Divertor heat flux profiles in discharges with negative triangularity and in advanced confinement regimes in DIII-D*

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Wider scrape-off layer (SOL) power fall off lengths were observed in diverted L-mode discharges with negative triangularity, when compared to H-mode plasmas with similar shaping. Despite the wider SOL, the L-mode discharges maintained H-mode-like energy confinement levels ($H_{98,y2} \approx 1$), albeit 10% lower than the similarly-shaped H-mode plasma. In DIII-D, centerpost-limited L-mode discharges with negative triangularity displayed H-mode-like energy confinement ($H_{98,y2} \approx 1.2$) without the presence of an H-mode-like pressure pedestal or edge localized modes (ELMs) \cite{1}. The characterization of the scrape-off layer (SOL) power exhaust channel is critical to assess the applicability of advanced core confinement regimes to future fusion devices and is investigated in this work.

Lower single null diverted DIII-D discharges with negative upper triangularity ($\delta_u \approx -0.2/-0.4$), near zero lower triangularity ($\delta_l \approx 0$) and ion VB drift towards the lower divertor were developed at plasma current $I_p=900$ kA and toroidal magnetic field $B_T=2$ T with neutral beam ($P_{\text{NBI}}=4$-13 MW) and electron cyclotron heating ($P_{\text{ECH}}=1.5$ MW). H-mode plasma, with high frequency (300-400 Hz) Type I ELMs, were obtained at reduced negative upper triangularity ($\delta_u \approx -0.2$) with identical auxiliary heating and same $I_p$. SOL power fall-off lengths ($\lambda_q$) were derived fitting the outer divertor heat flux profiles from infrared thermography with the Eich formula \cite{2}. The inter-ELM $\lambda_q$ measured in a negative upper triangularity H-mode discharge was generally consistent with expectations from the Eich scaling \cite{2} and comparable to $\lambda_q$ measured in discharges with similar shaping but positive upper triangularity. In L-mode discharges ($\delta_u \approx -0.4$) with NBI heating, $\lambda_q$ was up to 30% wider than in the corresponding H-mode discharge. Further broadening of $\lambda_q$ (up to 50% wider than in H-mode) was observed with the addition of electron cyclotron heating while maintaining $H_{98,y2} \approx 1.0$. Divertor heat flux profiles in negative upper triangularity discharges with a scan in lower triangularity as well as with reverse toroidal field will be presented. $\lambda_q$ in negative triangularity discharges will be compared to those in L-mode discharges with conventional triangularity. Heat flux profiles in additional advanced confinement regimes in DIII-D (e.g., Super-H mode) will also be investigated.

\begin{itemize}
  \item \cite{1} A. Marinoni, Phys. Plasmas 26, 042515 (2019).
  \item \cite{2} T. Eich, Nucl. Fusion 53, 093031 (2013).
\end{itemize}

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