*Author's Email:
linzeqiang@impcas.ac.cn

The study of high power couplers for CIADS*

Z.Q. Lin†[1], T.C. Jiang[1], S.C. Huang, R.X.Wang, T. Tan, Z.Q. Yang, C.L. Li, Y.L. Huang, S.X. Zhang, Z.H. Xue, M. Lu[1], F. Pan[1] and Y. He, Institute of Modern Physics, Lanzhou, China
1also at University of Chinese Academy of Sciences, Beijing,China
Y.M. Li, GLVAC Industrial Technology Research Institute of High Power Devices, Kunshan, China

ID: MOP073

ABSTRACT

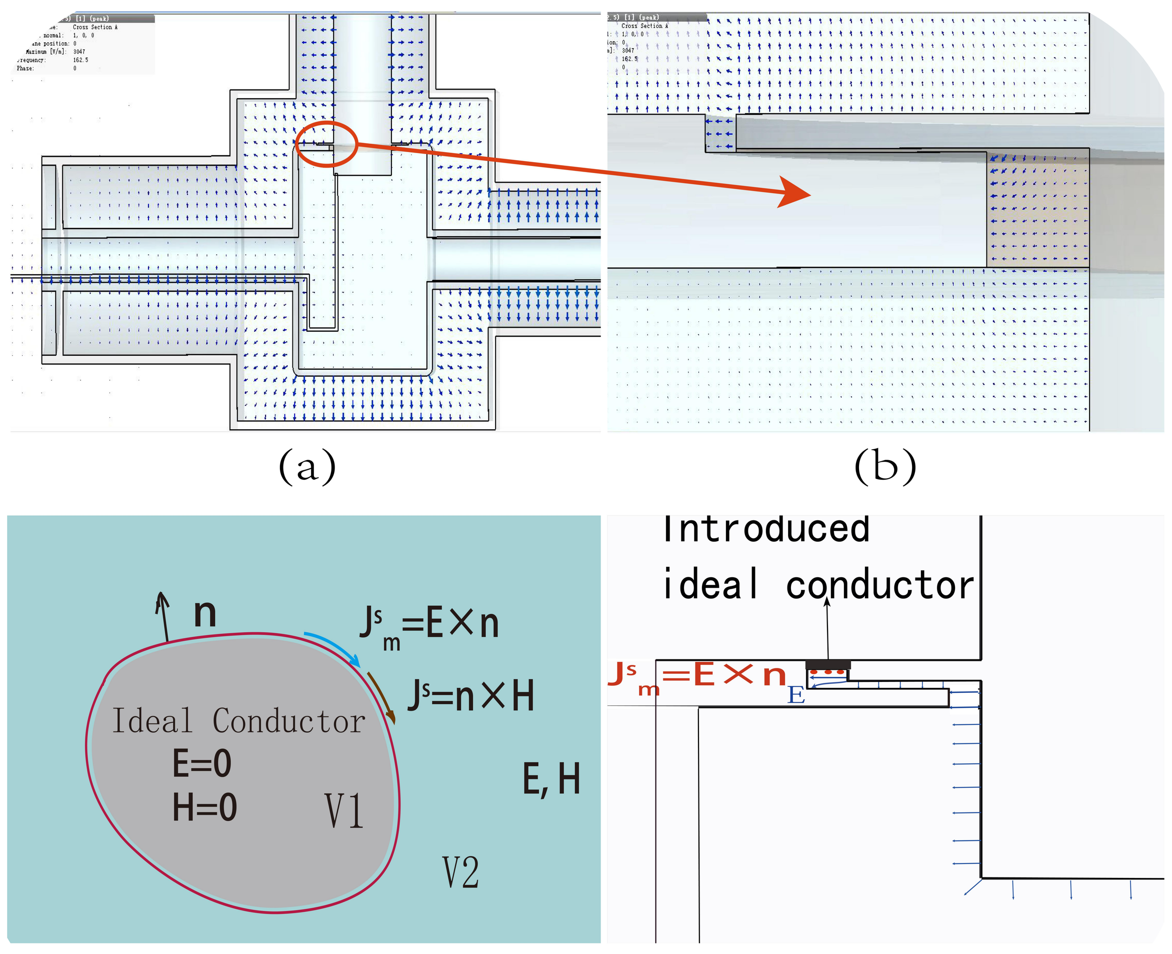
High power couplers with high operation reliability are needed for the superconducting cavities used in the Linac of CiADS project at IMP. This poster will report two works on high power coupler. The DC bias structure of the coupler was optimized to suppress the multipacting effect, where the series resistors were introduced to the wire of the DC bias to reduce the field propagating along the wire of DC bias. For the purpose of significantly decreasing the power needed to condition the coupler, a new RF conditioning scheme was developed, in which the couplers served as a standing wave resonator, and the position of the crests and troughs of the wave were tunable. The details of the design mentioned above will be depicted.

