

The Program and Budget of the University of California Observatories for FY14 and Beyond

S. M. Faber, Interim Director, June 2013

1) Goals of UCO in the next 10 years:

- Play a leadership role in the TMT consortium, guide scientific planning, and operations, and lead the construction of two first-light TMT instruments (IRIS infrared AO camera/spectrograph (UCLA) and MOBIE optical spectrograph (UCSC)).
- Lay the foundation for lead roles by UC in second-generation TMT instruments, such as the TMT high-resolution echelle spectrograph and the TMT Xtreme AO imager.
- Advance the technology of adaptive optics and install Next Generation Adaptive Optics at Keck.
- Support/lead construction and upgrades of Keck instruments, including the rapid-response Keck I tertiary mirror, the Cosmic Web Imager (KCWI, led by Caltech), new infrared detectors for OSIRIS and NIRSPEC, and other Keck instruments not yet on the drawing boards.
- Develop advanced astronomical technologies of the future.
- Reconstruct, revitalize, and equip the UCO Instrumentation Laboratories at UCSC.
- Transition Lick Observatory to external funding in a way that preserves the unique historical and public-outreach assets of the site and supports and extends scientific operations insofar as possible.
- Pursue a vigorous program of public information, education, outreach, and private development.

We would like the Board to vet and approve this list, including the last item. Should this item continue to be pursued even if UCO no longer had responsibility for Lick Observatory? I.e., are public information, education, outreach, and private development inherent in the Keck and TMT programs by themselves?

As of this writing, the UCO Strategic Planning Committee is preparing a final list of goals for UCO's long term strategic plan, for presentation to the Director. The above list of goals is congruent with the current draft, and the SPC and Interim Director are working together harmoniously to complete this task.

2) Keck and TMT priorities: We understand that the UCO Board would like to see a maximum amount of UCOP funds directed toward high-priority Keck and TMT instrumentation. This is a list of all prioritized instruments at both Keck and TMT. It will be seen by comparing to Section 3 and Table 1 that UCOP funds in FY14 are almost exclusively directed to these or to closely related projects:

High-priority Keck projects:

- *Keck Cosmic Web Imager (KCWI)*
- *Keck I Deployable Tertiary*
- *Next Generation Adaptive Optics (NGAO)*
- *OSIRIS infrared detector upgrade*
- *NIRSPEC infrared detector upgrade*

High-priority TMT projects:

- *TMT IRIS infrared AO camera and spectrograph*
- *TMT MOBIE optical spectrograph*

3) Planned projects underway at UCO for FY14: Table 1 presents a project-based budget for FY14 showing the costs of individual projects. This is useful to compare relative efforts and to see how projects might be moved around in priority (e.g., substituting a Keck project for Lick operating costs). Related projects have been grouped into single categories (e.g., Shane AO). All new Lick instruments have been removed except for the Kast spectrograph upgrade, which is supported by donor funds.

TMT related projects:

- *TMT MOBIE optical spectrograph:* First-light TMT instrument. Objective for FY14 is to complete the conceptual design and proceed to preliminary design. Hire senior group leaders. (Total project cost ~\$50 M.)
- *TMT IRIS infrared AO camera and spectrograph (UCLA):* First-light instrument. Objective for FY14 is to complete the conceptual design and proceed to preliminary design. Hire senior group leaders. (Total project cost ~\$35 M.)
- *TMT motor-control software:* Specific FY14 objective is to produce a conceptual design for universal motor-control software for TMT telescope and instrumentation. Long-term goal is to show off UCO software expertise that could be of further use to TMT. TMT support is being sought.
- *Advanced coatings research:* FY14 objectives are to 1) develop a high-reflectivity durable silver coating that meets TMT standards, and 2) advance designs for low-loss transmissive coatings for TMT and other instruments. A contract for Solgel coating of polarimeter optics for the Advanced Solar Telescope is being sought.
- *Shane AO:* See next.

Keck related projects:

- *Shane AO:* This project has three technology goals: 1) Validate MEMS design for deformable mirrors (the conventional piezo approach is failing). 2) Demonstrate a new fiber laser, which will produce a $\times 10$ times brighter laser guide star, greatly improving AO correction. 3) Demonstrate wind-predictive control, which uses measured wind-speeds to improve system temporal response; needed for visible-light AO. **All three improvements are critical for future AO systems, including NGAO at Keck and TMT AO.** FY14 objectives are to complete the optical system and new fiber laser and install them on the Shane telescope. Costs have been pruned to concentrate on technology return, not science.
- *Next Generation AO proposal:* FY14 objectives are to update the Keck NGAO design and prepare and submit a proposal to the NSF Astronomy Mid-scale program. Expected amount of proposal ~ \$10 M.
- *KCWI spectrograph (led by Caltech):* The Keck Cosmic Web Imager spectrograph is a brilliant design that enables spectra to be taken of extremely-low surface-brightness objects, such as gas clouds falling into primordial galaxies. UCO is building several subsystems. Funded FY14 objectives include fabricating and assembling the spectrograph camera and writing the detector readout software.
- *Keck support projects:* In FY14, UCO will provide mechanical designs for an upgrade to the Keck azimuth control system and a new AO laser-launch telescope mounting on Keck II. External funds from Keck are expected but are not yet in hand.
- *Remote observing support:* Remote observing stations designed by UCO exist on all campuses to enable remote observe at Keck and Lick. This item provides support and maintenance.

