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DEVELOPMENT OF AN HALF-CELL ACCELERATING STRUCTURE IN TSINGHUA *

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Abstract

We designed and fabricated a new half structure accelerator of 12 cells for exploring new fabrication method. The considering of alignment is unnecessary by milling two half of the accelerator separately. The gap between the two halves will damp the wakefield [1]. The frequency of the accelerator is 11.424 GHz, and the phase advance of each cell is 120°. We have fabricated this half-cell accelerator and the RF measurement results are presented.

INTRODUCTION

The half structure accelerator is a novel manufacturing method proposed by CERN which makes the accelerator much more convenient to assemble and reduces the fabrication cost. The gap between the two halves affects the surface field and 1 mm gap is the result of optimization in Ref [2]. The high precision milling of 3 µm tolerance are used in the fabrication to keep the structure close to the model in CST [3]. The RF measurement results show a good agreement with the simulation, both the electric field distribution and the S_{11} curve.

RF DESIGN

Single Cell Design

Figure 1 shows a quarter of the single cell model in CST. The eigen-mode frequency of the cavity is 11.424 GHz with a phase advance of 120°. We optimized the surface electric field at the iris for the high gradient performance.

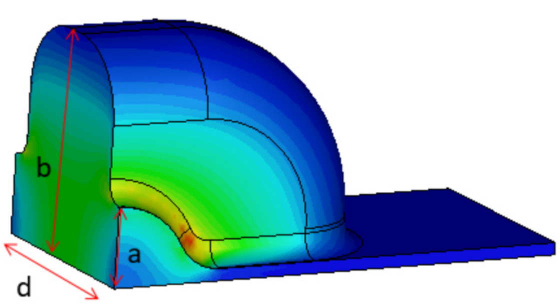

Figure 1: The single cell model in CST.

Table 1 presents the parameters of the cavity.

Table 1: Parameters of Single Cell

Parameters	Unit	Value
Frequency	GHz	11.424
Q		7283
2a	mm	3.31
2b	mm	9.39
d	mm	8.75
Group velocity	c	0.0198
R/Q	Ω/m	13528
Surface max E / axial E		1.9

Cavity Chain

There are 10 regular cells and two matching cells in the structure as shown in Fig. 2. The S_{11} at different frequencies can be found in Fig. 3.

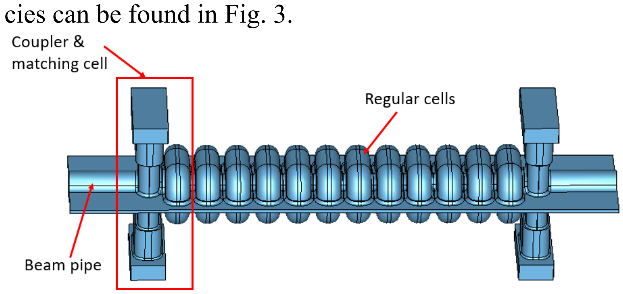

Figure 2: Cavity chain.

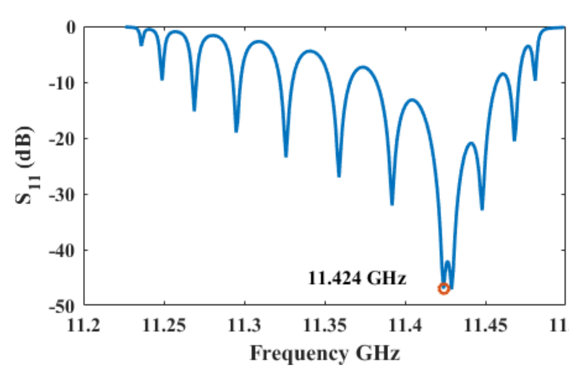

Figure 3: S_{11} versus frequency.

The reflection at the input port of the coupler is -47 dB and there are 12 peaks in the S_{11} curve correspond to different modes of the cavity chain. The filling time the accelerator is 17 ns and group velocity 0.0198 c. The axial electric field of each cell in Fig. 4 is uniform, which means the favourable performance of the coupler and matching cell.

