Design parameters – Summary

Overall characteristics		
Entrance pupil diameter	100-m	
Entrance pupil location	Primary mirror	
Exit pupil location	On M6	
Focal ratio	6.03	
Plate scale	2.924 mm / arc second	(on-axis)
Total field of view	10 arc minutes	(unvignetted)
Linear field size	13994.53 mm	
Diffraction-limited field of view (Strehl Ratio ≥ 0.80)		As-designed
λ=0.5 μm (on curved field with R=2209.8 mm)	142 arc seconds (diameter)	Field concave in the direction of light propagation
λ=2.2 μm (on curved field with R=2215.4 mm)	245 arc seconds (diameter)	
λ=5.0 μm (on curved field with R=2243.1 mm)	360 arc seconds (diameter)	
Image quality at edge of field (10 arc mins)		
Wavefront RMS	1.476 μm	
RMS spot size	0.052 arc seconds	
Field curvature	2209.8 mm	Oncave in the direction of light propagation
Central obscuration	35%	(linear)
Distortion at edge of 10 arc minutes field of view	1.31%	
Emissivity (with pupil mask)	20.3%	Incl. intersegments gaps, tensioning ropes
Telescope mount	Alt-az	Elevation axis above primary mirror

Overall characteristics				
Focal stations			6	Incl. 1 reserved for engineering instrumentation
Optical design characteristics				
Primary mirror	Shape		Spherical	
	Focal ratio		f/1.25	
Secondary mirror	Shape		Flat	
	Diameter		25.8-m	
M1-M2 separation			92517.5 mm	
M1 segments	Number		3048	Plus min. 98 spares
	Mass		387 Kg each	(if solid Zerodur)
	Cut		Hexagonal	
	Optical shape		Spherical	
	Radius of curvature		230-m	
	Dimension (flat-to-flat)		1.6-m	Incl. bevels
	Thickness		70 mm	For solid glass-ceramic substrate
	Substrate		Zerodur, ULE or Astrosital	Silicon Carbide or lightweight Zerodur as alternatives
	Axial support		18 points whiffle-tree	TBC; actively positioned (3 actuators per segment)
	Lateral support		Central	
M2 segments	Number		216	Plus min. 7 spares
	Mass		387 Kg each	(if solid Zerodur)
	Cut		Hexagonal	
	Optical shape		Flat	
	Dimension (flat-to-flat)		1.6-m	Incl. bevels
	Thickness		70 mm	For solid glass-ceramic substrate
	Substrate		Zerodur, ULE or Astrosital	Silicon Carbide or lightweight Zerodur as alternatives
	Axial support		18 points whiffle-tree	TBC; actively positioned (3 actuators per segment)
	Lateral support		Central	
Corrector			Four-elements	
M3	Type		Thin active meniscus	
	Shape		Aspheric, concave	
	Diameter (useful area)	Inner	1674.0 mm	No vignetting, natural guide stars
		Outer	8241.8 mm	
	Radius of curvature		18690 mm	
	Mirror substrate		TBD	Low-expansion glass or glass-ceramic
M4	Type		Thin active meniscus	

Overall characteristics				
	Shape		Aspheric, concave	
	Diameter (useful area)	Inner	1352.0 mm	No vignetting, natural guide stars
		Outer	7762.8 mm	
	Radius of curvature		19970 mm	
	Mirror substrate		TBD	Low-expansion glass or glass-ceramic
M5	Type		Thin adaptive shell	
	Shape		Aspheric, concave	
	Diameter (useful area)	Inner	420.0 mm	No vignetting, natural guide stars
		Outer	3916.4 mm	
	Radius of curvature		8504 mm	
	Mirror substrate		TBD	Provisional unit may be aluminium.
M6	Type		Thin adaptive shell	On tip-tilt mount for field stabilization
	Shape		Flat	
	Tilt angle		16^{o}	
	Diameter (useful area)	Inner		Elliptical; no vignetting, natural guide stars
		Outer	2440 x 2660 mm^2	
	Radius of curvature		Infinite	
	Mirror substrate		TBD	Provisional unit may be aluminium
Distance M2 – vertex of M4			28235 mm	
M3-M4 separation			11280 mm	
Distance vertex M4 to vertex M6			2150 mm	
Distance vertex M6 to vertex M5			5260.54 mm	
Backfocal distance (vertex M6 to vertex image surface)			13994.53 mm	
Adaptive Optics design characteristics				
SCAO				
Deformable mirror			M6	
Number of guide stars			1	
Number of sensing elements across pupil			97	Total active sub-apertures: 6354
Wavefront sensor type			Shack Hartman or IR Pyramid	
CCD pixels on Wavefront sensor			388x388 (SH), 194x194 (Pyr)	
Number of actuators across pupil			98	Total active actuators: 6820
Control bandwith			500 Hz	
Corrected field of view (diameter)			~1 arc minute	Limited by anisoplanatism
Wavelength range (science)			1.25µm - 20 µm	

