3D effects of magnetic perturbation coils on the edge/SOL properties in ASDEX Upgrade


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The use of non-axisymmetric magnetic perturbation (MP) coils for ELM mitigation and suppression has become an intense topic of investigation in recent years. Several machines, e.g. DIII-D, AUG, MAST, JET etc. are currently operating in- or ex-vessel saddle coils and have reported successful results. However, the basic understanding of MP field penetration and structure, and its impact on the tokamak edge parameters remains an outstanding issue. Several machines have also begun to address this topic, starting from the low collisionality, quiescent L-mode where a clear MP impact is generally observed. ASDEX Upgrade (AUG) is particularly well suited to this task with its flexible set of in-vessel saddle coils located above and below the low-field-side tokamak mid-plane which are capable of generating MPs with (predominant) toroidal mode numbers \( n = 0, 1, 2 \) and \( 4 \); and its extensive set of high resolution edge and scrape-off-layer (SOL) diagnostics for radial electric field \( E_r \) and density \( n_e \) turbulence measurements. Experimentally, density dependent thresholds are observed for the MP field penetration leading to \( E_r \) and \( n_e \) flattening in the near SOL, an \( n_e \) enhancement in the far SOL, splitting of the divertor strike-points, together with reversal of the confinement \( E_r \) well. The radial structure of the confinement region \( E_r \) and turbulence level are particularly sensitive to the degree of MP resonance with the edge rational field-lines (via \( I_p/q \) and/or MP poloidal phasing) specifically the turbulence is enhanced where the MP is resonant and reduced when non-resonant. The 3D structure of the MP has been mapped for various MP \( n = 1, 2 \) and \( 4 \) configurations by rotating the MP field toroidally - and is found to be different for the edge and near SOL regions. Modelling has also been undertaken using vacuum field line tracing and EMC3-Eirene simulations and has successfully matched the experiments, aiding a consistent interpretation of the MP impact at low plasma collisionality. Analysis of the MP impact at higher collisionalities is ongoing and will be presented.