Crescent-shaped spot modeling of runaway electron synchrotron radiation

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The energy of disruption generated runaway electrons (REs) can reach as high as tens of MeV and they can cause serious damage to plasma-facing surfaces in large tokamaks and ITER (see, e. g., [1]). At the same time, the quiescent RE generation in low density Ohmic discharges allows accurate measurement of runaway electron parameters [2].

For analysis of the synchrotron emission (SE) of REs in tokamaks (case of the finite pitch angle parameter, $v_\perp/|v_\parallel| \sim 1$) the analytical expressions have been obtained in [3] (nonlinear cone model). The motion along tokamak helical magnetic field with the longitudinal velocity $v_\parallel$, cyclotron gyration motion around the guiding centre with the finite transverse velocity $v_\perp$ with respect to the tokamak magnetic field, safety factor *q(r)*, the horizontal displacement of the drift surfaces of electrons with respect to the magnetic surfaces, and the position of the detector are taken into account. The results of [3] are used for qualitative modeling of DIII-D experiment [2] where the SE crescent-shaped spot was observed.

Presented results show that a crescent shape appears for a large pitch angle ($v_\perp/|v_\parallel| \sim 1$) and the relative absence of SE on the magnetic field lfs side is an artifact of the conservation of magnetic moment. These our conclusions confirm the statements of Refs. 2, 4.

Recall that the case of the small parameter $v_\perp/|v_\parallel| \ll 1$ (linear cone model) was considered in [5] and is used for experimental data analysis till now.

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