Study of the advance divertor magnetic configuration
on EAST under steady-state condition

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Heat and particle loads on the divertor are among the most challenging issues to be solved for next step fusion reactor [1, 2]. Alternative magnetic configurations may enable tokamak operation with a lower peak heat load than a standard Single Null (SN) divertor. These papers reports on the control of one of such alternatives - a divertor configuration with two close nulls called Quasi-Snowflake (QSF) [3] and the concept of Fish-tailing divertor on EAST. Up to 20 second QSF have been achieved under nearly truly steady state (vp=0) with injection of lower hybrid waves.

The natures of EAST with limited amount of the shaping coils with limited Ampere-turns and the far coil distances from plasma result in less flexibility and more difficulty in snowflake-like plasma shape. In 2014, a QSF shape with the second null distanced significantly from the primary one has been achieved. An increase of the connection length by ~30% and the flux expansion in the outer Strike Point (SP) region by a factor ~4 has been obtained with respect to the conventional EAST SN discharges, confirming the prediction by CREATE-NL tools [4]. It has been observed that in Low-Confinement (L-mode) discharge the peak of ion saturation current density in Langmuir Probes (LPs) drops once the QSF shape becomes stable compared to a SN case that could indicate a heat flux reduction. Preliminary interpretative 2D edge simulations have been performed using the TEXCY code [5] showing a good agreement between the Infrared Camera (IR) measured and simulated peak heat load that highlight a reduction for this quantity in QSF case, mainly due to the increase of the flux expansion with respect to the SN. In addition, predictive 2D edge simulations highlighted that the heat flux mitigation apparently improves at highest densities, and should be particularly evident with high additional heating power, since a stronger absolute drop of the loads has to develop for the same mitigation factor.

The second option for the heat spread is to use fish-tailing divertor. It is to reduce peak heat flux by fast scan of the strike points in certain amount of the divertor target area by set up a coil located near the divertor target and apply fast AC current. The initial calculation confirmed that if there is 5KA AC
current on a coil with distance of 10cm from the divertor target, heat load could be spread out in a width of 10 cm in a uniform distribution. This would result in the reduction of peak heat flux from 10 MW/m² to 2MW/m². The optimization of this coil location and current is in progress.

In 2015, the shape feedback control has been implemented for the control of the snowflake shape control. Heat flux expansion and higher particle removing rate have been demonstrated. 20-second plasma discharge has been achieved with the stable control of the quasi-snowflake shape.

References