RUSSIA

Gallium Sell-Off Threatens Detector

MOSCOW—An extraordinary confrontation between scientists and a Russian government ministry is taking place at a mine in the north Caucasus. Deep underground, the Soviet-American Gallium Experiment (SAGE)—one of the largest collaborative research projects between the two countries—has been measuring neutrinos from the sun's nuclear processes since the mid-1980s. But a government effort to confiscate the detector's 60 tons of ultrapure gallium, a valuable metal that researchers suspect would be sold to pay salaries in cash-strapped state businesses, could end SAGE's vigil.

With the help of Vladimir Fortov, a deputy prime minister until mid-March, when he was made minister of science, researchers managed to stave off the threat when officials showed up unannounced at the site in February. But talks between research representatives and officials of the ministry of fuel and power-production industries—which is carrying out the order—are at an impasse. Confiscation of the gallium, the Russian head of the SAGE collaboration, Vladimir Gavrin of the Institute of Nuclear Research (INR) in Moscow, wrote in a letter to Fortov, "would mean the ruin of the [neutrino] telescope and the Baksan neutrino observatory as a whole." U.S. collaborators at Los Alamos National Laboratory also wrote to Fortov expressing their alarm at the situation.

SAGE is one of two solar neutrino detectors built in the 1980s to try to resolve a major crisis for solar theorists. When the first generation of detectors began capturing solar neutrinos in the late 1960s, they detected only one-third of the number of neutrinos predicted by theory, casting doubt either on theorists' models of the sun's interior or particle physicists' understanding of neutrinos. These early detectors, however, could not pick up the low-energy neutrinos from the sun's primary power source, the fusion of hydrogen into helium—only those produced in tertiary nuclear reactions of heavier elements. SAGE and its rival GALLEX, in the Gran Sasso laboratory beneath the Italian Apennines, were designed to see whether the solar neutrino problem extends to proton fusion.

Both detectors rely on gallium, because a low-energy neutrino from proton fusion can transform a gallium nucleus into radioactive germanium-71, which can later be extracted from the detector material and counted. The GALLEX team opted to use gallium chloride, but in the late 1970s, a team at INR developed a technique for extracting tiny amounts of germanium-71 from pure gallium. In 1979, researchers persuaded the Soviet government to increase gallium production from 1 ton to more than 5 tons a year so that 60 tons of the metal could be made into a neutrino detector. In return, they promised to keep the gallium intact as a national reserve of the metal, which later could be used by the defense and electronics industries. The project got another boost in 1986, when the United States agreed to collaborate on the project and eventually contributed $9 million to the experiment's $60 million cost.

The first results of both SAGE and GALLEX, published in the early 1990s, confirmed the reality of the solar neutrino crisis, but researchers say there is much more science to be done. SAGE's ultimate aim is to keep running up until 2002, so that it can look for possible variations in neutrino flow during the 11-year cycle of solar activity.

In February, however, officials from an experimental chemical metallurgic plant of the Institute of Rare Metals came to the SAGE site under orders from the ministry of fuel and power-production industries to confiscate the gallium. The government order for the fuel ministry to seize the gallium came from the Cabinet level and appears to contravene rules covering the movements of national reserves. The fuel ministry has refused to state publicly what it intends to use the gallium for. "I can only guess that it is meant to be sold abroad," Gavrin told *Science*. "Its minimum price on the market is $200 per kilogram."

The researchers' reaction, however, was unequivocal: They refused to give up the gallium and stated that they would rather burn themselves in the mine shaft than let the plant officials take the metal. Observatory administrators immediately informed Fortov, emphasizing the threat not only to the experiment but to the gallium reserve. "During construction, the metal was highly purified and stored deep underground to protect it from radioactive contamination. This makes it a unique material for further research," wrote Gavrin.

As a deputy prime minister, Fortov was able to halt the order on 6 March. On 14 March, however, first Deputy Prime Minister Alexey Bolshakov issued a new order, calling for the removal of a smaller amount of gallium—7 tons. Bolshakov later lost his government seat in a Cabinet reshuffle, but the threat of this second order also hangs over SAGE.

