1. Purpose of Experiments

Include immediate goal of the experiments, scientific importance and/or programatic relevance.
Refer to any relevant program milestones or ITER R&D commitments.

To improve our vertical stability, and possibly our startup reliability, by reducing phase lag in the OH supplies.

2. Background

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

We have difficulties with vertical control; these are due at least in part to the behavior of the OH2 voltage regulators. We have observed a .005 to .008 second delay between input demand and output voltage in the OH2 supplies; this delay introduces a 180° phase shift at 100 hz; we often see vertical oscillations of the plasma near this frequency.

We also have difficulties with startup and current rise which might be related to the ripple which is occasionally observed in the OH1 current before commutation. These ripples inductively couple to the OH2 systems, and the hybrid feedback trying to cancel out the ripple, combined with the power supply delays, may in fact exacerbate it.

Yet another source of ripple in the OH2 supplies seems to be associated with crossover. We observe a voltage oscillation up to 50 volts amplitude (940526018 at 400 - 500 msec) near oh2l crossover.

In general, the problem of understanding the closed loop response of the power supply / coils / plasma / diagnostics /hybrid system is complicated by the dynamics of the power supply internal voltage regulation loops.

A large fraction of the delays in OH2 response are due to the voltage feedback loops internal to the supplies. These can be defeated fairly simply, by allowing only proportional gain in the internal feedback loop, and then by breaking the error input connection – breaking the loop. This would have the following effects:

1. The speed of the power supply response to demand should increase, possibly significantly.
2. The power supply gain will no longer (attempt to) be linear. It would still be approximately linear.

3. The output voltage will become more sensitive to alternator speed, loading, etc.

4. The behavior near crossover is predicted to change (Gwinn).

Point (1) is a clear win.

Points (2) and (3) are irrelevant nearly always during plasma operation, since the power supplies are nearly always under feedback control through the hybrid. The only period where we have used direct voltage control is just after commutation. During this period, getting the power supplies to respond at the required time is probably more important than having precise voltage control.

To minimize the programming changes required, the proportional gain could be adjusted to give the same small-signal gain we see now, at commutation time. This would make the amplitudes of the existing voltage programming approximately "valid"; the improved time response might require us to undo some adjustments we made to compensate the slow response of the supplies. This will also minimize the impact on controllers, where we rely on voltage ratios between power supplies to control plasma shape. (Since the shape depends on fields, therefore currents, not on voltages, we don’t keep these ratios constant now – the resistive drop isn’t compensated.)

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 plan would be to modify at least the OH supplies. The relevant section of MP 42 (Tinios, Horne) would then be run to quantify the new behavior. We would then attempt to get breakdown and plasma.

4. **Resources**

   Give values or range for:

   Toroidal Field: -5.3 T

   Plasma Current: -600kA – -800 kA

   Working gas species: D₂

   Density: \( \int ndl \approx 8 \times 10^{19} \) (non-critical)

   Equilibrium configuration (if possible, refer to database equilibria): Nearly irrelevant – appropriate to a piggyback expt?

   Pulse length, typical current & density waveforms, etc. Refer to database or sketch desired waveforms:
4.2 Auxiliary Systems

**RF Power, pulse length, phasing:** None

**Pellet Injection (species):** None

**Impurity blow-off injection:** None

**Special gas puffing:** None

4.3 Diagnostics

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

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.)

Nominal

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.

I’m told the power supply modifications can be done in 5 minutes per supply. Assuming that’s true,

1. Modify the supplies (15 min).

2. Run the pre-charge portion of the chosen shot; verify that feedback still works; perhaps adjust power supply gains (2 shots)

3. Run the relevant part of MP42 – 4 shots.

4. Attempt to get a plasma, by loading an old shot.

5. If we’re successful in making a plasma, we can try a different TF flattop, to test sensitivity of the power supply dynamics to different alternator load conditions.

6. If at the end of the run we conclude that getting an old shot to run requires an unacceptable amount of tweaking, return the supplies to their original state.

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.

See above.
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 vertical stability of the machine should be improved. Possibly the breakdown
reliability will also be improved.

7. References

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