1. Purpose of Experiments

The goal of this mini-proposal is to investigate changes in the sense of toroidal plasma rotation in ICRF heated discharges as the hydrogen (H) minority resonance layer is moved from the low field to high field side of the tokamak.

2. Background

Strong central toroidal plasma rotation has been measured in both ohmic and ICRF-heated discharges in Alcator C-Mod.\(^1\) Recently a theory for the sustainment of plasma rotation by ICRF injection has been proposed by F.W. Perkins.\(^2\) Model calculations from this theory predict that the sense of toroidal plasma rotation should change sign from co-current to counter-current as the (H)-minority resonance is moved from the low field to high field side of the tokamak. This effect can be tested on C-Mod through a straightforward set of experiments by varying the toroidal magnetic field strength \((B_0)\) from 5.9 T to 4.6 T.

3. Approach

The approach used in this experiment is relatively straightforward. A series of ICRF-heated discharges will be produced using D(H) minority heating. The magnetic field will be systematically decreased from about 5.8 – 6.0 T down to 4.5 – 4.6 T and the toroidal plasma rotation will be measured at each field using the high resolution X-ray spectroscopy diagnostic (HIREX), available on C-Mod.
4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

- **Toroidal Field**: 4.5 – 5.9 T
- **Plasma Current**: 0.8 MA
- **Working gas species**: D (majority) and H (minority) (use background H-concentration - no puffing)
- **Density**: $n_e = 2.5 \times 3.0 \times 10^{20} \text{ m}^{-3}$
- **Equilibrium configuration**: Lower single-null, 1.5 cm outer gap
- **Pulse length, typical current & density waveforms, etc.**: Use waveforms for fiducial H-mode at 5.4 T.

4.2 Auxiliary Systems

- **RF Power, pulse length, phasing**: 2.5 MW, 0.75 s pulse, D-Port $(0 - \pi)$, E-Port $(0 - \pi)$
- **Pellet Injection (species)**: none
- **Impurity blow-off injection**: none
- **Special gas puffing**: none
- **Other**: Machine should have boronized walls.

4.3 Diagnostics

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

- **HIREX**: for $T_i$ profiles and toroidal rotation measurement.
- **GPC 1 and GPC 2**: for $T_e$ profiles.
- **All standard core diagnostics**.

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.

1 run

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 contin-
gency plans, if appropriate.

(i) Start with a fiducial H-mode shot at \( B_0 \simeq 5.4 \) T and measure the toroidal plasma
rotation with HIREX looking at the plasma center.

(ii) Take shots at \( B_0 = (5.6, 5.8, 6.0) \) T, measuring the central plasma rotation.

(iii) Take shots at \( B_0 = (5.2, 5.0, 4.8, 4.6) \) T, again measuring the rotation using
HIREX.

(iv) Repeat the sequence of shots in items (i) - (iii) with the HIREX aimed off-axis at
\( r/a \simeq 0.25 \).

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 experiment will test the outstanding prediction of a theory for ICRF-induced
plasma rotation which says that the direction of toroidal plasma rotation in C-Mod should
reverse as the cyclotron resonance layer is moved from the low field to the high field side
of the tokamak.

7. References

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