

Discovery Channel Telescope - Access fee model

Revision of August 6, 2010

1. Overview

The Discovery Channel Telescope is a general purpose telescope being built by Lowell Observatory in partnership with Discovery Communications. Its primary mirror is of 4.28m clear aperture, and while the first light configuration provides exclusively for RC instrumentation, prime and Nasmyth capability exists as well. The f/6.3 RC focus includes an instrument cube that allows for fast switching between up to five instruments as well as housing the autoguider and wavefront sensor. Funded first-light instrumentation currently includes the Large Monolithic Imager (LMI) at the straight-through position of the instrument cube with a 13'x13' FOV and the Near Infrared High Throughput Spectrograph (NIHTS), covering JHK at R~100. The former Kitt Peak White Spectrograph may be available as an optical spectrograph, although Lowell is presently investigating a conceptual design for the Long Slit Echelle Spectrograph (LSES) to provide higher-resolution capability.

First light is presently scheduled for summer 2011 with a gradual ramp of science operations during the expected two-year commissioning period.

Lowell welcomes university or observatory partners in the DCT. We consider the interaction between faculty, students, and support staff of Lowell and partner institutions to be desirable, and while we expect the great majority of agreements will involve the research capabilities of the telescope, the unique public face of the DCT also allows multidisciplinary components to any partnership.

2. Investment in observing time on the DCT

We expect the principal basis of university or observatory partnerships will be an investment by the partner in return for nights on the telescope, and that investments will take one or more of three forms:

- cash,
- personnel (e.g., instrument design, operational support), and
- instruments.

2.1. Share of observing time

Partners will receive observing time in proportion to their contribution to the (1) total cost of the telescope and (2) the annual operations costs including instrument support.

The total cost includes the entire capital cost of the telescope, including (1) R&D investment by Lowell prior to establishment of the agreement with Discovery, (2) the capital and financing cost of the telescope plus guider and wavefront sensor (\$48M), (3) commissioning costs, and (4) the time value of money invested since ~2000.

The initial annual operating cost for the facility plus first light instrumentation (NIHTS and LMI), based on a detailed examination of the likely DCT operational model by Lowell staff in late 2009, is estimated to be

\$2.25M/year. Nights attributable to operations costs contributions will be adjusted annually to reflect actual costs plus inflation.

Lowell is willing to negotiate contributions on a per-night basis (e.g., “rental” mode) or as a longer-term capital investment in the telescope.

2.2. Distribution of time

Partners’ share of the observing time will be distributed among Lowell and all partner observing shares uniformly across months of the year and phases of the Moon. No weather or equipment failure adjustments will be made. Planned engineering nights will be charged in equal proportions to the observing shares of Lowell and all partners.

2.3. Valuation of contributions

The total value of any partner’s annual contribution will be the sum of cash payments plus a mutually agreed-upon valuation of the worth of instrumentation and personnel support to the project. In general, the total effective yearly contribution T will be

$$T = \alpha [\text{cash}] + \beta [\text{personnel}] + \gamma [\text{instruments}],$$

where $\alpha = 1.00$ and β and γ are negotiable. In any agreement we expect that both the quantities and the coefficients may vary from year to year.

The number of nights into which T is converted depends on the access model desired by the partner: per-night, a longer-term investment, or a combination of both.

2.3.1. Cash

Cash contributions will be converted to nights at full value. In the early years of DCT operation, due to the financing required to complete the telescope and the risk exposure assumed by Lowell, cash contributions are strongly preferred. We are working on other fronts to ease this mercenary attitude as rapidly as possible.

2.3.2. Personnel

Contributions of time and effort will be accorded the full value of the salary of the person(s) involved plus benefits at Lowell’s or the partner’s standard rate, whichever is lower, provided that the services rendered directly offset costs Lowell would have incurred. Overhead at the lower of Lowell’s or the partner’s negotiated rates will also be included in the valuation if the person is working remotely, but not if s/he is in residence at Lowell.

Valuation of in-kind services will be modified by a coefficient β that quantifies the degree to which the services offset costs borne by Lowell. As examples, a full time telescope operator would have $\beta = 1.00$, while the *ad absurdum* case of a programmer writing entirely unrelated software would have $\beta = 0.00$.

