Exotic Plasma Shape on HL-2M

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HL-2M tokamak is now under construction in China as a modification to the HL-2A facility. A powerful plasma shape design tool has been developed on HL-2M. With this tool, not only the conventional shapes (limiter, standard single null, standard double null, snowflake and tripod divertor), but many exotic plasma shapes have been designed. Those exotic shapes include crescent, negative triangularity, leaf, and flatfish.

This shape design tool has a friendly user interface; user can easily get their target shape just by drawing or editing the plasma shape (optionally divertor leg is part of plasma shape if there is one). Up to 5000 points on the plasma shape or divertor legs are used to build the overdetermined system which has a unique minimum-norm-residual solution; this solution is the equilibrium PF current for this plasma shape. GAQ plasma current distribution model are used in this tool. In order to make sure the solution is engineering feasible; a special constraint to minimize the PF current value in the overdetermined system is applied, so the actual solution is the compromise between the target shape and the engineering limit.

The PF current and voltage waveform to reach these exotic shapes have been calculated with a plasma resistive model to estimate the resistive flux consumption. The transition between different plasma configurations (the limiter and the exotic shape) can be simply realized by linearly interpolating the equilibrium component.

The experimental demonstration of these plasma shapes will provide a valuable test bed, not only for the study of plasma confinement and transport, but also for developing control algorithm and improving control performance for fusion reactor in the future.

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