Design of RF System for KIRAMS-30

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1. Introduction

At the KIRAMS, the design study of a 30Mev Cyclotron, tentatively called KIRAMS-30, has been developed in 2004. The 30MeV extraction energy has been chosen to produce various radioisotopes and to do scientific experiments. We report development of RF system and preparatory status of manufacture.

2. Methods and Results

2.1 Technical Specifications of RF System

KIRAMS-30 is designed to accelerate a negative hydrogen ion. For efficient accelerating, vacuum level is maintained under 10^{-6} torr. Material related with the RF system must be manufactured with diamagnetic body to not influence the magnetic field intensity[1]. Contrary to KIRAMS-13, KIRAMS-30 is designed to make use of the external multi-cusp ion source. So, central region design must be attentive to avoid interference between RF system and injection system. RF system needs cooling mechanism because power loss is changed into heat. Technical Specifications of RF system are shown in Table 1.

Table 1. Specifications fo RF System

Resonant Frequency	70 MHz
Harmonic Number	4^{th}
Dee Voltage	40kV
Cavity Shape	Coaxial Type
Resonant Mode	λ /2 fundamental mode
Matching Impedance	50 Ohm
Material	OFHC Copper
Dee Angle	39 degree
Coupling Type	Capacitive

2.2 RF Simulation

The RF resonator is designed with CST MicrowaveStudio(MWS) which is a specific tool for the fast and accurate 3D EM simulation of high frequency problems. The RF system is conceptually similar to the LC resonator circuit, where the resonant frequency is given by

$$f = \frac{1}{2\pi\sqrt{LC}} \qquad (1)$$

Where L is the inductance and C is the capacitance. In the calculation, we set f to be 70.0MHz, which is the forth harmonic of the revolution frequency of a beam. Two 30 degree dees are located in two valleys. Stems support the dees vertically.

At mechanical drawing of RF system, we consider following factors[2].

1) Mechanical stability
2) RF heating and cooling
3) Arcing and multipacting
4) Low maintenance
5) Low cost

The CAD drawing of KIRAMS-30 RF system is illustrated in Figure 1.

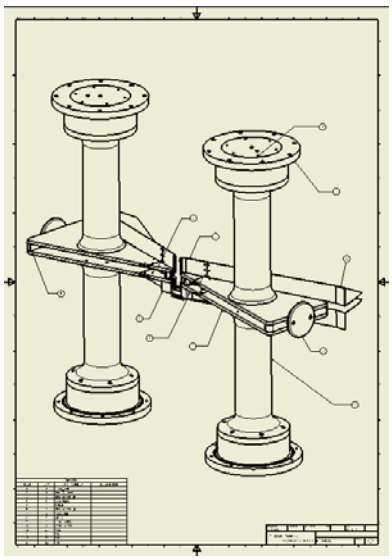

Figure 1. CAD Drawing of KIRAMS-30 RF System

Vector distribution of electric field and magnetic field are shown in Figure 2, 3. As these figures, ion beam is accelerated adequately and not interfered by magnetic field.

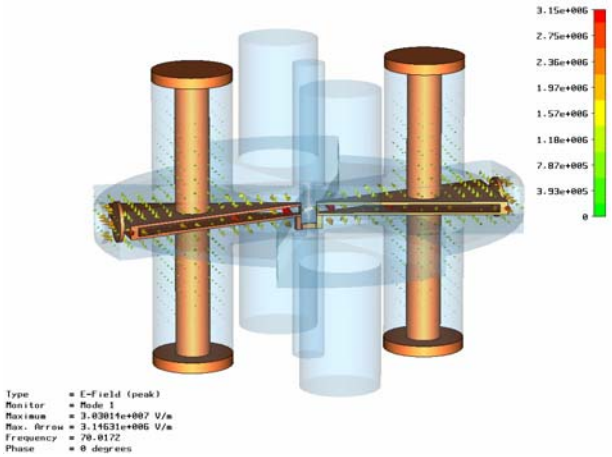

Figure 2. Vector distribution of electric field

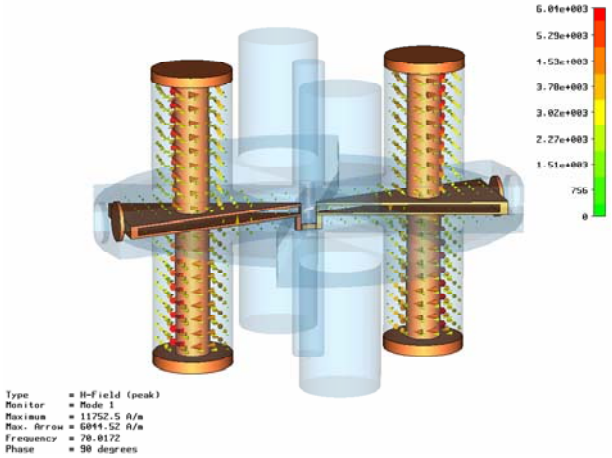

Figure 3. Vector distribution of magnetic field

The resonant frequency is 70.0172MHz calculated with MWS. Difference between simulation and specification is compensated for RF fine tuners. RF fine tuner tune the resonant frequency within narrow range. Figure 4 shows the frequency tuning range of fine tuners.

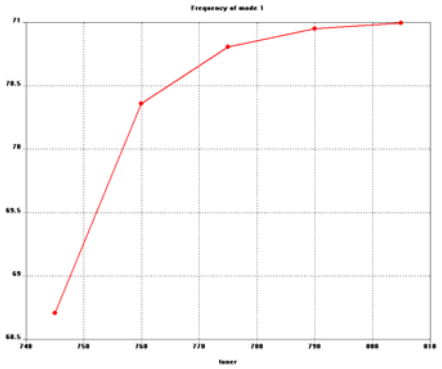

Figure 4. Frequency tuning range of fine tuners

3. Conclusion

In conclusion, we designed the RF system of the 30MeV cyclotron, KIRAMS-30. Simulation results are satisfied with technical specifications. Further research to analyze mechanical structure and cooling system is on going and prepare for manufacturing RF system.

REFERENCES

[1] In Su Jung, “A Design of KIRAMS-13 RF System for Regional Cyclotron Center”, The 17th international Conference on Cyclotron and Their Application, Tokyo 2004.

[2] Yoon Kang, “Coupler Electromagnetic Design”, HPC Workshop, TJNAF, 2002.