The field propagating along the wire of DC bias

- DC bias was used to suppress multipacting in input couplers
- Field in coupler can penetrate the DC bias capacitor and then propagating along the wire of DC bias.
- The field would affect the transmission performance of the coaxial coupler and can interfere the DC bias power supply .
- The generation of the field can be analyzed by The Principle of Schelkunoff

Fig.1. Simulation and theoretical analysis of the field along the wire.

- The ideal conductor and surface currents were introduced in The Principle of Schelkunoff



Reduction of the field along the DC bias wire

- The common method to block the field along the wire was introducing an inductance or ferrite choke to the wire, which was not always effective.
- Series resistors were found to block the field along the wire successfully.
- The S parameter and the RF loss of the wire with series resistors were related with the resistors' resistance.

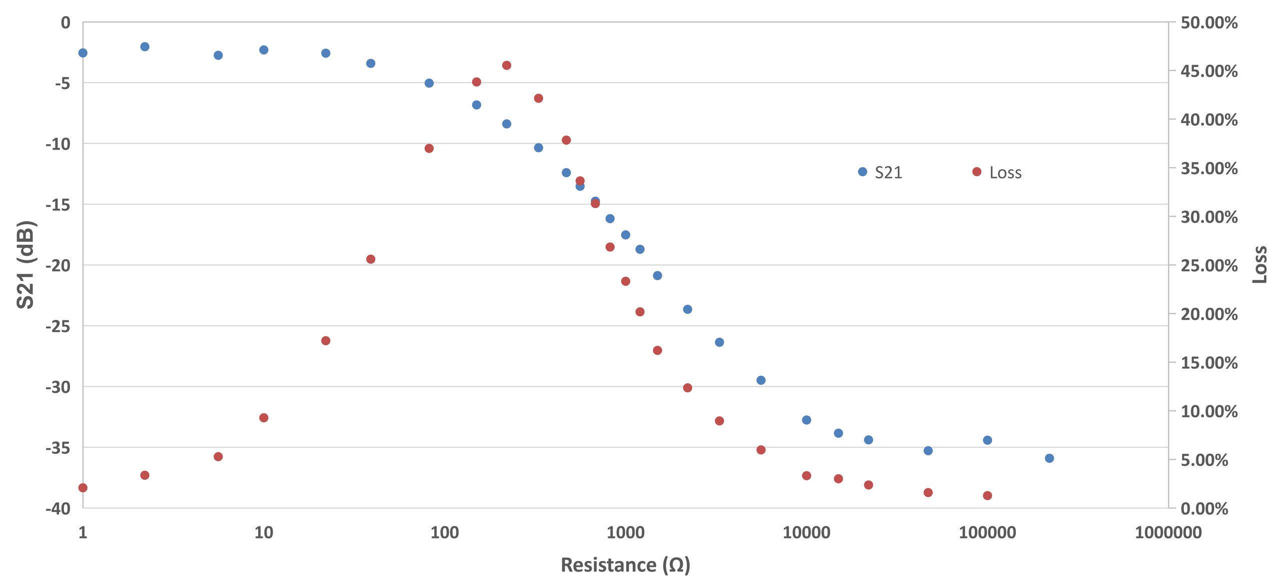


Fig.2 S21 parameter and RF loss of the resistors

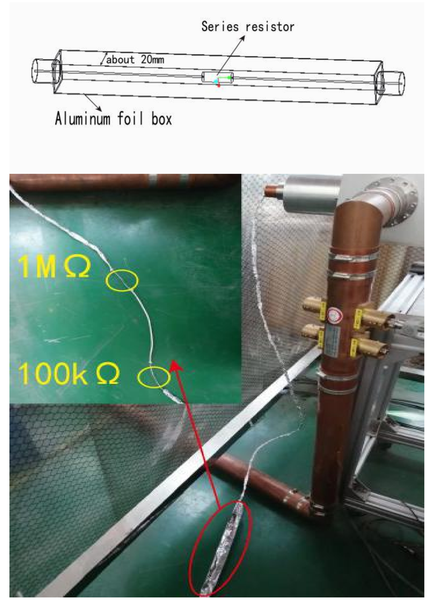
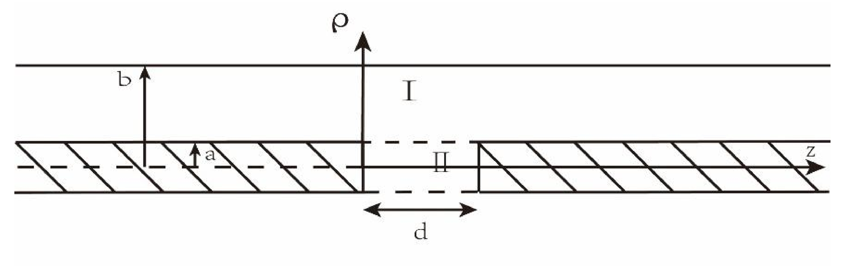


Fig.3 The DC bias wire with series resistors

- The principle of the resistor's blocking effect was analyzed



$$H_{\phi}^{total}(\rho,z)=H_{\phi}^{inc}(\rho,z)+H_{\phi}^{scatt}(\rho,z)$$

$$|\Gamma|=\left|H_{\phi}^{scatt}(\rho,-\infty)/H_{\phi}^{inc}(\rho,-\infty)\right|=\left|\frac{p_0 d J_0(k_2 a)}{2\ln(a/b)}\right|$$

