SESSION EX8

Friday, 23 October 1998, at 4.05 p.m.

Chairman: Yu.A. Sokolov (Russian Federation)

MHD STABILITY

Paper IAEA-CN-69/EX8/1 (presented by L.L. Lao)

DISCUSSION

R.J. GOLDSTON: Paper IAEA-CN-69/OV1/3 indicates some significant confinement degradation in the square discharges. How much degradation do you observe? Why do you believe that the "bulged" equilibria would do better on confinement?

L.L. LAO: The square discharges have H_{89P}~2, which is typical for DIII-D ELMy H-mode discharges and is low compared with the values of $H_{89P} > 3$ during the ELM-free phase of some of the DIII-D high performance discharges. The motivation for the "bulged" equilibria is rather to improve the n = 1 stability limit of the square discharge while still keeping the ELM amplitude low.

K. LACKNER: Realistically speaking, is it possible to impress sufficient squareness or localized plasma surface deformation under reactor conditions?

L.L. LAO: We have not done any quantitative analysis to evaluate the poloidal field coil requirements for these types of plasma geometry under reactor conditions. Clearly, there will be additional demands on the poloidal field coil system.

M.E. MAUEL: The ELM characteristics in DIII-D discharges with high squareness appear similar to the ELMs seen in the EDA H-mode in Alcator C-Mod. Can you comment on any similarities and differences between the Alcator C-Mod EDA ELMs and those seen on DIII-D discharges with various degrees of squareness?

L.L. LAO: The D_α signals look similar in the DIII-D high squareness discharges and the Alcator C-Mod EDA discharges. However, whereas the high squareness discharges have no second ballooning stability access, the EDA discharges are reported to have some edge second ballooning access (A.E. Hubbard, invited paper, 1997 APS).

Paper IAEA-CN-69/EX8/2 (presented by S. Günter)

DISCUSSION

J.D. CALLEN: Do you also observe neoclassical tearing modes triggered by ELMs? Also, what fractions of seed islands are triggered by the various possible sources - sawtooth crashes, fishbones, ELMs, or are there no obvious triggers?

S. GÜNTER: We do not see ELMs triggering neoclassical tearing modes. Only modes which occur without any observable seed islands are sometimes preceded by ELMs. In most cases, neoclassical tearing modes are triggered by sawteeth (~75%). In low density discharges with large heating power (especially with the perpendicular beams) fishbones trigger neoclassical modes (~20%). There are only a few cases where no seed island is observed (~5%).

A.W. MORRIS: If ECCD is used to reduce the neoclassical island width below a critical width, one would expect ion polarization or other stabilization mechanisms to reduce the width to zero. How close to this critical width are the ASDEX-Upgrade results?

S. GÜNTER: Below a critical width, one would expect stabilizing effects due to the ion polarization current and due to the reduced drive caused by the incomplete pressure flattening across small islands. We have reduced the island width from 8 to 5 cm. According to the theory, we are about 30 to 40% above the threshold below which the island should be stabilized as a result of the above effects.

M.E. MAUEL: You report variations in neoclassical tearing mode onset as the plasma density was adjusted. This, as you indicate, could be due to changes in collisionality, but it could also be due to changes in neutral beam induced plasma rotation. Have you investigated the dependence of tearing mode onset on changes in plasma rotation?

S. GÜNTER: We have varied the applied beam lines (parallel and perpendicular) and therefore the plasma rotation. We observed no remarkable differences in the onset conditions of neoclassical tearing modes due to changes in plasma rotation.

M.C. ZARNSTORFF: You claim that fishbone instabilities cause reconnection on the basis of the T_e evolution. Do you measure a change in the q-profile due to the mode via MSE (motional Stark effect)? How do you know that the T_e evolution is not due to transport caused by the mode?

S. GÜNTER: We have no direct proof of magnetic reconnection yet, since our MSE diagnostic is not fast enough to measure the development of the q-profile during one fishbone. We do, however, see a practically instantaneous decrease in the electron temperature over the whole region $0 < \rho < \rho_{q=1}$. Such behaviour should not be caused by increased transport at the q = 1 surface. Furthermore, taking into account only the temperature change caused by fishbones in a transport code (ASTRA) is not sufficient to explain the limited current profile peaking.

Paper IAEA-CN-69/EX8/3 (presented by A. Pochelon)

DISCUSSION

K. LACKNER: You explain your sawtooth modification experiments in terms of the hot bubble-cold crescent topology. Can you simulate it also in terms of the ideal kink based cold bubble - hot crescent, model?

A. POCHELON: The model used in the simulation relies on internal kink convection mixing due to magnetic reconnection and localized electron heating. The crescent shaped magnetic surfaces may become hot if the heat deposition occurs in this region. We doubt whether the present experimental data can be interpreted on the basis of an ideal MHD instability, but it would be interesting to test different models.

J.D. CALLEN: How localized is your ECH? Have you tried moving the heating position outside the $q = 1$ radius? If so, do you obtain results like those in RTP (Rijnhuizen Tokamak Project) (paper IAEA-CN-69/EX7/4)?

