SESSION OV4

Tuesday, 20 October 1998, at 8.50 a.m.

Chairman: D.D. RYUTOV (United States of America)

OVERVIEWS 4

Paper IAEA-CN-69/OV4/1 (presented by Y. Shimomura)

There was no discussion.

Paper IAEA-CN-69/OV4/2 (presented by B.C. Stratton)

DISCUSSION

Ya.I. KOLESNICHENKO: One explanation for the discrepancy between the experimentally observed beam ion loss and predictions using the ORBIT code could be that beam particles excite a plasma instability which affects velocity distribution. Have you observed any evidence of a plasma instability? In particular, have you observed ion cyclotron emission?

B.C. STRATTON: These plasmas had no, or very weak, MHD activity at the high frequencies that would be expected to interact with neutral beam ions. We did not measure the ion cyclotron emission in these discharges.

A. JAUN: I am puzzled by your conclusion that part of the instabilities ($n \simeq 4.5$) observed in the 100 kHz range are TAEs, and others ($n = 2$) are not. Do you have experimental evidence that only part of them scale with the Alfvén frequency, or does your conclusion derive only from the contradiction with the NOVA-K calculations?

B.C. STRATTON: The measured frequencies of all of these modes ($n = 2$-5) are observed to scale with the Alfvén phase velocity, so all of these modes are Alfvén frequency modes. Further work is needed to determine whether or not the $n = 2$ mode is a TAE or another type of Alfvén frequency mode.

B. SAOUTIC: You do not discriminate between ERS and RS plasmas. It is well known that strong rotation produces trajectory modification like orbit squeezing. Have you investigated the difference in alpha particle confinement or hot beam ion confinement between RS and ERS plasmas?

B.C. STRATTON: We did not study energetic alpha particle confinement or beam ion confinement in ERS plasmas, only in RS plasmas.

B. COPPI: What is the relative rise of the $q = 1$ region in the experiments described? For sawteeth to have a real effect on burning plasmas, the ratio of the volume contained within the $q = 1$ surface to the total volume should be considerable, typically $> 1/10$.

B.C. STRATTON: The $q = 1$ radius was typically in the range $r/a = 0.25$-0.3 in the studies of the effects of sawteeth on alpha particle confinement.

J.F. LYON: You compared ORBIT code calculations with pellet measurements of the alpha population for monotonic and reversed shear plasmas. It was necessary to normalize the measurement to the calculation for one of these cases, but why was it necessary to normalize for both since the difference between these is of interest?

B.C. STRATTON: The PCX diagnostic was not able to make absolute measurements of the alpha particle density, because the magnitude of the signals depended on the details of the pellet ablation, which varied from shot to shot. Thus, it was not possible to make a direct comparison of the measured relative alpha densities in the reversed shear and monotonic shear cases.

J.F. LYON: A correlation was seen between measured alpha loss signals and 2/1 MHD (Mirnov loop) signals, but there seemed to be a significant time delay between these signals. Do you understand the reason for this delay?

B.C. STRATTON: There was no delay between the measured alpha loss and Mirnov coil signals in this case.

Paper IAEA-CN-69/OV4/3 (presented by O. Gruber)

DISCUSSION

D. MOREAU: You mentioned performing simulations with the ASTRA code for studying the q-profile evolution in the internal transport barrier discharges. Did you try to simulate these discharges with a transport model which combines the effects of magnetic shear and E x B rotation shear, like the one we implemented in ASTRA, and which of these effects dominates in these discharges (either from direct experimental data, or from simulations)?

O. GRUBER: The q-profile evolution was done in ASTRA transport analysis using the measured T, n, Z_{eff} and P^*_{rad} profiles and neoclassical resistivity. In addition, current density modifications due to the observed fishbone activity were included. Transport modelling with ASTRA simulations, including both magnetic shear and E x B rotational shear, is under way.

R.J. GOLDSTON: This is a very impressive paper. Other than fast-particle effects, it is hard to think of a topic that the ASDEX Team has not reported here. Taking into account all of the key factors: β_N, H, τ^*_{He} / τ_E, Z_{eff}, n/n_{GW}, do we have an operating point for ITER and for a future power plant? A crucial issue is that a power plant must have about the same values for H, τ^*_{He} / τ_E and Z_{eff} as ITER, but possibly values for β_N and n/n_{GW} which are twice as high. In particular, how confident are you in the ρ^* scaling of neoclassical modes and what are the implications for the maximum m's and n's that will be excited?

