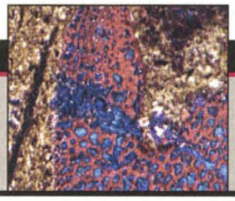
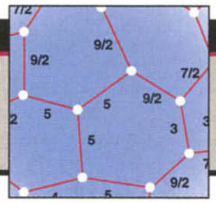




sample blood from three former hostages, although it's unclear whether it will make its findings public.

Some scientists believe that a far more potent compound was used. One candidate, Sutherland says, is etorphine, a derivative of morphine used by veterinarians to tranquilize elephants, rhinos, and other large animals. A dose of etorphine—estimated to be 1000 times as potent as morphine—large enough to knock out people in seconds would be close to the dose that would send someone into a coma and respiratory collapse, Sutherland says.

The fentanyl explanation is also challenged by Vil Mirzayanov, a chemist and former employee of the State Research Institute of Organic Chemistry and Technology in Moscow. Mirzayanov, who moved to Princeton, New Jersey, after blowing the whistle on Soviet chemical warfare research in the early 1990s (*Science*, 25 February 1994, p. 1083), claims his former institute is the only one in Russia with a research program in this area—and it never worked on derivatives of fentanyl. Indeed, when Mirzayanov contacted former colleagues back at the institute after the raid, "they all had to laugh" about the government's explanation, he says. Mirzayanov speculates that the Russians used a derivative of BZ, a powerful incapacitating agent that the U.S. military weaponized in the 1960s and 1970s. Mirzayanov's former institute had a supply of the compound that could be deployed immediately, he says. But Miller says BZ and related compounds are unlikely candidates because they are hallucinogenic, a symptom not reported by the hostages.

Meanwhile, experts disagree strongly on whether the use of the gas—or even its possession by Russian authorities—violated the chemical weapons treaty. The treaty allows the use of chemical agents for "law enforcement, including domestic riot control," and it requires member states to declare which substances they hold for those purposes. Some argue that the treaty's intent was to allow use of only a limited number of so-called riot control agents, such as tear gas. "There's no way in hell" the Russian operation would be permitted, claims Edward Hammond of the Sunshine Project, a group based in Austin, Texas, that opposes research on so-called nonlethal weapons in the United States. But others disagree. "I don't think they violated anything," says Harvard biologist Matthew Meselson, an expert in biological and chemical weapons.

If anything, the debate "shows that the treaty needs some work," says Jonathan Tucker, a senior fellow at the U.S. Institute of Peace in Washington, D.C. Tucker believes that the United States has refrained from criticizing Russia for using the gas because—apart from the fact that it needs support in its standoff with Iraq—it is operating in the gray zone itself. The Pentagon's Joint Non-Lethal Weapons Directorate is funding studies of nonlethal weapons, including "calmatives" such as Valium and Prozac (*Science*, 2 August, p. 764). Earlier this week, the National Research Council released a study recommending an expansion of that program (see p. 1153).

Yet although scientists criticize the Russian government for not being forthcoming about the nature of the gas, most agree that they had little choice but to use it. "At the end of the day, was there an alternative?" asks Sullivan. "There was no other way."

–MARTIN ENSERINK AND RICHARD STONE

With reporting by Andrei Allakhverdov and Vladimir Pokrovsky in Moscow.

ASTRONOMY

California Astronomers Eye 30-Meter Scope

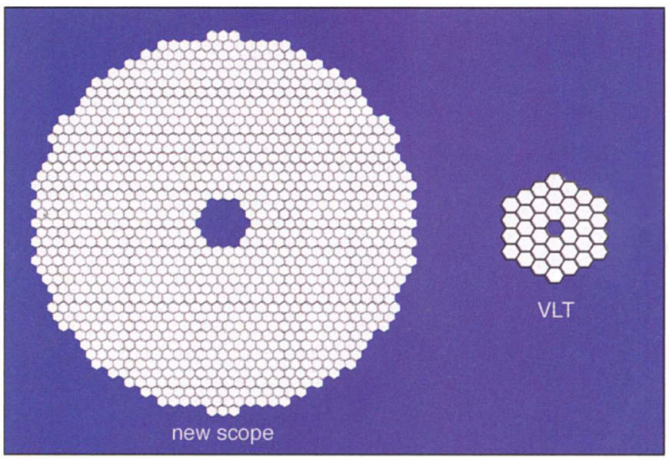
The creators of the world's largest optical telescopes have set their sights on something bigger—much bigger. Astronomers at the California Institute of Technology (Caltech) in Pasadena and the University of California (UC) hope to raise private money to build a telescope with a mirror 30 meters across. Caltech president David Baltimore announced a design study for the telescope as a centerpiece of a new fundraising campaign on 25 October, but Caltech and UC administrators haven't yet agreed on how best to proceed toward a venture that could cost $700 million over the next decade.

