COUPLER DESIGN FOR X-BAND HYBRID DIELECTRIC-IRIS- LOADED ACCELERATOR*

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Abstract

The coupler design for X-band hybrid dielectric-iris-loaded accelerator has been studied. Firstly, the S parameter versus the coupler cavity radius b, the iris aperture w and its thickness h has been simulated by Microwave Studio for the ordinary coupling cavity due to its simplicity. We have obtained the primary experiment result of the standing-wave ratio of the coupling cavity being 1.82. Secondly, the new coupler with the dual symmetric coupling ports , which first converts RF from TE to TM mode in a pure metal section and then a tapered transition section is added for high efficiency transmission to the dielectric accelerator section, has been calculated. The simulated results show that it is capable to convert the rectangular TE_{10} mode into circular TM_{01} mode with high efficiency.

INTRODUCTION

Coupler is an important part of the accelerator structure. The efficient delivery of power from RF sources to the accelerating structure depends crucially on the coupler cavity. The coupler geometry is intrinsically three-dimensional, make the design of the coupler cavity a nontrivial problem. We calculated the transmission properties of the ordinary coupler by Microwave Studio and made the measurements for the x-band hybrid dielectric-iris-loaded accelerating structure. To avoid the RF breakdown in the vicinity of the coupling slot for the new structure, the new scheme similar to reference [1] was studied in calculation. A tapered dielectric section is added to transmit RF power into the dielectric accelerator section, which makes the coupler independent of the dielectric properties. Otherwise, two coupling ports were adopted in order to eliminate field asymmetry in the coupler region and to minimize the BBU effects.

SIMPLE COUPLER DESIGN AND MEASUERMENT

Figure 1 shows the geometry for the simple coupler. The model plot is presented in figure 2 by Microwave Studio. It consists of two identical coupler cavities and two regular accelerator cavities. The coupler cavities are fed by BJ-100 rectangular waveguides. The operating frequency is chosen to be at X-band around 9.37GHz. Accordingly, the dimensions of the regular cells in our model have been designed for that frequency at the $2\pi/3$ phase advance per cell. The dimensions of the accelerator cavities are shown in this proceeding [2].

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As shown in figure 1, the tapered waveguide has been used to connect the coupler cavity and BJ-100 waveguide. The length of the tapered waveguide is 50.00mm. Its smaller aperture dimensions are 18.00mm and 3.60mm. The dimensions of the couplers are different in order to fulfilling the matching and tuning requirements. There are three dimensions to be determined: the coupler radius b, the iris aperture w and its thickness h. Assuming that the iris thickness h is held fixed, the design program is then to choose the two remaining dimensions in such a way that the matching and tuning are optimal.

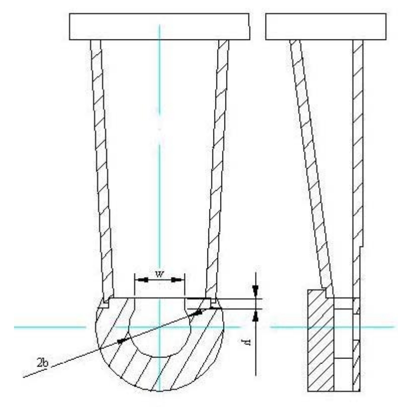

Figure 1: Sketch of the simple coupler

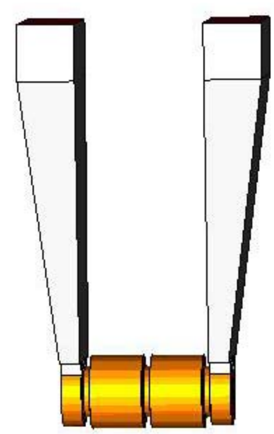

Figure 2: Model plot in using Microwave studio

Figure 3 shows the reflection coefficient S_{11} vs. the iris aperture w for different value of coupler radius b at the input waveguide port. The results show that when b is equal to 6.10mm and w= 7.46mm, S_{11} is -28.09dB.

