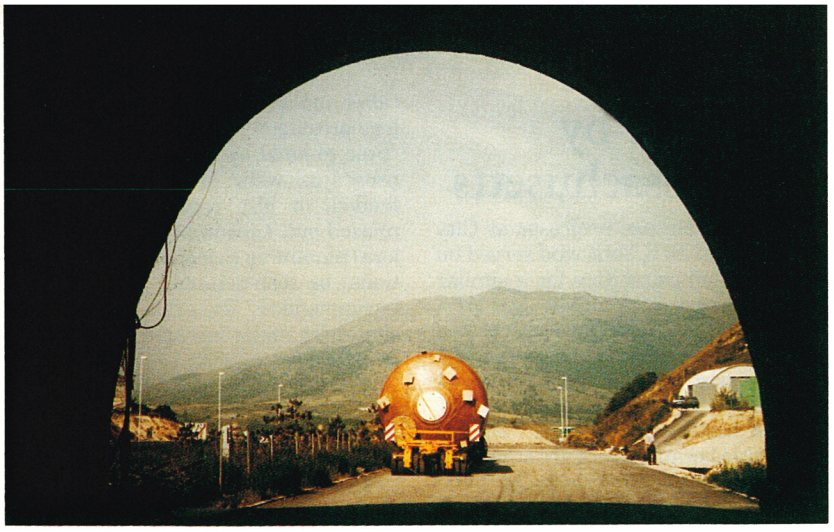

TILL KIRSTEN/MPIK HEIDELBERG

VIEW FROM THE ENTRANCE TO THE TUNNEL that houses the Gran Sasso National Laboratory. Solar neutrino experiments are housed deep inside the tunnel, shielded from cosmic rays by 1200 meters of rock. The tank shown could be used to hold the Gallium Neutrino Observatory's next 30 tons of gallium.

GALLEX spokesman Till Kirsten, of the Max Planck Institute for Nuclear Physics in Heidelberg, Germany. Nevertheless, since over 90% of solar neutrinos are produced by proton fusion (p–p neutrinos), and since radiochemical detection with gallium is still the only way to detect these low-energy neutrinos, these experiments will remain crucial, say Kirsten and others. "The first question that will be asked if the experiments with the rarer boron-8 or beryllium-7 neutrinos find something unexpected will be, What are the p–p neutrinos doing?" says Kirsten. "GNO will be needed as a backup for the interpretation of other experiments."

The GNO team will also look for nontrivial seasonal changes in solar neutrino flux and changes over a solar cycle. "If they do see a time variation, it would be a smoking gun for new physics," says Tom Bowles, the American spokesman for SAGE.

The most significant change planned in the GALLEX/GNO upgrade is an increase in the capture rate by increasing the gallium mass to 100 tons. (With 30 tons of gallium, less than half a p–p neutrino per day was captured.) But gallium is expensive, and the purchase of an additional 70 tons hasn't yet been approved by the Italian government, according to GNO spokesman Enrico Bellotti of the INFN. "First we must demonstrate that we can reduce the systematic error down to the range of the statistical error, or about 3–4%." So the electronics, optics, computing and counting systems will be overhauled. "This should take about a year," says Bellotti. "Then we'll certainly dare to ask our scientific and funding agencies for the money [for the gallium]."

The plan is to increase to 100 tons of gallium in two steps. The first step, to 60 tons, is planned for 1999, and will require only minor changes in the experiment's infrastructure. The second step, to the full 100 tons, will be more complicated and expensive, and the details will depend on whether all the gallium is in aqueous form in hydrochloric acid, or whether the final 40 tons is in the metal form (as at SAGE). It's more difficult to extract radioactive germanium—which is formed when a gallium atom captures an incident neutrino and is used as a measure of neutrino flux—from the metal than from the aqueous gallium, but a hybrid experiment would provide a method to cross-check for systematic errors, explains Bellotti.

GNO's operating costs, and most of the upgrade costs other than for the gallium, will be shared among the six Italian and German collaborating institutions, says Bellotti. "This doesn't worry me. The real problem is the cost of the gallium." Gallium is used widely in the semiconductor and defense industries, and currently has a market value of $300–400/kg. Bellotti hopes that GNO is included in the INFN's next 5-year plan, which is expected to be presented to the Italian government for approval in the latter part of 1998.

There is also some talk of merging SAGE's 57 tons of gallium with GNO's 30. At the moment, though, SAGE is busy fighting a move by the Russian government to sell the gallium for much-needed hard currency (see box), so a decision to merge is unlikely anytime soon.

TONI FEDER

A Besieged SAGE Is Safe, for Now

For several months, Russian scientists have been fending off attempts by their government to take and sell SAGE's gallium on the world market. By last month, the immediate threat had been averted, but the gallium's future had not yet been secured.

Located about a mile underground in the Caucasus in southern Russia, SAGE (the Russian–American Gallium Experiment) is an ongoing collaboration that, like GALLEX, was designed to measure the flux of solar neutrinos from proton fusion. Its 57 tons of pure gallium metal were provided by the Soviet Ministry of Metals in the early 1980s, but with the reshuffling of ministries since the collapse of the Soviet Union, the ownership of the gallium was thrown into question.

Vladimir Gavrin, of the Institute of Nuclear Research (INR) in Moscow, who heads SAGE, says that gallium is but one of many valuable materials that today's Ministry of Fuel and Energy has targeted for selling—ostensibly to get money to pay workers' salaries.

In January, "we were informed that the SAGE gallium now belongs to the ministry, and that 7 tons had already been sold," recounts Gavrin, adding that neither the Russian Academy of Sciences nor INR had been warned of the ministry's plans.

Gavrin and others in the Russian scientific community are fighting hard to save SAGE, chiefly by tirelessly petitioning government officials. In addition to such local efforts, a number of prominent scientists from the US, Italy and Germany have written letters expressing their alarm to Russia's prime minister, Victor Chernomyrdin, and to the minister of science, Vladimir Fortov—who, Gavrin says, is "the one person in the government who is really fighting for us."

In March, Fortov succeeded in forestalling the sale of the immediately threatened 7 tons of gallium, only to have the sale approved again ten days later, says Gavrin. Then, in May, Gavrin received word that Chernomyrdin had agreed to sign a decree against selling the gallium. But when PHYSICS TODAY went to press, it wasn't yet clear whether the property rights to the gallium would be transferred to INR, or whether the gallium would continue to be considered a national reserve, which, in time, says Gavrin, "would undoubtedly attract the same—or new—fans of easy profit."

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