On the basis of the test cavity measurement, we have designed a compact buncher cavity. Figure 3 shows cross section of the buncher cavity. The cavity has two sets of the Finemet cut cores with air gaps of 0.5 mm. A ring made of Macor is set at the acceleration gap for insulation. The size of the ring is the inner diameter of 86 mm, outer diameter of 114 mm and height of 10 mm.

We attached two parallel copper plates, one of which is with N-type connector, to the acceleration gap and we measured the rf characteristics of the cavity using the impedance analyzer. Figure 4 shows frequency dependence of the absolute value of the impedance and the phase. The *Q*-value of the cavity is 0.7 and the inductance is 0.7 μH at 30 MHz. Total gap capacitance including parasitic capacitance is estimated to be 40 pF. The measured characteristics of the buncher cavity agree well with the ones expected from the measured results of the test cavity.

To increase the transit time factor, two parallel mesh plates made of copper are placed at the acceleration gap shown in Fig. 3. The plates consist of mesh part with diameter of 75 mm and mesh-support frame with outer diameter of 95 mm. The mesh has hexagon shape [7] and the distance between the center of the hexagons is 2 mm. Width and thickness of the mesh are 0.1 mm. The distance between the mesh plates is 5 mm.

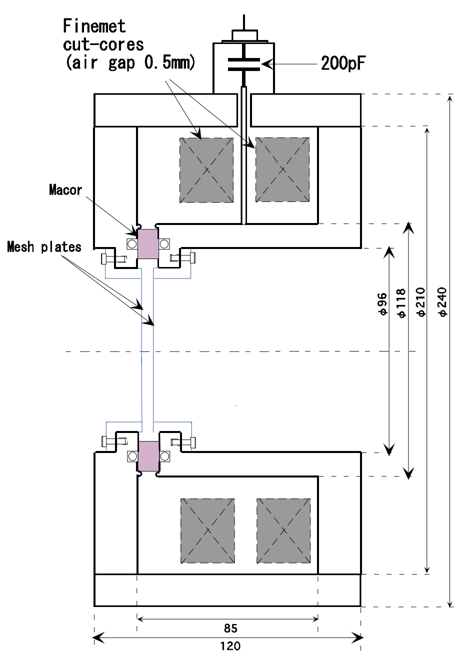


Fig. 3. Cross-sectional view of the buncher cavity.

## HIGH POWER TEST OF THE BUNCHER CAVITY

We have carried out the high power test using 3 kW rf amplifier which feeds the power to the cavity though 50 Ω coaxial cable. To match the input impedance of the cavity to 50 Ω, a capacitor of 200 pF is connected in series with the cavity and the cut cores are set in parallel.

Input and reflection power were measured by a vector voltmeter (HP, 8508A) using directional coupler. Figure 5 shows frequency dependence of the voltage standing wave ratio (VSWR). They are kept less than 1.3 between 20 and 45 MHz.

Peak gap voltage dependence of the cavity dissipation power for several frequencies is shown in Fig. 6. The gap voltages were measured by a voltage probe (Tektronix, P5102). Each curve shows fitted results of square function of the voltage. The shunt impedance is approximately 133 Ω at 30 MHz.

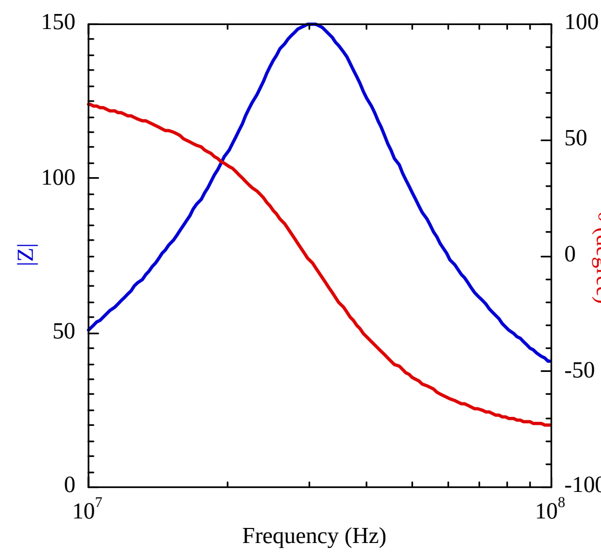


Fig. 4. Frequency dependence of absolute impedance and phase of the buncher cavity.

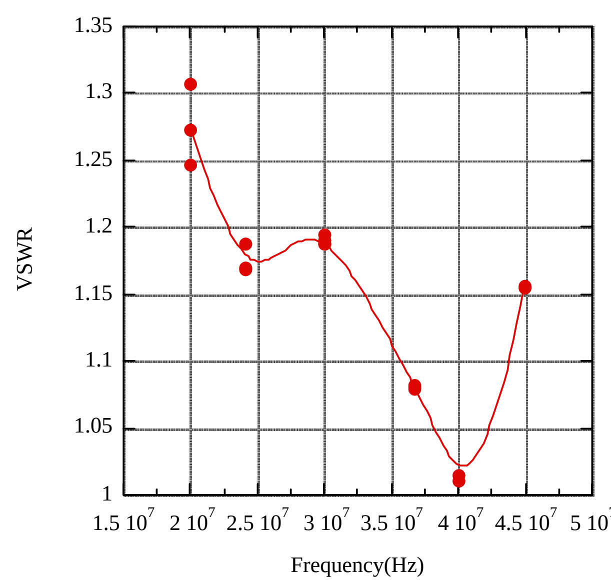


Fig. 5. Frequency dependence of the voltage standing wave ratio (VSWR) of the buncher cavity.