Fig.4 The coaxial line with a gap in the inner conductor

*<SCATTERING ANALYSIS FROM A GAP IN THE INNER CONDUCTOR OF A COAXIAL LINE>

The final blocking effect with series resistor was measured

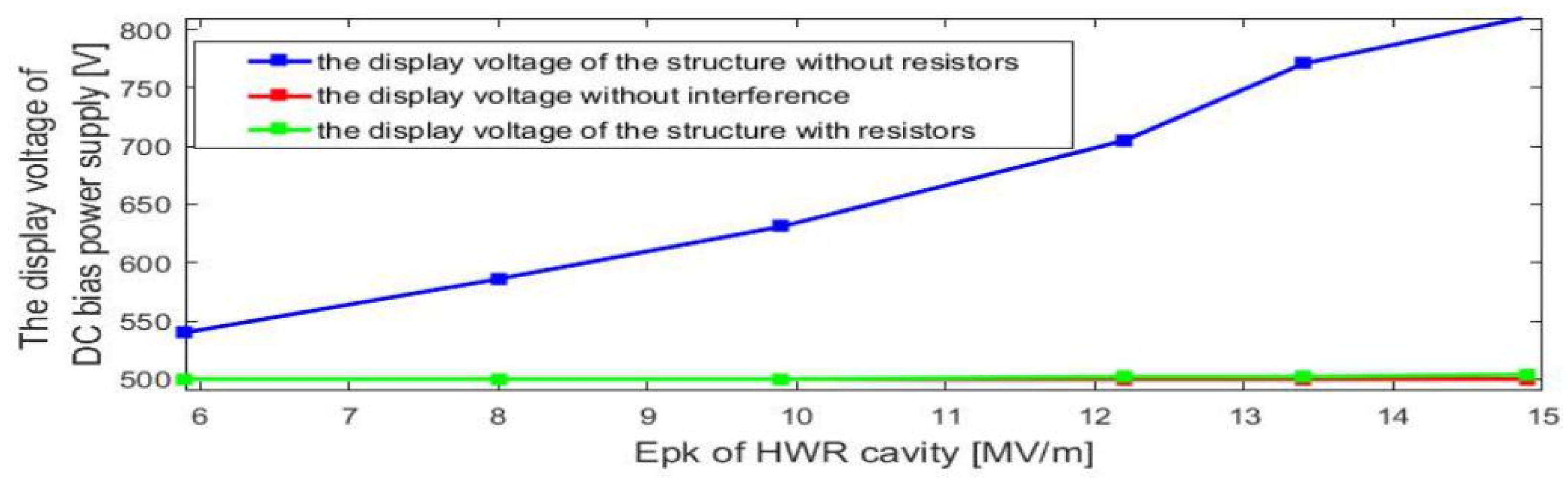


Fig.5 The display voltage of DC bias power supply at different status

The standing wave resonant conditioning scheme

- To reduce the power needed for the coupler conditioning, the resonant ring was the traditional choice, the power gain of which can hardly exceed 35-40.
- To further reduce the conditioning power, a pair of couplers were changed into a n*λ/2 resonantor as shown in Fig6.
- The movable short boards were connected to the tail of each coupler, to move the position of the crests and troughs of the resonant field between the boards.

