The RFQ is designed to accelerateproton beam from 35 keV to 2.1 MeV above which small neutron production and material activation will happen, and main parameters are listed in Table 1. The frequency of 162.5 MHz is chosen in order to decrease the power loss density of the cavity. The inter-vane voltage is 65 kV, which leads to a small kilpatric factor of 1.2 and can well reduce the probability of discharge. The twiss parameters and emittances of output beam are required to be less than 1.5, 0.33 πmm • mrad and 1 keV ns respectively, Table 1 shows all these requirements are met. Because the cavity is 420.8 cm long, it will be equally divided into four modules when fabrication.

The geometry of the RFQ cavity is shown in Fig. 1, which shows four-vane structure has been adopted. Pi-mode rods are utilized to increase the space between the operation frequency and adjacent dipole frequency. The average aperture γ_0 of the RFQ is 5.731 mm, and the ratio of vane-tip radius ρ to γ_0 is 0.75.

RF design has been done by the CST Microwave Studio code step by step, the sequence is thin cross section calculation, Pi-mode rods calculation, tuner calculation, cutback calculation and complete model calculation. One can see thatfrom Fig. 1, the full model has 16 pairs of pi-mode rods and 80 tuners. Parameters of the cavity are shown in Table 2.

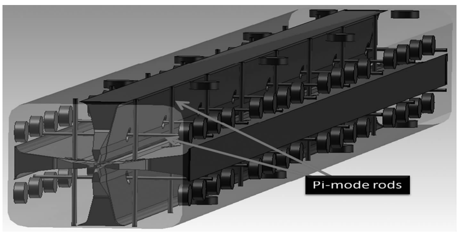

Fig. 1 Complete model of the ADS RFQ at IMP.

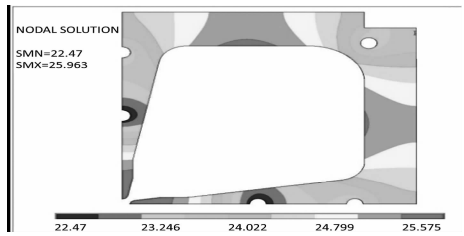

Fig. 2 Temperature contour of the ADS RFQ at IMP.

Table 2 Parameters of the RFQ cavity

Radius (mm)	Freq. (MHz)	Dipole freq. (MHz)	Q factor	Total power (kW)
173.03	162.513	183.6	14934	83.5

Thermal analysis was done with the ANSYS code to study the cavity cooling issues and to know about how to tune the cavity by adjustment of cooling water temperature. Layout of cooling channels is displayed in Fig. 2, there are total eight cooling channels (diameter is 12 mm) in the wall and four in vanes for each module. Temperature of the injecting cooling water was assumed 20 ℃, and velocity of the cooling water was 2.29 m per second. Basing on the data mentioned above, temperature distribution of the cavity is shown in Fig. 2, and the relationship between cavity shifting frequency and cooling water temperature is -16.125 kHz/℃ for vane and 12.875 kHz/℃ for wall respectively.

6 - 11 IMP Superconducting HWR Design, Fabrication and Cold Test

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Huang Shichun, Wang Fengfeng, Huang Yulu, Yang Yuzhang, Li Chunlong
Xue Zongheng, Zhang Rui, Zheng Hai, Shi Zhixiong, Wang Wenbin
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The R & D program of IMP superconducting HWR is based on the China ADS. The aim is to build and test a HWR prototype on December 2012. We have designed, fabricated and vertical tested a 162.5 MHz β=0.09 half-wave resonator (HWR) this year. The cavity can be operated at 4.2 K with E_{acc}>4.9 MV/m. Performance exceeds C-ADS specifications of an input power of 10 W at 4.2 K and E_{acc}=4.7 MV/m.

