

## Lick Observatory: Answers to Basic Questions

### S. M. Faber, Interim Director, June 2013

**1) What are the annual operating costs of Lick Observatory?** A group of UCSC faculty and staff plus Alex Filippenko and Aaron Barth scrutinized the Lick budget in early June once more. All agreed that the minimum cost for annual operations of the Shane 3-m telescope is roughly \$1.3 M, comprised of:

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|--|------------|
| • Mountain costs (staff and purchases):                | \$ 960 k   |
| • UCSC support (technical, software, business office): | <u>350</u> |
| • Total  | \$1,310 k  |

**2) Why is this amount lower than the \$2.8 M that Director Faber presented to the Board on March 30 and May 8?** There have been several changes since those early budgets:

- We now list only funds that can be redirected for other purposes by UCO (i.e., the true Lick “opportunity costs”). Thus, the \$640 K for maintenance and utilities paid by UCSC is not included.
- Operate only the Shane, close the Nickel and CAT, recalculate expenses even more stringently: saves \$110 K in the business office, \$60 K in UCSC technical support, \$80 K in mountain operations. (Arrangements to operate the Nickel on a fee-for-night basis or from other funds may be possible.)
- Delete support for Lick data archiving and reduce scope of Kast spectrograph upgrade by making self-supporting: saves \$100 K
- Omit aluminizing Shane primary mirror: saves \$20 K.
- Delete faculty support (not needed for barebones operations): saves \$60 K.
- Delete Shane AO: this is not a Lick instrument but is rather a critical development project for Keck and TMT AO. It would have to be done on another telescope even if Lick were closed. Closing Lick costs money for Shane AO, not saves it. Removing Shane AO reduces the Lick total by \$220 K.
- Correct a typo in Faber slides to Board: \$2.8 M should have been \$2.6 M.

The sum of these is \$1.5 M, which is the difference between the two numbers.

**3) Are there additional “hidden costs” of operating Lick that are not included above?** There are still hidden faculty costs to cover Lick telescope scheduling and TAC operations, but they are small.

**4) What are the current science priorities and opportunities at Lick Observatory, and what operating time scales do they require?** There are three classes of science priorities, with different opportunities and time scales:

- *Shane AO*: Demonstrates three vital new AO capabilities: 1) Validate MEMS design for deformable mirror (the conventional piezo approach is failing). 2) Demonstrate a new fiber laser, which can 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.*** \$2 M has already been spent from the NSF, and \$0.375 M will be spent from the Moore Foundation this year. *If Lick is not available for Shane AO, we will have to move it to another telescope, which would cost more money.*

Schedule: The Shane AO optics and laser will be installed in spring 2014. Fifteen months are needed to commission and achieve technical milestones. This sets a *minimum time scale* needed for Shane

operations of July 2015, i.e., **2 years** from this July 1. Productive science could continue indefinitely beyond this.

- *Automated Planet-Finder telescope (APF)*: This is no longer an official UCO project but is being taken over by the PIs (Marcy and Vogt) and is to become self-supporting as of July 1, 2013. Nevertheless, it is a cutting-edge project for exoplanet detection with exciting science opportunities now and an intimate connection in future to NASA's TESS mission that will search for exoplanets around the nearest stars. \$10 M has been raised from the Navy, NASA, and donors, and UCO has invested approximately \$2 M of Observatory funds, in return for which 20% of the time will be available to systemwide observers.

A contract exists with the U S Naval Observatory in which the Regents have committed to operate the APF for the purposes of exoplanet discovery for five years beyond its fully operational date, i.e., July 1, 2018, with an option to demand five more years beyond that. However, it is likely that three good years of operations would lay the groundwork for fund-raising for the final two years. ***A decision that results in closing the APF on a timescale much shorter than three years could violate the USNO contract.***

The APF can operate for \$200 K/yr as long as a critical mass of employees is present to run Shane, but a plan to run APF solo does not exist. Thus, funding decisions that impact Shane operations also impact APF. APF will be available for robotic operations starting in late summer 2013. Two PhD theses are planned but not yet started. These set a minimum timescale for APF of **3 years**, until July 2016. As noted, this timescale may be compatible with the USNO contract. Further scientific productivity is expected for many years.

- *Shane science projects*: There are currently 30 science projects running on the Shane telescope, with 6 grad PIs, 12 postdoc PIs, 8 faculty PIs, and 4 researcher PIs. The same proposals have 11 grad Co-I's, 9 postdoc Co-I's, 8 undergraduate Co-I's, 25 faculty Co-I's, and 12 researcher Co-I's. The vast fraction of these individuals are distinct – double-counting is minimal – and we estimate that the total of community of Shane users alone has about 75 distinct scientists, of whom half are grads, undergrads, and postdocs.
- *Other telescopes*: An additional 13 projects are running on other telescopes, mostly on the Nickel and KAIT. The Nickel is also a mainstay for educational programs, visitors programs, hands-on training, and remote observing for undergraduate astronomy laboratory classes (three campuses).

**5) How will Lick closure impact the Lick user community?** Before recommending curtailment of UCOP funding for Lick, the Board needs to understand the impact that closure would have on Lick science users. Accordingly, a questionnaire was sent to the UC astronomical community asking about Lick usage, and ~50 replies were received in two days, a remarkable response rate of close to 100%. To summarize: there are 44 ongoing projects and 15 planned projects. Altogether they include **20 PhD theses and 6 undergraduate theses** – 14 more undergraduates are members of teams. The programs are supported by \$11.5 M in grant funding, including several of the planned programs. Most programs are planning to operate for three years or longer. Closure in one year (July 2014) is deemed to have a “severe” or “catastrophic” effect on nearly all programs, easing to “moderate” for many programs in three years. However, 20/59 programs are counting on operating even beyond 3 years. Attached to this

white paper is an Excel file that summarizes all the responses and a text file that gives users comments. Forty-five users provided comments, many of them extensive. We urge that the Board read them.