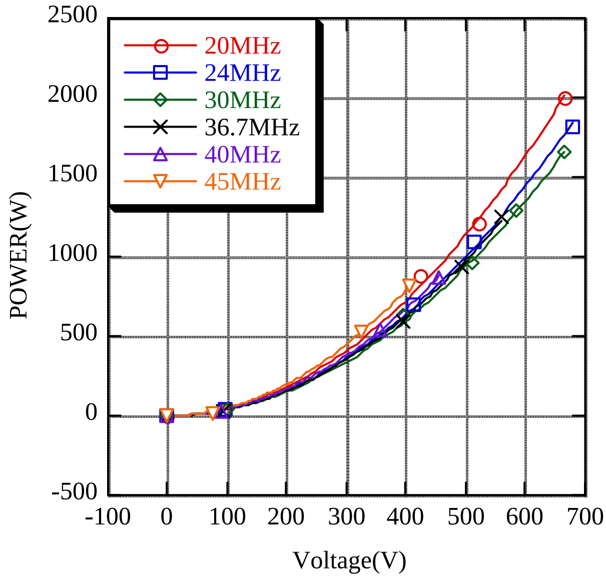


Fig. 6. Peak gap voltage dependence of the dissipation power of the buncher cavity.

## BEAM TEST OF THE BUNCHER CAVITY

The buncher cavity has been installed in the beam transport line of the HiECR ion source system. Figure 7 shows a photograph of the cavity. The cores are cooled by an electric fan.

Figure 8 shows typical beam current waveform using the buncher cavity. The beam current was detected by a Faraday cup at 2.3 m down stream of the cavity. In this case, 10 keV proton beam with average current of 20 μA was used. Frequency and peak voltage of the cavity were 30 MHz and 150 V, respectively. As shown the figure, beam structure of 30 MHz with the peak current of 32.5 μA was successfully obtained.

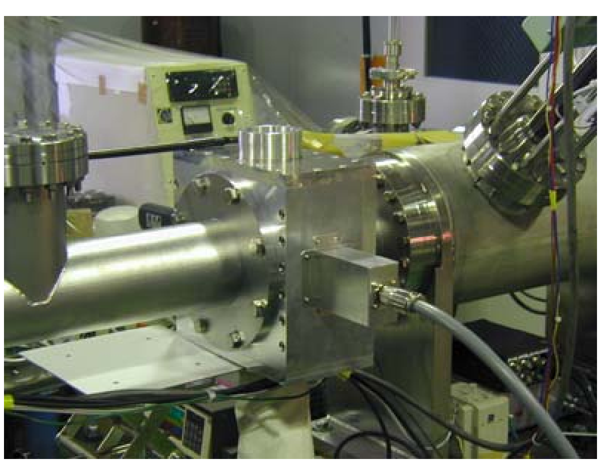

Fig. 7. The buncher cavity installed in the beam transport line of the HiECR.

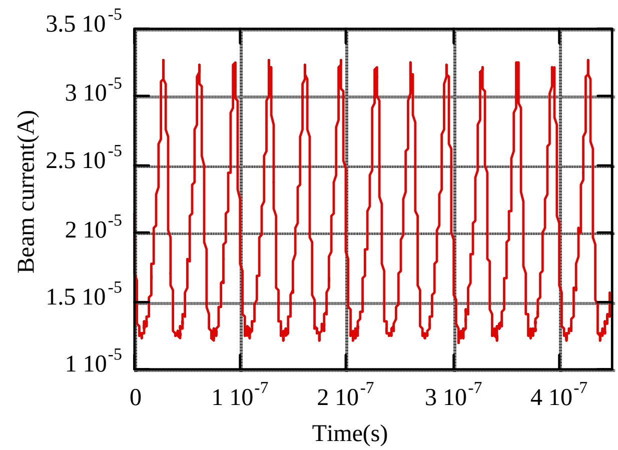


Fig. 8. Bunched beam current waveform.

## CONCLUSIONS

We developed a compact size buncher cavity using Finemet cut cores with operating frequencies between 18 and 45 MHz. A capacitor of 200 pF is connected in series with the cavity and the cut cores are in parallel to match the input impedance of the cavity to approximately 50 Ω. The voltage standing wave ratio is kept less than approximately 1.3 between 20 and 45 MHz.

We installed the buncher cavity in the beam transport line of the HiECR ion source system for the beam test. Beam structure of 30 MHz was successfully observed for 10 keV proton beam.

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