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High confinement in negative triangularity discharges in DIII-D

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Discharges with negative triangularity (-delta) shape have been created in DIII-D with H-mode-like confinement (H98y2 = 1.2) and high normalized beta (beta_N = 2.6) with L-mode-like edge pressure profiles and no ELMs. These inner-wall-limited plasmas with delta = -0.4 had the same global performance as a positive triangularity (delta = +0.4) ELMing H-mode discharge with the same I_p, elongation, and area. For negative delta shots where up to 11 MW of NB heating and 3 MW of ECH heating were applied, the plasma attained high toroidal beta of 1.9% while staying in L-mode and without disrupting. Preliminary fluctuation data shows negative delta plasmas have lower levels of density and electron temperature fluctuations, typically reduced by 20%, in the outer region of the plasma, 0.7 < r/a < 1.0, compared to equivalent positive delta discharges. This reduction of turbulence is consistent with gyro-kinetic simulations and is attributed to a modification of the toroidal precession drift of trapped electrons exerted by the negative triangularity. Correspondingly, transport analysis indicates reduced ion and electron diffusivities for negative delta compared to the positive delta cases. Also, the positive triangularity discharges had 30-50% lower neutron rates as the identically heated negative triangularity ones, due primarily to impurity retention and deuterium dilution. These results show that negative triangularity is a viable candidate for reactor scenarios with its high confinement, ELM-mitigated characteristics plus a more economical and effective option for divertor placement.
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