Table 1 Final design parameters of the IMP HWR

Parameters	Value	Unit
Frequency	162.5	MHz
β_{opt}	0.095	
U_{acc}	0.78	MV
E_{peak}	25	MV/m
B_{peak}	50	mT
R/Q_0	148	Ω
$G=R_s\times Q_0$	28.5	Ω
P	10	W
Q_0(4.4)	4.11×10^8	

The goal of the RF properties is to get a lower heat load and a higher accelerating gradient, which are determined by a higher R/Q_0 (R is the shunt impedance and Q_0 is the quality factor) and lower peak surface fields (B_{pk}/E_{acc} and E_{pk}/E_{acc}). There are four electron beams welding in the cavity high magnetic region when welding our HWR, and we can't grind this region, so the performance limitation in the HWR is the thermal-magnetic quench, which leads us to put more care to minimize B_{pk}/E_{acc}. In order to optimize the HWR geometry parameters, CST-MWS is used to conduct the RF simulation. Starting from a initial HWR model and varying the geometry parameters one at a time we were able to establish the general dependence of the important design parameters on the geometry parameters. The optimized RF parameters are show in Table 1.

The IMP HWR mainly consists of three parts, inner conductor, outer conductor and top/bottom covers. The inner conductor and outer conductor were fabricated from niobium sheets by deep drawing and electron-beam welding. The top/bottom covers were fabricated from niobium sheets by deep drawing. The beam pipes, coupler pipes and process ports pipes were fabricated form niobium rods by machining.

Fig. 1 The main parts of IMP HWR.

The residual resistance ratio (RRR) of niobium sheets and rods is 250. The main parts of IMP HWR are shown in Fig. 1. Particularly critical are the four electron-beam welds between inner conductor, outer conductor and top/bottom covers, which are made from the outside, and a reliable method for obtaining a smooth weld seam at the inner cavity surface was required. We assembled the three parts for HWR frequency measurement before final welding, as shown in Fig. 2. The fabricated two superconducting HWRs were shown in Fig. 3.

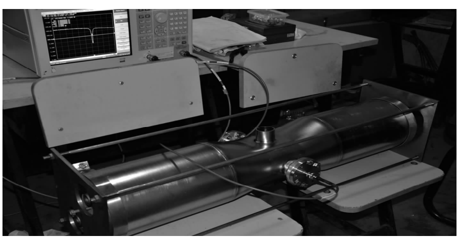

Fig. 2 Frequency measurement before final welding.

Fig. 3 The two fabricated superconducting HWRs.

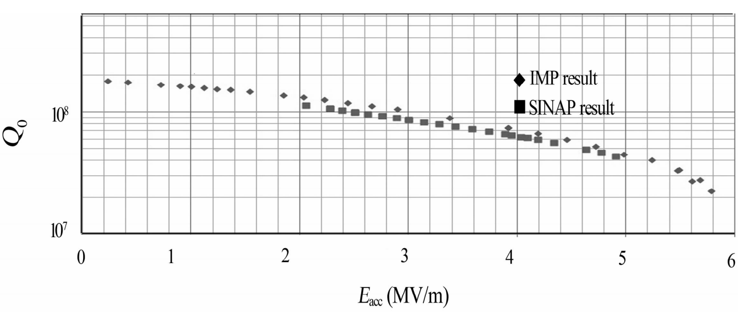

Fig. 4 HWR010-002 vertical test result.

The BCP uses the standard HF : HNO_3 : H_3PO_4 (1 : 1 : 2). The heavy etching of ~150 Mμm and light etching of ~20 μm at Shanghai Institute of Applied Physics. The HWR010-002 first cold test at Shanghai Institute of Applied Physics. The second cold test at Institute of Modern Physics. HWR010-002 was moved to class 100 area for HPR before the second cold test. The resulting Q_0 vs E_{acc} curves at 4.2 K cold test of two times are shown in Fig. 4. The HWR reached E_{acc} = 4.9 MV/m at the second cold test. Here E_{acc} is the total accelerating voltage divided by Leff, where Leff = βλ.