Lick related projects:

- *Lick Observatory operations:* Includes the mountain staff plus minimum maintenance and administrative support from UCSC; all new instrumentation costs supported by UCOP funds have

been removed. Mountain budget is \$1.3 M annually. Does not include Shane AO, which is a development project for Keck and TMT and would have to be moved elsewhere if Lick were closed.

- *Kast spectrograph upgrade*: Would replace aging red CCD detector in Kast spectrograph with new model having much higher sensitivity and photometric stability. Supported by donor funds, revenue-neutral.

4) Non-UCO projects paid for by external funds: These projects are *revenue-neutral* to UCO (except for technical administration; see notes to Table 1).

- *Gemini Planet-Finder Imager*: GPI is an extreme AO camera for the Gemini-South telescope in Chile that will find exoplanet solar systems. It is being assembled in the UCSC Instrument Lab. FY14 objectives are to complete assembly and ship to Chile.
- *Automated Planet-Finder telescope (APF)*: APF is a new 2.4-m reflecting telescope + custom Doppler spectrograph at Lick dedicated to finding the nearest extrasolar planets. Intensive effort this year has solved numerous problems, and the telescope is now nearly ready to be turned over to PIs Vogt and Marcy for commissioning and observing. By contract to the US Naval Observatory, which contributed \$6 M to the project, UCO is obligated to operate the APF for planet-finding for five years, and thus to July 2018. The project will become “revenue-neutral” in FY14 in the sense that UCO will continue to provide technical support, as paid for by the PIs.

5) What UCOP funds are being used to pay for projects that are NOT related to Keck or TMT?

With Shane AO classed as a Keck/TMT-related project and Kast and APF being self-supported, the only UCOP funds not being used for Keck and TMT instrumentation are the \$1.3 M for Lick operations.

6) Unfunded projects currently outside the FY14 budget: Funds are unlikely to be available for the following projects in FY14. They could be started by redirecting Lick operating funds, and thus are “opportunity costs” of Lick. If any of these Keck projects are supported by UCOP funds, we will propose to our Keck partners that UC receive observing nights in proportion to the UCOP funds expended. Investing UCOP funds in these projects in FY14 could strengthen future grant resubmissions.

- *Keck I rapid-response tertiary mirror*: Enables quick response to transient and time-sensitive astronomical phenomena by building a rotatable tertiary mirror that redirects beams rapidly to different instruments. \$195 K requested from NSF for salaries in FY14; not expected due to sequestration.
- *Keck OSIRIS IR detector upgrade (UCLA)*: Replacement of old infrared detector with modern detector, resulting in dramatic speed gains. \$187 K requested from NSF for FY14; not expected due to sequestration.
- *Keck NIRSPEC IR detector upgrade (UCLA)*: Replacement of old infrared detector with modern detector, resulting in dramatic speed and spectral-resolution gains. \$281 K requested from NASA for FY14. Was rejected once but will be resubmitted.
- *Additional work on KCWI*: This brilliant project is badly underfunded and would benefit greatly from work provided by UCO. There are many ways in which we could help. The amount is open-ended.
- *System engineers for IRIS and MOBIE*: According to UC hiring rules, new engineers cannot start work on TMT instruments until April 2015. This item would forward-fund two systems engineers to start in December 2013, giving both projects a head start and reducing risk.

7) Other potential budget needs for FY14 and beyond: Depending on the UCOP budget allocation for FY14 and various budget rulings from UCOP, funds for most of these items will likewise not exist in the FY14 budget, in which case they should also be considered Lick “opportunity costs”.

- *Service buyouts for systemwide Astronomy faculty:* These funds are needed to pay to pay for teaching buyouts and summer salary for the new distributed UCO faculty. Three full faculty at \$42 K each are requested for FY14. This sum will approximately double in FY15. Since these are faculty costs, we argue that they should be paid for from the UCO faculty retirement savings, not from the base UCO budget. We would like the Board to support this.
- *New project management/cost accounting software:* An external study of UCO business operations to be conducted in summer 2013 is expected to result in recommendations to replace a variety of antiquated accounting, project management, and database tools at UCSC. These are needed for MOBIE and to streamline business operations generally. The estimated cost of licenses and training is \$250 K.
- *Managing director:* The UCOAC and SPC have recommended hiring a full-time PhD astronomer to manage internal matters and to assist the Director with the complex web of external relationships with Keck, TMT, UC , and world astronomical communities. Hire in spring 2014.
- *Director salary and start-up funds:* These will be needed in FY15. As faculty costs, we argue that they should be paid for out of the UCO faculty retirement savings and ask the Board to support this.
- *Capital improvements fund:* The instrument laboratories need a variety of modern machining and mensurating equipment, especially at UCSC. The main need will be approximately 2018, when the new building is completed, but a capital improvements fund (for both sites) should be started now.

