Effect of the neutral beam current drive in the stability of LHD plasma: experimental results and numerical analysis

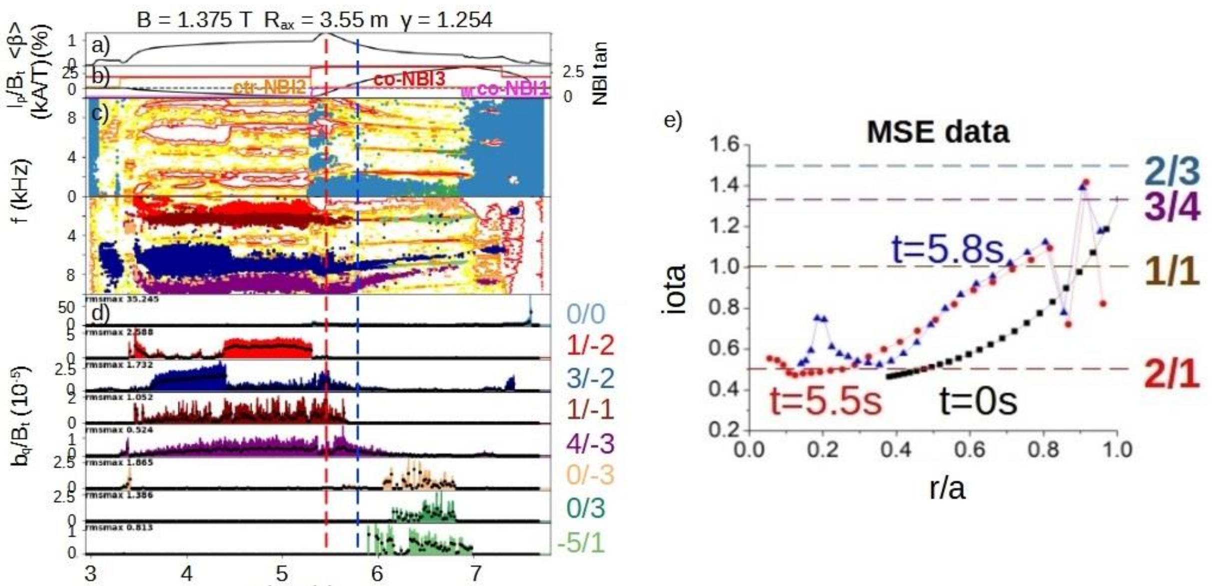
J. Varela[1*], K.Y. Watanabe[2], Y. Takemura[2], K. Nagaoka[2], D. Spong[3], L. Garcia[1], J. Ortiz[1], Y. Ghai[3] and LHD experimental group

[1] *University Carlos III of Madrid, 28911, Leganes, Madrid, Spain*

[2] *National Institute for Fusion Science, National Institute of Natural Science, Toki, 509-5292, Japan*

[3] *Oak Ridge National Laboratory, Oak Ridge, Tennessee, 37831-8071*

Experimental evidence indicates the neutral beam current drive (NBCD) in LHD plasma modifies the iota profile as well as the stability of the pressure gradient driven modes (PGDM) and Alfven Eigenmodes (AE). A set of experiments were performed during the 22nd and 23rd LHD campaigns dedicated to analyze the effect of the NBCD on the stability of PGDM and AE. The LHD operation scenario selected for the experiment is the inward shifted configurations, because the discharges show an improved transport although unfavorable MHD stability. The iota profile is measured using Motional Stark Effect (MSE) and the plasma stability is analyzed using the code FAR3d. The high thermal β shot 167800 (panel a) shows the stabilization of the n/m = 1/2 PGDM (panel c and d) in the transition between ctr- and co-NBCD phases of the discharge, caused by the up-shift of the iota profile and the evolution of the rational surface 1/2 from resonant to non resonant (panel e). On the other hand, several PGDM at the plasma periphery are further destabilized (panel c and d) during the ctr- to co-NBCD transition, probably due to a decrease of the magnetic shear at the plasma periphery as the iota profile up-shifts (panel b). In discharges with large ctr-NBCD and high thermal β (data not shown), 1/2 PGDM is further destabilized because the 1/2 rational surface resonates in the plasma core, the magnetic shear is weaker and the EP β threshold decreases. Likewise, discharges with low thermal β and plasma density, AEs are easy destabilized during the ctr-NBCD phase of the discharge although stabilized during the co-NBCD phase above a given toroidal current threshold. FAR3d simulations reproduce the PGDM and AE stability during the discharges identifying the optimization trends with respect to the NBCD.



(a) Averaged plasma β. (b) Plasma toroidal current and NBI heating pattern. c) PGDM frequency. d) Poloidal magnetic field perturbation dominant modes. e) Evolution of the iota profile measured by MSE diagnostic.