MULTIPAC 2.1 - MULTIPACTING SIMULATION PACKAGE WITH A 2D FEM FIELD SOLVER FOR A MICROSOFT WINDOWS SYSTEM*

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Abstract

MultiPac 2.1 for Microsoft Windows has been transferred from Linux version successfully. This software is a multipacting 2D simulation package for analyzing electron multipacting in axisymmetric RF structures with TM_{0nl}-mode, such as RF cavities, coaxial input couplers and ceramic windows. The multipacting behaviors of same RF structures have been simulated by using the MultiPac 2.1 of the Windows and Linux versions. The simulated results show that the MultiPac 2.1 of both versions have same outcomes for same RF structures. The installation and operation of the Windows MultiPac, and the way to obtain the MultiPac, have been introduced.

INTRODUCTION

Multipacting in RF structure is a resonant process, in which a large number of electrons build up a multipacting and absorbs the RF power [1]. This process may cause vacuum reduction and field breakdown especially in the high RF components, such as couplers, cavities and windows [2]. During operating a RF cavity, a multipacting could increase the beam emittance. For a superconducting RF cavity, a multipacting may not allow a cavity to increase its field level by raising the incident power, and increasing the dynamic heat load, and even lead a thermal breakdown [3]. In order to research the multipacting phenomena, several multipacting simulation software for 2D and 3D structures have been developed, but only MultiPac and Trak-3D include an electromagnetic field solver [4]. Trak-3D particle-tracking program is a part of a larger commercial electromagnetic package. MultiPac distributes freely for research.

MultiPac 2.1 is a multipacting 2D simulation package for analyzing an electron multipacting in axisymmetric RF structures with TM_{0nl}-mode, such as RF cavities, coaxial input couplers and ceramic windows [5]. It is originally written by P.Ylä-Oijala et al., and works with MATLAB 5.0 or 6.0 on Linux platform. Actually, most scientists and engineers use the Microsoft Windows platform more than the Linux. In order to use this code easily for Windows users, we have transferred the MultiPac 2.1 from the Linux system to the Windows system during designing the PEFP fundamental power coupler [6]. The revised MultiPac can work with Windows MatLab 6.0 or later editions smoothly. In this paper, the MultiPac simulation results of the Windows and Linux systems for the same RF structures were presented, the installation and operation of the Windows MutiPac 2.1 were also introduced.

HOW TO OBTAIN, INSTALL AND RUN THE PROGRAM

Windows MultiPac 2.1 has been running and tested successfully, here we introduce how to obtain, install and run it at Windows platform.

How to obtain it

The program MultiPac is not allowed to be used by any commercial company. In this case a request for calculation can be sent to P.Ylä-Oijala.

For scientific use an e-mail request for register should be addressed to Dieter.Proch@DESY.de, or authors of this paper by E-mail or letter. The program will be distributed via E-mail.

We intend to offer some E-mail help in the case of trouble when running the code. But we cannot act as a "hot line" to cover any start up trouble. Careful reading the manual and running the installed examples is necessary to get acquainted with the code. The program has been tested carefully and should be free of severe bugs. But we expect to make continuous improvements. Therefore information about (hopefully only) minor problems should be communicated to Dieter Proch from DESY. Obvious improvements will be implemented into the code by Pasi Ylä-Oijala and the new release will be send to the registered users. It is strongly recommended not to change the source code by individual users but to communicate back to DESY any idea for improvements.

How to install it

The users obtain a file "MultiPac-Win21.exe" for Windows. Double-click this file, and then follow the install steps as common Windows software.

How to run it

Before running it, a user needs to install a Windows MatLab 6.0 or later editions. Then follow the steps: 1. Edit input files according to the simulation RF structure; 2. Copy the input files to the MultiPac folder; 3. Run MultiPac at MatLab Window and obtain results. How to edit the input files and use the package for multipacting

simulations and some practical advises and examples are given in the user's manual [7].

RESULT COMPARISON BETWEEN LINUX AND WINDOWS VERSIONS OF THE MULTIPAC 2.1

In order to ensure that simulation results are correct, we compare the multipacting electron trajectories of the simulation results between the Windows and Linux versions. Normally, if the multipacting electron trajectories are same, other output results should be same, such as counter function, final impact energy, enhanced counter function etc. The RF structures, that we used, were three examples (*Demo Cavity, Demo Coupler, and Demo Window*), because results of these three examples are known by Linux users.

