November 31, 2009

Reviewer's Comments
NGAO November 17, 2009 Opto-mechanical Mini-review Review

An internal review of the opto-mechanical subsystem (aka optical relay) preliminary design was held on November 17, 2009. The review committee consisted of Richard Dekany, Thomas Stalcup, and Alex Delacroix.

The charge to reviewers is included as an Appendix to this report.

Technical feasibility and design completeness

The review committee found the functional requirements 'compliance' matrix to be reasonably accurate, including a number of TBD's and TBC's. These items should be addressed rapidly in order to stabilize the optical design, which can affect the WFS, science instrument, enclosure, and support structure. In addition,

- The goal of passing light as short as 0.6 microns to the science instrument should be made explicit in the requirements.
- A single ADC may not reach to 600nm; at the mini-review we agreed to proceed with one ADC design for NIR, and will evaluate performance to 600nm.
- The unvignetted FoR for the output port feeding the LGS WFS should be defined in the functional requirements.

The review committee found that the technical completeness of the AO relay optical design, including Zemax prescription and transmission estimates, were at a level appropriate for a preliminary design. The mechanical design, including manufacturing and alignment tolerances, however, were not as mature. In particular the committee found:

- Optical transmission of LGS light should be updated to used object distances between 80 km and 292 km to be consistent with 80 km at zenith to 100 km height at 70 deg zenith angle (per the current system requirements).
- Tolerancing of the optical parameters of the relay (such as OAP radii of curvature, deformable mirror placement, or K-mirror axis alignment) requires detailed analysis.
    - It was pointed out by Peter that misalignments in current system lead to 0.7% of M1 motion at the K1 DM (this will be ~1/2 a subap in the NGAO LGS WFS!)
    - It was agreed the SysE team would work to establish K-mirror requirements ASAP.
- Similarly, we will need tolerancing to determine the effect of manufacturing errors on the pupil size, location, and distortion.
- Tolerancing should be carried out for both initial alignment, and separately to identify the stability requirements of the optical relay under thermal and other mechanical drifts.

- Closer analysis of the pupil registration between each of the two DM's and the several WFS lenslets should be undertaken, in conjunction with the WFS teams.
- What is the impact of the curvature of the pupil, in terms of anisoplanatism caused by a non-planar pupil?
    - In passing, Don pointed out that the HO DM may have a typical radius of curvature of 300 mm. The narrow-field relay design should consider the impact of +- 300 mm radius of curvature on this element.
- The cleanliness environment of the AO relays within the AO enclosure needs further definition.

In addition, the optical performance of the optical relay over the 120 arcsec patrol range of the LGS WFS was in question. Specifically:

- There is a large, variable amount of wavefront error over the LGS field. Even if it can be calibrated out without using too much of the WFS range, the committee had concerns about what impact this will have on calibrations. The calibration file will have to change with field position. The large variation means that many points will have to be calibrated and possibly interpolate between them when in operation. This may not be too bad if it is purely astigmatism, or something that is very predictable.
- There remains uncertainty over the tilt variation of the output focal plane as a function of object distance.
- The Interferometer Feed requiring 1.1 - 4.1 microns to KI will impact LOWFS operation with KI – it was asked if we will need LO WFS operation less than 1.1 microns? Probably not, because there is no corresponding LO WFS advantage on the other telescope. So don't drive the LO WFS by KI observing mode. [This discussion led to a reconsideration of the operating modes as previously defined by Peter – subsequent to the mini-review Peter updated the observing modes defined in KAON 550.]
- The LGS WFS output window was confirmed to be part of the LGS WFS subsystem and will be further designed by that team.

Mechanical design is incomplete, particularly for the second-stage narrow-field relay, and the committee understands the LO WFS team will take the lead in considering that issue, in consultation with Reni, Chris, and Don.

- The mechanical mounting strategy for the relay optics need to be further development, in light of the tolerance analysis above.
- Detailed consideration should be given to the alignment behavior during cool-down of the AO relay from ambient (at which alignment is presumed to occur) and cold operation at minus fifteen (-15C). Unless the mechanical design is made specifically athermal, there is some concern the I&T of the AO relays will require successive instrument cool-down and warm re-alignment cycles. If expensive mitigations, such as an Invar bench, custom mounts, etc. will be required, this should be highlighted in time for the PDR.
- There was some question as to the pedigree of the specs on slide 13 of Chris L.'s

presentation. The numbers there appear general, and not necessarily indicative of analysis of the NGAO design.

The definition of the entrance window is immature. Several options exist including single v. double window design to prevent condensation, laminar dry air or nitrogen flow for the same purpose, and/or integration of the cold enclosure window with a window to the NGAO AO room. These require consideration before the PDR.

Overall, the committee felt progress was being made, but noted that all elements excluded from this review (particularly the interface definitions, which are needed urgently, and the enclosure and environment control systems) need high priority attention to meet the goals of our PDR.