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Passing Transition with a Double Phase Jump

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Reported by E. Raka

Subject Passing Transition With a Double Phase Jump

Observations and Conclusion

The beam intensity was reduced to 5.2×10^{12} and the "integrator" time was set to 2540 or about 305 msec from transtion. This reduces the d.c. loop gain of the radial control system. The latter was adjusted to give essentially zero signal at transition by using the L-20 current transformer for normalization and adding 12' to the delay cable.

Next, a clamping circuit was installed between the output of the radial position chassis and the input to the phase shifter. This made it possible to effectively open the radial loop at transition and then close it subsequently. In order to pass transition rapidly, the phase jump was adjusted to $(\pi/2 - \phi_s)$ and held there while the radial loop was opened. Then about 2.5 msec later the radial signal was unclamped and a fast radius shift signal was introduced. The latter was adjusted to partially cancel the radial error signal so as to produce an additional phase jump of $(\pi/2 - \phi_s)$ degrees. The result is passage through transition at the maximum possible rate with an accompanying rapid outward radius shift ($\approx$ 1.5 cm at a β_{min}) with no additional radial excursion.[1]

The signals in Figure 1 show the behavior of the radius, phase, and radial error signal. Also shown is the current transformer at 3.3 x 10^{11}/division. As can be seen, the loss is $\approx 10^{11}$ at 5.2×10^{12} and occurs more than 5 msec after transition. This is several milliseconds later than seen on October 23, 1985, when the radial loop was used to carry the beam through transition (see AGS Studies Report No. 191). The loss is slightly less for the method used here and the bunches are somewhat cleaner as can be seen in Figure 2. Again, the time was 470 msec from injection peaker where the momentum is 21.8 GeV/c, not 22.8 as reported in Studies Report No. 191. The bunches at 21.8 GeV are still $\approx$ 25 nsec wide corresponding to $\approx$ 1 eV sec area. Figure 3 shows the wall current monitor at 5 ms/division with ≈ 300 MHz bandwidth. The presence of bunch shape oscillations indicates some mismatch and hence potential dilution which on the basis of the 470 msec measurements, cannot be very great. Figure 4 shows the wall current monitor signal as seen on a 1 GHz bandwidth scope. We see the same bunch at approximately 1 msec intervals as it passes through transition. The two-step phase jump is readily apparent as is the onset of a microwave instability just before the second jump. Triggering is by counting down the rf frequency obtained from the cavity voltage.

This method makes it possible, therefore, to obtain the highest density bunches possible at high energies. With such bunches, studies of longitudinal or transverse impedances can be more readily be carried out.

[1]E. Raka, Betatron Frequency Jump at Transition in the Brookhaven AGS, AGS Div. 70-1.

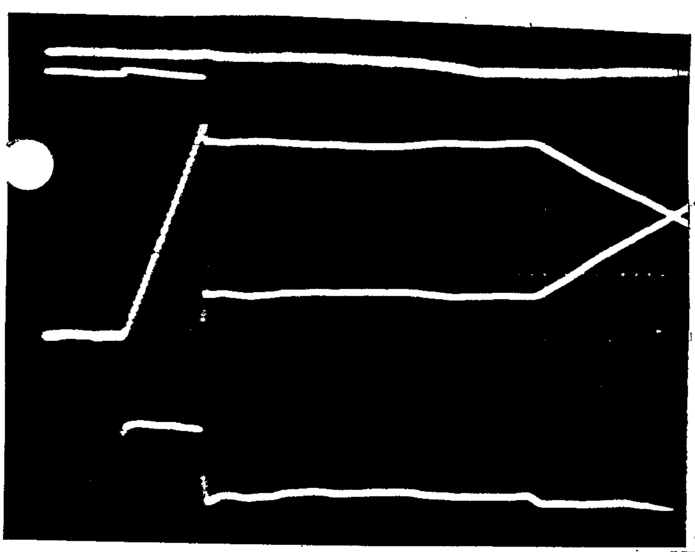

Figure 1 2msec/div.

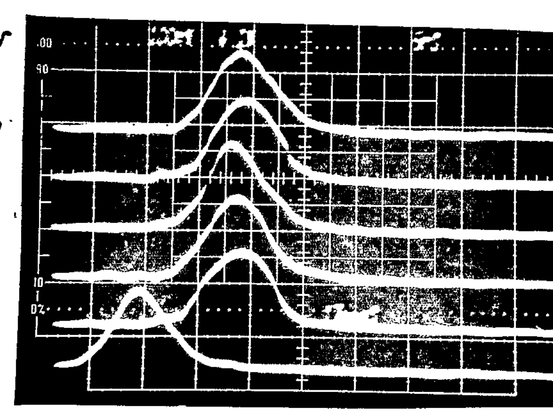

Figure 2 10nsec/div.

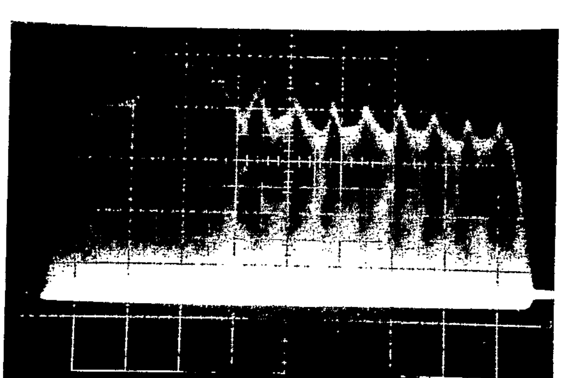

Figure 3 5msec/div.

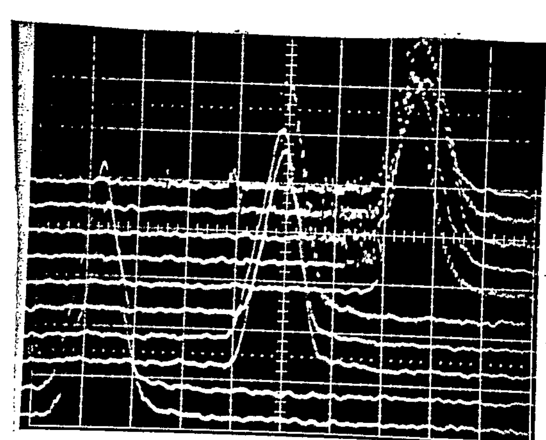

Figure 4 10nsec/div.