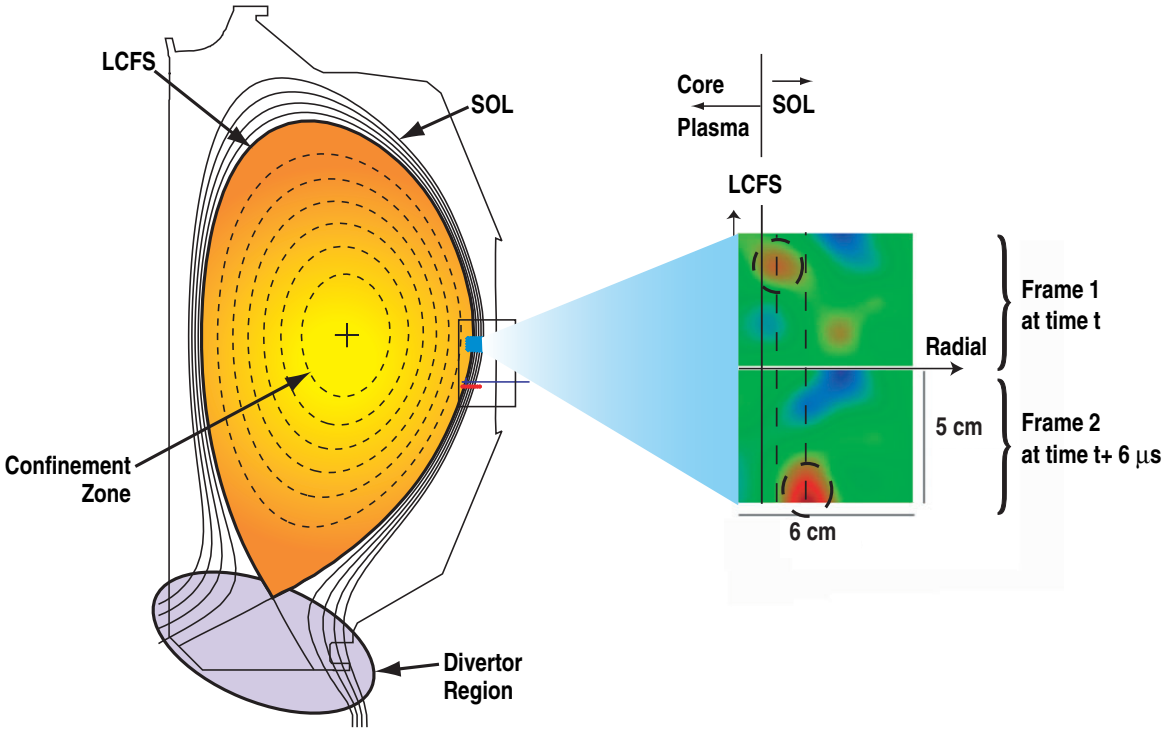
Intermittent Convective Transport In DIII-D Edge Plasmas

The DIII–D tokamak confines a hot plasma using magnetic fields. To isolate the hot, confined plasma from the vessel walls we use a magnetic configuration know as a divertor, which creates a gap, known as the scrape off layer (SOL), between the confinement zone and the wall. A cross section of this configuration is shown on the left side of the figure below. Plasma leaks out of the confinement zone (shown as an orange shaded region) and onto the magnetic field lines in the SOL that intersect the wall in the lower region of the vessel, the region we call the divertor. The conventional picture of plasma flow is that this escaping plasma should flow quickly along the field lines in the SOL to the divertor. This configuration has worked very well, and over the past 15 years many tokamaks using this configuration have made tremendous advances in the ability to confine and heat plasmas. However, recent work on DIII–D has shown that in some cases the rate at which plasma moves across the lines in the SOL is much higher than previously expected, and can cause a relatively large flux of particles onto regions of the wall other than the divertor. Understanding this cross field plasma transport is important to assure an adequate engineering design of the plasma facing wall.

The recent experiments on DIII–D indicate that the cross field transport has a component which is convective (streaming), rather than purely diffusive (random) as previously thought. Data indicate that the particles and energy exit the confined zone as intermittent plasma objects (IPO's) that travel rapidly towards the walls, accounting for 50% of the total cross field particle and energy transport. The frequency and intensity of the IPO's is seen to increase as the plasma density is increased. Although it is not known yet under which conditions these phenomena are dominating the SOL transport, this finding is consistent with previous observations of an anomalously thick SOL in the ALCATOR C-Mod tokamak.



Shown are two sequential time frames viewing the plasma near the SOL. The red zone is a localized region of increased density (IPO) that has moved both radially outward and vertically downward in the 6 μs between frames.

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