EIR: You say 2% of the Gross National Product is invested in health while 5% or more goes to pay the debt? Do you think it is correct to invert the equation, at least for public health?

Lima: Yes, that is a key, fundamental, question. The first thing is to check the legitimacy of that debt, whether it was contracted by the rules, where the money was invested, etc. But in any case, it is illicit that any debt contracted be unilaterally increased, and the debt increases every day, despite the fact that Brazil has gone through a true bloodletting, and everything it is doing today to pay it.

The country has to give priority to its interests and know the importance of public health in this picture. The developed countries spend an average of 10% of their GNP on health; but the fact is that we, in Brazil and the Third World countries, have a great social deficit in terms of employment, basic sanitation, food, nutrition, education. That debt must be at least three times the value of the foreign debt. It must be something like $300 billion.

This has to be redeemed so that individuals have the right to live. For example, life expectancy in the Brazilian Northeast is 40 years, due to the misery there. That must be overcome and a greater investment in health made. Brazil has spent 2% of its GNP on health since 1979. In that period alone, the annual GNP has been on the order of $200 billion, while, in the United States, it was $3 trillion; and there they spend 10% of the GNP on health, without even having the poverty which exists in Brazil. Therefore, Brazil should spend more on health, should channel investments toward basic questions—nutrition and hygiene to increase life expectancy. If we compare what the U.S. spends, although we have half their population, the difference is very, very big. There is a very great gap. . . .

EIR: Then, we could say that Brazil needs a minimum of 5% of GNP to reestablish minimum living standards in Brazil?

Lima: No, that is too little, because we have that social debt which has to be redeemed. We don't have schools, sewers; food is lacking. Such investments apparently don't have a return, since they don't have an economic return, no profit. But even so, every country today pays more than 10% of its GNP to see to the individual health of its citizens. So, 5% of GNP is too little.

EIR: That means that the debt should not be paid either with hunger or with health?

Lima: Without the slightest doubt; health cannot be sold nor risked in any way; health is an invaluable gift which is worth more than ordinary economic goods. The highest objective is to promote the citizen's health, based on modern funding and nutrition. I think of the great territorial size of Brazil, and then see our people of the Northeast. This is incomprehensible. This is unacceptable.

JET successes only the beginning

by Heinz Horeis

After the U.S. Tokamak Fusion Test Reactor (TFTR) had set a new record with a plasma temperature of 200 million degrees (Celsius) last August, the European tokamak JET (Joint European Torus) in Culham, England announced similar results: Recently, JET scientists were able to heat plasma to a temperature of 150 million degrees. Both results are spectacular, because these temperatures are well above the 100 million degrees required for a fusion reactor. However, both temperatures were achieved at plasma densities ($1-2 \times 10^{13}$ particles/cm^3 at JET) about 10 times below the value needed for a reactor.

Fusion scientists describe the requirements of a reactor-grade plasma by using the confinement value, the product of plasma density n and confinement time τ: At a certain density n, the plasma must be confined for a certain time τ, so the energy-producing reactions can take place in sufficient number. The confinement value should be around 10^{14} sec/cm^3. A confinement time of one second and a density of 10^{14} particles/cm^3 are typical values in magnetic fusion.

Seen against this background, other experiments recently undertaken at JET are much more important than those that led to the spectacular high temperatures. In earlier November, JET scientists achieved plasma densities and confinement times which are close to the cited values, at temperatures of 6 KeV (about 70 million degrees).

Producing the 'H-regime'

The idea for those successful experiments came from Dr. M. Keilhacker, who some time ago transferred from the Plasma Physics Institute (IPP) in Garching near Munich to Culham. At IPP, Keilhacker has led the experimental work on ASDEX, a middle-sized tokamak equipped with a so-called divertor. This is a special magnetic field configuration, which separates the inner region of the plasma from the boundary layers, thereby preventing impurities from the chamber wall from streaming into the plasma and degrading it.

ASDEX has operated this divertor very successfully. In 1982, the ASDEX team discovered that discharges of an "H-type" exist. These were later also found at other divertor-equipped experiments like Doublet-III. This discovery solved a problem that had caused many headaches. To achieve the required temperatures, the plasma must be heated from the outside, through the injection of high-energy neutral particle beams or the coupling of electromagnetic radiation. But normally, this external heating degrades plasma confinement, an unpleasant result, since not only future reactors, but also such experiments as JET and TFTR, must use very powerful heating.

