Other characteristics of the plant are: maximum magnetic field of 160,000 Gauss, plasma current of 3 MA, amperes, and a plasma beta of 0.5%.

Kadomtsev asks in his paper whether this line of thinking is worthwhile since "this goal" of the pilot plant "can be realized due to rejection of other fusion technologies which will be necessary for the demonstration reactor." He concludes that the physics data base required for the pilot plant "can be used as a basis for the subsequent proceeding to more promising tokamak reactor concepts."

More precisely, we can argue:

1) the use of advanced reactions, such as the non-neutron-generating deuterium-helium-3 reaction, as a fuel with the virtually no radioactive wastes being generated;

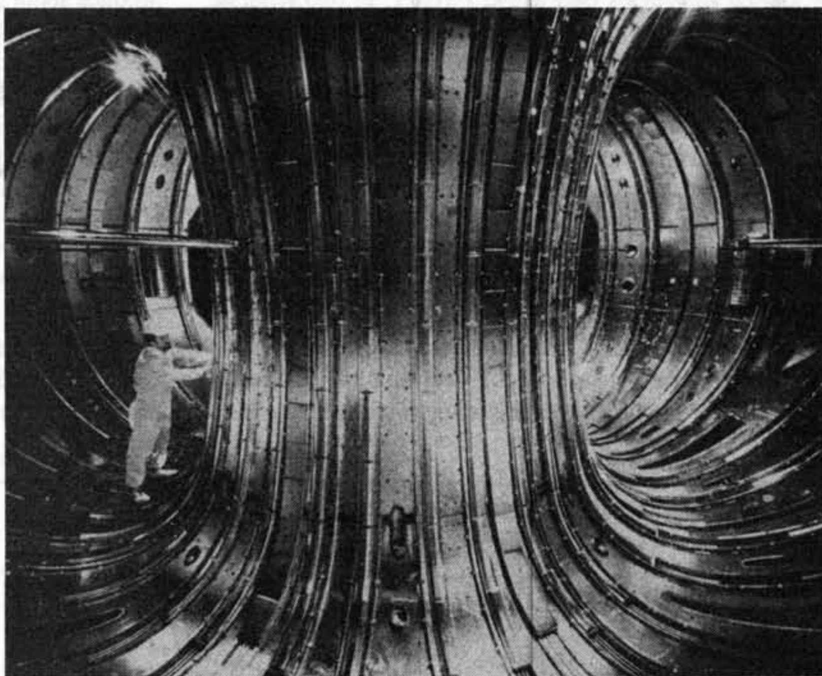
2) the development of schemes for direct synchrotron radiation conversion into electricity;

3) more acceptable solutions to the problem of plasma-wall interaction;

4) the possibilities of current drive by synchrotron radiation in combination with the bootstrap effect etc.

Thus the pilot plant "could show not only an opportunity to obtain electricity from fusion power but to initiate ways to some promising fusion technologies." Dr. Kadomtsev concludes, "The present data base for tokamaks with improved plasma confinement allows one to imagine the tokamak reactor concept for net electricity production."

How magnetic fusion works



Interior of the Joint European Torus Inconel vacuum vessel in which the hot gases are confined.

Nuclear fusion of hydrogen to form helium is the primary source of energy for stars like our Sun. In fact, other elements can be fused to form heavier elements, and in larger stars, helium is "burned" to form carbon. To achieve hydrogen nuclear fusion in the easiest case—fusing the two heavy isotopes of hydrogen, deuterium (D) and tritium (T)—the fuel must be raised to a temperature on the order of 100 million degrees Centigrade. At these temperatures, matter becomes ionized and this is called plasma. Plasma temperatures are measured in electron volts (eV); one electron volt is roughly equivalent to 11,000°C. For a fusion reactor, the temperature for D-T would have to be greater than 10,000 eV or 10 keV in scientific notation.

Because plasmas are good conductors, they can be confined and insulated by magnetic fields. Thus, magnetic "bottles" can be formed by magnetic fields which are either generated by external magnetic field coils or by electric currents carried by the plasma itself. The most stable and effective such magnetic bottle is the donut-shaped tokamak, which utilizes both external magnetic coils and a plasma current to generate its confining magnetic fields.

The electric current passing through the tokamak plasma does achieve some heating of the plasma to about 1 keV. But alternative heating systems, such as microwaves or radio waves or neutralized particle beams must be used to reach the required 10 keV temperatures.

For a power reactor, the product of the fuel density (in atoms per cubic centimeter) and the time the fuel is confined, measured in seconds, must be greater than 10^{14} second-atoms per cm^3. The tokamak operates in a density regime of about 10^{14} atoms per cm^3, so that the confinement time required is on the order of one second.