MULTIPACTING STUDIES FOR THE JAEA-ADS FIVE-CELL ELLIPTICAL SUPERCONDUCTING RF CAVITIES

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Abstract

The Five-cell Elliptical Superconducting Radio- Frequency Cavities (SRFC) provide the final acceleration in the JAEA-ADS linac (from 208 MeV to 1.5 GeV); thus, their performance is essential for the success of the JAEA-ADS project. After their optimization of the cavity geometry to achieve a high acceleration gradient with lower electromagnetic peaks, the next step in the R&D strategy is the accurate estimation of beam-cavity effects which can affect the performance of the cavities. To this end, multipacting studies were developed to investigate its effect in the cavity operation regimen and find countermeasures. The results of this study will help in the development of the SRFC models and in the consolidation of the JAEA-ADS project.

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Introduction

- Multipacting (MP) is an undesired resonant effect that limit the performance of the Superconducting RF cavities (SRFC).
- This is main concern for the JAEA-ADS project which employs SRFC to accelerate proton beam from 2.5 MeV to 1.5 GeV.
- To this end, we started the MP studies for the Five-cell Elliptical SRFC in CST Microwave studio.

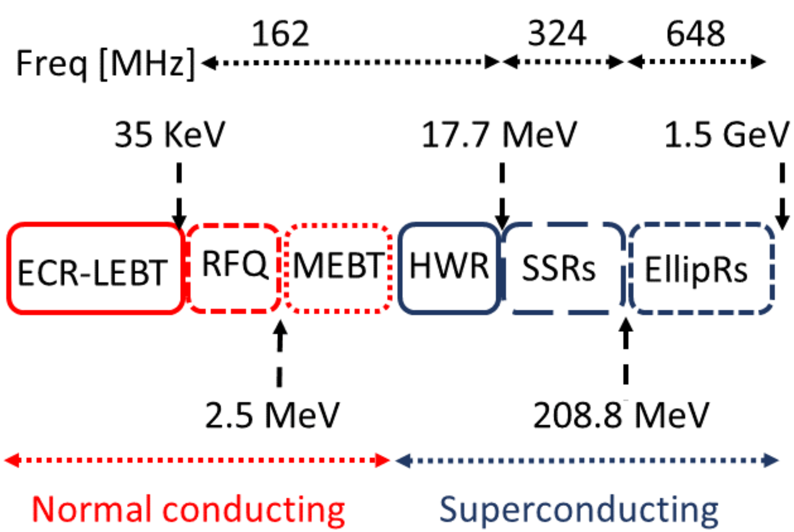


Figure 1: Schematic design of the JAEA-ADS linac.

Table 1: Parameters of the EllipR SRFC.

Parameter	5-cell Elliptical 1 (EllipR1)	5-cell Elliptical 2 (EllipR2)
Frequency (MHz)	648	648
β_g	0.68	0.89
E_{acc} range (MV/m)	2.3 - 13.8	10 - 14.2
Energy range (MeV)	208.8-583.4	583.4-1500

Simulations

The MP studies were done using CST Studio: MicroWave Studio and Particle Studio.

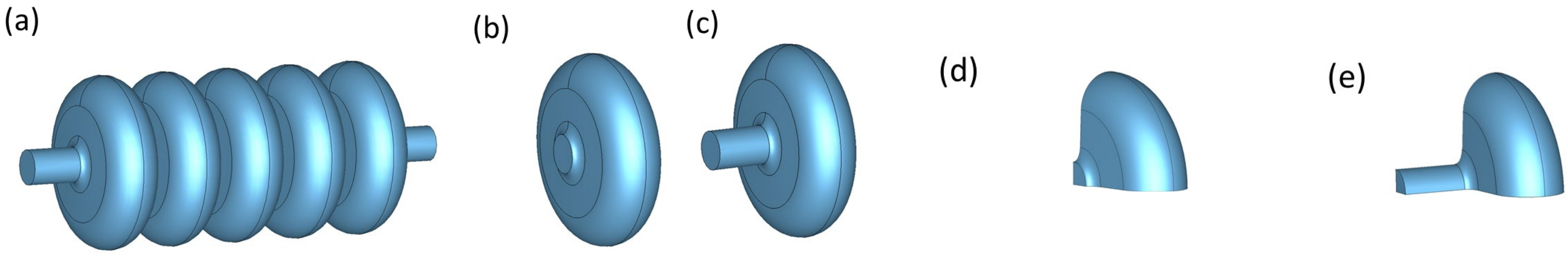


Figure 1: The full cavity geometry of the EllipR1 (a), Inner cell (b), End cell (c), one-quarter Inner cell (d) and one-quater End cell (e).

