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EX/P5-40: Fast Wave Power Flow along SOL Field Lines in NSTX

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The efficiency of fast wave (FW) heating and current drive can be reduced by a
myriad of edge RF power loss processes in the vicinity of the antenna and in the scrape off layer (SOL), prior to the RF power reaching the core plasma inside the last closed flux surface (LCFS). These processes include sheath dissipation by near fields on and in the vicinity of the antenna, propagation of power on open field lines to the divertor regions, and possibly others. These edge losses subtract directly from the power RF power deposited inside the LCFS and must be minimized in order to optimize fast wave performance generally. On NSTX up to 60% of the HHFW power coupled from the antenna can be lost to the SOL regions [1,2]. A large part of this edge power loss is deposited in bright spirals on the divertor floor and ceiling and can deliver up to ˜ 2 MW/m^2 of heat for ˜ 2 MW of coupled antenna power [2]. In this paper, magnetic field mapping with the SPIRAL code shows that the spirals are caused by HHFW power flowing along open field lines that originate at radii between the antenna and the LCFS. The spiralled geometry occurs because the field lines strike the divertor regions further around toroidally and further inward in major radius as the radii of the lines at the antenna midplane approach the LCFS. Magnetic pitch scans show that the spirals move inward in major radius in the divertor regions at a given toroidal location with increasing pitch, as observed with cameras, tile currents, and Langmuir probes. The magnetic mappings track this behavior quite well. This one-to-one mapping of edge power flow from the SOL in front of the antenna to the divertor region should validate advanced RF codes for the SOL (e.g. [6]) against power flow along the field lines. Such codes then can be used to understand this edge power loss process and to assure minimization of RF heat deposition and erosion in the divertor on ITER.
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[1] J.C. Hosea et al., AIP Conf Proceedings 1187 (2009) 105.
[2] G. Taylor et al., Physics of Plasmas 17 (2010) 056114.
[3] D.L. Green et al., Physical Review Letters 107 (2011) 145001.

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