Astronomy Foes Join Forces to Build Giant Telescope

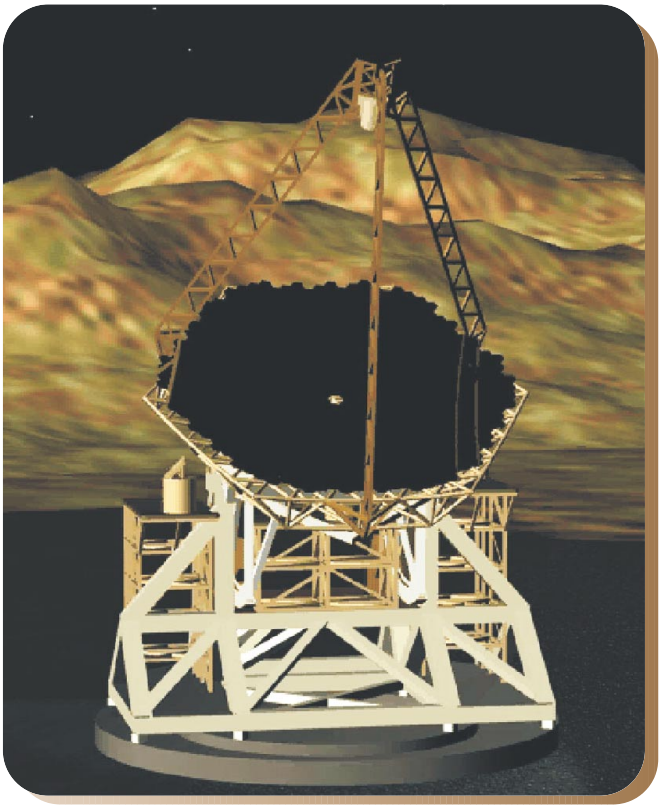
A new public–private partnership faces hurdles but promises to make the US a formidable international competitor in ground-based astronomy.

Public and private sectors of US ground-based astronomy have teamed up to design a 30-meter optical-infrared telescope. The alliance was formed to bolster the chances of realizing the project, but it could also herald a thawing of relations between the traditional rivals.

On 11 June, the Association of Universities for Research in Astronomy and the California Extremely Large Telescope (CELT) Development Corp, a partnership of Caltech and the University of California (UC), agreed to raise a total of $70 million for a detailed design of a 30-meter telescope (TMT; the private partners call their preexisting project CELT, and the public partners call theirs the Giant Segmented Mirror Telescope, or GSMT). AURA oversees public, or federally funded, optical observatories, and the CELT group is private, with funding from state and private sources. Canada and the CELT group initiated a similar bilateral agreement on the same day. The grand plan is to refine the design, choose a site, raise more money, and have the telescope up and running in time to work in tandem with the James Webb Space Telescope (JWST), the Hubble Space Telescope's successor, which NASA plans to launch in 2011.

Just as the Kecks and other ground-based telescopes complement the HST, astronomers want to use the TMT to do spectroscopy of very distant objects imaged by the JWST. Besides the unpredictable discoveries, the main goals for the TMT are to study the formation of galaxies and stars and to directly observe extrasolar planets. "Assuming the telescope has extraordinary image quality and diffraction-limited images," says Rolf Kudritzki, head of the University of Hawaii's Institute for Astronomy and chair of the GSMT science working group, "we can follow the production of elements, and how they got into the intergalactic medium, and how the intergalactic medium enriches in chemical composition. We can follow the merging of the first building blocks to form larger entities. We can follow the evolution of the universe over 12 billion years."

The TMT would have a diameter three times larger than any existing optical telescope. "No leap this big has ever been made. It's extremely ambitious," says astronomer Richard Ellis, Caltech's CELT representative. Estimates for the TMT start at $700 million, with annual costs put at $30 million to $70 million. "Everybody is recognizing the same thing, that public and private [observatories] have to pool resources to tackle new projects," says AURA chief William Smith. "The primary rationale is probably financial, but in most cases there is a technical benefit."