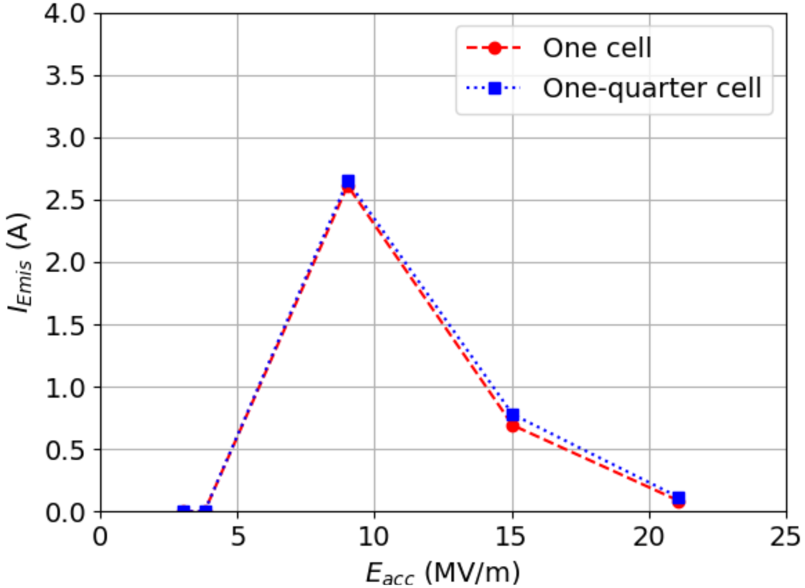


Figure 3: The comparison between one cell and one-quarter model of the Inner cell of EllipR1.

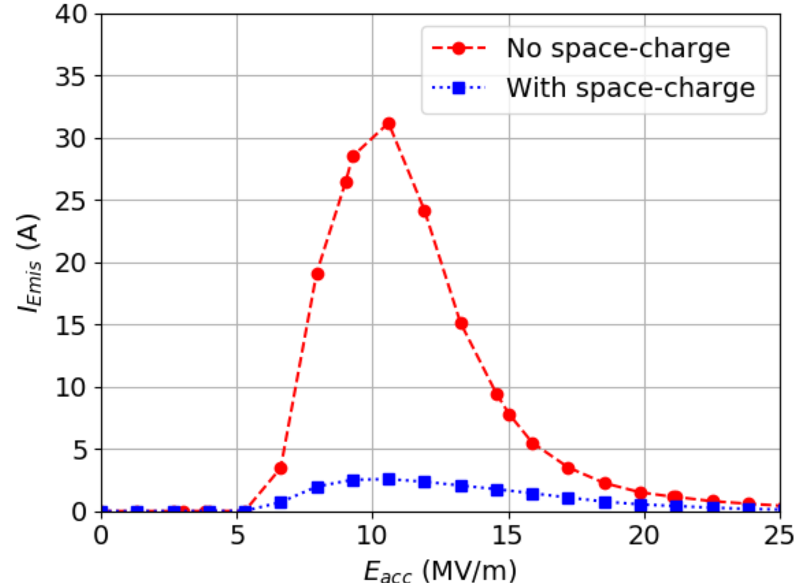
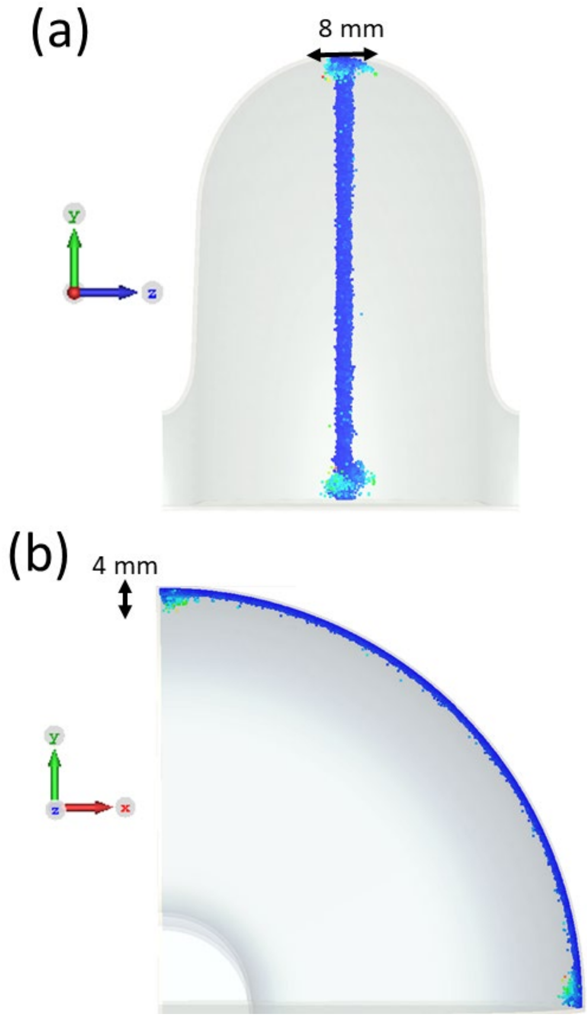


