RF SYSTEM FOR THE RCNP CYCLOTRON

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The MOPA RF system of RCNP AVF cyclotron operates 5.5-19.5 MHz and is able to deliver 200 kW RF power. The resonator of this system is 1/4λ mode coaxial type with a single 180° dee, and a sliding short is used. For the rapid and easy tuning of the MOPA system in variable energy experiments, the automatic pre-tuning system is developed. The resonator is tuned precisely with this system, and the multipactoring is overcome easily.

The schematic diagram of the automatic pre-tuning system is shown in fig.1. On the pre-tuning mode, the anode and screen voltages of the power tube 4648 are not applied. The resonator is excited very weakly with an FM signal (Δf=500kHz or 50 kHz). The resonance signal is picked up and amplified by the superheterodyne method. On the first step of pre-tuning, the position of the sliding short is adjusted within 10-30 kHz deviation from tuning point with Δf=500kHz FM signal. On the final step, the sliding short and the capacitive trimmer are adjusted within 1-3 kHz deviation from tuning point with Δf=50kHz FM signal. By pushing the "tuning" button on the console, above process proceeds sequentially. A frequency change needs 5 to 15 minutes.

An automatic tuning system is used to correct the tuning error during operation. The tuning error detector with automatic level controller, shwn in fig.2, detects the phase diffrence between the signals of control grid and anode of the 4648, and drives the capacitive trimmer.

A measurement of phase excursion or frequency deviation during operation is made. The block diagram of measuring system is shown in fig.3. An result measured accelarating 65MeV proton beam (17.0 MHz), is shown in fig. 4. The short term phase deviation is less than ±1°. The long term phase excursion is cntrolled within ±1° with the automatic tuning system.

A crowbar circuit is developed to protect the power tube. The crowbar circuit is able to remove the output DC voltage of the anode power supply within 1μs in the event of abnormal operation.

Highly stabilized power supplies are used and the ripple of dee voltage envelope is less than 10^{-4}(P-P)/P and 2×10^{-3}(P-P)/P , with and without dee voltage stabilizer, respectively.

Modulating the reference voltage of the dee voltage stabilizer the pulse operation of the RF system is possible and pulsed beam is obtained. The repitition rate is variable 1 to few handreds Hz.

The RF system has been worked more than 19,000 hours without serius failure since 1975.

Reference

1) I. Miura, T. Saito and A. Shimizu
RCNP Annual Report (1976) p. 12;
IEEE Trans. Nucl. Sci. NS-26 (1979) 2198

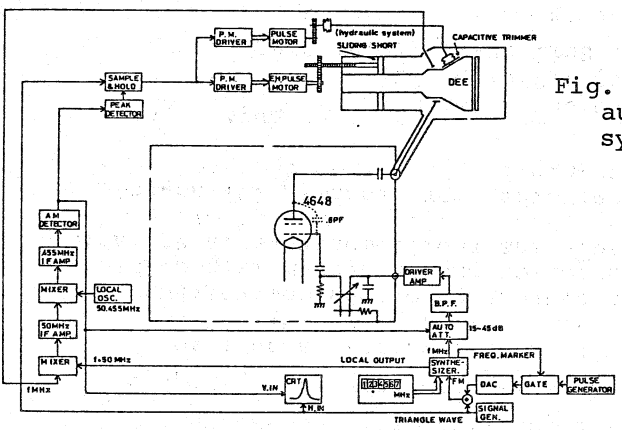

Fig. 1. Schematic diagram of automatic pre-tuning system.

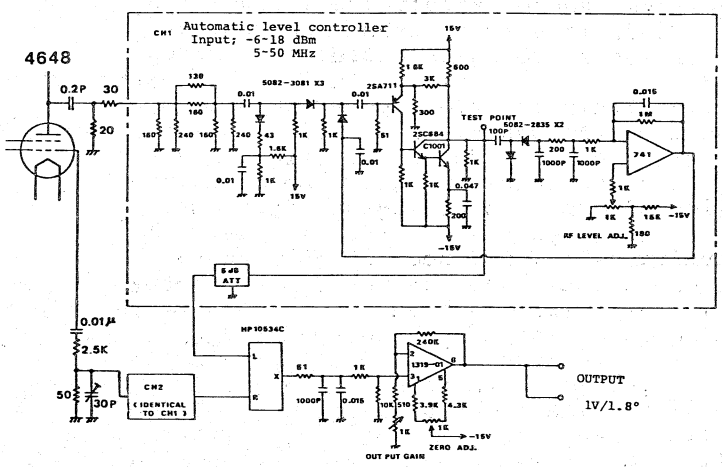

Fig. 2. Circuit diagram of tuning error detector and automatic level controller.

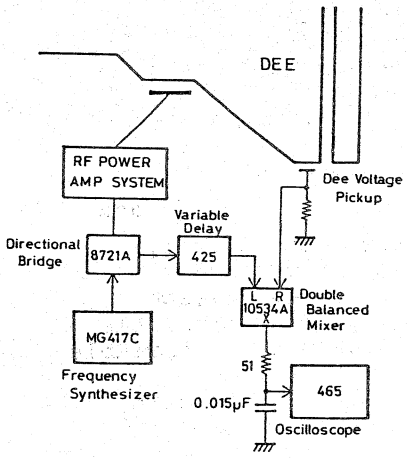

Fig. 3. Block diagram of phase measuring system.

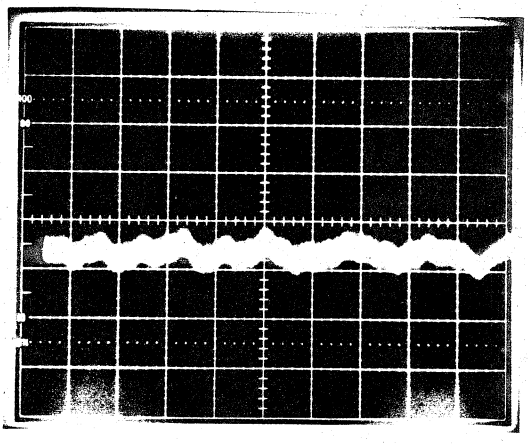

Fig. 4. Phase stability observed by the system shown in fig.3.
H; 20 ms/div
V; 1.5°/div
RF frequency; 17.0 MHz.