Investigation of parameter space for fully detached tokamak divertor operation*

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Abstract

A comparative computational study of detached divertor operation is carried out for a variety of divertor configurations, expanding on the initial work reported in Refs. [1,2]. Passively-stable fully detached divertor regimes are found to exist in a broad range of input power from the core, for several divertor configurations, particularly those with radially or vertically extended, tightly baffled, outer divertor legs, with or without a secondary X-point in the divertor leg volume. For concreteness, the parameters are centered around those of the ADX tokamak design [3] The simulations are carried out with the tokamak edge transport code UEDGE [4]. As the power from the core is varied, the detachment front merely shifts up or down in the leg but remains stable. The simulations show that long-legged divertors have a large increase of the peak power handling ability, by up to a factor of 10, compared to conventional short-legged divertors. The present work addresses sensitivity of the detached divertor regime to various parameters used in the model, including the anomalous radial plasma transport, neutral transport, impurity radiation, and geometry of plasma-facing material surfaces.

[1] M.V. Umansky et al., "Assessment of X-point target divertor configuration for power handling and detachment front control", accepted for publication in Nuclear Materials and Energy (2017).
[2] M.V. Umansky et al., "Attainment of a stable, fully detached plasma state in innovative divertor configurations", accepted for publication in Physics of Plasmas (2017).
[3] B. LaBombard et al., Nuclear Fusion 55, 053020 (2015).
[4] T.D. Rognlien et al., J. Nuc. Mat. 196, 347–123 (1992).

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