Progress of Long Pulse Discharges by ECH in LHD

Y. Yoshimura, H. Kasahara, M. Tokitani, R. Sakamoto, Y. Ueda[1], S. Ito, K. Okada, S. Kubo, T. Shimozuma, H. Igami, H. Takahashi, T. Ii, S. Kobayashi, Y. Mizuno, T. Akiyama, N. Ashikawa, S. Masuzaki, G. Motojima, M. Shoji, C. Suzuki, H. Tanaka, K. Tanaka, T. Tokuzawa, H. Tsuchiya, I. Yamada, R. Makino[2], K. Kobayashi[2], Y. Goto[2], H. Yamada, T. Mutoh, Y. Takeiri, A. Komori

National Institute for Fusion Science, Toki, Japan
1) Graduate School of Engineering, Osaka University, Osaka, Japan
2) Graduate School of Engineering, Nagoya University, Nagoya, Japan

First author email address: yoshimu@nifs.ac.jp

Until 2009, three high-power 77 GHz gyrotrons, over 1 MW each, have been installed and applied to LHD experiment [1, 2]. In addition, two 154 GHz gyrotrons of 1 MW each were installed in 2012 and 2014.

The 77 GHz gyrotrons suffer gradual increases of internal pressure during long pulse operation delivering power to LHD. To mitigate the problem, quasi-steady operation by combination of on-off operations of the 77 GHz gyrotrons has been performed. Operating two 77 GHz gyrotrons alternately at intervals of two minutes and an 84 GHz gyrotron continuously, a 30 min. long pulse discharge with the line average electron density n_{e_ave} of 0.7×10^{19} m^{-3} and the central electron temperature T_{e0} of 1.5 keV was achieved by the time-average injection power P_{inj} of 240 kW in 2012, showing significant progress in sustained density from the former 65 min. discharge with n_{e_ave} of 0.15×10^{19} m^{-3} and T_{e0} of 1.7 keV by P_{inj} of 110 kW of 84 GHz wave [3].

Each of the 154 GHz gyrotrons works well for CW operation, without noticeable increase of internal pressure contrary to the 77 GHz ones, due to its short wavelength reducing wave diffraction inside the tube and furnished sub-window to remove stray radiation inside the tube. In FY2014, long pulse plasma sustainment by ECH showed further progress by use of the 154 GHz gyrotrons. Operating two 77 GHz gyrotrons alternately and two 154 GHz gyrotrons continuously, a 39 min. long pulse discharge with n_{e_ave} of 1.1×10^{19} m^{-3} and T_{e0} of 2.5 keV was successfully performed by time-average P_{inj} of 350 kW.

References

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