In the early 1990s, as more sensitive detector will also be able to detecting Earth-size worlds. COROT's satellites will be technologically capable of Kepler, due in 2007. Unlike MOST, both COROT and Kepler will focus on fainter stars than MOST observes, and their vision will be limited to smaller sections of the sky, Metcalfe says. As a result, he argues, during the tail end of its 5-year life span, MOST will complement the other missions and will not become obsolete when they come on line.

Central Asia

Combating Radioactive Risks And Isolation in Tajikistan

The science academy of this war-weary country is reaching out for help in tracking down lost radioactive sources—and restoring scientific vitality

FAIZABAD, TAJIKISTAN—In the early 1990s, as civil war raged in this mountainous land, a terrorist's prize was here for the taking. Powerful radioactive sources lay buried in an open-air, gravel-covered pit on a compound ringed by a dilapidated concrete wall and chain-link fence. During the 5-year war, villagers and fighters pillaged nearby apple orchards and industrial sites. But the makings of dirty bombs—including radioisotopes such as cesium, cobalt, and americium in old Soviet gauges and other devices—remained untouched. “We were lucky,” says Gennady Krivopuskov, manager of the 6-hectare waste storage facility 50 kilometers northeast of the capital, Dushanbe. “Maybe the radiation hazard signs kept looters away.”

How long the rad cops’ luck will last is an open question. One or two derelict radioactive generators, which produce electricity from the heat harnessed from the decay of strontium-90, were never moved to this storage facility and remain unaccounted for, experts say. Each radioisotope thermoelectric generator (RTG) packs a whopping 40,000 curies—equivalent to the radioactivity from strontium-90 released during the 1986 Chornobyl explosion and fire. “How serious is it that they aren’t secured? Well, that depends on who has them,” says a Western diplomat. Last month, a U.S. Department of Energy (DOE) team was in Dushanbe to train specialists at the Nuclear and Radiation Safety Agency of the Academy of Sciences of the Republic of Tajikistan (AST) on how to detect abandoned sources. Search efforts are about to get under way.

Concern about RTGs as a serious proliferation threat first got attention 3 years ago, when the first teams to detect Procyon’s oscillations from the ground and biggest critic of MOST’s Procyon results, suspects that either light scattered back from Earth into the telescope washed out the data, or “noisier”-than-expected convection in the star’s atmosphere made the oscillations unreadable. The possibility of using MOST to study stars’ atmospheric churning “is, of course, itself interesting,” he adds. The MOST team revisited Procyon this year and plans to publish an analysis of the new measurements within a few months.

Things went more smoothly this year, when MOST fixed its gaze on Eta Bootis. This time the data matched both stellar models and earlier ground-based observations. By comparing the data against a library of over 300,000 theoretical stellar models, Matthews and his team have pegged the star’s age at 2.4 billion years, plus or minus 30 million years—about 10 times the precision of previous estimates. Studying a variety of sunlike stars with differences in mass, age, and composition will lead to better models, Christensen-Dalsgaard says.

As a bonus, MOST’s ability to measure exquisitely small variations in starlight enables it to double as an exoplanet explorer. At the meeting, the MOST team announced that the telescope had staked out an alien world around a far-off star and turned up subtle hints of an atmosphere and possible cloud cover. NASA’s Spitzer Space Telescope had detected the infrared glow from exoplanet HD209458b in March. MOST tracked the subtle dip in optical brightness as the planet slipped behind its parent star during its orbit.

By following the frequencies and amplitudes of the changes in stellar brightness, the team concluded that the planet is a gas giant 1.2 times as massive as Jupiter, parked less than 1/20 as far from its star as Earth is from the sun. Astronomers think HD209458b’s low reflectance (less than 40%, compared with 50% for Jupiter) sets limits on the planet’s atmosphere, in which the Hubble Space Telescope saw signs of carbon and oxygen in 2004. MOST will conduct a 45-day survey of the system later this summer with the hope of getting a clearer picture of the exoplanet’s atmosphere and even its weather: temperature, pressure, and cloud cover.

MOST’s asteroseismological monopoly is destined to be short-lived. Similar satellites on the horizon include the European COROT (Convection, Rotation, and planetary Transits) mission, slated for launch in June 2006, and NASA’s own planet seeker, Kepler, due in 2007. Unlike MOST, both satellites will be technologically capable of detecting Earth-size worlds. COROT’s more sensitive detector will also be able to look at many stars simultaneously, rather than one at a time, as MOST does. But COROT and Kepler will focus on fainter stars than MOST observes, and their vision will be limited to smaller sections of the sky, Metcalfe says. As a result, he argues, during the tail end of its 5-year life span, MOST will complement the other missions and will not become obsolete when they come on line.

Christensen-Dalsgaard agrees. “MOST is giving us the experience that we need to learn how stars behave photometrically and helps us learn how to choose targets for these later missions,” he says. “So in the next couple of years, we need to make the most out of MOST.”