A 30-meter telescope would let astronomers peer back almost to the Big Bang. But realizing such a telescope is likely to change the face of the US astronomy community. (Image created by Rick Robles, AURA New Initiatives Office.)

Culture shift

If joining forces is the best hope to muster money, it is also likely to shake up the astronomy community. "We are probably witnessing the end of the era of private supremacy," says Pennsylvania State University's Lawrence Ramsey, project scientist for the Hobby Eberly Telescope (HET). "Only the federal government—only NSF—has pockets deep enough to be a substantial partner in a TMT. NSF is the indispensable partner," says Matt Mountain, director of Gemini. The US 50% share in Gemini,together with the National Optical Astronomy Observatory (NOAO), makes up the public part of the new TMT partnership. "We have to go through the same culture shift that particle physics went through in the 1960s," Mountain adds. "That's why there is so much passion here—it's basically changing a way of life."

US ground-based optical astronomy is unusual in that it's a hybrid of public and private observatories. Rivalry between the two camps stretches back nearly a half century, to when AURA came on a scene that had been mostly populated by privately owned telescopes. Today, roughly two-thirds of the US share in big telescopes worldwide is private, and one-third is public (see the table on page 23). The main cooperative efforts between the public and private observatories so far are the 4-meter–class WIYN and

SOAR telescopes and new programs in which NSF pays for instrument and adaptive optics development at private facilities in exchange for observing time for the wider astronomy community. The telescope consortia both include NOAO, along with the Universities of Wisconsin and Indiana and Yale University (WIYN) and Brazil, Michigan State University, and the University of North Carolina, Chapel Hill (SOAR).

Generally, private observatories see themselves as less bureaucratic, quicker to respond to scientific opportunities, more flexible in allotting observing time, more efficient in their use of money, and, not coincidentally, more alluring to the best scientists than are public observatories. A particular sore spot is hard-to-raise operating funds: Astronomers at private observatories often say they could get a better science return from the public observatories' NSF money. For example, Ellis notes that the Kecks—the two 10-meter kings of optical astronomy built by the CELT team—cost less to run than Gemini, the 8-meter twins that are the pride of the public observatories. Even allowing for differences such as Gemini being an international collaboration split across two hemispheres, he says, "it's clear that the national resources have been much more generous than what's available for privates." As a consequence, he adds, astronomers at private observatories must be more self-reliant than those at public ones, which have larger staffs.

For their part, astronomers and managers at the public observatories point to the hallowed principle of providing telescope access to the entire astronomy community. They admit that NOAO has suffered an identity crisis in the past few years. But it is reclaiming a leadership role in optical and infrared astronomy, says the observatory's director, Jeremy Mould. "I think people are beginning to see the emergence of an effective national observatory." Adds Mountain, "Caltech and UC asked us to partner. That tells you that the public side is on a par with the private side. Caltech and UC are used to being a decade ahead. Gemini is what made us be players." In addition to access to federal money, Mountain says, the public side of the TMT partnership brings expertise in wind buffeting and adaptive optics and well-established relationships with Chile, a possible host for the telescope. (Mauna Kea in Hawaii and San Pedro Mártir in Mexico's Baja California are the other sites under consideration.)

US investment in the current generation of large telescopes worldwide

Private observatories	Diameter in meters	Location	Estimated US contribution to construction cost*
Keck Observatory	10 (2 telescopes)	Hawaii	$133 million (nonfederal funds) $50 million (NASA)
Magellan Project	6.5 (2 telescopes)	Chile	$68 million
Large Binocular Telescope	8.4 (2 telescopes)	Arizona	$53 million
Multiple Mirror Telescope	6.5	Arizona	$20 million
Hobby Eberly Telescope	9	Texas	$18.9 million
Southern African Large Telescope	10.5	South Africa	$7.5 million (US has a roughly 40% share in SALT)
Public observatories			
Gemini	8 (2 telescopes)	Hawaii and Chile	$92 million (US has a 50% share in Gemini)
		Total private investment	**$300.4 million**
		Total public investment	**$142 million**

*Figures were provided by officials from each observatory. They may not always be directly comparable, as capital costs are accounted for differently from place to place.

