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.

Study ohmic sawtooth instability with x-ray imaging arrays at various q’s, and with 100 kHz data sampling rates.

2. Background

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

A cursory examination of previous sawtooth data taken at 10 kHz showed little or no precursor oscillations, however, the adequacy of this sampling rate has been called into question. This afternoon we received the camac equipment which will enable the data from the xtomo arrays to be importance-sampled at 100 kHz.

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.

Set up a well-centered, low-elongation plasma exhibiting sawteeth superimposed on an x-ray background which is steady over 0.1 seconds of the discharge. (This frequently occurs starting at about 0.15 s, after the initial molybdenum radiation drops.) Moderate argon puffing is desirable, since it tends to enhance the x-ray visibility of the plasma core. Set up the data acquisition to record at 100 kHz for a 50-100 ms window at an appropriate time (typically 0.15-0.25 s). Look for precursor oscillations, sawtooth crash structure, and crash time. Vary the q by changing \( I_p \) and/or \( B_T \).

4. Resources
4.1 Machine and Plasma Parameters

Give values or range for:

**Toroidal Field**: nominally 5 T, but possibly 3-5 T

**Plasma Current**: start with max possible (0.5+ MA?), and reduce down to 0.2 MA in steps of 0.1 MA.

**Working gas species**: H

**Density**: high enough so that molybdenum emission does not saturate the x-ray arrays

**Equilibrium configuration** (if possible, refer to database equilibria): low elongation, well-centered

**Pulse length, typical current & density waveforms, etc.** Refer to database or sketch desired waveforms: see above. It would certainly be desirable to achieve a current flattop from 0.15 to 0.25 s, and to be able to control the flattop level.

4.2 Auxiliary Systems

**RF Power, pulse length, phasing**: No

**Pellet Injection (species)**: No

**Impurity blow-off injection**: No

**Special gas puffing**: Argon, at moderate levels

**Other**:

4.3 Diagnostics

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

Xtomo arrays, with 100 kHz importance-sampling window. If the 2-color interferometer system is capable of 100 kHz, it should be enabled also.

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.

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.

Set up a suitable shot at 5 T and 0.5+ MA. Introduce argon and adjust to give large, but not saturated, x-ray signals. Gate the 100 kHz x-ray window at an appropriate time. Step the plasma current down to 0.4, 0.3, and 0.2 MA. If time permits, try different toroidal fields.

Contingency: a big disruption occurring during the high-speed window would also be interesting.

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.

I would be surprised if we don’t see precursor oscillations, at least on some sawteeth. Also, I expect many of the crash times to be less than 100 µs, but if our sawteeth are the ideal interchange type, it could be significantly less owing to the relatively small size of our present \( q = 1 \) radius.

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