

Keck Next Generation Adaptive Optics NGS WFS Mini-Review Review Committee Report

Keck Adaptive Optics Note 738

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Reviewers overall impression:

The team has done a satisfactory job given the uncertainty in the requirements and the other related subsystems. The main AO subsystems are still being designed and undergoing changes at the present time. The review team was satisfied with the posted review material. The response of the design team to our questions asked before the review was also acceptable.

Specific charge to reviewers used at NGAO mini-reviews:

Is the architecture technically feasible?

The proposed design architecture appears technically feasible and does not require any breakthroughs or extensive technology development. The procurement of a CCD detector that meets all the requirements is the one exception. While this is a risk to the project, the design team and other NGAO team members have dealt with these issues before. The review team does not see this as a major area of concern but it should be monitored as the project proceeds.

Is the architecture cost effective?

The design team was not asked to make a detailed cost estimate for this review. The current design appears to be consistent with the cost of other single object NGS wavefront sensors constructed by our member institutions in the past. Therefore we anticipate that a good “basis of estimate” exists for this subsystem and believe the design to be cost effective.

Is the architecture sufficiently matured enough that it can be developed to the PDR level by May of 2010?

The design team will need to address the issues noted in the general comments section below but appears to be on track for completing a PDR level design by the end of May.

Are the requirements understood?

See comments below under “Requirements and Other Systems Engineering Issues”. The reviewers also recommend the following actions for the design team:

- Cross check what Truth Wavefront Sensor (TWFS) requirements of the LOWFS subsystem also apply to the NGS WFS low order mode (5x5).
- Cross check main AO relay and image rotator requirement implications for NGS WFS.

Is the architecture complete?

The architecture appears to be complete at this time.

Does the proposed design satisfy the requirements?

The review team will await the completion of the compliance matrix by the design team, before making any final statements about this.

General Comments and Recommended Design Team Actions

- Review team recommends that an “integrated” team be formed to address the issues associated with the insertion and removal of the IF dichroic. This requires the NGS WFS to be refocused and also causes a shift of beam on OAP3 of about 4mm. Viswa Velur has already made a start at understanding these issues, he appears to be the natural lead to the review team for this task. Viswa needs to work closely with Chris Lockwood, Reni Kupke and Alex Delacroix so that the final plan is understood by all effected subsystems. They should then have that plan approved by the senior management.
- NGS WFS design team needs to get current working optical (Reni Kupke) and mechanical (Chris Lockwood) design files for the main AO relays and AO bench.
- Design team should work with SciMeasure and Sean Adkins to verify that the camera based on the CCID74 will have the same packaging as the standard “Little Joe” envelope assumed in the design presentation.
- Design team should confirm with project leads that a square field stop not circular is the desired choice. Review team recommends this decision be added to the requirements database.
- Review team recommends that the design team use focal length and relevant physical scales when documenting the design and not use the f/#. The working f/# is not a good parameter to describe optical designs because of the irregular Keck pupil. This appears to be the cause of the confusion between f/19 or f/20 during the mini-review presentation.
- During presentation two methods to achieve wavefront sensor with both high order (~63x63) and low order (~5x5) while reusing many of the same components were discussed. Design team should document why the preferred method was used. Both of the suggested methods, constant focal length (proposed by Peter Wizinowich and Thomas Stalcup) and constant lenslet f-number (proposed by Viswa Velur) appear to have good and bad points. A small trade study “table” of these points should be added to the final NGS WFS design KAON.
- Design team should evaluate the use of optical sub assemblies that are mounted in small barrels or on common “risers” current use of all “post mounts” might have alignment issues as each optic is allowed to move independently.

- Review team suggests investigating linear PZT motors for lenslet positioning. The high order wavefront sensor mode will have a very tight DM-to-lenslet registration tolerance.
- Review team recommends that the requirements be modified to include a statement about maintaining DM-to-lenslet alignment after switching between the 5x5 mode and the 63x63 mode. Design team should investigate making the motions of the lenslet repeatable so that after a reconfiguration the DM-to-lenslet calibration does not need to be redone each time the wavefront sensing mode is changed.
- Review team recommends that the pupil imaging distortion be expressed in terms of the DM-to-lenslet misregistration.
- The field steering mirror design needs further work with issues, including:
 1. What are the final required sizes for each mirror to accommodate full field and beam walk
 2. Can the second FSM mirror be made smaller than 100 mm diameter
 3. Find gimbal mounts with smaller footprints
 4. Use as many common items for mounts, motors, etc. as possible
 5. Confirm precision and repeatability of commercial mounts is consistent with requirements.
- Design team should investigate the best location for a Na rejection filter for NGS WFS.
- Design team should complete preliminary thermal analysis by PDR.

Requirements and Other Systems Engineering Related Issues

The Review Team notes the following issues with the requirements compliance for the NGS WFS.

- The NGAO project still has some uncertainty about what is a genuine requirement placed on the NGS WFS and what is merely a design preference of three NGAO project leads. Often these desired quantities were merely communicated to the NGS WFS team verbally or in an email.
- The systems and functional requirements for NGAO went through an extensive revision in early March these requirements were changing as the NGS WFS design team was working on completing the work for this review.

- Relevant requirement for the NGS WFS are “encoded” in the wavefront error budget (KAON 716) and the various pages of the flowdown budget tool. Neither of these tools has been released in final form until this week (March 29, 2010).
- At present no wavefront error budget exists for the NGS WFS in any of its modes or science cases. See actions for systems engineering at end of the document.
- Exact size for Neptune and Uranus is not documented. Implications for wavefront sensing not understood.

Actions for systems engineering group members

Review team suggests the following action for NGAO System Engineering

- At present no wavefront error budget exists for the NGS WFS in any of its modes. Rich Dekany has offered to remedy this situation in the next few weeks, including implications from large objects (Uranus, Io, and Neptune) as well.
- Rich Dekany will bring the WFE budget in line with larger allocations to the static errors on the various WFS's (currently, a single allocation is made for all WFS).
- Rich Dekany will add a trade study for what happens if the NGS WFS (and LGS WFS) detectors (CCID74's, by choice) miss their expected noise performance specs to WFE budget (KAON 716).
- Chris Neyman will make the following changes to the subsystems compliance packets:
 1. Add a column for comments by the engineer completing the compliance matrix
 2. Add a pull down list item of “Done by Preliminary Design Review”
 3. Change “AO system wide” to “Overall AO system” as title of that tab.