Fueling DEMO: required flux and pellet injection parameters

B. Pégourié[a], J.-F. Artaud[a], J. Garcia[a], C. Day[b], P.T. Lang[c]

[(a)] *CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France*
[(b)] *Karlsruhe Institute of Technology, 76021 Karlsruhe, Germany*
[(c)] *Max Planck Institute for Plasma Physics, 85748 Garching, Germany*

Pellets have demonstrated their capacity for depositing matter in the plasma core and will be mandatory for DEMO fueling. In a previous work [1], both the poloidal domain for an optimal launching and corresponding range in the injection velocity were estimated, taking into account the technical constraints due to the available injectors and possible interaction of the guide tube with the different coils and machine structure elements. This was done using an *ad hoc* pellets size (ITER-like pellet: cylinder L = D = 5 mm, 6×10^{21} at.). But designing practically the fueling system (injector type and characteristics, guide tube trajectory) for DEMO requires an accurate definition of (*i*) the optimal launching point, (*ii*) the pellet size and velocity and (*iii*) the injection frequency.

This can be done through a closed loop modeling process, where the residence time of the pellet deposited material in the plasma core is calculated self-consistently with the plasma transport reaction to the pellet induced changes in the density and temperature profiles. This requires a parametric study for determining the injection frequency and possible changes in the plasma response as a function on the pellet size. For the present study, we use the CRONOS code [2] and GLF23 transport model [3], the pellet deposition profiles being calculated with the HPI2 pellet ablation/deposition code [4] using a preliminary design of the HFS guiding tubes [1]. DEMO parameters are those given in ref. [5].

This paper summarizes the main results of this study, showing that an injection frequency of ~ 3-8 Hz is required, depending on the pellet size (~ 6 Hz for ITER-like pellets). ELMs are only taken into account through simple assumptions (they play a role on two sides: (*i*) the fueling pellets must replace the material ejected from the pedestal by the ELMs and (*ii*) if ELM-pacing through pellet injection is used, the latter can contribute to the core fueling since – depending in their injection location - these pellets have probably to penetrate up to half the pedestal). Attention is paid to the simplification made in the simulation, namely that the SOL-core interaction is not taken into account (the density is assumed to be constant at the separatrix, which means that no fueling of the core from the SOL is considered).

The work is complemented by a study of the influence of the dispersion in the pellet injection angle and velocity on the source profile.

References:

[1] P.T. Lang *et al.*, Fusion Eng. Des. **96–97** (2015) 123 - B. Pégourié *et al.*, ECA, **Vol.40A** (2016) P4-076
[2] J.-F. Artaud *et al.*, Nucl. Fusion **50** (2010) 043001
[3] R. E.Waltz *et al.*, Phys. Plasmas **4** (1997) 2482
[4] B. Pégourié *et al.*, Plasma Phys. Control. Fusion **47** (2005) 17 & Nucl. Fusion **47** (2007) 44
[5] DEMO1 Reference Design, (2015 April) Document EFDA_D_2LBJRY v1.0