A Ka-band Relativistic Sheet Electron Beam Traveling Wave Tube Using Electric Coupling Input Structure

Yabin Zhang[1], Zhanliang Wang[1], Yubin Gong[1]* and Jinjun Feng[2]
[1]National Key Laboratory of Science and Technology on Vacuum Electronics, University of Electronic Science and Technology of China. Chengdu, Sichuan, China, 610054 (E-mail: ybgong@uestc.edu.cn)
[2]Beijing Vacuum Electronics Research Institute, Beijing 100015, China

Abstract—An electric coupling input structure has been proposed for a Ka-band relativistic sheet electron beam traveling wave tube (TWT). This kind of new input structure is easily to be realized and can facilitate the experiment process very much. The results show that this kind of new structure has a good transmission characteristics. The reflection coefficient S_{11} is less than *-25dB* from *30GHz* to *40GHz* and the transmission coefficient S_{21} is bigger than *0.05dB* at the same frequency range. The Ka-band relativistic sheet electron beam TWT with the new kind of input structure, can produce more than a MW pulse radiation.

I. INTRODUCTION

THE sheet electron beam vacuum electron devices have gained widespread notice because they can work at larger current with weaker space-charge effect and have the advantages to generate higher power, higher frequency microwave radiation[1]. Before that, we have done some researches on the relativistic sheet electron beam TWTs with waveguide input structure[2]. However, it's hard to do the experiment because it is difficult to adjust the tube location. A feasible electric coupling input structure is put forward to make the experiment easily, which is shown in Fig. 1.

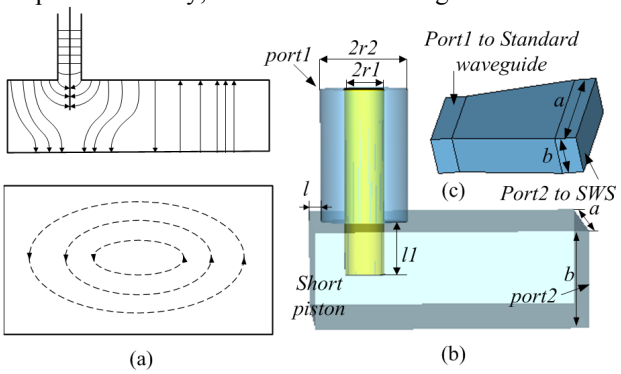

Fig. 1. The (a) sketch map and (b) vacuum model of the Electric coupling input structure for TE_{10} mode. (c) the waveguide input structure for comparison.

There are mainly three methods to stimulate TE_{10} mode in the rectangular waveguide[2]. Instead of the magnetic coupling and mixed coupling method, we select the electric coupling method as it is wideband, simply design and easily match.

In Fig. 1, a and b are waveguide's width and height respectively, while the radius of the probe is r_1 and the length reached into the waveguide is l_1. The distance l is for adjusting the position of the short piston. The outside coaxial radius is r_2.

Because the value of a is very large for relativistic sheet beam TWT because of its large electron beam current, so we set *9* modes to be considered for higher accuracy during the calculation.

II. RESULTS

After optimization, the geometric parameters are given in table *I* while the performance of this electric coupler is shown in Fig.2. The transmission loss S_{21}> *-0.05dB* and the reflection parameter $S_{11} < -25$ *dB* are achieved from *30GHz* to *40GHz*. The high-order modes are not easily motivated.

Table I. the geometric parameters of the coupler.

a	*10mm*	l_1	*2mm*
b	*3.6mm*	r_2	*1.63mm*
r1	*0.74mm*	*l*	*0.33mm*

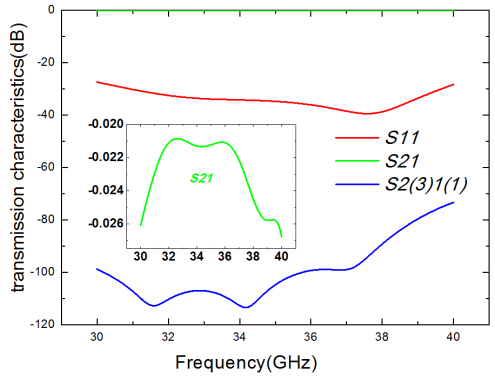

Fig. 2. The transmission characteristic of the coupler.

