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

This short experiment aims to produce a shape on C-Mod which is as close as possible to that used on JFT2M in studies of the “High Recycling Steady” (HRS) H-mode regime on JFT2M, which appears similar to the EDA H-mode on C-Mod. A later experimental proposal would then aim to compare the H-mode regimes and fluctuations in the two devices. Details will depend on results of upcoming JFT2M scans.

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

It is now generally recognized that H-mode regimes with small, or no, ELMs offer a major advantage over the Type I ELM regime in terms of divertor erosion, as well as compatibility with advanced operation regimes such as internal transport barriers. Such a regime on C-Mod is the Enhanced $D_{\alpha}$, (EDA) regime characterized by increased particle transport due to a high $m$ and $n$ quasicoherent mode[1]. At high powers, this evolves into an H-mode with ELMs. It has proven difficult to reproduce this regime robustly and in steady state on other devices, though similar fluctuations have been observed. More recently, a steady, quiescent regime has been attained on JFT-2M which has been named the High Recycling Steady (HRS) H-mode[2]. It has attractive global characteristics and is quite similar to the EDA. Detailed fluctuation measurements with magnetics, reflectometry and probes have been made [3] there is both a high frequency quasicoherent mode with $n\sim7$ and a lower frequency with $n=1$ mode. It is now of interest to compare the EDA and HRS regimes more systematically in terms of access conditions, fluctuation characteristics and global properties. If they indeed prove to be the same physical regime, then comparing devices of different sizes and plasma parameters should help to clarify the important dimensionless parameters and prospects for extrapolation to
burning plasma experiments. This will be a new collaboration. It was proposed via the ITPA pedestal group and approved at the Program Leaders meeting in Japan in November, 2003. JFT2M will run a small number of run weeks in 2004. They have recently scheduled a run day for HRS studies in early February, but have asked that C-Mod first try to demonstrate a matched shape before JFT2M experimental scans begin. A target is $\kappa \sim 1.5$, $\delta \sim 0.55$. See Figure 1, below.

Figure 1: Target JFT2M equilibrium from HRS studies
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.

Using ohmic discharges, start with a ‘standard’ C-mod shape and progressively decrease elongation to determine lower limit while maintaining good lower null discharge, and high delta. Start with ‘normal’ C-Mod aspect ratio, matching $q_{95}=3.3$. Once this is accomplished, attempt to increase value to JFT2M value of 5, and reduce $I_p$ accordingly.

4. Resources

4.1 Machine and Plasma Parameters
Give values or range for:

Toroidal Field: 4.9-5.4 T
Plasma Current: 0.4-1.0 MA
Working Gas Species: D
Density:
Equilibrium configuration (if possible, refer to database equilibria): See figures,

4.2 Auxiliary Systems

RF Power, pulse length, phasing: None required, though ~ 1-2 MW at 80 MHz would be useful. Compatible with RF at any freq
Pellet Injection (species): none
Impurity blow-off injection: none
Diagnostic Neutral Beam: none required
Special gas puffing: none
Other:

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

Mainly magnetics. Edge Thomson scattering should be operational to check the coverage with these shapes. Also should check the coverage of PCI for future QC mode measurements.

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.

One partial run (half day or less). Follow up MP will request one day, next campaign.
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.

1. Start with $k=1.6$, 4.9 T, $\Delta \sim 0.5$, 1 MA. (1 shots)
2. Reduce kappa to 1.5, or as close as we can while maintaining lower null (3 shots).
3. Adjust upper and lower delta for best match to JFT2M shape, and Ip for $q_{95}=3.3$. (3 shots)
4. Increase outer gap to attempt to raise aspect ratio to match JFT2M. This results in a very non-standard shape (see Figure 2), so it is unclear how close we will be able to come. Reduce Ip to $\sim 400$ kA to maintain $q_{95}$. If any RF is available, try adding some power ($\sim 1$ MW) to get an idea of coupling, and of whether EDA H-mode is seen. (4 shots.)

Total: 11-13 ‘good’ shots.

* EFITD 33x33 01/09/2004*

date ran =15-Jan-04
shot # = 1040115666
time(ms) = 700.00
chi**2 = 1.99
rout(cm) = 73.864
zout(cm) = -0.834
a(cm) = 15.956
elong = 1.525
utriang = 0.197
ltriang = 0.871
indent = 0.000
vol(cm3) = 5.21e+05
energy(J)= 1.81e+04
betat(%) = 0.292
betap = 0.384
li = 1.190
error = 8.22e-05
$q^*$ = 4.341
qout = 6.041
apsib = 3.330
dsep(cm) = 0.495
rm//rc = 74.5//73.7
zm//zc = 0.7//0.5
betapd = 1.095
betatd(%) = 0.834
wdia(J) = 5.17e+04
Fpolvs(A) = 0.00
Ihalo_t(A)= 0.00

data used:
ip(kA) = -400.000
bt0(T) = -5.000

Figure 2: Target C-Mod equilibrium for step 4, with matched aspect ratio. Red line is JFT2M shape.
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.

Will support a new international collaboration. The willingness of C-Mod to devote some time to this soon is a precondition to JFT2M using one of their few 2004 run days for EDA/HRS studies. Completion of the shape development is important to complete a realistic run plan for future comparison experiments. Depending on results we may attempt a dimensionless matching experiment, or simply compare fluctuation characteristics at different aspect ratios with more typical plasma parameters.

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

1 Greenwald et al, Phys. Plasmas 1999
2 Kamiya et al, IAEA 2002; NF2003