—ANDREW FAZEKAS

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Shock and Recovery

DUSHANBE—The hunt for hot sources (see main text) is one of several challenges that the Academy of Sciences of the Republic of Tajikistan (AST) faces as it attempts to recover from a brutal civil war that followed the Soviet collapse. Some of the academy’s prized assets, including a cosmic-ray physics laboratory, astronomical observatories, and a network of seismic stations, emerged surprisingly intact. But lingering memories of the civil war and ongoing concerns about Tajikistan’s anemic law enforcement—including an unsolved car bombing outside a government building last January—have put a damper on international cooperation.

During the Cold War, the Soviets bankrolled some high-profile Tajikistani projects. The Soviet Equatorial Meteor Expedition from 1968 to 1970, organized by AST’s Institute of Astrophysics, painted a detailed picture of meteor bombardment of Earth and wind patterns in the upper atmosphere. And in 1963, the Institute of Earthquake Engineering and Seismology inaugurated the Lyaur testing range, a unique facility where artificial earthquakes—simulated with explosives—probed the durability of full-scale model buildings constructed from novel seismic-resistant materials and designs.

By the early 1990s, however, most scientific activity in Tajikistan, the poorest of the 15 nations born from the old Soviet Union, had ground to a halt. During the worst years of the civil war, in 1992 and 1993, food was scarce, power outages frequent, public transportation virtually nonexistent, and the water supply and telephone lines unreliable. “Yet we came to work every day,” says Alla Aslitdinova, director of the academy’s central library. “I can’t explain why.” Thefts were commonplace. “People stole our computers and other equipment,” says Khursand Ibadinov, director of the astrophysics institute. “Fortunately, they left the telescopes,” he says, including a 40-centimeter Zeiss astrometry telescope at the Hissar observatory near Dushanbe.

Shelling, gunfire, and penury were not the only problems. The Russian government asserted ownership of the Murgab cosmic-ray research station, perched in the Pamir Mountains northeast of Dushanbe. Because of the dispute—which shows no signs of ending—“for 14 years no experiments have been carried out there,” says AST president Mamadshev Irlilov, a mathematician.

The country’s seismic stations, meanwhile, require an extensive upgrade from analog to digital instruments. But the investment would be worth it, says David Simpson, president of IRIS, a university seismological consortium based in Washington, D.C.: It could sharpen the monitoring of regional seismic hazards and help probe fundamental questions such as the geological structure of the Pamirs. Simpson led a seismological project at Nurek reservoir in Tajikistan from 1975 into the early 1980s. “Even under Soviet power at that time, it was a wonderful, friendly, and beautiful place to live and work,” he says.

AST researchers hope to soon end the isolation that has cocooned them since the civil war. “I have a dream to start academic and student exchanges” with U.S. universities, says Aslitdinova, who spent four months as a Fulbright scholar late last year at Northwestern University in Evanston, Illinois. It’s a dream many Tajikistani share, but one that will be a struggle to make come true.

When the International Atomic Energy Agency (IAEA) in Vienna helped secure a pair of abandoned generators in the Republic of Georgia (Science, 1 February 2002, p. 777). IAEA has since learned that more than 1000 such generators were produced in the Soviet Union; the vast majority stayed in Russia, where they were used primarily to power Arctic lighthouses. But in recent years scores have gone astray or been vandalized for scrap metal. In Tajikistan, where the generators were used to power remote weather stations, four RTGs have been recovered and are awaiting transfer to Russia for disposal, says Ulmas Mirsaidov, director of the radiation safety agency. Although Mirsaidov told Science that all RTGs in Tajikistan are now secured, DOE officials and a Western diplomat in Dushanbe say that units are missing; one or two is the best estimate based on present information.

Tajikistan’s radiation agency is now working with IAEA to compile an inventory of radiological sources. “We’re helping them make sense of their records and develop a search plan,” says Carolyn MacKenzie, a radiation source specialist with IAEA. There’s no indication that any RTGs have fallen into the wrong hands. Still, there’s a disconcerting lack of knowledge about where precisely to look. “When the Soviets left, the records weren’t passed on,” MacKenzie says. “We don’t have definite information,” adds Roman Khan, a health physicist at Argonne National Laboratory in Illinois. DOE’s Search and Secure Program, Khan says, has provided Mirsaidov’s agency with a suite of instruments—including a portable radiometer capable of detecting alpha and beta particles and gamma rays, a hand-held gamma ray spectrometer, and a broad energy germanium detector—for tracking down orphan sources.

The hope is that the loose RTGs can be located and stored as soon as possible at the Faizabad facility, a hilly territory alive with discus-sized tortoises, a cacophony of sparrows, and a riot of bright-red poppies. A short walk up the road, through an inner fence patrolled by a machine gun–toting guard, is a whitewashed building with a massive gray steel door. Buried here, 9 meters beneath the dirt floor, are a variety of radioactive sources, including x-ray fluorescence instruments containing americium-241 that were used for geological surveys, radiotherapy canisters filled with cobalt-60, and four RTGs recovered so far.

The repository was rebuilt last year with DOE and U.S. State Department support. The previous structure was frail indeed: On several occasions, high winds that sweep down from the mountains from September to March tore off the corrugated steel roof, says Krivopuskov, who after 26 years of service receives a salary of $12 per month. Thanks to the renovations, he claims, the sources “can stay here safely for 1000 years.” In the meantime, though, he and his colleagues must contemplate the fate of the sources that haven’t yet been secured.

—RICHARD STONE
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