EIGHTEENTH FUSION ENERGY CONFERENCE

SESSION EX7/TH5/IC

Monday, 9 October 2000, at 4:40 p.m.

Chair: M. PENG (USA)

SESSION EX7/TH5/IC: Stability 2 (provided by D. MIKKELSEN, USA)

Paper IAEA-CN77/EX7/1 (presented by P. Buratti)

DISCUSSION

I.H. HUTCHINSON: Since the septum is limiting performance, is there a proposal to remove it? If so, when will that take place?

P. BURATTI: There is a proposal to remove the divertor septum in order to have more flexibility in the configuration. A good power handling capability will be maintained by a horizontal protection plate. Septum removal is foreseen during the 2001 JET shutdown period.

EX7/TH5/IC/D

Paper IAEA-CN77/EX7/2 (presented by S. Takeji)

DISCUSSION

M. ZARNSTORFF: You interpret your fast collapse as starting with a resistive interchange mode. In previous analysis, JT-60U concluded that reversed shear/ITB discharges collapsed due to the n=1 kink mode at the shear-less surface, as also seen on other machines. Given the uncertainty of your MSE-measured q-profile, how certain is your identification of the resistive interchange mode?

S. TAKEJI: The normalized beta, β_N, of the discharge I showed is 0.77, and we confirmed that the reconstructed experimental equilibrium is completely stable against ideal low-n kink and infinite-n ballooning modes, even if the equilibrium is changed to be q_{min} \l^2 by sigma-scaling. Electron temperature perturbations which have indicated a resistive interchange mode are really localized near the large ∇T_e region even if the effect of ∇T_e is taken into account. Eigenfunctions of the n=1 kink mode should be broader.

P. SMEULDERS: How sure are you about the m value when the modes change their n-number from n=1 to 2 and 3?

S. TAKEJI: We are sure that m number is three for n=1 mode because m=3 is identified by magnetic measurement (the poloidal pickup coil array.) For n=2 mode, it seems that m=5 is reasonable also from the magnetic measurement. Since the dominant mode number changes from n=1 to n=2, then it probably changes for n=3. By considering the change of n number and of the q profile, we concluded that m=7 must be reasonable for the n=3 mode.

Paper IAEA-CN77/EX7/3 (presented by S. Günter)

DISCUSSION

P. DIAMOND: How does the width of the barrier compare to the width of the fishbone eigenfunction? If the fishbone is, indeed, the origin of ambipolarity breakdown leading to E_r amplification, there should be a relation between these. Also, is the fishbone computed self-consistently with the developing E_r in your modeling?

S. GÜNTER: The width of the fishbone eigenfunction in reversed shear plasmas is expected to be approximately equal to the size of the corresponding rational surfaces. Consistent with this distance, the ITB at the beginning is quite narrow, but the width grows together with it. For the case of positive shear reported, where we have directly measured the eigenfunction, it extends from the axis to the q=1 surface. The width of the ITB is somewhat smaller, in agreement with the region in which the fast particles are redistributed. We did not simulate the fishbone stability at all. We have, however, studied the response of the fast particle population to a fishbone of measured amplitude and frequency, indeed, so far, without including E_r effects.

C. GORMEZANO: You say that in ASDEX-U, ITBs are only produced when fishbones are present. In other experiments, ITBs can be produced without fishbones. Can you comment on this point?

S. GÜNTER: The fact that ITBs are only formed in the presence of fishbones on ASDEX Upgrade does not imply that fishbones are a necessary condition for ITB formation. If the plasma conditions are just marginal for an ITB formation, fishbones can act as a trigger like sawteeth triggering an H-mode transition. The preferential formation of ITBs in the proximity of low order rational surfaces in various tokamaks indicates a similar trigger mechanism. So, e.g., the formation of magnetic islands, at least transiently, affects the radial electric field, and could therefore act as a trigger as well.

Paper IAEA-CN77/IC/1 (presented by M.C. Zarnstorff)

DISCUSSION

S. OKUMURA: For such an experiment for a new concept, scheduled scenario of obtaining an improved confinement might not work. We need flexibility of the device to find new scenarios experimentally. Can you operate your flexible settings of iota profile dynamically? Also, please comment on your efforts to include a divertor in the coil design?

M.C. ZARNSTORFF: Many scenarios have been found to give enhanced confinement in tokamaks. One of the reasons we are optimizing for quasi-axisymmetry is to improve the possibility of developing tokamak-like enhanced confinement regimes. We plan to be able to dynamically change the coil currents during the discharge, giving dynamic control of the 3D shape and external iota. We have started to investigate possible divertor designs, which would likely be implemented after initial experimental investigations

S. MURAKAMI: I have a question about energetic ion confinement in your QA design. In your Monte Carlo simulation, do you use the magnetic configuration from actual modular coils?

M.C. ZARNSTORFF: The fast ion losses quoted are from simulations using the fixed-boundary equilibrium. Simulations using the reconstructed equilibrium from the modular coils have been done for co-tangential neutral-beam injection and reproduce the fixed-boundary equilibrium result. Simulations for counter-injection and the free-boundary equilibrium will be done.

F. ENGELMANN: Could you comment on the equilibrium control requirements arising because of the presence of a sizable bootstrap current which couples plasma profiles and configuration?

M.C. ZARNSTORFF: We plan to be able to vary the coil currents dynamically, to modify the equilibrium as desired. The presence of the bootstrap current contributes to the hoop stress, similar to the plasma pressure, requiring modification of the vertical field to adjust radial position. Since the bootstrap current contributes only 1/3 of the rotational transform (the rest is from the external coils), its effect on the equilibrium is much smaller than in a tokamak. In addition, due to the large coil generated transform, the design operates at low-q, producing much less bootstrap current than a bootstrap-consistent tokamak at the same beta. Since the external coils can be used to modify both the rotational transform and the shear, they can compensate for variations in the bootstrap current profile. The dependence of the beta-limit on pressure profile shape, including the self-consistent bootstrap current and the flexibility of the external coils, is being investigated.

Paper IAEA-CN77/EX7/4 (presented by A. Weller)

DISCUSSION

R. GOLDSTON: It appeared that the iota profile in your experiments had a maximum on axis, like a tokamak. Have you investigated cases with stellarator like shear - in other words, with the maximum iota at the outside?

A. WELLER: Yes, we have reversed the current resulting in a total iota-profile with a minimum on axis. In this case, the bootstrap current is opposite to the OH-current, and hence, the current density gradient in the outer part is slightly reduced. This is probably the cause for the absence of large tearing modes or disruption-like events under these conditions. Direct evidence of neoclassical modes and their stabilization due to the reversed shear was not obtained.