In this case the pellet penetrates just past mid-radius resulting immediately in a hollow density profile. The profile fills in over 200 ms and recovers to a peaked profile in ≅ 400 ms before the density begins to decay.

The temporal evolution of other plasma parameters after pellet injection is shown in Fig. 4. Concomitant with the rise in the density is a sharp fall in the electron and ion temperatures. Recovery begins immediately with the density slowly falling and the temperature rising but on a faster time scale such that there is a net increase in plasma energy that peaks some 700 ms after injection. The effect on the impurity content is that Z_{eff} is reduced from 2.5 down to 1.6, agreeing well with the value calculated from simple dilution of the existing plasma by the injection of pure deuterium. The neutron yield (D-D reaction rate) also increases in close agreement with the rise in deuterium density and temperature.

(c) On a longer time scale the net effect of the pellet is to produce a clean, high density plasma that lasts for ≅ 0.5 − 1 s after injection before most parameters return approximately to their pre-pellet values. Under certain plasma conditions the effect of the pellet is longer lived. The application of high power ICRF heating to such a centrally peaked density profile (Fig. 5), obtained when the pellet penetrates to the centre of the plasma, results in extremely high electron and ion temperatures and, coupled with the high deuteron concentration produces a greatly enhanced fusion neutron yield.

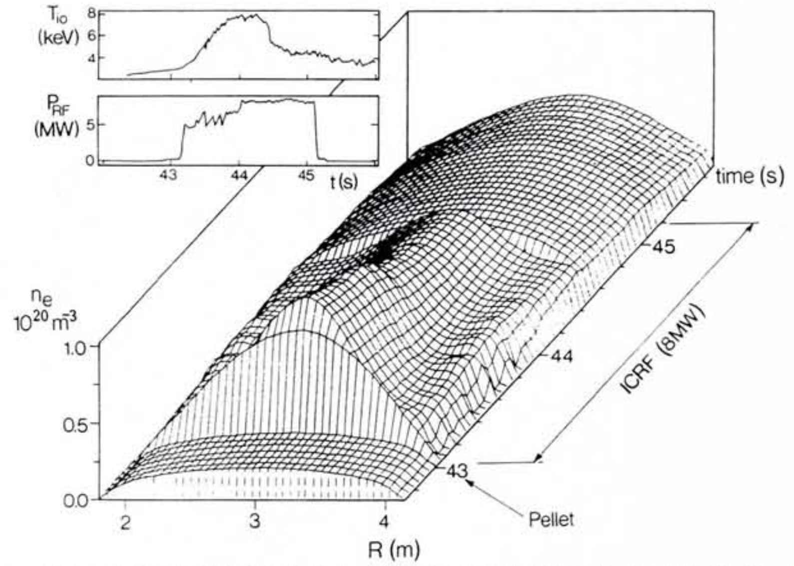

Fig. 5 — Temporal and spatial evolution of the electron density after pellet injection to the centre of the plasma followed immediately by high power ICRF heating. Also shown are the temporal evolution of the ion temperature and the ICRF input power.

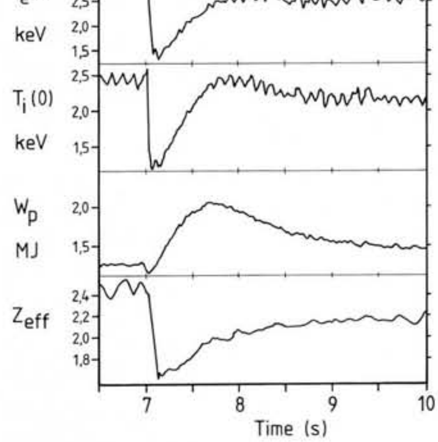

Fig. 4 — Temporal evolution of several plasma parameters after pellet injection. The D-D reaction rate R_{dd}, average electron density $\bar{n}_e$, central electron and ion temperatures T_e and T_i, total plasma energy content W_p and the impurity content Z_{eff}. This is a 3 MA discharge with no auxiliary heating, the pellet was injected at 7 s.

Conclusions

The results of recent experiments on JET have demonstrated the efficacy of pellet fuelling of high temperature plasmas. The direct fuelling of the core produces a pure, dense plasma with a centrally peaked density profile. The application of auxiliary heating to such plasmas can produce a long lived (> 1 s) dense, hot core giving a high fusion yield. Further work will concentrate on maintaining and extending the life time of these plasma conditions. Developmental work will continue on injector technology to increase the pellet speed for effective penetration of fusion temperature plasmas.

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FURTHER READING

Details of the JET Pellet Injector

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