$$P_e = \frac{4P_f\beta^2}{(1+2\beta)^2}. \tag{3}$$

As expressed in formula (1), when couplers are conditioned in traveling mode, the power dissipated on the cavity are solely decided by the forward P_f and the coupling β. The designed maximum conditioning power in traveling mode for the new test stand is 15 kW. In order to evaluate the tolerance of the power loss on the cavity, we push forward power to 20 kW, letting $P_f = 20$ kW. Fig. 2 describes the change of the power loss, reflected power and the power flowing from port2 with varying coupling β at $P_f = 20$ kW. It's worth noting that the power loss reaches to peak value (10 kW) at $\beta = 0.5$. And with the increase of coupling, P_c tends to be zero. In reality, the coupling is around 2 if the couplers is equipped with the online antenna. On one hand, we hope to condition the couplers in a situation similar to the online. So the coupling can't deviate too far from 2, though seriously overcoupling seems to produce considerable decrease of the power loss. On the other hand, the power loss should be kept below 5 kW, otherwise the heat dissipated on the cavity might be troublesome. As a result, we decided that the coupling will be chosen within the range of 3~4.

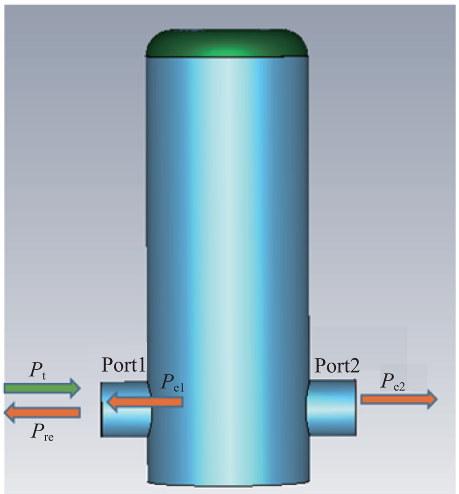

Fig. 1 (color online) The schematic of the power flow in traveling-wave conditioning mode.

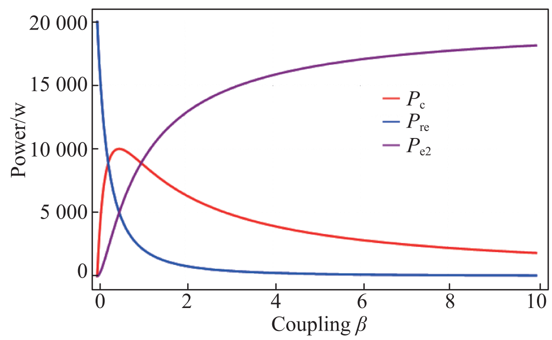

Fig. 2 (color online) The plot of P_f, P_{re} and P_e over varying β at $P_{re} = 20$ kW.

6 - 11 SRF Power Input Coupler for HWR010 at IMP

Li Yongming, Jiang Tiancai, Wang Ruoxu, Zhang Shenghu, Yue Weiming, Xiong Pingran, Li Chunlong, Liu Lubei, Zhang Shengxue, Song Yukun and He Yuan

The high power superconducting radiofrequency (SRF) input coupler is the connecting part between the SRF cavity and the RF transmission line. With the RF power transferred through the coupler, the SRF cavity can built up the electromagnetic field and then accelerate the beams. In addition to this RF transmission function, it also has to serve as a vacuum barrier for the SRF cavity vacuum.

The HWR010 coupler which designed by IHEP is a single ceramic window coupler. As if the window is damaged by arc or thermal stress, that will destroy the vacuum of the superconducting cavity, which means a catastropic failure for a superconducting accelerator. During the operation of the HWR010 accelerator, the single coupler was found to be damaged by the field emission from the SRF cavities. Fig. 1 shows the simulation result of the field emission (FE) electrons generated from the SRF cavity and bombarded on the surface of the ceramic windows. For several months operation, some of the couplers were leaking with very small leaking rate. But, such small leaking still caused the degradation of the cavities performance.

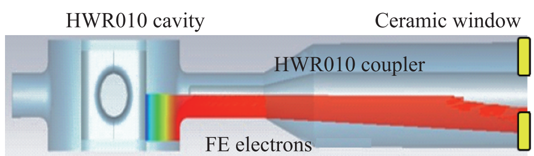

Fig. 1 (color online) Field emission electron hitting on the surface of ceramic window.

