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

Examine Ip rampup and flattop phases of the advanced scenario discharges at Bt = 3.4 T, utilizing the discharge startup established in MP 556 in July 2009, and the availability of 50 MHz ICRF heating.

The lower Ip of 600 and 450 kA will be examined with the lower Bt operation to establish new discharges based on discharge programming developed in MP576 ITER-like Startup (40 ms crow bar, early divert, reproducible Ip and density ramps). These plasma will have safety factors in the range of ITER and DEMO advanced tokamak plasma configurations of q95 = 3.5-4.7.

Comparisons will be made with the existing 600 and 450 kA discharges at 5.4 T, in particular, searching for lower li and higher betaN plasmas.

These will provide baseline discharges for the application of LH later in 2010.

If there is sufficient time discharges with q95 ~ 3.0 will be examined as preparation for 2.7 T operation later in run period.

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

The advanced scenario development on C-Mod is pursuing lower Bt to access higher betaN, ultimately targeting the no wall beta limit with low li, and lower q95 (~3.5-4.7, lower li) with ICRF and LH heating and current drive to establish discharge scenarios for projection to ITER and DEMO operations. The plasma current is usually in the range of
450-600 kA to enhance the bootstrap fraction, although the bootstrap fraction does not change with Bt variations, with other parameters held fixed. The startup phase of such discharges was established in MP556 1090711 for 3.4 T with ohmic plasmas, avoiding the Bt ramp down that was necessary when starting with 5.4 T startup. The availability of 50 MHz ICRF allows on-axis heating with the efficient minority H scheme at 3.4 T, and is an ideal opportunity to examine this regime.

Advanced tokamak discharges run in 2007 at 600 kA (MP492 1070711) and 2008 (MP 1080118) at 450 kA with Bt = 5.4 T are the benchmarks for comparison at these lower fields and ICRF heating.

2. 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.

3. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

- Toroidal Field: 3.4 T
- Plasma Current: 0.45, 0.60, 0.725 MA
- Working Gas Species: D
- Density: Target 1e20 m⁻², variable (cryopump not precluded).
- Equilibrium configuration (if possible, refer to database equilibria): Utilize MP556 resulting discharge 1090710010 (600 kA) and 1090710008 (450 kA).

4.2 Auxiliary Systems

- ICRF Power, pulse length, phasing: up to 3 MW, 50 MHz, 1.5 s duration
- LHCD Power, pulse length, phasing: none
- Pellet Injection (species): no
- Impurity blow-off injection: no
- Diagnostic Neutral Beam: Highly desirable
- Special gas puffing: NINJA (with D2) should be available.
- Non-axisymmetric Coils (Connections, Current): Yes; optimized to reduce locked modes.

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

Essential: Thomson, Magnetics, Hard x-rays, ECE, TCI, bolometers.
Desirable: MSE, CXRS, SOL probes.

4. 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.

One run day.

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.

Recover discharge from MP556 Low Bt Startup and Discharge Development, Ip = 600 kA (1090710010) (2 shots)

Incorporate any startup improvements such as 40 ms crowbar, early divert time, large bore, smooth Ip ramp and reproducible density rise, from run day 1090903 MP 576 Improvement of ITER-like Discharge Startup. (3 shots)

1) establish ohmic rampup baseline at Ip = 600 kA (2 shots)
   a. rampup Ip in 500 ms
   b. nL targeted to 0.5 x 10^{20} /m^2 at end of Ip ramp
   c. plasma elongation in flattop is 1.7-1.8
   d. flattop duration 0.7 s,
   e. standard C-Mod rampdown duration 0.5 s, power termination

2) establish ohmic rampup with full ICRF power at end of rampup (or slightly earlier), with appropriate density to enter H-mode as soon as possible in flattop phase. (2 shots)

3) setup ICRF power trajectory in the the rampup avoiding high radiation, utilizing density established in #2, full 3 MW ICRF beginning at end of rampup
   a. 1.0 MW at 100-120 ms, 2.0 MW at 220 ms (2 shots)
   b. 1.0 MW at 100-120 ms, 2.0 MW at 220 ms, and 3.0 MW at 320 ms (3 shots)

4) adjusting density nL > 0.6x10^{20} /m^2 to access H-mode during the ramp, inject ICRF power during the rampup, full 3 MW ICRF beginning at end of rampup
   a. 1.0 MW at 100-120 ms, 2.0 MW at 220 ms (2 shots)
   b. 1.0 MW at 100-120 ms, 2.0 MW at 220 ms, and 3.0 MW at 320 ms (3 shots)
   c. possible shifting of ICRF timing

5) establish ohmic baseline at Ip = 450 kA (1 shot)

6) establish ohmic rampup with full ICRF at end of rampup, with appropriate density to enter H-mode as soon as possible in flattop (1 shot)
7) apply ICRF heating trajectories from 600 kA cases in rampup for Ip = 450 kA, with full 3 MW ICRF beginning at end of rampup, and density setting to produce H-modes in rampup (4 shots)

8) establish ohmic baseline at Ip = 725 kA (1 shot)

9) establish ohmic rampup with full ICRF at end of rampup, with appropriate density to enter H-mode as soon as possible in flattop (1 shot)

10) apply ICRF heating trajectories from 600 kA cases in rampup for Ip = 725 kA, with full 3 MW ICRF beginning at end of rampup, and density setting to produce H-modes in rampup (4 shots)

5. 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.

Results will show the low Bt operation with the ICRF power sequencing in the rampup, L and H-mode regimes in the ramp and flattop, with particular emphasis on lower li and higher betaN. These discharges will provide the basis for future experiments with LH current drive.

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