Short Name	ID	Section	Category	Priority	PBS	Description	Rationale	Traceability	Status	n	Method	Originator	Created By	By	Modified Date	d	RD Notes	Compliance (VNV)
Purpose, General	FR-507	Overall	Functional	Essential	1.2.7	The laser guide star wavefront sensor subsystem, hereafter referred to as the LGS WFS, shall measure high-order wavefront aberrations induced upon light collected by the Keck telescope synthetic reference guide stars generated by the LGSF subsystem.	Measurement of atmospheric and other wavefront aberrations is critical to the concept of adaptive optics. Our requirement for high sky coverage fraction necessitates a sythetic laser guide star wavefront sensing architecture	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Demonstration	Chris Neyman		Richard Dekany	11/21/2009 12:42			OK
WFS Architecture		Overall	Functional	Essential	1.2.7	The LGS WFS shall use Shack-Hartmann type wavefront sensor	This choice was based on minimizing risk via a proven and well-understood architecture within the NGAO team	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Inspection	Richard Dekany			11/21/2009 13:44			OK
Operating Wavelength Bandpass	FR-523	Optical	Functional	Essential	1.2.7	The LGS WFS shall operate over the wavelength range of 589 - 594 nm	The LGS WFS utilizes Na atom D2 transition light at a wavelength of 589.159 nm, but for alignment and calibration purposes low-cost laser sources at 593.5 nm are commercially available	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Demonstration	Richard Dekany			11/21/2009 12:42			OK
Number of WFS		Overall	Functional	Essential	1.27	The LGS WFS shall measure light from up to 7 sodium LGS; 4 LGS in a Fixed Asterism and 3 LGS in a reconfigurable Patrolling Asterism	The Fixed Asterism LGS provide wavefront information for the tomographic measurement of the science wavefront while the Patrolling Asterism LGS provide wavefront information for each independent LO WFS NGS sharpening subsystem	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Demonstration	Richard Dekany			11/21/2009 12:42			OK
Fixed Asterism Geometry	FR-1867	Overall	Functional	Essential	1.27	The fixed asterism shall measure wavefronts from one (1) central on-axis LGS and three (3) LGS located on an equilateral triangle centered on the on-axis having a 10 arcsec angular radius	Analysis has shown that this tomographic asterism is sufficient to meet system performance requirements	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Demonstration	Viswa Velur		Richard Dekany	11/21/2009 12:42			OK
One WFS per LGS	FR-508	Overall	Functional	Essential	1.2.7	The LGS WFS shall measure the wavefront from one LGS per sensor channel	This is the standard configuration for multiple LGS systems. An alternative architecture of measuring all the LGS wavefronts using a single WFS requires an impractically large and fast WFS CCD. Note: "layer oriented" wavefront sensing is at yet unproven, see ESO MAD test in 2008. http://www.eso.org/projects/aot/mad/	KAON 499 "NGAO System Architecture Definition"	Draft	1	Inspection	Chris Neyman		Richard Dekany	11/21/2009 12:42			OK
Patrolling WFS Patrol Range	FR-1920	Mechanical	Functional	Essential	1.2.7	Each Patrolling WFS shall be positionable to measure light from an LGS located anywhere within a circular FoR of 120" diameter	Calculation of sky coverage (e.g. KAON 470) suggest that LO WFS NGS of sufficient brightness and proximity to the science target direction are likely to be identified with a 120" field surrounding the science direction. KAON 635 describes the advantage of the LGSF positioning Patrolling LGS a few arcsec radially outside each LO WFS NGS. KAON 644 describes the performance of the B2C architecture.	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Demonstration	Richard Dekany			11/21/2009 12:42			Need to check w/ Alex, used to be true
Patrolling WFS Packing	FR-1908	Overall	Unassigned	Unassigned	1.2.7	The Patrolling Asterism LGS WFS channels shall be able to measure wavefronts from two LGS beacons separated by 10 arcseconds.	Specifcation on size and crowding of pick-offs.	Eng. decision (V. Velur)	Draft	2	Demonstration	Viswa Velur		Richard Dekany	5/4/2009 9:20			OK
