EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral

Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

VLT PROGRAMME

VERY LARGE TELESCOPE

INSTRUMENTATION DIVISION

Technical Specification for the MACAO WFS Lenslet Array Unit

Doc. No. VLT-SPE-ESO-11640-2146
Issue: 2.1
Date: 02.02.2001

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CHANGE RECORD

ISSUE	DATE	SECTION/PAGE AFFECTED	REASON/INITIATION DOCUMENTS/REMARKS
1.0	May 10 2000	All	First Issue
2.0	Sept 09 2000	All	Second Issue
2.1	Feb 02 2001	Removed the sections concerning the Statement of Work	The document is now only a Technical Specifications document.

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Applicable documents

AD 1	VLT-SPE-ESO-10000-0004, VLT Environmental Specifications, Issue 6.0
AD 2	VLT-TRE-ESO-11640-2451, MACAO lenslet array unit design report 1.0
AD 3	VLT-SPE-ESO-11640-2460, MACAO technical specifications and statement of work for the two micro lenslet arrays 1.0

1 Scope

This document describes the functional specifications of the complete lenslet array unit required for the ESO-VLT MACAO Systems. Therefore, only the front geometry of the lenslet array and specifications concerning the overall throughput, cross-coupling between fibers (stray light going in one fibers coming from the wrong lenslets), fibers characteristics, and environmental conditions are given.

The number of required units is 7 (with some spare parts, probably in the number of 5).

2 Introduction

The purpose of the lenslet array unit is to divide an annular pupil (14 mm diameter image of the 8 m entrance pupil of the telescope, central obscuration ratio 0.14) into 60 subapertures. The light in the subapertures is integrated and fed via optical fiber links to 60 corresponding Avalanche Photo Diodes (APDs).

Before the lenslet array unit, relay optics including a vibrating membrane mirror will form intra- and extrafocal images on the lenslet array. This information is used to reconstruct the wavefront in real-time using the principle of the Curvature Wavefront Sensor (CWFS).

ESO made a complete design which is fulfilling the specifications presented in this document (see **AD 2** and **AD 3**).

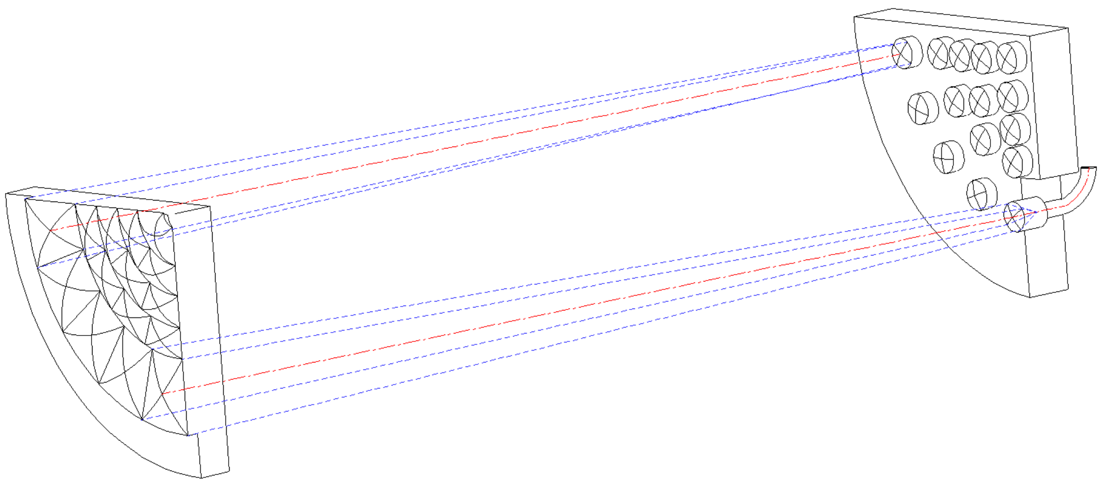

Figure 1: Possible solution of a lenslet array unit

Figure 1 presents a view of the lenslet array (left part of the drawing) and of the fibres interface (right part of the drawing) showing only a *possible configuration* for the system, which is using lenses (that might be arranged in a 2nd lenslet array) in front of the optical fibers.

