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Super-X Divertor High Power Density Devices

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The Super-X divertor (SXD), a new magnetic geometry that isolates the divertor from the main plasma, can solve the severe heat exhaust problem of fusion reactors as well as next-generation high power density devices. Using axisymmetric PF coils with currents comparable to standard divertor configurations, the SXD places divertor plates at the largest possible radius inside TF coils. This increases the plasma-wetted area by 2-3 times over flux-expansion alone (e.g., plate near main X-point, extreme plate tilting, X-divertor, snowflake divertor). The line length is also increased by 5-10 times. The reduction in core radiation enabled by SXD allows a high-power-density fusion experiment (HPDX), with beta 3 times and power density 10 times that of ITER. The HPDX could operate in the AT mode with R=2.2 m, A=2.5, and elongation 2.4-2.7, and produce 300-400 MW of fusion power during short periods of DT operation (like JET), with Q_{xt} = (fusion power) / (total electrical input) =1-2. HPDX with a Super-X divertor could demonstrate integrated performance with simultaneous high beta, good confinement, stability (including thermal stability for a self-heated plasma), and appropriate heat exhaust, all by means of reactor-pertinent methods.