Fixed Asterism Transmission, New		Optical	Performance	Essential	1.2.7	The optical transmission of the Fixed Asterism LGS WFS shall exceed 84% at initial assembly	The WFE Budget Flowdown allocates this transmission	KAON XXX, http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/FlowdownSummary/NGAO_PD_Phase_Flowdown_Budgets_v0_96_2003_Format.xls	Draft	1	Demonstration	Richard Dekany			11/21/2009 12:42			OK
Fixed Asterism Transmission, Degraded		Optical	Performance	Essential	1.2.7	The optical transmission of the Fixed Asterism LGS WFS shall exceed 74% one year after initial assembly	The WFE Budget Flowdown allocates this transmission	KAON XXX, http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/FlowdownSummary/NGAO_PD_Phase_Flowdown_Budgets_v0_96_2003_Format.xls	Draft	1	Demonstration	Richard Dekany			11/21/2009 12:42			OK based on above
Patrolling Asterism Transmission, New		Optical	Performance	Essential	1.2.7	The optical transmission of the Patrolling Asterism LGS WFS shall exceed 81% at initial assembly	The WFE Budget Flowdown allocates this transmission	KAON XXX, http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/FlowdownSummary/NGAO_PD_Phase_Flowdown_Budgets_v0_96_2003_Format.xls	Draft	1	Demonstration	Richard Dekany			11/21/2009 12:42			OK
Patrolling Asterism Transmission, Degraded		Optical	Performance	Essential	1.2.7	The optical transmission of the Patrolling Asterism LGS WFS shall exceed 66% one year after initial assembly	The WFE Budget Flowdown allocates this transmission	KAON XXX, http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/FlowdownSummary/NGAO_PD_Phase_Flowdown_Budgets_v0_96_2003_Format.xls	Draft	1	Demonstration	Richard Dekany			11/21/2009 12:42			OK
Fixed Asterism Pupil Registration		Optical	Performance	Essential	1.2.7	The Fixed Asterism lenslet array shall be aligned the LODM to better than 5% (P-V) of a subaperture in pupil x shear, pupil y shear, pupil x magnification, pupil y magnification, and pupil rotation	The WFE Budget Flowdown allocates a given wavefront error from these terms that are converted to pupil percentage via a TBD modeling process	Engineering decision (R. Dekany) until simulations can be performed	Draft	2	Test	Peter Wizinowich		Richard Dekany	11/21/2009 13:31			Need to check w/ Alex,probably OK
Patrolling Asterism Pupil Registration		Optical	Performance	Essential	1.2.7	The Patrolling Asterism lenslet array shall be aligned the LODM to better than 10% (P-V) of a subaperture in pupil x shear, pupil y shear, pupil x magnification, pupil y magnification, and pupil rotation, for any point in the patrol FoR	The WFE Budget Flowdown allocates a given wavefront error from these terms that are converted to pupil percentage via a TBD modeling process	Engineering decision (R. Dekany) until simulations can be performed, understanding the performance tolerance on the Patrolling Asterism is looser than that of the Fixed Asterism KAON XXX, http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/FlowdownSummary/NGAO_PD_Phase_Flowdown_Budgets_v0_96_2003_Format.xls	Draft	2	Test	Peter Wizinowich		Richard Dekany	11/21/2009 13:31			Need to check w/ Alex,probably OK
LGS WFS Window Assembly optical quality		Optical	Performance	Essential	1.2.7	The transmitted optical quality of the LGS WFS Window Assembly shall be better than TBD nm RMS and TBD nm P-V	Part of the flowdown of overall wavefront quality in the LGS WFS path		Draft	1	Test	Richard Dekany						-
LGS WFS Window Mounting Interface		Mechanical	Interface	Essential	1.2.7	The LGS WFS Window Assembly shall mount to the cold enclosure structure in a TBD manner			Draft	1	Inspection	Richard Dekany						-
LGS WFS Window Assembly Thermal Interface		Thermal	Interface	Essential	1.2.7	The WFS LGS Window Assembly shall serve as a thermal window for the AO cold enclosure			Draft	2	Design	Viswa Velur		Richard Dekany	9/25/2009 0:00			plano-convex lens?
