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.

This experiment will attempt to test the hypothesis that the addition of Li pellets to the plasma makes it easier to get into H mode. By attempting to achieve H modes at higher current and toroidal field, we also hope to extend the operating regime of H modes to further check the H mode power threshold scaling.

2. Background

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

There were indications during the 1993 campaign that the addition of Li pellets to the discharge may have helped the plasma to go into H mode at relatively high toroidal field (5.2 T) for the given ohmic input power. In addition, previous results on TFTR show that Li pellets improve wall conditioning and lead to enhanced neutron rates under supershot conditions [1]. Other machines also report beneficial effects of wall coatings such as boron to achieve H modes [2-5].

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.

See Experimental Plan.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 4.5-6.0 T if possible
**Plasma Current:** 850 kA - 1.1 MA  
**Working gas species:** D₂  
**Density:** 0.5-1.5 x 10²⁰ m⁻³  
**Equilibrium configuration** (if possible, refer to database equilibria): Lower single null diverted, e.g., 931022044  
**Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: Pulse length ≥ 1 s, standard flattop current, density, and TF.

### 4.2 Auxiliary Systems

**RF Power, pulse length, phasing:** none  
**Pellet Injection (species):** none  
**Impurity blow-off injection:** none  
**Special gas puffing:** standard A and B valves  
**Other:** This run requires a very clean machine that is running well and reproducibly shot to shot initially with no trace of Li.

### 4.3 Diagnostics

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

- Lithium pellet injector  
- Lithium spectroscopy diagnostics, e.g, MacPherson  
- Full Hα coverage  
- Scanning probe  
- Langmuir probes  
- Ratiomatic pressure guage  
- Plasma TV with Hα filter  
- Interferometer  
- ECE and Thomson Scattering if available  
- Bolometers  
- Visible bremsstrahlung

### 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.)

Negligible
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.

Given a well running clean tokamak, one run should be sufficient to compare discharges with and without Li pellets at high plasma current and relatively high toroidal field.

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, an attempt will be made to achieve H modes without Li pellets at high plasma current (up to 1.1 MA) and toroidal field (5.2 - 6 T) and low electron density \((0.5 \times 10^{20} \text{ m}^{-3})\). If H modes are easily achieved at 1.1 MA (or the highest reproducible plasma current) without Li pellets, then the current will be reduced by 50 kA steps until the H modes are no longer observed. If they are not observed, then the TF will be reduced until \(q_{95}\) of about 2.3 to decrease the expected threshold power required to achieve H mode and yet attempt to avoid disruption limits. If H modes are observed, an attempt will be made to clearly define the threshold first by raising the density, then by lowering the plasma current, or increasing the TF until the H modes disappear. (10 shots)

Once such a threshold is found, the conditions will be repeated at just above the H mode threshold with lithium pellets injected early in the discharge, perhaps 0.3 to 0.4 s for a series of shots to see if layers of Li on the wall affect the H mode threshold. If H modes are observed, the flat top TF or density will be raised gradually with continued Li pellet injection early in the discharge until H modes are no longer observed to attempt to find the H mode threshold with Li pellets. Also, attempts will be made to inject Li pellets into well developed H modes for transport studies. If H modes are not observed, plasma conditions will be returned to those when H modes were observed with continued Li pellet injection early in the discharge. If they are still not observed, the Li pellets will be injected late into the discharge just before the plasma current is ramped down and the TF or density will be gradually reduced until H modes are again observed. (15 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.

If H modes are not observed at all throughout the day, the experiment will be unsuccessful and simply indicate a dirty tokamak. If H modes are observed, then a threshold should be found and a change in this threshold with the addition of Li pellets will indicate whether or not Li pellets are beneficial to achieving H modes. The experiment should extend the operating regime for H modes and may help to determine an expected H mode threshold for ITER by attempting to reach power densities and \(n_e B_T\) values near to ITER operating conditions. The results may also contribute to the ASDEX, JET, DIII-D, and...
PBX H mode database as well as to the proposed ASDEX-Upgrade and C-Mod collaboration. Conference publications and or refereed publications should come out of these results.

7. References

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