

Specification for the preliminary optical design of the MAORY Post Focal relay and short notes about preliminary alignment procedure definition (V1.0, 20/02/19).

The object of these preliminary specifications is the optical design of the MAORY Post Focal Relay Optics (PFRO). The task is declared completed after the delivery of a zemax file that specify the optical design and a technical note that describes the provided drawings and explain the different options if available.

The preliminary optical design for the MAORY relay optics train shall fulfill the following specifications that can be detailed upon motivated request of the applicant.

1 SP1: PFRO transmission and wavelength specifications.

The following table is taken from the MAORY specifications. Some of the figures are still TBC but the reported numbers can be taken as reasonable assumptions having a 10% of variability range.

[R-MAO-91]
Transmission I: MAORY optics from the entrance focal plane to the output port(s) shall have transmission over the science fields of view greater than 65% (TBC) at all wavelengths in the range 1.0-2.5 μm .
[R-MAO-92]
Transmission II; MAORY optics from the entrance focal plane to the output port(s) shall have transmission over the science fields of view larger than 50% (TBC) at all wavelengths in the range 0.8-1.0 μm
[R-MAO-93]
Transmission III: as a design goal, the MAORY optics from the entrance focal plane to the output port(s) should transmit at all wavelengths in the range 0.6-0.8 μm provided this does not compromise the transmission at $>0.8 \mu\text{m}$.

Table 1 A table summarizing the transmission specifications for the PFRO

2 SP2: background generated by PFRO

The PFRO background shall fulfill the following specification as taken from MAORY specification document.

See ESO specification: [R-MAO-90]
The MCAO module thermal emissivity should, as a design goal, be less than 55% (TBC) of the thermal background of the sky and telescope measured in Ks filter. This value is for an assumed temperature of 5 degrees C and sky background of 13.5 mag/arcsec ² . Assumptions are TBC.

Table 2 Specification for the thermal background generated by the optics of the MAORY PFRO.

3 SP3: reimaged focal plane elements

The PFRO shall maintain the optical interfaces coming from the E-ELT at the exit focal plane of the optical train. The current optical interfaces of the E-ELT focal plane delivered as input to the MAORY PFRO are reported in the table below.

Element	F/	Plate Scale	Pupil position
Value	17.7	3.3mm/arcsec	24m before focal plane

Table 3 The main optical interfaces that the MAORY post focal relay has to reproduce in its exit focal plane.

4 SP4: reimaged focal plane quality

The reimaged focal plane after the Optical Relay shall fulfill these specifications:

Element	WF rms (53")	WF (160")	rms	Field distortion (160")
Value	<60nm	<100 nm		<2mas

Table 4 Basic specifications of the quality of the reimaged focal plane of the PFRO.

5 SP5: PFRO space constrains

The considered optical design is subject to space constrains and shall fit in the available space on the E-ELT Nasmith platform. The platform and space available are detailed below. A more detailed model of the telescope platform can be made available on request.

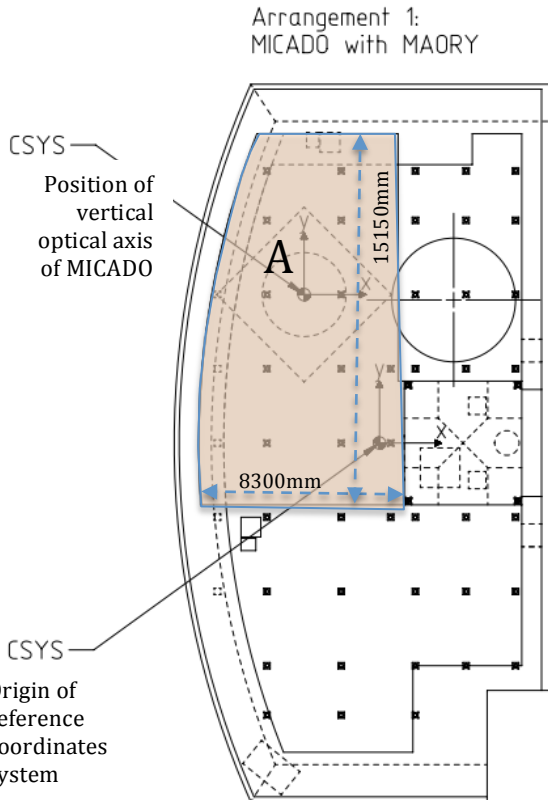


Figure 1 the space envelope available for the MAORY Post Focal Relay Optics. The two relevant points are the ELT focal plane position and the position of the MICADO focal plane. The coordinates of MICADO focal plane center are given in the text. Main dimensions of the Nasmith platform are given in the figure.

6 SP6: position of the reimaged focal plane

The PFRO shall provide the reimaged focal plane in a given position in space where the MICADO instrument is supposed to have its input focal plane. The coordinates of the MICADO focal plane center are reported in the table below. The coordinates are relative to the center of the E-ELT focal plane as available from the telescope on the Nasmith platform.

X coord [mm]	Y coord [mm]	Z coord [mm]
-3050	+6000	-1800

Table 5 Relative position of the MICADO center of the FoV in relative coordinates system introduced in figure 1.

7 SP7: conjugation of post focal DMs

The PFRO design shall provide conjugated planes for 2 deformable mirrors. The preliminary optical specifications for the two planes are reported in table 3.

	DM1	DM2
Conjugation altitude [km]	6	15
Beam footprint (DM) diameter [mm]	800/[400-500]	800/[400-500]

Table 6 The main elements of the post focal DMs conjugated planes. The two diameter refer to the possibility of using different DM technology with different actuator pitch.

Two different design options are required to accommodate deformable mirrors of different diameter. If one of the options is not accessible with a single kind of design related reasons should be detailed. The second option for the DM diameter is given as arrange value because of current uncertainties about the actuator pitch of the selected DM technology. In this case the design shall provide a value inside this range. This value could be updated when more information about the DM pitch will be available.

8 SP8: focal plane for LGS sources and LGS wavefront sensors

The optical design shall include a dichroic separating the science focal plane from Laser Guide Star focal plane. The optical quality and all the other specifications listed in the document shall remain verified when the dichroic is included in the design. Currently there is not a preferred option to transmit or reflect the scientific light. The operation of the dichroic is left open as an option in the design. The Laser Guide Star sources have the following main characteristics:

	min	max
Laser source altitude [km]	90	180
Reimaged focal plane Z (to NGS)	+6200mm	+2760mm
LGS source FoV	15"	
LGS constellation offset	45"	

Table 7 Main elements of the Laser Guide Star focal plane to be pick up by a dichroic element.

9 SP9: PFRO second port

The design of the PFRO shall provide a second focal plane by using additional optics or steering some of the PFRO optical components. This second focal plane has to have the same characteristics described in SP1 and SP2.

10 SP10: Consideration about optics shape of PFRO

The design should enforce at maximum the use of spherical surfaces and specify clearly when a non-spherical surface is required to provide the required optical interfaces.

11 Identification of a preliminary alignment procedure for the PFRO at AIV Europe.

The second task of the present contract is the definition of a preliminary alignment plan of the identified optical design for the AIV phase in Europe. The alignment plan should use best practice technologies like laser tracker metrology and other state of the art metrology systems. The alignment plan should use off-the shelf component as alignment tools as much as possible. Use of custom made tools for alignment if required should be carefully detailed and justified. The task is declared completed after the delivery of a technical note with a description of

the alignment procedure together with an identification of all the required metrology systems needed to implement it.