10. Adapter-Rotator

10.1 Requirements

The adapter-rotator is the interface between the telescope and an instrument. It has to fulfil the following requirements.

- Provide the sensors for the wavefront control. These are the sensors for tracking and field stabilization. for active optics and for adaptive optics. The design should allow for six sensors for active and adaptive optics each.
- Provide an attachment for the instrument (rotator interface flange).
- Provide the derotation of the field. This could be either a mechanical derotator at the outer edge of the adapter or an optical derotator.
- The back focal distance should be at least 100 mm. For "back focal distance " (BFD) at a telescope focus (see e.g. VLT) it is intended the distance between the Instrument Attachment Flange (Rotator interface flange Figure 10-1) and the focus on the optical axis measured outwards.
- The scientific field must have a diameter of at least 3 arcminutes.

Adapter-rotators requirements are highly provisional as feedback from instrument studies is. at the time of writing of this report. still being received. Extensive iterations shall take place in the design phase. The design may plausibly evolve towards specialized adapter-rotators tailored to specific functional modes (e.g. SCAO. MCAO).

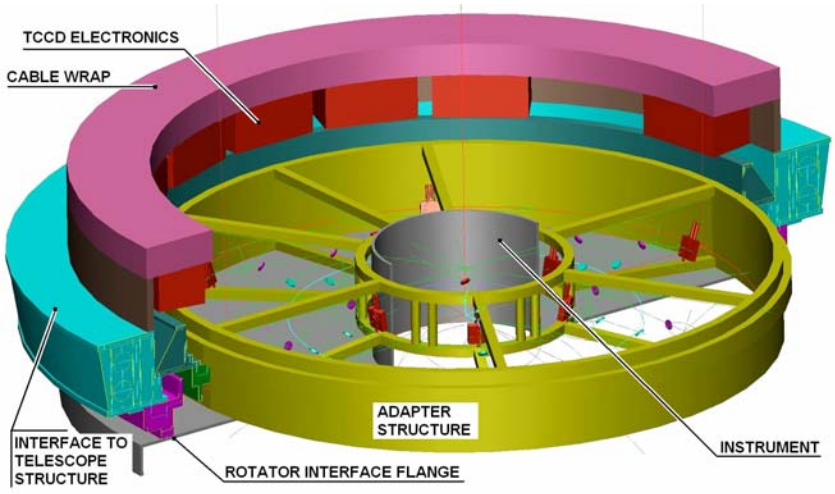

Figure 10-1: Adapter Rotator

Some of these requirements can also be supplied by the instrument itself. Therefore not all adapters have to be identical and have the full functionality. However. the type of adapter discussed in this section will fulfil all requirements mentioned above.