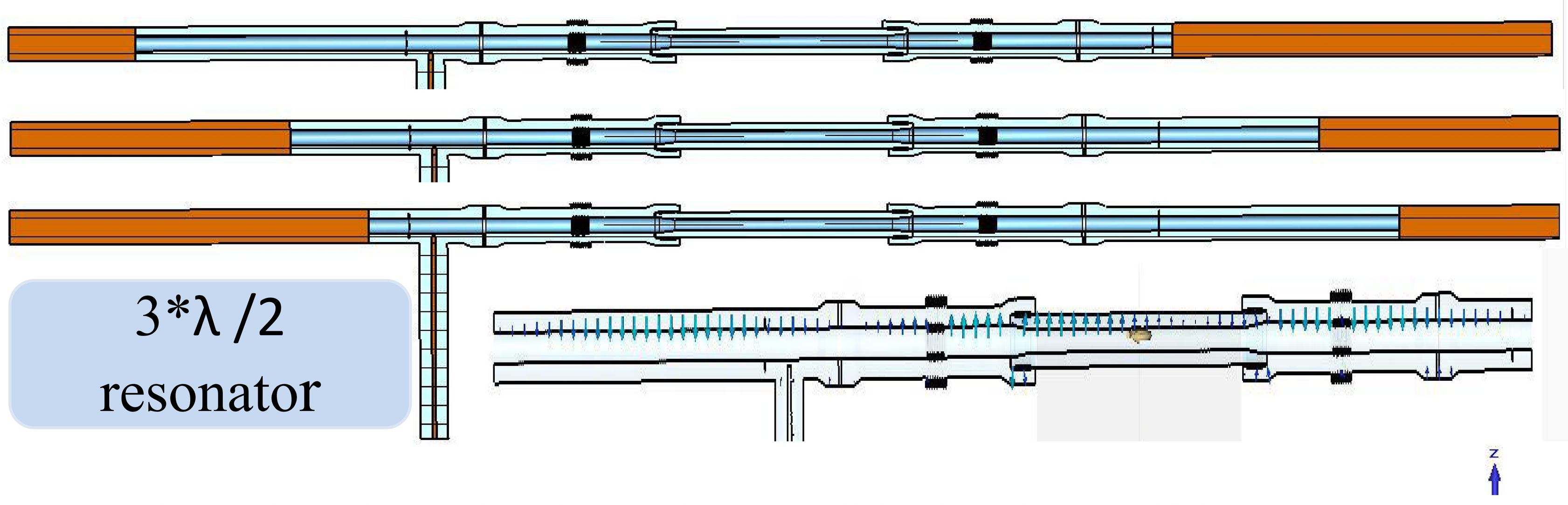


Fig.6 The schematic of couplers conditioning by a n*λ/2 resonator

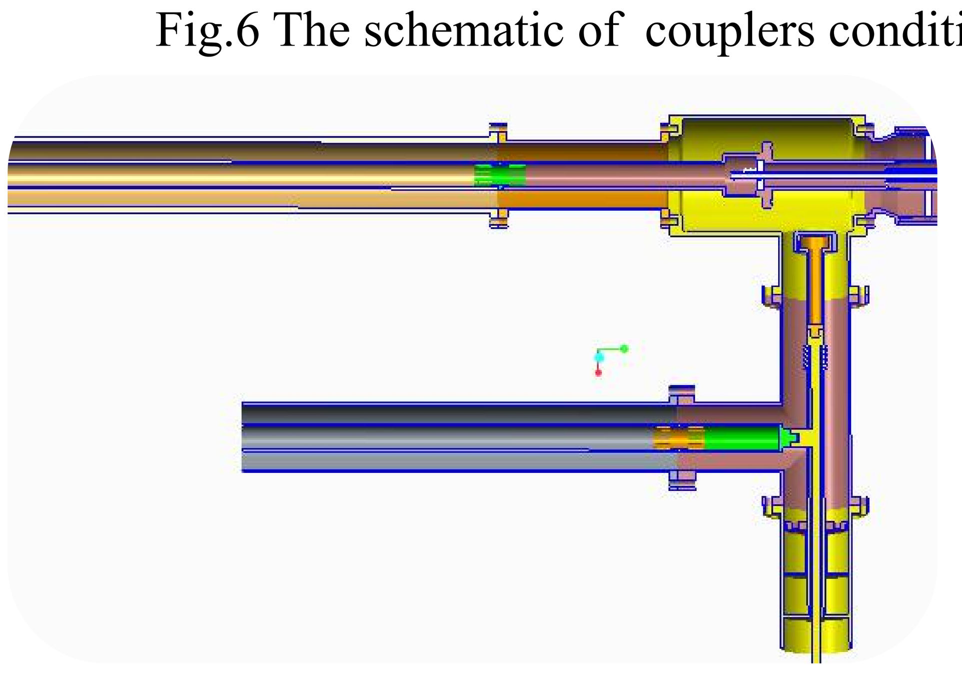


Fig.7 The left side of the mechanical structure

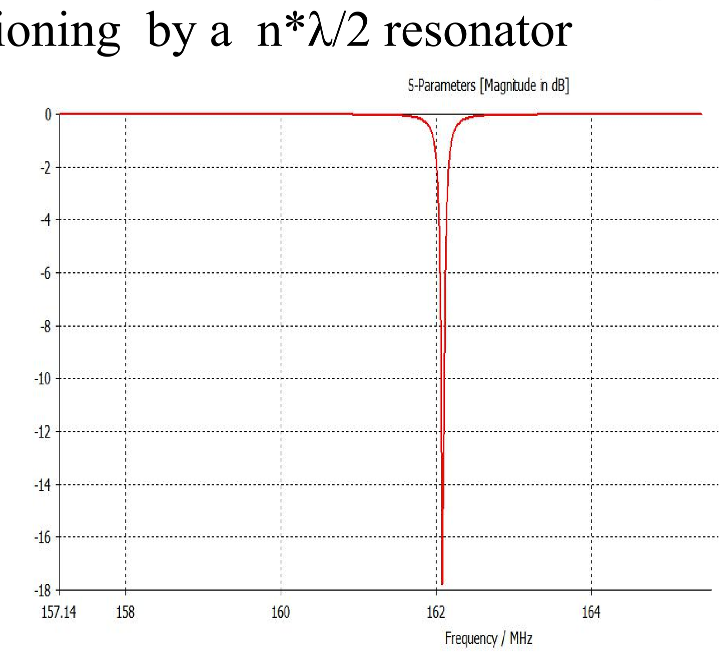


Fig.8 The S11 of the structure