Recognizing the complexity and variety of services that might be proposed, their valuation will be negotiated on a partner-by-partner basis. Most such negotiations will no doubt apply to science-related tasks, but we also note that the multi-faceted nature of DCT permits proposals for less easily quantified services (e.g., creation of

broadcast or online content and programming that may benefit the visibility and attractiveness of the DCT in indirect or deferred ways).

Therefore, Lowell proposes no standard equations for assigning β to any individual; we can only assert our sincere intent to deal with each partner fairly and all partners equably.

2.3.3. Instruments

We expect that instruments developed by Lowell or any partners, once fully commissioned, will generally be available to all DCT users as facility instruments. Support for these instruments will be included in the calculation of annual operating costs. However, should Lowell or a partner develop an instrument for exclusive use of its staff or of no interest to the staff of other partners in the project, support of that instrument will be the responsibility of the institution that developed it.

Recognizing that instrumentation may enable new grants or interest additional partners, Lowell may consider instruments countable as cash equivalents for observing time. The maximum annual valuation will be the development cost of the instrument amortized over 10 years, and adjustments similar to those for personnel will be made based on the use of the instrument by partners (i.e., $\gamma = 1.00$ for a full facility instrument, and $\gamma = 0.00$ for an exclusive-use instrument). As with personnel, these will be negotiated on a case-by-case basis.

2.4. Procedures for multi-year agreements

Sections 3 and 4 below outline the general terms for access to nights on the DCT, and as of late 2010 are based only upon estimates of operations costs, proper amortization, and operating efficiency. Changes to any of these quantities based on experience during early operations will obviously affect the cost per night.

Our philosophy in all agreements is that (1) Lowell must be able to provide adequate time on the DCT to meet the needs of its own staff and (2) partners should pay neither too much nor too little for their nights. In particular to accommodate the first point above, should operations costs fall substantially below the anticipated value, we prefer either to extend the duration of the partner's access at the agreed-upon number of nights per year, or to establish an agreement for reduced payment during that year to reflect the reduced per-night cost, rather than grant a larger number of nights.

We will review inflation and actual operation costs near the end of each fiscal (for Lowell, also calendar) year and report the results to all partners. The basic terms leading to cost per night will be applied equally to all partners, while the effects on payment schedules and/or duration of access will be agreed upon on a case-by-case basis.

3. Costs of construction and operation

Total cost to construct and commission the telescope:

Project R&D (< 2003):	\$1M
Construction:	\$45M (telescope + guider/WFS)
Financing of loan:	\$3M
Commissioning:	\$2M
Capital time value	\$2M
Total:	\$53M

Capital cost **C** amortized over 30 yr: **\$1.77M /yr**

Operating cost O (per year):	\$2.25M /yr in full ops, + 2.5%/yr or actual thereafter
Total operating cost over 30 years:	\$98.8M (based on 2.5% assumption)
Total operating cost over 20 years:	\$57.5M
Total operating cost over 10 years:	\$25.2M

Operating nights per year **N**: **300** (based on normal level of planned engineering and maintenance time for a large telescope)

4. Costs for per-night, long-term buy-in, and capital share

We will enter night rental agreements at the following rate.

Per-night cost $(C + O) / N$ **\$13,400 /nt** in full ops, + 2.5%/yr (or actual) for ops thereafter
(breakdown is \$7,500/nt ops + \$5,900/nt amortized capital)

We will also consider a buy-in for various periods as the fraction of the total capital cost amortized over the given period plus the operating cost over that time, providing partners with guaranteed access for all or much of the amortization period of the facility. At the end of any buy-in period, agreements would be renegotiated. Should a partner reach a buy-in term equal to the amortization period after one or more agreements, they would be considered to have a permanent share of the telescope proportional to the contribution, and subsequent access would be available at an operations-cost-only rate.

Full buy-in for 1 night, 30 years	\$506,000
Full buy-in for 1 night, 20 years	\$309,500
Full buy-in for 1 night, 10 years	\$142,900

Alternatively, a partner could purchase a full capital share of the telescope outright, paying from the outset for any nights thus acquired at the operations-only rate of \$7,500/nt.

