1. Purpose of Experiments

Include immediate goal of the experiments, scientific importance and/or programatic relevance. Refer to any relevant program milestones or ITER R&D commitments.

Measure the incremental thermal diffusivity from measurements of $T_e$ and heat flux due to local gradient changes and compare the plasma response with predictions of transport codes (TRANSP) and theory-based models (e.g., IFS-PPPL\(^1\)). Heat pulses required for the experiment would be produced by ambient sawteeth and direct on- or off-axis electron heating with Rf. These experiments would be very similar to the modulated ECH experiments on DIII-D\(^2\). In contrast to the DIII-D experiments, due to the localized power deposition profile, heat pulse propagation into and away from the core may be studied. Experimental results could be compared with transport simulations using model diffusivities such as IFS/PPPL, Itoh-Itoh, Multi-mode, etc.

2. Background

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

Plasma transport is modeled by a relation of fluxes and gradients described by a transport matrix consisting of the transport coefficients. Heat pulse experiments are important for testing the plasma response to local perturbations, which can then be compared to the predictions of theories. The new ECE radiometer provides high spatial and time resolution $T_e$ measurements ideal for the analysis of the propagation of a heat pulse (amplitude and phase), which can be used to estimate the incremental diffusivity $\chi_{inc}$.

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.

Make high spatial and temporal resolution measurements of electron temperature with the ECE radiometer for sawteething discharges in Ohmic and H-modes. Use the heat pulse
propagation measurements to measure the \( \chi_{inc} \) with a time-to-peak or Fourier method. Vary central Rf heating to change size of the sawteeth heat pulse. We propose to carry out analysis of past and current C-Mod discharges to develop the analysis routines and pick candidate discharges for off-axis electron heating in the next part.

Once candidate discharges are identified, use off-axis modulated RF heating of the electrons to produce heat pulses.

a. Sawteeth-free discharges would be ideal for analysis. Discharges with small coherent oscillations (similar to 960126008) would be preferable over sawteething discharges.

b. Alternatively, we need to pick a modulation frequency clearly separable from the sawteeth (Similar to MP 231, Greenwald et al.) This will have to be picked after the sensitivity of the ECE diagnostic to the modulation is determined during Rf deposition experiments.

4. Resources

4.1 Machine and Plasma Parameters
Give values or range for :

- **Toroidal Field:** 5.4 T
- **Plasma Current:** ~ 1 MA
- **Working gas species:** any
- **Density:** any
- **Equilibrium configuration (if possible, refer to database equilibria):** any
- **Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: any

4.2 Auxiliary Systems

- **RF Power, pulse length, phasing:** off-axis electron heating; power to be determined during Rf deposition experiments
- **Pellet Injection (species):** n/a
- **Impurity blow-off injection:** n/a
- **Special gas puffing:** n/a
- **Other:** n/a

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

GPC, \( n_e \), soft x-ray
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.)

within site limits

5. Experimental Plan
Will need about one half day to setup the modulation duty cycle, power and percentage such that the pulse propagation is seen with a clear phase delay. This can be done in the background during other RF power deposition experiments.

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.

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.

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.

Comparison of $\chi_{inc}$ with $\chi_{PB}$ from global power balance and TRANSP estimates of $c$ may provide a test of critical gradient models. $\chi_{inc} \gg \chi_{PB}$ would hint at the existence of a critical gradient and that the actual gradient is just above critical. In contrast, $\chi_{inc} \sim \chi_{PB}$ would imply either that there is no critical gradient or that the actual gradient is far greater than critical. By varying the heating power (and thus the electron heat flux $Q_e$) the relation $\chi(\nabla T_e)$ could perhaps be determined.

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