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Experimental Simulation of Burn Control Using DIII-D In-Vessel Coils

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A new approach has been developed to control fusion power by applying a non-axisymmetric magnetic field (n=3) using the DIII-D in-vessel coils (I-coils) to modify the energy confinement time. This has potential advantages for a power plant due to the reduced power requirements relative to auxiliary heating and that it may enable the control of the plasma response more rapidly than with fueling or impurity influxes due to recycling of the fuel gas and impurities. In the relatively low collisionality DIII-D discharges, the application of non-axisymmetric magnetic fields results in a decrease in confinement time and density pump-out. The stored energy, which is used as a surrogate for fusion power, was controlled by the application of non-axisymmetric fields. The regulation of the stored energy by means of I-coil feedback yields comparable to or more stationary conditions than by the conventional approach of varying the neutral beam power. Transient increases in neutral beam power were used to simulate alpha-heating excursions. The feedback loop largely compensated the increased heating power by increasing the I-coil current, which reduced the energy confinement time. The accompanying increased particle transport in the pedestal was compensated by means of feedback control of the density at the top of the pedestal using the Thomson scattering system and fueling by means of the gas system. TRANSP was used to examine fast ion and profile effects in the interpretation of these results. These experiments demonstrated that it is possible to control the stored energy, which is a proxy for fusion power, by means of applying non-axisymmetric magnetic fields.

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