6 - 45 Summary of RF Group in 2016

Xu Zhe

In 2016, the RF department mainly focused on RF commissioning of HIMM and room temperature linear accelerator, specially the R&D of synchrotron RF system in HIAF project of the 12th Five Year Plan. After all the efforts, many important results have been obtained.

We have made measurement and calculation of a few different MA cores from Germany and Chinese company at firstly, and then designed the synchrotron RF cavity (see Figs. 1 and 2) according to the measurement results. The research on pulsed high power amplifier and full digital LLRF (see Fig. 3) will continue. All of it faces new challenges for us in material and technology, a prototype RF system will be made to lay the successful foundation for RF system in HIAF project.

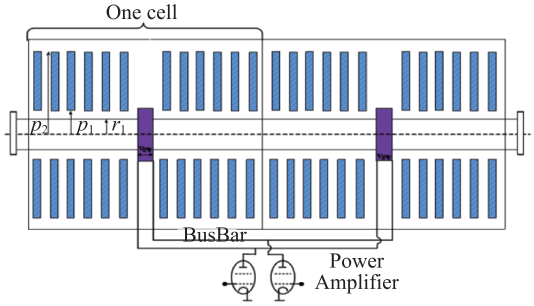

Fig. 1 (color online) Schemetic view of MA core cavity in HIAF.

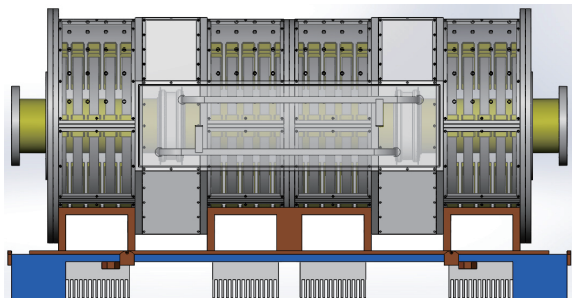

Fig. 2 (color online) 3D structure of MA cavity.

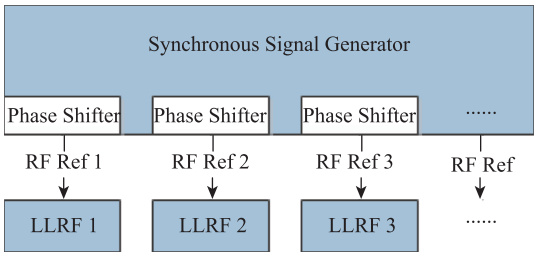

Fig. 3 (color online) Diagram of LLRF system.

6 - 46 Research on the Characteristics of Magnetic Alloy Ring Cores

Liang Lu, Jin Peng, Fu Xin and Xu Zhe

The performance of accelerating cavity for synchrotron depends on the characteristics of loaded magnetic alloy cores (MA-core). The testing of the MA-core from Vacuum Schmelze(VAC) was carried out. The core performance is described by the quality factor Q, magnetic permeability and the so called $\mu'_{\rm p}Qf$ value, which is often used as a figure of merit for MA materials since it determines the shunt impedance.

The MA-core is tested directly using a network analyzer (E5061B 100kHz-1.6GHz), the test principle and the four MA-core samples is shown in the Fig.1. The outer and inner diameter of the core is 90 and 59.4 mm, the

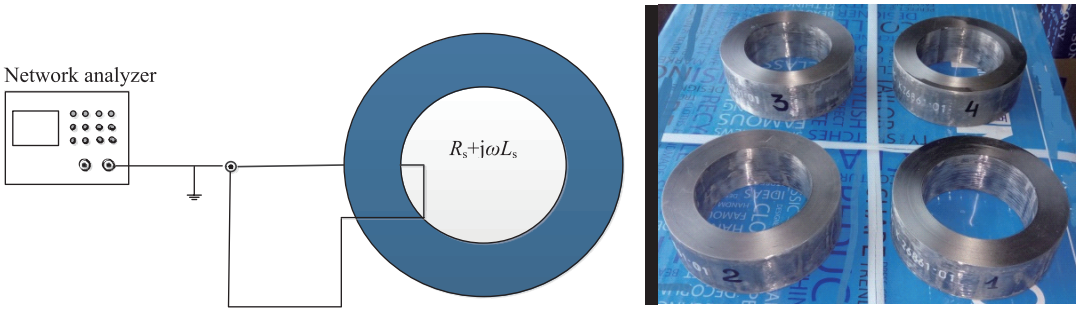

Fig. 1 (color online) The test principle and the MA-cores sample.

ribbon thickness is 20 μm and the core width is 30 mm.

