Absorption of Fast Waves on Fast Ions at Moderate to High Ion Cyclotron Harmonics on DIII-D*

R.I. Pinsker,[1] M. Porkolab,[2] C.C. Petty,[1] W.W. Heidbrink,[3]
F.W. Baity,[4] M. Choi,[1] R.W. Harvey,[5] M. Murakami,[4] and R. Prater[1]

[1]General Atomics, San Diego, CA 92186-5608, USA.
[2]Massachusetts Institute of Technology, Cambridge, MA, USA.
[3]University of California-Irvine, Irvine, CA, USA.
[4]Oak Ridge National Laboratory, Oak Ridge, TN, USA.
[5]CompX, Del Mar, CA, USA

Fast Wave Current Drive (FWCD) experiments on DIII-D and other tokamaks use direct electron damping, the coherent combination of Landau damping and transit time magnetic pumping, to damp the wave power in the core of the plasma. In many of these experiments a substantial fast ion population from neutral beam injection is present in the plasma core, so damping of the fast wave on the beam ions at harmonics of the ion cyclotron frequency becomes a potential loss process for FWCD. The absorption of fast waves by an injected 80 keV beam has been studied experimentally at the 4th and 8th harmonics (60 MHz and 115 MHz). In FWCD experiments at low density, the 4th harmonic damping was found to be an important loss process for electron current drive, while little 8th harmonic absorption was observed [1]. In subsequent efforts to project applications of FWCD to high performance Advanced Tokamak plasmas in DIII-D, it was found that the absorption at the 8th harmonic was predicted to become equally important as the 4th harmonic absorption, due to the higher density and the consequent better match between the perpendicular speed of the beam ions and the Alfven speed (the characteristic perpendicular phase velocity of the fast wave). We have recently reviewed and extended the linear theory of ion cyclotron harmonic damping in order to improve our understanding of this result of code modeling. In this paper, we apply that understanding to the results from previous DIII-D experiments [2] in which absorption on beams of different ion species (H+, He3+, and D+) were compared, and to the design of near-term experiments demonstrating high harmonic damping on beam ions. If available, results from these experiments will also be discussed. These results pertain directly to the effectiveness of FWCD in a burning plasma which will have a suprathermal population of alpha particles.

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[2] R.I. Pinsker, et al., Bull. Am. Phys. Soc. **44**, (1999) 172.

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