Subject: Influence of ICRF on sawtooth behavior

From: S.J. Wukitch, Y. Lin, P.T. Bonoli, E. Edlund, L. Lin, A. Parisot, M. Porkolab, G. Schilling, J. Wright

Group: RF group

Date: December 19, 2003

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

The goal of this mini-proposal is to investigate role of fast particle pressure and ion cyclotron current drive in modifying the sawtooth period.

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

Initial experiments conducted during the last campaign were successful in establishing reliable phased antenna operation and modification of the sawtooth period was pronounced. For a +90° phasing (10307090005), the sawtooth period was extended to 15 msec and decreased to 5 msec for a -90° (1030716006). The cyclotron resonance was ~1cm to the low field side of the magnetic axis.

A few recent near DN discharges have had monster sawteeth (sawtooth period > 0.05 sec, 1031124020, 1031125021, 1031211017, 1031217012, and 1031217027). The reason for these monster sawteeth is unclear. In a number of these discharges, modes in the 200-400 kHz range have been observed. These modes appear to scale with ICRF power and the mode frequency may be related to the ion tail energy.

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.
In order to maximize the ion energy, target plasmas with high temperature and low density need to be prepared. At 4.5 MW, a number of discharges near double null have large sawteeth and are good candidate discharges. For these shapes, scan antenna phase, RF power, plasma current, and B-field. In both cases, co-current, ctr-current, and heating discharges will be compared.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

- Toroidal Field: 5-6 T
- Plasma Current: 0.6-1.2 MA
- Working Gas Species: D
- Density: n04<0.8 x 10^{20} m^{-2}
- Equilibrium configuration (if possible, refer to database equilibria):
  - near DN single null discharge like 1031217027

4.2 Auxiliary Systems

- RF Power, pulse length, phasing: J-port: full power at 78 MHz, co-, ctr- and heating phasing for 1 sec. D and E-port: 2.5 MW to full power for 1 sec.
- Pellet Injection (species): none
- Impurity blow-off injection: none
- Diagnostic Neutral Beam: yes
- Special gas puffing: 
- Other:

4.3 Diagnostics

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

Standard set with active charge exchange if operational. Central MSE would also be useful but the plasma parameters will likely make this near impossible.

5. Experimental Plan

Both sections must be filled in.

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.

One 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 contingency plans, if appropriate.
Scan the RF power for central cyclotron resonance position for co-, ctr-, and heating phase. (12 shots)

Scan the plasma current with central deposition (0.6, 0.8, 1, 1.2 MA) (4 shots).

Place minority resonance near the q=1 surface on both the high field side and low field side for co-, ctr-, and heating phase with 4.5 MW of ICRF. (6 shots)

During a discharge, ramp B-field to scan the cyclotron resonance across the q=1 on both the high field and low field side for co-, ctr-, and heating phase. (6 shots)

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.

Establish a recipe for controlling the sawtooth period using minority heating on C-Mod.

Provide data to compare with other machines regarding ICRF control of sawteeth.

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