1. Purpose of Experiments

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

Investigate formation of internal transport barrier (ITB) possibly triggered or aided by RF driven flows

2. Background

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

Edge and core barriers are generally believed to be due to suppression of ion turbulence by sheared ExB flows[1]. Bifurcation can occur because of positive feedback between the pressure gradient, $E_r$, and sheared flow suppression. Since the diamagnetic contribution to $E_r$ is negative, rotation in the counter-current direction can enhance the effect and co-current rotation can inhibit it [2]. In C-Mod, we have consistently measured co-rotation which is particularly strong in RF heated H-modes (but which is present in RF heated L-mode and in ohmic H-modes as well,[3]). We have speculated that the existence of this “natural” co-rotation may prevent the formation of ITB’s in many circumstances. Further, if the rotation could be reduced or reversed, barriers might form much more readily. In fact, recent theories [4] suggest that the flow could be reversed by moving the ICRF resonance to the high-field side (inboard) of the plasma.

Recent experiments (see 1000523 and 1000607) to test this theory did show formation of density transport barriers and an apparent reduction/reversal of the toroidal flow. It is not clear however, if these results are related to the speculations discussed above.

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.
Regardless of the origin of the flow reduction/reversal, to test our hypothesis we would like to measure time dependent profiles of $T_i$, $V_\phi$, and $V_\theta$. This would allow us to calculate the shearing rate $\omega_{E \times B}(r)$ which is the term which is believed to stabilize turbulence. (Radial dependences are important since it is the gradient in $E_r$ which is important. The contributions from co-current rotation and the pressure gradient may or may not cancel depending on their profiles - offset gradients could lead to very high shearing rates.) This can then be compared to calculations of the linear growth rate $\gamma_L(r)$ from the gs2 code[5]. To confirm our hypothesis, changes in $\omega_{E \times B}(r)$ should lead changes in the density profile and should approach qualitatively $\gamma_L(r)$.

The physics of the barrier location is also of interest since for these shots $q_0 \leq 1$. Most experiments with ITBs are for $q_0 \geq 1$, with very weak or reversed shear.

Ideally the DNB diagnostics would be used since they can, in principle make these measurements across the entire plasma cross section. Ahead of this, reasonable measurements should be possible near the core with HIREX.

These experiments could be combined with other ITB modes accessible on C-Mod - namely the H/L and pellet induced barriers. The goal here would be to extend the duration of these barriers by counteracting the natural co-rotation of the plasma.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

**Toroidal Field**: 4.5T

**Plasma Current**: .8-1.0 MA

**Working gas species**: D (H) minority

**Density**: Targets $\sim 1.5 \times 10^{20} m^{-3}$

**Equilibrium configuration** (if possible, refer to database equilibria): normal, see 1000607007

**Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms:

4.2 Auxiliary Systems

**RF Power, pulse length, phasing**: Max available - at least equivalent to 1000606 - $\sim 2$-3 MW

**Pellet Injection (species)**: yes

**Impurity blow-off injection**: sure

**Diagnostic Neutral Beam**: sure

**Special gas puffing**: Argon

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

standard core diagnostics especially Hirex, TS, Neutrons. Dalsa, CXR if/when available.

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 - soon (perhaps a second when the DNB diagnostics are fully up and running)

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.

Day 1
1 Duplicate 1000523017. Scan Hirex to get temperature and rotation profiles, time histories. 10 shots
2 Fire pellets just before RF to obtain PEP mode. Vary field/resonance location, look for duration of PEP mode vs rotation and resonance location. Measure rotation and Ti profiles. 10 shots
3 Create fully developed density barrier, notch ICRF to drive H/L transition. Restore ICRF after 20-30 msec.

Day 2 would take place when the CXR diagnostic is operational and would include an RF power scan to look for the threshold as a function of $B_T$ (icrf resonance location).

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.

These experiments could provide an interesting test of the ExB shear flow paradigm for transport suppression. More importantly, they may offer a rare opportunity to control barriers through application of ICRF.

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