MULTIPACTOR IN ELLIPTICAL CAVITIES 800 MHz

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Abstract

The studies of the multipacting discharge possibility in elliptic single-cell cavities at 800 MHz with three types of hifger order modes couplers were done. The ranges of the field gradients where the conditions for the occurrence of first order multipacting discharge in the equatorial region, as well as the HOM field levels were determined.

INTRODUCTION

It is known that the equator area in the elliptical shape cavities is of the greatest risk in terms of multipactor discharge development where the first and the second orders stable trajectories could exist. In addition, HOM damping components such as corrugations, ribs and chokes can create additional resonance conditions for the development of a secondary electrons avalanche. The results of the multipactor discharge obtained using the three-dimensional modeling code MultiP-M 3D [1] have been published recently [2]. The number of particles percentage increase as a function of the field gradient for three resonator geometries smooth, fluted beam pipe and demountable damped structure are presentedin Figure 1.

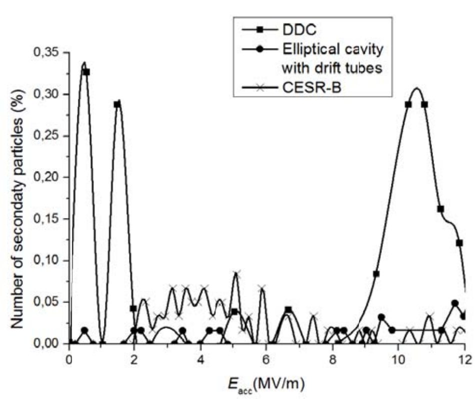

Figure 1: The number of particles percentage increase in the structure as a function of the field gradient for three resonator geometries smooth, fluted beam pipe and demountable damped structure.

For the mentioned structures, the first order trajectories in the equatorial region at low accelerating field gradientsof 2–4 MV/m (the numbers may vary slightly depending on the structure type), are of the highest danger of the multipactor discharge. Such trajectories can be eliminated by an additional purification of the cavity surface and subsequent surface conditioning. Beam pipe geometry doesn't provide any additional resonance conditions to start an avalanche of secondary electrons, except for the notch filter in demountable damped cavity (DDC) structure.

In this paper, we will examine in details the design of DDC and will provide the calculation results of the avalanche increase coefficient for that structure. The calculation was performed in CST Particle Studio [3].

MULTIPACTING DISCHARGE IN DDC

The model and the niobium secondary emission yield (SEY) plot that wereused in simulations are presented in Figures 2 and 3. The calculation of the number of particles increase in the structure as a function of time and different field gradients for demountable damped structure was done for 40 RF periods. The results of this calculation are shown in Figure 4.

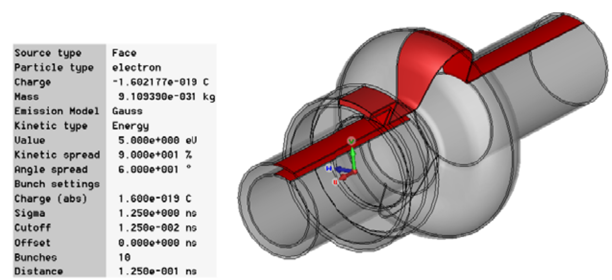

Figure 2: Demountable damped cavity (DDC).

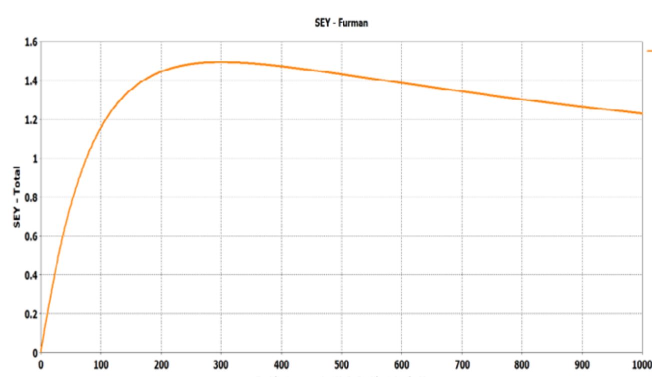

Figure 3: SEY plot for niobium.

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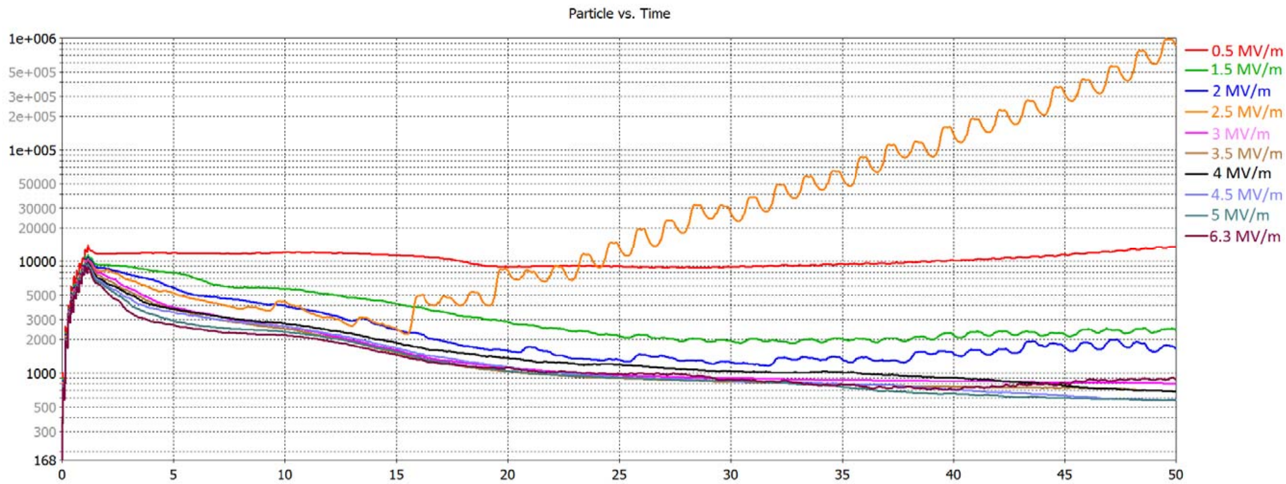


