1. Purpose of Experiments

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

This experiment will produce equivalently shaped plasmas on C-Mod and ASDEX Upgrade and attempt to match dimensionless parameters $\nu^*$, $\rho^*$ and $\beta$ near the edge of the plasma (the H-mode pedestal region), both at the L-H transition and in the fully developed H-mode.

2. Background

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

The proposed comparison is similar to that carried out between ASDEX-Upgrade and JET, as reported at APS (Quebec) and elsewhere [1]. In these experiments, it was found that $\nu^*$, $\rho^*$ and $\beta$ could be matched at the LH threshold, at least in a moderate density range. Matches of global dimensionless parameters and confinement in H-mode discharges have also been carried out between JET, C-Mod, AUG and DIII-D [2]. Edge profiles were not well measured in those experiments. The proposed experiment would extend such comparisons, and in addition should help to identify the relevant parameters which enable access to the EDA regime. Comparisons at the L-H transition will be carried out at a range of densities, since neutrals are most likely to be important near the low or high density limits.

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.
The approach taken will be to run C-Mod discharges of the same shape as recent high triangularity ASDEX-Upgrade discharges (specifically shot 13012, from 11 Jan 2000, which had \( \delta_u = 0.29, \delta_l = 0.46 \) and \( \kappa = 1.73 \) (Fig. 1). The usual guidelines for matching dimensionless parameters in the core plasma will be used for \( B_T, I_p \) etc. A series of densities will be run. At each density, power will be stepped up to give a) the power threshold and b) different power levels in H-mode. Pedestal profiles of \( n_e \) and \( T_e \) will be measured, averaging over a few edge TS pulses, and ELM/fluctuation behaviour characterized. Parameters selected are such that we expect most C-Mod H-modes to be in the EDA regime. Since C-Mod has \( R=0.68 \) m and AUG \( R=1.65 \) m, plasma parameters will be scaled according to \( r=R(AUG)/R(C-MOD)=2.43 \).

Because ASDEX-Upgrade cannot make good edge \( T_e \) measurements with \( B_T \) below 2 T, C-Mod will run at its maximum field of 6 T ( \( 2r^{5/4} = 6.07 \)). To match an AUG current of 800 kA, C-Mod \( I_p \) will be \( 0.8r^{-1/4} = 1.0 \)MA. This corresponds to \( q_{95} \sim 4.3 \), which should give EDA H-modes. There is some flexibility in density and power. Since AUG will have to run lower \( n_e(\sim r^{-2}) \) and \( P_{tot}(\sim r^{-3/4}) \) than C-Mod, we will use values at the high end of our range. Target ranges for line averaged density are \( 1.7 - 2.5 \times 10^{20} m^{-3} \) at the L-H transition and \( 3 - 4 \times 10^{20} m^{-3} \) in H-mode. It is recognized that 6 T is not ideal, since the RF heating will be off axis. However, since we will be comparing edge parameters this should not be as critical as in a core confinement comparison.

ASDEX Upgrade will then use this discharge series as a target to match dimensionless parameters, when the experiment resumes operation in March, 2001. Depending on the densities and power levels we are able to achieve, they will select appropriate ranges to scan density and power. Profiles of \( \nu^*, \rho^* \) and \( \beta \) will then be compared and matched pairs of discharges will be sought. Since power is not a free parameter at the L-H transition, part of the experiment will be to see if, when two dimensionless parameters are matched, the third is also the same.

If it proves possible to match all three dimensionless parameters in H-Mode, it will be of interest to see if the H-mode regime is similar. If AUG sees a regime similar to our EDA, this would be an important extension of the database in this regime. If not, it would indicate that other variables such as neutral density are critical. If, on the other hand, it proves impossible to match one of the parameters, this may be an important indicator of why C-Mod ELM fluctuation behaviour is generally different than on larger, lower field tokamaks.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

- Toroidal Field: 6 T
- Plasma Current: 1 MA
- Working gas species: Deuterium
Density: L-Mode $n_e l = 0.7 - 1.5 \times 10^{20} m^{-2}$

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

Pulse length, typical current & density waveforms, etc. Refer to database or sketch desired waveforms: $\delta_{u} = 0.29, \delta_{l} = 0.46$ and $\kappa = 1.73$ (Fig. 1)

4.2 Auxiliary Systems

RF Power, pulse length, phasing: 78-80 MHz, up to 3-4 MW. power stepped in 150 ms intervals

Pellet Injection (species):

Impurity blow-off injection:

Diagnostic Neutral Beam: nice but not essential

Special gas puffing:

Other:

4.3 Diagnostics

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

Edge TS, bremsstrahlung, Lyman alpha, ECE (including heterodyne), edge x-rays, PCI, reflectometry. Scanning probe if compatible with RF.

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 in 2000. To be followed by AUG run in spring 2001. If needed, some discharges for further iteration might be run in the 2001 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. Discharge development to match ASDEX-Upgrade shape. [This could be done on a previous run day without RF]. $\sim 8$ discharges.

2. Target density $n_e l = 1.2 \times 10^{20} m^{-2}$ (average $n_e \sim 2 \times 10^{20} m^{-3}$). Step power up, 150 ms/step. 1.0, 1.5, 2.5, 3.0, 3.5, 4.0(?) MW. 3-4 discharges.

3. Raise density to $n_e l \sim 1.5 \times 10^{20} m^{-2}$ (depending on available RF power; need to be comfortably over L-H threshold). Repeat power steps. 3-4 discharges.
4. Repeat at density $n_e l \sim 0.9 \times 10^{20} m^{-2}$ 3-4 discharges.

5. Time permitting, repeat at $n_e l \sim 0.6 \times 10^{20} m^{-2}$. This is expected to give ELM-free (not EDA) H-modes. 3-4 discharges.

   Total 24 discharges.

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.

   This experiment will be an important part of the US-DOE/IPP collaboration, specifically the C-Mod/AUG collaboration on H-Mode physics. We expect it to lead to a joint publication and conference presentation. Given the long upcoming C-Mod shutdown, it is important to take the first step in this comparison, which has been discussed for several years, in this campaign.

7. References

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