NINETEENTH FUSION ENERGY CONFERENCE

SESSION OV/2

Monday, 14 October 2002, at 14:25

Chair: H. BINDSLEV (Denmark)

SESSION OV/2: Magnetic Fusion Overview 2

Paper IAEA-CN94/OV/2-1 (presented by H. Zohm)

Discussion

Y. Kamada: You reported that type II ELMs appear when $\Delta x \leq 2$ cm. Is the critical Δx a function of density?

H. Zohm: Δx opens up a window in which we can access type II, but we still have to adjust the density (gas flow) in a relatively narrow range, so that a simple answer is not possible.

V. Parail: You report that ASDEX-Upgrade gets a quiescent H-mode with a high level of impurities. Simultaneously, a coherent MHD activity is observed. Does this mean that this MHD mode does not prevent impurities from accumulating?

H. Zohm: You have to remember that these discharges are with counter-NBI and are at very low density. We thus have high Z_{eff}, but no accumulation. Thus, the EHO is effective in transporting particles across the separatrix.

B. Coppi: What meaning do you attribute to the observation that $\eta_e = 2$? Theoretically, this would indicate only that the electrons behave as a one-dimensional species.

H. Zohm: We think that the observation may point towards the onset of, for example, the ETG at a critical η_e. This may still happen in transport barriers such as the edge pedestal where ITG/TEM is suppressed, but χ_e is still much higher than neoclassical.

Paper IAEA-CN94/OV/2-2 (presented by E.J. Synakowski)

Discussion

E.S. Marmar: From the curves comparing global confinement in L and H mode, it appears that the global confinement does not increase after the transition to H mode. There seems also to be a general dominance of the electron channel for energy transport. Do these results imply that the edge barrier is not effective at lowering electron energy transport, or do you have other thoughts on these observations?

E.J. Synakowski: First, to clarify, there are indeed many discharges in which the H mode transition increases the total stored energy over the L mode state fairly significantly. However, the effect you note is apparent in many plasmas. The fact that the electron channel is the dominant loss channel, and that the H mode transition may predominantly be a transition in the ion channel, may indeed play a role in these cases as you suggest. Another possibility we are considering is that the L to H transition yields a trade of good core confinement in the L mode case for good edge confinement in the H mode case. The general idea behind this picture is that the L mode core benefits from a more peaked density profile and stronger rotational shear, with comparatively poor edge confinement. Our early microstability analysis suggests that long wavelength modes may be stable or easily suppressed in these cases. However, the H mode may lose this favorable core confinement with the loss of density peaking and reduction of core rotational shear.

D.D. Ryutov: You have a rather high beta plasma. One can expect a substantial level of magnetic field fluctuations. Couldn't the electron heat losses be related to the magnetic field stochastization (destruction of magnetic flux surfaces)? A somewhat related question: do you ever see runaway electrons?

E.J. Synakowski: We are indeed entering a regime where high beta can yield new effects in the transport. We have done scoping studies with posited profiles using gyrokinetic codes that suggest that electromagnetic effects can emerge in plasmas in this range of beta. However, up until now, these effects tend to be subdominant in the analyses of real plasma profiles, but these studies have just begun. For example, in high beta L mode plasmas, analysis suggests that short wavelength ETG modes, with predominantly an electrostatic character, may be largely responsible for electron thermal transport. More speculatively, they may play a role in the electron–ion energy exchange. Having said that, we are just beginning to study the long pulse H modes, some of which have local beta values of up to 75%. It will be very interesting to see what the microstability analysis in these plasmas reveals regarding electromagnetic effects, microtearing, etc. As for runaway electrons, we can generate them with fast current ramps, but we avoid them easily with moderate gas puffing.

R.J. Buttery: What fraction of energy is in fast particles at high beta?

E.J. Synakowski: The fraction of the stored energy in the NSTX high beta plasmas analyzed thus far is typically 25–30%.

Paper IAEA-CN94/OV/2-3 (presented by B. Lloyd)

Discussion

J.D. Callen: In modeling of NTMs you emphasized the saturated phase, in particular the magnetic well (or curvature) effects, which seem well confirmed. But your figure did not model the early growth from the initial seed island. In a previous MAST paper it was indicated that an enhanced resistivity was needed to model the early time dynamics, in the Rutherford regime. Is this still the case?

B. Lloyd: The 3/2 island is excited close to its saturated size in a very rapid event coincident with the sawtooth crash. Modeling of the island evolution thereafter, in response to changes in beta poloidal, does require an enhanced resistivity within the island to match the experimental time response. Other coefficients in the modified Rutherford equation are close to their theoretically predicted values.

R. Maingi: Both START and NSTX have reported large off-axis density peaks or “ears”. Are “ears” observed in MAST, and how are they affected by the H-mode duration and ELMs?

B. Lloyd: We have already reported two years ago the observation of density “ears” on MAST. These are most pronounced during long ELM-free periods. During steady ELMing discharges these “ears” are much less pronounced or absent.

Paper IAEA-CN94/OV/2-4 (presented by F. Wagner)

Discussion

K. Ida: In LHD, the foot point of the ITB does not expand with increasing heating power because of the existence of a rational surface. How does the electron temperature profile change in W7-AS in a zone without magnetic shear? Does the temperature gradient increase at fixed foot point or does the foot point move outward at constant temperature gradient?

F. Wagner: The foot point is located at the transition from the ion to the electron root. The location is in agreement with the neo-classical calculation. I am not aware of any further systematic studies.

H. Yamada: You made a strong statement with regard to the isotope effect. Can you exclude any possibility of the existence of the isotope effect in stellarators?

F. Wagner: My statement applies to W7-AS. There is no obvious change in τ_E (this could already be interpreted as a small isotope effect) or P_{thr} where the working gas is changed from H to D. The details of the transition into the HDH regime (but not the confinement values) depend on the isotopic mass.

B. Coppi: What is the density dependence of the confinement time in these experiments? How different is it from that given by Motojima et al. (paper OV/1-6)? For both scalings it is clear that the confinement properties improve significantly with density and this is a strong positive indication for high density, high field concepts such as Ignitor.

F. Wagner: The density scaling is observed over a large density range from below $10^{19}m^{-3}$ to above $10^{20}m^{-3}$. The scaling is about $n^{0.6}$. It is not clear whether this stellarator observation can be transferred to tokamaks where the scaling can saturate (depending on the confinement regime). Most of the confinement data of W7-AS are collected at $B_T = 2.5$ T.