Last week, Fortov met with representatives of the fuel ministry, the chemical metallurgic plant, and the Russian Academy of Sciences. Each side stuck to its original position, and the fate of SAGE still hangs in the balance.

–Andrey Allakhverdov and Vladimir Pokrovsky

Allakhverdov and Pokrovsky are writers in Moscow.

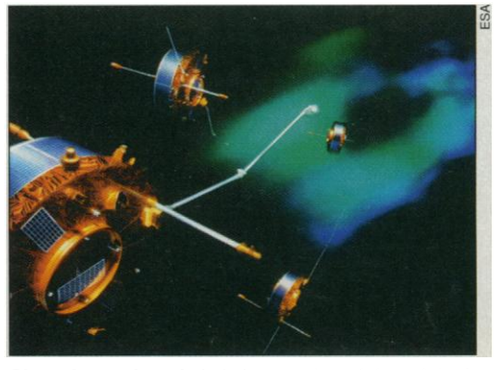
SPACE SCIENCE

Resurrected Cluster Gets the Green Light

PARIS—Ten months ago, European space scientists saw one of their most important projects disappear in a fireball when Europe's Ariane 5 rocket, carrying a quartet of satellites called Cluster, exploded on its first voyage. Last week, they got some good news: A key European Space Agency (ESA) committee gave final approval for a plan to launch a full complement of replacement satellites in 2000.

The Cluster mission is composed of four probes designed to fly in formation around Earth mapping its magnetosphere in unprecedented detail. Since the explosion, however, ESA has struggled to find funding for a second try, and it has mulled proposals for scaled-down versions of the project. Last December, ESA proposed freeing up funds for a full Cluster mission by pushing back launch dates on future missions, but three countries—France, Germany, and the United Kingdom—were unwilling to ante up a total of $45 million to replace the scientific payload.

The project was given a new lease on life when ESA's science program committee announced two measures last week: The agency will finance about 40% of the scientific payload—relieving some of the burden on the three reluctant space agencies—and it will cap the mission's cost at $248 million. The extra $20 million ESA is providing for the payload comes in part from raiding an $11.5 million contingency fund, and the rest by using spare parts from the four satellites that were destroyed. "It is an exceptional measure," says John Credland, former Cluster project manager and now act-



Close formation. Artist's impression of the original Cluster spacecraft mapping the magnetosphere.

ing head of the scientific projects department at ESA's European Space Research and Technology Centre in Noordwijk, the Netherlands.

Another mission-saving maneuver was to involve the Russians: STARSEM, a joint venture between launch company Arianespace and the Russian Space Agency, will launch the spacecraft using two Soyuz launchers, keeping launch costs down to about $70 million. "Without the proposal of STARSEM, the project would not have got off the ground," says ESA spokesperson Roger Elaerts. The three new spacecraft will be built by a European industrial consortium led by DASA/Daimler Benz Aerospace in Germany.

Most of the instruments have to be rebuilt, and the research teams immediately started hammering out plans to have their instruments ready by mid-1999. "The current schedule is quite tight, and it will really be a question of how quickly the national agencies will be able to make the funds available for us to start up," says principal investigator André Balogh of Imperial College London. But after almost a year of uncertainty, Cluster project scientists are delighted. Says Donald Gurnett of the University of Iowa, lead investigator on a NASA-funded radio interferometer project using Cluster: "I'm very excited."

–Alexander Hellemans

Alexander Hellemans is a science writer in Paris.

INDUSTRIAL RESEARCH

Slower Road for Clean-Car Program

An ambitious U.S. program to design efficient automobiles by the year 2000 will not reach its first big milestone, predicts a new report from the National Research Council (NRC). This peer-reviewed analysis of the flagship industrial-development program begun in 1993 by the Clinton Administration argues that it is premature to promote any specific clean-car technology at this time. Instead, the NRC panel recommends that government and industry continue their funding of R&D on new ideas, such as cars powered by gas turbines, flywheels, and fuel cells (see table).

