Improvement of dee voltage pickup for flat-top acceleration by the AVF cyclotron

M. Fukuda[1], H. Tamura[1], T. Saito[1], T. Yorita[1] and K. Hatanaka[1]
[1]*Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan*

New dee-voltage pickup electrodes of the K140 AVF cyclotron were installed to substantially improve Dee voltage control and monitoring for flat-top acceleration. Four individual pickup electrodes were mounted in an oxygen-free copper block as shown in Fig. 1. The block was placed near the acceleration gap at a distance of 60 mm from the side face of the dee electrode. The pickup electrode A, C and D have the same structure, consisting of two copper disks with a thickness of 5 and 12 mm. A number of ceramic chip capacitors were soldered in parallel in between the disks. A disk diameter is 50 mm for the pickup electrode A and 34 mm for B, C and D. Capacitance of the ceramic chip capacitors is about 2900, 1360 and 13600 pF for electrode A, C and D, respectively. Capacitance of the electrode B, without a ceramic chip capacitor, is determined mainly by the distance between dee and pickup electrode. The pickup electrode A, C and D were designed to produce a signal with an pickup-to-dee voltage ratio of $1/10^4$, $1/10^4$ and $1/10^5$, respectively. The pickup-to-dee voltage ratio of the electrode B has a large dependence on frequency. The pickup signal from the electrode A is used for acceleration voltage regulation. The electrode B provides a harmonic signal, after passing through a high-pass filter circuit, for a low-level control of a flat-top resonator. The electrode C supplies an RF reference signal to users and control systems of a beam buncher and a beam chopper. The pickup signal from the electrode D is used for monitoring the flat-top voltage waveform at a console. An example of a pickup signal observed at 77.084 MHz is shown in Fig. 2. Parameters of the pickup electrodes are summerized in Table 1.

Development of the flat-top accelerated beam is in progress. We have applied the flat-top acceleration technique to 87 MeV $^4He^{2+}$, (400 MeV after a ring cyclotron), 53 MeV proton (300 MeV), 19 MeV deuteron (80 MeV) and 640 MeV $^{86}Kr^{21+}$ beams so far. The 300 MeV proton beam was transferred to a gold target of WS course in achromatic mode, and energies of elastically-scattered particles were analyzed with the Grand-Raiden for beam quality evaluation. The energy resolution of the elastic peak has been estimated to be Δ E/E $= 1\times10^{-4}$. The beam intensity of the high quality proton beam has been remarkably increased by a factor of four.

Table 1: Parameters of the new dee pickup electrodes.

		Ceramic chip capacitor		
Electrode	Diameter(mm)	Unit capacitance(pF)	Voltage rating(V)	Number of chips
A	50	62	500	47
B	34	-	-	-
C	34	47	500	29
D	34	470	200	29

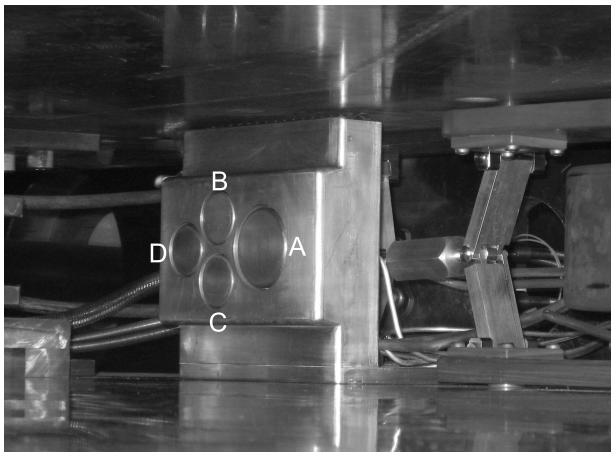

Figure 1: New dee pickup electrodes of the AVF cyclotron. The electrode A and D is aligned with a median plane of the cyclotron. The electrode B and C are placed at 20 mm off the median plane.

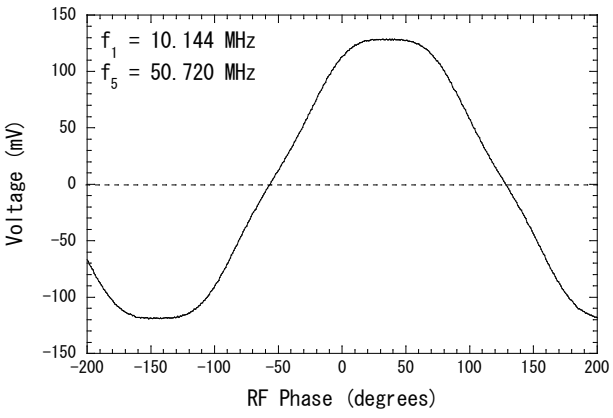

Figure 2: Dee voltage waveform for 87 MeV $^4He^{2+}$ acceleration, observed with the pickup electrode D. The fifth harmonic voltage was superimposed on the fundamental one for flat-top acceleration.