Based on the calculated results, the components of couplers have been made (figure 4). Lower-Power testing for the couplers was shown in Figure 5. SWR is measured with Network Analyzer Hp8722D under the condition of the coupler cavity radius b being held 6.10 mm and w

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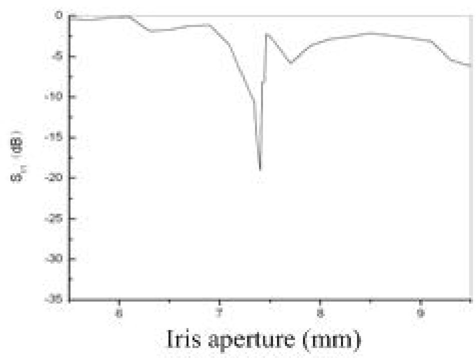
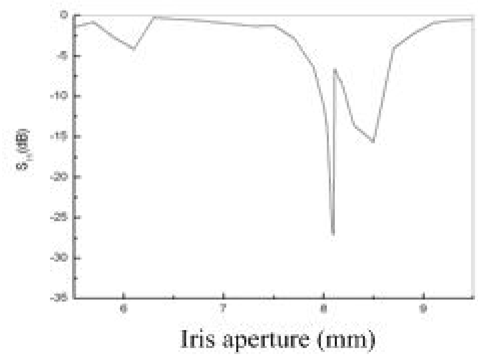
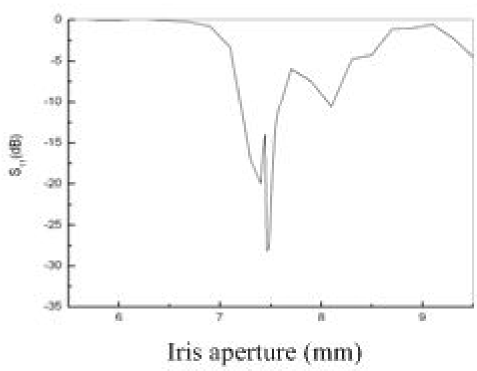


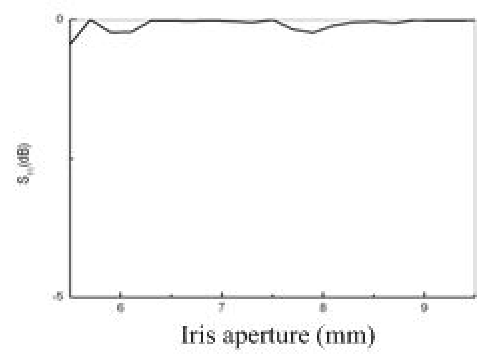
（a）b=5.20mm



(b) b=5.80mm



(c) b=6.10mm



(d) b=6.40mm

Figure 3: The calculated values of S_{11} vs the coupler widths

Figure.4: The components of the couplers

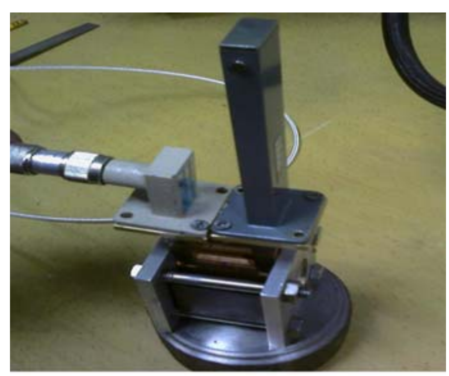


Figure.5: Lower-Power testing for the couple

being adjusted. The experimental results show that when w is equal to 7.4mm，SWR=3.84. By increasing the value of w, SWR gets smaller. We got the experimental result of SWR =1.82 with w=8.00mm. The deep experiment investigation is in progress

DUAL SIDE SYMMETRIC COUPLER WITH THE TAPERED TRANSITION

The new scheme is shown in figure 6. To assure that no powers are transmitted through one port to other and also no apparent reflection from the port, the dimensions of the coupling iris (w and a), the length of the tapered transition section (d) and the distance between the location of coupling iris and the end of the circular waveguide (l) were adjusted. When w=16.0mm, a=5.0mm, d=80.0mm, l=12.20mm and the coupling cavity radius b=13.45mm, the S parameters of the dual side symmetric coupler structure are given in figure 7. As shown in figure 7, S11 is approximately equals to S21 in amplitude at 9.37Hz, and the phase difference between S11 and S21 is about 175.4^0 .Under the above conditions, the SWR in BJ-100 was found out to be about 1.0 9 at 9.37GHz.

