

FIELD OPTIMIZATION TECHNIQUE OF THE MULTIGAP H-MODE RESONATORS

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Abstract

High frequency optimization of multigap IH-/CH-resonators involves the number of problems to be solved. It is important to obtain high values of effective shunt impedance and uniform accelerating field distribution along the axis. To reach both of these goals design of H-mode resonators contains flat vanes (pylons). This article presents the results of electrodynamic modelling of CH- and IH-resonators in case of zero gap between end walls of the vanes and resonator sidewall [1]. The values of the optimized shunt impedances, Q-factor and field flatness for IH- and CH-designs are presented.

INTRODUCTION

Investigated IH- and CH- cavities were designed for the beam velocities $\beta = 0.1$. The operating frequency of the inter-digital structures is equal to 162MHz. Whereas, CH-resonators operate in 324 MHz band since they are excited at higher operating mode H_{210} . Each cavity type works on π -mode. Cavity design in either case features constant period D along axis and acceleration gap between drift tubes $t = D/2$. Whole structure consists of 9 RF gaps with beam aperture diameter $D_a = 15mm$.

To estimate the field flatness following factor was used:

$$K = \frac{E_{min}}{E_{max}} \cdot 100\%,$$

where E_{min} and E_{max} – on-axis minimal and maximal accelerating field strengths.

ELECTRODYNAMIC MODEL

CH-resonator

As it was mentioned the CH-cavity design includes flat vanes (see fig.1.). Each pylon has one rectangular hole cut out at the last drift tube end. The opposite pylon part is flat but its position is variable and defined by parameter L_{gap} .

First step of the field flatness optimization consists in selection of correct start length of holding rods l_{stem} and correct vane height h_{vane} . It should be mentioned that each l_{stem} value (e.g. $l_{stem} = 35, 40, 45, 50$ mm) could be associated with different pylon geometries defined by h_{vane} . Almost all of these combinations could be tuned to the operating frequency by appropriate geometry of the pylon hole choice. But during selection the necessary geometry from all possible designs the field flatness also needs to be considered: in our case initial K values should lie in the range from 85% to 95%. Dimensions of possible holes could be different: for long rods ($l_{stem} =$

45,50mm) the longitudinal length reaches 110mm (which is quite large regarding $D = 46.3$ mm), for short rod length ($l_{stem} = 35$ mm) they become compact (as it shown at fig.1.). Maximum value of shunt impedance among all l_{stem} values stays unchanged. Thus there was chosen the geometry with short holding rods $l_{stem} = 35mm$, large vane $h_{vane} \sim 100$ mm and compact holes in it.

At the fig.2 the dependence of the field flatness during parametric sweep of L_{gap} is presented. All another geometric dimensions stay fixed.

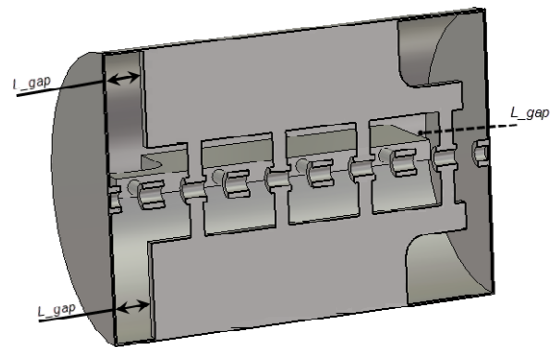


Figure 1: The designed layout. Each vane contains 1 rectangular hole and 1 movable sidewall (positioned by L_{gap}).

From the graph it could be found out that the best field flatness is observed in case of zero gap $L_{gap} = 0$ mm. According to the magnetic field distribution inside such geometry four separated magnetic fluxes around each vane combine in one common flux. Absolute value of magnetic field distribution is presented at fig. 3: the flux turns around the vane at point A, then goes through plane B to point C, makes another turn around vane and then continues the propagation to the point D in similar way.

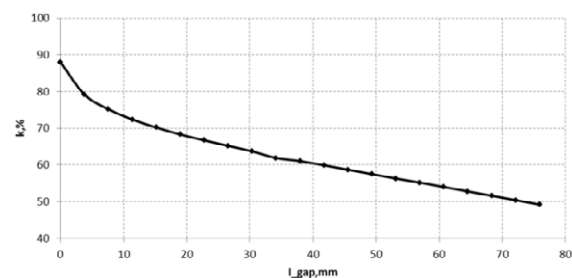


Figure 2: Dependence of the field flatness vs. distance L_{gap} .