The analysis of the new conditioning scheme

- The simulation power gain of the conditioning scheme can exceed 100 as shown in Fig.9 and Fig.10.
- The electromagnetic field distribution in the n*λ/2 resonator was similar to that in the coupler at standing wave status.
- The couplers had been proved to can be conditioned well at just standing wave status by changing the phase of reflecting wave.

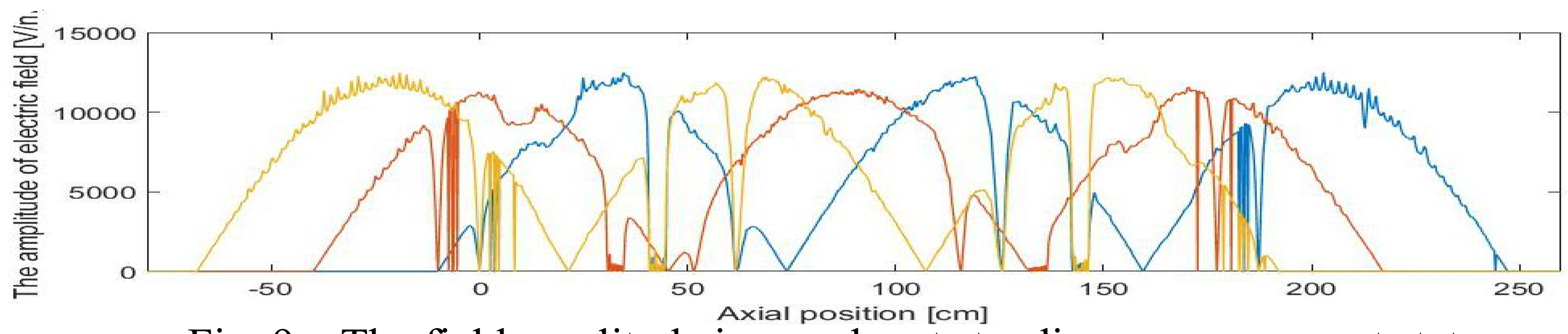


Fig. 9 The field amplitude in coupler at standing wave resonant status

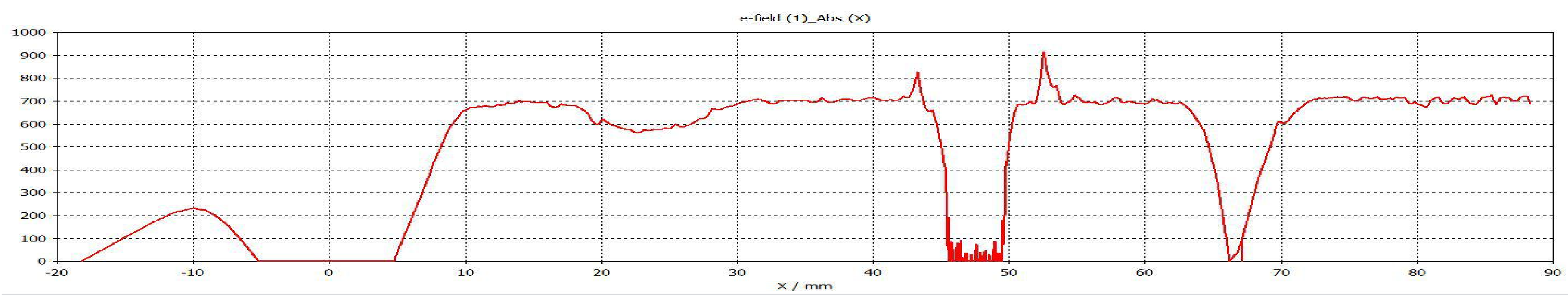


Fig. 10 The field amplitude in coupler at traveling wave status