Fusion Power

Sandia may be first to show energy gain

by Charles B. Stevens

Just over 16 years ago, *EIR* was the first to publish the details of Russian scientist Leonid Rudakov's proposed design for particle beam fusion energy targets. Now, researchers from the Sandia National Laboratory in Albuquerque, New Mexico report they have perfected their particle beam accelerator to the point where they will shortly be able to demonstrate such fusion targets in laboratory experiments. Perhaps this will open the road to realization of fusion electric power plants, but also of fusion-powered rockets of the type needed for colonization of Mars.

Nuclear fusion is the primary source of energy which both makes the stars shine and directly leads to the generation of the greater portion of the spectrum of chemical elements which make up our world. (These elements are the products of nuclear fusion reactions.) Nuclear fusion of hydrogen to form helium has long been known to have the capability of supplying the world with a source of cheap, clean energy. For example, one major fusion fuel is deuterium, the heavy isotope of hydrogen which contains a neutron and proton within its nucleus. There is sufficient deuterium within one gallon of sea water to generate the energy equivalent of 300 gallons of gasoline, and the extraction of this quantity of deuterium costs less than a few cents.

Inertial confinement fusion

There are three major approaches to generating nuclear fusion: 1) inertial confinement fusion, 2) magnetic confinement fusion, and 3) cold fusion. Inertial confinement fusion (ICF) was the first to be demonstrated with the development of the hydrogen bomb. In this case, the energy output of an atom bomb based on nuclear fission is converted in soft X-ray electromagnetic radiation. This radiation is then directed onto a sphere of fusion fuel. When properly configured, the radiation will compress and heat the fusion fuel to the conditions required to ignite the nuclear fusion reaction.

The goal of laboratory ICF is to develop a laser or particle beam with sufficient beam power densities to replicate this process on a microscopic scale and thus be able to ignite micro-pellets of fusion fuel. The ICF reactor would be like an internal combustion engine where micro-pellets would be ignited several times a second and the energy output could either drive a piston or provide a supply of heat to drive a steam turbine. In the ICF case, the "piston" could be a plasma driven through a magnetic field in order to provide the means for direct magnetohydrodynamic (MHD) generation of electricity.

Light ion beam accelerators

The Sandia ICF program is based on utilizing light ion beam accelerators. This is the same technology used to generate relativistic electron beams. Because this accelerator technology is highly developed and based on the simplest components, the light ion beam accelerators can achieve energy and power levels far greater than lasers for less than one-tenth the cost.

But the outstanding question has been whether the output beams of such accelerators can be sufficiently focused to achieve the required power densities needed for "driving" fusion pellet targets.

At the International Atomic Energy Agency 1992 World Fusion Meeting, held during the first week of October in Würzburg, Germany, scientists from Sandia reported that they have experimentally demonstrated a technique for focusing light ion beams on their Particle Beam Fusion Accelerator (PBFA II) facility. The technique consists of generating a magnetic plasma channel; this channel both focuses the ion beam and guides it to the fusion target.

The Sandia researchers state in their paper: "A proof-of-principle experiment has yielded important data on two-stage beam acceleration. . . . Together, these results with differing ion species . . . and differing diode configurations . . . demonstrate that controlled reduction of ion divergence has been achieved. This breakthrough has substantially increased the prospects for ion beam focusing and the utility of intense ion beams with optimal range for ICF target experiments."

The PBFA II is currently generating lithium ion beams with power densities of about 1 trillion watts per square centimeter. These beams have power depositions in fusion targets of 380 trillion watts of beam power per gram of fusion fuel. Near-term improvements, based on the "proof-of-principle" experiments, will increase this beam power density to 10 trillion watts per square centimeter and power deposition to 3,800 trillion watts per gram of target. This is within the projected range of what is needed to drive fusion targets which will generate more fusion energy than the energy needed to generate the particle beam, as discussed in the University of Wisconsin Hiball Reactor Study.

Because of recent budget cuts, the U.S. Department of Energy stopped the program to build a burning plasma experiment based on the magnetic fusion tokamak confinement approach. This means that it will be most likely the case that the Sandia PBFA II will be the first "hot fusion" laboratory approach to demonstrate significant energy gain.