6 - 19 Development of the Simulation of C-band Photocathode RF Gun

Zong Yang, Zhang Zimin, Cao Shuchun, Shen Xiaokang, Zhao Quantang and Wang Yanru

The program about the C-band linac for high energy density physics needs a high current photocathode electron gun with very short pulse which is designed in IMP. The quantity of the electric charge is 1nC per pulse, and the pulse width is several ps. The cavity about the gun is formed by a whole cell cavity and a 0.6 cell cavity. The RF characteristic about the 1.6 cell cavity of the electron gun is simulated with Superfish[1] and Parmela.

Fig. 1 shows the equivalent circuit diagram of the 1.6 cell C-band photocathode electron gun. In this figure, L_1, C_1 are the capacitor and inductor about the 0.6 cell cavity, and L_2, C_2 are the capacitor and inductor about the 1 cell cavity. The natural frequency of the 0.6 cell cavity is f_1, and the natural frequency of the 1 cell cavity is f_2.

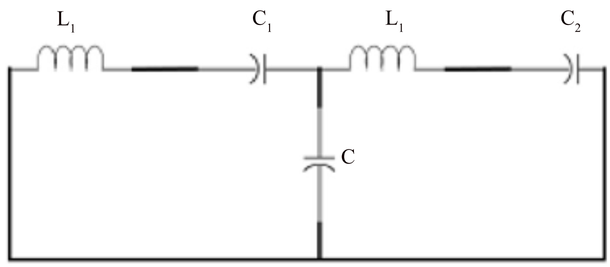

Fig. 1 The equivalent circuit diagram of the electron gun.

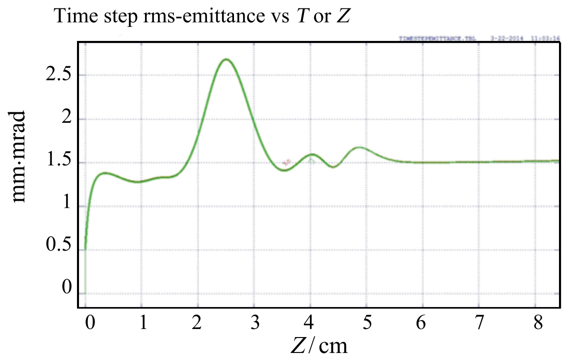

Fig. 2 (color online) The transverse emittance in the gun.

The simulation of the RF characteristics in the 1.6 cell cavity is worked by Superfish. Table 1 shows the RF characteristics results.

Table 1 The RF characteristics results of the 1.6 cell cavity.

The RF characteristics results about change the radius of 1 cell cavity R (the radius of the 0.6 cell cavity is 20.59 mm)						
R/mm	$F_{o.6}$/MHz	f_1/MHz	f_o/MHz	f_π/MHz	∣ f_o- f_o ∣ /MHz	∣ $f_{0.6}$- f_1 ∣ /MHz
21	5 707.929 6	5 715.412 5	5 706.808 6	5 716.533 5	9.724 9	7.482 9
21.005	5 707.929 6	5 713.960 4	5 706.611 6	5 715.278 4	8.666 8	6.030 8
21.01	5 707.929 6	5 712.508 9	5 706.352 7	5 714.085 8	7.733 1	4.579 3
21.012	5 707.929 6	5 711.928 6	5 706.225 8	5 713.632 4	7.406 6	3.999
21.014	5 707.929 6	5 711.348 3	5 706.082 7	5 713.195 2	7.112 5	3.418 7
21.016	5 707.929 6	5 710.768 2	5 705.921 3	5 712.776 5	6.855 2	2.838 6
21.018	5 707.929 6	5 710.188 2	5 705.739 6	5 712.378 2	6.638 6	2.258 6
21.02	5 707.929 6	5 709.608 3	5 705.535 4	5 712.002 5	6.4671	1.6787
21.022	5 707.929 6	5 709.028 5	5 705.306 9	5 711.651 2	6.3443	1.0989
21.024	5 707.929 6	5 708.448 8	5 705.052 8	5 711.325 6	6.2728	0.5192
21.026	5 707.929 6	5 707.869 3	5 704.772 2	5 711.026 7	6.2545	-0.060 3
21.028	5 707.929 6	5 707.289 9	5 704.464 9	5 710.754 6	6.289 7	-0.639 7
21.03	5 707.929 6	5 706.710 5	5 704.131 2	5 710.508 9	6.377 7	-1.219 1
21.035	5 707.929 6	5 705.262 8	5 703.190 7	5 710.001 7	6.811	-2.666 8
21.04	5 707.929 6	5 703.815 7	5 702.120 2	5 709.625 1	7.504 9	-4.113 9

It is also necessary to simulate the RF characteristics results about change the radius of 0.6 cell cavity. After these work, the data tell us these two methods give the same results about the RF characteristics. It means we can only change the radius of 0.6 or 1 cell cavity to research the RF characteristics about the gun.

