NBI ion losses at energy $E_0/2$ driven by NTMs.

H. E. Ferrari[1,2],R. Farengo[1,3], P. L. Garcia-Martinez[2], C. F. Clauser[4]

[1]*CNEA, CAB, Bariloche, Argentina*

[2]*CONICET, Argentina*
[3] *IB, UnCuyo, Bariloche, Argentina.*
[4] *Lehigh University, Bethlehem PA 18015, United States*

Energetic ion losses due to neoclassical tearing modes (NTM) have been reported in ASDEX U [1]. We have used a full orbit code [3] that includes the time dependent perturbed electric and magnetic fields to study this process. The perturbed fields were calculated employing the experimental information available and the method proposed in [4].

In a previous work we reported an increase in ion losses when the frequency of the NTM matches the precession frequency of the trapped particles ($f \sim \sqrt{E}$) [2]. In the ASDEX U experiment the frequency of the NTMs was 6 kHz and the precession frequency of the injected ions (at 93 KeV) was $f\_p \sim 8$kHz. For the ions with E0 = 93keV the losses are increased by a factor 2, from 2% in the static case to 4% in the rotating case.

Since a fraction of the injected neutral atoms ($\sim 1/3$) have an energy equal to half the maximum value (46.3 keVs) it is also important to study NTM induced losses at this energy. The 46.3 keV ions have an average precession frequency similar to the measured NTM frequency and the strong resonance results in a 23% loss of the trapped ions. These results show the importance of including the full time dependency of the perturbation.

[1] M. García-Muñoz et. al. *Nucl. Fus.* **47**, L10 (2007).
[2] H. E. Ferrari et al., APS-DPP 2020 Virtual Meeting, 9-13 November 2020. "*Energetic ion losses driven by resonant NTMs*".
[3] C. F. Clauser et al. *Comput. Phys. Comm.* **234**, 126 (2019).
[4] V. Igochine et al, *Nucl. Fus.* **43** 1801 (2003).