MOP030

RF measurement of SKKUCY-10 RF Cavity for Impedance Matching

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Abstract

The 10 MeV cyclotron was designed for next version in Sungkyunkwan University, after the SKKUCY-9 had developed for medical application for PET. The RF cavity, which generates the electric field in cyclotron, was designed based on a half-wavelength resonator and optimized to improve the unloaded quality factor (Q_0). The design specifications of RF cavity were resonance frequency 83.2 MHz, Q_0 5830 and Dee voltage 40 kV with geometrical values resonator length 560 mm, Dee angle 35° and Stem radius 16 mm. The RF cavity of the SKKUCY-10 was fabricated and installed inside the electromagnet, and RF characteristics were measured with a network analyzer. The RF coupling coefficient and characteristic impedance for desired condition were selected at 1.08 and 52 Ω, respectively. The RF coupling coefficient and characteristic impedance were measured 0.8-1.2, 52-49 Ω according to temperature as 15-21°C. The power coupler was checked for optimization of RF coupling coefficient and characteristic impedance, and the results show good agreement with simulated and measured data.

RF cavity for SKKUCY-10

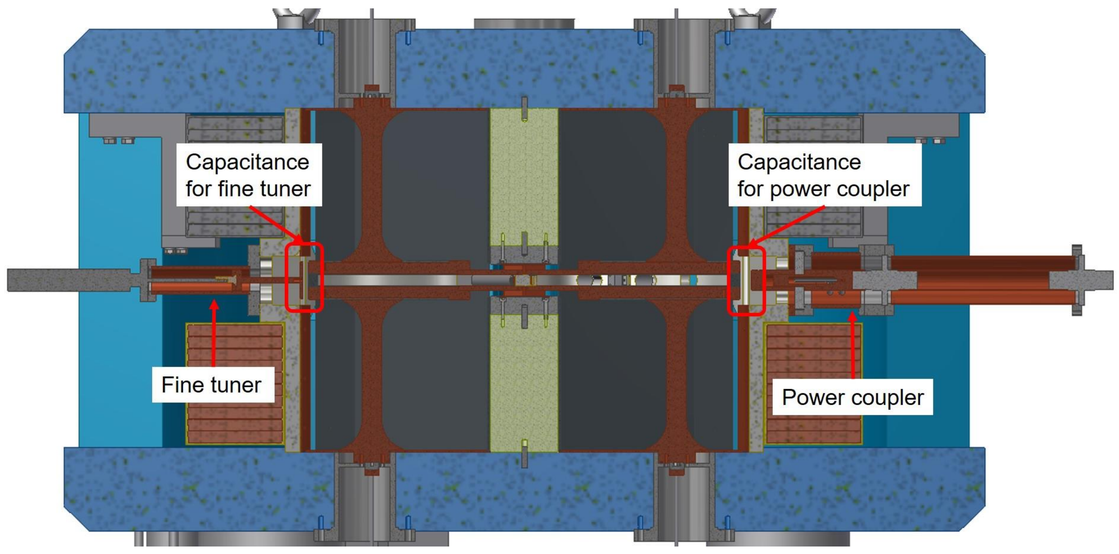


Figure 1. Power coupler and fine tuner for SKKUCY-10

Methods and Materials

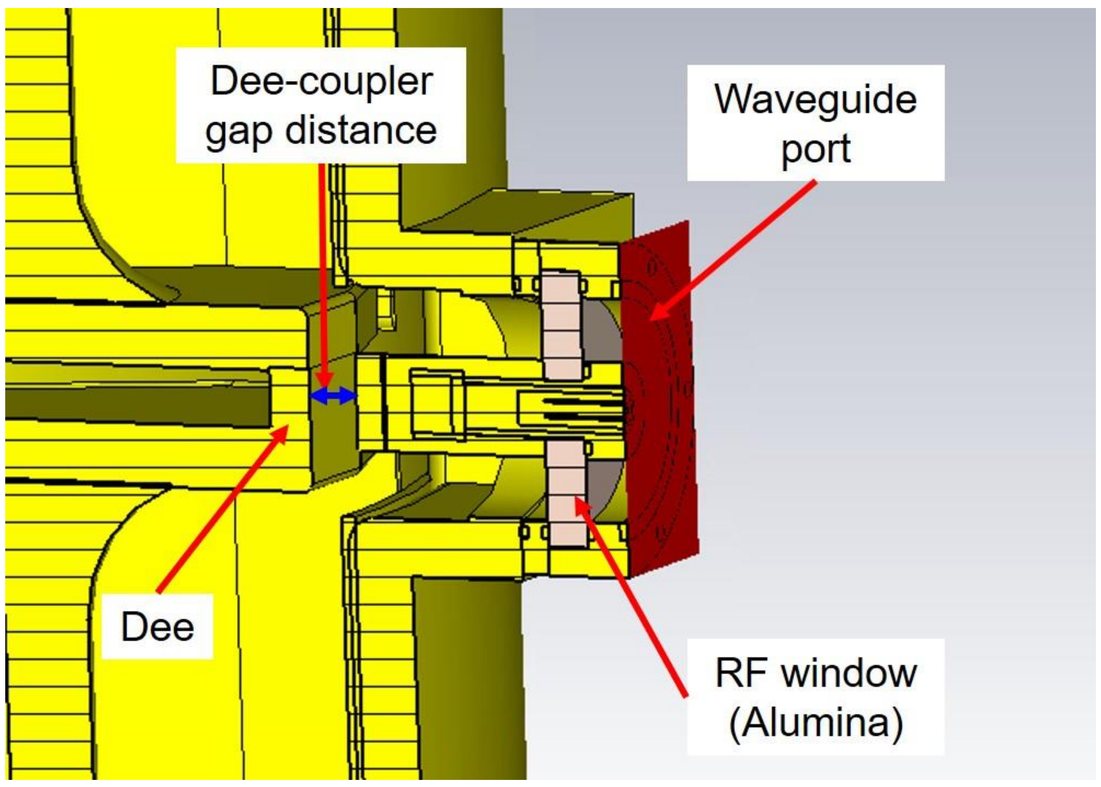


Figure 2. Scheme of power coupler

- Thermal effect
- Temperature > copper resistivity > unloaded quality factor > RF coupling coefficient

$$\rho_{T2} = \rho_{T1}(1 + \beta_T(T_2 - T_1))$$

- Beam loading effect
- Beam current > cavity dissipation power > shunt impedance > RF coupling coefficient

$$\beta = \left[\frac{i}{2}\cdot\sqrt{\frac{r_s}{p_c}} + \sqrt{1 + \frac{i^2 r_s}{4p_c}}\right]^2$$

Table 1. RF Specifications

Parameter	Value
Resonance frequency [MHz]	83.2
Coupling coefficient	1.03
Tuning range [MHz]	±0.5
Coupler gap distance [mm]	18.7
Tuner gap distance [mm]	5

Result

- Beam loading effect

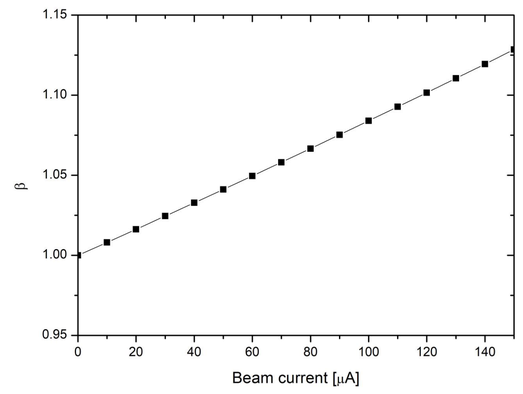


Figure 3. Calculation result of RF coupling coefficient according to beam current

- Thermal effect

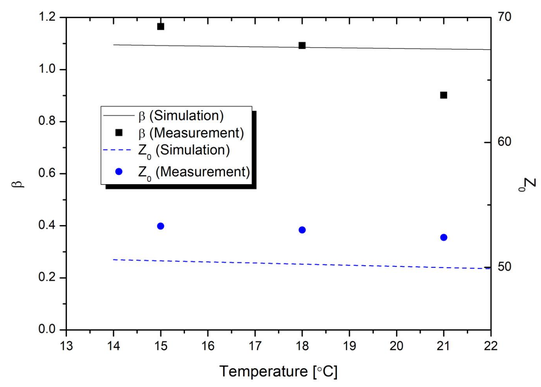
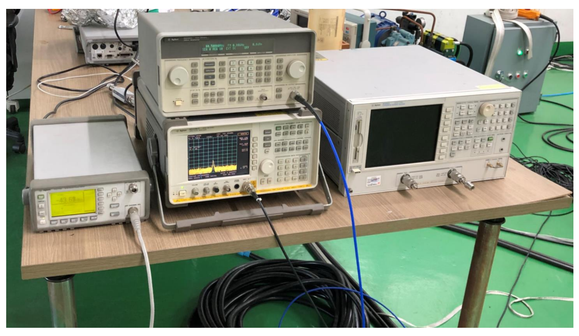
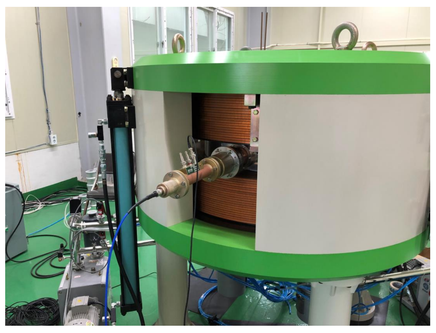
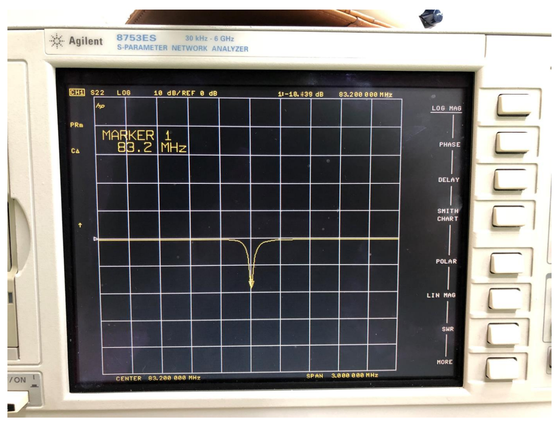


