

The following is based on a 2/14/06 telecon attended by the Chairs of the four NGAO Science Case Subcommittees (Liu, Marchis, Max, Wizinowich) + 2 edits from Liu.

Summary:

- During this telecon we identified generation of KPAO-type PSFs as the very highest priority (and making them available to the science groups).
- Peter was asked to produce a summary of the other technical support requests to date in order that they can be prioritized in future discussions.
- Since we have already started on the companion sensitivity problem, and this will clearly be needed, we will likely want to continue with this task.
- Mike expressed the desire to have zeroth order science cases from each subcommittee by the end of the month.
- We need to present the science case and technical proposal at the June 21 SSC meeting in Waimea. The subcommittee chairs should all plan to attend in person & the subcommittee members should try to be available to attend via phone.

Note: for more details on the science subcommittee thoughts look at the meeting summaries that can be found at <http://www2.keck.hawaii.edu/optics/ScienceCase/index.htm#Committees>.

KPAO-type PSFs:

- We need to define and produce a set of psfs that can be used by the science groups to evaluate the capabilities of the KPAO (narrow-field) system.
- To start with Mike suggested that we evaluate the good seeing case, since this tends to be where the most science comes out of the current system. Later we can consider different seeing cases. To start with Mike also suggested that we do zeroth order psf estimates and later do variability.
- Note that the first round of psfs that Chris sent around were for a large rms wavefront error (230 nm). Chris is working on producing psfs closer to the 120 nm requirement and reasonable fidelity. Claire suggested assuming a specific LGS configuration to start with.
- The science cases that will be evaluated using these psfs are the following:
 - Astrometric studies of the Galactic Center (GC). GC group would provide x,y positions, magnitudes and colors for all the point sources in the field at several epochs. We would then add in the psfs. The GC group would then use their tools to perform the astrometry and to determine the astrometric accuracy. This is the confusion-limited case. Small field (few arcsec diameter). Perform at J, H and K. Do for three psf cases: 180, 120 and 90 nm. Ignore distortion. Perhaps the science team could identify which stars should be used for IR tip/tilt references?
 - Multiple asteroids. They would like to provide a perfect image at several epochs, and technical group would provide back observed images. They would then use their existing tools to analyse the observed images. Need to generate images in the visible and near-IR. Can assume that asteroid is tip/tilt reference and that it is < 0.2" diameter.
 - Galilean satellites (Titan, Io). Create perfect visible, J, H and K images at different epochs (to make spatial changes). Then add psfs. Evaluate observed images to determine effectiveness of monitoring spatial changes.
 - Debris disks. Faint fuzzy stuff around stars. Interested in understanding the stability of a psf out in the halo. Would be interested in a set of 15-20 images to represent time variability over several hours. This is the one galactic science case that will be studied that would benefit from NGS AO.
 - Stellar populations in nearby galaxies. Confusion is key issue. Interested in photometry. Fields can be many arcmin. Would provide initial star field (x,y,mag,color), and then add psfs. Would then apply science tools to determine accuracy of color-magnitude diagram.
 - AGNs & super-massive black holes. Only interested in central 2".
 - Field galaxies. Assume ~ 5 per square arcmin? For the narrow field case could just add psf, but eventually also want to evaluate two wide field approaches. Assume a standard configuration of reference stars.

- Gravitational lensing. ~ 1 arcmin scale with few arcsec across individual galaxies. Would like to generate fake systems.
- Also might want to consider Supernova case - a psf within a galaxy.
- The summary of the 1st extragalactic telecon had the following very preliminary request related to psfs:
 - A library of psfs for each of the AO systems being considered (different Strehls, exposure times, observing wavelengths, seeing).
 - Statistics of the various psf characteristics for each AO system being considered.
 - Simulations of AO images of: 1) a crowded star-field with input point-sources specified by the extragalactic subcommittee, 2) a gravitationally lensed galaxy (+ cluster) with input specified by the extragalactic subcommittee.

Companion Sensitivity / Contrast Curve:

- Bruce, Chris and Peter met on 2/14 to define what we think we should do.
- We are planning to produce a delta magnitude versus separation result out to 1". Initially this will be done at H-band only and will assume a speckle noise limit for contrast (not photon noise limited). This will include the Keck pupil and segment aberrations. A simple NIRC2 (Lyot) coronagraph will be assumed (doesn't block segment gaps). Assume a 10 min integration, 40 and 100 nm tracking errors (may just want to explain the impact of the latter), cases of 120 and 180 nm total rms wavefront error, and 30 nm of internal non-common path error (1/2 each from high frequency and fixable errors). The sources of contrast reduction may need to be evaluated separately: Telescope phase errors (run AO simulation without atmosphere), telescope diffraction (Bruce estimate from simulation of telescope pupil), AO/atmospheric speckles (run AO simulation for 5 secs or 5 independent runs), and internal calibrations (use Bruce's spreadsheet to estimate from calibration errors and optical fabrication errors). We would like to achieve a result that is valid within a factor of 4. It would be good to anchor this result to the current Keck performance.
- The science cases that will benefit from this technical evaluation include the following:
 - Planets around low mass stars. Interested in resolution and contrast.
 - Multiple asteroids. May or may not want to use the coronagraph in this case (so benefit of coronagraph should be understood). To estimate orbit need both the primary and secondary in image. Coronagraph could help if asteroid not resolved. Note that detection and astrometry may be different tasks.

Other technical questions/tasks for prioritization:

- Where does NGS AO win over LGS AO?
- What is the state of psf reconstruction from AO data?
- Time variability of AO correction.
- Trade-off between spatial and spectral resolution.
- Wide field psfs for MCAO and MOAO systems.
- Psfs for studying the atmospheres of giant planets. Satellites are > 20" from planet. Jupiter is 40" diameter. Huge amount of scattered light from planet.
- Technical questions from Solar System 1/25 telecon summary:
 - New Figure: Graph SR vs wavelength with various error budgets and for **medium** seeing conditions. Question: What is the exterior seeing considered in the Technical Overview figure?
 - New Figure: **angular resolution** vs Wavelength with various error budget. Specifically, what will be the typical angular resolution at 0.70 and 0.45 microns with various reference magnitude and seeing conditions? It will be very useful for comparison with HST...
 - How can we estimate the **accuracy** of the photometry/astrometry. It must be linked to the SR stability. Any reference?
 - What is the drop off in magnitude expected with KPAO? What magnitude in visible shall we expect a tip-tilt correction mainly (i.e. a significant drop in SR).

- Profile of the Anisoplanatism aberration. The requirement is 60". What will be the profile of the off axis PSF (elongated toward the Tip tilt star?). How fast will it be degraded?
- How close to the reality are the C. Neyman PSF simulations? What is the most critical factors for the stability? the tomography reconstruction, number of LGS, number of sub-pupils on the DM, Number of actuators on the MEM?
- [Table of KPAO sensitivity to \(isolated\) point sources as a function of wavelength.](#)