1. Purpose of Experiments

Include immediate goal of the experiments, scientific importance and/or programmatic relevance. Refer to any relevant program milestones or ITER R&D commitments.

The purpose of this experiment is to extend impurity toroidal rotation velocity profiles to larger radii, to measure any central poloidal rotation, to determine the $E_r$ profiles, and if possible to augment this profile with magnetics, visible and DNB data. This is a high priority run of the Transport/Rotation Focus Group.

2. Background

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

Plasma rotation is closely associated with the transition to H-mode, although the relationship is chicken and egg. Most measured rotation profiles (and inferred $E_r$) are from NBI plasmas, usually at the edge, with significant momentum input, which obscures the connection between H-mode and rotation. Substantial toroidal rotation in ICRF-only plasmas with no direct momentum input has been documented. Ohmic H-mode plasmas rotate in a similar fashion. The question arises whether it’s the radial electric field which drives the rotation which induces the H-mode, or whether $E_r$ causes the H-mode, and the rotation is a consequence. Certainly the core toroidal rotation seems to be a consequence of the H-mode. Regardless of the causality, it is important to document the rotation radial profile and to connect the edge rotation inferred from magnetics and visible measurements. From the poloidal and toroidal rotation velocity profile, the $E_r$ profile may be determined from the force balance equation.

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.

The approach is to use HIREX to obtain rotation profiles, but since the toroidal component is only $6^\circ$, a high rotation velocity ($10^5$ m/s) is required. Use HIREX Jr for
reference, and put HIREX 1, 2 and 4 on He-like argon. HIREX 2 and 4 have the same
toroidal view and opposite poloidal views, while 1 and 2 have opposite toroidal views and
the same poloidal views. By scanning all 3 spectrometers simultaneously, the toroidal
and poloidal components may be determined. Several shots are needed at each radius to
improve statistics. Scan shot-to-shot out to r/a = .6 during repeatable EDA discharges.
Aggressive argon injection is necessary. Pre-ICRF pulse line measurements are necessary
because there is no absolute wavelength calibration for HIREX. At the same time, edge
rotation will be measured in the visible region, from the magnetics and if possible, from
the DNB.

4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: 5.4 T
Plasma Current: 800 kA
Working gas species: D₂
Density: good EDA
Equilibrium configuration (if possible, refer to database equilibria): like 980204015
Pulse length, typical current & density waveforms, etc. long pulse length Refer to database or
sketch desired waveforms:

4.2 Auxiliary Systems

RF Power, pulse length, phasing: maximum reproducible power at 80 MHz, long pulse,
at least 3 MW
Pellet Injection (species): no
Impurity blow-off injection: no
Special gas puffing: argon
Other:

4.3 Diagnostics

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

HIREX, (DNB), ECE, TCI, magnetics, neutrons, visible

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.)

formula?
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.

1 run

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 contin-
gency plans, if appropriate.

24 constant shots with good EDA, $n_e = 3 \times 10^{20}/m^3$, $I_p = 800$ kA, like 980204015. 3
shots with 2 and 4 at the center, 3 shots with 2 and 4 at ±4 cm, 3 shots with 1, 2 and 4
at ±8 cm, 5 shots with 1, 2 and 4 at ±12 cm, 5 shots with 1, 2, 4 and 5 at ±15 cm, and
5 shots with 1, 2, 4 and 5 at ±18 cm.

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.

Inclusion in a publication in progress.

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

J.E. Rice et al., NF 38, 75 (1998)