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

   Evaluate RF heating efficiency and confinement in L-mode and H-mode - with particular emphasis on the scaling with plasma temperature.

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

   Plasma performance in the past two years has been below the baseline established in the 1996-2000 campaigns. This must be the result of a change in RF power deposition, plasma confinement, calibration of the diagnostics, analysis routines or some combination of these. While the latter two effects cannot be ruled out, this explanation would seem to require coincidental changes in several diagnostics. It seems more likely that there has been a real change in plasma performance. A consistent picture can be obtained by assuming that only about 1/2 of the applied RF power is in fact absorbed by the thermal plasma. In this view, further degradation in H-mode confinement occurs because of the high fraction of radiated power relative to the actual (i.e. lower) total power.

   When significant RF power is applied, an L/H transition generally occurs for our standard equilibrium. Analysis of any long term change in plasma behavior is therefore complicated by the inherent variation in H-mode quality. “Good H-modes” typically require about 2 MW of heating and radiated power below 50-60% of the absorbed power. H-mode quality can also be effected by relatively subtle changes in the plasma edge. Thus we want to carry out a set of experiments in L-mode where these issues are not in play. Typically heating in L-mode has been carried out only during startup before the machine has been conditioned and when the H/D level is very high.
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.

We will attempt to study the issues raised above by running inner-wall limited discharges with strong RF heating at 0.8 MA. The total power should be moderately high, but we should not push performance - the power should be steady except for programmed notches designed to allow evaluation of the absorbed power via dW/dt analysis. Separate trips on each of the 3 antennas would be programmed to allow separate evaluation of each.

These studies would be carried out at a variety of densities. Recent experiments suggested that lower density - thus hotter - plasmas show better heating. If time permits, plasma currents of 0.6 and 1.0 MA could be run as well.

The L-mode studies would take about 0.4 seconds of each discharge. Following this period, the inner gap would be increased from 0 to about 1 cm to allow an H-mode plasma to develop from a fully heated discharge. This would provide further tests for the scaling of heating efficiency with temperature.

Careful spectroscopic study of impurities should accompany these experiments to determine the extent to which low or high Z impurities are present. Boron or nitrogen from the BN tiles may be a factor in the apparent drop in plasma performance.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 5.4 T

Plasma Current: 0.8 MA (0.6, 1.0 if time permits)

Working gas species: D2

Density: $n_e \sim 1.0 - 2.5 \times 10^{20}/m^3$

Equilibrium configuration (if possible, refer to database equilibria): inner wall limited, see 1030501026 for example

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

4.2 Auxiliary Systems

RF Power, pulse length, phasing: 3-3.5 MW with significant contributions from each antenna, total about 0.8 sec (Higher power would be welcome if it can be delivered without unprogrammed trips)

Pellet Injection (species): none
Impurity blow-off injection: none
Diagnostic Neutral Beam:
Special gas puffing: none
Other:

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

Standard core and edge diagnostics. All spectrometers capable of evaluating impurity content of plasma. 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

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.

3-5 shots: Set up shot, 0.8 MA, inner-wall limited (see for example 1030501026), \( n_e \sim 1.5 \times 10^{20}/m^3 \) RF heating with Prf-D \( \geq 1 \) MW; Prf-E \( \geq 1 \) MW Prf-J \( \geq 1.5 \) MW from 0.7 to 1.5 sec Notches of about 10 msec programmed into RF power:

D @ 0.8 sec.
E @ 0.9 sec.
J @ 1.0 sec.
D @ 1.2 sec.
E @ 1.3 sec.
J @ 1.4 sec.

3-5 shots: keeping the same RF program, lift the plasma off the inner limiter starting at 1.0 sec. There should be a 1 cm left gap by 1.1 sec.

3 shots: drop the density, \( n_e \sim 1.0 \times 10^{20}/m^3 \)
3 shots: raise the density, \( n_e \sim 2.3 \times 10^{20}/m^3 \)
3 shots: drop the current to 0.6 MA, drop the density, \( n_e \sim 1.0 \times 10^{20}/m^3 \)
3 shots: raise the density, \( n_e \sim 1.5 \times 10^{20}/m^3 \)
3 shots: raise the density, $n_e \sim 2.3 \times 10^{20}/m^3$
3 shots: raise the current to 1.0 MA, density fixed $n_e \sim 1.0 \times 10^{20}/m^3$
3 shots: drop the density, $n_e \sim 1.5 \times 10^{20}/m^3$
3 shots: drop the density, $n_e \sim 1.0 \times 10^{20}/m^3$

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.

Evaluation of RF heating efficiency; particularly the role of temperature. Confinement benchmark for L-modes for current campaign. Hopefully information to help improve things.

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