NGAO Functional Requirements

Key	Name	Sect	Cat	Priority	WBS	Description	Rationale	Traceability	Status	Version	Verification	Originator	Last Modified
FR-33	Second stage relay	Overall	Functional	Essential	1.2.5	The AO system shall have a second stage relay with a second deformable mirror located at an optical conjugate to the ground layer. The position of the second stage in the optical train is in series, after the first stage	The second DM is intended to correct the incoming wavefront to an accuracy consistent with the requirements for high Strehl narrow field instruments.	KAON 499 "NGAO System Architecture Definition"	Draft	1.0	Inspection	Chris Neyman	Mar 5, 2009 1:10 PM
FR-41	Second relay field of view	Optical	Performance	Essential	1.2.5	The second stage of the relay shall pass a circular unvignetted field of view of 20 arc seconds diameter with a goal of 40 arc seconds. (These fields are referenced to the sky)	This requirement is driven by need to image the science target itself along with surrounding astrometric reference stars	This requirement is derived from SRD requirements XXXX. The stressing science case is the imaging of the Galactic center see also: Architecture_reqments_summary_v7.xls	Draft	1.0	Test	Chris Neyman	Mar 5, 2009 1:10 PM
FR-43	Static optical quality of second relay	Optical	Performance	Essential	1.2.5	The static optical quality of the second AO relay shall be as high as possible over the entire field of view of the AO system. Uncorrectable static aberrations of the AO first and second relays shall be no more than 30 nm, including chromatic focal shift.	TBD	This requirement is derived from the Performance Budget, Wavefront Error and Encircled Energy spreadsheet. It meets the static aberration requirements of all science cases	Draft	1.0	Test	Don Gavel & Renate Kupke	Mar 5, 2009 1:11 PM
FR-47	Curvature of output focal plane, second relay	Optical	Functional	Essential	1.2.5	The focal plane curvature at the output of the second relay shall be known, so that instruments fed by the second relay may compensate for it, if necessary.	TBD	Interface document(s) to narrow field instruments (to be written)	Draft	1.0	Demonstration	Don Gavel & Renate Kupke	Mar 5, 2009 1:12 PM
FR-57	Pupil image size internal to the second relay	Optical	Performance	Essential	1.2.5	The pupil image size of the second relay shall be 25 mm.	This pupil size is driven by the choice of deformable mirror for the second relay. The requirement is to accommodate a DM having 64 actuators across the diameter of the pupil and we are assuming that the actuator pitch is 400 microns	KAON 499 "NGAO System Architecture Definition"	Draft	1.0	Test	Chris Neyman, Don Gavel	Mar 5, 2009 1:18 PM
FR-59	Output pupil distortion, entire relay	Optical	Performance	Essential	1.2.5	The combined first and second relay shall provide less than TBD% pupil distortion in the output beam.	This requirement will be driven by requirements or good practice for the instruments. For example it may take into account the feasible design of cold stops and other optics in the infrared instruments.	Wavefront error budget spread sheet version 1.26, dm-lenslet registration	Draft	1.0	Test	Chris Neyman, Don Gavel	Mar 5, 2009 1:19 PM
FR-1491	Lateral color, second relay	Optical	Performance	Essential	1.2.5	Lateral color shall be no more than (30 milli arc sec) TBD for the second relay.	Cause a minimal effect on NGS wavefront sensing accuracy. Assumption is that an ADC can correct for this.	Wavefront error budgets	Draft	1.0	Test	Renate Kupke, Don Gavel	Mar 5, 2009 1:11 PM
FR-1496	Field distortion, second relay	Optical	Functional	Essential	1.2.5	When both relays are used in combination, the optical distortion across the field at the output of the second relay shall be correctable by calibration of the AO system.	To first order, an astrometric grid can be established with internal fiducial. The Galactic Center science case will need to use an on-sky grid to establish distortion to the 0.25 mas level	Astrometric Accuracy Performance Budget http://www.oir.caltech.edu/twiki_oir/pub/Keck/NGAO/AstrometryBudget/ngao_astrometry.ppt - Jessica Lu	Draft	1.0	Demonstration	Don Gavel	Mar 5, 2009 1:11 PM

