



A study of the runaway relativistic electron avalanche and the feedback theory using GEANT4

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This study investigate the Runaway Relativistic Electron Avalanche (RREA) and the feedback process as well as the production of Bremsstrahlung photons from Runaway Electrons (REs). These processes are important to understand the production of the intense bursts of gamma-rays known as Terrestrial Gamma-Ray Flashes (TGFs). Results are obtained from Monte Carlo (MC) simulations using the GEometry ANd Tracking 4 (GEANT4) programming toolkit. The simulations takes into account the effects of electron ionisation, electron by electron scattering (Møller scattering) as well as positron and photon interactions, in the 250 eV–100 GeV energy range. Several physics libraries or “physics lists” are provided with GEANT4 to implement these physics processes in the simulations. We give a detailed analysis of the electron and the feedback multiplication, in particular the avalanche lengths, λ , the energy distribution and the feedback factor, γ . We also find that our results vary significantly depending on which physics list we implement. In order to verify our results and the GEANT4 programming toolkit, we compare them to previous results from existing models. In addition we present the ratio of the production of bremsstrahlung photons to runaway electrons. From this ratio we obtain the parameter, α , which describe the electron to photon relation.