1. Purpose of Experiments
   The purpose of this experiment is to investigate the effect of helium wall conditioning on density control in H-mode discharges.

2. Background
   All H-modes in C-Mod suffer from an uncontrolled plasma density rise starting at the transition to the higher confinement state. The plasma is fuelled with hydrogenic isotopes from the internal surfaces of the vessel. It is not clear at present which surfaces, i.e. limiters, walls or divertor plates, dominate this fuelling.

   We would like to reduce this density rise to give better control over our H-mode densities by pre-conditioning the vessel walls. Aside from giving us better control over our present H-mode physics studies, this experiment is also aimed toward assessing our ability to control plasma density for our future lower hybrid program.

   The method most likely to succeed in this involves bombardment of the vessel walls with helium ions in conditioning discharges. While there are many possible types of conditioning discharges, including, ECDC, tokamak discharges and GDC, it is the latter which is most likely to be effective. This is based partly on the experience on other machines, but also on the argument that such discharges ‘spray’ the entire inside vessel with helium ions (since no magnetic field is present), thus depleting a larger surface area of its hydrogen isotopes.

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 plan to run ICRF-heated H-mode discharges before and after helium GDC, comparing density behavior, confinement, etc. A key aspect of this work is the development of a gas puff fiducial—a short gas puff—the plasma density decay time to be taken as a global measure of the recycling behaviour of the walls. Such a puff was used routinely on TFTR for the same purpose.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

- **Toroidal Field**: 5.4 T
- **Plasma Current**: 0.8 MA
- **Working gas species**: $D_2$
- **Density**: We will vary the target density from $n_{l04} = 0.6$ up to $n_{l04} = 1.0$.
- **Equilibrium configuration** (if possible, refer to database equilibria): SNL
- **Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: standard fiducial will be acceptable perhaps with some modification of the separatrix strike point locations.

4.2 Auxiliary Systems

- **RF Power, pulse length, phasing**: minimum is 2 MW
- **Pellet Injection (species)**: No
- **Impurity blow-off injection**: No
- **Special gas puffing**: No
- **Other**:

4.3 Diagnostics

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

Edge profiles from, ECE, Kaiser (helium beam), FSP, ASP (midplane probe), Edge Thomson, reflectometer, X-ray arrays, bolometers, Z meter array, tangential interferometer. Also, RGA, all MKS and ion gauges. Core diagnostics, Thomson, Hirex, etc, needed. All L-alpha and H-alpha diagnostics.

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.)
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.

This experiment, since it is investigating density behavior and confinement, needs to be run when the machine has reached so called ‘plateau’ clean conditions. We expect the initial experiment to consist of one run equivalent, but could be spread out over several days. In the absence of ICRF heating, the density rise during Ohmic H-modes could be looked at. Care must be taken that our GDC conditioning does not damage the J-viewing mirror at A-port (Terry).

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.

First, we would establish a reference ICRF H-mode, e.g. 990924005, 800 kA, 5.4 T, nl04 target = 0.7, 2.7 MW heating. Then proceed with one hour of helium GDC (parameters to be determined). Followed by a repeat discharge with the same target density. Care must be taken to minimize the addition of gas before the application of heating power to avoid gassing up the walls. This is the reason for the relatively low target density.

If there is only a weak effect on the density behaviour then we propose a longer period of helium GDC, overnight and perhaps over a weekend, followed by a repeat H-mode discharge.

Once we start to see an effect of the conditioning then we propose to continue running repeat discharges to see how long the density control lasts. If the density during the H-mode phase remains low, then we will attempt gas puffing during the H-mode to bring up the density, basically demonstrating density control. Following discharges will attempt lower density during the H phase to see if the wall has been gassed up. Throughout these experiments gas puff fiducials will be used to quantify the wall conditioning.

The amount of gas puffed and extracted through the vacuum pumps will be monitored to determine an absolute capacity for hydrogenic isotopes.

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.

We anticipate that helium GDC will have a marked effect on the wall pumping and therefore on the density behaviour of tokamak discharges.

If we are successful in producing a strongly pumping wall but find that it saturates relatively quickly due to gas puffing, then it will make sense in the future to repeat this experiment with pellet fueling to reduce the gas load on the walls.
7. References
Include references both to external and internal literature or communications which bear on this proposal. See Section 2.