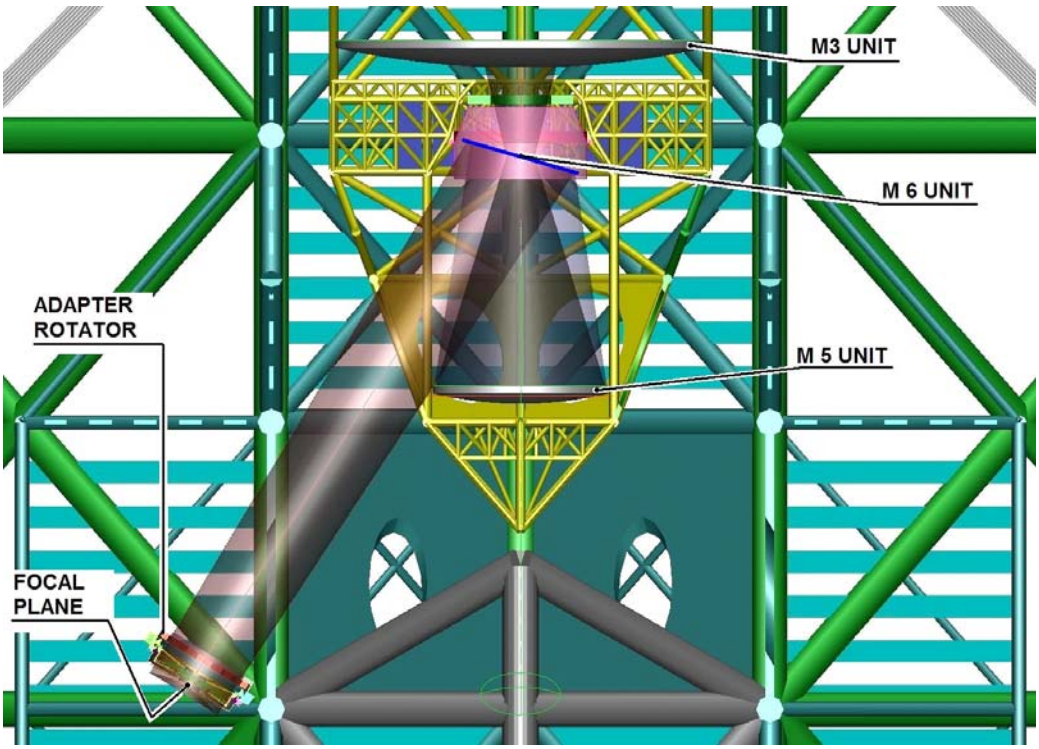

Figure 10-2: Adaptor Rotator location

10.2 Constraints

There are a few constraints for the design of the adapter:

- The diameter of approximately 2 meters is equivalent to a full field diameter of 10 arcminutes.
- The f-number is equal to 6.
- The maximum weight of an instrument to be attached to the Rotator is 4 tons(TBC).
- The focal surface is approximately a sphere with a radius of curvature of 2.210 metres.

The field of view will be divided into three areas.

- Instrument field: inner circle with a diameter of 3 arcminutes. This field is accessible to the instrument. Within this field the priority is given to the instrument. The field may be obscured by other devices of the adapter. but only if they are required by the instrument and do not interfere with the functionality of the instrument.
- Adaptive optics field: ring between 3 and 6 arcminutes diameter. In the field priority is given to the wavefront sensing for adaptive optics.
- Active optics field: ring between 6 and 10 arcminutes diameter. This field will be used for wavefront sensing for active optics.

10.3 Notional Design

A natural guide for the following notional design of the adapter is the symmetry of structure of the telescope.

- The wavefront sensor units are located on six radial bars with their axes of rotation on the center of the bars.
- Each unit consists of a rotating arm with the pick-up mirror on one side of the rotation axis and the detector on the other side.
- The distance of the pick-up mirror to the center of the unit is variable. The accessible area per unit is therefore an annular circle.
- The inclination of the pick-up mirrors follows the curvature of the focal surface.
- The planes of rotation of the units for active and adaptive optics are on different levels to avoid collisions between the units.
- To achieve sufficient instrument design volume of about 500 mm (measured from the focal plane vertex) the central instrument field (diameter of about 580 mm) will be unobstructed by mechanical devices. The instrument which will be attached to the adapter at a flange outside the 10 arcminutes field diameter will therefore have an additional design space at the center of the field with a diameter equivalent to the 3 arcminutes field diameter and a length of 500 mm.
- Located on an additional radial bar there will be one or more wavefront sensor units which can access the center of the field. These can be either close the focal surface for instruments which do not require a large back focal distance or at least at a distance of 500 mm from the focal surface for instruments which make use of the additional design space. In the latter case the pick-up mirror would have a size of at least 100 mm and could not be used to pick up a star close to the scientific target. If required the wavefront sensing for adaptive optics has to be provided by the instrument (for wavelength smaller than K and certain types of adaptive optics).
- Location of calibration units

