# Tearing mode seeding by externally provided resonant magnetic perturbations in the presence of Neoclassical Toroidal Viscosity

D. Meshcheriakov[1], M. Hoelzl[1], V. Igochine[1], S. Fietz[1], V. Bandaru[1], F. Orain[2], S. Günter[1], H. Zohm[1], ASDEX Upgrade Team and MST1 Team*

[1]*Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching b. M., Germany*

[2]*Centre de Physique Théorique, Ecole Polytechnique, CNRS, F-91128 Palaiseau Cedex, France*

**See author list of MST1 Team in H. Meyer et al, Nucl. Fusion 57,102014 (2017)*

The (Neoclassical) Tearing Mode is a plasma instability leading to the formation of the magnetic islands causing degradation of plasma confinement and even disruptions. These modes are marginally stable in the large present day devices and develop once being seeded by a sufficiently large perturbation. Non-axisymmetric external magnetic perturbation (MP) fields arise in every tokamak e.g. due to the imperfections in the external coils positions. Additionally many tokamaks, like ASDEX Upgrade (AUG), are equipped with, so-called, Resonant Magnetic Perturbation coils which produce a perturbation field for the control of Edge Localized Modes and other magnetohydrodynamical (MHD) instabilities.

The previous results [1] of numerical simulations of the tearing mode onset with the toroidal, two fluids, non-linear MHD code JOREK [2] showed good qualitative agreement with the experimental observations. The scan in the simulation parameters also included a set of parameters chosen to be as close as possible to one of the low collisionality L-mode plasma discharges with externally applied MP fields from ASDEX Upgrade [3]. Despite the good qualitative agreement, a higher amplitude of the perturbation field was required in order to get the mode penetration. The slow down of plasma rotation in the simulation was also not as efficient as in the experiment. This can partly be explained by the absence of the Neocalssical Toroidal Viscosity (NTV) in the code, which provides additional torque to the plasma in the presence of the non-axisymmetric magnetic field. In the present work, we show results of simulations with an input closer to realistic parameters and identify the threshold for mode penetration in several parameters like perturbation amplitude and rotation velocity. Additionally, we show the implementation of an NTV model in the JOREK code together with first results based on this extension.

**References**

[1] D. Meshcheriakov *et al.*, proc. 44nd EPS conf. plasm. phys. **P5.139**, (2017).

[2] G. Huysmans and O. Czarny, Nuclear Fusion **47**, (2007).

[3] S. Fietz *et al.*, proc. 42nd EPS conf. plasm. phys. **P1.123**, (2015).