Summary: The performance of long-leg versus standard divertor configurations is studied with UEDGE for otherwise identical conditions, using scrape-off layer plasma transport parameters based on the ADX tokamak design. It is found that standard vertical plate divertor exhibits a very small, or even non-existent power window for detachment. Under the same conditions, long leg divertors exhibit a large operational window, allowing a passively-stable detachment front. In particular, the X-point target divertor configuration attains stable detachment for a factor of ~10 variation in the input power.

1. Background: Configurations with a secondary X in divertor have been considered by many groups in recent years.

X-point target divertor (XPTD) is a long-leg concept that is thought to provide important performance enhancements.

2. Approach: Perform computational study of four divertor plate arrangements using same (or similar) magnetic configurations

Employ UEDGE boundary plasma modeling code, with recent upgrades that can handle secondary X-points in the divertor.

3. Results from SOL power scan: long-leg geometries open up access to large power windows for stable divertor detachment

Results are obtained using identical physics model, boundary conditions etc.
- Large operational window with detached divertor found for all three long-legged configurations.
- For SVPD, detached plasma solution has not been found; it may exist but at rather low input power.
- Radially (SXD, XPTD) or vertically (LVLD) extended outer leg is good for obtaining passively-stable, fully detached operation.
- Long leg vertical (LVLD) achieves detachment at about same power as radially extended leg (SXD).
- Secondary X-point in outer leg (XPTD) significantly extends the detached operation window, factor of ~10 in power.

4. UEDGE Output Details: Response of XPTD to variation in SOL Power

As input power $P_{in}$ is varied, the location of the detachment front radiating layer moves up or down along the leg as needed to match incoming power.

5. UEDGE Output Details: Response of SXD and LVLD to variation in SOL Power

Results are qualitatively similar to XPTD

6. Summary and Conclusions

Capability to model divertor configurations with a secondary X-point has been developed in UEDGE; this enables analysis of novel geometries.

Long-legged divertor configurations are studied computationally, for boundary plasma parameters matching projections for the ADX tokamak.
- X-point Target Divertor (XPTD)
  - Super-X Divertor (SXD)
  - Long vertical leg divertor (LVLD)
  - Also, for comparison a standard vertical plate divertor (SVPD)

Passively-stable, fully detached divertor regimes are found for tightly-baffled long-legged divertors, for a broad range of parameters.
- Detached state is attained at high power, up to ~10x higher than SVPD
- Detachment front stays far away from the main plasma
- Secondary X-point in divertor leg (XPTD) significantly extends detached divertor operation window – a factor of ~10 variation in power is obtained.
- Effects of outer wall gap and wall pumping are presently being investigated
- Promising results for stable, fully detached divertor operation at high power.