NGAO Preliminary Design Team Meeting #8

September 10, 2009

Meeting Minutes

The NGAO team met for 3 ½ hours to discuss the implications of the error budget flowdown reconciliation memo[1] prepared by R. Dekany. A number of recommendations in that memo were adopted, and a few changed as reflected in a new reconciliation memo v0.7 accompanying these minutes.

The basic schedule calls for addressing (nearly) all of these action items in time to be incorporated into an official 'version 1.0' release of the flowdown budget summary, which will be accompanied by a 'frozen' version of the WFE budget tool and HC performance budget tool, and an associated update to the Contour requirements database, all by the end of September. A target, then, for resolving action items below should be ½ of them done by 9/17 and the rest by 9/24/09.

Following this release, NGAO will adopt a more formal change-control process, as described in KAON 638.

Actions listed below should be executed in reference to the reconciliation memo v0.7 and the flowdown error budget summary v0.95, both found on the Flowdown Budgets TWiki site[2].

Action Items

Bouchez

Develop a timing flowdown for NGAO operations that can satisfy the requirement for '3 second dithers'. Consult with E. Johansson for communications overheads and WMKO mechanical staff re: telescope settling time, if necessary.

Dekany

Post an updated version of the reconciliation memo with the adopted changes (excluding those not adopted).

Determine optimal LOWFS circular cold stop diameter (between 9 and 10.949 meters).

Confirm the LODM stroke assumption in the WFE tool is 4 microns of surface figure.

Update WFE budget tool treatment of interactuator stroke limit errors to behave more sensibly in poor seeing conditions.

Integrate newest 'uptime flowdown' sheets into Version 1 of the flowdown budget summary, when prepared by C. Neyman.

Make explicit the contribution to the long-exposure NCP tip-tilt budget flowdown arising from K-mirror rotational errors. This should generate a Contour requirement that the LOWFS provide feedback to fine tune the rotation rate of the K-mirror, to meet some allowable error.

Revise the structure of the NCP error flowdown to make explicit the nature of common-path and NCP vibrations. Consider a separate call-out of vibration errors and drift errors.

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[1] NGAO_PD_Phase_Flowdown_Reconciliation_v0.6.doc available at http://www.oir.caltech.edu/twiki_oir/bin/view/Keck/NGAO/090902_Remote_NGAO_PD_Meeting_8

[2] Found under the 'Systems Engineering' heading of the main NGAO TWiki page.

Build a new WFE tool 'release' consistent with version 1 of the flowdowns budget. Add traceability of the flowdown summary sheet to this new release version. Provide all to E. Johansson who'll put it under version control as a reference.

Crepp

Prepare several slides on HC budget results for Keck Science Meeting **{DONE}**

Discuss with Gavel the appropriateness of the ½ DM hold latency in calculations that require -3db bandwidth to be approximated as some multiple of 1/(data latency).

> One argument goes like this: By the time the WFS has measured an error signal, it is on average ½ the frame time old. When the DM applies the correction it is initially latent by
>
> ½ WFS frame time + all compute latency
>
> however, this shape is kept on the DM for an entire DM hold time, so that by the time the next DM update arrives, there is an additional latency of ½ hold time, so
>
> data latency (average) = ½ WFS frame time + all compute latency + ½ DM Hold time
>
> Another way to think of it is that from the earliest WFS photon arrival (at start of frame) to the latest science photon corrected with that WFS signal (last moment before subsequent DM update), there elapses 1 frame time + all compute latency + 1 hold time = 2 frame times + all compute latency. Since this is pessimistic, we use the average (e.g. midpoint) frame values, or 2/2 = 1 frame time + all computer latency.

Regenerate the HC error budget once Version 1 of the flowdown summary is 'checked-in' (current version is 0.95). This will become a 'controlled' version of the budget that can be used for future traceability and reference.

Gavel

Provide Dekany with assumed (or measured if available?) GPI optical surface cleanliness assumptions and/or budgets.

Rework compute latency flowdown budget for 2kHz update rate, but consistent with 59 nm rms residual WFE.

Develop detailed servo law for NGAO in order to assess feasibility of the allocation of 'leaky integrator zero-point calibration error' of 15 nm, rms. One implication of this requirement may be that the DM shape to which the servo 'leaks' must be updated at some TBD frequency, and that this should be introduced as a Contour database requirement.

At PD TM#8, we discussed the need for simulations to determine the pupil registration requirements in mechanical/physical units, that correspond to the pupil registration flowdown budget sheet. Gavel agreed to look into this issue on the time-scale of a month. Until then, we will work toward maintaining 5% of the smallest subaperture size (5%/63 = 0.08% or 800 ppm) pupil registration for all significant pupil combinations identified in the flowdown budget[3].