The program, known as the Partnership for a New Generation of Vehicles (PNGV), began with a bang at a White House Rose Garden press conference in September 1993. President Clinton announced that he had forged a pact with leaders of the U.S. car companies to revitalize the industry for the next century. The goal was to create within a decade automobiles that would both meet stringent clean-air standards and get 80 miles to the gallon (34 km/l). (U.S. cars now average 20 to 30 miles per gallon.) Since then, government and industry have been spending roughly $600 million a year to develop futuristic autos, according to the Commerce Department. This year, the program was supposed to begin choosing technological "winners" that would be developed into "concept vehicles" by 2000 and manufactured starting in 2004.

But the NRC review, chaired by Trevor Jones of the Echlin auto-parts company in Cleveland, says it is unrealistic to adhere to PNGV's original schedule. While PNGV has developed many new high-tech auto components, the report says, researchers haven't integrated them into car designs that could compete in the market. It "no longer appears to be tenable," says the NRC report, to try to pick winners in 1997. And if PNGV were to do so, the report says, "nonconventional technologies [would] run the risk of being discontinued or discarded." Everyone realized from the beginning, Jones says, that it would be a "very big stretch" to meet these deadlines; now, he says, it's time to acknowledge that the R&D program must be lengthened and expanded.

At present, the NRC panel says, none of the proposed new designs "will come close to meeting the cost objectives" within initial deadlines. And the one innovation with the "highest potential" for meeting the original goals is not so radical: It's an advanced diesel engine known as the compression ignition direct injection engine (CIDI). While lightweight CIDIs might satisfy the program's cost and efficiency requirements, the report notes, they might not meet new limits on airborne particles being considered by the Environmental Protection Agency. (Diesel engines emit more particles than do gasoline engines.) But unless the partners step up their R&D investments in CIDI technology, the report warns, even these engines won't be ready for mass production by 2004. However, the report does praise the partnership for developing many innovations, such as automobile fuel cells that can run on more than one type of fuel, high-power lithium batteries, and lightweight composite materials.

The Commerce Department and the industry coalition that oversee PNGV issued a joint statement on the NRC report, agreeing that "some technologies are not progressing at a pace consistent with the established program timetable." But Commerce spokesperson Virginia Miller emphasized that PNGV has pushed industry to move faster. As evidence, she cites announcements since January by Detroit's three big auto companies that over the next 2 years they plan to develop demonstration cars that will achieve a 50% increase in mileage. General Motors is testing several ideas, including a CIDI-powered car and two hybrid propulsion systems. Chrysler is planning a gasoline-fed fuel-cell car. And Ford is building a diesel-electric vehicle. But none of these is a finalist in the PNGV competition, says Ron Beeber, spokesperson for USCAR, the coalition of auto companies involved in the project. The companies "haven't said 'This is what our concept for 2000 will look like,' " Beeber explains. "These are just examples of projects they've been doing and [proof] that progress is being made."

–Eliot Marshall

NRC'S RANKING OF NEW CAR TECHNOLOGIES

Major subsystems	Critical technical barriers	Likelihood of meeting technical objectives	Likelihood of meeting cost	Likelihood of meeting schedule	Overall potential regardless of schedule
Propulsion					
Advanced diesel (CIDI)	Combustion control NO_x catalyst	●		●	●
Fuel cell	Fuel processor/reformer				
Turbine	Structural ceramics Exhaust heat recovery				
Stirling engine	Heat exchangers Leakage control				
Energy Storage					
Li-ion battery	Scale-up, system safety	●			
Ni hydride battery	Efficiency, power density				
Ultracapacitor	Efficiency, self-discharge, safety				
Flywheel	Safety				●
Power electronics	Efficiency			●	●

● High Medium Low

SOURCE: NRC