ISR PERFORMANCE REPORT

RUN 587, 3.4.1975, Ring 2, 15 GeV
RUN 590, 7.4.1975, Ring 1, 26 GeV

Blow-up of the bunch area (3)

Summary: The longitudinal density in a bunch was determined from measurements of bunch length, debunching time and spill-out. The results are still not very clear but show that smaller longitudinal focusing (smaller RF voltage) results in smaller density.

1. Introduction

The density of an ISR stack is at least two times smaller than the injected density. During the voltage turn-down we get a blow-up of the bunch area. In this experiment we tried to get some more data on the density in the bunch as a function of RF voltage and f.

2. Experiment

The bunches were trapped and matched; then the RF voltage was reduced to a final value. The density under this condition was measured by three methods:

a) The beam was kept bunched in the final stationary bucket and its bunch length was measured. From this, the known RF voltage and the inductive impedance, the bunch area in units of $\Delta(\beta y), \Delta\phi_{RF}$ was calculated. The current per bunch divided by this area gives the average density.

b) The final voltage was turned off and the debunching time measured. The bunch area was then calculated from this debunching time and the bunch length. It agreed well with the area obtained from the first method. These two methods work only as long as the bucket area is larger than the bunch area and no current is spilled out.

c) Here a normal acceleration programme was used. The bunches in the final buckets were accelerated against a scraper target. The current in the final bucket was obtained from the difference between the initial and the spilled out current. The bunch area must be equal to the area of the final bucket, which was calculated from the RF parameters and the known wall inductance.
This final bucket contains mostly the central part of the original bunch where the density is higher. We corrected for that to obtain the average density we would find in the whole bunch.

3. Results

The obtained densities are plotted in Fig. 1 against the phase oscillation frequency \( f_s \) which was calculated from the RF voltage and \( \Gamma \), and which was not corrected for wall inductance and final bunch length. The densities at \( \Gamma = 0 \) were obtained from bunch lengths and debunching times, while all the other points are based on spill-out measurements. These two sets of measurements do not agree well with each other. However, Fig. 1 clearly shows that the density gets smaller for smaller phase oscillation frequencies.

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Fig. 1. Density in the bunch vs. synchrotron frequency.

Density
Amps/bunch area

$E = 15 \text{ GeV}$
$I_{\text{initial}} = 65 \text{ mA}$

- $\Gamma = 0.1$
- $\Gamma = 0.3$
- $\Gamma = 0.5$
- $\Gamma = 0.7$
- $\Gamma = 0$

$E = 26 \text{ GeV}$
$I_{\text{initial}} = 89 \text{ mA}$