Alcator C-MOD
Mini-Proposal

Subject: Restart Operation: January 1999
MP No. 206

From: S. M. Wolfe
Date: 31-Dec-1998

Approved by: ____________________________ Date Approved: ________________

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

Resume plasma operations after the recent shutdown. Provide suitable target plasmas for alignment, calibration, etc., of main diagnostic systems.

This MP includes establishment of suitable ohmic targets for RF operation using the D & E port antennas, using the nominal 5.4 T, 80 MHz D(H) minority heating scheme. If there is a separate MP for conditioning of these RF systems, then those runs will be scheduled once a satisfactory target plasma is reliably obtained; otherwise, conditioning will be considered part of this MP. In any case, completion of this MP requires demonstration of physics-quality boronized H-mode plasmas, with standard diagnostics on-line.

A secondary purpose of this MP is to provide training and experience for new C-Mod Physics Operators.

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

C-Mod has been off-line since the TF “event” in Feb, 1998. The machine has been completely dismantled, repaired, and reassembled. New diagnostics were added (CXRS, BES, MSE, Correlation ECE, edge-viewing arrays, etc), and most diagnostics have been removed and re-installed. In addition, a new ICRF antenna has been installed at J-port, doubling the installed available RF power. There have also been modifications to the limiter configuration, with the replacement of the AB full limiter by a split limiter, the addition of a midplane limiter near K, and the transfer of the full limiter from FG to GH. The divertor region has been modified by the addition of the flappers. There have also been changes in the gas system, notably the transfer of the main piezo-valve from K-side to C-side, where the conductance to the plasma may be reduced. While the power systems remain in essentially the same configuration as during the last campaign, some maintenance has been performed on the supplies.
Before normal physics runs can resume, it will be necessary to re-establish reliable operation, provide time for diagnostic re-alignment and calibration, checkout the new gas puffing system, and condition some of the antennas.

This MP is patterned after MP#170A [1], which dealt with similar issues before the 1998 Campaign.

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.

Before attempting plasma shots, the power systems and hybrid will have been exercised to verify proper operation, and the magnetics signals will be checked out. The machine should have been baked and discharge cleaned, but not boronized.

Starting with a suitable segment 1 from the 1998 campaign (e.g. 980220003), tweak the startup as necessary to get breakdown and current rise. This may take several days. Based on past experience, after a good null and current rise have been established, it will still be necessary to have a number of cleanup runs before a good plasma is obtained. Shot quality will be monitored to determine whether additional discharge cleaning is required, or if tokamak plasmas are sufficient for the remaining conditioning.

Once reasonable plasmas are obtained, a series of nominally identical (fiducial) shots will be run at 0.8 MA to allow for diagnostic alignment and perhaps for RF conditioning. Variations from fiducial conditions, but within previously established operating parameters, will be carried out as indicated in support of the commissioning efforts.

Conditioning activities and diagnostic alignments and calibrations requiring specific shot sequences with parameters which are not expected to be of general interest or utility should be covered by separate mini-proposals. Less fussy alignments, calibrations, or conditioning will be included as piggyback experiments.

A call has been issued for new Physics Operators, and qualification of candidates will take place during the Startup phase of C-Mod operation. Once the major bugs have been worked out of the system, trainees will be assigned to serve as Assistant PO’s during these runs, eventually graduating to the Physop chair.

4. Resources

4.1 Machine and Plasma Parameters
Give values or range for:

- **Toroidal Field:** flattop values of 5.4 T
- **Plasma Current:** 0.8 MA, with possibility of variation $0.6 \leq I_p \leq 1.2$ MA if required
- **Working gas species:** D$_2$, D$_2$ with H$_2$ minority
Density: \( \text{NL}_04 = 1.0 \times 10^{20} \text{ m}^{-2} \), other values if required

Equilibrium configuration (if possible, refer to database equilibria): SNB, start from 0.8MA fiducial, like 980220003

Pulse length, typical current & density waveforms, etc. Refer to database or sketch desired waveforms: Flattop to 1.2 sec or longer

4.2 Auxiliary Systems

RF Power, pulse length, phasing: D- and E-port antennas, for conditioning.

Pellet Injection (species): if requested

Impurity blow-off injection: as requested

Special gas puffing: Initially none. Ar for HIREX, once relatively non-disruptive plasma is established.

Other:

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

Magnetics. ECE with grating set for 5.4 T. \( \text{D}_\alpha \). Ratiomatic. TCI. Others as available.

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.)

Minimal.

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.

The first part of this experiment, getting plasmas, will have to be scheduled and completed before any other runs this campaign. RF conditioning and special diagnostic commissioning runs may be interspersed with the later aspects. Most of the runs will be carried out before the first boronization, but at least one post-boronization run is called for.

Up to three weeks have been allotted, if absolutely necessary.
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) Get plasma (1-5 days)
2) Cleanup discharges, increase reliability (2-5 days)
3) Constant shots for diagnostic alignment, etc. (As many as required, or to end of second week, whichever comes first.) Document plasma prior to boronization.
4) After boronization, verify boronized operation, including startup, H-mode behavior. (1-4 days)

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.

Machine, and diagnostics ready for normal physics operation. If there is not a separate MP for RF conditioning, then conditioning of the RF up to at least 2 MW, which should give access to EDA H-modes for physics studies, will be a goal of these runs.

A new crop of Physics Operators should qualify during these (and related) runs.

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