RF SYSTEM FOR THE RCNP RING CYCLOTRON

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Abstract

The RF system for the RCNP ring cyclotron ran quite satisfactorily more than 8000 hours since november 1991 without any serious trouble. The RF system consists of three acceleration cavities and one flat-topping cavity. The flat-topping system operates successfully to accelerate high quality beams ($\Delta E/E<10^{-4}$).

Introduction

In order to accelerate high quality beams by the ring cyclotron, very high stabilities of acceleration voltages and phases are required. Typical characteristics of the RF system are as follows.

Acceleration frequency	30-52MHz
Maximum acceleration voltage	530kV
Voltage stability	10^{-4}p-p/p
Phase stability	0.1deg.
Flat-topping frequency	90-156MHz
Maximum deceleration voltage	170kV
Voltage stability	10^{-3}p-p/p
Phase stability	0.1deg.

Stability of the RF system

The deceleration flat-topping voltage is 11.37% of total acceleration voltage. Effect of the flat-topping system is shown in Fig.1. To maintain voltage variation less than 10^{-4}, high phase stabilities are required for the acceleration voltages and the flat-topping voltage.

Highly stabilized power supplies are used for the amplifier systems. The ripple of the Rf voltage of the final amplifiers are about $5x10^{-3}$ peak to peak without RF voltage stabilizer. Main component of the ripple voltage of the acceleration cavities are originate from line frequency (2x60 Hz and 5x60Hz) and vibration of the cavities(16-20Hz). Both are well eliminated by the voltage stabilizers. The dc stability and ripple of the acceleration voltages are 10^{-4} peak to peak/peak each. Fig.2 shows typical wave form of the ripple voltage of the acceleration voltage at 400kV (acceleration of 300MeV proton) including background noise of the ripple monitoring circuit. Cursor lines correspond to amplitude of 10^{-4} peak to peak voltage.

The phase of the flat-topping voltage is roughly ($\sim\pm$1deg.)adjusted by monitoring an orbit of accelerated beams. The phase is adjusted to minimize

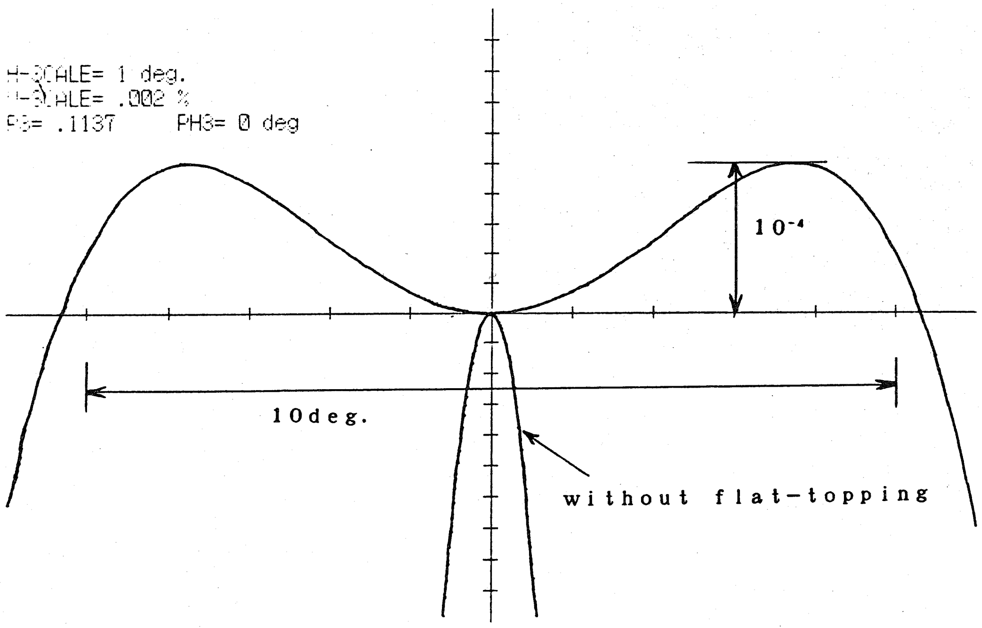

Fig.1 Acceleration voltage with and without flat-topping voltage.

the energy gain per turn. Fig.3 shows relative position of the 2nd turn orbit observed with main probe vs. phase of flat-topping voltage. Final adjustment of the phase within 0.1deg. is performed by measurement of the energy spread of the beam with the spectrograph (GRAND RAIDEN).

