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Runaway electron modelling in the ETS self-consistent core transport simulator

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Relativistic runaway electrons are of major concern in tokamaks. Some nice tools have been developed in the recent decades, but we still miss a self-consistent simulation tool that could simultaneously capture all aspects of this phenomenon. The EUROfusion Code Development for integrated modelling project (WPCD) facilitates integration of different plasma simulation tools this by providing an Integrated Modelling framework (EU-IM) [1], and a standard data structure for communication that enables relatively easy integration of different physics codes. A three-level modelling approach was adopted to runaway electron simulation within the EU-IM [2]. Recently, a number of runaway electron modelling actors have been integrated into this framework. The first level of modelling (Runaway Indicator) is limited to the indication if runaway electron generation is possible or likely. The second level (Runaway Fluid) adopts a similar approach to the GO code [3], using analytical formulas to estimate changes in the runaway electron current density. The third level is based on the solution of the electron kinetics. One such code is LUKE [4] that can handle the toroidicity-induced effects by solving the bounce-averaged Fokker-Planck equation. Another approach is used in NORSE [5], which features full nonlinear collision operator that makes it capable of simulating major changes in the electron distribution, like slide-away. These runaway-electron modelling codes have been integrated into the EU-IM infrastructure, and into the European Transport Simulator (ETS) [6], which is a fully capable 1.5D core transport simulator. ETS with Runaway Fluid could be benchmarked to the GO code implementing similar physics [2]. Coherent integration of kinetic solvers requires more effort on the coupling, especially regarding the definition of the boundary between runaway and thermal populations, and on consistent calculation of resistivity. Some of these issues are discussed in detail providing some proposed solutions.

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