Figure 4. Results of RF coupling coefficient and characteristics impedance







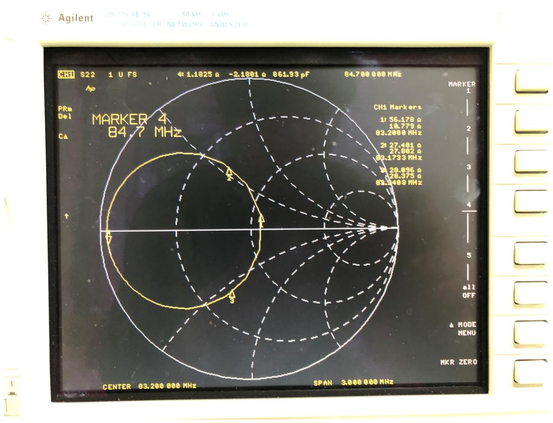


Figure 5. RF system of SKKUCY-10 and RF cold test

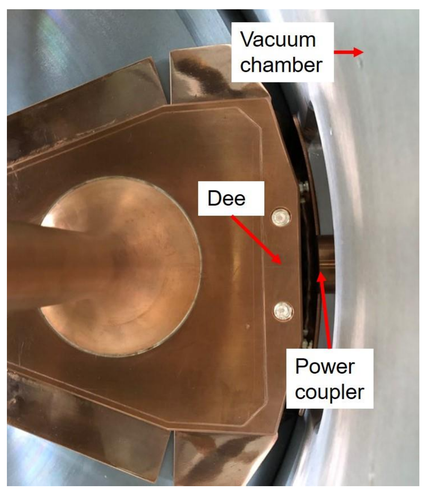


Figure 6. Dee and power coupler in SKKUCY-10 RF cavity

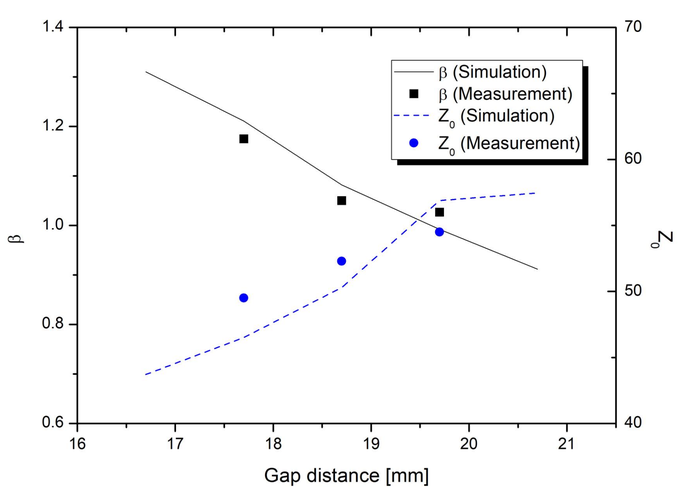


Figure 7. Results of RF coupling coefficient and characteristics impedance

Conclusion

The RF coupling coefficient and characteristic impedance were simulated and measured with consideration s of thermal and beam loading effect. The RF system of 10 MeV cyclotron (SKKUCY-10) was analysed with specifications, resonant frequency 83.2 MHz, Q_0 5830 and Dee voltage 40 kV with geometrical values resonator length 560 mm, Dee angle 35° and Stem radius 16 mm. The RF cavity of the SKKUCY-10 was fabricated and installed inside the electromagnet, and RF characteristics were measured with a network analyzer. The RF coupling coefficient and characteristic impedance for desired condition were selected at 1.08 and 52 Ω, respectively. The RF coupling coefficient and characteristic impedance were measured 0.8-1.2, 52-49 Ω according to temperature as 15-21°C. The power coupler was checked for optimization of RF coupling coefficient and characteristic impedance, and the results show good agreement with simulated and measured data.

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