Thermonuclear fusion

Inertial confinement in trouble

Washington

ANTARES, the world's most powerful fusion research laser, could face premature retirement later this year after only two years in operation, unless the US Congress takes pity on the $63.5 million instrument. The laser, at Los Alamos National Laboratory, is being used for experiments in inertial confinement fusion, but has proved to be the instrument of its own fate: it has clearly demonstrated that carbon dioxide lasers such as Antares have no potential for economic fusion. Hopes of a reprieve are now pinned on the possible use of Antares in the Strategic Defense Initiative (SDI) programme of research into anti-missile defences.

Antares is capable of producing a 40-kilojoule pulse of light lasting for one nanosecond. The problem is that radiation of wavelength 10.3 micrometres is, with the benefit of hindsight, too long for economic fusion power. When focused onto a glass bead containing fusion fuel, radiation of this wavelength stimulates the emission of hot electrons that pre-heat the fuel and so prevent the high degree of compression and simultaneous high temperature needed to achieve plasma ignition. Carbon dioxide lasers would be useful only if their cost dropped drastically, to about $10 per joule. This is an unlikely prospect; Antares costs $1,500 per joule, and the cheapest imaginable mass-produced carbon dioxide laser would still cost $300 per joule.

The administration's inertial confinement fusion budget request for fiscal year 1986 assumes that Antares will be taken out of service before the end of 1985. The total request at $70 million is about the figure for the current year. Donald Kerr, director at Los Alamos, has testified before Congress that about 100 people may lose their jobs in inertial confinement fusion if the proposed cuts go ahead.

David Cartwright, principal programme manager for inertial confinement fusion at Los Alamos, has recently informally requested an extra $5 million to allow the current series of experiments on Antares to be completed, because recent results suggest that the temperature of the troublesome hot electrons can be reduced by increasing pulse duration from about 1 nanosecond to 5 nanoseconds. This sum would nevertheless keep Antares in operation for only a few months, and would not allow modifications for new experiments. Hence the hopes that the SDI organization might take an interest.

Cartwright says Antares is the only national facility that could be used to test the predicted effects of high intensity laser radiation on nuclear warhead re-entry vehicles. The pulse length and power could without much difficulty be increased to a few microseconds and 0.25 megajoules, a region of importance for laser weapon concepts. Mirrors would have to be repositioned so that, instead of converging in three dimensions on a single point, the laser beams would illuminate a larger spot from one side. A request for $15 million has been made to the SDI organization for this purpose. Antares might also be used to drive X-ray lasers, also of SDI interest.

Congress is sympathetic to the idea of keeping Antares running, and both houses have authorized sums of around $145 million for inertial confinement fusion — twice the administration's request. The appropriations hearings, which will decide how much will actually be spent, have, however, only just started.

Some support for Antares has come from the National Academy of Sciences, which is carrying out for Congress a study of inertial confinement fusion. The committee responsible has made known its opinion that it would be unwise to dismantle a facility while its usefulness is still being evaluated. Congress might therefore take this cue to override the Office of Management and Budget, as it has been known to do before. Congressional aides warn, however, that there may be jurisdictional obstacles to supporting Antares directly through the SDI organization, if only because that would entail a transfer of funds between two subcommittees. On Capitol Hill, subcommittees' territories are guarded jealously, and the political difficulties are seen as far more daunting than the technical modifications that Antares itself would need.

The other major fusion research laser facility in the United States, known as Nova, is close to completion at Lawrence Livermore laboratory. The light produced by the neodymium-glass lasers in Nova has a wavelength of around 1 micrometre, but is then frequency-multiplied by a factor of 3 to give light with 0.35 micrometre wavelength. Even this is not expected to

Uranium enrichment

France also plumps for lasers

THE French nuclear fuel company, COGEMA, announced earlier this month plans to enrich uranium by laser, rather than by the diffusion or centrifugation of uranium hexafluoride gas, and said that this would cut costs by a factor of two. But one French observer says the statement is a "bluff" prompted by competition with the United States for the supply of enriched uranium to Japan and by a wish to pre-empt the announcement by the US Department of Energy of its decision to adopt the laser process.

Research on laser enrichment has been under way at the laboratory of the Commissariat à l'Energie Atomique at Saclay, near Paris, for some years. But the feeling in France appears to have been that the technique was not yet required, so that the project has been poorly supported. According to M. Claude Bearnaud, director of the isotope separation research unit at Saclay, it will be 15 years before full-scale laser separation plants are in operation.

Bearnaud spends some FF 100 million (about £9 million) a year on laser separation experiments with the French SILVA process, which is similar to the AVLIS process, developed by Lawrence Livermore Laboratory in the United States, using uranium metal vapour. But following the COGEMA announcement, he expects his budget to rise next year by some 20–30 per cent, taking SILVA to the "pre-pilot phase". The separation of kilogram quantities of uranium will come only later, Bearnaud says. The Lawrence Livermore Laboratory, after a year's frantic competition with the Oak Ridge advanced gas centrifuge, has now claimed the successful enrichment of some five kilogrammes of uranium.

Even so, says Bearnaud, there is no commercial need for a laser plant as yet. So why the US haste? One British laser physicist believes the spur may be the need to accumulate separated plutonium for the increasing numbers of US multi-warhead (MIRV-ed) missiles. In these missiles space is at a premium, and plutonium, with a lower critical mass than uranium, makes smaller triggers. The United States has plenty of plutonium in spent fuel from its 90-odd pressurized water reactors, but that is contaminated with isotopes which dampen the fast chain reaction which is essential in warhead applications.

AVLIS, or SILVA, could help. The principles could be applied to any isotope system, but Bearnaud says he is not at liberty to say if his group has worked on plutonium.

For commercial uranium separation, on the other hand, French sources are more forthcoming. Estimates are that the optimum size of a laser plant will be some ½–1 million units "separative work" (SWU) a year, enough to supply three to six 1,000-MW pressurized water reactors with fuel. By comparison, the giant Eurodif diffusion plant at Tricastin in France is capable of nearly 11 million SWU a year, but is under-utilized. Laser separation will be cheaper in the long run, according to Bearnaud. Indeed, COGEMA is said to have offered in Japan to halve future enriched uranium prices.

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