A double ceramic windows coupler was designed based on the IHEP version to solve the problem of the vacuum leaking. The double windows hardly have influence in RF transmission compared with the single window coupler. With the new design, the FE electron will be stopped by the new design donut stopper. Fig. 2 shows the structure of the double ceramic windows coupler and the FE electron simulation. The new couplers were condition to 14 kW cw power in travelling wave mode and more than 8 kW cw power in standing-wave mode on the RF condition plant. Five double ceramic window couplers delivered power to HWR010 of the China ADS Inject II online successfully. The maximum transmission power is 10 kW during 10 MeV beam commission in December 2016.

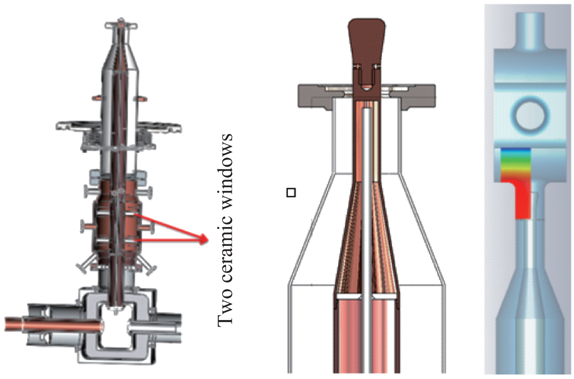

Fig. 2 (color online) View of new HWR010 coupler and FE electron simulation.

6 - 12 Design of a Double Spoke Cavity for CADS

Jiang Tiancai, Zhang Shenghu, Li Yongming, Yue Weiming, Xiong Pingran, Li Chunlong, Liu Lubei, Zhang Shengxue, Wang Ruoxu, Song Yukun, Guo Hao, Huang Yulu, You Zhiming and He Yuan

Spoke cavities have been developed and have apparent advantages for high current proton accelerator based on superconductivity at low and medium energy region. As the research and the technical reserve, Institute of Modern Physics(IMP) has started the R&D program of a double spoke cavity (operating frequency 325 MHz, β_0=0.52), within the framework of China Accelerator Driven System(C-ADS) project. The RF design and mechanical structure design have been finished, and two prototype cavities were manufactured in Harbin.

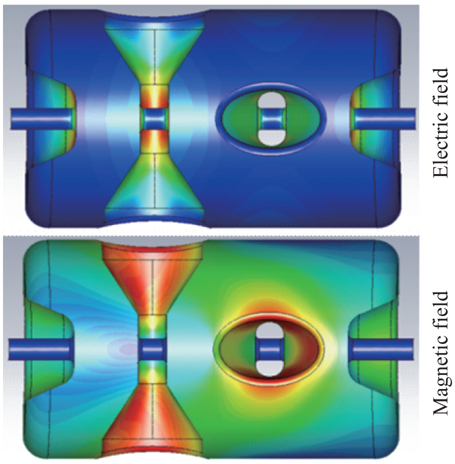

Fig. 1 (color online) The electromagnetic field distribution.

The main goal in the RF design of superconducting cavity is to get a higher accelerating gradient and a lower heat load, which are determined by a lower peak surface fields (E_p/E_{acc} and B_p/E_{acc}) and a higher $G{\cdot}R/Q_0$ (G is the geometrical factor, R is the shunt impedance and Q_0 is the quality factor). Table 1 summarizes all RF parameters of the cavity design; the effective length is defined as $L_{eff}=3\beta_0\lambda/2$. Fig. 1 shows the electric and magnetic fields distribution in the double spoke RF volume.

Mechanical structures have been studied to control the impacts of the various mechanical deformations. They are required to stiffen the cavity to withstand the vacuum load, and to reduce the frequency shifts caused by mechanical resonance. All the components, shown in Fig. 2(a) are formed by deep drawing and machining, and connected by electron-beam welding (EBW).

The IMP DSR052 after fabrication and welding is shown in Fig. 2(b). Leak test and RF test at room temperature have been done. The two cavities are proposed to be tested at low temperature in July of 2017.