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[3] The 5% of a subap working tolerance is based on wave-optics simulations performed for the N=64 across PALM-3000 system.

Johansson

Develop flowdown budget for system software to meet the implication of no more than 15nm of stale reconstructor error – the error due to the fact that the reconstructor has become out-of-date. There may be two or more timescales to worry about: 1) updates due to rotation of the partially illuminated subapertures in the HOWFS's, and 2) updates due to $C_n^2(h,t)$ changes that affect the optimal tomography reconstruction.

Kupke

Contact Sergei at WMKO to confirm M1, M2, and M3 reflectivities assumed in flowdown.

Confirm that AO system surface counts in flowdown summary v0.95 properly treat the instrument and WFS windows (e.g. no double counting with an "AO system exit window".

Double check that emissivity calculations in the flowdown summary are made for 30 degree zenith angle (and not at zenith). If necessary, update for 30 degree zenith angle (this will then require an update to the NGAO cooled enclosure temperature.) – note: reassigned from Dekany

Confirm (or modify) emissivity calculations in the flowdown summary to reflect the degradation assumptions in Table 1 of the reconciliation memo v0.7. This may lead to a reassessment of the required system temperature to meet emissivity requirements.

Develop 'correctable' and 'uncorrectable' AO system wavefront error flowdowns, paralleling the 'transmission per surface' flowdown with a 'quality per surface' formalism, including allocation of allowable wavefront figure error to minimize total optics cost. (See Table 7 of the flowdown reconciliation memo (v0.7) for initial guidelines.)

Develop a small quasi-flowdown budget to investigate to minimum distance the NGAO system can operate from the overhead (zenith) keyhole. The limit may be set by one or more of the following: K-mirror max rotation rate, telescope azimuth slew rate (and how does the former behave when the later is saturated?), the update rate for the rotating reconstructor calculation for partially illuminated subapertures, etc.? First look should be broad and shallow to identify requirements drivers.

McGrath

We have a system emissivity requirement of < 30% above that of sky + telescope in K-band. Clarify whether this means across the integrated K-band, at 2.2 microns, at 2.4 microns, or other? Evaluate science impact of assuming integrated K-band vs. 2.4 microns (would likely drive enclosure temperature by a few degrees). Until complete, we will assume the requirement must be levied at 2.4 microns.

Neyman

Develop an initial uptime budget in concert with the NGAO subsystem leads, based on the basic sound approach in the current flowdown budget. Goal should be to highlight unusually difficult requirements early to influence design choices. Experience with first-gen AO system failures at Keck should be considered important

Stalcup

Confirm LGSF BTO transmission degradation assumptions in Table 1 of the reconciliation memo v0.7 in light of the comment that 'dust can get 'cooked' onto laser beam train surfaces' even with relatively modest laser fluences encountered with few-millimeter diameter beams.

Troy

Develop a flowdown budget for the ability of the NGAO TTFA sensor to measure atmospheric focus and astigmatism from the same guide star providing tip-tilt signal. Discuss details with R. Dekany.

Velur

Confirm LGS HOWFS design uses an existing lens as the 'window' separating the cold AO system environment and the LGS subass'ly. Answer question, "Do we need a double window?" at the HOWFS interface, as we do at the input window to the AO enclosure? Confirm conclusions with Kupke.

Confirm LOWFS design includes a circular cold stop. Work with Dekany to incorporate optimum stop diameter (until then, assume 9m effective inscribed pupil diameter.)

Revisit the LOWFS design to try to increase the transmission from sky to focal plane (currently 0.30). This may require changing the architecture – begin with review of the full surface count lists.

Perform an analysis to confirm that 4x4 pixel sampling in the fixed-asterism HOWFS is sufficient to meet the allocated 40 nm, rms of 'dynamical WFS zero-point calibration error'. In other words, that changes to fixed-asterism HOWFS spot size do not result in the shift of non-zero centroid offsets to a degree resulting in more than 40 nm, rms science wavefront error. This should be written up as a separate KAON as part of the HOWFS design task.

Unassigned

Add requirement to Contour for the allowable reflectivity/transmission degradation after one year of NGAO operations for all optical components.

Develop a flowdown budget for PSF stability. This will likely require some definition of the appropriate PSF metrics. We need to distinguish between expected Strehl stability, EE stability, and PSF shape stability (for example parameterized by a moment expansion?) It is very unclear how this flowdown would be converted into requirements for the NGAO system, but could influence issues such as centroid offset stability in the fixed-asterism HOWFS (perhaps leveling some new requirements on the HOWFS subass'ly) or introduce a new routine calibration procedure (such as the modified Gersberg-Saxton (MSG) algorithm for PSF tuning used at Palomar). Priority should be placed on determining drivers that can degrade PSF stability.