Assessment of X-Point Target Divertor Configuration for Power Handling and Detachment Front Control

M. Umansky$^1$, M. Rensink$^1$, T. Rognlien$^1$, B. LaBombard$^2$, D. Brunner$^2$, J. Terry$^2$, and D. G. Whyte$^2$

$^1$Lawrence Livermore National Laboratory (LLNL), Livermore, CA 94550, USA
$^2$Massachusetts Institute of Technology (MIT), Cambridge, MA 02139, USA

Corresponding Author: M. Umansky, umansky1@llnl.gov

The challenges that will be facing the divertor in a tokamak-based fusion reactor prompt the search for innovative divertor configurations that use nonstandard magnetic geometry and additional X-points. Standard tokamak edge plasma transport codes such as UEDGE and SOLPS can be invaluable tools for exploration and evaluation of alternate divertor configurations for potential performance enhancements; however the presence of secondary X-points in the divertor has, up to now, hindered such application. A recent upgrade to UEDGE allows including a secondary X-point in the divertor, and in the present study UEDGE is used to analyze the recently proposed X-point target divertor that combines a radially extended outer leg with a secondary X-point placed in the outer leg volume. It is found in the modeling that as the input power into SOL is reduced to a threshold value, the outer divertor leg transitions to a fully detached state with the detachment front localized near the secondary X-point. Reducing the power further results in the front shifting upstream but remaining stable. As the power is reduced, the detachment front eventually moves to the primary X-point, which is associated with an X-point MARFE. However, for the X-point target divertor a fully detached divertor regime is maintained over a factor of 5–10 variation in the input power while for an otherwise similar parameter variation performed with a standard vertical plate divertor a much smaller detachment operational window is found. These results suggest that a stable, fully detached divertor operation over a wide parameter range may be realized for a tokamak with radially extended outer divertor legs.