3 Lenslet array unit optical specifications

The dimensions and the *geometry of the lenslet array* shall be according to Figure 2 (which does not include the interface with the fibres and the fibres themselves). It consists of 60 keystone shaped lenslets, typical for curvature wavefront sensors. Note that the actual shape of the lenslets varies from ring to ring.

The radial location of the *lenslet vertexes* is indicated with small circles in the lenslet array top view. In Table 2 the spot positions are given in terms of angles and radial distances (starting counter-clock-wise from spot #1). The tolerance on the position of the vertexes is 10 μm.

The *external ring* acts as a mechanical reference and has no optical purpose (it can be identified in Figure 2 as the surface defined by 8.75mm < R < 11.50mm).

The *cross-talk between fibers* is less than 1%. Each of the 60 subapertures must correspond to one specific fiber which can be interfaced with the APD modules.

Optical specifications apart from the ones given above are listed in Table 1.

Table 1: Lenslet array unit specifications

Wavelength range	450-950nm
Overall transmission of each subaperture	> 85% in the wavelength range 450-950nm
Field of View	30 arcminutes (= 3 arcseconds on the sky with the VLT magnification of ~570)
Fibres type	Silica multimode
Fibres connector	FC connector (goal: AR coated)
Fibres core diameter	100μm
Fibres length	2.3 meters
Numerical Aperture	0.22 - 0.35

