Integrated core performance and heat/particle exhaust with edge transport barriers

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The integration of high-performance core plasma with efficient divertor power/particle exhaust is a critical challenge for today's tokamaks and future reactors. Divertor detachment in H-mode scenario offers a promising solution to the challenge of plasma-wall interactions for steady-state high-performance operation of fusion reactors. The experiments to control the excessively high power load with impurity seeding have been carried out in a number of tokamaks including ASEDX-U, DIII-D, EAST, JET, JT-60U, KSTAR with either tungsten or graphite divertor. Significant progress has been made to improve the core plasma confinement, and thus core-edge integration during impurity seeding assisted radiative divertor or detachment. The comparison of core-edge integration with different seeded impurity species are made, such as neon, argon, nitrogen and so on. The change of edge transport barrier (pedestal) structure due to the control of divertor heat load is investigated in detail. The compatibility of high confinement core and divertor detachment with both ITB and ETB in high beta_p H-mode scenario is introduced, together with the benefit for confinement due to ITB-ETB interaction during detachment. The core high-Z impurity exhaust, which is of great importance for long pulse operation, is investigated with tungsten divertors. In addition to conventional divertor configuration, the power exhaust of alternatively innovative divertor concepts such as X-point divertor, snowflake divertor and compact radiative divertor will also be reviewed. As to the particle exhaust, which is essential for sustainable long pulse particle balance, the active control techniques for steady-state operation will be presented. The effect of fuel particle recycling and recycled impurities on the pedestal behavior will be reviewed.