Utilizing extreme scale HPC for full-f gyrokinetic particle simulation in realistic diverted tokamak geometry[1,2]

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A whole volume core-edge gyrokinetic simulation requires a full-f simulation, in self-consistent multi-scale between background (neoclassical) and turbulence dynamics. The main reason for the necessity of full-f is that the edge plasmas across the magnetic separatrix and in contact with the wall are in non-thermal equilibrium, making the popular delta-f technique inapplicable. Another reason is that the neoclassical physics may be as important as the turbulence physics in the edge region. Such a simulation inevitably requires an extremely large number of particles on extreme scale HPC. Fortunately, HPC has been developing rapidly in the recent years, with the anticipation to being exa-scale in less than a decade. Such a code XGC1 has been developed in the US SciDAC Center for Plasma Edge Simulation (CPES), which is now headquartered at PPPL. XGC1 is designed for leadership class supercomputers and shows efficient scalability up to the maximal available number (~223,000) of computing cores on the fastest scientific computer "Jaguar" in US. Various enabling computational technologies leading XGC1 to the full-f and extreme scale computing capabilities will be discussed, together with the scientific discoveries achieved so far. Developmental plans to utilize the future HPCs will also be discussed.

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