Simulations of bremsstrahlung and synchrotron radiation from runaway electrons

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The main method for diagnosing runaway electrons in tokamak experiments is to measure the radiation they emit. Both the bremsstrahlung (BR) [1, 2] and synchrotron radiation (SR) [3, 4] emission from runaways is strongly dependent on particle energy, pitch angle and position, and thus provide valuable insight into runaway electron dynamics. In this contribution we present recent developments of the *Synchrotron-detecting Orbit Following Toolkit* (SOFT) [5], which has previously been used to study SR images and spectra [5, 6]. Specifically we present the implementation of BR and the polarization of SR in SOFT, and analyze the effects of first-order corrections to the guiding-center motion.

Due to the strong anisotropy of both BR and SR, the camera images from both types of radiation depend strongly, and in a similar way, on the runaway pitch-angle and radial distributions [6]. The amount of emitted SR however increases with energy, while it decreases for BR, thus causing different parts of the momentum-space distribution function to dominate emission of each type, effectively allowing different parts of momentum-space to be analyzed.

Another technique suggested for acquiring sufficient data to unambiguously infer both the dominant energy and pitch angle of the runaways is to measure the polarization components of SR. We consider its usefulness as a diagnostic technique as well as its implementation in SOFT.

The high energy of runaway electrons is associated with large guiding-center drift orbits which shift guiding-centers away from magnetic flux surfaces and hence modify spatial distribution of runaways. The high energy is however also associated with perturbations to the particles' gyro-motion, which will change the gyro-averaged angular distribution of radiation emitted by runaways and which must also be considered in a consistent treatment. We estimate the relative importance of these effects from a radiation-detection point-of-view and show that they must both be included in a model based on first order guiding-center theory.

References

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