Self-consistent modeling of divertor plasma and target plate for strike-point sweeping scenarios in SPARC

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Operating at 12.5 T on axis, with a plasma current of 8.65 MA and total fusion power of 100 MW, SPARC (presently at a “V1C” design) [1] is projected to have a power exhaust heat flux width of ~0.2 mm with an unmitigated parallel heat flux of up to 30 GW/m² entering the divertor. To handle the divertor heat flux, the current plan is to utilize sweeping of the divertor target strike points [2]. A key aspect of physics involved in strike point sweeping is the delayed response of the material surfaces which release the accumulated hydrogen according to plasma parameters next to the surface, but on its own time scale governed by hydrogen dynamics in the wall [3]. Thus, modeling of strike point sweeping requires solving a complicated plasma-wall coupled problem. To address this, self-consistent calculations are undertaken coupling the UEDGE code for modeling of the divertor plasma dynamics [4] and the FACE code for modeling of heat transfer and hydrogen retention and outgassing dynamics in the wall material [5]. Building on recent progress with UEDGE-FACE coupling in 1D [6], a 2D coupling algorithm is being developed in which multiple instances of FACE are run in parallel to represent “active wall” physics across the target plate surface. Coupling with FACE extends the UEDGE modeling capabilities, allowing one to explore some poorly understood and potentially important issues in divertor plasma modeling. In the present study, the coupled calculations are applied to investigate the impact of dynamic hydrogen recycling on the divertor plasma and target heat load during sweeping of the target strike point in fully or partially detached divertor scenarios in SPARC.