IAEA FEC 2014

Contribution ID: **81** Type: **Poster**

The Role of Lithium Conditioning in Achieving High Performance, Long Pulse H-Mode Discharges in the NSTX and EAST Devices

Thursday, October 16, 2014 2:00 PM (4h 45m)

The role lithium wall conditioning on the achievement of high performance, long pulse discharges in NSTX and EAST is documented. Common observations include a reduction in hydrogenic recycling, confinement enhancement, and the elimination of ELMs. The plasma confinement and pulse length in both devices improve with increasing lithium conditioning. In NSTX, the impurity accumulation which occurred when natural ELMs were suppressed by lithium conditioning, was ameliorated by triggering controlled ELMs, e.g. with pulsed 3D fields. In EAST, active lithium conditioning during discharges has overcome this problem, producing an ELM-free H-mode with controlled density and impurities.
In NSTX, analysis was done on lithium scans with high δ and κ, more prototypical of the shapes envisioned for NSTX-U. The improvements in pulse length, reduction in recycling, and elimination of ELMs in these highly shaped discharges reflect those with lower shaping. The edge density and pressure gradients were reduced in the outermost 5% of the profile in both the high and intermediate shapes, which is critical for the edge stability improvement. Moreover, while the pressure gradient was reduced, the pedestal broadened, increasing the pressure at the pedestal top and overall performance.
In EAST, the extensive lithium wall conditioning routinely applied via evaporators prior to a run day was integral to the 32 second long H-mode pulse lengths. However, during the course of a run day, the efficacy of the lithium coating can decline, and thus conditioning during discharged by injecting lithium powder into the edge plasma has been investigated. As in NSTX, large ELMs were eliminated, in this case with real time lithium injection. Although the radiated power and edge soft X-ray emission were moderately higher in the discharges with active conditioning, these and the line-averaged electron density remained relatively constant in time, in contrast to the NSTX observations which showed secular rises in these quantities with large lithium doses.
In summary, the results from both devices demonstrate several common benefits of lithium conditioning. The new observation on EAST of a quasi-steady discharge devoid of large ELMs improves the prospects for the applicability of lithium conditioning for future devices, removing one of the obstacles to progress in NSTX experiments.

Paper Number

EX/P6-54

Country or International Organisation

US

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Session Classification: Poster 6