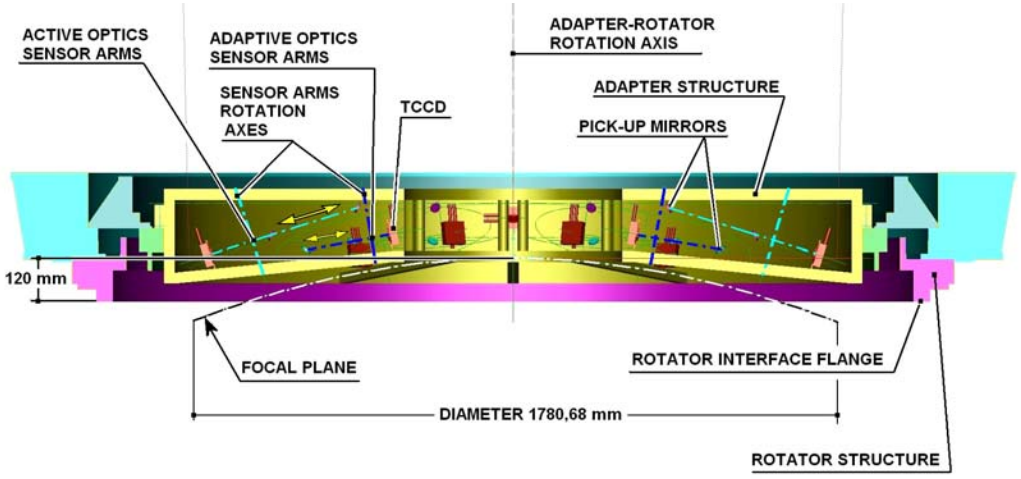

Figure 10-3: Adapter Rotator section

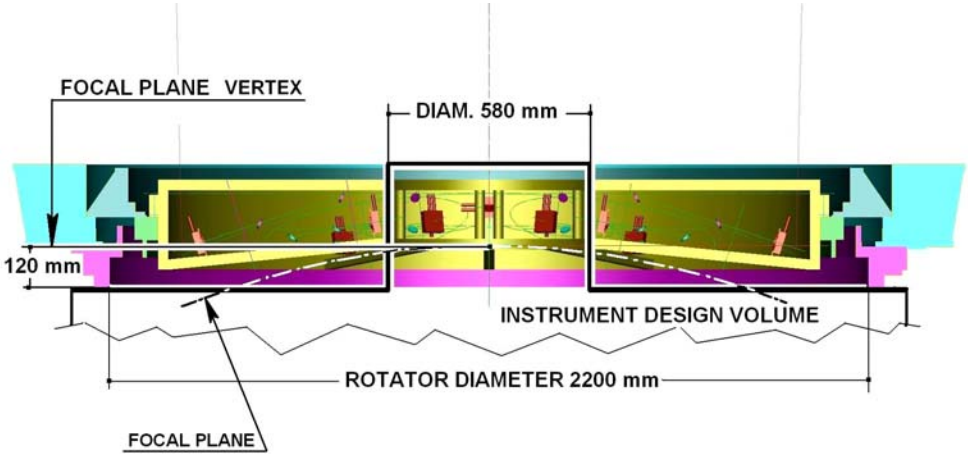

Figure 10-4: Adapter Rotator Instrument design volume

For heavy instruments which exceed the weight limit the focus could be transferred by an additional flat mirror to a platform perpendicular to the optical axis of the telescope.

Not all adapter have to be identical. On focal station may be reserved for technical instruments where the center of the field can be accessed without any restrictions imposed by scientific instruments

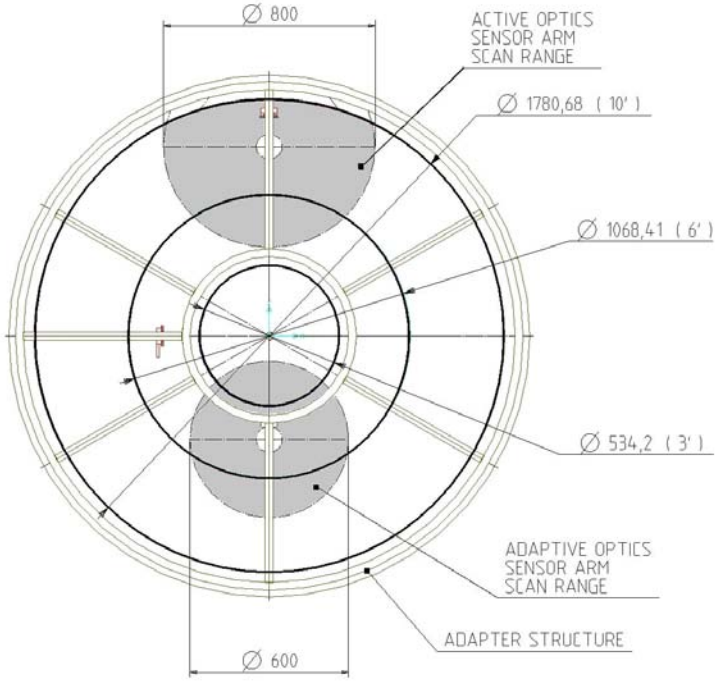

Figure 10-5: Pickup mirror scan range

10.3.1 Pick-up mirrors

The A/R design includes 13 pickup mirrors.

- 6 scanning pickup mirrors for Adaptive Opitcs
- 6 scanning pickup mirrors for Active Opitcs
- 1 pickup mirror for Active Opitcs which can be positioned on and off on axis.

