

Flat-top acceleration system of the AVF cyclotron

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A new flat-top acceleration system of the AVF cyclotron has been developed to improve the intensity and quality of the injection beam for the ring cyclotron [1]. A schematic layout of the RF system of the AVF cyclotron is shown in Fig. 1. An additional flat-top (FT) cavity with a length of 700 mm and an outer diameter of 170 mm is capacitively coupled to a main resonator. A flat-topped dee voltage waveform can be generated by superimposing a harmonic voltage on the fundamental one [2]. A wide range of harmonic frequencies from 50 to 90 MHz is covered by the FT system. Three kinds of harmonic modes, fifth, seventh and ninth harmonics, have been made practicable to realize the FT acceleration in the whole fundamental frequency range between 6 and 18 MHz. The FT system using the higher order harmonics has the advantage of saving power for generation of the harmonic voltage, since the n -th harmonic voltage required for the FT waveform production is $\frac{1}{n^2}$ of the fundamental one [3].

The maximum peak harmonic voltage of 5 kV can be produced on the dee electrode by feeding the power from a 10 kW transistor amplifier [4]. The transmission line of the FT cavity can be well-matched to the main resonator at an impedance of 50 Ω by optimizing the cavity parameters such as positions of a capacitive coupler electrode, a movable-short plate, a tuner plate and a variable capacitor of a power feeder.

The performance of the FT system has been investigated so far in the power tests using the following fifth harmonic frequencies; 77.084 MHz for a 53 MeV proton (to be accelerated up to 300 MeV by the ring cyclotron), 50.582 MHz for a 44 MeV deuteron (200 MeV), 58.250 MHz for a 88 MeV $^3\text{He}^{2+}$ (420 MeV) and 50.720 MHz for a 87 MeV $^4\text{He}^{2+}$ (400 MeV). We have also succeeded in generating the seventh and ninth harmonic voltages at 71.008 MHz for a 87 MeV $^4\text{He}^{2+}$ (400 MeV) and 60.750 MHz for a 19 MeV deuteron (80 MeV), respectively. The FT voltage waveform at 77.084 MHz for the 53 MeV proton acceleration has been successfully observed with the dee voltage pickup as shown in Fig. 2. Beam developments for the FT acceleration are now in progress.

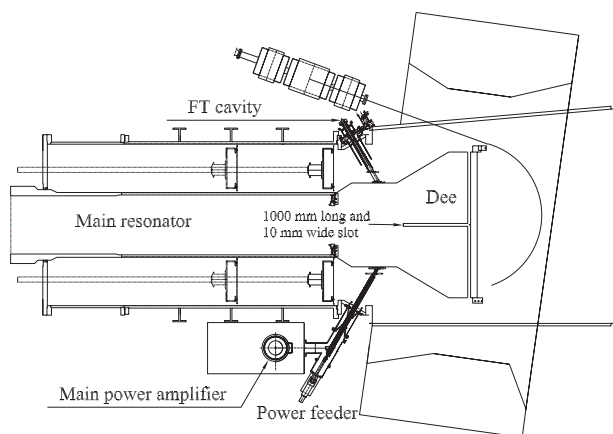


Figure 1: Schematic layout of the RF system of the AVF cyclotron. The FT cavity is coupled to the main resonator at the opposite side of the main power feeder. A new slotted dee electrode was installed to shift the frequency of the transversal parasitic resonance.

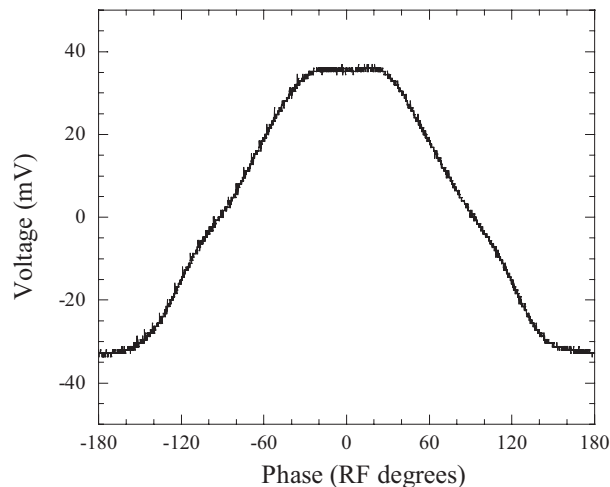


Figure 2: Flat-topped voltage waveform at the fundamental frequency of 15.417 MHz, required for 53 MeV proton acceleration, observed with the dee voltage pickup.

References

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