Dust divertor shield in a tokamak fusion reactor

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We present the dust divertor shield [1], a new plasma-facing component (PFC) concept which could be used to protect the divertor and exhaust the wall heat load in a magnetic fusion reactor. The dust shield relies on the presence of a magnetic sheath-presheath near the divertor plate and on the dynamics of externally introduced solid particulate or dust grains in such environment.

The magnetic sheath is characterized by a strong electric field perpendicular to the divertor plate and by sonic ion plasma flows. Dust grains externally introduced in the sheath-presheath charge almost instantaneously by plasma collection and electron emission. In the direction perpendicular to the plate, the electrostatic force can balance plasma and neutral drags so that the dust grains can have their equilibrium position in the sheath-presheath. In the poloidal and toroidal directions, the plasma drag is unbalanced, leading to dust motion and acceleration. Thus, dust grains externally introduced at one end of the divertor are naturally circulated by the sheath plasma flow and can be collected at the other end. See Fig. 1. The system can be designed such that the grains will not melt/ablate during their transit across the divertor and therefore will not pollute the plasma. The dust shield can then protect the integrity of the divertor and exhaust the heat load.

Essentially, the dust shield concept replaces the liquid metal wall in the liquid metal PFC concept by solid particulate. Thus, it retains the benefits of a replaceable PFC for a steady-state fusion reactor without the typical problems associated with the liquid metal wall (high vapor pressure and flow drive). We will present preliminary results of our investigation to quantify the physics constraints and engineering design freedom for the dust shield scheme.

[1] X. Z. Tang, G. L. Delzanno, *Dust divertor for a tokamak fusion reactor*, submitted (2009).

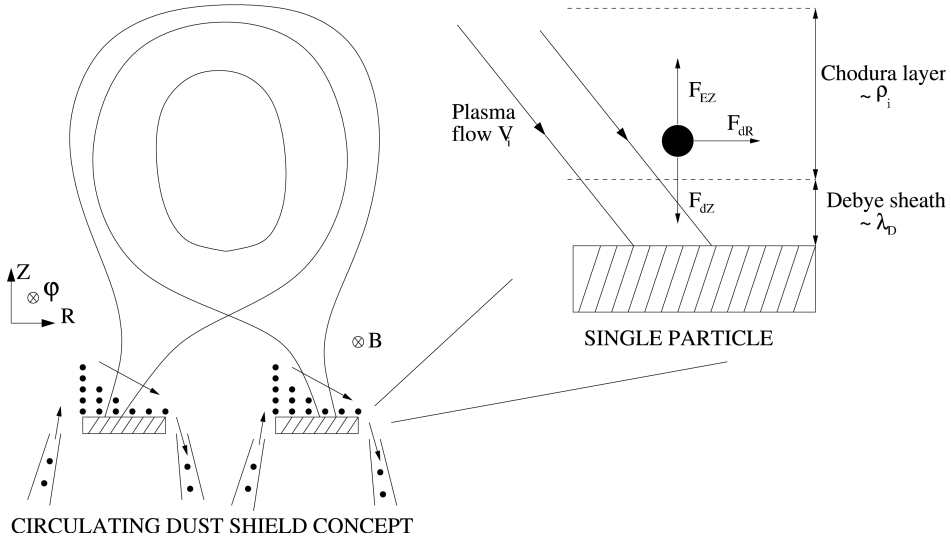

Fig 1: Dust shield concept (left) and single particle perspective (right).