OV1/D

EIGHTEENTH FUSION ENERGY CONFERENCE

SESSION OV1

Wednesday, 4 October 2000, at 11:40 a.m.

Chair: T. TAMANO (Japan)

SESSION OV1: Magnetic Fusion Overview 1 (provided by M. KIKUCHI, Japan)

Paper IAEA-CN77/OV1/1 (presented by Y. Kamada)

DISCUSSION

R.J. GOLDSTON: Have you been able to increase the normalized beta through ECCD stabilization of the NTM?

Y. KAMADA: So far, the full stabilization has been achieved at β_N~1. In this regime, recovery of β_N is not clearly observed. At higher β_N, only partial stabilization has been achieved, in this case also, no clear recovery has been observed.

B. COPPI: Do you have any comment to make on the characteristics of spontaneous rotation (not induced by neutral beams) in your experiments?

Y. KAMADA: Although causality between the pressure and the rotation profile has not been clarified, we have often observed a characteristic shape of the rotation profile even without toroidal momentum input.

K. LACKNER: In the diagrams where you show the approach towards ITER requirements in the different high performance regimes, the values of q_{95} achieved were missing. At which values of q_{95} were these results achieved?

Y. KAMADA: In the case if high βp ELMy H-mode where the full non-inductive current drive was achieved, q_{95}=4.8. In the quasi steady reversed shear discharge with the high bootstrap fraction of 80%, q_{95}=9.3.

F. ENGELMANN: Do you have any recent information on particle transport across the internal transport barrier and, if so, is this transport consistent with the requirements of He exhaust in a reactor?

Y. KAMADA: Yes, We have evaluated the impurity accumulation for He, C, Ne and Ar. Although the impurity density profiles are peaked inside ITB, up to now, no selective accumulation of impurities has been observed, In other words, density profiles of deuterium and impurity ions are almost similar.

Paper IAEA-CN77/OV1/2 (presented by C. Gormezano)

DISCUSSION

B. COPPI: You have indicated that the optimal range of operation in terms of q_ψ^{95} corresponds to $q_\psi^{95} = 3$. Given that sawtooth oscillations are important in the dynamics of fusion burning plasmas, could you comment on the effects of these oscillations in this regime?

C. GORMEZANO: For values of q_{95} below 3 it is correct to say that the sawteeth amplitude grows and there is a clear link between the NTM threshold and sawteeth amplitude. On the other hand, the surface of q=1 increases and some other effects (ion polarization screening) are affected. Disentangling these effects is under study.

V.E. GOLANT: Your results show an essential increase of the energy confinement time. Does it correspond to any scaling for confinement times.

C. GORMEZANO: No, they do not correspond to an established confinement scaling. They are possibly linked to parameters which are not (yet) included in scaling laws such as triangularity density peaking, edge pedestal, etc.

Paper IAEA-CN77/OV1/3 (presented by S.L. Allen)

DISCUSSION

K. IDA: The flat temperature profile inside the electron thermal barrier shows that the electron transport is diffusive and there is no heat pinch. This result seems to be inconsistent with the heat pinch experiment with off-axis ECH reported from DIII-D several years ago. What physical mechanism causes the difference between the plasma with heat pinch and the plasma without heat pinch?

S.L. ALLEN: The two plasmas are quite different. In particular the more recent discharges have a different q-profile (Negative Central Shear) and have an ITB. There are theories that the q-profile can affect the heat pinch.

J.G. JACQUINOT: Can you clarify the question of impurity accumulation towards the magnetic axis when you create a good internal confinement barrier in steady state.

S.L. ALLEN: The coherent edge mode (located very close to the separatrix) removes particles and provides density and impurity control in the presence of a “double” ITB or QDB regime. For example, the measured radial profile of carbon density for these discharges does not increase substantially during the QDB regime.

R.J. GOLDSTON: The advances in $\beta_N H$ you show are very nice, but it looked like I_p in many of your discharges was about 1.2 MA, and I remember 1.6 MA in many cases on DIII-D, even 2 MA. Are these results giving us some guidance on where to operate in q?

S.L. ALLEN: DIII-D high performance discharges have been operated over a wide range of plasma currents (1.2-2.0 MA) in Fig.1. The most recent discharges (large circles) were operated at q_{95}~5.5 (#98549, #98977) and q_{95}~4.5 (#104276). As presented in Luce, et.al., (these proceedings, Fig.2) these discharges have an increased bootstrap current fraction which is advantageous for advanced tokamak operation.

D. FRIGIONE: What is the edge safety factor in those shots where you find good confinement above the Greenwald limit?

S.L. ALLEN: The discharges shown with operation above the Greenwald density (~1.4 n_e/n_{GW}) have a range in q_{95} of 3-4.

Paper IAEA-CN77/OV1/4 (presented by M. Fujiwara)

DISCUSSION

I.H. HUTCHINSON: You showed good confinement of ICRF energetic tail ions in the inward shifted case, but what about the outward shifted case? Do you have evidence of fast ion loss in the outward shifted equilibrium?

M. FUJIWARA: ICRF heating was attempted in the 2^{nd} campaign with standard (outward shifted) configuration with limited success. Due to the difference of the heating regime, half of the power absorbed by electrons and the formation of high energy tail was not enough to study the confinement. Measurements of the direct loss are planned in the 4^{th} campaign.

Yu. KOLESNICHENKO: One of your conclusion is that the energetic ions with an energy of up to 200 keV are well confined. Does it mean that you observed loss of these ions? What was the effect of β on the fast ion confinement?

M. FUJIWARA: Due to our observation, energetic particles in LHD slow down classically without loss after termination of ICRF, when $n_e > 10^{19} m^{-3}$ ($T_e \sim 2$ keV), at high B_T (2.75 T) and low beta (<0.5 %) condition. Studies on the beta effect and direct detection of loss particles are planned in the coming experimental campaign.

F. WAGNER: Is your density profile after 5 pellets flat or peaked? What maximal density does LHD achieve when the pellet refuelling is replaced by gas puff refuelling? Are the density limits governed by radiation and the given heating power?

M. FUJIWARA: Density peaking after pellet injection has been observed. Even hollow density profile due to shallow penetration turns to be a peaked one. The density limit in gas-puff fuelled discharges is partly determined by the pulse length. Excess neutrals to build up density in a limited pulse length cause radiation collapse. Gas-puff fuelled discharges do not achieve the high density realized by pellet injection. The present density limit is determined by the power balance between radiation and heating power. The maximum density in the case of pellet injection is limited by the mass of the pellets.