Figure 4: Number of particles increase in the structure as a function of time and different field gradients for demountable damped structure.

Figure 4 shows that the trajectories of electrons are observed in a wide range of accelerating gradients. According to the simulation results, we have calculated the avalanche growth rate (1) for different levels of the accelerating gradient – see Figure 5.

$$N=N_0 e^{\alpha t} \qquad (1)$$

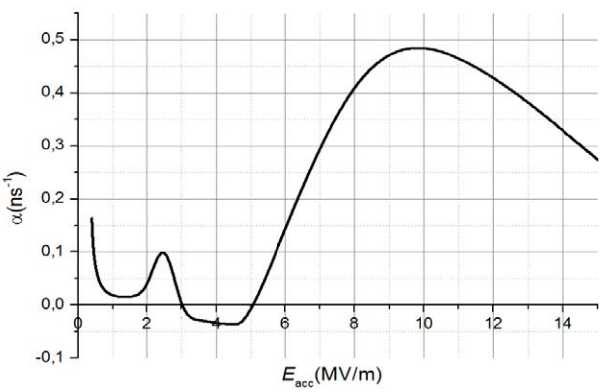
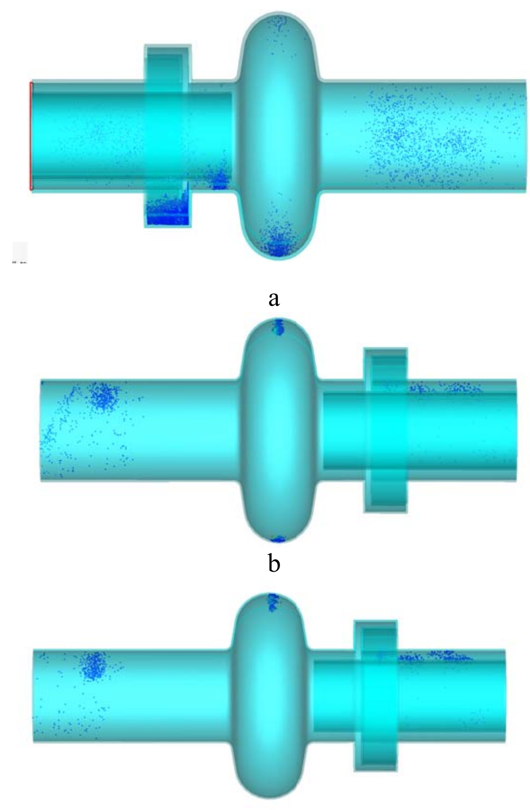


Figure 5: Avalanche growth rate at different levels of the accelerating gradient in demountable damped structure.

The areas with the remaining electron trajectories after 40 RF periods are presented on Figure 5 for different accelerating gradients.At low accelerating gradients, the stable trajectories are observed in the notch filter. The trajectories that remain active after 40 RF periods haveα = 0.16. The particle growth is also observed at the equator and coaxial parts, but is less intense.At high accelerating field gradient of about 7 MV/m, the stable trajectories with α = 0.41are observed in the equator area/. For accelerating gradients higher than 15 MV/m, the trajectories with α = 0.27 are also observed in the equator area of the accelerating cavity..



a

b

c

Figure 6: Regions of secondary electrons that remain active after 40 RF cycles. a) at 0.4 MV/m; b) at 7.5 MV/m; c) at 15 MV/m.

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SUMMARY

The results provided by MultP-M code [2] are in agreement with the results of calculations in CST PS [3]. For low accelerating gradients stable multipacting trajectories are observed in the notch filter and coaxial line of demountable damped structureare. Rate of of its avalanche growth is $\alpha < 0.15$. Such trajectories which correspond tosoft multipactor discharge can be eliminated by an additional purification of the cavity surface and subsequent conditioning. At higher accelerating field gradients of about 7 MV/m, the avalanche growth rate increases up to $\alpha = 0.41$. The operating gradient of this structure is 10 MV/m, so obviously the multipacting discharge can possibly become a problem after reaching the this field level.

REFERENCES

[1] Gusarova M.A. et al. Multipacting simulation in accelerator RF structure // Nuclear Instrument and Methods in Physics Research A. 599. P. 100. 2009.

[2] Ya. Shashkov et al, Comparison of higher order modes damping techniques for 800 MHz single cell superconducting cavities, Nuclear Instruments and Methods in Physics Research A 767, 2014, pp 271–280.

[3] http://www.cst.com

[4] Ya. Shashkov et al, Analysis of Higher Order Modes Damping Techniques for 800 MHz Single Cell Superconducting Cavities, This proceedings.

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