Multipactor Modeling in 2D for Open Insight into the EM Behavior of Metalic Microwave Components

Tomasz Nalecz[1], Michal Baranowski[2], Malgorzata Celuch[1], Adam Lamecki[3], Lukasz Nowicki[1], Michal Mrozowski[3]

[1]QWED Sp. z o. o., Krzywickiego 12, 02-078 Warsaw, Poland

[2]Faculty of Electronics Telecommunications and Informatics, Gdansk University of Technology, Gabriela Narutowicza 11/12, 80-233 Gdansk, Poland

[3]EM Invent sp. z o.o., Trzy Lipy 3, 80-172 Gdansk, Poland

***Index Terms* — computer simulation, multipactor, secondary electron emission.**

I. Summary

Multipactor is an exponential increase in electron count within microwave components caused by high-power microwave energy within a vacuum environment [1]. Multipactor is usually undesirable, thus designers analyze its likelihood . Due to cost of multipactor experiments, computer simulations are typically used. The Multipactor 2D is soon to be available Open Platform tool which performs two dimensional simulations of electrons dynamics and secondary emission in rectangular waveguide in its height and width plane. The project started within the Polish Space Fellowship Internship Program and is adapted to use surface roughness parameters in a EUREKA-Eurostars 5G Foil project.

The model simulates a rectangular waveguide with variable dimensions, frequency, and power of an electromagnetic signal and with given initial number of electrons.

The simulation model uses equations such as to define field components from power of the signal [2], the differential of the Lorentz equations in time domain [3] for the electron's dynamics and modified Vaughan SEY model [4] to simulate secondary emission of the electrons which depends on the waveguide material and its roughness, the energy of the electron and an angle of the impact. To optimize the algorithm, macroparticles [5] are being used instead of individual electrons.

The power threshold is defined by investigating dynamics of the electrons number in time. The model results were compared with the results from Ansys software [6] in Fig. 1.

For both Multipactor 2D and Ansys software the same case was simulated, except in Ansys restricted length of the waveguide was simulated to come closer to the problem of our 2D solver.

Deviations between the results may be related to the limitations of the 2D simulation. For both models, the multipactor threshold was between 7.5 and 8.5 *kW*. In the case just above the threshold power (Fig. 1), in both simulations we have the same electron number dynamics – a general decrease with cyclical increases, which indicates the possibility of a multipactor. This means that our model, despite its limitations, reproduced the described phenomenon well.

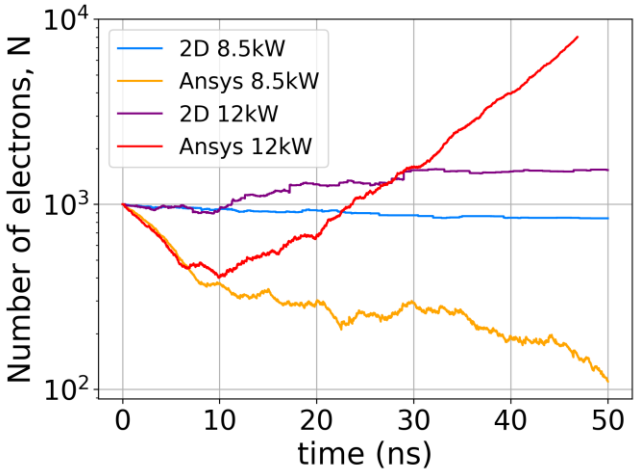

Fig. 1. Example of the Simulations Results for the field power 8.5 *kW*

ACKNOWLEDGMENT

This work continues within the EUREKA-Eurostars 5G_Foil project co-funded by the Polish National Centre for Research and Development under contracts InnovativeSMEs/4/100/5G_Foil/2023 and InnovativeSMEs/4/90/5G_Foil/2023

IV. References

[1] J. Vaughan, "Multipactor," IEEE Trans. Electron Devices, vol. 35, p. 1172, July 1988.

[2] Pozar, D. M. "Microwave Engineering, 4th Edition". Wiley 2011

[3] Y. Li and W. Cui, "Prediction of multipactor thresholds in passive microwave components using an improved simulation method," *2012 9th European Radar Conference*, Amsterdam, Netherlands, 2012, pp. 594-597

[4] C. Vicente *et al,* "Multipactor breakdown prediction in rectangular waveguide based components," *IEEE MTT-S International Microwave Symposium Digest, 2005.*, Long Beach, CA, USA, 2005, pp. 1055-1058

[5] R. W. Hockney, J. W. Eastwood, Computer simulation using particles, New York: McGraw-Hill, 1981.

[6] Ansys HFSS, Ansys 2022