The network analyzer outputs the relation of the equivalent series resistance R_s and series inductance L_s of the MA-core with the frequency. The result of test was shown in Fig.2. The characteristics of the MA-core can be obtained by using the following relation equations. Fig.3 shows the change of quality factor Q and $\mu'_p Qf$ value with respect to frequency.

$$Q(f) = \frac{2\pi f \cdot L_s(f)}{R_s(f)},$$

$$\mu'_s(f) = \frac{L_s(f)}{\mu_0 2d \times \ln\frac{\rho 2}{\rho 1} \times 10^{-7}},$$

$$\mu'_p Qf = \mu'_s \left(1 + \frac{1}{Q^2}\right) Q.$$

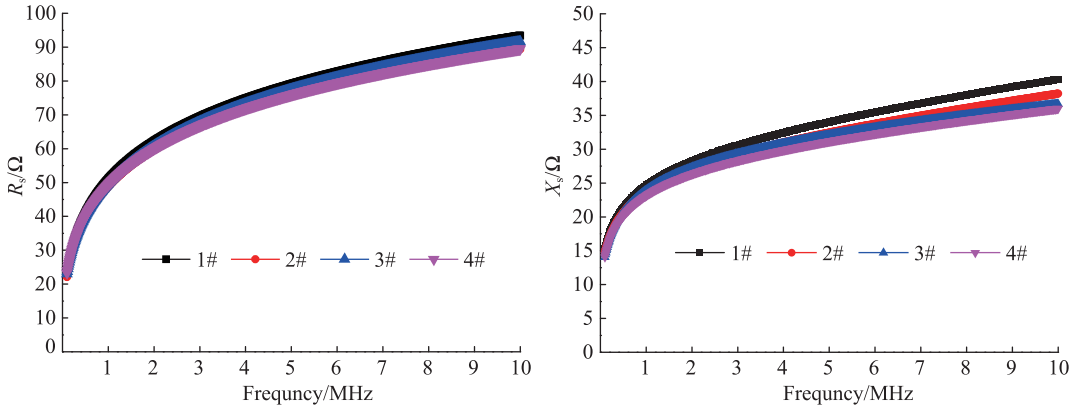

Fig. 2 (color online) The result of tests of cores.

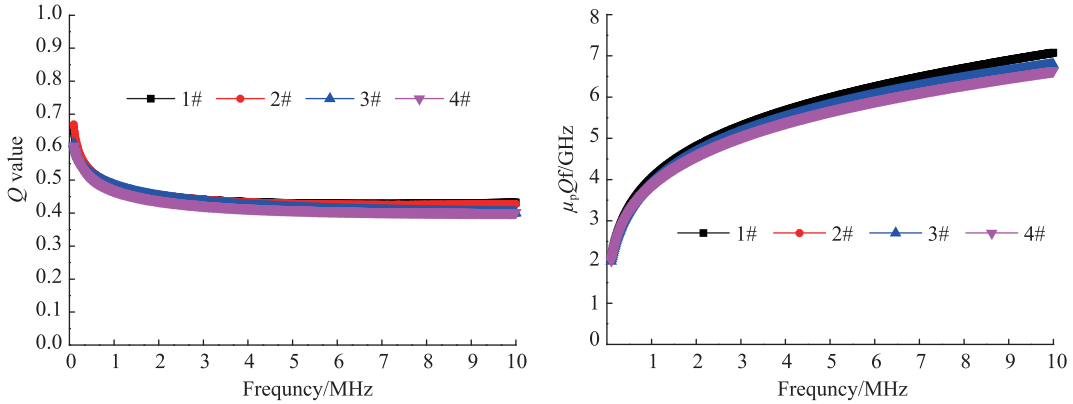

Fig. 3 (color online) The change of quality factor Q and $\mu'_p Qf$ value with respect to frequency.

According to the test results, the MA-core of VAC have good consistency. The Q value is less than 0.7, which nearly equal and reaches our requirement. If the VAC-cores loaded is used in our accelerating cavity, the detuning phase at both ends of frequency range reaches our desired value. But the $\mu'_p Qf$ value is a bit smaller than our desired value, and it will lead to much lower impedance of the accelerating cavity. This is due to the very wide bandwidth of the MA-core.