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

Evaluate D(\(^3\)He) minority heated H-mode performance by comparing \(^3\)He and H minority heating using discharges with matching conditions.

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

This mini-proposal is a revision of previous mini-proposal where the performance of D(\(^3\)He) and D(H) minority heated discharges were compared. The results showed that in spite of the theoretically expected weaker single pass absorption in the D(\(^3\)He) case, the H-mode threshold for D(H) and D(\(^3\)He) were quite similar. This result suggests that in L-mode multiple pass absorption is quite effective and therefore the overall heating effectiveness in D(\(^3\)He) is similar to D(H). However, there was limited data from H-modes and this small data set suggested the H-mode performance was slightly less than for D(H) heated discharges. The lower performance has obvious implications for 8 T operation where the D(\(^3\)He) is the ICRF heating scenario for C-Mod. In the past, much attention has been focused on the role of the inherently weaker single pass absorption for D(\(^3\)He) than D(H). With J antenna at 50 MHz, a direct comparison with D(H) heating (D and E) of the H-mode quality can be assessed in identical discharges. If the resulting H-mode performance would turn out to be lower, one explanation is increased impurity radiation. We can move parasitic resonances either out or into the core plasma by changing the B\(_T\) field and these discharges would test whether the performance decrement is associated with higher impurity radiation. Another means to compare H-modes is to reduce the plasma current where impurity confinement is lower than at high plasma currents with higher impurity confinement.
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.

Using the same target discharges, monitor the H-mode performance for both D($^3$He) and D(H) heated discharges at the 2 and 3 MW level for 0.6 MA and 1 MA discharges. Although we do not currently have high power (5 MW), high confinement H-mode discharges from this campaign, a power scan up to 5 MW would be explored. At the 4 MW level, the power mix from the antennas (D,E,J) would be scanned so that in one discharge J would be dominant (0.5,0.5,3), another discharge would be dominated by D and E (1.5,1.5,1), and another would be balanced (1,1,2). A similar set of discharges would be done at 5 MW. The target discharges will utilize H-modes triggered in LSN and then transitioned to USN for density control with between shot boronization to minimize the variation due to machine conditions at high power. This comparison will be done at an optimum $^3$He concentration where the power fraction going to mode conversion is low. The $^3$He will be tracked in relative terms by monitoring the $^3$He in the divertor and calibrated against TORIC in the mode conversion regime from a previous experiment. From previous runs, we found that the $^3$He puff required was much smaller if done before the plasma is diverted and we plan to do the same here.

4. Resources

4.1 Machine and Plasma Parameters
Give values or range for:

- Toroidal Field: 4.8-5.6 T
- Plasma Current: 0.6-1.0 MA
- Working Gas Species: D
- Density: $n_04\sim0.8\times10^{20} m^{-2}$
- Equilibrium configuration (if possible, refer to database equilibria): 1070510011

4.2 Auxiliary Systems

- RF Power, pulse length, phasing: J-port at 50 MHz, 0.5 sec, heating phase
- Pellet Injection (species): none
- Impurity blow-off injection: none
- Diagnostic Neutral Beam: yes
- Special gas puffing: $^3$He (B-side upper at 15 psi) and similar waveform to …
- Other:

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

Standard plus impurity monitoring, FRECE, GPC, $^3$He monitor, H monitor, PCI.

5. Experimental Plan
Both sections must be filled in.

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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 with overnight boronization on previous night

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.

Initial target discharges will be a discharge like 1070510011 (Ip=1 MA, nl04≈0.8) with the field at 5.2 T instead of 5.4 T.

1. Using 2 MW, perform four discharges utilizing only D+E or J. (4 shots)
   If prad is flat throughout H-mode, add 2 MW from other antenna in second half of RF pulse.
2. Using ~3 MW, perform four discharges utilizing only D+E or J. (4 shots)
   Using same target discharge, plasma response with combined D, E, and J-port with a fast turnoff on J-port. (4 shots)
   If prad is flat throughout H-mode, add 2 MW from other antenna in second half of RF pulse.

To ensure consistent discharges, start between shot boronization.

3. Using 4 MW net power with the following power mix: (6 discharges)

   Power from D+E J in MW’s
   - a. 1 3
   - b. 3 1
   - c. 2 2

   If performance appears worse for D($^3$He), repeat #2 at 0.6 MA. (4 shots)

4. raise BT to 5.6 T and repeat #2 (4 shots)
5. lower BT to 4.8 T and repeat #2 (4 shots)

If discharges look similar in performance, raise total power to 5 MW and use the following mix. (6 shots)

   D+E [MW] J [MW]
   - a. 2 3
   - b. 3 2
   - c. 2.5 2.5

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.

Allow assessment of H-mode performance for weak versus strong single pass absorption scenario in near identical discharges.

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

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