1. Purpose of Experiments

The goal of these experiments is to study turbulence localized at the internal transport barrier (ITB) region in low density plasmas: http://www.psfc.mit.edu/cmod/sciprogram/ideas2005/Mirror_agenda/Ideas05_basse_core_turbulence.ppt.

Nonlinear GS2 simulations indicate that turbulence plays a central role in the sustainment of ITBs [1]. Localized density fluctuation measurements in the peaked density region do not exist. Line integrated phase-contrast imaging (PCI) density fluctuation measurements passing through the peaked density region display a strong increase in amplitude due to additional on-axis ion cyclotron radio frequency (ICRF) heating [2].

Our goal is to measure turbulence locally in the peaked density region using reflectometry; with and without on-axis ICRF heating. The measurements will be compared to simulations.

2. Background

On the 30th of May 2003 experiments described in mini-proposal (MP) 327 were carried out. The purpose of these experiments was to create low density enhanced Dα (EDA) high (H) confinement mode plasmas because these would be suitable target plasmas for lower hybrid current drive (LHCD) scenarios.

Since having a steady EDA H-mode is a prerequisite for ITB formation, we propose to use low density EDA H-mode plasmas to form low density ITBs.

Two new, high frequency, ordinary (O) mode reflectometer channels became operational in 2003, one at 132 GHz ($2.2 \times 10^{20}$ m$^{-3}$), the other at 140 GHz ($2.4 \times 10^{20}$ m$^{-3}$).
m\(^{-3}\)) [3]. The 132 GHz channel is operating reliably, and will be the main core fluctuation diagnostic during these experiments. The 88 GHz (1.0 \times 10^{20} \text{ m}^{-3}) channel will act as a monitor of the quasi-coherent (QC) mode present in EDA H-mode.

PCI is required to be running for these discharges as well, both to establish that the plasmas are in EDA H-mode, to acquire line integrated measurements before and during the ITBs and to confirm the increased turbulence level in response to additional on-axis heating.

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.

We adopt the approach used in MP 327, i.e. reducing the plasma current \(I_p\) to reduce the EDA H-mode density.

Fig. 21 in http://www.psfc.mit.edu/people/basse/backup/pop_basse_three.pdf shows Thomson scattering density profiles and reflectometry measurements for one of the discharges created on the 30th of May 2003 (1030530020). The EDA H-mode pedestal height is low for these plasmas compared to standard EDA H-modes, allowing the high frequency reflectometer channels to reflect off the core plasma if an ITB were to form.

The major difference from the MP 327 plasmas is that we will use 70 MHz instead of 80 MHz ICRF to obtain off-axis heating on the low-field side (LFS). It should be on the LFS because in this case a core 80 kHz mode is seen by the Fusion Research Center electron cyclotron emission (FRCECE) diagnostic [4]. Additional on-axis heating at 80 MHz will be applied to investigate whether turbulence increases locally at the ITB. If it does, this would verify simulation results.

4. Resources

4.1 Machine and Plasma Parameters
Give values or range for:

- **Toroidal Field**: 5.4 T for 80 MHz on-axis and 70 MHz off-axis ICRF heating (LFS).
- **Plasma Current**: 600 kA.
- **Working gas species**: Deuterium (ICRF Hydrogen minority heating).
- **Density**: Initial central density of EDA H-modes should be \(\sim 2 \times 10^{20} \text{ m}^{-3}\).

Equilibrium configuration (if possible, refer to database equilibria): Shot 1030530020.

Pulse length, typical current & density waveforms, etc. Refer to database or sketch desired waveforms:
- Full length (2 s) plasmas.
4.2 Auxiliary Systems

**RF Power, pulse length, phasing:** All available ICRF heating.

**Pellet Injection (species):** No.

**Impurity blow-off injection:** No.

**Diagnostic Neutral Beam:** Yes.

**Special gas puffing:** Argon for rotation measurements.

**Other:**

4.3 Diagnostics

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

Thomson scattering (edge and core), visible bremsstrahlung, ECE (GPC1 and GPC2), FRCECE, magnetics, toroidal rotation, CXRS (W.L. Rowan will make piggyback measurements), D_α, PCI and reflectometry.

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 full run day is required.

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.

1) Engineer a low density ITB discharge using off-axis ICRF heating on the LFS (5 shots).

2) Scan the target density so that the core reflectometer channel (132 GHz) reflects off different parts of the ITB (10 shots).

3) Scan additional on-axis ICRF heating power to verify predicted effects on core turbulence. From PCI measurements we know that there is a significant increase of line integrated turbulence in response to on-axis ICRF heating (10 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 low density ITB discharge scenario in C-Mod; this will also be useful for diagnostics requiring a low density for optimum performance (e.g. CXRS).
Study localized measurements of turbulence at the ITB, close to and further away from the foot by scanning the EDA H-mode target density.

Test nonlinear GS2 simulations predicting a significant increase of core turbulence in response to additional on-axis heating.

Obtain conclusive evidence as to whether the core 80 kHz mode observed using the FRCECE diagnostic exists.

Publications in papers and at conferences would ensue.

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