Overall characteristics		
GLAO		
Deformable mirror	M6	
Number of guide stars	Up to 6	
Number of sensing elements across pupil	97	Total active sub-apertures: 6354 per WFS
Wavefront sensor type	Shack Hartman	
CCD pixels on Wavefront sensor	388x388	
Number of actuators across pupil	98	Total active actuators: 6820
Control bandwith	500 Hz	
Corrected field of view (diameter)	Up to 6 arc minutes	
Wavelength range (science)	1.25µm - 2.5 µm	
MCAO		
Deformable mirror	M6+M5	
Number of guide stars	Up to 6	
Number of sensing elements across pupil	97	Total active sub-apertures: 6354 per WFS
Wavefront sensor type	Shack Hartman	
CCD pixels on Wavefront sensor	388x388	
Number of actuators across pupil (M6)	98	Total active actuators: 6820
Number of actuators across the meta-pupil (M5, 6 arcmin)	145	Total active actuators: 16512
Control bandwith	500 Hz	
Corrected field of view (diameter)	1’	
Wavelength range (science)	1.25µm - 2.5 µm	
XAO		
Deformable mirror	M6 + 2 post focal	
Number of guide stars	1	
Number of sensing elements across pupil	150 and 500	
Wavefront sensor type	Pyramid and Shack Hartman	
CCD pixels on Wavefront sensor	300x300 and 1000x1000	
Number of actuators across pupil	~150 and ~500	
Control bandwith	3000 Hz and 1000Hz	
Corrected field of view (diameter)	~4’’	
Wavelength range (science)	0.6µm-0.8 µm and 1.0µm -1.7µm	
MOAO		
Deformable mirror	M6 (stroke) + up to 30 MEMs	MEMs DM button for each IFU (30 simultaneously)
Number of guide stars	Up to 10	

Overall characteristics			
Number of sensing elements across pupil		97	Total active sub-apertures per WFS button 6354
Wavefront sensor type		Shack Hartman	
CCD pixels on Wavefront sensor		388x388	
Number of actuators across pupil		98	Total active actuators per IFU: 6820
Control bandwith		500 Hz	
Corrected field of view (diameter)		0	Correction on each object individually
Wavelength range (science)		1.25µm - 2.5 µm	
Mechanical design characteristics			
Overall Dimensions	Diameter	155 m	
	Height	130 m	From ground level
Rotating Mass		14834.5 tons	(2004 design iteration)
Focal Stations	Number	6	1 focal station reserved for engineering instrument
	Max. instrument mass	15 tons each	including Adaptor Rotator
Main structural material		Mild steel	
Altitude Mass Moment of Inertia		1.123×10^{10} kg m^2	(2004 design iteration)
Azimuth Mass Moment of Inertia		3.368×10^{10} kg m^2	(2004 design iteration)
Main axes Drive and Bearing Systems		Friction Drive and Bearing	Bogies
Azimuth Rotation		360 degrees	
Altitude Rotation		$\pm$ 90 degrees	maximum maintenance range
Altitude require torque		19.6 MNm	2004 Version
Azimuth require torque		58.7 MNm	2004 Version
Sky coverage (altitude)		0.5 to 70 degree (ZD)	From 60 to 70 vignetting due to foundation
Blind angle at zenith		$\leq \pm$ 0,5 degree	Paranal location
Maximum Altitude and Azimuth Acceleration		0.1 degree s^{-2}	
Maximum Altitude axis velocity		0.1 degree s^{-1}	
Maximum Azimuth axis velocity		0.5 degree s^{-1}	
Locked rotor frequency		2.58 Hz	2004 version
Gravity M1-M2 differential rigid body displacements			
Piston		3.4 mm	
Tilt		13.1 arcsec	
Decenter		17.6 mm	
Altitude axis control bandwith		1.8 Hz	Tailored to high wind disturbance rejection
Azimuth axis control bandwith		0.6 Hz	Tailored to low wind disturbance on azimuth axis
Tracking accuracy (Altitude and Azimuth axes)		0.3 arcsec rms	With 10m/s wind speed

Overall characteristics			
Field stabilization range (M6 surface tip-tilt)		Min. ± 31 arcsec PTV	Equivalent to ±1.44 arc seconds on-sky
Field Stabilization bandwith		2 Hz	Performed at Mirror 6
Fiel Stabilization accuracy (M6 surface tip-tilt)		0.01 arcsec rms	Equivalent to 0.00046 arc seconds on-sky
Segment Position actuators			
	Maximum load	1700 N	Compression (M1) or tension (M2)
	Accuracy	± 5 nm	Goal ± 2 nm
	Stroke	15 mm	Goal 30 mm
	Control bandwitdh	10 Hz	Over fine stroke at nm level
Sliding enclosure			
Overall dimensions	height	147 m	
	Length	242 m	
	Width	242 m	
Enclosed volume		4100000 m^3	
Surface area		102000 m^2	
Mass		37000 t	30000 t structural steel, 7000 t cladding
Material			
	Structure	Mild steel	
	Cladding	Aluminium sandwich panels	
	Pneumatic seal	Polyester canvas	Coating: polychloroprene
Maximum deflection under gravity load		150 mm	Vertical
Maximum deflection under operational wind load		200 mm	
Maximumdeflection under OBE		300 mm	
Maximum delection under survival wind load		450 mm	
Maximum deflectin under MLE		550 mm	
First eigenfrequency		0.4 Hz	
Maximum displacement speed		0.8 m/s	Time to move from day to night position 15 minutes
Minimum time for opening arches		TBD	
Distance between day and night parking position		410 m	Axis to axis
Arches drive system		bogies	
Enclosure drive system		Winches and cables	
Site Integration design characteristics			
Handling and hoisting facilieties		3 tons	Most of the telescope structure parts can be integrated using small payload facilities.
Metrology		Low tolerances	Most of the telescope structure parts can be integrated using

Overall characteristics		
		low accuracy measurement devices.
Maintenance design characteristics		
Redundancy		The redundancy of parts and sub-systems embedded in to the design, assures the avalability of the telescope.
Segments recoatings	5.1 per day (peak)	Assuming unprotected Al coating, 2-years lifetime
Corrector mirrors recoating (duration)	2 weeks	Expected maximum frequency once every 2 years.