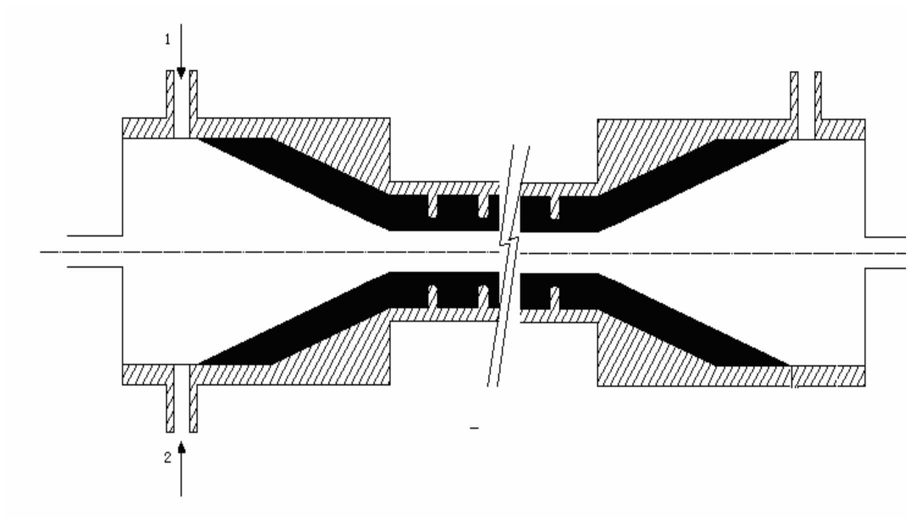


Figure 6: Scheme of the dual side coupler

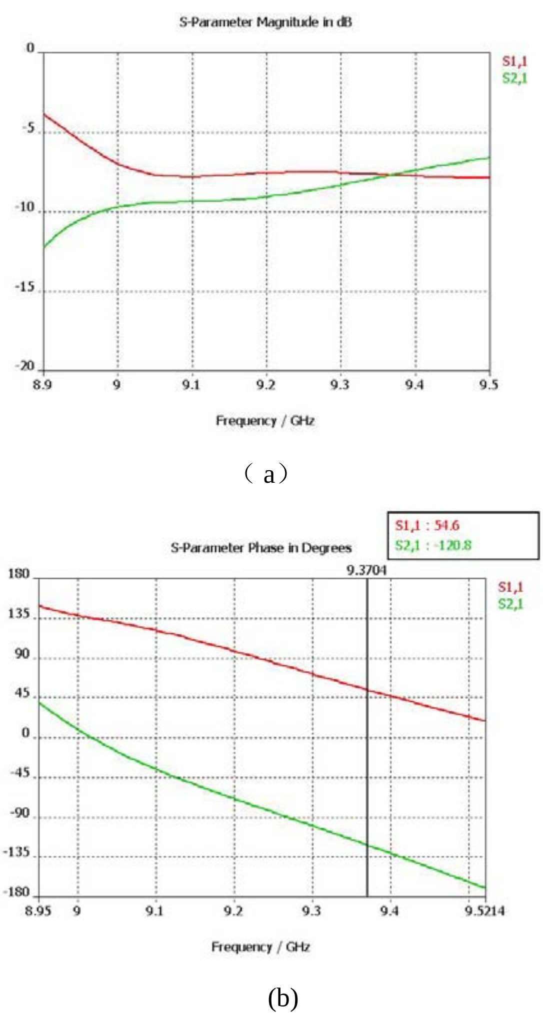


Figure 7: S parameter of dual side coupler

(a) Magnitude of S parameters (b) phase of S parameters

SUMMARY

The S parameter versus the coupler cavity radius b, the iris aperture w and its thickness h has been simulated by Microwave Studio for the ordinary coupling cavity. We have obtained the preliminary experiment result of the standing-wave ratio of the coupling cavity being 1.82. The dual side symmetric coupler, which first converts RF from TE to TM mode in a pure metal section and then a tapered transition section is added for high efficiency transmission to the dielectric accelerator section, has been calculated for the new structure. The simulated results show that it is capable to convert the rectangular TE_{10} mode into circular TM_{01} mode with high efficiency.

ACKNOWLEDGMENTS

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REFERENCES

[1] Wanming Liu, Wei Gai, Design of dielectric accelerator using TE-TM mode converter.

[2] Cong-Feng Wu, Lin Hui, Wang Lin, etc., Model cavity investigations and calculations on HOM for an X-band hybrid dielectric-iris-loaded accelerating structure, Proceedings of the 2007 Particle Accelerator Conference.

