1. Purpose of Experiments
   
   The goal of this mini-proposal is to demonstrate fast wave current drive using the 40 MHz RF system.

2. Background
   
   The antennas were reconfigured to allow current drive phasing (directional wave launch) at 40 MHz. 40 MHz is more favorable for fast wave current drive than 80 MHz because of lower phase velocity (for the same antenna configuration) and higher $\beta_e$ (for the same heating scenario). Theoretical estimates indicate improvement in single-pass absorption by as much as an order of magnitude for 40 MHz compared to 80 MHz.

3. Approach
   
   In order to demonstrate fast wave current drive, relatively low densities will be used. For FWCD experiments it is important to minimize absorption by ions. This will be achieved by placing ion resonances well away from the plasma core (about 3.5 T for 40 MHz). Absorption by electrons will be most efficient at the plasma center. The driven current will be estimated by comparing the current drive phasing and anti-current drive phasing.

4. Resources
4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 3.5 T

Plasma Current: scan 0.4–0.8 MA

Working gas species: D

Density: $n_e = 1 \times 10^{20} \text{ m}^{-3}$

Equilibrium configuration (if possible, refer to database equilibria): Lower single-null, 1 cm outer gap

Pulse length, typical current & density waveforms, etc. Refer to database or sketch desired waveforms: current flat-top of at least 0.6 sec.

4.2 Auxiliary Systems

RF Power, pulse length, phasing: 2 MW to full power at 40 MHz, current drive phasing

Pellet Injection (species): none

Impurity blow-off injection: none

Special gas puffing: none

Other:

4.3 Diagnostics

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

All available diagnostics. ECE polychromator with appropriate grating.

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 contingency plans, if appropriate.

Start at $3.5 \, \text{T}$ and $\bar{n}_e = 1 \times 10^{20} \, \text{m}^{-3}$. The RF power will be fixed at 2–3 MW (maximum power that can be run reliably). Several shots will be required to tune the RF system for current drive phasing. The field will be varied in the range 3.2–3.8 T to find the optimum condition for FWCD. Plasma current will be varied in the range 0.4–0.8 MA (start from higher current). A phasing scan (minimum of $+90^\circ$ and $-90^\circ$, additionally $0^\circ$ and $180^\circ$ if possible) will be carried out under the optimum condition, during which absorbed power will be measured using RF power modulation. Take a comparison shot at twice the density with current drive phasing.

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.

Demonstration of FWCD. Comparison of current drive efficiency between FWCD and MCCD.

7. References

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