A NEW REBUNCHER AT THE BEAM LINE FROM SFC TO SSC FOR HIRFL

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Abstract

A new rebuncher was constructed and tested successfully with beams in HIRFL at IMP in last year. There were two old identical rebunchers on the beam line from SFC to SSC in HIRFL[1]. But they have never been worked well with some serious problems since 1988. The new rebuncher was decided to build instead of old one in order to improve the performance of the HIRFL accelerator system and also to meet the needs of the CSR project. The new rebuncher based on λ/4 coaxial resonator with a shorting plate and two movable plates. It has wide resonant frequency range from 22 to 54 MHz. The RF power feed into the cavity by coupling loop, the maximum output power of the amplifier is up to 40kW and the bunching voltage on the two gaps is more than 150 kV.

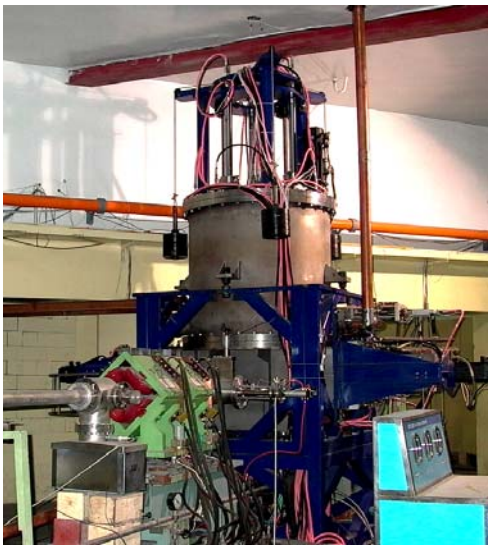

Fig. 1. Photograph of the new Rebuncher

RF RESONATOR

A quarter-wave resonator structure[2] was selected in order to get high bunching voltage on the gap of the rebuncher. Because the space is very limited in SSC hall and the frequency range of the rebuncher is so wide (22 to 54 MHz). The complex tuning system includes a shorting plate and two movable plates were designed to reduce the size of the rebuncher. Figure2 shows a schematic layout of the resonator. The main parameters (such as resonant frequency, Q-value and power consumption and so on) of the rebuncher were calculated by transmission line method and MAFIA program. The two results were quite similar by using those two methods. The new RF resonator was manufactured by Shanghai KELIN Technology Development Corp in China. The complex tuning system (include five control objects) were designed and constructed by Nanjing Hong Zong Da Electronic Engineering Co Ltd in China.

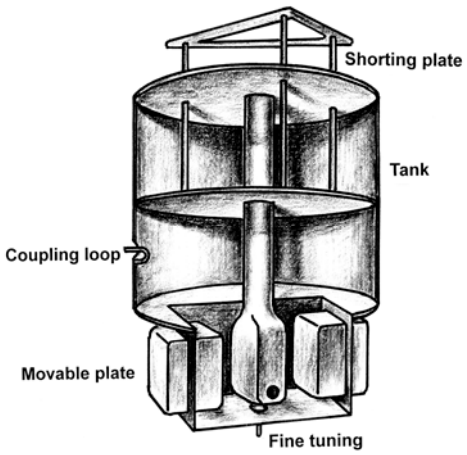

Fig.2. Schematic drawing of the new rebuncher. The inner dimensions are about: diameter of the tank (Φ1000mm), height (1500mm).

Figure 3 shows the calculated and measured resonant frequencies of the rebuncher. Although the RF resonator was made without any model tests the measured results for real cavity were very satisfactory.

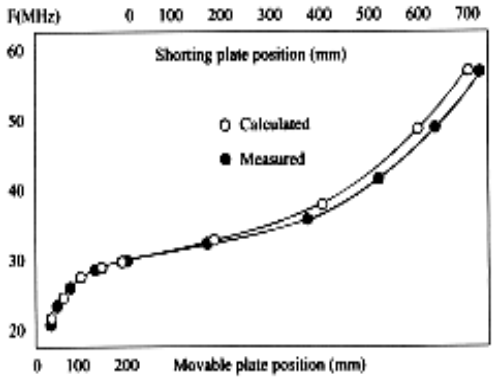

Fig.3. Frequency tuning characteristics

Figure 4 shows the Q-values about calculated and measured results for the rebuncher. The calculations overestimate the measured values by about 30%. This is considered to result from the fact that calculation does not

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realistically treat the roughness of the wall surface and the imperfection of the electric contact.