Figure 1 shows that the output results of the first order multipacting electron trajectory in the *Demo Cavity* by Windows and Linux are the same. In the (A) and (B) of Fig. 1, on the top it is the trajectory in (*r, z*) coordinates, in the middle it is the zoomed plot of the same trajectory and on the bottom it is the trajectory in (*r, t*) coordinates, where *t* is the time in RF periods.
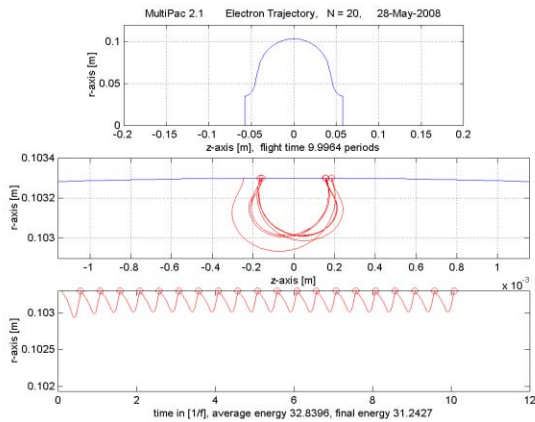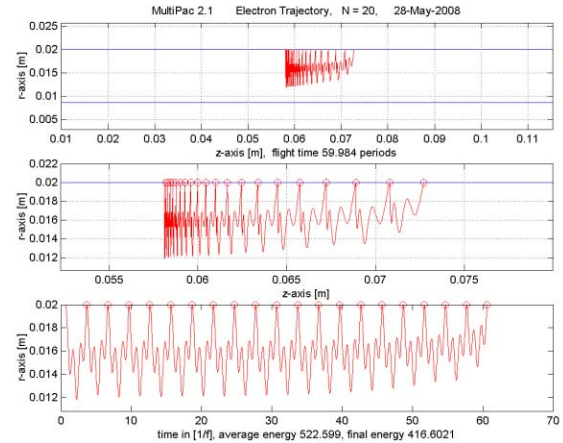

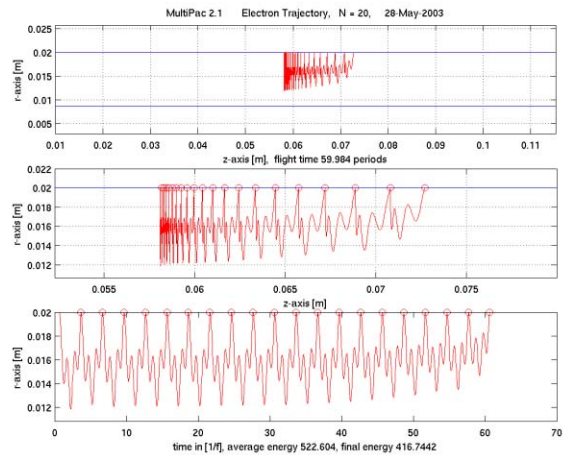(A). Electron trajectory result by Windows MultiPac.
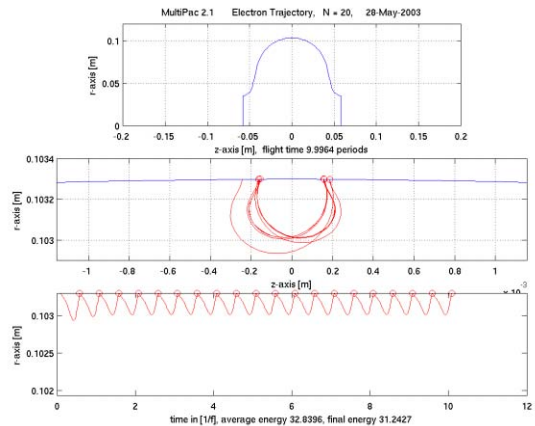
(B). Electron trajectory result by Linux MultiPac.

Figure 1: The two-point first order electron trajectories in a 1.3 GHz TESLA cavity (*Demo Cavity*) when the peak electric field is 47.5 MV/m.

