Measurements of beam ion losses on DIII-D due to MHD instabilities*

R.K. Fisher[1], D.C. Pace[2], M. García-Muñoz[3], R.L. Boivin[1], E.D. Frederickson[4], W.W. Heidbrink[2], C.M. Muscatello[2], R. Nazikian[4], C.C. Petty[1], M.A. Van Zeeland[1], and Y.B. Zhu[2]

[1]*General Atomics, PO Box 85608, San Diego, California 92186-5608, USA*
[2]*University of California-Irvine, Irvine, California, USA*
[3]*Max-Planck-Institut für Plasmaphysik, Garching, Germany*
[4]*Princeton Plasma Physics Laboratory, Princeton, NJ, USA*

A new scintillator-based fast ion loss diagnostic (FILD) has been installed on DIII-D with the >100 kHz time response needed to study beam ion losses induced by Alfvén eigenmodes and other MHD instabilities [1]. The design is based on the approach developed on ASDEX Upgrade [2]. A CCD camera operating at ≤160 Hz measures the pitch angle and gyroradius of the ion losses based on the position of the ions striking the 2-D scintillator. For fast time response measurements, a beam splitter and fiberoptics couple a portion of the scintillator light (decay time ~490 ns) to a photomultiplier array. The collimated entrance aperture, scintillator and graphite heat shield make up the detector head, which is inserted through a radial port below the outer midplane.

By correlating the beam ion loss results from the new FILD with observations of the internal mode structures in DIII-D and data from other diagnostics providing information on fast ions, we hope to gain insight on the fast ion loss orbits and loss mechanisms involved in the instabilities. Reverse orbit following techniques are used to trace the lost ions to their possible origin within the plasma. Modulation of the neutral beam sources allows observation of the prompt losses from each of the beam lines, and allows tests of the FILD capabilities and performance. The measured results are consistent with the expected pitch angles and energies for prompt losses.

The initial FILD results on DIII-D include the observation of beam ion losses due to a variety of MHD instabilities of interest to fast ion behaviour in tokamaks. Bursts of beam ion losses at high pitch angles and across a range of energies occur during large sawtooth crashes. Frequency analysis of the high bandwidth FILD PMT signals shows evidence of fast ion losses due to toroidal Alfvén eigenmodes, reversed-shear Alfvén eigenmodes, and nonlinear tearing mode instabilities.

[1] R.K. Fisher, et al., presentation at HTPD 2010, Wildwood, NJ.
[2] M. Garcia-Muñoz, et al., Rev. Sci. Instrum. **80**, 053503 (2009).

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