6 - 12 Vertical Test System Development and Cavity Test Result

Chang Wei, Li Chunlong, Xue Zongheng, Song Yukun, Zhang Rui, Zhu Zhenglong and Gao Zheng

The vertical test system development at IMPCAS has been completed. It is served for superconducting radio frequency (SRF) resonance cavity testing. This system based on VCO hardware and Labview softwarehas been designed for low-beta superconducting cavity testing and the operating frequency is 162.5 MHz.

The hardware system contains VCO, power amplify, PLL loop, power meter and environmental monitor. The testing system design flow chart is shown in Fig. 1.

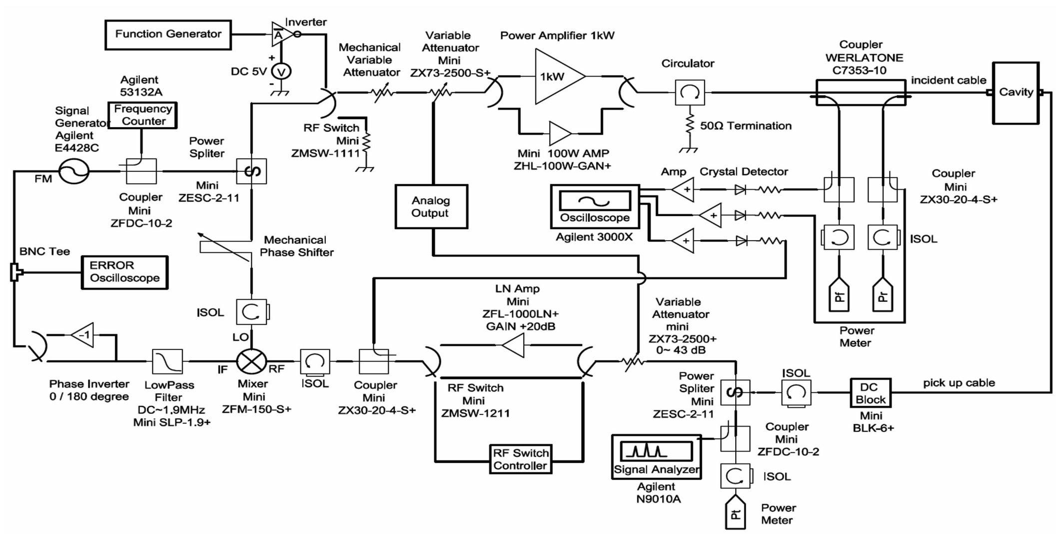

Fig. 1 Test system design flow chart.

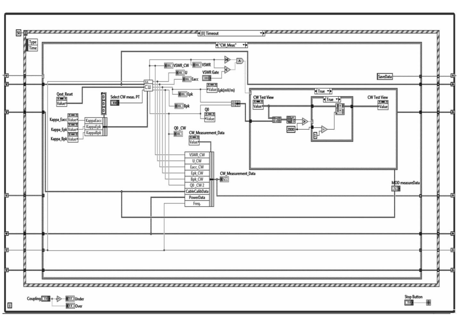

Fig. 2 Labview code State Machine and Event Structure.

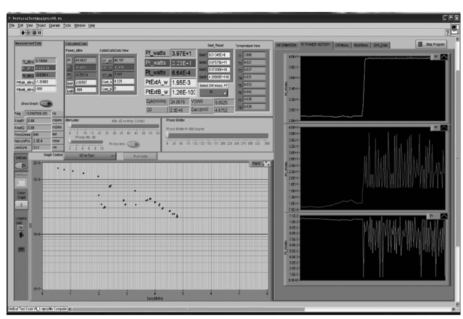

Fig. 3 User Interface.

Agilent E4428C with FM function has been selected for VCO part. It can convert maximum 1 V error voltage to maximum 1 MHz frequency shift. Power amplify part contains two amplify, smaller one is 100 W but wide frequency bandwidth for high order conditioning, bigger one is 1 kW but narrow frequency bandwidth for testing and high power conditioning. PLL loop is based on analog mixer. The LO port of