LGS WFS Support Structure Interface to Nasmyth Platform		Mechanical	Interface	Essential	1.2.7	The LGS WFS will be supported by a support structure that mounts directly to the Nasmyth platform	The B2C architecture elected to not cool the LGS WFS to the relay cold temperature and therefore LGS WFS needs its own support structure	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Inspection	Richard Dekany			11/21/2009 12:42			OK
Packaging	FR-538	Mechanical	Functional	Essential	1.2.7	The optics, mechanisms, and electronics of the LGS WFS shall interface with the AO system and the AO	To be better defined in one or more ICD's	LGS WFS ICD's (TBD)	Draft	2	Inspection	Chris Neyman		Richard Dekany	8/24/2009 9:58			-
LGS WFS Support Structure Alignment, Position		Mechanical	Implementation	Essential	1.2.7	The LGS WFS support structure shall be aligned to the required optical bench interface point to better than 1 mm.	In the F/45 LGS WFS input focal plane, 1 mm corresponds to approx. 0.25 arcseconds on sky. A misalignment of the Fixed LGS asterism to the optical axis of the telescope (and thus to the NGAO science path output) of 0.25 arcseconds will have negligable anisoplanatism impact on science.	http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/NewKAONs/NGAO_B2C_architecture_performance_v4.pdf	Draft	1	Inspection	Richard Dekany			11/21/2009 12:42			probably OK
LGS WFS Supoprt Structure Alignment, Angle		Mechanical	Implementation	Essential	1.2.7	The LGS WFS support structure shall be aligned to the required optical bench interface optical axis direction to better than 2 arcminutes (physical angle at the interface point)	The LODM and the LGS WFS pupils need to be aligned to better than TBC % pupil shear due to angular input errors at the front focal point of the LGS WFS.	http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/NewKAONs/NGAO_B2C_architecture_performance_v4.pdf	Draft	1	Inspection	Richard Dekany			11/21/2009 12:46			no plan on how to do this yet; need to design jig.
LGS WFS Support Structure Stability		Mechanical	Performance	Essential	1.2.7	The LGS WFS support structure shall be stable to a level better than (x,y,z,thetax,thethay,thethaz) = (TBD, TBD, TBD, TBD, TBD) with respect to the telescope coordinate system.	The LGS WFS support structure must be stable enough to not induce pupil shear between the LODM and Fixed Asterism lenslet array by more than TBD % of a subaperture	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Inspection	Richard Dekany			11/21/2009 12:46			-
LGS range related focus correction mechanism	FR-513	Overall	Functional	Essential	1.2.7	The LGS WFS shall have changeable focus with respect to the output beam from the wide field relay for LGS distances ranging from 80 km to 292 km from the Observatory.	The nearest distance of 80 km is the lowest practical sodium layer height at zenith; 292 km corresponds to the highest practical sodium height (100 km) at an elevation angle of 20 degrees	FR-1958	Draft	2	Test	Chris Neyman		Richard Dekany	5/1/2009 13:29			probably OK (need to change the focus control range from 150 to 205 mm), this of course makes the focus error
LGS WFS Tip-Tilt Mirrors		Overall	Functional	Essential	1.2.7	Each LGS WFS channel shall be equipped with a tip-tilt (TT) mirror to keep the LGS spots centered on the WFS subaperture centers	The idea is to use the LGS WFS tip-tilt signal to drive a TT mirror to keep the LGS spots centered on the WFS. This provides for better bandwidth as compared to having an uplink TT mirror at the laser launch.	Eng. decision D. Gavel	Draft	1	Design	Don Gavel	Velur		9/25/2009 0:00			OK
LGS WFS Tip-Tilt Mirror Rate		Overall	Performance	Essential	1.2.7	Each of the LGS WFS TT mirrors shall operate at up to 1000 Hz (TBC)	This UTT bandwidth is required to model the control architecture.	Eng. decision V. Velur	Draft	1	Design	Viswa Velur			9/25/2009 0:00			OK
LGS WFS Tip-Tilt Mirror Dynamic Range		Overall	Performance	Essential	1.2.7	Each of the LGS WFS TT mirrors shall have an on-sky throw of 5" P-V (TBC)	The accuracy and travel are required for determining capture range, dynamic range and centroid offsets.	Eng. decision V. Velur	Draft	2	Demonstration	Viswa Velur		Richard Dekany	9/25/2009 0:00			NOT OK (now they work to 2.2" on sky), can we change this #?