For the simulation about the beam dynamics of the electron beam in C-band electron gun, we use Parmela to calculate the beam energy and the transverse emittance. Table 2 shows the relation between the inject phase and the beam energy, and Fig. 2 shows the simulated result of transverse emittance in the gun.

Table 2 The relation between the inject phase and the beam energy.

Phase/(°)	Beam energy/MeV
25	6.03
45	5.75
60	5.31
75	4.48
90	4.36

Reference

[1] J. H. Billen, L. M. Young "Poisson Superfish", Los Alamos National Laboratory, LA-UR-96-1834 (2006), Version 7.17.

6 - 20 Upgrade Work of HIRFL Power Supply System

Gao Daqing, Zhou Zhongzu and Power supply group

As the indispensable component of accelerator, the performance of power supply system is directly related with the performance of accelerator. In order to obtain a high quality beam and improve the operation efficiency of HIRFL (Heavy Ion Research Facility in Lanzhou), the upgrade work of the existing equipments is never stopped in the power supply system. In 2014, the work was mainly focused on improving the performance of CSRe (cooling storage experimental ring) and RIBLL 2 (Radioactive Ion Beam Line in Lanzhou).

Digital upgrade

The analog controllers were replaced by digital controllers based on FPGA, by doing that the performances of the traditional power supplies which used the old analog controllers had been improved, such as that of TR5 and TR6 scanning power supply, main ring dipole magnet correction coil power supply, main ring quadrupole magnet power supply, *etc*. Fig. 1 displays the measurement results of the new digital power supply of main ring quadrupole magnet, the tracking error was $\pm$ 4.16$\times 10^{-5}$, which was much better than the old one.

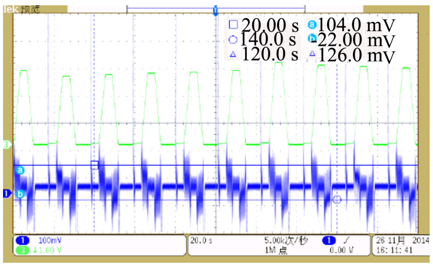

Fig. 1 (color online) Measurement results of the main ring quadrupole magnet power supply.

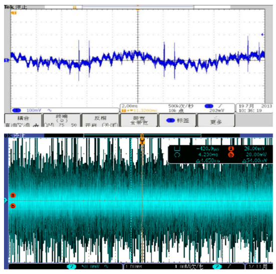

Fig. 2 (color online) Ripple wave results of CSRe dipole magnet power supply after modification.

Reliability improvement

In order to improve the reliability of power supply, some partial modifications were done according to the different problems of different power supplies. For example, busbar modification was made for 1BSW and NB01, ripple rejection for CSRe dipole magnet power supplies, cooling water and fuse modifications for SSC main power supplies, parameter adjustment for SFC power supplies, and so on. As shown in Fig. 2, the ripple wave of CSRe dipole magnet power supply was reduced by half after modification.

Grounding wire and electromagnetic compatibility improvements

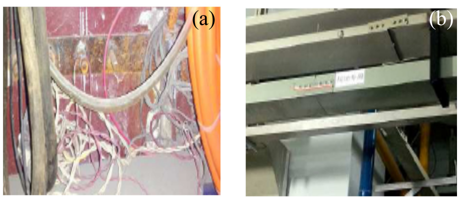

Fig. 3 Grounding bar in building 2. (a) Grounding bar before improvement. (b) Grounding bar after improvement.

To improve the quality of power supply, some modifications on the ground wires of the building 2 were implemented and electromagnetic noise measurements and suppression were conducted for power supplies. Fig. 3 shows the grounding bar of building 2 before and after improvement. As shown in Fig. 4, the noise amplitude decreased by three orders after improvement.