As noted in the UCO Program Review Group report, the Lick community is quite distinct from Keck (only 33% overlap), so Lick closure will disenfranchise students and postdocs outright and shift many faculty and senior researchers to Keck, increasing the burden on that already oversubscribed telescope.

Other Lick science highlights include: 1) The annual systemwide Graduate Observational Astronomy Workshop, which was recently funded by \$200,000 from a private donor for the next five years. 2) The annual COSMOS Summer Research Experiences for talented high school students. 3) Research projects for high school students that traditionally rank high in the Intel and Siemens science talent competitions. 4) Use of the Nickel for undergraduate astronomy laboratory classes on three campuses. 5) A unique polarimetry instrument program. 6) A forefront optical detector development program. These are in addition to the already mentioned Shane AO and APF science programs.

**6) What are the educational, outreach, and development opportunities at Lick?** Lick has a vibrant ongoing summer visitors program that is fully booked for Summer 2013. Thirty-five thousand visitors visit annually. We have signed MOUs with the UCB Center for Science Education and the Tech Museum of San Jose for education programs. Lick is the main site for UC astronomy development activities. Regardless of the science operations, a strong effort should be made to convert the Main Building and 36-inch Great Refractor into self-supporting historic attractions, in the spirit of the Mount Wilson Institute.

**7) Impacts on operations of curtailing UCOP funds: general considerations.** Before recommending curtailment of UCOP funding for Lick, the Board needs to understand the impact that closure would have on Lick operations. This section discusses the ramifications of various time scales.

- Employees will begin to look for other jobs at least a year in advance of whatever deadline is set. Hence, if  $N$  years of full operations are needed (for whatever reason), a commitment to  $N+1$  years must be assumed in the plan.
- We foresee that hiring new staff in the final two years of operations will be impossible – not only will candidates not be interested in such short-term jobs, the long training periods for most Lick jobs would make useful employee lifetimes too short.
- Operations in the final year will depend on whether departees carry away critical single-point knowledge or whether they are part of a larger group. Departure of a single critical employee could shut all of Lick down, but the departure of redundant employees could be coped with, for example, by operating the Shane for fewer nights. How this would unfold is unpredictable.
- The net budgetary impact is hard to predict: retaining critical employees for the whole period may require special incentives, which will increase costs, but operating the Shane for fewer nights would decrease costs.
- The two forefront science projects, Shane AO and APF, are also the best hopes for raising funds to convert science operations to be revenue neutral. The high-resolution AO imaging and high-spectral resolution robotic spectroscopy offered by these projects are virtually unique and could attract rental fees from external users. Rapid shutdown would greatly diminish the chances to perfect and advertise these capabilities.
- Recovering from mothballing is deemed by experts to be extremely problematic. We should assume that the shutdown of a telescope is a one-way trip and that the telescope will never operate again.

- Special situation: One (of four) telescope operator retires July 1, 2013, and a second retires July 1, 2014. The training period for this position is 6 months. If we commit to 3 years of operations, we need to hire a new teleop now. In the 1- or 2-year scenarios, we would not hire a new teleop and would operate the Shane for fewer nights. (This has already started; we just announced the closure of the Shane for 10 nights in July 2013 owing to lack of a telescope operator.)

## 8) Specific time scales:

- *One-year scenario:* One year does not meet the minimum time scale needed by Shane AO, but operating for one full year would at least permit a few science users to have a softer landing. However, employee flight would probably be severe, so the ability to operate for the entire year is doubtful. Pro: saves maximum dollars. Cons: does not achieve minimum goals for either Shane AO or science. Ramp-down is unpredictable and likely to be messy. Time to plan for repurposing is totally inadequate.
- *Two-year scenario:* Two years is the minimum time set by Shane AO, which needs 2 years of Shane operations, but not necessarily at full time. The announced commitment would be two years, and the Shane would operate at 75%-time in Year 1 and 50%-time in Year 2. Pro: redirects Lick funds to Keck and TMT projects with reasonable speed. Cons: May not allow enough time to plan repurposing. Shane AO has to go perfectly. The time to demonstrate Shane AO and APF capabilities is very short. Shane is reduced to 50% time in Year 2. Large and deleterious impact on many science users. Reduction to 50% Shane operations in Year 2 might impact morale and lead to premature employee flight.
- *Three-year scenario:* Would lengthen operations by one more year, with Shane operations during Years 2 and 3 at 75%-time. The announced commitment would be three years. Operates Shane at 75%-time for all years. Pros: Meets commitments to science users much better. Some insurance against unforeseen delays to Shane AO. The time to demonstrate Shane AO and APF capabilities becomes reasonable. Repurposing can proceed at a more reasoned and deliberate pace. Employees are more likely to stay longer, at least through two years. Cons: Postpones redirection of Lick funds to Keck and TMT by one more year. Repurposing may lose some urgency.

**9) If Lick were closed, how else would funds be spent?** Many vital needs exist that could be filled by redirecting Lick operations funds, as described in Sections 6 and 7 of the program white paper. Options include four Keck projects (rapid-response tertiary mirror, two new “hot” IR detectors for Keck, work on the brilliant KCWI spectrograph); an earlier and stronger start on both TMT first-light instruments; important project management software; a managing director; and systemwide faculty teaching buyouts and summer salaries. If redirected to Keck instruments and with the agreement of the Keck partners, Lick operations costs of \$1.3 M could purchase 13-26 nights of extra Keck observing time per year for UC observers.

