1. Purpose of Experiments

The immediate goal of this experiment is to condition the ICRF antennas so that they may provide high levels of RF power to the plasma.

2. Background

1. Condition antenna to 40-50 kV in vacuum; determine DC1 calibration factor in vacuum at low power.

2. Condition antenna in plasma to high power, 2.5 MW D+E or 2.5 MW J; determine DC2 calibration factor in plasma at low power, calibrate power control.

3. Approach

1. For the vacuum conditioning phase, no machine fields or plasma discharges are required; ECDC must be off.

2. For the plasma conditioning phase, fiducial discharges with \( n_e l_{04} \cong 11 \cdot 10^{20} m^{-2} \) and \( \sim 1 \text{ cm outer gap} \) are required. A range of antenna loading conditions will be explored by varying the density, plasma current and/or the outer gap as required in H-mode. The antenna will be considered to be adequately conditioned if little density rise is observed in L-Mode and the antenna power, D+E or J alone, reaches 2.5 MW for 0.5 sec. Piggy-back experiments can be accommodated if they do not interfere with the objective of this experiment.
4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

**Toroidal Field:** 5.4 T

**Plasma Current:** 0.8 - 1.2 MA

**Working gas species:** D, with possibly different concentrations of H

**Density:** $(1-2) \cdot 10^{20} \text{ m}^{-3}$ line average

**Equilibrium configuration** (if possible, refer to database lower single null diverted or inner-wall limited, centered on midplane, 1 cm outer gap equilibria):

**Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: current flat-top up to 1.0 sec

4.2 Auxiliary Systems

**RF Power, pulse length, phasing:** up to full power, up to 0.5 sec

**Pellet Injection (species):** none

**Impurity blow-off injection:** none

**Special gas puffing:** D, H

**Other:** none

4.3 Diagnostics

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

All RF-related diagnostics plus standard plasma diagnostics; H/D ratio especially useful.

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.)

Less than $10^{13}$ per shot

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.

Vacuum conditioning, especially if performed between plasma discharges, may require up to one week. Conditioning in plasma discharges may require only one run, but increased caution during the conditioning phase to minimize arcing damage may lead to the requirement of several runs.
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. For the vacuum conditioning phase, assume that the majority of the conditioning is performed between plasma discharges, no magnetic fields or plasmas are required. ECDC must be off. The vacuum tune will be obtained, and the DC1 calibration factor will be determined at low power. As the antenna voltage is raised to the 40-50 kV range by increasing the transmitter power, voltage protection interlocks will be tested.

2. For the plasma conditioning phase, reproducible fiducial plasmas with \( n_e l_{04} \approx 1 \cdot 10^{20} m^{-2} \) and \( \sim 1 \) cm outer gap are required. To obtain the DC2 calibration factor, 6-8 discharges are needed with low RF power. Further 3-4 discharges will be needed to obtain the power calibration factor. The RF power will then be worked up to moderate levels, and by detuning the matching system, the arc detection interlocks and retry circuits will be tested. The RF power will then be worked up to 1.25 MW per transmitter, 2.5 MW total into the D plus E antennas or 2.5 MW into the J antenna, and the pulse length will be extended to 0.5 sec. The plasma density, current and/or outer gap will be varied in order to vary the antenna loading, and the overall system performance and plasma response will be documented.

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 procedure is expected to result in a well-conditioned antenna capable of reliable high-power operation into the plasma.

7. References

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

ICRF antenna operating experience on both TFTR and C-Mod.