Corona research and CEST (Corona Simulation Electron Tool)

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The prediction of the electric breakdown thresholds is of paramount importance for the design of RF space systems. The progressive outgassing of the spacecraft systems with the altitude combined with the presence of free electrons in the local environment create the physical conditions to trigger low pressure electric discharges in on board RF systems when the communication equipments are switched on. These charge avalanches are driven by electrons accelerated by the intense RF electric field which ionize the neutral gas atoms or molecules remaining in the open spaces of the communication system and also by secondary emission by energized electrons hitting the walls of the waveguides.

The CEST (Corona Electron Simulation Tool) software models the discharge buildup during the first cycles of the RF wave for both, the low pressure multipaction (below 10^{-4} mB) and the corona breakdown at intermediate pressures (roughly, between 10^{-4} to 10^{-1} mB, which is also denominated collisional multipactor). This software simulates the charge multiplication processes in a simplified model of the waveguide through the numerical integration of the individual trajectories of the electrons. The motions and speeds of electrons are calculated by using the stochastic Langevin equations where the RF field and friction with the neutral gas are the deterministic driving forces and a random force describes the elastic scatter of electrons by elastic collisions with the neutral gas atoms. Both, the impact ionization of the neutral gas and the production of electrons at the walls of the waveguide are considered by means of realistic models accounting for the secondary emission properties of employed materials. The basis of the physical model of CEST will be presented and the differences with previous simulation schemes also will be discussed. The results of the simulations for RF breakdown using CEST recover the previous results for multipactor for low neutral gas pressures obtained with rather different deterministic models and predict fairly well the measured thresholds found in laboratory experiments for corona RF breakdown. The transition from multipaction to corona discharge and the different roles in the charge avalanche of the electrons produced by secondary emission and those originated by electron impact ionization when the neutral gas pressure increases will be also discussed.