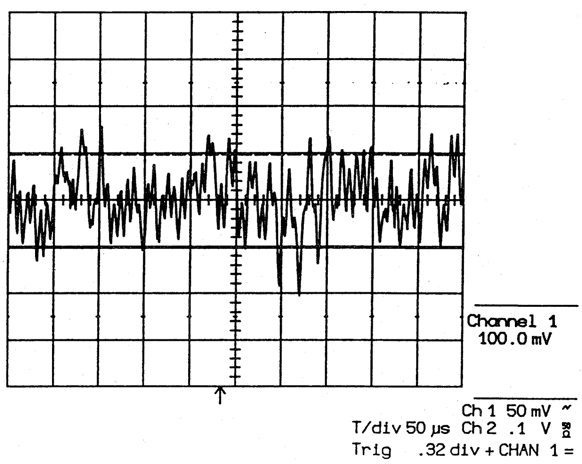

Fig.2 Typical wave form of the ripple voltage of the acceleration voltage at 400kV.

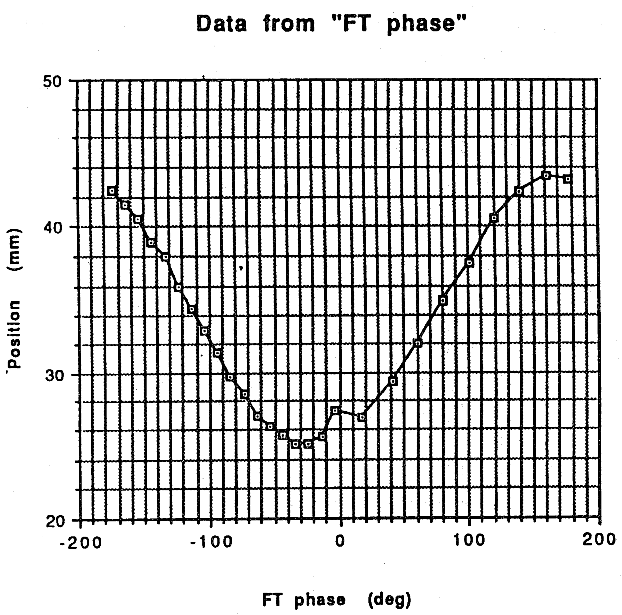

Fig.3 Relative position of the 2nd turn orbit of the accelerated beam vs. phase of the flat-topping voltage.

<u>RF leakage from the cavity</u>

The RF leakage power from the cavities through the beam aperture caused serious damages to the trim coil feeds-through. RF shields for the trim coil feeds -through were set on both sides of the flat-topping cavity. Although the cutoff frequency determined by the beam aperture is higher than acceleration frequency , the leakage power from the acceleration cavities also caused serious troubles because of their large RF powers. The RF shields for the acceleration cavities will be set this summer. The leaked RF signal disturbs various electric devices, for example beam diagnostic system etc.. The leakage should be reduced as little as possible. The leakage is induced by vertical asymmetry of the resonator. Symmetric settings of the tuning devices and good vacuum are important. Under a bad vacuum, asymmetric multi-pactoring discharges often break out and cause RF leaks. A monitoring system for the RF leakage is now being developed.

<u>References</u>

[1] I. Miura et al., Comissioning of the RCNP ring cyclotron. RCNP annual report 1991, pp.149-152

[2] M. Fujiwara et al., Magnetic apectrograph "GRAND RAIDEN". RCNP annual report 1991, pp.173-176