New Supercomputer Capability Enables Turbulence Simulation of Reactor-scale Plasmas

A key issue in designing a fusion reactor is the realistic assessment of the level of turbulent transport for reactor-grade plasma conditions. Up until very recently, this has been done by extrapolating to the larger reactors, the transport properties observed in the smaller size experimental devices. This approach relies on empirical models of transport scaling that have often stirred debates about reliability. Taking advantage of the power recently accessible in new supercomputer capabilities, researchers at the Princeton Plasma Physics Laboratory (PPPL) have now been able to take a major step forward in the understanding of turbulent transport behavior in reactor-sized plasmas by using direct numerical simulations. These advanced simulations have just become feasible because of the recent development of better physics models and efficient numerical algorithms along with the newly available massively parallel computer, IBM SP, at the National Energy Research Supercomputing Center (NERSC) which is the fastest non-classified computer in the world.

Simulation results show that, for plasma parameters corresponding to the present-day experimental condition, turbulent transport level increases with the plasma device size even though fluctuation eddy size remains similar, as shown in the figure. This is consistent with recent fluctuation measurement in DIII-D tokamak. However, for fusion reactor-scale plasmas, the transport level becomes independent of device size. This is a more favorable scaling as the size of the plasma increases and will have important consequence in designing fusion reactor. This work will be featured in papers TR1, UI1.002, and FP1.031. -Contact Zhihong Lin, Princeton Plasma Physics Laboratory, Princeton, NJ 08543 (609-243-3543, zlin@pppl.gov, http://w3.pppl.gov/zlin/simulation).