Magnetic fusion program slashed

by Charles B. Stevens

This year's cuts in the Department of Energy's magnetic-fusion research budget herald a major shift of the U.S. program away from the realization of commercial energy production. The contraction in the size of U.S. fusion projects, as well as funding cuts, will now put the Japanese and European programs almost a decade ahead of the formerly leading U.S. effort.

Ironically, it will also derail major advances in plasma and fusion science: The large, commercial-power-oriented experiments are about to produce entirely new fusion plasma regimes of immense scientific importance.

The excuse for these budget reductions is to increase the scientific productivity of the program by emphasizing low-cost, small experiments. Ostensibly, the directing concept is to focus on small, high-power-density fusion systems that would appear to best meet the short-term needs of the beam-weapon program (Strategic Defense Initiative). High-power-density fusion systems lead to the direct generation of forms of energy needed to drive beam weapons, for example, x-rays to pump excimer and x-ray lasers. But because high-power-density systems involve much greater engineering difficulties for commercial power production, where capital cost and reactor lifetime are factors, the commercial fusion research emphasis has been on lower cost, longer lasting low-power-density systems.

In the case of powering beam weapons, issues such as reactor lifetime and reactor capital cost are not primary. For example, in powering beam weapons, a fusion reactor would only have to last upwards of one hour.

The FY 1986 budgets

Besides the complete massacre of the inertial-confinement (e.g., laser) fusion budget with a 54% cut from $154 million in 1985 to $70 million in 1986, the magnetic-confinement program is being cut from $437 to $390 million, with most funds being deleted from operation of large experiments such as the Princeton Tokamak Fusion Test Reactor (TFTR) and the Lawrence Livermore National Lab MFTF-B Tandem Mirror. The Princeton PLT tokamak and any significant planning for large-scale fusion-ignition test reactors will be ended.

This will have the following results: 1) The TFTR demonstration of actual breakeven and net energy production with deuterium-tritium fusion fuel will be delayed until 1989, thereby giving the lead to the European JET. 2) Tandem mirror research will be essentially shelved, despite the existence of a very large and potentially productive facility. 3) JET will achieve fusion plasma ignition before the United States has even completed plans for constructing an ignition device. 4) Extremely important applied and fundamental work on plasma-wave heating, current drive, and control will loose their primary research facility, Princeton's PLT.

While gutting main-line research, $2 million will be added to the exploration of advanced fusion concepts such as reversed field pinch and compact tori.

This trade-off is based on a falsehood. It is true that the smaller systems offer great potentials for compact, high-power-density fusion reactors. Over the past decade, significant progress has been made with these advanced concepts. But it is the large, main-line experiments which have been the workhorses of continuing progress in plasma and fusion science. It is only from the firm base established by these devices that more advanced concepts have arisen.

Thus, the linear, "limited resources" method of research management now being introduced will produce the opposite effect to that intended.

From almost every type of scientific measurement, it has become increasingly evident that the size of a magnetic plasma determines its operating capabilities. The reason for this is that small plasmas are almost transparent to x-ray radiation generated by plasma electrons and ions. And this means the plasma is not truly isolated from external factors. These small plasmas are dominated by what should be only edge effects. With the larger machines like the TFTR, the edge effects are removed from the interior of the plasma and only dominate a thin layer of the outer skin.

Scientifically, almost all magnetic-confinement schemes are not fully understood. The tokamak has achieved the best results to date and will certainly succeed in producing net-energy fusion plasmas. But these large tokamaks promise to also illuminate the nature of true magnetic plasmas for the first time. By penetrating this frontier, entirely new possibilities for creating fusion plasmas and other applications will emerge.

In sum, when the President's science advisor, Dr. George "Jay" Keyworth, demands less emphasis on large experiments like the TFTR and more on smaller, more "scientific" experiments, he is arguing that you cut off your head to increase the blood flow to freezing hands and feet. Both the large and small experiments are essential to the realization of economical fusion power. The large tokamak experiments uniquely provide the plasma volumes needed to enter the realm of true plasma dynamics.

Simply diverting this research into what appears to be the best configurations for high-power density based on our current knowledge of plasma and fusion processes is not the best route to high-density fusion.