Status of Lower Hybrid Fast Wave Research on VEST

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Efficient current drive scheme in central or off-axis region is required for the steady state operation of tokamak fusion reactor. The current drive by using the fast wave in frequency range higher than two times lower hybrid resonance frequency ($\omega > 2\omega_{lh}$), so called Lower Hybrid Fast Wave, could be such a scheme in high density high temperature reactor-grade tokamak since it has deeper penetration characteristic compared to the slow wave in the same frequency range and relatively higher parallel wave electric field favorable for current drive compared to the fast waves in other frequency ranges.[1,2] A proof-of-principle experiment was planned on VEST in 2014, and a 10 kW RF power of 500 MHz klystron from old broadcasting system and comb-line traveling wave antenna with $N_{||}$ of three to five had been successfully developed and installed through collaboration between KAERI, KWU, SNU, and KAPRA during 2015 ~2017.[1,3,4] After hard RF conditioning due to multipactor discharge, about 2 kW RF power was able to be coupled in the magnetic field of 0.1 T for 2018 though the plasma response was weak and ambiguous.[5] Recently, the magnetic field was upgraded to 0.2 T for wider coupling window of the LHFW and pulse power of about 6 kW was successfully coupled. As a result, evident increase of plasma current of about 1 kA was observed accompanying drastic increase of electron temperature. Considering the electron temperature as low as several ten eV and narrow coupling window due to low magnetic field on VEST, the result seems to be inspiring for the current drive research by using LHFW. Currently hard X-ray diagnostic is under preparation to confirm the current drive by the LHFW and system upgrade is under planning for higher power injection.[6,7] This work is supported by National R&D program through NRF of Korea under grant no. 2019M1A7A1A03089797 and 2019M1A7A1A03089799)

References

1. S.H.Kim et al., Fusion Engineering and Design, 109-111, 707-711 (2016).
2. S.H.Kim et al., EPJ Web of Conferences, 157, 03203 (2017).
3. S.H.Kim et al., 2017 International Spherical Tokamak Workshop (2017). 4. H.W.Lee et al., Fusion Engineering and Design, 136, 1505-1509 (2018).
5. S.H.Kim et al., 27th Fusion Energy Conference (2018).
6. S.H.Kim et al., 2020 Japan-Korea H&CD physics and technology Workshop (2021).
7. S.H.Kim et al., 28th Fusion Energy Conference (2021).

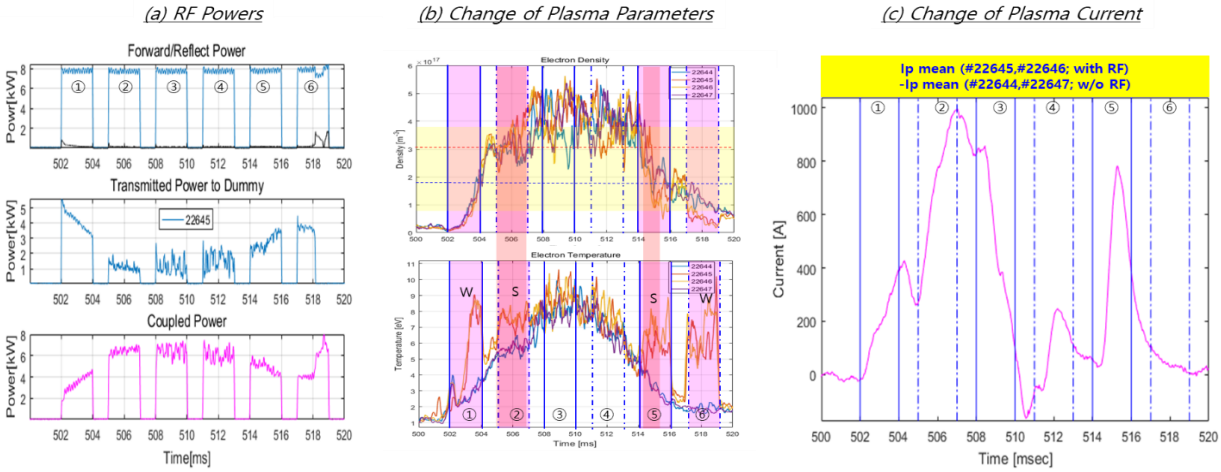

Figure 1. (a) forward, reflected, transmitted RF powers and coupled power calculated from the RF powers where the power is injected in pulse mode to prohibit arcing near or inside the antenna, (b) and (c) change of plasma parameters and plasma current by the coupled power.