

RI-MODE IN THE DIII-D TOKAMAK WITH A NEON INDUCED RADIATING MANTLE*

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The RI-mode regime, with high radiating power fractions from 0.5 to 1.0 and energy confinement enhancements over ITER89-P L-mode scaling presently from 1.6 to 4, is an attractive operating scenario for fusion ignition devices. Radiating mantle discharges in DIII-D have achieved these conditions with neon gas injection in both inside wall limited and diverted configurations and with either an L-mode or H-mode edge.

Discharges in DIII-D with characteristics similar to TEXTOR RI-mode limited discharges will be discussed and confinement scalings will be compared to the TEXTOR RI-mode scaling relation. DIII-D inside wall limited RI-mode discharges exhibit a drop in edge electron temperature immediately after the initial neon puff and then a subsequent drop, $T_e(\text{LCFS}) \leq 30$ eV, accompanied by an increase in the NeVIII line intensity, several hundred ms later. This latter phase is characteristic of the TEXTOR RI-mode with best operation to date in sawtooth discharges, $q_{95} \approx 3$, $P_{\text{NB}} = 9.5$ MW, and $1.2 < \ell_i < 1.4$. Densities of $0.5 < n_e/n_{\text{GW}} < 0.75$ have been achieved where n_{GW} is the Greenwald density limit. Future experiments are planned to extend operation to higher densities, $n_e/n_{\text{GW}} \approx 1$, where TEXTOR has observed the highest normalized energy confinement.

In addition to RI-mode inside wall limited discharges, high performance diverted VH-mode and ELMing H-mode discharges with neon induced radiation have also been observed in DIII-D. Quasi-steady state ELMing discharges with β_{NH} up to 6 have been obtained. These discharges also exhibited a relatively high normalized inductance $1.05 < \ell_i < 1.35$ when compared to reference VH-mode discharges, suggesting that neon injection might be a useful tool for current profile control. Neon impurity concentrations in these discharges were of order 1%, producing only a moderate increase in $Z_{\text{eff}}(0)$, $\Delta Z_{\text{eff}}(0, \text{neon}) \lesssim 1$. We will discuss the similarities and differences between RI-mode and similar discharges without impurity induced radiation. In particular the impurity profiles, fluctuation behavior, the role of plasma rotation, and transport analysis will be presented. Future plans, including extending RI-mode to higher normalized parameters, will also be discussed.

*Work supported by U.S. Department of Energy under Contracts DE-AC03-89ER51114, DE-AC05-96OR22464, W-7405-ENG-48 and Grant DE-FG03-95ER54294.

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