# Investigation of X-rays Generated Electromagnetic Pulse on a Spacecraft

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Irradiation of any object by intense fluxes of penetrating radiation leads to emission of electrons from the outer and inner surfaces of the object and to emergence of a system-generated electromagnetic pulse (SGEMP), which can deteriorate radioelectronic equipment. Spacecraft with large amounts of microprocessor equipment in control and communication systems can be especially sensitive to the action of electromagnetic fields. Because of the specific features of their operation, these systems cannot be reliably protected and rapidly replaced upon damage. Experimental investigations of the SGEMP in spacecraft are extremely complicated and are material and time expensive. In this case, a large portion of research is performed using of computational experiments based on mathematical models of generation of electromagnetic fields with allowance for formation of powerful electron fluxes under the action of photon radiation.

This computational technology is based on a hierarchical system of mathematical models consisting of self-consistent one- and two-dimensional models based on the Vlasov–Maxwell equations and a three-dimensional electrodynamic model based on the Maxwell equations and spacecraft models that rather accurately describe all physical processes that are typical of origination of secondary electromagnetic fields and the object geometry.

The simulation of SGEMP phenomena was performed stage by stage with consecutive transitions from simple to more complicated models. The first stage involves the use of one-dimensional self-consistent models, which allow a detailed study of influence of initial data and materials properties on characteristics of the electromagnetic field. At the second stage, numerical experiments are performed with two-dimensional self-consistent models, which take into account the influence of finite size of the object on generation of electromagnetic fields.

The final stage of simulation involves the use of a three-dimensional model for taking into account the mutual influence of individual elements of the spacecraft and the attitude of the latter with respect to the radiation direction; currents obtained in self-consistent calculations with the above-mentioned two-dimensional models of the object are used in this simulation.

Simulation results of an electromagnetic pulse generation on a spacecraft under the action of X-ray and gamma radiation are described.