# High-Harmonic Ion Cyclotron Heating in DIII-D: Beam-Ion Absorption and Sawtooth Stabilization

W.W. HEIDBRINK[a], E. FREDRICKSON[b], T.K. MAU[c], C.C. PETTY[d], R.I. PINSKER[d], M. PORKOLAB[e], B.W. RICE[f]

[a]University of California, Irvine, California, USA
[b]Princeton Plasma Physics Laboratory, New Jersey, USA
[c]University of California, San Diego, California, USA
[d]General Atomics, San Diego, California, USA
[e]Massachusetts Institute of Technology, Cambridge, Massachusetts, USA
[f]Lawrence Livermore National Laboratory, Livermore, California, USA

ABSTRACT. Combined neutral beam injection and fast wave heating at the fourth cyclotron harmonic produce an energetic deuterium beam-ion tail in the DIII-D tokamak. When the concentration of thermal hydrogen exceeds $\gtrsim$5%, the beam-ion absorption is suppressed in favor of second harmonic hydrogen absorption. As theoretically expected, the beam absorption increases with beam-ion gyroradius; also, central absorption at the fifth harmonic is weaker than central absorption at the fourth harmonic. For central heating at the fourth harmonic, an energetic, perpendicular, beam population forms inside the $q = 1$ surface. The beam-ion tail transiently stabilizes the sawtooth instability but destabilizes toroidicity-induced Alfvén eigenmodes (TAE). Saturation of the central heating correlates with the onset of the TAE. Continued expansion of the $q = 1$ radius eventually precipitates a sawtooth crash; complete magnetic reconnection is observed.

*To be submitted to Nuclear Fusion.*