

August 1, 2006

MEMS-AO / ViLLaGEs Preliminary Design Review

Response to Reviewers' Comments

The review went well with very helpful suggestions coming from the reviewers. The purpose of this memo is to respond to those suggestions and to recommend courses of action.

1. Perhaps the issue of most concern that I took from the meeting was the ambitious project schedule. There are two issues in changing the schedule: one, the risk of additional costs associated with having to extend work into next year; and two, the risk that slowing down the project would negatively impact its importance and timeliness with regard to next generation Keck and TMT AO instruments.

Response:

We shall make a more conservative project plan and assess the change to costs. I believe the major time impact will be at the tail end of the project, during I&T and experiments stages, and that the increase will come in the form of additional manpower that is mostly leveraged from LAO personnel.

The risk to importance and timeliness was assuaged by Brent Ellerbroek and Mike Bolte: the experiment results will still remain highly important to Keck and TMT even if they come next year.

As per recommendations, we will plan on closed-loop (and open-loop) testing using a turbulence generator in the lab prior to telescope installation.

2. The mechanical flexure analysis was not completed. There were also some gaps in the opto/mechanical design, particularly on the science camera path (focus mechanism, filters). Mike Bolte and Dave Palmer have suggested we have a critical design review.

Response:

A critical design review covering the opto-mechanical final design is now scheduled for September 1. Chris Lockwood expects to finish both the mechanical design and flexure analysis to CDR levels by then.

3. The pixel size on the wavefront sensor camera is too coarse, putting experiment 2 at risk because it will depend critically on the wavefront sensor linearity.

Response:

We will perform simulations of the wavefront sensor performance under typical Lick seeing conditions to determine if this is a problem with the current pixel scale. As a fall back we will investigate optical design with a finer pixel scale, along with the impact on fabrication of the field stop that prevents pixel cross-talk. Should the resulting design prevent fitting two Hartmann pupils on the CCD, we have the fall-back option of using a second high speed camera as the "truth" or scoring wavefront sensor (also see comment 4).

4. Brent Ellerbroek has suggested we add a second high speed camera, with both far-field and wavefront sensing capability, as a scoring camera on the science leg.

Response:

We will add modifications to the science leg that will allow mounting of a high speed camera (another SciMeasure littlejoe head) on the science leg. We will estimate the costs required for design/fab and software support of this additional camera. The hardware cost for a second SciMeasure is \$40K.

5. Putting multiple beams on the wavefront sensor forces them all to operate with the same camera setup parameters (frame rate, camera gain).

Response:

Two of the beams (open and closed loop) are from the same source so they should operate on the same setup parameters. The laser beam diagnostic leak brightness can be adjusted separately using the $\frac{1}{4}$ wave plate and ND filters.

6. The glycol cooler is probably not necessary. Controlling air flow in a generally downward direction with the dome fans on should prevent convective heating from generating turbulence on the optical bench.

Response:

This is a great idea which saves us considerable trouble and total energy use. We will design in an air-path, with possible ducting and insulation, to carry the heat away from the electronics rack.

7. The laser guidestar radiometry calculations were not presented.

Response:

This is a Phase 2 issue, so we didn't prepare much on this, thinking it to be outside the scope. The radiometry calculation has been done, and is implicit within the error budget presented in the introductory viewgraphs. It is grounded in experimental returns reported by Bob Fugate. We can certainly prepare a short memo on our assumptions and calculations.

8. Brent Ellerbroek suggested that only a single DM is necessary in Phase 2, rather than a second DM for just the laser. The DM can be the laser-coated (not MEMS) device we were planning to use for Phase 2 laser uplink control, since the MEMS on-sky demonstration is already achieved in Phase 1. This might simplify the overall control system and optical design.

Response:

Since the laser DM has a different clear aperture size than the MEMS DM, requiring additional beam reformatting optics, it is not clear that this results in an overall simplified optical design. The control loop architecture still remains fundamentally different for uplink vs downlink, so software savings also seems unlikely. But, we will look into it.

9. The tip/tilt mirror has a resonance at 1kHz, which is the AO system frame rate, threatening tip/tilt stability.

Response:

This spec was with a 1 inch mirror. A smaller mirror can be used in our system (it is at a pupil in a 3.6mm beam) reducing moment of inertia. The tip/tilt control loop does not need to operate at the same bandwidth as the high-order control loop so it will be designed, with a mirror resonance in mind, to roll off appropriately.

10. The ImagineOptics mirror is slow and dissipates a lot of heat.

Response:

This is a Phase 2 issue. We haven't decided on a mirror for the laser uplink control yet. Obviously bandwidth is an important parameter.

11. The VME crate can be eliminated. If we need 200 volt driver boards then we could use the JPL-built boards. If we need 300 volt driver boards then we could use the BostonMicromachine boards. Neither of these require VME.

Response:

The main issue is the cost of manpower to rewrite drivers. We want to keep the present design as baseline because it is a duplicate of the 3 meter system.

12. It may be impossible to fit it through the door of the 1 meter dome.

Response:

We will look in to how to transport the system, possibly in two pieces, into the basement of the 1 meter dome, from which it can be hoisted (through much bigger doors in the floor) to the telescope level. Right now, it doesn't look impossible, but would require a lot of recabling. Dave Cowley has suggested that the dome basement be the prep lab and permanent storage location.

13. There is no plan to build a GUI

Response:

We plan to use the GUI from the 3-meter AO system. We will have to make appropriate modifications however so this is a good point.

14. RT SW programming should be starting now; MEMS drivers are a big chunk of that; but, MEMS driver HW hasn't been selected yet.

Response:

MEMS driver HW has been selected: the baseline is RedNun cards and the VME system we are familiar with. We will get started with that. In parallel we will investigate the BostonMicromachines drivers (which they will loan us for evaluation) and plan, as a backup option, to use them if 300 Volts is needed. The determination of 300 vs 200 Volts depends upon the outcome of a Hartmann test of the 1 meter primary figure, to be completed in the September time frame.