The production of the H-regime solved this dilemma. Compared to "normal" discharges, H-type discharges are characterized by much better confinement—higher temperature, higher density, higher beta (beta is the ratio of the pressure of the plasma gas to the pressure of the magnetic field). The H-regime has been proven to exist over a wide range and can now be produced on a routine basis. However, it is necessary to produce a divertor that confines the plasma effectively at its boundary, preventing particles from streaming in or out of the plasma.

JET is not equipped with special divertor coils, but it can use its poloidal field coils to create a comparable magnetic field configuration: a magnetic separater that insulates an inner region from an outer region of the plasma—without, however, having a divertor chamber to which the flow of the outer region is directed, as in the case of a "normal" divertor. As it turned out, one can do without this chamber. With the configuration described above, JET could produce discharges of the H-typ, using additional heating with a power of 5 to 10 MW (ASDEX used 3 to 4 MW).

The confinement was improved by a factor of 2 to 2.5 compared to normal limiter discharges, and at a temperature of 6 KeV and a density of 7×10^{13} particles/cm^3, a confinement time ranging from 0.6-0.7 sec (10 MW heating) to 0.8 to 1.0 sec (5 MW). This gives a confinement value τ of $0.5 - 0.7 \times 10^{14}$ sec/cm^3, less than a factor of 2 below the desired value.

This result is not as spectacular as the 150 or 200 million degrees, but more important. Decisive are not single records for only one parameter, but the combination of the three values, temperature, density, and confinement time. What the JET scientists have achieved now are results that can be evaluated as the best produced by any large tokamak. This is also illustrated by a comparison with the TFTR, which—besides the record temperature mentioned above—achieved plasma values comparable to those of JET. However, this was achieved with relatively larger "efforts": 10 to 20 MW of heat power was focused in the TFTR plasma, twice as much as the heating power used in JET, and this in a plasma volume 5 times smaller than that of JET.

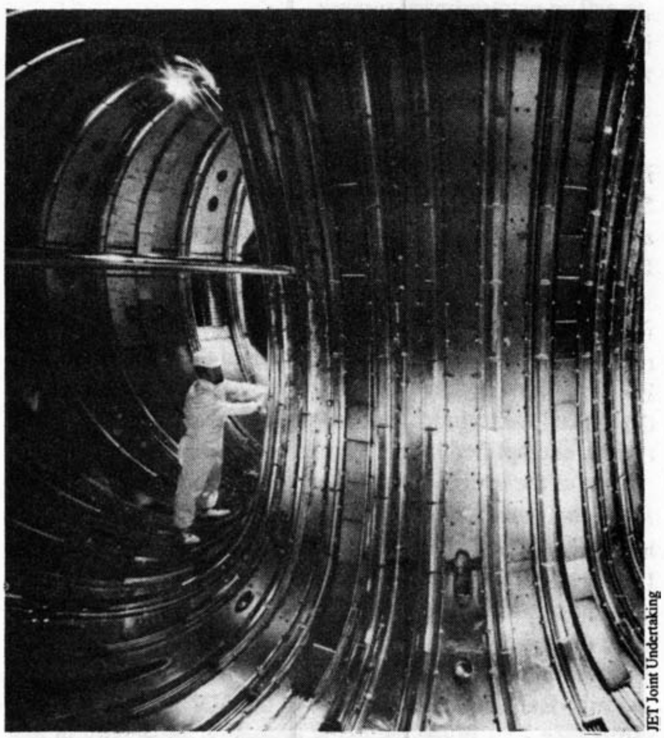
The recent experiments also have important consequences for the technology. They have shown that a special divertor is not necessary to achieve good confinement. The divertor-like configuration produced with existing coils is sufficient. This will allow simpler technical solutions to problems in future devices, because additional coils and chambers are not necessary.

Next steps

Had the JET team which is experimenting today with deuterium plasma used a deuterium-tritium fuel (DT), they would have achieved a Q-value of 0.2. Q gives the ratio of energy output generated by the fusion reaction to the energy input to achieve that reaction. At $Q = 1$, breakeven is achieved, where the fusion energy equals the energy invested. At a later phase, 1989-90, JET will operate with DT fuel and is expected to reach $Q = 1$. The recent results are a big step torward this objective.

At the beginning of December, JET was shut down to allow for upgrading and improvment. A second neutral beam line will be installed and the number of antennas for heating will be increased from 3 to 8. This will provide JET with the full heating power of 45 MW.

The device will also be strengthened mechanically to allow a plasma current of 7 mega amperes (MA), more than the design value of 6 MA. The experiments above were run with 2 to 3 MA. It is already proven that confinement time increases linearly with the current, and this alone will lead to a significant improvement of the confinement.



JET Joint Undertaking

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