The mammoth observatory, dubbed the California Extremely Large Telescope (CELT), would sport a segmented mirror three times as wide as the ones on each of the twin Keck Telescopes in Hawaii. The ninefold boost in light-gathering area would give CELT the power to trace virtually the entire history of galaxy formation in the universe and peer deeply into regions where stars and planets arise. Two years ago, U.S. astronomers identified such a facility as their top ground-based priority to complement other powerful tools—notably the James Webb Space Telescope, the planned successor to the Hubble Space Telescope.

Star-studded teams in the United States and Europe are pitching competing visions of giant telescopes to their government agencies (*Science*, 18 June 1999, p. 1913). However, CELT's goal of obtaining purely private funding—and the team's nifty design work to date—might give the California group an edge. "CELT certainly has the momentum and the attention of the rest of the community," says Matt Mountain, director of the Gemini Observatory and its twin 8.1-meter telescopes in Hawaii and Chile. "They have the bit between their teeth."

Indeed, CELT's backers would like nothing better than to jump out of the gate as they did when the privately funded Keck Observatory opened on Mauna Kea a decade ago, years before any other huge telescopes existed. The same key players at Caltech and UC are in place, spearheaded by Keck designer Jerry Nelson of UC Santa Cruz. "This is the partnership we want," says Caltech astronomer Richard Ellis, director of Caltech Optical Observatories.

The current blueprint for CELT pushes Nelson's iconic honeycomb-mirror design to a grand scale. Instead of 36 hexagonal mirrors as in each Keck telescope, CELT would use 1080 mirrors acting as one smooth sur-

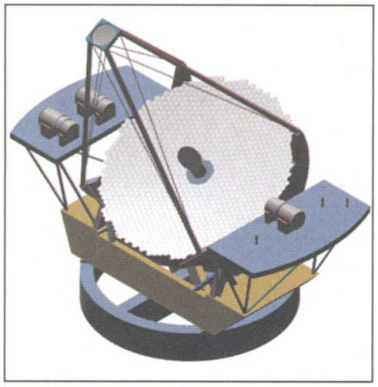


Really big glass. The California Extremely Large Telescope's 1080-piece mirror would dwarf one of the Keck Telescope mirrors.

CREDIT: CELT

face. CELT's 1.0-meter mirrors would be easier to make, polish, and handle than Keck's 1.8-meter units, and they would also be less prone to sagging and other distortions.

Nelson feels confident that building such a fly's eye is within reach. However, giving it a clear view of the heavens will take optical wizardry. A 30-meter telescope will gaze through such a wide cylinder of atmosphere that astronomers must compensate for turbulence in many places at once. Caltech astronomer Richard Dekany and Nelson's team at the National Science Foundation–funded Center for Adaptive Optics in Santa Cruz envision a system of seven lasers arrayed in a ring to spark artificial stars in a layer of sodium atoms 90 kilometers high. Ultrafast computer processors would analyze the stars' wiggles and adjust the flexible surfaces of additional mirrors near the observing instruments, erasing the blurs.



Next generation. CELT could go from model to reality in a decade.

"Correcting distortion in the volume of our entire field of view is a huge complication," Nelson says. "At Keck we sort of knew about it, but we didn't think about it during the design." In contrast, nearly one-third of CELT's projected budget would pay for adaptive optics alone. That investment is worth the risk, Ellis notes: "We'll resolve areas of the sky equivalent to what Hubble sees in each imaging pixel and get detailed spectra of those regions. That's a phenomenal advance."

Another key issue is where to build the observatory. The long-range development plan for Mauna Kea allots a site for a giant telescope on the volcano's northern shield, but the viewing conditions there might not be as good as at the now-crowded summit. Moreover, notes Caltech astronomer S. George Djorgovski, native groups in Hawaii might fight such a prominent addition. "Mauna Kea may not be politically viable," he says.

Under consideration are sites in dry northern Chile, both near the coast and in the high Atacama Desert. Djorgovski heads a group working with the U.S. National Optical Astronomy Observatory (NOAO) to conduct "vigorous site testing" at unnamed locations in Chile. Astronomers also are studying clear-weather spots in northern Mexico and the southwestern United States.