Just how the public–private partnership will work in practice is still fuzzy. Both sides expect that everything from designing the telescope and its instruments to allocating observing time will be divvied up in proportion to the partners' contributions. At the same time, the sheer cost makes it likely that telescope time will be distributed in a queue-mode, the way the public facilities do it now. "We are still feeling our way," says Joseph Miller, director of Lick Observatory and UC's CELT representative. "The question is, How will it work? And will it work?" One issue, for example, is how to stay nimble while also incorporating the more cumbersome decision making process of a federally funded project. "There are days when I really worry about it," Miller says. But, he adds, "if we can make this work, it will be a good thing."

'Like boiling gasoline'

Despite broad support for closer public–private interactions, not all astronomers are thrilled with the AURA–CELT agreement. "Defusing this have–have-not business would be a huge plus," says Frank Bash, director of the University of Texas's McDonald Observatory, referring to the perception that astronomers are split according to whether or not they have access to private telescopes. "But it was way too early to choose a project. Others would have liked to compete." Bash was one of fifteen astronomers, most of them at AURA member institutions and four of them directors of private observatories, who sent AURA's Smith a letter of protest. In it, they wrote that AURA's tying the knot with CELT without first evaluating other concepts for extremely large telescopes "precludes fair and open competition." The letter's tone, says Bash, "was reasonably low key. But it could flare up. It's like boiling gasoline."

AURA counters that both building a TMT and finding partners to do so were top priorities for ground-based astronomy in the National Academy of Sciences' 2001 *Astronomy and Astrophysics in the New Millennium* decadal survey. Says Smith, "There are other telescope groups that have alternatives. There are other ways to spend money and attention. But we chose to follow the decadal survey." The other concepts—notably a 25-meter scaled-up HET and a 20-meter version of a Magellan telescope, both under discussion by private groups—are completely different, he says. "There are only two credible designs for TMTs on the planet," adds Mountain.

In any case, AURA is careful to specify in the agreement that its research contributions should "directly benefit other large aperture telescope efforts." Accordingly, the public partners expect to work on such broadly applicable things as mirror coatings, detectors, advanced gratings, and site characterization. More than keeping open the possibility of involvement in other 30-meter–class telescopes, AURA has its eye on collaborating later with Europe on an even larger telescope.

The public–private partnership in

the US, meanwhile, brings urgency to Europe's decision on whether to build a 30-meter–class telescope or go straight to a 50- to 100-meter one. "The fact that [AURA and CELT] have joined makes their project more likely to succeed. It also makes a European one more likely to succeed," says Roberto Gilmozzi, director of the European Southern Observatory's Very Large Telescope and principal investigator for ESO's 100-meter Overwhelmingly Large Telescope (OWL). "The natural timescale of OWL is 15 years. If CELT moves ahead in 10 years, the [European astronomy] community would ask us to do something faster. The biggest pressure is that Europe not lag behind." The new partnership, adds Tim de Zeeuw of Leiden University in the Netherlands and a member of both the AURA board and the ESO council, "has stimulated the ESO to look carefully at its own future planning. Do we compete? Or do we at some point join forces?"

Toni Feder

South Dakota Governor Pushes for Underground Lab as Homestake Water Rises

NSF officials say approval of a science laboratory in the Homestake mine can come only after a multistep review process that takes "many months to many years." But a determined Republican governor and South Dakota's congressional delegation may bring politics to the science.

Deep in South Dakota's Homestake mine, in shafts and chambers that had been dry for decades, there is the sound of moving water. Flowing in at a rate of nearly 500 gallons per minute, the water has been filling Homestake since 10 June, when Barrick Gold Corp of Canada, the company that owns the mine, kept its promise to shut off the pumps that protected against flooding.

