

On access of hybrid scenarios by interplay between core-edge-SOL in KSTAR

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We report the way to access hybrid regime, defined as stationary regimes with $\beta_N \geq 2.4$ and $H_{89} \geq 2.0$ at $q_{95} < 6.5$ without or with very mild sawtooth activities, by core-edge-SOL interplay in KSTAR [1].

To access and sustain the steady hybrid scenario, the evolution of the core q profile should be controlled. Early heating is widely used as a recipe for the hybrid scenario in various tokamak devices [2-4]. It can access the hybrid regime by delaying the current diffusion by moderate heating in the ramp-up phase. Also, the current overshoot approach utilizes an ion temperature gradient (ITG) favorable magnetic shear configuration [5], broadening the q-profile near the connection region between core and pedestal.

A Double null (DN) transition using the dRsep control affects the pedestal stability as well as the density drop resulting in core improvement. This approach exhibits obvious changes in edge localized mode (ELM) characteristics. Also, it can be inferred that the accompanying decrease of the density and increase of the D_{α} baseline level was caused by the change in the SOL transport owing to the strike point change and formation of the ‘active’ upper X-point. Achieved confinement enhancement by these approaches is extensively studied with 0D performance analysis, 1D kinetic profile dynamics, power balance analysis with ASTRA [6], linear gyro-kinetic simulation through GKW [7], calculation of neutral beam heating by NUBEAM [8], and edge pedestal stability analysis based on the Edge

Peeling-Ballooning Mode (PBM) theory [9]. Based on these analyses, a comprehensive confinement enhancement mechanism has been proposed by interplay of core-edge-SOL plasmas (Figure 1a).

Long pulse operation of hybrid scenario has been established with this finding (Figure 1b) and the method to sustain this stationary hybrid scenario in the long pulse is discussed.

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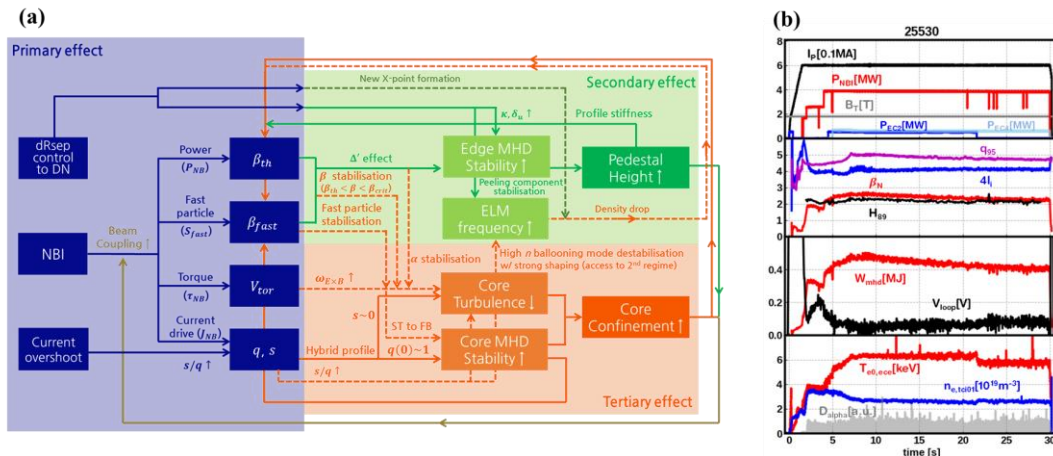


Figure 1. (a) Hypothesis of mechanism of confinement enhancement in KSTAR hybrid scenario and (b) a long pulse hybrid scenario in KSTAR (Shot 25530).