None of this will matter unless Caltech and UC raise the money, starting with about $70 million for a detailed design study. Caltech's description of CELT in its $1.4 billion campaign announcement focused only on its own role, ruffling some feathers at UC. However, UC administrators won't make a public statement about CELT until the institutions sign a long-delayed legal agreement.

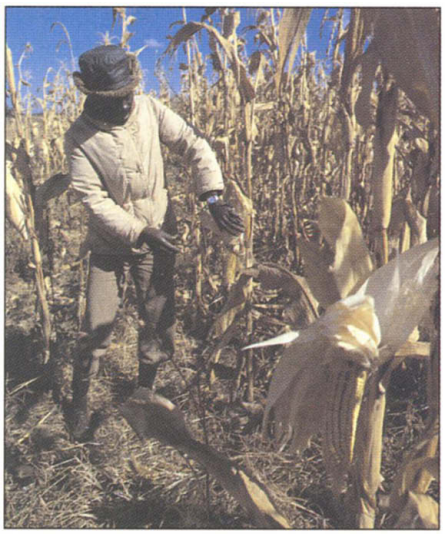
UC's chancellors endorse CELT, but, according to astronomers, they fret about its cost when the vicissitudes of the California state budget put pressure on donations for other needs. With federal funds for astronomy in similar straits, the solution might involve some hybrid of CELT and a U.S.-funded Giant Segmented Mirror Telescope through NOAO, says Mountain. "People are hopelessly optimistic about how many of these things they're going to have," he says. "We may struggle to operate more than one."

–ROBERT IRION

FOOD AID

Zambia Rejects GM Corn On Scientists' Advice

CAMBRIDGE, U.K.—In a stunning decision, the government of Zambia last week rejected thousands of tons of corn donated by the United States because it is likely to contain genetically modified (GM) kernels. The refusal leaves an estimated 2.9 million people at risk of starvation, according to the United Nations Food and Agriculture Organization. But it turns out that the government was only following the advice of its own experts: *Science* has learned that a delegation of Zambian scientists and economists, after completing a fact-finding tour of labs and GM regulatory offices in South Africa, Eu-



Drought. Zambian farmer inspects dried corn.

ScienceScope

Break for Beluga There's fresh hope for the world's largest freshwater fish. Last month, the secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora banned the five nations bordering the Caspian Sea from exporting the meat or caviar of the beluga sturgeon for the rest of 2002. Conservationists criticized the body for lifting a similar ban earlier this year (*Science*, 22 March, p. 2191). Its latest decision came after Caspian states failed to present a coherent picture of sturgeon stocks and how the fish can be harvested sustainably. The states are now scrambling to make a case for 2003 quotas.

Moves are afoot to protect the beluga indefinitely. Last July, the U.S. Fish and Wildlife Service (FWS) proposed listing the beluga as an endangered species, which would end the legal import of beluga products into the United States, the biggest consumer. More than 50 scientists backed the move in a 28 October letter to U.S. Interior Secretary Gale Norton. FWS has up to a year to decide but is under pressure to make an emergency ruling before the spring harvest.

Nod for Nonlethal "Nonlethal weapons" might seem a misnomer after Russian security forces killed 118 people with an incapacitating gas in a besieged Moscow theater last month (see p. 1150). Still, similar weapons, aimed at knocking people or equipment out without killing, are a potentially valuable tool for the U.S. military, according to a National Academy of Sciences report released this week. Research in the area should be stepped up, according to the study, which was commissioned by the Marine Corps and the Navy.

Nonlethal weapons include a broad array of compounds and technologies, from foul-smelling gases and slippery foams to microwaves that knock out ships. The panel, chaired by Miriam John, vice president of Sandia National Laboratories' California Division, says such weapons are needed by a modern military increasingly focused on preventing terrorist attacks, enforcing embargoes, and peacekeeping—all while trying to minimize casualties.

But critics say the report comes close to encouraging violations of the Chemical Weapons Convention, which bans the stockpiling and use of chemical weapons. The panel does acknowledge that some nonlethal weapons skirt the treaty. But Jonathan Tucker, a senior fellow at the U.S. Institute of Peace in Washington, D.C., says the report's discussion of the pact is "confusing at best and sophistry at worst."

CREDITS: (TOP TO BOTTOM) CELT; CHRISTINE OSBORNE/CORBIS