

PROSPECTS FOR OFF-AXIS NEUTRAL BEAM CURRENT DRIVE IN THE DIII-D TOKAMAK*

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ABSTRACT

Off-axis neutral beam (NB) current drive (CD) has the potential to supply substantial off-axis current drive for the demonstration steady state, advanced tokamak scenarios. A modification of the two existing DIII-D NB beamlines is proposed to allow off-axis current drive with NB injection vertically steered to drive current as far off axis as half the plasma radius. The profile and magnitude of the driven current is calculated using the NUBEAM Monte-Carlo module in TRANSP and ONETWO transport codes. When the beam is injected in the same direction as the toroidal field, off-axis CD of ≈ 45 kA/MW is calculated at normalized radius (square-root of the toroidal flux), $\rho = 0.5$ with full width half maximum of 0.45 in ρ . The dimensionless CD efficiency is comparable or somewhat better than that for electron cyclotron current drive (ECCD) at the same location and plasma parameters. The efficiency stays nearly constant in going from on-axis to off-axis CD. The localization and magnitude of the off-axis NBCD are sensitive to the alignment of the NB injection relative to the helical pitch of the magnetic field lines, and thus to the direction of the toroidal field and plasma current. The driven current is still localized off axis for fast ion diffusivities up to $1 \text{ m}^2/\text{s}$. The calculations show that the off-axis NBCD can supply much of the off-axis CD for the steady-state scenarios under consideration, leaving ECCD for fine-tuning of the current profile and real-time control.

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