8) Roles of UCSC faculty in FY14 and beyond: Non-retired 11-month faculty at UCSC will continue to work at full effort on UCO tasks for the duration of their appointments, and retiring faculty plan to contribute voluntarily. Final assignments for FY14 have been delayed owing to uncertainty in retirements, the FY14 budget, and Lick operations. A tentative list is below. All non-retired UCSC faculty will have well defined duties that will be reviewed by the UCOAC.

- TMT instrumentation: Bernstein
- TMT collaboration (Boards, Master Agreement, Science Advisory Committee): Bolte, Illingworth
- Keck instrumentation: Rockosi, Prochaska
- AO development (in support of Keck and TMT): Max, Rockosi
- Coatings research (in support of TMT): Bolte
- Keck telescope time allocation and scheduling: Smith
- Lick operations: Prochaska, Smith
- Development/fund-raising: Guhathakurta, Smith
- Public information, education, and outreach: Brodie, Koo, Max, Prochaska
- UC relations: Koo
- Lick repurposing: Faber, Smith
- UCSC Instrument Laboratory renovations: Faber, Bernstein, Rockosi

9) FY14 budget: This section presents the UCO budget in FY14 and in future years. Columns show the total cost, the cost covered by external funds, and the net cost of each project to UCO. A fourth column shows the cumulative running total of net costs.

The top section of the table shows the *planned instrument projects* in FY14, broken down by cost. Project costs include technical labor, research scientists, plus technical administrative costs pro-rated across all projects. It is seen that all planned projects either support Keck and TMT or are “revenue-neutral” in the sense that external funds cover all costs except for technical overhead (APF, Kast spectrograph). The notes give details. The planned projects have been chosen because they have high priority at Keck and TMT OR because they bring in needed cash to operate the technical division (revenue-neutral), and

preferably both. The last project line contains as-yet-unallocated technical labor. It could be used to support TBD new proposals, to provide contingency for planned projects, and, to the extent that skills match, to start work on the unfunded projects in the next section.

The spirit of these estimates is to show the amount of effort and resources that could be reallocated to other projects if priorities were changed. However, as we have stressed to the Board many times, it is very hard merely to lay off one technical staff member or cancel one planned project because the list reflects a jigsaw-puzzle process that has carefully matched people to technical needs and to funding. Changes to the list or to the employee roster would require that this process be repeated.

The lower part of the first section shows the fixed expenses for FY14: faculty, director's office administration, the UCLA IR Lab, and Lick. Two faculty who are known to be retiring are not included. Support to UCLA is increased by \$40 k to \$340 k based on their compelling request (they have not had an increase in several years). The \$1.3 M for Lick Observatory operations was reviewed by faculty from UCB and UCI and now reflects a broad consensus (see white paper on Lick Observatory operations). This \$1.3 M figure reflects the value of resources that would be freed up if Lick were not operated, and thus the "opportunity cost" of Lick.

The assumed external funds are \$776 k. This is conservative, and we are seeking actively to increase this number through additional contracts (see comments in the table).

Assuming a budget of \$7.548 M with no strings attached (i.e., no faculty salary sequestration) and the above level of external funding, the net uncommitted funds in FY14 are \$323 k. This is the sum (plus any new external funds that can be gained) that is available to fund other needs. Candidate needs are shown in the bottom two sections of the table. The top half is the list of Keck and TMT projects from Section 6, totaling \$900 K plus a TBD amount for KCWI. The bottom half is the list of items from Section 7, some of which are one-time funds (\$550 k) and some of which are increases to the permanent budget (\$886 k). All of these latter expenditures are vitally necessary. The bad news is that we cannot afford many of them soon. The good news is that they are comparable to the Lick operating costs, and thus will be affordable at such time Lick becomes revenue-neutral.

UCOAC input will be sought before any decisions are made concerning the allocation of uncommitted funds.

In conclusion, we have presented this budget assuming that **faculty salary savings are retained by UCO**. This is equivalent to **keeping the budget whole and flat at \$7.548 M**, and is the case that we have argued relentlessly for many months to all relevant bodies. Amounting to ~\$500 k in FY14, these faculty saving are what allow the budget to balance this year. They are expected to increase to ~\$1.5 M in roughly the next four years, which exceeds Lick operations by \$200 k. Hence, Lick repurposing by dint of great effort could succeed, saving \$1.3 M, but if the faculty savings are taken away **the net allocation to Keck and TMT will not increase**.