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FR-1498	Transmission, second relay	Optical	Performance	Essential	1.2.5	The optical transmission of the second relay shall be as follows: 1. Transmission in the wavelength range XXXnm to YYYnm [IR Science wavebands] will be TBD %. 2. Transmission in the wavelength range XXXnm to YYYnm [Visible Science wavebands] will be TBD %		Wavefront error budget (natural guide stars), Background and Transmission budgets-KAON 501 (science light)	Draft	1.0	Test	Chris Neyman, Don Gavel	Mar 5, 2009 1:12 PM
FR-1500	Output focal ratio, second relay	Optical	Performance	Essential	1.2.5	The output focal ratio of the second relay shall be greater than f/40	The output focal ratio was chosen as an architectural design decision considering back focal distance, room for the instrument switchyard, reasonable output pupil size and location, and reasonable plate scale for infrared science instruments. This requirement may be revisited as science instrument concepts mature.	Engineering decision Don Gavel (Brian Bauman)	Draft	1.0	Test	Don Gavel	Mar 5, 2009 1:13 PM
FR-1501	Exit pupil location, entire relay	Optical	Functional	Essential	1.2.5	The output of the AO optical relays shall be a telecentric beam (pupil at infinity).	The pupil location was chosen to simplify the design of the NGS WFS. A telecentric system does not require tilt with field to keep the chief ray constant on entering the wavefront sensor.	Engineering decision of AO relay design team (see System Design Manual)	Draft	1.0	Demonstration	Don Gavel	Mar 5, 2009 1:18 PM
FR-1506	Telescope pupil image grid distortion, second relay	Optical	Performance	Essential	1.2.5	The pupil grid distortion at the output of the second relay shall be less than 0.2 %.	Assumption is that "push matrix" calibration will be able to measure this distortion sufficiently for the RTC to correct wavefronts in open loop to the required wavefront accuracy	Wavefront Error Budgets, and design study for AO relay (see System Design Manual)	Draft	1.0	Test	Renate Kupke	Mar 5, 2009 1:20 PM
FR-1508	Telescope pupil image aberrations, second relay	Optical	Performance	Essential	1.2.5	The pupil aberration at the tweeter mirror in the second relay shall be less than 10% of a subaperture on DM.	The telescope will map to the tweeter mirror with a point spread function whose width depends on the field being corrected, in this case 30 arcseconds.	Wavefront Error Budgets	Draft	1.0	Test	Renate Kupke	Mar 5, 2009 1:21 PM
FR-1509	Output pupil distortion, entire relay	Optical	Performance	Essential	1.2.5	The pupil distortion at the output of the combined first and second relay shall be less than 10%.	This requirement will be driven by requirements or good practice for the instruments. For example it may take into account the feasible design of cold stops and other optics in the infrared instruments.	***Needs to be traced to instrument requirements ***	Draft	1.0	Test	Chris Neyman, Don Gavel	Mar 5, 2009 1:20 PM
FR-1511	Telescope pupil image tilt, second relay	Overall	Performance	Essential	1.2.5	The pupil tilt at the tweeter mirror, in the second relay shall be less than 6 mm at the edge of the 25 mm DM	There will be a large tilt of the pupil at the plane of the woofer, due to the nature of producing the pupil with an off-axis parabola. This tilt will act like an uncertainty in the conjugate height being corrected. The uncertainty in conjugate height = (magnification)^2 x (edge displacement). Magnification = 400 (10 m -> 25 mm). A 6 mm tilt will cause 1 km conjugate height variability	Anisoplanatic error in wavefront error budgets.	Draft	1.0	Test	Renate Kupke	Mar 5, 2009 1:19 PM
FR-1512	Telescope pupil image tilt, combined relay	Optical	Functional	Essential	1.2.5	The output pupil tilt from the entire relay shall be compatible with the input requirements of the science intstruments it	The combined first and second relay provides an output pupil that is seen by the science instruments, which will have cold	***Needs to be traced to instrument requirements ***	Draft	1.0	Test	Chris Neyman, Don Gavel	Mar 5, 2009 1:20 PM

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						feeds.	pupil cold stops and an optical design that will need to be compatible with this interface.						