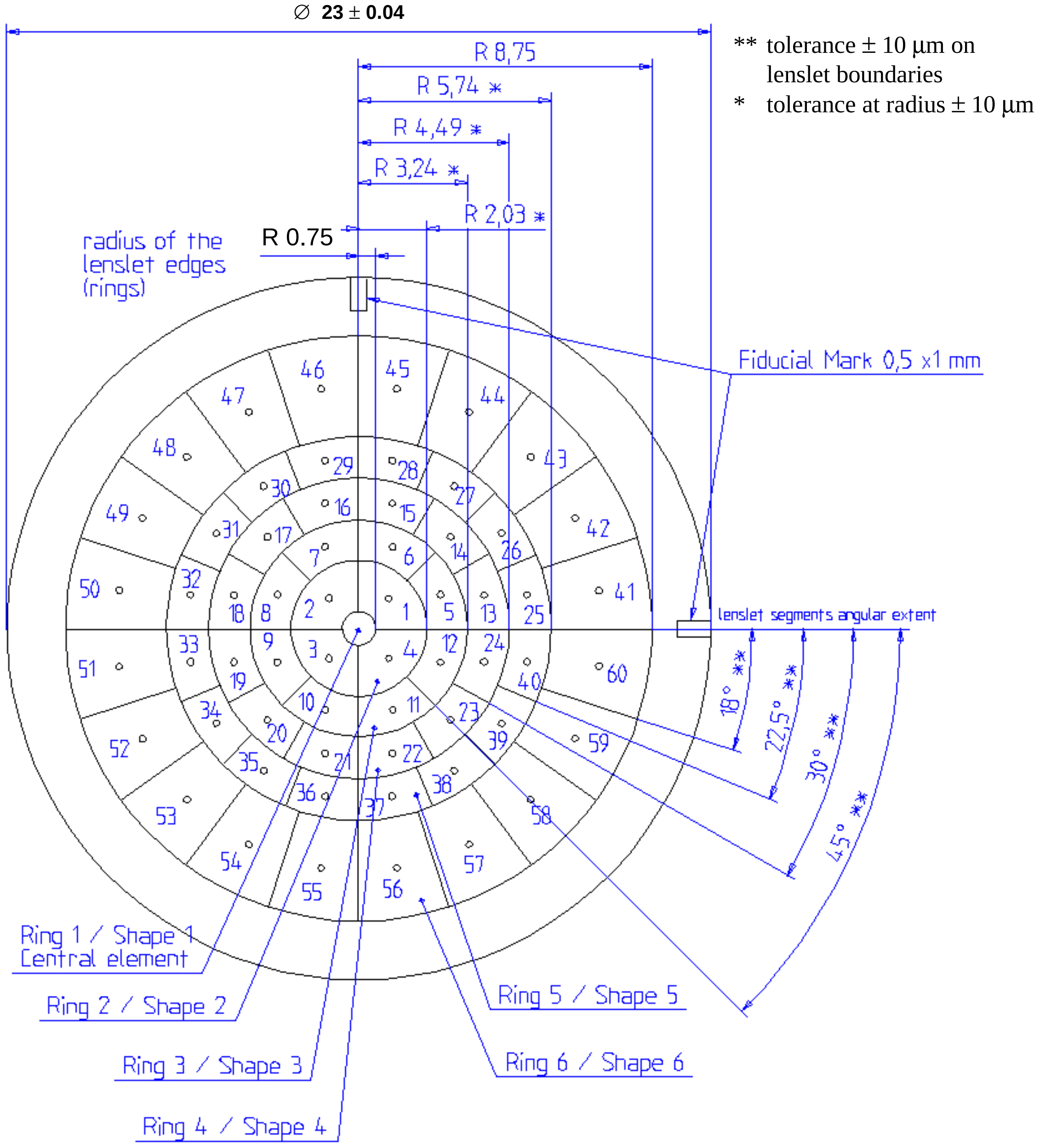

Figure 2: lenslet array top view

Table 2 lists the positions of the lenslet vertexes in polar coordinates:

Spot #	Angle (deg)	Radius (mm)	Spot #	Angle (deg)	Radius (mm)	Spot #	Angle (deg)	Radius (mm)	Spot #	Angle (deg)	Radius (mm)
1	45	1.265	2	135	1.265	3	225	1.265	4	315	1.265
5	22.5	2.635	6	67.5	2.635	7	112.5	2.635	8	157.5	2.635
9	202.5	2.635	10	247.5	2.635	11	292.5	2.635	12	337.5	2.635
13	15	3.865	14	45	3.865	15	75	3.865	16	105	3.865
17	135	3.865	18	165	3.865	19	195	3.865	20	225	3.865
21	255	3.865	22	285	3.865	23	315	3.865	24	345	3.865
25	11.25	5.115	26	33.75	5.115	27	56.25	5.115	28	78.75	5.115
29	101.25	5.115	30	123.75	5.115	31	146.25	5.115	32	168.75	5.115
33	191.25	5.115	34	213.75	5.115	35	236.25	5.115	36	258.75	5.115
37	281.25	5.115	38	303.75	5.115	39	326.25	5.115	40	348.75	5.115
41	9	7.245	42	27	7.245	43	45	7.245	44	63	7.245
45	81	7.245	46	99	7.245	47	117	7.245	48	135	7.245
49	153	7.245	50	171	7.245	51	189	7.245	52	207	7.245
53	225	7.245	54	243	7.245	55	261	7.245	56	279	7.245
57	297	7.245	58	315	7.245	59	333	7.245	60	351	7.245

Table 2: lenses vertexes

4 Lenslet array unit mechanical specifications

4.1 Reference marks

Two fiducial marks for the indication of the orientation of the lenslet array unit shall be present on the external ring, as indicated in Figure 2. The dimension of the reference marks shall be of 0.5mm x 1.0mm (depth 25µm) and the precision of positioning of the mark itself shall be better than 0.1mm.

4.2 Labels

Each lenslet array unit should be labelled with a unique identifier (e.g. LA1, LA2, …).
ESO provides a numbering for each lenslet of the lenslet array unit (see Figure 2). Each fibre shall be labelled correspondingly on the connector side accordingly to the numbering provided by ESO.

5 Environmental specifications

All the specifications given in this document shall be met under the environmental conditions described in AD1.
However, particular care shall be given to the following conditions:

- Functional air temperature range: -10°C to +30°C
- Operational air temperature range: 0°C to +15°C
- Typical air temperature gradient at night: -0.4°C/hour
- Operating altitude: 0-2700m a.s.l.
- Humidity: <95% non condensing