Divertor research and modeling [1] gives us reasonable confidence that the current conventional divertor configuration will likely handle the power loads of ITER. On the other hand it is clear from contemplating DEMO concepts [2], that the parallel-to-$\mathbf{B}$ heat flux density towards the divertor, $q_{\parallel}$, could be significantly (~10x) larger than ITER, raising concerns for attaining and utilizing detachment and the resulting reduction of peak heat flux at the divertor to below engineering limits. Two paths are being pursued to address the DEMO exhaust power challenge: a) Lower $q_{\parallel}$ through core radiation to levels similar to that predicted for ITER; and b) utilize ‘alternative’ divertor geometries to enhance the capability of the divertor plasma itself to further lower the peak $q_{\parallel}$ reaching the target though enhancing cross-field transport and/or more radiative and neutral losses. The first path (a) has been successful in raising core radiation while minimizing losses in core confinement [3-5] but has the potential to degrade core confinement and He pumping. The second path (b) has so far been less clearly successful than the first in further reducing heat loads and tends to increase the divertor engineering costs/difficulty for a reactor. We will likely want to combine aspects of both paths to achieve what is needed. In this talk the second path of enhancing divertor properties is explored.

First we note that there are multiple areas beyond reducing $q_{\parallel}$ where the conventional divertor could be improved: 1) Change the access to detachment to lower core operating density and impurity concentration or, for those held constant, detachment at higher $P_{\text{SOL}}$; 2) Enhance the controllability of detachment, ideally keeping the cold, recombining region away from the core plasma (x-point) in the divertor proper, while still maximizing divertor dissipation of $q_{\parallel}$; 3) Enhance the compression of impurities and neutrals in the divertor; 5) Enhance divertor-core compatibility (covered mostly by the earlier criteria); and 6) ‘do no harm’ – ideally achieve the enhancements in 1-5 without degradation in any area.

The predicted characteristics of ‘alternative’ divertor configurations that lead to reductions in peak divertor $q_{\parallel}$ can be grouped along the following lines - increasing flux tube length and thus the potential for more radiating volume in the divertor, through poloidal flux expansion (as in the snowflake or x-divertor) or just a longer divertor; Enhancing cross-field transport as a secondary x-point is brought closer to the first (snowflake); Enhancing total flux expansion by shifting the divertor target to larger $R$, or lower $B$ (e.g. Super-X and X-point target) which lowers $q_{\parallel}$ through increasing flux tube area, $A$, for constant $q_{\parallel}A$. The results from current experiments are not yet clear (in my opinion) due to a variety of factors. Modelling has been somewhat clearer; Lower $q_{\parallel}$ at the target and lower detachment thresholds are found for the Super-X configuration [6,7], awaiting experimental confirmation. Brief overviews of the above will be presented.