8th INTERNATIONAL CONFERENCE,
BRUSSELS, 1–10 JULY 1980
The Conference was attended by 447 participants and 21 observers from 29 countries and two international organizations

Plasma Physics and Controlled Nuclear Fusion Research

During the last decade, growing efforts have been devoted to studying the possible forms an electricity-producing thermonuclear reactor might take and the various technical problems that will have to be overcome.

Previous IAEA Conferences took place in Salzburg (1961), Culham (1965), Novosibirsk (1968), Madison (1971), Tokyo (1974), Berchtesgaden (1976) and Innsbruck (1978) The exchange of information that has characterized this series of meetings is an important example of international co-operation and has contributed substantially to progress in controlled fusion research. The results of experiments in major research establishments, as well as the growing scientific insights in the field of plasma physics, give hope that the realization of nuclear fusion will be made possible on a larger scale and beyond the laboratory stage by the end of this century.

The increase of the duration of existing tokamak discharges requires solution of the impurity control problem. First results from the new big machines equipped with the poloidal divertor recently came into operation. PDX (USA) and ASDEX (F.R. of Germany) show that various divertor configurations can be established and maintained and that the divertors function in the predicted manner. The reduction of high-Z impurities on these machines by a factor 10 was achieved.

As a result of extensive research on radio-frequency (RF) plasma heating on tokamaks: PLT (USA), TFR (France), JFT-2 (Japan), the efficiency of this attractive method of plasma heating comparable to neutral beam heating was demonstrated. It was shown that the density of the input power of about 5–10 kW/cm^2 is achievable and this limit is high enough for application to reactor-like machines.

One of the inspiring results reported at the conference was the achievement of $<\beta>$ value (the ratio of plasma pressure to magnetic field pressure) of ~ 3% on tokamaks T-11 (USSR) and ISX-B (USA). It is important to note that this value exceeds the theoretical limit of instability for plasma with circular cross-section, and no deterioration of the confinement was observed.

The results on tokamak indicate that at present a solid scientific basis has been established for design of a tokamak reactor.

A big success in the stellarator programme has also been achieved. For the first time, the dense, clean, high-temperature plasma was obtained in current-free regime on

Wendelstein VII-A stellarator in Garching (F.R. of Germany). A special procedure of transition from current to current-free regime was developed for it. The plasma confinement in this regime appeared to be better. A new machine, Heliotron-E (Japan), was brought into operation which promises to give impressive results in the near future.

As far as open confinement systems are concerned, the key issue for them remains the suppression of the end losses. On GAMMA-6 (Japan) and TMX (USA) machines, the effect of ambipolar potential on longitudinal plasma losses was established. It appeared possible to increase the plasma confinement time by 9 times compared to the case of "open ends". The record value of the electron temperature $\sim 3.10^5$ degrees was achieved on TMX machine, however, in the presence of high-level fluctuations decreasing ion confinement

The general emphasis of the theoretical papers was on interpretation of scaling laws. At present, it seems that the theories of the neutral injection and ion cyclotron minority heating of plasmas are both well understood and fit the experimental data. Very encouraging results obtained recently are that, by optimizing the plasma shape and current profile,stable β of the order of 10 per cent could be achieved in tokamaks For reactors, the uncertainties in confinement scaling laws and heating theory lead to rather wide ranges in estimates of the required heating power. The papers in this area show the need for more work

Many papers on inertial confinement systems by the large laser experiments seem to be marshalling for the next large experiments Some results are presented on interactions of shorter wavelength laser light with pellets and that indicated superior performance in agreement with theory. Impressive results were presented on harmonic conversion of neodymium laser light to the third harmonic at 80 per cent efficiency.

The technology of ion beam generation for inertial confinement systems showed great advances that are the basis for the current emphasis on this driver system.

Perhaps the most striking aspect of the technology papers was the motivation of their authors to deal with problems that were focussed on the International Tokamak Reactor workshop (INTOR) or the Engineering Test Facility (ETF). This applied to divertor analysis, tritium systems and tritium breeding blankets

Advances in neutral beam system technology were impressive, but demonstrate clearly the problems to be faced if neutral beams must be employed on reactors.

At the opening ceremony the Artsimovich Memorial Lecture was given by Prof. Palumbo, Director of the Fusion Programme of the Commission of European Communities (CEC), on the origin and role of international co-operation in fusion research. The lecture was welcomed by the participants especially due to the successful activity of the INTOR workshop at the IAEA A special session on INTOR was arranged on 30 June 1980 to report on the results of Zero Phase of this project.