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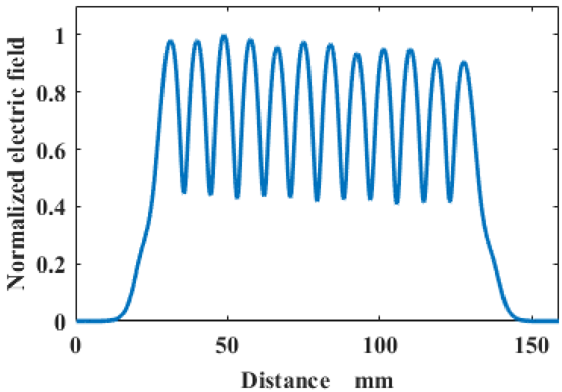

Figure 4: Axial electric field.

MECHANIC DESIGN

Figures 5 and 6 show the inside view of the two halves and the cross view of the accelerator with waveguides and flanges. There is a pot on one half for the solder when brazing. Two circular waveguides at the end of beam pipe will connecting with CF35 flanges. A water jacket will surround the accelerator for cooling.

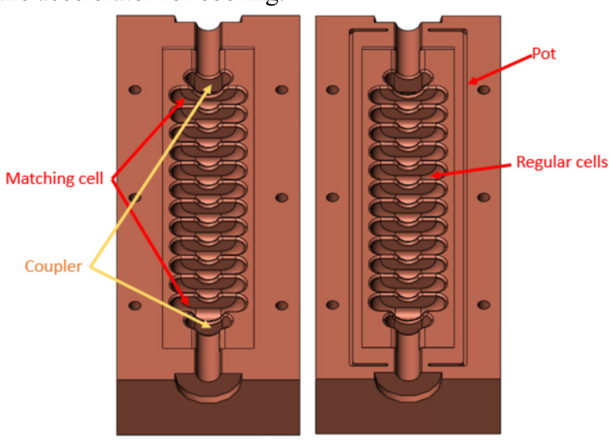

Figure 5: The two halves.

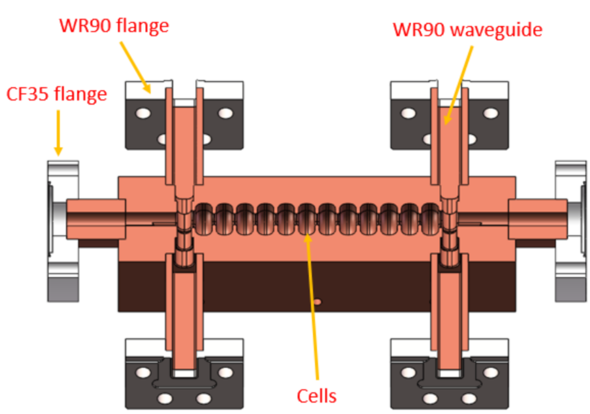

Figure 6: The cross section.

COLD TEST RESULTS

The RF measurement was conducted with a Rohde & Schwarz ZVA 40 VNA in Fig. 7. Two clamps fixed the flanges of the accelerator and VNA cables. A stepping motor pulls the bead for the testing for electric field of each cell. The room temperature is 21.4 °C.

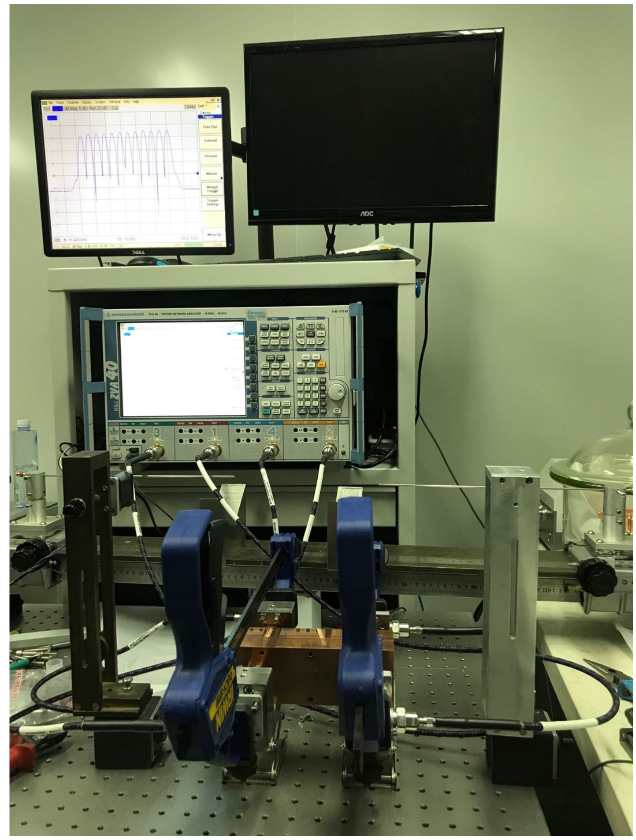
Figure 7: The photograph of bead pulling.

