

TW ACCELERATING STRUCTURES WITH MINIMAL SURFACE ELECTRIC FIELD

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I. INTRODUCTION

In relation to the development of linear colliders requirement appeared in the accelerating structures with high accelerating rate, that can't exceed the value defined by electric break-down. It has been known that electrical strength depends on maximal electric field on the structure surface E_m , which can be connected with accelerating rate E through the overvoltage factor K_m by the equation $K_m = E_m/E$.

As a result of numerical simulation of the different accelerating structures operating in stored energy mode [1] it has been found that K_m depends on the accelerating structure type (TW, SW) and disk edge shape and can be decreased through the change to elliptical disk edge shape. The criterion of ellipticity is its eccentricity $\varepsilon = t/(2h)$ (Fig.1). Note, that parabolic disk edges [2] has similar shape, but in this case overvoltage at points of conjugation between the disk and paraboloid may occur.

In this report we more extensively consider the possibility of the minimal overvoltage factor obtaining in $2\pi/3$ TW structure, that was chosen as an operating in the main colliders projects [3], [4].

II. GENERAL

We carried out the numeric simulation of $2\pi/3$ TW structure (Fig.2). The simulation was made for the various values of aperture $2a/\lambda$, disk thickness t/λ and eccentricity ε . In order for the structure geometric parameters to be in the limits of developing structures, we chose the following ranges of parameters: $t/\lambda = 0.056 \div 0.11$, $2a/\lambda = 0.19 \div 0.457$, enclosing by this means parameters of SLAC [5], NLC [3] and JLC [4].

The numeric simulation was carried out with the computer code SUPERLANS [6], that allows to calculate the traveling waves in axisymmetrical periodical structures with acceptable accuracy.

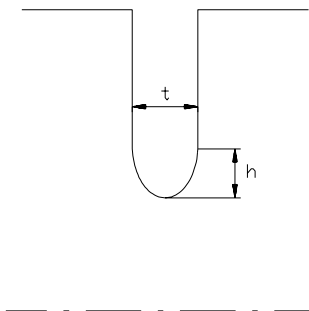


Figure 1. The disk edge geometry.

III. RESULTS

In the Fig.3 the calculated dependences of overvoltage factor K_m from eccentricity ε at various values of structure geometric parameters $2a/\lambda$ and $2t/\lambda$ are shown. Each figure contains curves for three aperture magnitudes at the fixed disk thickness. For convenience the same dependences are shown in the Fig.4, but in this case the curves are grouped together so that the single picture contains dependences for three disk thickness values at the fixed aperture.

As is clear from Fig.1, $\varepsilon = 1$ corresponds to the round edge geometry and $\varepsilon < 1$ – to the more “sharp” one.

For each pair of parameters (a,t) there is an optimal value of ε , at which K_m (i.e. E_m) is minimal, and later eccentricity decreasing leads to the increasing of overvoltage factor. As this takes place the major E_m decreasing (up to 30–40 %) is made possible for the “conventional” structures with rather small apertures (for the group velocity $v_g \simeq 0.01c$). At the largest apertures that are used, for example, in NLC project structure (where $v_g \simeq 0.1c$), E_m decreasing doesn't exceed 5–10 %.

It is reasonable that disk thickness increasing allows some more decreasing of E_m .

In deciding on a structure geometric parameters (a,t) it should be realized that they make a great influence on the shunt impedance Z value. As an illustration in the Fig.5,6 dependences of shunt impedance from a and t are shown. This curves correspond to the operating frequency 11.4 GHz (as in [3], [4] projects) and round disk edge shape. As our calculations show, the eccentricity doesn't make the appreciable influence on Z and v_g .

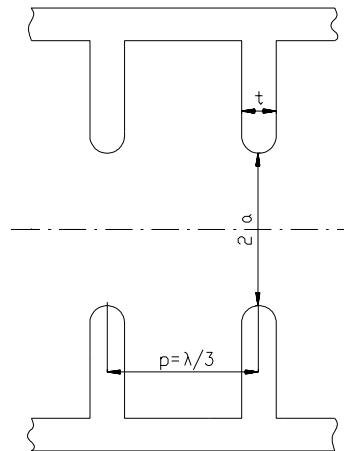


Figure 2. Schematic cross section of $2\pi/3$ TW structure.