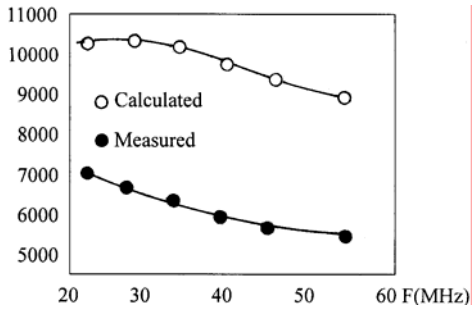

Fig.4. Calculated and measured Q-values.

The main parameters of the rebuncher were shown in Tab.1. The movable coupling loop was designed to get excellent match between amplifier and resonator. At most of operating frequencies the SWR could be less than 1.1 by tuning the coupling loop and movable plates. The input impedances are almost close to 50 Ω. So it's easy to get high voltage in the bunching gaps.

Parameters	Calculated	Measured
Frequency	22~54MHz	20.5~55.7MHz
Q-Value	10500~ 8900	7000~5500
Input impedance	50Ω	50Ω
SWR	≤1.5	≤1.2
S_{11}	≤−13db	≤−20db

Table1. The main parameters for calculating and measuring of the rebuncher

AMPLIFIER

The Power amplifier consists of two stages. The signal from the amplitude controller goes into the 100W Wide Band Amplifier, then driven the first stage and final stage. The ceramic-metal tetrode FU-116 that made in China was chosen in first stage. The maximum output power is 10kW. In final stage the ceramic-metal tetrode TH571B that made in THOMSON Company was used. The cw output power is up to 60kW. The final stage of amplifier has a grounded grid configuration. All of the equipments of the amplifier were especially designed and manufactured by Nanjing Hong Zong Da Electronic Engineering Co Ltd in China.

POWER TEST

High power tests with 50 Ω dummy load and cavity had been performed successful for the amplifier, which has a cw power of 40kW at maximum between 22MHz and 54MHz. The maximum RF bunching voltage on the gaps have been obtained more then 150kV so far. The vacuum of the cavity stays around 1×10^{-7}Torr with a turbo-molecular pump of 1500l/s and a cryogenics pump operating during the experiments.

EXPERIMENT WITH BEAM

Bunching tests with several beams have been done since last year. The beam from SFC through the rebuncher went to the SSC. The typical experiment was successful with beam $40Ar^{8+}$ at the operation frequency 27.0346MHz. The output power of the amplifier was 26kW at the bunching voltage around 130kV_p. Vacuum of the rebuncher was better than 1×10^{-7}Torr.

Figure 5 shows the Photograph about the graphic of the beam with bunching and without bunching.

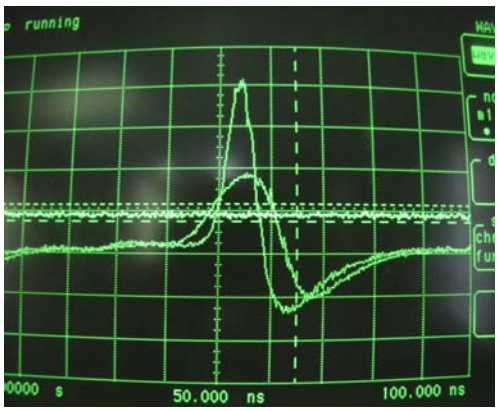

Fig. 5. Photograph of oscilloscope with bunched (high and narrow) beam and without bunching

CONCLUSIONS

The new rebuncher has been operating well since last year. It made more improvements for the matching between SFC and SSC. The beam density (inject into SSC) may increases around 2 or 3 times than before. It's very useful for HIRFL accelerator system and CSR project.

ACKNOWLEDGMENTS

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REFERENCES

[1] Proceedings of Heavy-Ion Research Facility in Lanzhou Vol.8 1989

[2] M. DI Giacomo, C. Bieth GANIL RAPPORT INTERNE No.567.94