LGS WFS Tip-Tilt Mirror Accuracy		Overall	Performance	Essential	1.2.7	Each of the LGS WFS TT mirrors shall have an on-sky accuracy of 50 milli-arcsec (TBC)	The accuracy and travel are required for determining capture range, dynamic range and centroid offsets.	Eng. decision V. Velur	Draft	1	Demonstration	Richard Dekany			9/25/2009 0:00			OK (~ 1milliarcsec on sky accuracy)
Fixed Asterism LGS WFS Subaperture Spot Size		Optical	Performance	Essential	1.2.7	The contribution from optical design, fab, and alignment errors from the entire AO relay plus LGS WFS optical train on Fixed Asterism LGS WFS subaperture image quality shall be less than 0.25 arcsec FWHM	Need a flowdown among the various parts. Some of this is done in the Flowdown Budgets spreadsheet	KAON XXX WFE Budget V2.0	Draft	1	Design	Viswa Velur			9/25/2009 0:00			perhaps OK, alignment tolerancing is not to be done in this phase of the project!
Fixed WFS Format		Optical	Functional	Essential	1.2.7	The Fixed Asterism LGS WFS shall sample the wavefront with 63 subapertures across the telescope circumscribed diameter	The choice of 63 is determined by the WFE budget and assumes SOR-like laser return for each LGS beacon. 63 is chosen to match the scale of the HODM (N = 64 actuators available). The exact size is intentionally a little vague as the exact lenslet spacing w.r.t. the telescope pupil is a design choice, and because a few % nutation of the pupil will be present.	KAON 642 Design Changes in Support of Build-to-Cost; FR-2156 needs to be made consistent with this	Draft	1	Inspection	Richard Dekany			11/21/2009 13:49		Why is there no desire for a guard-ring of actuators to control the edge behavior (e.g. via extrapolation?)	OK (I assume this means 63 subaps across 10.949 m circle ... that's what's been done)
Patrolling WFS Format		Optical	Functional	Essential	1.2.7	The Fixed Asterism LGS WFS shall sample the wavefront with 31 subapertures across the telescope circumscribed diameter	The choice of 31 is determined by the LO WFS Sharpening WFE budget and assumes SOR-like laser return for each LGS beacon. 31 is chosen to match the scale of the LO WFS MEMS DM's (N = 32 actuators available). The exact size is intentionally a little vague as the exact lenslet spacing w.r.t. the telescope pupil is a design choice, and	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1	Inspection	Richard Dekany			11/21/2009 13:49		Why is there no desire for a guard-ring of actuators to control the edge behavior (e.g. via	OK (I assume this means 31 subaps across 10.949 m circle ... that's what's been done)
Operating Environment		Overall	Functional	Essential	1.2.7	The LGS WFS shall meet all of its functional and performance requirements for ambient (outside the LGS WFS) temperatures between -5C and 5C	The ambient temperature surrounding the LGS WFS shall be kept in the range of TBD to TBD.	Engineering decision (R. Dekany) informed by TBC statistics of ambient Nasmyth temperature today and TBD plans for NGAO Room air handling	Draft	1	Test	Richard Dekany			11/21/2009 13:19			perhaps OK
Engineering Environment		Overall	Functional	Essential	1.2.7	The LGS WFS shall meet all of its functional (but not performance) requirements for ambient (outside the LGS WFS) temperatures between -15C and 25C	The system will be integrated and tested at common room temperature	Engineering decision (R. Dekany)	Draft	1	Test	Richard Dekany			11/21/2009 13:19			perhaps OK
