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RESEARCH ON THE NEW CAVITY STRUCTURE OF RFQ ACCELERA-TOR WITH BENT VANES AT IMP

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ABSTRACT

A new cavity structure of RFQ accelerator with bent vanes has been proposed at IMP. The new structure can reduce the lateral dimension of the cavity and possesses simple cooling structure in the low frequency field. In this paper, the dynamics of an 81.25 MHz bent-vane RFQ has been designed as a prototype device of the bent-vane RFQ. The 2D EM simulation of the bent-vane RFQ has been performed.

1 INTRODUCTION

In order to overcome the disadvantages of four-rod and four-vane RFQ in the CW condition and the low frequency band, we put forward a kind of new RFQ accelerator structure called bent-vane type RFQ at Institute of Modern Physics (IMP), Chinese Academy of Sciences. The bent-vane type RFQ combines the advantages of four-rod type RFQ and four-vane type RFQ. It significantly reduces the lateral dimension of the cavity in the low frequency field and has a water-cooled system with a simple structure and sufficient cooling efficiency.

DYNAMICS DESIGN

The beam dynamics design of the bent-vane RFQ is simulated by the code RFQGen. Taking into account research requirements and cost, the design parameters of the bent-vane RFQ are listed in Table 1.

Table 1: The design parameters of the bent-vane RFQ

Parameter	Value
Particle	He^+(q/A=1/4)
Frequency(MHz)	81.25
Beam current(mA)	5
Input energy(keV/u)	4
Output energy(keV/u)	42.5
Vane voltage(kV)	70
Vane length(mm)	533.76
Kilpatrick factor	1.73
Transmission efficiency(%)	96.9

2D EM SIMULATION

Table 2: The parameters of the bent-vane RFQ cross-section

Parameter	Value	Parameter	Value
r_0	5.347 mm	L	275 mm
ρ	0.75	R_V	20 mm
α_1	10 Deg.	α_2	5 Deg.
L_1	10 mm	R_w	40 mm
L_2	5 mm	L_4	10 mm
R_{b1}	5 mm	R_{b2}	5 mm
L_3	10 mm		

The cross-section profile is important in the bent-vane RFQ EM design, which is shown in Fig. 2. The cross-section geometry of the bent-vane RFQ is defined with 13 independent variables. Their Preliminary optimization values are listed in Table 2.

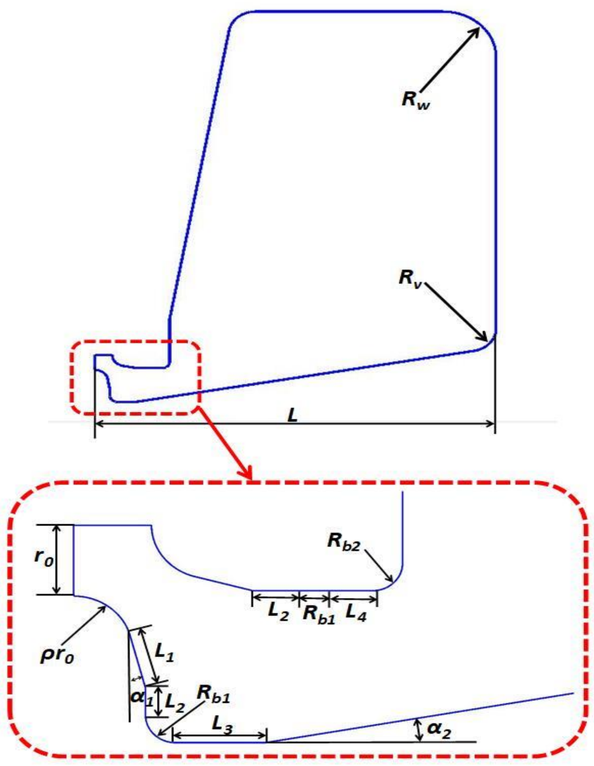

Figure 2: The cross-section profile of the bent-vane RFQ.

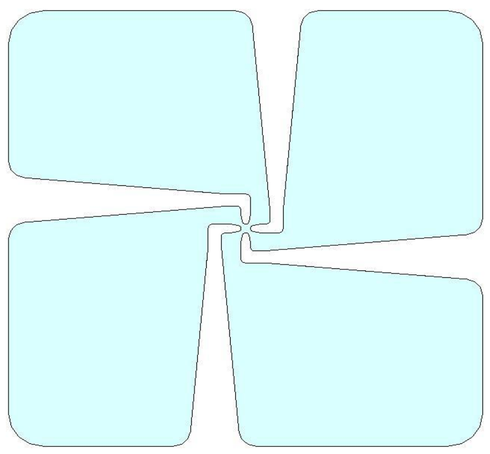

Figure 3: The slice model of the bent-vane RFQ.

Particle beam can be accelerated, focused and bunched in TE210 mode. In the bent-vane RFQ, TE210 mode is found in electrode tip, shown in Fig. 4.

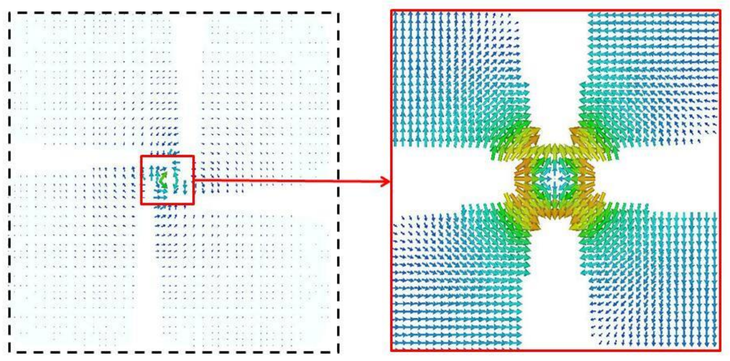

Figure 4: The electric field distribution of the bent-vane RFQ.

The final RF parameters of the slice model of the bent-vane RFQ are listed in Table 3

Table 3: The RF parameters of the slice model

Parameter	Value
Frequency	81.246 MHz
Nearest dipole mode frequency	79.569 MHz
Quality factor	18446
Peak electric field	16.06 MV/m
Power loss	11.59 W/mm
L	279.11 mm

CONCLUSION AND FUTURE PLAN

A new cavity structure of RFQ accelerator is proposed called the bent-vane RFQ at IMP. The dynamics of an 81.25 MHz bent-vane RFQ has been designed as a proto-type device of the bent-vane RFQ. The 2D EM simulation of the bent-vane RFQ has been performed. The cross-section geometry of the new structure is defined with 13 independent variables. The TE210 mode is verified in the bent-vane RFQ. The slice model RF parameters are simulated and achieved. 3D simulation and Multi-physics study will be performed in the near future.