

# Dynamics of H-mode Pedestal Formation in L-H Transitions in DIII-D\*

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A fast reciprocating Langmuir probe array has been used in conjunction with other profile and fluctuation diagnostics to investigate the development of the edge transport barrier in L-H transitions in the DIII-D tokamak. The discharges studied had a lower single null divertor configuration with the ion grad-B drift toward the X-point, a configuration that produces a low H-mode power threshold (about 1 MW for these discharges). Core Thomson scattering was configured with 2 ms laser spacing to follow the buildup of the H-mode pedestal, while the density fluctuation level  $\tilde{n}_{rms}$  at  $k_q = 1 \text{ cm}^{-1}$  was measured with the far infrared, coherent scattering diagnostic. Radial localization of the density fluctuation signal was approximated by integrating the fluctuation power over the negative frequencies that correspond to Doppler shifted fluctuations by the negative radial electric field  $E_r$  well. The  $\tilde{n}_{rms}$  level drops at the L-H transition, then recovers on the same timescale as the pedestal electron temperature  $T_e$  and pressure, and significantly slower than the timescale for the pedestal density to increase. Just before the onset of the first Type I ELM, the  $\tilde{n}_{rms}$  level has recovered to nearly the L-mode level before the L-H transition.

Probe data was acquired across the L-H transition by plunging the probe into the L-mode just at various times with respect to the L-H transition, allowing the formation of the H-mode pedestal to be followed. As previously reported, the auto-bicoherence increases significantly for a period of 5-10 ms beginning 4-6 ms before the L-H transition, and displays 3-wave coupling consistent with expectations for electrostatic Reynolds stress drive of mean flows [Moyer, *et al.* Phys. Rev. Lett. **87** (13) (2001)]. This increased 3-wave coupling dies out as the pedestal pressure gradient increases, suggesting that although the electrostatic Reynolds stress may initiate the negative  $E_r$  well formation, the established H-mode transport barrier is maintained by the diamagnetic component of the radial electric field  $E_r$ . However, although the  $\tilde{n}_{rms}$  and  $E_{qrms}$  are reduced nearly an order of magnitude within 50 ms of the L-H transition, the cross-field convective particle and heat transport are already reduced by a factor of 2-3 before the fluctuation levels change due to a change in the cross-phase of the  $n$  and  $E_q$  fluctuations. In contrast, the  $T_e$  fluctuations and turbulent conductive heat transport in similar discharges do not change significantly, indicating that for these plasma conditions, the H-mode transport barrier is largely convective in nature. These results are suggestive of edge turbulence simulations in which the edge fluctuations change character prior to the L-H transition [Drake *et al.*, Phys. Rev. Lett. **77**, 494 (1996)].

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