables

The deliverables will be as follows:

1. A project plan detailing the design and manufacturing plan and schedule.
2. A detailed manufacturing drawing of the collimator mirror, prepared to an approved standard such as ISO10110.
3. A theoretical prediction or measured data for the expected mirror coating performance.
4. A coated witness piece that has demonstrated compliance with thermal cycling.
5. 2-off collimator mirrors, with reflective coating.
6. A certificate of conformance for each of the mirrors, covering points 1 to 5 listed in section 5.3.
7. Packaging and shipping of the mirrors to the UK Astronomy Technology Centre in Edinburgh.