A. POCHELON: The relative power deposition width $\Delta\rho/a$ depends on the different launching geometries used. The power deposition location has been varied from plasma axis to nearly plasma edge - much further out than the $q = 1$ radius. This has been done through poloidal angle sweep of the EC beam, vertical plasma position sweep through the EC beam ($\Delta\rho/a \sim 0.1$-0.2) and toroidal field sweep ($\Delta\rho/a \leq 0.1$).

When using typically 500 kW EC power - one launcher - for these off-axis power deposition studies, TCV q profiles showed only small modifications: on-axis sawtooth activity was maintained, although with a slightly modified inversion radius. So far, we have not seen off-axis sawteeth as in RTP. We have, however, seen central humpback sawteeth maintaining nearly identical inversion radius, for power deposition at two distinct radial locations in a toroidal field sweep, and therefore with very localized power deposition, in a geometry similar to RTP.

Y. NAGAYAMA: Your model is based on the full reconnection model. However, present q profile measurements using, for example, MSE (motional stark effect) or FIR (far-infrared) polarimeter show that the island width of the $m = 1$ mode is 1/3 of the $q = 1$ radius. Can you modify your model to be consistent with the q-profile measurements?

A. POCHELON: The theoretical model does not rely on full reconnection. Sawtooth crashes with partial reconnection can also be simulated. However, for the TCV discharges we have analysed, we find that - assuming full reconnection - a satisfactory simulation of the experimental data is obtained, at least qualitatively speaking. We are aware that different plasma regimes exist in different tokamaks, where partial sawtooth reconnection may be more realistic.

Paper IAEA-CN-69/EX8/4 (presented by J. Manickam)

DISCUSSION

K. LACKNER: I have a comment regarding the self-consistency of the treatment of the E_r-fast particle interaction in the stability calculations. As E_r is presumably produced by intrinsic effects and is not directly externally driven, I think a stability calculation should also include the response of the E_r field, even in a linear stability consideration.

J. MANICKAM: Your statement holds, if the E_r field across the entire plasma cross-section needs to be considered. In our case, however, the interaction of the fast particles is determined by the overlap of the distribution with the mode structure. Since the distribution peaks near the core and the mode peaks near the ITB, the region of overlap is quite small. Consequently, the radial E_r in that localized region has a dominant contribution, and effects of the averaged E_r, which might influence the mode frequency, can be neglected.

M.E. MAUEL: You indicate that the radial mode structure of the BLM becomes much broader with a larger edge displacement as q-min decreases. For these modes, what is the effect on stability as a conducting wall is moved to the edge of the plasma?

J. MANICKAM: Since these instabilities are driven primarily by the internal localized pressure gradient in the low shear region, they are less sensitive to external boundary conditions and only a modest beta increase is expected when a conducting wall is moved closer to the plasma edge.

Paper IAEA-CN-69/EX8/5 (presented by R.J. Buttery)

DISCUSSION

H. ZOHM: Initial studies on this subject indicated a critical error field of ~10^{-5}. Could you point out the main element in your present analysis that increased the threshold to 10^{-4}?

R.J. BUTTERY: Early cross-machine analyses (~ 1992) used differing plasma configurations and error harmonics and were based solely on (2,1) component of field. Also JET thresholds were based on field calculated from design. New analyses have measured much higher thresholds (x2-3) indicating additional error sources. The new analyses use a combined harmonic quantity, B_{pen}, which includes the effects of sidebands to give equivalent pure (2,1) yield. They are also based on similar shape and parameter plasmas. Thus thresholds have risen substantially on JET, slightly on DIII-D, and fallen on COMPASS-D. A dimensional scaling argument is used to scale from JET data, as the COMPASS-D results indicate a different physics regime which highlights uncertainties.

Paper IAEA-CN-69/EX8/6 (presented by Y. Kusama)

DISCUSSION

S. BERNABEI: Strong burst modes have been observed during ICRF heating in TFTR. It seems that they are responsible for some losses, but they are always accompanied by energetic particle modes with n ~ 8, with large losses. Are these observed in JT-60U during NNB heating?

Y. KUSAMA: In NNB injection on JT-60U, the burst mode itself seems to be an energetic particle mode with n = 1-2. Any small drop in the neutron emission rate is accompanied by the burst mode. However, larger losses of energetic ions are considered to be accompanied by the saturation of neutron emission rate and electron temperature when energetic particle modes of n = 3 ~ 12 are excited in ICRF heating of low shear plasma.

K. TOI: Regarding the parameter dependence of the frequencies of the burst and chirping modes, are they really in the TAE frequency range?

Y. KUSAMA: The parameter dependence of the frequencies of the burst and chirping modes has not yet been clarified. It has been found from analysis of the Alfvén continuum and measured mode frequency that the frequency chirping of the burst mode starts from the TAE gap. However, the frequency chirps down below the lower Alfvén continuum, which determines the TAE gap.