Dissipated Power		Thermal	Implementation	Essential	1.2.7	The LGS WFS subsystem shall not dissipate greater than TBD Watts into the AO Room environment	We do not wish the LGS WFS to become a source of NCP turbulence above a TBD level. (This should flow from an overall heat dissipation budget.)	TBD	Draft	1	Inspection	Richard Dekany			11/21/2009 13:19			-
Reliability, Fixed Asterism		Reliability	Performance	Essential	1.2.7	The MTBF for each Fixed Asterism LGS WFS shall be greater than TBD hours.	This should come from the uptime flowdown budget which is still being worked on	KAON XXX, http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/FlowdownSummary/NGAO_PD_Phase_Flowdown_Budgets_v0_96_2003_Format.xls	Draft	1	Design	Richard Dekany			11/21/2009 13:39			-
Reliability, Patrolling Asterism		Reliability	Performance	Essential	1.2.7	The MTBF for each Fixed Asterism LGS WFS shall be greater than TBD hours.	This should come from the uptime flowdown budget which is still being worked on	KAON XXX, http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/FlowdownSummary/NGAO_PD_Phase_Flowdown_Budgets_v0_96_2003_Format.xls	Draft	1	Design	Richard Dekany			11/21/2009 13:39			-
Patrolling Asterism LGS WFS Acquisition Accuracy	FR-1526	Mechanical	Performance	Essential	1.2.7	Patrolling LGS acquisition accuracy due to absolute positioing accuracy of the OSM shall be better than 100 milliarcseconds	Requirement needs to be flown down to the (probe arm) the WFS channel, the uplink TT mirror and the requirement on asterism deformation	Anna Moore's OSM KAON,*in press*	Draft	2	Test	Viswa Velur and Anna Moore		Richard Dekany	11/21/2009 15:06			perhaps OK, need to check with Alex.

Fixed Asterism WFS Linearity		Optical	Performance	Essential	1.2.7	The Fixed Asterism LGS WFS shall measure input subaperture tilts with better than 2.6% linearity over the operating dynamic range	Because NGAO operates in open-loop it is essential that the Fixed Asterism LGS WFS be exquisitely calibratable. The WFE budget suggests typical centroid motion residuals of ~150 mas RMS in median conditions (roughly measurement noise plus anisoplanatism on 10 arcsec radius), or ~750 mas for 5-sigma motions. We know that ~20 mas errors lead to ~20 nm science WFE (which is our WFE Budget Flowdown allocation (TBC)). So, we'd like better than 20/750 = 2.6% linearity.	KAON 692	Draft	1 Test	Richard Dekany		11/21/2009 15:02	This requirement also sets limits on allowable ghosting and cross-talk	1.3% non-linearity over 1.5 wave range, per Hardy
Patrolling Asterism WFS Linearity		Optical	Performance	Essential	1.2.7	The Fixed Asterism LGS WFS shall measure input subaperture tilts with better than 7% linearity over the operating dynamic range	Because the LO WFS Sharpening AO systems operate in open-loop it is essential that the Patrolling Asterism LGS WFS be exquisitely calibratable. The WFE budget suggests typical centroid motion residuals of ~300 mas RMS in median conditions (roughly measurement noise, bandwidth noise, and FA), or ~1500 mas for 5-sigma motions. We know that ~300 mas RMS centroid motion from measurement errors lead to ~75 nm LOWFS NGS WFE, so, we'd like better than perhaps 1/3 of this from nonlinearities. This corresponds to about (300/1500)*(1/3) = 7% non-linearity.	KAON 692	Draft	1 Test	Richard Dekany		11/21/2009 15:02	This requirement also sets limits on allowable ghosting and cross-talk	7.6% non-linearity over 2.5 waves, per Hardy