Full capital share, 1 night **\$177,000**

5. Discussion regarding BU

This section is to outline a possible arrangement for investment in the DCT. Variations on the theme are of course possible and we look forward to discussing them.

The baseline figures below consider a \$10,000,000 investment and a buy-in of approximately 60 nights of time per year as the ideal level for the BU astronomers. We also assume that donors will be more motivated if the investment constitutes a permanent presence for BU on the telescope rather than paying for operations costs. We are glad to have any final agreement include ongoing access to the Anderson Mesa telescopes as well. The options below are meant only to stimulate discussion and give some idea of the nights and numbers involved, and are not a formal proposal.

- The most straightforward option for a \$10M investment is to purchase a permanent capital share of 56 nights. All use of the telescope would then cost \$7,500/night at an operational cost of \$2.25M/year. If yearly operations costs turned out to be lower, actual would be charged. This method of investment could be an advantageous way to deal with early uncertainties in the rate of ramp-up of operations costs.
- A second option would be to assign \$7M as purchasing a capital share of 40 nights, with the remaining \$3M covering operations costs of 400 nights at the full rate of \$7,500/night. This would then completely cover BU's expenses for at least 10 years. The operations money would go further, of course, if actual costs were less than \$2.25M/yr.

Under either model, we also can incorporate the value of Dan Clemens's instrument Flexi (understanding, of course, that it has yet to be funded). A typical procedure is to amortize an instrument over 10 years and assign that full value, or some fraction of it, to telescope access (see 2.3 above). Dan estimates the cost of Flexi as \$2M, meaning we could value it to as much as \$200K/yr, or about 15 nights, if available on DCT as a facility instrument. Under the second option above, this would be a way to increase BU's time share to as much as 55 nights/yr. Under the first, it could defray operations fees at the DCT and Anderson Mesa. A few caveats to consider regarding this:

- At least in the early going, Lowell needs cash. We therefore will be quite conservative about the number, magnitude, and valuation of instruments-for-time and people-for-time agreements. There is therefore advantage in striking early for potential partners wishing to arrive at such deals.
- Although Flexi would not be ready by the time DCT began science operations (hopefully in 2012), we would be willing to credit BU nights for its availability in advance of its arriving at the telescope. Were we to do this for a few years and have the instrument not be funded, we would not be able to continue the valuation, but neither would we retroactively extract time thus awarded from future access.

There are two other components to our partnership for which we would look forward to establishing a reasonable accommodation.

- Access to 50% (~160-180 nights depending on planned engineering) of the Perkins telescope (not including expenses and Brian Taylor's time) is \$135,000/year, or almost exactly 10 DCT nights. This could be folded into any new payment agreement by reducing DCT access slightly, or counting part of the Flexi valuation to defray it, and could probably be established at some tradeoff better than 1:1 to acknowledge economy of scale.

- Support of multidisciplinary activities could be counted with the \$10M investment, supported via a slight augmentation of it (e.g., a buy-in of \$10.5M could provide \$50,000/year for broader impact work for 10 years), and/or pursued via additional funding sources (something Lowell has had great success with over the last decade).

The table below summarizes the rough access levels for various levels of investment for the two bulleted options on the previous page. Any final agreement will surely differ from these numbers, especially in terms of agreeing on Anderson Mesa and multidisciplinary activities, but we expect not by a large amount.

Investment	100% to capital share (ops extra)	70% to capital share (some ops covered)
\$5M	28 nights	20 nights + >200 nights of ops
\$8M	45 nights	32 nights + >320 nights of ops
\$10M	56 nights	40 nights + >400 nights of ops
\$12M	67 nights	48 nights + >480 nights of ops
Flexi	<= 15 nights/yr for 10 yr	

We are open to a variety of payment schedules, and are glad to consider models other than a lump sum. We would like to offer our initial partners a very reasonable deal on such arrangements, so we are glad to entertain a set of annual payments for a nominal “financing” consideration. Were this set, for example, at 1%, we could accept ten payments of \$1,000,000/year plus \$10,000/year.