Alcator C-Mod

Mini-Proposal

MP No. 501

Subject: Fluctuations in ITB Plasmas

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Group: Transport

Date: July 12, 2007

Approved by: **Date Approved:**

1. Purpose of Experiments

Include immediate goal of the experiments, scientific importance and/or programmatic relevance. Refer to any relevant program milestones.

The primary purpose of this experiment is to study the instabilities that are associated with ITB development and saturation in Alcator C-MOD. The CXRS group and Darin Ernst would also like to study impurity transport in ITBs in conjunction with this proposal.

2. Background

Discuss Physics Basis of the proposed research. Prior results at Alcator or elsewhere, and any related work being carried out separately.

ITBs form in EDA H-Mode plasmas which have been created with off-axis ICRF heating. It is expected that this is due to suppression of outgoing flux driven my micro-turbulence. PCI chordal measurements have shown evidence of an instability that grows late in the ITB as the density becomes more peaked. This instability is even more pronounced if central rf heating is added after the ITB has formed. In the case of the central rf heating, gyrokinetic simulations by Ernst, comparing PCI and simulated wavelength spectra, has shown that the measurements are consistent with TEM driven fluctuations just inside of the barrier foot [IAEA ‘06]. The TEMs are driven unstable by the steep density gradient in conjunction with increased core temperature during on-axis ICRH [PoP ‘04].

Recent modifications to the PCI diagnostic which installed a rotating phase plate can supply two critical pieces of information: the direction of propagation of the instability and its approximate location.

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.

The plan is to form EDA H-mode plasmas with 70 Mhz ICRF and 5.4 T magnetic field, allowing the development of an ITB. Central 80 Mhz ICRF will be added after the ITB develops. As much data as possible will be collected from fluctuation diagnostics during the time of the ITB. Diagnostics which support modeling and simulation such as ion and electron temperature, rotation, density, impurity density and q profile (if available) will be collected. Care will be taken to optimize the available diagnostics for theses shots. The field of 5.4 T is selected so that ECE diagnostics will not be cut off during the ITB.

If 70 Mhz is not available, this can be done at either 6.3 T and 80 Mhz, but without the central heating.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 5.4 T
Plasma Current: 0.9-1.0 MA
Working Gas Species: D2
Density: ~ 2 x 10^{20} line averaged
Equilibrium configuration (if possible, refer to database equilibria): standard good ITB discharge

4.2 Auxiliary Systems

RF Power, pulse length, phasing: Standard; maximum power available, but constant for all discharges
Pellet Injection (species):
Impurity blow-off injection:
Diagnostic Neutral Beam: for CXRS and MSE
Special gas puffing: Argon for HIREX
Non-axisymmetric Coils (Connections, Current);
Other: Boronization the night before

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

All standard core diagnostics, Reflctometry, TS (Edge and Core), VB, ECE (GPC1 and GPC2), FRCECE, magnetics, MSE, PCI, TCI, Dα, HIREX, CXRS

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 Day

Set up standard equilibrium with EDA H-modes with 70 Mhz and 5.4 T to obtain ITB 1-10 shots

Determine optimum time to inject 80 Mhz rf: Scan power and/or timing of central heating, checking to be sure that all relevant data has been obtained: 15-20 shots.

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.

We anticipate that the fluctuation measurements obtained in this run will further clarify the relative roles of TEM, ITG, and ETG instabilities that arise during ITB plasmas, and supply copious data for comparison with simulation and other analysis. Extremely strong on-axis heating may result in dominantly ITG modes, while less on-axis heating is expected to produce TEMs.

7. References

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

D. R. Ernst *et al.*, "Role of trapped electron mode turbulence in internal transport barrier control in Alcator C-Mod," Phys. Plasmas **11**(5) (2004) 2637.

D. R. Ernst *et al.*, "Identification of TEM Turbulence through Direct Comparison of Nonlinear Gyrokinetic Simulations with Phase Contrast Imaging Density Fluctuation Measurements," Proc. 21st Int'l. Atomic Energy Agency Fusion Energy Conference, Chengdu, China, 16-21 October 2006, oral paper IAEA-CN-149/TH/1-3.