Also it should be noted that during parametric sweep resonant frequency and shunt impedance had negligible changes: frequency was shifted from 324MHz

($L_{gap} = 0$ mm) to 328MHz ($L_{gap} = 60$ mm), effective shunt impedance was changed from 86 MΩ/m ($L_{gap} = 0$ mm) to 82 MΩ/m ($L_{gap} = 60$ mm). According to this results it is clear that for such type of resonator the case $L_{gap} = 0$ mm is preferable.

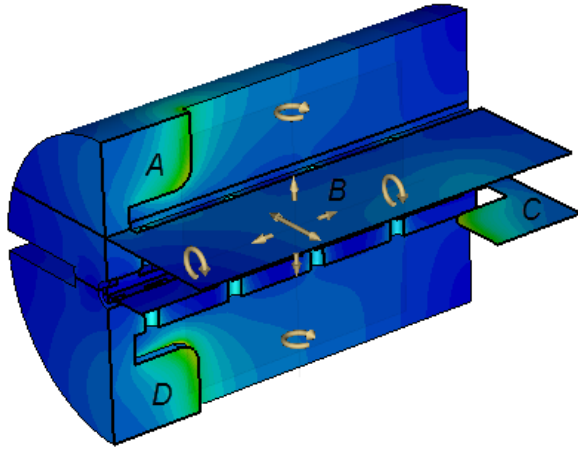


Figure 3: Magnetic field distribution inside CH-resonator.

After preliminary design the final adjustment of the field distribution and electrodynamic characteristics should be performed. That was achieved by optimizing the holes inside the pylons. Right geometry allows one to get 15% increase of shunt impedance with field flatness better than 95%. Electrodynamic characteristics and the field distribution are presented at the table 1 and figure 4 correspondingly.

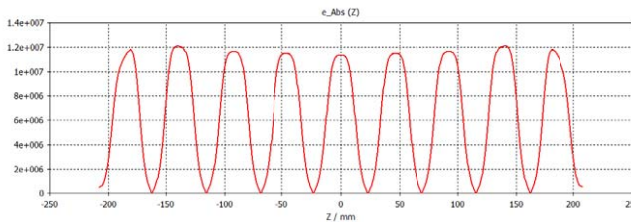


Figure 4: E-field distribution on the axes of CH-resonator.

IH-resonator

The same technique was used for the field tuning on the axis of interdigital structure. The example of final layout is presented at fig.5. Dependence of the field flatness from the parameter has the same behavior as CH-structure (see fig.2.)

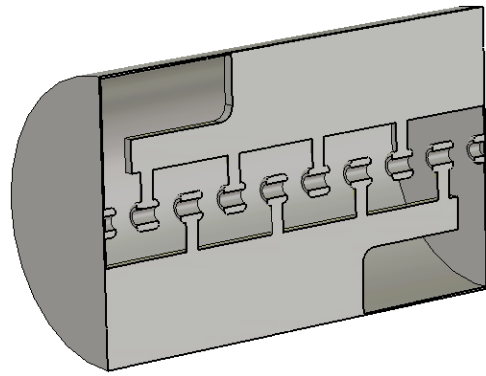


Figure 5: Final IH-cavity layout.

Final tuning was performed by hole in the vane design optimization. Electrodynamic characteristics and the field distribution are presented at the table 1 and figure 6 correspondingly. It should be noted that for IH-resonators operating frequency and field flatness stay fixed with addition or removal of two RF gaps.

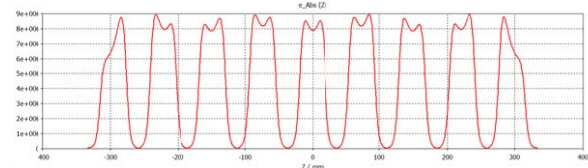


Figure 6: Field distribution on the axes of IH- resonator.

Table 1. Electrodynamic characteristics of CH-/IH-structures.

Parameter	Value	
Type of resonator	CH-	IH-
Operating frequency, MHz	324	162
Number of periods	9	9
Length of the resonator, mm	323,85	647,70
Effective shunt impedance, MOhm/m	91	125
Transit time factor	0,843	0,850
Q – factor	14700	17250
Field flatness, %	95	98

CONCLUSION

Electrodynamic parameters optimization technique for H-mode resonator was developed. Results of numerical modelling are presented.

REFERENCES

[1] P.N. Ostroumov, A. Barcikowski, B. Clift et al. High power test of A 57-MHz CW RFQ. Proc. of LINAC’06, THP079.

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