1. Purpose of Experiments

Look for changes in density fluctuations, particularly those at short wavelength and high frequency, in low density Ohmic regimes, where transport is known to be dominated by the electron channel. The goal is to correlate electron transport levels with fluctuations at scales that might correspond to predicted instabilities.

2. Background

The origin and nature of anomalous electron transport is one of the most critical unsolved transport problems. At the present time, we don’t even know which turbulence scales (from $\rho_e$ to $a$) are important. As the density is lowered in Ohmic heated plasmas, energy confinement falls below L-mode and begins to follow the neo-Alcator scaling (where $\tau_E \sim n_e$; $\chi_e \sim 1/n_e$). Power balance calculations show that the ion and electron channels are largely decoupled (for shot 950606009, $\tau_{ic} \sim 55$ msec > $\tau_E \sim 15$ msec) and thus the Ohmic power, which goes into the electrons, would be lost mainly via the electron channel. Lowering the power through the ion channel will reduce the drive for ITG and may allow ion confinement to drop closer to neoclassical levels. These plasmas are a target of opportunity for the upgraded PCI diagnostic which has very good signal to noise and high frequency response. Modifications should allow measurement up to $k_R \sim 30$
Since the spatial scale for the turbulence which causes electron transport is not known in any regime, measurements over a wide range is desirable.

3. Approach

Describe the methodology to be employed; explain the rationale for the choice of parameters, etc. Describe the analysis techniques to be employed in interpreting the data, if applicable. If the approach is standard or otherwise self-evident, this section may be absorbed into the Experimental Plan.

Run a series of Ohmic plasmas starting above the “breakpoint” density between the neo-Alcator and L-mode regimes (see figure). To avoid spending time finding the appropriate discharge conditions, we will attempt to duplicate the shots from the 95-96 campaigns where the linear confinement regime was first studied on C-Mod. Several scans would be performed using different shapes, all limited on the inner wall and with lower than normal elongation. PCI is the primary fluctuation diagnostic, though it would be useful to be monitoring the reflectometer at the same time. PCI should be configured to look at high k. Standard profile diagnostics should be available to allow calculation of electron and ion power balance. The machine conditions are probably not critical, though it should be clean enough to allow operation at low density, where $Z_{\text{EFF}}$ tends to increase in any event. The A coils should be used to avoid locked modes. If an opportunity to get a few shots in H$_2$ discharges occur, these would be useful to investigate the $\rho$ scaling of the $k_s$ spectrum observed. The two equilibria and currents proposed correspond to scans performed in 95-96.
The results of these experiments will be compared to calculations using the gs2 microstability code using the detailed profile data from the actual shots. TRANSP runs will be used for power balance calculations.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 5.2 T
Plasma Current: 0.8 and 0.5 MA
Working Gas Species: D
Density: \( \tilde{n}_e = 1.5 \rightarrow 0.4 \)

Equilibrium configuration (if possible, refer to database equilibria): two equilibria to be tested 1) standard shape, inner wall limited (951207032), 2) near circular, inner wall limited (950606009)

4.2 Auxiliary Systems

RF Power, pulse length, phasing: Nope
Pellet Injection (species):
Impurity blow-off injection:
Diagnostic Neutral Beam: (May be needed for piggy-back run)
Special gas puffing: very low density
Non-axisymmetric Coils (Connections, Current): Certainly
Other:

4.3 Diagnostics

List required diagnostics, and any special setup or configuration, e.g. non-standard digitization rate.

PCI (high-k preferred), reflectometer, TS, HIREX, ECE, Neutrons, TCI, Z-meter, bolometry
5. Experimental Plan
Both sections must be filled in.

5.1 Run sequence Plan
Specify total number of runs required, and any special requirements, such as consecutive days, no Monday runs, extended run period – 10 hours maximum – etc.

1 Run (+ a few shots in H₂ if and when we change gases)

5.2 Shot sequence plan
For each run day, give detailed specification for proposed shot sequence: number of shots at each condition, specific parameters and auxiliary systems requirements, etc. Include contingency plans, if appropriate.

Set up at 5.3 T, 0.8 MA, $\bar{n}_e = 1.5 \times 10^{20}$, $\kappa = 1.5$, inner-wall limited
1. Scan density down shot to shot to about $0.4 \times 10^{20}$ (10-15 shots)
2. Reduce $\kappa$ to 1.0, $I_P$ to 0.5; Scan density shot by shot from 1.5 to 0.4 (balance of run)
3. If an opportunity to run a few shots in H₂ appears, repeat a few promising discharges from 1 or 2.

6. Anticipated Results
Discuss possible experimental outcomes and implications. Indicate if the program may be expected to lead to publications, milestone completions, improved operating techniques, etc. Indicate if the experiments are intended to contribute to a joint research effort, or an external database.

Identification of wavelength and frequency ranges important for anomalous electron transport in C-Mod.

7. References
Include references both to external and internal literature or communications which bear on this proposal. See Section 2.

Invited preview talk on electron transport by P. Diamond

White paper on transport by TTF by P. Terry et al.