Fixed Asterism WFS Dynamic Range		Optical	Performance	Essential	1.2.7	The Fixed Asterism LGS WFS shall have an operating dynamical range of at least +- 1 arcsecond (on-sky)	This WFS must be able to capture the tip-tilt removed (because it's short exposure) image motion typical of open loop sensing at Mauna Kea. For an ~17 cm subaperture, this is about 0.3 arcsec RMS (TBC), so +- 1 arcsecond should allow for capture	KAON 692	Draft	1 Test	Richard Dekany		11/21/2009 15:02	Need this calculation in KAON 692	this is +/- 1.5 waves
Patrolling Asterism WFS Dynamic Range		Optical	Performance	Essential	1.2.7	The Patrolling Asterism LGS WFS shall have an operating dynamical range of at least +- 1.4 arcsecond (on-sky)	The Patrolling WFS must be able to capture the anisoplanatic image motion when the tomography loop is closed (driving the LODM, but without tip-tilt correction). Because it is possible for the isoplanatic angle to become quite small compared to the patrol FoR, we require sqrt(2) operating range here than for the Fixed WFS's to handle the case of the LODM correction being entirely independent of the WFE in the LO WFS direction.	KAON 692	Draft	1 Test	Richard Dekany		11/21/2009 15:02		this is +/-2.5 waves
Pixels per subaperture	FR-530	Optical	Functional	Essential	1.2.7	Each LGS WFS shall sample their Shack-Hartmann subimages with 4 pixels per subaperture.	While strictly a design choice, we include this among the requirements because certain calibrations elsewhere in the NGAO system depend on this choice	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1 Design	Peter Wizinowich	Richard Dekany	5/4/2009 8:46		OK
Fixed Asterism LGS WFS Field Stops	FR-531	Optical	Functional	Essential	1.2.7	The Fixed Asterism LGS WFS shall have a field stop to mitigate subaperture cross-talk, that also serves as a spatial filter of square diameter TBD arcseconds	We want to mitigate the impact of aliasing errors for the high-contrast LGS science case(s). For N=63 subapertures, we think (TBC) some benefit of anti-aliasing can be realized.	Engineering Decision (V. Velur and R. Dekany)	Draft	2 Inspection	Peter Wizinowich	Richard Dekany	5/4/2009 8:49		OK (3.6" field stop)
Patrolling Asterism LGS WFS Field Stops	FR-531	Optical	Functional	Essential	1.2.7	The Patrolling Asterism LGS WFS shall have a field stop to mitigate subaperture cross-talk	Experience with Shack-Hartmann LGS WFS's shows this to be a useful protection again subaperture cross-talk	Engineering Decision (V. Velur and R. Dekany)	Draft	1 Inspection	Peter Wizinowich	Richard Dekany	5/4/2009 8:49		OK (3.6" square field stop)
Detector Performance, Fixed Asterism LGS WFS		Electrical	Performance	Essential	1.2.7	The Fixed Asterism LGS WFS CCD shall meet the following specifications: dark current < 0.01 e-/sec/pixel at -40C, read noise < 2 e-/pixel/read at 500 fps,	We assume here 4 x 4 pixel sampling to arrive at these specs from the WFE Budget	KAON XXX WFE Budget V2.0	Draft	2 Test	Chris Neyman	Richard Dekany	11/21/2009 14:55		-
Detector Performance, Patrolling Asterism LGS WFS		Electrical	Performance	Essential	1.2.7	The Patrolling Asterism LGS WFS CCD shall meet the following specifications: dark current < 0.01 e-/sec/pixel at -40C, read noise < 2 e-/pixel/read at 500 fps,	We assume here 4 x 4 pixel sampling to arrive at these specs from the WFE Budget	KAON XXX WFE Budget V2.0	Draft	2 Test	Chris Neyman	Richard Dekany	11/21/2009 14:55		-
