Université Grenoble Alpes

SPECIAL TECHNICAL SPECIFICATIONS (CCTP)

PUBLIC TENDER FOR STANDARD SUPPLIES AND SERVICES

Prototype acquisition – Micro Mirror Array

CCTP no.: 25FSM035

Grenoble Institute of Planetology and Astrophysics

(IPAG)

414 rue de la piscine,

38400 Saint Martin d'Hères

Domaine Universitaire

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ELT	Extremely Large Telescope
ESO	European Southern Observatory
MMA	Micro mirror array

1 SCOPE

1.1 Customer presentation

IPAG is a joint planetology and astrophysics laboratory of Grenoble Alpes University (UGA) and the French National Centre for Scientific Research (CNRS).

Among other things, IPAG is involved in the development of instrumentation for ground-based telescopes, in particular those that are run by the European Southern Observatory (ESO).

1.2 Scientific application

This call is related to the ERC-funded EXACT project that aims at understanding and pushing the limits to the detection and characterization of exoplanets.

One of the main limitations to these observations is our imperfect ability to correct for the amplitude and phase aberrations of the electric field. Devices that can adapt the system to these aberrations are lacking in both spatial resolution, and speed. In particular, strong amplitude aberrations are expected with the upcoming 40m Extremely Large Telescope from ESO because of the high segmentation of its primary mirror.

In addition, pupil amplitude apodization is used to lower the diffracted light of the star next to it to increase the signal-to-noise ratio (SNR) of planets located there. This is usually done by using a limited number of pupil masks. The ability to control the amplitude with a single dynamic device would remove the need for these pupil masks, and it would allow for a large number of patterns to be used, and enable a characterization strategy with patterns with a much higher throughput than conventional ones.

One of the objectives of the EXACT project is to test in the laboratory novel control technologies with superior specifications in terms of spatial resolution and speed, with a goal of controlling the electric field with spatial frequencies larger than 100 cycles/pupil, at 3-5 kHz frequencies.

1.3 Object of the call

The object of the present call is to acquire a tip-tilt micro-mirror array (MMA) – an array composed of many micron-sized actuators, located across an orthogonal grid, and which can each be controlled in tip and tilt – and its control electronics, which will be used to control the MMA from a computer.

The goal of the MMA will be to spatially control the amplitude of the incoming beam in the visible and near-infrared part of the spectrum.

The micro-mirrors of the MMA shall have a tip and tilt movement capability to redirect the incoming light towards a chosen direction within a limited solid angle. Each micro-mirror shall be able to move at a high frequency, and it shall be possible to store a series of patterns in the memory of the control electronics in advance so that they can be displayed at this frequency. Real-time control of the MMA from a computer through the electronics may be performed at a lower frequency. The deflection of any micro-mirror shall be set independently from the deflection set for the other micro-mirrors.

2 SPECIFICATIONS

2.1 Environment constraints

2.1.1 Operation temperature range

The micro-mirror arrays shall fulfill the specifications in the following temperature range:

20°C $\leq$ Temperature $\leq$ 30°C

2.2 Micro-mirror arrays specifications

The specifications of the first type of MMA are given below in Table 1.

SPECIFICATIONS	VALUES
Numbers of mirrors along both axes	300 or more
Shape of each micro-mirrors	Square
Size of each micro-mirror (µm)	More than 30µm, and less than 60µm
Deflectivity range[1] (deg)	-3deg to +3deg
Deflectivity precision[2] (deg)	0.05deg or less
Spectral range (µm)	0.5µm to 2.5µm
Reflectivity[3]	80% or more
Fill factor[4]	90% or more
MMA frame rate[5]	3 kHz or more
Number of pre-loaded frames[6]	500 or more
Real-time control frequency[7]	10 Hz or more
Fraction of non-operable micro-mirrors[8]	1% or less
Fraction of dead micro-mirrors[9]	0.1% or less

Surface quality[10]	1µm peak-to-valley
Optical surface temperature[11]	20°C or less

Table 1: Specifications of the MMA

1: The deflectivity range defines the minimum and maximum tip and tilt angles that the micro-mirrors shall be capable of. Mirrors shall be capable of moving in tip and tilt within this range.

2: The deflectivity precision provides a 1-sigma statistical estimate of the error with which an angle of 0 deg and 1deg within the deflectivity range shall be obtained, i.e., the difference between the required tip or tilt command (0 deg or 1deg) shall be less than or equal to the deflectivity precision for a least 68% of the micro-mirrors. This assumes than the MMA would be controlled at a real-time frequency of 1Hz.

3: The reflectivity is defined as the minimum value of the flux ratio between the light reflecting from and incidenting on the MMA optical surface for all the wavelengths within the wavelength range. It does not include the loss due to the fill factor.

4: The fill factor is defined as the ratio between the total reflective surface of the micro-mirrors, and the surface supporting the array.

5: The MMA frame rate is defined as the frequency at which the mirrors of the MMA shall be capable of moving to display frames that have been previously loaded into the electronics memory from a computer. This is not equivalent to the display rate, i.e. the effective frequency at which frames can be displayed, and which may be lower to accommodate for settling time.

6: The number of pre-loaded frames is defined as the number of frames which can be loaded into the electronics memory from a computer.

7: The real-time control frequency is defined as the frequency at which frames which have not been previously loaded from a computer into the electronics memory can be displayed on the MMA.

8: The fraction of non-operable micro-mirrors is defined as the ratio between the number of non-operative micro-mirrors, and the total number of micro-mirrors of the MMA. Non-operative micro-mirrors are defined as incapable of tip or tilt absolute values larger than half of the nominal value (3deg).

9: The fraction of dead micro-mirrors is defined as the ratio between the number of dead micro-mirrors, and the total number of micro-mirrors of the MMA. Dead micro-mirrors are defined as incapable of moving, and having a non-chosen angle with respect to the MMA surface.

10: The surface quality is defined as the height difference between the highest and lowest micro-mirrors of the MMA, excluding the dead micro-mirrors, and assuming that the mirrors are controlled to have a zero deflection. The height of each micro-mirror is assumed to be measured at the center of the mirror.

11: The temperature of the optical surface is assumed to be measured while the device is operated the temperature range defined in section 2.1.1.

2.3 Verification tests

The manufacturer shall provide a report demonstrating the compliance of the device for the following specifications:

- Deflectivity precision, for both zero-deflection and one-degree deflection cases for all micro-mirrors,

- Fraction of non-operable micro-mirrors,
- Fraction of dead micro-mirrors,
- Surface quality (for instance using interferometric measurements).

2.4 Driver and software

The MMA shall be delivered with a set of drivers (such as DLL libraries) and softwares allowing them to be controlled with a computer. A software development kit (SDK) shall be provided by the manufacturer.

2.5 Deliverable documentation

The MMA shall be delivered with a documentation composed of:

- A user manual
- A test report as defined in section 2.3
- A mechanical interface plan
- A software control reference manual
- A RoHS certificate shall be delivered
- A NIMP 15 certificate conformity if a wooden box is used

--- End of document ---