A Comparison of Sawteeth in Bean and Oval Shaped Plasmas*

E.A. Lazarus,[1] M.E. Austin,[2] K.H.Burrell,[3] R.J. Jayakumar,[4] T.C. Luce,[3]
M.A. Makowski,[4] T.H. Osborne,[3] C.C. Petty, [3] P.A. Politzer,[3] R. Prater,[3]
H. Reimerdes,[5] J.T. Scoville,[3] M.R.Wade,[1] and F.L. Waelbroeck[2]

[1]*Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, Tennessee 37831*
[2]*University of Texas, Austin, Texas 87812*
[3]*General Atomics, P.O. Box 85608, San Diego, California 92186-5608*
[4]*Lawrence Livermore National Laboratory, P.O. 808, Livermore, California 94551*
[5]*Columba University, New York, New York USA*

A set of experiments has been conducted in DIII–D to compare sawteeth in bean and oval shaped, inner-wall limited plasmas. The distinction is that the oval will violate the ideal Mercier criterion with q_0 somewhat above 1, while a low κ bean shape will remain ideally Mercier stable with q_0 somewhat below 1. The experimental arrangement allows us to change shape on successive discharges which helps minimize systematic errors in the data. The principal diagnostics are motional Stark effect for the internal poloidal field, electron cyclotron emission for electron temperature, multi-pulse Thomson scattering for the density profile, and charge exchange recombination (CER) for ion temperature and toroidal velocity. The experimental conditions are constant conditions for about 2 s with 2.5 MW of neutral beam heating, which is needed for the diagnostics. For the bean, central T_e shows maximum, and minimum values of 3.1, and 1.8 keV respectively, while for the oval, central T_e shows maximum, and minimum values of 2.7, and 2.2 keV. The stored energy perturbation for the bean is 40 kJ of 280 kJ, whereas the global energy perturbation in the oval is minimal. For the bean, central T_i shows maximum, and minimum values of 3.5 and 2.2 keV respectively, whereas for the oval, central T_i shows maximum, and minimum values of 4.8, and 3.1 keV respectively. That is, the ion temperature sawtooth amplitude is larger than the electron temperature sawtooth amplitude in the oval, whereas in the bean, they are of comparable amplitude. New results with all CER channels having greatly improved signal-to-noise ratio, adequate to resolve sawteeth, will be reported.

Other major observations are: (a) In the bean the q-profile is monotonic and $q_{min} < 1$ at the time of the sawtooth crash (q_{min} is the spatial minimum). In the oval the q-profile is not monotonic and $q_{min} > 1$ at the time of the sawtooth crash. q_{min} occurs at $\rho \approx 0.3$. (b) In the oval the minimum values of $q_{min}(t)$ rise as κ and β_P are increased. (c) When electron cyclotron heating is added near the center of the plasma, the bean develops a strong ∇T_e, whereas in the oval ∇T_e remains quite small. However, the experiments with added ECH heating did not have the same deposition radius in the two shapes and these are being repeated with better control of the ECH deposition. The new results will be reported. (d) The temporal behavior of the central ion temperature also shows marked differences. In the oval, the ion temperature wave form is quite similar to that of the electron temperature. In the bean, as T_e rises, at about 40% of its peak value the toroidal rotation velocity saturates and begins to decline. When T_e reaches 50%, T_i saturates and begins to decline. At present, the only firm conclusion is that ion behavior, relative to electron behavior during the sawtooth, is significantly altered by the shape change.

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