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New regime for high-beta hybrid using off-axis electron cyclotron current drive on DIII-D[1] C.C. PETTY, J.R. FERRON, T.H. OSBORNE, K.E. THOME, M.A. VAN ZEELAND, General Atomics, C.T. HOLCOMB, LLNL, F. TURCO, Columbia U. — The DIII-D tokamak has developed a new regime for high-beta hybrid plasmas where the broad current profile is achieved with off-axis electron cyclotron current drive (ECCD) rather than anomalous poloidal magnetic flux pumping. The high-beta hybrid regime without sawteeth is a candidate for the Q=5 steady-state scenario on ITER, but the anomalous flux pumping mechanism that maintains $q_{min}>1$ is not yet understood. Experiments on DIII-D have found that high performance with β_N =3.7 and H_{98y2} =1.6 is maintained at high-density (above cutoff density for on-axis ECCD) when 3.4 MW of ECCD is moved from $\rho<0.2$ to ρ =0.5. In this new hybrid regime, the change in ECCD profile from on-axis to off-axis is predicted from TRANSP simulations of the neoclassical poloidal flux evolution to increase q_{min} by 0.5 to a value well above 1, in agreement with MSE-constrained equilibrium reconstructions and consistent with the disappearance of the fishbone instability, showing there is no evidence for anomalous flux pumping. Off-axis ECCD allows higher density operation without encountering the density cutoff, which increases the confinement time. About half of the confinement improvement is due to 30% lower electron thermal transport; the remaining improvement is due to reduced beam ion transport that correlates with weaker Alfven eigenmode activity.

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C.C. Petty
General Atomics

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