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.

Obtain H-modes and corresponding threshold data and ELM/EDA character for plasmas diverted into the upper chamber. This will help to clarify the roles of triangularity, divertor geometry, and neutral recycling in the H-mode threshold and EDA phenomenon observed on Alcator C-Mod. Reversed toroidal field is required.

2. Background

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

It has been established that triangularity, especially of the active x-point, affects the character of the H-mode, with higher triangularity lending itself to the advantageous EDA operation, and lower triangularity to more ELM-free behavior, with the associated difficulties of impurity accumulation. The closed geometry of the lower divertor makes triangularity scans simultaneous scans of divertor geometry from nearly touching the inner nose through to operation on the top of the outer divertor. There is evidence that the upper triangularity, which is not involved in these divertor changes, also has an effect on the edge barrier character, but the data are not as clear cut. Operating the plasma into the upper divertor chamber, which is open, avoids most of the strike-point geometry changes, and will enable us to establish much more clearly whether the effects we observe are a consequence of stability changes with plasma shape or are linked more intimately to divertor configuration and recycling location.

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 triangularity scan in shot 980204040, if it were inverted, would be acceptable for operation into the upper divertor flat plate at least until 1.1s. After that time the strike-point would have reached the gussets. The acceptable time interval provides essentially the complete triangularity scan from 0.6 to 0.4 (at the x-point). In point of fact, operating into the upper chamber will enable us to go to substantially higher $\delta$ because there is no inner nose. It may be advantageous to do the sweep in the opposite direction (low to high) because the effects of OH precharge are to draw the strike-point away from the gussets for the same x-point position. However, it is usually easier for the RF to couple to EDA at the earlier part of its pulse, which would be favored by a high-to-low scan.

In addition, it would be highly desirable to establish the H-mode threshold for upper x-point plasmas, because the recycling is totally different, there being essentially no neutral baffling at the top. If we can see any differences, these might help to identify the role of neutrals. If there is no difference, that would be an important result in itself. Therefore some threshold power scans at different triangularities will be conducted. These scans should be done with both directions of $B_t$, so as to address the drift direction, which we know is important.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 5.4-5.6T

Plasma Current: 1 MA

Working gas species: Deuterium

Density: At least high and low density targets (say $\int ndl = 0.7, 1.5 \times 10^{20}$ m$^{-2}$) and if time allows, an intermediate case.

Equilibrium configuration (if possible, refer to database equilibria): Inverted form of standard shapes. Scans like 980204040/1 but probably with even greater triangularity, and possibly scanning from low to high.

Pulse length, typical current & density waveforms, etc. Refer to database or sketch desired waveforms: Probably no longer than about 1.2s because of concerns about the gussets.

4.2 Auxiliary Systems

RF Power, pulse length, phasing: Threshold power scans plus moderate to high power steadily applied from about 0.5s to 1.1s for triangularity scans.

Pellet Injection (species): None

Impurity blow-off injection: One or two, e.g. scandium.

Special gas puffing:

Other:
4.3 Diagnostics

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

Threshold and edge barrier diagnostics. Especially, ECE, edge x-ray, reflectometer (if poss). Sufficient core diagnostics for energy accounting. Lower divertor diagnostics mostly will have no plasma, and so be irrelevant.

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.)

Typical for a good day.

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.

One and a half run-days is proposed. The first half day with normal $B_t$ direction to establish operation into the upper divertor and explore the adverse-drift thresholds. The second day with reversed $B_t$.

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.

Day 1: Obtain upper x-point equilibrium, 5 shots. Do threshold power scan at each of 3 triangularities, 2 densities, 6 shots. Contingency, 5 shots, total 16 shots.

Day 2: Breakdown and initiation with reversed field is assumed to be established already. Obtain upper x-point equilibrium, 5 shots. Perform triangularity scans at 3 densities, 6 shots. Do threshold power scans at each of 3 triangularities, 3 densities, 9 shots. Contingency, 10 shots. Total 30 shots.

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.

Unequivocal documentation of triangularity effects on H-mode threshold and character. Information on neutral effects on H-mode. Extra field-direction information.

7. References

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

MP 143b Triangularity effects.

Session summaries from 980204.