RF STACKING SYSTEM OF TARN

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The role of RF system in TARN is to stack the heavy ion beam in the longitudinal phase space with a repetition rate of 50 Hz. It is composed of low level electronics and high power parts including the accelerating cavity. The schematic diagram of the RF stacking system is shown in Fig. 1.

The main part of the low level electronics is function generation and servomechanism for the RF voltage and frequency control. The dynamic range of the RF voltage should be 40 dB and typical voltage rating is 1100 volt.

Low level electronics plays an important role to obtain the phase lock mechanism between the beam and RF accelerating field. Also it is used to control the accelerating voltage and frequency so as to obtain the optimum RF stacking condition. A program of the RF voltage is obtained considering the phase space area of the injected beam, acceleration of the beam from the injection orbit to the stacked orbit and the adiabaticity of the beam dynamics through the period of beam deposition.[1)]

According to a PLL theory, cut-off frequency is decided by synchrotron oscillation frequency. The cut-off frequency of LPF is selected to kept the constant phase angle ($\cos \phi_s = 0.5$) with LPF controller.

The function generator is composed of computer system and DAC with timing control system. At present, the resolution of the voltage amplitude is decided by DAC system and is 1/256.

Many circuit modules are housed in the case of NIM type and communication between each circuit module is wired with coaxial cable.

The main part of high power parts is RF cavity, RF amplifier and its coupling transformer. The RF cavity is composed of 24 plates of ferrite cores, cooling plates and bias current feeder.

The characteristics of ferrite core was studied to obtain the low loss material in the range of wide frequency region.[2)] In order to cool the ferrite cores, the water cooling plate made of cupper is inserted between each ferrite core. The cooling pipe of synflex is connected to each cooling plate, which prepares the insulation and flexibility and they are concentrated to the main cooling pipe.

The RF power amplifier and ferrite bias current power supply are located near the RF cavity in order to suppress the sprious signal. The bus bar of bias current feeder is shielded with punched metal plate and is shorted to earth ground. A parasitic oscillation in the ferrite bias power supply is suppressed by means of RF shorting network in the feeding circuit. The maximum rating of the power supply is 1000 ampere with 10 volt.

The RF amplifier with frequency range of 7 to 28 MHz prepares the maximum rating of 5 KW with power gain of 14 dB. A remote control system for the frequency tuning in the RF amplifier is performed by the pulse motor controlled variable inductor and vacuum condenser.

The coupling transformer between the RF cavity and the RF amplifier provides a matching of the shunt impedance of the ferrite loaded RF cavity and the output impedance of the amplifier. The step up ratio of voltage is chosen as 8 and maximum power rating is designed so as to be operated in a CW operation mode.

References

1) S. Yamada and T. Katayama, INS-NUMA-12, 1979.
2) Proceeding of the 2nd symposium on accelerator science and technology, March, 1978, Japan, p59.

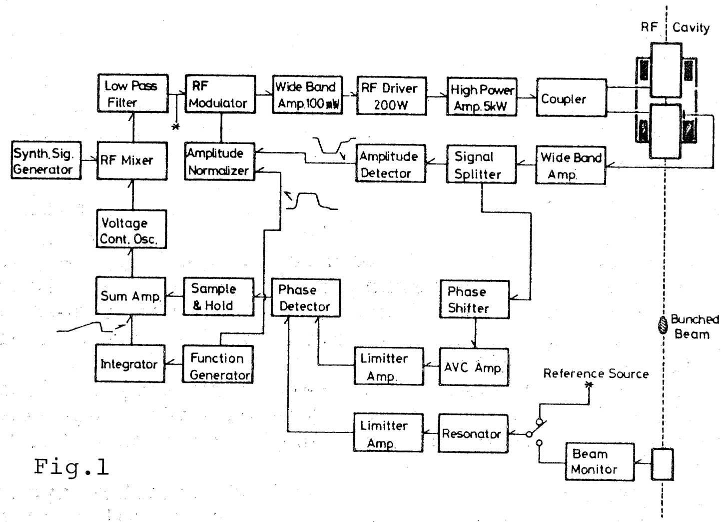

Fig.1

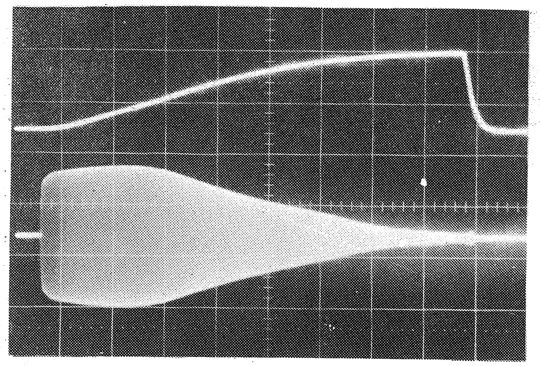

Fig. 2 Accelerating voltage and frequency for RF stacking process, where the upper shows frequency change due to integration of voltage function and the lower shows accelerating voltage.
Vertical scale; upper is 200 KHz/div, lower is 400 volt/div
Horizontal scale; 2.5 ms/div

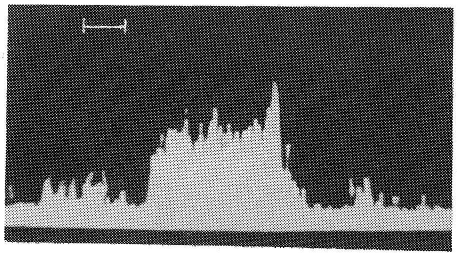

Fig. 3 Spectrum analyzed stacked beam (H_e^{++} 28 MeV), where the band width of spectrum analyzer is 30 KHz and sweep range is 500 KHz per division. Harmonic number is 4th.