Figure 2 shows that the output results of the third order multipacting electron trajectory in the *Demo Coupler* by Windows and Linux are the same. In the (A) and (B) of Fig. 2, on the top it is the trajectory in (*r, z*) coordinates, in the middle it is the zoomed plot of the same trajectory and on the bottom it is the trajectory in (*r, t*) coordinates. The initial point is on the left hand side and we find that the trajectory is drifting away from the electric filed maximum. The electric filed maximum is at $z = \lambda/4 = 0.057$ m.
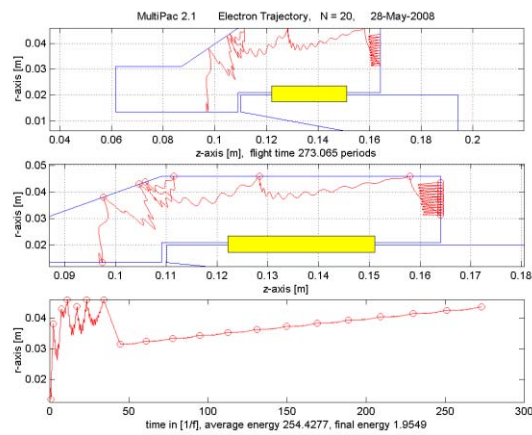

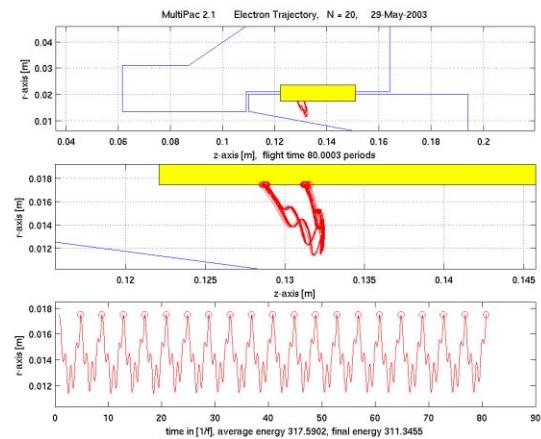(A). Electron trajectory result by Windows MultiPac.

(B). Electron trajectory result by Linux MultiPac.

Figure 2: A one-point third order multipacting electron trajectory in a coaxial line (*Demo Coupler*) with a standing wave when the RF power is 169.9 kW.

A window of a coaxial input power coupler is used to maintain a RF cavity vacuum. Therefore, a multipacting could happen both in the air side (warm window) and in the vacuum side (cold window). The multipacting electron trajectories in the warm window and in the cold window of the DESY type TTF III window (*Demo Window*) have been simulated by Windows and Linux MultiPac, separately; the results are the same, as shown in Fig. 3 and Fig. 4. A little difference in the coordinate range display of the trajectories is caused by the different MatLab versions of Windows and Linux.

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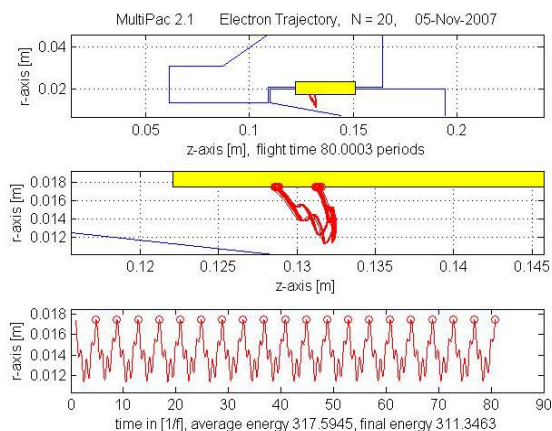(A). Electron trajectory result by MS Windows MultiPac.
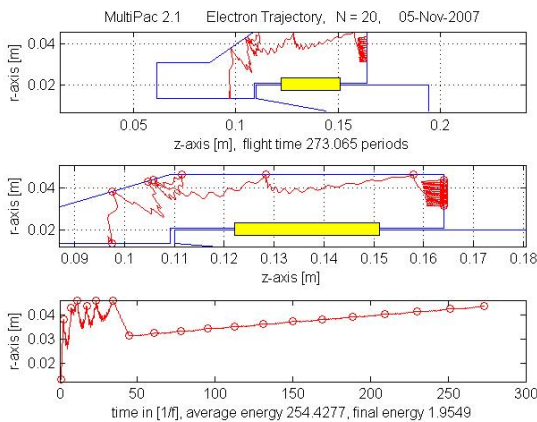
(B). Electron trajectory result by Linux MultiPac.

Figure 3: A one-point four order multipacting electron trajectory in the warm window of the DESY type TTF III window at an RF power of 920 kW.

CONCLUSION

The simulation results for the same RF structures simulated by Windows and Linux MultiPac show that the Windows MultiPac can give the same results as that by Linux MultiPac. The MultiPac 2.1 has been transferred successfully to a Windows platform.

(A). Electron trajectory result by MS Windows MultiPac.

(B). Electron trajectory result by Linux MultiPac.

Figure 4: A one-point four order multipacting electron trajectory in the cold window of DESY type TTF III window at RF power of 920 kW.

ACKNOWLEDGEMENT

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