Increased core ion temperatures in high-beta advanced scenarios in AUG: Disentangling ExB-shear and fast ion effects using gyrokinetic simulations

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Advanced tokamak (AT) scenarios combine many aspects that are attractive for the operation of future nuclear fusion power plants; Not only do they feature improved stability and confinement, they allow also greatly extended pulse lengths and have even been demonstrated to be able to run completely non-inductively[1]. Additionally, AT experiments often feature peaked temperature profiles associated with a suppressed turbulent transport. The mechanisms behind these reductions of transport are as of yet not fully understood. While recent numerical studies using the gyrokinetic code GENE [2] find fast ion effects to be the key player [3], also the $E\times B$-shear is thought to contribute to a reduction of core turbulence[4]. To investigate the importance of these effects, experiments have been conducted in ASDEX Upgrade (AUG) that vary the $E\times B$-shear and fast ion content by partially replacing NBI with ICRF heating while keeping β_{pol} constant. In these studies, that were previously reported in [5] and [6], these two competing effects were disentangled via statistical means; no correlation has been found between the $E\times B$-shear and an increase in R/LT_{i}. To further the theoretical understanding of these two effects, nonlinear fluxtube GENE simulations have now been performed. These simulations benefited from HPC resources from CINECA Marconi-Fusion (Project FUA35_STATS). They compare two time-points of one of these high-beta non-inductive AT scenarios, performed in AUG, that feature peaked core ion temperatures. The first of these two time-points features a higher $E\times B$-shear and lower fast ion content, in the second time-point the situation is reversed. By first matching the ion power balance and then varying only one parameter at a time, the fast ion and $E\times B$-shear effects could be disentangled in GENE. To achieve a match with the ion powerbalance in the time-point with lower $E\times B$-shear and higher fast ion content, it proved necessary to include two fast ion species (deuterium and hydrogen minority) with realistic bi-maxwellian distribution functions. This is made possible by a recent extension in the GENE code [7]. Details and results of this numerical study will be reported in this contribution.

References

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