Wick Haxton, the principal investigator for a group that wants to create a National Underground Science and Engineering Laboratory (NUSEL) at Homestake, sits in his University of Washington office frustrated by the rising water, NSF, and just about everything else that has turned the proposed conversion of the mine into a high-stakes drama. In mid-July, Haxton's group sent NSF a Homestake underground lab "reference design project book" detailing where and how NUSEL would build research facilities within the mine. The book, a year in the making, "was produced with a lot of science and engineering hours of work," he said. Beyond sending the project book, Haxton said, his group simply has to wait. "We can't do anything more without access to the site."

He can, however, calculate how fast the water is rising in Homestake and how long it will be before the water threatens the NUSEL proposal. "The 7400-foot level is the area we want to develop," he said of the 8000-foot-deep mine. "We've been told in 18 months the water would be at that level. It appears the water is rising a little more slowly than expected, but if it reaches that level [7400 feet], then you really have to reassess your plans."

Indemnification intrigue

The idea of converting Homestake into a national science lab primarily for neutrino physics seemed obvious and relatively simple when it was first proposed in 2000 (see PHYSICS TODAY, January 2001, page 23). University of Pennsylvania astrophysicist Ken Lande raised the possibility after he heard that the mine was going to be closed. The neutrino physics community, familiar with Homestake because physicist Raymond Davis conducted a Nobel Prize–winning neutrino experiment there in the mid-1960s, enthusiastically endorsed Lande's idea. In 2001, an ad hoc study group led by physicist John Bahcall and supported by NSF and the Department of Energy, recommended Homestake as the site for an underground lab. But mine owners, concerned about possible lawsuits over environmental issues and potential health claims from former workers, wanted to simply close the mine and let it flood.

Barrick officials are not yet satisfied with liability protection schemes proposed by South Dakota, and weren't happy with an indemnification bill called the Homestake Mine Conveyance Act that passed Congress last year. The company refused an offer from South Dakota to take some of the $10 million in federal money that had been given to the state as development funding, and announced in May that it was on the verge of turning off the pumps. As the pumps were about to stop, NSF officials said an external advisory panel was completing an engineering study to determine which of several competing sites was most feasible for an underground lab. The panel picked Homestake as the most suitable from an engineering standpoint, but that didn't mean the mine had actually been selected as the official NSF site.

As the engineering study was concluding and the pumps were about to stop, Lande and his colleague, physicist Alfred Mann, flew to the town of Lead, near the mine, and pleaded for Barrick to keep the pumps on (see PHYSICS TODAY, June 2003, page 26). City and state officials joined in, as did the entire South Dakota congressional delegation. Fifteen Nobel laureates even wrote Barrick a letter asking that the mine be kept dry.

South Dakota Governor Mike Rounds has a background in insurance, not science, and although scientific pleas have failed to stop the flooding, he has moved forward "with an aggressive time frame" to make sure the Homestake lab is built. He talks enthusiastically about "the opportunity to bring pure and applied research into our region," and about the cultural change a world-class science facility would bring to South Dakota's Black Hills, where Homestake is located. "There is an opportunity to have our people learning from scientists who come in from all over the world," he said. "This could be a mecca of pure research. We want that."

Rounds plans to create a nonprofit, state-run authority to obtain the mine from Barrick. To make that happen, he said, he will call a special session of the state legislature before the end of the year. Rounds said the authority would assume the liability for Homestake, which would allow Barrick to insulate itself against future claims. The authority would purchase an insurance policy to cover any claims that might arise from Homestake, and that would insulate the state government. "We're talking a pretty good-sized insurance policy, but it's available," Rounds said.

First, he has to get an agreement from Barrick, and Rounds said that, by the end of August, he expected to have a signed option to obtain the mine. "We understand we're dealing with a business organization that has nothing to gain by doing this," he said. If the authority is then created, and if NSF commits to constructing an un-