The kinematics design and the scan ranges shown in Figure 10-5 are only tentative.

10.4 Adapter-Rotator configuration vs instruments and functions.

The Adapter Rotator configuration can be tailored to the different instrument and AO Systems requirement. Table 10-1. Table 10-2 and Table 10-3 indicate possible design requirements and options.

Instrument/ AO system	**Wavelength Range of operation / Scientific FoV**	**Interface to telescope**	**AO type/ nr. WS pick up arms**	**ADC Requirements**	**Remarks**
CODEX	400-700nm/ 4" (tbc)	Fed by fiber or optical train at a stable location	Low order AO (tbc)	Possibly . in the instrument	Target red light (via dichroic) to be used for WFS (m(I)=16-18)
T-OWL	2500-5000nm and 10-20μm/ ~ 17"x17"	Imager attached to adapter/possibly not requiring rotation.	AO not required in N.Q bands. SCAO for L.M (tbc)	tbd	Entrance window of instrument as dichroic to split the two spectral ranges. Spectrograph option not yet finalized.
QUANTEYE	400-700nm/ 120"	Attached to adapter. rotating	Low order AO (tbc)	Not required	Two apertures . one on the center field+ reference within 60 arcsec.
MOMFIS	800-2300 nm/ 360"	Present design cannot be attached to A/R. To heavy. to big.	MOAO/ WS to be distributed in field	In the instrument (1st order correction over the all field useful	Multi-LGS probably required. Need to have WF sensing close to actual targets
ONIRICA (central field)	30-60"	Attached. rotating. within 5 tons (tbc)	MCAO . high order correction	tbd	ONIRICA asks for more WFSs (up to 12. tbc)
ONIRICA (large field)	Annular 1'-6' (max)	Attached. rotating. within 5 tons (tbc)	MCAO. low order correction	tbd	
EPICS	R and J bands/ 4"x4" max	Detatched from adapter; possibly requiring gravity-invariant platform	XAO/Not in Adapter	External ADC could help .internal one needed in any case.	Postfocal AO with WFS
SCOWL	350.450 and 850 μm bands / 150 "	Attached to adapter. rotation not required. Weight at 5.6tons	No standard AO	Not required	Monitor of H2O at different position over aperture at 0.1-1 Hz resolution may be needed
Hyper-telescope Cam					No information available.

Table 10-1. Adapter-rotator requeirements for a set of representative instruments.

Instrument AO system	Scientific Field		AO Field					
	Scientific FoV [']	Allowable Obscuration	Scan FoV [']	Allowable Obscuration (adapter mechanics. % area)	AO pick up arms	AO pick-ip arm stability & tracking over 20' exposure time [µm]	WFS FoV ["]	Remarks
SCAO	1' (TBC)	Goal None Requ. TBD	1'	Goal None Requ. TBD	Not in Adapter	0.4 mas	2-3"	Optimized wavelength for the WFS and the overall stability requirements favors to have WFS close to the instrument (see also TOWL narrow field). IR Pyramid and visible SH WFS
GLAO	Goal 6' Requ. 3'	Goal None Requ. TBD	Requ. 2-6' Goal 1'-6'		6-8	3-5 mas	2-3"	Conflict between scientific and WFS FoV may require moving the WFSs in instrument with large dichroic (TBC)
TOWL narrow	~10" (TBC)		~10" (TBC)		Not in adapter	N.A	N.A.	Entrance window of instrument as dichroic
TOWL wide	TBD							TBD
MOAO MOMFIS	6'		6'	TBD	Not in adapter	N.A.	N.A.	Multi-LGS required
MCAO ONIRICA	1'	Requ. None	6'	TBD	6-12	0.4 mas	2-3"	ONIRICA asks for more WFSs (12) (TBC by study made by INAF)
EPICS/XAO	10"		10"		Not in Adapter	N.A.	N.A.	Postfocal AO with WFS

Table 10-2: Adapter-rotator requirements for a set of representative AO Systems.

Number of WFS	Scan Field	FoV	Tracking Accuracy	Remarks
6 Shack-Hartmann Type	From 6' to 10 '	2" - 3 "	0.1 " over 1' exposure time.	At least one piston step sensor. Baseline: Only on the technical focus for measurement at the beginning of the night. Focal: On every focus for closed loop control of th piston step by optical measurements.

Table 10-3 Adapter-rotator requirements for Active Optics.