Turbulence driven widening of the near-SOL power width in H-Mode discharges at ASDEX Upgrade

T.Eich1, P. Manz1, R.J.Goldston2, D.Brida1, P.David1, M.Faitsch1, P.Hennequin3, B.Kurzan1, B.Sieglin1, E.Wolfrum1, the EUROfusion MST1 team4 and the AUG Team1

1 Max Planck Institute for Plasma Physics, Garching, Germany
2 Princeton Plasma Physics Laboratory, Princeton, NJ08543, USA
3 LPP, Ecole Polytechnique, CNRS, 91128 Palaiseau, France
4 See: H.Meyer et al 2017 Nucl. Fusion 57 102014

Operation of tokamaks with H-Mode characteristics and at high densities is generally foreseen for future high-power fusion systems, including ITER. The ease of access to divertor detachment via impurity seeding scales to first order proportional to \( (n_{sep}/n_{GW})^2 \cdot \lambda_q/\rho_{s, pol} \) [1] with \( \lambda_q \) being the power width, \( \rho_{s, pol} = \sqrt{T_{sep} \cdot m_D/e/B_{pol}} \), \( T_{sep} \) and \( n_{sep} \) the separatrix temperature and density, respectively. Divertor heat flux data from infra red (IR) from various tokamaks in H-Mode regime scales approximately like \( \rho_{s, pol} \). However, the IR based scaling comes with the restrictions that only low-gas-puff discharges were considered. Here, we extend the low edge density data base with high density plasmas reaching the H-mode density limit by using Thomson-Scattering to measure the electron temperature decay length which will set the near-SOL power width through parallel heat conduction, \( \lambda_{Te} \simeq 7/2 \cdot \lambda_q \). As the principal result we present a generalized power width scaling which reads as \( \lambda_q \propto \rho_{s, pol} \cdot (1 + 2.8\alpha_t^{1.8}) \) where \( \alpha_t \) describes a normalized collisionality \( \alpha_t = 3 \cdot 10^{-18} R q^2 n Z_{eff} T^{-2} \). The parameter \( \alpha_t \) describes the relative importance of the interchange effect on drift-wave turbulence as proposed by Scott[2] and is found for our data base to be about inversely proportional to the diamagnetic parameter \( \alpha_d \) in [3]. This new scaling shows (a) in the limit of low edge densities (\( \alpha_t \simeq 0.15 \)) accurate agreement to the IR based scaling and (b) at elevated separatrix densities (\( \alpha_t \simeq 0.8 \)) that the power width is broadened by a factor of about three albeit accompanied by a confinement degradation to near L-Mode levels. We show that the confinement degradation is dominated by a reduction of the pedestal top pressure. Importantly, plasmas with higher shaping (higher triangularity) show a reduced confinement degradation at the same separatrix densities. We will present the experimental data base, new scaling results and discuss implications for ITER.

References