Contribution ID: **779** Type: **Regular Poster**

# High Field Side Launch Lower Hybrid Current Drive for CFETR

*Friday 14 May 2021 10:10 (20 minutes)*

The China Fusion Engineering Test Reactor (CFETR) will be a large tokamak ($R_0 = 7$ m, $a = 2.2$ m) operating at moderately high magnetic field ($B_0 = 6.4$ T) with the mission of bridging the technological and scientific gaps between ITER and DEMO. Auxiliary current drive will be needed to supplement the self-driven bootstrap current and provide an MHD-stable current profile. This paper assesses the applicability of lower hybrid current drive (LHCD) for two potential operating scenarios[1]: the "hybrid"scenario in which some of the plasma current is sustained by the Ohmic transformer, and the fully non-inductive "steady state"scenario.
The $\pi$Scope workflow engine[2] was used to set up a large number of ray tracing/Fokker-Planck simulations ($> 10^4$) with parametric scans in the antenna poloidal position and launched $n_{||}$ for both the hybrid and steady state scenarios to study the potential benefits of launching lower hybrid waves from the high field side (HFS) versus the low field side (LFS). Fig. 1 shows the results of one such scan for the "hybrid"scenario spanning HFS launch positions of 135° to 225° (where 0° is the low field side midplane).

Indico rendering error

Could not include image: [404] Error fetching image

Modeling predicts efficient off-axis current drive (~1.3 MA for 20 MW launched power) with a peak near $\theta_1$ of 0.6-0.65 for waves launched from the high field side (HFS). Waves launched from the low field side (LFS) damp at larger radius ($n_{||}$ ~ 0.9) with similar efficiency to HFS launch. Stability analysis of the CFETR scenarios favors current drive profiles peaked near the mid-radius, with the region near $r/a$ = 0.6 particularly attractive for the hybrid scenario (see Fig. 2), while the steady state scenario requires current drive at $r/a$ = 0.5 to suppress unstable MHD modes.

Indico rendering error

Could not include image: [404] Error fetching image

Indico rendering error

Could not include image: [404] Error fetching image

The effect of wave scattering$r/a$ from density blobs in the edge/scrape-off-layer region was assessed through rotation of the perpendicular wavenumber at the ray starting point. Simulations show that the effect of scattering can be quite large both in efficiency and damping location, however by adjusting the launched $r/a$ much of the unperturbed performance can be recovered. Furthermore, scattering from density blobs can be assumed to be negligible for waves launched from the HFS in a double null configuration where measurements show a quiescent scrape-off-layer with effectively zero blobby transport[3].

This work is supported by US DoE Grant Nos. DE-SC0010492 and DE-FG02-91ER54109, the National Key R&D Program of China (Nos. 2016YFA0400600), and the National Natural Science Foundation of China (Nos. 11675214, 11775259, and11975266).

$n_{||}$ Chen, Jiale, et al. "Self-consistent modeling of CFETR baseline scenarios for steady-state operation." Plasma Physics and Controlled Fusion 59.7 (2017): 075005.
[4] Shiraiwa, S., et al. "πScope: Python based scientific workbench with MDSplus data visualization tool." Fusion Engineering and Design 112 (2016): 835-838.
[1] Andrews and Perkins. Physics of Fluids 26, 2537 (1983)
[2] Bonoli, P. T., et al. "High field side lower hybrid wave launch for steady state plasma sustainment." Nuclear Fusion 58.12 (2018): 126032.

## Country or International Organization

United States

## Affiliation

MIT Plasma Science and Fusion Center

**Author:** WALLACE, Gregory (MIT Plasma Science and Fusion Center)

**Co-authors:** DING, Bojiang (Institute of Plasma Physics, Chinese Academy of Sciences); LI, Miaohui (Institute of Plasma Physics,Chinese Academy of Sciences (ASIPP)); CHEN, Jiale; BAEK, Seung Gyou (MIT PSFC); BONOLI, Paul (Massachusetts Institute of Technology); SHIRAIWA, Syun'ichi (PSFC, MIT); Mr LIU, Liang (Institute of Plasma Physics, Chinese Academy of Sciences); Mr WU, Chenbin (Institute of Plasma Physics, Chinese Academy of Sciences)

**Presenter:** WALLACE, Gregory (MIT Plasma Science and Fusion Center)

**Session Classification:** P7 Posters 7

**Track Classification:** Fusion Energy Technology