Operational Enhancements in DIII-D Quiescent H-Mode Plasmas*

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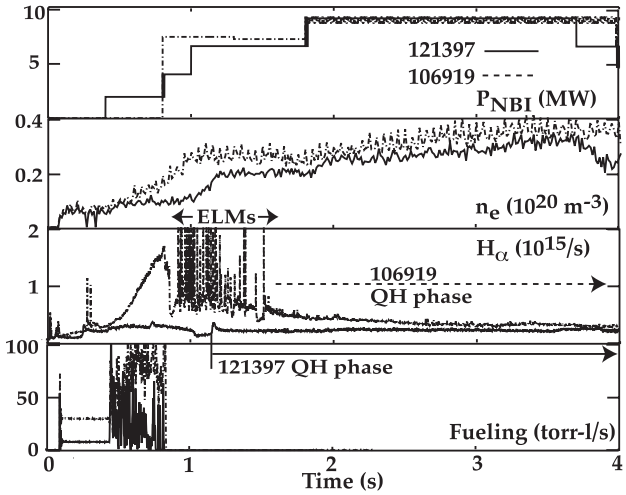
In recent experiments performed on DIII-D, we concentrated on extending the operating range and improving the overall performance of quiescent H-mode (QH) plasmas. The QH-mode offers an attractive, high-performance operating mode for burning plasmas due to the absence of pulsed edge-localized-mode-driven losses to the divertor (ELMs). Using counter neutral-beam injection (NBI), we achieve steady plasma conditions with the presence of an edge harmonic oscillation (EHO) replacing the ELMs and providing control of the edge pedestal density. As shown in the figure, by carefully controlling the startup conditions, we are able to access the QH regime directly, without first encountering an extended, detrimental ELMing phase. Employing triangularity ramps, we have increased the operating range of both the pedestal density and pressure. We include these pedestal conditions in the equilibrium calculations by incorporation of the self-consistent bootstrap-current. The resulting calculated edge current density is consistent with measurements from the lithium beam Zeeman polarimetry diagnostic. Previously, we had observed that injection of electron cyclotron (EC) power in the core region provides an ability to control density profile peaking. Using a combination of EC injection for density profile control and NBI ramps, we increased the overall stored energy achieving $\beta_N \sim 3$. This combination of EC and NBI also modifies the q profile and achieves a long duration (~3 s) where the on-axis value of q remains stationary and near 1.5. QH-mode plasmas remain markedly resilient to changes in auxiliary heating power where up to 3 MW of EC power and 15 MW of NBI have been injected without loss of the desirable pedestal conditions. We include these pedestal conditions in the equilibrium calculations by incorporation of the self-consistent bootstrap-current. The resulting calculated edge current density is consistent with measurements from the lithium beam Zeeman polarimetry diagnostic. We will discuss details of experiments on DIII-D that lead to an expanded range of operation.



Shot 121397 enters QH phase without ELMs as compared with an earlier QH shot, 106919, ELMing prior to the QH phase.

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