1. Purpose of Experiments

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

This experiment is intended to examine the detailed dependence of H-mode pedestal parameters on magnetic balance. In doing so, this experiment will contribute to a high priority effort to examine pedestal widths in plasmas with variations in edge magnetic shear. In addition, sensitivity of pedestal scalings to magnetic balance may inform H-mode edge modeling on ITER, which is being designed to run in a topology close to double null.

2. Background

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

Recent C-Mod experimental campaigns have had increased focus on operation with magnetic configurations other than the usual case, i.e. strongly single null with the ion grad-B drift directed toward the active X-point. The influence of magnetic geometry on phenomena such as scrape-off layer (SOL) flows, divertor asymmetries and H-mode power thresholds has been documented previously, and continues to receive study. What remains less thoroughly characterized is the role of magnetic topology on the edge pedestal in H-mode discharges. The pedestal structure, which strongly influences core confinement, can be affected significantly by topology, through a number of mechanisms. These include changes to magnetic shear layers, edge recycling patterns and SOL flows.

Experiments in 2006 demonstrated a tendency for H-mode pedestals initiated with unfavorable drift direction (i.e., with the grad-B drift directed away from the X-point) to exhibit lower density and higher temperature than pedestals in comparable H-modes with
favorable drift direction. Edge pressures matched reasonably well, though the shift toward lower $n_e$, higher $T_e$ resulted in much lower pedestal collisionality. With unfavorable drift direction came higher input power thresholds and higher edge $T_e$ in the L-mode prior to transition. Thus, one could speculate that low collisionality at the L-H transition promotes the growth of a higher-$T_e$, lower-$n_e$ H-mode. Recently, though, H-mode experiments in nearly double null equilibria seemed to indicate that collisionality might be regulated purely by changing magnetic balance within a steady H-mode, regardless of the target conditions.

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 propose to make ICRF-heated H-modes in discharges with varied magnetic topology. Discharges will be swept dynamically between lower single null (LSN) and upper single null (USN), while maintaining H-mode throughout. Edge profiles and fluctuations will be documented, as will plasma rotation and flows. Discharges that scan through DN are potentially useful for an experimental proposal by Marr, which is focused on radial transport of toroidal momentum. A companion set of H-modes will be made in static topologies, including both double null (DN) and SN with varied separation between separatives (SSEP).

The precision SSEP control scheme utilized in prior scans through DN (e.g. 1070614009) is not suitable for large swings in SSEP. Since a substantial range of SSEP is called for, along with good X-point and strike positioning, an alternate method will be used. This will involve programming fixed upper and lower X-points, and shifting the plasma center $Z_{CUR}$ up or down to obtain roughly the desired values of SSEP.

4. Resources

4.1 Machine and Plasma Parameters
Give values or range for:

- **Toroidal Field:** 5.4T (can be run in either field direction)
- **Plasma Current:** 800kA
- **Working Gas Species:** $D_2$
- **Density:** $n_0=8\times10^{19}\text{m}^{-2}$
- Equilibrium configuration (if possible, refer to database equilibria): $\kappa\sim1.6$, $\delta_{av}\sim0.35$, magnetic balance scannable as described in Section 3.

4.2 Auxiliary Systems

- **RF Power, pulse length, phasing:** 3MW @80MHz, heating phasing. At least 700ms.
- **Pellet Injection (species):** none
- **Impurity blow-off injection:** none
- **Diagnostic Neutral Beam:** yes, for CXRS measurements
- **Special gas puffing:** $D_2$ from NINJA for diagnostics
- **Non-axisymmetric Coils (Connections, Current):** standard locked mode compensation
Cryopump may be used for some shots, if it is available

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

Required: Edge Thomson, ECE, toroidal and poloidal LFS CXRS, inner wall CXRS, TCI, PCI, reflectometry.
Useful: X-ray $T_i$, rotation diagnostics (Ar puff should be 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 run day with a well-boronized machine is required.

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.

H-modes will be initiated in discharges with a variety of topologies, using ICRF beginning at 0.6s. Two discharges are required at each condition.

Scan LSN $\rightarrow$ USN: SSEP should range from $-15\text{mm}$ at 0.7s to $+15\text{mm}$ at 1.3s.
1. Scan LSN $\rightarrow$ USN: SSEP should range from $-10\text{mm}$ at 0.7s to $+10\text{mm}$ at 1.3s.
2. Scan LSN $\rightarrow$ USN: SSEP should range from $-5\text{mm}$ at 0.7s to $+5\text{mm}$ at 1.3s.
3. Scan USN $\rightarrow$ LSN: SSEP should range from $+15\text{mm}$ at 0.7s to $-15\text{mm}$ at 1.3s.
4. Scan USN $\rightarrow$ LSN: SSEP should range from $+10\text{mm}$ at 0.7s to $-10\text{mm}$ at 1.3s.
5. Scan USN $\rightarrow$ LSN: SSEP should range from $+5\text{mm}$ at 0.7s to $-5\text{mm}$ at 1.3s.
7—15. Hold SSEP fixed at the following values: $-15$, $-10$, $-5$, $-2$, $0$, $+2$, $+5$, $+10$ and $+15$.

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.

The pedestal behavior as a function of SSEP will be mapped out in terms of both dimensional ($n_e$, $T_e$, $L_n$, $L_T$) and dimensionless ($\nu^*$, $\alpha_{MHD}$) parameters. We will also search for changes in pedestal width, particularly near DN. As mentioned above, this experiment will contribute to a high priority effort to examine pedestal widths in plasmas with variations in edge magnetic shear. In addition, sensitivity of pedestal scalings to magnetic balance may inform H-mode edge modeling on ITER, which is being designed to run with a relatively small separatrix separation.
Developing robust SSEP sweeps in uninterrupted H-mode phases will also constitute an improved technique for combining H-mode operation with upper chamber cryopumping. As initial attempts on June 14, 2006 showed, steady H-modes could be generated with relatively low input power in LSN, then nudged toward USN, allowing for pumping to be “turned on” during the H-mode.

Results should contribute to multiple student theses, and will support several presentations at upcoming meetings: APS-DPP, IAEA H-mode workshop, ITPA Pedestal TG meeting.

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