Contribution ID: **440** Type: **Poster**

ELM Suppression and Internal Transport Barrier Formation by Krypton Seeding in KSTAR Plasmas

Friday 26 October 2018 08:30 (4 hours)

Impurity seeding with noble gases, such as krypton (Kr), is regarded as a promising way to mitigate divertor heat loads. In this study, ELMs were successfully suppressed by Kr injection in the KSTAR divertor region and the relation between ELM behaviour and Kr amount was studied in KSTAR plasmas with 0.5 MA plasma current and 2.5 T toroidal field. Figures 1(a)-(c) show the plasma parameters with different levels of Kr injection. After achieving an intermediate level of Kr seeding, ELM crashes were briefly suppressed and grassy ELMs occurred with slight reduction of line-integrated electron density, core electron temperature and stored energy, while there was no effect on ELMs for a low level of Kr. The ELM suppression time became longer at a higher level of Kr injection. Figures 1(d) and 1(e) represent the same background plasma parameters at intermediate and high injection levels seen in Figures 1(b) and 1(c), respectively, but with the presence of on-axis ECH. Compared to Figure 1(c), longer and more stable ELM suppression was possible with a high level of Kr injection with ECH (Figure 1(e)). Detailed analysis including peeling-ballooning stability is on-going to understand the ELM suppression mechanisms with Kr profiles and ECH. At a certain level of Kr injection, an internal transport barrier (ITB) was formed after ELM mitigation and it was maintained until the termination of the plasma. As shown in Figure 2(a), core electron temperature, stored energy and Dα signal gradually decrease after Kr injection at 6.0 s. After a sudden increase of core electron temperature at 10 s, electron and ion temperatures and toroidal rotation profiles show strong central peaking (Figure 2(b)), which are the commonly observed feature of an ITB. Both electron and ion heat diffusivities at the plasma core, obtained by TRANSP calculation, also drop significantly after ITB formation, which suggests the reduction of core thermal transport or improvement of core thermal confinement. Two-dimensional radiation profiles obtained by the imaging bolometer diagnostic show off-axis Kr accumulation after ITB formation, while Kr was accumulated mainly in the plasma core before the ITB. Detailed analysis of Kr impurity transport is on-going to investigate the role of Kr impurity on ITB formation.

Country or International Organization

Korea, Republic of

Paper Number

EX/P7-8

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Session Classification: P7 Posters