Figure 4: The space-charge effect in the multipacting studies for the Inner cell of EllipR1.

Equator geometry



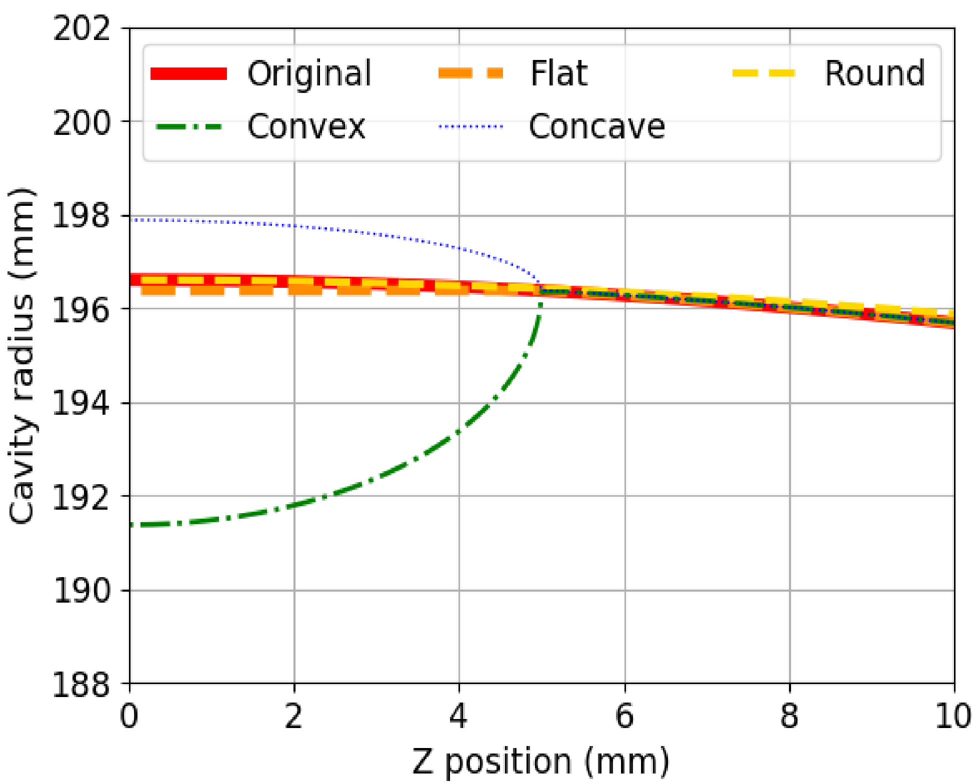


Figure 6: A close up of the cavity profile, yz-plane, around the equator for the different geometries used to analysis the multipacting effects.

Figure 5: The multipacting location in the cell on the yz-plane (a) and on xy-plane (b).

