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 establish the RF heated H-mode database with up to 4 MW of RF source power (3.5 MW net power into the plasma) by scanning the density and plasma current at the RF power level of 3 MW. Global energy confinement (H-factor) scaling well above the threshold will be the main subject of 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.

Mini-proposal 054 (ICRF Conditioning) was completed on January 18, 1995 and the full ICRF power is available for heating experiments. During our earlier experiments several brief H-mode transitions were observed. These H-modes are considered to be marginally above the threshold. In this mini-proposal, global energy confinement well above the threshold will be studied systematically. Study of the H-mode power threshold is covered under a separate mini-proposal.

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.

To achieve the objective of this mini-proposal we will try to optimize the condition to obtain high quality H-mode in contrast to the approach we will take in studying the L-mode plasmas. Density, plasma current, and RF power will be varied to study the scaling of global energy confinement. The range of parameter scans will be similar to that for the L-mode ICRF Heating mini-proposal, but the emphasis is on studying the quality of H-mode confinement (most likely at the expense of compromising on the total input power).
4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

**Toroidal Field:** 5.3 T

**Plasma Current:** 0.8 MA typical, scan 0.4–1.2 MA.

**Working gas species:** D, possibly with H minority (< 5%).

**Density:** $10^{20}$ m$^{-3}$ typical, scan over as wide a range as possible.

**Equilibrium configuration** (if possible, refer to database equilibria): 950215027

**Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: current flat-top to at least 1 sec, longer if possible.

4.2 Auxiliary Systems

**RF Power, pulse length, phasing:** up to full power, with power feedback on both transmitters

**Pellet Injection (species):** none

**Impurity blow-off injection:** none

**Special gas puffing:** D/H, possibly NINJA

**Other:**

4.3 Diagnostics

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

All available diagnostics. In particular, divertor diagnostics (including the fast scanning probe), spectroscopy (impurity lines, H$\alpha$/D$\alpha$), charge exchange, bolometry, and temperature diagnostics.

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.)

Of the order of $10^{13}$ per shot under optimum conditions.

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.

2 – 3 good runs (depends on useful number of shots per run). These runs should be scheduled when both RF systems are operating reliably at high power, with power feedback.

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.

Start from a diverted plasma which has been determined to be a good ICRF H-mode target, similar to 950215027. Adjustment to the equilibrium may be needed to push the upper X-point out, set the outer and inner gaps, and fine-tune the outer strike point for the Edge Group. It is likely that certain criteria (which will likely include a sufficient outer gap) will have developed as a result of other H-mode related mini-proposals. It is assumed that a suitable target plasma has been developed by the time these runs are scheduled, but if not several shots may be required to develop a suitable target plasma.

The minority concentration to be used for the density and current scans will be determined from a preliminary hydrogen concentration scan performed prior to these runs. Scan density over as wide a density range as possible at 0.8 MA. Data will be obtained at 4 densities (e.g., \( n_e = 0.8, 1.2, 1.8, \) and \( 2.5 \times 10^{20} \) m\(^{-3} \), exact densities to be determined by operational limits). A minimum of 2 shots at each density will be taken, with and without the fast scanning probe. Additional shots may be required if it is necessary to retune the antenna. For each shot there will be 2 levels of RF pulses, 200 msec each. The power levels will be approximately 2.5 MW (highest power that is achievable reliably) and 3.5 MW (highest power achievable). Vary the plasma current (0.4 and 1.2 MA) and repeat the density scan at each current. Additional data at intermediate current (e.g., 0.6 MA, only at one density) may be required if the \( I_p \) dependence does not appear to be linear.

Pick the best condition based on results of the density and current scans, and reduce the outer gap. This is an effort to raise the RF power to the maximum power. Document the effects of smaller outer gap on H-mode performance (confinement, radiated power, impurity content, divertor operation, etc.).

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.

Document global confinement scaling, core plasma transport, and edge plasma behavior in strongly ICRF heated H-mode plasmas. Parameter window for obtaining the H-mode with presently available power will also be obtained.

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