Analysis of the energetic particle transport in D-T JET experiment: multi species non linear simulations

J. Varela[1], J. Garcia[2], S. Mazzi[3], Y. Kazakov[3], Ž. Štancar[4], M. Baruzzo[5,6], J. Ongena[7], D. Spong[8], L.Garcia[9], Y. Ghai[8], D. Zarzoso[10], J. Ortiz[9] and M. Poradzinski[11], JET contributors and EUROfusion Tokamak Exploitation team

[1] *Institute for Fusion Studies, Department of Physics, University of Texas at Austin, Austin, Texas 78712, USA*
[2] *CEA, IRFM, F-13108 Saint Paul-lez-Durance, France*
[3] *Laboratory for Plasma Physics, LPP-ERM/KMS, TEC Partner, 1000 Brussels, Belgium*
[4] *United Kingdom Atomic Energy Authority, Culham Science Centre, Abingdon, UK*
[5] *Consorzio RFX, Corso Stati Uniti 4, Padova, Italy*
[6] *ENEA for EUROfusion, Via E. Fermi 45, 00044, Frascati (Roma), Italy*
[7] *Plasma Physics Laboratory – Royal Military Academy, Renaissancelaan 30, 1000 Brussels, Belgium*
[8] *Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-8071, USA*
[9] *Universidad Carlos III de Madrid, 28911 Leganes, Madrid, Spain*
[10] *Aix-Marseille Universite, CNRS, Centrale Marseille, M2P2, UMR 7340 Marseille, France*
[11] *Institute of Plasma Physics and Laser Microfusion, Hery str. 23, 01-497, Warsaw, Poland*

The present study is dedicated to analyze the Alfven Eigenmode (AE) activity in JET Deuterium-Tritium (D-T) discharges, the closest experiment to reactor-like operation. AEs are driven by the combined effect of tangential NBIs (passing D) and ion cyclotron resonance heating (trapped H) driven energetic particle (EP). A set of nonlinear simulations are performed with the gyro-fluid FAR3d code to reproduce the AE activity and EP transport observed in the discharge #99896 induced by single EP species as well as multiple EP populations. The EP transport caused by Toroidal AEs (TAEs) and fish-bone, induced by passing D and trapped H respectively, is rather low leading to EP losses below 2 %. On the other hand, a hypothetical scenario with an alpha particle population one order of magnitude larger compared to the experiment leads to the destabilization of core localized Beta induced AE (BAE) inducing 15 % of alpha particle losses. Multiple EP simulations show important nonlinear couplings between EP species. Simulations including trapped H and alpha particles indicate fish-bones may induce alpha particle losses up to 12 % although TAEs have a smaller impact on the alpha particle transport, leading to losses below 2 %, trends qualitatively consistent with the experiment observation that indicate negligible alpha particle losses by TAE although around 5 % losses by fish-bones. Consequently, nonlinear effects in multiple EP populations must be considered in the analysis of EP transport in reactor relevant plasma to reproduce experimental observations.