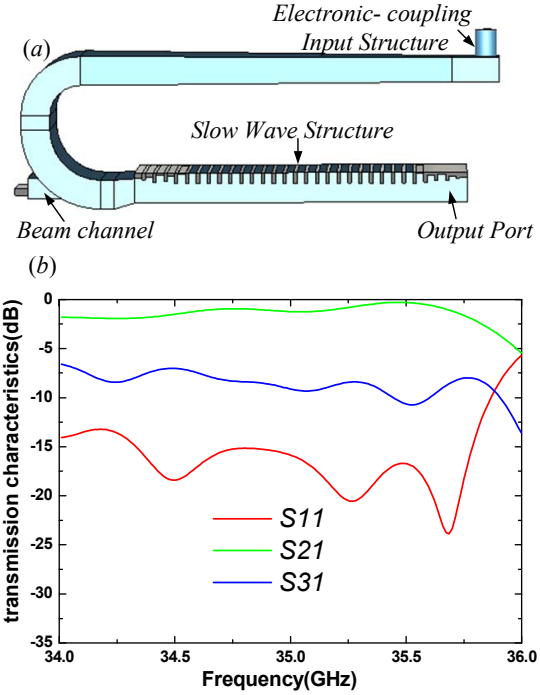

Fig. 3. (a) the model of TWT (b) The transmission characteristic of the RTWT

The transmission characteristic of this RTWT with the electric coupling input structure and the whole tube's transmission characteristic are shown in Fig.3. This tube mainly include the electric coupling input structure, the beam channel, the slow wave structure the output structure and the transition structures between them.

The transmission loss S_{21}> *-3dB* and the reflection parameter $S_{11} < -15$ *dB* are achieved from *34.5GHz* to *35.5GHz*.

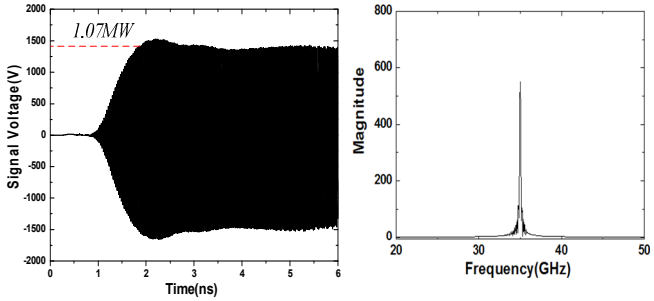

Fig. 4 the voltage signal of the radiation and the FTT result

With an input signal of *5KW*, the TWT using this coupler can generate a pulse radiation with an average power of *1.07MW* which is shown in Fig.4.

III. SUMMARY

In this paper, an electric coupling input structure has been designed which is proved to be suitable for high power relativistic sheet electron beam TWT. Using this input structure a *1.07MW* radiation is obtained at *35GHz*.

IV. ACKNOWLEDGEMENTS

This work is supported by the National Science Fund for Distinguished Young Scholars of China (Grant 61125103) and National Key Lab Foundation of China (Grant No.CEMEE2014K0206B) and by the Fundamental Research Funds for the Central Universities (Grant No.ZYGX2013J054 and No.ZYGX2013Z002).

REFERENCES

[1]. Zhanliang Wang, Yubin Gong, et al, "High Power Millimeter Wave BWO Driven by Sheet Electron Beam", IEEE Transactions on Electron Devices, vol. 60, no. 1, pp.471-477 JAN, 2013.

[2]. Yabin Zhang, Zhanliang Wang, Yubin Gong, et al, "Ka-band Traveling Wave Tube Driving by Relativistic Sheet Electron Beam," IVEC, 2015.

[3]. Huang Hongjia. "Microwave theory". Beijing: Science Press, 1963.