Manufacture of CEPC 650MHz 800kW CW Klystron

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Abstract: *This paper describes the manufacture process of CEPC 650MHz 800kW continuous wave klystron. Klystron mainly includes electron gun, high frequency cavities, output window, collector, etc. Aerospace Information Research Institute, Chinese Academy of Sciences (AIR) has completed the design review of klystron, structural optimization, machining, cavity cold test, component welding, electron gun degassing, and klystron assembling. Now the first klystron has been manufactured.*

Keywords: CEPC, Klystron, Manufacture, AIR

Introduction

The Circular Electron-Positron Collider (CEPC) is a high-energy particle accelerator project proposed by Chinese high-energy physicists and under planning to replace the Beijing Positron Collider, which is about to reach its expected life. 650MHz 800kW Continuous Wave klystron is an important part of CEPC and provides microwave power for superconducting high frequency cavity.

In order to develop the 650MHz 800kW CW klystron, Institute of High Energy Physics (IHEP), Aerospace Information Research Institute (AIR) and Guoli Electronic Technology Company form a cooperation group to complete the project jointly. AIR is responsible for the design review of klystron, structural optimization, machining, cavity cold test, component welding, electron gun degassing, and klystron assembling. [1-2].

Simulation Review

The simulation review of the klystron includes simulation of the parameters of the cavities、beam wave interaction and electron optics. CST is used to calculate the frequency, characteristic impedance, external quality factor and higher order modes of the cavities. And AJDISK is used to calculate the efficiency, gain, frequency band. Also, the magnetic configuration and beam trajectory are simulated by EGUN. All the simulation results are in good agreement with IHEP design. Figure 1 shows the electron beam trajectory under the constraint of magnetic field.

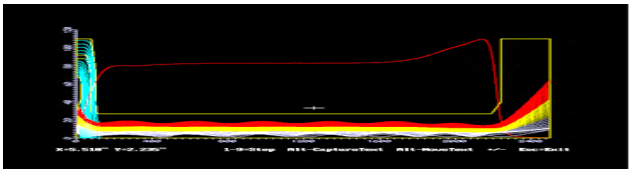

Figure 1. Electron beam trajectory

Structural Optimization and Machining

The structure, welding and assembly technology of electron gun, window, cavities and collector are optimized for improving welding reliability and high frequency performance of klystron. And then the engineering drawing is finished and the part machining is completed.

Cavity Component Welding and Cold Test

Then the welding of no.1-no.6 cavities and output window have been completed successively in hydrogen furnace. The welded cavity components are shown in Figure 2.

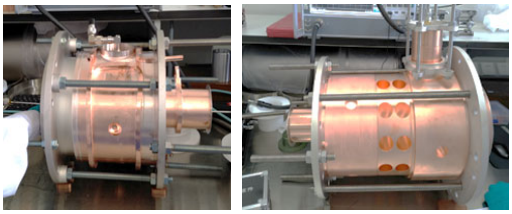

Figure 2. The welded cavity components

The welding of output cavity and window is very difficult. In the welding experiment, the temperature rise and fall are controlled according to the temperature difference of different positions. The microwave window and output cavity are welded successfully.

The parameters of the cavities and the output window are measured after the cavity components welded, and the results meet the design requirements.

Electron Gun Degassing and Assembling

Cathode component of electron gun consisting of cathode, focusing electrode and conductor cylinder is degassed in induction furnace as shown in Figure 3.

Figure 3. Electron gun degassing

Then the electron gun is assembled after degassed. Insulating porcelain, modulation anode, anode and exhaust pipe are also included in eletron gun assembly, in addition to the cathode component. Figure 4 shows the eletron gun assembly.

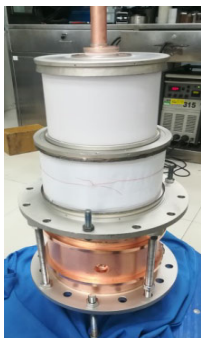

Figure 4. Eletron gun assembly

Klystron Assembling

Figure 5. Assembling process and argon arc welding

Completing the alignment and fixation of each cavity assembly and electron gun, and finishing welding between cavitie assemblies. At last the fabrication of the 650MHz 800kW CW klystron is finished, as shown in Figure 6.

Figure 6. Klystron has been manufactured

Follow-up Work

After the completion of klystron manufacturing, the following work still needs to be done, including baking exhaust, magnetic field installation, cooling water pipe installation, insulation oil cylinder installation, etc. And the klystron can run in the high energy accelerator after high power test.

Conclusion

In this paper, manufacturing process of the 650MHz 800kW CW klystron is introduced. The klystron is the first P-band high power CW klystron made in China and will be used in CEPC which represents the improvement of manufacturing technology of klystron in China.

References

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