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A Note on the Accelerated Beam Obtained in the Michigan Radial Sector F.F.A.G. Electron Model*

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The present note summarizes progress on the Michigan F.F.A.G. betatron model described elsewhere.[1]

The model was first studied statically and the values of ν_x and ν_z were determined at the injection radius. The method[2] used was to inject with a D.C. electron gun at the center of a plus magnet, define several electron "rays" with a perforated screen at the center of the next plus magnet, and then to observe the beam spots on a phosphor in the eighth plus magnet (seven-eighths of the way around the machine.) For the design values of current, the measured ν_s were: $\nu_x = 2.87$, $\nu_z = 2.12$ in contrast with the theoretical values: $\nu_x = 2.80$, $\nu_z = 1.81$. The effect on ν_x and ν_z of changing the ratio of current through the plus magnets to the current through the minus magnets was studied, and some data were obtained on the

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[1]MURA - FTC/ROH/LWJ/DWK/KMT - 1
MURA - FTC/DWK - 1
MURA - FTC - 2
Cole, Kerst, Haxby, Jones, and Terwilliger
Phys. Rev. <u>100</u> 1246-7 (1955)

[2]MURA - AMS - 1

effect of changing k. Appreciable non-linearities were observed in the oscillations, and for the radial motion these were ascertained to correspond to a decrease in ν_x of 6% in going from zero amplitude to two centimeter amplitude (taken at the center of plus magnets).

The D.C. gun was then replaced by a pulsed, high emmission standard betatron injector in attempting to obtain accelerated beam. The injector pulse width is about 0.1 microseconds long at peak energy; the pulse height is ~30 Kev. A fast (1/2 microsecond) 500 volt pulse was added to the voltage provided by the sinusoidally excited betatron core (40 volts per turn peak) to expand the particle orbits away from the injector rapidly. With this system operating, electrons were observed accelerated to maximum energy (about 400 Kev.). The beam was observed both as an x-ray beam in a scintillator and as a current pulse on a probe. The beam can be observed at any energy up to the maximum by varying the probe radius. The time delay of the full energy beam is of the order of 200 microseconds when operating with maximum betatron accelerating voltage. This corresponds to about 10^4 particle revolutions. The full energy accelerated beam contains of the order of 10^7 electrons per pulse.

While observing beam accelerated through only about 2000 revolutions (the field region where k can be varied conveniently), a systematic search was made for nearby stable regions of the $\nu_x - \nu_z$ plane. Three such regions within the range of k and current ratio tunings were found. (Assignments of ν_x are made assuming zero amplitudes of oscillation). One region was the design region ($\nu_x = 2.7 - 2.9$, $\nu_z = 1.55 - 1.85$); one was for smaller ν_x ($\nu_x = 2.4 - 2.6$, $\nu_z = 1.5 - 1.85$); and the third was for larger ν_z ($\nu_x = 2.6 - 2.8$, $\nu_z = 2.25 - 2.35$). This last region was spotty, tuning controls were critical, and the beam was poor. Actual values of ν_x may be lower than those listed due to finite oscillation amplitudes. (In this machine, the theoretically unstable $\sigma = \frac{2\pi}{3}$ occurs for $\nu = 2.67$.) In the first two regions a full energy accelerated beam was obtained. Under optimum conditions, in the design region, an appreciable beam remained when the 500 volt expander was turned off.

Detailed reports covering the structure of the accelerator, the static (σ) tests, and the accelerated beam tests will be prepared in the future.