1. **Purpose of Experiments**

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

   In this experiment we make use of the newly upgraded reflectometry system in order to observe and analyze changes in fluctuations radially localized at the foot of low density ITBs. The main new feature of the reflectometer is the addition of a swept frequency signal with a 122GHz to 131GHz frequency range \( (n_e=1.84-2.14 \times 10^{20} \text{ m}^{-3}) \) that can be scanned 50 times throughout a shot by setting the cycle period to 10ms. This upgrade should enable us to measure density fluctuation levels at a number of closely spaced radial locations within one discharge.

   In addition to the swept frequency channel, the fixed frequency reflectometry channels will be used to measure fluctuation amplitudes at the pedestal. Also, additional diagnostics will be required to complement the fluctuation measurements, including PCI, FRCECE, CXRS, HIREX and Thomson Scattering.

2. **Background**

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

   Characterization of turbulent behavior at the foot of the ITB has become of great interest for the understanding of ITB formation and sustainment. Initial studies conducted on Alcator C-Mod plasmas focused on the propagation of sawtooth generated heat pulses across ITB barriers [1][2]. It was shown that, in order to properly explain the slowing down of radial heat pulse propagation across the barrier region, the thermal diffusivity \( \chi_{hp} \) must be modeled to experience a “notch” decrease in value at the ITB barrier location. The width of this “notch” decrease is of order of lcm. The change in thermal diffusivity is associated with the suppression of microinstabilities, particularly those due to ITG modes.
It has been shown that the addition of modest on-axis heating prolongs the duration of the transport barrier. Nonlinear simulations show that this is due to the instability of TEM modes during the on-axis heating [3].

With the upgraded reflectometry system, we are in a unique position to scan the pedestal region and investigate evidence of transport suppression due to ITG stabilization, as well as changes due to instability of TEM modes.

Previous MPs have shown interest in measuring turbulence phenomena during low density ITB plasmas, such as MP403 (N. Basse, et al.) and MP456 (M. Greenwald, et al.).

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.

The approach to be taken depends on the availability of the J-Port 70MHz ICRF.

1) If the 70MHz ICRF is available:

If it is determined that the cryopump is reliable for operation on the run day, and the effect of the cryopump (to first order) is to directly lower the density (n04) of a given prescribed shot, then a shot like 1070614005 is chosen as an equilibrium shot, for which we would also use ICRF in order to induce an ITB for B7=5.5T using 70MHz off-axis heating (the LFS off-axis heating is chosen in order to maximize the use of ECE diagnostics). The target SSEP for the equilibrium shot would be set to approximately –3mm in order to properly utilize the capabilities of the cryopump. The ITB formed on 1060707025 will be a good reference for the ITB we’re looking for, hopefully with n04~8x10^{-19}m^{-2}.

The goal during the day would be to create EDA H-modes that lead to ITBs with densities of 1.84-2.14x10^{20}m^{-3} at the foot of the ITB such that the swept frequency channel will probe for fluctuations at the density barrier.

Depending on availability, moderate central heating could be applied (80 MHz) after the formation of the ITB in order to prolong its duration. This would also give the opportunity to search for hints of TEM instabilities arising at the barrier.

One could also setup control shots with similar parameters as shots that lead to ITBs, but lowering the magnetic field so that the absorption happens further inward (r/a<0.5), this would be done in order to systematically see the differences in levels of fluctuations that arise during ITB formation.

2) If the 70MHz ICRF is NOT available:

If the scenario is such that J-port cannot be set at 70MHz, then the magnetic field will be raised to B7=6.3T so that the 80MHz will heat off axis at the LFS. The difference with this approach is that on axis heating would become unavailable during the run. This would still leave the possibility of studying the onset of the ITB formation, but we would lose the chance of prolonging the ITB through on-axis heating.

It is important to consider the issue of impurity accumulation in this experiment due to its role in the collapse of the ITB. There is also evidence of an inverse relationship between the central density and the Z_{eff}. For these reasons, it is proposed to boronize the machine
overnight before the run day and to have the possibility of between shot boronization available during the run.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

- Toroidal Field: 5.4T for 70MHz LFS off-axis heating (80MHz on-axis) 6.3T or 4.5T if 70MHz is not available (for 80MHz LFS and HFS respectively)
- Plasma Current: 600-800kA
- Working Gas Species: D(H)
- Density: n04~0.5-9x10^19m^-2
- Equilibrium configuration (if possible, refer to database equilibria): 1070614005 for scenarios 1 and 2

4.2 Auxiliary Systems

- RF Power, pulse length, phasing: Hopefully 70MHz at J, 80MHz at D+E
- Pellet Injection (species): None
- Impurity blow-off injection: None
- Diagnostic Neutral Beam: Yes
- Special gas puffing: Ar (for HIREX)(Being careful to maintain ITB)
- Non-axisymmetric Coils (Connections, Current); Standard configuration for feed-back controlled reduction of error fields
- Other: Cryopump requested

4.3 Diagnostics

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

Reflectometry, TS (Edge and Core), VB, ECE (GPC1 and GPC2), FRCECE, magnetics, BES, PCI, TCI, Dn, HIREX, MSE, neutrons, bolometry, CXRS (McPherson)

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 day

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.

For Scenerio 1)
We can start with a run similar to 1070614005 (B_t=5.6T, n_l04~8x10^{-19}m^{-2} and I_p~800kA) but with the ICRF set at 70MHz and starting at around 0.6s, setting the target SSEP to ~3mm.
- Use the first 5-10 shots varying n_l04 and I_p to reach long lasting EDA H-modes. Note that the cryopump would be used as an improved control for the baseline n_l04 and for improved ICRF coupling.
- Hopefully, after these shots, ITBs start forming.
- If the density at the foot of the ITB is outside the range of the swept frequency (n_e=1.84-2.14x10^{20}m^{-3}), the baseline n_l04 would be varied accordingly.
- After ~5 reliable ITBs, we can lower the magnetic field (5.5T -> 5.2T) with the same parameters as the ITBs in order to study control shots without ITBs (3 shots).
- After the control shots, approx. 5 shots would be used with off and on axis heating in order to have prolonged ITBs, these can be used to try to find evidence of TEM instability.

For Scenario 2)
We can follow the same procedure as with scenario 1 (with B_t=6.2T), except, the last step could not be achieved (prolonged ITBs). The advantage in this case would be the possibility of scanning more of the I_p, n_l04 space to increase the database of low n_e ITB 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.
- Test and implement the upgraded swept reflectometry channel during ITB
- Measure density fluctuation changes at the foot of the ITB
- Test theory and simulation regarding the role of ITG and TEM modes in the formation and sustainment of ITBs.
- APS presentation
- Contribution to PhD thesis research.

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