1. Purpose of Experiments

The goal of this mini-proposal is to develop understanding of the enhanced $D_\alpha$ H-mode, in particular the role of neutrals, using controlled gas puffing.

2. Background

Prior to boronization, only short duration H-modes were observed under standard operating conditions. However, long duration H-modes were obtained with heavy gas puffing into the H-mode plasma (runs 951205 and 951206). After boronization, the source of neutrals is often dominated by the wall, especially if wall outgassing (for example by overnight ECDC in He) is not performed, and is therefore not well controlled. Initially, the density of the target plasma was used as the control knob, but it is now known that different types of H-mode are obtained for the same target density, depending on the wall condition (uncontrolled source of gas). In this mini-proposal, active gas puffing will be used in combination with a well outgassed wall in order to affect the edge transport barrier in a controlled manner.

3. Approach

This experiment should be performed in a recently boronized and subsequently well conditioned machine, since obtaining high-quality enhanced-$D_\alpha$ H-modes (better than 960116027) is the eventual goal of this mini-proposal. An overnight He ECDC session
should precede the run to minimize the wall source. Under this condition, ELM-free H-modes are expected in the absence of gas puffing. Systematically increase gas puffing shot by shot and document the change in H-mode behavior.

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:** D

**Density:** $n_e \simeq 1.5-2 \times 10^{20} \text{ m}^{-3}$ (target plasma)

**Equilibrium configuration** (if possible, refer to database equilibria): Lower single-null (similar to 960116027), 1 cm outer gap, low strike point

**Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: current flat-top duration of at least 0.6 sec (end of flat-top at 1.2 sec).

4.2 Auxiliary Systems

**RF Power, pulse length, phasing:** High power (2.5–3 MW)

**Pellet Injection (species):** none

**Impurity blow-off injection:** not required but can accommodate

**Special gas puffing:** yes (capability for large throughput, may need to use the capillaries too)

**Other:**

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

All standard H-mode (especially edge transport barrier “pedestal”) diagnostics, as specified in MP192 (“Dynamic $q$ scans in Enhanced D$\alpha$ H-modes”).

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.)

$10^{14}$ total.
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.

Approximately 7 shots, at the beginning of a run following overnight He ECDC.

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.

Obtain an ELM-free H-mode at a target density of $n_e \approx 2 \times 10^{20} \text{ m}^{-3}$ (reduce the target density if necessary). Systematically increase gas puffing (turn off density feedback and use preprogramming) shot by shot (3 shots upwards, followed by 3 shots downwards) and document the change in H-mode behavior.

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.

A better understanding for the role of neutrals in the edge transport barrier. Optimization of the enhanced-D$_\alpha$ H-mode (i.e., high H-factor, low radiated power, quasi-steady-state) may be achieved, and a recipe for obtaining high-quality enhanced D$_\alpha$ H-mode may be established, if successful.

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