Results

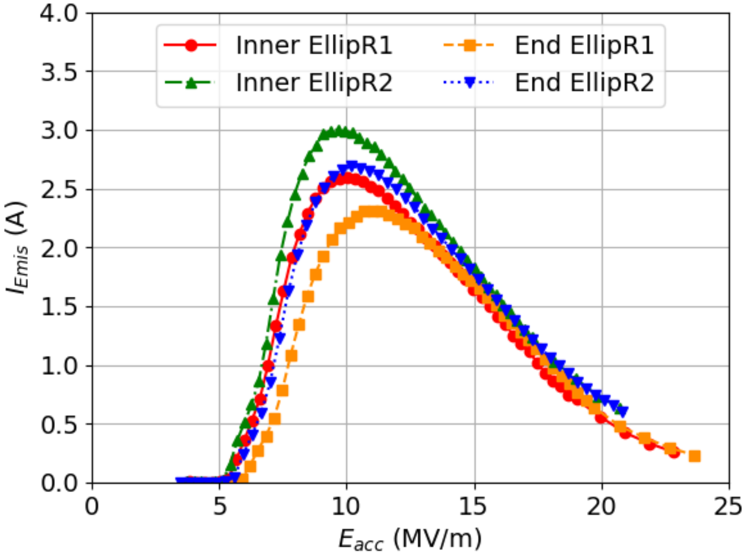


Figure 7: The average I_{Emis} for the Inner and End cells of the EllipRs cavities.

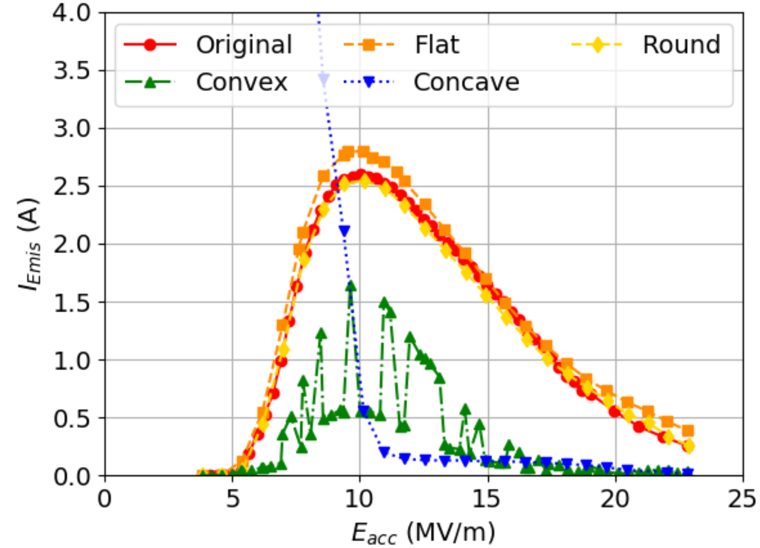


Figure 8 :The average I_{Emis} of the inner EllipR1 for the different geometries.

The geometry effect in the electric field was evaluated by using the geometrical parameter p[1] defined as

$$p = \left({}^{dE_n}/_{dr} \right) /_{\omega B_o}$$

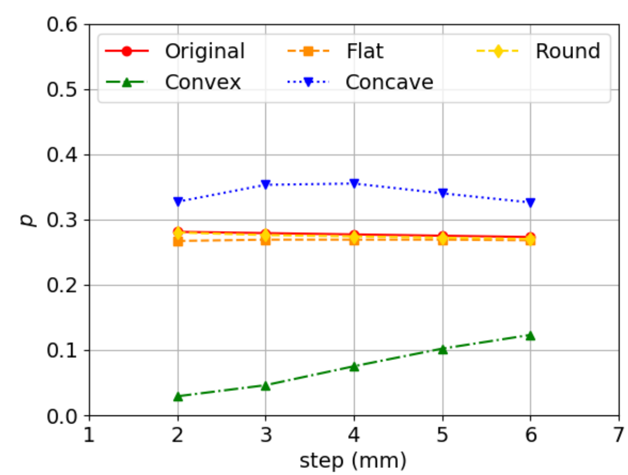


Figure 9 :p values of the Inner EllipR1 for the different geometries.

[1]V. Shemelin, “Multipactor in crossed rf field on the cavity equator”, *Phys. Rev. ST Accel. Beams*, vol. 16, 012002.

Conclusions

- Multipacting is presented in the accelerating gradient operational range of Elliptical cavities.
- Convex geometry reduce the I_{Emiss} peak by 48% to the baseline design.
- This reduction can be related with the decreasing of the p value.
- The convex geometry offers advantage reducing the I_{Emiss} peak, but represents a challenges for the cavity machining.