O. GRUBER: I believe we certainly have operating points for the cost-reduced driven ITER design. Firstly, the lower density of $n/n_{GW} \simeq 0.8$ offers the "standard H-mode scenario" with high confinement and the proven stabilization of neoclassical modes necessary for attaining high β_N values. Secondly, our improved performance mode with H-mode edge barrier and internal transport barrier at q-profiles, which are still monotonous but flat with $q(0) > 1$, opens the operational space further. In particular, the high $nT\tau_E$ values on axis will support this inductively driven regime.

Regarding a future power plant, β_N will certainly have to be raised if we want true steady-state capability (non-inductively driven) and the ARIES designs propose $n/n_{GW} \geq 1$, which we have not yet achieved in advanced scenarios. Further work is needed, particularly concerning control of MHD. With respect to neoclassical modes, I would refer you to paper IAEA-CN-69/EX8/2 by S. Günter et al. One has to consider that ITER or power plants will operate not only at lower ρ^*, but also at higher effective collisionality ν^*/ρ^*, which stabilizes neoclassical modes.

Paper IAEA-CN-69/OV4/4 (presented by F. Romanelli)

DISCUSSION

M. PORKOLAB: Have you done comparison experiments with ECH without current ramp (i.e. flat-top current and density) at the same values of n_e, T_e and, if so, how does ΔT_e compare? In other words, how great is the effect of the reversed modified shear on transport during electron heating.

F. ROMANELLI: We do not measure the safety factor profile. On the basis of the current diffusion simulation, we find that in discharges with weak magnetic shear the electron thermal conductivity is very low when MHD activity is quenched, a condition which is difficult to achieve with positive magnetic shear.

K. IDA: Does the very low thermal diffusivity explain the time evolution of electron temperature? In other words, does the thermal diffusivity derived from the radial profile of heat flux vs temperature gradient ($Q(r)$, $n\nabla T_e(r)$) agree with that derived from the time evolution of heat flux vs temperature gradient ($Q(t)$, $n\nabla T(t)$)?

F. ROMANELLI: We have performed a time-dependent 1-D predictive simulation of low/reversed magnetic shear discharges using a mixed Bohm-gyroBohm model, which shows reasonable agreement with the experimental results.

Y.K.M. PENG: With reference to the plan to study confinement on FTU without plasma rotation, have you made an estimate of the diamagnetic drift velocities of the very high T_e plasma and compared it with the plasma sound speed?

F. ROMANELLI: There are plans to study confinement without plasma rotation externally injected, i.e. in a situation similar to that of a reactor. The diamagnetic velocity can be an order of magnitude higher than in ohmic plasmas.

K. HANADA: How do you deal with the OH field effect in η_{CD}? In the steady-state operation region, η_{CD} becomes quite low as compared with that in OH plasma. The OH field effect needs to be considered.

F. ROMANELLI: If a residual electric field is present, we attribute the change in the bulk plasma resistivity to the change in electron temperature and Z_{eff}. Theoretical calculation shows that the effect of hot electron conductivity is small and can be neglected in our analysis.

Paper IAEA-CN-69/OV4/5 (presented by S. Okamura)

DISCUSSION

R.J. GOLDSTON: In one of the viewgraphs in your oral presentation you showed that CHS had violated low-mode MHD stability. What ideal or resistive modes were considered?

S. OKAMURA: That line is actually the $D_I = 0.2$ contour line which is an approximate condition of the ideal low-mode stability boundary for heliotron/torsatrons (c.f. Ichiguchi, K., et al., Nucl. Fusion 33 (1993) 481 - reference [28] in my paper).

J.F. LYON: Is there any evidence for ballooning modes? Are you able to detect them at the beta values you have? Are they expected?

S. OKAMURA: Magnetic fluctuation measurements give no evidence of ballooning modes. As we have detectors at the local bad curvature region, we should be able to detect them if they appear.

D.A. SPONG: Do you measure strong losses of your energetic beam ions during either the fishbone or TAE activity?

S. OKAMURA: We have observed synchronized losses of fast ions detected by our loss ion probe for fishbone but no measurable loss for TAE. Since no precise evaluation has been made of the absolute value of the losses, we cannot say at present whether they are strong or not.