Alcator C-MOD
Mini-Proposal

Subject: Restart C-MOD 1995
From: S. Wolfe, S. Horne, I. Hutchinson
Date: October 18, 1995

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 or ITER/TPX R&D commitments.

   The purpose of these runs is to re-establish normal tokamak operation, following four
   month hiatus and modifications to power supplies, hybrid computer, and internals. We will
   also establish a new fiducial shot for reference during the upcoming campaign. Checkout of
   various diagnostics will also be possible during these runs. If time permits, a new startup
   technique using only pulsed gas (no steady fill) will be developed; this will probably be
   required with Boronization, and undoubtedly will be needed when and if we implement
   cryopumping.

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

   In addition to the usual issues relating to machine cleanliness and conditioning, several
   changes have been made to the power and control system since last June’s shutdown which
   will likely require some minor modifications to the startup sequence.

   The power supply assignments to the EF2U&L coils and to the EF4 series pair have
   been changed. The EF2 coils are now driven by a series/parallel configuration of TMX sup-
   plies which nominally provide the same voltage as previously, but up to twice the current,
   i.e. up to 8kA; An administrative limit of 5500 A (PLC setting) has been recommended
   for these supplies. The additional TMX supplies for the EF2s were taken from the EF4
   coils, which are now driven by two of the old Alcator C TF supplies (Robicon). These
   supplies will provide up to 5kA (suggested administrative limit) at about 20% reduction
   in voltage from the previous configuration, i.e. we now should get a maximum voltage
   around 800V.

   New integrators have been installed on the EF2’s and EF4 bus rogowski coils, with
   gains reduced by a factor of two from previous. This change has been entered in the
   Engineering tree, and is picked up automatically by the Hybrid P-to-V expression; however,
   all predictors involving these currents will need to be re-calculated and some of the factors
will need to be reduced. The demand gain on the EF4 supply has also been changed; this change has now been entered in the Hybrid tree. All controllers will need to be recalculated. There has also been a minor change in the location of two flux loops, F16 and F17; these probably require no action.

The hybrid computer itself has had new RT-node software loaded, and PCS has been modified accordingly. All timing is now done using an on-board counter, rather than using a Jorway for matrix timing and on-board counters for the Wavegen. Asynchronous segment switches are now (mostly) implemented, and time stamps for each matrix switch are now generated and returned to the tree after the shot. The fizzle detector is no longer set from the PCS screen. None of these modifications should impact standard operation, but we need to be aware that some unexpected behavior may have sneaked past the testing process.

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.

We will select a shot from last run period, and perform the necessary magic to make PCS happy with its new inputs and outputs. We will then go through the usual tweaking to get a good null and look for a breakdown. Verify proper operation of all supplies and control signals. Once a breakdown is achieved, further tweaking will probably be required to get a good current rise. Initially, we will limit the plasma current to 600kA, because the first plasmas will probably be quite resistive. If it looks like the plasmas are cleaning up satisfactorily, we will increase the current to 800kA and then to 1MA “standard” shots. We should establish an 800kA and/or 1MA fiducial shot, for future use, to replace the old 600kA shot #940603015, established in MP061.

If time permits, we will attempt a no-fill startup, using only pulsed gas. With the gas permissive bypassed or otherwise disabled to insure a fixed (possibly zero) voltage on the valve, a full voltage pulse will be applied through the hybrid at some negative time. Timing and width of the pulse will be varied to give the same pressure at t=0 as for the steady fill. Plenum pressure should be kept constant at a pre-determined value for all shots.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 5.3T
Plasma Current: 0.6 to 1MA
Working gas species: D2
Density: to be determined

Equilibrium configuration (if possible, refer to database equilibria): SNB, x-point control

Pulse length, typical current & density waveforms, etc. Refer to database or sketch desired waveforms: 1.6sec

4.2 Auxiliary Systems

RF Power, pulse length, phasing: None
Pellet Injection (species): None
Impurity blow-off injection: None
Special gas puffing: None (turn off fill for pulse-only startup)
Other:

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

Magnetics, H-alpha, TV (standard plasma view), ECE, Hard X-ray, TCI, Z-meter, Visible and UV spectroscopy, Moly Monitor, Bolometry, Ratiomatic gauge.

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.

Two runs should be sufficient, provided machine cleanliness is satisfactory. By definition, these will be the first runs of the campaign. Until this MP is completed, no other runs will be possible; it may be necessary to schedule additional ECDC if we are not successful after two days.

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.

Start from a suitable 5T shot from May or June 1995. This should be an 800kA, moderate density, diverted shot suitable for use as a fiducial. Set up PCS appropriately, changing current flattop in Segment 2 to 600kA. Tweak up null to get breakdown (3-10 shots).
Evaluate current rise (if any). Tweak fields and fill to optimize current rise. Assess state of machine conditioning. If plasmas are too resistive and don’t seem to be cleaning up, go back to ECDC; else continue to try for flattop. Pay careful attention to EF2/EF4 currents and try to keep off limits. (5-15 shots).

Raise current to 800kA. Continue to monitor EF2 and EF4 current levels. Follow usual disruption policy: don’t push current if disruptions are a problem. Continue to observe clean-up. (5-10 shots).

Raise current to 1MA, if machine condition and disruptivity permit. (3 shots)

If time permits, begin development of pulse-gas only startup. (5-20 shots). Up to one day may be spent on developing this scenario.

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.

The goal is to get the tokamak operational again, preferably with a new startup scenario that does not use a steady pre-fill.

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