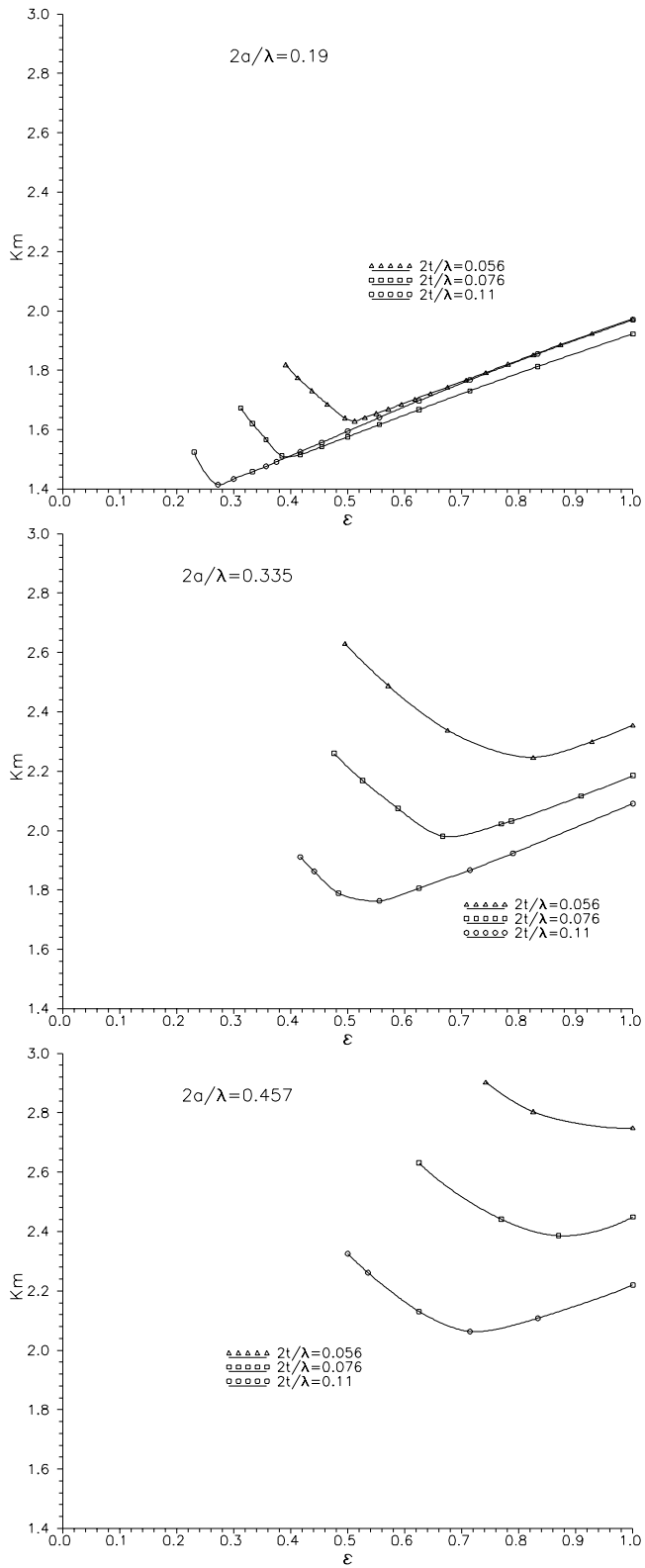


Figure 3. Overvoltage factor against eccentricity for various t/λ at fixed apertures.