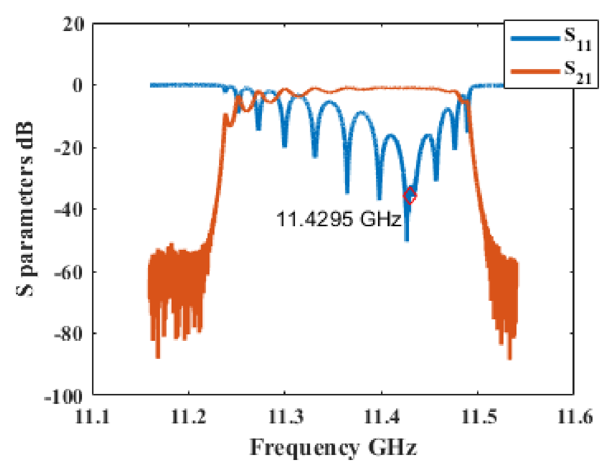

Figure 8: Frequency versus S_{11} and S_{21}.

We first get S_{11} and S_{21} curves by frequency sweeping. The S_{11} and S_{21} are -35.98 dB and -0.942 dB at the working frequency 11.4295 GHz. There are 12 peaks in Fig. 8 responds to the peaks in the simulation results in Fig 3. The S_{11} in complex plane is shown in Fig. 9. The frequency of $2\pi/3$ mode is 11.4295 GHz and has a shift of 5.5 MHz comparing to the one in Fig. 3, but it is acceptable for the high power test. The Q of the structure calculated by S_{21} is 6700.

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The peak near 2π/3 mode can be clearly distinct, which the milling is precise enough.

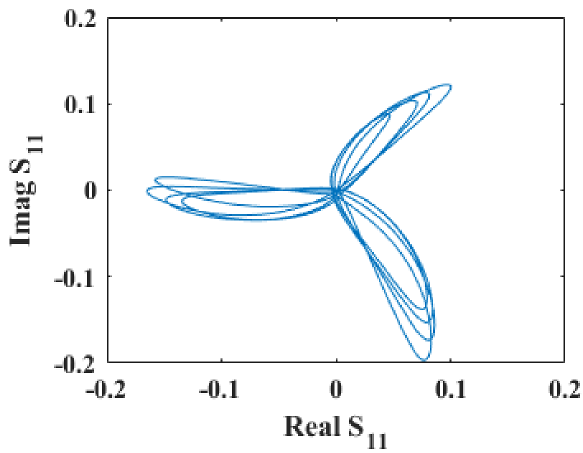

Figure 9: S_{11} in complex plane.

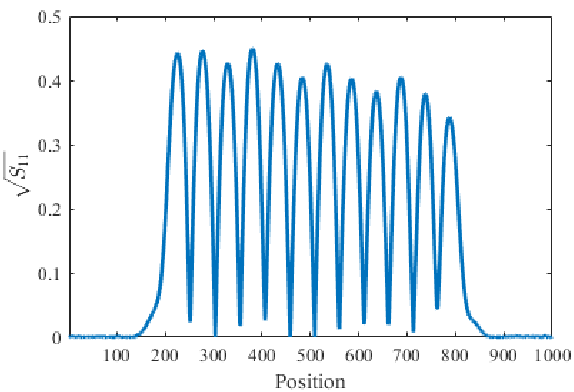

Figure 10: Axial field distribution.

The electric field on axis measured from bead-pull method is shown in Fig. 10. The field distribution of cold test shows favourable accordance with simulation. However, there is very small reflection from output matching making a standing wave pattern.

CONCLUSION

The first half-cell structure of 11.424 GHz has been designed and fabricated in Tsinghua University. Cold test of the accelerator shows favourable accordance with the simulation results. The structure will be brazed and high gradient test will be conducted on the X band high power test facility of Tsinghua University. The half-cell structure will be a considerable option of accelerator designing in the future.

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