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

The goal of this mini-proposal is to develop 8 T H-mode discharges with $^3$He minority heating.

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

Developing standard 8 T H-mode discharges is important for future 8 T experiments. In the 1996 Winter campaign, record 8 T H-mode discharges were obtained (960213016 and 960213017). In this campaign (1998 Winter), considerable effort has been devoted to optimizing the RF absorption at 8 T. The total absorbed power (determined by break-in-slope analysis of EFIT stored plasma energy) versus $^3$He concentration peaks sharply around 2-5% (corresponds to 25-35 msec puff from B-side upper). The total absorbed power to injected power is 75-80%. Coincidently, the 8 T H-mode record also used similar concentration (based on programmed $^3$He puffing). Developing good 8 T H-mode (within the present limits) has not been investigated.

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.

This mini-proposal is an extension of the RF $^3$He minority heating experiments carried out during this campaign. In the previous experiments, the $^3$He concentration has been scanned over a wide range of values (2-30%) to explore RF absorption physics. Here, the $^3$He concentration will be fixed at 2-5% (25-35 msec programmed puff with 35 V maintenance) and plasma density, toroidal field, plasma current, and RF waveform will be scanned. The plasma density will be scanned to find an optimum density for entering...
H-mode. During this campaign, the density has been $0.9-1.0 \times 10^{20}$ m$^{-3}$. A full scan over available density range should provide an opportunity to map out the present density limits bearing in mind the limited source power. Scanning the toroidal field may allow entry into H-mode at lower power (H-mode power threshold scales linearly with B-field). Lower field, however, moves the deposition off-axis which may offset any gain from lowering the field. A current scan may provide a window where the energy confinement is good and the impurity accumulation is minimized. The recent experience is that impurity accumulation causes those H-modes which are briefly obtained to collapse. Second, dynamic q-scans have shown EDA H-modes are more easily obtained at higher q and are sustained as the q is decreased dynamically. Varying the programmed RF waveform may also help minimize deleritious RF effects on the plasma when the RF transitions on. Density rises of 10-20\% have been observed with the RF turn on in previous 8 T discharges during this campaign. A fresh boronization should, also, make a significant impact on impurity accumulation and RF fueling. The record 8 T discharges were obtained after an overnight boronization with He ECDC for 2 hours before the run (960213). Record 5.4 T H-mode discharges were obtained this run campaign following a boronization. Antenna fueling, also, appeared less for these discharges, but the reason is unclear because fueling could be heating scenario dependent.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for :

- **Toroidal Field:** 7.0–8 T
- **Plasma Current:** 0.8–1.5 MA
- **Working gas species:** D (majority) and $^3$He (variable concentration)
- **Density:** $n_e = 1–3 \times 10^{20}$ m$^{-3}$
- **Equilibrium configuration** (if possible, refer to database equilibria): Lower single-null, $\sim 1$ cm outer gap
- **Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: current flat-top of at least 0.6 sec.

4.2 Auxiliary Systems

- **RF Power, pulse length, phasing:** 2 MW to full power, power modulation for absorption calculation
- **Pellet Injection (species):** none
- **Impurity blow-off injection:** none
- **Special gas puffing:** $^3$He from a separate valve (need to calibrate the pulse gas valve)
- **Other:**
4.3 Diagnostics
List required diagnostics, and any special setup or configuration, e.g. non-standard digitization rate.

All available diagnostics. Spectroscopic determination of $^3$He concentration. ECE polychromator with appropriate grating.

4.4 Neutron Budget
Estimate the neutron dose rate at the site boundary. Give basis for estimate. (Once some experience has been gained a standard formula will be provided for estimating dose rates.)

Less than $10^{13}$ per shot.

5. Experimental Plan

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.

Fresh boronization and 2 consecutive runs or an extended 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.

Begin by repeating conditions from 960213016 ($n_{\text{t}} \approx 0.9 \times 10^{20}$ and $I_p 1.23$ MA). A recent representative 8 T discharge is 960212018.

Vary RF wave form to minimize negative RF impact. (3-4 shots)
Scan target density $n_{\text{t}} = [0.5,0.8,0.9,1.0,1.1,1.3]$ (8-10 shots)
Scan toroidal field 7.4, 7.6, 7.8, and 8.0 T at 2-3 densities. (6-8 shots)
Scan from shot-to-shot 0.8, 1.0, and 1.2 MA and dynamic current scan 0.8-1.2 MA and 1.2-0.8 MA at 2-3 densities. (8-12 shots)

D- and E-port antennas will be offset at the end of the RF pulse to allow the total absorbed power to be determined.

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.

Develop 8 T H-mode discharge for future investigation. Contribute data to the H-mode and threshold databases.

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