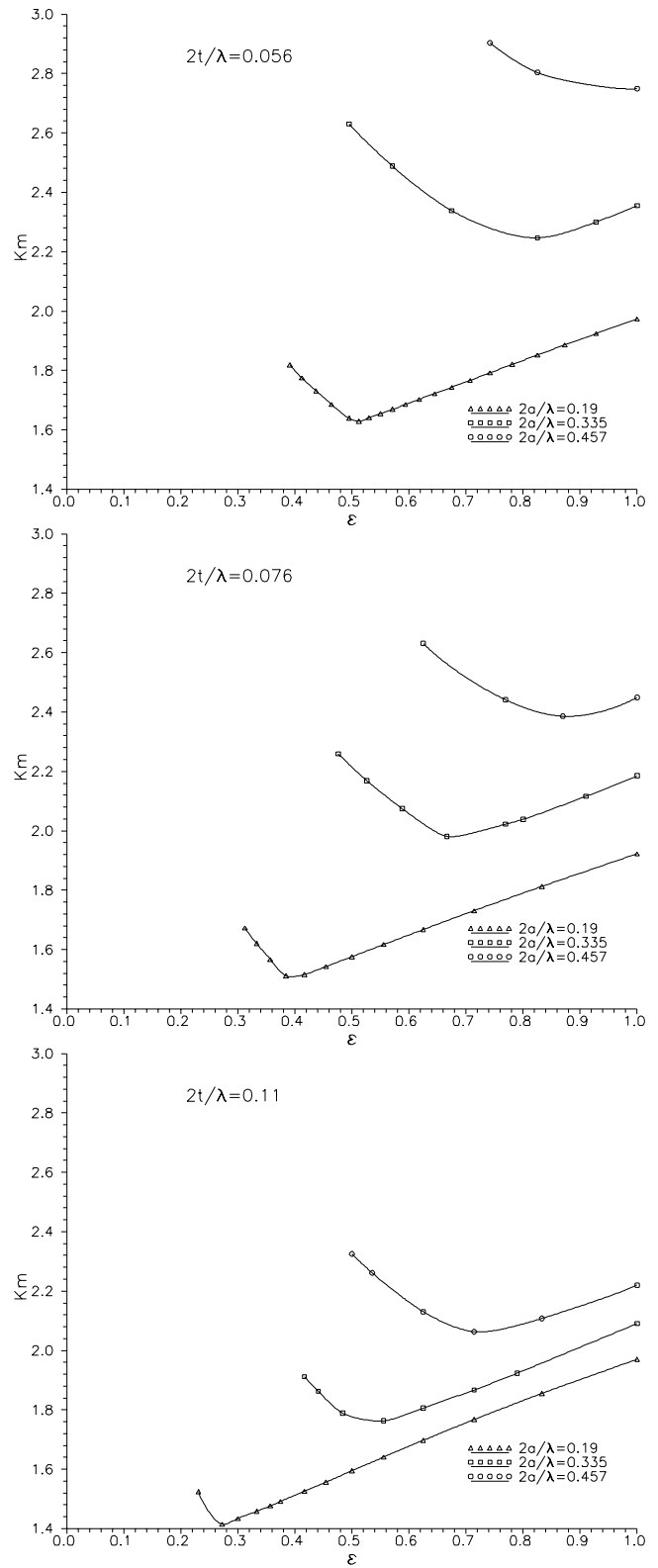


Figure 4. Overvoltage factor against eccentricity for various $2a/\lambda$ at fixed thickness.

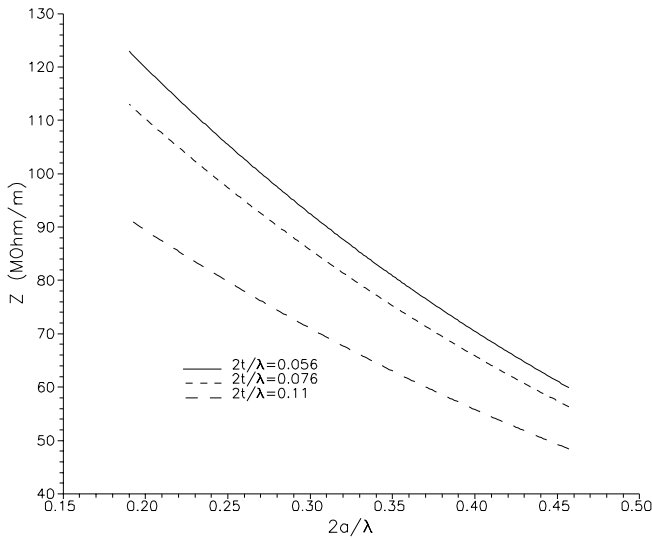


Figure 5. Shunt impedance against aperture for various thickness.

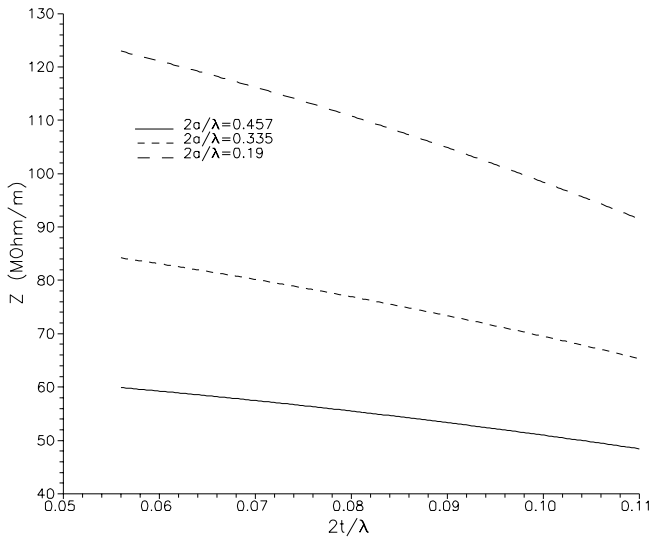


Figure 6. Shunt impedance against thickness for various apertures.

IV. CONCLUSION

Our research displayed that in TW accelerating structures the maximal surface electric field decreasing (i.e. increasing of the structure electrical strength) can be obtained through the choosing of optimal disk edge shape. For “conventional structures” with rather small apertures the E_m decreasing can be as great as 30–40 % practically at the same value of shunt impedance. For structures with enlarged apertures (NLC-type) this effect is more weaker and comprises 5–10 %.

References

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