Keck Next Generation Adaptive Optics

NGAO System Design Phase: Work Scope Planning Sheet

WBS Element Title: **Throughput and Background Performance Budgets**
WBS Element Number: **3.1.1.3 and 3.1.1.4**
Work Package Lead: Antonin Bouchez
Work Package Participants: N/A

1. Work Scope

WBS Dictionary Entry: 3.1.1.3: Development of optical transmission budgets for each of the science path(s), HOWFS, LOWFS(s), and slow WFS.
3.1.1.4: Development of thermal background budget for the IR science and wavefront sensor instruments.

Requirements: I will compute the optical and infrared transmission and background delivered to the NGAO science instruments, HOWFS, LOWFS (both visible and near-IR), and slow WFS.

2. Inputs:

Requires optical prescription (order of components, materials, and coatings) of the NGAO system and Keck telescope. However, can begin work using the NGAO proposal point design and explore the effects of reasonable departures from this. Will use the optical sky brightness measurements of Krisciunas[1], and the Gemini Integration Time Calculator sky brightness model[2] in the near-infrared.

3. Products:

This work package will generate:

1) A technical report describing the assumptions, methods, and results of the study. As the results are expected to be a strong function of optical design, the report will focus on describing the effect of architectural choices on the transmission and thermal background delivered to the various sensors.

2) An error budget tool which allows the lunar phase, telescope zenith angle, temperature of the AO enclosure, and the number, order, and type of optics in each path to be adjusted. The output of this tool will be the transmission (as a function of wavelength, and averaged over standard bands) and background light (photons s^{-1} $arcsec^{-2}$ nm^{-1} as a function of wavelength, and magnitudes $arcsec^{-2}$ averaged over standard bands) delivered to each focus.

4. Methodology:

The transmission calculation is simple, the main effort being in the gathering of transmission and reflection spectra for the relevant materials and coatings. The surface and volume transmission spectra in the light path from outer space to each focus are then multiplied to determine the final transmission spectrum.

The computation of thermal background at each focus is similar, with the integration beginning with the observed atmospheric emission spectrum. Each surface and volume then adds thermal emission (emissivity spectrum times blackbody flux) and attenuates upstream emission. The calculation is continued to each focus.
The error budget tool will first be developed in IDL, then transferred to Excel if deemed necessary by the EC.

5. Estimate of effort:

80 hours

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[1] Krisciunas, K., Optical Night-Sky Brightness at Mauna Kea over the Course of a Complete Sunspot Cycle, PASP **109**, 1181-1188, 1997.
[2] http://www.gemini.edu/sciops/ObsProcess/obsConstraints/ocSkyBackground.html

6. Approvals:

Control	Name	Date
Authored by:	**Anthonin Bouchez**	**01/18/07**
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	NGAO EC Chair	