LGS WFS CCD Detector Geometry		Electrical	Functional	Essential	1.2.7	The LGS WFS CCD's shall have rectilinear pixel geometry	Since the issue often arises for some reason, we add this requirement to be explicit that NGAO will not use radial geometry CCD's as is planned by TMT NFIRAOS	KAON 642 Design Changes in Support of Build-to-Cost	Draft	1 Inspection	Richard Dekany		11/21/2009 15:02		OK
WFS Camera Controller		Electrical	Functional	Essential	1.2.7	Each LGS WFS camera shall have a unique AO Camera Controller	A design choice, but one that impacts the interfaces	Engineering Decision (V. Velur and R. Dekany)	Draft	1 Demonstration	Richard Dekany				-
WFS Camera Controller Functions		Overall	Functional	Essential	1.2.7	Each LGS WFS camera controller shall be remotely controllable by the AO device control system to turn the camera on/off and to change the required control parameters including pixel read rates, readout programs, biases, clamp and filter settings	Need to be able to control the camera remotely to run the AO system remotely	Common practice with WFS detectors	Draft	2 Design	Viswa Velur	Richard Dekany	11/21/2009 16:12		OK
Fixed Asterism LGS WFS Camera Rates		Electrical	Functional	Essential	1.2.7	The Fixed Asterism LGS WFS Cameras shall be operable at the following selectable frame rates: (TBD, TBD, TBD, 2,000 fps)	We need to decide on frame rates in conjunction with the RTC folks - should depend on available mesospheric sodium. Max rate set by HC budget.		Draft	1 Demonstration	Richard Dekany				probably OK
Patrolling Asterism LGS WFS Camera Rates		Electrical	Functional	Essential	1.2.7	The Patrolling Asterism LGS WFS Cameras shall be operable at the following selectable frame rates: (TBD, TBD, TBD, 1,000 fps)	We need to decide on frame rates in conjunction with the RTC folks - should depend on available mesospheric sodium. Max rate set by sharpening ability at Gal Center with IRS7.		Draft	1 Demonstration	Richard Dekany				OK
LGS WFS Motion Controller		Electrical	Interface	Essential	1.2.7	Motion control for the LGS WFS mechanisms shall be provided by the AO Controls subsysetm	The philosophy is that there is no LGS WFS controller per se (aside from the quasi-embedded WFS camera controllers) - Yes, this is a requirement on the AO Controls, but it's here to remind all the control system has not been omitted								OK
						Device: Patrolling LGS WFS Unit Focus — DOF per stage: 1 Patrolling LGS WFS Unit rotation — 1 Patrolling LGS WFS OSM — 2 LGS WFS Assy focus — 1									OK/ -
LGS WFS Mechanism Degrees of Freedom	FR-540	Mechanical	Performance	Essential	1.2.7	Motion control requirements for the LGS WFS: Number and type of mechanisms is TBD. Speed of mechanism motions is TBD. Accuracy of the mechanism motions is TBD. Focus tracking accuracy is TBD.	Eng. decision on motor control helps purchase and software development for the whole NGAO project.	http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/ControlsSystems/MotionControlArchitectureStudy_KAON643_v1_1.doc	Draft	1 Test	Chris Neyman		5/1/2009 13:13	Why is this a requirement? Sounds like design choices.	
Interface to AO real-time control system	FR-548	Interface	Interface	Essential	1.2.7	The LGS WFS shall have an interface to the real-time control system (RTC). The pixel data from the LGSWFS focal planes shall be routed to the RTC for the purpose of reconstruction the wavefront over a TBD data interface.	"Cascaded Relay Requirement Flowdown and Open Issues", R. Dekany NGAO Team Meeting #9 and KAON 499 "NGAO System Architecture Definition		Draft	2 Demonstration	Chris Neyman	Richard Dekany	5/4/2009 9:16		OK